

FEATURES

- ▶ Industrial SMD Package
- ▶ Fully Regulated Output Voltage
- ▶ Low Ripple & Noise
- ▶ Excellent Efficiency up to 97%
- ▶ Operating Ambient Temp. Range -40°C to +90°C
- ▶ No Min. Load Requirement
- ▶ Over Temp. and Short Circuit Protection
- ▶ Remote ON/OFF Control, Output Voltage Trim
- ▶ Qualified for Lead-free Reflow Solder Process
According to IPC/JEDEC J-STD-020D.1
- ▶ Tape & Reel Package Available



PRODUCT OVERVIEW

The MINMAX M78SA series is a new range of switching regulators designed as a drop-in replacement for old LM78xx linear regulators with low efficiency. The very high efficiency of these step-down converters allow an operating temperature up to 80°C at full-load without need of any heatsink. 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 ⁽⁶⁾ VDC	Output Voltage		Output Current	Max. capacitive Load μF	Efficiency (typ.)	Efficiency (typ.)
		Normal	Adjust Range ⁽⁸⁾	Max.		@Min. Vin	@Max. Vin
		VDC	VDC	mA		%	%
M78SAR015-0.5	4.75 ~ 32	1.5	1.4~2.5	500	220	73	63
M78SAR018-0.5		1.8	1.5~3	500	220	82	71
M78SAR025-0.5		2.5	1.5~3	500	220	87	77
M78SAR033-0.5		3.3	3~5.5	500	220	91	81
M78SAR05-0.5	6.5 ~ 32	5	3~8	500	220	94	86
M78SAR065-0.5	8 ~ 32	6.5	3.3~11	500	220	95	88
M78SAR09-0.5	11 ~ 32	9	4.5~12.6	500	220	96	92
M78SAR12-0.5	15 ~ 32	12	4.5~13.5	500	220	97	94
M78SAR15-0.5	18 ~ 32	15	4.5~15.5	500	220	97	95

Input Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input Surge Voltage (1 sec. max.)		-0.3	---	34	VDC
Internal Filter Type		Capacitor			
Input Filter	All Models	Internal Capacitor			
Short Circuit Input Power		---	---	1.5	W
Input Current	@No Load	---	5	---	mA

Remote On/Off Control

Parameter	Conditions	Min.	Typ.	Max.	Unit
Converter On		Open or 2.4V < Vr < 5V			
Converter Off		GND or 0 < Vr < 1.6V			
Standby Input Current	Supply Off & 24 Vin	---	---	35	μA

Output Specifications

Parameter	Conditions		Min.	Typ.	Max.	Unit
Output Voltage Setting Accuracy			---	±2.0	±3.0	%Vnom.
Line Regulation	Vin=Min. to Max. @Full Load	1.5V to 6.5V	---	±0.2	±0.4	%
		9V to 15V	---	±0.1	±0.2	%
Load Regulation	Io=10% to 100%	1.5V to 6.5V	---	±0.4	±0.6	%
		9V to 15V	---	±0.25	±0.4	%
Minimum Load	No minimum Load Requirement					
Ripple & Noise	0-20MHz Bandwidth	1.5V to 6.5V	---	---	30	mV _{P-P}
		9V to 15V	---	---	40	mV _{P-P}
Transient Recovery Time	50% Load Step Change		---	100	---	µsec
Transient Response Deviation			---	±2	---	%
Temperature Coefficient			---	---	±0.015	%/°C
Short Circuit Protection	Continuous, Automatic Recovery					

General Specifications

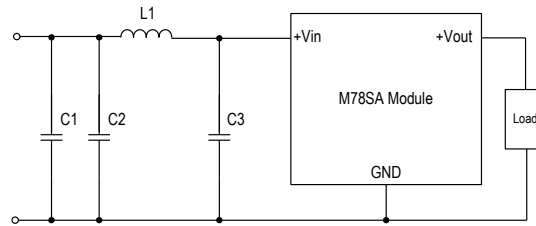
Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage		none			
Switching Frequency		280	330	380	KHz
MTBF(calculated)	MIL-HDBK-217F@25°C, Ground Benign	2,000,000			Hours
Moisture Sensitivity Level (MSL)	IPC/JEDEC J-STD-020D.1	Level 2			

Environmental Specifications

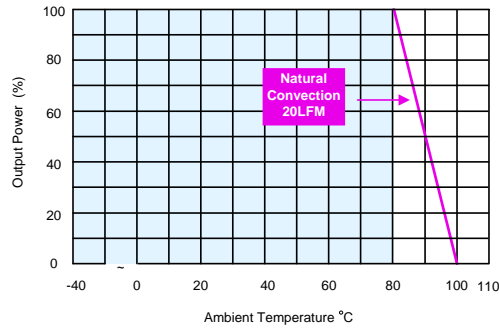
Parameter	Conditions	Min.	Typ.	Max.	Unit
Operating Ambient Temperature Range (See Power Derating Curve)	Natural Convection	-40	---	+90	°C
Case Temperature		---	---	+100	°C
Storage Temperature		-55	---	+125	°C
Thermal Shutdown	Internal IC junction	---	160	---	°C
Humidity (non condensing)		---	---	95	% rel. H
Cooling	Natural Convection				
Lead-free reflow solder process	IPC/JEDEC J-STD-020D.1				

EMC Specifications

Parameter	Standards & Level		Performance
EMI	Radiation without adding any external components		Class B
	Conduction with external components		
EMS	ESD	EN61000-4-2 Air±8kV	A
	Radiated immunity	EN61000-4-3 3V/m	A
	Fast transient ₍₄₎	EN61000-4-4 ±0.5kV	A
	Conducted immunity	EN61000-4-6 3Vrms	A
	PFMF	EN61000-4-8 3A/m	A

EMI Filter meets Conducted EMI EN55022 class B; FCC part 15 level A


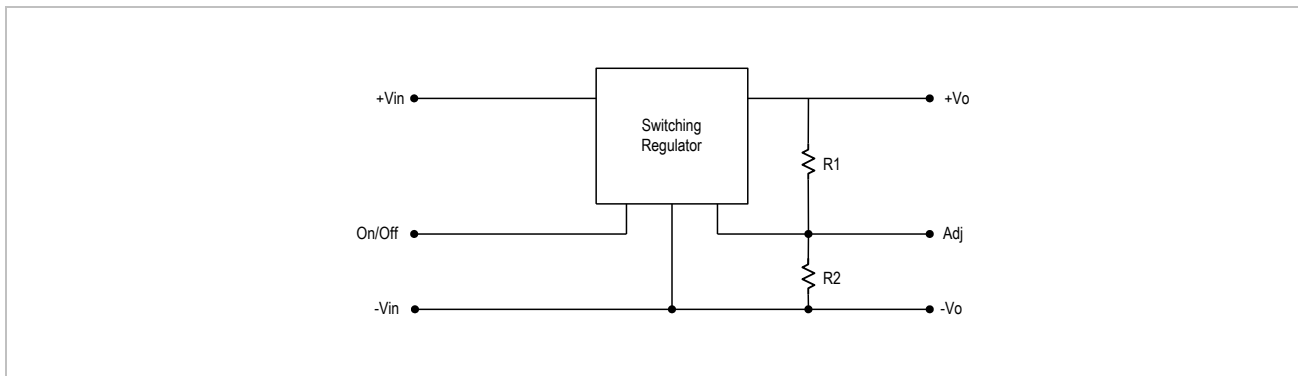
Class	C1	C2	C3	L1
Class A	---	4.7 μ F/50V 1206 MLCC	4.7 μ F/50V 1206 MLCC	Würth Elektronik NO. 744774033
Class B	4.7 μ F/50V 1206 MLCC	4.7 μ F/50V 1206 MLCC	4.7 μ F/50V 1206 MLCC	Würth Elektronik NO. 74477410

Power Derating Curve

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 factory.
- 3 We recommend to protect the converter by a slow blow fuse in the input supply line.
- 4 The M78SA series can meet EN61000-4-4 by adding a capacitor across the input pins. Suggested capacitor CHEMI-CON KY 330 μ F/100V.
- 5 That "natural convection" is about 20LFM but is not equal to still air (0 LFM).
- 6 With a input capacitor 22 μ F/50V for input voltage >28VDC, the input voltage allows 32VDC, max.
- 7 Input voltage must be higher than output voltage set:>1.5V for 3.3V~5V and >3V for 6.5V~15V.
- 8 Specifications are subject to change without notice.

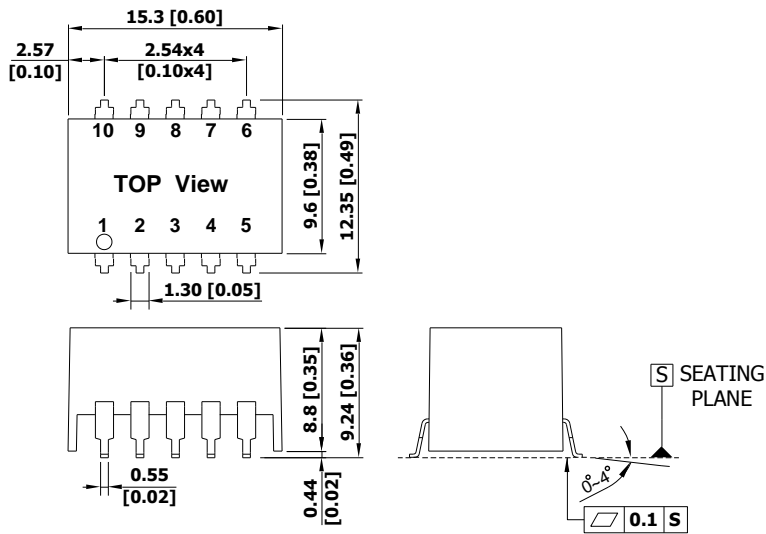
Adjustment Resistor Values

Vout(nom.)	M78SAR015-0.5		M78SAR018-0.5		M78SAR025-0.5		M78SAR033-0.5		M78SAR05-0.5		M78SAR065-0.5		M78SAR09-0.5		M78SAR12-0.5		M78SAR15-0.5	
	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2
1.4 (V)	1 KΩ																	
1.5 (V)			3KΩ		200Ω													
1.8 (V)		6.49 KΩ			12KΩ													
2.5 (V)		0.47 KΩ		11.8KΩ														
3.0 (V)				4.64KΩ		44.2KΩ	88.4KΩ		17KΩ									
3.3 (V)									27KΩ	15KΩ								
3.6 (V)								60.4KΩ	42KΩ	21.5KΩ								
3.9 (V)								28KΩ	58KΩ	30.1KΩ								
4.5 (V)								11.3KΩ	180KΩ	56.3KΩ	26KΩ	17KΩ	10.5 KΩ					
4.9 (V)								7.15KΩ	850KΩ	78.7KΩ	36KΩ	24KΩ	15.8 KΩ					
5.0 (V)								6.34KΩ		86KΩ	39KΩ	26KΩ	17.4 KΩ					
5.1 (V)								5.9KΩ	231KΩ	97KΩ	42KΩ	28KΩ	18.7 KΩ					
5.5 (V)								3.9KΩ	56.2KΩ	154KΩ	56KΩ	36KΩ	24.9 KΩ					
6.5 (V)									14KΩ		112KΩ	63KΩ	42.2 KΩ					
8.0 (V)									2.32KΩ		22.6KΩ	400KΩ	125KΩ	78.7 KΩ				
9.0 (V)											9.53KΩ		200KΩ	113 KΩ				
10 (V)											3.92KΩ	54.9KΩ	345KΩ	160 KΩ				
11 (V)											825Ω	16.5KΩ	740KΩ	232 KΩ				
12 (V)												3.6KΩ		340 KΩ				
12.6 (V)												0Ω	180KΩ	464 KΩ				
13.5 (V)													57.6 KΩ	787 KΩ				
15.5 (V)																		300 KΩ

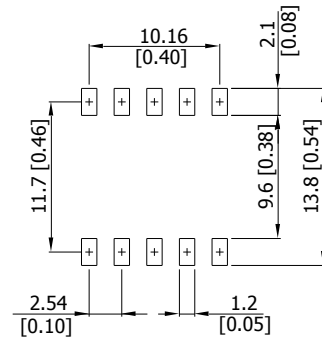


Package Specifications

Mechanical Dimensions



Connecting Pin Patterns



- ▶ 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)

Pin Connections

Pin	Function
1	+Vin
2	+Vin
3	GND
4	+Vout
5	+Vout
6	Vadj.
7	GND
8	GND
9	GND
10	Remote On/Off

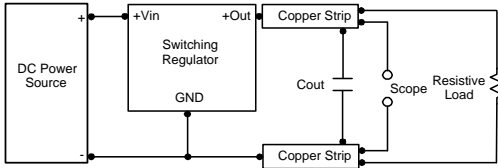
Physical Characteristics

Case Size	: 15.3x9.6x8.8mm (0.60x0.38x0.35 inches)
Case Material	: Non-Conductive Black Plastic (flammability to UL 94V-0 rated)
Pin Material	: phosphor bronze
Weight	: 1.7g

Test Setup

Peak-to-Peak Output Noise Measurement Test

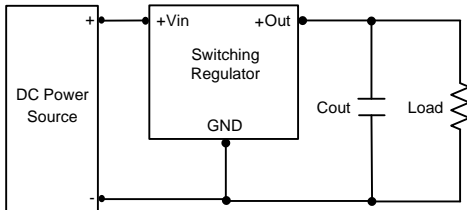
Use a Cout 0.47 μ F ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is 0-20 MHz. Position the load between 50 mm and 75 mm from the DC/DC Converter.



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 M78SA 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.