

NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input 1.0 Vdc - 3.3 Vdc/12 A Output

bel
POWER PRODUCTS

xRAH-12Fxx0 Series RoHS Compliant Rev.A

- Non-Isolated
- Fixed frequency (300 kHz)
- Low profile package (7.82 mm)
- Under-voltage lockout (UVLO)
- UL60950-1 Recognized (UL/cUL)
- OCP/SCP
- Trim function (Option)
- Remote On/Off
- Remote Sense (SMD module)



Description

The Bel xRAH-12Fxx0 series are part of the low cost non-isolated dc/dc converter series. These converters are available in a range of output voltages from 1.0 Vdc to 3.3 Vdc. It is packaged in a compact, overmolded package rated at 12 A. The output is closely regulated and the efficiency of 3.3 Vdc output module is typically 93% at full load. Typical features include remote on/off, input 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
3.3 V	4.5 V - 5.5 V	12 A	39.6 W	93%	SRAH-12F330	VRAH-12F330
2.5 V	3.6 V - 5.5 V	12 A	30.0 W	89%	SRAH-12F250	VRAH-12F250
1.8 V	3.0 V - 5.5 V	12 A	21.6 W	87%	SRAH-12F180	VRAH-12F180
1.5 V	3.0 V - 5.5 V	12 A	18.0 W	84%	SRAH-12F150	VRAH-12F150
1.2 V	3.0 V - 5.5 V	12 A	14.4 W	82%	SRAH-12F120	VRAH-12F120
1.0 V	3.0 V - 5.5 V	12 A	12.0 W	80%	SRAH-12F100	VRAH-12F100

- 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	-	6 V	
Output Enable Terminal Voltage	-0.3 V	-	7 V	
Ambient Temperature	-40 °C	-	85 °C	
Storage Temperature	-55 °C	-	125 °C	

Input Specifications

Parameter	Min	Typ	Max	Notes
Input Voltage				
Vo=3.3 V	4.5 V	-	5.5 V	
Vo=2.5 V	3.6 V	-	5.5 V	
Vo=1.8-1.0 V	3.0 V	-	5.5 V	
Input Current (no load)	-	120 mA	200 mA	
Input Current (full load)				
Vo=3.3 V	-	-	11 A	
Vo=2.5 V	-	-	10.5 A	
Vo=1.8 V	-	-	9.0 A	
Vo=1.5 V	-	-	8.1 A	
Vo=1.2 V	-	-	6.5 A	
Vo=1.0 V	-	-	5.2 A	
Remote Off Input Current	-	2 mA	5 mA	

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Input Specifications (continued)

Parameter	Min	Typ	Max	Notes
Input Reflected Ripple Current (pk-pk)	-	260 mA	320 mA	With simulated source impedance of 500 nH, 5 Hz to 20 MHz; use a 270 uF/6.3 V cap with ESR=0.03 ohm max at 100 kHz
Input Reflected Ripple Current (rms)	-	75 mA	120 mA	
I ² t Inrush Current Transient	-	0.09 A ² s	0.2 A ² s	
Turn on Voltage Threshold		2.1 V	-	
Turn off Voltage Threshold	-	2 V	2.4 V	

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

Output Specifications

Parameter	Min	Typ	Max	Notes	
Output Voltage Set Point				Test conditions: Vin=5 V, Io= 50% load	
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	-	±1 mV	±4 mV		
Load Regulation	-	±2 mV	±5 mV		
Regulation Over Temperature (-40 °C to +85 °C)					
Vo=3.3 V	-	±10 mV	±15 mV		
Vo=2.5 V	-	±9 mV	±13 mV		
Vo=1.8 V	-	±7 mV	±12 mV		
Vo=1.5 V	-	±6 mV	±11 mV		
Vo=1.2 V	-	±5 mV	±10 mV		
Vo=1.0 V	-	±4 mV	±9 mV		
Output Current	0 A	-	12 A		
Current Limit Threshold	20 A	-	30 A		
Short Circuit Surge Transient	-	0.3 A ² s	0.6 A ² s		
Ripple and Noise (rms)	-	12 mV	21 mV	Test conditions: 0-20 MHz BW; 1 uF ceramic capacitor and 330 uF external capacitor at the output.	
Ripple and Noise (pk-pk)	-	50 mV	90 mV		
Turn on Time	-	5 mS	10 mS		
Overshoot at Turn on	-	0%	3%		
Output Capacitance	330 uF	-	4800 uF		
Transient Response					
50% ~ 100% Max Load	Overshoot	Vo=3.3 V	-	110 mV	Test conditions: di/dt=0.5A/us, Vin=5V, with 330uF external load capacitance.
	Settling Time		-	40 uS	
100% ~ 50% Max Load	Overshoot	Vo=3.3 V	-	110 mV	
	Settling Time		-	40 uS	
50% ~ 100% Max Load	Overshoot	Vo=2.5 V	-	100 mV	
	Settling Time		-	30 uS	
100% ~ 50% Max Load	Overshoot	Vo=2.5 V	-	100 mV	
	Settling Time		-	30 uS	
50% ~ 100% Max Load	Overshoot	Vo=1.0 V - 1.8 V	-	90 mV	
	Settling Time		-	20 uS	
100% ~ 50% Max Load	Overshoot	Vo=1.0 V - 1.8 V	-	90 mV	
	Settling Time		-	20 uS	

Note: All specifications are typical at 5 V input, full load at 25 °C unless otherwise stated.

NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

1.0 Vdc - 3.3 Vdc/12 A Output



General Specifications

Parameter	Min	Typ	Max	Notes	
Efficiency	Vo=3.3 V	90%	93%	-	Vin=5 V, full load
	Vo=2.5 V	86%	89%	-	
	Vo=1.8 V	84%	87%	-	
	Vo=1.5 V	81%	84%	-	
	Vo=1.2 V	79%	82%	-	
	Vo=1.0 V	77%	80%	-	
Efficiency	Vo=1.8 V	85%	88%	-	Vin=3.3 V, full load
	Vo=1.5 V	81%	84%	-	
	Vo=1.2 V	79%	82%	-	
	Vo=1.0 V	76%	79%	-	
Switching Frequency	250 kHz	300 kHz	350 kHz		
Output Trim Range	90%Vo	-	110%Vo		
Remote Sense Compensation	-	-	10%	SMD module	
MTBF	4,038,174 hours			Calculated Per Bell Core SR-332 (Io = 9.6 A, Vin=5 V; Ta = 25 °C)	
Dimensions (surface mount)	Inches (L x W x H)	0.78 x 0.70 x 0.32			
	Millimeters (L x W x H)	19.81 x 17.78 x 8.128			
Dimensions (vertical)	Inches (L x W x H)	0.70 x 0.308 x 0.65			
	Millimeters (L x W x H)	17.78 x 7.82 x 16.51			
Weight	-	5.1 g	-		

Control Specifications

Parameter	Min	Typ	Max	Notes
Remote On/Off				
Signal Low (Unit Off)	-	-	0.9 V (Vin=3.0 V)	Remote on/off pin open, unit on.
	-	-	1.35 V (Vin=4.5 V)	
	-	-	1.65 V (Vin=5.5 V)	
Signal High (Unit On)	2.1 V (Vin=3.0 V)	-	-	
	3.15 V (Vin=4.5 V)	-	-	
	3.85 V (Vin=5.5 V)	-	-	

NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

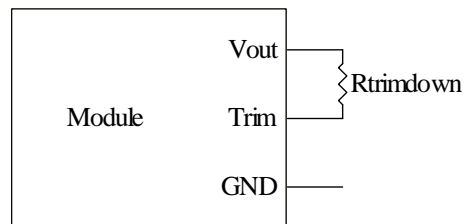
1.0 Vdc - 3.3 Vdc/12 A Output

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POWER PRODUCTS

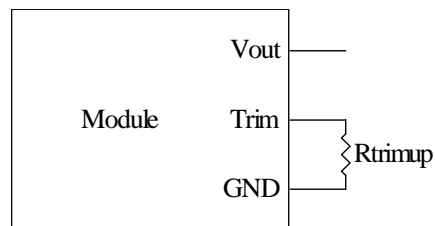
Output Trim Equations

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.

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



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



Vnom	A	B	C	D
3.3	161.391	161.900	43.330	100.000
2.5	111.674	208.900	43.330	147.000
1.8	68.576	287.900	43.330	226.000
1.5	50.000	287.900	43.330	226.000
1.2	31.240	208.900	43.330	147.000
1.0	18.850	161.900	43.330	100.000

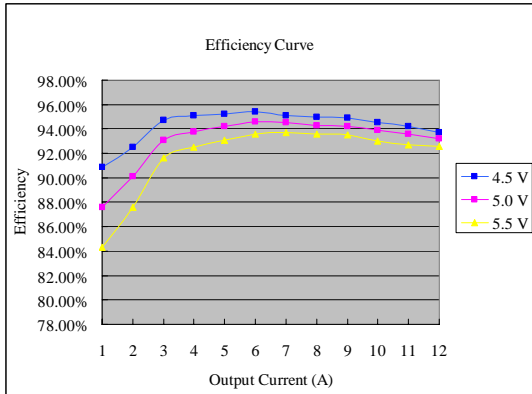
NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

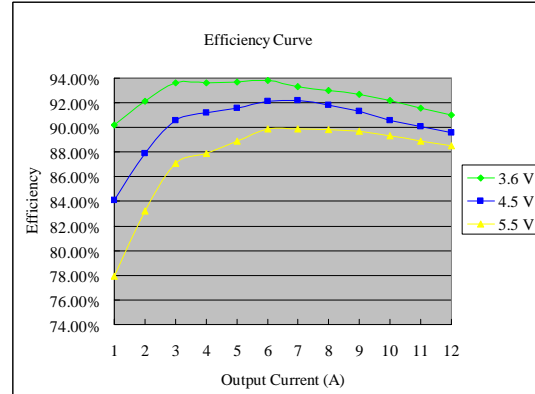
1.0 Vdc - 3.3 Vdc/12 A Output



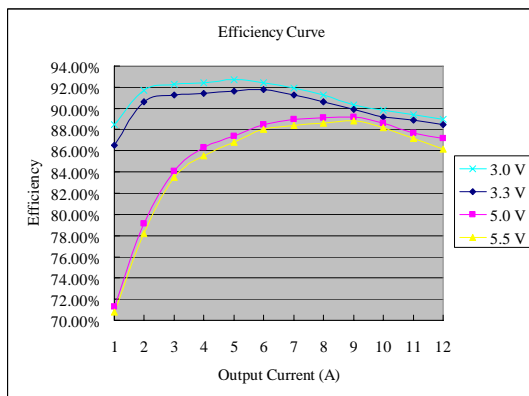
Efficiency Data



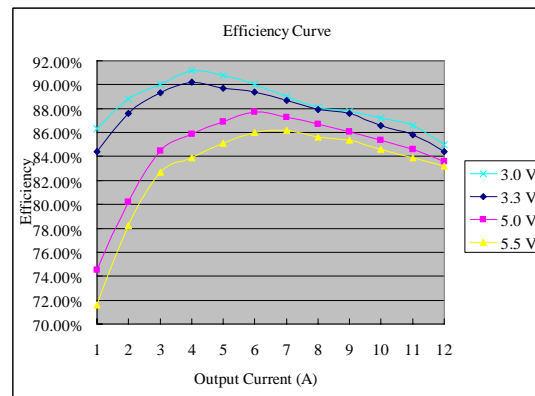
xRAH-12F330



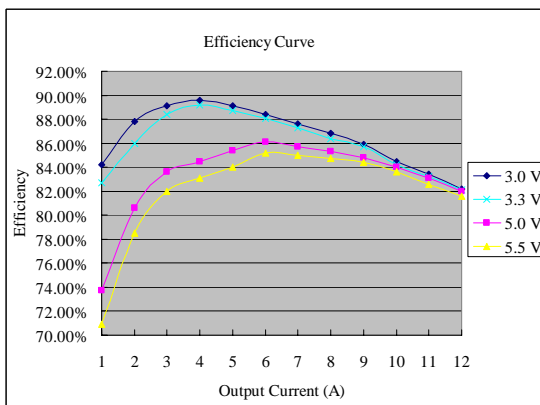
xRAH-12F250



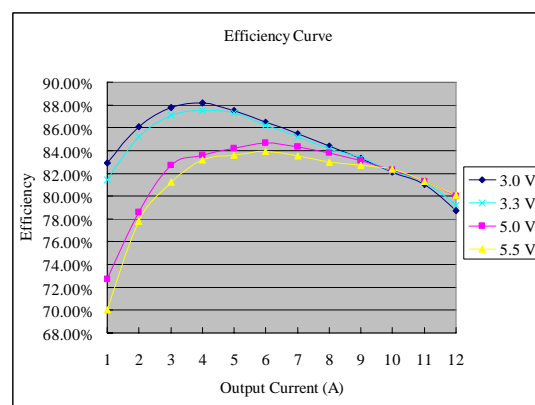
xRAH-12F180



xRAH-12F150



xRAH-12F120



xRAH-12F100

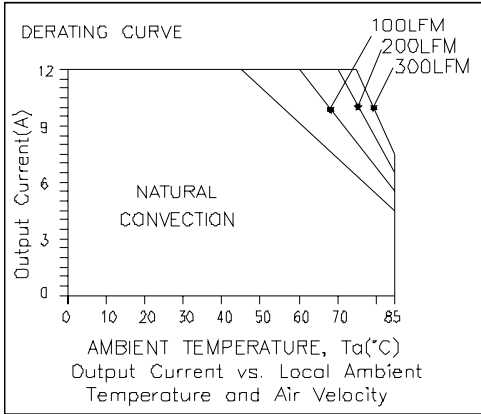
NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

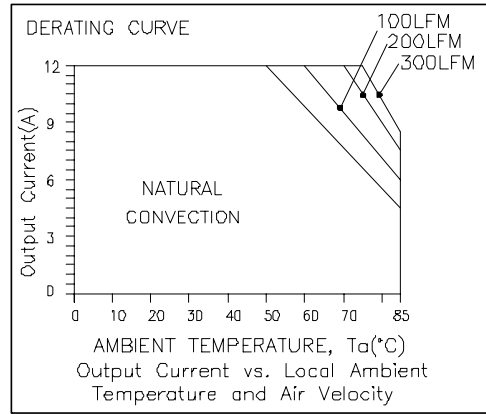
1.0 Vdc - 3.3 Vdc/12 A Output



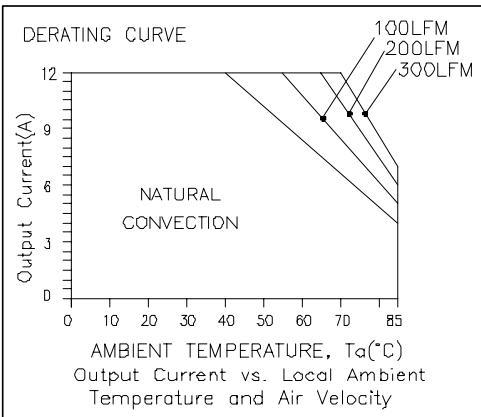
Thermal Derating Curves



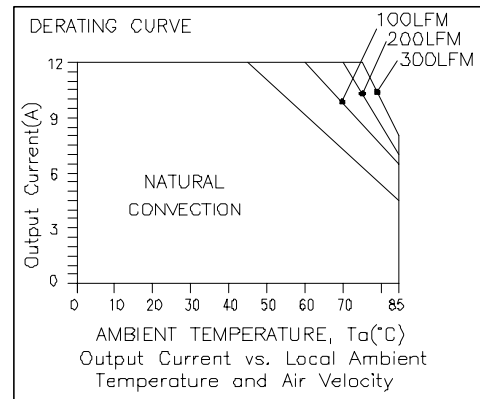
SRAH-12F330



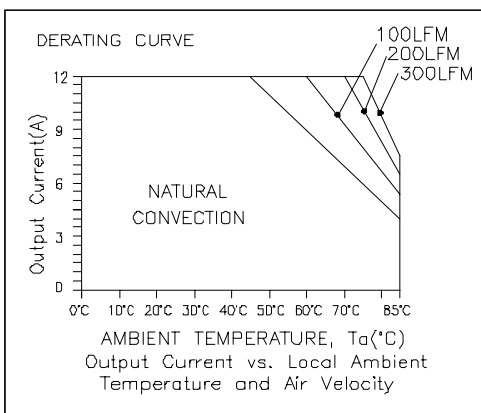
VRAH-12F330



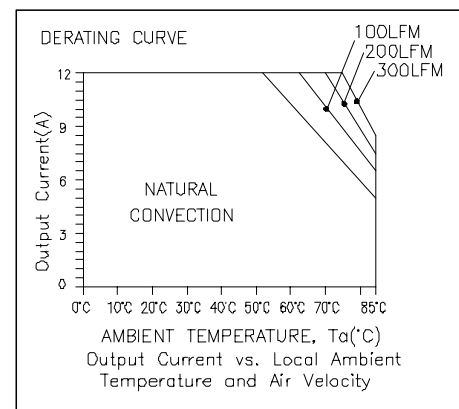
SRAH-12F250



VRAH-12F250



SRAH-12F180



VRAH-12F180

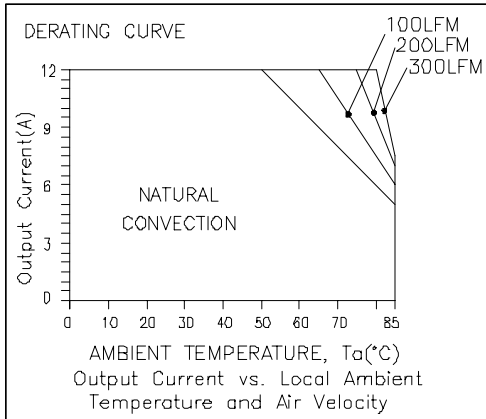
NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

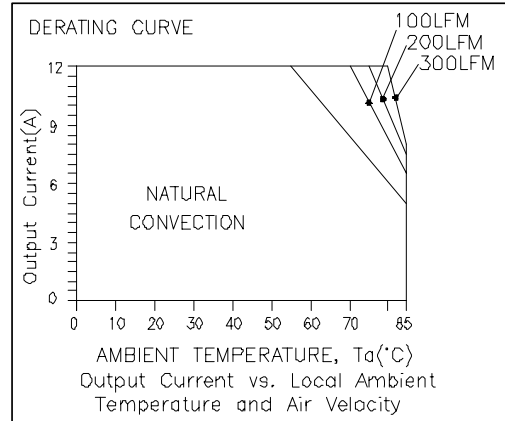
1.0 Vdc - 3.3 Vdc/12 A Output



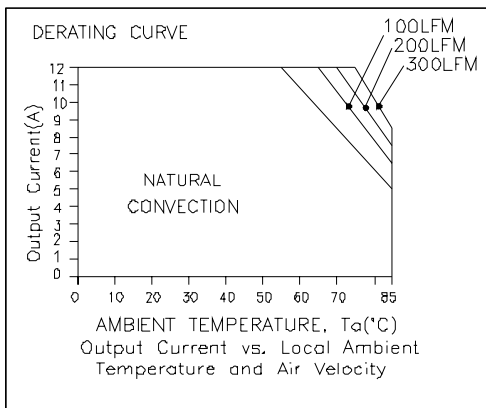
Thermal Derating Curves (continued)



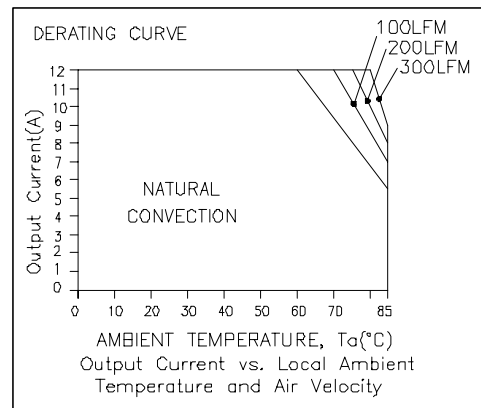
SRAH-12F150



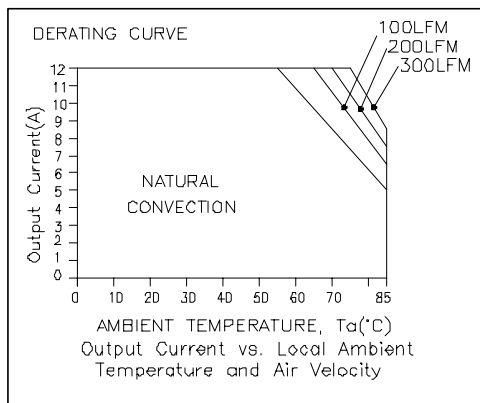
VRAH-12F150



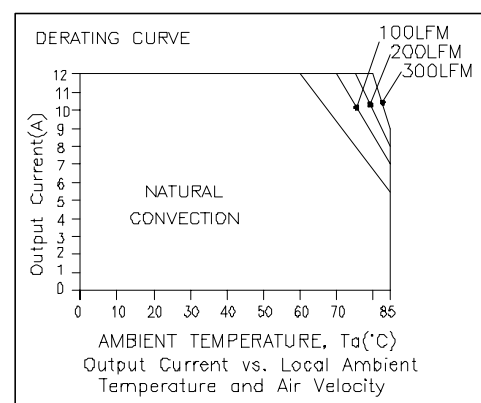
SRAH-12F120



VRAH-12F120



SRAH-12F100



VRAH-12F100

Test Condition: Derating curves are tested at 5 V input.

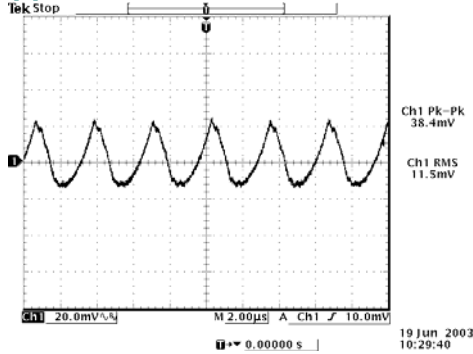
NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

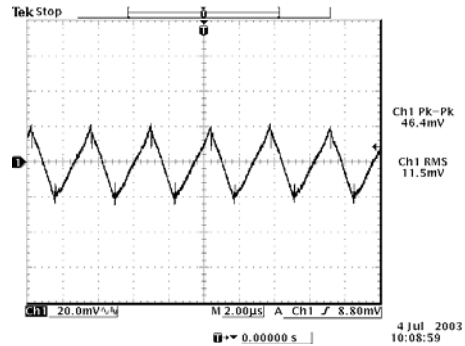
1.0 Vdc - 3.3 Vdc/12 A Output



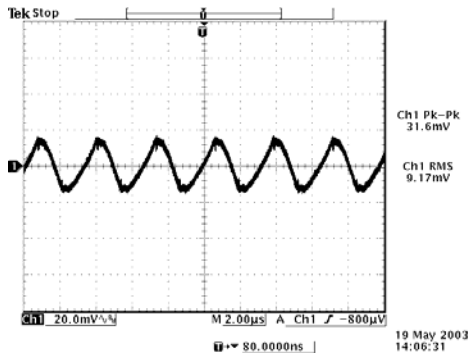
Ripple and Noise Waveforms



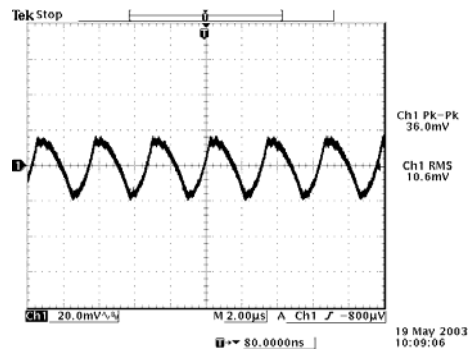
5 Vdc Input, 3.3 Vdc Output



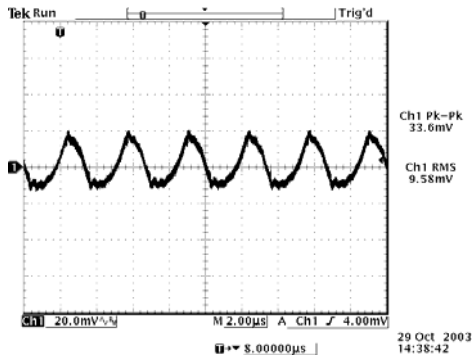
5 Vdc Input 2.5 Vdc Output



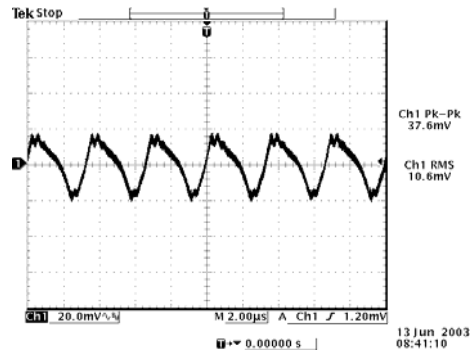
3.3 Vdc Input, 1.8 Vdc Output



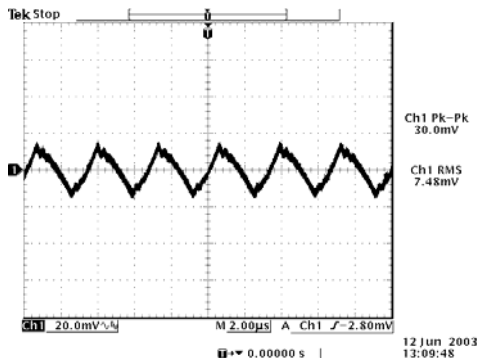
5 Vdc Input 1.8 Vdc Output



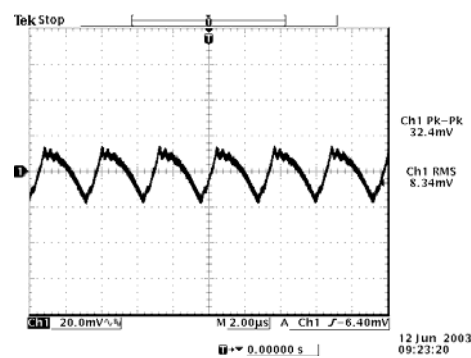
3.3 Vdc Input, 1.5 Vdc Output



5 Vdc Input 1.5 Vdc Output



3.3 Vdc Input, 1.2 Vdc Output



5 Vdc Input 1.2 Vdc Output

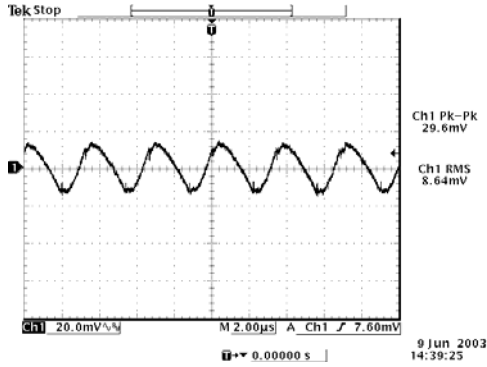
NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

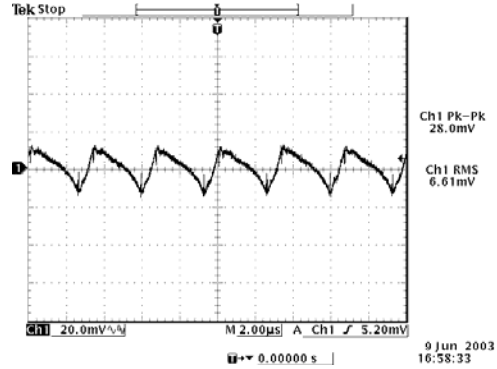
1.0 Vdc - 3.3 Vdc/12 A Output



Ripple and Noise Waveforms (continued)



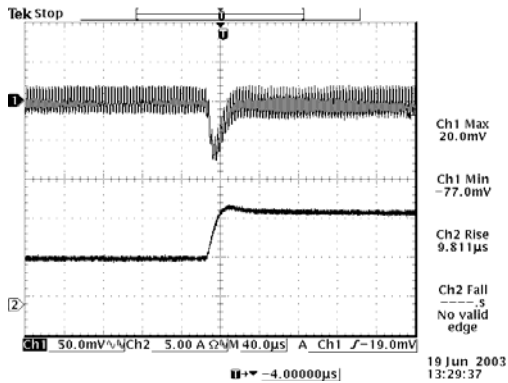
3.3 Vdc Input, 1.0 Vdc Output



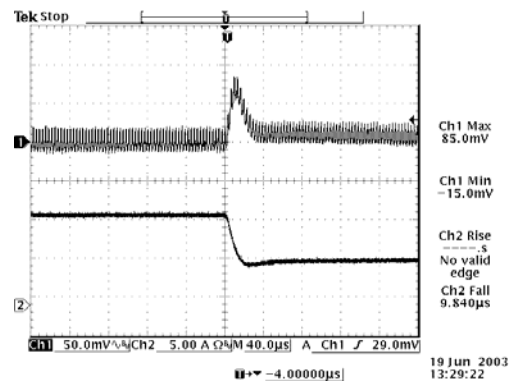
5 Vdc Input 1.0 Vdc Output

Note: Ripple and Noise at full load, with 1 μ F ceramic capacitor and a 330 μ F tantalum capacitor at the output, $T_a=25$ deg C.

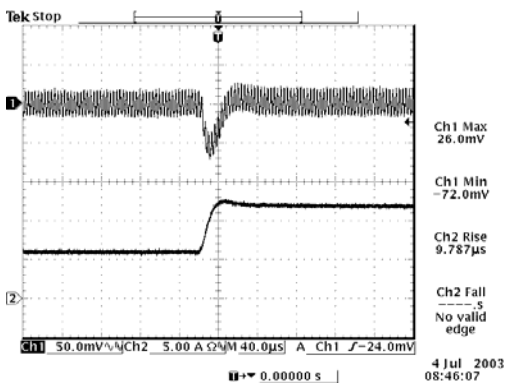
Transient Response Waveforms



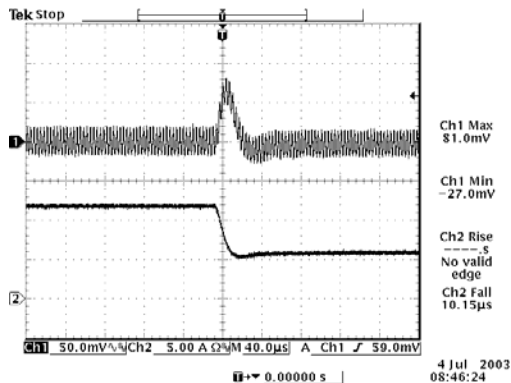
50% to 100% load 5.0 Vdc Input 3.3 Vdc Output



100% to 50% load 5.0 Vdc Input 3.3 Vdc Output



50% to 100% load 5.0 Vdc Input 2.5 Vdc Output



100% to 50% load 5.0 Vdc Input 2.5 Vdc Output

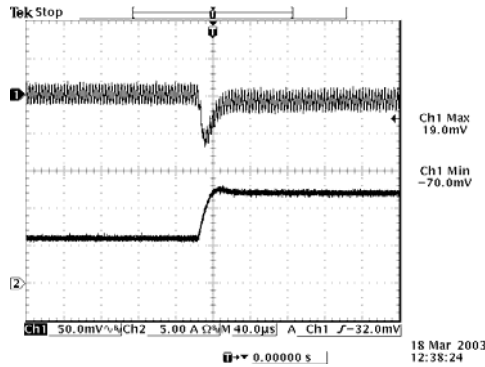
NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

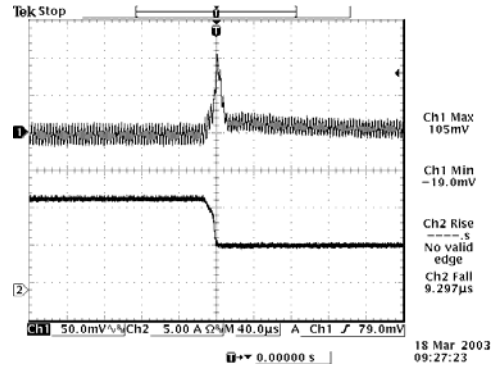
1.0 Vdc - 3.3 Vdc/12 A Output



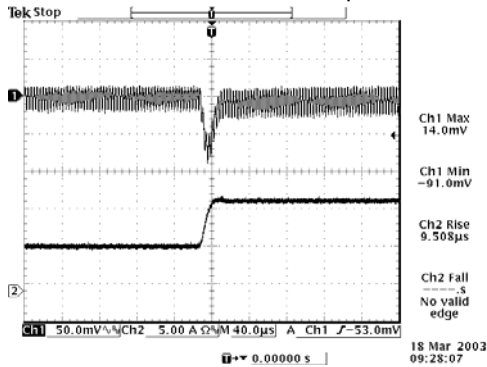
Transient Response Waveforms (continued)



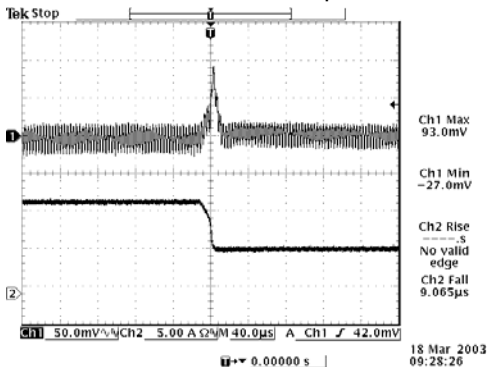
50% to 100% load 3.3 Vdc Input 1.8 Vdc Output



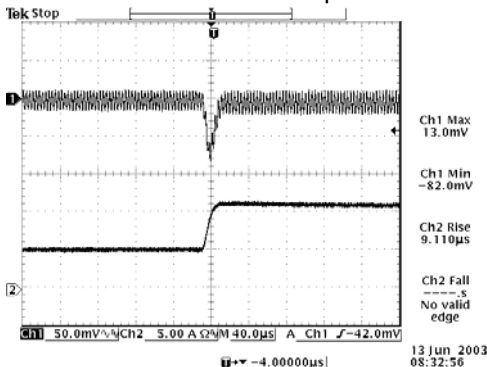
100% to 50% load 3.3 Vdc Input 1.8 Vdc Output



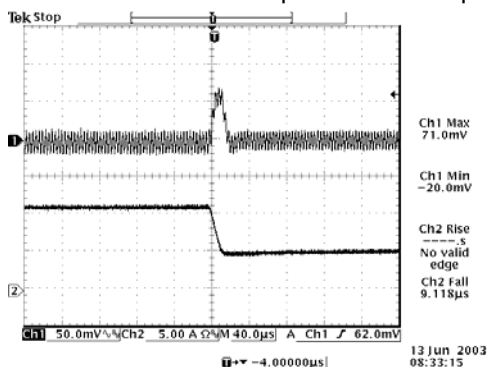
50% to 100% load 5 Vdc Input 1.8 Vdc Output



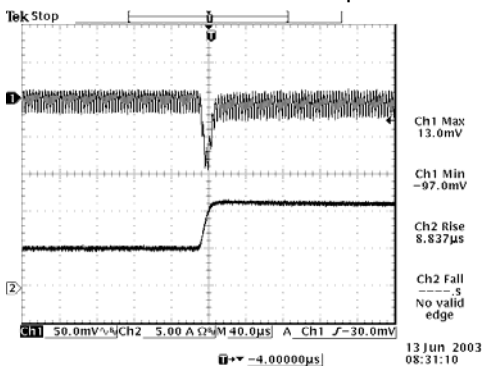
100% to 50% load 5 Vdc Input 1.8 Vdc Output



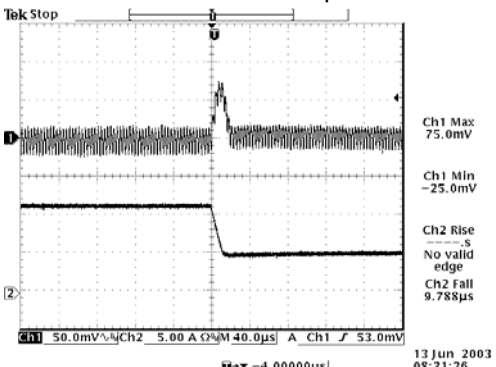
50% to 100% load 3.3 Vdc Input 1.5 Vdc Output



100% to 50% load 5 Vdc Input 1.8 Vdc Output



50% to 100% load 5 Vdc Input 1.5 Vdc Output



100% to 50% load 3.3 Vdc Input 1.5 Vdc Output

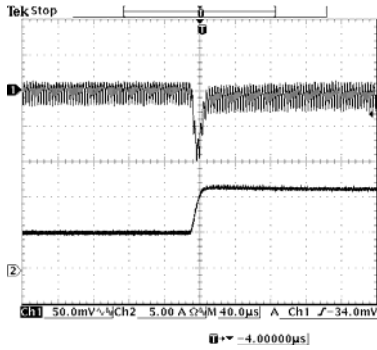
NON-ISOLATED DC/DC CONVERTERS

3.0 Vdc - 5.5 Vdc Input

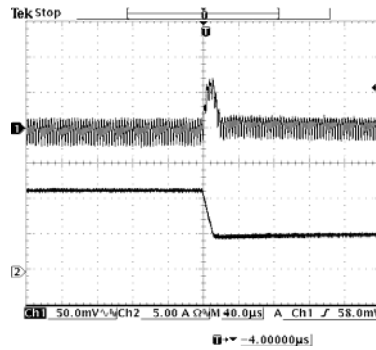
1.0 Vdc - 3.3 Vdc/12 A Output



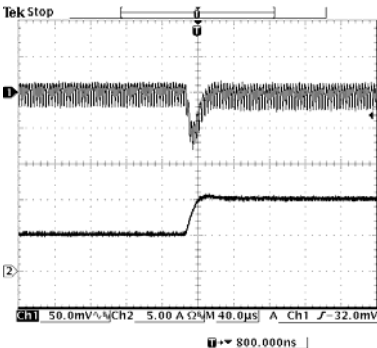
Transient Response Waveforms (continued)



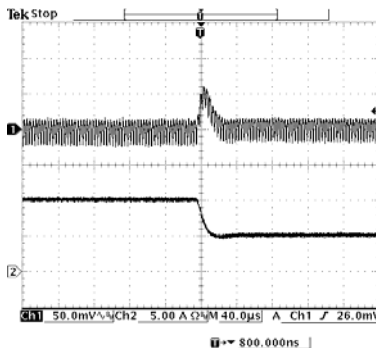
50% to 100% load 3.3 Vdc Input 1.2 Vdc Output



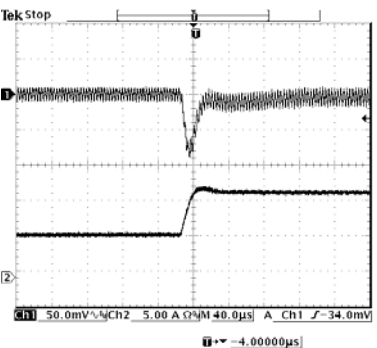
100% to 50% load 3.3 Vdc Input 1.2 Vdc Output



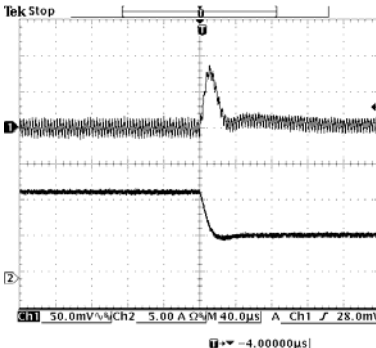
50% to 100% load 5 Vdc Input 1.2 Vdc Output



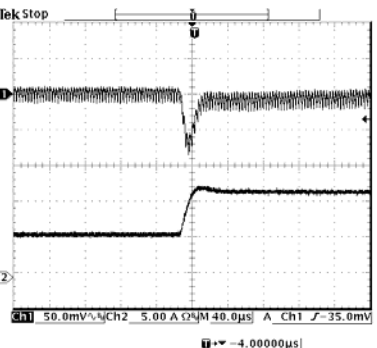
100% to 50% load 5 Vdc Input 1.2 Vdc Output



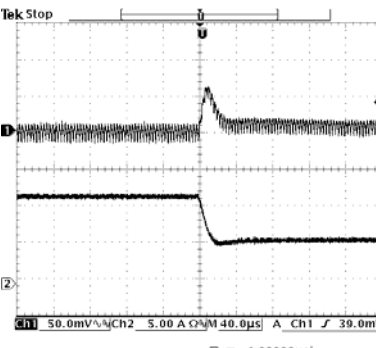
50% to 100% load 5 Vdc Input 1.0 Vdc Output



100% to 50% load 5 Vdc Input 1.0 Vdc Output



50% to 100% load 3.3 Vdc Input 1.0 Vdc Output



100% to 50% load 3.3 Vdc Input 1.0 Vdc Output

Note: Transient response at $di/dt=0.5$ A/uS, with external load capacitance = 330 uF, $T_a=25$ deg C.

NON-ISOLATED DC/DC CONVERTERS

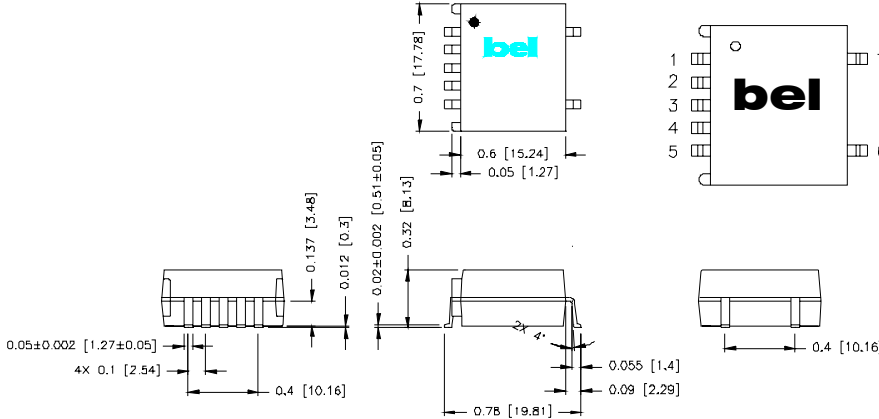
3.0 Vdc - 5.5 Vdc Input

1.0 Vdc - 3.3 Vdc/12 A Output



Mechanical Outline

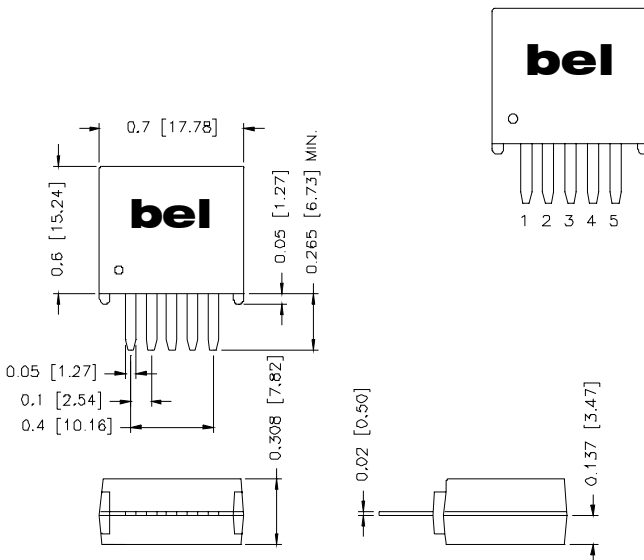
SRAH-12Fxx0



Pin Connections

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

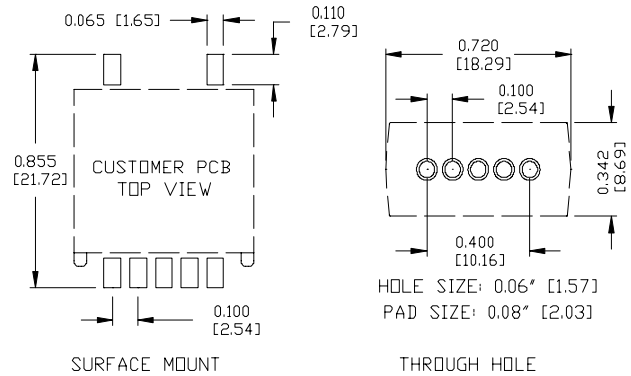
VRAH-12Fxx0



Pin Connections

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

RECOMMENDED PCB PAD LAYOUT



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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