

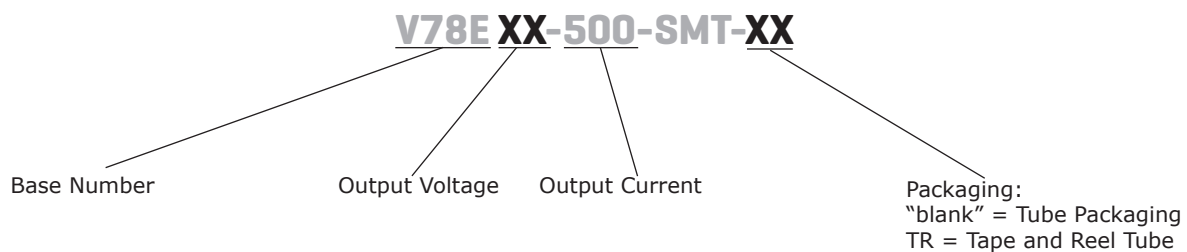
**SERIES: V78E-500-SMT | DESCRIPTION: NON-ISOLATED DC SWITCHING REGULATOR**
**FEATURES**

- 500 mA of output current
- efficiency up to 95%
- SMT package
- industrial operating temp -40~+85°C
- industry standard footprint
- no load input current of 0.2 mA
- output short circuit protection on output

**MODEL**

MODEL	input voltage <sup>1</sup>		output voltage (Vdc)	output current max (mA)	output power max (W)	ripple & noise <sup>2</sup> max (mVp-p)	efficiency <sup>3</sup> typ (%)
	typ (Vdc)	range (Vdc)					
V78E01-500-SMT	12	4.75~28	1.5	500	0.75	50	76
V78E02-500-SMT	12	4.75~32	2.5	500	1.25	50	81
V78E03-500-SMT	24	4.75~36	3.3	500	1.65	50	86
V78E05-500-SMT	24	6.5~36	5	500	2.5	50	90
V78E06-500-SMT	24	8~36	6.5	500	3.25	50	92
V78E09-500-SMT	24	12~36	9	500	4.5	50	93
V78E12-500-SMT	24	15~36	12	500	6	50	94
V78E15-500-SMT	24	19~36	15	500	7.5	50	95

- Notes:
1. For input voltages higher than 30 Vdc, a 22  $\mu$ F / 50 V input capacitor is required.
  2. Tested at nominal input, 20 MHz bandwidth, with 10  $\mu$ F electrolytic and 1  $\mu$ F ceramic capacitor on the output. For 1.5~3.3 Vdc output models, tested at 20~100% load. For all other models, tested at 10~100% load. At loads below 20% for 1.5~3.3 Vdc output models, the max ripple and noise will be 100 mVp-p. At loads below 10% for all other models, the max ripple and noise will be 150 mVp-p.
  3. Measured at min  $V_{in}$ , full load.
  4. All specifications are measured at  $T_a=25^\circ\text{C}$ , humidity < 75%, nominal input voltage, and rated output load unless otherwise specified.

**PART NUMBER KEY**

## INPUT

parameter	conditions/description	min	typ	max	units
operating input voltage <sup>5</sup>		4.75		36	Vdc
filter	capacitor filter				
input reverse polarity protection	no				
no-load input current			0.2	1.5	mA
remote on/off <sup>6</sup>	turn on (3.2~8 Vdc or open circuit) turn off (<0.8 Vdc) input current when switched off		0.03	0.1	mA

Note: 5. See Model section on page 1 for specific input voltage ranges.

6. The voltage of remote ON/OFF pin is relative to GND pin.

## OUTPUT

parameter	conditions/description	min	typ	max	units
maximum capacitive load <sup>7</sup>				680	μF
voltage accuracy	at full load, input voltage range 1.5, 2.5, 3.3 Vdc output models all other models		±2 ±2	±4 ±3	% %
line regulation	at full load, input voltage range		±0.2	±0.4	%
load regulation	at 10~100 % load, input voltage range 1.5, 2.5 Vdc output models all other models			±1 ±0.6	% %
voltage adjustment	input voltage range		±10		%Vo
switching frequency	at full load, input voltage range 1.5 Vdc output model all other models		370 700		kHz kHz
transient recovery time	at nominal input voltage, 25% load step change		0.2	1	ms
transient response deviation	at nominal input voltage, 25% load step change		50	200	mV
temperature coefficient	operating temperature -40 °C to +85 °C			±0.03	%/°C

Note: 7. The maximum capacitive load was tested at nominal input voltage, full load.

## PROTECTIONS

parameter	conditions/description	min	typ	max	units
short circuit protection	continuous, auto recovery				

## SAFETY AND COMPLIANCE

parameter	conditions/description	min	typ	max	units
safety approvals	designed to meet 62368: EN, BS EN				
conducted emissions	CISPR32/EN55032, class B (external circuit required, see Figure 3-b)				
radiated emissions	CISPR32/EN55032, class B (external circuit required, see Figure 3-b)				
ESD	IEC/EN61000-4-2, contact ± 4kV, class B				
radiated immunity	IEC/EN61000-4-3, 10V/m, class A				
EFT/burst	IEC/EN61000-4-4, ± 1kV, class B (external circuit required, see Figure 3-a)				
surge	IEC/EN61000-4-5, line-line ± 1kV, class B (external circuit required, see Figure 3-a)				
conducted immunity	IEC/EN61000-4-6, 3 Vr.m.s, class A				
MTBF	as per MIL-HDBK-217F, 25°C	2,000,000			hours
RoHS	yes				

## ENVIRONMENTAL

parameter	conditions/description	min	typ	max	units
operating temperature	see derating curve	-40		85	°C
storage temperature		-55		125	°C
storage humidity	non-condensing			95	%

## SOLDERABILITY

parameter	conditions/description	min	typ	max	units
reflow soldering	see reflow profile, refer to IPC/JEDEC J-STD-020D.1			245	°C



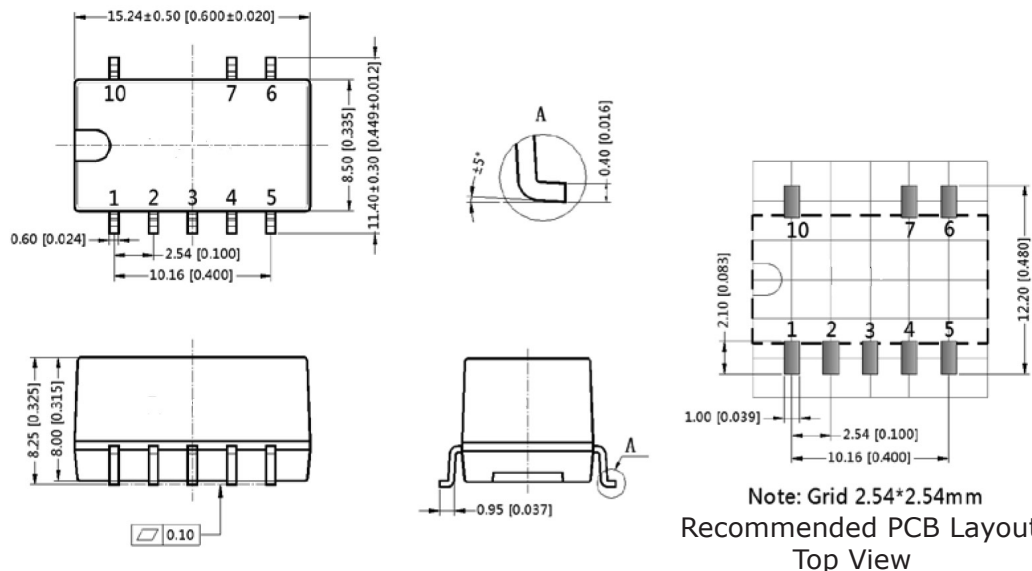
## MECHANICAL

parameter	conditions/description	min	typ	max	units
dimensions	15.24 x 8.50 x 8.25 [0.60 x 0.335 x 0.325 inch]				mm
case material	black flame-retardant and heat resistant plastic (UL94V-0)				
weight			1.5		g

## MECHANICAL DRAWING

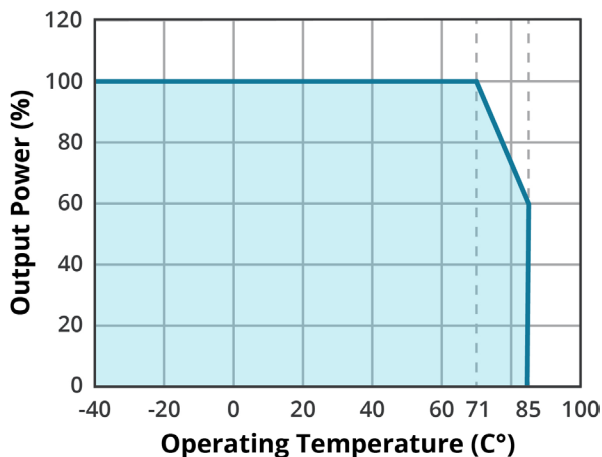
units: mm [inch]  
 tolerance: ±0.50[±0.020]  
 pin section tolerance: ±0.10[±0.004]

PIN CONNECTIONS	
PIN	FUNCTION
1	+VIN
2	+VIN
3	GND
4	+VOUT
5	+VOUT
6	V adj
7	GND
10	remote on/off



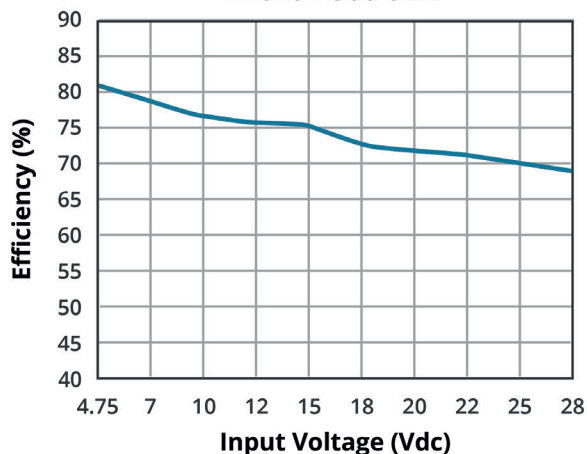
## DERATING CURVE

**TEMPERATURE DERATING CURVE**

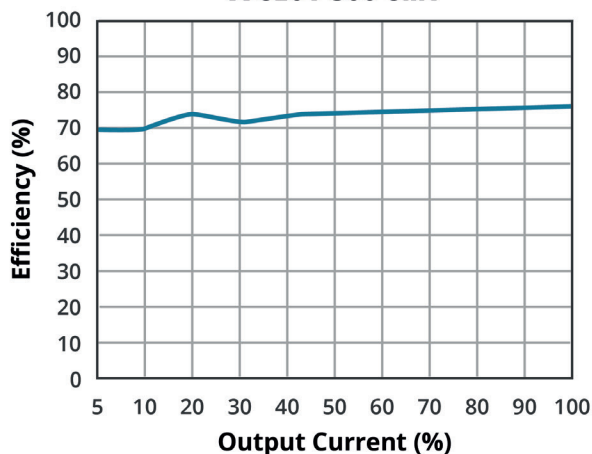


## EFFICIENCY CURVES

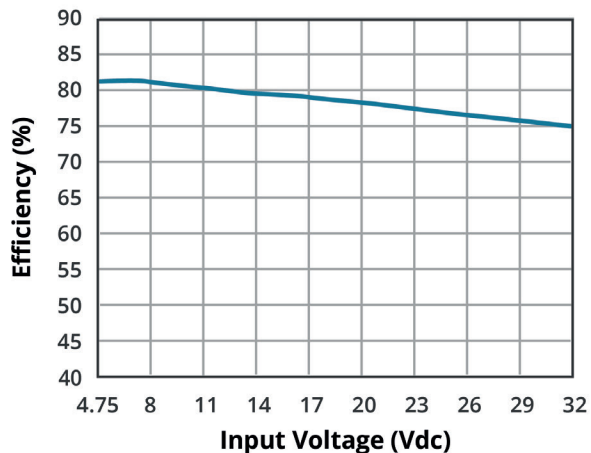
**EFFICIENCY VS INPUT VOLTAGE  
(full load)  
V78E01-500-SMT**



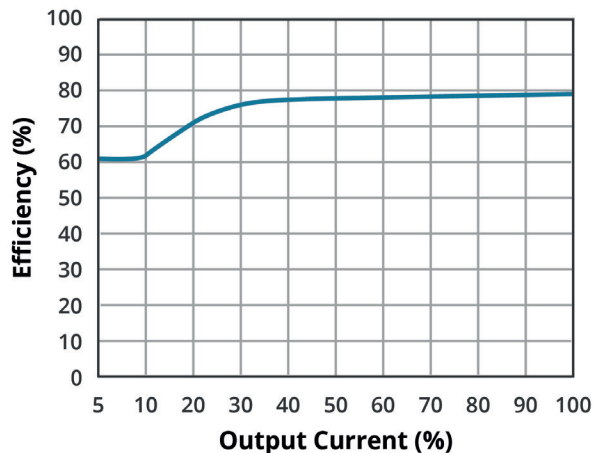
**EFFICIENCY VS OUTPUT LOAD  
(at nominal input)  
V78E01-500-SMT**



**EFFICIENCY VS INPUT VOLTAGE  
(full load)  
V78E02-500-SMT**

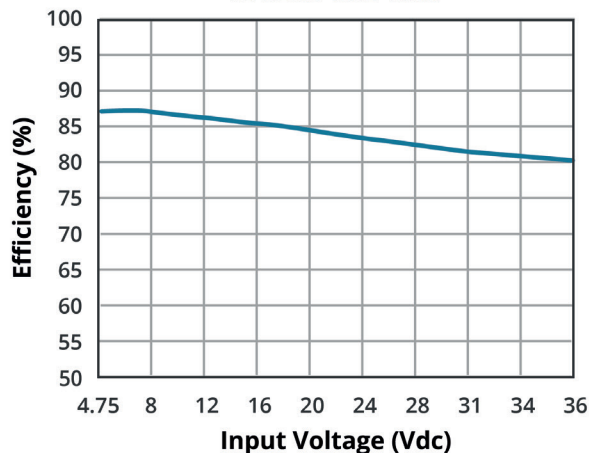


**EFFICIENCY VS OUTPUT LOAD  
(at nominal input)  
V78E02-500-SMT**

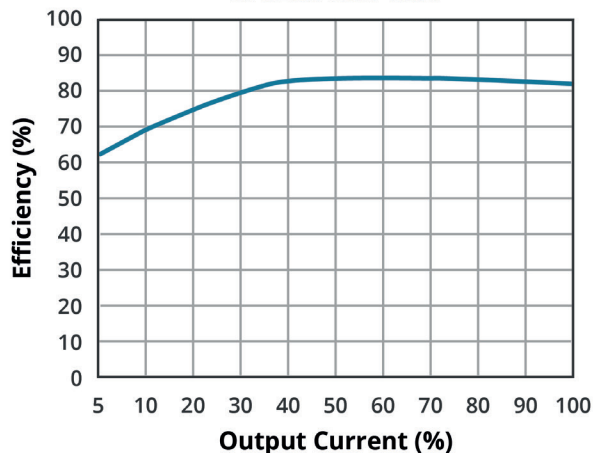


## EFFICIENCY CURVES (CONTINUED)

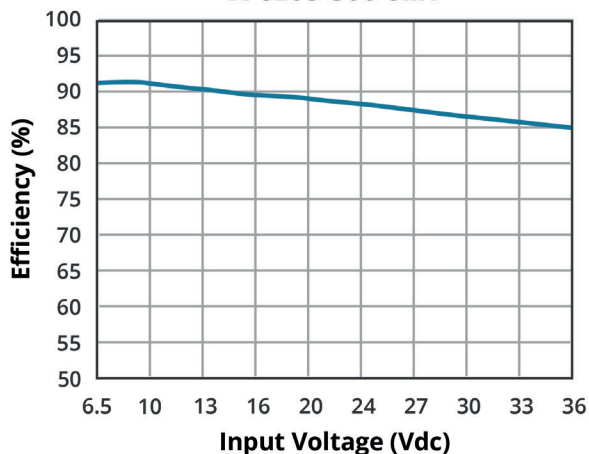
**EFFICIENCY VS INPUT VOLTAGE  
(full load)  
V78E03-500-SMT**



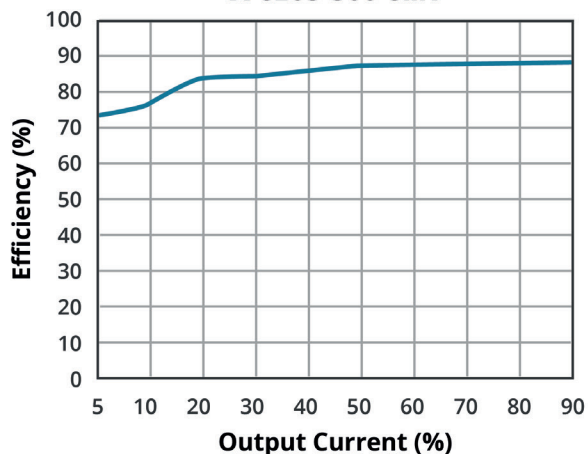
**EFFICIENCY VS OUTPUT LOAD  
(at nominal input)  
V78E03-500-SMT**



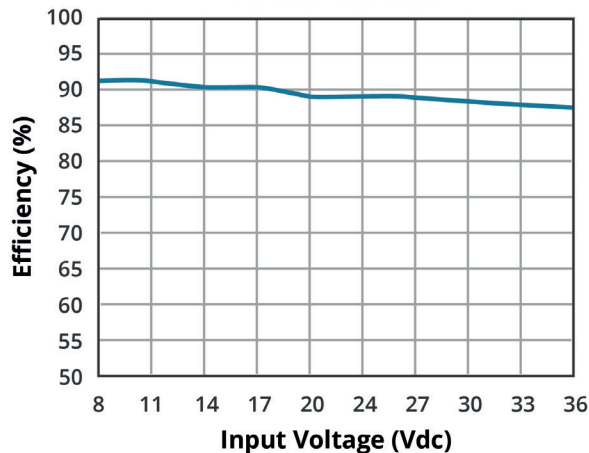
**EFFICIENCY VS INPUT VOLTAGE  
(full load)  
V78E05-500-SMT**



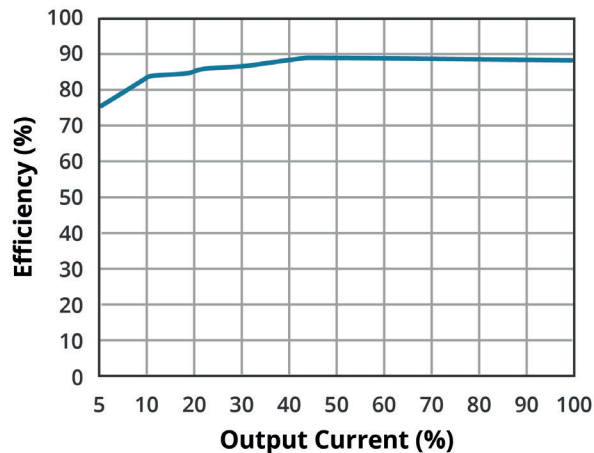
**EFFICIENCY VS OUTPUT LOAD  
(at nominal input)  
V78E05-500-SMT**



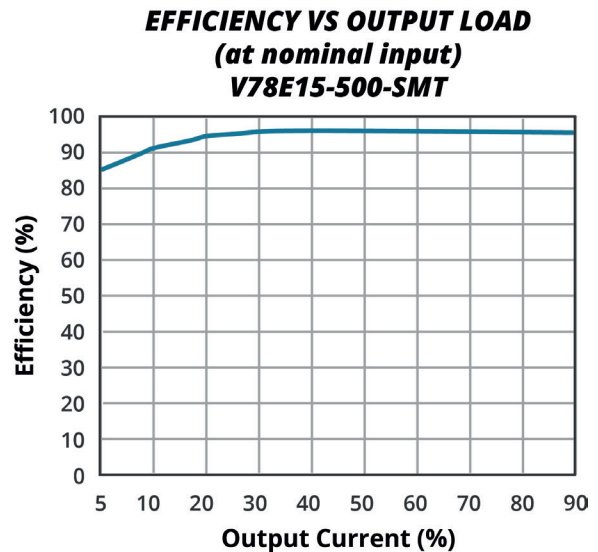
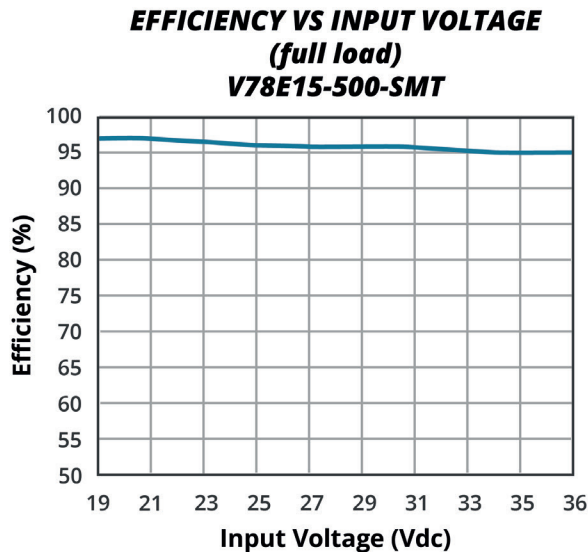
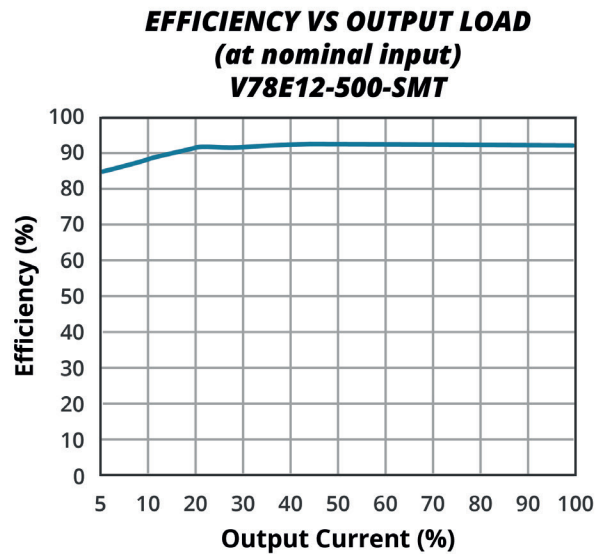
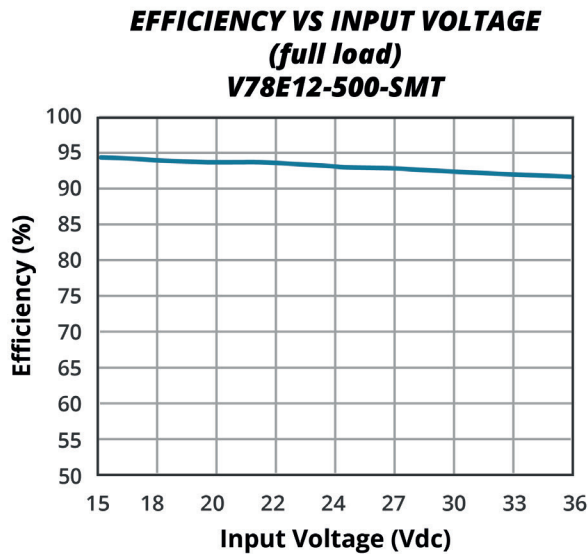
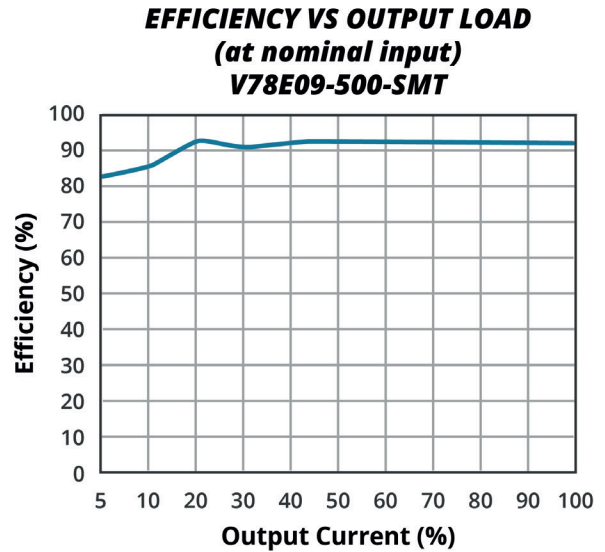
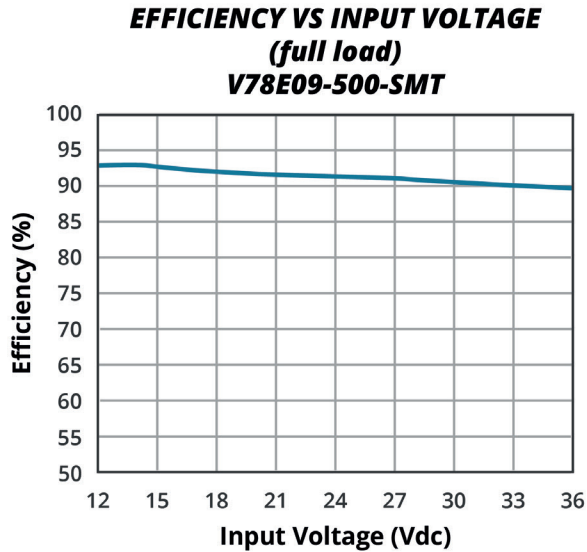
**EFFICIENCY VS INPUT VOLTAGE  
(full load)  
V78E06-500-SMT**



**EFFICIENCY VS OUTPUT LOAD  
(at nominal input)  
V78E06-500-SMT**

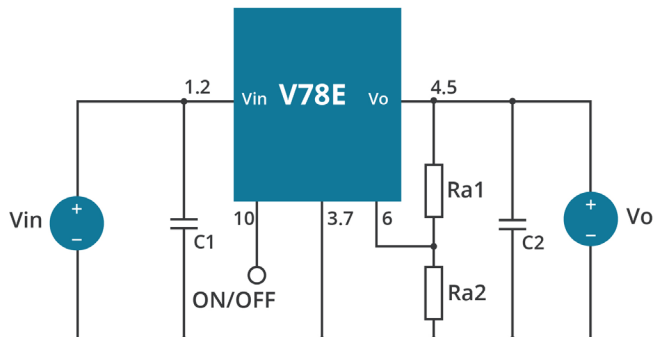


## EFFICIENCY CURVES (CONTINUED)

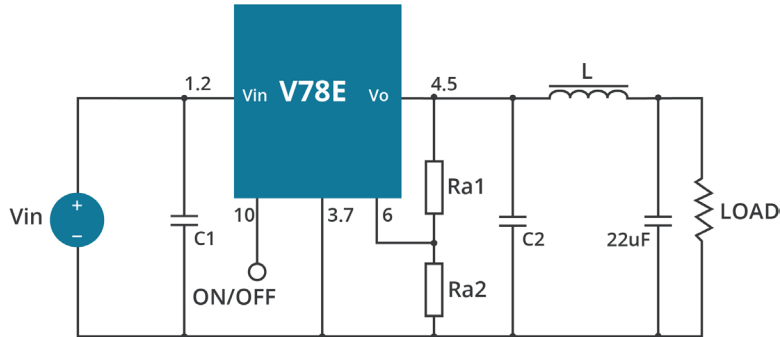


## TYPICAL APPLICATION CIRCUIT

**Figure 1**  
Application Circuit



**Figure 2**  
LC Filter Application Circuit

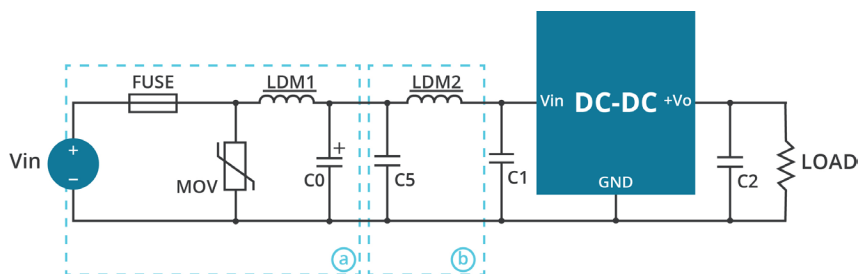


**Table 1**

Model Number	C1 (ceramic capacitor)	C2 (ceramic capacitor)	Ra1/Ra2 (Vadj resistance)
V78E01-500-SMT	10 $\mu$ F/50 V	22 $\mu$ F/10 V	refer to Vadj resistance calculation
V78E02-500-SMT	10 $\mu$ F/50 V	22 $\mu$ F/10 V	
V78E03-500-SMT	10 $\mu$ F/50 V	22 $\mu$ F/10 V	
V78E05-500-SMT	10 $\mu$ F/50 V	22 $\mu$ F/16 V	
V78E06-500-SMT	10 $\mu$ F/50 V	22 $\mu$ F/16 V	
V78E09-500-SMT	10 $\mu$ F/50 V	22 $\mu$ F/25 V	
V78E12-500-SMT	10 $\mu$ F/50 V	22 $\mu$ F/25 V	
V78E15-500-SMT	10 $\mu$ F/50 V	22 $\mu$ F/25 V	

## EMC RECOMMENDED CIRCUIT

**Figure 3**



**Table 2**

Recommended external circuit components	
FUSE	choose according to actual input current
MOV	S20K30
LDM1	82 $\mu$ H
C0	680 $\mu$ F/50 V
C1, C2	refer to table 1
C5	4.7 $\mu$ F/50 V
LDM2	12 $\mu$ H

- Note:
- C1 & C2 are required and should be connected as close to the module pins as possible.
  - C1 & C2 can be increased as needed and the use of tantalum or low ESR electrolytic capacitors would be recommended.
  - To reduce the output ripple further, it is recommended to add an "LC" filter at the output (see figure 2) with a 10~47  $\mu$ H L component.

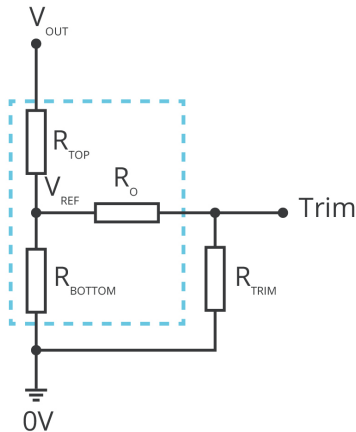
## APPLICATION NOTES

### Output voltage trimming

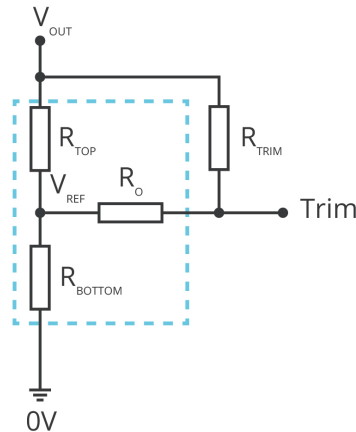
Leave open if not used.

Figure 4

Trim up



Trim down



$$R_{TRIM} = \frac{a \cdot R_{BOTTOM}}{R_{BOTTOM} - a} - R_O \quad a = \frac{V_{REF}}{V_{OUT} - V_{REF}} \cdot R_{TOP}$$

Formula for Trim up

$$R_{TRIM} = \frac{a \cdot R_{TOP}}{R_{TOP} - a} - R_O \quad a = \frac{V_{OUT} - V_{REF}}{V_{REF}} \cdot R_{BOTTOM}$$

Formula for Trim down

Table 3

V <sub>NOM</sub> (Vdc)	R <sub>TOP</sub> (kΩ)	R <sub>BOTTOM</sub> (kΩ)	R <sub>O</sub> (kΩ)	V <sub>REF</sub> (V)
1.5 <sup>11</sup>	7.5	7.5	15	0.75
2.5	27	11.858	51	0.765
3.3	33	9.9	47	0.765
5	75	13.5	75	0.765
6.5	75	10	51	0.765
9	75	4.7	27	0.765
12	51	5.1	27	0.765
15	82	4.423	27	2.0.765

Note: 11. The 1.5 Vdc output model can only be adjusted up.

Note: Value for R<sub>TOP</sub>, R<sub>BOTTOM</sub>, R<sub>O</sub>, and V<sub>REF</sub> refer to Table 3  
 R<sub>TRIM</sub>: Trim Resistor  
 a: User-defined parameter, no actual meanings  
 V<sub>OUT</sub>: The trim up/down voltage



## REVISION HISTORY

rev.	description	date
1.0	initial release	09/12/2018
1.01	features and safety line updated, packaging removed	01/14/2021
1.02	product image updated	05/19/2021
1.03	updated derating and efficiency curves and circuit figures	06/09/2021
1.04	PN key updated	03/02/2022
1.05	safeties updated	07/25/2022
1.06	output voltage trimming updated	06/07/2023

The revision history provided is for informational purposes only and is believed to be accurate.



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