Features

- Less than 75mW standby power consumption at 230VAC with typical application circuit
- Integrated 750V BJT
- Primary-side sensing and regulation without TL431 and opto-coupler
- BCM fast start up technology
- No need for control loop compensation
- Less than ±5% constant voltage and current regulation at universal AC input
- Ultra Low start-up and low operation current
- Built-in Leading Edge Blanking(LEB)
- Programmable cable drop compensation
- Multi-mode PWM and PFM operation for efficiency improving.
- Output Over Voltage Protection,VDD OVP and Clamp,Cycle-by-Cycle Current Limiting
- SOP8 Package

Applications

- Small Power Adapter
- Cell Phone Charger
- Digital Cameras Charger
- Linear Regulator/RCC Replacement

General Description

SP2607AF is a high performance offline PSR power switch for low power AC/DC charger and adapter applications. It operates in primary-side sensing and regulation. Thus, opto-coupler and TL431 are not required. In CC control, the output current and power setting can be adjusted externally by the sense resistor R_{CS} at CS PIN. In CV control, multi-mode operations are utilized to achieve high performance and high efficiency. In addition, good load regulation is achieved by the built-in cable drop compensation. SP2607AF operates in PFM in CC mode, and it operates in PWM+PFM in CV mode with frequency reduction at light/medium load. The chip consumes very low operation current. It achieves less than 75mW standby power to meet all global energy efficiency regulations.

SP2607AF offers comprehensive protection coverage with auto-recovery feature including Cycle-by-Cycle current limiting, VDD over voltage protection (OVP), output over voltage protection, load short circuit protection, VDD under voltage lockout (UVLO), OTP etc.

SP2607AF is offered in SOP8 packages.

Simplified Application

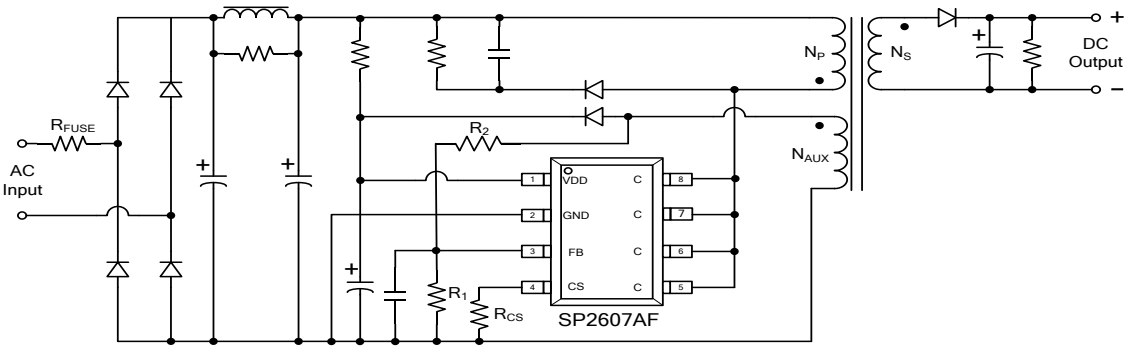
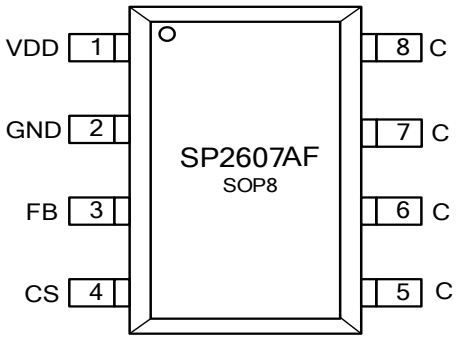


Figure 1.Simplified Application of SP2607AF

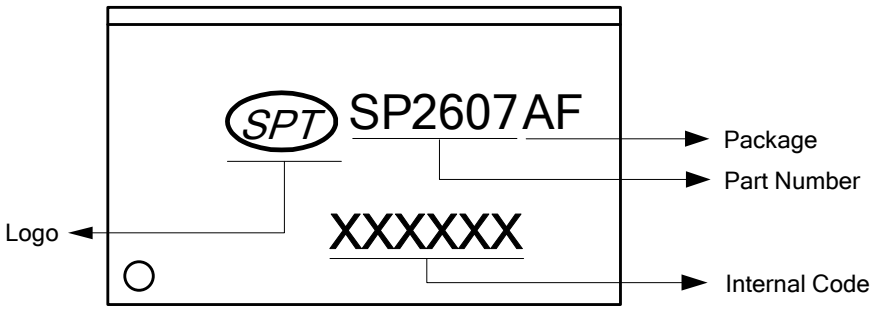
Pin Function Description



Pin No.	Pin Name	Function Description
1	VDD	Power Supply for IC
2	GND	Ground
3	FB	The voltage feedback from auxiliary winding
4	CS	Current Sense Input Pin
5,6,7,8	C	Connected to the C of Internal Power BJT

Ordering and Marking Information

Part Number	Package Description	Top Marking	Package Form
SP2607AF	SOP8, Pb-free	SP2607AF	SOP8



Package Dissipation Rating

Package	θ_{JC} （℃/W）	θ_{JA}（℃/W）
SOP8	50	130

Absolute Maximum Ratings

Symbol	Description	Value	Units
VDRAIN_MAX	Drain Input Voltage	-0.3 to 750	V
VDD	VDD Input Voltage	-0.3 to 30	V
VFB,VCS	FB,CS Input Voltage	-0.3 to 7	V
TJ	Operating Junction Temperature	-40 to 150	℃
TSTORAGE	Min/Max Storage Temperature	-55 to 150	℃
TL	Lead Temperature (Soldering. 10secs)	260	℃

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 under recommended operating conditions is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Symbol	Description	Value	Units
VDD	VDD Supply Voltage	7 ~ 22	V

Output Power Table

Part Number	90VAC to 265VAC
SP2607AF	**Adapter**[1]
	12W

Note:

1. Maximum continuous power in a typical non-ventilated enclosed adapter measured at +50℃ ambient, T_{CASE}＜120℃.
2. Maximum continuous power in an open frame design with adequate heatsinking measured at +25℃ ambient, T_{CASE} ＜120℃.

Block Diagram

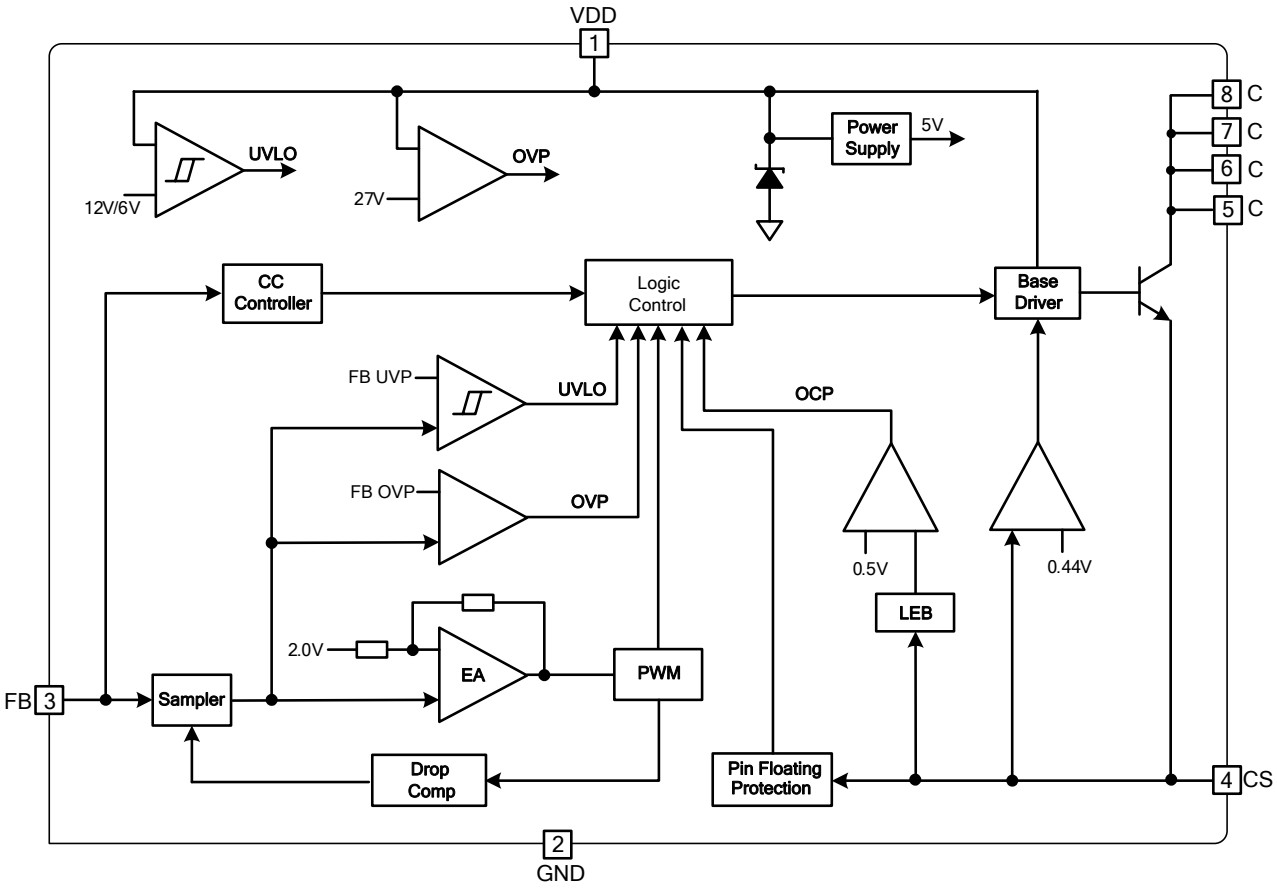


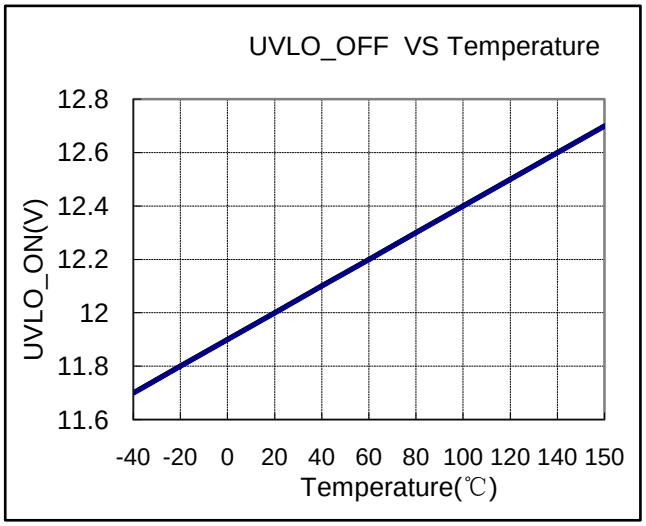
Figure 2.Block diagram of SP2607AF

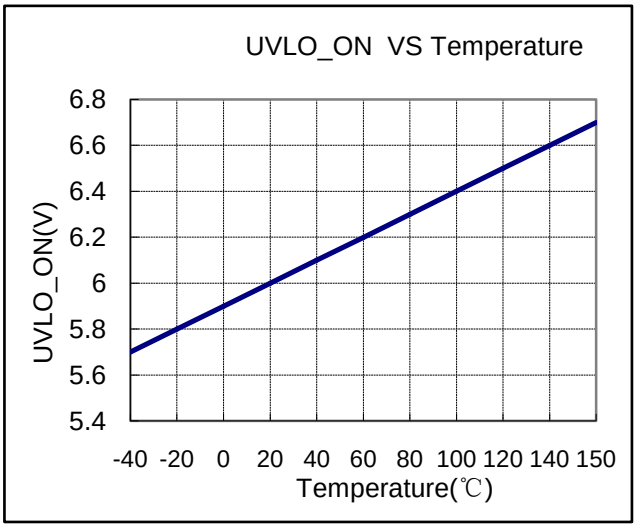
Electrical Characteristics

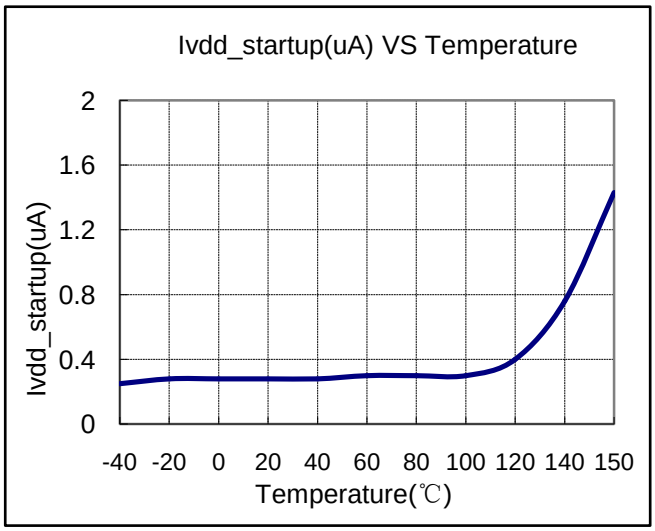
VDD=15V, TA=25℃, unless otherwise noted.

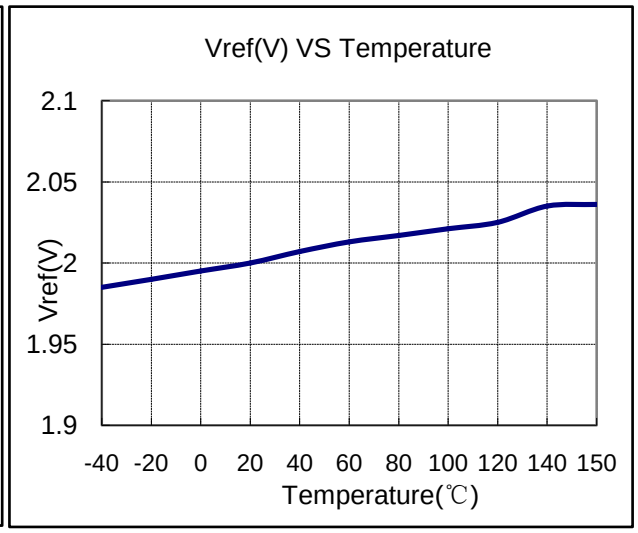
Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
Supply Voltage Section						
$I_{start-up}$	Start up current	VDD=UVLO_OFF-1V		1	10	uA
I_{OP}	Operating Current		0.4	0.6	1	mA
UVLO(OFF)	VDD under voltage lockout exit	VDD Going Up	11	12	13	V
UVLO(ON)	VDD under voltage lockout enter	VDD Going Down	5	6	7	V
V_{DD_OVP}	VDD over voltage protection		24.5	26	27.5	V
V_{DD_Clamp}	Clamping voltage			28.5		V
Current Sense Input Section						
T_{LEB}	LEB time			500		ns
V_{TH_OC}	Minimum over current threshold		490	500	510	mV
T_{D_OC}	OCP propagation delay			100		nS
FB Input Section						
V_{FB_REF}	Reference voltage for FB threshold		1.98	2	2.02	V
V_{FB_OVP}	Output Over voltage threshold			2.4		V
V_{FB_DEM}	Demagnetization comparator threshold			0.1		V
T_{OFF_MAX}	Maximum Toff		2.5	3	3.5	mS
VFB_UVP	Output under voltage threshold			0.65		V
TCC /TDEM	Ratio between switching period in CC mode and demagnetization time			2		mS
I_{CABLE_MAX}	Maximum cable compensation current			40		uA
BJT Section						
VCBO	C-B Breakdown voltage		750			V
VCEO	C-E Breakdown voltage		450			V
I_C	Collect Current			1.8		A
On Chip Over Temperature Section						
T_{OTP}	Over temperature trigger point			150		℃

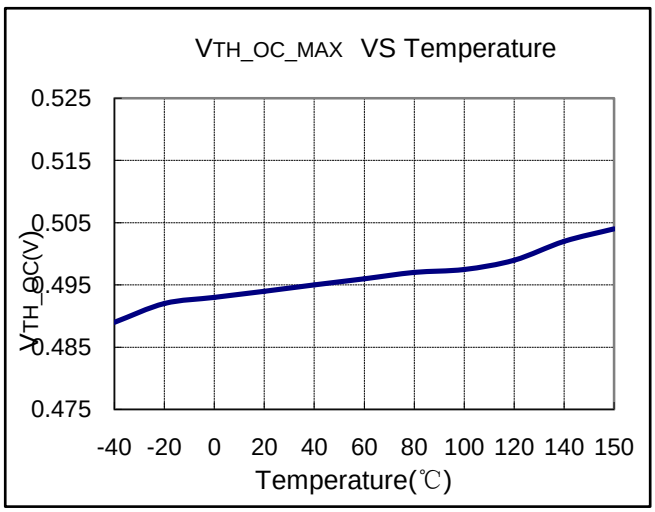
Characterization Plots

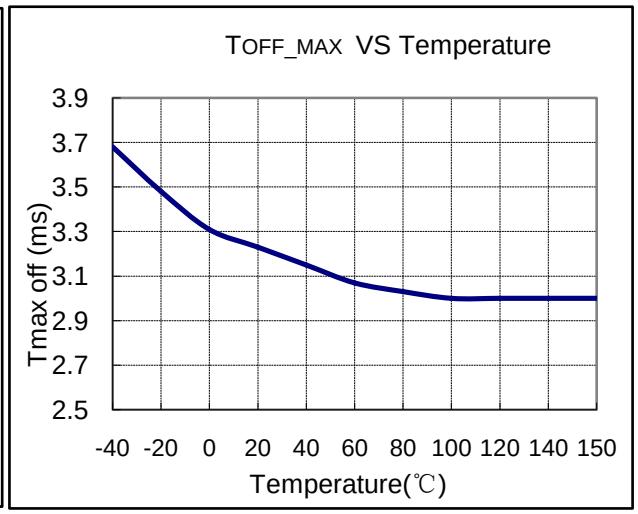




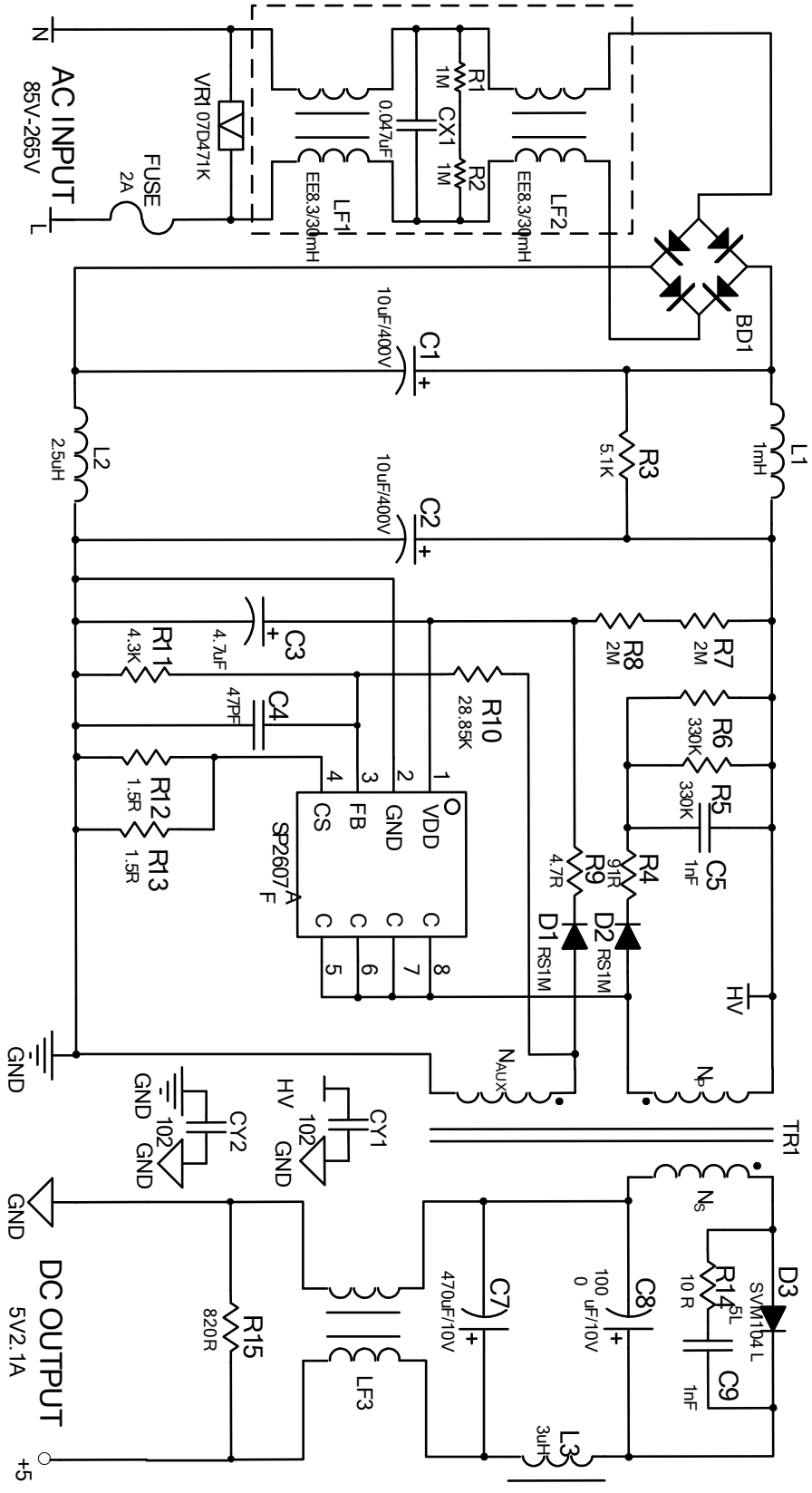








Applications Example



Functional Description

SP2607AF is a cost effective PSR power switch optimized for off-line low power AC/DC application including battery chargers and adapter. It operates in primary side sensing and regulation, thus opto-coupler and TL431 are not required. Proprietary built-in CV and CC control can achieve high precision CC/CV control. Easily meets all global energy efficiency regulations.

Fast Start up Control

Startup current of SP2607AF is designed to be very low, so the voltage of the capacitance in VDD could be charged up to the turn-on level quickly and then IC starts to work. Thus a large value resistor can be used in the startup circuit which will minimize the power loss when startup process is still reliable.

Operating Current

The Operating current of SP2607AF is as low as 600uA (typical). Good efficiency and less than 75mW standby power is achieved with the low operating current.

CC/CV Operation

SP2607AF is designed to produce good CC/CV control characteristic. 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 mode, the output voltage is regulated through the primary side control. In CC operation mode, SP2607AF will regulate the output current constant regardless of the output voltage drop.

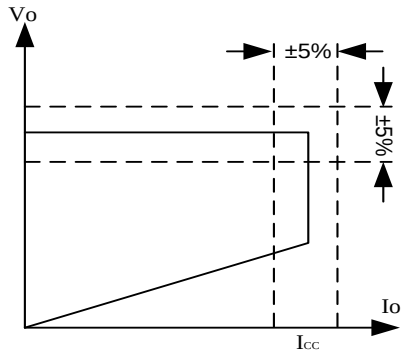


Figure 3.Typical CC/CV Curve

Principle of Operation

To support SP2607AF 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 primary current transfers to the secondary at the amplitude as below:

$$I_S = \frac{N_P}{N_S} \cdot I_P \quad (1)$$

The auxiliary voltage reflects the output voltage as shown in Figure 4. and it is given by

$$V_{AUX} = \frac{N_{AUX}}{N_S} \quad (2)$$

Where ΔV indicates the voltage drop of the output diode.

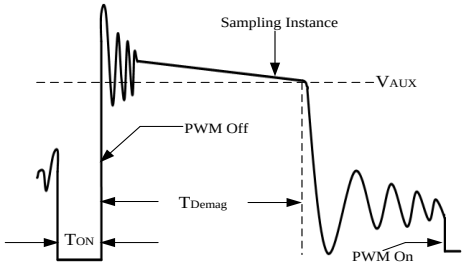


Figure 4.Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB (Pin 2), the auxiliary voltage is sampled at the end of the demagnetization and it is hold until the next sampling. The sampled voltage is compared with reference voltage Vref (typical 2V) and the error is amplified. The error amplifier output reflects the load condition and controls the PWM switching frequency to regulate the output voltage, thus constant output voltage can be achieved.

When sampled voltage is below Vref and the error amplifier output reaches its maximum, the switching frequency is controlled by the sampled voltage to regulate the output, thus the constant output current can be achieved.

Adjustable CC point and Output Power

In SP2607AF, the CC point and maximum output power can be externally adjusted by external current sense resistor Rcs at CS pin. The output power is adjusted through CC point change. The larger Rcs, the smaller CC point is, and the output power becomes smaller which is shown in Fig.5.

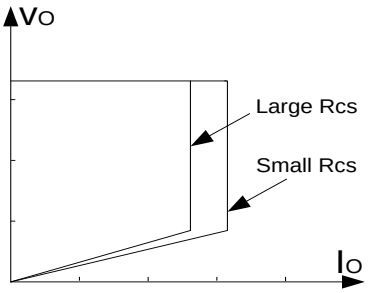


Figure 5.Adjustable output power by changing Rs

Operation Switching Frequency

The switching frequency of SP2607AF is adaptively controlled according to the load conditions and the operation modes. For flyback operating in DCM, the maximum output power is given by 1

$$P_{O\_MAX} = \frac{1}{2} L_P \cdot F_{SW} \cdot I_P^2 \quad (3)$$

Where Lp indicate the inductance of primary winding and Ip is the peak current of primary winding and Ip is the peak current of primary winding. Refer to the equation 3, the change of the primary winding inductance results in the change of the maximum output power and the constant output current in CC mode. To compensate the change from variations of primary winding inductance, the switching frequency is locked by an internal loop and the switching frequency is

$$F_{SW} = \frac{1}{2T_{Demag}} \quad (4)$$

Since T_{Demag} is inversely proportional to the inductance, as a result, the product L_P and F_{sw} is constant, thus the maximum output power and constant current in CC mode will not change as primary winding inductance change, Up to ±7% variation of the primary winding inductance can be compensated.

Programmable Cable Drop Compensation

In SP2607AF, cable drop compensation is implemented to achieve good load regulation. An offset voltage is generated at FB by an internal current flowing into the resister divider. The current is inversely proportional to the output load current, and the drop due to the cable loss can be compensated. As the load current decreases from full-load to no-load, the offset voltage at FB will increase. It can also be programmed by adjusting the resistance of the divider to compensate the drop for various cable lines used.

The maximum load compensation voltage is

$$\Delta V = (I_{CABLE\_MAX} \cdot R_2 \cdot 10^{-6}) \cdot N \quad (5)$$

When N is the ratio of auxiliary windings and secondary windings.

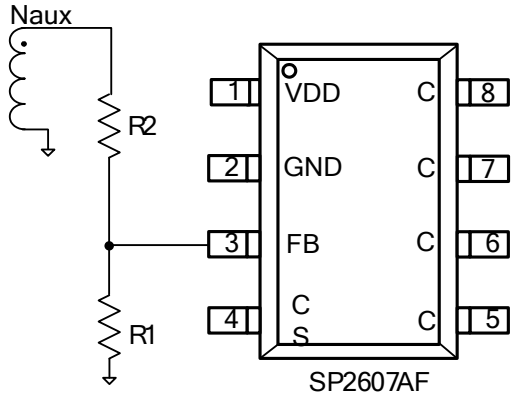


Figure 6.Cable Drop Compensation

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in SP2607AF. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sense voltage spike at initial power BJT on state so that the external RC filtering RC filtering on sense input is no longer needed. The current limiting comparator is determined by the current sense input voltage and the EA output voltage.

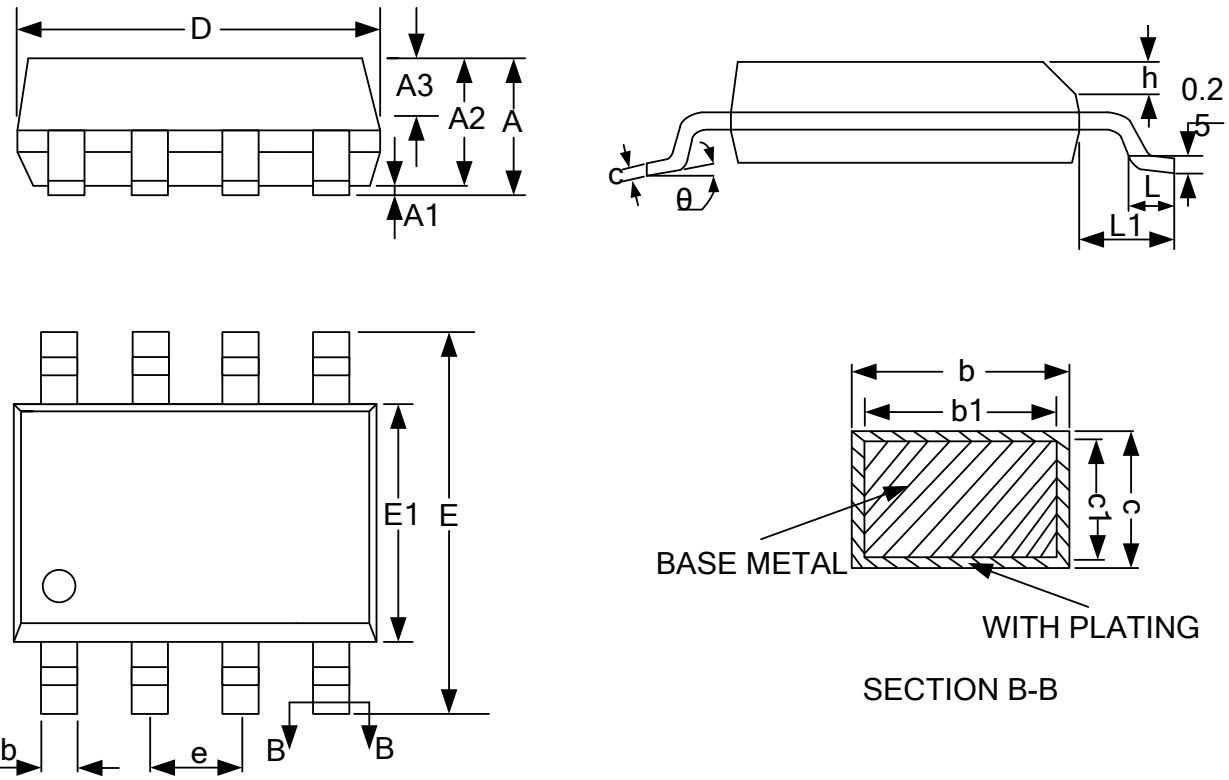
Protection Control

Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting, VDD over voltage protection(OVP), FB under voltage lockout (UVLO) short circuit protection, under voltage lockout(UVLO),OTP etc.

VDD is supplied by transformer auxiliary winding output. The output of SP2607AF is shut down when VDD drops

below UVLO limit and Switcher enters power on start-up sequence thereafter.

Package Information（Units:mm）



SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
A	—	—	1.75	D	4.70	4.90	5.10
A1	0.05	—	0.15	E	5.80	6.00	6.20
A2	1.30	1.40	1.50	E1	3.70	3.90	4.10
A3	0.60	0.65	0.70	e	1.27BSC		
b	0.39	—	0.48	h	0.25	—	0.50
b1	0.38	0.41	0.43	L	0.50	—	0.80
c	0.21	—	0.26	L1	1.05BSC		
c1	0.19	0.20	0.21	θ	0	—	8°

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