Advanced Data Sheet
July, 26 2002

tyco Electronics

Austin Lynx™ SMT Non-Isolated dc-dc Power Modules: 3.0 Vdc - 5.5 Vdc Input, 0.9 Vdc - 3.3 Vdc Output, 10 A

Applications

- Workstations, Servers, and Desktop computers
- Distributed Power Architectures
- Telecommunications equipment
- Latest generation ICs (DSP, FPGA, ASIC) and Microprocessor-powered applications
- LANs/WANs
- Data processing Equipment

Options

- Remote Sense

Features

- Delivers 10A output current
- High efficiency: 94% at 3.3V output at full load
- Small size and low profile
  33 mm x 13.5 mm x 8.3 mm
  (1.3 in x 0.53 in x 0.33 in)
- Light Weight 0.23 oz (6.5 g)
- High Reliability: Calculated MTBF > 10M hours at 25 °C
- Cost-efficient open frame design
- Wide operating temperature range: –40 °C to + 85 °C
- Surface Mount Package, Tape & Reel
- Output overcurrent protection with auto-restart
- Overtemperature protection
- Constant frequency (300 kHz)
- Adjustable output voltage:
  ± 10% of V_O (–5% to + 10% for 0.9 V output)
- Remote ON/OFF
- *UL*† 60950 Recognized, *CSA*‡ 22.2 No. 60950-00 Certified, and EN60950 (*VDE* § 0805):2001-12 Licensed

† *UL* is a registered trademark of Underwriters Laboratories, Inc.
‡ *CSA* is a registered trademark of Canadian Standards Association.
§ *VDE* is a trademark of Verband Deutscher Elektrotechniker e.V.

Description

Austin Lynx™ power modules are non-isolated dc-dc converters that can deliver 10 A of output current with full load efficiency of 94% at 3.3 V output. These open frame modules in surface-mount-package enable designers to develop cost-and space efficient solutions. Standard features include remote ON/OFF, output voltage adjustment, overcurrent and overtemperature protection.

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute maximum 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 device reliability.

Parameter	Symbol	Min	Max	Unit
Input Voltage Continuous	V_{IN}	0	6.5	Vdc
Operating Ambient Temperature	T_A	–40	+85	°C
Storage Temperature	T_{stg}	–55	+125	°C

Electrical Specifications

Table 1. Input Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	V_{IN}	3.0		5.5	Vdc
Maximum Input Current (V_I = 0 to $V_{I,max}$; I_O = $I_{O,max}$)	$I_{I,max}$			9.5	A
Input Reflected-Ripple Current (5 Hz to 20 MHz; 1 µH source impedance; T_A = 25 °C; C_{IN} = 200 µF)			30		mAp-p
Input Ripple Rejection (100 - 120Hz)			40		dB

Fusing Considerations

CAUTION: This power module is not internally fused. An input line fuse must always be used.

To preserve maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a fast-acting fuse with a maximum rating of 20A.

Electrical Specifications (continued)

Table 2. Output Specifications

Parameter	Device	Symbol	Min	Typ	Max	Units
Output Voltage Set Point (V_I = 5V; $I_O = I_{O,max}$; T_A = 25 °C)	AXH010A0S0R9-SR AXH010A0S1R0-SR AXH010A0P-SR AXH010A0M-SR AXH010A0Y-SR AXH010A0D-SR AXH010A0G-SR AXH010A0F-SR	$V_{O,set}$ $V_{O,set}$ $V_{O,set}$ $V_{O,set}$ $V_{O,set}$ $V_{O,set}$ $V_{O,set}$ $V_{O,set}$	0.886 0.985 1.182 1.47 1.764 1.97 2.45 3.234	0.9 1.0 1.2 1.5 1.8 2.0 2.5 3.3	0.914 1.015 1.218 1.53 1.836 2.03 2.55 3.366	Vdc Vdc Vdc Vdc Vdc Vdc Vdc Vdc
Output Voltage (Over all Line, Load, and Temperature conditions until end of life)	AXH010A0S0R9-SR AXH010A0S1R0-SR AXH010A0P-SR AXH010A0M-SR AXH010A0Y-SR AXH010A0D-SR AXH010A0G-SR AXH010A0F-SR	V_O V_O V_O V_O V_O V_O V_O V_O	0.873 0.970 1.164 1.455 1.746 1.94 2.425 3.2	— — — — — — — —	0.927 1.03 1.236 1.545 1.854 2.06 2.575 3.4	Vdc Vdc Vdc Vdc Vdc Vdc Vdc Vdc
Output Regulation Line ($V_I = V_{I,min}$ to $V_{I,max}$) Load ($I_O = I_{O,min}$ to $I_{O,max}$) Temperature (T_A = –40 °C to +85 °C)	 All All All	 — — —	 — — —	 0.2 0.4 0.5		 %$V_{O, set}$ %$V_{O, set}$ %$V_{O, set}$
Output Ripple & Noise C_{out} = 10 µF Tantalum, 1 µF Ceramic RMS Peak-to-Peak (5 Hz to 20 MHz)	 All All	 — —	 — —	 7 25	 15 30	 mVrms mVp-p
Output Current	All	I_O		—	10	A
Output Current Limit Inception (V_O = 90% $V_{O,set}$)	 All	 I_O		 17		 A
Output Short Circuit Current (average)	All	I_O		3		A
Efficiency (V_I = 5V; $I_O = I_{O,max}$; T_A = 25°C)	AXH010A0S0R9-SR AXH010A0S1R0-SR AXH010A0P-SR AXH010A0M-SR AXH010A0Y-SR AXH010A0D-SR AXH010A0G-SR AXH010A0F-SR	η η η η η η η η		81 83 85 87 89 89 91 94		% % % % % % % %
Switching Frequency	All	f_{sw}	—	300	—	kHz

General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (I_O = 100% of $I_{O, max}$; T_A = 25 °C)		10,240,000		hours
Weight		5.5 (0.19)	6.5 (0.23)	g (oz.)

Solder Ball and Cleanliness Requirements

This open frame (no case or potting) module will meet the solder ball requirements per J-STD-001B. These requirements state that solder balls must neither be loose nor violate the power module minimum electrical spacing. The cleanliness designator of the open frame module is C00 (per J specification).

Feature Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions. See Feature Descriptions and Design Considerations sections for further information.

Parameter	Device	Symbol	Min	Typ	Max	Unit
Remote On/Off Signal Interface (V_I = 3.0 V to 5.5 V; open collector npn transistor or equivalent compatible; signal referenced to GND terminal; see Figure 20 and Feature Descriptions section)						
(ON/OFF pin open)—Module On:						
$I_{on/off}$ = 0.0 µA						
$V_{on/off}$ = V_{IN}	All	$I_{on/off}$			50	µA
(ON/OFF < 0.8 V)—Module Off:						
$I_{on/off}$ = 0.5 mA	All	$V_{on/off}$			6.5	V
$V_{on/off}$ = 0.8 V	All	$I_{on/off}$			1	mA
Turn-on Time (I_O = 80% of $I_{O, max}$; V_O within ±1% of steady state; see Figure 12)	All	—		5		ms
Output Voltage Set-point Adjustment Range	AXH010A0S0R99-SR	V_{trim}	–5		+10	%$V_{O, set}$
	All others	V_{trim}	–10		+10	%$V_{O, set}$
Overtemperature Protection (shutdown)	All	T_{Q1} / T_{Q2}	—	110	125	°C

Characteristic Curves

Following figures provide typical characteristics curves at room temperature (T_A = 25 °C)

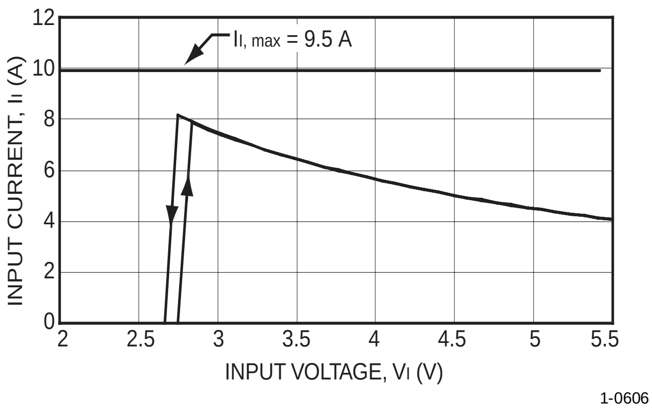


Figure 1. Typical Input Characteristic at 10 A Output Current

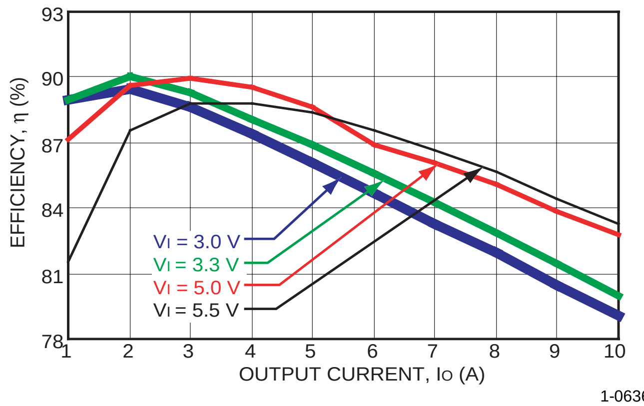


Figure 4. Converter Efficiency vs. Output Current AXH010A0S1R0-SR (1.0 V Output Voltage)

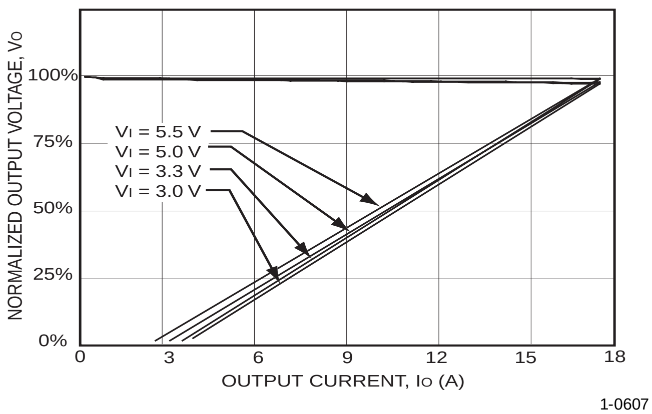


Figure 2. Output Voltage and current Characteristics

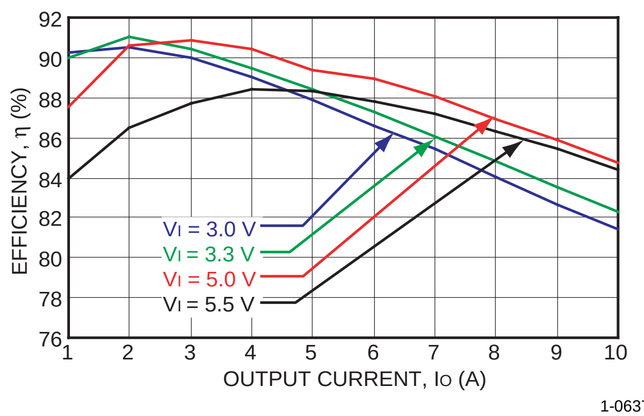


Figure 5. Converter Efficiency vs. Output Current AXH010A0P-SR (1.2 V Output Voltage)

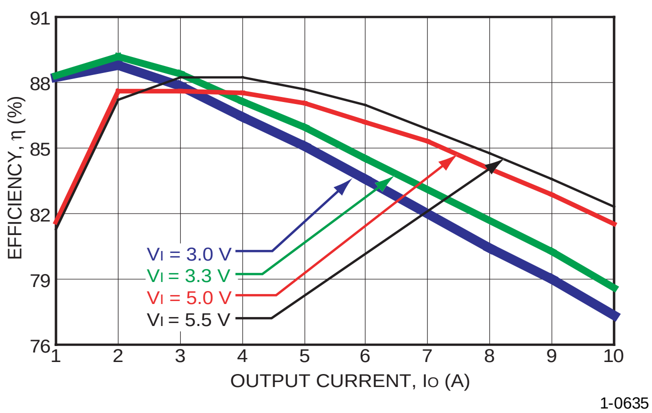


Figure 3. Converter Efficiency vs. Output Current AXH010A0S0R9-SR (0.9 V Output Voltage)

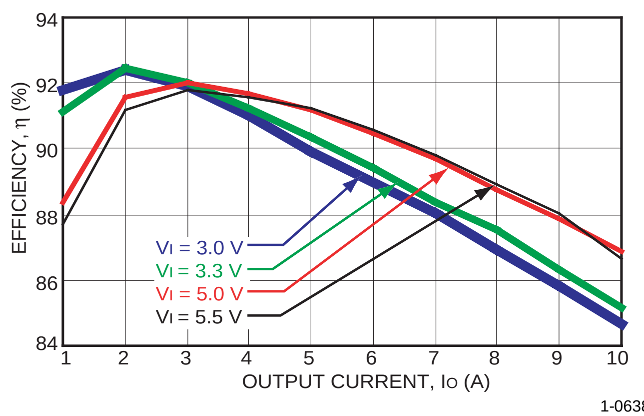


Figure 6. Converter Efficiency vs. Output Current AXH010A0M-SR (1.5 V Output Voltage)

Characteristic Curves (continued)

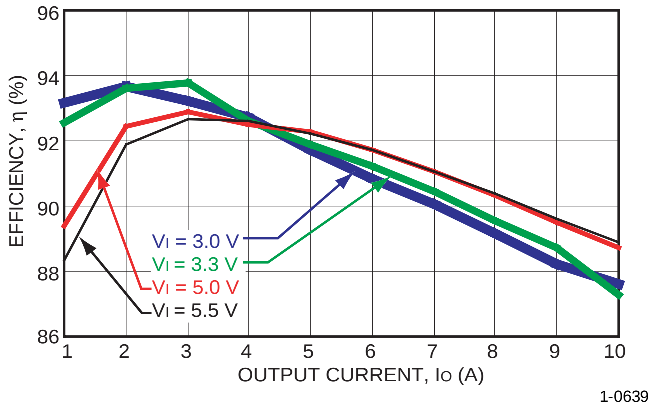


Figure 7. Converter Efficiency vs. Output Current AXH010A0Y-SR (1.8 V Output Voltage)

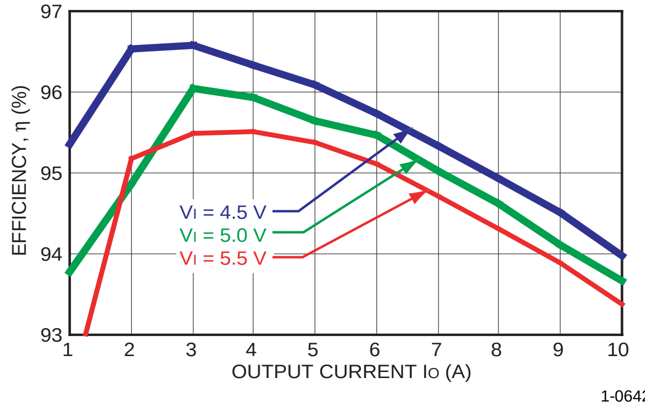


Figure 10. Converter Efficiency vs. Output Current AXH010A0F-SR (3.3 V Output Voltage)

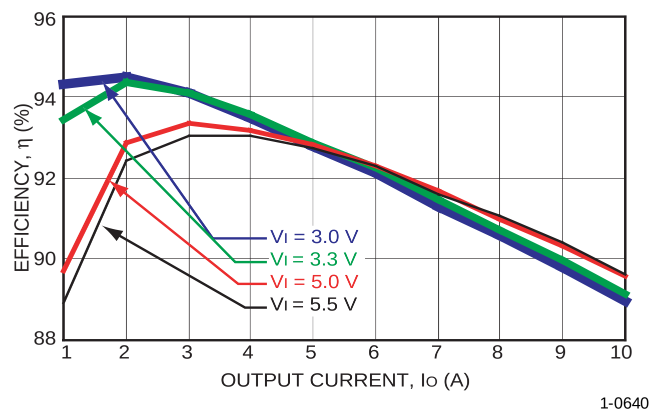


Figure 8. Converter Efficiency vs. Output Current AXH010A0D-SR (2.0 V Output Voltage)

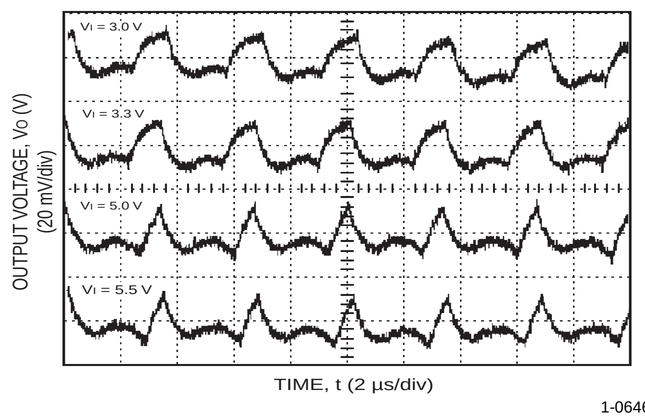


Figure 11. Typical Output Ripple Voltage at 10 A Output Current

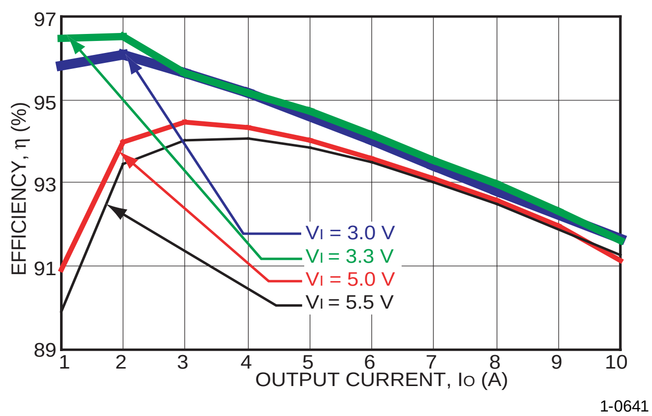


Figure 9. Converter Efficiency vs. Output Current AXH010A0G-SR (2.5 V Output Voltage)

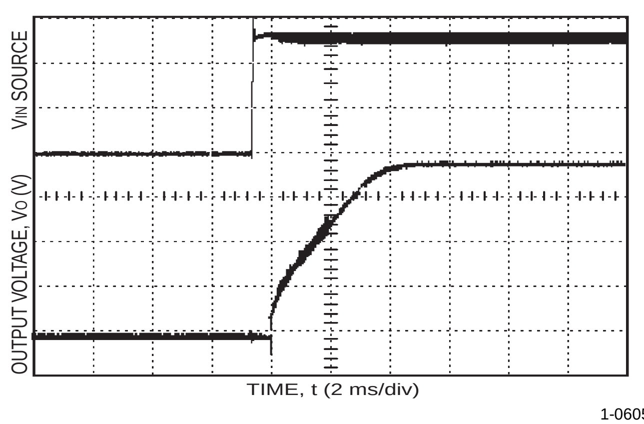


Figure 12. Typical Start-Up Transient

Characteristic Curves (continued)

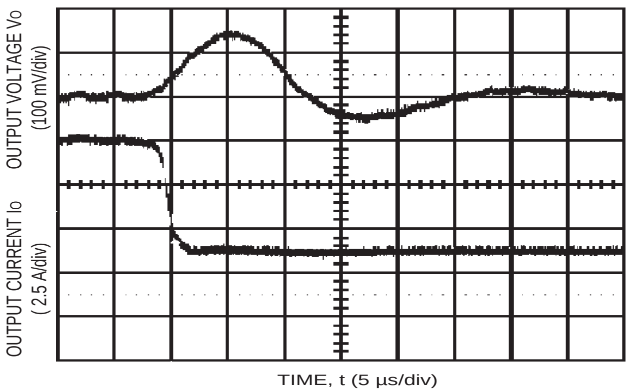


Figure 13. Typical Transient Response to Step Load Change at 2.5 A/µs from 100% to 50% of $I_{O,max}$ at 3.3 V Input (C_{OUT} = 1 µF ceramic, 10 µF Tantalum)

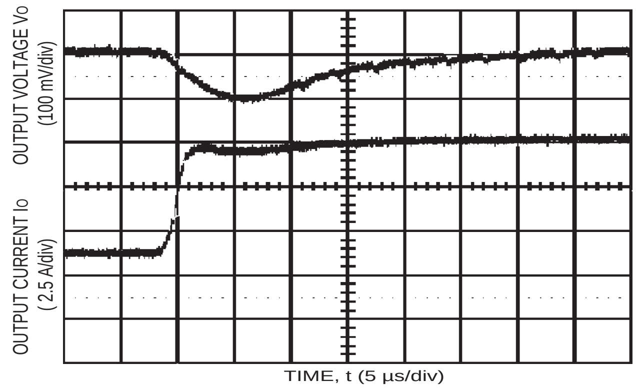
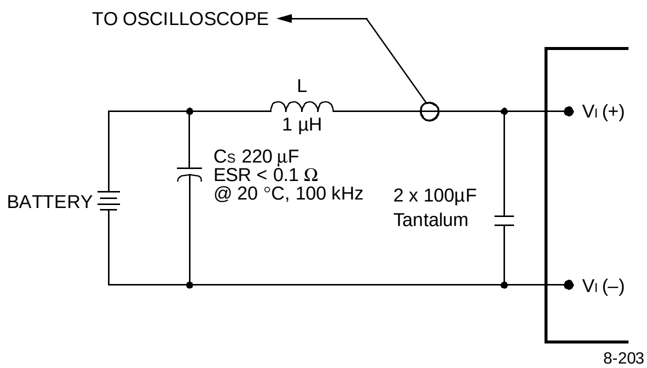


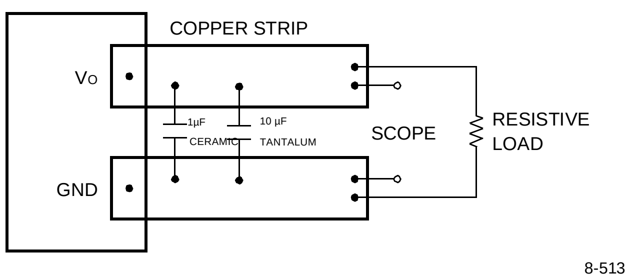
Figure 14. Typical Transient Response to Step Load Change at 2.5 A/µs from 50% to 100% of $I_{O,max}$ at 3.3 V Input (C_{OUT} = 1 µF ceramic, 10 µF Tantalum)

Test Configurations



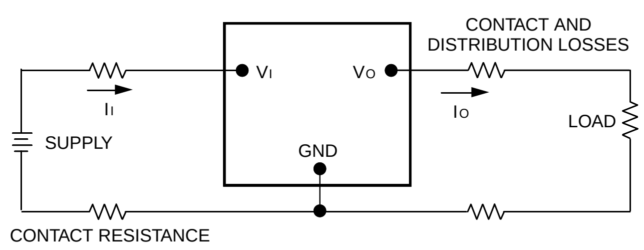
Note: Input reflected-ripple current is measured with a simulated source inductance of 1µH. Capacitor Cs offsets possible battery impedance. Current is measured at the input of the module.

Figure 15. Input Reflected-Ripple Test Setup



Note: Use a 10 µF tantalum and a 1 µF capacitor. Scope measurement should be made using a BNC socket. Position the load between 51 mm and 76 mm (2 in. and 3 in.) from the module.

Figure 16. Peak-to-Peak Output Noise and Startup Transient Measurement Test Setup



Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

$$\eta = \left(\frac{V_O \times I_O}{V_I \times I_I}\right) \times 100 \quad \%$$

Figure 17. Output Voltage and Efficiency Measurement Test Setup

Design Considerations

Input Source Impedance

To maintain low-noise and ripple at the input voltage, it is critical to use low ESR capacitors at the input to the module. Figure 18 shows the input ripple voltage (mVp-p) for various output models using a 150 µF low ESR polymer capacitor (Panasonic p/n: EEFUE0J151R, Sanyo p/n: 6TPE150M) in parallel with 47 µF ceramic capacitor (Panasonic p/n: ECJ-5YB0J476M, Taiyo Yuden p/n: CEJMK432BJ476MMT). Figure 19 depicts much lower input voltage ripple when input capacitance is increased to 450 µF (3 x 150 µF) polymer capacitors in parallel with 94 µF (2 x 47 µF) ceramic capacitor.

The input capacitance should be able to handle an AC ripple current of at least:

$$I_{rms} = I_{out}\sqrt{\frac{V_{out}}{V_{in}}\left[1 - \frac{V_{out}}{V_{in}}\right]} \qquad A_{rms}$$

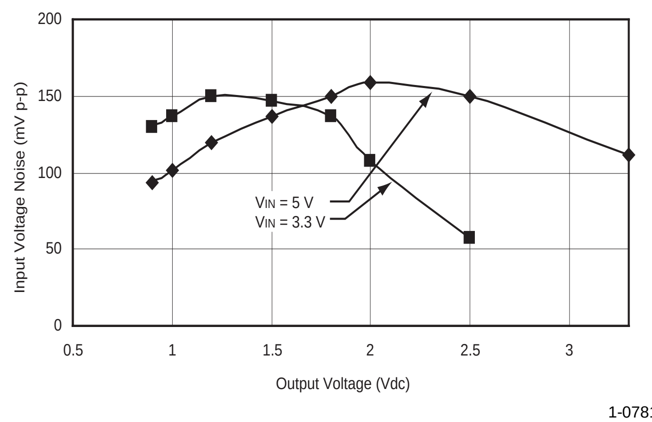


Figure 18. Input Voltage Ripple for Various Output Models, IO = 10 A (CIN = 150 µF polymer // 47 µF ceramic)

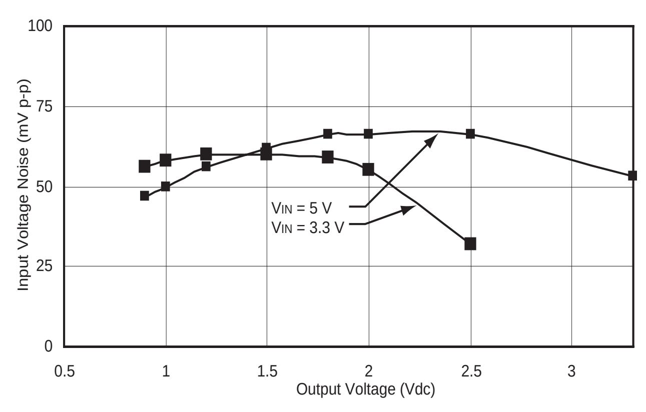


Figure 19. Input Voltage Ripple for Various Output Models, IO = 10 A (CIN = 3x150 µF polymer // 2x47 µF ceramic)

Design Considerations (continued)

Input Source Impedance (continued)

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the module. An input capacitance must be placed close to the input pins of the module, to filter ripple current and ensure module stability in the presence of inductive traces that supply the input voltage to the module.

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 standard, i.e., *UL* 60950, *CSA* C22.2 No. 60950-00, EN60950 (*VDE* 0805):2001-12.

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 maximum 20 A fast-acting fuse in the ungrounded lead.

Feature Descriptions

Remote On/Off

The Austin Lynx™ SMT power module features an ON/OFF control pin for remote on/off operation. To switch the module on and off, connect an open collector npn transistor between the ON/OFF pin and the GND pin (see Figure 20).

The module is enabled when the ON/OFF pin is left open or the transistor is off (in the open collector state). The maximum allowable leakage current of the transistor when $V_{on/off}$ = 0.3 V and V_{IN} = 5.5 V is 50 µA. The module is disabled when the ON/OFF pin is pulled low or the transistor is active.

See Feature Specifications (Remote ON/OFF Signal Interface) and Figure 20 for details.

If not using the ON/OFF feature, leave the ON/OFF control pin open.

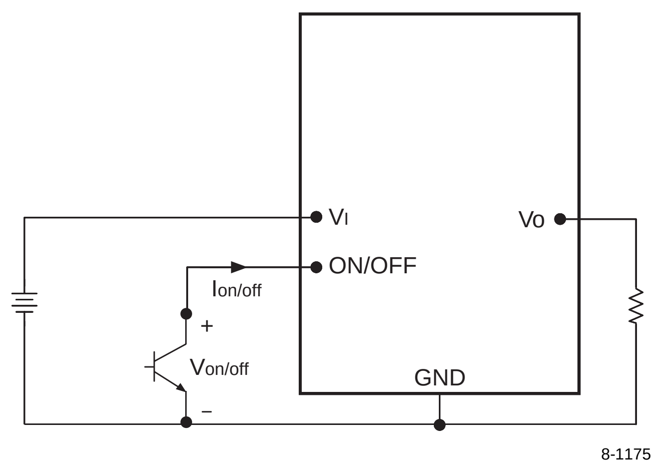


Figure 20. Remote On/Off Implementation

Output Voltage Set-Point Adjustment (Trim)

Output voltage set-point adjustment allows the output voltage set point to be increased or decreased by connecting either an external resistor or a voltage source between the TRIM pin and either the V_O pin (decrease output voltage) or GND pin (increase output voltage).

Feature Descriptions (continued)

Output Voltage Set-Point Adjustment (Trim) (continued)

For TRIM-UP using an external resistor, connect $R_{trim-up}$ between the TRIM and GND pins (Figure 21). The value of $R_{trim-up}$ defined as:

$$R_{trim-up} = \frac{24080}{\Delta V_{out}} - R_{buffer} \quad \Omega$$

ΔV_{out} is the desired output voltage set-point adjustment
R_{buffer} is defined in Table 3 for various models

Table 3. Austin Lynx™ Trim Values

$V_{O,\ set}$	R_{buffer}
3.3 V	59 kΩ
2.5 V	78.7 kΩ
2.0 V	100 kΩ
1.8 V	100 kΩ
1.5 V	100 kΩ
1.2 V	59 kΩ
1.0 V	30.1 kΩ
0.9 V	5.11 kΩ

Note: $V_{O,\ set}$ is the typical output voltage for the unit.

For example, to trim-up the output voltage of 1.5V module (AXH010A0M-SR) by 8% to 1.62V, $R_{trim-up}$ is calculated as follows:

$$\Delta V_{out} = 0.12V$$

$$R_{buffer} = 100k\Omega$$

$$R_{trim-up} = \frac{24080}{0.12} - 100k$$

$$R_{trim-up} = 100.66k$$

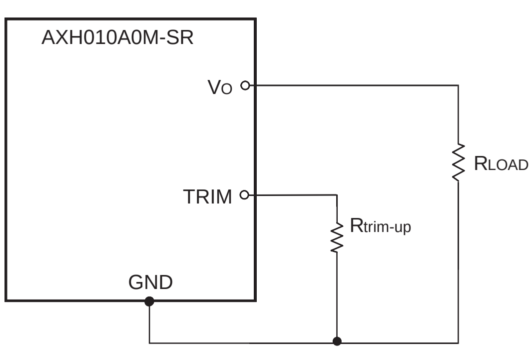


Figure 21. Circuit Configuration to trim-up output voltage

For trim-down using an external resistor, connect $R_{trim-down}$ between the TRIM and V_{OUT} pins of the module (Figure 22). The value of $R_{trim-down}$ is defined as:

$$R_{trim-down} = \left[\left(\frac{V_{out} - 0.8}{\Delta V_{out}} - 1\right) x30100\right] - R_{buffer} \quad \Omega$$

V_{out} is the typical set point voltage of a module
ΔV_{out} is the desired output voltage adjustment
R_{buffer} defined is Table 3 for various models.

For example, to trim-down the output voltage of 2.5 V module (AXH010G-SR) by 8% to 2.3V, $R_{trim-down}$ is calculated as follows:

$$\Delta V_{out} = 0.2V$$

$$V_{out} = 2.5V$$

$$R_{buffer} = 78.7k$$

$$R_{trim-down} = \left[\left(\frac{2.5 - 0.8}{0.2} - 1\right) x30100\right] - 78700$$

$$R_{trim-down} = 147.05k\Omega$$

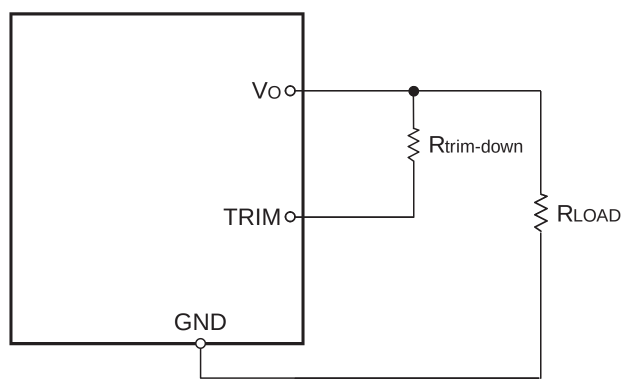


Figure 22. Circuit Configuration to trim-down output voltage

For Trim-up using an external voltage source, apply a voltage from TRIM pin to ground using the following equation:

$$V_{trim-up} = 0.8 - \left[\Delta V_{out} x \frac{R_{buffer}}{30100}\right]$$

Feature Descriptions (continued)

Output Voltage Set-Point Adjustment (Trim) (continued)

For Trim-down using an external voltage source, apply a voltage from TRIM pin to ground using the following equation:

$$V_{trim\text{-}down} = 0.8 - \left[\Delta V_{out} x \frac{R_{buffer}}{30100}\right]$$

$V_{trim\text{-}up}$ is the external source voltage for trim-up
$V_{trim\text{-}down}$ is the external source voltage for trim-down
ΔV_{out} is the desired output voltage set-point adjustment
R_{buffer} is defined in Table 3 for various models

If the TRIM feature is not being used, leave the TRIM pin disconnected.

Remote Sense

Austin Lynx™ SMT power modules offer an option for a Remote-Sense function. When the Device Code description includes a suffix “3”, pin 3 is added to the module and the Remote-Sense is an active feature. See the Ordering Information at the end of this document for more information.

Remote-Sense minimizes the effects of distribution losses by regulating the voltage at the load via the SENSE and GND connections (See Figure 23). The voltage between the SENSE pin and V_O pin must not exceed 0.5V. Although both the Remote-Sense and Trim features can each increase the output voltage (V_O), the maximum increase is not the sum of both. The maximum V_O increase is the larger of either the Remote-Sense or the Trim.

The amount of power delivered by the module is defined as the output voltage multiplied by the output current (V_O x I_O). When using SENSE and/or TRIM, the output voltage of the module can increase which, if the same output current is maintained, increases the power output by the module. Make sure that the maximum output power of the module remains at or below the maximum rated power. When pin 3 is present but the Remote-Sense feature is not being used connect SENSE to V_O at the module to regulate the output voltage at the load.

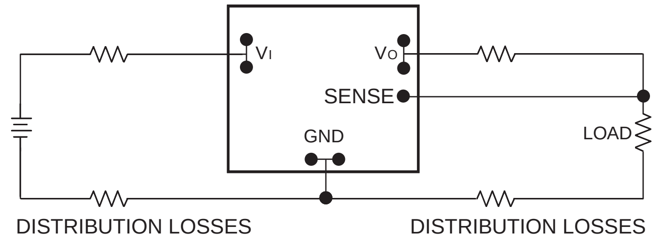


Figure 23. Effective Circuit Configuration for Remote-Sense Operation

Overcurrent Protection

To provide protection in a fault condition, the unit is equipped with internal overcurrent protection. The unit operates normally once the fault condition is removed.

The power module will supply up to 170% of rated current for less than 1.25 seconds before it enters thermal shutdown.

Overtemperature Protection

To provide additional protection in a fault condition, the unit is equipped with a nonlatched thermal shutdown circuit. The shutdown circuit engages when Q1 or Q2 (shown in Figure 24) exceeds approximately 110 °C. The unit attempts to restart when Q1 or Q2 cool down and cycles on and off while the fault condition exists. Recovery from shutdown is accomplished when the cause of the overtemperature condition is removed.

Thermal Considerations

The power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment.

The thermal data presented is based on measurements taken in a wind tunnel. The test setup shown in Figure 25 was used to collect data for Figures 26 and 27. Note that the airflow is parallel to the short axis of the module as shown in Figure 24. The derating data applies to airflow along either direction of the module's short axis.

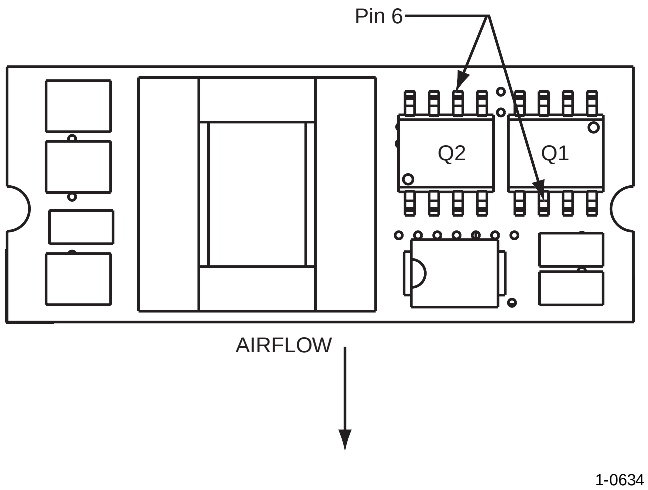


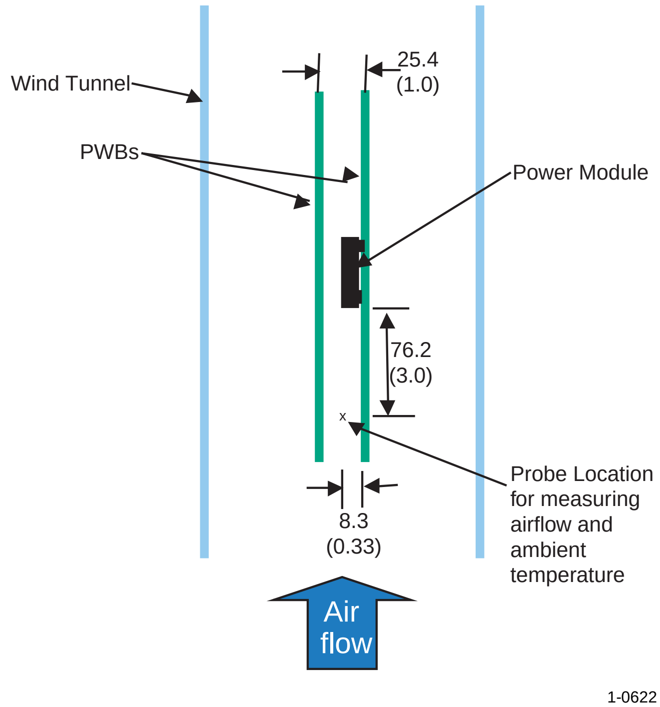
Figure 24. Temperature Measurement Location

The temperature at either location should not exceed 110 °C. The output power of the module should not exceed the rated power for the module ($V_{O,\,set}$ x $I_{O,\,max}$).

Convection Requirements for Cooling

To predict the approximate cooling needed for the module, refer to the Power Derating curves in Figures 26 and 27.

These derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be checked as shown in Figure 24 to ensure it does not exceed 110 °C.



Note: Dimensions are in millimeters and (inches).

Figure 25. Thermal Test Setup

Proper cooling can be verified by measuring the power module's temperature at Q1-pin 6 and Q2-pin 6 as shown in Figure 24.

Thermal Considerations (continued)

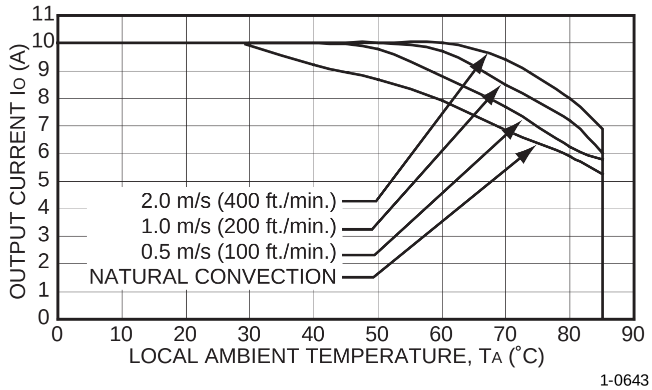


Figure 26. Typical Power Derating vs. Output Current for 3.3 V_{IN}

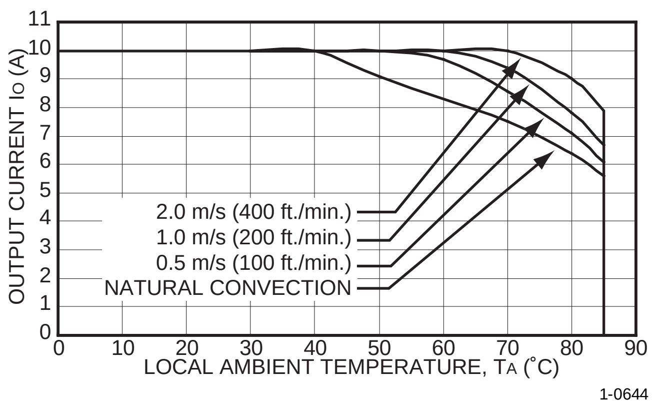


Figure 27. Typical Power Derating vs. Output Current for 5.0 V_{IN}

Layout Considerations

Copper paths should not be routed directly underneath the module.

Reflow Profile

An example of a reflow profile (using 63/37 solder) for the Austin Lynx™ SMT Power Module is:

- Pre-heating zone: room temperature to 183 °C (2.0 to 4.0 minutes maximum)
- Initial ramp rate: < 2.5 °C per second
- Soaking zone: 155 °C to 183 °C – 60 to 90 seconds typical (2.0 minutes maximum)
- Reflow zone ramp rate: 1.3 °C to 1.6 °C per second
- Reflow zone: 210 °C to 235 °C peak temperature – 30 to 60 seconds typical (90 seconds maximum)

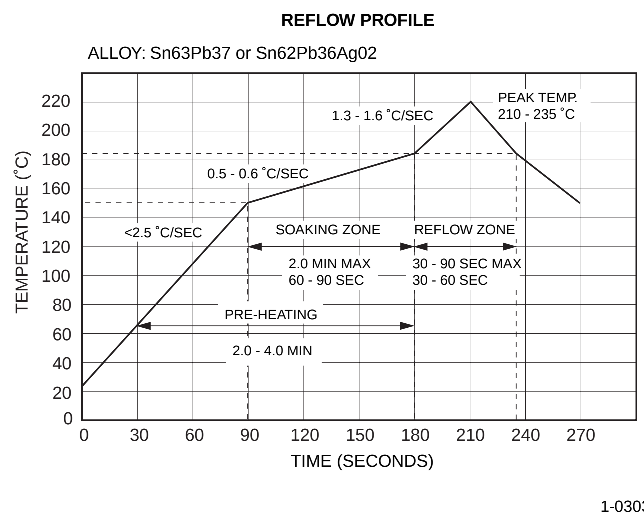


Figure 28. Reflow Profile

Pick and Place Location

Although the module weight is minimized by using open-frame construction, the modules have a relatively large mass compared to conventional surface-mount components. To optimize the pick-and-place process, automated vacuum equipment variables such as nozzle size, tip style, vacuum pressure, and placement speed should be considered. Austin Lynx™ SMT modules have a flat surface which serves as a pick-and-place location for automated vacuum equipment. The module’s pick-and-place location is identified by the target symbol on the top label as shown in Figure 29.

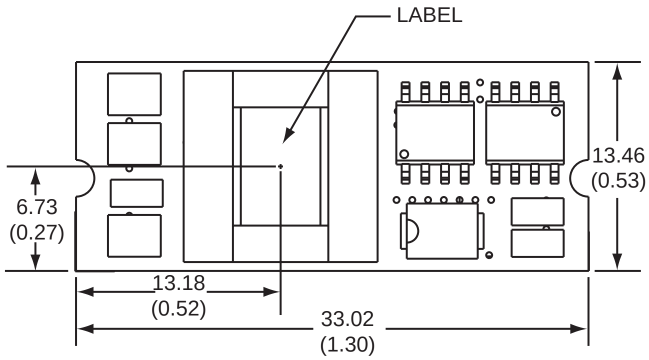


Figure 29. Pick and Place Location

Surface-Mount Tape & Reel

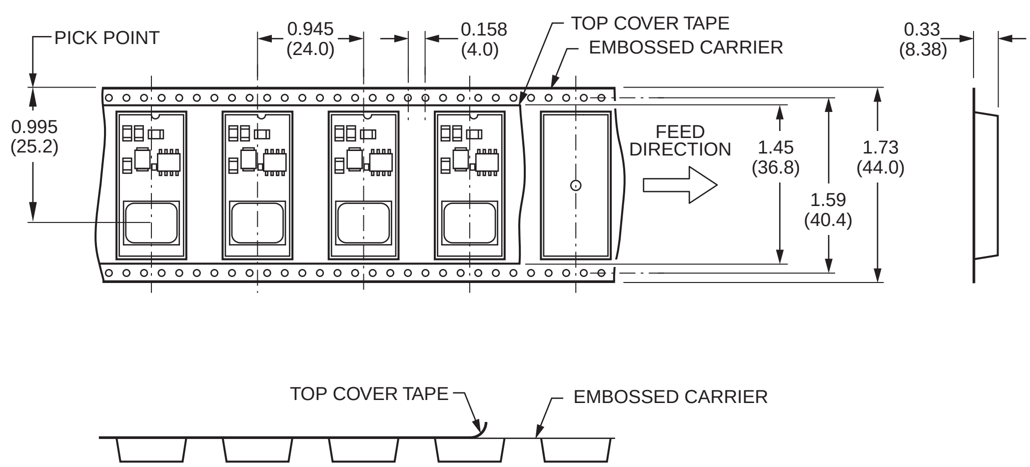
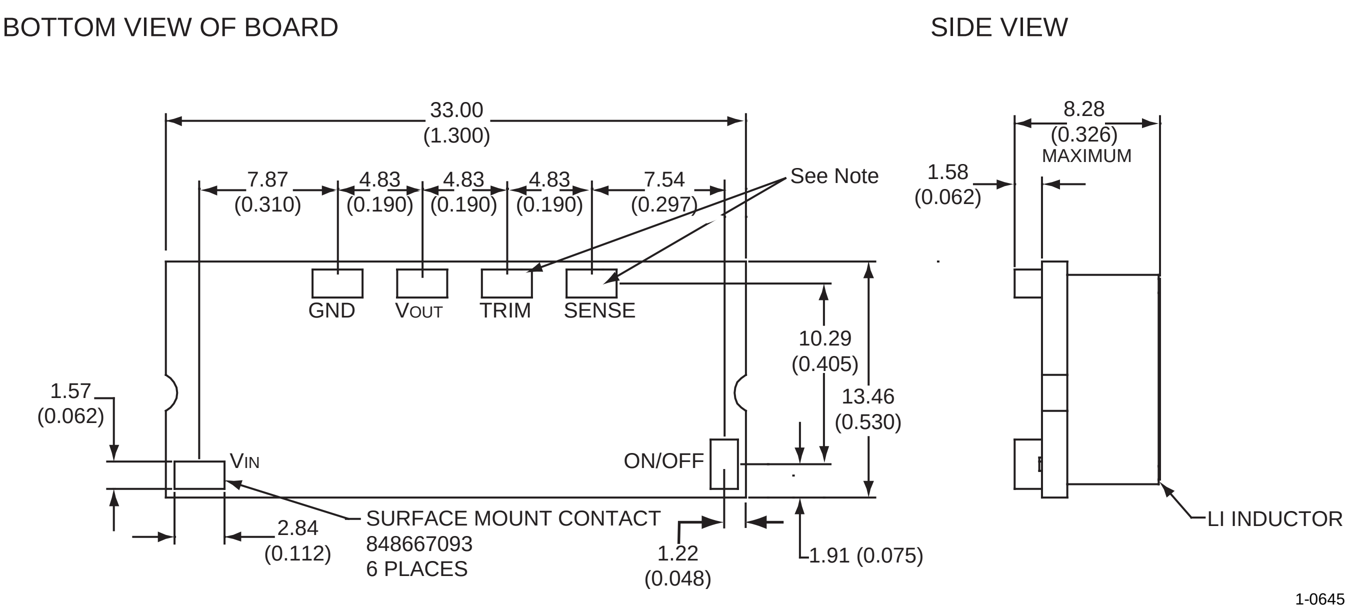


Figure 30. Tape Dimensions

Mechanical Outline Diagram

Dimensions are in millimeters and (inches).

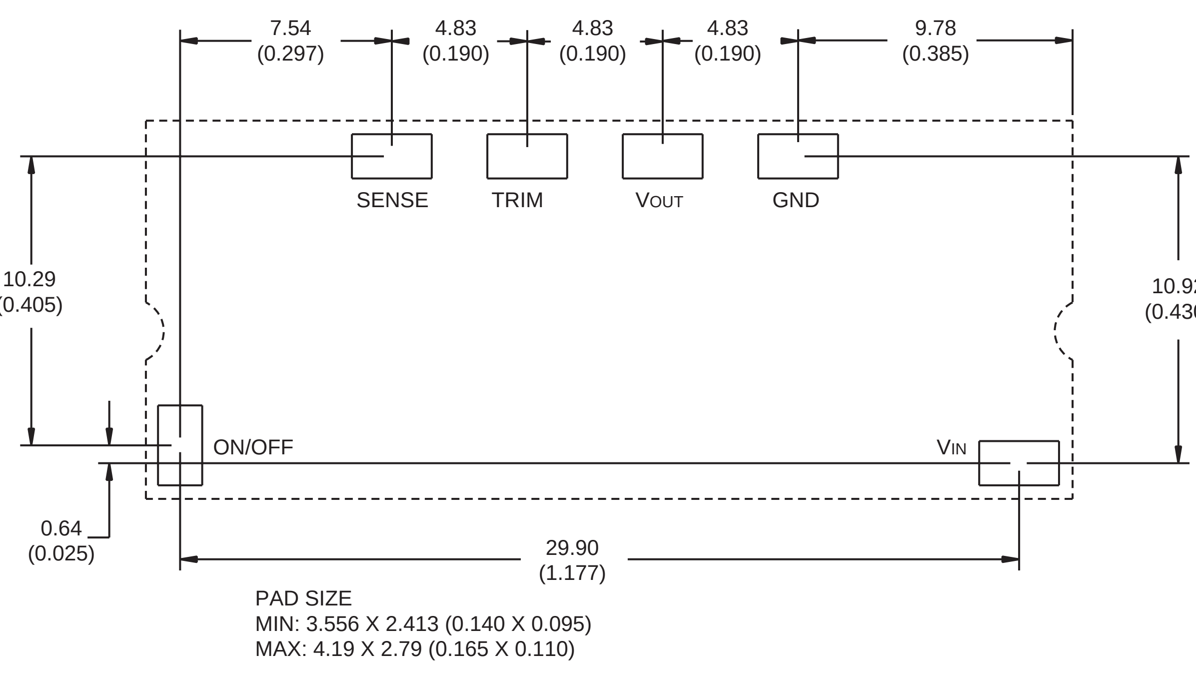
Tolerances: x.x ± 0.5 mm (0.02 in.), x.xx ± 0.25 mm (0.010 in.), unless otherwise noted.



Note: Sense Pin and Trim Pin are custumer specified options.

Recommended Pad Layout

Dimensions are in millimeters and (inches).



Ordering Information

Please contact your Tyco Electronics' Account Manager or Field Application Engineer for pricing and availability.

Table 4. Device Codes with TRIM

Device Code	Input Voltage	Output Voltage(s)	Output Current	Efficiency	Connector Type	Comcodes
AXH010A0S0R99-SR	3.0 - 5.5	0.9 V	10 A	81%	SMT	108966177
AXH010A0S1R09-SR	3.0 - 5.5	1.0 V	10 A	83%	SMT	108966110
AXH010A0P9-SR	3.0 - 5.5	1.2 V	10 A	85%	SMT	108966144
AXH010A0M9-SR	3.0 - 5.5	1.5 V	10 A	87%	SMT	108966136
AXH010A0Y9-SR	3.0 - 5.5	1.8 V	10 A	89%	SMT	108966169
AXH010A0D9-SR	3.0 - 5.5	2.0 V	10 A	89%	SMT	108966102
AXH010A0G9-SR	3.0 - 5.5	2.5 V	10 A	91%	SMT	108966128
AXH010A0F9-SR	4.5 - 5.5	3.3 V	10 A	94%	SMT	108966094

Table 5. Device Codes without TRIM*

Device Code	Input Voltage	Output Voltage(s)	Output Current	Efficiency	Connector Type	Comcodes
AXH010A0S0R9-SR	3.0 - 5.5	0.9 V	10 A	81%	SMT	108967597
AXH010A0S1R0-SR	3.0 - 5.5	1.0 V	10 A	83%	SMT	108967605
AXH010A0P-SR	3.0 - 5.5	1.2 V	10 A	85%	SMT	108967571
AXH010A0M-SR	3.0 - 5.5	1.5 V	10 A	87%	SMT	108967563
AXH010A0Y-SR	3.0 - 5.5	1.8 V	10 A	89%	SMT	108967589
AXH010A0D-SR	3.0 - 5.5	2.0 V	10 A	89%	SMT	108967530
AXH010A0G-SR	3.0 - 5.5	2.5 V	10 A	91%	SMT	108967555
AXH010A0F-SR	4.5 - 5.5	3.3 V	10 A	94%	SMT	108967548

Optional remote sense feature can be ordered using suffix 3 shown in Table 6. For example, a AXH010A0Y-SR with remote sense is AXH010A0Y3-SR

Table 6. Options

Option	Suffix
Remote Sense	3

tyco / Electronics

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