

MR4011SRU Series

Ultra-Wide Input, 40W Railway/Rolling Stock DC/DC Converters



Key Features:

- 40W Output Power
- 40 -160 VDC Input Range
- 3 kV Reinforced Isolation
- Efficiency to 91%
- EN 62368 Approved
- EN 50155 Approved
- EN 55032 Compliant
- Compact 1 x 2 Inch Case
- -40°C to +85°C Operation
- Industry Standard Pin-Out
- Chassis Mount Option
- DIN Rail Mount Option

RoHS



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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		40.0	110.0	160.0	VDC	
Input Start Voltage	$I_{OUT} = 100\%$			40.0	VDC	
Under Voltage Shutdown	$I_{OUT} = 100\%$	28.0	36.0		VDC	
Reflected Ripple Current			25		mA	
Start Up Time	Nominal Input, Constant Load		20		mS	
Input Filter	π (Pi) Filter					
Output						
Parameter	Conditions	Min.	Typ.	Max.	Units	
Output Voltage Accuracy	$I_{OUT} = 0\%$ to 100%		± 1.0	± 3.0	%	
Output Trim Range			± 10		%	
Line Regulation	$V_{IN} = \text{Min to Max}$		± 0.4	± 1.0	%	
Load Regulation	$I_{OUT} = 10\%$ to 100%		± 0.5	± 1.0	%	
Ripple & Noise (20 MHz)	See Note 1		150	200	mV P - P	
Transient Recovery Time, See Note 2	25% Load Step Change		300	500	μSec	
Transient Response Deviation			± 3.0	± 5.0	%	
Output Power Protection		110		210	%	
Over Voltage Protection		110		160	VDC	
Temperature Coefficient			± 0.02	± 0.03	%/°C	
Output Short Circuit, See Note 3	Continuous (Autorecovery)					
General						
Parameter	Conditions	Min.	Typ.	Max.	Units	
Isolation Voltage, See Note 4	Input - Output	3,000			VDC	
	Input/Output - Case	1,500			VDC	
Isolation Resistance	500 VDC	1,000			M Ω	
Isolation Capacitance	100 kHz/0.1V		2,200	3,000	pF	
Switching Frequency			220		kHz	
Environmental						
Parameter	Conditions	Min.	Typ.	Max.	Units	
Operating Temperature Range	Ambient	-40	+25	+85	°C	
Storage Temperature Range		-55		+125	°C	
Cooling	Free Air Convection					
Humidity	RH, Non-condensing			95	%	
Physical						
Case Size	See Mechanical Diagrams (Starting Page 7)					
Case Material	Aluminum Alloy With Non-Conductive Base (UL94-V0)					
Weight	See Mechanical Diagrams (Starting Page 7)					
Remote On/Off						
Parameter	Conditions	Min.	Typ.	Max.	Units	
Unit On	See Note 5	3.5		12.0	VDC	
Unit Off	See Note 5	0		1.2	VDC	
Off Idle Current			2.0	10.0	mA	
Reliability Specifications						
Parameter	Conditions	Min.	Typ.	Max.	Units	
MTBF	MIL HDBK 217F, 25°C, Gnd Benign	500			kHours	
Shock & Vibration Test	IEC 61373 - Category 1, Grade B					
Absolute Maximum Ratings						
Parameter	Conditions	Min.	Typ.	Max.	Units	
Input Voltage Surge (1 Sec)		-0.7		180	VDC	
Lead Temperature	1.5 mm From Case for 10 Sec			300	°C	

Caution: Exceeding Absolute Maximum Ratings may damage the module. These are not continuous operating ratings.

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Model Selection Guide

Model Number	Input					Output			Efficiency (% Typ)	Capacitive Load (µF, Max)	Fuse Rating Slow-Blow (A)
	Voltage (VDC)			Current (mA)		Voltage (VDC)	Current (A, Max)	Current (mA, Min)			
	Nominal	Range	Max	Full-Load	No-Load						
MR4011S-03RU(-H)	110	40 - 160	170	353	15	3.3	10.000	0.0	87	10,000	2.0
MR4011S-05RU(-H)	110	40 - 160	170	423	15	5.0	8.000	0.0	88	10,000	2.0
MR4011S-12RU(-H)	110	40 - 160	170	423	15	12.0	3.333	0.0	91	2,700	2.0
MR4011S-15RU(-H)	110	40 - 160	170	423	15	15.0	2.667	0.0	91	1,680	2.0
MR4011S-24RU(-H)	110	40 - 160	170	423	15	24.0	1.677	0.0	89	680	2.0
MR4011S-48RU(-H)	110	40 - 160	170	423	15	24.0	0.833	0.0	89	470	2.0

Notes:

- When measuring output ripple, it is recommended that an external ceramic capacitor (approx 10 µF) be placed from the +VOUT to the -VOUT pins.
- Transient recovery is measured to within a 1% error band for a load step change of 25%. For the 3.3 VDC and 5 VDC output models, the response deviation is ±5% Typ, ±8% Max.
- Short circuit protection is provided by a "hiccup mode" circuit.
- Input-output and input-output-case isolation is tested for 60 sec with a leakage current of 1 mA max. With a leakage current of 5 mA, I/O isolation is 1.5 kVAC min.
- If the on/off pin is left open, the unit operates. If it is grounded, the unit will shut off.
- Operation at no-load will not damage the unit, but they may not meet all specifications.
- These units should not be operated over +85°C. Exceeding +85°C may damage the unit.
- It is recommended that a fuse be used on the input of a power supply for protection. The fuse should be chosen according to the actual input current of the application. See the Model Selection table above for a suggested size for these units.
- These units are available in a package that has an integrated heatsink. For this option add a "-H" to the model number. See the mechanical diagrams or call the factory for more information.

For the A2S adapter board option, add the suffix "-A2S" to the model number (i.e. MR4011S-24RU-A2S) See Pages 7 & 8

For the A4S adapter board option, add the suffix "-A4S" to the model number (i.e. MR4011S-03RU-A4S) See Pages 7 & 8

EMC Characteristics: EN 60950

Parameter	Conditions	Criteria	Level
Conducted Emissions	EN 55032		Class A (See Simple Connection)
			Class B (See Typical Connection)
Radiated Emissions	EN 55032		Class A (Without External Components)
			Class B (See Typical Connection)
ESD	EN 61000-4-2	B	±8 kV Air ±6 kV Contact
RS	EN 61000-4-3	A	20V/m
EFT, See Note 2 At Right	EN 61000-4-4	B	±4 kV
Surge, See Note 3 At Right	EN 61000-4-5	B	±2 kV Line to Line (2Ω, 18 µF)
CS	EN 61000-4-6	A	10V rms

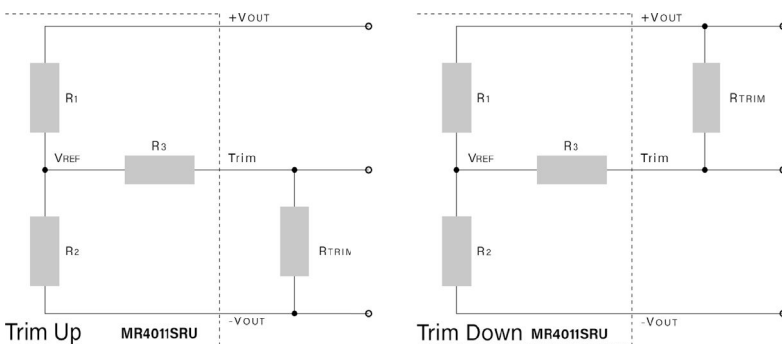
Notes:

- All EMC tests are conducted with a 100 µF/200V capacitor connected across the unit inputs. Contact the factory for more information.
- To meet the requirements of EN 61000-4-4 (±4 kV), use the "Typical Connection" diagrams as shown on page 5. Contact the factory for more information.
- To meet the requirements of EN 61000-4-5 (±2 kV line to line, ±4 kV line to Grnd), use the "Typical Connection" diagrams as shown on page 5. Contact the factory for more information.
- To meet the requirements of EN 50121-3-2 (±2 kV line to line, ±4 kV line to Grnd), use the "Typical Connection" diagrams as shown on page 5. Contact the factory for more information.

EMC Characteristics: EN 50155

Parameter	Conditions	Criteria	Level
Conducted Emissions	EN 50121-3-2		150 kHz - 500 kHz 99 dB µV
	EN 55016-2-1		150 kHz - 500 kHz 93 dB µV
Radiated Emissions	EN 50121-3-2		30 MHz - 230 MHz 40 dB µV/m at 10 m
	EN 55016-2-1		230 MHz - 1 GHz 47 dB µV/m at 10 m
ESD, See Note 4 At Right	EN 50121-3-2	B	±8 kV Air ±6 kV Contact
RS	EN 50121-3-2	B	20V/m
EFT	EN 50121-3-2	A	±2 kV (5/50 nS, 5 kHz)
Surge	EN 50121-3-2	B	±1 kV Line to Line (42Ω, 0.5 µF)
CS	EN 50121-3-2	A	0.15 MHz - 80 MHz 10V rms

External Trim



External Trim Notes:

An external resistor can be used to adjust the converter output up/down by about 10%. The connection is shown in the diagram above. The required resistor value is calculated by the formulas:

Where: RTRIM = The value of the external trim resistor
 VOUT = The desired output voltage
 The value of R1, R2, R3 and VREF are given in the table below.

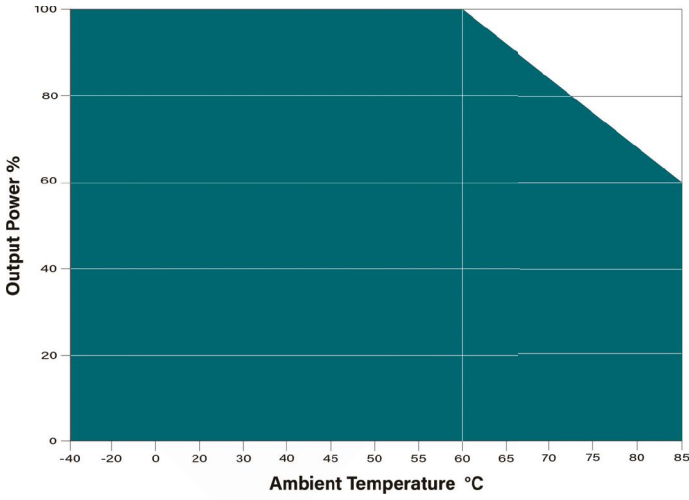
Parameter	Output Voltage (VDC)					
	3.3	5.0	12	15	24	48
R1 (kΩ)	4.801	2.883	11.00	14.384	24.872	55.28
R2 (kΩ)	2.870	2.870	2.870	2.870	2.870	3.000
R3 (kΩ)	10.00	10.00	15.00	15.00	17.80	20.00
VREF (V)	1.24	2.50	2.50	2.50	2.50	2.50

$$\text{Trim Up} = R_{TRIM} = \frac{A \times R_2}{R_2 - A} - R_3 \quad \text{Where: } A = \frac{V_{REF}}{V_{OUT} - V_{REF}} \times R_1$$

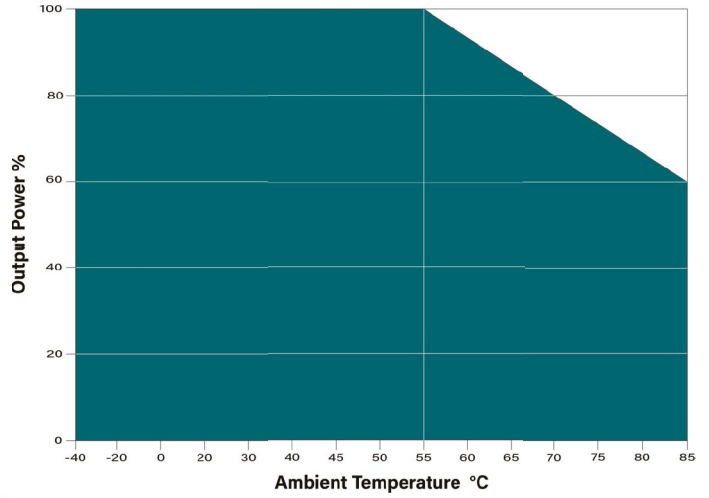
$$\text{Trim Down} = R_{TRIM} = \frac{A \times R_1}{R_1 - A} - R_3 \quad \text{Where: } A = \frac{V_{OUT} - V_{REF}}{V_{REF}} \times R_2$$

If not used, the Trim pin (pin 4) should be left open. Please contact the factory for more information.

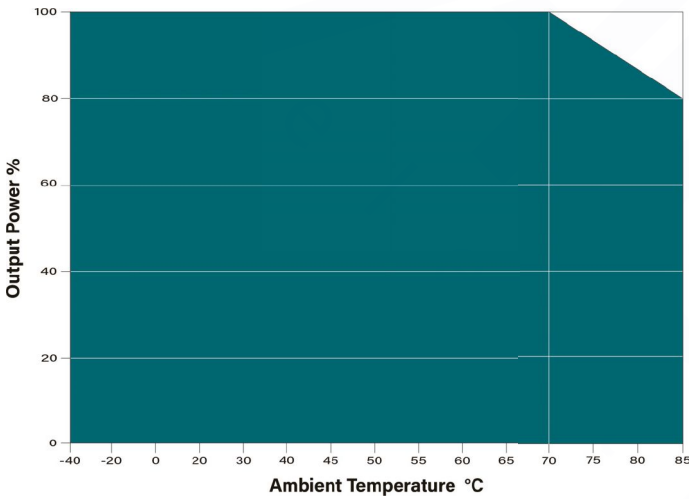
Temperature Derating:
3.3 V_{OUT}, 40 V_{IN}, With Heatsink



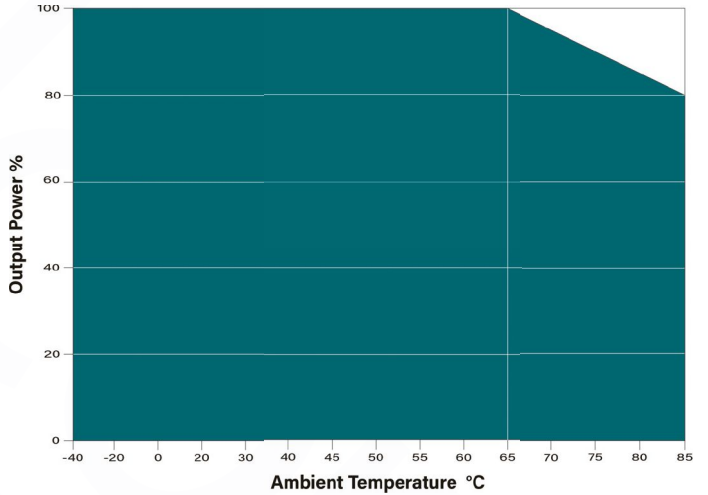
Temperature Derating:
3.3 V_{OUT}, 40 V_{IN}, Without Heatsink



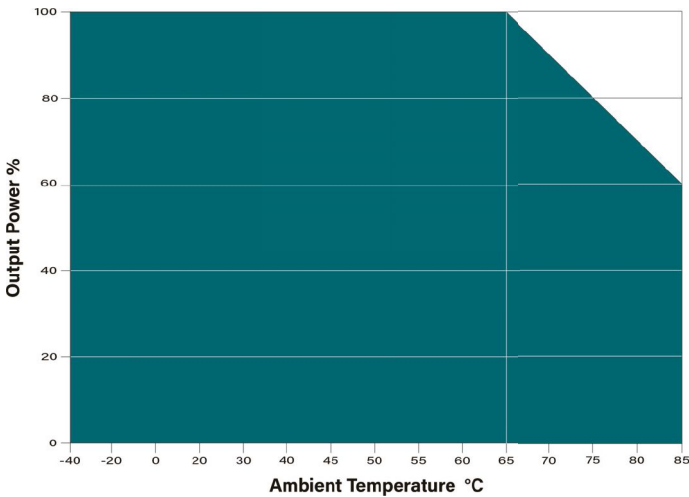
Temperature Derating:
12 V_{OUT}, 40 V_{IN}, With Heatsink



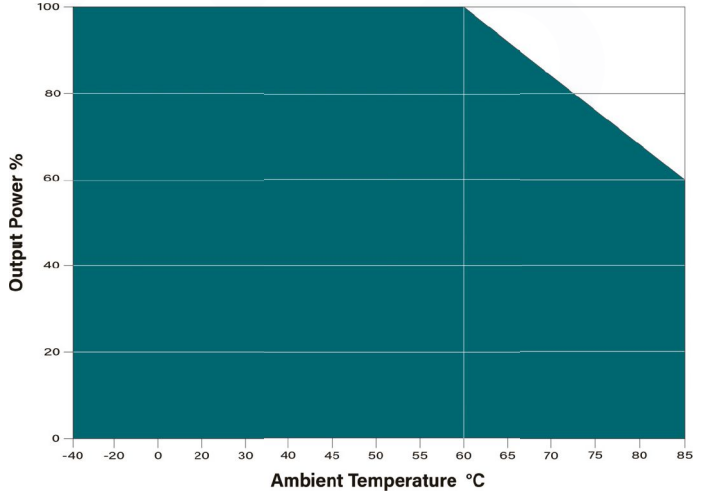
Temperature Derating:
12 V_{OUT}, 40 V_{IN}, Without Heatsink



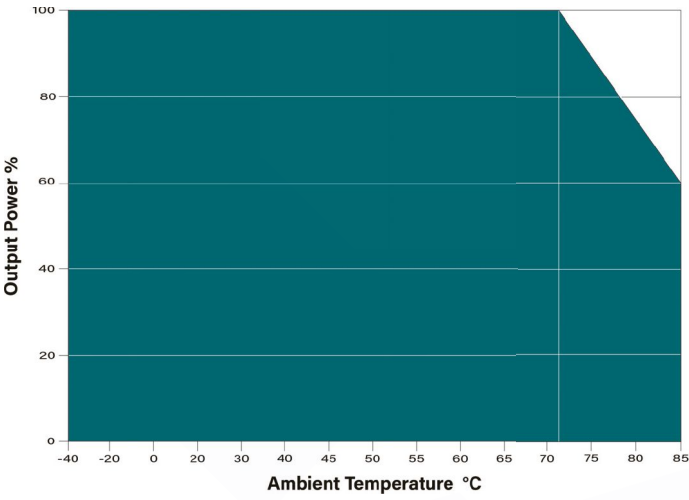
Temperature Derating:
24 V_{OUT}, 40 V_{IN}, With Heatsink



Temperature Derating:
24 V_{OUT}, 40 V_{IN}, Without Heatsink



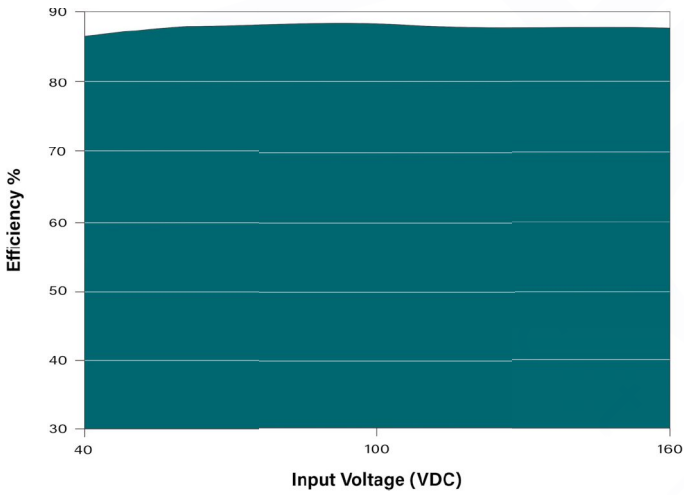
Temperature Derating:
All Other Models With Heatsink



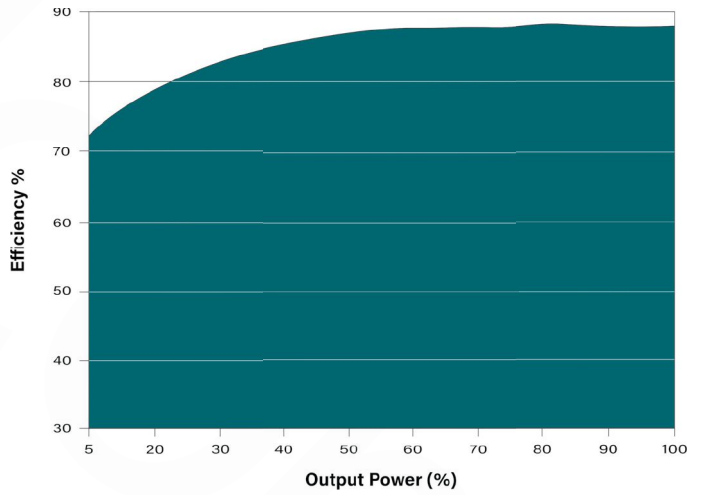
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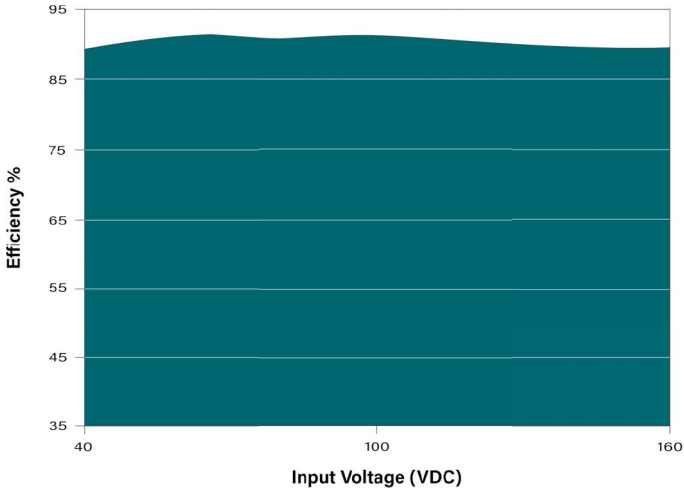
Efficiency vs Input Voltage: 5 VOUT Models



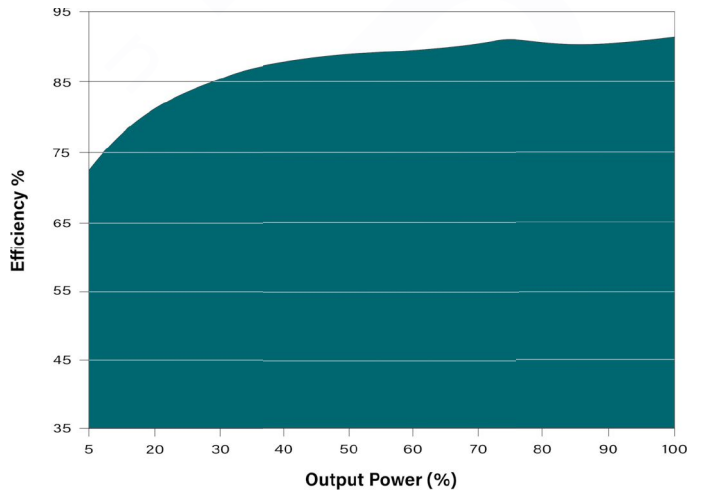
Efficiency vs Output Load: 5 VOUT Models



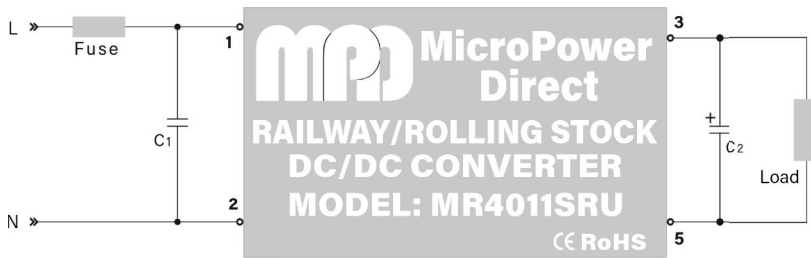
Efficiency vs Input Voltage: 24 VOUT Models



Efficiency vs Output Load: 24 VOUT Models



Simple Connection

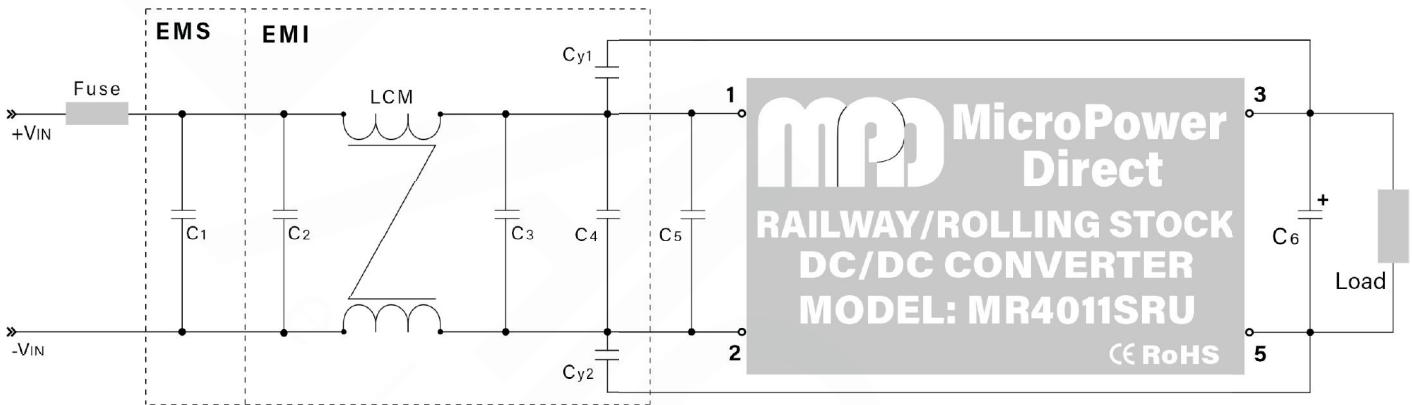


Model	Fuse	C1	C2
MR4011S-03RU	2A Slow Blow	100 μ F 250V	470 μ F/16V
MR4011S-05RU			470 μ F/16V
MR4011S-12RU			220 μ F/25V
MR4011S-15RU			220 μ F/25V
MR4011S-24RU			100 μ F/35V
MR4011S-48RU			100 μ F/35V

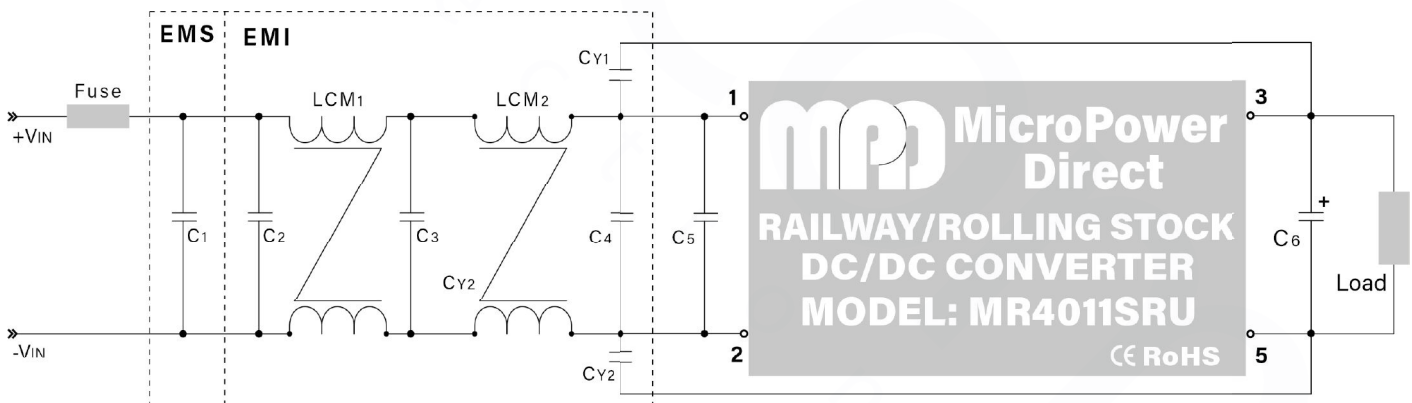
The diagram above illustrates a typical application connection of the MR4011SRU series. Notes on this circuit (starting with the input circuit) are:

1. It is recommended that an external fuse be used. The suggested fuse is given in the table above.
2. All units are rated for EN 55032 (CE/RE) class A with the simple circuit illustrated above.
3. The MR4011SRU is specified without external components. If output noise levels lower than the specified limits are required, the addition of C1 and C2 should be sufficient for most applications. The recommended values are shown in the table at right. The output filtering capacitor C2 is a high frequency, low resistance electrolytic capacitor. Capacitor C1 is ceramic. Voltage derating of capacitors should be 80% or above.

Typical Connection: 3.3 Vout, 5 Vout, 12 Vout, 15 Vout, 24 Vout Models



Typical Connection: 48 Vout Models



For applications that require meeting EMC standards, the diagrams above illustrate the typical connection of the MR4011SRU series. The units do not require external components to operate as specified. Some notes on these diagrams (starting with the input circuit) are:

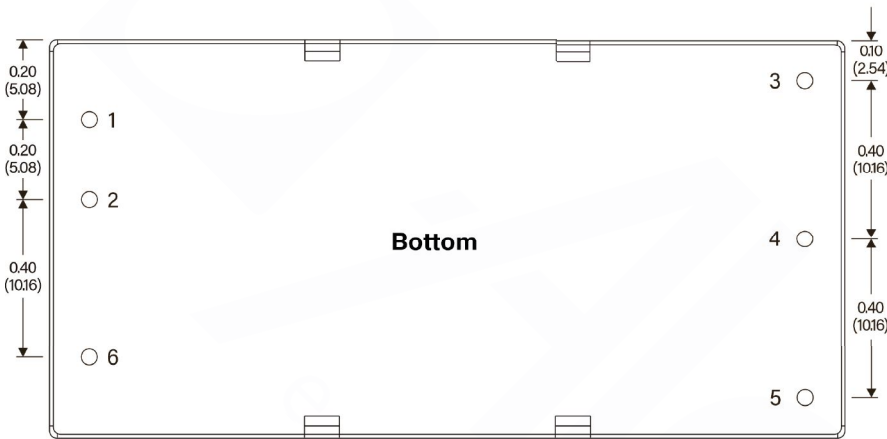
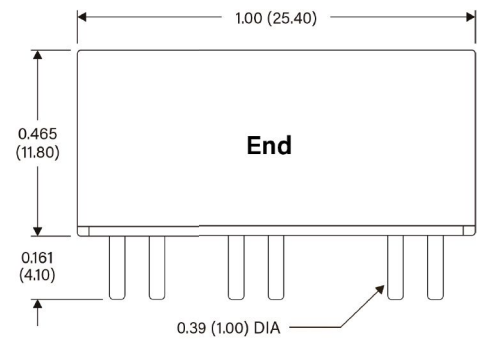
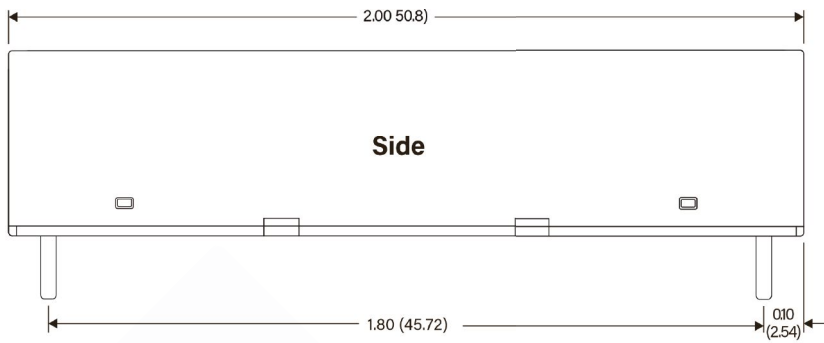
1. An external fuse should be used in all power module applications. The recommended fuse is shown in the model chart on page 2.
2. All input/output filtering capacitors should have a low equivalent impedance. Any output capacitors used should be high frequency, low resistance electrolytic capacitors. Care must be taken in choosing this capacitor not to exceed the capacitive load specification for the unit. Voltage derating of all capacitors should be 60% or greater.

3. Recommended values for components are:

Component	Value
C1	100 μ F/200V
C2	2.2 μ F/250V
LCM1	15 mH
C3	2.2 μ F/250V
LCM2	2.2 mH
C4	100 μ F 250V
C5	100 μ F 250V
CY3	2,200 pF/ 4 kVAC
CY4	2,200 pF/ 4 kVAC
C6	See Note 5

4. In many applications simply adding input/output capacitors will enhance the input surge protection and reduce output ripple sufficiently. See the "Simple Connection on page 5 for suggested values.

Mechanical Dimensions



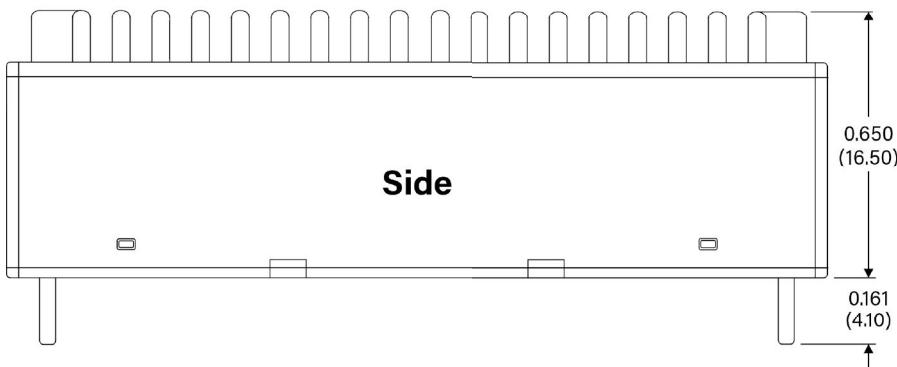
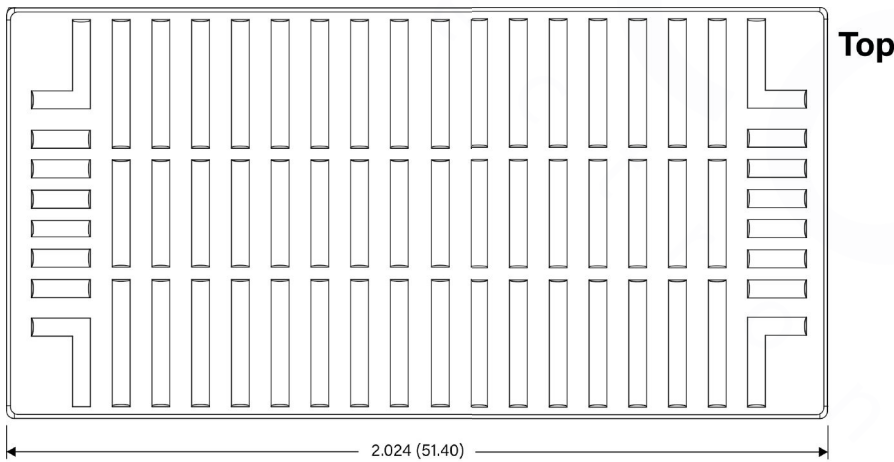
Pin Connections

Pin	Function
1	+VIN
2	-VIN
3	+VOUT
4	-VOUT
5	Trim
6	Remote On/Off

Notes:

- All dimensions are typical in inches (mm)
- General Tolerance = ± 0.02 (± 0.50)
- Pin Tolerance = ± 0.004 (± 0.10)
- Recommended pin hole size (on the application PC Board) is $\varnothing 0.059$ ($\varnothing 1.50$)
- Weight (Typ) = 1.13 Oz (32.3g)

Mechanical Dimensions: With Optional Heatsink



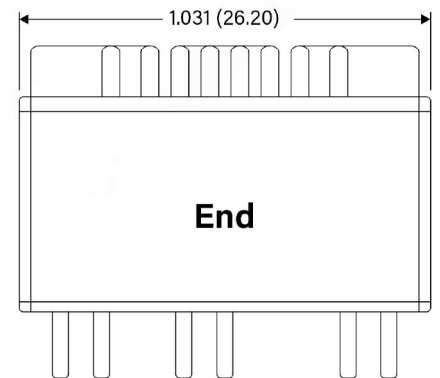
Pin Connections

Pin	Function
1	+VIN
2	-VIN
3	+VOUT
4	-VOUT
5	Trim
6	Remote On/Off

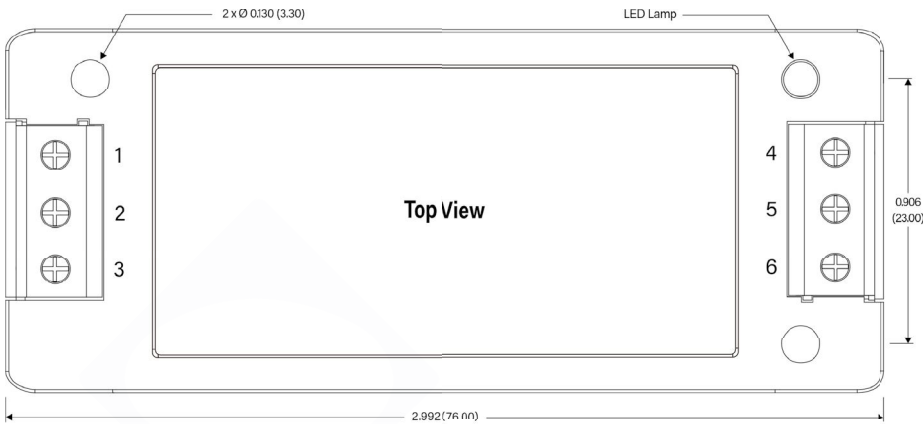
For the heatsink option, add suffix "H" to the model number (i.e. **MR4011S-05RU-H**)

Notes:

- All dimensions are typical in inches (mm)
- General Tolerance = ± 0.02 (± 0.50)
- Pin Tolerance = ± 0.004 (± 0.10)
- Recommended pin hole size (on the application PC Board) is $\varnothing 0.059$ ($\varnothing 1.50$)
- Weight (Typ) = 1.44 Oz (41g)



Mechanical Dimensions: With A2S Adapter Board



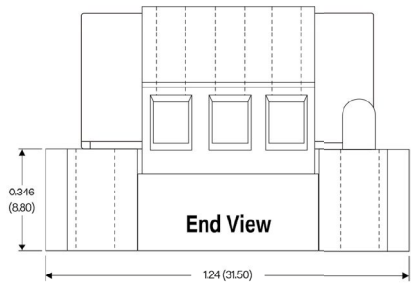
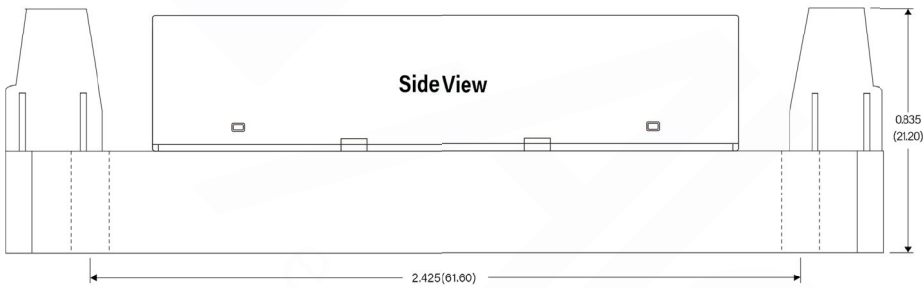
Pin Connections

Pin	Function
1	No Connection
2	GND
3	+VIN
4	-VOUT
5	No Connection
6	+VOUT

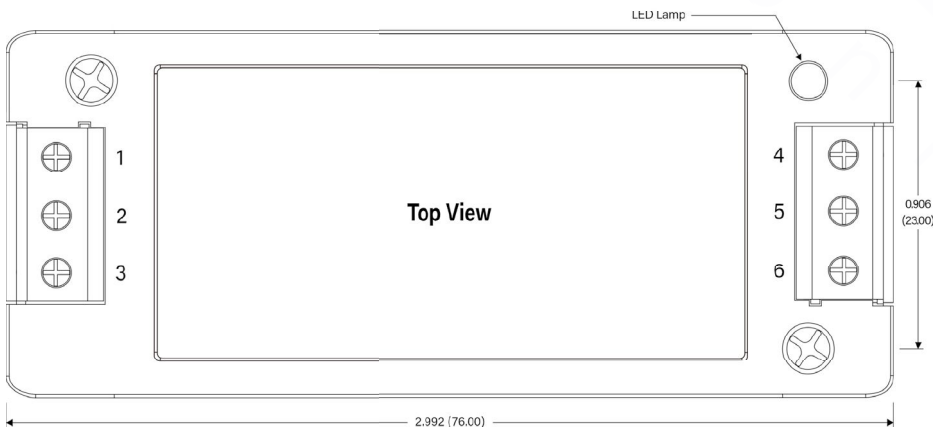
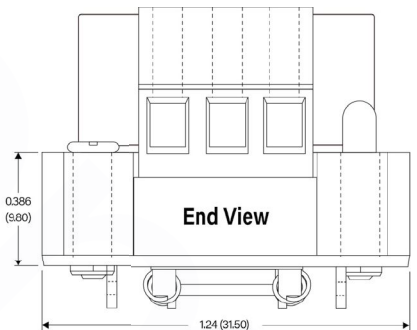
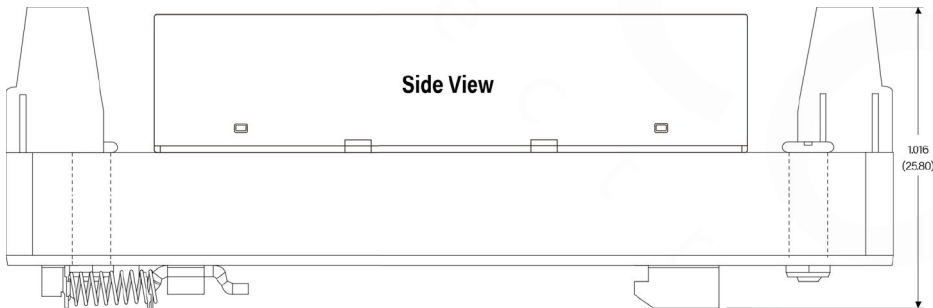
For the A2S adapter board option, add suffix "A2S" to the model number (i.e. **MR4011S-05RU-A2S**)

Notes:

- All dimensions are typical in inches (mm)
- General Tolerance = ± 0.02 (± 0.50)
- Wire Range: 24 to 12 AWG
- Weight (Typ) = 1.98 Oz (56.3g)
- Tightening Torque: 0.4 N*m Max.



Mechanical Dimensions: With A4S Adapter Board



Pin Connections

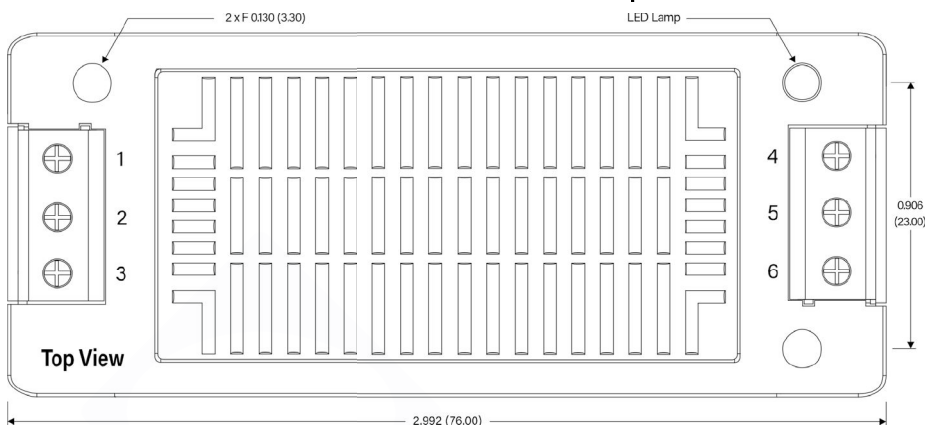
Pin	Function
1	No Connection
2	GND
3	+VIN
4	-VOUT
5	No Connection
6	+VOUT

For the A4S adapter board option, add suffix "A4S" to the model number (i.e. **MR4011S-05RU-A4S**)

Notes:

- All dimensions are typical in inches (mm)
- General Tolerance = ± 0.02 (± 0.50)
- Wire Range: 24 to 12 AWG
- Weight (Typ) = 2.69 Oz (76.3g)
- Tightening Torque: 0.4 N*m Max.

Mechanical Dimensions: With Heatsink & A2S Adapter Board



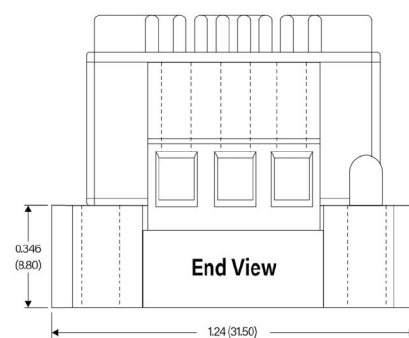
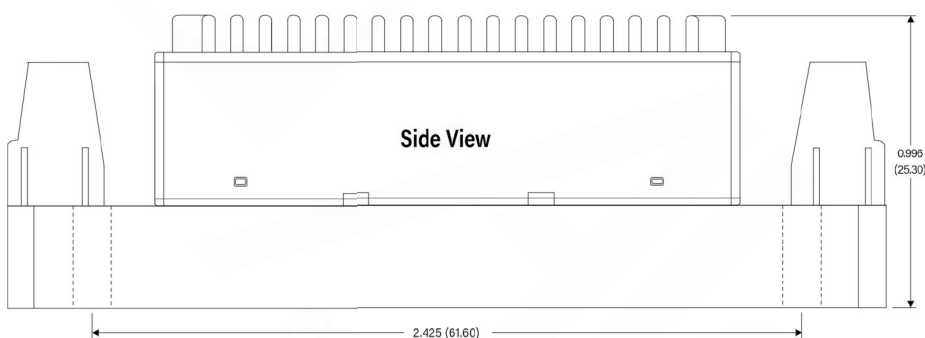
Pin Connections

Pin	Function	Pin	Function
1	No Connection	4	-VOUT
2	GND	5	No Connection
3	+VIN	6	+VOUT

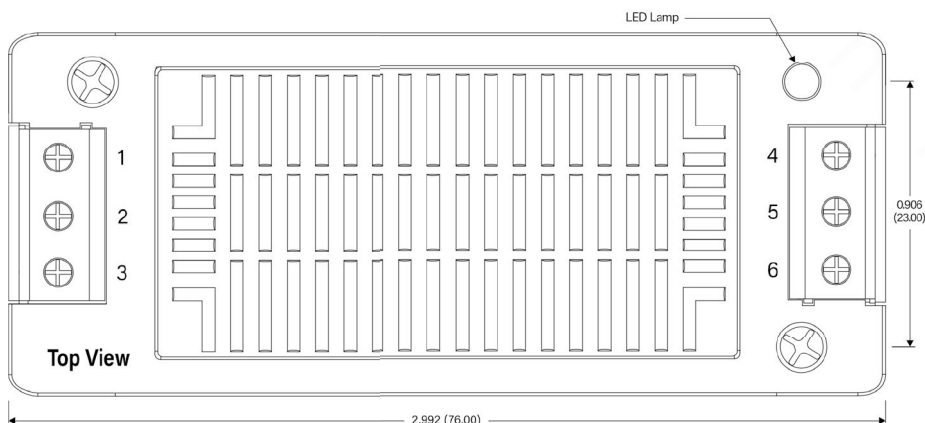
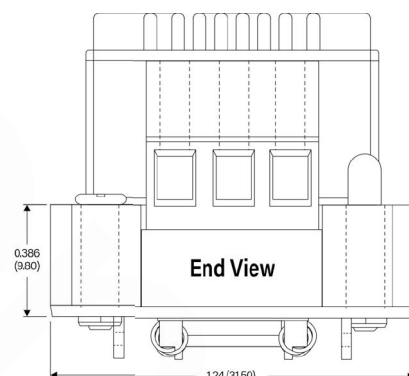
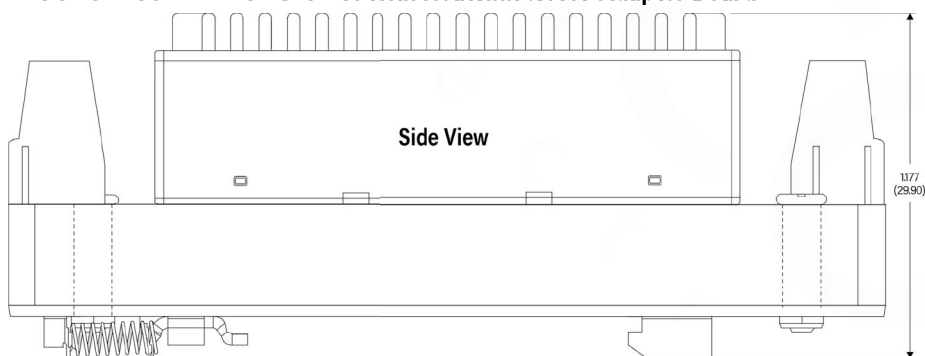
For the A2S adapter board option, add suffix "A2S" to the model number (i.e. MR4011S-05RU-HA2S)

Notes:

- All dimensions are typical in inches (mm)
- General Tolerance = ± 0.02 (± 0.50)
- Wire Range: 24 to 12 AWG
- Weight (Typ) = 2.29 Oz (65g)
- Tightening Torque: 0.4 N*m Max.



Mechanical Dimensions: With Heatsink & A4S Adapter Board



Pin Connections

Pin	Function	Pin	Function
1	No Connection	4	-VOUT
2	GND	5	No Connection
3	+VIN	6	+VOUT

For the A4S adapter board option, add suffix "A4S" to the model number (i.e. MR4011S-05RU-HA4S)

Notes:

- All dimensions are typical in inches (mm)
- General Tolerance = ± 0.02 (± 0.50)
- Wire Range: 24 to 12 AWG
- Weight (Typ) = 2.99 Oz (85g)
- Tightening Torque: 0.4 N*m Max.

