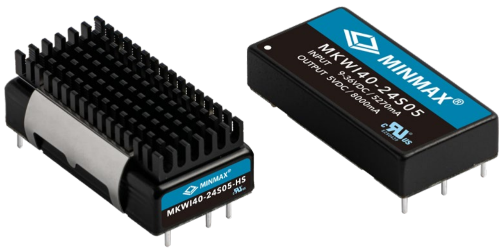
FEATURES

- Smallest Encapsulated 40W Converter
- Ultra-compact 2" X 1" Package
- Ultra-wide 4:1 Input Voltage Range
- Fully Regulated Output Voltage
- Excellent Efficiency up to 91%
- I/O Isolation 1500 VDC
- Operating Ambient Temp. Range -40℃ to +80℃
- No Min. Load Requirement
- Overload/Voltage/Temp. and Short Circuit Protection
- Remote On/Off Control, Output Voltage Trim
- Shielded Metal Case with Insulated Baseplate
- UL/cUL/IEC/EN 62368-1(60950-1) Safety Approval & CE Marking



PRODUCT OVERVIEW

The MINMAX MKWI40 series is the latest generation of high performance DC-DC converter modules setting a new standard concerning power density. The product offers fully 40W in an encapsulated, shielded metal package with dimensions of just 2.0"x1.0"x0.4". All models provide ultra-wide 4:1 input voltage range and precisely regulated output voltages.
Advanced circuit topology provides a very high efficiency up to 91% which allows an operating temperature range of -40℃ to +80℃. Further features include remote On/Off, trimmable output voltage, under-voltage lockout as well as overload and over-temperature protection. Typical applications for these converters are battery operated equipment, instrumentation, distributed power architectures in communication and industrial electronics and many other space critical applications.

Model Selection Guide

Model Number	Input Voltage (Range)	Output Voltage	Output Current		Input Current		Reflected Ripple Current	Over Voltage Protection	Max. capacitive Load	Efficiency (typ.)
			Max.	Min.	@Max. Load	@No Load				@Max. Load
	VDC	VDC	mA	mA	mA(typ.)	mA(typ.)	mA (typ.)	VDC	µF	%
MKWI40-24S033	24 (9 ~ 36)	3.3	8000	0	1240	90	30	3.9	21000	89
MKWI40-24S05		5	8000	0	1850	90		6.2	13600	90
MKWI40-24S12		12	3330	0	1870	95		15	2400	89
MKWI40-24S15		15	2670	0	1870	105		18	1500	89
MKWI40-24S24		24	1670	0	1835	115		30	600	91
MKWI40-24D12		±12	±1670	±145	1890	65		±15	1200#	88
MKWI40-24D15		±15	±1330	±110	1890	65		±18	750#	88
MKWI40-48S033	48 (18 ~ 75)	3.3	8000	0	620	55	20	3.9	21000	89
MKWI40-48S05		5	8000	0	930	55		6.2	13600	90
MKWI40-48S12		12	3330	0	930	60		15	2400	90
MKWI40-48S15		15	2670	0	930	65		18	1500	90
MKWI40-48S24		24	1670	0	918	75		30	600	91
MKWI40-48D12		±12	±1670	±145	950	45		±15	1200#	88
MKWI40-48D15		±15	±1330	±110	950	45		±18	750#	88

For each output

Input Specifications

Parameter	Conditions / Model	Min.	Typ.	Max.	Unit
Input Surge Voltage (100ms. max.)	24V Input Models	-0.7	---	50	VDC
	48V Input Models	-0.7	---	100	
Start-Up Threshold Voltage	24V Input Models	---	---	9	
	48V Input Models	---	---	18	
Under Voltage Lockout	24V Input Models	---	8.3	---	
	48V Input Models	---	16.5	---	
Start Up Time (Power On)	Nominal Vin and Constant Resistive Load	---	---	30	ms
Input Filter	All Models	Internal LC Type			

Remote On/Off Control

Parameter	Conditions	Min.	Typ.	Max.	Unit
Converter On	3.5V ~ 12V or Open Circuit				
Converter Off	0V ~ 1.2V or Short Circuit				
Control Input Current (on)	Vctrl = 5.0V	---	0.5	---	mA
Control Input Current (off)	Vctrl = 0V	---	-0.5	---	mA
Control Common	Referenced to Negative Input				
Standby Input Current	Nominal Vin	---	2.5	---	mA

Output Specifications

Parameter	Conditions / Model		Min.	Typ.	Max.	Unit
Output Voltage Setting Accuracy			---	---	±1.0	%Vnom.
Output Voltage Balance	Dual Output, Balanced Loads		---	---	±2.0	%
Line Regulation	Vin=Min. to Max. @Full Load		---	---	±0.5	%
Load Regulation	Min. Load to Full Load	Single Output	---	---	±0.5	%
		Dual Output	---	---	±1.0	%
Load Cross Regulation (Dual Output)	Asymmetrical Load 25%/100% Full Load		---	---	±5.0	%
Minimum Load	No Minimum Load Requirement for Single Output Models, for dual Output Models see Table					
Ripple & Noise	0-20 MHz Bandwidth	3.3V & 5V Models	---	---	100	mV P-P
		12V, 15V & 24V Models	---	---	150	mV P-P
		Dual Output Models	---	---	150	mV P-P
Transient Recovery Time	25% Load Step Change		---	250	---	μsec
Transient Response Deviation			---	±3	±5	%
Temperature Coefficient			---	---	±0.02	%/°C
Trim Up / Down Range (See Page 8)	% of Nominal Output Voltage	24Vo Models	---	---	+20 / -10	%
		Other Models	---	---	±10	
Over Load Protection	Current Limitation at 150% typ. of Iout max., Hiccup					
Short Circuit Protection	24Vo Models		Continuous, Automatic Recovery (Hiccup Mode 0.3Hz typ.)			
	Other Models		Continuous, Automatic Recovery (Hiccup Mode 1.5Hz typ.)			

General Specifications

Parameter	Conditions / Model	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	60 Seconds	1500	---	---	VDC
	1 Seconds	1800	---	---	VDC
I/O Isolation Resistance	500 VDC	1000	---	---	MΩ
I/O Isolation Capacitance	100kHz, 1V	---	---	1500	pF
Switching Frequency	24Vo Models	---	285	---	kHz
	Other Models	---	320	---	kHz
MTBF(calculated)	MIL-HDBK-217F@25°C, Ground Benign	328,000			Hours
Safety Approvals	UL/cUL 60950-1 recognition(CSA certificate), IEC/EN 60950-1(CB-report)				
	UL/cUL 62368-1 recognition(UL certificate), IEC/EN 62368-1(CB-report)				

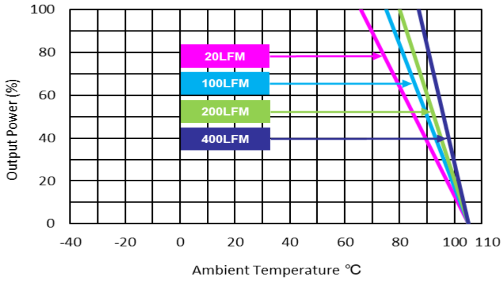
EMC Specifications

Parameter	Standards & Level			Performance
EMI(5)	Conduction	EN55032	With external components	Class A
	Radiation			
EMS(5)	EN 55035			
	ESD	EN61000-4-2 air ± 8kV , Contact ± 6kV		A
	Radiated immunity	EN61000-4-3 10V/m		A
	Fast transient	EN61000-4-4 ±2kV		A
	Surge	EN61000-4-5 ±1kV		A
	Conducted immunity	EN61000-4-6 10Vrms		A
	PFMF	EN61000-4-8 3A/m		A

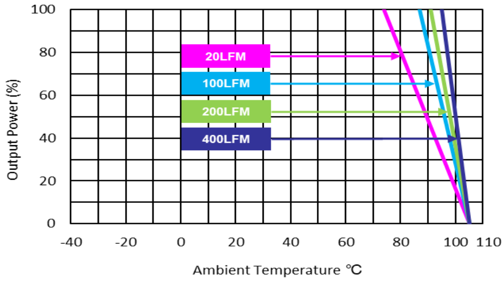
Environmental Specifications

Parameter	Conditions / Model	Min.	Max.		Unit
			without Heatsink	with Heatsink	
Operating Ambient Temperature Range Nominal Vin, Load 100% Inom. (for Power Derating see relative Derating Curves)	MKWI40-XXS033	-40	66	73	℃
	MKWI40-24S05, MKWI40-48S05		51	61	
	MKWI40-48S12, MKWI40-48S15				
	MKWI40-24S12, MKWI40-24S15		45	57	
	MKWI40-24S24, MKWI40-48S24		57	66	
	MKWI40-24D12, MKWI40-24D15		40	52	
	MKWI40-48D12, MKWI40-48D15				
Thermal Impedance	20LFM Convection without Heatsink	12.0	---		℃/W
	20LFM Convection with Heatsink	10.0	---		℃/W
	100LFM Convection without Heatsink	9.0	---		℃/W
	100LFM Convection with Heatsink	5.4	---		℃/W
	200LFM Convection without Heatsink	8.0	---		℃/W
	200LFM Convection with Heatsink	4.5	---		℃/W
	400LFM Convection without Heatsink	6.0	---		℃/W
	400LFM Convection with Heatsink	3.0	---		℃/W
Case Temperature		---	+105		℃
Thermal Protection	Shutdown Temperature	110℃ typ.			
Storage Temperature Range		-50	+125		℃
Humidity (non condensing)		---	95		% rel. H
RFI	Six-Sided Shielded, Metal Case				
Lead Temperature (1.5mm from case for 10Sec.)		---	260		℃

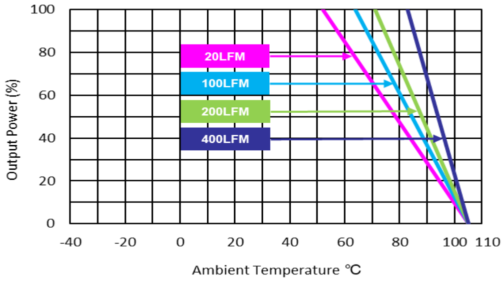
Power Derating Curve



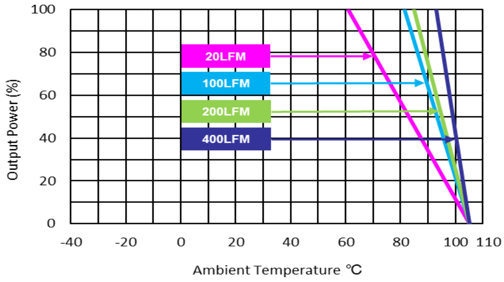
MKWI40-24S033, MKWI40-48S033 Derating Curve without Heatsink



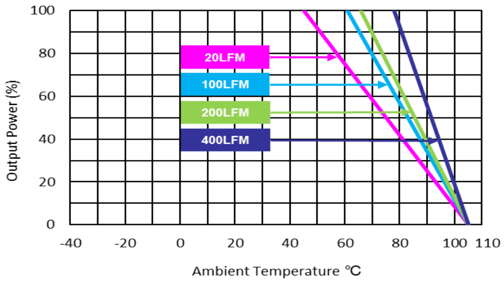
MKWI40-24S033, MKWI40-48S033 Derating Curve with Heatsink



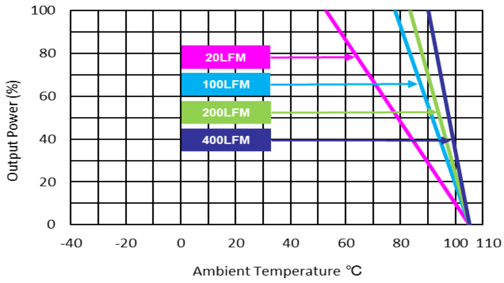
MKWI40-24S05, MKWI40-48S05, MKWI40-48S12, MKWI40-48S15
Derating Curve without Heatsink



MKWI40-24S05, MKWI40-48S05, MKWI40-48S12, MKWI40-48S15
Derating Curve with Heatsink

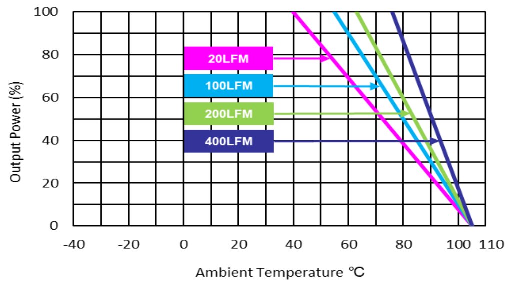


MKWI40-24S12, MKWI40-24S15 Derating Curve without Heatsink

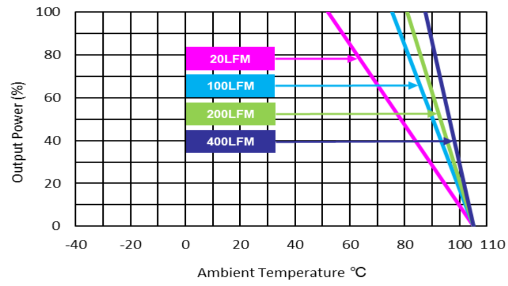


MKWI40-24S12, MKWI40-24S15 Derating Curve with Heatsink

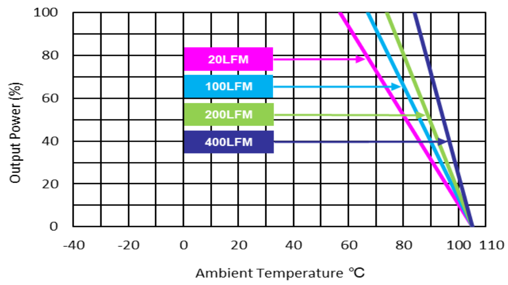
Power Derating Curve



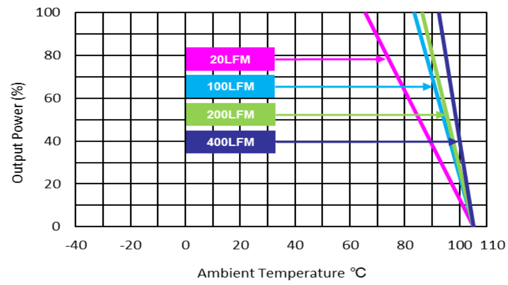
MKWI40-24D12, MKWI40-24D15, MKWI40-48D12, MKWI40-48D15
Derating Curve without Heatsink



MKWI40-24D12, MKWI40-24D15, MKWI40-48D12, MKWI40-48D15
Derating Curve with Heatsink



MKWI40-24S24, MKWI40-48S24 Derating Curve without Heatsink



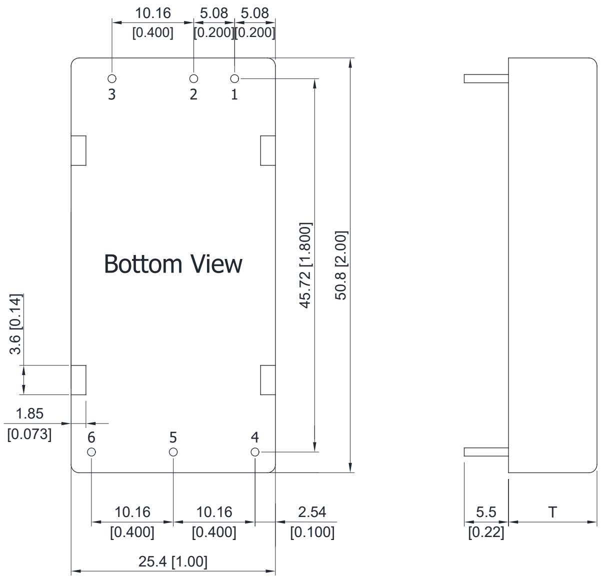
MKWI40-24S24, MKWI40-48S24 Derating Curve with Heatsink

Notes

1. Specifications typical at Ta=+25℃, resistive load, nominal input voltage and rated output current unless otherwise noted.
2. Transient recovery time is measured to within 1% error band for a step change in output load of 75% to 100%.
3. Ripple & Noise measurement with a 1μF/50V M/C and a 10μF50V T/C.
4. We recommend to protect the converter by a slow blow fuse in the input supply line.
5. Other input and output voltage may be available, please contact MINMAX.
6. The external components might be required to meet EMI/EMS standard for some of test items. Please contact MINMAX for the solution in detail.
7. Do not exceed maximum power specification when adjusting output voltage.
8. Specifications are subject to change without notice.
9. The repeated high voltage isolation testing of the converter can degrade isolation capability, to a lesser or greater degree depending on materials, construction, environment and reflow solder process. Any material is susceptible to eventual chemical degradation when subject to very high applied voltages thus implying that the number of tests should be strictly limited. We therefore strongly advise against repeated high voltage isolation testing, but if it is absolutely required, that the voltage be reduced by 20% from specified test voltage. Furthermore, the high voltage isolation capability after reflow solder process should be evaluated as it is applied on system.

Package Specifications

Mechanical Dimensions



Pin Connections

Pin	Single Output	Dual Output	Diameter mm (inches)
1	+Vin	+Vin	Ø 1.0 [0.04]
2	-Vin	-Vin	Ø 1.0 [0.04]
3	Remote On/Off	Remote On/Off	Ø 1.0 [0.04]
4	+Vout	+Vout	Ø 1.0 [0.04]
5	-Vout	Common	Ø 1.0 [0.04]
6	Trim	-Vout	Ø 1.0 [0.04]

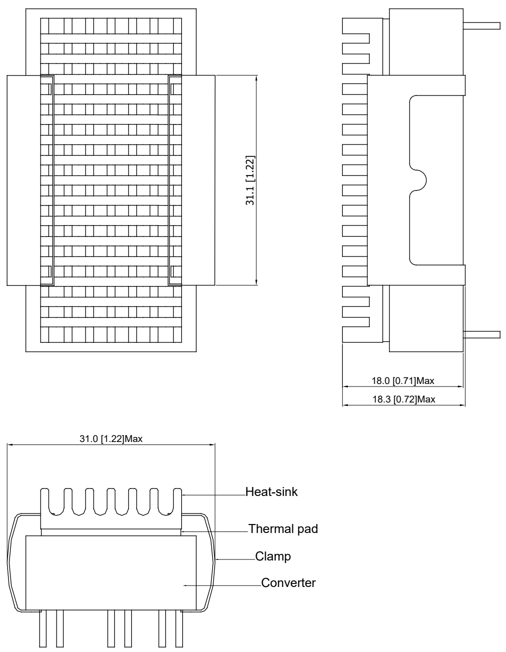
T: 11.0mm(0.43 inch) for 24V Output Models
T: 10.2mm(0.40 inch) for Other Output Models

- ►All dimensions in mm (inches)
- ►Tolerance: X.X±0.25 (X.XX±0.01)
  X.XX±0.13 (X.XXX±0.005)
- ►Pin diameter tolerance: X.X±0.05 (X.XX±0.002)

Physical Characteristics

Case Size (24V Output)	:	50.8x25.4x11.0mm (2.0x1.0x0.43 inches)
Case Size (Other Output)	:	50.8x25.4x10.2mm (2.0x1.0x0.40 inches)
Case Material	:	Metal With Non-Conductive Baseplate
Base Material	:	FR4 PCB (flammability to UL 94V-0 rated)
Pin Material	:	Copper Alloy
Weight	:	30g

Heatsink For 24V Output Models (Option –HS)



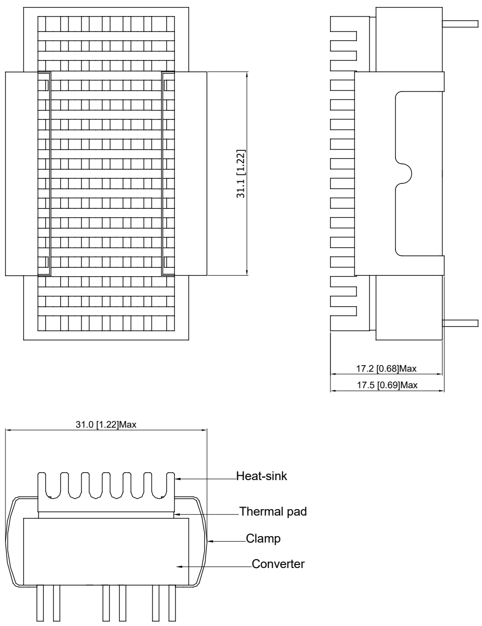
Physical Characteristics

Heatsink Material	:	Aluminum
Finish	:	Black Anodized Coating
Weight	:	9g

► The advantages of adding a heatsink are:

1. To improve heat dissipation and increase the stability and reliability of the DC-DC converters at high operating temperatures.
2. To increase operating temperature of the DC-DC converter, please refer to Derating Curve.

Heatsink For Other Output Models (Option –HS)



Physical Characteristics

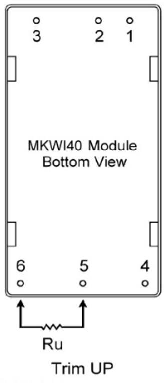
Heatsink Material	:	Aluminum
Finish	:	Black Anodized Coating
Weight	:	9g

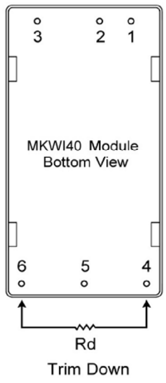
► The advantages of adding a heatsink are:

1. To improve heat dissipation and increase the stability and reliability of the DC-DC converters at high operating temperatures.
2. To increase operating temperature of the DC-DC converter, please refer to Derating Curve.

External Output Trimming

Output can be externally trimmed by using the method shown below



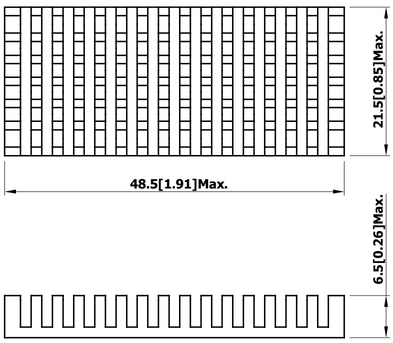


	MKWI40-XXS033		MKWI40-XXS05		MKWI40-XXS12		MKWI40-XXS15		MKWI40-XXS24	
Trim Range (%)	Trim down (kΩ)	Trim up (kΩ)	Trim down (kΩ)	Trim up (kΩ)	Trim down (kΩ)	Trim up (kΩ)	Trim down (kΩ)	Trim up (kΩ)	Trim down (kΩ)	Trim up (kΩ)
1	72.61	60.84	138.88	106.87	413.55	351.00	530.73	422.77	333.39	---
2	32.55	27.40	62.41	47.76	184.55	157.50	238.61	189.89	148.80	243.70
3	19.20	16.25	36.92	28.06	108.22	93.00	141.24	112.26	87.26	---
4	12.52	10.68	24.18	18.21	70.05	60.75	92.56	73.44	56.50	108.50
5	8.51	7.34	16.53	12.30	47.15	41.40	63.35	50.15	38.04	---
6	5.84	5.11	11.44	8.36	31.88	28.50	43.87	34.63	25.73	63.43
7	3.94	3.51	7.79	5.55	20.98	19.29	29.96	23.54	16.94	---
8	2.51	2.32	5.06	3.44	12.80	12.37	19.53	15.22	10.35	40.90
9	1.39	1.39	2.94	1.79	6.44	7.00	11.41	8.75	5.22	---
10	0.50	0.65	1.24	0.48	1.35	2.70	4.92	3.58	1.12	27.38
12	---	---	---	---	---	---	---	---	---	18.37
14	---	---	---	---	---	---	---	---	---	11.93
16	---	---	---	---	---	---	---	---	---	7.10
18	---	---	---	---	---	---	---	---	---	3.34
20	---	---	---	---	---	---	---	---	---	0.34

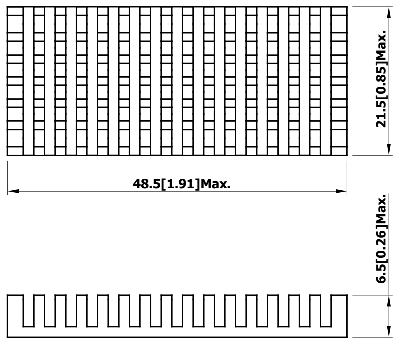
Order Code Table For Converter and Converter With Heatsink		
Standard	With heatsink	Without Remote On/Off
MKWI40-24S033	MKWI40-24S033-HS	MKWI40-24S033-N
MKWI40-24S05	MKWI40-24S05-HS	MKWI40-24S05-N
MKWI40-24S12	MKWI40-24S12-HS	MKWI40-24S12-N
MKWI40-24S15	MKWI40-24S15-HS	MKWI40-24S15-N
MKWI40-24S24	MKWI40-24S24-HS	MKWI40-24S24-N
MKWI40-24D12	MKWI40-24D12-HS	MKWI40-24D12-N
MKWI40-24D15	MKWI40-24D15-HS	MKWI40-24D15-N
MKWI40-48S033	MKWI40-48S033-HS	MKWI40-48S033-N
MKWI40-48S05	MKWI40-48S05-HS	MKWI40-48S05-N
MKWI40-48S12	MKWI40-48S12-HS	MKWI40-48S12-N
MKWI40-48S15	MKWI40-48S15-HS	MKWI40-48S15-N
MKWI40-48S24	MKWI40-48S24-HS	MKWI40-48S24-N
MKWI40-48D12	MKWI40-48D12-HS	MKWI40-48D12-N
MKWI40-48D15	MKWI40-48D15-HS	MKWI40-48D15-N

Order Code Table For Heatsink kit (including: Heatsink x1, Clamp x 2, Thermal Pad x1)

HS-K001 (Other Output)



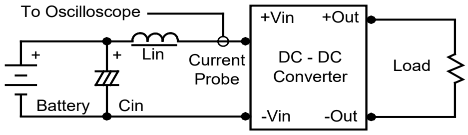
HS-K002 (24V Output)



Test Setup

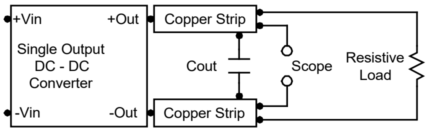
Input Reflected-Ripple Current Test Setup

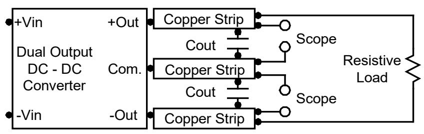
Input reflected-ripple current is measured with a inductor Lin (4.7μH) and Cin (220μF, ESR < 1.0Ω at 100 kHz) to simulate source impedance.
Capacitor Cin, offsets possible battery impedance. Current ripple is measured at the input terminals of the module, measurement bandwidth is 0-500 kHz.



Peak-to-Peak Output Noise Measurement Test

Use a 1μF ceramic capacitor and a 10μF tantalum capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is 0-20 MHz. Position the load between 50 mm and 75 mm from the DC-DC Converter.





Technical Notes

Remote On/Off

Positive logic remote on/off turns the module on during a logic high voltage on the remote on/off pin, and off during a logic low. To turn the power module on and off, the user must supply a switch to control the voltage between the on/off terminal and the -Vin terminal. The switch can be an open collector or equivalent. A logic low is 0V to 1.2V. A logic high is 4.7V to 12V. The maximum sink current at the on/off terminal (Pin 3) during a logic low is -100μA. The maximum allowable leakage current of a switch connected to the on/off terminal (Pin 3) at logic high (2.5V to 100V) is 5μA.

Overcurrent Protection

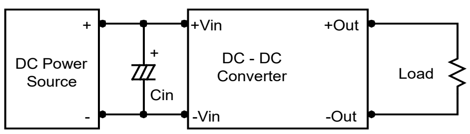
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

Overvoltage Protection

The output overvoltage clamp consists of control circuitry, which is independent of the primary regulation loop, that monitors the voltage on the output terminals. The control loop of the clamp has a higher voltage set point than the primary loop. This provides a redundant voltage control that reduces the risk of output overvoltage. The OVP level can be found in the output data.

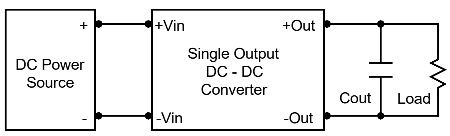
Input Source Impedance

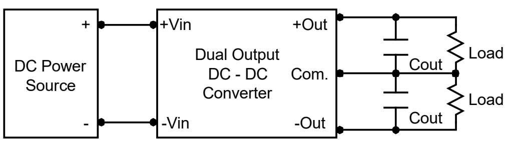
The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module.
In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup.
Capacitor mounted close to the power module helps ensure stability of the unit, it is recommended to use a good quality low Equivalent Series Resistance (ESR < 1.0Ω at 100 kHz) capacitor of a 10μF for the 24V and 48V devices.



Output Ripple Reduction

A good quality low ESR capacitor placed as close as practicable across the load will give the best ripple and noise performance. To reduce output ripple, it is recommended to use 4.7μF capacitors at the output.



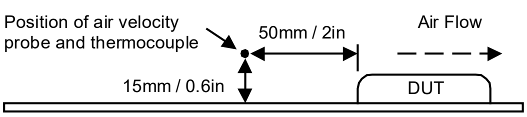


Maximum Capacitive Load

The MKWI40 series has limitation of maximum connected capacitance at the output. The power module may be operated in current limiting mode during start-up, affecting the ramp-up and the startup time. The maximum capacitance can be found in the data sheet.

Thermal Considerations

Many conditions affect the thermal performance of the power module, such as orientation, airflow over the module and board spacing. To avoid exceeding the maximum temperature rating of the components inside the power module, the case temperature must be kept below 105°C. The derating curves are determined from measurements obtained in a test setup.



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