MINMAX®

MSHU100 Series
Electric Characteristic Note

MSHU100 Series EC Note

DC-DC CONVERTER 2W, Reinforced Insulation, Medical Safety

FEATURES

- **Industrial Standard SMD Package**
- **Unregulated Output Voltage**
- **I/O Isolation 4000VAC with Reinforced Insulation, rated for 300Vrms Working Voltage**
- **Low I/O Leakage Current < 2μA**
- **Operating Ambient Temp. Range -25℃ to +80℃**
- **Cleaning-washable Process Available(option)**
- **Qualified for Lead-free Reflow Solder Process According to**
- **IPC/JEDEC J-STD-020D.1**
- **Tape & Reel Package Available**
- **Medical EMC Standard with 4th Edition of EMI EN 55011 and EMS EN 60601-1-2 Approved**
- **Medical Safety with 1xMOPP & 2xMOOP per 3rd Edition of IEC/EN 60601-1 & ANSI/AAMI ES60601-1 Approved**
- **Risk Management Report Acquisition according to ISO 14971**
- **UL/cUL/IEC/EN 62368-1(60950-1) Safety Approval & CE Marking**

Applications

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

Product Overview

Introducing the MINMAX MSHU100 series – 2W DC-DC converter modules delivering an exceptionally high I/O isolation voltage of 4000VAC with reinforced insulation, rated for a stable 300Vrms working voltage. Housed in a compact SMD package, this product offers 15 models with 5V, 12V, or 24VDC input options, and choices for single or dual output voltages.

The MSHU100 DC-DC converters present an economical solution for a wide range of applications in instrumentation, industrial controls, medical equipment, and wherever a certified supplementary or reinforced insulation system is necessary to comply with prescribed safety standards.

The MSHU100 series is approved to IEC/EN/ES 60601-1 3rd edition for 1xMOPP & 2xMOOP and comes with an ISO 14971 Medical Device risk management file, ensuring not only adherence to high-performance standards but also compliance with strict safety benchmarks.

Table of contents

Model Selection Guide

Model Number	Input Voltage (Range)	Output Voltage	Output Current	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	%
MSHU102	5 (4.5 ~ 5.5)	5	400	606	90	12	330	66
MSHU104		12	165	600		10		66
MSHU105		15	133	605		10		66
MSHU108		±12	±83	553		10	100#	72
MSHU109		±15	±66	542		10		73
MSHU112	12 (10.8 ~ 13.2)	5	400	253	40	12	330	66
MSHU114		12	165	250		10		66
MSHU115		15	133	252		10		66
MSHU118		±12	±83	224		10	100#	74
MSHU119		±15	±66	220		10		75
MSHU122	24 (21.6 ~ 26.4)	5	400	126	30	12	330	66
MSHU124		12	165	125		10		66
MSHU125		15	133	126		10		66
MSHU128		±12	±83	112		10	100#	74
MSHU129		±15	±66	110		10		75

For each output

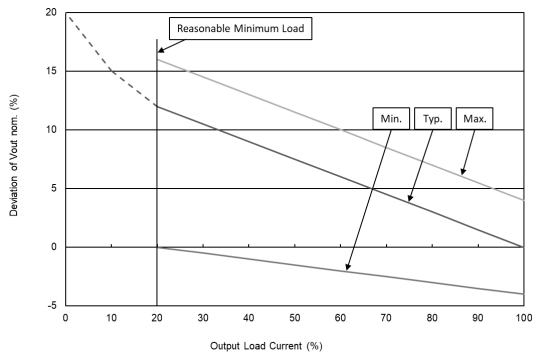
Input Specifications

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			

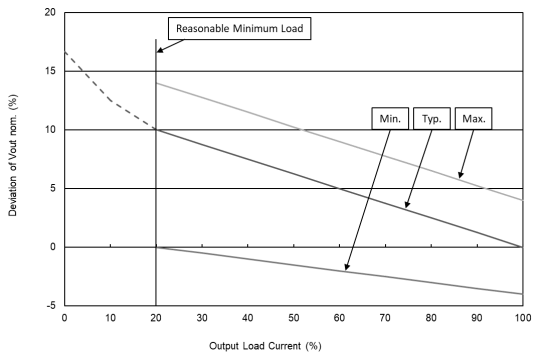
Output Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Output Voltage Setting Accuracy		---	±2.0	±4.0	%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	---	---	150	mV P-P
Temperature Coefficient		---	±0.01	±0.02	%/°C
Short Circuit Protection	0.5 Second Max., Automatic Recovery				

Output Voltage Tolerance



(5V Output)



(All other Output)

Isolation, Safety Standards

Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	60 Seconds Reinforced insulation, rated for 300Vrms working voltage	4000	---	---	VAC
I/O Isolation Test Voltage	Flash tested for 1 Second	6000	---	---	V_{PK}
Leakage Current	240VAC, 60Hz	---	---	2	µA
I/O Isolation Resistance	500 VDC	10	---	---	GΩ
I/O Isolation Capacitance	100kHz, 1V	---	15	20	pF
Safety Standards	UL/cUL 62368-1, 60950-1, CSA C22.2 No. 60950-1				
	ANSI/AAMI ES60601-1, CAN/CSA-C22.2 No. 60601-1				
	IEC/EN 62368-1, 60950-1, IEC/EN 60601-1 3rd Edition 1xMOPP & 2xMOOP				
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)				
	ANSI/AAMI ES60601-1 1xMOPP & 2xMOOP recognition(UL certificate), IEC/EN 60601-1 3rd Edition(CB-report)				

General Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Switching Frequency		50	80	100	kHz
MTBF (calculated)	MIL-HDBK-217F@25°C, Ground Benign	2,000,000	---	---	Hours
Moisture Sensitivity Level (MSL)	IPC/JEDEC J-STD-020D.1	Level 2			

Environmental Specifications

Parameter	Min.	Max.	Unit
Operating Ambient Temperature Range (See Power Derating Curve)	-25	+80	°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		

Notes

1 Specifications typical at Ta=+25°C, 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.

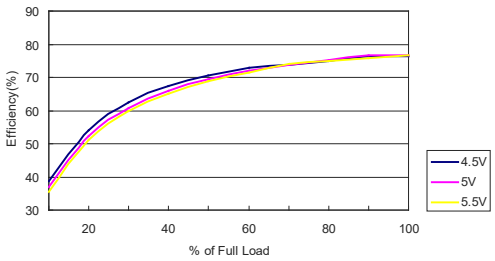
4 Other input and output voltage may be available, please contact MINMAX.

5 Specifications are subject to change without notice.

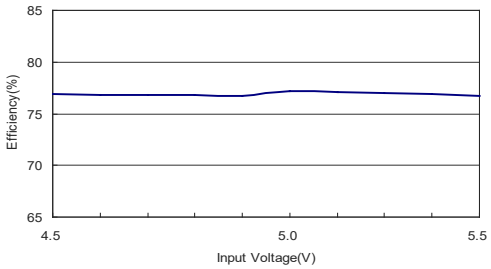
6 The repeated high voltage isolation testing of the converter can degrade isolation capability, to a lesser or greater degree depending on materials, construction, environment and reflow solder process. Any material is susceptible to eventual chemical degradation when subject to very high applied voltages 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

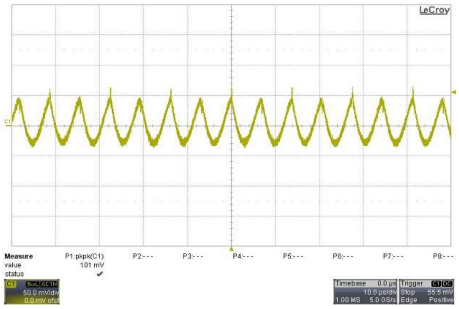
All test conditions are at 25℃ The figures are identical for MSHU102



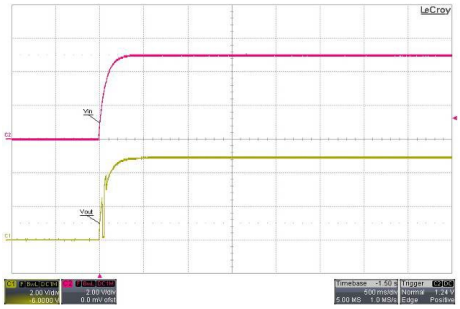
Efficiency Versus Output Current



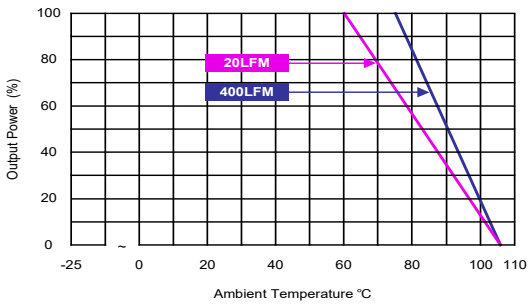
Efficiency Versus Input Voltage
Full Load



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



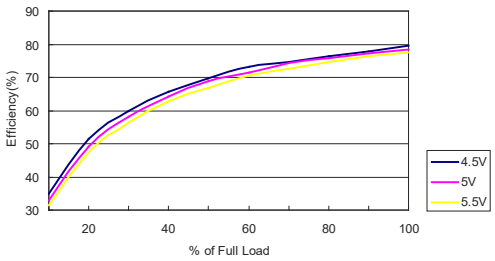
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



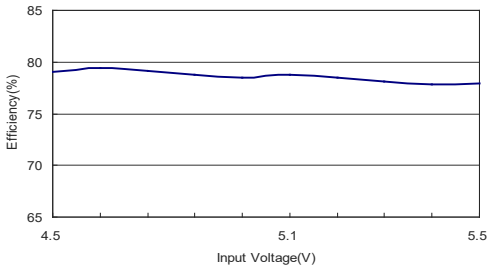
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

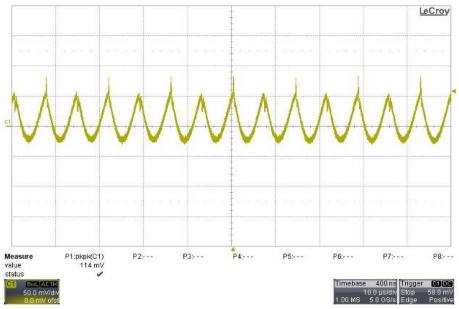
All test conditions are at 25℃ The figures are identical for MSHU104



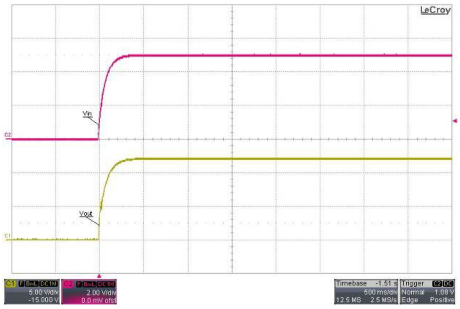
Efficiency Versus Output Current



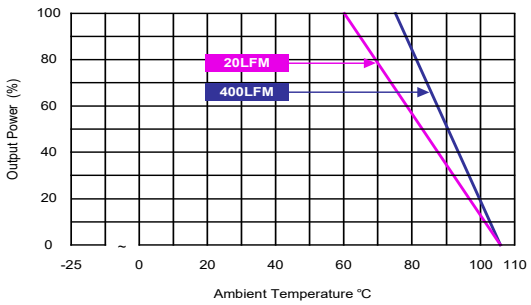
Efficiency Versus Input Voltage
Full Load



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



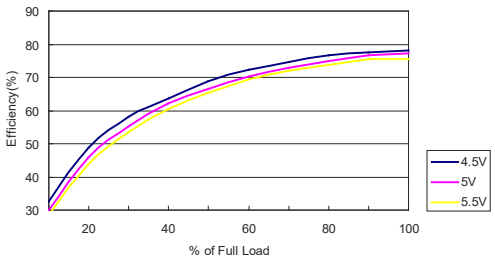
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



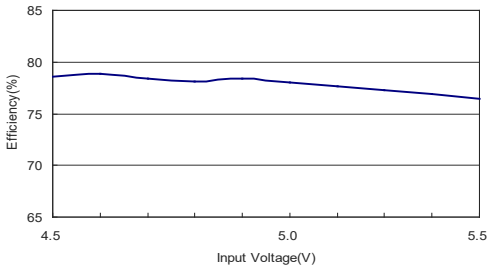
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

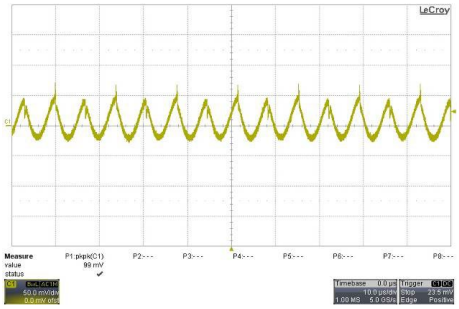
All test conditions are at 25℃ The figures are identical for MSHU105



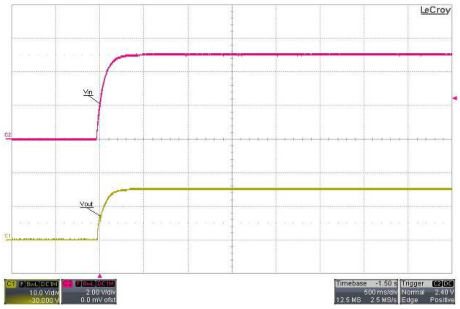
Efficiency Versus Output Current



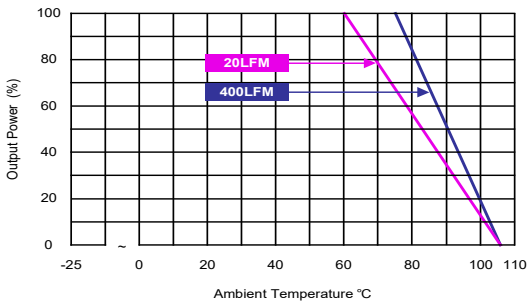
Efficiency Versus Input Voltage
Full Load



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



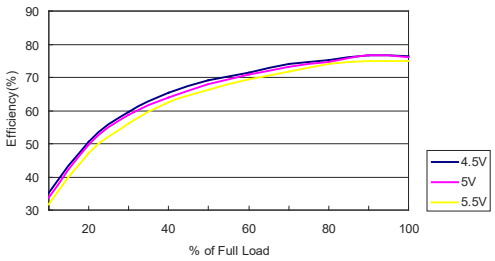
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



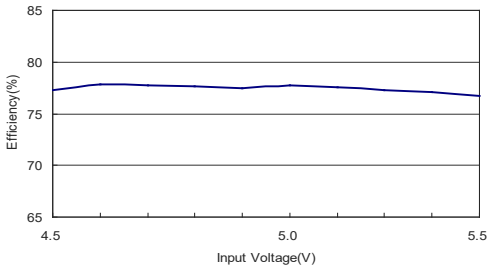
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

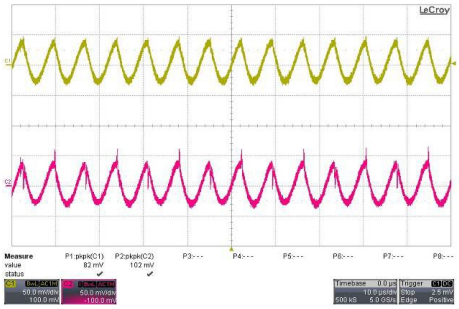
All test conditions are at 25℃ The figures are identical for MSHU108



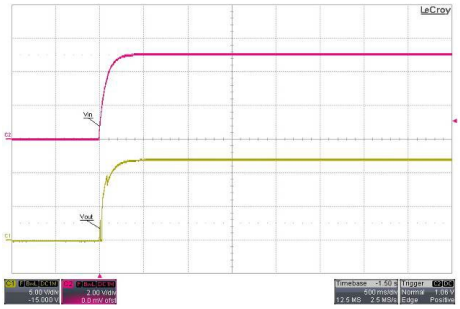
Efficiency Versus Output Current



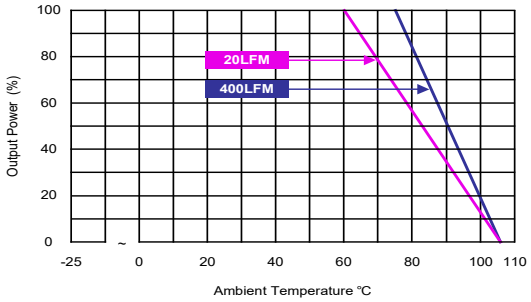
Efficiency Versus Input Voltage
Full Load



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



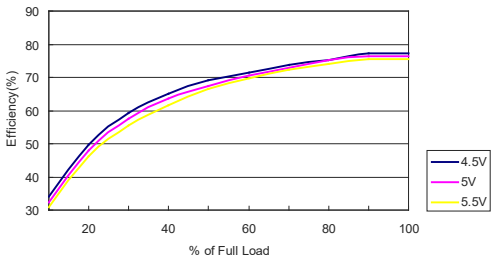
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



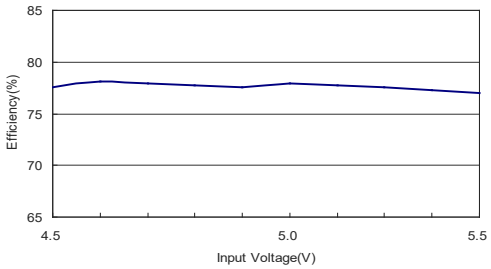
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

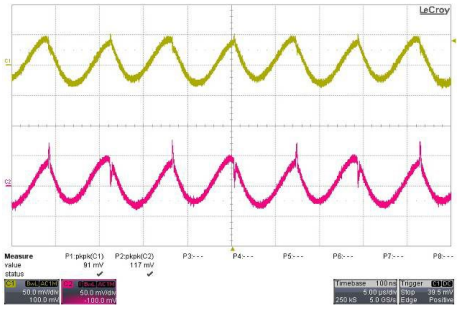
All test conditions are at 25℃ The figures are identical for MSHU109



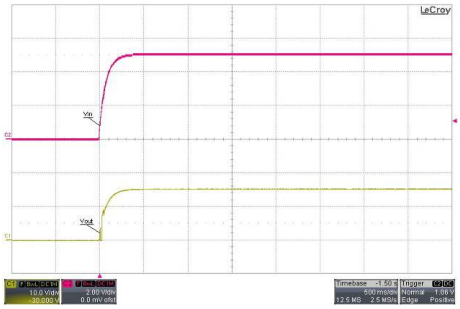
Efficiency Versus Output Current



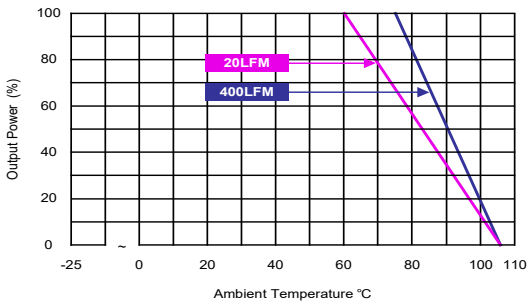
Efficiency Versus Input Voltage
Full Load



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



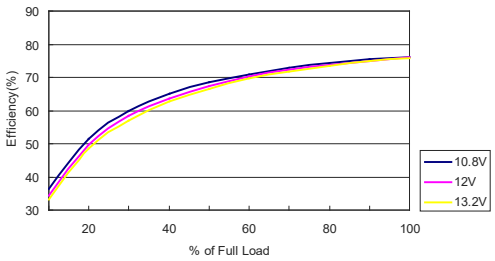
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



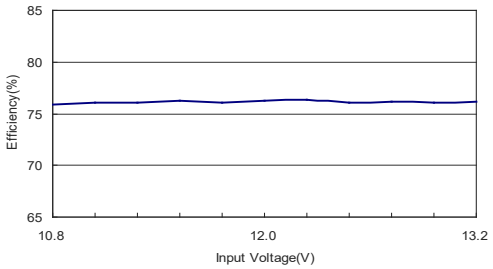
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

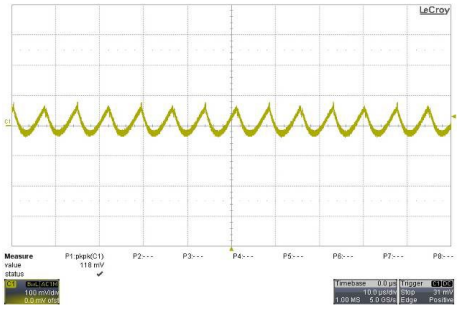
All test conditions are at 25℃ The figures are identical for MSHU112



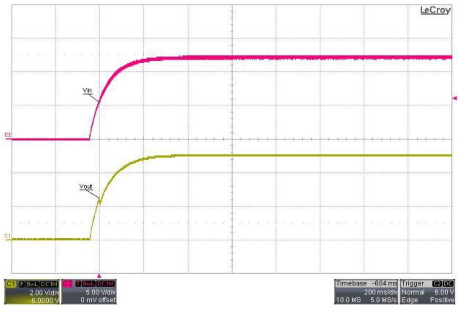
Efficiency Versus Output Current



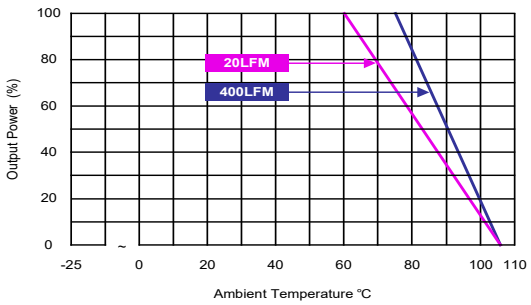
Efficiency Versus Input Voltage
Full Load



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



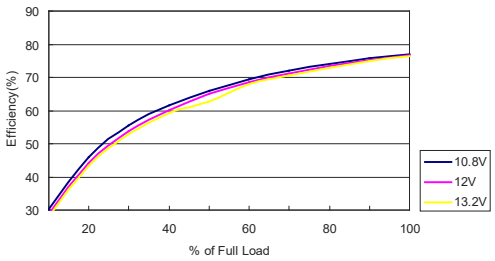
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



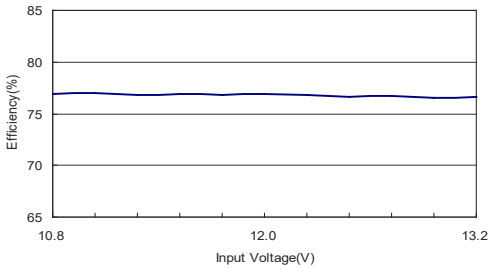
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

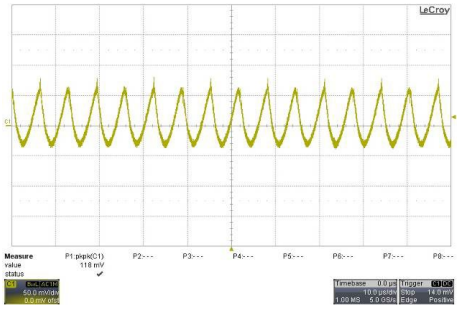
All test conditions are at 25℃ The figures are identical for MSHU114



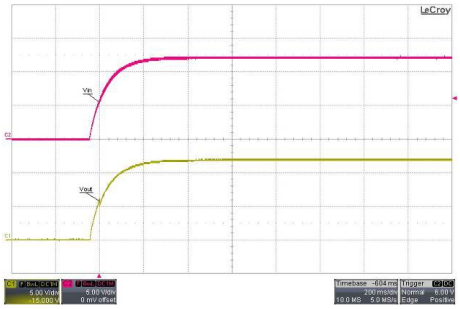
Efficiency Versus Output Current



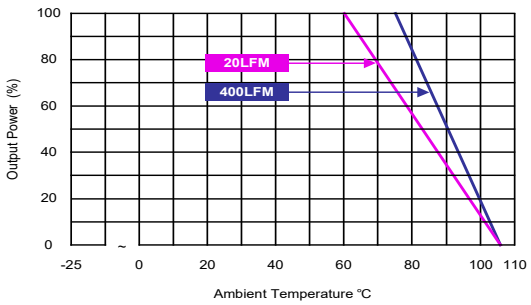
Efficiency Versus Input Voltage
Full Load



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



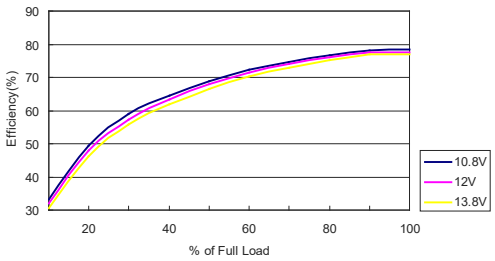
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



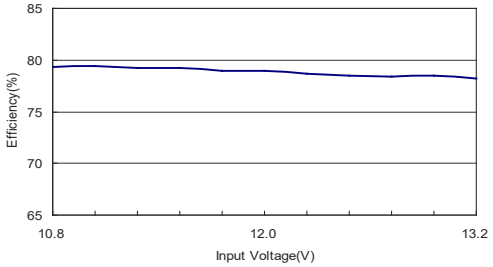
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

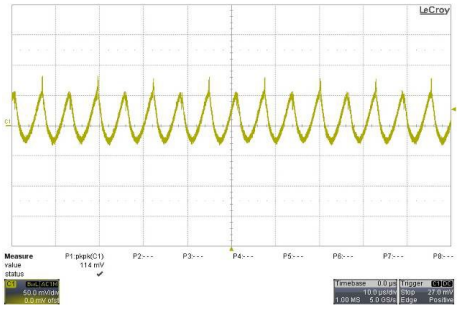
All test conditions are at 25℃ The figures are identical for MSHU115



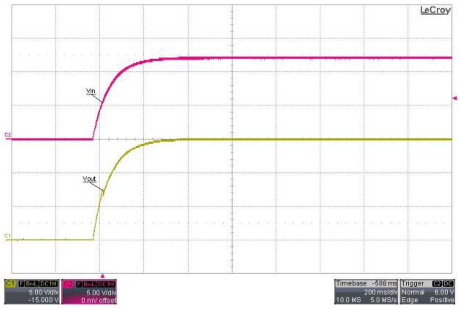
Efficiency Versus Output Current



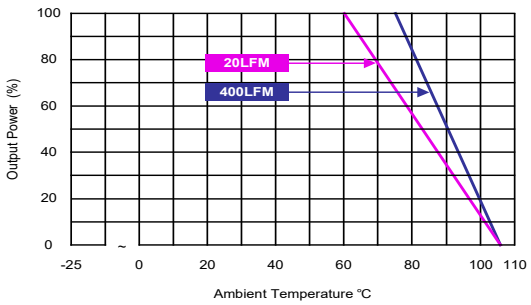
Efficiency Versus Input Voltage
Full Load



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



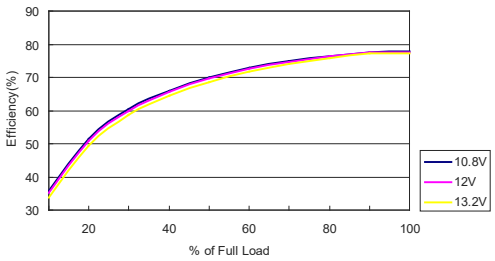
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



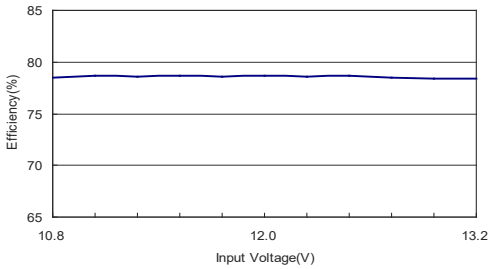
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

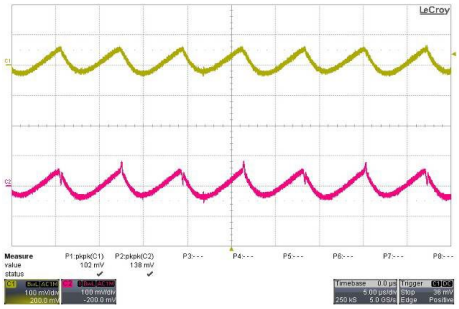
All test conditions are at 25℃ The figures are identical for MSHU118



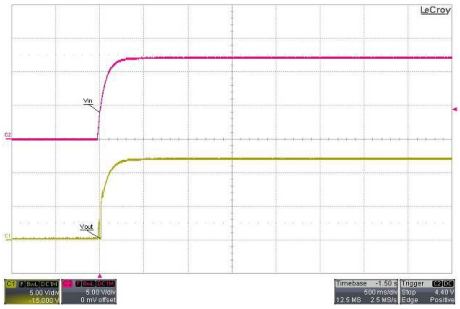
Efficiency Versus Output Current



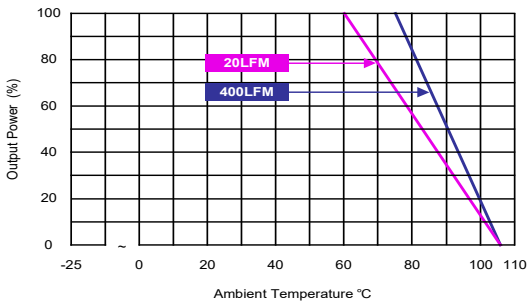
Efficiency Versus Input Voltage
Full Load



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



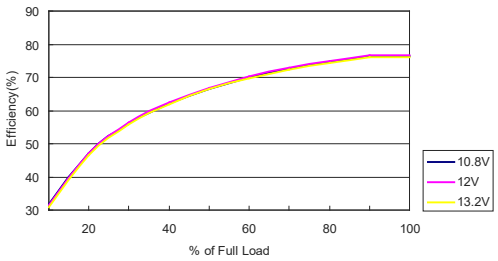
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



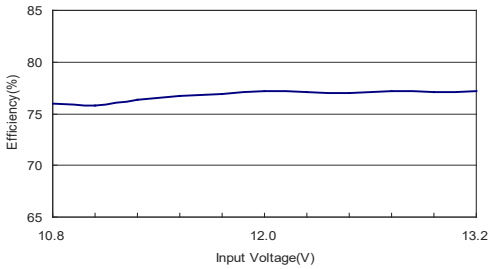
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

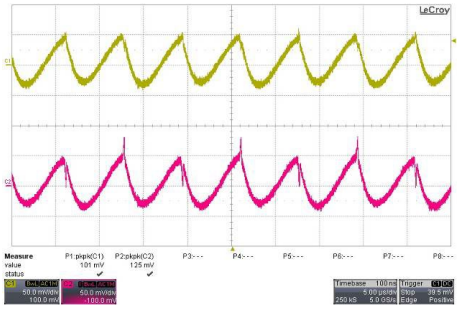
All test conditions are at 25°C The figures are identical for MSHU119



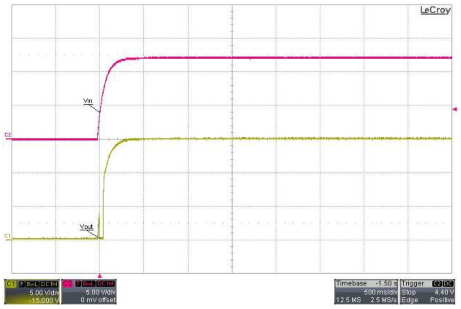
Efficiency Versus Output Current



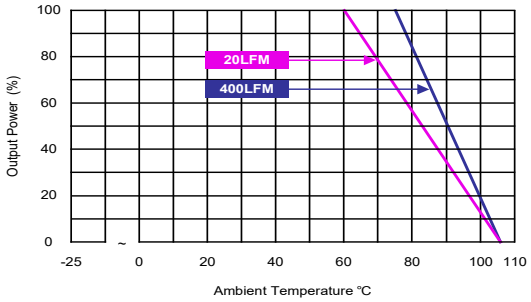
Efficiency Versus Input Voltage
Full Load



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



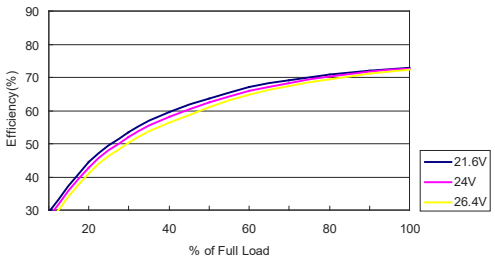
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



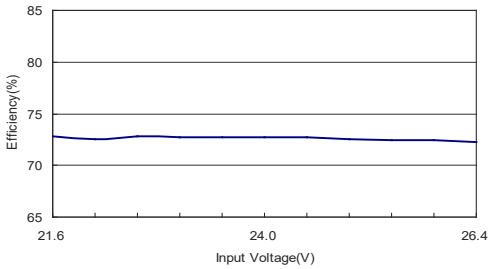
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

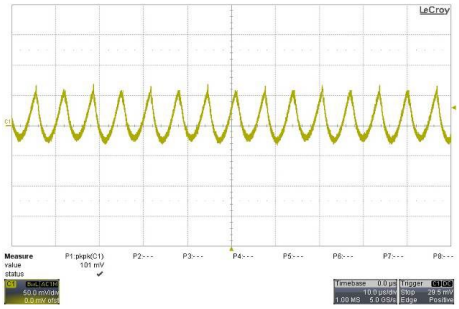
All test conditions are at 25℃ The figures are identical for MSHU122



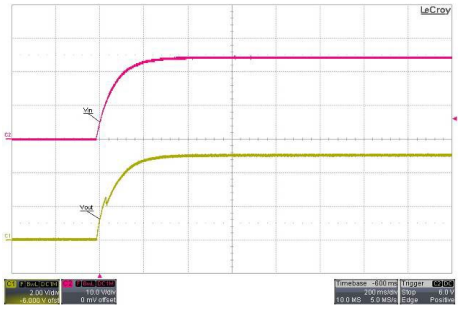
Efficiency Versus Output Current



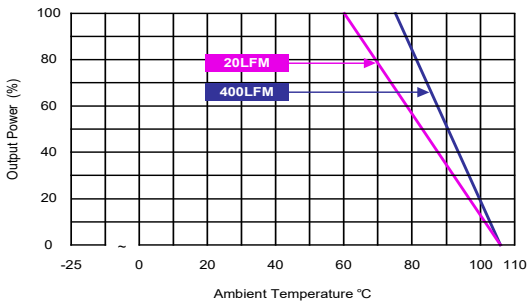
Efficiency Versus Input Voltage
Full Load



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



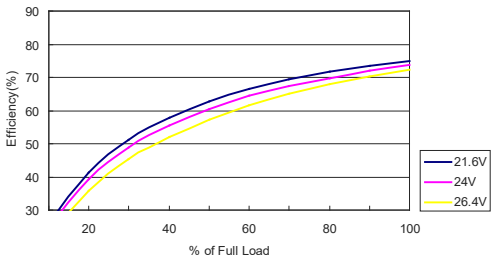
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



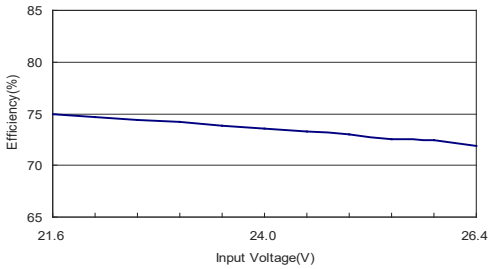
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

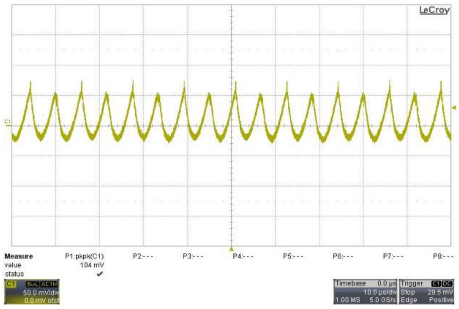
All test conditions are at 25℃ The figures are identical for MSHU124



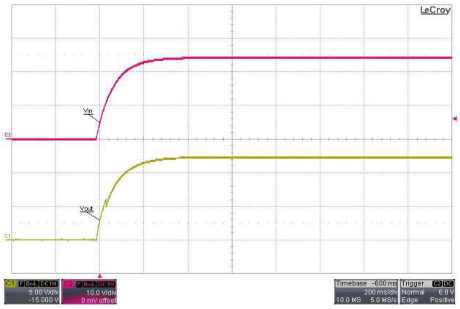
Efficiency Versus Output Current



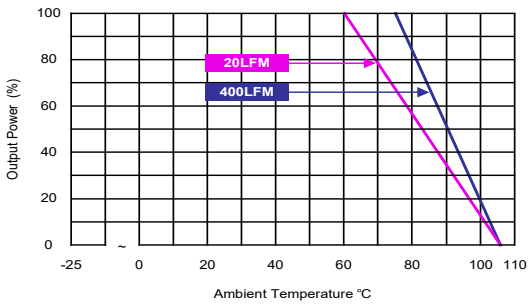
Efficiency Versus Input Voltage
Full Load



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



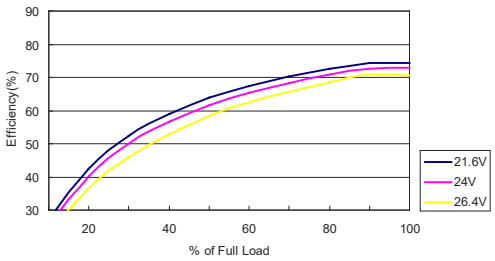
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



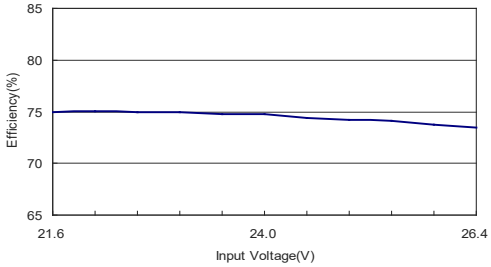
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

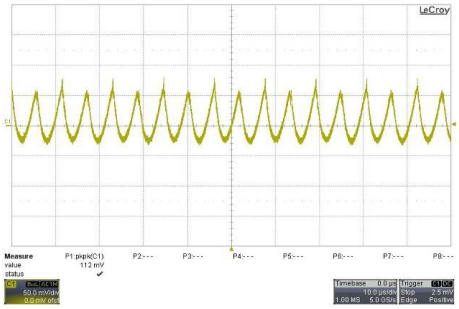
All test conditions are at 25℃ The figures are identical for MSHU125



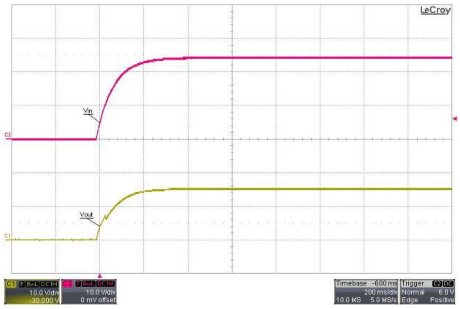
Efficiency Versus Output Current



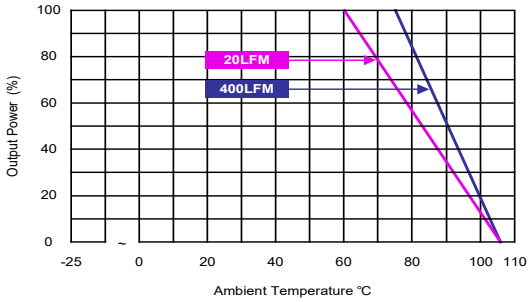
Efficiency Versus Input Voltage
Full Load



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



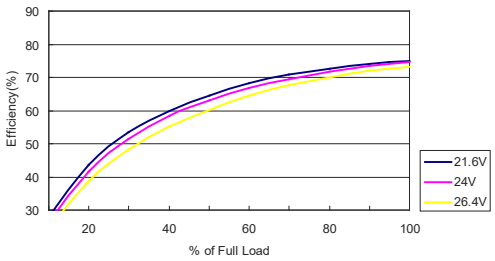
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



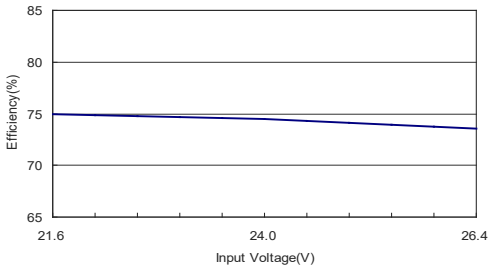
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

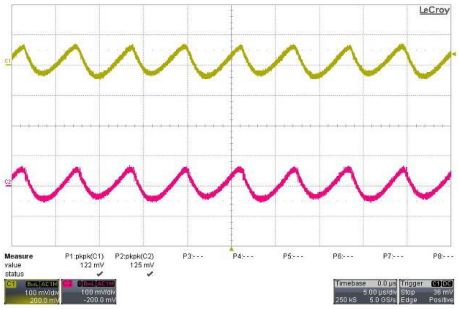
All test conditions are at 25℃ The figures are identical for MSHU128



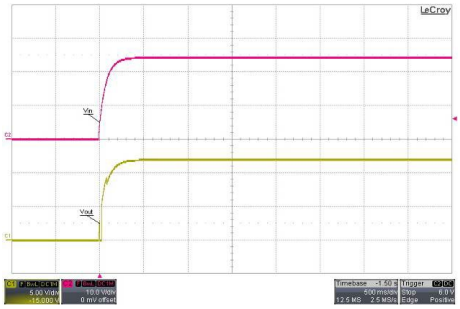
Efficiency Versus Output Current



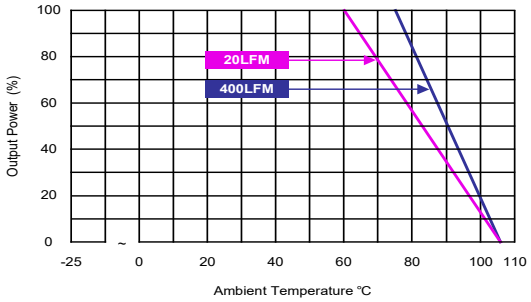
Efficiency Versus Input Voltage
Full Load



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



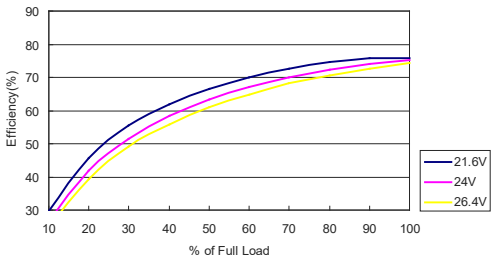
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



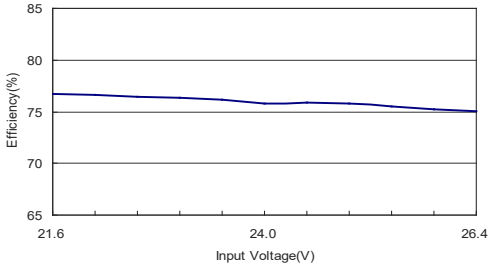
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

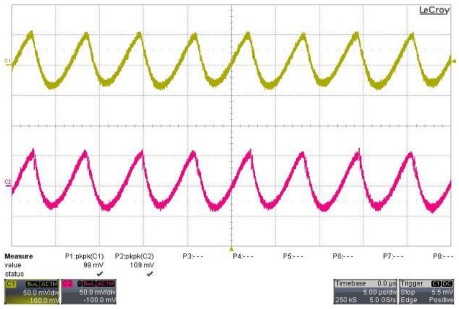
All test conditions are at 25℃ The figures are identical for MSHU129



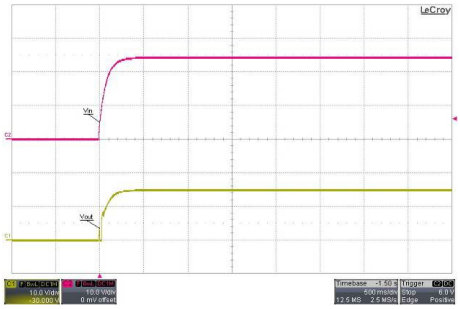
Efficiency Versus Output Current



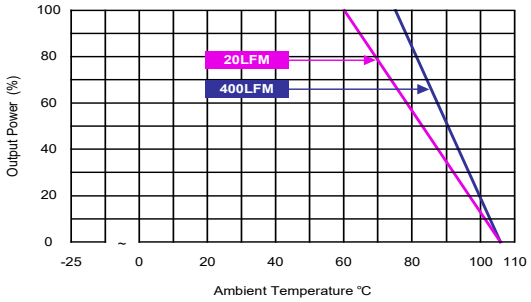
Efficiency Versus Input Voltage
Full Load



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



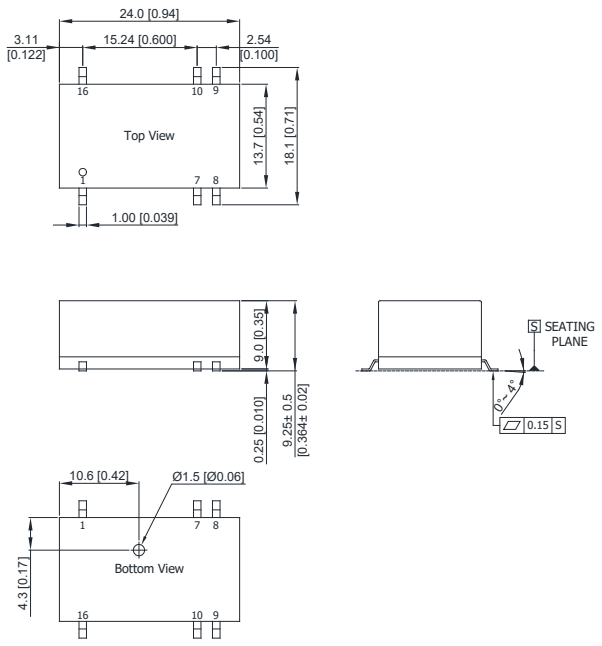
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



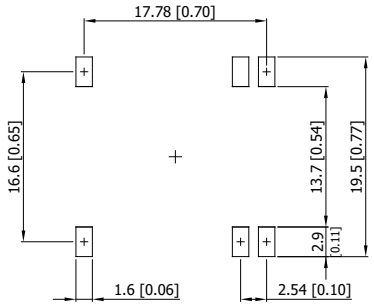
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

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
7	NC	NC
8	NC	Common
9	+Vout	+Vout
10	-Vout	-Vout
16	+Vin	+Vin

NC: No Connection

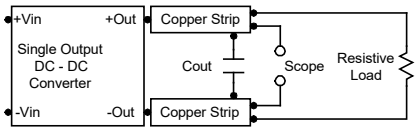
Physical Characteristics

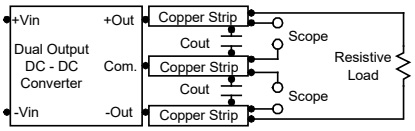
Case Size	:	24.0x13.7x9.0mm (0.94x0.54x0.35 inches)
Case Material	:	Plastic resin (flammability to UL 94V-0 rated)
Pin Material	:	Phosphor Bronze
Weight	:	3.75g

Test Setup

Peak-to-Peak Output Noise Measurement Test

Use a Cout 0.47µF 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.





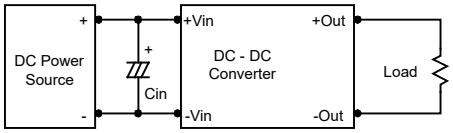
Technical Notes

Maximum Capacitive Load

The MSHU100 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 330µF capacitive load for single outputs. The maximum capacitance can be found in the data sheet.

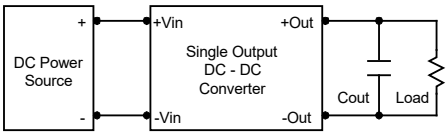
Input Source Impedance

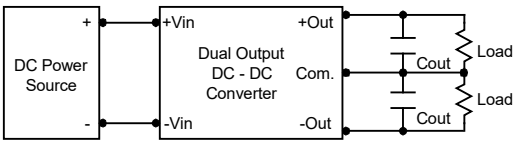
The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup.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

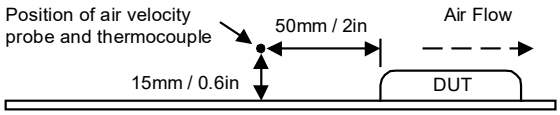
A good quality low ESR capacitor placed as close as practicable across the load will give the best ripple and noise performance. To reduce output ripple, it is recommended to use 3.3µF capacitors at the output.





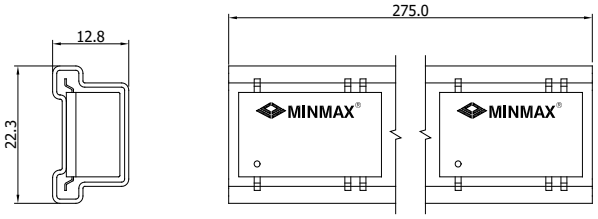
Thermal Considerations

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

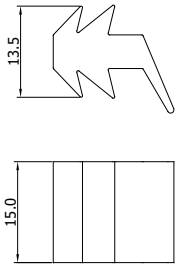


Packaging Information for Tube

Tube



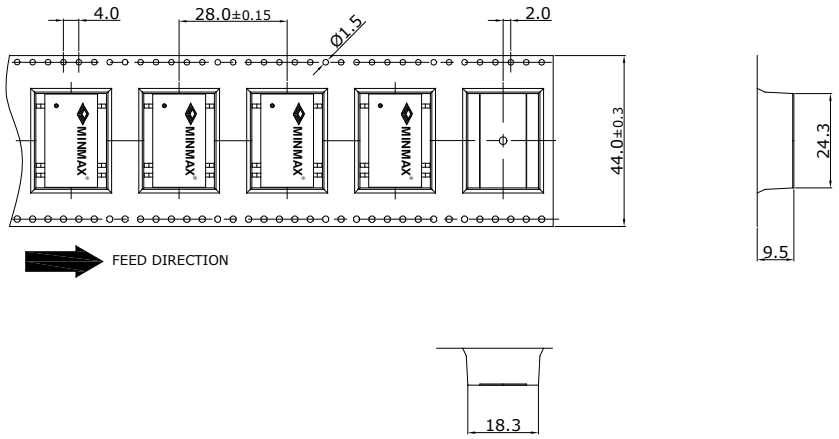
Plug



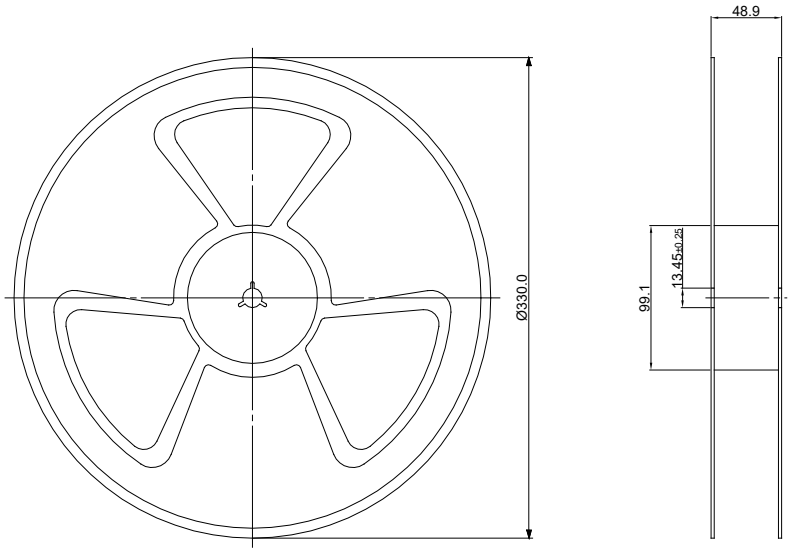
Unit: mm
10 PCS per TUBE

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.

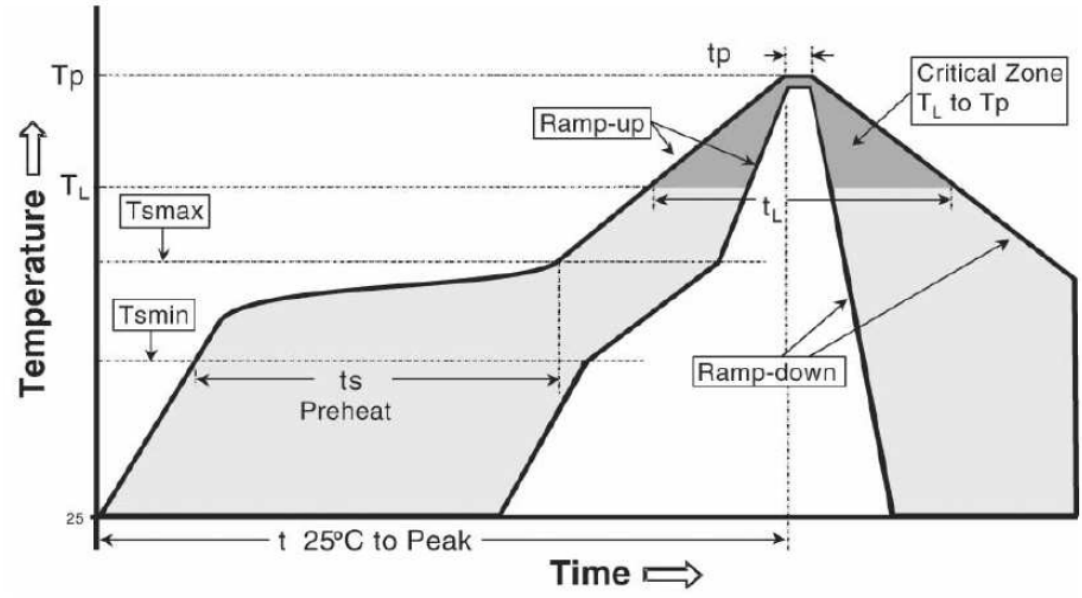


Table 4-1 SnPb Eutectic Process-Classification Temperatures (T_C)

	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	S	H	U	10	2
	Package Type SMD-16	I/O Isolation Voltage 4000 VAC	Output Regulation Unregulated	Input Voltage Range 10: 4.5 ~ 5.5 VDC 11: 10.8 ~ 13.2 VDC 12: 21.6 ~ 26.4 VDC	Output Voltage 2: 5 VDC 4: 12 VDC 5: 15 VDC 8: ±12 VDC 9: ±15 VDC

MTBF and Reliability

The MTBF of MSHU100 series of DC-DC converters has been calculated using

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

Model	MTBF	Unit
MSHU102	3,201,281	Hours
MSHU104	3,309,888	
MSHU105	3,309,888	
MSHU108	3,136,025	
MSHU109	3,143,418	
MSHU112	3,293,537	
MSHU114	3,426,124	
MSHU115	3,426,124	
MSHU118	3,333,334	
MSHU119	3,333,334	
MSHU122	3,245,436	
MSHU124	3,436,426	
MSHU125	3,436,426	
MSHU128	3,097,174	
MSHU129	3,097,174	