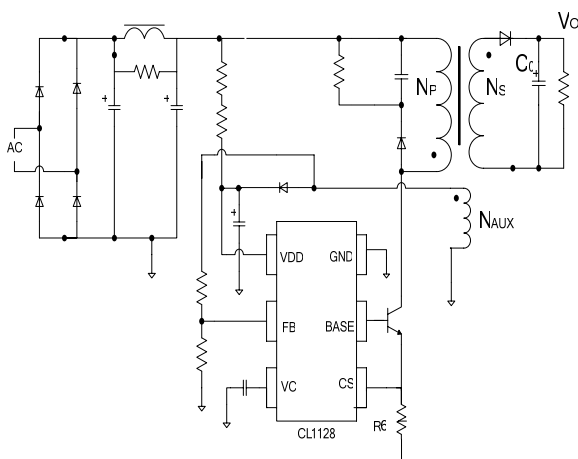


High Precision CC/CV Primary-Side Controller

FEATURES

- ◆ 5% Constant Voltage Regulation, 5% Constant Current Regulation at Universal AC input
- ◆ Primary-side Sensing and Regulation Without TL431 and Opto-coupler
- ◆ Low Start-up Current: 1 μ A (Typical)
- ◆ Low Static Current: 300 μ A (Typical)
- ◆ Programmable CV and CC Regulation
- ◆ Adjustable Constant Current and Output Power Setting
- ◆ Built-in Secondary Constant Current Control with Primary Side Feedback
- ◆ Peak-Current-Mode Control
- ◆ Compensates for transformer inductance tolerances
- ◆ Compensates for cable voltage drop
- ◆ Built-in Leading Edge Blanking (LEB)
- ◆ Cycle-by-Cycle Current Limiting
- ◆ VDD Under-Voltage lockout (UVLO)
- ◆ VDD Over-Voltage Protection(OVP)

TYPICAL APPLICATIONS



pin order in schem is for demonstration not for real

APPLICATIONS

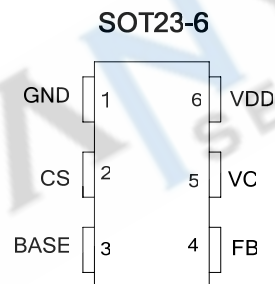
AC/DC offline SMPS for

- ◆ Cell Phone Charger
- ◆ Digital Cameras Charger
- ◆ Small Power Adapter
- ◆ Auxiliary Power for PC, TV etc.
- ◆ Linear Regulator/RCC Replacement

SI1128 is offered in SOT23-6 package.

PIN CONFIGURATION

The pin map is shown as below for SOT23-6.



Pin order is oriented by marking

GENERAL DESCRIPTION

The SI1128 is an excellent primary side feedback controller, which integrates several functions of protections. It minimizes the components counts and is available in a tiny SOT-26 package. Those make it an ideal design for low cost applications. SI1128 is especially designed for below 10W application such as mobile phone charger application etc.

It provides functions of low startup current and leading-edge blanking of the current sensing. Also, the SI1128 features OVP(Over Voltage Protection) to prevent the circuit being damaged from the abnormal conditions.

In most cases, the power supply with primary-side feedback controller would accompany with some serious load regulation effect. To deal with this problem, the SI1128 consists of dedicated load regulation compensation circuit to improve it.

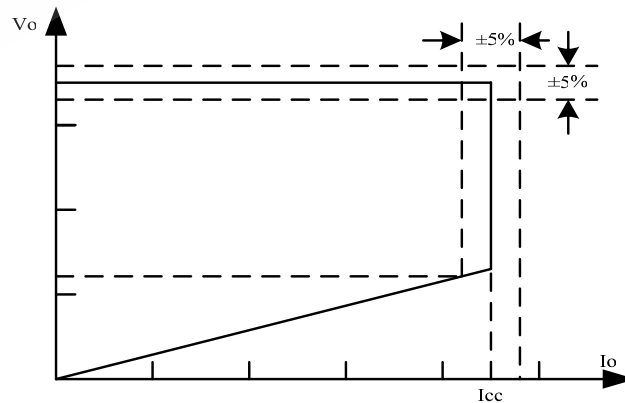


Fig.1. Typical CC/CV Curve

PACKAGE DISSIPATION RATING

Package	$R_{\theta JA}$ (°C/W)
SOT23-6	200

ABSOLUTE MAXIMUM RATINGS (Note)

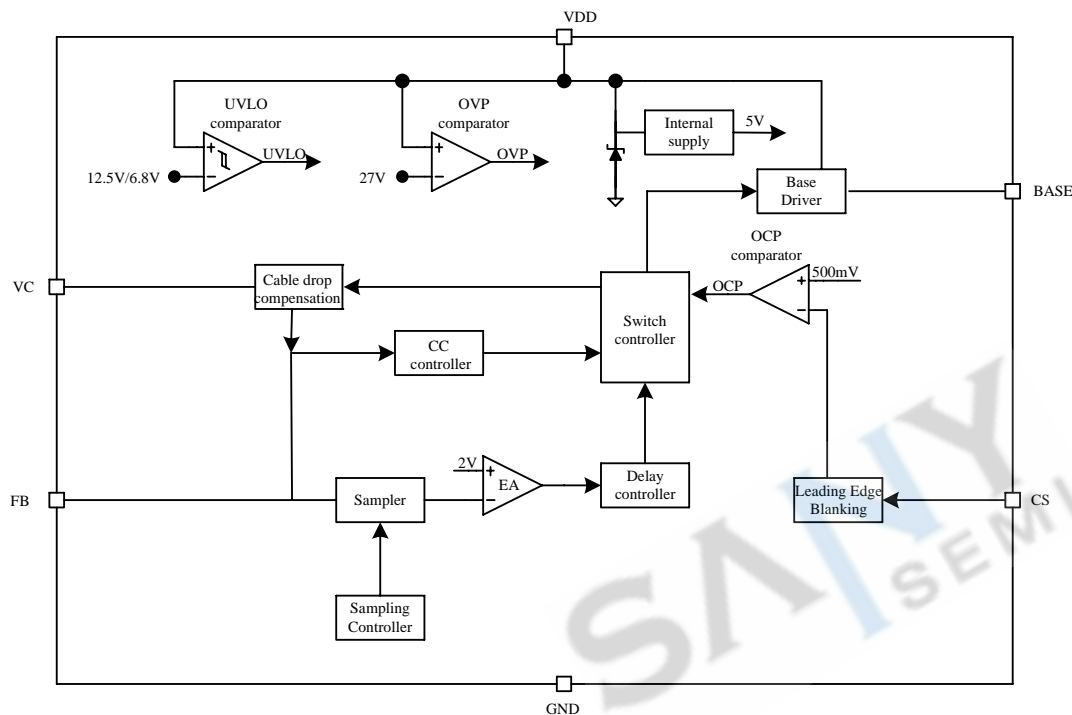
Parameter	VALUE
V_{DD} Voltage	-0.3 to 30
BASE Voltage	-0.3 to 7V
VC Voltage	-0.3 to 7V
CS Input Voltage	-0.3 to 7V
FB Input Voltage	-0.3 to 7V
Max Operating Junction Temperature T	150 °C
Min/Max Storage Temperature T_{stg}	-55 to 150 °C
Lead Temperature (Soldering, 10secs)	260 °C

Note: Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated “recommended operating conditions” is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

TERMINAL ASSIGNMENTS

Pin Num	Pin Name	I/O	Description
1	GND	P	Ground
2	CS	I	The primary side current sense
3	BASE	O	Base drive output to drive the external BJT
4	FB	I	Inverting input to the error amplifier
5	VC	I	Low pass filter capacitor for voltage compensation
6	VDD	P	Supply voltage pin

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

(TA = 25°C, VDD=15V, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD) Section						
I _{start-up}	Start up Current	V _{DD} =11V		1	3	uA
I _{static}	Static Current	V _{DD} =15V		300	400	uA
UVLO(ON)	V _{DD} Under Voltage Lockout Enter	V _{DD} falling	6.0	6.8	7.6	V
UVLO(OFF)	V _{DD} Under Voltage Lockout Exit	V _{DD} rising	11.5	12.5	13.5	V
Maximum V _{DD} operation voltage					25	V
OVP	Over voltage protection Threshold		25	27	29	V
Current Sense Input Section						
T _{LEB}	LEB time			500		ns
V _{th_oc}	Over current threshold		485	500	515	mV
T _{d_oc}	OCP Propagation delay			110		ns
FB Input Section						
Vref_fb	Reference voltage for feedback threshold		1.98	2.00	2.02	V
T _{pause_min}				2.0		uS
T _{pause_max}	Maximum pause		8	10	12	mS
I _{comp_cable}	Maximum cable compensation current		42	45	48	uA
BASE Drive section						
I _{s_max}	Base sourcing maximum current		20	30	40	mA
I _{s_preoff}	Base sourcing current after pre-off		0.5	1	1.5	mA
R _{dson_l}	Base drive low side on resistor			1		ohm

Application Information

Operation Overview

This highly integrated PSR controller contains several features to enhance the performance of low-power flyback converters. The patented topology of the PSR controller allows for simplified of circuit designs, particularly battery charger applications. It operates in primary side sensing and regulation, thus opto-coupler and TL431 are not required. CV and CC control can be accurately achieved without secondary feedback circuitry. As a result, a low-cost, smaller, and lighter charger is produced when compared to a conventional design or a linear transformer.

Under Voltage Lockout (UVLO)

An UVLO comparator is implemented to detect the voltage of VDD pin. It would assure the supply voltage enough to turn on the CL1128 controllers and further to drive the power BJT. A hysteresis is built in to prevent the shutdown from the voltage dip during startup. The turn-on and turn-off threshold level are set at 12.5V and 6.8V, respectively.

CC/CV Operation

SI1128 is designed to produce good CC/CV control characteristic as shown in the Fig. 1. Battery chargers are typically designed for two modes of operation, constant-voltage charging and constant-current charging. When the battery voltage is low, the charger operates on a constant current charging. This is the main method for charging batteries and most of the charging energy is transferred into the batteries. When the battery voltage reaches its end-of-charge voltage, the current begins to taper-off. The charger then enters the constant voltage method of charging. Finally, the charging current continues to taper-off until reaching zero.

Output Voltage setting

The SI1128 monitors the auxiliary fly-back signal from FB pin through a resistor divider pair of R_a and R_b . An error signal, which represents the difference between the voltage at FB and the reference voltage, is integrated with the error amplifier to control switching duty cycle. The output voltage is determined by the following relationship. For improving the output voltage accuracy, the transformer leakage inductance should be reduced as much as possible.

$$V_{OUT} = 2V \left(1 + \frac{R_a}{R_b}\right) \left(\frac{N_s}{N_a}\right)$$

Where,

R_a and R_b are the top and bottom feedback resistor value,

N_s and N_a are the turn ratios of transformer secondary and auxiliary

The load regulation and line regulation for primary side feedback control are sensitive to the structure of transformer. For getting good regulation and efficiency, the sandwich structure consisting of two secondary separate parallel layer windings surrounding primary winding is recommended.

Inductance Correction Circuitry

If the primary magnetizing inductance is either too high or low the converter will automatically compensate for this by adjusting the oscillator frequency. Since this controller is designed to operate in discontinuous-conduction mode the output power is directly proportional to the set primary inductance and its tolerance can be completely compensated with adjustments to the

switching frequency.

Current Sensing and Leading Edge

Blanking Cycle-by-Cycle current limiting is offered in SI1128. The switch current is detected by a sense resistor into the CS pin. When the power switch is turned on, a turn-on spike will occur on the sense-resistor. To avoid false-termination of the switching pulse, 500ns leading-edge blanking is built in. During this blanking period, the current sense comparator is disabled and the gate driver can not be switched off.

BASE Drive

The external power BJT is driven by a dedicated base driver of SI1128. Soft driver design elimination was used to minimize heat dissipation, increase efficiency, and enhance reliability.

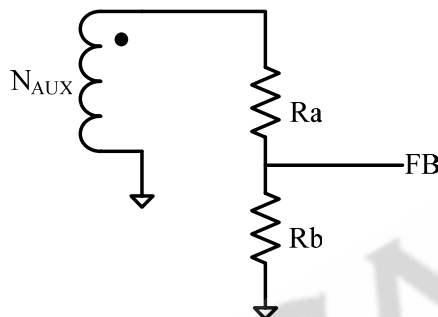
Programmable Cable drop Compensation

In CV regulation control, the on-time of switch only regulates on-board voltage, not including output cable. Different cable wire gauge or length results in different output voltage. The SI1128 has a cable compensation function used to compensate the output voltage drop due to output cable loss. An offset voltage is generated at FB by an internal current flowing into the resistor divider. As the converter load increases from no-load to the peak power point (transition point between CV and CC) the voltage drop introduced across the output cable is compensated by increasing internal current flowing into the resistor divider.

The percentage of maximum compensation is

$$\frac{\Delta V}{V_{OUT}} = \frac{I_{comp} \times (R_a // R_b) \times 10^{-6}}{2} \times 100\%$$

ΔV is load compensation voltage and V_{OUT} is output voltage, R_a and R_b is divide voltage resistance at FB Pin.

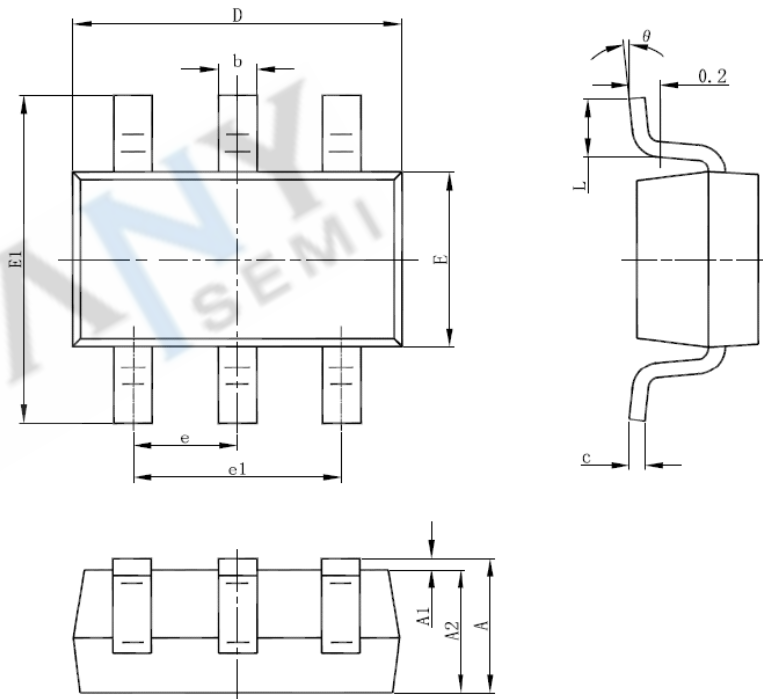


Protection Control

Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), VDD clamp and Under Voltage Lockout on VDD (UVLO). VDD is supplied by transformer auxiliary winding output. The output of SI1128 is shut down when VDD drops below UVLO (ON) limit and the power converter enters power on start-up sequence thereafter.

PACKAGE MECHANICAL DATA

SOT23-6



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.000	1.300	0.039	0.051
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.800	3.020	0.110	0.119
E	1.500	1.700	0.059	0.067
E1	2.600	3.000	0.102	0.118
e	0.950 (BSC)		0.037 (BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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