



**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
- designed to meet IEC/EN 62368-1
- industry standard footprint
- no load input current of 0.2 mA
- output short circuit protection on output

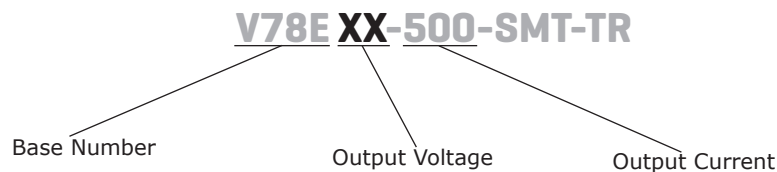


**MODEL**

MODEL	input voltage <sup>1</sup>		output voltage	output current	output power	ripple & noise <sup>2</sup>	efficiency <sup>3</sup>
	typ (Vdc)	range (Vdc)	(Vdc)	max (mA)	max (W)	max (mVp-p)	typ (%)
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

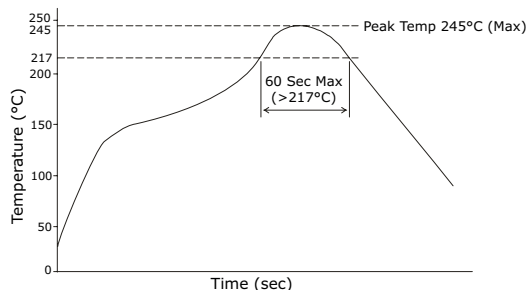
parameter	conditions/description	min	typ	max	units
safety approvals	CE				
conducted emissions	CISPR32/EN55032, class B (external circuit required, see Figure 3-b)				
radiated emissions	CISPR32/EN55032, class B (external circuit required, see Figure 3-b)				
ESD	IEC/EN61000-4-2, contact ± 4kV, class 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



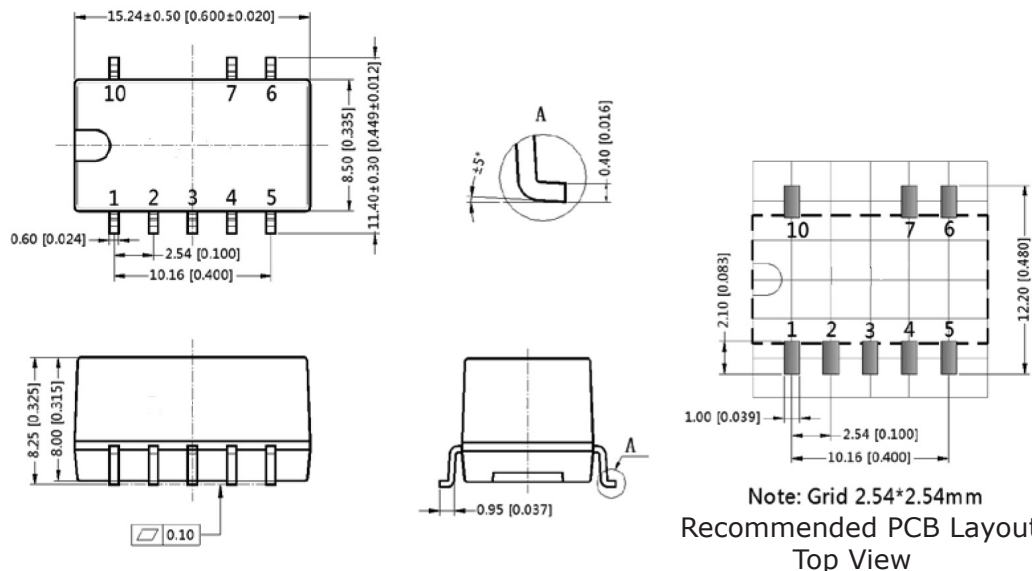
## MECHANICAL

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

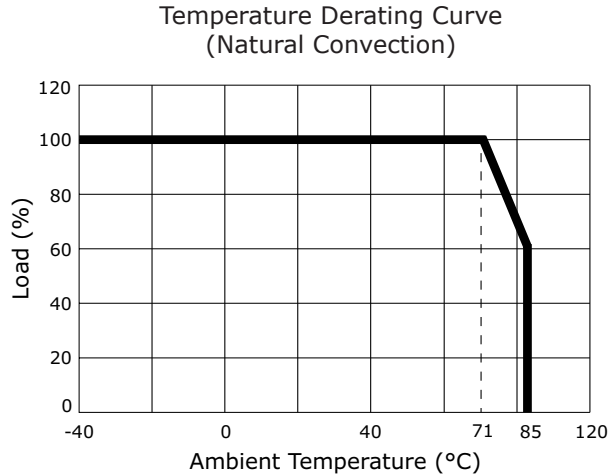
## MECHANICAL DRAWING

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

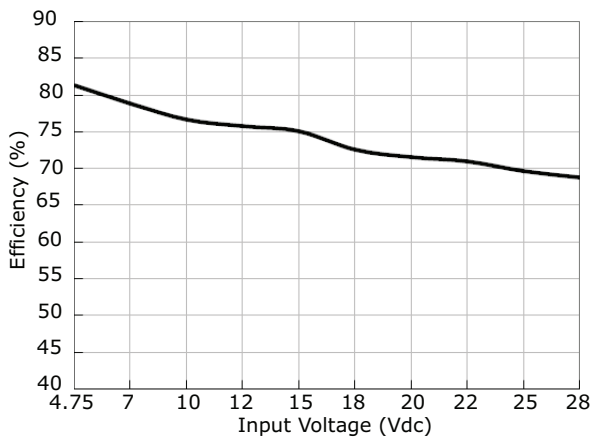


## DERATING CURVE

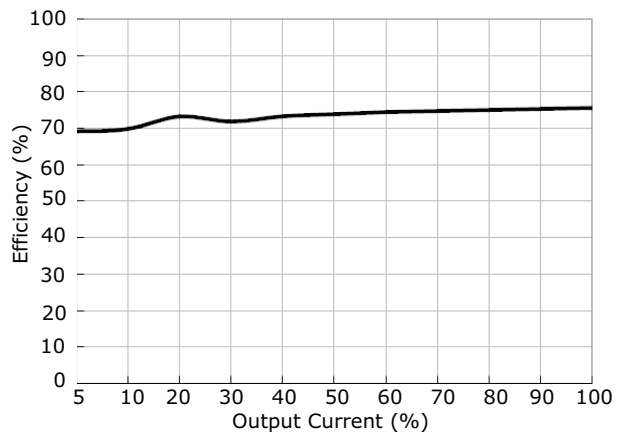


## EFFICIENCY CURVES

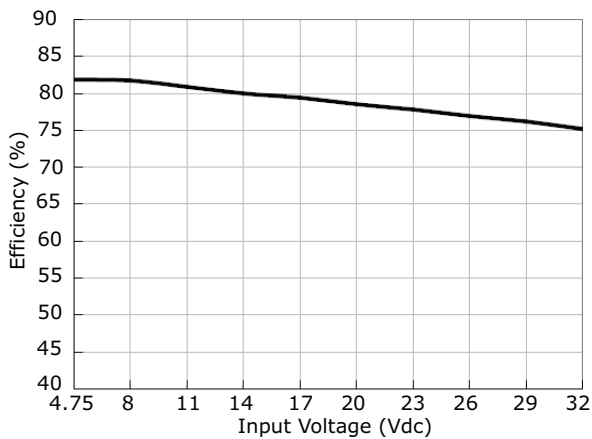
V78E01-500-SMT Efficiency Curve  
Efficiency vs. Input Voltage  
(at full load)



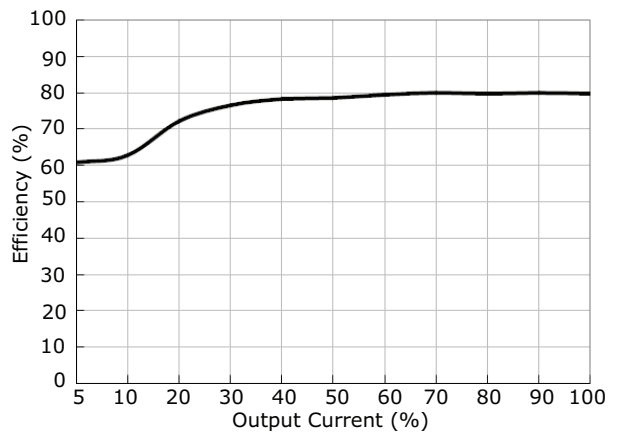
V78E01-500-SMT Efficiency Curve  
Efficiency vs. Load Current  
(at Vin nominal)



V78E02-500-SMT Efficiency Curve  
Efficiency vs. Input Voltage  
(at full load)

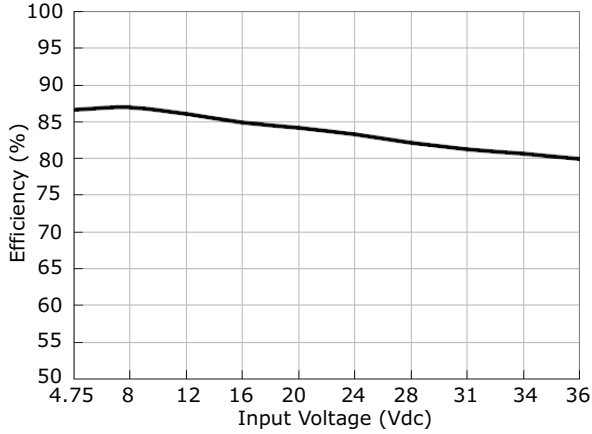


V78E02-500-SMT Efficiency Curve  
Efficiency vs. Load Current  
(at Vin nominal)

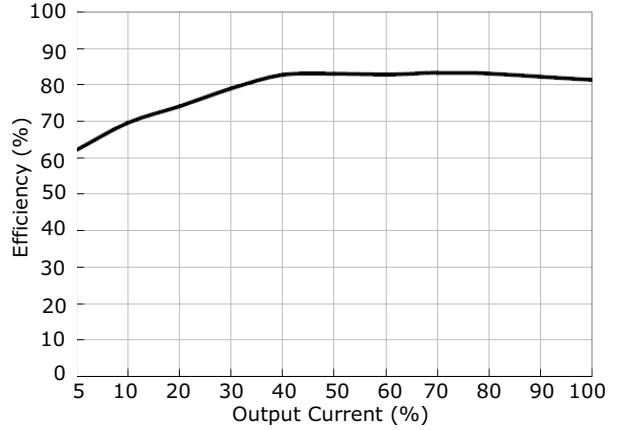


## EFFICIENCY CURVES (CONTINUED)

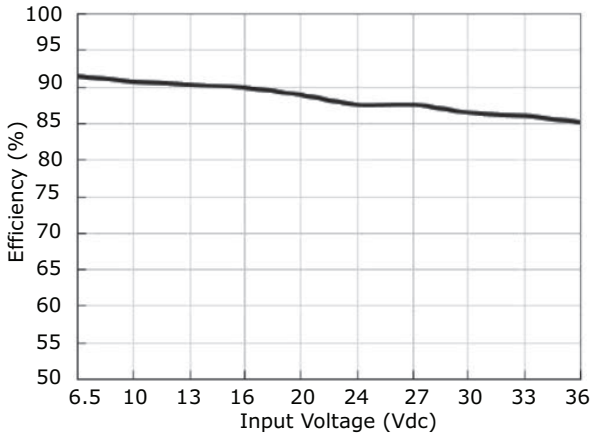
V78E03-500-SMT Efficiency Curve  
Efficiency vs. Input Voltage  
(at full load)



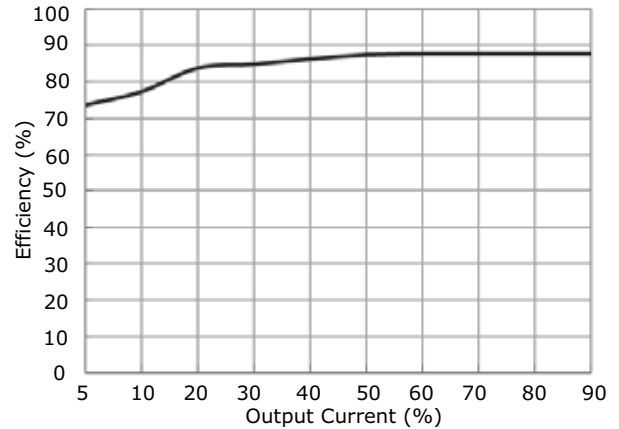
V78E03-500-SMT Efficiency Curve  
Efficiency vs. Load Current  
(at Vin nominal)



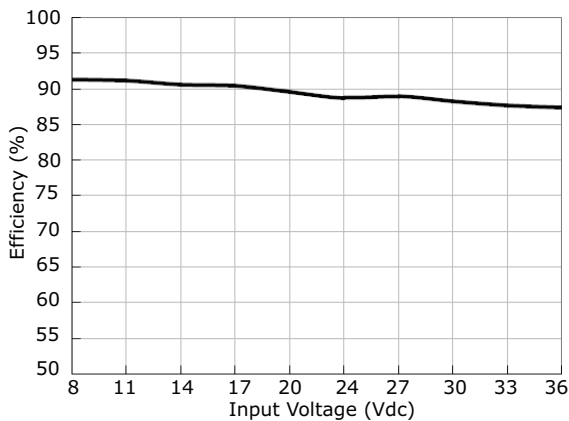
V78E05-500-SMT Efficiency Curve  
Efficiency vs. Input Voltage  
(at full load)



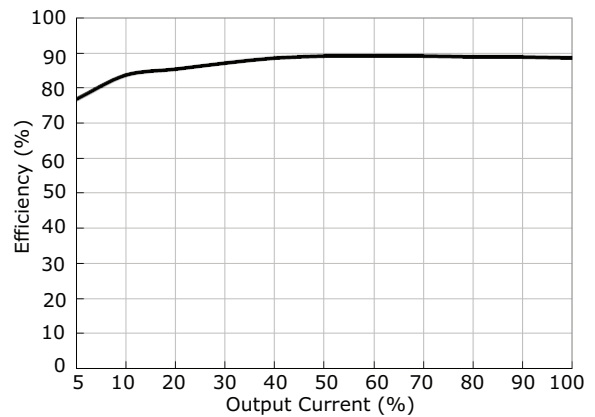
V78E05-500-SMT Efficiency Curve  
Efficiency vs. Load Current  
(at Vin nominal)



V78E06-500-SMT Efficiency Curve  
Efficiency vs. Input Voltage  
(at full load)

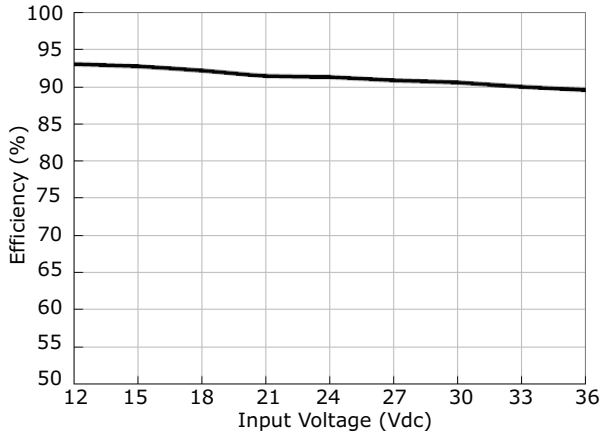


V78E06-500-SMT Efficiency Curve  
Efficiency vs. Load Current  
(at Vin nominal)

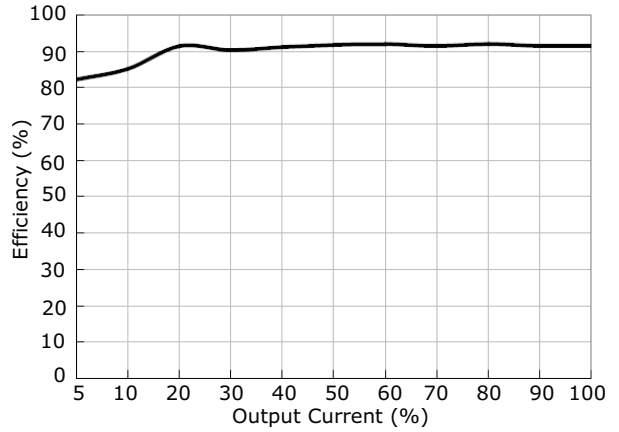


## EFFICIENCY CURVES (CONTINUED)

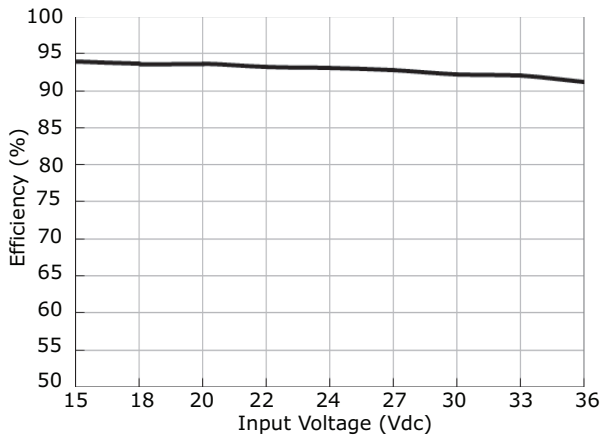
V78E09-500-SMT Efficiency Curve  
Efficiency vs. Input Voltage  
(at full load)



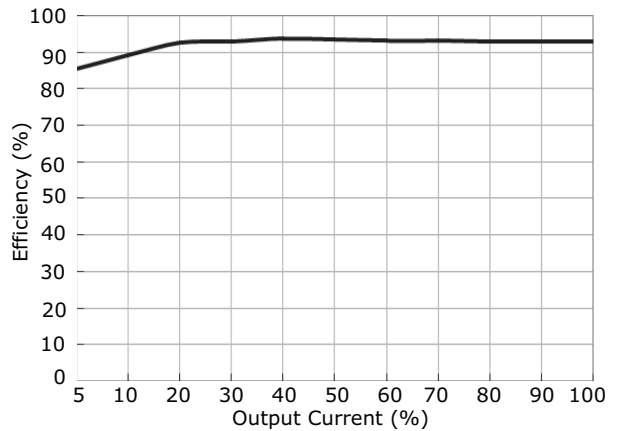
V78E09-500-SMT Efficiency Curve  
Efficiency vs. Load Current  
(at Vin nominal)



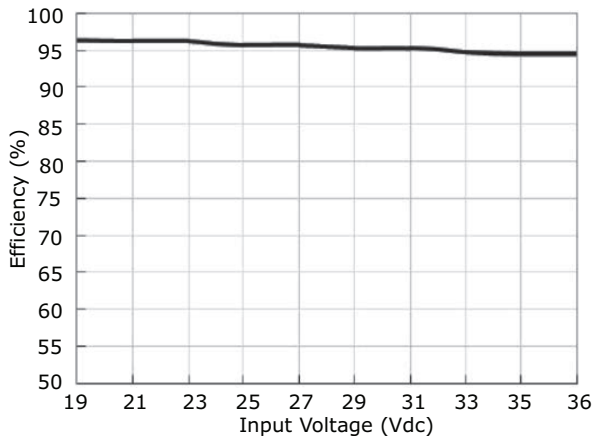
V78E12-500-SMT Efficiency Curve  
Efficiency vs. Input Voltage  
(at full load)



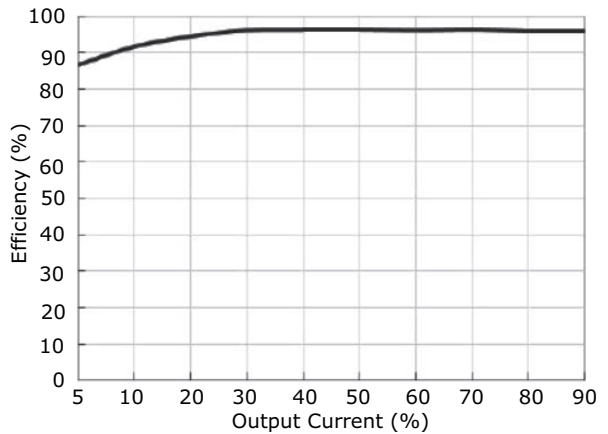
V78E12-500-SMT Efficiency Curve  
Efficiency vs. Load Current  
(at Vin nominal)



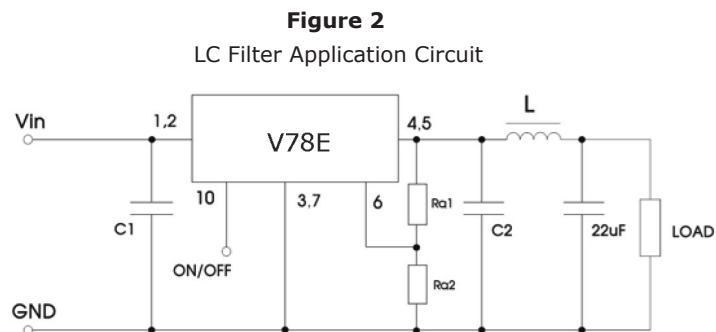
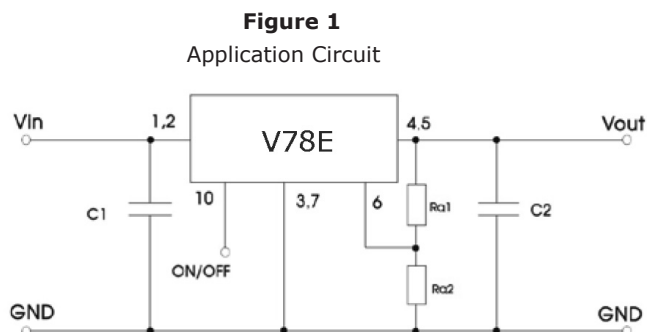
V78E15-500-SMT Efficiency Curve  
Efficiency vs. Input Voltage  
(at full load)



V78E15-500-SMT Efficiency Curve  
Efficiency vs. Load Current  
(at Vin nominal)



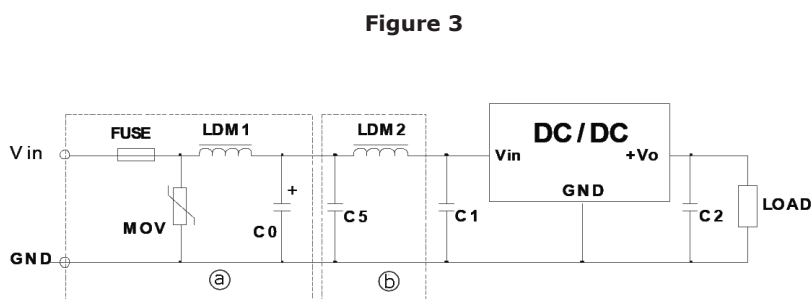
## TYPICAL APPLICATION CIRCUIT



**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



**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

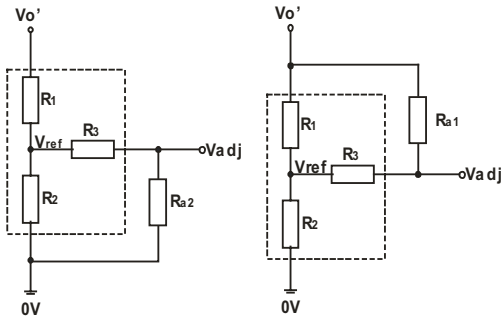
- Note:
- C1 & C2 are required and should be connected as close to the module pins as possible.
  - C1 & C2 can be increased as needed and the use of tantalum or low ESR electrolytic capacitors would be recommended.
  - To reduce the output ripple further, it is recommended to add an "LC" filter at the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

## APPLICATION NOTES

- Output voltage trimming**  
Leave open if not used.

**Figure 4**

Application Circuit for Trim pin  
(part in broken line is the interior of models)



Formula for Trim Resistor

$$\text{up: } R_{a2} = \frac{a R_2}{R_2 - a} - R_3 \quad a = \frac{V_{ref}}{V_{o'} - V_{ref}} \cdot R_1$$

$$\text{down: } R_{a1} = \frac{a R_1}{R_1 - a} - R_3 \quad a = \frac{V_{o'} - V_{ref}}{V_{ref}} \cdot R_2$$

Note: Value for R1, R2, R3, and Vref refer to Table 3  
Ra1/Ra2: Trim Resistor  
a: User-defined parameter, no actual meanings  
Vo': The trim up/down voltage

**Table 3**

Vout (Vdc)	R1 (kΩ)	R2 (kΩ)	R3 (kΩ)	Vref (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	51	4.7	27	0.765
12	75	5.1	27	0.765
15	82	4.423	27	0.765

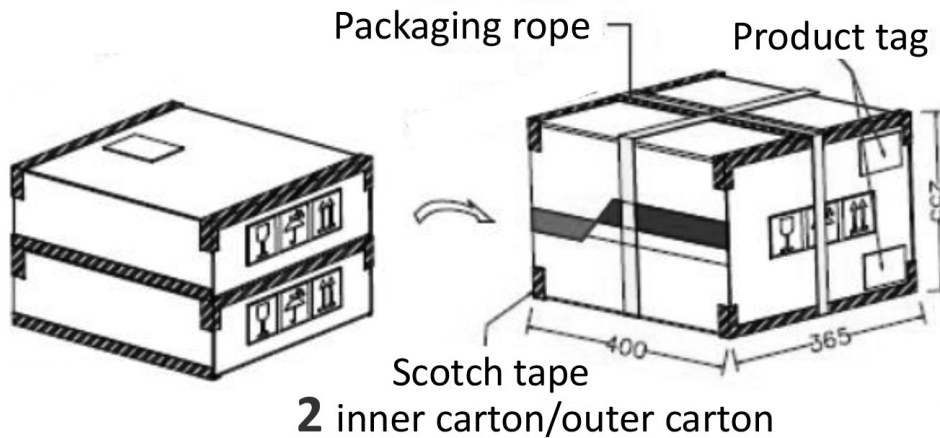
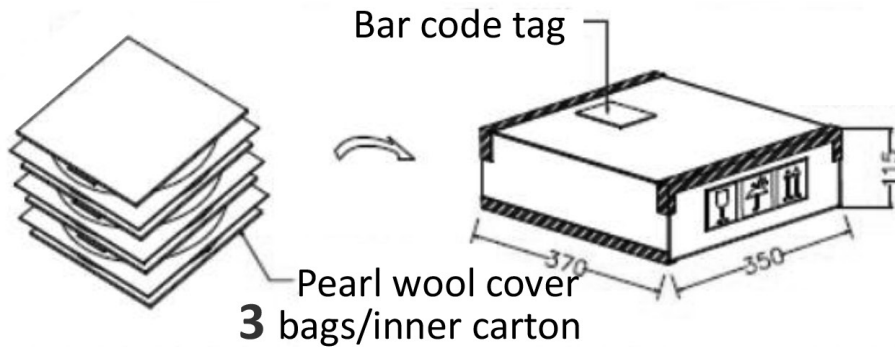
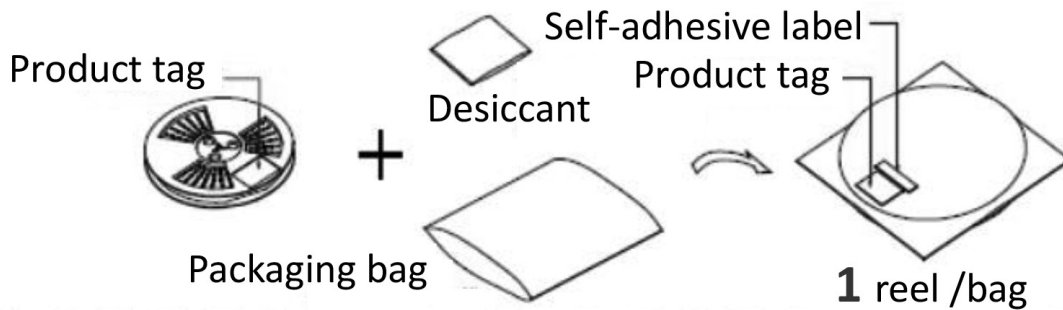
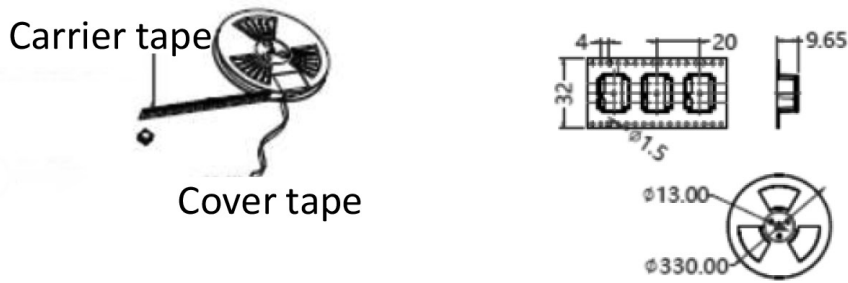
Note: 11. The 1.5 Vdc output model can only be adjusted up.



## PACKAGING

units: mm

Reel Size: Ø330 mm  
 Reel QTY: 300 pcs per tray  
 Carton Box Size: 400 x 365 x 255 mm  
 Carton Box QTY: 1,800 pcs per carton box



## REVISION HISTORY

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rev.	description	date
1.0	initial release	09/12/2018

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



**CUI INC**<sup>®</sup>

**Headquarters**  
20050 SW 112th Ave.  
Tualatin, OR 97062  
**800.275.4899**

Fax 503.612.2383  
**cui.com**  
techsupport@cui.com

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### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

Skype отдела продаж:

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