

NON-ISOLATED DC/DC CONVERTERS

10.8Vdc – 13.2 Vdc Input 1 Vdc - 5 Vdc / 10A Output



Jul. 09, 2012

Bel Power, Inc. , a subsidiary of Bel Fuse, Inc.

VRPB-10A series RoHS Compliant Rev.A

Features

- Non-Isolated
- High Efficiency
- Fixed Frequency
- Low cost
- Overtemperature Shutdown
- Class 2, Category 2, Non-Isolated DC/DC Converter (refer to IPC-9592A)
- Remote On/Off
- OCP/SCP
- Undervoltage lockout
- Remote Sense

Description

The Bel VRPB-10AXXX is a part of the low cost non-isolated dc to dc converter Power Module series. The modules use a SIP package for ease of layout and space savings. The output is closely regulated and the efficiency is typically 94% at full load.

Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number Active High	Model Number Active Low
5.0 V	10.8 -13.2 V	10 A	50 W	94%	VRPB-10A50S	VRPB-10A50L
3.3 V	10.8 -13.2 V	10 A	33 W	92%	VRPB-10A33S	VRPB-10A33L
2.5 V	10.8 -13.2 V	10 A	25 W	90%	VRPB-10A25S	VRPB-10A25L
2.0 V	10.8 -13.2 V	10 A	20 W	88%	VRPB-10A20S	VRPB-10A20L
1.8 V	10.8 -13.2 V	10 A	18 W	87%	VRPB-10A18S	VRPB-10A18L
1.5 V	10.8 -13.2 V	10 A	15 W	86%	VRPB-10A15S	VRPB-10A15L
1.2 V	10.8 -13.2 V	10 A	12 W	83%	VRPB-10A12S	VRPB-10A12L
1.0 V	10.8 -13.2 V	10 A	10 W	82%	VRPB-10A10S	VRPB-10A10L

Notes: 1. Add "G" suffix at the end of the model number listed above to indicate Tray Packaging. Change the first letter of the model number from "V" to "O" for horizontal mount package.
2. Add "H" suffix at the end of the model number to indicate Tray packaging and RoHS compliant without requiring exemption 7c-III.

Part Number Explanation

$\frac{V}{1} \frac{R}{2} \frac{PB}{3} - \frac{10}{4} \frac{A}{5} \frac{xx}{6} \frac{x}{7}$

- 1---Vertical mount
- 2--- RoHS 6, change "R" to "7" means RoHS 5
- 3---Series name
- 4---Series code
- 5---Wide input range (10.8-13.2V)
- 6---Wide trim
- 7---Enable

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Absolute Maximum Ratings

Parameter	Min	Typ	Max	Units	Notes
Input Voltage (continuous)	-0.3	-	15	V	
Output Enable Terminal Voltage	-0.3	-	15	V	
Ambient Temperature	-40	-	85	°C	
Storage Temperature	-40	-	125	°C	

Note: Ratings Use beyond the maximum ratings may cause a reliability degradation of the converter or may permanently damage the device.

Input Specifications (continued)

Parameter	Min	Typ	Max	Units	Notes
Input Voltage	10.8	-	13.2V	V	
Input Current	-	-	5.5	A	
Input Current (No load)	-	-	80	mA	
Remoted Off Input Current	-	3	20	mA	
Input Reflected Ripple Current	-	-	120	mA _{rms}	
Input Reflected Ripple Current(pk-pk)	-	-	330	mA _{pk-pk}	
I ² t Inrush Current Transient	-	0.05	0.1	A ² s	
Turn-on Voltage Threshold	-	9.7	-	V	
Turn-off Voltage Threshold	8.0	9.3	10.0	V	

Note: Input reflected ripple current is tested with a 22uF tantalum input capacitor and simulated source impedance of 800nH, 5Hz to 20MHz.

Output Specifications

Parameter	Min	Typ	Max	Unit	Notes
Output Voltage Set Point					Vin=12V, Iout=full load, Ta=25°C. Total error band ±4.5% over all operating conditions and temperatures until end of life.
Vo = 5.0V	4.900	5.0	5.100	V	
Vo = 3.3V	3.247	3.3	3.353		
Vo = 2.5V	2.460	2.5	2.540		
Vo = 2.0V	1.968	2.0	2.032		
Vo = 1.8V	1.771	1.8	1.829		
Vo = 1.5V	1.476	1.5	1.524		
Vo = 1.2V	1.181	1.2	1.219		
Vo = 1.0V	0.984	1.0	1.016		
Load Regulation					
Vo = 5.0V	-	2	6	mV	
Vo = 3.3V	-	2	6		
Vo = 2.5V	-	2	6		
Vo = 2.0V	-	2	6		
Vo = 1.8V	-	2	6		
Vo = 1.5V	-	2	6		
Vo = 1.2V	-	2	6		
Vo = 1.0V	-	2	6		

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Output Specifications

Parameter	Min	Typ	Max	Unit	Notes
Line Regulation					
Vo = 5.0V	-	2	4	mV	
Vo = 3.3V	-	2	4		
Vo = 2.5V	-	2	4		
Vo = 2.0V	-	2	4		
Vo = 1.8V	-	2	4		
Vo = 1.5V	-	2	4		
Vo = 1.2V	-	2	4		
Vo = 1.0V	-	2	4		
Regulation Over Temperature					
Vo = 5.0V	-	16	20	mV	
Vo = 3.3V	-	16	20		
Vo = 2.5V	-	16	20		
Vo = 2.0V	-	16	20		
Vo = 1.8V	-	16	20		
Vo = 1.5V	-	16	20		
Vo = 1.2V	-	16	20		
Vo = 1.0V	-	16	20		
Total Output Voltage Regulation					
Vo = 5.0V	-	20	30	mV	
Vo = 3.3V	-	20	30		
Vo = 2.5V	-	20	30		
Vo = 2.0V	-	20	30		
Vo = 1.8V	-	20	30		
Vo = 1.5V	-	20	30		
Vo = 1.2V	-	20	30		
Vo = 1.0V	-	20	30		
Output Ripple and Noise					0-20MHz BW, 22uF tantalum cap on output.
Vo = 5.0V	-	50	75	mV _{pk-pk}	
Vo = 3.3V	-	45	60		
Vo = 2.5V	-	40	55		
Vo = 2.0V	-	30	45		
Vo = 1.8V	-	30	45		
Vo = 1.5V	-	30	45		
Vo = 1.2V	-	25	40		
Vo = 1.0V	-	30	40		
Output Ripple and Noise					
Vo = 5.0V	-	17	25	mV _{rms}	
Vo = 3.3V	-	14	22		
Vo = 2.5V	-	10	15		
Vo = 2.0V	-	9	15		
Vo = 1.8V	-	8	12		
Vo = 1.5V	-	6	10		
Vo = 1.2V	-	6	10		
Vo = 1.0V	-	8	10		
Output Current Range	0	-	10	A	
Output DC Current Limit	13	-	22	A	

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Output Specifications(continued)

Parameter	Min	Typ	Max	Unit	Notes
Short Circuit Surge Transient					
Vo = 5.0V	-	0.8	1.5	A ² S	
Vo = 3.3V	-	0.8	1.5		
Vo = 2.5V	-	0.8	1.5		
Vo = 2.0V	-	0.8	1.5		
Vo = 1.8V	-	0.8	1.5		
Vo = 1.5V	-	0.8	1.5		
Vo = 1.2V	-	0.8	1.5		
Vo = 1.0V	-	0.8	1.5		
Turn on Time	-	-	150	mS	
Overshoot at Turn on	-	0	3	%	
Output Capacitance	0	-	3300	uF	
Transient Response					
DV 50% to 100% of Max Load	5.0 V	-	200	250	di/dt=0.5A/us, Vin=12Vdc, Ta=25°C, and with a 22uF Tantalum cap on output.
Settling Time		-	50	80	
DV 100% to 50% of Max Load		-	200	250	
Settling Time		-	50	80	
DV 50% to 100% of Max Load	3.3 V	-	160	200	
Settling Time		-	50	80	
DV 100% to 50% of Max Load		-	160	200	
Settling Time		-	50	80	
DV 50% to 100% of Max Load	2.5 V	-	180	220	
Settling Time		-	50	80	
DV 100% to 50% of Max Load		-	180	220	
Settling Time		-	50	80	
DV 50% to 100% of Max Load	2.0 V	-	140	180	
Settling Time		-	50	80	
DV 100% to 50% of Max Load		-	140	180	
Settling Time		-	50	80	
DV 50% to 100% of Max Load	1.8 V	-	140	180	
Settling Time		-	50	80	
DV 100% to 50% of Max Load		-	140	180	
Settling Time		-	50	80	
DV 50% to 100% of Max Load	1.5 V	-	140	180	
Settling Time		-	50	80	
DV 100% to 50% of Max Load		-	140	180	
Settling Time		-	50	80	
DV 50% to 100% of Max Load	1.2 V	-	100	150	
Settling Time		-	50	80	
DV 100% to 50% of Max Load		-	100	150	
Settling Time		-	50	80	
DV 50% to 100% of Max Load	1.0 V	-	100	150	
Settling Time		-	50	80	
DV 100% to 50% of Max Load		-	100	150	
Settling Time		-	50	80	

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

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General Specifications

Parameter	Min	Typ	Max	Unit	Notes
Efficiency					
Vo = 5.0V	91	94	-	%	Vin=12V, full load and Ta=25°C
Vo = 3.3V	89	92	-		
Vo = 2.5V	87	90	-		
Vo = 2.0V	85	88	-		
Vo = 1.8V	84	87	-		
Vo = 1.5V	83	86	-		
Vo = 1.2V	80	83	-		
Vo = 1.0V	79	82	-		
Switching Frequency	180	200	220	kHz	
Overtemperature Shutdown	-	130	-	Deg. C	
Remote Sense Compensation	-	-	10	%	
Output Voltage Trim Range					
Vo = 5.0V	90	-	110	%	
Vo = 3.3V	90	-	110		
Vo = 2.5V	90	-	110		
Vo = 2.0V	90	-	110		
Vo = 1.8V	90	-	110		
Vo = 1.5V	90	-	110		
Vo = 1.2V	90	-	110		
Vo = 1.0V	95	-	110		
MTBF	2,729,927			hours	Vout=3.3V, Vin=12.0V, Iout=80% load, Ta=25°C. No forced air.
Dimensions					
Inches (L × W × H)	2.0 x 0.55 x 0.387				
Millimeters (L × W × H)	50.80 x 13.97 x 9.84				
Weight	-	10	-	g	

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

Control Specifications

Parameter	Min	Typ	Max	Notes
Remote On/Off				
Signal Low (Unit Off)	-0.3 V	-	0.4 V	VRPB-10AXXS; Active High; Remote On/Off pin open, Unit on.
Signal High (Unit On)	2.8 V	-	13.2 V	
Signal Low (Unit On)	-0.3 V	-	0.4 V	VRPB-10AXXL; Active Low; Remote On/Off pin open, Unit off.
Signal High (Unit Off)	2.8 V	-	13.2 V	

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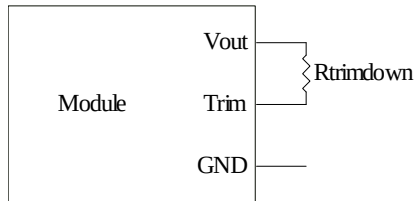
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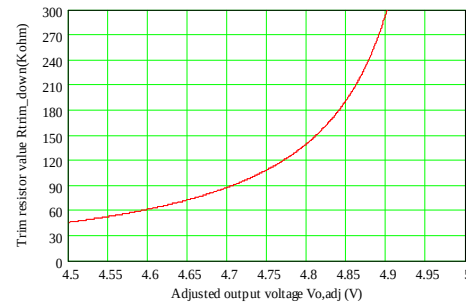
Output Trim Equations

VRPB-10A50x

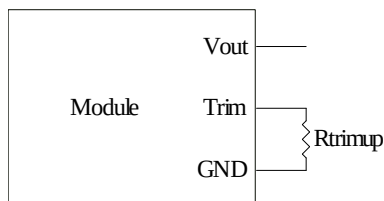
Trim down test circuit



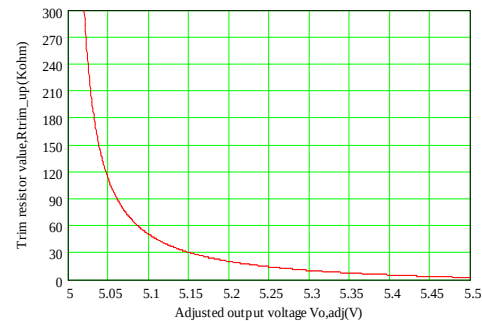
$$R_{trim_down} = \left(\frac{7.5(V_{qadj} - 0.8)}{V_{nom} - V_{qadj}} - 10 \right) \text{Kohm}$$



Trim up test circuit



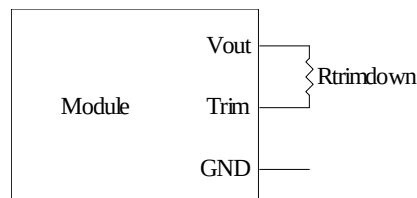
$$R_{trim_up} = \left(\frac{6}{V_{qadj} - V_{nom}} - 10 \right) \text{Kohm}$$



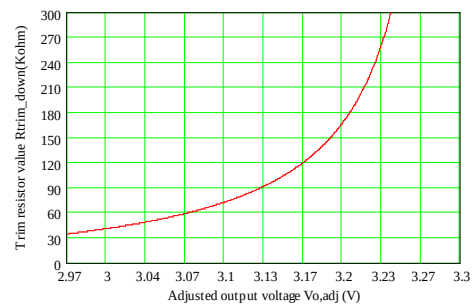
Notes: 1. Vnom=5.0V 2. Vo,adj is the desired output voltage

VRPB-10A33x

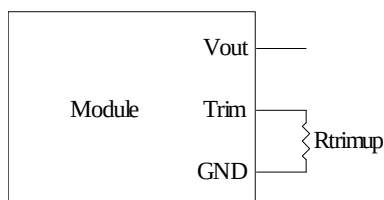
Trim down test circuit



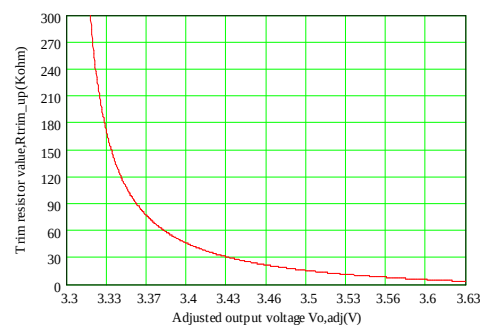
$$R_{trim_down} = \left(\frac{7.5(V_{qadj} - 0.8)}{V_{nom} - V_{qadj}} - 15 \right) \text{Kohm}$$



Trim up test circuit



$$R_{trim_up} = \left(\frac{6}{V_{qadj} - V_{nom}} - 15 \right) \text{Kohm}$$



Notes: 1. Vnom=3.3V 2. Vo,adj is the desired output voltage

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10.8Vdc – 13.2 Vdc Input 1 Vdc - 5 Vdc / 10A Output



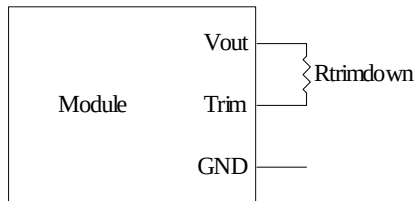
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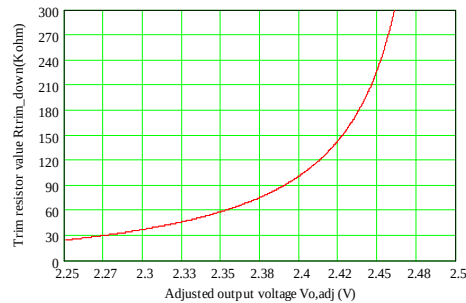
Output Trim Equations

VRPB-10A25x

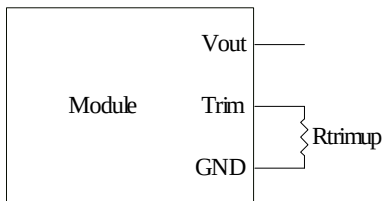
Trim down test circuit



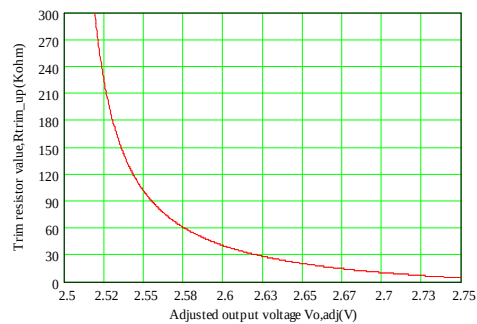
$$R_{trim_down} = \left(\frac{7.5(V_{qadj} - 0.8)}{V_{nom} - V_{qadj}} - 20 \right) \text{Kohm}$$



Trim up test circuit



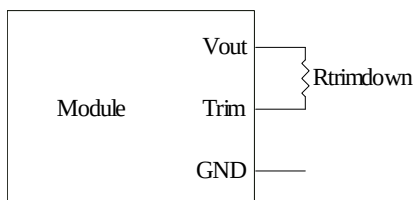
$$R_{trim_up} = \left(\frac{6}{V_{qadj} - V_{nom}} - 20 \right) \text{Kohm}$$



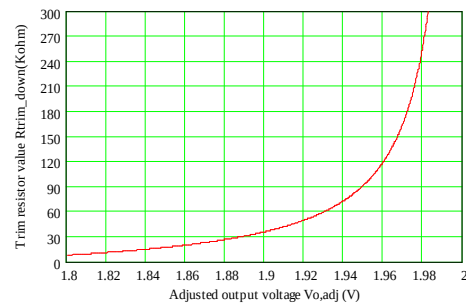
Notes: 1. Vnom=2.5 V 2. Vo,adj is the desired output voltage

VRPB-10A20x

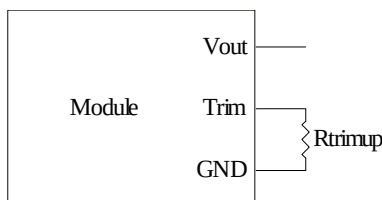
Trim down test circuit



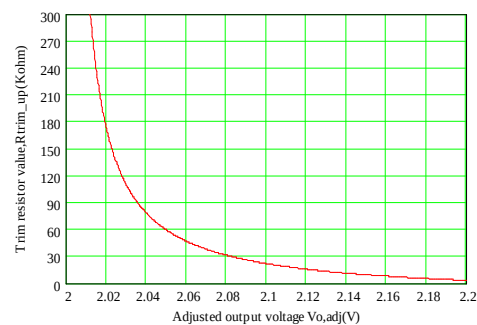
$$R_{trim_down} = \left(\frac{4.64(V_{qadj} - 0.8)}{V_{nom} - V_{qadj}} - 154 \right) \text{Kohm}$$



Trim up test circuit



$$R_{trim_up} = \left(\frac{3.72}{V_{qadj} - V_{nom}} - 154 \right) \text{Kohm}$$



Notes: 1. Vnom=2.0 V 2. Vo,adj is the desired output voltage

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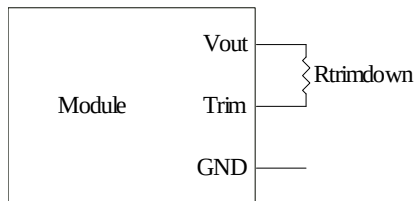
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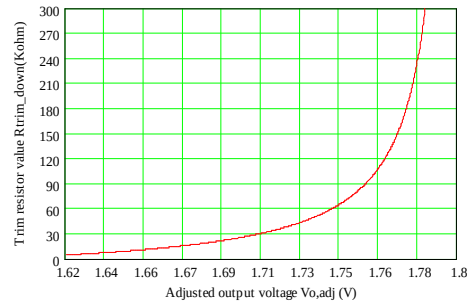
Output Trim Equations

VRPB-10A18x

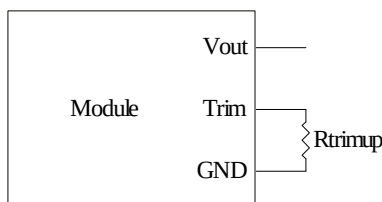
Trim down test circuit



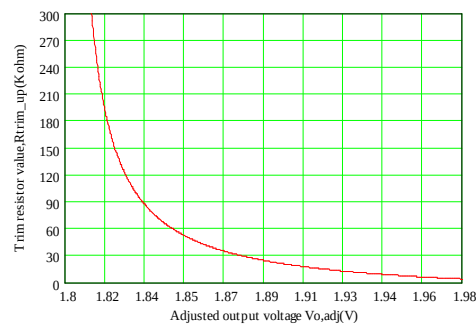
$$R_{trim_down} = \left(\frac{4.64(V_{qadj} - 0.8)}{V_{nom} - V_{qadj}} - 169 \right) \text{Kohm}$$



Trim up test circuit



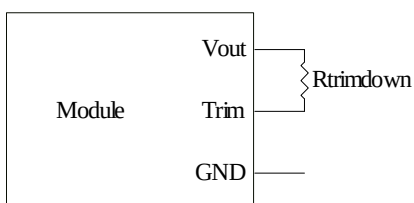
$$R_{trim_up} = \left(\frac{3.72}{V_{qadj} - V_{nom}} - 169 \right) \text{Kohm}$$



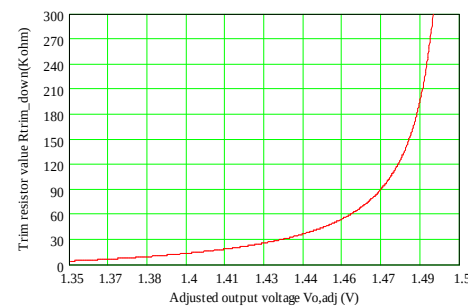
Notes: 1. Vnom=1.8 V 2. Vo,adj is the desired output voltage

VRPB-10A15x

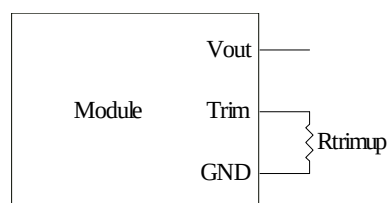
Trim down test circuit



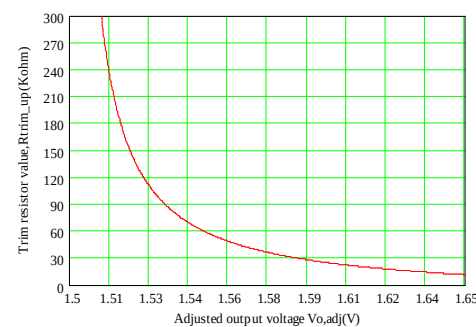
$$R_{trim_down} = \left(\frac{4.64(V_{qadj} - 0.8)}{V_{nom} - V_{qadj}} - 133 \right) \text{Kohm}$$



Trim up test circuit



$$R_{trim_up} = \left(\frac{3.72}{V_{qadj} - V_{nom}} - 133 \right) \text{Kohm}$$



Notes: 1. Vnom=1.5 V 2. Vo,adj is the desired output voltage

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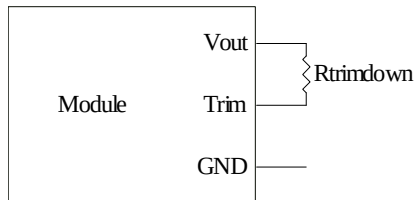
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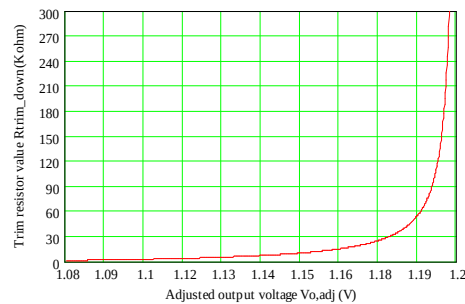
Output Trim Equations

VRPB-10A12x

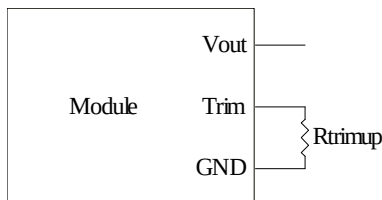
Trim down test circuit



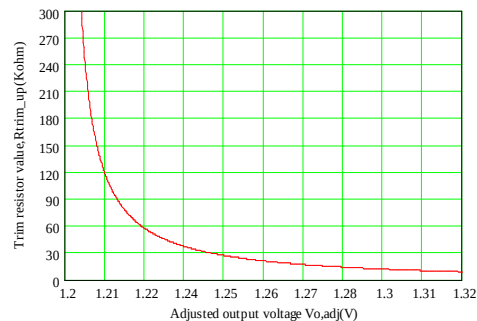
$$R_{trim_down} = \left(\frac{1.82(V_{qadj} - 0.8)}{V_{nom} - V_{qadj}} \right) - 3.16 \text{ Kohn}$$



Trim up test circuit



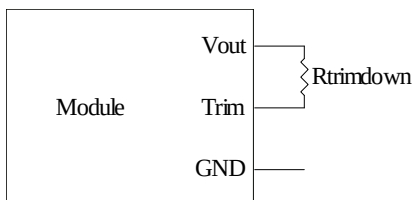
$$R_{trim_up} = \left(\frac{1.46}{V_{qadj} - V_{nom}} \right) - 3.16 \text{ Kohn}$$



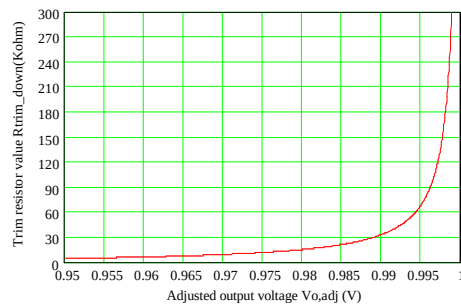
Notes: 1. Vnom=1.2 V 2. Vo,adj is the desired output voltage

VRPB-10A10x

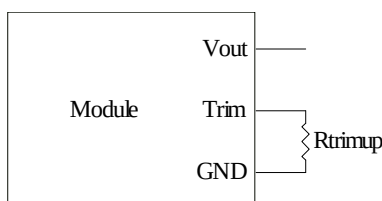
Trim down test circuit



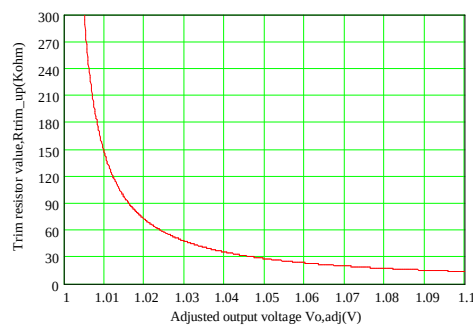
$$R_{trim_down} = \left(\frac{1.82(V_{qadj} - 0.8)}{V_{nom} - V_{qadj}} \right) - 0.909 \text{ Kohn}$$



Trim up test circuit



$$R_{trim_up} = \left(\frac{1.46}{V_{qadj} - V_{nom}} \right) - 0.909 \text{ Kohn}$$



Notes: 1. Vnom=1.0 V 2. Vo,adj is the desired output voltage

NON-ISOLATED DC/DC CONVERTERS

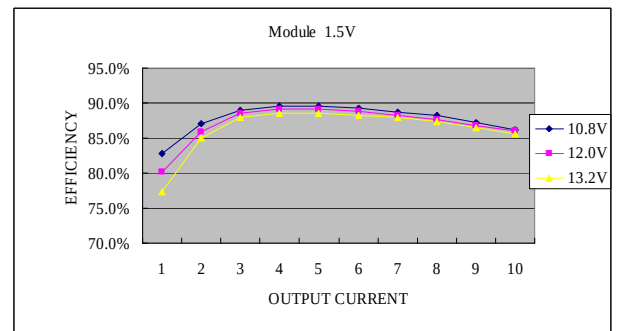
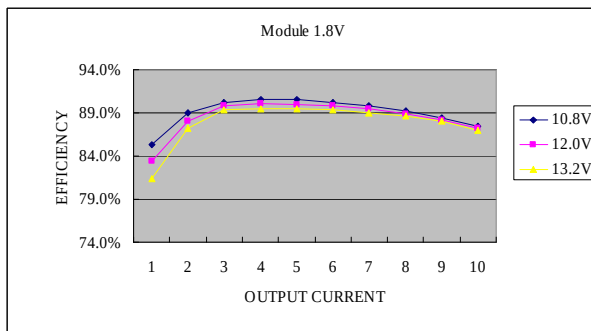
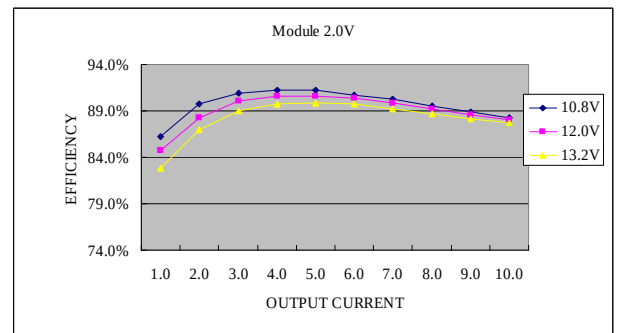
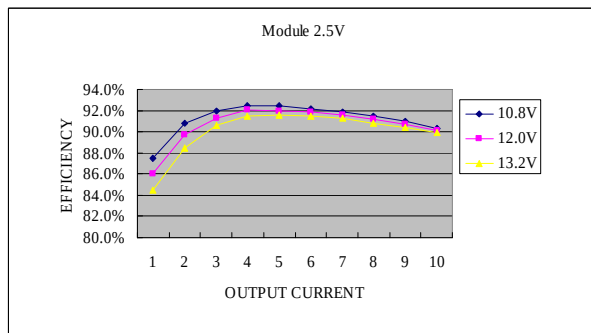
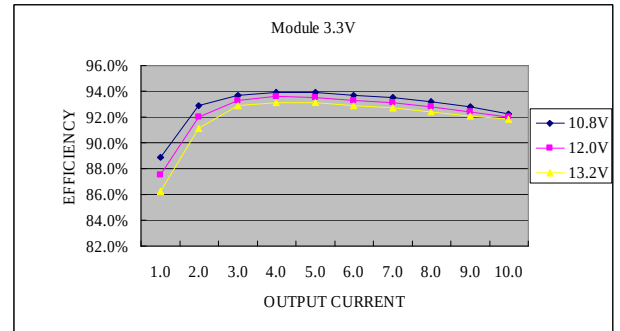
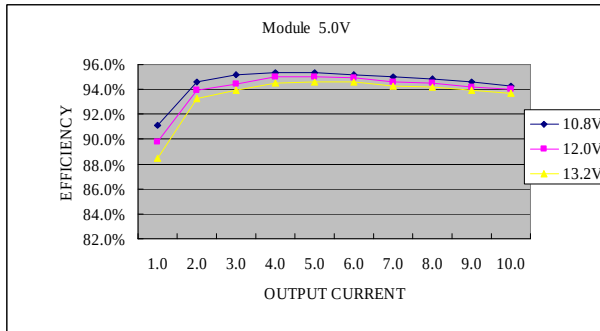
10.8Vdc – 13.2 Vdc Input 1 Vdc - 5 Vdc / 10A Output



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Efficiency Data



NON-ISOLATED DC/DC CONVERTERS

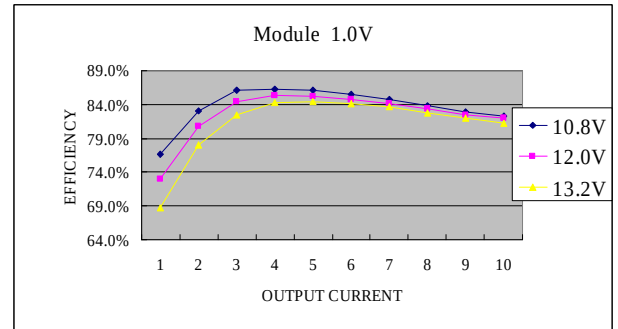
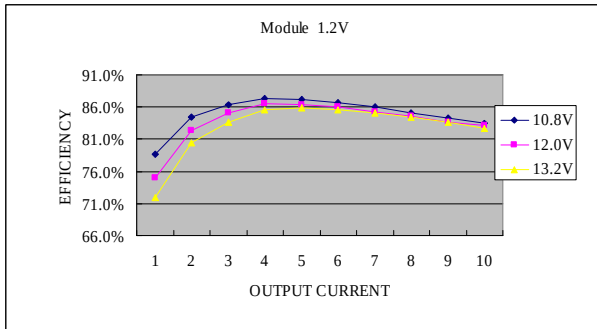
10.8Vdc – 13.2 Vdc Input 1 Vdc - 5 Vdc / 10A Output



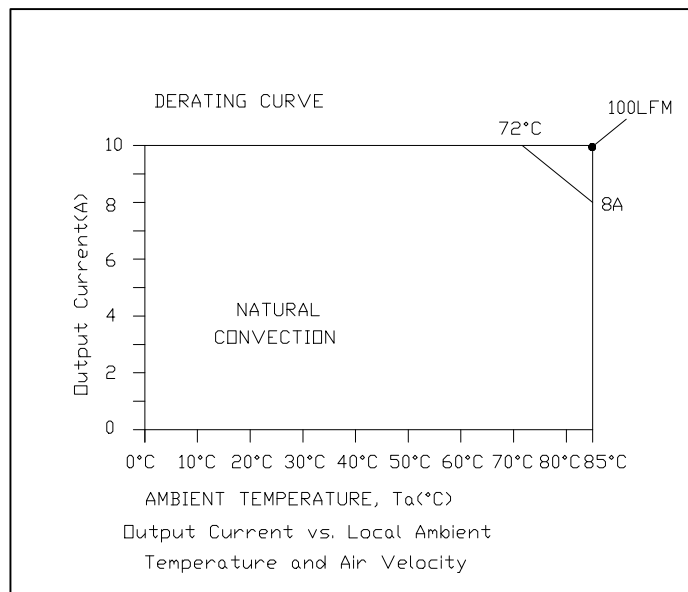
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Efficiency Data



Thermal Derating Curves



NON-ISOLATED DC/DC CONVERTERS

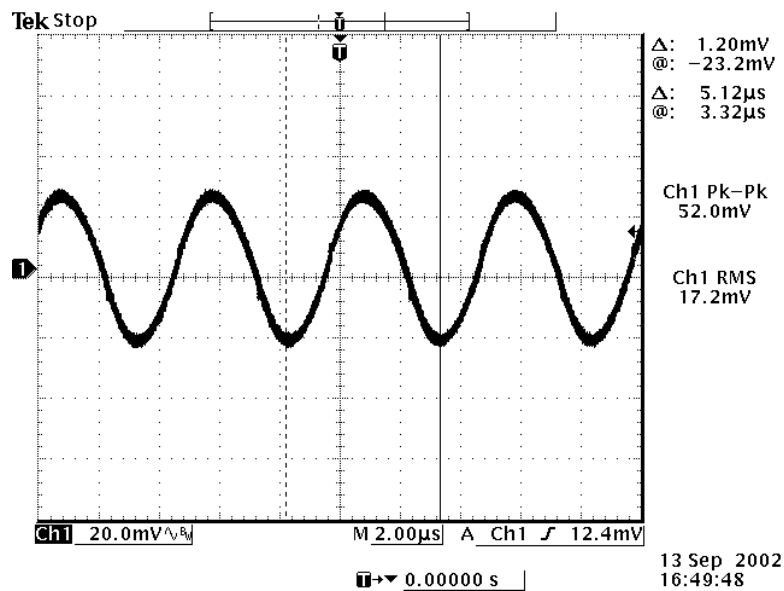
10.8Vdc – 13.2 Vdc Input 1 Vdc - 5 Vdc / 10A Output



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Ripple and Noise Waveforms

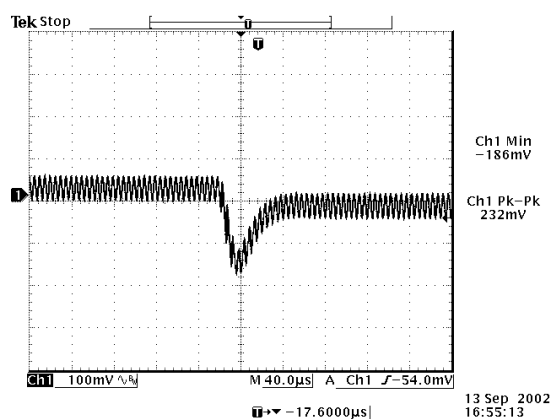


Note: Output ripple and noise at 12Vdc input, 5V output, full load with an external 22µF tantalum capacitor and $T_a=25^\circ\text{C}$.

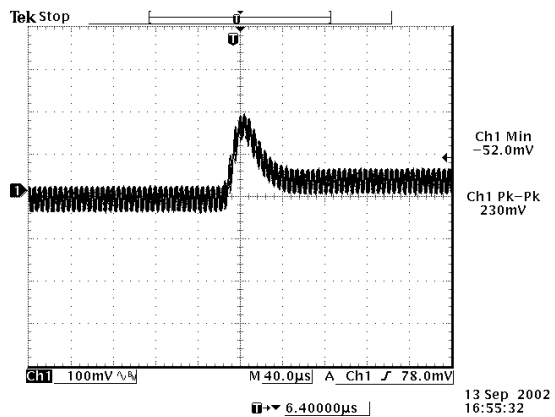
Transient Response Waveforms

Test Condition 1:

$di/dt=0.5\text{A}/\mu\text{s}$ and external load capacitance $C_o=22\mu\text{F}$ (Tantalum capacitor)



50% to 100% load transient at 12V input/5V output and $T_a=25^\circ\text{C}$



100% to 50% load transient at 12V input and $T_a=25^\circ\text{C}$

NON-ISOLATED DC/DC CONVERTERS

10.8Vdc – 13.2 Vdc Input 1 Vdc - 5 Vdc / 10A Output



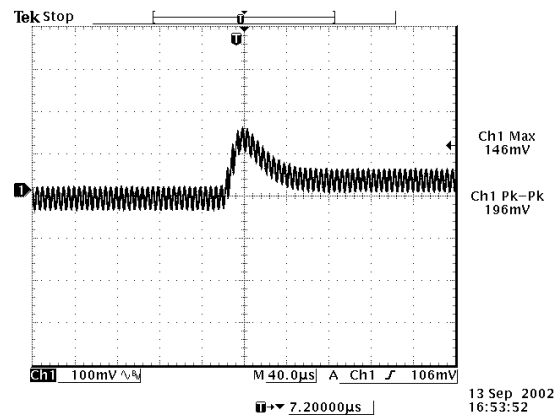
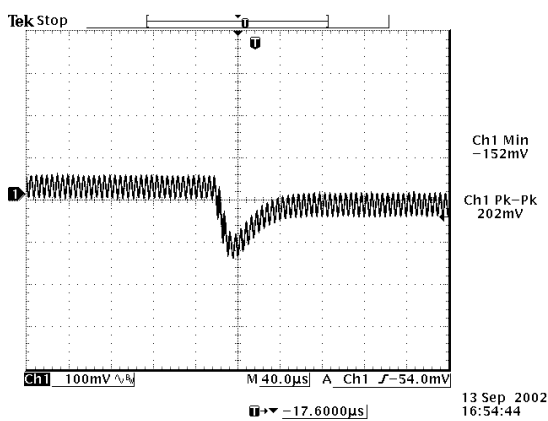
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Transient Response Waveforms(continued)

Test Condition 2:

di/dt=0.5A/uS, external load capacitance Co=470uF(Aluminum capacitor)

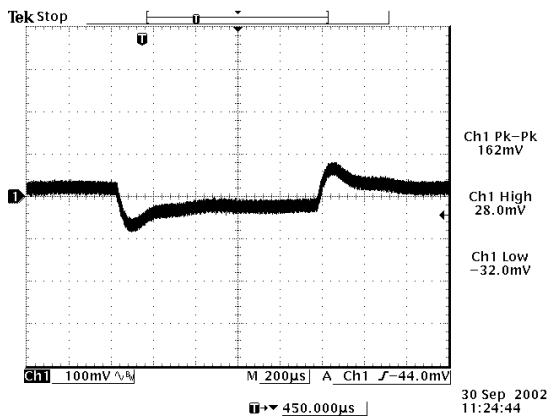


3 50% to 100% load transient at 12V input/5V output and Ta=25°C

100% to 50% load transient at 12V input/5V output and Ta=25°C

Test Condition 3:

di/dt=0.5A/uS, external load capacitance Co=2000uF(OS-CON capacitor)



5 50% load transient at 12V input/5V output and Ta=25°C

NON-ISOLATED DC/DC CONVERTERS

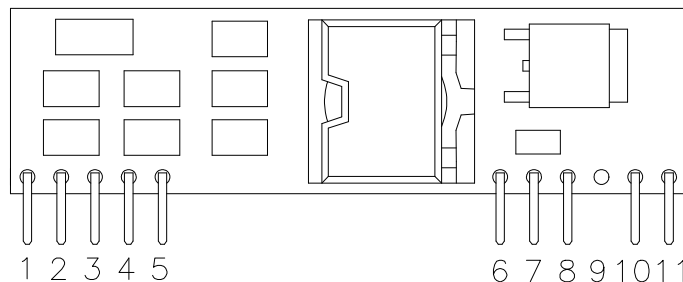
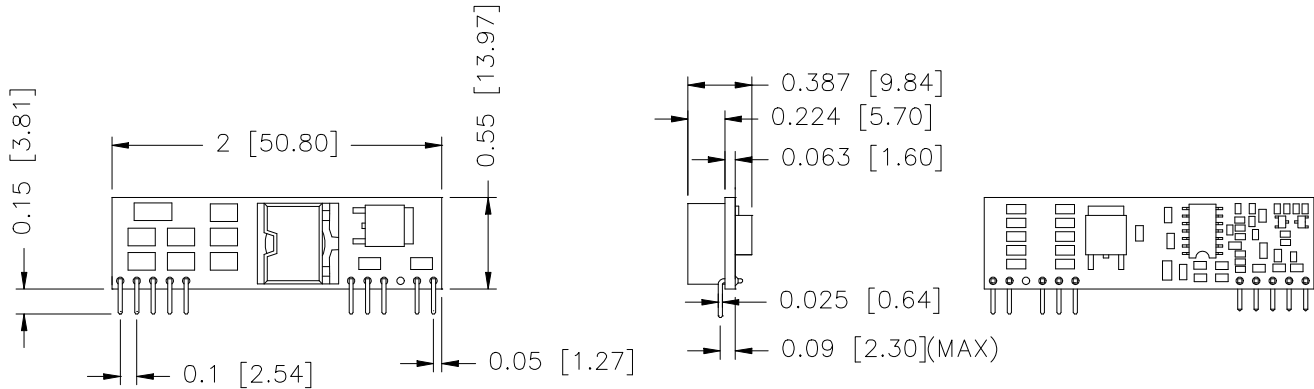
10.8Vdc – 13.2 Vdc Input 1 Vdc - 5 Vdc / 10A Output



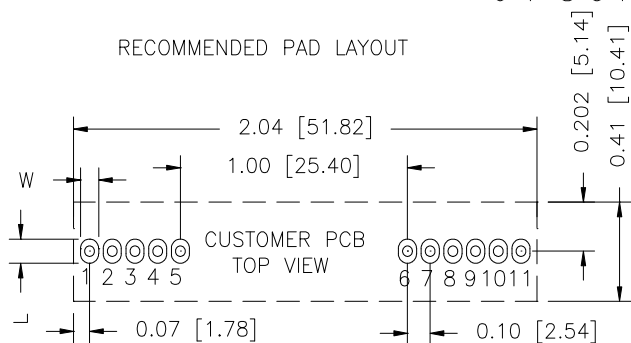
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Mechanical Outline



RECOMMENDED PAD LAYOUT



HOLE SIZE: $\varnothing 0.043 \pm 0.003$ [1.08±0.08]
 PAD SIZE: W 0.063 ± 0.002 [1.63±0.05]
 L 0.10 ± 0.004 [2.54±0.10] BOTH SIDE

Pin Connections

Pin	Function
1	+Vout
2	+Vout
3	Opt. Remote Sense(+)
4	+Vout
5	Ground
6	Ground
7	+Vin
8	+Vin
9	Not used
10	Trim
11	Remote On/Off

Note: This module is recommended and compatible with Pb-Free Wave Soldering and must be soldered using a peak solder temperature of no more than 260 °C for less than 5 seconds.

Note:

- 1) All Pins: Material - Copper Alloy;
Finish – 3 micro inches minimum Gold over 50 micro inches minimum Nickel plate.
- 2) Undimensioned components are shown for visual reference only.
- 3) All dimensions in inches (mm); Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm) x.xxx +/-0.010 in. (x.xx +/-0.25mm).

NON-ISOLATED DC/DC CONVERTERS

10.8Vdc – 13.2 Vdc Input 1 Vdc - 5 Vdc / 10A Output



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Revision History

Date	Revision	Changes Detail	Approval
2012-07-09	PA	First release	HL

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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CORPORATE

Bel Fuse Inc.
206 Van Vorst Street
Jersey City, NJ 07302
Tel 201-432-0463
Fax 201-432-9542
www.belfuse.com

FAR EAST

Bel Fuse Ltd.
8F/ 8 Luk Hop Street
San Po Kong
Kowloon, Hong Kong
Tel 852-2328-5515
Fax 852-2352-3706
www.belfuse.com

EUROPE

Bel Fuse Europe Ltd.
Preston Technology Management Centre
Marsh Lane, Suite G7, Preston
Lancashire, PR1 8UD, U.K.
Tel 44-1772-556601
Fax 44-1772-888366
www.belfuse.com