

## NON-ISOLATED DC/DC CONVERTERS

8.3 Vdc - 14 Vdc Input

0.75 Vdc - 5.5 Vdc/6 A Output

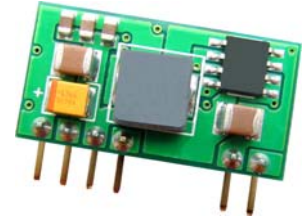
**bel**  
POWER PRODUCTS

**VRBA-06A2Ax**

**RoHS Compliant**

**Rev.A**

- Non-Isolated
- High Efficiency
- High Power Density
- Fixed Frequency
- Remote On/Off
- Active Low/High (Option)
- Under-Voltage Lockout (UVLO)
- OCP/SCP
- Wide Input Range
- Wide Trim Range
- Flexible Output Voltage Sequencing



### Description

The Bel VRBA-06A2Ax modules are a series of non-isolated dc/dc converters that 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 5.5 Vdc over a wide range of input voltage (8.3 Vdc - 14 Vdc). These modules have a sequencing feature that enables designers to implement various types of output voltage sequencing when powering multiple voltages on a board. The open-frame construction and small footprint enable designers to develop cost and space-efficient solutions. Standard features include remote On/Off, over current protection, short current protection, wide input, and programmable output voltage.

### 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 - 5.5 V | 8.3 V - 14 V  | 6 A                 | 33 W              | 92%                | VRBA-06A2AL             | VRBA-06A2A0              |

- Notes:** 1. Change the last character "L" to "C" to indicate 0.20" pin length.  
2. Add "G" suffix at the end of the model number to indicate Tray Packaging.  
3. 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 | -   | 15 V   |       |
| Output Enable Terminal Voltage  | -0.3 V | -   | 15 V   |       |
| Sequencing Voltage <sup>1</sup> | -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. VRBA-06A2Ax 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 or leave the SEQ pin floating.

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### Input Specifications

| Parameter                                 | Min   | Typ                    | Max                   | Notes                                                                                                      |
|-------------------------------------------|-------|------------------------|-----------------------|------------------------------------------------------------------------------------------------------------|
| Input Voltage                             | 8.3 V | 12 V                   | 14 V                  |                                                                                                            |
| Input Current (full load)                 |       |                        |                       |                                                                                                            |
| Vo=5.0 V                                  | -     | 2.75 A                 | 4.0 A                 |                                                                                                            |
| Vo=3.3 V                                  | -     | 1.85 A                 | 2.8 A                 |                                                                                                            |
| Vo=2.5 V                                  | -     | 1.45 A                 | 2.2 A                 |                                                                                                            |
| Vo=1.8 V                                  | -     | 1.05 A                 | 1.6 A                 |                                                                                                            |
| Vo=0.75 V                                 | -     | 0.55 A                 | 0.8 A                 |                                                                                                            |
| Input Current (no load)                   |       |                        |                       |                                                                                                            |
| Vo=5.0 V                                  | -     | -                      | 100 mA                |                                                                                                            |
| Vo=0.75 V                                 | -     | -                      | 20 mA                 |                                                                                                            |
| Remote Off Input Current                  | -     | 1 mA                   | 2 mA                  |                                                                                                            |
| Input Reflected Ripple Current (pk-pk)    | -     | 120 mA                 | -                     | Tested with two 100 uF/25 V tantalum input capacitors & simulated source impedance of 1uH, 5 Hz to 20 MHz. |
| Input Reflected Ripple Current (rms)      | -     | 40 mA                  | -                     |                                                                                                            |
| I <sup>2</sup> t Inrush Current Transient | -     | 0.002 A <sup>2</sup> s | 0.02 A <sup>2</sup> s |                                                                                                            |
| Turn-on Voltage Threshold                 | -     | 8.1 V                  | 8.2 V                 |                                                                                                            |
| Turn-off Voltage Threshold                | -     | 7.5 V                  | 8.0 V                 |                                                                                                            |

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

### Output Specifications

| Parameter                                                 | Min         | Typ                   | Max        | Notes                                                                                                    |
|-----------------------------------------------------------|-------------|-----------------------|------------|----------------------------------------------------------------------------------------------------------|
| Output Voltage Set Point                                  | -2%Vo,set   | -                     | 2%Vo,set   | Vin=12 V, Io=Iomax                                                                                       |
| Output Voltage Set Point                                  | -2.5%Vo,set | -                     | 3.5%Vo,set | Over all operating input voltages, resistive loads and temperature conditions                            |
| Adjustment Range Selected by External Resistor or Voltage | 0.7525 V    | -                     | 5.5 V      |                                                                                                          |
| Load Regulation                                           | -0.5%Vo,set | 0.4%Vo,set            | 0.5%Vo,set | Io=Io, min to Io, max                                                                                    |
| Line Regulation                                           | -0.4%Vo,set | 0.3%Vo,set            | 0.4%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                                   | 7.2 A       | -                     | 18 A       |                                                                                                          |
| Short Circuit Surge Transient                             | -           | 0.25 A <sup>2</sup> s | -          |                                                                                                          |
| Ripple and Noise (pk-pk)                                  |             |                       |            | Tested with 0-20 MHz, with 10 uF/10 V tantalum capacitor & 1uF/10 V TDK ceramic capacitor at the output. |
| Vo=0.75 V                                                 | -           | 20 mV                 | -          |                                                                                                          |
| Vo=3.3 V                                                  | -           | 60 mV                 | -          |                                                                                                          |
| Vo=5.0 V                                                  | -           | 75 mV                 | -          |                                                                                                          |
| Ripple and Noise (rms)                                    |             |                       |            |                                                                                                          |
| Vo=0.75 V                                                 | -           | 7 mV                  | -          |                                                                                                          |
| Vo=3.3 V                                                  | -           | 20 mV                 | -          |                                                                                                          |
| Vo=5.0 V                                                  | -           | 25 mV                 | -          |                                                                                                          |
| Turn on Time                                              | -           | 8 mS                  | 10 mS      |                                                                                                          |
| Overshoot at Turn on                                      | -           | 0%                    | 3%         |                                                                                                          |
| Output Capacitance                                        |             |                       |            |                                                                                                          |
| ESR ≥ 1mohm                                               | 0 uF        | -                     | 1000 uF    |                                                                                                          |
| ESR ≥ 10mohm                                              | 0 uF        | -                     | 3000 uF    |                                                                                                          |

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### Output Specifications (continued)

| Parameter                 | Min                 | Typ | Max    | Notes                                                                                                         |
|---------------------------|---------------------|-----|--------|---------------------------------------------------------------------------------------------------------------|
| <b>Transient Response</b> |                     |     |        |                                                                                                               |
| 50% ~ 100% Max Load       | Vo = 0.75 V - 5.5 V | -   | 200 mV | di/dt=2.5 A/uS; Vin=12 V; and with 10 uF/10 V tantalum capacitor & 1 uF/10 V ceramic capacitor at the output. |
| Settling Time             |                     | -   | 50 uS  |                                                                                                               |
| 100% ~ 50% Max Load       |                     | -   | 200 mV |                                                                                                               |
| Settling Time             |                     | -   | 50 uS  |                                                                                                               |

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

### General Specifications

| Parameter                     | Min                | Typ     | Max     | Notes                                                      |
|-------------------------------|--------------------|---------|---------|------------------------------------------------------------|
| Efficiency                    |                    |         |         | Measured at Vin=12 V, full load                            |
| Vo=5.0 V                      | 87%                | 90%     | -       |                                                            |
| Vo=3.3 V                      | 85%                | 88%     | -       |                                                            |
| Vo=2.5 V                      | 82%                | 85%     | -       |                                                            |
| Vo=1.8 V                      | 80%                | 83%     | -       |                                                            |
| Vo=0.75 V                     | 68%                | 71%     | -       |                                                            |
| Switching Frequency           | 250 kHz            | 300 kHz | 350 kHz |                                                            |
| Over Temperature Shutdown     | -                  | 135 °C  | -       |                                                            |
| Output Trim Range (wide trim) | 0.7525 V           | -       | 5.5 V   |                                                            |
| MTBF                          | 3,266,517 hours    |         |         | Calculated Per Bell Core SR-332 (Io = Nominal; Ta = 25 °C) |
| Dimensions                    |                    |         |         |                                                            |
| Inches (L x W x H)            | 1 x 0.5 x 0.243    |         |         |                                                            |
| Millimeters (L x W x H)       | 25.4 x 12.7 x 6.16 |         |         |                                                            |
| Weight                        | -                  | 3 g     | -       |                                                            |

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

### Control Specifications

| Parameter                       | Min    | Typ    | Max    | Notes                                                                       |
|---------------------------------|--------|--------|--------|-----------------------------------------------------------------------------|
| Signal Low (Unit Off)           | -0.3 V | -      | 0.4 V  | VRBA-06A2A0; 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  | VRBA-06A2AL; Remote On/Off pin open, Unit on.                               |
| Signal High (Unit Off)          | 2.5 V  | -      | 14 V   |                                                                             |
| Sequencing Voltage              | 0 V    | -      | Vin    | Sequencing Voltage applied on SEQ pin 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               |        |        |        |                                                                             |
| Power-Up                        | -      | 100 mV | 200 mV |                                                                             |
| Power-Down                      | -      | 200 mV | 400 mV |                                                                             |

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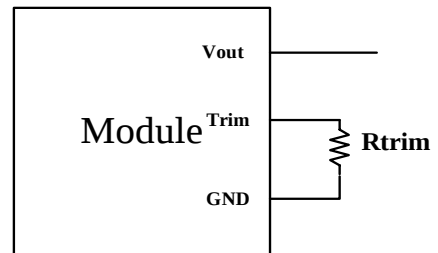
0.75 Vdc - 5.5 Vdc/6 A Output

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### Output Trim Equations

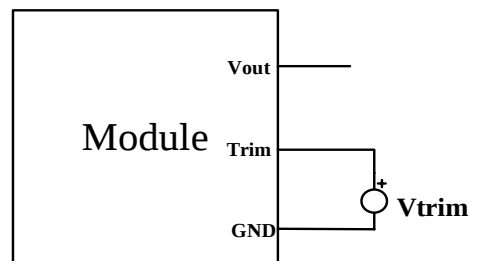
Equation for calculating the trim resistor (in kΩ) given the desired adjusted voltage ( $V_{adj}$ ) is shown below. The Trim Up resistor should be connected between the Trim pin and Ground.

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



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

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



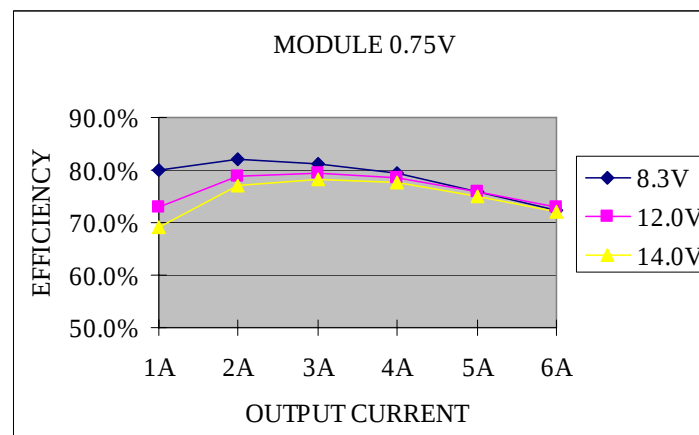
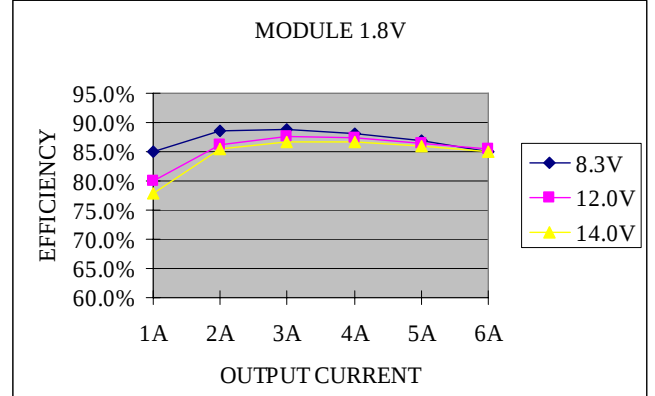
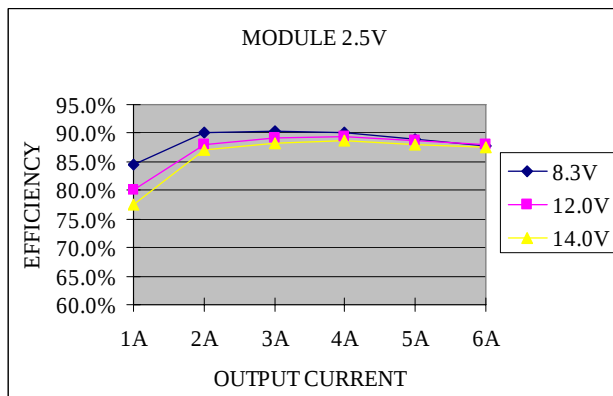
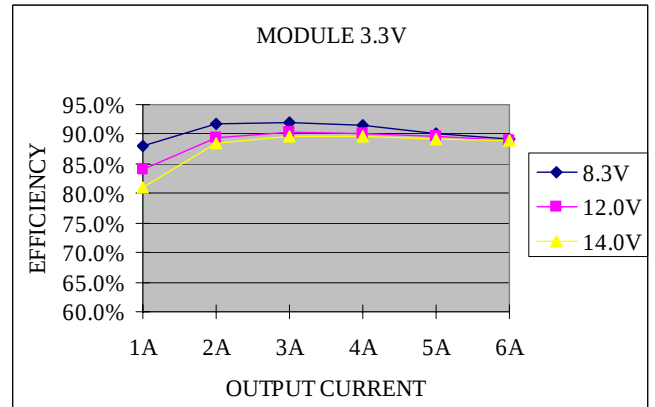
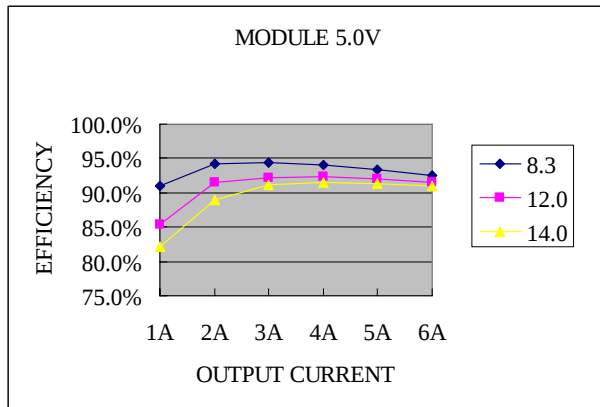
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### Efficiency Data



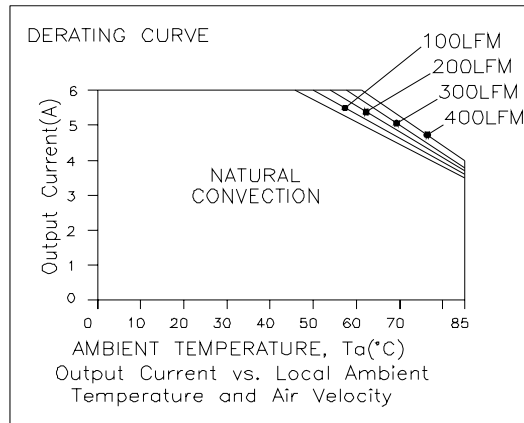
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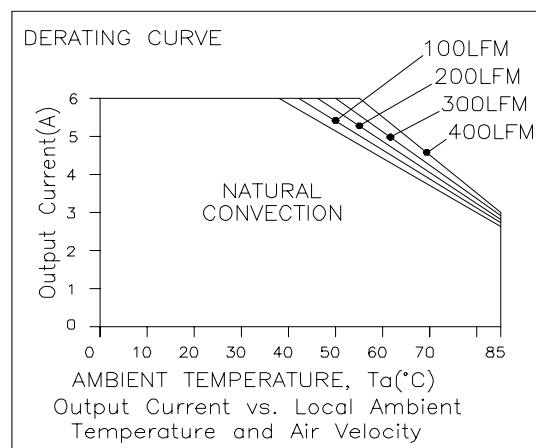
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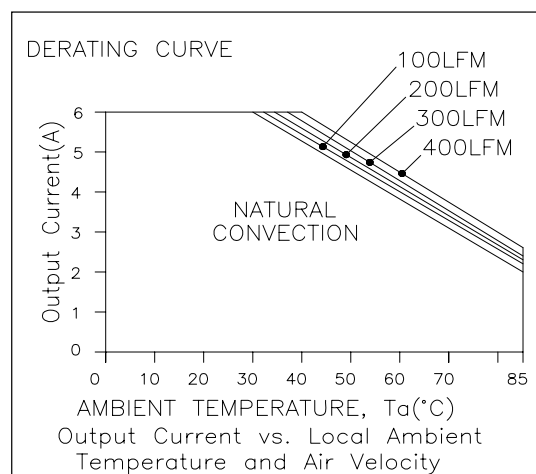
### Thermal Derating Curves



$V_{in}=12\text{ V}$ ,  $V_o=0.75\text{ V}$



$V_{in}=12\text{ V}$ ,  $V_o=2.5\text{ V}$



$V_{in}=12\text{ V}$ ,  $V_o=5.0\text{ V}$

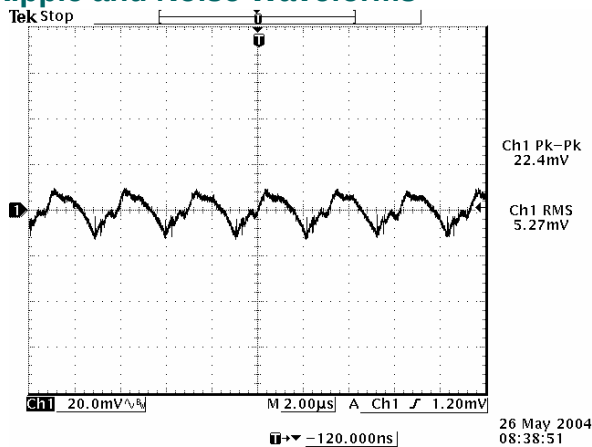
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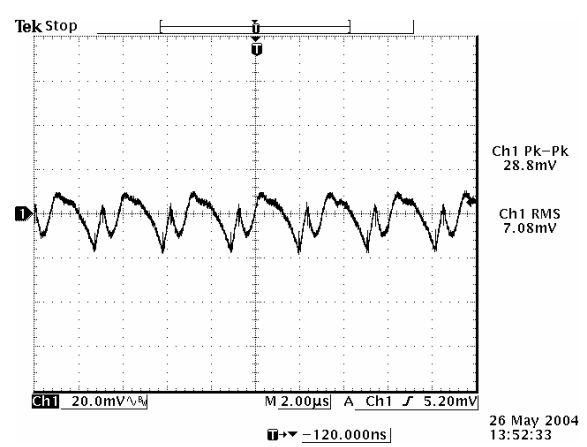
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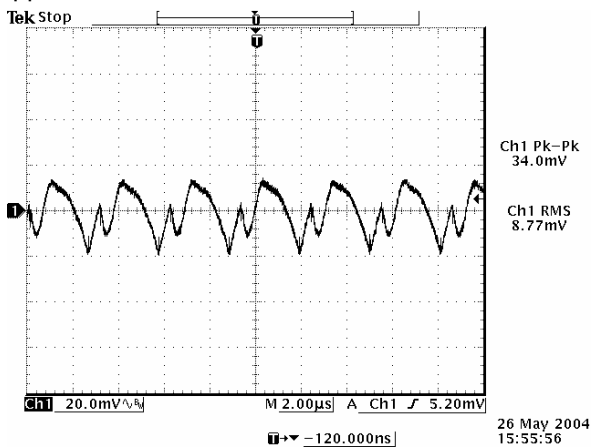
### Ripple and Noise Waveforms



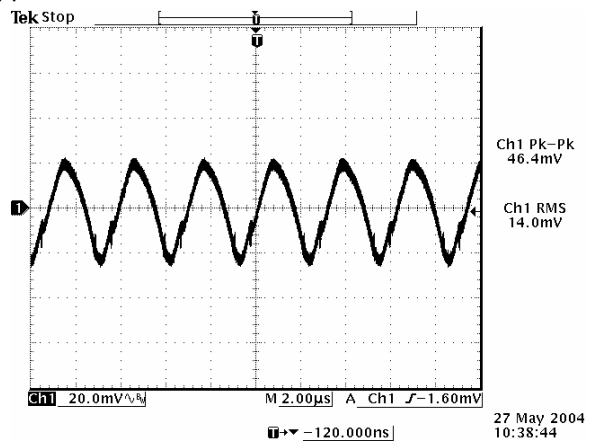
Ripple and noise at full load,  $V_{in}=12\text{ V}$ ,  $V_o=0.75\text{ V}$



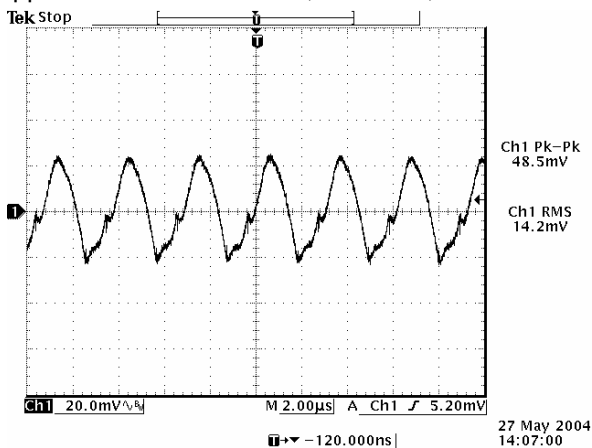
Ripple and noise at full load,  $V_{in}=12\text{ V}$ ,  $V_o=1.2\text{ V}$



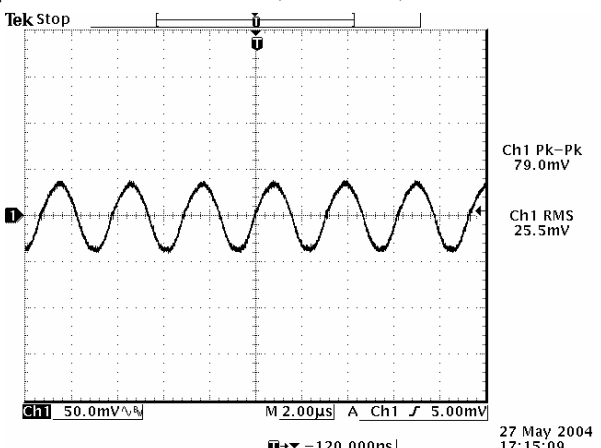
Ripple and noise at full load,  $V_{in}=12\text{ V}$ ,  $V_o=1.8\text{ V}$



Ripple and noise at full load,  $V_{in}=12\text{ V}$ ,  $V_o=2.5\text{ V}$



Ripple and noise at full load,  $V_{in}=12\text{ V}$ ,  $V_o=3.3\text{ V}$



Ripple and noise at full load,  $V_{in}=12\text{ V}$ ,  $V_o=5.0\text{ V}$

**Note:** The output ripple and noise is tested at 0-20 MHz BW, 10  $\mu\text{F}$ /10 V tantalum capacitor and 1  $\mu\text{F}$ /10 V ceramic capacitor,  $T_a=25\text{ deg C}$ .

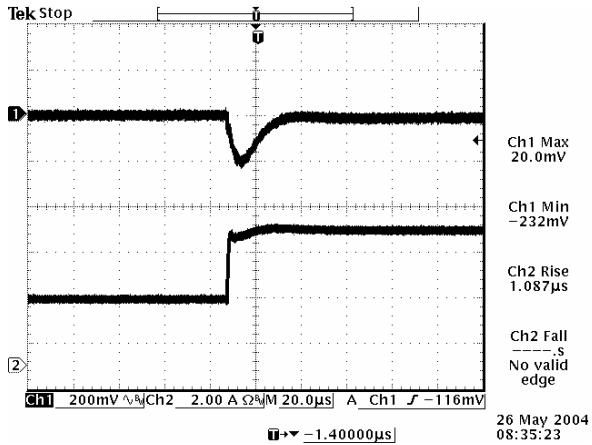
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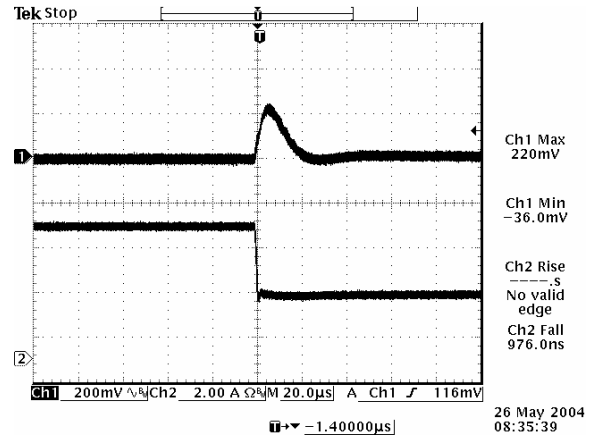
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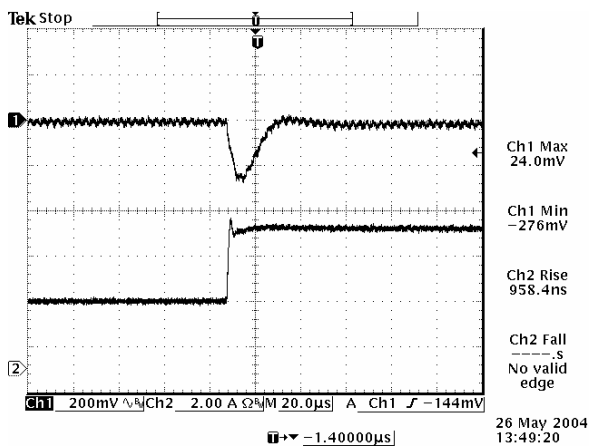
## Transient Response Waveforms



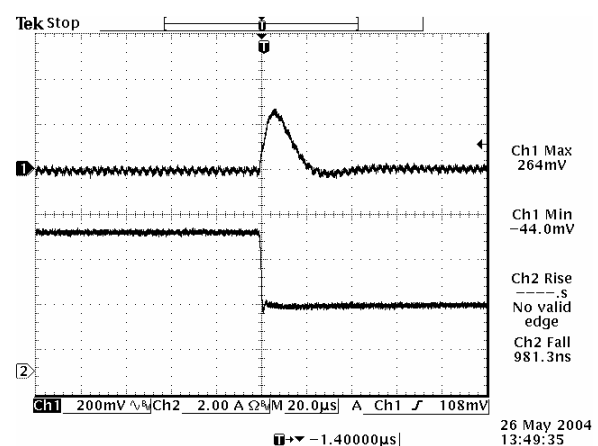
50% to 100% load step at  $V_{in}=12\text{ V}$ ,  $V_o=0.75\text{ V}$



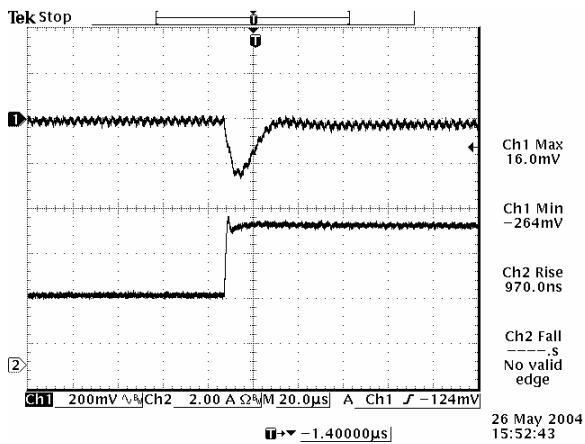
100% to 50% load step at  $V_{in}=12\text{ V}$ ,  $V_o=0.75\text{ V}$



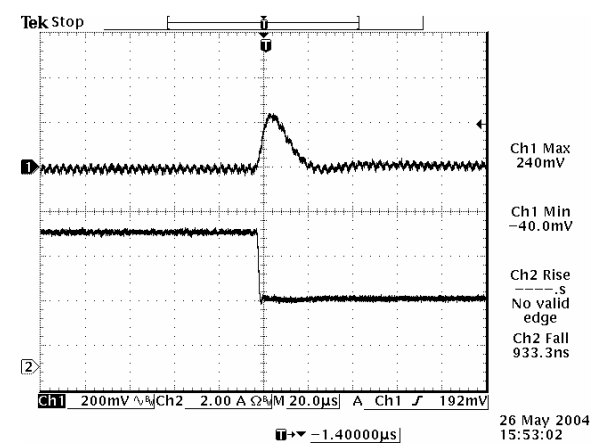
50% to 100% load step at  $V_{in}=12\text{ V}$ ,  $V_o=1.2\text{ V}$



100% to 50% load step at  $V_{in}=12\text{ V}$ ,  $V_o=1.2\text{ V}$



50% to 100% load step at  $V_{in}=12\text{ V}$ ,  $V_o=1.8\text{ V}$



100% to 50% load step at  $V_{in}=12\text{ V}$ ,  $V_o=1.8\text{ V}$

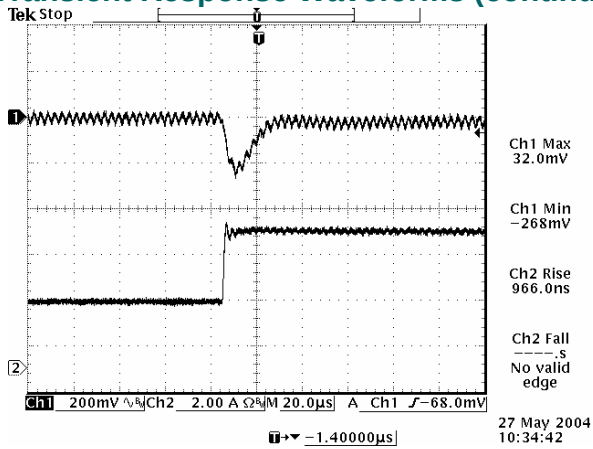
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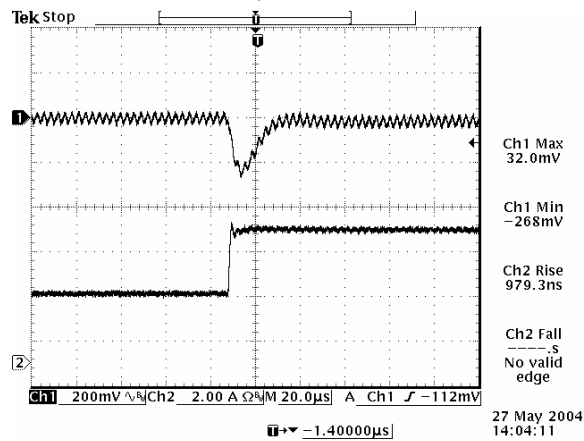
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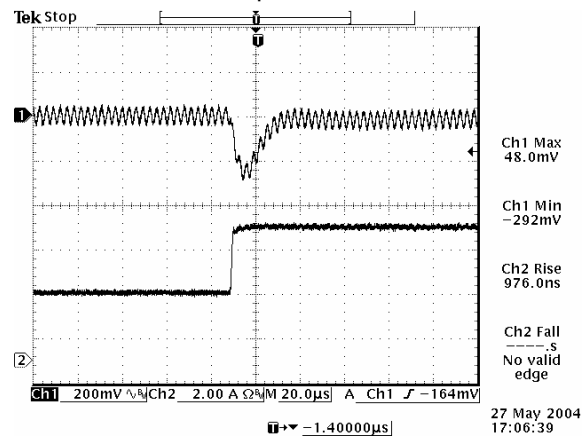
## Transient Response Waveforms (continued)



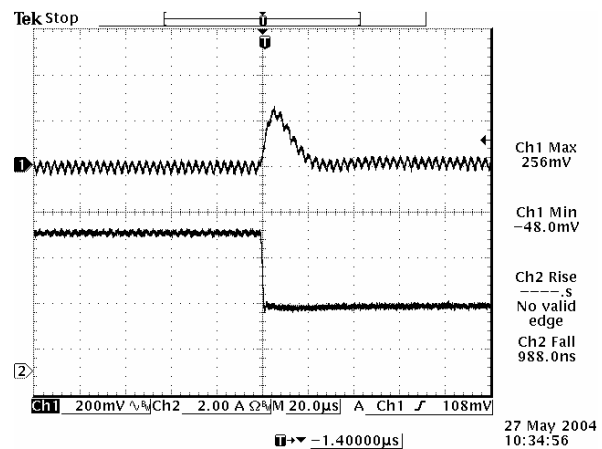
50% to 100% load step at  $V_{in}=12\text{ V}$ ,  $V_o=2.5\text{ V}$



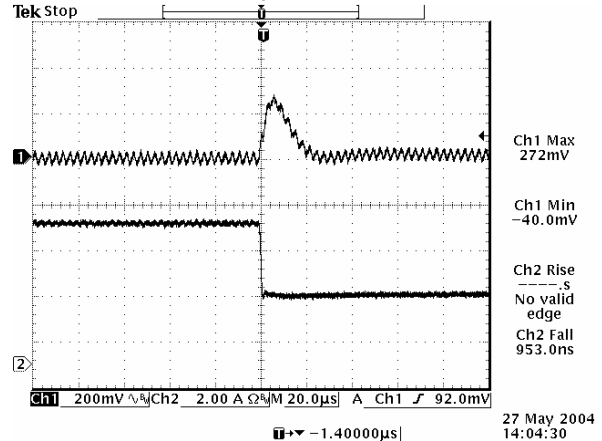
50% to 100% load step at  $V_{in}=12\text{ V}$ ,  $V_o=3.3\text{ V}$



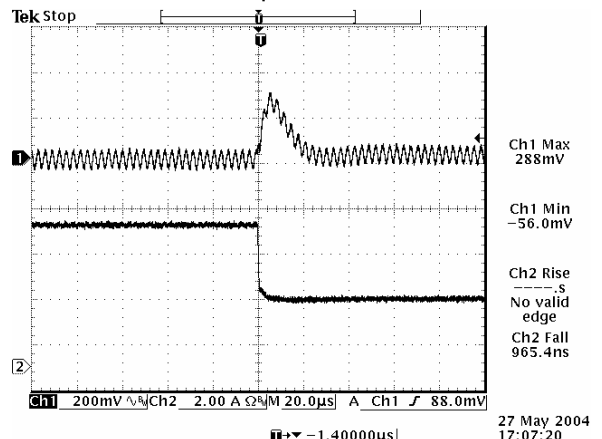
50% to 100% load step at  $V_{in}=12\text{ V}$ ,  $V_o=5.0\text{ V}$



100% to 50% load step at  $V_{in}=12\text{ V}$ ,  $V_o=2.5\text{ V}$



100% to 50% load step at  $V_{in}=12\text{ V}$ ,  $V_o=3.3\text{ V}$



100% to 50% load step at  $V_{in}=12\text{ V}$ ,  $V_o=5.0\text{ V}$

**Note:** Transient response is tested at  $di/dt=2.5\text{ A/uS}$ , with 10  $\mu\text{F}/10\text{ V}$  tantalum capacitor and 1  $\mu\text{F}/10\text{ V}$  ceramic capacitor,  $T_a=25\text{ deg C}$ .

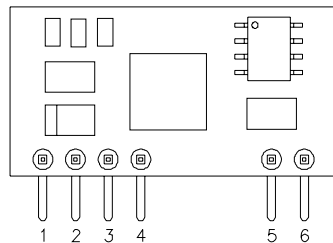
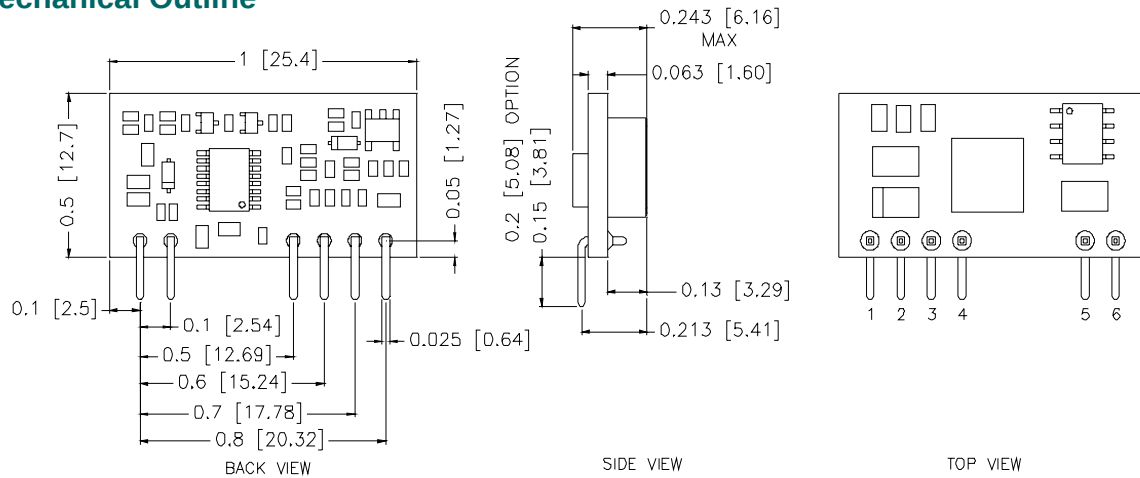
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8.3 Vdc - 14 Vdc Input

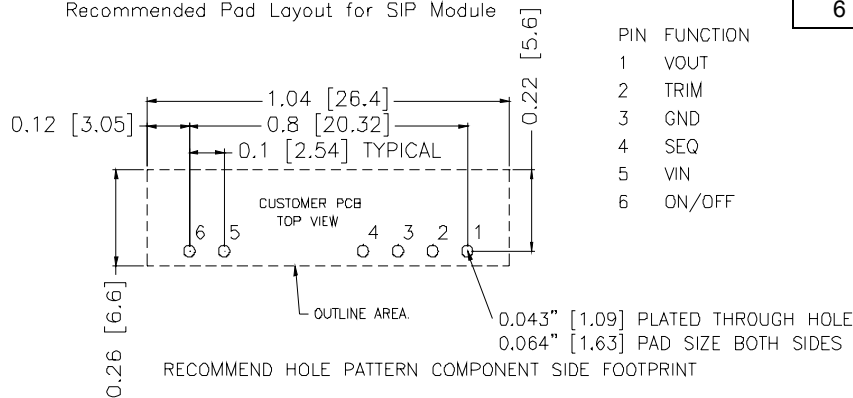
0.75 Vdc - 5.5 Vdc/6 A Output



## Mechanical Outline



Recommended Pad Layout for SIP Module



| PIN | FUNCTION |
|-----|----------|
| 1   | VOUT     |
| 2   | TRIM     |
| 3   | GND      |
| 4   | SEQ      |
| 5   | VIN      |
| 6   | ON/OFF   |

## Pin Connections

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

## 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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### CORPORATE

Bel Fuse Inc.  
206 Van Vorst Street  
Jersey City, NJ 07302  
Tel 201-432-0463  
Fax 201-432-9542  
[www.belfuse.com](http://www.belfuse.com)

### FAR EAST

Bel Fuse Ltd.  
8F/ 8 Luk Hop Street  
San Po Kong  
Kowloon, Hong Kong  
Tel 852-2328-5515  
Fax 852-2352-3706  
[www.belfuse.com](http://www.belfuse.com)

### EUROPE

Bel Fuse Europe Ltd.  
Preston Technology Management Centre  
Marsh Lane, Suite G7, Preston  
Lancashire, PR1 8UD, U.K.  
Tel 44-1772-556601  
Fax 44-1772-888366  
[www.belfuse.com](http://www.belfuse.com)