MINMAX®

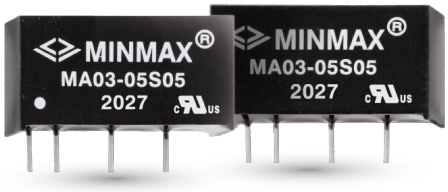
MA03 Series

Electric Characteristic Note

MA03 Series EC Note

DC-DC CONVERTER 3W, SIP Package

Features



- **Industrial Standard SIP-7 Package**
- **Semi-regulated Output Voltage**
- **Very High Efficiency up to 89%**
- **High I/O Isolation 1000VDC**
- **Operating Ambient Temp. Range -40℃ to +95℃**
- **UL/cUL/IEC/EN 62368-1(60950-1) Safety Approval**

Applications

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

Product Overview

The MINMAX MA03 series is a range of isolated 3W DC-DC converter modules in a small SIP-package. There are 12 models available with 5V, 12V or 24VDC input. These products have a typical load regulation of 5.0% to 7.0% depending on model.

The MA03 DC-DC converters are a compromise between a more expensive fully regulated converter and a non-regulated converter. They offer the designer a solution for many cost critical applications where the output voltage variation has to be kept in a certain limit under all load conditions.

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	%
MA03-05S05	5 (4.5 ~ 5.5)	5	600	723	50	8	220	83
MA03-05S09		9	333	689		7		87
MA03-05S12		12	250	701		7		85.5
MA03-05S15		15	200	686		6		87.5
MA03-12S05	12 (10.8 ~ 13.2)	5	600	298	40	6	220	84
MA03-12S09		9	333	285		5		87.5
MA03-12S12		12	250	284		4.5		88
MA03-12S15		15	200	281		4		89
MA03-24S05	24 (21.6 ~ 26.4)	5	600	152	30	5.8	220	82
MA03-24S09		9	333	147		4.8		85
MA03-24S12		12	250	146		4.3		85.5
MA03-24S15		15	200	147		3.5		85

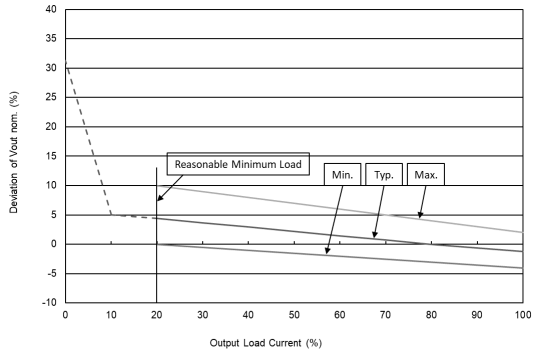
Input Specifications

Parameter	Model	Min.	Typ.	Max.	Unit
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 Voltage Range	5V Input Models	4.5	5	5.5	
	12V Input Models	10.8	12	13.2	
	24V Input Models	21.6	24	26.4	
Input Filter	All Models	Internal Capacitor			

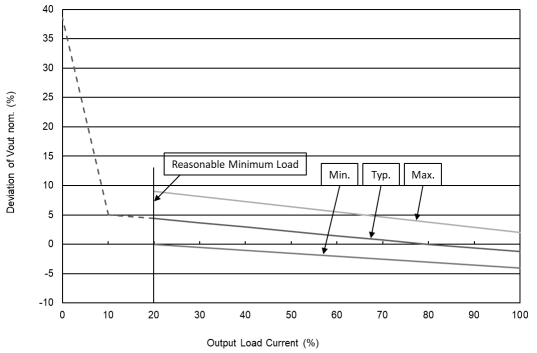
Output Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Line Regulation	For Vin Change of 1%	---	±1.01	±1.2	%
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	---	---	100	mV_{P-P}
Temperature Coefficient		---	±0.01	±0.02	%/℃
Short Circuit Protection	0.5 Second Max., Automatic Recovery				

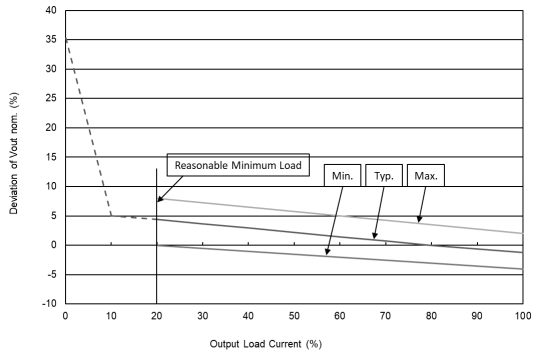
Output Voltage Tolerance



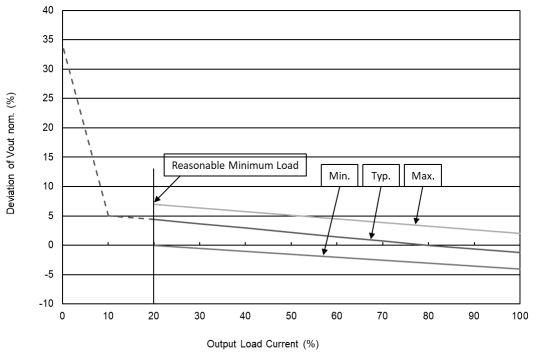
MA03-05S05
Output Voltage VS Output Load Current



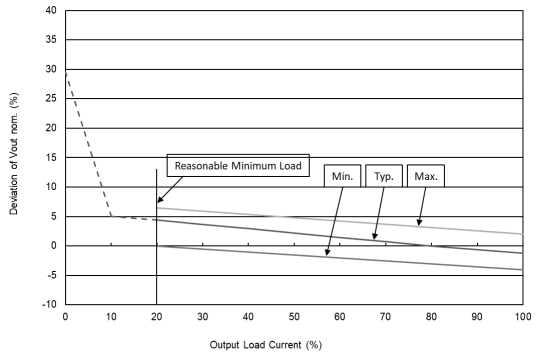
MA03-05S09, MA03-05S12
Output Voltage VS Output Load Current



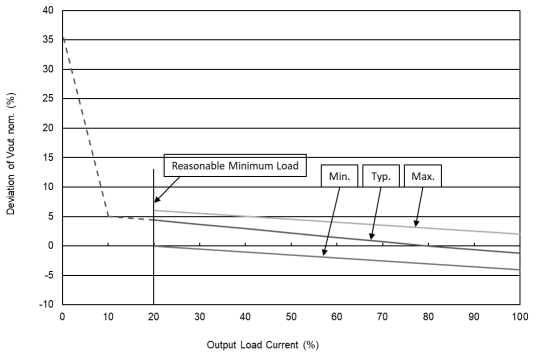
MA03-05S15, MA03-12S05
Output Voltage VS Output Load Current



MA03-12S09
Output Voltage VS Output Load Current

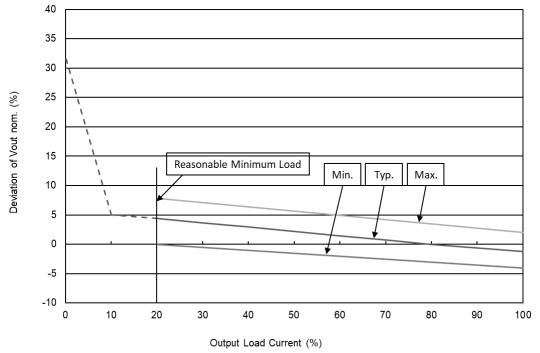


MA03-12S12
Output Voltage VS Output Load Current



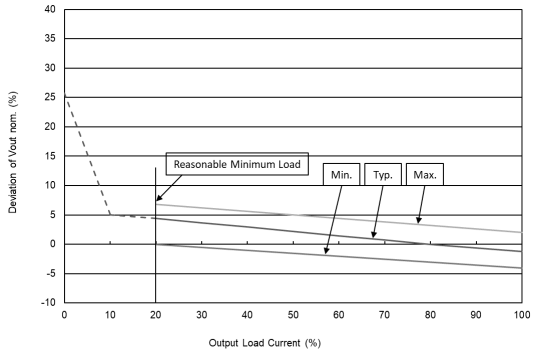
MA03-12S15
Output Voltage VS Output Load Current

Output Voltage Tolerance



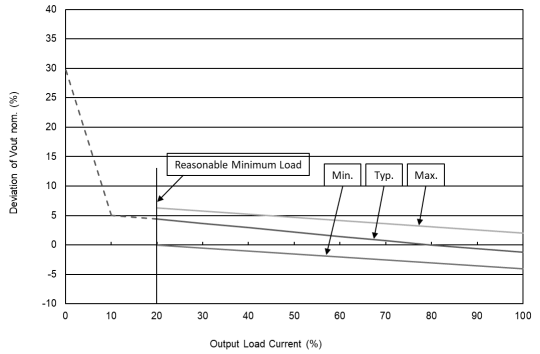
MA03-24S05

Output Voltage VS Output Load Current



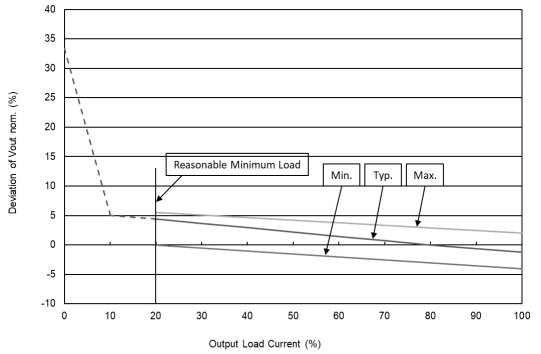
MA03-24S09

Output Voltage VS Output Load Current



MA03-24S12

Output Voltage VS Output Load Current



MA03-24S15

Output Voltage VS Output Load Current

General Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	60 Seconds	1000	---	---	VDC
	1 Second	1200	---	---	VDC
I/O Isolation Resistance	500 VDC	1000	---	---	MΩ
I/O Isolation Capacitance	100kHz, 1V	---	60	120	pF
Switching Frequency		---	60	---	kHz
MTBF (calculated)	MIL-HDBK-217F@25°C, Ground Benign	2,000,000			Hours
Safety Approvals	UL/cUL 60950-1 recognition(CSA certificate), IEC/EN 60950-1(CB-report)				
	UL/cUL 62368-1 recognition(UL certificate), IEC/EN 62368-1(CB-report)				

Environmental Specifications

Parameter	Min.	Max.	Unit
Operating Ambient Temperature Range (See Power Derating Curve)	-40	+85	℃
Case Temperature	---	+100	℃
Storage Temperature Range	-50	+125	℃
Humidity (non condensing)	---	95	% rel. H
Lead Temperature (1.5mm from case for 10Sec.)	---	260	℃

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.

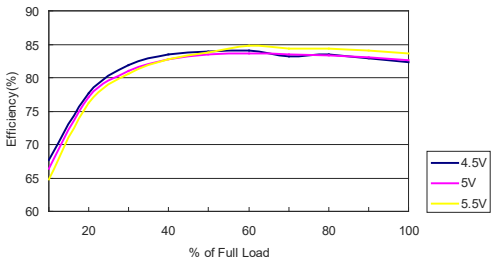
4 Other input and output voltage may be available, please contact MINMAX.

5 Specifications are subject to change without notice.

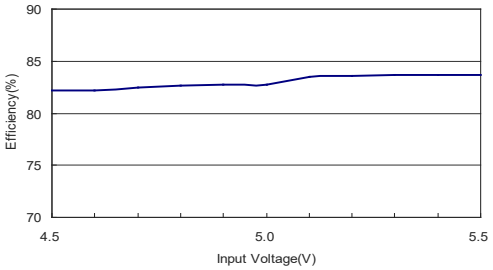
6 The repeated high voltage isolation testing of the converter can degrade isolation capability, to a lesser or greater degree depending on materials, construction, environment and reflow solder process. Any material is susceptible to eventual chemical degradation when subject to very high applied voltages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

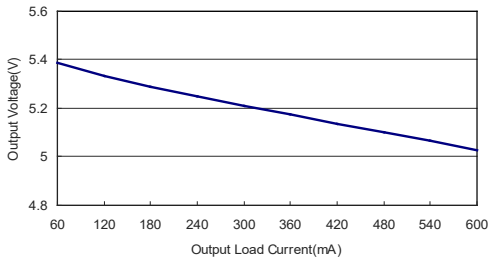
All test conditions are at 25°C The figures are identical for MA03-05S05



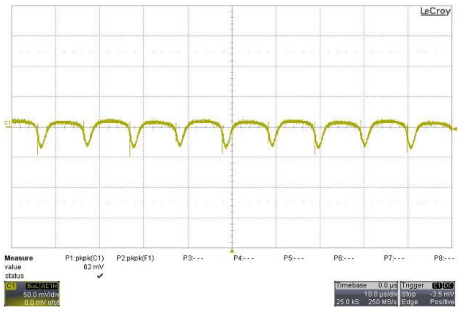
Efficiency Versus Output Current



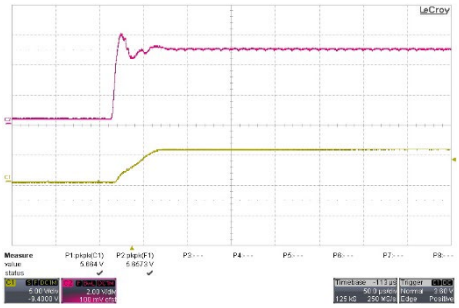
Efficiency Versus Input Voltage
Full Load



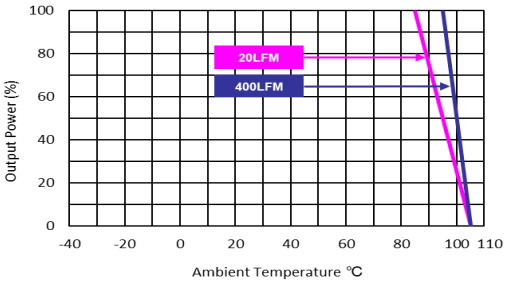
Output Voltage Versus Output Current



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



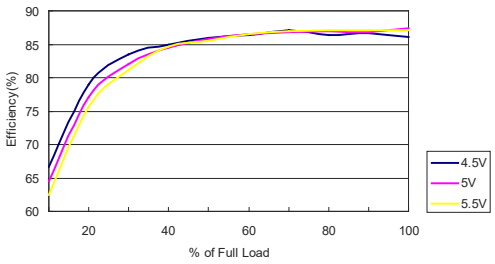
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



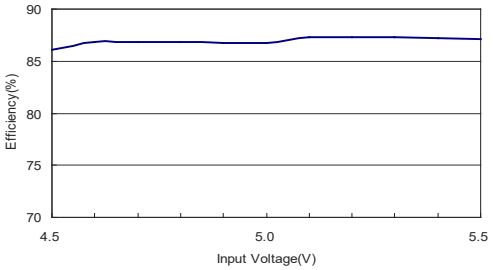
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

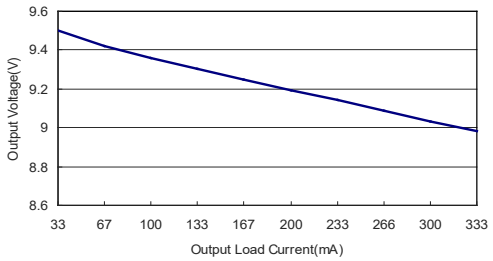
All test conditions are at 25°C The figures are identical for MA03-05S09



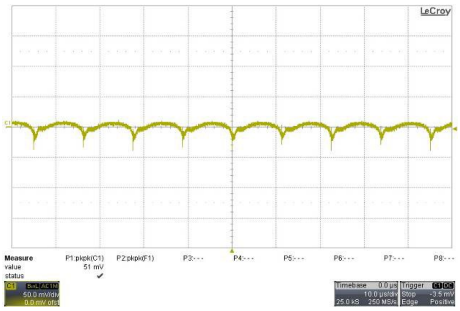
Efficiency Versus Output Current



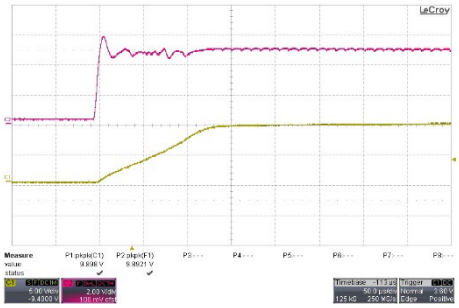
Efficiency Versus Input Voltage
Full Load



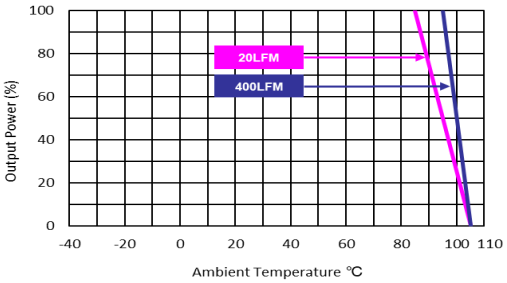
Output Voltage Versus Output Current



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



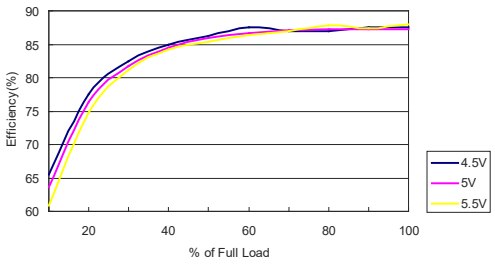
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



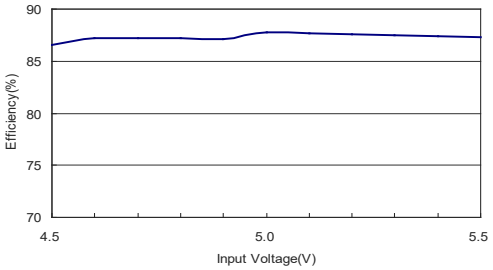
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

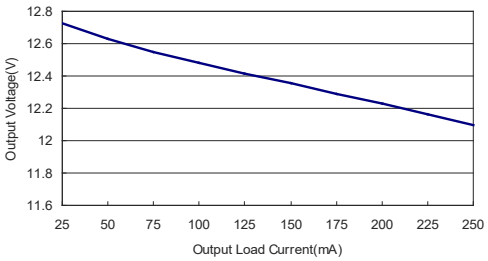
All test conditions are at 25°C The figures are identical for MA03-05S12



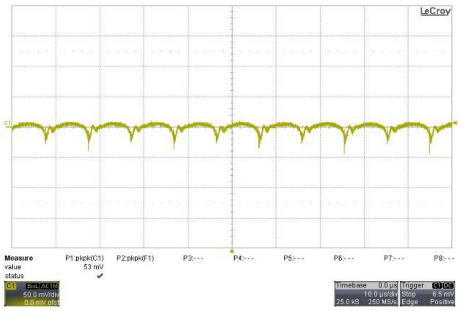
Efficiency Versus Output Current



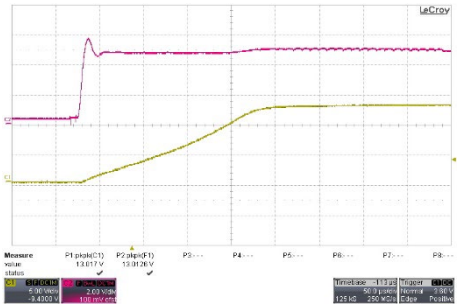
Efficiency Versus Input Voltage
Full Load



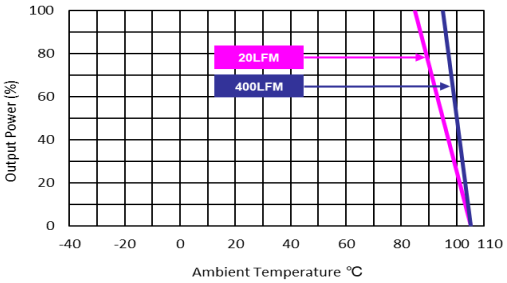
Output Voltage Versus Output Current



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



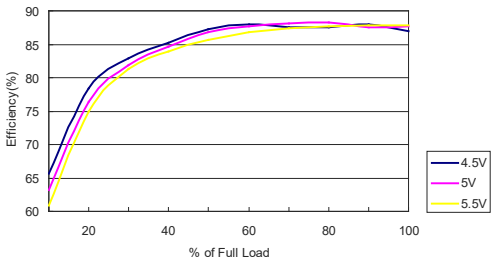
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



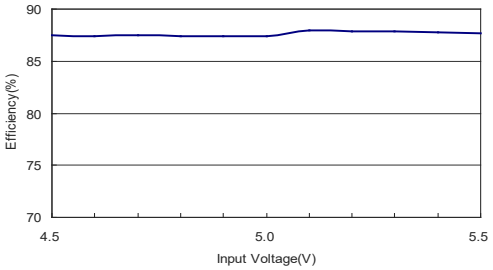
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

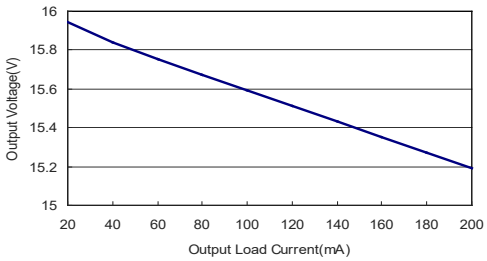
All test conditions are at 25°C The figures are identical for MA03-05S15



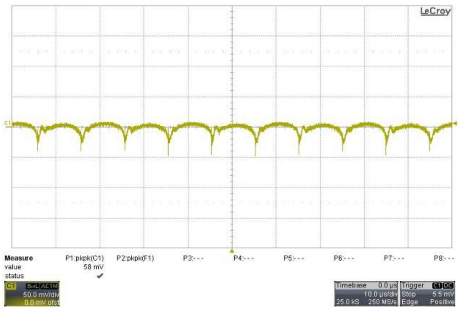
Efficiency Versus Output Current



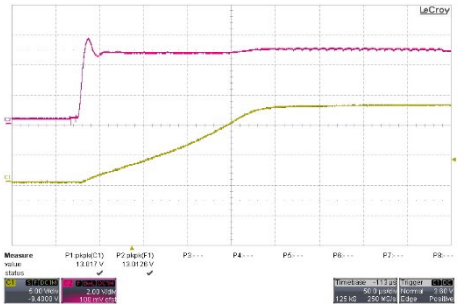
Efficiency Versus Input Voltage
Full Load



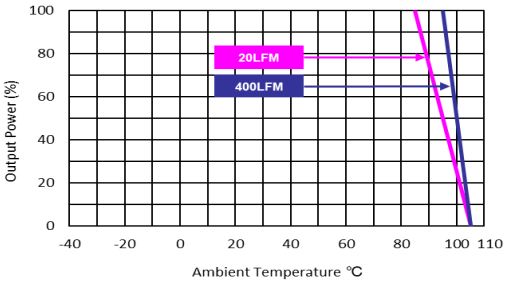
Output Voltage Versus Output Current



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



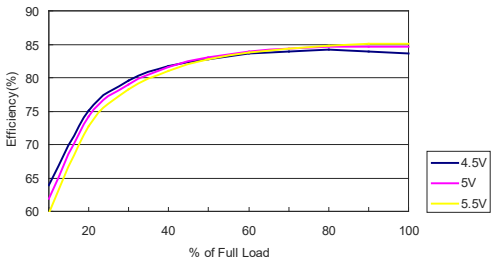
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



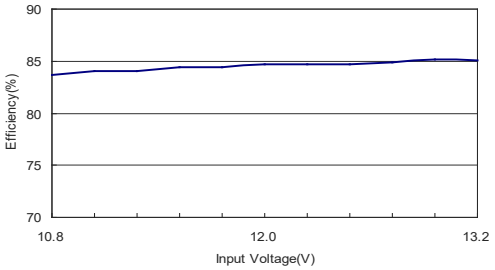
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

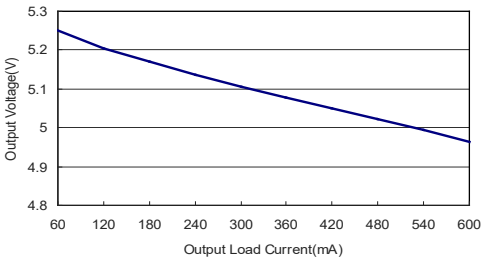
All test conditions are at 25°C The figures are identical for MA03-12S05



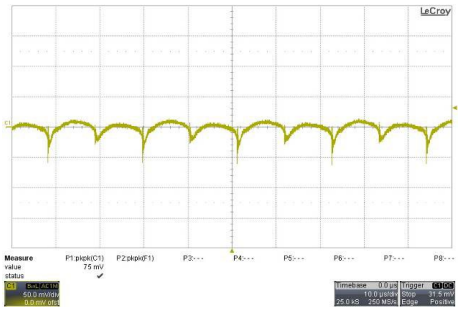
Efficiency Versus Output Current



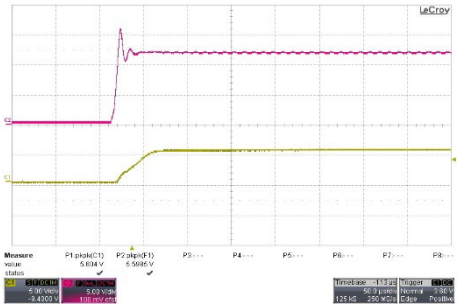
Efficiency Versus Input Voltage
Full Load



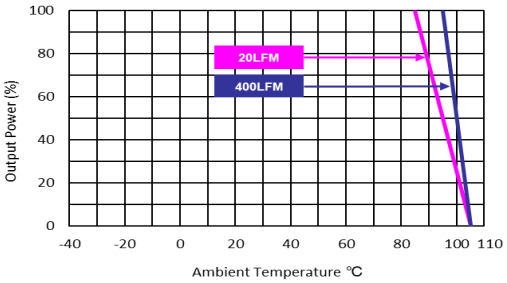
Output Voltage Versus Output Current



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



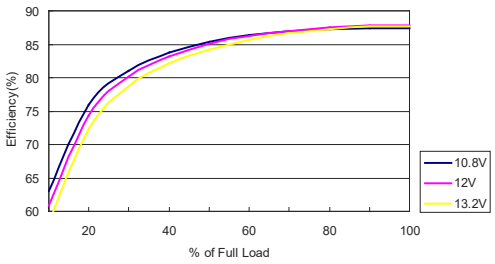
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



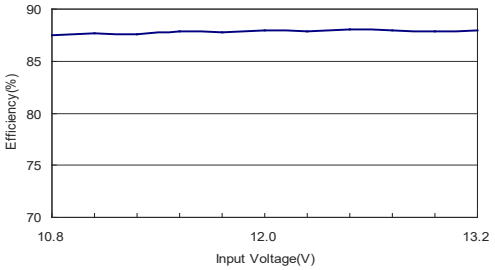
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

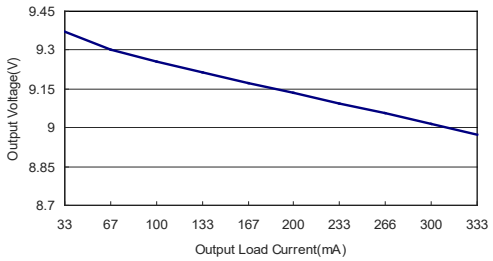
All test conditions are at 25°C The figures are identical for MA03-12S09



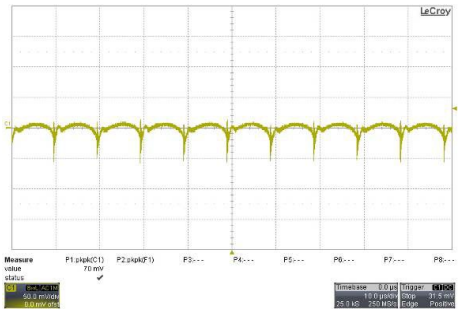
Efficiency Versus Output Current



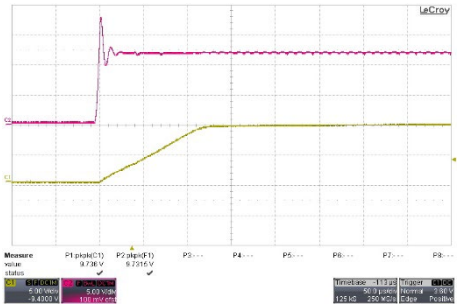
Efficiency Versus Input Voltage
Full Load



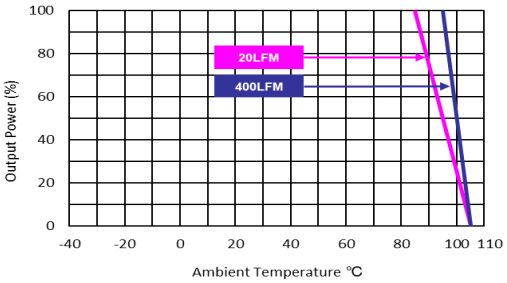
Output Voltage Versus Output Current



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



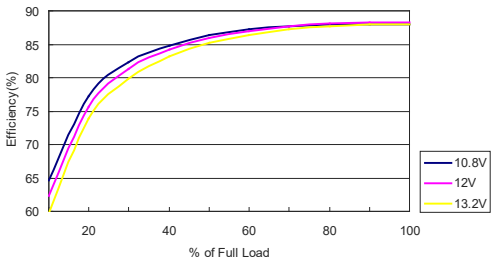
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



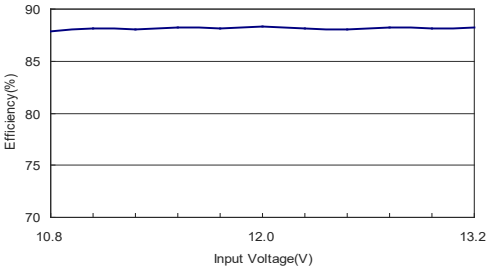
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

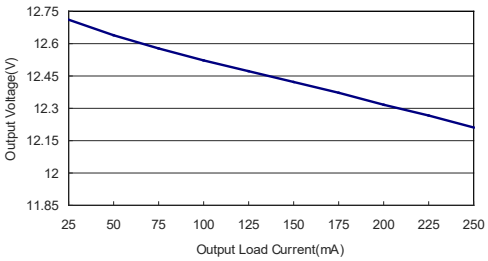
All test conditions are at 25°C The figures are identical for MA03-12S12



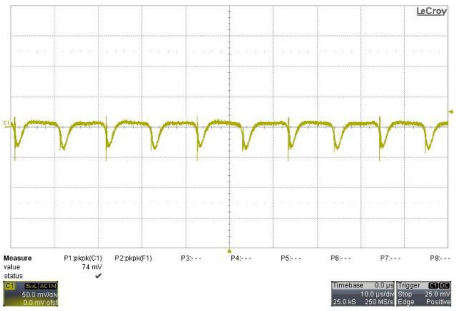
Efficiency Versus Output Current



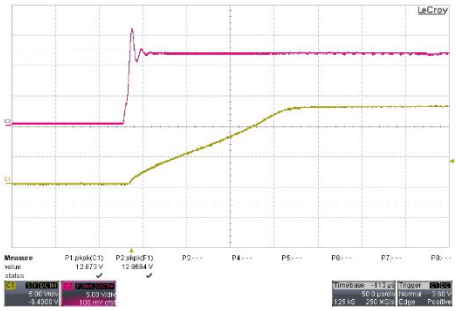
Efficiency Versus Input Voltage
Full Load



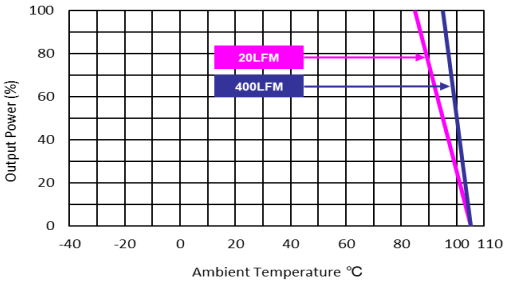
Output Voltage Versus Output Current



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



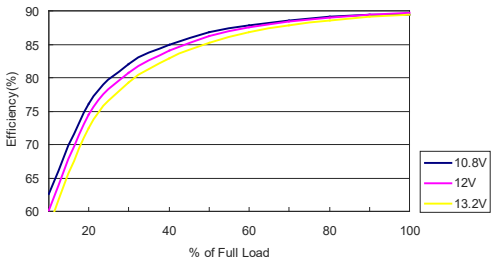
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



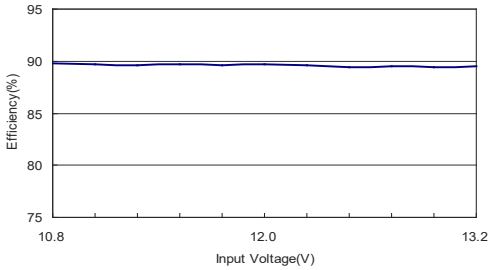
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

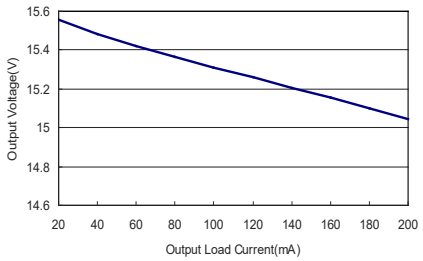
All test conditions are at 25℃ The figures are identical for MA03-12S15



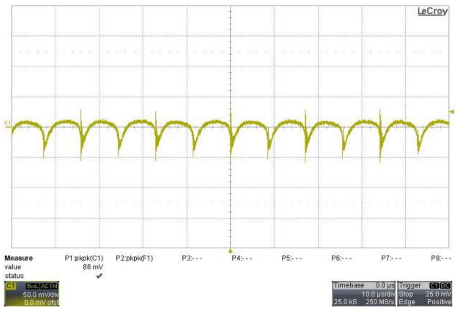
Efficiency Versus Output Current



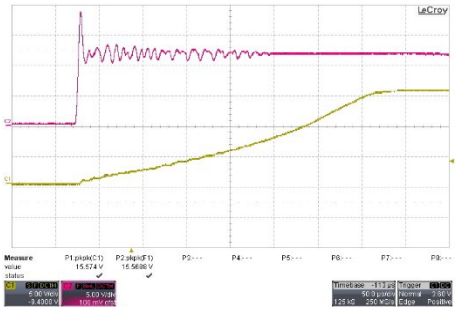
Efficiency Versus Input Voltage
Full Load



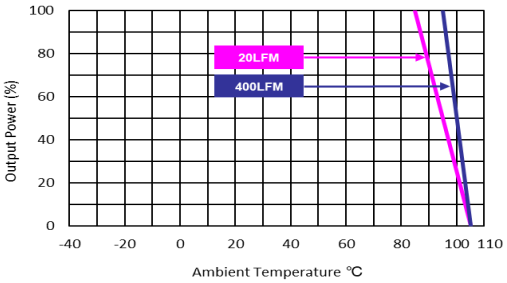
Output Voltage Versus Output Current



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



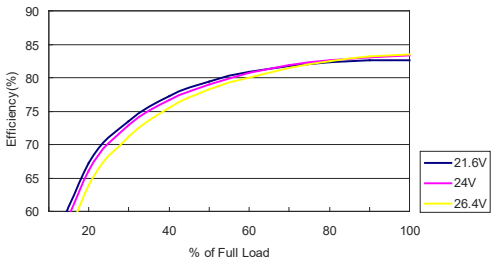
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



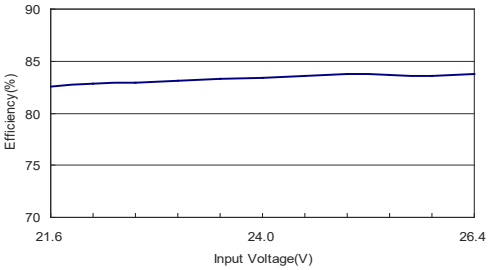
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

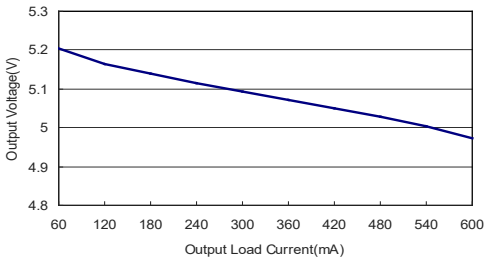
All test conditions are at 25°C The figures are identical for MA03-24S05



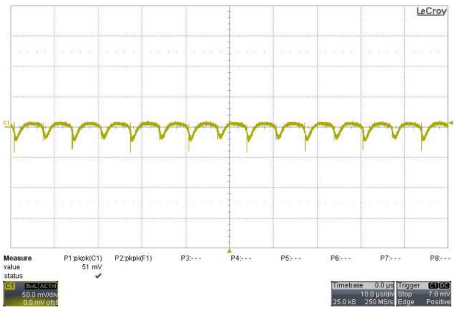
Efficiency Versus Output Current



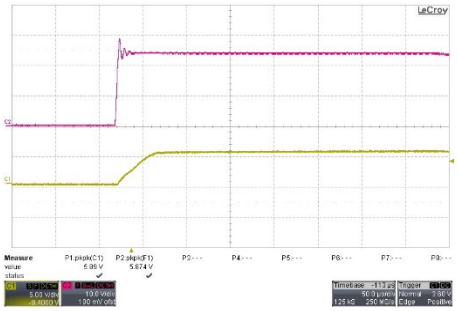
Efficiency Versus Input Voltage
Full Load



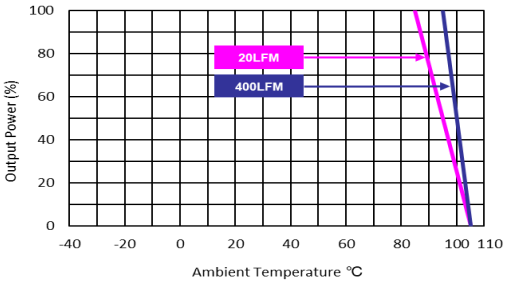
Output Voltage Versus Output Current



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



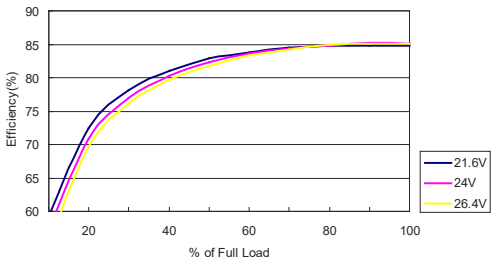
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



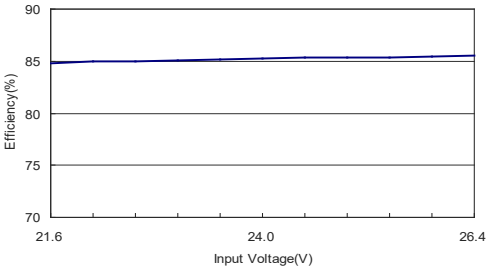
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

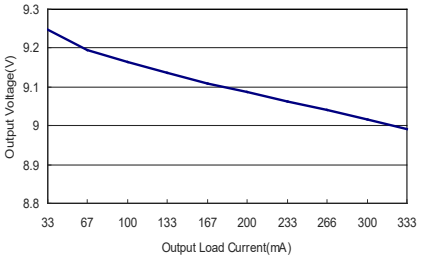
All test conditions are at 25°C The figures are identical for MA03-24S09



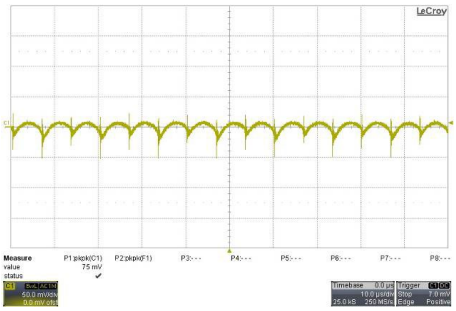
Efficiency Versus Output Current



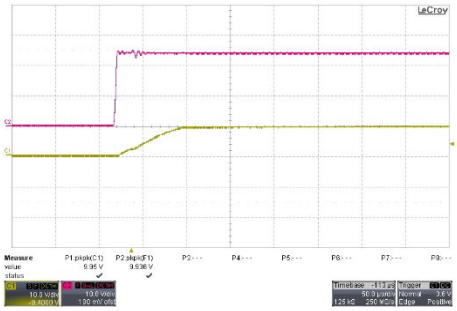
Efficiency Versus Input Voltage
Full Load



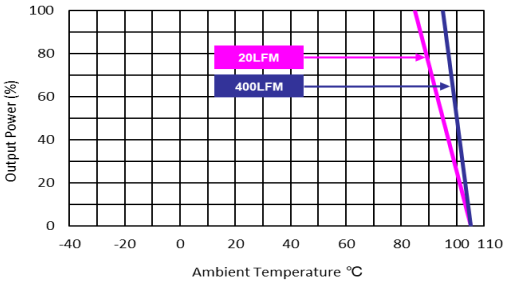
Output Voltage Versus Output Current



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



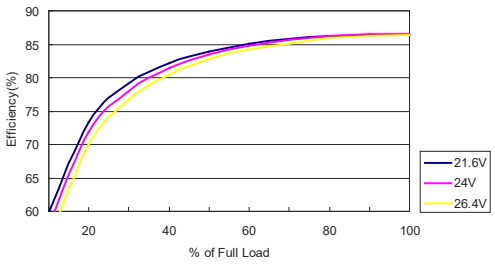
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



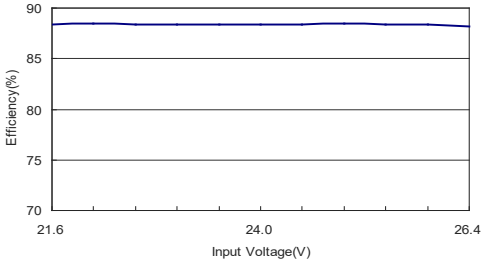
Derating Output Current Versus Ambient Temperature and Airflow
V_{in}=$V_{in\ nom}$

Characteristic Curves

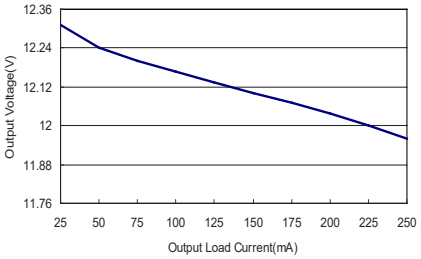
All test conditions are at 25°C The figures are identical for MA03-24S12



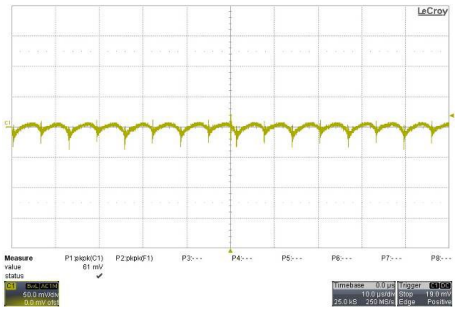
Efficiency Versus Output Current



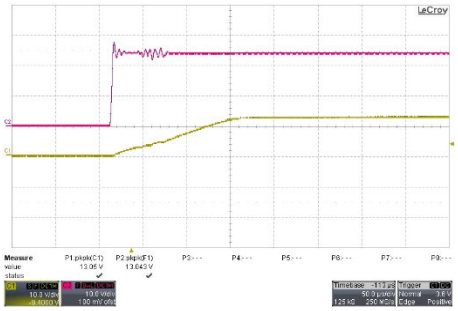
Efficiency Versus Input Voltage
Full Load



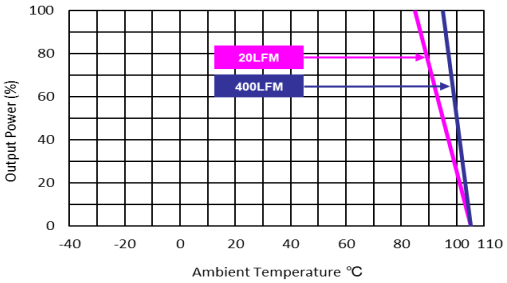
Output Voltage Versus Output Current



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



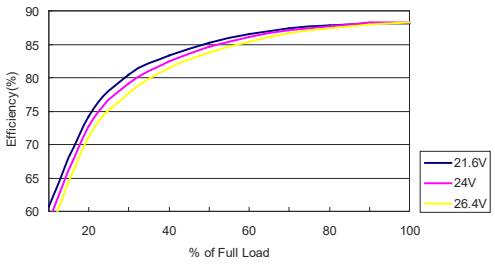
Typical Input Start-Up and Output Rise Characteristic
$V_{in}=V_{in\ nom}$; Full Load



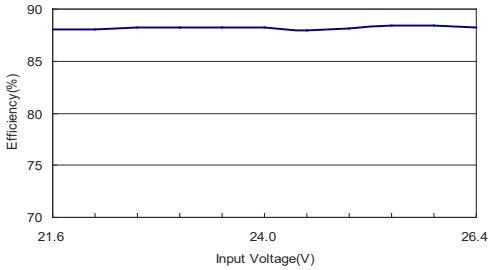
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in}=V_{in\ nom}$

Characteristic Curves

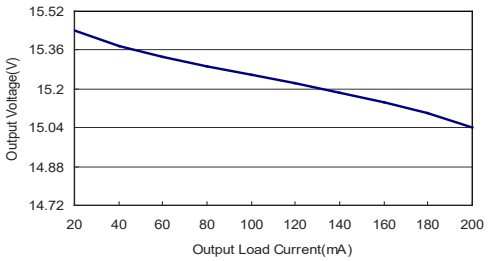
All test conditions are at 25°C The figures are identical for MA03-24S15



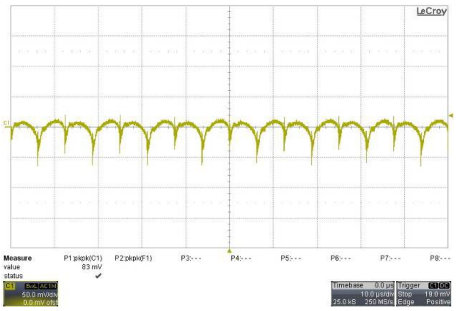
Efficiency Versus Output Current



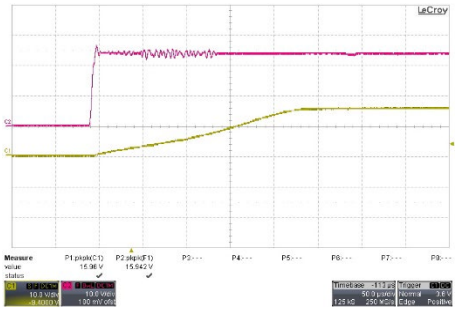
Efficiency Versus Input Voltage
Full Load



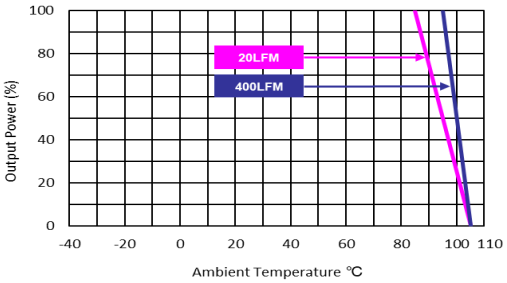
Output Voltage Versus Output Current



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



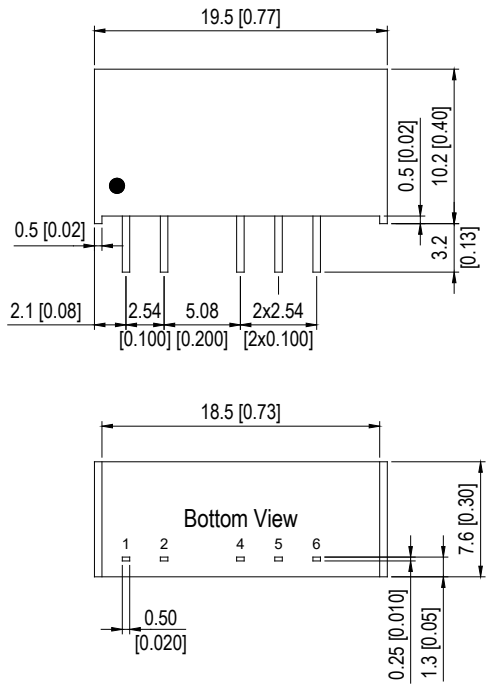
Typical Input Start-Up and Output Rise Characteristic
V_{in}=$V_{in\ nom}$; Full Load



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

Package Specifications

Mechanical Dimensions



Pin Connections

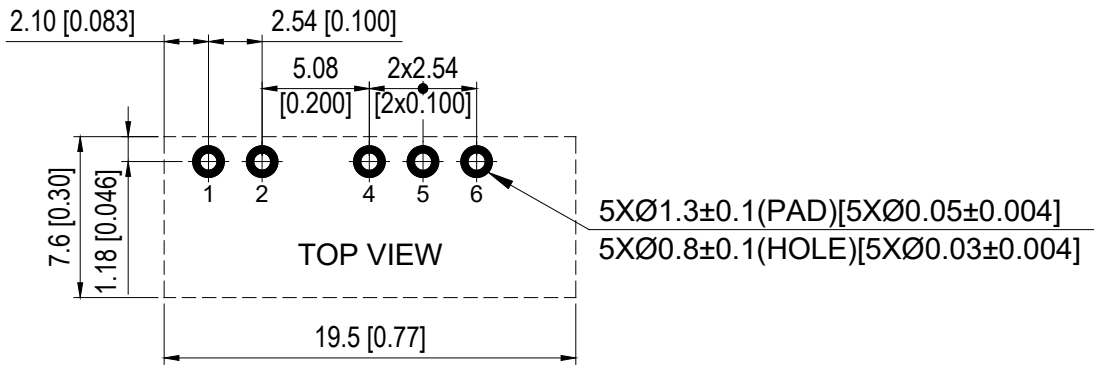
Pin	Function
1	+Vin
2	-Vin
4	-Vout
5	No Pin
6	+Vout

- 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)

Physical Characteristics

Case Size	:	19.5x7.6x10.2mm (0.77x0.30x0.40 inches)
Case Material	:	Plastic resin (flammability to UL 94V-0 rated)
Pin Material	:	Alloy 42
Weight	:	2.2g

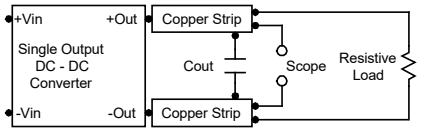
Recommended Pad Layout



Test Setup

Peak-to-Peak Output Noise Measurement Test

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



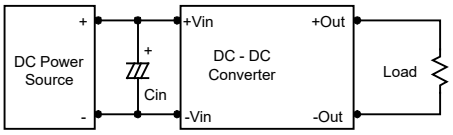
Technical Notes

Maximum Capacitive Load

The MA03 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 220µF maximum capacitive load for devices. The maximum capacitance can be found in the data sheet.

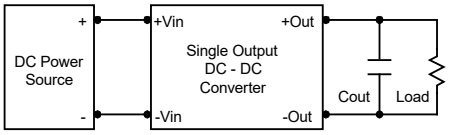
Input Source Impedance

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 < 1.0Ω 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 devices.



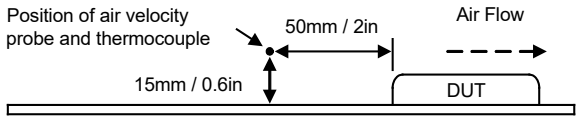
Output Ripple Reduction

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 1.0µF capacitors at the output.



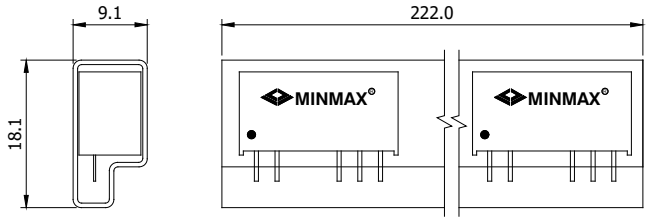
Thermal Considerations

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 100°C. The derating curves are determined from measurements obtained in a test setup.

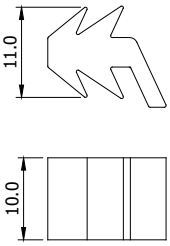


Packaging Information for Tube

Tube



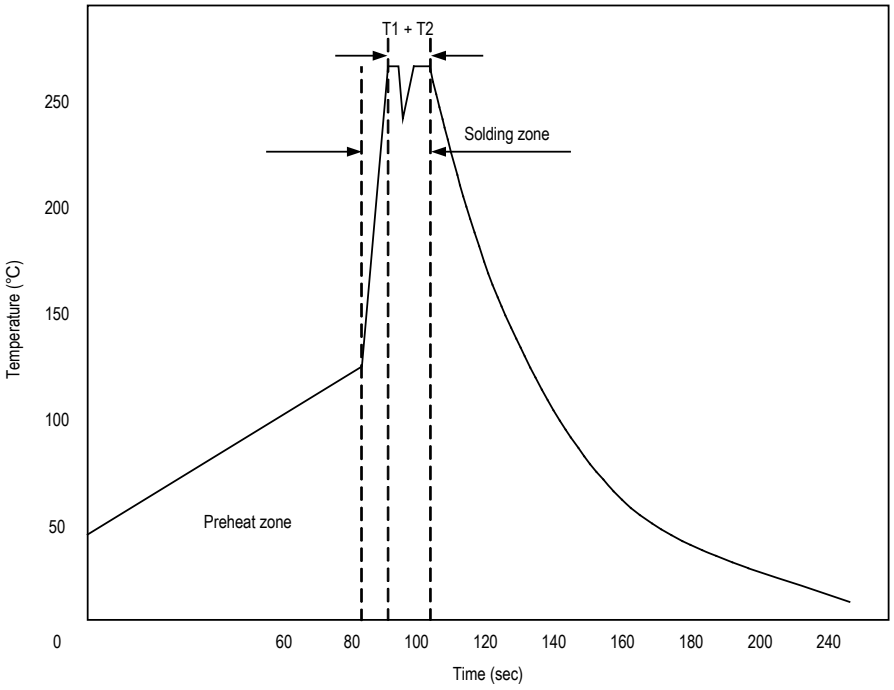
Plug



Unit: mm
10 PCS per TUBE

Wave Soldering Considerations

Lead free wave solder profile



Zone	Reference Parameter
Preheat	Rise temp. speed：3℃/sec max.
zone	Preheat temp.：100~130℃
Actual	Peak temp.：250~260℃
heating	Peak time(T1+T2)：4~6 sec

Hand Welding Parameter

Reference Solder: Sn-Ag-Cu：Sn-Cu：Sn-Ag

Hand Welding: Soldering iron：Power 60W

Welding Time: 2~4 sec

Temp.: 380~400℃

Part Number Structure

M	A	03	-	05	S	05

Package Type
SIP-7

Output Power
3 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

Output Voltage

05:	5	VDC
09:	9	VDC
12:	12	VDC
15:	15	VDC

MTBF and Reliability

The MTBF of MA03 series of DC-DC converters has been calculated using

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

Model	MTBF	Unit
MA03-05S05	4,901,961	Hours
MA03-05S09	5,118,362	
MA03-05S12	5,629,838	
MA03-05S15	5,111,821	
MA03-12S05	4,914,005	
MA03-12S09	5,124,920	
MA03-12S12	5,124,920	
MA03-12S15	5,124,920	
MA03-24S05	4,947,434	
MA03-24S09	5,072,923	
MA03-24S12	5,056,890	
MA03-24S15	5,072,923	