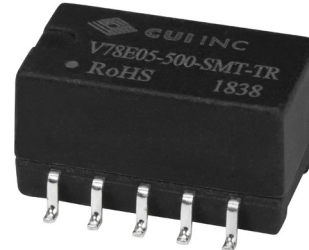


**SERIES: V78E-500-SMT | DESCRIPTION: NON-ISOLATED DC SWITCHING REGULATOR**
**FEATURES**

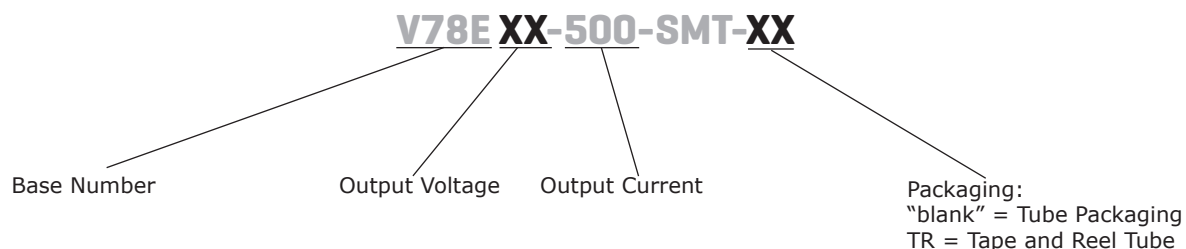
- 500 mA of output current
- efficiency up to 95%
- SMT package
- industrial operating temp -40~+85°C
- industry standard footprint
- no load input current of 0.2 mA
- output short circuit protection on output

**MODEL**

|                | input voltage <sup>1</sup> |                | output voltage<br>(Vdc) | output current<br>max<br>(mA) | output power<br>max<br>(W) | ripple & noise <sup>2</sup><br>max<br>(mVp-p) | efficiency <sup>3</sup><br>typ<br>(%) |
|----------------|----------------------------|----------------|-------------------------|-------------------------------|----------------------------|-----------------------------------------------|---------------------------------------|
|                | typ<br>(Vdc)               | range<br>(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)<br>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              |     | ±2   | ±4    | %     |
|                                      | 1.5, 2.5, 3.3 Vdc output models                |     | ±2   | ±3    | %     |
|                                      | all other models                               |     |      |       |       |
| line regulation                      | at full load, input voltage range              |     | ±0.2 | ±0.4  | %     |
| load regulation                      | at 10~100 % load, input voltage range          |     |      | ±1    | %     |
|                                      | 1.5, 2.5 Vdc output models                     |     |      | ±0.6  | %     |
|                                      | all other models                               |     |      |       |       |
| voltage adjustment                   | input voltage range                            |     | ±10  |       | %Vo   |
| switching frequency                  | at full load, input voltage range              |     |      |       |       |
|                                      | 1.5 Vdc output model                           |     | 370  |       | kHz   |
|                                      | all other models                               |     | 700  |       | 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

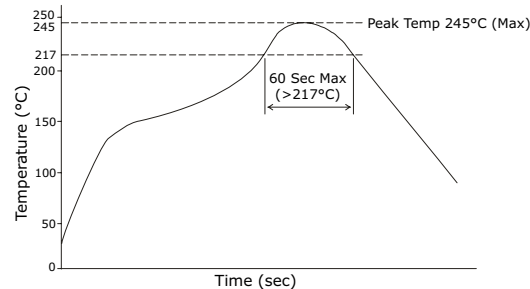
| parameter           | conditions/description                                                                | min       | typ | max | units |
|---------------------|---------------------------------------------------------------------------------------|-----------|-----|-----|-------|
| safety approvals    | 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    |



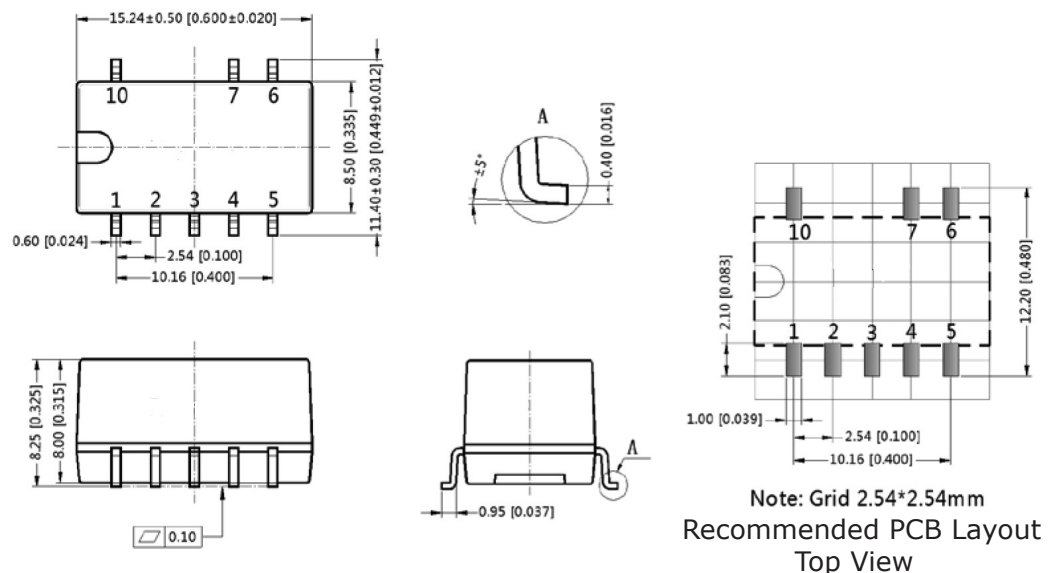
## MECHANICAL

| 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

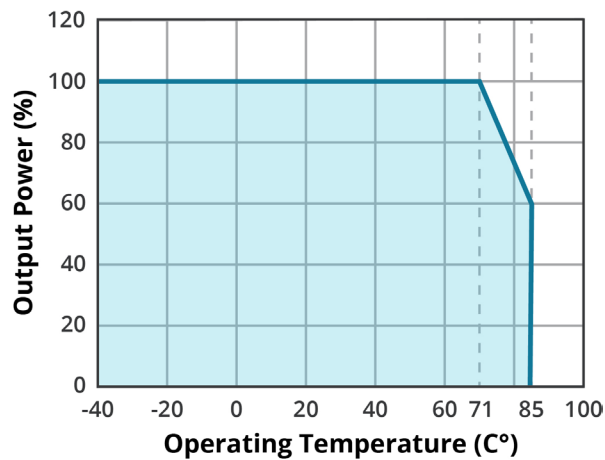
units: mm [inch]  
 tolerance:  $\pm 0.50$  [ $\pm 0.020$ ]  
 pin section tolerance:  $\pm 0.10$  [ $\pm 0.004$ ]

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



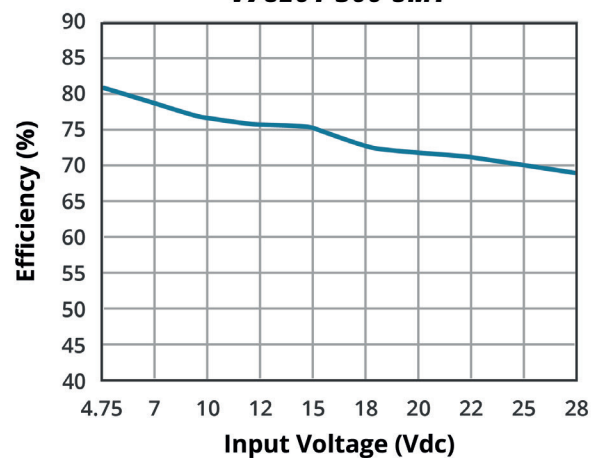
## DERATING CURVE

**TEMPERATURE DERATING CURVE**

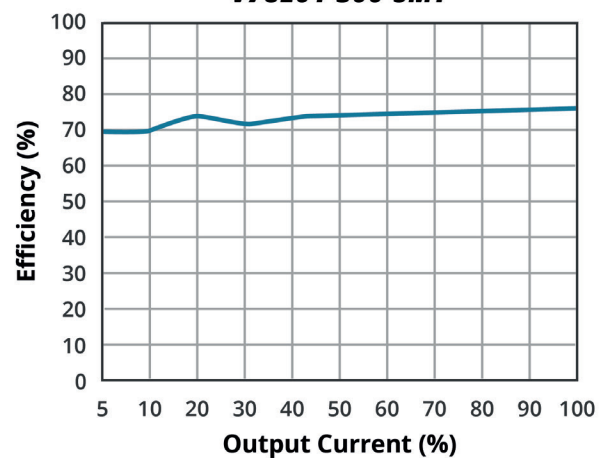


## EFFICIENCY CURVES

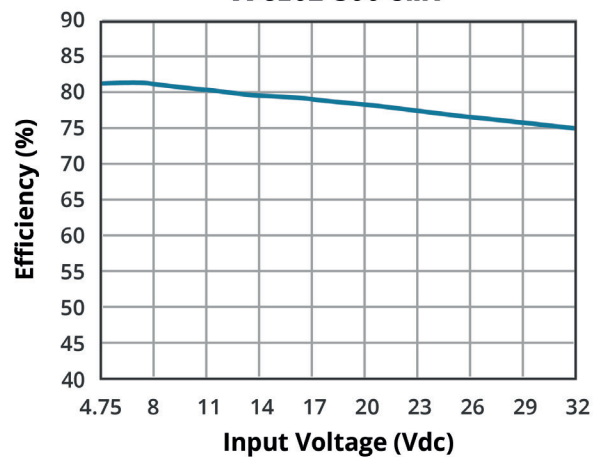
**EFFICIENCY VS INPUT VOLTAGE  
(full load)  
V78E01-500-SMT**



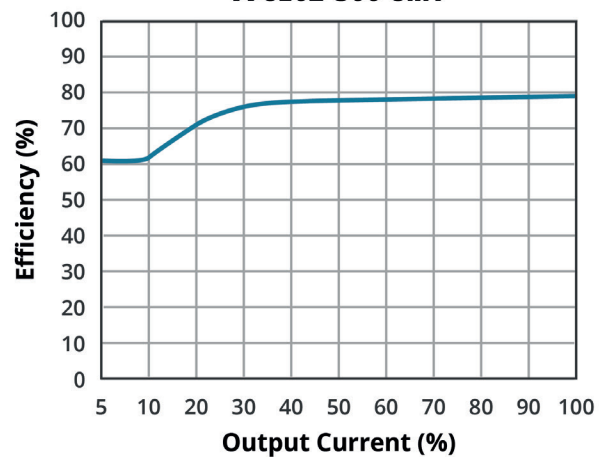
**EFFICIENCY VS OUTPUT LOAD  
(at nominal input)  
V78E01-500-SMT**



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

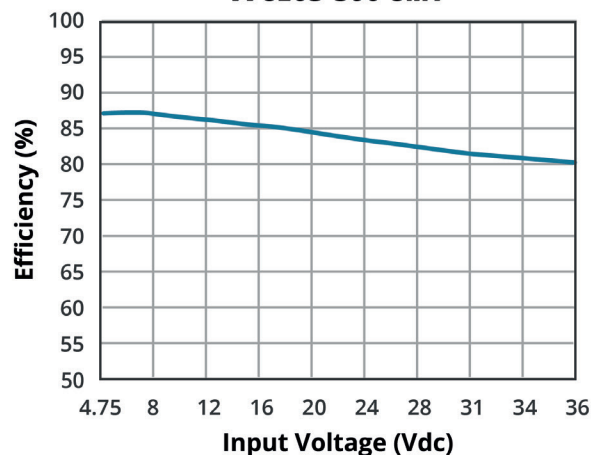


**EFFICIENCY VS OUTPUT LOAD  
(at nominal input)  
V78E02-500-SMT**

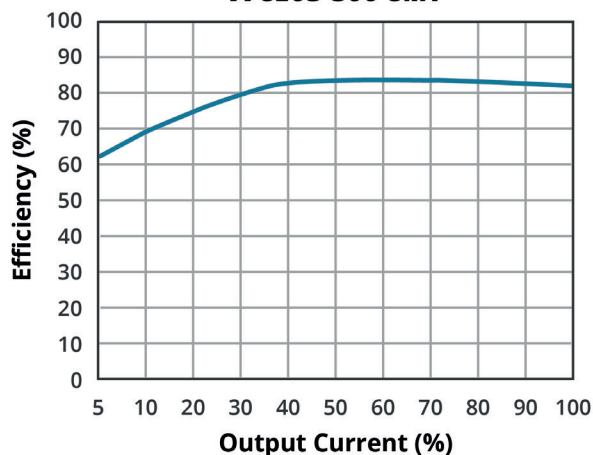


## EFFICIENCY CURVES (CONTINUED)

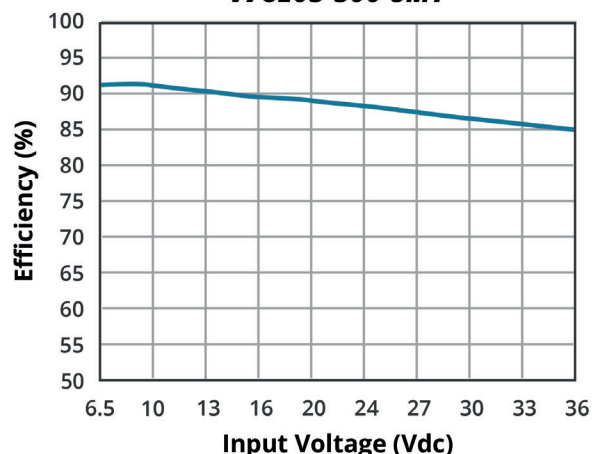
**EFFICIENCY VS INPUT VOLTAGE**  
**(full load)**  
**V78E03-500-SMT**



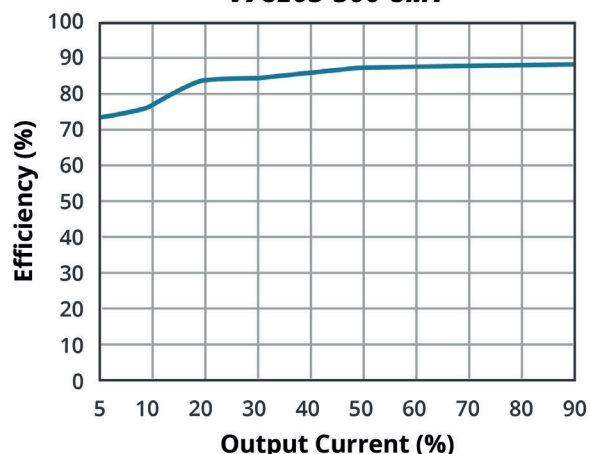
**EFFICIENCY VS OUTPUT LOAD**  
**(at nominal input)**  
**V78E03-500-SMT**



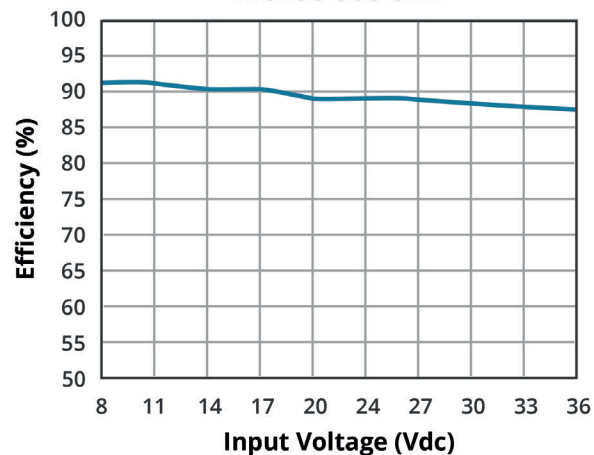
**EFFICIENCY VS INPUT VOLTAGE**  
**(full load)**  
**V78E05-500-SMT**



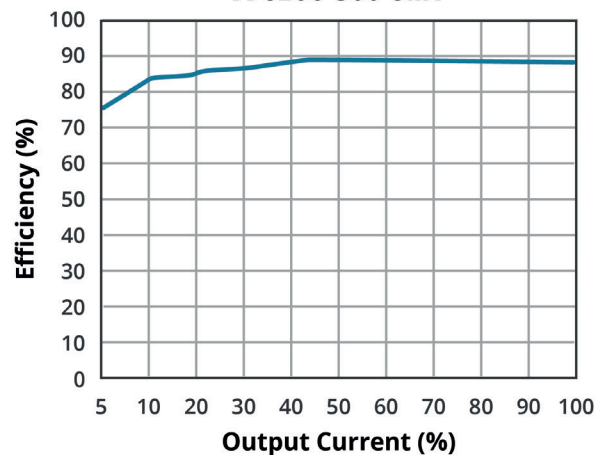
**EFFICIENCY VS OUTPUT LOAD**  
**(at nominal input)**  
**V78E05-500-SMT**



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

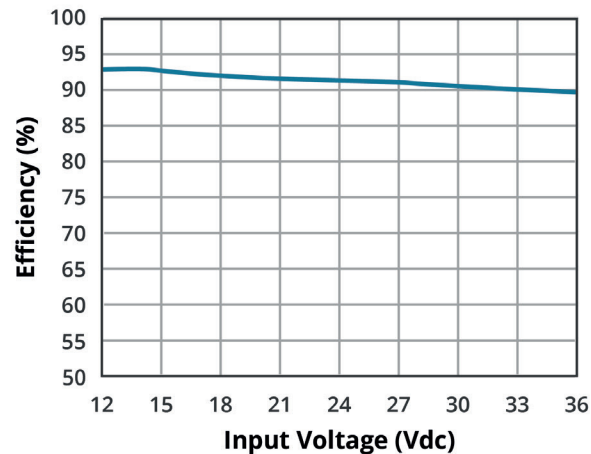


**EFFICIENCY VS OUTPUT LOAD**  
**(at nominal input)**  
**V78E06-500-SMT**

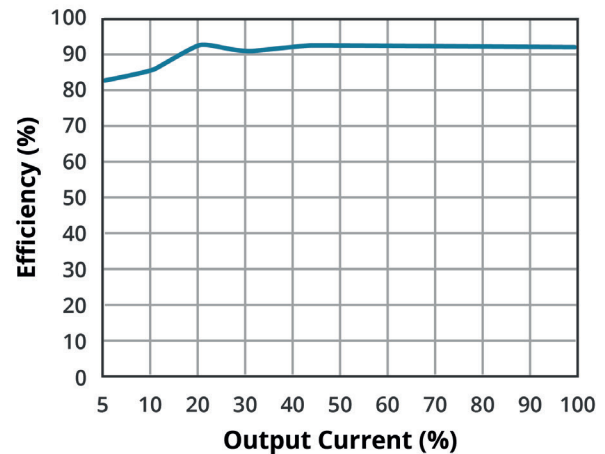


## EFFICIENCY CURVES (CONTINUED)

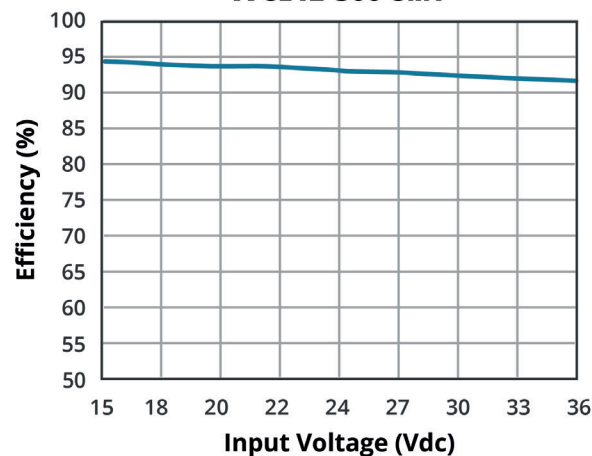
**EFFICIENCY VS INPUT VOLTAGE**  
**(full load)**  
**V78E09-500-SMT**



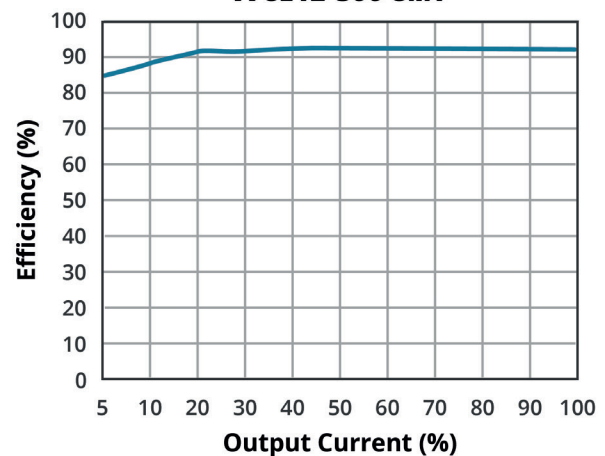
**EFFICIENCY VS OUTPUT LOAD**  
**(at nominal input)**  
**V78E09-500-SMT**



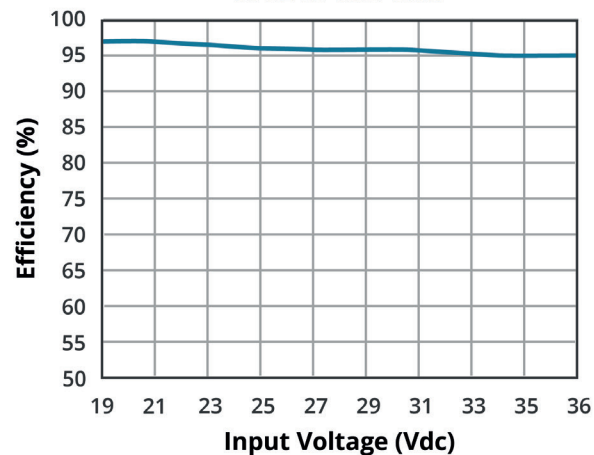
**EFFICIENCY VS INPUT VOLTAGE**  
**(full load)**  
**V78E12-500-SMT**



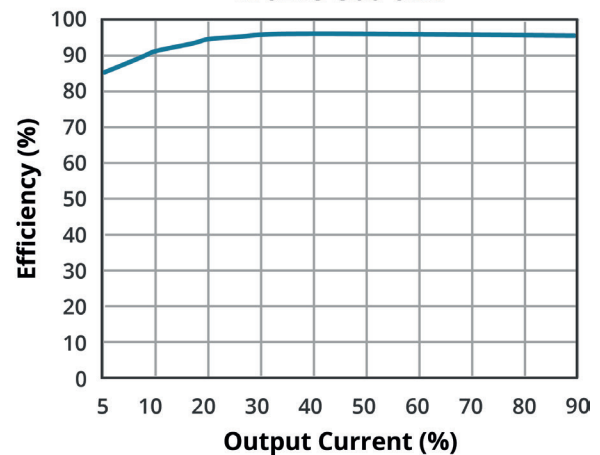
**EFFICIENCY VS OUTPUT LOAD**  
**(at nominal input)**  
**V78E12-500-SMT**



**EFFICIENCY VS INPUT VOLTAGE**  
**(full load)**  
**V78E15-500-SMT**



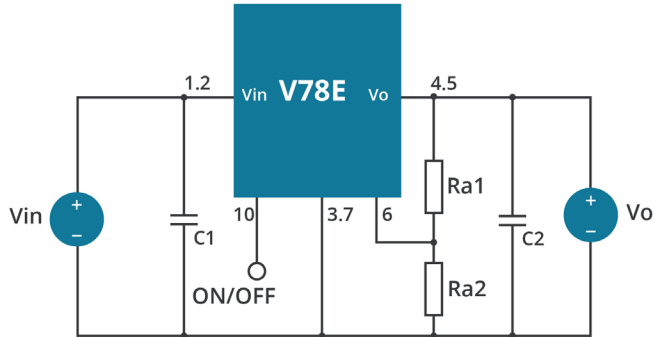
**EFFICIENCY VS OUTPUT LOAD**  
**(at nominal input)**  
**V78E15-500-SMT**



## TYPICAL APPLICATION CIRCUIT

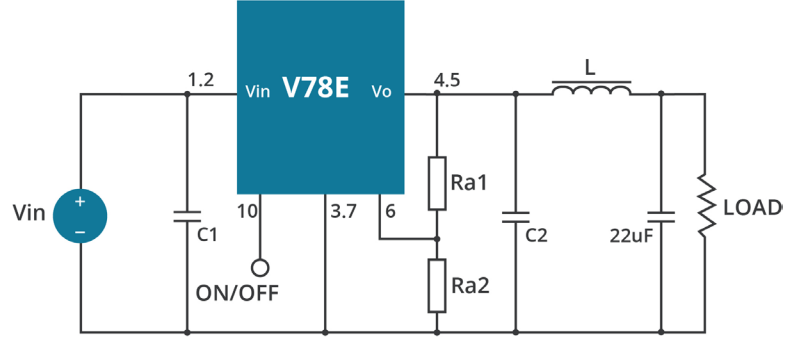
**Figure 1**

Application Circuit



**Figure 2**

LC Filter Application Circuit

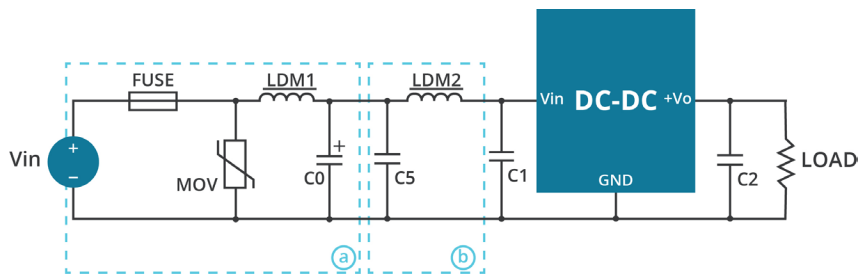


**Table 1**

| Model Number   | C1<br>(ceramic capacitor) | C2<br>(ceramic capacitor) | Ra1/Ra2<br>(Vadj resistance)               |
|----------------|---------------------------|---------------------------|--------------------------------------------|
| V78E01-500-SMT | 10 $\mu$ F/50 V           | 22 $\mu$ F/10 V           | refer to Vadj<br>resistance<br>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.

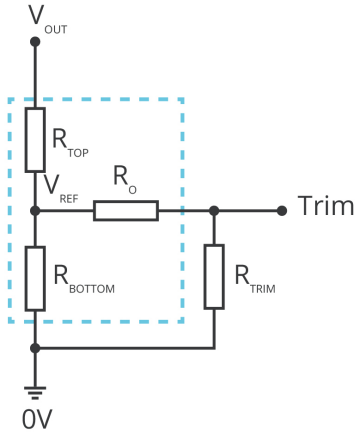
## APPLICATION NOTES

### Output voltage trimming

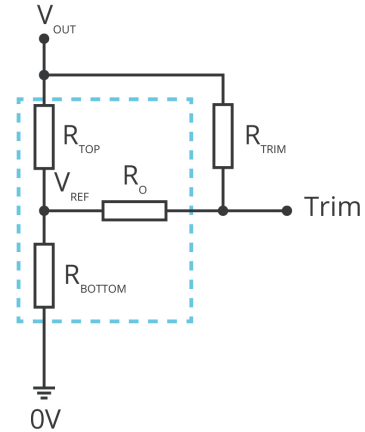
Leave open if not used.

Figure 4

Trim up



Trim down



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

Formula for Trim up

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

Formula for Trim down

Table 3

| $V_{\text{NOM}}$  | $R_{\text{TOP}}$ | $R_{\text{BOTTOM}}$ | $R_O$ | $V_{\text{REF}}$ |
|-------------------|------------------|---------------------|-------|------------------|
| (Vdc)             | (kΩ)             | (kΩ)                | (kΩ)  | (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  $R_{\text{TOP}}$ ,  $R_{\text{BOTTOM}}$ ,  $R_O$ , and  $V_{\text{REF}}$  refer to Table 3  
 $R_{\text{TRIM}}$ : Trim Resistor  
 $a$ : User-defined parameter, no actual meanings  
 $V_{\text{OUT}}$ : 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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CUI offers a two (2) year limited warranty. Complete warranty information is listed on our website.

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