

## NON-ISOLATED DC/DC CONVERTERS

6.5 Vdc - 13.8 Vdc Input, 1.025 Vdc - 1.2 Vdc/30 A Output



Nov. 11, 2010

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

**VRP1-30E3A0**

**RoHS Compliant**

**Rev.B**

### Features

- Non-Isolated
- High Efficiency
- Fixed Frequency
- High Power Density
- Wide Input
- Remote Sense
- Remote On/Off
- Class 1, Category 2, Non-Isolated DC/DC Converter (refer to IPC-9592)
- Under Voltage Protection
- Output Over-Voltage Shutdown
- Wide Operating Temperature Range
- OCP/SCP
- Power Good Signal
- 3 Bit VID Trim
- Low Cost

### Applications

- Networking
- Computers and peripherals
- Telecommunications

### Description

The Bel VRP1-30E3A0 is part of the non-isolated dc/dc converter Power Module series. The module uses a SIP package. This converter is available output voltage trim via the 3 bit VID range from 1.025 Vdc to 1.2 Vdc over a wide range of input voltage ( $V_{in} = 6.5 - 13.8$  Vdc). The efficiency is typically 82% @ 12Vin and 1.2Vout at full load.

### Part Selection

| Output Voltage      | Input Voltage      | Max. Output Current | Max. Output Power | Typical Efficiency | Model Number Active High |
|---------------------|--------------------|---------------------|-------------------|--------------------|--------------------------|
| 1.025 Vdc - 1.2 Vdc | 6.5 Vdc - 13.8 Vdc | 30 A                | 36 W              | 82%                | VRP1-30E3A0              |

**Notes:** Add "G" suffix at the end of the model number to indicate Tray Packaging.

### Part Number Explanation

V R P1 - 30 E 3A 0  
1 2 3 4 5 6 7

- 1---Vertical mount
- 2---RoHS 6, change "R" to "7" means RoHS 5
- 3---Series name, SIP
- 4---Series code, 30A output
- 5--- Wide input range (6.5-13.8V)
- 6---Wide trim
- 7---Suffix

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### Absolute Maximum Ratings

| Parameter                              | Min  | Typ | Max | Unit | Notes |
|--|------|-----|-----|------|-------|
| Continuous non-operating Input Voltage | -0.3 | -   | 15  | V    |       |
| Remote On/Off                          | -0.3 | -   | 15  | V    |       |
| Ambient Temperature                    | 0    | -   | 70  | °C   |       |
| Storage Temperature                    | -40  | -   | 125 | °C   |       |

**Note:** Ratings used beyond the maximum ratings may cause a reliability degradation of the converter or may permanently damage the device.

### Input Specifications

| Parameter                                 | Min | Typ | Max  | Unit             | Notes  |
|---|-----|-----|------|------------------|--|
| Operating Input Voltage                   | 6.5 | 12  | 13.8 | V                |  |
| Input Current (full load)                 | -   | -   | 7    | A                |  |
| Input Current (no load)                   | -   | 200 | 400  | mA               |  |
| Remote Off Input Current                  | -   | 20  | -    | mA               |  |
| Input Reflected Ripple Current (rms)      | -   | 30  | 50   | mA               | With simulated source impedance of 10uH, 5Hz to 20MHz. Use a 100uF/100V electrolytic capacitor with ESR=1 ohm max, at 200KHz@25°C. |
| Input Reflected Ripple Current (pk-pk)    | -   | 75  | 120  | mA               |  |
| I <sup>2</sup> t Inrush Current Transient | -   | -   | 1    | A <sup>2</sup> s |  |
| Turn-on Voltage Threshold                 | 6.0 | 6.2 | 6.5  | V                |  |
| Turn-off Voltage Threshold                | 5.3 | 5.5 | 5.7  | V                |  |

**CAUTION:** This converter is not internally fused. An input line fuse must be used in application.

Recommend a fast-acting fuse with maximum rating of 15A on system board. Refer to the fuse manufacturer's datasheet for further information.

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

### Output Specifications

| Parameter                                    | Min   | Typ  | Max   | Unit              | Notes  |
|--|-------|------|-------|-------------------|--|
| Output Voltage Set Point                     | 1.211 | 1.22 | 1.229 | V                 | VID=000, I <sub>o</sub> =0A  |
| Adaptive Positioning                         | -     | 6    | -     | mOhm              | Droop Impedance  |
| Line Regulation                              | -     | ±5   | ±10   | mV                |  |
| Regulation Over Temperature (0deg.C-70deg.C) | -     | ±5   | ±10   | mV                |  |
| Ripple and Noise (pk-pk)                     | -     | 40   | 60    | mV                | 0-20MHz BW, 831uF cap on output.                                   |
| Ripple and Noise (rms)                       | -     | 25   | 35    | mV                |  |
| Ripple and Noise (pk-pk) under worst case    | -     | -    | 80    | mV                | over all operating input voltage, load and temperature conditions. |
| Output Current Range                         | 0     | -    | 30    | A                 |  |
| Output DC Current Limit                      | -     | 120  | -     | %I <sub>out</sub> | OCP latch off  |
| Turn on Time                                 | -     | 10   | 15    | mS                |  |
| Rise Time                                    | -     | 5    | 10    | mS                |  |

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## Output Specifications (continued)

| Parameter                 | Min           | Typ | Max | Unit | Notes  |   |
|---------------------------|---------------|-----|-----|------|--|---|
| Overshoot at Turn on      | -             | -   | 5   | %    |  |   |
| Output Capacitance        | -             | 831 | -   | uF   | 470uF Tan cap+1*1uF+4*10+6*22+4*47uF ceramic cap |   |
| <b>Transient Response</b> |               |     |     |      |  |   |
| ΔV50%~75% of Max Load     | Overshoot     | -   | -   | 60   | mV   | di/dt=2.5A/us, Vin=12.0Vdc, Ta=25°C, 831uF cap on output. |
|                           | Settling Time | -   | -   | 50   | uS   |   |
| ΔV75%~50% of Max Load     | Overshoot     | -   | -   | 60   | mV   |   |
|                           | Settling Time | -   | -   | 50   | uS   |   |

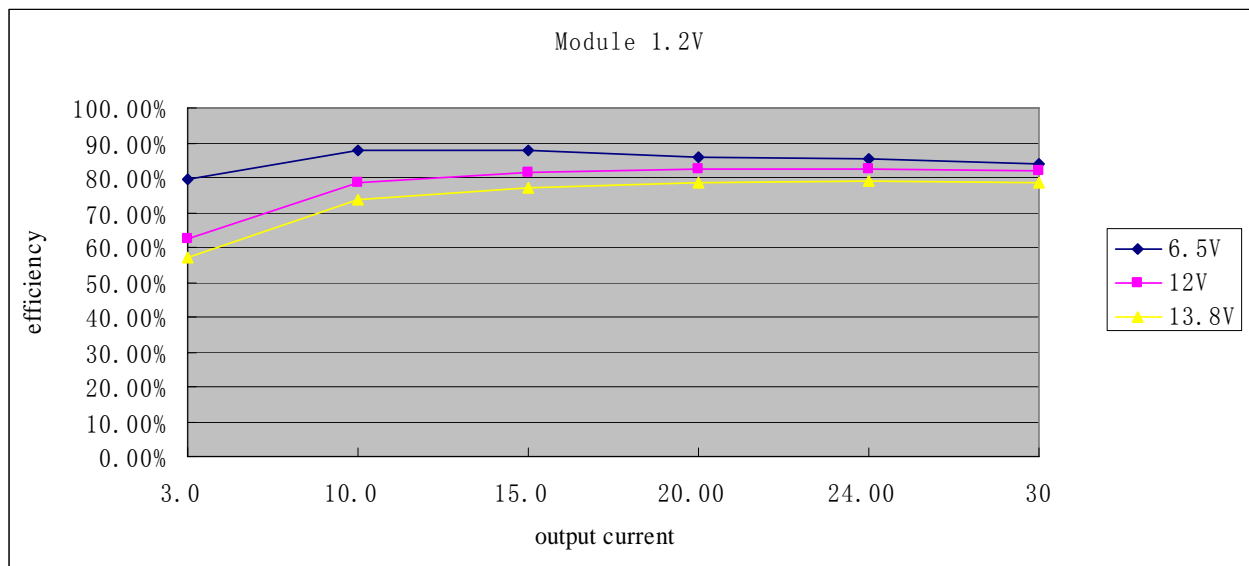
**Note:** All specifications are typical at nominal input, full load at 25°C unless otherwise stated.

## General Specifications

| Parameter               | Min                   | Typ  | Max | Unit | Notes   |
|-------------------------|-----------------------|------|-----|------|---|
| Efficiency              | -                     | 82   | -   | %    | Vin=12.0V, full load  |
| Switching Frequency     | -                     | 500  | -   | kHz  |   |
| Weight                  | -                     | 10.2 | -   | g    |   |
| FIT                     | 625                   |      |     | -    | Calculated Per Bell Core SR-332 (Io=80%load, Ta = 25 °C, FIT=10 <sup>9</sup> /MTBF) |
| Dimensions              |                       |      |     | -    |   |
| Inches (L x W x H)      | 1.20 x 0.61 x 0.65    |      |     |      |   |
| Millimeters (L x W x H) | 30.48 x 15.49 x 16.52 |      |     |      |   |

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

## Efficiency Data



# NON-ISOLATED DC/DC CONVERTERS

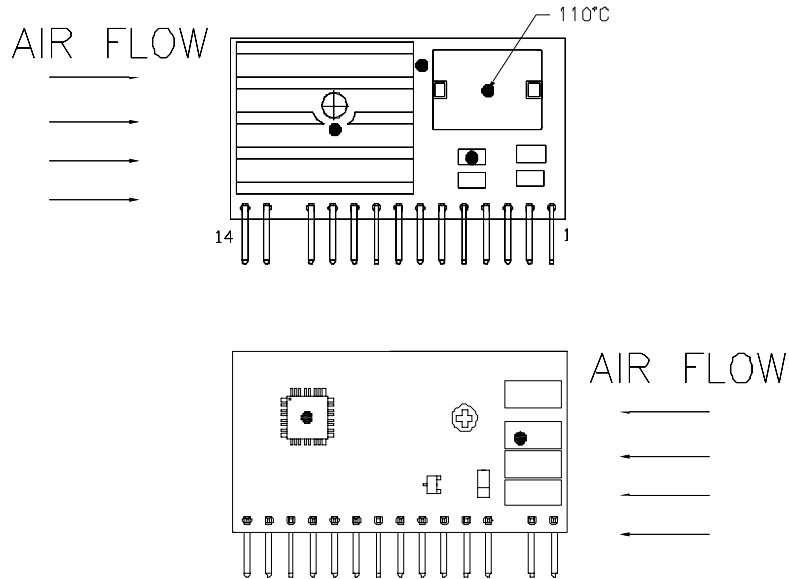
6.5 Vdc - 13.8 Vdc Input, 1.025 Vdc - 1.2 Vdc/30 A Output



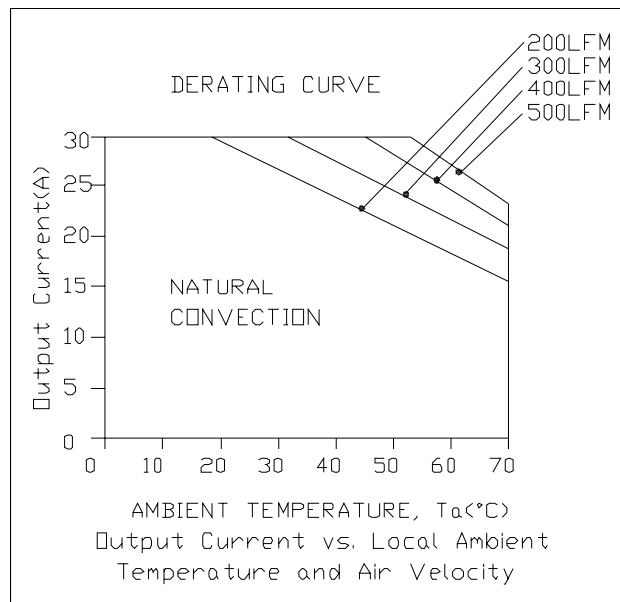
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## Thermal Derating Curves



The thermal reference point Tref is shown above. For reliable operation this temperature should not exceed 110°C. The output power of the module should not exceed the rated power for the module.



Vin=12V, Vo=1.2V

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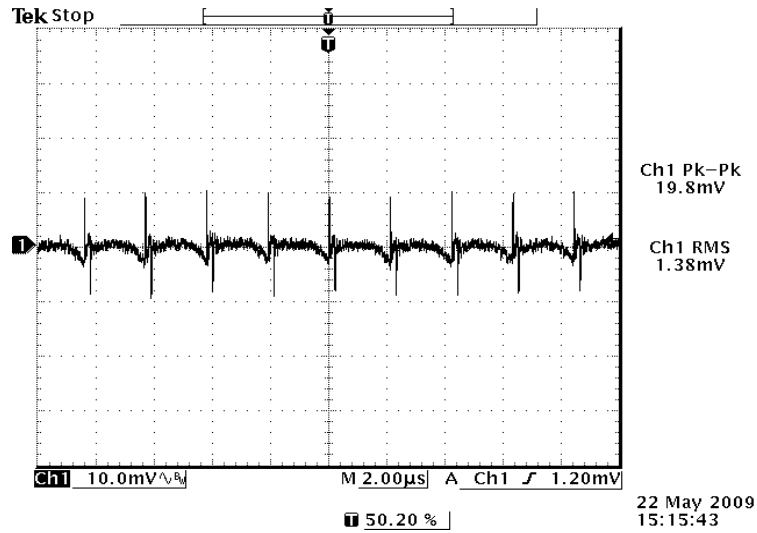
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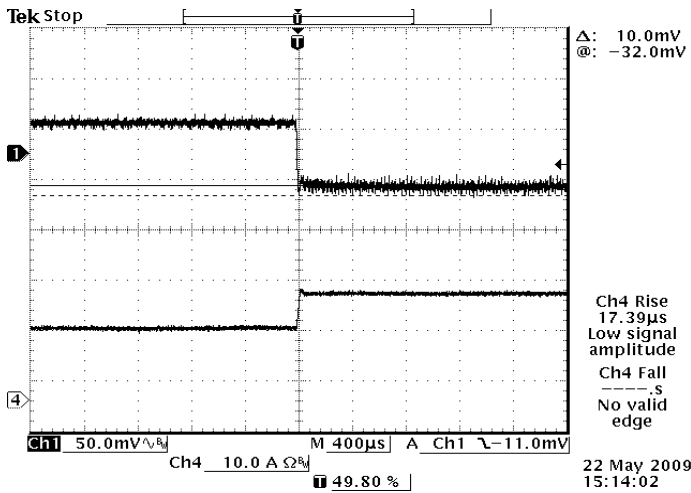
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## Ripple and Noise Waveform

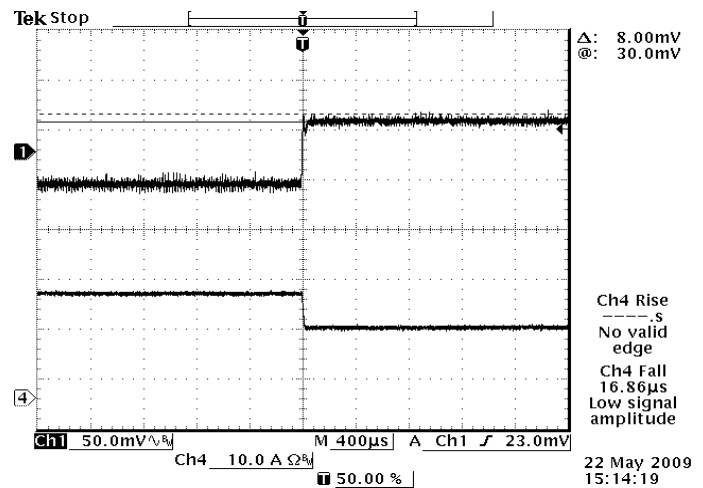


12Vdc input, 1.2V output

## Transient Response Waveforms



Vin=12V,Vo=1.2V,50%~75% load



Vin=12V,Vo=1.2V,75%~50% load

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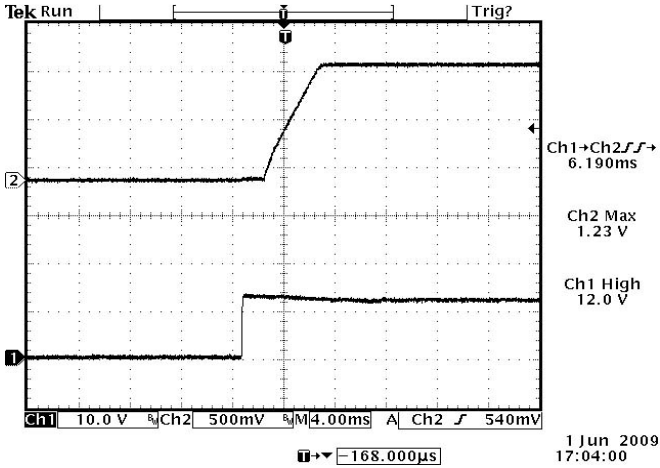


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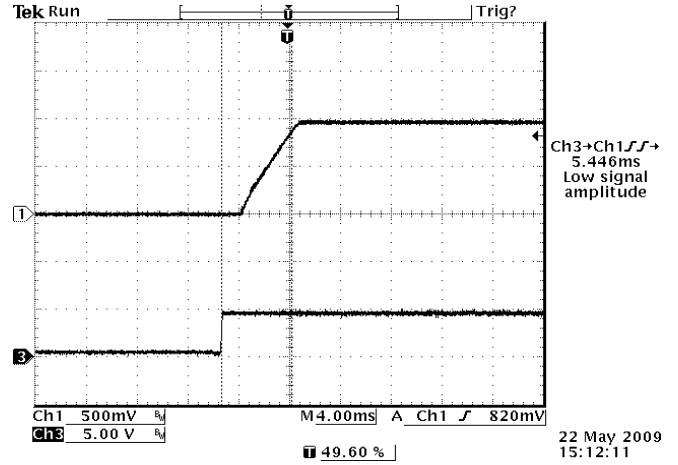
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## Startup & Shutdown

### Startup time

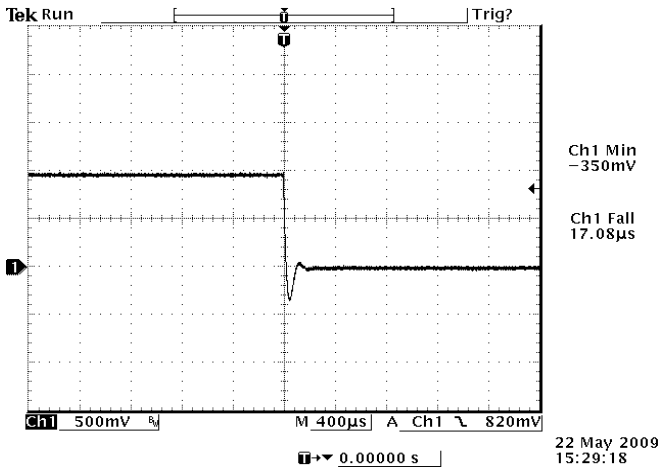


Startup from Vin  
Ch2: Vo  
Ch1: Vin  
Vin=12V,Vo=1.2V, full load with 831uF cap



Startup from on/off  
Ch2: Vo  
Ch1: on/off  
Vin=12V,Vo=1.2V full load with 831uF cap

### Shutdown



Vin=12V, Vo=1.2V, full load with 831uF cap

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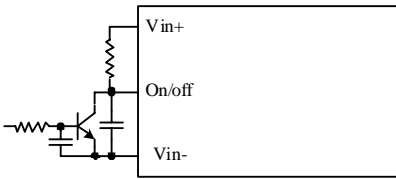
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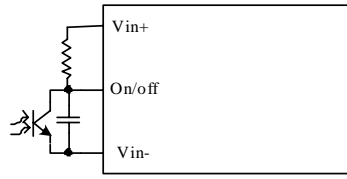
## Remote On/Off

| Parameter             |             | Min  | Typ | Max | Unit | Notes                                 |
|-----------------------|-------------|------|-----|-----|------|---------------------------------------|
| Signal Low (Unit Off) | Active High | -0.3 | -   | 0.4 | V    | The remote on/off pin open, Unit off. |
| Signal High (Unit On) |             | 2    | -   | 5.5 | V    |                                       |
| Current Sink          |             | 0    | -   | 1   | mA   |                                       |

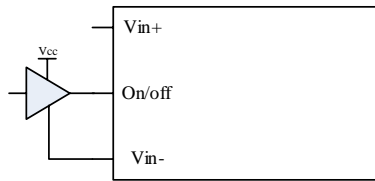
### Recommended remote on/off circuit for active high



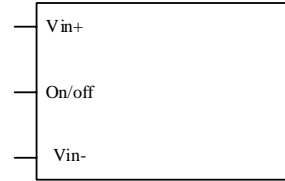
Control with open collector/drain circuit



Control with photocoupler circuit



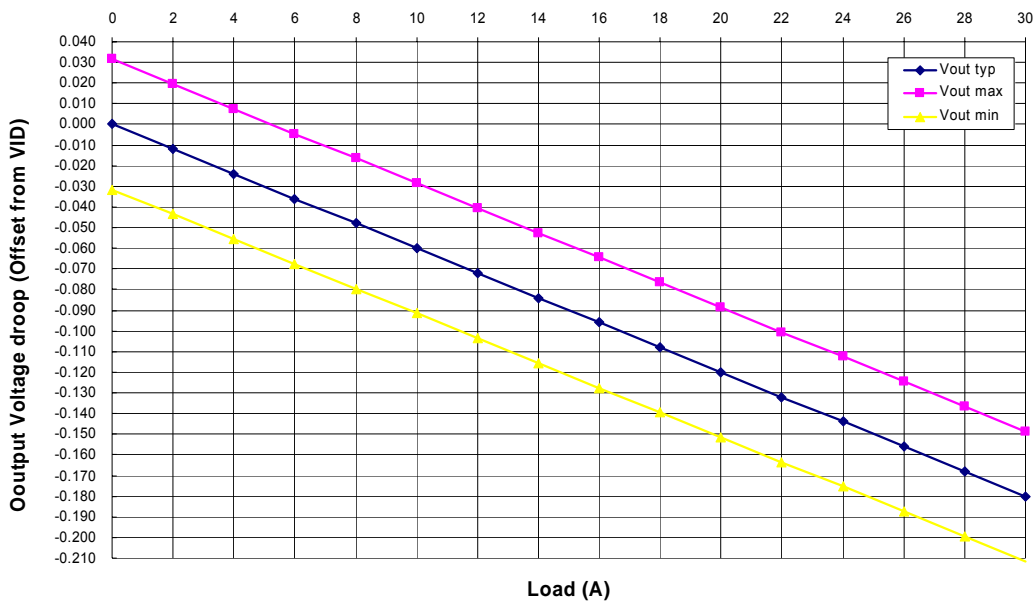
Control with logic circuit



Permanently off

## Load Line

6 mΩ Load Line with ±31.5 mV Tolerance Band



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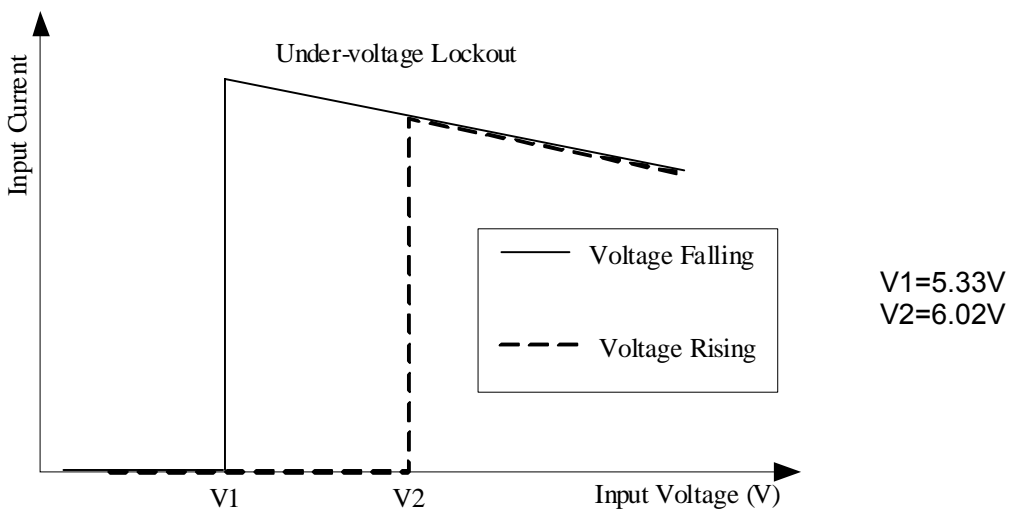
## Output Voltage Set-Point Adjustment

Trim up circuit (using 3 bit VID: VID2, VID3 and VID4)

| VID Hex | VID7 | VID6 | VID5 | VID4 | VID3 | VID2 | VID1 | VID0 | DAC Voltage | Output Voltage Set Point (DAC+20mv, Io=0A) |
|---------|------|------|------|------|------|------|------|------|-------------|--|
| 42      | 0    | 1    | 0    | 0    | 0    | 0    | 1    | 0    | 1.200V      | 1.220V                                     |
| 46      |      |      |      | 0    | 0    | 1    |      |      | 1.175V      | 1.195V                                     |
| 4A      |      |      |      | 0    | 1    | 0    |      |      | 1.150V      | 1.170V                                     |
| 4E      |      |      |      | 0    | 1    | 1    |      |      | 1.125V      | 1.145V                                     |
| 52      |      |      |      | 1    | 0    | 0    |      |      | 1.100V      | 1.120V                                     |
| 56      |      |      |      | 1    | 0    | 1    |      |      | 1.075V      | 1.095V                                     |
| 5A      |      |      |      | 1    | 1    | 0    |      |      | 1.050V      | 1.070V                                     |
| 5E      |      |      |      | 1    | 1    | 1    |      |      | 1.025V      | 1.045V                                     |

**Note:** VID [4:2] is set to 000b which will set VID=1.2V as default.

## Input Under-voltage Lockout





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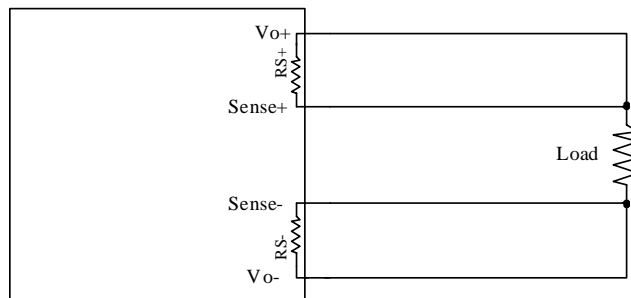
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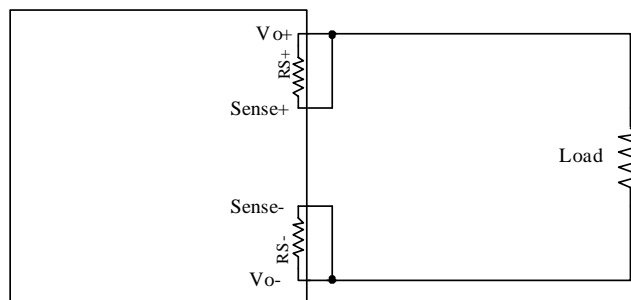
### Remote Sense

This module has remote sense compensation feature. It can minimize the effects of resistance between module's output and load in system layout and facilitates accurate voltage regulation at load terminals or other selected point.

1. The remote sense lines carries very little current and hence do not require a large cross-sectional area.
2. This module compensates for a maximum drop of 10% of the nominal output voltage.
3. If the unit is already trimmed up, the available remote sense compensation range should be correspondingly reduced. The total voltage increased by trim and remote sense should not exceed 10% of the nominal output voltage.
4. When using remote sense compensation, all the resistance, parasitic inductance and capacitance of the system are incorporated within the feedback loop of this module. It can make an effect on the module's compensation, affecting the stability and dynamic response. A 0.1uF ceramic capacitor can be connected at the point of load to de-couple noise on the sense wires.
5. Recommend the connection of remote sense compensation as below figure. There are a resistor RS+ (51.1 ohm) from Vo+ to Sense+ and a resistor RS- (51.1 ohm) from Vo- to Sense- inside of this module.



6. If not using remote sense compensation, please connect sense directly to output at module's pin, that is, connect sense+ to Vo+ and sense- to Vo- at module's pin, the shorter the better. See below figure.



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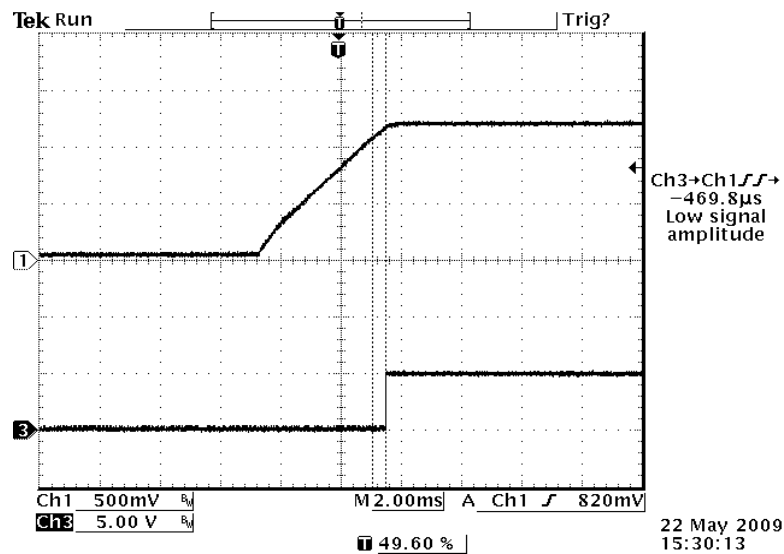


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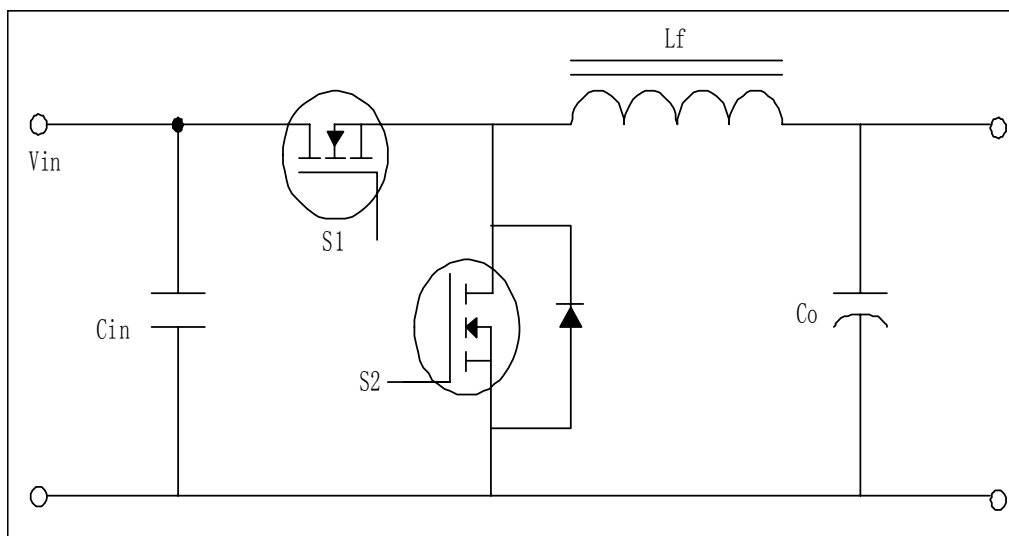
## Power Good

1. This module has a power good indicator output. Power good pin used positive logic and is open collector.
2. Power good pin can sink 10mA.
3. The maximum voltage pulled up externally on Power Good pin should not exceed 6V.
4. When a successful soft-start is completed, the power good pin will be pulled high.



CH1: Output Voltage CH3: Power Good  
Typical Start-up Using Remote ON/OFF (Vin=12.0V, Vout=1.2V, Io=30A)

## Fundamental Circuit Diagram



# NON-ISOLATED DC/DC CONVERTERS

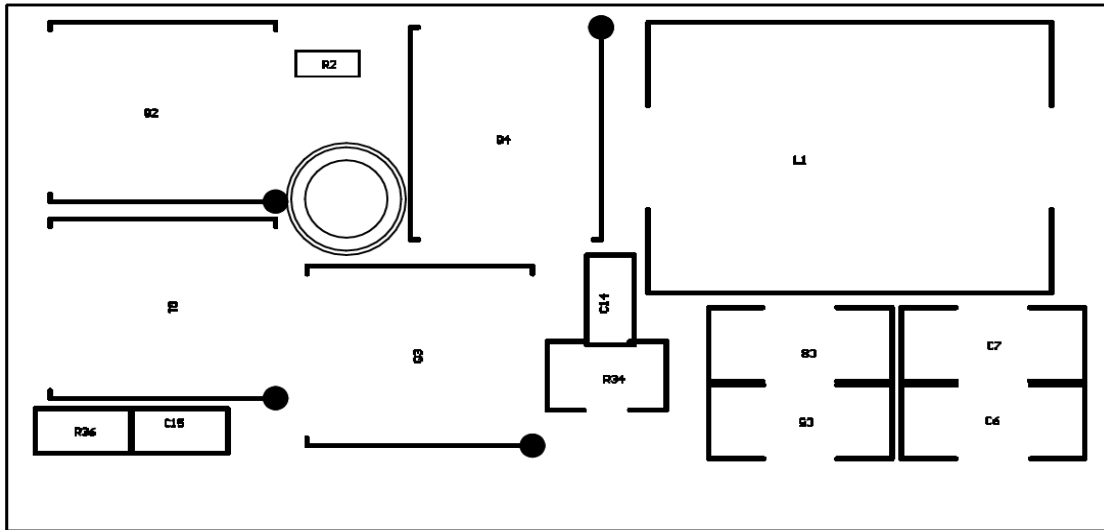
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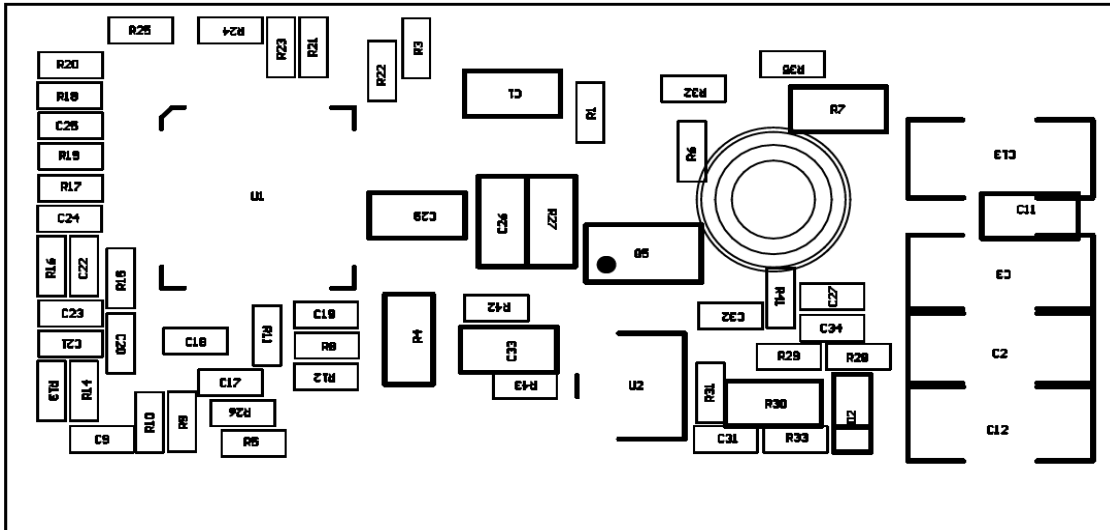
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## Layout



Layout of components on top side



Layout of components on bottom side

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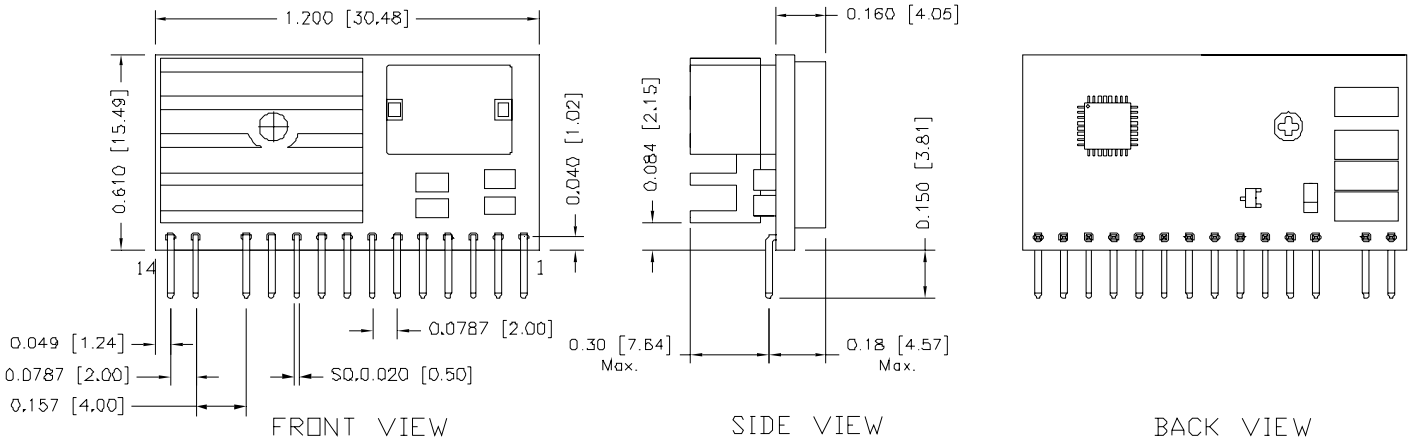
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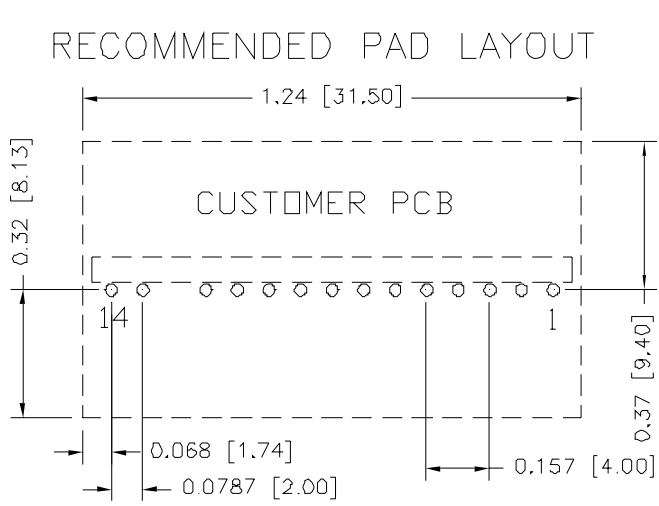
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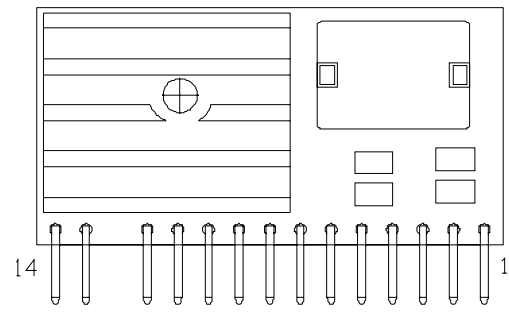
## Mechanical Outline



\*PIN TYPE CAN BE 0.025"X0.025" SQUARE, 0.025"X0.020" RECTANGULAR, OR, 0.020"X0.020" SQUARE



HOLE SIZE:  $\varnothing$ 0.040 [1.01]  
 PAD SIZE:  $\varnothing$ 0.059 [1.50]



| Pin | Function | Pin | Function |
|-----|----------|-----|----------|
| 1   | GND      | 8   | Vsense+  |
| 2   | GND      | 9   | VID2     |
| 3   | Vout     | 10  | VID3     |
| 4   | Vout     | 11  | VID4     |
| 5   | Vout     | 12  | Enable   |
| 6   | PWRGD    | 13  | Vin      |
| 7   | Vsense-  | 14  | GND      |

**Note:** This module is recommended and compatible with Pb-Free Wave Soldering and must be soldered using a peak solder temperature of no more than 260 °C for less than 5 seconds.

**Note:**

- 1) All Pins: Material - Copper Alloy;  
 Finish – 3 micro inches minimum Gold over 50 micro inches minimum Nickel plate.
- 2) Undimensioned components are shown for visual reference only.
- 3) All dimensions in inches (mm); Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm) x.xxx +/-0.010 in. (x.xx +/-0.25mm).

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### Signal Definitions

| Pin Name             | Pin Description  |
|----------------------|--|
| GND                  | Common return for both input and output.   |
| Vout                 | Output voltage of the converter.   |
| PWRGD                | PWRGD indicates that soft-start has completed and the output voltage is within the regulated range around VID setting.   |
| Vsense-              | Negative remote sense.   |
| Vsense+              | Positive remote sense.   |
| VID2<br>VID3<br>VID4 | Logic level inputs used to set the output voltage, refer to VID table. Connect VID0 thru VID1 pins to open-drain outputs with external pull-up resistors or to active-pull-up outputs. Valid logic low is -0.3V to 0.4V, valid logic high level is 0.8V to 5.3V. |
| Enable               | Logic level input used to enable the converter when high.  |
| Vin                  | Input voltage of the converter.  |

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### Revision History

| Date       | Revision | Changes Detail          | Approval |
|------------|----------|-------------------------|----------|
| 2010-09-09 | A        | First release           | YF Sun   |
| 2010-11-11 | B        | Update mechanical size. | YF Sun   |

### 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

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