

# VRAE-10E1A0 Series

## Non-Isolated DC-DC Converter

### MicroSIP Series

The Bel VRAE-10E1A Series is a part of the non-isolated DC/DC converter Power Module series. The modules use a SIP package. These converters are available in a range of output voltages from 0.59 VDC to 5.1 VDC over a wide range of input voltage 4.5 VDC -13.8 VDC. The efficiency is typically 91% at 3.3 Vout (Vin = 12 VDC) at full load.



#### Key Features & Benefits

- Wide Input Voltage Range 4.5 VDC – 13.8 VDC
- 0.59 VDC – 5.1 VDC / 10 A Output
- Non-Isolated
- High Efficiency
- Fixed Frequency
- Low Cost
- Under-Voltage Lockout
- OCP/SCP
- Remote On/Off
- Class II, Category 2, Non-Isolated DC/DC Converter (refer to IPC-9592B)
- UL60950-1-2 2nd Edition Recognized (UL/cUL)

#### Applications

- Networking
- Computers and Peripherals
- Telecommunications

## 1. MODEL SELECTION

| PART NUMBER | OUTPUT VOLTAGE     | INPUT VOLTAGE      | MAX. OUTPUT CURRENT | MAX. OUTPUT POWER | TYPICAL EFFICIENCY |
|-------------|--------------------|--------------------|---------------------|-------------------|--------------------|
| VRAE-10E1A0 | 0.59 VDC - 5.1 VDC | 4.5 VDC - 13.8 VDC | 10 A                | 50 W              | 91%                |

### PART NUMBER EXPLANATION

| V              | R                | AE          | - | 10             | E            | 1A             | x               | x                  |
|----------------|------------------|-------------|---|----------------|--------------|----------------|-----------------|--------------------|
| Mount Type     | RoHS             | Series Name |   | Output Current | Input Range  | Output Voltage | Suffix          | Package            |
| Vertical Mount | RoHS 6 Compliant | SIP         |   | 10 A           | 4.5 - 13.8 V | 0.59 - 5.1 V   | 0 – Active High | G – Tray Packaging |

## 2. ABSOLUTE MAXIMUM RATINGS

| PARAMETER            | DESCRIPTION | MIN  | TYP | MAX  | UNITS |
|----------------------|-------------|------|-----|------|-------|
| Input Supply Voltage |             | -0.3 | -   | 15   | V     |
| Ambient Temperature  |             | -40  | -   | 85   | °C    |
| Storage Temperature  |             | -55  | -   | 125  | °C    |
| Altitude             |             | -    | -   | 2000 | m     |

**NOTE:** All specifications are typical at 25 °C unless otherwise stated.

## 3. INPUT SPECIFICATIONS

| PARAMETER                                 | DESCRIPTION                                                                                                                                                                                   | MIN  | TYP | MAX  | UNIT             |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|------|------------------|
| Input Voltage                             | $V_o \leq 3.63$ V                                                                                                                                                                             | 4.5  | -   | 13.8 | V                |
|                                           | $V_o > 3.63$ V                                                                                                                                                                                | 7.0  | -   | 13.8 |                  |
| Input Current (Full load)                 | An input line fuse must always be used.                                                                                                                                                       | -    | -   | 9.5  | A                |
| Input Current (No load)                   |                                                                                                                                                                                               | -    | -   | 120  | mA               |
| Remote Off Input Current                  |                                                                                                                                                                                               | -    | 10  | 25   | mA               |
| Input Reflected Ripple Current (pk-pk)    | With simulated source impedance of 1000 nH, 5 Hz to 20 MHz Use a 1000 $\mu$ F / 25 V AL-Cap with ESR = 0.03 ohm max and 2*100 $\mu$ F/25V Tan-Cap with ESR = 0.013 ohm max at 100 kHz @ 25°C. | -    | 30  | 100  | mA               |
| Input Reflected Ripple Current (rms)      |                                                                                                                                                                                               | -    | 15  | 30   | mA               |
| I <sup>2</sup> t Inrush Current Transient |                                                                                                                                                                                               | -    | -   | 1    | A <sup>2</sup> s |
| Turn-on Voltage Threshold                 | A 30.1K resistor is connected from Enable to Vin                                                                                                                                              | 4.15 | 4.3 | 4.45 | V                |
| Turn-off Voltage Threshold                |                                                                                                                                                                                               | 3.7  | 4.1 | 4.3  | V                |

**NOTE:** All specifications are typical at 25 °C unless otherwise stated.

#### 4. OUTPUT SPECIFICATIONS

| PARAMETER                         | DESCRIPTION                                                                                                                                                             | MIN  | TYP       | MAX     | UNIT             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------|---------|------------------|
| Output Voltage Set Point Accuracy | $V_{in} = 12\text{ V}$ , $I_{out} = \text{full load}$                                                                                                                   | -2   | -         | +2      | % $V_o$ , set    |
| Load Regulation                   |                                                                                                                                                                         | -    | $\pm 0.3$ | $\pm 1$ | % $V_o$ , set    |
| Line Regulation                   |                                                                                                                                                                         | -    | $\pm 0.3$ | $\pm 1$ | % $V_o$ , set    |
| Regulation Over Temperature       |                                                                                                                                                                         | -    | 0.3       | -       | % $V_o$ , set    |
| Output Current                    |                                                                                                                                                                         | 0    | -         | 10      | A                |
| Output DC Current Limit           |                                                                                                                                                                         | 10.2 | 13        | 15      | A                |
| Output Ripple and Noise (pk-pk)   | 0 – 20 MHz BW, with a 1 $\mu\text{F}$ ceramic capacitor and a 10 $\mu\text{F}$ tantalum cap at output.                                                                  | -    | 70        | 100     | mV               |
| Output Ripple and Noise (rms)     |                                                                                                                                                                         | -    | 20        | 30      | mV               |
| Short Circuit Surge Transient     |                                                                                                                                                                         | -    | -         | 5       | A <sup>2</sup> s |
| Turn-on Time                      |                                                                                                                                                                         | -    | -         | 7       | ms               |
| Overshoot at Turn-on              |                                                                                                                                                                         | -    | -         | 1       | %                |
| Output Capacitance                |                                                                                                                                                                         | 0    | -         | 1000    | $\mu\text{F}$    |
| <b>TRANSIENT RESPONSE</b>         |                                                                                                                                                                         |      |           |         |                  |
| 50% ~ 100% Max Load               | $di/dt = 2.5\text{ A}/\mu\text{S}$ ; $V_{in} = 12\text{ V}$ ;<br>with 10 $\mu\text{F}$ tantalum cap and 1 $\mu\text{F}$ ceramic at the output, $T_a = 25^\circ\text{C}$ | -    | 120       | 200     | mV               |
| Settling Time                     |                                                                                                                                                                         | -    | 30        | 50      | $\mu\text{s}$    |
| 100% ~ 50% Max Load               |                                                                                                                                                                         | -    | 120       | 200     | mV               |
| Settling Time                     |                                                                                                                                                                         | -    | 20        | 50      | $\mu\text{s}$    |

**NOTE:** All specifications are typical at normal input, full load at  $T_a = 25^\circ\text{C}$  unless otherwise stated.

#### 5. GENERAL SPECIFICATIONS

| PARAMETER                 | DESCRIPTION                                                                                                                               | MIN   | TYP                  | MAX | UNIT |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------------|-----|------|
| Efficiency                | $V_o = 5.0\text{ V}$                                                                                                                      | 91    | 93                   | -   | %    |
|                           | $V_o = 3.3\text{ V}$                                                                                                                      | 89    | 91                   | -   |      |
|                           | $V_o = 2.5\text{ V}$                                                                                                                      | 87    | 89                   | -   |      |
|                           | $V_o = 1.8\text{ V}$                                                                                                                      | 84    | 86                   | -   |      |
|                           | $V_o = 1.5\text{ V}$                                                                                                                      | 83    | 85                   | -   |      |
|                           | $V_o = 1.2\text{ V}$                                                                                                                      | 80    | 82                   | -   |      |
|                           | $V_o = 0.9\text{ V}$                                                                                                                      | 73    | 75                   | -   |      |
| Switching Frequency       |                                                                                                                                           | -     | 500                  | -   | kHz  |
| Output Voltage Trim Range | Wide Trim                                                                                                                                 | 0.591 | -                    | 5.1 | V    |
| MTBF                      | Calculated Per Bell Core SR-332<br>( $I_o = 80\%$ load; $V_{in} = 12\text{ V}$ ; $V_o = 5\text{ V}$ ; 200 LFM; $T_a = 25^\circ\text{C}$ ) |       | 7 677 401            |     | h    |
| Weight                    |                                                                                                                                           | -     | 3.5                  | -   | g    |
| Dimensions (L x W x H)    |                                                                                                                                           |       | 0.65 x 0.41 x 0.32   |     | in   |
|                           |                                                                                                                                           |       | 16.51 x 10.41 x 8.13 |     | mm   |

**NOTE:** All specifications are typical at  $25^\circ\text{C}$  unless otherwise stated.

#### 6. CONTROL SPECIFICATIONS

| PARAMETER                          | DESCRIPTION                                | MIN  | TYP | MAX | UNIT |
|------------------------------------|--------------------------------------------|------|-----|-----|------|
| <b>Remote On/Off (Active High)</b> |                                            |      |     |     |      |
| Signal Low (Unit Off)              | Remote On/Off Pin is open, the unit is off | -0.3 | -   | 0.4 | V    |
| Signal High (Unit On)              |                                            | 2.0  | -   | 5.5 | V    |



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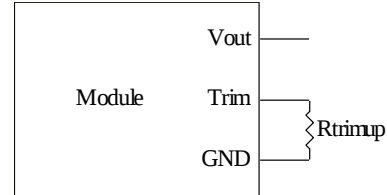
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## 7. OUTPUT TRIM EQUATIONS

Equation for calculating the trim resistor given the desired output voltage ( $V_o$ ) is shown below. The  $R_{trim}$  resistor should be connected between the trim pin and GND pin.

$$R_{trim} = \frac{1.182}{V_o - 0.591} k\Omega$$



## 8. RIPPLE AND NOISE WAVEFORM

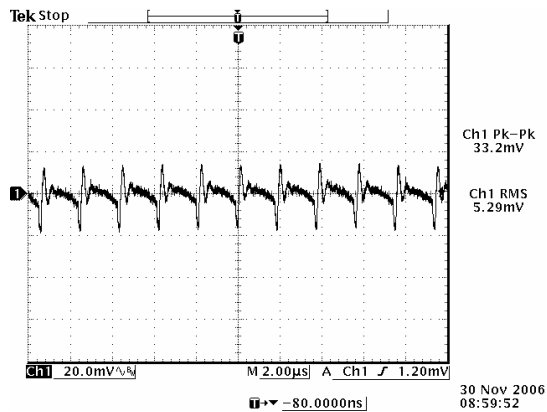


Figure 6. 12 V input, 0.591 V output

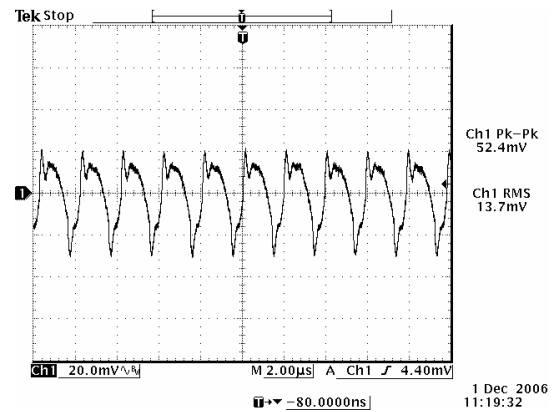


Figure 7. 12 V input, 3.3 V output.

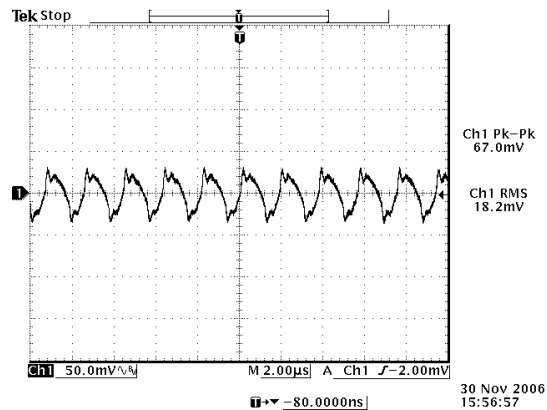
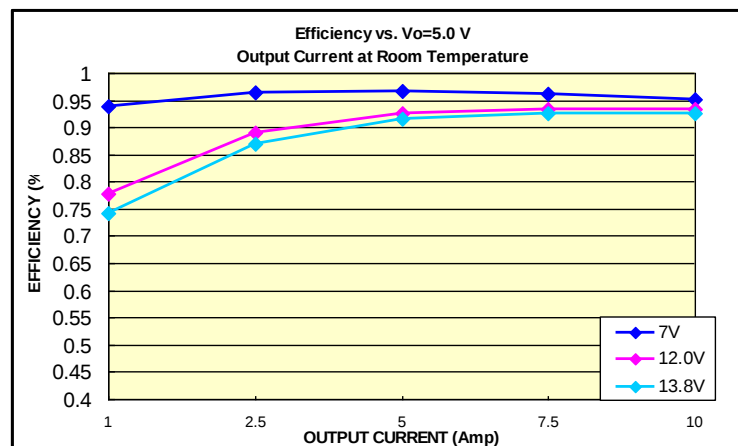
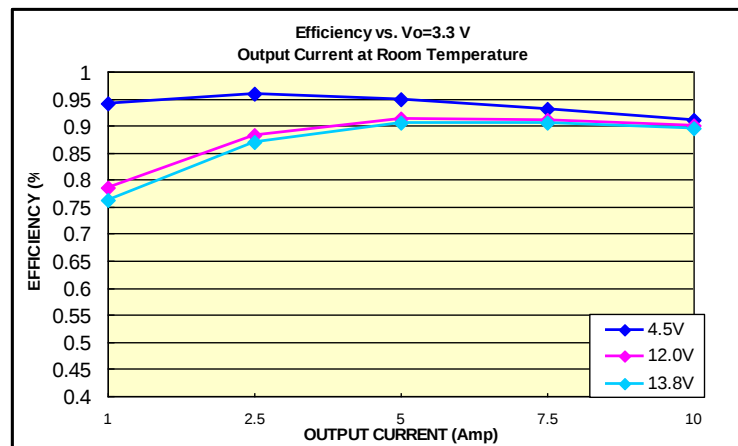
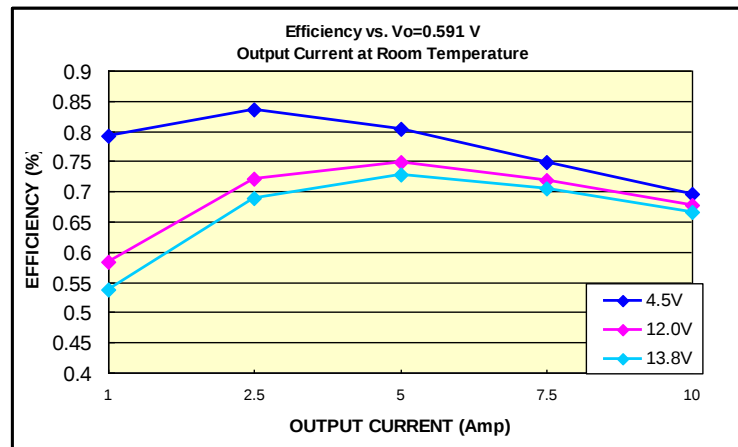


Figure 8. 12 V input, 5.0 V output.

**NOTE:** Ripple and noise at full load, 0-20 MHz BW, with a 1  $\mu$ F ceramic cap and a 10  $\mu$ F tantalum cap, and  $T_a=25^\circ\text{C}$ .

## 9. EFFICIENCY DATA



## 10. THERMAL DERATING CURVES

The thermal reference point  $T_{ref}$  is shown below. For reliable operation this temperature should not exceed 115 °C. The output power of the module should not exceed the rated power for the module.

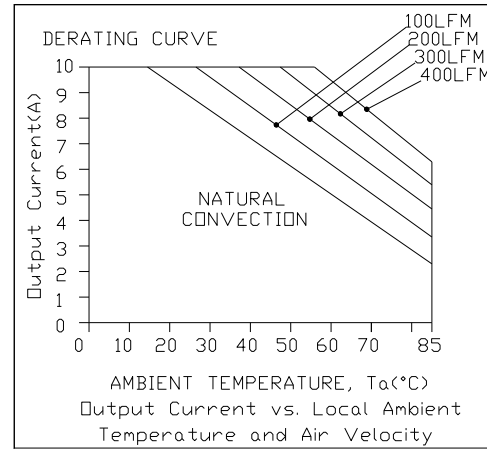
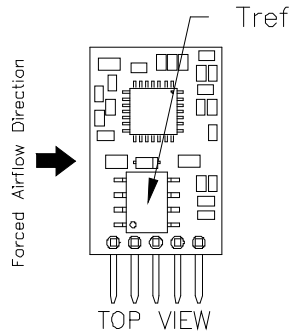


Figure 1.  $V_{in}=12\text{ V}$ ,  $V_{out}=5\text{ V}$

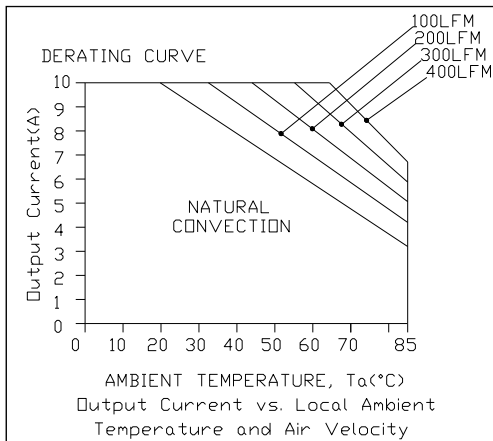


Figure 2.  $V_{in}=12\text{ V}$ ,  $V_{out}=3.3\text{ V}$

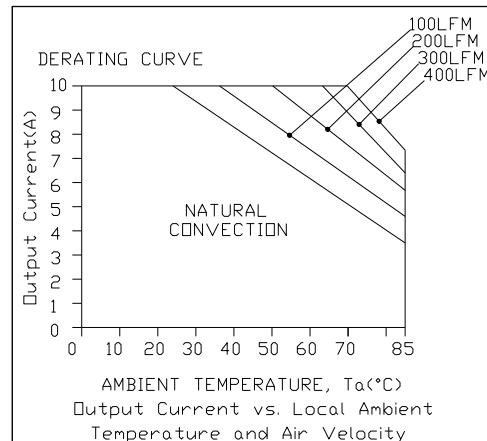


Figure 3.  $V_{in}=12\text{ V}$ ,  $V_{out}=2.5\text{ V}$

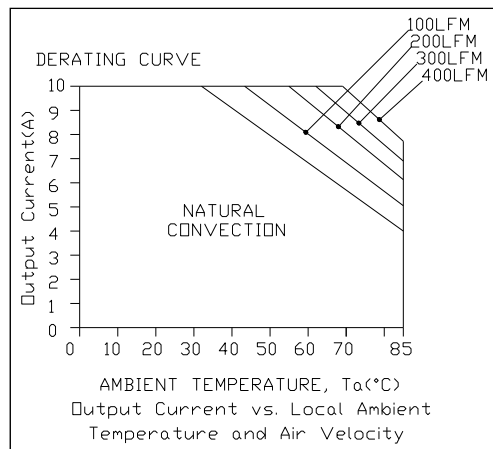


Figure 4.  $V_{in}=12\text{ V}$ ,  $V_{out}=1.2\text{ V}$

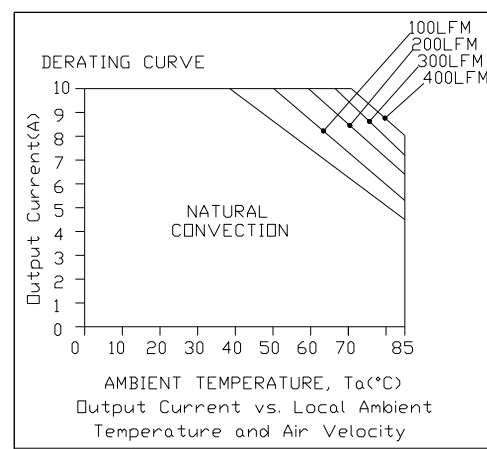


Figure 5.  $V_{in}=12\text{ V}$ ,  $V_{out}=0.59\text{ V}$

## 11. TRANSIENT RESPONSE WAVEFORMS

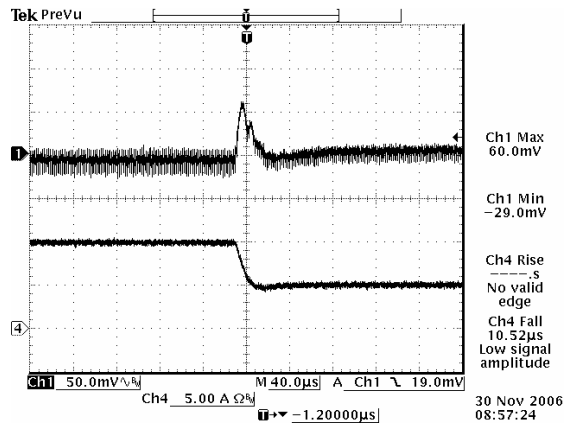


Figure 9. 100% to 50% load step at 12 V input, 0.591 V output

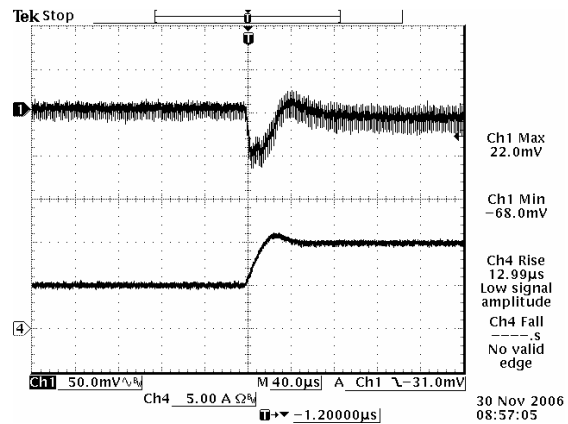


Figure 10. 50% to 100% load step at 12 V input, 0.591 V output

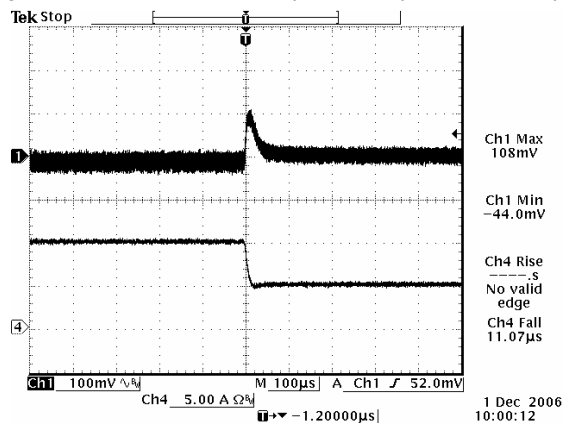


Figure 11. 100% to 50% load step at 12 V input, 3.3 V output

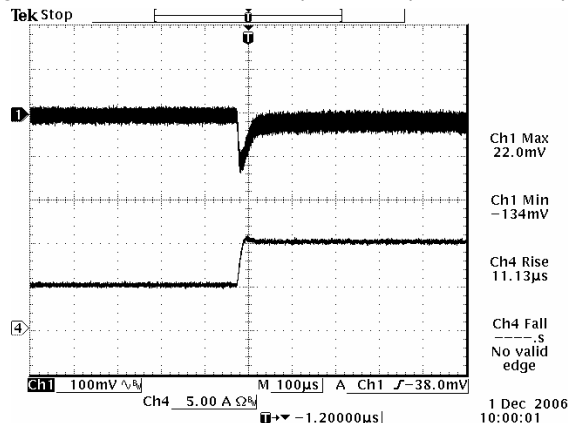


Figure 12. 50% to 100% load step at 12 V input, 3.3 V output

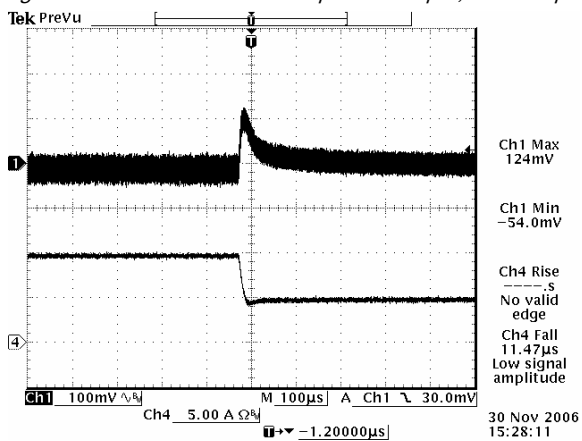


Figure 13. 100% to 50% load step at 12 V input, 5.0 V output

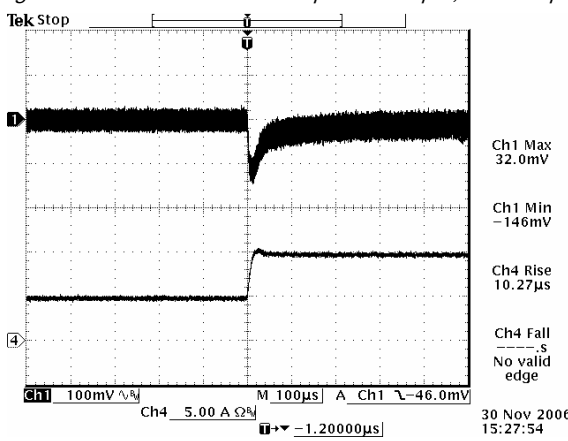
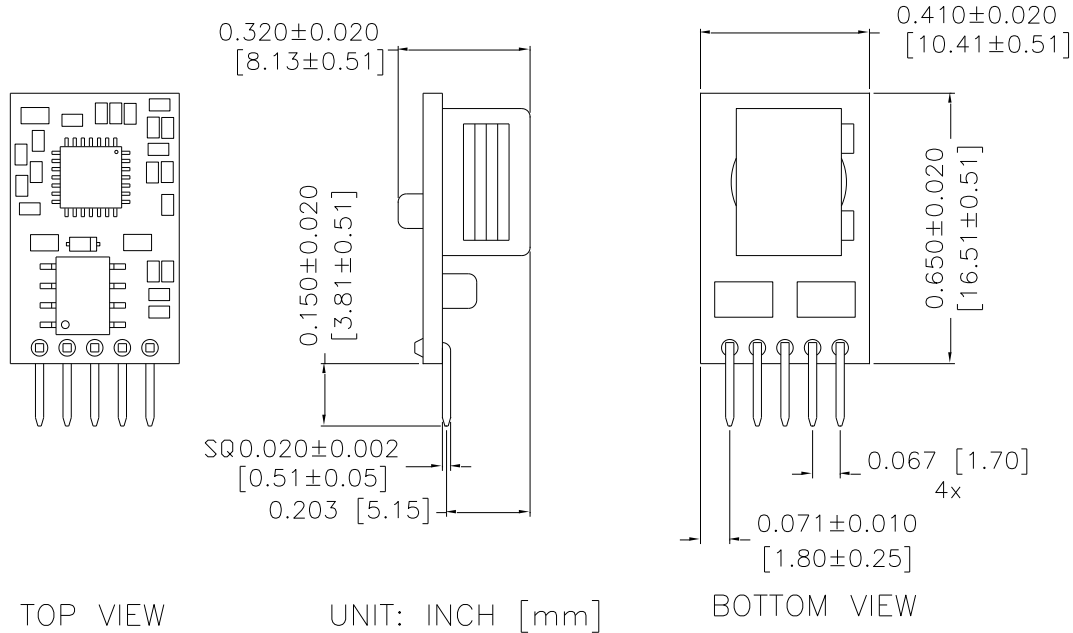


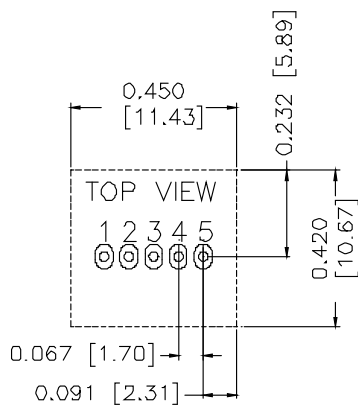
Figure 14. 50% to 100% load step at 12 V input, 5.0 V output

**NOTE:** Transient response at  $di/dt=0.25 \text{ A}/\mu\text{s}$ , with a  $1\mu\text{F}$  ceramic cap and a  $10\mu\text{F}$  tantalum cap at the output, and  $T_a=25^\circ \text{C}$ .

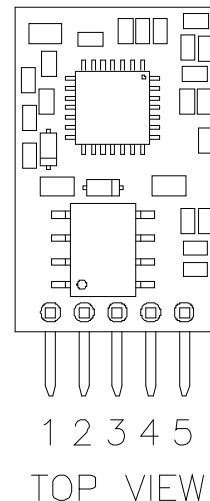
## 12. MECHANICAL OUTLINE



## RECOMMENDED PAD LAYOUT



PAD: LENGTH 0.067 [Ø1.7] BOTH SIDE  
 WIDTH 0.047 [Ø1.2] BOTH SIDE  
 HOLE: Ø0.035 [Ø0.89] BOTH SIDE



## PIN CONNECTIONS

| PIN | NAME   |
|-----|--------|
| 1   | ENABLE |
| 2   | Vin    |
| 3   | GND    |
| 4   | Vout   |
| 5   | Trim   |

**NOTE:** This module is recommended and compatible with Pb-Free Wave Soldering and must be soldered using a peak solder temperature of no more than 260°C for less than 5 seconds.

**NOTES:**

- 1) All Pins: Material - Copper Alloy;  
Finish – 3 micro inches minimum Gold over 50 micro inches minimum Nickel plate.
- 2) Undimensioned components are shown for visual reference only.
- 3) All dimensions in inches (mm); Tolerances: x.xx +/-0.02 in [0.5 mm]. x.xxx +/-0.010 in [0.25 mm].

### 13. ASSEMBLY NOTE

Modules were designed for vertical insertion into host board. Experiments should be performed to make sure that the units meet the intended tilt specification. A fixture may be needed to make the module stand upright in assembly.

### 14. REVISION HISTORY

| DATE       | REVISION | CHANGE DESCRIPTION                                                                             | APPROVAL     |
|------------|----------|------------------------------------------------------------------------------------------------|--------------|
| 2010-04-22 | G        | Change operating temp range from 0~70°C to -40~85°C<br>Add the data of full load input current | XF JIANG     |
| 2010-10-07 | H        | Update Thermal Derating Curves                                                                 | XF JIANG     |
| 2014-3-24  | I        | Update MD                                                                                      | Shiyong Qian |
| 2015-12-28 | J        | Add Assembly Note. Update mechanical drawing                                                   | Falling Tao  |
| 2017-12-15 | K        | Datasheet updated to the new Bel template                                                      |              |

**For more information on these products consult: [tech.support@psbel.com](mailto:tech.support@psbel.com)**

**NUCLEAR AND MEDICAL APPLICATIONS** - Products are not designed or intended for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems.

**TECHNICAL REVISIONS** - The appearance of products, including safety agency certifications pictured on labels, may change depending on the date manufactured. Specifications are subject to change without notice.



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