

NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 13.2 Vdc Input 1.0 Vdc - 5.0 Vdc/6 A Output

bel
POWER PRODUCTS

xRAH-06Exx0 Series RoHS Compliant Rev.A

- Non-Isolated
- Fixed Frequency (400 kHz)
- Remote On/Off
- Under-voltage Lockout (UVLO)
- OCP/SCP (Latch off)
- Trim Function
- Low Profile Package (7.82 mm)
- UL60950-1 Recognized (UL/cUL)



Description

The Bel xRAH-06Exx0 is part of the low cost non-isolated dc/dc converter series. The modules use a surface mount package or vertical package for ease of layout and space savings, with a low profile of only 7.82 mm. The output is closely regulated and the efficiency of 3.3 Vdc output module is typically 91% 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	Part Number Surface Mount	Part Number Vertical Mount
5.0 Vdc	8.0 Vdc - 13.2 Vdc	6 A	30.0 W	94%	SRAH-06E500	VRAH-06E500
3.3 Vdc	4.5 Vdc - 13.2 Vdc	6 A	19.8 W	91%	SRAH-06E330	VRAH-06E330
2.5 Vdc	4.5 Vdc - 13.2 Vdc	6 A	15.0 W	89%	SRAH-06E250	VRAH-06E250
1.8 Vdc	4.5 Vdc - 13.2 Vdc	6 A	10.8 W	86%	SRAH-06E180	VRAH-06E180
1.5 Vdc	4.5 Vdc - 13.2 Vdc	6 A	9.0 W	84%	SRAH-06E150	VRAH-06E150
1.2 Vdc	4.5 Vdc - 13.2 Vdc	6 A	7.2 W	81%	SRAH-06E120	VRAH-06E120
1.0 Vdc	4.5 Vdc - 13.2 Vdc	6 A	6.0 W	79%	SRAH-06E100	VRAH-06E100

- Notes:** 1. Add "0" suffix at the end of the model number to indicate "Tube Packaging", and "R" for "Reel Packaging", and "G" for "Tray Packaging".
2. 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	-	14 V	
Output Enable Terminal Voltage	-0.3 V	-	6.5 V	
Ambient Temperature	-40 °C	-	85 °C	
Storage Temperature	-40 °C	-	125 °C	

Input Specifications

Parameter	Min	Typ	Max	Notes
Input Voltage	4.5 V	-	13.2 V	
Input Current (full load)				
Vo=5.0 V	-	-	4.8 A	
Vo=3.3 V	-	-	5.5 A	
Vo=2.5 V	-	-	4.5 A	
Vo=1.8 V	-	-	3.4 A	
Vo=1.5 V	-	-	2.9 A	
Vo=1.2 V	-	-	2.4 A	
Vo=1.0 V	-	-	2.0 A	

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Input Specifications (continued)

Parameter	Min	Typ	Max	Notes
Input Current (no load)				When Vout=5 V, Vin=8 V-13.2 V, Otherwise Vin=4.5 V-13.2 V
Vo=5.0 V	-	55 mA	95 mA	
Vo=3.3 V	-	50 mA	85 mA	
Vo=2.5 V	-	45 mA	75 mA	
Vo=1.8 V	-	40 mA	65 mA	
Vo=1.5 V	-	35 mA	60 mA	
Vo=1.2 V	-	32 mA	55 mA	
Vo=1.0 V	-	30 mA	50 mA	
Remote Off Input Current	-	2 mA	-	
Input Reflected Ripple Current (pk-pk)	-	150 mA	250 mA	With simulated source impedance of 500 nH, 5 Hz to 20 MHz; use two 270 uF/16 V Oscon capacitors with ESR = 0.018 ohm max. at 100 kHz
Input Reflected Ripple Current (rms)	-	60 mA	120 mA	
I ² t Inrush Current Transient	-	0.04 A ² s	0.1 A ² s	
Turn-on Voltage Threshold	-	4.2 V	4.5 V	Only applicable to 1.0 V to 3.3 V output modules.
Turn-off Voltage Threshold	3.2 V	3.6 V	4.0 V	

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

Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point				Test condition: Vin=8 V, Iout=half load
Vo=5.0 V	4.900 V	5.0 V	5.100 V	
Vo=3.3 V	3.234 V	3.3 V	3.366 V	
Vo=2.5 V	2.450 V	2.5 V	2.550 V	
Vo=1.8 V	1.764 V	1.8 V	1.836 V	
Vo=1.5 V	1.470 V	1.5 V	1.530 V	
Vo=1.2 V	1.176 V	1.2 V	1.224 V	
Vo=1.0 V	0.980 V	1.0 V	1.020 V	
Line Regulation				
Vo=5.0 V	-	±8 mV	±10 mV	
Vo=3.3 V	-	±5 mV	±8 mV	
Vo=2.5 V	-	±4 mV	±8 mV	
Vo=1.8 V	-	±3 mV	±6 mV	
Vo=1.5 V	-	±2 mV	±4 mV	
Vo=1.2 V	-	±2 mV	±4 mV	
Vo=1.0 V	-	±2 mV	±4 mV	
Load Regulation				
Vo=5.0 V	-	±8 mV	±15 mV	
Vo=3.3 V	-	±6 mV	±10 mV	
Vo=2.5 V	-	±5 mV	±8 mV	
Vo=1.8 V	-	±4 mV	±6 mV	
Vo=1.5 V	-	±3 mV	±5 mV	
Vo=1.2 V	-	±3 mV	±5 mV	
Vo=1.0 V	-	±3 mV	±5 mV	

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Output Specifications (continued)

Parameter	Min	Typ	Max	Notes	
Regulation Over Temperature (-40 °C to 85 °C)					
Vo=5.0 V		±15 mV	±30 mV		
Vo=3.3 V		±10 mV	±20 mV		
Vo=2.5 V	-	±10 mV	±20 mV		
Vo=1.8 V		±8 mV	±15 mV		
Vo=1.5 V		±6 mV	±12 mV		
Vo=1.2 V		±5 mV	±10 mV		
Vo=1.0 V		±5 mV	±8 mV		
Output Current	0 A	-	6 A		
Current Limit Threshold	7 A	-	15 A	Latch Off	
Short Circuit Surge Transient	-	0.003 A ² s	0.006 A ² s	Latch Off	
Ripple and Noise (rms)	-	30 mV	50 mV	BW = 0-20 MHz; with 1 uF ceramic capacitor & 10 uF Aluminum capacitor at the output.	
Ripple and Noise (pk-pk)		50 mV	100 mV		
Turn on Time	-	-	30 mS		
Overshoot at Turn on	-	3%	7%		
Output Capacitance	0 uF	-	2400 uF		
Transient Response					
50% ~ 100% Max Load	Overshoot	-	150 mV	200 mV	di/dt = 0.5 A/uS; Vin = 8 V; with a 220 uF Tantalum capacitor at the output.
	Settling Time	-	100 uS	150 uS	
100% ~ 50% Max Load	Overshoot	-	150 mV	200 mV	
	Settling Time	-	100 uS	150 uS	

Note: All specifications are typical at 8 V input, full load at 25 °C unless otherwise stated.

General Specifications

Parameter	Min	Typ	Max	Notes
Efficiency				Measured at Vin=8V, full load
Vo=5.0 V	91%	94%	-	
Vo=3.3 V	88%	91%	-	
Vo=2.5 V	86%	89%	-	
Vo=1.8 V	83%	86%	-	
Vo=1.5 V	81%	84%	-	
Vo=1.0 V	76%	79%	-	
Switching Frequency	340 kHz	400 kHz	460 kHz	
Output Trim Range	90% Vo	-	110% Vo	
MTBF	6,922,389 hours			Calculated Per Bell Core SR-332 (Vin=8 V; Vo=3.3 V; Io = 4.8 A; Ta = 25 °C)
Dimensions (surface mount)				
Inches (L x W x H)	0.78 x 0.7 x 0.32			
Millimeters (L x W x H)	19.81 x 17.78 x 8.13			
Dimensions (vertical)				
Inches (L x W x H)	0.7 x 0.308 x 0.65			
Millimeters (L x W x H)	17.78 x 7.82 x 16.51			
Weight	-	5.5 g	-	

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

NON-ISOLATED DC/DC CONVERTERS

4.5 Vdc - 13.2 Vdc Input 1.0 Vdc - 5.0 Vdc/6 A Output



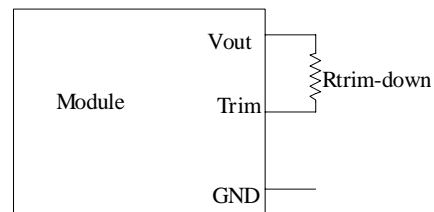
Control Specifications

Parameter	Min	Typ	Max	Notes
Remote On/Off				
Signal Low (Unit Off)	-0.3 V	-	1.25 V	Remote on/off pin open, unit on.
Signal High (Unit On)	3.5 V	-	6.5 V	

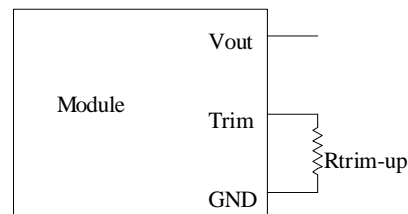
Output Trim Equations

Equations for calculating the trim resistor (in kΩ) given the desired adjusted voltage (V_{adj}) and the nominal output voltage of the converter (V_{nom}) are shown below. The Trim Down resistor should be connected between the Trim pin and V_{out} . The Trim Up resistor should be connected between the Trim pin and Ground. Only one of the resistors should be used for any given application.

$$R_{trim-down} = \frac{A}{V_{nom} - V_{adj}} - B$$



$$R_{trim-up} = \frac{C}{V_{adj} - V_{nom}} - D$$



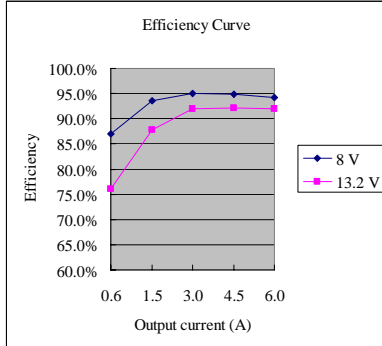
Vnom	A	B	C	D
5.0	272.745	133.400	37.140	71.500
3.3	167.607	152.800	37.140	90.900
2.5	117.622	152.800	37.140	90.900
1.8	74.394	152.800	37.140	90.900
1.5	329.981	1365.000	219.000	1000.000
1.2	219.000	666.000	219.000	301.000
1.0	100.252	898.000	149.400	649.000

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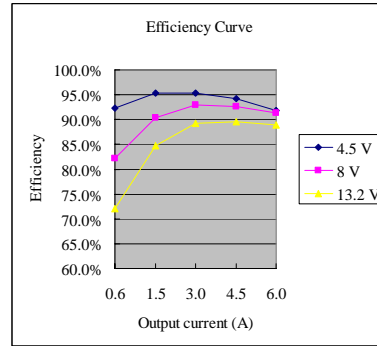
4.5 Vdc - 13.2 Vdc Input 1.0 Vdc - 5.0 Vdc/6 A Output



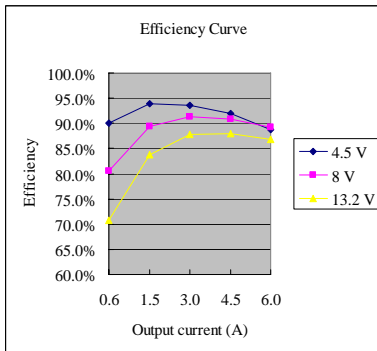
Efficiency Data



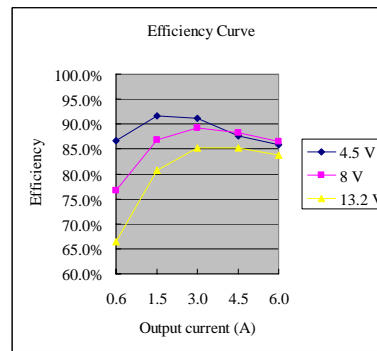
Vo=5.0 V



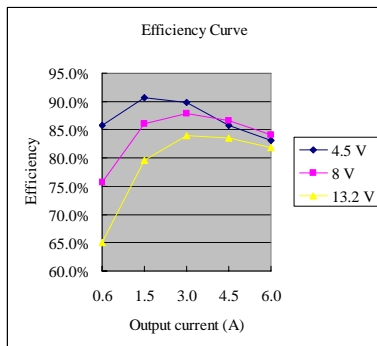
Vo=3.3 V



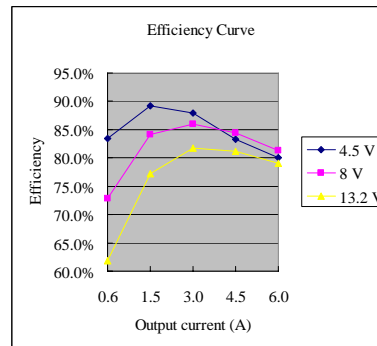
Vo=2.5 V



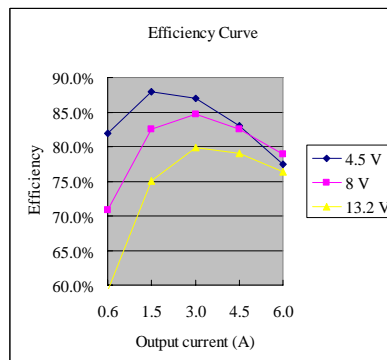
Vo=1.8 V



Vo=1.5 V



Vo=1.2 V



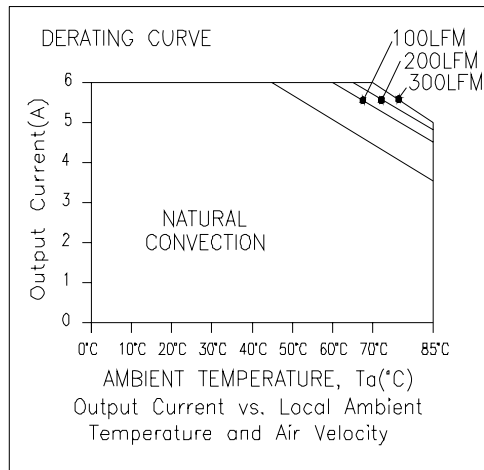
Vo=1.0 V

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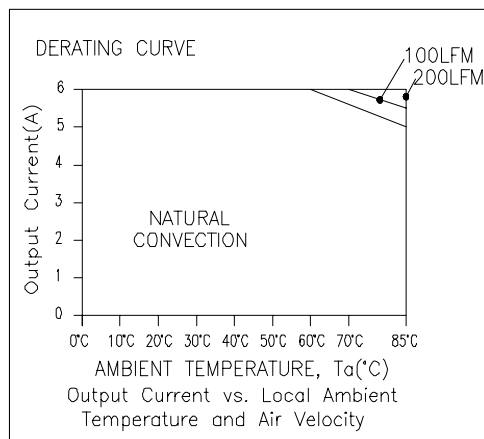
4.5 Vdc - 13.2 Vdc Input 1.0 Vdc - 5.0 Vdc/6 A Output

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Thermal Derating Curves



$V_o=3.3\text{ V} - 5.0\text{ V}$



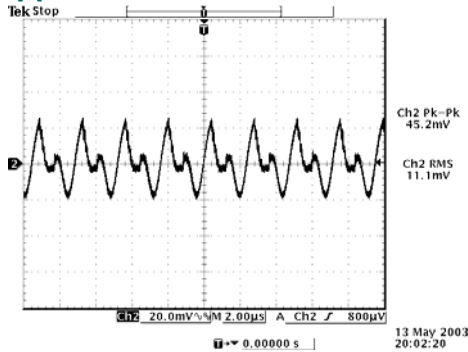
$V_o=1.0\text{ V} - 2.5\text{ V}$

NON-ISOLATED DC/DC CONVERTERS

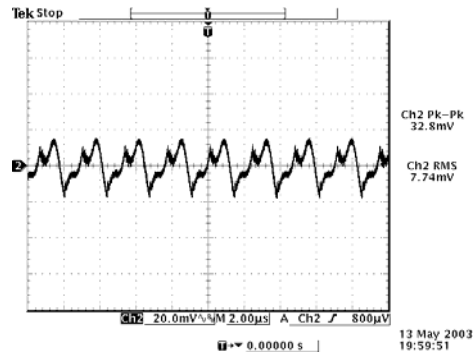
4.5 Vdc - 13.2 Vdc Input 1.0 Vdc - 5.0 Vdc/6 A Output



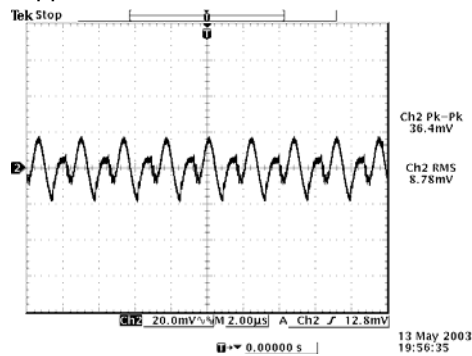
Ripple and Noise Waveforms



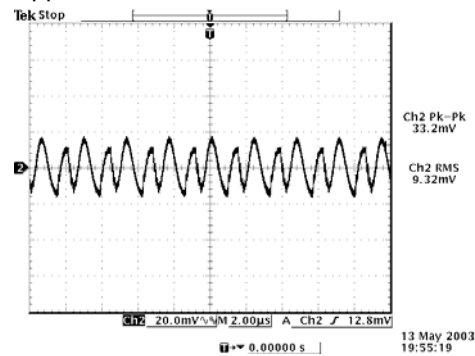
Ripple and noise at max load 5.0 Vdc output



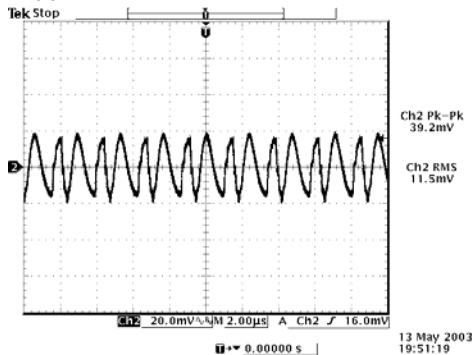
Ripple and noise at max load 3.3 Vdc output



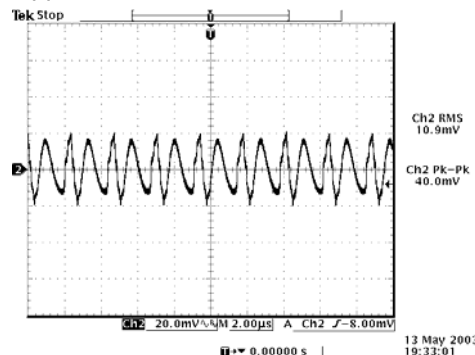
Ripple and noise at max load 2.5 Vdc output



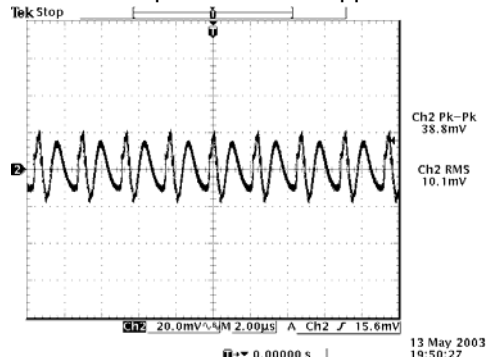
Ripple and noise at max load 1.8 Vdc output



Ripple and noise at max load 1.5 Vdc output



Ripple and noise at max load 1.2 Vdc output



Ripple and noise at max load 1.0 Vdc output

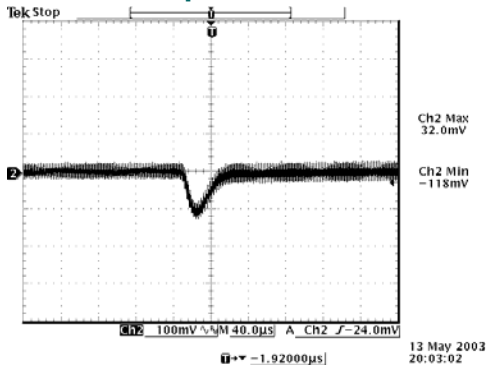
Note: Ripple and Noise at 8 Vdc input, 0-20 MHz BW, with 1 μ F ceramic capacitor & 10 μ F Aluminum capacitor at the output, $T_a=25$ deg C.

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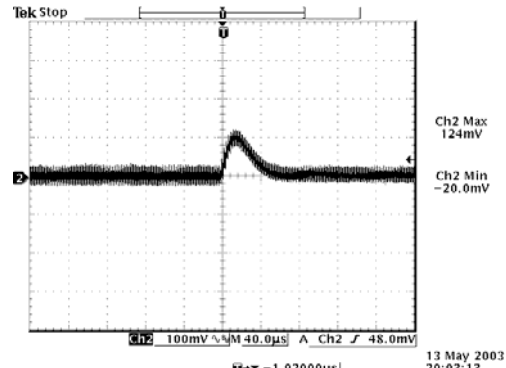
4.5 Vdc - 13.2 Vdc Input 1.0 Vdc - 5.0 Vdc/6 A Output



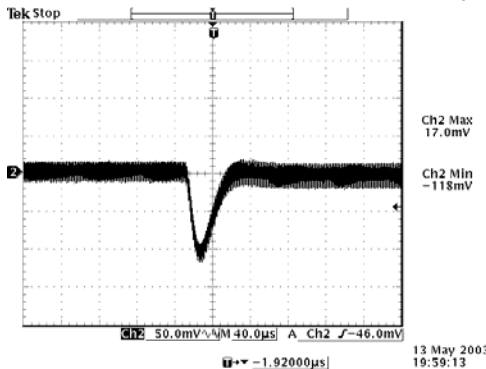
Transient Response Waveforms



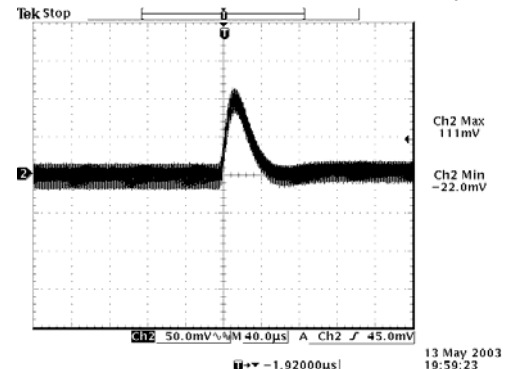
Transients 50% to 100% load 5 Vdc output



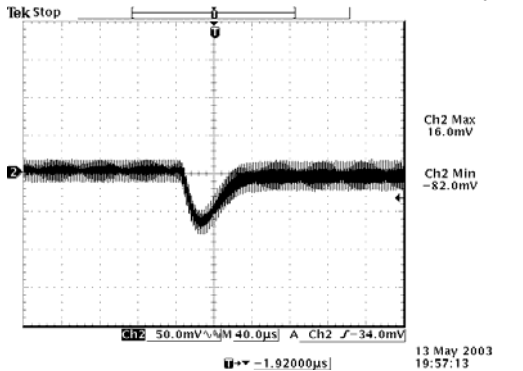
Transients 100% to 50% load 5 Vdc output



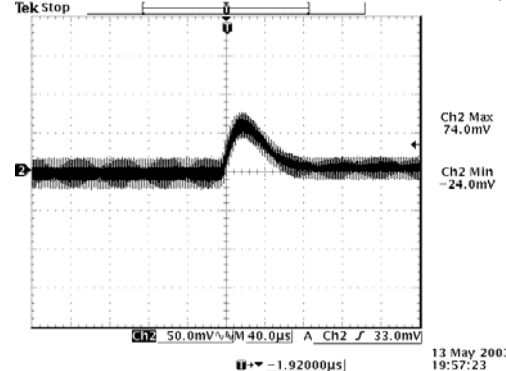
Transients 50% to 100% load 3.3 Vdc output



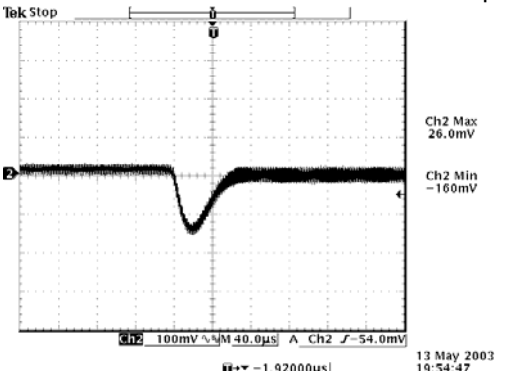
Transients 100% to 50% load 3.3 Vdc output



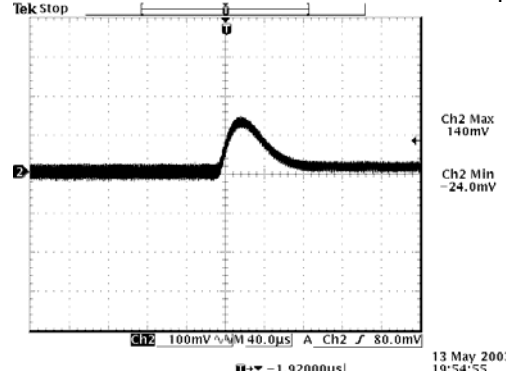
Transients 50% to 100% load 2.5 Vdc output



Transients 100% to 50% load 2.5 Vdc output



Transients 50% to 100% load 1.8 Vdc output



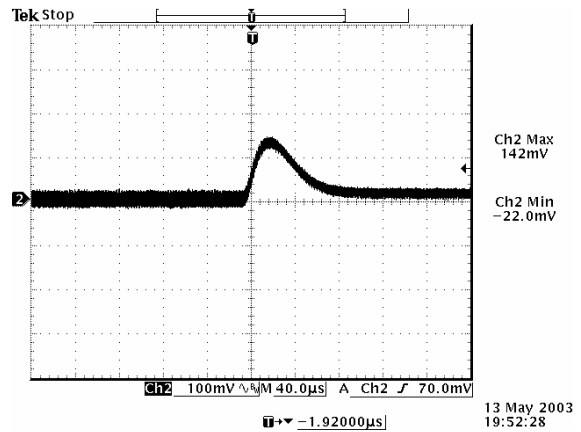
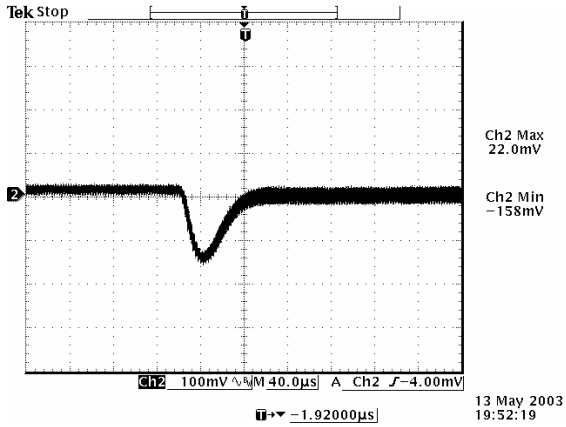
Transients 100% to 50% load 1.8 Vdc output

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4.5 Vdc - 13.2 Vdc Input 1.0 Vdc - 5.0 Vdc/6 A Output

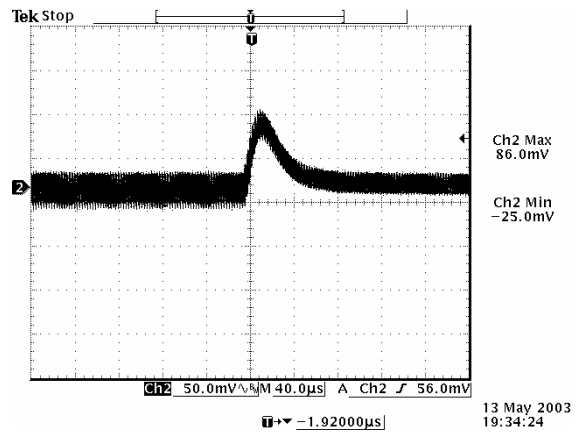
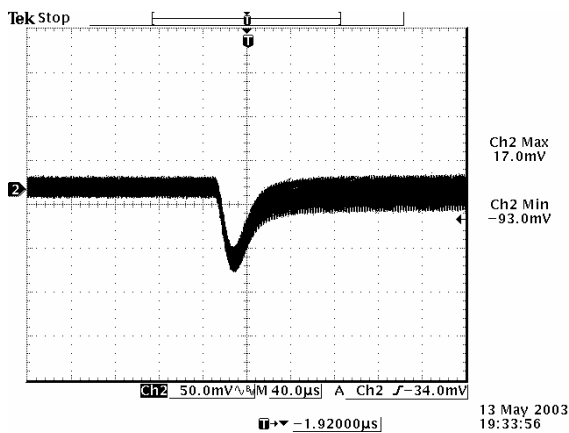


Transient Response Waveforms (continued)



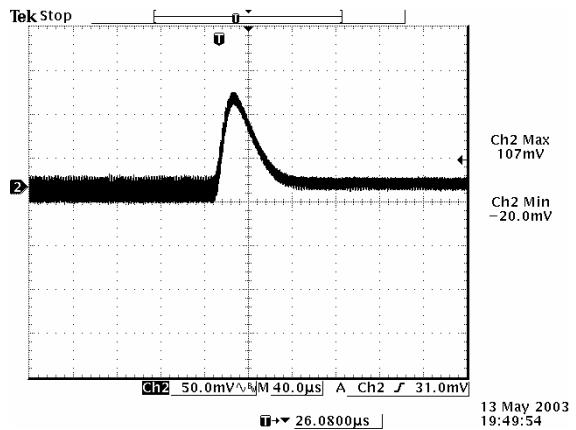
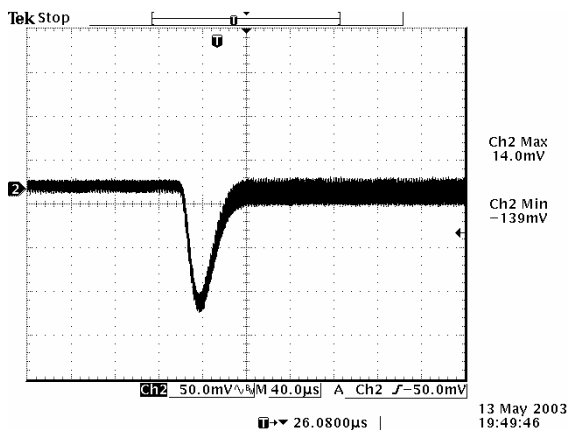
Transients 50% to 100% load 1.5 Vdc output

Transients 100% to 50% load 1.5 Vdc output



Transients 50% to 100% load 1.2 Vdc output

Transients 100% to 50% load 1.2 Vdc output



Transients 50% to 100% load 1.0 Vdc output

Transients 100% to 50% load 1.0 Vdc output

Note: Transient Response at 12 V input, di/dt=0.5 A/uS, with 220 uF tantalum cap at the output, Ta=25 deg C.

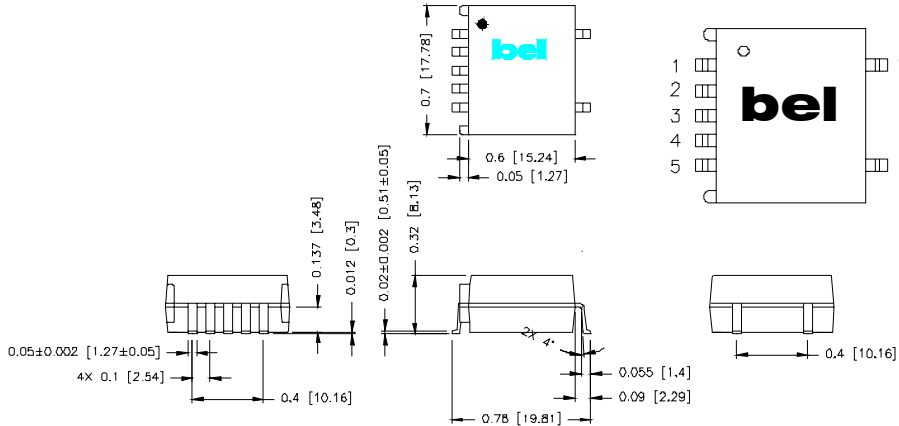
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Mechanical Outline

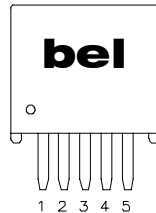
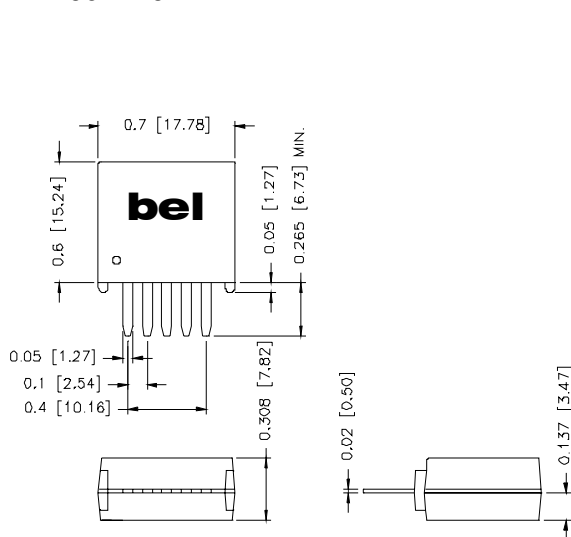
SRAH-06Exx0



Pin Connections

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

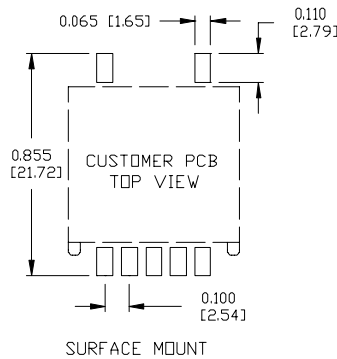
VRAH-06Exx0



Pin Connections

Pin	Function
1	Remote On/Off
2	Vin
3	Ground
4	Vout
5	Trim

RECOMMENDED PCB PAD LAYOUT



HOLE SIZE: 0.06" [1.57]
PAD SIZE: 0.08" [2.03]

RoHS Compliance

Complies with the European Directive 2002/95/EC, calling for the elimination of lead and other hazardous substances from electronic products. These parts are not however compatible with the higher temperatures associated with lead free solder processes and must be soldered using a reflow profile with a peak temperature of no more than 240 °C.



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