

## FEATURES

- ▶ Smallest Encapsulated 40W Converter
- ▶ Ultra-compact 2" X 1" Package
- ▶ Ultra-wide 4:1 Input Voltage Range
- ▶ Fully Regulated Output Voltage
- ▶ Excellent Efficiency up to 91%
- ▶ 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 62368-1(60950-1) Safety Approval & CE Marking



## PRODUCT OVERVIEW

The MINMAX MKWI40 series is the latest 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 ultra-wide 4:1 input voltage range and precisely regulated output voltages.

Advanced circuit topology provides a very high efficiency up to 91% which allows an operating temperature range of -40°C to +80°C. Further features include remote On/Off, trimmable output voltage, under-voltage lockout 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.           | Min. | @Max. Load    | @No Load |                          |                         |                      |                   |
|               |                       |                | mA             | mA   | mA(typ.)      | mA(typ.) |                          |                         |                      | @Max. Load        |
|               | VDC                   | VDC            | mA             | mA   | mA(typ.)      | mA(typ.) | mA (typ.)                | VDC                     | μF                   | %                 |
| MKWI40-24S033 | 24<br>(9 ~ 36)        | 3.3            | 8000           | 0    | 1240          | 90       | 30                       | 3.9                     | 21000                | 89                |
| MKWI40-24S05  |                       | 5              | 8000           | 0    | 1850          | 90       |                          | 6.2                     | 13600                | 90                |
| MKWI40-24S12  |                       | 12             | 3330           | 0    | 1870          | 95       |                          | 15                      | 2400                 | 89                |
| MKWI40-24S15  |                       | 15             | 2670           | 0    | 1870          | 105      |                          | 18                      | 1500                 | 89                |
| MKWI40-24S24  |                       | 24             | 1670           | 0    | 1835          | 115      |                          | 30                      | 600                  | 91                |
| MKWI40-24D12  |                       | ±12            | ±1670          | ±145 | 1890          | 65       |                          | ±15                     | 1200#                | 88                |
| MKWI40-24D15  | 48<br>(18 ~ 75)       | ±15            | ±1330          | ±110 | 1890          | 65       | 20                       | ±18                     | 750#                 | 88                |
| MKWI40-48S033 |                       | 3.3            | 8000           | 0    | 620           | 55       |                          | 3.9                     | 21000                | 89                |
| MKWI40-48S05  |                       | 5              | 8000           | 0    | 930           | 55       |                          | 6.2                     | 13600                | 90                |
| MKWI40-48S12  |                       | 12             | 3330           | 0    | 930           | 60       |                          | 15                      | 2400                 | 90                |
| MKWI40-48S15  |                       | 15             | 2670           | 0    | 930           | 65       |                          | 18                      | 1500                 | 90                |
| MKWI40-48S24  |                       | 24             | 1670           | 0    | 918           | 75       |                          | 30                      | 600                  | 91                |
| MKWI40-48D12  |                       | ±12            | ±1670          | ±145 | 950           | 45       |                          | ±15                     | 1200#                | 88                |
| MKWI40-48D15  |                       | ±15            | ±1330          | ±110 | 950           | 45       |                          | ±18                     | 750#                 | 88                |

# For each output

### 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                        | ---              | 8.3  | ---  |      |
|                                   | 48V Input Models                        | ---              | 16.5 | ---  |      |
| Start Up Time (Power On)          | Nominal Vin and Constant Resistive Load | ---              | ---  | 30   | ms   |
| Input Filter                      | All Models                              | Internal LC Type |      |      |      |

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**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.            |
| Output Voltage Balance              | Dual Output, Balanced Loads                                                            |                       | ---                                                     | ---  | ±2.0      | %                 |
| Line Regulation                     | Vin=Min. to Max. @Full Load                                                            |                       | ---                                                     | ---  | ±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 Models      | ---                                                     | ---  | 100       | mV <sub>P-P</sub> |
|                                     |                                                                                        | 12V, 15V & 24V Models | ---                                                     | ---  | 150       | mV <sub>P-P</sub> |
|                                     |                                                                                        | Dual Output Models    | ---                                                     | ---  | 150       | mV <sub>P-P</sub> |
| Transient Recovery Time             | 25% Load Step Change                                                                   |                       | ---                                                     | 250  | ---       | μsec              |
| Transient Response Deviation        |                                                                                        |                       | ---                                                     | ±3   | ±5        | %                 |
| Temperature Coefficient             |                                                                                        |                       | ---                                                     | ---  | ±0.02     | %/°C              |
| Trim Up / Down Range (See Page 6)   | % of Nominal Output Voltage                                                            | 24Vo Models           | ---                                                     | ---  | +20 / -10 | %                 |
|                                     |                                                                                        | Other Models          | ---                                                     | ---  | ±10       |                   |
| Over Load Protection                | Current Limitation at 150% typ. of Iout max., Hiccup                                   |                       |                                                         |      |           |                   |
| Short Circuit Protection            | 24Vo Models                                                                            |                       | Continuous, Automatic Recovery (Hiccup Mode 0.3Hz typ.) |      |           |                   |
|                                     | Other Models                                                                           |                       | Continuous, Automatic Recovery (Hiccup Mode 1.5Hz typ.) |      |           |                   |

**General Specifications**

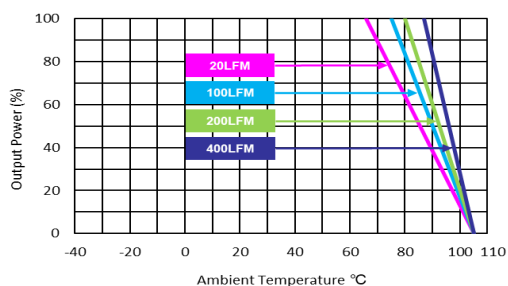
| Parameter                 | Conditions / Model                                                     | Min.    | Typ. | Max. | Unit  |
|---------------------------|------------------------------------------------------------------------|---------|------|------|-------|
| I/O Isolation Voltage     | 60 Seconds                                                             | 1500    | ---  | ---  | VDC   |
|                           | 1 Seconds                                                              | 1800    | ---  | ---  | VDC   |
| I/O Isolation Resistance  | 500 VDC                                                                | 1000    | ---  | ---  | MΩ    |
| I/O Isolation Capacitance | 100kHz, 1V                                                             | ---     | ---  | 1500 | pF    |
| Switching Frequency       | 24Vo Models                                                            | ---     | 285  | ---  | kHz   |
|                           | Other Models                                                           | ---     | 320  | ---  | kHz   |
| MTBF(calculated)          | MIL-HDBK-217F@25°C, Ground Benign                                      | 328,000 |      |      | Hours |
| Safety Approvals          | UL/cUL 60950-1 recognition(CSA certificate), IEC/EN 60950-1(CB-report) |         |      |      |       |
|                           | UL/cUL 62368-1 recognition(UL certificate), IEC/EN 62368-1(CB-report)  |         |      |      |       |

**EMC Specifications**

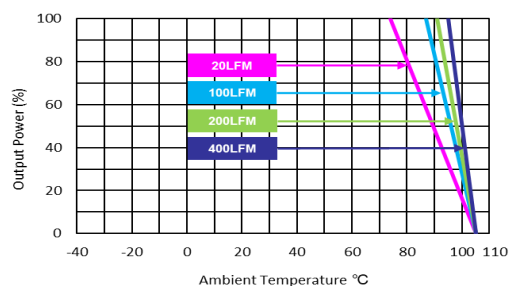
| EMC Specifications |                    |                                       |                          |             |
|--------------------|--------------------|---------------------------------------|--------------------------|-------------|
| Parameter          |                    | Standards & Level                     |                          | Performance |
| EMI                | Conduction         | EN55032                               | With external components | Class A     |
|                    | Radiation          |                                       |                          |             |
| 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           |
|                    | PFMF               | EN61000-4-8 3A/m                      |                          | A           |

**Environmental Specifications**

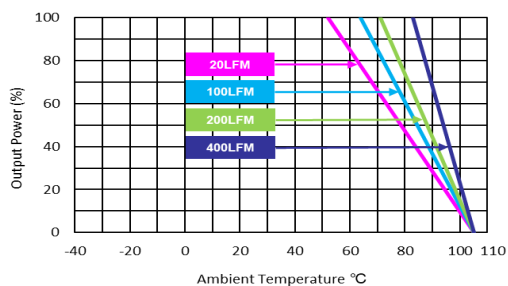
| Parameter                                                                                                                | Conditions / Model                 | Min.       | Max.             |               | Unit     |
|--------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------|------------------|---------------|----------|
|                                                                                                                          |                                    |            | without Heatsink | with Heatsink |          |
| Operating Ambient Temperature Range<br>Nominal Vin, Load 100% Inom.<br>(for Power Derating see relative Derating Curves) | MKWI40-XXS033                      | -40        | 66               | 73            | °C       |
|                                                                                                                          | MKWI40-24S05, MKWI40-48S05         |            | 51               | 61            |          |
|                                                                                                                          | MKWI40-48S12, MKWI40-48S15         |            |                  |               |          |
|                                                                                                                          | MKWI40-24S12, MKWI40-24S15         |            | 45               | 57            |          |
|                                                                                                                          | MKWI40-24S24, MKWI40-48S24         |            | 57               | 66            |          |
|                                                                                                                          | MKWI40-24D12, MKWI40-24D15         |            | 40               | 52            |          |
|                                                                                                                          | MKWI40-48D12, MKWI40-48D15         |            |                  |               |          |
| Thermal Impedance                                                                                                        | 20LFM Convection without Heatsink  | 12.0       | ---              |               | °C/W     |
|                                                                                                                          | 20LFM Convection with Heatsink     | 10.0       | ---              |               | °C/W     |
|                                                                                                                          | 100LFM Convection without Heatsink | 9.0        | ---              |               | °C/W     |
|                                                                                                                          | 100LFM Convection with Heatsink    | 5.4        | ---              |               | °C/W     |
|                                                                                                                          | 200LFM Convection without Heatsink | 8.0        | ---              |               | °C/W     |
|                                                                                                                          | 200LFM Convection with Heatsink    | 4.5        | ---              |               | °C/W     |
|                                                                                                                          | 400LFM Convection without Heatsink | 6.0        | ---              |               | °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 |
| RFI                                                                                                                      | Six-Sided Shielded, Metal Case     |            |                  |               |          |
| Lead Temperature (1.5mm from case for 10Sec.)                                                                            |                                    | ---        | 260              |               | °C       |

**Power Derating Curve**


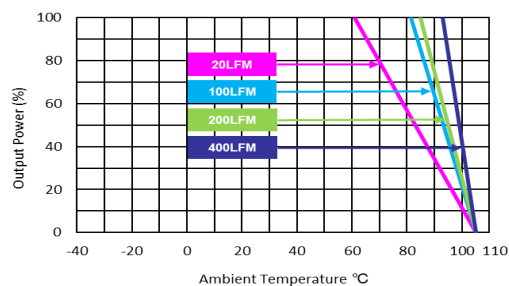
MKWI40-24S033, MKWI40-48S033 Derating Curve without Heatsink



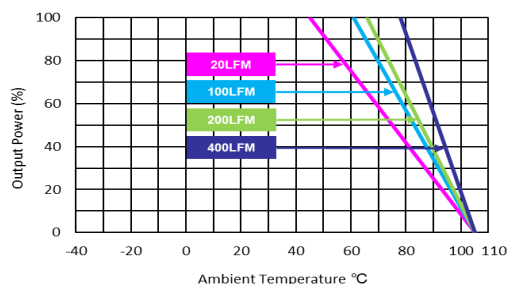
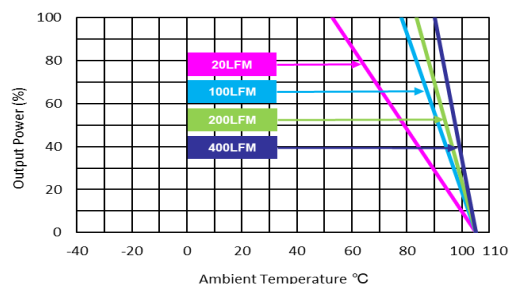
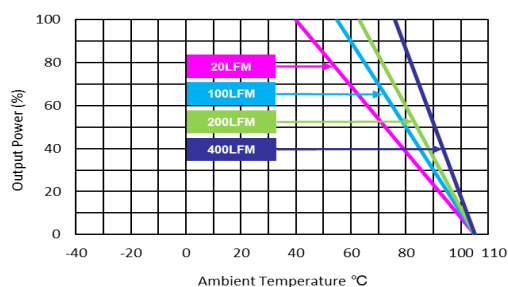
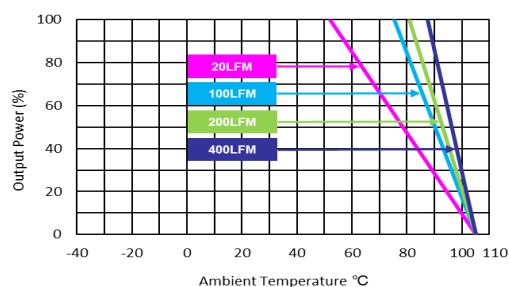
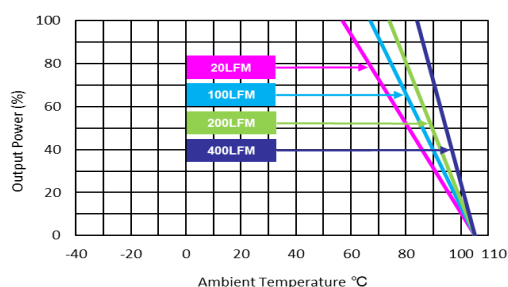
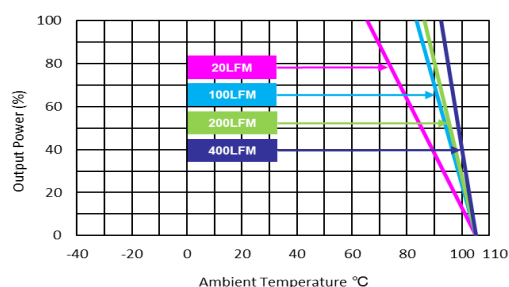
MKWI40-24S033, MKWI40-48S033 Derating Curve with Heatsink



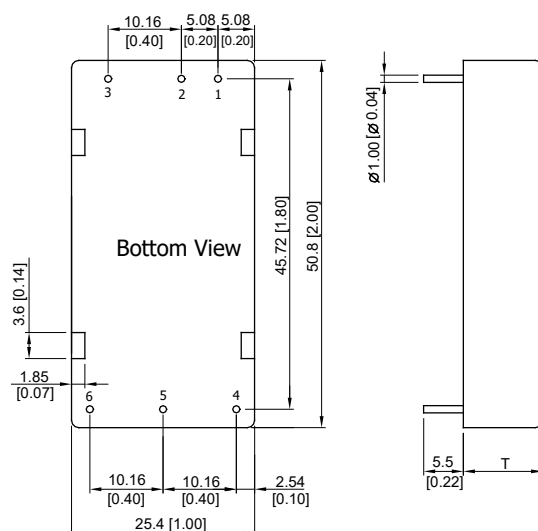
MKWI40-24S05, MKWI40-48S05, MKWI40-48S12, MKWI40-48S15 Derating Curve without Heatsink



MKWI40-24S05, MKWI40-48S05, MKWI40-48S12, MKWI40-48S15 Derating Curve with Heatsink

**Power Derating Curve**

**MKWI40-24S12, MKWI40-24S15 Derating Curve without Heatsink**
**MKWI40-24S12, MKWI40-24S15 Derating Curve with Heatsink**

**MKWI40-24D12, MKWI40-24D15, MKWI40-48D12, MKWI40-48D15 Derating Curve without Heatsink**
**MKWI40-24D12, MKWI40-24D15, MKWI40-48D12, MKWI40-48D15 Derating Curve with Heatsink**

**MKWI40-24S24, MKWI40-48S24 Derating Curve without Heatsink**
**MKWI40-24S24, MKWI40-48S24 Derating Curve with Heatsink**
**Notes**

- 1 Specifications typical at  $T_a = +25^\circ\text{C}$ , resistive load, nominal input voltage and rated output current unless otherwise noted.
- 2 Transient recovery time is measured to within 1% error band for a step change in output load of 75% to 100%.
- 3 Ripple & Noise measurement with a  $1\mu\text{F}$  M/C and a  $10\mu\text{F}$  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 MINMAX.
- 6 To meet EN61000-4-4 & EN61000-4-5 an external filter requested, please contact MINMAX.
- 7 Do not exceed maximum power specification when adjusting output voltage.
- 8 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)

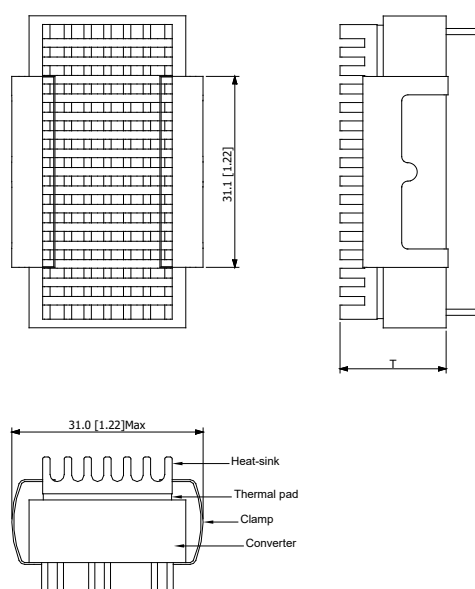
► Tolerance: X.X±0.25 (X.XX±0.01)

X.XX±0.13 (X.XXX±0.005)

► Pin diameter  $\varnothing 1.0 \pm 0.05$  (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(0.71 inch) for 24V Output Models

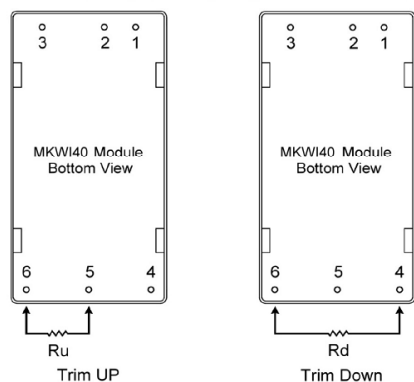
T: 17.2mm(0.68 inch) for Other Output Models

► 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.

### External Output Trimming

Output can be externally trimmed by using the method shown below

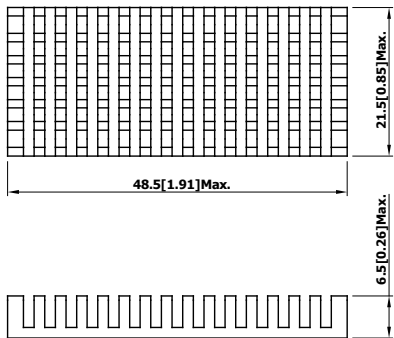
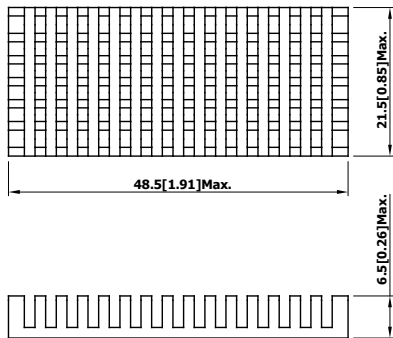


|                | MKWI40-XXS033           |                       | MKWI40-XXS05            |                       | MKWI40-XXS12            |                       | MKWI40-XXS15            |                       | MKWI40-XXS24            |                       |
|----------------|-------------------------|-----------------------|-------------------------|-----------------------|-------------------------|-----------------------|-------------------------|-----------------------|-------------------------|-----------------------|
| Trim Range (%) | Trim down (k $\Omega$ ) | Trim up (k $\Omega$ ) | Trim down (k $\Omega$ ) | Trim up (k $\Omega$ ) | Trim down (k $\Omega$ ) | Trim up (k $\Omega$ ) | Trim down (k $\Omega$ ) | Trim up (k $\Omega$ ) | Trim down (k $\Omega$ ) | Trim up (k $\Omega$ ) |
| 1              | 72.61                   | 60.84                 | 138.88                  | 106.87                | 413.55                  | 351.00                | 530.73                  | 422.77                | 333.39                  | ---                   |
| 2              | 32.55                   | 27.40                 | 62.41                   | 47.76                 | 184.55                  | 157.50                | 238.61                  | 189.89                | 148.80                  | 243.70                |
| 3              | 19.20                   | 16.25                 | 36.92                   | 28.06                 | 108.22                  | 93.00                 | 141.24                  | 112.26                | 87.26                   | ---                   |
| 4              | 12.52                   | 10.68                 | 24.18                   | 18.21                 | 70.05                   | 60.75                 | 92.56                   | 73.44                 | 56.50                   | 108.50                |
| 5              | 8.51                    | 7.34                  | 16.53                   | 12.30                 | 47.15                   | 41.40                 | 63.35                   | 50.15                 | 38.04                   | ---                   |
| 6              | 5.84                    | 5.11                  | 11.44                   | 8.36                  | 31.88                   | 28.50                 | 43.87                   | 34.63                 | 25.73                   | 63.43                 |
| 7              | 3.94                    | 3.51                  | 7.79                    | 5.55                  | 20.98                   | 19.29                 | 29.96                   | 23.54                 | 16.94                   | ---                   |
| 8              | 2.51                    | 2.32                  | 5.06                    | 3.44                  | 12.80                   | 12.37                 | 19.53                   | 15.22                 | 10.35                   | 40.90                 |
| 9              | 1.39                    | 1.39                  | 2.94                    | 1.79                  | 6.44                    | 7.00                  | 11.41                   | 8.75                  | 5.22                    | ---                   |
| 10             | 0.50                    | 0.65                  | 1.24                    | 0.48                  | 1.35                    | 2.70                  | 4.92                    | 3.58                  | 1.12                    | 27.38                 |
| 12             | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | 18.37                 |
| 14             | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | 11.93                 |
| 16             | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | 7.10                  |
| 18             | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | 3.34                  |
| 20             | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | ---                   | ---                     | 0.34                  |

**Order Code Table For Converter and Converter With Heatsink**

| Standard      | With heatsink    | Without Remote On/Off |
|---------------|------------------|-----------------------|
| MKWI40-24S033 | MKWI40-24S033-HS | MKWI40-24S033-N       |
| MKWI40-24S05  | MKWI40-24S05-HS  | MKWI40-24S05-N        |
| MKWI40-24S12  | MKWI40-24S12-HS  | MKWI40-24S12-N        |
| MKWI40-24S15  | MKWI40-24S15-HS  | MKWI40-24S15-N        |
| MKWI40-24S24  | MKWI40-24S24-HS  | MKWI40-24S24-N        |
| MKWI40-24D12  | MKWI40-24D12-HS  | MKWI40-24D12-N        |
| MKWI40-24D15  | MKWI40-24D15-HS  | MKWI40-24D15-N        |
| MKWI40-48S033 | MKWI40-48S033-HS | MKWI40-48S033-N       |
| MKWI40-48S05  | MKWI40-48S05-HS  | MKWI40-48S05-N        |
| MKWI40-48S12  | MKWI40-48S12-HS  | MKWI40-48S12-N        |
| MKWI40-48S15  | MKWI40-48S15-HS  | MKWI40-48S15-N        |
| MKWI40-48S24  | MKWI40-48S24-HS  | MKWI40-48S24-N        |
| MKWI40-48D12  | MKWI40-48D12-HS  | MKWI40-48D12-N        |
| MKWI40-48D15  | MKWI40-48D15-HS  | MKWI40-48D15-N        |

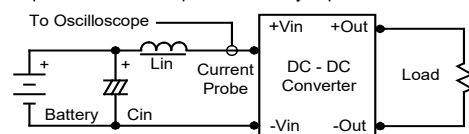
**Order Code Table For Heatsink kit (including: Heatsink x1, Clamp x 2, Thermal Pad x1)**

| HS-K001 (Other Output)                                                             | HS-K002 (24V Output)                                                                |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |

## Test Setup

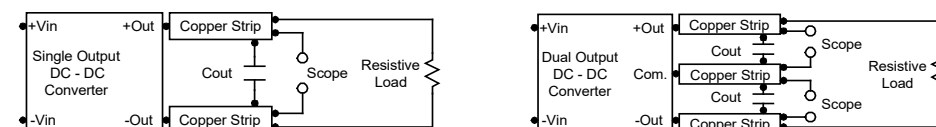
### Input Reflected-Ripple Current Test Setup

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  $100\text{ kHz}$ ) 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  $1\mu F$  ceramic capacitor and a  $10\mu F$  tantalum 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

### 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  $-V_{in}$  terminal. The switch can be an open collector or equivalent. A logic low is  $0V$  to  $1.2V$ . A logic high is  $4.7V$  to  $12V$ . The maximum sink current at the on/off terminal (Pin 3) during a logic low is  $-100\mu A$ . The maximum allowable leakage current of a switch connected to the on/off terminal (Pin 3) at logic high ( $2.5V$  to  $100V$ ) is  $5\mu A$ .

### Overcurrent Protection

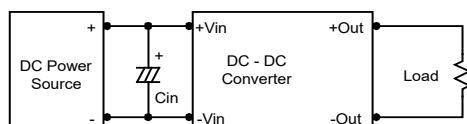
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

### Overvoltage Protection

The output overvoltage clamp consists of control circuitry, which is independent of the primary regulation loop, that monitors the voltage on the output terminals. The control loop of the clamp has a higher voltage set point than the primary loop. This provides a redundant voltage control that reduces the risk of output overvoltage. The OVP level can be found in the output data.

### Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup. Capacitor mounted close to the power module helps ensure stability of the unit, it is recommended to use a good quality low Equivalent Series Resistance ( $ESR < 1.0\Omega$  at  $100\text{ kHz}$ ) 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 MKWI40 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  $105^{\circ}C$ . The derating curves are determined from measurements obtained in a test setup.

