

Description

The AP3125B is a current mode PWM controller which is optimized for high-performance, low standby power and cost-effective offline flyback converters.

The PWM switching frequency at normal operation is internally fixed (about 65kHz). In middle load, the IC will enter green mode to improve system efficiency with the help of frequency foldback. A minimum switching frequency (about 20kHz) is set to avoid the audible noise. In no load or light load, the IC will enter the burst mode to minimize standby power. Furthermore, the frequency dithering function is built-in to reduce EMI emission.

Internal slope compensation allows more stable Peak-Current Mode control over wide range of input voltage and load conditions. Internal line compensation ensures constant output power limit over entire universal line voltage range.

Comprehensive protection features are included, such as cycle-by-cycle current limit (OCP), VCC Overvoltage Protection (VOVP), internal OTP, Overload Protection (OLP) and pins' fault protection. Built-in Brownout (BNO) and Line Overvoltage Protection (LOVP) are also integrated in the AP3125B.

Features

- Very Low Startup Current
- Current Mode Control
- Non-Audible-Noise Green-Mode Control
- Internal Slope Compensation
- Soft Start During Startup Process
- Frequency Foldback for High Average Efficiency
- Secondary Winding Short Protection with FOCP
- Soft Switching for Reducing EMI
- VCC Maintain Mode
- Brownout Protection (BNO)
- Line Overvoltage Protection (LOVP)
- Useful Pin Fault Protection:
 - SENSE Pin Floating
 - SENSE Pin Short to Ground
 - FB/Optocoupler Open/Short
- Comprehensive System Protection Feature:
 - VCC Overvoltage Protection (VOVP)
 - Overload Protection (OLP)
- Mini Size with Packages
- Pin to Pin Compatible with AP3105NA/NV/NL/NR
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](#) or your local Diodes representative.**

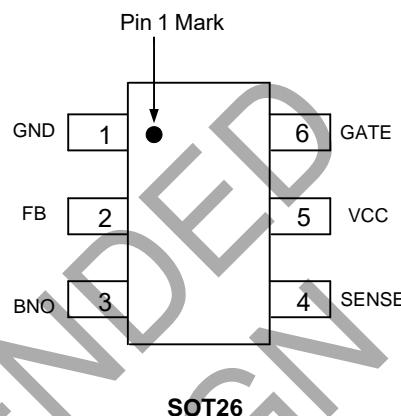
<https://www.diodes.com/quality/product-definitions/>

Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Assignments

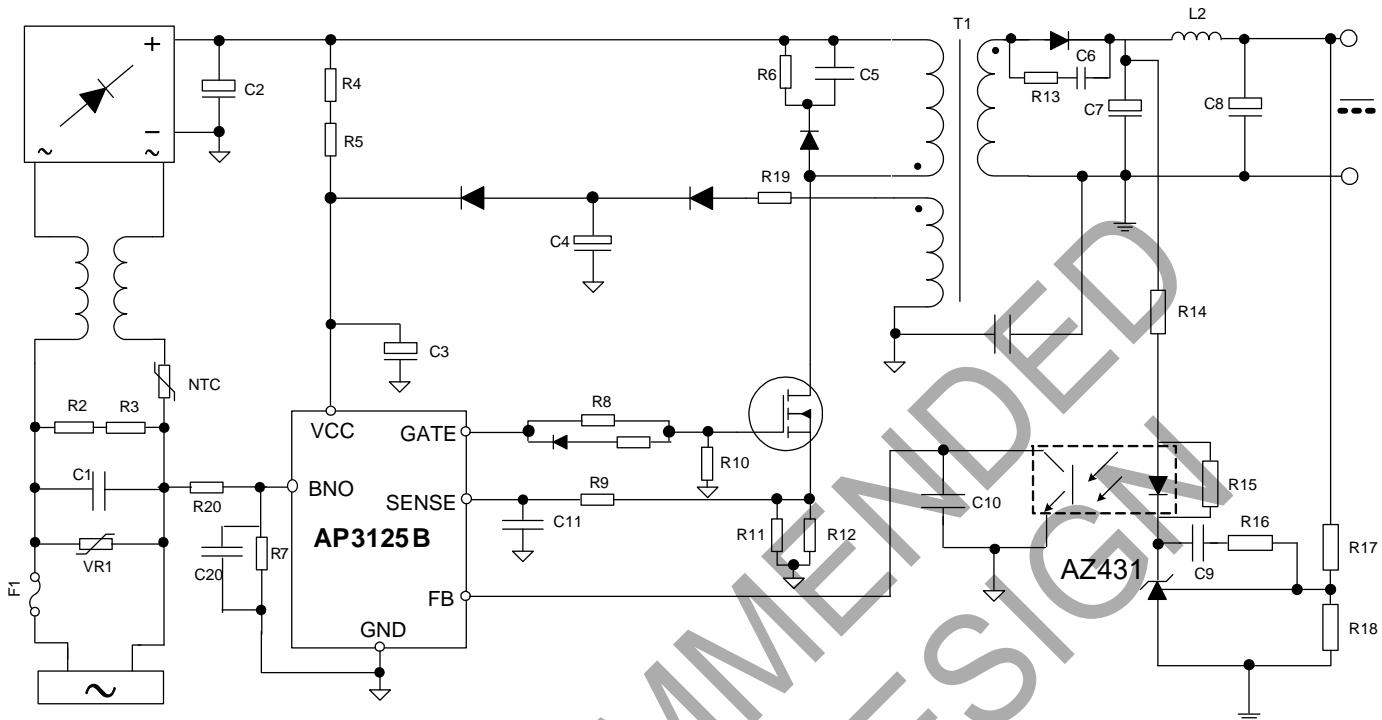
(Top View)



Applications

- Switching AC-DC adapters/chargers
- ATX/BTX auxiliary power
- Set-top box (STB) power supplies
- Open frame switching power supplies

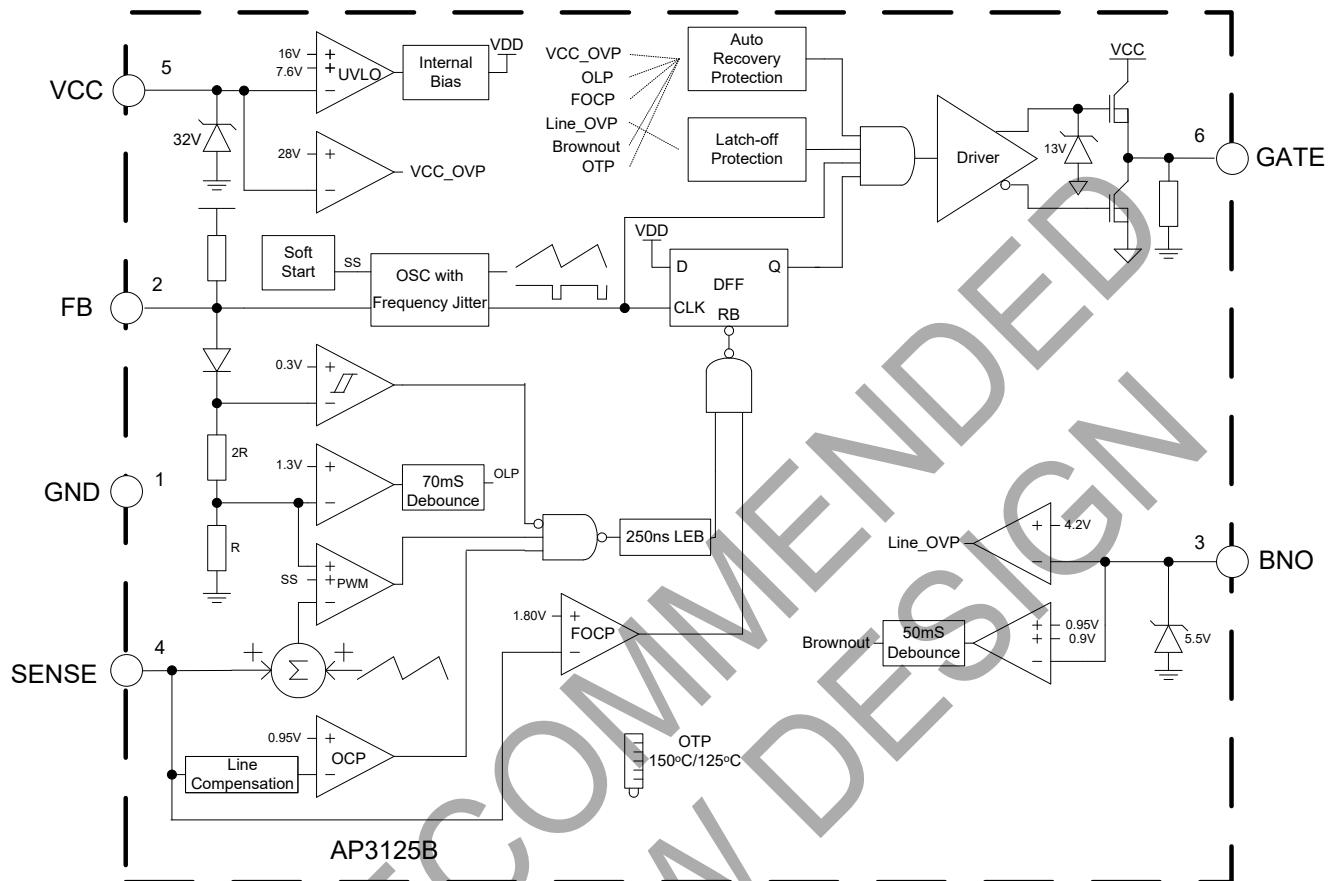
Typical Applications Circuit



Pin Descriptions

Pin Number	Pin Name	Function
1	GND	Signal Ground. Current return for driver and control circuits
2	FB	Feedback. Directly connected to the opto-coupler
3	BNO	Control Brownout Protection
4	SENSE	Current Sense
5	VCC	Supply Voltage of Driver and Control Circuits
6	GATE	Gate Driver Output

Functional Block Diagram



Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating	Unit
V _{CC}	Power Supply Voltage	30	V
I _O	Gate Output Current	350	mA
V _{FB} , V _{SENSE} , V _{BNO}	Input Voltage to FB, SENSE, BNO	-0.3 to 7	V
θ _{JA}	Thermal Resistance (Junction to Ambient)	250	°C/W
P _D	Power Dissipation at T _A < +25°C	500	mW
T _J	Operating Junction Temperature	-40 to +150	°C
T _{TSG}	Storage Temperature Range	+150	°C
—	ESD (Human Body Model)	3000	V
—	ESD (Machine Model)	300	V

Note: 4. Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V _{CC}	Supply Voltage	10	25	V

Electrical Characteristics (@ $T_A = +25^\circ\text{C}$, $V_{CC} = 16\text{V}$, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply Voltage (VCC Pin)						
I _{STARTUP}	Startup Current	—	—	1	10	µA
I _{CC}	Operating Supply Current	$V_{FB} = 0, C_L = 1\text{nF}$	0.5	0.7	1	mA
		$V_{FB} = 3\text{V}, C_L = 0$	0.6	1.2	2.0	
—	U _{VLLO} (on)	—	14.5	15.8	16.5	V
—	V _{CC} Maintain	—	8.6	9.1	9.6	V
—	U _{VLLO} (off)	—	7.1	7.6	8.1	V
—	V _{CC} OVP	—	27	28.5	30	V
—	V _{CC} Clamp	I _{CC} = 5mA	31	34	—	V
PWM Section/Oscillator Section						
—	Maximum Duty Cycle	—	70	75	80	%
—	Oscillation Frequency	—	60	65	70	kHz
—	Green Mode Frequency	—	20	—	30	kHz
—	Frequency Temperature Stability	-20°C to +125°C (Note 5)	—	—	5	%
—	Frequency Voltage Stability	V _{CC} = 12V to 30V	—	—	3	%
—	Frequency Dithering	—	±4	±6	±8	%
Current Sense Section (SENSE Pin)						
V _{CS}	Maximum SENSE Voltage	$V_{FB} = 4.5\text{V}$	0.9	0.95	1	V
—	FOCP Voltage	—	1.5	1.7	1.9	V
—	SENSE Shorted Protection Threshold	—	—	0.1	—	V
—	LEB Time of SENSE	—	150	250	350	ns
—	Delay to Output (Note 5)	—	—	100	—	ns
—	Soft-Start Time	—	3	5	8	ms
Feedback Input Section (FB Pin)						
—	The Ratio of Input Voltage to Current Sense Voltage	—	2.5	3	3.5	V/V
—	Input Impedance	—	12	15	18	kΩ
—	Source Current	$V_{FB} = 0$	-0.2	-0.27	-0.34	mA
—	Green Mode Threshold	—	—	2.1	—	V
—	Input Voltage for Zero Duty	—	1.3	1.55	1.8	V
Output Section (GATE Pin)						
—	Output Low Level	$I_O = 20\text{mA}, V_{CC} = 12\text{V}$	—	—	1	V
—	Output High Level	$I_O = 20\text{mA}, V_{CC} = 12\text{V}$	8	—	—	V
—	Output Clamping Voltage	—	11	13	15	V
—	Rising Time (Note 5)	$C_L = 1\text{nF}, V_{CC} = 13\text{V}$	—	150	250	ns
—	Falling Time (Note 5)	$C_L = 1\text{nF}, V_{CC} = 13\text{V}$	—	50	100	ns

Note: 5. Guaranteed by design.

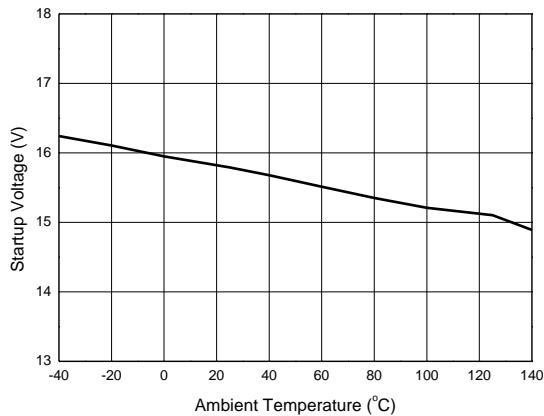
Electrical Characteristics (continued) (@TA = +25°C, Vcc = 16V, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Brownout Section (BNO Pin)						
—	Brown-in Voltage	—	0.93	0.95	0.97	V
—	Brownout Voltage	—	0.88	0.9	0.92	V
—	Clamping Voltage	I _{CLAMP} = 1mA	—	5.5	—	V
—	Line OVP	—	4.1	4.2	4.3	V
Delay Time Section						
—	Delay of Short-Circuit Protection	—	—	70	—	ms
—	Delay of Hiccup Protection	VCC OVP	—	5	—	Cycles
—	De-Bounce Time of Brownout	—	—	50	—	ms
Internal OTP Section						
—	OTP Enter	—	—	+150	—	°C
—	OTP Exit	—	—	+125	—	°C

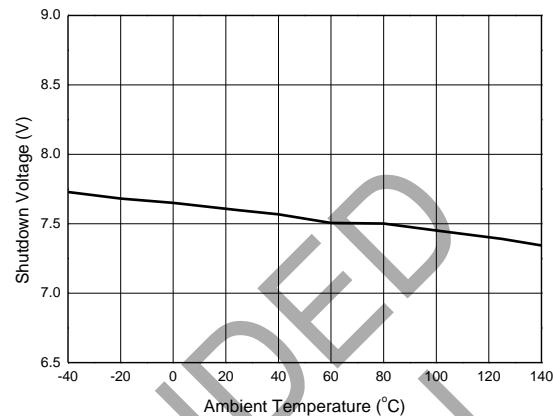
NOT RECOMMENDED
FOR NEW DESIGN

Performance Characteristics

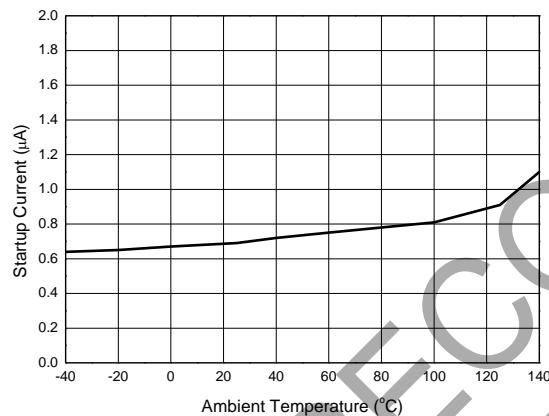
Startup Voltage vs. Ambient Temperature



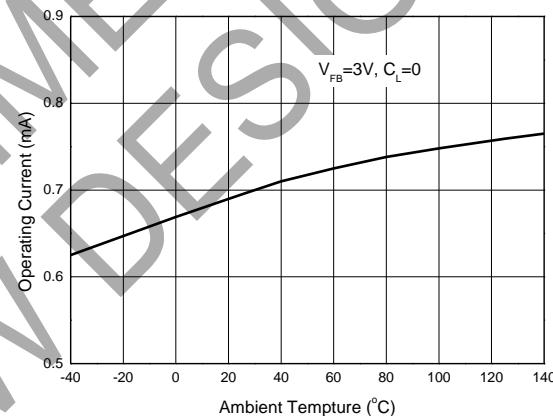
Shutdown Voltage vs. Ambient Temperature



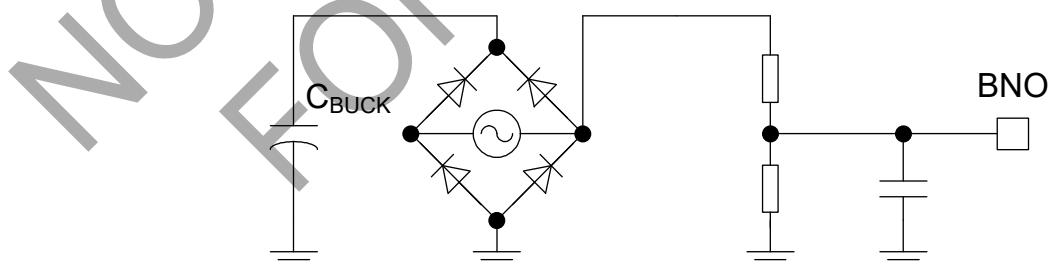
Startup Current vs. Ambient Temperature



Operating Current vs. Ambient Temperature



BNO Utilization for Brownout



Operation Description

The AP3125B is specifically designed for off-line AC-DC power supply used in LCD monitor, notebook adapter and battery charger applications. It offers a cost-effective solution with a versatile protection function.

Startup Current and UVLO

The startup current of AP3125B is optimized to realize ultra low current (1 μ A typical) so that VCC capacitor can be charged more quickly. The direct benefit of low startup current is the availability of using large startup resistor, which minimizes the resistor power loss for high voltage AC input.

An UVLO comparator is included in AP3125B to detect the voltage on VCC pin. It ensures that AP3125B can draw adequate energy from holdup capacitor during power-on. The turn-on threshold is 16V and the turn-off threshold is 7.6V.

Current Sense Comparator and PWM Latch

The AP3125B operates as a current mode controller, the output switch conduction is initiated by every oscillator cycle and is terminated when the peak inductor current reaches the threshold level established by the FB pin. The inductor current signal is converted to a voltage signal by inserting a reference sense resistor R_s . The inductor current under normal operating conditions is controlled by the voltage at FB pin. The relation between peak inductor current (I_{PK}) and V_{FB} is:

$$I_{PK} = (V_{FB} - 0.8) / 3R_s$$

Moreover, FOCP with 1.8V threshold is only about 100ns delay, which can avoid some catastrophic damages such as secondary rectifier short test. Few drive cycles can alleviate the destruction range and get better protection.

Leading-Edge Blanking

A narrow spike on the leading edge of the current waveform can usually be observed when the power MOSFET is turned on. A 250ns leading-edge blank is built-in to prevent the false-triggering caused by the turn-on spike. During this period, the current limit comparator is disabled and the gate driver can not be switched off.

At the time of turning off the MOSFET, a negative undershoot (maybe larger than -0.3V) can occur on the SENSE pin. So it is strongly recommended to add a small RC filter or at least connect a resistor "R" on this pin to protect the IC (shown as Figure 1).

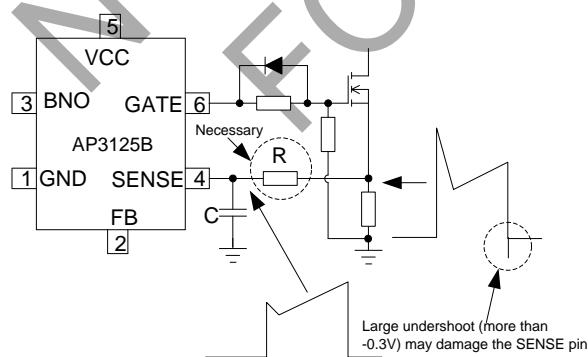


Figure 1

Built-in Slope Compensation

It is well known that a continuous current mode SMPS may become unstable when the duty cycle exceeds 50%. The built-in slope compensation can improve the stability, so there is no need for design engineer to spend much time on that.

FB Pin and Short-Circuit Protection

This pin is normally connected to the optocoupler and always paralleled with a capacitor for loop compensation. When the voltage at this pin is greater than 4.5V and lasts for about 70ms, the IC will enter the protection mode. For AP3125B, the system will enter hiccup mode to wait the Vcc decreasing to low UVLO level, then the IC will try to restart until the failure removed. And when this voltage is less than 1.55V, the IC will stop the drive pulse immediately. Therefore, this feature can be used for short-circuit protection, which makes the system immune from damage. Normally, output short makes the V_{FB} value to the maximum because the optocoupler is cut off.

Vcc Maintain Mode

During light load or step load, V_{FB} will drop and be lower than 1.55V, thus the PWM drive signal will be stopped, and there is no more new energy transferred due to no switching. Therefore, the IC supply voltage may reduce to the shutdown threshold voltage and system may enter the unexpected restart mode. To avoid this, the AP3125B hold a so-called Vcc maintain mode which can supply energy to VCC.

When Vcc decreases to a setting threshold, the Vcc maintain comparator will output some drive signal to make the system switch and provide a proper energy to VCC pin. The Vcc maintain function will cooperate with the PWM and burst mode loop which can make the output voltage variation be within the regulation. This mode is very useful for reducing startup resistor loss and achieving a better standby performance with a low value VCC capacitor. The Vcc is not easy to touch the shutdown threshold during the startup process and step load. This will also simplify the system design. The minimum VCC voltage is suggested to be designed a little higher than Vcc maintain threshold thus can achieve the best balance between the standby and step load performance.

System Protection and Pin Fault Protection

The AP3125B provides versatile system and pin fault protections. The OCP comparator realizes the cycle-by-cycle current limiting (OCP). In universal input line voltage, the IC realizes the constant overload protection (OLP). VCC over voltage protection can be applied as the primary OVP or opto-coupler broken protection. The AP3125B also has pin fault connection protection including floating and short connection. The floating pin protection includes the SENSE, FB, etc. The short pin protection includes the CTRL pin short protection. When these pins are floated or CTRL pin is shorted to ground, PWM switching will be disabled, thus protecting the power system.

Operation Description (continued)

Brownout Protection Function

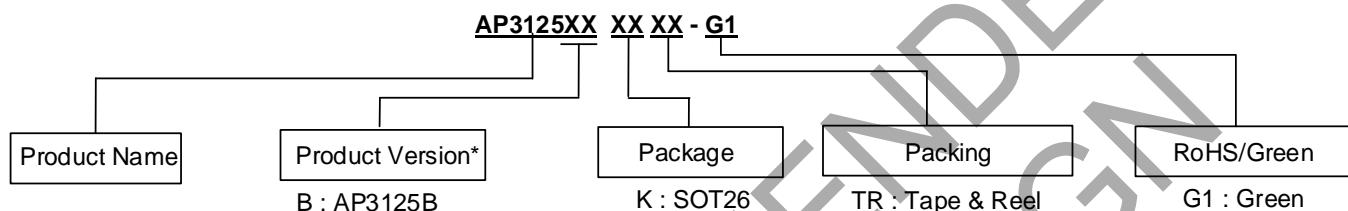
To avoid potential high current stress at low line voltage, AP3125B introduces reliable brownout protection. AC line voltage information is sampled through a voltage divider network, adjusting the divider ratio to achieve expected brownout protection voltage. A typical 0.1nF capacitor is strongly recommended to parallel with BNO pin to bypass any accidental spike in AC line for preventing false trigger. When the voltage across BNO pin is higher than 0.95V and Vcc reaches UVLO/ON, the GATE pin will output drive signals. If the BNO

voltage falls below 0.9V and lasts for 50ms, the GATE pin will turn off and the system will enter hiccup mode until the line voltage rises over its brown-in voltage again.

Internal OTP Protection Function

The AP3125B integrates an internal temperature sensor. It has a trigger window of +150°C enter and +125°C exit. The internal OTP protection mode is auto-recovery mode.

Ordering Information (Note 6)



Diodes Incorporated IC's Pb-free products with "G1" suffix in the part number, are RoHS compliant and green.

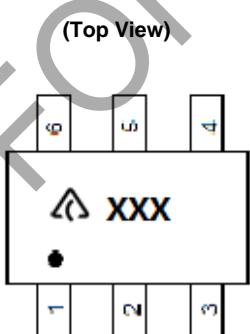
Orderable Part Number	Package	Marking ID	Packing	
			Qty.	Carrier
AP3125BKTR-G1	SOT26	GLV	3000	Tape & Reel

Note: 6. For packaging details, go to our website at <https://www.diodes.com/design/support/packaging/diodes-packaging/>.

Product Version Classification (With Different Protection Functions)

Product Version	Frequency	VOVP	OLP & SOCP	BNO	LOVP
AP3125B	65kHz	Auto-Recoverable	Auto-Recoverable	Auto-Recoverable	Latch

Marking Information



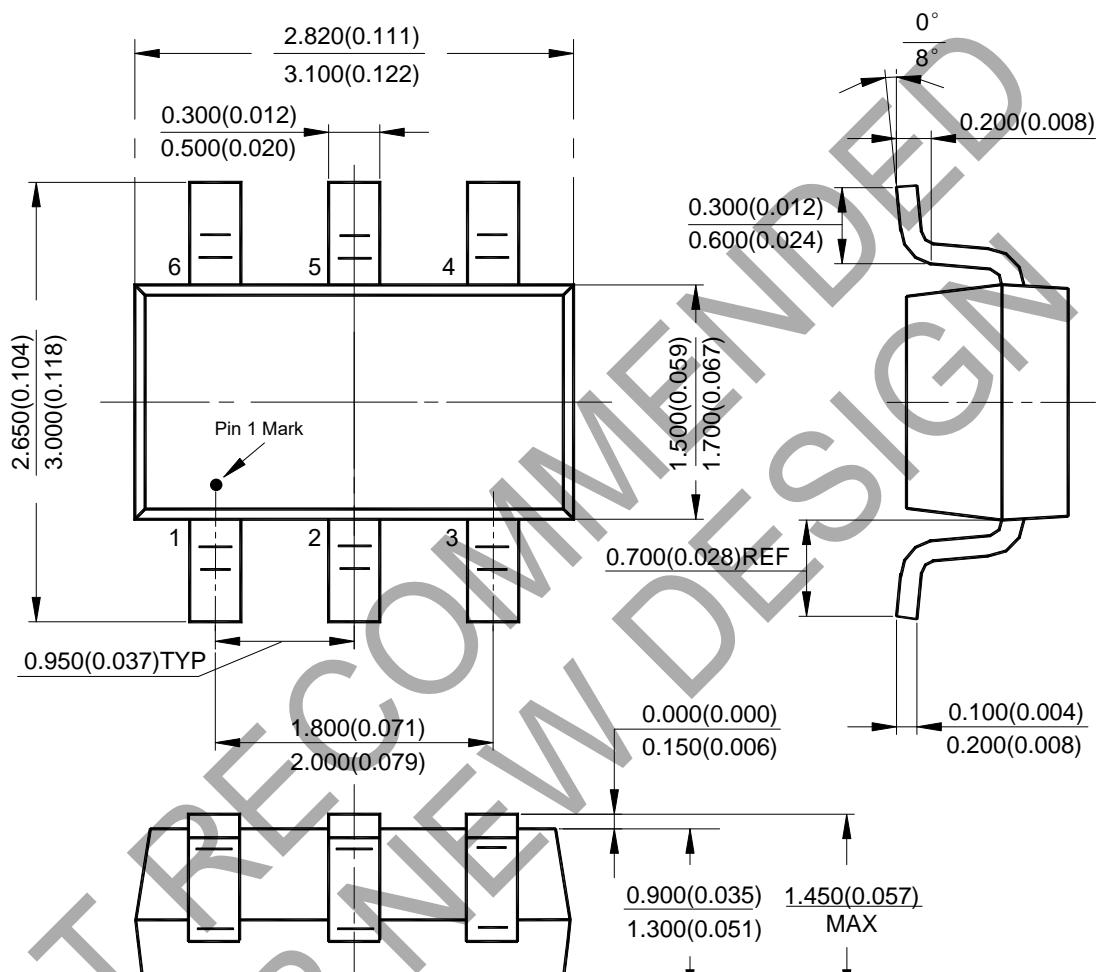
: Logo

XXX: Marking ID (See Ordering Information)

Package Outline Dimensions (All dimensions in mm(inch).)

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

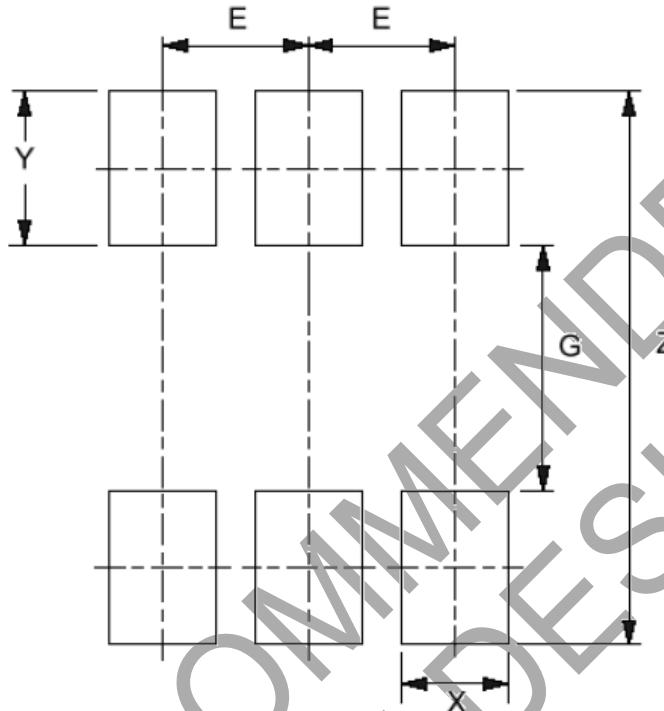
(1) Package Type: SOT26



Suggested Pad Layout

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

(1) Package Type: SOT26



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	3.600/0.142	1.600/0.063	0.700/0.028	1.000/0.039	0.950/0.037

IMPORTANT NOTICE

1. DIODES INCORPORATED (Diodes) AND ITS SUBSIDIARIES MAKE NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO ANY INFORMATION CONTAINED IN THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).
2. The Information contained herein is for informational purpose only and is provided only to illustrate the operation of Diodes' products described herein and application examples. Diodes does not assume any liability arising out of the application or use of this document or any product described herein. This document is intended for skilled and technically trained engineering customers and users who design with Diodes' products. Diodes' products may be used to facilitate safety-related applications; however, in all instances customers and users are responsible for (a) selecting the appropriate Diodes products for their applications, (b) evaluating the suitability of Diodes' products for their intended applications, (c) ensuring their applications, which incorporate Diodes' products, comply the applicable legal and regulatory requirements as well as safety and functional-safety related standards, and (d) ensuring they design with appropriate safeguards (including testing, validation, quality control techniques, redundancy, malfunction prevention, and appropriate treatment for aging degradation) to minimize the risks associated with their applications.
3. Diodes assumes no liability for any application-related information, support, assistance or feedback that may be provided by Diodes from time to time. Any customer or user of this document or products described herein will assume all risks and liabilities associated with such use, and will hold Diodes and all companies whose products are represented herein or on Diodes' websites, harmless against all damages and liabilities.
4. Products described herein may be covered by one or more United States, international or foreign patents and pending patent applications. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks and trademark applications. Diodes does not convey any license under any of its intellectual property rights or the rights of any third parties (including third parties whose products and services may be described in this document or on Diodes' website) under this document.
5. Diodes' products are provided subject to Diodes' Standard Terms and Conditions of Sale (<https://www.diodes.com/about/company/terms-and-conditions/terms-and-conditions-of-sales/>) or other applicable terms. This document does not alter or expand the applicable warranties provided by Diodes. Diodes does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.
6. Diodes' products and technology may not be used for or incorporated into any products or systems whose manufacture, use or sale is prohibited under any applicable laws and regulations. Should customers or users use Diodes' products in contravention of any applicable laws or regulations, or for any unintended or unauthorized application, customers and users will (a) be solely responsible for any damages, losses or penalties arising in connection therewith or as a result thereof, and (b) indemnify and hold Diodes and its representatives and agents harmless against any and all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim relating to any noncompliance with the applicable laws and regulations, as well as any unintended or unauthorized application.
7. While efforts have been made to ensure the information contained in this document is accurate, complete and current, it may contain technical inaccuracies, omissions and typographical errors. Diodes does not warrant that information contained in this document is error-free and Diodes is under no obligation to update or otherwise correct this information. Notwithstanding the foregoing, Diodes reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes.
8. Any unauthorized copying, modification, distribution, transmission, display or other use of this document (or any portion hereof) is prohibited. Diodes assumes no responsibility for any losses incurred by the customers or users or any third parties arising from any such unauthorized use.
9. This Notice may be periodically updated with the most recent version available at <https://www.diodes.com/about/company/terms-and-conditions/important-notice>

The Diodes logo is a registered trademark of Diodes Incorporated in the United States and other countries.
All other trademarks are the property of their respective owners.
© 2025 Diodes Incorporated. All Rights Reserved.

www.diodes.com