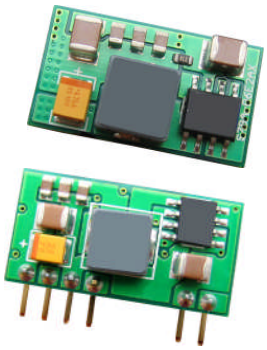
# NON-ISOLATED DC/DC CONVERTERS

**4.5 Vdc -14 Vdc Input  0.75 Vdc - 5.0 Vdc/6 A Output**

*Jan. 25, 2013*

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

**xRBA-06E2Ax Series  RoHS Compliant  Rev.D**



## Features

- Non-Isolated
- High Efficiency
- High Power Density
- Fixed Frequency
- Flexible Output Voltage Sequencing
- Under-voltage Lockout (UVLO)
- Remote On/Off
- OCP/SCP
- Wide Input
- Wide Trim Range
- Certificated to UL60950-1/CSA C22.2 No.60950-1, 2rd edition, am1

## Applications

- Networking
- Computers and peripherals
- Telecommunications

## Description

The Bel xRBA-06E2Ax modules are a series of non-isolated dc/dc converters that can deliver up to 6 A of output current with full load efficiency of 92% at 5.0 Vdc output. These modules provide precisely regulated voltage programmable via external resistor from 0.75 Vdc to 5.0 Vdc over a wide range of input voltage. These modules have a sequencing feature that enables designers to implement various types of output voltage sequencing when powering multiple voltages on a board. Their open-frame construction and small footprint enable designers to develop cost and space-efficient solutions. Standard features include remote On/Off, programmable output voltage and over current protection.

## Part Selection

| Output Voltage | Input Voltage | Max. Output Current | Max. Output Power | Typical Efficiency | Model Number Surface Mount | Model Number Vertical Mount |
|---|---|---|---|---|---|---|
| 5.0 V | 7.0 V - 14 V | 6 A | 30.0 W | 92% | SRBA-06E2Ax | VRBA-06E2Ax |
| 0.75 V - 3.3 V[1] | 4.5 V - 14 V | 6 A | 19.8 W | 88% | SRBA-06E2Ax | VRBA-06E2Ax |

**Notes**: 1. These modules use a buck topology, so the output voltages must be 0.5 V less than the input voltage.
2. Use “0” to replace “x” for remote on/off active high logic and use “L” for active low logic. Change the last character “L” to “C” to indicate 0.20” pin length. Add “G” suffix at the end of the model numbers to indicate Tray Packaging.

### Part Number Explanation

| x | R | BA | – | 06 | E | 2A | x |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | | 4 | 5 | 6 | 7 |

**1---Change “x” to “0” indicated Horizontal mount, Change “x” to “V” indicated 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.**

## 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 | |
| Sequencing Voltage [1] | -0.3 V | - | Vin | |
| Ambient Temperature | -40 °C | - | 85 °C | |
| Storage Temperature | -55 °C | - | 125 °C | |

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

1. xRBA-06E2Ax series of modules include a sequencing feature that enables users to implement various types of output voltage sequencing in their applications. This is accomplished via an additional sequencing pin. When the sequencing feature is not used, tie the SEQ pin to Vin.

## Input Specifications

| Parameter | Min | Typ | Max | Notes |
|---|---|---|---|---|
| Input Voltage | | | | |
| Vo, set≤3.3 V | 4.5 V | 12 V | 14 V | |
| Vo, set=5.0 V | 7.0 V | 12 V | 14 V | |
| Input Current (full load) | | | | |
| Vo=5.0 V | - | 2.75 A | 4.8 A | |
| Vo=3.3 V | - | 1.85 A | 4.8 A | |
| Vo=1.8 V | - | 1.05 A | 3.2 A | |
| Vo=0.75 V | - | 0.55 A | 1.8 A | |
| Input Current (no load) | | | | |
| Vo=5.0 V | - | - | 100 mA | |
| Vo=0.75 V | - | - | 20 mA | |
| Remote Off Input Current | - | 3 mA | 5 mA | |
| Input Reflected Ripple Current (pk-pk) | - | 120 mA | 200 mA | With simulated source impedance of 1 uH, 5 Hz to 20 MHz and two 100 uF/25 V external input tantalum capacitors. |
| Input Reflected Ripple Current (rms) | - | 60 mA | 100 mA | |
| $I^2t$ Inrush Current Transient | - | 0.002 $A^2s$ | 0.02 $A^2s$ | |
| Turn-on Voltage Threshold | | | | |
| Vo, set≤3.3 V | - | 4.3 V | 4.5 V | |
| Vo, set=5.0 V | - | 6.0 V | 6.5 V | |
| Turn-off Voltage Threshold | | | | |
| Vo, set≤3.3 V | - | 4.0 V | 4.3 V | Shut down or below 90% set point. |
| Vo, set=5.0 V | - | 5.5 V | 6.0 V | |

## Output Specifications

| Parameter | Min | Typ | Max | Notes |
|---|---|---|---|---|
| Output Voltage Set Point | -2%Vo,set | - | 2%Vo,set | Vin=12 V, full load |
| Output Voltage Set Point [1] | -2.5%Vo,set | - | 3.5%Vo,set | |
| Load Regulation | -0.7%Vo,set | 0.4%Vo,set | 0.7%Vo,set | Io=Io, min to Io, max |
| Line Regulation | -0.7%Vo,set | 0.3%Vo,set | 0.7%Vo,set | Vin=Vin, min to Vin, max |
| Regulation Over Temperature (-40 °C to +85 °C) | - | 0.5%Vo,set | - | Tref=Ta, min to Ta, max |
| Output Current | 0 A | - | 6 A | |
| Current Limit Threshold | 6.8 A | - | 15 A | |
| Short Circuit Surge Transient | - | 0.25 $A^2s$ | - | |

## Output Specifications(continued)

| Parameter | Min | Typ | Max | Notes |
|---|---|---|---|---|
| Ripple and Noise (pk-pk) | | | | Tested with 0-20 MHz, with 10 uF/10 V tantalum capacitor & 1 uF/10 V ceramic capacitor at the output |
| Vo=5.0 V | - | 100 mV | 140 mV | |
| Vo=3.3 V | - | 80 mV | 120 mV | |
| Vo=0.75 V | - | 35 mV | 7 0 mV | |
| Ripple and Noise (rms) | | | | |
| Vo=5.0 V | - | 35 mV | 50 mV | |
| Vo=3.3 V | - | 25 mV | 40 mV | |
| Vo=0.75 V | - | 10 mV | 15 mV | |
| Turn on Time | - | 6 mS | 12 mS | |
| Overshoot at Turn on | - | 0% | 3% | |
| Output Capacitance | | | | |
| ESR ≥ 1mohm | 0 uF | - | 1000 uF | |
| ESR ≥ 10mohm | 0 uF | - | 2200 uF | |
| **Transient Response** | | | | |
| 50% ~ 100% Max Load | All outputs | - | 200 mV | 350 mV | di/dt=2.5 A/uS; Vin=12 V; and with 10 uF/10 V tantalum capacitor & 1uF/10 V ceramic capacitor at the output. |
| Settling Time | | - | 25 uS | 50 uS | |
| 100% ~ 50% Max Load | | - | 200 mV | 350 mV | |
| Settling Time | | - | 25 uS | 50 uS | |

**Notes**: All specifications are typical at nominal input (Vin=12 V), full load at 25 °C unless otherwise stated.

1. Over all operating input voltages, resistive loads and temperature conditions.

## General Specifications

| Parameter | Min | Typ | Max | Notes |
|---|---|---|---|---|
| Efficiency | | | | Measured at Vin=12 V, full load |
| Vo=5.0 V | 88% | 92% | - | |
| Vo=3.3 V | 85% | 88% | - | |
| Vo=1.8 V | 80% | 84% | - | |
| Vo=0.75 V | 68% | 73% | | |
| Switching Frequency | 220 kHz | 250 kHz | 280 kHz | |
| Output Voltage Trim Range (wide trim) | 0.7525 V | - | 5 V | |
| MTBF | 3,079,469 hours | | | Calculated Per Bell Core SR-332 (Vin=12 V; Vo=3.3 V, Io=4.8 V; Ta = 25 °C) |
| Dimensions | | | | Surface Mount |
| Inches (L × W × H) | 0.8 x 0.45 x 0.251 | | | |
| Millimeters (L × W × H) | 20.32 x 11.42 x 6.38 | | | |
| Dimensions | | | | Vertical Mount |
| Inches (L × W × H) | 1.0 x 0.5 x 0.243 | | | |
| Millimeters (L × W × H) | 25.4 x 12.7 x 6.16 | | | |
| Weight | - | 5 g | - | |

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

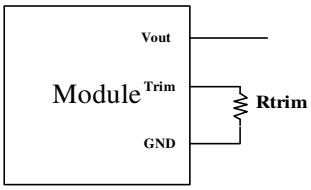
## Control Specifications

| Parameter | Min | Typ | Max | Notes |
|---|---|---|---|---|
| **Remote On/Off** | | | | |
| Signal Low (Unit Off) | -0.3 V | - | 0.4 V | xRBA-06E2A0; Remote On/Off pin open, Unit on. |
| Signal High (Unit On) | 2.5 V | - | 14 V | |
| Signal Low (Unit On) | -0.3 V | - | 0.4 V | xRBA-06E2AL; Remote On/Off pin open, Unit on. |
| Signal High (Unit Off) | 2.5 V | - | 14 V | |
| **Voltage Sequencing** | | | | |
| Sequencing Voltage | 0.05 V | - | Vin | Sequencing Voltage should be higher than output voltage. |
| Sequencing Slew Rate Capability | - | - | 2 V/mS | |
| Sequencing Delay Time | 10 mS | - | - | Delay from Vin, min to application of voltage on SEQ pin |
| Tracking Accuracy<br>Power-Up<br>Power-Down | <br>-<br>- | <br>100 mV<br>200 mV | <br>200 mV<br>400 mV | |

## Output Trim Equations

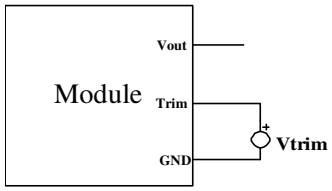
Equation for calculating the trim resistor (in kΩ) given the desired adjusted voltage (Vadj) is shown below. The Trim Up resistor should be connected between the Trim pin and Ground.

$$R_{trim} = \frac{10.507}{V_{adj} - 0.7525} - 1$$

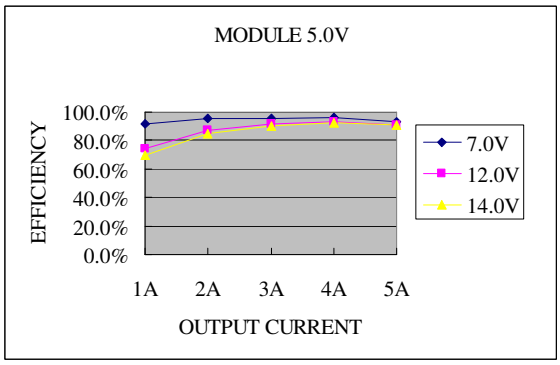


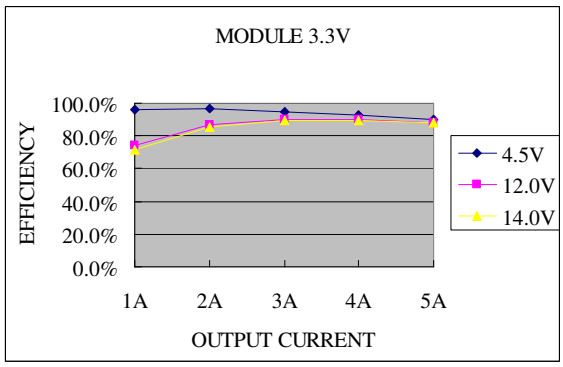

Equation for calculating the trim voltage (in V) given the desired adjusted voltage (Vadj) is shown below. The Trim Up voltage should be connected between the Trim pin and Ground.

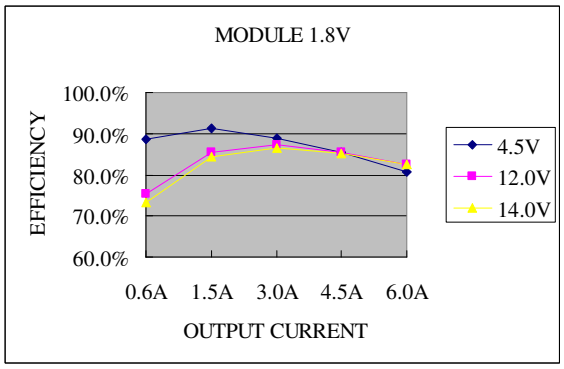
$$V_{trim} = 0.7 - 0.0667 \times (V_{adj} - 0.7525)$$

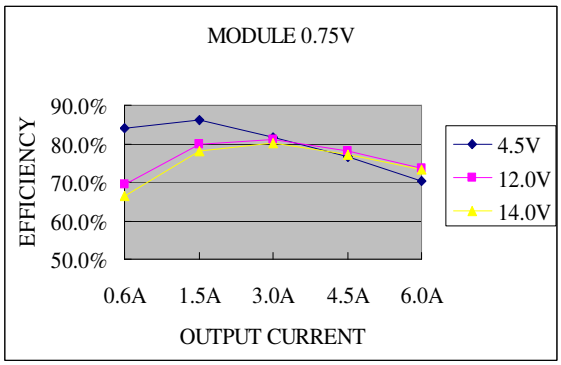


## Efficiency Data

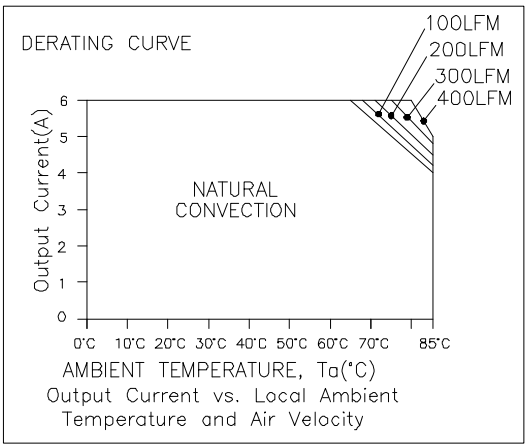


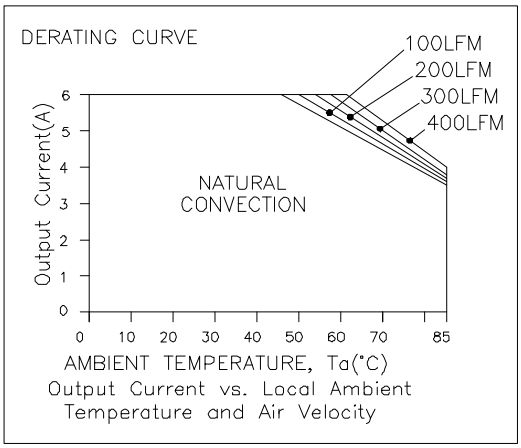



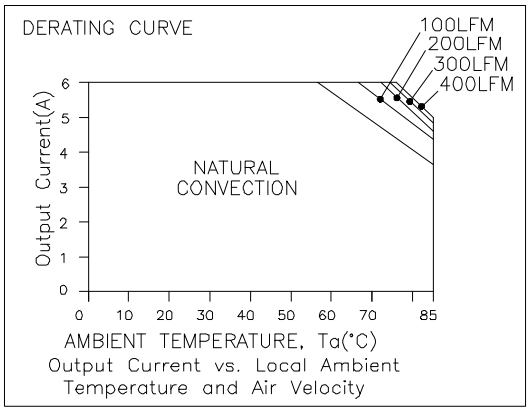
## Thermal Derating Curves



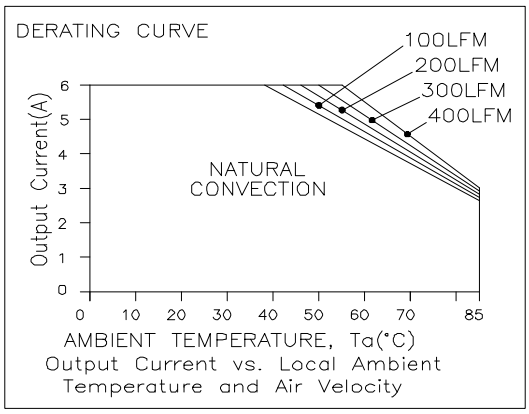

SRBA-06E2Ax, Vo=0.75 V



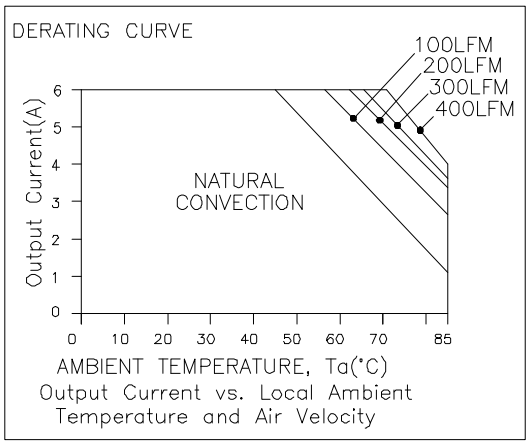

VRBA-06E2Ax, Vo=0.75 V



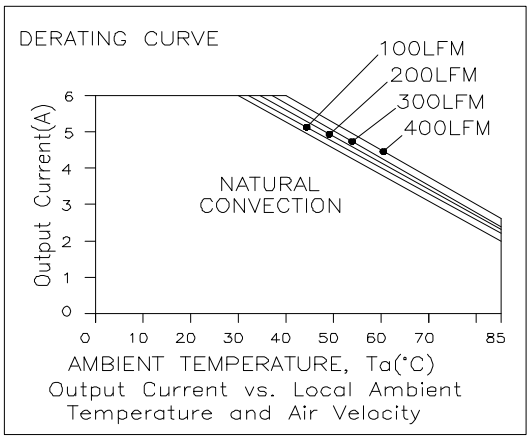

SRBA-06E2Ax, Vo=2.5 V




VRBA-06E2Ax, Vo=2.5 V

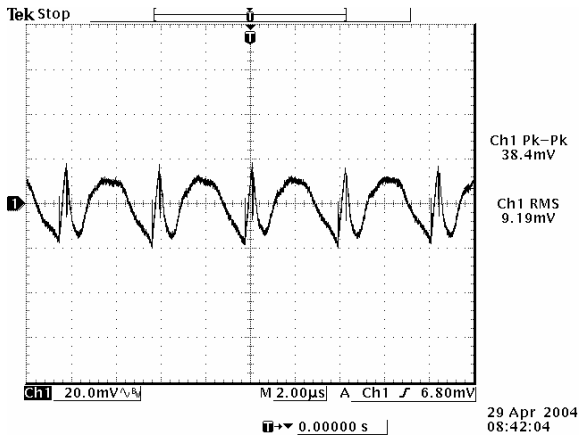



SRBA-06E2Ax, Vo=5.0 V

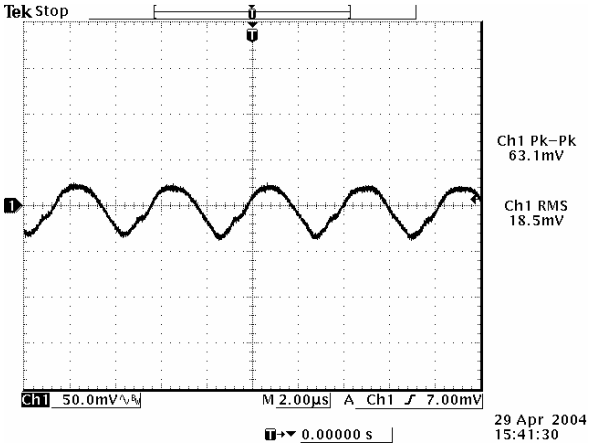



VRBA-06E2Ax, Vo=5.0 V

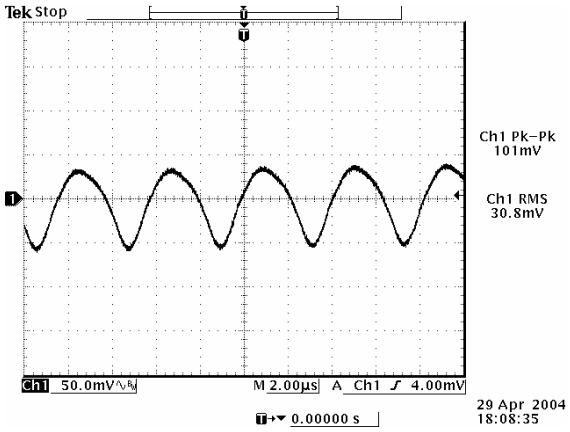
## Ripple and Noise Waveforms



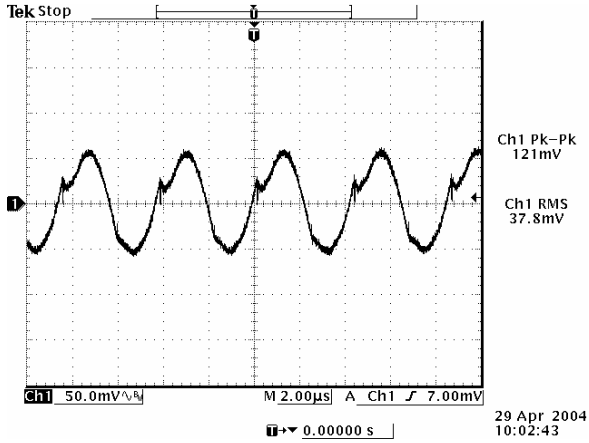

Ripple and noise at full load, Vo=0.75 V




Ripple and noise at full load, Vo=1.8 V



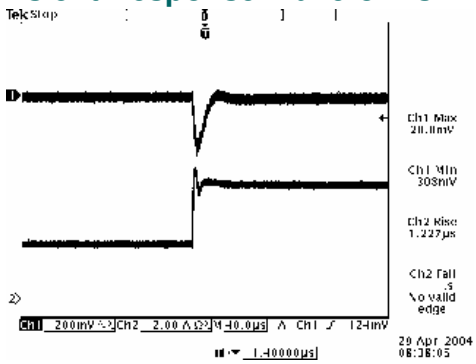

Ripple and noise at full load, Vo=3.3 V



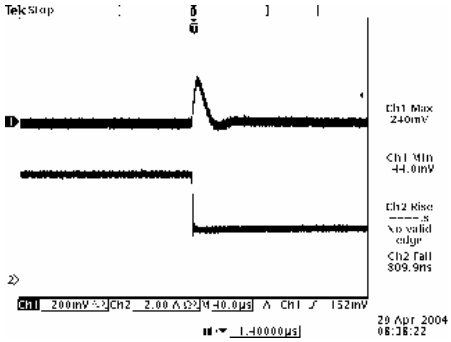

Ripple and noise at full load, Vo=5.0 V

**Note:** Ripple and noise at 12 V input, 0-20 MHz BW, 10 uF/10 V tantalum capacitor and 1 uF/10 V ceramic capacitor, Ta=25 deg C.

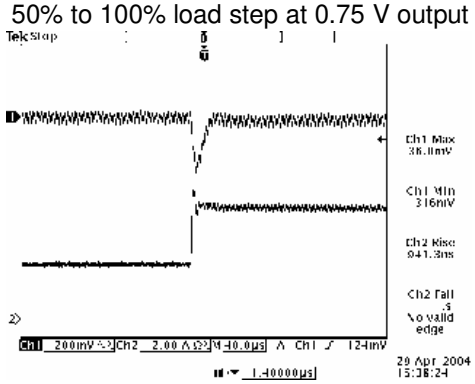
## Transient Response Waveforms



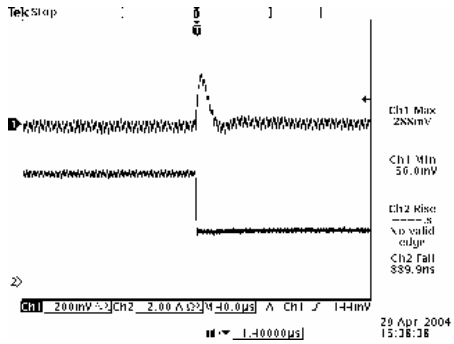

50% to 100% load step at 0.75 V output



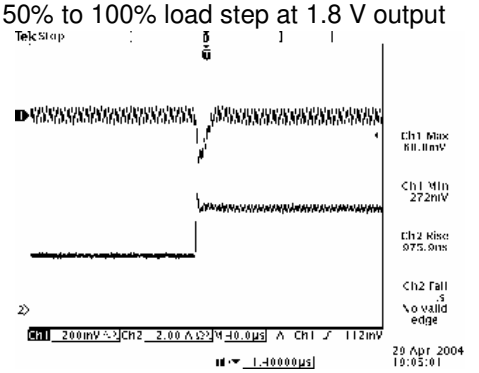

100% to 50% load step at 0.75 V output



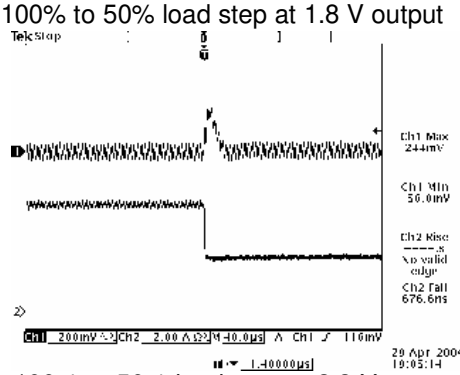

50% to 100% load step at 1.8 V output



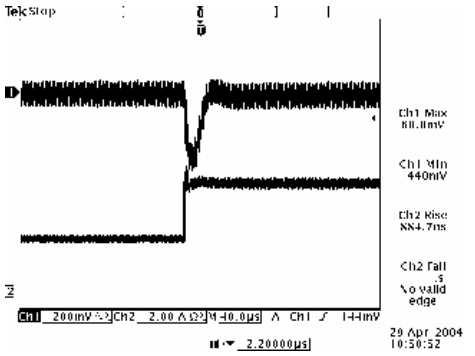

100% to 50% load step at 1.8 V output



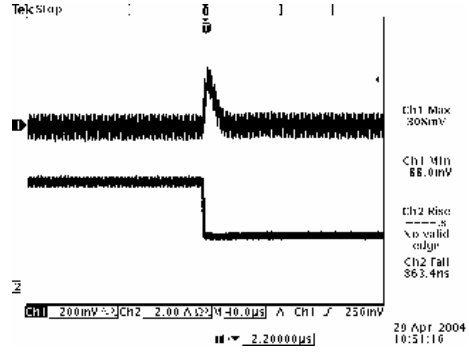

50% to 100% load step at 3.3 V output




100% to 50% load step at 3.3 V output




50% to 100% load step at 5.0 V output

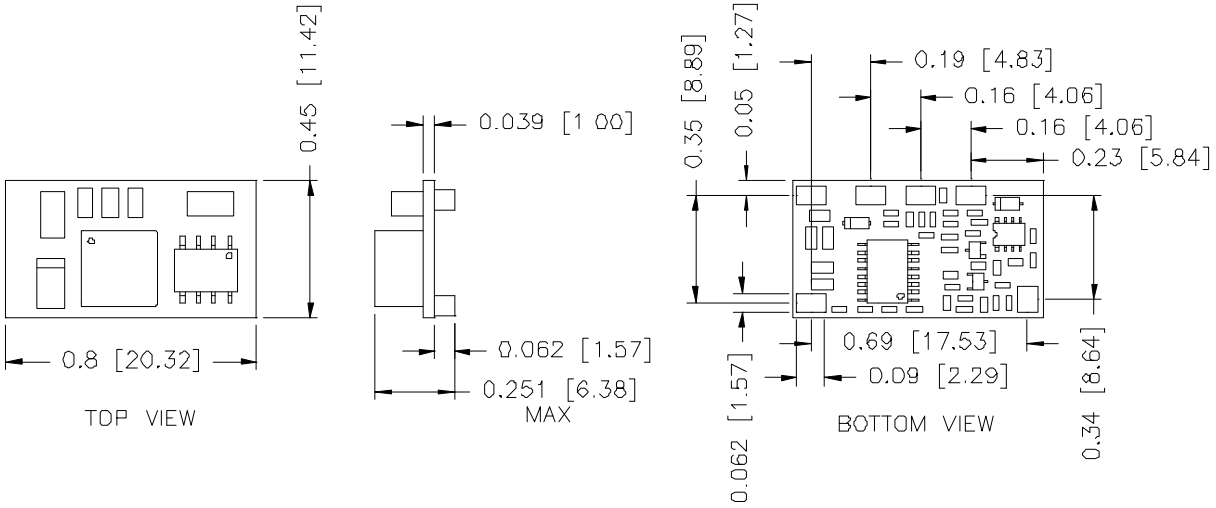


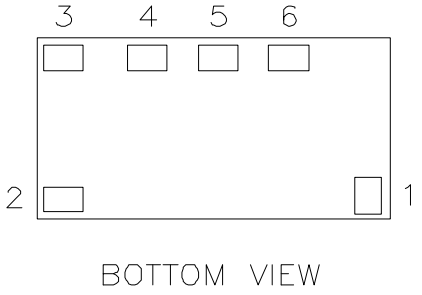

100% to 50% load step at 5.0 V output

**Note:** Transient response at 12 V input, di/dt=2.5 A/uS, with 10 uF/10 V tantalum capacitor and 1uF/10 V ceramic capacitor, and Ta=25 deg C.

## Mechanical Outline

### SRBA-06E2Ax

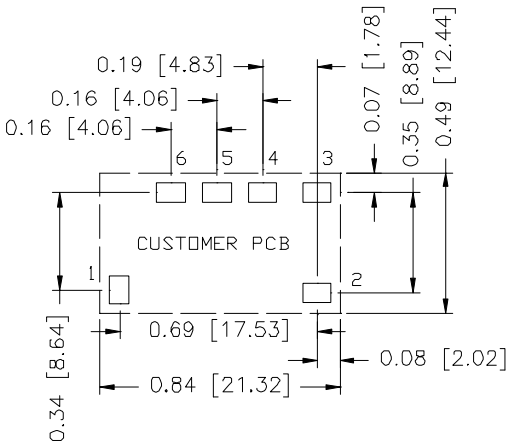



## Pin Connections

| Pin | Function |
|---|---|
| 1 | Remote On/Off |
| 2 | Vin+ |
| 3 | SEQ |
| 4 | Ground |
| 5 | Trim |
| 6 | Vout+ |

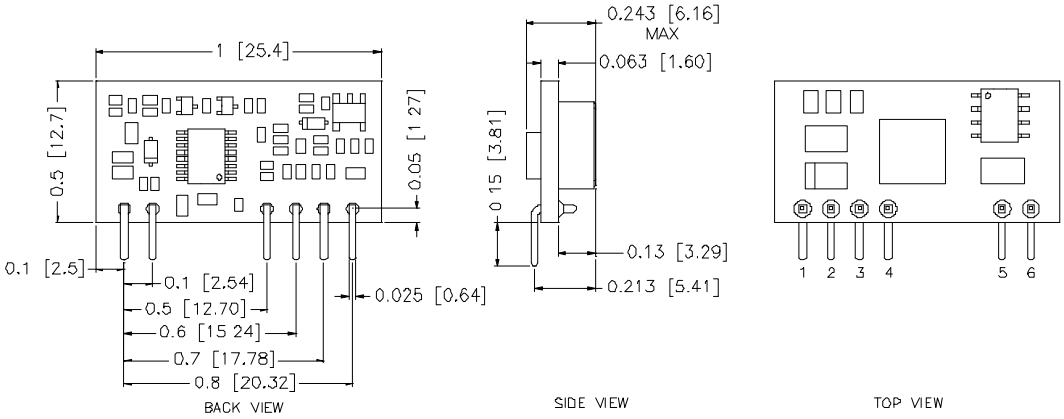
RECOMMENDED PAD LAYOUT

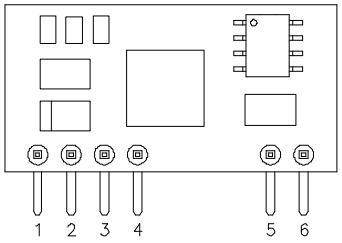



PAD SIZE:
MIN: 0.12"* 0.095" (3.05mm * 2.41mm)
MAX: 0.135"* 0.11" (3.43mm * 2.79mm)

## Mechanical Outline (continued)

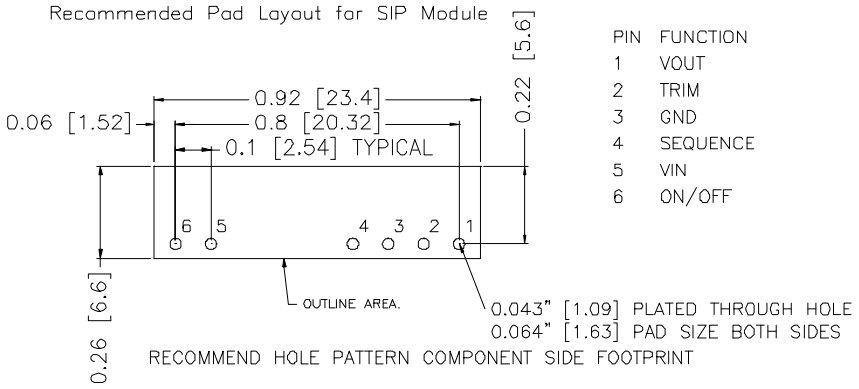
### VRBA-06E2Ax




### Pin Connections

| Pin | Function |
|---|---|
| 1 | Vout+ |
| 2 | Trim |
| 3 | Ground |
| 4 | SEQ |
| 5 | Vin+ |
| 6 | Remote On/Off |




**Note: 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 245 °C.**

## Revision History

| Date | Revision | Changes Detail | Approval |
|---|---|---|---|
| 2007-01-12 | A | Add a note under P/N Part | Lynn |
| 2008-01-22 | B | | HL |
| 2011-08-25 | C | Update the reflow solder temperature. | HL |
| 2013-01-25 | D | 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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