

# 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	$di/dt = 2.5\text{ A}/\mu\text{S}$ ; $V_{in} = 12\text{ V}$ ; 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 ( $I_o = 80\%$ 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 xH)			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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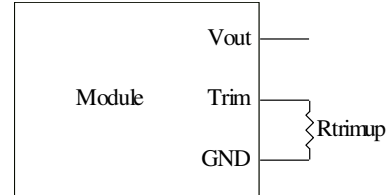
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## 7. OUTPUT TRIM EQUATIONS

Equation for calculating the trim resistor given the desired output voltage ( $V_o$ ) 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

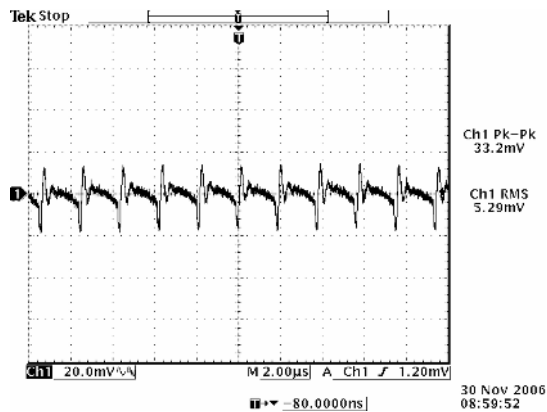


Figure 6. 12 V input, 0.591 V output

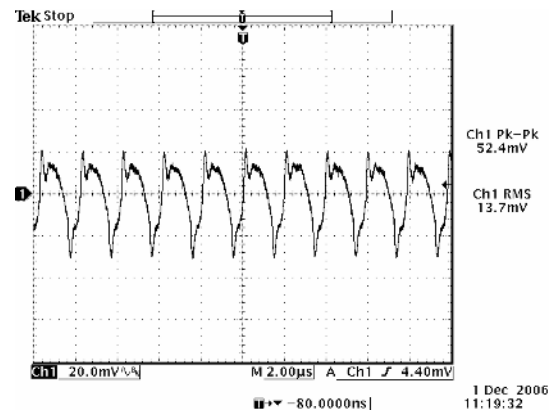


Figure 7. 12 V input, 3.3 V output.

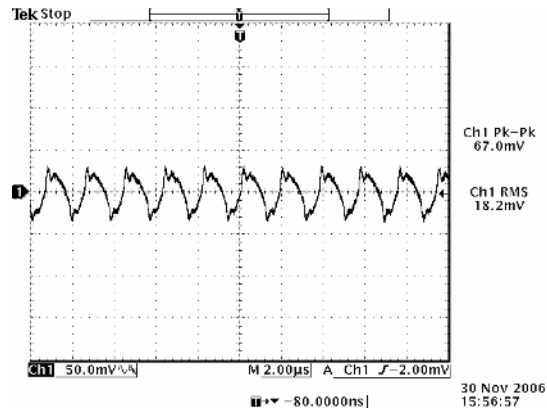
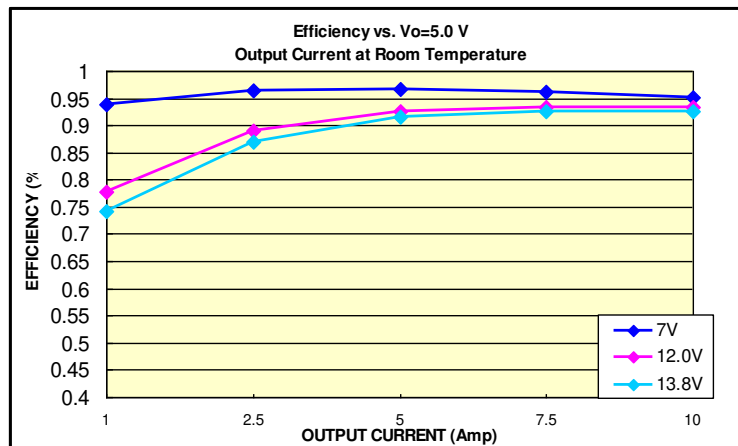
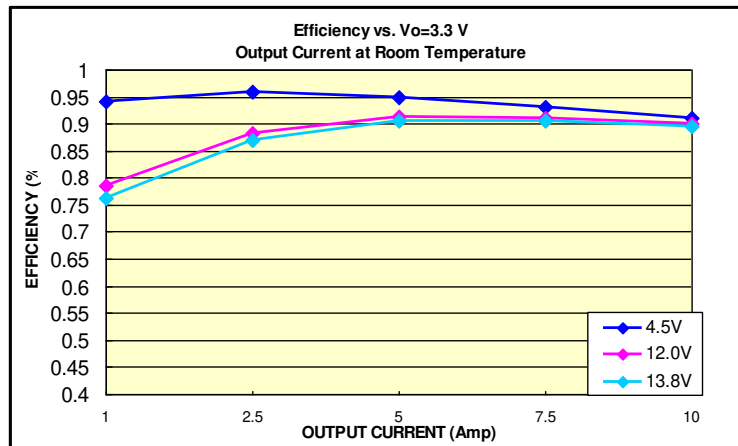
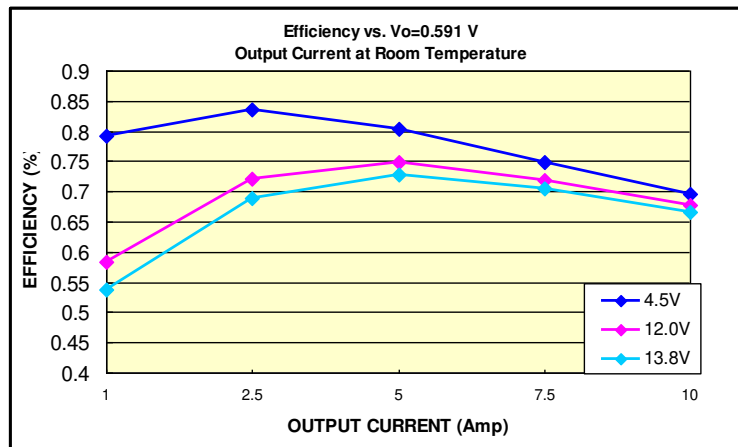


Figure 8. 12 V input, 5.0 V output.

**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 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.

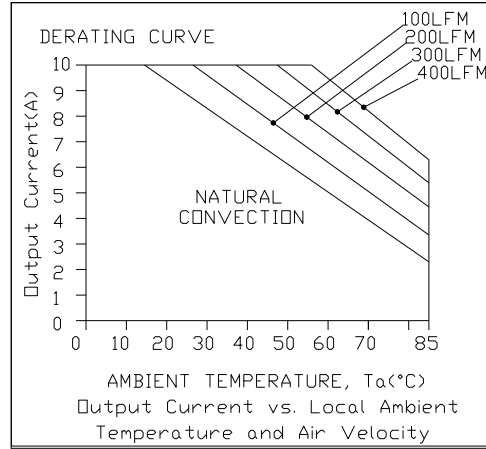
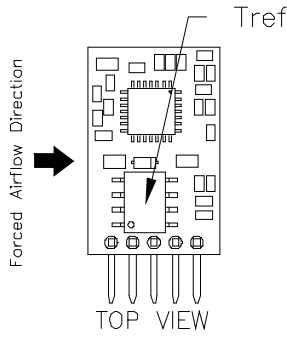


Figure 1.  $V_{in}=12\text{ V}$ ,  $V_{out} = 5\text{ V}$

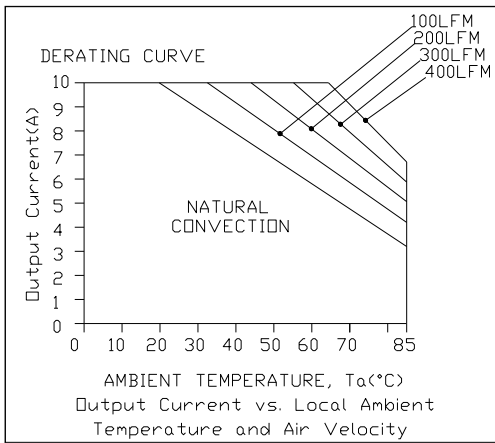


Figure 2.  $V_{in}=12\text{ V}$ ,  $V_{out} = 3.3\text{ V}$

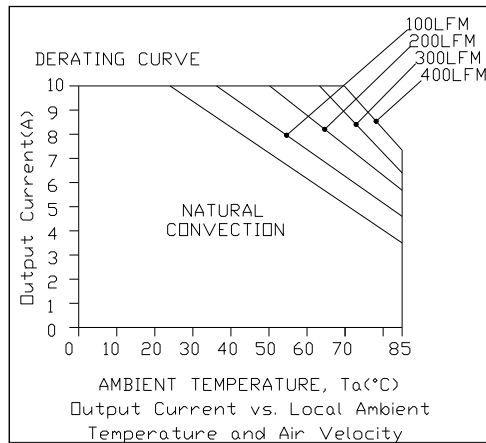


Figure 3.  $V_{in}=12\text{ V}$ ,  $V_{out} = 2.5\text{ V}$

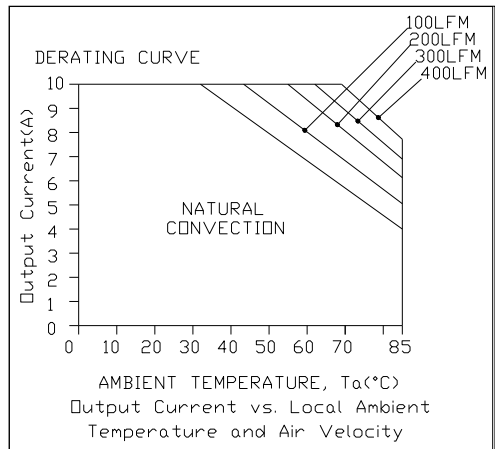


Figure 4.  $V_{in}=12\text{ V}$ ,  $V_{out} = 1.2\text{ V}$

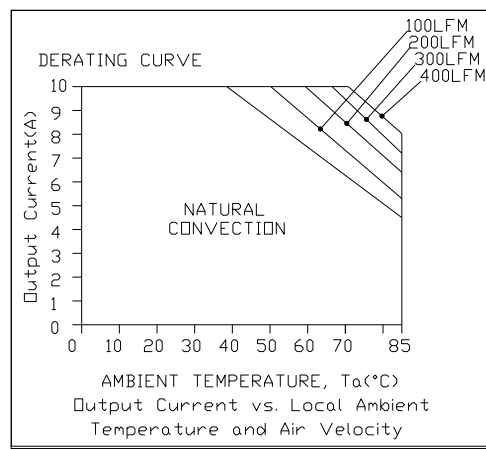


Figure 5.  $V_{in}=12\text{ V}$ ,  $V_{out} = 0.59\text{ V}$

## 11. TRANSIENT RESPONSE WAVEFORMS

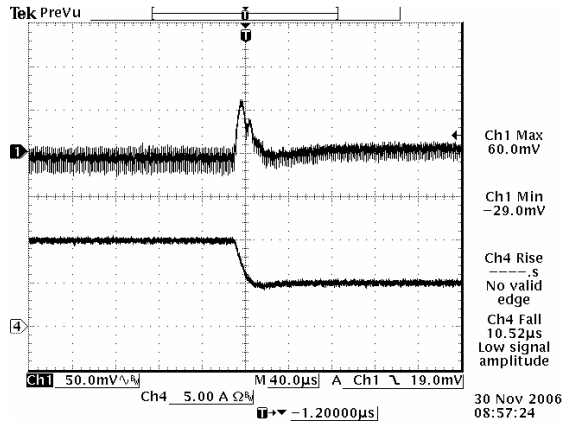


Figure 9. 100% to 50% load step at 12 V input, 0.591 V output

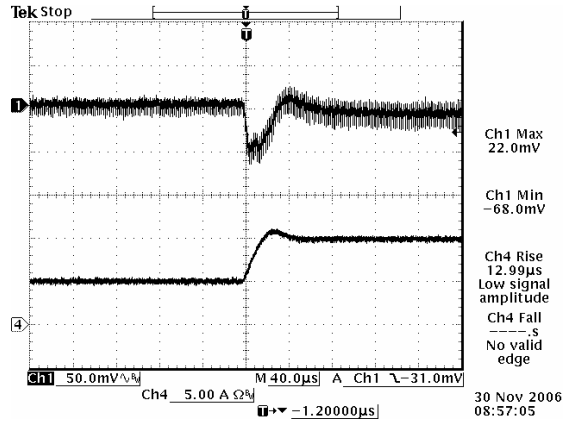


Figure 10. 50% to 100% load step at 12 V input, 0.591 V output

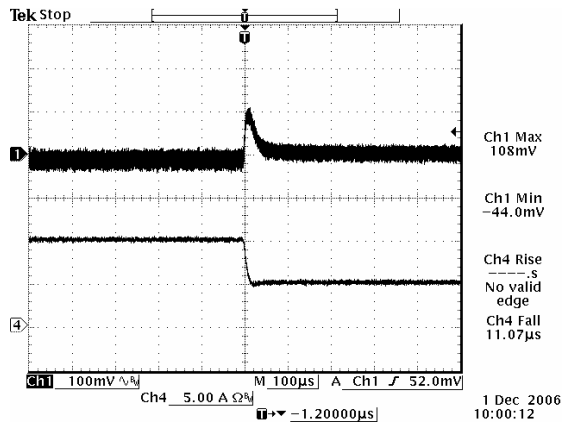


Figure 11. 100% to 50% load step at 12 V input, 3.3 V output

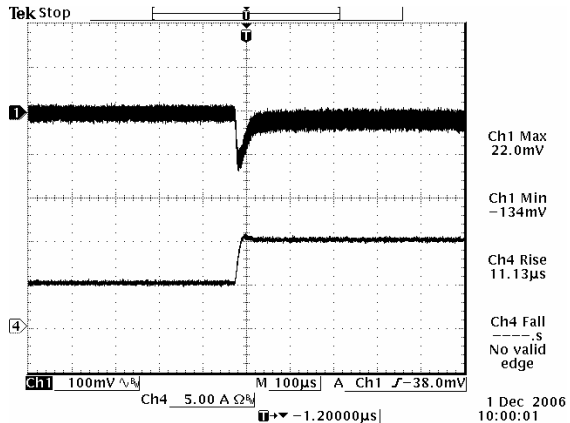


Figure 12. 50% to 100% load step at 12 V input, 3.3 V output

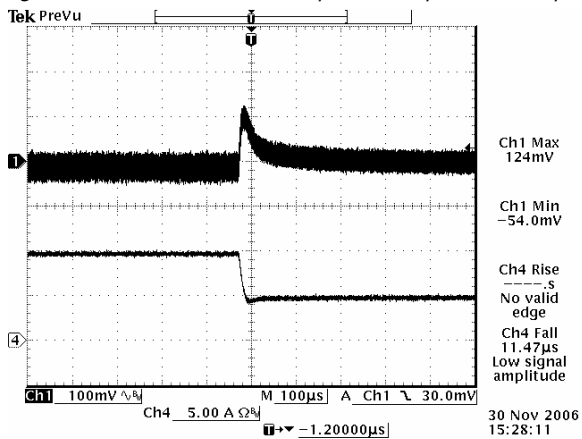


Figure 13. 100% to 50% load step at 12 V input, 5.0 V output

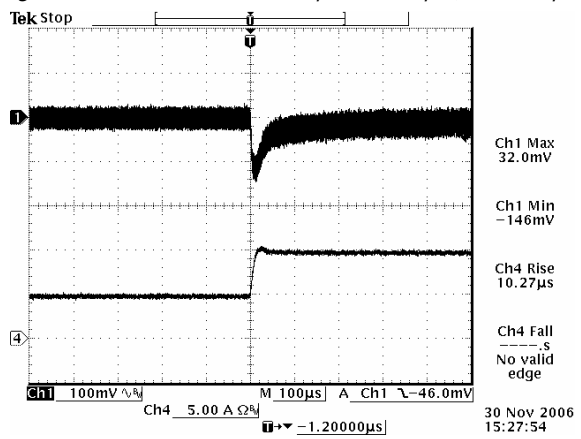
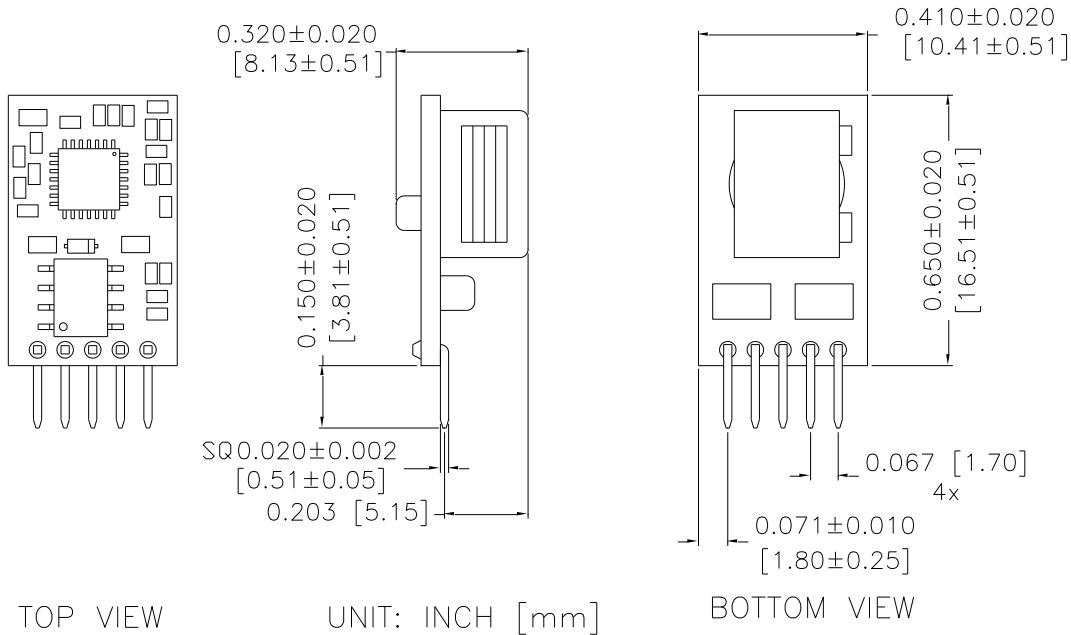


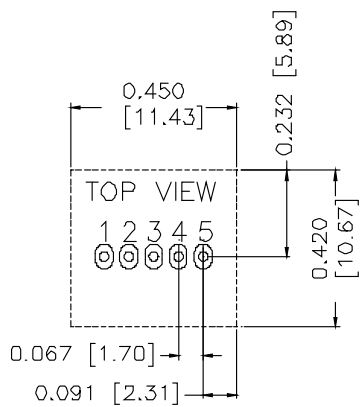
Figure 14. 50% to 100% load step at 12 V input, 5.0 V output

**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  $T_a=25^\circ \text{C}$ .

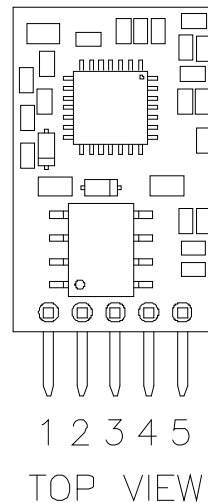
## 12. MECHANICAL OUTLINE



### 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 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.

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