

## NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 14 Vdc Input

0.75 Vdc - 3.63 Vdc/10 A Output

Jan. 25, 2013

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

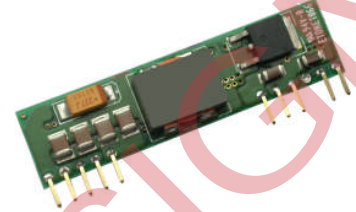
VRBC-10E1Ax

RoHS Compliant

Rev.B

### Features

- Non-Isolated
- High Efficiency
- Fixed Frequency
- Remote Sense
- Low Cost
- Under-Voltage Lockout (UVLO)
- Over Temperature Shutdown
- Certificated to UL60950-1/CSA C22.2 No.60950-1, 2rd edition, am1
- Wide Input
- Wide trim
- OCP/SCP
- Remote On/Off
- Active Low/High (option)
- Industrial Temperature Range
- UL60950-1 Recognized (UL/cUL)



### Applications

- Networking
- Computers and peripherals
- Telecommunications

### 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 Vdc to 3.63 Vdc over a wide range of input voltage ( $V_{in} = 4.5 \text{ Vdc} - 14 \text{ Vdc}$ ). The efficiency is typically 94.3% at 3.3 Vdc output at 5.0 Vdc 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

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

### Part Number Explanation

$\frac{V}{1} \frac{R}{2} \frac{BC}{3} - \frac{10}{4} \frac{E}{5} \frac{1A}{6} \frac{x}{7}$

1---Vertical mount

2---RoHS 6, change "R" to "7" means RoHS 5

3---Series name

4---Series code

5---Wide input range (4.5-14V)

6---Wide trim

7---Option, "x" of the model part number to be 0-9, A-Z, which will represent the special request of customer.

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## 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				
$V_{o,set} < 3.0\text{ V}$	4.5 V	-	14 V	
$V_{o,set} \geq 3.0\text{ V}$	$V_{o,set} + 1.5\text{ V}$	-	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 x 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 <sup>2</sup> t 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.

## Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point	-2% $V_{o,set}$	-	2% $V_{o,set}$	$V_{in}=5\text{ V}$ & $12\text{ V}$ , full load
Load Regulation	-	0.1% $V_{o,set}$	-	
Line Regulation	-	0.1% $V_{o,set}$	-	
Regulation Over Temperature (-40 °C to +85 °C)	-	0.3% $V_{o,set}$	-	$T_{ref}=T_a$ , min to $T_a$ , max
Output Current	0 A	-	10 A	
Current Limit Threshold	-	200% $I_{o,out}$	-	
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	$V_o = 0.75\text{ V} - 3.63\text{ V}$	-	160 mV	$di/dt=2.5\text{ A/uS}$ ; $V_{in}=5\text{ V}$ & $12\text{ V}$ ; 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.

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### General Specifications

Parameter	Min	Typ	Max	Notes
Efficiency				
Vo=3.3 V	-	94.3%	-	Measured at Vin=5 V, full load
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				
Vo=3.3 V	-	93.0%	-	Measured at Vin=12 V, full load
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.

### 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)	-	-	Vin, max	
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	-	Vin, max	

## NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 14 Vdc Input

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**bel**

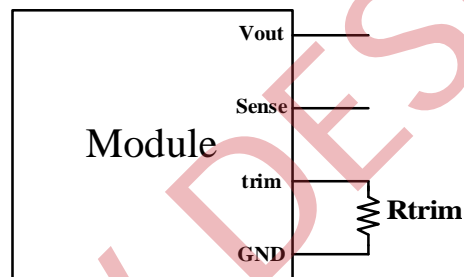
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### Output Trim Equations

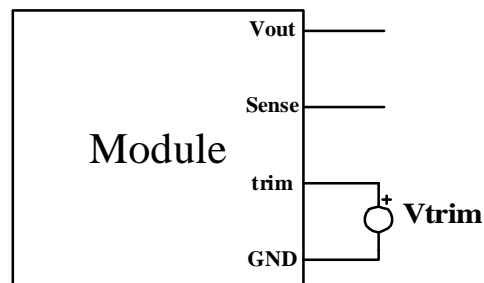
Equation for calculating the trim resistor (in  $\Omega$ ) given the desired output voltage ( $V_o$ ) is shown below. The Trim Up resistor should be connected between the Trim pin and Ground.

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



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.

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



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4.5 Vdc - 14 Vdc Input

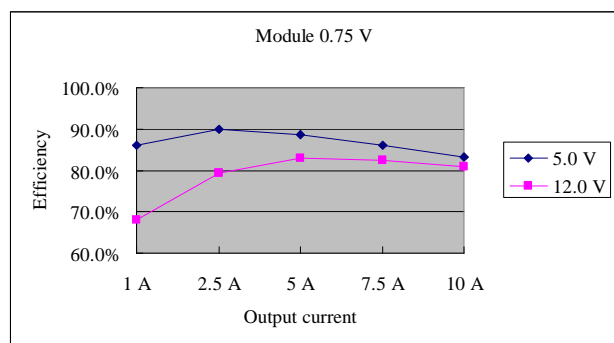
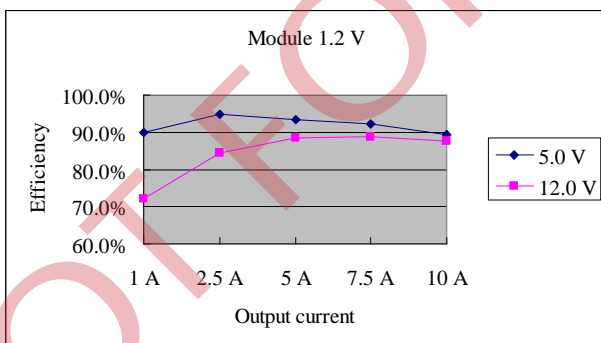
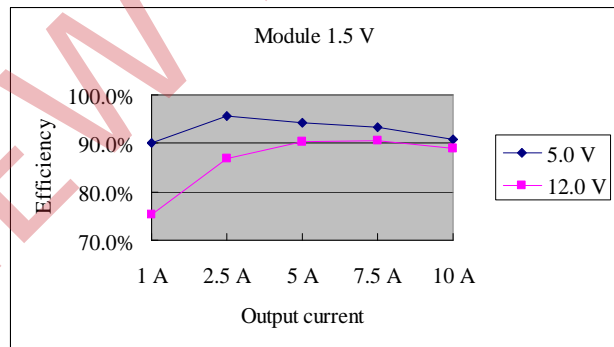
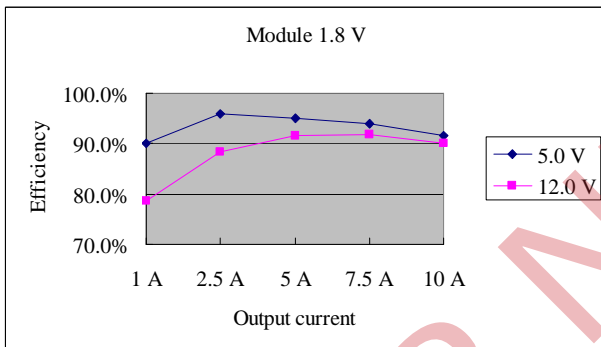
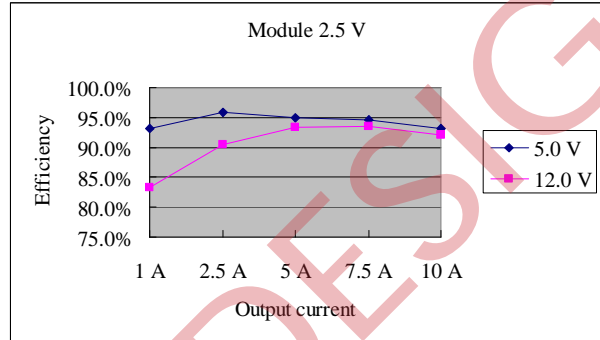
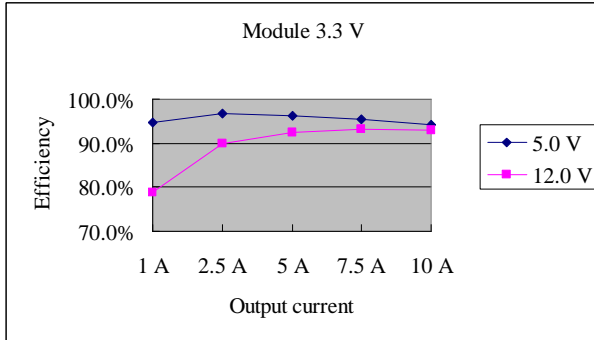
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## Efficiency Data



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4.5 Vdc - 14 Vdc Input

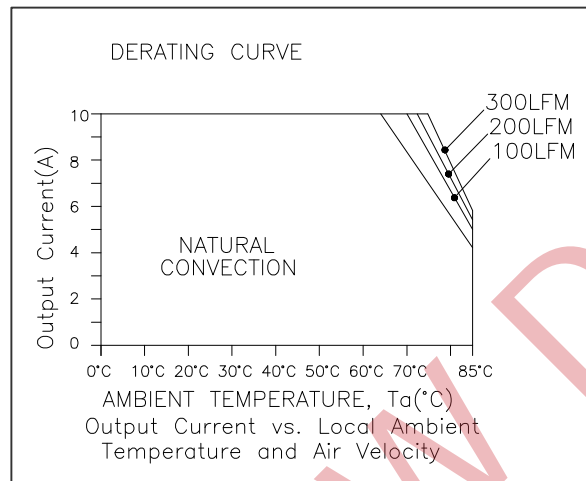
0.75 Vdc - 3.63 Vdc/10 A Output



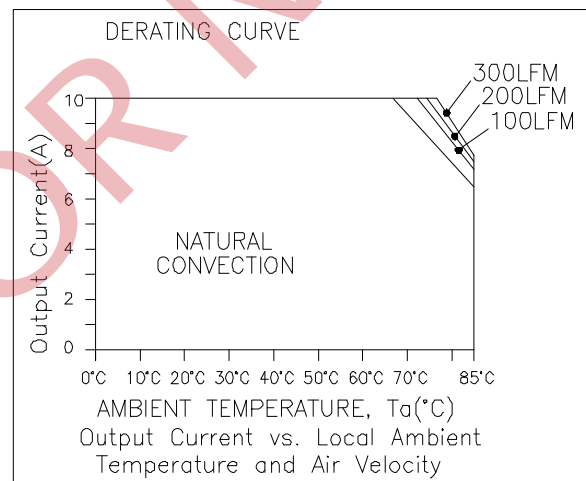
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## Thermal Derating Curves



Vin=12 V, Vo = 3.3 V



Vin=5 V, Vo = 3.3 V

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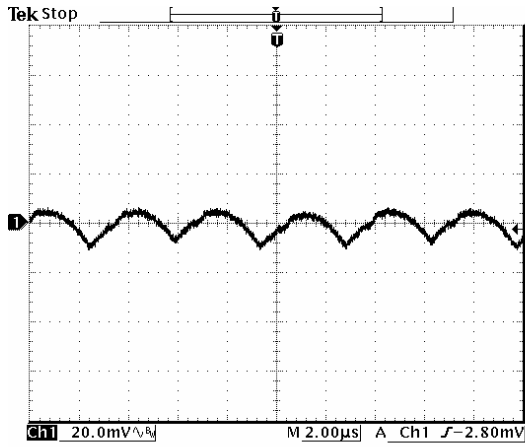
0.75 Vdc - 3.63 Vdc/10 A Output



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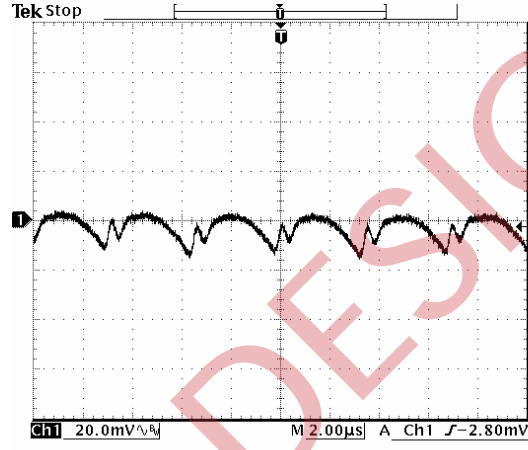
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## Ripple and Noise Waveforms



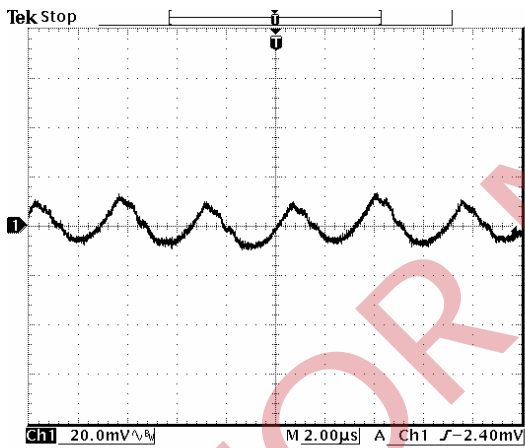
Vin=5 V, Vo=0.75 V

17 Aug 2004 14:19:31



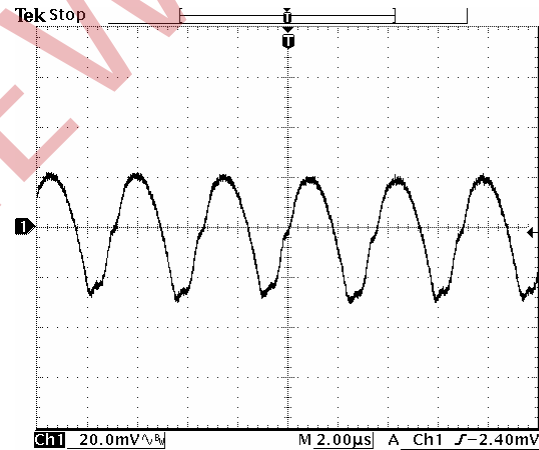
Vin=12 V, Vo=0.75 V

17 Aug 2004 14:20:10



Vin=5 V, Vo=3.3 V

18 Aug 2004 11:13:40



Vin=12 V, Vo=3.3 V

18 Aug 2004 11:14:16

**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

4.5 Vdc - 14 Vdc Input

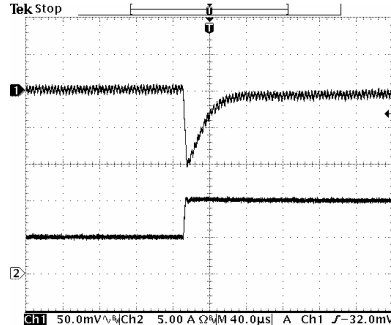
0.75 Vdc - 3.63 Vdc/10 A Output



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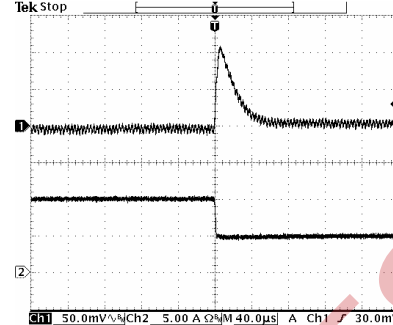
## Transient Response Waveforms



Ch1 Max  
9.00mV  
Ch1 Min  
-105mV  
Ch2 Rise  
1.655µs  
Ch2 Fall  
No valid edge

17 Aug 2004  
09:23:44

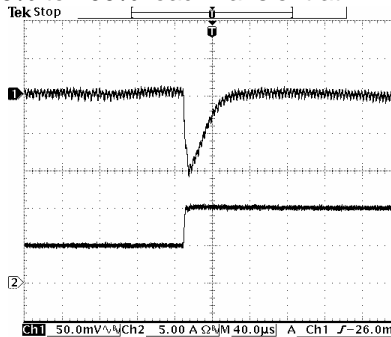
50% to 100% load Transient at Vin=5 V, Vo=0.75 V



Ch1 Max  
109mV  
Ch1 Min  
-13.0mV  
Ch2 Rise  
No valid edge  
Ch2 Fall  
1.675µs

17 Aug 2004  
09:24:16

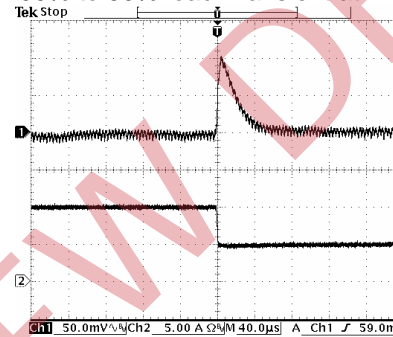
100% to 50% load Transient at Vin=5 V, Vo=0.75 V



Ch1 Max  
11.0mV  
Ch1 Min  
-111mV  
Ch2 Rise  
1.696µs  
Ch2 Fall  
No valid edge

17 Aug 2004  
09:25:06

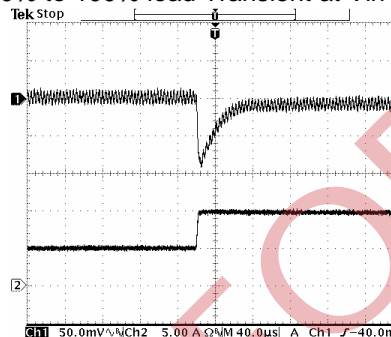
50% to 100% load Transient at Vin=12 V, Vo=0.75 V



Ch1 Max  
102mV  
Ch1 Min  
-15.0mV  
Ch2 Rise  
No valid edge  
Ch2 Fall  
1.594µs

17 Aug 2004  
09:25:26

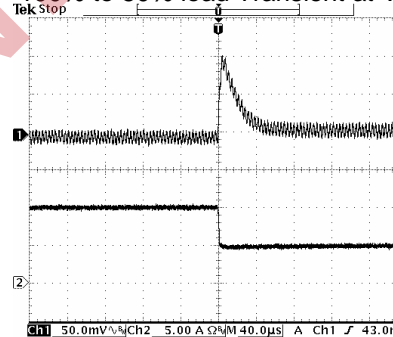
100% to 50% load Transient at Vin=12 V, Vo=0.75 V



Ch1 Max  
15.0mV  
Ch1 Min  
-91.0mV  
Ch2 Rise  
1.650µs  
Low signal amplitude  
Ch2 Fall  
No valid edge

17 Aug 2004  
09:19:51

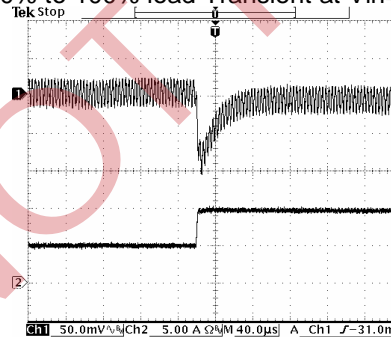
50% to 100% load Transient at Vin=5 V, Vo=3.3 V



Ch1 Max  
105mV  
Ch1 Min  
-15.0mV  
Ch2 Rise  
No valid edge  
Ch2 Fall  
1.575µs

17 Aug 2004  
09:20:19

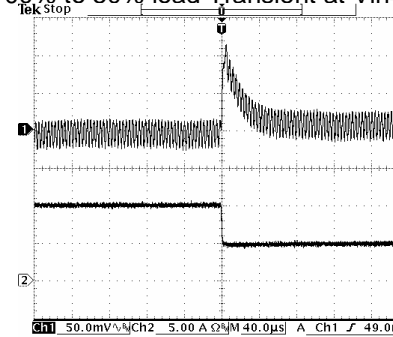
100% to 50% load Transient at Vin=12 V, Vo=3.3 V



Ch1 Max  
22.0mV  
Ch1 Min  
-108mV  
Ch2 Rise  
1.632µs  
Low signal amplitude  
Ch2 Fall  
No valid edge

17 Aug 2004  
09:21:27

50% to 100% load Transient at Vin=12 V, Vo=3.3 V



Ch1 Max  
113mV  
Ch1 Min  
-28.0mV  
Ch2 Rise  
No valid edge  
Ch2 Fall  
1.600µs

17 Aug 2004  
09:21:53

100% to 50% load Transient at Vin=12 V, Vo=3.3 V

Note: Transient response at di/dt=2.5 A/uS, external load with 470 uF tantalum capacitor at the output.



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4.5 Vdc - 14 Vdc Input

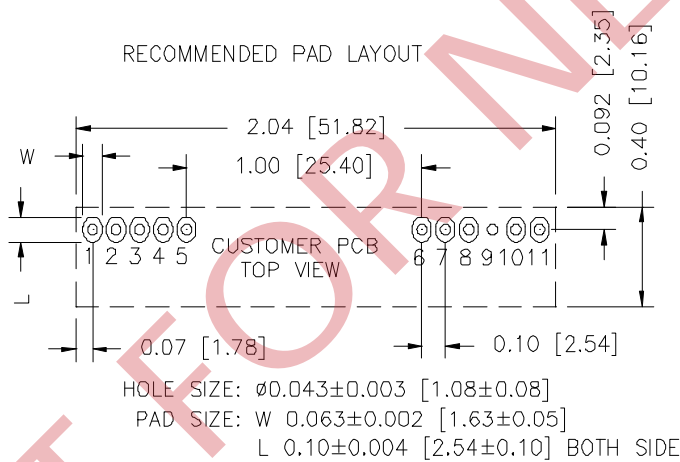
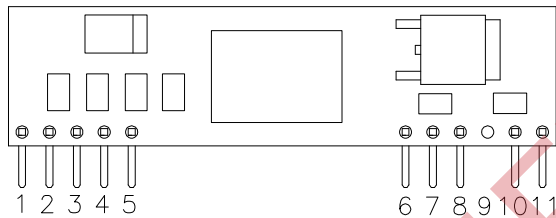
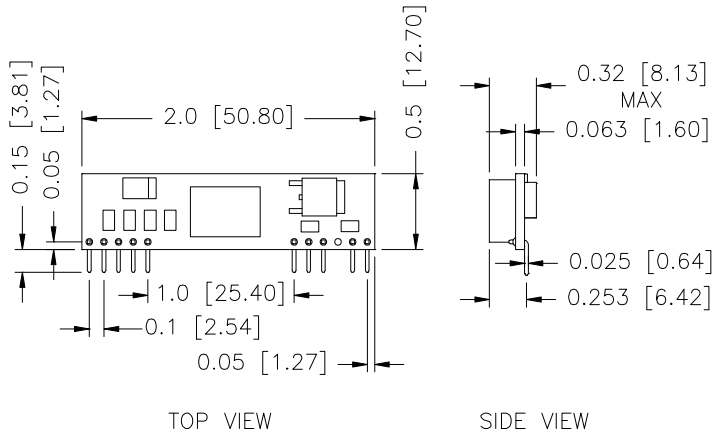
0.75 Vdc - 3.63 Vdc/10 A Output



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## 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

### 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. (x.x +/-0.5mm) x.xxx +/-0.010 in. (x.xx +/-0.25mm).

## NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 14 Vdc Input

0.75 Vdc - 3.63 Vdc/10 A Output



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### Revision History

Date	Revision	Changes Detail	Approval
2007-01-17	A	Change version to A	Lynn
2013-01-25	B	Update UL.	HL

### 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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