

Typical unit

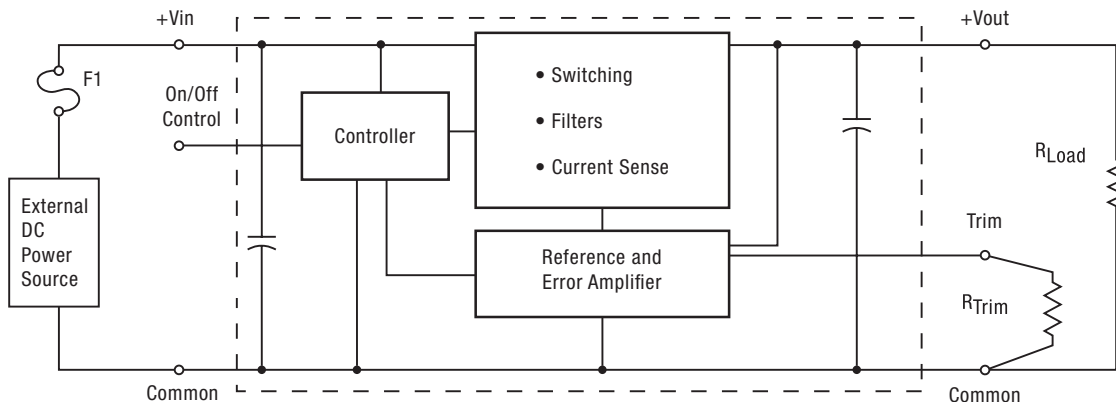
## FEATURES

- 700 KHz operation
- 5.5-13.8 Vdc input voltage range
- Programmable output voltage from 0.591-6.0 VDC
- High power conversion efficiency at 95%
- Outstanding thermal derating performance
- Over temperature and over current protection
- Forced Positive On/off option for EMC
- 1.2 x 0.71 x 0.61 inches (30.5 x 18.1 x 15.5 mm)
- Meets UL/EN/IEC 60950-1 safety certification
- RoHS-6 hazardous substance compliance
- Power Good

## PRODUCT OVERVIEW

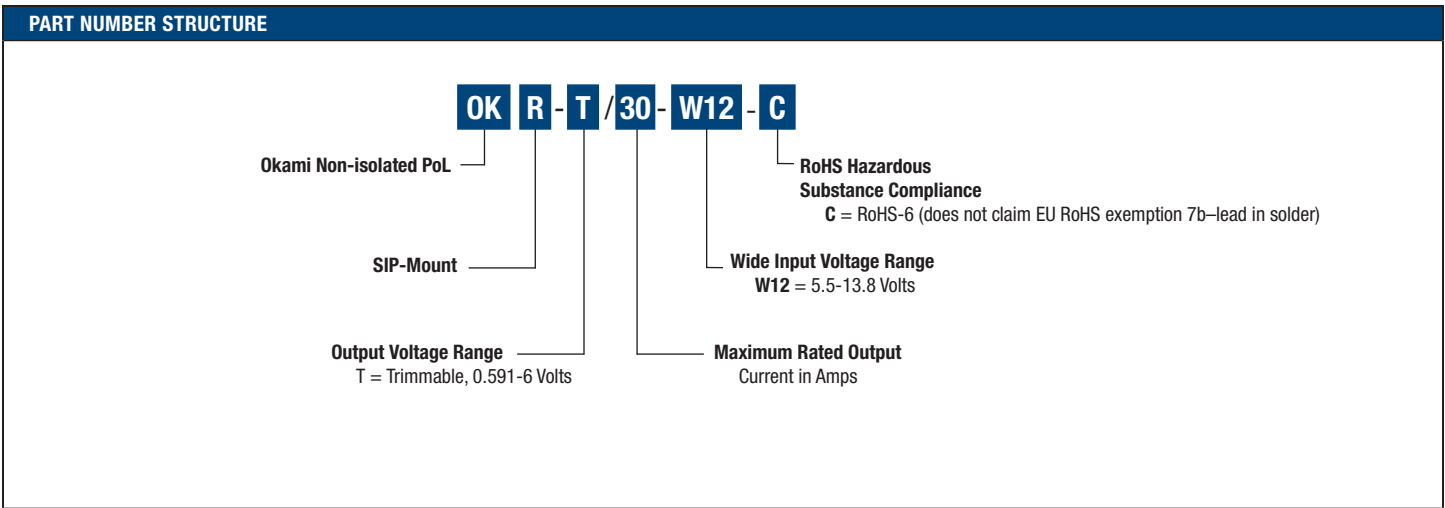
The OKR-T/30-W12-C model is a miniature SIP non-isolated Point-of-Load (PoL) DC-DC power converters measuring only 1.2 x 0.71 x 0.61 inches (30.5 x 18.1 x 15.5 mm). The wide input range is 5.5 to 13.8 Volts DC. Based on 700 KHz synchronous buck topology, the high power conversion efficient Point of Load (PoL) module features programmable output voltage and On/Off control, under voltage lock out (UVLO), overcurrent and over temperature protections. These units meet all standard UL/EN/ IEC 60950-1 safety certifications and RoHS-6 hazardous substance compliance.

Figure 1. Connection Diagram



| PERFORMANCE SPECIFICATIONS SUMMARY AND ORDERING GUIDE |              |                 |               |             |                   |        |                  |               |                   |                       |            |      |   |
|---|--------------|-----------------|---------------|-------------|-------------------|--------|------------------|---------------|-------------------|-----------------------|------------|------|---|
| Root Model  | Output       |                 |               |             |                   |        | Input            |               |                   |                       | Efficiency |      | Package                                   |
|   | Vout (Volts) | Iout (Amps max) | Power (Watts) | R/N (mVp-p) | Regulation (Max.) |        | Vin Nom. (Volts) | Range (Volts) | Iin, no load (mA) | Iin, full load (Amps) | Min.       | Typ. | Dimensions: inches (mm)                   |
|   |              |                 |               | Max.        | Line              | Load   |                  |               |                   |                       |            |      |   |
| OKR-T/30-W12-C  | 0.591-6      | 30              | 180           | 25          | ±0.15%            | ±0.15% | 12               | 5.5-13.8      | 150               | 13.2                  | 93%        | 95%  | 1.2 x 0.71 x 0.61<br>(30.5 x 18.1 x 15.5) |

- ① Dimensions are in inches (mm).
- ② Ripple and Noise is shown at Vout=1.8V. See specs for details.
- ③ All specifications are at nominal line voltage, Vout = 5V and full load, +25 °C unless otherwise noted. Models are tested with an external 22µF input capacitor and external 22µF (1) ceramic/100µF (1) polymer output capacitors.
- ④ Vin must be a minimum of 2V higher than Vout.



**FUNCTIONAL SPECIFICATIONS**

| ABSOLUTE MAXIMUM RATINGS  | Conditions  | Minimum | Typical/Nominal | Maximum | Units |
|---------------------------|---|---------|-----------------|---------|-------|
| Input Voltage, Continuous | Full power operation                                | 5.5     | 12              | 13.8    | Vdc   |
| Output Power              |   |         |                 | 180     | W     |
| Output Current            | Current-limited, no damage, short-circuit protected | 0       |                 | 30      | A     |
| On/Off Control            |   |         |                 | Vin     | Vdc   |
| Power Good Pin            |   |         |                 | 7       | Vdc   |
| Storage Temperature Range | Vin = Zero (no power)                               | -40     |                 | 125     | °C    |

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

| INPUT                           |   |      |      |      |                      |
|---------------------------------|---|------|------|------|----------------------|
| Operating voltage range         |   | 5.5  | 12   | 13.8 | Vdc                  |
| Recommended External Fuse       | Fast blow   |      |      | 40   | A                    |
| Turn On/Start-up threshold      | Rising input voltage  | 5.25 | 5.40 | 5.55 | Vdc                  |
| Undervoltage Shutdown           |   | 4.25 | 4.35 | 4.55 | Vdc                  |
| Internal Filter Type            | C-Type  |      |      |      |                      |
| Input current                   |   |      |      |      |                      |
| Full Load Conditions            | Vin = nominal (5Vset)   |      | 13.2 |      | A                    |
| Low Line                        | Vin @ min, 5Vset  |      | 22.3 |      | A                    |
| Inrush Transient                |   |      | 1    |      | A <sup>2</sup> -Sec. |
| Short Circuit Input Current     |   |      | NA   |      | mA                   |
| No Load Input Current           | Vout = 5V   |      | 150  |      | mA                   |
| Shut-Down Mode Input Current    |   |      | 20   |      | mA                   |
| Reflected (back) ripple current | Measured at input with specified filter<br>Cin = 100µF, Cbus = 1000µF, Lbus = 1µH |      | 10   |      | mA, pk-pk            |

| GENERAL and SAFETY |   |    |           |  |       |
|--------------------|---|----|-----------|--|-------|
| Efficiency         | 12Vin, 5Vout, 30A   | 93 | 95        |  | %     |
| Safety             | Certified to UL-60950-1, CSA-C22.2 No.60950-1, IEC/60950-1, 2nd edition |    | Yes       |  |       |
| Calculated MTBF    | Per Telcordia SR332, issue 1 class 3, ground fixed, Tambient = +25°C    |    | 6,737,187 |  | Hours |
| Calculated MTBF    | Per Mil-HDBK-217N2 Method   |    | 9,074,537 |  | Hours |

| DYNAMIC CHARACTERISTICS     |  |  |     |     |      |
|-----------------------------|--|--|-----|-----|------|
| Fixed Switching Frequency   |  |  | 700 |     | KHz  |
| Startup Time                |  |  | 4   | 10  | mS   |
| Dynamic Load Response       | (Iout 50% - 75% nom, within 2% of Vout set, di/dt = 1A/µSec) |  |     | 50  | µSec |
| Dynamic Load Peak Deviation |  |  |     | 150 | mV   |

| FEATURES and OPTIONS                      |                        |      |       |       |    |
|---|------------------------|------|-------|-------|----|
| Remote On/Off Control                     |                        |      |       |       |    |
| Positive Logic, ON state                  | Pin pulled high        | 1.2  |       | 5     | V  |
| Control Current, ON state                 |                        | 0.04 |       | 1.3   | mA |
| Positive Logic, OFF state                 | Pin open or pulled low | 0    |       | 0.7   | V  |
| Control Current, OFF state                | open collector/drain   | 0    |       | 6     | µA |
| Remote Sense                              |                        |      |       |       | mV |
| Power Good Option                         |                        |      |       |       |    |
| PGOOD, Open Drain Configuration, Sinking: |                        |      |       |       |    |
| Vout window for PGOOD: Upper limit        |                        | +8.3 | +12.5 | +16.2 | %  |
| Vout window for PGOOD: Lower limit        |                        | -15  | -12.5 | -9.2  | %  |

| OUTPUT                           |                            |       |      |     |            |
|----------------------------------|----------------------------|-------|------|-----|------------|
| Total Output Power               |                            | 0     |      | 180 | W          |
| Voltage                          |                            |       |      |     |            |
| Nominal Output Voltage Range     | See trim formula           | 0.591 |      | 6   | Vdc        |
| Setting Accuracy                 | At 50% load                |       | ±1.5 |     | % of Vnom. |
| Output Voltage Overshoot-Startup |                            |       |      | 5   | % Vo set   |
| Current                          |                            |       |      |     |            |
| Output Current Range             | Continuous                 | 0     |      | 30  | A          |
| Current Limit Inception          | 98% of Vnom., after warmup | 37    | 47   | 56  | A          |

**FUNCTIONAL SPECIFICATIONS (CONT.)**

| OUTPUT (CONT.)                                     | Conditions   | Minimum | Typical/Nominal                         | Maximum | Units           |
|--|--|---------|---|---------|-----------------|
| <b>Short Circuit</b>                               |  |         |   |         |                 |
| Short Circuit Current                              | Hiccup technique, autorecovery within ±1% of Vout    |         | 2.87                                    |         | A               |
| Short Circuit Duration (remove short for recovery) | Output shorted to ground, no damage                  |         |   |         |                 |
| <b>Regulation</b>                                  |  |         |   |         |                 |
| Total Regulation Band                              |  | -3      |   | 3       | % Vo set        |
| Line Regulation                                    | Vin = min to max, output @ nominal load              |         |   | ±0.15   | %               |
| Load Regulation                                    | Min load to max load                                 |         |   | ±0.15   | %               |
| Ripple and Noise                                   | 1.8Vo, 12Vin   |         | 15                                      | 25      | mV pk-pk        |
| Temperature Coefficient                            |  |         | 0.02                                    |         | % of Vnom./°C   |
| Maximum Capacitive Loading                         | Low ESR; > 1 mohm<br>ESR > 15 mohm                   |         | 1000<br>2400                            |         | µF<br>µF        |
| <b>MECHANICAL</b>                                  |  |         |   |         |                 |
| Outline Dimensions                                 | L x W x H  |         | 1.2 x 0.71 x 0.61<br>30.5 x 18.1 x 15.5 |         | Inches<br>mm    |
| Weight   |  |         | 0.44<br>12.4                            |         | Ounces<br>Grams |
| <b>ENVIRONMENTAL</b>                               |  |         |   |         |                 |
| Operating Ambient Temperature Range                | full power, all output voltages, see derating curves | 0       |   | 70      | °C              |
| Storage Temperature                                | Vin = Zero (no power)                                | -40     |   | 125     | °C              |
| RoHS rating  |  |         | RoHS-6                                  |         |                 |

**Trim Connections**

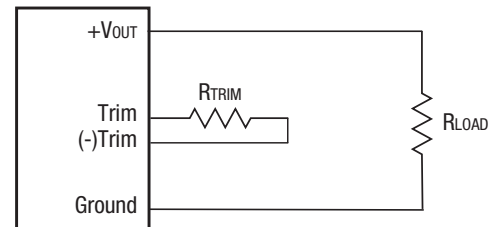
**Output Voltage Adjustment**

The output voltage may be adjusted over a limited range by connecting an external trim resistor (Rtrim) between the Trim pin and (-)Trim. The Rtrim resistor must be a 1/10 Watt precision metal film type, ±0.5% accuracy or better with low temperature coefficient, ±100 ppm/oC. or better. Mount the resistor close to the converter with very short leads or use a surface mount trim resistor.

In the tables below, the calculated resistance is given. Do not exceed the specified limits of the output voltage or the converter’s maximum power rating when applying these resistors. Also, avoid high noise at the Trim input. However, to prevent instability, you should never connect any capacitors to Trim.

**OKR-T/30-W12-C**

| Output Voltage | Calculated Rtrim (Ω) |
|----------------|----------------------|
| 6 V.           | 218.5                |
| 5 V.           | 268                  |
| 3.3 V.         | 436                  |
| 2.5 V.         | 619                  |
| 1.8 V.         | 978                  |
| 1.5 V.         | 1300                 |
| 1.2 V.         | 1940                 |
| 1.0 V.         | 2890                 |
| 0.591 V.       | ∞ (open)             |

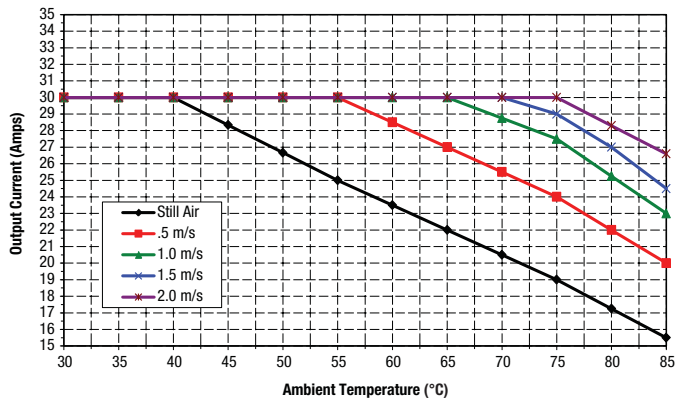


**Resistor Trim Equation, OKR-T/30-W12-C:**

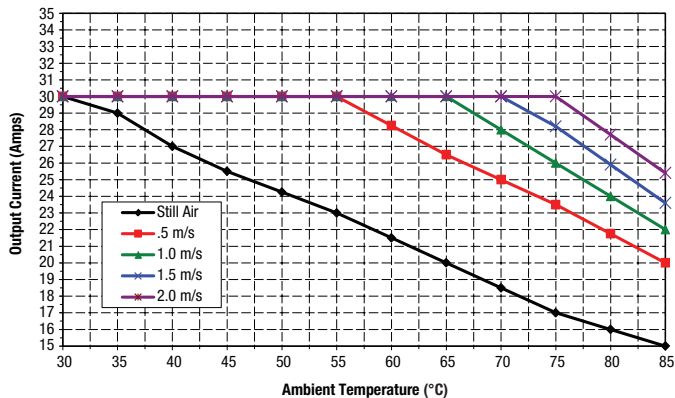
$$R_{TRIM} (k\Omega) = \frac{1.182}{(V_{OUT} - 0.591)}$$

**OKR-T/30-W12-C PERFORMANCE DATA**

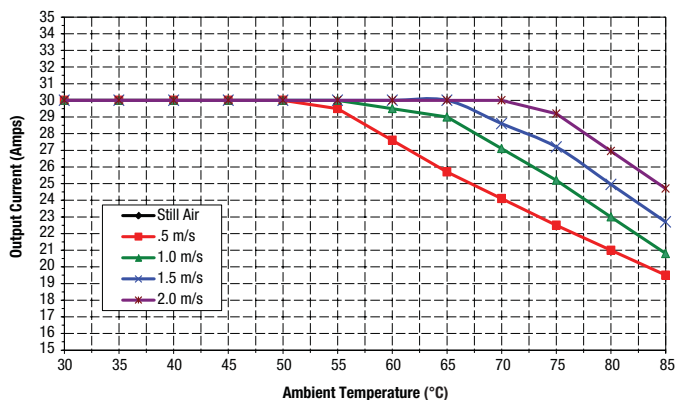
Temperature Derating @1Vout  
Vin 12V (air flow from Pin 13 (input) to Pin 1 (output) on PCB)



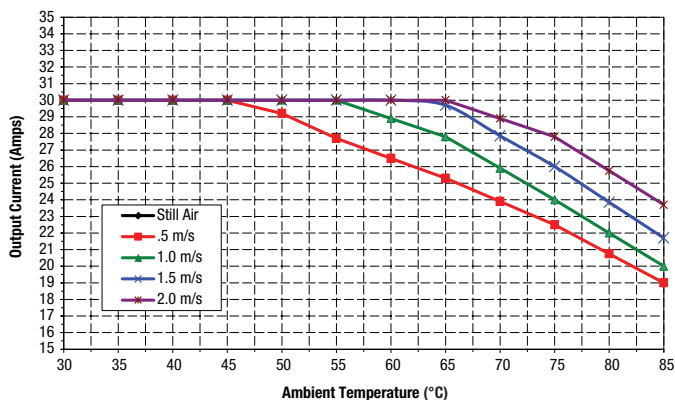
Temperature Derating @1.8Vout  
Vin 12V (air flow from Pin 13 to Pin 1 on PCB)



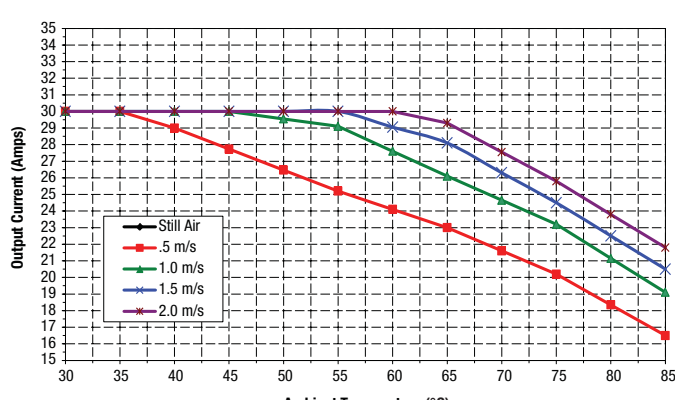
Temperature Derating @2.5Vout  
Vin 12 (air flow from Pin 13 to Pin 1 on PCB)



Temperature Derating @3.3Vout  
Vin 12 (air flow from Pin 13 to Pin 1 on PCB)

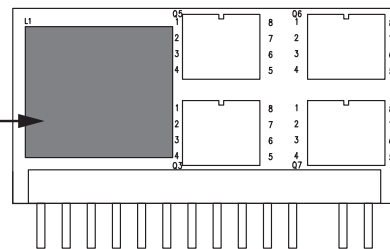


Temperature Derating @5Vout  
Vin 12 (air flow from Pin 13 to Pin 1 on PCB)



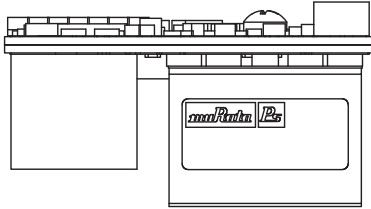
Thermal Reference Point

Thermal reference point  
115°C max. (L1)

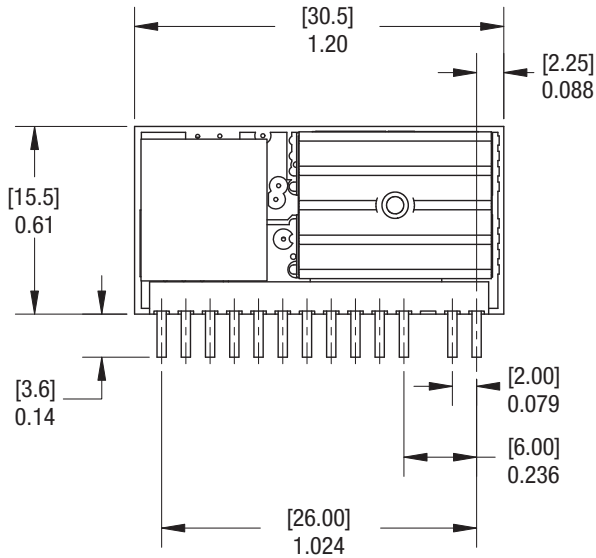


**MECHANICAL SPECIFICATIONS**

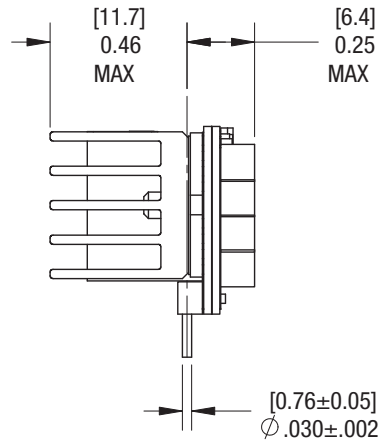
**TOP VIEW**



**FRONT VIEW**



**END VIEW**



**INPUT/OUTPUT CONNECTIONS**  
**OKR-T/30-W12-C**

| Pin   | Function |
|-------|----------|
| J1-1  | Vout     |
| J1-2  | Vout     |
| J1-3  | Vout     |
| J1-4  | PGND     |
| J1-5  | PGND     |
| J1-6  | Enable   |
| J1-7  | -Trim    |
| J1-8  | +Trim    |
| J1-9  | PGood    |
| J1-10 | -Sense   |
| J1-11 | +Sense   |
| J1-12 | Vin      |
| J1-13 | Vin      |

DIMENSIONS ARE IN INCHES [mm]

TOLERANCES:  
2 PLACE ±.02      ANGLES: ±1°  
3 PLACE ±.010

COMPONENTS SHOWN ARE FOR REFERENCE ONLY

MATERIAL:  
Ø .030 HEADER PINS: COPPER ALLOY  
SUPPORT PINS: TIN PLATED BRASS

FINISH: (ALL HEADER PINS)  
200µ" MIN MATTE TIN OVER NICKEL (40µ" MIN)

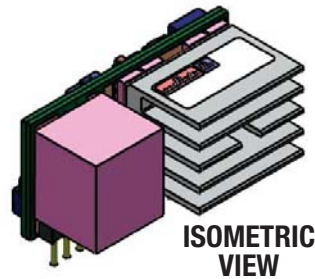
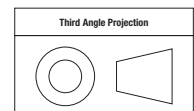


Figure 3. OKR-T/30-W12-C  
Component locations are typical.

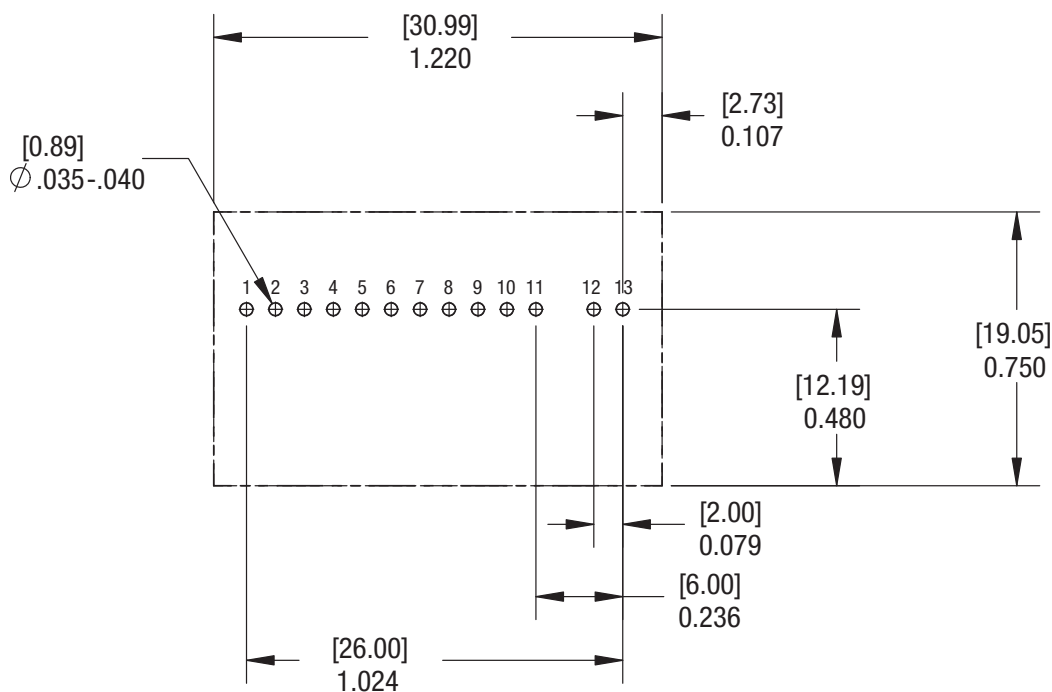
Dimensions are in inches (mm shown for ref. only).



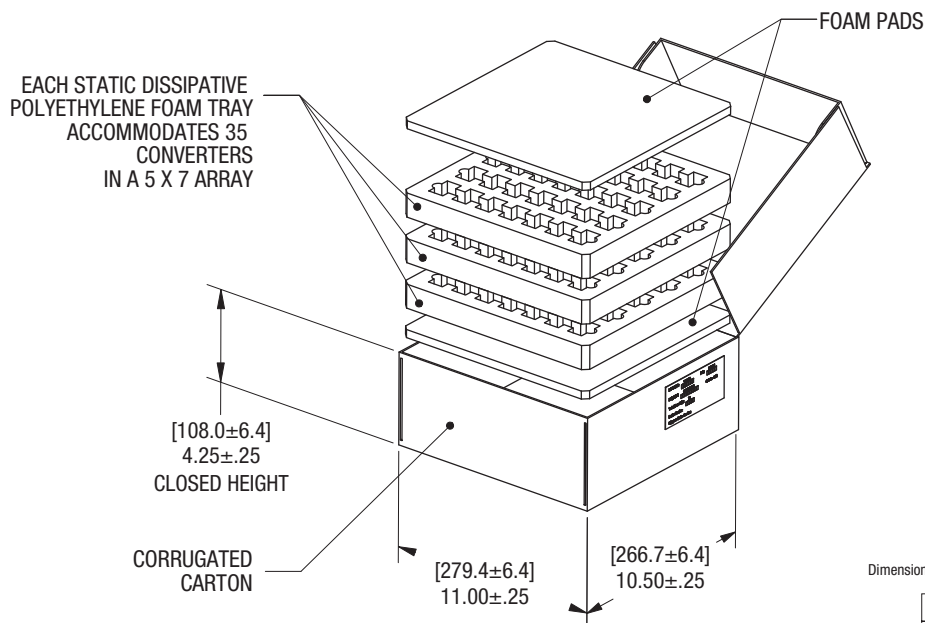
Tolerances (unless otherwise specified):  
.XX ± 0.02 (0.5)  
.XXX ± 0.010 (0.25)  
Angles ± 2°

Components are shown for reference only.

**RECOMMENDED FOOTPRINT (VIEW FROM TOP)**



**STANDARD PACKAGING**



EACH STATIC DISSIPATIVE  
POLYETHYLENE FOAM TRAY  
ACCOMMODATES 35  
CONVERTERS  
IN A 5 X 7 ARRAY

FOAM PADS

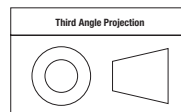
[108.0±6.4]  
4.25±.25  
CLOSED HEIGHT

CORRUGATED  
CARTON

[279.4±6.4]  
11.00±.25

[266.7±6.4]  
10.50±.25

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.

35 UNITS PER TRAY  
3 TRAYS PER CARTON

MPQ = 105 UNITS

**TECHNICAL NOTES**

**Input Fusing**

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

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, i.e. IEC/EN/UL 60950-1.

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

Under normal start-up conditions, converters will not begin to regulate properly until the ramping-up input voltage exceeds and remains at the Start-Up Threshold Voltage (see Specifications). Once operating, converters will not turn off until the input voltage drops below the Under-Voltage Shutdown Limit. Subsequent restart will not occur until the input voltage rises again above the Start-Up Threshold. This built-in hysteresis prevents any unstable on/off operation at a single input voltage.

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 Time**

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

These converters include a soft start circuit to moderate the duty cycle of its PWM controller at power up, thereby limiting the input inrush current.

The On/Off Remote Control interval from On command to Vout 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 accuracy band. The specification assumes that the output is fully loaded at maximum rated current. Similar conditions apply to the On to Vout regulated specification such as external load capacitance and soft start circuitry.

**Recommended Input Filtering**

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

For best performance, we recommend installing a low-ESR capacitor immediately adjacent to the converter's input terminals. The capacitor should be a ceramic type such as the Murata GRM32 series or a polymer type. Initial

suggested capacitor values are 10 to 22  $\mu\text{F}$ , rated at twice the expected maximum input voltage. Make sure that the input terminals do not go below the undervoltage shutdown voltage at all times. More input bulk capacitance may be added in parallel (either electrolytic or tantalum) if needed.

**Recommended Output Filtering**

The minimum external output capacitance required for proper operation is 50 $\mu\text{F}$  ceramic type. The maximum external output capacitance is 100 $\mu\text{F}$  ceramic and 470 $\mu\text{F}$  POSCAP. Operating outside of these minimum and maximum limits may affect the performance of the unit.

**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. In the figure below, the Cbus and Lbus components simulate a typical DC voltage bus. Please note that the values of Cin, Lbus and Cbus will vary according to the specific converter model.

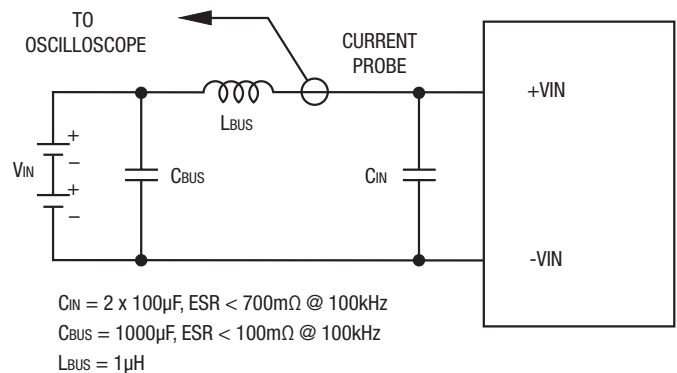


Figure 4: Measuring Input Ripple Current

In the figure below, the two copper strips simulate real-world printed circuit impedances between the power supply and its load. In order to minimize circuit errors and standardize tests between units, scope measurements should be made using BNC connectors or the probe ground should not exceed one half inch and soldered directly to the test circuit.

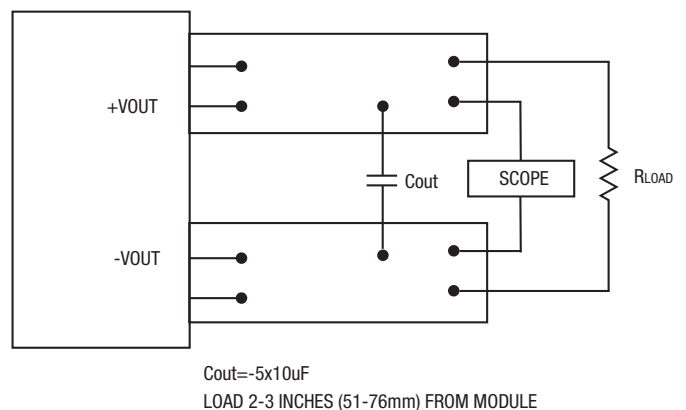


Figure 5: Measuring Output Ripple and Noise (PARD)



**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.

**Thermal Shutdown**

To prevent many over temperature problems and damage, these converters include thermal shutdown circuitry. If environmental conditions cause the temperature of the DC-DC's to rise above the Operating Temperature Range up to the shutdown temperature, an on-board electronic temperature sensor will power down the unit. When the temperature decreases below the turn-on threshold, 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 may shut down suddenly without warning. Be sure to thoroughly test your application to avoid unplanned thermal shutdown.

**Temperature Derating Curves**

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

Note that the temperatures are of the ambient airflow, not the converter itself which is obviously running at higher temperature than the outside air. Also note that very low flow rates (below about 25 LFM) are similar to “natural convection,” that is, not using fan-forced airflow.

Murata Power Solutions makes Characterization measurements in a closed cycle wind tunnel with calibrated airflow. We use both thermocouples and an infrared camera system to observe thermal performance.

**CAUTION:** If you routinely or accidentally exceed these Derating guidelines, the converter may have an unplanned Over Temperature shut down. Also, these graphs are all collected at slightly above Sea Level altitude. Be sure to reduce the derating for higher density altitude.

**Output Current 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 may briefly rise above its rated value in normal operation as long as the average output power is not exceeded. This enhances reliability and continued operation of your application. If the output current is too high, the converter will enter the short circuit condition.

**Output Short Circuit Condition**

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 primary side voltages will also drop, thereby shutting down the PWM controller. Following a time-out period, the PWM will restart, causing the output voltage to begin ramping up 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. A short circuit can be tolerated indefinitely.

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.

**External Enable On/Off Control**

The forced On/Off enable option uses positive logic for the external control. The converter may be powered ON by applying a positive voltage (logic HI) between the On/Off pin and the negative power input (-Vin). This positive voltage is referred to -Vin and must be in the range of at least +1.5V and not to exceed the power supply input voltage (+Vin). The current drain is 1 mA max. when turned on.

If the On/Off pin is left open, an internal 100 KΩ pulldown resistor will turn the converter OFF. The OFF condition may also be commanded by grounding the pin or from an external logic LO voltage not to exceed +0.4 Volts. All voltages are referred to the -Vin negative power input.

If you wish to control the On/Off circuit by external logic rather than a switch, carefully compare your logic threshold voltages with that of the On/Off input.

The circuit below indicates the equivalent input. Please avoid false signals from ground bounce errors on the On/Off control.

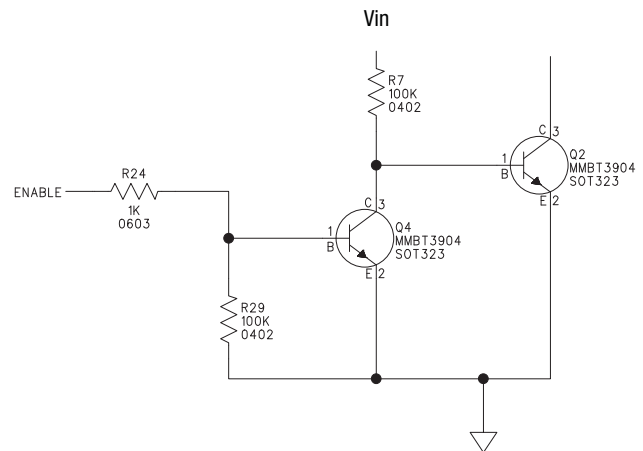


Figure 6. On/Off Control Circuit

**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. 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 |

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 ISO 9001 and 14001 REGISTERED



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