

# NON-ISOLATED DC/DC CONVERTERS

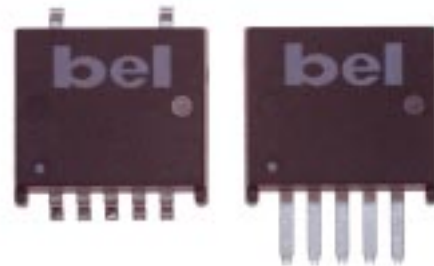
12V Input / 1.5V – 5.0V Output / 3A



BP05xRAH-03A

## SRAH-03A / VRAH-03A Series RoHS Compliant

- Nonisolated
- Compact, low profile surface mount package
- Fixed frequency
- High efficiency means less power dissipation
- Excellent thermal performance
- Optimized for cost
- Remote on/off
- Undervoltage lockout (UVLO)
- Over current and short circuit protection



### Description

The Bel SRAH-03A and VRAH-03A modules are a series of non-isolated, step down DC/DC power converters that operate from a nominal 12V source. These converters are available in a range of output voltages from 1.5V to 5.0V. They are packaged in a compact, overmolded package rated at 3A. Optional lead forming provides a vertical mount product for minimal footprint or a surface mount option for a very low profile. Standard features include remote on/off, over current and short circuit protection, and output voltage adjust. These products may be used almost anywhere low voltage silicon is employed and a 12V source is available. Typical applications include file servers, routers, line cards and other computing and communications equipment.

### Applications

- Distributed power architectures
- Data networking equipment
- Telecommunications
- Computers and peripherals

### Part Number Selection

| Output Voltage | Input Voltage | Max. Output Current | Max. Output Power | Typical Efficiency | Part Number Surface Mount | Part Number Vertical Mount |
|----------------|---------------|---------------------|-------------------|--------------------|---------------------------|----------------------------|
| 5.0V           | 12V           | 3A                  | 15W               | 91%                | SRAH-03A500               | VRAH-03A500                |
| 3.3V           | 12V           | 3A                  | 9.9W              | 90%                | SRAH-03A330               | VRAH-03A330                |
| 2.5V           | 12V           | 3A                  | 7.5W              | 88%                | SRAH-03A250               | VRAH-03A250                |
| 1.8V           | 12V           | 3A                  | 5.4W              | 85%                | SRAH-03A180               | VRAH-03A180                |
| 1.5V           | 12V           | 3A                  | 4.5W              | 84%                | SRAH-03A150               | VRAH-03A150                |

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### Absolute Maximum Ratings

| Parameter                      | Symbol | Min  | Typical | Max  | Unit |
|--------------------------------|--------|------|---------|------|------|
| Continuous Input Voltage       | Vin    | -0.3 |         | 13.2 | V    |
| Output Enable Terminal Voltage | Vouten | -0.3 |         | 13.2 | V    |
| Ambient Temperature            | Tamb   | -40  |         | 85   | °C   |
| Storage Temperature            | Tstor  | -40  |         | 125  | °C   |

Note: Use beyond the maximum ratings may cause a reliability degradation of the DC/DC converter or may permanently damage the device.

### Input Specifications

| Parameter   | Module                               | Symbol | Min  | Typical | Max                              | Units             |
|---|--------------------------------------|--------|------|---------|----------------------------------|-------------------|
| Operating Input Voltage                           | All                                  | Vin    | 10.8 |         | 13.2                             | V                 |
| Input Current                                     | 5.0V<br>3.3V<br>2.5V<br>1.8V<br>1.5V | Iin    |      |         | 1.7<br>1.2<br>0.9<br>0.75<br>0.6 | A                 |
| No Load Input Current                             | All                                  |        |      |         | 100                              | mA                |
| Remote Off Input Current                          |                                      |        |      | 3       | 10                               | mA                |
| Input Reflected Ripple Current <sup>1</sup>       | All                                  |        |      | 30      |                                  | mA <sub>rms</sub> |
| Input Reflected Ripple Current (P-P) <sup>1</sup> | All                                  |        |      | 140     |                                  | mApk              |
| I <sub>pt</sub> Inrush Current Transient          | All                                  |        |      | 0.005   | 0.01                             | A <sup>2</sup> s  |
| Turn On Voltage Threshold                         | All                                  |        |      | 9.4     |                                  | V                 |
| Turn Off Voltage Threshold                        | All                                  |        | 8.0  | 9.0     | 10.0                             | V                 |

Note: Input capacitance 270µF/16V, ESR = 0.03 Ω max at 100kHz @ 25° C.

1. With simulated source impedance of 500nH, 5Hz to 20MHz.

# NON-ISOLATED DC/DC CONVERTERS

## 12V Input / 1.5V – 5.0V Output / 3A



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### Output Specifications

| Parameter                             | Module | Symbol    | Min   | Typical | Max   | Units            |
|---------------------------------------|--------|-----------|-------|---------|-------|------------------|
| Output Voltage Set Point <sup>1</sup> | 5.0V   | Vout      | 4.920 | 5.0     | 5.080 | V                |
|                                       | 3.3V   |           | 3.247 | 3.3     | 3.353 |                  |
|                                       | 2.5V   |           | 2.460 | 2.5     | 2.540 |                  |
|                                       | 1.8V   |           | 1.771 | 1.8     | 1.829 |                  |
|                                       | 1.5V   |           | 1.476 | 1.5     | 1.524 |                  |
| Load Regulation                       | 5.0V   |           |       | 10      | 16.5  | mV               |
|                                       | 3.3V   |           |       | 10      | 16.5  |                  |
|                                       | 2.5V   |           |       | 5       | 10    |                  |
|                                       | 1.8V   |           |       | 5       | 10    |                  |
|                                       | 1.5V   |           |       | 5       | 10    |                  |
| Line Regulation                       | 5.0V   |           |       | 10      | 16    | mV               |
|                                       | 3.3V   |           |       | 5       | 10    |                  |
|                                       | 2.5V   |           |       | 3       | 5     |                  |
|                                       | 1.8V   |           |       | 3       | 5     |                  |
|                                       | 1.5V   |           |       | 3       | 5     |                  |
| Regulation Over Temperature           | 5.0V   |           |       | 20      | 30    | mV               |
|                                       | 3.3V   |           |       | 12      | 25    |                  |
|                                       | 2.5V   |           |       | 8       | 20    |                  |
|                                       | 1.8V   |           |       | 5       | 10    |                  |
|                                       | 1.5V   |           |       | 5       | 10    |                  |
| Total Output Voltage Regulation       | 5.0V   |           |       | 40      | 62.5  | mV               |
|                                       | 3.3V   |           |       | 27      | 51.5  |                  |
|                                       | 2.5V   |           |       | 16      | 35    |                  |
|                                       | 1.8V   |           |       | 13      | 25    |                  |
|                                       | 1.5V   |           |       | 13      | 25    |                  |
| Output Ripple and Noise <sup>2</sup>  | All    |           |       | 40      | 100   | mVp-p            |
| Output Ripple and Noise <sup>2</sup>  | All    |           |       | 10      | 20    | mVrms            |
| Output Current Range                  | All    | Iout      | 0     |         | 3     | A                |
| Output DC Current Limit               | All    | Ioutlim   | 3.6   |         | 7.5   | A                |
| Short Circuit Surge                   | All    | Ioutsurge |       | 0.35    | 0.7   | A <sup>2</sup> s |
| Turn on Time                          | All    | Ton       |       | 12      | 20    | ms               |
| Overshoot at Turn On <sup>3</sup>     | All    |           |       | 0       | 3     | %                |
| Output Capacitance                    | All    | Cout      | 0     |         | 1200  | μF               |

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

1. Vin = 12V, Iout = full load, Ta = 25° C.
2. 0 - 20 MHz, 0.1μF ceramic cap on output.
3. Overshoot at turn on output capacitance is 100μF.

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### Output Specifications

| Parameter                              | Module | Symbol | Min | Typical | Max | Units   |
|--|--------|--------|-----|---------|-----|---------|
| <b>Transient Response <sup>4</sup></b> |        |        |     |         |     |         |
| $\Delta V$ 50% to 100% of Max Load     | 5.0V   |        |     | 100     | 200 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| $\Delta V$ 100% to 50% of Max Load     |        |        |     | 100     | 200 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| <b>Transient Response <sup>4</sup></b> |        |        |     |         |     |         |
| $\Delta V$ 50% to 100% of Max Load     | 3.3V   |        |     | 80      | 150 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| $\Delta V$ 100% to 50% of Max Load     |        |        |     | 80      | 150 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| <b>Transient Response <sup>4</sup></b> |        |        |     |         |     |         |
| $\Delta V$ 50% to 100% of Max Load     | 2.5V   |        |     | 70      | 100 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| $\Delta V$ 100% to 50% of Max Load     |        |        |     | 70      | 100 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| <b>Transient Response <sup>4</sup></b> |        |        |     |         |     |         |
| $\Delta V$ 50% to 100% of Max Load     | 1.8V   |        |     | 70      | 100 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| $\Delta V$ 100% to 50% of Max Load     |        |        |     | 70      | 100 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| <b>Transient Response <sup>4</sup></b> |        |        |     |         |     |         |
| $\Delta V$ 50% to 100% of Max Load     | 1.5V   |        |     | 70      | 100 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |
| $\Delta V$ 100% to 50% of Max Load     |        |        |     | 70      | 100 | mV      |
| Settling Time                          |        | Ts     |     | 40      | 80  | $\mu s$ |

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

4. di/dt = 0.5A/1 $\mu s$ , Ta = 25° C without external load capacitance.

# NON-ISOLATED DC/DC CONVERTERS

## 12V Input / 1.5V – 5.0V Output / 3A



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### General Specifications

| Parameter                              | Module | Symbol | Min | Typical | Max | Units |
|--|--------|--------|-----|---------|-----|-------|
| Efficiency <sup>1</sup>                | 5.0V   | $\eta$ | 89  | 91      |     | %     |
|  | 3.3V   |        | 88  | 90      |     |       |
|  | 2.5V   |        | 86  | 88      |     |       |
|  | 1.8V   |        | 83  | 85      |     |       |
|  | 1.5V   |        | 82  | 84      |     |       |
| Switching Frequency                    | 5.0V   | Fsw    | 470 | 500     | 530 | kHz   |
|  | 3.3V   |        | 340 | 370     | 400 |       |
|  | 2.5V   |        | 270 | 300     | 330 |       |
|  | 1.8V   |        | 270 | 300     | 330 |       |
|  | 1.5V   |        | 270 | 300     | 330 |       |
| Output Voltage Trim Range <sup>2</sup> | All    |        | 90  |         | 110 | %     |
| Weight                                 | All    |        |     | 4.9     |     | g     |

1. Vin=12V, full load and Ta=25° C.

2. See graphs on pages 11 - 13.

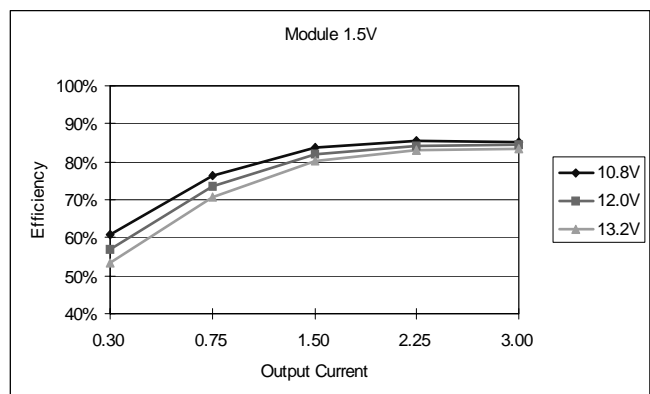
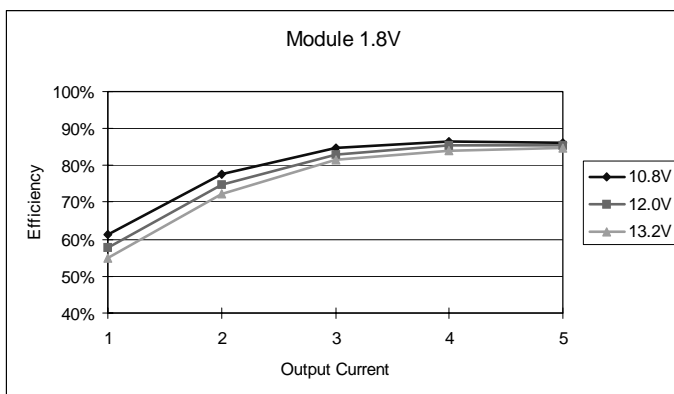
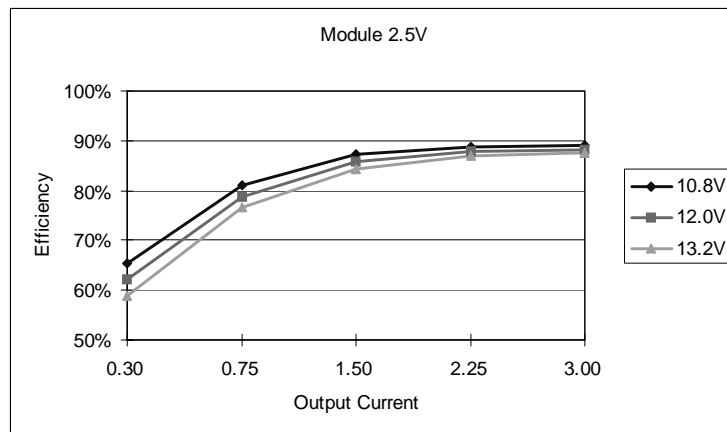
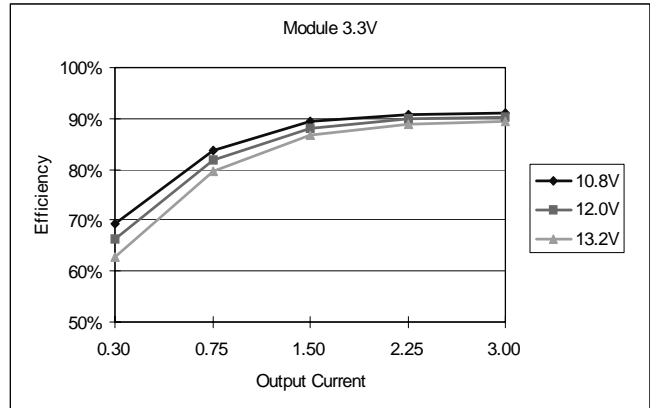
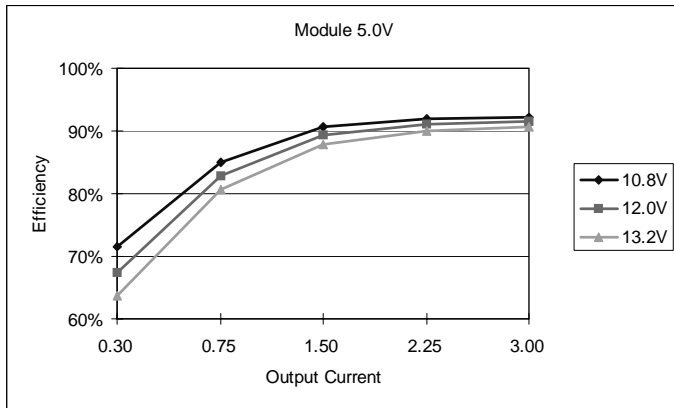
### Control Specifications

| Parameter                  | Module | Symbol | Min  | Typical | Max  | Units |
|----------------------------|--------|--------|------|---------|------|-------|
| Remote On/Off <sup>3</sup> | All    | Vouten |      |         |      | V     |
| Signal Low (Unit Off)      | All    |        | -0.3 |         | 1    | V     |
| Signal High (Unit On)      | All    |        | 2.8  |         | 13.2 | V     |

3. With remote on/off pin 1 open, the module is on.

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**Efficiency Data**



Note: On/off pin designed to work with an open collector/drain switch.

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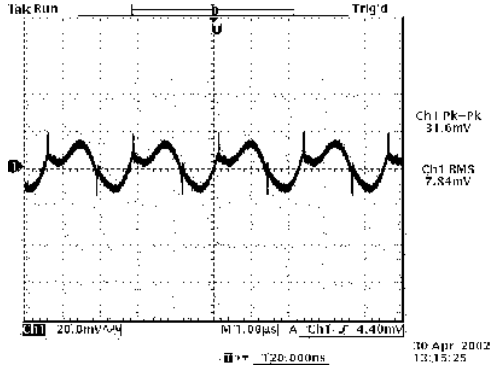
12V Input / 1.5V – 5.0V Output / 3A



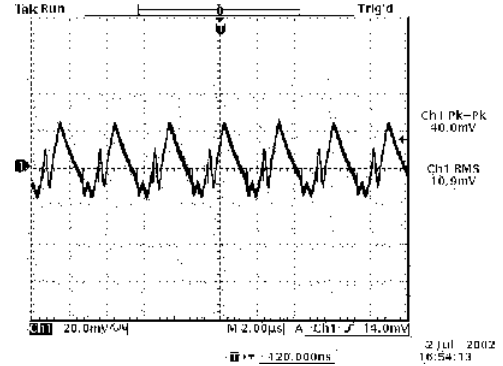
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## Ripple and Noise

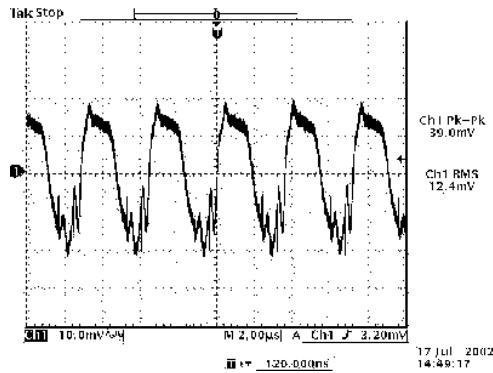
0.1 $\mu$ F ceramic cap added at the output.



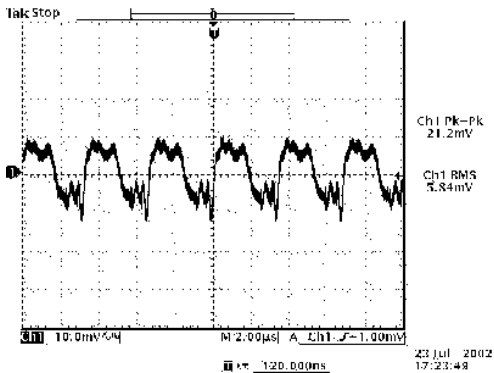
Ripple and noise at full load and 12Vdc input, 5.0Vdc output and  $T_a=25^\circ\text{C}$



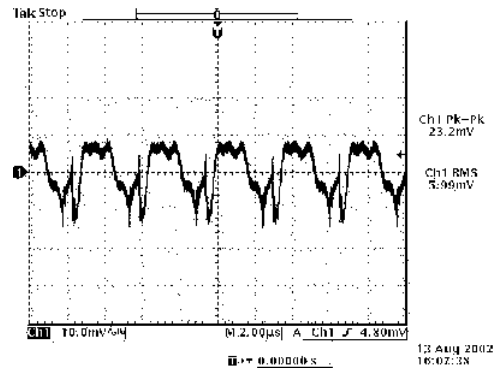
Ripple and noise at full load and 12Vdc input, 3.3Vdc output and  $T_a=25^\circ\text{C}$



Ripple and noise at full load and 12Vdc input, 2.5Vdc output and  $T_a=25^\circ\text{C}$



Ripple and noise at full load and 12Vdc input, 1.8Vdc output and  $T_a=25^\circ\text{C}$

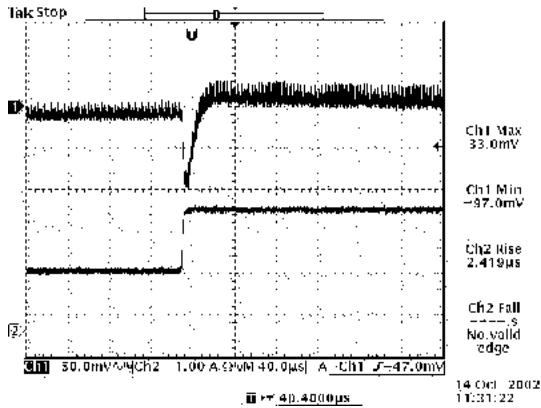


Ripple and noise at full load and 12Vdc input, 1.5Vdc output and  $T_a=25^\circ\text{C}$

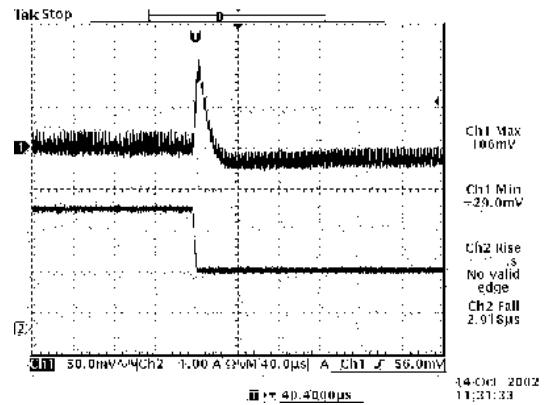
BP05xRAH-03A

### Transient Response

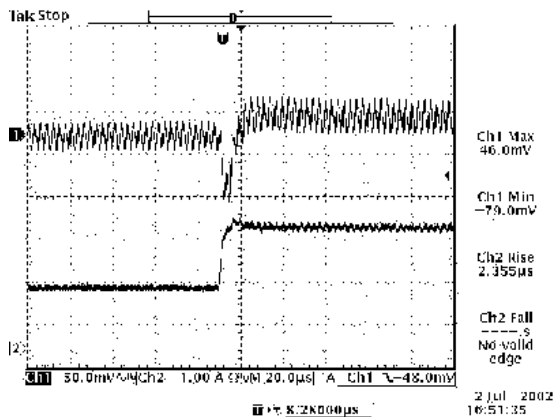
Transient response:  $di/dt = 0.5A/\mu S$ , no external load capacitance



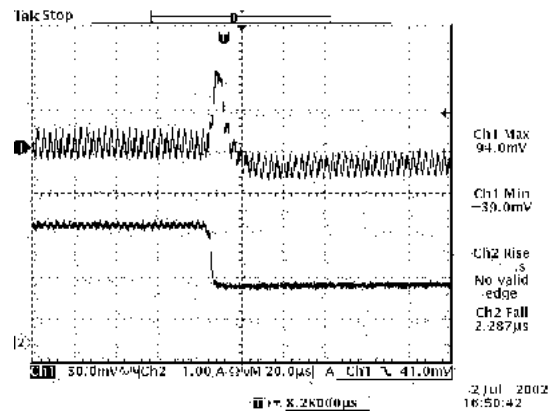
Vout=5.0V  
50% to 100% load transients at 12V input and Ta=25° C



Vout=5.0V  
100% to 50% load transients at 12V input and Ta=25° C



Vout=3.3V  
50% to 100% load transients at 12V input and Ta=25° C



Vout=3.3V  
100% to 50% load transients at 12V input and Ta=25° C



# NON-ISOLATED DC/DC CONVERTERS

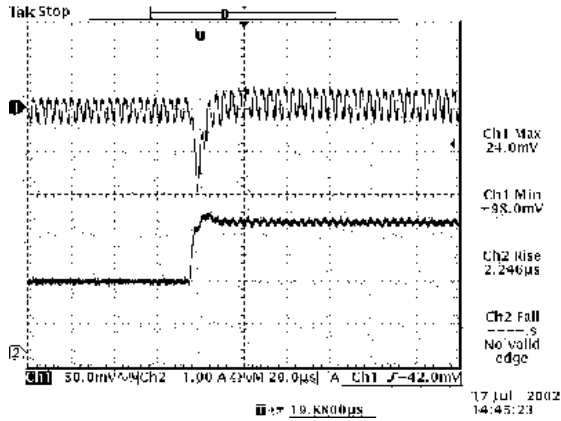
## 12V Input / 1.5V – 5.0V Output / 3A



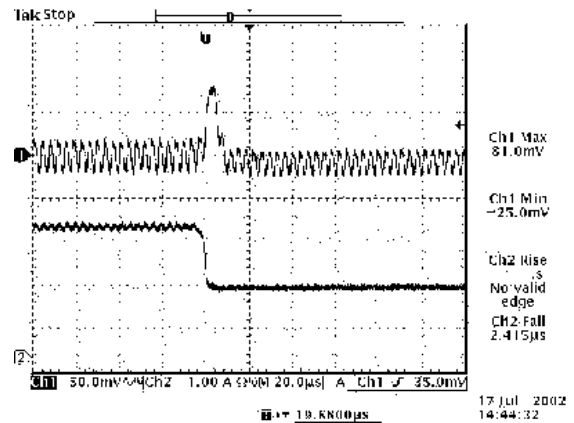
BP05xRAH-03A

### Transient Response

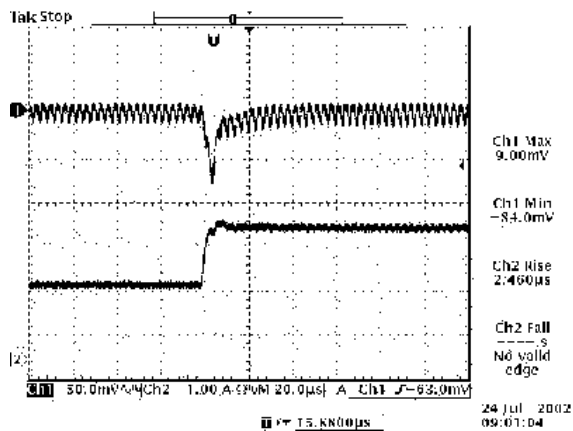
Transient response:  $di/dt = 0.5A/\mu S$ , no external load capacitance



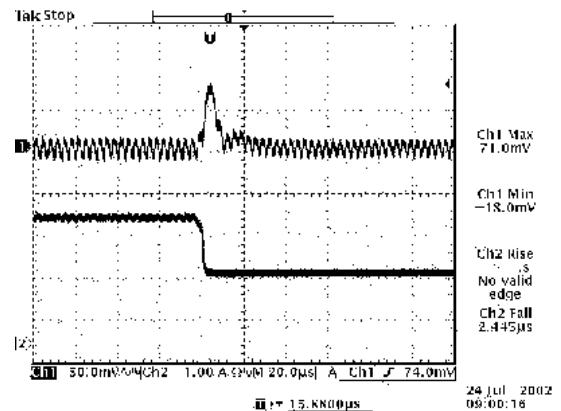
Vout=2.5V  
50% to 100% load transients at 12V input and Ta=25° C



Vout=2.5V  
100% to 50% load transients at 12V input and Ta=25° C



Vout=1.8V  
50% to 100% load transients at 12V input and Ta=25° C

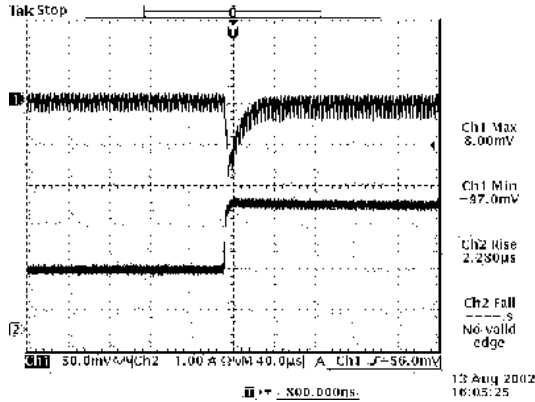


Vout=1.8V  
100% to 50% load transients at 12V input and Ta=25° C

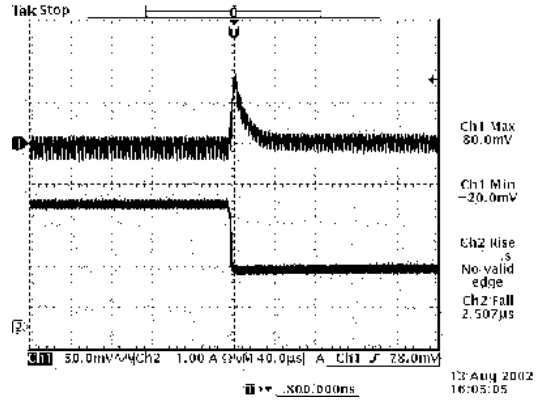
BP05xRAH-03A

### Transient Response

Transient response:  $di/dt = 0.5A/\mu S$ , no external load capacitance



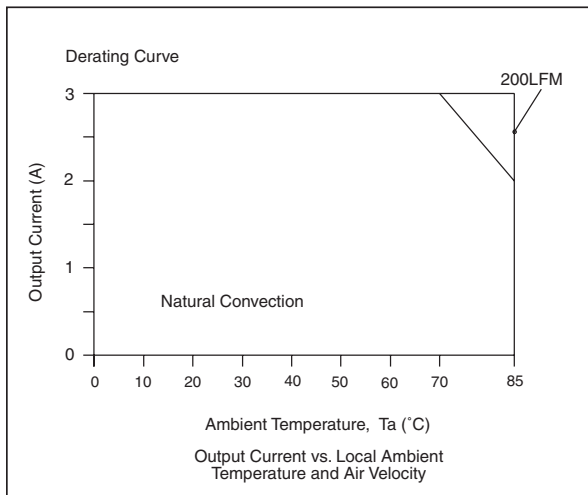
Vout=1.5V  
50% to 100% load transients at 12V input and Ta=25° C



Vout=1.5V  
100% to 50% load transients at 12V input and Ta=25° C

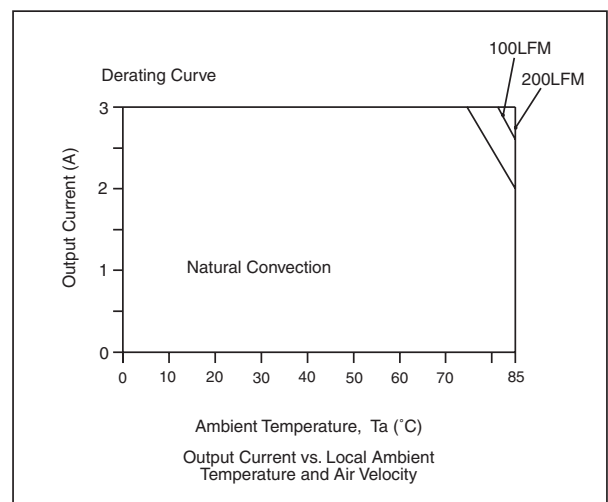
### Thermal Considerations

xRAH-03A500



xRAH-03A150  
xRAH-03A180

xRAH-03A250  
xRAH-03A330



# NON-ISOLATED DC/DC CONVERTERS

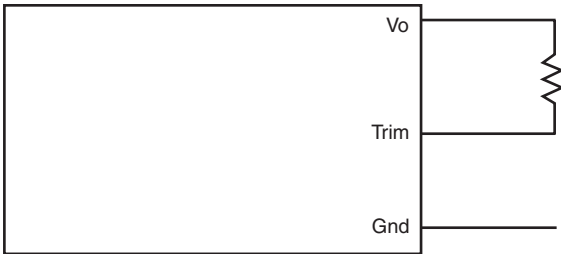
12V Input / 1.5V – 5.0V Output / 3A



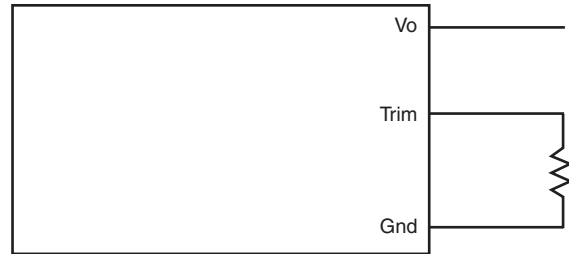
BP05xRAH-03A

## Output Voltage Set-Point Adjustment

Trim Down Test Circuit



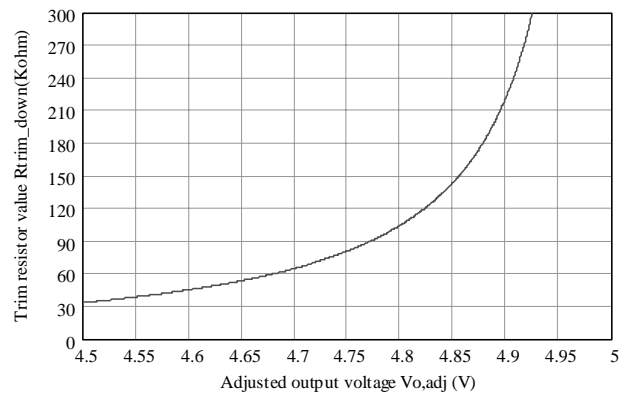
Trim Up Test Circuit



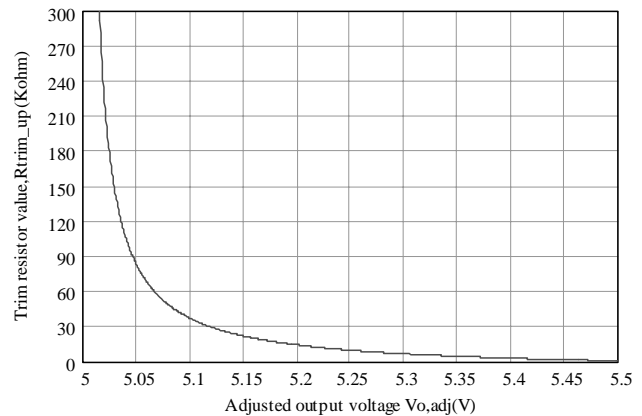
## Output Voltage Set-Point Adjustment

### xRAH-03A500 Trim Resistor Calculation

$$R_{\text{trim down}} = \left( \frac{23.703}{V_o - V_{o, \text{adj}}} - 13.87 \right) \text{ Kohm}$$



$$R_{\text{trim up}} = \left( \frac{4.496}{V_{o, \text{adj}} - V_o} - 8.25 \right) \text{ Kohm}$$

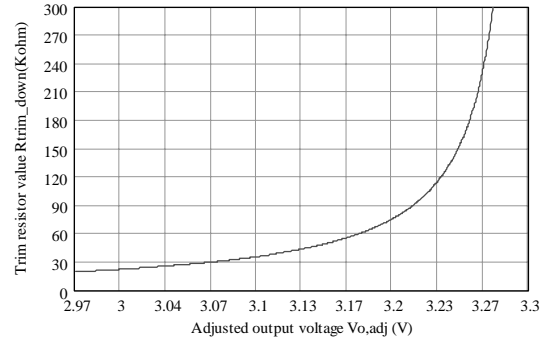


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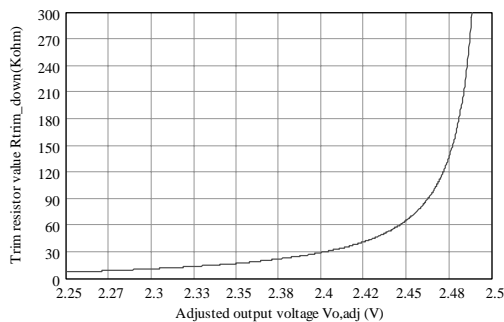
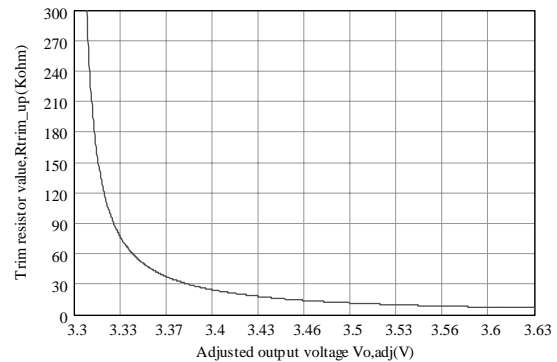
### Output Voltage Set-Point Adjustment

#### xRAH-03A330 Trim Resistor Calculation

$$R_{\text{trim down}} = \left( \frac{7.92}{V_o - V_{o, \text{adj}}} - 4.38 \right) \text{ Kohm}$$

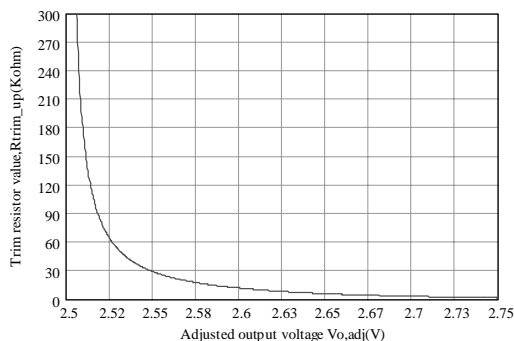


$$R_{\text{trim up}} = \left( \frac{2.536}{V_{o, \text{adj}} - V_o} - 1.21 \right) \text{ Kohm}$$



#### xRAH-03A250 Trim Resistor Calculation

$$R_{\text{trim down}} = \left( \frac{3.694}{V_o - V_{o, \text{adj}}} - 7.77 \right) \text{ Kohm}$$



$$R_{\text{trim up}} = \left( \frac{1.72}{V_{o, \text{adj}} - V_o} - 5.62 \right) \text{ Kohm}$$

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## 12V Input / 1.5V – 5.0V Output / 3A

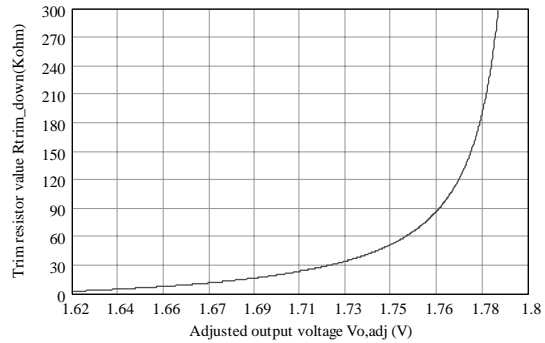


BP05xRAH-03A

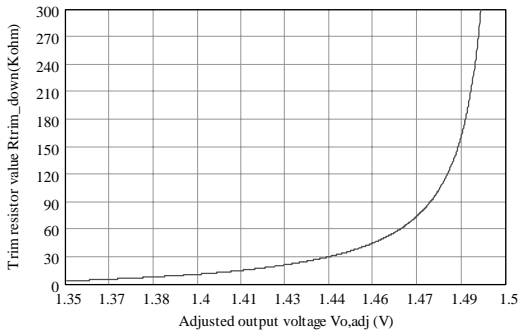
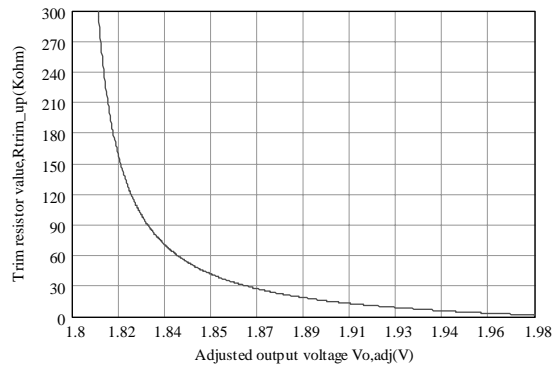
### Output Voltage Set-Point Adjustment

#### xRAH-03A180 Trim Resistor Calculation

$$R_{\text{trim down}} = \left( \frac{3.849}{V_o - V_{o, \text{adj}}} - 19.23 \right) \text{ Kohm}$$

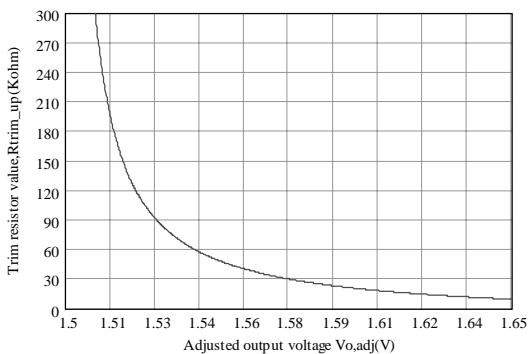


$$R_{\text{trim up}} = \left( \frac{3.064}{V_{o, \text{adj}} - V_o} - 15.4 \right) \text{ Kohm}$$



#### xRAH-03A150 Trim Resistor Calculation

$$R_{\text{trim down}} = \left( \frac{2.698}{V_o - V_{o, \text{adj}}} - 14.83 \right) \text{ Kohm}$$



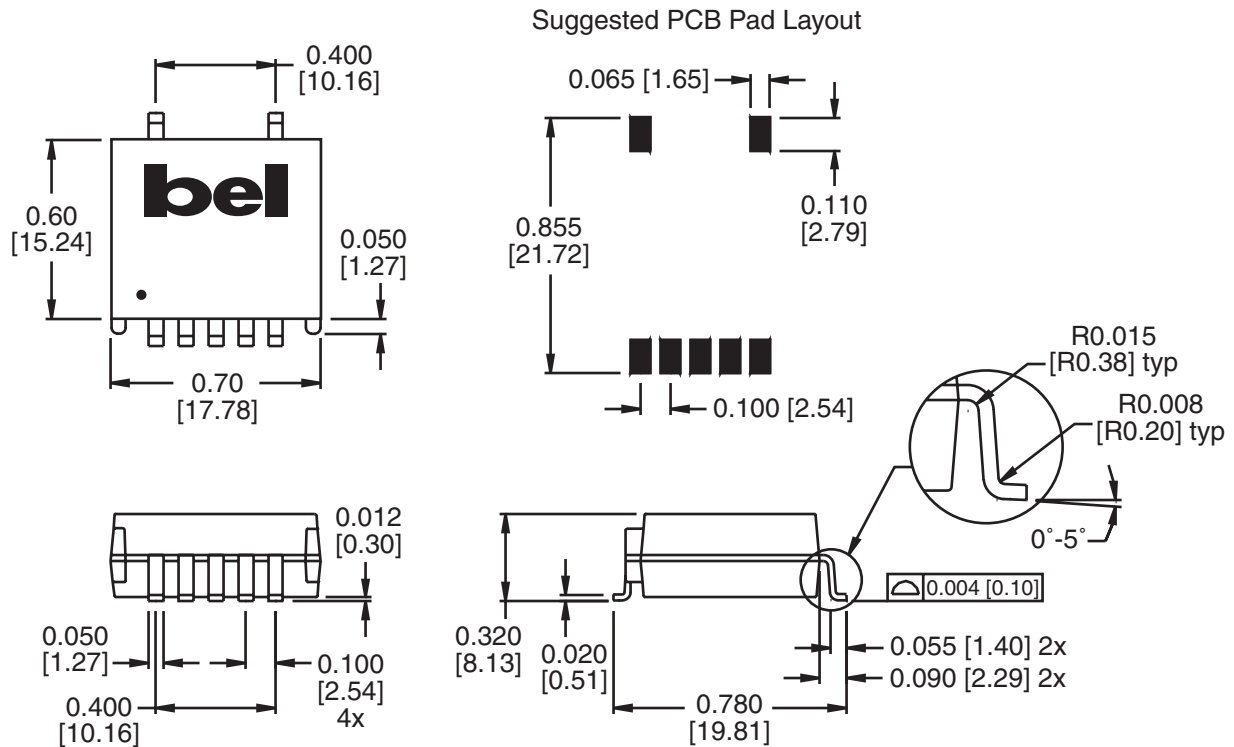
$$R_{\text{trim up}} = \left( \frac{3.064}{V_{o, \text{adj}} - V_o} - 11 \right) \text{ Kohm}$$

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BP05xRAH-03A

### Mechanical

SRAH-03A



Dimensions are in inches [millimeters].  
Standard dimension tolerance is  $\pm 0.005$  [0.13] unless otherwise noted.

| Pin | Function      |
|-----|---------------|
| 1   | Remote On/Off |
| 2   | +Vin          |
| 3   | Ground        |
| 4   | +Vo           |
| 5   | Trim          |
| 6   | No Connection |
| 7   | No Connection |



# NON-ISOLATED DC/DC CONVERTERS

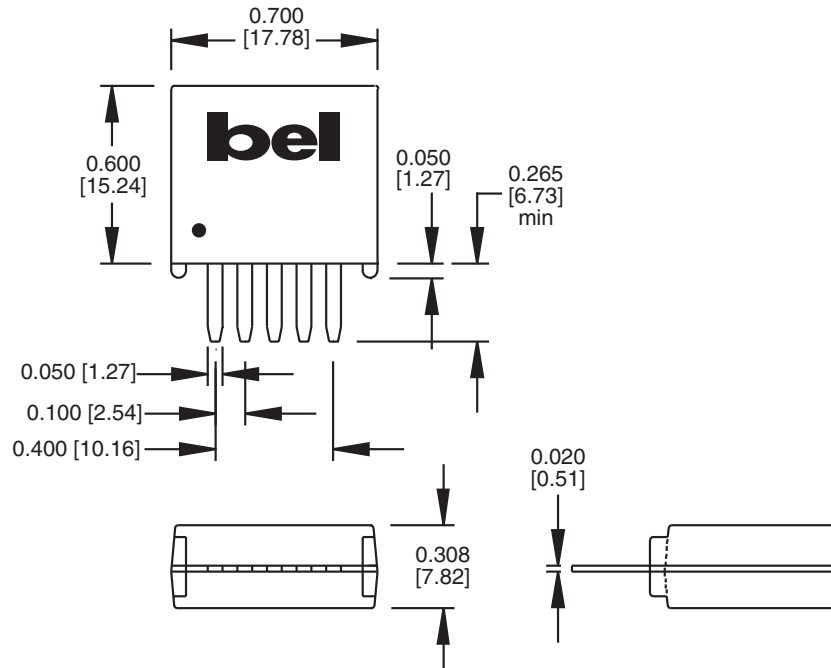
## 12V Input / 1.5V – 5.0V Output / 3A



BP05xRAH-03A

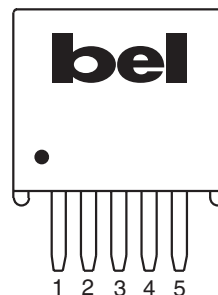
### Mechanical

VRAH-03A



Dimensions are in inches [millimeters].  
 Standard dimension tolerance is  $\pm 0.005$  [0.13] unless otherwise noted.

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



### 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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