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## NON-ISOLATED DC/DC CONVERTERS

12 Vdc Input

0.9 Vdc - 5.0 Vdc/20 A Output

**bel**  
POWER PRODUCTS

**xRPF-20A1A0**

**RoHS Compliant**

**Rev.A**

- Non-Isolated
- Fixed Frequency (275 kHz)
- High Efficiency
- High Power Density
- Power Good Output Signal (open collector)
- Under-Voltage Lockout (UVLO)
- Wide Trim Range
- Converter Can Sink and Source Current
- OCP/SCP
- Remote On/Off
- Low Cost



### Description

The Bel xRPF-20A1A0 is a new high density open frame non-isolated converter series for space sensitive applications. Each model has a wide input range (10.2 Vdc - 13.8 Vdc) and offers a wide range of output voltage (0.9 Vdc - 5.0 Vdc) with a 20 A load. An external resistor adjusts the output voltage from its pre-set value of 0.9 Vdc to any value up to the 5.0 Vdc maximum. Typical efficiency is 92% at  $V_o=5$  Vdc,  $V_{in}=12$  Vdc at full load. Typical features include remote on/off, under-voltage lockout, over-current protection and short circuit protection.

### Part Selection

| Output Voltage | Input Voltage | Max. Output Current | Max. Output Power | Typical Efficiency | Model Number Vertical Mount | Model Number Horizontal Mount |
|----------------|---------------|---------------------|-------------------|--------------------|-----------------------------|-------------------------------|
| 0.9 V - 5.0 V  | 12 V          | 20 A                | 100 W             | 92%                | VRPF-20A1A0                 | ORPF-20A1A0                   |

- Notes:** 1. 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 | -   | 13.8 V |       |
| Output Enable Terminal Voltage | -0.3 V | -   | 13.8 V |       |
| Ambient Temperature            | 0 °C   | -   | 80 °C  |       |
| Storage Temperature            | -40 °C | -   | 125 °C |       |

### Input Specifications

| Parameter                | Min    | Typ     | Max    | Notes                                                                             |
|--------------------------|--------|---------|--------|-----------------------------------------------------------------------------------|
| Input Voltage            | 10.2 V | -       | 13.8 V |                                                                                   |
| Input Current (Source)   |        |         |        |                                                                                   |
| $V_o=5.0$ V              | -      | 9.1 A   | -      |                                                                                   |
| $V_o=2.5$ V              | -      | 4.9 A   | -      |                                                                                   |
| $V_o=0.9$ V              | -      | 2.2 A   | -      |                                                                                   |
| Input Current (Sink)     |        |         |        |                                                                                   |
| $V_o=2.5$ V              | -      | -3.44 A | -      | Able to sink 20 A output current at any output voltage up to and including 2.5 V. |
| $V_o=0.9$ V              | -      | -0.97 A | -      |                                                                                   |
| Input Current (No Load)  | -      | 95 mA   | -      |                                                                                   |
| Remote Off Input Current | -      | 5 mA    | 10 mA  |                                                                                   |

# NON-ISOLATED DC/DC CONVERTERS

12 Vdc Input

0.9 Vdc - 5.0 Vdc/20 A Output



## Input Specifications (continued)

| Parameter                              | Min   | Typ    | Max    | Notes                                                                                                                           |
|----------------------------------------|-------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------|
| Input Reflected Ripple Current (pk-pk) |       |        |        | Tested with simulated source impedance of 1.5 uH 5Hz to 20 MHz, and 2 × 270 uF/16 V Oscon capacitors (ESR ≤ 20 mΩ) at the input |
| Vo=5.0 V                               | -     | 280 mA | 350 mA |                                                                                                                                 |
| Vo=3.3 V                               | -     | 250 mA | 320 mA |                                                                                                                                 |
| Vo=2.5 V                               | -     | 200 mA | 280 mA |                                                                                                                                 |
| Vo=0.9 V                               | -     | 150 mA | 250 mA |                                                                                                                                 |
| Input Reflected Ripple Current (rms)   |       |        |        |                                                                                                                                 |
| Vo=5.0 V                               | -     | 80 mA  | 120 mA |                                                                                                                                 |
| Vo=3.3 V                               | -     | 70 mA  | 100 mA |                                                                                                                                 |
| Vo=2.5 V                               | -     | 45 mA  | 80 mA  |                                                                                                                                 |
| Vo=0.9 V                               | -     | 40 mA  | 60 mA  |                                                                                                                                 |
| External Input Capacitance             | -     | 540 uF | -      |                                                                                                                                 |
| Turn-on Voltage Threshold              | 8.5 V | 9.0 V  | 9.5 V  |                                                                                                                                 |
| Turn-off Voltage Threshold             | 7.0 V | 7.6 V  | 8.3 V  |                                                                                                                                 |

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

## Output Specifications

| Parameter                       | Min            | Typ   | Max                  | Notes                                                                                                                                            |                                                                                                                                                       |
|---------------------------------|----------------|-------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Voltage Set Point        | -2.5%Vo,set    | -     | 2.5%Vo,set           | Vin=12 V, Io=Iomax, full load                                                                                                                    |                                                                                                                                                       |
| Output Voltage Set Point        | -3.5%Vo,set    | -     | 3.5%Vo,set           | Over all operating input voltage, resistive load, and temperature conditions                                                                     |                                                                                                                                                       |
| Load Regulation                 |                |       |                      | Io=Iomin to Iomax                                                                                                                                |                                                                                                                                                       |
| Vo=5.0 V                        | -              | -     | 0.4%Vo,set           |                                                                                                                                                  |                                                                                                                                                       |
| Vo=3.3 V                        | -              | -     | 0.4%Vo,set           |                                                                                                                                                  |                                                                                                                                                       |
| Vo=2.5 V                        | -              | -     | 0.5%Vo,set           |                                                                                                                                                  |                                                                                                                                                       |
| Vo=0.9 V                        | -              | -     | 1%Vo,set             |                                                                                                                                                  |                                                                                                                                                       |
| Line Regulation                 | -              | -     | 0.5%Vo,set           | Vin=Vinmin to Vinmax                                                                                                                             |                                                                                                                                                       |
| Output Ripple and Noise (pk-pk) |                |       |                      | Tested at 0-20 MHz BW, with a 680 uF/6.3 V Oscon capacitor (ESR ≤ 12 mΩ), 10uF/16V Tantalum capacitor, and 10nF ceramic capacitor at the output. |                                                                                                                                                       |
| Vo=5.0 V                        | -              | 65 mV | 80 mV                |                                                                                                                                                  |                                                                                                                                                       |
| Vo=3.3 V                        | -              | 60 mV | 75 mV                |                                                                                                                                                  |                                                                                                                                                       |
| Vo=2.5 V                        | -              | 55 mV | 70 mV                |                                                                                                                                                  |                                                                                                                                                       |
| Vo=0.9 V                        | -              | 45 mV | 55 mV                |                                                                                                                                                  |                                                                                                                                                       |
| Output Ripple and Noise (rms)   |                |       |                      |                                                                                                                                                  |                                                                                                                                                       |
| Vo=5.0 V                        | -              | 18 mV | 25 mV                |                                                                                                                                                  |                                                                                                                                                       |
| Vo=3.3 V                        | -              | 15 mV | 25 mV                |                                                                                                                                                  |                                                                                                                                                       |
| Vo=2.5 V                        | -              | 15 mV | 20 mV                |                                                                                                                                                  |                                                                                                                                                       |
| Vo=0.9 V                        | -              | 10 mV | 15 mV                |                                                                                                                                                  |                                                                                                                                                       |
| Output Current                  | 0 A            | -     | 20 A                 |                                                                                                                                                  |                                                                                                                                                       |
| Current Limit Threshold         | 25 A           | -     | 40 A                 |                                                                                                                                                  |                                                                                                                                                       |
| Short Circuit Surge Transient   | -              | -     | 0.1 A <sup>2</sup> s |                                                                                                                                                  |                                                                                                                                                       |
| Turn on Time                    | -              | 5 mS  | 10 mS                |                                                                                                                                                  |                                                                                                                                                       |
| Overshoot at Turn on            | -              | 0%Vo  | 3%Vo                 |                                                                                                                                                  |                                                                                                                                                       |
| Output Capacitance              |                |       |                      |                                                                                                                                                  |                                                                                                                                                       |
| Vo=5.0 V                        | 680 uF         | -     | 5080 uF              |                                                                                                                                                  |                                                                                                                                                       |
| Vo=2.5 V                        | 680 uF         | -     | 7840 uF              |                                                                                                                                                  |                                                                                                                                                       |
| Vo=0.9 V                        | 680 uF         | -     | 11000 uF             |                                                                                                                                                  |                                                                                                                                                       |
| <b>Transient Response</b>       |                |       |                      |                                                                                                                                                  |                                                                                                                                                       |
| 50% ~ 75% Max Load              | Vo=0.9 V-5.0 V | -     | 100 mV               | 150 mV                                                                                                                                           | di/dt=2.5 A/uS; Vin=12 V; with a 680 uF/6.3 V Oscon capacitor (ESR ≤ 12 mΩ), 10 uF/16 V Tantalum capacitor and 10 nF ceramic capacitor at the output. |
| Settling Time                   |                | -     | 40 uS                | 80 uS                                                                                                                                            |                                                                                                                                                       |
| 75% ~ 50% Max Load              |                | -     | 100 mV               | 150 mV                                                                                                                                           |                                                                                                                                                       |
| Settling Time                   |                | -     | 40 uS                | 80 uS                                                                                                                                            |                                                                                                                                                       |

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



# NON-ISOLATED DC/DC CONVERTERS

12 Vdc Input

0.9 Vdc - 5.0 Vdc/20 A Output



## General Specifications

| Parameter                   | Min                   | Typ     | Max     | Notes                                                      |
|-----------------------------|-----------------------|---------|---------|------------------------------------------------------------|
| Efficiency (Current Source) |                       |         |         | Measured at Vin=12 V, full load.                           |
| Vo=5.0 V                    | 89%                   | 92%     | -       |                                                            |
| Vo=3.3 V                    | 86%                   | 89%     | -       |                                                            |
| Vo=2.5 V                    | 83%                   | 86%     | -       |                                                            |
| Efficiency (Current Sink)   |                       |         |         |                                                            |
| Vo=2.5 V                    | 79%                   | 82%     | -       |                                                            |
| Vo=0.9 V                    | 60%                   | 63%     | -       |                                                            |
| Switching Frequency         | 240 kHz               | 275 kHz | 310 kHz |                                                            |
| Output Voltage Trim Range   | 0.9 V                 | -       | 5.0 V   | Vo=0.9 V when the Trim pin is open.                        |
| MTBF                        | 5,570,000 hours       |         |         | Calculated Per Bell Core SR-332 (Io = Nominal; Ta = 25 °C) |
| Dimensions                  |                       |         |         | VRPF-20A1A0                                                |
| Inches (L x W x H)          | 1.2 x 1.1 x 0.457     |         |         |                                                            |
| Millimeters (L x W x H)     | 30.48 x 27.94 x 11.6  |         |         |                                                            |
| Dimensions                  |                       |         |         | ORPF-20A1A0                                                |
| Inches (L x W x H)          | 1.2 x 1.1 x 0.508     |         |         |                                                            |
| Millimeters (L x W x H)     | 30.48 x 27.94 x 12.91 |         |         |                                                            |
| Weight                      | -                     | 15 g    | -       |                                                            |

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

## Control Specifications

| Parameter                     | Min    | Typ | Max    | Notes                            |
|-------------------------------|--------|-----|--------|----------------------------------|
| <b>Remote On/Off</b>          |        |     |        |                                  |
| Signal Low (Unit Off)         | -0.3 V | -   | 0.8 V  | Remote On/Off pin open, unit on. |
| Signal High (Unit On)         | 2.4 V  | -   | 13.8 V |                                  |
| <b>Power Good</b>             |        |     |        |                                  |
| Power Good Delay <sup>1</sup> | -      | -   | 8 mS   |                                  |

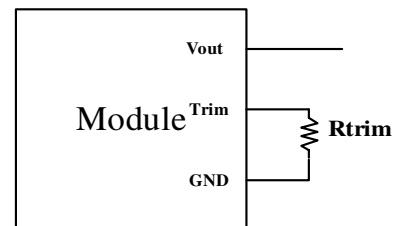
**Note:** All specifications are typical at 25 °C unless otherwise stated.

- The power good signal is an open collector output. When the output of the module reaches 90% of the nominal set point, the power good pin is set high.

## Output Trim Equations

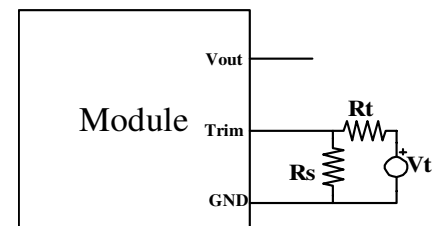
Equation for calculating the trim resistor (in kΩ) given the desired adjusted voltage (Vadj) is shown below. The Trim Up resistor should be connected between the Trim pin and Ground. Trim values should not be less than 280Ω.

$$R_{trim} = \frac{1.17}{V_{adj} - 0.9}$$



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

$$R_t = \frac{R_s \times (1.3V_t - 1.17)}{1.17 - R_s \times (V_{adj} - 0.9)}$$



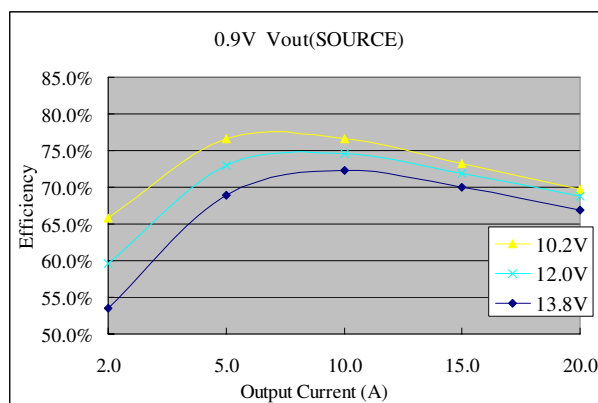
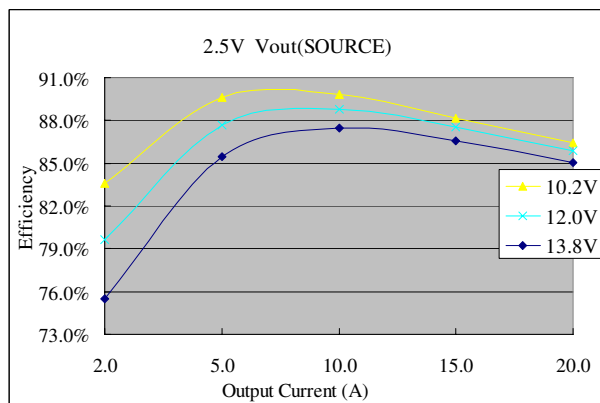
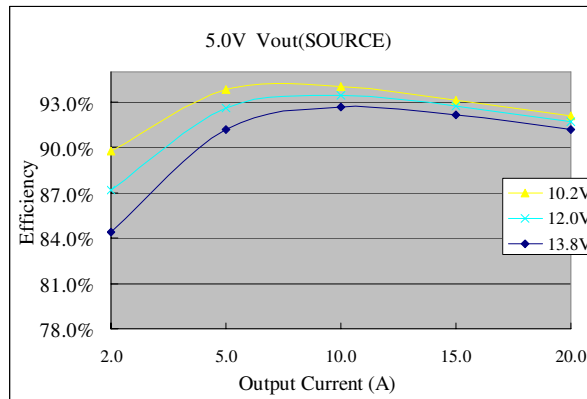
# NON-ISOLATED DC/DC CONVERTERS

12 Vdc Input

0.9 Vdc - 5.0 Vdc/20 A Output



## Efficiency Data



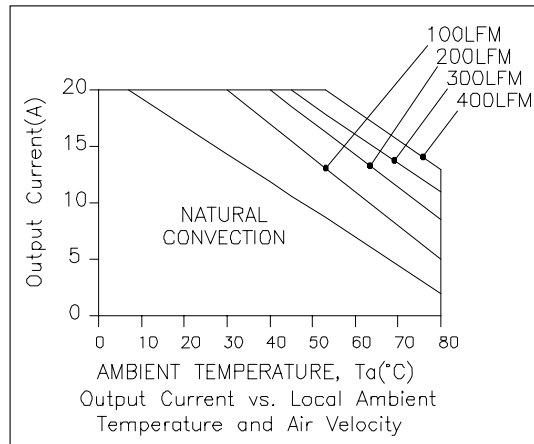
# NON-ISOLATED DC/DC CONVERTERS

12 Vdc Input

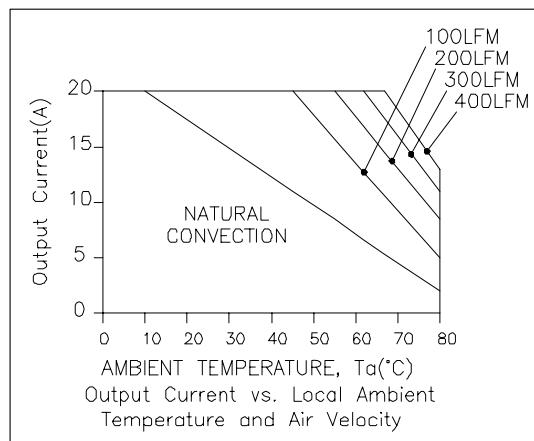
0.9 Vdc - 5.0 Vdc/20 A Output



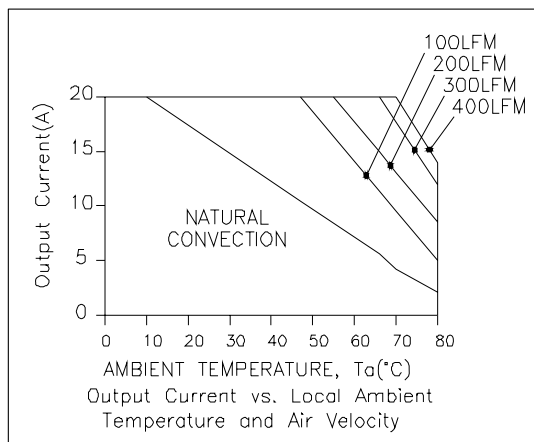
## Thermal Derating Curves



$V_o=5\text{ V}; V_{in}=12\text{ V}$



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



$V_o=0.9\text{ V}; V_{in}=12\text{ V}$

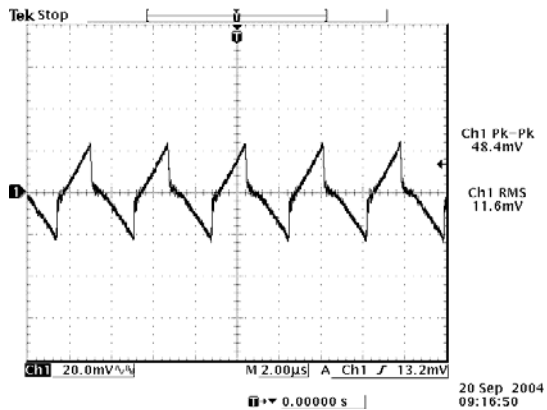
# NON-ISOLATED DC/DC CONVERTERS

12 Vdc Input

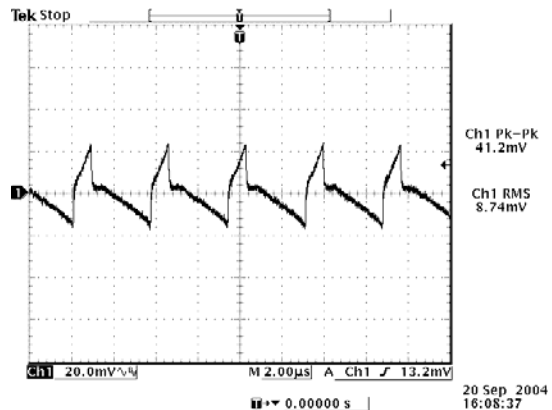
0.9 Vdc - 5.0 Vdc/20 A Output



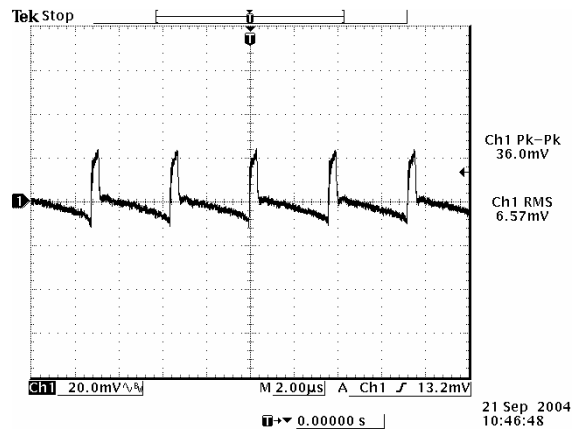
## Ripple and Noise Waveforms



12 V input, 5.0 V output



12 V input, 2.5 V output



12 V input, 0.9 V output

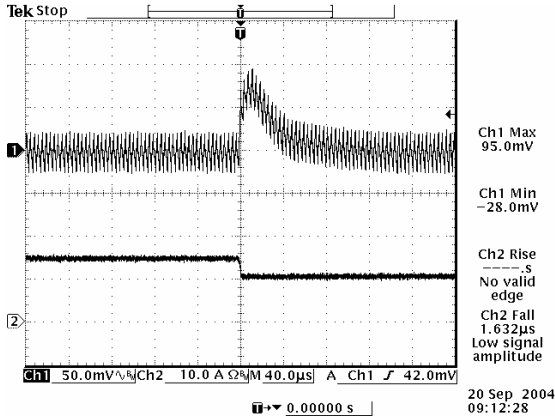
**Note:** Ripple and noise at full load, 0-20MHz BW, with 680 uF/6.3 V Oscon cap, 10 uF/16 V Tan cap and 10 nF ceramic cap at the output, Ta=25 deg C.

# NON-ISOLATED DC/DC CONVERTERS

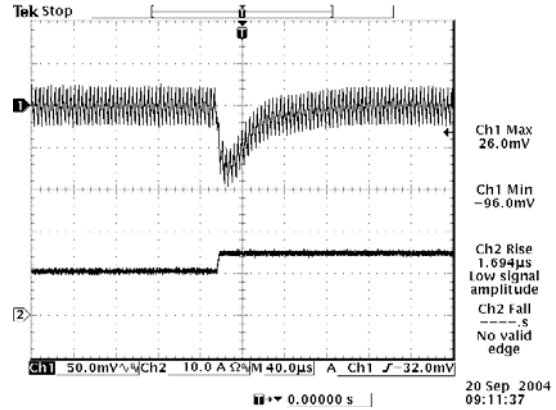
12 Vdc Input      0.9 Vdc - 5.0 Vdc/20 A Output



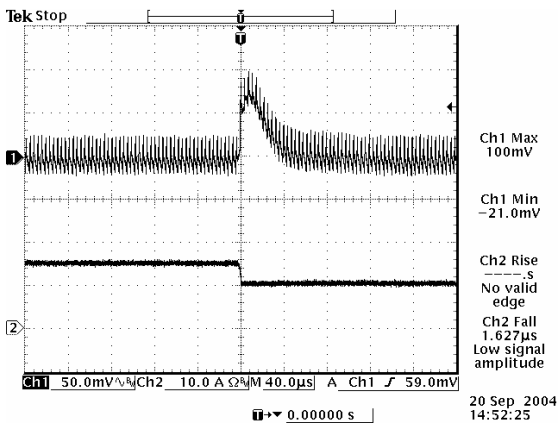
## Transient Response Waveforms



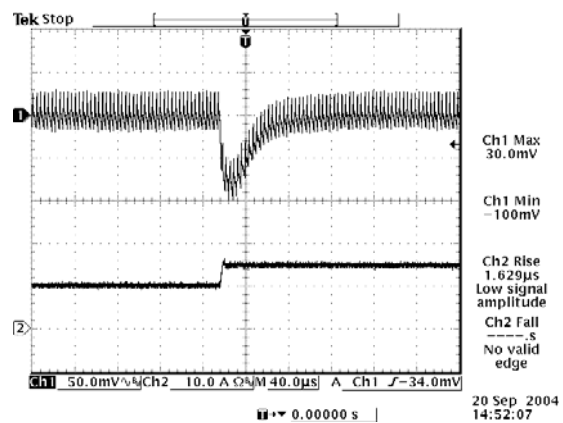
75% to 50% load step, 5.0 Vdc output



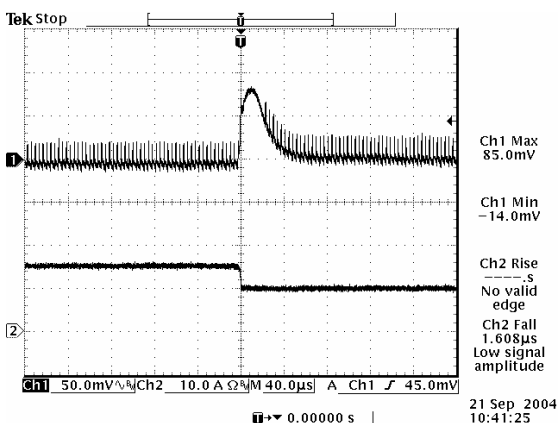
50% to 75% load step, 5.0 Vdc output



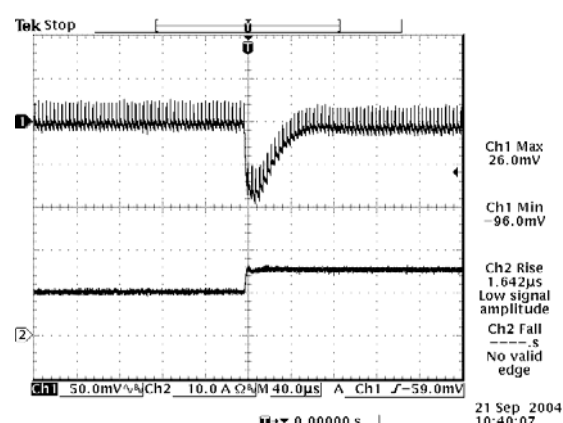
75% to 50% load step, 2.5 Vdc output



50% to 75% load step, 2.5 Vdc output



75% to 50% load step, 0.9 Vdc output



50% to 75% load step, 0.9 Vdc output

**Note:** Transient response at  $di/dt=2.5 \text{ A}/\mu\text{S}$ , with a 680  $\mu\text{F}/6.3 \text{ V}$  Oscon cap, a 10  $\mu\text{F}/16 \text{ V}$  Tan cap and a 10 nF ceramic cap at the output,  $T_a=25 \text{ deg C}$ .



# NON-ISOLATED DC/DC CONVERTERS

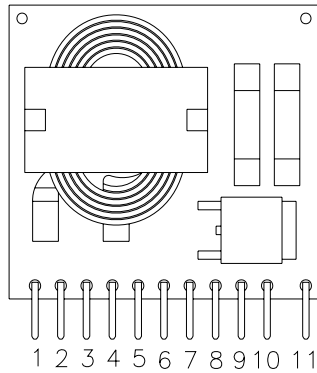
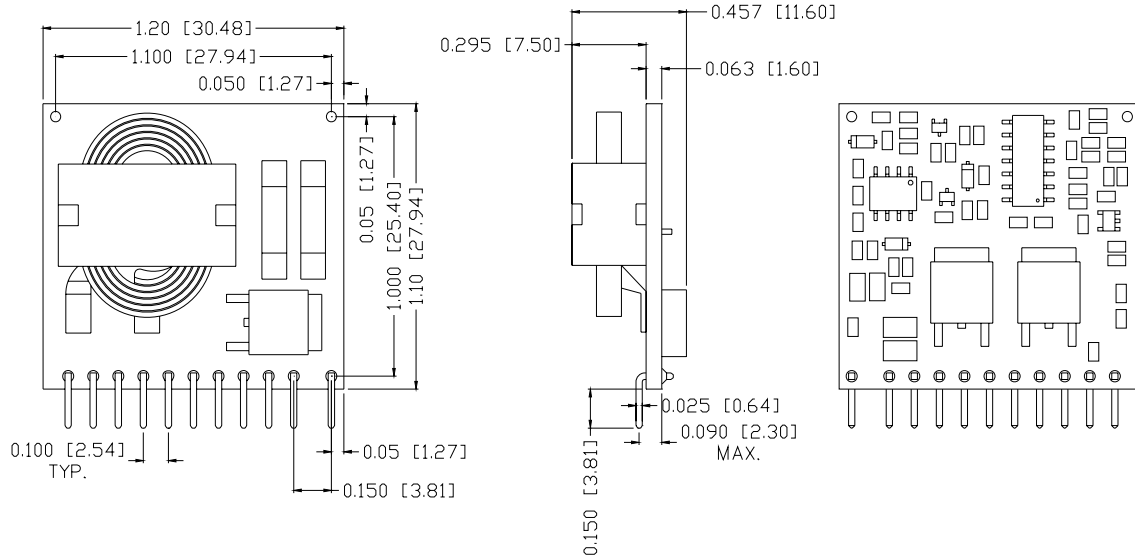
12 Vdc Input

0.9 Vdc - 5.0 Vdc/20 A Output



## Mechanical Outline

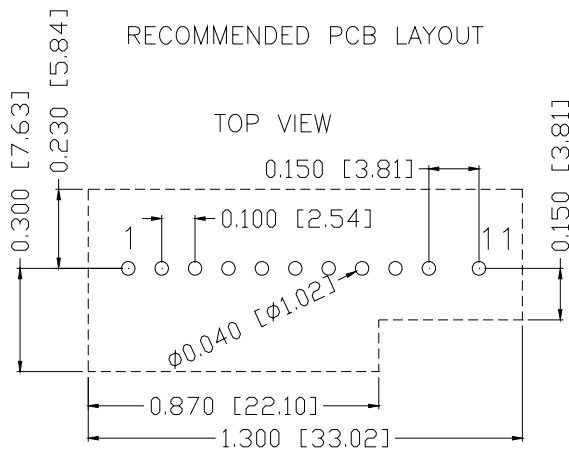
### VRPF-20A1A0



## Pin Connections

| Pin | Function      |
|-----|---------------|
| 1   | Vout          |
| 2   | Vout          |
| 3   | Vout          |
| 4   | Trim          |
| 5   | Remote On/Off |
| 6   | Power Good    |
| 7   | Ground        |
| 8   | Ground        |
| 9   | Reserved      |
| 10  | Vin           |
| 11  | Vin           |

## RECOMMENDED PCB LAYOUT



# NON-ISOLATED DC/DC CONVERTERS

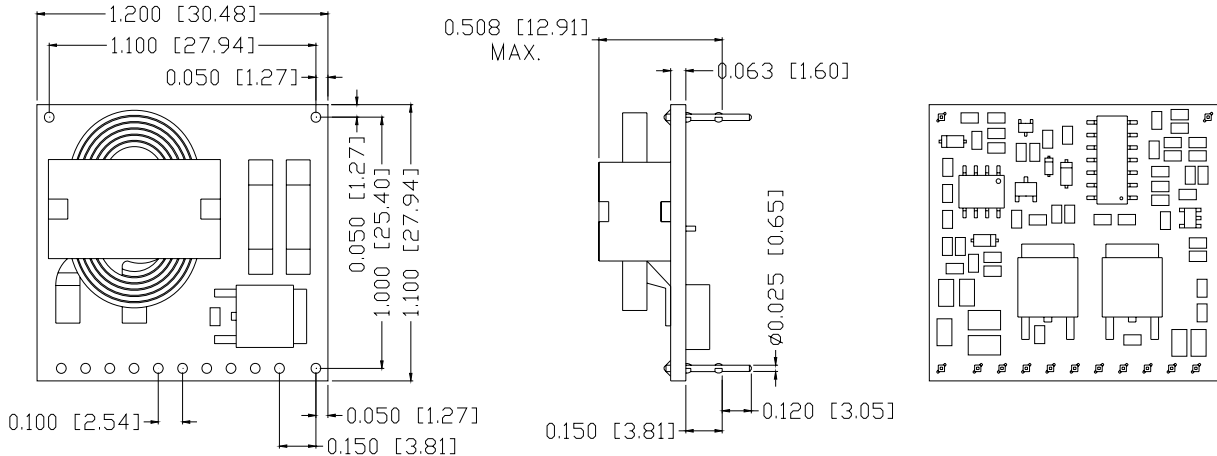
12 Vdc Input

0.9 Vdc - 5.0 Vdc/20 A Output

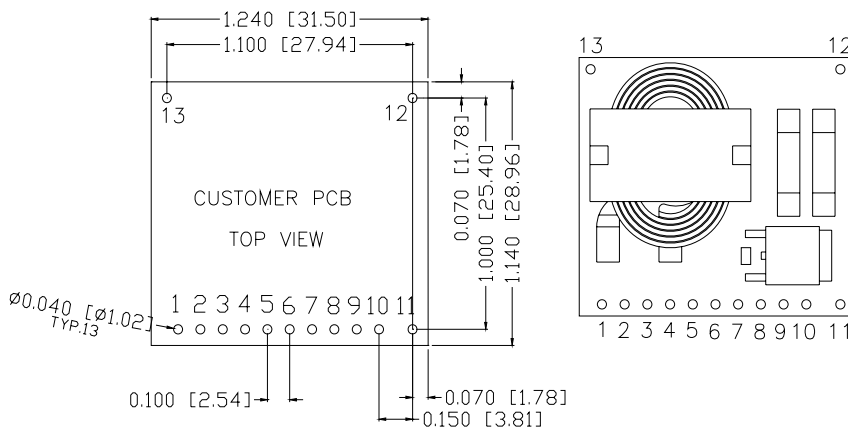


## Mechanical Outline (continued)

### ORPF-20A1A0



#### RECOMMENDED PCB LAYOUT



## Pin Connections

| Pin | Function      |
|-----|---------------|
| 1   | Vout          |
| 2   | Vout          |
| 3   | Vout          |
| 4   | Trim          |
| 5   | Remote On/Off |
| 6   | Power Good    |
| 7   | Ground        |
| 8   | Ground        |
| 9   | Pwrgd_set     |
| 10  | Vin           |
| 11  | Vin           |
| 12  | Support Pin   |
| 13  | Support Pin   |

## 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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