

FEATURES

- ▶ **Smallest Encapsulated 50W Converter!**
- ▶ **Package Size 2.0" x 1.0" x 0.4"**
- ▶ **Wide 2:1 Input Range**
- ▶ **Excellent Efficiency up to 92%**
- ▶ **Over-Temperature Protection**
- ▶ **I/O-isolation Voltage 1500VDC**
- ▶ **Remote On/Off Control**
- ▶ **Shielded Metal Case with Isolated Baseplate**
- ▶ **Heatsink (Optional)**
- ▶ **UL/cUL/IEC/EN 60950-1 Safety Approval**
- ▶ **3 Years Product Warranty**


PRODUCT OVERVIEW

The MINMAX MKW50 series is the latest generation of high performance dc-dc converter modules setting a new standard concerning power density. The product offers fully 50W in an encapsulated, shielded metal package with dimensions of just 2.0"x1.0"x0.4". All models provide wide 2:1 input voltage range and precisely regulated output voltages.

Advanced circuit topology provides a very high efficiency up to 92% which allows an operating temperature range of -40°C to +80°C. Further features include remote On/Off, trimmable output voltage, under-voltage shutdown 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) VDC	Output Voltage VDC	Output Current Max. mA	Input Current		Reflected Ripple Current mA(typ.)	Over Voltage Protection VDC	Max. capacitive Load µF	Efficiency (typ.)
				@Max. Load	@No Load				@Max. Load
				mA(typ.)	mA(typ.)				%
MKW50-12S033	12 (9 ~ 18)	3.3	10000	3090	85	50	3.9	25800	89
MKW50-12S05		5	10000	4630	110		6.2	17000	90
MKW50-12S12		12	4170	4580	160		15	2900	91
MKW50-12S15		15	3330	4580	160		18	1900	91
MKW50-12S24		24	2080	4570	250		30	750	91
MKW50-24S033	24 (18 ~ 36)	3.3	10000	1550	50	40	3.9	25800	89
MKW50-24S05		5	10000	2260	70		6.2	17000	92
MKW50-24S12		12	4170	2260	85		15	2900	92
MKW50-24S15		15	3330	2260	85		18	1900	92
MKW50-24S24		24	2080	2290	110		30	750	91
MKW50-48S033	48 (36 ~ 75)	3.3	10000	770	35	30	3.9	25800	89
MKW50-48S05		5	10000	1130	45		6.2	17000	92
MKW50-48S12		12	4170	1130	50		15	2900	92
MKW50-48S15		15	3330	1130	50		18	1900	92
MKW50-48S24		24	2080	1150	60		30	750	91

Input Specifications

Parameter	Model	Min.	Typ.	Max.	Unit	
Input Surge Voltage (100ms. max)	12V Input Models	-0.7	---	25	VDC	
	24V Input Models	-0.7	---	50		
	48V Input Models	-0.7	---	100		
Start-Up Threshold Voltage	12V Input Models	---	---	9		
	24V Input Models	---	---	18		
	48V Input Models	---	---	36		
Under Voltage Lockout	12V Input Models	---	8.3	---		
	24V Input Models	---	16.5	---		
	48V Input Models	---	33	---		
Input Polarity Protection	None					
Start Up Time	Power Up	Nominal Vin and Constant Resistive Load	---	---	30	ms
	Remote On/Off		---	---	30	ms
Conducted EMI	All Models	Internal LC Filter (for EN55022, Class A and FCC level A compliance see note 7)				
Short Circuit Current	--- (Hiccup Mode 1.5 Hz typ, 24V Output Model: 0.3 Hz typ.)					

Output Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit	
Output Voltage Setting Accuracy		---	---	±1.0	%V _{nom.}	
Line Regulation	V _{in} =Min. to Max. @ Full Load	---	---	±0.5	%	
Load Regulation	Min. Load to Full Load	---	---	±0.5	%	
Minimum Load	No minimum Load Requirement					
Ripple & Noise	0-20 MHz Bandwidth	3.3V & 5V Models ⁽³⁾	---	---	100	mV _{P-P}
		12V, 15V & 24V Models ⁽³⁾	---	---	150	mV _{P-P}
Transient Recovery Time	25% Load Step Change ⁽²⁾	---	250	---	µsec	
Transient Response Deviation		---	±3	±5	%	
Temperature Coefficient		---	---	±0.02	%/°C	
Over Current Protection	Current Limitation at 150% typ. of I _{out} max., Hiccup					
Short Circuit Protection	Hiccup Automatic Recovery					
Over Voltage Protection	For Shutdown Voltage see Model Selection Guide					

General Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage (rated)	60 Seconds	1500	---	---	VDC
I/O Isolation Resistance	500 VDC	1000	---	---	MΩ
I/O Isolation Capacitance	100KHz, 1V	---	---	2200	pF
Switching Frequency	24Vo Models	---	285	---	KHz
	Other Models	---	320	---	KHz
MTBF(calculated)	MIL-HDBK-217F@25°C, Ground Benign	224,700			Hours
Safety Approvals	UL/cUL 60950-1 recognition (CSA certificate), IEC/EN 60950-1(CB-scheme)				

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)	V _{ctrl} = 5.0V	---	0.5	---	mA
Control Input Current (off)	V _{ctrl} = 0V	---	-0.5	---	mA
Control Common	Referenced to Negative Input				
Standby Input Current	Nominal V _{in}	---	2.5	---	mA

Output Voltage Trim

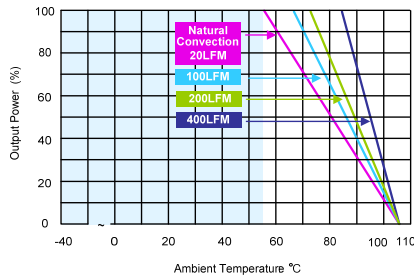
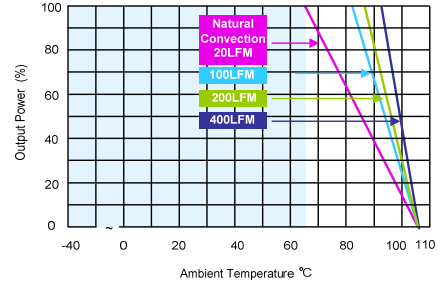
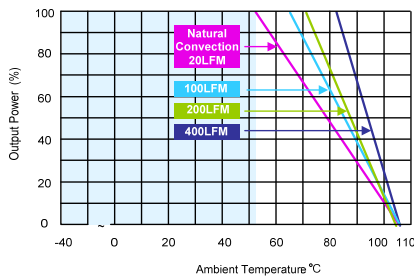
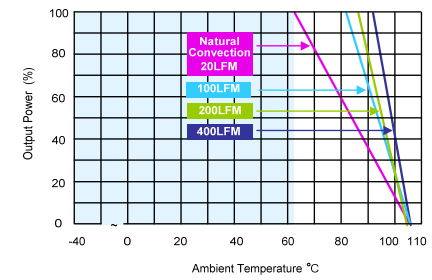
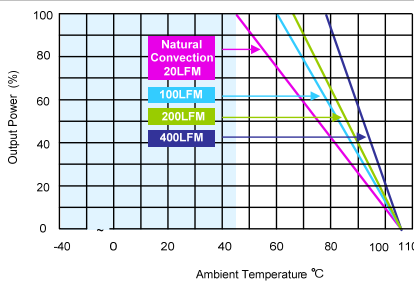
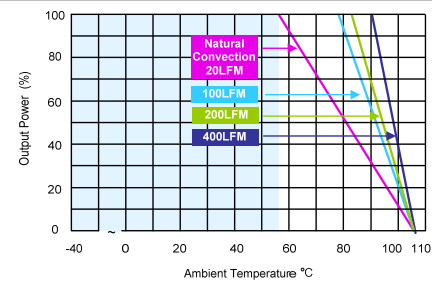
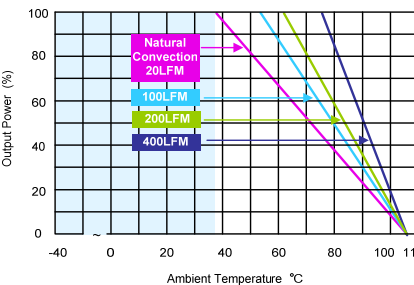
Parameter	Conditions	Min.	Typ.	Max.	Unit	
Trim Up / Down Range ⁽⁹⁾	% of Nominal Output Voltage	24Vo Models	+20 / -10	---	---	%
		Other Models	±10	---	---	%

Environmental Specifications

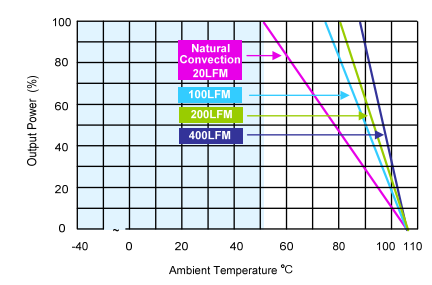
Parameter	Model	Min.	Max.		Unit
			without Heatsink	with Heatsink	
Operating Temperature Range Natural Convection ⁽¹⁰⁾ Nominal V _{in} , Load 100% I _{nom.} (for Power Derating see relative Derating Curves)	MKW50-XXS033	-40	56	64	°C
	MKW50-24S05, MKW50-24S12		53	62	
	MKW50-24S15, MKW50-48S05				
	MKW50-48S12, MKW50-48S15				
	MKW50-12S12, MKW50-12S15		46	56	
	MKW50-12S24, MKW50-24S24				
	MKW50-48S24		38	49	
MKW50-12S05					
Thermal Impedance	Natural Convection without Heatsink	12.1	---	---	°C/W
	Natural Convection with Heatsink	9.8	---	---	°C/W
	100LFM Convection without Heatsink	9.2	---	---	°C/W
	100LFM Convection with Heatsink	5.4	---	---	°C/W
	200LFM Convection without Heatsink	7.8	---	---	°C/W
	200LFM Convection with Heatsink	4.5	---	---	°C/W
	400LFM Convection without Heatsink	5.2	---	---	°C/W
400LFM Convection with Heatsink	3.0	---	---	°C/W	
Case Temperature		---	+105		°C
Thermal Protection	Shutdown Temperature		110°C typ.		
Storage Temperature Range		-50	+125		°C
Humidity (non condensing)		---	95		% rel. H
Cooling	Free-Air convection				
RFI	Six-Sided Shielded, Metal Case				
Lead Temperature (1.5mm from case for 10Sec.)		---	260		°C

EMC Specifications

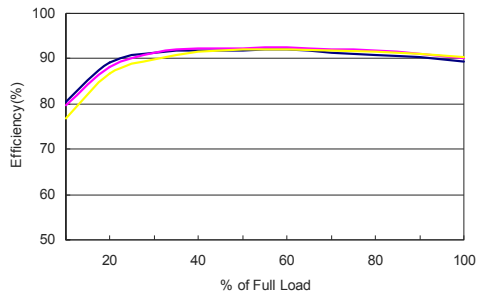
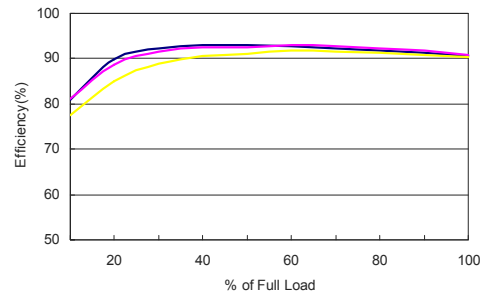
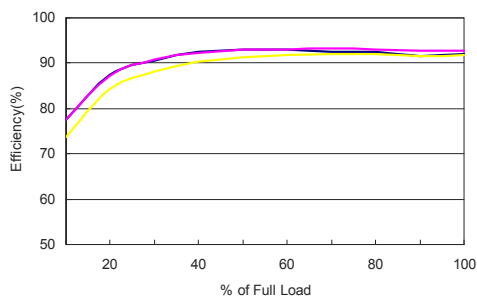
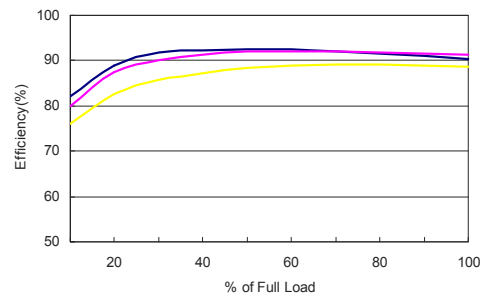
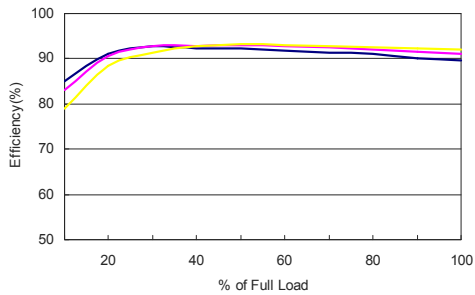
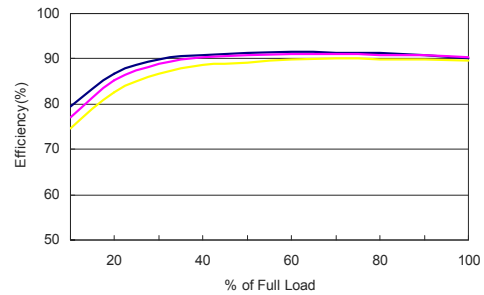
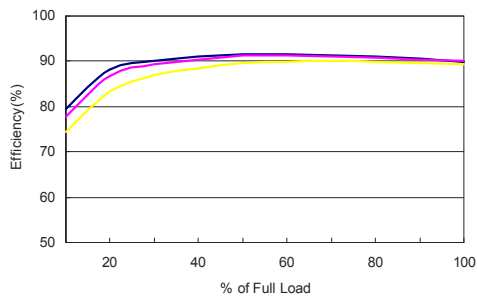
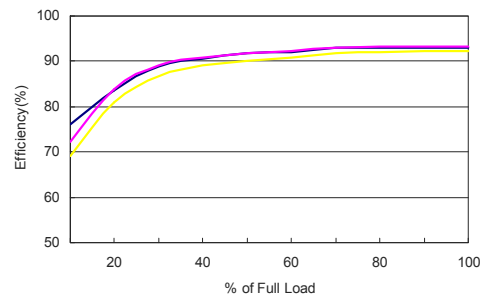
Parameter	Standards & Level		Performance
EMI	EN55022, FCC part 15		Class A (7)
EMS	EN55024		
	ESD	EN61000-4-2 air \pm 8kV , Contact \pm 6kV	A
	Radiated immunity	EN61000-4-3 10V/m	A
	Fast transient (8)	EN61000-4-4 \pm 2kV	A
	Surge (8)	EN61000-4-5 \pm 1kV	A
Conducted immunity	EN61000-4-6 10Vrms	A	

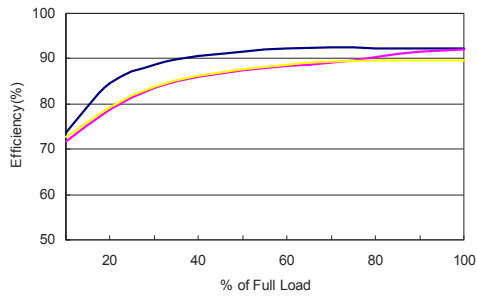
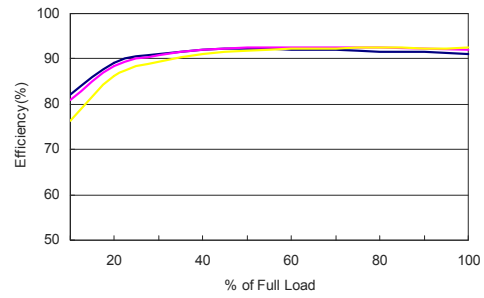
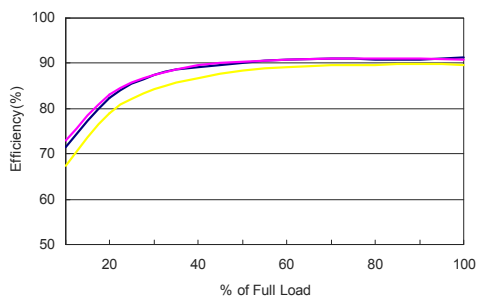
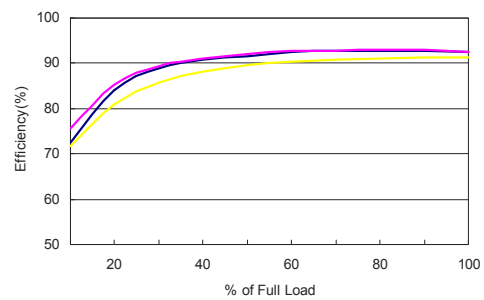
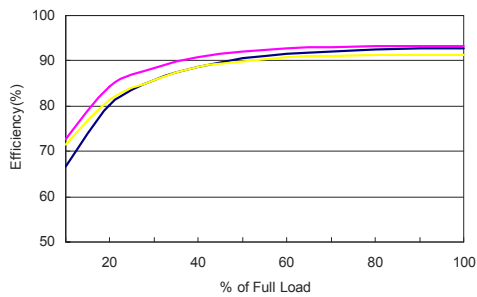
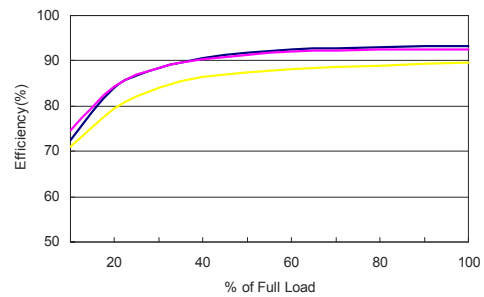
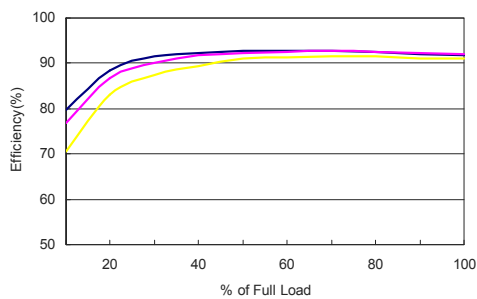
Power Derating Curve

 MKW50-12S033, MKW50-24S033, MKW50-48S033
 Derating Curve without Heatsink

 MKW50-12S033, MKW50-24S033, MKW50-48S033
 Derating Curve with Heatsink

 MKW50-24S05, MKW50-24S12, MKW50-24S15, MKW50-48S05,
 MKW50-48S12, MKW50-48S15 Derating Curve without Heatsink

 MKW50-24S05, MKW50-24S12, MKW50-24S15, MKW50-48S05,
 MKW50-48S12, MKW50-48S15 Derating Curve with Heatsink

 MKW50-12S12, MKW50-12S15, MKW50-12S24, MKW50-24S24,
 MKW50-48S24 Derating Curve without Heatsink

 MKW50-12S12, MKW50-12S15, MKW50-12S24, MKW50-24S24,
 MKW50-48S24 Derating Curve with Heatsink


MKW50-12S05 Derating Curve without Heatsink



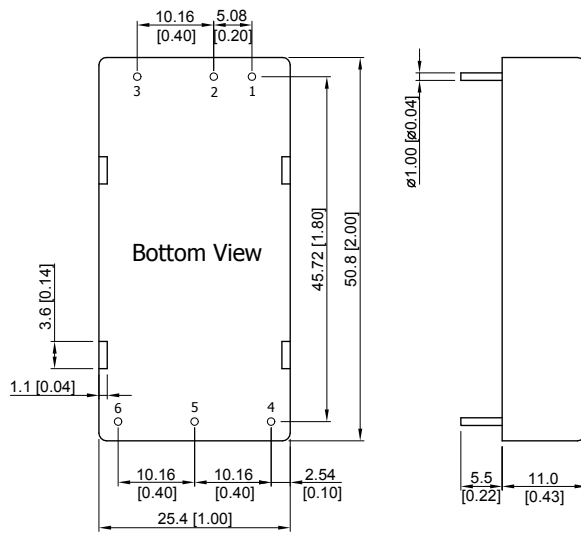
MKW50-12S05 Derating Curve with Heatsink

Efficiency Curve @25°C

MKW50-12S033 Efficiency vs Load Current

MKW50-12S05 Efficiency vs Load Current

MKW50-12S12 Efficiency vs Load Current

MKW50-12S15 Efficiency vs Load Current

MKW50-12S24 Efficiency vs Load Current

MKW50-24S033 Efficiency vs Load Current

MKW50-24S05 Efficiency vs Load Current

MKW50-24S12 Efficiency vs Load Current

Efficiency Curve @25°C

MKW50-24S15 Efficiency vs Load Current

MKW50-24S24 Efficiency vs Load Current

MKW50-48S033 Efficiency vs Load Current

MKW50-48S05 Efficiency vs Load Current

MKW50-48S12 Efficiency vs Load Current

MKW50-48S05 Efficiency vs Load Current

MKW50-48S15 Efficiency vs Load Current
MKW50-48S24 Efficiency vs Load Current

Notes

- 1 Specifications typical at Ta=+25°C, 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 MLCC and a 10µF Tantalum Capatitor.
- 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 factory.
- 6 To order the converter with heatsink, please add a **suffix -HS** (e.g. MKW50-12S05-HS) to order code.
- 7 The MKW50 series can meet EN55022 Class A with parallel an external capacitor to the input pins. (12Vin: 22µF/25V 1210 MLCC, 24Vin: 3.3µF/50V 1210 MLCC, 48Vin: 2.2µF/100V 1210 MLCC.
- 8 To meet EN61000-4-4 & EN61000-4-5 an external capacitor across the input pins is required. Suggested capacitor: CHEMI-CON KY 330µF/100V.
- 9 Do not exceed maximum power specification when adjusting output voltage.
- 10 That "natural convection" is about 20LFM but is not equal to still air (0 LFM).
- 11 Specifications are subject to change without notice.

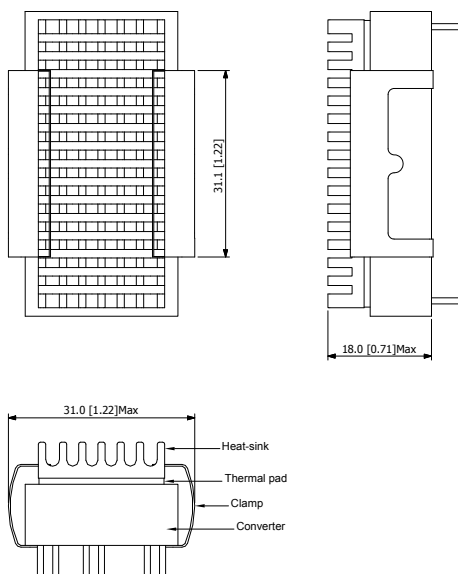
Package Specifications
Mechanical Dimensions

Pin Connections

Pin	Function
1	+Vin
2	-Vin
3	Remote On/Off
4	+Vout
5	-Vout
6	Trim

- ▶ All dimensions in mm (inches)
- ▶ Tolerance: X.X±0.25 (X.XX±0.01)
X.XX±0.13 (X.XXX±0.005)
- ▶ Pin diameter $\phi 1.0 \pm 0.05$ (0.04±0.002)

Physical Characteristics

Case Size	: 50.8x25.4x11.0mm (2.0x1.0x0.43 inches)
Case Material	: Aluminium Alloy, Black Anodized Coating
Base Material	: FR4 PCB (flammability to UL 94V-0 rated)
Pin Material	: Copper Alloy with Gold Plate Over Nickel Subplate
Potting Material	: Epoxy (UL94-V0)
Weight	: 30g

Heatsink (Option -HS)

Physical Characteristics

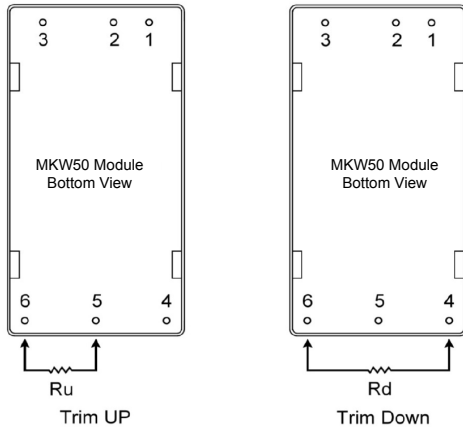
Heatsink Material	: Aluminum
Finish	: Black Anodized Coating
Weight	: 9g

▶ 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


MKW50-XXS033 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	72.61	32.55	19.20	12.52	8.51	5.84	3.94	2.51	1.39	0.50	KOhms
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox1.01	Vox1.02	Vox1.03	Vox1.04	Vox1.05	Vox1.06	Vox1.07	Vox1.08	Vox1.09	Vox1.10	Volts
Ru=	60.84	27.40	16.25	10.68	7.34	5.11	3.51	2.32	1.39	0.65	KOhms

MKW50-XXS05 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	138.88	62.41	36.92	24.18	16.53	11.44	7.79	5.06	2.94	1.24	KOhms
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox1.01	Vox1.02	Vox1.03	Vox1.04	Vox1.05	Vox1.06	Vox1.07	Vox1.08	Vox1.09	Vox1.10	Volts
Ru=	106.87	47.76	28.06	18.21	12.30	8.36	5.55	3.44	1.79	0.48	KOhms

MKW50-XXS12 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	413.55	184.55	108.22	70.05	47.15	31.88	20.98	12.80	6.44	1.35	KOhms
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox1.01	Vox1.02	Vox1.03	Vox1.04	Vox1.05	Vox1.06	Vox1.07	Vox1.08	Vox1.09	Vox1.10	Volts
Ru=	351.00	157.50	93.00	60.75	41.40	28.50	19.29	12.37	7.00	2.70	KOhms

MKW50-XXS15 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	530.73	238.61	141.24	92.56	63.35	43.87	29.96	19.53	11.41	4.92	KOhms
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox1.01	Vox1.02	Vox1.03	Vox1.04	Vox1.05	Vox1.06	Vox1.07	Vox1.08	Vox1.09	Vox1.10	Volts
Ru=	422.77	189.89	112.26	73.44	50.15	34.63	23.54	15.22	8.75	3.58	KOhms

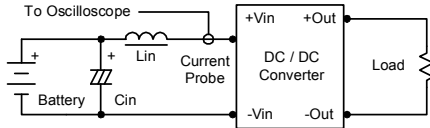
MKW50-XXS24 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	333.39	148.80	87.26	56.50	38.04	25.73	16.94	10.35	5.22	1.12	KOhms
Trim up	2	4	6	8	10	12	14	16	18	20	%
Vout=	Vox1.02	Vox1.04	Vox1.06	Vox1.08	Vox1.1	Vox1.12	Vox1.14	Vox1.16	Vox1.18	Vox1.2	Volts
Ru=	243.70	108.50	63.43	40.90	27.38	18.37	11.93	7.10	3.34	0.34	KOhms

Test Setup

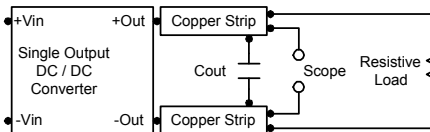
Input Reflected-Ripple Current Test Setup

Input reflected-ripple current is measured with an inductor L_{in} (4.7 μ H) and C_{in} (220 μ F, ESR < 1.0 Ω at 100 KHz) to simulate source impedance. Capacitor C_{in} , 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 1 μ F ceramic capacitor and a 10 μ F 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 3.5V to 12V. The maximum sink current at the on/off terminal (Pin 3) during a logic low is -100 μ A.

Overcurrent Protection

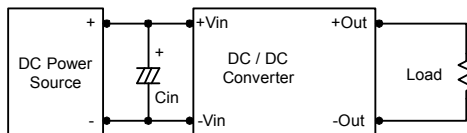
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

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.

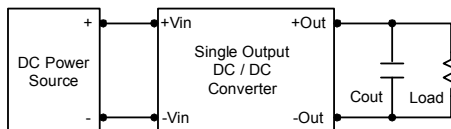
Input Source Impedance

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 < 1.0 Ω at 100 KHz) capacitor of a 33 μ F for the 12V input devices and a 10 μ F 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 4.7 μ F capacitors at the output.



Maximum Capacitive Load

The MKW50 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.

