General Description

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

It provides constant voltage, constant current and cable compensation,

Also, the EST.26xxAR 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-8 package. Those make it an ideal design for low cost applications.

Hazardous Substance Free/
RoHs/REACH Compliant

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

SOP-8L

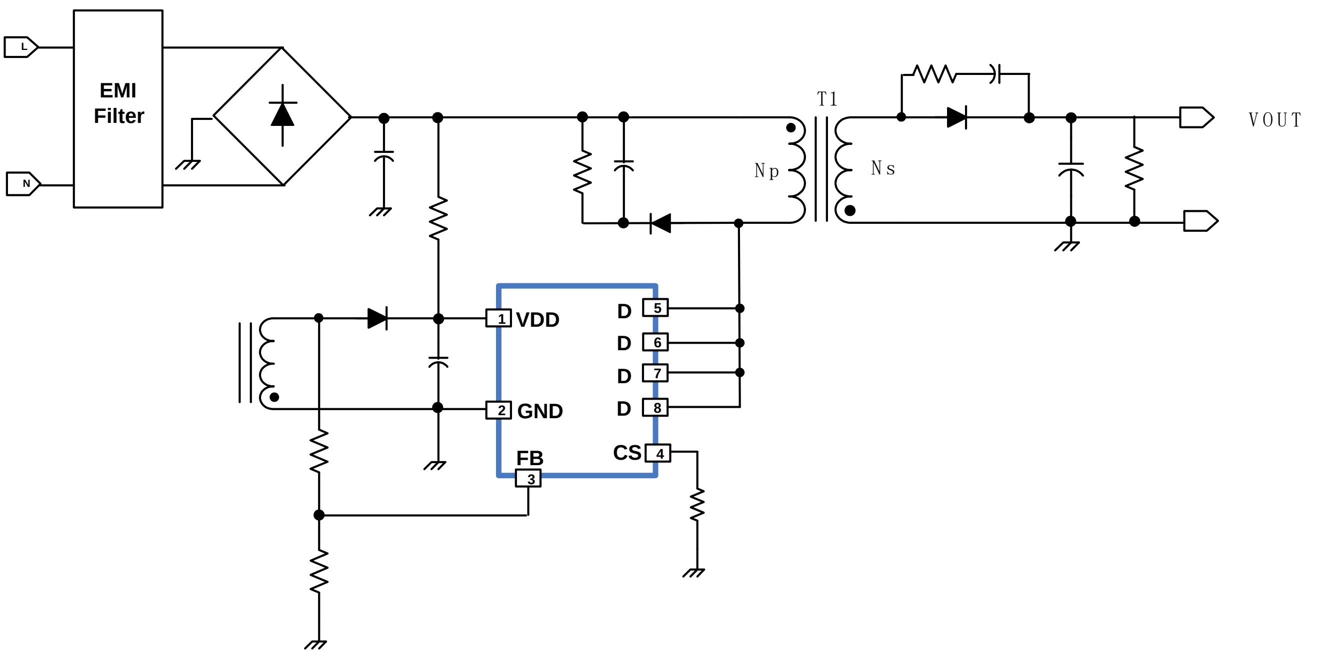
Application

- Low power AC/DC offline SMPS for
- Cell phone charger
- Replacement for Linear adapter
- Lower power adapter and Tablet PC

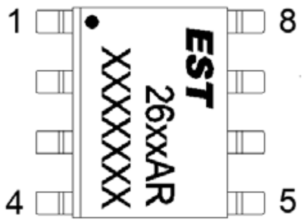
Ordering Information

Order Number	Package Type	Packing	Note
EST2607/9/11/13/15/17/19AR	SOP-8L	Tape & Reel	Green

Application Circuit



Pin connection and Marking (Top View)



EST: LOGO
26xxAR: XX=MOS Type;
A= series NO
R= smd
XXXXXXX: Production lot code

Pin Assignments and Package Type

SOP-8	Pin Name	Description
1	VDD	Power supply pin
2	GND	Ground
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.
5,6,7,8	DRAIN	HV MOSFET Drain Pin. The Drain pin is connected to the primary lead of the transformer.

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	℃

Notes: Maximum practical continuous power in an Adapter design with sufficient drain pattern as a heat sink, at 50℃ ambient

Absolute Maximum Ratings

Parameter Symbol		Symbol	Limit Values		Unit	Remark
			Min.	Max		
Supply Voltage V_{DD}		V_{DD}	-0.3	32	V	
FB,CS		V_{FB},V_{CS}	-0.3	7	V	
DRAIN Voltage (off state)		V_{DRAIN}	-0.3	BV_{DSS}	V	
Operation Junction Temperature		Tj	-40	125	℃	
Operation Ambient Temperature		TA	-25	85	℃	
Storage Temperature		T_{stg}	-55	150	℃	
Power Dissipation	Ta = 25℃	PD	-	556	mW	SOP-8
Junction-to-Ambient Thermal Resistance*		$θ_{JA}$	-	180	℃/W	
Junction-to-Case Thermal Resistance**		$θ_{JC}$	-	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 T_J enters into OTP)
**Measure on the DRAIN pin close to plastic interface
***Measure on the PKG top surface

DC Electrical Characteristics

(VDD = 15V, TA = 25°C, unless otherwise specified.)

V_{DD} SECTION

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Start-up current	$I_{Start-up}$			6	uA	V_{DD} = 9.5V
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}		0.6		mA	V_{DD} = 15V, FB >V_{ref}
Operating supply current	I_{DD-OP}	0.8	1.6	2.1	mA	V_{DD} = 15V, FS = F_{OSC},G_{ATE}=1nF
V_{DD} over voltage protection level	V_{OVP}	25.5	26.5	27.5	V	

CURRENT-SENSE SECTION

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Leading edge blanking	T_{LEB}	300	400	500	ns	
Over current threshold low	V_{CS-L}	0.65	0.7	0.75	V	Min Duty
Over current threshold high	V_{CS-H}	0.85	0.9	0.95	V	T_{ON} ≈ 9.3uS

FB SECTION

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Feedback input voltage	V_{ref_fb}	1.97	2	2.03	V	
Feedback UVP	V_{FB_UVP}	0.7	0.8	0.9	V	
Max Discharge time protection	Tdis_	19	20	21	uS	
Cable Compensation Current	I_{BC}	38	40	42	uA	

Timer Section

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Maximum frequency for A version	F_{max}	60	65	70	KHz	
Minimum frequency	F_{min}	740	840	940	Hz	
Maximum duty cycle	D_{MAX}	53	58	63	%	
Jitter range	F_J		±5		%	
Soft start	T_SS		8		mS	
Over temperature protection	T_{OTP}		150		℃	Guarantee by Design
OTP Hysteresis	T_{OTP_HYS}		20		℃	

POWER MOSFET SECTION

Parameter	Symbol	Test Conditions	B_{VDSS}	Typ.	Max.	Unit
EST.2607AR	RDS(ON)	VGS=10V ID=0.4A	650V	14	17	Ω
EST.2609AR	RDS(ON)	VGS=10V ID=0.5A	650V	9	12	Ω
EST.2611AR	RDS(ON)	VGS=10V ID=1A	650V	4.5	5	Ω
EST.2613AR	RDS(ON)	VGS=10V ID=1.5A	650V	3.0	4	Ω
EST.2615AR	RDS(ON)	VGS=10V ID=2A	650V	2.4	2.8	Ω
EST.2617AR	RDS(ON)	VGS=10V ID=3.0A	650V	2.1	2.6	Ω
EST.2619AR	RDS(ON)	VGS=10V ID=3.4A	650V	1.4	1.6	Ω

Block Diagram

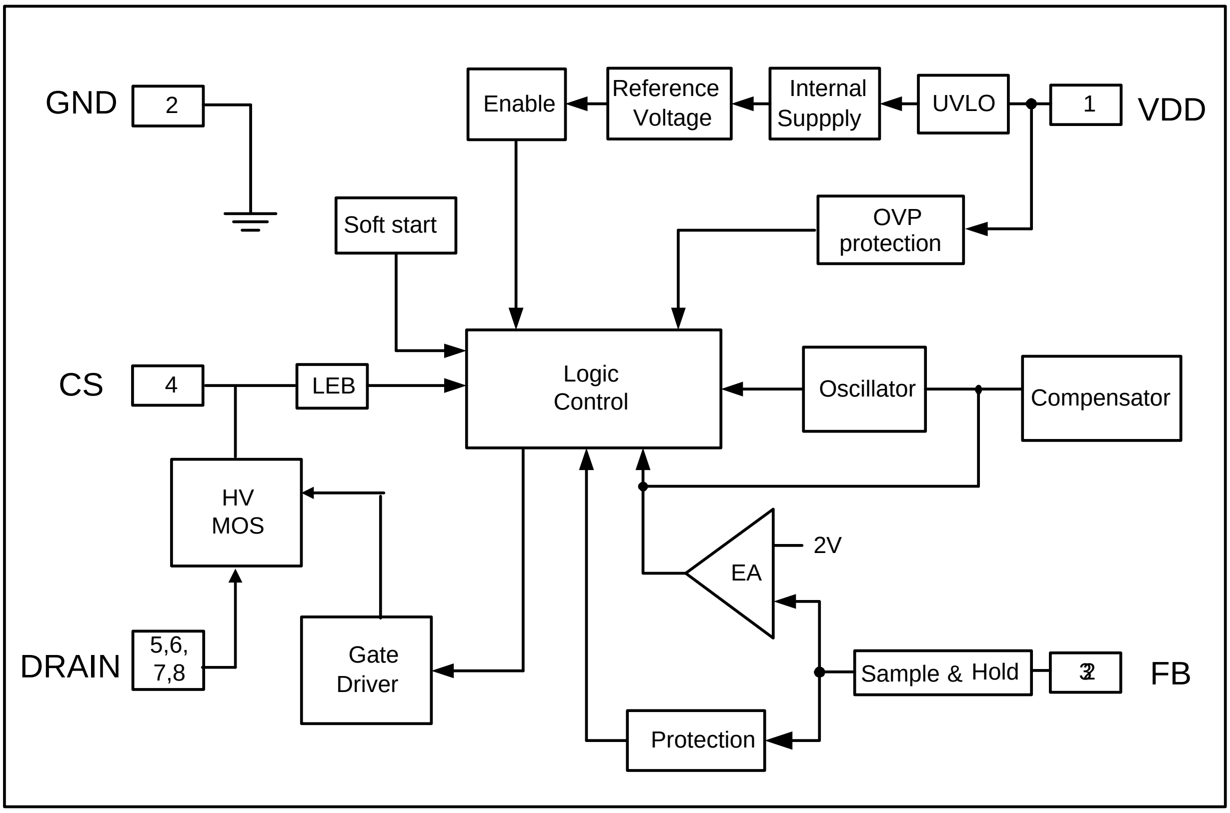


Fig. 3

Application Note

Functional Description

1. Start-up

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

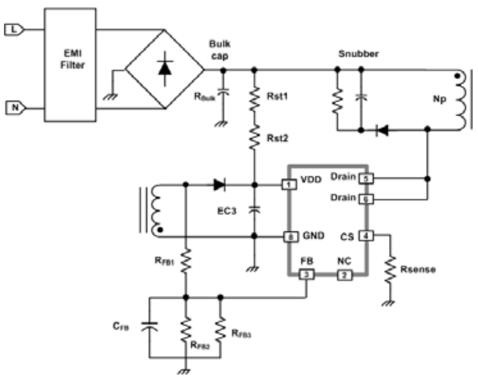


Fig 1. Application circuit

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.26xxAR 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 (RFB1+ RFB2//RFB3) , 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 (ICB) to compensate the voltage drop depend on various loading. It is easy realize the constant voltage.

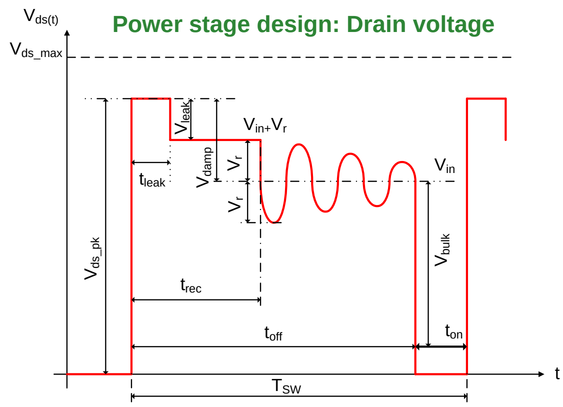


Fig-2. MOSFET waveform

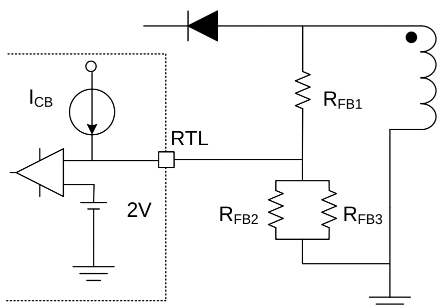


Fig-3 Sampling circuit

Set VOUT1=5V , VOUT2=5.5V , ICB=40uA , RFB2//RFB3=RD , Shottky VFL =0.2V , VFH =0.5V, the equivalent Resistance of current source ICB, RZ 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

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

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

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

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

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

$$R_Z\cong6.667K$$

$R_Z=\frac{R_{FB1}\times R_D}{R_{FB1}+R_D}=6.667K$ □ □ (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 (Ipk) and Tdis to estimates Iout, 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 ,

Iout = 1/2 * Is* Tdis

EST.26xxAR will set Tdis / T as constant value, 0.5, by decreasing the frequency, therefore,

Iout = 1/4 * Is and Is = N * Ip

So, it can control the constant current by modify Rcs.

Please keep the ratio of Tdis / Ton must ≧1 to make sure the condition of CC mode.

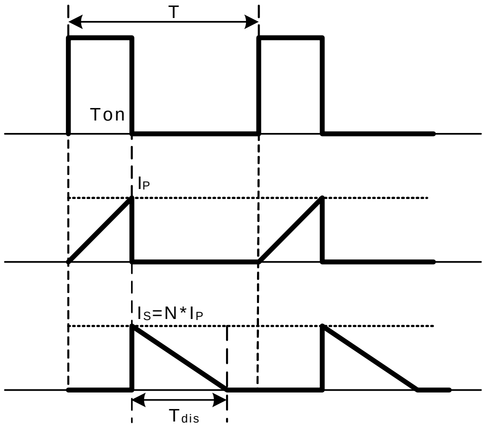


Fig-4. sampling waveform

4. Suggestion of operation frequency

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

Let Tdis / T= 0.5，Iout = 1/4 * Is，and Tdis / Is = Vout / Ls，and then gets Ls (2nd side inductance) and Lp (primary side inductance). That is say, max frequency is determined by the Lp

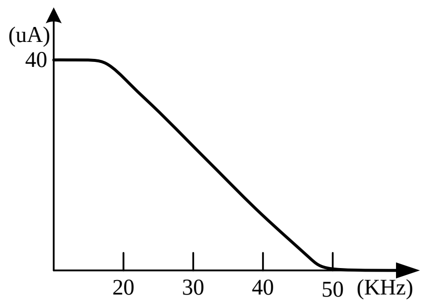


Fig-5. Frequency v.s ICB

5. CV/CC mode

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

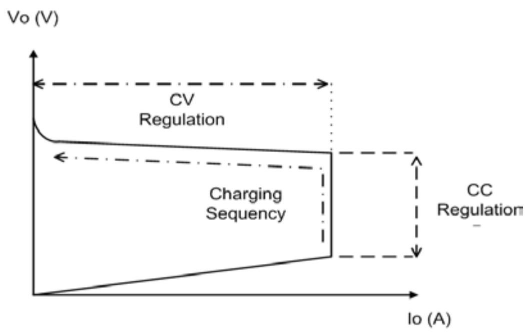


Fig-6. Characteristic of V-I curve

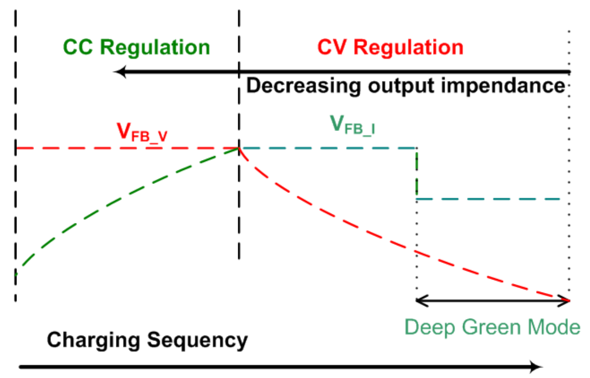


Fig-7. Sequence of charging

6. Green-Mode Operation

The EST.26xxAR uses voltage regulation error amplifier output (Vcomp) 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 Vcomp decrease below 3V, the frequency linearly decreases from 65KHz. When EST.26xxAR enters into deep-green mode, the frequency is reduce to minimum frequency of 800Hz, gaining power saving to help meet internal criteria.

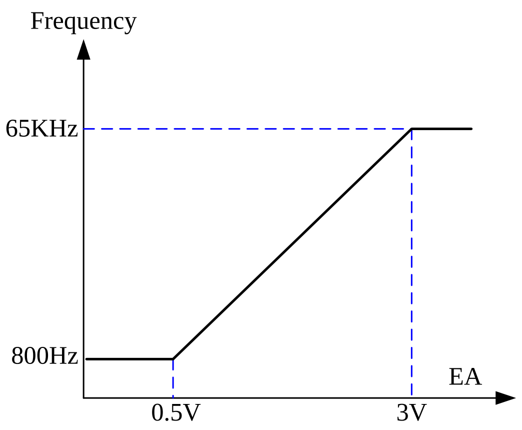


Fig-8. frequency v.s EA

7. Pin 6 DRV,

The EST.26xxAR 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.26xxAR., 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.

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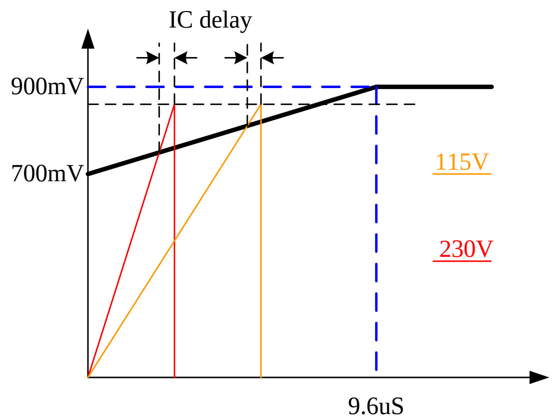


Fig-9. Over current protection curve

8-2. SCP (Short Circuit Protection)

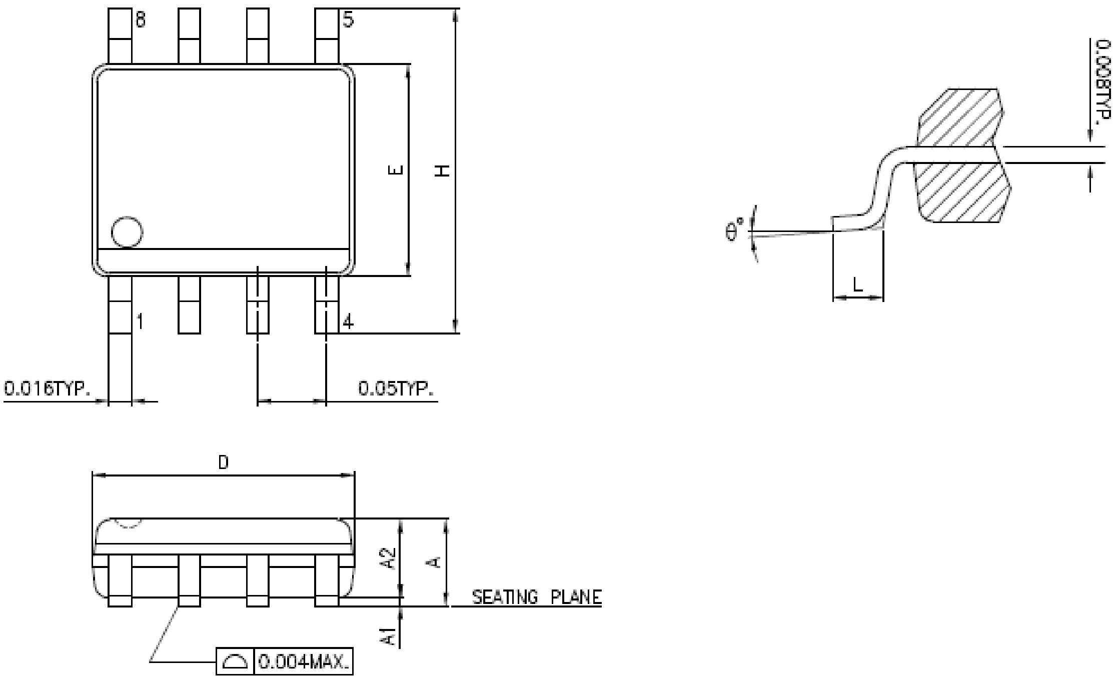
When VFB< 0.8V and sustains 4 cycle, it will turn off the MOSFET, at the same time, VDD will decrease to the level of UVLO off, and system will be restart-up, it is so call hiccup mode or auto recovery mode.

8-3. OVP (Over Voltage Protection)

VDD over-voltage protection prevents damage fromover-voltage conditions. If the VDD 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.

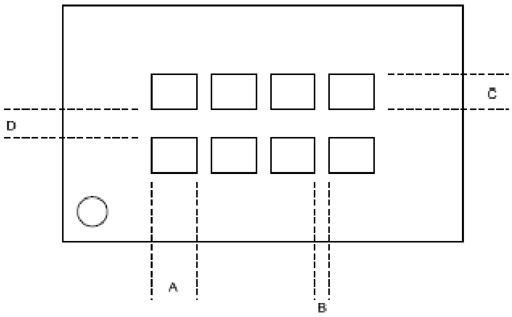
Package Information

SOP-8L 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°

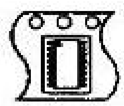
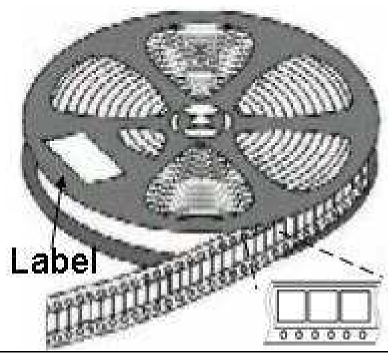
Body Marking



Package Type	A	B	C	D
SOP-8	0.3 mm	0.1 mm	0.35 mm	0.2 mm

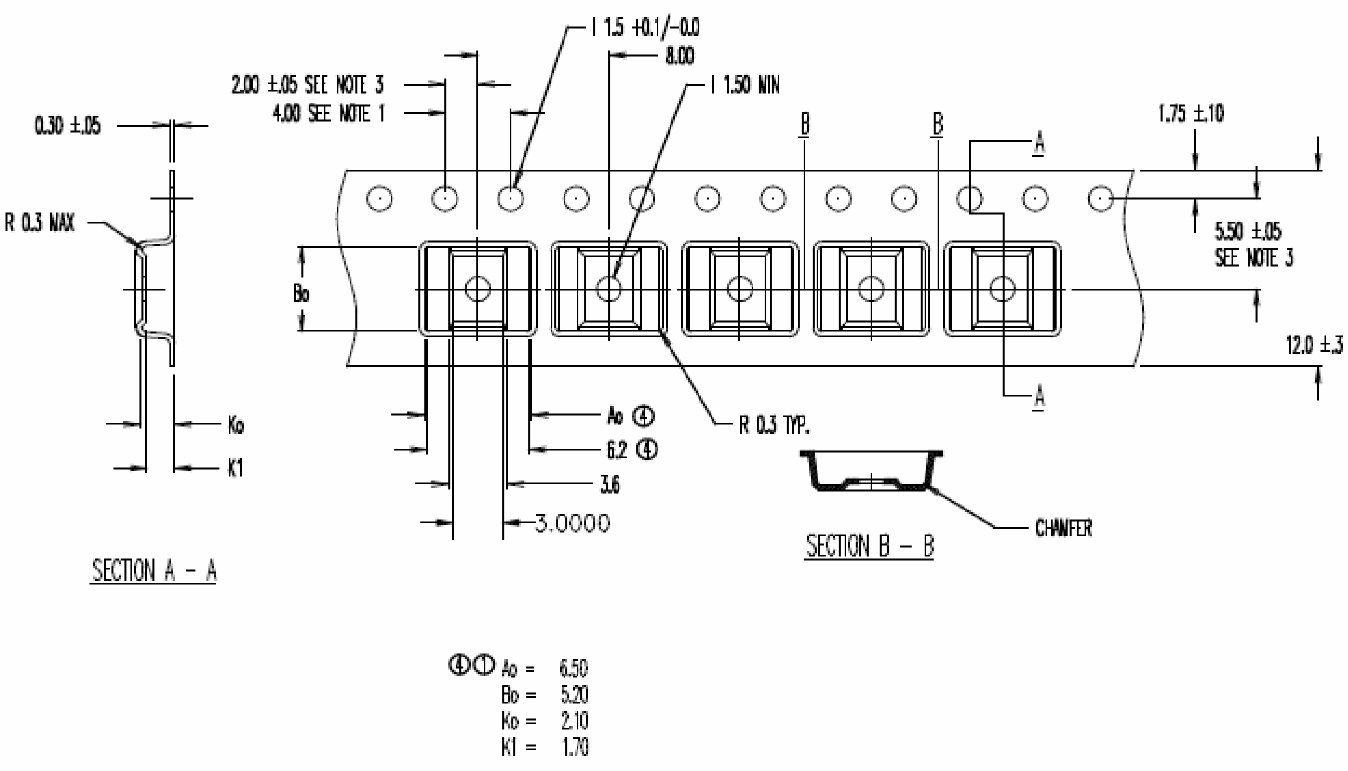
Line #	Mark Number	Contents
Line 1 :	1 thru 4	Name : S202
Line 2 :	1 thru 4	Date code : 1020

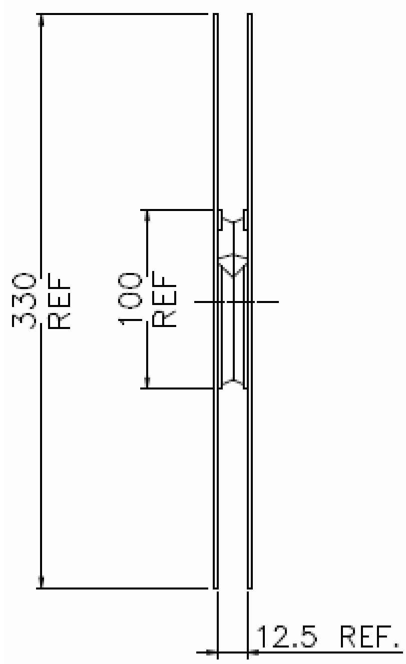
SOP-8 Shipping Packing

Package Type (Device)	**SOP**
Orientation in Carrier	
Termination 1 Orientation by Quadrant	1 2 / 3 4
Reel 绕卷Type 及Label 位置	
Q'ty (Reel)	**2500**

SOP-8 Tape Reel Data

(Size: mm)





EST.26xxAR High Precision CC/CV Primary-Side

Update History

Revision	Date	Update
1.00	August 06, 2016	Preliminary version