Green Mode Off-line Power Switch with Brown-Out Protections

Rev. P02

General Description

The LD7932R integrated a 700V power MOSFET and a current mode PWM controller in a DIP-7 package. It takes less components counts or circuit space, especially ideal for those total solutions of low cost.

The implemented functions include low startup current, green-mode power-saving operation, leading-edge blanking of the current sensing and internal slope compensation. It also features more protections like OLP (Over Load Protection) and OVP (Over Voltage Protection) to prevent circuit damage occurred under abnormal conditions.

Furthermore, the Frequency Swapping function is to reduce the noise level and thus helps the power circuit designers to easily deal with the EMI filter design by spending minimum amount of component cost and developing time.

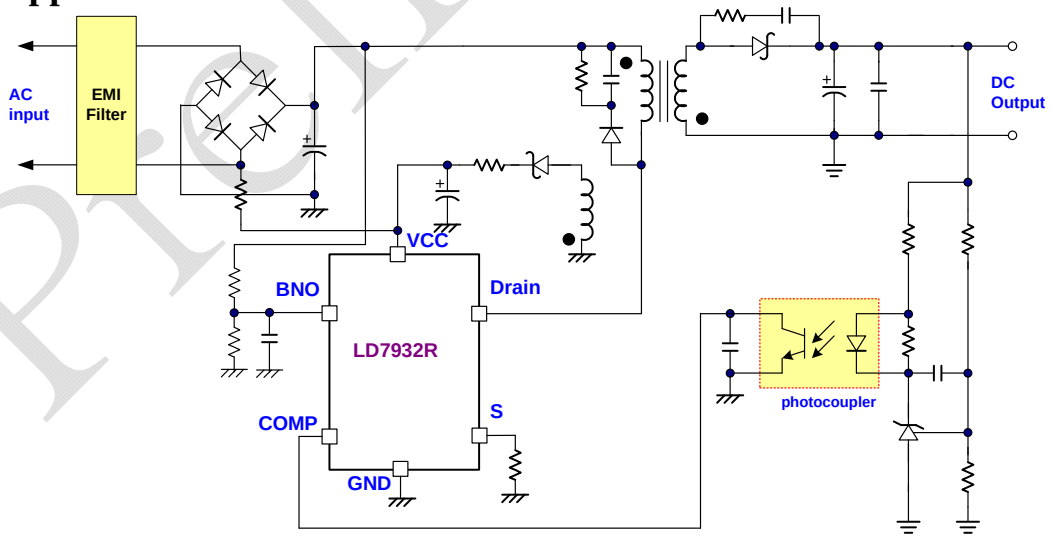
Features

- Built-in 700V Power MOSFET
- High-Voltage CMOS Process with Excellent ESD protection
- Very Low Startup Current (<20μA)
- Current Mode Control
- Green Mode Control
- UVLO (Under Voltage Lockout)
- LEB (Leading-Edge Blanking) on CS Pin
- Internal Frequency Swapping
- Internal Slope Compensation
- Internal OTP Protection
- OVP (Over Voltage Protection) on Vcc Pin
- Brownout Protection
- OLP (Over Load Protection)

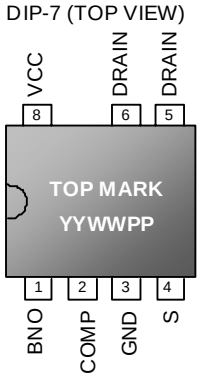
Applications

- Switching AC/DC Adaptor
- Open Frame Switching Power Supply

Typical Application



Pin Configuration



YY: Year code
WW: Week code
PP: Production code

Ordering Information

Part number	Package	Top Mark	Shipping
LD7932R GM	DIP-7 (Green Package)	LD7932R GM	3600 /tube /Carton

The LD7932R are ROHS compliant.

Protection Mode

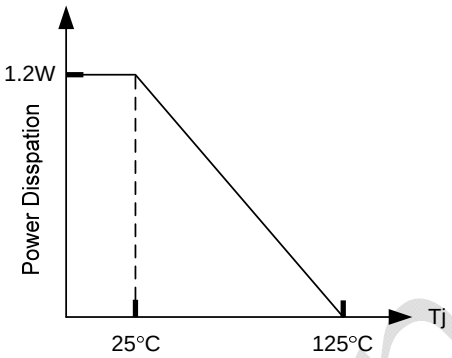
Switching Freq.	VCC OVP	OLP	BNO Pin
65kHz	Auto recovery	Auto recovery/ 65ms	Auto recovery

Pin Descriptions

PIN (DIP-7)	NAME	FUNCTION
1	BNO	Brownout Protection Pin. Connected a resistor divider from this pin to AC mains input to set the brownout level and line compensation. When the voltage of this pin is lower than threshold voltage, the PWM output will be off.
2	COMP	Voltage feedback pin (same as the COMP pin in UC384X), By connecting a photo-coupler to close the control loop and achieve the regulation.
3	GND	Ground of the controller
4	S	Source of internal power MOSFET, connecting a sense resistor to ground.
5	Drain	Drain terminal of the internal power MOSFET
6	Drain	Drain terminal of the internal power MOSFET
8	VCC	Supply voltage pin

Output Power Table & De-rating Curve

Product	Drain Current	Rds(on) *	230VAC ± 15% **		90~264VAC **	
			Adapter	Open Frame	Adapter	Open Frame
LD7932R	2A	6Ω	12~14W	14~16W	10~12W	12~14W



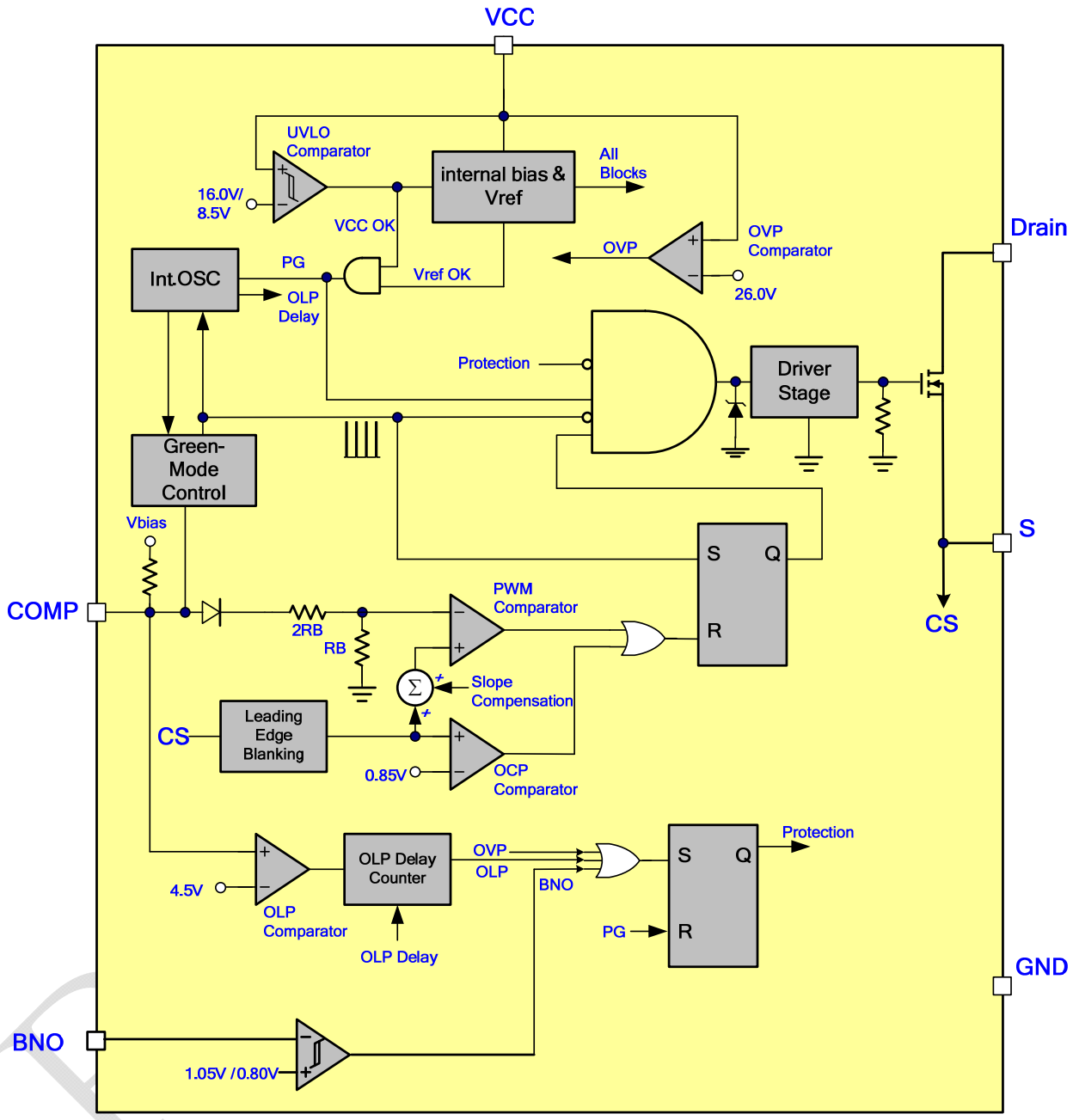
*Typ.@25°C, V_{CC}=12V Drain Current=1A

**Calculated maximum Input Power Rating at Ta=25°C

Recommended Operating Conditions

Item	Min.	Max.	Unit
Supply Voltage Vcc	10	24	V
Start-up resistor Value	540K	1.8M	Ω
COMP pin Capacitor Value	4.7	220	nF

Block Diagram



Absolute Maximum Ratings

Supply Voltage VCC	-0.3V ~29V
COMP, BNO, S	-0.3V ~6V
OUT	-0.3V ~Vcc+0.3V
Drain	-0.3V ~700V
Continuous drain current[1], TC=25°C	2.0A
Maximum Junction Temperature	150°C
Operating Ambient Temperature	-40°C to 85°C
Operating Junction Temperature	-40°C to 125°C
Storage Temperature Range	-65°C to 150°C
Package Thermal Resistance (DIP-7, θ_{JA})	80°C/W
Total Power Dissipation of DIP-7, Ta=25°C	1.2W
Lead temperature (Soldering, 10sec)	260°C
ESD Voltage Protection, Human Body Model	2.5 KV
ESD Voltage Protection, Machine Model	250 V

1. Repetitive rating: Pulse width limited by maximum junction temperature

2. w/o heat-sink, under natural convection

Caution:

Stresses beyond the ratings specified in “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Characteristics

(T_A = +25°C unless otherwise stated, V_{CC}=15.0V)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage (Vcc Pin)					
Startup Current			12	20	μA
Operating Current (with 1nF load on OUT pin)	V_{COMP}=0V		1.0		mA
	V_{COMP}=3V		2.0		mA
	OLP Tripped/ Auto		0.47		mA
	OVP Tripped/ Auto		0.47		mA
UVLO (off)		7.5	8.5	9.5	V
UVLO (on)		15	16	17	V
OVP Level		25	26	27	V
Voltage Feedback (Comp Pin)					
Short Circuit Current	V_{COMP}=0V		0.25		mA
Open Loop Voltage	COMP pin open		5.4		V
Green Mode Threshold VCOMP			2.4		V
Zero Duty Threshold VCOMP			1.5		V
Zero Duty Hysteresis			100		mV
Current Sensing (CS Pin)					
Maximum Input Voltage, V_{CS_OFF}		0.8	0.85	0.9	V
Leading Edge Blanking Time			350		ns
Internal Slope Compensation	0% to D_{MAX}. (Linearly increase)		300		mV
Input impedance		1			MΩ
Delay to Output			100		ns
Oscillator for Switching Frequency					
Frequency, FREQ		60	65	70	kHz
Green Mode Frequency, FREQG			25		kHz
Trembling Frequency			± 4.0		kHz
Temp. Stability	(-20°C ~85°C)		5		%
Voltage Stability	(VCC=11V-25V)			1	%

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
OLP (Over Load Protection)					
OLP Trip Level		4.3	4.5	4.7	V
OLP Delay Time			65		ms
Brownout Protection (BNO Pin)					
Brownout Turn-On Trip Level		1.00	1.05	1.10	V
Brownout Turn-Off Trip Level		0.75	0.80	0.85	V
BNO Pin De-bounce Time			250		us
On Chip OTP (Over Temperature)					
OTP Level			140		°C
OTP Hysteresis			30		°C
Soft Start Duration					
Soft Start Duration			2		ms

Electrical Characteristics for MOSFET

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Drain to Source Breakdown Voltage					
Breakdown Voltage BV_{DSS}	Vcc=0V, COMP=0V, I_D=250μA	700			V
Drain Leakage Current					
Drain-Source Leakage Current	V_{DS}=700V, Vcc=0V, T_J=25°C	0		1	μA
	V_{DS}=560V, Vcc=0V, T_J=125°C	0		10	
Drain on Resistance					
Drain to S pin On-Resistance	I_D=1A; V_{CC}=15V; Tj=25°C		6		Ω

Typical Performance Characteristics

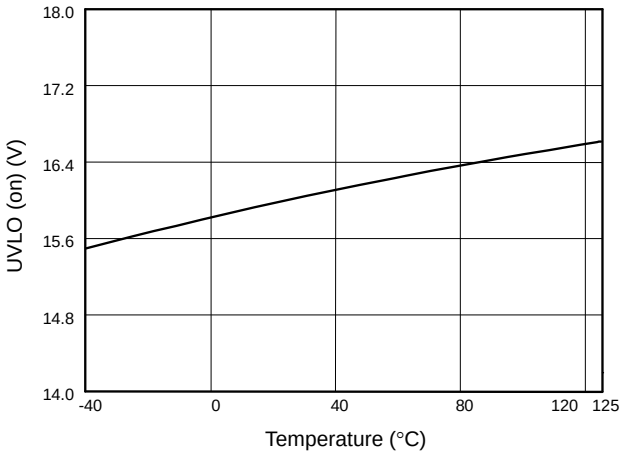


Fig. 1 UVLO (on) vs. Temperature

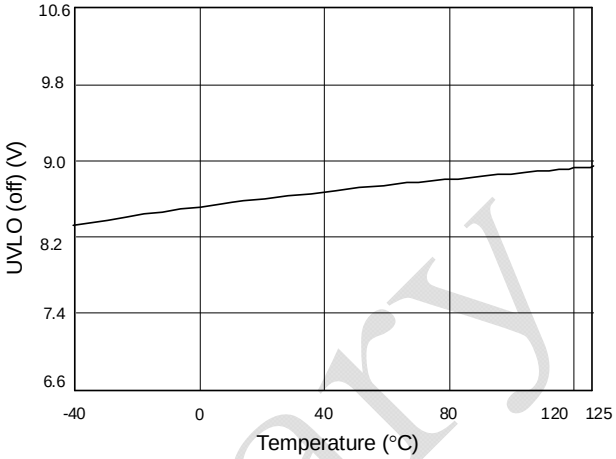


Fig. 2 UVLO (off) vs. Temperature

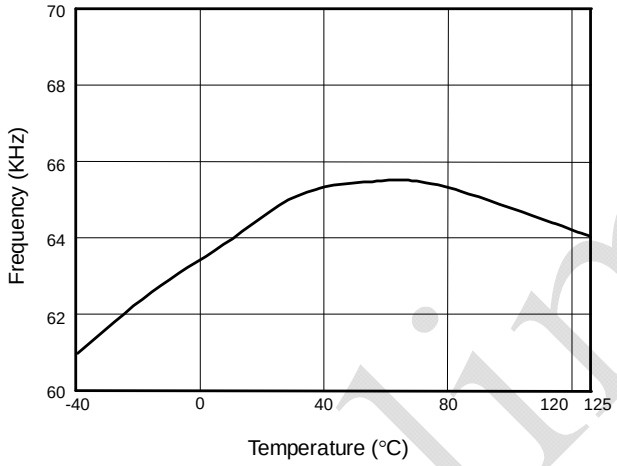


Fig. 3 Frequency vs. Temperature

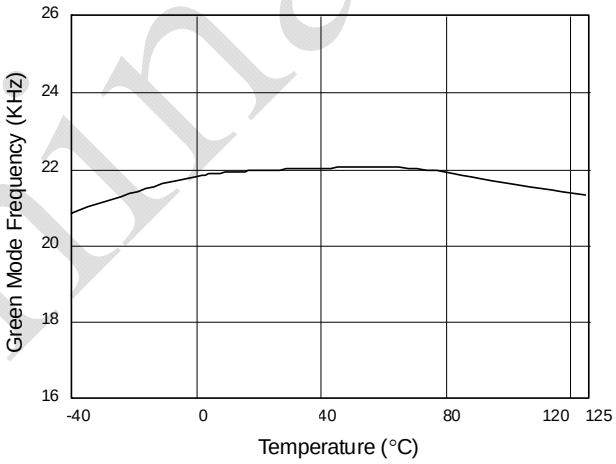


Fig. 4 Green Mode Frequency vs. Temperature

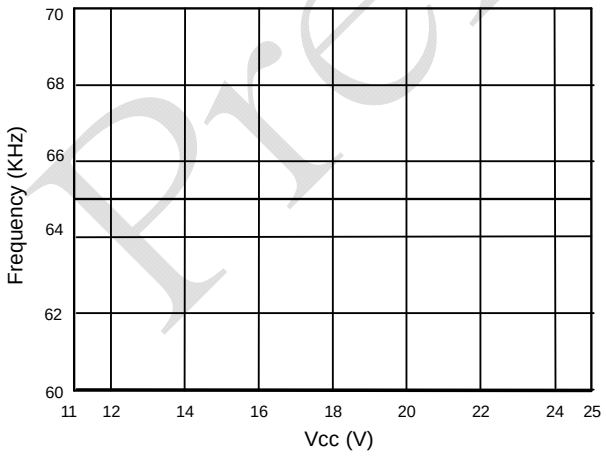


Fig. 5 Frequency vs. Vcc

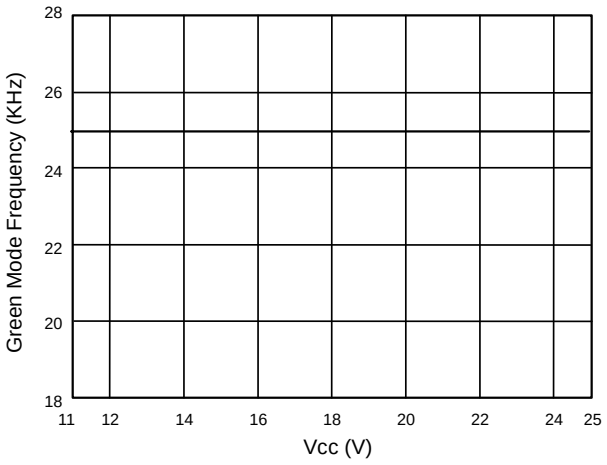


Fig. 6 Green Mode Frequency vs. Vcc

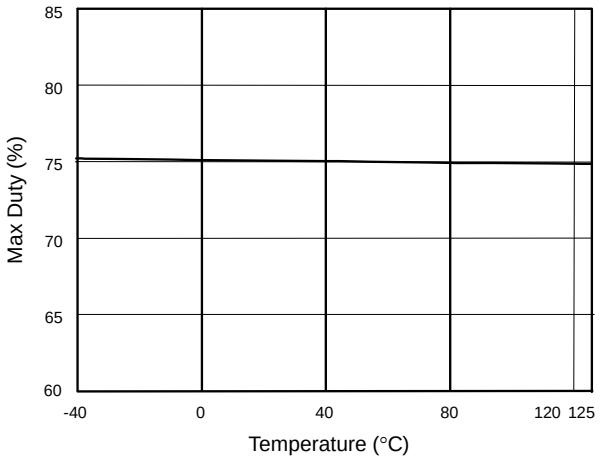


Fig. 7 Max Duty vs. Temperature

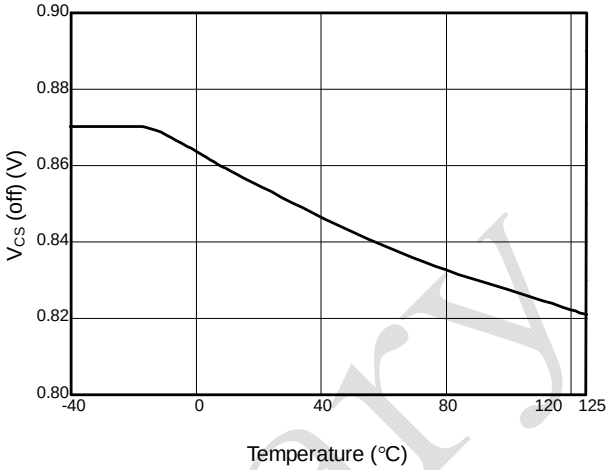


Fig. 8 V_{CS} (off) vs. Temperature

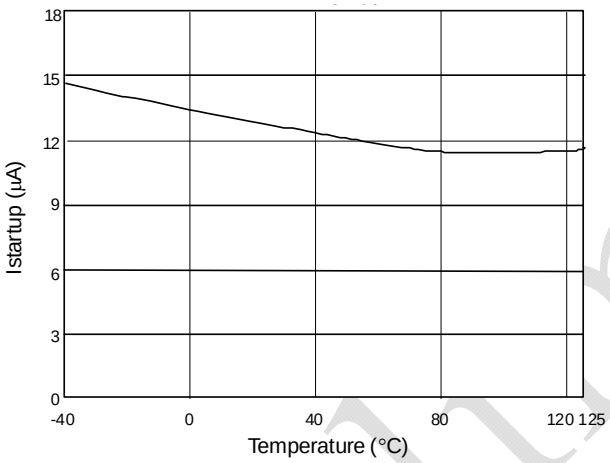


Fig. 9 Startup Current (Istartup) vs. Temperature

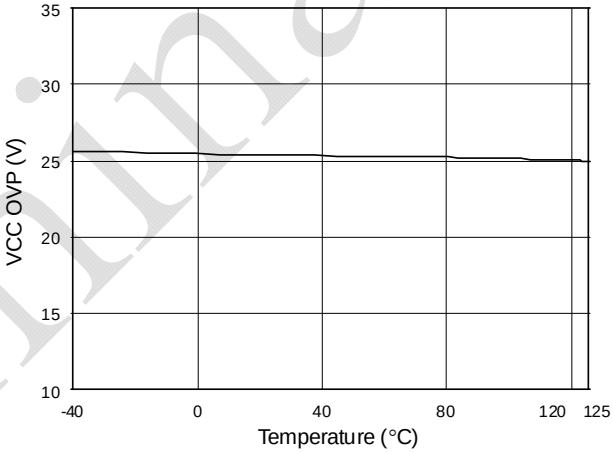


Fig. 10 VCC OVP vs. Temperature

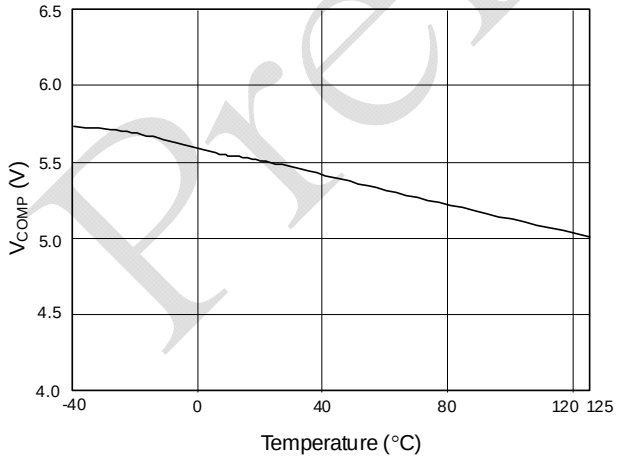


Fig. 11 V_{COMP} open loop voltage vs. Temperature

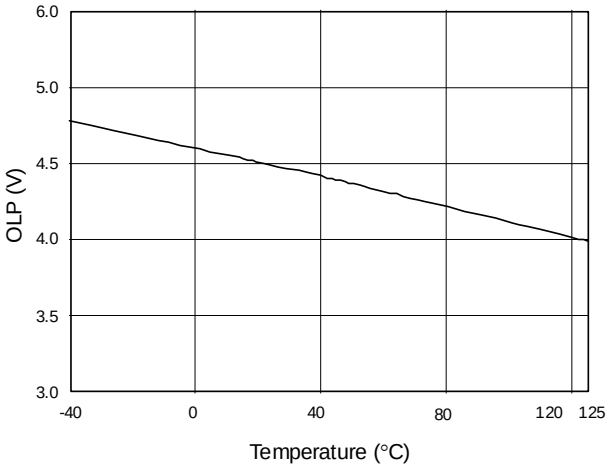


Fig. 12 OLP-Trip Level vs. Temperature

Application Information

Operation Overview

The LD7932R meets the green-power requirement and is intended for the use in those modern switching power suppliers and adaptors which demand higher power efficiency and power-saving. It integrated more functions to reduce the external components counts and the size. Its major features are described as below.

Under Voltage Lockout (UVLO)

An UVLO comparator is implemented in it to detect the voltage on the VCC pin. It would assure the supply voltage enough to turn on the LD7932R PWM controller and further to drive the power MOSFET. As shown in Fig. 13, 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 16.0V and 8.5V, respectively.

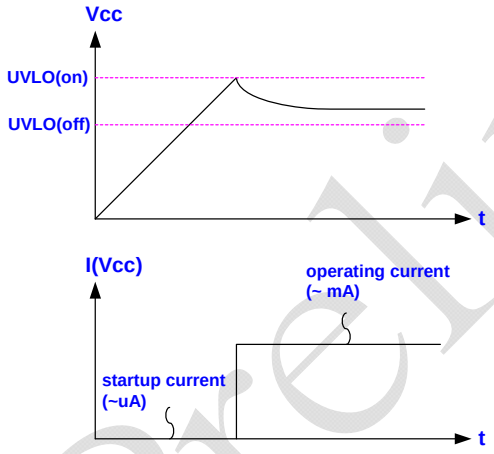


Fig. 13

Startup Current and Startup Circuit

The typical startup circuit to generate V_{CC} of the LD7932R is shown in Fig. 14. During the startup transient, the V_{CC} is below UVLO threshold. Before it has sufficient voltage to develop OUT pulse to drive the power MOSFET, R1 will provide the startup current to charge the capacitor C1. Once V_{CC} obtains enough voltage to turn on the LD7932R and further to deliver the gate drive signal, it will enable the auxiliary winding of the transformer to provide supply current. Lower startup current requirement on the PWM controller will help to increase the value of R1 and then reduce the power consumption on R1. By using CMOS process and the special circuit design, the maximum startup current for LD7932R is only 20μA.

If a higher resistance value of the R1 is chosen, it will usually take more time to start up. To carefully select the value of R1 and C1 will optimize the power consumption and startup time.

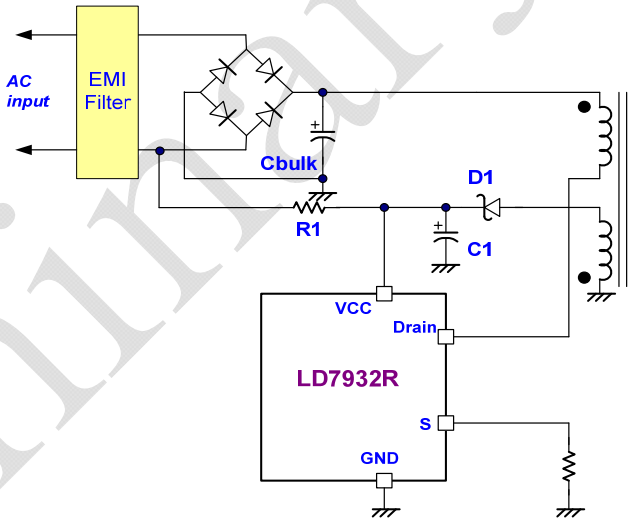


Fig. 14

Current Sensing and Leading-edge Blanking

The typical current mode of PWM controller feedbacks both current signal and voltage signal to close the control loop and achieve regulation. As shown in Fig. 15, the LD7932R detects the primary MOSFET current from the CS pin, which is not only for the peak current mode control but also for the pulse-by-pulse current limit. The maximum voltage threshold of the current sensing pin is set at 0.85V. From above, the MOSFET peak current can be obtained from below.

$$I_{PEAK(MAX)} = \frac{0.85V}{R_S}$$

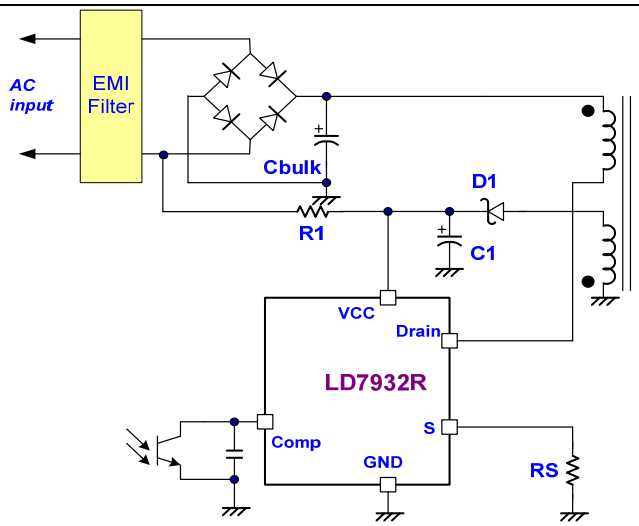


Fig. 15

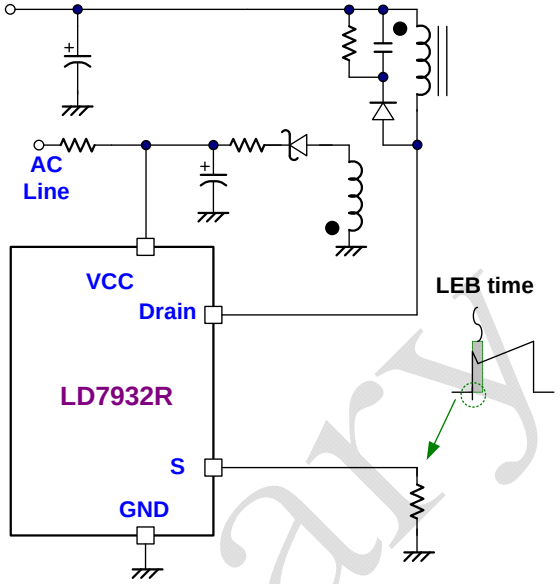


Fig. 16

A leading-edge blanking (LEB) time is included in the input of CS pin to prevent the false-trigger from the current spike. (As shown in Fig.16).

Maximum Duty-Cycle

The maximum duty-cycle of LD7932R is limited to 75% to avoid the transformer saturation.

Voltage Feedback Loop

The voltage feedback signal is provided from the TL431 at the secondary side through the photo-coupler to the COMP pin of the LD7932R. Similar to UC3842, the LD7932R would carry a diode voltage offset at the stage to feed the voltage divider at the ratio of RA and RB, that is,

$$V_{-(PWM_{COMPARATOR})} = \frac{RB}{RA+RB} \times (V_{COMP} - V_F)$$

A pull-high resistor is embedded internally and can be eliminated externally.

Internal Slope Compensation

In the conventional applications, the problem of the stability is a critical issue for current mode controlling, when it operates over 50% duty-cycle. As UC384X, It takes slope compensation from injecting the ramp signal of the RT/CT pin through a coupling capacitor. It therefore requires no extra design for the LD7932R since it has integrated it already.

On/Off Control

The LD7932R can be turned off by pulling COMP pin lower than 1.5V. The gate output pin of the LD7932R will be disabled immediately under such condition. The off-mode can be released when the pull-low signal is removed.

Over Load Protection (OLP) - Auto Recovery

To protect the circuit from damage due to over-load condition and short or open-loop condition, the LD7932R is implemented with smart OLP function. It also features auto recovery function; see Fig. 17 for the waveform. In

case of fault condition, the feedback system will force the voltage loop toward the saturation and then pull the voltage high on COMP pin (VCOMP). When the V_{COMP} ramps up to the OLP threshold of 4.5V and continues over OLP delay time, the protection will be activated and then turn off the gate output to stop the switching of power circuit.

With the protection mechanism, the average input power will be minimized to remain the component temperature and stress within the safe operating area.

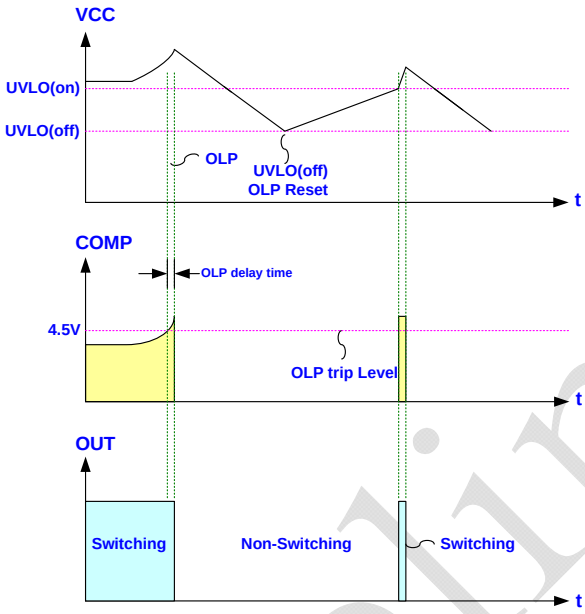


Fig. 17

OVP (Over Voltage Protection) on Vcc - Auto Recovery

The maximum VGS ratings of the power MOSFETs are mostly for 30V. To prevent the VGS enter fault condition, LD7932R series are implemented with OVP function on Vcc. Whenever the Vcc voltage is higher than the OVP threshold, the output gate drive circuit will be shutdown simultaneously and the switching of the power MOSFET is disabled until the next UVLO(on).

The Vcc OVP functions of LD7932R are auto-recoverable. If the OVP condition, usually caused by open-loop of feedback, is not released, the Vcc will tripped the OVP level again and re-shutdown the output. The Vcc works in hiccup mode. Figure 18 shows its operation.

Otherwise, when the OVP condition is removed, the Vcc level will be resumed and the output will automatically return to the normal operation.

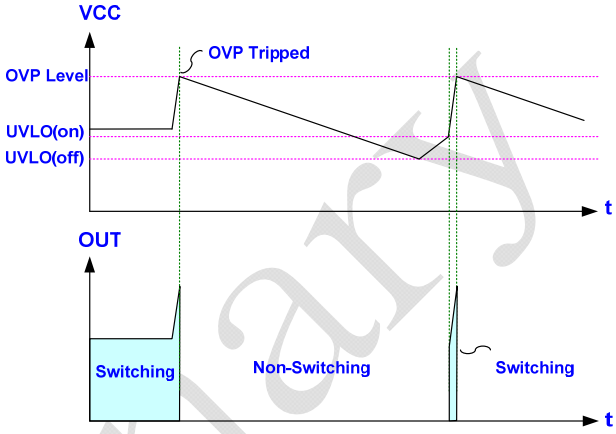


Fig. 18

Brownout Protection

The LD7932R programmable to set the brownout protection point though BNO pin. The voltage across the BNO pin is proportional to the bulk capacitor voltage, referred as the line voltage. A brownout comparator is implemented to detect the abnormal line condition. As soon as the condition is detected, it will shut down the controller to prevent the damage. Figure 19 shows the operation. When VBNO falls below 0.80V, the gate output will be kept off even Vcc has already achieved UVLO(ON). It therefore makes Vcc hiccup between UVLO(ON) and UVLO(OFF). Unless the line voltage is large enough to pull VBNO larger than 1.05V, the gate output will not start switching even when the next UVLO(ON) is tripped. A hysteresis is implemented to prevent the false trigger during turn-on and turn-off. Figure 20 shows the circuit.

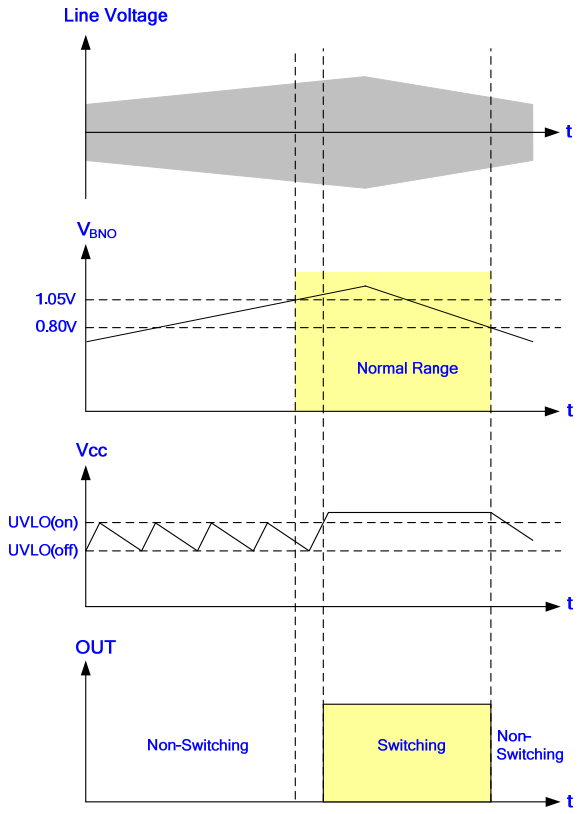


Fig. 19

Oscillator and Switching Frequency

The LD7932R is implemented with Frequency Swapping function which helps the power supply designers to both optimize EMI performance and lower system cost. The switching frequency substantially centers at 65KHz, and swap between a range of ±4KHz.

Green-Mode Operation

By using the green-mode control, the switching frequency can be reduced under the light load condition. This feature helps to improve the efficiency in light load conditions. The green-mode control is Leadtrend Technology's own property.

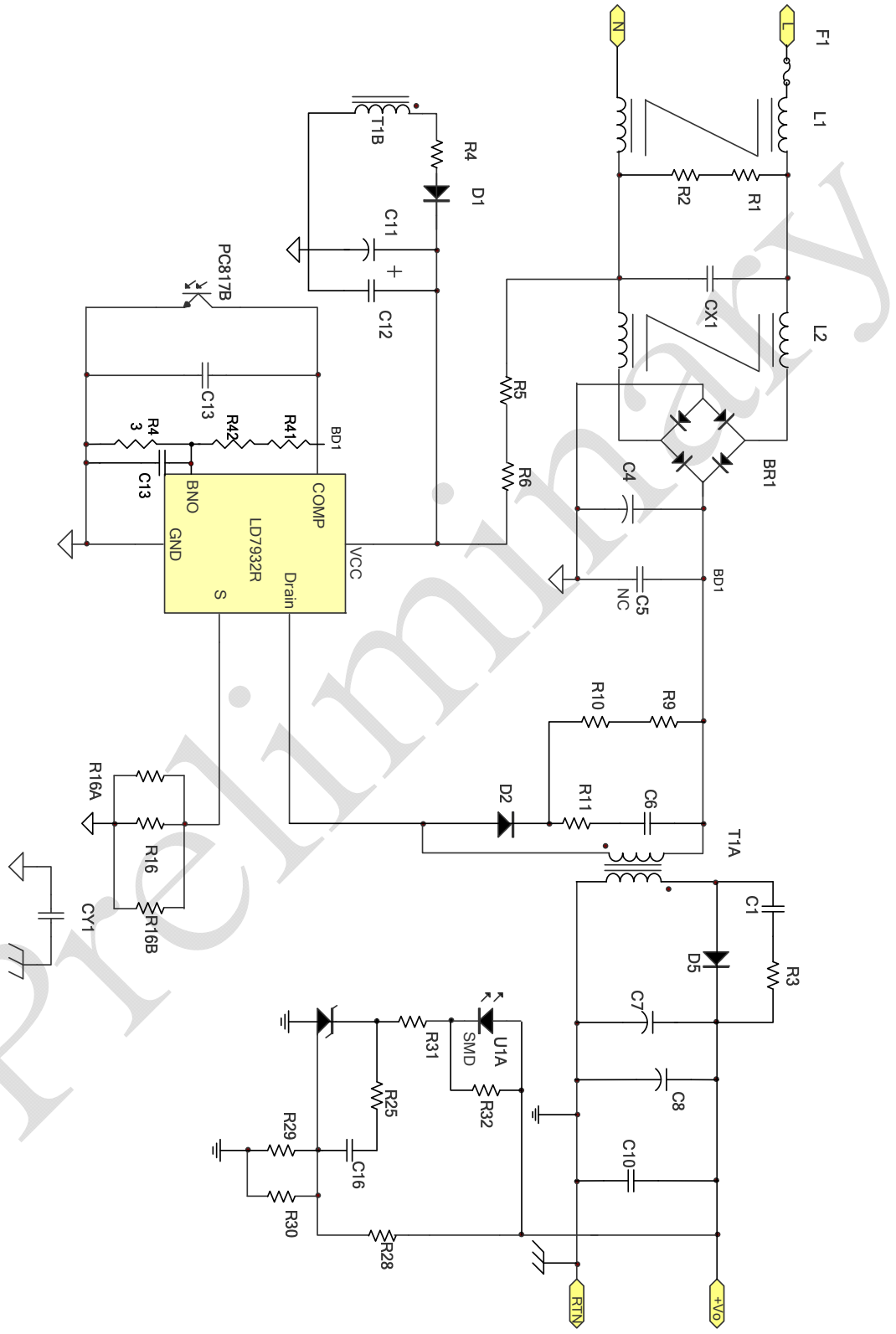
Fault Protection

There are several critical protections integrated in the LD7932R to prevent from damage to the power supply. Those damages usually come from open or short conditions on the pins of LD7932R.

In case under such conditions listed below, the gate output will turn off immediately to protect the power circuit.

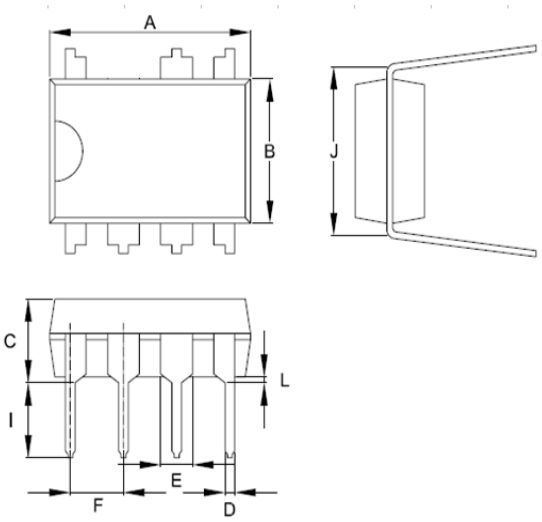
1. CS pin floating
2. COMP pin floating

Reference Application Circuit --- 12.5W (5V/2.5A)



Package Information

DIP-7



	Dimension in Millimeters		Dimensions in Inches	
Symbol	Min	Max	Min	Max
A	9.017	10.160	0.355	0.400
B	6.096	7.112	0.240	0.280
C	-----	5.334	------	0.210
D	0.356	0.584	0.014	0.023
E	1.143	1.778	0.045	0.070
F	2.337	2.743	0.092	0.108
I	2.921	3.556	0.115	0.14
J	7.366	8.255	0.29	0.325
L	0.381	------	0.015	--------

Important Notice

Leadtrend Technology Inc. reserves the right to make changes or corrections to its products at any time without notice. Customers should verify the datasheets are current and complete before placing order.

Revision History

Rev.	Date	Change Notice