

Description

The AP3502F is a 340kHz fixed frequency, current mode, PWM synchronous buck (step-down) DC-DC converter, capable of driving a 2A load with high efficiency, excellent line and load regulation. The device integrates N-channel power MOSFET switches with low on-resistance. Current mode control provides fast transient response and cycle-by-cycle current limit.

The AP3502F employs complete protection to ensure system security, including output Over Voltage Protection, input Under Voltage LockOut, programmable soft-start, and Over Temperature Protection.

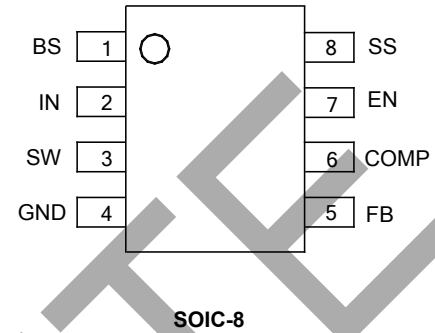
This IC is available in SOIC-8 package.

Features

- Input Voltage Range: 4.5V to 18V
- Fixed 340kHz Frequency
- High Efficiency: up to 95%
- Output Current: 2A
- Current Mode Control
- Built-In Over Current Protection
- Built-In Thermal Shutdown Function
- Built-In UVLO Function
- Built-In Over Voltage Protection
- Programmable Soft-start

Pin Assignments

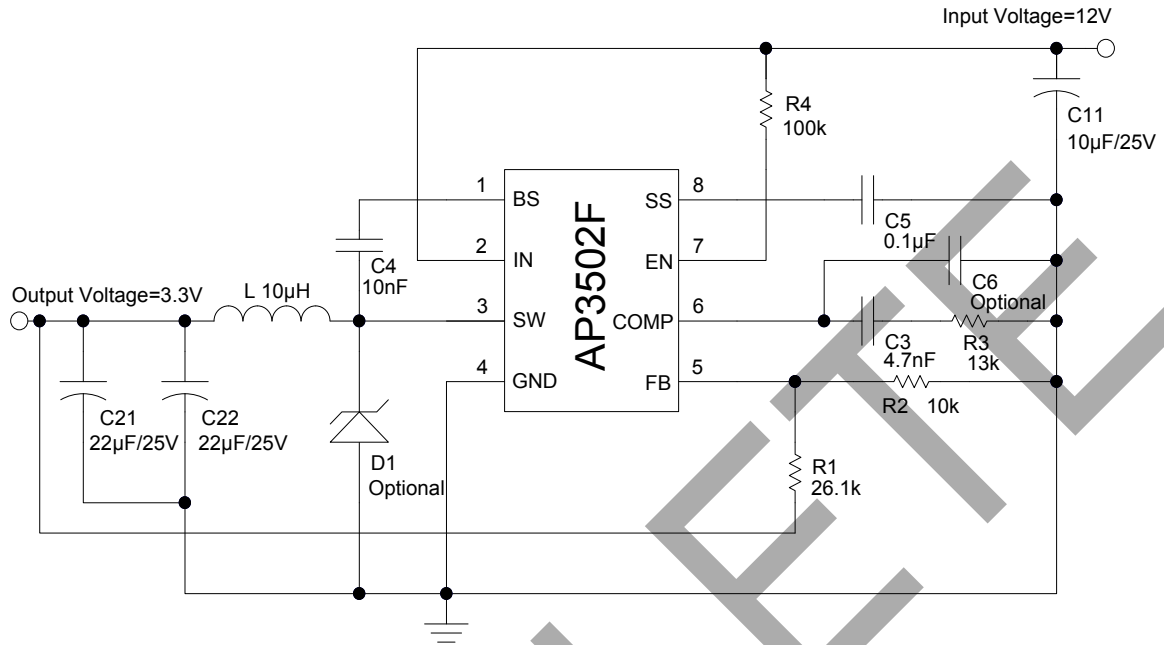
(Top View)



Applications

- LCD TV
- Set Top Box
- Portable DVD
- Digital Photo Frame

Typical Applications Circuit



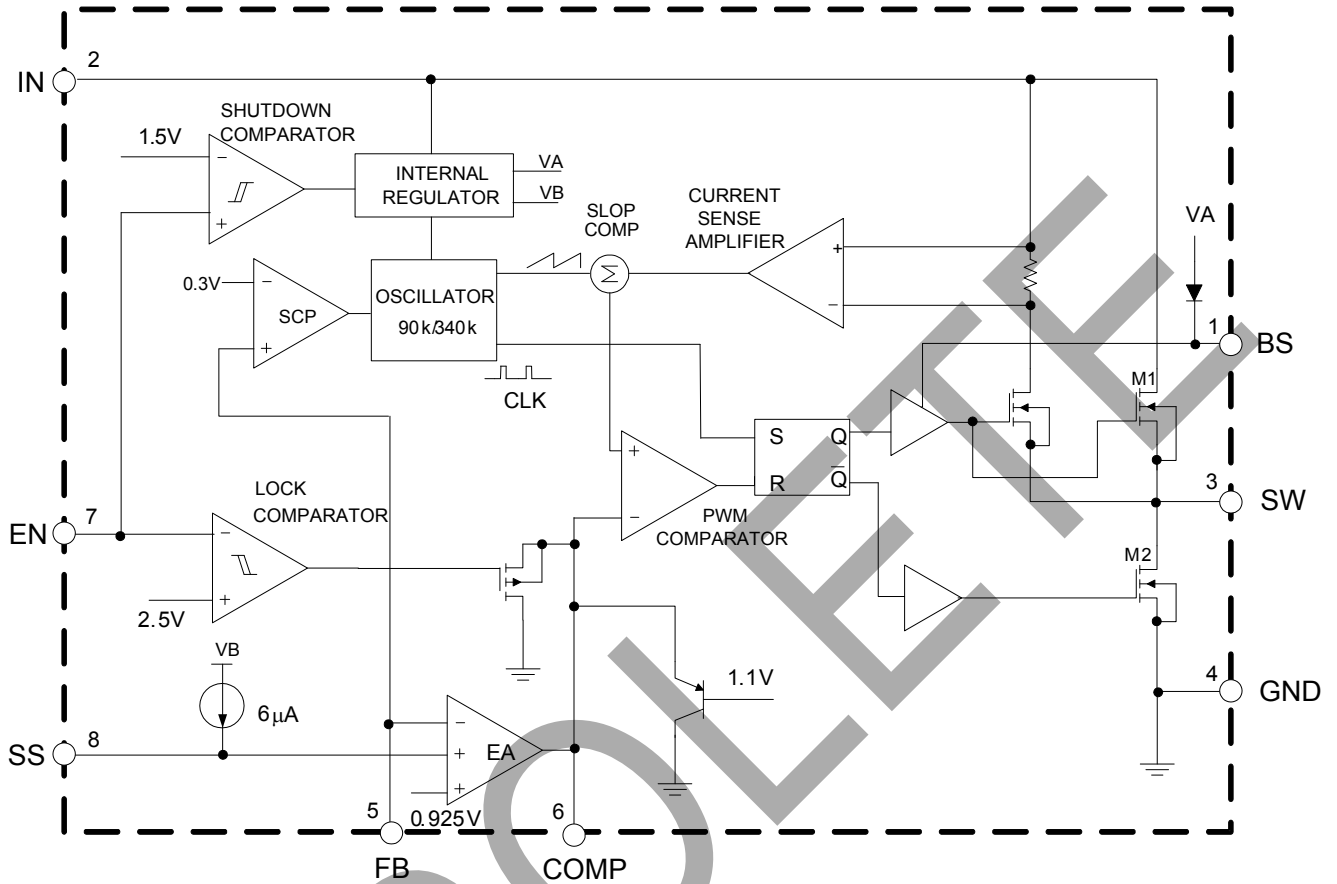
Pin Descriptions

Pin Number	Pin Name	Function
1	BS	Bootstrap pin. A bootstrap capacitor is connected between the BS pin and SW pin. The voltage across the bootstrap capacitor drives the internal high-side power MOSFET
2	IN	Supply power input pin. A capacitor should be connected between the IN pin and GND pin to keep the input voltage constant
3	SW	Power switch output pin. This pin is connected to the inductor and bootstrap capacitor
4	GND	Ground pin
5	FB	Feedback pin. This pin is connected to an external resistor divider to program the system output voltage. When the FB pin voltage exceeds 1.1V, the over voltage protection is triggered. When the FB pin voltage is below 0.3V, the oscillator frequency is lowered to realize short circuit protection
6	COMP	Compensation pin. This pin is the output of the transconductance error amplifier and the input to the current comparator. It is used to compensate the control loop. Connect a series RC network from this pin to GND. In some cases, an additional capacitor from this pin to GND pin is required
7	EN	Control input pin. EN is a digital input that turns the regulator on or off. Drive EN high/low to turn on/off the regulator. Pull up with 100kΩ resistor for automatic startup
8	SS	Soft-start control input pin. SS controls the soft-start period. Connect a capacitor from SS to GND to set the soft-start period. A 0.1µF capacitor sets the soft-start period to 15ms. To disable the soft-start feature, leave SS unconnected

OBSOLETE - PART DISCONTINUED

Functional Block Diagram

OBSOLETE - PART DISCONTINUED



Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Value	Unit
V_{IN}	IN Pin Voltage	-0.3 to 20	V
V_{EN}	EN Pin Voltage	-0.3 to V_{IN}	V
V_{SW}	SW Pin Voltage	21	V
V_{BS}	BS Pin Voltage	-0.3 to $V_{SW}+6$	V
V_{FB}	FB Pin Voltage	-0.3 to 6	V
V_{COMP}	COMP Pin Voltage	-0.3 to 6	V
V_{SS}	SS Pin Voltage	-0.3 to 6	V
θ_{JA}	Thermal Resistance	105	°C/W
T_J	Operating Junction Temperature	+150	°C
T_{STG}	Storage Temperature	-65 to +150	°C
T_{LEAD}	Lead Temperature (Soldering, 10sec)	+260	°C
V_{HBM}	ESD (Human Body Model)	2000	V
V_{MM}	ESD (Machine Model)	200	V

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" may 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 may affect device reliability.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Voltage	4.5	18	V
T_A	Operating Ambient Temperature	-40	+85	°C

Electrical Characteristics ($T_A=+25^{\circ}\text{C}$, $V_{IN}=V_{EN}=12\text{V}$, $V_{OUT}=3.3\text{V}$, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
SUPPLY VOLTAGE (IN PIN)						
V_{IN}	Input Voltage	–	4.5	–	18	V
I_Q	Quiescent Current	$V_{FB}=1\text{V}, V_{EN}=3\text{V}$	–	1.2	1.4	mA
I_{SHDN}	Shutdown Supply Current	$V_{EN}=0\text{V}$	–	0.1	10	μA
UNDER VOLTAGE LOCKOUT						
V_{UVLO}	Input UVLO Threshold	V_{IN} Rising	3.65	4.00	4.25	V
V_{HYS}	Input UVLO Hysteresis	–	–	200	–	mV
ENABLE (EN PIN)						
–	EN Shutdown Threshold Voltage	–	1.1	1.5	2	V
–	EN Shutdown Threshold Voltage Hysteresis (Note 2)	–	–	350	–	mV
–	EN Lockout Threshold Voltage	–	2.2	2.5	2.7	V
–	EN Lockout Hysteresis	–	–	210	–	mV
VOLTAGE REFERENCE (FB PIN)						
V_{FB}	Feedback Voltage	–	0.907	0.925	0.943	V
V_{FBOV}	Feedback Over Voltage Threshold	–	–	1.1	–	V
I_{FB}	Feedback Bias Current	$V_{FB}=1\text{V}$	-0.1	–	0.1	μA
MOSFET						
$R_{DS(ON)H}$	High-side Switch On-resistance(Note 3)	$I_{SW}=0.2\text{A}/0.7\text{A}$	–	100	–	m Ω
$R_{DS(ON)L}$	Low-side Switch On-resistance(Note 3)	$I_{SW}=-0.2\text{A}/-0.7\text{A}$	–	100	–	m Ω
CURRENT LIMIT						
I_{LEAKH}	High-side Switch Leakage Current	$V_{IN}=18\text{V}, V_{EN}=V_{SW}=0\text{V}$	–	0.1	10	μA
I_{LIMH}	High-side Switch Current Limit	–	2.7	3.5	–	A
I_{LIML}	Low-side Switch Current Limit	From Drain to Source	–	1.4	–	A
SWITCHING REGULATOR						
f_{OSC1}	Oscillator Frequency	–	280	340	400	kHz
f_{OSC2}	Short Circuit Oscillator Frequency	–	–	90	–	kHz
D_{MAX}	Max. Duty Cycle	$V_{FB}=0.85\text{V}$	–	90	–	%
D_{MIN}	Min. Duty Cycle	$V_{FB}=1\text{V}$	–	–	0	%

OBSOLETE – PART DISCONTINUED

Electrical Characteristics (Cont. $T_A=+25^{\circ}\text{C}$, $V_{IN}=V_{EN}=12\text{V}$, $V_{OUT}=3.3\text{V}$, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
ERROR AMPLIFIER						
A_{EA}	Error Amplifier Voltage Gain (Note 2)	–	–	400	–	V/V
G_{EA}	Error Amplifier Transconductance	–	–	800	–	$\mu\text{A/V}$
G_{CS}	COMP to Current Sense Transconductance	–	–	3.5	–	A/V
THERMAL SHUTDOWN						
T_{OTSD}	Thermal Shutdown (Note 2)	–	–	+160	–	$^{\circ}\text{C}$
T_{HYS}	Thermal Shutdown Hysteresis (Note 2)	–	–	+30	–	$^{\circ}\text{C}$
SOFT START (SS PIN)						
t_{SS}	Soft-start Time (Note 2)	$C_{SS}=0.1\mu\text{F}$	–	15	–	ms
–	Soft-start Current	$V_{SS}=0\text{V}$	–	6	–	μA

Notes: 2. Not tested, guaranteed by design.

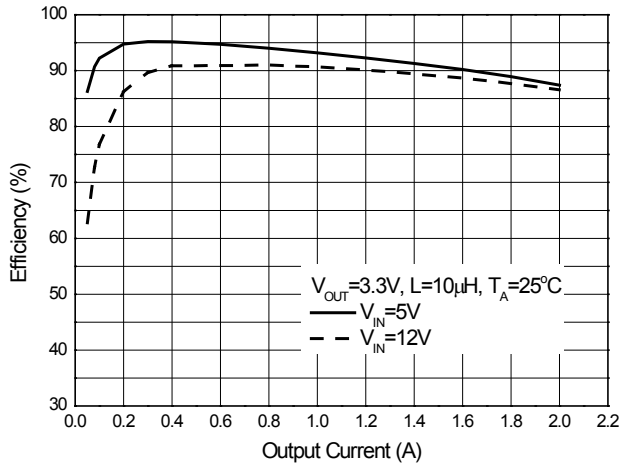
$$3. R_{DS(on)} = \frac{V_{SW1} - V_{SW2}}{I_{SW1} - I_{SW2}}$$

OBSOLETE – PART DISCONTINUED

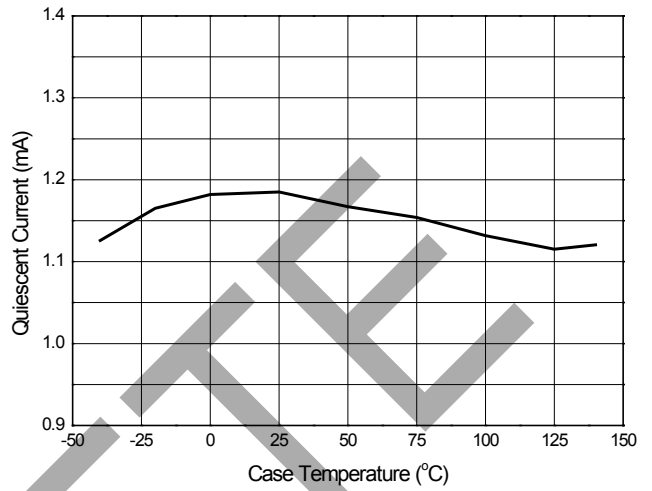
OBSOLETE

Performance Characteristics ($T_A=+25^{\circ}\text{C}$, $V_{IN}=12\text{V}$, $V_{OUT}=3.3\text{V}$, unless otherwise noted.)

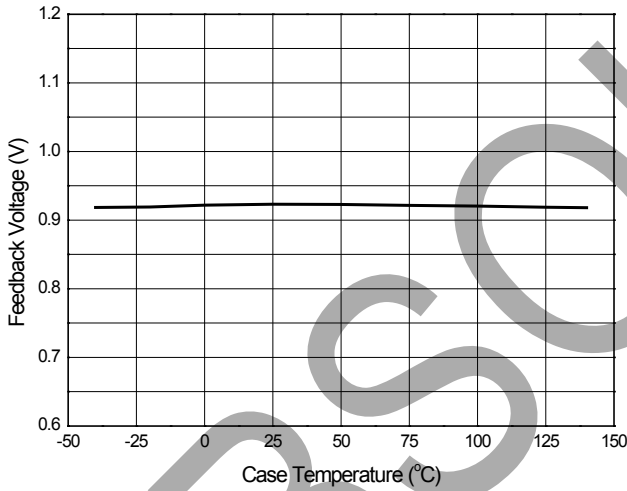
Efficiency vs. Output Current



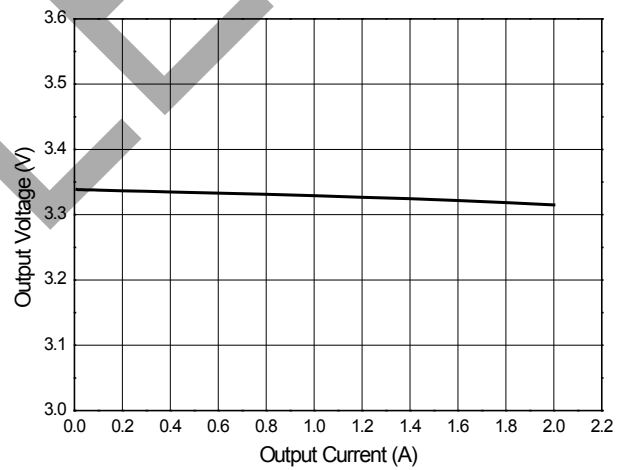
Quiescent Current vs. Case Temperature



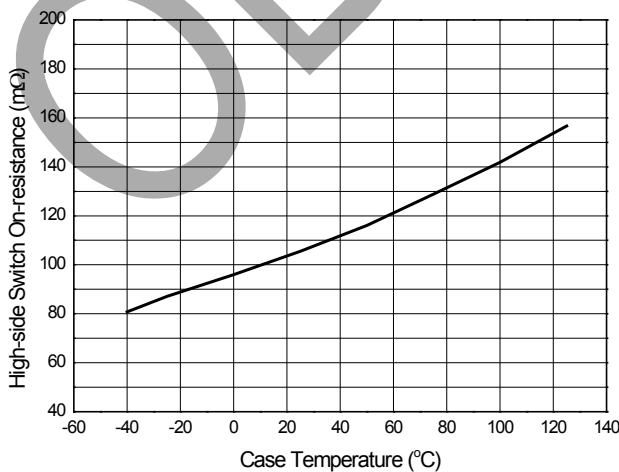
Feedback Voltage vs. Case Temperature



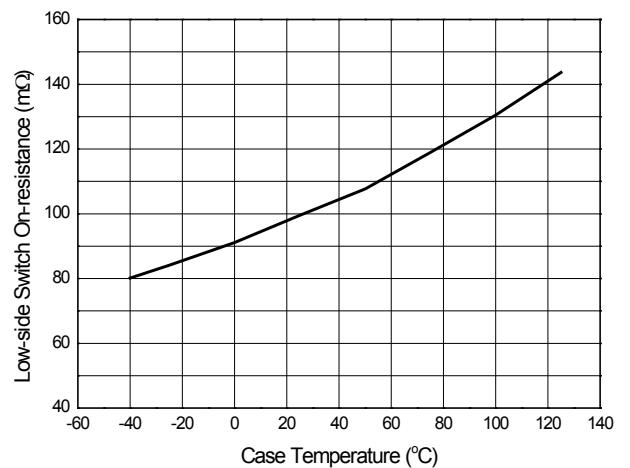
Output Voltage vs. Output Current



High-side Switch On-resistance vs. Case Temperature



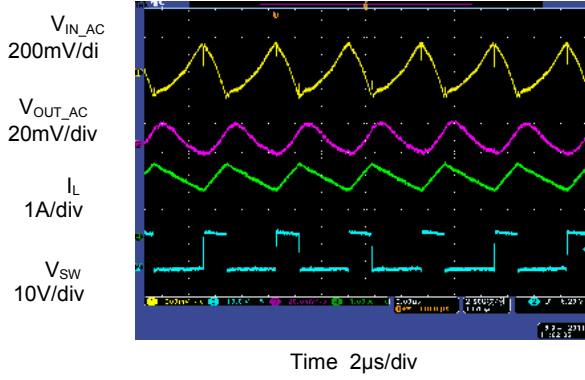
Low-side Switch On-resistance vs. Case Temperature



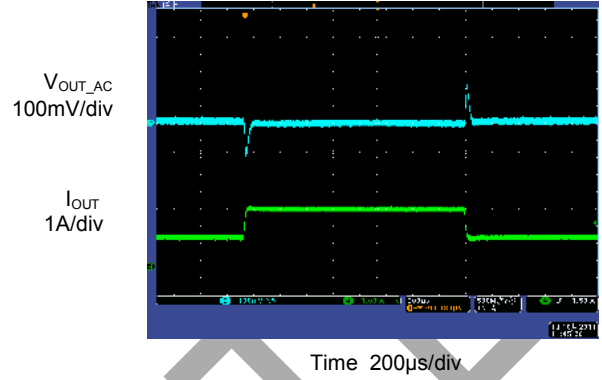
OBSOLETE - PART DISCONTINUED

Performance Characteristics (Cont. $T_A=+25^{\circ}\text{C}$, $V_{IN}=12\text{V}$, $V_{OUT}=3.3\text{V}$, unless otherwise noted.)

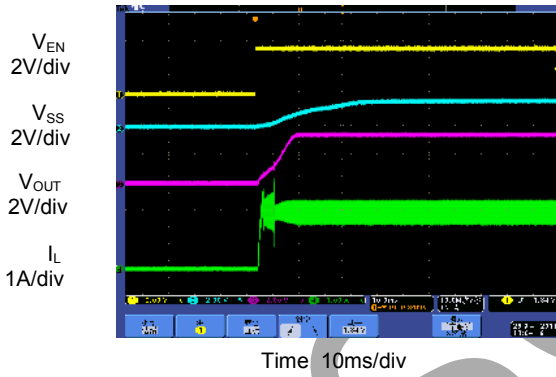
Output Ripple ($I_{OUT}=2\text{A}$)



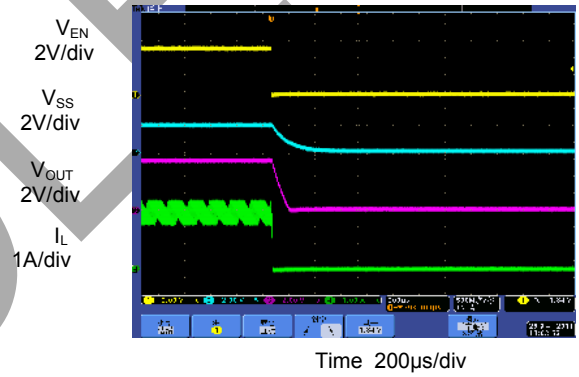
Load Transient ($I_{OUT}=1\text{A to }2\text{A}$)



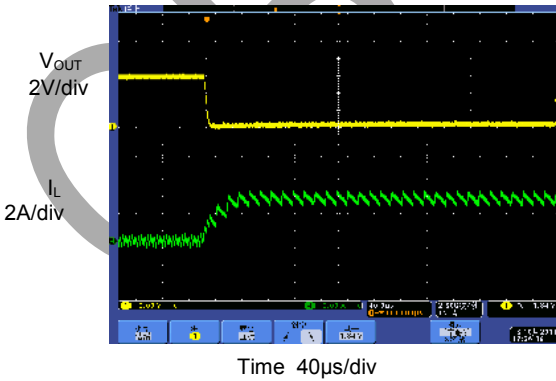
Enable Turn on Characteristic
($V_{IN}=12\text{V}$, $V_{EN}=3.3\text{V}$, $V_{OUT}=3.3\text{V}$, $I_L=2\text{A}$)



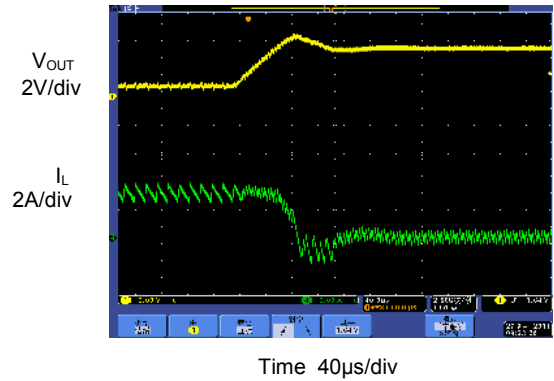
Enable Turn off Characteristic
($V_{IN}=12\text{V}$, $V_{EN}=3.3\text{V}$, $V_{OUT}=3.3\text{V}$, $I_L=2\text{A}$)



Short Circuit Protection ($I_{OUT}=0\text{A}$)

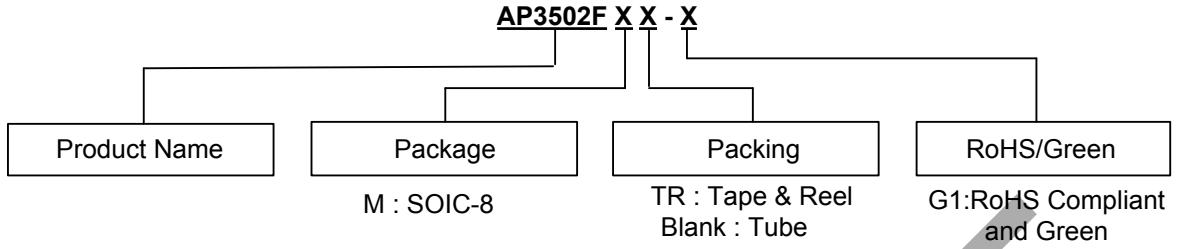


Short Circuit Recovery ($I_{OUT}=0\text{A}$)



OBSOLETE - PART DISCONTINUED

Ordering Information



Package	Temperature Range	Part Number	Marking ID	Packing
SOIC-8	-40 to +85°C	AP3502FM-G1	3502FM-G1	Tube
		AP3502FMTR-G1	3502FM-G1	Tape & Reel

OBSOLETE - PART DISCONTINUED

OBSOLETE

IMPORTANT NOTICE

1. DIODES INCORPORATED AND ITS SUBSIDIARIES (“DIODES”) 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 the 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.

Copyright © 2021 Diodes Incorporated

www.diodes.com