18V, 2A Synchronous DC-DC Buck Converter AP3512E

General Description

The AP3512E is a 500kHz 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 AP3512E exhibits high efficiency at light load. The device integrates N-channel power MOSFET switch with low on-resistance. Current mode control provides fast transient response and cycle-by-cycle current limit.

The AP3512E employs complete protection to ensure system security, including output Over Voltage Protection, input Under Voltage Lock Out, programmable Soft-start, Over Temperature Protection and hiccup mode Short Circuit Protection.

This IC is available in SOIC-8 and PSOP-8 packages.

Features

- Input Voltage Range: 4.5V to 18V
- Fixed 500kHz Frequency
- High Efficiency at Light Load
- 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
- Hiccup Mode SCP

Applications

- Monitor
- TV
- STB
- Datacom

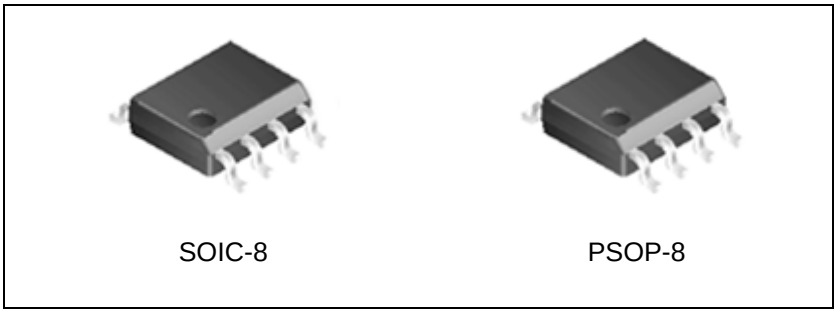

Figure 1. Package Types of AP3512E

Pin Configuration

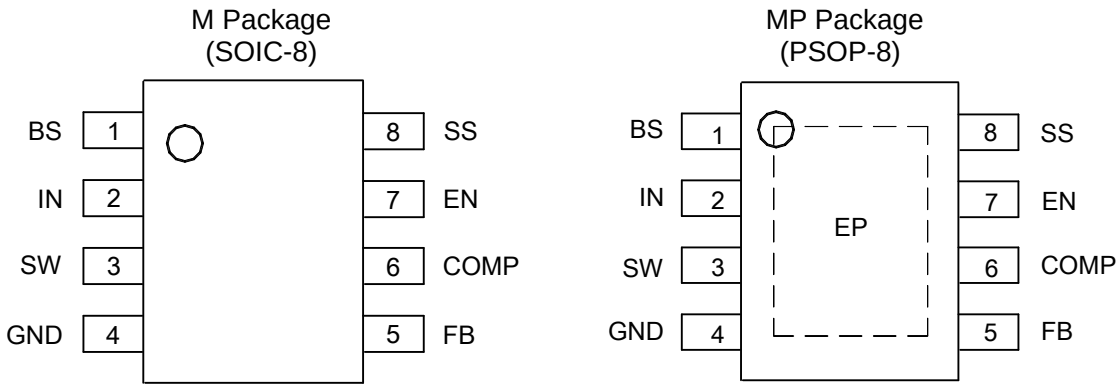

Figure 2. Pin Configuration of AP3512E (Top View)

Pin Description

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 NMOS switch.
2	IN	Supply input pin. A capacitor should be connected between the IN pin and GND pin to keep the DC 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. This pin is used to compensate the control loop. Connect a series RC network from this pin to GND pin. In some cases, an additional capacitor from this pin to GND pin is required.
7	EN	Enable Input. EN is a digital input that turns the regulator on or off. Drive EN high to turn on the regulator, drive it low to turn off. 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.
	EP	Exposed pad. It should be connected to GND in PCB layout

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Functional Block Diagram

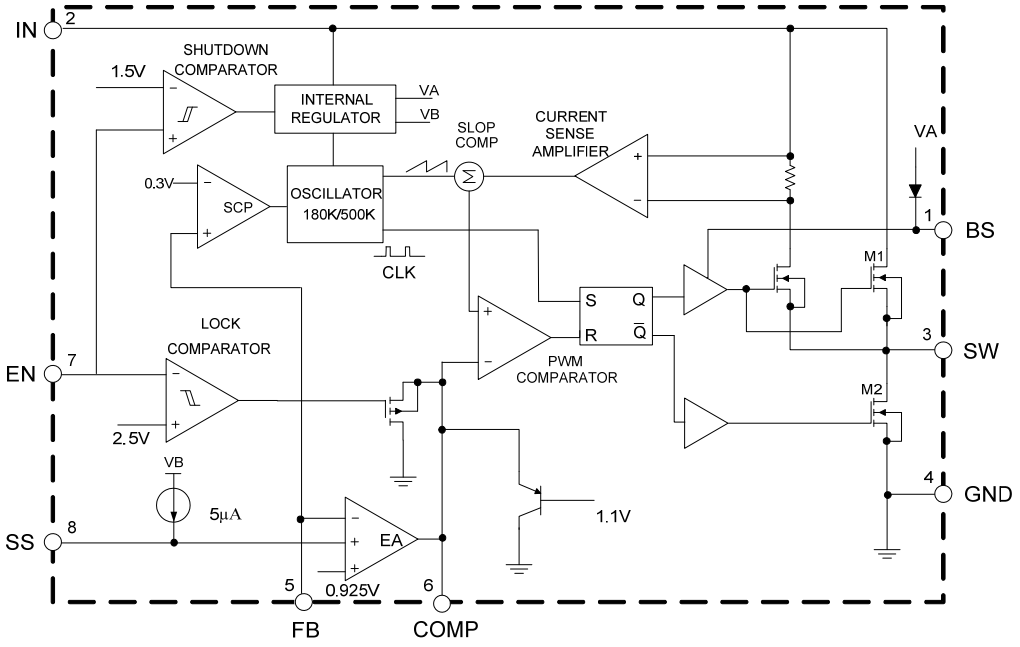
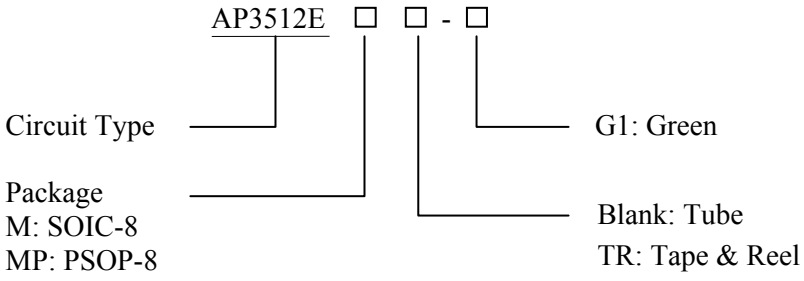


Figure 3. Functional Block Diagram of AP3512E

Ordering Information



Package	Temperature Range	Part Number	Marking ID	Packing Type
SOIC-8	-40 to 85°C	AP3512EM-G1	3512EM-G1	Tube
		AP3512EMTR-G1	3512EM-G1	Tape & Reel
PSOP-8	-40 to 85°C	AP3512EMPTR-G1	3512EMP-G1	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Value		Unit
IN Pin Voltage	V_{IN}	-0.3 to 20		V
EN Pin Voltage	V_{EN}	-0.3 to V_{IN}		V
SW Pin Voltage	V_{SW}	21		V
BS Pin Voltage	V_{BS}	-0.3 to V_{SW}+6		V
FB Pin Voltage	V_{FB}	-0.3 to 6		V
COMP Pin Voltage	V_{COMP}	-0.3 to 6		V
SS Pin Voltage	V_{SS}	-0.3 to 6		V
Operating Junction Temperature	T_J	150		ºC
Storage Temperature	T_{STG}	-65 to 150		ºC
Lead Temperature (Soldering, 10sec)	T_{LEAD}	260		ºC
Thermal Resistance (Junction to Ambient)	θ_{JA}	SOIC-8	105	ºC/W
		PSOP-8	60	
ESD (Human Body Model)	V_{HBM}	2000		V
ESD (Machine Model)	V_{MM}	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

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

Electrical Characteristics

V_{IN}=V_{EN}=12V, V_{OUT}=3.3V, T_A=25ºC, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
SUPPLY VOLTAGE (IN PIN)						
Input Voltage	V_{IN}		4.5		18	V
Quiescent Current	I_Q	V_{FB}=1V, V_{EN}=3.3V		1.2	1.4	mA
Shutdown Supply Current	I_{SHDN}	V_{EN}=0V		0.1	1.0	μA
UNDER VOLTAGE LOCKOUT						
Input UVLO Threshold	V_{UVLO}	V_{IN} Rising	3.65	4.0	4.25	V
Input UVLO Hysteresis	V_{HYS}			0.2		V
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)						
Feedback Voltage	V_{FB}		0.907	0.925	0.943	V
Feedback Over Voltage Threshold	V_{FBOV}			1.1		V
Feedback Bias Current	I_{FB}	V_{FB}=1V	-0.1		0.1	μA
MOSFET						
High-side Switch On-resistance (Note 3)	R_{DSONH}	I_{SW}=0.2A&0.7A		100		mΩ
Low-side Switch On-resistance (Note 3)	R_{DSONL}	I_{SW}=-0.2A&-0.7A		100		mΩ
CURRENT LIMIT						
High-side Switch Leakage Current	I_{LEAKH}	V_{IN}=18V, V_{EN}=0V, V_{SW}=0V		0.1	10	μA
High-side Switch Current Limit	I_{LIMH}		4.3	5.6		A
Low-side Switch Current Limit	I_{LIML}	From drain to source		50		mA
SWITCHING REGULATOR						
Oscillator Frequency	f_{OSC1}		410	500	590	kHz
Short Circuit Oscillator Frequency	f_{OSC2}			180		kHz

Electrical Characteristics (Continued)

V_{IN}=V_{EN}=12V, V_{OUT}=3.3V, T_A=25ºC, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Max. Duty Cycle	D_{MAX}	V_{FB}=0.85V		90		%
Min. Duty Cycle	D_{MIN}	V_{FB}=1V			0	%
ERROR AMPLIFIER						
Error Amplifier Voltage Gain (Note 2)	A_{EA}			400		V/V
Error Amplifier Transconductance	G_{EA}			800		μA/V
COMP to Current Sense Transconductance	G_{CS}			5.2		A/V
THERMAL SHUTDOWN						
Thermal Shutdown (Note 2)	T_{OTSD}			160		ºC
Thermal Shutdown Hysteresis (Note 2)	T_{HYS}			30		ºC
SOFT START (SS PIN)						
Soft-start Time (Note 2)	t_{SS}	C_{SS}=0.1μF		15		ms
Soft-start Current				5		μA

Note 2: Not tested, guaranteed by design.

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

Typical Performance Characteristics

V_{IN}=12V, V_{OUT}=3.3V, L=4.7µH, T_A=25°C, unless otherwise noted.

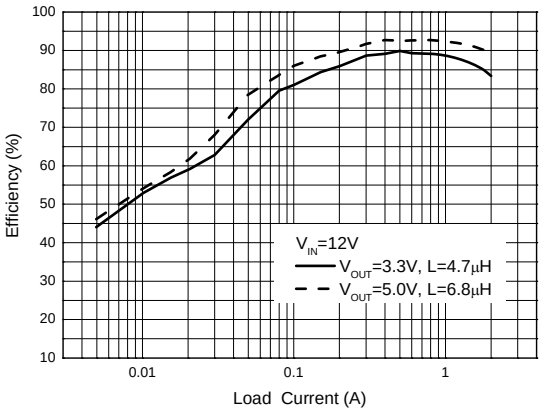


Figure 4. Efficiency vs. Load Current

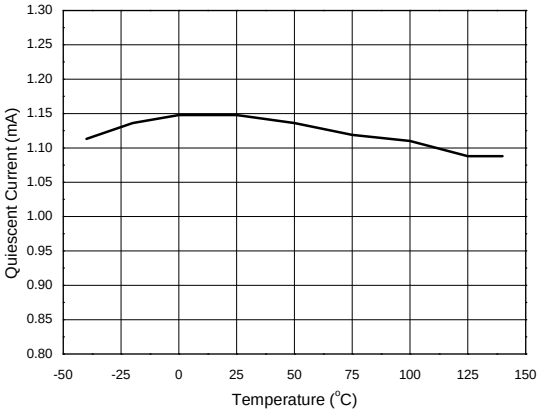


Figure 5. Quiescent Current vs. Temperature

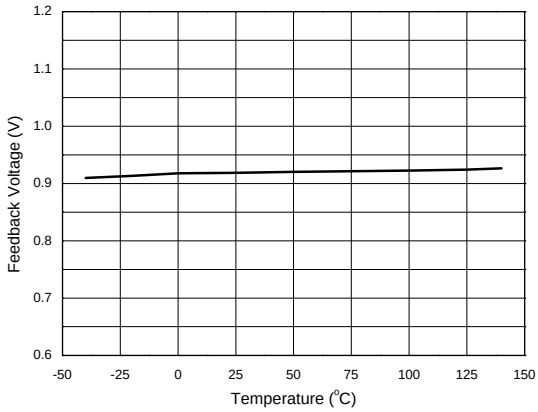


Figure 6. Feedback Voltage vs. Temperature

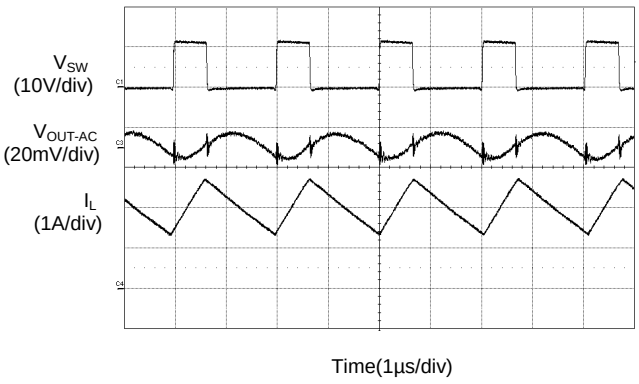


Figure 7. Output Ripple (I_{OUT}=2A)

Typical Performance Characteristics (Continued)

V_{IN}=12V, V_{OUT}=3.3V, L=4.7μH, T_A=25°C, unless otherwise noted.

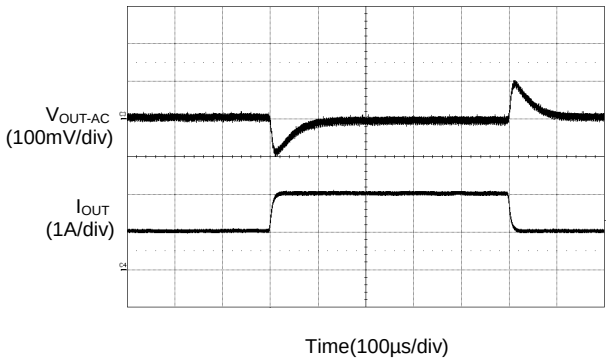


Figure 8. Load Transient Response (I_{OUT}=1A to 2A)

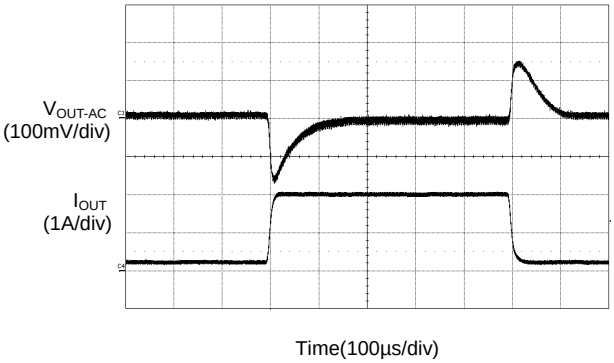


Figure 9. Load Transient Response (I_{OUT}=0.2A to 2A)

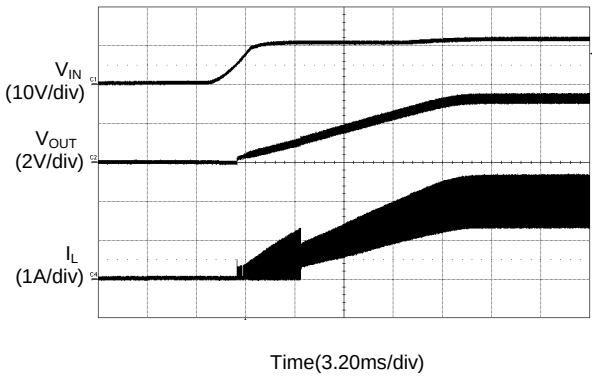


Figure 10. Power On from VIN (I_{OUT}=2A)

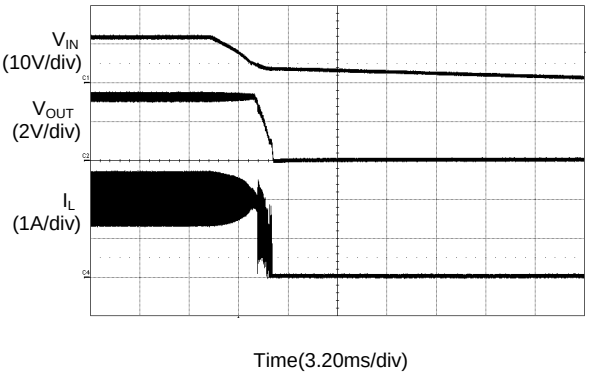


Figure 11. Power Off from VIN (I_{OUT}=2A)

Typical Performance Characteristics (Continued)

V_{IN}=12V, V_{OUT}=3.3V, L=4.7μH, T_A=25°C, unless otherwise noted.

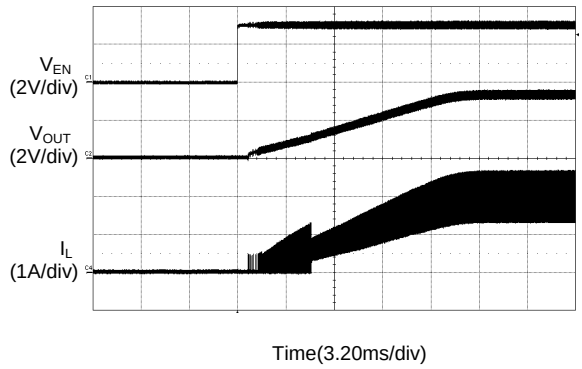


Figure 12. Power On from EN (I_{OUT}=2A)

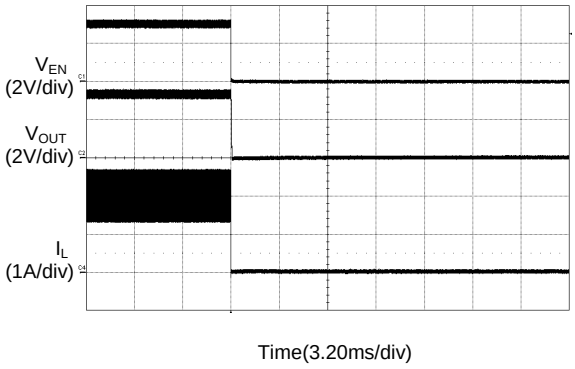


Figure 13. Power Off from EN (I_{OUT}=2A)

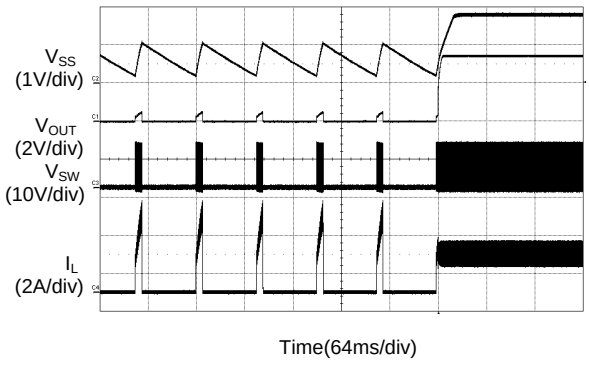


Figure 14. Short Circuit Protection (I_{OUT}=2A)

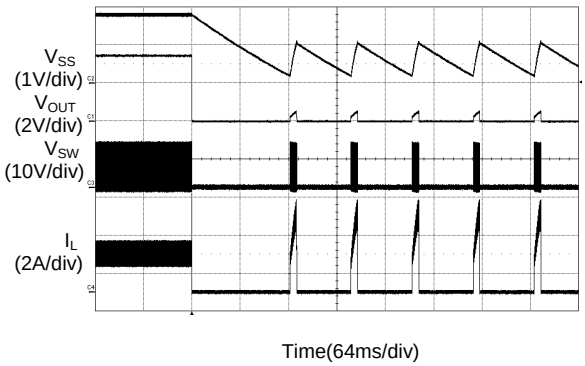


Figure 15. Short Circuit Protection Recovery (I_{OUT}=2A)

Typical Application

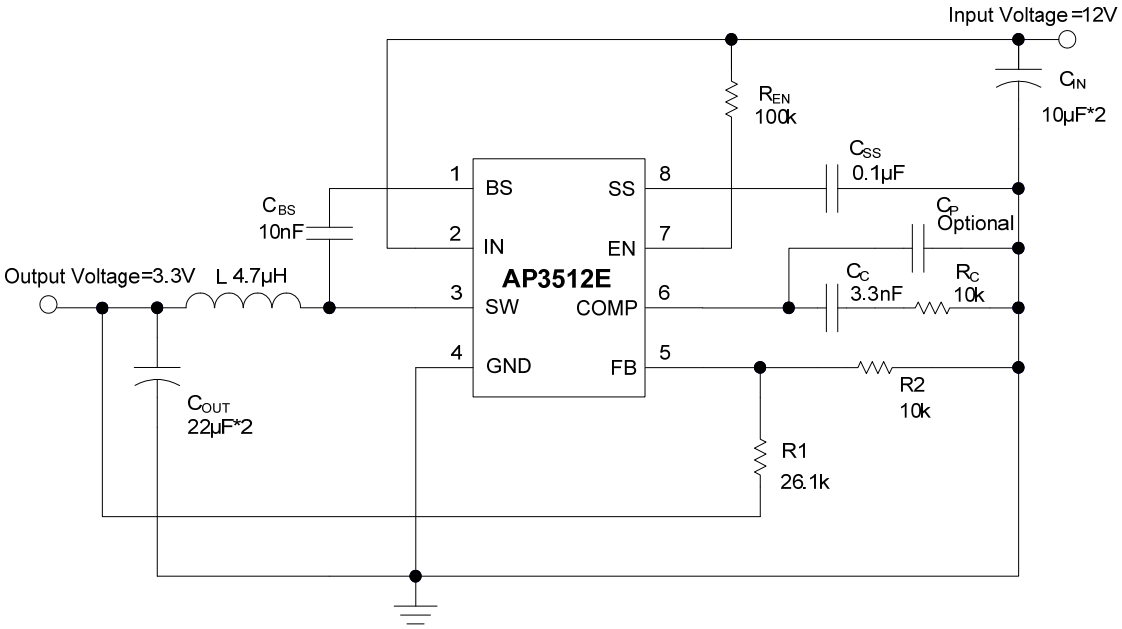
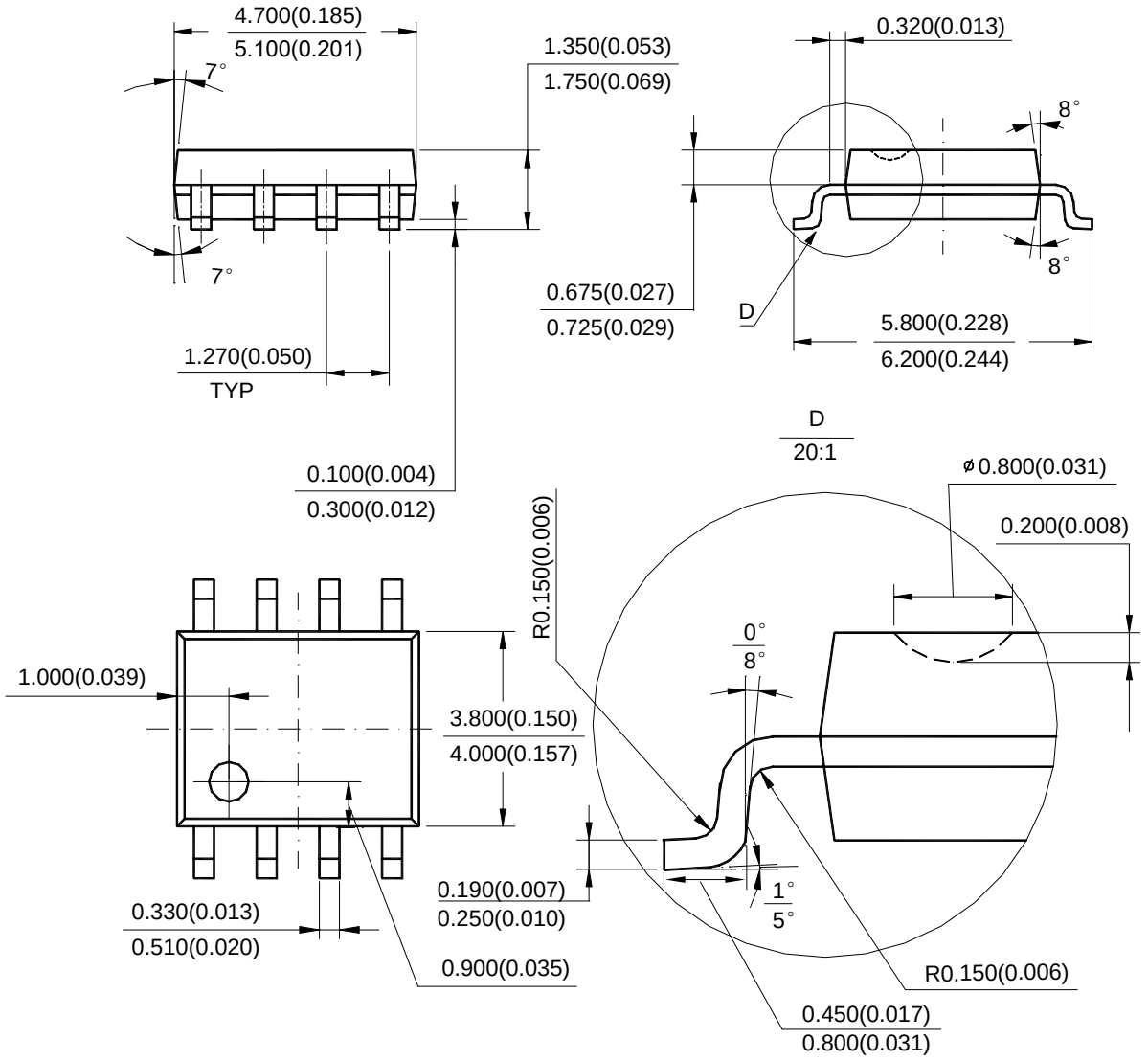


Figure 16. Typical Application Circuit of AP3512E

Mechanical Dimensions

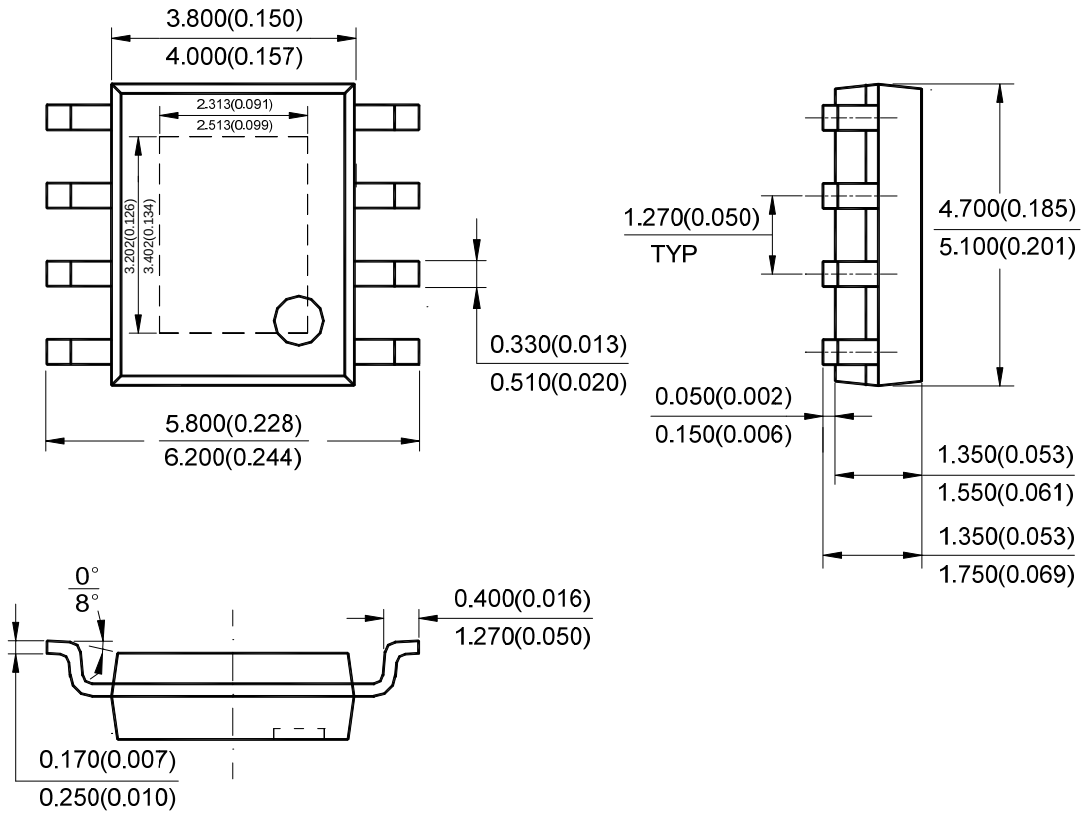
SOIC-8 **Unit: mm(inch)**



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

Mechanical Dimensions (Continued)

PSOP-8 **Unit: mm(inch)**



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

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