Description

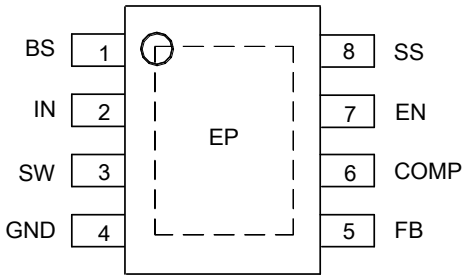
The AP3513E is a 500kHz fixed frequency, current mode, PWM synchronous buck (step-down) DC-DC converter, capable of driving a 3A load with high efficiency, excellent line and load regulation. The AP3513E exhibits high efficiency at light load. The device integrates N-channel power MOSFET switch with low on-resistance. Current mode control provides fast transient response and cycle-by-cycle current limit.

The AP3513E 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 SO-8EP package.

Pin Assignments

(Top View)



SO-8EP

Features

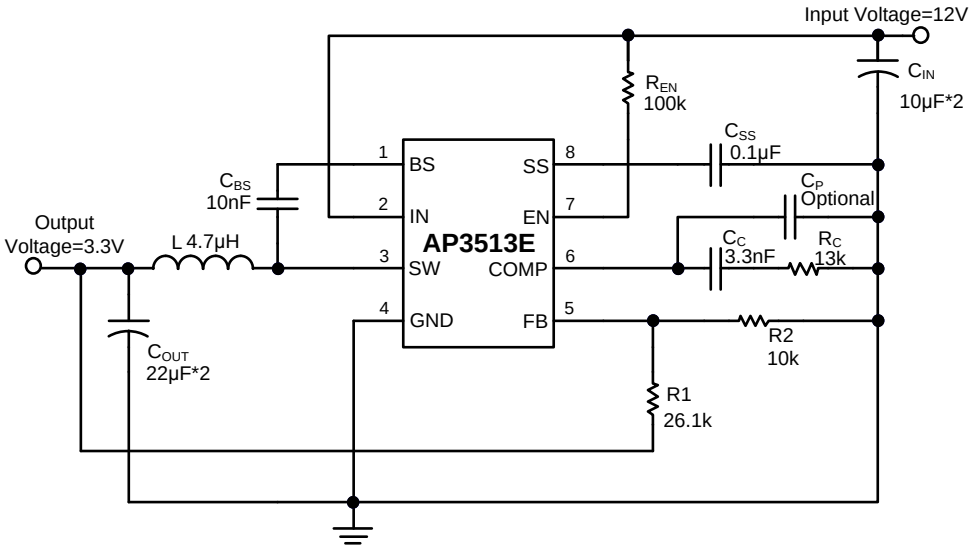
- Input Voltage Range: 4.5V to 18V
- Fixed 500kHz Frequency
- High Efficiency at Light Load
- Output Current: 3A
- Current Mode Control
- Built-in Over Current Protection
- Built-in Thermal Shutdown Function
- Built-in UVLO Function
- Built-in Over Voltage Protection
- Programmable Soft-start
- Hiccup Mode SCP
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3**)

Applications

- Monitor
- TV
- STB
- Datacom

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.

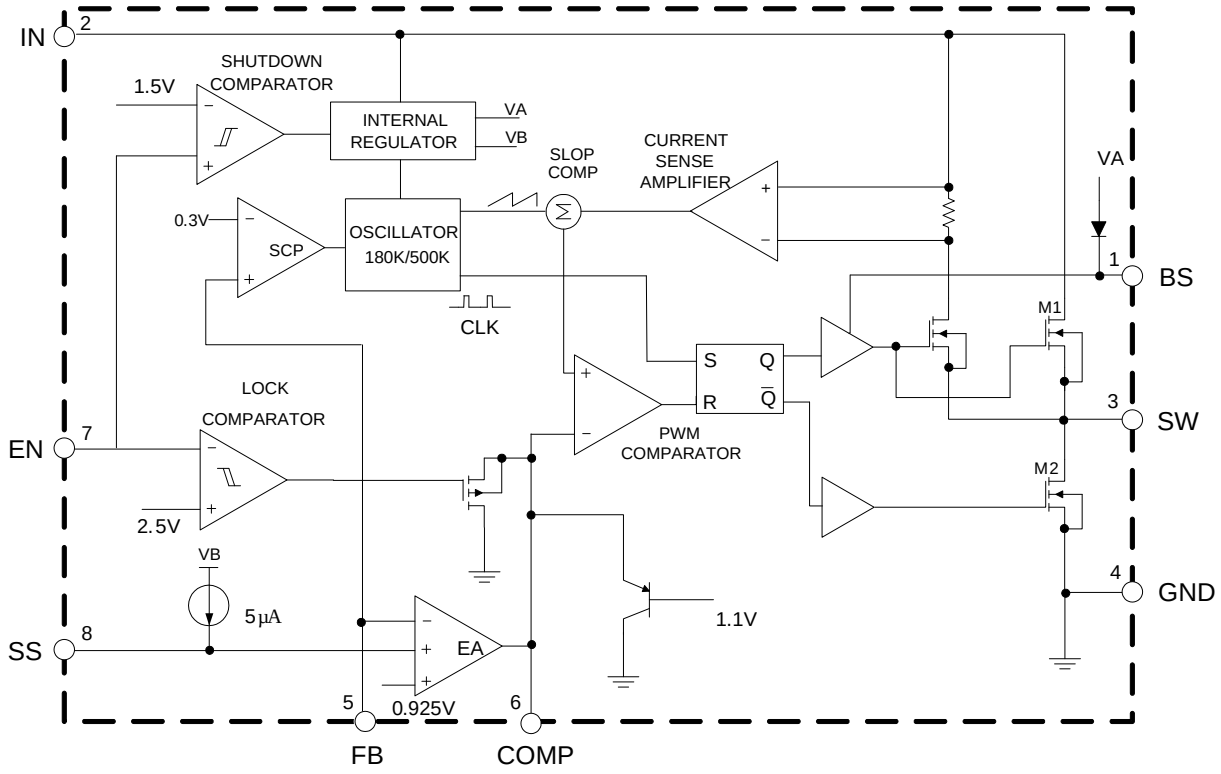
Typical Applications Circuit



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 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.

Functional Block Diagram



Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating		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
T_J	Operating Junction Temperature	+150		°C
T_{STG}	Storage Temperature	-65 to +150		°C
T_{LEAD}	Lead Temperature (Soldering, 10s)	+260		°C
θ_{JA}	Thermal Resistance (Junction to Ambient)	SO-8EP	60	°C/W
V_{HBM}	ESD (Human Body Model)	2000		V
V_{MM}	ESD (Machine Model)	200		V

Note 4: 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 (V_{IN} = V_{EN} = 12V, V_{OUT} = 3.3V, T_A = +25°C, 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} = 3.3V	–	1.2	1.4	mA
I_{SHDN}	Shutdown Supply Current	V_{EN} = 0V	–	0.1	1.0	µA
UNDER VOLTAGE LOCKOUT						
V_{UVLO}	Input UVLO Threshold	V_{IN} Rising	3.65	4.0	4.25	V
V_{HYS}	Input UVLO Hysteresis	–	–	0.2	–	V
ENABLE (EN PIN)						
–	EN Shutdown Threshold Voltage	–	1.1	1.5	2	V
–	EN Shutdown Threshold Voltage Hysteresis (Note 5)	–	–	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 6)	I_{SW} = 0.2A and 0.7A	–	100	–	mΩ
R_{DSONL}	Low-side Switch On-resistance (Note 6)	I_{SW} = -0.2A and -0.7A	–	100	–	mΩ
CURRENT LIMIT						
I_{LEAKH}	High-side Switch Leakage Current	V_{IN} = 18V, V_{EN} = 0V, V_{SW} = 0V	–	0.1	10	µA
I_{LIMH}	High-side Switch Current Limit	–	4.3	5.6	–	A
I_{LIML}	Low-side Switch Current Limit	From Drain to Source	–	50	–	mA
SWITCHING REGULATOR						
f_{OSC1}	Oscillator Frequency	–	410	500	590	kHz
f_{OSC2}	Short Circuit Oscillator Frequency	–	–	180	–	kHz
D_{MAX}	Max. Duty Cycle	V_{FB} = 0.85V	–	90	–	%
D_{MIN}	Min. Duty Cycle	V_{FB} = 1V	–	–	0	%

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

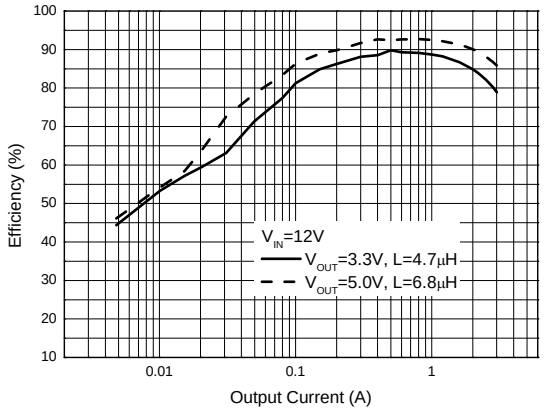
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
ERROR AMPLIFIER						
A_{EA}	Error Amplifier Voltage Gain (Note 5)	–	–	400	–	V/V
G_{EA}	Error Amplifier Transconductance	–	–	800	–	μA/V
G_{CS}	COMP to Current Sense Transconductance	–	–	5.2	–	A/V
THERMAL SHUTDOWN						
T_{OTSD}	Thermal Shutdown (Note 5)	–	–	+160	–	°C
T_{HYS}	Thermal Shutdown Hysteresis (Note 5)	–	–	+30	–	°C
SOFT START (SS PIN)						
t_{SS}	Soft-start Time (Note 5)	C_{SS} = 0.1μF	–	15	–	ms
–	Soft-start Current	–	–	5	–	μA

Notes: 5. Not tested, guaranteed by design.

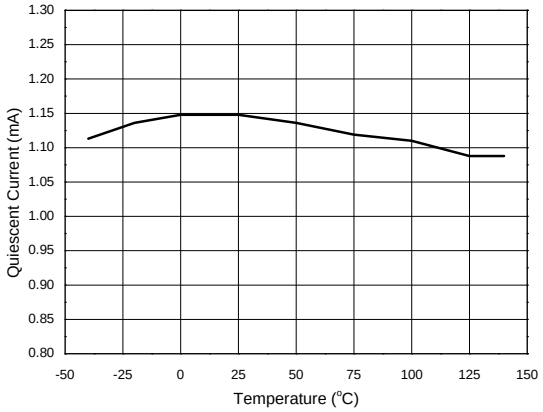
6. $R_{DS(ON)} = \frac{V_{SW1} - V_{SW2}}{I_{SW1} - I_{SW2}}$

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

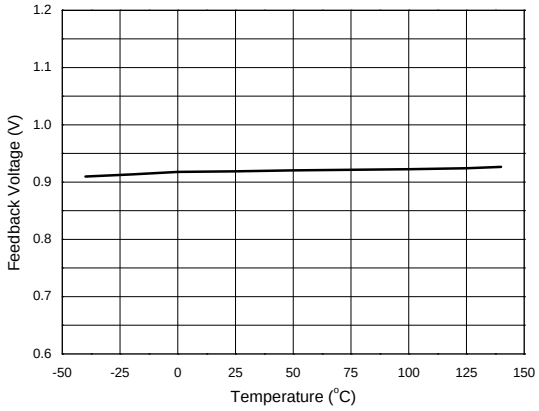
Efficiency vs. Output Current



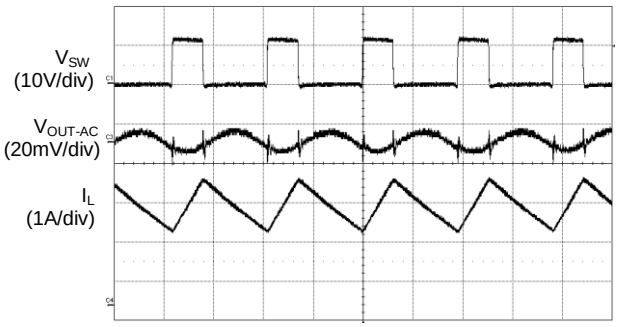
Quiescent Current vs. Temperature



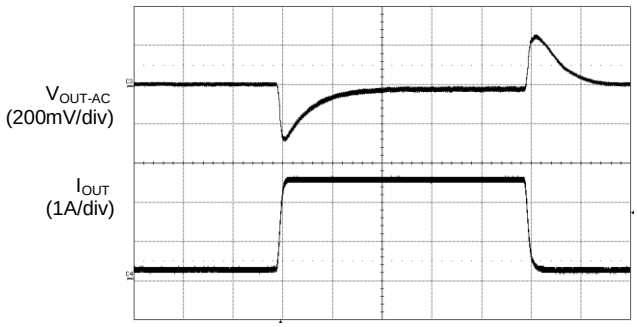
Feedback Voltage vs. Temperature



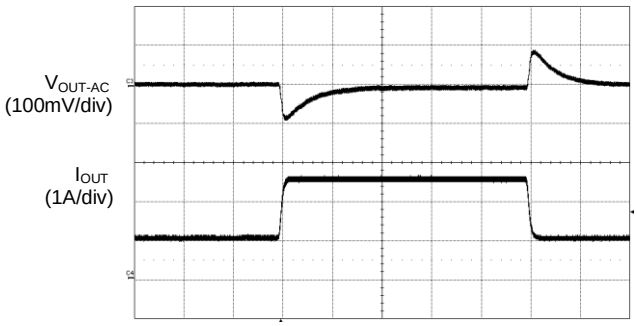
Output Ripple (I_{OUT} = 2.5A)



Load Transient Response (I_{OUT} = 0.2A to 2.5A)

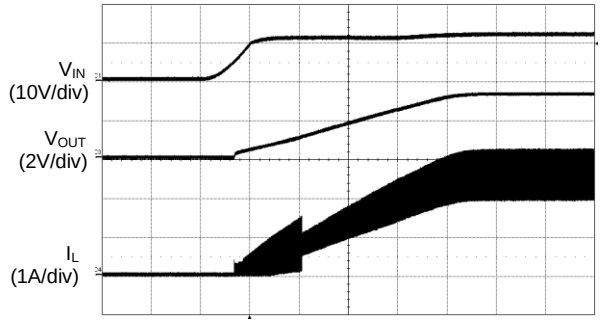


Load Transient Response (I_{OUT} = 1A to 2.5A)



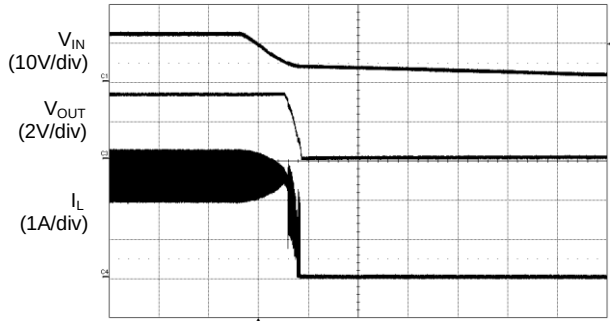
Performance Characteristics (Cont. V_{IN} = 12V, V_{OUT} = 3.3V, L = 4.7µH, T_A = +25°C, unless otherwise noted.)

Power On from V_{IN} (I_{OUT} = 2.5A)



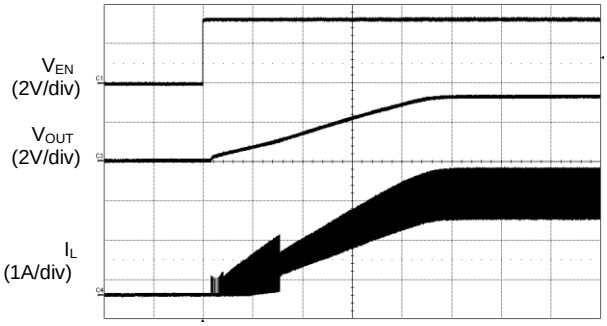
Time (3.20ms/div)

Power Off from V_{IN} (I_{OUT} = 2.5A)



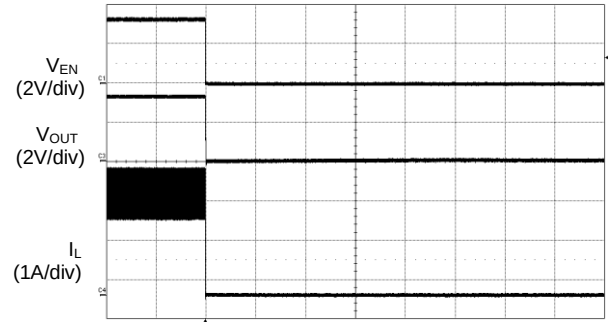
Time (3.20ms/div)

Power On from EN (I_{OUT} = 2.5A)



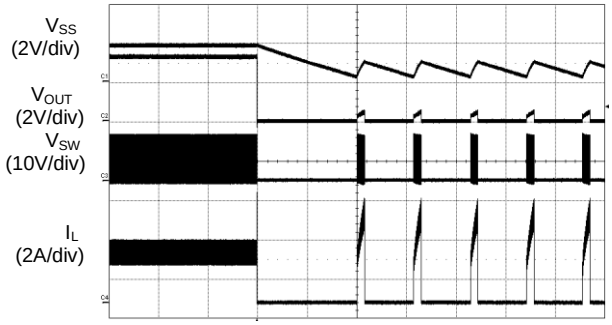
Time (3.20ms/div)

Power Off from EN (I_{OUT} = 2.5A)



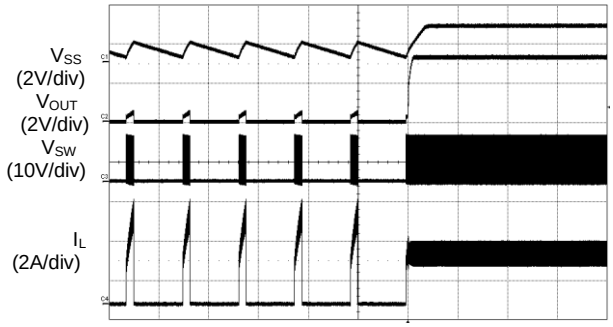
Time (3.20ms/div)

Short Circuit Protection (I_{OUT} = 2.5A)



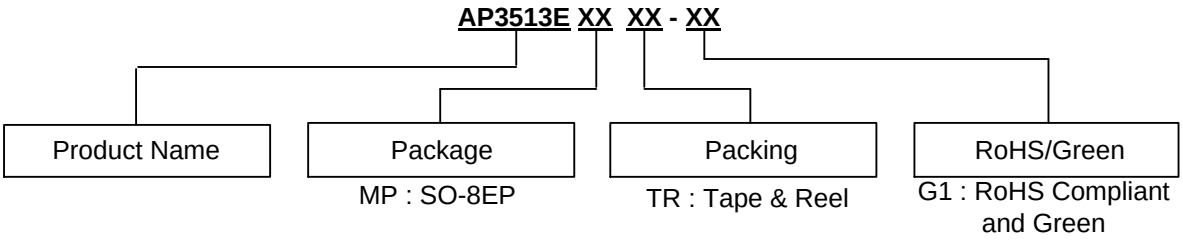
Time (64ms/div)

Short Circuit Protection Recovery (I_{OUT} = 2.5A)



Time (64ms/div)

Ordering Information



Package (Note 8)	Temperature Range	Part Number	Packing	Status (Note 7)
SO-8EP	-40 to +85°C	AP3513EMPTR-G1	4000/Tape & Reel	In Production

Notes: 7. All Tube versions are End of Life with replacement in Tape & Reel versions.
8. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information

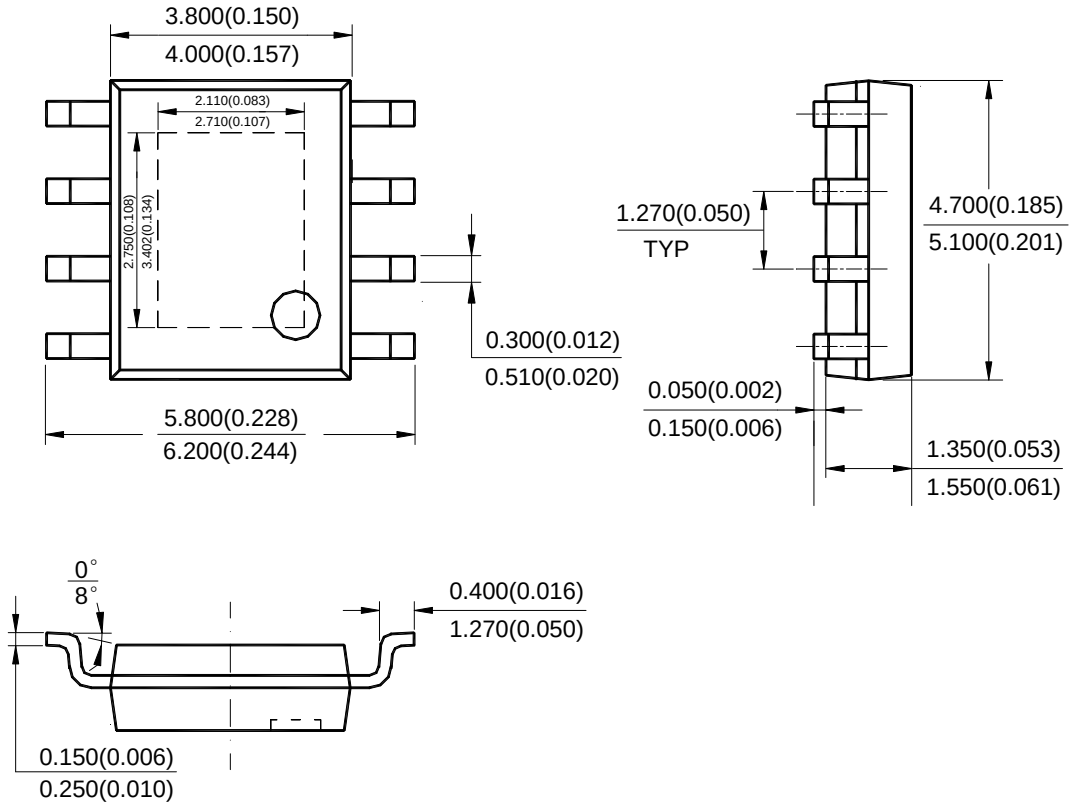
SO-8EP

(Top View)

First and Second Lines: Logo and Marking ID
Third Line: Date Code
Y: Year
WW: Work Week of Molding
A: Assembly Site Code
XX: 7th and 8th Digits of Batch Number

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

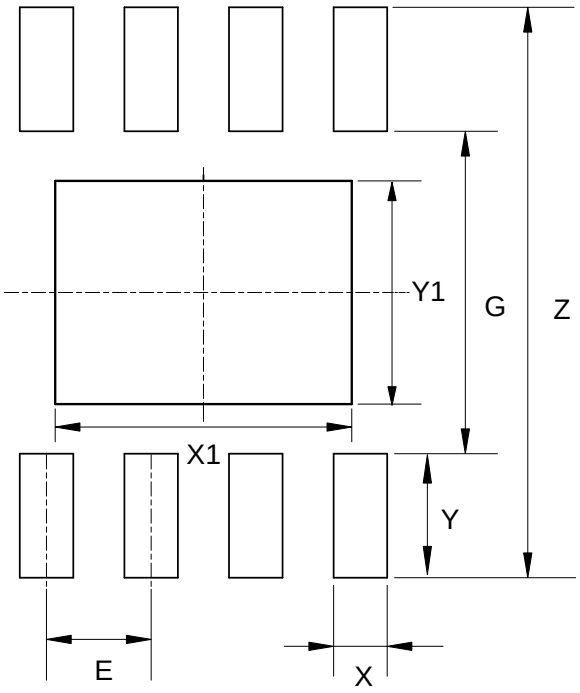
Package Type: SO-8EP



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

Suggested Pad Layout

Package Type: SO-8EP



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	X1 (mm)/(inch)	Y1 (mm)/(inch)	E (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059	3.600/0.142	2.700/0.106	1.270/0.050

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