

NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 13.8 Vdc Input

0.59 Vdc - 5.1 Vdc / 6 A Output

bel
POWER PRODUCTS

VRAE-06E1AQ

RoHS Compliant

Rev.B

- Non-Isolated
- High Efficiency
- Fixed Frequency
- Low Cost
- Wide Input
- Under-Voltage Lockout
- Wide Trim
- OCP/SCP
- Remote On/Off



Description

The Bel VRAE-06E1AQ 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 ($V_{IN} = 4.5 \text{ Vdc} - 13.8 \text{ Vdc}$). The efficiency is typically 91% at 3.3 Vout ($V_{in}=12 \text{ Vdc}$) at full load.

Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number Active High
0.59 Vdc - 5.1 Vdc	4.5 Vdc - 13.8 Vdc	6 A	30 W	91%	VRAE-06E1AQ

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".

Absolute Maximum Ratings

Parameter	Min	Typ	Max	Notes
Input Supply Voltage	-0.3 V	-	15 V	
Ambient Temperature	0 °C	-	70 °C	
Storage Temperature	-55 °C	-	125 °C	

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

Input Specifications

Parameter	Min	Typ	Max	Notes
Operating Input Voltage				
$V_{O, \text{set}} \leq 3.63 \text{ V}$	4.5 V	-	13.8 V	
$V_{O, \text{set}} > 3.63 \text{ V}$	7.0 V	-	13.8 V	
Input Current (full load)	-	-	5 A	An input line fuse must always be used.
Input Current (no load)	-	50 mA	100 mA	
Remote Off Input Current	-	10 mA	25 mA	
Input Reflected Ripple Current (pk-pk)	-	80 mA	150 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)	-	25 mA	50 mA	
I^2t Inrush Current Transient	-	-	1 A ² s	
Turn on Voltage Threshold	4.15 V	4.3 V	4.45 V	A 30.1K resistor is connected from Enable to Vin
Turn off Voltage Threshold	3.7 V	4.1 V	4.3 V	

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

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Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point Accuracy	-2%Vo,set	-	2%Vo,set	Vin= 12 V, Iout=full load
Load Regulation	-	±0.3%Vo,set	±1%Vo,set	
Line Regulation	-	±0.3%Vo,set	±1%Vo,set	
Temperature Regulation	-	0.3%Vo,set	0.5%Vo,set	
Output Current	0 A	-	6 A	
Output DC Current Limit	7.2 A	9 A	12 A	
Output Ripple and Noise (pk-pk)	-	50 mV	70 mV	0-20 MHz BW, with a 1 uF ceramic and a 10 uF tantalum capacitor at the output.
Output Ripple and Noise (rms)	-	15 mV	25 mV	
Short Circuit Surge Transient	-	-	5 A ² s	
Turn on Time	-	2 mS	5 mS	
Overshoot at Turn on	-	-	1%	
Output Capacitance	0 uF	-	1000 uF	
Transient Response				
50% ~ 100% Max Load	Vo =All	-	200 mV	di/dt=0.25 A/uS; Vin=12 V; with a 10 uF tantalum capacitor and a 1 uF ceramic capacitor at the output.
Settling Time		-	20 uS	
100% ~ 50% Max Load		-	200 mV	
Settling Time		-	20 uS	

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

General Specifications

Parameter	Min	Typ	Max	Notes
Efficiency				Vin=12 V
Vo=5.0 V	91%	93%	-	
Vo=3.3 V	89%	91%	-	
Vo=2.5 V	85%	87%	-	
Vo=1.8 V	82%	84%	-	
Vo=1.5 V	80%	82%	-	
Vo=1.2 V	77%	79%	-	
Vo=0.9 V	72%	74%	-	
Switching Frequency	-	500 kHz	-	
Output Voltage Trim Range (Wide Trim)	0.591 V	-	5.1 V	
MTBF	8,440,749 hours			Calculated Per Bell Core SR-332 (Io = 80% load; Vin=12 V; Vo=5 V; 200 LFM; Ta = 25 °C)
Dimensions				
Inches (L x W x H)	0.65 x 0.41 x 0.295			
Millimeters (L x W x H)	16.51 x 10.41 x 7.50			
Weight	-	2.2 g	-	

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

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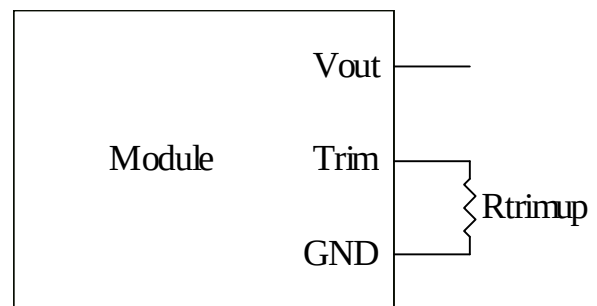
Control Specifications

Parameter	Min	Typ	Max	Notes
Remote On/Off				
Signal Low (Unit Off)	-0.3 V	-	0.4 V	Remote On/Off pin open, unit on.
Signal High (Unit On)	2.0 V	-	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.

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



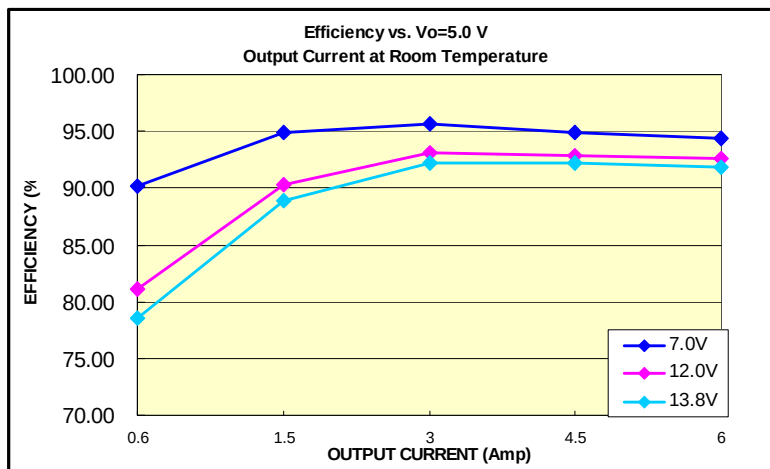
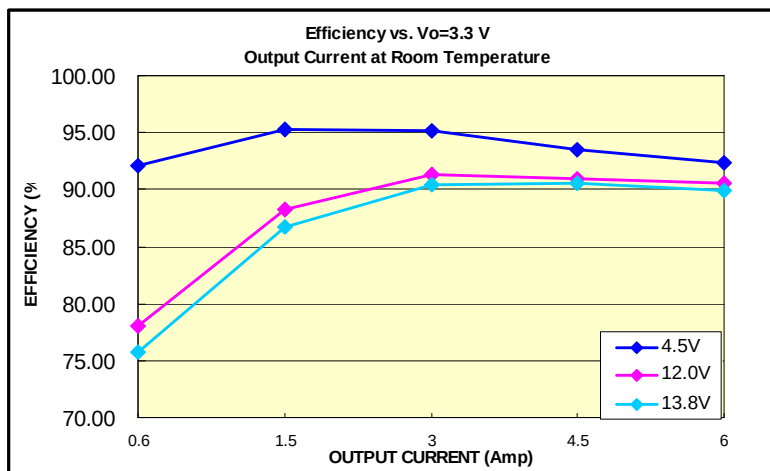
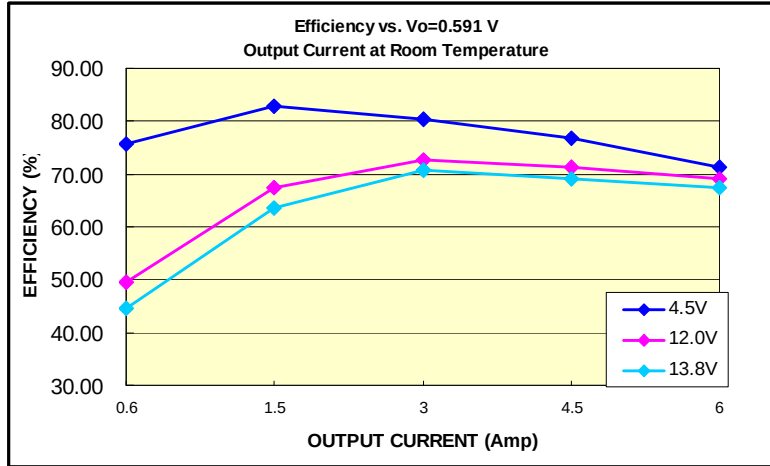
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Efficiency Data



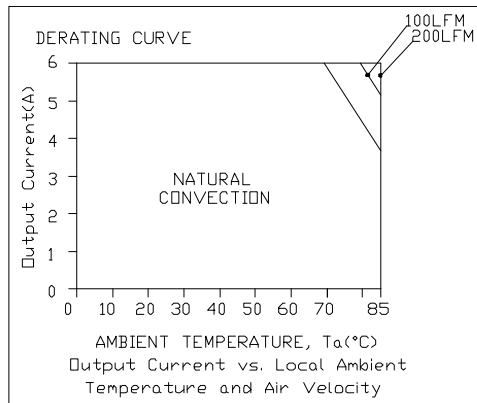
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4.5 Vdc - 13.8 Vdc Input

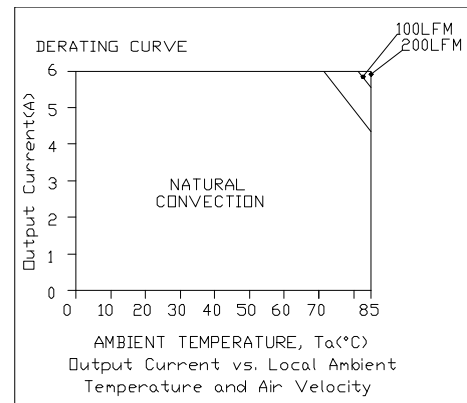
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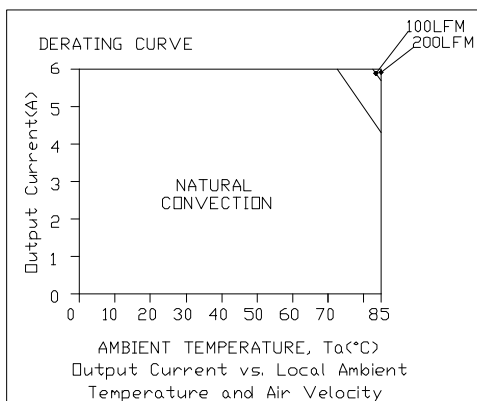
Thermal Derating Curves



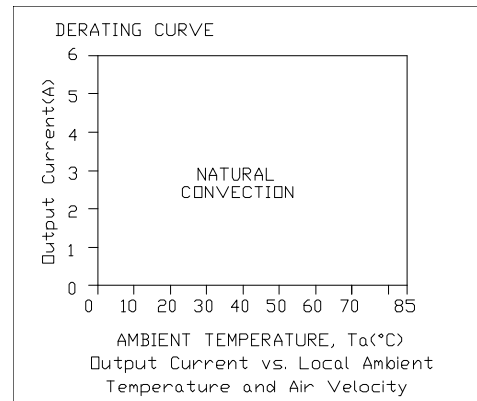
Vin=12 V, Vout=5 V



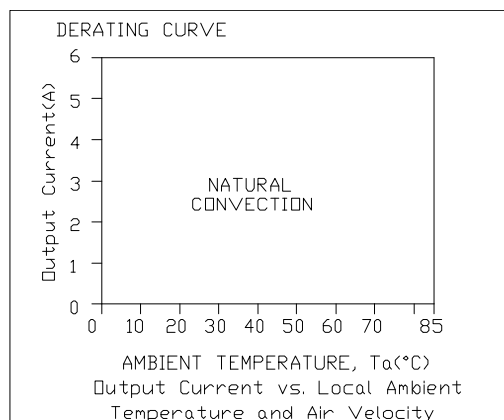
Vin=12 V, Vout=3.3 V



Vin=12 V, Vout=2.5 V



Vin=12 V, Vout=1.2 V



Vin=12 V, Vout=0.59 V

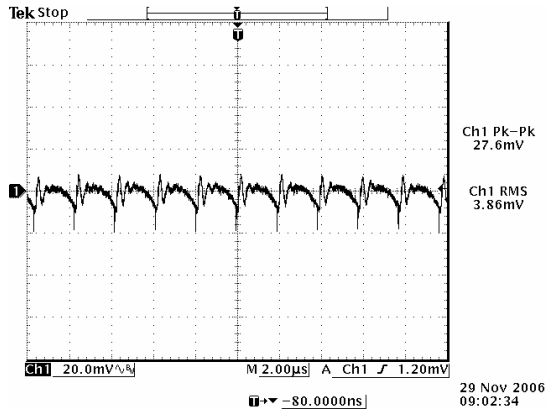
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4.5 Vdc - 13.8 Vdc Input

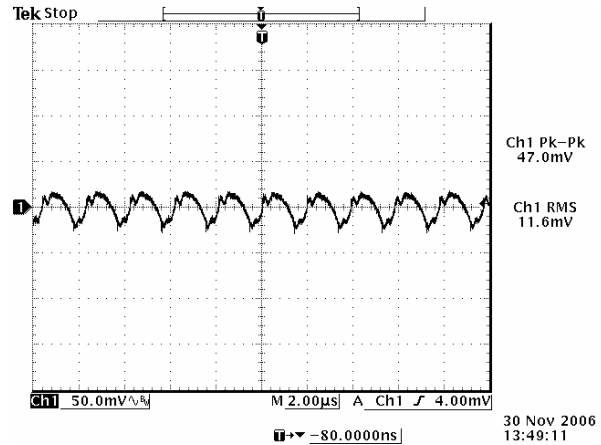
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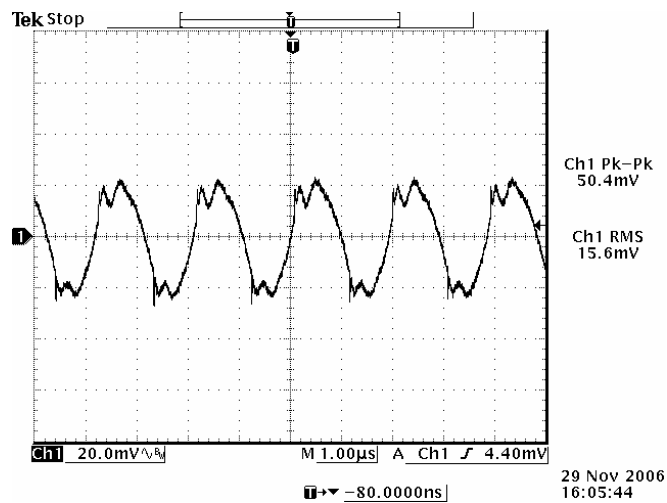
Ripple and Noise Waveform



12 V input, 0.591 V output



12 V input, 3.3 V output



12 V input, 5.0 V output

Note: Ripple and noise at full load, 0-20MHz BW, with a 1 μ F ceramic and a 10 μ F tantalum capacitor at the output, $T_a=25$ deg C.

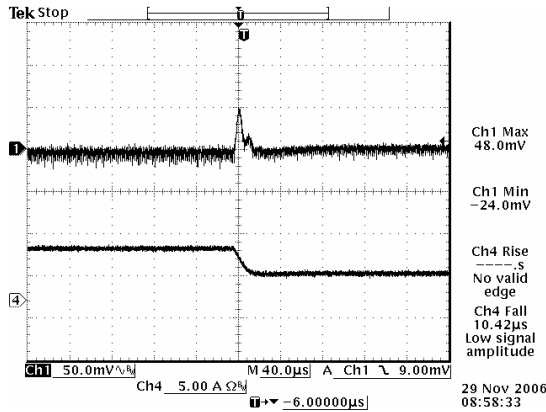
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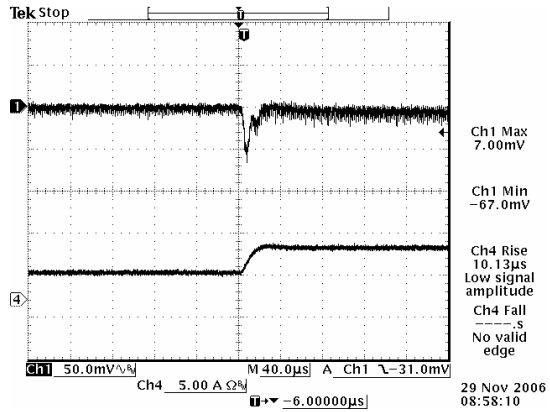
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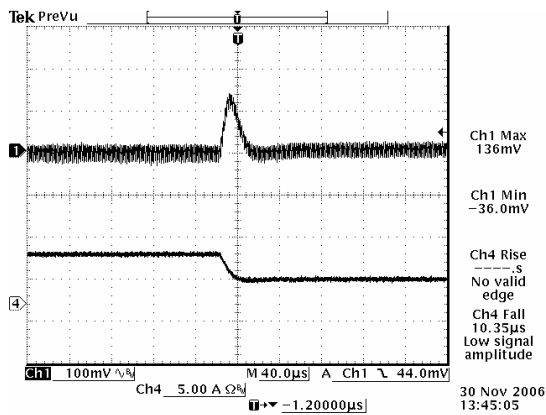
Transient Response Waveforms



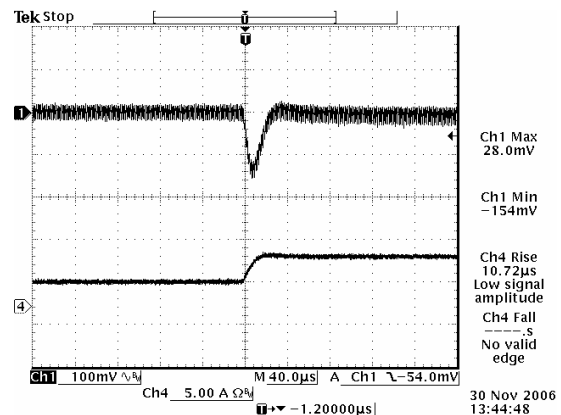
100% to 50% load step at 12 V input, 0.591 V output



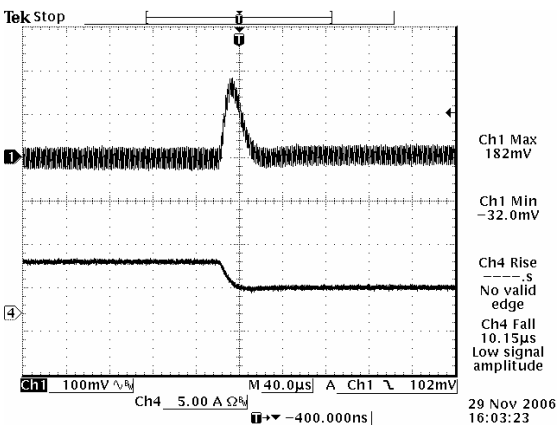
50% to 100% load step at 12 V input, 0.591 V output



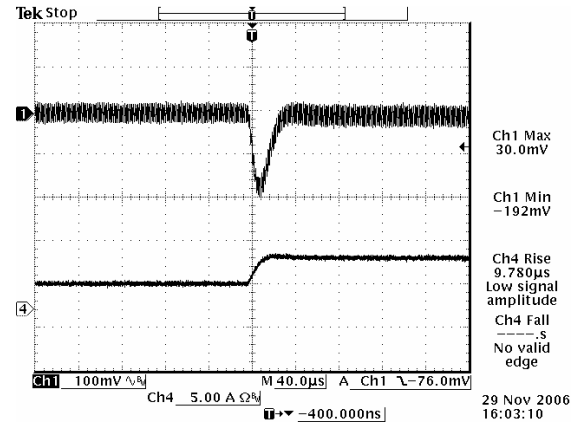
100% to 50% load step at 12 V input, 3.3 V output



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



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



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

Note: Transient response at $di/dt=0.25$ A/μs, with a 1μF ceramic cap and a 10 μF tantalum cap at the output, and $T_a=25$ deg C.

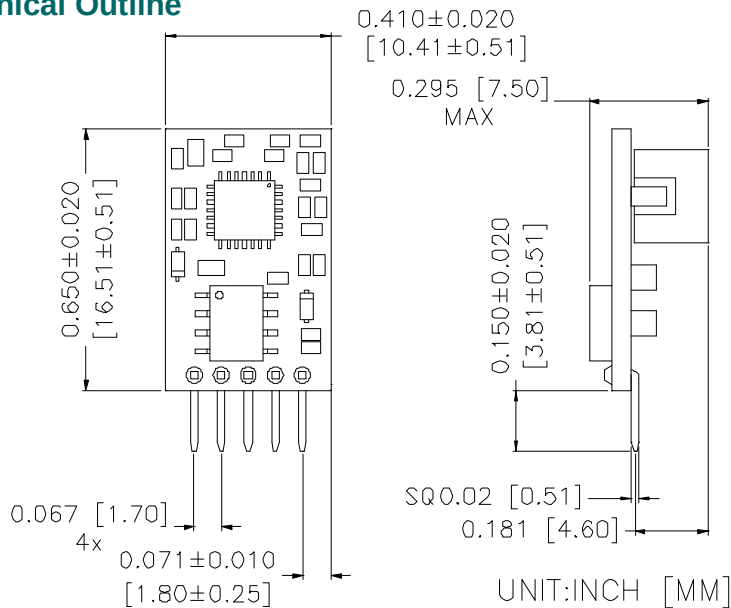
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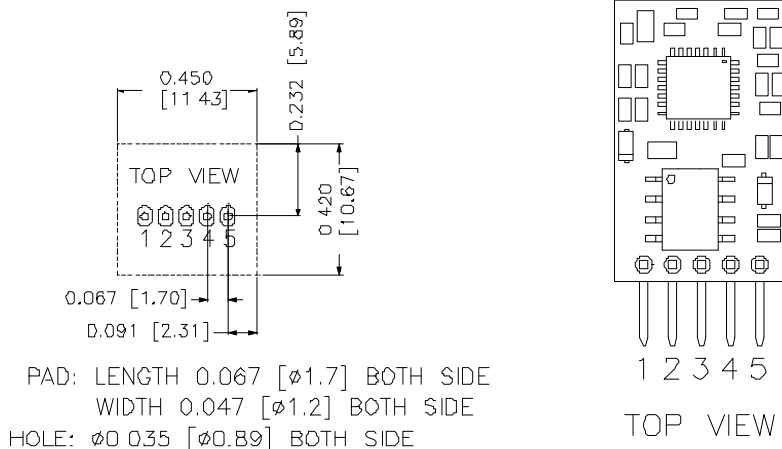
Mechanical Outline



TOP VIEW

BOTTOM VIEW

RECOMMENDED PAD LAYOUT



Pin Connections

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

RoHS Compliance

Complies with the European Directive 2002/95/EC, calling for the elimination of lead and other hazardous substances from electronic products.



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