

## 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 & FCC Level 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 tight 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) VDC	Output Voltage VDC	Output Current		Input Current		Reflected Ripple Current mA (typ.)	Over Voltage Protection VDC	Max. capacitive Load μF	Efficiency (typ.) %
			Max.	@Max. Load	@No Load	mA (typ.)				
			mA	mA(typ.)	mA(typ.)					%
MJWI15-24S033	24 (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 (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	Supply Off & Nominal Vin	---	3	---	mA

**Output Specifications**

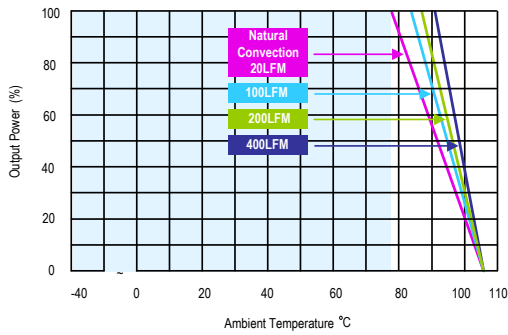
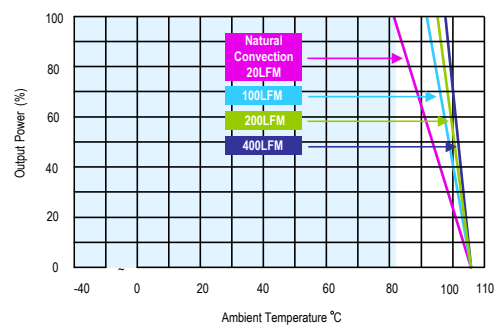
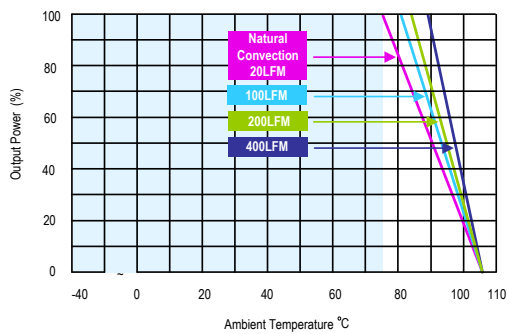
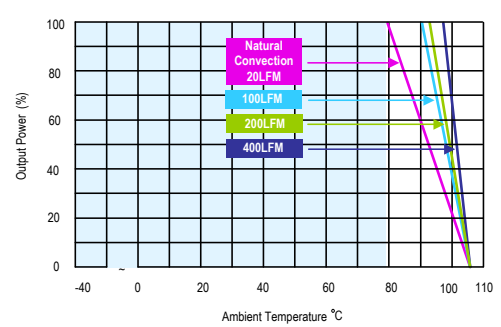
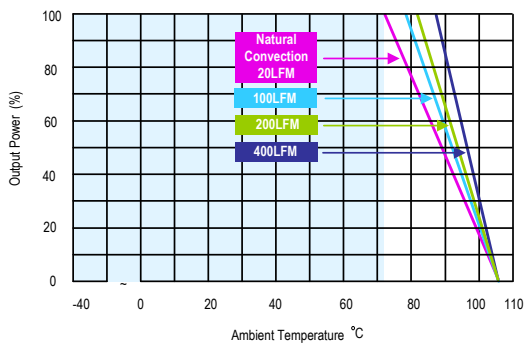
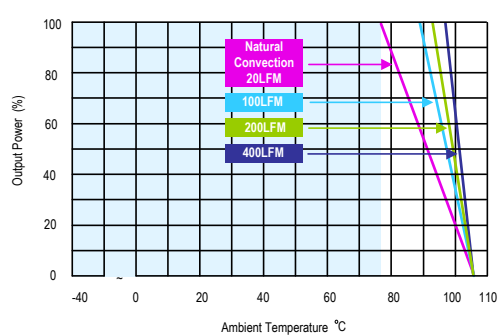
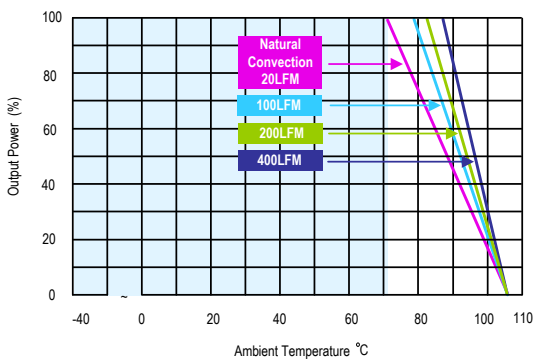
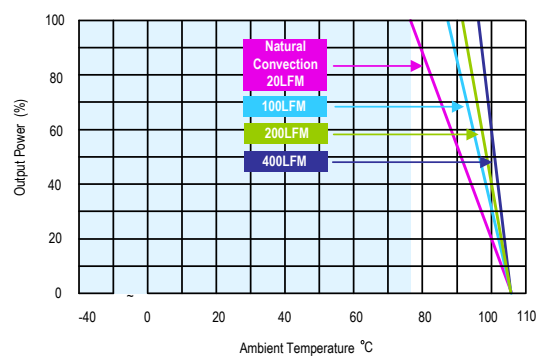
Parameter	Conditions / Model	Min.	Typ.	Max.	Unit		
Output Voltage Setting Accuracy		---	---	±1.0	%Vnom.		
Output Voltage Balance	Dual Output, Balanced Loads	---	---	±2.0	%		
Line Regulation	Vin=Min. to Max. @Full Load	Single Output	---	---	±0.2	%	
		Dual Output	---	---	±0.5	%	
Load Regulation	Io=0% to 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	Hiccup Mode 0.7 Hz typ., Automatic Recovery						

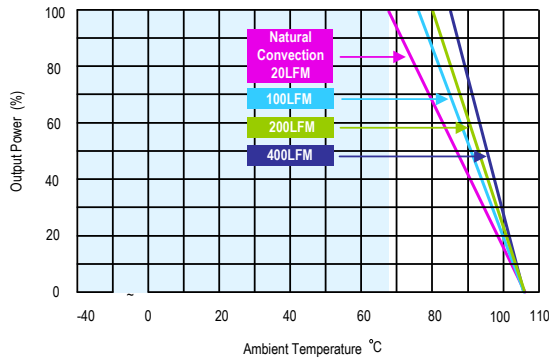
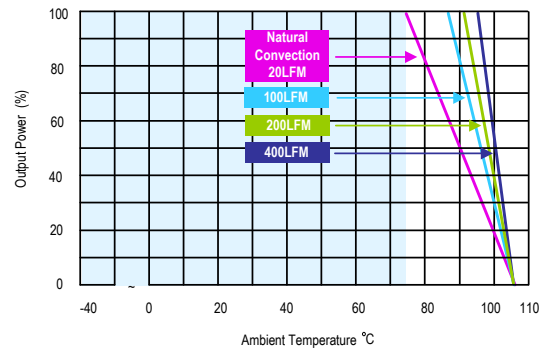
**General Specifications**

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)				

Environmental Specifications					
Parameter	Conditions/Model	Min.	Max.		Unit
			without Heatsink	with Heatsink	
Operating Ambient Temperature Range Natural Convection <sup>(7)</sup> Nominal Vin, Load 100% Inom. (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 MJWI15-24D15, MJWI15-48S12 MJWI15-48S15, MJWI15-48D15		+71	+77	
	MJWI15-24S05, MJWI15-24S12 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
Cooling	Natural Convection				
RFI	Six-Sided Shielded, Metal Case				
Lead Temperature (1.5mm from case for 10Sec.)		---	260	---	°C

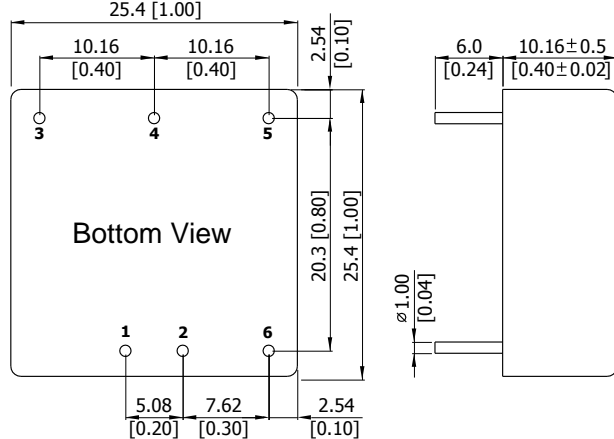
EMC Specifications			
Parameter	Standards & Level		Performance
EMI	Conduction	EN 55032, FCC part 15	Class A
EMS	EN 55024		
	ESD	EN 61000-4-2 Air± 8kV , Contact ±6kV	A
	Radiated immunity	EN 61000-4-3 10V/m	A
	Fast transient <sup>(6)</sup>	EN 61000-4-4 ±2kV	A
	Surge <sup>(6)</sup>	EN 61000-4-5 ±1kV	A
	Conducted immunity	EN 61000-4-6 10V/rms	A
	PFMF	EN 61000-4-8 100A/m	A

**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**

- Specifications typical at  $T_a = +25^\circ\text{C}$ , resistive load, nominal input voltage and rated output current unless otherwise noted.
- Transient recovery time is measured to within 1% error band for a step change in output load of 75% to 100%.
- Ripple & Noise measured with a  $1\mu\text{F}$  MLCC.
- We recommend to protect the converter by a slow blow fuse in the input supply line.
- Other input and output voltage may be available, please contact factory.
- To meet EN 61000-4-4 & EN 61000-4-5 an external capacitor across the input pins is required.  
Suggested capacitor : XXS033, XXS05: CHEMI-CON KY Series  $470\mu\text{F}/100\text{V}$ .  
Other Models: CHEMI-CON KY Series  $220\mu\text{F}/100\text{V}$ .
- That "natural convection" is about 20LFM but is not equal to still air (0 LFM).
- Specifications are subject to change without notice.

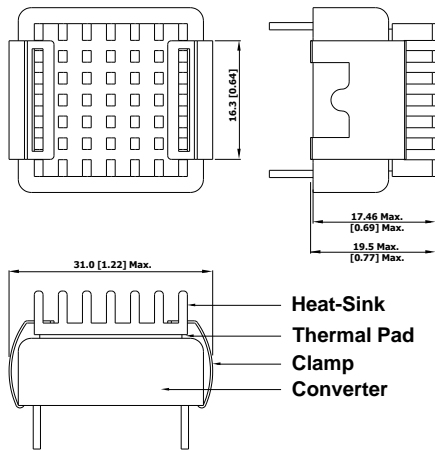
**Package Specifications**
**Mechanical Dimensions**

**Pin Connections**

Pin	Single Output	Dual Output
1	+Vin	+Vin
2	-Vin	-Vin
3	+Vout	+Vout
4	Trim	Common
5	-Vout	-Vout
6	Remote On/Off	Remote On/Off

- ▶ All dimensions in mm (inches)
- ▶ Tolerance:  $X.X \pm 0.5$  ( $X.XX \pm 0.02$ )  
 $X.XX \pm 0.25$  ( $X.XXX \pm 0.01$ )
- ▶ Pin diameter  $\phi 1.0 \pm 0.05$  ( $0.04 \pm 0.002$ )

**Physical Characteristics**

Case Size	: 25.4x25.4x10.16mm (1.0x1.0x0.4 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	: 15g

**Heatsink (Option -HS)**
**Mechanical Dimensions**


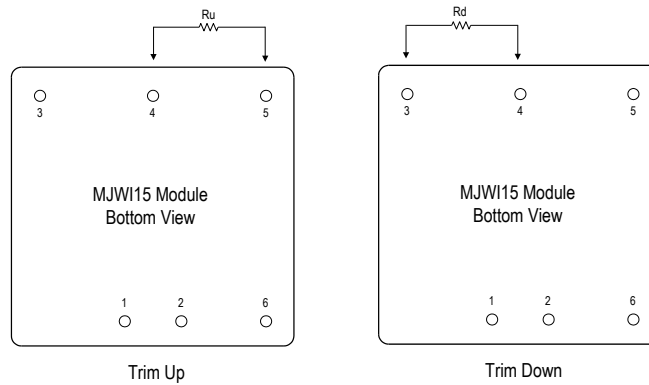
Heatsink Material: Aluminum  
Finish: Anodic treatment (black)  
Weight: 2g

► 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


**MJWI15-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

**MJWI15-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

**MJWI15-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

**MJWI15-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

**MJWI15-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=	598.66	267.78	157.49	102.34	69.25	47.19	31.44	19.62	10.43	3.08	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=	487.14	218.02	128.31	83.46	56.55	38.61	25.79	16.18	8.70	2.72	KOhms

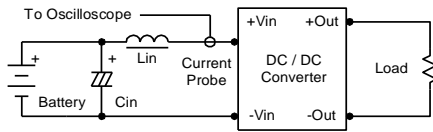
Order Code Table	
Standard	With heatsink
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MJWI15-24S05	MJWI15-24S05-HS
MJWI15-24S12	MJWI15-24S12-HS
MJWI15-24S15	MJWI15-24S15-HS
MJWI15-24S24	MJWI15-24S24-HS
MJWI15-24D12	MJWI15-24D12-HS
MJWI15-24D15	MJWI15-24D15-HS
MJWI15-48S033	MJWI15-48S033-HS
MJWI15-48S05	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

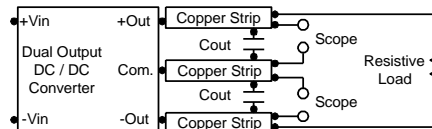
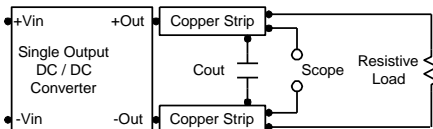
### Input Reflected-Ripple Current Test Setup

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

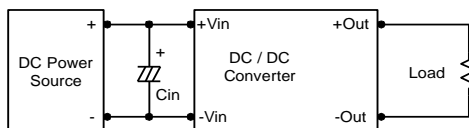
The output overvoltage clamp consists of control circuitry, which is independent of the primary regulation loop, that monitors the voltage on the output terminals. The control loop of the clamp has a higher voltage set point than the primary loop. This provides a redundant voltage control that reduces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

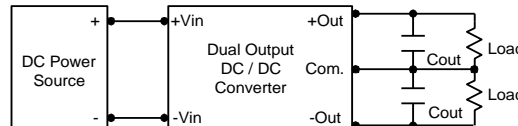
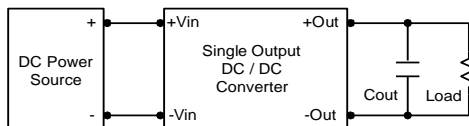
In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup.

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 4.7 $\mu$ 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.

