

## FEATURES

- ▶ Industrial Standard 1" 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 +90°C
- ▶ Low No Load Power Consumption
- ▶ No Min. Load Requirement
- ▶ Under-voltage, Overload/Voltage and Short Circuit Protection
- ▶ Remote On/Off Control, Output Voltage Trim
- ▶ Shielded Metal Case with Insulated Baseplate
- ▶ Conducted EMI EN 55032 Class A Approved
- ▶ UL/cUL/IEC/EN 62368-1(60950-1) Safety Approval & CE Marking



## PRODUCT OVERVIEW

The MINMAX MJWI15 series are cost optimized DC-DC converter modules offering 15W output power in a 1"x1"x 0.4" shielded metal package with industry standard pinout. All models provide ultra-wide 4:1 input voltage range and fixed output voltage regulation.

State-of-the-art circuit topology provides a high efficiency up to 91% allowing an operating temperature range of -40°C to +90°C. For increased temperature performance the modules are available with an optional clip-on heatsink. Further features include remote On/Off control, trimmable output voltage, under-voltage protection, overload protection, over voltage protection, short circuit protection and no min. load requirement as well.

Typical applications for these DC-DC converters are battery operated equipment, instrumentation, distributed power architectures in communication and industrial electronics and other space critical applications.

### Model Selection Guide

| Model Number  | Input Voltage (Range) | Output Voltage | Output Current |            | Input Current |           | Reflected Ripple Current | Over Voltage Protection | Max. capacitive Load | Efficiency (typ.) |
|---------------|-----------------------|----------------|----------------|------------|---------------|-----------|--------------------------|-------------------------|----------------------|-------------------|
|               |                       |                | Max.           | @Max. Load | @No Load      |           |                          |                         |                      |                   |
|               | VDC                   | VDC            | mA             | mA(typ.)   | mA(typ.)      | mA (typ.) | VDC                      | µF                      | %                    |                   |
| MJWI15-24S033 | 24<br>(9 ~ 36)        | 3.3            | 3400           | 544        | 10            | 50        | 3.9                      | 5800                    | 86                   |                   |
| MJWI15-24S05  |                       | 5              | 3000           | 710        | 10            |           | 6.2                      | 5100                    | 88                   |                   |
| MJWI15-24S12  |                       | 12             | 1250           | 710        | 10            |           | 15                       | 870                     | 88                   |                   |
| MJWI15-24S15  |                       | 15             | 1000           | 702        | 10            |           | 18                       | 560                     | 89                   |                   |
| MJWI15-24S24  |                       | 24             | 625            | 687        | 10            |           | 30                       | 220                     | 91                   |                   |
| MJWI15-24D12  |                       | ±12            | ±625           | 702        | 15            |           | ±15                      | 440#                    | 89                   |                   |
| MJWI15-24D15  |                       | ±15            | ±500           | 702        | 15            |           | ±18                      | 280#                    | 89                   |                   |
| MJWI15-48S033 | 48<br>(18 ~ 75)       | 3.3            | 3400           | 272        | 8             | 30        | 3.9                      | 5800                    | 86                   |                   |
| MJWI15-48S05  |                       | 5              | 3000           | 355        | 8             |           | 6.2                      | 5100                    | 88                   |                   |
| MJWI15-48S12  |                       | 12             | 1250           | 351        | 8             |           | 15                       | 870                     | 89                   |                   |
| MJWI15-48S15  |                       | 15             | 1000           | 351        | 8             |           | 18                       | 560                     | 89                   |                   |
| MJWI15-48S24  |                       | 24             | 625            | 343        | 8             |           | 30                       | 220                     | 91                   |                   |
| MJWI15-48D12  |                       | ±12            | ±625           | 347        | 10            |           | ±15                      | 440#                    | 90                   |                   |
| MJWI15-48D15  |                       | ±15            | ±500           | 351        | 10            |           | ±18                      | 280#                    | 89                   |                   |

# For each output

| Input Specifications              |   |                  |      |      |      |  |
|-----------------------------------|---|------------------|------|------|------|--|
| Parameter                         | Conditions / Model                      | Min.             | Typ. | Max. | Unit |  |
| Input Surge Voltage (1 sec. 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 Shutdown            | 24V Input Models                        | ---              | 7.5  | ---  |      |  |
|                                   | 48V Input Models                        | ---              | 16   | ---  |      |  |
| Start Up Time (Power On)          | Nominal Vin and Constant Resistive Load | ---              | ---  | 30   | ms   |  |
| Input Filter                      | All Models                              | Internal LC Type |      |      |      |  |

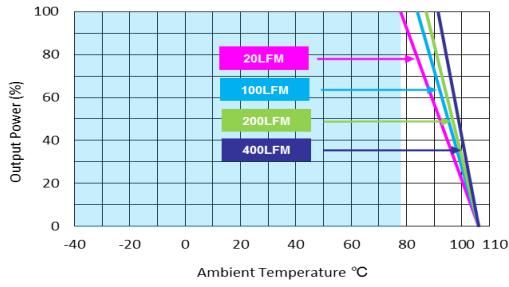
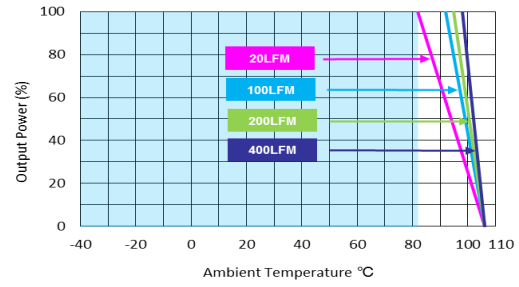
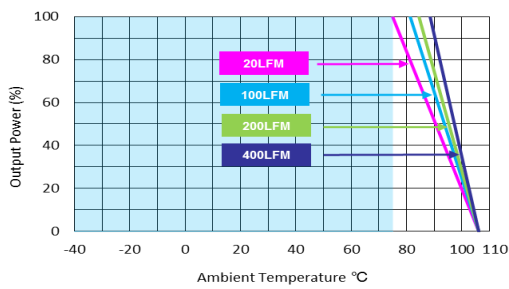
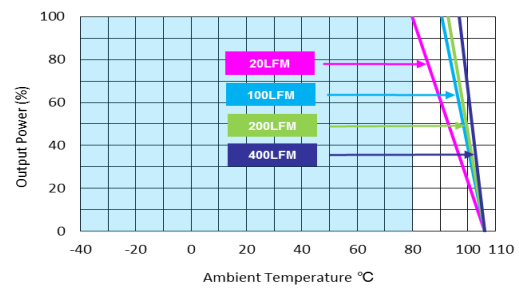
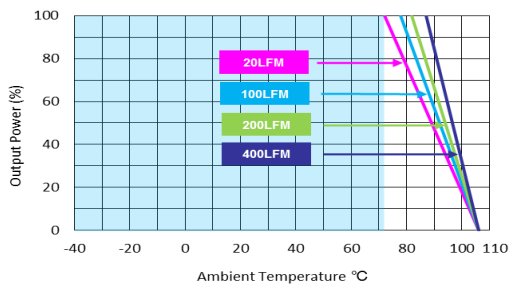
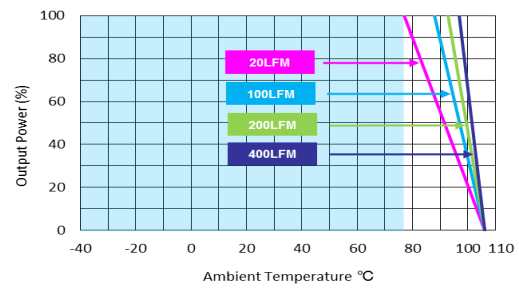
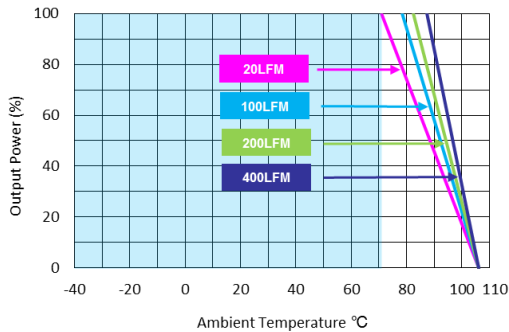
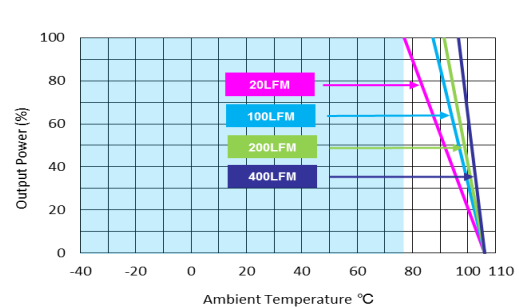
| Remote On/Off Control       |                              |      |      |      |      |  |
|-----------------------------|------------------------------|------|------|------|------|--|
| Parameter                   | Conditions                   | Min. | Typ. | Max. | Unit |  |
| Converter On                | 3.5V ~ 12V or Open Circuit   |      |      |      |      |  |
| Converter Off               | 0V ~ 1.2V or Short Circuit   |      |      |      |      |  |
| Control Input Current (on)  | Vctrl = 5.0V                 | ---  | ---  | 0.5  | mA   |  |
| Control Input Current (off) | Vctrl = 0V                   | ---  | ---  | -0.5 | mA   |  |
| Control Common              | Referenced to Negative Input |      |      |      |      |  |
| Standby Input Current       | Nominal Vin                  | ---  | 3    | ---  | mA   |  |

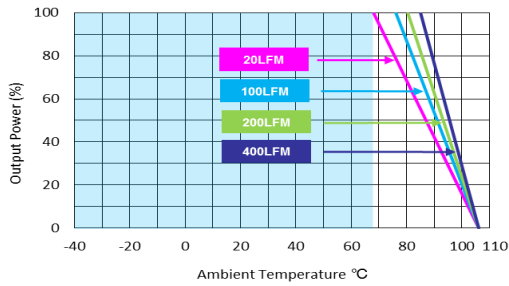
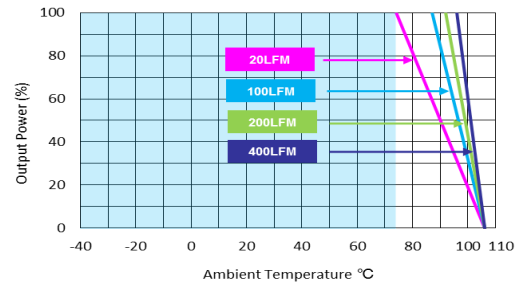
| Output Specifications               |   |                               |                |       |        |      |                   |
|-------------------------------------|---|-------------------------------|----------------|-------|--------|------|-------------------|
| Parameter                           | 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                             | Single Output                 | ---            | ---   | ±0.2   | %    |                   |
|                                     |   | Dual Output                   | ---            | ---   | ±0.5   | %    |                   |
| Load Regulation                     | Io=0% to 100%   | Single Output                 | 3.3V & 5V      | ---   | ---    | ±0.5 | %                 |
|                                     |   |                               | 12V, 15V & 24V | ---   | ---    | ±0.2 | %                 |
|                                     |   | Dual Output                   | ---            | ---   | ±1.0   | %    |                   |
| Load Cross Regulation (Dual Output) | Asymmetrical Load 25%/100% Full Load                    | ---                           | ---            | ±5.0  | %      |      |                   |
| Minimum Load                        | No minimum Load Requirement                             |                               |                |       |        |      |                   |
| Ripple & Noise                      | 0-20 MHz Bandwidth                                      | 3.3V & 5V Models              |                | ---   | ---    | 75   | mV <sub>P-P</sub> |
|                                     |   | 12V, 15V & Dual Output Models |                | ---   | ---    | 100  | mV <sub>P-P</sub> |
|                                     |   | 24V Models                    |                | ---   | ---    | 150  | mV <sub>P-P</sub> |
| Transient Recovery Time             | 25% Load Step Change                                    | ---                           | 300            | ---   | μsec   |      |                   |
| Transient Response Deviation        |   | ---                           | ±3             | ±5    | %      |      |                   |
| Temperature Coefficient             |   | ---                           | ---            | ±0.02 | %/°C   |      |                   |
| Trim Up / Down Range                | % of Nominal Output Voltage                             | ---                           | ---            | ±10   | %      |      |                   |
| Over Load Protection                | Hiccup  | ---                           | 150            | ---   | %      |      |                   |
| Short Circuit Protection            | Continuous, Automatic Recovery (Hiccup Mode 0.7Hz typ.) |                               |                |       |        |      |                   |

| General Specifications                 |   |           |      |      |       |  |
|--|---|-----------|------|------|-------|--|
| Parameter                              | Conditions  | Min.      | Typ. | Max. | Unit  |  |
| I/O Isolation Voltage                  | 60 Seconds  | 1500      | ---  | ---  | VDC   |  |
|  | 1 Second  | 1800      | ---  | ---  | VDC   |  |
| Isolation Voltage Input/Output to case |   | 1000      | ---  | ---  | VDC   |  |
| I/O Isolation Resistance               | 500 VDC   | 1000      | ---  | ---  | MΩ    |  |
| I/O Isolation Capacitance              | 100kHz, 1V  | ---       | ---  | 1500 | pF    |  |
| Switching Frequency                    |   | ---       | 330  | ---  | kHz   |  |
| MTBF(calculated)                       | MIL-HDBK-217F@25°C, Ground Benign                                     | 1,374,698 | ---  | ---  | Hours |  |
| Safety Approvals                       | UL/cUL 60950-1 recognition(UL certificate), IEC/EN 60950-1(CB-report) |           |      |      |       |  |
|  | UL/cUL 62368-1 recognition(UL certificate), IEC/EN 62368-1(CB-report) |           |      |      |       |  |

| EMC Specifications |                    |                                      |                             |
|--------------------|--------------------|--------------------------------------|-----------------------------|
| Parameter          | Standards & Level  |                                      | Performance                 |
| EMI                | Conduction         | EN 55032                             | Without external components |
|                    | Radiation          |                                      | With external components    |
| EMS                | EN 55024           |                                      |                             |
|                    | ESD                | EN 61000-4-2 Air± 8kV , Contact ±6kV | A                           |
|                    | Radiated immunity  | EN 61000-4-3 10V/m                   | A                           |
|                    | Fast transient (6) | EN 61000-4-4 ±2kV                    | A                           |
|                    | Surge (6)          | EN 61000-4-5 ±1kV                    | A                           |
|                    | Conducted immunity | EN 61000-4-6 10V/rms                 | A                           |
|                    | PFMF               | EN 61000-4-8 100A/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) | MJWI15-24S24, MJWI15-48S24   | -40  | +78              | +82           | °C       |
|  | MJWI15-48D12   |      | +75              | +80           |          |
|  | MJWI15-24S033, MJWI15-48S033   |      | +72              | +77           |          |
|  | MJWI15-24S15, MJWI15-24D12<br>MJWI15-24D15, MJWI15-48S12<br>MJWI15-48S15, MJWI15-48D15 |      | +71              | +77           |          |
|  | MJWI15-24S05, MJWI15-24S12<br>MJWI15-48S05   |      | +68              | +74           |          |
| Thermal Impedance  | 20LFM Convection without Heatsink  | 18.2 | ---              | ---           | °C/W     |
|  | 20LFM Convection with Heatsink   | 15.3 | ---              | ---           | °C/W     |
|  | 100LFM Convection without Heatsink   | 13.9 | ---              | ---           | °C/W     |
|  | 100LFM Convection with Heatsink  | 8.8  | ---              | ---           | °C/W     |
|  | 200LFM Convection without Heatsink   | 12.1 | ---              | ---           | °C/W     |
|  | 200LFM Convection with Heatsink  | 6.8  | ---              | ---           | °C/W     |
|  | 400LFM Convection without Heatsink   | 9.1  | ---              | ---           | °C/W     |
| 400LFM Convection with Heatsink  | 4.6  | ---  | ---              | °C/W          |          |
| Case Temperature   |  | ---  | +105             | ---           | °C       |
| 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**

 MJWI15-24S24, MJWI15-48S24  
 Derating Curve without Heatsink

 MJWI15-24S24, MJWI15-48S24  
 Derating Curve with Heatsink

 MJWI15-48D12  
 Derating Curve without Heatsink

 MJWI15-48D12  
 Derating Curve with Heatsink

 MJWI15-24S033, MJWI15-48S033  
 Derating Curve without Heatsink

 MJWI15-24S033, MJWI15-48S033  
 Derating Curve with Heatsink

 MJWI15-24S15, MJWI15-24D12, MJWI15-24D15  
 MJWI15-48S12, MJWI15-48S15, MJWI15-48D15  
 Derating Curve without Heatsink

 MJWI15-24S15, MJWI15-24D12, MJWI15-24D15  
 MJWI15-48S12, MJWI15-48S15, MJWI15-48D15  
 Derating Curve with Heatsink

**Power Derating Curve**

 MJWI15-24S05, MJWI15-24S12, MJWI15-48S05  
 Derating Curve without Heatsink

 MJWI15-24S05, MJWI15-24S12, MJWI15-48S05  
 Derating Curve with Heatsink

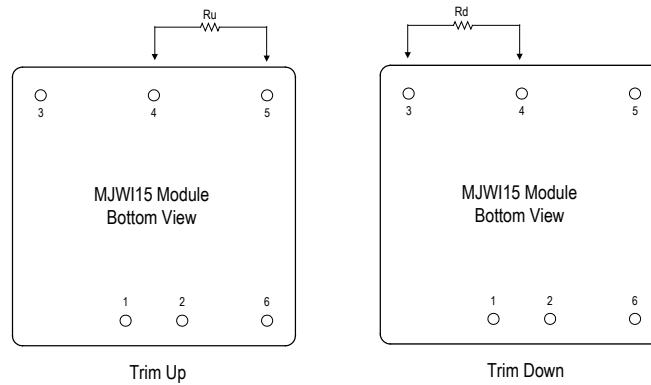
**Notes**

- 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 measured with a  $1\mu\text{F}$  MLCC.
- 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 EN 61000-4-4 & EN 61000-4-5 an external capacitor across the input pins is required, please contact MINMAX.
- 7 Specifications are subject to change without notice.



**External Output Trimming**

Output can be externally trimmed by using the method shown below



| Trim Range (%) | MJWI15-XXS033  |              | MJWI15-XXS05   |              | MJWI15-XXS12   |              | MJWI15-XXS15   |              | MJWI15-XXS24   |              |
|----------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|--------------|
|                | Trim down (kΩ) | Trim up (kΩ) | Trim down (kΩ) | Trim up (kΩ) | Trim down (kΩ) | Trim up (kΩ) | Trim down (kΩ) | Trim up (kΩ) | Trim down (kΩ) | Trim up (kΩ) |
| 1              | 72.61          | 60.84        | 138.88         | 106.87       | 413.55         | 351.00       | 530.73         | 422.77       | 598.66         | 487.14       |
| 2              | 32.55          | 27.40        | 62.41          | 47.76        | 184.55         | 157.50       | 238.61         | 189.89       | 267.78         | 218.02       |
| 3              | 19.20          | 16.25        | 36.92          | 28.06        | 108.22         | 93.00        | 141.24         | 112.26       | 157.49         | 128.31       |
| 4              | 12.52          | 10.68        | 24.18          | 18.21        | 70.05          | 60.75        | 92.56          | 73.44        | 102.34         | 83.46        |
| 5              | 8.51           | 7.34         | 16.53          | 12.30        | 47.15          | 41.40        | 63.35          | 50.15        | 69.25          | 56.55        |
| 6              | 5.84           | 5.11         | 11.44          | 8.36         | 31.88          | 28.50        | 43.87          | 34.63        | 47.19          | 38.61        |
| 7              | 3.94           | 3.51         | 7.79           | 5.55         | 20.98          | 19.29        | 29.96          | 23.54        | 31.44          | 25.79        |
| 8              | 2.51           | 2.32         | 5.06           | 3.44         | 12.80          | 12.37        | 19.53          | 15.22        | 19.62          | 16.18        |
| 9              | 1.39           | 1.39         | 2.94           | 1.79         | 6.44           | 7.00         | 11.41          | 8.75         | 10.43          | 8.70         |
| 10             | 0.50           | 0.65         | 1.24           | 0.48         | 1.35           | 2.70         | 4.92           | 3.58         | 3.08           | 2.72         |

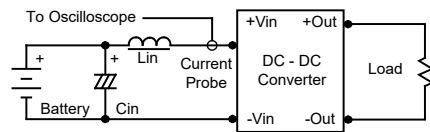
**Order Code Table**

| Standard      | With heatsink    |
|---------------|------------------|
| MJWI15-24S033 | MJWI15-24S033-HS |
| MJWI15-24S05  | MJWI15-24S05-HS  |
| MJWI15-24S12  | MJWI15-24S12-HS  |
| MJWI15-24S15  | MJWI15-24S15-HS  |
| MJWI15-24S24  | MJWI15-24S24-HS  |
| MJWI15-24D12  | MJWI15-24D12-HS  |
| MJWI15-24D15  | MJWI15-24D15-HS  |
| MJWI15-48S033 | MJWI15-48S033-HS |
| MJWI15-48S05  | MJWI15-48S05-HS  |
| MJWI15-48S12  | MJWI15-48S12-HS  |
| MJWI15-48S15  | MJWI15-48S15-HS  |
| MJWI15-48S24  | MJWI15-48S24-HS  |
| MJWI15-48D12  | MJWI15-48D12-HS  |
| MJWI15-48D15  | MJWI15-48D15-HS  |

## Test Setup

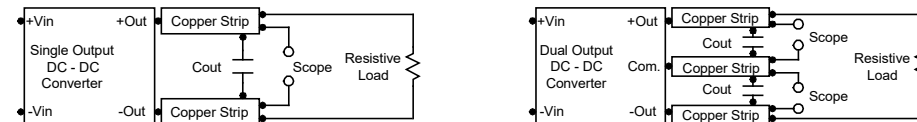
### Input Reflected-Ripple Current Test Setup

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

Use a 1 $\mu$ F ceramic 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 6) during a logic low is -500 $\mu$ A. The maximum allowable leakage current of a switch connected to the on/off terminal (Pin 6) at logic high (3.5V to 12V) is 10mA.

### Overload Protection

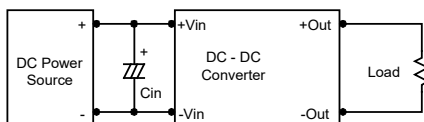
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

### 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.

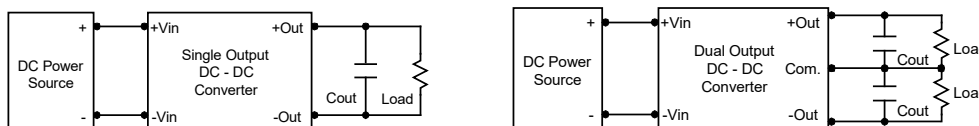
### Input Source Impedance

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 1 $\mu$ F capacitors at the output.



### Maximum Capacitive Load

The MJWI15 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.

