FEATURES

- Smallest Encapsulated 50W Converter
- Ultra-compact 2" X 1" Package
- Wide 2:1 Input Voltage Range
- Fully Regulated Output Voltage
- Excellent Efficiency up to 92%
- 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 60950-1 Safety Approval



CSA 60950-1

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)	Output Voltage	Output Current	Input Current		Reflected Ripple Current	Over Voltage Protection	Max. capacitive Load	Efficiency (typ.)
			Max.	@Max. Load	@No Load				@Max. Load
	VDC	VDC	mA	mA(typ.)	mA(typ.)	mA(typ.)	VDC	μF	%
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 Shutdown		12V Input Models	---	8.3	---	
		24V Input Models	---	16.5	---	
		48V Input Models	---	33	---	
Start Up Time	Power Up	Nominal Vin and Constant Resistive Load	---	---	30	ms
	Remote On/Off		---	---	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.
Line Regulation	Vin=Min. to Max. @ Full Load		---	---	±0.5	%
Load Regulation	Io=0% to 100%		---	---	±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
Trim Up / Down Range (See Page 8)	% of Nominal Output Voltage	24Vo Models	---	---	+20 / -10	%
		Other Models	---	---	±10	%
Over Load Protection	Hiccup		---	150	---	%
Short Circuit Protection	24Vo Models		Hiccup Mode 0.3Hz typ. Automatic Recovery			
	Other Models		Hiccup Mode 1.5Hz typ. Automatic Recovery			

General Specifications

Parameter	Conditions / Model	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	60 Seconds	1500	---	---	VDC
	1 Second	1800	---	---	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-report)				

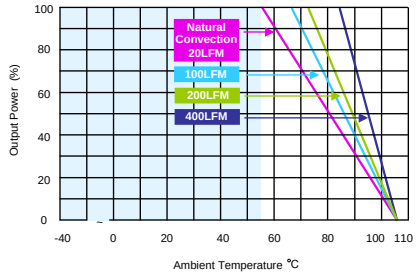
Environmental Specifications

Parameter	Conditions / Model	Min.	Max.		Unit
			without Heatsink	with Heatsink	
Operating Ambient Temperature Range Natural Convection (9) Nominal Vin, Load 100% Inom. (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				
	MKW50-12S05		38	49	
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	Natural Convection				
RFI	Six-Sided Shielded, Metal Case				
Lead Temperature (1.5mm from case for 10Sec.)		---	260		°C

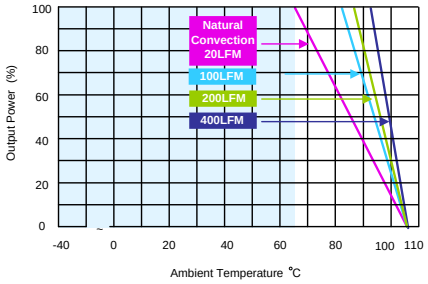
EMC Specifications

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

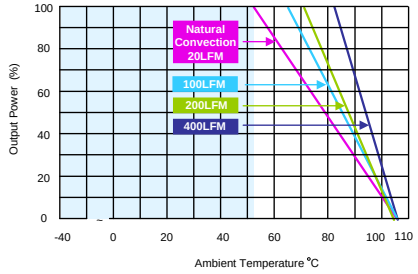
Power Derating Curve



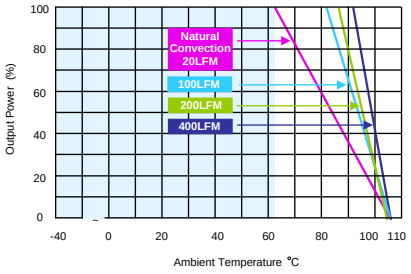
MKW50-12S033, MKW50-24S033, MKW50-48S033
Derating Curve without Heatsink



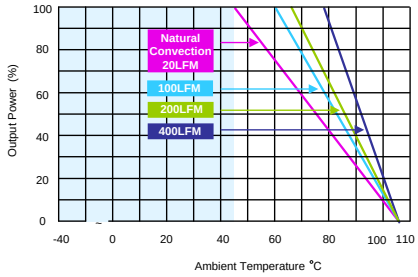
MKW50-12S033, MKW50-24S033, MKW50-48S033
Derating Curve with Heatsink



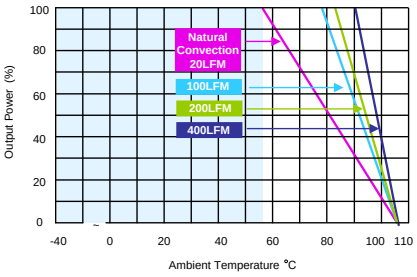
MKW50-24S05, MKW50-24S12, MKW50-24S15, MKW50-48S05,
MKW50-48S12, MKW50-48S15 Derating Curve without Heatsink



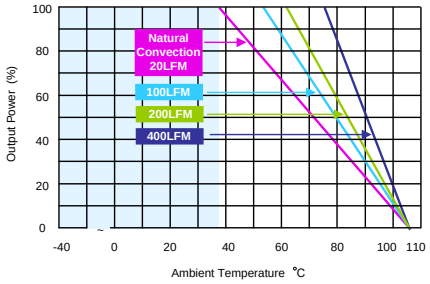
MKW50-24S05, MKW50-24S12, MKW50-24S15, MKW50-48S05,
MKW50-48S12, MKW50-48S15 Derating Curve with Heatsink



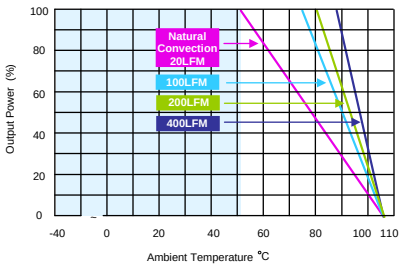
MKW50-12S12, MKW50-12S15, MKW50-12S24, MKW50-24S24,
MKW50-48S24 Derating Curve without Heatsink



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

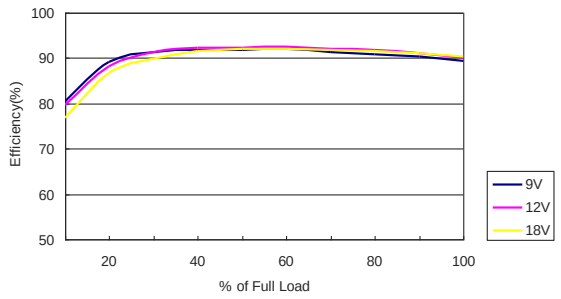


MKW50-12S05 Derating Curve without Heatsink

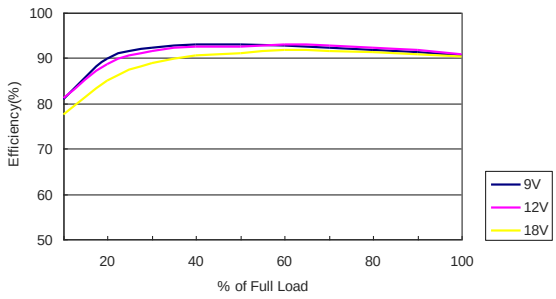


MKW50-12S05 Derating Curve with Heatsink

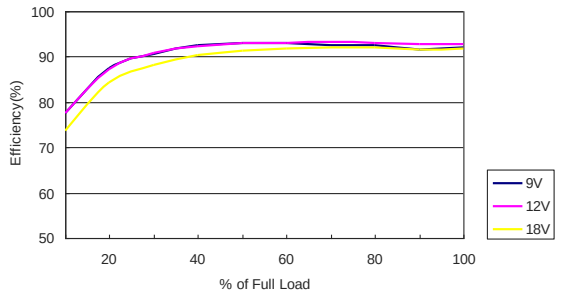
Efficiency Curve @25℃



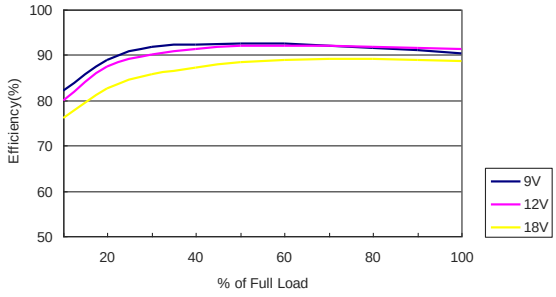
MKW50-12S033 Efficiency vs Load Current



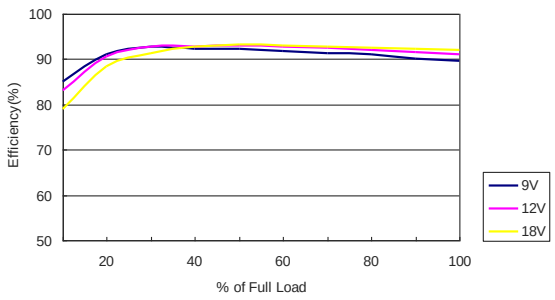
MKW50-12S05 Efficiency vs Load Current



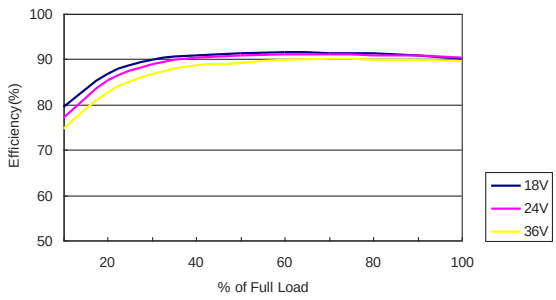
MKW50-12S12 Efficiency vs Load Current



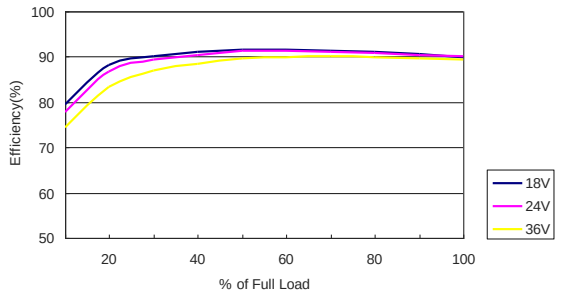
MKW50-12S15 Efficiency vs Load Current



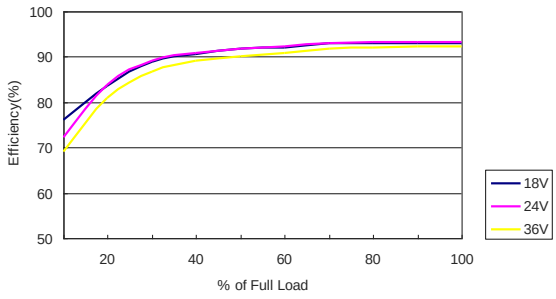
MKW50-12S24 Efficiency vs Load Current



MKW50-24S033 Efficiency vs Load Current

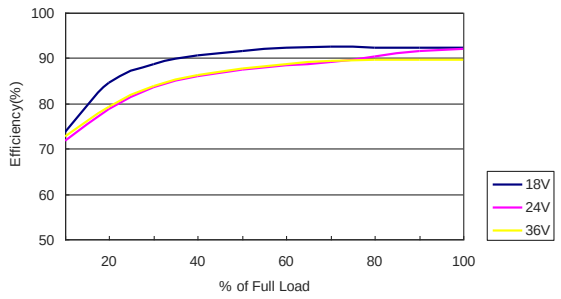


MKW50-24S05 Efficiency vs Load Current

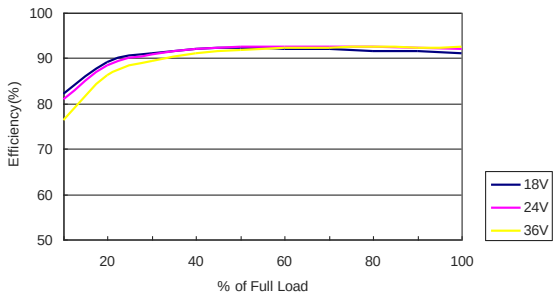


MKW50-24S12 Efficiency vs Load Current

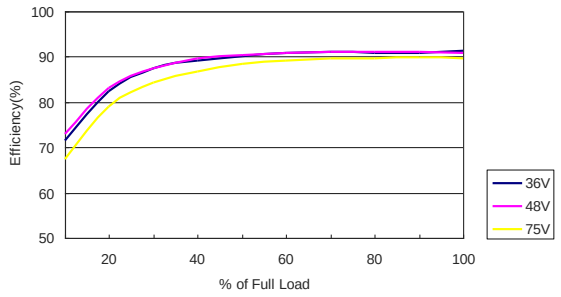
Efficiency Curve @25℃



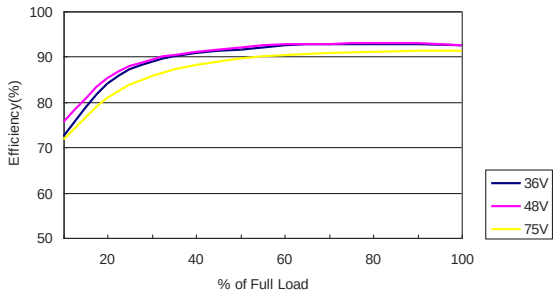
MKW50-24S15 Efficiency vs Load Current



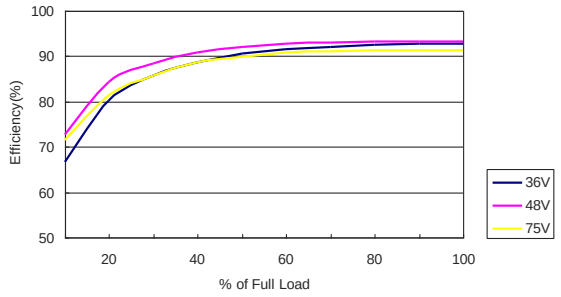
MKW50-24S24 Efficiency vs Load Current



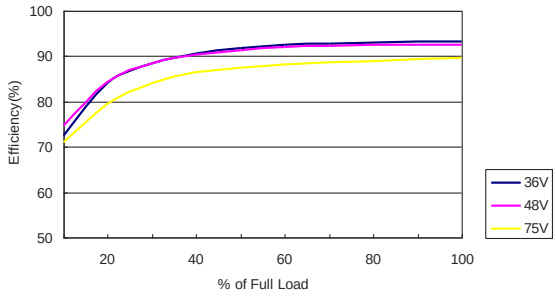
MKW50-48S033 Efficiency vs Load Current



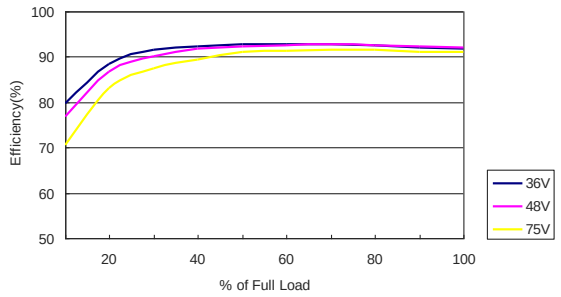
MKW50-48S05 Efficiency vs Load Current



MKW50-48S12 Efficiency vs Load Current



MKW50-48S15 Efficiency vs Load Current



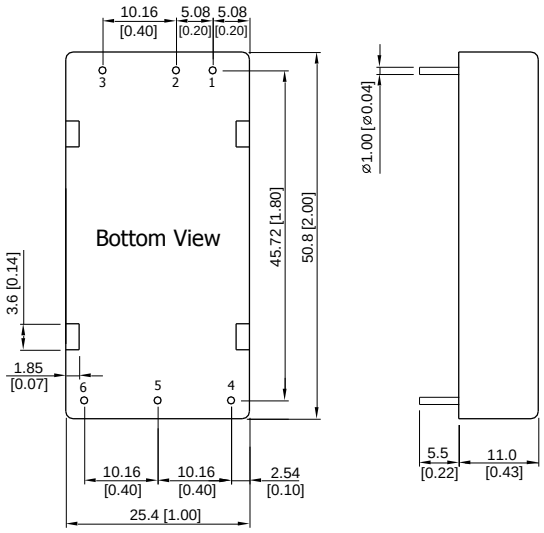
MKW50-48S24 Efficiency vs Load Current

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 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 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.
7 To meet EN61000-4-4 & EN61000-4-5 an external capacitor across the input pins is required. Suggested capacitor: 330μF/100V.
8 Do not exceed maximum power specification when adjusting output voltage.
9 That "natural convection" is about 20LFM but is not equal to still air (0 LFM).
10 Specifications are subject to change without notice.

Package Specifications

Mechanical Dimensions



Pin Connections

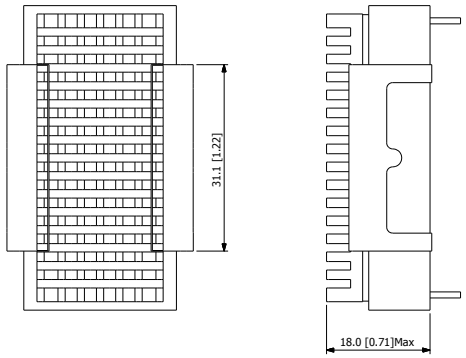
Pin	Function
1	+Vin
2	-Vin
3	Remote On/Off
4	+Vout
5	-Vout
6	Trim

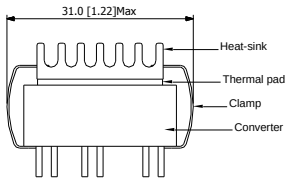
- All dimensions in mm (inches)
- Tolerance: X.X±0.25 (X.XX±0.01)
  X.XX±0.13 (X.XXX±0.005)
- Pin diameter ∅ 1.0 ±0.05 (0.04±0.002)

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)





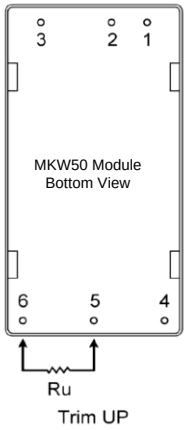
Physical Characteristics		
Heatsink Material	:	Aluminum
Finish	:	Black Anodized Coating
Weight	:	9g

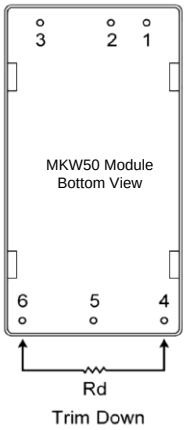
▶ The advantages of adding a heatsink are:

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

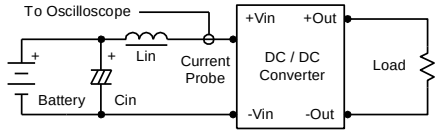
Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	333.39	148.80	87.26	56.50	38.04	25.73	16.94	10.35	5.22	1.12	KOhms
Trim up	2	4	6	8	10	12	14	16	18	20	%
Vout=	Vox1.02	Vox1.04	Vox1.06	Vox1.08	Vox1.1	Vox1.12	Vox1.14	Vox1.16	Vox1.18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

Order Code Table	
Standard	With heatsink
MKW50-12S033	MKW50-12S033-HS
MKW50-12S05	MKW50-12S05-HS
MKW50-12S12	MKW50-12S12-HS
MKW50-12S15	MKW50-12S15-HS
MKW50-12S24	MKW50-12S24-HS
MKW50-24S033	MKW50-24S033-HS
MKW50-24S05	MKW50-24S05-HS
MKW50-24S12	MKW50-24S12-HS
MKW50-24S15	MKW50-24S15-HS
MKW50-24S24	MKW50-24S24-HS
MKW50-48S033	MKW50-48S033-HS
MKW50-48S05	MKW50-48S05-HS
MKW50-48S12	MKW50-48S12-HS
MKW50-48S15	MKW50-48S15-HS
MKW50-48S24	MKW50-48S24-HS

Test Setup

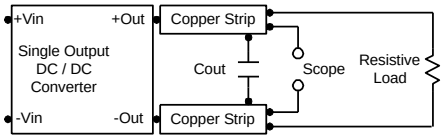
Input Reflected-Ripple Current Test Setup

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 3.5V to 12V. The maximum sink current at the on/off terminal (Pin 3) during a logic low is -100μA.

Overload Protection

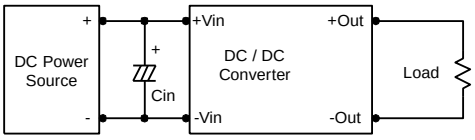
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

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.

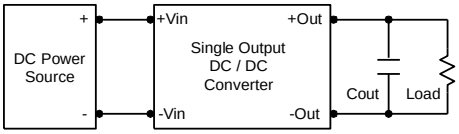
Input Source Impedance

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 33μF for the 12V input devices and 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 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.

