

## NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 24 Vdc Input 0.9 Vdc - 3.3 Vdc/3 A, 5 Vdc/2 A Output

**bel**  
POWER PRODUCTS

xRAH-03L2A0

RoHS Compliant

Rev.A

- Non-Isolated
- High Efficiency
- High Power Density
- Low Cost
- Remote On/Off
- Fixed Frequency
- OCP/SCP
- UL60950-1 Recognized (UL/cUL)



### Description

The Bel xRAH-03L2A0 modules are a series of non-isolated, step down dc/dc converters that operate from a nominal 12 Vdc source. These converters are available in an output voltage range from 0.9 Vdc to 5 Vdc. It is packaged in a compact, overmolded package rated at 3 A (0.9 Vdc-3.3 Vdc) and 2 A (5 Vdc). Optional lead forming provides a vertical mount product for minimal footprint or a surface mount option for a very low profile. The output is closely regulated and the efficiency is typically 91% at full load. Typical features include remote on/off, over current protection and short circuit protection.

### Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Part Number Surface Mount	Part Number Vertical Mount
0.9 V - 5.0 V	5 V - 24 V	3 A	10 W	91%	SRAH-03L2A0	VRAH-03L2A0

- 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	-	25 V	
Output Enable Terminal Voltage	-0.3 V	-	24 V	
Ambient Temperature	-40 °C	-	85 °C	
Storage Temperature	-40 °C	-	125 °C	

### Input Specifications

Parameter	Min	Typ	Max	Notes
Input Voltage				
Vo=5.0 V	9 V	-	24 V	
Vo=3.3 V	5 V	-	24 V	
Vo=2.5 V	5 V	-	24 V	
Vo=1.8 V	5 V	-	18 V	
Vo=1.5 V	5 V	-	15 V	
Vo=1.2 V	5 V	-	12 V	
Vo=0.9 V	5 V	-	9 V	
Input Current (no load)	-	-	100 mA	
Input Current (full load)	-	-	2.5 A	
Remote Off Input Current	-	3 mA	10 mA	
Input Reflected Ripple Current (pk-pk)	-	200 mA	-	With simulated source impedance of 500 nH, 5 Hz-20 MHz. Use one 2*47 uF/35 V Tantalum capacitor and one 3.3 uF/50 V ceramic capacitor at the output.
Input Reflected Ripple Current (rms)	-	50 mA	-	
I <sup>2</sup> t Inrush Current Transient	-	0.05 A <sup>2</sup> s	0.1 A <sup>2</sup> s	
Turn on Voltage Threshold	-	4.0 V	-	
Turn off Voltage Threshold	3.5 V	-	4.9 V	

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## Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point				Test conditions: Io=50% full load.
Vo=5.0 V	4.850 V	5.0 V	5.150 V	
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	1.746 V	1.8 V	1.854 V	
Vo=1.5 V	1.470 V	1.5 V	1.530 V	
Vo=1.2 V	1.176 V	1.2 V	1.224 V	
Vo=0.9 V	0.882 V	0.9 V	0.918 V	
Line Regulation				
Vo=5.0 V	-	±15 mV	±35 mV	
Vo=3.3 V	-	±15 mV	±35 mV	
Vo=2.5 V	-	±15 mV	±35 mV	
Vo=1.8 V	-	±10 mV	±25 mV	
Vo=1.5 V	-	±10 mV	±25 mV	
Vo=1.2 V	-	±10 mV	±25 mV	
Vo=0.9 V	-	±10 mV	±25 mV	
Load Regulation				
Vo=5.0 V	-	±25 mV	±65 mV	
Vo=3.3 V	-	±25 mV	±65 mV	
Vo=2.5 V	-	±25 mV	±50 mV	
Vo=1.8 V	-	±20 mV	±40 mV	
Vo=1.5 V	-	±20 mV	±40 mV	
Vo=1.2 V	-	±10 mV	±30 mV	
Vo=0.9 V	-	±10 mV	±30 mV	
Regulation Over Temperature (-40 °C to +85 °C)				
Vo=5.0 V	-	±60 mV	±100 mV	
Vo=3.3 V	-	±60 mV	±100 mV	
Vo=2.5 V	-	±50 mV	±90 mV	
Vo=1.8 V	-	±50 mV	±90 mV	
Vo=1.5 V	-	±40 mV	±80 mV	
Vo=1.2 V	-	±30 mV	±70 mV	
Vo=0.9 V	-	±30 mV	±70 mV	
Output Current Range				
Vo=5.0 V	0 A	-	2 A	
Vo=0.9 V-3.3 V	0 A	-	3 A	
Output DC Current Limit	4 A	-	8 A	
Short Circuit Surge Transient	-	0.8 A <sup>2</sup> s	1.5 A <sup>2</sup> s	
Ripple and Noise (rms)	-	20 mV	50 mV	Test conditions: 0-20 MHz BW, with 220 uF/ 10 V Tantalum capacitor and 22 uF/10 V ceramic capacitor at the output.
Ripple and Noise (pk-pk)				
Vo=5.0 V	-	50 mV	100 mV	
Vo=3.3 V	-	50 mV	100 mV	
Vo=2.5 V	-	40 mV	80 mV	
Vo=1.8 V	-	40 mV	80 mV	
Vo=1.5 V	-	40 mV	80 mV	
Vo=1.2 V	-	30 mV	60 mV	
Vo=0.9 V	-	30 mV	60 mV	
Turn on Time	-	7 mS	10 mS	
Overshoot at Turn on	-	0%	3%	
Output Capacitance	240 uF	-	1200 uF	

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### Output Specifications (continued)

Parameter		Min	Typ	Max	Notes		
<b>Transient Response</b>							
50% ~ 100% Max Load	Overshoot	3.3 V-5.5 V	-	120 mV	180 mV	di/dt=0.5 A/uS, with a 220 uF/10 V tantalum cap and a 22 uF/10 V ceramic cap at the output	
	Settling Time		-	50 uS	100 uS		
100% ~ 50% Max Load	Overshoot		-	120 mV	180 mV		
	Settling Time		-	50 uS	100 uS		
50% ~ 100% Max Load	Overshoot		0.9 V-2.5 V	-	100 mV		150 mV
	Settling Time			-	50 uS		100 uS
100% ~ 50% Max Load	Overshoot	-		100 mV	150 mV		
	Settling Time	-		50 uS	100 uS		

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

### General Specifications

Parameter	Vin	Min	Typ	Max	Notes
Efficiency					Vin=12.0 V; Io=Iomax
Vo=5.0 V	12 V	87%	91%	-	
Vo=3.3 V	12 V	84%	88%	-	
Vo=2.5 V	12 V	82%	86%	-	
Vo=1.8 V	12 V	79%	83%	-	
Vo=1.5 V	12 V	76%	80%	-	
Vo=1.2 V	8 V	74%	78%	-	
Vo=0.9 V	5 V	71%	75%	-	
Switching Frequency		250 kHz	300 kHz	360 kHz	
MTBF		9,900,543 hours			Calculated Per Bell Core SR-332 (Vin=12 V; Vo=3.3 V, Io = 2.4 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)		19.812 x 17.78 x 8.128			
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		-	4.9 g	-	

### Control Specifications

Parameter	Min	Typ	Max	Notes
<b>Remote On/Off</b>				
Signal Low (Unit Off)	-0.3 V	-	1 V	Remote on/off pin is open, Unit On
Signal High (Unit On)	2.8 V	-	24 V	
Current Sink	-3 mA	-	5 mA	

# NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 24 Vdc Input 0.9 Vdc - 3.3 Vdc/3 A, 5 Vdc/2 A Output

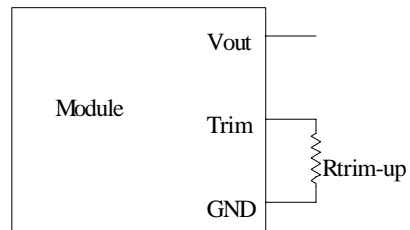


## Output Trim Equations

Equations for calculating the trim resistor (in kΩ) given the desired adjusted voltage ( $V_{adj}$ ) and the nominal output voltage of the converter ( $V_o$ ) 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.

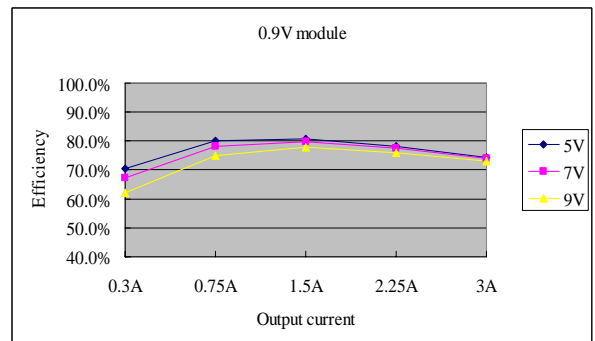
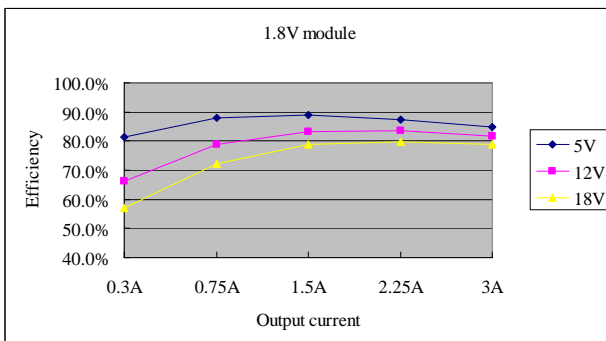
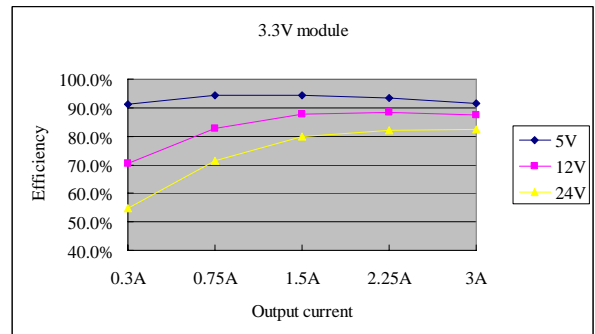
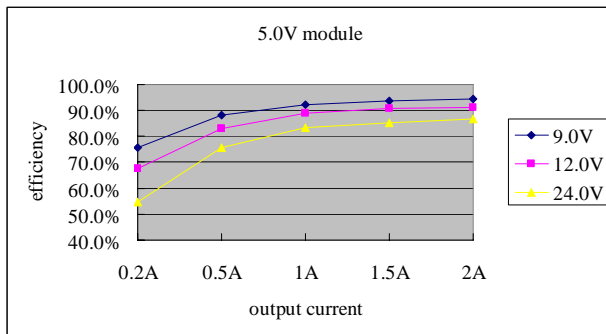
$$R_{trim-up} = \frac{6.928}{V_{adj} - V_o} - 1$$

$V_o$ (V)	$R_{trim}(k\Omega)$
0.902	Open
1.2	22.248
1.5	10.585
1.8	6.715
2.5	3.335
3.3	1.889
5	0.691



**Note:** Output voltage  $V_o=0.902$  V when  $R_{trim\_up}$  is not connected.

## Efficiency Data

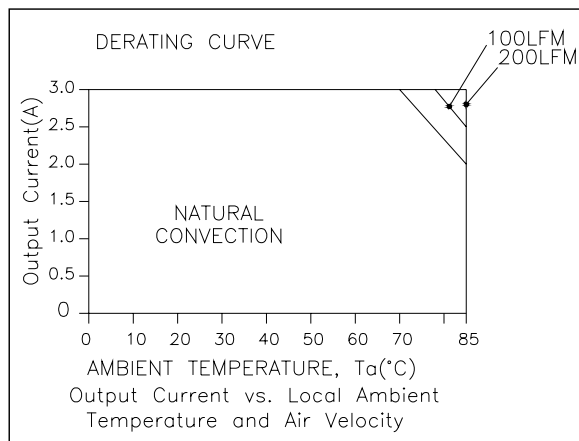


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### Thermal Derating Curve



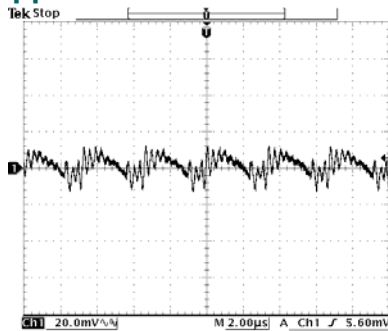
xRAH-03L2A0

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5 Vdc - 24 Vdc Input 0.9 Vdc - 3.3 Vdc/3 A, 5 Vdc/2 A Output



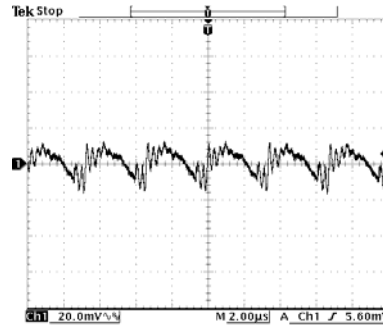
## Ripple and Noise Waveforms



Ch1 Pk-Pk  
24.8mV  
Ch1 RMS  
5.14mV

4 Apr 2005  
16:29:04

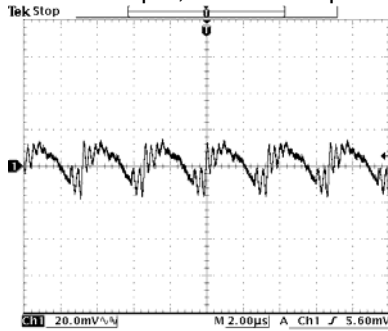
5 Vdc Input, 0.9 Vdc Output



Ch1 Pk-Pk  
29.6mV  
Ch1 RMS  
6.22mV

4 Apr 2005  
16:32:55

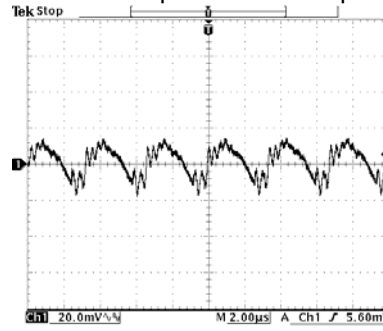
12 Vdc Input 1.2 Vdc Output



Ch1 Pk-Pk  
32.8mV  
Ch1 RMS  
7.37mV

4 Apr 2005  
16:35:04

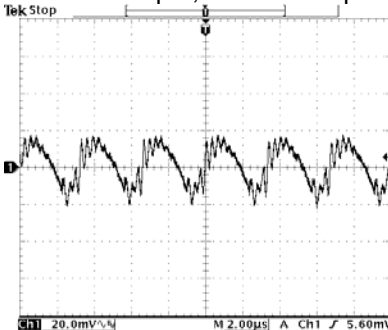
5 Vdc Input, 1.5 Vdc Output



Ch1 Pk-Pk  
32.8mV  
Ch1 RMS  
7.88mV

4 Apr 2005  
16:36:09

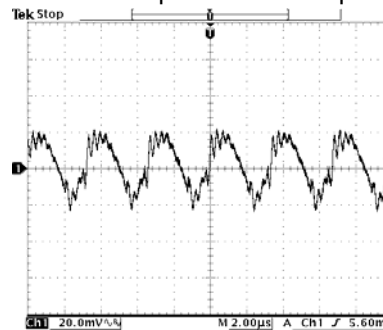
12 Vdc Input 1.8 Vdc Output



Ch1 Pk-Pk  
39.6mV  
Ch1 RMS  
10.1mV

4 Apr 2005  
16:37:39

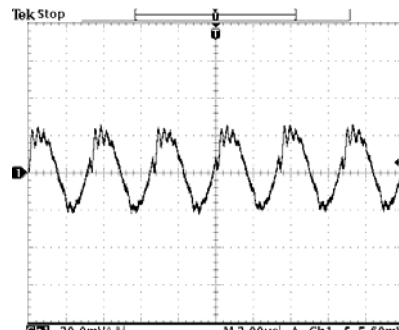
12 Vdc Input, 2.5 Vdc Output



Ch1 Pk-Pk  
45.6mV  
Ch1 RMS  
12.4mV

4 Apr 2005  
16:39:16

12 Vdc Input 3.3 Vdc Output



Ch1 Pk-Pk  
48.4mV  
Ch1 RMS  
14.4mV

4 Apr 2005  
16:40:34

12 Vdc Input, 5.0 Vdc Output

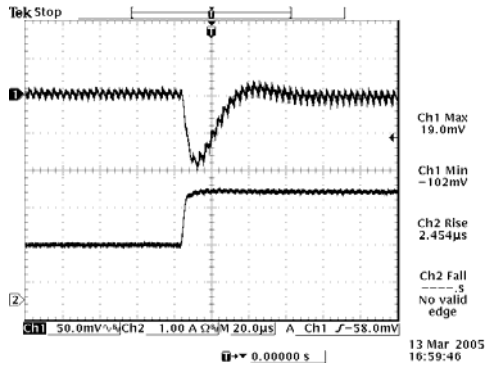
**Note:** Ripple and noise at full load, 0-20MHz BW, Ta=25 deg C.

# NON-ISOLATED DC/DC CONVERTERS

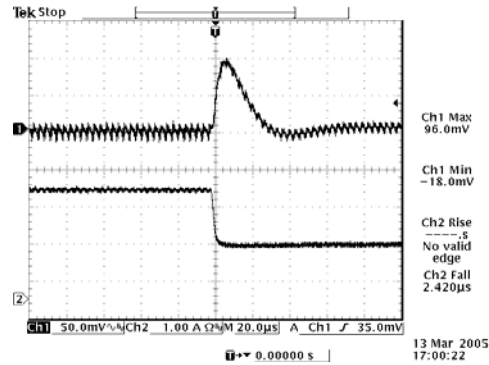
5 Vdc - 24 Vdc Input 0.9 Vdc - 3.3 Vdc/3 A, 5 Vdc/2 A Output



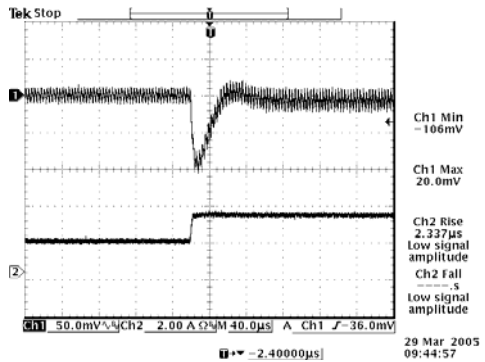
## Transient Response Waveforms



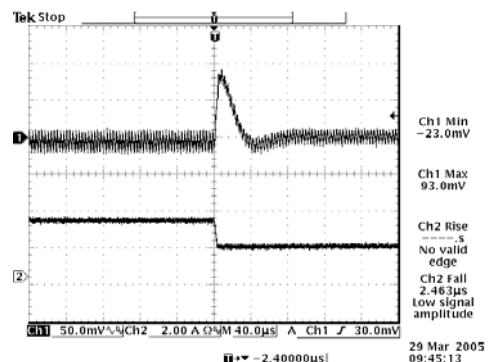
50% to 100% load 5 Vdc Input 0.9 Vdc Output



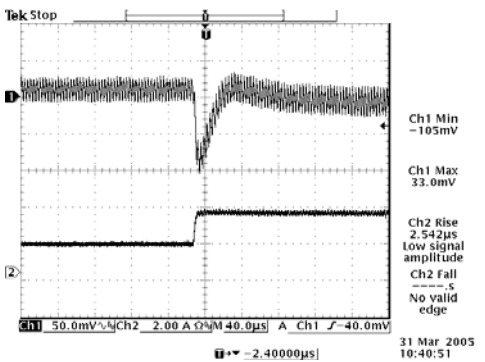
100% to 50% load 5 Vdc Input 0.9 Vdc Output



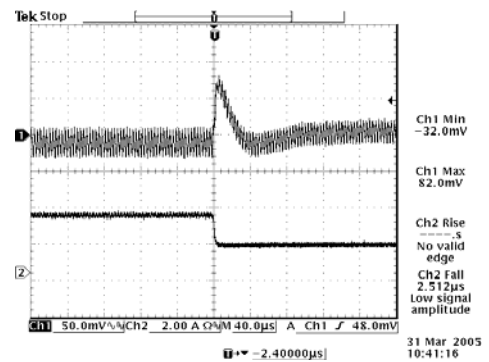
50% to 100% load 12 Vdc Input 1.2 Vdc Output



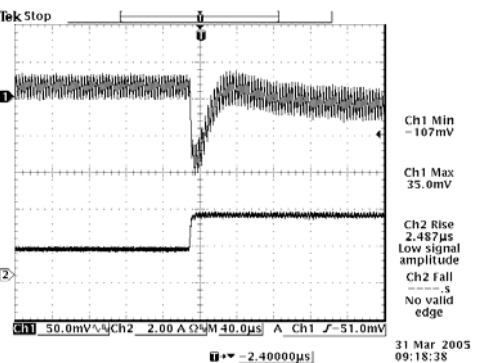
100% to 50% load 12 Vdc Input 1.2 Vdc Output



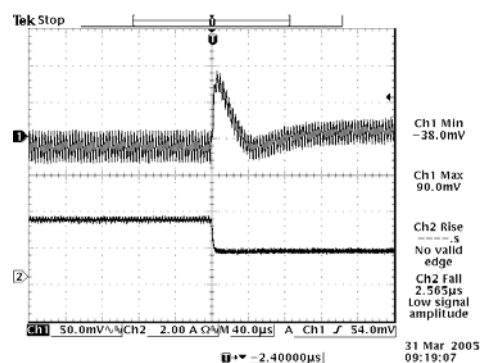
50% to 100% load 12 Vdc Input 1.5 Vdc Output



100% to 50% load 12 Vdc Input 1.5 Vdc Output



50% to 100% load 12 Vdc Input 1.8 Vdc Output



100% to 50% load 12 Vdc Input 1.8 Vdc Output

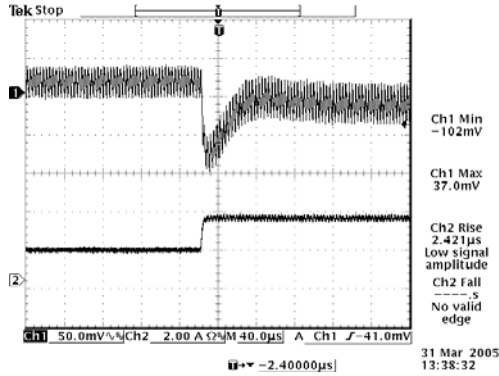


# NON-ISOLATED DC/DC CONVERTERS

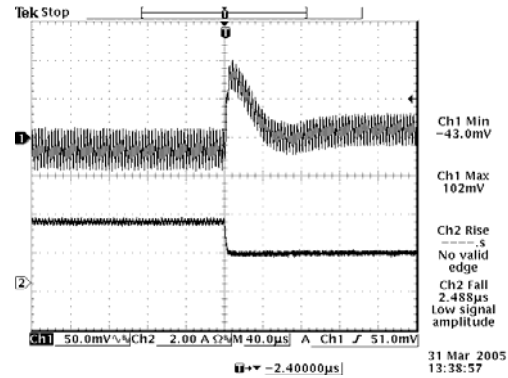
5 Vdc - 24 Vdc Input 0.9 Vdc - 3.3 Vdc/3 A, 5 Vdc/2 A Output



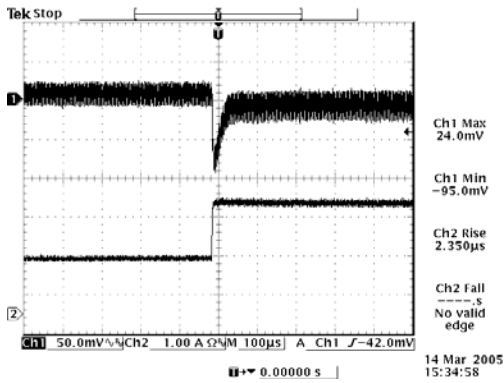
## Transient Response Waveforms(continued)



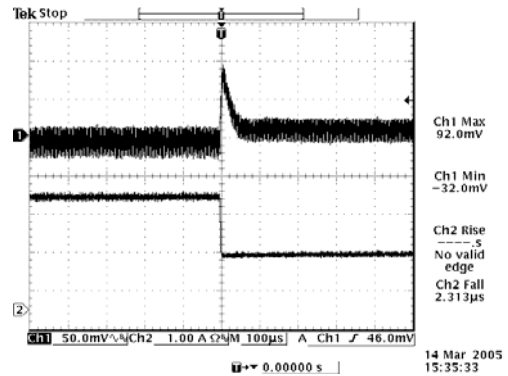
50% to 100% load 12 Vdc Input 2.5 Vdc Output



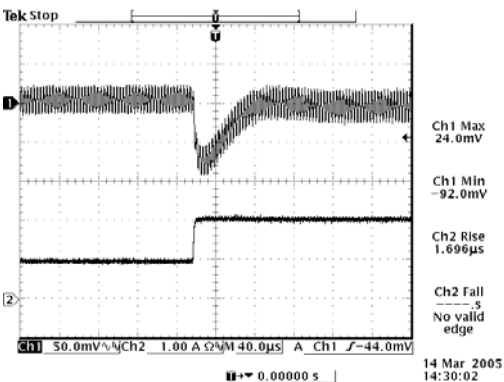
100% to 50% load 12 Vdc Input 2.5 Vdc Output



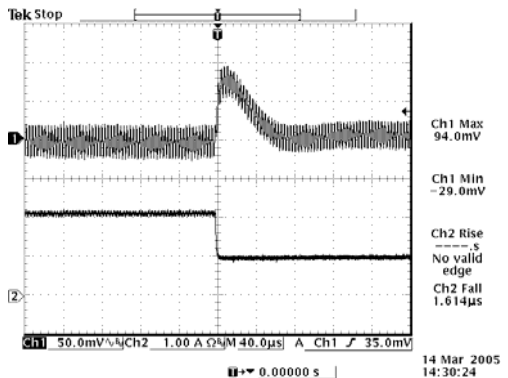
50% to 100% load 12 Vdc Input 3.3 Vdc Output



100% to 50% load 12 Vdc Input 3.3 Vdc Output



50% to 100% load 12 Vdc Input 1.5 Vdc Output



100% to 50% load 12 Vdc Input 1.5 Vdc Output

**Note:** Transient Response at  $di/dt=0.5$  A/µS, with a 220 µF/10 V tantalum cap and a 22 µF/10 V ceramic cap at the output, and  $T_a=25$  deg C.



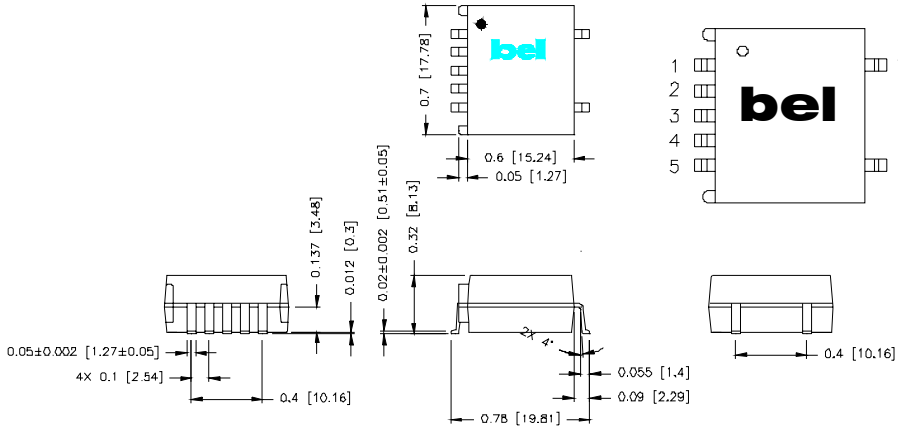
# NON-ISOLATED DC/DC CONVERTERS

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## Mechanical Outline

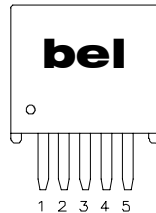
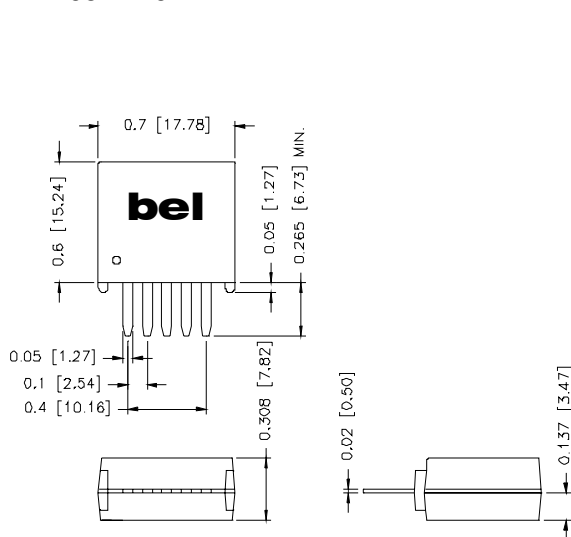
### SRAH-03L2A0



### Pin Connections

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

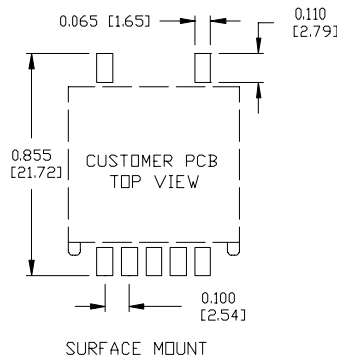
### VRAH-03L2A0



### Pin Connections

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

### RECOMMENDED PCB PAD LAYOUT



HOLE SIZE: 0.06" [1.57]  
PAD SIZE: 0.08" [2.03]

## 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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