Green Mode Power Switch with BNO

REV：00

General Description

The LD7912J is a green mode PWM controller integrated with a 700V MOSFET in a DIP-7 package. It's capable to operate at fixed frequency of 100KHz. With multi-functions built in this device , such as high voltage startup, Burn-in/out /OLP/OVP/OTP protection, internal current mode slope compensation, and green-mode power-saving operation under light load or no load condition, this highly integrated device provides high efficiency, low external component counts, and low cost solution for compact power applications.

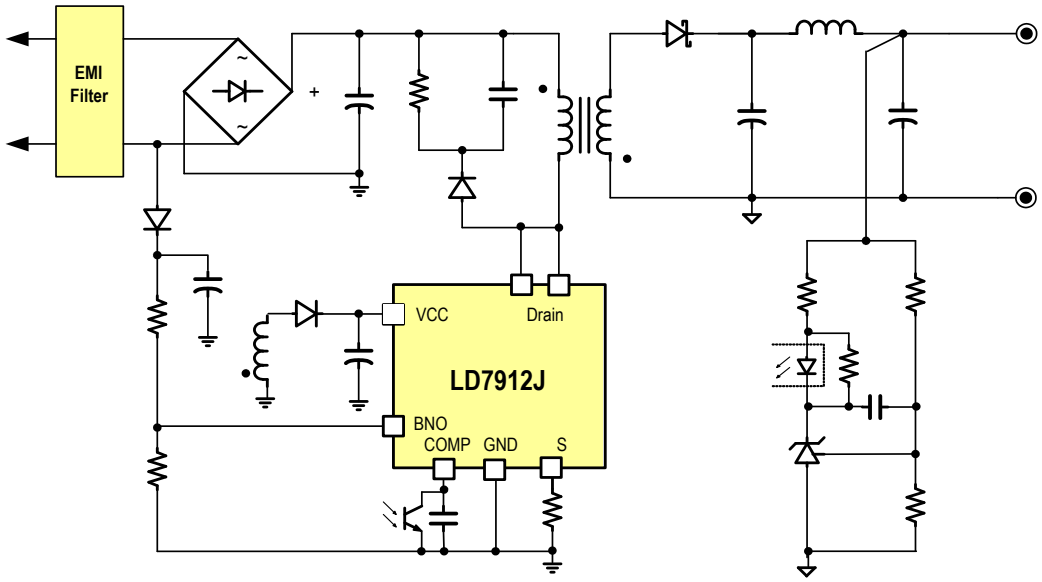
Features

- Built-in 700V Power MOSFET
- Built-in High Voltage startup circuit
- Fixed Switching Frequency at 100KHz
- Frequency Swapping for EMI improve
- Internal High Voltage Startup Circuit
- Under Voltage Lockout (UVLO) on VCC Pin
- Current Mode Control with Slope Compensation
- Green-Mode Control for Power Saving
- OVP / OLP / Internal Thermal Shut Down

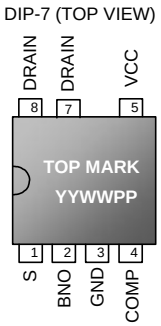
Applications

- Switching AC/DC Adaptor
- LCD TV or PC Standby Power
- SMPS for LCD Monitor

Typical Application



Pin Configuration



YY: Year code (D: 2004, E: 2005)
WW: Week code
PP: Production code

Ordering Information

Part number	Package	Top Mark	Shipping
LD7912J GM6	DIP-7	LD7912JGM6	3600/ Tube/ Carton

TheLD7912J is Green Packaged.

Protection Mode

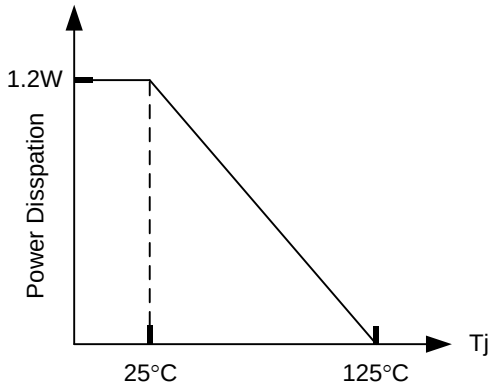
Switching Freq.	VCC OVP	OLP	Internal OTP
100kHz	Auto recovery	Auto recovery	Auto recovery

Pin Descriptions

PIN	NAME	FUNCTION
1	S	Source terminal of internal power MOSFET. Connect it with a sense resistor to ground.
2	BNO	Brown-in/out Protection Pin. Connect a resistor divider with it to Input Voltage. If the voltage drops below threshold voltage, it will disable the PWM output.
3	GND	Ground of the controller
4	COMP	Feedback control pin. Connect a photo-coupler and a capacitor with it to close the control loop and achieve a stable regulation.
5	VCC	Power Supply to Vcc
6	NC	NC
7,8	Drain	Drain terminal of the internal power MOSFET

Recommended Operating Conditions

Product	Drain Current	Rds(on)	230VAC ± 15%		90~264VAC*	
			Adapter	Open Frame	Adapter	Open Frame
LD7912J	2A	6Ω	14W	16W	12W	14W



* Typ Vcc=12V & Drain Current =1A at Ta =25°C

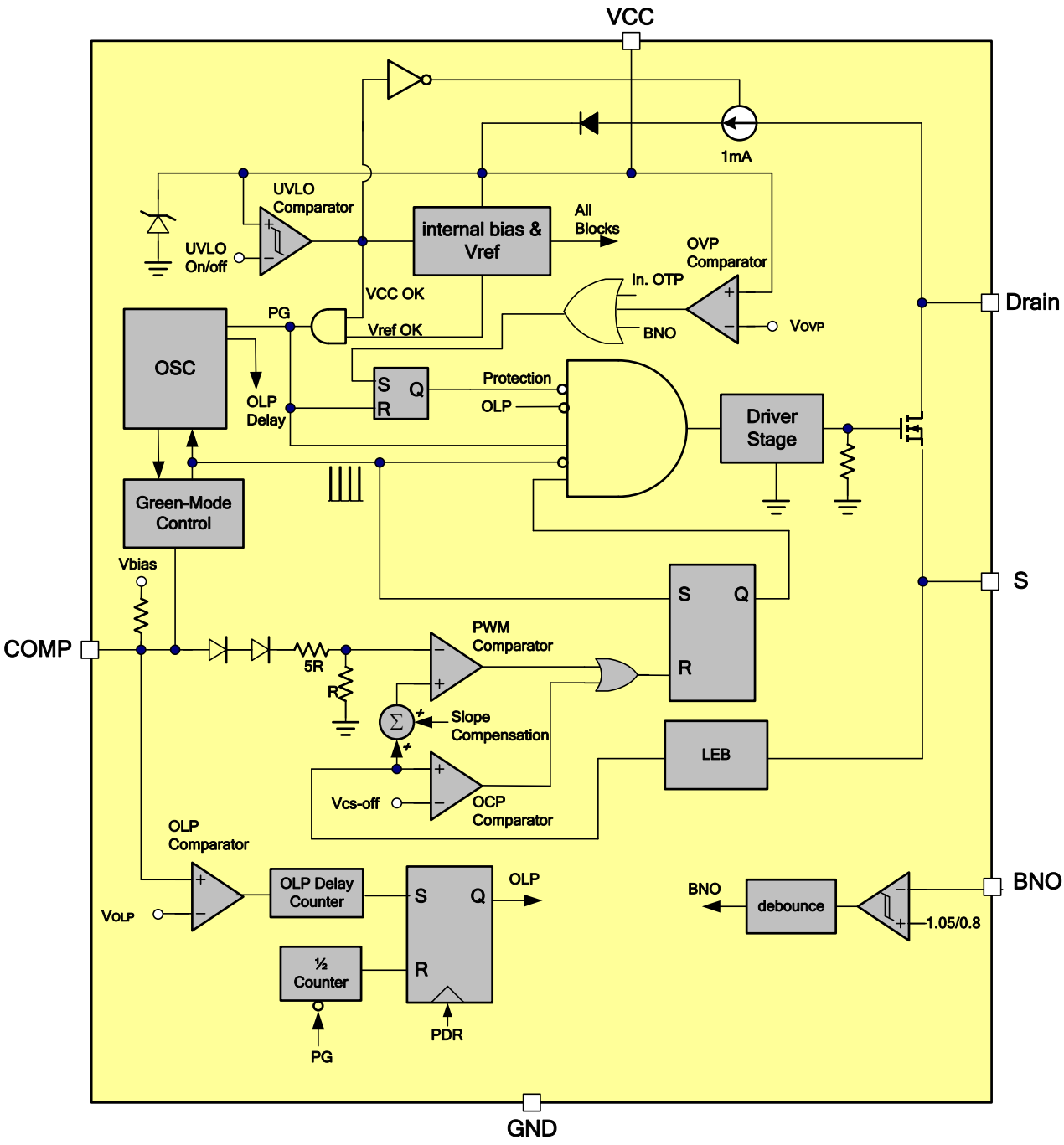
**Calculated maximum Input Power Rating at Ta =25°C

Item	Min.	Max.	Unit
Supply Voltage Vcc	11	25	V
Vcc Capacitor	10	47	μF
COMP Capacitor Value	2.2	100	nF

Note:

1. It's essential to connect a capacitor with it to filter out the undesired switching noise to secure stable operation.
2. The small signal components should be routed around the IC as close as possible.

Block Diagram



Absolute Maximum Ratings

Supply Voltage VCC	-0.3V~30V
COMP, BNO	-0.3V ~7V
S pin DC Voltage	-0.3V ~7V
S pin negative pulse voltage (Duration Time < 100nS)	-1.5V
Drain	-0.3V~700V
Peak Pulse drain current	2A
Total Maximum Power Dissipation of (25°C)	1.25W
Package thermal resistance (DIP-7)	
θ_{JA}	80°C/W
θ_{JC}	35°C/W
Operating Junction Temperature Range	-40°C to 125°C
Operating Ambient Temperature Range	-40°C to 85°C
Storage Temperature Range	-65°C to 150°C
Lead temperature (Soldering, 10sec)	260°C
ESD Voltage Protection, Human Body Model (Exclusive Drain Pin)	2.5KV
ESD Voltage Protection, Machine Model (Exclusive Drain Pin)	250 V

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

(Ta=25°C, V_{CC}=15.0V , unless otherwise stated,) **Electrical Characteristics for Control Section**

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
High Voltage Supply (Drain Pin)					
High Voltage Current Source	V_{CC}<UVLO(on), HV=500V	0.5	1.0	1.5	mA
Off State Leakage Current	V_{CC}>UVLO(off), HV=500V	-	8	35	μA
Supply Voltage (Vcc Pin)					
Startup Current		200	300	400	μA
Operating Current	V_{COMP}=0V		1.0		mA
	V_{COMP}=3V		2		mA
	OLP Tripped		0.6		mA
	OVP Tripped		0.6		mA
UVLO (off)		8.0	9.0	10.0	V
UVLO (on)		15.0	16.0	17.0	V
OVP on Vcc Pin		25	26	27	V
Voltage Feedback (Comp Pin)					
Short Circuit Current	V_{COMP}=0V	0.2	0.26	0.32	mA
Open Loop Voltage	COMP pin open	5.5	6	6.5	V
Fixed Frequency Mode			2.5		V
Green Mode Threshold V_{COMP}			2.1		V
Zero Duty Trip Level(off)			1.6		V
Hysteresis			100		mV
Current Sense Comparator (Cs Pin)					
Maximum Input Voltage Vcs_off		0.425	0.45	0.475	V
Leading Edge Blanking Time			380		ns
Input impedance		1		10	MΩ
Delay to Output			100		ns
Oscillator & Control					
Frequency		94	100	106	kHz
Green Mode Frequency		22	25	28	kHz
Frequency Swapping	fs = 100kHz		±6.2		kHz

Electrical Characteristics

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Frequency Temp. Stability	-25~85°C		5		%
Voltage Stability	V_{CC}=11~25V)		-	1	%
Maximum Duty			75		%
OLP (Over Load Protection)					
OLP Trip Level			5.0		V
OLP Delay Time			84		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		200	250	300	μs
Soft Start					
Soft Start Duration			4		ms
On Chip OTP					
OTP Level			140		°C
Hysteresis			30		°C

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 on Resistance					
Drain to S pin On-Resistance	I_D=2A; V_{CC}=15V; Tj=25°C		6		Ω

Typical Performance Characteristics

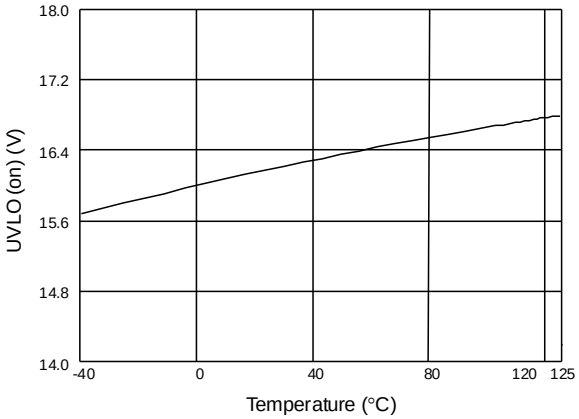


Fig. 1 UVLO (on) vs. Temperature

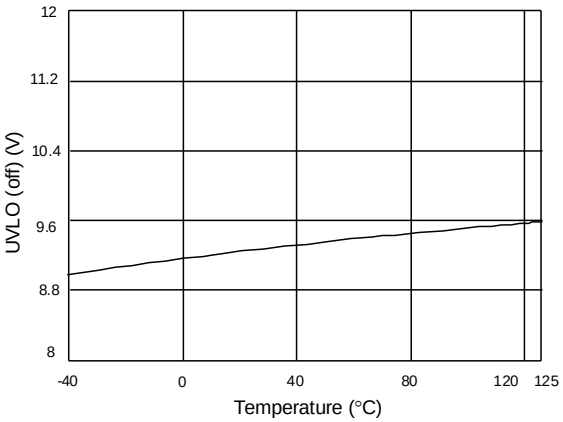


Fig. 2 UVLO (off) vs. Temperature

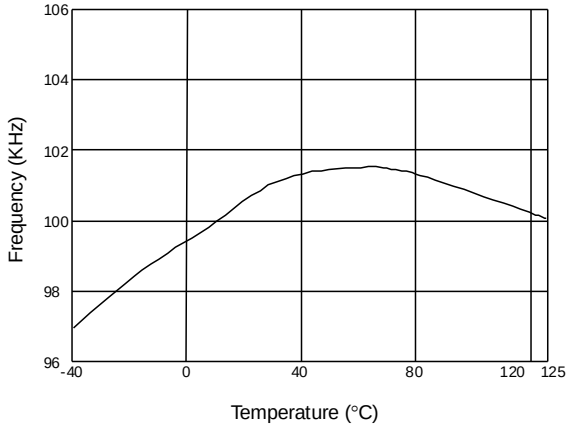


Fig. 3 Frequency vs. Temperature

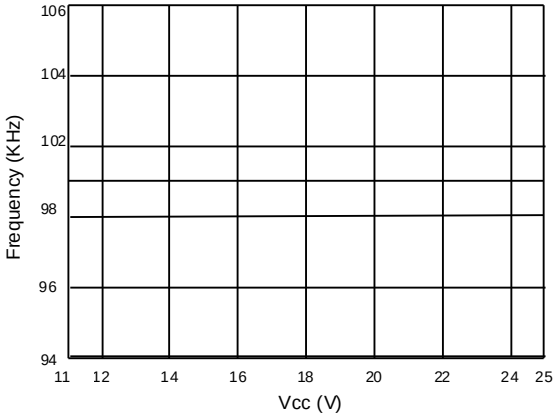


Fig. 4 Frequency vs. Vcc

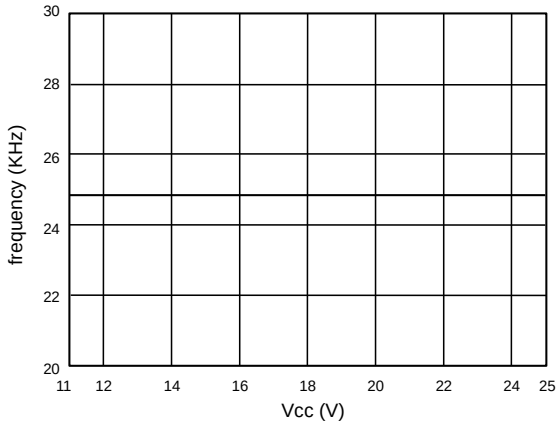


Fig. 5 Green mode frequency vs. Vcc

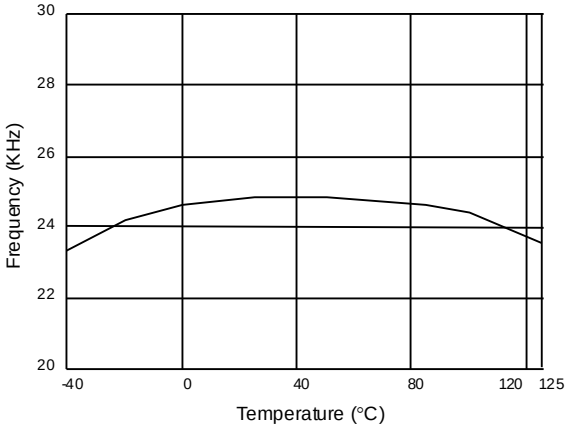


Fig. 6 Green Mode Frequency vs. Temperature

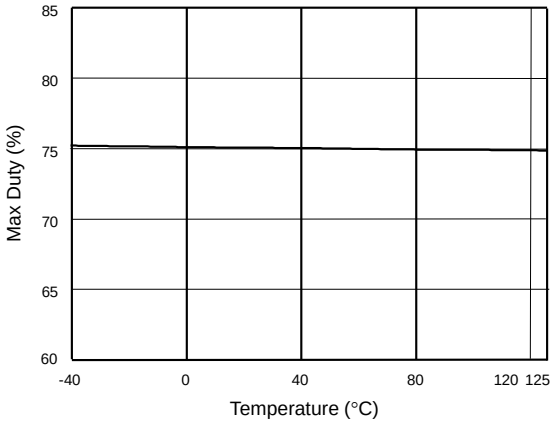


Fig. 7 Max Duty vs. Temperature

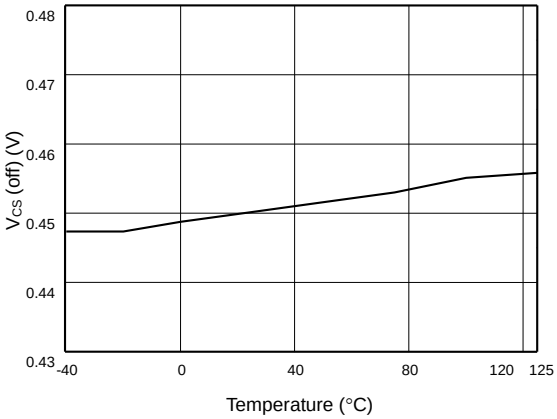


Fig. 8 V_{CS} (off) vs. Temperature

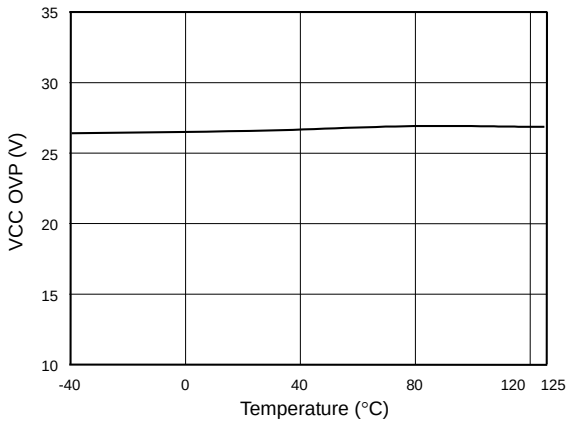


Fig. 9 VCC OVP vs. Temperature

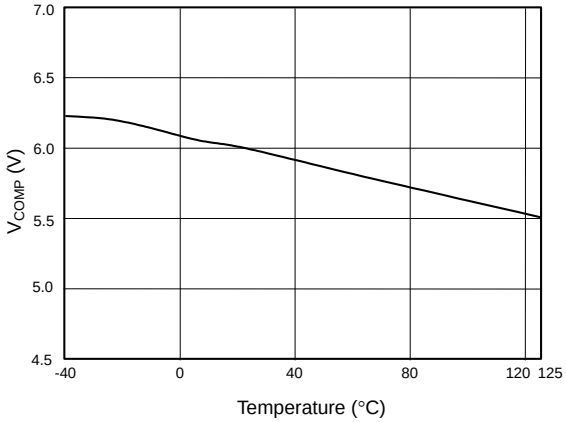


Fig. 10 V_{COMP} open loop voltage vs. Temperature

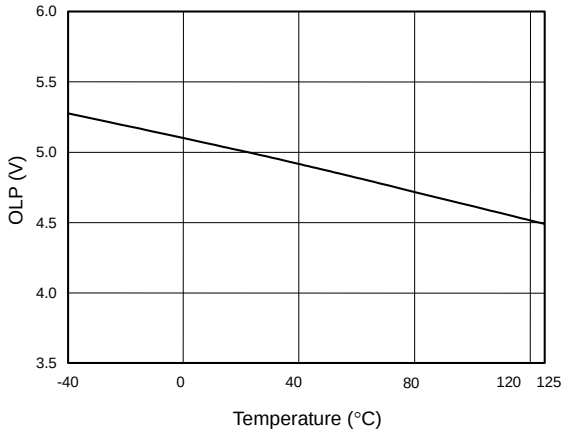


Fig. 11 OLP-Trip Level vs. Temperature

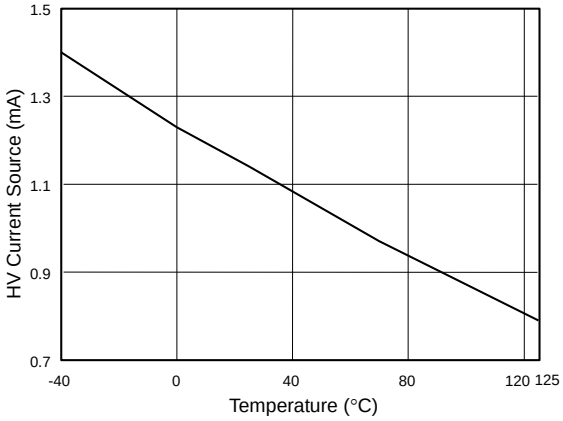


Fig. 12 HV Current Source vs. Temperature (HV=500V, Vcc=0V)

Application Information

Operation Overview

The LD7912J is a green-mode controller, ideal for those modern switching power suppliers and adaptors requiring high efficiency and low loss. With integrated multi-functions in this device, the LD7912J could minimize the external components counts and reduce the product size. The major features are described as below.

High Voltage Startup Circuit

The traditional PWM controller requires an external startup resistor to provide the startup current. However large resistor spends more time to start up while small one produces more power loss. To optimize the circuit performance and energy saving, the LD7912J features high voltage startup to enhance the performance.

As shown in Fig. 13, during startup, a high-voltage(HV) constant current source (~1mA) sinks current from the Drain pin to provide start-up current to the PWM IC and Vcc charge current to capacitor C1. During this period, the PWM IC sinks only 300μA, thus most of the rested HV current is reserved to charge the Vcc capacitor. After the Vcc rises over UVLO(on) threshold, the HV current source will be shut off to activate the LD7912J. Vcc supply current is then provided from the auxiliary winding of the transformer. Therefore, it can minimize the power loss and achieve power saving during startup.

In using such configuration, the turn-on delay time will be almost same no matter in low-line or high-line conditions.

Under Voltage Lockout (UVLO)

An UVLO comparator is implemented in LD7912J to detect the voltage over VCC pin. It would assure the supply voltage enough to turn on the LD7912J PWM controller and further to drive the internal power MOSFET. As shown in Fig. 14, a hysteresis is built in to prevent shutdown from the voltage dip during startup. The turn-on and turn-off threshold level are set at 16.0V and 9.0V, respectively.

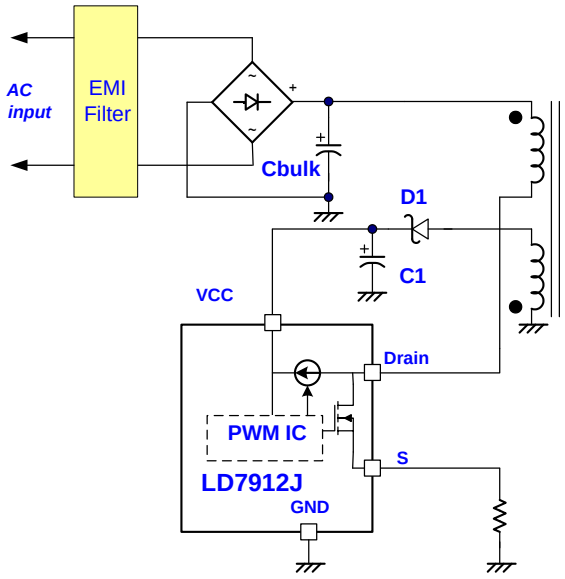


Fig. 13

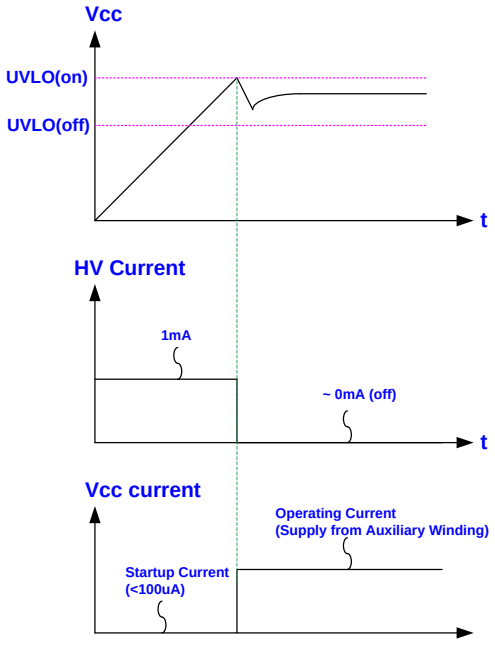


Fig. 14

Current Sensing and Leading-edge Blanking

Through current and voltage signal delivered from the typical current mode of PWM controller, it is able to close the control loop and achieve regulation. The LD7912J detects the internal MOSFET current from S pin and pulse-by-pulse limit current. The maximum voltage threshold of the current sensing pin is Vcs_off (~0.45V). The MOSFET peak current can be obtained from below equation.

$$I_{PEAK(MAX)} = \frac{Vcs\_off}{R_S}$$

Due to the integrated leading edge blanking circuit and internal spike filter, it is free from external LC filter parts.

Internal Slope Compensation

Stability is crucial for current mode control when it operates at CCM and more than 50% of duty-cycle. To stabilize the control loop, the slope compensation is required in the traditional UC384X design by injecting the ramp signal from the RT/CT pin through a coupling capacitor. With this function built in, the LD7912J is ideal to optimize the external circuit design.

On/Off Control

The gate driver of LD7912J can be disabled immediately by pulling COMP pin voltage level below Zero Duty Trip Level. The disable-mode will be released once COMP pin voltage level ramps higher above Zero Duty Trip Level.

Oscillator and Switching Frequency

The switching frequency of LD7912J is fixed at 100KHz to provide the optimized operations in the good conditions of EMI performance, thermal treatment, component sizes and transformer design. The swapping frequency is internally set between ±6.2KHz to incorporate with 100KHz switching frequency.

Green-Mode Operation

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

Maximum Duty-Cycle

The maximum duty-cycle of LD7912J is limited to 75% to avoid the transformer saturation.

Voltage Feedback Loop

The voltage feedback signal is provided from the TL431 in the secondary side through the photo-coupler to the COMP pin of LD7912J. The input stage of LD7912J, as UC384X, is incorporated with 2 diodes voltage offset circuit and a voltage divider with 1/6 ratio. Therefore,

$$V_{+(PWM_{COMPARATOR})} = \frac{1}{6} \times (V_{COMP} - 2V_F)$$

A pull-high resistor is embedded internally to eliminate an external one.

OVP (Over Voltage Protection) on Vcc

LD7912J is implemented with OVP function on Vcc. As Vcc voltage rises above OVP threshold voltage, the output gate drive circuit will be shutdown and stop the switching of the power MOSFET.

If the fault condition is removed, the LD 7912J will automatic restart at the next UVLO(on).

If the fault condition is not removed till next UVLO(on), the Vcc will trip to OVP level and shutdown the output again.

Then the Vcc will work in hiccup mode. The Fig. 16 shows its operation.

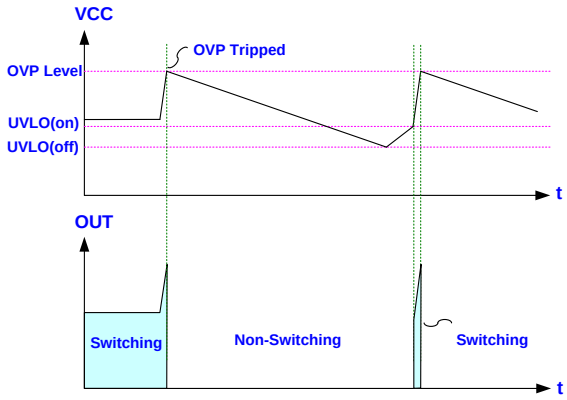


Fig. 16

Over Load Protection (OLP)

To protect the circuit from being damaged under over load condition or short circuit condition, the LD7912J is implemented with OLP function for it. The Fig. 17 shows the waveforms of the OLP operation. While in OLP condition, the feedback loop will force the COMP pin voltage (V_{COMP}) increase to provide more power to output. When the V_{COMP} trips up to the OLP threshold of 5V and it stays for longer than the OLP delay time, the LD7912J will turn off the gate output to stop the switching. The OLP delay time is to prevent false triggering during power-on and turn-off transient. Typically, the OLP delay time will be around 83mS. With such protection mechanism, the average input power during OLP can be reduced to minimum level so that the component temperature and stress can be controlled within safe operating area.

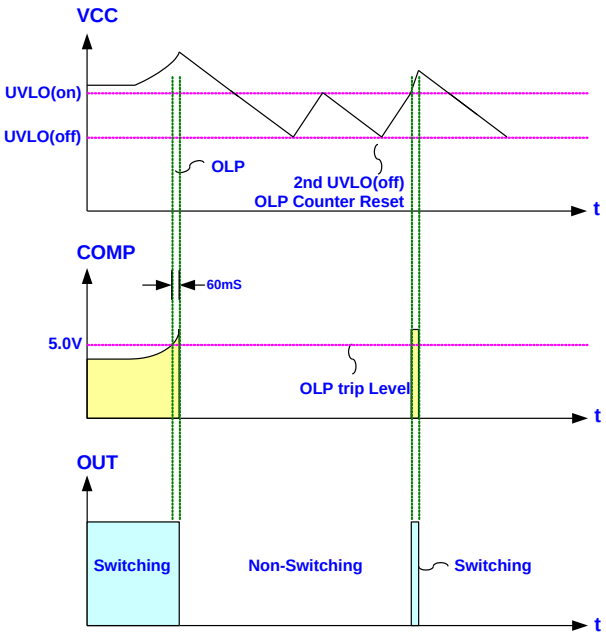


Fig. 17

Brownout Protection

The LD7912J is programmed 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 from damage. Fig. 18 shows the operation. When VBNO falls below 0.80V, the gate output will remain 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.

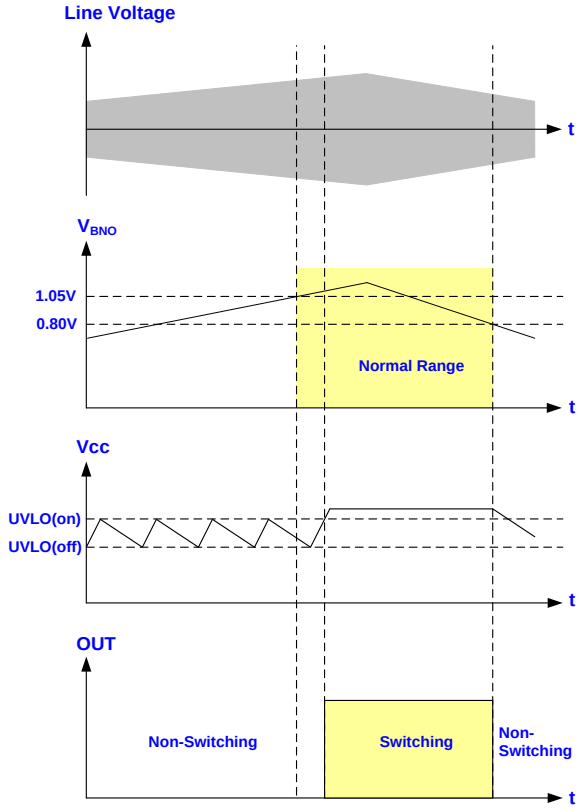


Fig. 18

Open/Short fault Protection

Some crucial protections were integrated in the LD7912J to prevent the power supply from damage in either open or short fault condition. The LD7912J will shut down to protect the power circuit under following open or short conditions:

1. COMP pin short to ground
2. S pin floating

Internal Thermal Shut Down

In order to protect IC from thermal damage, once junction temperature is above 140°C, the LD7912J will shut itself down and would not restart until its temperature cools down to 110°C(Typ.).

Power Dissipation and Thermal Management

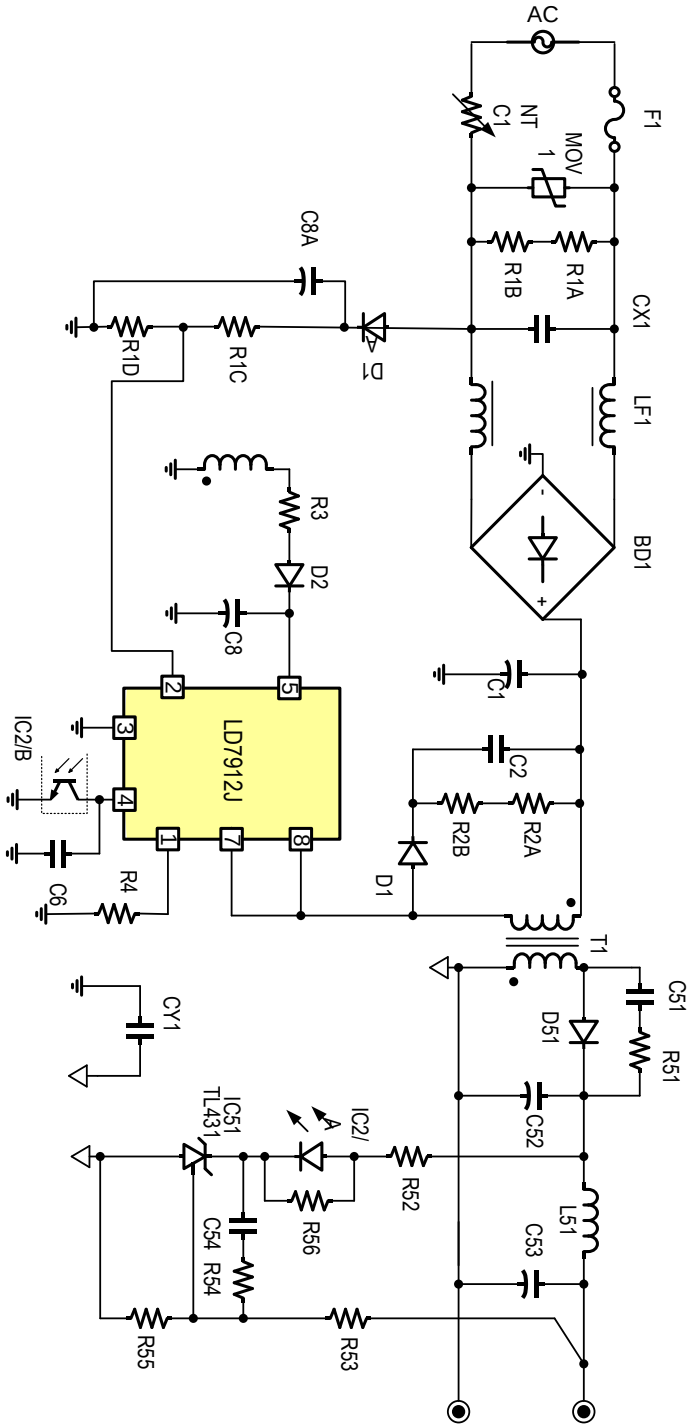
The power supply designer should consider seriously for the operating case temperature and operating junction temperature for the LD7912J. The maximum operating junction temperature is 125°C. The switcher should NOT operate in any condition over this limit.

Junction Temp.(T_J)

= Case Temp.(Tc) + Power loss * thermal resistance(θ_{JC})

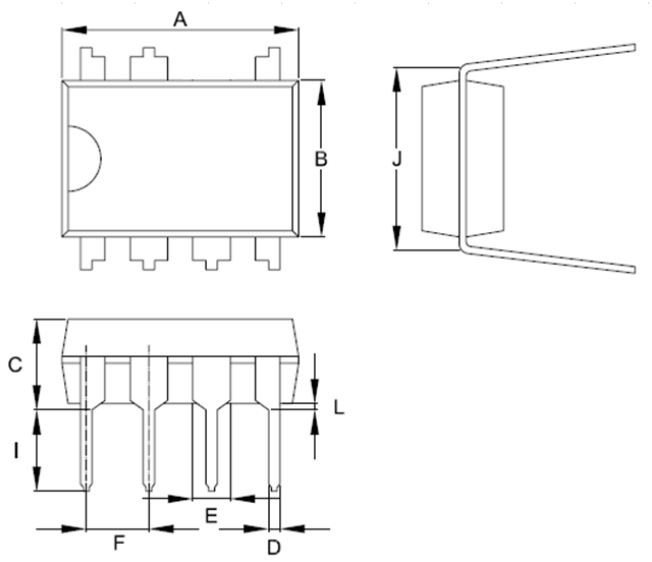
Reference Application Circuit- 5V/2.5A

Pin <0.1W @Po=0W & AC264Vin



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	0.107
I	2.921	3.556	0.115	0.140
J	7.366	8.255	0.290	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
00	5/31/2012	Original Specification