FEATURES

- ▶ Smallest Encapsulated 40W Converter!
- ▶ Package Size 2.0"x 1.0"x 0.4"
- ▶ Wide 2:1 Input Range
- ▶ Excellent Efficiency up to 92%
- ▶ Operating Temp. Range -40°C to +80°C
- ▶ Over-temperature Protection
- ▶ I/O-isolation Voltage 1500VDC
- ▶ Remote On/Off Control
- ▶ Shielded Metal Case with Isolated Baseplate
- ▶ Heatsink (Optional)
- ▶ CSA/UL/IEC/EN 60950-1 Safety Approval
- ▶ 3 Years Product Warranty

C US CB Scheme RoHS Compliant 3 year warranty

PRODUCT OVERVIEW

The MINMAX MKW40 series is a new 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 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. Load
			Max.	Min.	@Max. Load	@No Load				
	VDC	VDC	mA	mA	mA(typ.)	mA(typ.)	mA (typ.)	VDC	µF	%
MKW40-12S033	12 (9 ~ 18)	3.3	8000	0	2470	120	50	3.9	21000	89
MKW40-12S05		5	8000	0	3750	160		6.2	13600	89
MKW40-12S12		12	3330	0	3750	160		15	2400	89
MKW40-12S15		15	2670	0	3700	150		18	1500	90
MKW40-12S24		24	1670	0	3670	160		30	600	91
MKW40-12D12		±12	±1670	±145	3790	70		±15	1200#	88
MKW40-12D15		±15	±1330	±110	3790	60		±18	750#	88
MKW40-24S033	24 (18 ~ 36)	3.3	8000	0	1220	75	30	3.9	21000	90
MKW40-24S05		5	8000	0	1830	80		6.2	13600	91
MKW40-24S12		12	3330	0	1830	85		15	2400	91
MKW40-24S15		15	2670	0	1830	75		18	1500	91
MKW40-24S24		24	1670	0	1835	85		30	600	91
MKW40-24D12		±12	±1670	±145	1870	50		±15	1200#	89
MKW40-24D15		±15	±1330	±110	1870	45		±18	750#	89
MKW40-48S033	48 (36 ~ 75)	3.3	8000	0	610	40	20	3.9	21000	90
MKW40-48S05		5	8000	0	920	50		6.2	13600	91
MKW40-48S12		12	3330	0	910	50		15	2400	92
MKW40-48S15		15	2670	0	910	50		18	1500	92
MKW40-48S24		24	1670	0	918	50		30	600	91
MKW40-48D12		±12	±1670	±145	940	65		±15	1200#	89
MKW40-48D15		±15	±1330	±110	940	65		±18	750#	89

For each output

Input Specifications

Parameter		Model	Min.	Typ.	Max.	Unit
Input Surge Voltage (1 sec. 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 page 9)			
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	%Vnom.
Output Voltage Balance	Dual Output, Balanced Loads		---	---	±2.0	%
Line Regulation	Vin=Min. to Max.		---	---	±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 Output 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
Over Current Protection	Current Limitation at 150% typ. of Iout 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	---	---	1500	pF
Switching Frequency	24Vo Models	---	285	---	KHz
	Other Models	---	320	---	KHz
MTBF(calculated)	MIL-HDBK-217F@25℃, Ground Benign	328,000			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)	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 Voltage Trim

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

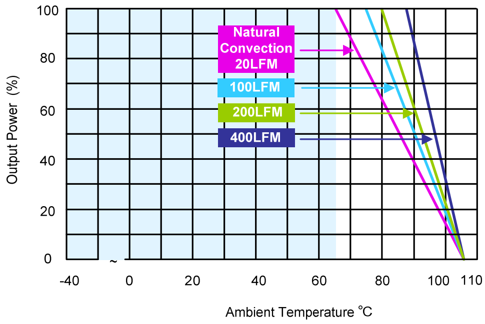
Environmental Specifications

Parameter	Model	Min.	Max.		Unit
			without Heatsink	with Heatsink	
Operating Temperature Range Natural Convection (10) Nominal Vin, Load 100% Inom. (for Power Derating see relative Derating Curves)	MKW40-XXS033	-40	66	73	℃
	MKW40-XXS05		46	57	
	MKW40-XXS12				
	MKW40-XXS15				
	MKW40-XXS24				
	MKW40-XXDXX		40	52	
Thermal Impedance	Natural Convection without Heatsink	12.0	---		℃/W
	Natural 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
Cooling	Free-Air convection				
RFI	Six-Sided Shielded, Metal Case				
Lead Temperature (1.5mm from case for 10Sec.)		---	260		℃

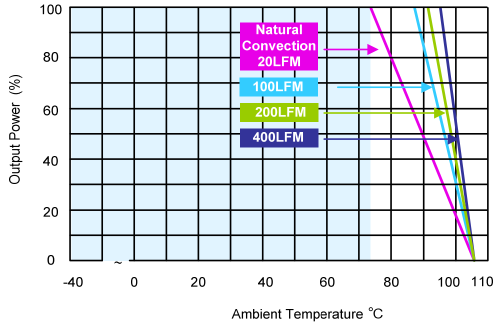
EMC Specifications

Parameter	Standards & Level		Performance
EMI	EN55022, FCC part 15		Class A (See Page 9)
EMS	EN55024		
	ESD	EN61000-4-2 air ± 8kV , Contact ± 6kV	B
	Radiated immunity	EN61000-4-3 10V/m	A
	Fast transient (8)	EN61000-4-4 ±2kV	A
	Surge (8)	EN61000-4-5 ±1kV	B
	Conducted immunity	EN61000-4-6 10Vrms	A

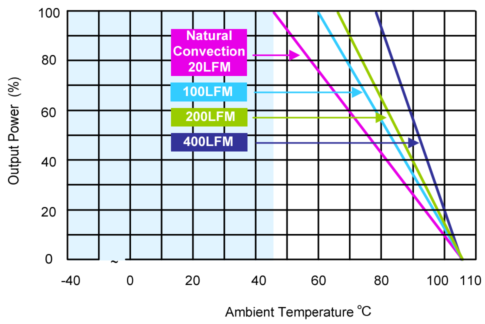
Power Derating Curve



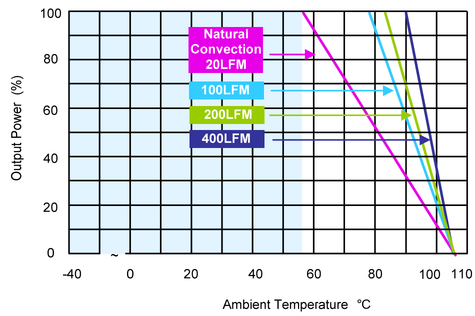
MKW40-XXS033 Derating Curve without Heatsink



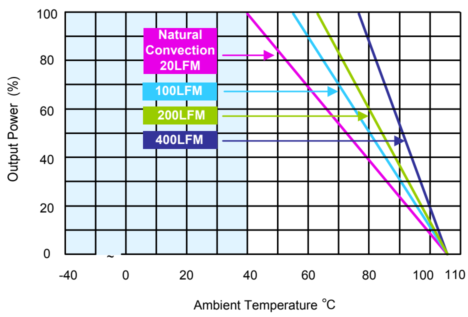
MKW40-XXS033 Derating Curve with Heatsink



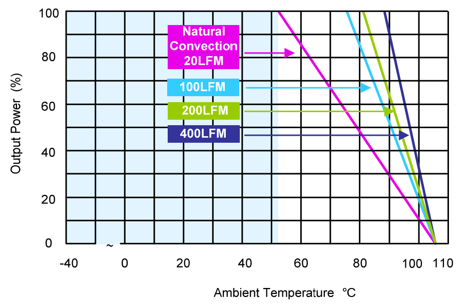
MKW40-XXS05, MKW40-XXS12, MKW40-XXS15,MKW40-XXS24
Derating Curve without Heatsink



MKW40-XXS05, MKW40-XXS12, MKW40-XXS15, MKW40-XXS24
Derating Curve with Heatsink

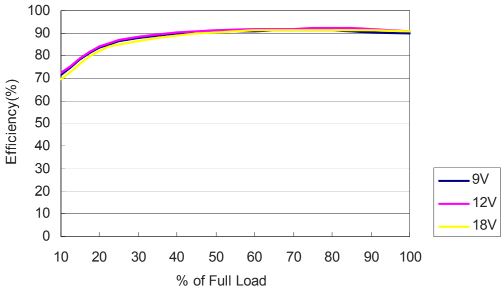


MKW40-XXDXX Derating Curve without Heatsink

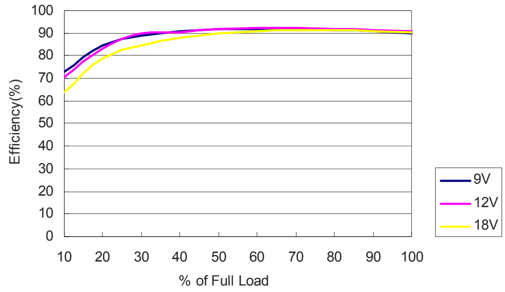


MKW40-XXDXX Derating Curve with Heatsink

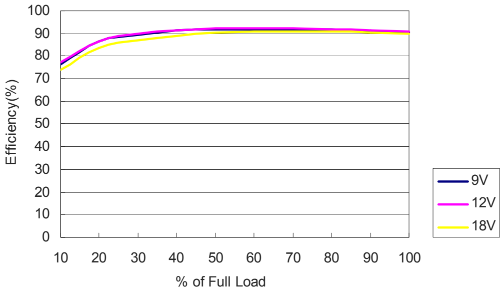
Efficiency Curve @25℃



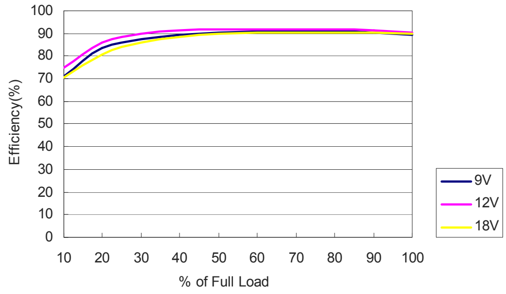
MKW40-12S033 Efficiency vs Load Current



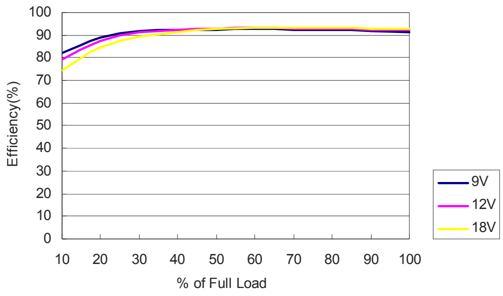
MKW40-12S05 Efficiency vs Load Current



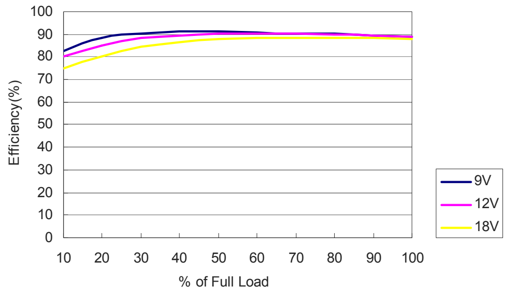
MKW40-12S12 Efficiency vs Load Current



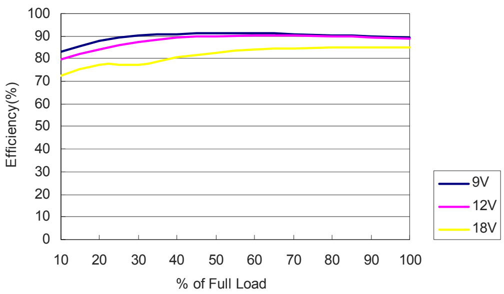
MKW40-12S15 Efficiency vs Load Current



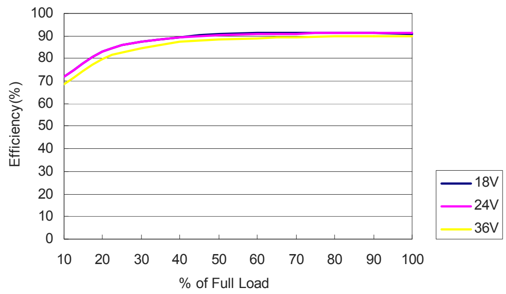
MKW40-12S24 Efficiency vs Load Current



MKW40-12D12 Efficiency vs Load Current

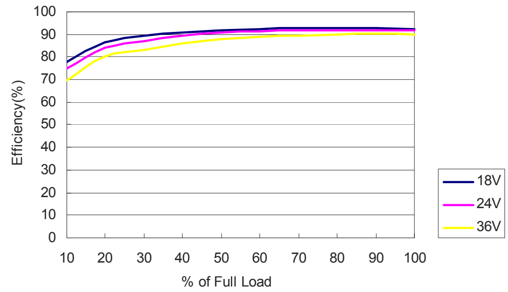


MKW40-12D15 Efficiency vs Load Current

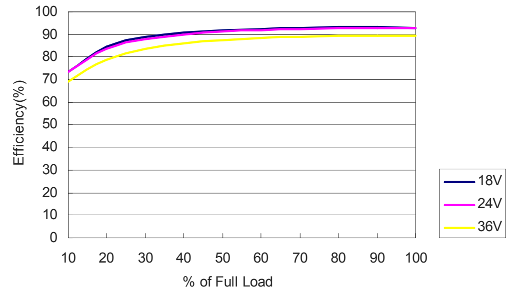


MKW40-24S033 Efficiency vs Load Current

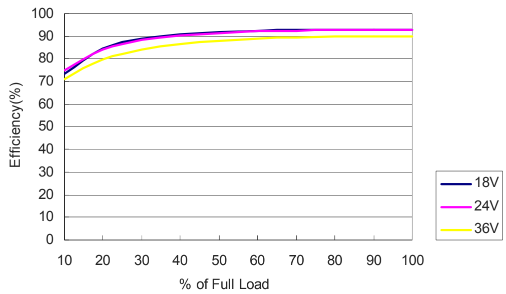
Efficiency Curve @25℃



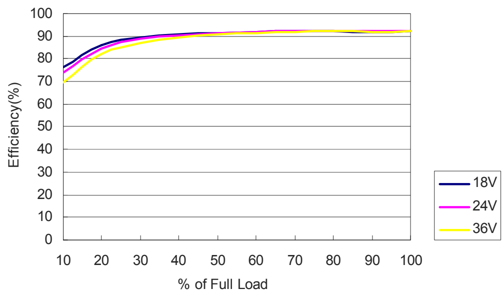
MKW40-24S05 Efficiency vs Load Current



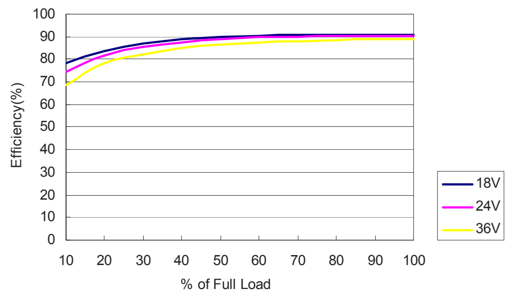
MKW40-24S12 Efficiency vs Load Current



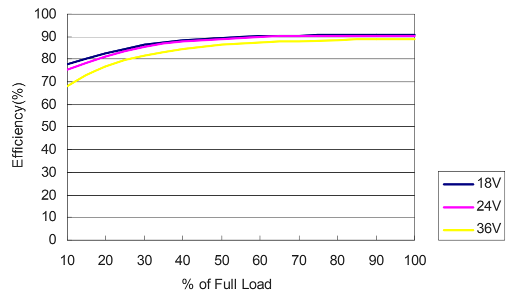
MKW40-24S15 Efficiency vs Load Current



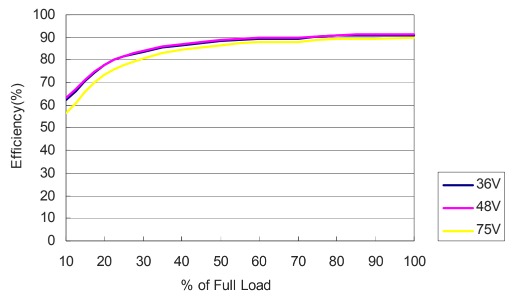
MKW40-24S24 Efficiency vs Load Current



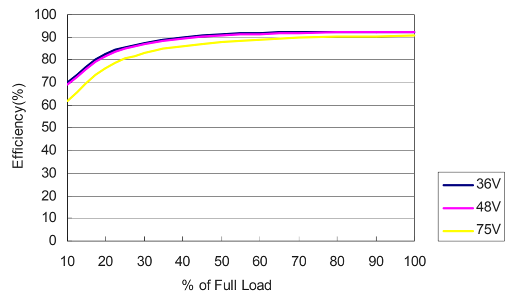
MKW40-24D12 Efficiency vs Load Current



MKW40-24D15 Efficiency vs Load Current

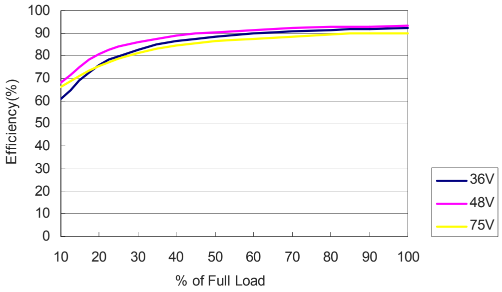


MKW40-48S033 Efficiency vs Load Current

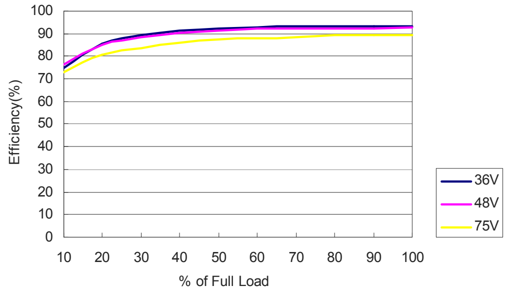


MKW40-48S05 Efficiency vs Load Current

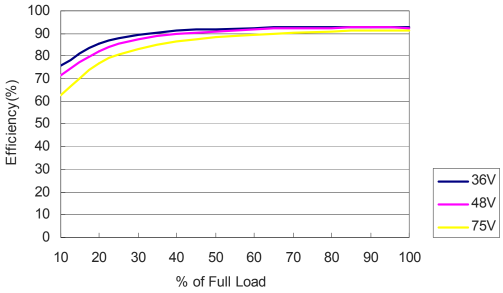
Efficiency Curve @25℃



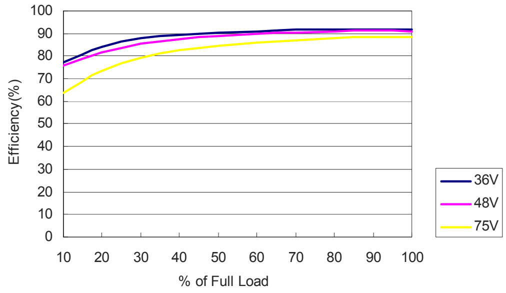
MKW40-48S12 Efficiency vs Load Current



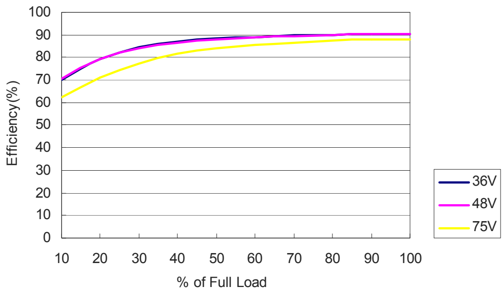
MKW40-48S15 Efficiency vs Load Current



MKW40-48S24 Efficiency vs Load Current



MKW40-48D12 Efficiency vs Load Current



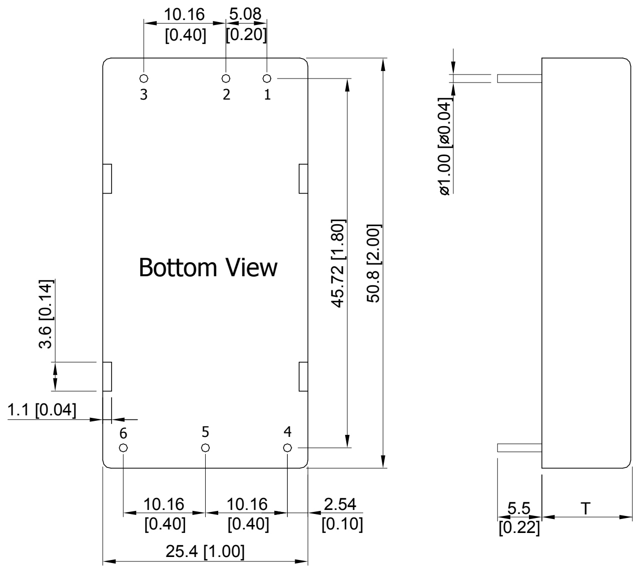
MKW40-48D15 Efficiency vs Load Current

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 M/C and a 10μF 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 factory.
6	To order the converter with heatsink, please add a **suffix –HS** (e.g.MKW40-12S05-HS) to order code.
7	To order the converter without Remote On/Off function, please add a **suffix -N** (e.g.MKW40-12S05-N) to order code.
8	To meet EN61000-4-4 & EN61000-4-5 by adding a capacitor across the input pins.Suggested capacitor: CHEMI-CON KXG 330μF/200V.
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	Single Output	Dual Output
1	+Vin	+Vin
2	-Vin	-Vin
3	Remote On/Off	Remote On/Off
4	+Vout	+Vout
5	-Vout	Common
6	Trim	-Vout

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

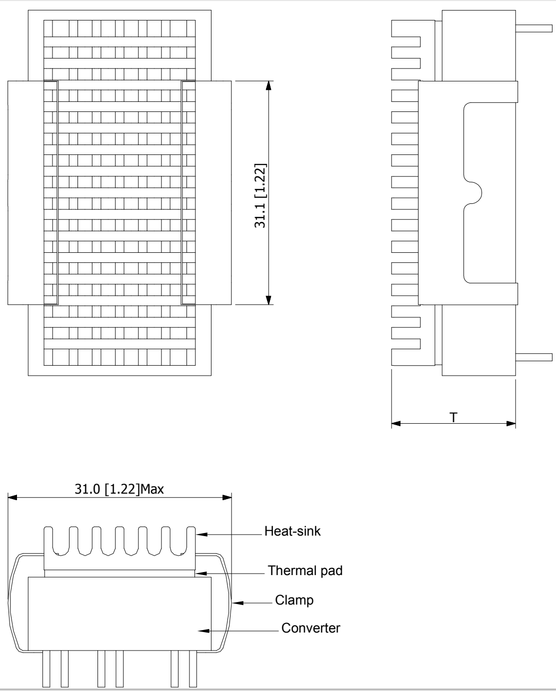
T: 10.2mm(0.40 inch) for Other Output Models

- All dimensions in mm (inches)
- Tolerance: X.X±0.25 (X.XX±0.01)
  X.XX±0.13 (X.XXX±0.005)
- Pin diameter ∅ 1.0 ±0.05 (0.04±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	:	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
Weight	:	30g

Heatsink (Option –HS)



Physical Characteristics

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

T: 18.0mm(0.43 inch) for 24V Output Models

T: 17.2mm(0.40 inch) for Other Output Models

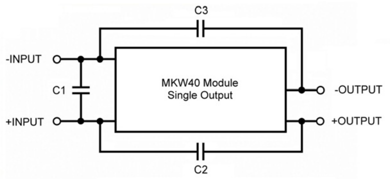
- The advantages of adding a heatsink are:

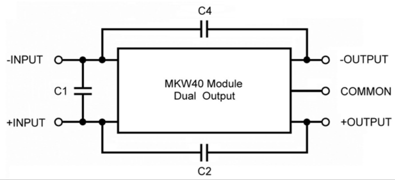
1. To improve heat dissipation and increase the stability and reliability of the DC/DC converters at high operating temperatures.

2. To increase operating temperature of the DC/DC converter, please refer to Derating Curve.

EMI-Filter to meet EN 55022, class A; FCC part 15 ,level A

Conducted and radiated emissions EN55022 Class A

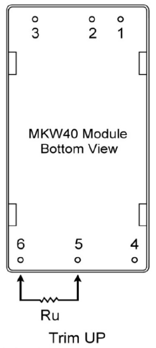


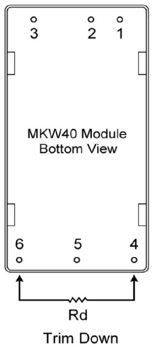


Part No.	MKW40-12SXX	MKW40-24SXX	MKW40-48SXX	MKW40-12DXX	MKW40-24DXX	MKW40-48DXX
C1	10µF/25V 1812 MLCC	4.7µF/50V 1812 MLCC	2.2µF/100V 1812 MLCC	10µF/25V 1812 MLCC	4.7µF/50V 1812 MLCC	2.2µF/100V 1812 MLCC
C2	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC
C3	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC	None	None	None
C4	None	None	None	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC	1000pF/2KV 1808 MLCC

External Output Trimming

Output can be externally trimmed by using the method shown below





MKW40-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

MKW40-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

MKW40-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

MKW40-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

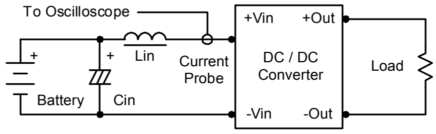
MKW40-XXS24 Trim Table

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

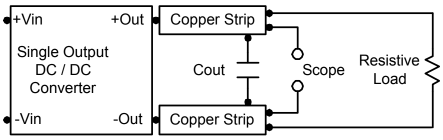
Input Reflected-Ripple Current Test Setup

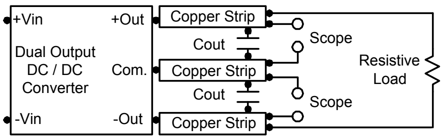
Input reflected-ripple current is measured with a inductor Lin (4.7μH) and Cin (220μF, ESR < 1.0Ω at 100 KHz) to simulate source impedance. Capacitor Cin, offsets possible battery impedance. Current ripple is measured at the input terminals of the module, measurement bandwidth is 0-500 KHz.



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.

Overcurrent Protection

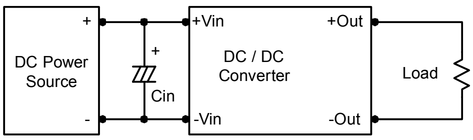
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

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.

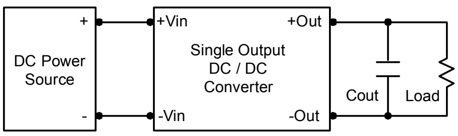
Input Source Impedance

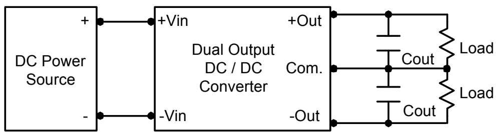
The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module.
In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup.
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 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.



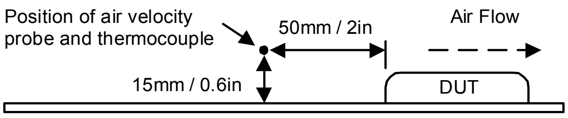


Maximum Capacitive Load

The MKW40 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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