# TRV 1 Series

# Application Note

DC/DC Converter 5Vdc ±10%, 12Vdc ±10% or 24Vdc ±10% Input
5.0Vdc, 9Vdc, 12Vdc & 15Vdc Single Outputs, 1W, in SIL package


226037

**Features**

- Single output up to 200mA
- 1 watts maximum output power
- High efficiency up to 88%
- Input to output isolation: 3000Vdc for 1 minute
- Large operating temperature range from –40°C up to +85°C
- Approved according to IEC/EN/UL 60950-1

**Applications**

- Distributed power architectures
- Workstations
- Computer equipment
- Communications equipment

Complete TRV 1 datasheet can be downloaded at:

http://www.tracopower.com/products/trv1.pdf

## General Description

The Tracopower TRV 1 series is a new range of high isolated 1W DC/DC converter modules in a small SIP-package. There are 24 models available with 5V, 12V or 24VDC input and 5Vdc, 9Vdc, 12Vdc or 15Vdc output voltage. These products provided have a typical load regulation of 3.5% to 5.5% depending on model and have a high I/O isolation of 3000Vdc for 1 minute.

The TRV 1 DC/DC converters are a compromise between a more expensive fully regulated converter and a non-regulated converter. They offer to designers a new solution for many cost critical applications where the output voltage variation has to be kept in a certain limit under all load conditions.

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| Absolute Maximum Rating | | | | |
|---|---|---|---|---|
| **Parameter** | **Model** | **Min** | **Max** | **Unit** |
| Input Voltage<br>Input Surge Voltage (1 second) | 5Vdc Input Models | -0.7 | 9 | Vdc |
| | 12Vdc Input Models | -0.7 | 18 | |
| | 24Vdc Input Models | -0.7 | 30 | |
| Operating Ambient Temperature<br>Without Derating | All | -40 | +85 | °C |
| Operating Case Temperature | All | --- | +90 | °C |
| Storage Temperature | All | -50 | +125 | °C |

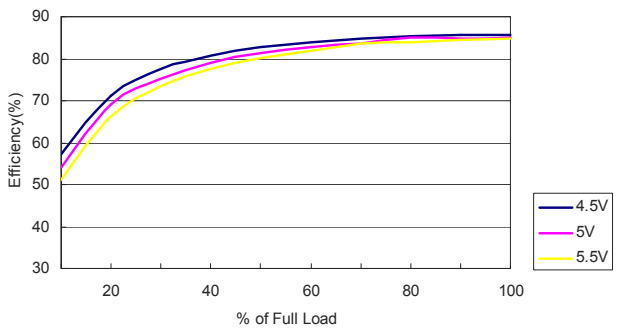
| Output Specification | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Model** | **Min** | **Nominal** | **Max** | **Unit** |
| Output Regulation<br>Line ($V_{in\ min}$ to $V_{in\ max}$ at Full Load) | All | | ±1.05 | ±1.2 | % |
| Output Regulation<br>Load (20% to 100% of Full Load) | TRV 1-0511 | | | 6.2 | % |
| | TRV 1-0519 | | | 5.5 | |
| | TRV 1-0512 | | | 5.5 | |
| | TRV 1-0513 | | | 5 | |
| | TRV 1-1211 | | | 5 | |
| | TRV 1-1219 | | | 3.3 | |
| | TRV 1-1212 | | | 3.6 | |
| | TRV 1-1213 | | | 2.9 | |
| | TRV 1-2411 | | | 5 | |
| | TRV 1-2419 | | | 3.5 | |
| | TRV 1-2412 | | | 3.5 | |
| | TRV 1-2413 | | | 3 | |
| Output Ripple & Noise<br>Peak-to-Peak (5Hz to 20MHz bandwidth) | | | 30 | 60 | mV pk-pk |
| Temperature Coefficient | All | | ±0.01 | ±0.02 | %/°C |
| Output Current | TRV 1-xx11 | 4 | | 200 | mA |
| | TRV 1-xx19 | 2 | | 110 | |
| | TRV 1-xx12 | 1.5 | | 84 | |
| | TRV 1-xx13 | 1 | | 67 | |
| Output Short Circuit Protection | All | 0.5 Second Max. | | | |

| Input Specification | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Model** | **Min** | **Nominal** | **Max** | **Unit** |
| Operating Input Voltage | 5V Input Models | 4.5 | 5 | 5.5 | Vdc |
| | 12V Input Models | 10.8 | 12 | 13.2 | |
| | 24V Input Models | 21.6 | 24 | 26.4 | |
| Input Current (Maximum value at $V_{in}$ = $V_{in\ nom}$; Full Load) | TRV 1-0511 | | 238 | | mA |
| | TRV 1-0519 | | 229 | | |
| | TRV 1-0512 | | 231 | | |
| | TRV 1-0513 | | 230 | | |
| | TRV 1-1211 | | 99 | | |
| | TRV 1-1219 | | 96 | | |
| | TRV 1-1212 | | 95 | | |
| | TRV 1-1213 | | 95 | | |
| | TRV 1-2411 | | 50 | | |
| | TRV 1-2419 | | 48 | | |
| | TRV 1-2412 | | 48 | | |
| | TRV 1-2413 | | 48 | | |
| Input Standby Current (Typical value at $V_{in}$ = $V_{in\ nom}$; No Load) | TRV 1-0511 | | 30 | | mA |
| | TRV 1-0519 | | | | |
| | TRV 1-0512 | | | | |
| | TRV 1-0513 | | | | |
| | TRV 1-1211 | | 12 | | |
| | TRV 1-1219 | | | | |
| | TRV 1-1212 | | | | |
| | TRV 1-1213 | | | | |
| | TRV 1-2411 | | 11 | | |
| | TRV 1-2419 | | | | |
| | TRV 1-2412 | | | | |
| | TRV 1-2413 | | | | |

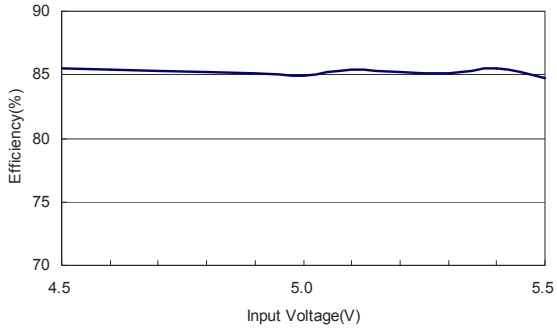
| General Specification | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Model** | **Min** | **Nominal** | **Max** | **Unit** |
| Efficiency ($V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$ = 25°C) | TRV 1-0511 | | 84 | | % |
| | TRV 1-0519 | | 86.5 | | |
| | TRV 1-0512 | | 87 | | |
| | TRV 1-0513 | | 87.5 | | |
| | TRV 1-1211 | | 84 | | |
| | TRV 1-1219 | | 86 | | |
| | TRV 1-1212 | | 88 | | |
| | TRV 1-1213 | | 88 | | |
| | TRV 1-2411 | | 84 | | |
| | TRV 1-2419 | | 86.5 | | |
| | TRV 1-2412 | | 87.5 | | |
| | TRV 1-2413 | | 87.5 | | |
| Isolation Voltage<br>Input to Output (for 60 seconds) | | 3000 | | | Vdc |
| Isolation Resistance | All | 10 | | | GΩ |
| Isolation Capacitance | | 30 | 60 | 120 | pF |
| Switching Frequency | | 50 | 100 | 120 | KHz |
| MTBF<br>MIL-STD-217F, $T_C$ = 25°C | | 2,000,000 | | | Hours |

## Characteristic Curves

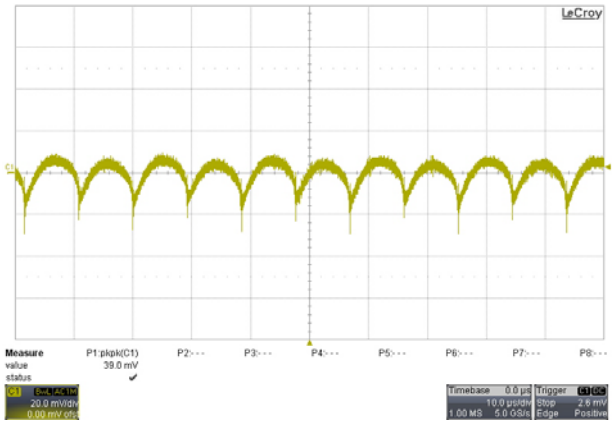
All test conditions are at 25°C. The figures are identical for TRV 1-0511



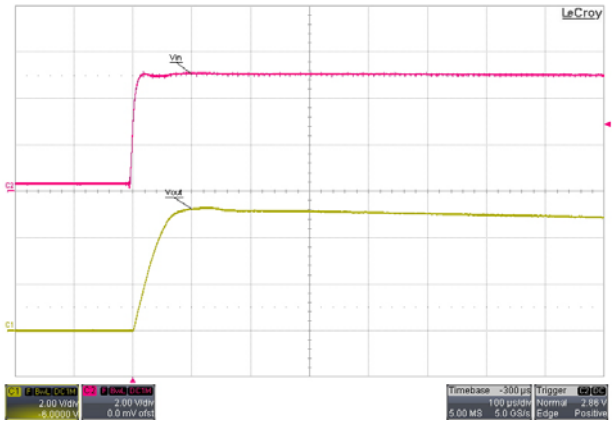

Efficiency Versus Output Current



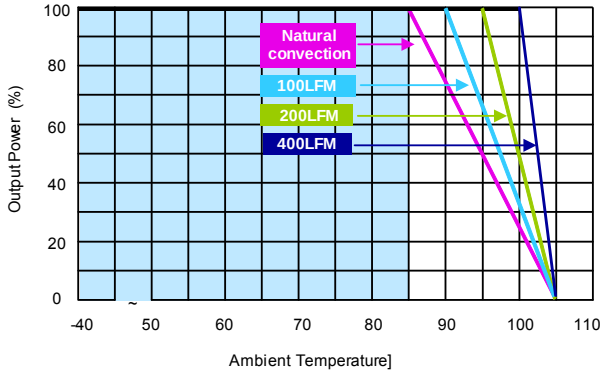

Efficiency Versus Input Voltage. Full Load



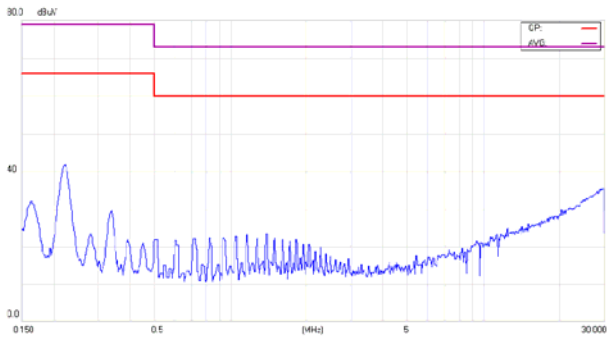

Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



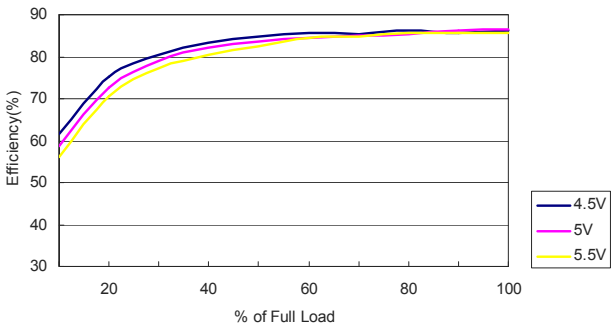

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



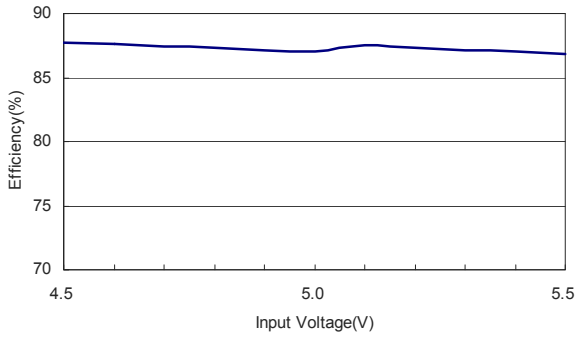

Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

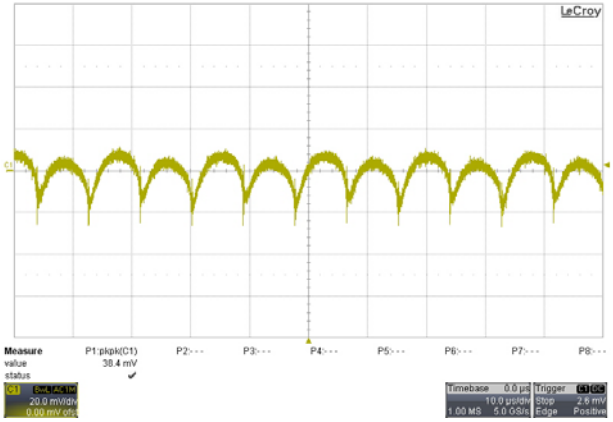
All test conditions are at 25°C. The figures are identical for TRV 1-0519



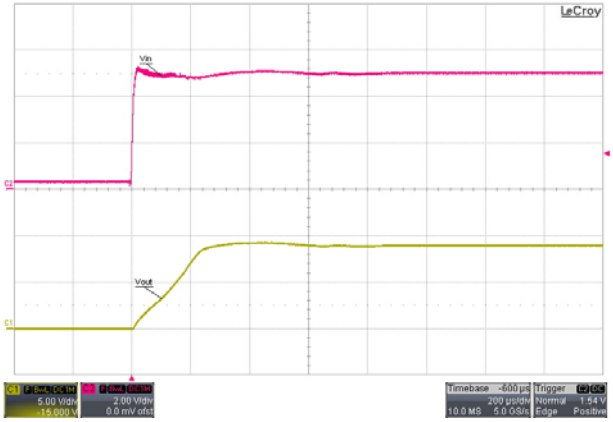

Efficiency Versus Output Current



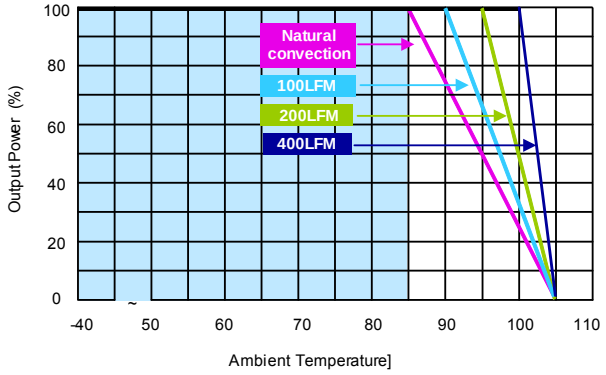

Efficiency Versus Input Voltage. Full Load



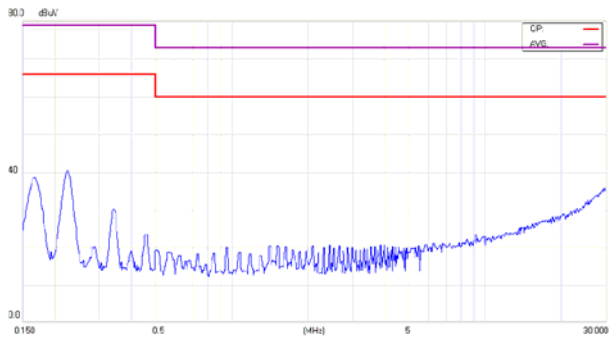

Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



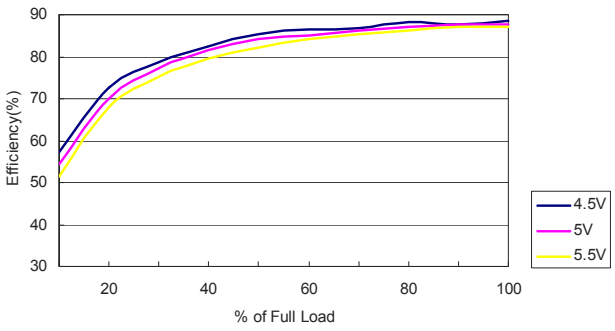

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



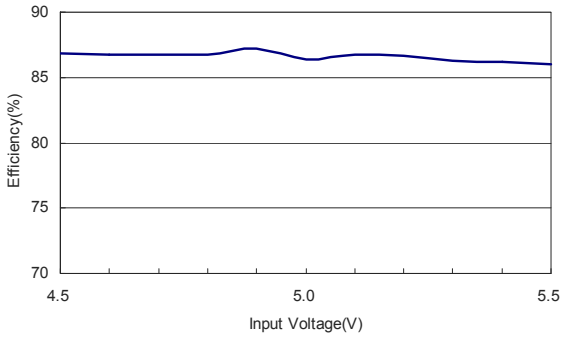
Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

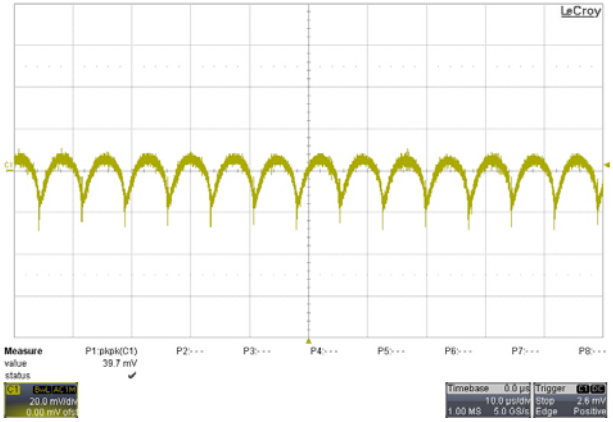
All test conditions are at 25°C. The figures are identical for TRV 1-0512



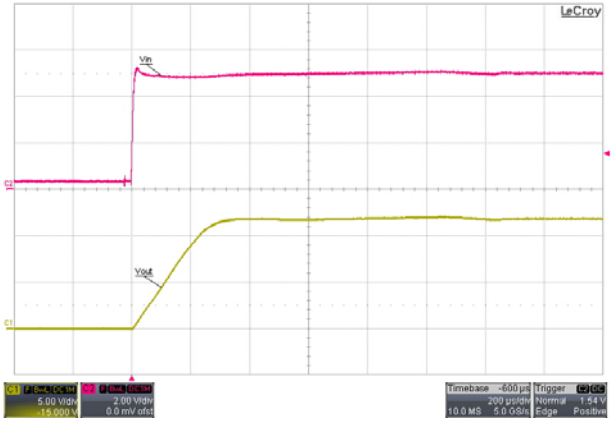

Efficiency Versus Output Current



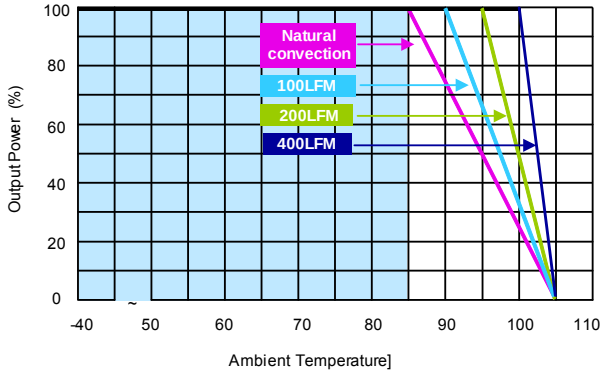

Efficiency Versus Input Voltage. Full Load



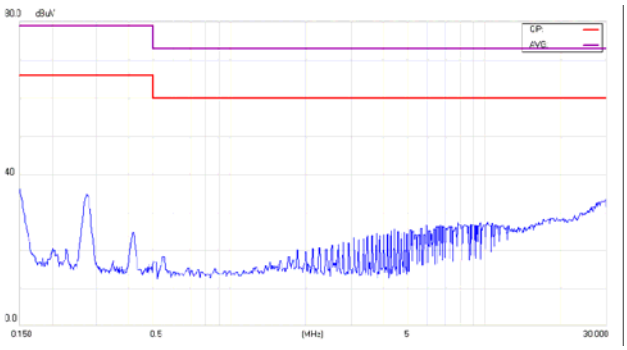

Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



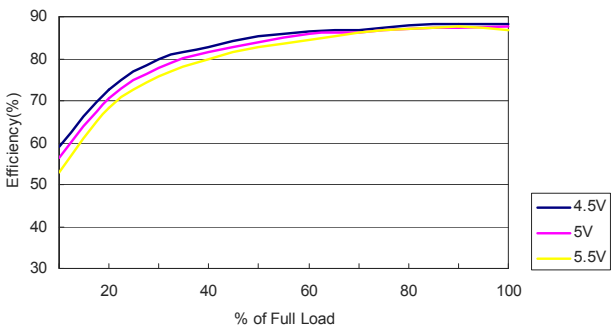

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



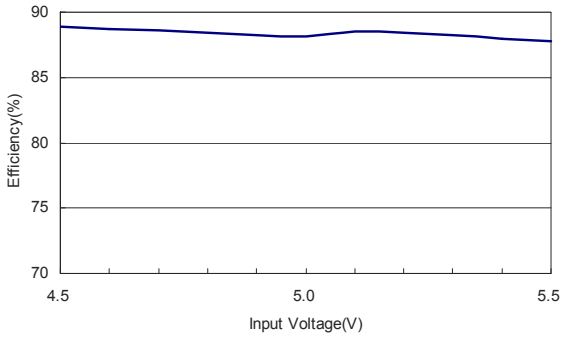
Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

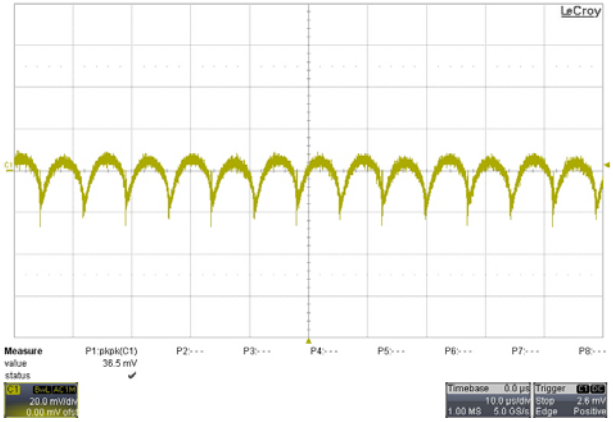
All test conditions are at 25°C. The figures are identical for TRV 1-0513



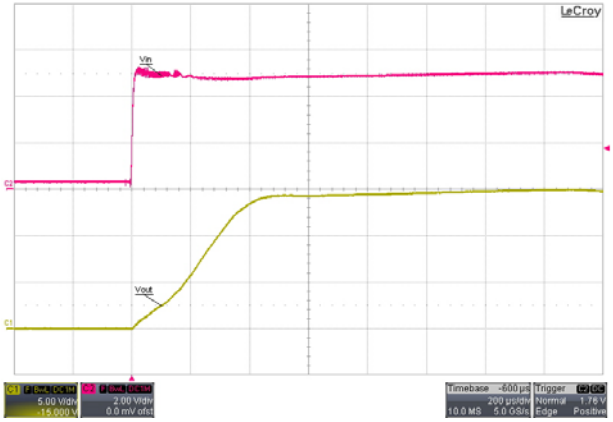

Efficiency Versus Output Current



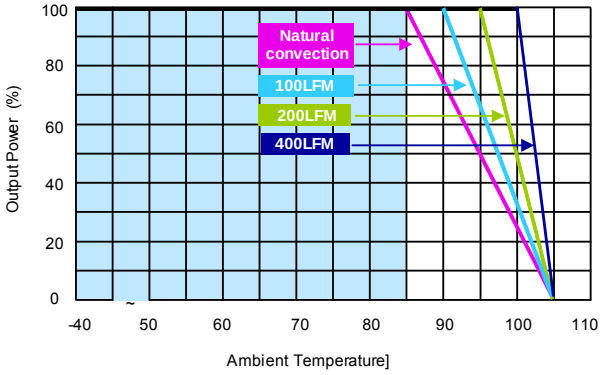

Efficiency Versus Input Voltage. Full Load



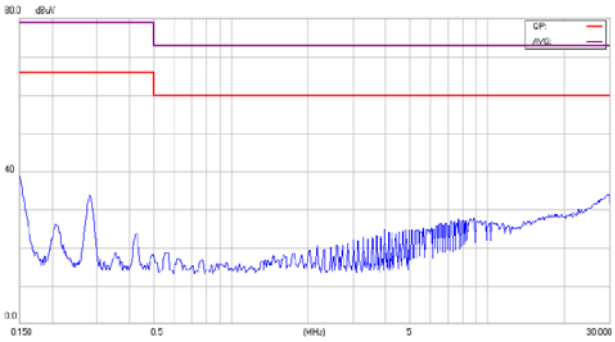

Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



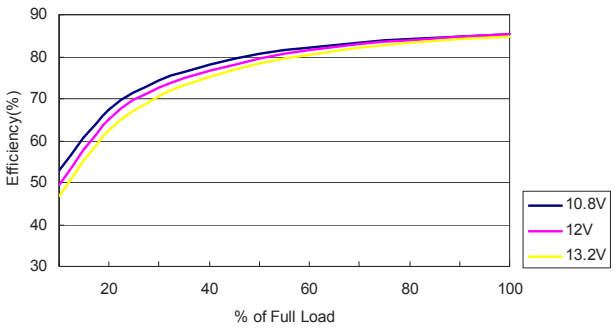

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



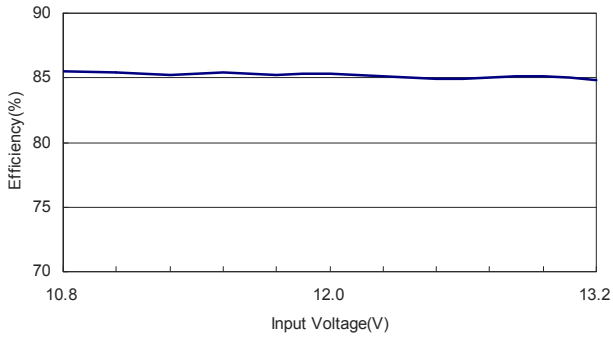
Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

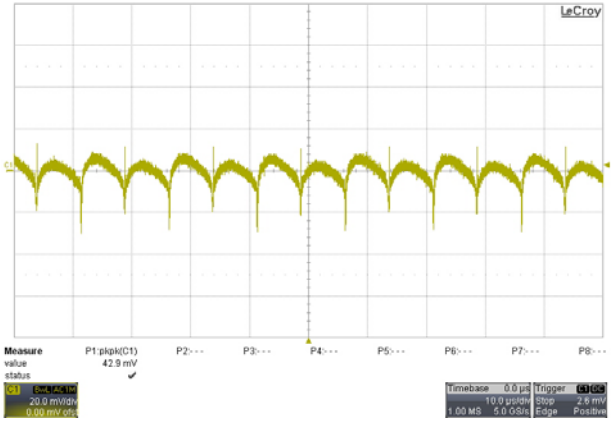
All test conditions are at 25°C. The figures are identical for TRV 1-1211



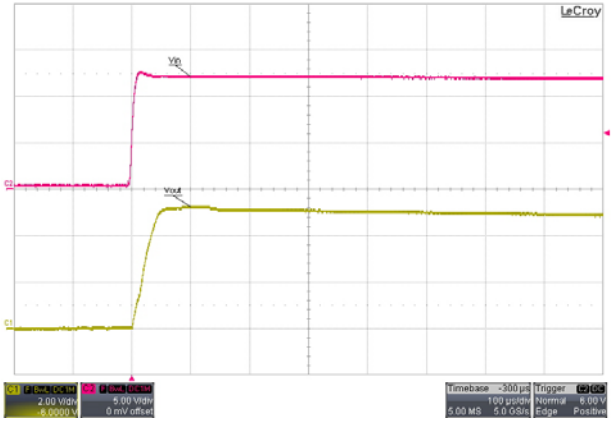

Efficiency Versus Output Current



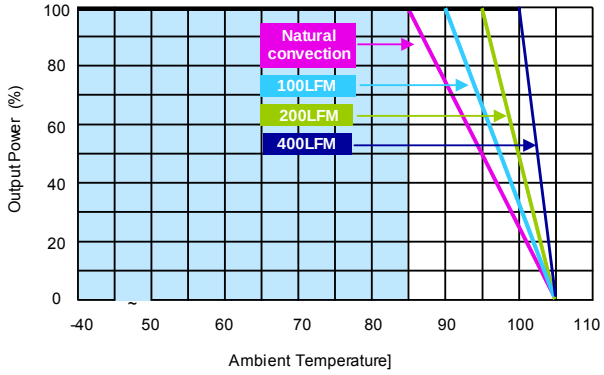

Efficiency Versus Input Voltage. Full Load



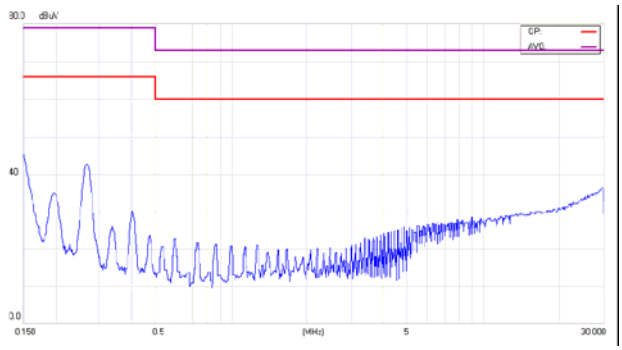

Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



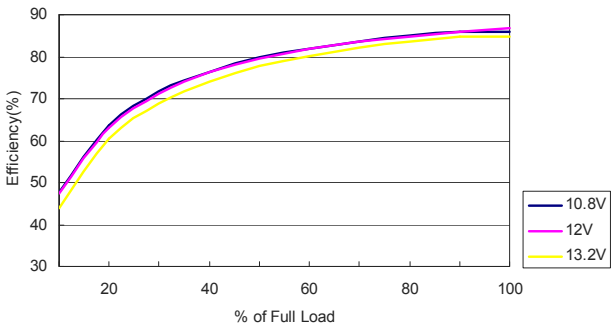

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



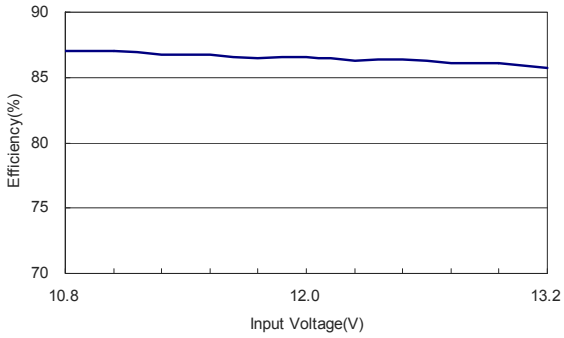

Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

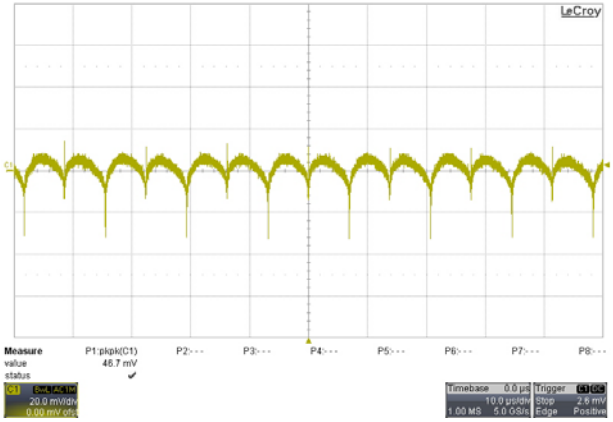
All test conditions are at 25°C. The figures are identical for TRV 1-1219




Efficiency Versus Output Current

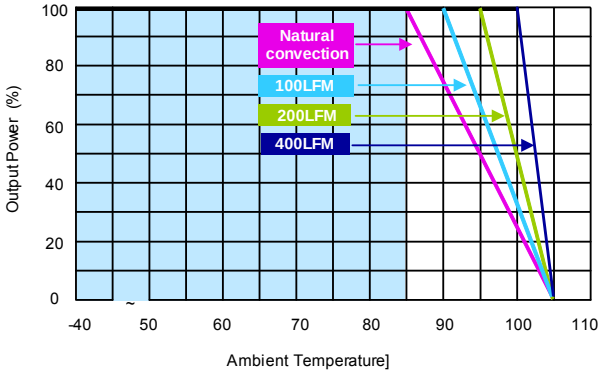



Efficiency Versus Input Voltage. Full Load

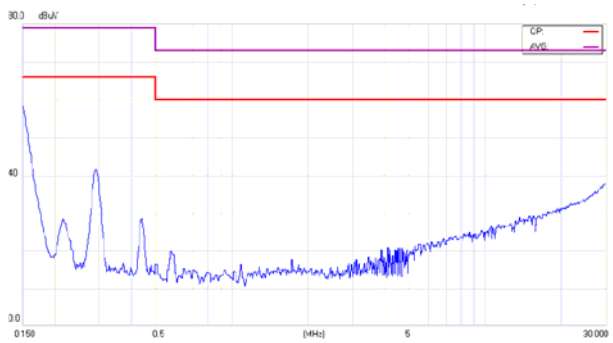



Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$


Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



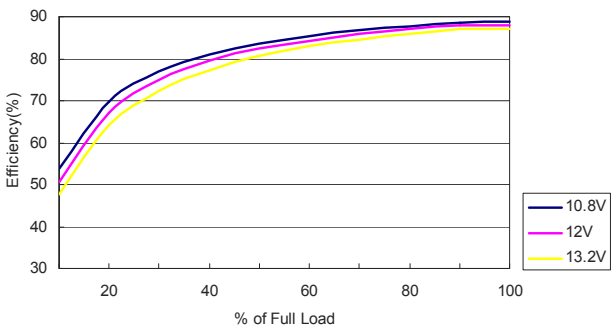

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



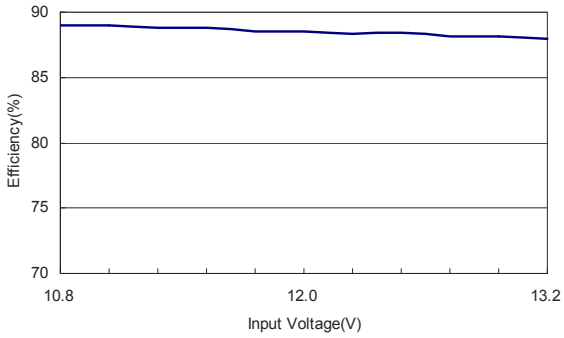
Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

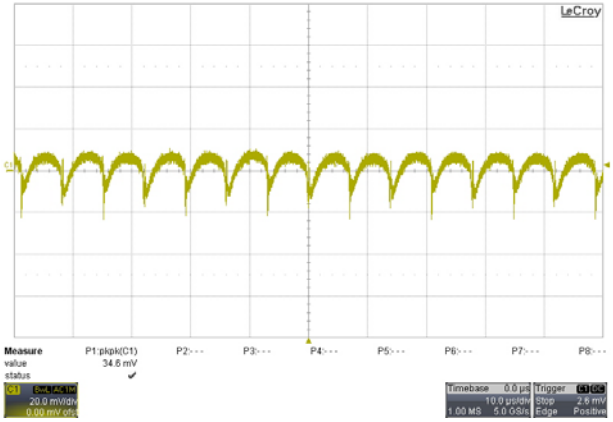
All test conditions are at 25°C. The figures are identical for TRV 1-1212



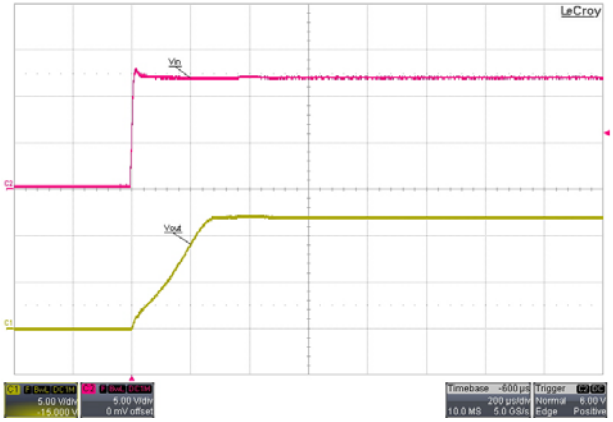

Efficiency Versus Output Current



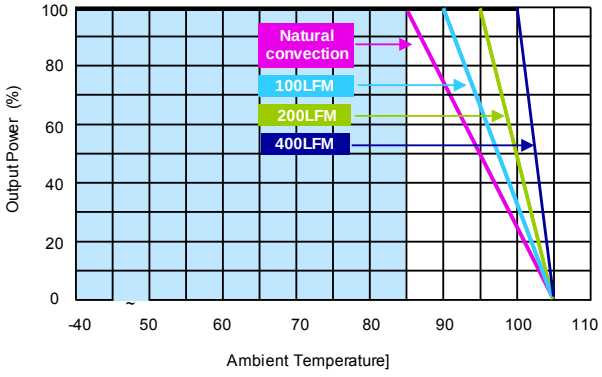

Efficiency Versus Input Voltage. Full Load



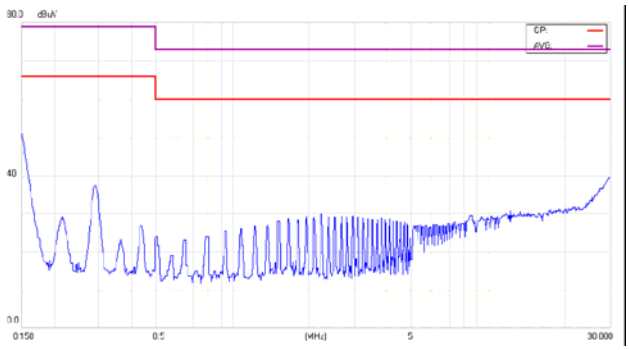

Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



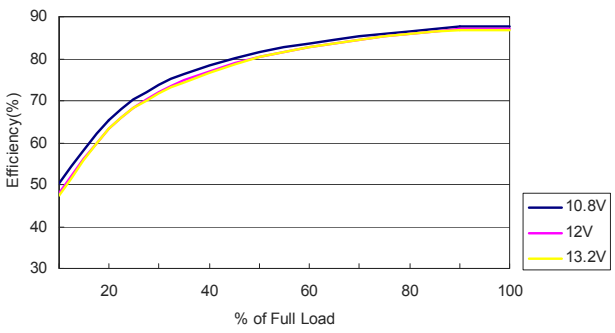

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in} = V_{in\ nom}$



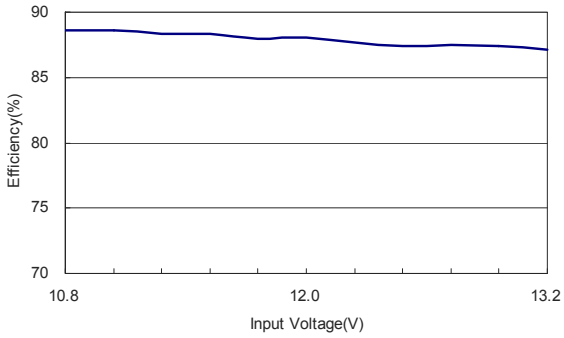
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load

## Characteristic Curves

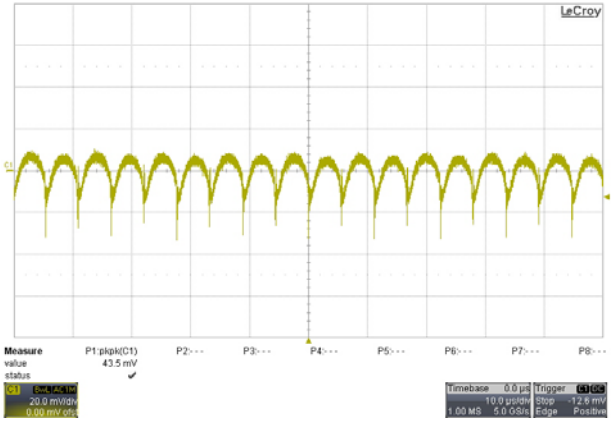
All test conditions are at 25°C. The figures are identical for TRV 1-1213




Efficiency Versus Output Current

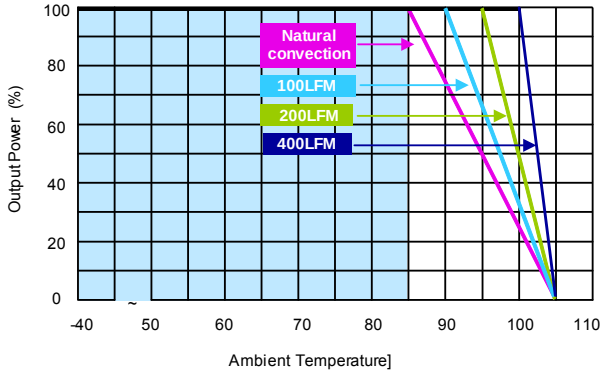



Efficiency Versus Input Voltage. Full Load

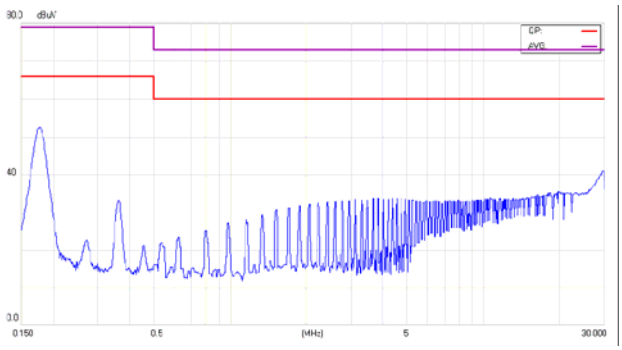



Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$


Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



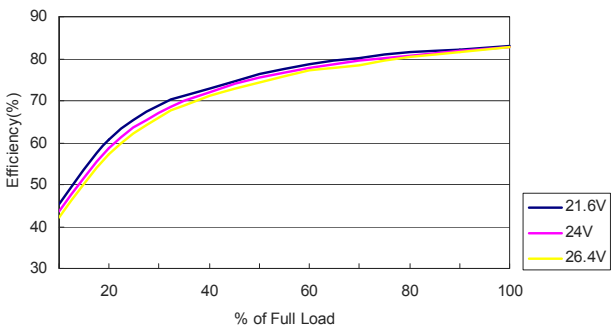

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



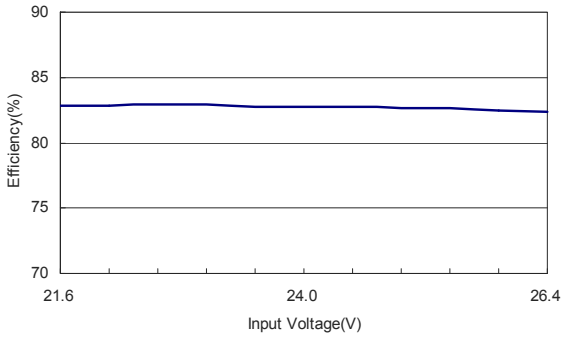
Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

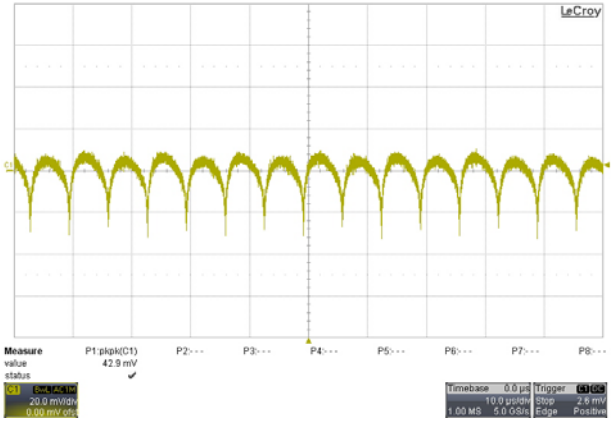
All test conditions are at 25°C. The figures are identical for TRV 1-2411



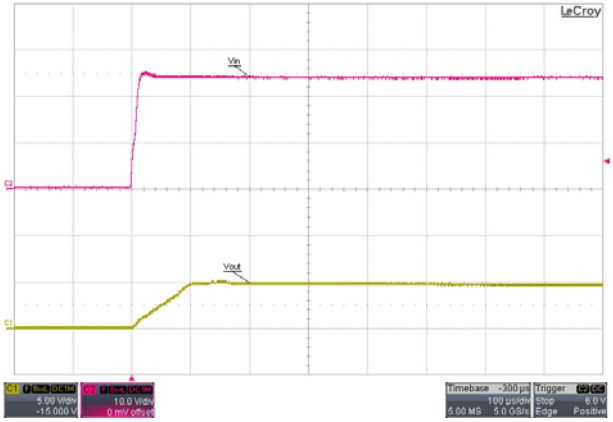

Efficiency Versus Output Current



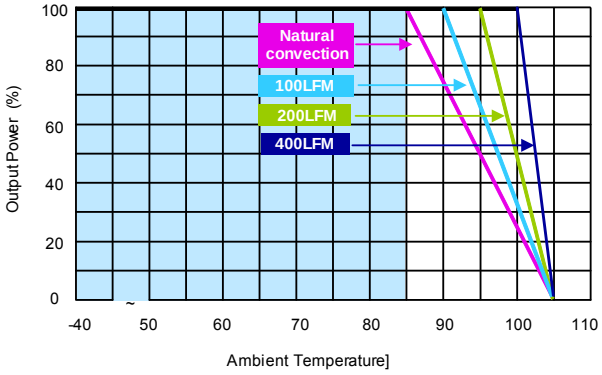

Efficiency Versus Input Voltage. Full Load



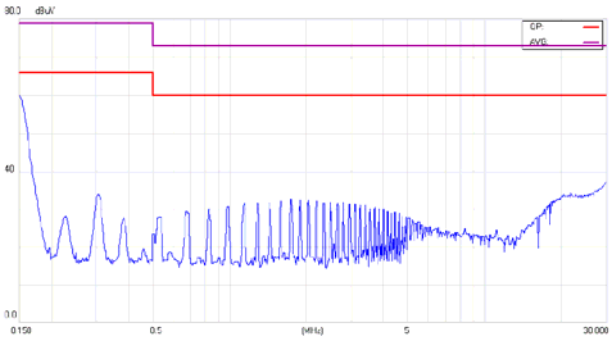

Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



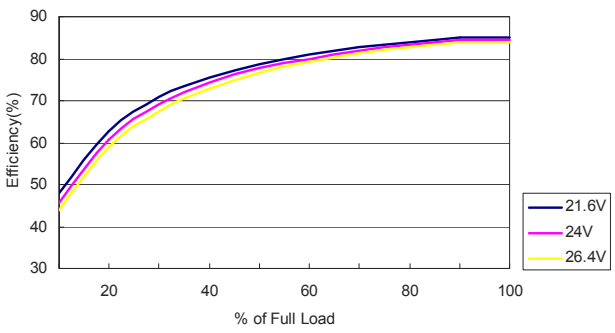

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



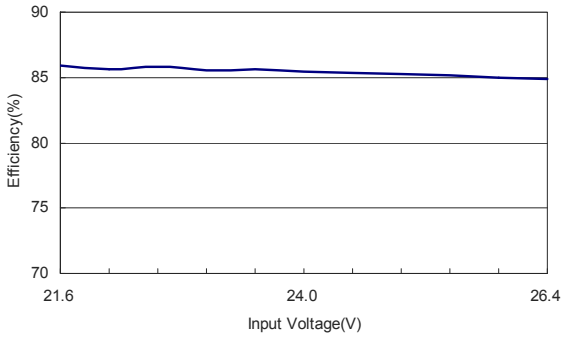
Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

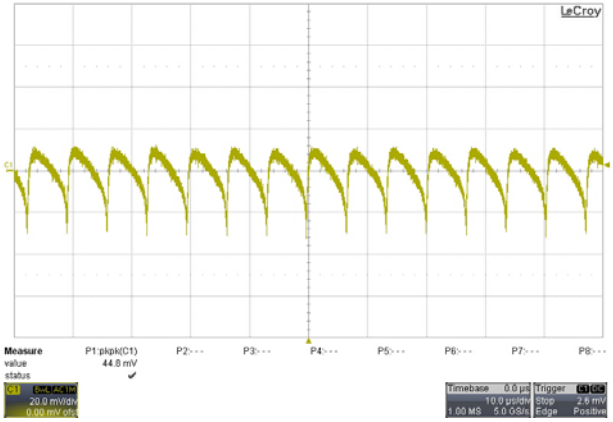
All test conditions are at 25°C. The figures are identical for TRV 1-2419



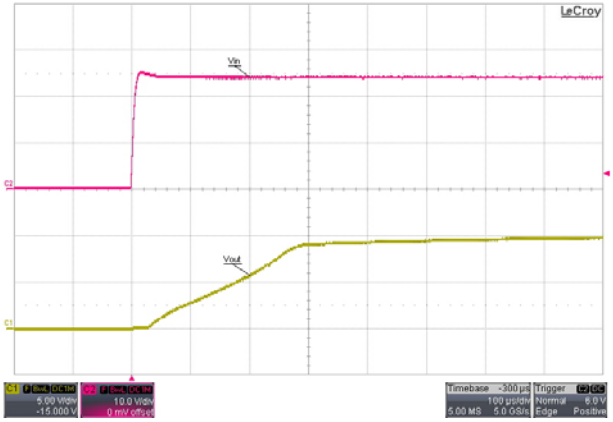

Efficiency Versus Output Current



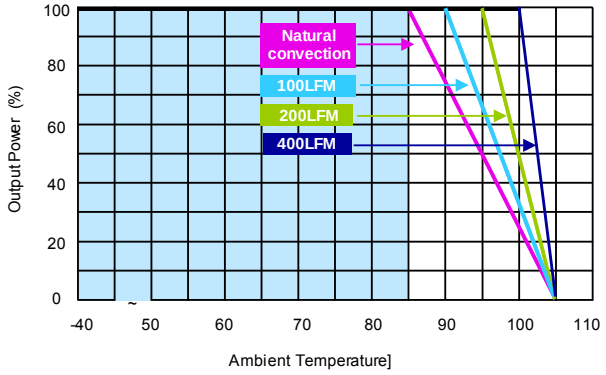

Efficiency Versus Input Voltage. Full Load



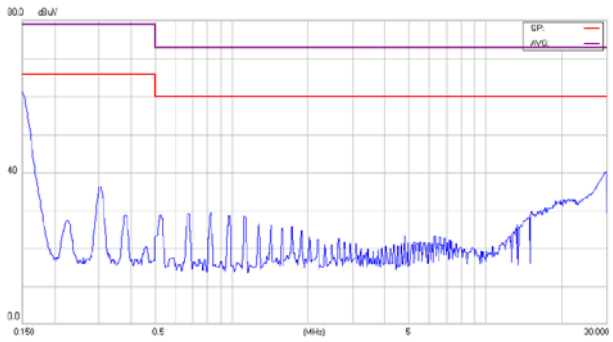

Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



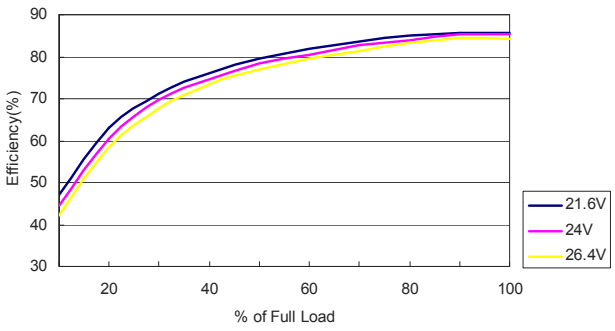

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



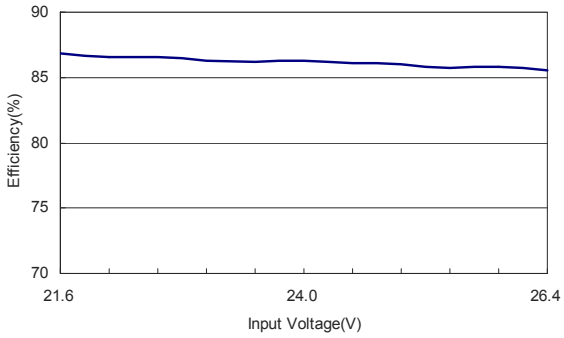
Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

## Characteristic Curves

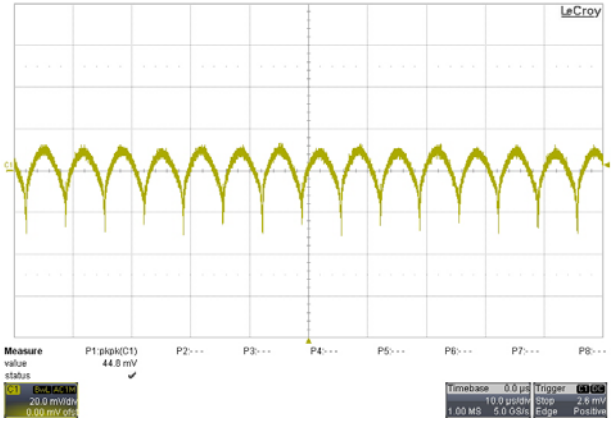
All test conditions are at 25°C. The figures are identical for TRV 1-2412



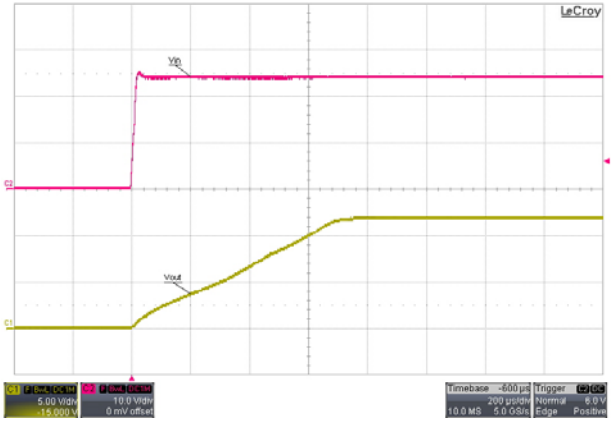

Efficiency Versus Output Current



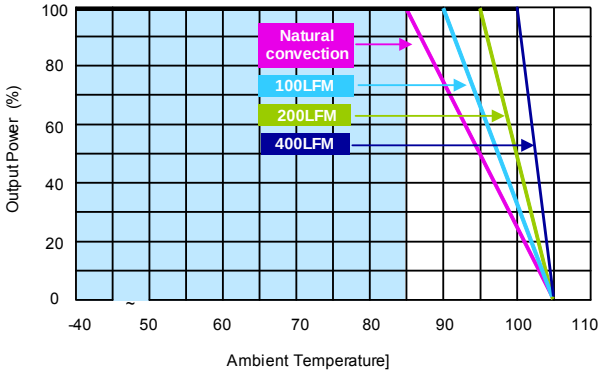

Efficiency Versus Input Voltage. Full Load



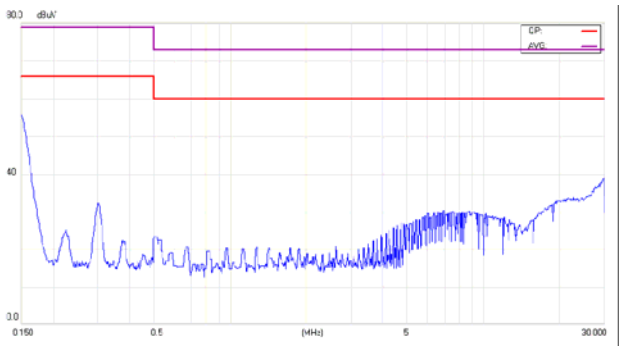

Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



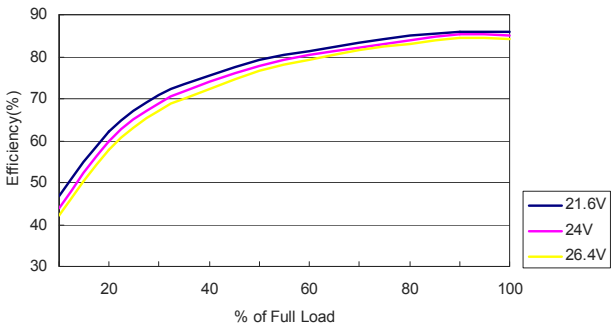

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in} = V_{in\ nom}$



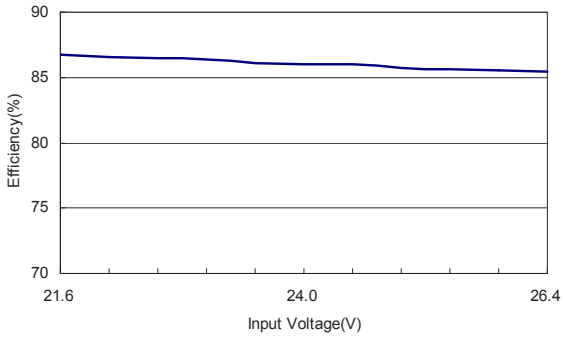
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load

## Characteristic Curves

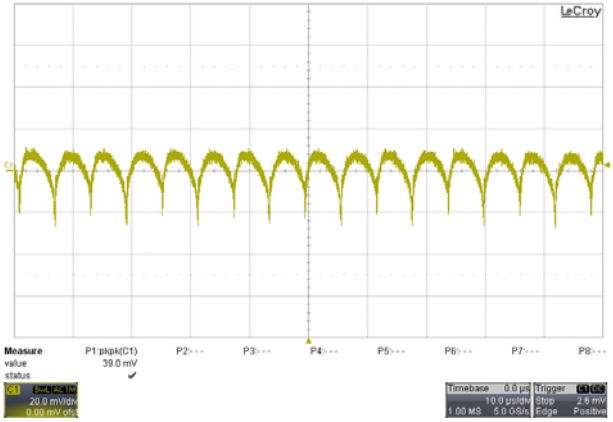
All test conditions are at 25°C. The figures are identical for TRV 1-2413



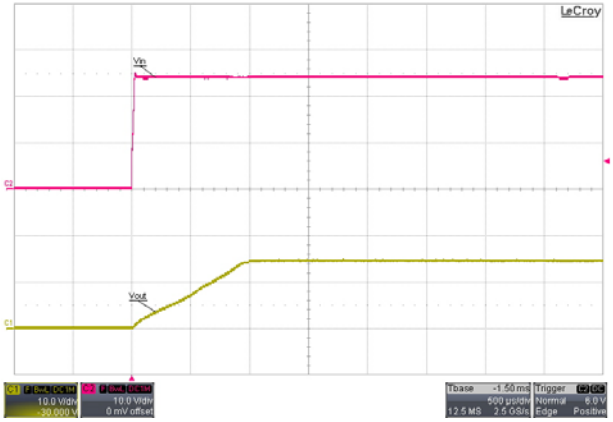

Efficiency Versus Output Current



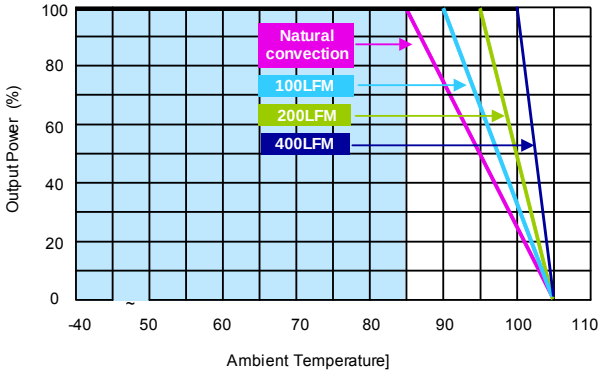

Efficiency Versus Input Voltage. Full Load



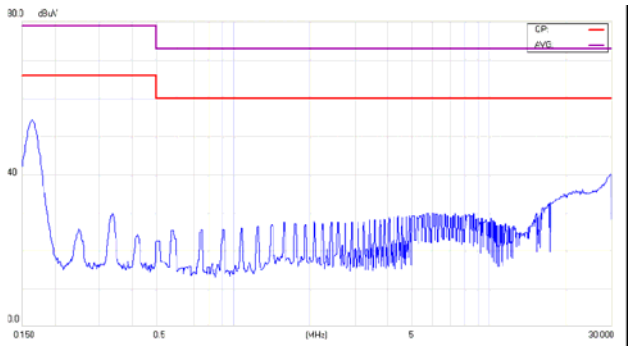

Typical Output Ripple and Noise.
$V_{in}$ = $V_{in\ nom}$; Full Load; $T_A$




Typical Input Start-Up and Output Rise Characteristic
$V_{in}$ = $V_{in\ nom}$; Full Load



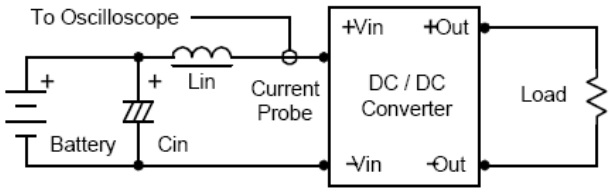

Derating Output Current Versus Ambient Temperature and Airflow; $V_{in}$ = $V_{in\ nom}$



Conduction Emission of EN55022 Class A
$V_{in}$ = $V_{in\ nom}$; Full Load

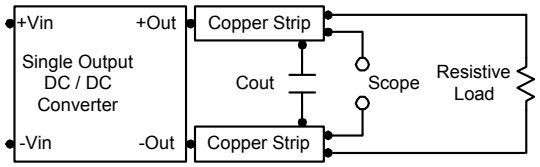
## Testing Configurations

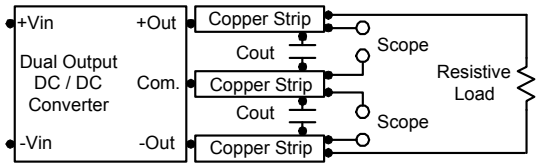
### Input reflected-ripple current measurement test up

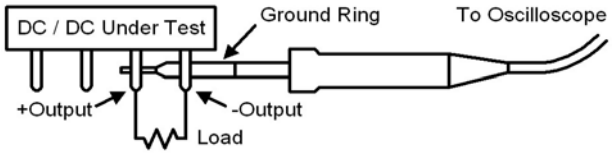



| Component | Value | Reference |
|---|---|---|
| L | 10µH | ----- |
| C | 1µF (ESR<1.0Ω at 100KHz) | Aluminum Electrolytic Capacitor |

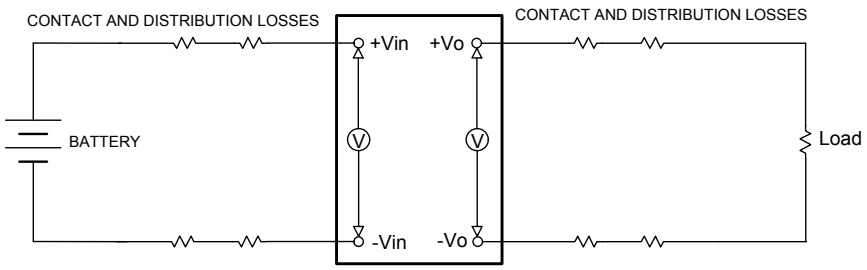
### Peak-to-peak output ripple & noise measurement test up



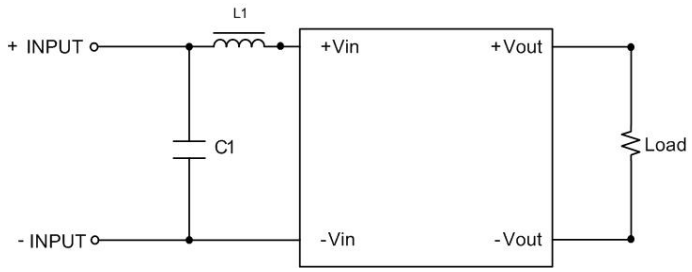




### Output voltage and efficiency measurement test up

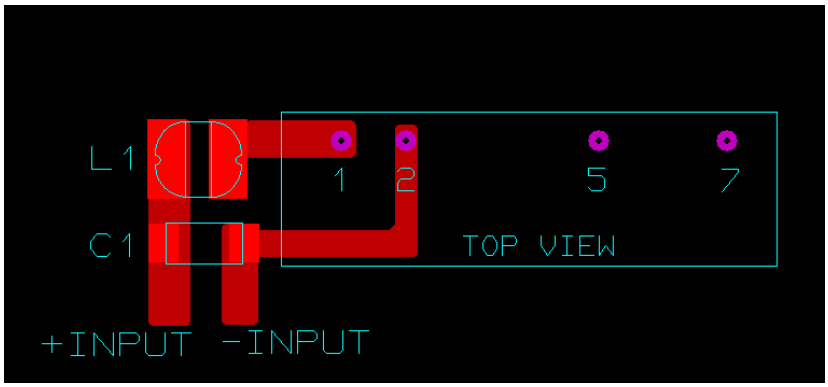



$$Efficiency = \left( \frac{V_{out} \times I_{out}}{V_{in} \times I_{in}} \right) \times 100\% = [\%]$$

## EMC considerations




Recommended circuit to comply EN55022 Class A Limits

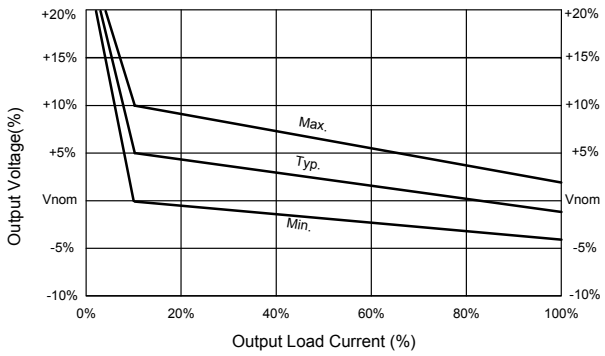



Recommended PCB Layout with Input Filter

To: comply with EN 55022 Class A following components are recommended:

| Model | Component | Value |
|---|---|---|
| TRV 1-05xx & TRV 1-12xx | C1 | 1µF/25V 1206 MLCC |
| | L1 | 12µH SR0302MS/0.75A |
| TRV 1-24xx | C1 | 4.7µF/50V 1206 MLCC |
| | L1 | 6.8µH SCD03021T/0.85A |

## Tolerance Envelopes Graph

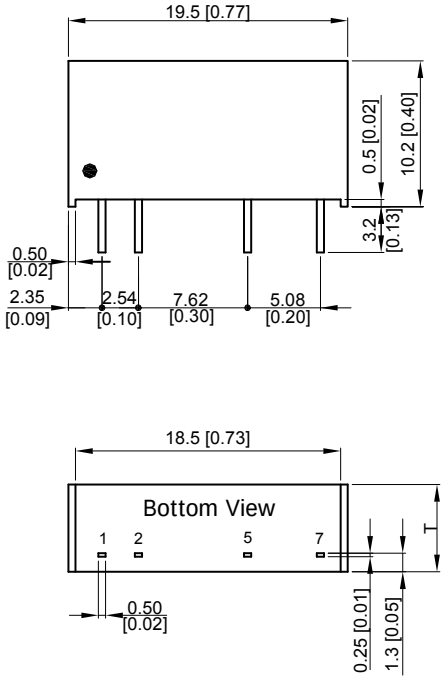



## Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup.

Capacitor mounted close to the power module helps ensure stability of the unit, it is recommended to use a good high quality low Equivalent Series Resistance (ESR < 1.0Ω at 100 KHz) capacitor of a 2.2µF for the 5V input devices, a 1.0µF for the 12V input devices and a 0.47µF for the 24V devices.

## Mechanical Dimensions



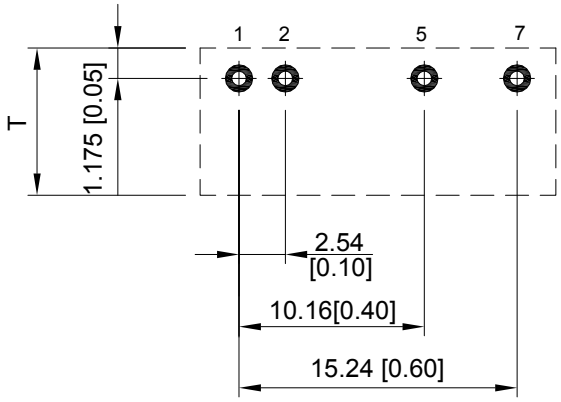

| Pin Connections | |
|---|---|
| Pin | Function |
| 1 | +Vin |
| 2 | -Vin |
| 5 | -Vout |
| 7 | +Vout |

T = 6.1mm [0.24”] for 5V & 12V Input Models
T = 7.1mm [0.28”] for 24V Input Models

Weight: 2.2g (5V & 12V Input Models)
2.6g (24V Input Models)

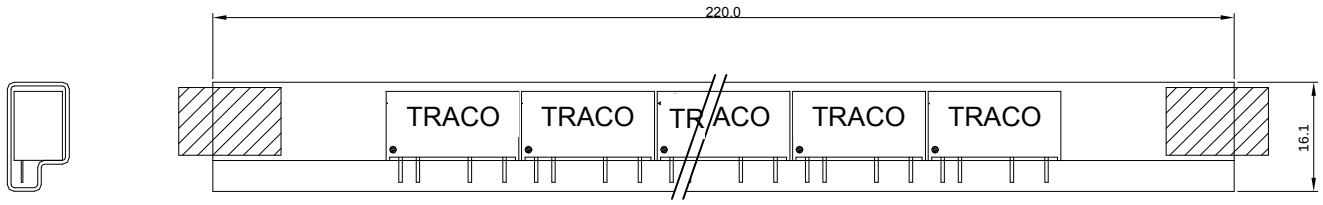
1. All dimensions in mm (inches)
   Tolerance: X.X ±0.25 (X.XX ±0.01”)
   X.XX ±0.13 (X.XXX ±0.005”)
2. Pin pitch tolerance: ±0.25 (±0.01”)
3. Pin dimension tolerance: ±0.1 (±0.004”)

## Recommended Pad Layout for Single & Dual Output Converter




1. All dimensions in Inches (mm)
   Tolerance: x.xx ±0.02” (x.x ±0.5mm)
   x.xxx ±0.01” (x.xx ±0.25mm)
2. Pin pitch tolerance: ±0.01” (±0.25mm)
3. Pin dimension tolerance: ±0.004” (±0.1mm)

## Packaging Information

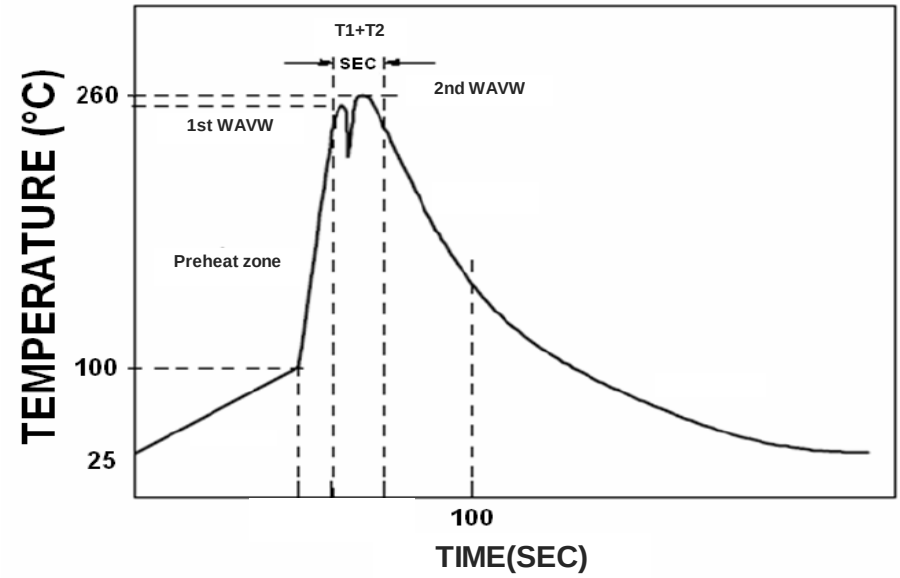



unit:mm

10 PCS per TUBE

## Soldering and Reflow Considerations

Lead free wave solder profile for TRV 1 Series



## Part Number Structure

| Model Number | Input Range (Vdc) | Output Voltage (Vdc) | Max. Output Current (mA) | Input Current at Full Load[1] (mA) | Efficiency[2] (%) |
|---|---|---|---|---|---|
| TRV 1-0511 | 4.5 – 5.5 | 5 | 200 | 238 | 84 |
| TRV 1-0519 | 4.5 – 5.5 | 9 | 110 | 229 | 86.5 |
| TRV 1-0512 | 4.5 – 5.5 | 12 | 84 | 231 | 87 |
| TRV 1-0513 | 4.5 – 5.5 | 15 | 67 | 230 | 87.5 |
| TRV 1-1211 | 10.8 – 13.2 | 5 | 200 | 99 | 84 |
| TRV 1-1219 | 10.8 – 13.2 | 9 | 110 | 96 | 86 |
| TRV 1-1212 | 10.8 – 13.2 | 12 | 84 | 95 | 88 |
| TRV 1-1213 | 10.8 – 13.2 | 15 | 67 | 95 | 88 |
| TRV 1-2411 | 21.6 – 26.4 | 5 | 200 | 50 | 84 |
| TRV 1-2419 | 21.6 – 26.4 | 9 | 110 | 48 | 86.5 |
| TRV 1-2412 | 21.6 – 26.4 | 12 | 84 | 48 | 87.5 |
| TRV 1-2413 | 21.6 – 26.4 | 15 | 67 | 48 | 87.5 |

Note 1. Maximum value at nominal input voltage and full load of standard type.

Note 2. Typical value at nominal input voltage and full load.

## Safety and Installation Instruction

**Fusing Consideration**

**Caution**: This power module is not internally fused. An input line fuse must always be used.

This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of sophisticated power architecture. To maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a normal-blow fuse with following maximum ratings: TRV 1-05xx → 500mA, TRV 1-12xx → 200mA and TRV 1-24xx → 100mA. Based on the information provided in this data sheet on Inrush energy and maximum dc input current; the same type of fuse with lower rating can be used. Refer to the fuse manufacturer's data for further information.

## MTBF and Reliability

The MTBF of TRV 1 series of DC/DC converters has been calculated using:

MIL-HDBK 217F NOTICE2, Operating Temperature 25°C, Ground Benign.

| Model | MTBF | Unit |
|---|---|---|
| TRV 1-0511 | 5,301,524 | Hours |
| TRV 1-0519 | 3,944,773 | Hours |
| TRV 1-0512 | 2,857,143 | Hours |
| TRV 1-0513 | 2,343,292 | Hours |
| TRV 1-1211 | 5,333,334 | Hours |
| TRV 1-1219 | 3,962,358 | Hours |
| TRV 1-1212 | 2,865,330 | Hours |
| TRV 1-1213 | 2,348,796 | Hours |
| TRV 1-2411 | 4,901,961 | Hours |
| TRV 1-2419 | 3,838,771 | Hours |
| TRV 1-2412 | 2,737,850 | Hours |
| TRV 1-2413 | 2,262,443 | Hours |