

# 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



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## 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    | $\mu\text{F}$    |
| TRANSIENT RESPONSE                |   |      |           |         |                  |
| 50% ~ 100% Max Load               |   | -    | 120       | 200     | mV               |
| Settling Time                     | $di/dt = 2.5\text{ A}/\mu\text{S}$ ; $V_{in} = 12\text{ V}$ ;<br>with 10 $\mu\text{F}$ tantalum cap and 1 $\mu\text{F}$ ceramic at the output, $T_a = 25\text{ }^\circ\text{C}$ | -    | 30        | 50      | $\mu\text{s}$    |
| 100% ~ 50% Max Load               | $V_o = \text{All}$  | -    | 120       | 200     | mV               |
| Settling Time                     |   | -    | 20        | 50      | $\mu\text{s}$    |

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

#### 6. CONTROL SPECIFICATIONS

| PARAMETER                   | DESCRIPTION                                | MIN  | TYP | MAX | UNIT |
|-----------------------------|--|------|-----|-----|------|
| Remote On/Off (Active High) |  |      |     |     |      |
| 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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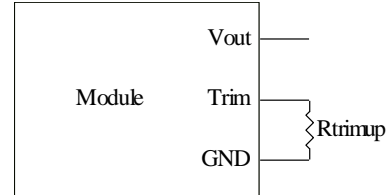
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## 7. OUTPUT TRIM EQUATIONS

Equation for calculating the trim resistor given the desired output voltage (Vo) is shown below. The Rtrim 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

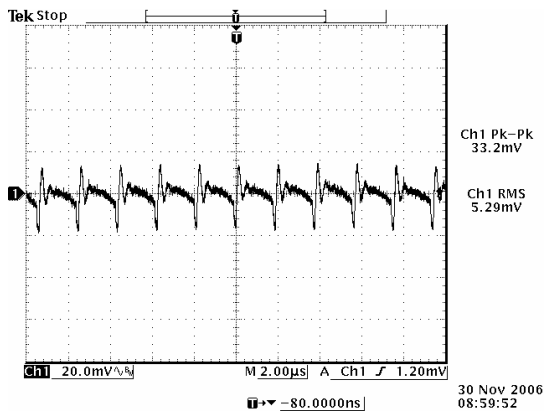


Figure 6. 12 V input, 0.591 V output

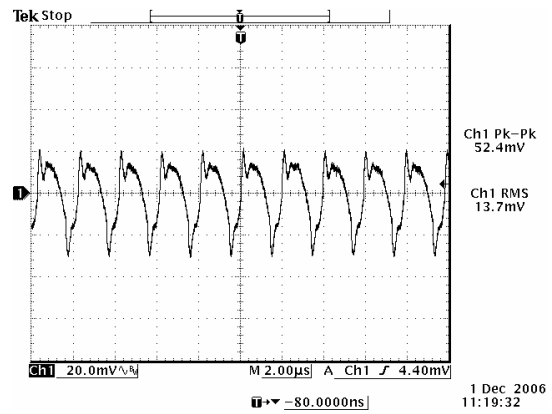


Figure 7. 12 V input, 3.3 V output.

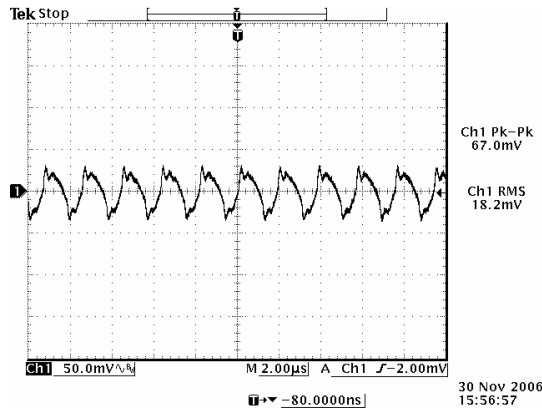
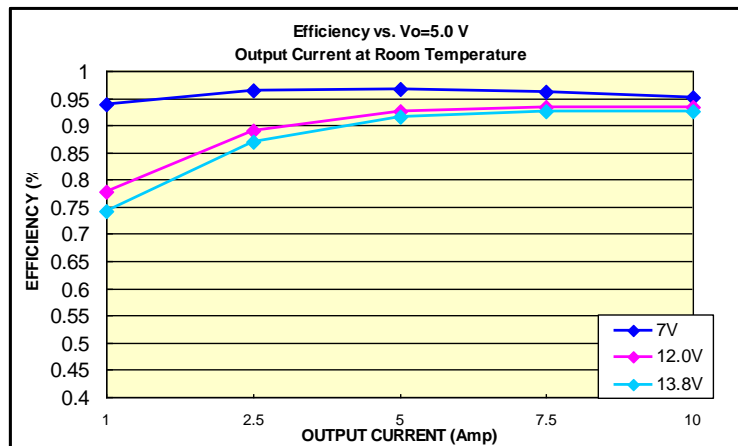
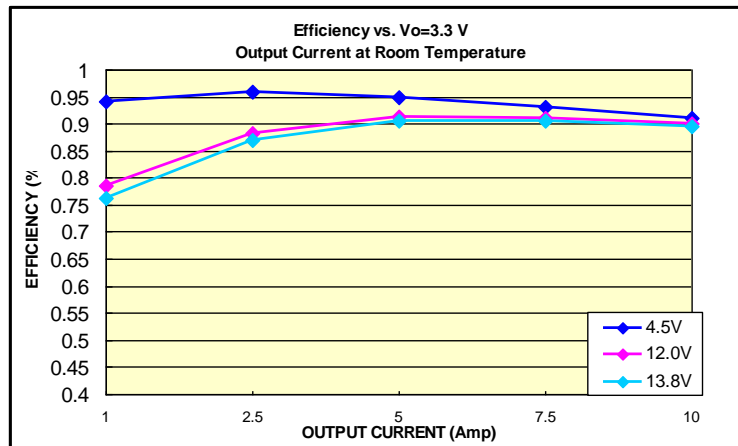
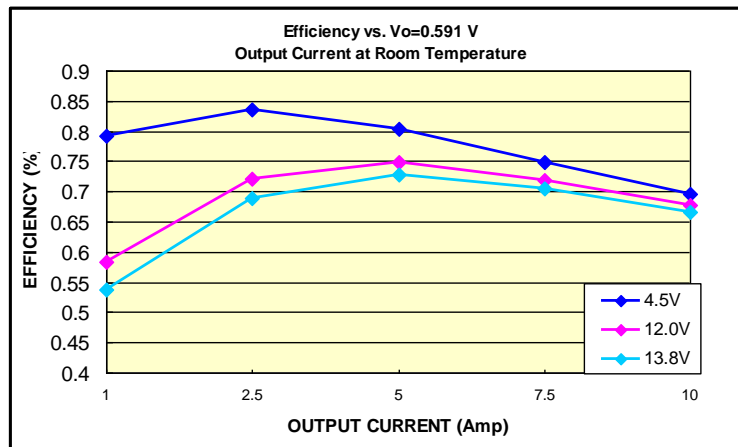


Figure 8. 12 V input, 5.0 V output.

**NOTE:** Ripple and noise at full load, 0-20 MHz BW, with a 1 µF ceramic cap and a 10 µF tantalum cap, and Ta=25 °C.

## 9. EFFICIENCY DATA



## 10. THERMAL DERATING CURVES

The thermal reference point Tref 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.

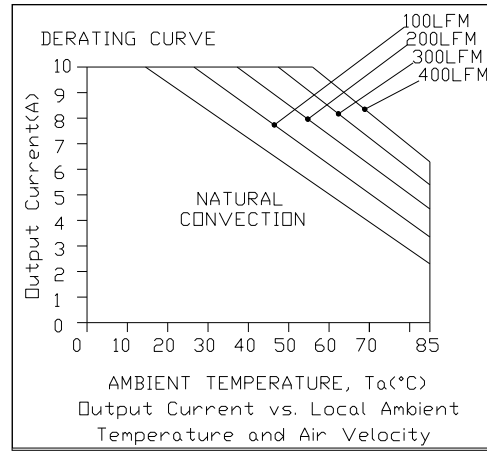
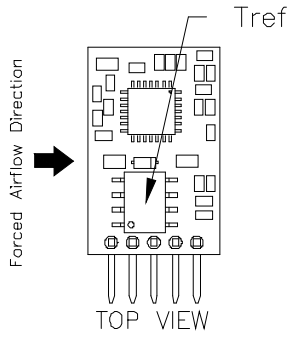


Figure 1. Vin=12 V, Vout = 5 V

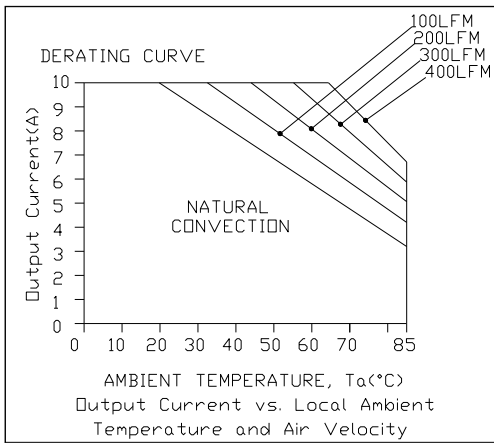


Figure 2. Vin=12 V, Vout = 3.3 V

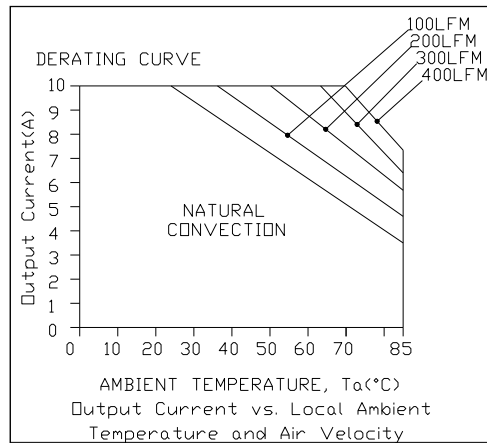


Figure 3. Vin=12 V, Vout = 2.5 V

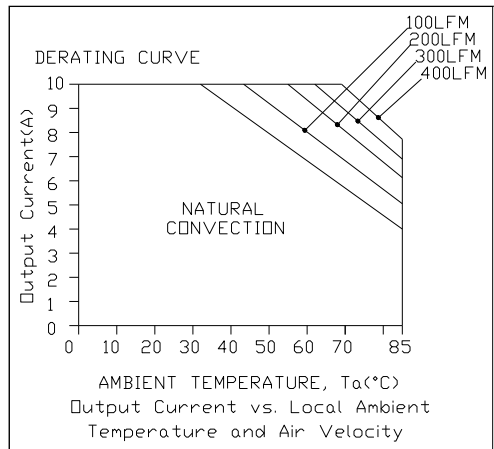


Figure 4. Vin=12 V, Vout = 1.2 V

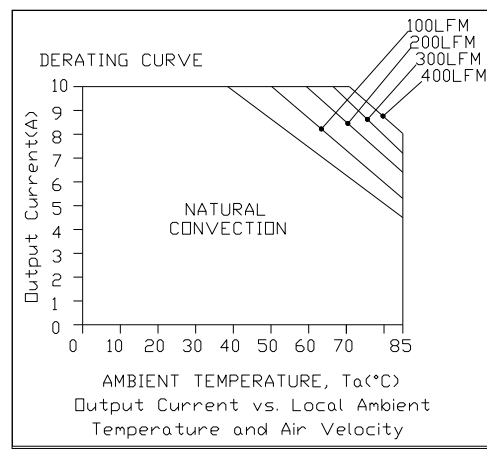


Figure 5. Vin=12 V, Vout = 0.59 V

## 11. TRANSIENT RESPONSE WAVEFORMS

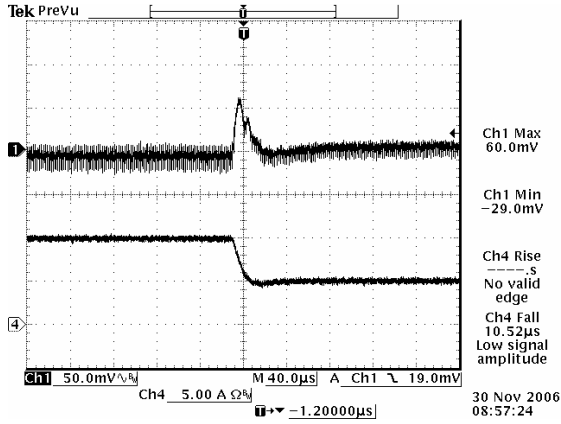


Figure 9. 100% to 50% load step at 12 V input, 0.591 V output

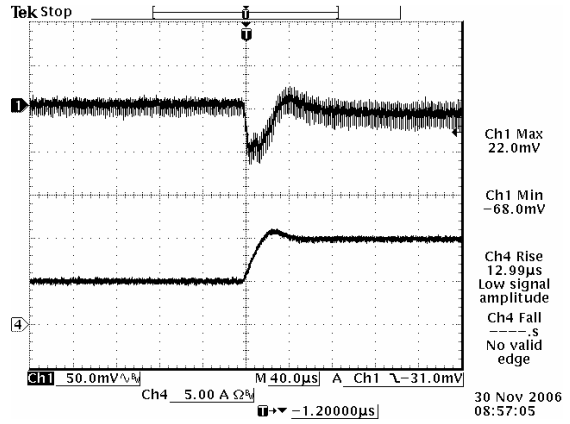


Figure 10. 50% to 100% load step at 12 V input, 0.591 V output

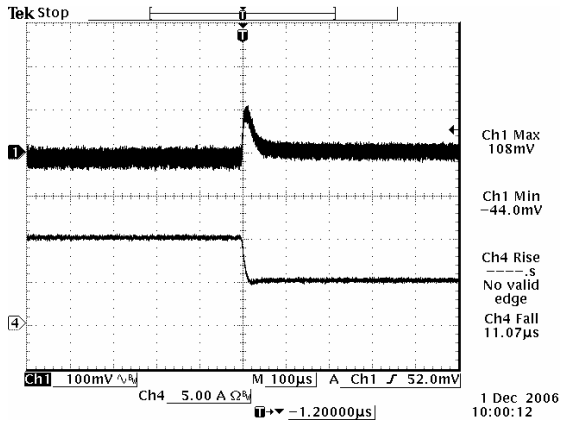


Figure 11. 100% to 50% load step at 12 V input, 3.3 V output

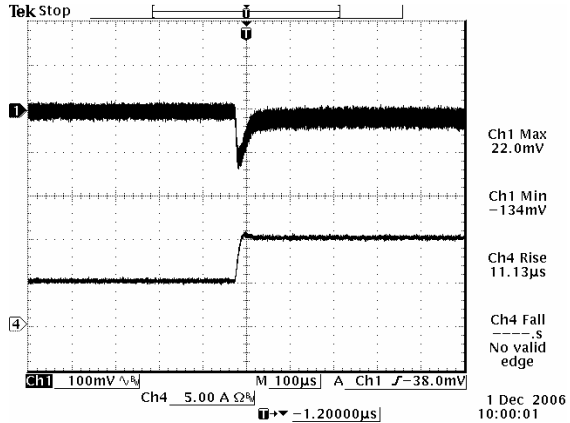


Figure 12. 50% to 100% load step at 12 V input, 3.3 V output

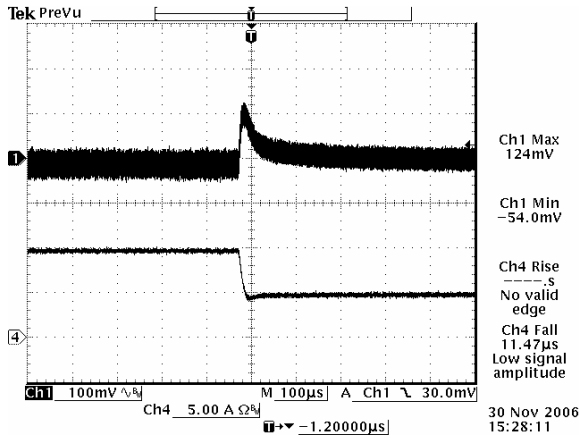


Figure 13. 100% to 50% load step at 12 V input, 5.0 V output

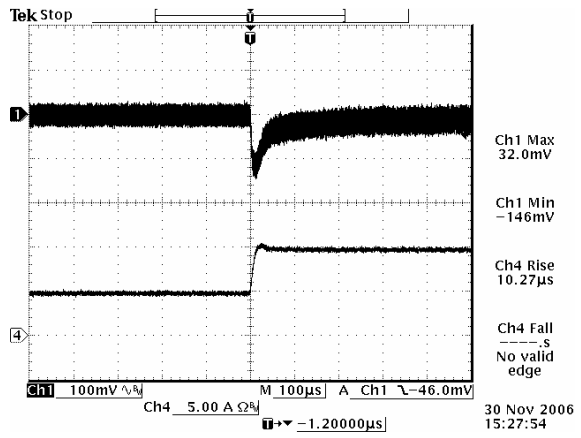
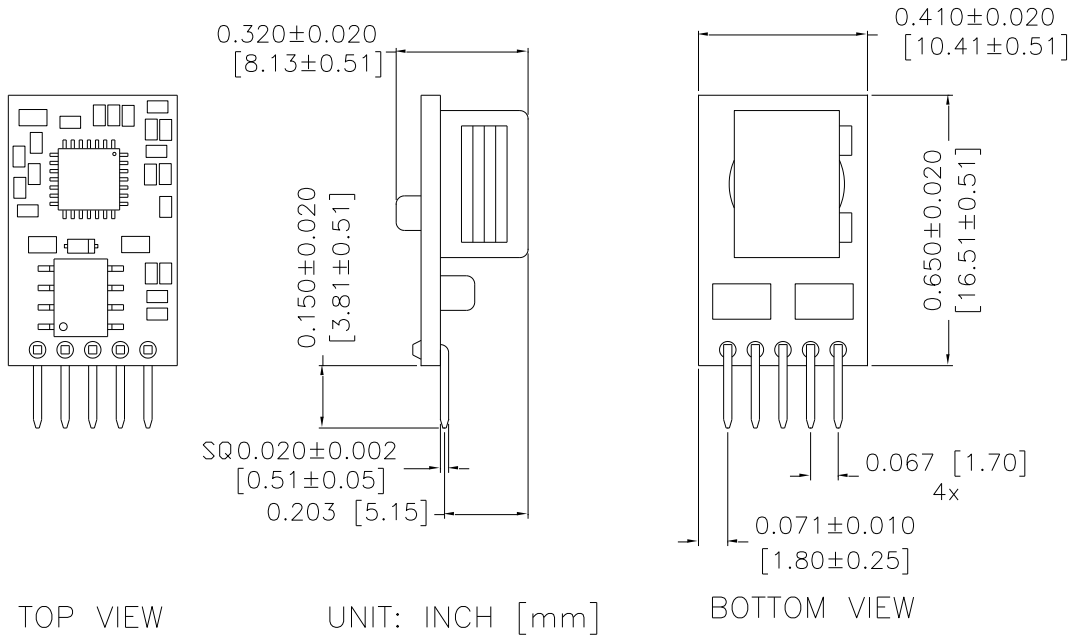


Figure 14. 50% to 100% load step at 12 V input, 5.0 V output

**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

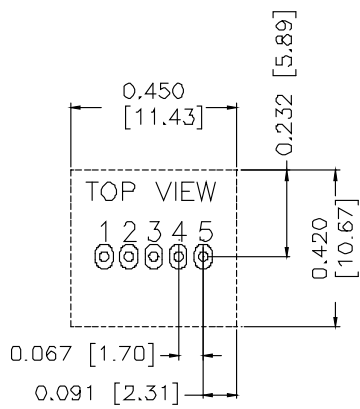


TOP VIEW

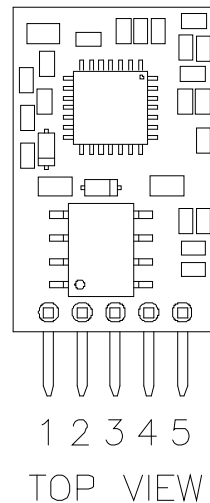
UNIT: INCH [mm]

BOTTOM VIEW

### 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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