

**FEATURES**

- ▶ SMD-Package 15.3x9.6x8.8 mm
- ▶ Very high Efficiency up to 97%
- ▶ Excellent Line/Loads Regulation
- ▶ Low Ripple and Noise
- ▶ Short Circuit Protection
- ▶ Operating Temp.Range -40°C to +90°C
- ▶ Thermal Shutdown
- ▶ Low Stand-by Current
- ▶ 3 Years Product Warranty



**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 <sup>(6)</sup> VDC	Output Voltage		Output Current Max. mA	Max. capacitive Load µF	Efficiency (typ.)	
		Normal	Adjust Range <sup>(6)</sup> VDC			@Min. Vin	@Max. Vin
		VDC	VDC	VDC		%	%
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			
Internal Power Dissipation		---	---	0.4	W
Short Circuit Input Power		---	---	1.5	W
Input Current	@No Load	---	5	---	mA

**Output Specifications**

Parameter	Conditions	Min.	Typ.	Max.	Unit	
Output Voltage Setting Accuracy		---	±2.0	±3.0	%Vnom.	
Line Regulation	Vin=Min. to Max.	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	%
Min.Load	No minimum Load Requirement					
Ripple & Noise	0-20MHz Bandwidth	1.5V to 6.5V	---	---	30	mV <sub>P-P</sub>
		9V to 15V	---	---	40	mV <sub>P-P</sub>
Transient Recovery Time	50% Load Step Change	---	100	---	µsec	
Transient Response Deviation		---	±2	---	%	
Temperature Coefficient		---	---	±0.015	%/°C	
Short Circuit Protection	Continuous					

**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			

**Remote On/Off Control**

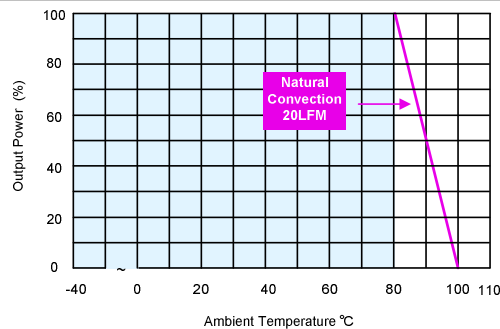
Parameter	Conditions	Min.	Typ.	Max.	Unit
Converter On	Open or $2.4V < V_r < 5V$				
Converter Off	GND or $0 < V_r < 1.6V$				
Standby Input Current	Supply Off & 24 Vin	---	---	35	μA

**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
Lead-free reflow solder process	IPC/JEDEC J-STD-020D.1				

**EMC Specifications**

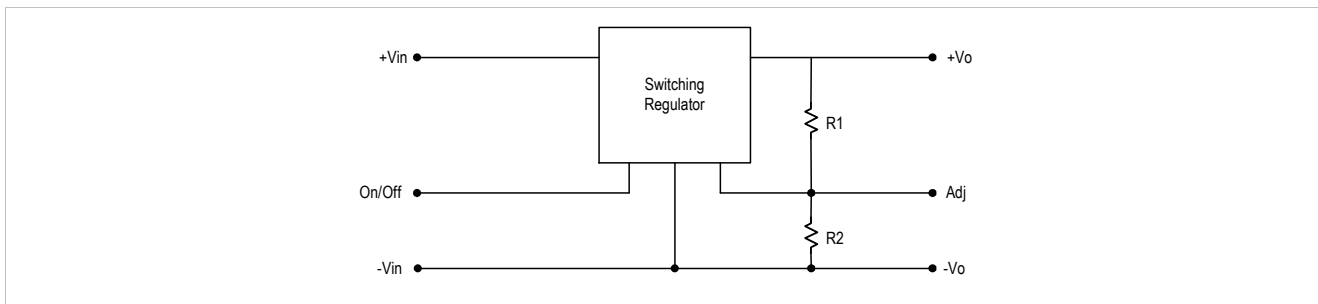
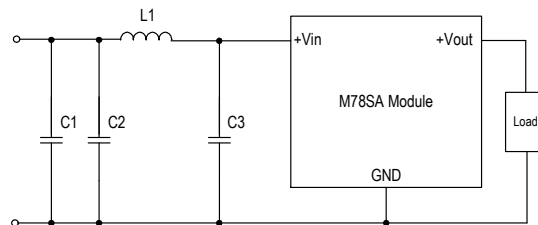
Parameter	Standards & Level	Performance
Conducted EMI	Compliance to EN55022 and FCC part 15	Class B (See Page 3)
Radiated Emissions	EN55022	Class B
ESD	EN61000-4-2 air±8KV	Class A
Radiated immunity	EN61000-4-3 3V/m	Class A
Fast transient (4)	EN61000-4-4 ±0.5KV	Class A
Conducted immunity	EN61000-4-6 3Vrms	Class A
Magnetic Field Immunity	EN61000-4-8 3A/m	Class A

**Power Derating Curve**

**Notes**

- Specifications typical at  $T_a = +25^\circ\text{C}$ , resistive load, nominal input voltage, rated output current unless otherwise noted.
- Other input and output voltage may be available, please contact factory.
- We recommend to protect the converter by a slow blow fuse in the input supply line.
- The M78SA series can meet EN61000-4-4 by adding a capacitor across the input pins. Suggested capacitor CHEMI-CON KY 330μF/100V.
- That "natural convection" is about 20LFM but is not equal to still air (0 LFM).
- With a input capacitor 22μF/50V for input voltage >28VDC, the input voltage allows 32VDC, max.
- Specifications are subject to change without notice.
- Input voltage must be higher than output voltage set: >1.5V for 3.3V~5V and >3V for 6.5V~15V.

**Adjustment Resistor Values**

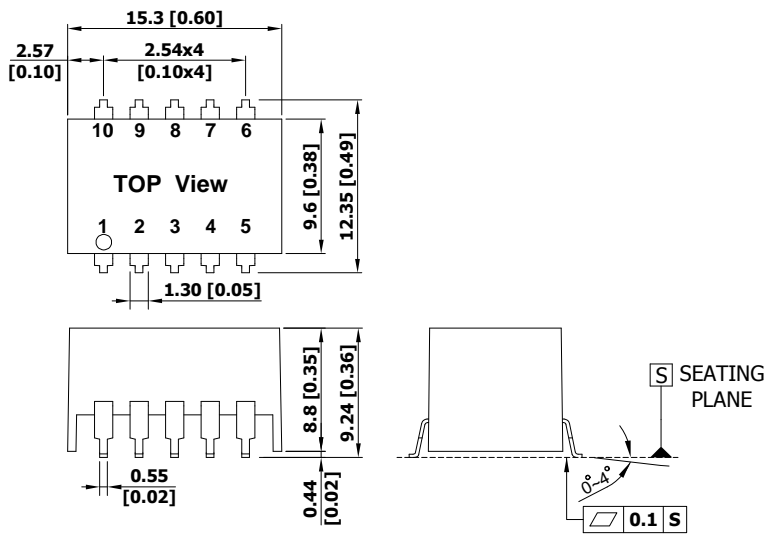
Vout(nom.)	M78SAR015-0.5		M78SAR018-0.5		M78SAR025-0.5		M78SAR033-0.5		M78SAR05-0.5		M78SAR065-0.5		M78SAR09-0.5		M78SAR12-0.5		M78SAR15-0.5	
	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2
1.4 (V)	1 K $\Omega$																	
1.5 (V)			3K $\Omega$		200 $\Omega$													
1.8 (V)		6.49 K $\Omega$			12K $\Omega$													
2.5 (V)		0.47 K $\Omega$		11.8K $\Omega$														
3.0 (V)				4.64K $\Omega$		44.2K $\Omega$	88.4K $\Omega$		17K $\Omega$									
3.3 (V)									27K $\Omega$	15K $\Omega$								
3.6 (V)								60.4K $\Omega$	42K $\Omega$	21.5K $\Omega$								
3.9 (V)								28K $\Omega$	58K $\Omega$	30.1K $\Omega$								
4.5 (V)								11.3K $\Omega$	180K $\Omega$	56.3K $\Omega$	26K $\Omega$	17K $\Omega$	10.5 K $\Omega$					
4.9 (V)								7.15K $\Omega$	850K $\Omega$	78.7K $\Omega$	36K $\Omega$	24K $\Omega$	15.8 K $\Omega$					
5.0 (V)								6.34K $\Omega$		86K $\Omega$	39K $\Omega$	26K $\Omega$	17.4 K $\Omega$					
5.1 (V)								5.9K $\Omega$	231K $\Omega$	97K $\Omega$	42K $\Omega$	28K $\Omega$	18.7 K $\Omega$					
5.5 (V)								3.9K $\Omega$	56.2K $\Omega$	154K $\Omega$	56K $\Omega$	36K $\Omega$	24.9 K $\Omega$					
6.5 (V)									14K $\Omega$		112K $\Omega$	63K $\Omega$	42.2 K $\Omega$					
8.0 (V)									2.32K $\Omega$		400K $\Omega$	125K $\Omega$	78.7 K $\Omega$					
9.0 (V)											9.53K $\Omega$	200K $\Omega$	113 K $\Omega$					
10 (V)											3.92K $\Omega$	54.9K $\Omega$	160 K $\Omega$					
11 (V)											82 $\Omega$	16.5K $\Omega$	232 K $\Omega$					
12 (V)												3.6K $\Omega$	340 K $\Omega$					
12.6 (V)												0 $\Omega$	180K $\Omega$	464 K $\Omega$				
13.5 (V)													57.6 K $\Omega$	787 K $\Omega$				
15.5 (V)																		300 K $\Omega$


**EMI-Filter to meet EN 55022, class A, class B; FCC part 15 ,level A**


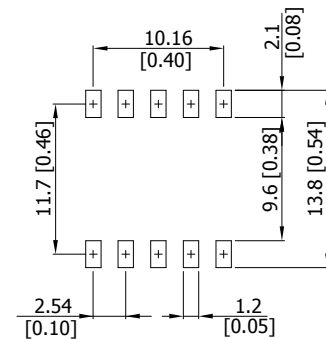
Class	C1	C2	C3	L1
Class A	---	4.7 $\mu$ F/50V 1206 MLCC	4.7 $\mu$ F/50V 1206 MLCC	Würth Elektronik NO. 744774033
Class B	4.7 $\mu$ F/50V 1206 MLCC	4.7 $\mu$ F/50V 1206 MLCC	4.7 $\mu$ F/50V 1206 MLCC	Würth Elektronik NO. 74477410

**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