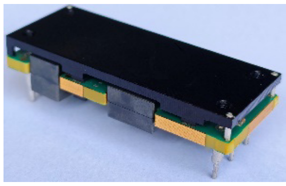
muRata
INNOVATOR IN ELECTRONICS

MPE165-54V3.1-D48NB-C

165W Eighth-Brick Isolated DC/DC Converter



FEATURES

- 36-75V Input Voltage Range
- Output Voltage 54V @ 3.1A
- Industry standard Eighth-Brick
- Integrated Baseplate for Thermal Performance
- High Efficiency up to 95.5%
- Pre-Bias Start-Up
- Low Input Ripple & Noise
- Over-Current/Voltage/Temperature Protection
- Remote On/Off (negative logic – standard configuration)
- Basic Insulation, 2250Vdc Isolation
- RoHS Compliant

SAFETY APPROVALS

- UL 62368-1 3rd edition
- IEC 62368-1:2018
- CSA-C22.2 No. 62368-1-19

APPLICATIONS

- Power-over-Ethernet (PoE)
- Server, storage, and networks
- Telecom and industrial

PRODUCT OVERVIEW

MPE165-54V3.1-D48NB-C is an analog-isolated DC/DC converter in an eighth-brick format. It offers a 54V Vout range and wide Vin ranges from 36-75V, which is typically needed in industrial, telecom, and datacom applications. MPE165-54V3.1-D48NB-C can operate over a temperature range from -40°C up to +85°C. Additionally, it can deliver up to 165W with high efficiency up to 94.5% typical at 48Vin / 50% load.

Standard features for this module include remote control, over voltage protection, over current protection, and over temperature protection.

ORDERING GUIDE[1]

Part Number	Vin Range	Vout (Nominal)	Iout	Pout	Length inch (mm)	Width inch (mm)	Height inch (mm)
MPE165-54V3.1-D48NB-C	36-75Vdc	54Vdc	3.1	165	58.42	22.86	13.4

[1] All parameters shown represent anticipated performance.

ABSOLUTE MAXIMUM RATING

Parameter	Conditions	Min.	Typ.	Max.	Units
Input Voltage		36	-	75	Vdc
Output Current		0	-	3.1	A
On/Off Pin Voltage		0	-	15	Vdc
Operating Ambient Temperature		-40	-	85	°C
Storage Ambient Temperature		-55	-	125	°C
Isolation Voltage, Input to Output		-	-	2250	Vdc

INPUT CHARACTERISTICS

Parameter	Conditions	Min.	Typ.	Max.	Units
Input Voltage Operating Range		36	48	75	Vdc
Turn-on Voltage	Ramp Up	32	34	36	
Turn-off Voltage	Ramp Down	30	32	34	
Input Current		-	-	6	Adc

ON/OFF CONTROL

Parameter	Conditions	Min.	Typ.	Max.	Units
Positive Logic ("P" Suffix)	2	-	-	-	
Unit OFF: On/Off Pin open or:		0	-	1	Vdc
Unit ON: On/Off Pin		3.5	-	15	
Control Pin Shutdown Current		-	1	2	mA
Negative Logic ("N" Suffix)	2	-	-	-	
Unit OFF: On/Off Pin open		2.5	-	15	Vdc
Unit ON: On/Off Pin		-0.1	-	0.8	
Control Pin Shutdown Current		-	1	2	mA

[1] Enable signal is referenced to Vin(-). Designed to be driven with open collector logic.
[2] Unit is disabled via control pin, open collector configuration.

ENVIRONMENTAL CHARACTERISTICS					
Parameter	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
Operating Ambient Temperature		-40	-	85	°C
Operating Case Temperature	1	-40	-	120	
Thermal Protection/Shutdown (case temperature: measured in center)		120	130	140	
Storage Temperature		-55	-	125	
Altitude, Operating		-500	-	13120	feet
EMI					
Conducted (FCC part 15, EN55032)			Class A		
Radiated (FCC part 15, EN55032)			Class A		

[1] Case temperature: measured in the center.

GENERAL & SAFETY					
Parameter	**Conditions[1]**	**Min.**	**Typ..**	**Max.**	**Units**
Efficiency	Peak Efficiency	-	95.5	-	%
	Vin=48V, Full Load	-	94.5	-	
Switching Frequency		160	180	200	kHz
Turn On Time					
Vin On to 10% of Vout		-	-	20	ms
Remote On to 10% Vout		-	-	30	
Rise time		-	-	130	
Isolation					
Input to Output Test Voltage		-	-	2250	Vdc
Input to Baseplate Test Voltage		-	-	1500	
Baseplate to Output Test Voltage		-	-	1500	
Safety Rating		-	Basic	-	
Isolation Resistance		-	100	-	MOhm
Isolation Capacitance		-	1500	-	pF
Safety Approvals					
Designed to meet the following requirements:	UL62368-1 3rd Edition, CSA-C22.2 No. 62368-1-19, IEC 62368-1:2018		Yes		
Calculated MTBF	Belcore, Telcordia SR-332, Issue2, Method 1, Class 3, Gf		2600		kHours

MECHANICAL INFORMATION					
Parameter	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
Dimensions – (L x W x H)		2.3 x 0.9 x 0.53			Inches
		58.42 x 22.86 x 13.4			mm
Weight			0.58		Ounces
			16.5		Grams
Pin Diameter			0.062 & 0.040		Inches
			1.524 & 1.016		mm
Pin Length	1		0.180		Inches
			4.57		mm
Baseplate Material		Black anodized aluminum			

[1] Standard pin length = 0.180”, special order for 0.110” and 0.145” pin lengths. Contact Murata Power Solutions for details. Minimum order quantity required.

INPUT CURRENT					
Parameter	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
Full Load Conditions	Vin = 48 V, Iout = 3.1A	-	3.6	5.0	Adc
Low Line Input Current	Vin = 36 V, Iout = 3.1A	-	4.9	5.5	
No Load Input Current	Vin = 48 V, Iout = 0A	-	50	100	mA
Shut-Down Mode Input Current		-	5	30	
Reflected Ripple Current[2]	With external input filter	-	-	300	
Reflected Ripple Current	No filtering	-	-	1500	mA p-p

[1] General conditions for the module under testing unless otherwise specified:

- Ambient Temperature +25°C
- Vin typical; Vout nominal load
- With 1 µF ceramic & 10 µF tantalum & 270 µF electrolytic capacitors across output pins; 270 µF/100 V external input capacitors.

[2] Measured at the input of module with a simulated source impedance of 12 µH, 270 µF, 100 V, across source, 33 µF, 100 V external capacitors across input pins.

OUTPUT VOLTAGE CHARACTERISTICS					
Parameter	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
Output Voltage	Output voltage setting accuracy (measured @ 50% load)	53.46	54	54.54	Vdc
Output Current		0	-	3.1	A
Current Limit Inception	98% of Vout	4	5.5	7	
Short Circuit Current	RMS current at OCP in hiccup mode	-	8.0	-	
Short Circuit Duration	Output shorted to ground		Continuous		
Total Output Voltage Range	Over sample, line, load, temperature, and life	52.38	-	55.62	Vdc
Remote Sense Compensation		-	-	4	%
Line Regulation		-	-	100	mV
Load Regulation		-	-	100	mV
Output Current		0	-	3.1	
Output Ripple/Noise[1]	(Vin = Vin_nom and Io = Io_min to Io_max, tested with a 1.0 µF ceramic, 10 µF tantalum and 270 µF low ESR polymer capacitor across the load)	-	100	300	mVpp

VOLTAGE ADJUSTMENT RANGE					
Parameter	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
Trim Down: Trim (pin #6) to -V_{out} Sense (pin #5)		-20			%
$R_{(t\_down)}[k\Omega] = 1/((V_{o\_nom} - V_o)/(V_{o_{nom}})$-2					
Trim Up: Trim (pin #6) to +V_{out} Sense (pin #7)				+7	%
$R_{t\_up}\ [k\Omega] = 1 * V_{o\_nom} * (1+\Delta)/(1.225 * \Delta)$ -1/Δ-2 $\Delta = \|(V_{o\ nom} - V_o)/V_{o_{nom}}\|$					

Note: Trim up can only be up to 7%.

DYNAMIC LOAD RESPONSE					
Parameter	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
(I_{out} 50 – 75-50% nom, 1 A /µs, 5ms within 1% of V_{out})				100	µs
Peak Deviation			±200	±400	mV
(I_{out} 25-75%-25% nom, 1 A /µs, 5ms within 1% of V_{out})				200	µs
Peak Deviation			±400	±600	mV

ELECTRICAL CHARACTERISTICS CURVES (Ta=25°C)

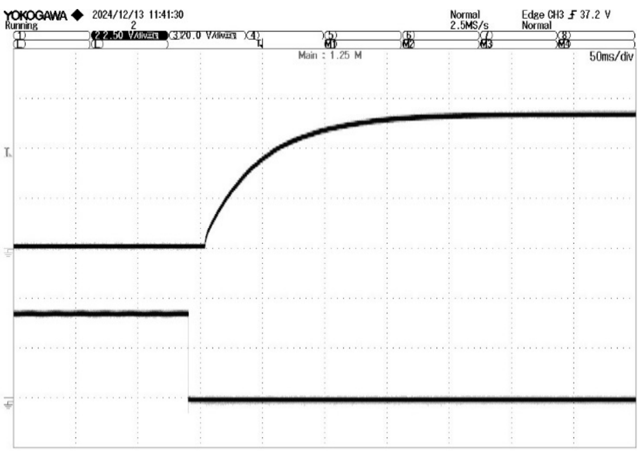


Figure 1. Enable ON
48Vin, Full Load, 270μF min. cap load

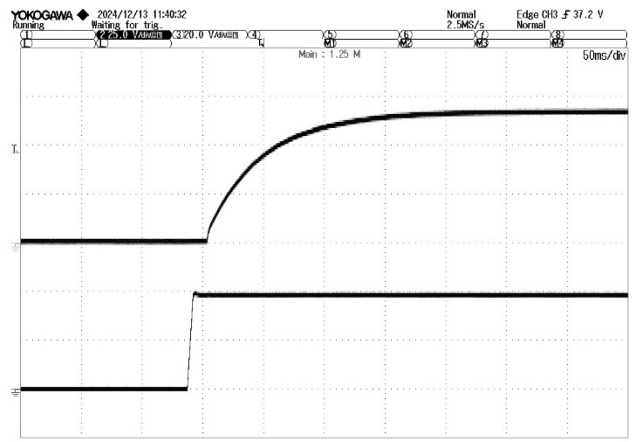


Figure 2. Vin ON
48Vin, Full Load, 270μF min. cap load

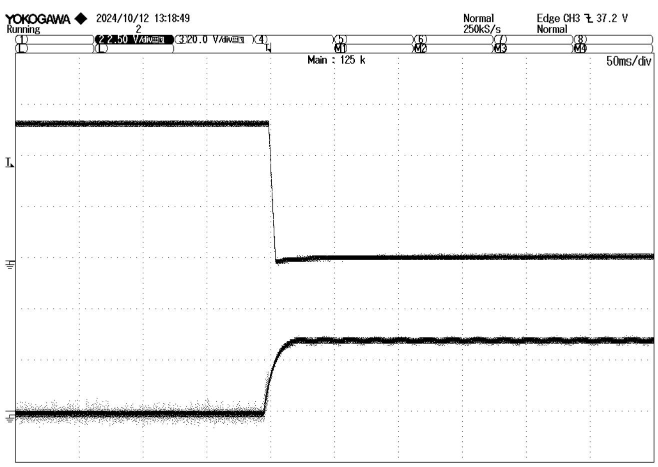


Figure 3. Enable OFF
48Vin, Full Load, 270μF min. cap load

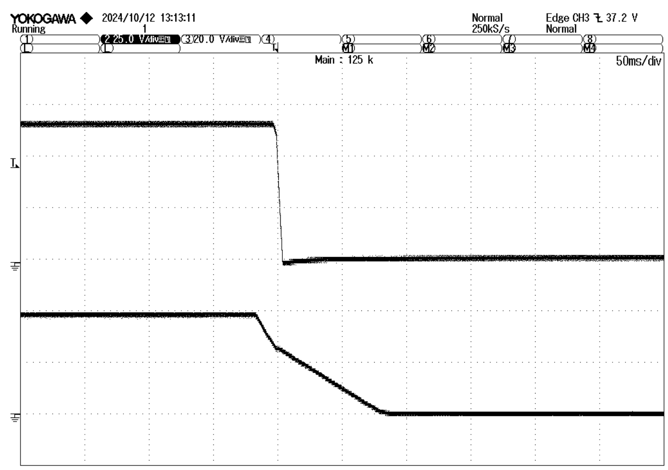


Figure 4. Vin OFF
48Vin, Full Load, 270μF min. cap load

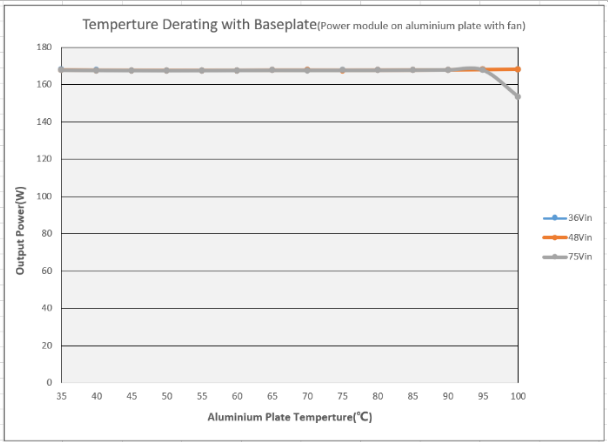


Figure 5. Output Current Derating – Cold Wall

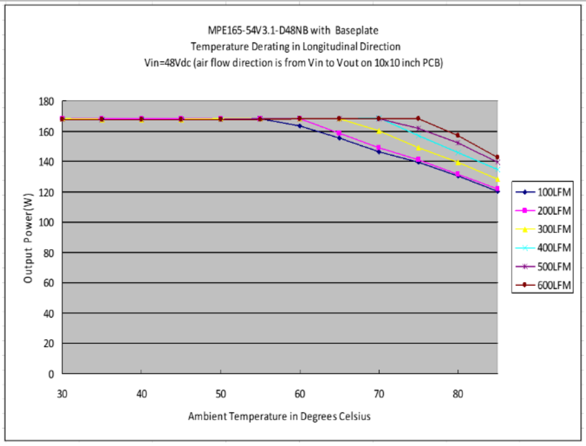


Figure 6. Output Current Derating – Baseplate Vin = 48V

ELECTRICAL CHARACTERISTICS CURVES (Ta=25°C) continued

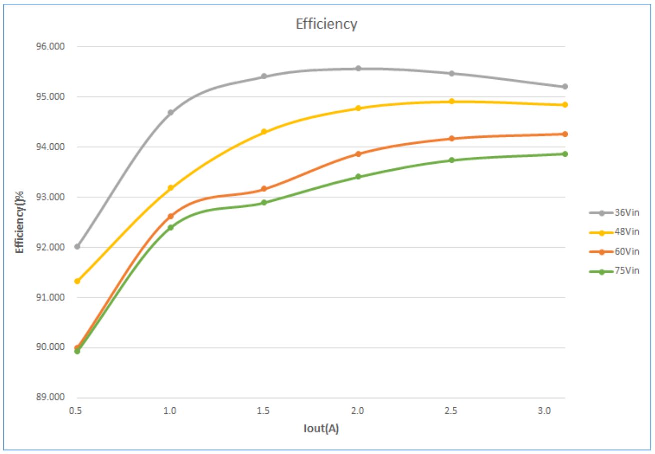


Figure 7. Efficiency Vs. Line Voltage & Load Current @ 25°C

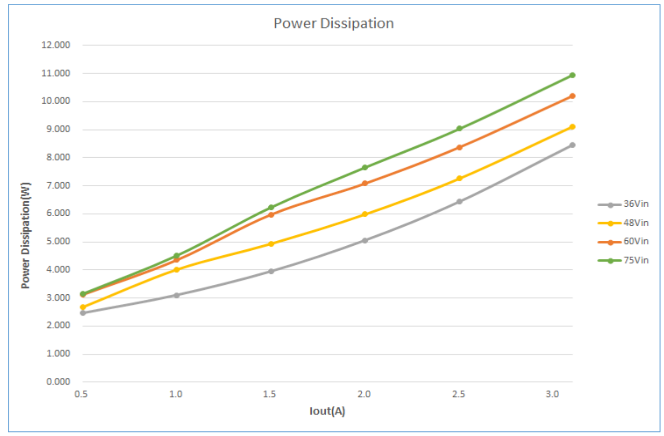


Figure 8. Power Dissipation vs. Load Current @ 25°C

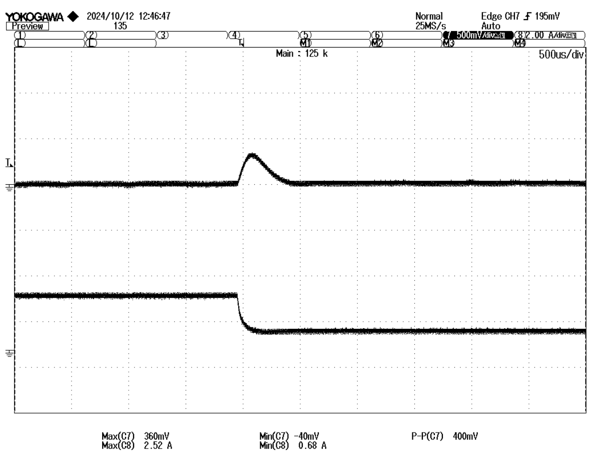


Figure 9. Output Transient Response
48Vin, 25%-75% Load

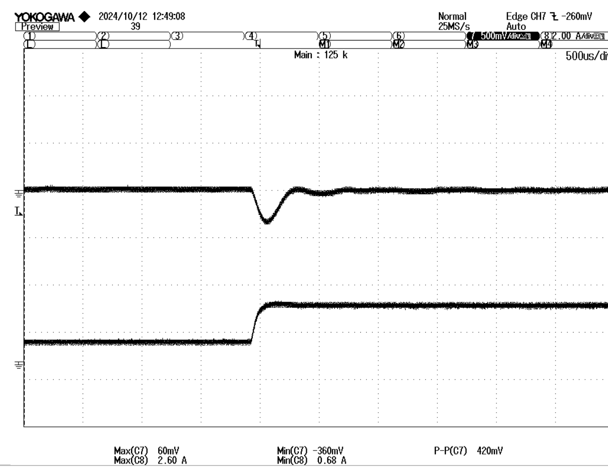


Figure 10. Output Transient Response
48Vin, 25%-75% Load2

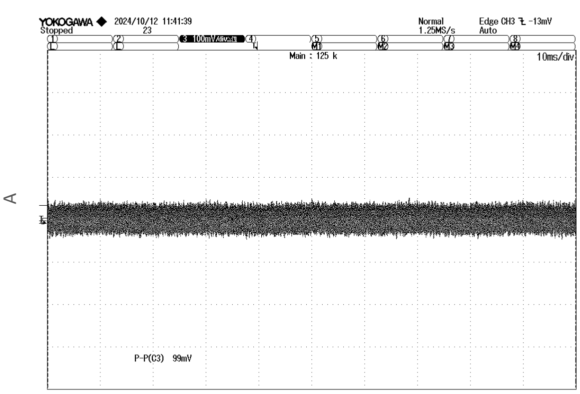


Figure 11. Ripple & Noise
48Vin, Full Load, 1µF+10µF

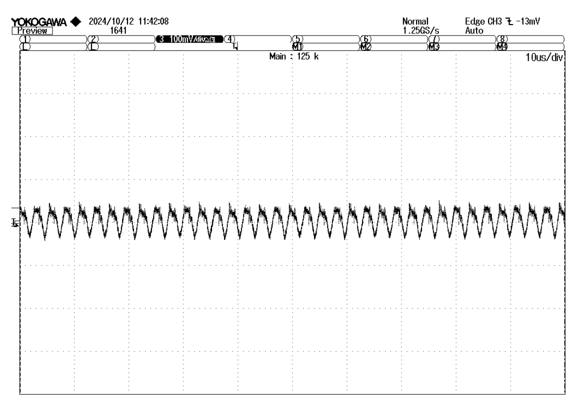
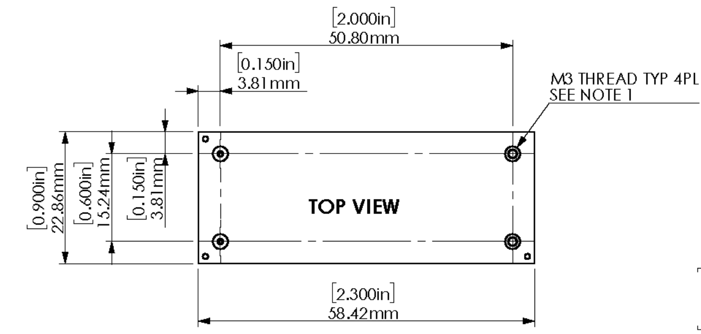
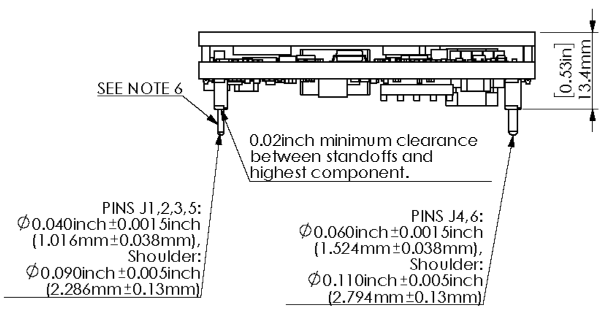
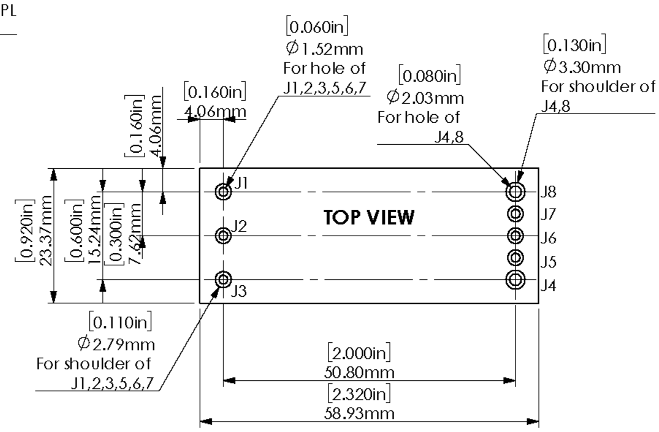


Figure 12. Ripple & Noise
48Vin, Full Load, 1µF+10µF

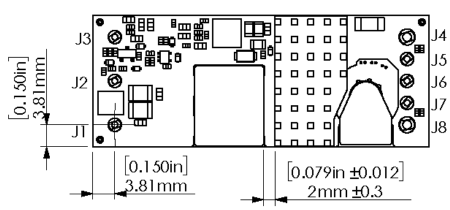
MECHANICAL SPECIFICATIONS







RECOMMENDED FOOTPRINT



Pin	Designation
J1	Vin+
J2	ENABLE
J3	Vin-
J4	Vout-
J5	SENSE-
J6	TRIM
J7	SENSE+
J8	Vout+

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: ALLDIMENSION ARE IN INCHE[MILLIMETER].
4: ALL TOLERANCES: x.xxin, ±0.02in(x.xmm, ±0.5mm),
x.xxxin, ±0.01in(x.xxmm, ±0.25mm).

6: STANDARD PIN LENGTH: 0.180inch,
FOR L1 PIN LENGTH OPTION IN MODEL NAME,
USE L1 PIN WITH PIN LENGTH TO 0.110inch,
FOR L2 PIN LENGHT OPTION IN MODEL NAME,
USE L2 PIN WITH PIN LENGTH TO 0.145inch.

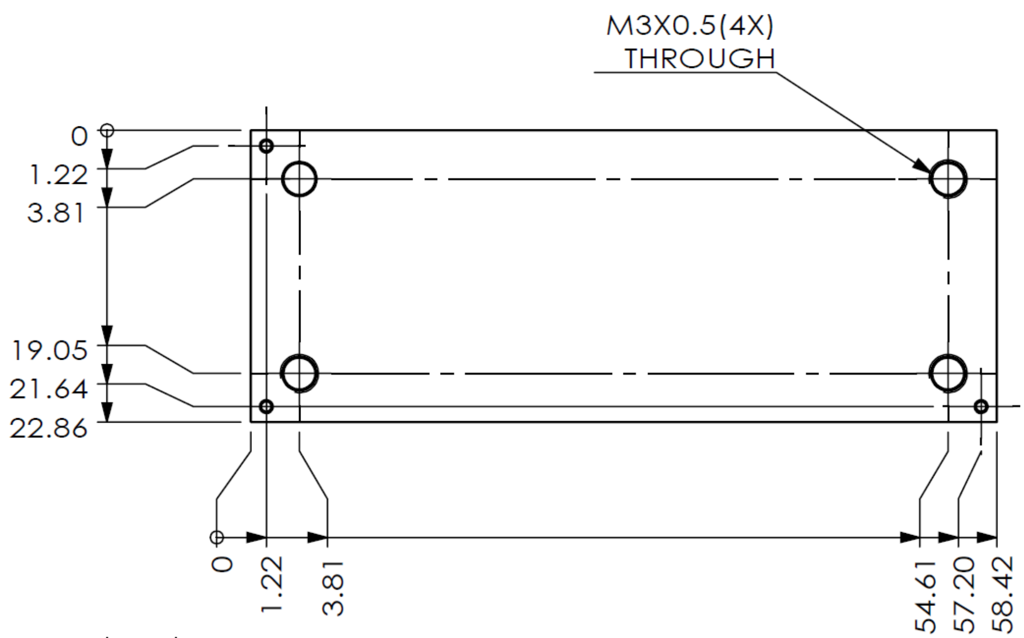
Note: This mechanical outline represents the likeness of an actual product and might not include all fine details.

PIN DEFINITION/DETAILS

Input/Output Pinouts				
Pin #	**Diameter (inches)**	**Length (inches)**	**Name**	**Function**
J1	0.04	0.18	Vin+	Positive input voltage
J2	0.04	0.18	ENABLE	Turns unit On (low) and Off (high or open)
J3	0.04	0.18	Vin-	Negative input voltage
J4	0.06	0.18	Vout-	Negative output voltage
J5	0.04	0.18	Sense-	Remote Sense negative
J6	0.04	0.18	Trim	TRIM Function
J7	0.04	0.18	Sense+	Remote Sense positive
J8	0.06	0.18	Vout+	Positive output voltage

1. Tolerance on pin diameter is ± 0.002", tolerance on pin length is ± 0.010"
2. Unit's footprint on PCB has pin holes that are 40 mils 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.

BASEPLATE DETAILS

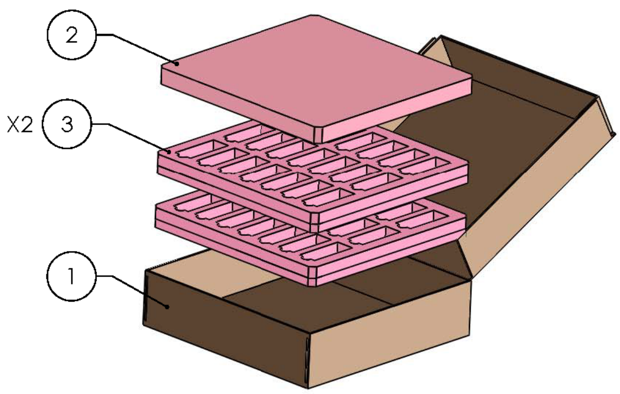


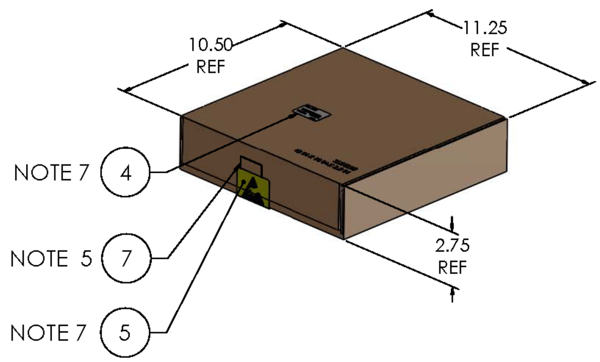
1	Baseplate must have four heatsink mounting holes in the locations shown above.
2	Heatsink mounting holes must not be chamfered.
3	Heatsink mounting holes must be deep enough to allow for 110mils of screw penetration into baseplate with a minimum three-thread engagements.
4	M3 screw used to bolt unit's baseplate to other surfaces must not exceed 0.110" (2.8mm) depth below the surface of the baseplate. Applied torque per screw should not exceed 5.3in-lb (0.6Nm).
5	Supplier must incorporate a means of preventing metal shavings from heatsink mounting holes from causing damage to the unit.
6	Tolerances: .xx ± 0.02", .xxx± 0.010".

SHIPPING PACKAGING DETAILS

ITEM NO. (7770118)	PART NUMBER	DESCRIPTION	QTY
1	2300208	SHIPPING BOX, 10" X 10" X 2.50"	1
2	2300221	SHIPPING TRAY BASE (PAD) .75" THICK	1 (NOTE 8)
3	2300238	SHIPPING TRAY, 1/8 BRICK (21 CAVITY)	2
4	2300159	LABEL, 1.0" X 1.5" PAPER	1
5	5600-01098-0	LABEL, PRE-PRINTED ESD ATTENTION	1
6	5652-01166-0	LABEL, PAPER, 2.0" X 4.0"	1 (NOTE 6)
7	6200-01211-0	ESD TAPE, 3/4" WIDE	.33'

ITEMS ABOVE REFER TO 7770118 BOM AND ARE FOR REFERENCE ONLY, REFER TO APPROPRIATE BOM FOR COMPLETE LIST OF PARTS





NOTES:

1. THIS DOCUMENT DEFINES THE GENERAL PACKING RULES FOR APPLICABLE SHIPPING KIT . INFORMATION FOR SEALING AND MARKING IS NOT PART OF THIS DOCUMENT.
2. REFER TO SHIPPING KIT BOM DETAILS.
3. INSERT UNITS INTO FOAM POCKETS IN TRAYS PER 61398 APPROX AS SHOWN
4. EACH FOAM TRAY (2300238) CONTAINS 21 UNITS. IN FULL MPQ QUANTITIES, TWO TRAYS EQUAL A TOTAL OF 42 (2x21) UNITS PER BOX.
5. FRONT FLAP SHALL BE SEALED WITH ESD TAPE SPECIFIED OR EQUIVALENT AFTER THE BOX IS CLOSED.
6. LABEL (ITEM 6) USED FOR MFR OVERPACK CARTON
7. APPLY ESD LABEL (ITEM 5) OVER TAPE USED TO SEAL BOX AND APPLY IDENTIFICATION LABEL (ITEM 4) APPROX AS SHOWN.
8. PAD (ITEM 2) MAY, AT MFR'S OPTION, BE EXCHANGED FOR THINNER PAD IF FOAM STACKUP EXCEEDS CARTON HEIGHT BY >1/8" OR ADDITIONAL PAD MAY BE ADDED IF STACKUP IS BELOW INSIDE CARTON HEIGHT BY >1/8"
   ALTERNATE PADS: 1/4" THK=2300216, 3/8" THK=2300218, 1/2" THK=2300219, 3/4" THK=2300221

TECHNICAL NOTES

SOLDERING GUIDELINES

Murata Power Solutions recommends the following specifications when installing these converters. These specifications vary depending on the solder type. Exceeding these specifications can cause damage to the product. Be cautious when there is high atmospheric humidity. A mild pre-bake (100° C for 30 minutes) is recommended. Your production environment might differ; therefore, thoroughly review these guidelines with process engineers.

Wave Solder Operation for Through-Hole Mounted Products (THMT)	
For Sn/Ag/Cu based solders:	
Maximum Preheat Temperature	115
Maximum Pot Temperature	270
Maximum Solder Dwell Time	7 seconds
For Sn/Pb based solders:	
Maximum Preheat Temperature	105
Maximum Pot Temperature	250
Maximum Solder Dwell Time	6 seconds

Input Fusing

Certain applications and 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, it is recommended to use 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.
Users should be aware however 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. Such situations could oscillate. To prevent this, make sure the operating input voltage is well 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 varies 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 varies according to the specific converter model.

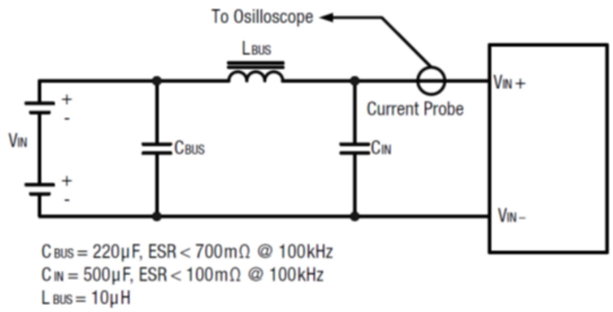


Figure 13. Measuring Input Ripple Current

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.

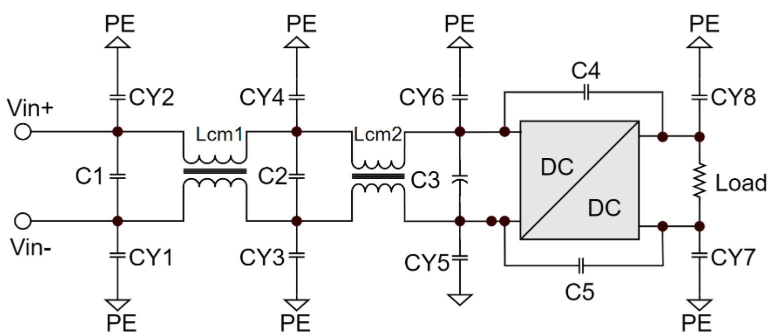


Figure 14. Recommended Input Filter

Conducted Emissions Parts List

Reference	Description
C1, C2	1μF
C3	470μF
CY1, CY2, CY3, CY4, CY5, CY6	4.7nF
C4, C5, CY7, CY8	4.7nF*2
Lcm1, Lcm2	0.5mH

CONDUCTED EMISSIONS TEST RESULTS

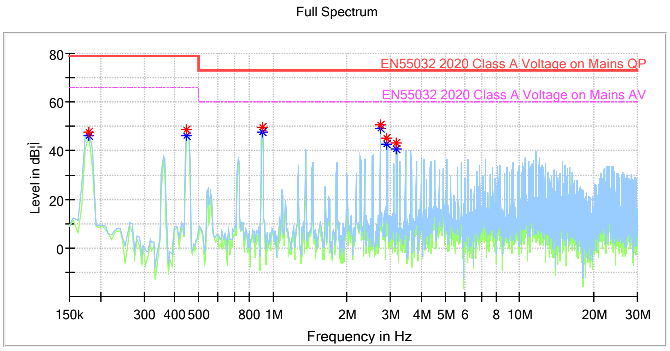


Figure 15. Vin = 48V, Class A, N-Line

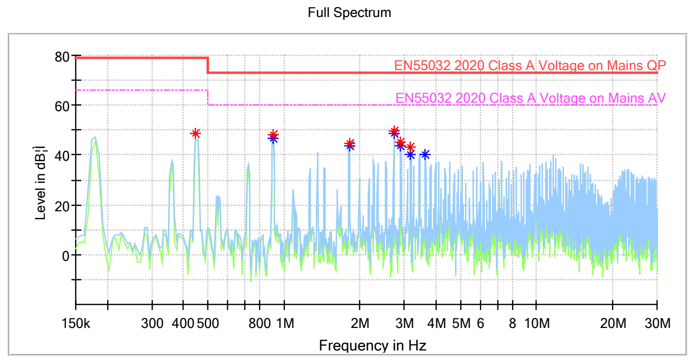


Figure 16. Vin = 48V, Class A, L-Line

[1] Layout Recommendations

Most applications can use the filtering that is already installed inside the converter or with the addition of the recommended external capacitors. For greater emissions suppression, consider additional filter components and 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, it is recommended to use an engineer who is experienced at emissions suppression.

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 might 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.

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. Ensure to thoroughly test the application to the fan flowrate specifications.

Temperature Derating Curves

The graphs in this data sheet illustrate typical operations 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 the derating guidelines, the converter might have an unplanned Over Temperature shut down. Also, these graphs are all collected near sea level altitude. Ensure 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 drops 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 automatically restores 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 –Vin. The device is off (disabled) when the On/Off is left open or is pulled high to approximately +15V with respect to –Vin.

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. There is a finite time in milliseconds (see Specifications) between the time of On/Off Control activation and a stable, regulated output. This time will vary slightly with output load type and current and input conditions.

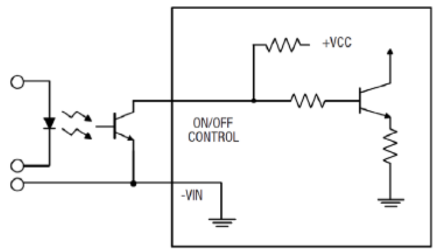


Figure 17. Driving the On/Off Control Pin (suggested circuit)

Output Capacitive Load

These converters do not require added external capacitance 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 might cause regulation problems, slower transient response and possible instability. Proper wiring of the Sense inputs improves 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 might tolerate somewhat higher capacitance. Also, capacitors with higher ESR can use a larger capacitance.

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.

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.

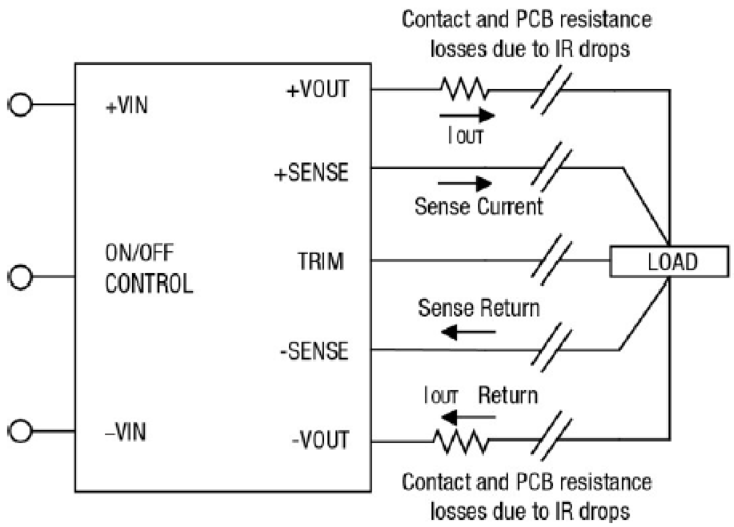


Figure 18. Remote Sense Circuit Configuration

NOTE: Observe Sense inputs tolerance to avoid improper operation: The value of the Output Sense Range depends on the Output voltage, which decreases as the increases of the output voltage. 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).

[Vout(+)-Vout(-)] - [Sense(+)-Sense(-)] ≤ Output Sense Range

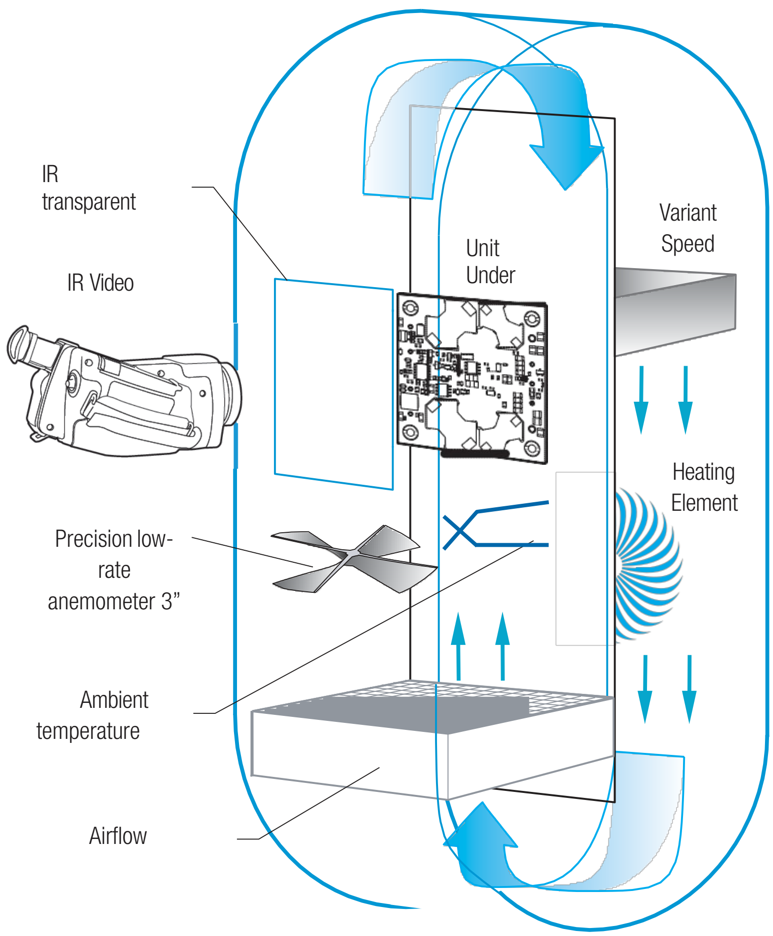


Figure 19. Vertical Wind Tunnel

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. 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.