

## 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-06E1AC**

**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-06E1AC 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-06E1AC

**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				
$V_{o,set} \leq 3.63 \text{ V}$	4.5 V	-	13.8 V	
$V_{o,set} > 3.63 \text{ V}$	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 <sup>2</sup> 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 <sup>2</sup> s		
Turn on Time	-	2 mS	5 mS		
Overshoot at Turn on	-	-	1%		
Output Capacitance	0 uF	-	1000 uF		
<b>Transient Response</b>					
50% ~ 100% Max Load	Vo =All	-	200 mV	250 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	50 uS	
100% ~ 50% Max Load		-	200 mV	250 mV	
Settling Time		-	20 uS	50 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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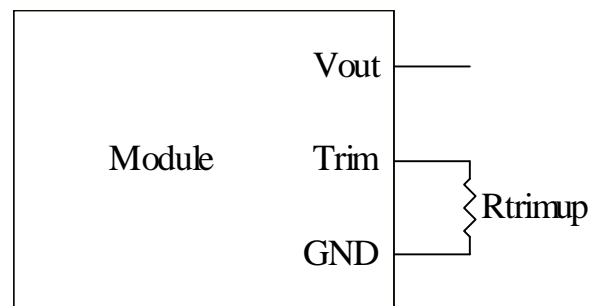
### Control Specifications

Parameter	Min	Typ	Max	Notes
<b>Remote On/Off</b>				
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.

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



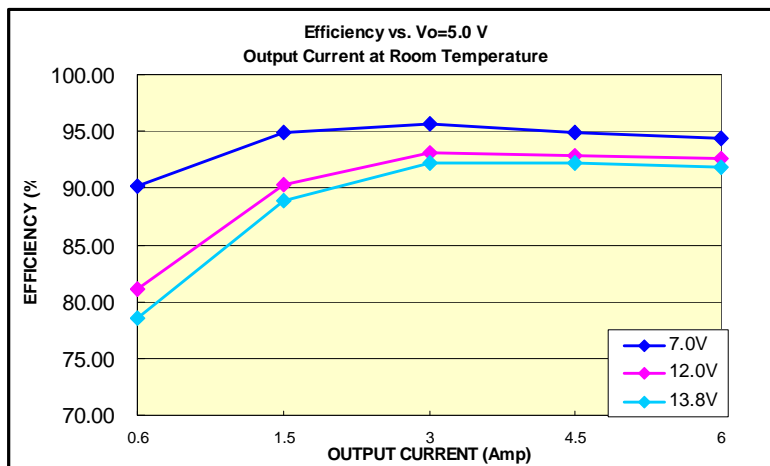
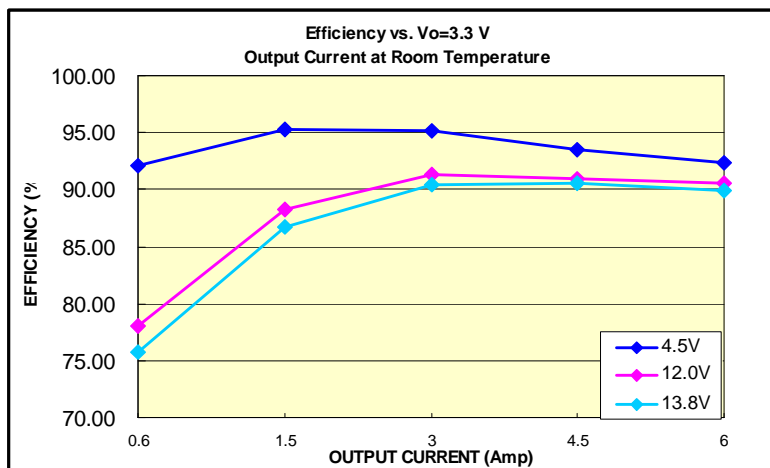
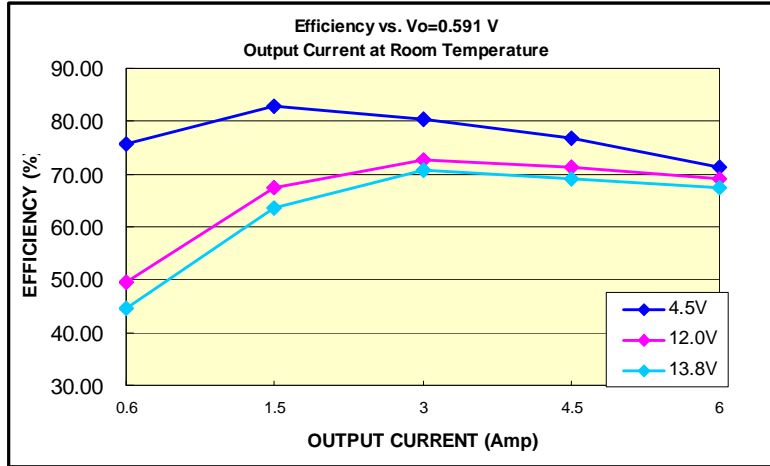
# NON-ISOLATED DC/DC CONVERTERS

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## Efficiency Data



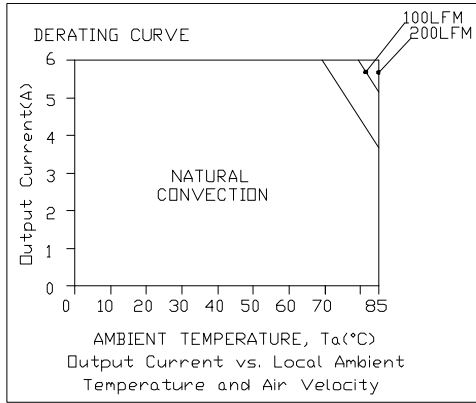
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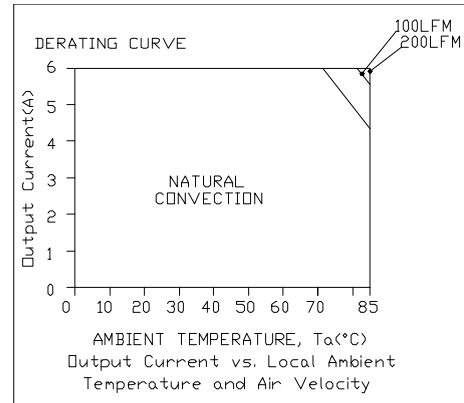
0.59 Vdc - 5.1 Vdc / 6 A Output



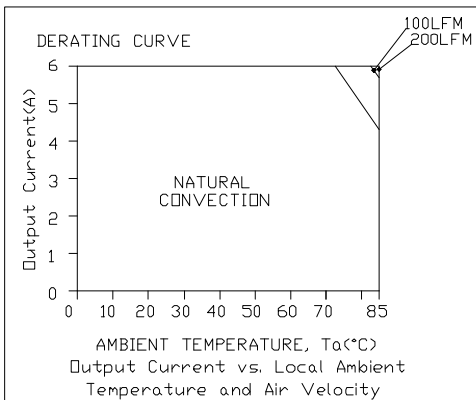
## Thermal Derating Curves



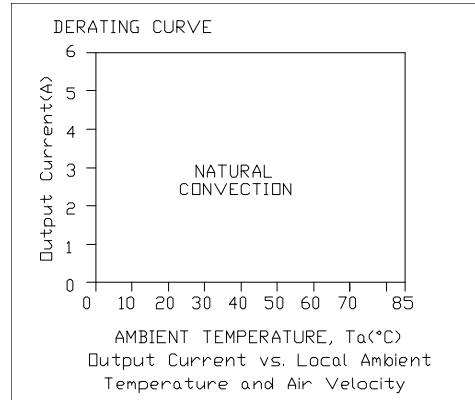
Vin=12 V, Vout=5 V



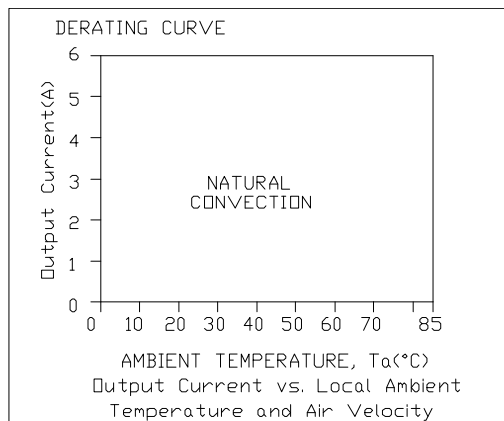
Vin=12 V, Vout=3.3 V



Vin=12 V, Vout=2.5 V



Vin=12 V, Vout=1.2 V



Vin=12 V, Vout=0.59 V

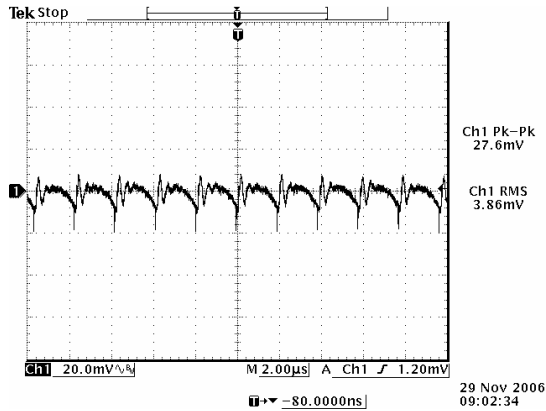
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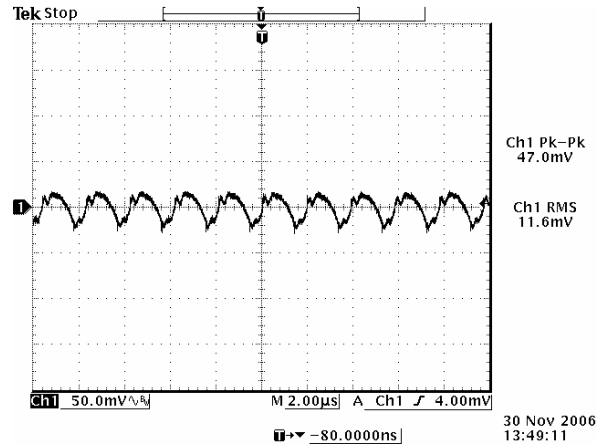
0.59 Vdc - 5.1 Vdc / 6 A Output



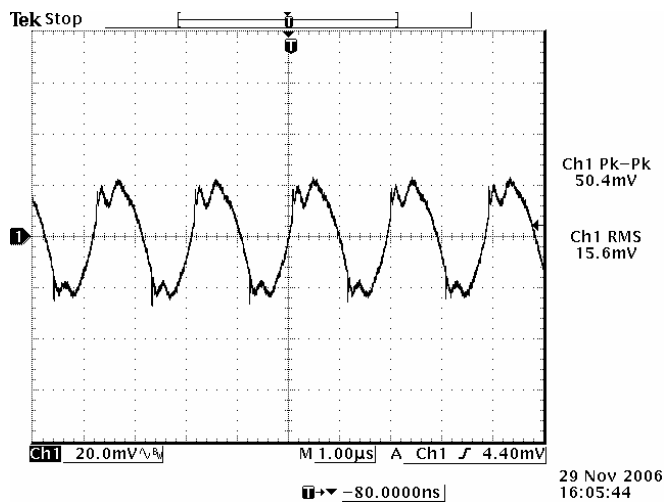
## Ripple and Noise Waveform



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  $\mu$ F ceramic and a 10  $\mu$ F tantalum capacitor at the output,  $T_a=25$  deg C.

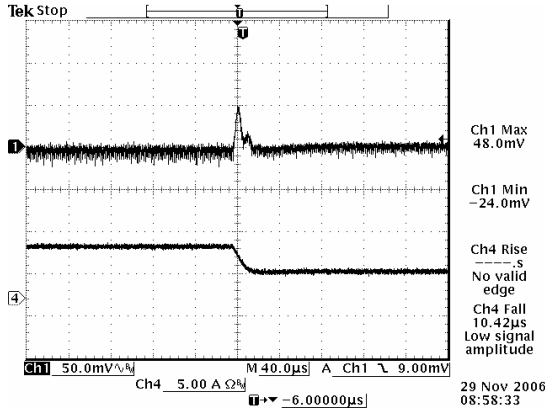
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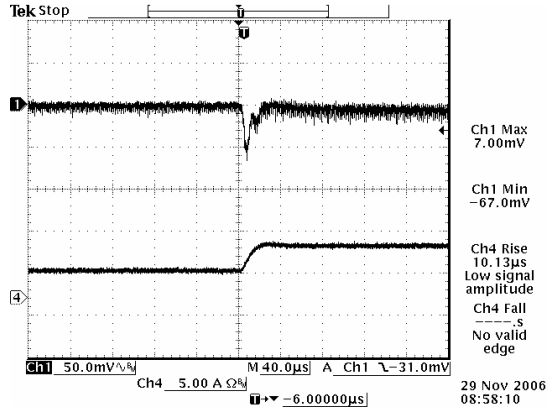
0.59 Vdc - 5.1 Vdc / 6 A Output



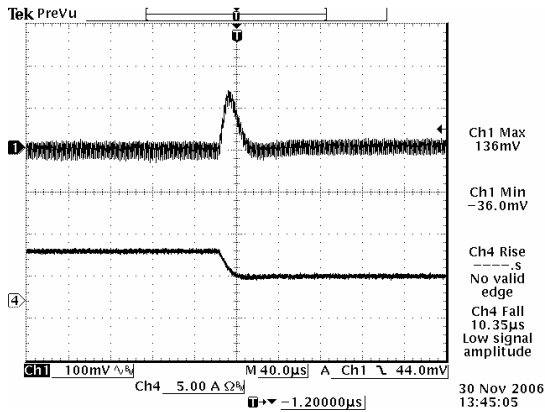
## Transient Response Waveforms



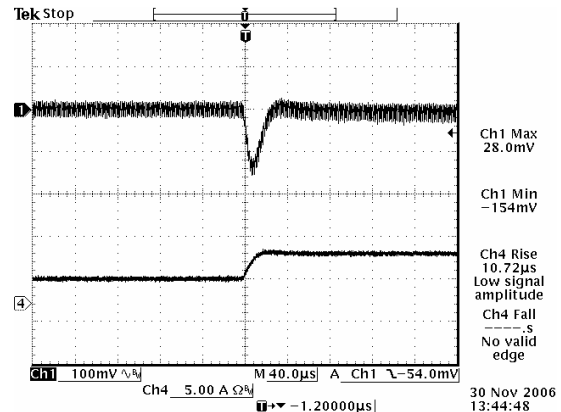
100% to 50% load step at 12 V input, 0.591 V output



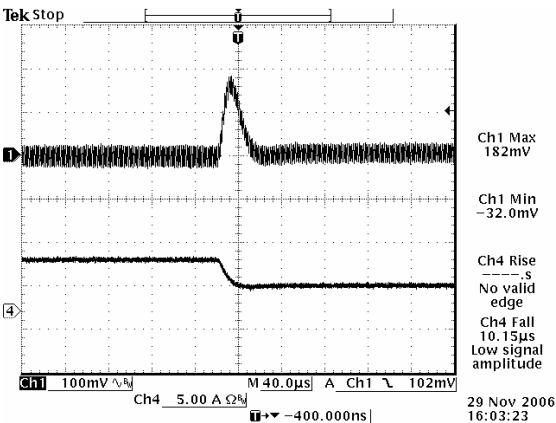
50% to 100% load step at 12 V input, 0.591 V output



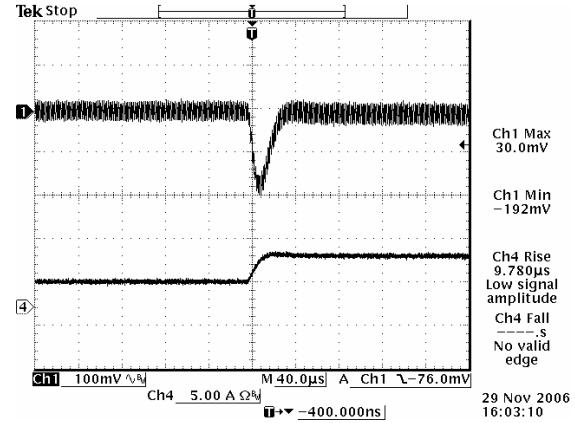
100% to 50% load step at 12 V input, 3.3 V output



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.

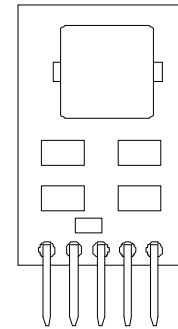
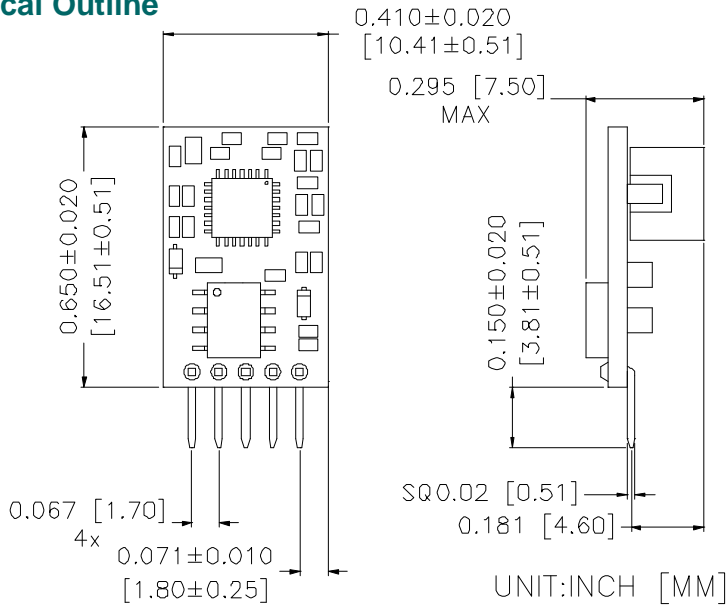
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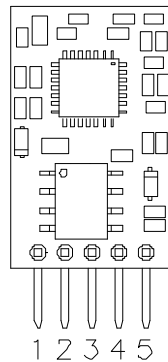
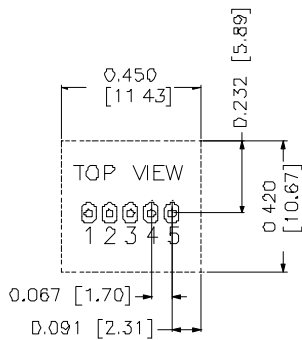
## Mechanical Outline



TOP VIEW

BOTTOM VIEW

RECOMMENDED PAD LAYOUT



TOP VIEW

## Pin Connections

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

PAD: LENGTH 0.067 [φ1.7] BOTH SIDE  
 WIDTH 0.047 [φ1.2] BOTH SIDE  
 HOLE: φ0.035 [φ0.89] BOTH SIDE

## 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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