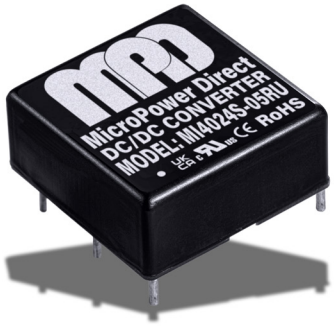
MI4000RU

Very Compact, 1 x 1 In 40W, 4:1 Input Range DC/DC Converters



Key Features:

- 40W Output Power
- Very Compact MiniDIP Case
- Meets EN 62368
- Wide 4:1 Input Range
- High Efficiency
- Heatsink Available
- Wide Operating Temp Range
- 1,500 VDC Isolation
- Single and Dual Outputs
- >1.05 MHour MTBF
- Shielded Metal Case
- Remote On/Off Control
- -40 to +80°C Temp Range

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	24 VDC Input	9.0	24.0	36.0	VDC
	48 VDC Input	18.0	48.0	75.0	
Input Start-up Threshold	24 VDC Input			9.0	VDC
	48 VDC Input			18.0	
Under Voltage Shutdown	24 VDC Input		7.80		VDC
	48 VDC Input		16.50		
Start-Up Time	Power Up		30	50	mS
	Remote On		30	50	
Input Filter	π (Pi) Filter				

Output

Parameter	Conditions	Min.	Typ.	Max.	Units
Output Voltage Accuracy				±1.0	%
Output Voltage Balance	Dual Output, Balanced Loads			±2.0	%
Line Regulation	V_{IN} = Min To Max			±0.2	%
Load Regulation	I_{OUT} = 0% To 100%			±0.3	%
Cross Regulation	Asymetrical Load (25%/100%)			±0.3	%
Minimum Load		0			W
Ripple & Noise, 5 VOUT	With 10 uF MLCC/33uF/35V Polymer		75	100	mV Pk-Pk
(±) 12 VOUT, (±)15 VOUT	With 10 uF MLCC/33uF/35V Polymer		100	125	
24 VOUT	With 10 uF MLCC/33uF/35V Polymer		150	200	
48 VOUT, 54 VOUT	With 2.2 uF MLCC		280	330	
Transient Recovery Time	See Note 1			500	µSec
Transient Response Deviation			±25		%
Overload Protection	See Note 2	110		180	%
Temperature Coefficient			±0.01	±0.02	%/°C
Output Short Circuit	See Note 3	Continuous (Autorecovery)			

General

Parameter	Conditions	Min.	Typ.	Max.	Units
Isolation Voltage	60 Seconds	1,500			VDC
	1 Second	1,800			
	Input/Output to Case	1,000			
Isolation Resistance	500 VDC	1,000			MΩ
Isolation Capacitance	100 kHz, 1V		1,500		pF
Switching Frequency	5 VOUT		185		kHz
	All Other Models		210		

Environmental

Parameter	Conditions	Min.	Typ.	Max.	Units
Operating Temperature Range	Ambient, 5, 48 & 54 VOUT Models	-40	+25	+60	°C
	Ambient, All Other Models	-40	+25	+65	
Max Case Temperature				+105	°C
Storage Temperature Range		-50		+125	°C
Cooling	Free Air Convection				
Humidity	RH, Non-condensing			95	%

Physical

Case Size & Weight	See Mechanical Diagram (Page 8)
Case Material	Aluminum Alloy, Black Anodized Coating (UL-94V0)

Reliability Specifications

Parameter	Conditions	Min.	Typ.	Max.	Units
MTBF	MIL HDBK 217F, 25°C, Gnd Benign	1.051			MHours
Safety Standards	UL/cUL 62368-1 recognition (UL certificate pending)				

Absolute Maximum Ratings

Parameter	Conditions	Min.	Typ.	Max.	Units
Input Voltage Surge (1 Sec)	24 VDC Input			50.0	VDC
	48 VDC Input			100.0	
Lead Temperature	1.5 mm From Case For 10 Sec			260	°C

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

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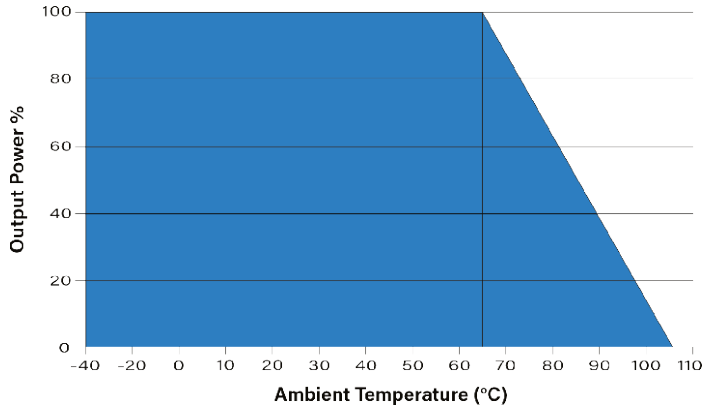
Model Number	Input				Output			Efficiency (%, Typ)	Capacitive Load (µF Max) See Note 4	Fuse Rating Slow-Blow (mA)	Use Derating Curves
	Voltage (VDC)		Current (mA)		Voltage (VDC)	Current (mA, Max)	Current (mA, Min)				
	Nominal	Range	Full-Load	No-Load							
MI4024S-05RU(-H)	24	9.0 - 36.0	1,832	8.0	5.0	8,000	0.0	90	12000	3,000	3, 4
MI4024S-12RU(-H)	24	9.0 - 36.0	1,821	8.0	12.0	3,350	0.0	91	2000	3,000	1, 2
MI4024S-15RU(-H)	24	9.0 - 36.0	1,834	8.0	15.0	2,700	0.0	91	1200	3,000	1, 2
MI4024S-24RU(-H)	24	9.0 - 36.0	1,868	8.0	24.0	1,700	0.0	90	560	3,000	1, 2
MI4024S-48RU(-H)	24	9.0 - 36.0	1,856	8.0	48.0	835	0.0	89	120	3,000	3, 4
MI4024S-54RU(-H)	24	9.0 - 36.0	1,830	8.0	54.0	740	0.0	90	100	3,000	3, 4
MI4024D-12RU(-H)	24	9.0 - 36.0	1,868	8.0	±12.0	±1,700	0.0	90	1000	3,000	1, 2
MI4024D-15RU(-H)	24	9.0 - 36.0	1,854	8.0	±15.0	±1,350	0.0	90	680	3,000	1, 2
MI4048S-05RU(-H)	48	18.0 - 75.0	906	5.0	5.0	8,000	0.0	91	12000	2,000	3, 4
MI4048S-12RU(-H)	48	18.0 - 75.0	901	5.0	12.0	3,350	0.0	92	2000	2,000	1, 2
MI4048S-15RU(-H)	48	18.0 - 75.0	907	5.0	15.0	2,700	0.0	92	1200	2,000	1, 2
MI4048S-24RU(-H)	48	18.0 - 75.0	924	5.0	24.0	1,700	0.0	91	560	2,000	1, 2
MI4048S-48RU(-H)	48	18.0 - 75.0	928	5.0	48.0	835	0.0	89	120	2,000	3, 4
MI4048S-54RU(-H)	48	18.0 - 75.0	915	5.0	54.0	740	0.0	90	100	2,000	3, 4
MI4048D-12RU(-H)	48	18.0 - 75.0	934	5.0	±12.0	±1,700	0.0	90	1000	2,000	1, 2
MI4048D-15RU(-H)	48	18.0 - 75.0	938	5.0	±15.0	±1,350	0.0	89	680	2,000	1, 2

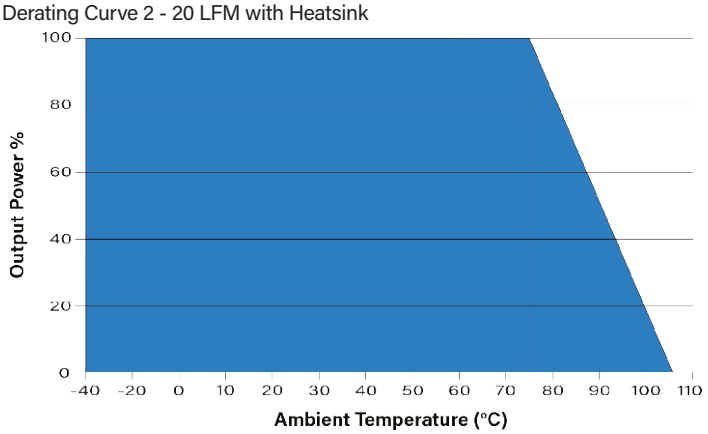
Notes:
1. Transient recovery is measured to within a 1% error band for a load step change of 25%.
2. Over Power protection is provided by a "hiccup mode" current limiting circuit.
3. Short circuit protection is provided by a "hiccup mode" circuit.
4. The specified maximum capacitive load is for each output.
6. To meet the requirements of EN 61000-4-4 and EN 61000-4-5, an external capacitor must be placed across the input to the unit. The recommended value for all models is 330 µF/80V.
7. On dual output models, the cross regulation for asymetrical loads (25%/100%) is ±5% max.
8. Operation at no-load will not damage these units.
9. It is recommended that a fuse be used on the input of a power supply for protection. See the Model Selection table above for the correct rating.

Power Derating Curves, See Model Chart for correct curves

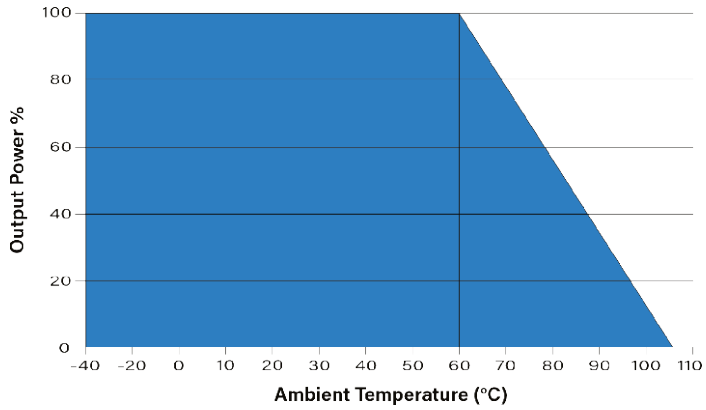
Derating Curve 1 - 20 LFM without Heatsink



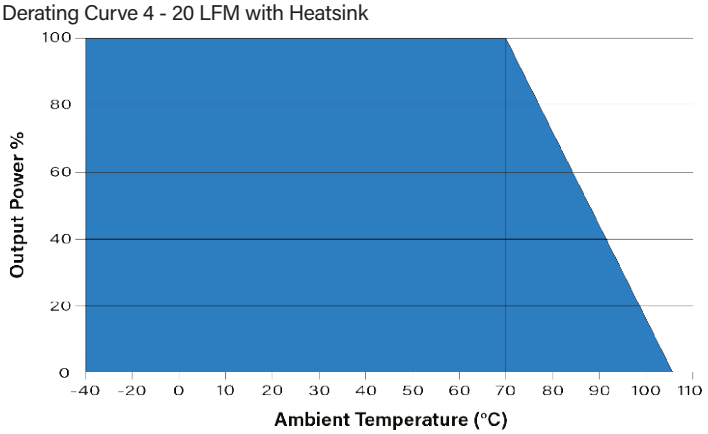
Derating Curve 2 - 20 LFM with Heatsink



Derating Curve 3 - 20 LFM without Heatsink



Derating Curve 4 - 20 LFM with Heatsink

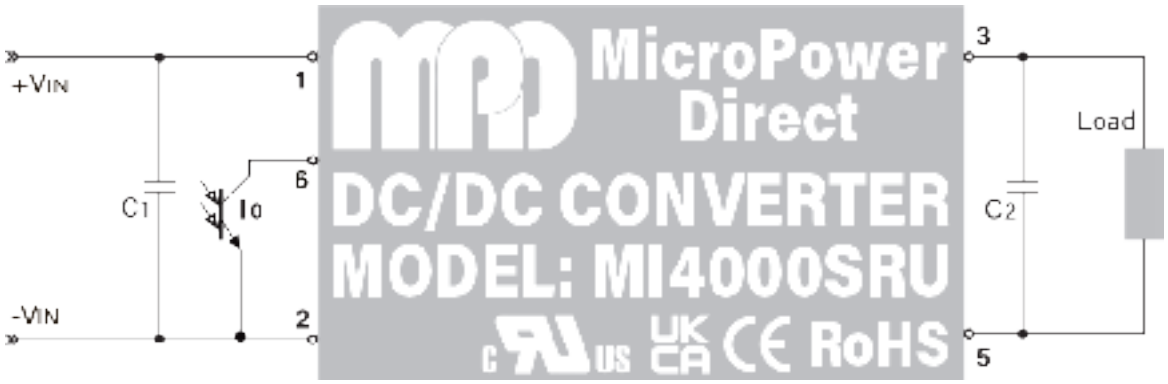


EMI/EMC Characteristics

Parameter	Standard	Criteria	Level
Radiated Emissions	EN 55032		Class A
Conducted Emissions	EN 55032		Class A
ESD	EN 61000-4-2	A	±6 kV Contact
			±8kV Air
RS	EN 61000-4-3	A	10V/m
EFT, See note at right	EN 61000-4-4	A	±2 kV
Surge, See note at right	EN 61000-4-5	A	±2 kV
CS	EN 61000-4-6	A	10 Vrms
PFMF	EN 61000-4-8	A	1,000 A/m (1s)

These converters will meet the requirements of EN 55032 class A or B conducted emissions with external components. Example circuits are shown below and on page 4. For more information contact the factory.

Simple Connection

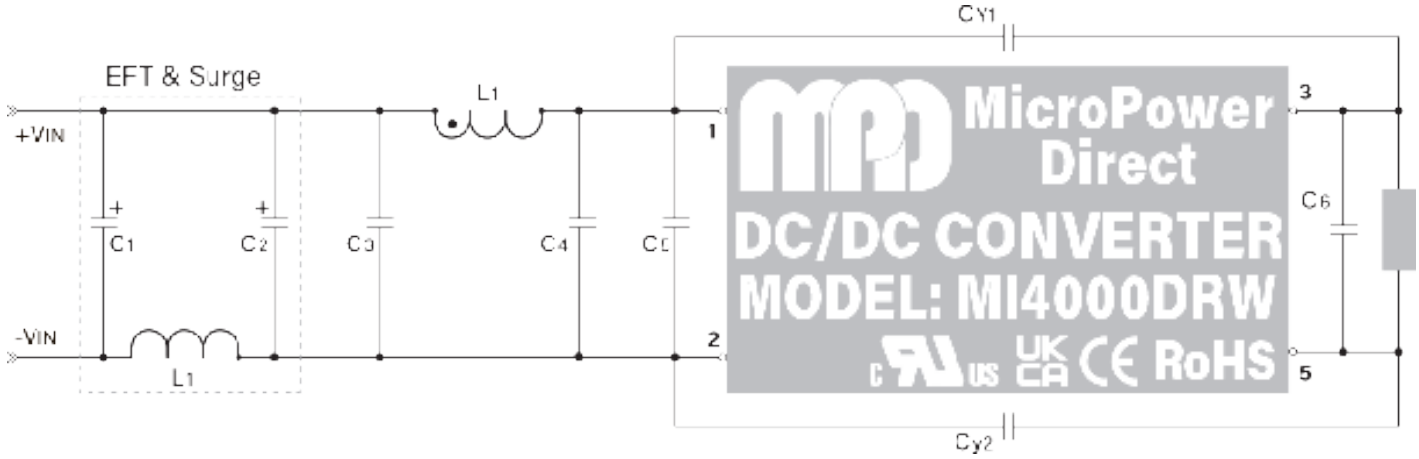


The diagram above illustrates a typical connection of the **MI4000RU**. For applications that do not require the circuit to meet EMI/EMC specifications, the capacitors C1 and C2 will reduce input/output ripple and improve the converter stability over time and temperature. The recommended component value is 68 µF (for both capacitors).

The **MI4000RU** also includes a positive logic ON/OFF control circuit. This turns the unit on when a logic high is applied to the On/Off control pin (Pin 6), and off when a logic low (GND) is applied. If the remote ON/OFF is not used, pin 6 should be left open.

Model	C1	C2
MI4024xRU	68 µF	68 µF
MI4048xRU	68 µF	68 µF

Typical EMI Connection: Class A

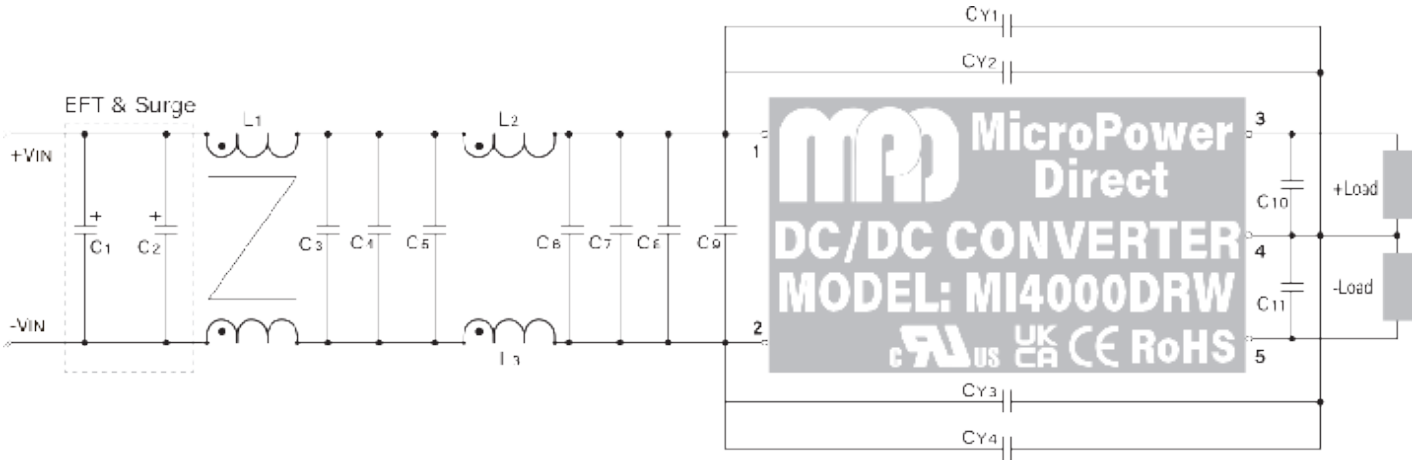


The addition of some external filtering components is required to meet the requirements of EN 55032 radiated emissions class A. For single output units, the circuit illustrated above should be sufficient.

To enhance stability and reduce output ripple, this simple connection also includes low ESR (<1Ω at 100 kHz) capacitors C6,(used to insure start up) and C7 (to reduce output ripple & noise) These compnents should be connected close to the module. Suggested values are given in the table at right.

Model	C1, C2	L3	C3, C4	CY1, CY2	C5,C6
MI4024S-48RU, MI4024S-54RU	1200 µF/50V Chemi-Con KY	2.2 µH/9.8A 74438367022	10 µF/50V 1206	2,200 pF/2kV 1206	68 µF/50V
All Other MI4024 Models	1200 µF/50V Chemi-Con KY	2.2 µH/9.8A 74438367022	10 µF/50V 1206	1,000 pF/2kV 1206	68 µF/50V
MI4048-12RU MI4048-15RU MI4048-24RU	470 µF/100V Chemi-Con KY	2.2 µH/9.8A 74438367022	3.3 µF/100V 1206	1,000 pF/2kV 1206 X7R	68 µF/50V
All Other MI4048 Models		2.2 µH/9.8A 74438367022	3.3 µF/100V 1206	2,200 pF/2kV 1206	68 µF/50V

Typical EMI Connection: Class B, Single Output

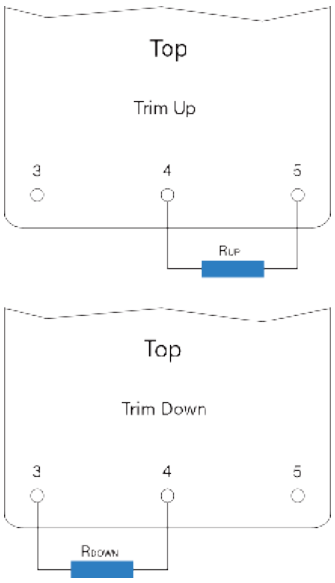


Meeting the requirements of EN 55032 radiated emissions class B also requires the addition of some external filtering components. For dual output units, addition of C1, C3, C4 and L1 should be sufficient.

To enhance stability and reduce output ripple, this simple connection includes low ESR (<1Ω at 100 kHz) capacitors C6,(used to insure start up) and C7 (to reduce output ripple & noise) These compnents should be connected close to the module. Suggested values are given in the table at right.

Model	C1, C2	L1	C3, C4, C5 C6, C7, C8	L2, L3	CY1, CY4	CY2, CY3	C9, C10,C11
MI4024S-05RU MI4024S-12RU MI4024S-15RU	1200 µF/50V Chemi-Con KY	2 mH 7448031002	10 µF/50V 1206	2.2 µH/9.8A 74438367022		2,200 pF/2kV 1206	68 µF/50V
All Other MI4024 Models	1200 µF/50V Chemi-Con KY	2 mH 7448031002	10 µF/50V 1206	2.2 µH/9.8A 74438367022	1,000 pF/2kV 1206	2,200 pF/2kV 1206	68 µF/50V
MI4048-05RU MI4048-12RU MI4048-15RU	470 µF/100V Chemi-Con KY	2 mH 7448031002	4.7 µF/100V 1210	4.7 µH/8.2A 7443845030047		2,200 pF/2kV 1206	68 µF/50V
All Other MI4048 Models	470 µF/100V Chemi-Con KY	2 mH 7448031002	4.7 µF/100V 1210	4.7 µH/8.2A 7443845030047	2,200 pF/2kV 1206	2,200 pF/2kV 1206	68 µF/50V

External Trim



An external resister may be added to adjust the converter output on single output units.

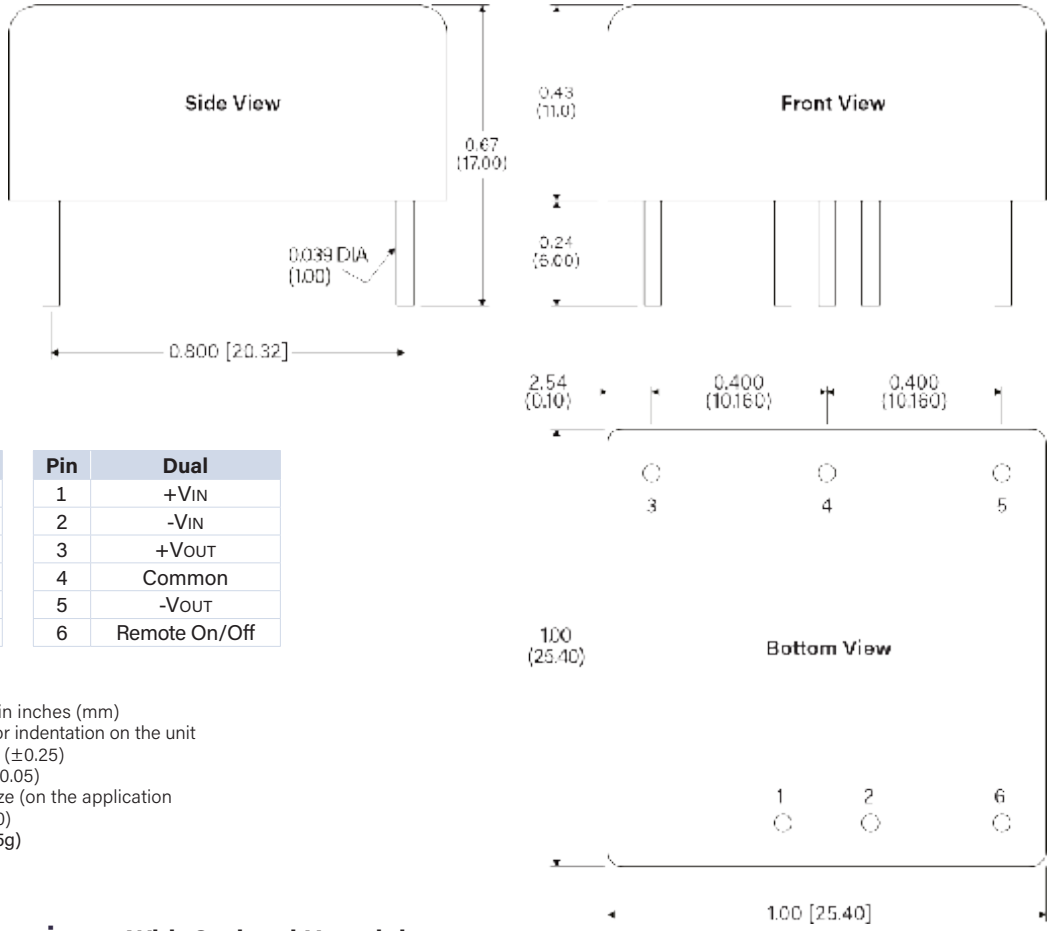
To adjust the output **UP**, connect a 5%, 3W resistor between the minus output pin (5) and the Vout trim pin (4). To adjust the output **DOWN**, connect a 5%, 3W resistor between the plus output pin (3) and the Vout trim pin (4).

The trim table at right gives suggested resistor values for this adjustment.

	Model No.					
	MI40xxS-05		MI40xxS-12		MI40xxS-15	
Range %	Trim Down (KΩ)	Trim Up (KΩ)	Trim Down (KΩ)	Trim Up (KΩ)	Trim Down (KΩ)	Trim Up (KΩ)
1	138.88	106.87	413.55	351.00	530.73	422.77
2	62.41	47.76	184.55	157.50	238.61	189.89
3	36.92	28.06	108.22	93.00	141.24	112.26
4	24.18	18.21	70.05	60.75	92.56	73.44
5	16.53	12.30	47.15	41.40	63.35	50.15
6	11.44	8.36	31.88	28.50	43.87	34.63
7	7.79	5.55	20.98	19.29	29.96	23.54
8	5.06	3.44	12.80	12.37	19.53	15.22
9	2.94	1.79	6.44	7.00	11.41	8.75
10	1.24	0.48	1.35	2.70	4.92	3.58

	Model No.					
	MI40xxS-24		MI40xxS-48		MI40xxS-54	
Range %	Trim Down (KΩ)	Trim Up (KΩ)	Trim Down (KΩ)	Trim Up (KΩ)	Trim Down (KΩ)	Trim Up (KΩ)
1	598.97	486.83	2,043.74	1,685.06	2,774.19	2,196.91
2	267.93	217.87	913.77	755.03	1,243.64	982.46
3	157.59	128.21	537.11	445.02	733.46	577.64
4	102.42	83.38	348.78	290.02	478.37	375.23
5	69.31	56.49	235.79	197.01	325.32	253.78
6	47.24	38.56	160.46	135.01	223.28	172.82
7	31.48	25.75	106.65	90.72	150.40	114.99
8	19.66	16.14	66.29	57.51	95.74	71.61
9	10.46	8.67	34.90	31.67	53.22	37.88
10	3.11	2.69	9.79	11.01	19.21	10.89

Mechanical Dimensions



Pin Connections

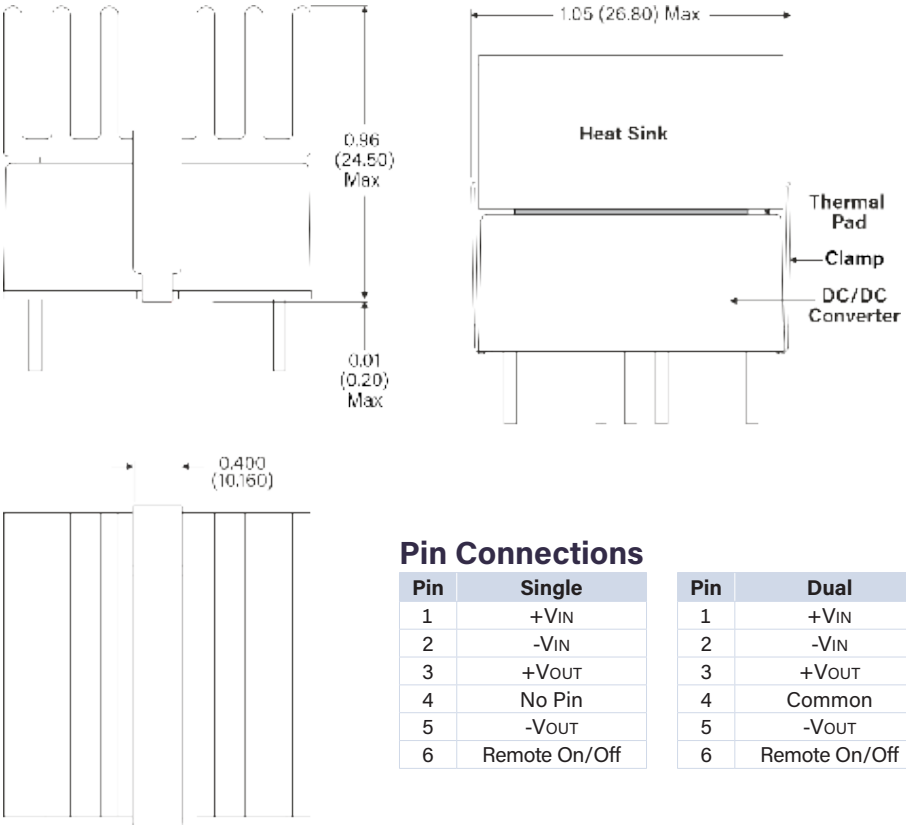
Pin	Single
1	+VIN
2	-VIN
3	+VOUT
4	No Pin
5	-VOUT
6	Remote On/Off

Pin	Dual
1	+VIN
2	-VIN
3	+VOUT
4	Common
5	-VOUT
6	Remote On/Off

Notes:

- All dimensions are typical in inches (mm)
- Pin 1 is marked by a "dot" or indentation on the unit
- General tolerance = ±0.01 (±0.25)
- Pin Tolerance = ±0.002 (±0.05)
- Recommended pin hole size (on the application PC Board) is Ø 0.05 (Ø 1.30)
- Weight (Typ) = **0.53 Oz (15g)**

Mechanical Dimensions: With Optional Heatsink



Pin Connections

Pin	Single
1	+VIN
2	-VIN
3	+VOUT
4	No Pin
5	-VOUT
6	Remote On/Off

Pin	Dual
1	+VIN
2	-VIN
3	+VOUT
4	Common
5	-VOUT
6	Remote On/Off

For the heatsink option, add suffix "H" to the model number (i.e. **MI1024S-12RW-H**)

Notes:

- All dimensions are typical in inches (mm)
- Pin 1 is marked by a "dot" or indentation on the unit
- General Tolerance = ±0.01 (±0.25)
- Pin Tolerance = ±0.002 (±0.05)
- Recommended pin hole size (on the application PC Board) is Ø 0.05 (Ø 0.130)
- Weight (Typ) = **0.60 Oz (17g)**

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