

## NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 14 Vdc Input 0.75 Vdc - 3.63 Vdc/16 A Output

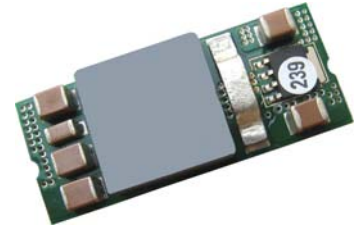
**bel**  
POWER PRODUCTS

SRBC-16E2Ax

RoHS Compliant

Rev.A

- Non-Isolated
- High Efficiency
- High Power Density
- Excellent Thermal Performance
- Low Cost
- Flexible Output Voltage Sequencing (option)
- Able to Sink & Source Current
- Industrial Temperature Range
- Under-voltage Lockout (UVLO)
- Over Temperature Protection
- OCP/SCP
- Wide Input
- Wide Trim
- Remote On/Off
- Active Low/High (option)
- Remote Sense



### Description

The Bel SRBC-16E2Ax is part of the non-isolated dc/dc converter series. The modules use a SMT package. These converters are available in a range of output voltages from 0.75 Vdc to 3.63 Vdc over a wide range of input voltage ( $V_{in} = 4.5 \text{ Vdc} - 14 \text{ Vdc}$ ). The Bel SRBC-16E2Ax has a sequencing feature that enables designers to implement various types of output voltage sequencing when powering. The efficiency is typically 92% at 3.3 Vdc output at full load.

### Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number Active Low	Model Number Active High
0.75 V - 3.63 V	4.5 V - 14 V	16 A	58 W	92%	SRBC-16E2AL	SRBC-16E2A0

**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 number 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	
Sequencing Voltage <sup>1</sup>	-0.3 V	-	$V_{in}$	
Ambient Temperature	-40 °C	-	85 °C	
Storage Temperature	-55 °C	-	125 °C	

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

1. SRBC-16E2Ax series of modules include a sequencing feature that enables users to implement various types of output voltage sequencing in their applications. This is accomplished via an additional sequencing pin. When not using the sequencing feature, either, tie the SEQ pin to  $V_{in}$  or leave it unconnected.

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### Input Specifications

Parameter	Min	Typ	Max	Notes
Input Voltage				
Vo,set < 3.0 V	4.5 V	-	14 V	
Vo,set ≥ 3.0 V	Vo,set +1.5 V	-	14 V	
Input Current (full load)	-	-	15 A	
Input Current (no load)	-	100 mA	-	
Remote Off Input Current	-	2 mA	-	
Input Reflected Ripple Current (pk-pk)	-	-	400 mA	Tested with one 1000 uF/25 V AL input capacitor with ESR=0.03 ohm max and 6 × 47 uF/16 V tantalum capacitors with ESR=0.013 ohm max at 100 kHz, & simulated source impedance of 1000 nH, 5 Hz to 20 MHz.
Input Reflected Ripple Current (rms)	-	-	150 mA	
I <sup>2</sup> t Inrush Current Transient	-	0.2 A <sup>2</sup> s	0.4 A <sup>2</sup> s	
Turn-on Voltage Threshold	-	4.2 V	-	
Turn-off Voltage Threshold	3.7 V	-	4.2 V	

### Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point	-2% Vo,set	-	2% Vo,set	Vin=12 V, full load
Load Regulation	-	0.1% Vo,set	-	Io=Iomin to Iomax
Line Regulation	-	0.1% Vo,set	-	Vin=Vinmin to Vinmax
Regulation Over Temperature (-40 °C to +85 °C)	-	0.3% Vo,set	-	Tref=Tamin to Tamax
Output Current	0 A	-	16 A	
Current Limit Threshold	-	180% Io	-	
Short Circuit Surge Transient	-	1 A <sup>2</sup> s	3 A <sup>2</sup> s	
Ripple and Noise (pk-pk)	-	30 mV	75 mV	Tested with 0-20 MHz, 10 uF tantalum capacitor & 1 uF TDK ceramic capacitor at the output
Ripple and Noise (rms)	-	12 mV	30 mV	
Turn on Time	-	12 mS	20 mS	
Overshoot at Turn on	-	-	1% Vo,set	
Output Capacitance	-	-	5000 uF	
<b>Transient Response</b>				
50% ~ 100% Max Load	All	-	150 mV	di/dt=2.5 A/uS; Vin=12 V; and with 2 × 150 uF polymer capacitors at the output
Settling Time		-	50 uS	
100% ~ 50% Max Load		-	150 mV	
Settling Time		-	50 uS	

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

## NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 14 Vdc Input 0.75 Vdc - 3.63 Vdc/16 A Output



### General Specifications

Parameter	Min	Typ	Max	Notes
Efficiency Vo=3.3 V Vo=2.5 V Vo=1.8 V Vo=1.5 V Vo=1.2 V Vo=0.75 V	- - - - - -	92% 90% 88% 87% 85% 79%	- - - - - -	Measured at Vin=12 V, full load
Efficiency Vo=3.3 V Vo=2.5 V Vo=1.8 V Vo=1.5 V Vo=1.2 V Vo=0.75 V	- - - - - -	92% 90% 87% 86% 83% 78%	- - - - - -	Measured at Vin=5 V, full load
Switching Frequency	200 kHz	230 kHz	260 kHz	
Over Temperature Shutdown <sup>1</sup>	-	130 °C	-	
Output Trim Range (Wide Trim)	0.7525 V	-	3.63 V	
Remote Sense Compensation	-	-	0.5 V	
MTBF	2,666,488 hours			Calculated Per Bell Core SR-332 (Io =80% Iomax; Vo=3.3 V; Vin=12 V; Ta = 25 °C)
Dimensions Inches (L x W x H) Millimeters (L x W x H)	1.30 x 0.53 x 0.315 33.02 x 13.46 x 8.00			
Weight	-	8 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)	-0.2 V	-	0.3 V	SRBC-16E2A0; Remote On/Off pin open, Unit on.
Signal High (Unit On)	-	-	Vin, max	
Signal Low (Unit On)	-0.2 V	-	0.3 V	SRBC-16E2AL; Remote On/Off pin open, Unit on.
Signal High (Unit Off)	2.5 V	-	Vin, max	
<b>Voltage Sequencing</b>				
Sequencing Delay Time	25 mS	-	-	Delay from Vinmin to application of voltage on SEQ pin
Sequencing Slew Rate Capability	-	-	2 V/mS	Vinmin to Vinmax; Iomin to Iomax; Vseq<Vo
Tracking Accuracy Power-Up Power-Down	- -	100 mV 200 mV	200 mV 400 mV	

## NON-ISOLATED DC/DC CONVERTERS

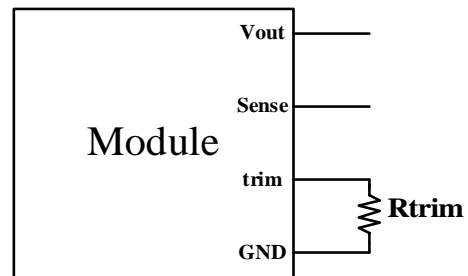
4.5 Vdc - 14 Vdc Input 0.75 Vdc - 3.63 Vdc/16 A Output

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POWER PRODUCTS

### Output Trim Equations

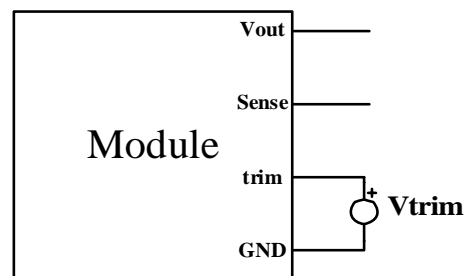
Equation for calculating the trim resistor (in  $\Omega$ ) given the desired output voltage ( $V_o$ ) is shown below. The Trim Up resistor should be connected between the Trim pin and Ground.

$$R_{trimup} = \frac{10500}{V_o - 0.7525} - 1000$$



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

$$V_{trimup} = 0.7 - 0.0667 \times (V_o - 0.7525)$$

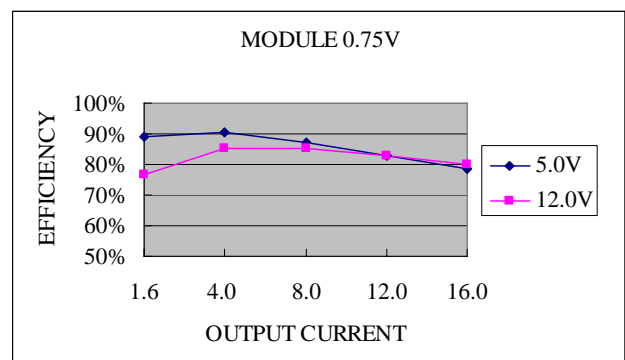
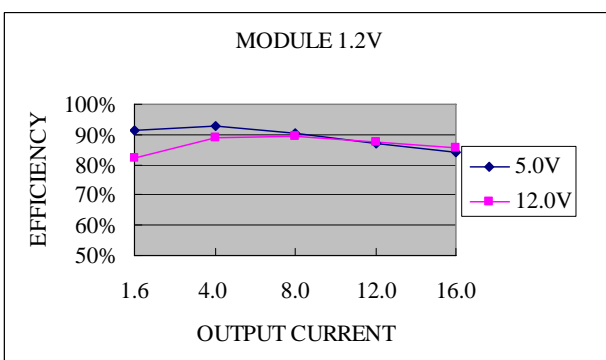
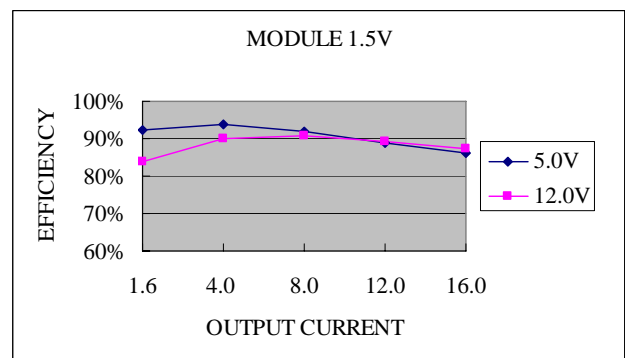
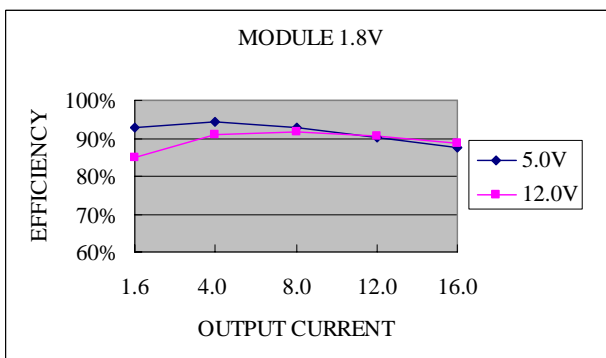
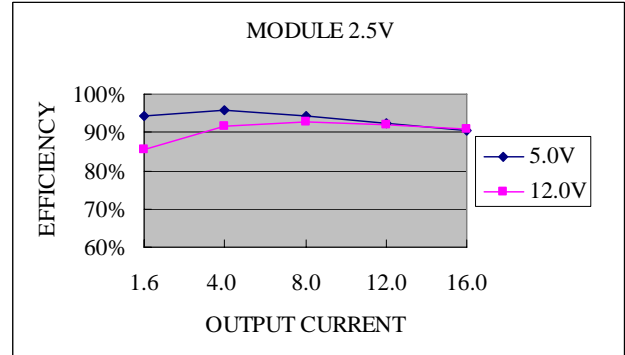
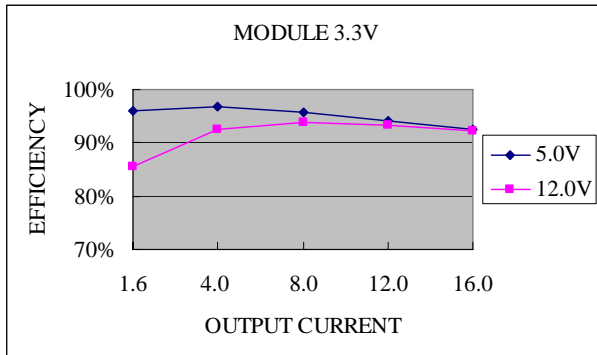


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4.5 Vdc - 14 Vdc Input 0.75 Vdc - 3.63 Vdc/16 A Output



## Efficiency Data

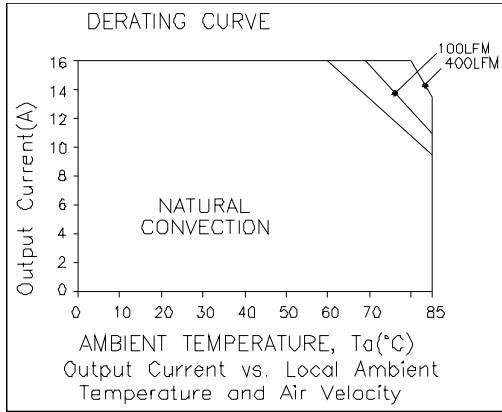


# NON-ISOLATED DC/DC CONVERTERS

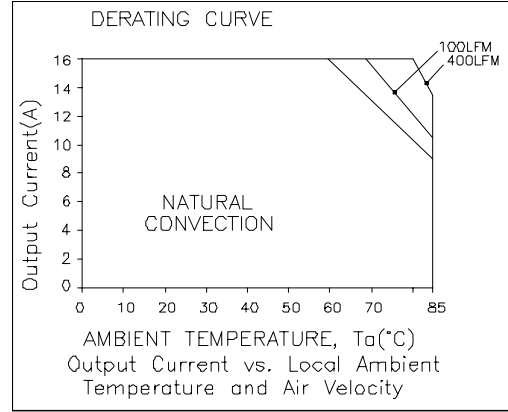
4.5 Vdc - 14 Vdc Input 0.75 Vdc - 3.63 Vdc/16 A Output



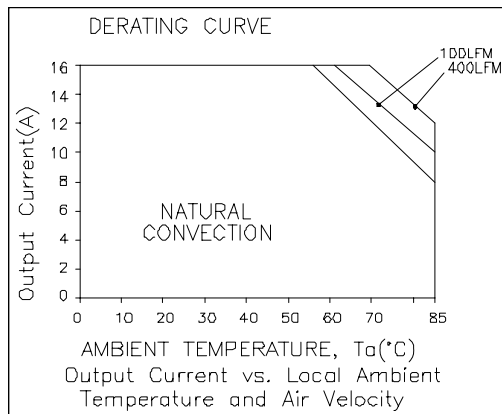
## Thermal Derating Curves



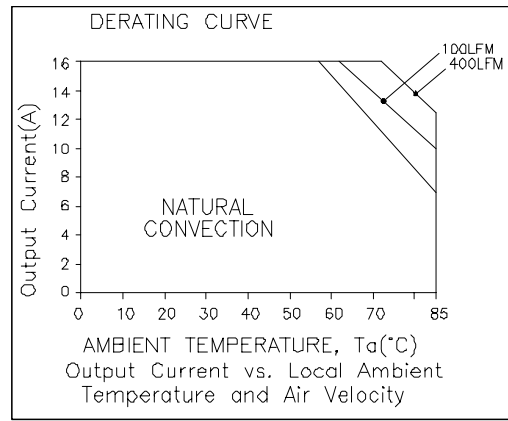
$V_{in}=5\text{ V}, V_o=0.75\text{ V}$



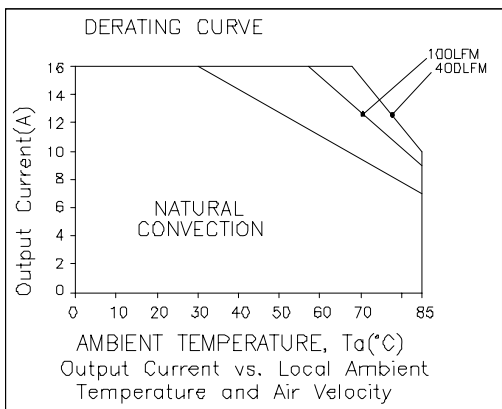
$V_{in}=12\text{ V}, V_o=0.75\text{ V}$



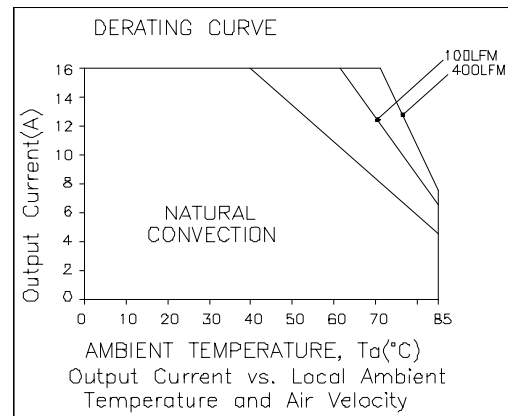
$V_{in}=5\text{ V}, V_o=1.8\text{ V}$



$V_{in}=12\text{ V}, V_o=1.8\text{ V}$



$V_{in}=5\text{ V}, V_o=3.3\text{ V}$



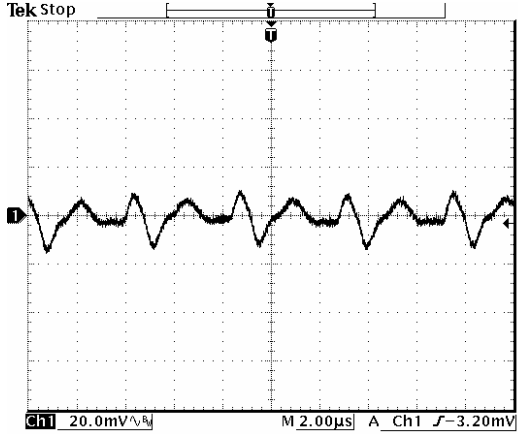
$V_{in}=12\text{ V}, V_o=3.3\text{ V}$

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4.5 Vdc - 14 Vdc Input 0.75 Vdc - 3.63 Vdc/16 A Output

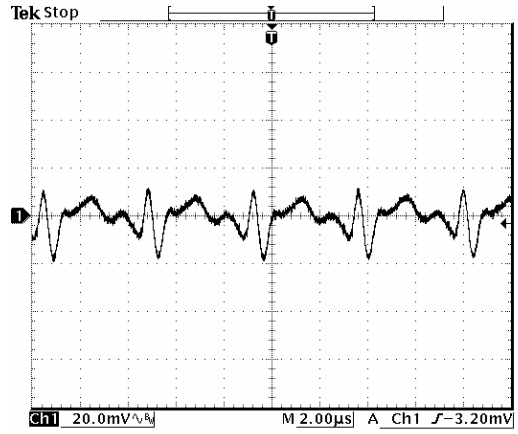


## Ripple and Noise Waveforms



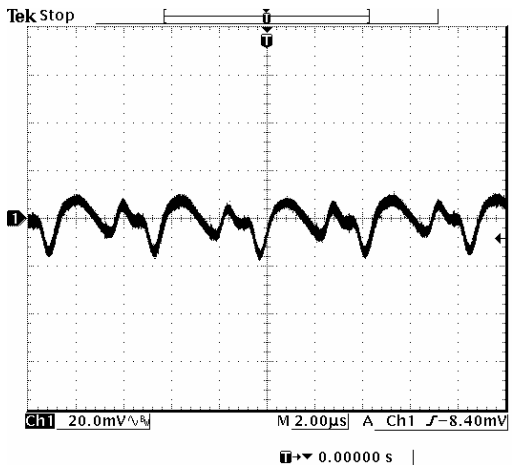
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Vin=5 V, Vo=0.7525 V



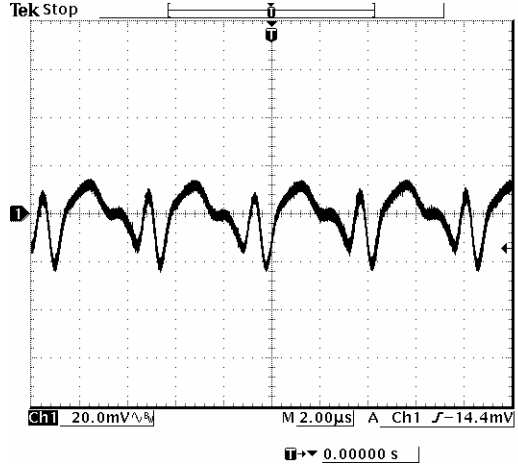
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Vin=12 V, Vo=0.7525 V



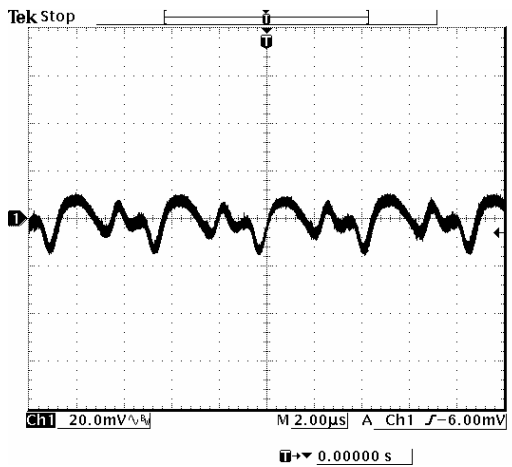
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11:16:37

Vin=5 V, Vo=1.2 V



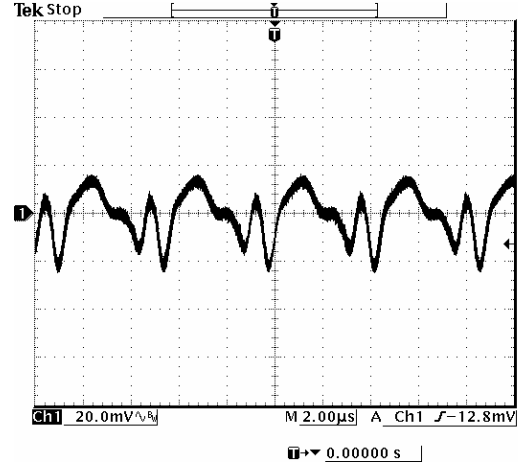
21 Apr 2004  
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Vin=12 V, Vo=1.2 V



21 Apr 2004  
11:17:27

Vin=5 V, Vo=1.5 V



21 Apr 2004  
11:17:50

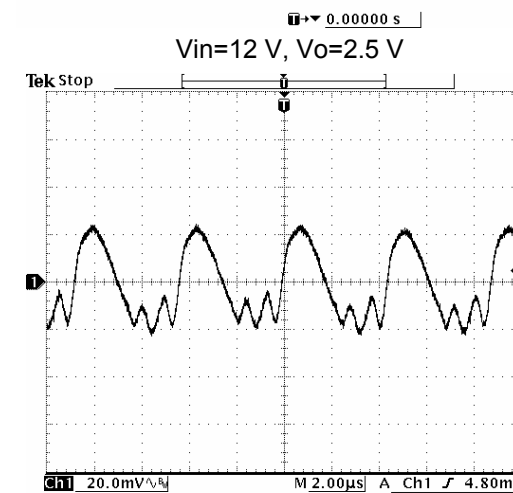
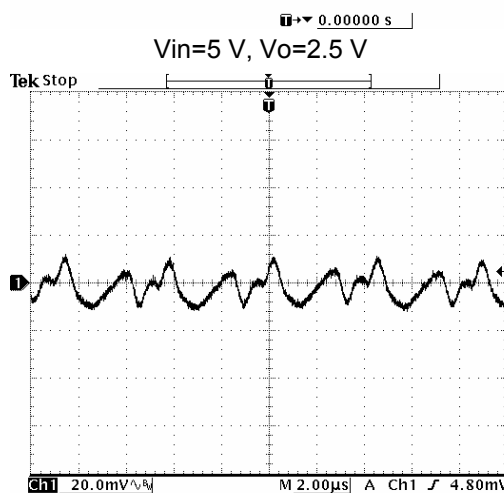
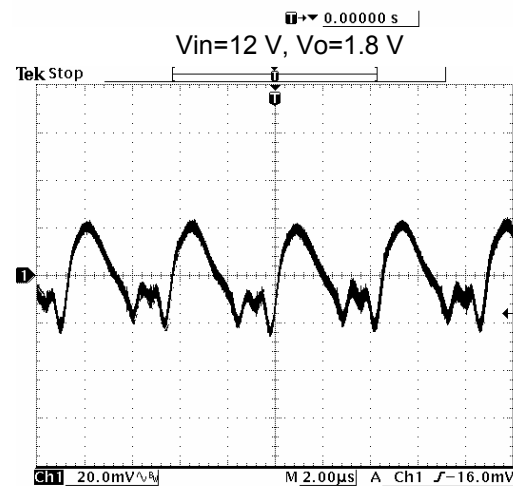
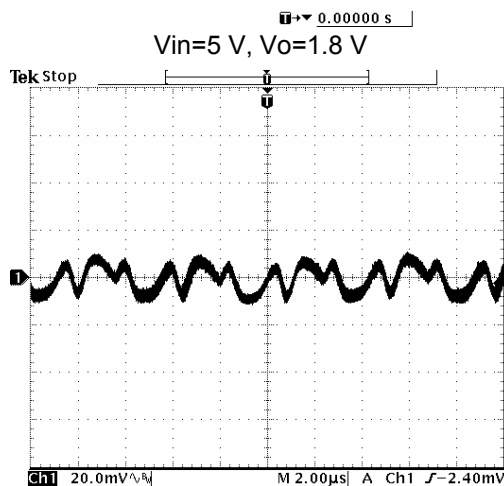
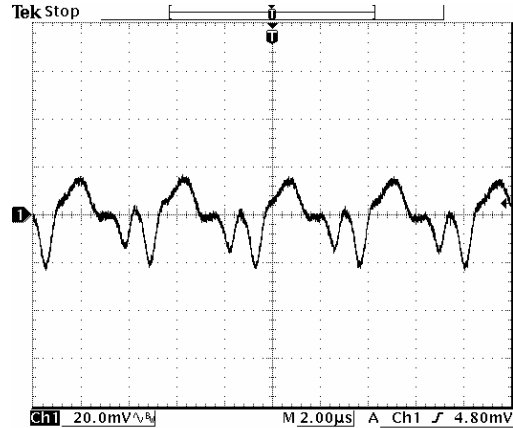
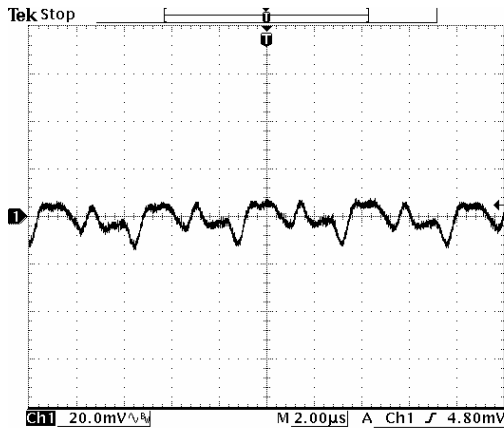
Vin=12 V, Vo=1.5 V

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4.5 Vdc - 14 Vdc Input 0.75 Vdc - 3.63 Vdc/16 A Output



## Ripple and Noise Waveforms (continued)



Vin=5 V, Vo=3.3 V

Vin=12 V, Vo=3.3 V

**Note:** Ripple and noise at full load, with 10µF tantalum capacitor and 1µF ceramic at the output, and Ta=25°C.

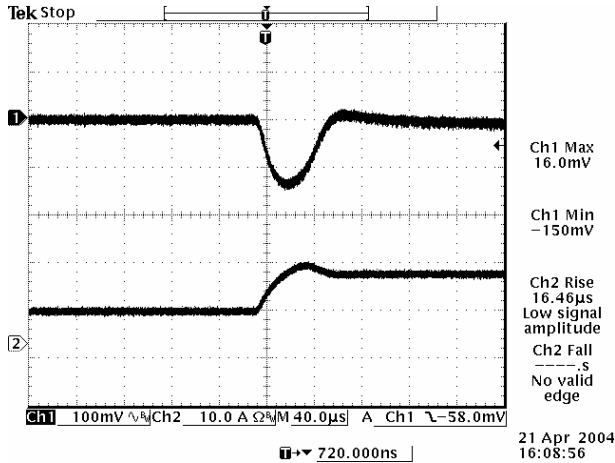


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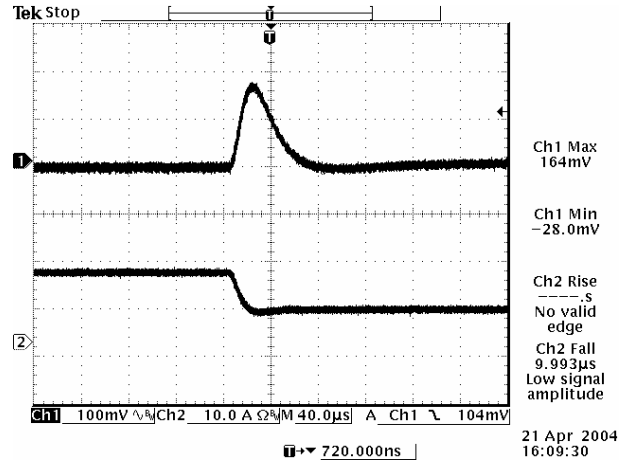
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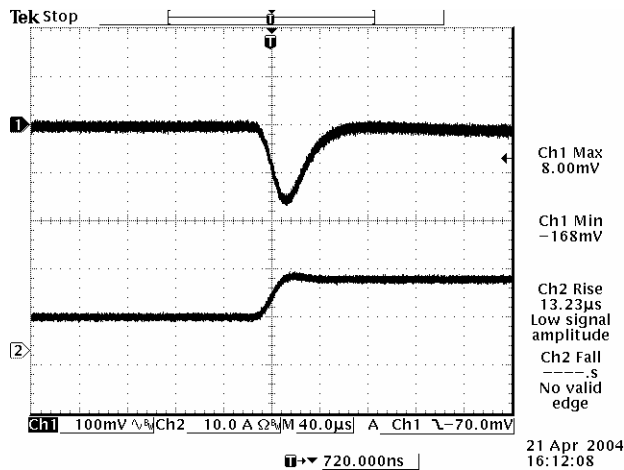
## Transient Response Waveforms



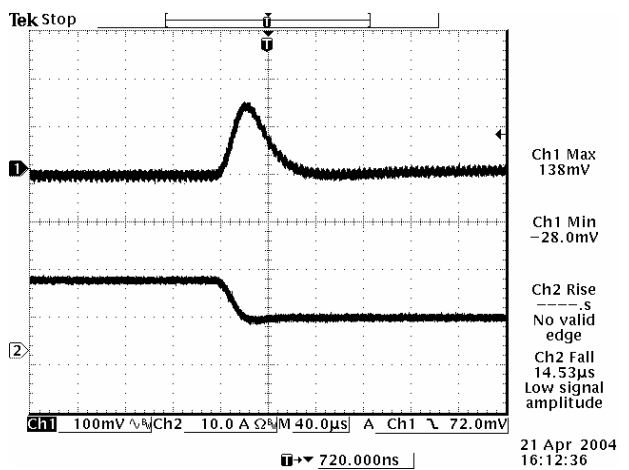
50% to 100% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=0.75\text{ V}$



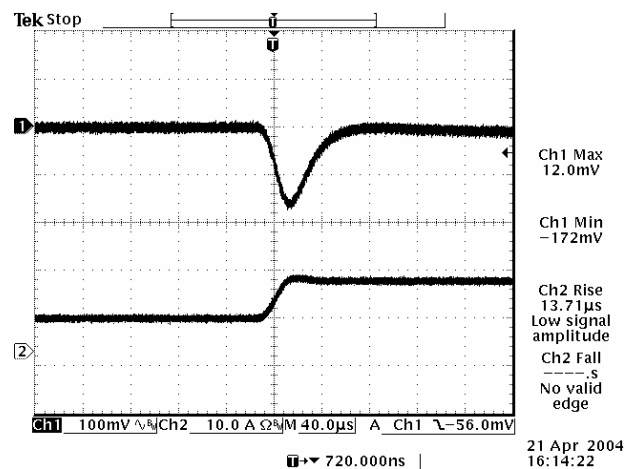
100% to 50% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=0.75\text{ V}$



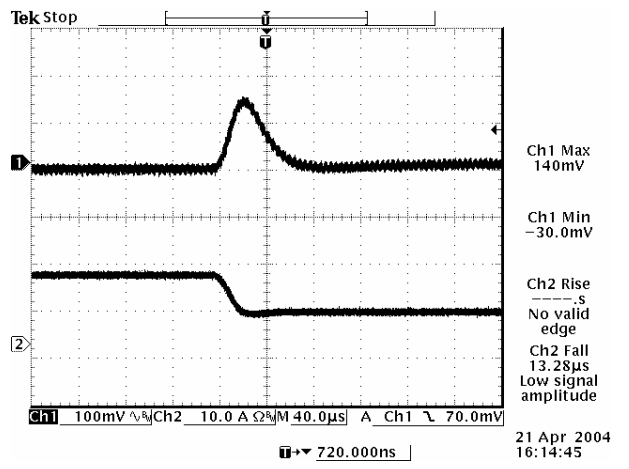
50% to 100% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=1.2\text{ V}$



100% to 50% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=1.2\text{ V}$



50% to 100% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=1.5\text{ V}$



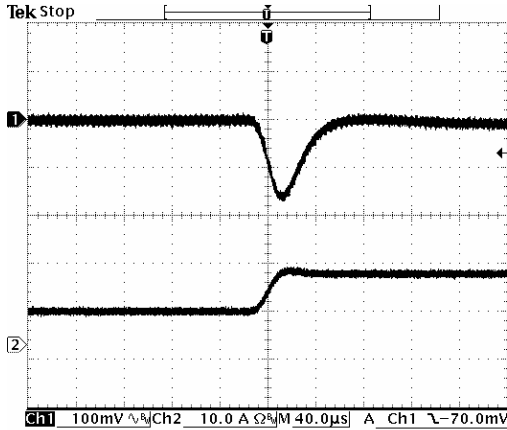
100% to 50% load Transient at  $V_{in}=5\text{ V}$ ,  $V_o=1.5\text{ V}$

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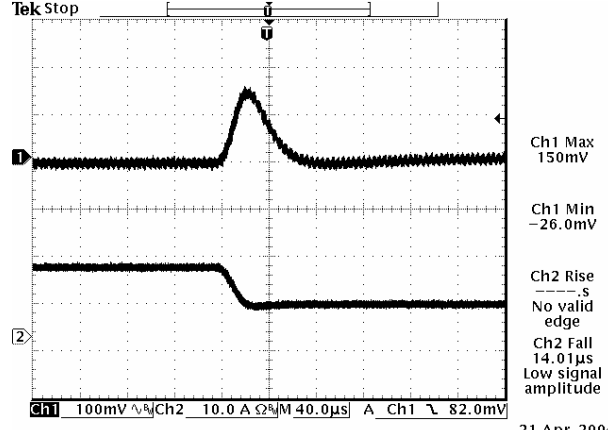
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## Transient Response Waveforms (continued)



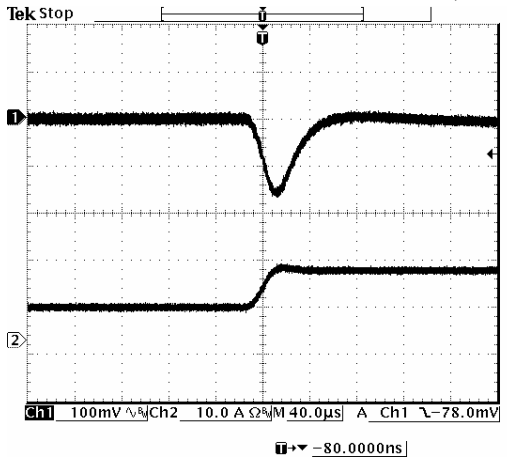
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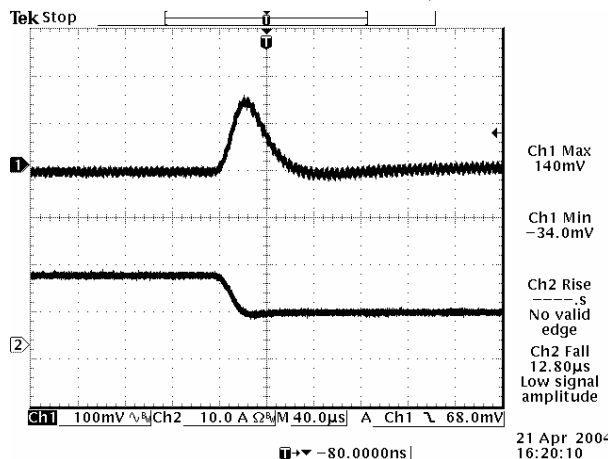
21 Apr 2004 16:17:59

50% to 100% load Transient at Vin=5 V, Vo=1.8 V

100% to 50% load Transient at Vin=5 V, Vo=1.8 V



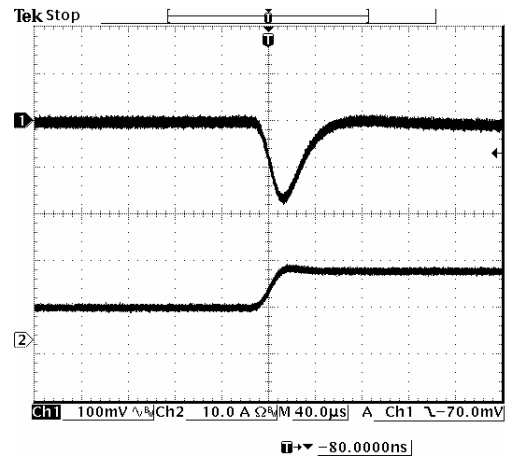
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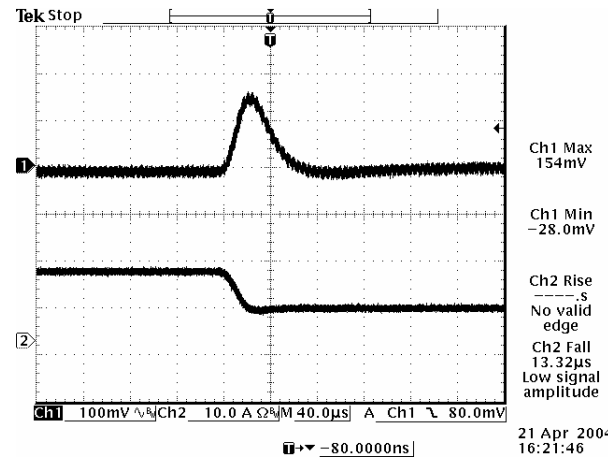
21 Apr 2004 16:20:10

50% to 100% load Transient at Vin=5 V, Vo=2.5 V

100% to 50% load Transient at Vin=5 V, Vo=2.5 V



21 Apr 2004 16:21:26



21 Apr 2004 16:21:46

50% to 100% load Transient at Vin=5 V, Vo=3.3 V

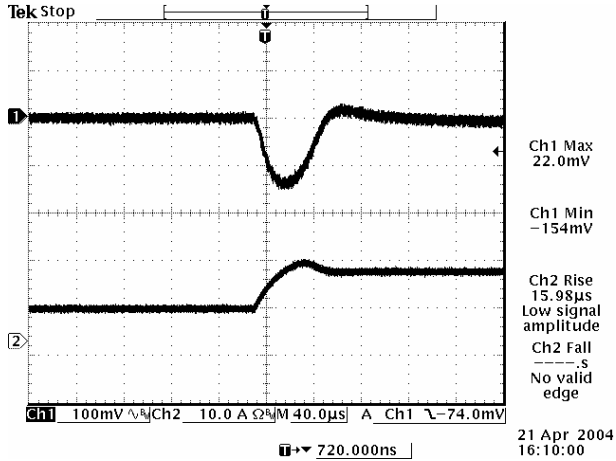
100% to 50% load Transient at Vin=5 V, Vo=3.3 V

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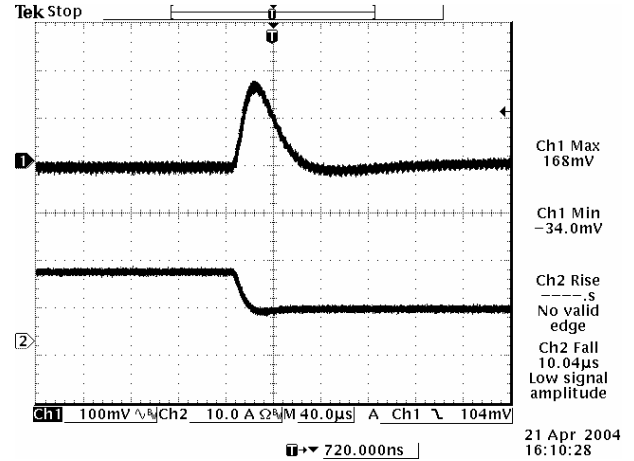
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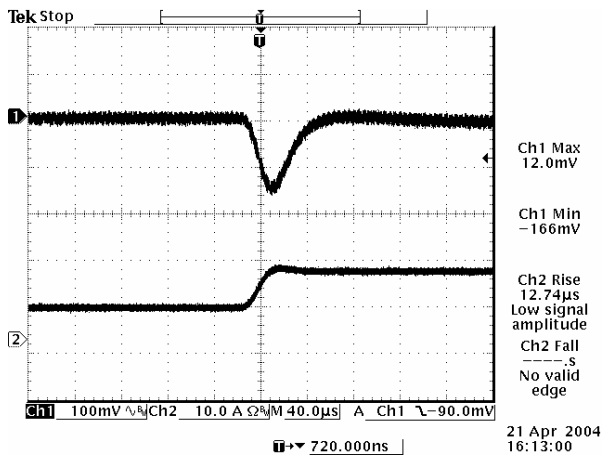
## Transient Response Waveforms (continued)



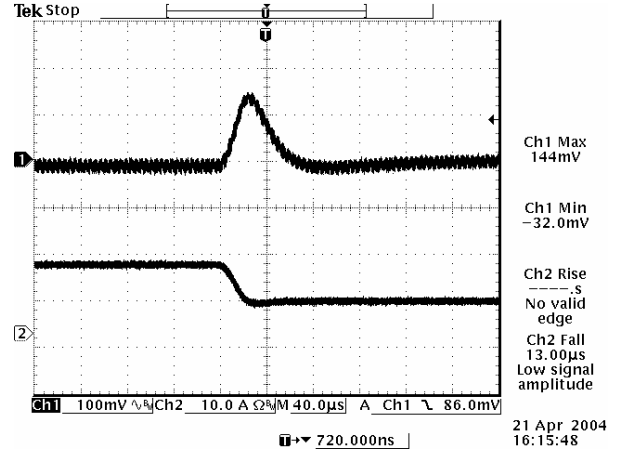
50% to 100% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=0.75\text{ V}$



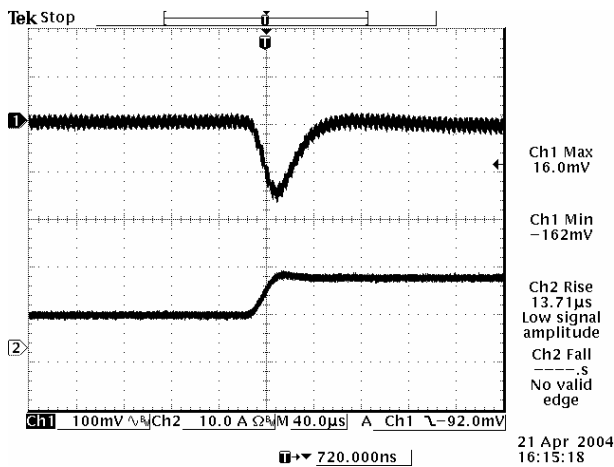
100% to 50% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=0.75\text{ V}$



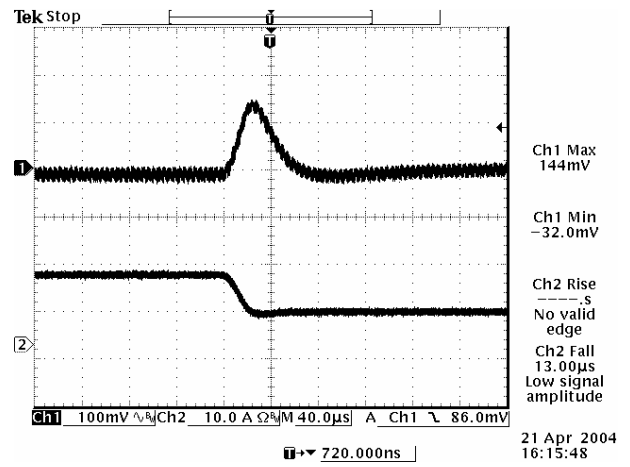
50% to 100% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=1.2\text{ V}$



100% to 50% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=1.2\text{ V}$



50% to 100% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=1.5\text{ V}$



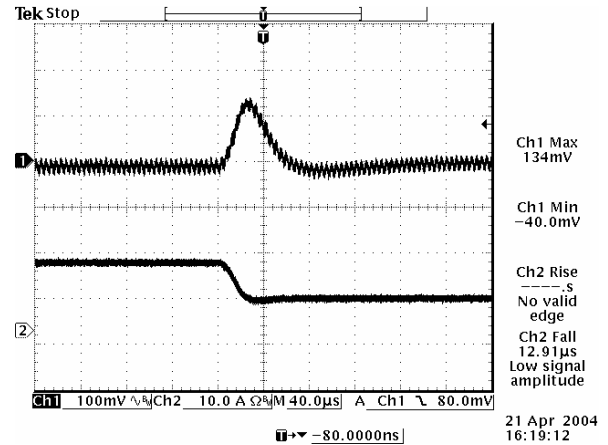
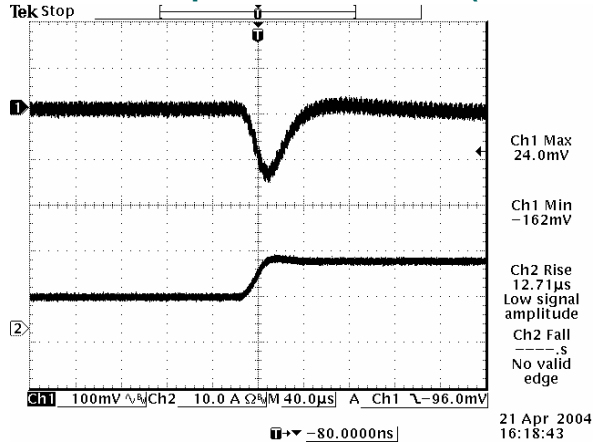
100% to 50% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=1.5\text{ V}$

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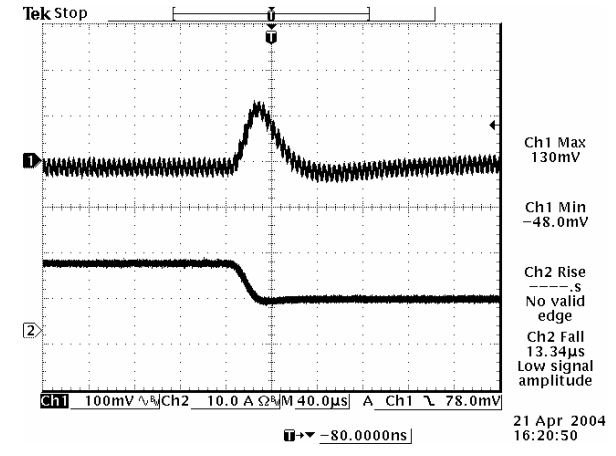
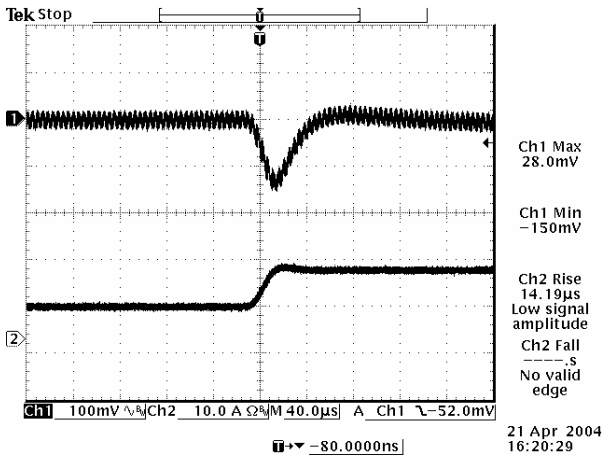


## Transient Response Waveforms (continued)



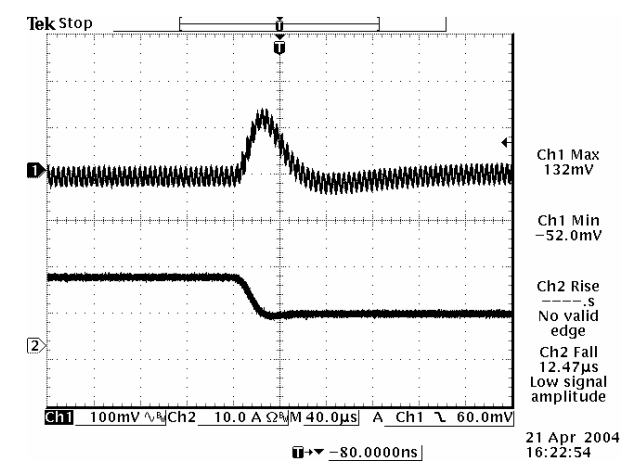
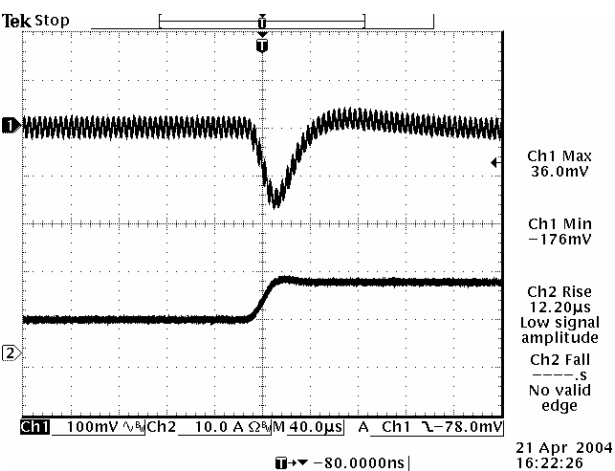
50% to 100% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=1.8\text{ V}$

100% to 50% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=1.8\text{ V}$



50% to 100% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=2.5\text{ V}$

100% to 50% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=2.5\text{ V}$



50% to 100% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=3.3\text{ V}$

100% to 50% load Transient at  $V_{in}=12\text{ V}$ ,  $V_o=3.3\text{ V}$

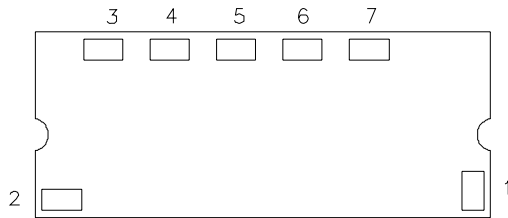
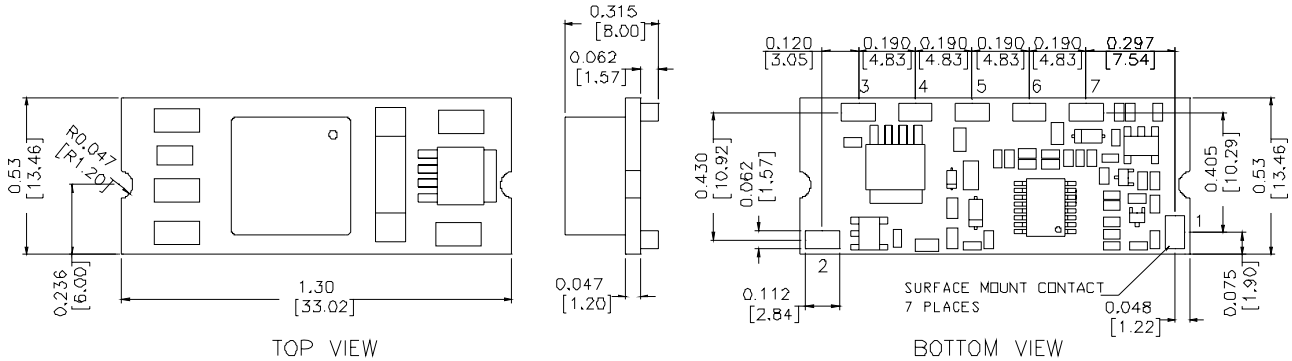
**Note:** Transient response with external load capacitance  $C_{ext}=2 \times 150\mu\text{F}$  (Polymer capacitors), and  $T_a=25^\circ\text{C}$ .

# NON-ISOLATED DC/DC CONVERTERS

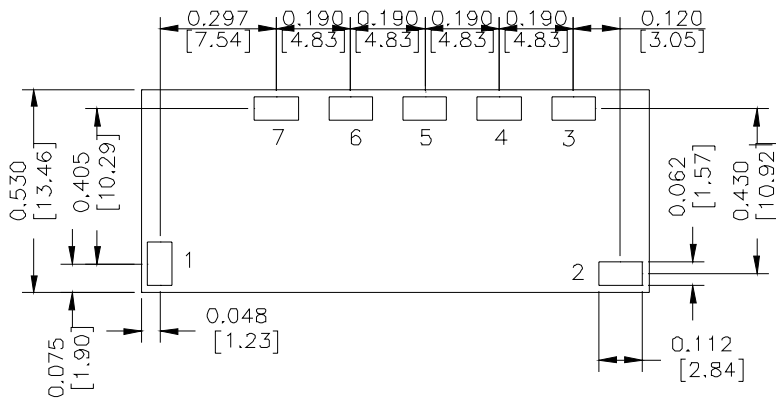
4.5 Vdc - 14 Vdc Input 0.75 Vdc - 3.63 Vdc/16 A Output



## Mechanical Outline



### RECOMMENDED PAD LAYOUT



### Pin Connections

Pin	Function
1	Remote On/Off
2	Vin
3	SEQ
4	Ground
5	Vout
6	Trim
7	Remote Sense

**PAD SIZE:**  
 MIN: 0.14" \* 0.095" (3.56mm \* 2.41mm)  
 MAX: 0.165" \* 0.11" (4.19mm \* 2.79mm)

### 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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