Low-Power Primary Side Regulation Power Switch SDC3106

General Description

SDC3106 is a high performance off-line PSR controller for low-power AC/DC charger and adapter applications which integrates 700V power BJT. It works in Pulse Frequency Modulation Mode and provides operating frequency dithering function to improve EMC performance of power supply. It operates in primary-side sensing and regulation. Consequently, opto-coupler and TL431 could be eliminated. SDC3106 provides ±5% constant voltage and constant current regulation at universal AC input.

Features

- Primary side control without opto-coupler and TL431
- 30mW standby power, meeting six-star standard
- Built-in output cable voltage drop compensation
- Built-in AC compensation
- CV/CC regulation ± 5%
- Flyback topology in DCM operation
- Pulse frequency modulation mode
- Enhanced audio noise suppression
- Built-in leading edge blanking
- Over voltage protection
- Short circuit protection
- Package: DIP-8/SOP-8
- Output power range[note1]:
  SDC3106(SOP-8) ≤ 6W
  SDC3106(DIP-8) ≤ 7.5W

Applications

- Adapters/Chargers for cell/cordless phones, PDAs, MP3 and other portable devices
- LED driver
- Standby and auxiliary power supplies

DIP-8

SOP-8

Note1：Typical continuous power in a non-ventilated enclosed adapter measured at +45°C ambient.

Pin Configuration

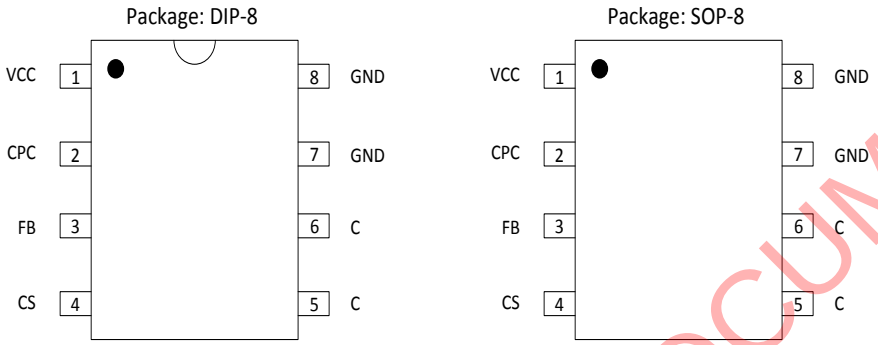


Figure 2. Pin Configuration

Pin Number	Pin Name	Function
1	VCC	Power supply pin
2	CPC	This pin connects a capacitor for output cable voltage drop compensation and audio noise suppression
3	FB	The voltage feedback from the auxiliary winding
4	CS	The primary current sense pin, this pin connects a current sense resistor
5、6	C	This pin is connected to an internal power BJT's collector
7、8	GND	Ground

Table 1. Pin Description

Block Diagram

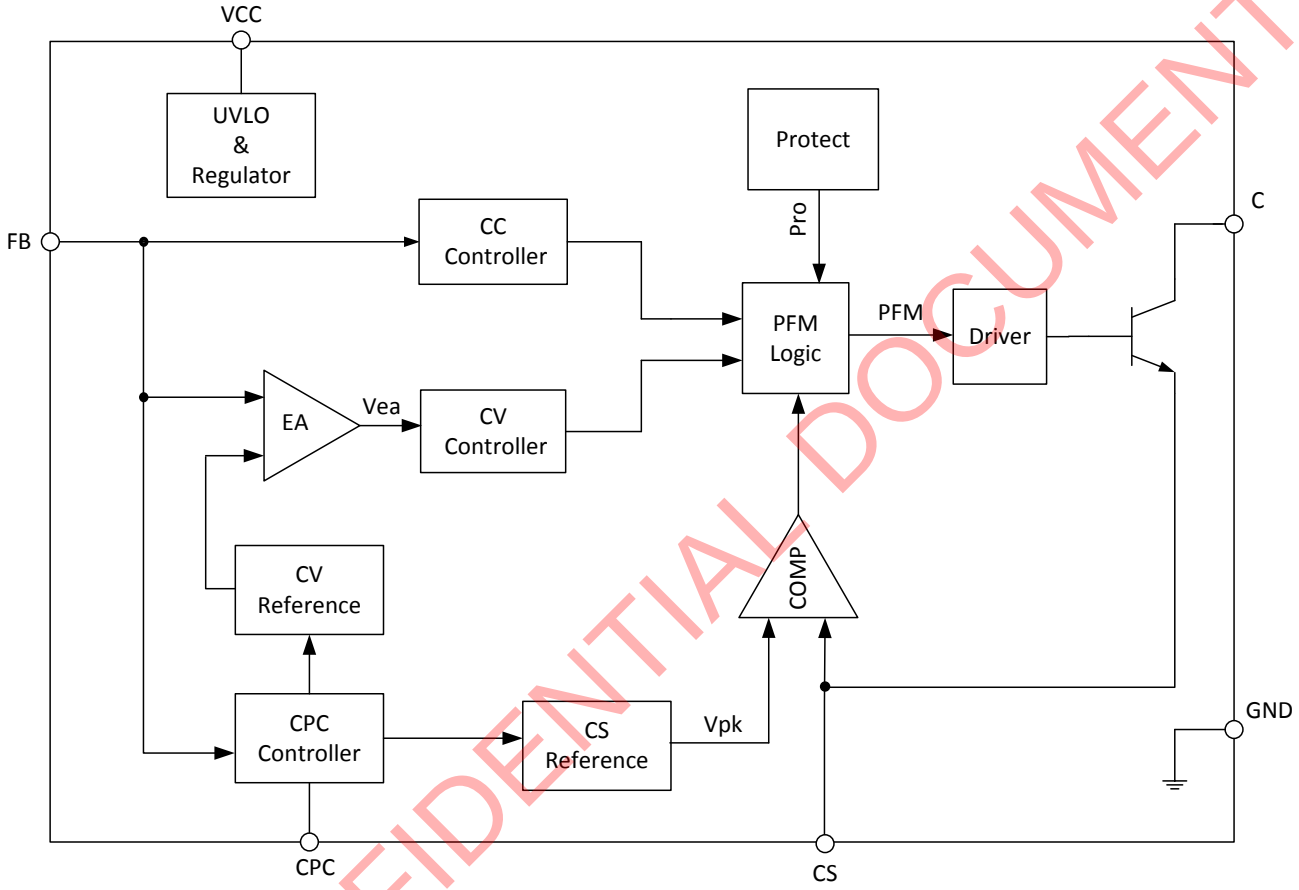
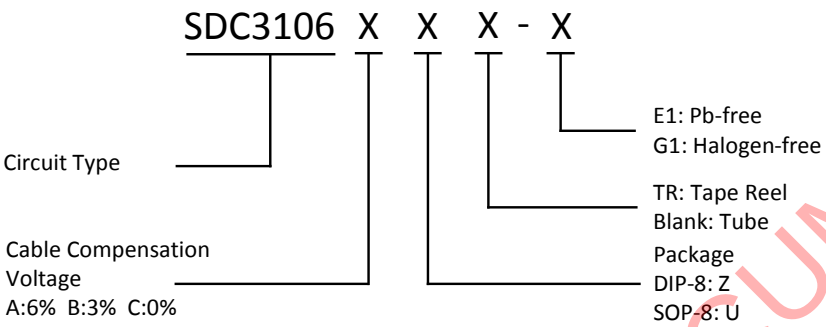


Figure 3. Functional Block Diagram

Ordering Information



Package	Temperature Range	Part Number		Marking ID		Packing Type
		Pb-free	Halogen-free	Pb-free	Halogen-free	
DIP-8	-40~85℃	SDC3106AZ-E1	SDC3106AZ-G1	3106A	3106AG	Tube
		SDC3106BZ-E1	SDC3106BZ-G1	3106B	3106BG	Tube
		SDC3106CZ-E1	SDC3106CZ-G1	3106C	3106CG	Tube
SOP-8		SDC3106AUTR-E1	SDC3106AUTR-G1	3106A	3106AG	Tape Reel
		SDC3106BUTR-E1	SDC3106BUTR-G1	3106B	3106BG	Tape Reel
		SDC3106CUTR-E1	SDC3106CUTR-G1	3106C	3106CG	Tape Reel

Absolute Maximum Ratings

(NOTE: Stresses greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device.)

Parameter	Symbol	Value	Unit
VCC to GND	V_{CC}	-0.3~30	V
CS, OUT to GND	V_{CS}, V_{CPC}	-0.3~7	V
FB input voltage	V_{FB}	-40~7	V
Peak value of switching current	I_{PK}	540	mA
Collector-base voltage of integrated BJT	V_{CBO}	-0.3~700	V
Collector current of integrated BJT	I_C	1.8	A
Operating junction temperature T_J	T_{Jmax}	150	℃
Storage temperature T_{STG}	T_{STG}	-55~150	℃
Lead temperature (Soldering, 10sec)	T_{LEAD}	260	℃
Latch-up test per JEDEC 78	-	200	mA
ESD,HBM model per Mil-Std-883H,Method 3015	HBM	2000	V
ESD,MM model per JEDEC EIA/JESD22-A115	MM	200	V

Table 2. Absolute Maximum Ratings

Recommended Operating Conditions

Parameter	Min	Max	Unit
VCC supply voltage	6	30	V
Operating temperature range	-40	85	℃
Operating frequency	55	100	kHz

Table 3. Recommended Operating Conditions

Electrical Characteristics (Ta=25°C,Vcc=15V, unless otherwise specified)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Power Current Section						
Start-up threshold	V_{TH}	-	13	15.5	18	V
Minimal operating voltage	V_{OFF}	-	5.4	6.0	6.6	V
Start-up current	I_{ST}	$V_{CC}=V_{TH}$-1, before start-up	0	0.2	0.6	uA
Operating current	I_{CC}	-	-	500	-	uA
Current Sense Section						
Current sense threshold voltage in CC mode	V_{CS}	-	475	500	525	mV
Leading edge blanking	t_{LEB}	-	-	500	-	ns
Feedback Input Section						
FB leakage current	I_{FB}	V_{FB}=4V	1.6	2.2	3.0	uA
Feedback threshold	V_{FB}	Full Load	3.98	4.04	4.10	V
AC Compensation Section						
Built-in line compensation current	I_{LINE}	V_{FB}= -10V	-	10	-	uA
Built-in line compensation resistor	R_{LINE}	-	-	3.3	-	kΩ
Cable Compensation Section						
Cable compensation voltage	-	SDC3106A	-	6	-	%
	-	SDC3106B	-	3	-	%
	-	SDC3106C	-	0	-	%
BJT Section						
Collector-base Voltage	V_{CBO}	I_C=0.1mA	700	-	-	V
Collector-base cutoff current	I_{CBO}	V_{CB}=700V,I_E=0mA		-	0.1	mA
DC current gain	h_{FE}	V_{CE}=5V， I_C=0.5A	15	-	50	-
Protection Section						
FB over voltage protection	V_{FB_OVP}	-	7.0	8.0	9.0	V
Maximum off time of primary side	t_{OFF_MAX}	-	-	16	-	ms
Maximum on time of primary side	t_{ONP_MAX}	-	-	18	-	us

Table 4. Electrical Characteristics

Operation Description

Start-up

The start-up current of SDC3106 is designed to be very low (typ. 0.2uA), so that VCC could be charged up above UVLO threshold level and device starts up quickly. A large value start-up resistor can therefore be used to minimize the power loss in application.

Operating Current

The operating current of SDC3106 is as low as 500uA, so that good efficiency and very low standby power(less than 30mW) is achieved.

CC/CV Operation

SDC3106 is designed to produce CC/CV control characteristic as shown in the figure 4.

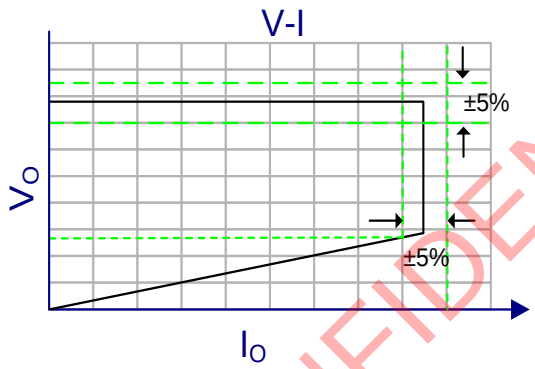


Figure 4. Typical CC/CV Curve

In charger applications, a discharged battery charging starts in the CC portion of the curve until it is nearly full charged and smoothly switches to operate in CV portion of the curve. The CC portion provides output current limiting. In CV operation, the output voltage is regulated through the primary side control. In CC operation mode, SDC3106 will regulate the output current constant regardless of the output voltage drop.

Principle of Operation

To support SDC3106 proprietary CC/CV control, system needs to be designed in DCM mode for flyback system.

In the DCM flyback converter, the output voltage can be sensed via the auxiliary winding. During BJT turn-on time, the load current is supplied from the output filter capacitor, and the current in the primary winding ramps up. When BJT turns off, the energy stored in the primary winding is transferred to the secondary side such that the output current is:

$$I_O = \frac{1}{2} \times \frac{T_{ONS}}{T_{SW}} \times \frac{N_P}{N_S} \times I_{PK}$$

I_O -- The average current of secondary side
T_{ONS} -- The conduction time when secondary side diode is "ON"
T_{SW} -- The period of switching frequency
N_P -- The primary side winding
N_S -- The secondary side winding
I_{PK} -- Peak value of primary side current

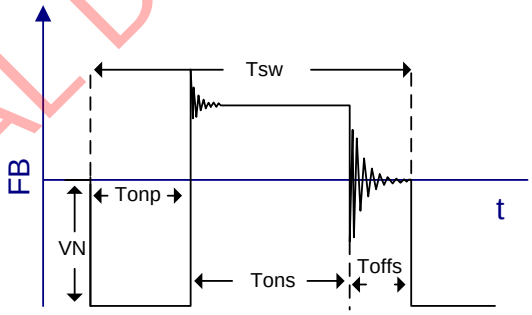


Figure 5. Auxiliary Voltage Waveform

In CC operation mode, SDC3106 calculates the output current through the peak value of primary side current and the ratio of the secondary side diode conduction time and the switching period.

In CC mode of SDC3106, the ratio of T_{ONS} and T_{SW} is 0.5, and the V_{CS} is about 0.5V. So the output current can be approximated as:

$$I_O = \frac{1}{8} \times \frac{1}{R_{CS}} \times \frac{N_P}{N_S}$$

The auxiliary voltage reflects the output voltage as shown in Figure 5 and it is given by

$$V_{AUX} = \frac{N_{AUX}}{N_S} \times (V_O + V_D)$$

V_{AUX} -- The transient voltage at auxiliary winding
N_{AUX} -- The auxiliary winding
N_S -- The secondary side winding
V_O -- The average voltage of secondary side
V_D -- The drop voltage of the output diode

In CV mode, the output voltage is stabilized through the sampled FB voltage being regulated to a constant value of 4.04 V (typ.). The relationship between V_{AUX} and V_{FB} is given by

$$V_{AUX} = V_{FB}\left(1+\frac{R_{FB1}}{R_{FB2}}\right)$$

Where V_{FB} is the voltage of FB pin, R_{FB1} is the upper resistor of FB, and R_{FB2} is the lower resistor of FB.

Thus, the full load output voltage Vo can be expressed as:

$$V_O = \frac{V_{FB}\times N_S \times\left(1+\frac{R_{FB1}}{R_{FB2}}\right)}{N_{AUX}} - V_D$$

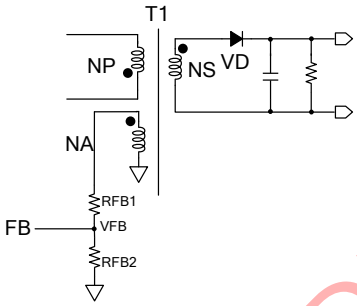


Figure 6. FB Feedback Scheme

Operation Switching Frequency and Audio Noise Suppression

The switching frequency of SDC3106 is adaptively controlled according to the load conditions and the operation modes. Considering power BJT is integrated, the operation switching frequency is recommended below 100 kHz.

Since the system working in DCM mode, the maximum output power is given by

$$P_O = \frac{1}{2}\times L_P \times F_{SW} \times I_{PK}^2$$

Where L_P is transformer primary inductance, I_{PK} is primary peak current in a switching cycle, F_{SW} is switching frequency.

Via a resistor divider connected between the auxiliary winding and FB, the output voltage is sampled indirectly. Then, SDC3106 regulates the switching frequency by controlling the switching off time according to the voltage on FB pin, thus constant voltage (CV) output can be achieved.

The switching frequency decreases along with the load conditions, so it will drop into audio frequency range (20Hz~20kHz) inevitably, which causes audio noise. SDC3106 uses two-stage peak current controlling technology, whose peak current switches to a smaller value under light load condition. Thus, the switching frequency is increased, and audio noise is suppressed.

To ensure that the audio noise suppression function is effective, the maximum switching frequency of the system is recommended above 55 kHz.

Protection Functions

Good power supply system reliability is achieved with SDC3106 rich protection features including short/open circuit protection of current sense resistor and FB upper/lower resistors, FB over voltage protection (OVP), VCC under voltage lockout (UVLO) protection, and maximum on-time protection.

Typical Application

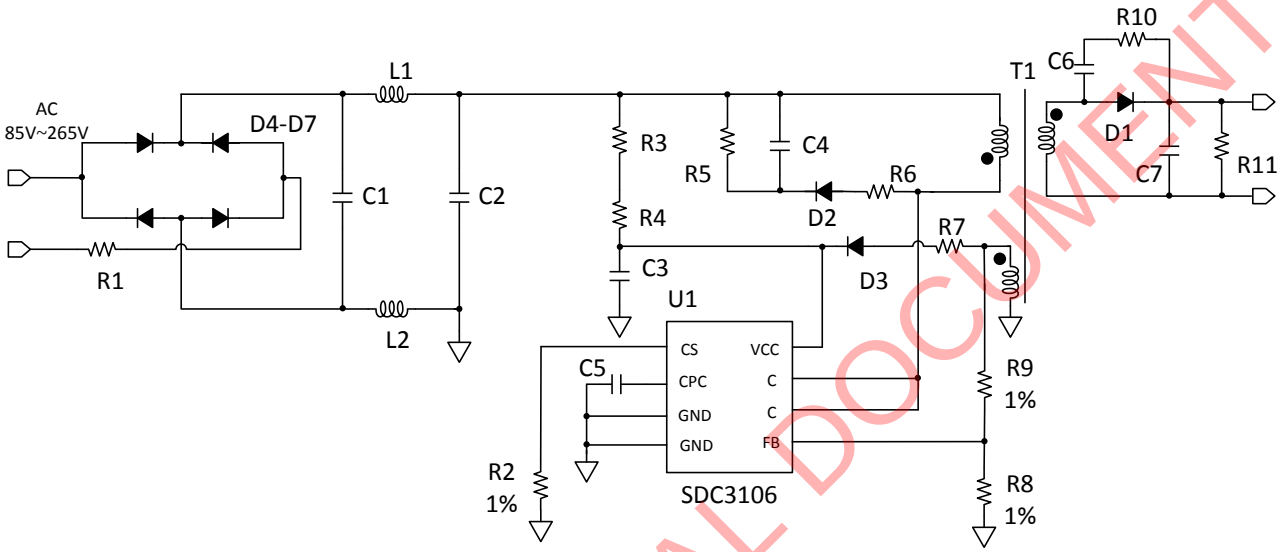
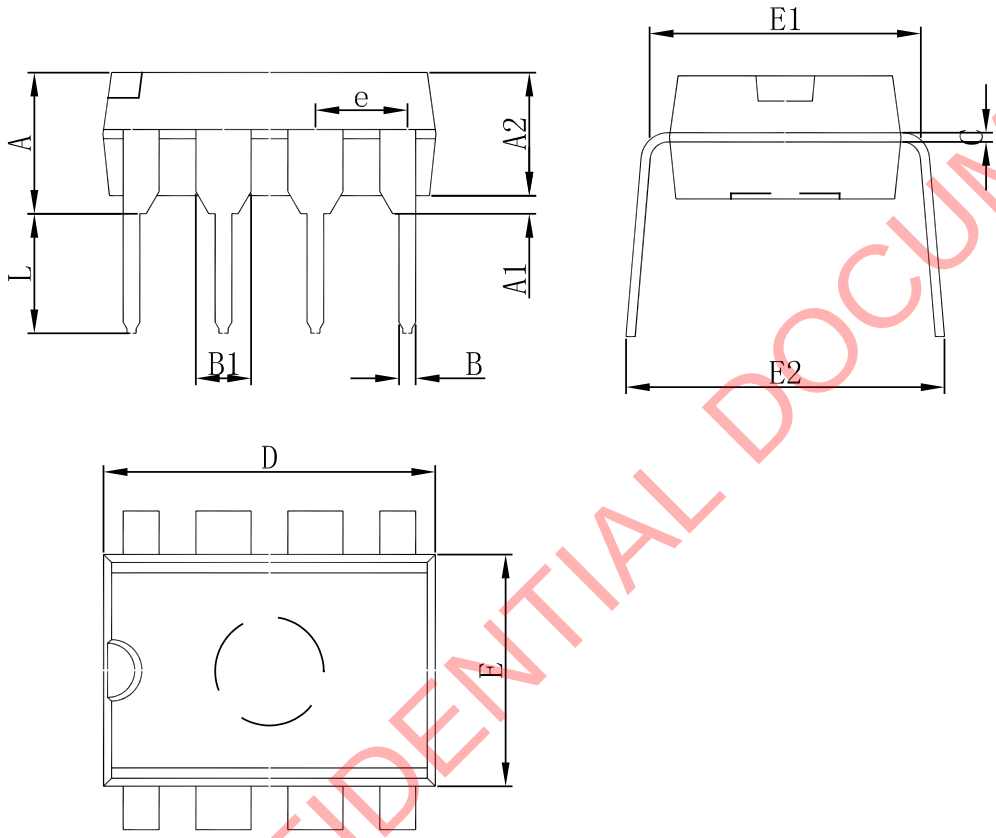


Figure 7. Typical Application

Package Information

DIP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524(BSC)		0.060(BSC)	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540(BSC)		0.100(BSC)	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354

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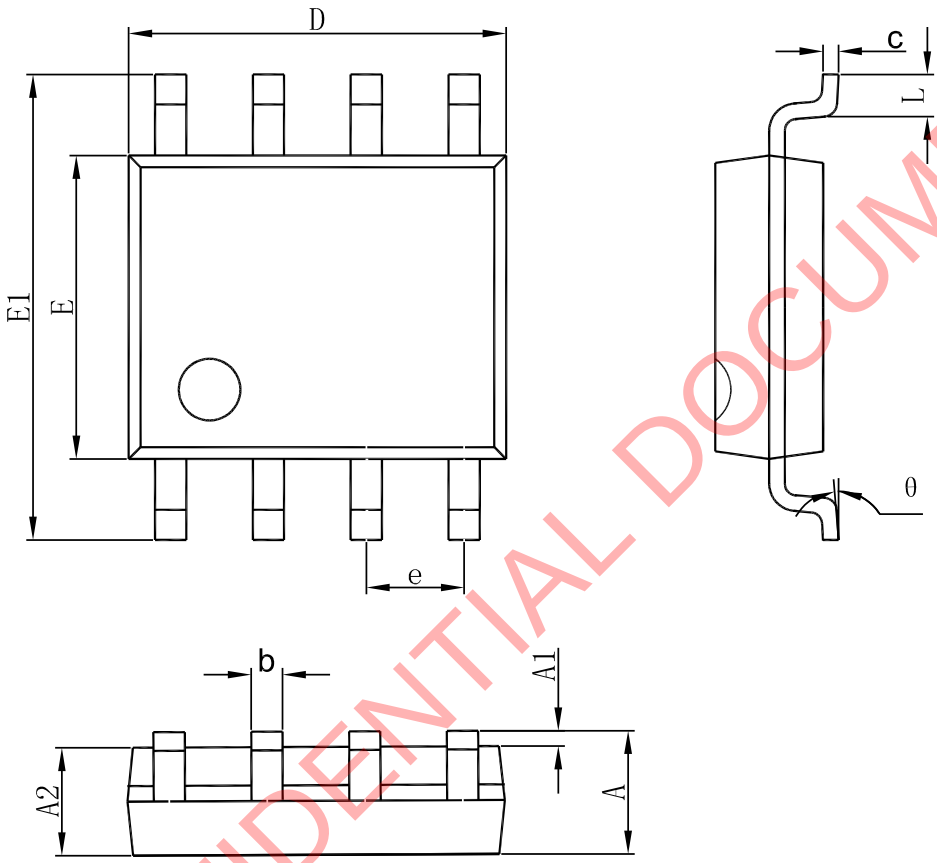

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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