

## NON-ISOLATED DC/DC CONVERTERS

7.0 Vdc - 13.2 Vdc Input

1.2 Vdc - 3.3 Vdc/5 A Output

**bel**  
POWER PRODUCTS

xRAH-05Exx0

RoHS Compliant

Rev.A

- Non-Isolated
- High Efficiency
- High Power Density
- Fixed Frequency (280 kHz)
- Trim Function
- Remote On/Off
- Under-Voltage Lockout
- OCP/SCP
- Low Profile Package (7.82 mm)
- UL60950-1 Recognized (UL/cUL)



### Description

The Bel xRAH-05Exx0 is part of the low cost non-isolated dc/dc converter Power Module series. The modules use a SMD or SIP package for ease of layout and space savings. The output is closely regulated and the efficiency of 3.3 Vdc output module is typically 91% at full load.

### Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Part Number Surface Mount	Part Number Vertical Mount
3.3 V	7.0 V - 13.2 V	5 A	16.5 W	91%	SRAH-05E330	VRAH-05E330
2.5 V	7.0 V - 13.2 V	5 A	12.5 W	89%	SRAH-05E250	VRAH-05E250
1.8 V	7.0 V - 13.2 V	5 A	9 W	87%	SRAH-05E180	VRAH-05E180
1.5 V	7.0 V - 13.2 V	5 A	7.5 W	85%	SRAH-05E150	VRAH-05E150
1.2 V	7.0 V - 13.2 V	5 A	6 W	83%	SRAH-05E120	VRAH-05E120

- Notes:** 1. Add "0" suffix at the end of the model number to indicate "Tube Packaging", and "R" for "Reel Packaging", and "G" for "Tray Packaging".  
2. All part numbers above indicate RoHS 6. Change the second letter "R" to "7" for RoHS 5 part numbers.

### Absolute Maximum Ratings

Parameter	Min	Typ	Max	Notes
Input Voltage (continuous)	-0.3 V	-	14 V	
Output Enable Terminal Voltage	-0.3 V	-	14 V	
Ambient Temperature	-40 °C	-	85 °C	
Storage Temperature	-40 °C	-	125 °C	

### Input Specifications

Parameter	Min	Typ	Max	Notes
Input Voltage	7 V	-	13.2 V	
Input Current (no load)	-	70 mA	100 mA	
Input Current (full load)	-	-	2.8 A	
Remote Off Input Current	-	3 mA	-	
Input Reflected Ripple Current (pk-pk)	-	120 mA	240 mA	With simulated source impedance of 500 nH, 5 Hz to 20 MHz. Use one 270 uF/ 16 V OSCON capacitor with ESR=0.018 ohm max, at 100kHz at the input
Input Reflected Ripple Current (rms)	-	50 mA	100 mA	
I <sup>2</sup> t Inrush Current Transient	-	0.04 A <sup>2</sup> s	0.1 A <sup>2</sup> s	
Turn on Voltage Threshold	-	5 V	6 V	
Turn off Voltage Threshold	3.2 V	3.8 V	-	

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

# NON-ISOLATED DC/DC CONVERTERS

7.0 Vdc - 13.2 Vdc Input

1.2 Vdc - 3.3 Vdc/5 A Output



## Output Specifications

Parameter	Min	Typ	Max	Notes	
Output Voltage Set Point				Test conditions: I <sub>o</sub> =50% full load.	
Vo=3.3 V	3.200 V	3.3 V	3.400 V		
Vo=2.5 V	2.425 V	2.5 V	2.575 V		
Vo=1.8 V	1.745 V	1.8 V	1.855 V		
Vo=1.5 V	1.455 V	1.5 V	1.545 V		
Vo=1.2 V	1.164 V	1.2 V	1.236 V		
Line Regulation					
Vo=3.3 V	-	±15 mV	±30 mV		
Vo=2.5 V	-	±15 mV	±30 mV		
Vo=1.8 V	-	±5 mV	±10 mV		
Vo=1.5 V	-	±5 mV	±10 mV		
Vo=1.2 V	-	±5 mV	±10 mV		
Load Regulation					
Vo=3.3 V	-	±10 mV	±20 mV		
Vo=2.5 V	-	±10 mV	±20 mV		
Vo=1.8 V	-	±5 mV	±10 mV		
Vo=1.5 V	-	±5 mV	±10 mV		
Vo=1.2 V	-	±5 mV	±10 mV		
Regulation Over Temperature (-40 °C to +85 °C)	-	±20 mV	±40 mV		
Output Current Range	0 A	-	5 A		
Output DC Current Limit	6.5 A	-	12.5 A		
Short Circuit Surge Transient	-	0.04 A <sup>2</sup> s	0.1 A <sup>2</sup> s		
Ripple and Noise (rms)	-	20 mV	50 mV	0-20 MHz BW, with 330u F tantalum cap and 10 uF ceramic cap at output.	
Ripple and Noise (pk-pk)	-	60 mV	100 mV		
Turn on Time	-	-	60 mS		
Overshoot at Turn on	-	-	5%		
Output Capacitance	330 uF	-	2200 uF		
<b>Transient Response</b>					
50% ~ 100% Max Load	Overshoot	3.3 V	-	120 mV	Test conditions: di/dt=0.5 A/us, Vin=10 Vdc, with 330 uF tantalum cap and 10 uF ceramic cap at output.
	Settling Time		-	60 uS	
100% ~ 50% Max Load	Overshoot		-	120 mV	
	Settling Time		-	60 uS	
50% ~ 100% Max Load	Overshoot	1.2 V-2.5 V	-	120 mV	
	Settling Time		-	60 uS	
100% ~ 50% Max Load	Overshoot		-	120 mV	
	Settling Time		-	60 uS	

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

## Control Specifications

Parameter	Min	Typ	Max	Notes
<b>Remote On/Off</b>				
Signal Low (Unit Off)	-0.3 V	-	1.2 V	Remote on/off pin open, Unit On
Signal High (Unit On)	3 V	-	14 V	

# NON-ISOLATED DC/DC CONVERTERS

7.0 Vdc - 13.2 Vdc Input

1.2 Vdc - 3.3 Vdc/5 A Output



## General Specifications

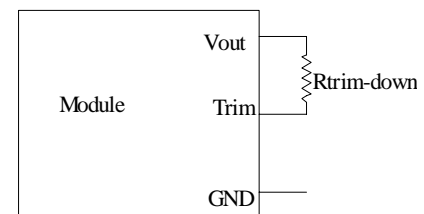
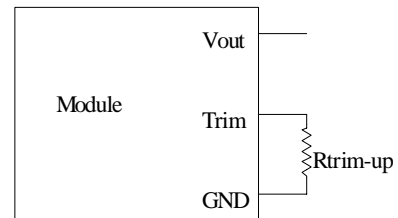
Parameter	Min	Typ	Max	Notes
Efficiency				Vin=10 V, full load.
Vo=3.3 V	88%	91%	-	
Vo=2.5 V	86%	89%	-	
Vo=1.8 V	84%	87%	-	
Vo=1.5 V	82%	85%	-	
Vo=1.2 V	80%	83%	-	
Switching Frequency	200 kHz	280 kHz	360 kHz	
Output Voltage Trim Range	90%	-	110%	
MTBF	TBD			Calculated Per Bell Core SR-332 (Vin=10 V; Vo=3.3 V; Io =5 A; Ta = 25 °C)
Dimensions (surface mount)				
Inches (L x W x H)	0.78 x 0.7 x 0.32			
Millimeters (L x W x H)	19.81 x 17.78 x 8.13			
Dimensions (vertical)				
Inches (L x W x H)	0.7 x 0.308 x 0.65			
Millimeters (L x W x H)	17.78 x 7.82 x 16.51			
Weight	-	5 g	-	

## Output Trim Equations

Equations for calculating the trim resistor given the desired adjusted voltage (Vadj) and the nominal output voltage of the converter (Vo) are shown below. The Trim Up resistor should be connected between the Trim pin and Ground. Only one of the resistors should be used for any given application.

$$R_{trim\_up} = \left( \frac{A}{V_{o,adj} - V_o} - B \right) K\text{ohm}$$

$$R_{trim\_down} = \left( \frac{C}{V_o - V_{o,adj}} - D \right) K\text{ohm}$$



Output Voltage	A	B	C	D
3.3 V	17.2	40.2	53.841	61.7
2.5 V	4.496	5.62	9.556	11.24
1.8 V	3.064	10	3.849	13.83
1.5 V	3.712	5.62	3.254	10.26
1.2 V	3.712	5.62	1.87	10.26

**Note:** Vo=3.304 V for 3.3 V output voltage; Vo=1.805 V for 1.8 V output voltage; Vo=1.501 V for 1.5 V output voltage; Vo=1.203 V for 1.2 V output voltage.

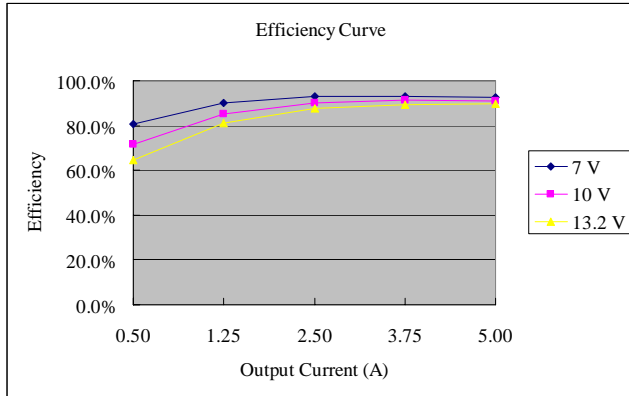
# NON-ISOLATED DC/DC CONVERTERS

7.0 Vdc - 13.2 Vdc Input

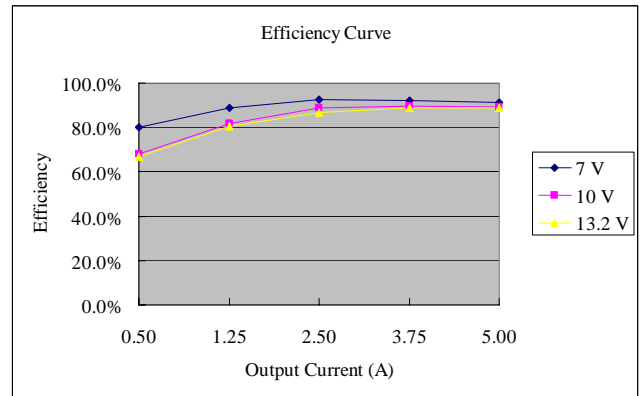
1.2 Vdc - 3.3 Vdc/5 A Output



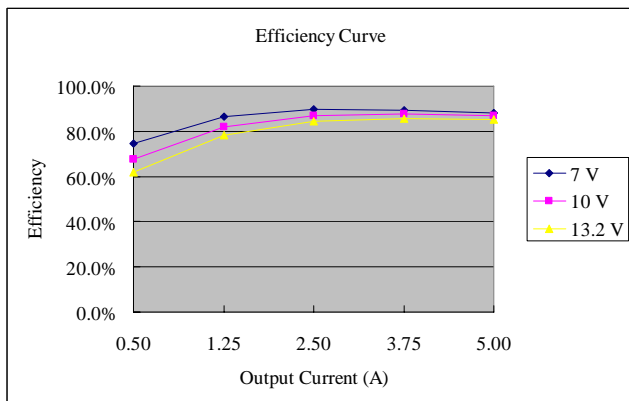
## Efficiency Data



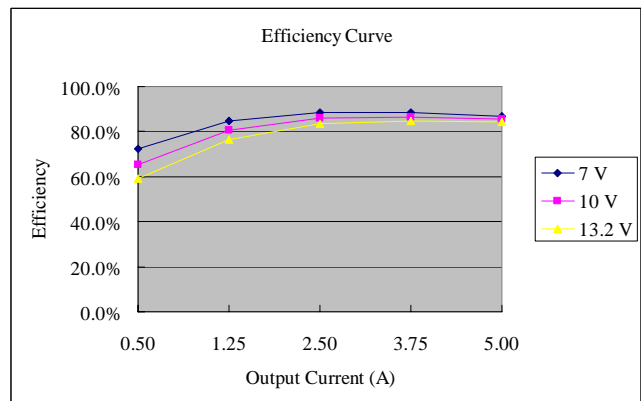
$V_o=3.3\text{ V}$



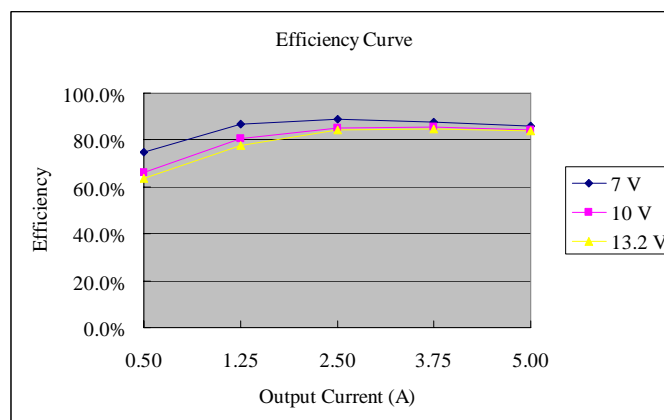
$V_o=2.5\text{ V}$



$V_o=1.8\text{ V}$



$V_o=1.5\text{ V}$



$V_o=1.2\text{ V}$

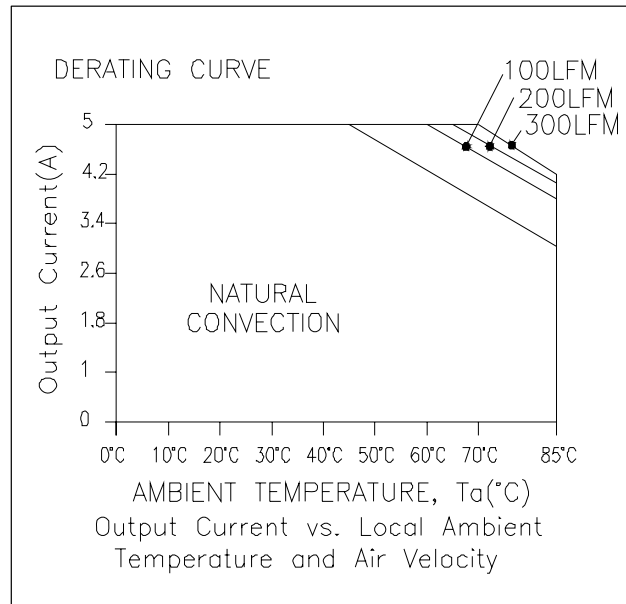
# NON-ISOLATED DC/DC CONVERTERS

7.0 Vdc - 13.2 Vdc Input

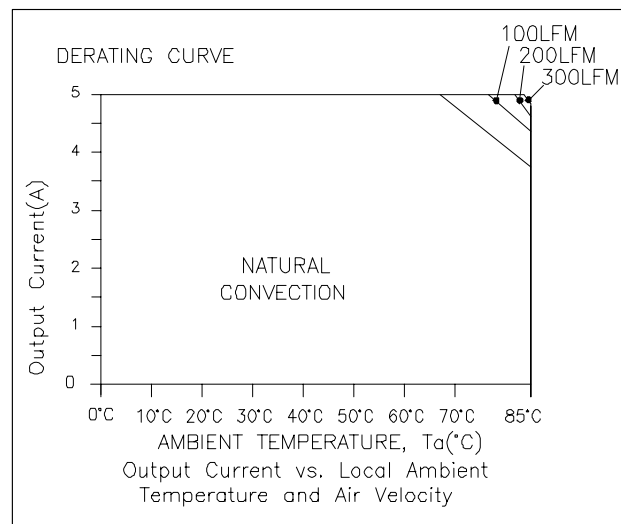
1.2 Vdc - 3.3 Vdc/5 A Output



## Thermal Derating Curves



$V_o=3.3\text{ V}$



$V_o=1.8\text{ V}$

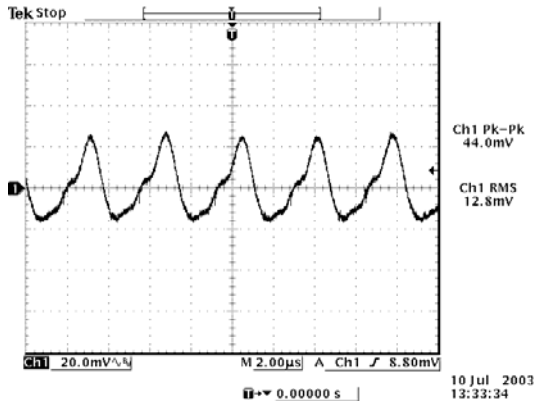
# NON-ISOLATED DC/DC CONVERTERS

7.0 Vdc - 13.2 Vdc Input

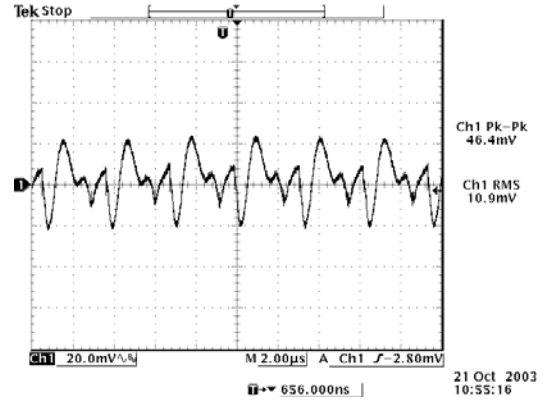
1.2 Vdc - 3.3 Vdc/5 A Output



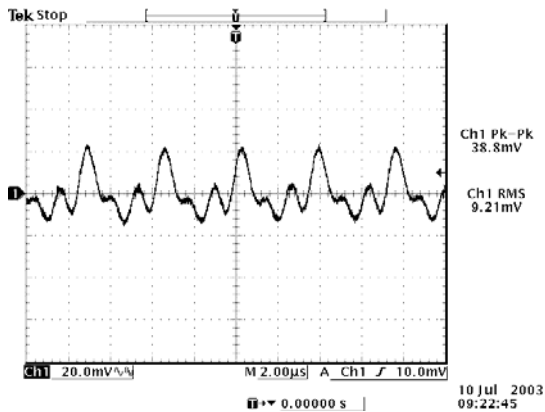
## Ripple and Noise Waveforms



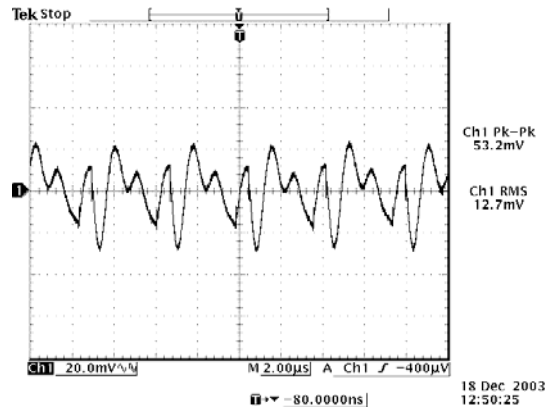
10 Vdc input, 3.3 Vdc output



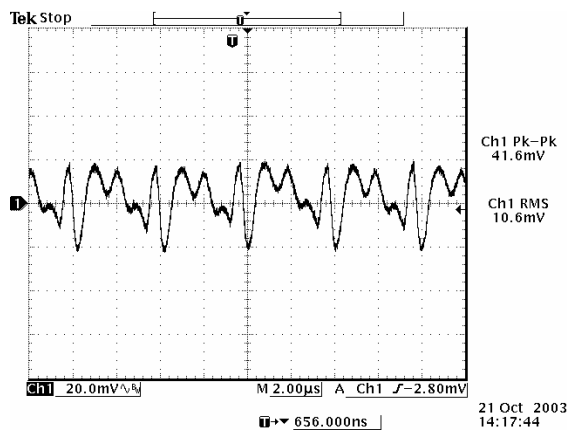
10 Vdc input, 2.5 Vdc output



10 Vdc input, 1.8 Vdc output



10 Vdc input, 1.5 Vdc output



10 Vdc input 1.2 Vdc output

**Note:** Ripple and noise at max load, 0-20MHz BW, with 330 uF tantalum cap and 10 uF ceramic cap at the output, Ta=25 deg C.

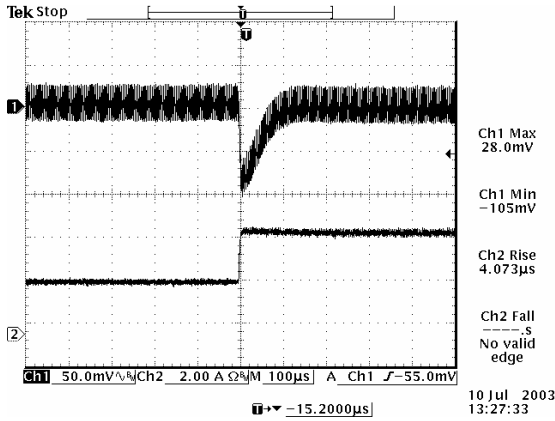
# NON-ISOLATED DC/DC CONVERTERS

7.0 Vdc - 13.2 Vdc Input

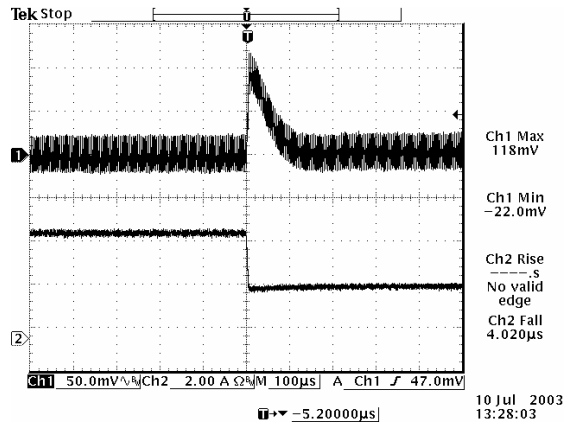
1.2 Vdc - 3.3 Vdc/5 A Output



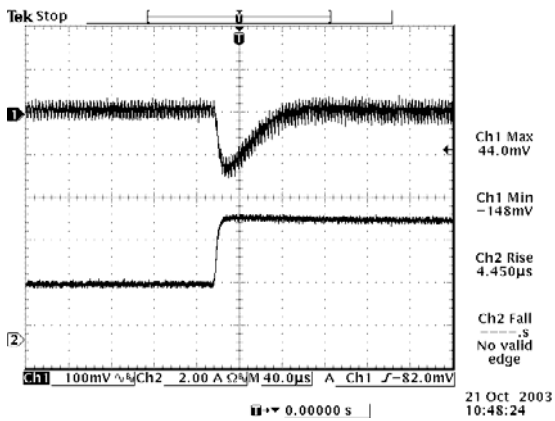
## Transient Response Waveforms



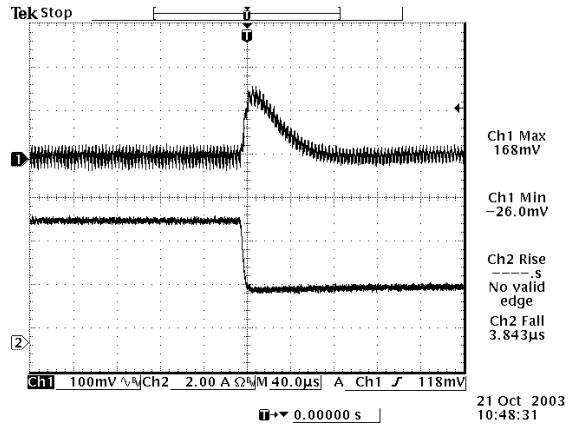
50% to 100% load, 3.3 Vdc output



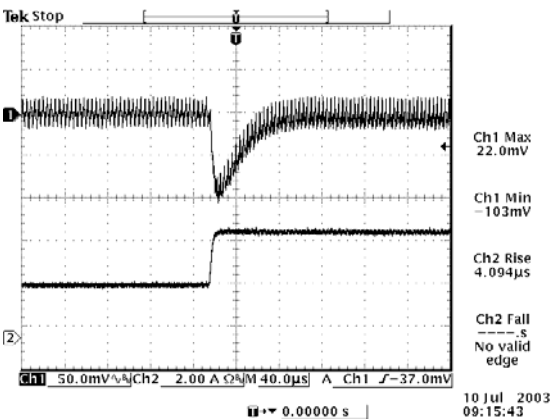
100% to 50% load, 3.3 Vdc output



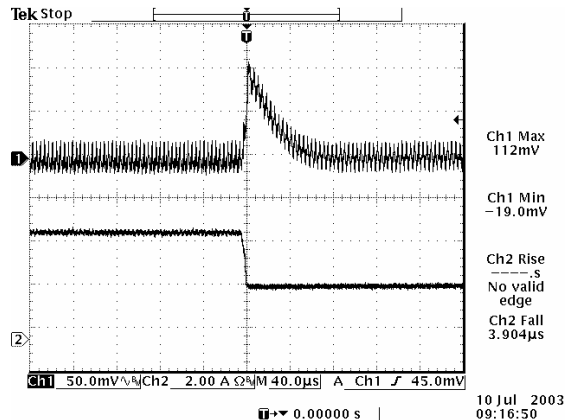
50% to 100% load, 2.5 Vdc output



100% to 50% load, 2.5 Vdc output



50% to 100% load, 1.8 Vdc output



100% to 50% load, 1.8 Vdc output

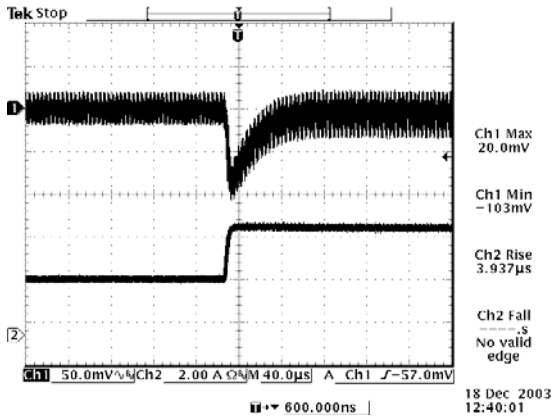
# NON-ISOLATED DC/DC CONVERTERS

7.0 Vdc - 13.2 Vdc Input

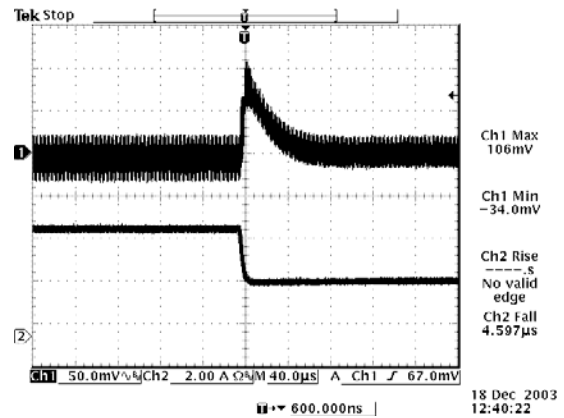
1.2 Vdc - 3.3 Vdc/5 A Output



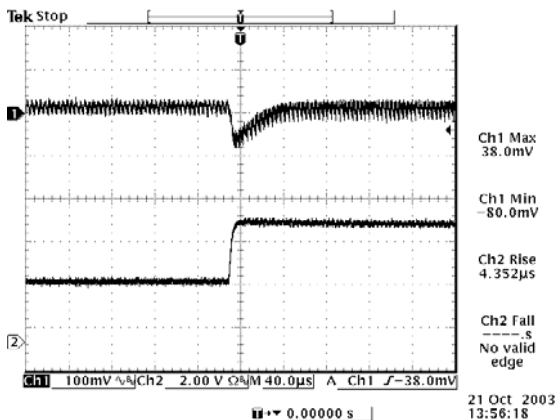
## Transient Response Waveforms (continued)



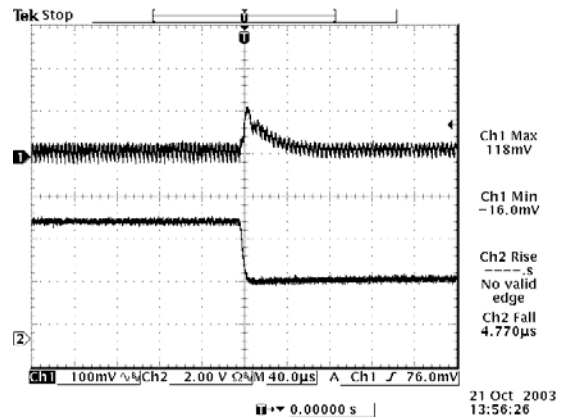
50% to 100% load, 1.5 Vdc output



100% to 50% load, 1.5 Vdc output



50% to 100% load, 1.2 Vdc output



100% to 50% load, 1.2 Vdc output

**Note:** Transient Response at 10 Vdc input,  $di/dt=0.5$  A/µS, with 330 µF tantalum cap and 10 µF ceramic cap at the output,  $T_a=25$  deg C.



# NON-ISOLATED DC/DC CONVERTERS

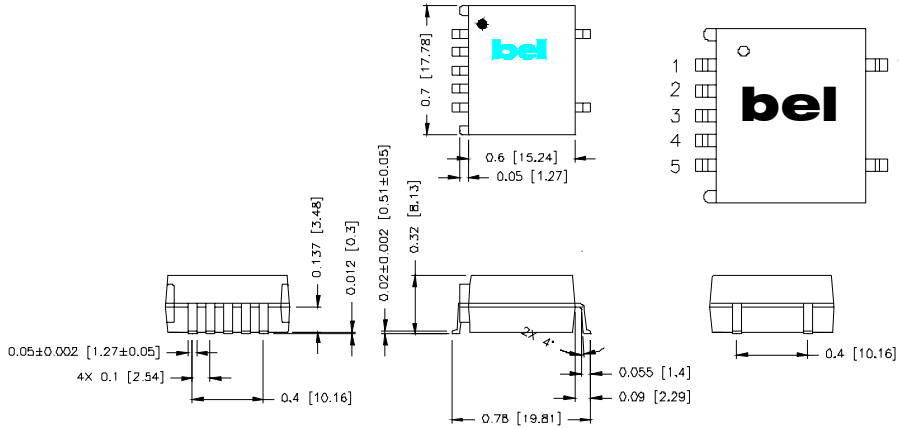
7.0 Vdc - 13.2 Vdc Input

1.2 Vdc - 3.3 Vdc/5 A Output



## Mechanical Outline

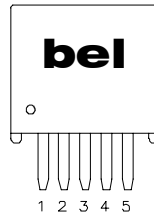
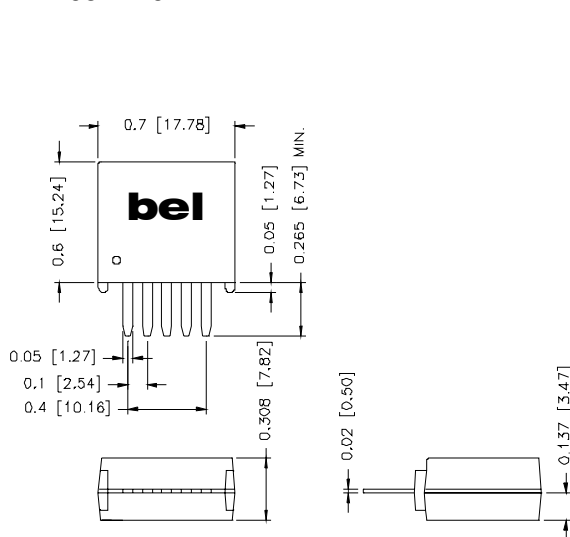
### SRAH-05Exx0



### Pin Connections

Pin	Function
1	Remote On/Off
2	Vin
3	Ground
4	Vout
5	Trim
6	N/A
7	N/A

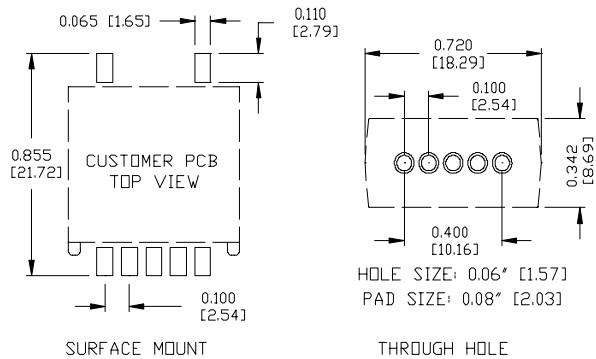
### VRAH-05Exx0



### Pin Connections

Pin	Function
1	Remote On/Off
2	Vin
3	Ground
4	Vout
5	Trim

### RECOMMENDED PCB PAD LAYOUT



## RoHS Compliance

Complies with the European Directive 2002/95/EC, calling for the elimination of lead and other hazardous substances from electronic products. These parts are not however compatible with the higher temperatures associated with lead free solder processes and must be soldered using a reflow profile with a peak temperature of no more than 240 °C.



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