



MINMAX[®]

MSLU400 Series

Electric Characteristic Note

MSLU400 Series EC Note

DC-DC CONVERTER 2W, SMD-Package

Features

- ▶ Industrial SMD Package
- ▶ Unregulated Output Voltage
- ▶ I/O Isolation 1500 VDC
- ▶ Operating Ambient Temp. Range -40°C to +92.5°C
- ▶ Cleaning-washable Process Available (option)
- ▶ Qualified for Lead-free Reflow Solder Process
According to IPC/JEDEC J-STD-020D.1
- ▶ Tape & Reel Package Available



Applications

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

Product Overview

The MINMAX MSLU400 series is a range of 2W DC-DC converters in a SMD- Package featuring I/O isolation of 1500VDC. The very small footprint makes this product the ideal solution for many applications where a voltage has to be isolated i.e for noise reduction, ground loop elimination, in digital interfaces or where a converted voltage is required.

An excellent efficiency allows an operating temperature range of -40°C to +85°C. With a new package design these, converters are fully qualified for the higher temperature profile used in lead-free reflow solder processes. For automated SMD production lines, the product can be supplied in tape & reel package.

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Model Selection Guide

Model Number	Input Voltage (Range)	Output Voltage	Output Current	Input Current		Load Regulation	Max. capacitive Load	Efficiency (typ.)
				Max.	@No Load			@Max. Load
	VDC	VDC	mA	mA(typ.)	mA(typ.)	%(max.)	μF	%
MSLU401	5 (4.5 ~ 5.5)	3.3	500	471	60	11	47	70
MSLU402		5	400	548		11	47	73
MSLU404		12	165	514		11	10	77
MSLU406		±5	±200	541		10	10#	74
MSLU408		±12	±83	524		7	4.7#	76
MSLU409		±15	±66	521		7	4.7#	76
MSLU411	12 (10.8 ~ 13.2)	3.3	500	191	30	8	47	72
MSLU412		5	400	222		8	47	75
MSLU414		12	165	209		5	10	79
MSLU418		±12	±83	208		5	4.7#	80
MSLU419		±15	±66	206		5	4.7#	80
MSLU421	24 (21.6 ~ 26.4)	3.3	500	96	15	8	47	72
MSLU422		5	400	111		8	47	75
MSLU424		12	165	105		5	10	79
MSLU428		±12	±83	105		5	4.7#	79
MSLU429		±15	±66	104		5	4.7#	79

For each output

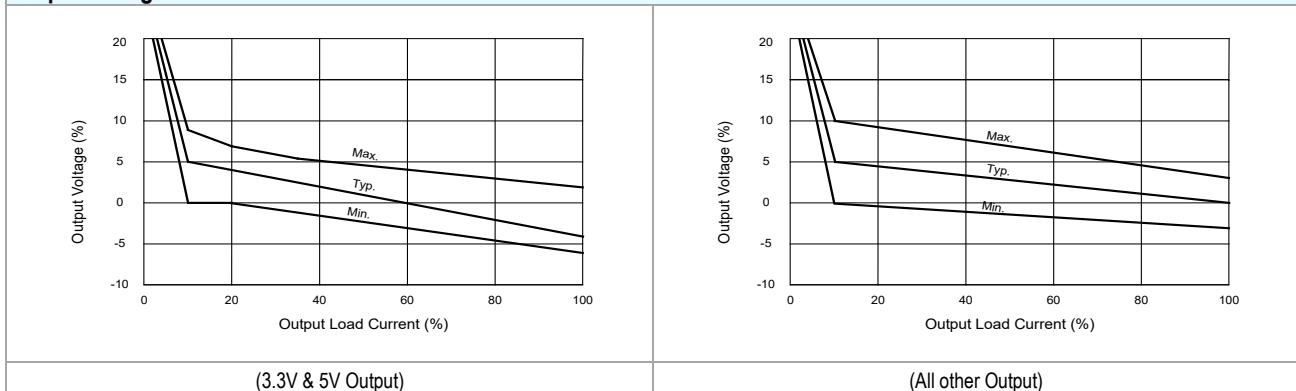
Input Specifications

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	VDC
	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 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			
Ripple & Noise	0-20 MHz Bandwidth	---	---	120	mV _{P-P}
Temperature Coefficient		---	±0.01	±0.02	%/°C
Short Circuit Protection	0.5 Second Max., Automatic Recovery				

Output Voltage Tolerance



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	---	60	100	pF
Switching Frequency		50	100	120	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

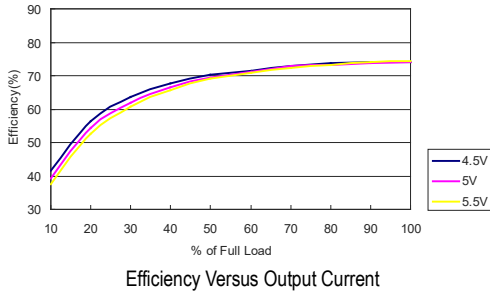
Parameter	Min.	Max.	Unit
Operating Ambient Temperature Range (See Power Derating Curve)	-40	+92.5	°C
Case Temperature	---	+105	°C
Storage Temperature Range	-50	+125	°C
Humidity (non condensing)	---	95	% rel. H
Lead-free Reflow Solder Process	IPC/JEDEC J-STD-020D.1		

Notes

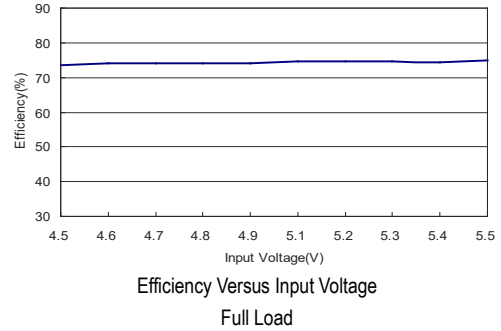
- Specifications typical at Ta=+25°C, resistive load, nominal input voltage and rated output current unless otherwise noted.
- These power converters require a minimum output loading to maintain specified regulation, operation under no-load conditions will not damage these modules; however they may not meet all specifications listed.
- We recommend to protect the converter by a fast blow fuse in the input supply line.
- Other input and output voltage may be available, please contact MINMAX.
- Specifications are subject to change without notice.
- 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

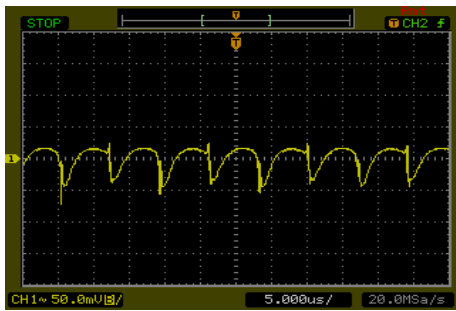
All test conditions are at 25°C The figures are identical for MSLU401



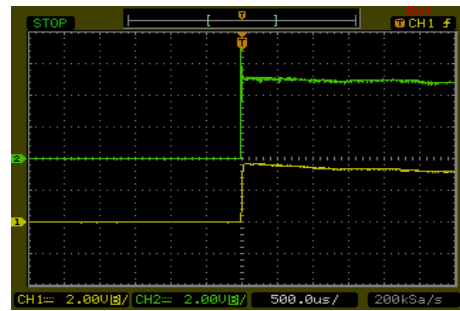
Efficiency Versus Output Current



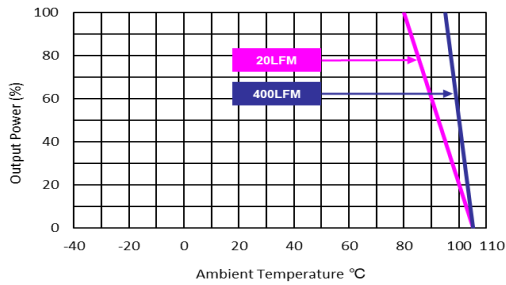
Efficiency Versus Input Voltage Full Load



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



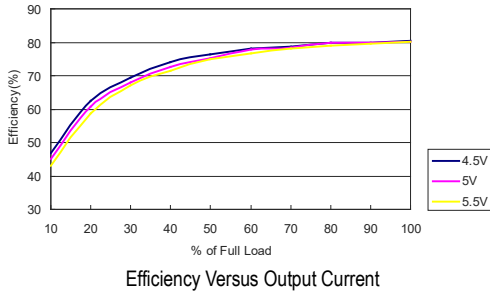
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



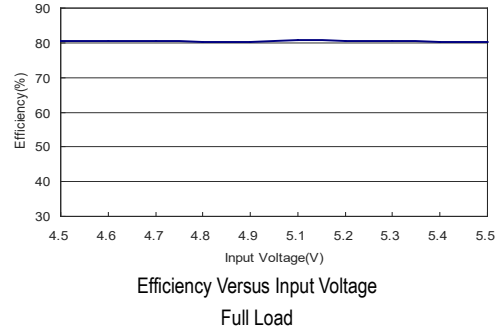
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

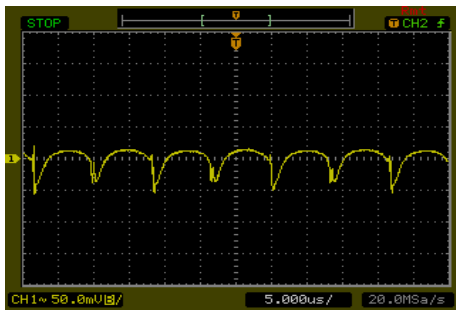
All test conditions are at 25°C The figures are identical for MSLU402



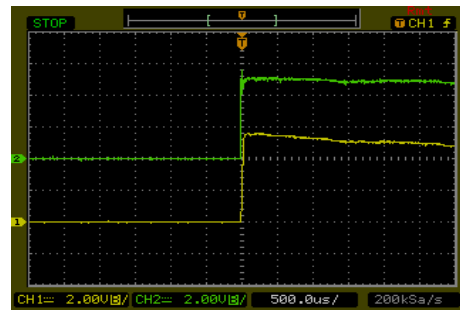
Efficiency Versus Output Current



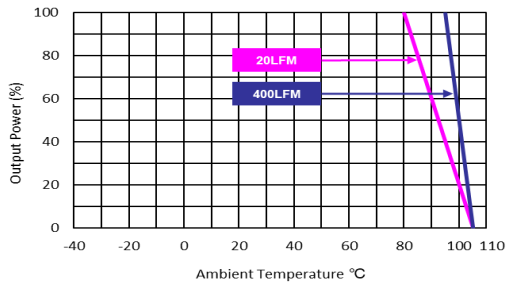
Efficiency Versus Input Voltage Full Load



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



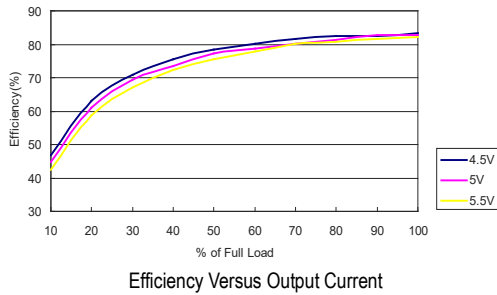
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



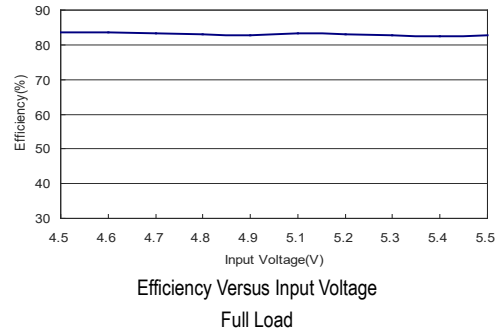
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

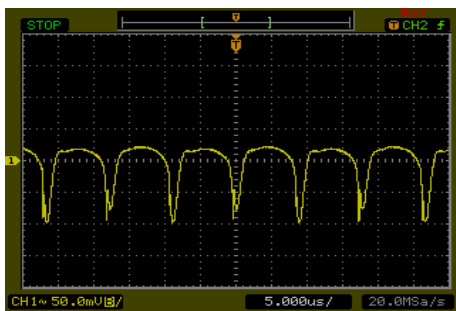
All test conditions are at 25°C The figures are identical for MSLU404



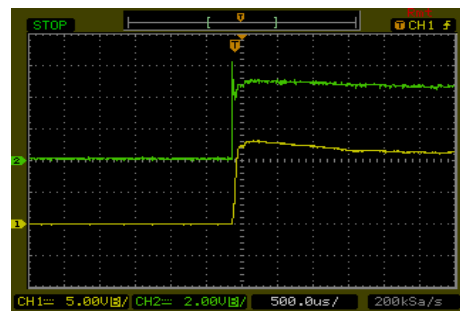
Efficiency Versus Output Current



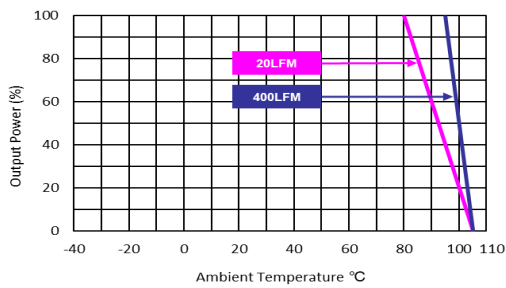
Efficiency Versus Input Voltage Full Load



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



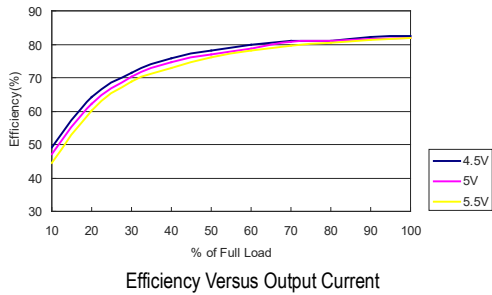
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



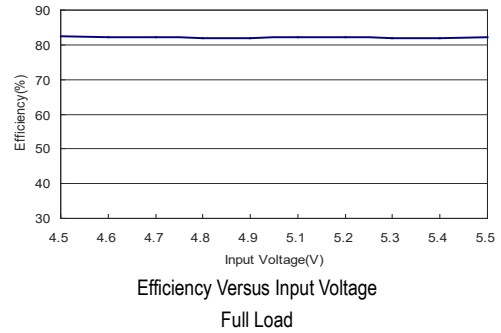
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

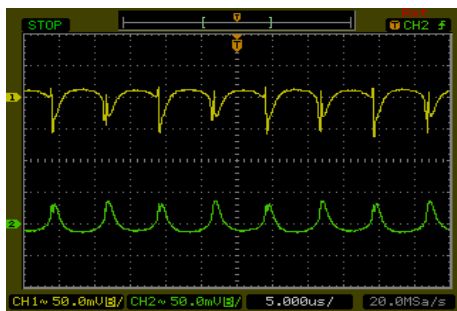
All test conditions are at 25°C The figures are identical for MSLU406



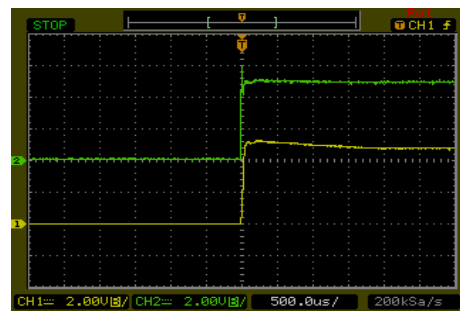
Efficiency Versus Output Current



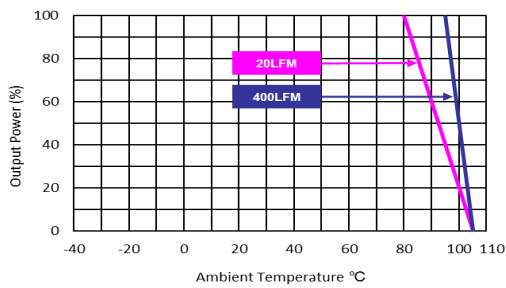
Efficiency Versus Input Voltage Full Load



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



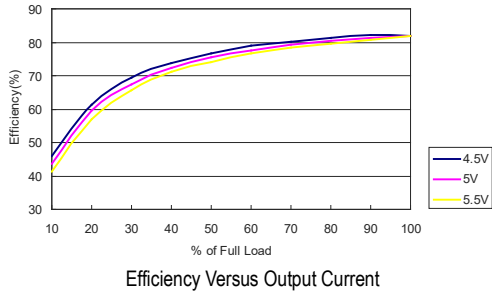
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



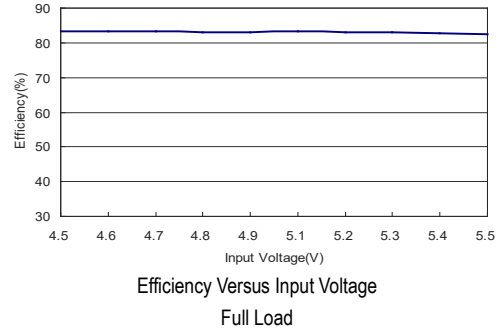
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

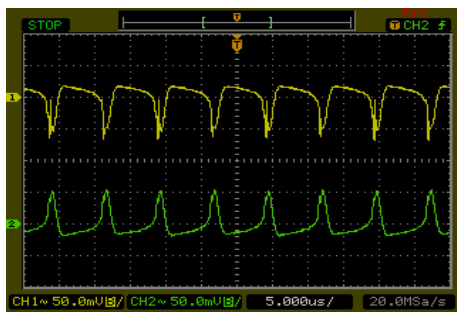
All test conditions are at 25°C The figures are identical for MSLU408



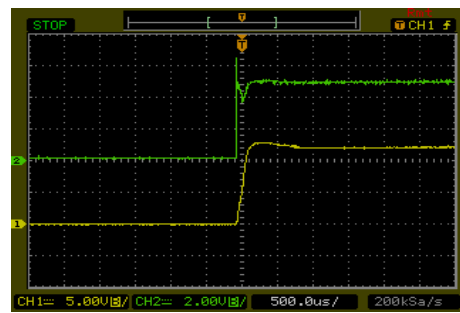
Efficiency Versus Output Current



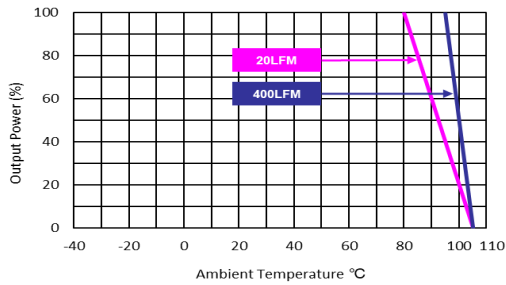
Efficiency Versus Input Voltage
Full Load



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



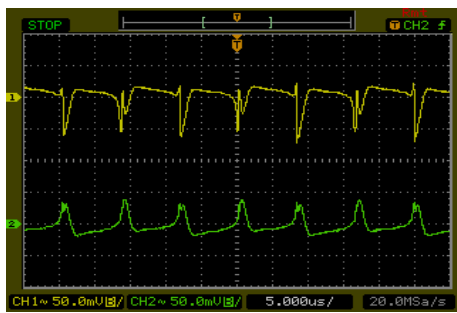
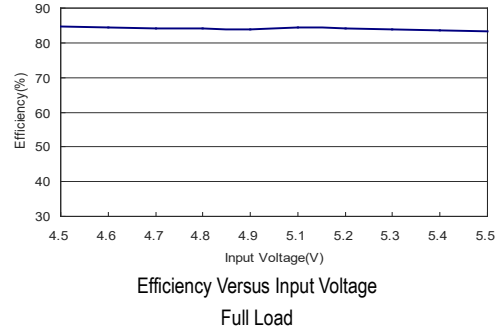
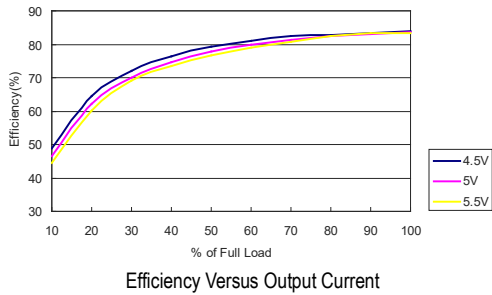
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



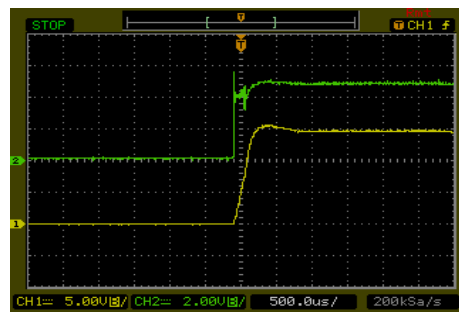
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

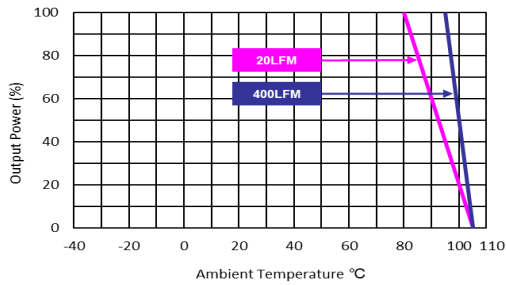
All test conditions are at 25°C The figures are identical for MSLU409



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



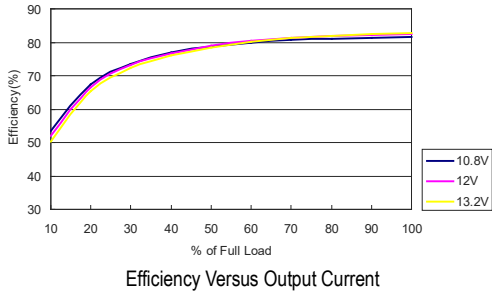
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



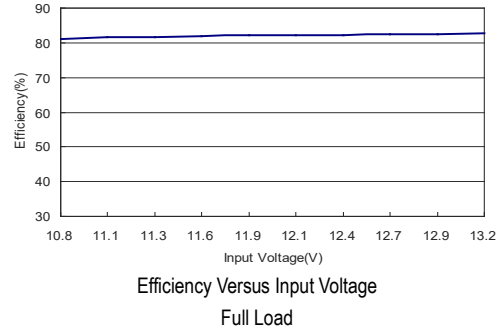
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

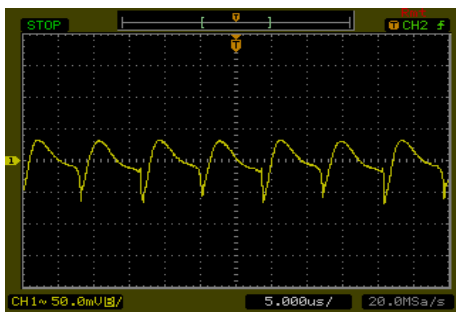
All test conditions are at 25°C The figures are identical for MSLU411



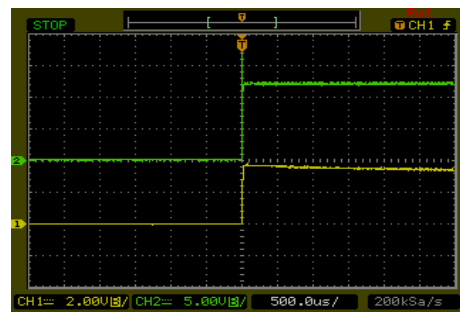
Efficiency Versus Output Current



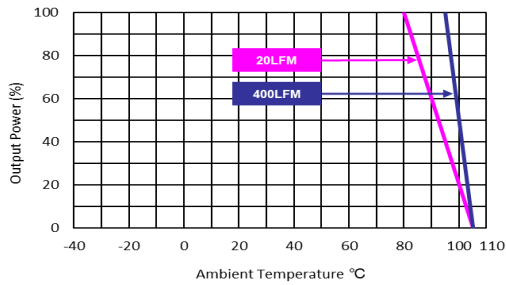
Efficiency Versus Input Voltage Full Load



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



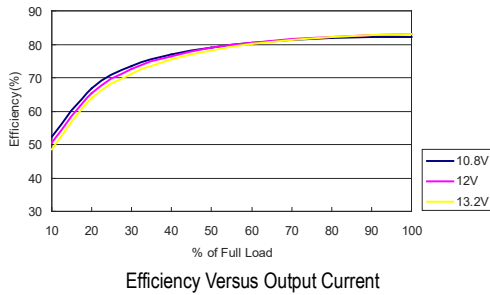
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



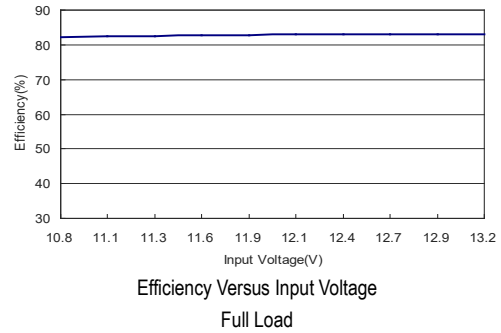
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

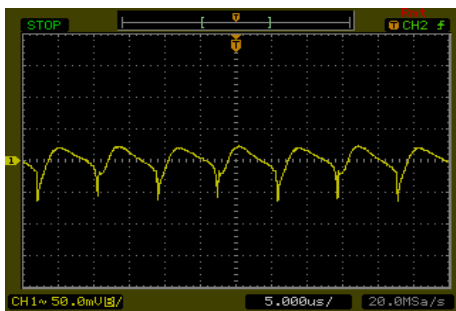
All test conditions are at 25°C The figures are identical for MSLU412



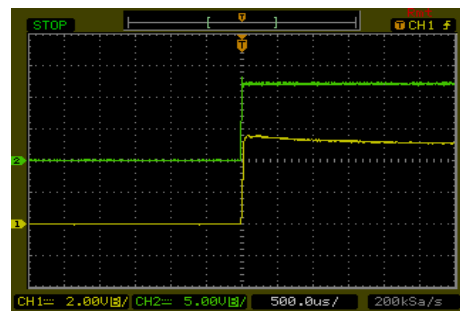
Efficiency Versus Output Current



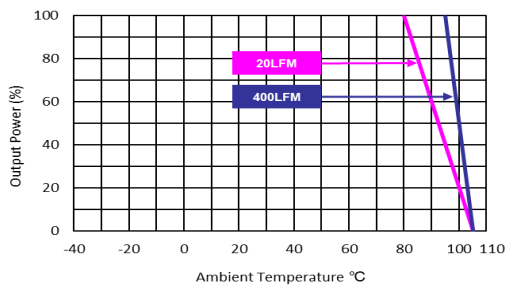
Efficiency Versus Input Voltage
Full Load



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



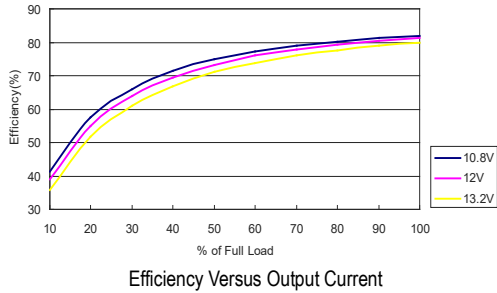
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



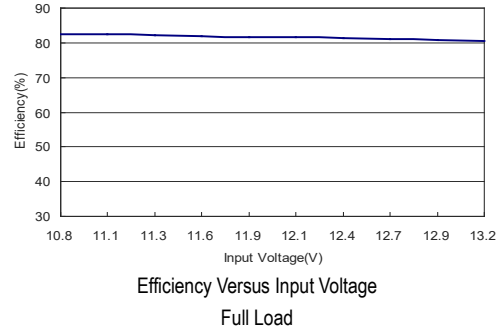
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

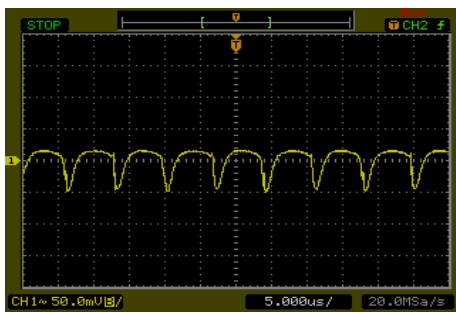
All test conditions are at 25°C The figures are identical for MSLU414



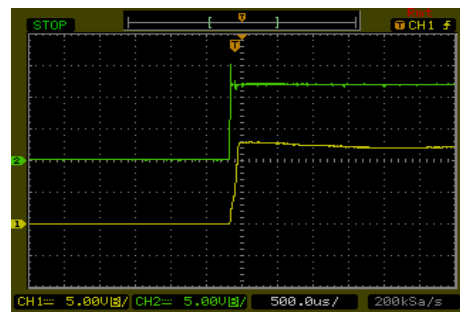
Efficiency Versus Output Current



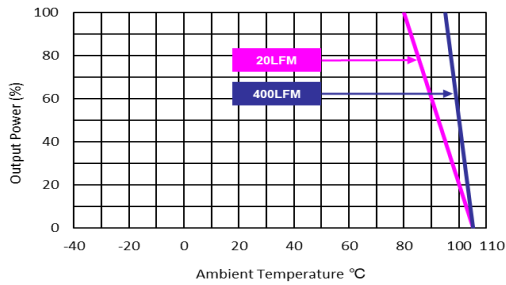
Efficiency Versus Input Voltage Full Load



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



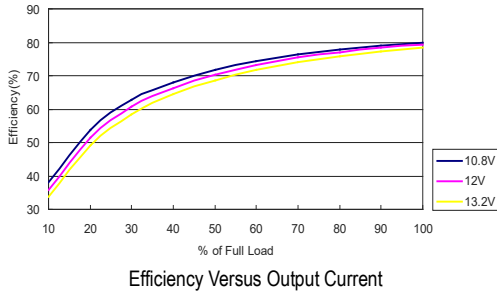
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



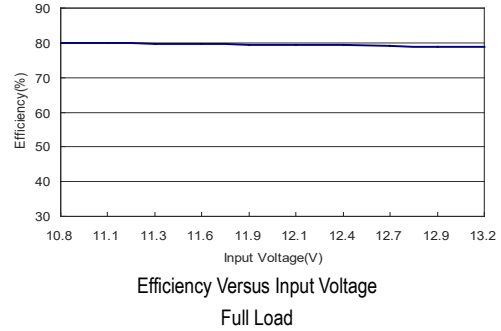
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

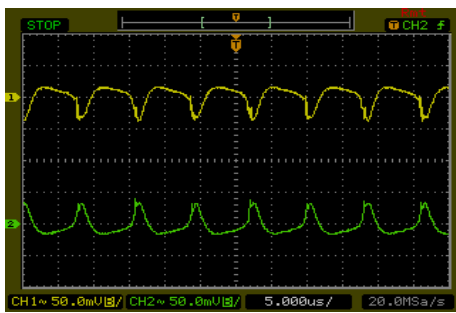
All test conditions are at 25°C The figures are identical for MSLU418



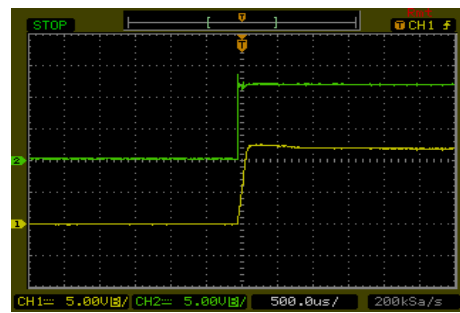
Efficiency Versus Output Current



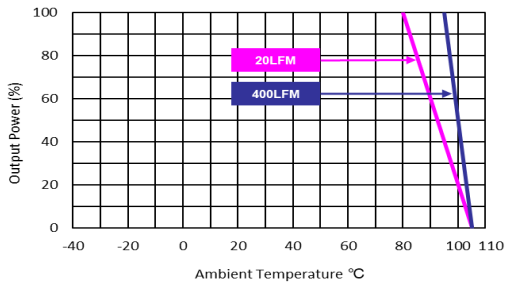
Efficiency Versus Input Voltage
Full Load



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



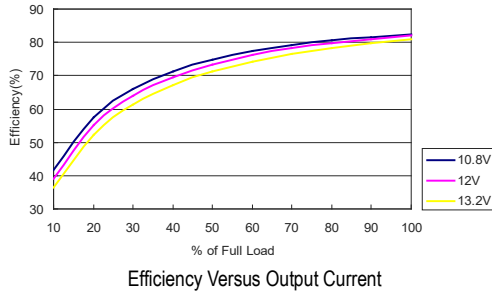
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



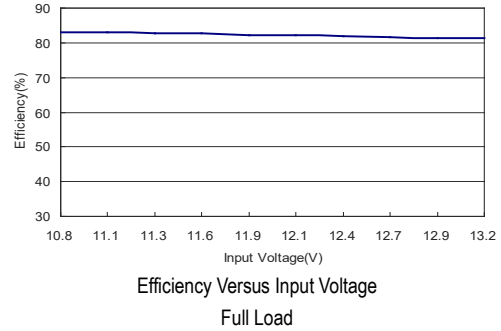
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

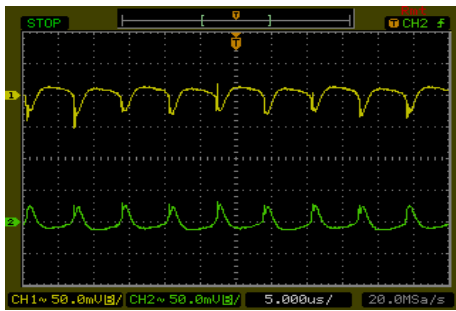
All test conditions are at 25°C The figures are identical for MSLU419



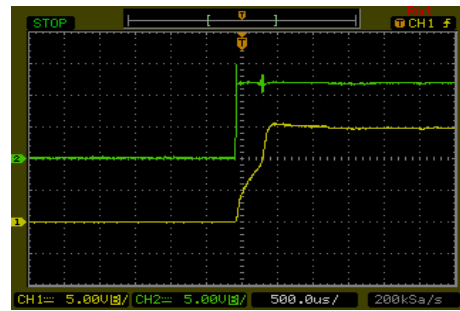
Efficiency Versus Output Current



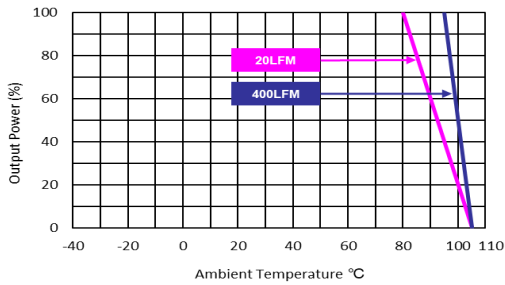
Efficiency Versus Input Voltage
Full Load



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



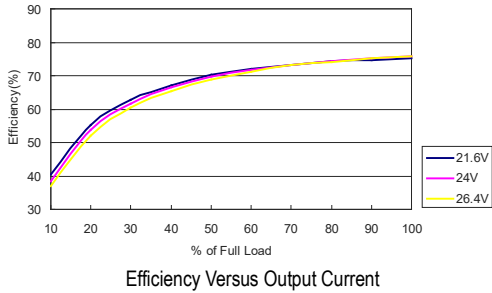
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



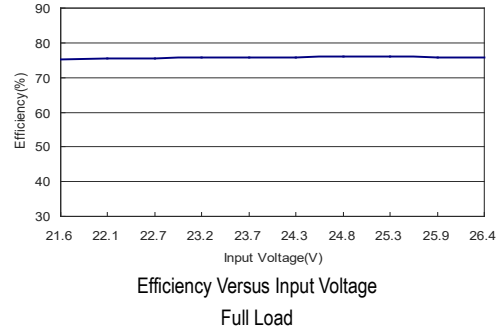
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

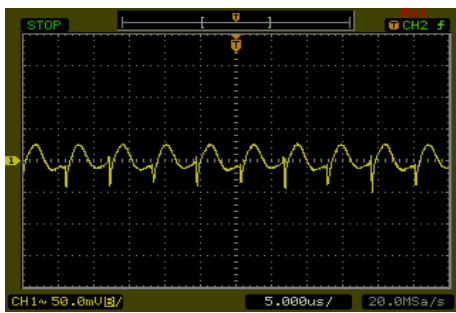
All test conditions are at 25°C The figures are identical for MSLU421



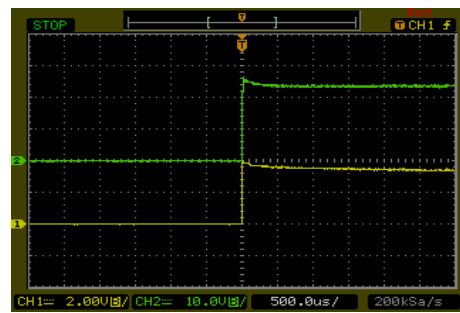
Efficiency Versus Output Current



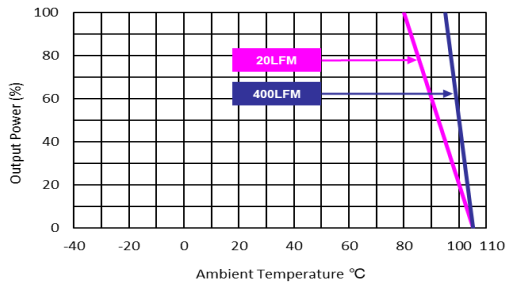
Efficiency Versus Input Voltage
Full Load



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



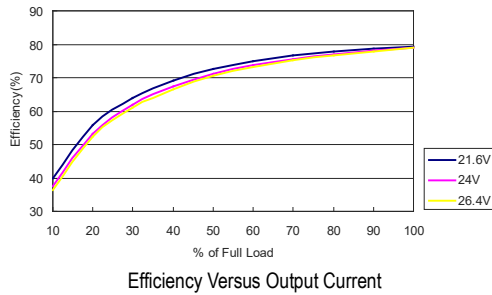
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



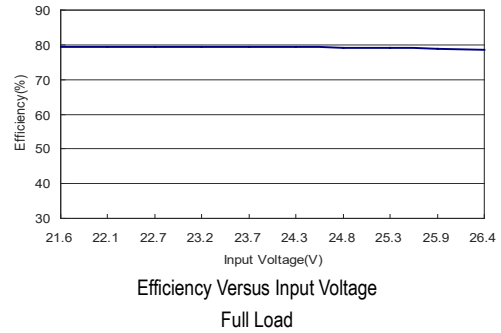
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

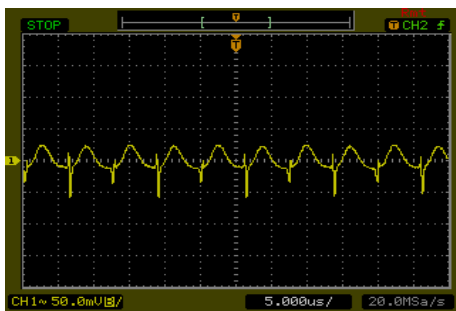
All test conditions are at 25°C The figures are identical for MSLU422



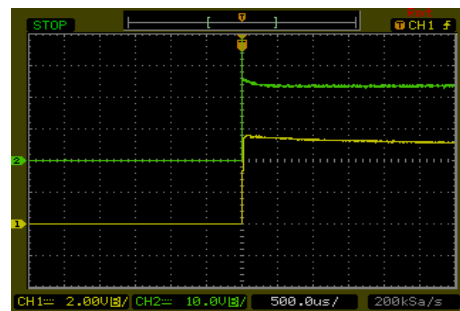
Efficiency Versus Output Current



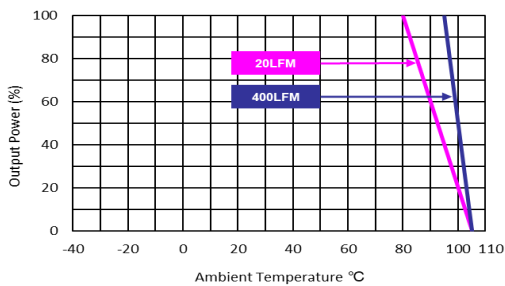
Efficiency Versus Input Voltage
Full Load



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



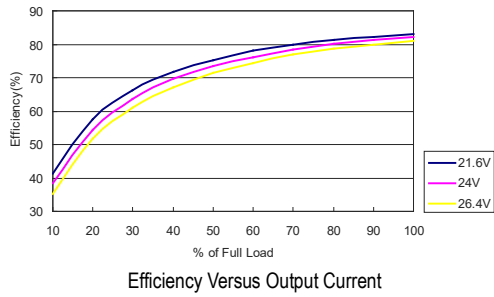
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



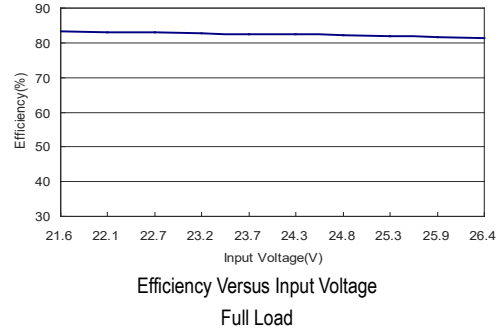
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

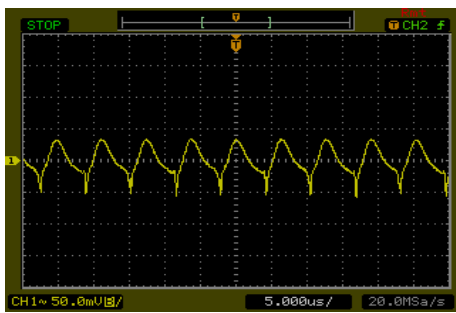
All test conditions are at 25°C The figures are identical for MSLU424



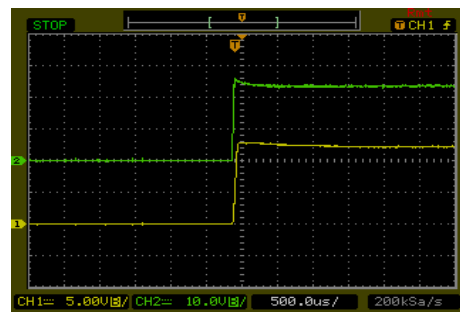
Efficiency Versus Output Current



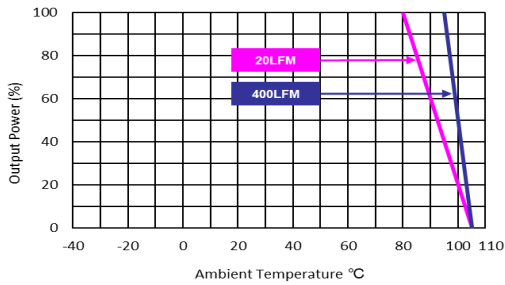
Efficiency Versus Input Voltage
Full Load



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



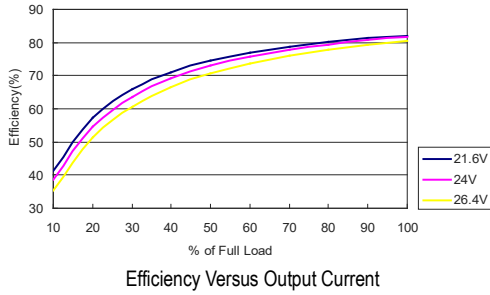
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



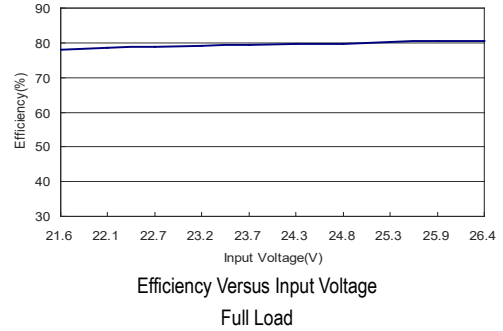
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Characteristic Curves

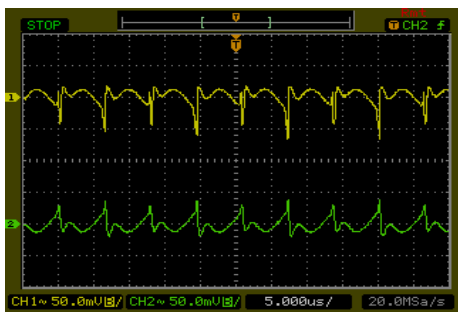
All test conditions are at 25°C The figures are identical for MSLU428



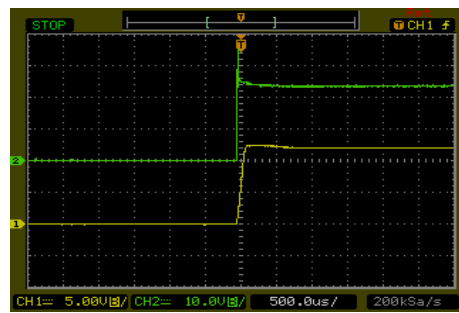
Efficiency Versus Output Current



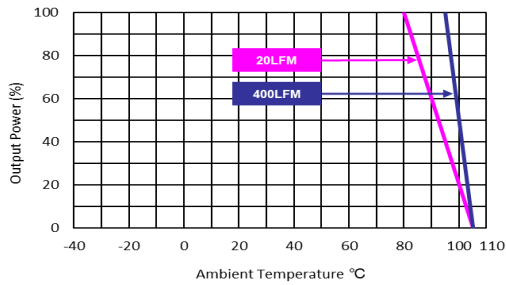
Efficiency Versus Input Voltage
Full Load



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



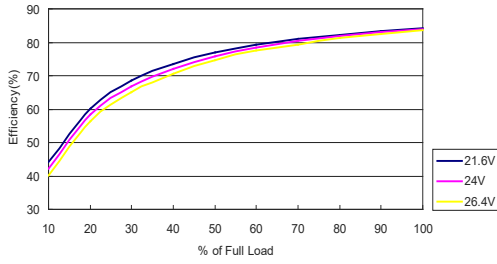
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



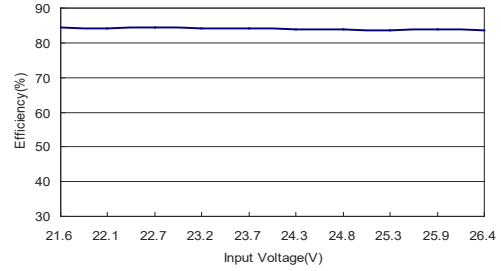
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in\ nom}$

Characteristic Curves

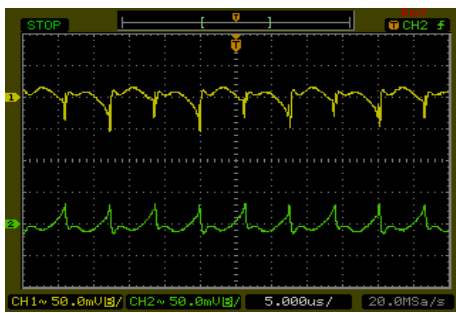
All test conditions are at 25°C The figures are identical for MSLU429



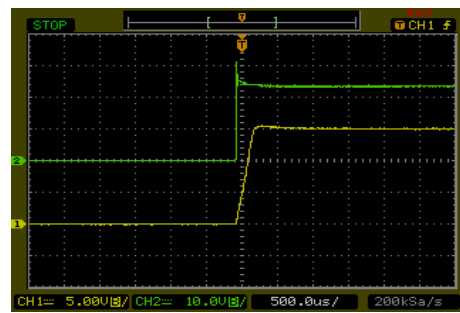
Efficiency Versus Output Current



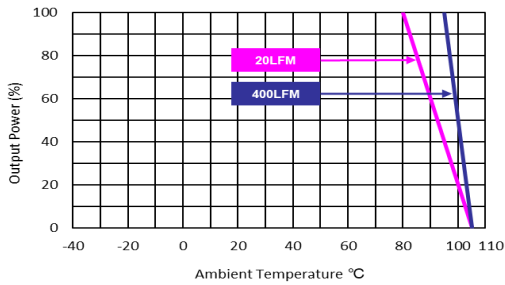
Efficiency Versus Input Voltage
Full Load



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



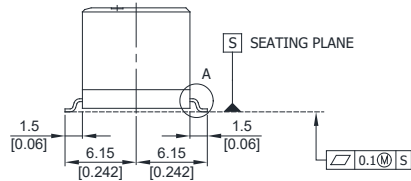
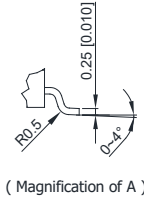
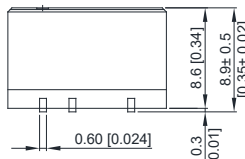
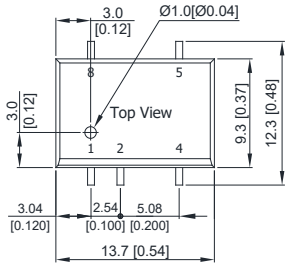
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in nom}$; Full Load



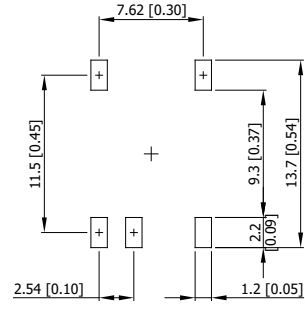
Derating Output Current Versus Ambient Temperature and Airflow
 $V_{in}=V_{in nom}$

Package Specifications

Mechanical Dimensions (Single Output)

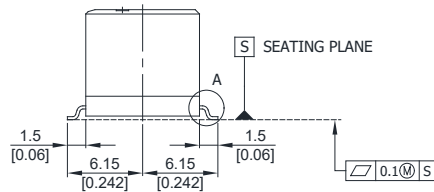
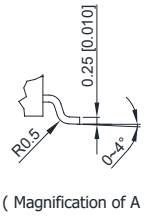
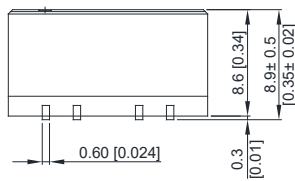
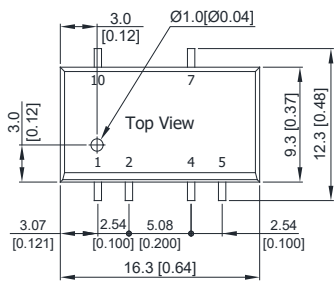


Connecting Pin Patterns

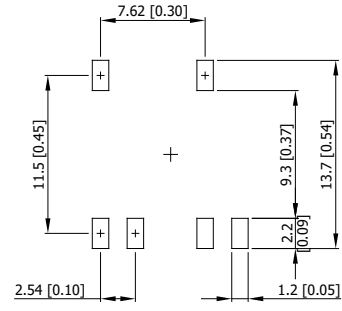


Package Specifications

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
4	-Vout	Common
5	+Vout	-Vout
7	No Pin	+Vout
8	NA	No Pin
10	No Pin	NA

NA : Not Available for Electrical Connection

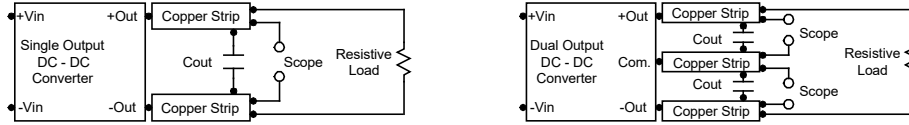
Physical Characteristics

Case Size (Single Output)	: 13.7x9.3x8.6mm (0.54x0.37x0.34 inches)
Case Size (Dual Output)	: 16.3x9.3x8.6mm (0.64x0.37x0.34 inches)
Case Material	: Plastic resin (flammability to UL 94V-0 rated)
Pin Material	: Phosphor Bronze
Weight (Single Output)	: 1.5g
Weight (Dual Output)	: 2.2g

Test Setup

Peak-to-Peak Output Noise Measurement Test

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



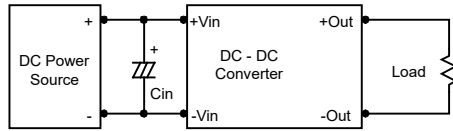
Technical Notes

Maximum Capacitive Load

The MSLU400 series has limitation of maximum connected capacitance at the output. The power module may be operated in current limiting mode during start-up, affecting the ramp-up and the startup time. The maximum capacitance can be found in the data sheet.

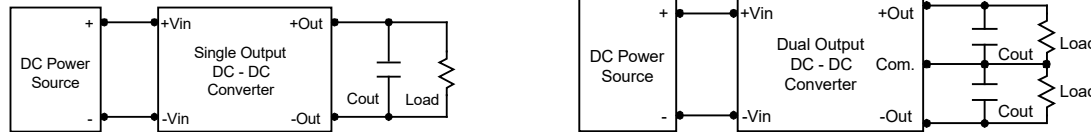
Input Source Impedance

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 commended to use a good quality low Equivalent Series Resistance (ESR < 1.0 Ω at 100 kHz) capacitor of a 2.2 μ F for the 5V input devices, a 1.0 μ F for the 12V input devices and a 0.47 μ F for the 24V devices.



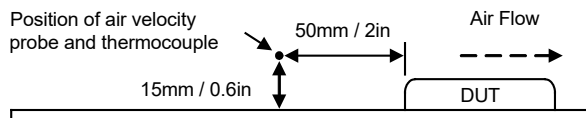
Output Ripple Reduction

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 1.5 μ F capacitors at the output.



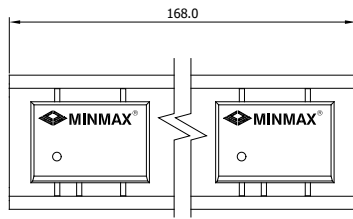
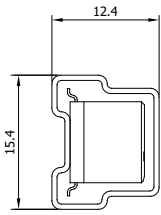
Thermal Considerations

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.

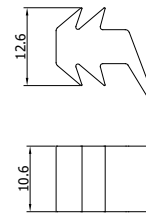


Packaging Information for Tube (Single Output)

Tube



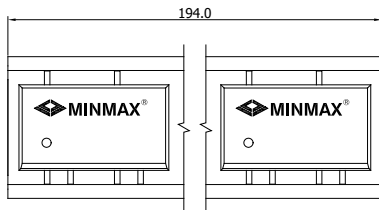
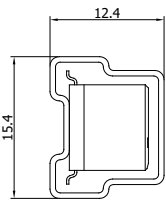
Plug



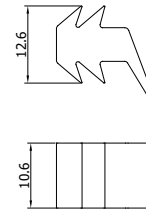
Unit: mm
10 PCS per TUBE

Packaging Information for Tube (Dual Output)

Tube



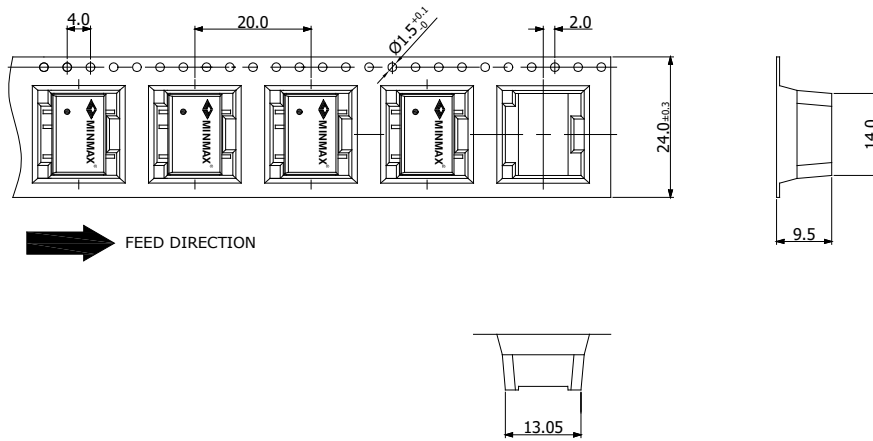
Plug



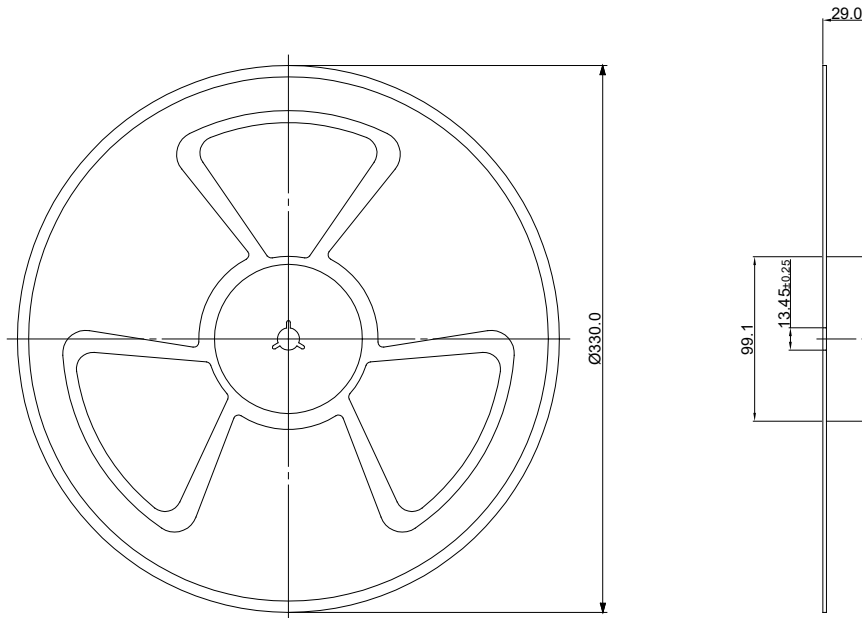
Unit: mm
10 PCS per TUBE

Packaging Information for Tape & Reel (Single Output)

Tape



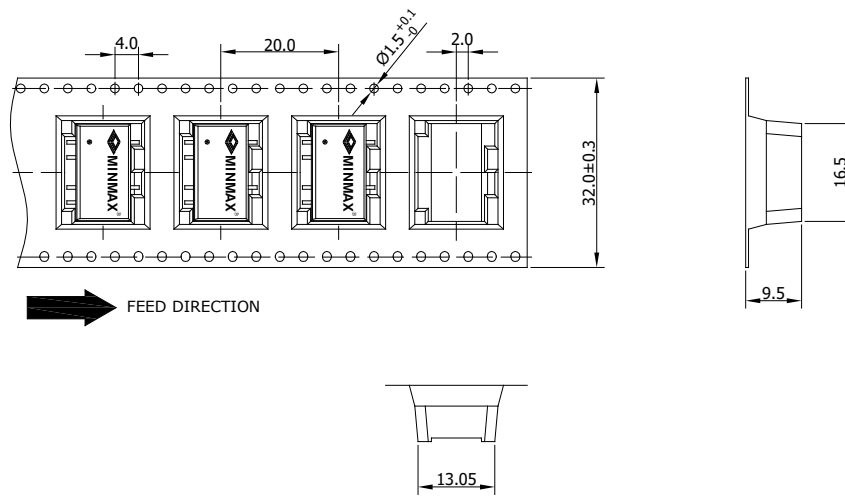
Reel



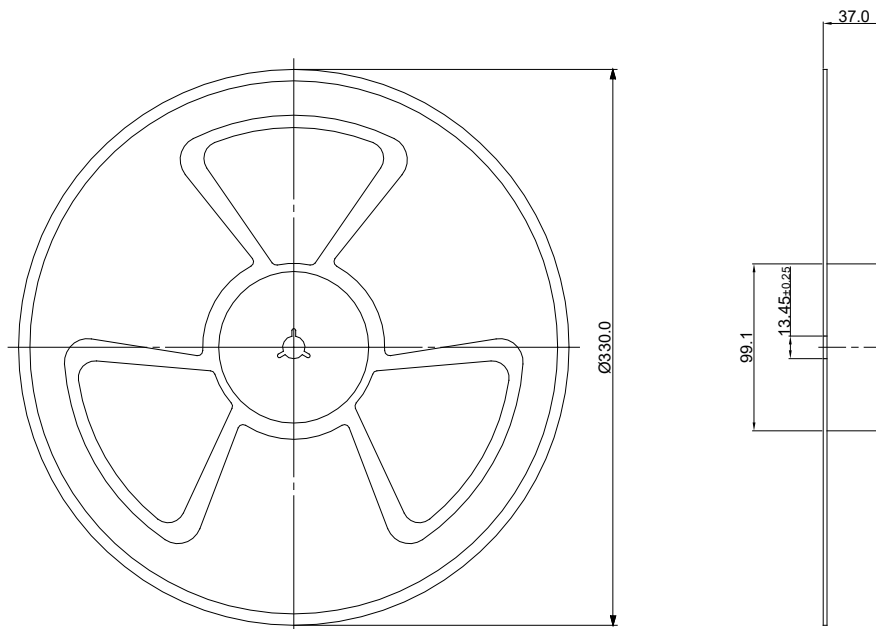
Packaging Style	Quantity
With Heatsink Tube	N/A
Tape and Reel to IEC 286-3 Specifications	300

Packaging Information for Tape & Reel (Dual Output)

Tape



Reel



Packaging Style	Quantity
With Heatsink Tube	N/A
Tape and Reel to IEC 286-3 Specifications	300

Soldering and Reflow Considerations

Profile	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate(T_s max. To T_p)	3°C/second max.	3°C/second max.
Preheat		
· Temperature Min (T_{smin})	100°C	150°C
· Temperature Max (T_{smax})	150°C	200°C
· Time (T_{smin} to T_{smax}) (ts)	60~120 seconds	60~180 seconds
Time maintained above:		
· Temperature (T_L)	183°C	217°C
· Time (t_L)	60~150 seconds	60~150 seconds
Peak Temperature (T_p)	See Table 4-1	See Table 4-2
Time within 5°C of actual Peak Temperature (t_p) 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 (t_p) specified for the reflow profiles is a "supplier" minimum and "user" maximum.

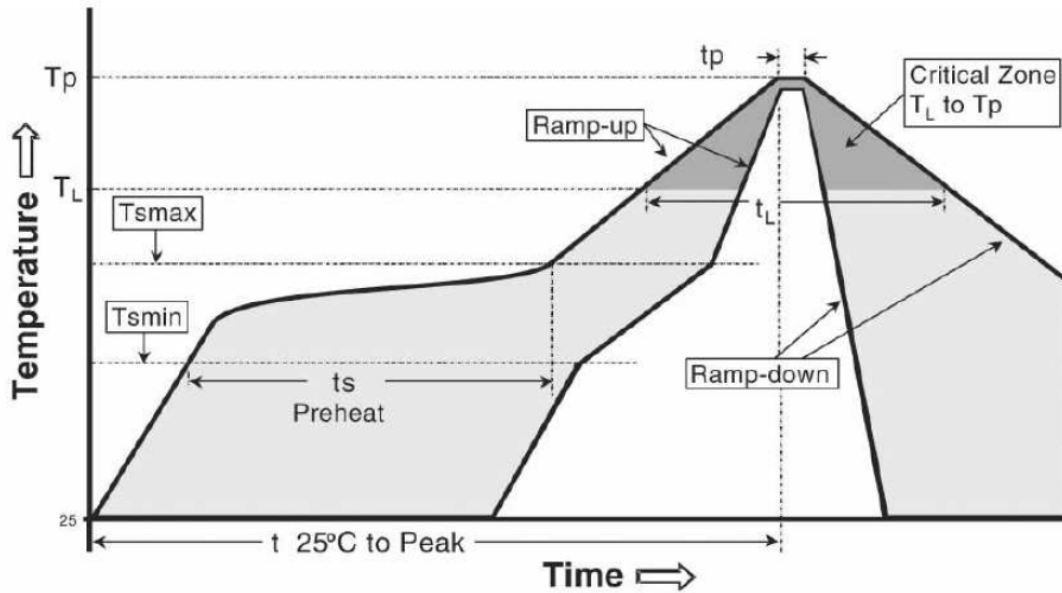


Table 4-1 SnPb Eutectic Process-Classification Temperatures (T_c)

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

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

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

Part Number Structure				
M	SL	U	40	1
	Package Type SMD-24	Output Regulation Unregulated	Input Voltage Range 40: 4.5 ~ 5.5 VDC 41: 10.8 ~ 13.2 VDC 42: 21.6 ~ 26.4 VDC	Output Voltage 1: 3.3 VDC 2: 5 VDC 4: 12 VDC 6: ±5 VDC 8: ±12 VDC 9: ±15 VDC

MTBF and Reliability

The MTBF of MSLU400 series of DC-DC converters has been calculated using

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

Model	MTBF	Unit
MSLU401	2,838,893	Hours
MSLU402	2,841,918	
MSLU404	2,968,460	
MSLU406	2,788,428	
MSLU408	2,942,258	
MSLU409	2,919,708	
MSLU411	3,472,222	
MSLU412	3,185,982	
MSLU414	3,263,974	
MSLU418	2,969,562	
MSLU419	2,969,562	
MSLU421	3,498,032	
MSLU422	3,513,395	
MSLU424	3,289,474	
MSLU428	3,490,402	
MSLU429	2,973,978	