Data Sheet

Type Description : High Precision CC/CV Primary-Side Power Switch

Product Name : EST26xxA

Reversion : V1.0

Reversion Date : May, 2016

Page : 11 Pages

General Description

The EST.26xxA is an excellent primary side feedback converter. It can meet the Energy-Star® specification for AC/DC single output power supplies with no-load power consumption less than 100mW.

It provides constant voltage, constant current and cable compensation,

Also, the EST.26xxA series is built-in the VDD over-voltage protection and FB pins to prevent the circuit being damaged from the abnormal conditions.

It minimizes the components counts and is available in a tiny SOP-7 and DIP-7 package. Those make it an ideal design for low cost applications.

Features

- Primary-Side Control, No Opto-Coupler Needed
- Very low startup current (<6uA)
- Directly drive MOSFET
- Constant-Voltage(CV) and constant-current (CC)
- Good dynamic <+/-5%
- LEB (Leading-edge blanking) on CS Pin
- Non-audible-noise Green mode control
- VDD OVP-voltage Protection
- Cable Compensation for CV regulation
- Over Temperature Protection
- RoHS compliant and Halogen free

DIP-7L

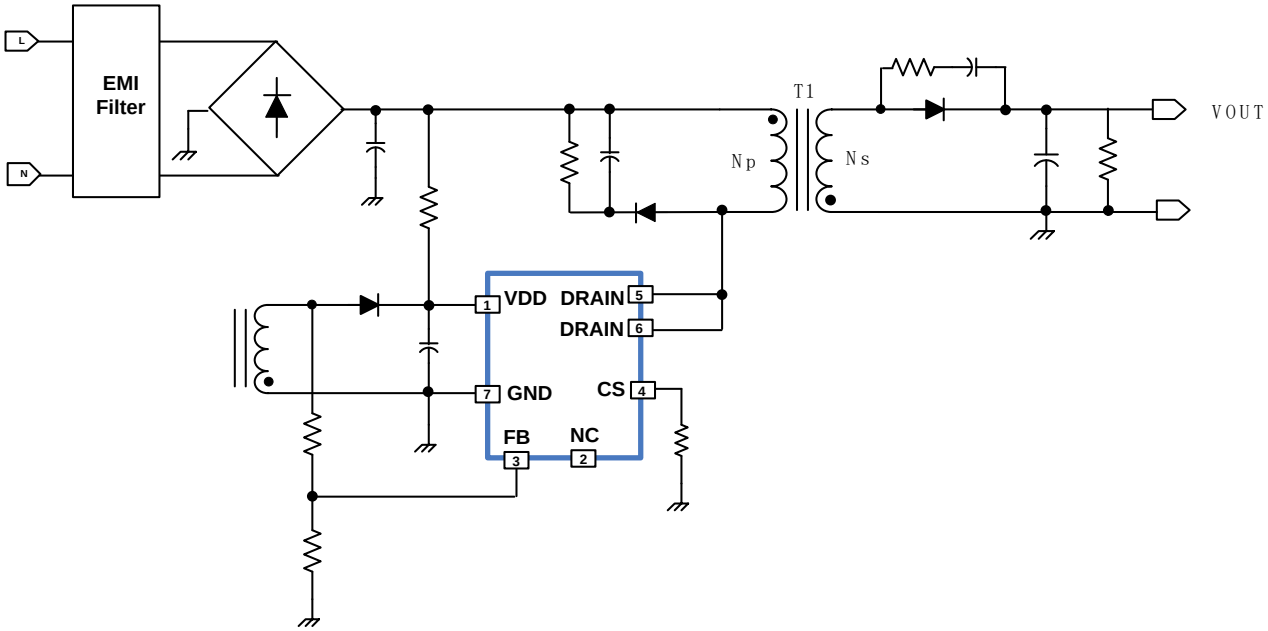
SOP-7L

Application

Low power AC/DC offline SMPS for

- Cell phone charger
- Replacement for Linear adapter
- Lower power adapter and Tablet PC Switching

Application Circuit

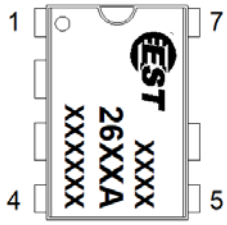


Ordering Information

Part Number	Package	Packaging	Note
EST2606/2608/2610/2612/2616AS-SOP7	SOP-7	Tape & Reel	Green
EST2612/2616A-DIP7	DIP-7	Tube	

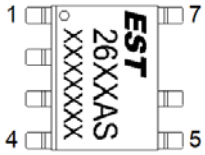
Note: EST lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. EST lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020C for MSL classification at lead-free peak reflow temperature. EST defines “Green” to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight)

Pin Assignments and Package Type



DIP-7L

EST: LOGO
XXXX: Dote Code
26xxA: xx=MOS Type;
XXXXXX: Production lot code



SOP-7L

EST: LOGO
26xxAS: xx=MOS Type;
S= Smd
XXXXXXX: Production lot code

DIP-7 SOP-7	Pin Name	Description
1	V_{DD}	Power supply pin
2	NC	NC
3	FB	The voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
4	CS	Sense the transformer winding voltage waveform.
5,6	DRAIN	HV MOSFET Drain Pin. The Drain pin is connected to the primary lead of the transformer.
7	GND	Ground

Recommended Operating Conditions

Parameter	Symbol	Min.	Max	Unit
Supply Voltage V_{DD}	V_{DD}	10.5	26	V
Startup Resistor Value	Rstar	1	15	MΩ
Ambient temperature range	Topr	-40	85	℃

Absolute Maximum Ratings

Parameter Symbol		Symbol	Limit Values		Unit	Remark
			Min.	Max		
Supply Voltage VCC		VCC	-0.3	30	V	
FB,CS,RTL		V_{FB},V_{CS},V_{RTL}	-0.3	7	V	
DRAIN Voltage (off state)		V_{DRAIN}	-0.3	BVDSS	V	
Operation Junction Temperature		Tj	-40	150	℃	
Operation Ambient Temperature		TA	-25	85	℃	
Storage Temperature		T_{stg}	-55	150	℃	
Power Dissipation @TA=85℃		PD	-	1.5	W	
Junction-to-Ambient Thermal Resistance*	Ta = 25℃	θ_{JA}		80	℃/W	DIP-7
Junction-to-Case Thermal Resistance**	Ta = 25℃	θ_{JC}		20	℃/W	
Junction-to-Top Thermal Resistance***	Ta = 25℃	θ_{JT}		35	℃/W	
Junction-to-Ambient Thermal Resistance*	Ta = 25℃	θ_{JA}		150	℃/W	SOP-7
Junction-to-Case Thermal Resistance**	Ta = 25℃	θ_{JC}		39	℃/W	
Lead temperature (Soldering, 10 sec)			-	260	℃	
ESD Voltage Protection	HBM	$V_{ESD-HBM}$	-	3.0	KV	
	MM	V_{ESD-MM}	-	300	V	

Stress beyond 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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliablity.
*Free standing with no heatsink; withoud copper clad.(Measurement condition – just before junction temperature TJ enters into OTP)
**Measure on the DRAIN pin close to plastic interface
***Measure on the PKG top surface

DC Electrical Characteristics (VCC =15V, Ta=25°C)

V_{DD} SECTION

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Start-up current	$I_{Start-up}$	V_{DD} = 9.5V			6	uA
On threshold voltage	V_{DD-ON}		14.5	15.5	16.5	V
Off threshold voltage	V_{DD-OFF}		7.5	8.5	9.5	V
NO Load Operating Supply Current	I_{DD-NL}	V_{DD} = 15V, FB >V_{ref}		0.6		mA
Operating supply current	I_{DD-OP}	V_{DD} = 15V, FS = F_{OSC},G_{ATE}=1nF	0.8	1.6	2.1	mA
V_{DD} over voltage protection level	V_{OVP}		27	28.5	30	V

CURRENT-SENSE SECTION

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Leading edge blanking	T_{LEB}		300	400	500	ns
Over current threshold	V_{CS-TH}	Min Duty	0.7	0.75	0.8	V

FB SECTION

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Feedback input voltage	V_{ref_fb}		1.97	2	2.03	v
Cable Compensation Current	I_{BC}		38	40	42	uA
Blanking time	T_{LEB_FB}	Guarantee by Design		2		uS

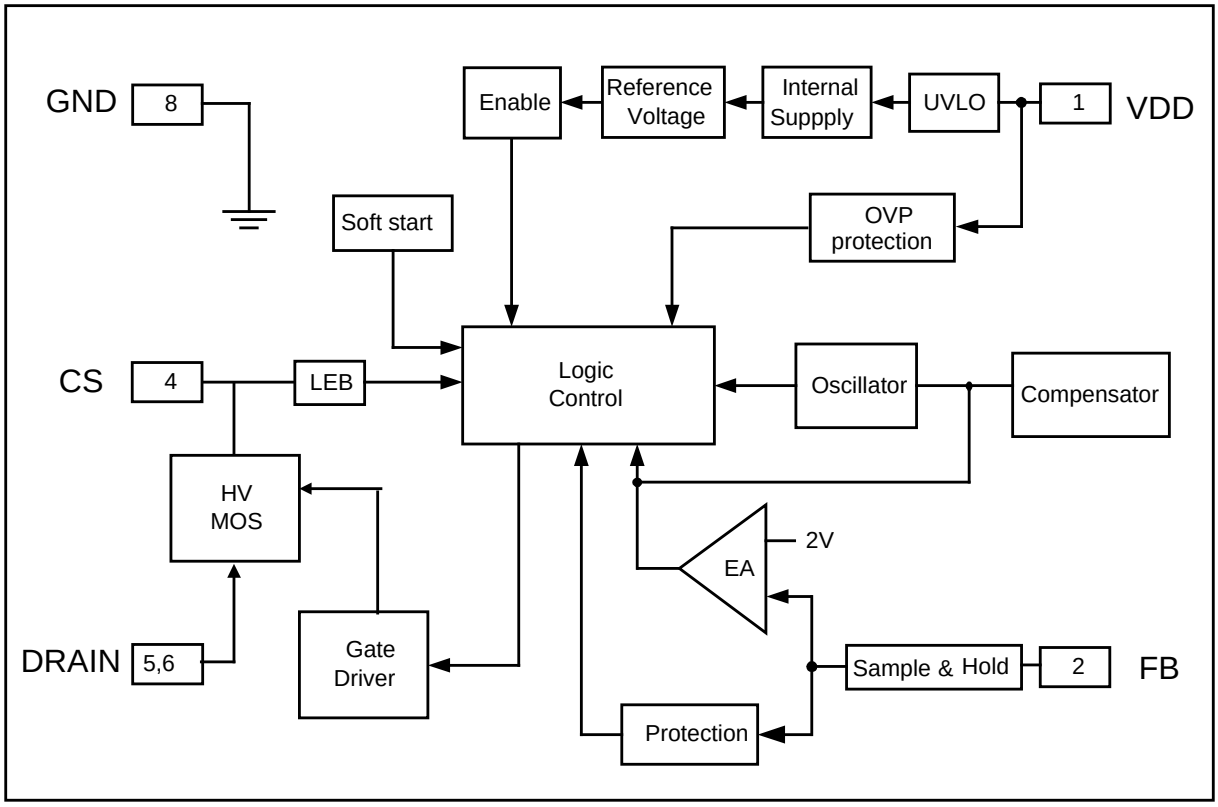
Gate Section

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Maximum frequency for A version	F_{OSC}		60	65	70	KHz
Maximum duty cycle	D_{MAX}			50		%
Jitter range	F_J			±5		%
Soft start	T_SS	F_{OSC}=65KHz		6		mS
Over temperature protection	T_{OTP}	Guarantee by Design		150		℃
OTP Hysteresis	T_{OTP_HYS}	Guarantee by Design		20		℃

Power MOSFET Section :

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
MOSFET Drain-source Breakdown Voltage	**BV_{DSS}**	**VGS=0V ID=250uA**	**650**			**V**
EST.2606AS SOP-7	$R_{DS(ON)}$	VGS=10V ID=0.4A		14	17	Ω
EST.2608AS SOP-7	$R_{DS(ON)}$	VGS=10V ID=0.5A		9	12	Ω
EST.2610AS SOP-7	$R_{DS(ON)}$	VGS=10V ID=1A		4.5	5	Ω
EST2612AS SOP-7	$R_{DS(ON)}$	VGS=10V ID=0.6A		3.2	4.0	Ω
EST.2612A DIP-7						
EST.2616AS SOP-7	$R_{DS(ON)}$	VGS=10V ID=2A		2.2	2.4	Ω
EST.2616A;DIP-7						

Block Diagram



Application Note

Functional Description

1.Start-up

The start-up circuit of EST.26xxA is shown in Fig-1 .It sets wide UVLO_ON-Off as 15.5V and 8.5V, , meanwhile, it easy to use high resistance (>10MΩ), caused its very low start-up current , which gives consideration to start-up consumption and start-up time. The timing of soft start is 3ms.

The start-up of power is through the function of UVLO comparator , refer to block function diagram, which detects the voltage of VDD. During start-up, start-up current is sink from Cbulk (<6uA) and charging to EC3, and chip working after VDD level is higher than VDD_ON , and then, chip will be power by aux winding. EST.26xxA series is process with low power mix-mode process (5V and 40V), which max start-up current is smaller than 6uA.

The operation current of EST.26xxA is smaller than 1.5mA, so we can select smaller EC3 (C_VDD) and operates under multi-mode methodology to enhance the efficiency.

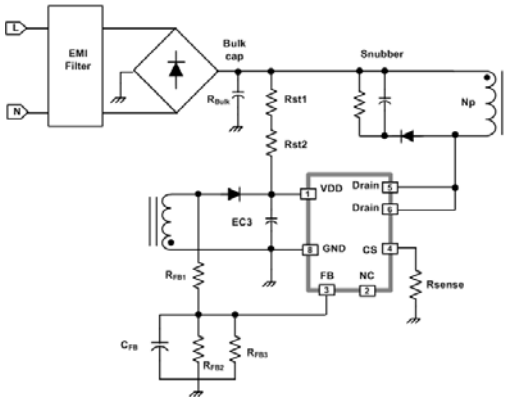


Fig 1. Application circuit

The start-up time is determined by RST1+RST2 and EC3. It is trade off between startup time and a higher startup resistance. Therefore, carefully select the value of Rstart and EC3 to optimize the power consumption and startup time.

It is also built-in the soft-start to reduce the stress of discrete components during start-up.

2. The modification of Constant voltage and cable compensation

For cellular phone charger applications, the battery is located at the end of cable, therefore, it is suffer voltage drop on the actual battery voltage. EST.26xxA has built-in cable voltage drop compensation, which provides a constant output voltage at the end of the cable over the whole loading range in CV mode.

It is built-in detector (error amplifier) to sample the on/off waveform signal of MOSFET, which can mapping the status of output voltage and discharge time of 2nd side diode, and then to modify the output voltage by modification of duty of MOSFET.

To clamp the voltage of auxiliary winding during the end of demagnetization by the resistance divider (R_{FB1}+ R_{FB2}//R_{FB3}) , and sustains it until next cycle. The clamp voltage compares to the voltage of internal error amplifier, Vref (2.0 V), which is proportional to the output voltage. Therefore, the adjustment of Vout can sink one the compensation current (I_{CB}) to compensate the voltage drop depend on various loading. It is easy realize the constant voltage.

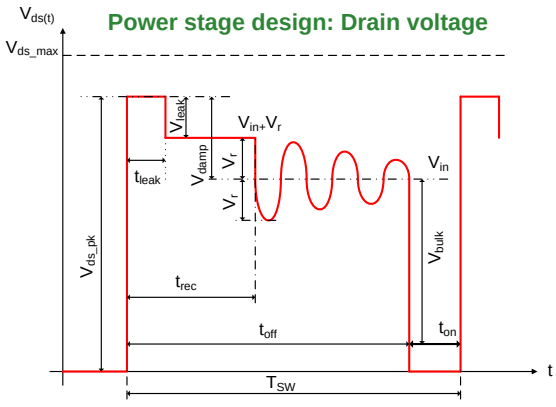


Fig-2. MOSFET waveform

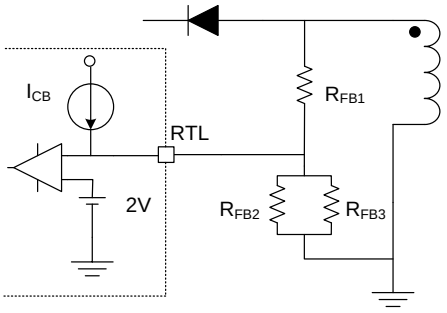


Fig-3 Sampling circuit

Set V_{OUT1}=5V , V_{OUT2}=5.5V , I_{CB}=40uA , $R_{FB2}//R_{FB3}=R_D$, Shottky V_{FL} =0.2V , V_{FH} =0.5V, the equivalent Resistance of current source I_{CB}, R_Z is :

No Loading

$$V_{DD1}=3\times(V_{OUT1}+V_{FL})=3\times(5+0.2)=15.6V$$

$$V_{DD1}\times(\frac{R_D}{R_{FB1}+R_D})+I_{CB}\times R_Z=V_{REF}$$

$$15.6\times(\frac{R_D}{R_{FB1}+R_D})+40\times10^{-6}\times R_Z=2.....(1)$$

Full Loading

$$V_{DD2}=3\times(V_{OUT2}+V_{FH})=3\times(5.5+0.5)=18V$$

$$V_{DD2}\times(\frac{R_D}{R_{FB1}+R_D})=V_{REF}$$

$$18\times(\frac{R_D}{R_{FB1}+R_D})=2.....(2)$$

$$(1)\times18-(2)\times15.6$$

$$18\times40\times10^{-6}\times R_Z=4.8$$

$$R_Z\cong6.667K$$

$$R_Z=\frac{R_{FB1}\times R_D}{R_{FB1}+R_D}=6.667K\ \square\ \square\ (2)$$

$$18\times6.667K\times\frac{1}{R_{FB1}}=2$$

$R_{FB1}\cong60K\Omega$; $R_D\cong7.5K\Omega$

3. Constant Current Output Regulation

As we know, PSR need to operates under discontinue mode (DCM), therefore, we can use the peak current of primary side (I_{pk}) and T_{dis} to estimates I_{out}, and then to determines the cut-off time of MOSFET. So, it can modify the total power and provides constant current.

As Fig-4, the output current ,

I_{out} = 1/2 * I_s* T_{dis}

TEST.26xxA will set T_{dis} / T as constant value, 0.5, by decreasing the frequency, therefore,

I_{out} = 1/4 * I_s and I_s = N * I_p

So, it can control the constant current by modify $R_{cs.}$ Please keep the ratio of T_{dis} / T_{on} must ≧1 to make sure the condition of CC mode.

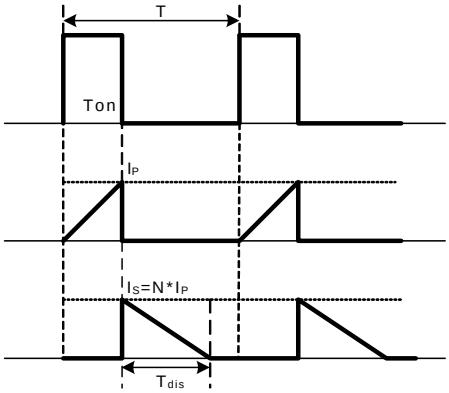


Fig-4. sampling waveform

4. Suggestion of operation frequency

The cable compensation of EST.26xxA refers to Fig-5. To make sure the compensation is well done, please keep the max frequency of system ≧ 50KHz.

Let T_{dis} / T= 0.5 · I_{out} = 1/4 * I_s · and T_{dis} / I_s = V_{out} / L_s · and then gets L_s (2nd side inductance) and L_p (primary side inductance). That is say, max frequency is determined by the Lp

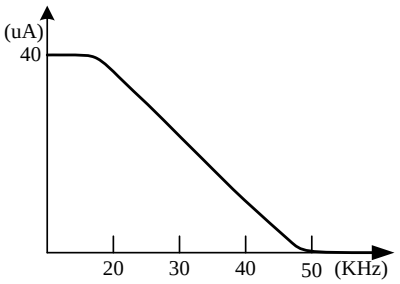


Fig-5. Frequency v.s I_{CB}

5. CV/CC mode

Fig-6 and Fig-7 is basic characteristic of CC and CV mode.

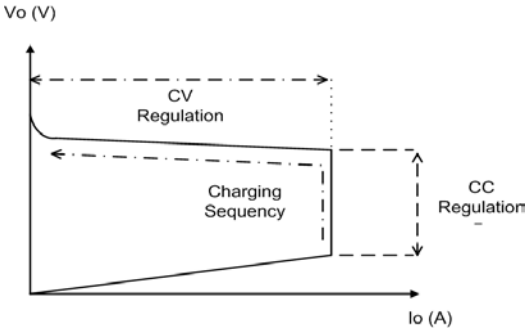


Fig-6. Characteristic of V-I curve

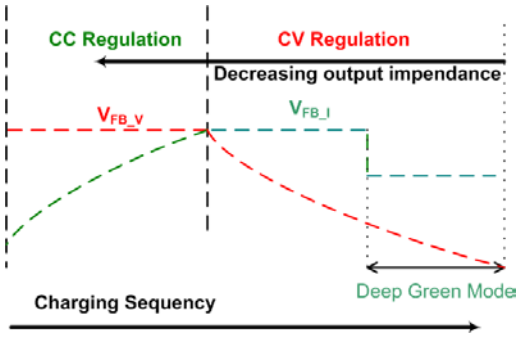


Fig-7. Sequence of charging

6. Green-Mode Operation

The EST.26xxA uses voltage regulation error amplifier output (V_{comp}) as an indicator of the output load and modulates the PWM/PFM frequency, as show in Fig-8. The switching frequency decrease as load decreases. In heavy load conditions, the switching frequency is fixed at 65KHz. As V_{comp} decrease below 3V, the frequency linearly decreases from 65KHz. When EST.26xxA enters into deep-green mode, the frequency is reduce to minimum frequency of 800Hz, gaining power saving to help meet internal criteria.

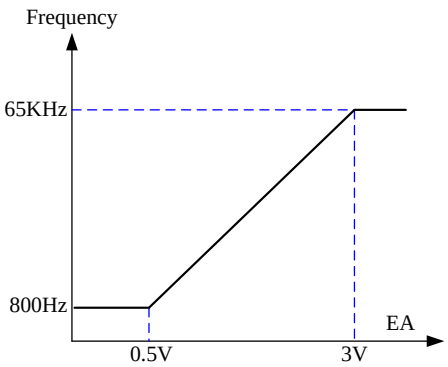


Fig-8. frequency v.s EA

7.Pin 6 DRV,

The EST.26xxA output stage is a fast totem-pole gated river to enhance the capability of driving, and also can balance it with smart soft-drive to improve the EMI immunity.

8. Protection

8-1. CS OCP (Over Current Protection)

Fig-9 is shown the OCP curve of EST.26xxA., which is cycle-by-cycle current limit . It can avoid the stress of MOSFET under saturation of transformer, and also keep Ip under various AC line voltage to make consistence of output current.

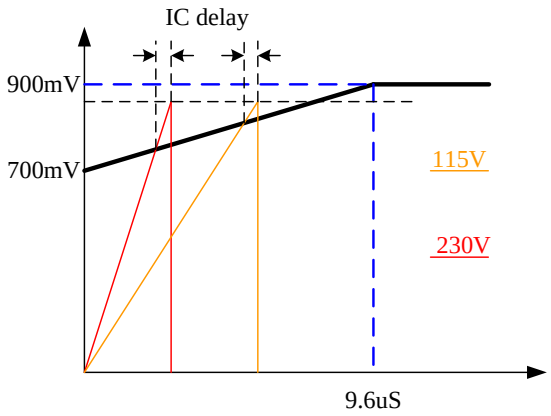


Fig-9. Over current protection curve

8-2. SCP (Short Circuit Protection)

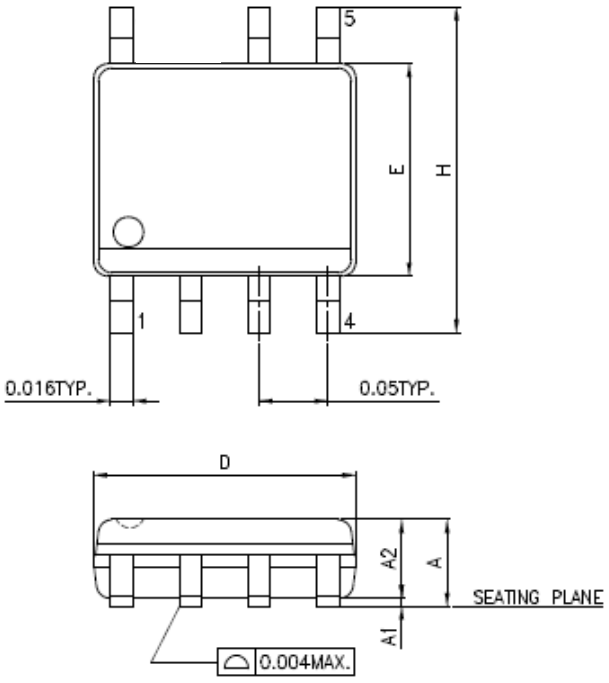
When V_{FB}< 0.8V and sustains 4 cycle, it will turn off the MOSFET, at the same time, V_{DD} will decrease to the level of UVLO off, and system will be restart-up, it is so call hiccup mode or auto recovery mode.

8-3. OVP (Over Voltage Protection)

V_{DD} over-voltage protection prevents damage fromover-voltage conditions. If the V_{DD} voltage exceeds 28V at open-loop feedback condition, OVP is triggered and the PWM switching is disabled. The OVP has a de-bounce time to prevent false triggering due to switching noises.

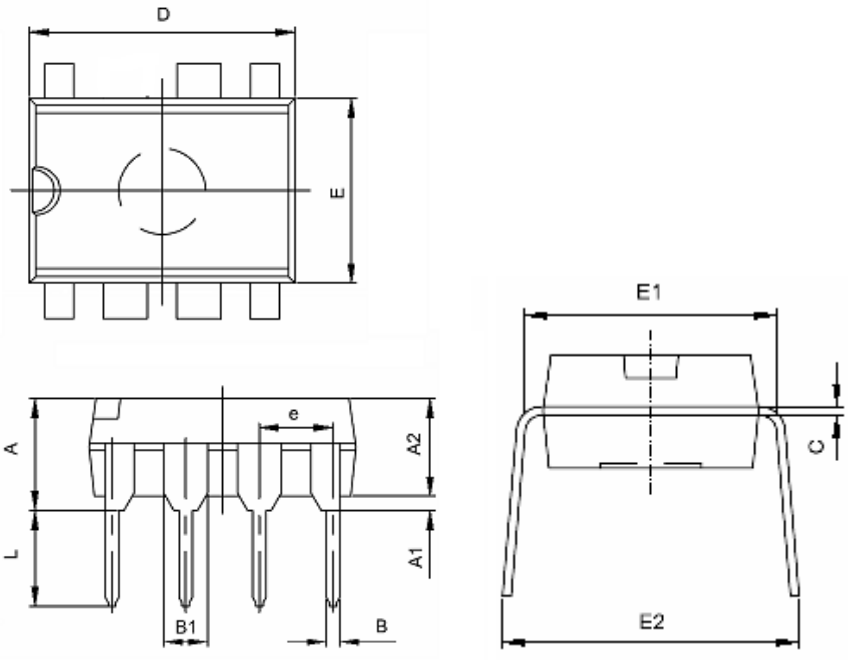
Package Information

SOP-7 Package （mm）



Symbols	Dimensions In Inches			Dimensions In millimeters		
	MIN.	NOR.	MAX.	MIN.	NOR.	MAX.
A	0.050	0.061	0.072	1.270	1.549	1.829
A1	0.000	------	0.010	0.000	------	0.254
A2	------	------	0.062	------	------	1.575
D	0.185	0.193	0.200	4.699	4.902	5.080
E	0.147	0.154	0.160	3.734	3.912	4.064
H	0.225	0.237	0.249	5.715	6.020	6.325
L	0.013	0.033	0.053	0.330	0.838	1.346
θ	0°	4°	8°	0°	4°	8°

DIP-7 Package



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	0.360	0.560	0.014	0.022
B1	1.524(TYP)		0.060(TYP)	
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	7.620(TYP)		0.300(TYP)	
e	2.540(TYP)		0.100(TYP)	
L	3.000	3.600	0.118	0.142
E2	8.200	9.400	0.323	0.370