

NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 13.8 Vdc Input

0.59 Vdc - 5.1 Vdc / 10 A Output



May 12, 2016

Bel Power Inc., a subsidiary of Bel Fuse Inc.

VRAE-10E1AE

RoHS Compliant

Rev.D

- Non-Isolated
- High Efficiency
- Fixed Frequency
- Low Cost
- Wide Input
- Class 2, Category 2, Isolated DC/DC Converter (refer to IPC-9592B)
- Approved to UL/CSA60950-1, 2nd +A2 version (Pending)
- Under-Voltage Lockout
- Wide Trim
- OCP/SCP
- Remote On/Off

Description

The Bel VRAE-10E1AE is 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 (VIN = 4.5 Vdc - 13.8 Vdc). The efficiency is typically 91% at 3.3 Vout (Vin=12 Vdc) at full load.

Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number
0.59 V - 5.1 V	4.5 V - 13.8 V	10 A	50 W	91%	VRAE-10E1AE

Notes: 1. All part numbers above indicate RoHS 6. Change the second letter "R" to "7" for RoHS 5 part numbers.
2. Add "G" suffix at the end of the model numbers listed above to indicate "Tray Packaging".

Ordering Part Number

V R AE - 10 E 1A E x
1 2 3 4 5 6 7 8

1---Mounting type,

2---RoHS Status,

3---Series name,

4---Output Current,

5---Input range,

6---Output voltage,

7---Active logic and HSK feature,

8---Package type,

V – Vertical mount

R – RoHS 6

AE – SIP Series name

10 – 10A Output Current

E – 4.5-13.8V input

1A – 0.59-5.1V output

E – active high, without HSK plate

G – Tray packaging

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Absolute Maximum Ratings

Parameter	Min	Typ	Max	Unit	Notes
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.

Input Specifications

Parameter	Min	Typ	Max	Unit	Notes
Operating Input Voltage					
$V_{o,set} \leq 3.63$ V	4.5	-	13.8	V	
$V_{o,set} > 3.63$ V	7.0	-	13.8		
Input Current (full load)	-	-	9.5	A	An input line fuse must always be used.
Input Current (no load)	-	-	120	mA	
Remote Off Input Current	-	10	25	mA	
Input Reflected Ripple Current (pk-pk)	-	30	100	mA	With simulated source impedance of 1000 nH, 5 Hz to 20 MHz. Use a 1000 uF/25 V AL-Cap with ESR=0.03 ohm max and 2*100 uF/25V Tan-Cap with ESR=0.013 ohm max at 100 kHz@25°C.
Input Reflected Ripple Current (rms)	-	15	30	mA	
I ² t Inrush Current Transient	-	-	1	A ² s	
Turn on Voltage Threshold	4.15	4.3	4.45	V	A 30.1K resistor is connected from Enable to Vin
Turn off Voltage Threshold	3.7	4.1	4.3	V	

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

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Output Specifications

Parameter	Min	Typ	Max	Unit	Notes	
Output Voltage Set Point	-2	-	2	%Vo,set	Vin= 12 V, Iout=full load	
Load Regulation	-	±0.3	±1	%Vo,set		
Line Regulation	-	±0.3	±1	%Vo,set		
Temperature Regulation	-	0.3	-			
Output Current	0	-	10	A		
Output DC Current Limit	10.2	13	15	A		
Output Ripple and Noise (pk-pk)	-	8	16	mV	0-20MHz BW	
Output Ripple and Noise (rms)	-	2	4	mV		
Short Circuit Surge Transient	-	-	5	A ² s		
Turn on Time	-	-	7	ms		
Overshoot at Turn on	-	-	1	%		
Output Capacitance	470	-	6*470	uF	470uf polymer, ESR=12mR.	
Transient Response						
50% ~ 100% Max Load	Vo=2.62V Vo=1.05V	-	20	40	mV	di/dt=0.25 A/uS; Vin= 12 V
Settling Time		-	150	300	ms	
100% ~ 50% Max Load		-	20	40	mV	
Settling Time		-	150	300	ms	

Note: All specifications are typical at normal input, full load at Ta= 25°C unless otherwise stated.

General Specifications

Parameter	Min	Typ	Max	Unit	Notes
Efficiency Vo=2.62 V Vo=1.05 V	86 76	88 78	- -	%	Vin=12 V
Switching Frequency	-	500	-	kHz	
Output Voltage Trim Range (Wide Trim)	0.591	-	5.1	V	
MTBF	7,677,401			hours	Calculated Per Bell Core SR-332 (Io = 80% load; Vin=12 V; Vo=5 V; 200 LFM; Ta = 25 °C)
Dimensions Inches (L × W × H) Millimeters (L × W × H)	0.65 x 0.41 x 0.32 16.51 x 10.41 x 8.13				
Weight	-	3.5	-	g	

Note: 1. All specifications are typical at 25 °C unless otherwise stated.

2. Test condition of the transient response: di/dt=0.25A/us, Vin=12V, Ta=25°C.

Vo=2.62V, output capacitance:3*470uf(polymer)+12*22uf(c)+1*10uf(c);

Vo=1.05V, output capacitance:2*470uf(polymer)+7*22uf(c)+1*10uf(c)+3*1uf(c)+30*0.1uf(c)

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Control Specifications

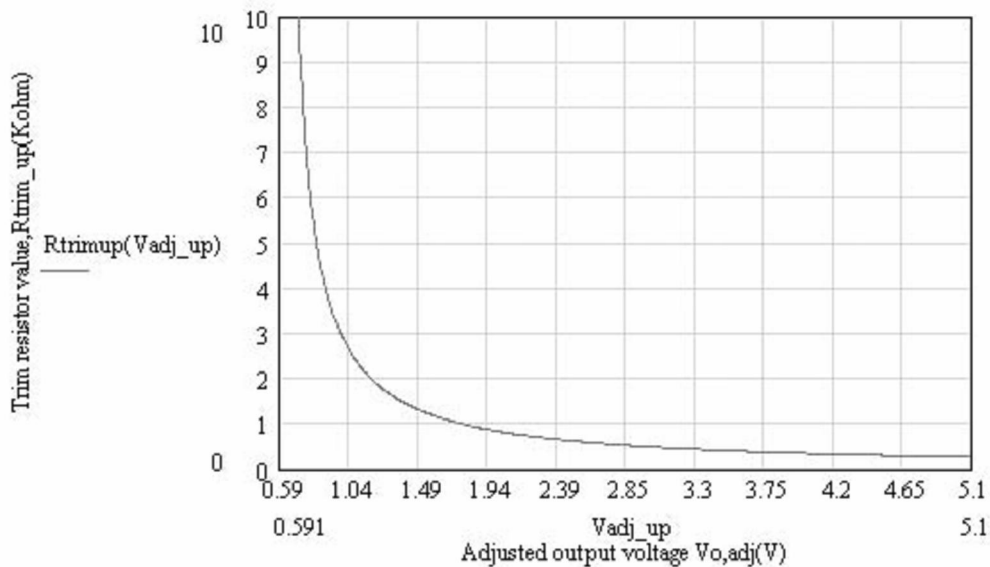
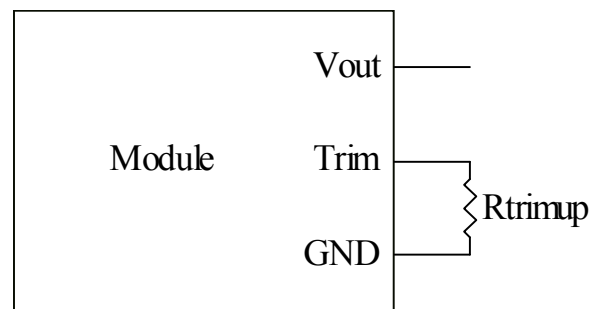
Parameter	Min	Typ	Max	Unit	Notes
Remote On/Off					
Signal Low (Unit Off)		-0.3	-0.4	V	Remote On/Off Pin is open, the unit is off.
Signal High (Unit On)		2.0	5.5	V	

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.

VRAE-10E1AE Trim up Resistor Calculate

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



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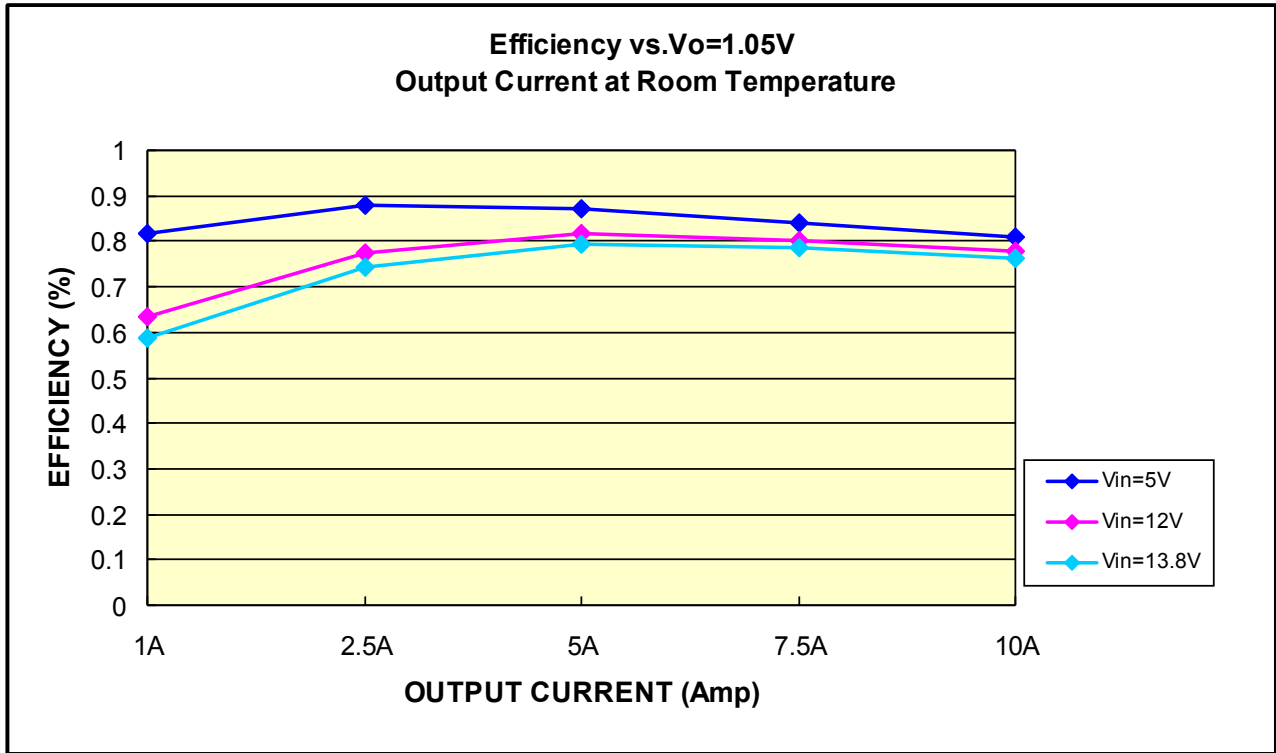
0.59 Vdc - 5.1 Vdc / 10 A Output



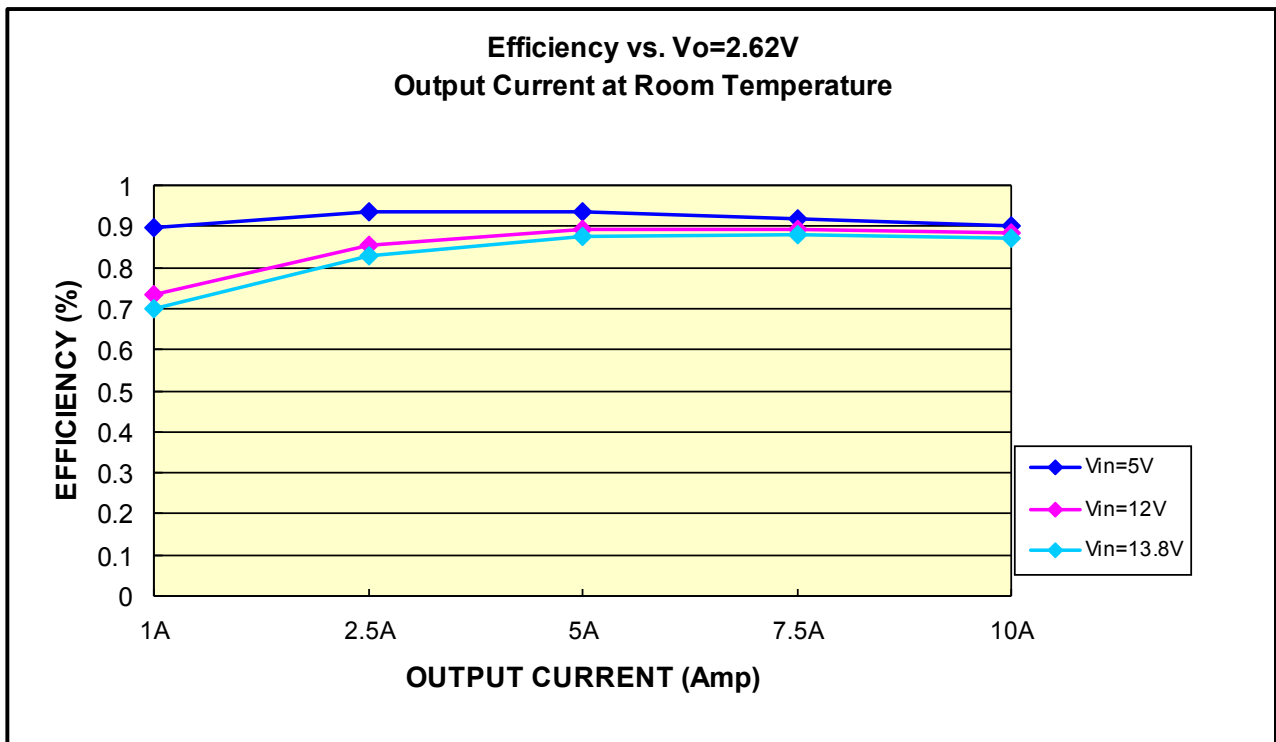
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Efficiency Data



Vo=1.05V



Vo=2.62V

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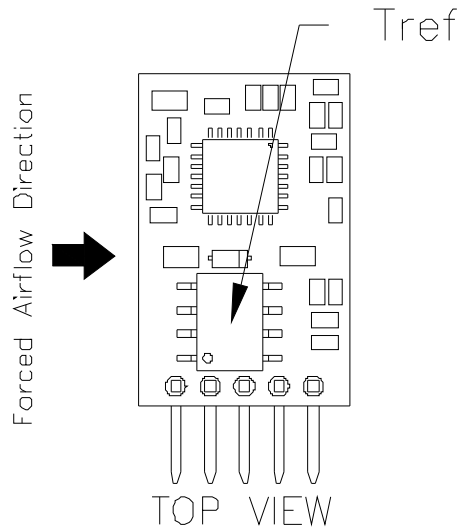
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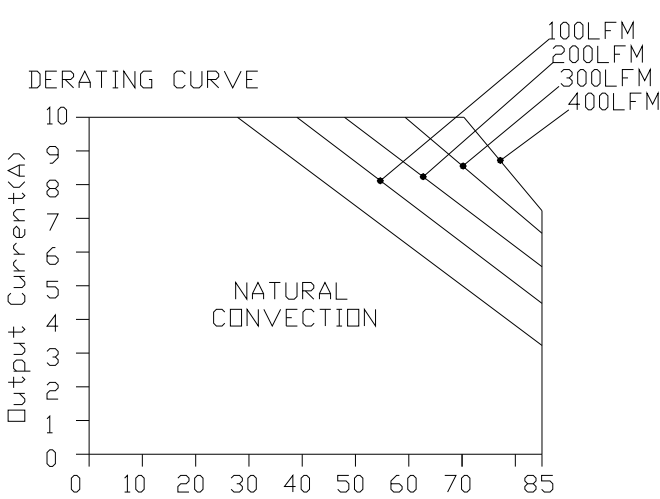
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Thermal Derating Curves

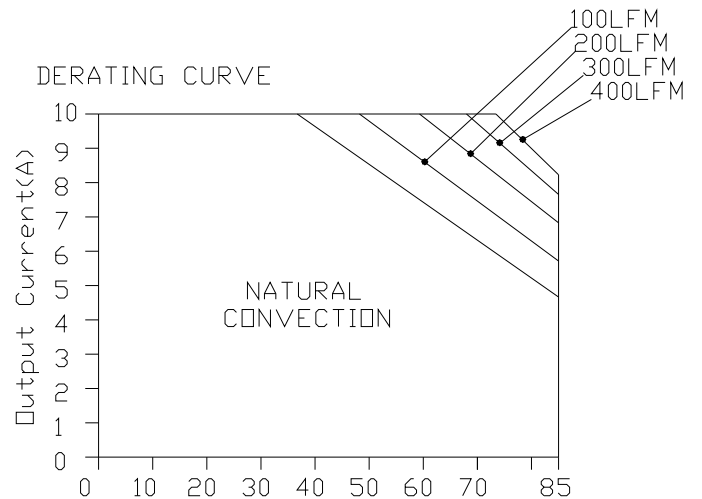


The thermal reference point T_{ref} is shown above. For reliable operation this temperature should not exceed 115°C. The output power of the module should not exceed the rated power for the module.



Output Current vs. Local Ambient Temperature and Air Velocity

$V_{in}=12V, V_{out}=2.62V$



Output Current vs. Local Ambient Temperature and Air Velocity

$V_{in}=12V, V_{out}=1.05V$

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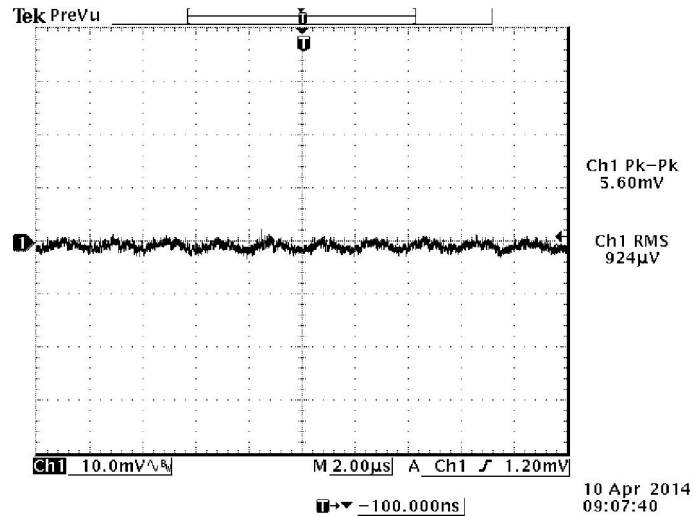
0.59 Vdc - 5.1 Vdc / 10 A Output



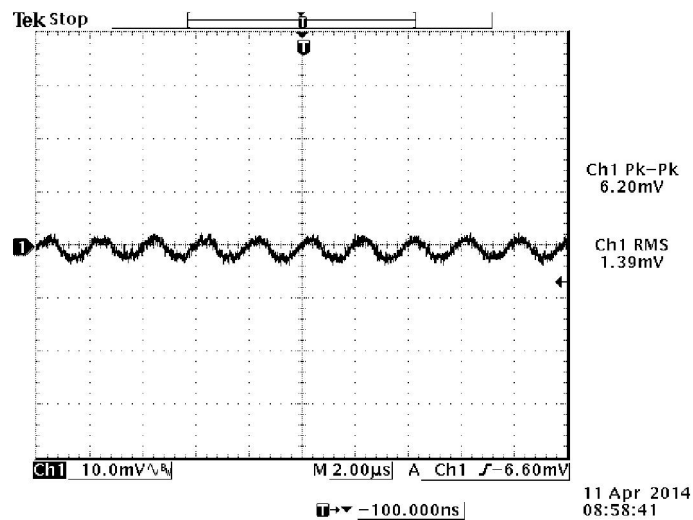
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Ripple and Noise Waveforms



Ripple and noise at full load, 12V input 1.05V output and $T_a=25$ degC



Ripple and noise at full load, 12V input 2.62V output and $T_a=25$ degC

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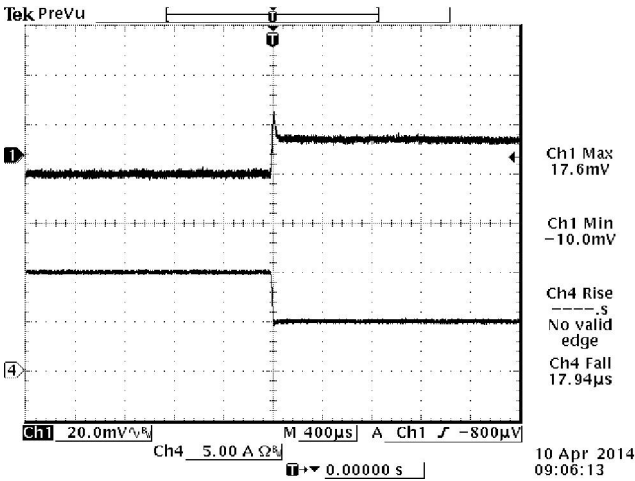
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Transient Response Waveforms

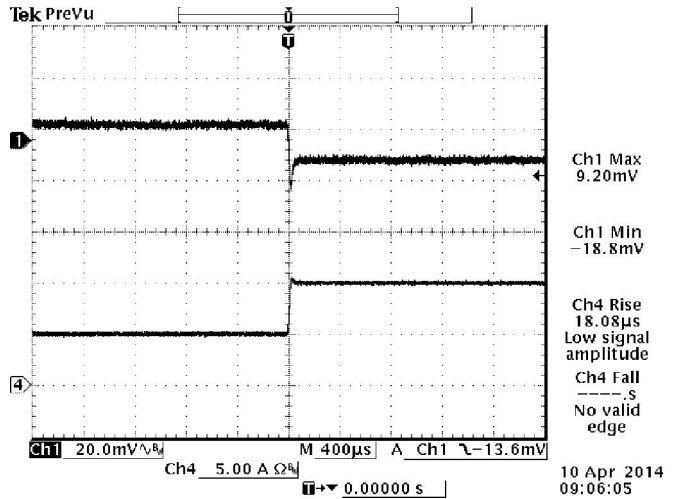


100%-50% Load Transients at $V_{in}=12V$

$V_{out}=1.05V@T_a=25^{\circ}C$

output capacitance:

$2*470\mu f(\text{polymer})+7*22\mu f(c)+1*10\mu f(c)+3*1\mu f(c)+30*0.1\mu f(c)$

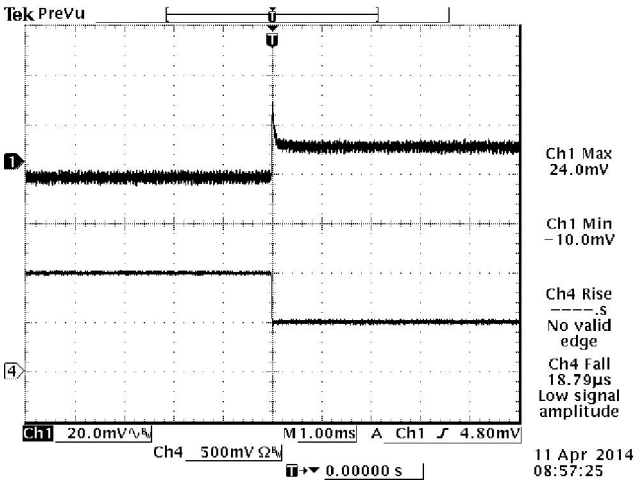


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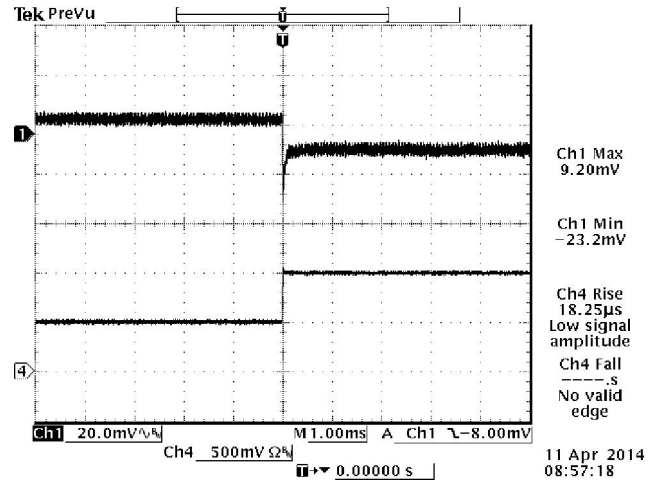


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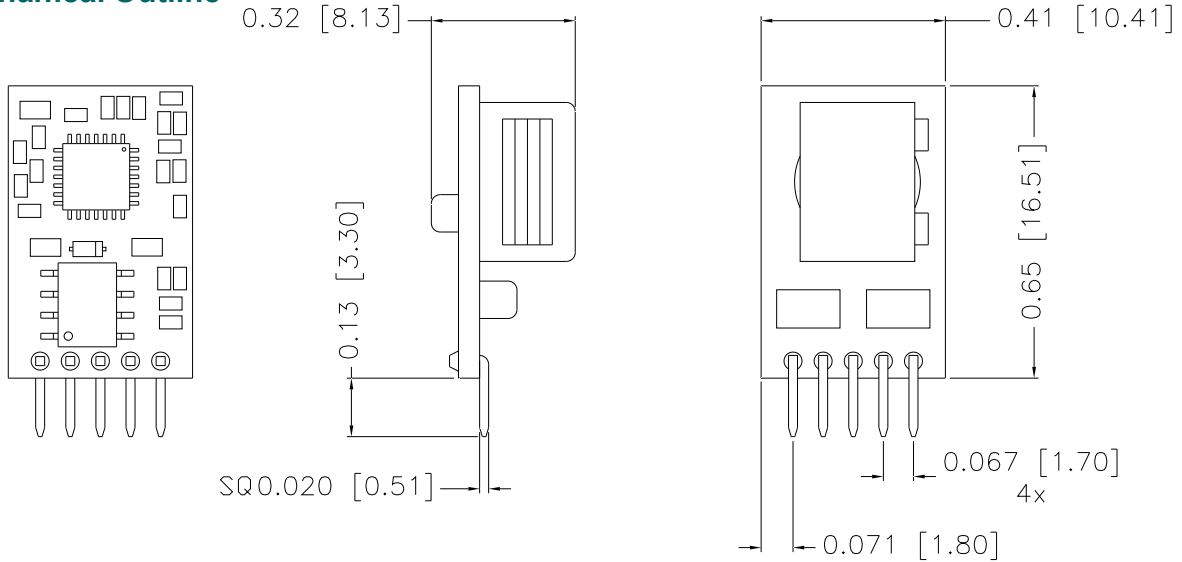
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Assembly Note

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

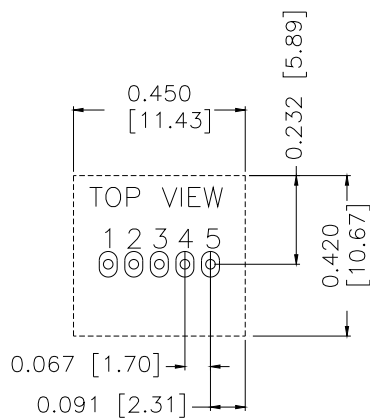
Mechanical Outline



TOP VIEW
RECOMMENDED PAD LAYOUT

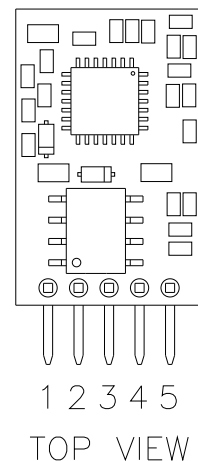
UNIT: INCH [mm]

BOTTOM VIEW



Pin Connections

Pin	Function
1	ENABLE
2	Vin
3	GND
4	Vout
5	Trim



PAD: LENGTH 0.067 [ø1.7] BOTH SIDE

WIDTH 0.047 [ø1.2] BOTH SIDE

HOLE: ø0.035 [ø0.89] BOTH SIDE

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.

Note:

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[0.5mm] x.xxx +/-0.010 in[0.25mm].

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Datasheet Revision History

Date	Revision	Changes Detail	Approval
2014-4-18	A	First release.	XF JIANG
2014-5-13	B	Update output capacitance, transient response.	XF JIANG
2016-01-04	C	Add Assembly Note. Update mechanical drawing	XF JIANG
2016-05-12	D	Add thermal reference location of the module in TD	XF JIANG

RoHS Compliance

Complies with the European Directive 2011/65/EU, calling for the elimination of lead and other hazardous substances from electronic products.



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