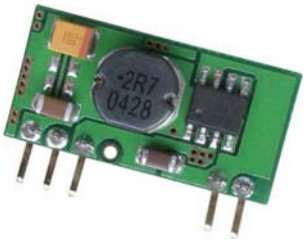
NON-ISOLATED DC/DC CONVERTERS

2.4 Vdc - 5.5 Vdc Input 0.75 Vdc - 3.63 Vdc/3 A Output

VRBA-03F1Ax RoHS Compliant Rev.A

- Non-Isolated
- High Efficiency
- High Power Density
- Fixed Frequency (300 kHz)
- Under-voltage Lockout (UVLO)
- OCP/SCP
- Remote On/Off
- Wide Trim Range
- Converter Can Sink and Source Current



Description

The Bel VRBA-03F1Ax modules are a series of non-isolated dc/dc converters that deliver up to 3 A of output current with full load efficiency of 94% at 3.3 Vdc output. These modules provide precisely regulated voltage programmable via external resistor from 0.75 Vdc to 3.63 Vdc over a wide range of input voltage (2.4 Vdc - 5.5 Vdc). The open-frame construction and small footprint enable designers to develop cost and space-efficient solutions. Standard features include remote On/Off, over current protection, short circuit protection, under-voltage lockout, and programmable output voltage.

Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number Active Low	Model Number Active High
0.75 V - 3.63 V[1]	2.4 V - 5.5 V	3 A	10 W	94%	VRBA-03F1AL	VRBA-03F1A0

Notes: 1. These modules use a buck topology, so the output voltages must be 0.5 V less than the input voltage.
2. Add “G” to the end of the Model Number to indicate Tray Packaging.
3. 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	-	5.8 V	
Output Enable Terminal Voltage	-0.3 V	-	5.5 V	
Ambient Temperature	-40 °C	-	85 °C	
Storage Temperature	-55 °C	-	125 °C	

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

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Input Specifications

Parameter	Min	Typ	Max	Notes
Input Voltage	2.4 V	-	5.5 V	Vo, set ≤ Vin-0.5 V
Input Current (full load)				
Vo=3.3 V	-	2.11 A	-	
Vo=2.5 V	-	1.61 A	-	
Vo=2.0 V	-	1.32 A	-	
Vo=1.8 V	-	1.20 A	-	
Vo=1.5 V	-	1.01 A	-	
Vo=1.2 V	-	0.83 A	-	
Vo=0.75 V	-	0.55 A	-	
Input Current (no load)				
Vo=3.3 V	-	50 mA	-	
Vo=0.75 V	-	20 mA	-	
Remote Off Input Current	-	2 mA	-	
Input Reflected Ripple Current (pk-pk)	-	45 mA	-	Tested with simulated source impedance of 1 uH, 5 Hz to 20 MHz.
Input Reflected Ripple Current (rms)	-	12 mA	-	
I^2t Inrush Current Transient	-	-	0.04 A^2s	
Turn-on Voltage Threshold	-	2.05 V	2.4 V	
Turn-off Voltage Threshold	1.7 V	2.0 V	-	

Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point	-2% Vo,set	-	2% Vo,set	Vin=5 V, 50%Io max
Output Voltage Set Point	-3% Vo,set	-	3% Vo,set	Over all operating input voltage, resistive load and temperature conditions until end of life.
Adjustment Range Selected by External Resistor or Voltage	0.7525 V	-	3.63 V	
Load Regulation	-	0.2% Vo,set	-	Io=Iomin to 50% Iomax
Line Regulation	-	0.2% Vo,set	-	Vin=Vinmin to Vinmax
Regulation Over Temperature (-40 °C to +85 °C)	-	0.4% Vo,set	-	Tref=Tamin to Tamax
Output Current	0 A	-	3 A	
Current Limit Threshold	4 A	-	9.5 A	
Short Circuit Surge Transient	-	0.32 A^2s	-	
Ripple and Noise (pk-pk)	-	30 mV	50 mV	Tested with 0-20 MHz, with 10 uF tantalum capacitor & 1 uF /10 V ceramic capacitor at the output
Ripple and Noise (rms)	-	10 mV	15 mV	
Turn on Time	-	10 mS	14 mS	
Overshoot at Turn on	-	-	1%	
Output Capacitance				
ESR ≥ 1 mohm	0 uF	-	1000 uF	
ESR ≥ 10 mohm	0 uF	-	3000 uF	
Transient Response				
50% ~ 100% Max Load	Vo = 0.75 V - 3.63 V	-	150 mV	-	di/dt=2.5 A/uS; Vin=5 V; and with 10 uF tantalum capacitor & 1 uF/10 V TDK ceramic capacitor at the output
Settling Time		-	40 uS	-	
100% ~ 50% Max Load		-	150 mV	-	
Settling Time		-	40 uS	-	

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

General Specifications

Parameter	Min	Typ	Max	Notes
Efficiency				
Vo=3.3 V	-	94%	-	Measured at Vin=5 V, full load
Vo=2.5 V	-	93%	-	
Vo=2.0 V	-	91%	-	
Vo=1.8 V	-	90%	-	
Vo=1.5 V	-	89%	-	
Vo=1.2 V	-	87%	-	
Vo=0.75 V	-	81.5%	-	
Switching Frequency	250 kHz	300 kHz	350 kHz	
Output Voltage Trim Range	0.7525 V	-	3.63 V	
MTBF	9,776,636 hours			Calculated Per Bell Core SR-332 (Vin=5 V; Io = 2.4 A, Vo=1.8 V; Ta=25 °C)
Dimensions				
Inches (L × W × H)	1.00 x 0.50 x 0.27			
Millimeters (L × W × H)	25.41 x 12.70 x 6.85			
Weight	-	5 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)	-0.2 V	-	0.3 V	Active High: VRBA-03F1A0; Remote On/Off pin open, Unit on.
Signal High (Unit On)	-	-	Vin, max	
Signal Low (Unit On)	-0.2 V	-	0.3 V	Active Low: VRBA-03F1AL; Remote On/Off pin open, Unit on.
Signal High (Unit Off)	1.5 V	-	Vin, max	

Output Trim Equations

A: Equation for calculating the trim resistor (in kΩ) given the desired adjusted voltage (Vadj) is shown below. The Trim Up resistor should be connected between the Trim pin and Ground.

$$R_{trim} = \frac{21.07}{V_{adj} - 0.7525} - 5.11$$

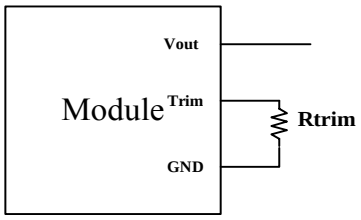
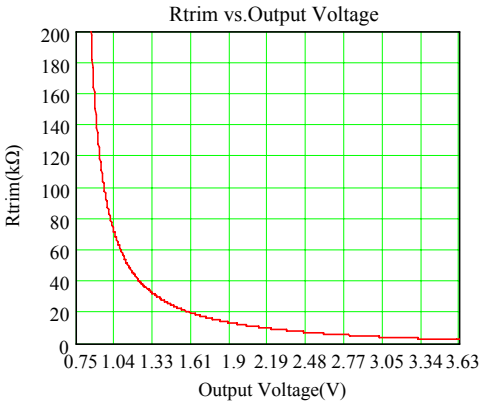


Table 1

Vadj (V)	Rtrim (KΩ)
0.7525	Open
1.2	41.973
1.5	23.077
1.8	15.004
2.0	11.779
2.5	6.947
3.3	3.16



B. Equation for calculating the trim voltage (in V) given the desired adjusted voltage (Vadj) is shown below. The Trim Up voltage should be connected between the Trim pin and Ground.

$$V_{trim} = 0.7 - 0.1698 \times (V_{adj} - 0.7525)$$

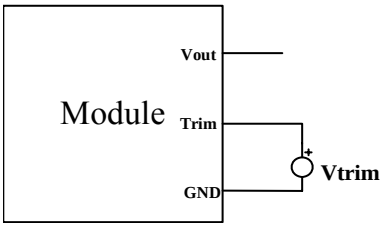
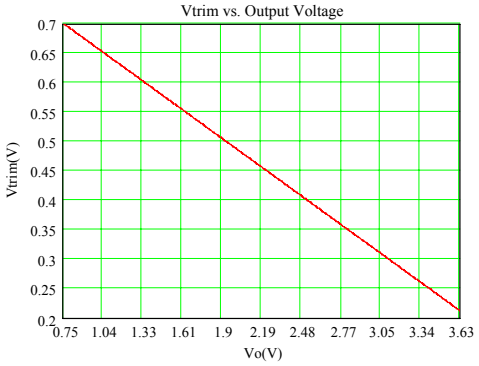
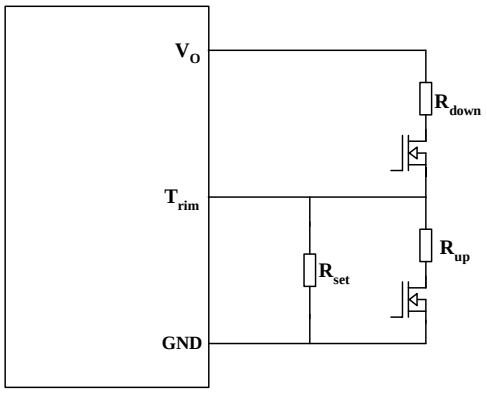


Table 2

Vadj (V)	Vtrim (V)
0.7525	Open
1.2	0.624
1.5	0.5731
1.8	0.5221
2.0	0.4882
2.5	0.4033
3.3	0.267



C.



$$Rset = \frac{21.07}{Vo - 0.7525} - 5.11 \text{ KΩ}$$

$$Rup = \frac{21.07 \cdot Rset - 5.11 \cdot Vm\_up \cdot Rset + 3.845 \cdot Rset}{Vm\_up \cdot Rset + 5.11 \cdot Vm\_up - 0.753\,Rset - 24.915} \text{ KΩ}$$

Vm_up: Margin up value after output voltage is set with Rset

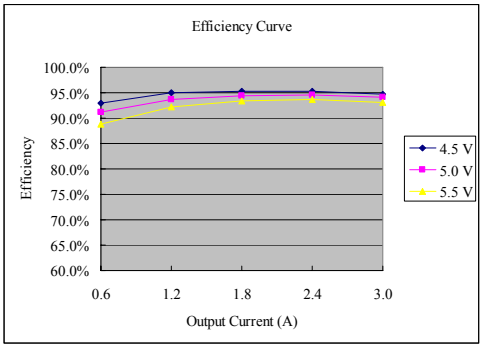
$$Rdown = \frac{5.978 \cdot Vm\_down \cdot Rset - 4.230 \cdot Rset}{0.128 \cdot Rset - 0.868 \cdot Vm\_down - 0.170 \cdot Vm\_down \cdot Rset + 4.230} \text{ KΩ}$$

Vm_down: Margin down value after output voltage is set with Rset

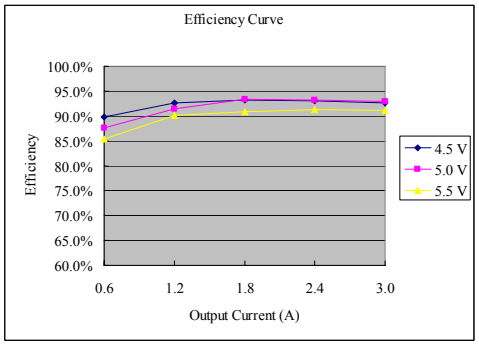
$$Vm\_down \geq 90\% Vo$$

Note: Output voltage Vo=0.7525 V when Trim pin is not connected.

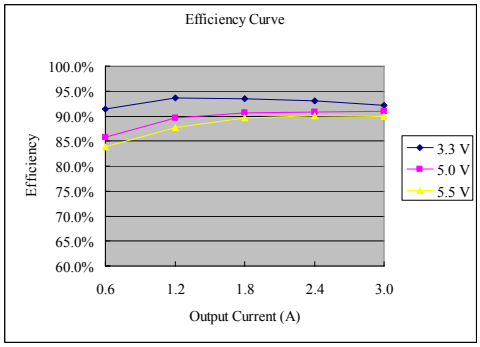
Efficiency Data



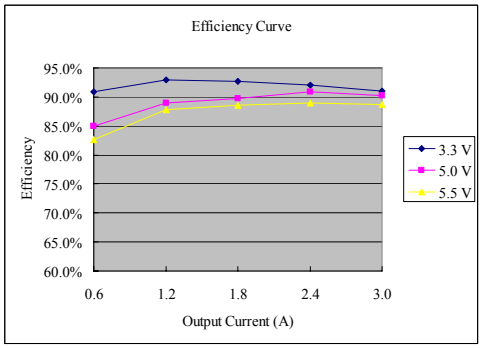
Vo=3.3 V



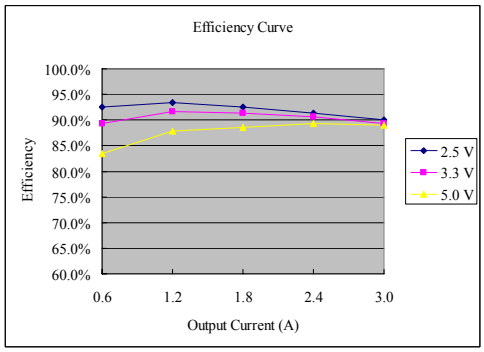
Vo=2.5 V



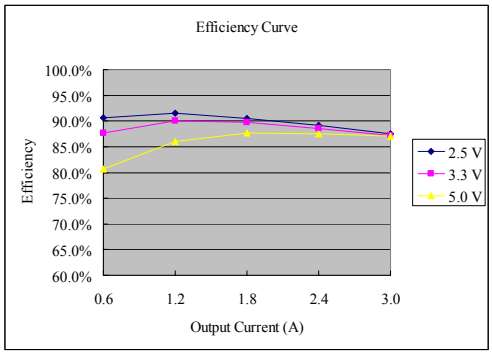
Vo=2.0 V



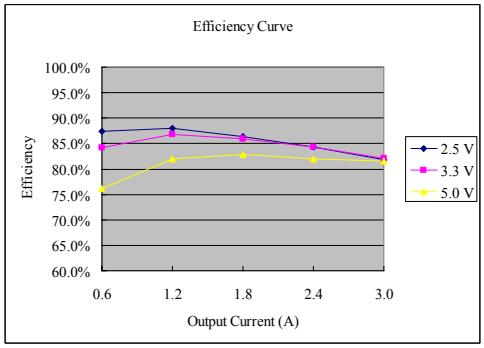
Vo=1.8 V



Vo=1.5 V

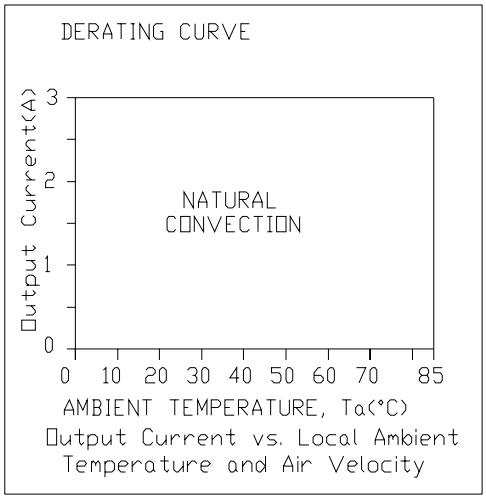


Vo=1.2 V



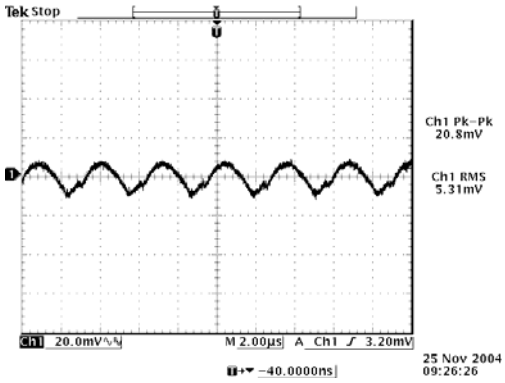
Vo=0.75 V

Thermal Derating Curve

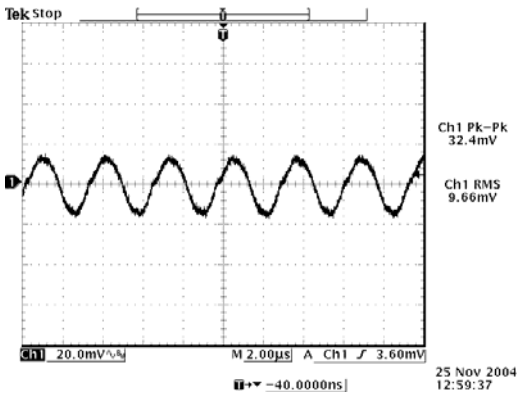


Output Current vs. Local Ambient Temperature and Air Velocity

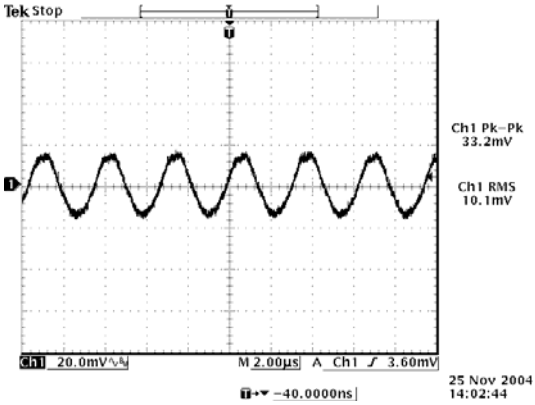
Ripple and Noise Waveforms



5.0 V input, 0.75 V output



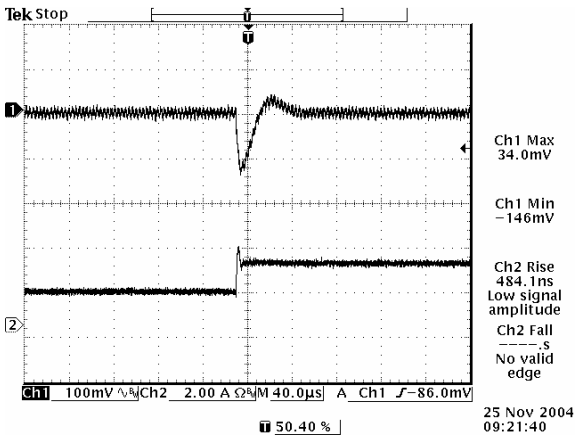
5.0 V input, 1.8 V output



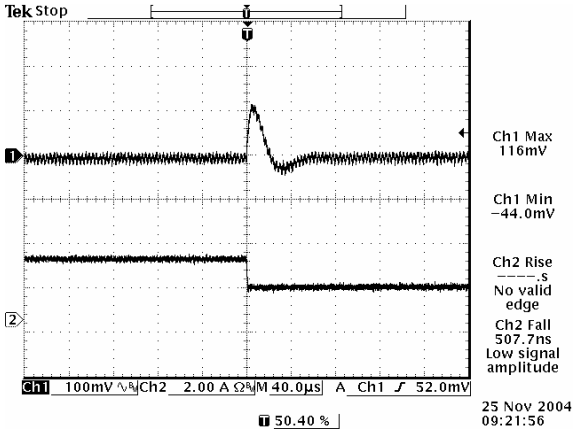
5.0 V input, 3.3 V output

Note: Ripple and noise at full load, 0-20 MHz BW, 10 uF/10 V tantalum cap and 1 uF/10 V ceramic cap at the output, and Ta=25 deg C.

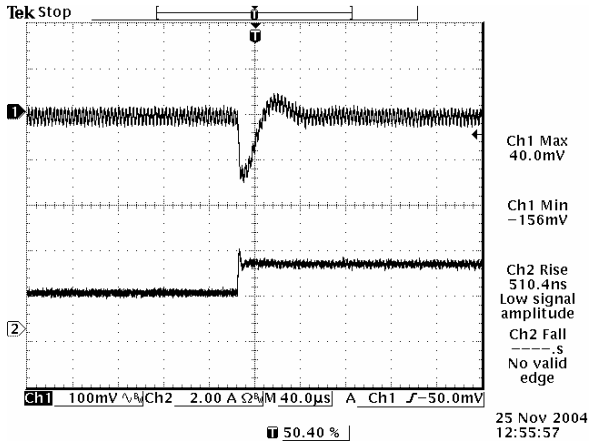
Transient Response Waveforms



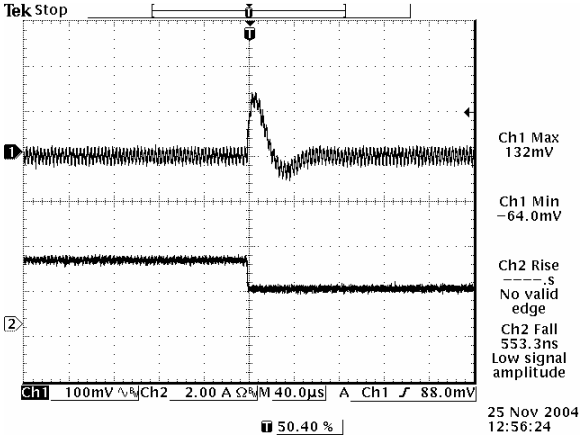
Transients 50% to 100% load 0.75 Vdc output



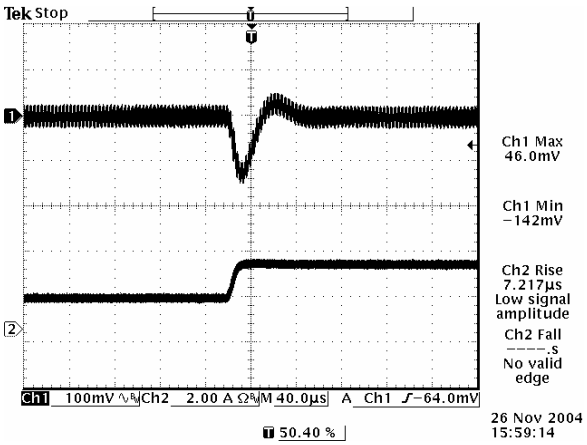
Transients 100% to 50% load 0.75 Vdc output



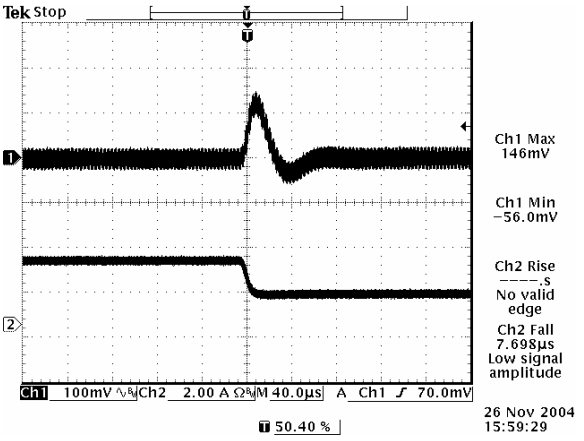
Transients 50% to 100% load 1.8 Vdc output



Transients 100% to 50% load 1.8 Vdc output



Transients 50% to 100% load 3.3 Vdc output



Transients 100% to 50% load 3.3 Vdc output

Note: Transient response at 5 Vdc input, di/dt=2.5 A/uS, with 10 uF/10 V tantalum cap and 1 uF/10 V ceramic cap at the output, Ta=25 deg C.

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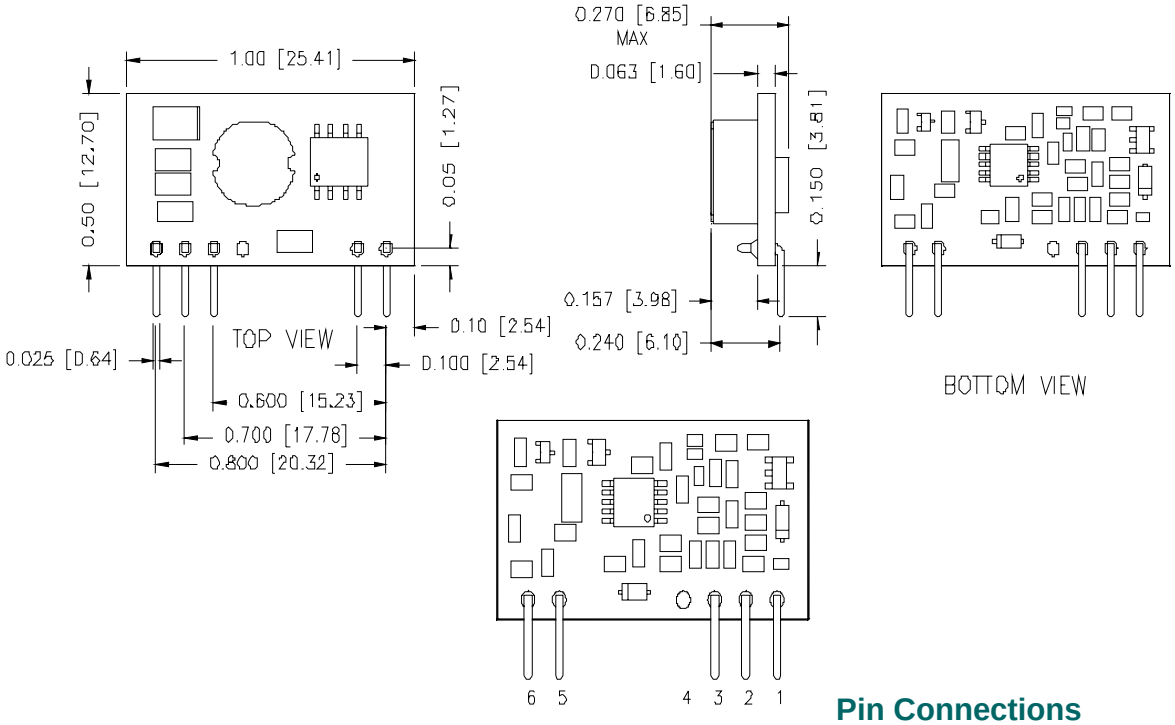
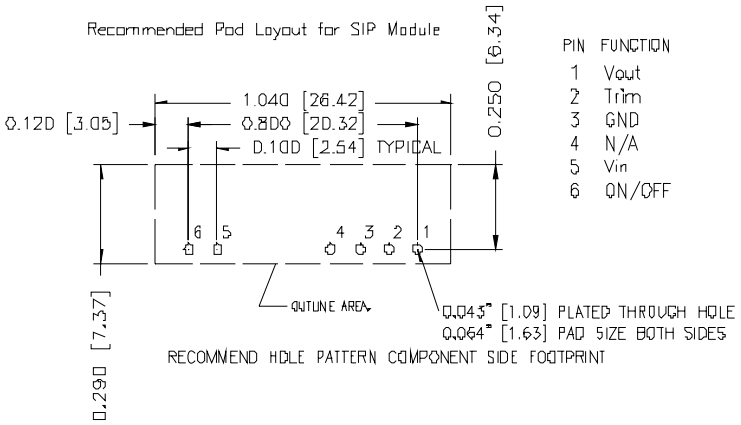
Mechanical Outline



Pin Connections

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



RoHS Compliance

Complies with the European Directive 2002/95/EC, calling for the elimination of lead and other hazardous substances from electronic products.

CORPORATE

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