

## 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



## 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.

### Model Selection Guide

Model Number	Input Voltage Range <sub>(6)</sub>	Output Voltage	Output Current	Max. capacitive Load	Efficiency (typ.)	Efficiency (typ.)
	VDC	VDC	Max.		@Min. Vin	@Max. Vin
			mA	μF	%	%
<b>M78AR033-1</b>	6.5 ~ 32	3.3	1000	470	93	87
<b>M78AR05-1</b>	6.5 ~ 32	5	1000	470	94	90
<b>M78AR12-1</b>	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	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 <sub>P-P</sub>
		12V	---	---	75	mV <sub>P-P</sub>
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**

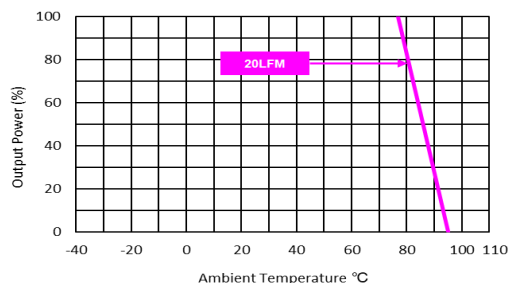
Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	None				
Switching Frequency		---	420	---	kHz
MTBF(calculated)	MIL-HDBK-217F@25°C, Ground Benign	9,000,000	---	---	Hours

**EMC Specifications**

Parameter	Standards & Level			Performance
EMI	Conduction	EN55022	With external components	Class A,B <sup>(7)</sup>
	Radiation		Without external components	
EMS	ESD	EN61000-4-2 Air±8kV		A
	Radiated immunity	EN61000-4-3 3V/m		A
	Fast transient <sup>(4)</sup>	EN61000-4-4 ±0.5kV		A
	Conducted immunity	EN61000-4-6 3Vrms		A
	PFMF	EN61000-4-8 3A/m		A

**Environmental Specifications**

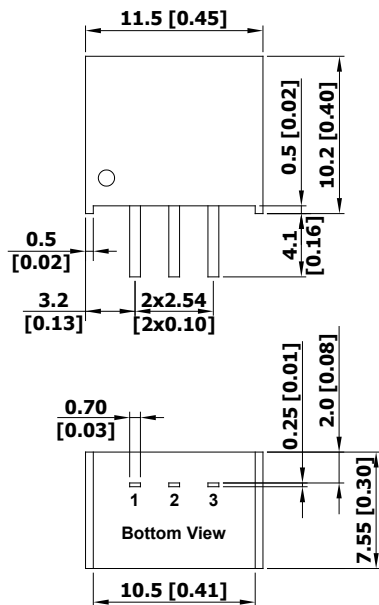
Parameter	Conditions	Min.	Typ.	Max.	Unit
Operating Ambient Temperature Range (See Power Derating Curve)		-40	---	+85	°C
Case Temperature		---	---	+95	°C
Storage Temperature		-55	---	+125	°C
Thermal Shutdown	Internal IC junction	---	150	---	°C
Humidity (non condensing)		---	---	95	% rel. H
Lead-free reflow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

**Power Derating Curve**

**Notes**

- Specifications typical at Ta=+25°C, resistive load, nominal input voltage, rated output current unless otherwise noted.
- Other input and output voltage may be available, please contact MINMAX.
- We recommend to protect the converter by a slow blow fuse in the input supply line.
- To meet EN61000-4-4 an external capacitor across the input pins is required, please contact MINMAX.
- With a input capacitor 22µF/50V (CHEMI-CON KY) for input voltage >28VDC, the input voltage allows 32VDC, max.
- To meet EN55022 Class A,B an external filter, please contact MINMAX.
- Specifications are subject to change without notice.

**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)

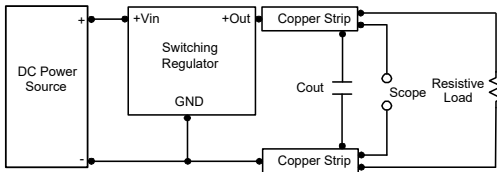
**Physical Characteristics**

Case Size	: 11.5x7.55x10.2mm (0.45x0.30x0.40 inches)
Case Material	: Non-Conductive Black Plastic (flammability to UL 94V-0 rated)
Pin Material	: Phosphor Bronze with Tin Plate Over Nickel Subplate
Weight	: 2.2g

## Test Setup

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

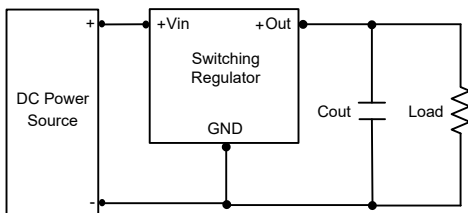
Use a  $C_{out}$  0.47 $\mu$ F ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is 0-20 MHz. Position the load between 50 mm and 75 mm from the DC-DC Converter.



## Technical Notes

### 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 $\mu$ 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.