MINMAX®

MSCU01M Series

Electric Characteristic Note

MSCU01M Series EC Note

DC-DC CONVERTER 1W, Reinforced Insulation, Medical Safety

Features

- ►**Industrial Standard SMD Package**
- ►**Unregulated Output Voltage**
- ►**I/O Isolation 4000VAC with Reinforced Insulation, rated for 250Vrms Working Voltage**
- ►**Low I/O Leakage Current < 2µA**
- ►**Operating Ambient Temp. Range -40℃ to 95℃**
- ►**Cleaning-washable Process Available (option)**
- ►**Qualified for Lead-free Reflow Solder Process According to IPC/JEDEC J-STD-020D.1**
- ►**Tape & Reel Package Available**
- ►**Short Circuit Protection**
- ►**Medical EMC Standard with 4th Edition of EMI EN 55011 and EMS EN 60601-1-2 Approved**
- ►**Medical Safety with 2xMOPP per 3rd Edition of IEC/EN 60601-1 & ANSI/AAMI ES60601-1 Approved with CE Marking**
- ►**Risk Management Report Acquisition according to ISO 14971**

Applications

- ►Distributed power architectures
- ►Workstations
- ►Computer equipment
- ►Communications equipment

Product Overview

Introducing the MINMAX MSCU01M series – 1W medical-approved isolated DC-DC converters encased in an enclosed SMD-14 package, purposefully designed for medical applications. With an array of 15 models catering to input voltages of 5, 12, and 24VDC, and offering output voltages of 5, 12, 15, ±12, and ±15VDC, this series ensures versatility to meet the diverse requirements of medical devices.

The MSCU01M series boasts an I/O isolation specified for 4000VAC with reinforced insulation, rated for a steadfast 250Vrms working voltage. Additional features include short circuit protection, low I/O leakage current of 2µA max, and an operating ambient temperature range from -40°C to 95°C without derating. Aligned with the 4th edition medical EMC standard, the series holds medical safety approval with 2xMOPP (Means Of Patient Protection) per the 3rd edition of IEC/EN 60601-1 & ANSI/AAMI ES 60601-1.

In adherence to ISO 14971 Medical Device Risk Management, the MSCU01M series undergoes a thorough risk assessment process. This ensures not only compliance with high-performance standards but also alignment with the stringent safety benchmarks outlined in ISO 14971. Elevate your medical devices with the MINMAX MSCU01M series – where advanced technology meets safety, performance, and Medical Device Risk Management Report Acquisition.

Table of contents

Model Selection Guide

Model Number	Input Voltage (Range)	Output Voltage	Output Current		Input Current		Max. capacitive Load	Efficiency (typ.)
			Max.	Min.	@Max. Load	@No Load		@Max. Load
	VDC	VDC	mA	mA	mA(typ.)	mA(typ.)	μF	%
MSCU01-05S05M	5 (4.5 ~ 5.5)	5	200	4	263	50	220	76
MSCU01-05S12M		12	84	1.68	252			80
MSCU01-05S15M		15	68	1.36	246			83
MSCU01-05D12M		±12	±42	±0.84	252		100#	80
MSCU01-05D15M		±15	±33	±0.66	236			84
MSCU01-12S05M	12 (10.8 ~ 13.2)	5	200	4	110	35	220	76
MSCU01-12S12M		12	84	1.68	106			79
MSCU01-12S15M		15	68	1.36	106			80
MSCU01-12D12M		±12	±42	±0.84	106		100#	79
MSCU01-12D15M		±15	±33	±0.66	103			80
MSCU01-24S05M	24 (21.6 ~ 26.4)	5	200	4	55	20	220	76
MSCU01-24S12M		12	84	1.68	53			80
MSCU01-24S15M		15	68	1.36	53			80
MSCU01-24D12M		±12	±42	±0.84	53		100#	80
MSCU01-24D15M		±15	±33	±0.66	52			80

* Min. Output Current for Lower Load Regulation # For each output

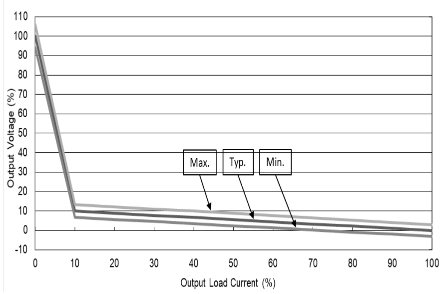
Input Specifications

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			

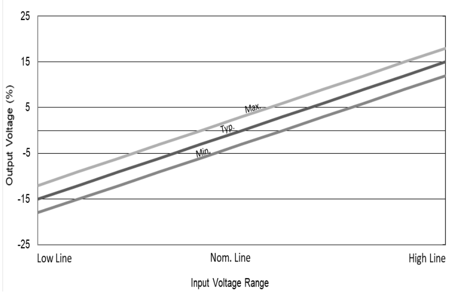
Output Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Output Voltage Setting Accuracy		---	±1.0	±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=10% to 100%	---	---	±10	%
Ripple & Noise	0-20 MHz Bandwidth	---	---	100	mV P-P
Temperature Coefficient		---	±0.01	±0.02	%/℃
Short Circuit Protection	Continuous, Automatic Recovery				

Output Voltage Tolerance



Output Voltage VS Output Load Current



Output Voltage VS Input Voltage Range

Isolation, Safety Standards					
Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	60 Seconds Reinforced insulation, rated for 250Vrms working voltage	4000	---	---	VAC
Leakage Current	240VAC, 60Hz	---	---	2	μA
I/O Isolation Resistance	500 VDC	10	---	---	GΩ
I/O Isolation Capacitance	100kHz, 1V	---	20	---	pF
Safety Standards	ANSI/AAMI ES60601-1, CAN/CSA-C22.2 No. 60601-1				
	IEC/EN 60601-1 3rd Edition 2xMOPP				
Safety Approvals	ANSI/AAMI ES60601-1 2xMOPP recognition(UL certificate), IEC/EN 60601-1 3rd Edition(CB-report)				

General Specifications					
Parameter	Conditions	Min.	Typ.	Max.	Unit
Switching Frequency		---	55	---	kHz
MTBF (calculated)	MIL-HDBK-217F@25℃, Ground Benign	4,771,507	---	---	Hours
Moisture Sensitivity Level (MSL)	IPC/JEDEC J-STD-020D.1	Level 2			

EMC Specifications				
Parameter	Standards & Level			Performance
EMI(5)	Conduction	EN 55011	With external components	Class A
	Radiation		Without external components	
EMS(5)	EN 60601-1-2 4th			
	ESD	EN 61000-4-2 Air ± 15kV , Contact ± 8kV		A
	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	EN 61000-4-8 30A/m		A

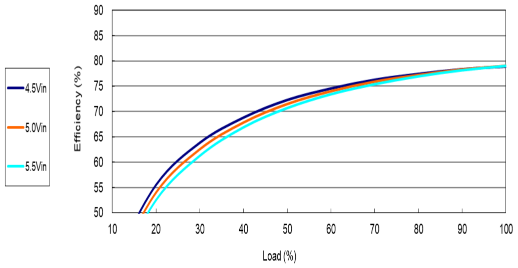
Environmental Specifications			
Parameter	Min.	Max.	Unit
Operating Ambient Temperature Range (See Power Derating Curve)	-40	+95	℃
Case Temperature	---	+105	℃
Storage Temperature Range	-50	+125	℃
Humidity (non condensing)	---	95	% rel. H
Lead-free Reflow Solder Process	IPC/JEDEC J-STD-020D.1		

Notes

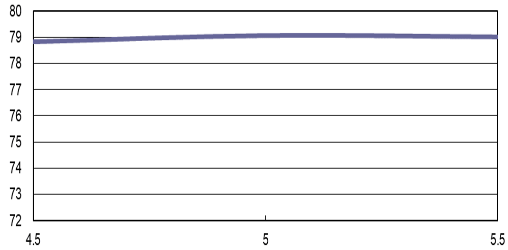
1. Specifications typical at Ta=+25℃, resistive load, nominal input voltage and rated output current unless otherwise noted.
2. These power converters require a minimum output loading to maintain specified regulation, operation under no-load conditions will not damage these modules; however they may not meet all specifications listed.
3. We recommend to protect the converter by a 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.

Characteristic Curves

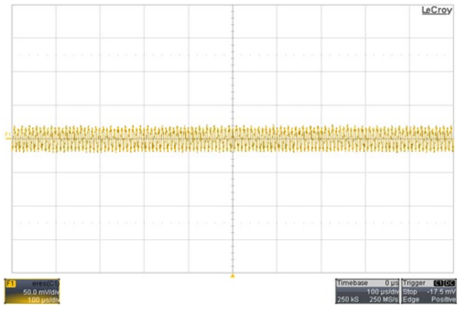
All test conditions are at 25℃ The figures are identical for MSCU01-05S05M



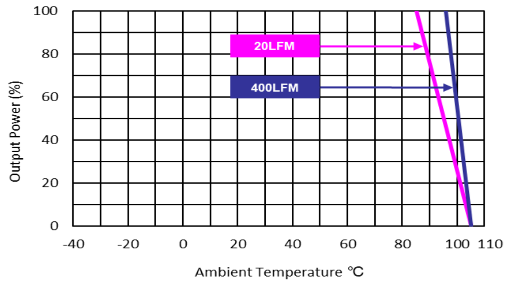
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



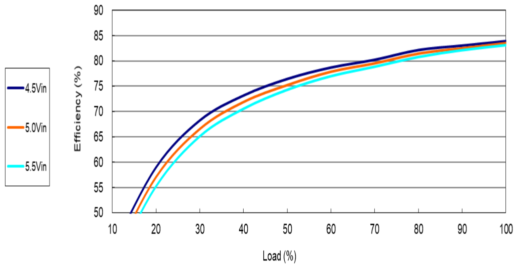
Typical Output Ripple and Noise
$V_{in}=V_{in\ nom}$; Full Load



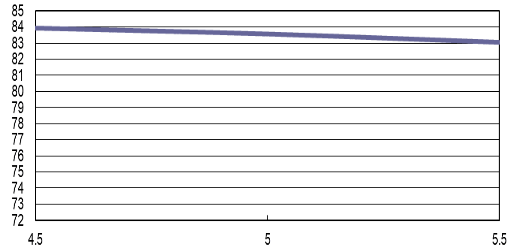
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in}=V_{in\ nom}$

Characteristic Curves

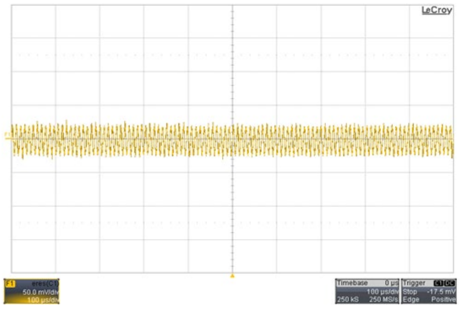
All test conditions are at 25℃ The figures are identical for MSCU01-05S12M



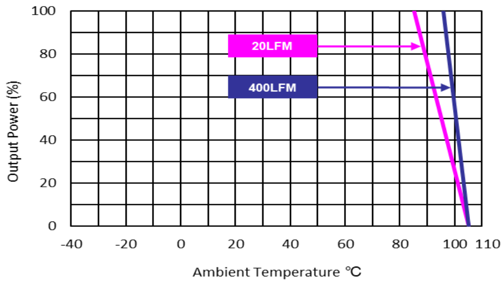
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



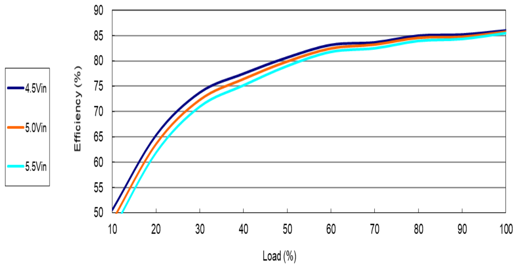
Typical Output Ripple and Noise
$V_{in}=V_{in\ nom}$; Full Load



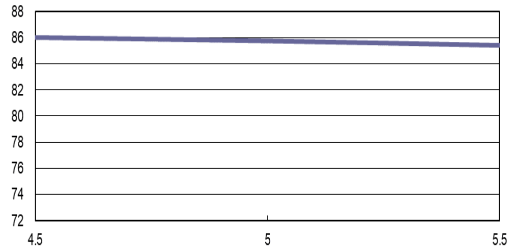
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in}=V_{in\ nom}$

Characteristic Curves

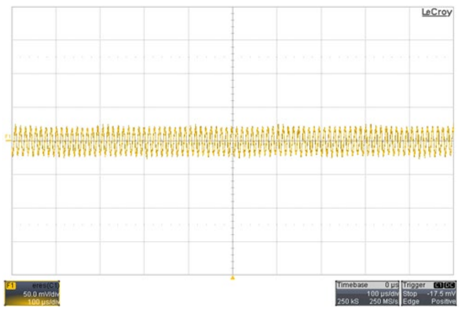
All test conditions are at 25℃ The figures are identical for MSCU01-05S15M



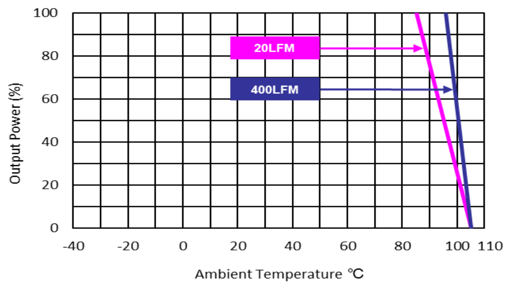
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

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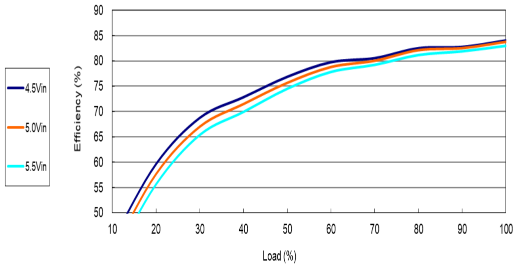
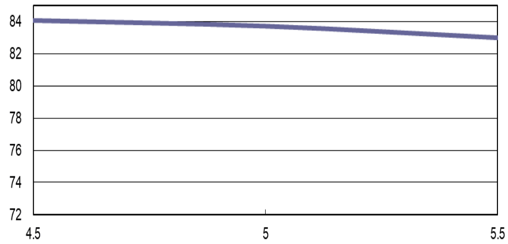
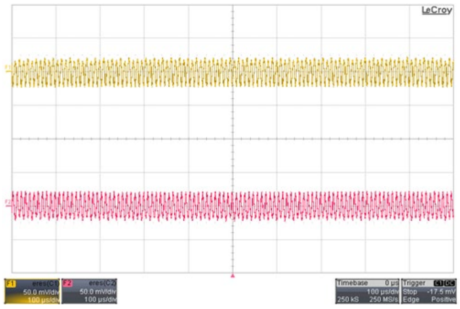


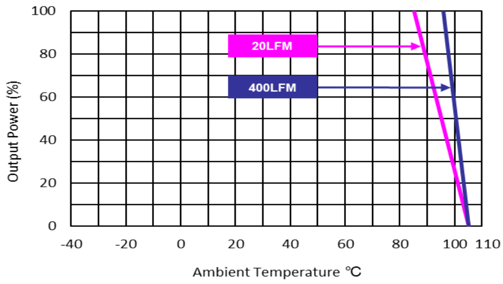
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



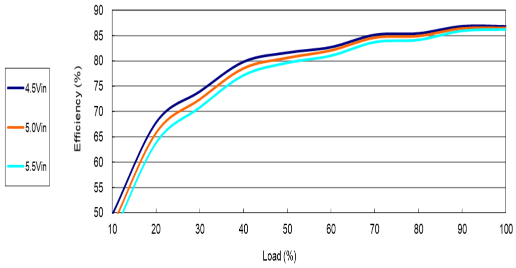
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



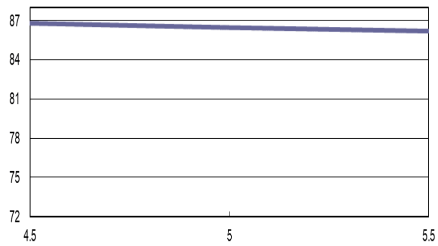
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

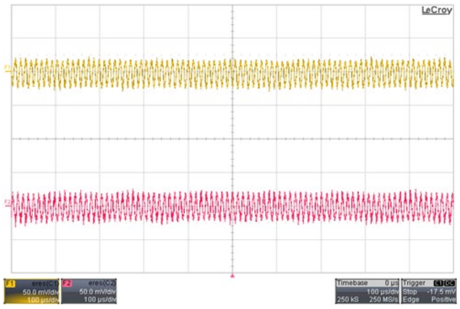
All test conditions are at 25℃ The figures are identical for MSCU01-05D15M



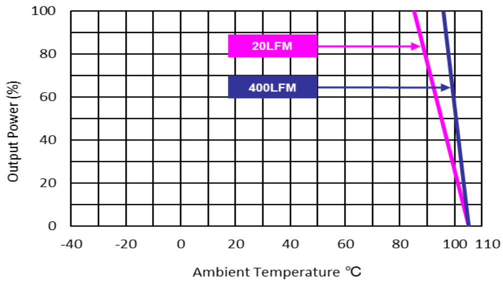
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



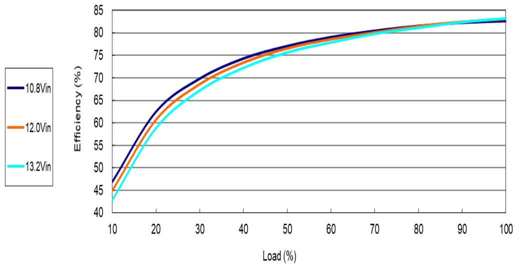
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



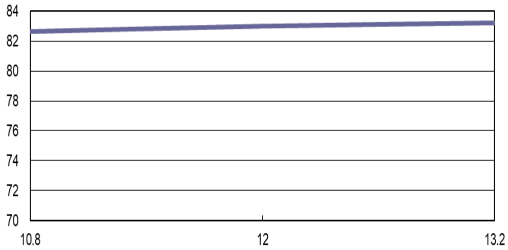
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

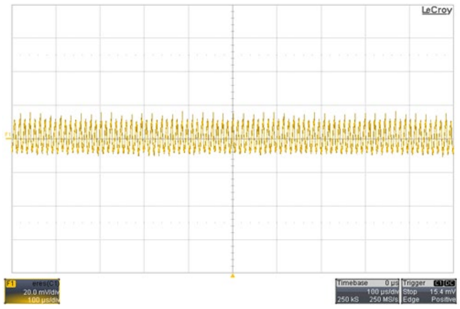
All test conditions are at 25℃ The figures are identical for MSCU01-12S05M



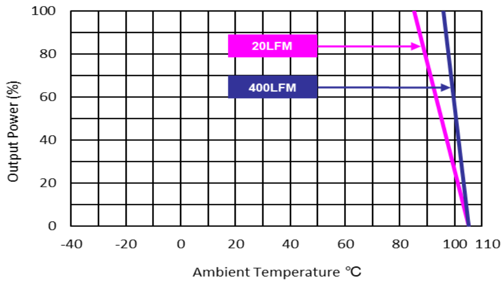
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



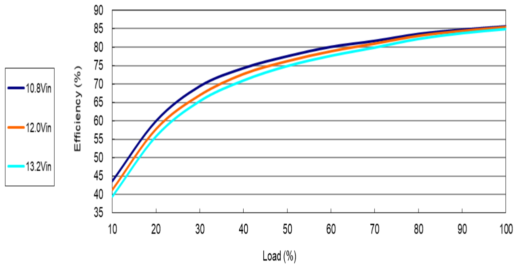
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



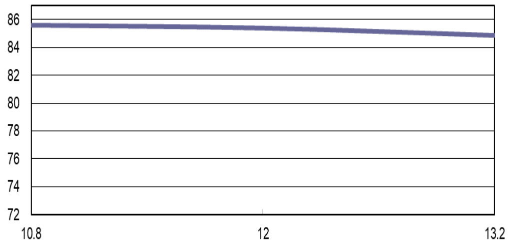
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

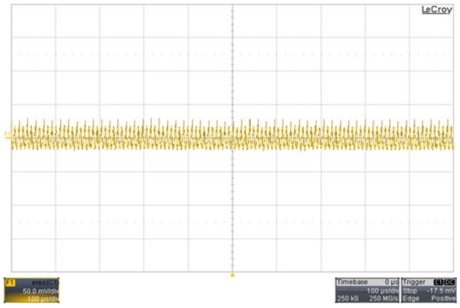
All test conditions are at 25℃ The figures are identical for MSCU01-12S12M



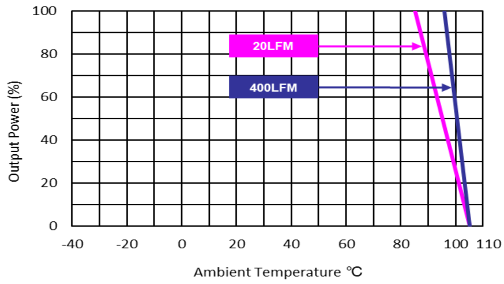
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



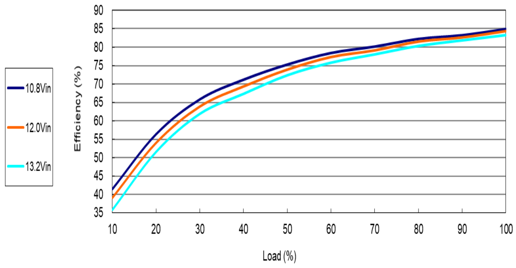
Typical Output Ripple and Noise
$V_{in}=V_{in\ nom}$; Full Load



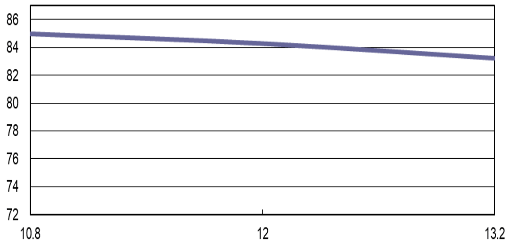
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in}=V_{in\ nom}$

Characteristic Curves

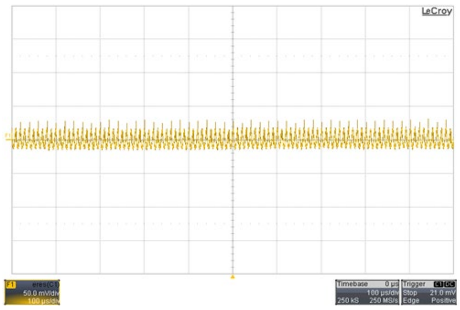
All test conditions are at 25℃ The figures are identical for MSCU01-12S15M



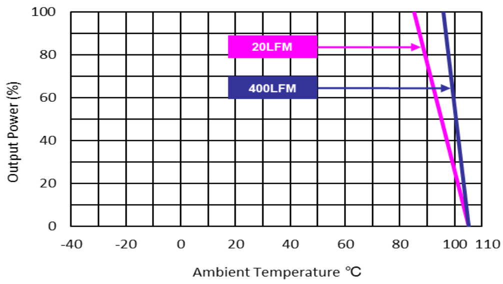
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



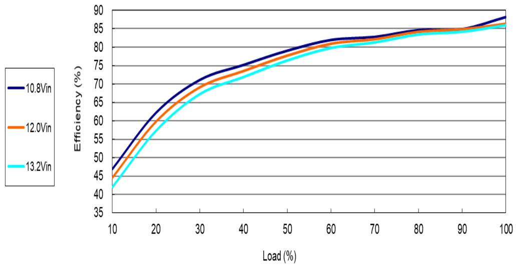
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



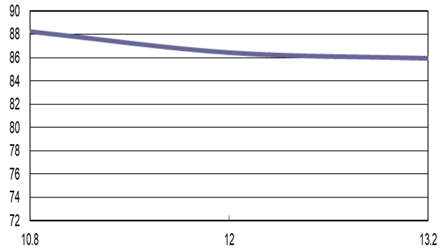
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

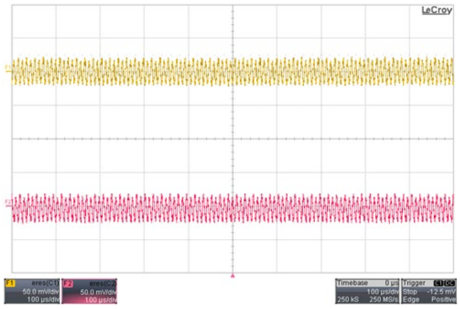
All test conditions are at 25℃ The figures are identical for MSCU01-12D12M



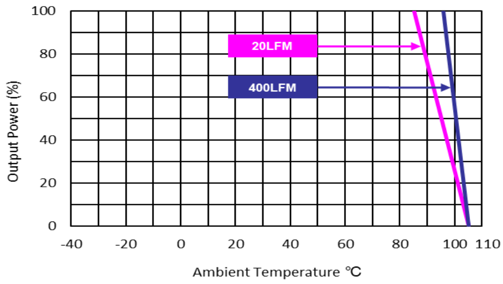
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



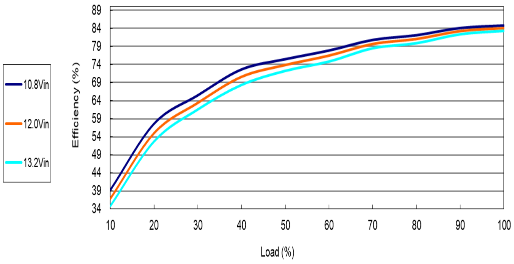
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



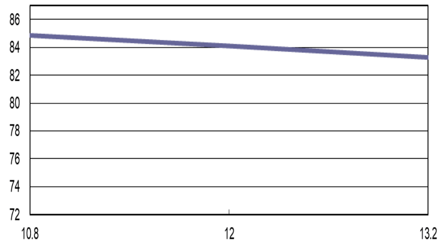
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

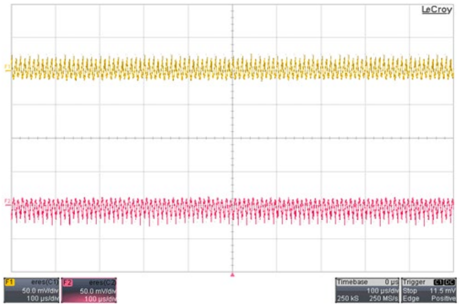
All test conditions are at 25℃ The figures are identical for MSCU01-12D15M



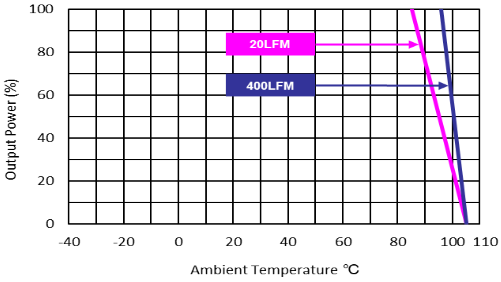
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



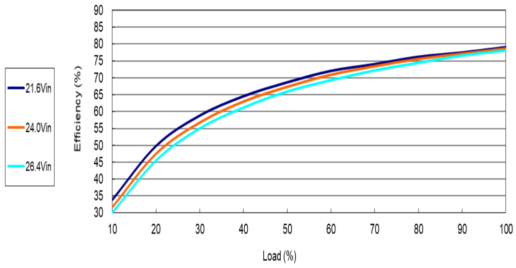
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



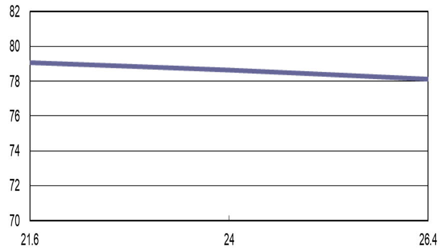
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

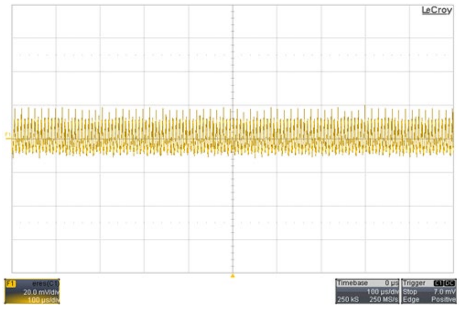
All test conditions are at 25℃ The figures are identical for MSCU01-24S05M



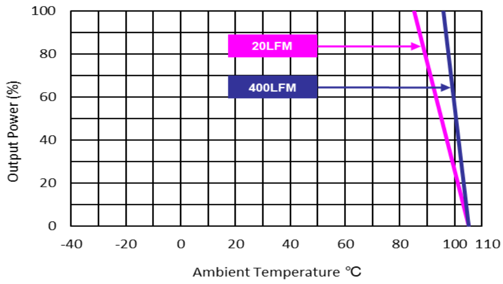
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



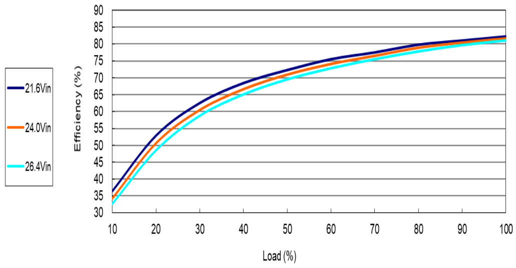
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



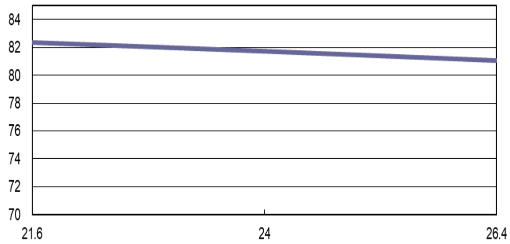
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

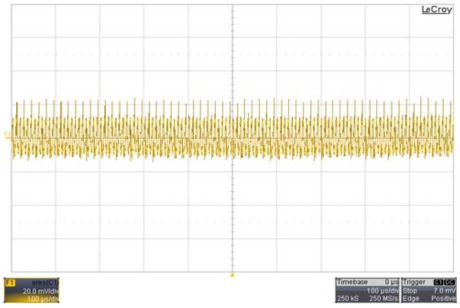
All test conditions are at 25℃ The figures are identical for MSCU01-24S12M



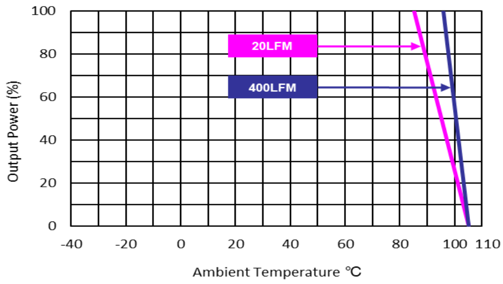
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



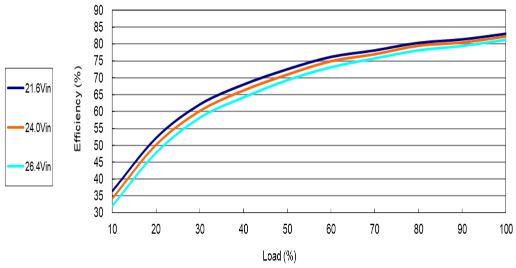
Typical Output Ripple and Noise
$V_{in}=V_{in\ nom}$; Full Load



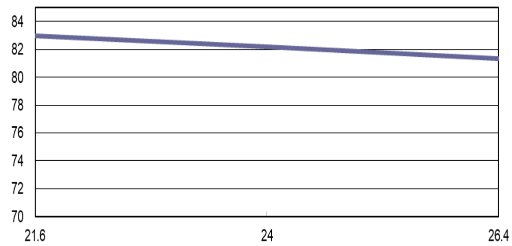
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in}=V_{in\ nom}$

Characteristic Curves

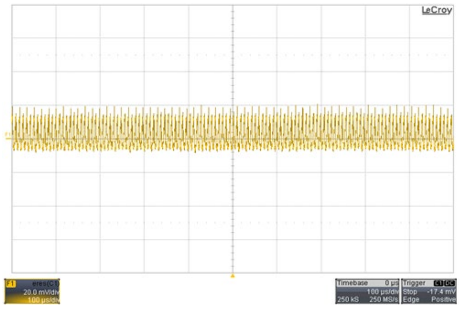
All test conditions are at 25℃ The figures are identical for MSCU01-24S15M



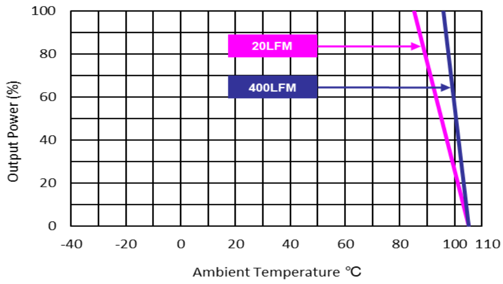
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



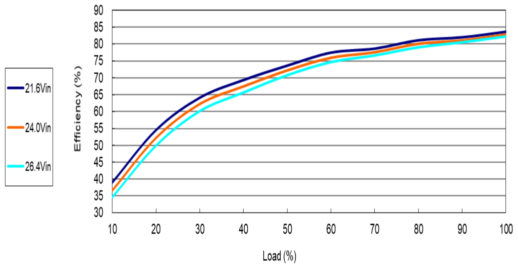
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



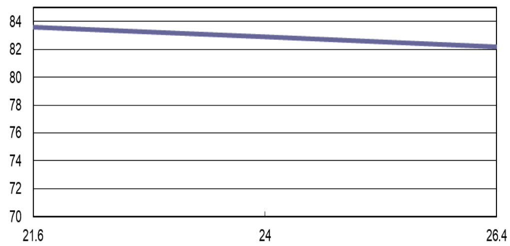
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

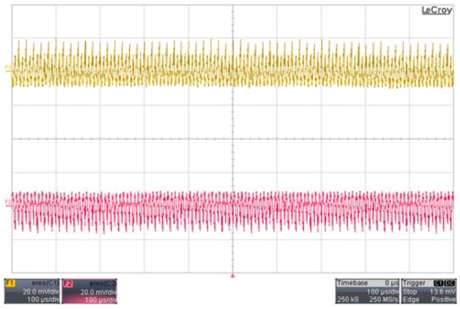
All test conditions are at 25℃ The figures are identical for MSCU01-24D12M



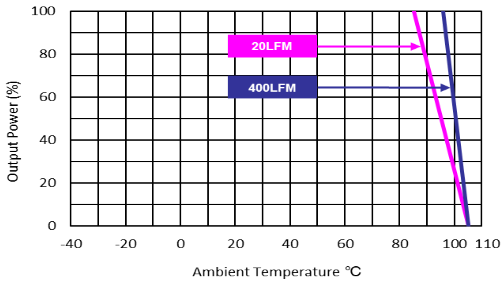
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



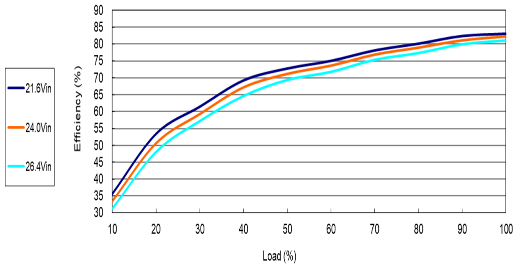
Typical Output Ripple and Noise
V_{in}=$V_{in\ nom}$; Full Load



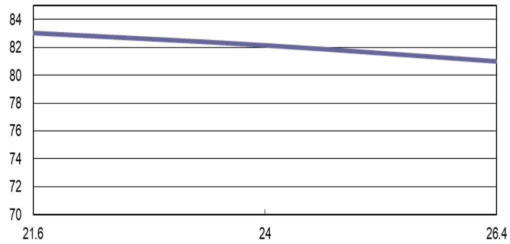
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

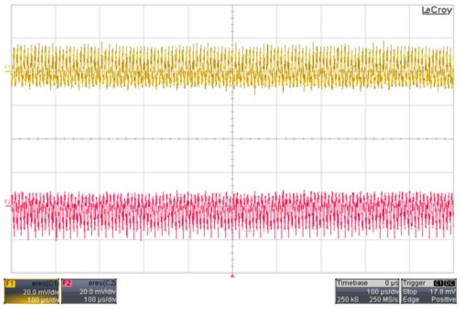
All test conditions are at 25℃ The figures are identical for MSCU01-24D15M



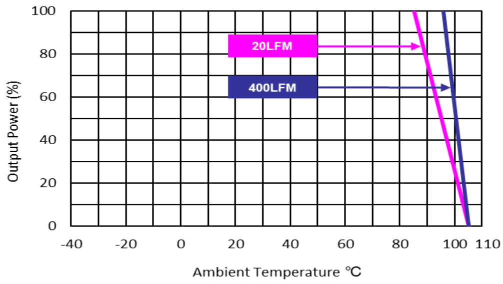
Efficiency Versus Output Current



Efficiency Versus Input Voltage
Full Load



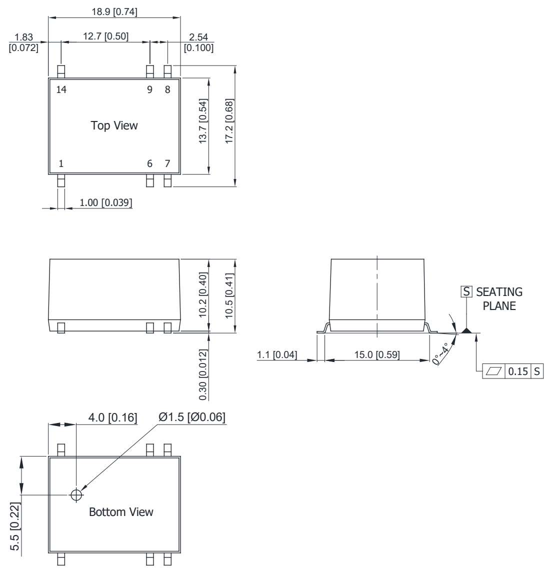
Typical Output Ripple and Noise
$V_{in}=V_{in\ nom}$; Full Load



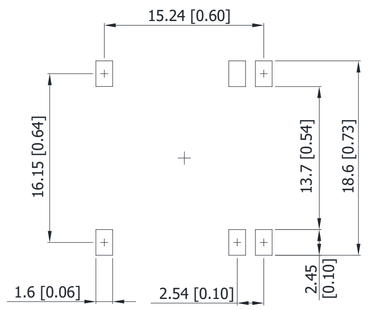
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in}=V_{in\ nom}$

Package Specifications

Mechanical Dimensions



Connecting Pin Patterns



- All dimensions in mm (inches)
- Tolerance: X.X±0.5 (X.XX±0.02)
  X.XX±0.25 (X.XXX±0.01)
- Pins ±0.05 (±0.002)

Pin Connections

Pin	Single Output	Dual Output
1	-Vin	-Vin
6	NC	Common
7	NC	-Vout
8	+Vout	+Vout
9	-Vout	Common
14	+Vin	+Vin

NC: No Connection

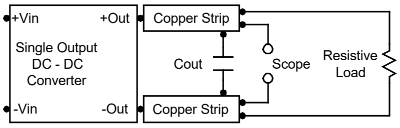
Physical Characteristics

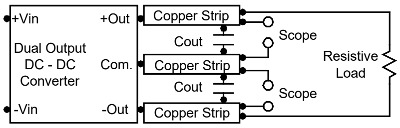
Case Size	:	18.9x13.7x10.2 mm (0.74x0.54x0.40 inches)
Case Material	:	Plastic resin (flammability to UL 94V-0 rated)
Pin Material	:	Phosphor Bronze
Weight	:	4.1g

Test Setup

Peak-to-Peak Output Noise Measurement Test

Refer to the output specifications or add 4.7μF capacitor if the output specifications undefine Cout.. 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.





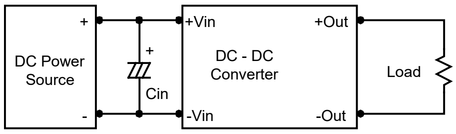
Technical Notes

Maximum Capacitive Load

The MSCU01M 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 100μF maximum capacitive load for dual outputs and 220μF capacitive load for single outputs. The maximum capacitance can be found in the data sheet.

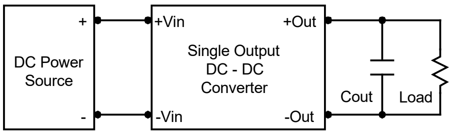
Input Source Impedance

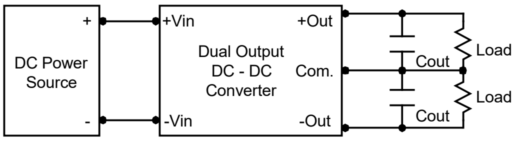
The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup. 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

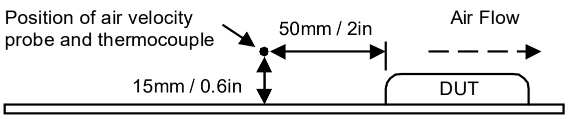
A good quality low ESR capacitor placed as close as practicable across the load will give the best ripple and noise performance. To reduce output ripple, it is recommended to use 3.3μF capacitors at the output.





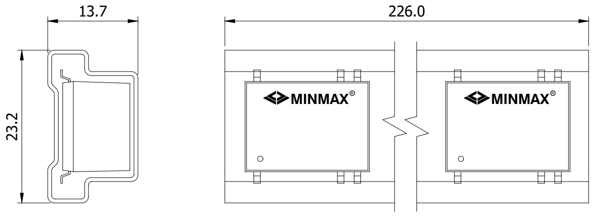
Thermal Considerations

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.

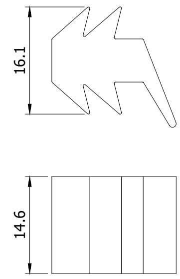


Packaging Information for Tube

Tube



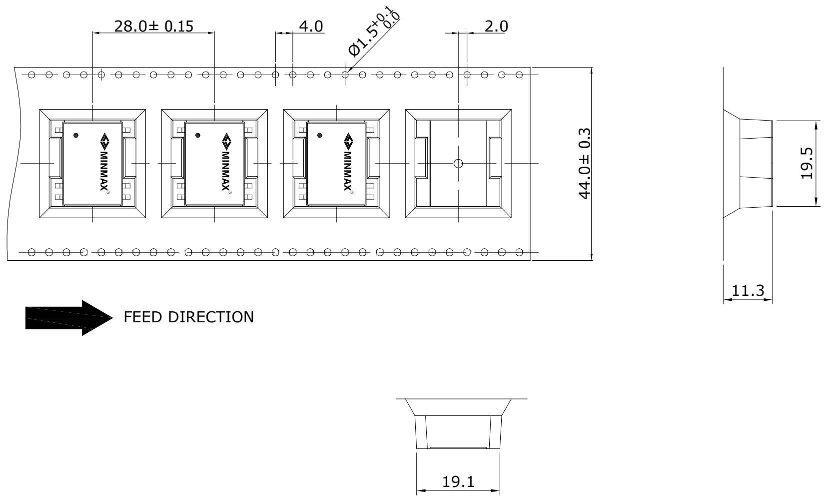
Plug



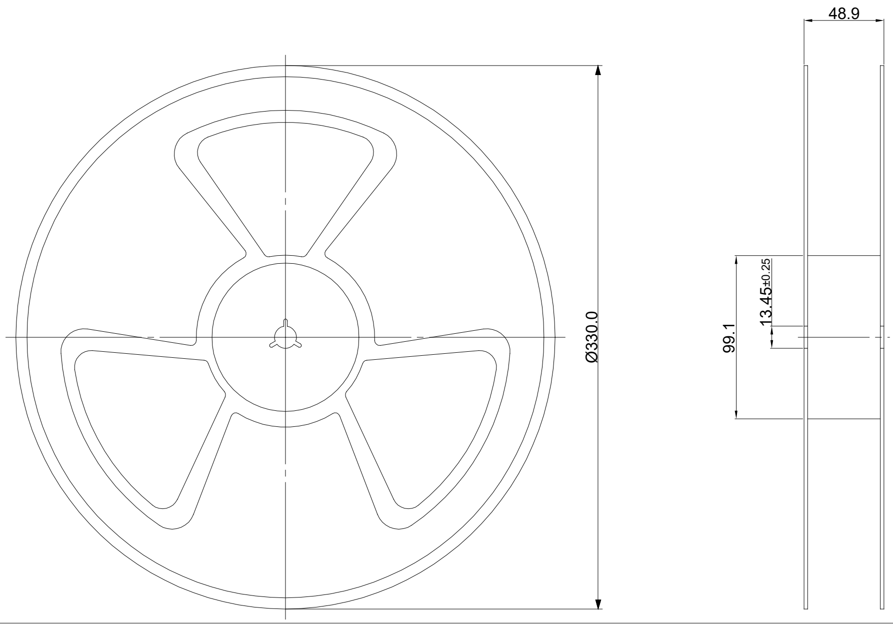
Unit: mm
10 PCS per TUBE

Packaging Information for Tape & Reel

Tape



Reel



Packaging Style	Quantity
With Heatsink Tube	N/A
Tape and Reel to IEC 286-3 Specifications	200

Soldering and Reflow Considerations

Profile	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate(Ts max. To Tp)	3°C/second max.	3°C/second max.
Preheat · Temperature Min ($Ts_{min.}$) · Temperature Max ($Ts_{max.}$) · Time (Ts_{min} to Ts_{max}) (ts)	 100°C 150°C 60~120 seconds	 150°C 200°C 60~180 seconds
Time maintained above: · Temperature (T_L) · Time (t_L)	 183°C 60~150 seconds	 217°C 60~150 seconds
Peak Temperature (Tp)	See Table 4-1	See Table 4-2
Time within 5°C of actual Peak Temperature (tp)[2]	10~30 seconds	20~40 seconds
Ramp-down Rate	6°C/second max.	6°C/second max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.

Note 1: All temperatures refer to topside of the package, measured on the package body surface.
Note 2: Time within 5°C of actual peak temperature (tp) specified for the reflow profiles is a "supplier" minimum and "user" maximum.

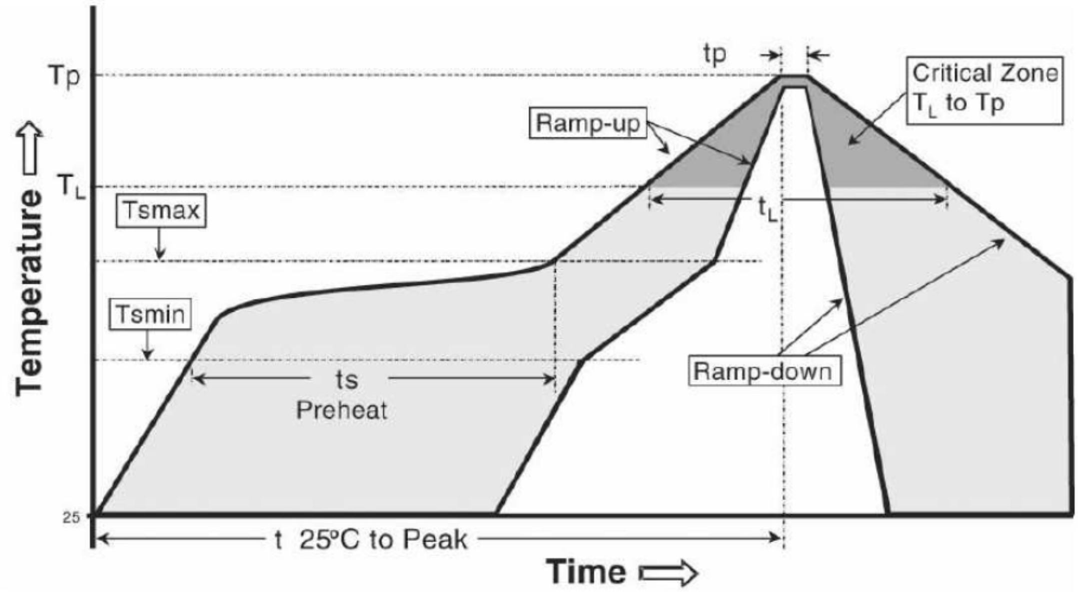


Table 4-1 SnPb Eutectic Process-Classification Temperatures (T_C)

	Volume mm^3	Volume mm^3
Package Thickness	<350	≥350
<2.5mm	235°C	220°C
≥2.5mm	220°C	220°C

Table 4-2 Pb-Free Process-Classification Temperatures (T_C)

	Volume mm^3	Volume mm^3	Volume mm^3
Package Thickness	<350	350-2000	>2000
<1.6mm	260°C	260°C	260°C
1.6mm-2.5mm	260°C	250°C	245°C
>2.5mm	250°C	245°C	245°C

Part Number Structure

M	SC	U	01	-	05	S	05	M
	Package Type SMD-14	Output Regulation Unregulated	Output Power 1 Watt		Input Voltage Range 05: 4.5 ~ 5.5 VDC 12: 10.8 ~ 13.2 VDC 24: 21.6 ~ 26.4 VDC	Output Quantity S: Single D: Dual	Output Voltage 05: 5 VDC 12: 12 VDC 15: 15 VDC	Application Medical

MTBF and Reliability

The MTBF of MSCU01M series of DC-DC converters has been calculated using

MIL-HDBK 217F NOTICE2, Operating Temperature 25℃, Ground Benign.

Model	MTBF	Unit
MSCU01-05S05M	4,774,882	Hours
MSCU01-05S12M	5,042,214	
MSCU01-05S15M	5,239,310	
MSCU01-05D12M	5,042,214	
MSCU01-05D15M	5,303,730	
MSCU01-12S05M	4,771,507	
MSCU01-12S12M	4,974,054	
MSCU01-12S15M	5,039,132	
MSCU01-12D12M	4,974,054	
MSCU01-12D15M	5,039,132	
MSCU01-24S05M	4,774,937	
MSCU01-24S12M	5,042,198	
MSCU01-24S15M	5,040,895	
MSCU01-24D12M	5,042,198	
MSCU01-24D15M	5,040,895	