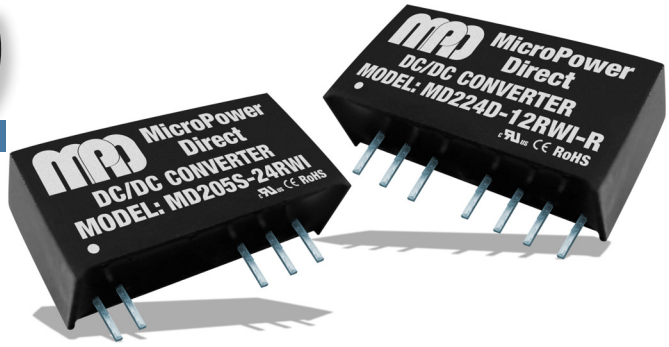
# MD200RW(I)

## 2W High Isolation, Single & Dual Output DC/DC Converters




### Key Features:

- 2W Output Power
- 1 kV to 3 kV Isolation
- UL 62368 Approved
- Miniature SIP Case
- Short Circuit Protection
- Efficiency to 81%
- -40°C to +85°C Operation
- Wide 2:1 Input Range
- Remote On/Off Control

### Electrical Specifications

Specifications typical @ +25°C, nominal input voltage & rated output current, unless otherwise noted. Specifications subject to change without notice.

**Input**

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Input Voltage Range | 5 VDC Input | 4.5 | 5.0 | 9.0 | VDC |
| | 12 VDC Input | 9.0 | 12.0 | 18.0 | |
| | 24 VDC Input | 18.0 | 24.0 | 36.0 | |
| | 48 VDC Input | 36.0 | 48.0 | 72.0 | |
| Input Reflected Ripple | | | 35.0 | | mA Pk-Pk |
| Input Filter | Capacitor Filter | | | | |

**Output**

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Output Voltage Accuracy | | | | ±2.0 | % |
| Line Regulation | For VIN Change of 1% | | | ±0.5 | % |
| Load Regulation | See Note 2 | | | ±1.0 | % |
| Cross Regulation | See Note 3 | | | | |
| Ripple & Noise (20 MHz) | | | | 80 | mV P - P |
| Temperature Coefficient | | | ±0.02 | | %/°C |
| Output Short Circuit | Continuous (Autorecovery) | | | | |

**General**

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Isolation Voltage | Standard Model | 1,000 | | | VDC |
| | High Isolation "I" Suffix | 3,000 | | | |
| Isolation Resistance | | 1,000 | | | MΩ |
| Isolation Capacitance | | | | 60 | pF |
| Switching Frequency | | 100 | | 650 | kHz |

**EMI Characteristics**, See Note 4

| Parameter | Standard | Criteria | Level |
|---|---|---|---|
| Radiated Emissions | EN 55032 | | Class A |
| Conducted Emissions | EN 55032 | | Class A |
| ESD | EN 61000-4-2 | A | ±8kV Air |
| | | | ±6 kV Contact |
| RS | EN 61000-4-3 | A | 10V/m |
| EFT | EN 61000-4-4 | A | ±2 kV |
| Surge | EN 61000-4-5 | A | ±1 kV L-L |
| CS | EN 61000-4-6 | A | 10 Vrms |
| PFMF | EN 61000-4-8 | A | 1A/m |

**Environmental**

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Operating Temperature Range | Ambient | -40 | +25 | +85 | °C |
| | Case | | | +100 | |
| Storage Temperature Range | | -40 | | +125 | °C |
| Cooling | Free Air Convection | | | | |
| Humidity | RH, Non-condensing | | | 95 | % |

**Physical**

| | |
|---|---|
| Case Size | 0.86 x 0.36 x 0.44 in. (See Mechanical Diagram on Page 6) |
| Case Material | Non-Conductive Black Plastic (UL94-V0) |
| Weight | 0.156 Oz (4.5g) (See Mechanical Diagram on Page 6) |

**Reliability Specifications**

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| MTBF | MIL HDBK 217F, 25°C, Gnd Benign | 1.61 | | | MHours |
| Safety Standards | UL/cUL 62368-1 Recognition (UL Certificate) | | | | |

**Absolute Maximum Ratings**

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Input Voltage Surge (0.1 Sec) | 5 VDC Input | | | 12.0 | VDC |
| | 12 VDC Input | | | 24.0 | |
| | 24 VDC Input | | | 40.0 | |
| | 48 VDC Input | | | 80.0 | |
| Lead Temperature | 1.5 mm From Case for 10 Sec | | | 260 | °C |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## Model Selection Guide

| Model Number | Input | | | | Output | | | Efficiency (%, Typ) | Capacitive Load (µF, Max) | Fuse Rating Slow-Blow (mA) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Voltage (VDC) | | Current (mA) | | Voltage (VDC) | Current (mA, Max) | Current (mA, Min) | | | |
| | Nominal | Range | Full-Load | No-Load | | | | | | |
| MD205S-03RW(I)(-R) | 5.0 | 4.5 - 9.0 | 508 | 20 | 3.3 | 500 | 125 | 65 | 3,300 | 1,000 |
| MD205S-05RW(I)(-R) | 5.0 | 4.5 - 9.0 | 588 | 25 | 5.0 | 400 | 100 | 68 | 3,300 | 1,000 |
| MD205S-09RW(I)(-R) | 5.0 | 4.5 - 9.0 | 555 | 50 | 9.0 | 222 | 56 | 72 | 470 | 1,000 |
| MD205S-12RW(I)(-R) | 5.0 | 4.5 - 9.0 | 563 | 85 | 12.0 | 167 | 42 | 71 | 470 | 1,000 |
| MD205S-15RW(I)(-R) | 5.0 | 4.5 - 9.0 | 555 | 30 | 15.0 | 133 | 33 | 72 | 470 | 1,000 |
| MD205S-24RW(I)(-R) | 5.0 | 4.5 - 9.0 | 555 | 70 | 24.0 | 83 | 21 | 72 | 220 | 1,000 |
| MD205D-03RW(I)(-R) | 5.0 | 4.5 - 9.0 | 493 | 25 | ±3.3 | ±250 | ±63 | 67 | 1,000 | 1,000 |
| MD205D-05RW(I)(-R) | 5.0 | 4.5 - 9.0 | 493 | 35 | ±5.0 | ±200 | ±50 | 67 | 1,000 | 1,000 |
| MD205D-09RW(I)(-R) | 5.0 | 4.5 - 9.0 | 548 | 30 | ±9.0 | ±111 | ±28 | 73 | 220 | 1,000 |
| MD205D-12RW(I)(-R) | 5.0 | 4.5 - 9.0 | 548 | 35 | ±12.0 | ±83 | ±21 | 73 | 220 | 1,000 |
| MD205D-15RW(I)(-R) | 5.0 | 4.5 - 9.0 | 556 | 40 | ±15.0 | ±67 | ±17 | 72 | 220 | 1,000 |
| MD205D-24RW(I)(-R) | 5.0 | 4.5 - 9.0 | 580 | 120 | ±24.0 | ±42 | ±10 | 69 | 100 | 1,000 |
| MD212S-03RW(I)(-R) | 12 | 9.0 - 18.0 | 196 | 15 | 3.3 | 500 | 125 | 70 | 3,300 | 500 |
| MD212S-05RW(I)(-R) | 12 | 9.0 - 18.0 | 216 | 10 | 5.0 | 400 | 100 | 77 | 3,300 | 500 |
| MD212S-09RW(I)(-R) | 12 | 9.0 - 18.0 | 214 | 15 | 9.0 | 222 | 56 | 78 | 470 | 500 |
| MD212S-12RW(I)(-R) | 12 | 9.0 - 18.0 | 216 | 15 | 12.0 | 167 | 42 | 77 | 470 | 500 |
| MD212S-15RW(I)(-R) | 12 | 9.0 - 18.0 | 210 | 15 | 15.0 | 133 | 33 | 79 | 470 | 500 |
| MD212S-24RW(I)(-R) | 12 | 9.0 - 18.0 | 214 | 25 | 24.0 | 83 | 21 | 78 | 220 | 500 |
| MD212D-03RW(I)(-R) | 12 | 9.0 - 18.0 | 196 | 15 | ±3.3 | ±250 | ±63 | 70 | 1,000 | 500 |
| MD212D-05RW(I)(-R) | 12 | 9.0 - 18.0 | 228 | 20 | ±5.0 | ±200 | ±50 | 73 | 1,000 | 500 |
| MD212D-09RW(I)(-R) | 12 | 9.0 - 18.0 | 210 | 20 | ±9.0 | ±111 | ±28 | 79 | 220 | 500 |
| MD212D-12RW(I)(-R) | 12 | 9.0 - 18.0 | 210 | 15 | ±12.0 | ±83 | ±21 | 79 | 220 | 500 |
| MD212D-15RW(I)(-R) | 12 | 9.0 - 18.0 | 210 | 20 | ±15.0 | ±67 | ±17 | 79 | 220 | 500 |
| MD212D-24RW(I)(-R) | 12 | 9.0 - 18.0 | 219 | 35 | ±24.0 | ±42 | ±10 | 76 | 100 | 500 |
| MD224S-03RW(I)(-R) | 24 | 18.0 - 36.0 | 94 | 8 | 3.3 | 500 | 125 | 73 | 3,300 | 200 |
| MD224S-05RW(I)(-R) | 24 | 18.0 - 36.0 | 108 | 8 | 5.0 | 400 | 100 | 77 | 3,300 | 200 |
| MD224S-09RW(I)(-R) | 24 | 18.0 - 36.0 | 107 | 10 | 9.0 | 222 | 56 | 78 | 470 | 200 |
| MD224S-12RW(I)(-R) | 24 | 18.0 - 36.0 | 105 | 12 | 12.0 | 167 | 42 | 79 | 470 | 200 |
| MD224S-15RW(I)(-R) | 24 | 18.0 - 36.0 | 104 | 12 | 15.0 | 133 | 33 | 80 | 470 | 200 |
| MD224S-24RW(I)(-R) | 24 | 18.0 - 36.0 | 105 | 15 | 24.0 | 83 | 21 | 79 | 220 | 200 |
| MD224D-03RW(I)(-R) | 24 | 18.0 - 36.0 | 97 | 8 | ±3.3 | ±250 | ±63 | 71 | 1,000 | 200 |
| MD224D-05RW(I)(-R) | 24 | 18.0 - 36.0 | 108 | 8 | ±5.0 | ±200 | ±50 | 77 | 1,000 | 200 |
| MD224D-09RW(I)(-R) | 24 | 18.0 - 36.0 | 108 | 8 | ±9.0 | ±111 | ±28 | 77 | 220 | 200 |
| MD224D-12RW(I)(-R) | 24 | 18.0 - 36.0 | 102 | 8 | ±12.0 | ±83 | ±21 | 81 | 220 | 200 |
| MD224D-15RW(I)(-R) | 24 | 18.0 - 36.0 | 105 | 12 | ±15.0 | ±67 | ±17 | 80 | 220 | 200 |
| MD224D-24RW(I)(-R) | 24 | 18.0 - 36.0 | 107 | 25 | ±24.0 | ±42 | ±10 | 78 | 100 | 200 |
| MD248S-03RW(I)(-R) | 48 | 36.0 - 72.0 | 50 | 6 | 3.3 | 500 | 125 | 69 | 3,300 | 100 |
| MD248S-05RW(I)(-R) | 48 | 36.0 - 72.0 | 55 | 6 | 5.0 | 400 | 100 | 76 | 3,300 | 100 |
| MD248S-09RW(I)(-R) | 48 | 36.0 - 72.0 | 55 | 6 | 9.0 | 222 | 56 | 76 | 470 | 100 |
| MD248S-12RW(I)(-R) | 48 | 36.0 - 72.0 | 53 | 6 | 12.0 | 167 | 42 | 78 | 470 | 100 |
| MD248S-15RW(I)(-R) | 48 | 36.0 - 72.0 | 53 | 6 | 15.0 | 133 | 33 | 78 | 470 | 100 |
| MD248S-24RW(I)(-R) | 48 | 36.0 - 72.0 | 54 | 8 | 24.0 | 83 | 21 | 77 | 220 | 100 |
| MD248D-03RW(I)(-R) | 48 | 36.0 - 72.0 | 48 | 6 | ±3.3 | ±250 | ±63 | 71 | 1,000 | 100 |
| MD248D-05RW(I)(-R) | 48 | 36.0 - 72.0 | 57 | 6 | ±5.0 | ±200 | ±50 | 73 | 1,000 | 100 |
| MD248D-09RW(I)(-R) | 48 | 36.0 - 72.0 | 55 | 6 | ±9.0 | ±111 | ±28 | 76 | 220 | 100 |
| MD248D-12RW(I)(-R) | 48 | 36.0 - 72.0 | 53 | 6 | ±12.0 | ±83 | ±21 | 78 | 220 | 100 |
| MD248D-15RW(I)(-R) | 48 | 36.0 - 72.0 | 52 | 8 | ±15.0 | ±67 | ±17 | 80 | 220 | 100 |
| MD248D-24RW(I)(-R) | 48 | 36.0 - 72.0 | 56 | 12 | ±24.0 | ±42 | ±10 | 74 | 100 | 100 |

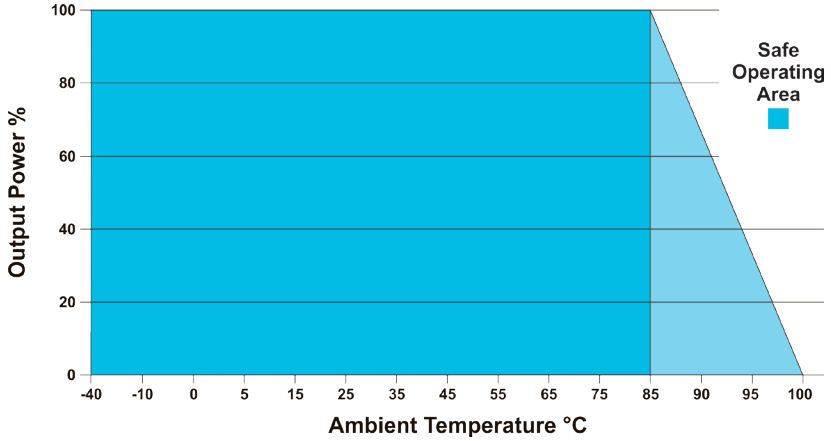
For Remote Control option, add suffix "**R**" to model number (i.e. **MD224D-05RW(I)-R**)

For High Isolation option, add suffix "**I**" to model number (i.e. **MD224D-05RWI**)

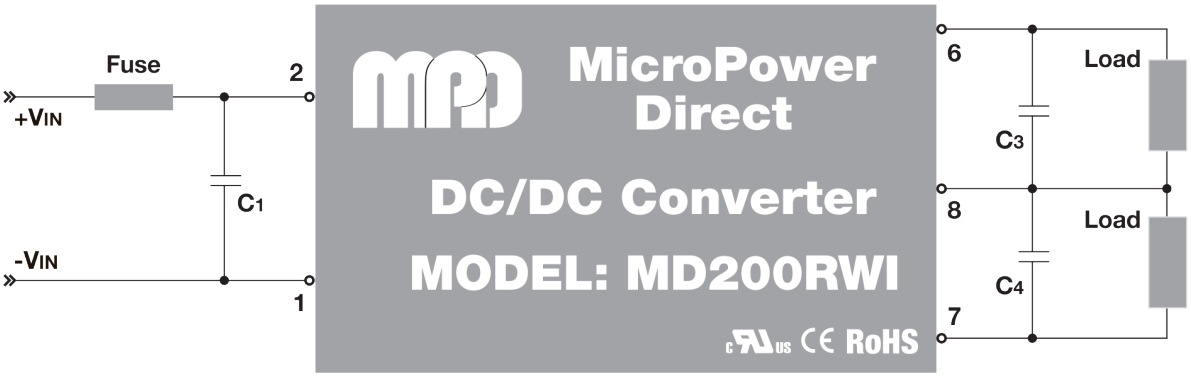
**Notes:**

1. Output capacitive load is specified for each output.
2. Load regulation is measured over a range of 25% IOUT to 100% IOUT.
3. Measured with one load changing from 25% to 100% load while the other output is at 100% load. Output voltage is set to within ±5%.
4. To meet the requirements of EN 61000-4-4 and EN 61000-4-5, external components are needed. See page 3 for a typical connection. Contact the factory for more information.
5. Operation at no-load will not damage the unit, but they may not meet all specifications.
6. It is recommended that a fuse be used on the input of a power supply for protection. See the Model Selection tables for the correct rating.

## Derating Curve

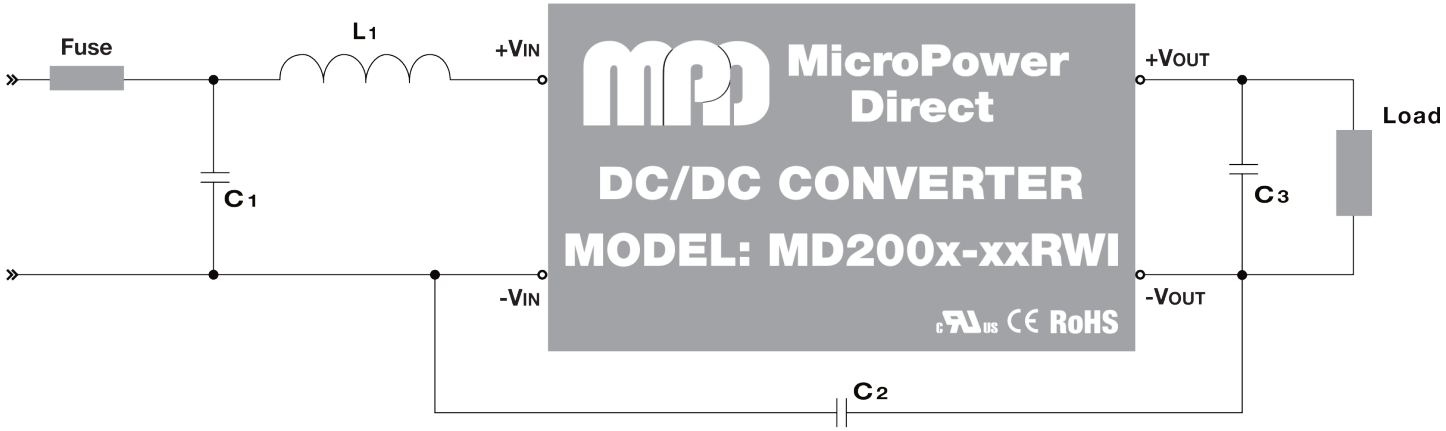


## Simple Connection




The diagram above illustrates a simple connection of the MD200RW(I) series. For applications that do not require the circuit to meet EMi/EMC specifications, the capacitors $C_1$, $C_3$ and $C_4$ will reduce input/output ripple and improve the converter stability over time and temperature. The recommended component values are 100 $\mu$F for $C_1$ and 10 $\mu$F for $C_3$ & $C_4$.

## Typical Connection



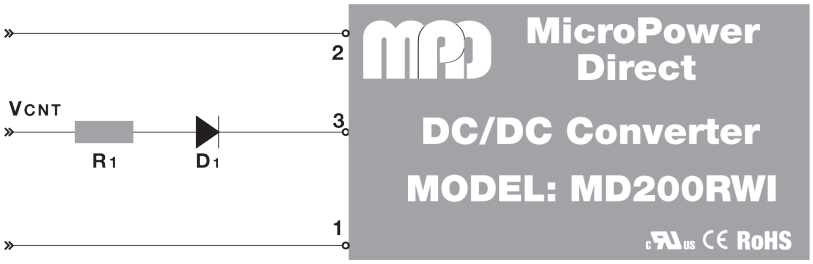

The diagram above shows a typical connection of the MD200RW(I) series for an application that requires compliance to EMI/EMC standards (as specified on page 1). Some notes on these components are:

1. An external fuse is recommended to protect the unit in the event of a fault on the input line. A recommended value is given in model selection table on page 2.
2. The output filtering capacitor ($C_3$) is a high frequency, low resistance electrolytic capacitor. Care must be taken in choosing this capacitor not to exceed the capacitive load specification for the unit. Voltage derating of capacitors should be 80% or above.
3. Suggested component values are:

| Component | Value |
|---|---|
| $C_1$ | 220 µF/100V |
| $L_1$ | 6.8 µH |
| $C_2$ | MLCC 470 pF/3 kV |
| $C_3$ | See $C_3$/$C_4$ in Table Above |

4. In many applications, simply adding input/output capacitors will enhance the input surge protection & and reduce output ripple sufficiently. In this case, the unit could be connected as shown in the simple connection above, without the other filter components. Recommended capacitor values are given above.

## Remote ON/OFF Control

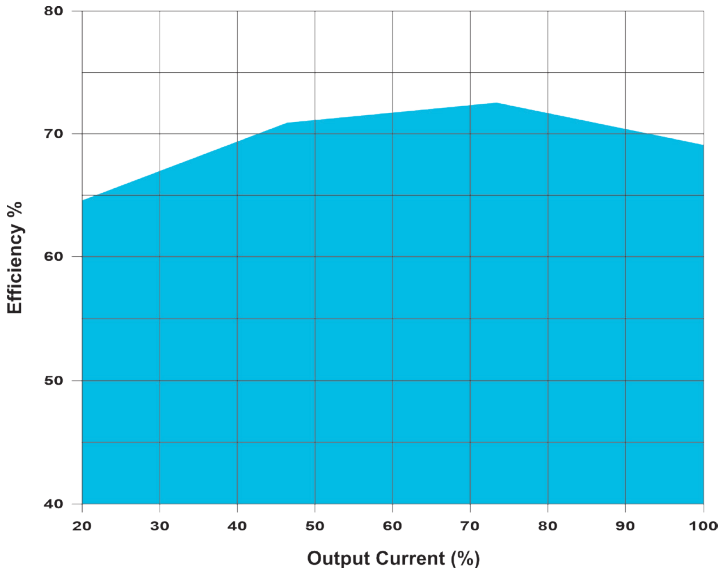



The MD200RW(I) is available with an optional remote control input. This input (pin 3) is referenced to the minus input (pin 1). The unit operates when these pins are connected or (if they are not connected), if there is no voltage applied to pin 3 through $R_1$ and $D_1$.

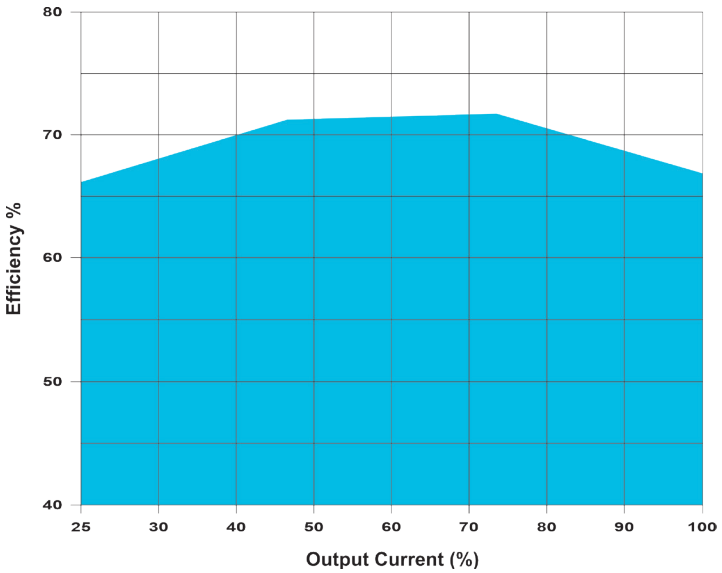
When 4.5 to 15 V max (3.5 mA to 15 mA max) is applied to pin 3 through $R_1$ and $D_1$, the unit will shut down. The off idle current is typically 5 mA.

The diagram at left shows a simple connection for the control pin. To order units with the control input, add a "-R" to the model number (i.e. MD205D-12RW(I)-R).

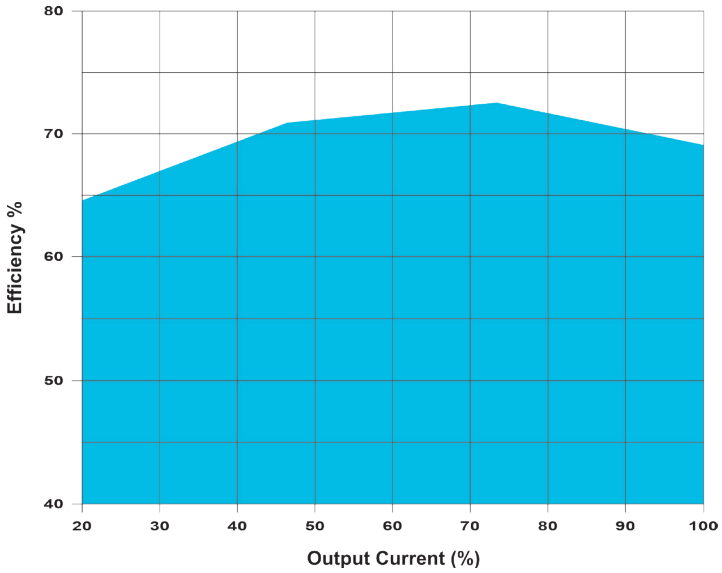
## Efficiency vs Output Load: 5 VIN, Low Line



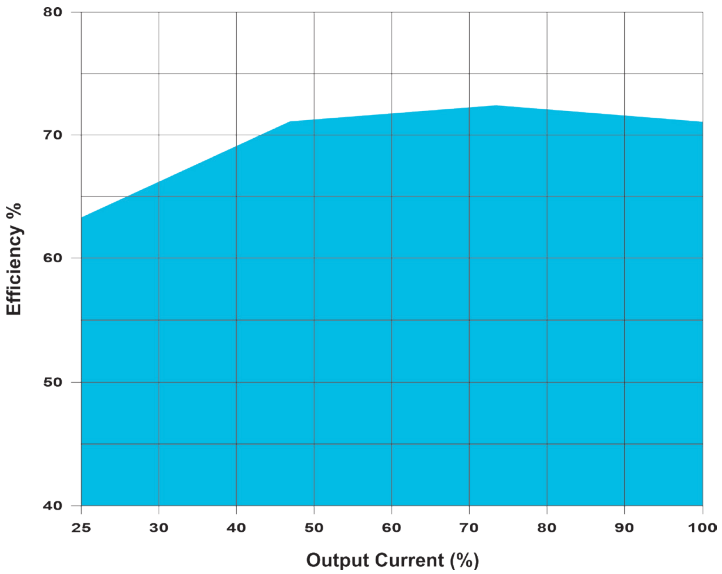

## Efficiency vs Output Load: 5 VIN, Nominal Line



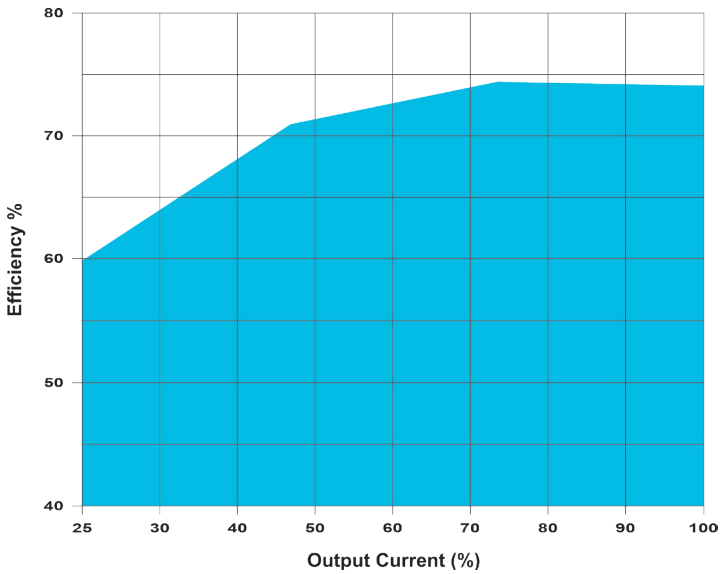

## Efficiency vs Output Load: 5 VIN, High Line



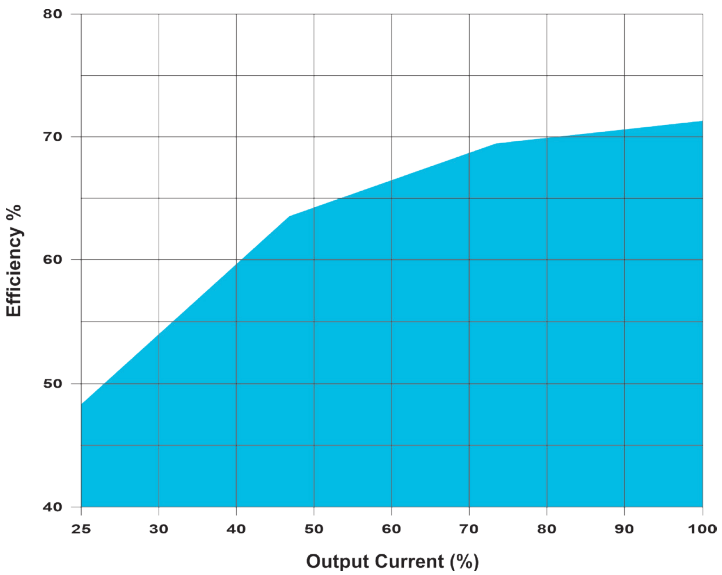

## Efficiency vs Output Load: 12 VIN, Low Line



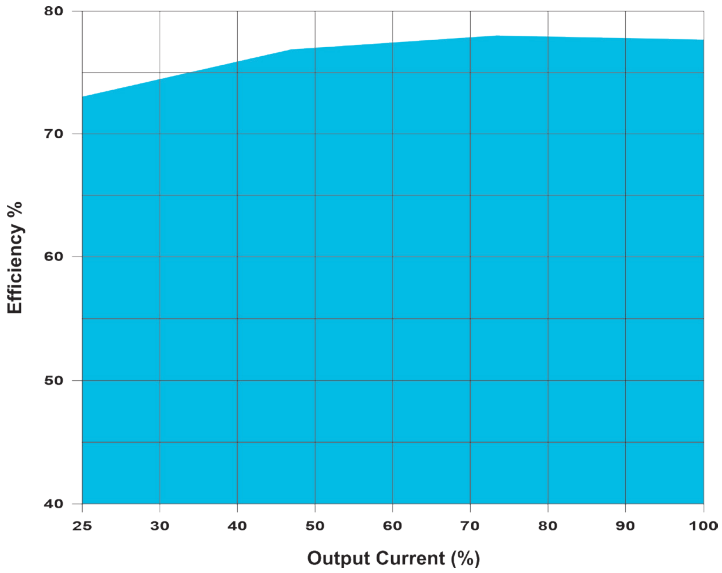

## Efficiency vs Output Load: 12 VIN, Nominal Line



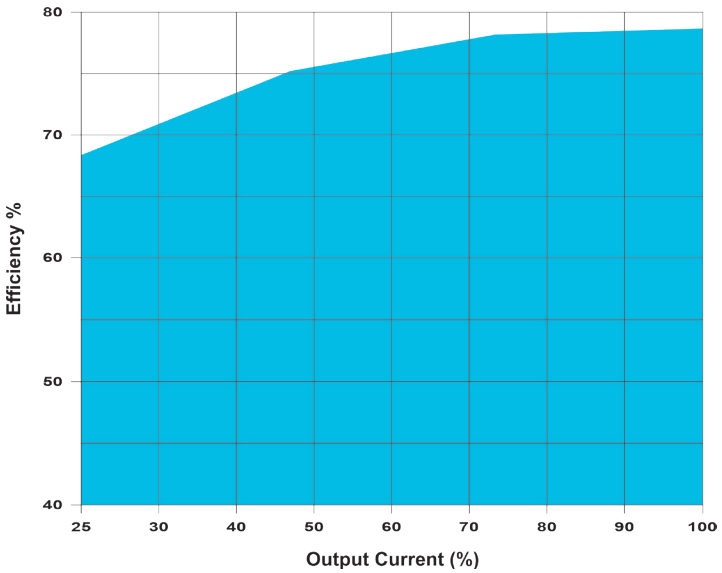

## Efficiency vs Output Load: 12 VIN, High Line



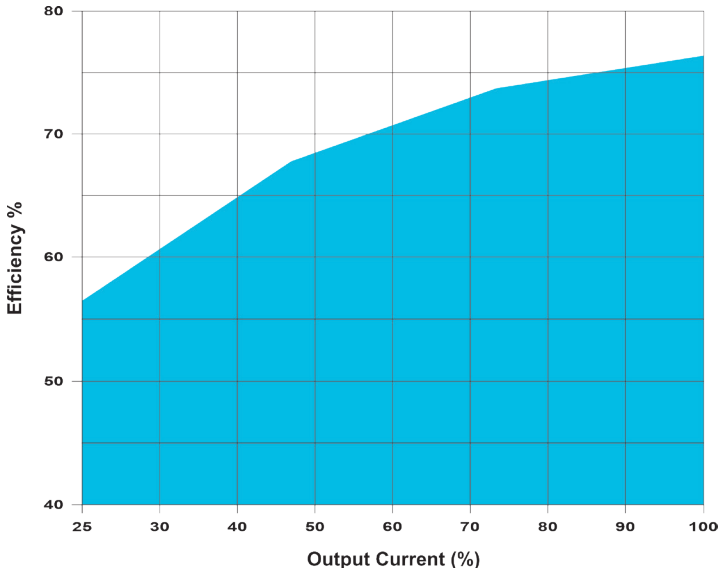
## Efficiency vs Output Load: 24 VIN, Low Line



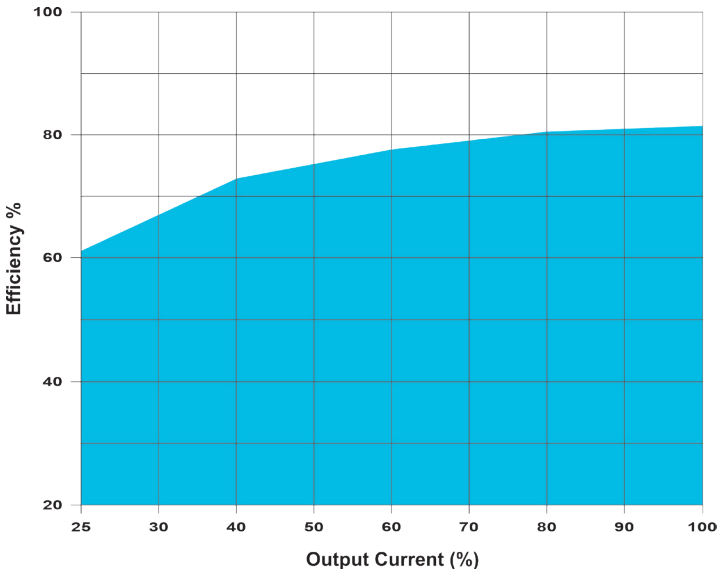

## Efficiency vs Output Load: 24 VIN, Nominal Line



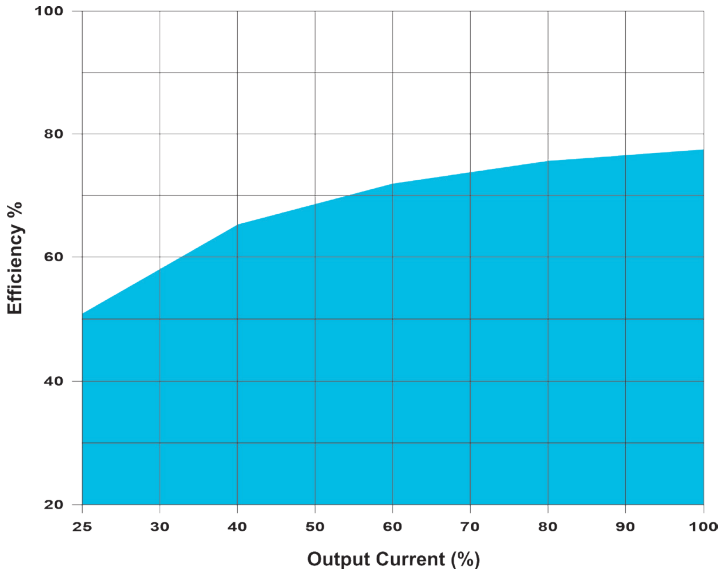

## Efficiency vs Output Load: 24 VIN, High Line



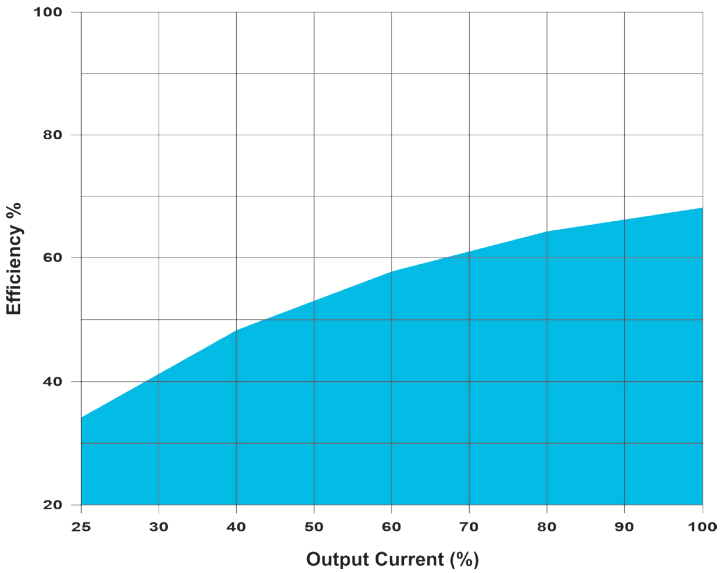

## Efficiency vs Output Load: 48 VIN, Low Line




## Efficiency vs Output Load: 48 VIN, Nominal Line




## Efficiency vs Output Load: 48 VIN, High Line

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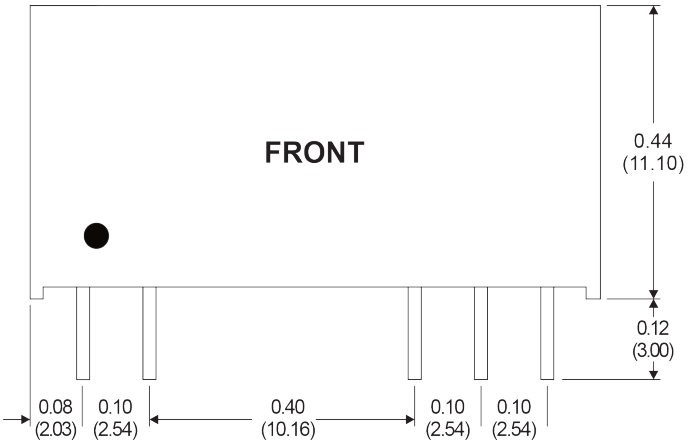
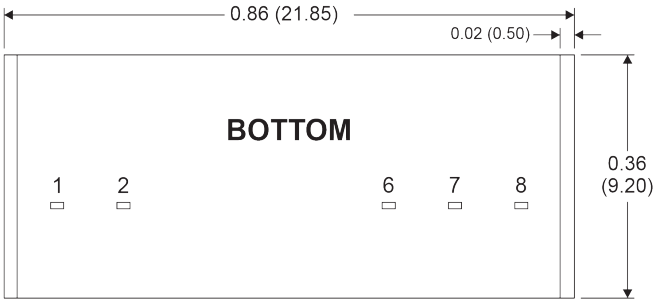
## Mechanical Dimensions, Single Output Models



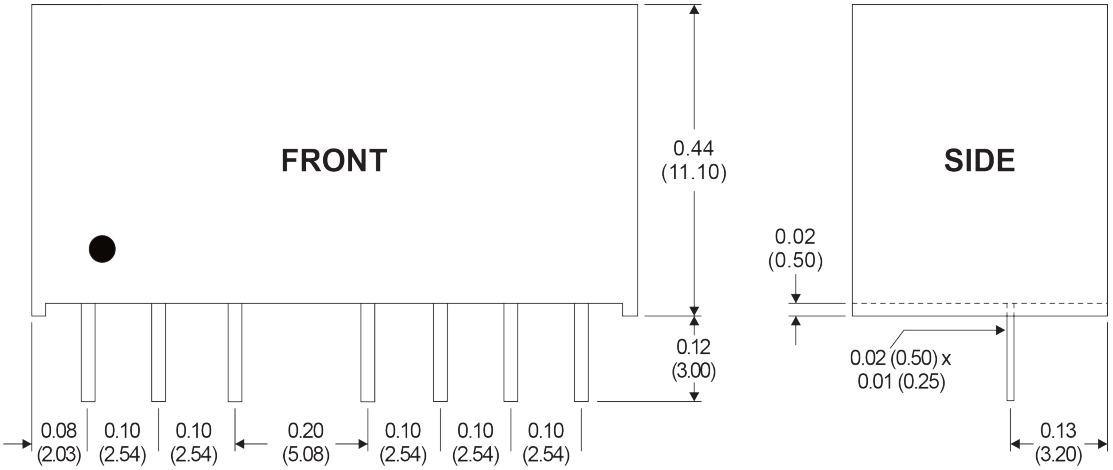

### Pin Connections

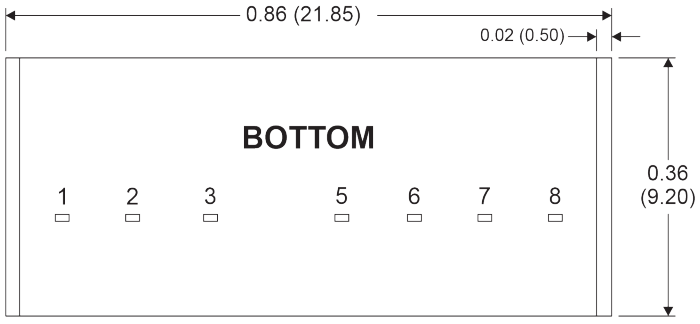
| Pin | Single Output |
|---|---|
| 1 | -VIN |
| 2 | +VIN |
| 6 | +VOUT |
| 7 | +VOUT |
| 8 | No Connection |

Notes:

- All dimensions are typical in inches (mm)
- General Tolerances: ±0.02 (±0.5)
- Pin Pitch & Length Tolerance: ±0.014 (±0.35)
- Pin 1 is marked by a "dot" or indentation on the unit

## Mechanical Dimensions, Dual Output Models & Units with Remote Control




**Notes:**

- All dimensions are typical in inches (mm)
- General Tolerances: ±0.02 (±0.5)
- Pin Pitch and length tolerance: ±0.014 (±0.35)
- Pin 1 is marked by a "dot" or indentation on the unit

### Pin Connections

| Pin | Dual Output |
|---|---|
| 1 | -VIN |
| 2 | +VIN |
| 3 | No Connection |
| 5 | No Connection |
| 6 | +VOUT |
| 7 | -VOUT |
| 8 | Common |
| **Pin** | **Single Output + R** |
| 1 | -VIN |
| 2 | +VIN |
| 3 | Remote On/Off |
| 5 | No Connection |
| 6 | +VOUT |
| 7 | -VOUT |
| 8 | No Connection |
| **Pin** | **Dual Output + R** |
| 1 | -VIN |
| 2 | +VIN |
| 3 | Remote On/Off |
| 5 | No Connection |
| 6 | +VOUT |
| 7 | -VOUT |
| 8 | Common |

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