

NON-ISOLATED DC/DC CONVERTERS

5.5 Vdc - 13.8 Vdc Input 0.6 Vdc - 5.1 Vdc/1.5 A Output



June 03, 2009

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

xRAE-01E1A0 RoHS Compliant PRELIMINARY Rev.E

Features

- Non-Isolated
- High Efficiency
- Fixed Frequency
- Low Cost
- Wide Input
- Class 1, Category 2, Non-Isolated DC/DC Converter (refer to IPC-9592)
- TUV EN60950-1 Recognized (Pending)
- Input Under-Voltage Lockout
- Wide Trim
- OCP/SCP
- Remote On/Off

Applications

- Networking
- Computers and peripherals
- Telecommunications

Description

The Bel xRAE-01E1A0 is part of the non-isolated dc/dc converter Power Module series. These converters are available in a range of output voltages from 0.6 Vdc to 5.1 Vdc over a wide range of input voltage ($V_{IN} = 5.5 \text{ Vdc} - 13.8 \text{ Vdc}$).

Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number	
					Vertical Thru Hole Mount	Horizontal Surface Mount
0.6 Vdc -5.1 Vdc	5.5 Vdc-13.8 Vdc	1.5 A	7.65 W	84%	VRAE-01E1A0	SRAE-01E1A1

Notes: Add "G" suffix at the end of the model number to indicate Tray Packaging.

Part Number Explanation

$\frac{V}{1} \frac{R}{2} \frac{AE}{3} - \frac{01}{4} \frac{E}{5} \frac{1A}{6} \frac{0}{7}$

- 1 --- Vertical mount, change "V" to "S" means Surface mount
- 2 --- RoHS 6, change "R" to "7" means RoHS 5
- 3 --- Series name
- 4 --- Series code
- 5 --- Wide input range (5.5-13.8V)
- 6 --- Wide output range (0.6-5.1V)
- 7 --- Mount option

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Absolute Maximum Ratings

Parameter	Min	Typ	Max	Unit	Notes
Input Supply Voltage	-0.3	-	15	V	
Ambient Temperature	0	-	70	°C	
Storage Temperature	-55	-	125	°C	

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

Input Specifications

Parameter	Min	Typ	Max	Unit	Notes
Operating Input Voltage	5.5	12	13.8	V	
Input Current (full load)	-	-	1.4	A	
Input Current (no load)	-	40	100	mA	
Remote Off Input Current	-	10	25	mA	
Input Reflected Ripple Current (rms)		10	20	mA	With simulated source impedance of 1000 nH, 5 Hz to 20 MHz. Use a 1000 uF/25 V AL-Cap with ESR=0.03 ohm max and 2*100 uF/25V Tan-Cap with ESR=0.013 ohm max at 100 kHz@25°C.
Input Reflected Ripple Current (pk-pk)	-	30	50	mA	
I ² t Inrush Current Transient	-	-	1	A ² s	
Turn-on Voltage Threshold	4.00	4.15	4.30	V	

CAUTION: This converter is not internally fused. An input line fuse must be used in application.

Recommend a fast-acting fuse with maximum rating of 3A on system board. Refer to the fuse manufacture's datasheet for further information.

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

Output Specifications

Parameter	Min	Typ	Max	Unit	Notes
Output Voltage Set Point	-2	-	2	%Vo,set	Vin= 12 V, Iout=full load
Load Regulation	-	±0.2	±0.5	%Vo,set	
Line Regulation	-	±0.2	±0.5	%Vo,set	
Regulation Over Temperature (0deg.C-70deg.C)	-	0.3	-	%Vo,set	
Ripple and Noise (pk-pk)	-	10	20	mV	0-20 MHz BW, with a 10 uF tantalum capacitor and 1 uF ceramic capacitor at the output.
Ripple and Noise (rms)	-	3	6	mV	
Ripple and Noise (pk-pk) under worst case	-	15	30	mV	over all operating input voltage, load and temperature conditions.
Output Current Range	0	-	1.5	A	
Output DC Current Limit	2.56	3.2	3.94	A	

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Output Specifications (continued)

Parameter		Min	Typ	Max	Unit	Notes
Short Circuit Surge Transient		-	-	1	A ² s	Vo≤20 mV, Hiccup Mode
Turn on Time		-	3	5	mS	
Overshoot at Turn on		-	-	1	%	
Output Capacitance		0	-	1000	uF	
Transient Response						
△V50%~100% of Max Load	Overshoot	-	40	80	mV	di/dt=0.25 A/uS; Vin=12 V; with a 10 uF tantalum capacitor and a 1 uF ceramic capacitor at the output.
	Settling Time	-	50	100	uS	
△V100%~50% of Max Load	Overshoot	-	40	80	mV	
	Settling Time	-	50	100	uS	

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

General Specifications

Parameter		Min	Typ	Max	Unit	Notes
Efficiency						Vin=12 V
	Vo=5.0 V	85	88	-	%	
	Vo=3.3 V	81	84	-	%	
	Vo=0.6 V	45	50	-	%	
Switching Frequency		-	500	-	kHz	
Output Voltage Trim Range		0.6	-	5.1	V	
Weight		-	2	-	g	
FIT		100			-	Calculated Per Bell Core SR-332 (Vin=12 V, Vo=5.0 V, Io=80% load, 0 LFM, Ta = 25 °C, FIT=10 ⁹ /MTBF)
Dimensions					-	VRAE-01E1A0
					-	
Inches (L × W × H)		0.40 x 0.41 x 0.284			-	SRAE-01E1A1
Millimeters (L × W × H)		10.16 x 10.41 x 7.21			-	
Inches (L × W × H)		0.40 x 0.41 x 0.309			-	SRAE-01E1A1
Millimeters (L × W × H)		10.16 x 10.41 x 7.85			-	

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

NON-ISOLATED DC/DC CONVERTERS

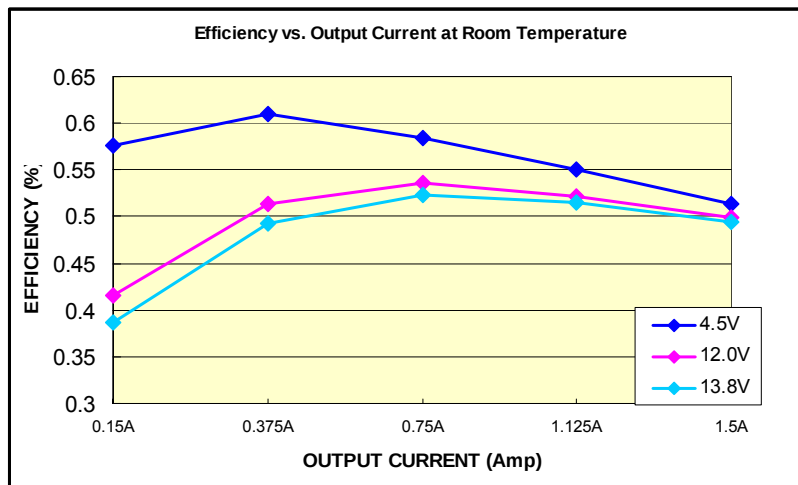
5.5 Vdc - 13.8 Vdc Input 0.6 Vdc - 5.1 Vdc/1.5 A Output



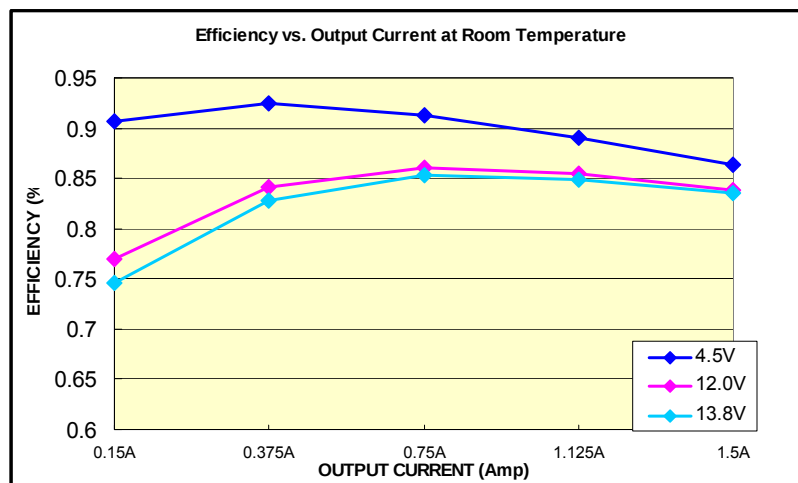
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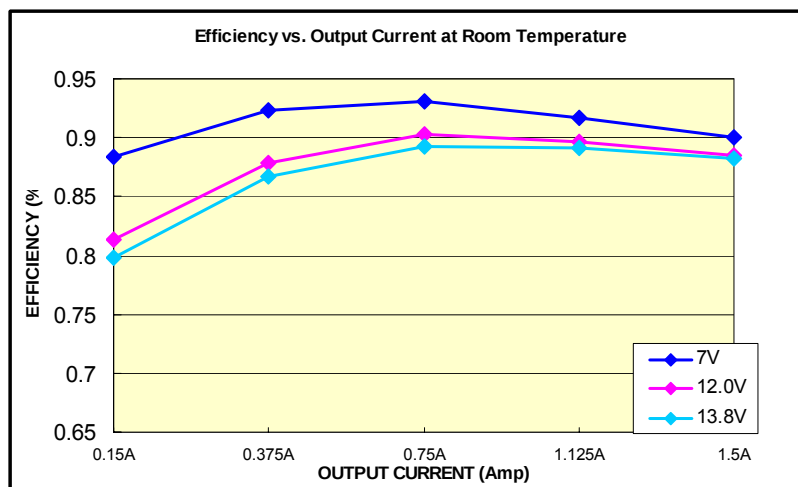
Efficiency Data



$V_o=0.6V$



$V_o=3.3V$



$V_o=5.0V$

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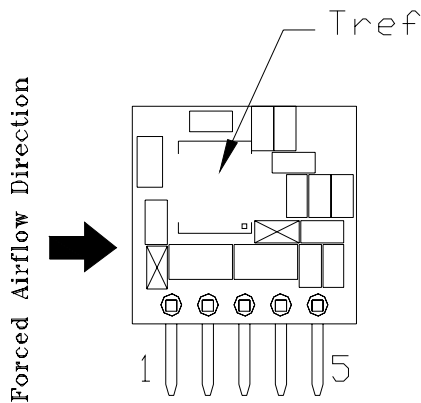
5.5 Vdc - 13.8 Vdc Input 0.6 Vdc - 5.1 Vdc/1.5 A Output



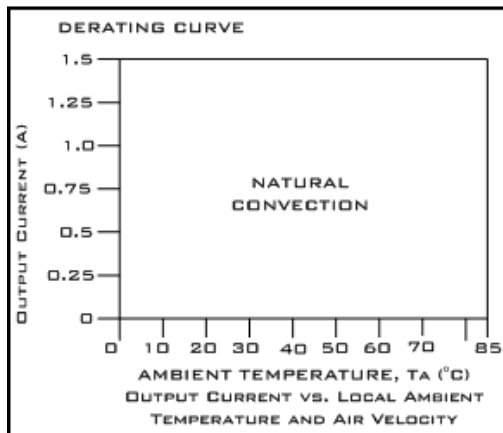
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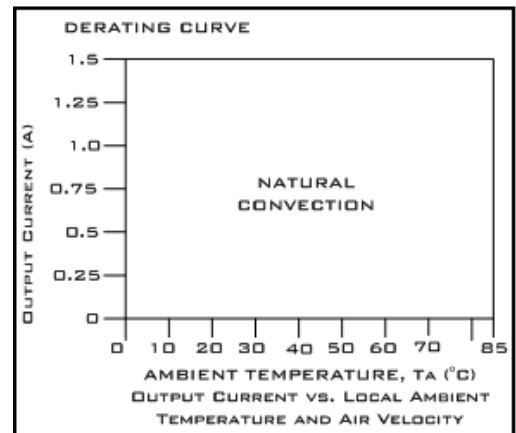
Thermal Derating Curves



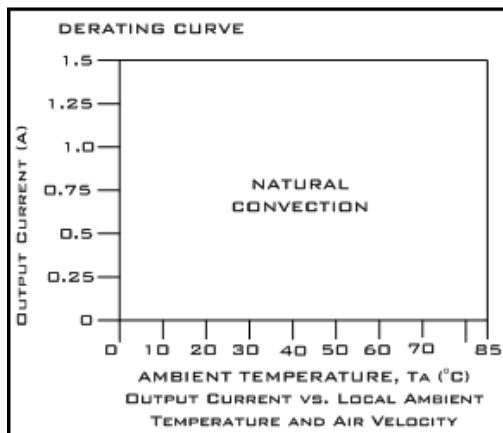
The thermal reference point T_{ref} is shown above. For reliable operation this temperature should not exceed 115°C . The output power of the module should not exceed the rated power for the module.



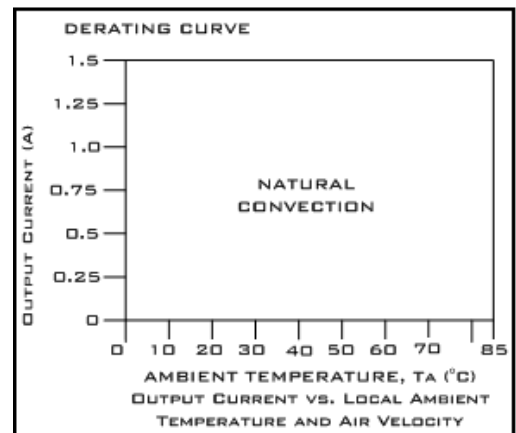
Vin=12 V, Vout=5 V



Vin=12 V, Vout=3.3 V



Vin=12 V, Vout=2.5 V



Vin=12 V, Vout=1.2 V

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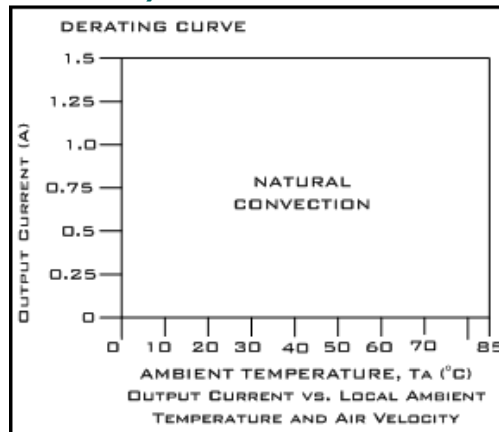
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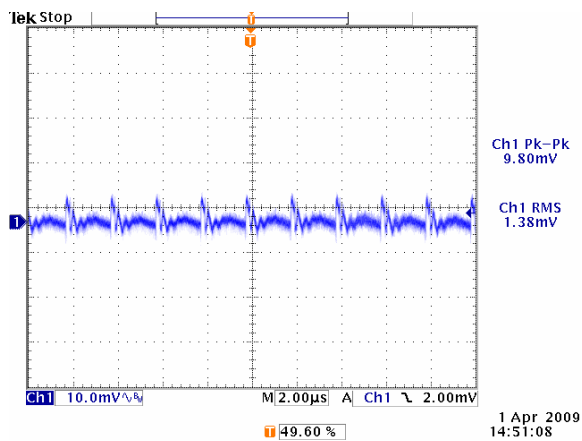
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Thermal Derating Curves (continued)

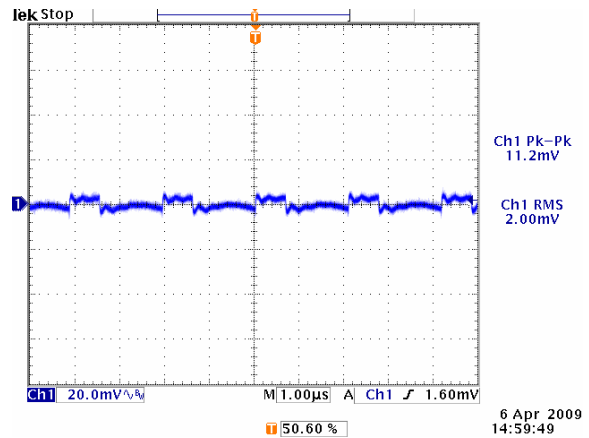


Vin=12 V, Vout=0.6 V

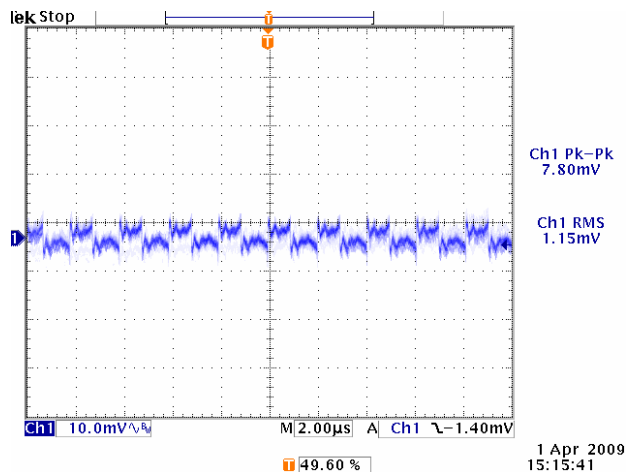
Ripple and Noise Waveforms



12V input, 0.6V output



12V input, 3.3V output



12V input, 5V output

Note: Ripple and Noise at 0-20 MHz BW, with a 10 uF tantalum capacitor and 1 uF ceramic capacitor at the output

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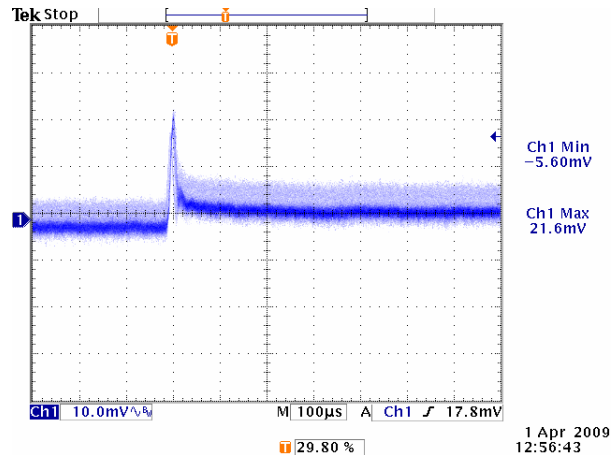
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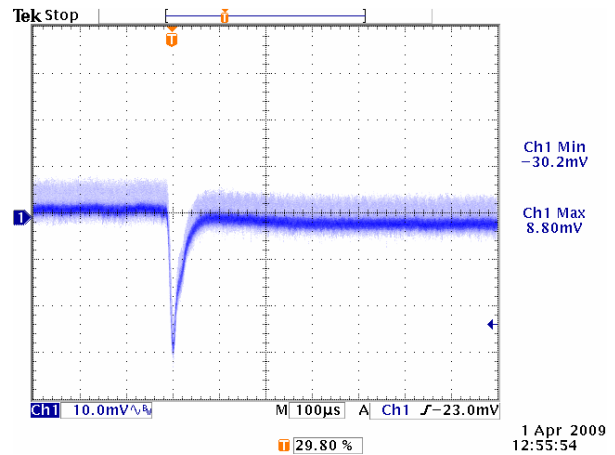
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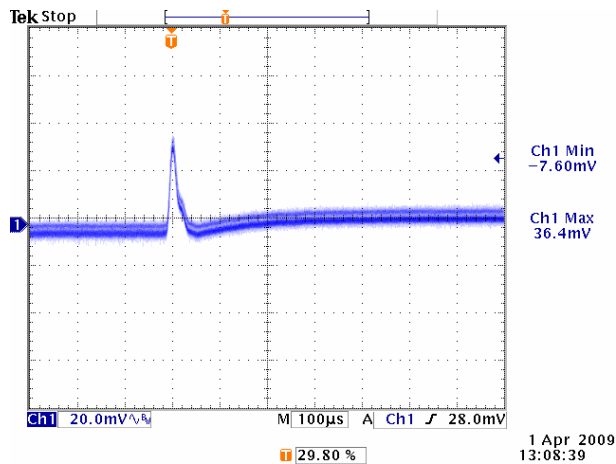
Transient Response Waveforms



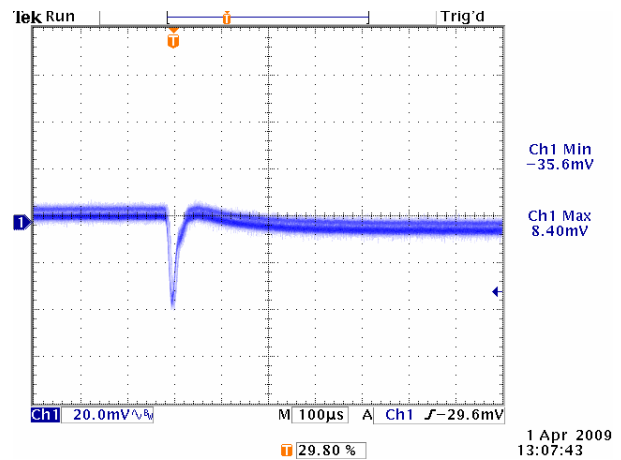
100%-50% Load Transients at $V_{in}=12V$, $V_{out}=0.6V$



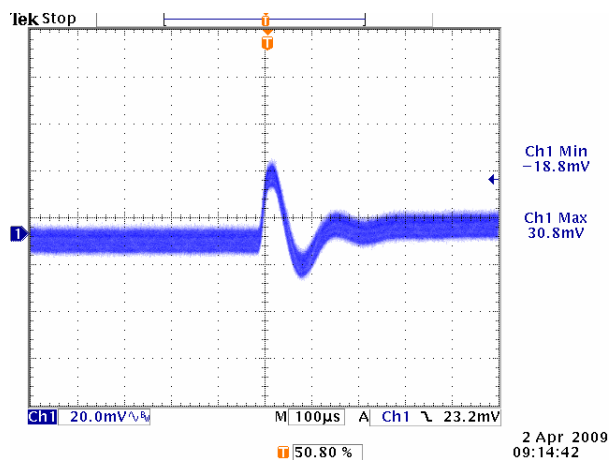
50%-100% Load Transients at $V_{in}=12V$, $V_{out}=0.6V$



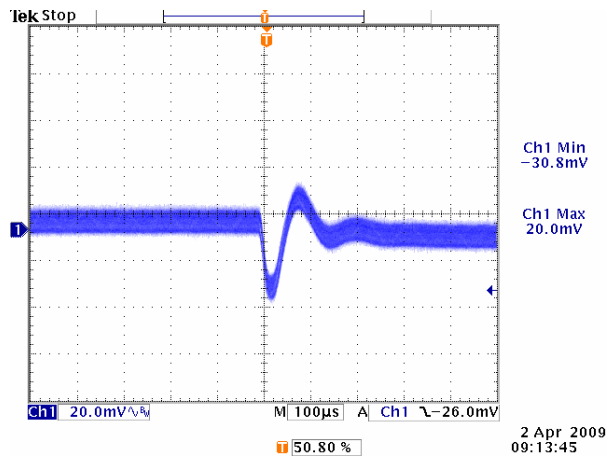
100%-50% Load Transients at $V_{in}=12V$, $V_{out}=3.3V$



50%-100% Load Transients at $V_{in}=12V$, $V_{out}=3.3V$



100%-50% Load Transients at $V_{in}=12V$, $V_{out}=5.0V$



50%-100% Load Transients at $V_{in}=12V$, $V_{out}=5.0V$

Note: Transients at $di/dt=0.25 A/\mu s$; $V_{in}=12 V$; with a 10 μF tantalum capacitor and a 1 μF ceramic capacitor at the output.

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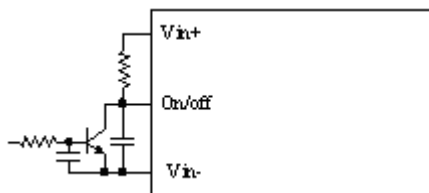
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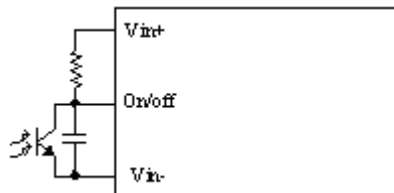
Remote On/Off

Parameter		Min	Typ	Max	Unit	Notes
Signal Low (Unit Off)	True	-0.3	-	0.8	V	Remote On/Off Pin is open, the unit is off.
Signal High (Unit On)	Active High	2.4	-	6.0	V	

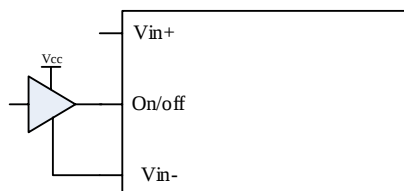
Recommended remote on/off circuit for true active high



Control with open collector/drain circuit



Control with photocoupler circuit

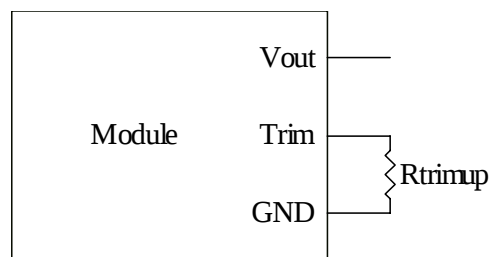


Control with logic circuit

Output Trim Equations

Equation for calculating the trim resistor given the desired output voltage (V_o) is shown below. The R_{trim} resistor should be connected between the trim pin and GND pin.

$$R_{trim} = \frac{1.176}{V_o - 0.6} \text{ k}\Omega$$



Over Current Protection

The module is equipped with internal current-limiting circuitry in order to provide protection in a fault output overload condition. The module will be in hiccup mode when the output current exceeds the current limit.

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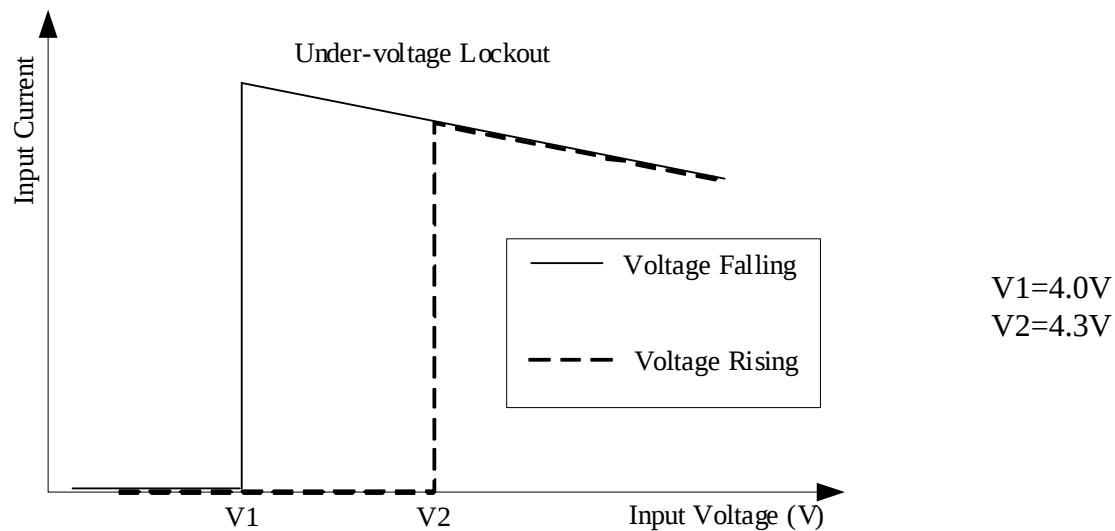
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Input Under-voltage Lockout



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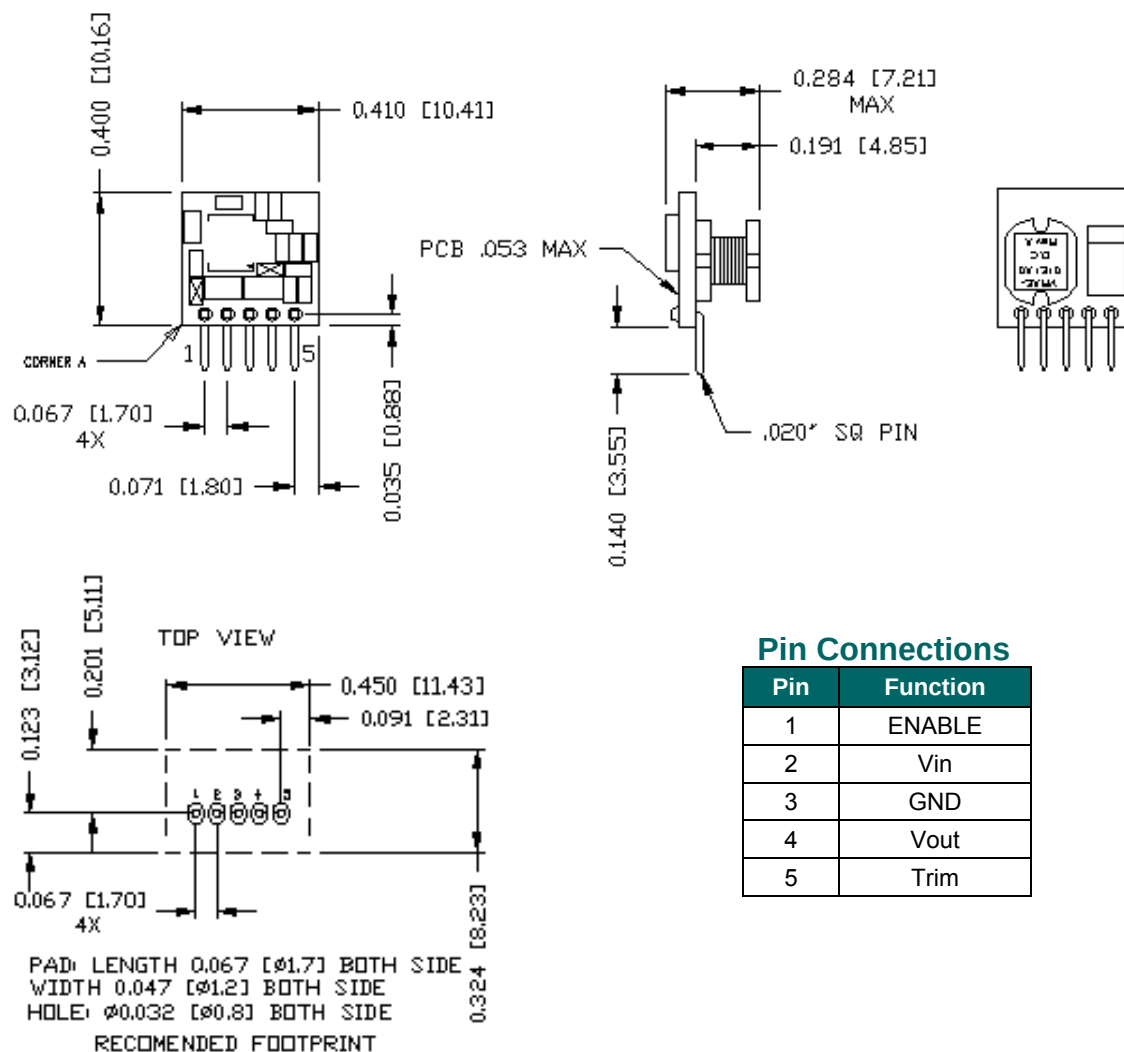


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Mechanical Outline

VRAE-01E1A0



Pin Connections

Pin	Function
1	ENABLE
2	Vin
3	GND
4	Vout
5	Trim

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.

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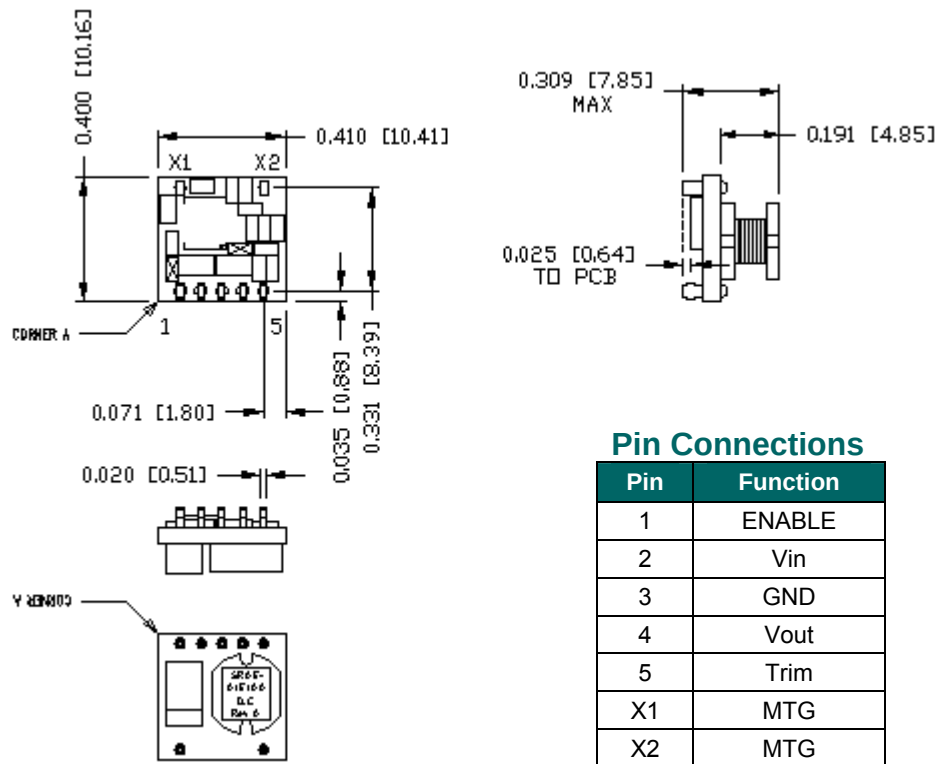


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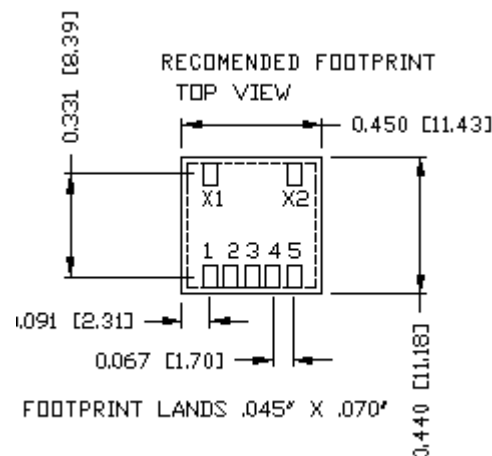
Mechanical Outline (continued)

SRAE-01E1A1



Pin Connections

Pin	Function
1	ENABLE
2	Vin
3	GND
4	Vout
5	Trim
X1	MTG
X2	MTG



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

Notes:

- 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 +/-0.005 in. (x.xx +/-0.13mm).

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Revision History

Date	Version	Changes Detail	Approval
2009-3-16	A	First release	
2009-4-2	B	Update mechanical drawing	
2009-4-21	C	1. Add thermal reference point; 2. Remove some "TBD" information.	
2009-5-5	D	1. Replace the "TBD" in specification with data; 2. Add efficiency curve, NR and TR waveforms; 3. Update Trim	HAN
2009-6-3	E	The maximum voltage for Signal High (Unit On) is changed from 18V to 6V.	T. Bubriski

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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