



MINMAX[®]

M78AR-1 Series

Electric Characteristic Note

M78AR-1 Series EC Note

Switching Regulator 1A, SIP Package

Features

- ▶ Industrial Standard SIP-3 Package
- ▶ Pin-out compatible with LM78xx Linear Regulators
- ▶ Fully Regulated Output Voltage
- ▶ Low Ripple & Noise
- ▶ Excellent Efficiency up to 96%
- ▶ Operating Ambient Temp. Range -40°C to +85°C
- ▶ Low No Load Power Consumption
- ▶ No Min. Load Requirement
- ▶ Over Temp. and Short Circuit Protection



Applications

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

Product Overview

The MINMAX M78AR-1 series is a range of switching regulators designed as a drop-in replacement for old LM78xx linear regulators with low efficiency. The regulators come in a package which fits in the standard TO-220 footprint of linear regulators.

The high efficiency and low stand-by power consumption of these switching regulators offer the designer a new, cost-efficient solution for many applications.

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Model Selection Guide

Model Number	Input Voltage Range ⁽⁶⁾	Output Voltage	Output Current	Max. capacitive Load	Efficiency (typ.)	Efficiency (typ.)
			Max.		@Min. Vin	@Max. Vin
	VDC	VDC	mA	μF	%	%
M78AR033-1	6.5 ~ 32	3.3	1000	470	93	87
M78AR05-1	6.5 ~ 32	5	1000	470	94	90
M78AR12-1	15 ~ 32	12	1000	470	96	94

Input Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input Surge Voltage (1 sec. max.)		-0.3	---	34	VDC
Short Circuit Input Power		---	---	1.5	W
Input Current	@No Load	---	1	---	mA
Input Filter	All Models	Internal Capacitor			

Output Specifications

Parameter	Conditions / Model		Min.	Typ.	Max.	Unit
Output Voltage Setting Accuracy			---	---	±2.0	%Vnom.
Line Regulation	Vin=Min. to Max. @Full Load	3.3V, 5V	---	±0.2	±0.4	%
		12V	---	±0.1	±0.2	%
Load Regulation	Io=10% to 100%	3.3V, 5V	---	±0.4	±0.6	%
		12V	---	±0.25	±0.4	%
Minimum Load	No minimum Load Requirement					
Ripple & Noise	0-20MHz Bandwidth	3.3V, 5V	---	---	50	mV _{P-P}
		12V	---	---	75	mV _{P-P}
Transient Recovery Time	50% Load Step Change		---	250	---	μsec
Transient Response Deviation			---	±2	---	%
Temperature Coefficient			---	---	±0.015	%/°C
Short Circuit Protection	Continuous, Automatic Recovery					

General Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	None				
Switching Frequency		---	420	---	kHz
MTBF(calculated)	MIL-HDBK-217F@25°C, Ground Benign	9,000,000	---	---	Hours

EMC Specifications

Parameter	Standards & Level			Performance
EMI ₍₅₎	Conduction	EN 55022	With external components	Class A, B
	Radiation		Without external components	
EMS ₍₅₎	ESD	EN61000-4-2 Air±8kV		A
	Radiated immunity	EN61000-4-3 3V/m		A
	Fast transient	EN61000-4-4 ±0.5kV		A
	Conducted immunity	EN61000-4-6 3Vrms		A
	PFMF	EN61000-4-8 3A/m		A

Environmental Specifications

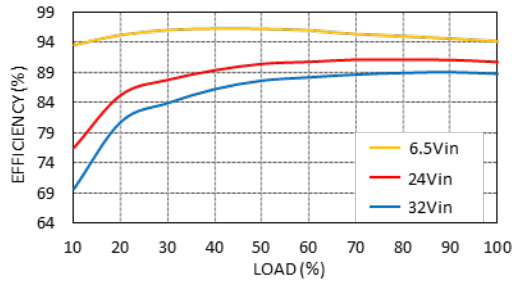
Parameter	Conditions	Min.	Typ.	Max.	Unit
Operating Ambient Temperature Range (See Power Derating Curve)		-40	---	+85	°C
Case Temperature		---	---	+95	°C
Storage Temperature		-55	---	+125	°C
Thermal Shutdown	Internal IC junction	---	150	---	°C
Humidity (non condensing)		---	---	95	% rel. H
Lead-free reflow solder process (1.5mm from case for 10Sec.)		---	---	260	°C

Notes

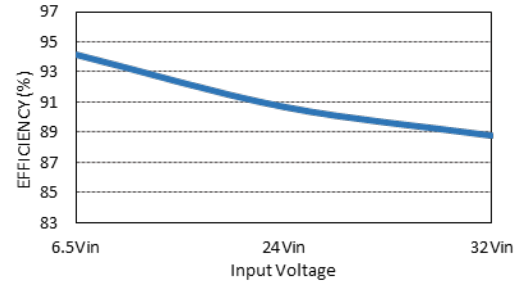
- 1 Specifications typical at Ta=+25°C, resistive load, nominal input voltage, rated output current unless otherwise noted.
- 2 Other input and output voltage may be available, please contact MINMAX.
- 3 We recommend to protect the converter by a slow blow fuse in the input supply line.
- 4 With a input capacitor 22μF/50V (CHEMI-CON KY) for input voltage >28VDC, the input voltage allows 32VDC, max.
- 5 The external components might be required to meet EMI/EMS standard for some of test items. Please contact MINMAX for the solution in detail.
- 6 Specifications are subject to change without notice.

Characteristic Curves

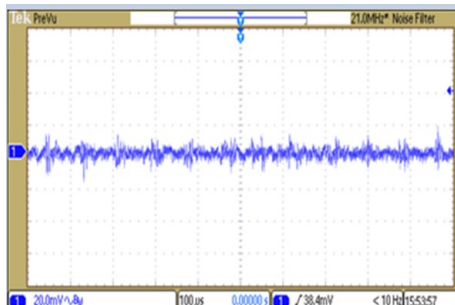
All test conditions are at 25°C The figures are identical for M78AR033-1



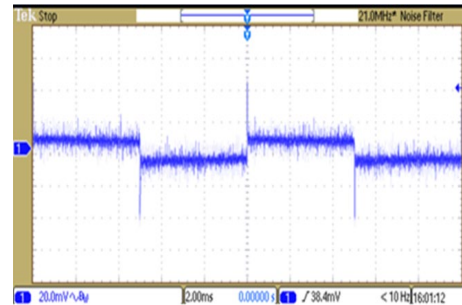
Efficiency Versus Output Current



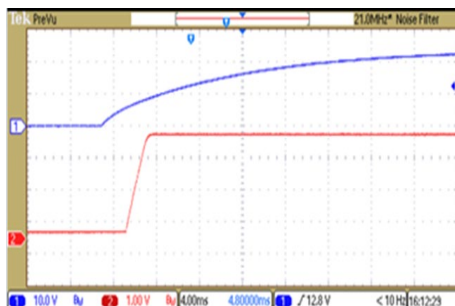
Efficiency Versus Input Voltage
Full Load



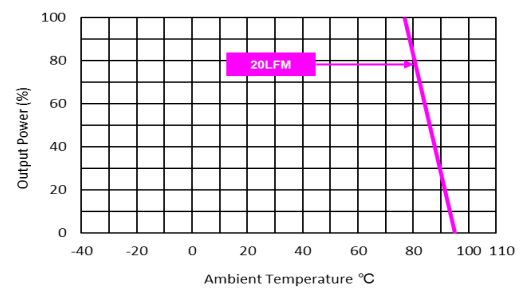
Typical Output Ripple and Noise
 $V_{in}=V_{in\ nom}$; Full Load



Transient Response to Dynamic Load Change
from 100% to 75% of Full Load ; $V_{in}=V_{in\ nom}$



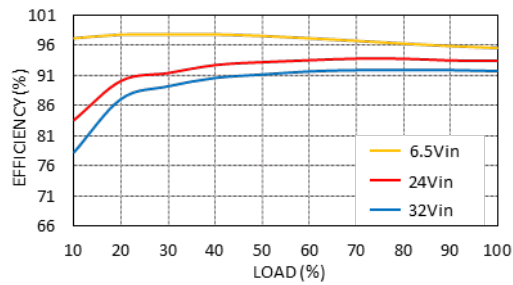
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



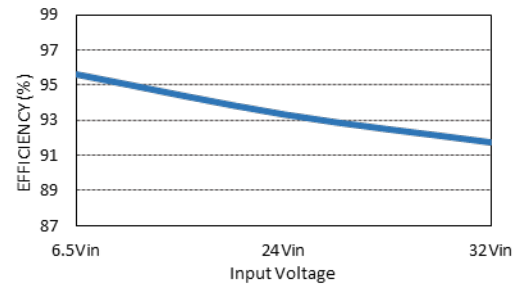
Derating Output Current Versus Ambient Temperature
 $V_{in}=V_{in\ nom}$

Characteristic Curves

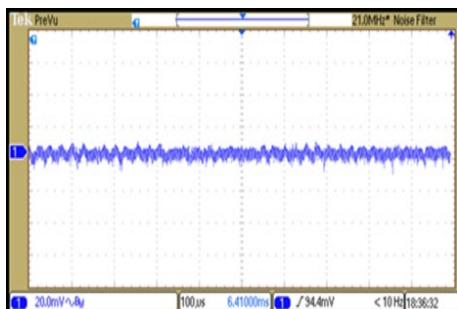
All test conditions are at 25°C The figures are identical for M78AR05-1



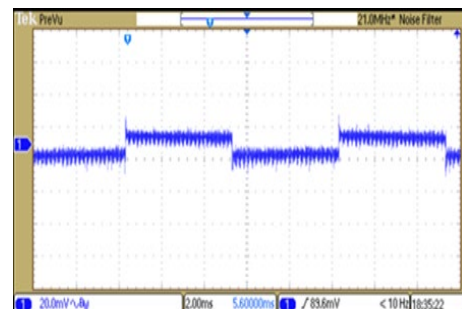
Efficiency Versus Output Current



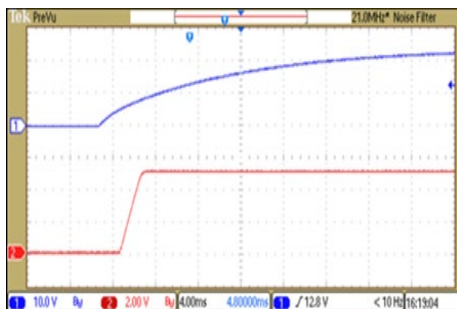
Efficiency Versus Input Voltage
Full Load



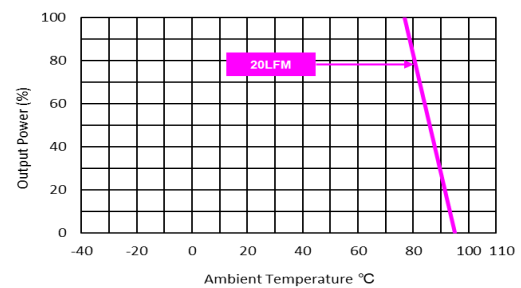
Typical Output Ripple and Noise
 $V_{in}=V_{in\ nom}$; Full Load



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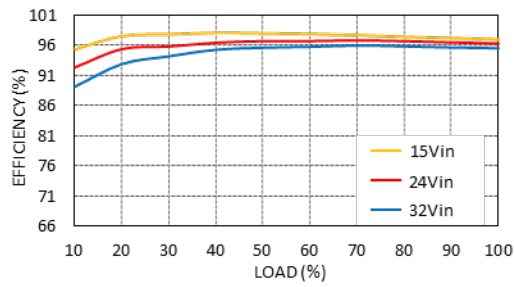
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



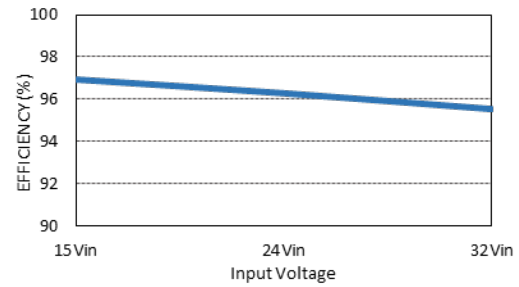
Derating Output Current Versus Ambient Temperature
 $V_{in}=V_{in\ nom}$

Characteristic Curves

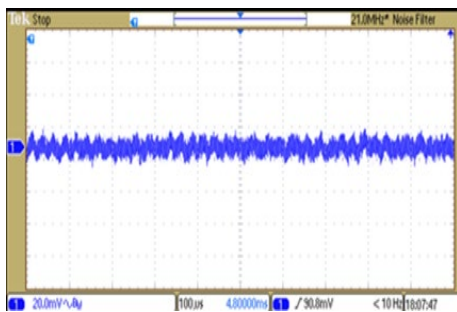
All test conditions are at 25°C The figures are identical for M78AR12-1



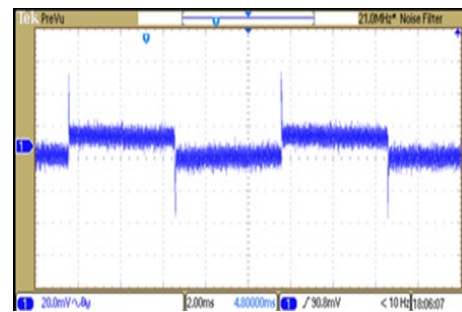
Efficiency Versus Output Current



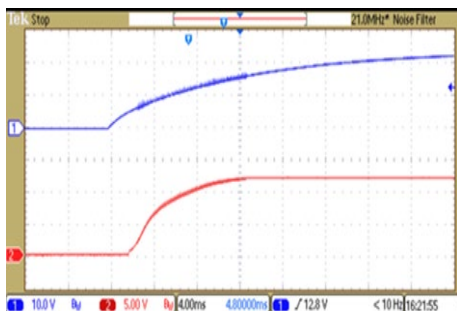
Efficiency Versus Input Voltage
Full Load



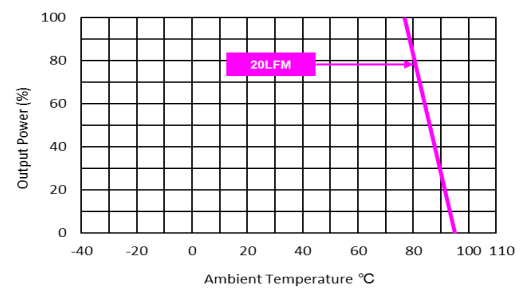
Typical Output Ripple and Noise
 $V_{in}=V_{in\ nom}$; Full Load



Transient Response to Dynamic Load Change
from 100% to 75% of Full Load ; $V_{in}=V_{in\ nom}$



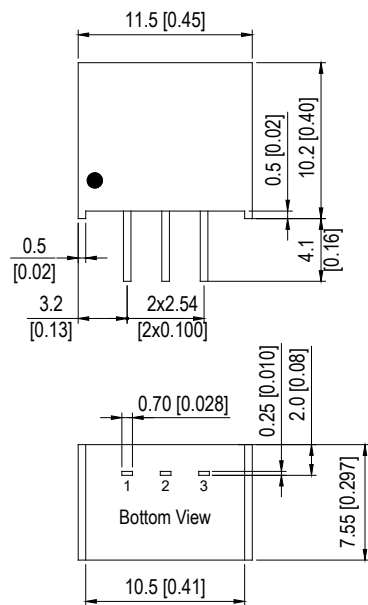
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}=V_{in\ nom}$; Full Load



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

Package Specifications

Mechanical Dimensions



Pin Connections

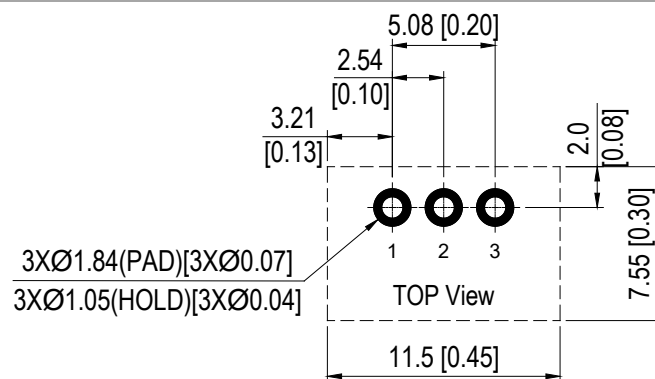
Pin	Function
1	+Vin
2	GND
3	+Vout

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

Physical Characteristics

Case Size	: 11.5x7.55x10.2mm (0.45x0.30x0.40 inches)
Case Material	: Plastic resin (flammability to UL 94V-0 rated)
Pin Material	: Phosphor Bronze
Weight	: 2.2g

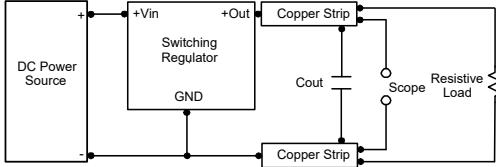
Recommended Pad Layout



Test Setup

Peak-to-Peak Output Noise Measurement Test

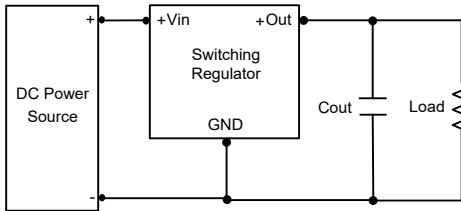
Use a Cout 0.47 μ F ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is 0-20 MHz. Position the load between 50 mm and 75 mm from the DC-DC Converter.



Technical Notes

Output Ripple Reduction

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



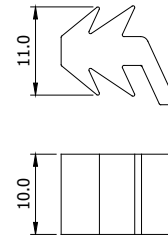
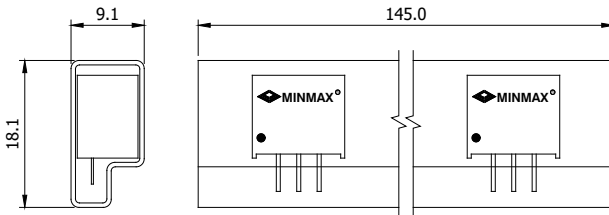
Maximum Capacitive Load

The M78AR-1 series has limitation of maximum connected capacitance on the output. The power module may operate 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.

Packaging Information for Tube

Tube

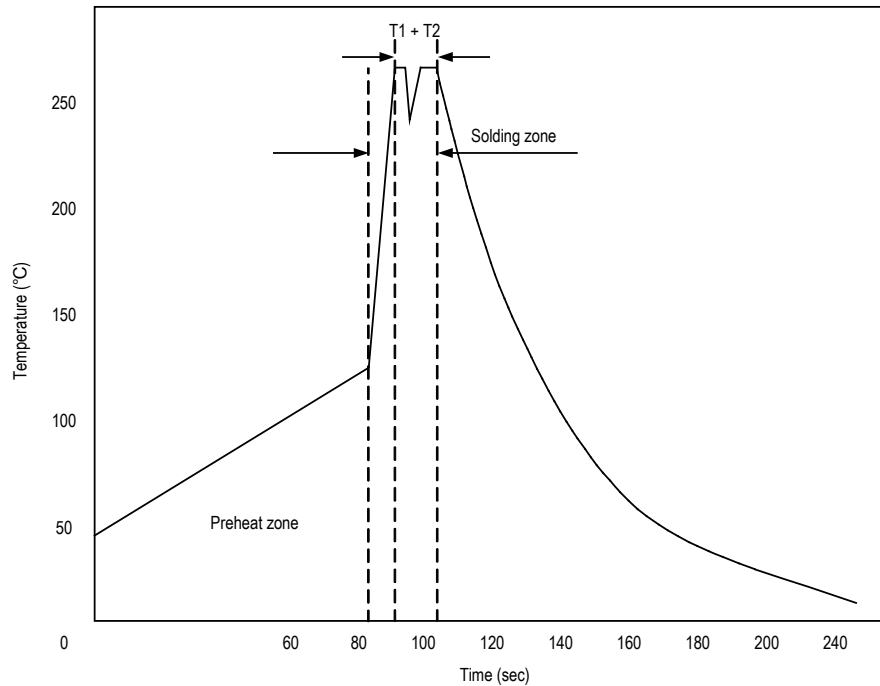
Plug



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

M	78	A	R	033	-	1
Pin-out compatible With LM78xx Linear Regulator		Package Type SIP-3	Output Regulation Regulated	Output Voltage 033: 3.3 VDC 05: 5 VDC 12: 12 VDC	Output Current 1: 1 A	

MTBF and Reliability

The MTBF of M78AR-1 series of DC-DC converters has been calculated using

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

Model	MTBF	Unit
M78AR033-1	9,137,482	Hours
M78AR05-1	9,334,114	
M78AR12-1	9,354,489	