

**FEATURES**

- ▶ Industrial Standard 2" X 1" Package
- ▶ Wide 2:1 Input Voltage Range
- ▶ Fully Regulated Output Voltage
- ▶ I/O Isolation 4200VAC with Reinforced Insulation, rated for 300Vrms Working Voltage
- ▶ Low Leakage Current < 5 $\mu$ A
- ▶ Operating Ambient Temp. Range -40°C to +85°C
- ▶ No Min. Load Requirement
- ▶ Under-voltage, Overload/Voltage and Short Circuit Protection
- ▶ EMI Emission EN 55011 Class A & FCC Level A Approved
- ▶ Medical EMC Standard with 4<sup>th</sup> Edition of EMI EN 55011 and EMS EN 60601-1-2 Approved
- ▶ Medical Safety with 2xMOPP per 3<sup>rd</sup> Edition of IEC/EN 60601-1 & ANSI/AAMI ES60601-1 Approved with CE Marking


**PRODUCT OVERVIEW**

The MINMAX MKW15M series is a new range of high performance 15W medical approved DC-DC converter within encapsulated 2"x1" package which specifically design for medical applications. There are 21 models available for input voltage of 12, 24, 48VDC with wide 2:1 input range and tight output voltage. The I/O isolation is specified for 4200VAC with reinforced insulation, which rated for 300Vrms working voltage. Further features include under-voltage, overload, short circuit protection, no min. load requirement, EMI emission EN 55011 class A approved, low leakage current 5 $\mu$ A max. and operating ambient temp. range by -40°C to 85°C by high efficiency up to 90%. MKW15M series conform to 4<sup>th</sup> edition medical EMC standard, medical safety with 2xMOPP (Means Of Patient Protection) per 3<sup>rd</sup> edition of IEC/EN 60601-1 & ANSI/AAMI ES60601-1 approved.

The MKW15M series offer a superior solution for demanding application in medical instrument requesting a certified supplementary and reinforced insulation system to comply with latest medical safety approval for 2xMOPP requirement.

**Model Selection Guide**

Model Number	Input Voltage (Range) VDC	Output Voltage VDC	Output Current	Input Current		Reflected Ripple Current mA(typ.)	Over Voltage Protection VDC	Max. capacitive Load $\mu$ F	Efficiency (typ.)
			Max. mA	@Max. Load mA(typ.)	@No Load mA (typ.)				@Max. Load %
MKW15-12S05M	12 (9 ~ 18)	5	3000	1453	20	100	6.2	5100	86
MKW15-12S051M		5.1	3000	1483			6.2		86
MKW15-12S12M		12	1250	1404			15		89
MKW15-12S15M		15	1000	1420			18		88
MKW15-12S24M		24	625	1420			27		88
MKW15-12D12M		$\pm 12$	$\pm 625$	1420			$\pm 15$		88
MKW15-12D15M		$\pm 15$	$\pm 500$	1404			$\pm 18$		89
MKW15-24S05M	24 (18 ~ 36)	5	3000	710	15	50	6.2	5100	88
MKW15-24S051M		5.1	3000	724			6.2		88
MKW15-24S12M		12	1250	702			15		89
MKW15-24S15M		15	1000	702			18		89
MKW15-24S24M		24	625	694			27		90
MKW15-24D12M		$\pm 12$	$\pm 625$	694			$\pm 15$		90
MKW15-24D15M		$\pm 15$	$\pm 500$	702			$\pm 18$		89
MKW15-48S05M	48 (36 ~ 75)	5	3000	355	10	30	6.2	5100	88
MKW15-48S051M		5.1	3000	362			6.2		88
MKW15-48S12M		12	1250	355			15		88
MKW15-48S15M		15	1000	347			18		90
MKW15-48S24M		24	625	351			27		89
MKW15-48D12M		$\pm 12$	$\pm 625$	351			$\pm 15$		89
MKW15-48D15M		$\pm 15$	$\pm 500$	355			$\pm 18$		88

# For each output

Input Specifications						
Parameter	Conditions / Model	Min.	Typ.	Max.	Unit	
Input Surge Voltage (100 ms 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	---	7.5	---		
	24V Input Models	---	15	---		
	48V Input Models	---	33	---		
Start Up Time (Power On)	Nominal Vin and Constant Resistive Load	---	---	30	ms	
Input Filter	All Models	Internal Pi Type				

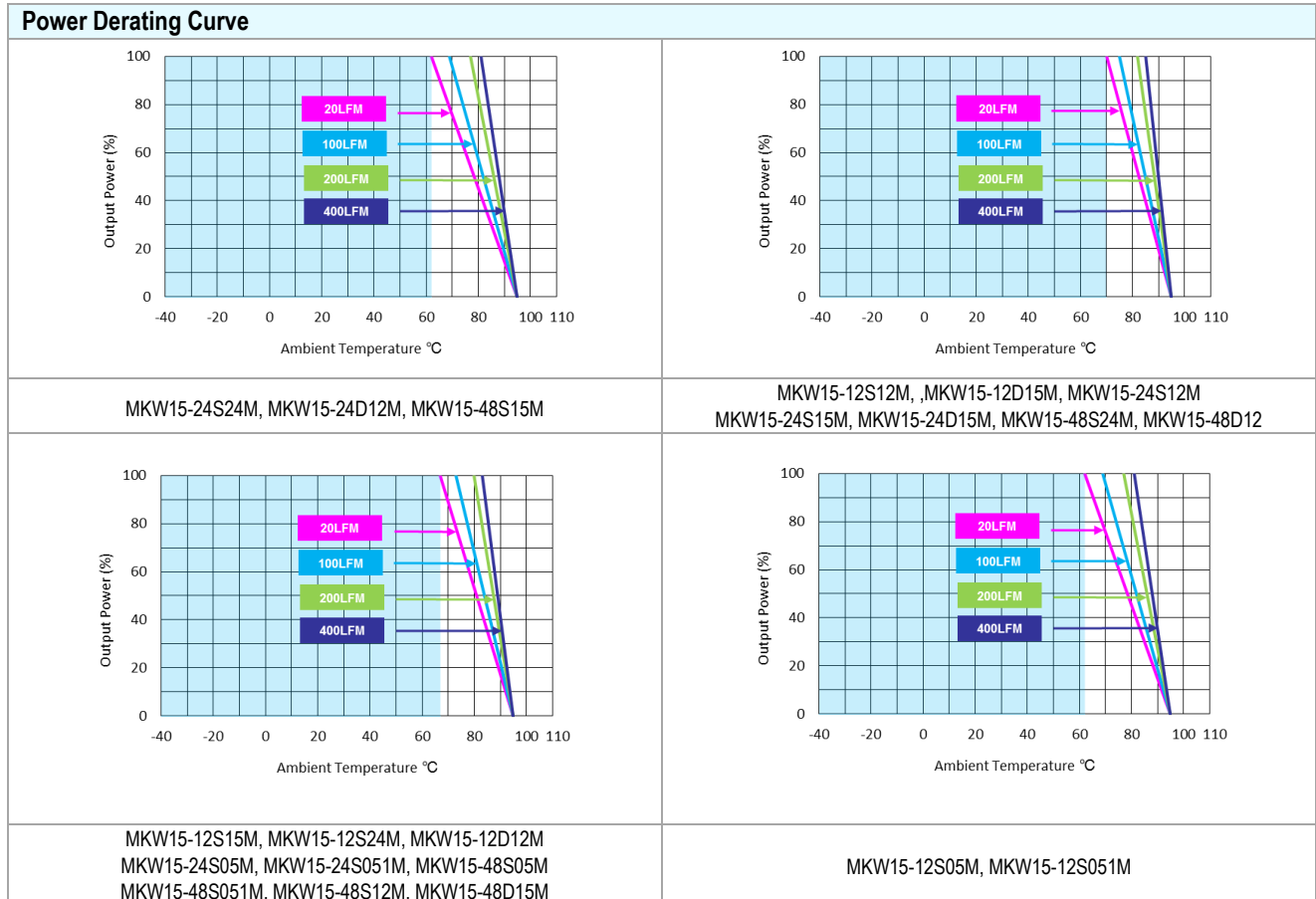
Output Specifications						
Parameter	Conditions / Model	Min.	Typ.	Max.	Unit	
Output Voltage Setting Accuracy		---	---	±1.0	%Vnom.	
Output Voltage Balance	Dual Output, Balanced Loads	---	---	±2.0	%	
Line Regulation	Vin=Min. to Max. @Full Load	---	---	±0.5	%	
Load Regulation	Io=0% to 100%	Single Output	---	---	±0.5	%
		Dual Output	---	---	±1.0	%
Minimum Load	No minimum Load Requirement					
Ripple & Noise	0-20 MHz Bandwidth	5V & 5.1Vo	---	50	---	mV <sub>P-P</sub>
		12V, 15V, ±12V, ±15Vo	---	100	---	mV <sub>P-P</sub>
		24Vo	---	150	---	mV <sub>P-P</sub>
Transient Recovery Time	25% Load Step Change <sub>(2)</sub>	---	---	300	µsec	
Transient Response Deviation		---	±3	±5	%	
Temperature Coefficient		---	---	±0.02	%/°C	
Over Load Protection	Hiccup	---	150	---	%	
Short Circuit Protection	Continuous, Automatic Recovery (Hiccup Mode 0.7Hz typ.)					

Isolation, Safety Standards						
Parameter	Conditions	Min.	Typ.	Max.	Unit	
I/O Isolation Voltage	60 Seconds Reinforced insulation, rated for 300Vrms working voltage	4200	---	---	VACrms	
Leakage Current	240VAC, 60Hz	---	---	5	µA	
I/O Isolation Resistance	500 VDC	10	---	---	GΩ	
I/O Isolation Capacitance	100kHz, 1V	---	---	80	pF	
Safety Standards	ANSI/AAMI ES60601-1, CAN/CSA-C22.2 No. 60601-1 IEC/EN 60601-1 3 <sup>rd</sup> Edition 2xMOPP					
Safety Approvals	ANSI/AAMI ES60601-1 2xMOPP recognition (UL certificate), IEC/EN 60601-1 3 <sup>rd</sup> Edition (CB-report)					

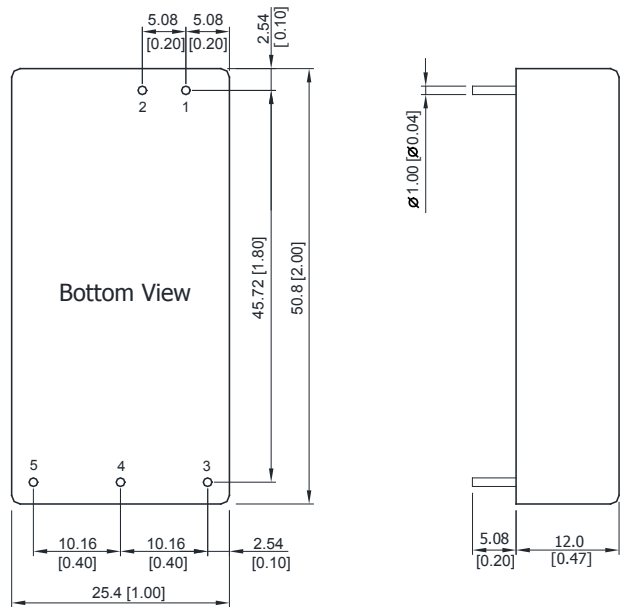
General Specifications						
Parameter	Conditions	Min.	Typ.	Max.	Unit	
Switching Frequency		---	285	---	kHz	
MTBF(calculated)	MIL-HDBK-217F@25°C, Ground Benign	1,428,181	---	---	Hours	

Environmental Specifications						
Parameter	Conditions / Model	Min.	Max.	Unit		
Operating Ambient Temperature Range Nominal Vin, Load 100% Inom. (for Power Derating see relative Derating Curves)	MKW15-24S24M, MKW15-24D12M, MKW15-48S15M MKW15-12S12M, MKW15-12D15M, MKW15-24S12M MKW15-24S15M, MKW15-24D15M, MKW15-48S24M MKW15-48D12	-40	73	°C		
	MKW15-12S15M, MKW15-12S24M, MKW15-12D12M MKW15-24S05M, MKW15-24S051M, MKW15-48S05M MKW15-48S051M, MKW15-48S12M, MKW15-48D15M MKW15-12S05M, MKW15-12S051M		70			
			67			
			62			
Thermal Impedance		13	---	°C/W		
Case Temperature		---	+95	°C		
Storage Temperature Range		-50	+125	°C		
Humidity (non condensing)		---	95	% rel. H		
Altitude		---	4000	M		
Lead Temperature (1.5mm from case for 10Sec.)		---	260	°C		

EMC Specifications			
Parameter	Standards & Level		Performance
EMI	Conduction & Radiation	EN 55011, FCC part 15	Class A
	EN 60601-1-2 4 <sup>th</sup>		
EMS	ESD	EN 61000-4-2 Air $\pm 15$ kV, Contact $\pm 8$ kV	A
	Radiated immunity	EN 61000-4-3 10V/m	A
	Fast transient <sub>(5)</sub>	EN 61000-4-4 $\pm 2$ kV	A
	Surge <sub>(6)</sub>	EN 61000-4-5 $\pm 1$ kV	A
	Conducted immunity	EN 61000-4-6 10Vrms	A
	PFMF	EN 61000-4-8 100A/m	A



- ### Notes
- Specifications typical at  $T_a = +25^\circ\text{C}$ , resistive load, nominal input voltage and rated output current unless otherwise noted.
  - Transient recovery time is measured to within 1% error band for a step change in output load of 75% to 100%.
  - We recommend to protect the converter by a slow blow fuse in the input supply line.
  - Other input and output voltage may be available, please contact factory.
  - To meet EN 61000-4-4 & EN 61000-4-5 an external capacitor across the input pins is required.  
Suggested capacitor: 12XXX & 24XXX: CHEMI-CON KY Series 560 $\mu\text{F}$ /50V // Diode: V15P8-M3  
48XXX: CHEMI-CON KY Series 560 $\mu\text{F}$ /100V // Diode: V15P10
  - Specifications are subject to change without notice.

Package Specifications																			
<p><b>Mechanical Dimensions</b></p>  <p>The drawing shows a rectangular package with a bottom view and a side view. The bottom view shows a total width of 25.4 mm (1.00 inches) and a total height of 50.8 mm (2.00 inches). Pin 1 is at the top center, pin 2 is to its left, and pins 3, 4, and 5 are along the bottom edge. The side view shows a height of 12.0 mm (0.47 inches) and a pin diameter of 1.00 mm (0.04 inches).</p>	<p><b>Pin Connections</b></p> <table border="1"> <thead> <tr> <th>Pin</th> <th>Single Output</th> <th>Dual Output</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>+Vin</td> <td>+Vin</td> </tr> <tr> <td>2</td> <td>-Vin</td> <td>-Vin</td> </tr> <tr> <td>3</td> <td>+Vout</td> <td>+Vout</td> </tr> <tr> <td>4</td> <td>No Pin</td> <td>Common</td> </tr> <tr> <td>5</td> <td>-Vout</td> <td>-Vout</td> </tr> </tbody> </table> <p>                     ▶ All dimensions in mm (inches)                      ▶ Tolerance: X.X±0.5 (X.XX±0.02)                                        X.XX±0.25 (X.XXX±0.01)                      ▶ Pin diameter <math>\varnothing 1.0 \pm 0.05</math> (0.04±0.002)                 </p>	Pin	Single Output	Dual Output	1	+Vin	+Vin	2	-Vin	-Vin	3	+Vout	+Vout	4	No Pin	Common	5	-Vout	-Vout
Pin	Single Output	Dual Output																	
1	+Vin	+Vin																	
2	-Vin	-Vin																	
3	+Vout	+Vout																	
4	No Pin	Common																	
5	-Vout	-Vout																	

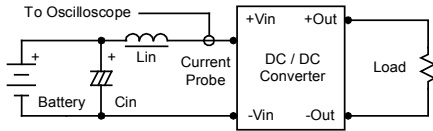
### Physical Characteristics

Case Size	: 50.8x25.4x12.0mm (2.0x1.0x0.47 inches)
Case Material	: Non-Conductive Black Plastic (flammability to UL 94V-0 rated)
Pin Material	: Tinned Copper
Weight	: 30g

### Test Setup

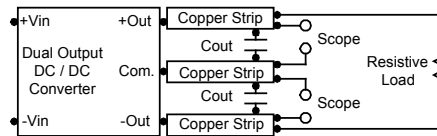
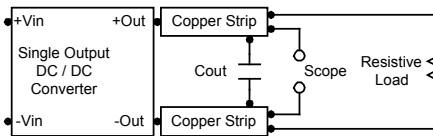
#### Input Reflected-Ripple Current Test Setup

Input reflected-ripple current is measured with an inductor  $L_{in}$  ( $4.7\mu\text{H}$ ) and  $C_{in}$  ( $220\mu\text{F}$ ,  $\text{ESR} < 1.0\Omega$  at  $100\text{ kHz}$ ) 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  $0\text{-}500\text{ kHz}$ .



#### Peak-to-Peak Output Noise Measurement Test

Use a  $C_{out}$   $4.7\mu\text{F}$  ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is  $0\text{-}20\text{ MHz}$ . Position the load between  $50\text{ mm}$  and  $75\text{ mm}$  from the DC/DC Converter.



### Technical Notes

#### Overload Protection

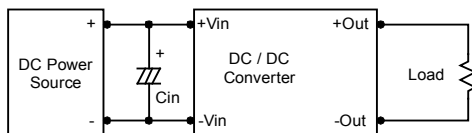
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

#### 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.

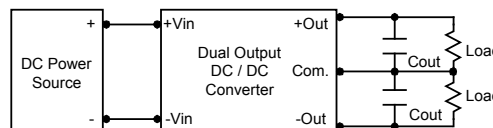
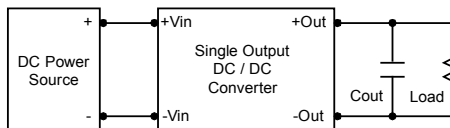
#### Input Source Impedance

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 on the input to insure startup. By using a good quality low Equivalent Series Resistance ( $\text{ESR} < 1.0\Omega$  at  $100\text{ kHz}$ ) capacitor of a  $10\mu\text{F}$  for the  $12\text{V}$  input devices and a  $4.7\mu\text{F}$  for the  $24\text{V}$  input devices and a  $2.2\mu\text{F}$  for the  $48\text{V}$  devices, capacitor mounted close to the power module helps ensure stability of the unit.



#### 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  $4.7\mu\text{F}$  capacitors at the output.



#### Maximum Capacitive Load

The MKW15M series has limitation of maximum connected capacitance on the output. The power module may operate in current limiting mode during start-up, affecting the ramp-up and the startup time. Connect capacitors at the point of load for best performance. 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  $95^\circ\text{C}$ . The derating curves are determined from measurements obtained in a test setup.

