

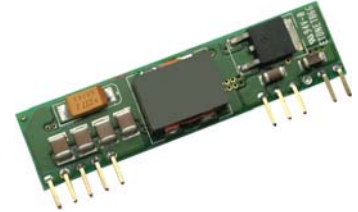
## NON-ISOLATED DC/DC CONVERTERS

4.5 V - 14 V Input    0.75 V - 3.63 V/10 A Output

**bel**  
POWER PRODUCTS

### VRBC-10E1Ax Series    RoHS Compliant

- Non-Isolated
- High Efficiency
- Fixed Frequency
- Remote Sense
- Low Cost
- Under-Voltage Lockout (UVLO)
- Over Temperature Shutdown
- Wide Input
- Wide trim
- OCP/SCP
- Remote On/Off
- Active Low/High (option)
- Industrial Temperature Range



### Description

The Bel VRBC-10E1Ax is part of the non-isolate dc/dc power converter series. The modules use a SIP package. These converters are available in a range of output voltages from 0.75 V to 3.63 V over a wide range of input voltage ( $V_{in} = 4.5 \text{ V} - 14 \text{ V}$ ). The efficiency is typically 94.3% at 3.3 V output at 5.0 V input at full load.

### Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number Active Low	Model Number Active High
0.75 V - 3.63 V	4.5 V - 14 V	10 A	36.3 W	94.3%	VRBC-10E1AL	VRBC-10E1A0

**Note:** Add "G" suffix at the end of the model number to indicate Tray Packaging.

### Absolute Maximum Ratings

Parameter	Min	Typ	Max	Notes
Input Voltage (continuous)	-0.3 V	-	15 V	
Output Enable Terminal Voltage	-0.3 V	-	15 V	
Ambient Temperature	-40 °C	-	85 °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
Input Voltage $V_{o,set} < 3.0 \text{ V}$ $V_{o,set} \geq 3.0 \text{ V}$	4.5 V $V_{o,set} + 1.5 \text{ V}$	- -	14 V 14 V	
Input Current (full load)	-	-	8.6 A	An input line fuse must always be used.
Input Current (no load)	-	40 mA	-	
Remote Off Input Current	-	2 mA	-	
Input Reflected Ripple Current (pk-pk)	-	-	400 mA	Tested with one 1000 uF/25V AL input capacitor with ESR=0.03ohm max and 4 × 47 uF/16V Tantalum capacitors with ESR=0.013 ohm max at 100 kHz, & simulated source impedance of 1000nH, 5 Hz to 20MHz.
Input Reflected Ripple Current (rms)	-	-	150 mA	
$I^2t$ Inrush Current Transient	-	0.2 A <sup>2</sup> s	0.4 A <sup>2</sup> s	
Turn-on Voltage Threshold	-	4.3 V	-	
Turn-off Voltage Threshold	-	4.0 V	-	

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

## NON-ISOLATED DC/DC CONVERTERS

4.5 V - 14 V Input    0.75 V - 3.63 V/10 A Output



### Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point	-2% Vo,set	-	2% Vo,set	Vin=5 V & 12 V, full load
Load Regulation	-	0.1% Vo,set	-	
Line Regulation	-	0.1% Vo,set	-	
Regulation Over Temperature (-40 °C to +85 °C)	-	0.3Vo,set	-	Tref=Ta, min to Ta, max
Output Current	0 A	-	10 A	
Current Limit Threshold	-	200% Io,out	-	
Short Circuit Surge Transient	-	1 A <sup>2</sup> s	3 A <sup>2</sup> s	
Ripple and Noise (pk-pk)	-	30 mV	80 mV	Tested with 0-20 MHz, with 10 uF tantalum capacitor & 1 uF ceramic capacitor at the output
Ripple and Noise (rms)	-	12 mV	35 mV	
Turn on Time	-	8 mS	20 mS	
Overshoot at Turn on	-	-	1%	
Output Capacitance	0 uF	-	5600 uF	
<b>Transient Response</b>				
50% ~ 100% Max Load	Vo = 0.75 V - 3.63 V	-	160 mV	di/dt=2.5 A/uS; Vin=5 V & 12 V; and with 470 uF Tantalum capacitor at the output
Settling Time		-	50 uS	
100% ~ 50% Max Load		-	160 mV	
Settling Time		-	50 uS	

**Note:** All specifications are typical at nominal input, full load at 25 °C unless otherwise stated.

### General Specifications

Parameter	Min	Typ	Max	Notes
Efficiency				Measured at Vin=5 V, full load
Vo=3.3 V	-	94.3%	-	
Vo=2.5 V	-	93.0%	-	
Vo=1.8 V	-	91.5%	-	
Vo=1.5 V	-	90.8%	-	
Vo=1.2 V	-	89.3%	-	
Vo=0.75 V	-	83.0%	-	
Efficiency				Measured at Vin=12 V, full load
Vo=3.3 V	-	93.0%	-	
Vo=2.5 V	-	92.0%	-	
Vo=1.8 V	-	90.0%	-	
Vo=1.5 V	-	89.0%	-	
Vo=1.2 V	-	87.5%	-	
Vo=0.75 V	-	81.0%	-	
Switching Frequency	265 kHz	300 kHz	335 kHz	
Over Temperature Shutdown	-	130 °C	-	
Output Voltage Trim Range	0.7525 V	-	3.63 V	
Remote Sense Compensation	-	-	0.5 V	
MTBF	5,114,191 hours			Calculated Per Bell Core SR-332 (Io = 80%Io,max; Vo=3.3 V; Vin=12 V; Ta = 25 °C)
Dimensions				
Inches (L x W x H)	2.0 x 0.5 x 0.32			
Millimeters (L x W x H)	50.8 x 12.7 x 8.13			
Weight	-	7.1 g	-	

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

## NON-ISOLATED DC/DC CONVERTERS

4.5 V - 14 V Input    0.75 V - 3.63 V/10 A Output



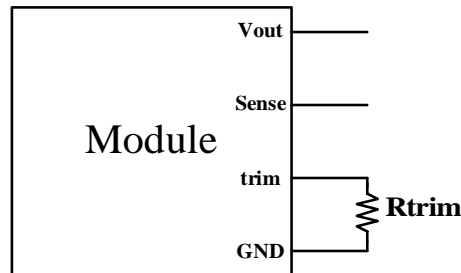
### Control Specifications

Parameter	Min	Typ	Max	Notes
<b>Remote On/Off</b>				
Signal Low (Unit Off)	-0.2 V	-	0.3 V	VRBC-10E1A0; Remote On/Off pin open, Unit on.
Signal High (Unit On)	-	-	V <sub>in, max</sub>	
Signal Low (Unit On)	-0.2 V	-	0.3 V	VRBC-10E1AL; Remote On/Off pin open, Unit on.
Signal High (Unit Off)	2.5 V	-	V <sub>in, max</sub>	

### Output Trim Equations

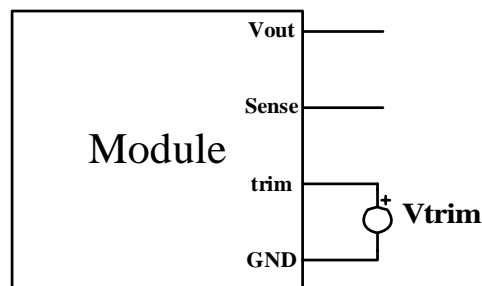
Equation for calculating the trim resistor (in  $\Omega$ ) given the desired output voltage ( $V_o$ ) is shown below. The Trim Up resistor should be connected between the Trim pin and Ground.

$$R_{trim} = \frac{10500}{V_o - 0.7525} - 1000$$



Equation for calculating the trim voltage (in V) given the desired output voltage ( $V_o$ ) is shown below. The Trim Up voltage should be connected between the Trim pin and Ground.

$$V_{trim} = 0.7 - 0.0667 \times (V_o - 0.7525)$$

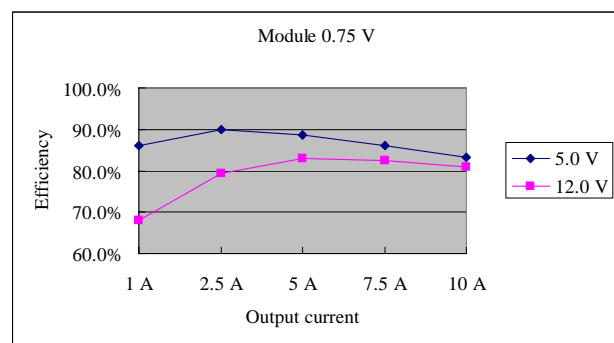
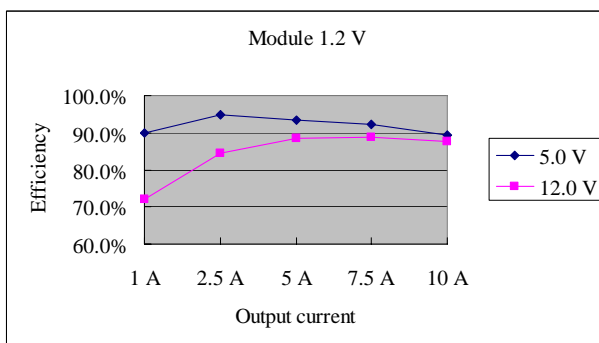
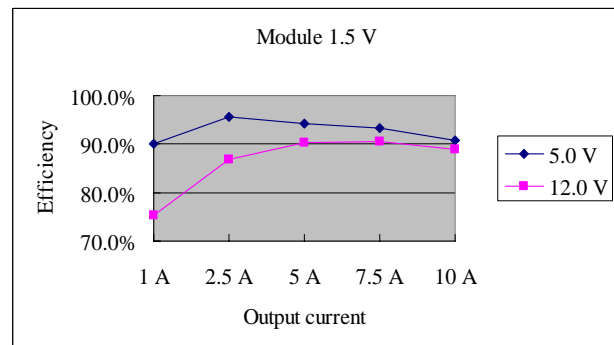
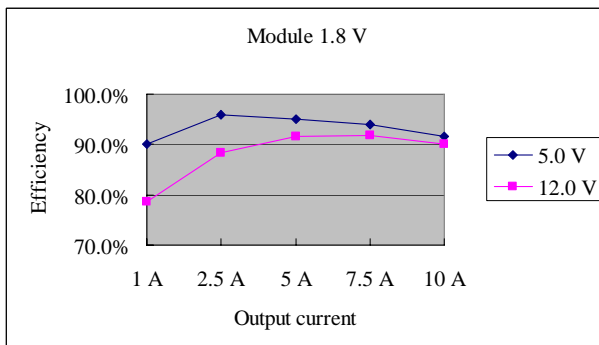
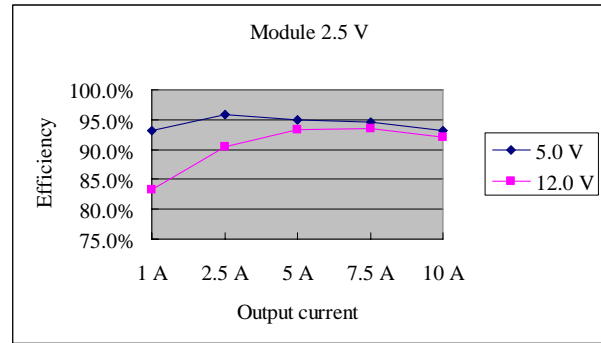
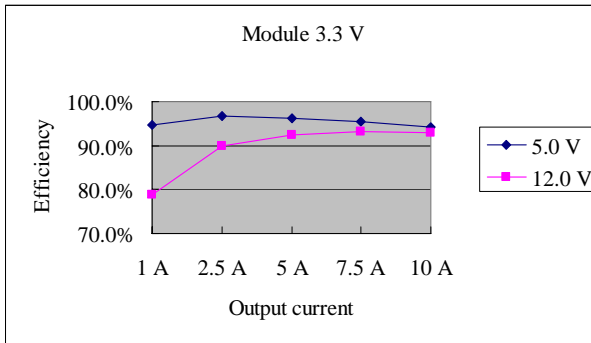


# NON-ISOLATED DC/DC CONVERTERS

4.5 V - 14 V Input    0.75 V - 3.63 V/10 A Output



## Efficiency Data

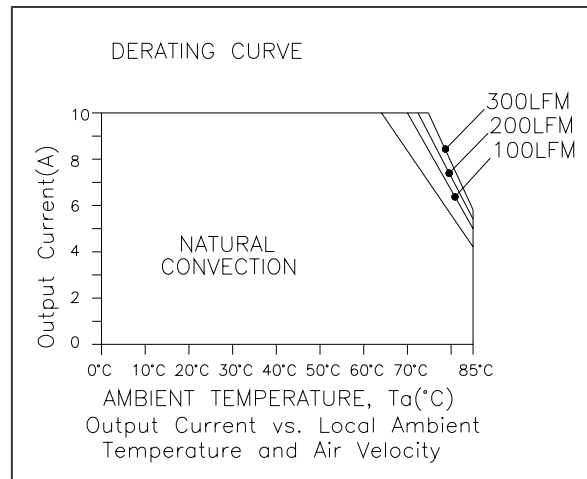


# NON-ISOLATED DC/DC CONVERTERS

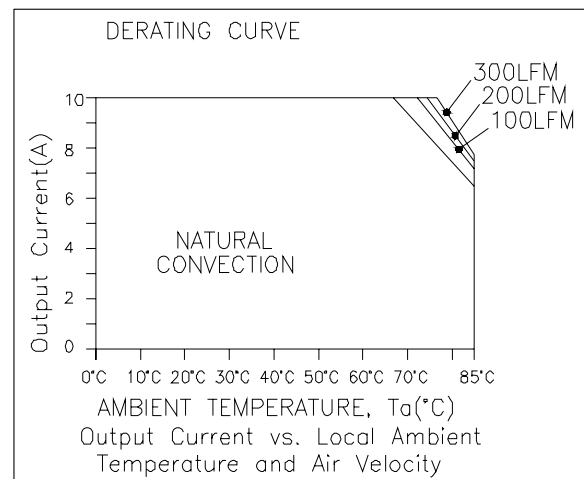
4.5 V - 14 V Input    0.75 V - 3.63 V/10 A Output



## Thermal Derating Curves



$V_{in}=12\text{ V}$ ,  $V_o = 3.3\text{ V}$



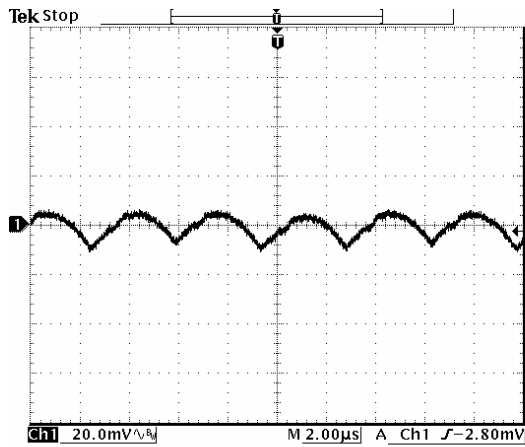
$V_{in}=5\text{ V}$ ,  $V_o = 3.3\text{ V}$

# NON-ISOLATED DC/DC CONVERTERS

4.5 V - 14 V Input    0.75 V - 3.63 V/10 A Output

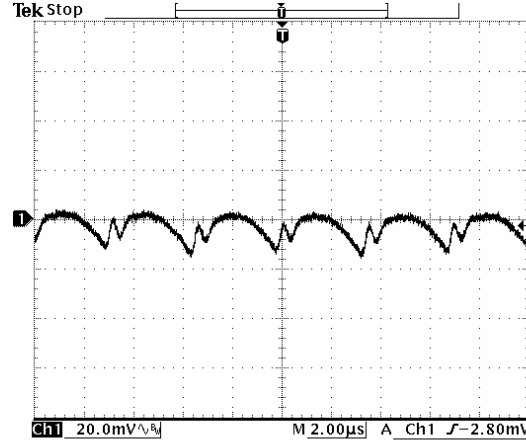


## Ripple and Noise Waveforms



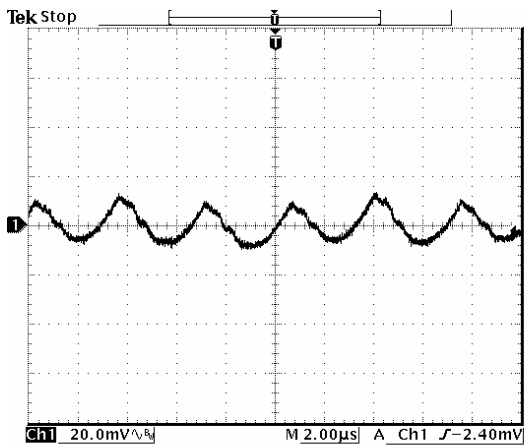
17 Aug 2004  
14:19:31

Vin=5 V, Vo=0.75 V



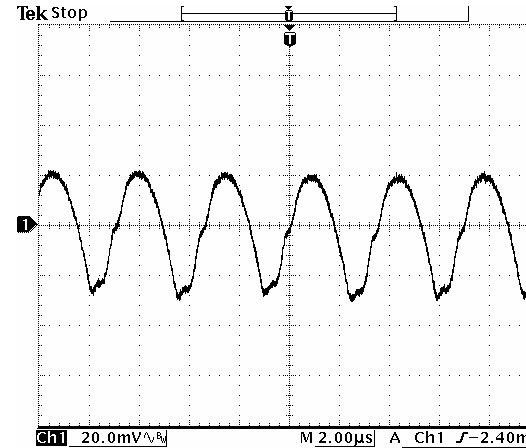
17 Aug 2004  
14:20:10

Vin=12 V, Vo=0.75 V



18 Aug 2004  
11:13:40

Vin=5 V, Vo=3.3 V



18 Aug 2004  
11:14:16

Vin=12 V, Vo=3.3 V

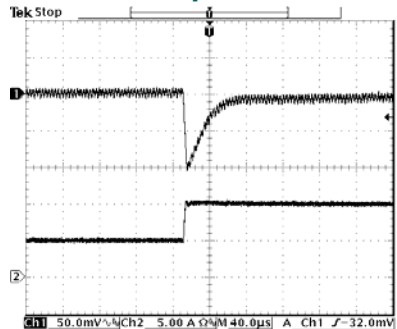
**Note:** Ripple and noise at full load, external load with 10 uF tantalum capacitor and 1 uF ceramic at the output, and Ta=25 deg C.

# NON-ISOLATED DC/DC CONVERTERS

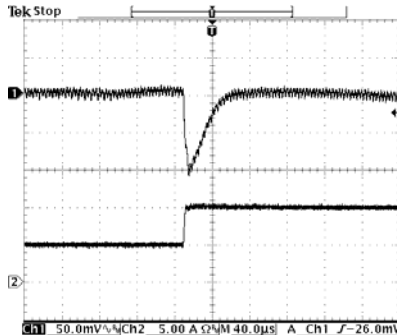
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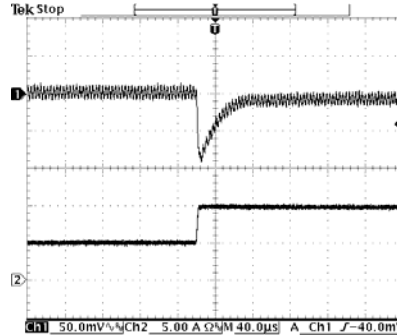
## Transient Response Waveforms



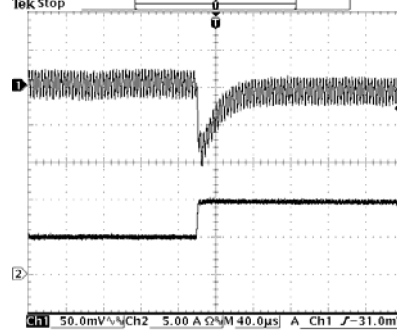
50% to 100% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=0.75\text{ V}$



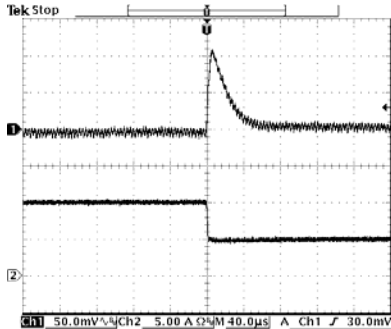
50% to 100% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=0.75\text{ V}$



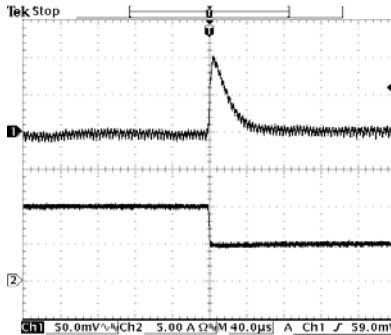
50% to 100% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=3.3\text{ V}$



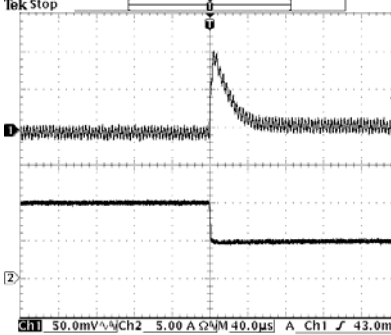
50% to 100% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=3.3\text{ V}$



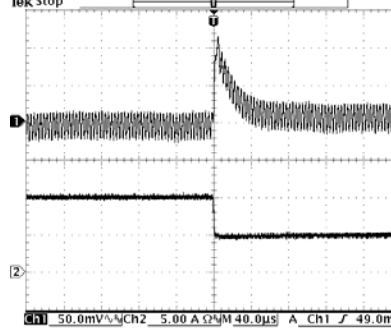
100% to 50% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=0.75\text{ V}$



100% to 50% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=0.75\text{ V}$



100% to 50% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=3.3\text{ V}$



100% to 50% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=3.3\text{ V}$

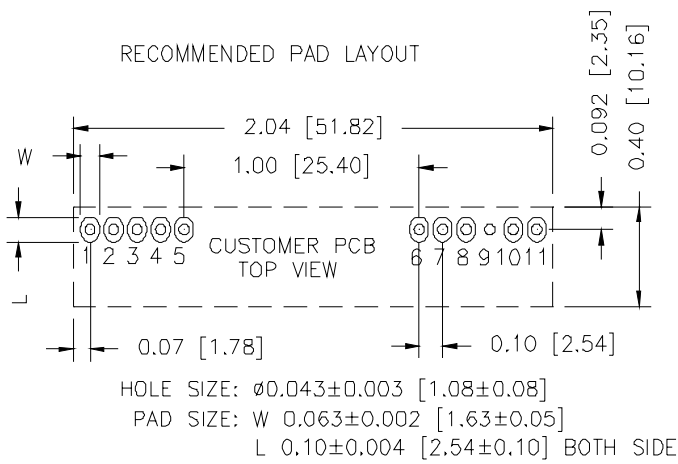
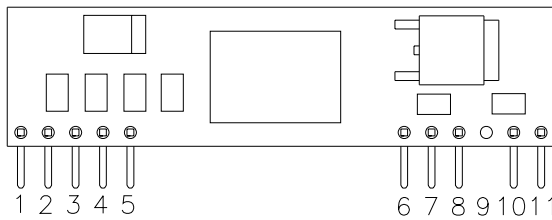
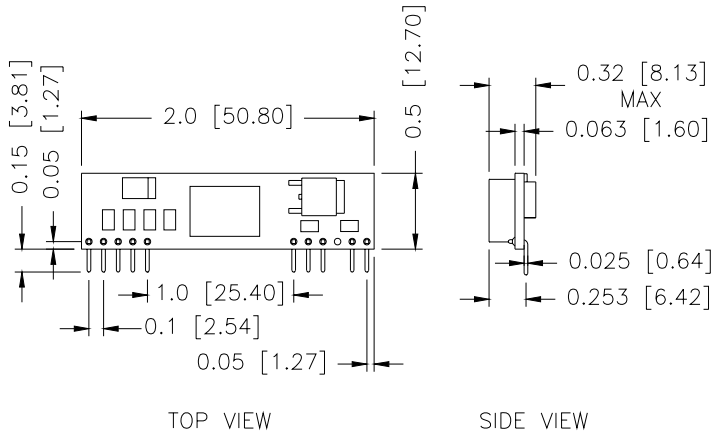
**Note:** Transient response at  $di/dt=2.5\text{ A}/\mu\text{S}$ , external load with 470  $\mu\text{F}$  tantalum capacitor at the output.

# NON-ISOLATED DC/DC CONVERTERS

4.5 V - 14 V Input    0.75 V - 3.63 V/10 A Output



## Mechanical Outline



## Pin Connections

Pin	Function
1	Vout
2	Vout
3	Remote Sense
4	Vout
5	Ground
6	Ground
7	Vin
8	Vin
9	N/A
10	Trim
11	Remote On/Off

## 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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