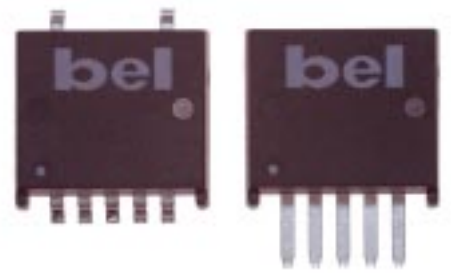
NON-ISOLATED DC/DC CONVERTERS
12V Input / 0.9V – 5.0V Output / 5A

bel POWER PRODUCTS

BP05xRAH-05A

SRAH-05A / VRAH-05A Series

- Nonisolated
- Compact, low profile surface mount package
- Fixed frequency
- High efficiency means less power dissipation
- Excellent thermal performance
- Optimized for cost
- Remote on/off
- Undervoltage lockout (UVLO)
- Over current and short circuit protection



Description

The Bel SRAH-05A and VRAH-05A modules are a series of non-isolated, step down DC/DC power converters that operate from a nominal 12V source. These converters are available in a range of output voltages from 0.9V to 5.0V. They are packaged in a compact, overmolded package rated at 5A. Optional lead forming provides a vertical mount product for minimal footprint or a surface mount option for a very low profile. Standard features include remote on/off, over current and short circuit protection, output voltage adjust and industrial temperature ranges (-40° to +85° C). The output is closely regulated and the efficiency is typically 91.5% at full load. These products may be used almost anywhere low voltage silicon is employed and a 12V source is available. Typical applications include file servers, routers, line cards and other computing and communications equipment.

Applications

- Distributed power architectures
- Data networking equipment
- Telecommunications
- Computers and peripherals

Part Number Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Part Number Surface Mount	Part Number Vertical Mount
5.0V	12V	5A	25W	91.5%	SRAH-05A500	VRAH-05A500
5.0V	12V	5A	25W	91.5%	SRAH-05A50F*	VRAH-05A50F*
3.3V	12V	5A	16.5W	88%	SRAH-05A330	VRAH-05A330
2.5V	12V	5A	12.5W	86%	SRAH-05A250	VRAH-05A250
1.8V	12V	5A	9.0W	83%	SRAH-05A180	VRAH-05A180
1.5V	12V	5A	7.5W	81%	SRAH-05A150	VRAH-05A150
1.2V	12V	5A	6.0W	78%	SRAH-05A120	VRAH-05A120
1.0V	12V	5A	5.0W	76%	SRAH-05A100	VRAH-05A100
0.9V	12V	5A	4.5W	73%	SRAH-05A090	VRAH-05A090
0.9 ~ 3.63V	12V	5A	18.2W	88%	SRAH-05A1A0	VRAH-05A1A0
0.9 ~ 3.63V	12V	5A	18.2W	88%	SRAH-05A1AF*	VRAH-05A1AF*

* F indicates fast start up.

Absolute Maximum Ratings

Parameter	Symbol	Min	Typical	Max	Unit
Continuous Input Voltage	Vin	-0.3		15	V
Output Enable Terminal Voltage	Vouten	-0.3		15	V
Ambient Temperature	Tamb	-40		85	°C
Storage Temperature	Tstor	-40		125	°C

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

Input Specifications

Parameter	Module	Symbol	Min	Typical	Max	Units
Operating Input Voltage	All	Vin	10.8		13.2	V
Input Current	5.0V 3.3V 2.5V 1.8V 1.5V 1.2V 1.0V 0.9V	Iin			2.8 2.0 1.5 1.2 1.0 0.8 0.7 0.65	A
No Load Input Current	All				50	mA
Remote Off Input Current	All			3	10	mA
Input Reflected Ripple Current[1]	All			50		mA_{rms}
Input Reflected Ripple Current (P-P)[1]	All			150		mApk
I^2t Inrush Current Transient	All			0.006	0.012	A^2s
Turn On Voltage Threshold	All			9.8		V
Turn Off Voltage Threshold	All		8.5	9.0	9.6	V

Note: Input capacitance one 270µF/16V, ESR = 0.018 Ω max at 100kHz @ 25° C.
1. With simulated source impedance of 500nH, 5Hz to 20MHz.

Output Specifications

Parameter	Module	Symbol	Min	Typical	Max	Units
Output Voltage Set Point [1]		Vout				V
	5.0V		4.9	5	5.1	
	3.3V		3.247	3.3	3.353	
	2.5V		2.460	2.5	2.540	
	1.8V		1.771	1.8	1.829	
	1.5V		1.476	1.5	1.524	
	1.2V		1.181	1.2	1.219	
	1.0V		0.984	1.0	1.016	
	0.9V		0.886	0.9	0.914	
Load Regulation						mV
	5.0V			15	30	
	3.3V			8	20	
	2.5V			8	20	
	1.8V			5	15	
	1.5V			5	15	
	1.2V			5	15	
	1.0V			5	15	
	0.9V			4	15	
Line Regulation						mV
	5.0V			3	10	
	3.3V			3	10	
	2.5V			3	10	
	1.8V			2	10	
	1.5V			2	10	
	1.2V			2	10	
	1.0V			1	10	
	0.9V			1	10	
Regulation Over Temperature (-40° to 85° C)						mV
	5.0V			40	70	
	3.3V			40	70	
	2.5V			35	70	
	1.8V			20	40	
	1.5V			15	30	
	1.2V			10	20	
	1.0V			6	12	
	0.9V			5	10	
Total Output Voltage Regulation (-40° to 85° C)						mV
	5.0V			58	110	
	3.3V			51	100	
	2.5V			46	100	
	1.8V			27	65	
	1.5V			22	45	
	1.2V			17	45	
	1.0V			12	37	
	0.9V			10	35	

Note: All specifications are typical at nominal input, full load at 25° C unless otherwise stated.
1. Vin = 12V, Iout = full load, Ta = 25° C.

Output Specifications

Parameter	Module	Symbol	Min	Typical	Max	Units
Output Ripple and Noise [2]	5.0V 3.3V 2.5V 1.8V 1.5V 1.2V 1.0V 0.9V			70 70 60 50 50 40 30 30	100 100 100 100 80 80 60 60	mVp-p
Output Ripple and Noise [2]	5.0V 3.3V 2.5V 1.8V 1.5V 1.2V 1.0V 0.9V			30 30 30 20 20 15 15 10	60 60 60 40 40 30 30 20	mVrms
Output Current Range	All	Iout	0		5	A
Output DC Current Limit	All	Ioutlim	6		12.5	A
Short Circuit Surge	5.0V 3.3V 2.5V 1.8V 1.5V 1.2V 1.0V 0.9V	Ioutsurge		0.9 0.60 0.70 0.85 0.85 1.05 1.1 1.1	1.8 1.2 1.4 1.7 1.7 2.1 2.2 2.2	A^2s
Turn on Time	5.0V 3.3V 2.5V 1.8V 1.5V 1.2V 1.0V 0.9V 0.9V	Ton		180 130 130 130 130 130 130 130 130	250 200 200 200 200 200 200 200 200	ms
Turn on Time[3]	0.9V - 5.0V	Ton		10	20	ms
Overshoot at Turn On	All			0	3	%
Overshoot at Turn On[3]	1.2 - 5.0V 0.9V - 1.0V			0 3	3 10	%
Output Capacitance	All	Cout	0		2200	µF

Note: All specifications are typical at nominal input, full load at 25° C unless otherwise stated.
2. 0 - 20MHz, 22µF/6.3V X5R ceramic cap on output (10µF/10V X5R ceramic cap for 5.0V module).
3. For fast start up modules.

Output Specifications

Parameter	Module	Symbol	Min	Typical	Max	Units
Transient Response [3]						
ΔV 50% to 100% of Max Load	5.0V			100	150	mV
Settling Time		Ts		60	100	µs
ΔV 100% to 50% of Max Load				100	150	mV
Settling Time		Ts		60	100	µs
Transient Response [3]						
ΔV 50% to 100% of Max Load	3.3V			100	150	mV
Settling Time		Ts		50	80	µs
ΔV 100% to 50% of Max Load				100	150	mV
Settling Time		Ts		50	80	µs
Transient Response [3]						
ΔV 50% to 100% of Max Load	2.5V			100	150	mV
Settling Time		Ts		50	80	µs
ΔV 100% to 50% of Max Load				100	150	mV
Settling Time		Ts		50	80	µs
Transient Response [3]						
ΔV 50% to 100% of Max Load	1.8V			100	150	mV
Settling Time		Ts		50	80	µs
ΔV 100% to 50% of Max Load				100	150	mV
Settling Time		Ts		50	80	µs

Note: All specifications are typical at nominal input, full load at 25° C unless otherwise stated.
3. di/dt = 0.5A/uS, Ta = 25° C. 0.9V ~ 3.3V modules with 220µF/6.3V Tant cap (5.0V module with 100µF/10V tant cap).

Output Specifications

Parameter	Module	Symbol	Min	Typical	Max	Units
Transient Response [3]						
ΔV 50% to 100% of Max Load	1.5V			80	120	mV
Settling Time		Ts		50	80	µs
ΔV 100% to 50% of Max Load				80	120	mV
Settling Time		Ts		50	80	µs
Transient Response [3]						
ΔV 50% to 100% of Max Load	1.2V			80	120	mV
Settling Time		Ts		50	80	µs
ΔV 100% to 50% of Max Load				80	120	mV
Settling Time		Ts		50	80	µs
Transient Response [3]						
ΔV 50% to 100% of Max Load	1.0V			80	120	mV
Settling Time		Ts		50	80	µs
ΔV 100% to 50% of Max Load				80	120	mV
Settling Time		Ts		50	80	µs
Transient Response [3]						
ΔV 50% to 100% of Max Load	0.9V			80	120	mV
Settling Time		Ts		50	80	µs
ΔV 100% to 50% of Max Load				80	120	mV
Settling Time		Ts		50	80	µs

Note: All specifications are typical at nominal input, full load at 25° C unless otherwise stated.
3. di/dt = 0.5A/uS, Ta = 25° C. 0.9V ~ 3.3V modules with 220µF/6.3V Tant cap (5.0V module with 100µF/10V tant cap).

General Specifications

Parameter	Module	Symbol	Min	Typical	Max	Units
Efficiency[1]	5.0V 3.3V 2.5V 1.8V 1.5V 1.2V 1.0V 0.9V	η	89 86 84 81 79 76 74 71	91 88 86 83 81 78 76 73		%
Switching Frequency	0.9V ~ 3.3V 5.0V	Fsw	210 330	250 370	290 410	kHz
Output Voltage Trim Range (Wide Trim)[2]	0.9V				403	%
Output Voltage Trim Range (Narrow Trim)[2]	5.0V 3.3V 2.5V 1.8V 1.5V 1.2V 1.0V 0.9V		90 90 90 90 90 90 90 90		110 110 110 110 110 110 110 110	%
Weight	All			4.9		g

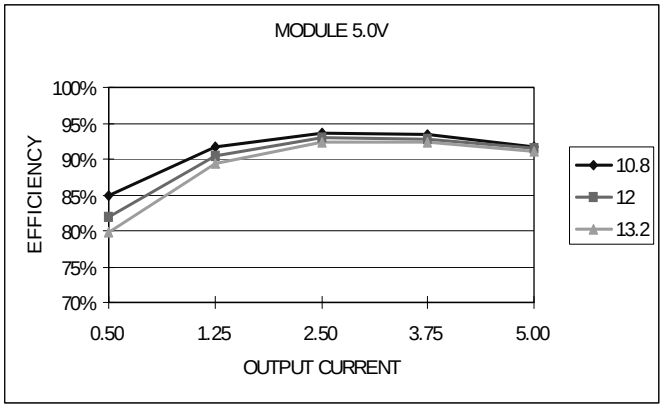
1. Vin=12V, full load and Ta=25° C.
2. See graphs on pages 17-25.

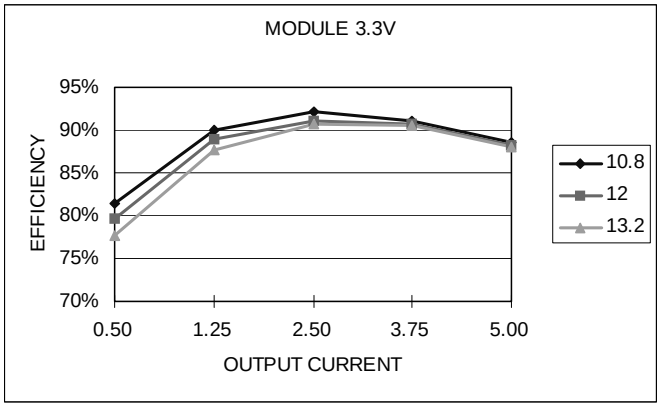
Control Specifications

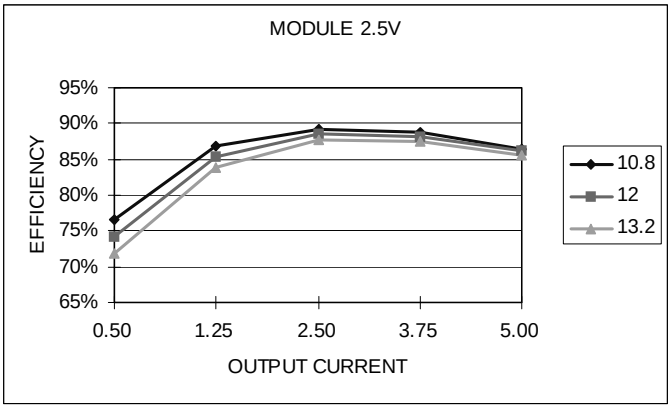
Parameter	Module	Symbol	Min	Typical	Max	Units
Remote On/Off [3]	All	Vouten				V
Signal Low (Unit Off)	All		-0.3		1	V
Signal High (Unit On)	All		2.8		13.2	V

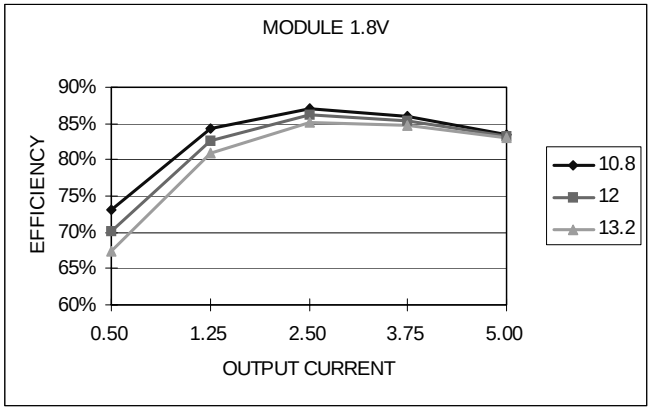
3. With remote on/off pin 1 open, the module is on.

Efficiency Data

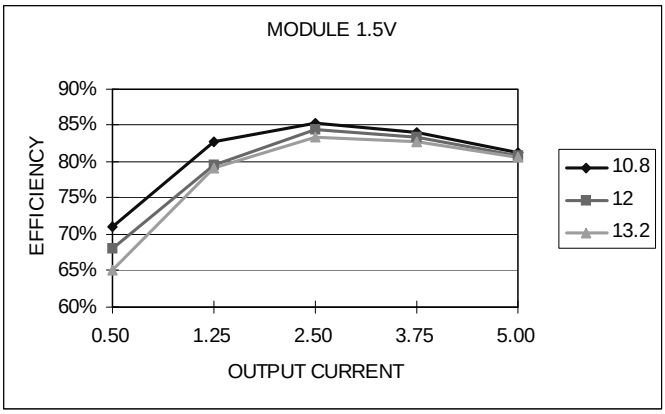


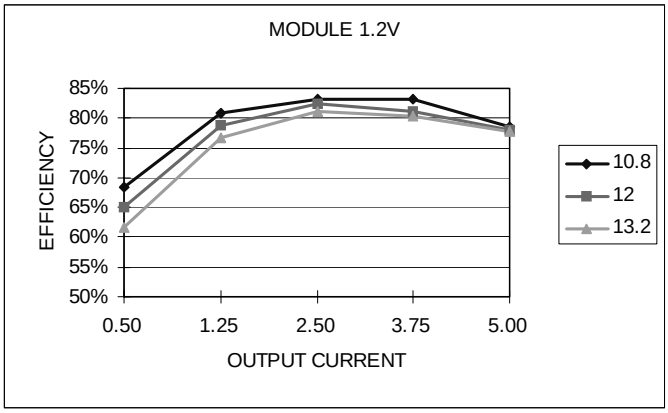


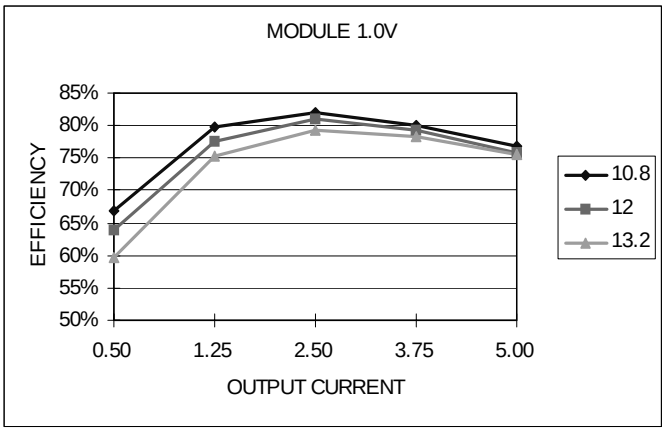


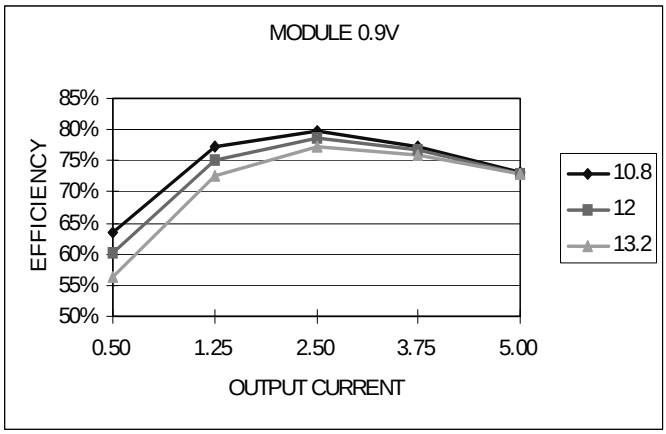


Efficiency Data



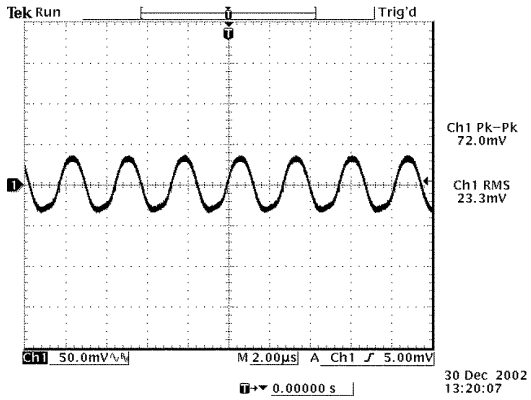




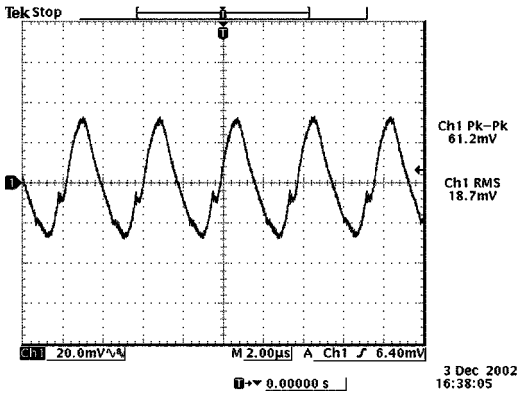


Ripple and Noise

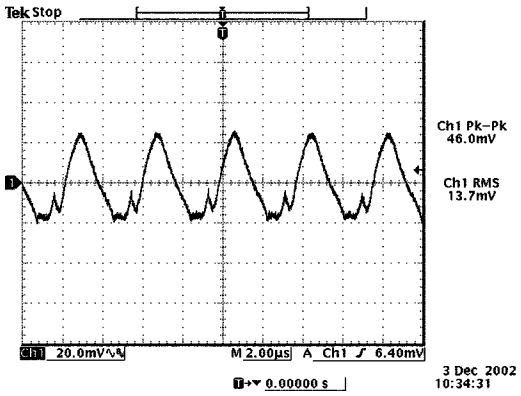
0.9V ~ 3.3V modules with 22µF/6.3V X5R ceramic cap at the output.
5.0V module with 10µF/10V X5R ceramic cap at the output.



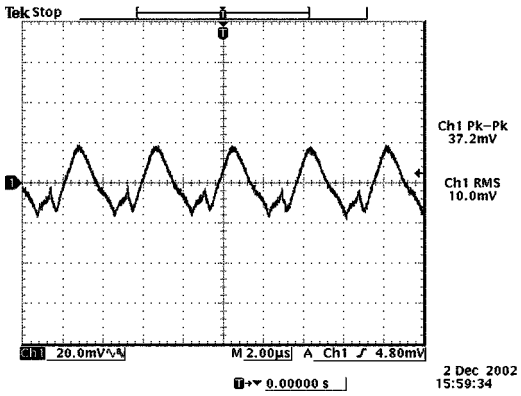
Ripple and noise at full load and 12Vdc input, 5.0Vdc output and Ta=25° C



Ripple and noise at full load and 12Vdc input, 3.3Vdc output and Ta=25° C



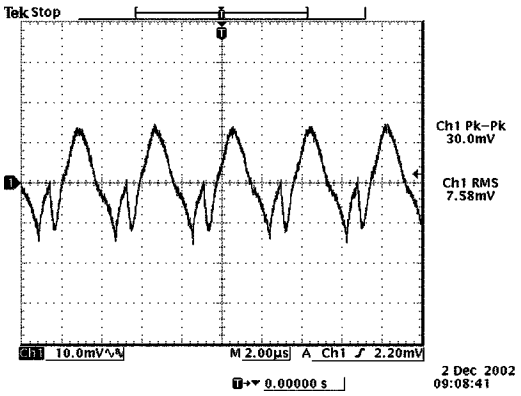
Ripple and noise at full load and 12Vdc input, 2.5Vdc output and Ta=25° C



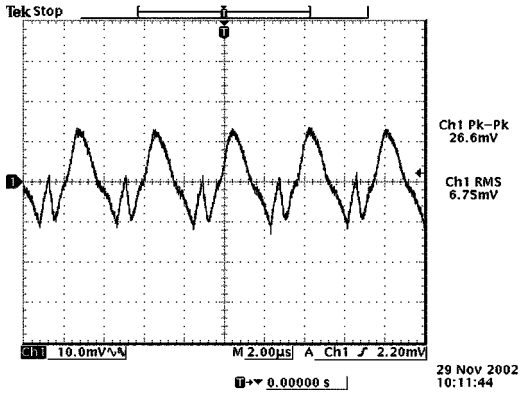
Ripple and noise at full load and 12Vdc input, 1.8Vdc output and Ta=25° C

Ripple and Noise

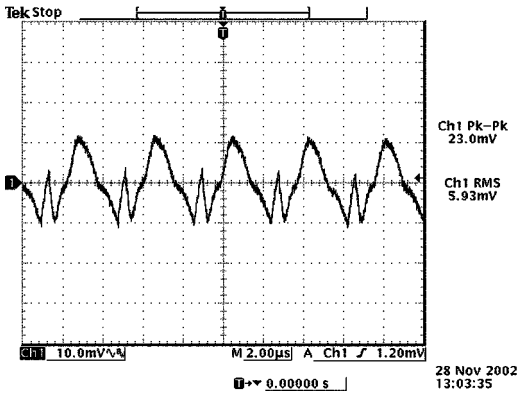
0.9V ~ 3.3V modules with 22µF/6.3V X5R ceramic cap at the output.
5.0V module with 10µF/10V X5R ceramic cap at the output.



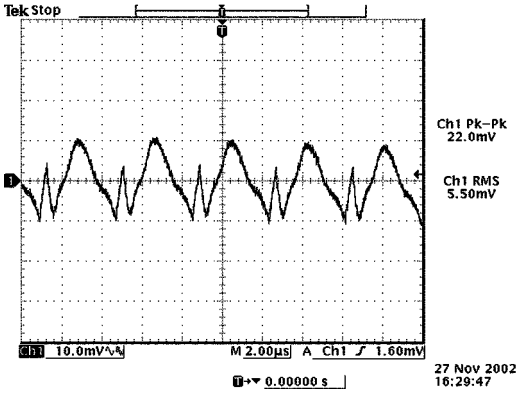
Ripple and noise at full load and 12Vdc input,
1.5Vdc output and Ta=25° C



Ripple and noise at full load and 12Vdc input,
1.2Vdc output and Ta=25° C



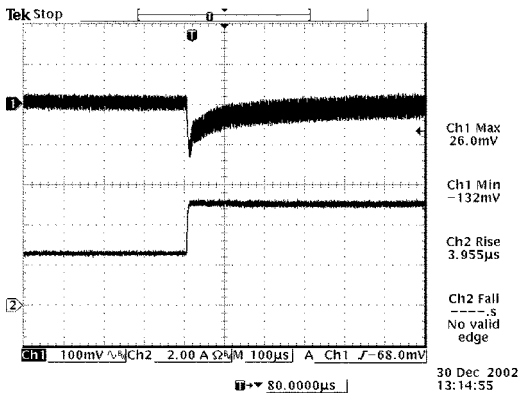
Ripple and noise at full load and 12Vdc input,
1.0Vdc output and Ta=25° C



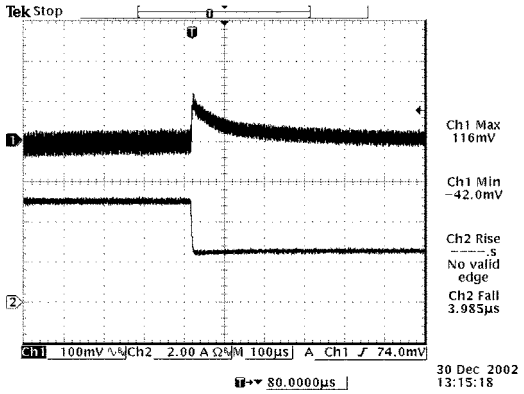
Ripple and noise at full load and 12Vdc input,
0.9Vdc output and Ta=25° C

Transient Response

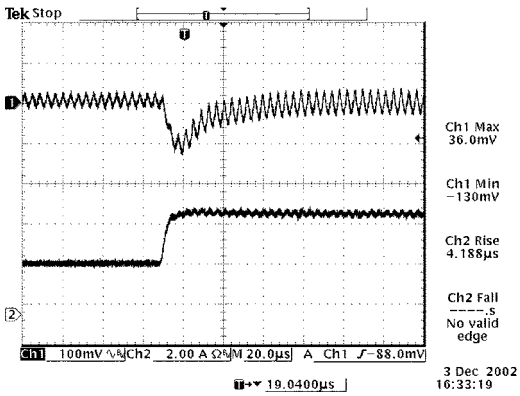
Transient response: di/dt = 0.5A/µS, 0.9V ~ 3.3V modules with 220µF/6.3V tant cap, 5.0V module with 100µF/10V tant cap.



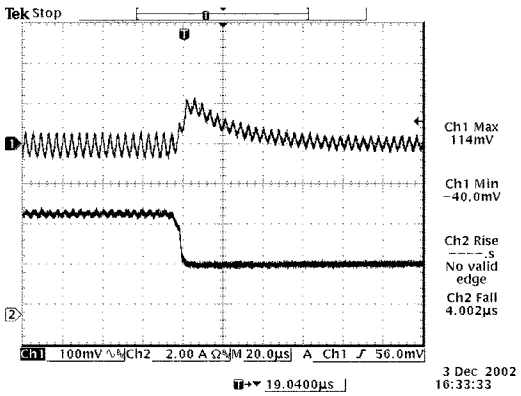
Vout=5.0V
50% to 100% load transients at 12V input and Ta=25° C



Vout=5.0V
100% to 50% load transients at 12V input and Ta=25° C



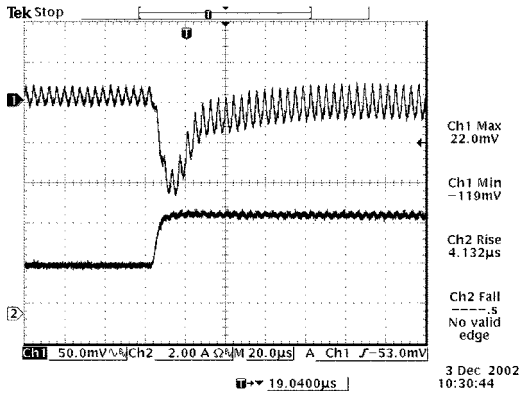
Vout=3.3V
50% to 100% load transients at 12V input and Ta=25° C



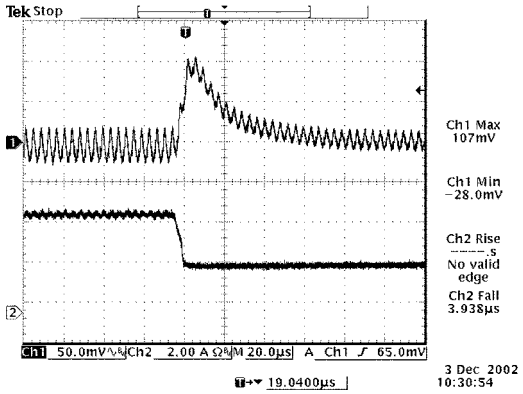
Vout=3.3V
100% to 50% load transients at 12V input and Ta=25° C

Transient Response

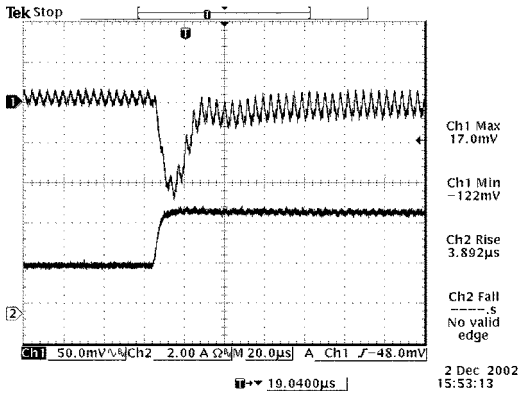
Transient response: di/dt = 0.5A/µS, 0.9V ~ 3.3V modules with 220µF/6.3V tant cap, 5.0V module with 100µF/10V tant cap.



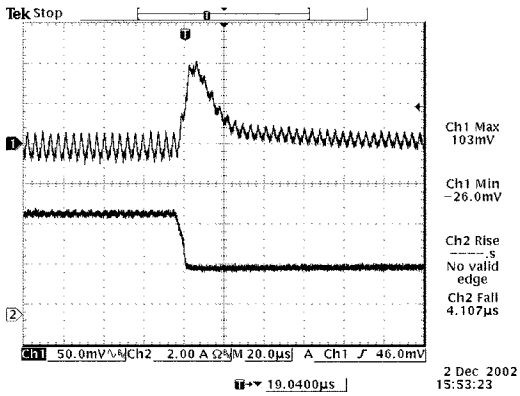
Vout=2.5V
50% to 100% load transients at 12V input and Ta=25° C



Vout=2.5V
100% to 50% load transients at 12V input and Ta=25° C



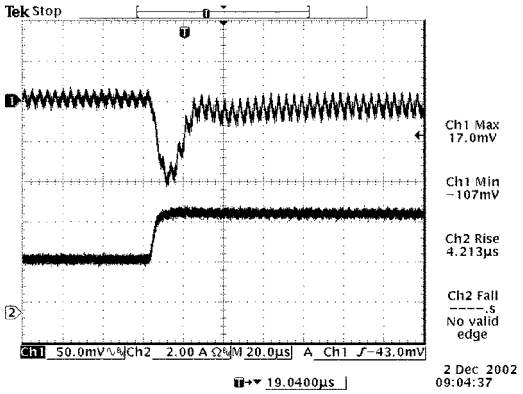
Vout=1.8V
50% to 100% load transients at 12V input and Ta=25° C



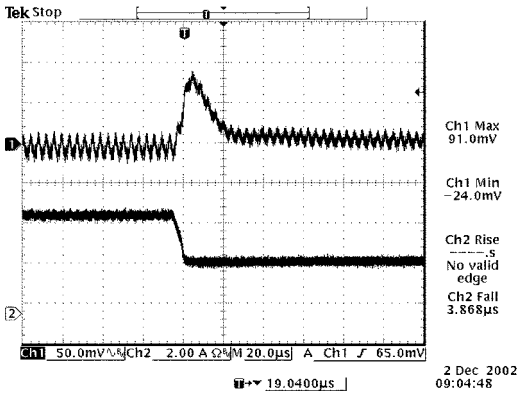
Vout=1.8V
100% to 50% load transients at 12V input and Ta=25° C

Transient Response

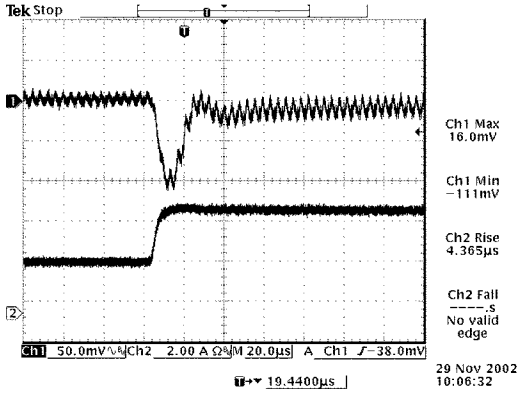
Transient response: di/dt = 0.5A/µS, 0.9V ~ 3.3V modules with 220µF/6.3V tant cap, 5.0V module with 100µF/10V tant cap.



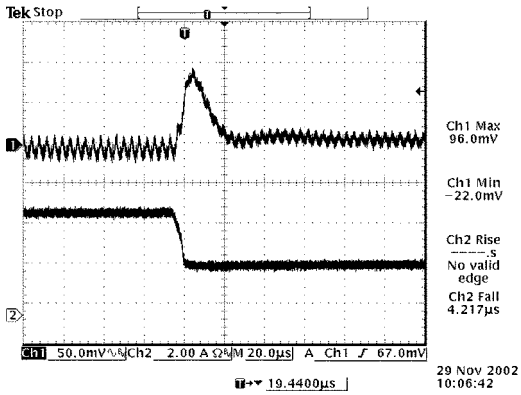
Vout=1.5V
50% to 100% load transients at 12V input and Ta=25° C



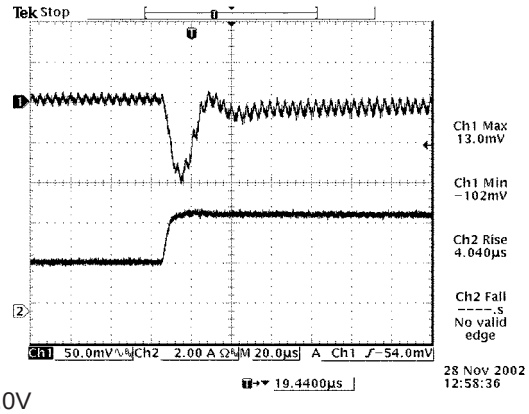
Vout=1.5V
100% to 50% load transients at 12V input and Ta=25° C



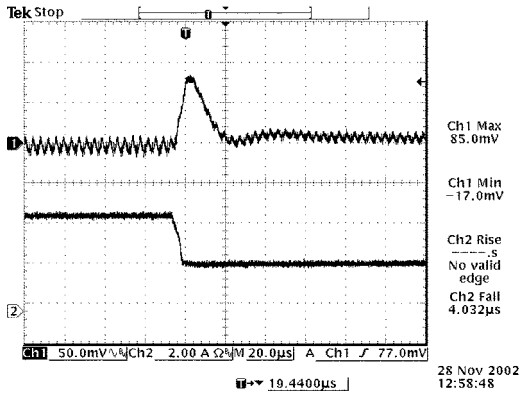
Vout=1.2V
50% to 100% load transients at 12V input and Ta=25° C



Vout=1.2V
100% to 50% load transients at 12V input and Ta=25° C



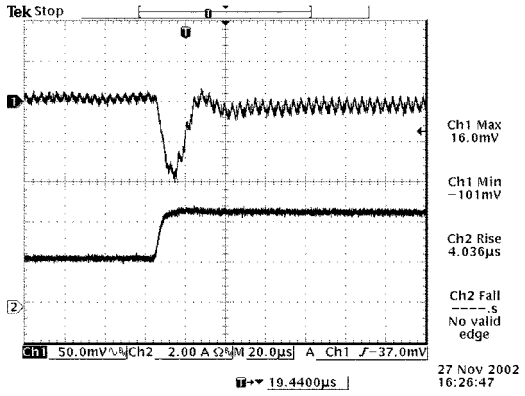
Vout=1.0V
50% to 100% load transients at 12V input and Ta=25° C



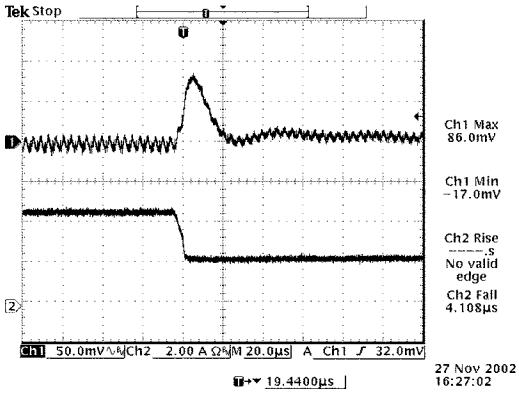
Vout=1.0V
100% to 50% load transients at 12V input and Ta=25° C

Transient Response

Transient response: di/dt = 0.5A/µS, 0.9V ~ 3.3V modules with 220µF/6.3V tant cap, 5.0V module with 100µF/10V tant cap.



Vout=0.9V
50% to 100% load transients at 12V input and Ta=25° C

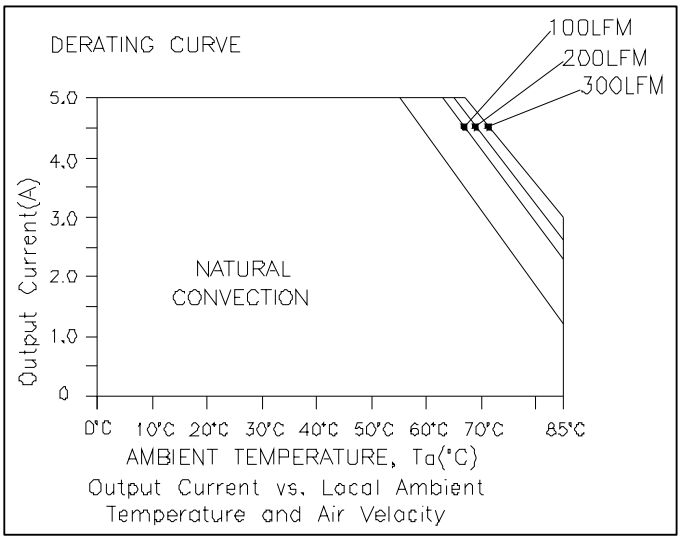


Vout=0.9V
100% to 50% load transients at 12V input and Ta=25° C

Thermal Considerations

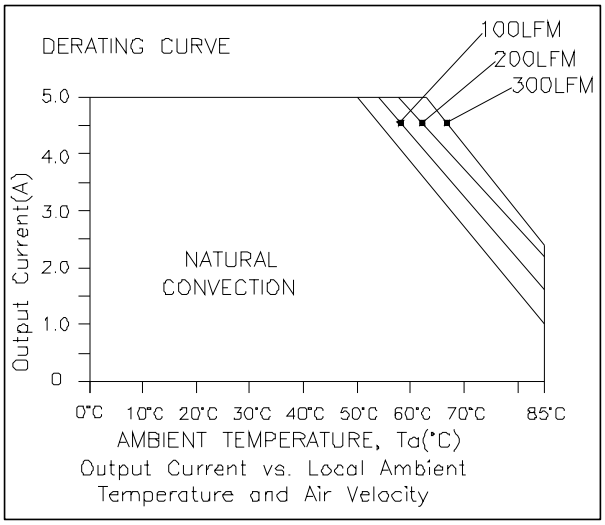
Vin = 12V

xRAH-05A1A0
0.9 ~ 1.8V

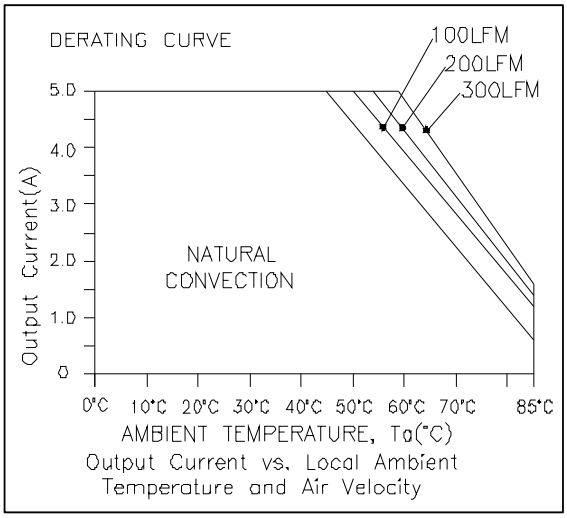


Thermal Considerations

xRAH-05A1A0
2.5V ~ 3.3V

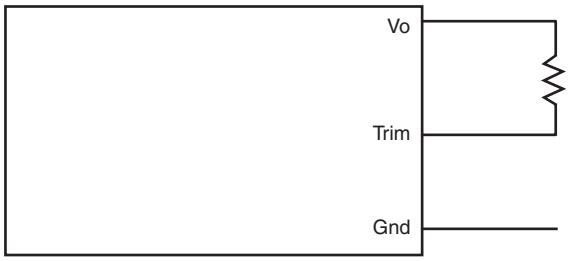


xRAH-05A500

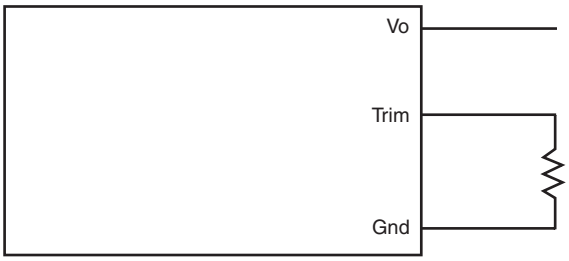


Output Voltage Set-Point Adjustment

Trim Down Test Circuit

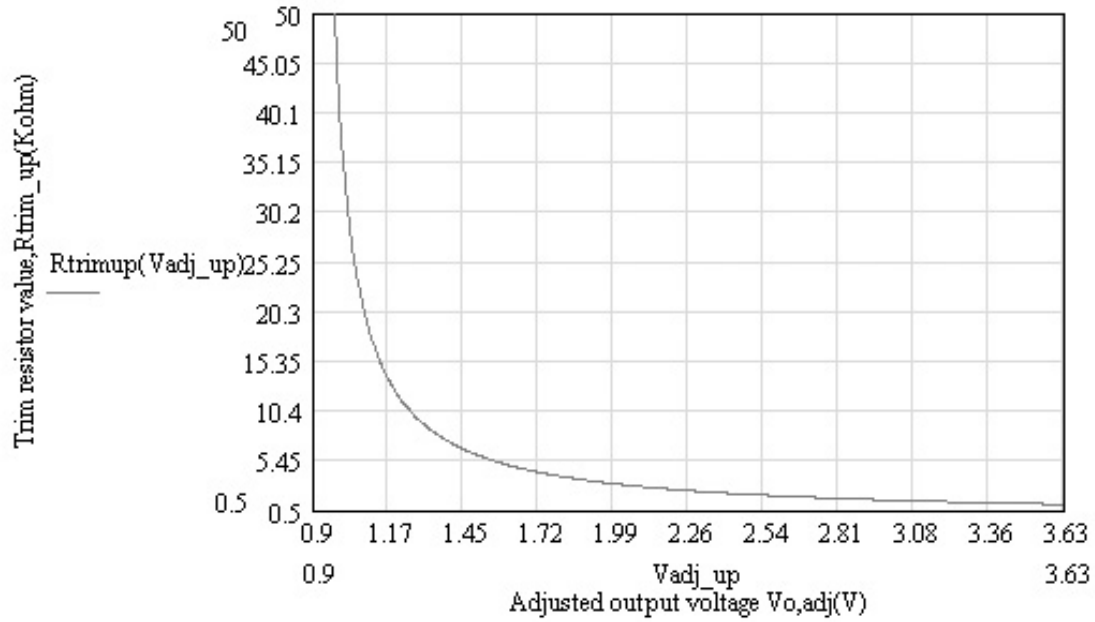


Trim Up Test Circuit



xRAH-05A1A0 Trim Resistor Calculation

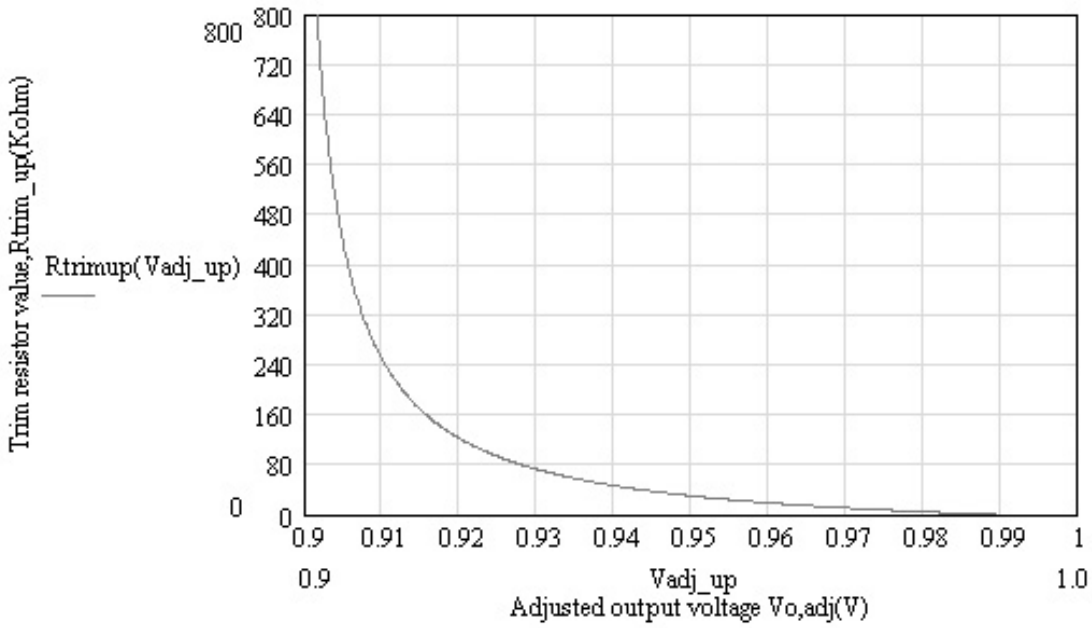
$$\text{Rtrim up} = \left(\frac{3.712}{\text{Vo, adj} - \text{Vo}} - 0.261\right) \text{ Kohm}$$



Output Voltage Set-Point Adjustment

xRAH-05A090 Trim Resistor Calculation

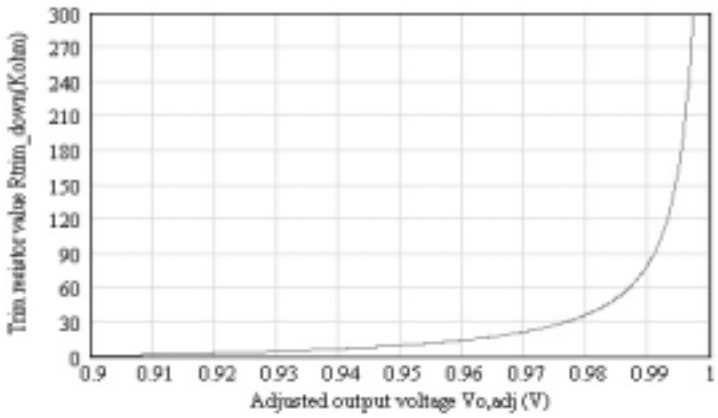
$$\text{Rtrim up} = \left(\frac{3.712}{\text{Vo, adj} - \text{Vo}} - 40.2\right) \text{ Kohm}$$



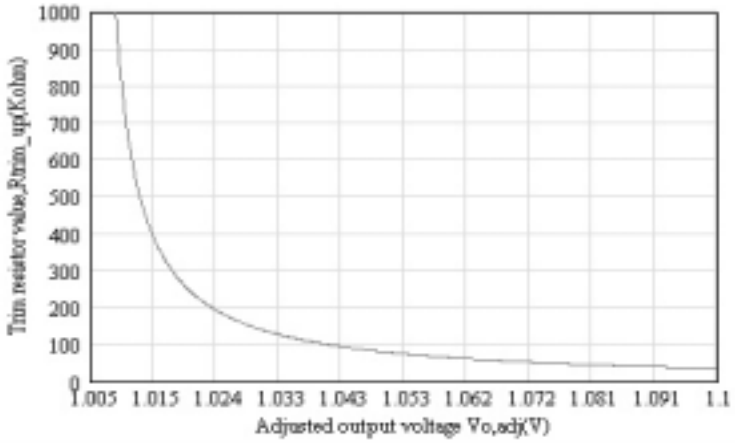
Output Voltage Set-Point Adjustment

xRAH-05A100 Trim Resistor Calculation

$$\text{Rtrim down} = \left(\frac{0.9516}{Vo,\ adj - Vo} - 8.47\right) \text{Kohm}$$



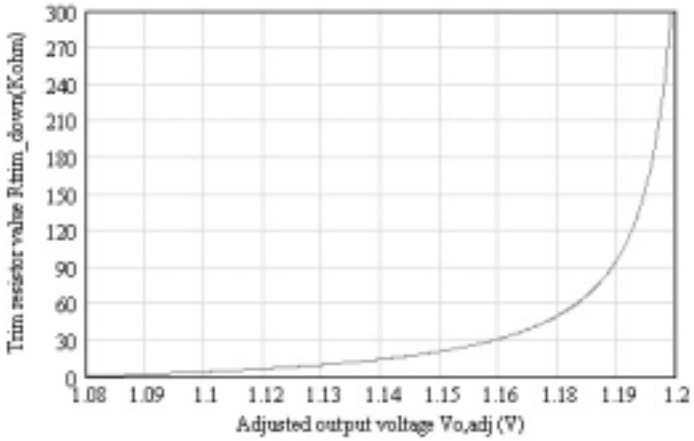
$$\text{Rtrim up} = \left(\frac{3.712}{Vo,\ adj - Vo} - 3.83\right) \text{Kohm}$$



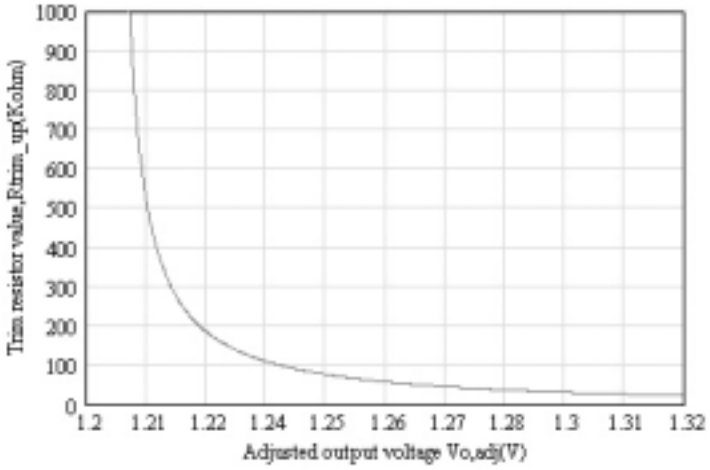
Output Voltage Set-Point Adjustment

xRAH-05A120 Trim Resistor Calculation

$$\text{Rtrim down} = \left(\frac{1.879}{Vo,\,adj - Vo} - 14.640\right)\ \text{Kohm}$$



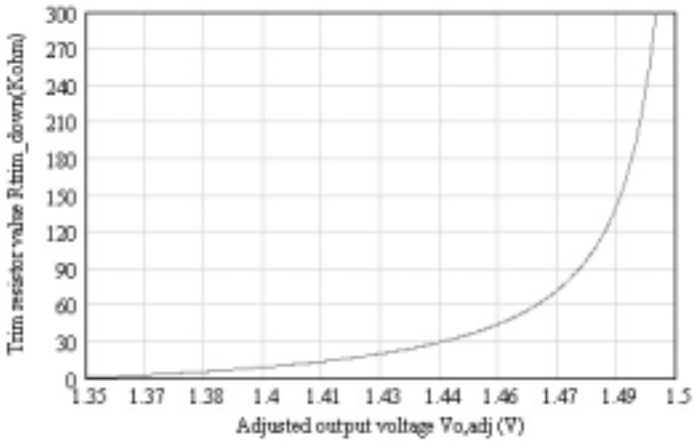
$$\text{Rtrim up} = \left(\frac{3.712}{Vo,\,adj - Vo} - 10\right)\ \text{Kohm}$$



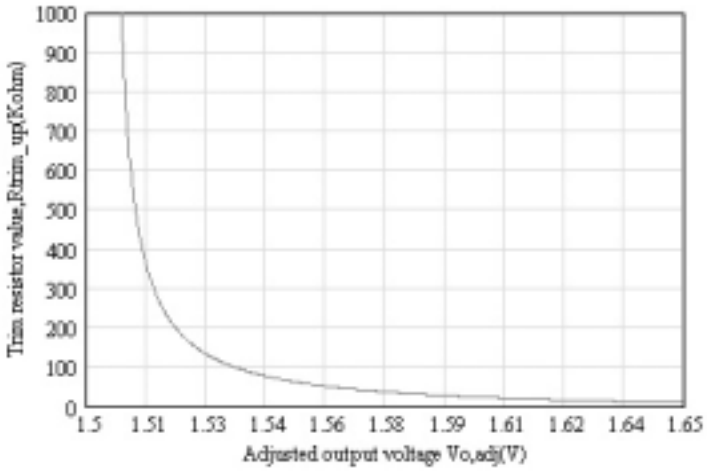
Output Voltage Set-Point Adjustment

xRAH-05A150 Trim Resistor Calculation

$$\text{Rtrim down} = \left(\frac{3.273}{Vo,\ adj - Vo} - 20.84\right) \text{ Kohm}$$



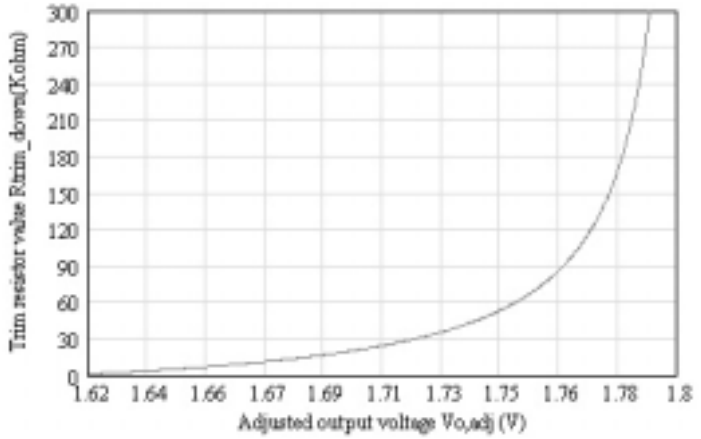
$$\text{Rtrim up} = \left(\frac{3.712}{Vo,\ adj - Vo} - 16.2\right) \text{ Kohm}$$



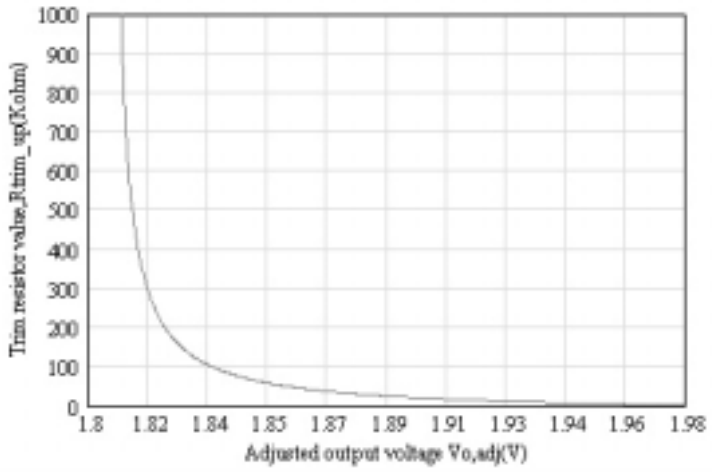
Output Voltage Set-Point Adjustment

xRAH-05A180 Trim Resistor Calculation

$$\text{Rtrim down} = \left(\frac{4.669}{Vo,\,adj - Vo} - 24.24\right) \text{Kohm}$$



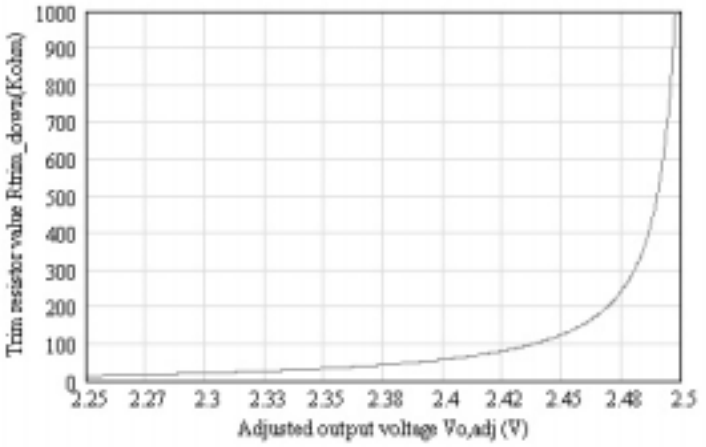
$$\text{Rtrim up} = \left(\frac{3.712}{Vo,\,adj - Vo} - 19.6\right) \text{Kohm}$$



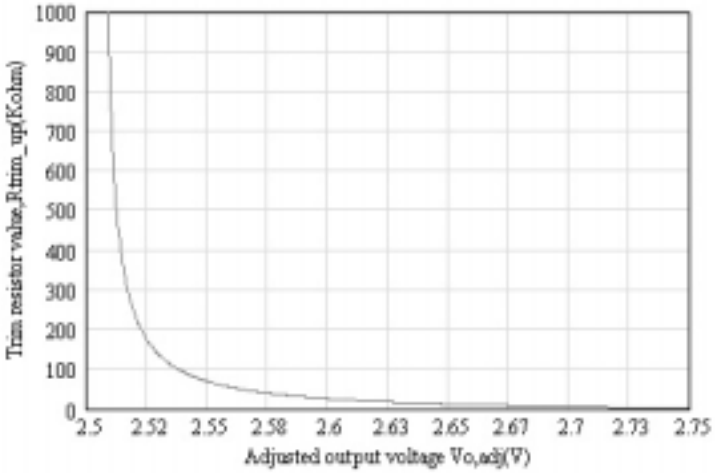
Output Voltage Set-Point Adjustment

xRAH-05A250 Trim Resistor Calculation

$$\text{Rtrim down} = \left(\frac{7.912}{Vo,\,adj - Vo} - 17.94\right) \text{Kohm}$$



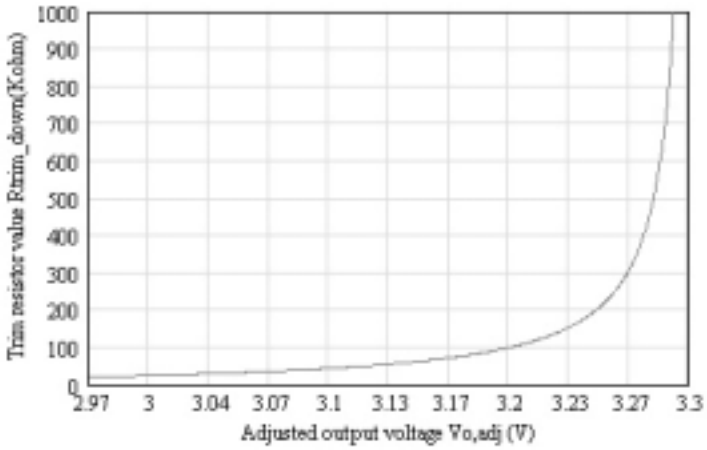
$$\text{Rtrim up} = \left(\frac{3.712}{Vo,\,adj - Vo} - 13.3\right) \text{Kohm}$$



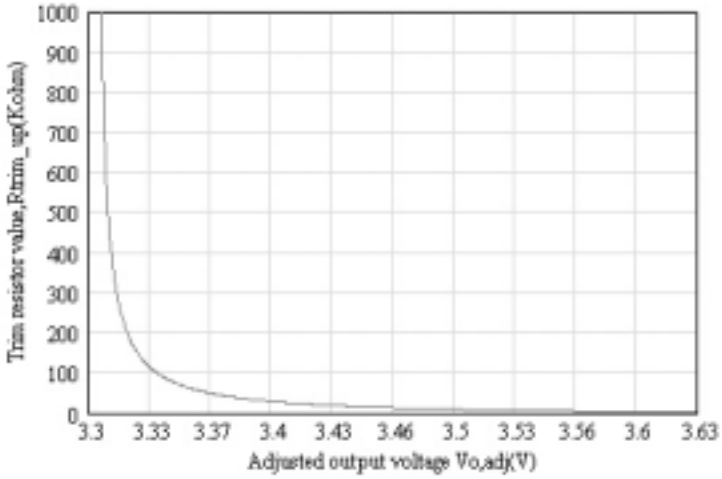
Output Voltage Set-Point Adjustment

xRAH-05A330 Trim Resistor Calculation

$$\text{Rtrim down} = \left(\frac{11.614}{Vo,\ adj - Vo} - 14.64\right) \text{Kohm}$$



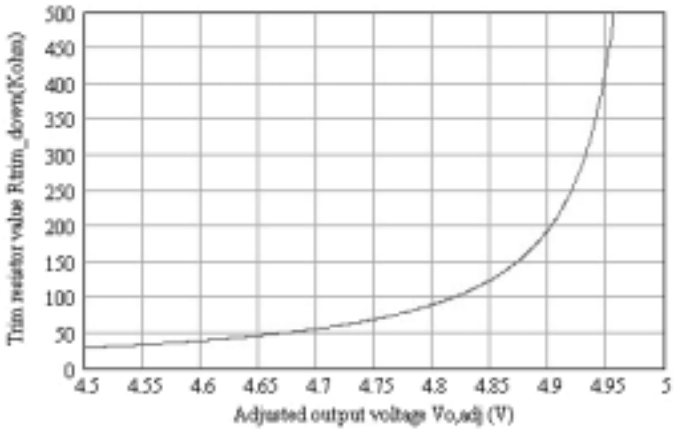
$$\text{Rtrim up} = \left(\frac{3.712}{Vo,\ adj - Vo} - 10\right) \text{Kohm}$$



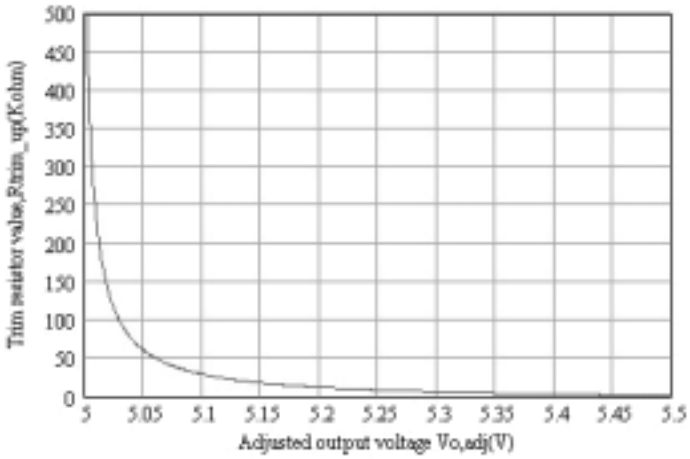
Output Voltage Set-Point Adjustment

xRAH-05A500 Trim Resistor Calculation

$$\text{Rtrim down} = \left(\frac{19.4618}{Vo,\ adj - Vo} - 10.83\right) \text{Kohm}$$

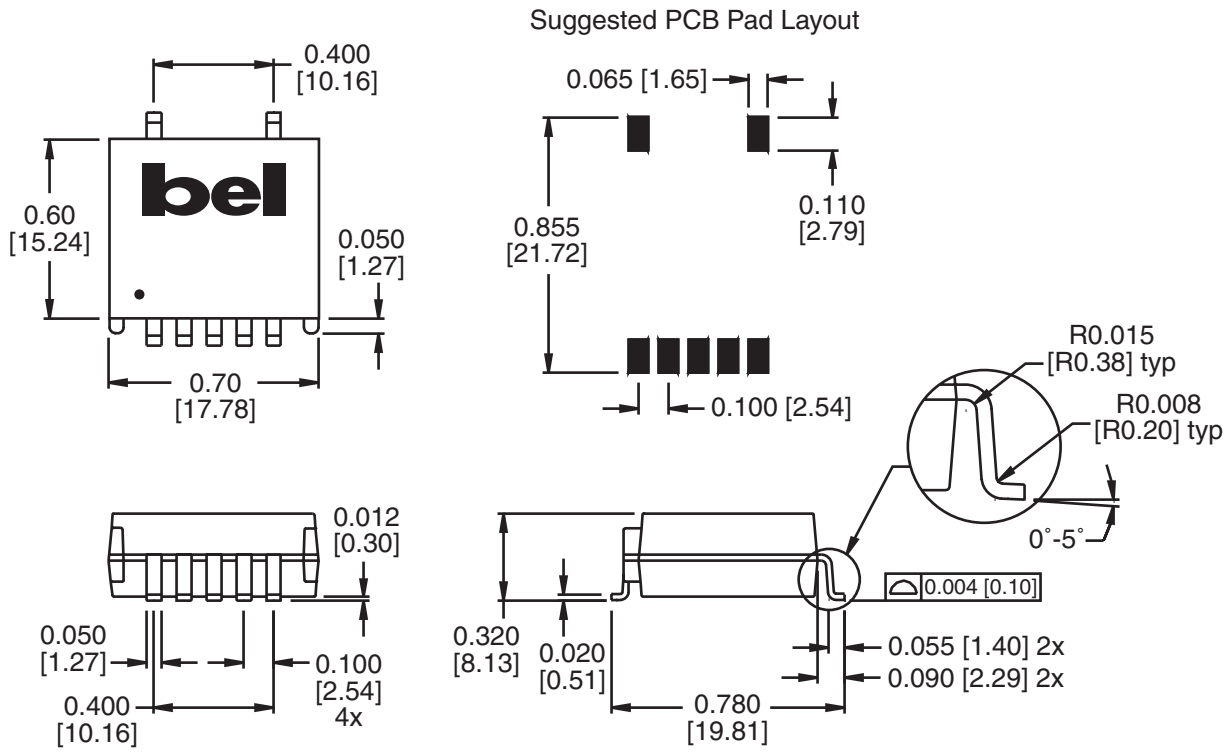


$$\text{Rtrim up} = \left(\frac{3.712}{Vo,\ adj - Vo} - 6.19\right) \text{Kohm}$$



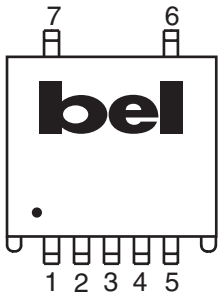
Mechanical

SRAH-05A



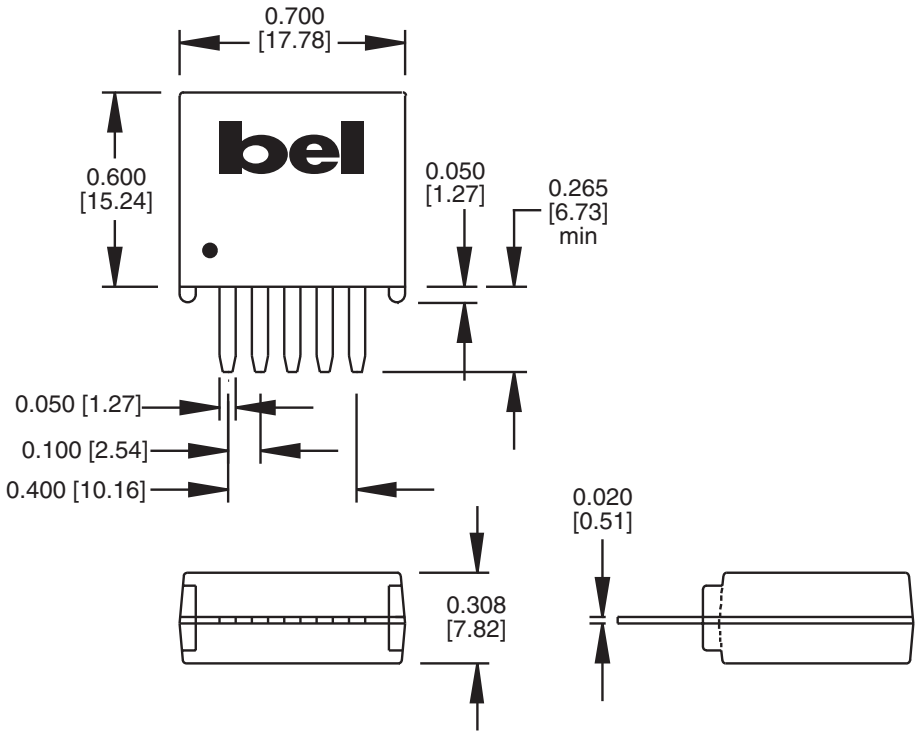
Dimensions are in inches [millimeters].
Standard dimension tolerance is ±0.005 [0.13] unless otherwise noted.

Pin	Function
1	Remote On/Off
2	+Vin
3	Ground
4	+Vo
5	Trim
6	No Connection
7	No Connection



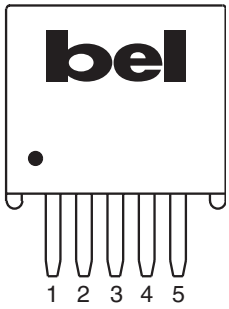
Mechanical

VRAH-05A



Dimensions are in inches [millimeters].
Standard dimension tolerance is ±0.005 [0.13] unless otherwise noted.

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



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 240ºC.

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