# NON-ISOLATED DC/DC CONVERTERS

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

**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 | - | |
| $I^2t$ Inrush Current Transient | - | 0.05 $A^2s$ | 0.1 $A^2s$ | |
| Turn on Voltage Threshold | - | 4.0 V | - | |
| Turn off Voltage Threshold | 3.5 V | - | 4.9 V | |

## Output Specifications

| Parameter | Min | Typ | Max | Notes |
|---|---|---|---|---|
| Output Voltage Set Point | | | | |
| VO=5.0 V | 4.850 V | 5.0 V | 5.150 V | Test conditions: Io=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 | 1.746 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 $A^2s$ | 1.5 $A^2s$ | |
| 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 | |

## Output Specifications (continued)

| Parameter | | | Min | Typ | Max | Notes |
|---|---|---|---|---|---|---|
| **Transient Response** | | | | | | |
| 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 | | | | | |
| Vo=5.0 V | 12 V | 87% | 91% | - | Vin=12.0 V; Io=Iomax |
| 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 × W × H) | 0.78 x 0.7 x 0.32 | | | | |
| Millimeters (L × W × H) | 19.812 x 17.78 x 8.128 | | | | |
| Dimensions (vertical) | | | | | |
| Inches (L × W × H) | 0.7 x 0.308 x 0.65 | | | | |
| Millimeters (L × W × H) | 17.78 x 7.82 x 16.51 | | | | |
| Weight | - | 4.9 g | - | | |

## Control Specifications

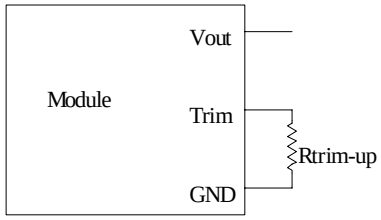
| Parameter | Min | Typ | Max | Notes |
|---|---|---|---|---|
| **Remote On/Off** | | | | |
| Signal Low (Unit Off) | -0.3 V | - | 1 V | Remote on/off pin is open, Unit On |
| Signal High (Unit On) | 2.8 V | - | 24 V | |
| Current Sink | -3 mA | - | 5 mA | |

## Output Trim Equations

Equations for calculating the trim resistor (in kΩ) 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.

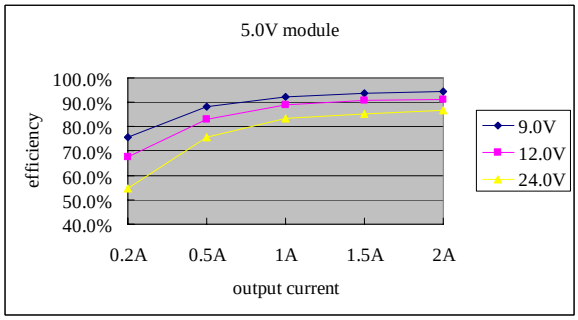
$$R_{trim-up} = \frac{6.928}{V_{adj} - V_o} - 1$$

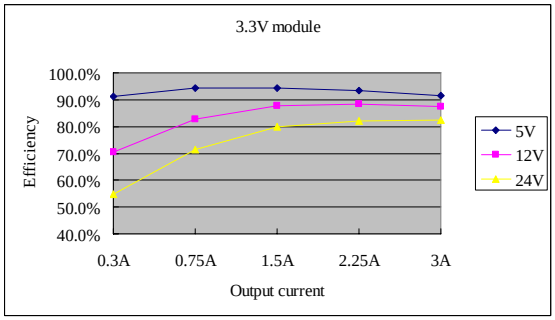
| Vo (V) | Rtrim(kΩ) |
|---|---|
| 0.902 | Open |
| 1.2 | 22.248 |
| 1.5 | 10.585 |
| 1.8 | 6.715 |
| 2.5 | 3.335 |
| 3.3 | 1.889 |
| 5 | 0.691 |

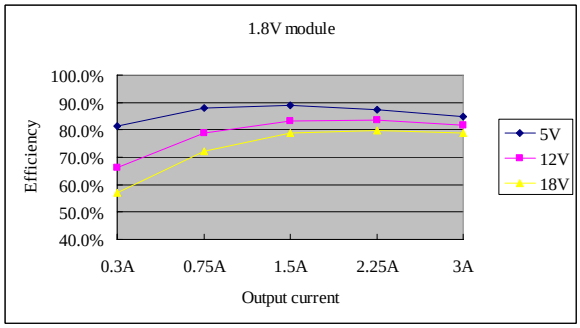


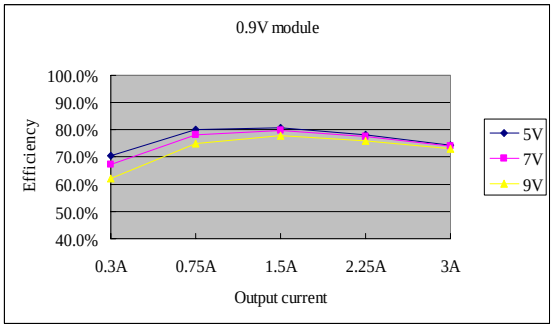

**Note:** Output voltage Vo=0.902 V when Rtrim_up is not connected.

## Efficiency Data

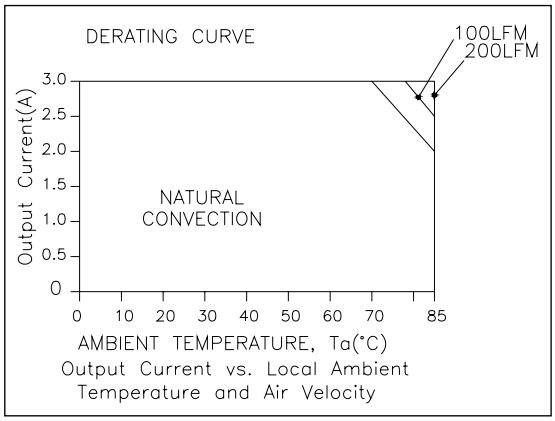


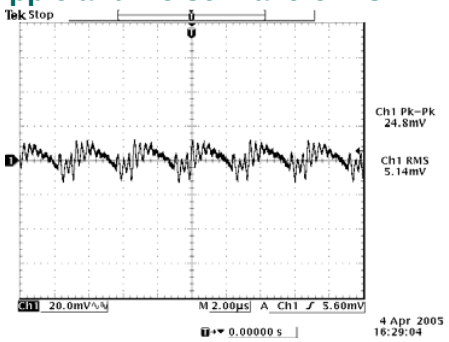



## Thermal Derating Curve

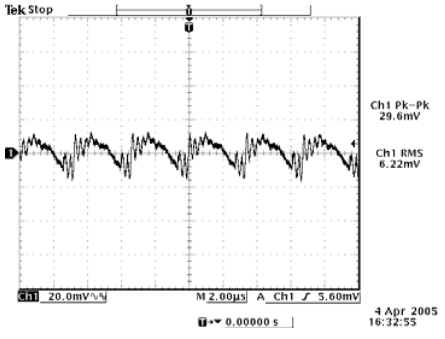



xRAH-03L2A0

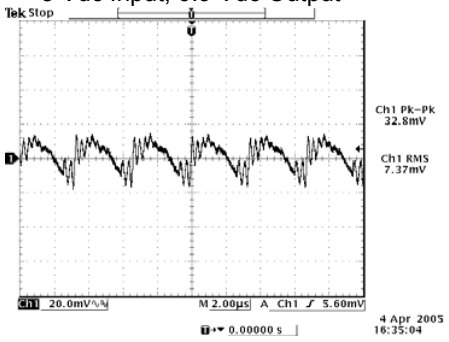
## Ripple and Noise Waveforms



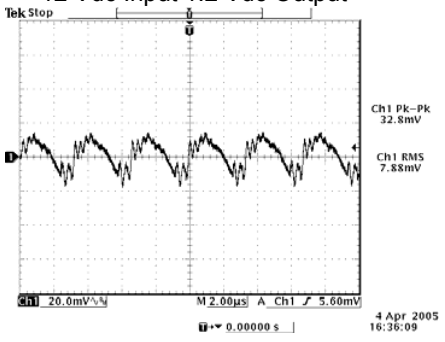

5 Vdc Input, 0.9 Vdc Output



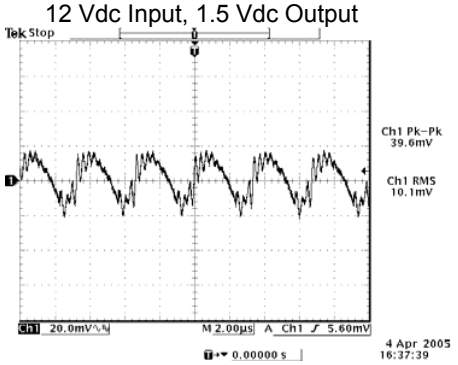

12 Vdc Input 1.2 Vdc Output



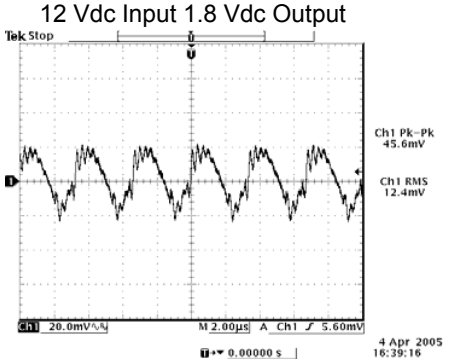

12 Vdc Input, 1.5 Vdc Output



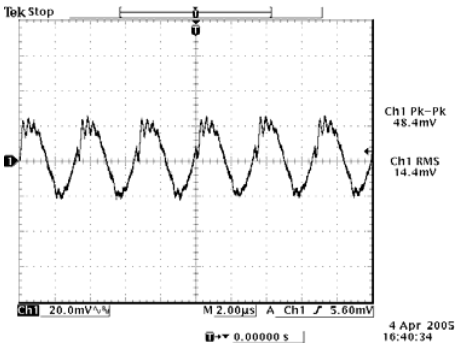

12 Vdc Input 1.8 Vdc Output




12 Vdc Input, 2.5 Vdc Output



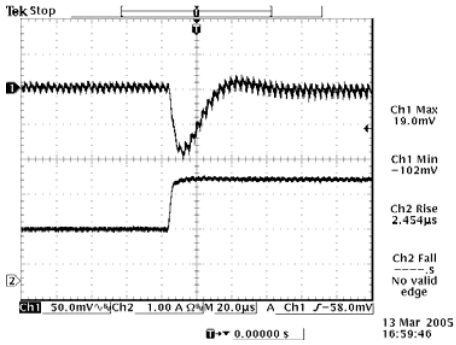

12 Vdc Input 3.3 Vdc Output



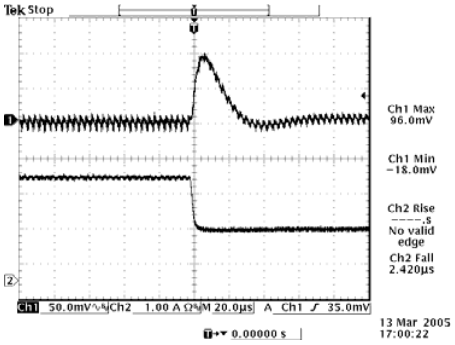

12 Vdc Input, 5.0 Vdc Output

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

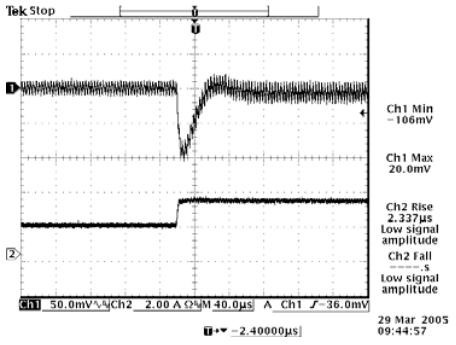
## Transient Response Waveforms



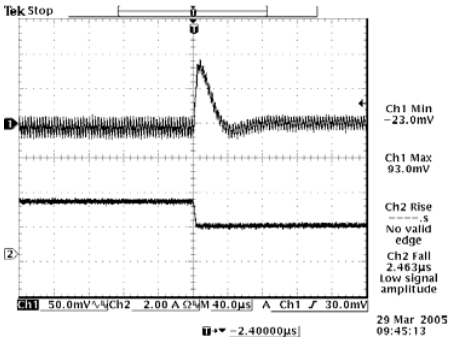

50% to 100% load 5 Vdc Input 0.9 Vdc Output



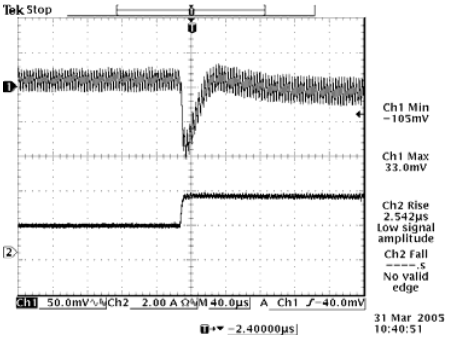

100% to 50% load 5 Vdc Input 0.9 Vdc Output



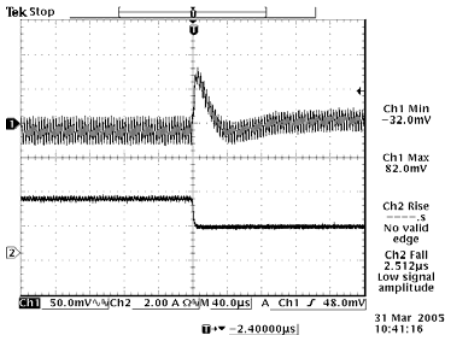

50% to 100% load 12 Vdc Input 1.2 Vdc Output



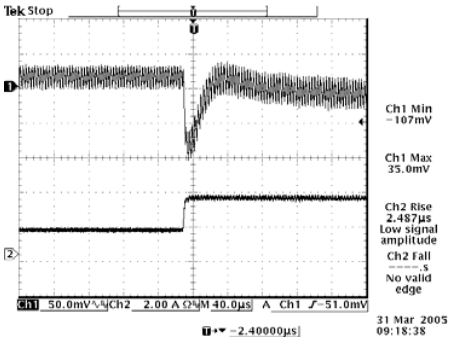

100% to 50% load 12 Vdc Input 1.2 Vdc Output



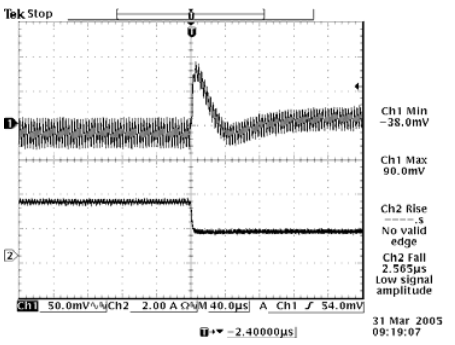

50% to 100% load 12 Vdc Input 1.5 Vdc Output




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

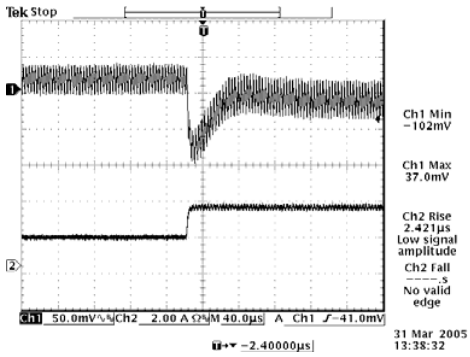



50% to 100% load 12 Vdc Input 1.8 Vdc Output

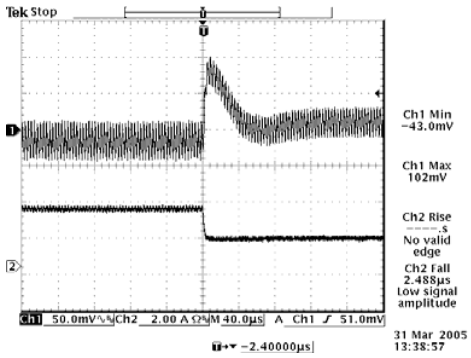



100% to 50% load 12 Vdc Input 1.8 Vdc Output

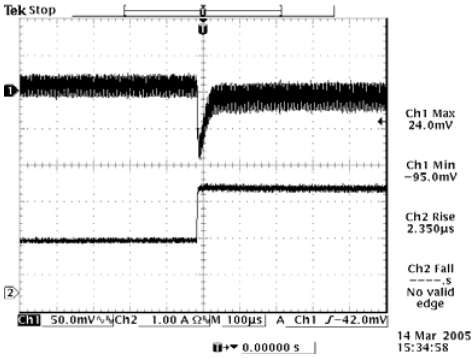
## Transient Response Waveforms(continued)



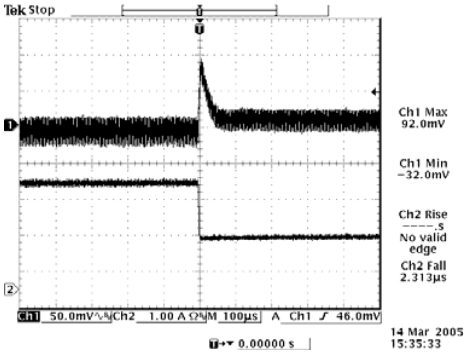

50% to 100% load 12 Vdc Input 2.5 Vdc Output



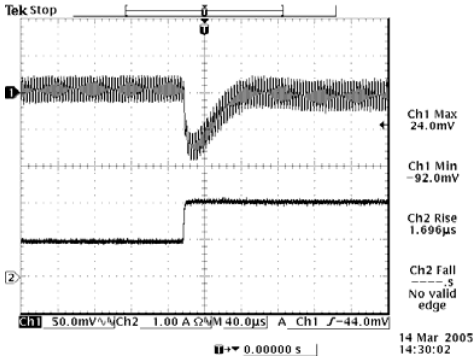

100% to 50% load 12 Vdc Input 2.5 Vdc Output



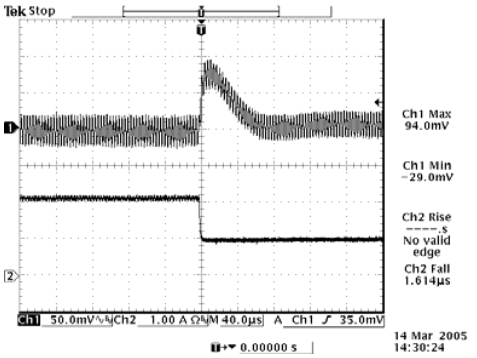

50% to 100% load 12 Vdc Input 3.3 Vdc Output




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

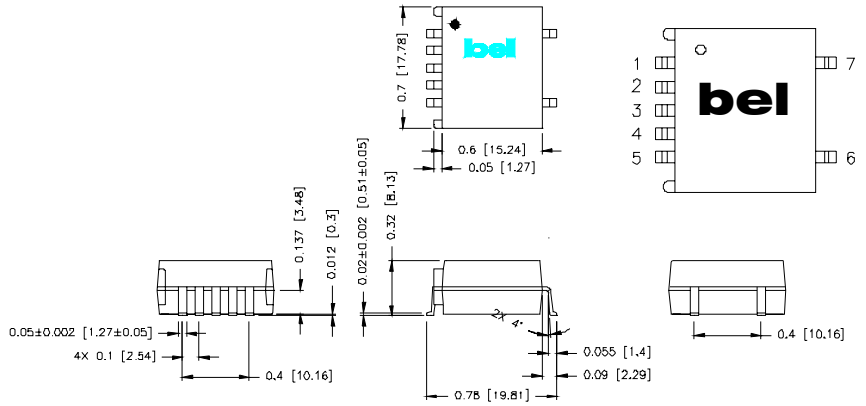
**Note:** Transient Response at di/dt=0.5 A/uS, with a 220 uF/10 V tantalum cap and a 22 uF/10 V ceramic cap at the output, and Ta=25 deg C.

# NON-ISOLATED DC/DC CONVERTERS

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

## Mechanical Outline

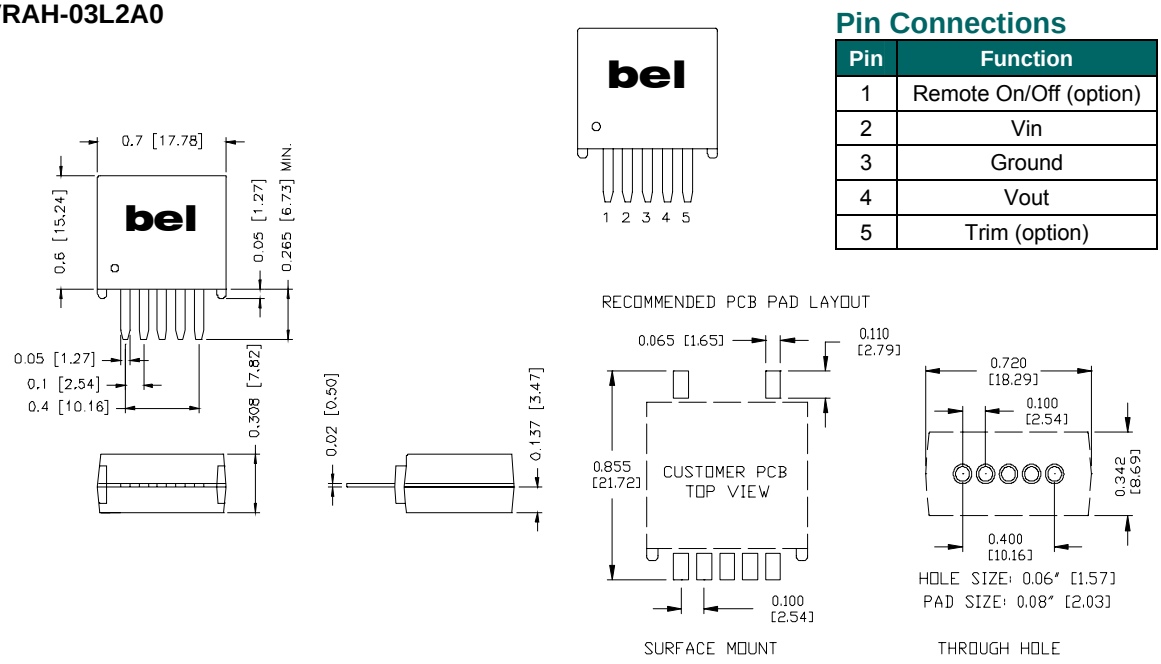
### SRAH-03L2A0




### 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) |

## 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 ºC.



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