



**MINMAX<sup>®</sup>**

MA01-HI Series

Electric Characteristic Note

# MA01-HI Series EC Note

DC-DC CONVERTER 1W, High Isolation, SIP Package

## Features

- ▶ Industrial Standard SIP-7 Package
- ▶ Encapsulated 1W Converter
- ▶ Unregulated Output Voltage
- ▶ Ultra-high I/O Isolation 5200VDC
- ▶ Wide Operating Ambient Temp. Range
- ▶ Short Circuit Protection
- ▶ UL/cUL/IEC/EN 62368-1, UL/cUL 60950-1 Safety Approval



## Applications

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

## Product Overview

The MINMAX MA01-HI Series is an encapsulated 1W DC-DC converter in an industry-standard SIP-7 package, featuring ultra-high 5200 VDC I/O isolation to protect sensitive circuits and break ground loops. With unregulated outputs, built-in short-circuit protection, and a wide operating ambient temperature range, it delivers a robust, cost-effective isolated bias/signal-rail for industrial control, sensing, and communications. Compliance with UL/cUL/IEC/EN 62368-1 streamlines safety certification and speeds time-to-market.

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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.	@Max. Load				
			VDC	VDC	mA			mA(typ.)	@No Load
MA01-05S033HI	5 ±10%	3.3	303	286	35	20	1000	70	
MA01-05S05HI		5	200	286		15	470	70	
MA01-05S09HI		9	111	266		10	470	75	
MA01-05S12HI		12	84	261		10	220	77	
MA01-05S15HI		15	66	254		10	220	78	
MA01-05D05HI		±5	±100	282		15	220#	71	
MA01-05D09HI		±9	±56	269		10	220#	75	
MA01-05D12HI		±12	±42	262		10	100#	77	
MA01-05D15HI		±15	±33	254		10	100#	78	
MA01-05A1509HI		15	+33	260		10	100	76	
	-9	-55	220						
MA01-12S033HI	12 ±10%	3.3	303	117	17	20	1000	71	
MA01-12S05HI		5	200	117		15	470	71	
MA01-12S09HI		9	111	110		10	470	76	
MA01-12S12HI		12	84	108		10	220	78	
MA01-12S15HI		15	66	104		10	220	79	
MA01-12D05HI		±5	±100	116		15	220#	72	
MA01-12D09HI		±9	±56	111		10	220#	76	
MA01-12D12HI		±12	±42	108		10	100#	78	
MA01-12D15HI		±15	±33	104		10	100#	79	
MA01-12A1509HI		15	+33	107		10	100	77	
	-9	-55	220						
MA01-15S033HI	15 ±10%	3.3	303	95	16	20	1000	70	
MA01-15S05HI		5	200	95		15	470	70	
MA01-15S09HI		9	111	89		10	470	75	
MA01-15S12HI		12	84	90		10	220	75	
MA01-15S15HI		15	66	84		10	220	79	
MA01-15D05HI		±5	±100	94		15	220#	71	
MA01-15D09HI		±9	±56	90		10	220#	75	
MA01-15D12HI		±12	±42	86		10	100#	78	
MA01-15D15HI		±15	±33	84		10	100#	79	
MA01-15A1509HI		15	+33	87		10	100	76	
	-9	-55	220						
MA01-24S033HI	24 ±10%	3.3	303	60	12	20	1000	70	
MA01-24S05HI		5	200	60		15	470	70	
MA01-24S09HI		9	111	56		10	470	75	
MA01-24S12HI		12	84	53		10	220	78	
MA01-24S15HI		15	66	52		10	220	80	
MA01-24D05HI		±5	±100	59		15	220#	71	
MA01-24D09HI		±9	±56	56		10	220#	75	
MA01-24D12HI		±12	±42	55		10	100#	77	
MA01-24D15HI		±15	±33	53		10	100#	78	
MA01-24A1509HI		15	+33	55		10	100	75	
	-9	-55	220						

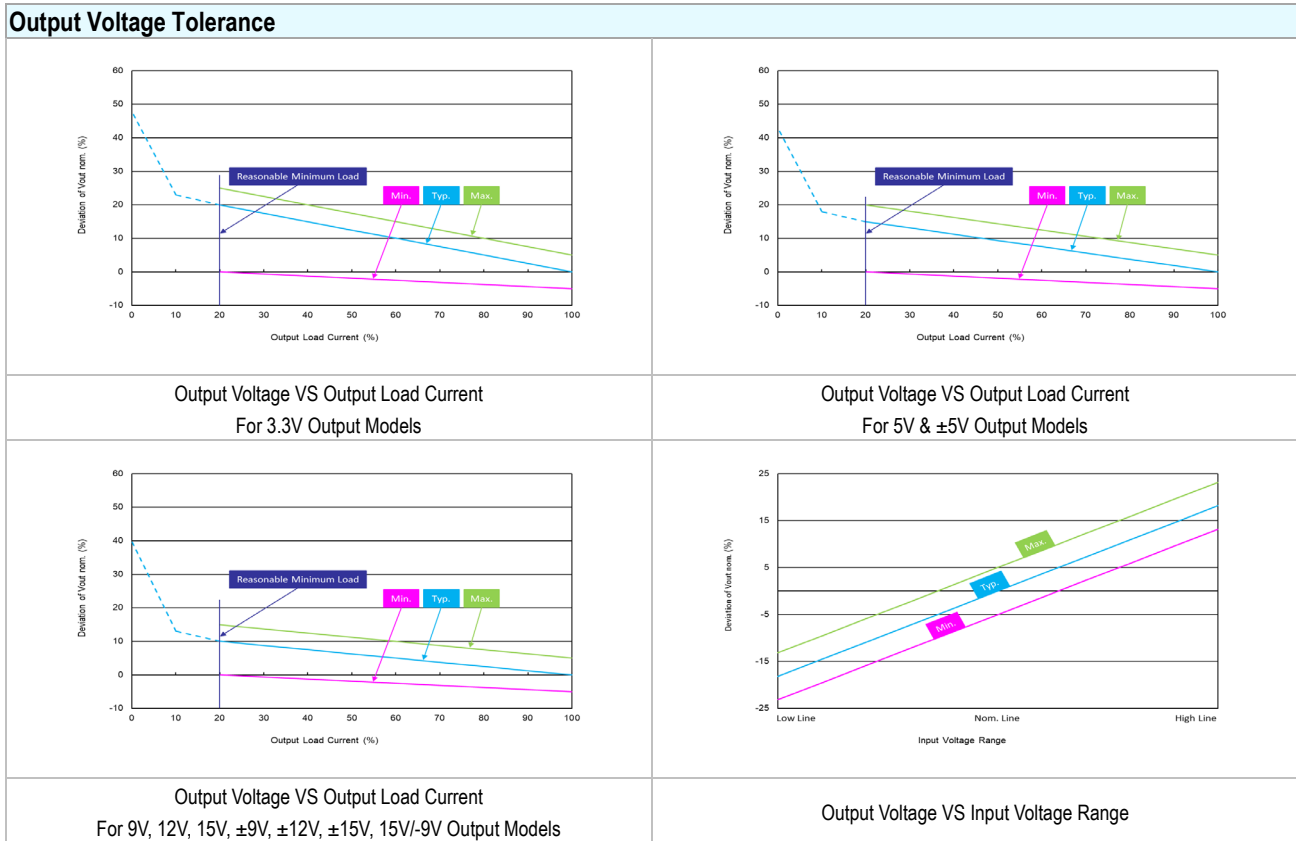
\*Please refer to the attached graph for the minimum load value.

# For each output

**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	
	15V Input Models	-0.7	---	20	
	24V Input Models	-0.7	---	30	
Input Voltage Range	5V Input Models	4.5	5	5.5	VDC
	12V Input Models	10.8	12	13.2	
	15V Input Models	13.5	15	16.5	
	24V Input Models	21.6	24	26.4	
Input Filter	All Models	Internal Capacitor			

Output Specifications						
Parameter	Conditions	Min.	Typ.	Max.	Unit	
Output Voltage Setting Accuracy		---	---	±5.0	%Vnom.	
Output Voltage Balance	Dual Output, Balanced Loads	---	±0.1	±1.0	%	
Line Regulation	For Vin Change of 1%	---	±1.2	---	%	
Load Regulation	Io=20% to 100%	See Model Selection Guide				
Ripple & Noise	0-20MHz Bandwidth	---	---	100	mV <sub>P-P</sub>	
Temperature Coefficient		---	±0.01	±0.02	%/ <sup>o</sup> C	
Short Circuit Protection	Continuous, Automatic Recovery					



General Specifications						
Parameter	Conditions	Min.	Typ.	Max.	Unit	
I/O Isolation Voltage	Rated for 60 seconds	5200	---	---	VDC	
	Tested for 1 second	5700	---	---	VDC	
I/O Isolation Resistance	500 VDC	10	---	---	GΩ	
I/O Isolation Capacitance	100kHz, 1V	---	7	---	pF	
Switching Frequency		---	100	---	kHz	
MTBF (calculated)	MIL-HDBK-217F@25°C, Ground Benign	2,004,750	---	---	Hours	
Safety Approvals	UL/cUL 60950-1 recognition (CSA certificate)					
	UL/cUL 62368-1 recognition (UL certificate), IEC/EN 62368-1 (CB-report)					

**Environmental Specifications**

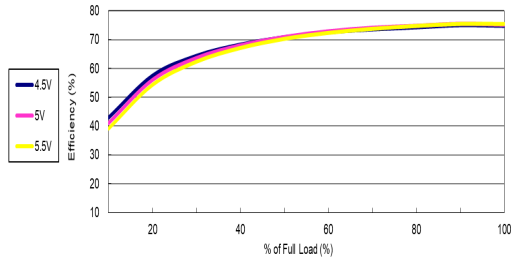
Parameter	Min.	Max.	Unit
Operating Ambient Temperature Range (For Power Derating see relative Derating Curve)	-40	+85	°C
Case Temperature	---	+100	°C
Storage Temperature Range	-55	+125	°C
Humidity (non condensing)	---	95	% rel. H
Lead Temperature (1.5mm from case for 10Sec.)	---	260	°C

**Notes**

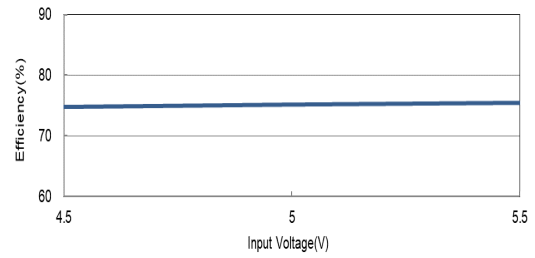
- 1 Specifications typical at Ta=+25°C, resistive load, nominal input voltage and rated output current unless otherwise noted.
- 2 Please do not operate the product without a minimum load condition.
- 3 We recommend to protect the converter by a slow blow fuse in the input supply line.
- 4 Other input and output voltage may be available, please contact factory.
- 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**

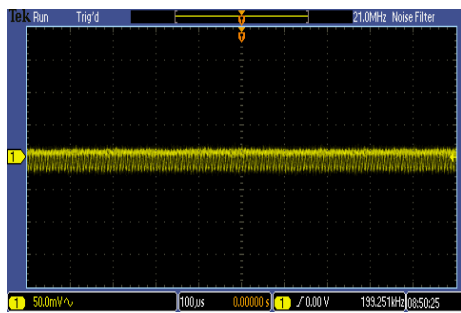
All test conditions are at 25°C The figures are identical for MA01-05S033HI



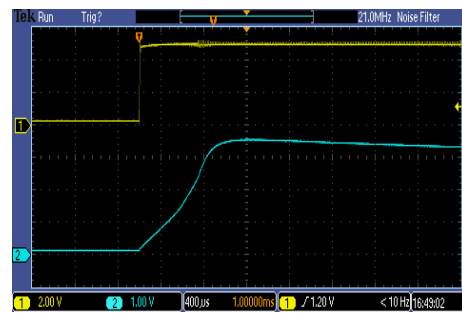
Efficiency Versus Output Current



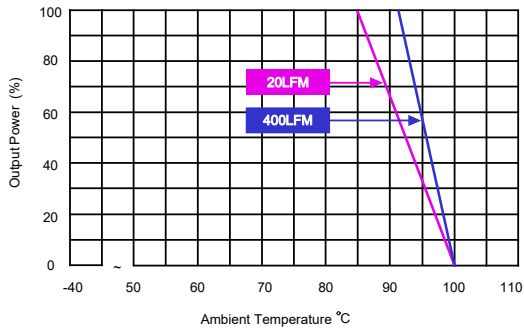
Efficiency Versus Input Voltage Full Load



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



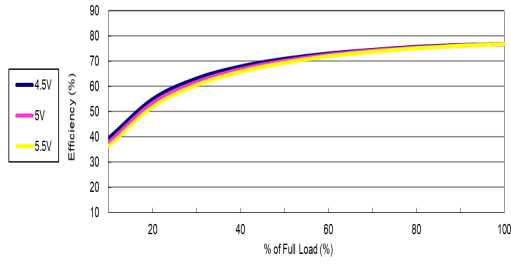
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



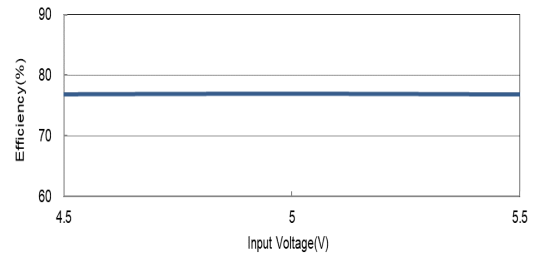
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

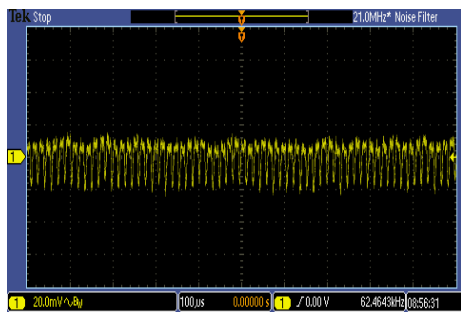
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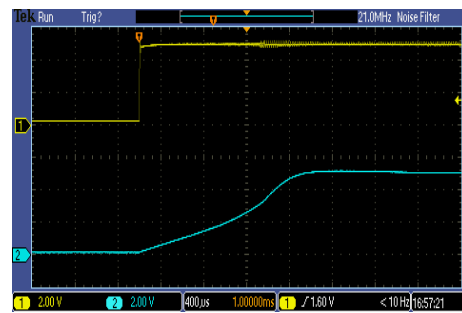
Efficiency Versus Output Current



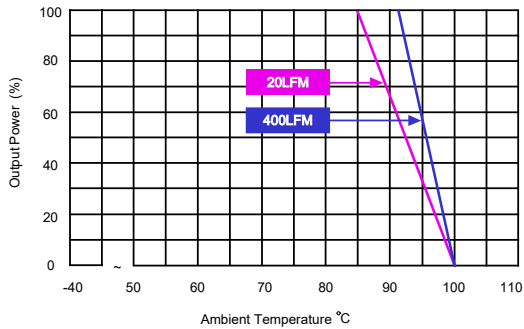
Efficiency Versus Input Voltage Full Load



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



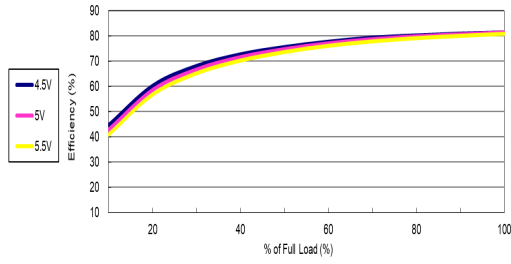
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$  ; Full Load



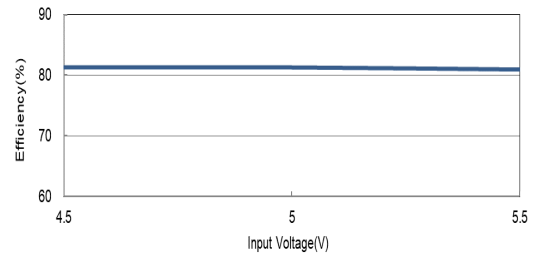
Derating Output Current Versus Ambient Temperature and Airflow  
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**Characteristic Curves**

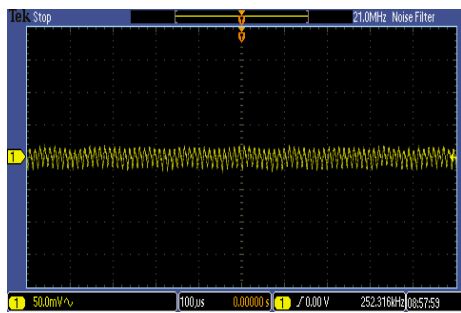
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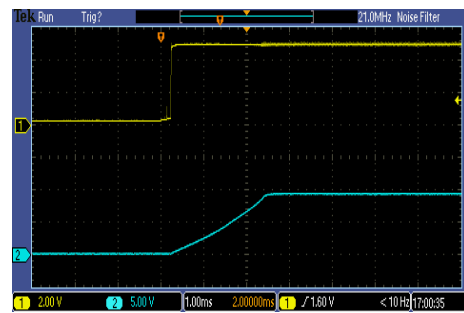
Efficiency Versus Output Current



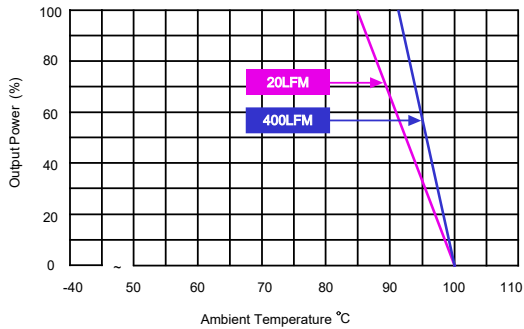
Efficiency Versus Input Voltage  
Full Load



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



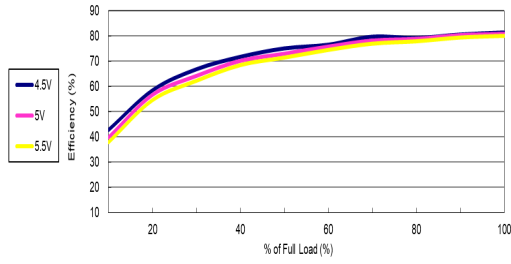
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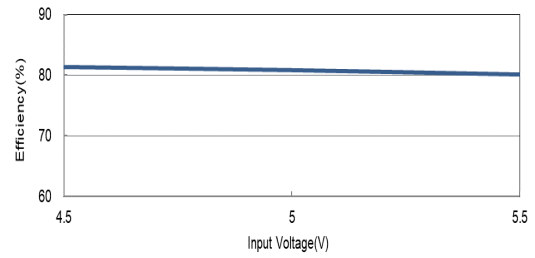
Derating Output Current Versus Ambient Temperature and Airflow  
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**Characteristic Curves**

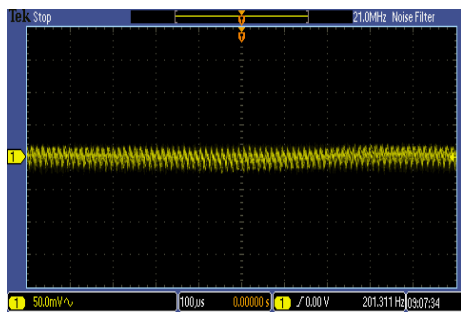
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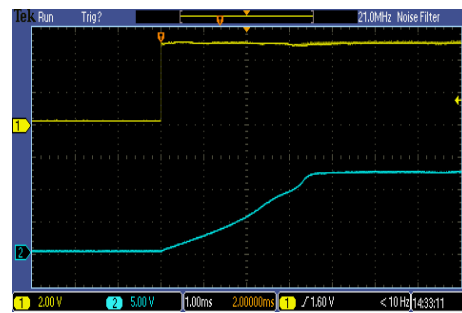
Efficiency Versus Output Current



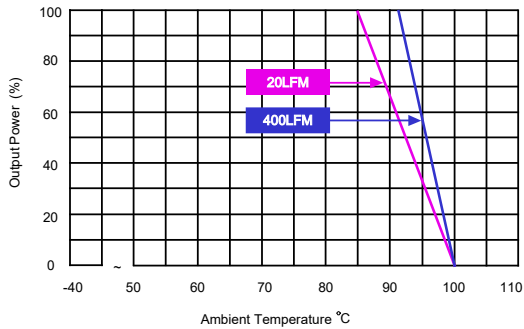
Efficiency Versus Input Voltage  
Full Load



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



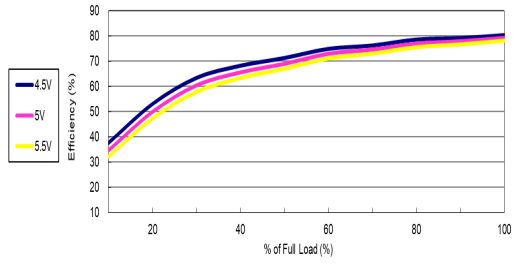
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



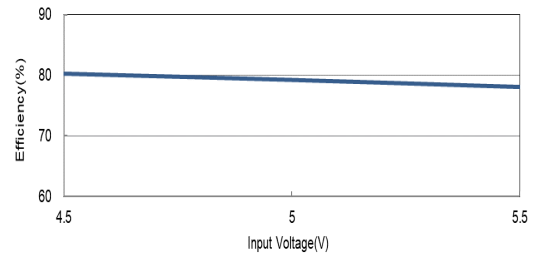
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

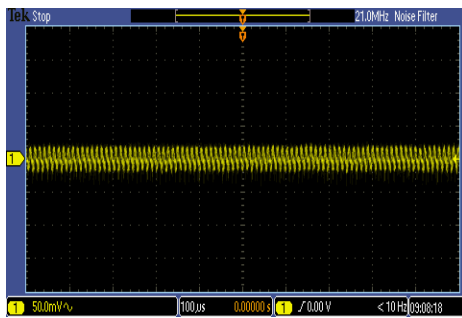
All test conditions are at 25°C The figures are identical for MA01-05S15HI



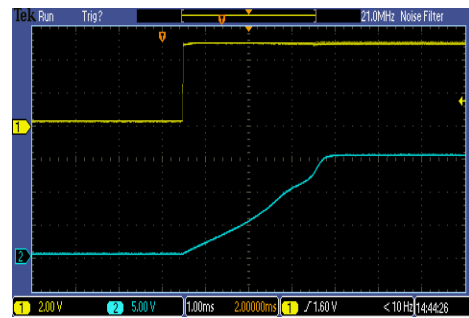
Efficiency Versus Output Current



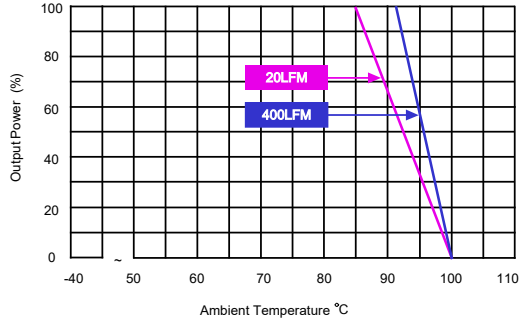
Efficiency Versus Input Voltage Full Load



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



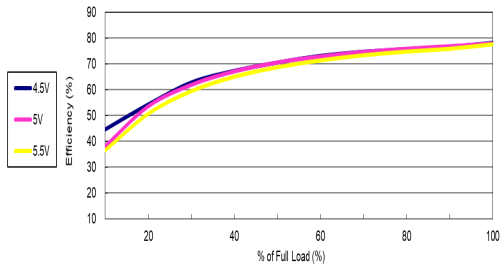
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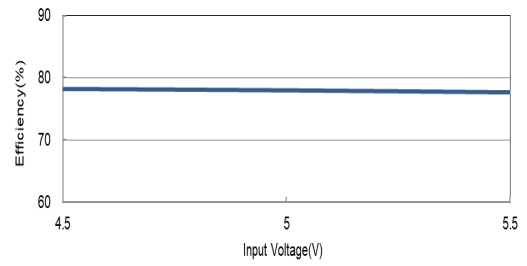
Derating Output Current Versus Ambient Temperature and Airflow  
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**Characteristic Curves**

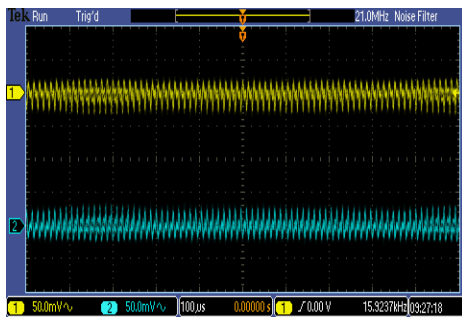
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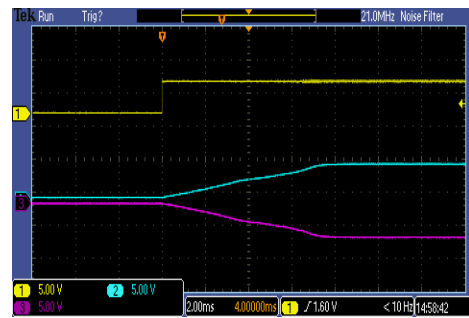
Efficiency Versus Output Current



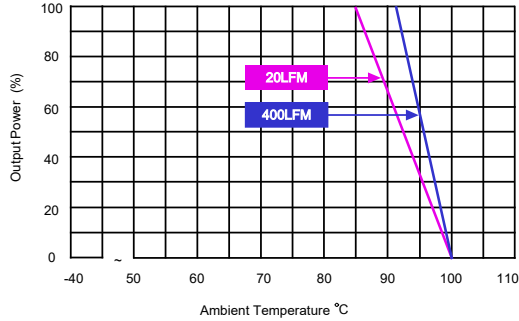
Efficiency Versus Input Voltage  
Full Load



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



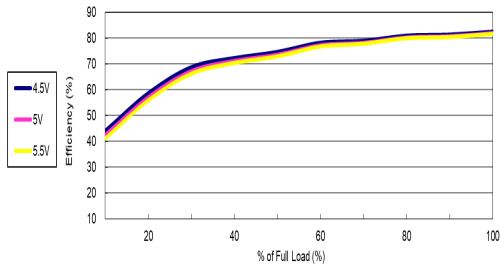
Typical Input Start-Up and Output Rise Characteristic  
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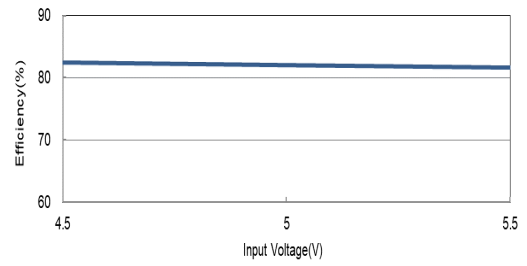
Derating Output Current Versus Ambient Temperature and Airflow  
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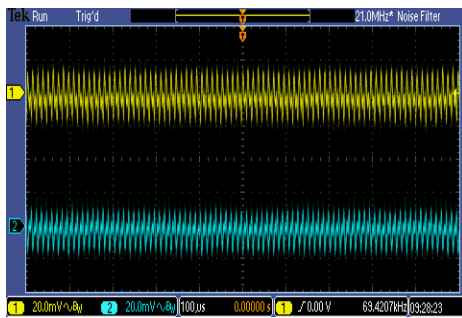
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Efficiency Versus Output Current



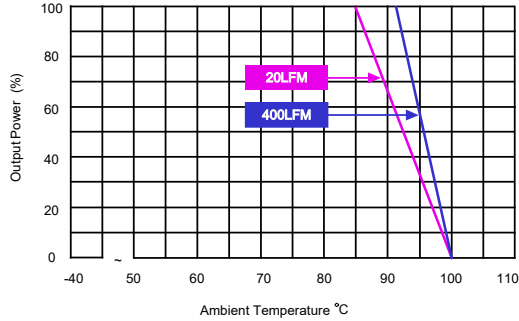
Efficiency Versus Input Voltage Full Load



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



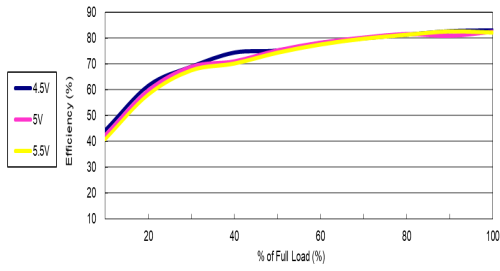
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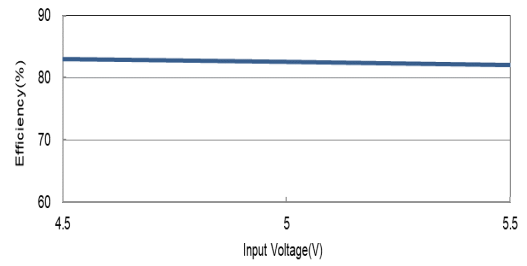
Derating Output Current Versus Ambient Temperature and Airflow  
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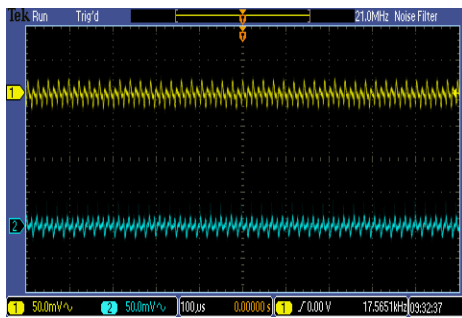
All test conditions are at 25°C The figures are identical for MA01-05D12HI



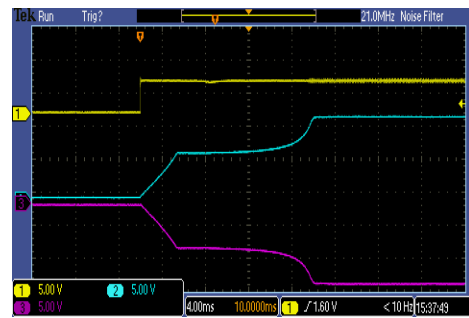
Efficiency Versus Output Current



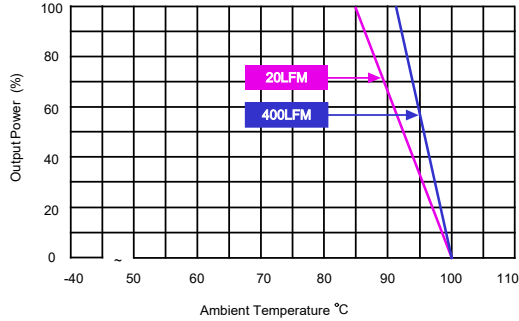
Efficiency Versus Input Voltage  
Full Load



Typical Output Ripple and Noise  
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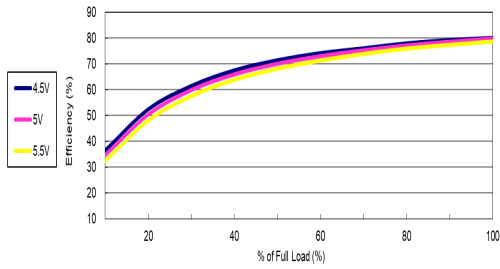
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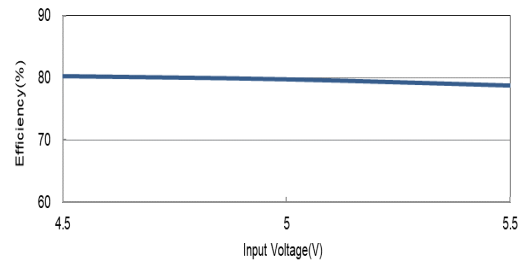
Derating Output Current Versus Ambient Temperature and Airflow  
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**Characteristic Curves**

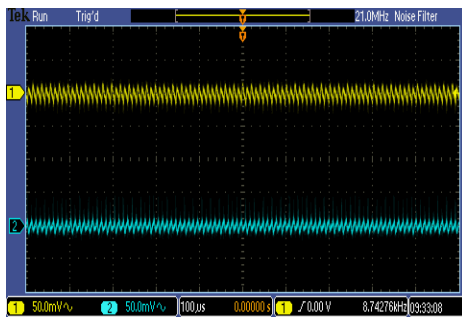
All test conditions are at 25°C The figures are identical for MA01-05D15HI



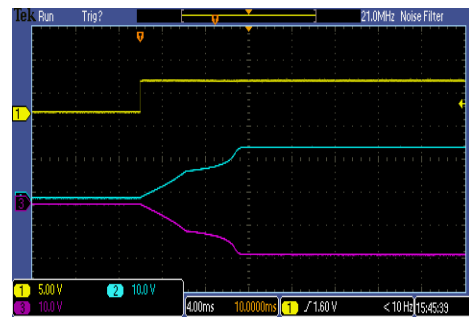
Efficiency Versus Output Current



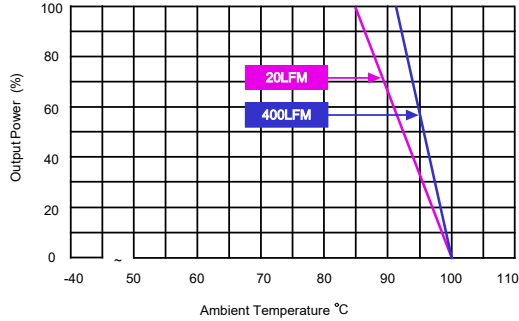
Efficiency Versus Input Voltage  
Full Load



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



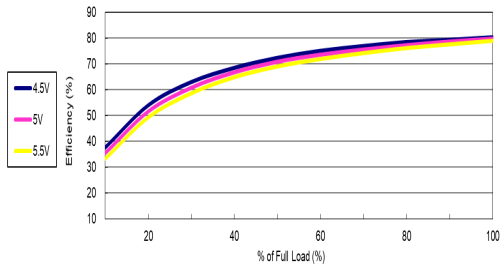
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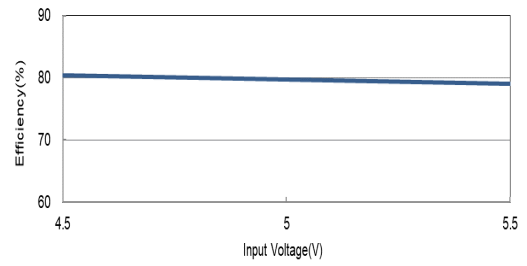
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

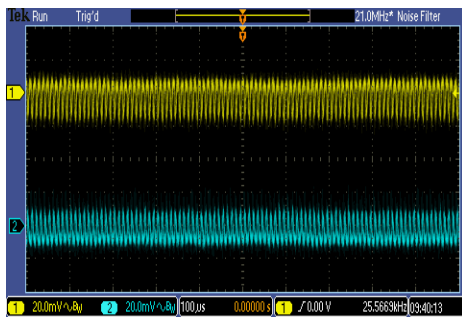
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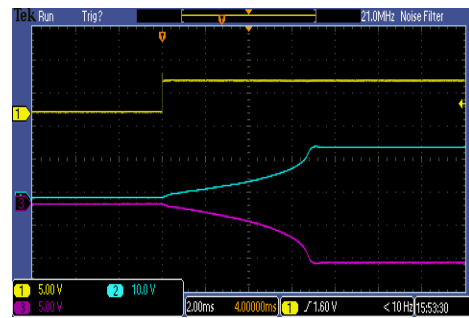
Efficiency Versus Output Current



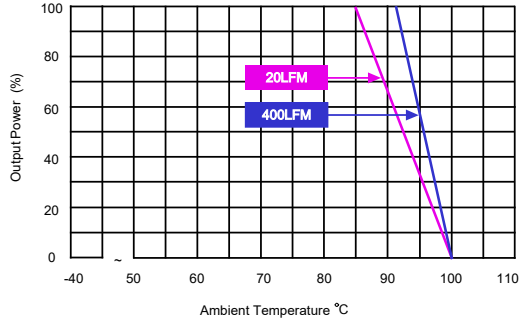
Efficiency Versus Input Voltage Full Load



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



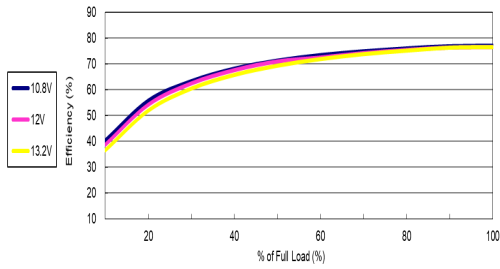
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



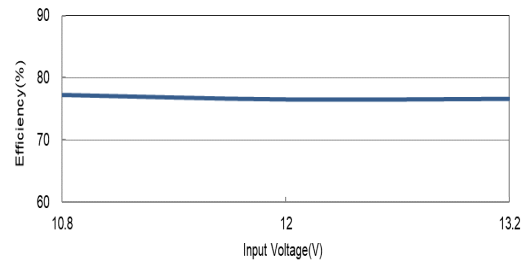
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

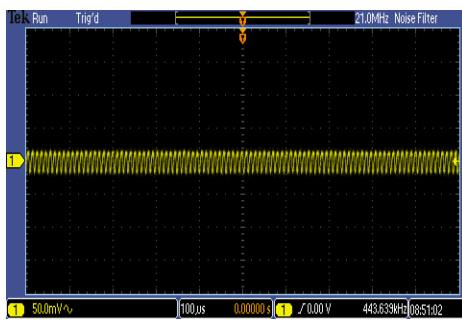
All test conditions are at 25°C The figures are identical for MA01-12S033HI



Efficiency Versus Output Current



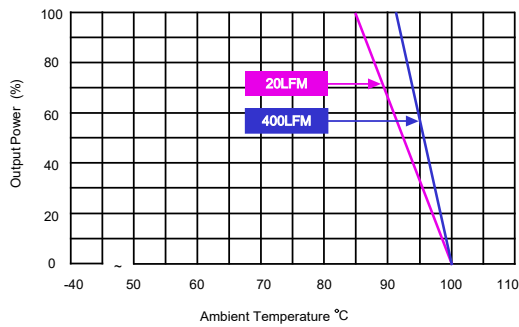
Efficiency Versus Input Voltage  
Full Load



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



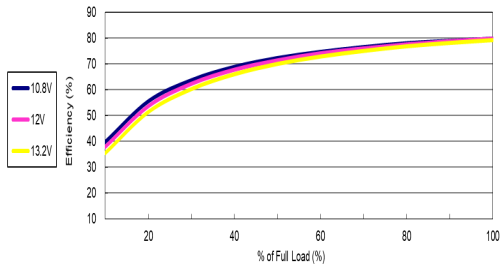
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



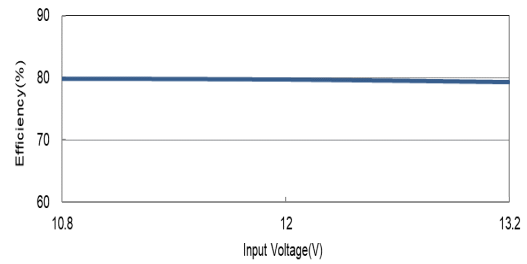
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

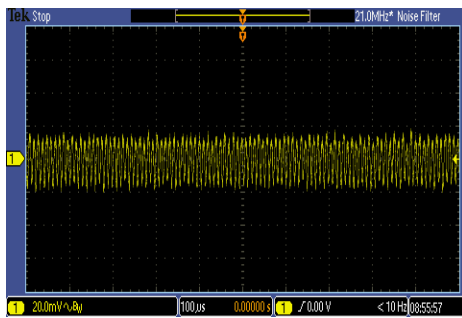
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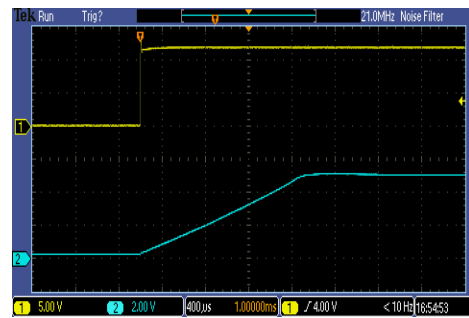
Efficiency Versus Output Current



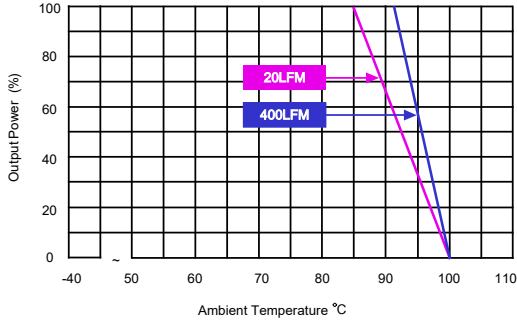
Efficiency Versus Input Voltage  
Full Load



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



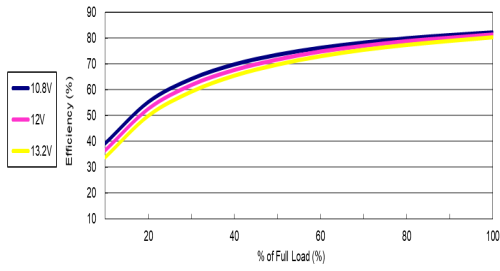
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



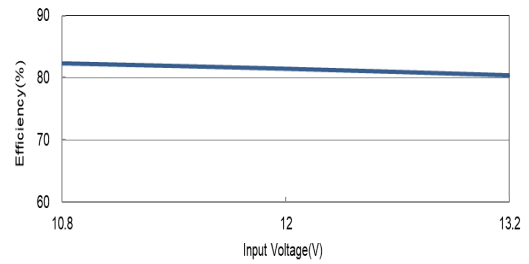
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

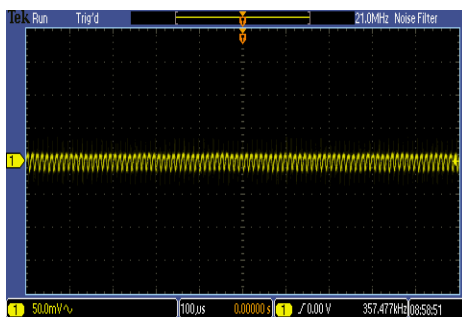
All test conditions are at 25°C The figures are identical for MA01-12S09HI



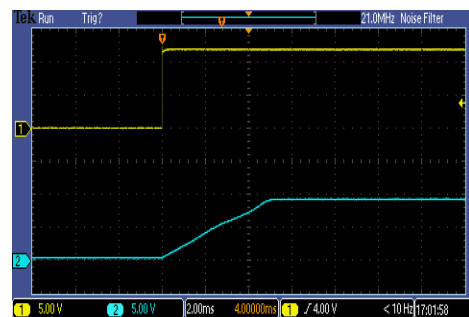
Efficiency Versus Output Current



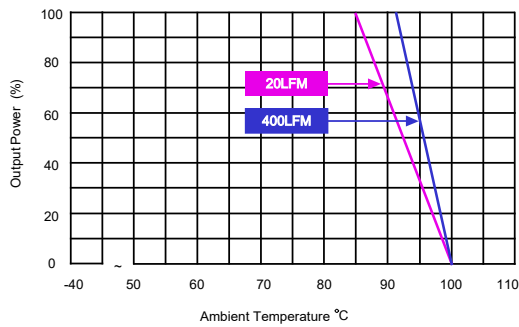
Efficiency Versus Input Voltage  
Full Load



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



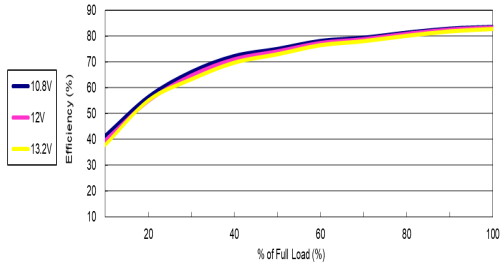
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



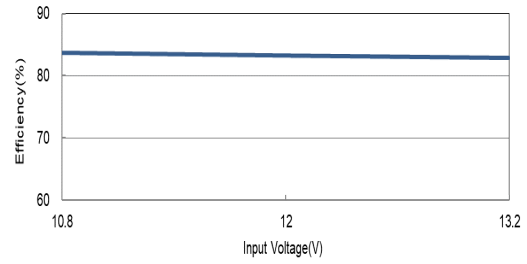
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

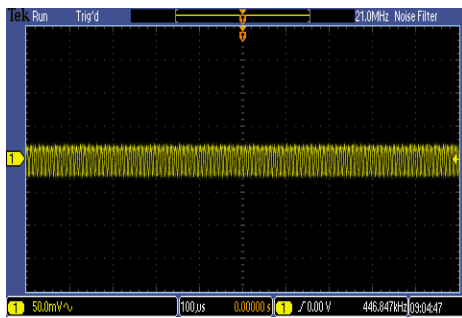
All test conditions are at 25°C The figures are identical for MA01-12S12HI



Efficiency Versus Output Current



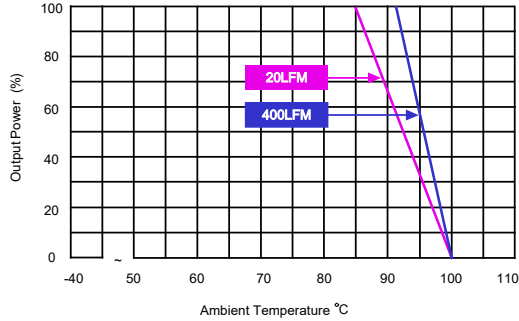
Efficiency Versus Input Voltage  
Full Load



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



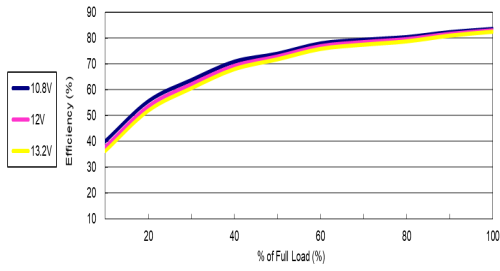
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



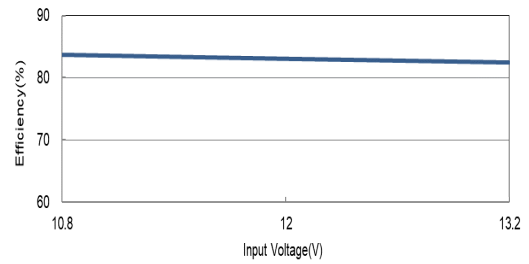
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

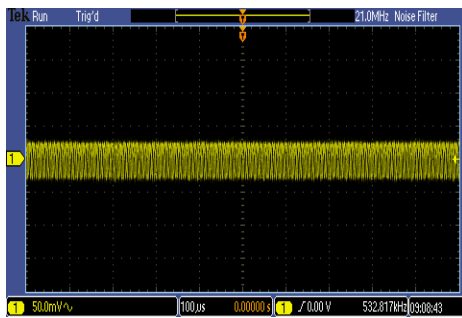
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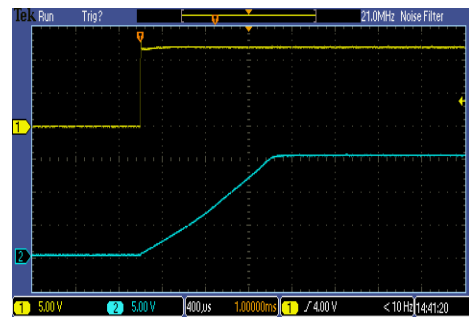
Efficiency Versus Output Current



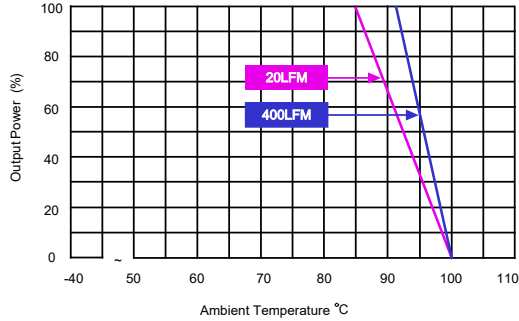
Efficiency Versus Input Voltage  
Full Load



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



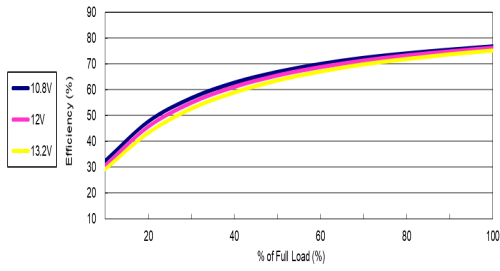
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



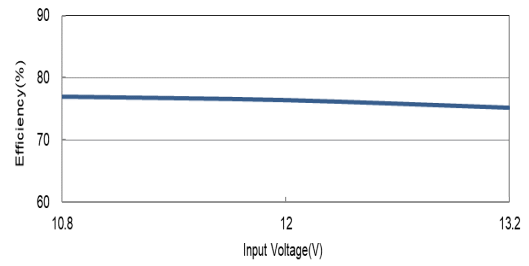
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

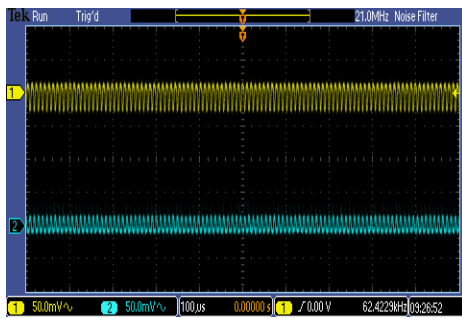
All test conditions are at 25°C The figures are identical for MA01-12D05HI



Efficiency Versus Output Current



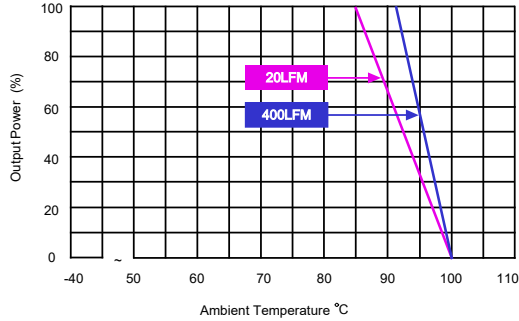
Efficiency Versus Input Voltage  
Full Load



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



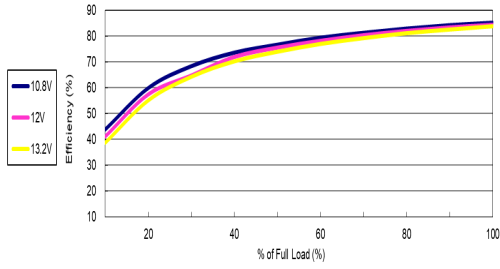
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



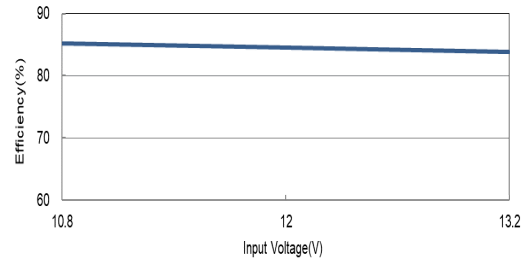
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

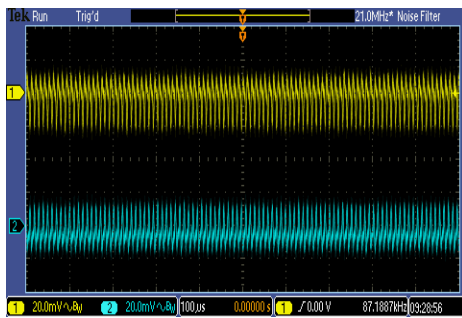
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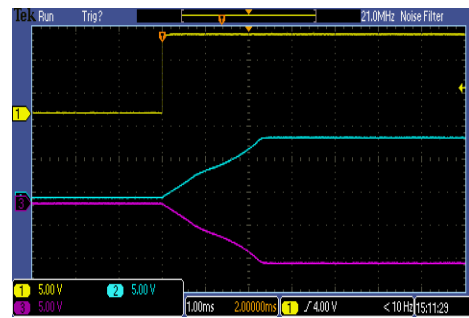
Efficiency Versus Output Current



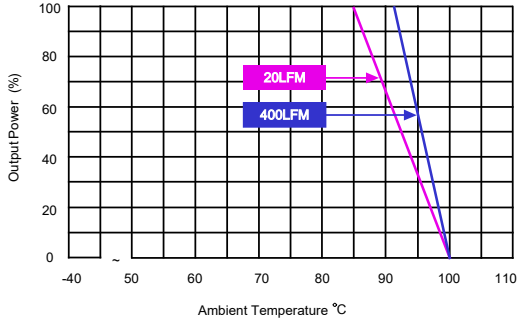
Efficiency Versus Input Voltage Full Load



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



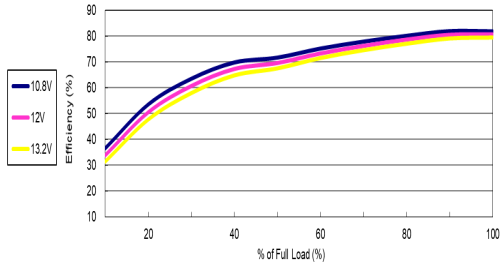
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



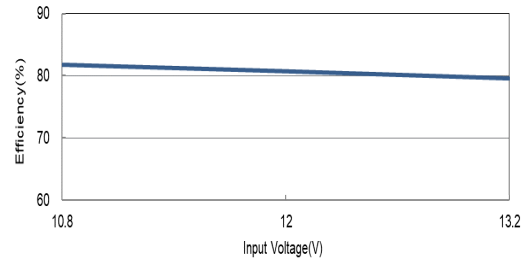
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

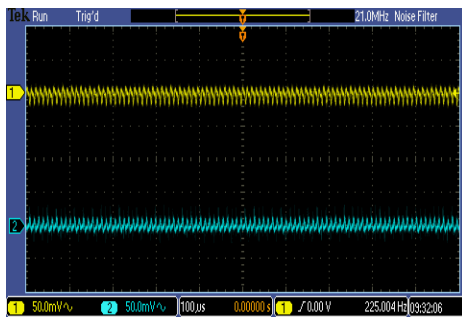
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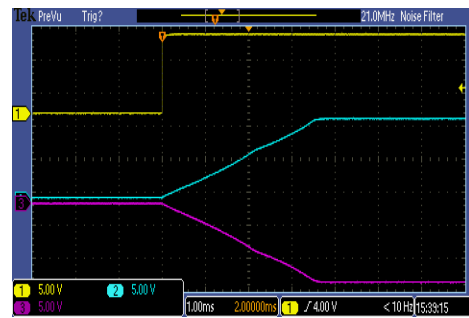
Efficiency Versus Output Current



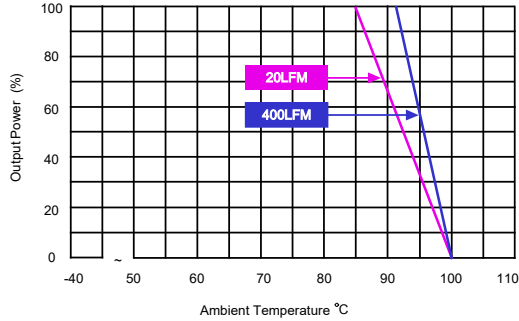
Efficiency Versus Input Voltage  
Full Load



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



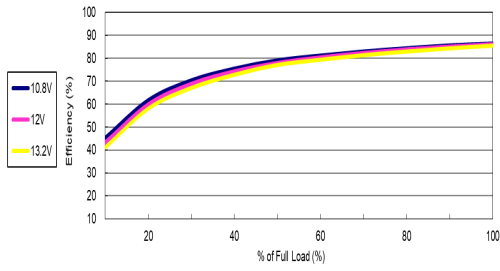
Typical Input Start-Up and Output Rise Characteristic  
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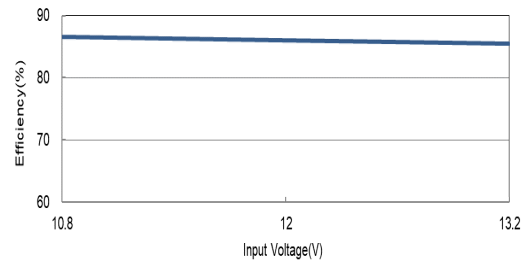
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

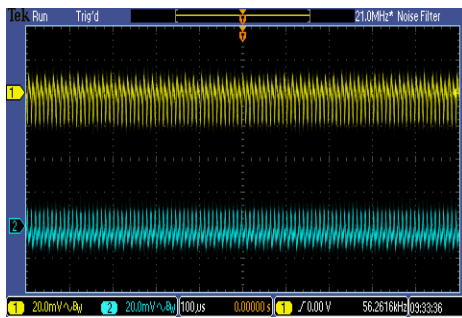
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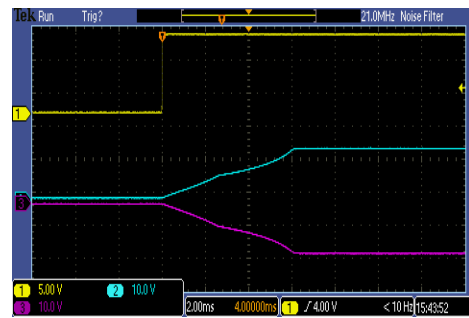
Efficiency Versus Output Current



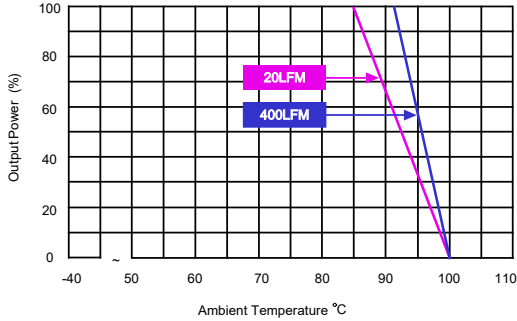
Efficiency Versus Input Voltage Full Load



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



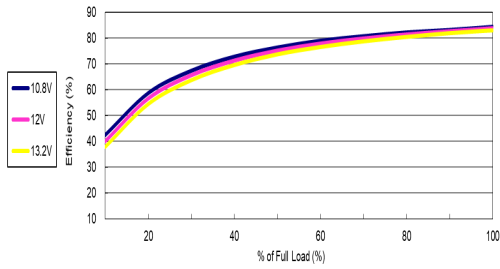
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



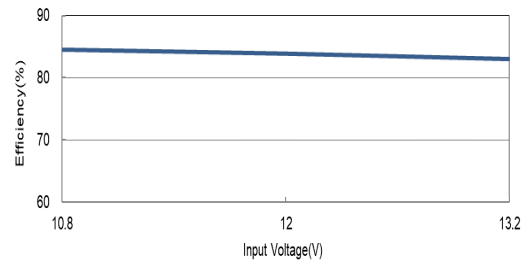
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

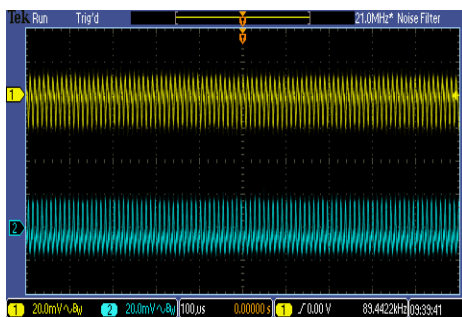
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Efficiency Versus Output Current



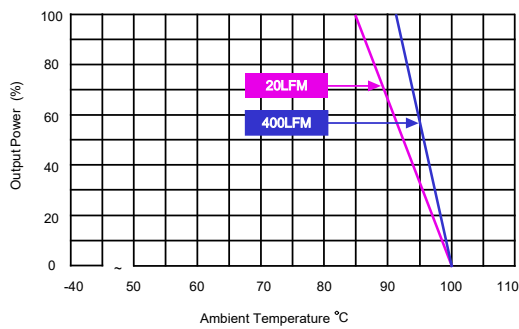
Efficiency Versus Input Voltage Full Load



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



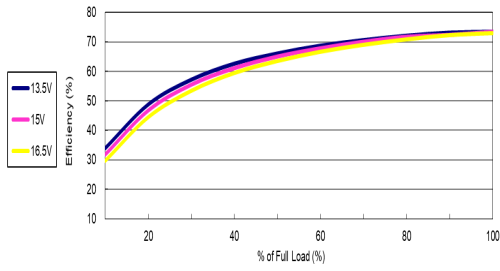
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



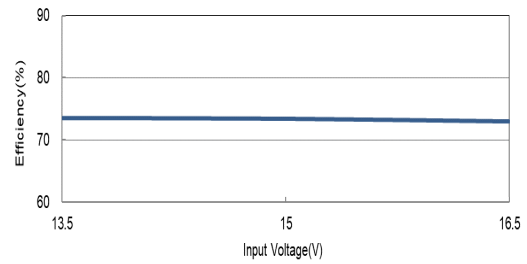
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

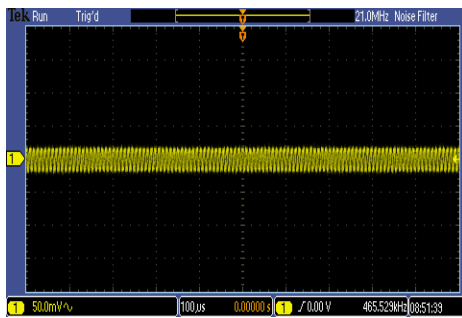
All test conditions are at 25°C The figures are identical for MA01-15S033HI



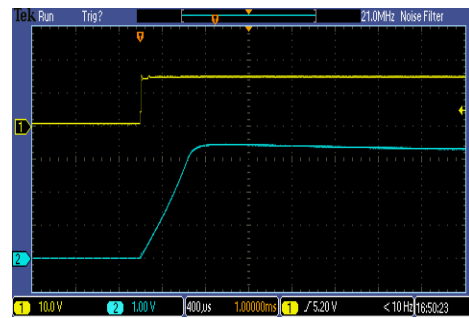
Efficiency Versus Output Current



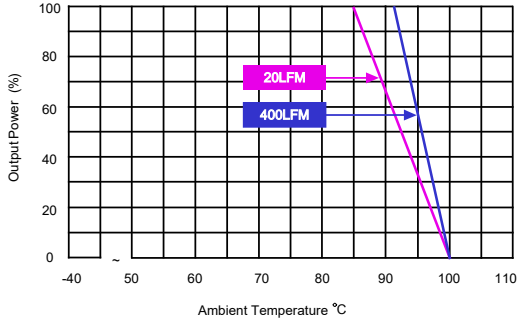
Efficiency Versus Input Voltage Full Load



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



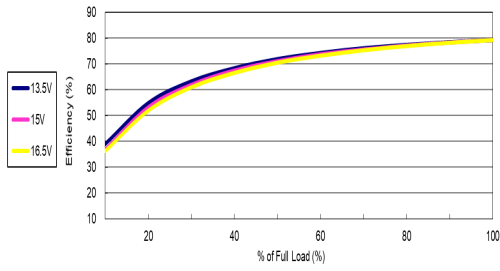
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



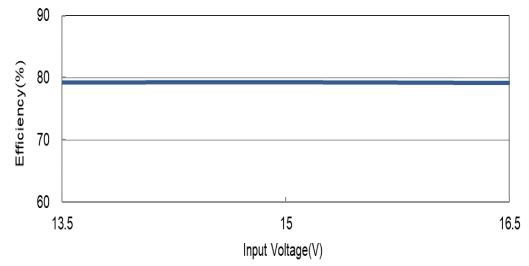
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

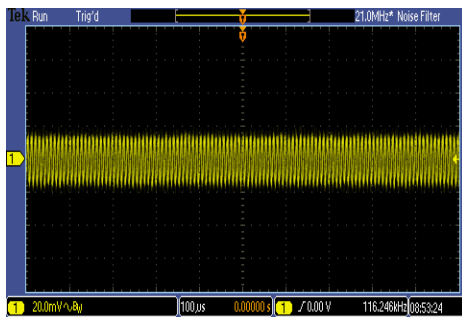
All test conditions are at 25°C The figures are identical for MA01-15S05HI



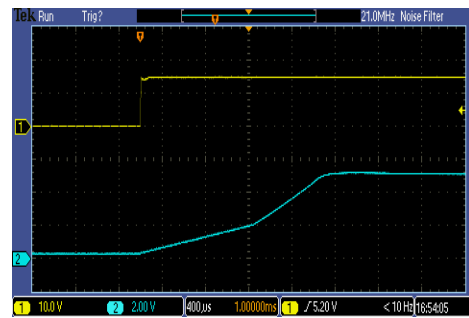
Efficiency Versus Output Current



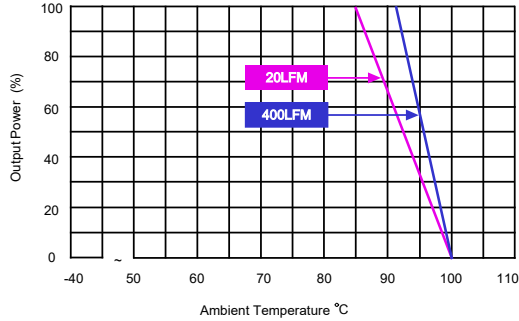
Efficiency Versus Input Voltage  
Full Load



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



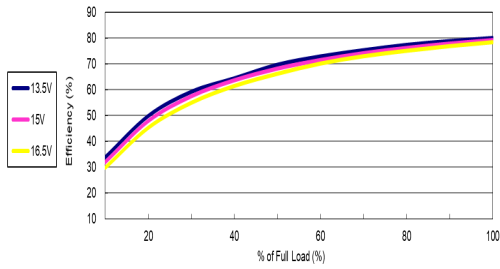
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



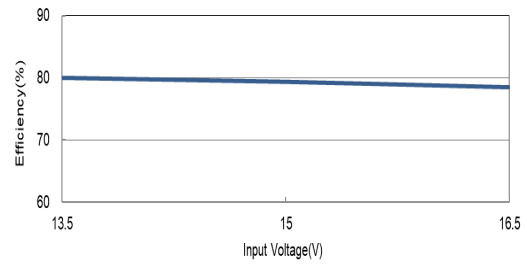
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

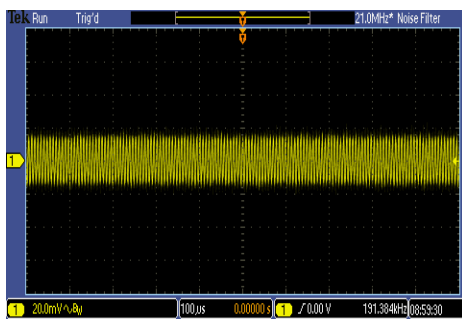
All test conditions are at 25°C The figures are identical for MA01-15S09HI



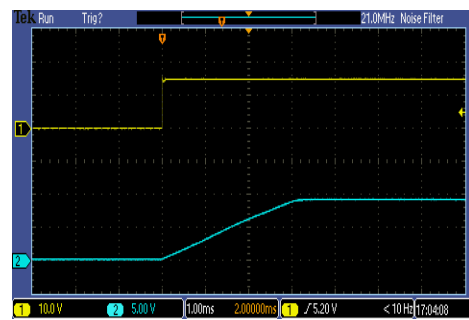
Efficiency Versus Output Current



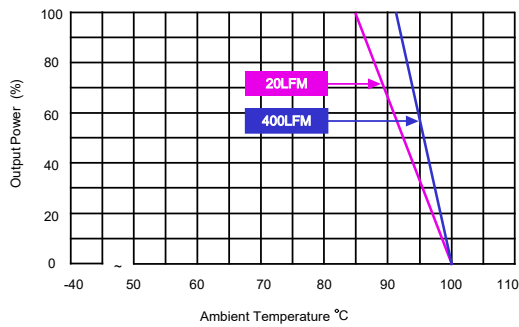
Efficiency Versus Input Voltage  
Full Load



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



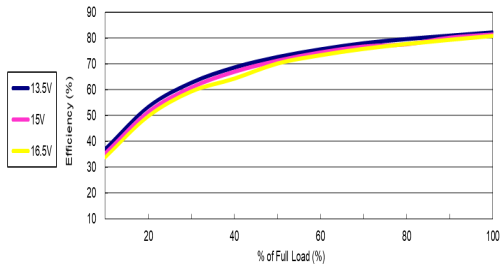
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



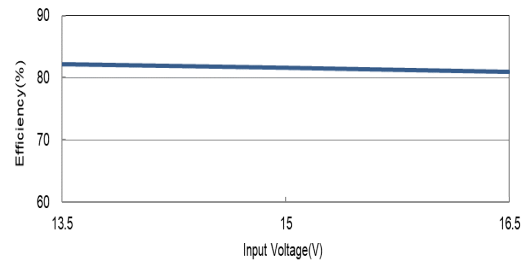
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

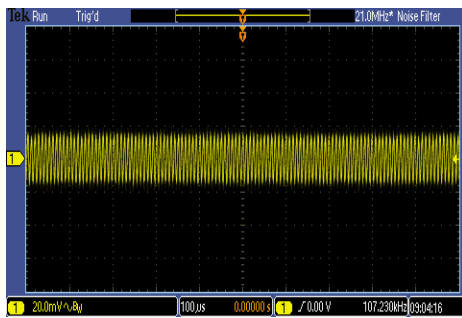
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Efficiency Versus Output Current



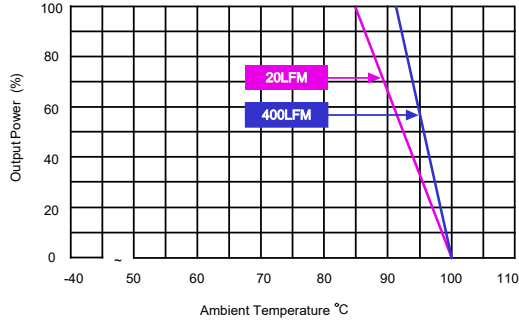
Efficiency Versus Input Voltage  
Full Load



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



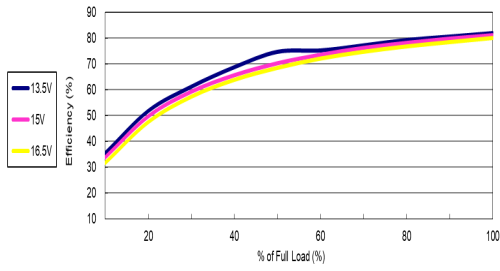
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



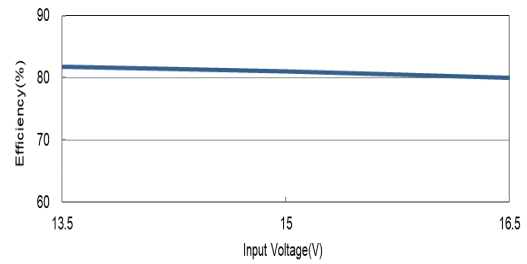
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

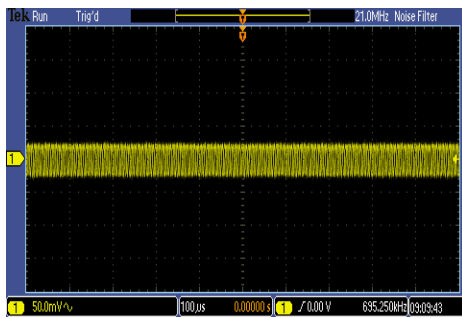
All test conditions are at 25°C The figures are identical for MA01-15S15HI



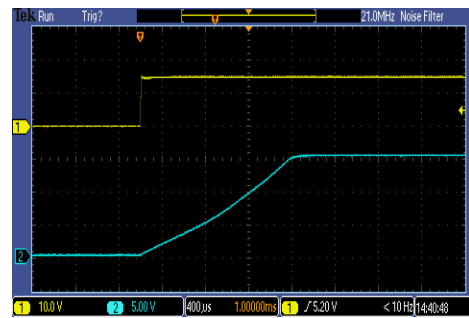
Efficiency Versus Output Current



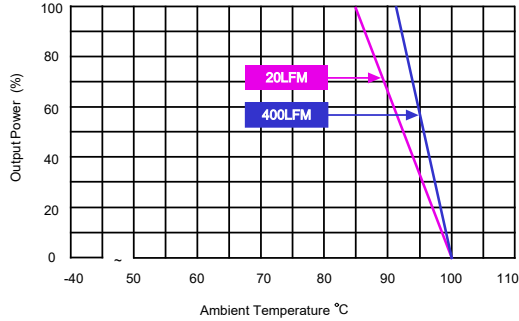
Efficiency Versus Input Voltage  
Full Load



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



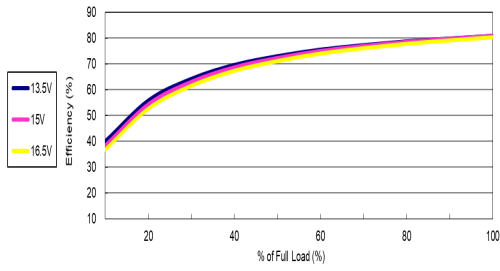
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



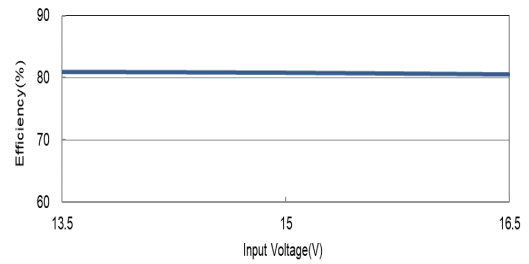
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

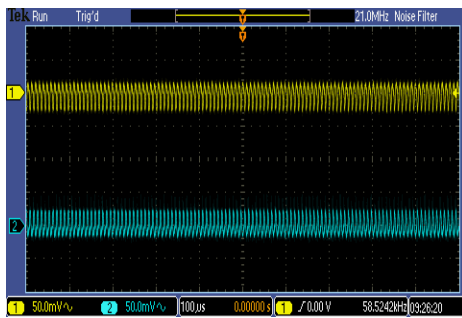
All test conditions are at 25°C The figures are identical for MA01-15D05HI



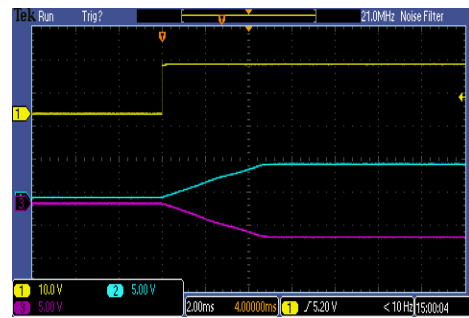
Efficiency Versus Output Current



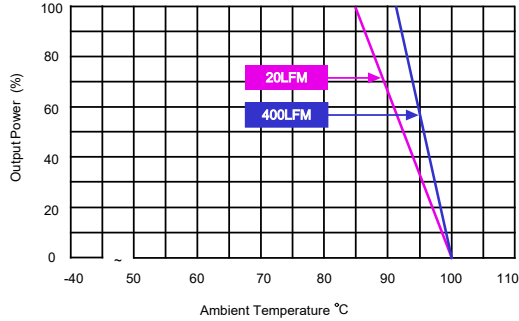
Efficiency Versus Input Voltage  
Full Load



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



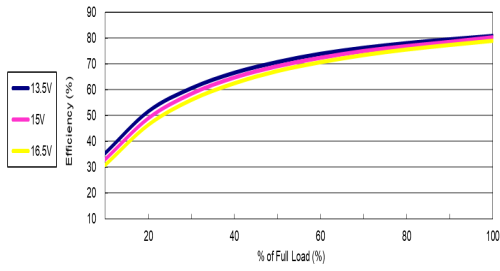
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



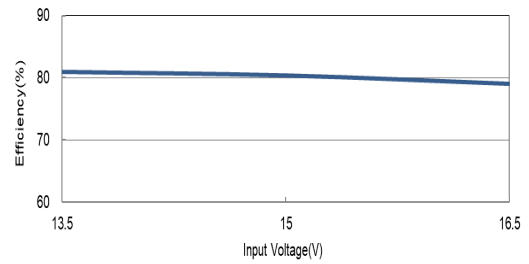
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

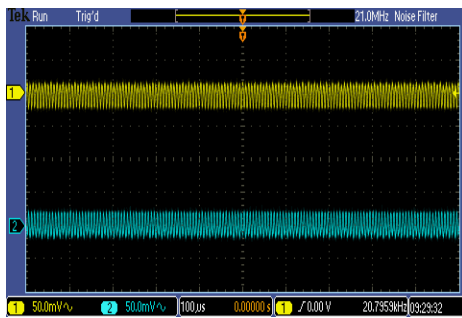
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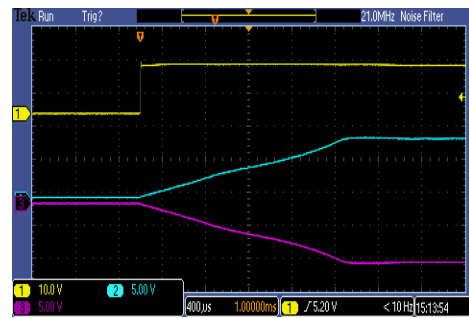
Efficiency Versus Output Current



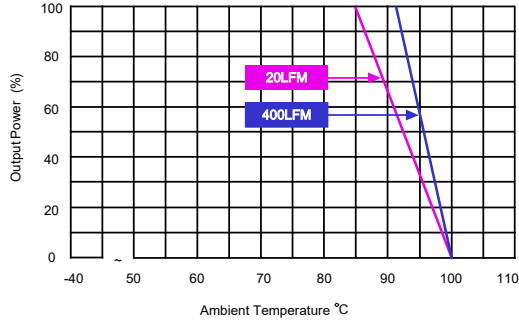
Efficiency Versus Input Voltage  
Full Load



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



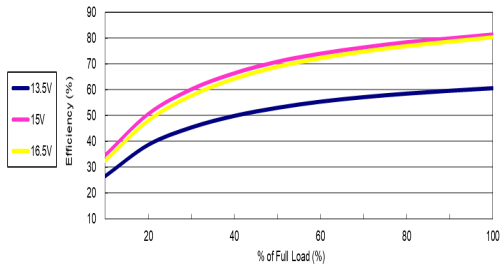
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



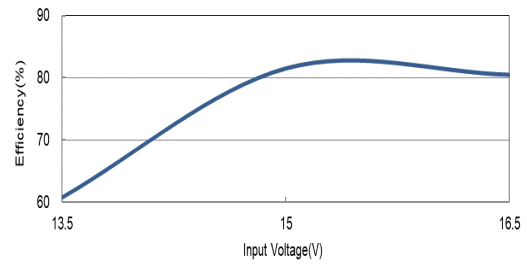
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

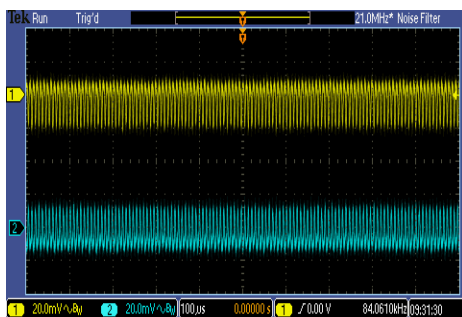
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Efficiency Versus Output Current



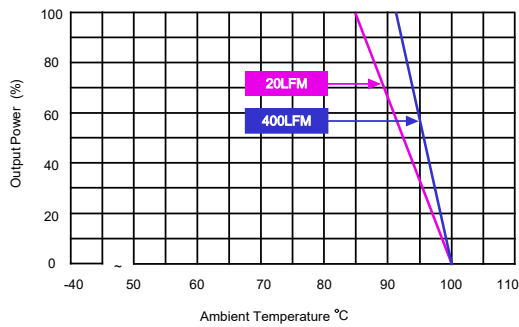
Efficiency Versus Input Voltage  
Full Load



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



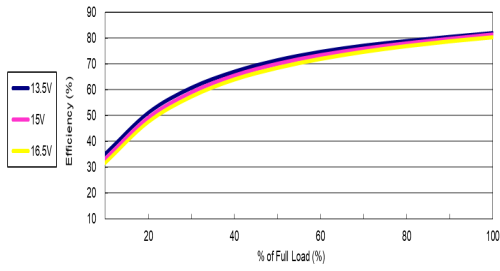
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



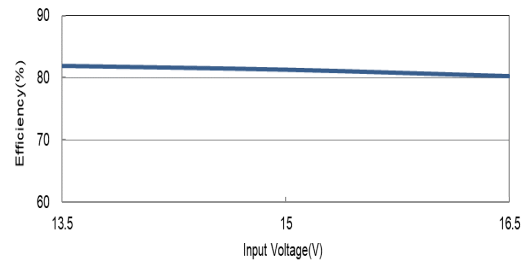
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

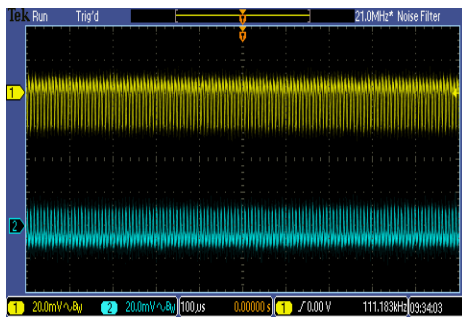
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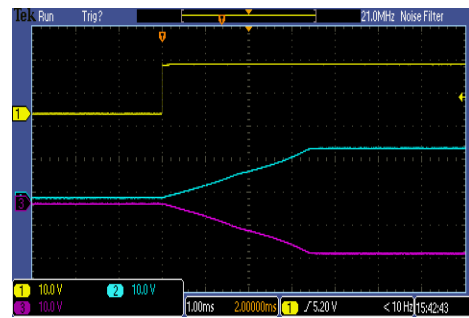
Efficiency Versus Output Current



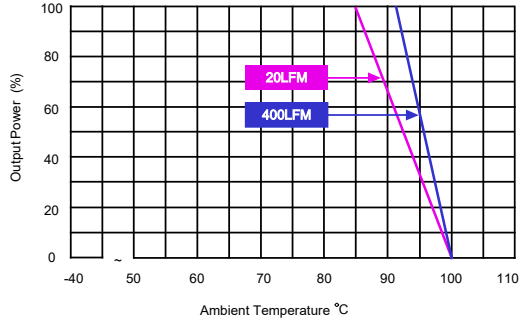
Efficiency Versus Input Voltage  
Full Load



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



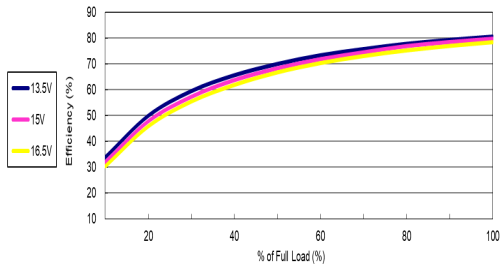
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



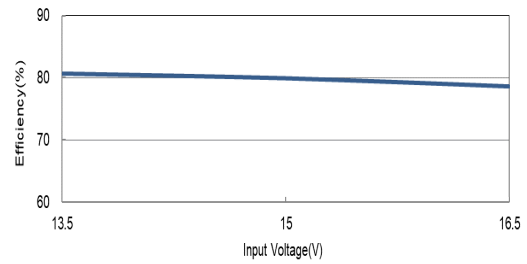
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

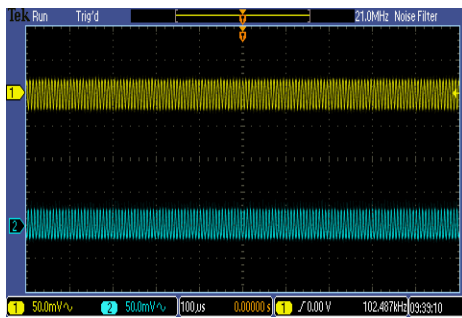
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Efficiency Versus Output Current



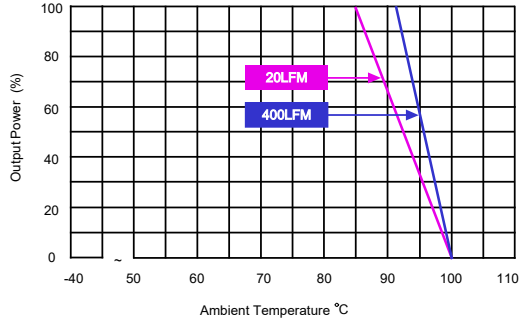
Efficiency Versus Input Voltage  
Full Load



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



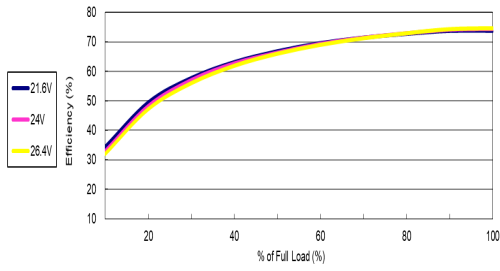
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



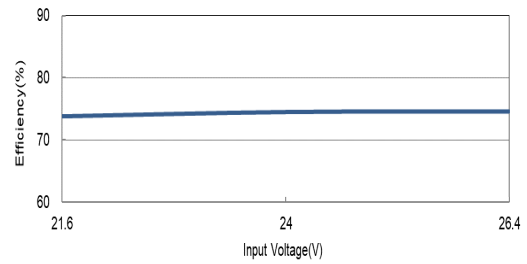
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

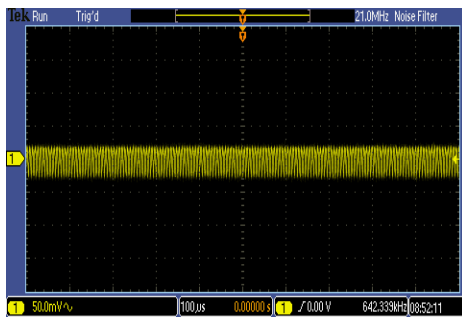
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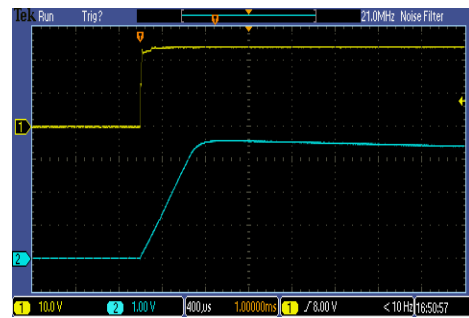
Efficiency Versus Output Current



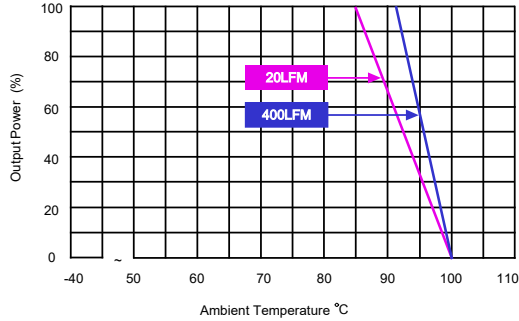
Efficiency Versus Input Voltage  
Full Load



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



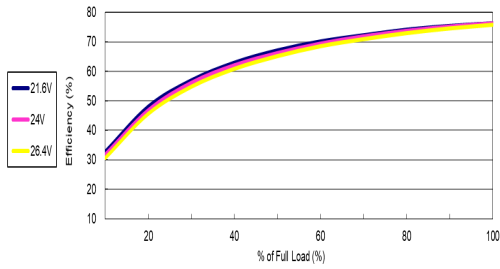
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



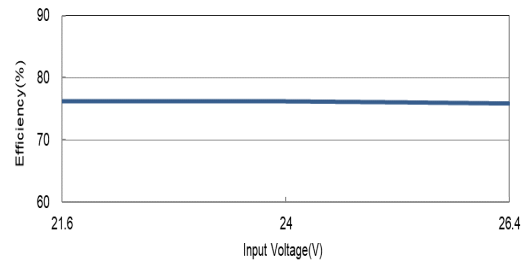
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

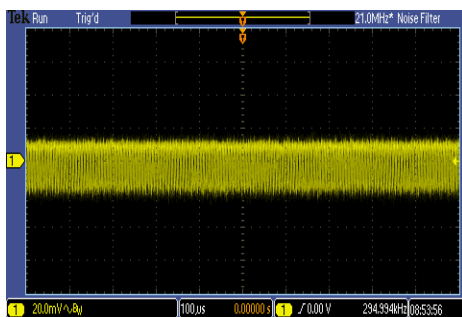
All test conditions are at 25°C The figures are identical for MA01-24S05HI



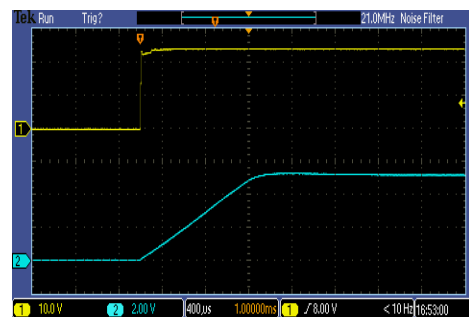
Efficiency Versus Output Current



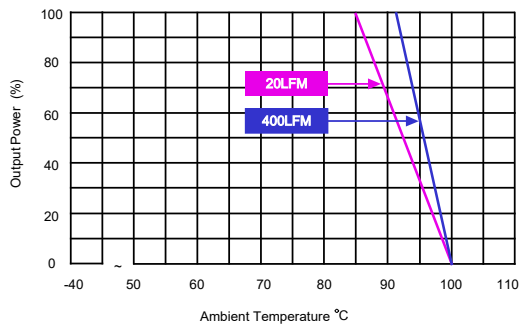
Efficiency Versus Input Voltage  
Full Load



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



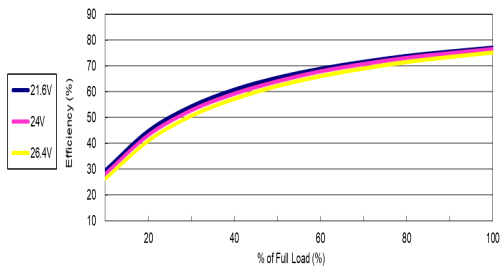
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in nom}$ ; Full Load



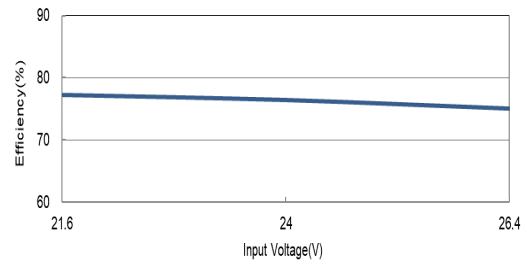
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in nom}$

**Characteristic Curves**

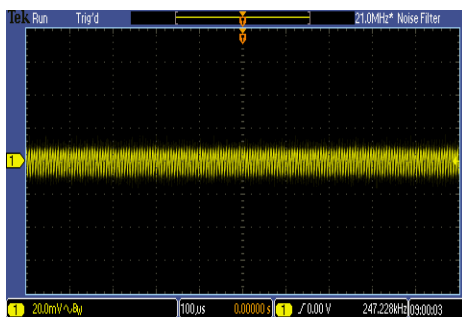
All test conditions are at 25°C The figures are identical for MA01-24S09HI



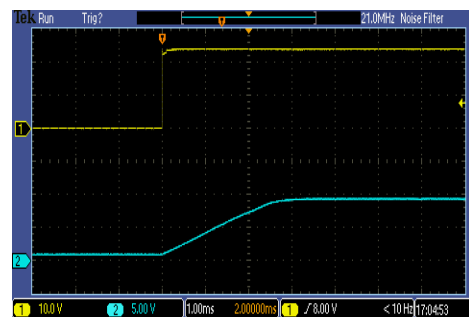
Efficiency Versus Output Current



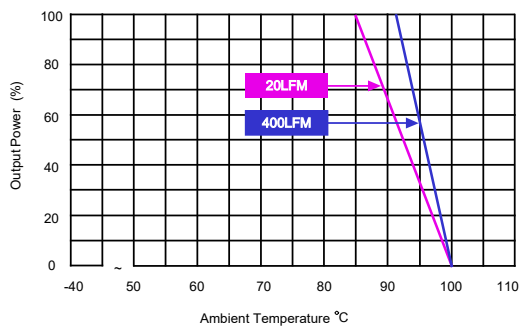
Efficiency Versus Input Voltage  
Full Load



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



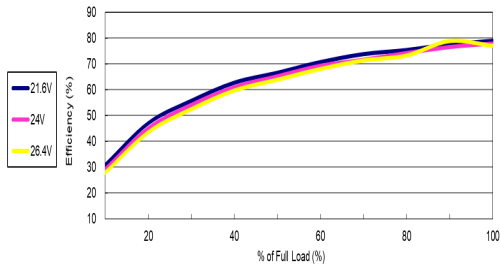
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



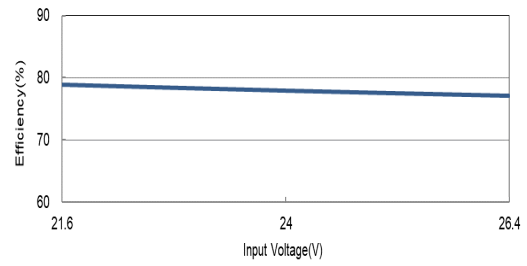
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

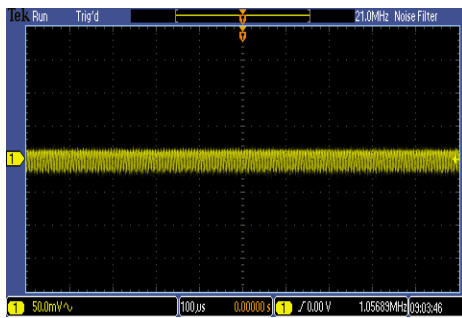
All test conditions are at 25°C The figures are identical for MA01-24S12HI



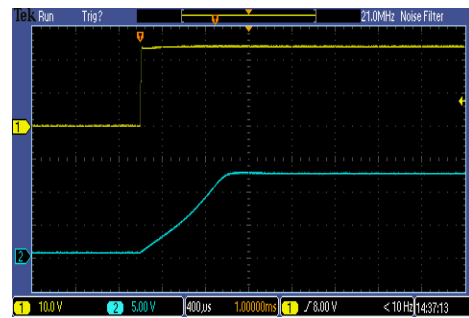
Efficiency Versus Output Current



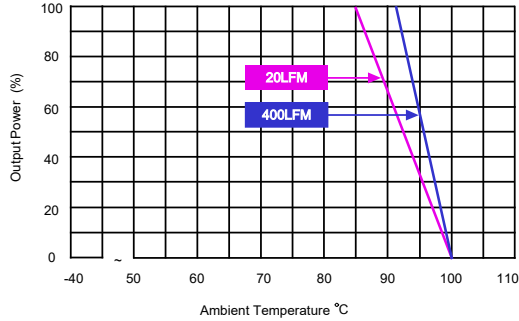
Efficiency Versus Input Voltage  
Full Load



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



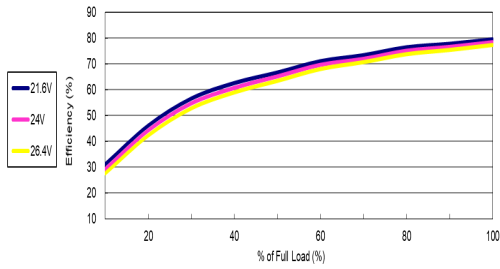
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



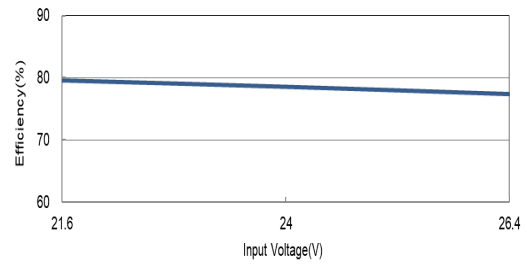
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

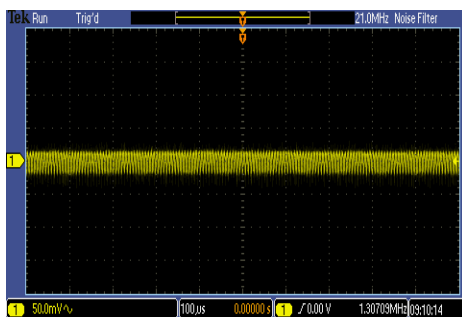
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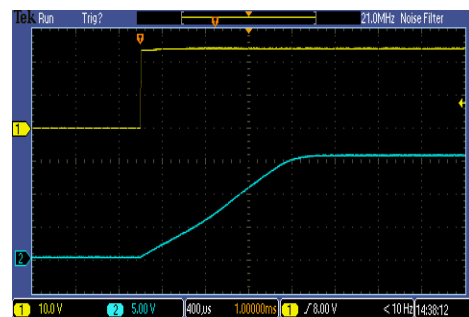
Efficiency Versus Output Current



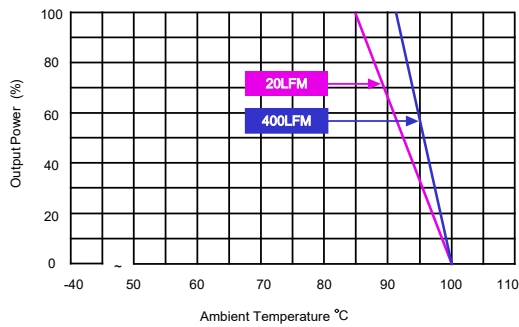
Efficiency Versus Input Voltage  
Full Load



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



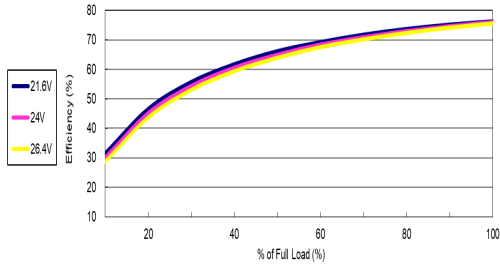
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



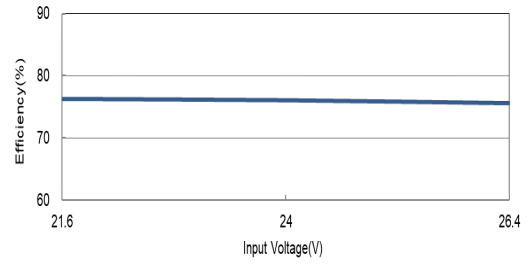
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

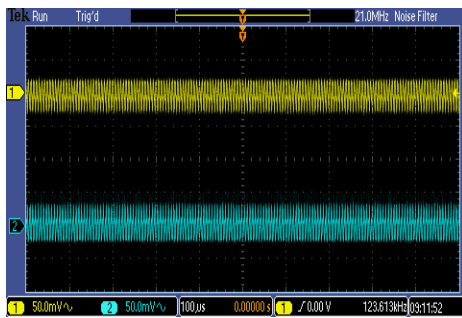
All test conditions are at 25°C The figures are identical for MA01-24D05HI



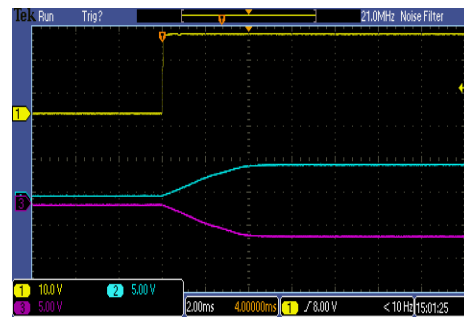
Efficiency Versus Output Current



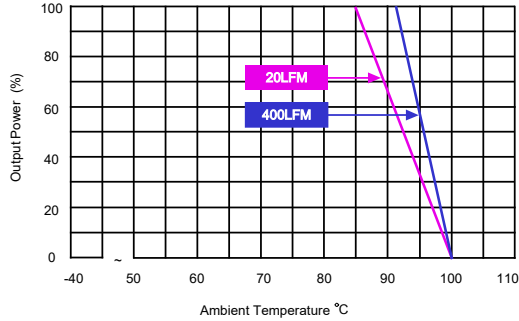
Efficiency Versus Input Voltage  
Full Load



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



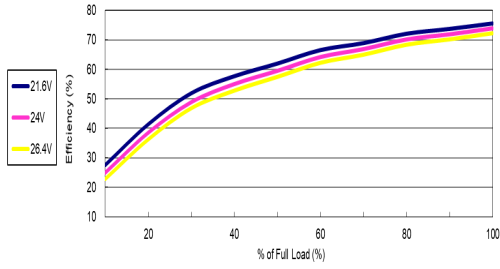
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



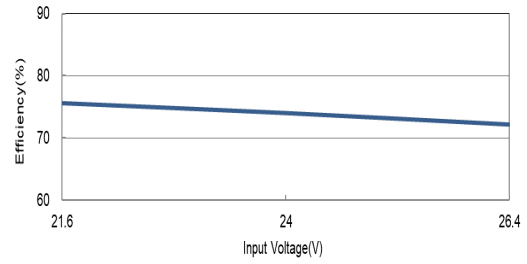
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

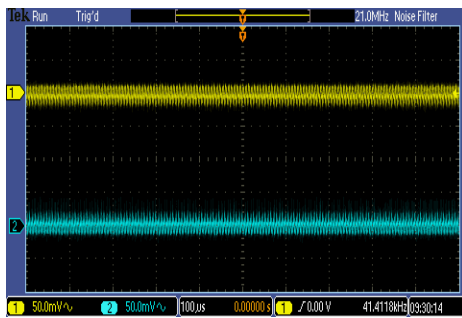
All test conditions are at 25°C The figures are identical for MA01-24D09HI



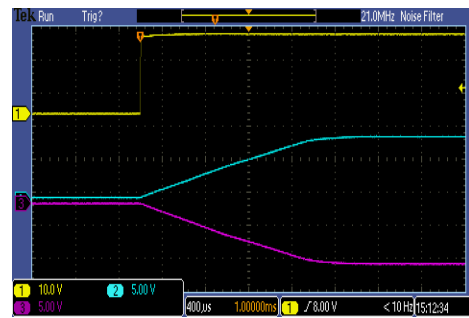
Efficiency Versus Output Current



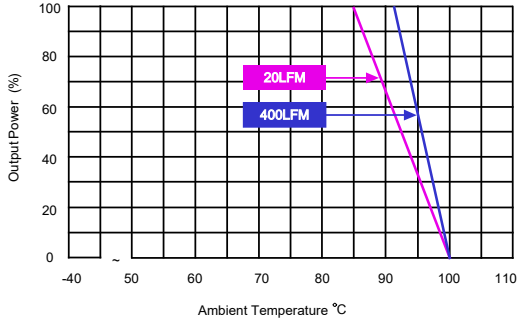
Efficiency Versus Input Voltage Full Load



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



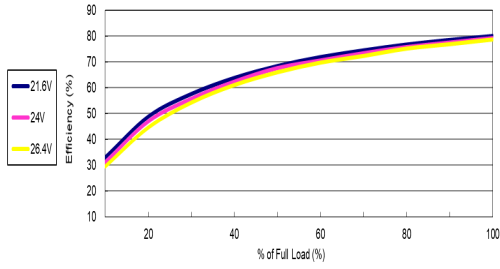
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



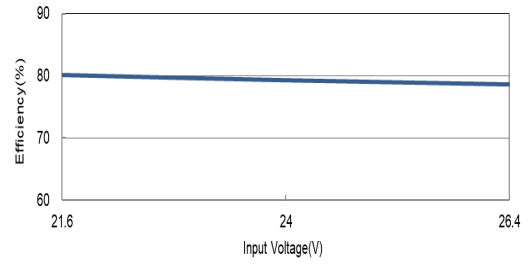
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

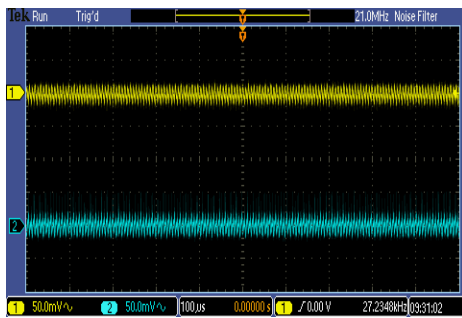
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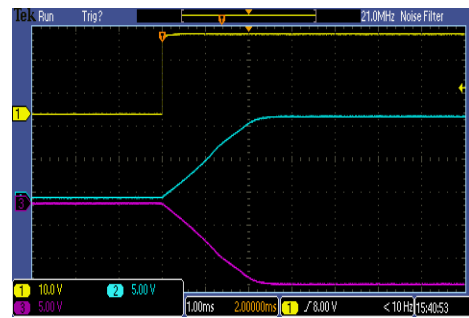
Efficiency Versus Output Current



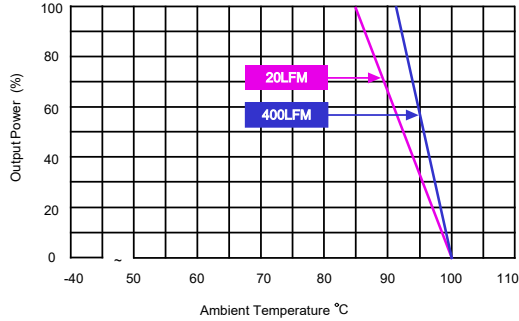
Efficiency Versus Input Voltage  
Full Load



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



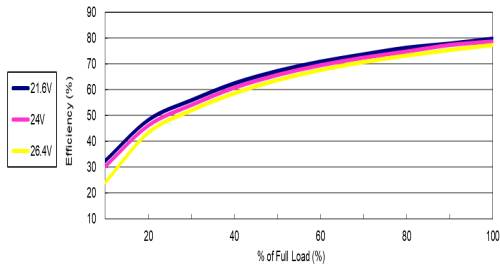
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



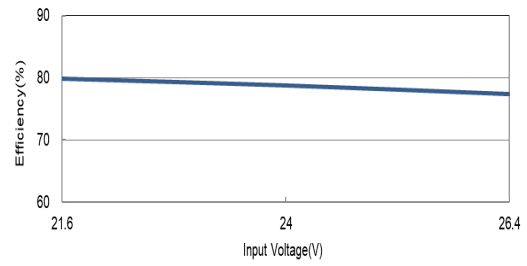
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

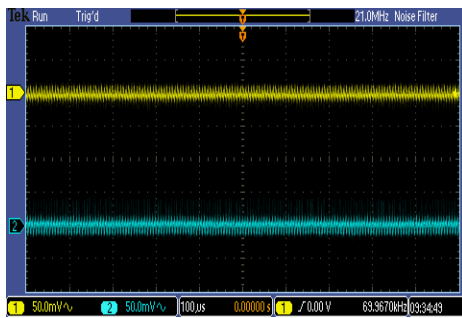
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Efficiency Versus Output Current



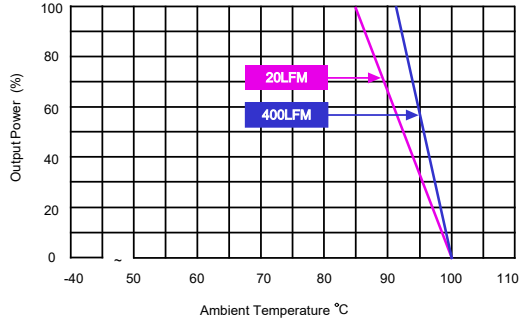
Efficiency Versus Input Voltage  
Full Load



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



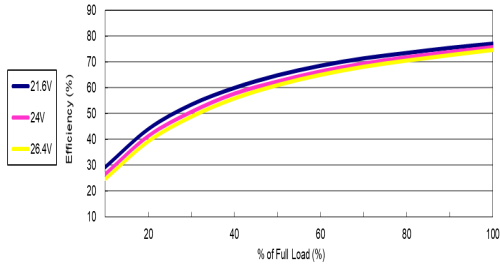
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



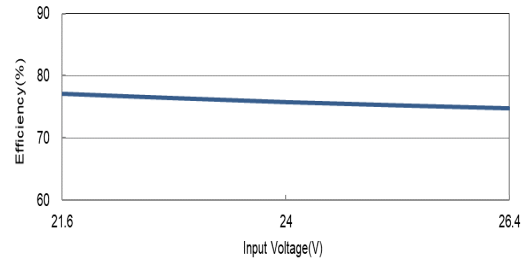
Derating Output Current Versus Ambient Temperature and Airflow  
 $V_{in}=V_{in\ nom}$

**Characteristic Curves**

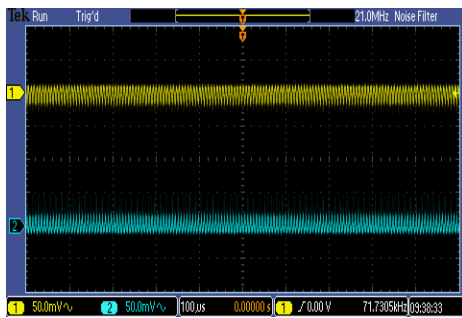
All test conditions are at 25°C The figures are identical for MA01-24A1509HI



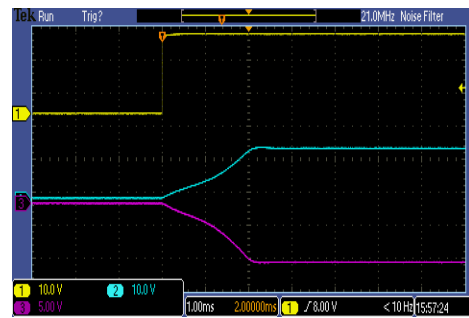
Efficiency Versus Output Current



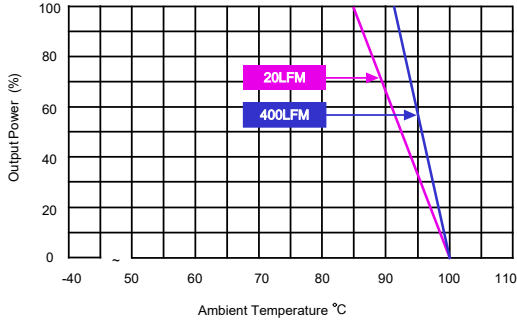
Efficiency Versus Input Voltage Full Load



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



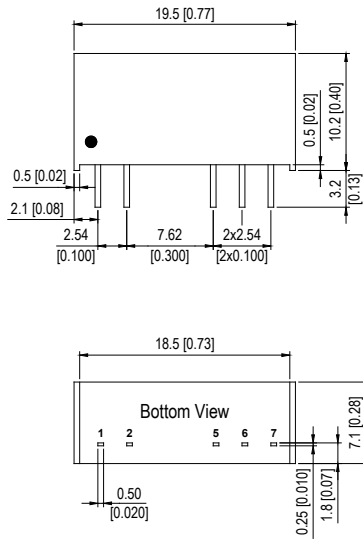
Typical Input Start-Up and Output Rise Characteristic  
 $V_{in}=V_{in\ nom}$ ; Full Load



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

### Package Specifications

#### Mechanical Dimensions



#### Pin Connections

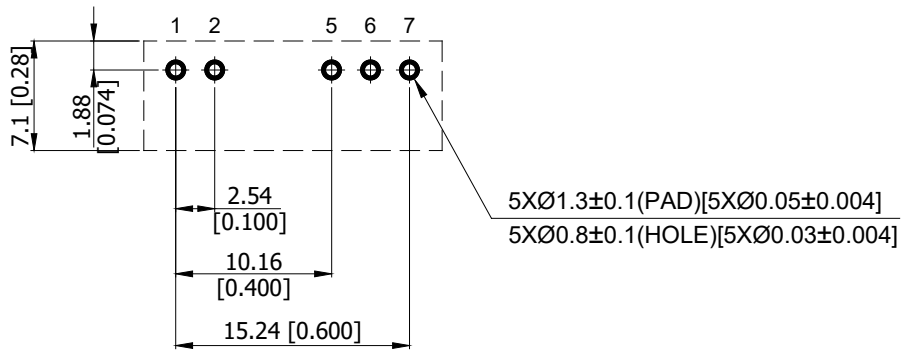
Pin	Single Output	Dual Output
1	+Vin	+Vin
2	-Vin	-Vin
5	-Vout	-Vout
6	No Pin	Common
7	+Vout	+Vout

- ▶ All dimensions in mm (inches)
- ▶ Tolerance: X.X±0.5 (X.XX±0.02)  
X.XX±0.25 (X.XXX±0.010)
- ▶ Pins ±0.05(±0.002)

### Physical Characteristics

Case Size	: 19.5x7.1x10.2mm (0.77x0.28x0.40 inches)
Case Material	: Plastic resin (flammability to UL 94V-0 rated)
Pin Material	: Alloy 42
Weight	: 2.4g

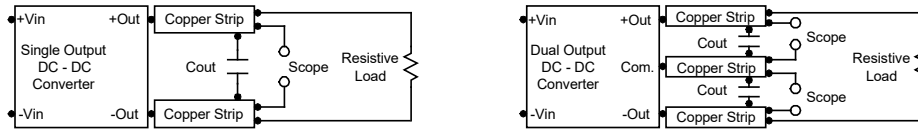
### Recommended Pad Layout



### Test Setup

#### Peak-to-Peak Output Noise Measurement Test

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



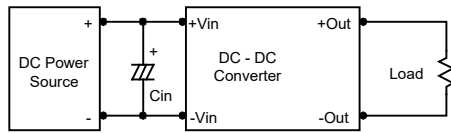
### Technical Notes

#### Maximum Capacitive Load

The MA01-HI 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.

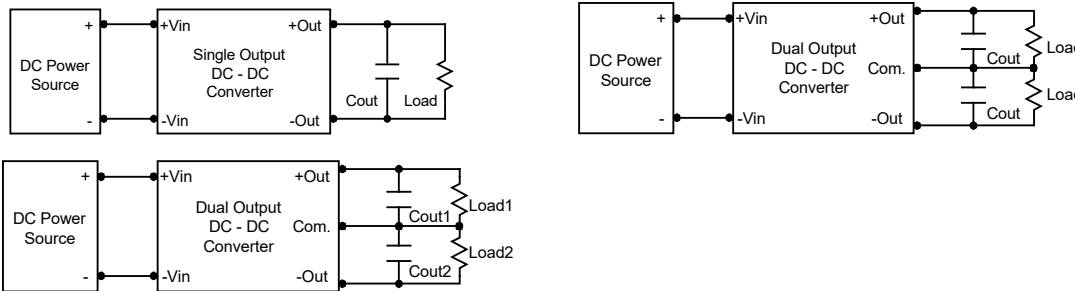
#### Input Source Impedance

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 recommended to use a good quality low Equivalent Series Resistance (ESR < 1.0 $\Omega$  at 100 kHz) capacitor of a 2.2 $\mu$ F for the 5V input devices, a 1.0 $\mu$ F for the 12V,15V input devices and a 0.47 $\mu$ F for the 24V devices.



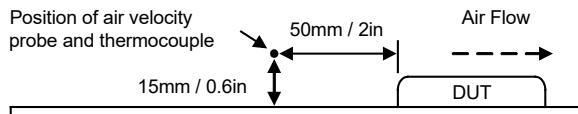
#### Output Ripple Reduction

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 1.0 $\mu$ F capacitors at the output.



#### Thermal Considerations

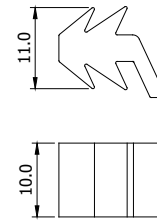
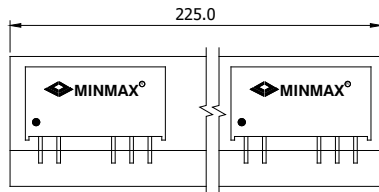
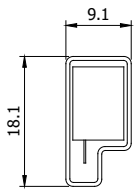
Many conditions affect the thermal performance of the power module, such as orientation, airflow over the module and board spacing. To avoid exceeding the maximum temperature rating of the components inside the power module, the case temperature must be kept below 100°C. The derating curves are determined from measurements obtained in a test setup.



**Packaging Information for Tube**

Tube

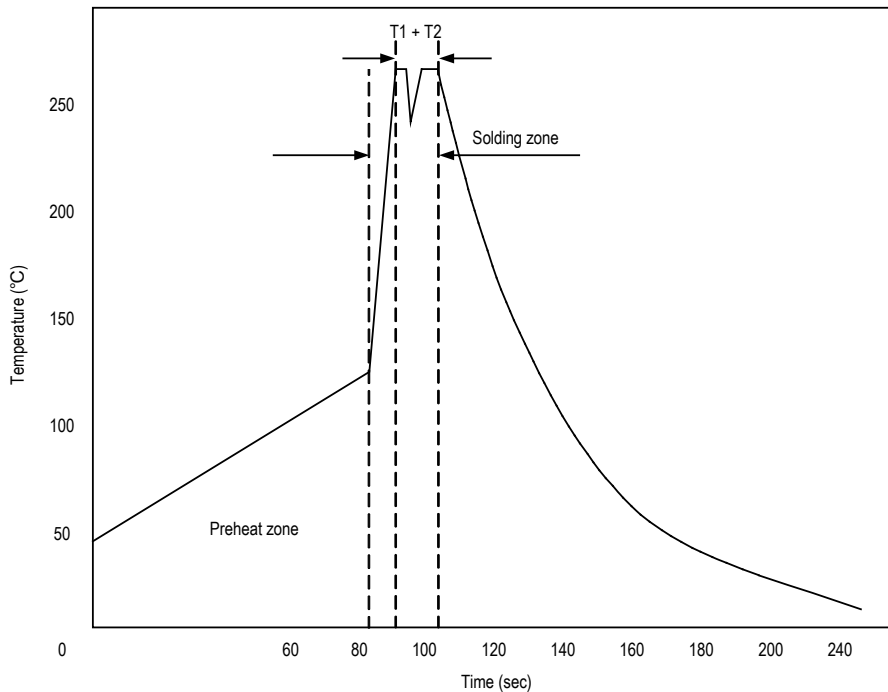
Plug



Unit: mm  
10 PCS per TUBE

**Wave Soldering Considerations**

Lead free wave solder profile



Zone	Reference Parameter
Preheat	Rise temp. speed : 3°C/sec max.
zone	Preheat temp. : 100~130°C
Actual	Peak temp. : 250~260°C
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°C

**Part Number Structure**

<b>M</b>	<b>A</b>	<b>01</b>	-	<b>05</b>	<b>S</b>	<b>033</b>	<b>HI</b>
Package Type SIP-7	Output Power 1 Watt			Input Voltage Range 05: 5 ±10% VDC 12: 12 ±10% VDC 15: 15 ±10% VDC 24: 24 ±10% VDC	Output Quantity S: Single D: Dual A: Asymmetrical	Output Voltage 033: 3.3 VDC 05: 5 VDC 09: 9 VDC 12: 12 VDC 15: 15 VDC 1509: 15/-9 VDC	I/O Isolation Voltage 5200 VDC

**MTBF and Reliability**

The MTBF of MA01-HI series of DC-DC converters has been calculated using

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

Model	MTBF	Unit
MA01-05S033HI	2,037,750	Hours
MA01-05S05HI	2,191,200	
MA01-05S09HI	2,105,400	
MA01-05S12HI	2,149,950	
MA01-05S15HI	2,168,100	
MA01-05D05HI	2,051,650	
MA01-05D09HI	2,210,750	
MA01-05D12HI	2,173,750	
MA01-05D15HI	2,151,550	
MA01-05A1509HI	2,166,350	
MA01-12S033HI	2,076,300	
MA01-12S05HI	2,034,450	
MA01-12S09HI	2,126,250	
MA01-12S12HI	2,274,750	
MA01-12S15HI	2,272,050	
MA01-12D05HI	2,054,500	
MA01-12D09HI	2,187,500	
MA01-12D12HI	2,245,250	
MA01-12D15HI	2,313,500	
MA01-12A1509HI	2,196,250	
MA01-15S033HI	2,118,150	
MA01-15S05HI	2,038,500	
MA01-15S09HI	2,177,550	
MA01-15S12HI	2,177,550	
MA01-15S15HI	2,286,900	
MA01-15D05HI	2,079,000	
MA01-15D09HI	2,244,000	
MA01-15D12HI	2,085,600	
MA01-15D15HI	2,133,450	
MA01-15A1509HI	2,187,900	
MA01-24S033HI	2,143,750	
MA01-24S05HI	2,007,500	
MA01-24S09HI	2,233,750	
MA01-24S12HI	2,258,750	
MA01-24S15HI	2,258,750	
MA01-24D05HI	2,004,750	
MA01-24D09HI	2,244,000	
MA01-24D12HI	2,244,000	
MA01-24D15HI	2,046,000	
MA01-24A1509HI	2,326,500	