FEATURES

- **Compact Industrial SMD Package**
- **Unregulated Output Voltage**
- **I/O Isolation 1500 VDC**
- **Efficiency up to 91%**
- **Short Circuit Protection (Hiccup Mode)**
- **Wide Operating Temperature Range**
- **Cleaning-washable Process Available (optional)**
- **Qualified for Lead-free Reflow Solder Process according to IPC/JEDEC J-STD-020D.1**

PRODUCT OVERVIEW

The MINMAX brand new MSU02 series is a compact 2W industrial SMD package DC-DC converter that offers unregulated output voltages of 3.3, 5, 12, 15, 24, ±5, ±12, and ±15 VDC, with 1500 VDC I/O isolation and up to 91% efficiency. The MSU02 series features short-circuit protection (Hiccup Mode). A wide operating temperature range ensures consistent performance under various conditions. Additionally, the MSU02 series is qualified for lead-free reflow soldering in accordance with IPC/JEDEC J-STD-020D.1, with an optional cleaning-washable process available.

The MSU02 series is perfectly suited for industrial applications such as automation systems, industrial sensors, control equipment, and IoT applications. Its compact size and robust performance make it an excellent choice for installations requiring efficient, high-quality power conversion in space-constrained environments.

Model Selection Guide

Model Number	Input Voltage (Range)	Output Voltage	Output Current (2)	Input Current		Load Regulation	Max. capacitive Load	Efficiency (typ.)
			Max.	@Max. Load	@No Load			@Max. Load
	VDC	VDC	mA	mA(typ.)	mA(typ.)	% (max.)	μF	%
MSU02-05S033	5 (4.5 ~ 5.5)	3.3	600	472	12	8	2200	84
MSU02-05S05		5	400	455		7	1000	88
MSU02-05S12		12	167	441		6	180	91
MSU02-05S15		15	134	442		6	120	91
MSU02-05S24		24	83	443		7	47	90
MSU02-05D05		±5	±200	460		7	470#	87
MSU02-05D12		±12	±83	438		6	100#	91
MSU02-05D15		±15	±67	442		6	68#	91
MSU02-12S033	12 (10.8 ~ 13.2)	3.3	600	199	7	9	2200	83
MSU02-12S05		5	400	194		6	1000	86
MSU02-12S12		12	167	186		5	180	90
MSU02-12S15		15	134	184		5	120	91
MSU02-12S24		24	83	187		5	47	89
MSU02-12D05		±5	±200	190		6	470#	88
MSU02-12D12		±12	±83	185		5	100#	90
MSU02-12D15		±15	±67	184		5	68#	91
MSU02-24S033	24 (21.6 ~ 26.4)	3.3	600	98	5	6	2200	84
MSU02-24S05		5	400	96		5	1000	87
MSU02-24S12		12	167	94		3	180	90
MSU02-24S15		15	134	93		3	120	90
MSU02-24S24		24	83	92		4	47	90
MSU02-24D05		±5	±200	96		5	470#	87
MSU02-24D12		±12	±83	92		3	100#	90
MSU02-24D15		±15	±67	92		3	68#	91

For each output

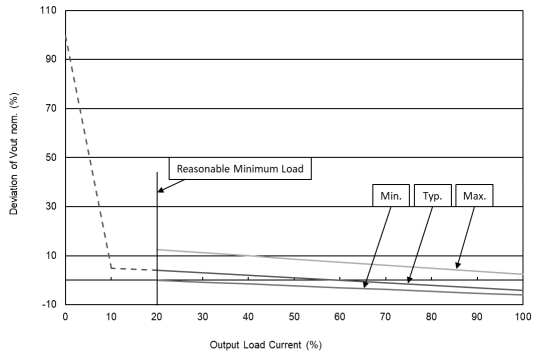
Input Specifications

Parameter	Model	Min.	Typ.	Max.	Unit
Input Voltage Range	5V Input Models	4.5	5	5.5	VDC
	12V Input Models	10.8	12	13.2	
	24V Input Models	21.6	24	26.4	
Input Surge Voltage (1 sec. max.)	5V Input Models	-0.7	---	9	
	12V Input Models	-0.7	---	18	
	24V Input Models	-0.7	---	30	
Input Filter	All Models	Internal Capacitor			

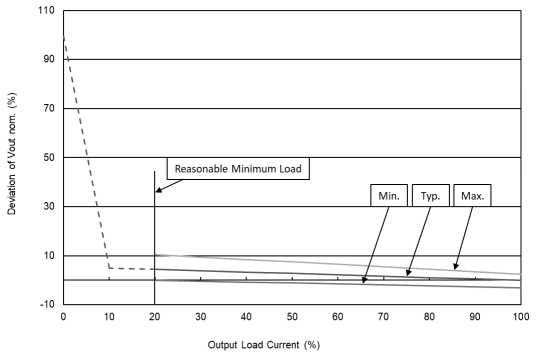
Output Specifications

Parameter	Conditions / Model	Min.	Typ.	Max.	Unit
Output Voltage Setting Accuracy		---	---	±3.0	%Vnom.
Output Voltage Balance	Dual Output, Balanced Loads	---	±0.1	±1.0	%
Line Regulation	For Vin Change of 1%	---	±1.2	±1.5	%
Load Regulation	Io=20% to 100%	See Model Selection Guide (Operation at lower load will not damage the converter, but it may not meet all specifications)			
Ripple & Noise	0-20 MHz Bandwidth	---	---	120	mV_{P-P}
Temperature Coefficient		---	±0.01	±0.02	%/°C
Short Circuit Protection	Continuous, Automatic Recovery (Hiccup Mode)				

Output Voltage Tolerance



Output Voltage VS Output Load Current



Output Voltage VS Input Voltage Range

General Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	60 Seconds	1500	---	---	VDC
	1 Second	1800	---	---	VDC
I/O Isolation Resistance	500 VDC	1000	---	---	MΩ
I/O Isolation Capacitance	100kHz, 1V	---	40	100	pF
Switching Frequency		---	240	---	kHz
MTBF (calculated)	MIL-HDBK-217F@25°C, Ground Benign	4,474,521	---	---	Hours
Moisture Sensitivity Level (MSL)	IPC/JEDEC J-STD-020D.1	Level 2			

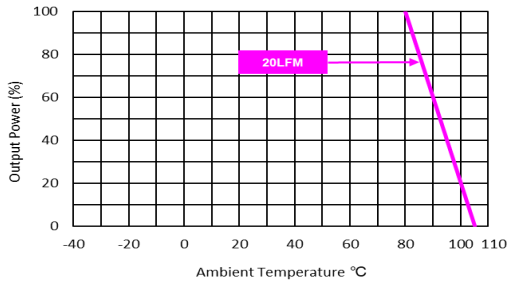
EMC Specifications

Parameter	Standards & Level			Performance
EMI(5)	Conduction	EN 55032	With external components	Class A
	Radiation			
EMS(5)	EN 55035			
	ESD	Direct discharge	Indirect discharge HCP & VCP	A
		EN 61000-4-2 Air ± 8kV	Contact ± 6kV	
	Radiated immunity	EN 61000-4-3 10V/m		A
	Fast transient	EN 61000-4-4 ±2kV		A
	Surge	EN 61000-4-5 ±2kV		A
	Conducted immunity	EN 61000-4-6 10Vrms		A
	PFMF	EN61000-4-8 30A/m for Continuous; 1000A/m for 1 s		A

Environmental Specifications

Parameter	Min.	Max.	Unit
Operating Ambient Temperature Range (See Power Derating Curve)	-40	+80	℃
Case Temperature	---	+105	℃
Storage Temperature Range	-50	+125	℃
Humidity (non condensing)	---	95	% rel. H
Lead-free Reflow Solder Process	IPC/JEDEC J-STD-020D.1		

Power Derating Curve

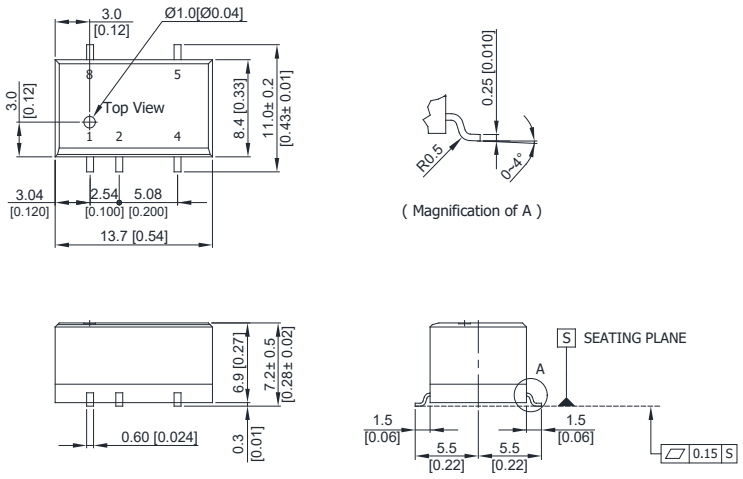


Notes

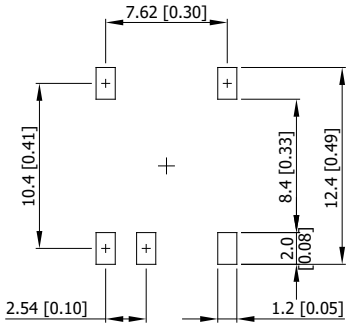
1 Specifications typical at Ta=+25℃, resistive load, nominal input voltage and rated output current unless otherwise noted.
2 These power converters require a minimum output loading to maintain specified regulation, operation under no-load conditions will not damage these modules; however they may not meet all specifications listed.
3 We recommend to protect the converter by a fast blow fuse in the input supply line.
4 Other input and output voltage may be available, please contact MINMAX.
5 The external components might be required to meet EMI/EMS standard for some of test items. Please contact MINMAX for the solution in detail.
6 Specifications are subject to change without notice.
7 The repeated high voltage isolation testing of the converter can degrade isolation capability, to a lesser or greater degree depending on materials, construction, environment and reflow solder process. Any material is susceptible to eventual chemical degradation when subject to very high applied voltages thus implying that the number of tests should be strictly limited. We therefore strongly advise against repeated high voltage isolation testing, but if it is absolutely required, that the voltage be reduced by 20% from specified test voltage. Furthermore, the high voltage isolation capability after reflow solder process should be evaluated as it is applied on system.

Package Specifications

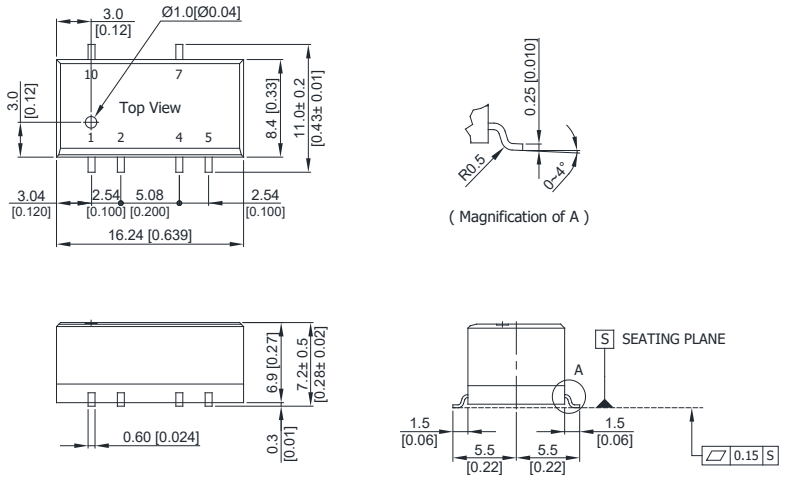
Mechanical Dimensions (Single Output)



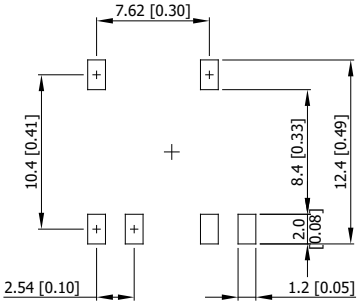
Connecting Pin Patterns



Mechanical Dimensions (Dual Output)



Connecting Pin Patterns



- All dimensions in mm (inches)
- Tolerance: X.X±0.25 (X.XX±0.01)
  X.XX±0.13 (X.XXX±0.005)
- Pins ±0.05 (±0.002)

Pin Connections

Pin	Single Output	Dual Output
1	-Vin	-Vin
2	+Vin	+Vin
3	No Pin	No Pin
4	-Vout	Common
5	+Vout	-Vout
6	No Pin	No Pin
7	No Pin	+Vout
8	NA	No Pin
9	---	No Pin
10	---	NA

NA : Not Available for Electrical Connection

Physical Characteristics

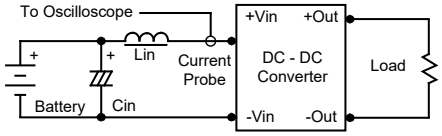
Case Size (Single Output)	:	13.7x8.4x6.9mm (0.54x0.33x0.27 inches)
Case Size (Dual Output)	:	16.24x8.4x6.9mm (0.64x0.33x0.27 inches)
Case Material	:	Plastic resin (flammability to UL 94V-0 rated)
Pin Material	:	Phosphor Bronze
Weight (Single Output)	:	1.6g
Weight (Dual Output)	:	1.78g

Order Code Table	
Standard	For cleaning-washable process
MSU02-05S033	MSU02-05S033-W
MSU02-05S05	MSU02-05S05-W
MSU02-05S12	MSU02-05S12-W
MSU02-05S15	MSU02-05S15-W
MSU02-05S24	MSU02-05S24-W
MSU02-05D05	MSU02-05D05-W
MSU02-05D12	MSU02-05D12-W
MSU02-05D15	MSU02-05D15-W
MSU02-12S033	MSU02-12S033-W
MSU02-12S05	MSU02-12S05-W
MSU02-12S12	MSU02-12S12-W
MSU02-12S15	MSU02-12S15-W
MSU02-12S24	MSU02-12S24-W
MSU02-12D05	MSU02-12D05-W
MSU02-12D12	MSU02-12D12-W
MSU02-12D15	MSU02-12D15-W
MSU02-24S033	MSU02-24S033-W
MSU02-24S05	MSU02-24S05-W
MSU02-24S12	MSU02-24S12-W
MSU02-24S15	MSU02-24S15-W
MSU02-24S24	MSU02-24S24-W
MSU02-24D05	MSU02-24D05-W
MSU02-24D12	MSU02-24D12-W
MSU02-24D15	MSU02-24D15-W

Test Setup

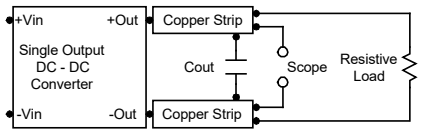
Input Reflected-Ripple Current Test Setup

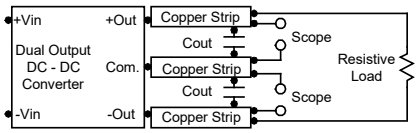
Input reflected-ripple current is measured with a inductor Lin (4.7μH) and Cin (220μF, ESR < 1.0Ω at 100 kHz) to simulate source impedance. Capacitor Cin, offsets possible battery impedance. Current ripple is measured at the input terminals of the module, measurement bandwidth is 0-500 kHz.



Peak-to-Peak Output Noise Measurement Test

Use a Cout 0.33μF 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.





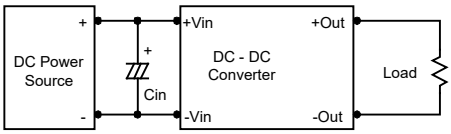
Technical Notes

Maximum Capacitive Load

The MSU02 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. For optimum performance we recommend 33μF maximum capacitive load. The maximum capacitance can be found in the data sheet.

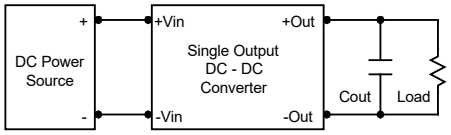
Input Source Impedance

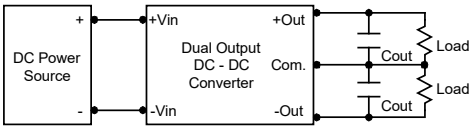
The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup. 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 < 1.0Ω at 100 kHz) capacitor of a 2.2μF for the 5V input devices, a 1.0μF for the 12V input devices and a 0.47μF for the 24V input 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 3.3μF capacitors at the output.





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℃. The derating curves are determined from measurements obtained in a test setup.