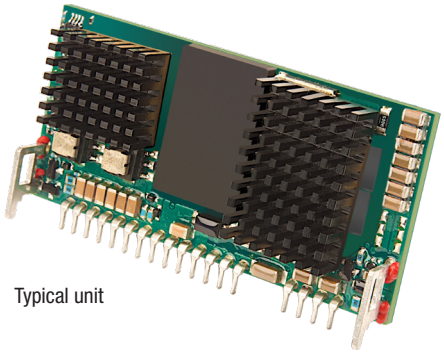
Murata Power Solutions

SPC-54/4.4-L12PG-C

240W PoE+ Regulated Converter

11-13.2Vin, 54.2V/4.44A Single Output, High Efficiency SIP Converter



Typical unit

FEATURES

- 240 Watts total output power
- 94% Ultra-high efficiency @ full load, 100LFM
- 12V Input (11-13.2V range)
- 54.2V/4.44A Output for PoE+ (Power-over-Ethernet)
- Input Over/Under Voltage Shutdown
- 320kHz fixed switching frequency
- Fully isolated, 2250V (BASIC)
- Low 500mVp-p ripple/noise max value.
- PGOOD signal
- Stable no-load operation
- Thermal shutdown
- Fully I/O protected
- UL 1950/IEC 60950 certification
- Output over voltage latch

ORDERING GUIDE SUMMARY					
Model	Vout Range	Iout Range	Vin Range	Ripple/Noise	Efficiency
SPC-54/4.4-L12PG-C	54.2V	0-4.44A	11-13.2V	500mVp-p (max)	94%

INPUT CHARACTERISTICS		
Parameter	Typ. @ 25°C, full load	Notes
Voltage Range	11-13.2 Volts	12V nominal
Current, full power	24.5 Amps	Vin = 11V
Turn On/Start-up Threshold	10.3-11 Volts	Vin increasing
Undervoltage Shutdown	9-9.9 Volts	Vin decreasing
No Load Current	300mA	Vin = 12V

OUTPUT CHARACTERISTICS		
Parameter	Typ. @ 25°C, full load	Notes
Voltage	54.2 Volts	±1%
Current	0 to 4.44 Amps	No minimum load
Power Output	240 Watts	
Ripple & Noise	500mVp-p	20MHz bandwidth, 100µF output capacitance
Line and Load Regulation	±1%/±1%	
Overcurrent Protection	5.33 Amps	With hiccup auto-restart
Overvoltage Proteciton	56-60Vdc	Latching, Reset by recycling Vin or Enable pin
Overtemperature Protection	130 °C	
Efficiency (minimum)	92.8%	80% load, Vin nom.
Efficiency (typical)	94%	

GENERAL SPECIFICATIONS		
Parameter	Typ. @ 25°C, full load	Notes
Dynamic Load Response	500µsec	50-75-50% step to 1% of Vout
Operating Ambient Temperature	–40 to +80°C	
Safety Features	UL 1950, IEC/EN60950	

PHYSICAL SPECIFICATIONS		
Parameter	Inches	Millimeters
Dimensions	2.60 x 0.69 x 1.25	66.0 x 17.5 x 31.75

RoHS COMPLIANT

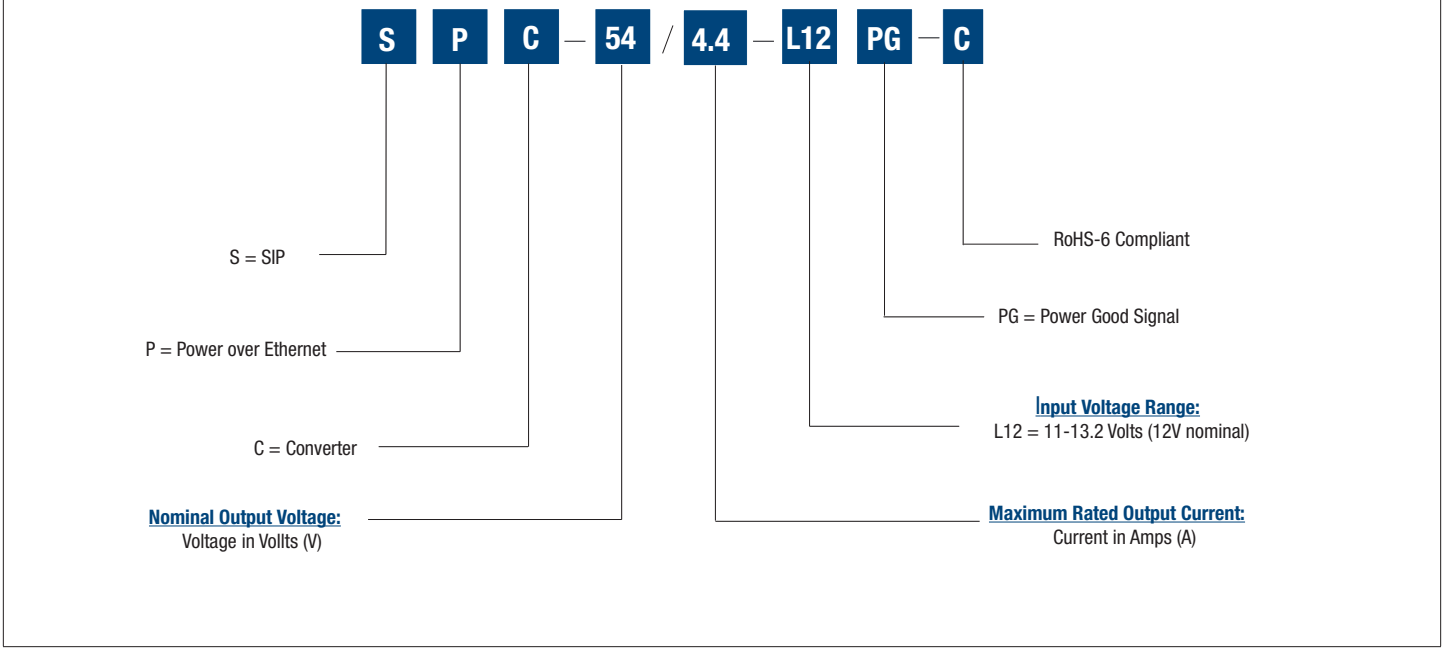
For full details go to www.murata-ps.com/rohs

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PERFORMANCE SPECIFICATIONS AND ORDERING GUIDE

Model ①	Output						Input				Efficiency 80% load, Vin nom.		Package (Pinout)
	V_{OUT} (Volts)	I_{OUT} (Amps, Max.)	Power (Watts)	R/N (mV pk-pk) Max.	Regulation (Max.) Line	Regulation (Max.) Load	V_{IN} Nom. (Volts)	Range (Volts)	I_{IN}, no load (mA)	Vin @ min, full load (Amps)	% Min.	% Typ.	
SPC-54/4.4-L12PG-C	54.2	4.44	240	500	±1%	±1%	12	11-13.2	300	24.5	92.8	94	See mechanical drawing

PART NUMBER STRUCTURE



FUNCTIONAL SPECIFICATIONS ① ②

ABSOLUTE MAXIMUM RATINGS	Conditions	Minimum	Typical/Nominal	Maximum	Units
Input Voltage, Continuous	Full power operation	0		13.2	Vdc
Isolation Voltage	Input to output tested 100 mS			2250	Vdc
Input Reverse Polarity	None, install external fuse		None		Vdc
On/Off Remote Control	Power on or off, referred to -Vin	0		5	Vdc
Output Power		0		240	W
Output Current	Current-limited, no damage, short-circuit protected	0		4.44	A
Storage Temperature Range	Vin = Zero (no power)	-55		125	˚C
Absolute maximums are stress ratings. Exposure of devices to greater than any of these conditions may adversely affect long-term reliability. Proper operation under conditions other than those listed in the Performance/Functional Specifications Table is not implied nor recommended.					
INPUT					
Operating voltage range		11	12	13.2	Vdc
Input Voltage Slew Rate				1	V/µs
Turn On/Start-up threshold	Rising input voltage	10.3		11	Vdc
Turn Off/Undervoltage lockout	Falling input voltage	9.2		9.9	Vdc
Hysteresis			1	4	Vdc
Overvoltage Shutdown		13.8		14.8	Vdc
Reverse Polarity Protection	None, install external fuse		None		Vdc
Internal Filter Type			Pi		
Input current					
Full Load Conditions	Vin = nominal			22.5	A
Low Line	Vin = minimum			24.5	A
Inrush Transient					
Peak Current				30	A
I²t				0.1	A^2/sec
No Load Input Current	Iout = minimum, unit = ON		300	500	mA
Shut-Down Mode Input Current			10		mA
Reflected (back) ripple current	The external input capacitance shall be the max capacitance			0.1	Arms
Back Ripple Current	no filtering			2	Arms
Input Capacitance ③		250		750	µF
GENERAL and SAFETY					
Efficiency (Ta = 25°C, 100 LFM, airflow across long axis, Vin = 12V)	80% of Irated ≤ Iout ≤ 100% of Irated	92.8	94		%
	50% of Irated ≤ Iout < 80% of Irated	91.8	93.5		%
	20% of Irated	86.8	88.5		%
Efficiency (Ta = 80°C, 250 LFM, airflow across long axis, Vin = 12V)	80% of Irated ≤ Iout ≤ 100% of Irated	92.8	94		%
	50% of Irated ≤ Iout < 80% of Irated	91.8	93.5		%
	20% of Irated	86.8	88.5		%
Isolation					
Isolation Voltage	Input to output, continuous	2250			Vdc
Insulation Safety Rating			basic		
Isolation Resistance			10		MΩ
Isolation Capacitance			3300		pF
Safety	Certified to UL-60950-1, CSA-C22.2 No.60950-1, IEC60950-1, 2nd edition		Yes		
Calculated MTBF	Per Telcordia SR332, issue 1 class 3, ground fixed, Tambient = +25˚C	1			Hours x 10^6
Service Life at 40°C ambient temperature with 80% load		10			years
ESD					
Human Body Model (HBM)			± 2000		V
Charged Device Model (CDM)			± 500		V
Machine Model (MM)			± 200		V

FUNCTIONAL SPECIFICATIONS (CONT.)

DYNAMIC CHARACTERISTICS	Conditions	Minimum	Typical/Nominal	Maximum	Units
Fixed Switching Frequency			320		KHz
Startup Time	Vin On to Vout regulated (100% resistive load)			30	mS
Startup Time	Remote ON to 10% Vout (50% resistive load)			30	mS
Turn-On/Turn-Off					
Turn-On Delay ④				30	mS
Output Voltage Rise Time ⑤				80	mS
Pre-Bias Voltage ⑥				100	%
Turn-On Overshoot ⑦				2	%
Turn-Off Undershoot ⑧				0	%
Dynamic Load Response	1A/µS, 25% of full load change		500	800	µSec
Dynamic Load Peak Deviation	1A/µS, 25% of full load change			±1000	mV
FEATURES and OPTIONS					
Remote On/Off Control					
Enable Logic, ON state		2		12	V
Enable Logic, OFF state	Pin open = OFF	0		0.8	V
Control Pin Shutdown Current				0.5	mA
OUTPUT					
Total Output Power	See Derating		240		W
Voltage					
Nominal Output Voltage	Vin = 12V; Iout = 2.22A	53.658	54.2	54.742	Vdc
Setting Accuracy		-1		1	% of Vnom.
Current					
Output Current Range		0	4.44	4.44	A
Minimum Load			No minimum load		
Current Limit Inception	98% of Vnom., after warmup	4.88		6.2	A
Short Circuit					
Short Circuit Duration (remove short for recovery)	Output shorted to ground, no damage		Hiccup		
Short circuit protection method	Current limiting				
Overvoltage Protection					
Overvoltage Detection	Latching, requires recycling Vin or Enable pin	56.0	57.5	60.0	Vdc
Regulation					
Line Regulation	Vin = min. to max. Vout = nom.			±1	%
Load Regulation	Iout = min. to max. Vin = nom.			±1	%
Ripple and Noise	20 MHz BW, with 0.1µF and 1µF ceramic capacitors, and 100µF output capacitance			500	mV pk-pk
Temperature Coefficient	At all outputs		±0.02		% of Vnom./°C
Maximum Capacitive Loading	Full resistive load	0		1620	µF
Power Good Signal Characteristics ⑨ ⑩					
Output Voltage for PGOOD triggering		50		55	V
Power Good High State Voltage	Equals to external bias voltage, see technical notes			5	V
Power Good High State Current (into Pin)				10	µA
Power Good low State Voltage				0.8	V
Power Good low State Current (into Pin)				2.5	mA
MECHANICAL					
Outline Dimensions			2.60x 0.69 x 1.25		Inches
			66x 17.5 x 31.75		mm
Weight			2.2		Ounces
			62		Grams
Through Hole Pin Diameter			0.025*0.025		Inches
			0.64*0.64		mm
Through Hole Pin Material			Copper alloy		

FUNCTIONAL SPECIFICATIONS (CONT.)

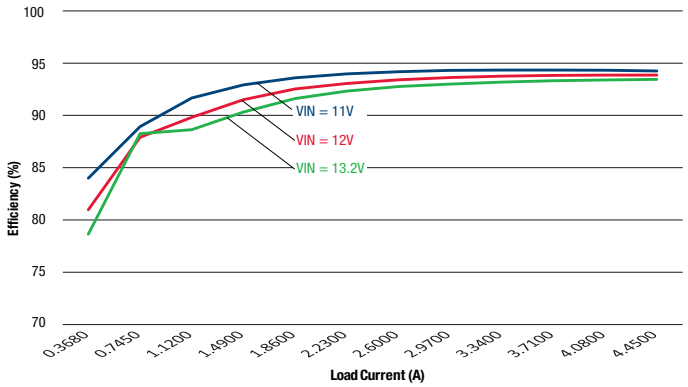
TH Pin Plating Metal and Thickness	Nickel subplate		3-7.6		µm
	Tin overplate		2.54-7.6		µm
ENVIRONMENTAL					
Operating Ambient Temperature Range	No Derating, Full Power, 100 LFM, Vertical mount	-40		80	°C
Storage Temperature	Vin = Zero (no power)	-55		125	°C
Thermal Protection/Shutdown				130	°C
Available airflow					
Io = 4.44A, Ta = 25°C		100			LFM
Electromagnetic Interference (EMI) Conducted, EN55022/CISPR22	External filter required		B		Class
Radiated, EN55022/CISPR22			B		Class
Relative humidity, Operating, non-condensing		10		90	%
Relative humidity, Non-Operating, non-condensing		5		95	%
Altitude (without output derating at 70°C)		4000		10,000	feet
RoHS rating			RoHS-6		

Notes

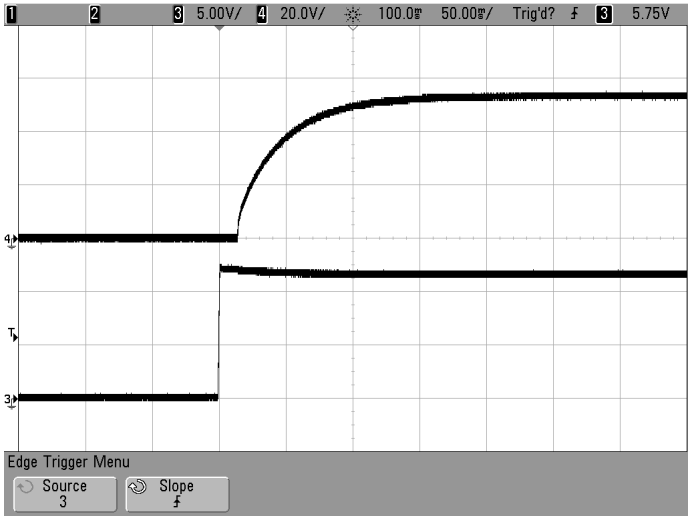
① Typical at TA = +25°C under nominal line voltage and nominal-load conditions, unless noted.
② Devices have no minimum-load requirements and will regulate under no-load conditions.
③ External capacitance could be all ceramic or a mix of electrolytic and ceramic.
④ a) Period between Vin connection and Vout rising to 10% of final value when Enable signal is existing, or b) Period between Enable signal connection and Vout rising to 10% of final value when Vin is existing.
⑤ The output rise time measured from 10% of Vnom to the lower limit of the regulation band with 0% to 100% load and external cap.
⑥ The Power supply will start up normally and without any demage under a pre-bias output voltage.
⑦ Tested under all loading conditions.
⑧ Tested under all loading conditions.
⑨ Pgood is referenced to Vin(-). An external pull-up resistor is connected between PGOOD pin and a bias voltage. A high signal shown in the pin represents the good status of the output voltage.
⑩ Tested under full operating temperature and input voltage ranges.

PERFORMANCE DATA AND OSCILLOGRAMS

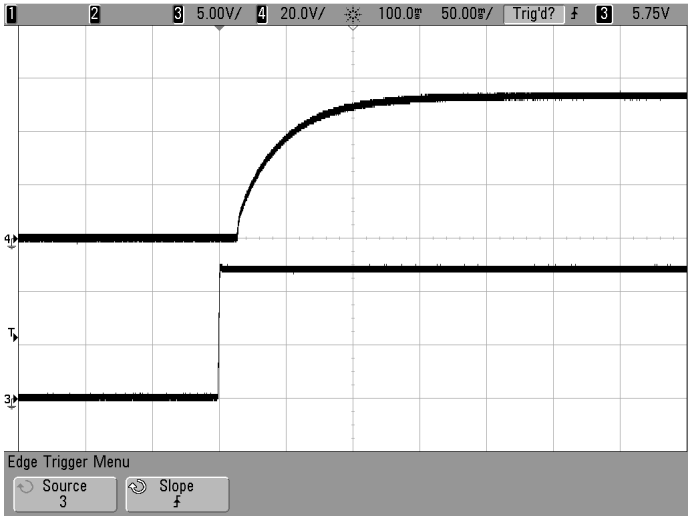
Efficiency vs. Line Voltage and Load Current @ Ta = +25°C



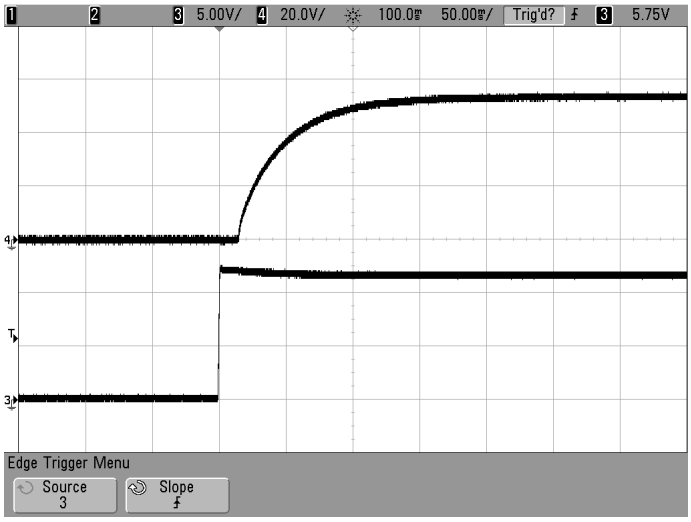
Vin Startup Delay, Vin = 12V, Iout = 4.44A, Channel #3 = 5V/div - Vin, Channel #4 = 20V/div - Vout, Ta = 25°C, Cload = 100µF



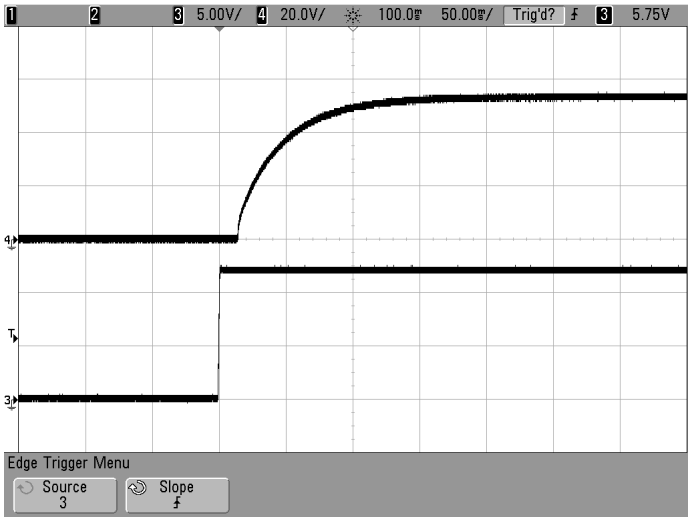
Vin Startup Delay, Vin = 12V, Iout = 0A, Channel #3 = 5V/div - Vin, Channel #4 = 20V/div - Vout, Ta = 25°C, Cload = 100µF



Vin Startup Delay, Vin = 12V, Iout = 4.44A, Channel #3 = 5V/div - Vin, Channel #4 = 20V/div - Vout, Ta = 25°C, Cload = 1620µF

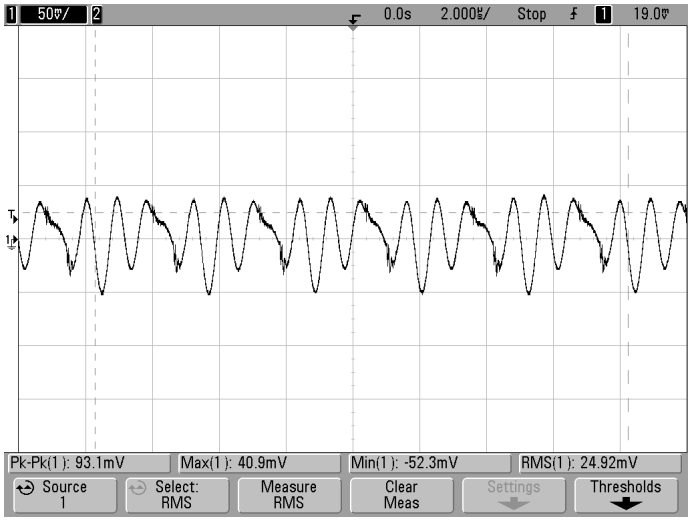


Vin Startup Delay, Vin = 12V, Iout = 0A, Channel #3 = 5V/div - Vin, Channel #4 = 20V/div - Vout, Ta = 25°C, Cload = 1620µF

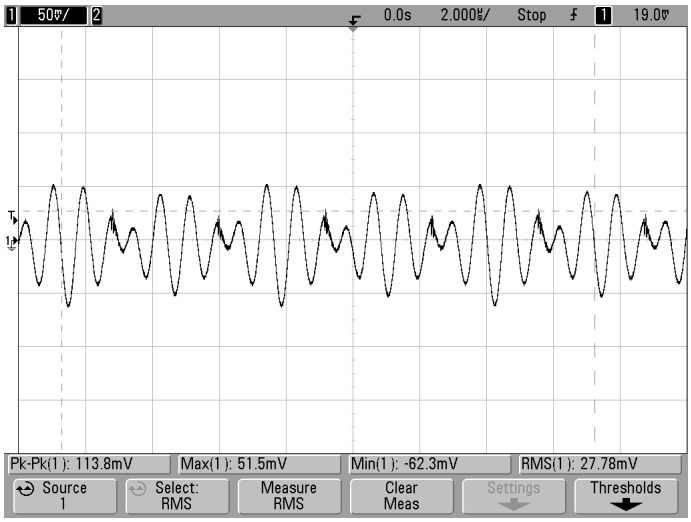


PERFORMANCE DATA AND OSCILLOGRAMS

Output Ripple & Noise, Vin = 12V, Iout = 4.44A, Ta = 25°C, Cload = 100µf, BW = 20Mhz

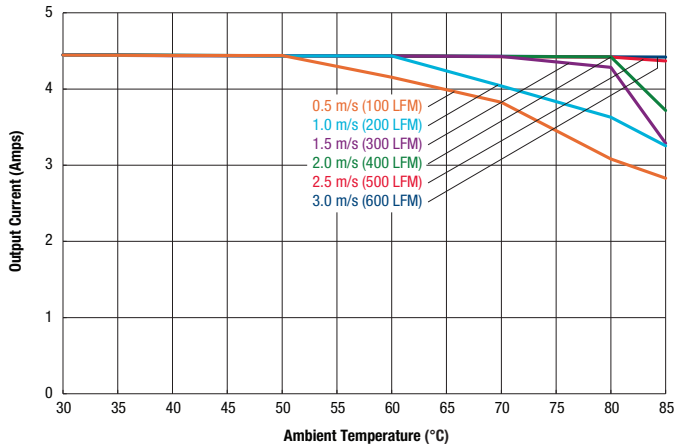


Output Ripple & Noise, Vin = 12V, Iout = 0A, Ta = 25°C, Cload = 100µf, BW = 20Mhz

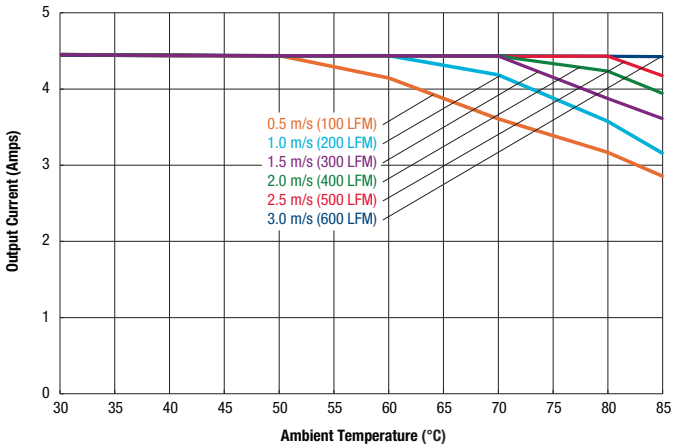


PERFORMANCE DATA AND OSCILLOGRAMS

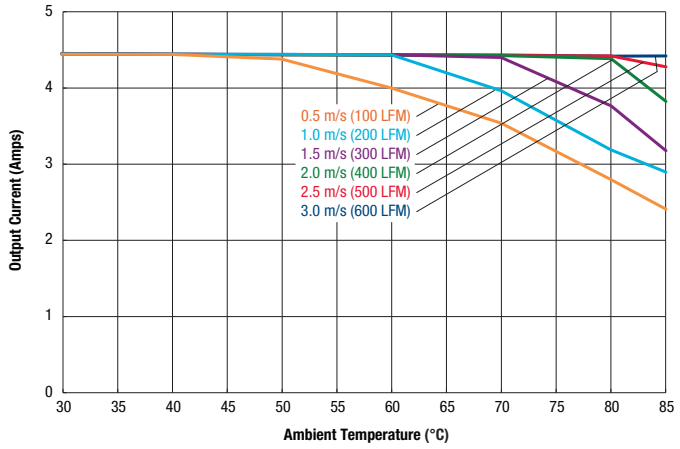
Maximum Current Temperature Derating
(Vin = 11V, airflow from Vin to Vout)



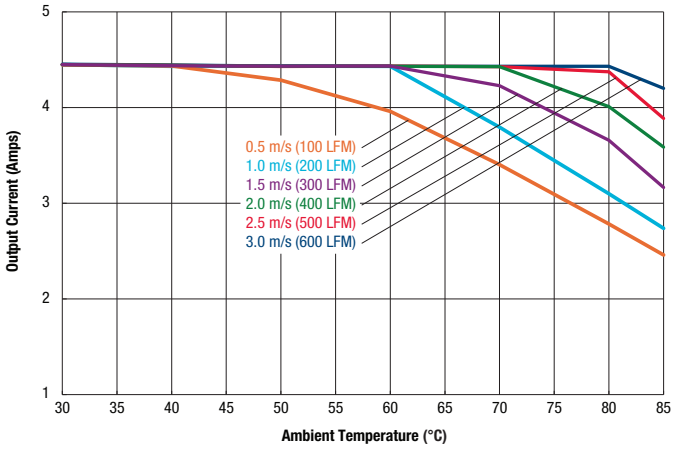
Maximum Current Temperature Derating
(Vin = 11V, airflow from Vout to Vin)



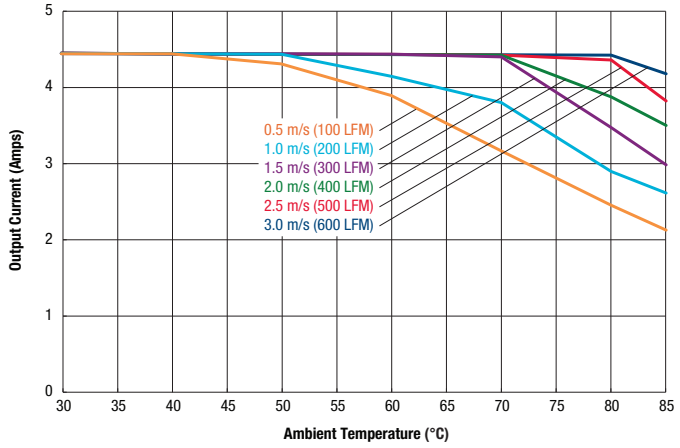
Maximum Current Temperature Derating
(Vin = 12V, airflow from Vin to Vout)



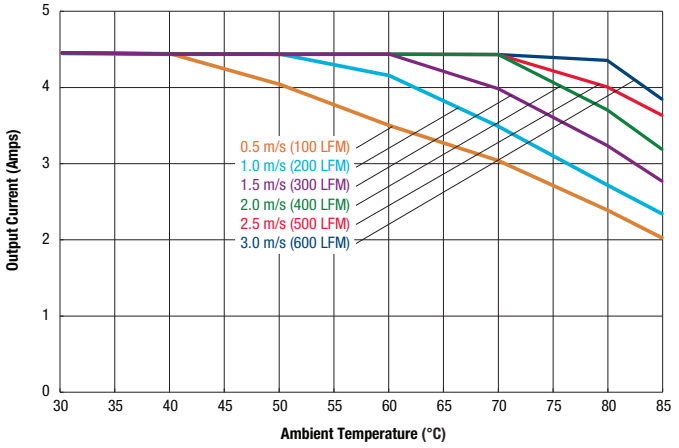
Maximum Current Temperature Derating
(Vin = 12V, airflow from Vout to Vin)



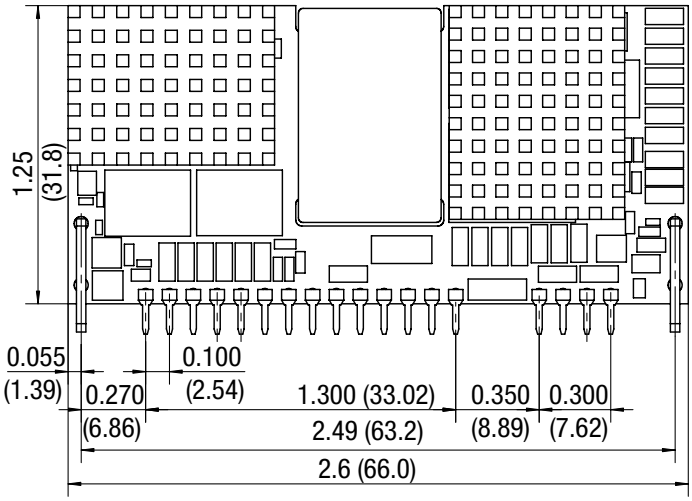
Maximum Current Temperature Derating
(Vin = 13.2V, airflow from Vin to Vout)

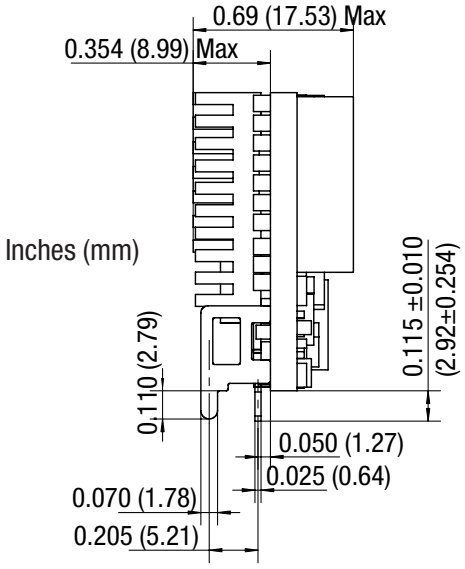


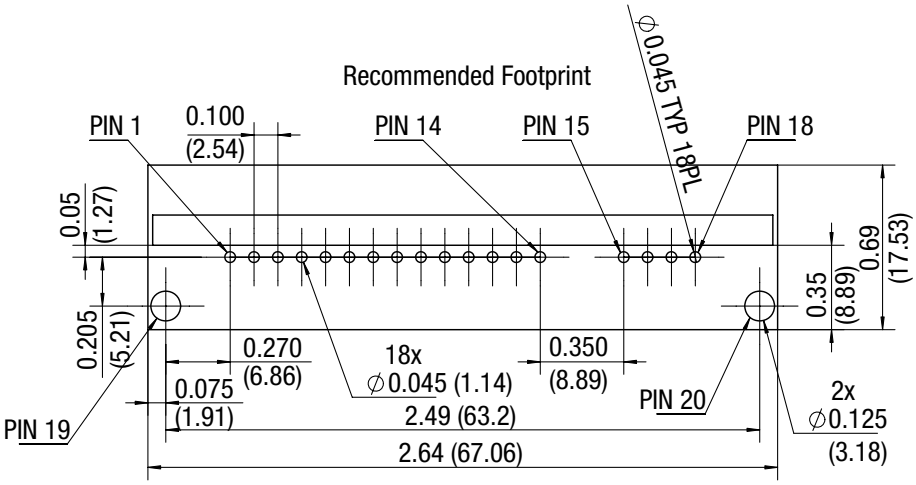
Maximum Current Temperature Derating
(Vin = 13.2V, airflow from Vout to Vin)



MECHANICAL SPECIFICATIONS

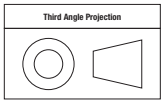






INPUT/OUTPUT CONNECTIONS	
Pin	Function
1	THOT1_MCU(+)
2	THOT2_MCU(-)
3	PGOOD
4	Enable
5	Vin(-)
6	Vin(-)
7	Vin(-)
8	Vin(-)
9	Vin(-)
10	Vin(+)
11	Vin(+)
12	Vin(+)
13	Vin(+)
14	Vin(+)
15	Vout(-)
16	Vout(-)
17	Vout(+)
18	Vout(+)
19	SUPPORT#1
20	SUPPORT#2

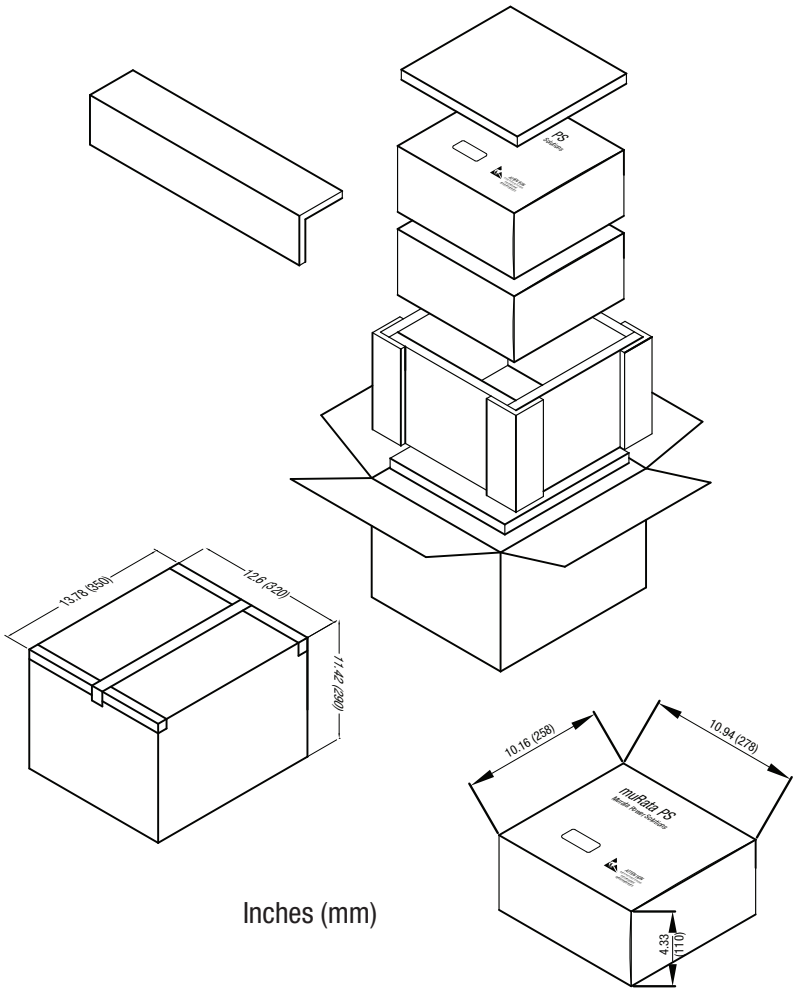
Dimensions are in inches (mm shown for ref. only).



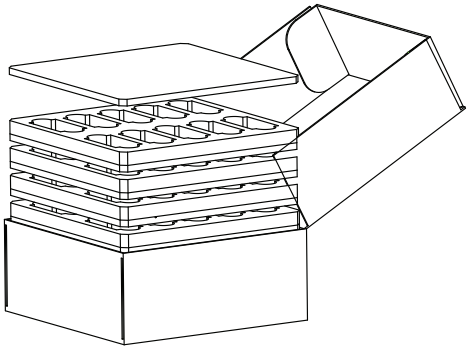
Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2°

Components are shown for reference only.

SHIPPING TRAYS AND BOXES



Inches (mm)



Two boxes per carton, each containing 4 trays with 10 pcs per tray
MOQ = 80 pcs

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.

Technical Notes

I/O Filtering and Noise Reduction

The SPC is tested and specified with external output capacitors. These capacitors are necessary to accommodate our test equipment and may not be required to achieve desired performance in your application. The SPC is designed with high-quality, high-performance internal I/O caps, and will operate within spec in most applications with no additional external components.

In particular, the SPC input capacitors are specified for low ESR and are fully rated to handle the units' input ripple currents. Similarly, the internal output capacitors are specified for low ESR and full-range frequency response.

In critical applications, input/output ripple/noise may be further reduced using filtering techniques, the simplest being the installation of external I/O caps.

External input capacitors serve primarily as energy-storage devices. They minimize high-frequency variations in input voltage (usually caused by IR drops in conductors leading to the DC/DC) as the switching converter draws pulses of current. Input capacitors should be selected for bulk capacitance (at appropriate frequencies), low ESR, and high rms-ripple-current ratings. The switching nature of modern DC/DC's requires that the dc input voltage source have low ac impedance at the frequencies of interest. Highly inductive source impedances can greatly affect system stability. Your specific system configuration may necessitate additional considerations.

Input Fusing

Most applications and or safety agencies require the installation of fuses at the inputs of power conversion components. The SPC Series may have an optional input fuse. Therefore, if input fusing is mandatory, either a normal-blow or a fast-blow fuse with a value no greater than twice the maximum input current should be installed within the ungrounded input path to the converter.

Input Overvoltage and Reverse-Polarity Protection

The SPC does not incorporate input reverse-polarity protection. Input voltages in excess of the specified absolute maximum ratings and input polarity reversals of longer than "instantaneous" duration can cause permanent damage to these devices.

Start-Up Time

The V_{IN} to V_{OUT} Start-Up Time is the interval between the time at which a rising input voltage crosses the lower limit of the specified input voltage range and the fully loaded output voltage enters and remains within its specified regulation band. Actual measured times will vary with input source impedance, external input capacitance, and the slew rate and final value of the input voltage as it appears to the converter.

The On/Off to V_{OUT} Start-Up Time assumes the converter is turned off via the On/Off Control with the nominal input voltage already applied to the converter. The specification defines the interval between the time at which the converter is turned on and the fully loaded output voltage enters and remains within its specified regulation band.

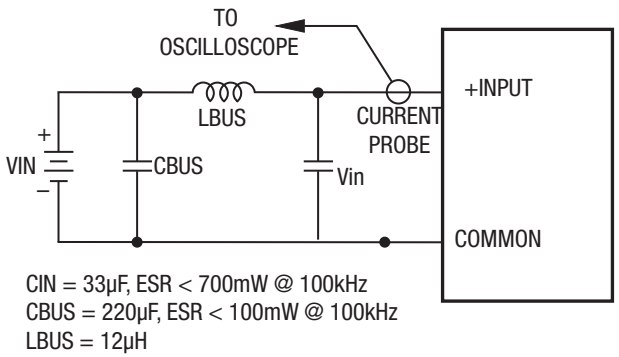


Figure 1. Measuring Input Ripple Current

Thermal Considerations and Thermal Protection

The typical output-current thermal-derating curves shown below enable designers to determine how much current they can reliably derive from each model of the SPC under known ambient-temperature and air-flow conditions. Similarly, the curves indicate how much air flow is required to reliably deliver a specific output current at known temperatures.

The highest temperatures in SPC's occur at their output inductor, whose heat is generated primarily by I^2R losses. The derating curves were developed using thermocouples to monitor the inductor temperature and varying the load to keep that temperature below +110°C under the assorted conditions of air flow and air temperature. Once the temperature exceeds +125°C (approx.), the thermal protection will disable the converter using the hiccup shutdown mode.

Undervoltage Shutdown

When the input voltage falls below the undervoltage threshold, the converter will terminate its output. However, this is not a latching shutdown mode. As soon as the input voltage rises above the Start-Up Threshold, the converter will restore normal operation. This small amount of hysteresis prevents most uncommanded power cycling. Since some input sources with higher output impedance will increase their output voltage greater than this hysteresis as soon as the load is removed, it is possible for this undervoltage shutdown to cycle indefinitely. To prevent this, be sure that the input supply always has adequate voltage at full load.

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.

Remote On/Off Control

The SPC may be turned off or on using the external remote on/off control. This terminal consists of a digital input to the internal PWM controller through a protective resistor and diode.

The on/off input circuit should be CMOS logic referred to the –Input power terminal however TTL or TTL-LS logic will also work or a switch to ground. If preferred, you can even run this using a bipolar transistor in “open collector” configuration or an “open drain” FET transistor with on/off pulled up to external 3.3V, 5V or 12V bias as below.

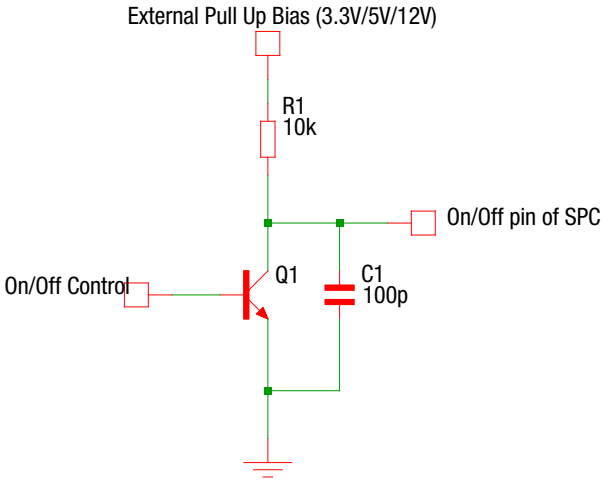


Figure 2. Remote On/Off Control Circuit

Since its base-emitter voltage will change with a negative thermal coefficient over the temperature, external controller can drive a small amount of current into this transistor(diode) and measure the voltage to determine the temperature.

SPC's over temperature protection is functioned by other internal circuit, and these THOT-MCU signals are only provided to external MCU for temperature monitoring. If this temperature monitoring is not needed, please just leave these THOT-MCU pins open. Over temperature protection still functions by other internal circuits.

Please note the circuit connected to this THOT-MCU should be referenced to Vin(-).

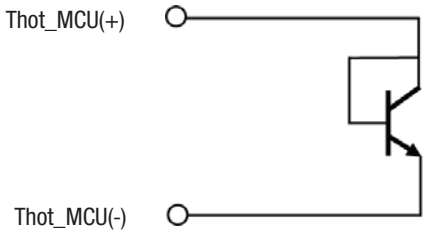


Figure 4. Temperature sensing circuit

Power Good

SPC unit provides an open-drain/open-collector type circuit representing that the output voltage is within the required voltage band. An external pull-up resistor should be placed between the PGOOD pin and an external bias voltage. The signal is referenced to the Vin(-). The signal will go to the high state when output voltage reaches a typical value, and returns to the low state when the output voltage falls below 50V.

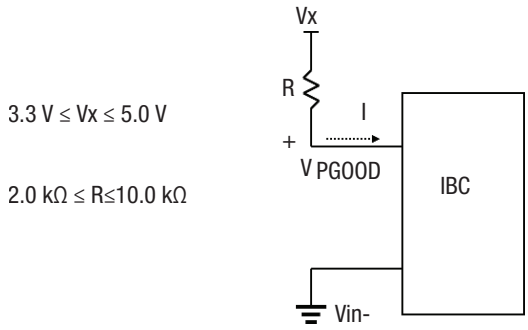


Figure 3. External circuit configuration for PGOOD signal

Hottest Component Temperature Indicating Signal

The SPC unit features a hottest component temperature indicating signal output. There is a dedicated internal signal type NPN transistor close to the hottest component inside SPC. This transistor has no electric connection to other internal circuit, just leave 2 connections out.

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:		**For Sn/Pb based solders:**	
Maximum Preheat Temperature	115° C.	Maximum Preheat Temperature	105° C.
Maximum Pot Temperature	270° C.	Maximum Pot Temperature	250° C.
Maximum Solder Dwell Time	7 seconds	Maximum Solder Dwell Time	6 seconds

Emissions Performance

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

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

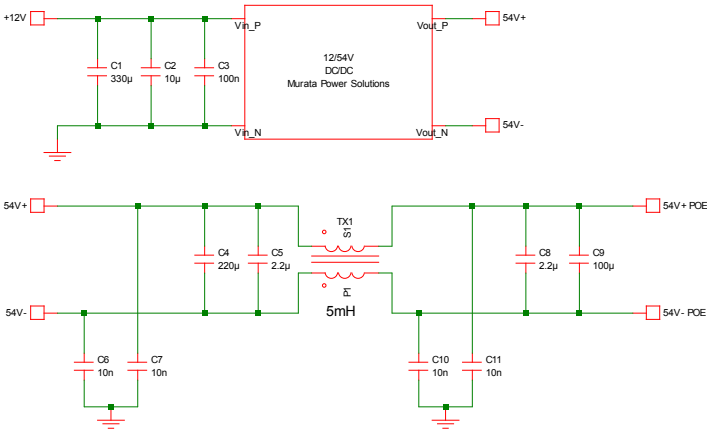


Figure 5. Conducted Emissions Test Circuit

[1] Conducted Emissions Parts List

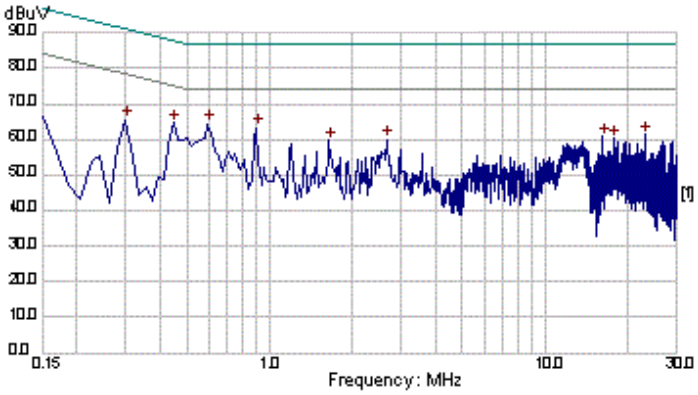
Reference	Part Number	Description	Vendor
C1	EKZM250ESS331MHB5D	Aluminum Electrolytic Capacitor 25V 330µF ±20%	NIPPON Chemicon
C2	GRM31CR71E106KA12	SMD CERAMIC 25V 10µF ±10% 1206	MURATA
C3	GRM219R71E104KA01	SMD CERAMIC 25V 0.1µF ±10% 0805	MURATA
C4	EKY-101ESS221MK25S	Aluminum Electrolytic Capacitor 100V 220µF ±20%	NIPPON Chemicon
C5, C8	GRM31CR72A225KA73	SMD CERAMIC 100V 2.2µF ±10% 1206	MURATA
C6, C7, C10, C11	DE2F3KY103MA3BM02	Ceramic capacitor CAP Y2/X1 CD 250VAC 2200pF M E VI 7.5	MURATA
C9	EKY-101ESS101MK16S	Aluminum Electrolytic Capacitor 100V 100µF ±20%	NIPPON Chemicon
CM	C20200-13	EMI filter common choke minimum 5mH 8.9A	ITG-Electronics

[2] Conducted Emissions Test Equipment Used

Hewlett Packard HP8594L Spectrum Analyzer – S/N 3827A00153

2Line V-networks LS1-15V 50Ω/50Uh Line Impedance Stabilization Network

[3] Conducted Emissions Test Results



Graph 1. Conducted emissions performance, CISPR 22, Class B, full load

[4] Layout Recommendations

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

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

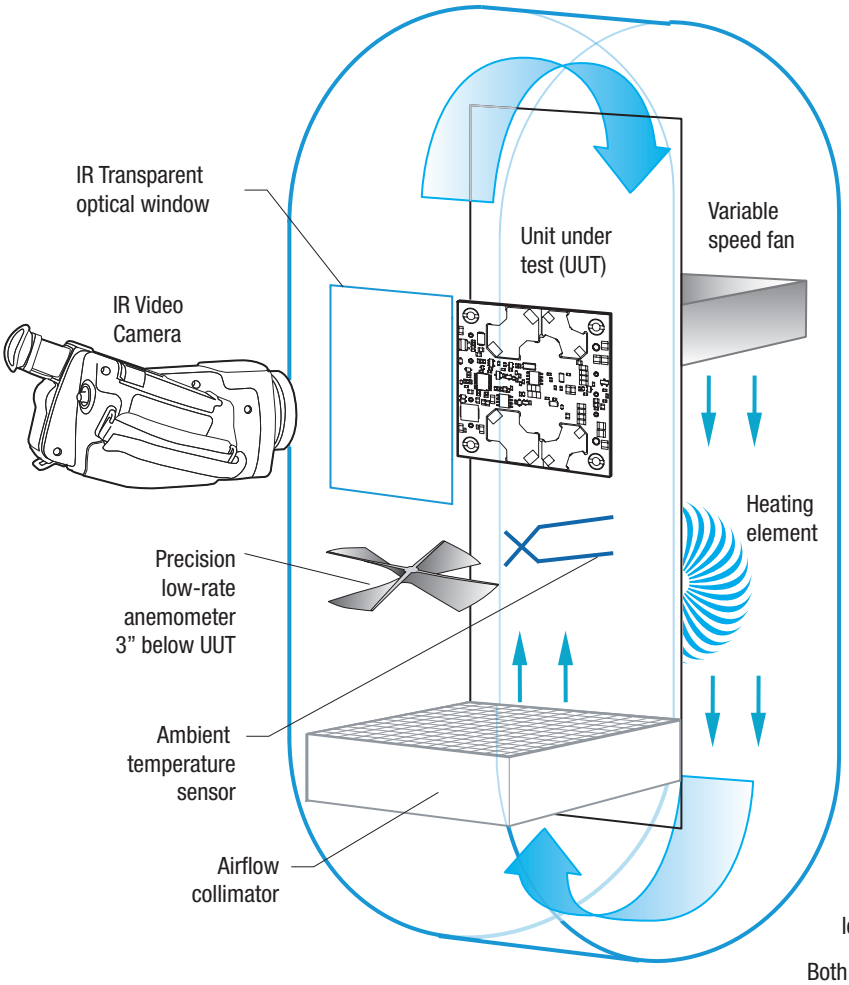


Figure 6. Vertical Wind Tunnel

Vertical Wind Tunnel

Murata Power Solutions employs a custom-designed enclosed 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 can watch thermal characteristics of the Unit Under Test (UUT) with both dynamic loads and static steady-state conditions. A special optical port is used which is transparent to infrared wavelengths. The computer files from the IR camera can be studied for later analysis.

Both through-hole and surface mount converters are soldered down to a 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 both 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 airflow collimator mixes the heat from the heating element to make uniform temperature distribution. The collimator also reduces the amount of turbulence adjacent to the UUT by restoring laminar airflow. Such turbulence can change the effective heat transfer characteristics and give 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.

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