

**FEATURES**

- ▶ Smallest Encapsulated 50W Converter
- ▶ Ultra-compact 2" X 1" Package
- ▶ Ultra-wide 4:1 Input Voltage Range
- ▶ Fully Regulated Output Voltage
- ▶ Excellent Efficiency up to 92%
- ▶ I/O Isolation 1500 VDC
- ▶ Operating Ambient Temp. Range -40°C to +80°C
- ▶ 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 & CE Marking


**PRODUCT OVERVIEW**

The MINMAX MKW150 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 ultra-wide 4:1 input voltage range and precisely regulated output voltages.

A very high efficiency up to 92% which allows an operating temperature range of -40°C to +80°C is achieved by advanced circuit topology. 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.           | @No Load | @Max. Load    | @No Load |                          |                         |                      |                   |
|               | VDC                   | VDC            | mA             | mA(typ.) | mA(typ.)      | mA(typ.) | VDC                      | μF                      | %                    |                   |
| MKW150-24S033 | 24<br>(9 ~ 36)        | 3.3            | 10000          | 1528     | 80            | 40       | 3.9                      | 26000                   | 90                   |                   |
| MKW150-24S05  |                       | 5              | 10000          | 2290     | 60            |          | 6.2                      | 17000                   | 91                   |                   |
| MKW150-24S12  |                       | 12             | 4170           | 2267     | 80            |          | 15                       | 3000                    | 92                   |                   |
| MKW150-24S15  |                       | 15             | 3330           | 2263     | 80            |          | 18                       | 2000                    | 92                   |                   |
| MKW150-24S24  |                       | 24             | 2080           | 2286     | 80            |          | 30                       | 750                     | 91                   |                   |
| MKW150-48S033 | 48<br>(18 ~ 75)       | 3.3            | 10000          | 764      | 40            | 30       | 3.9                      | 26000                   | 90                   |                   |
| MKW150-48S05  |                       | 5              | 10000          | 1145     | 30            |          | 6.2                      | 17000                   | 91                   |                   |
| MKW150-48S12  |                       | 12             | 4170           | 1134     | 60            |          | 15                       | 3000                    | 92                   |                   |
| MKW150-48S15  |                       | 15             | 3330           | 1134     | 60            |          | 18                       | 2000                    | 92                   |                   |
| MKW150-48S24  |                       | 24             | 2080           | 1143     | 50            |          | 30                       | 750                     | 91                   |                   |

**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   | ---                                     | 7.5  | ---  |      |
|                                  | 48V Input Models   | ---                                     | 16   | ---  |      |
| Input Polarity Protection        | None               |   |      |      |      |
| Start Up Time                    | Power Up           | ---                                     | ---  | 30   | ms   |
|                                  | Remote On/Off      | Nominal Vin and Constant Resistive Load | ---  | ---  | 30   |
| Input Filter                     | All Models         | Internal LC Type                        |      |      |      |

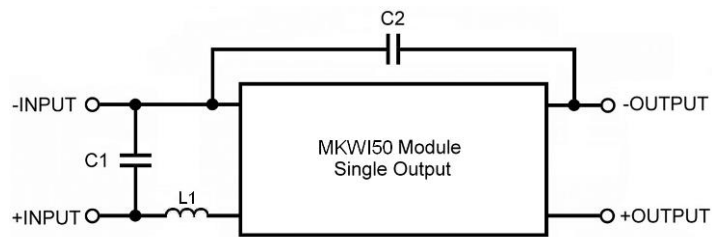
| Remote On/Off Control       |                              |      |      |      |      |
|-----------------------------|------------------------------|------|------|------|------|
| Parameter                   | Conditions                   | Min. | Typ. | Max. | Unit |
| Converter On                | 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                    | Min. Load to Full Load                      | ---                                  | ---  | ±0.5      | %      |                   |
| Minimum Load                       | No minimum Load Requirement                 |                                      |      |           |        |                   |
| Ripple & Noise                     | 0-20 MHz Bandwidth                          | 3.3V & 5V Models <sup>(3)</sup>      | ---  | ---       | 100    | mV <sub>P-P</sub> |
|                                    |   | 12V, 15V & 24V Models <sup>(3)</sup> | ---  | ---       | 150    | mV <sub>P-P</sub> |
| Transient Recovery Time            | 25% Load Step Change <sup>(2)</sup>         | ---                                  | 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 | %      |                   |
|                                    | % of nominal output voltage (Other Models)  | ---                                  | ---  | ±10       | %      |                   |
| Over Load Protection               | Hiccup                                      | ---                                  | 150  | ---       | %      |                   |
| Short Circuit Protection           | Hiccup Mode 0.3 Hz typ., Automatic Recovery |                                      |      |           |        |                   |

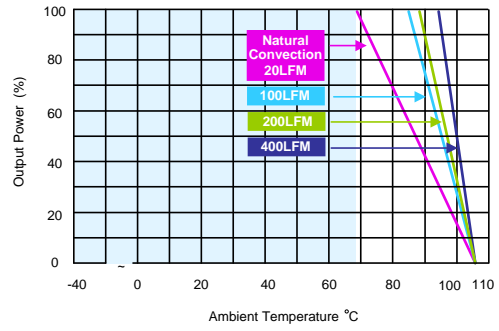
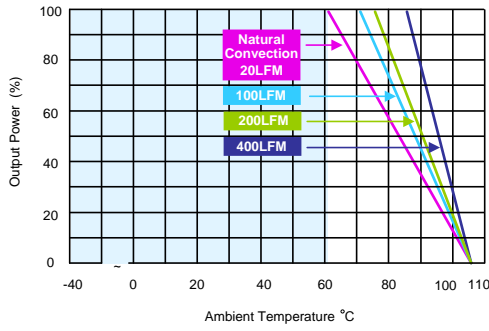
| General Specifications    |  |         |      |      |       |
|---------------------------|--|---------|------|------|-------|
| Parameter                 | Conditions   | Min.    | Typ. | Max. | Unit  |
| I/O Isolation Voltage     | 60 Seconds   | 1500    | ---  | ---  | VDC   |
|                           | 1 Seconds  | 1800    | ---  | ---  | VDC   |
| I/O Isolation Resistance  | 500 VDC  | 1000    | ---  | ---  | MΩ    |
| I/O Isolation Capacitance | 100KHz, 1V   | ---     | ---  | 2200 | pF    |
| Switching Frequency       |  | ---     | 285  | ---  | KHz   |
| MTBF(calculated)          | MIL-HDBK-217F@25°C, Ground Benign  | 230,900 |      |      | Hours |
| Safety Approvals          | UL/cUL 60950-1 recognition (CSA certificate), IEC/EN 60950-1 (CB-report) |         |      |      |       |

| Parameter   | Conditions / Model                  | Min. | Max.             |               | Unit     |
|---|-------------------------------------|------|------------------|---------------|----------|
|   |                                     |      | without Heatsink | with Heatsink |          |
| Operating Ambient Temperature Range<br>Natural Convection <sup>(8)</sup><br>Nominal Vin, Load 100% Inom.<br>(for Power Derating see relative Derating Curves) | MKW150-24S033, MKW150-48S033        | -40  | 61               | 69            | °C       |
|   | MKW150-24S12, MKW150-24S15          |      | 53               | 62            |          |
|   | MKW150-48S12, MKW150-48S15          |      | 46               | 57            |          |
|   | MKW150-24S05, MKW150-24S24          |      |                  |               |          |
| 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                    | EN 55032, FCC part 15                          | Class A     |
|                    | EN 55024                      |  |             |
| EMS                | ESD                           | EN 61000-4-2 air $\pm$ 8kV , Contact $\pm$ 6kV | A           |
|                    | Radiated immunity             | EN 61000-4-3 10V/m                             | A           |
|                    | Fast transient <sup>(6)</sup> | EN 61000-4-4 $\pm$ 2kV                         | A           |
|                    | Surge <sup>(6)</sup>          | EN 61000-4-5 $\pm$ 1kV                         | A           |
|                    | Conducted immunity            | EN 61000-4-6 10Vrms                            | A           |

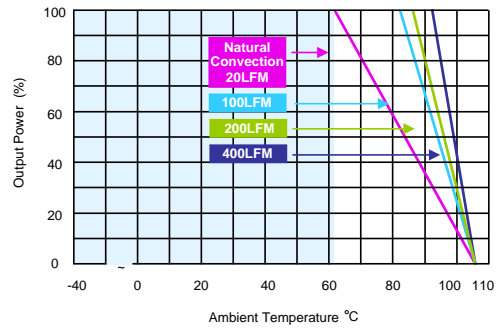
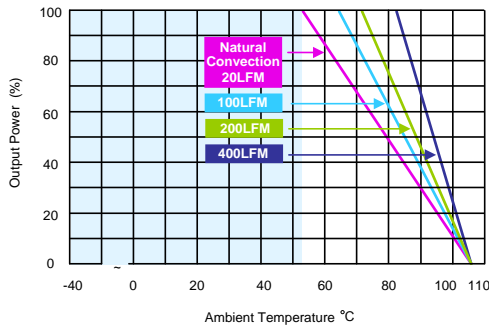
**External Filter meets Conducted EMI EN55032 class A; FCC part 15 level A**


| Model        | C1                             | C2                   | L1          |
|--------------|--------------------------------|----------------------|-------------|
| MKW150-24SXX | 10 $\mu$ F/50V 1210 X7S MLCC   | 1000pF/2KV 1206 MLCC | 1.5 $\mu$ H |
| MKW150-48SXX | 3.3 $\mu$ F/100V 1210 X7S MLCC | 1000pF/2KV 1206 MLCC | 6.8 $\mu$ H |

**Power Derating Curve**


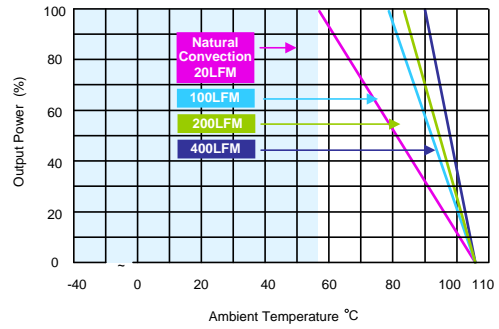
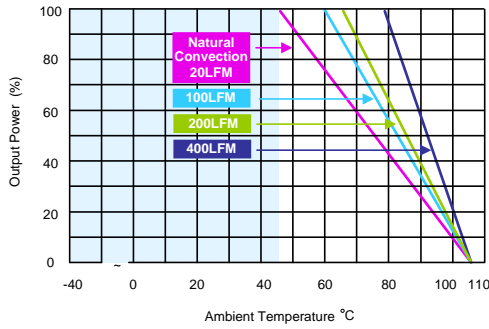
MKWI50-24S033, MKWI50-48S033 Derating Curve without Heatsink

MKWI50-24S033, MKWI50-48S033 Derating Curve with Heatsink



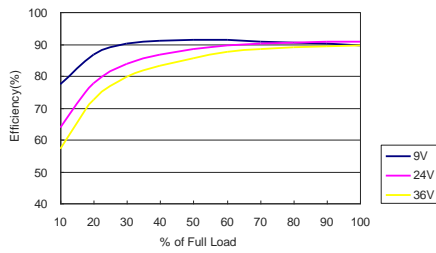
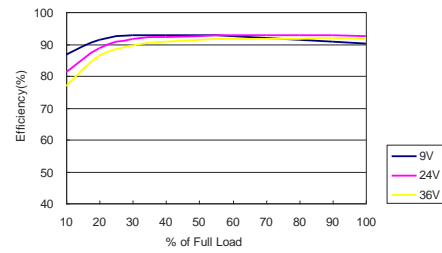
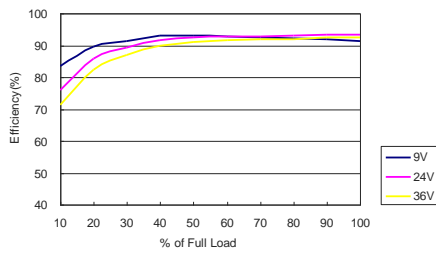
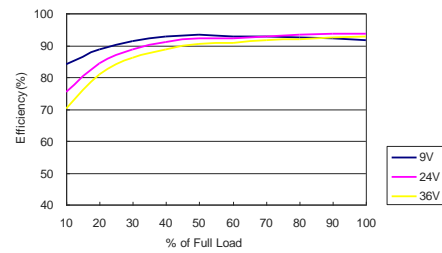
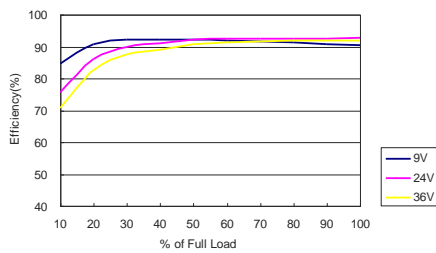
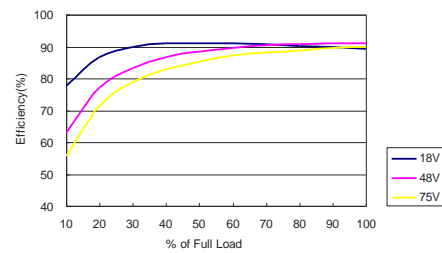
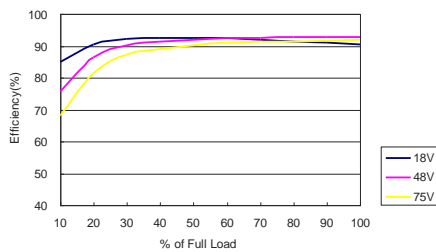
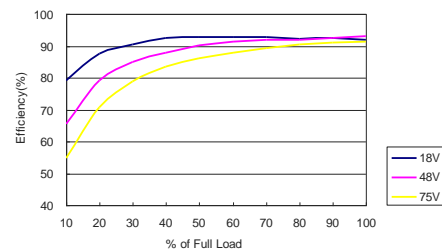
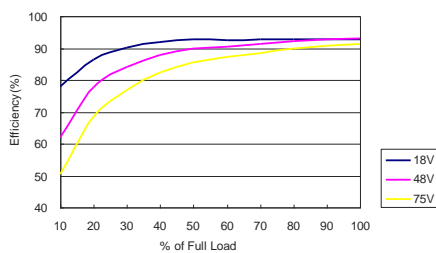
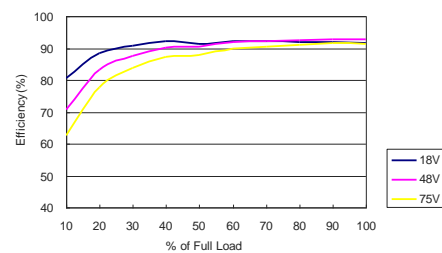
MKWI50-24S12, MKWI50-24S15, MKWI50-48S12, MKWI50-48S15 Derating Curve without Heatsink

MKWI50-24S12, MKWI50-24S15, MKWI50-48S12, MKWI50-48S15 Derating Curve with Heatsink



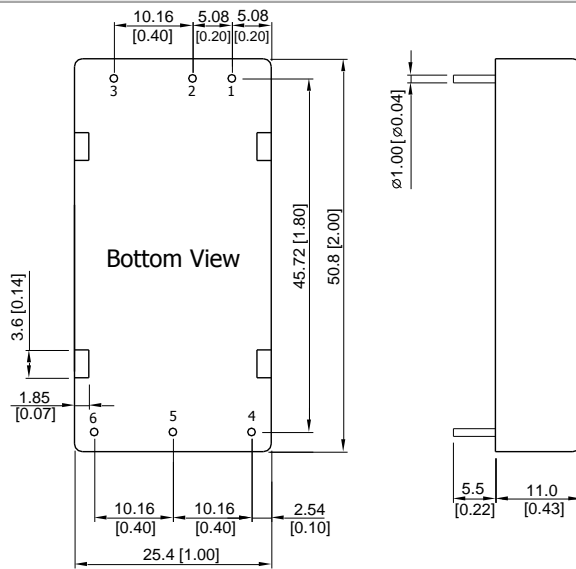
MKWI50-24S05, MKWI50-24S24, MKWI50-48S05, MKWI50-48S24 Derating Curve without Heatsink

MKWI50-24S05, MKWI50-24S24, MKWI50-48S05, MKWI50-48S24 Derating Curve with Heatsink

**Efficiency Curve @25°C**

**MKWI50-24S033 Efficiency vs Load Current**

**MKWI50-24S05 Efficiency vs Load Current**

**MKWI50-24S12 Efficiency vs Load Current**

**MKWI50-24S15 Efficiency vs Load Current**

**MKWI50-24S24 Efficiency vs Load Current**

**MKWI50-48S033 Efficiency vs Load Current**

**MKWI50-48S05 Efficiency vs Load Current**

**MKWI50-48S12 Efficiency vs Load Current**

**MKWI50-48S15 Efficiency vs Load Current**

**MKWI50-48S24 Efficiency vs Load Current**

**Notes**

- 1 Specifications typical at Ta=+25°C, resistive load, nominal input voltage, 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 Capacitor.
- 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 meet EN61000-4-4 & EN61000-4-5 an external capacitor across the input pins is required .Suggested capacitor : 220μF/100V.
- 7 Do not exceed maximum power specification when adjusting output voltage.
- 8 That "natural convection" is about 20LFM but is not equal to still air (0 LFM).
- 9 Specifications are subject to change without notice.

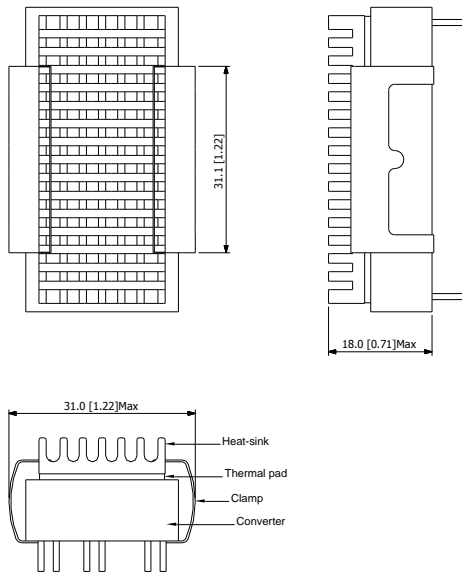
**Package Specifications**
**Mechanical Dimensions**

**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  $\varnothing 1.0 \pm 0.05$  (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           | : 34g   |

**Heatsink (Option -HS)**

**Physical Characteristics**

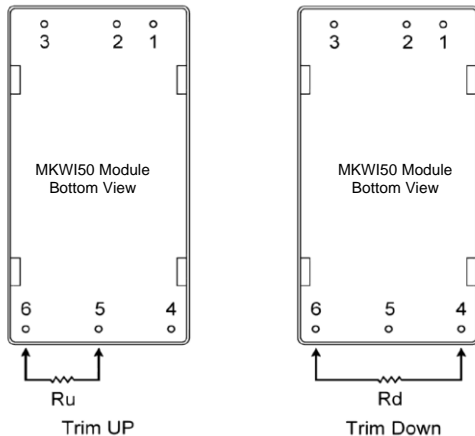
|                   |   |                        |
|-------------------|---|------------------------|
| Heatsink Material | : | Aluminum               |
| Finish            | : | Black Anodized Coating |
| Weight            | : | 9g                     |

**► 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



MKW150-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 |

MKW150-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 |

MKW150-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 |

MKW150-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 |

MKW150-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 |

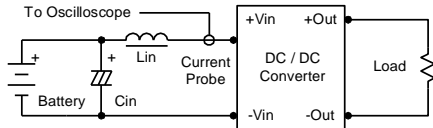


| Order Code Table |                  |
|------------------|------------------|
| Standard         | With heatsink    |
| MKW150-24S033    | MKW150-24S033-HS |
| MKW150-24S05     | MKW150-24S05-HS  |
| MKW150-24S12     | MKW150-24S12-HS  |
| MKW150-24S15     | MKW150-24S15-HS  |
| MKW150-24S24     | MKW150-24S24-HS  |
| MKW150-48S033    | MKW150-48S033-HS |
| MKW150-48S05     | MKW150-48S05-HS  |
| MKW150-48S12     | MKW150-48S12-HS  |
| MKW150-48S15     | MKW150-48S15-HS  |
| MKW150-48S24     | MKW150-48S24-HS  |

## Test Setup

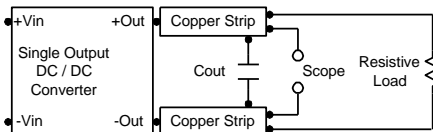
### Input Reflected-Ripple Current Test Setup

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

Refer to the output specifications or add 4.7 $\mu$ F capacitor if the output specifications undefine  $C_{out}$ . 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 $\mu$ A.

### Overload Protection

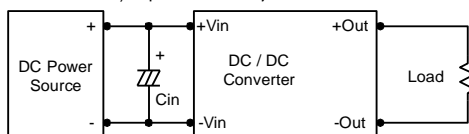
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

### 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.

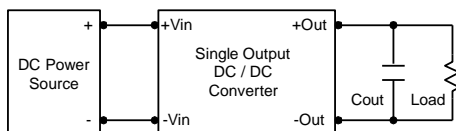
### Input Source Impedance

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  $\Omega$  at 100 KHz) capacitor of a 10 $\mu$ 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 $\mu$ F capacitors at the output.



### Maximum Capacitive Load

The MKW150 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.

