



G1135N-SG

High Precision CC/CV Primary-Side PWM Power Switch

1. General Description

G1135N-SG is a high performance offline PWM Power switch for low power AC/DC charger and adaptor application. It operates in primary side regulation. Consequently, opto-coupler and TL431 could be eliminated.

Proprietary Constant Voltage (CV) and Constant Current (CC) control is integrated as shown in the Fig.1. In CC control, the current and output 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. Device operates in PFM in CC mode as well at large load condition and it operates in PWM with frequency reduction at light/medium load.

G1135N-SG offers perfect protection function with auto-recovery features including Cycle-by-Cycle current limiting (OCP), VDD UVLO and OVP, VDD clamp, Secondary rectifier Diode short protection etc.

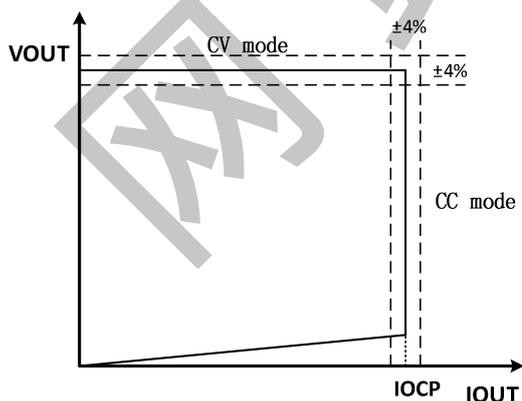


Fig.1. Typical CC/CV Curve

Features

- ◆ Built-in High-Voltage Power MOS
- ◆ 4% CV and CC Regulation at Universal AC input
- ◆ Standby Power consumption less than 70mW
- ◆ Programmable CV and CC Regulation
- ◆ No audible noise over entire operating range
- ◆ Programmable cable drop compensation
- ◆ Integrated line voltage and load voltage constant current compensation
- ◆ Built-in Leading Edge Blanking (LEB)
- ◆ comprehensive protection coverage
 - VDD under voltage lockout with hysteresis (UVLO)
 - VDD over voltage protection (VDD OVP)
 - Cycle-by-Cycle current limiting
 - Output over voltage protection (Output OVP)
 - Secondary rectifier diode Open and short circuit protection
 - Secondary winding Open and short circuit protection
 - FB pin to GND short circuit protection
- ◆ Pb-free SOP8

Applications

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

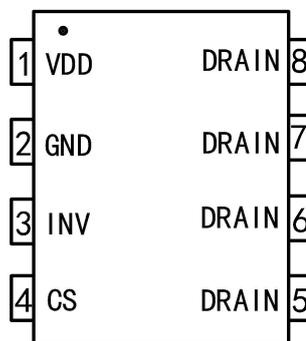


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2. Products Information

2.1 Pin configuration



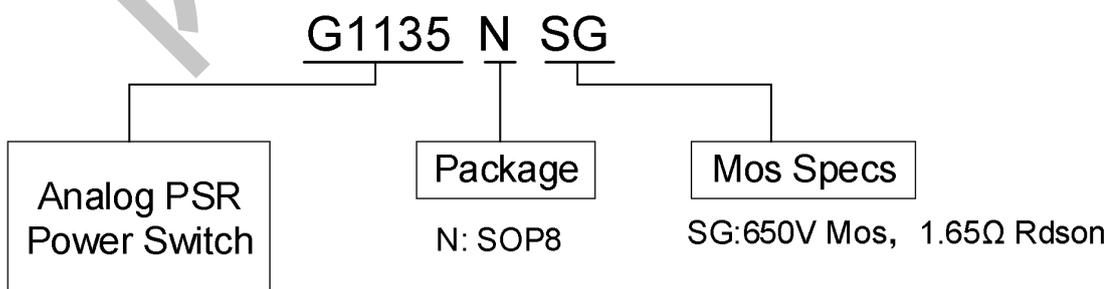
SOP8 Package

Fig.2. G1135N-SG Pin Configuration

Pin Name	I/O	Description
VDD	Power Input	Power Supply
INV	Analog Input	The Voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
CS	Analog Input	Current sense input. Connected to primary current sensing resistor.
DRAIN	Output	HV MOSFET Drain Pin. The Drain pin is connected to the primary lead of the transformer
GND	Ground	Ground

2.2 Ordering Information

Part Number	Marking ID	Package	Packing
G1135N-SG	G1135NSG	SOP8	4000/Tape&Reel



2.3 Marking Information



Year Code

A	B	C	D	E	F	G	H	I	J	K	L	M
2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038

2.4 Series Description

Product	Package	90~264VAC Recommended max output power
G1135N-SG	SOP8	20W

Note: Maximum practical continuous power in an Adapter design with sufficient drain pattern as a heat sink, at 40°C ambient. Higher output power is possible with extra added heat sink or air circulation to reduce thermal resistance. The recommended output power does not mean that this power can be made, which is determined by the actual ambient temperature and the actual shell size and whether the glue is filled.

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2.5 Block diagram

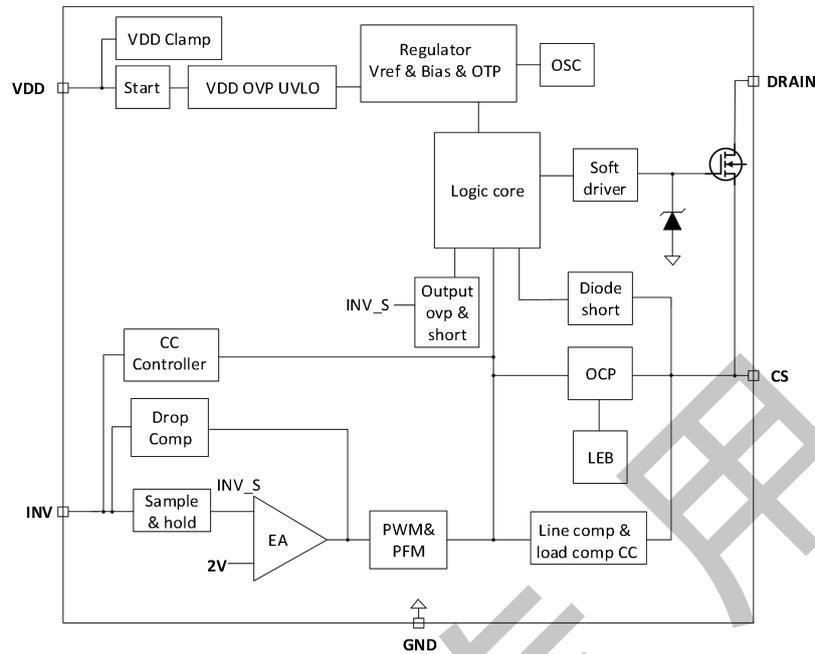


Fig.3. Block Diagram

3. Absolute Maximum Ratings

Description	Absolute Maximum Ratings
VDD Voltage	-0.3 to VDD_clamp
HV MOSFET Drain Voltage	-0.3 to BVdss
VDD Zener Clamp Continuous Current	10 mA
CS Input Voltage	-0.3 to 7V
INV Input Voltage	-0.3 to 7V
Max Operating Junction Temperature T_J	150°C
Min/Max Storage Temperature T_{stg}	-55 to 150°C
Lead Temperature (Soldering, 10secs)	260°C
Package Dissipation Rating for DIP7 $R_{\theta JA1}^2$	75°C/W
Package Dissipation Rating for SOP7/8 $R_{\theta JA2}^2$	90°C/W

Notes:

1. Stress beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability
2. Drain Pin Connected to 100mm² PCB copper clad.

Recommended Operation Ratings

Parameter	Ratings	Unit
VDD Supply Voltage	10~25	V
Environment Temperature	-20~85	°C
Maximum Operation frequency	90	kHz
Minimum Operation frequency	35	kHz

Note: The maximum operation frequency is not set in IC, and the maximum operation frequency is set in scheme design.

4. Electrical Characteristics

(TA = 25°C, VDD=18V, unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Supply Voltage (VDD Pin)						
I _{VDD_ST}	Start Current	VDD=UVLO_OFF-0.5V		2	10	uA
I _{VDD_OP}	Operation Current	VDD=18V		0.6	0.9	mA
UVLO_ON	VDD Under Voltage Lockout Enter	VDD falling	6.8	7.8	8.8	V
UVLO_OFF	VDD Under Voltage Lockout Exit	VDD rising	14	15	16	V
V _{DD_OVP}	VDD Over voltage protection	Ramp up VDD until Gate is off	26	28	30	V
V _{DDClamp}	VDD clamp voltage	I _{VDD} =5mA	32	34	36	V
Current Sense (CS Pin)						
T _{LEB}	LEB time			500		nS
V _{TH_OC}	Over current threshold		490	500	510	mV
T _{D_OC}	Over current detection and control delay			100		nS
Error Amplifier Section (INV Pin)						
V _{REF_EA}	Reference voltage for Error Amplifier		1.98	2.00	2.02	V
V _{INV_OVP}	Output over voltage threshold based INV		2.3	2.4	2.5	V
V _{thCC_shutdown}	CC mode shut down threshold			0.55		V
T _{D_CC_shutdown}	CC mode shut down debounce time			30		ms
V _{INV_DEG}	Degaussing comparator			20		mV

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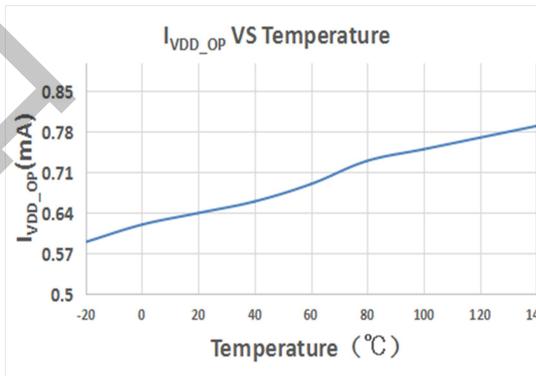
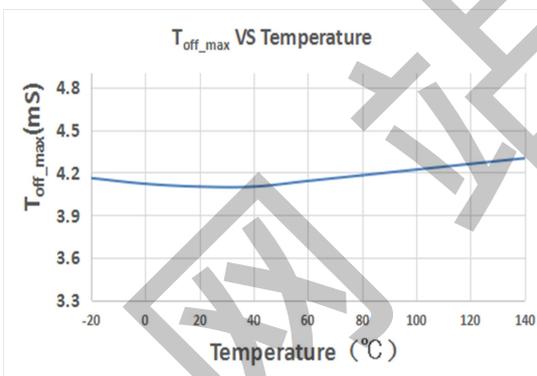
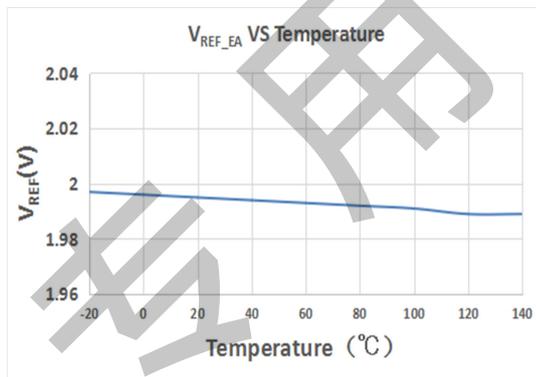
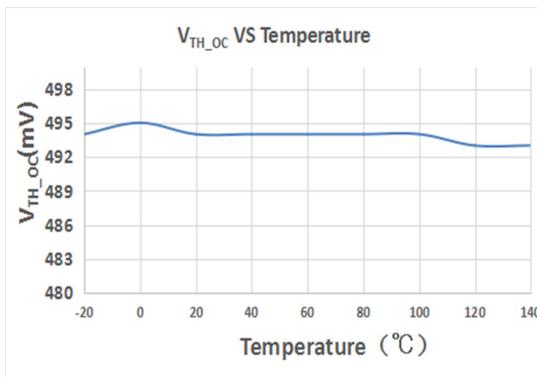
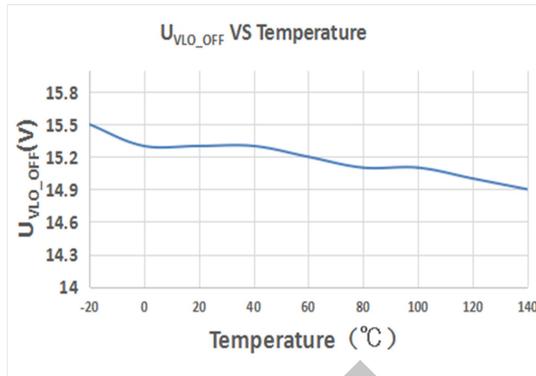
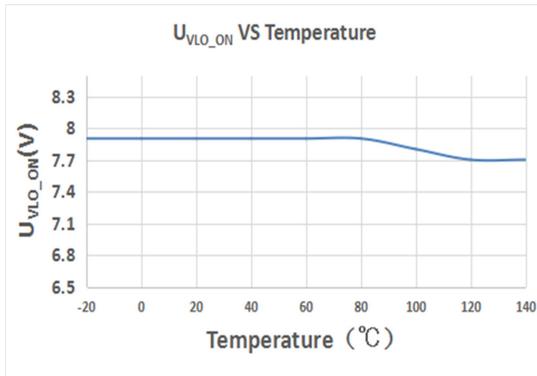
	threshold					
T _{off_min}	Minimum turn off time			2		uS
T _{off_max}	Maximum turn off time		3.6	4	4.4	mS
I _{Cable_max}	Maximum cable compensation current		45	50	55	uA
Over-temperature protection						
T _{SD}	OTP shutdown Threshold			150		°C
T _{SD_R}	OTP shutdown recovery			115		°C

MOSFET SECTION

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
G1135N-SG						
BV _{dss}	Mosfet Drain-Source Breakdown Voltage	I _D =250uA	650			V
R _{dson}	Static drain to source on resistance	V _{GS} =10V, I _D =3A		1.65		Ω
I _{D1(DC)}	Continuous Drain Current	T _C =25°C		6		A
I _{D2(DC)}	Continuous Drain Current	T _C =100°C		3.75		A
I _{DM(pluse)}	Pulsed Drain Current			24		A

Note: These parameters are not 100% tested, guaranteed by design and characterization.

5. CHARACTERIZATION



6. OPERATION DESCRIPTION

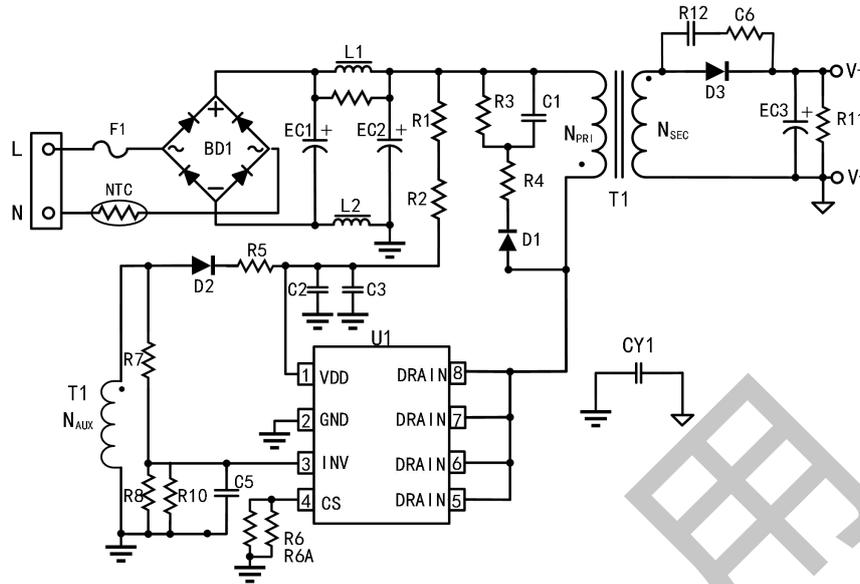


Fig.4. G1135N-SG Typical Application

G1135N-SG is a cost effective PWM power switch optimized for off-line low power AC-DC applications including battery chargers and adaptors. 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 meeting most adaptor and charger application requirements.

6.1 Startup Current and Operating Current

Startup current of G1135N-SG is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss in application. The Operating current of G1135N-SG is as low as 0.7mA. Good efficiency is achieved with the low operating current together with Multi-mode control features.

6.2 Soft Drive

G1135N-SG soft drive optimizes system EMI performance. Internal GATE pin have 16V high-level clamp circuits to prevent Gate damage during VDD high-voltage input.

6.3 CC/CV Operation

G1135N-SG is designed to produce good CC/CV control characteristic as shown in the Fig.1. 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.

In an AC/DC adapter, the normal operation occurs only on the 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, G1135N-SG will regulate the output current constant regardless of the output voltage drop.

6.4 Principle of Operation

To support G1135N-SG proprietary CC/CV control, system needs to be designed in DCM mode for flyback system (Refer to Fig.4). In the DCM flyback converter, the output voltage can be sensed via the auxiliary winding. During MOSFET turn-on time, the load current is supplied from the output filter capacitor C_o . The current in the primary winding ramps up. When MOSFET turns off, the primary current transfers to the secondary at the

amplitude of

$$I_{PKS} = \frac{N_P}{N_S} I_{PK} \quad (1)$$

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

$$V_{aux} = \frac{N_{aux}}{N_S} * (V_{out} + V_f) \quad (2)$$

Where V_f indicates the drop voltage of the output Diode.

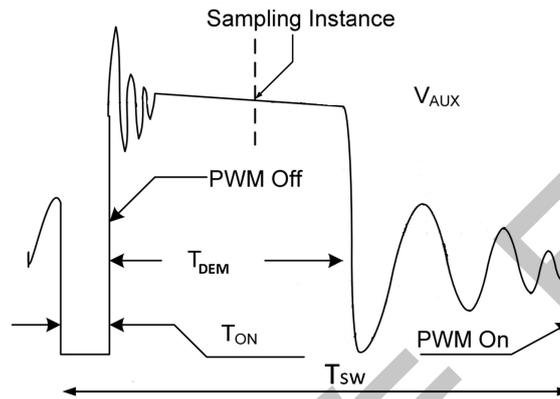


Fig.5. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and INV pin, 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 V_{REF_EA} (2.0V) and the error is amplified. The error amplifier output reflects the load condition, controls the PWM switching frequency and duty cycle to regulate the output voltage, thus constant output voltage can be achieved. When sampled voltage is below V_{REF_EA} and the error amplifier output reaches its maximum, the switching frequency is controlled by the sampled voltage thus the output voltage to regulate the output current, thus the constant output current can be achieved.

6.5 Constant current control

The G1135N-SG can realize high precision constant current output control By using the timing relation between INV pin voltage and CS pin voltage. As shown in the figure. 6. in the constant voltage output mode, when the output power of the system increases and approaches the constant current output control point, the main inductance current reaches the maximum value.

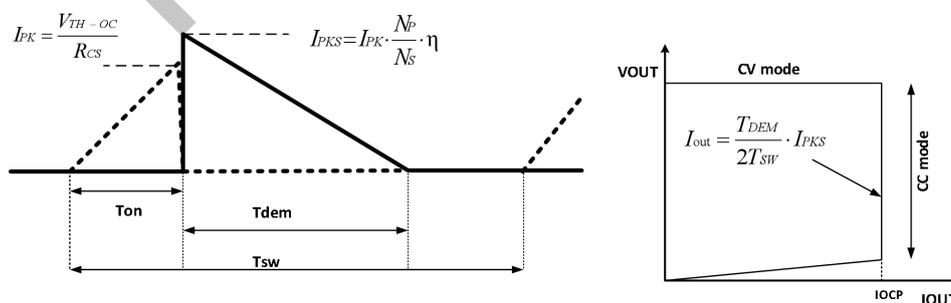


Fig.6. constant current

As shown in figure. 6. , the primary inductor current, transformer turn ratio, T_{DEM} and T_{SW} determine the average output current of the secondary side. If the leakage inductance is

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ignored, the equation for the average output current of the secondary side is shown in Fig. 6. When the output current reaches the output reference of the primary side constant current control module, the IC will enter the FM mode, no matter how the output voltage is lower than the constant voltage output standard or exactly, as long as the VDD voltage is not lower than its U_{VLO_ON} voltage, the IC will continue to work.

the ratio of T_{dem} to T_{sw} is strictly controlled to 1/2 in constant current output mode, so the actual average output current can be expressed as:

$$I_{out} = \frac{1}{4} \frac{V_{TH-OC} \cdot N_P \cdot \eta}{R_{CS} \cdot N_S} \quad (3)$$

η :Transformer conversion efficiency.

R_{CS} :Sampling Resistance between MOSFET S Pole and GND.

6.6 Adjustable CC point and Output Power

In G1135N-SG, the CC point and maximum output power can be externally adjusted by external current sense resistor R_{CS} at CS pin as illustrated in Typical Application Diagram. The output power is adjusted through CC point change. The larger R_{CS} , the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Fig.7.

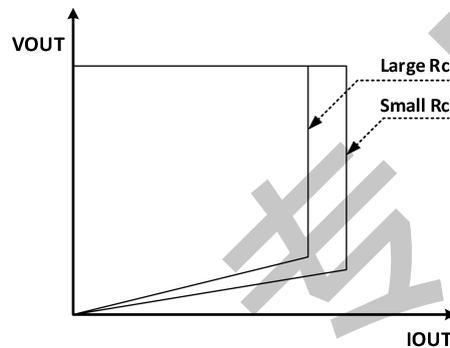


Fig.7. Adjustable output power by changing R_{CS}

6.7 Multi-mode constant voltage operation

As shown in figure 8, in order to meet the demanding requirements of average efficiency and standby power consumption, the G1135N-SG uses a combination of PFM control (FM) and PAM control (AM).

When the output is close to full load, the system works in FM mode. Between light and full load condition, the system works in AM mode and FM mode. When the system is close to no-load output, the system works in FM mode to reduce standby power consumption. With this control technology, the system can obtain standby power consumption lower than that of 70mW.

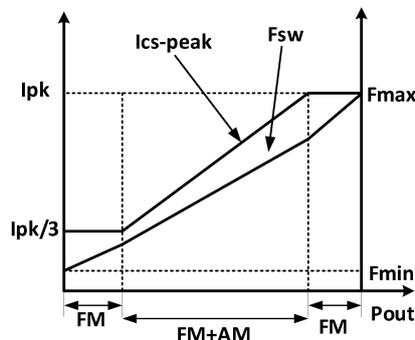


Fig.8. FM mode and AM mode

6.8 Operation switching frequency

The switching frequency of G1135N-SG is adaptively controlled according to the load conditions and the operation modes. No external frequency setting components are required. The operation switching frequency at maximum output power is recommended to 90 KHz.

For flyback operating in DCM, The maximum output power is given by

$$P_{outmax} = P_{inmax}\eta = \frac{1}{2} \cdot L_P \cdot f_{sw} \cdot I_{PK}^2 \cdot \eta \quad (4)$$

Where L_P indicates the inductance of primary winding, I_{PK} is the peak current of primary winding and η is System conversion efficiency . Refer to the equation 4, 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 such that the switching frequency is

$$f_{sw} = \frac{1}{2 \cdot T_{DEM}} \quad (5)$$

Since T_{DEM} 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 changes. Up to +/-10% variation of the primary winding inductance can be compensated.

6.9 Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in G1135N-SG current mode PWM control. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial internal power MOSFET on state so that the external RC filtering on sense input is no longer needed. The PWM duty cycle is determined by the current sense input voltage and the error amplifier output voltage.

6.10 Programmable Cable drop Compensation

In G1135N-SG,Cable drop compensation is implemented to achieve good load regulation.An offset voltage is generated at INV pin by an internal current flowing into the resistor divider.the current is proportional to the switching off time,as a result,it is inversely proportional to the output load current,thus 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 INV will increase.It can also be programmed by adjusting the resistances of the divider to compensate the drop for various cable lines used.

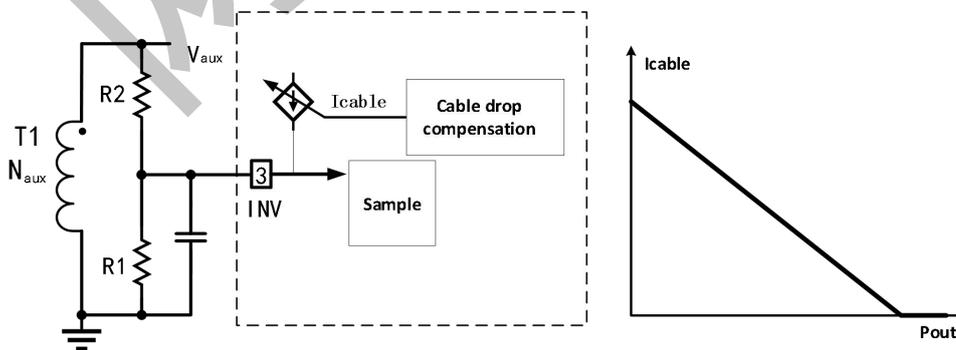


Fig.9. Cable drop compensation

The actual compensation can be adjusted by adjusting the divider resistance values of R1 and R2. The percentage of maximum compensation is

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$$\frac{\Delta V_{\text{ cable}}}{V_{\text{out}}} \approx \frac{I_{\text{cable-max}} (R1 // R2)}{V_{\text{REF_EA}}} \times 100\% \quad (6)$$

For example: R1=3K, R2=20K, then:

$$\frac{\Delta V_{\text{ cable}}}{V_{\text{out}}} \approx \frac{50\mu\text{A} (3\text{K} // 20\text{K})}{2} \times 100\% = 6.5\%$$

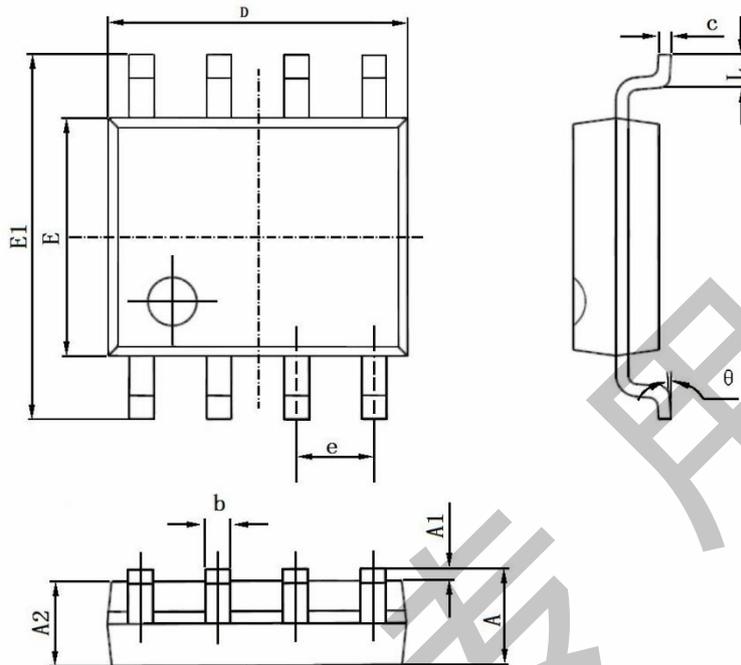
6.11 Protection

Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), VDD OVP, Under Voltage Lockout on VDD (UVLO), Output short circuit protection, Over-temperature protection (OTP), Output overvoltage undervoltage protection and so on. These protection functions can be automatically restored without the need to restart.

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7. Package Information

SOP8:



Symbol	Dimension in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	4.700	5.150	0.185	0.203
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

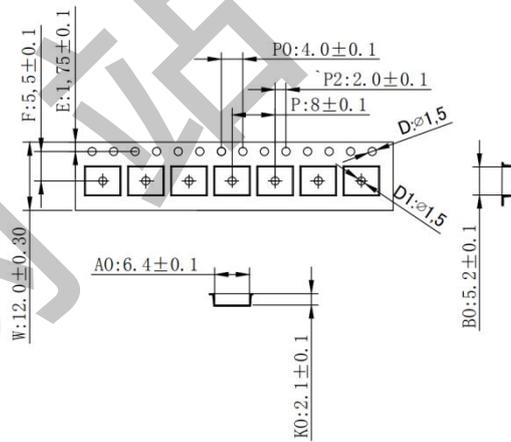
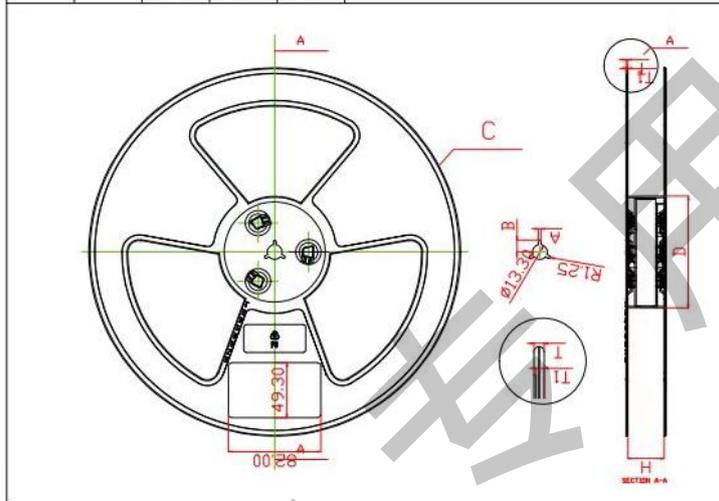
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8. Tape and Reel Information

Tape and Reel:

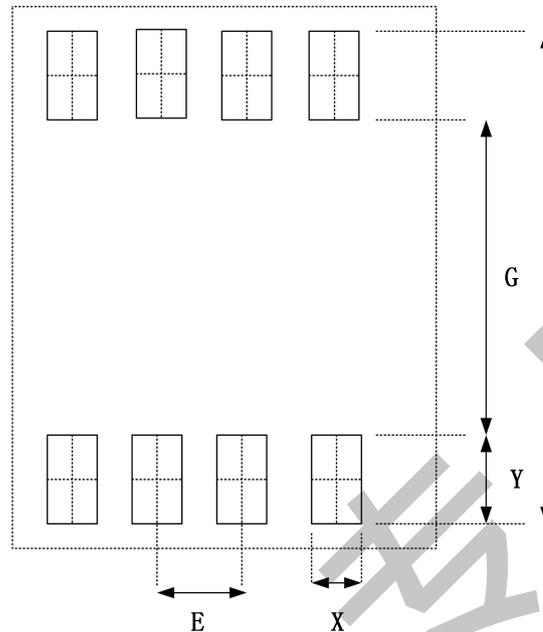
H	12	16	24	32
C±0.2	330	330	330	330
T1±0.2	1.45	1.45	1.45	1.45
B±0.2	10.7	10.7	10.7	10.7
A±0.2	2.5	2.5	2.5	2.5
T±0.2	1.85	1.85	1.85	1.85
D±0.2	100	100	100	100



9. Suggested pad Layout

SOP8:

Grid placement courtyard



尺寸	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
数值	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059	1.270/0.050

IMPORTANT NOTICE

Data and specifications subject to change without notice.

This product has been designed and qualified for Industrial Level and Lead-Free.

Qualification Standards can be found on GS's Web site.

Global Semiconductor HEADQUARTERS:

Scotia Centre, 4th Floor, P.O.Box 2804, George Town, Grand Cayman KY1-1112, Cayman

Visit us at www.globalsemi-group.com for sales contact information.

Addendum:

IR-Reflow Profile For Pb-free Leads

Pb-free Process – Package Classification Reflow Temperatures

Package Thickness	T _p (°C)		
<2.5 mm	255 +10 °C*		

* Tolerance: The device manufacturer/supplier shall assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0°C. For example 260°C+0°C) at the rated MSL level.

Profile Feature	Pb-Free Assembly
Average ramp-up rate (TL to TP)	3°C/second max.
Preheat	
-Temperature Min (T _{Smin})	150°C
-Temperature Max (T _{Smax})	200°C
-Time (min to max) (t _s)	60-180 seconds
Time maintained above:	
-Temperature (TL)	217°C
-Time (t _L)	60-150 seconds
Peak/Classification Temperature (T _p)	See Pb-free Process
Time within 5°C of actual Peak Temperature (t _p)	20-40 seconds
Ramp-down Rate	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

Notes: All temperatures refer to topside of the package. Measured on the body surface.

