QR-Mode PWM Controller with Integrated Protections

Features

- Low Start-Up Current
- Multi-Mode Operation (QR/PFM)
  - QR Operation @ Full/Medium Load
  - Burst Mode at No Load
- Switching frequency is up to 160KHz
- 8ms Soft-start
- Over Current Protection (OCP)
- Over Load Protection (OLP)
- Short circuit protection (SCP)
- Adjustment OVP on ZCD Pin
- Over Voltage Protection on VCC Pin
- Input Over Voltage Protection (Vin OVP)
- Brown in/out
- Peak load function
- Output diode Short circuit protection
- On Chip OTP Protection

Description

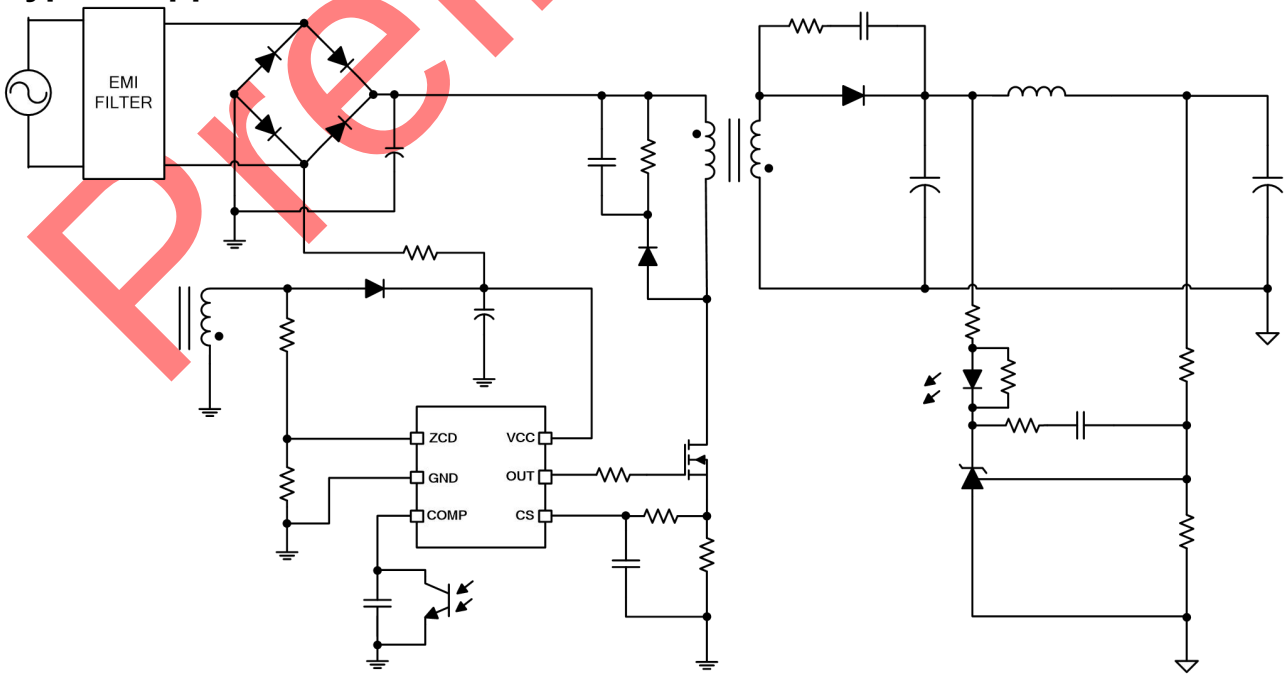
GR1235Q is a high performance multi-mode (QR/PFM) PWM controller for flyback converter. It could turn standby mode to green mode for high switching efficiency. It provides functions of low startup current, Over Current Protection Over Voltage Protection, Short circuit protection Output diode Short circuit protection and internal OTP to prevent the circuit being damaged.

Application

- Switching AC/DC power adapter
- SMPS Power Supply

Preliminary

Typical Application Information



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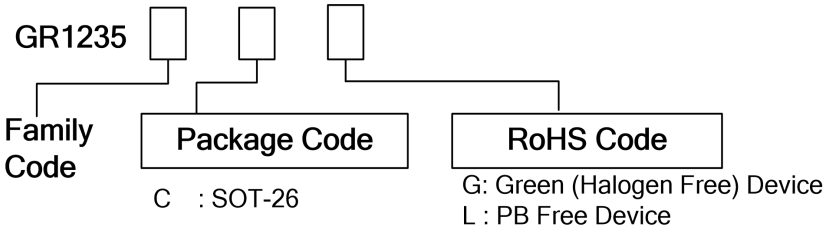
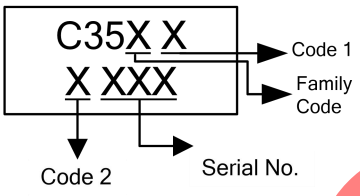
Ordering and Marking Information



SOT-26



Code 1	8	9	A	B		G	H	I	J
Year	2008	2009	2010	2011		2016	2017	2018	2019
Code 2	1	2	3	4		9	A	B	C
Month	Jan.	Feb.	Mar.	Apr.		Sep.	Oct.	Nov.	Dec.

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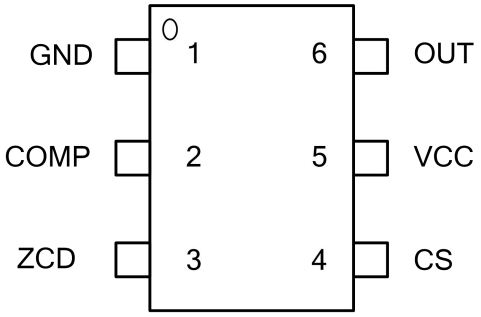
Pin Configuration

SOT-26 (TOP VIEW)



Pin Description

Pin No.	Name	Function
1	GND	Ground reference pin
2	COMP	Voltage feedback pin, by connecting a photo-coupler to control the duty cycle
3	ZCD	This pin is for quasi-resonant detection ,OVP and Brown in/out.
4	CS	Current sense pin, connected to sense resistor for sensing the MOSFET current signal
5	VCC	Power supply pin
6	OUT	The output driver for driving the external MOSFET

Preliminary

Absolute Maximum Ratings

Supply voltage VCC ---------- 30V

COMP, CS, ZCD---------- -0.3~6.0V

OUT ---------- -0.3~Vcc+0.3V

Junction temperature ---------- 150℃

Storage temperature range ---------- -65℃ ~ 150 ℃

SOT-26 package thermal resistance ---------- 250℃/W

Power dissipation(SOT-26, at ambient temperature 85℃) ---------- 250mW

Lead temperature(SOT-26 , soldering, 10 sec) ---------- 230℃

Lead temperature (All Pb free packages, soldering, 10 sec) ---------- 260℃

ESD, human body model ---------- 2.5KV

ESD, machine model ---------- 250V

Caution: The “Absolute Maximum Ratings” are those values beyond which the safety of the device cannot be guaranteed and may cause permanent damage to the IC. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the Electrical Characteristics section of the specification is not implied. The “Electrical Characteristics” table defines the conditions for actual device operation. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

Recommended Operating Conditions

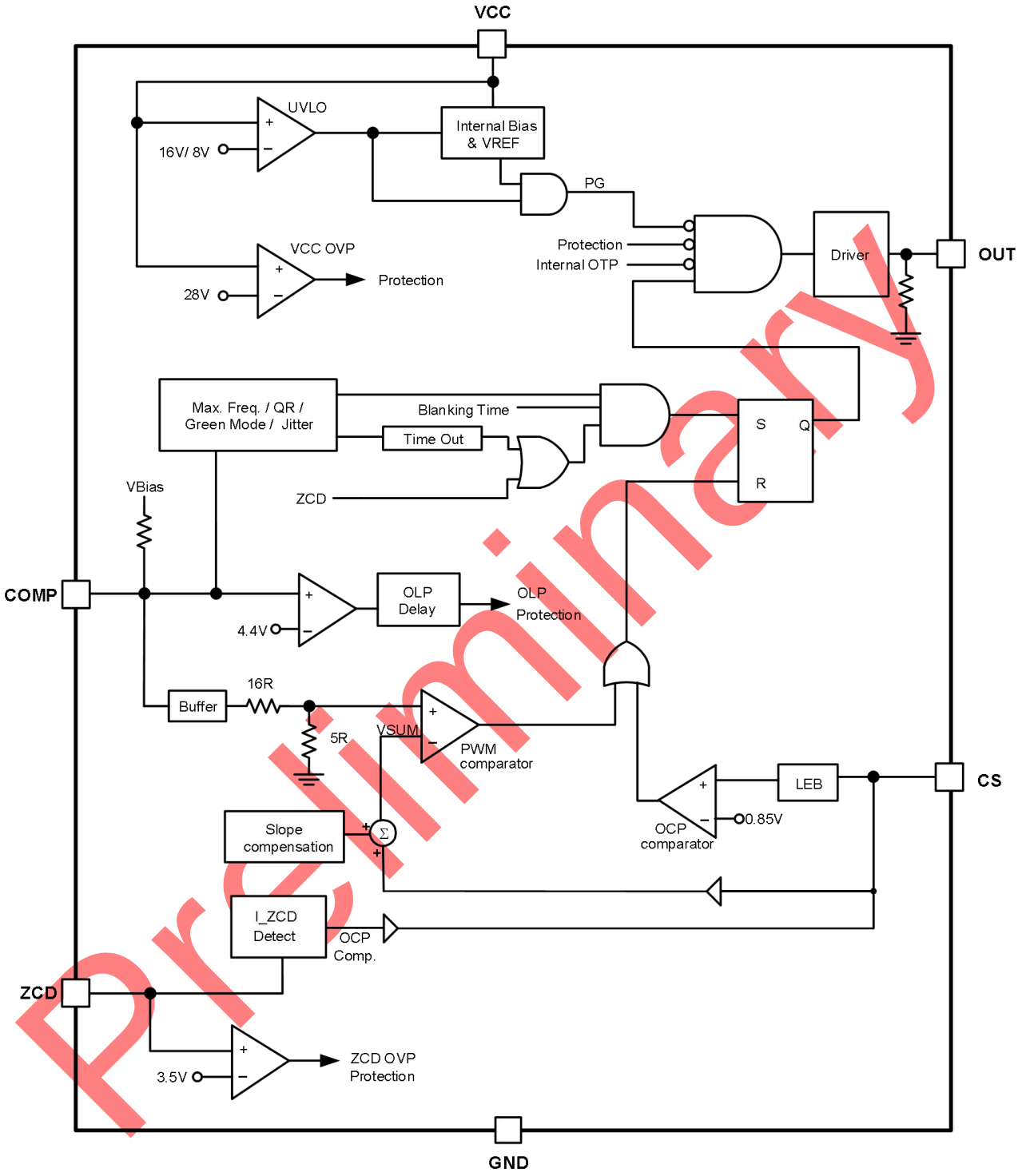
Item	Min.	Max.	Unit
Operating Junction temperature	-40	125	℃
Operating ambient temperature	-40	85	℃
Start Up Resistor (AC Half side)	540k	2.2M	Ω
Supply voltage VCC	9.5	26.5	V
VCC Capacitor	2.2	10	μF
COMP pin paralleling capacitor	1	33	nF
CS pin paralleling capacitor	100	1000	pF

Note:

- Not to exceed the maximum junction temperature of the IC, this relates to the operating power of the IC and the thermal resistance of the IC-package as above.
- The small signal components should be placed to IC pin as possible.
- A chemical capacitor and 1206 SMD ceramic capacitor are recommend for VCC to avoid noise of Resonance
- It’s essential to connect VCC pin with a SMD ceramic capacitor (0.1μF~0.47μF) to filter out the undesired switching noise for stable operation.
- Connecting a capacitor to COMP pin is also essential to filter out the undesired switching noise for stable operation.

Preliminary

Block Diagram



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Electrical Characteristics (TA = +25℃ unless otherwise stated, VCC = 15.0V)

Parameter		Min.	Typ.	Max.	Unit
SUPPLY VOLTAGE (VCC Pin)					
Startup current VCC=UVLO ON-0.1V			2	5	uA
Operating current (with 1nF load on OUT pin), Vcomp = 0V		0.35	0.55	0.75	mA
Operating current (with 1nF load on OUT pin), Vcomp = 2.5V			5		mA
Operating current (with 1nF load on OUT pin), protection tripped (VCC OVP, OLP, ZCD OVP/UVP)		0.8	1	1.2	mA
UVLO-OFF		7	8	9	V
UVLO-ON		15	16.0	17	V
VCC Mode Entry Point			8.5		V
Hysteresis			0.5		V
OVP level on VCC pin		26.5	28	29.5	V
OVP level on VCC pin Debounce Time*			100		μS
VOLTAGE FEEDBACK (COMP Pin)					
Short circuit current, Vcomp = 0V		150	200	250	uA
Open loop voltage, COMP pin open		4.9	5.3	5.7	V
Green Mode Start voltage			3.6		V
Green Mode end voltage			1.9		V
Burst Mode voltage		0.95	1.0	1.05	V
Hysteresis			100		mV
OLP trip level, Vcomp		4.2	4.4	4.6	V
OLP delay time			50		ms
CURRENT SENSING (CS Pin)					
Maximum input voltage,VCS(OFF)		0.80	0.85	0.90	V
Leading-edge blanking time			250		nS
Input impedance		1			MΩ
Delay to Output*			100		nS
The protection level of output diode Short circuit			0.9		V
De-bounce time of output diode Short circuit protection			4		Pulse

Preliminary

Electrical Characteristics (TA = +25℃ unless otherwise stated, VCC = 15.0V)

Parameter		Min.	Typ.	Max.	Unit
ZCD (ZCD Pin)					
Upper Clamp Level, IZCD=1mA		4	4.6	5.2	V
Lower Clamp Level, IZCD=-1mA		-0.8	-0.5		V
ZCD Blanking Time*			2.5		μs
ZCD OVP		3.4	3.5	3.6	V
OVP OVP De-bounce Time*			4		cycle
UVP Level		0.7	0.8	0.9	V
After UVP De-bounce Time			4		cycle
VIN OVP, protection tripped current		380	400	420	uA
Vin OVP de-bounce time			32		mS
Brown in tripped level		105	110	115	uA
Brown out tripped level		95	100	105	uA
Brown out de-bounce time			72		mS
OSCILLATOR					
QR max. Frequency			160		kHz
Green Mode Frequency		20	22	24	kHz
Jitter Frequency (CCM Mode)			±6		%
Soft Start Time (CS Pin)					
Soft Start Time*		6	8	10	ms
GATE DRIVER OUTPUT (OUT Pin)					
Output low level, VCC = 18V, Io = 20mA				1	V
Output high level, VCC = 18V, Io = 20mA		8			V
Rising time, load capacitance = 1000pF*			200		ns
Falling time, load capacitance = 1000pF*			20		ns
VGATE-clamp (VCC = 20V) D/E mode GaN			10/5.5		V
Maximun duty cycle		75	80	85	%
Internal OTP (Guaranteed by Design)					
OTP*			140		℃
Hysteresis*			30		℃

*Guaranteed by Design.

Preliminary

Typical Performance Characteristics

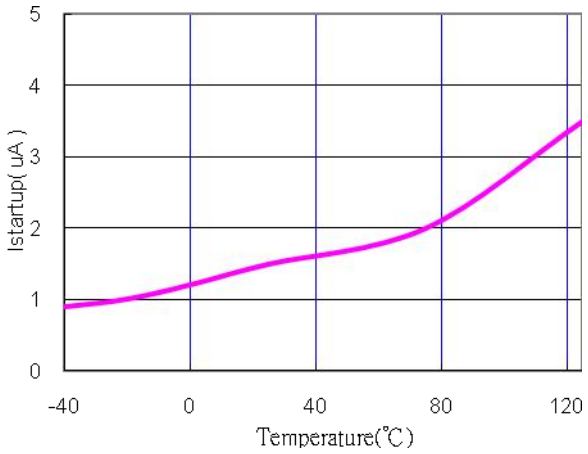


Fig. 1 Istartup current vs. Temperature

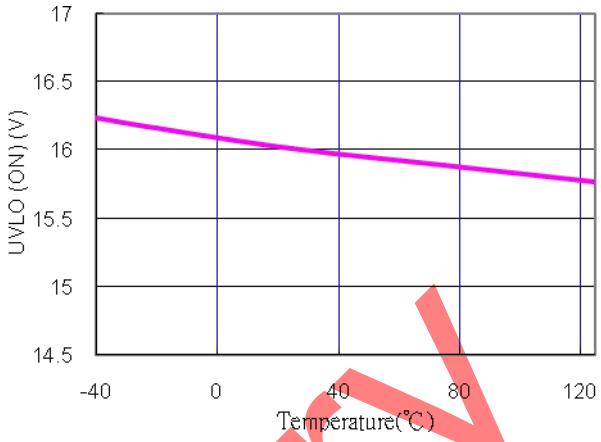


Fig. 2 UVLO (ON) vs. Temperature

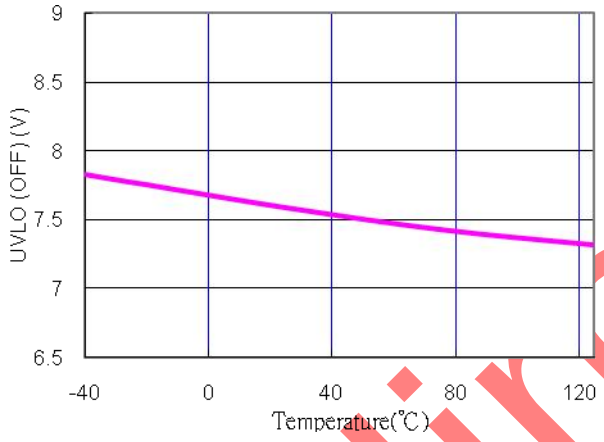


Fig. 3 UVLO (OFF) vs. Temperature

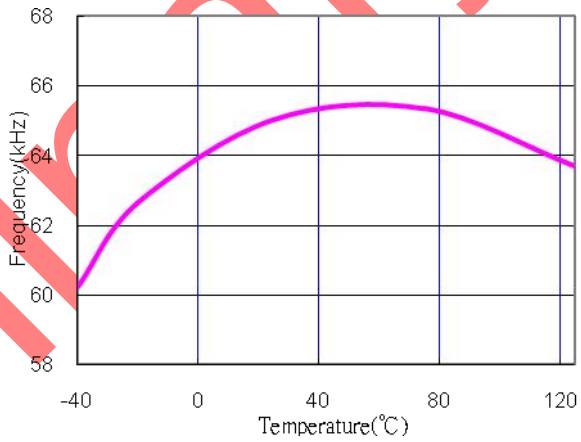


Fig. 4 CCM Frequency vs. Temperature

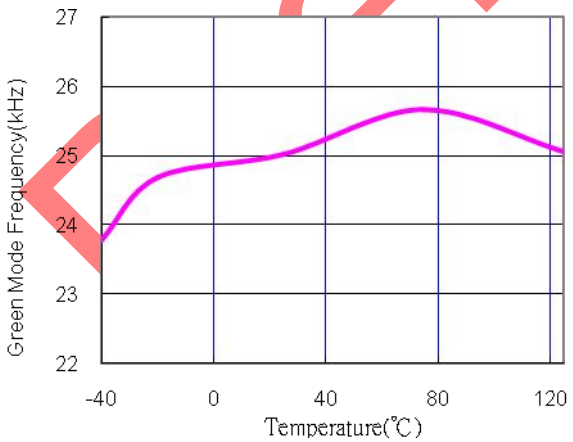


Fig. 5 Green Mode Frequency vs. Temperature

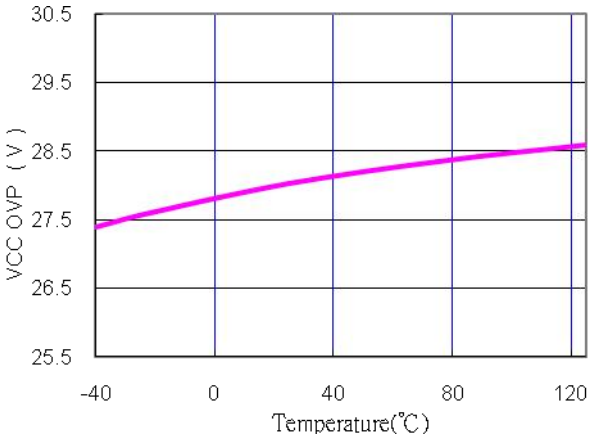


Fig. 6 VCC OVP vs. Temperature

Preliminary

Application Information

Overview

GR1235 series is a high performance multi-mode (QR/DCM) PWM controller for flyback converter. This results in a low-cost solution for low power AC/DC adapters. It integrated more functions to reduce the external components counts and the size. Its major features are described as below.

Start-up Current

The typical start-up current is 2uA. Very low start-up current allows the PWM controller to increase the value of start-up resistor and then reduce the power dissipation on it.

Under-voltage Lockout (UVLO)

A hysteresis UVLO comparator is implemented in GR1236 series, then the turn-on and turn-off thresholds level are fixed at 16V and 8V respectively. This hysteresis ensures that the start-up capacitor will be adequate to supply the chip during start-up. The hysteresis is show in Fig. 7.

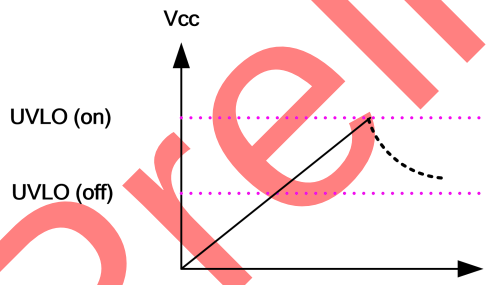


Fig.7

Multi-Mode Operation

GR1235 Q is a multi-mode (QR/PFM) controller.

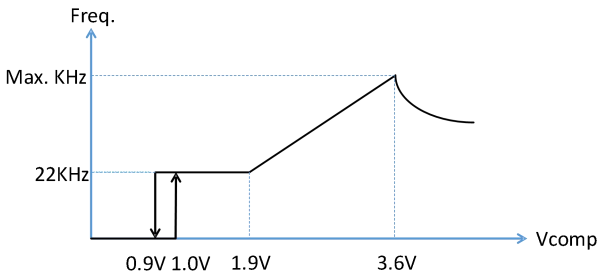


Fig.8

Quasi-Resonant Detection

ZCD pin detects leak of transformer and resonance of parasitic capacitance of MOSFET and turn on MOSFET at nearby trough of wave of resonance to reduce power loss and improve efficiency.

Leading-edge Blanking (LEB)

Each time the power MOSFET is switched on, a turn-on spike will inevitably occur at the sense resistor. To avoid fault trigger, a leading-edge blanking time is built in. During this blanking period, the current-limit comparator is disabled and cannot switch off the gate driver.

Over-voltage Protection (OVP) on VCC Auto Recovery mode

Over-voltage Protection is implemented in GR1235 series for being damaged from abnormal condition. When VCC voltage is higher than OVP level, the Output of Gate driver will be shut down.VCC OVP is auto-recovery. Once the condition of over voltage happened, the Gate driver will be shut down until the next turn-ON. This operation is an Hiccup mode. (Fig.9)

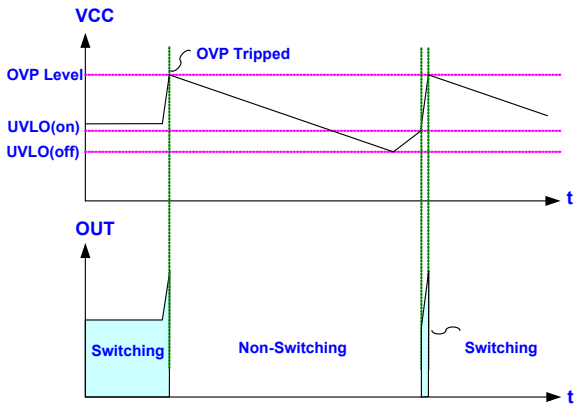


Fig.9

Output OVP on ZCD - Auto Recovery mode

Preliminary

An output overvoltage protection is implemented in GR1235 series, as shown in Fig. 11. It senses the auxiliary voltage via the divided resistors. The overvoltage protection works by sampling the plateau voltage after a delay time. The sampling voltage level is compared with internal threshold voltage 3.5V. If the sampling voltage exceeds the ZCD OVP trip level, ZCD OVP circuit switches the power MOSFET off. ZCD OVP function is an auto-recovery type protection.

Output Under-voltage Protection (UVP) on ZCD– Auto Recovery mode

To protect the circuit from damage due to output short condition, an auto-recovery type of UVP protection is implemented for it. If the QRD voltage declines below 0.8V for over 4cycle, the protection will be activated to turn off the gate until the next UVLO-ON.

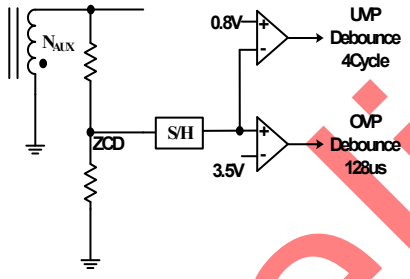


Fig.10

ZCD Vin OVP – Auto Recovery mode

To prevent circuit from being damaged, ZCD Vin OVP is implemented in GR1235 series. As the Iaux more than 400 uA of OVP current, IC will entrance prevent mode until the next UVLO-ON, as shown in Fig.11.

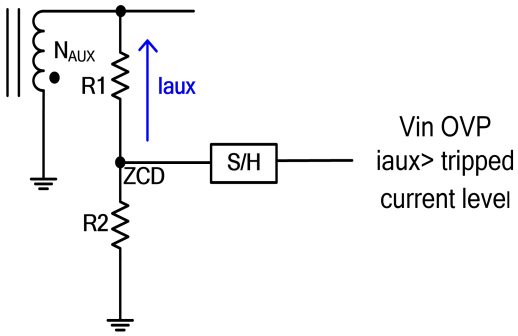


Fig.11

Brown-In/Brown-Out Protection- Auto Recovery mode

GR1236 series have BNI/BNI function. This function is detected by internal circuit on ZCD pin, as show in Fig.11. If Iaux<IBNI, BNI Protection is triggered. The de-bounce time is 2~5CLK. During the BNI, If Iaux<IBNO,BNO protection is triggered. The formula is as follows:

$$Vac\_BNI = \frac{Np}{Naux} * Ibni * R1 * \frac{1}{\sqrt{2}}$$

$$Vac\_BNO = \frac{Np}{Naux} * Ibno * R1 * \frac{1}{\sqrt{2}}$$

Adjustable H/L Line compensation

The circuit auxiliary winding R1 (Upper arm resistance) and connecting ZCD pin for keeping in VIN voltage consistency. The relation of IZCD and IOCP is IOCP=0.5*IZCD. The CS OCP source current, which via the resistors of R and Rcs, could compensates Voltage (△Vcs) because input voltage in H line makes Voltage Offset, as shown in Fig.12.

Preliminary

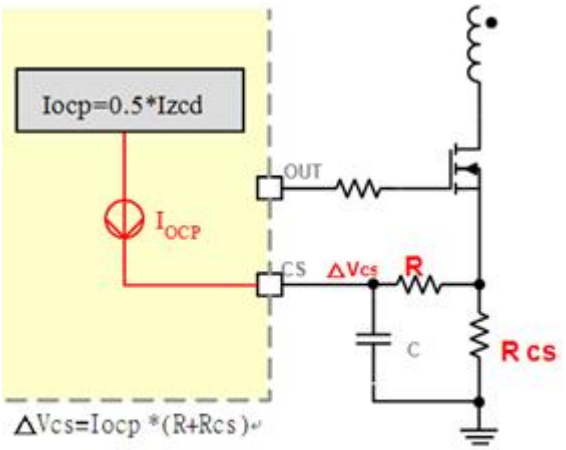


Fig.12

Gate Clamp/Soft Driving

Driver output is clamped by an internal 12.5V clamping circuit to prevent from undesired over-voltage gate signals. And under the conditions listed below, the gate output will turn off immediately to protect the power circuit. GR1235 series also has soft driving function to minimize EMI.

VCC Mode

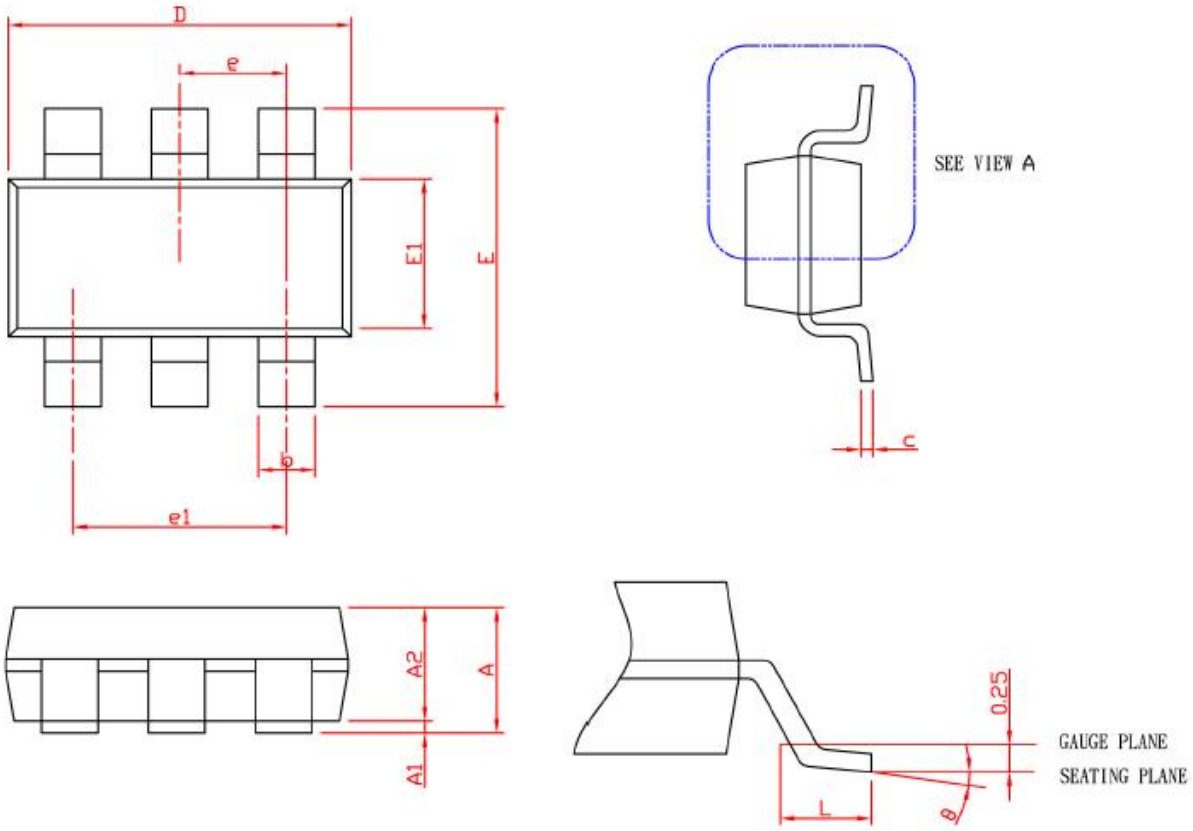
In order to avoid the output voltage shut down by load changing from full to no load, GR1235 series is built-in the VCC mode function. When the load from full changes to no load, the output voltage will overshoot and pull low the COMP pin by feedback loop (Into burst mode). Thus the duty will disappear and no power delivers to the secondary. If there is without any mechanism to prevent this situation, the VCC pin voltage will down to UVLO off and the IC will re-start again.

The VCC mode function is used to prevent the output re-start again when load changes. So never let the system operate on the VCC mode at no load. The system should operate on burst mode, otherwise the input power maybe become larger.

Preliminary

封装信息

SOT-26



SYMBOL	SOT-26			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.45		0.057
A1	0.00	0.15	0.000	0.006
A2	0.90	1.30	0.035	0.051
b	0.30	0.50	0.012	0.020
c	0.08	0.22	0.003	0.009
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.30	0.60	0.012	0.024
θ	0°	8°	0°	8°

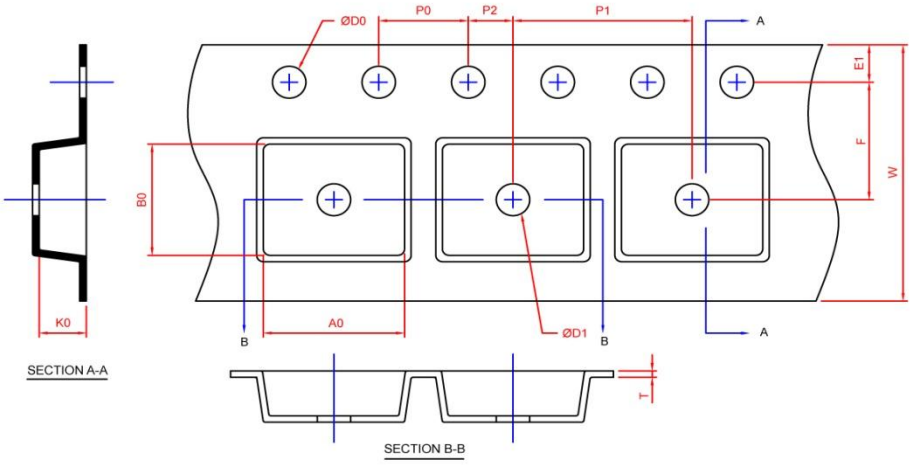
Note: 1. Followed from JEDEC MO-178 AB.

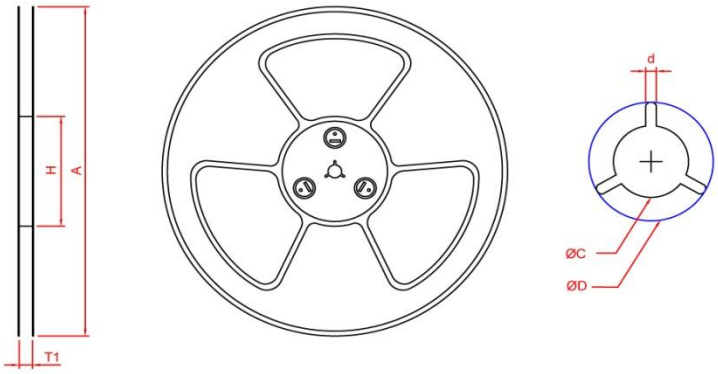
2. Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 10 mil per side

Preli.

包装信息

SOT-26





Application	A	H	T1	C	d	D	W	E1	F
SOT-26	178.0±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0±0.30	1.75±0.10	3.5±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.0±0.10	4.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.0 M----IN.	0.6+0.00 -0.40	3.20±0.20	3.10±0.20	1.50±0.20

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOT -26	8	5.3	3000

(mm)

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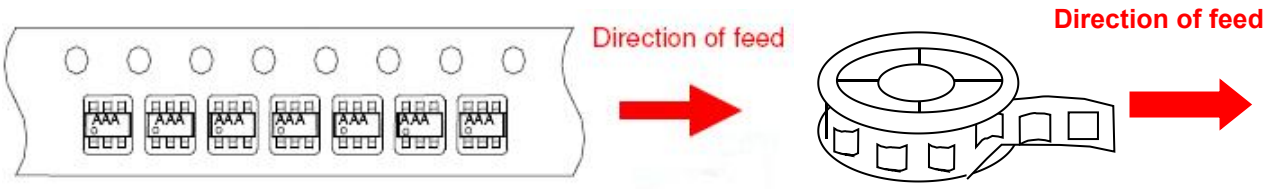
SOT 26



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Revision History

Ver.	Date	Change Notice
A	2018/11/14	GR1235中文版，release

Preliminary