

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
- ▶ Qualified for Lead-free Reflow Solder Process according to IPC/JEDEC J-STD-020D.1
- ▶ UL/cUL/IEC/EN 62368-1 Safety Approval (Pending)


PRODUCT OVERVIEW

The MINMAX brand new MSU01 series is a compact industrial SMD package DC-DC converter designed for space-constrained applications that require reliable performance. It features unregulated output voltages of 3.3, 5, 12, 15, 24, ± 5 , ± 12 , and ± 15 VDC, with I/O isolation of 1500 VDC, delivering up to 91% efficiency. The MSU01 series includes short-circuit protection (Hiccup Mode) and a wide operating temperature range, making it suitable for harsh industrial environments. The series is safety approved to UL/cUL/IEC/EN 62368-1 standards, ensuring compliance with international safety requirements. Additionally, the MSU01 series is fully qualified for lead-free reflow solder processes in accordance with IPC/JEDEC J-STD-020D.1 and supports a cleaning-washable process as a standard feature.

The MSU01 series is ideal for various industrial applications such as sensor systems, industrial control equipment, automation systems, and IoT devices where space is limited and reliability is critical. Its compact form factor and robust design make it a perfect fit for demanding industrial applications that require high performance in challenging conditions.

Model Selection Guide

Model Number	Input Voltage (Range)	Output Voltage	Output Current (2)	Input Current		Load Regulation	Max. capacitive Load	Efficiency (typ.)		
				Max.	@No Load					
				VDC	mA			@Max. Load	@No Load	% (max.)
MSU01-033S033	3.3 (2.97 ~ 3.63)	3.3	300	357	12	10	2200	84		
MSU01-033S05		5	200	348		8	1000	87		
MSU01-05S033	5 (4.5 ~ 5.5)	3.3	300	233	12	7	2200	85		
MSU01-05S05		5	200	227		7	1000	88		
MSU01-05S12		12	83	221		4	180	90		
MSU01-05S15		15	67	223		4	120	90		
MSU01-05S24		24	42	224		4	47	90		
MSU01-05D05		± 5	± 100	230		7	470#	87		
MSU01-05D12		± 12	± 42	224		4	100#	90		
MSU01-05D15		± 15	± 33	218		4	68#	91		
MSU01-12S033		12 (10.8 ~ 13.2)	3.3	300		98	7	6	2200	84
MSU01-12S05			5	200		96		6	1000	87
MSU01-12S12	12		83	93	4	180		89		
MSU01-12S15	15		67	94	4	120		89		
MSU01-12S24	24		42	95	6	47		88		
MSU01-12D05	± 5		± 100	95	6	470#		88		
MSU01-12D12	± 12		± 42	93	4	100#		90		
MSU01-12D15	± 15		± 33	92	4	68#		90		
MSU01-24S033	24 (21.6 ~ 26.4)		3.3	300	51	5		6	2200	81
MSU01-24S05			5	200	50			6	1000	84
MSU01-24S12		12	83	49	4		180	85		
MSU01-24S15		15	67	49	4		120	86		
MSU01-24S24		24	42	49	4		47	85		
MSU01-24D05		± 5	± 100	51	6		470#	82		
MSU01-24D12		± 12	± 42	49	4		100#	85		
MSU01-24D15		± 15	± 33	49	4		68#	85		

For each output

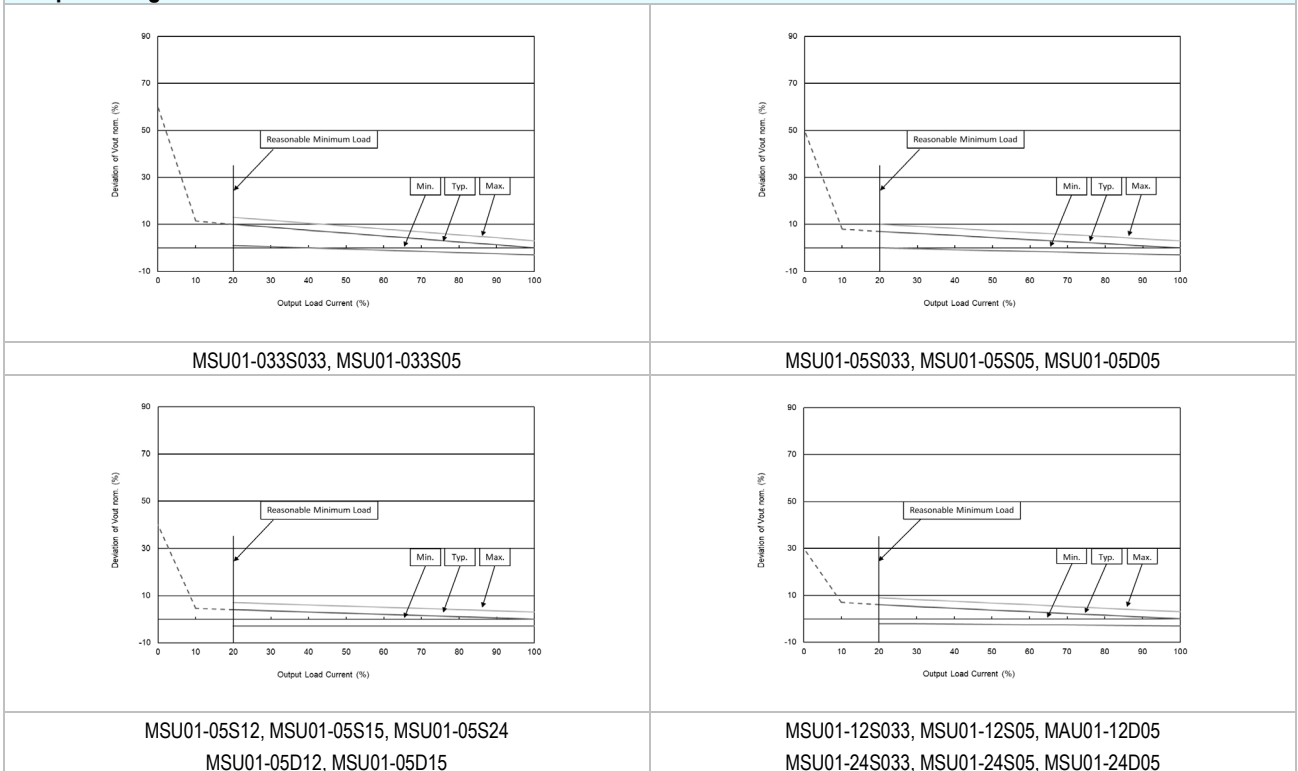
Input Specifications

Parameter	Model	Min.	Typ.	Max.	Unit
Input Voltage Range	3.3V Input Models	2.97	3.3	3.63	VDC
	5V Input Models	4.5	5	5.5	
	12V Input Models	10.8	12	13.2	
	24V Input Models	21.6	24	26.4	
Input Surge Voltage (1 sec. max.)	3.3V Input Models	-0.7	---	6	VDC
	5V Input Models	-0.7	---	9	
	12V Input Models	-0.7	---	18	
	24V Input Models	-0.7	---	30	
Internal Filter	All Models	Internal Capacitor			

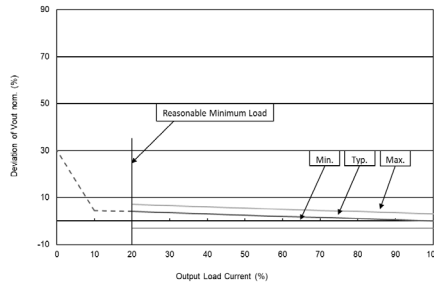
Output Specifications

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 3.3V Input Measured with a 0.1µF/25V MLCC Other Input	---	---	100	mV _{P-P}
Temperature Coefficient		---	±0.01	±0.02	%/°C
Short Circuit Protection	Continuous, Automatic Recovery (Hiccup Mode)				

Output Voltage Tolerance



Output Voltage Tolerance



MSU01-12S12, MSU01-12S15, MSU01-12S24, MSU01-12D12, MSU01-12D15
MSU01-24S12, MSU01-24S15, MSU01-24S24, MSU01-24D12, MSU01-24D15

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	5,013,824	---	---	Hours
Moisture Sensitivity Level (MSL)	IPC/JEDEC J-STD-020D.1	Level 2			
Safety Approvals (Pending)	UL/cUL 62368-1 recognition (UL certificate), IEC/EN 62368-1 (CB-report)				

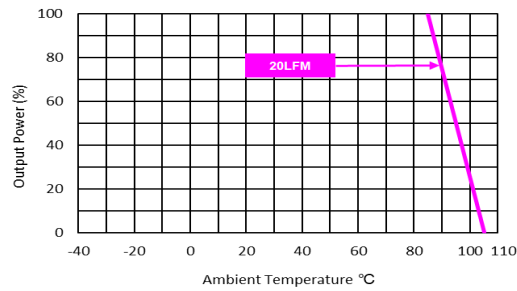
EMC Specifications

Parameter	Standards & Level			Performance
EMI _(s)	Conduction	EN 55032	With external components	Class A
	Radiation			
EMS _(s)	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 ±1kV		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	+85	°C
Case Temperature	---	+105	°C
Storage Temperature Range	-50	+125	°C
Humidity (non condensing)	---	95	% rel. H
Lead-free Reflow Solder Process	IPC/JEDEC J-STD-020D.1		

Power Derating Curve

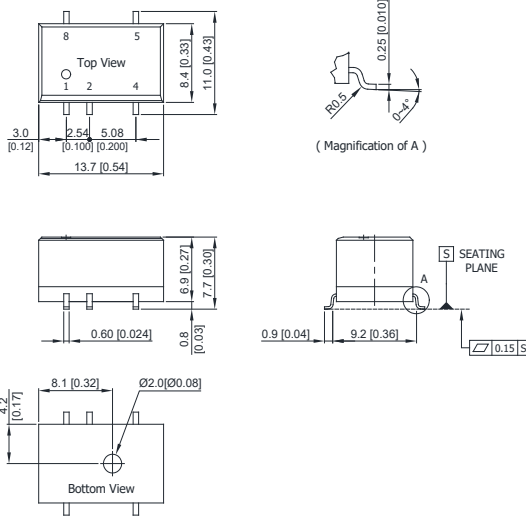


Notes

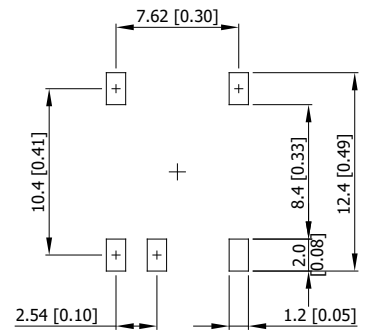
- 1 Specifications typical at $T_a=+25^{\circ}\text{C}$, resistive load, nominal input voltage and rated output current unless otherwise noted.
- 2 Please do not operate the product without a minimum load condition.
- 3 We recommend to protect the converter by a slow blow fuse in the input supply line.
- 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

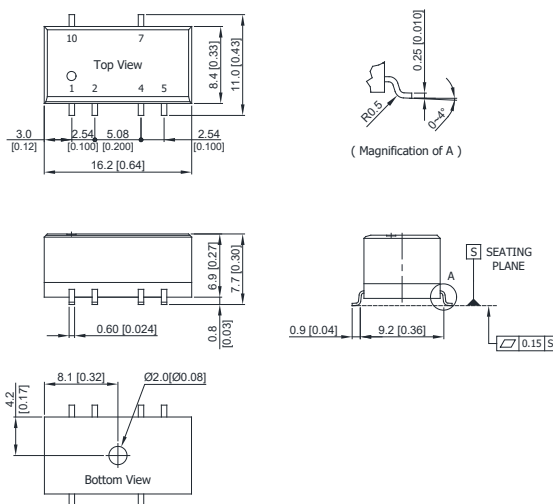
Mechanical Dimensions (Single Output)



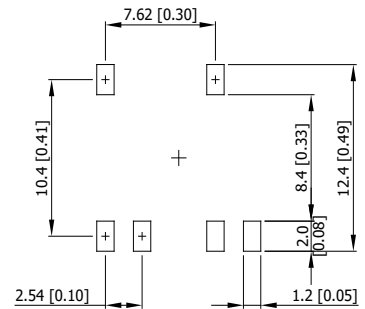
Connecting Pin Patterns



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

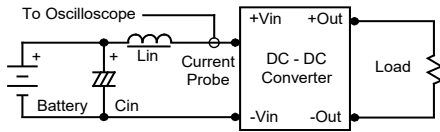
Physical Characteristics

Case Size (Single Output)	: 13.7x8.4x6.9mm (0.54x0.33x0.27 inches)
Case Size (Dual Output)	: 16.2x8.4x6.9mm (0.64x0.33x0.27 inches)
Case Material	: Plastic resin (flammability to UL 94V-0 rated)
Pin Material	: Phosphor Bronze
Weight (Single Output)	: 1.32g
Weight (Dual Output)	: 1.5g

Test Setup

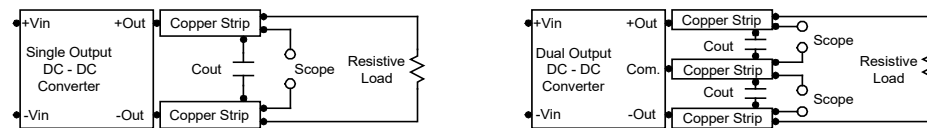
Input Reflected-Ripple Current Test Setup

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 $0\text{--}500\text{ kHz}$.



Peak-to-Peak Output Noise Measurement Test

Use a C_{out} $0.33\mu F$ ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is $0\text{--}20\text{ MHz}$. Position the load between 50 mm and 75 mm from the DC-DC Converter.



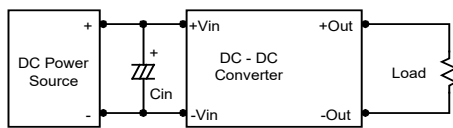
Technical Notes

Maximum Capacitive Load

The MSU01 series has a 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.

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 $4.7\mu F$ for the 3.3V input devices, a $2.2\mu F$ for the 5V input devices, a $1.0\mu F$ for the 12V input devices and a $0.47\mu F$ 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 $3.3\mu F$ 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°C . The derating curves are determined from measurements obtained in a test setup.

