

## NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 13.8 Vdc Input      0.6 Vdc - 5.0 Vdc/40 A Output

**bel**  
POWER PRODUCTS

xRP2-40E1A0

RoHS Compliant

Rev.D

- Non-Isolated
- High Efficiency
- Fixed Switching Frequency
- Low Cost
- Excellent Thermal Performance
- Wide Input Voltage Range
- Wide Output Trim Range
- Output Over-Voltage Shutdown
- OCP/SCP
- Low Output Ripple
- Power Good Signal
- Remote On/Off



### Description

The xRP2-40E1A0 is a non-isolated dc/dc converter that operates over a wide range of input voltage ( $V_{in} = 5 \text{ Vdc} - 13.8 \text{ Vdc}$ ). This unit can provide a precisely regulated output voltage from 0.6 Vdc to 5.0 Vdc and can deliver up to 40 A of output current. This unit is designed to be highly efficient and low cost. The converter is provided in an industry standard package.

### Part Selection

| Output Voltage | Input Voltage  | Max. Output Current | Max. Output Power | Typical Efficiency ( $V_o=1.8 \text{ Vdc}$ ) | Part Number Horizontal Mount | Part Number Vertical Mount |
|----------------|----------------|---------------------|-------------------|--|------------------------------|----------------------------|
| 0.6 V - 5.0 V  | 5.0 V - 13.8 V | 40 A                | 200 W             | 87%  | 0RP2-40E1A0                  | VRP2-40E1A0                |

**Notes:** 1. All part numbers above indicate RoHS 6. Change the second letter "R" to "7" for RoHS 5 part numbers.  
2. Add "G" suffix at the end of the model numbers listed above to indicate "Tray Packaging".

### Absolute Maximum Ratings

| Parameter                      | Min    | Typ | Max    | Notes |
|--------------------------------|--------|-----|--------|-------|
| Input Voltage (continuous)     | -0.3 V | -   | 15 V   |       |
| Output Enable Terminal Voltage | -0.3 V | -   | 15 V   |       |
| Ambient Temperature            | 0 °C   | -   | 70 °C  |       |
| Storage Temperature            | -55 °C | -   | 125 °C |       |

### Input Specifications

| Parameter                              | Min                      | Typ             | Max                | Notes  |
|--|--------------------------|-----------------|--------------------|--|
| Input Voltage                          |                          |                 |                    |  |
|  | $V_o \leq 2.8 \text{ V}$ | 5 V             | 12 V               | 13.8 V   |
|  | $V_o > 2.8 \text{ V}$    | $1.8 \cdot V_o$ | 12 V               | 13.8 V   |
| Input Current (full load)              | -                        | -               | 30 A               |  |
| Input Reflected Ripple Current (pk-pk) | -                        | 35 mA           | -                  | With simulated source impedance of 1 uH, 5 Hz to 20 MHz. Use a 1000 uF/16 V electrolytic capacitor with ESR=0.1 ohm max, at 100 kHz at 25°C. |
| Input Reflected Ripple Current (rms)   | -                        | 10 mA           | -                  |  |
| $I^2t$ Inrush Current Transient        | -                        | -               | 1 A <sup>2</sup> s |  |
| Turn-on Voltage Threshold              | 4.4 V                    | 4.6 V           | 4.8 V              |  |
| Under Voltage Threshold                | 4.0 V                    | 4.3 V           | 4.6 V              |  |

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

# NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 13.8 Vdc Input

0.6 Vdc - 5.0 Vdc/40 A Output



## Output Specifications

| Parameter   | Min                        | Typ                        | Max   | Notes  |   |
|---|----------------------------|----------------------------|---|--|---|
| Output Voltage Set Point<br>Vo ≥ 1 V<br>Vo < 1 V  | -1.5 % Vo<br>-10 mV        | -<br>-                     | +1.5 % Vo<br>+10 mV                                 | Vin=Vinmin, Io=Iomax   |   |
| Load Regulation<br>Vo ≥ 2.5 V<br>Vo < 2.5 V   | -<br>-                     | -<br>-                     | 0.6% Vo<br>12 mV                                    |  |   |
| Line Regulation<br>Vo ≥ 2.5 V<br>Vo < 2.5 V   | -<br>-                     | -<br>-                     | 0.3% Vo<br>9 mV                                     |  |   |
| Regulation Over Temperature<br>(0 °C to +70 °C)   | -                          | -                          | 0.02% Vo/C  |  |   |
| Output Current  | 0 A                        | -                          | 40 A  |  |   |
| Current Limit Threshold   | 105% Io                    | 130% Io                    | 160% Io   |  |   |
| Output Ripple and Noise (pk-pk)<br>Vo=5.0 V<br>Vo=3.3 V<br>Vo=2.5 V<br>Vo=1.5 V<br>Vo=1.0 V<br>Vo=0.6 V | -<br>-<br>-<br>-<br>-<br>- | -<br>-<br>-<br>-<br>-<br>- | 120 mV<br>60 mV<br>40 mV<br>40 mV<br>30 mV<br>30 mV | Test conditions:<br>0-20MHz BW, with a 1µF ceramic capacitor and a 10 uF Tantalum cap at output. |   |
| Output Ripple and Noise (rms)<br>Vo=5.0 V<br>Vo=3.3 V<br>Vo=2.5 V<br>Vo=1.5 V<br>Vo=1.0 V<br>Vo=0.6 V   | -<br>-<br>-<br>-<br>-<br>- | -<br>-<br>-<br>-<br>-<br>- | 30 mV<br>30 mV<br>20 mV<br>20 mV<br>15 mV<br>15 mV  |  |   |
| Turn On Time  | -                          | -                          | 10 mS   |  |   |
| Rise Time   | -                          | -                          | 3 mS  |  |   |
| Overshoot at Turn on and off  | -                          | -                          | 0.5%  |  |   |
| Output Capacitance<br>ESR ≥ 1 mΩ  | 0 uF                       | -                          | 4700 uF   |  |   |
| <b>Transient Response</b>   |                            |                            |   |  |   |
| 0% ~ 50% Max Load   | Vo=All                     | -                          | -   | 300 mV   | Test conditions:<br>di/dt = 10 A/uS; Vin =12 V; |
| Settling Time   |                            | -                          | -   | 100 uS   |   |
| 50% ~ 0% Max Load   |                            | -                          | -   | 300 mV   |   |
| Settling Time   |                            | -                          | -   | 100 uS   |   |

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

# NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 13.8 Vdc Input      0.6 Vdc - 5.0 Vdc/40 A Output



## General Specifications

| Parameter                     | Min                  | Typ        | Max        | Notes   |
|-------------------------------|----------------------|------------|------------|---|
| Efficiency                    |                      |            |            | Measured at Vin=12 V, full load.  |
| Vo=5.0 V                      | 91%                  | 94%        | -          |   |
| Vo=3.3 V                      | 89%                  | 92%        | -          |   |
| Vo=2.5 V                      | 87%                  | 90%        | -          |   |
| Vo=1.8 V                      | 84%                  | 87%        | -          |   |
| Vo=1.5 V                      | 82%                  | 85%        | -          |   |
| Vo=1.2 V                      | 79%                  | 82%        | -          |   |
| Vo=1.0 V                      | 76%                  | 79%        | -          |   |
| Vo=0.6 V                      | 68%                  | 71%        | -          |   |
| Switching Frequency           | -                    | 500 kHz    | -          |   |
| Output Voltage Trim Range     | 0.6 V                | -          | 5 V        | Trim pin is open, Vo = 0.6 V.   |
| Over Voltage Protection       | 110% Vo,set          | 115%Vo,set | 130%Vo,set | Vin=12 V, Io=full load.   |
| MTBF                          | 2,392,000 hours      |            |            | Calculated Per Bell Core SR-332 (Io = 80%Iomax; Vin=12 V; Ta = 25 °C;ORP2-40E1A0) |
|                               | 3,061,000 hours      |            |            | Calculated Per Bell Core SR-332 (Io = 80%Iomax; Vin=12 V; Ta = 25 °C;VRP2-40E1A0) |
| Dimensions (horizontal mount) |                      |            |            |   |
| Inches (L x W x H)            | 1.45 x 1.10 x 0.50   |            |            |   |
| Millimeters (L x W x H)       | 36.83 x 27.94 x 12.7 |            |            |   |
| Dimensions (vertical mount)   |                      |            |            |   |
| Inches (L x W x H)            | 1.45 x 1.10 x 0.377  |            |            |   |
| Millimeters (L x W x H)       | 36.83 x 27.94 x 9.58 |            |            |   |
| Weight                        | -                    | 19 g       | -          |   |

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

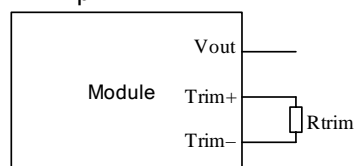
## Control Specifications

| Parameter                          | Min    | Typ | Max     | Notes                                   |
|------------------------------------|--------|-----|---------|---|
| <b>Remote On/Off (Active High)</b> |        |     |         |   |
| Signal Low (Unit Off)              | -0.3 V | -   | 0.8 V   | Remote On/Off pin is open, unit is off. |
| Signal High (Unit On)              | 2.0 V  | -   | Vin,max |   |
| Current Source/Sink                | 0 mA   | -   | 3.3 mA  |   |
| <b>PwGood (PowerGood)</b>          |        |     |         |   |
| PwGood = High = Power Good         | 2.4 V  | -   | 5.25 V  |   |
|                                    | -      | -   | 2 mA    |   |
| PwGood = Low = Power Not Good      | 0 V    | -   | 0.4 V   |   |
|                                    | -      | -   | 4 mA    |   |

## Output Trim Equation

The Trim resistor should be connected between the Trim+ pin and Trim- pin.

$$R_{trim} = \frac{1.2}{V_o - 0.6} (K\Omega)$$



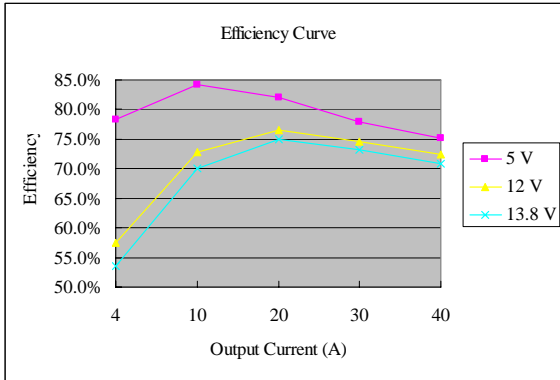
# NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 13.8 Vdc Input

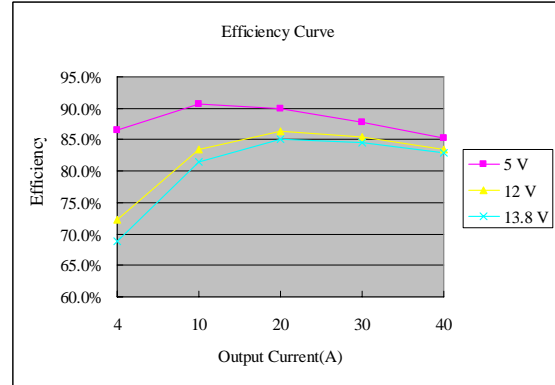
0.6 Vdc - 5.0 Vdc/40 A Output



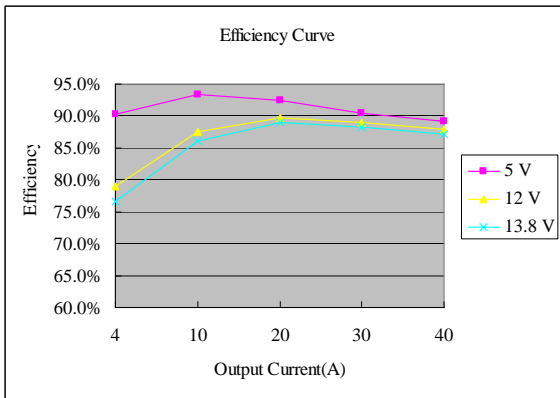
## Efficiency Data



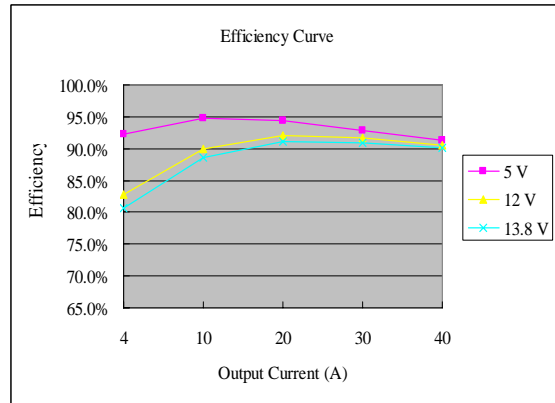
Vout = 0.6 V



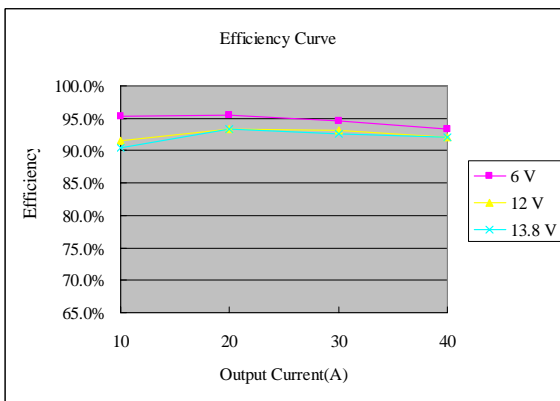
Vout = 1.2 V



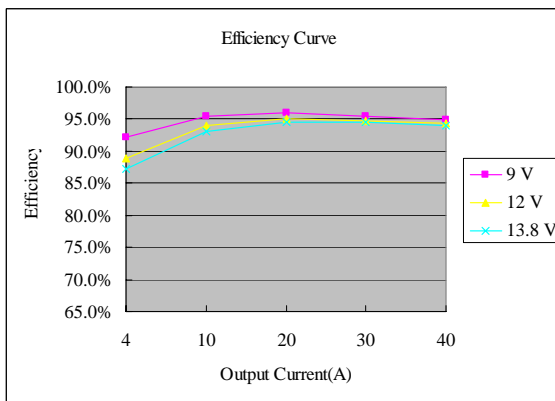
Vout = 1.8 V



Vout = 2.5 V



Vout = 3.3 V



Vout = 5.0 V

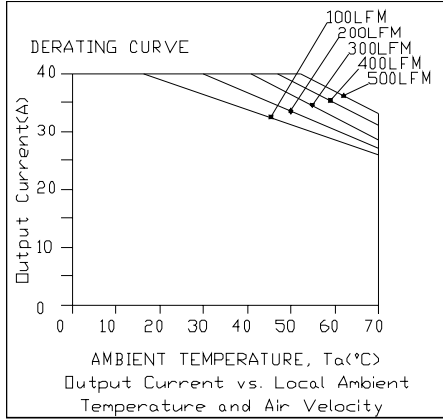
# NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 13.8 Vdc Input

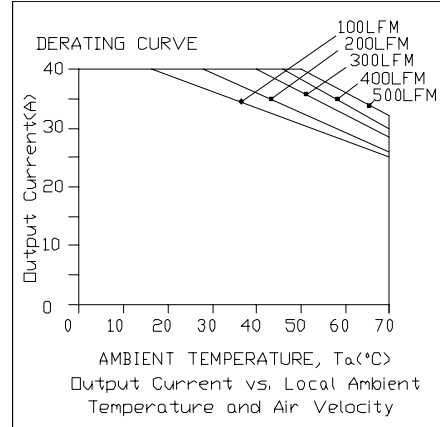
0.6 Vdc - 5.0 Vdc/40 A Output



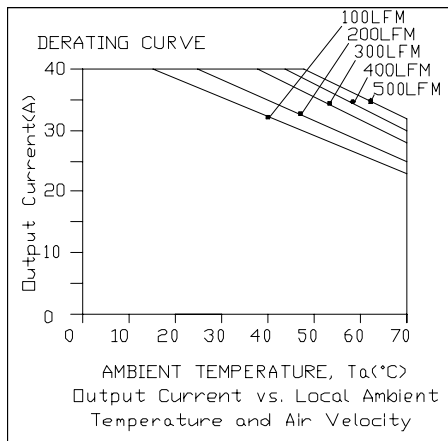
## Thermal Derating Curves



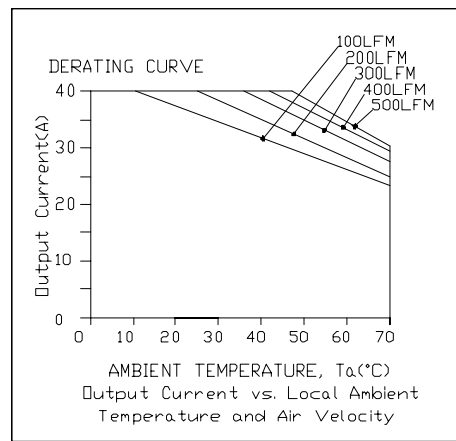
Vin=12 V, Vo=0.6 V



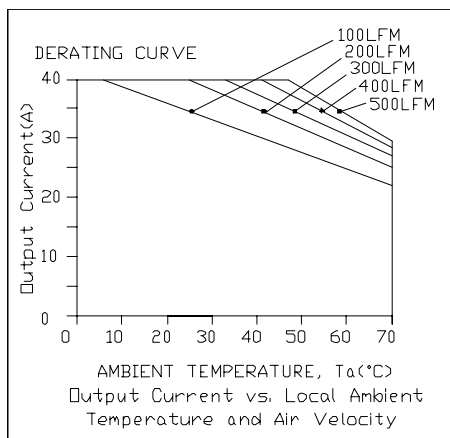
Vin=12 V, Vo=1.2 V



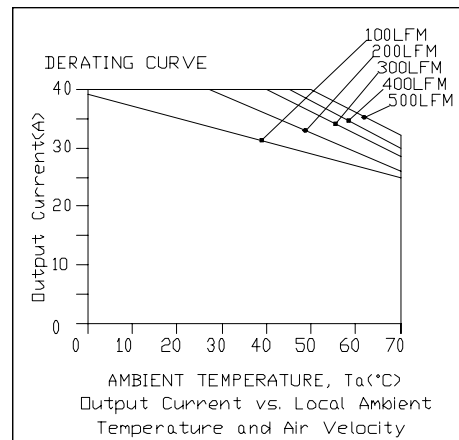
Vin=12 V, Vo=1.8 V



Vin=12 V, Vo=2.5 V



Vin=12 V, Vo=3.3 V



Vin=12 V, Vo=5.0 V

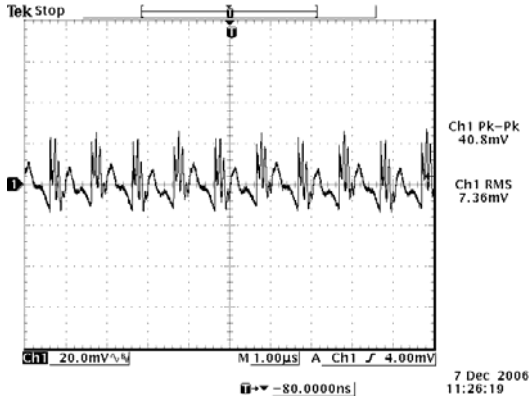
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5 Vdc - 13.8 Vdc Input

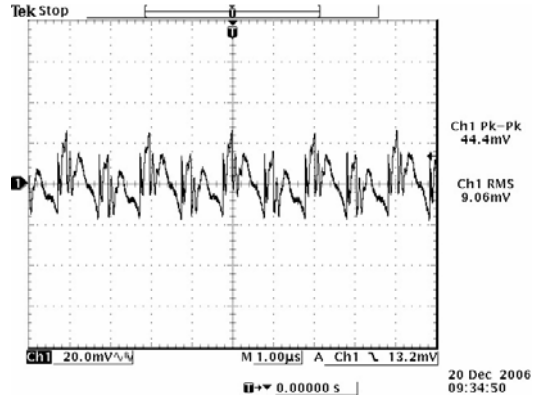
0.6 Vdc - 5.0 Vdc/40 A Output



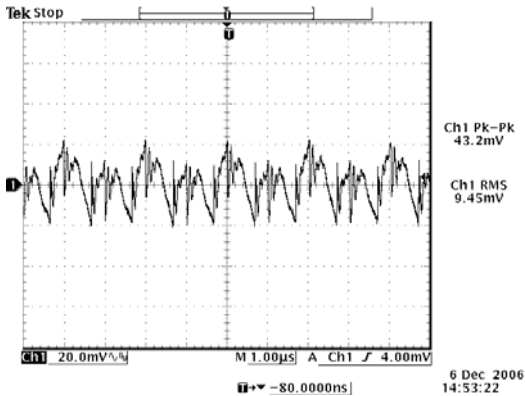
## Ripple and Noise Waveforms



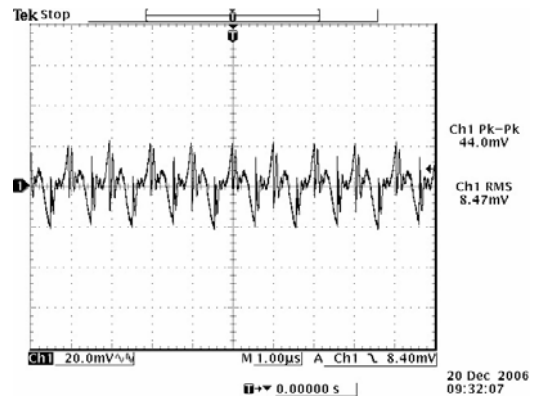
12 Vdc input, 0.6 Vdc/40 A output



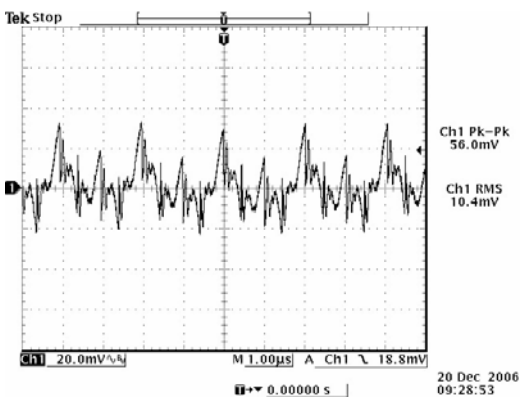
12 Vdc input, 1.2 Vdc/40 A output



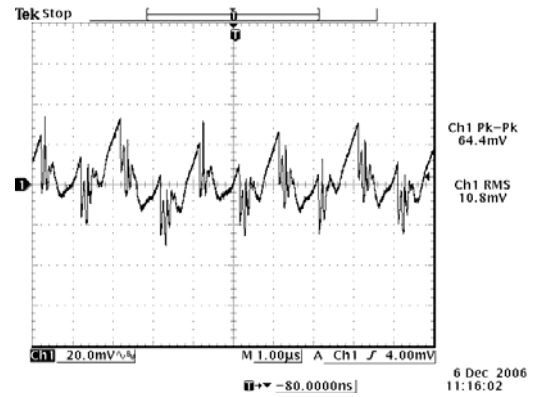
12 Vdc input, 1.8 Vdc/40 A output



12 Vdc input, 2.5 Vdc/40 A output



12 Vdc input, 3.3 Vdc/40 A output



12 Vdc input, 5.0 Vdc/40 A output

**Note:** Ripple and noise at full load, 0-20 MHz BW, with a 10 uF tantalum cap and a 1uF ceramic cap at the output, and Ta=25 deg C.

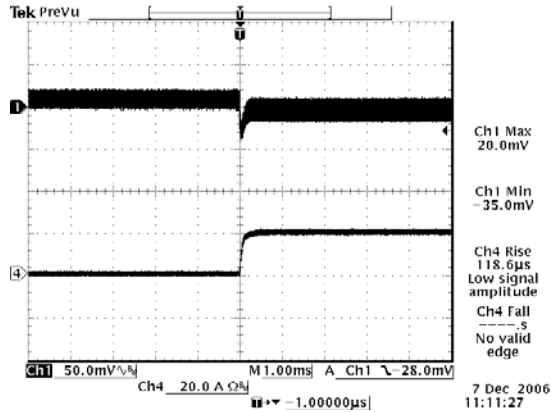
# NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 13.8 Vdc Input

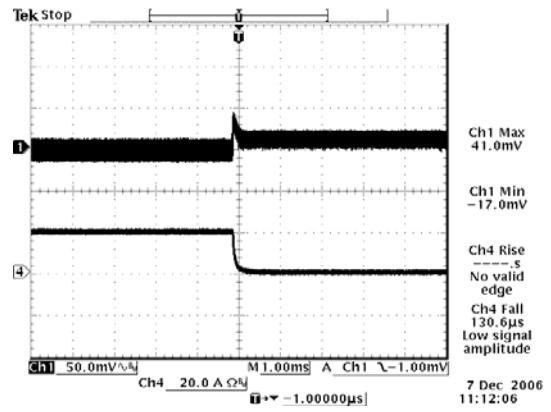
0.6 Vdc - 5.0 Vdc/40 A Output



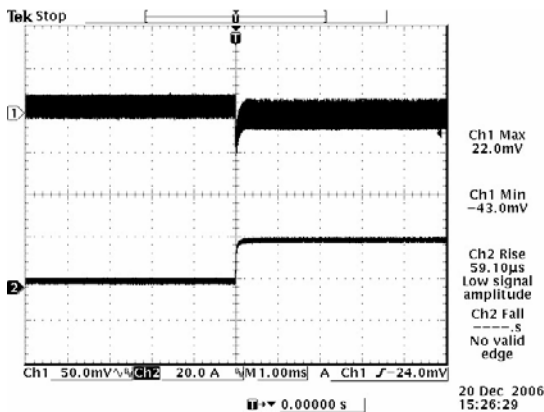
## Transient Response Waveforms



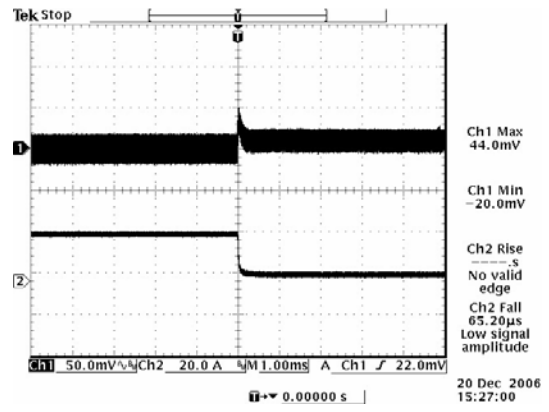
Vout= 0.6 V 0%-50% Load Transients



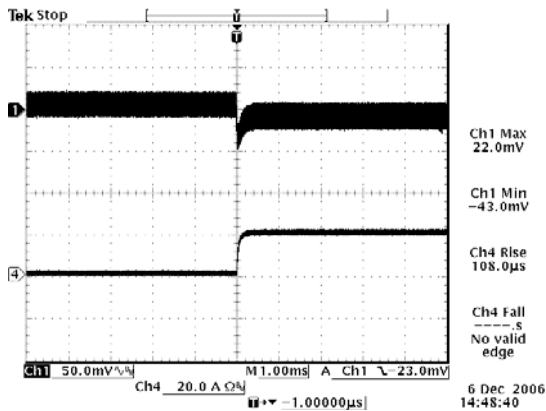
Vout=0.6 V 50%-0% Load Transients



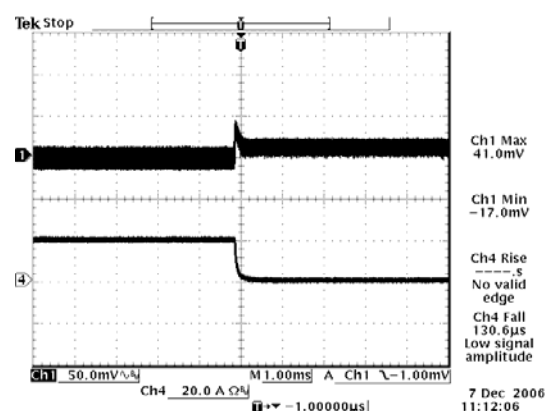
Vout=1.2 V 0%-50% Load Transients



Vout=1.2 V 50%-0% Load Transients



Vout=1.8 V 0%-50% Load Transients



Vout=1.8 V 50%-0% Load Transients



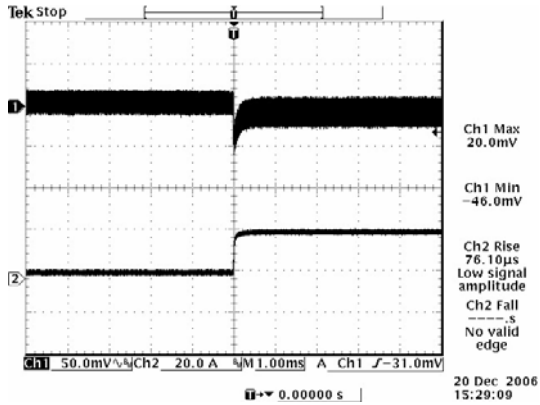
# NON-ISOLATED DC/DC CONVERTERS

5 Vdc - 13.8 Vdc Input

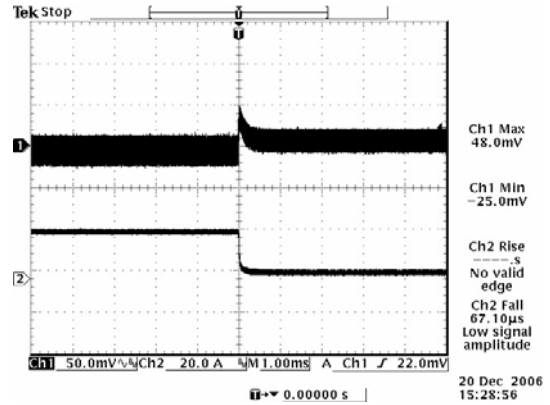
0.6 Vdc - 5.0 Vdc/40 A Output



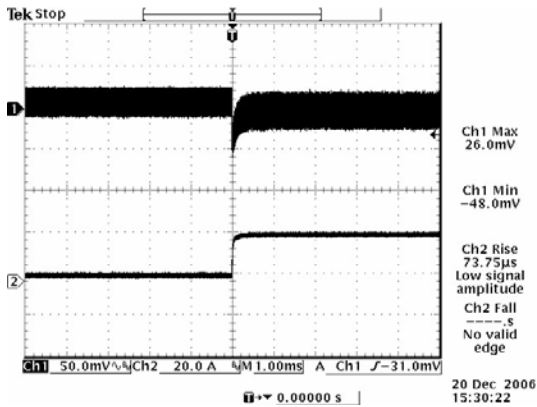
## Transient Response Waveforms (continued)



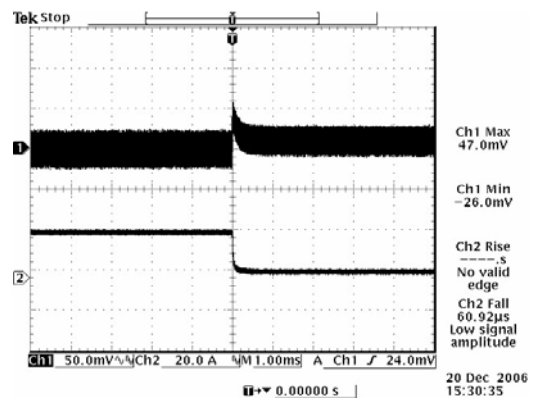
Vout= 2.5 V 0%-50% Load Transients



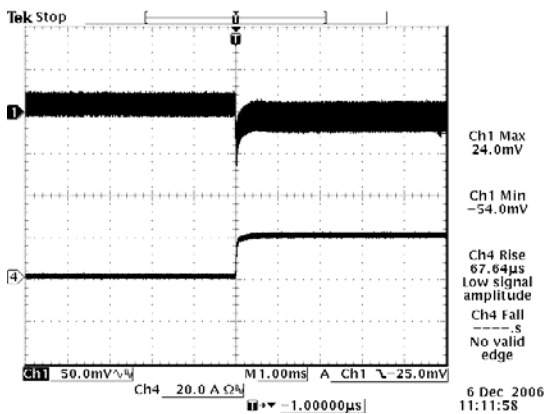
Vout=2.5 V 50%-0% Load Transients



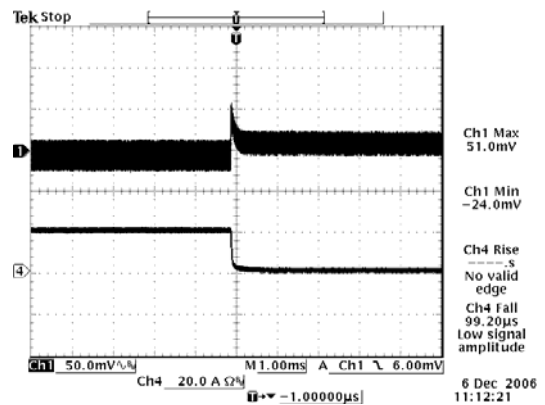
Vout=3.3 V 0%-50% Load Transients



Vout=3.3 V 50%-0% Load Transients



Vout=5 V 0%-50% Load Transients



Vout=5 V 50%-0% Load Transients

**Note:** Transient response at  $di/dt = 10 \text{ A}/\mu\text{s}$ , with external electrolytic cap 4700  $\mu\text{F}$ , and  $T_a=25 \text{ deg C}$ .



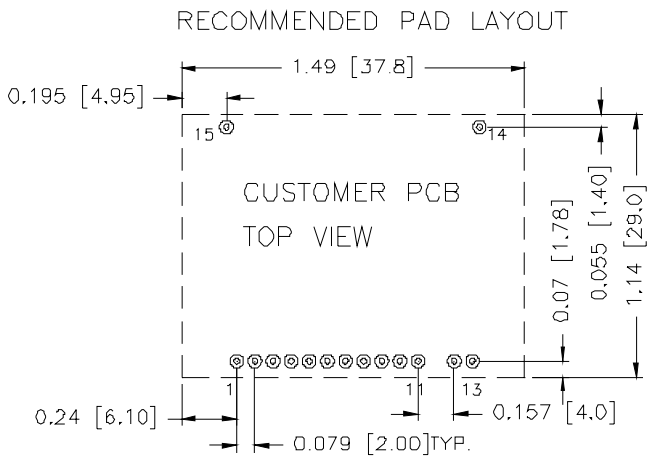
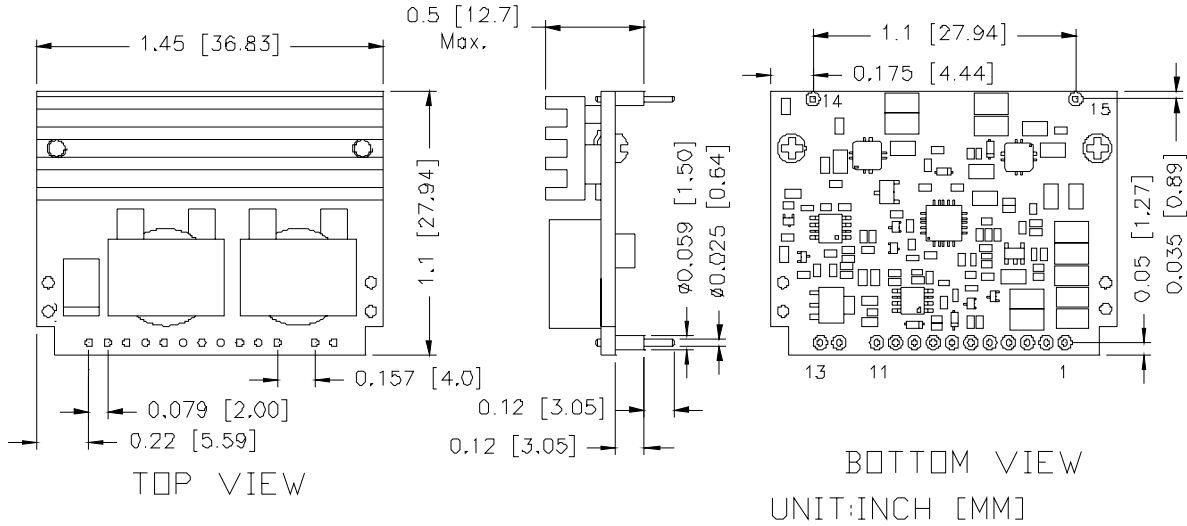
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5 Vdc - 13.8 Vdc Input      0.6 Vdc - 5.0 Vdc/40 A Output

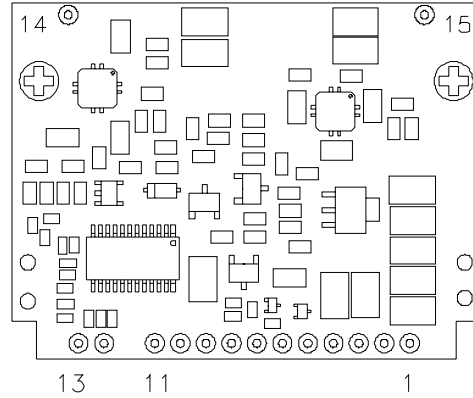


## Mechanical Outline

### 0RP2-40E1A0



2 SUPPORT PAD THR. HOLES  $\varnothing 0.085$  [ $\varnothing 2.2$ ] BOTH SIDE  
13 PIN PAD THR. HOLES:  $\varnothing 0.032$  [ $\varnothing 0.8$ ] BOTH SIDE



## Pin Connections

| Pin | Function | Pin | Function |
|-----|----------|-----|----------|
| 1   | Vout     | 9   | PwGOOD   |
| 2   | Vout     | 10  | Sense-   |
| 3   | Vout     | 11  | Sense+   |
| 4   | GND      | 12  | Vin      |
| 5   | GND      | 13  | Vin      |
| 6   | Enable   | 14  | GND      |
| 7   | Trim-    | 15  | GND      |
| 8   | Trim+    |     |          |

# NON-ISOLATED DC/DC CONVERTERS

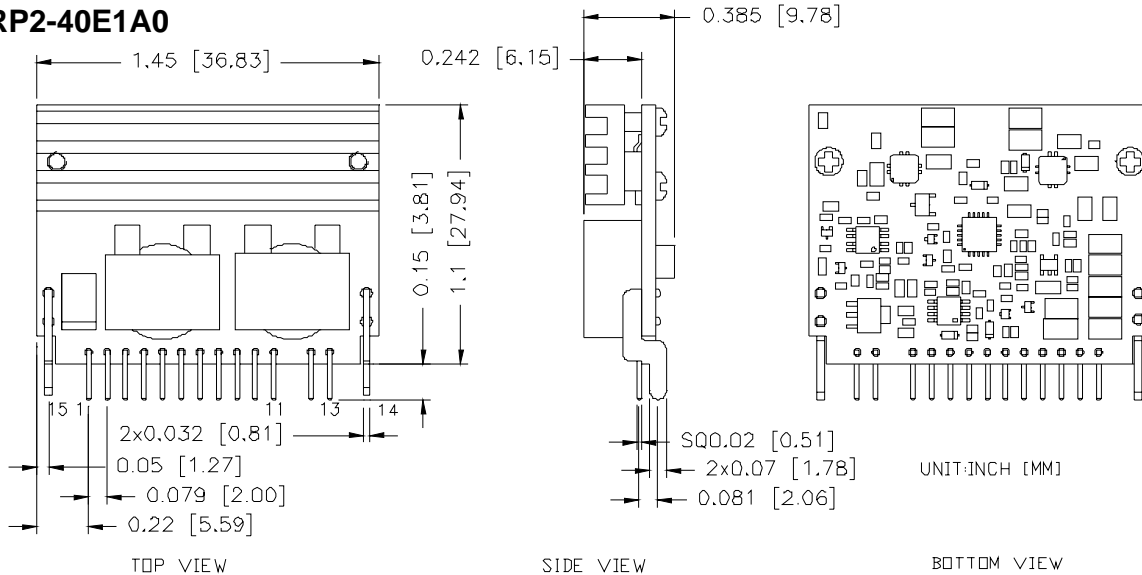
5 Vdc - 13.8 Vdc Input

0.6 Vdc - 5.0 Vdc/40 A Output



## Mechanical Outline

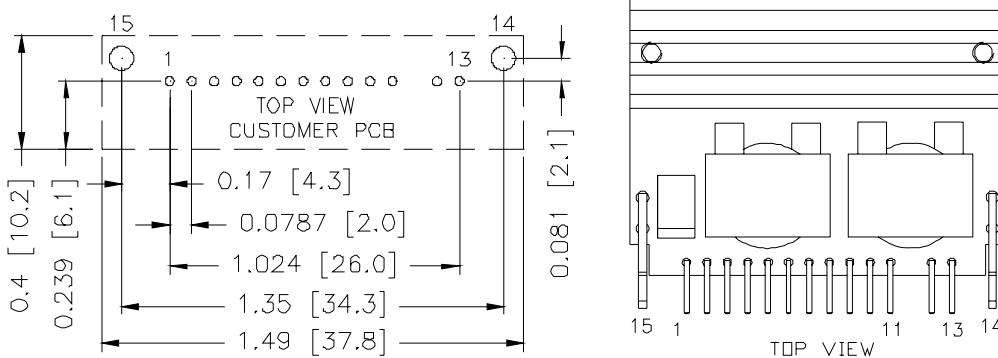
### VRP2-40E1A0



## Pin Connections

| Pin | Function |
|-----|----------|
| 1   | Vout     |
| 2   | Vout     |
| 3   | Vout     |
| 4   | GND      |
| 5   | GND      |
| 6   | Enable   |
| 7   | Trim-    |
| 8   | Trim+    |
| 9   | PwGOOD   |
| 10  | Sense-   |
| 11  | Sense+   |
| 12  | Vin      |
| 13  | Vin      |
| 14  | GND      |
| 15  | GND      |

## RECOMMENDED PAD LAYOUT



14 15 SUPPORT PAD THR. HOLES  $\phi$ 0.085 [ $\phi$ 2.2] BOTH SIDE

1~13 PIN PAD THR. HOLES:  $\phi$ 0.032 [ $\phi$ 0.8] BOTH SIDE

## 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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