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.

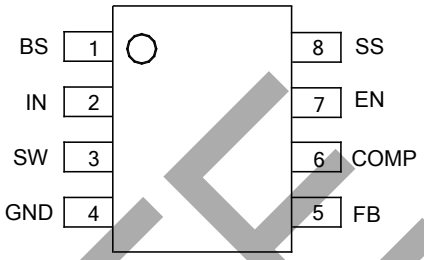
This IC is available in SOIC-8 package.

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)

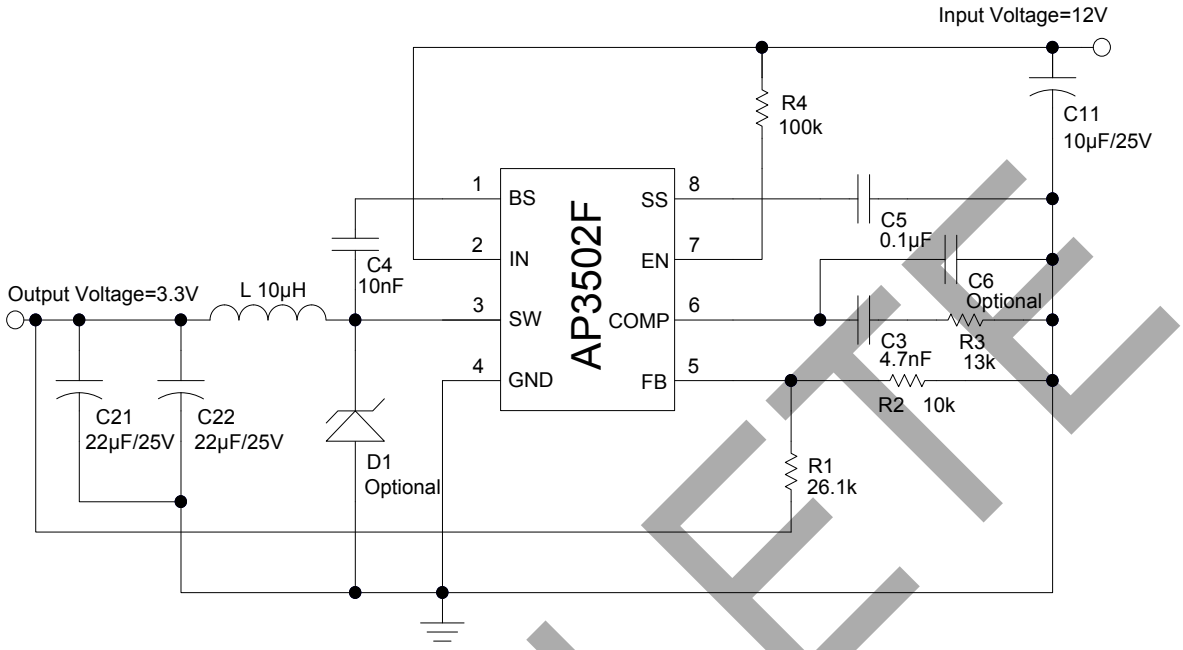


SOIC-8

Applications

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

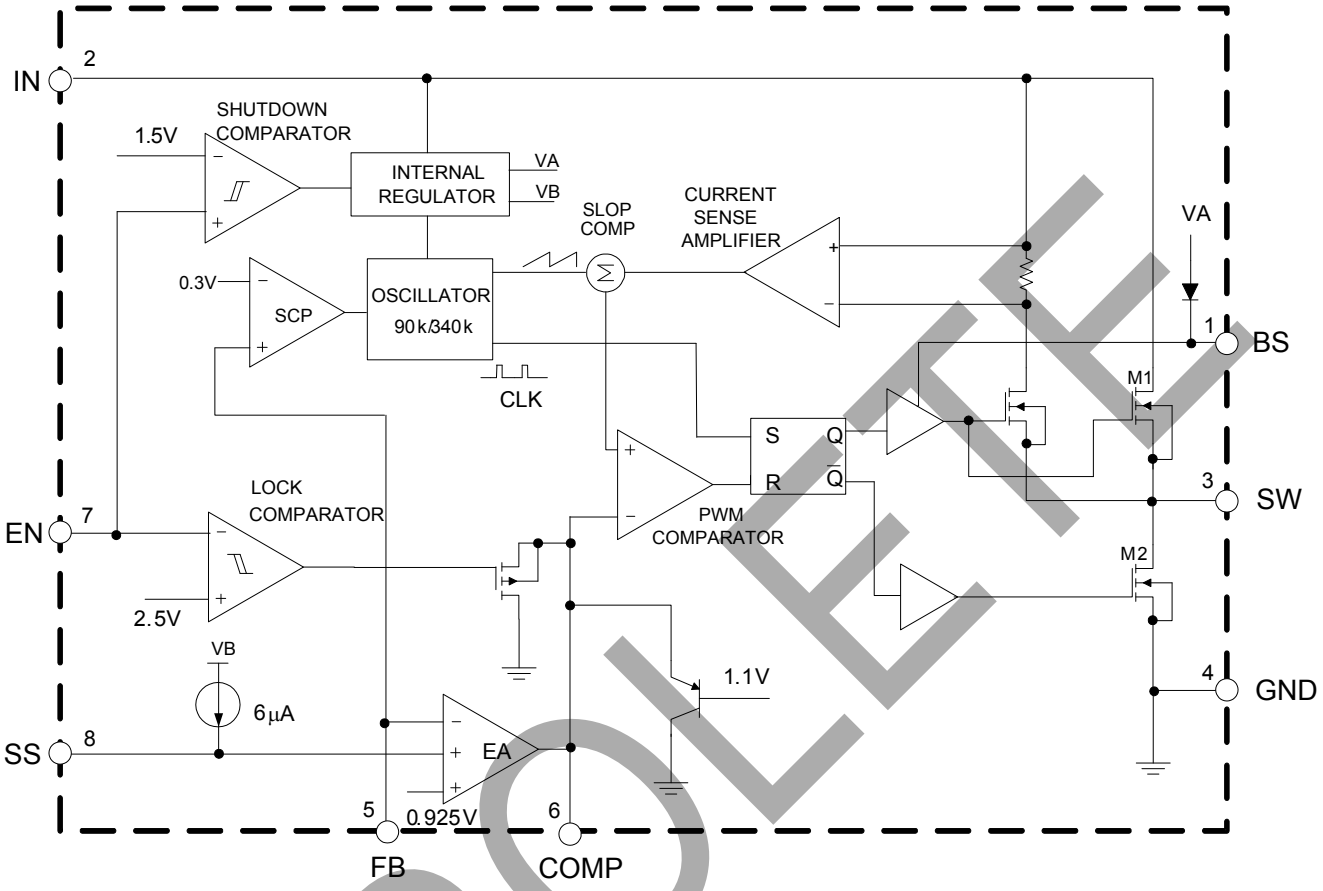
Typical Applications Circuit



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

Functional Block Diagram



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°C, V_{IN}=V_{EN}=12V, V_{OUT}=3.3V, 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}=1V,V_{EN}=3V	_	1.2	1.4	mA
I_{SHDN}	Shutdown Supply Current	V_{EN}=0V	_	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}=1V	-0.1	_	0.1	μA
MOSFET						
R_{DSONH}	High-side Switch On-resistance(Note 3)	I_{SW}=0.2A/0.7A	_	100	_	mΩ
R_{DSONL}	Low-side Switch On-resistance(Note 3)	I_{SW}=-0.2A/-0.7A	_	100	_	mΩ
CURRENT LIMIT						
I_{LEAKH}	High-side Switch Leakage Current	V_{IN}=18V,V_{EN}=V_{SW}=0V	_	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}=0.85V	_	90	_	%
D_{MIN}	Min. Duty Cycle	V_{FB}=1V	_	_	0	%

Electrical Characteristics (Cont. T_A=+25ºC, V_{IN}=V_{EN}=12V, V_{OUT}=3.3V, unless otherwise specified.)

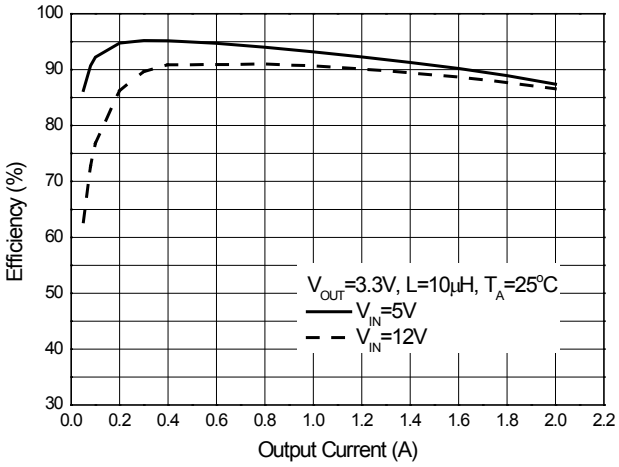
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
ERROR AMPLIFIER						
A_{EA}	Error Amplifier Voltage Gain (Note 2)	_	_	400	_	V/V
G_{EA}	Error Amplifier Transconductance	_	_	800	_	μA/V
G_{CS}	COMP to Current Sense Transconductance	_	_	3.5	_	A/V
THERMAL SHUTDOWN						
T_{OTSD}	Thermal Shutdown (Note 2)	_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

Notes: 2. Not tested, guaranteed by design.

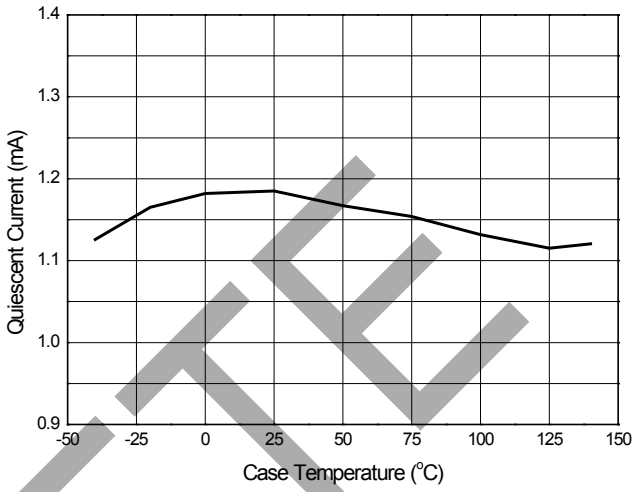
3. $R_{DSON}=\frac{V_{SW1}-V_{SW2}}{I_{SW1}-I_{SW2}}$

Performance Characteristics (T_A=+25°C, V_{IN}=12V, V_{OUT}=3.3V, unless otherwise noted.)

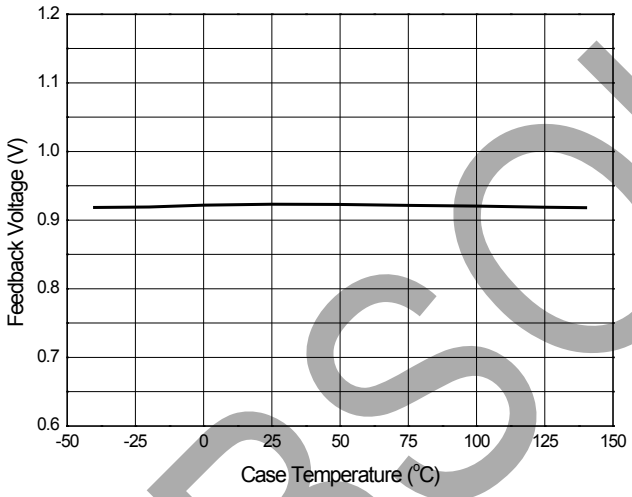
Efficiency vs. Output Current



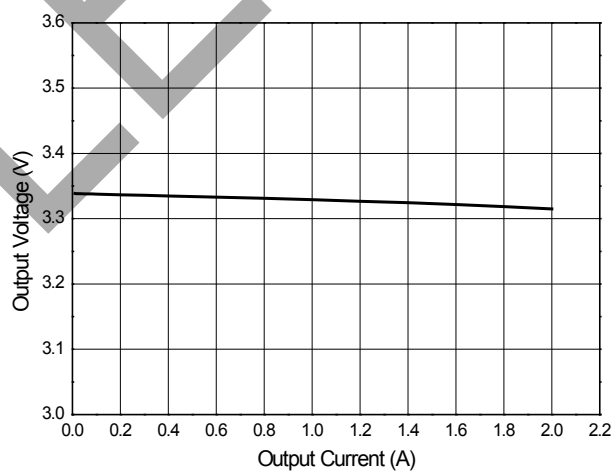
Quiescent Current vs. Case Temperature



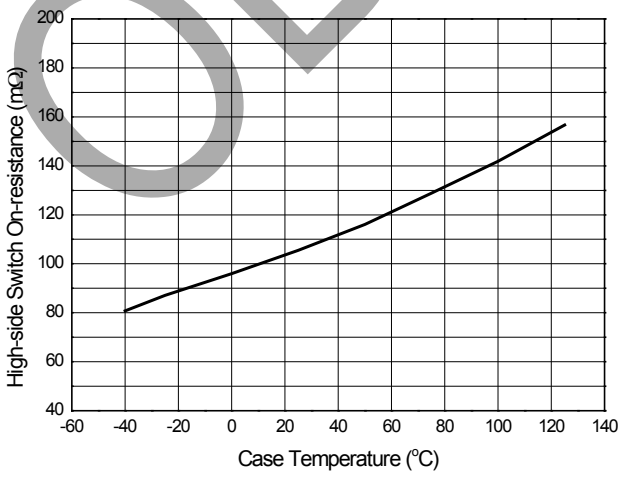
Feedback Voltage vs. Case Temperature



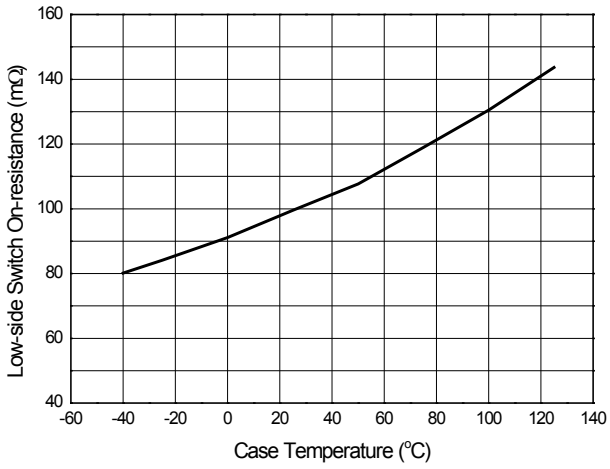
Output Voltage vs. Output Current



High-side Switch On-resistance vs. Case Temperature

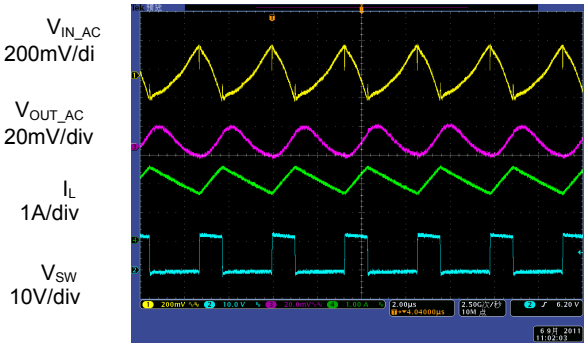


Low-side Switch On-resistance vs. Case Temperature



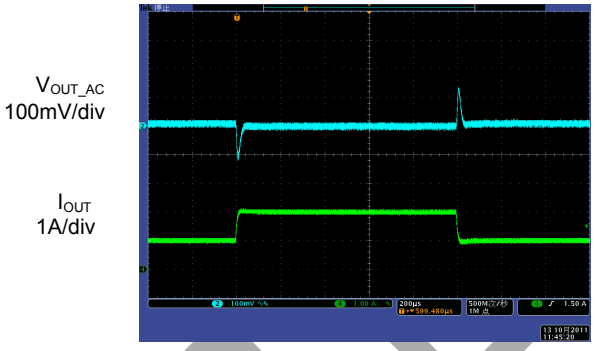
Performance Characteristics (Cont. T_A=+25ºC, V_{IN}=12V, V_{OUT}=3.3V, unless otherwise noted.)

Output Ripple (I_{OUT}=2A)



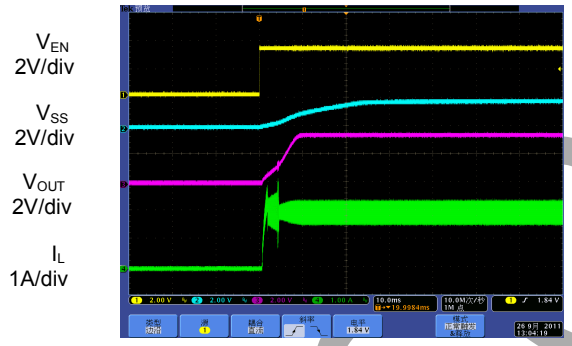
Time 2μs/div

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



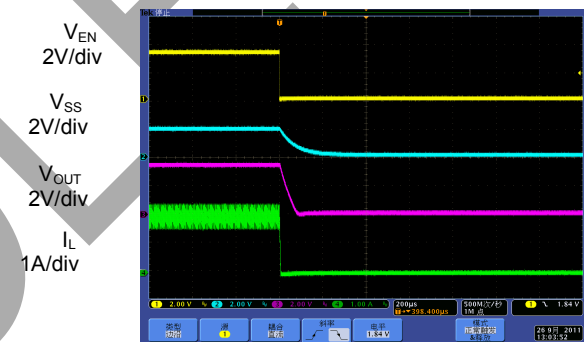
Time 200μs/div

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



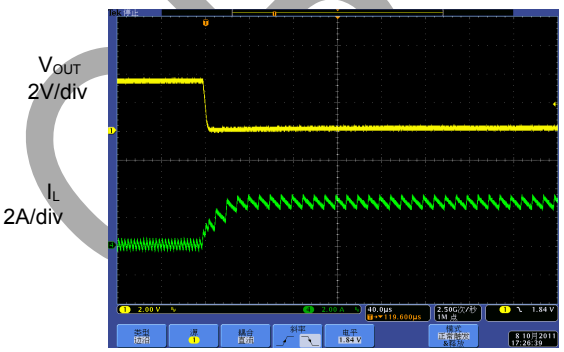
Time 10ms/div

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



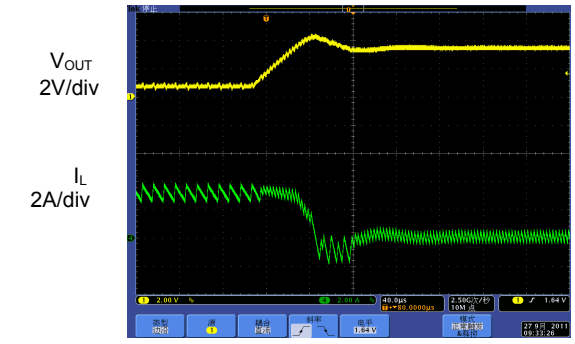
Time 200μs/div

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



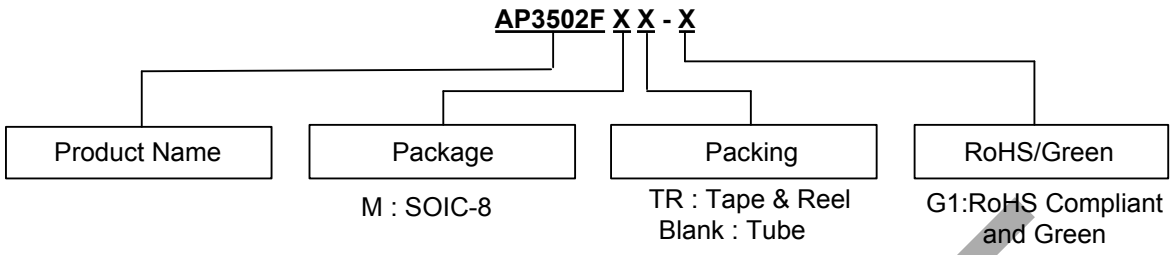
Time 40μs/div

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



Time 40μs/div

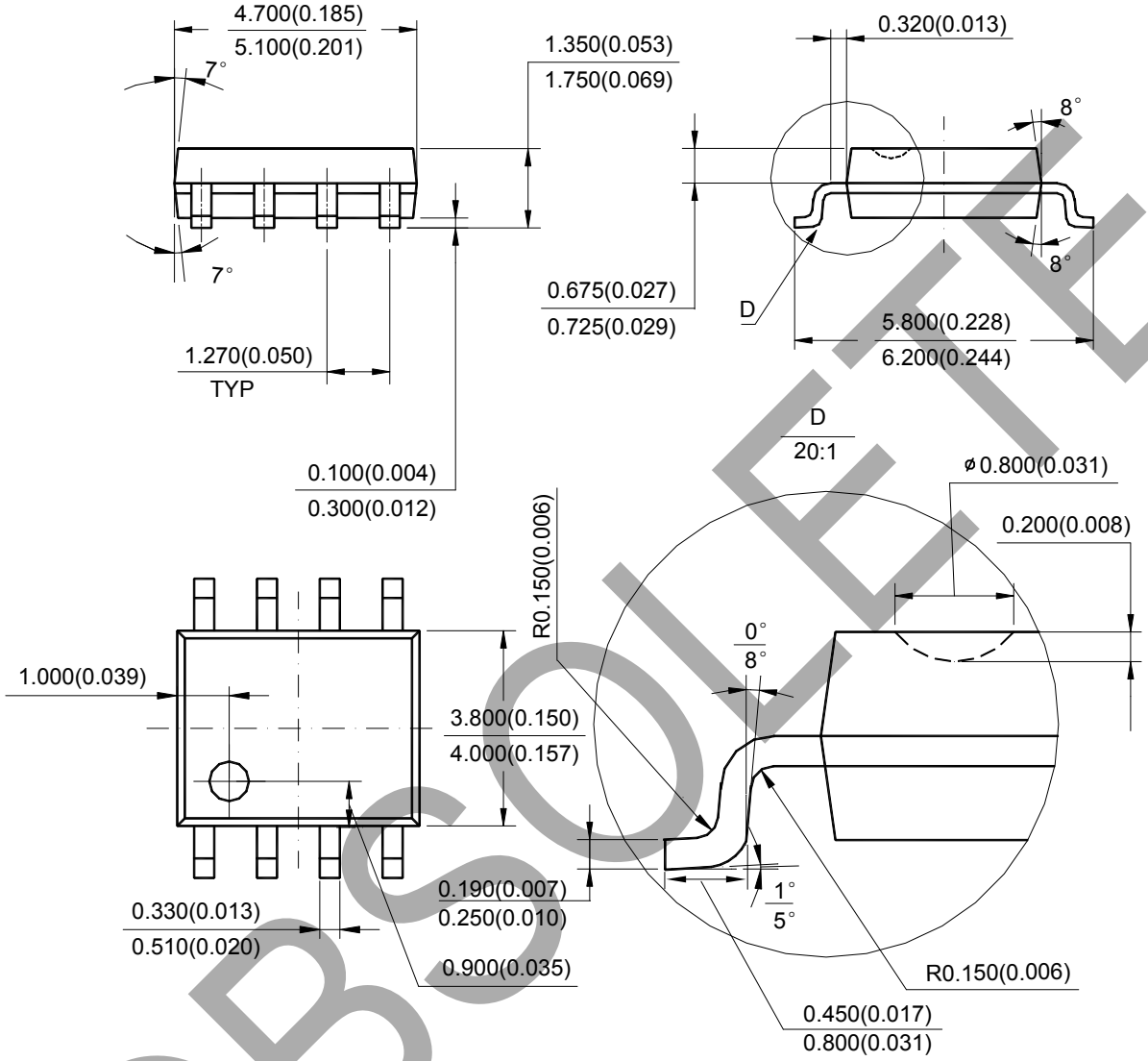
Ordering Information



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

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

(1) Package Type: SOIC-8



Note: Eject hole, oriented hole and mold mark is optional.

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