

## NON-ISOLATED DC/DC CONVERTERS

### 5V Input / 1.2V – 3.3V Output / 15A

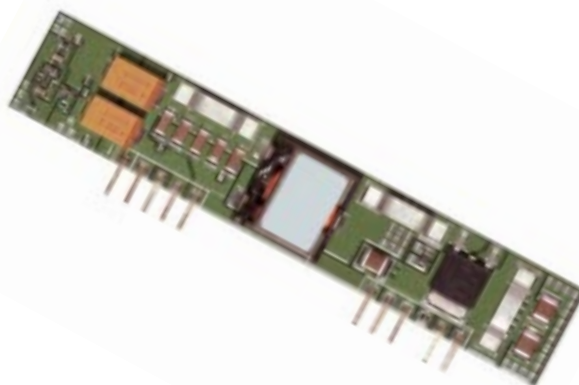


BP06VRPD-15B

#### VRPD-15B Series

#### RoHS Compliant

- Nonisolated
- Industry standard pinout
- Fixed frequency
- High efficiency means less power dissipation
- Optimized for cost
- Remote on/off
- Undervoltage lockout (UVLO)
- Over current and short circuit protection
- Remote sense
- Over temperature shutdown protection



### Description

The Bel VRPD-15B modules are a series of non-isolated, step down DC/DC power converters that operate from a nominal 5V source. These converters are available in a range of output voltages from 1.2V to 3.3V. They are packaged in an industry standard, single-in-line footprint and provide a maximum 15A output. Standard features include remote on/off, over current and short circuit protection, output voltage adjust and remote sense. These products may be used almost anywhere low voltage silicon is employed and a 5V 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

### Options

- Reverse remote on/off logic

### Part Number Selection

| Output Voltage | Input Voltage | Max. Output Current | Max. Output Power | Typical Efficiency | Part Number Active High | Part Number Active Low |
|----------------|---------------|---------------------|-------------------|--------------------|-------------------------|------------------------|
| 3.3V           | 5V            | 15A                 | 49.5W             | 93%                | VRPD-15B330             | VRPD-15B33L            |
| 2.5V           | 5V            | 15A                 | 37.5W             | 91%                | VRPD-15B250             | VRPD-15B25L            |
| 1.8V           | 5V            | 15A                 | 27.0W             | 89%                | VRPD-15B180             | VRPD-15B18L            |
| 1.5V           | 5V            | 15A                 | 22.5W             | 86%                | VRPD-15B150             | VRPD-15B15L            |
| 1.2V           | 5V            | 15A                 | 18.0W             | 83%                | VRPD-15B120             | VRPD-15B12L            |

BP02V7PD-15B

### Absolute Maximum Ratings

| Parameter                      | Symbol | Min  | Typical | Max | Unit |
|--------------------------------|--------|------|---------|-----|------|
| Continuous Input Voltage       | Vin    | -0.3 |         | 6   | V    |
| Output Enable Terminal Voltage | Vouten | -0.3 |         | 6   | V    |
| Ambient Temperature            | Tamb   | 0    |         | 70  | °C   |
| Storage Temperature            | Tstor  | -55  |         | 105 | °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    | 4.5 | 5       | 5.5                               | V                 |
| Input Current                                     | 3.3V<br>2.5V<br>1.8V<br>1.5V<br>1.2V | Iin    |     |         | 13.5<br>10.5<br>7.6<br>6.5<br>5.3 | A                 |
| No Load Input Current                             | All                                  |        |     | 70      | 100                               | mA                |
| Remote Off Input Current                          | All                                  |        |     | 6       | 10                                | mA                |
| Input Reflected Ripple Current <sup>1</sup>       | All                                  |        |     | 50      | 80                                | mA <sub>rms</sub> |
| Input Reflected Ripple Current (P-P) <sup>1</sup> | All                                  |        |     | 135     | 160                               | mApk              |
| I <sup>2</sup> t Inrush Current Transient         | All                                  |        |     | 0.18    |                                   | A <sup>2</sup> s  |
| Turn On Voltage Threshold                         | All                                  |        |     | 4.25    |                                   | V                 |
| Turn Off Voltage Threshold                        | All                                  |        |     | 3.85    |                                   | V                 |

Note: Input capacitance a 680μF/6.3V and a 270μF/16V Oscon caps

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

# NON-ISOLATED DC/DC CONVERTERS

## 5V Input / 1.2V – 3.3V Output / 15A



### Output Specifications

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| Parameter                             | Module                               | Symbol    | Min   | Typical                                   | Max   | Units            |
|---------------------------------------|--------------------------------------|-----------|-------|-------------------------------------------|-------|------------------|
| Output Voltage Set Point <sup>1</sup> | 3.3V                                 | Vout      | 3.234 | 3.3                                       | 3.366 | V                |
|                                       | 2.5V                                 |           | 2.450 | 2.5                                       | 2.550 |                  |
|                                       | 1.8V                                 |           | 1.764 | 1.8                                       | 1.836 |                  |
|                                       | 1.5V                                 |           | 1.470 | 1.5                                       | 1.530 |                  |
|                                       | 1.2V                                 |           | 1.176 | 1.2                                       | 1.224 |                  |
| Load Regulation                       | 3.3V                                 |           |       | 8                                         | 16.5  | mV               |
|                                       | 2.5V                                 |           |       | 6                                         | 12.5  |                  |
|                                       | 1.8V                                 |           |       | 6                                         | 11.0  |                  |
|                                       | 1.5V                                 |           |       | 5                                         | 10.5  |                  |
|                                       | 1.2V                                 |           |       | 5                                         | 10.5  |                  |
| Line Regulation                       | 3.3V                                 |           |       | 5                                         | 10    | mV               |
|                                       | 2.5V                                 |           |       | 3                                         | 7.5   |                  |
|                                       | 1.8V                                 |           |       | 3                                         | 6.0   |                  |
|                                       | 1.5V                                 |           |       | 2                                         | 4.5   |                  |
|                                       | 1.2V                                 |           |       | 2                                         | 4.5   |                  |
| Regulation Over Temperature           | 3.3V                                 |           |       | 15                                        | 35    | mV               |
|                                       | 2.5V                                 |           |       | 10                                        | 25    |                  |
|                                       | 1.8V                                 |           |       | 7                                         | 20    |                  |
|                                       | 1.5V                                 |           |       | 5                                         | 15    |                  |
|                                       | 1.2V                                 |           |       | 5                                         | 15    |                  |
| Total Output Voltage Regulation       | 3.3V                                 |           |       | 28                                        | 61.5  | mV               |
|                                       | 2.5V                                 |           |       | 19                                        | 45    |                  |
|                                       | 1.8V                                 |           |       | 16                                        | 37    |                  |
|                                       | 1.5V                                 |           |       | 12                                        | 30    |                  |
|                                       | 1.2V                                 |           |       | 12                                        | 30    |                  |
| Output Ripple and Noise <sup>2</sup>  | 3.3V                                 |           |       | 50                                        | 100   | mVp-p            |
|                                       | 2.5V                                 |           |       | 50                                        | 100   |                  |
|                                       | 1.8V                                 |           |       | 48                                        | 90    |                  |
|                                       | 1.5V                                 |           |       | 45                                        | 80    |                  |
|                                       | 1.2V                                 |           |       | 38                                        | 70    |                  |
| Output Ripple and Noise <sup>2</sup>  | 3.3V                                 |           |       | 25                                        | 30    | mVrms            |
|                                       | 2.5V                                 |           |       | 20                                        | 25    |                  |
|                                       | 1.8V                                 |           |       | 18                                        | 23    |                  |
|                                       | 1.5V                                 |           |       | 15                                        | 20    |                  |
|                                       | 1.2V                                 |           |       | 12                                        | 17    |                  |
| Output Current Range                  | All                                  | Iout      | 0     |                                           | 15    | A                |
| Output DC Current Limit               | All                                  | Ioutlim   | 19.5  |                                           | 37.5  | A                |
| Short Circuit Surge                   | 3.3V<br>2.5V<br>1.8V<br>1.5V<br>1.2V | Ioutsurge |       | 0.041<br>0.048<br>0.070<br>0.081<br>0.095 |       | A <sup>2</sup> s |
| Turn on Time                          | All                                  | Ton       |       | 11                                        | 20    | ms               |
| Overshoot at Turn On                  | All                                  |           |       | 0                                         | 3     | %                |
| Output Capacitance                    | All                                  | Cout      | 0     |                                           | 6800  | μF               |

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

1. Vin = 5V, Iout = full load, Ta = 25° C.

2. 0 - 20MHz, 0.1μF ceramic cap on output.

## Output Specifications

| Parameter                       | Module | Symbol | Min | Typical | Max | Units |
|---------------------------------|--------|--------|-----|---------|-----|-------|
| Transient Response <sup>3</sup> |        |        |     |         |     |       |
| ΔV 50% to 100% of Max Load      | 3.3V   |        |     | 88      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| ΔV 100% to 50% of Max Load      |        |        |     | 85      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| Transient Response <sup>3</sup> |        |        |     |         |     |       |
| ΔV 50% to 100% of Max Load      | 2.5V   |        |     | 95      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| ΔV 100% to 50% of Max Load      |        |        |     | 95      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| Transient Response <sup>3</sup> |        |        |     |         |     |       |
| ΔV 50% to 100% of Max Load      | 1.8V   |        |     | 94      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| ΔV 100% to 50% of Max Load      |        |        |     | 92      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| Transient Response <sup>3</sup> |        |        |     |         |     |       |
| ΔV 50% to 100% of Max Load      | 1.5V   |        |     | 95      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| ΔV 100% to 50% of Max Load      |        |        |     | 95      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| Transient Response <sup>3</sup> |        |        |     |         |     |       |
| ΔV 50% to 100% of Max Load      | 1.2V   |        |     | 80      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |
| ΔV 100% to 50% of Max Load      |        |        |     | 75      | 150 | mV    |
| Settling Time                   |        | Ts     |     | 20      | 50  | μs    |

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

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

# NON-ISOLATED DC/DC CONVERTERS

## 5V Input / 1.2V – 3.3V Output / 15A



BP06VRPD-15B

### General Specifications

| Parameter                              | Module                               | Symbol | Min                        | Typical                    | Max | Units |
|----------------------------------------|--------------------------------------|--------|----------------------------|----------------------------|-----|-------|
| Efficiency <sup>1</sup>                | 3.3V<br>2.5V<br>1.8V<br>1.5V<br>1.2V | $\eta$ | 91<br>89<br>87<br>84<br>81 | 93<br>91<br>89<br>86<br>83 |     | %     |
| Switching Frequency                    | All                                  | Fsw    | 230                        | 300                        | 340 | kHz   |
| Overtemperature Shutdown               | All                                  | Tc     |                            | 120                        |     | °C    |
| Output Voltage Trim Range <sup>2</sup> | All                                  |        | 90                         |                            | 110 | %     |
| Weight                                 | All                                  |        |                            | 15                         |     | g     |

1. Vin=5V, full load and Ta=25° C.

2. See graphs on pages 11-13.

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### Control Specifications

| Parameter                  | Module      | Symbol | Min  | Typical | Max | Units |
|----------------------------|-------------|--------|------|---------|-----|-------|
| Remote On/Off <sup>3</sup> |             | Vouten |      |         |     | V     |
| Signal Low (Unit Off)      | V7PD-15Bxx0 |        | -0.3 |         | 0.8 | V     |
| Signal High (Unit On)      |             |        | 2.5  |         | 5.5 | V     |
| Signal Low (Unit On)       | V7PD-15BxxL |        | -0.3 |         | 0.8 | V     |
| Signal High (Unit Off)     |             |        | 2.5  |         | 5.5 | V     |

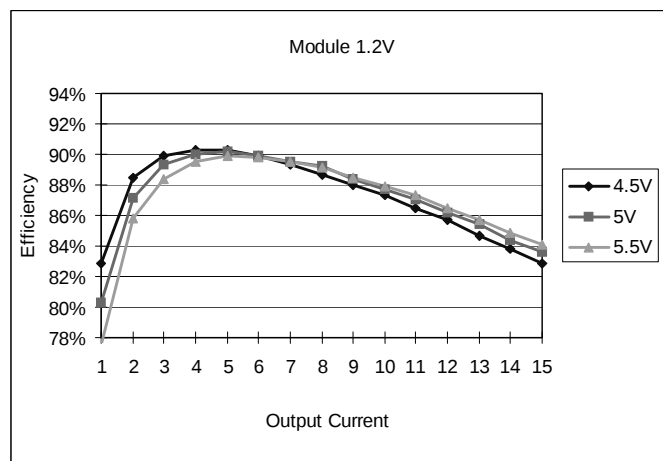
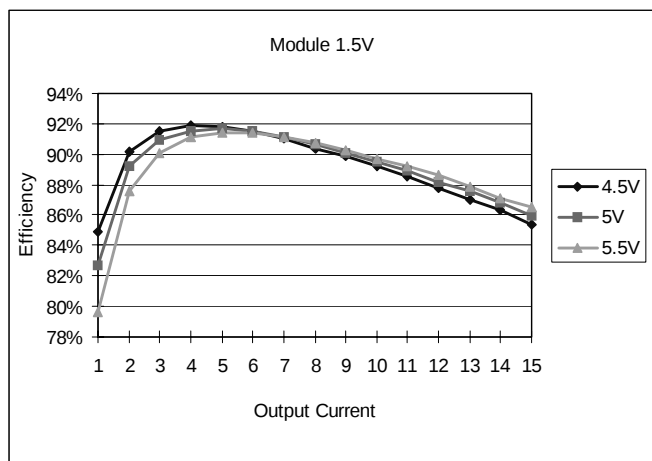
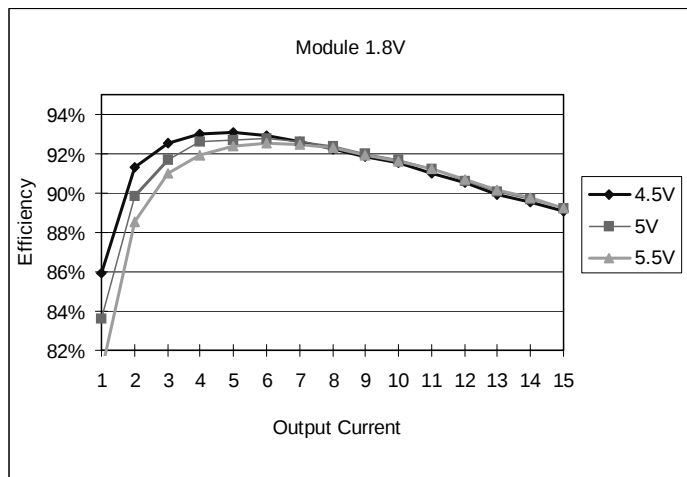
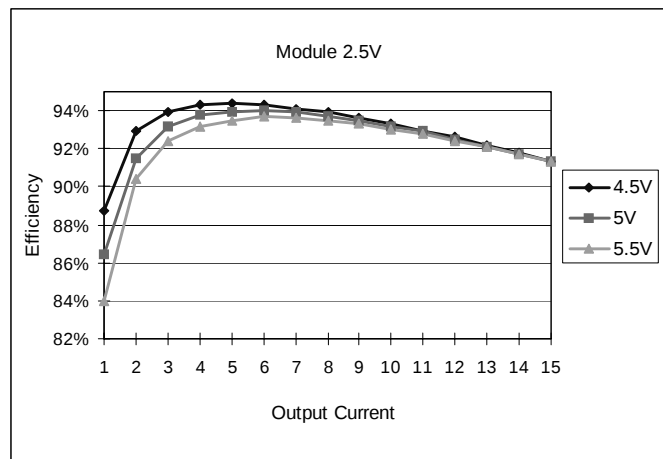
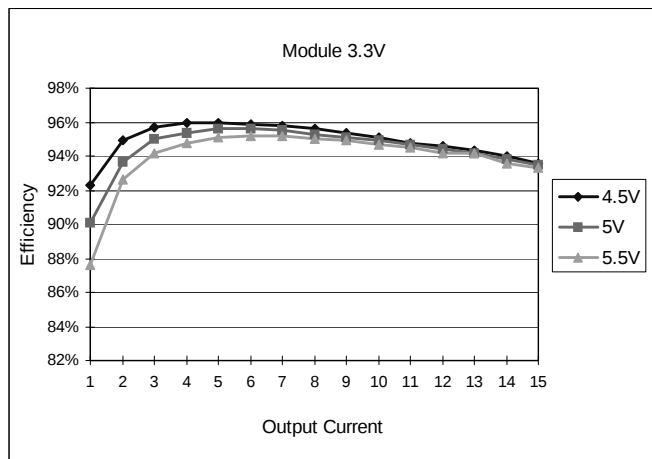
3. With remote on/off pin 11 open, the module is on.

## NON-ISOLATED DC/DC CONVERTERS

5V Input / 1.2V – 3.3V Output / 15A

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### Efficiency Data



# NON-ISOLATED DC/DC CONVERTERS

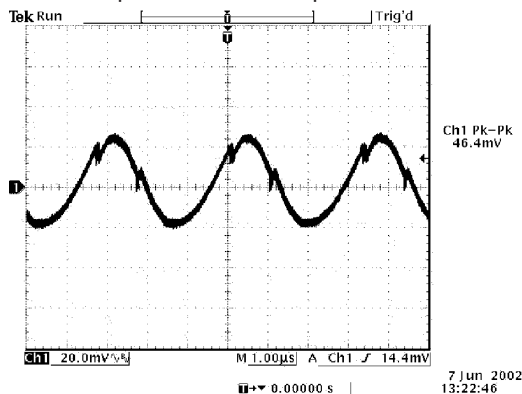
## 5V Input / 1.2V – 3.3V Output / 15A



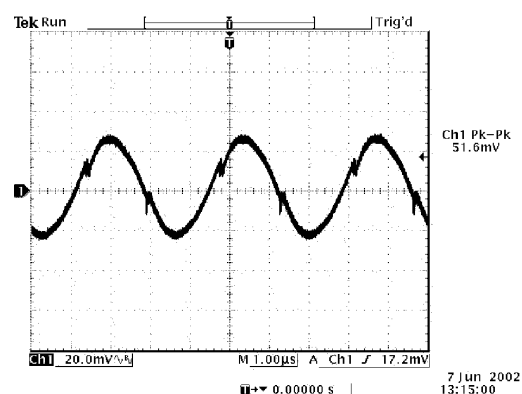
BP06VRPD-15B

### Ripple and Noise

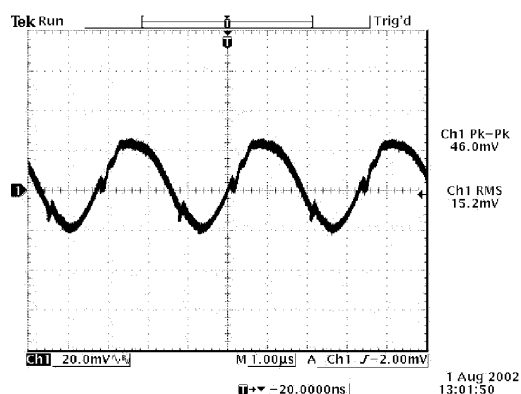
0.1 $\mu$ F ceramic cap added at the output.



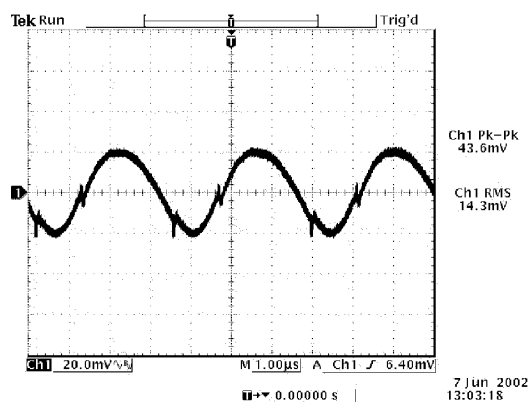
Ripple and noise at full load and 5Vdc input, 3.3Vdc output and Ta=25° C



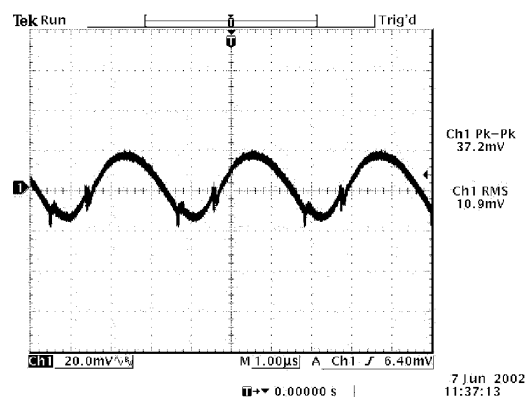
Ripple and noise at full load and 5Vdc input, 2.5Vdc output and Ta=25° C



Ripple and noise at full load and 5Vdc input, 1.8Vdc output and Ta=25° C



Ripple and noise at full load and 5Vdc input, 1.5Vdc output and Ta=25° C



Ripple and noise at full load and 5Vdc input, 1.2Vdc output and Ta=25° C



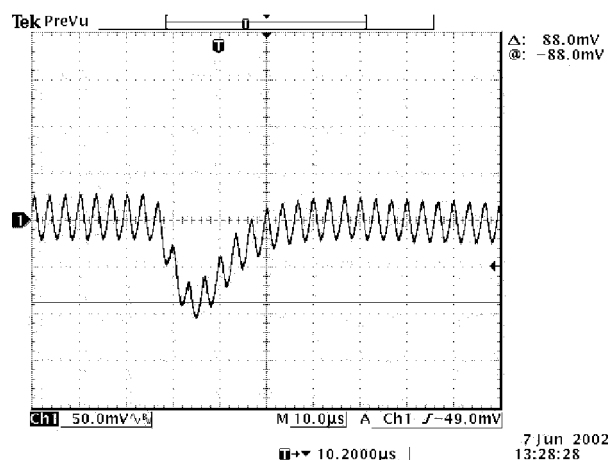
## NON-ISOLATED DC/DC CONVERTERS

### 5V Input / 1.2V – 3.3V Output / 15A

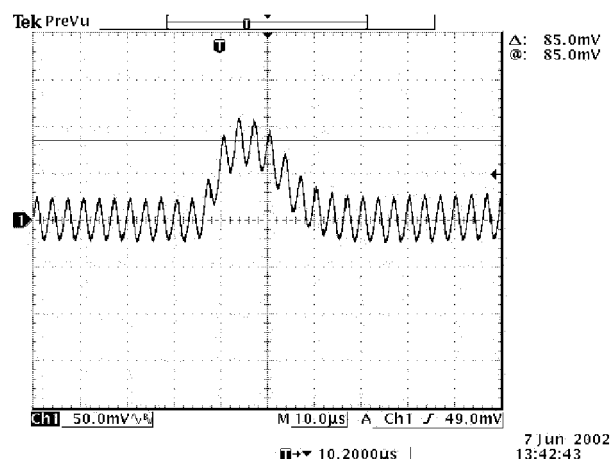
BP02V7PD-15B

### Transient Response

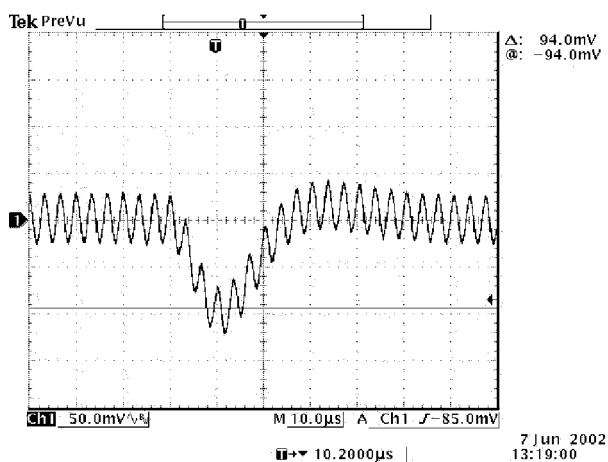
Transient response:  $di/dt = 0.5A/\mu S$ , no external load capacitance



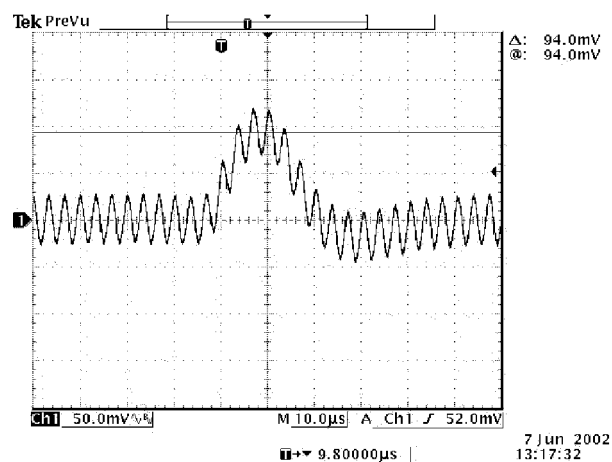
Vout=3.3V  
50% to 100% load transients at 5V input and Ta=25° C



Vout=3.3V  
100% to 50% load transients at 5V input and Ta=25° C



Vout=2.5V  
50% to 100% load transients at 5V input and Ta=25° C



Vout=2.5V  
100% to 50% load transients at 5V input and Ta=25° C

# NON-ISOLATED DC/DC CONVERTERS

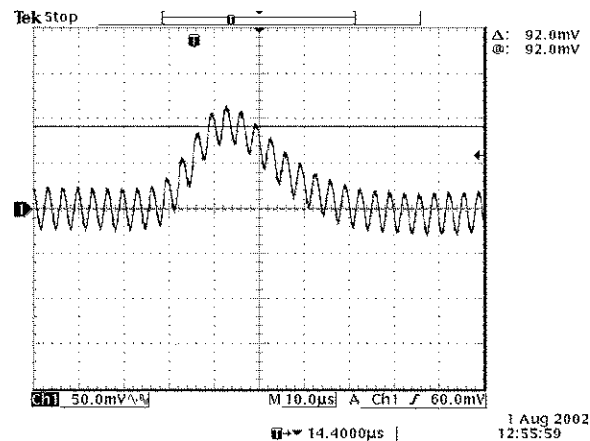
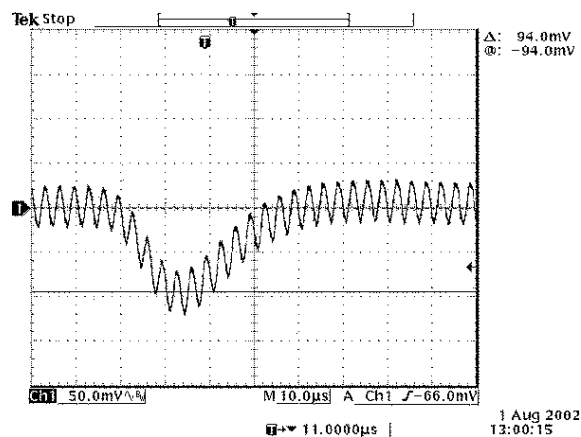
## 5V Input / 1.2V – 3.3V Output / 15A

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POWER PRODUCTS

BP06VRPD-15B

### Transient Response

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

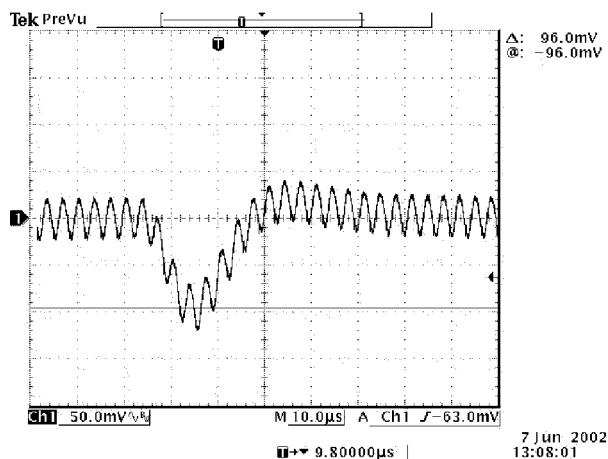


Vout=1.8V  
50% to 100% load transients at 5V input and Ta=25° C

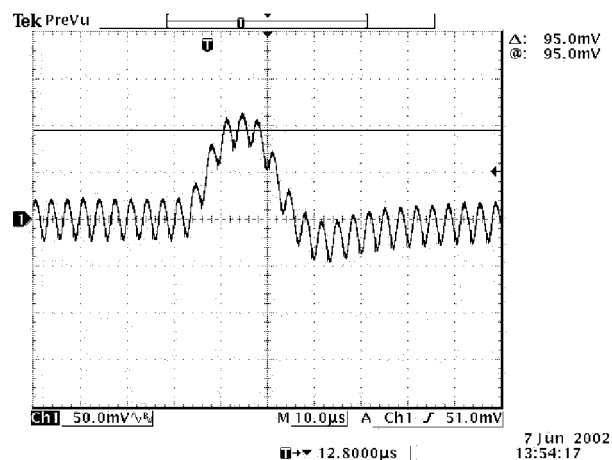
Vout=1.8V  
100% to 50% load transients at 5V input and Ta=25° C

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Vout=1.5V  
50% to 100% load transients at 5V input and Ta=25° C



Vout=1.5V  
100% to 50% load transients at 5V input and Ta=25° C



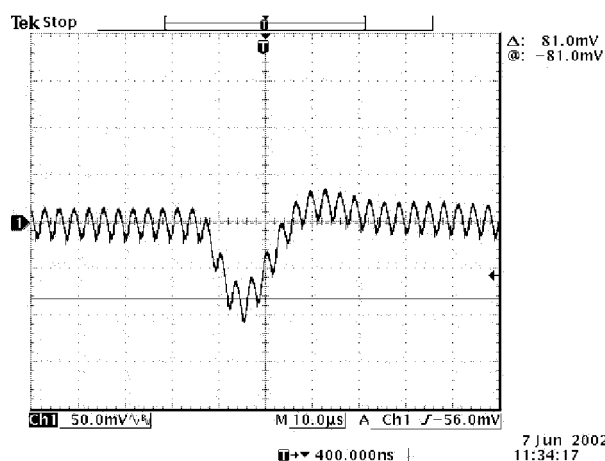
## NON-ISOLATED DC/DC CONVERTERS

5V Input / 1.2V – 3.3V Output / 15A

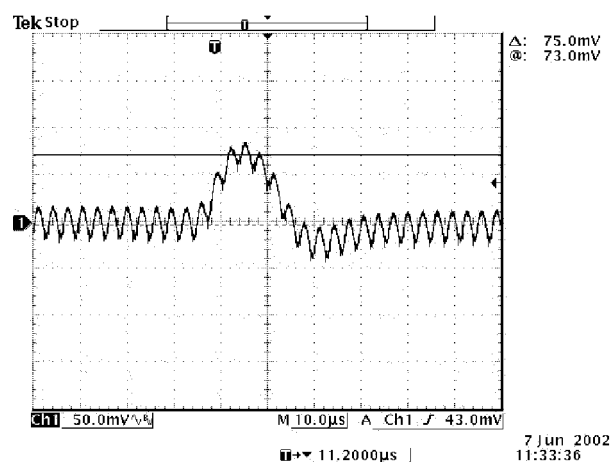
BP02V7PD-15B

### Transient Response

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



Vout=1.2V  
50% to 100% load transients at 5V input and Ta=25° C

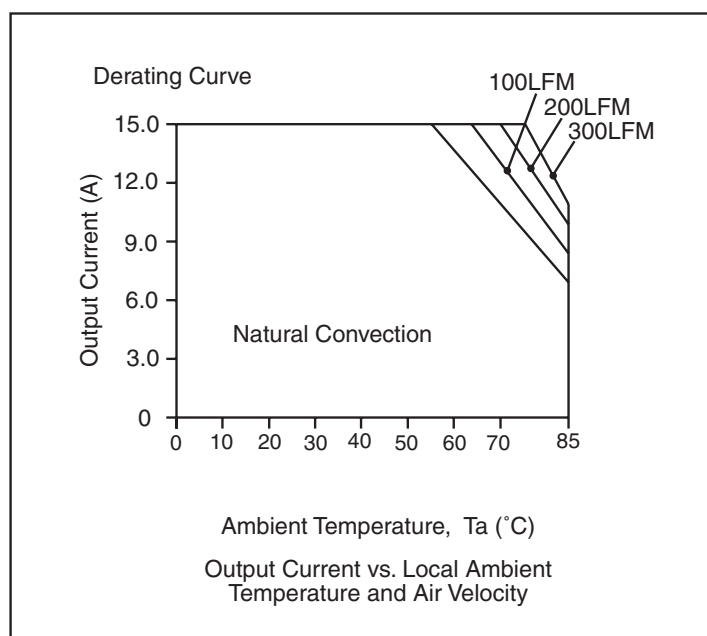


Vout=1.2V  
100% to 50% load transients at 5V input and Ta=25° C

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### Thermal Considerations

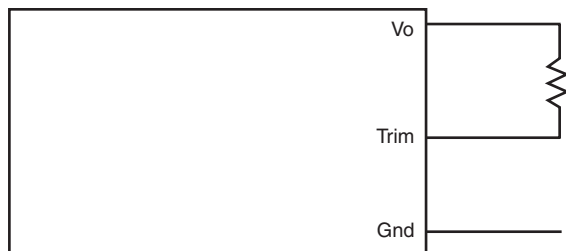
V7PD-15B



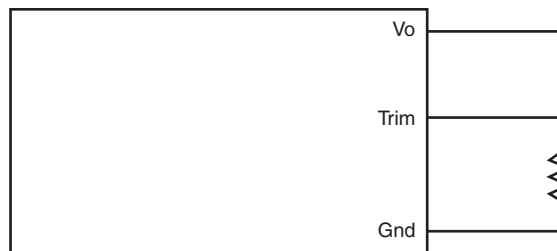
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## Output Voltage Set-Point Adjustment

Trim Down Test Circuit



Trim Up Test Circuit



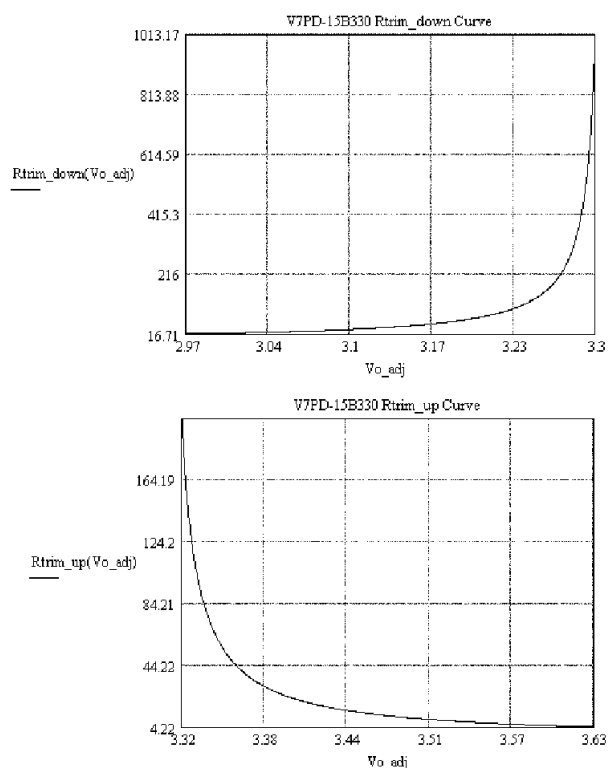
## Output Voltage Set-Point Adjustment

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### VRPD-15B33x Trim Resistor Calculation

$$R_{\text{trim down}} = \left( \frac{3.17 V_o \text{ adj} - 0.767 V_o \text{ nom}}{V_o \text{ nom} - V_o \text{ adj}} - 3.65 \right) \text{ Kohm}$$

$$R_{\text{trim up}} = \left( \frac{0.767 V_o \text{ nom}}{V_o \text{ adj} - V_o \text{ nom}} - 3.65 \right) \text{ Kohm}$$



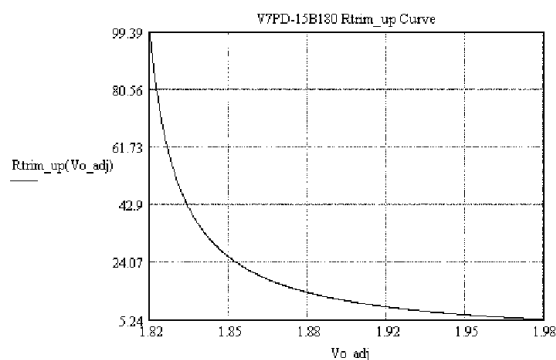
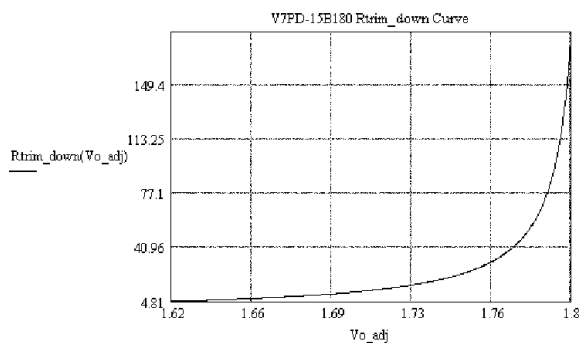
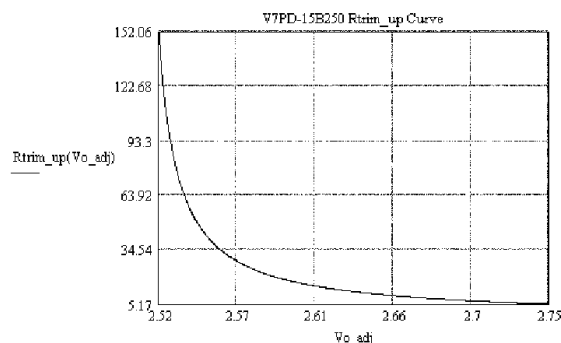
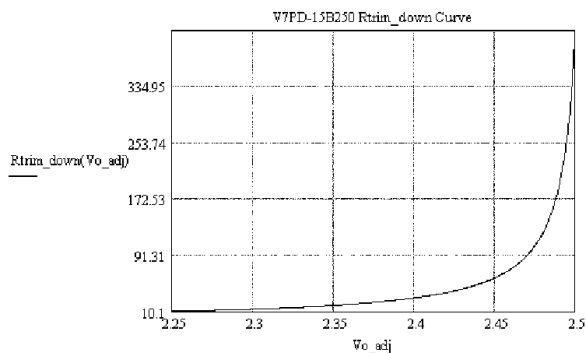
BP02V7PD-15B

## Output Voltage Set-Point Adjustment

### VRPD-15B25x Trim Resistor Calculation

$$R_{\text{trim down}} = \left( \frac{2.16 V_o \text{ adj} - 0.689 V_o \text{ nom}}{V_o \text{ nom} - V_o \text{ adj}} - 2 \right) \text{ Kohm}$$

$$R_{\text{trim up}} = \left( \frac{0.689 V_o \text{ nom}}{V_o \text{ adj} - V_o \text{ nom}} - 2 \right) \text{ Kohm}$$



### VRPD-15B18x Trim Resistor Calculation

$$R_{\text{trim down}} = \left( \frac{1.51 V_o \text{ adj} - 0.668 V_o \text{ nom}}{V_o \text{ nom} - V_o \text{ adj}} - 1.78 \right) \text{ Kohm}$$

$$R_{\text{trim up}} = \left( \frac{0.668 V_o \text{ nom}}{V_o \text{ adj} - V_o \text{ nom}} - 1.78 \right) \text{ Kohm}$$

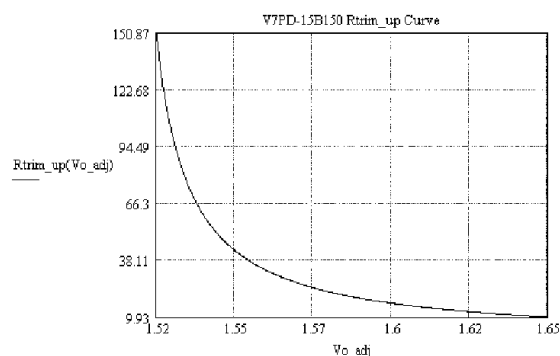
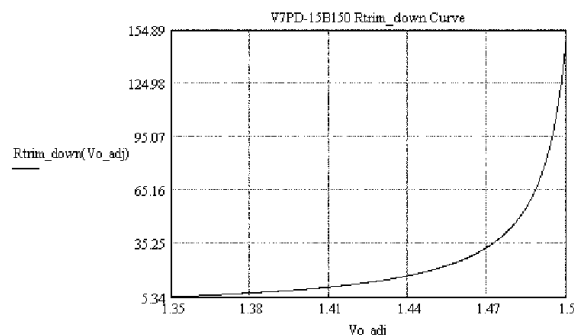
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## Output Voltage Set-Point Adjustment

### VRPD-15B15x Trim Resistor Calculation

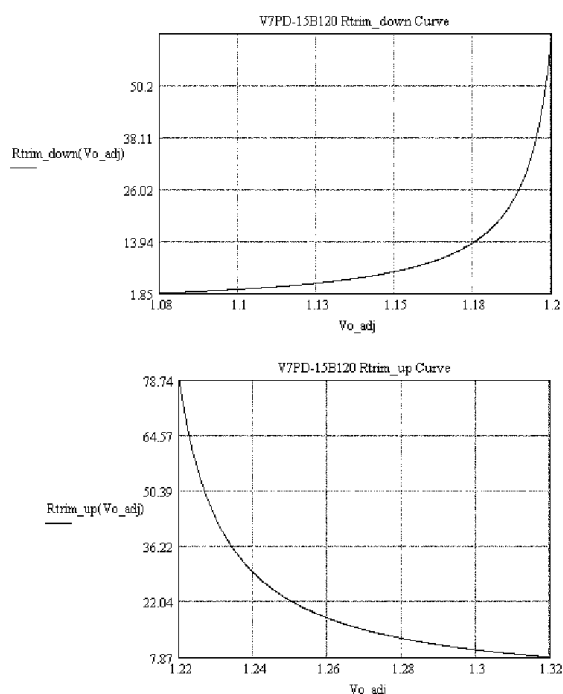
$$R_{\text{trim down}} = \left( \frac{2.06 V_{o \text{ adj}} - 1.092 V_{o \text{ nom}}}{V_{o \text{ nom}} - V_{o \text{ adj}}} - 1.78 \right) \text{ Kohm}$$

$$R_{\text{trim up}} = \left( \frac{1.092 V_{o \text{ nom}}}{V_{o \text{ adj}} - V_{o \text{ nom}}} - 1.78 \right) \text{ Kohm}$$



DataSheet4L

DataSheet



### VRPD-15B12x Trim Resistor Calculation

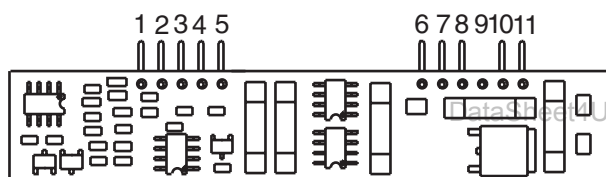
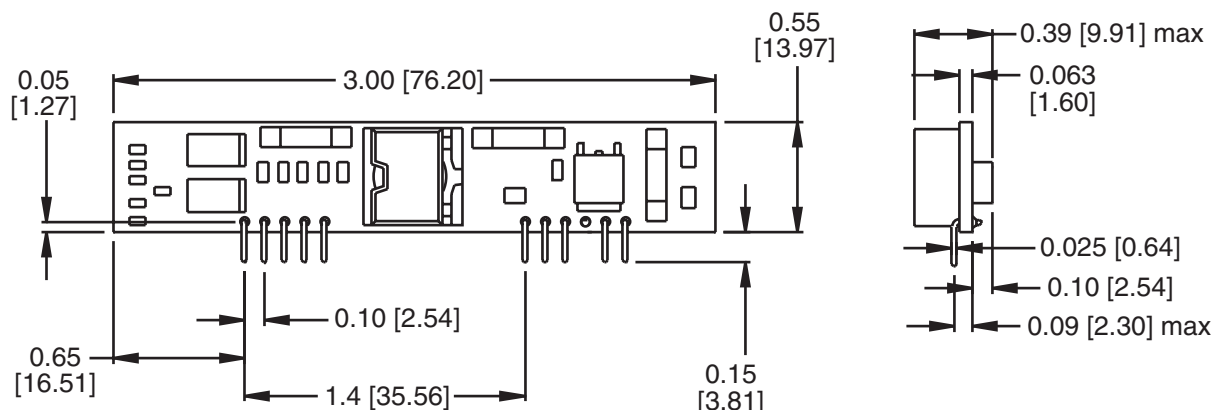
$$R_{\text{trim down}} = \left( \frac{1.22 V_{o \text{ adj}} - 0.808 V_{o \text{ nom}}}{V_{o \text{ nom}} - V_{o \text{ adj}}} - 0.825 \right) \text{ Kohm}$$

$$R_{\text{trim up}} = \left( \frac{0.808 V_{o \text{ nom}}}{V_{o \text{ adj}} - V_{o \text{ nom}}} - 0.825 \right) \text{ Kohm}$$

BP06VRPD-15B

### Mechanical

#### VRPD-15B



Dimensions are in inches [millimeters].

Standard dimension tolerance is  $\pm 0.005$  [0.13] unless otherwise noted.

| Pin | Function      |
|-----|---------------|
| 1   | +Vo           |
| 2   | +Vo           |
| 3   | Remote Sense  |
| 4   | +Vo           |
| 5   | Ground        |
| 6   | Ground        |
| 7   | +Vin          |
| 8   | +Vin          |
| 9   | Not Used      |
| 10  | Trim          |
| 11  | 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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