SUPLET®

Technical Specification

DC-DC Converter Non-isolated

BAA10P5N5BSG

3.0Vdc to 13.8Vdc Input；0.59～5.1Vdc/10A Output

RoHS Compliant

Features

- Compliant to RoHS6 EU Directive 2011/65/EU
- Delivers up to 10A output current
- High efficiency up to 93%
- Small size and profile
- Low output ripple and noise
- Wide operating temperature range
- Constant switching frequency 620kHz
- Exceptional thermal performance
- High reliability
- Remote On/Off positive logic
- Input under voltage lockout
- Output over current protection
- Short circuit protection
- Meets the voltage and current requirements for ETSI 300-132-2 and complies with and licensed for Basic Insulation rating per IEC60950 3-1 2005

Applications

- Distributed Power Architectures
- Wireless Networks
- Access and Optical Network Equipment
- Enterprise Networks
- Latest generation IC's (DSP, FPGA, ASIC) and Microprocessor powered applications

Description

BAA10P5N5BSG is a non-isolated DC/DC converter that provides a high efficiency single output. It can operate from 3.0Vdc to 13.8Vdc input and 0.59Vdc～5.1Vdc/10A output. The remote control logic is positive. The converter turns off when the REM pin is at logic low (0Vdc～0.2 Vdc/1μA) and turns on when it is left open or at logic high (that should be ensured above 0.5Vdc). The power good indicator/output adjustment function is alternative. The output adjustment (default option) is upward when a external resistor is connected between "TRIM" and "GND", and the minimum 0.59V output is attainable when the TRIM pin is left open. The POWER GOOD is available when the TRIM option is not used and the indicator output will be logic low when the output voltage is excess of ±10% of the set point.

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only, functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect the device reliability.

Parameter	Units	Specifications			Notes & conditions
		Min.	Typ.	Max.	
Input Voltage	Vdc	-	-	13.8	Continuous
Operating Ambient Temperature	℃	-40	-	70	Forced air cooling
Storage Temperature	℃	-40	-	125	
Operating Humidity	RH(%)	0	-	95	Non-condensing
Storage Humidity	RH(%)	0	-	95	Non-condensing
Operating Altitude	m	0	-	3000	
Storage Altitude	m	0	-	3000	

Electrical Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and room temperature conditions.

Input Characteristics

Parameter		Units	Specifications			Notes & conditions
			Min.	Typ.	Max.	
Operating Input Voltage	$V_O \leqslant 2.5V$	Vdc	3.0	-	13.8	Add a external 25V/22uF tantalum capacitor at input when Vin≥9V
	$V_O=3.3V$		4.3	-	13.8	
	$V_O=5.0V$		6.0	-	13.8	
Maximum Input Current		A	-	8.27	-	Vin=3.3V/V_O=2.5V,I_O=I_O(max)

Input No load Current	mA	-	80	-	Vin=Vin(min) to Vin(max), $I_{O=}$0,module enabled
Input Reflected Ripple Current (Peak-to-Peak)	%	-	0.5	-	See Test Configurations section
Inrush Transient	A^2S	-	0.01	-	
Recommended Input Fuse	A	-	-	15	

Remote Control Characteristics

Parameter	Units	Specifications			Notes & conditions
		Min.	Typ.	Max.	
Turn on voltage	Vdc	Vin	-	5	Vin≤5V,V_{REM}(max)=Vin; Vin >5V,V_{REM}(max)=5V. Converter guaranteed on when REM pin is left open
Turn off voltage	Vdc	0	-	0.2	

Output Characteristics

Parameter		Units	Specifications			Notes & conditions
			Min.	Typ.	Max.	
Output Voltage Set-Point		Vdc	0.59	0.6/0.9/1.2/1.5/1.8/2.5/3.3/5.0	5.1	Io=0 to Io(max)
Output Current		A	-	-	10	
Line Regulation		%Vo	-	0.2	-	Vin=Vin(min) to Vin(max) Io=Io(nom), Ambient temperature
Load Regulation		%Vo	-	0.5	-	Vin=Vin(nom) Io=0 to Io(max) Ambient temperature
Output Voltage Accuracy		%Vo	-	-	1	Vin=Vin(min) to Vin(max) Io=0 to Io(max)
Output Current Limit Point		A	-	16	-	
Temperature Coefficient		ppm/℃	-	200	-	Ambient Temperature -40℃～70℃
External Capacitive	V_O=0.6V, 0.9V	μF	-	-	8400	with aluminum electrolytic capacitor at output

Load	V_O=1.2V		-	-	6000	
	V_O=1.5V		-	-	4500	
	V_O=1.8V		-	-	3000	
	V_O=2.5V		-	-	2300	
	V_O=3.3V, 5.0V		-	-	1100	
Ripple and Noise	V_O=0.6V	mV	-	15	-	Measured with 1uF Ceramic external capacitor,20MHz
	V_O=0.9V		-	25	-	
	V_O=1.2V		-	25	-	
	V_O=1.8V		-	25	-	
	V_O=2.5V		-	30	-	
	V_O=5.0V		-	45	-	
Dynamic Response	V_O=0.6V	mV/μs	-	30/40	-	25%~50%Io(nom), di/dt=2.5A/μS. with 25V/22uF tantalum capacitor at input and 1uF ceramic capacitor at output
	V_O=0.9V		-	27/45	-	
	V_O=1.2V		-	27/30	-	
	V_O=1.8V		-	30/20	-	
	V_O=2.5V		-	30/20	-	
	V_O=5.0V		-	55/20	-	
	V_O=0.6V	mV/μs	-	70/50	-	50%~75% Io(nom), di/dt=2.5A/μS with 25V/22uF tantalum capacitor at input and 1uF
	V_O=0.9V		-	50/45	-	

	V_O=1.2V		-	55/45	-	ceramic capacitor at output
	V_O=1.8V		-	60/35	-	
	V_O=2.5V		-	65/35	-	
	V_O=5.0V		-	100/20	-	
Turn-on Delay Time	V_O=0.6V	ms	-	0.7	-	Delay from instant at which Vin=Vin(min) until Vo=10% of Vo(nom)
	V_O=0.9V		-	0.6	-	
	V_O=1.2V		-	0.5	-	
	V_O=1.8V		-	0.5	-	
	V_O=2.5V		-	0.4	-	
	V_O=5.0V		-	0.3	-	
Turn-on Rise Time	V_O=0.6V	ms	-	1.2	-	Time for Vo to rise from 10% of Vo(nom) to 90% of Vo(nom)
	V_O=0.9V		-	1.2	-	
	V_O=1.2V/1.8V/2.5V		-	1.3	-	
	V_O=5.0V		-	1.4	-	

Protection Characteristics

Parameter		Units	Specifications			Notes & conditions
			Min.	Typ.	Max.	
Input Under Voltage Lockout	Turn-on Threshold	Vdc	-	3.0	-	
	Turn-off Threshold	Vdc	-	2.7	-	
Output Over Current Protection		A	-	16	-	

Short Circuit Protection		-	Yes	-	Hiccup mode Automatic recovery

General Specifications

Parameter			Units	Specifications			Notes & conditions
				Min.	Typ.	Max.	
Efficiency	Vin=5V	V_O=0.6V	%	-	72	-	Ambient Temperature 25℃, 100%load
		V_O=0.9V		-	80	-	
		V_O=1.2V		-	83	-	
		V_O=1.8V		-	87	-	
		V_O=2.5V		-	91	-	
	Vin=12V	V_O=5.0V		-	93	-	
	Vin=5V	V_O=0.6V		-	80	-	Ambient Temperature 25℃, 50%load
		V_O=0.9V		-	86	-	
		V_O=1.2V		-	88	--	
		V_O=1.8V		-	91	-	
		V_O=2.5V		-	94	-	
	Vin=12V	V_O=5.0V		-	94	-	
MTBF			Hour	8,000,000			Telcordia SR332, 40℃
FIT				125			10^9/MTBF
Weight			g	-	2.7	-	

Switching Frequency	kHz	-	620	-	
Safety	Compliant to IEC60950-1,UL60950-1,EN60950-1 and GB4943				
Vibration	IEC60068-2-6:10-500Hz sweep,0.75mm excursion,10g acceleration,10minutes in each 3 perpendicular directions				
Transportation	ETS300019-1-2				
Shock	IEC60068-2-27:200g acceleration, duration 3 ms,6 drops in each 3 perpendicular directions				

Characteristic Curves

Efficiency

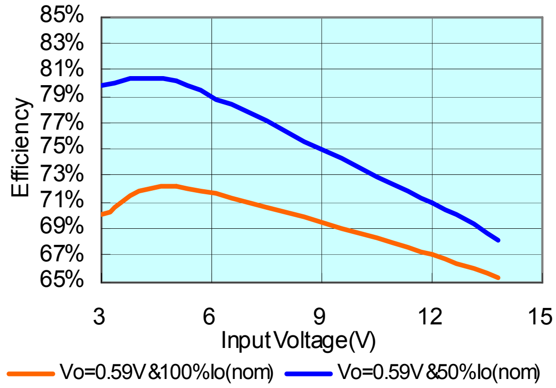


Figure1. Converter Efficiency Vs. Input Voltage@25℃

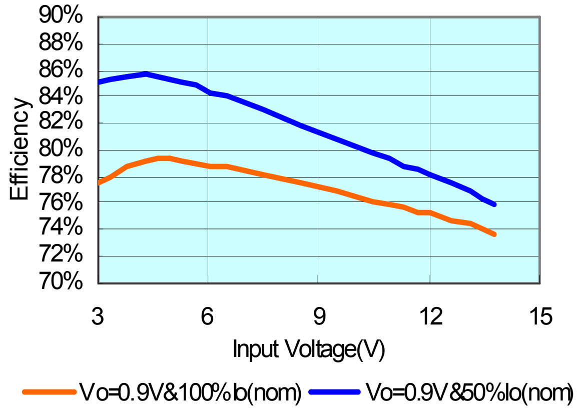


Figure2. Converter Efficiency Vs. Input Voltage @25℃

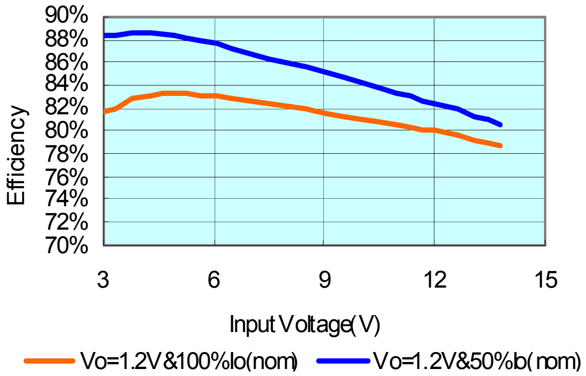


Figure3. Converter Efficiency Vs. Input Voltage @25℃

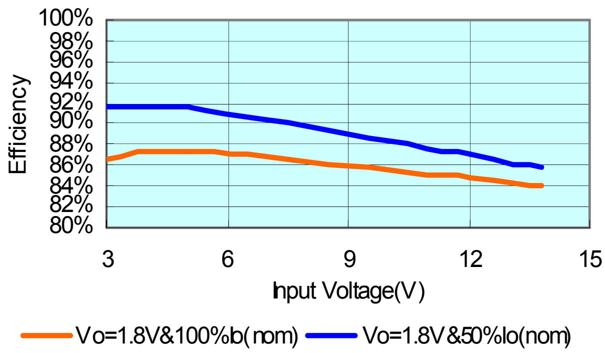


Figure4. Converter Efficiency Vs. Input Voltage @25℃

Efficiency continued

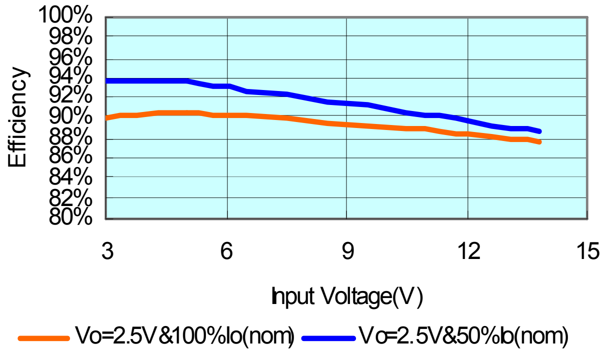


Figure5. Converter Efficiency Vs. Input Voltage @25℃

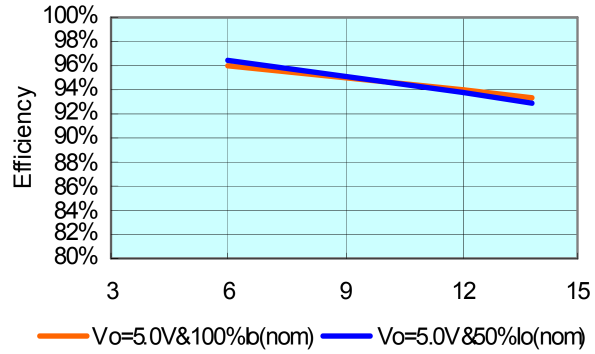


Figure6. Converter Efficiency Vs. Output Current @25℃

Derating

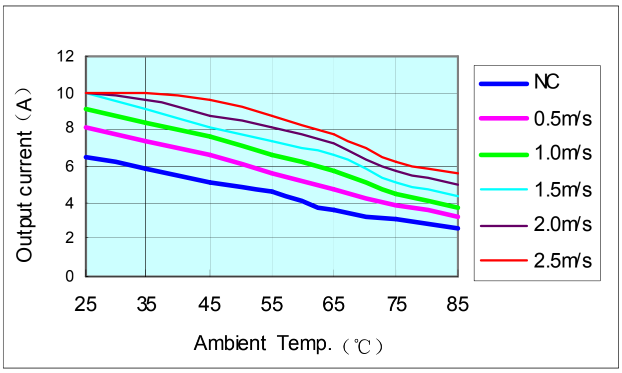


Figure 7. Vin=12.0V/Vo=5.0V Derating Curve

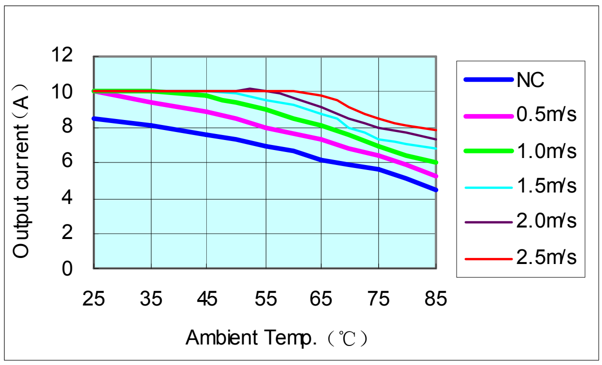


Figure 8. Vin=12.0V/Vo=2.5V Derating Curve

Derating continued

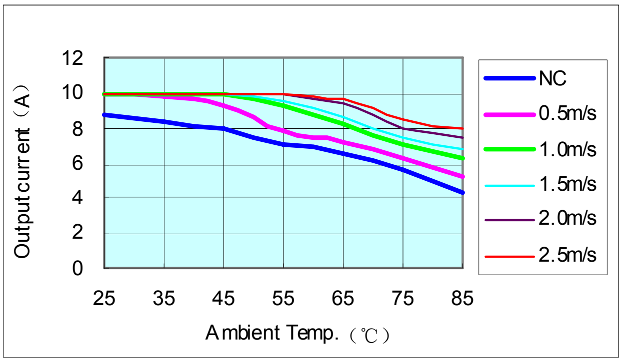


Figure 9. Vin=12.0V/Vo=0.9V Derating Curve

Dynamic Response

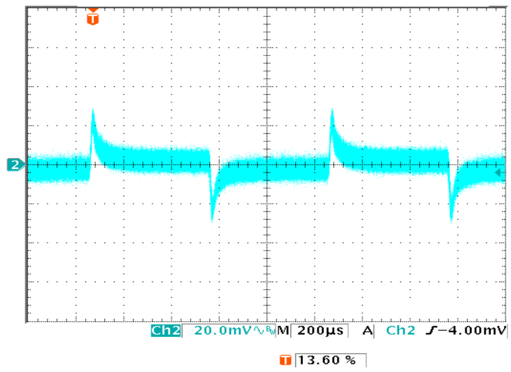


Figure 10. Vin=5V/Vo=0.59V, 25%~50%load, 2.5A/μS @25℃

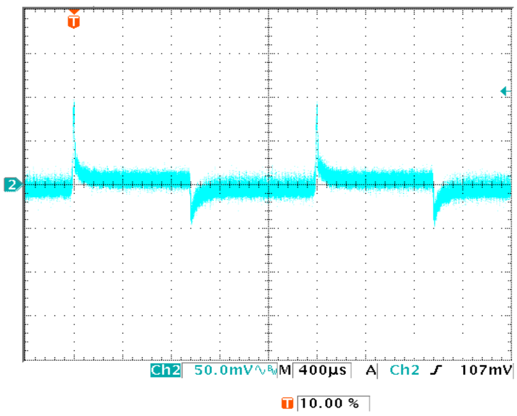


Figure 11. Vin=5V/Vo=0.59V, 50%~75%load, 2.5A/μS @25℃

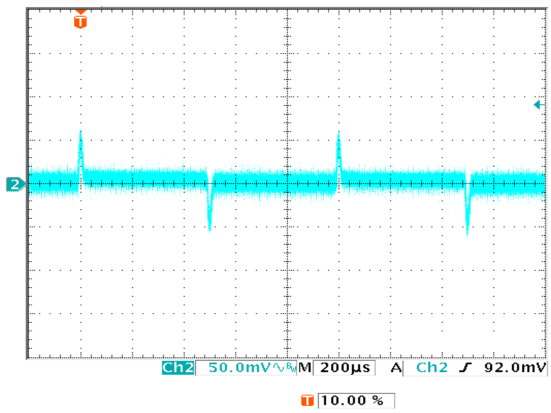


Figure 12. Vin=5V/Vo=0.9V, 25%~50%load, 2.5A/μS @25℃

Dynamic Response continued

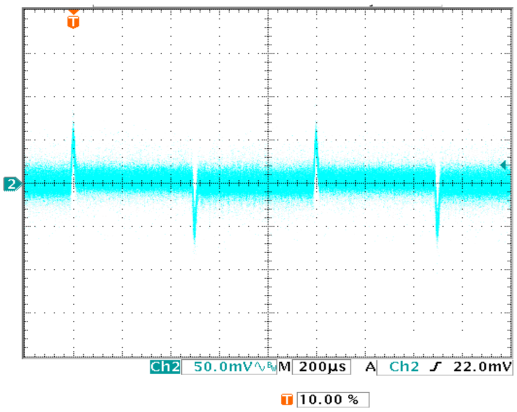


Figure 13. Vin=5V/Vo=0.9V, 50%~75%load, 2.5A/μS @25℃

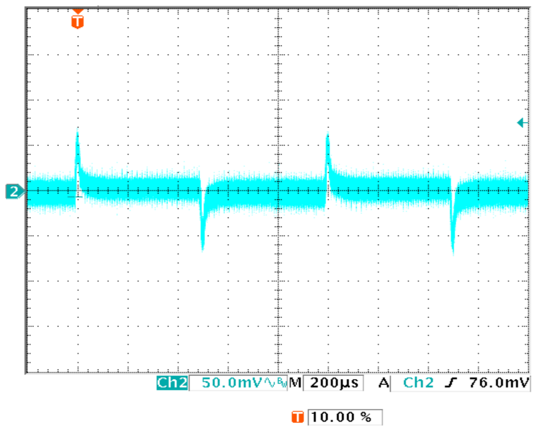


Figure 14. Vin=5V/Vo=1.8V, 25%~50%load, 2.5A/μS @25℃

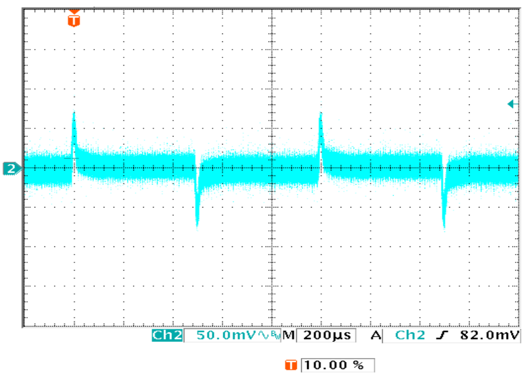


Figure 15. Vin=5V/Vo=1.8V, 50%~75%load, 2.5A/μS@25℃

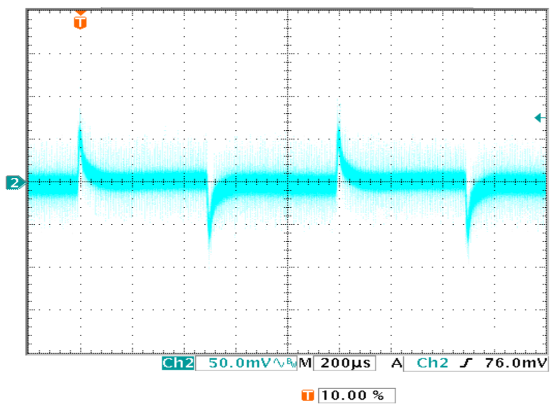


Figure 16. Vin=5V/Vo=2.5V, 25%~50%load, 2.5A/μS @25℃

Dynamic Response continued

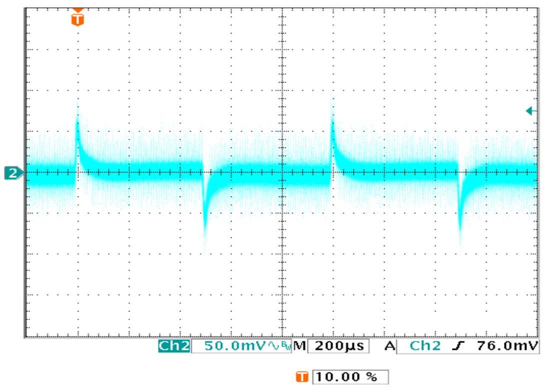


Figure 17. Vin=5V/Vo=2.5V, 50%~75%load, 2.5A/µS @25℃

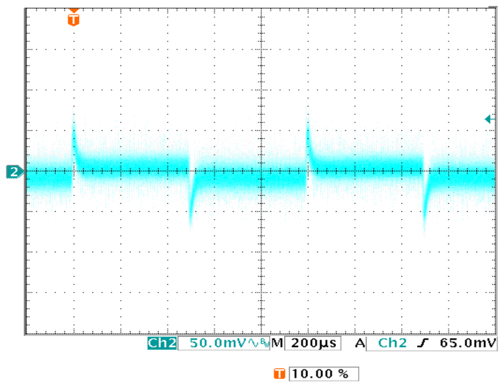


Figure 18. Vin=12V/Vo=5.0V, 25%~50%load, 2.5A/µS @25℃

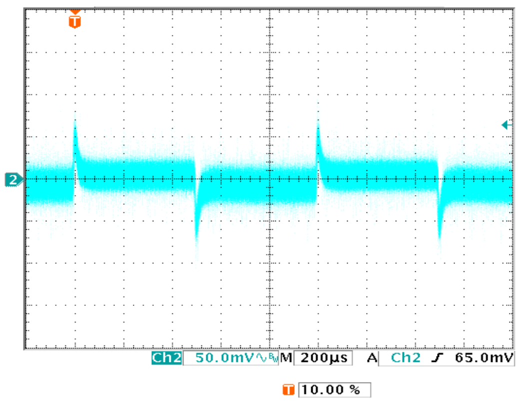


Figure 19. Vin=12V/Vo=5.0V, 50%~75%load, 2.5A/µS @25℃

Start-up

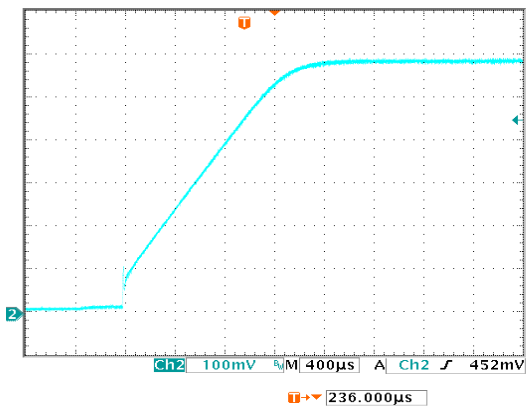


Figure 20. Vin=5V/Vo=0.59V, 100%load@25℃

Start-up continued

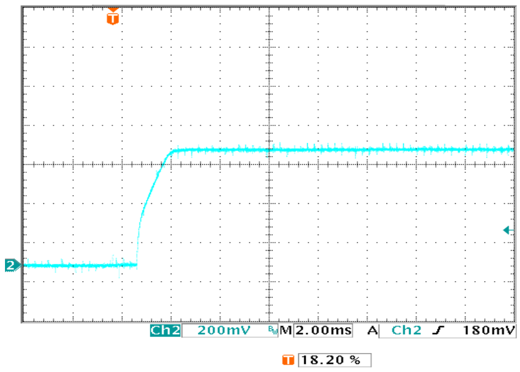


Figure 21. Vin=5V/Vo=0.59V, no-load@25℃

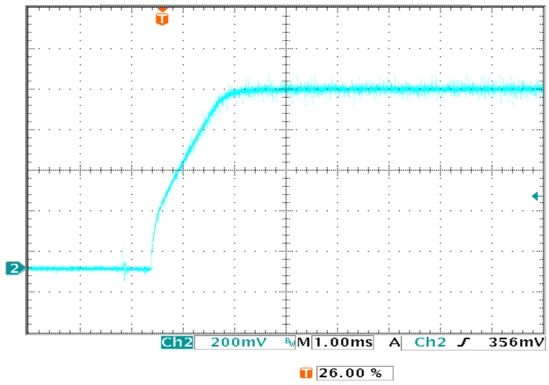


Figure22. Vin=5V/Vo=0.9V, 100%load@25℃

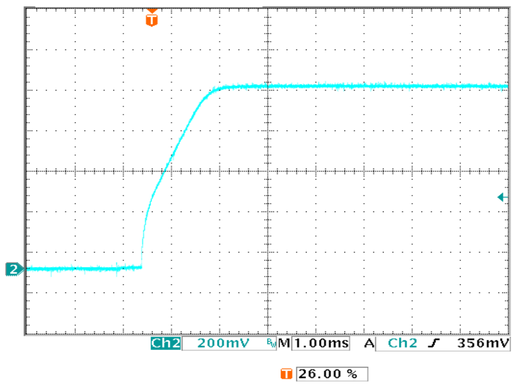


Figure 23. Vin=5V/Vo=0.9V, no-load@25℃

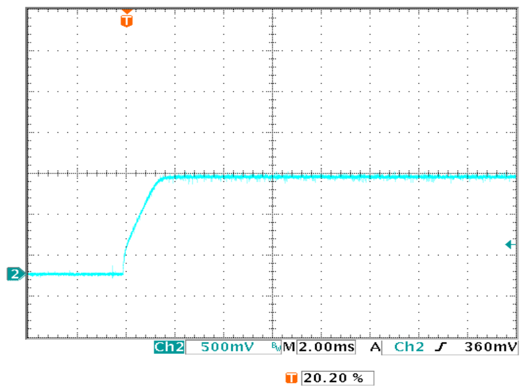


Figure 24. Vin=5V/Vo=1.2V, 100%load@25℃

Start-up continued

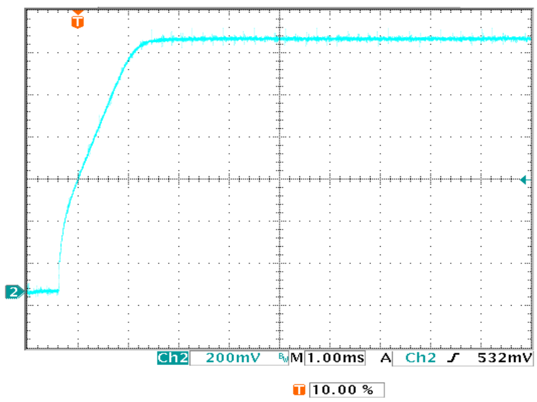


Figure 25. Vin=5V/Vo=1.2V, no-load@25℃

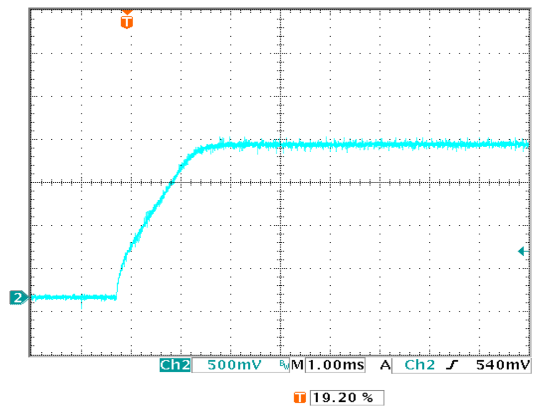


Figure 26. Vin=5V/Vo=1.8V, 100%load@25℃

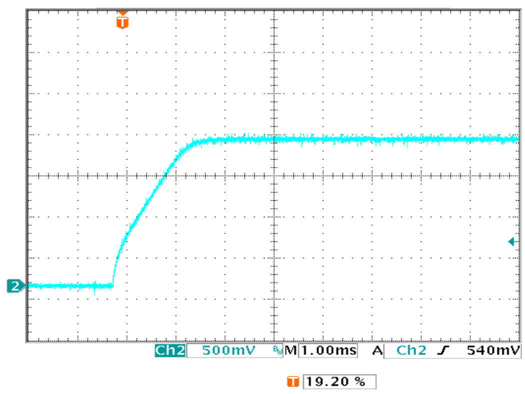


Figure 27. Vin=5V/Vo=1.8V, no-load@25℃

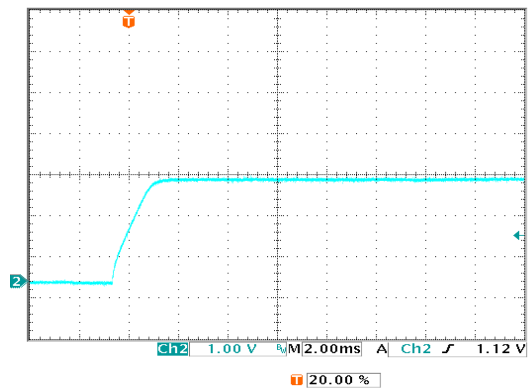


Figure 28. Vin=5V/Vo=2.5V, 100%load@25℃

Start-up continued

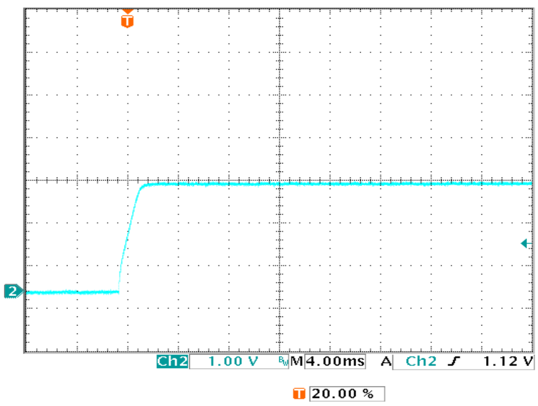


Figure 29. Vin=5V/Vo=2.5V, no-load@25℃

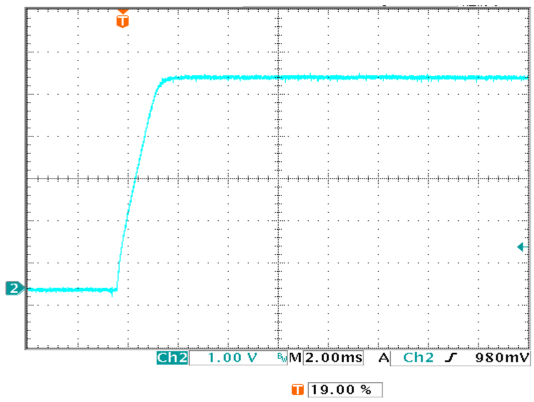


Figure 30. Vin=12V/Vo=5.0V, 100%load@25℃

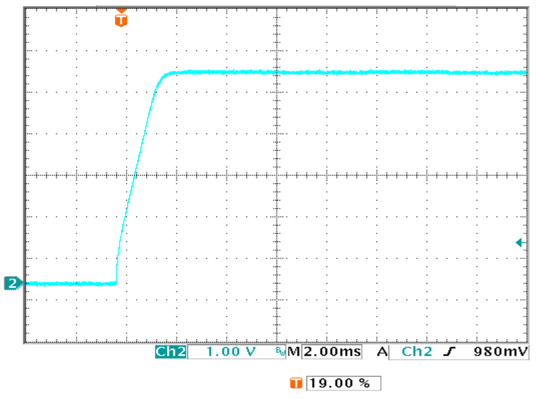


Figure 31. Vin=12V/Vo=5.0V, no-load@25℃

Output ripple & noise

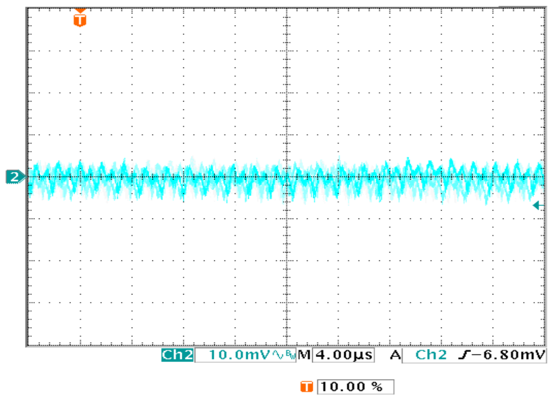


Figure 32. Vin=5V/Vo=0.59V, 100%load@25℃

Output ripple & noise continued

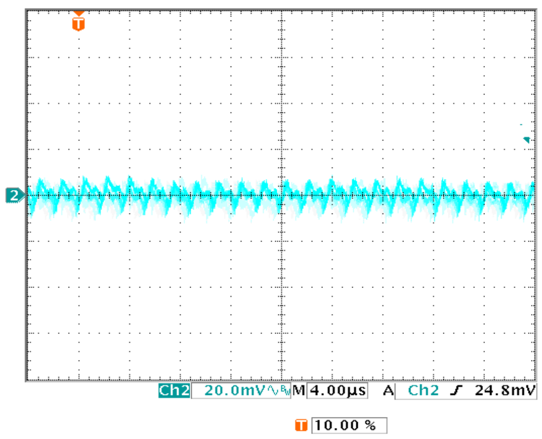


Figure 33. Vin=5V/Vo=0.9V, 100%load@25℃

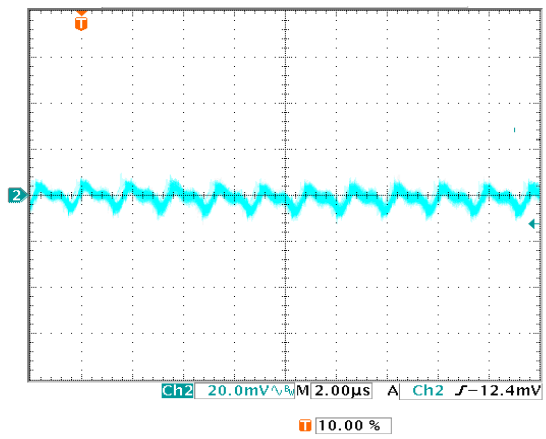


Figure 34. Vin=5V/Vo=1.2V, 100%load@25℃

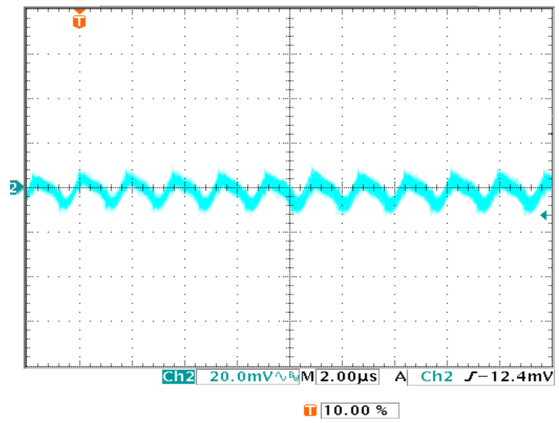


Figure 35. Vin=5V/Vo=1.8V, 100%load@25℃

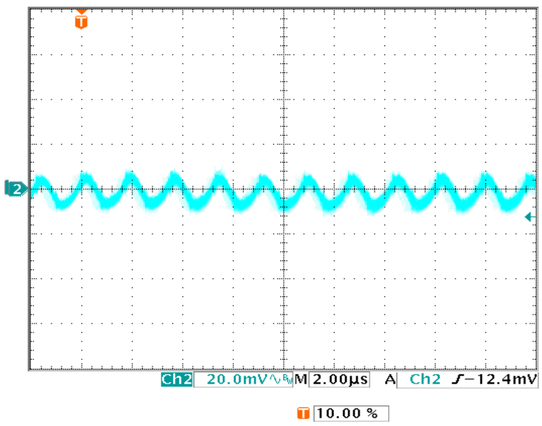
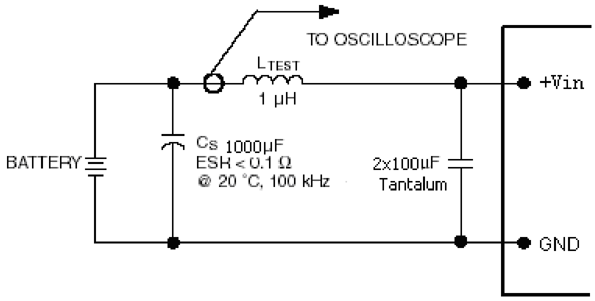


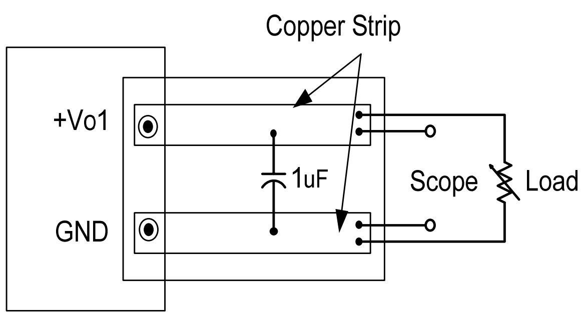
Figure 36. Vin=5V/Vo=2.5V, 100%load@25℃

Test Configurations



Note: Measure input reflected ripple current with a simulated source inductance of 1µH. The measurement points for input reflected ripple current is showed above.

Figure 37. Input Reflected Ripple Current Test Setup



Note: Scope measurements should be made using a BNC socket with a 1µF ceramic capacitor. Position the oscilloscope probe between 51mm and 76mm (2in and 3in) from the module

Figure38. Peak-to-Peak Output Ripple Test Setup

Safety Considerations

For safety agency approval the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standards, i.e., UL 60950-1, CSA C22.2 No. 60950-1-03, and VDE 0850:2001-12 (EN60950-1) Licensed.

For the converter output to be considered meeting the requirements of safety extra-low voltage (SELV), the input must meet SELV requirements. The power module has extra-low voltage (ELV) outputs when all inputs are ELV.
The input to these units is to be provided with a fastacting fuse with a maximum rating of 15A in the positive input lead.

Design Considerations

Input and Output Filter

The BAA power module should be connected to a low ac-impedance input source. A highly inductive source can affect the stability of the power module. An input capacitor must be placed directly adjacent to the input pin of the module, to minimize input ripple voltage and ensure module stability.
To reduce the output ripple and improve the dynamic response to a step load change, additional capacitor at the output can be used. For stable operation of the module, limit the capacitor to less than the maximum output capacitance as specified in the electrical specification table.
Figure 39 shows the typical application circuit with input and output filters.

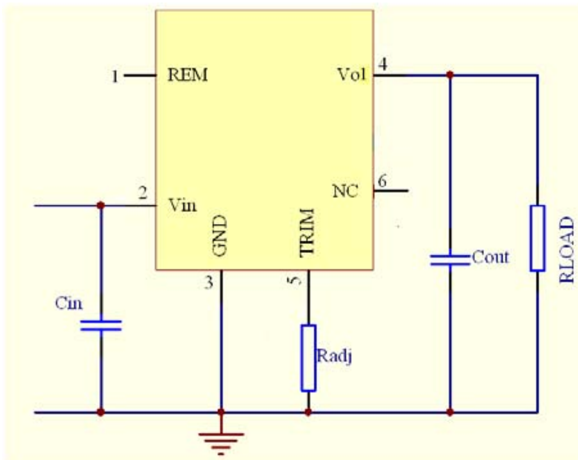


Figure 39. Typical application circuit

Feature Descriptions

Remote On/Off

The BAA power modules feature an On/Off pin (REM) for remote On/Off control of the module. The remote On/Off operation is available by using a MOSFET, keeping the dissipation to a minimum.

To turn the module on, the REM pin should be left open, and to turn the module off, the REM pin should be at 0~0.2Vdc.

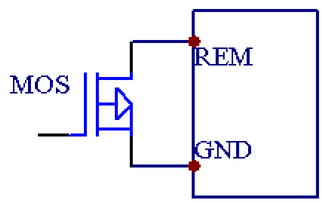


Figure 40. Remote On/Off Application Circuit

Output Voltage Programming

The output voltage of the module can be programmed to any voltage from 0.59Vdc to 5.1Vdc by connecting a single resistor R_{adj} between the TRIM and GND pins (shown in Figure 41). Without an external resistor between the TRIM and ground, that is to say, the TRIM pin is left open, the output voltage is 0.59Vdc. To calculate the value of the resistor R_{adj} for a particular output voltage Vo1, use the following equation:

$$R_{adj} = \frac{1.182}{Vo - 0.591} K\Omega$$

Where Vo = desired voltage.

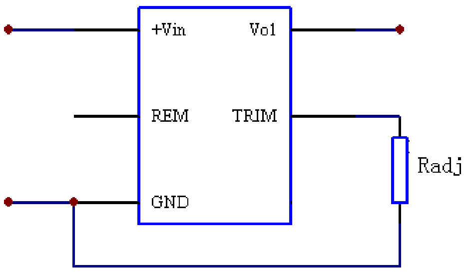


Figure 41. Output voltage programming application

The table below provides the R_{adj} values required for some common output voltages:

Vo (Vdc)	R_{adj} (KΩ)	Vo (Vdc)	R_{adj} (KΩ)
0.9	3.825	2.0	0.839
1.2	1.941	2.5	0.619
1.5	1.300	3.3	0.436
1.8	0.978	5.0	0.268

Power Good Indicator

The BAA power module has a power good indicator output. This output pin uses positive logic and is open-collector. The Power Good uses the same pin as the trim function and is not available if trim option is used. Also, the power good output is able to sink 10mA.

When the output of the module is within ±10% of the nominal set point, the power good pin can be pulled high. Note that Power Good should not be pulled higher than the following conditions:

If, Vin ≤ 5V, V_{pgood} (max) = Vin

If, Vin > 5V, V_{pgood} (max) = 5V.

Protection Features

Input Under Voltage Lockout

At input voltages below the input under-voltage lockout limit, the module operation is disabled. The module will begin to operate at an input voltage above the under-voltage lockout turn-on threshold.

Output Over current Protection

To provide protection in an output overload fault condition, the module is equipped with internal current-limiting circuitry and can endure current limiting for an unlimited duration. At the instance of current-limit inception, the module enters a "hiccup" mode of operation, whereby it shuts down and automatically attempts to restart. While the fault condition exists, the module will remain in this mode until the fault is cleared. The unit operates normally once the output current is reduced back into its specified range.

Over Temperature Protection

These modules feature an over-temperature protection circuit to safeguard against thermal damage. The circuit shuts down and latches off the module when the maximum device reference temperature is exceeded. The module can be restarted by cycling the dc input power for at least one second or by toggling the remote on/off signal for at least one second.

Thermal Considerations

Modules operate in a variety of thermal environments; however, sufficient cooling should always be provided to help ensure reliable operation. Considerations include ambient temperature, airflow, module power dissipation, and the need for increased reliability. A reduction in the operating temperature of the module will result in an increase in reliability. The thermal data presented here is based on physical measurements taken in a wind tunnel. Note that the airflow is parallel to the long axis of the module as shown in Figure 42. The derating data applies to airflow in either direction of the module's long axis. The thermal reference point, Tref1and Tref2, used to monitor the temperature limits of the product, is shown in Figure 42. For reliable operation the temperature should not exceed 120℃.

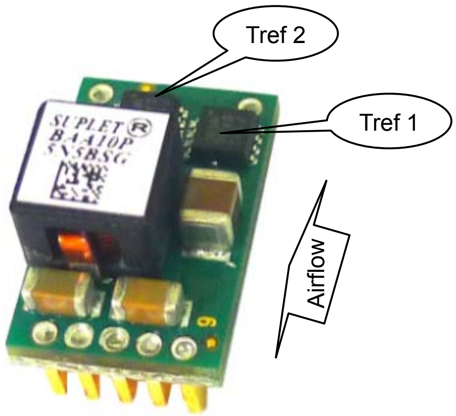


Figure42. Thermal test position and wind direction

Heat Transfer via Convection

Increased airflow over the module enhances the heat transfer via convection. Thermal derating curves showing the maximum output current that can be delivered at different local ambient temperature (TA) for airflow conditions ranging from natural convection and up to 2.5m/s are shown in the Characteristics Curves section.

Surface Mount Information

Reflow Soldering Information

These power modules are large mass, low thermal resistance devices and typically heat up slower than other SMT components. It is recommended that the customer review data sheets in order to customize the solder reflow profile for each application board assembly.

The following instructions must be observed when SMT soldering these units. Failure to observe these instructions may result in the failure of or cause damage to the modules, and can adversely affect long-term reliability.

Typically, the eutectic solder melts at 217℃, wets the land, and subsequently wicks the device connection. Sufficient time must be allowed to fuse the plating on the connection to ensure a reliable solder joint. There are several types of SMT reflow technologies currently used in the industry. These surface mount power modules can be reliably soldered using natural forced convection, IR (radiant infrared), or a combination of convection/IR. For reliable soldering the solder reflow profile should be established by accurately measuring the modules pin connector temperatures.

Lead-free (Pb-free) solder processes

For Pb-free solder processes, a pin temperature (T_{PIN}) in excess of the solder melting temperature (T_L, +217 to +221°C for Sn/Ag/Cu solder alloys) for more than 30 seconds, and a peak temperature of +235°C on all solder joints is recommended to ensure a reliable solder joint.

For Pb-free solder processes, the product is qualified for MSL 3 according to IPC/JEDEC standard J-STD-020C. During reflow, T_P must not exceed +245°C at any time.

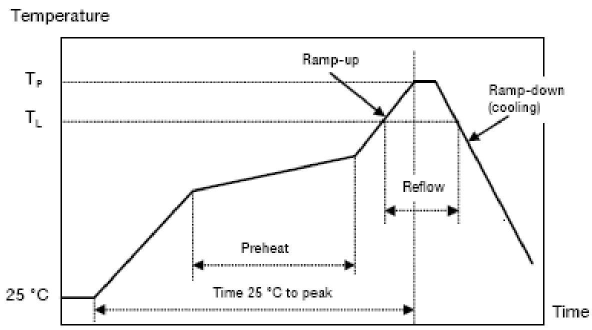


Figure43. Recommended reflow profile.

Reflow process specifications		Pb-free
Average ramp-up rate		3°C/s max
Solder melting temperature (lim)	T_L	+217°C
Time above T_L		30 s~90s
Minimum pin temperature	T_{pin}	+235°C
Peak product temperature	T_p	+245°C
Average ramp-down rate		6°C/s max
Time 25°C to peak		6 minutes max

Soldering Information （Through-Hole Version）

The product is intended for through-hole mounting in a PCB. When wave soldering is used, the temperature on the pins is specified to maximum 270 °C for maximum 10 seconds.

Maximum preheat rate of 4 °C/s and temperature of max 150 °C is suggested, when hands soldering care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

When PIP(Pin in Paste) Soldering is used, please refer to “Lead-free (Pb-free) solder processes” section for surface mounting version.

A no-clean (NC) flux is recommended to avoid entrapment of cleaning fluids in cavities inside of the DC/DC power module. The residues may affect long time reliability and isolation voltage.

MSL Rating

The module has a MSL rating of 3 according to IPC/JEDEC standard J-STD-020D.

Post Solder Cleaning and Drying Considerations

Post solder cleaning is usually the final circuit-board assembly process prior to electrical board testing. The result of inadequate cleaning and drying can affect both the reliability of a power module and the testability of the finished circuit-board assembly.

Outline Diagram

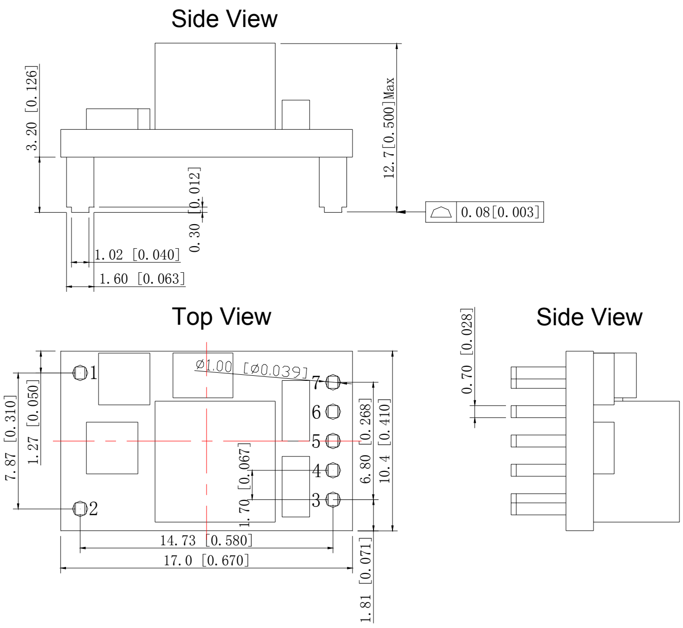


Figure44. Outline Diagram

Note: Dimensions are in mm [inch].

Tolerances: x.x mm ± 0.5mm [x.x in. ± 0.02 in.],

x.xx mm ± 0.25 mm [x.xxx in. ± 0.010 in.] (Unless otherwise indicated).

Pin Designations

Pins No.	Symbols	Functions
1,2	NC	Location pin
3	TRIM/POWERGOOD	Output voltage adjustment / Power good indicator
4	Vo1	Positive output
5	GND	Negative input and output
6	+Vin	Positive input
7	REM	Remote control

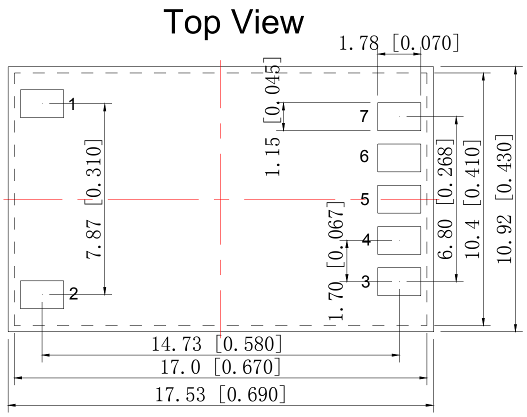


Figure45. Recommended Pad Layout

Note: Dimensions are in mm [inch].

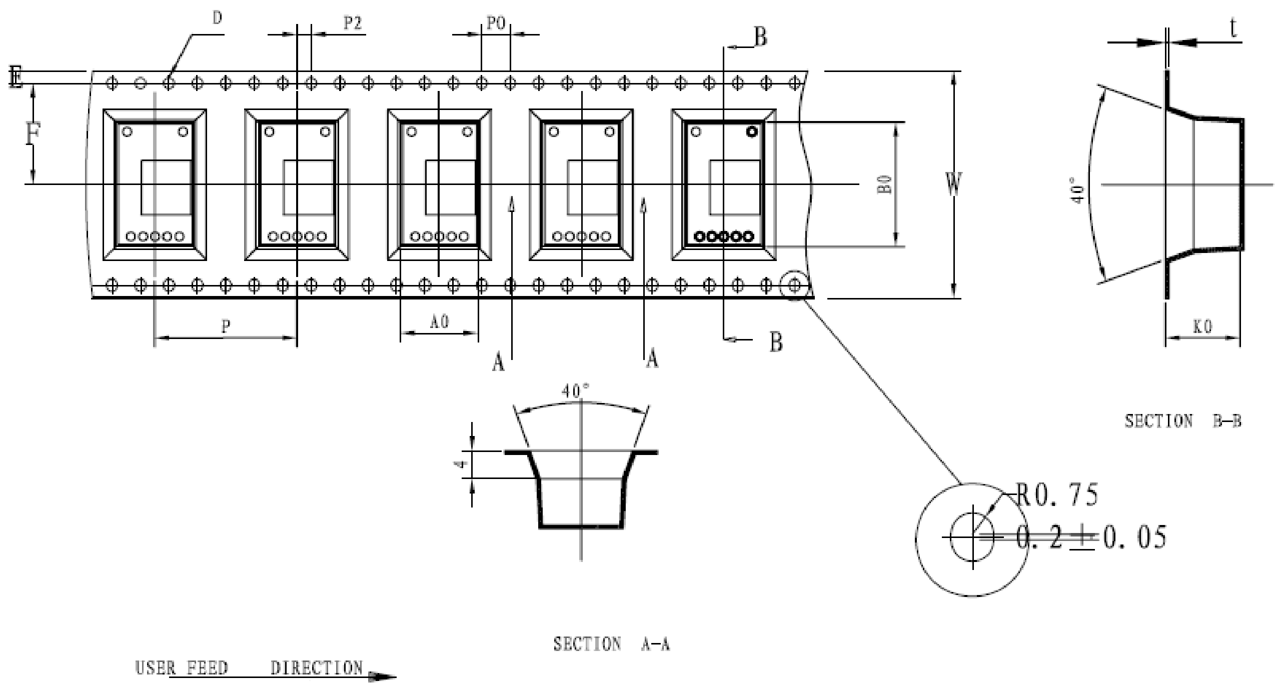
Tolerances: x.x mm ± 0.5mm [x.x in. ± 0.02 in.],

x.xx mm ± 0.25 mm [x.xxx in. ± 0.010 in.] (Unless otherwise indicated).

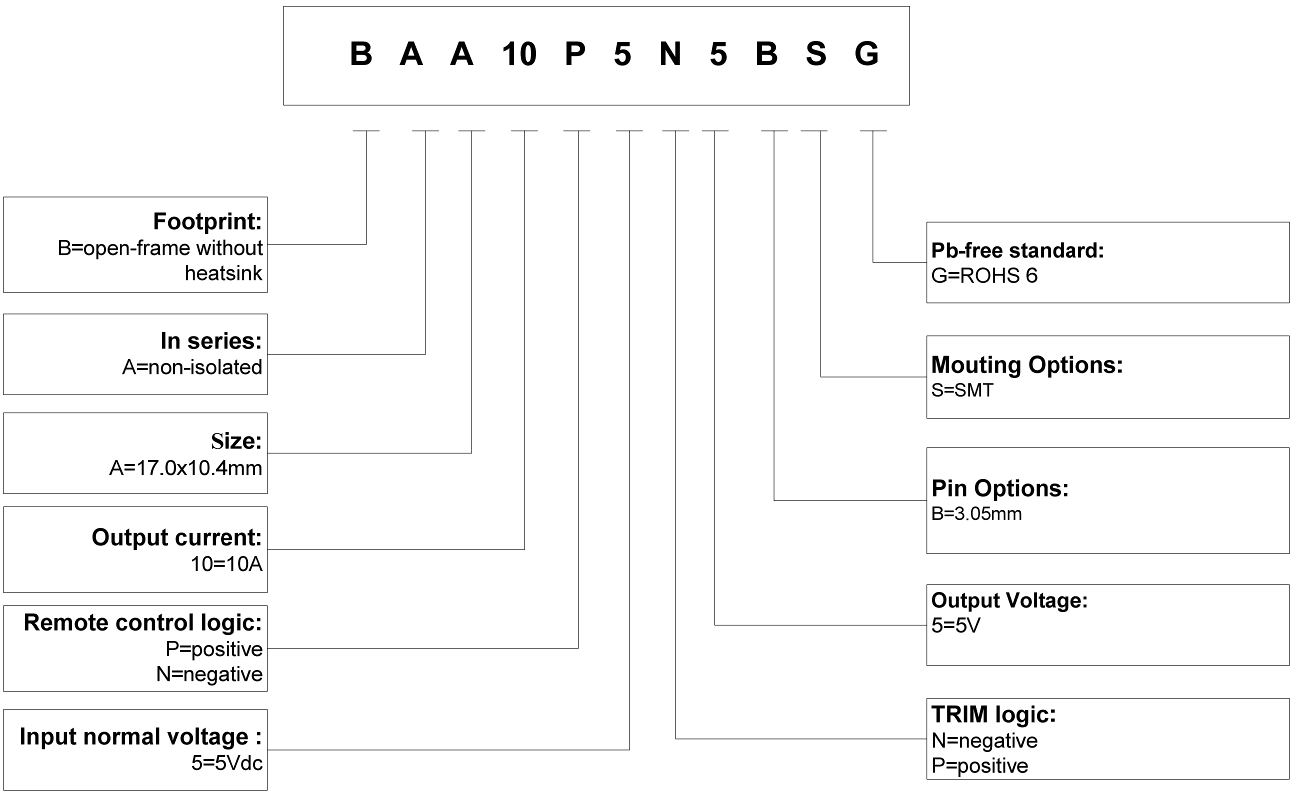
Packaging Details

The modules are supplied in tape & reel as standard.
All Dimensions are in millimeters and in inches.

ITEM	W	A0	B0	K0	P	F	E	D	P0	P2	t	13"	
DIM	32.0	10.9	17.5	10.5	20.0	14.2	1.75	1.50	4.00	2.00	0.5	Length/ tape	Capacity /tape
TOLE	+0.30 -0.30	+0.10 -0.10	+0.10 -0.10	+0.10 -0.10	+0.10 -0.10	+0.10 -0.10	+0.10 -0.10	+0.10 -0.10	+0.10 -0.10	+0.15 -0.15	+0.05 -0.05	6.5m	300pcs



Naming Rules On Models



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