LD9010A

12/08/2016

Green Mode Power Switch for Non-isolation Power Converter

REV. 00

General Description

The LD9010A is a green mode PFM driver integrated with 700V MOSFET in a SOP package. It is capable to operate at a maximum frequency of 65 kHz. There are many functions built-in this IC, such as ultra-high voltage startup with high voltage regulator, inner loop feedback control by VCC, internal thermal shutdown, and green mode operation for power saving under light load or no load condition. This highly integrated device optimizes the efficiency and provides a low cost solution with minimum external component counts for non-isolation power converter applications.

Features

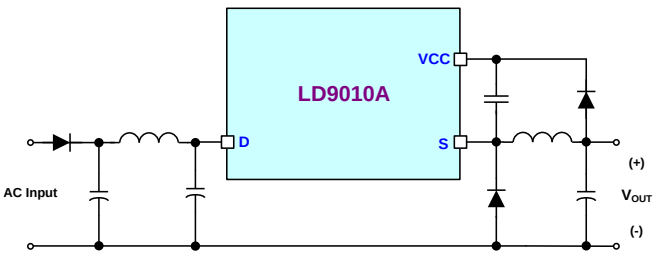
- VCC Inner Loop Feedback Control
- Integrated with 700V Power MOSFET
- Built-in Ultra High Voltage Startup Circuit
- Maximum Switching Frequency at 65 kHz
- Frequency Swapping for EMI improvement
- Green Mode Control for Power Saving
- Internal Thermal Shutdown

Applications

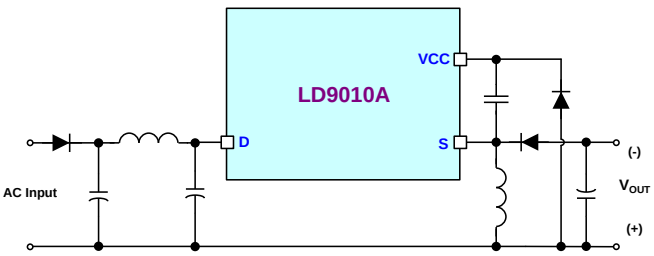
- Small home appliances
- Non-isolation power converter

Typical Application

Buck converter:

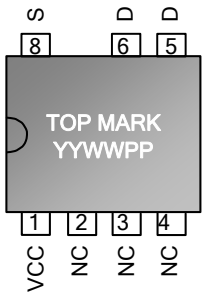


Buck-boost converter:



Pin Configuration

SOP7 / DIP-7 (TOP VIEW)



YY, Y : Year code
WW, W : Week code
PP : Production code

Ordering Information

Part number	Package		Top Mark	Shipping
LD9010AGR	SOP-7	Green package	LD9010AGR	2500 / tape / reel
LD9010AGM7	DIP-7	Green package	LD9010AGM7	3600 / tube / carton

The LD9010A is ROHS compliant/Green Packaged.

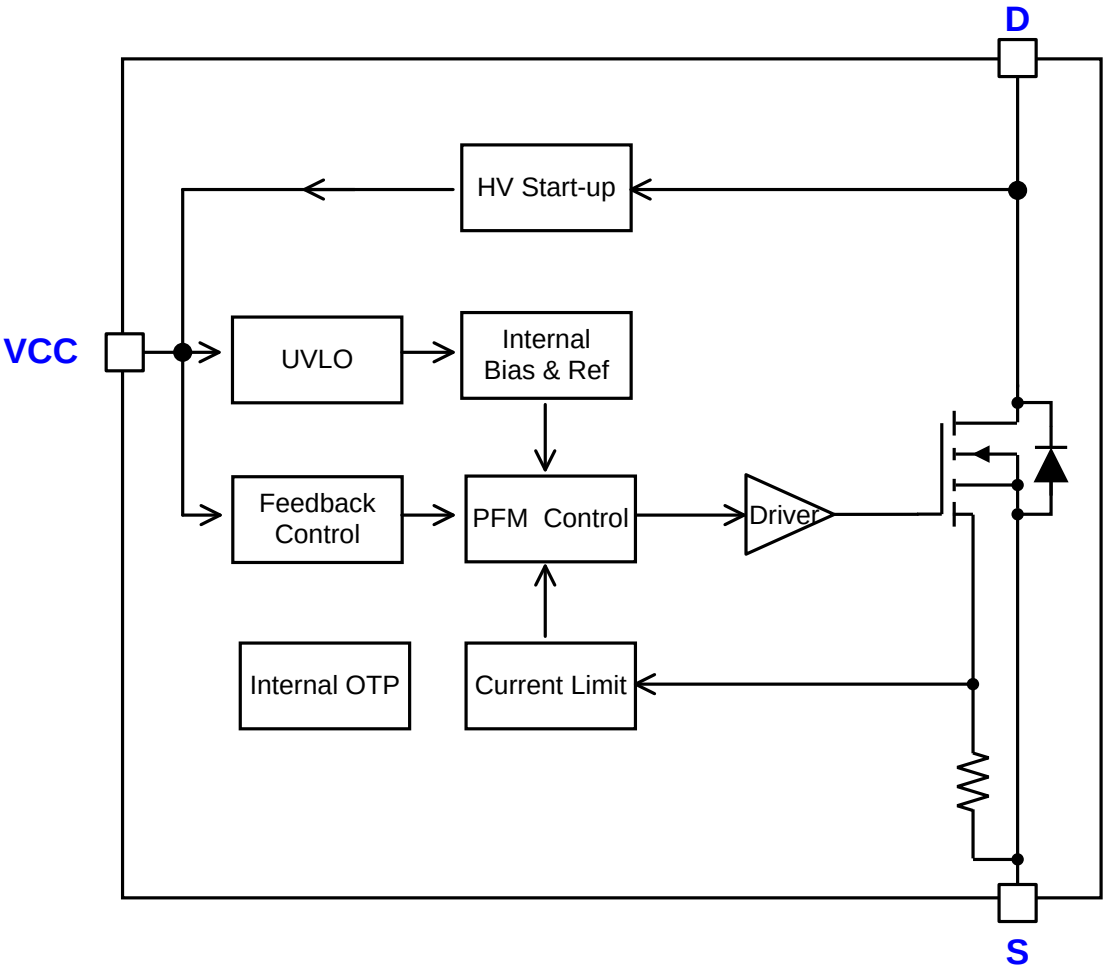
Protection Mode

Part number	OLP	OTP(Internal)
LD9010A	Auto-Restart	Auto-Restart

Pin Descriptions

Pin	NAME	FUNCTION
1	VCC	Power Supply to VCC with inner loop voltage feedback controlled
2, 3, 4	NC	Unconnected Pin or connect to single GND.
5, 6	D	Drain terminal of the internal power MOSFET.
8	S	Source terminal of internal power MOSFET.

Block Diagram



Absolute Maximum Ratings

VCC	-0.3V ~ 30V
D pin	-0.3V ~ 700V
EAS (IAS=0.25A; VDD=100V; L=10mH)	20mJ
Maximum Junction Temperature	150°C
Storage Temperature Range	-65°C ~ 150°C
Power Dissipation (SOP-7, at Ambient Temperature = 85°C)	250mW
Power Dissipation (DIP-7, at Ambient Temperature = 25°C)	1.25W
Package Thermal Resistance (SOP-7, θ_{JA})	160°C/W
Package Thermal Resistance (DIP-7, θ_{JA})	80°C/W
Lead Temperature (Soldering, 10sec)	260°C
ESD Voltage Protection, Human Body Model	2.5KV
ESD Voltage Protection, Machine Model	250V

Caution:

Stress exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stress above Recommended Operating Conditions may affect device reliability.

Recommended Operating Conditions

Item	Min.	Max.	Unit
VCC Capacitor *Note1	4.7	10	µF
Power Inductor	820	1200	µH
Output Capacitor	68	220	µF
Operation Junction Temperature Range	-40	125	℃

NOTE1: Select capacitor on VCC pin, please consider temperature coefficient and check the value at operation temp range

Electrical Characteristics

(VCC=12V, T_A=25°C, unless otherwise specified.)

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
Supply Voltage (VCC Pin)						
VCC Regulation Voltage	Normal Operation threshold	V_{CC_BUR}	12.0	12.35	12.7	V
Quiescent Current		I_{CC_ST}			160	µA
VCC over load protect level		V_{CC_OLP}	11.4		12	V
VCC over load protection delay time		T_{OLP}		50		mS
Operating Current		I_{CC_OP}			1.5	mA
UVLO(ON)		V_{CC_ON}	12.5	13.5	14.5	V
UVLO(OFF)		V_{CC_OFF}	8	8.5	9	V
Current Sense						
Inductor Peak Current Limit		V_{CL_1}	320	350	380	mA
Minimum on Time	*	T_{LEB}		300		ns
Oscillator for Switching Frequency						
Maximum Switching Frequency		F_{SW}	60	65	70	kHz
Maximum Duty Cycle		D_{MAX}	45	50	55	%
Trembling Frequency		F_T		+/-6		kHz
Minimum On Time		T_{ON_MIN}		400		nS
Green Mode Frequency		F_{GREEN}		25		kHz
HV Startup (Drain Pin)						
High-Voltage Current Source	V_{CC} < UVLO(ON)	I_{HV_1}			3.5	mA
Leakage Current	V_{CC} > UVLO(ON)	I_{LK}			30	µA
MOSFET						
Breakdown Voltage	V_{CC}=0V, I_{DS}=250µA	BV_{DSS}	700			V
$R_{DS(ON)}$	V_{CC}=12V, I_{DS}=0.25A	R_{DSON}		20	28	Ω
Internal OTP						
Thermal Shutdown Point	*	T_{SD}		140		°C
Thermal Shutdown Hysteresis	*	T_{SD_HYS}		30		°C

*: Guaranteed by Design

Typical Performance Characteristics

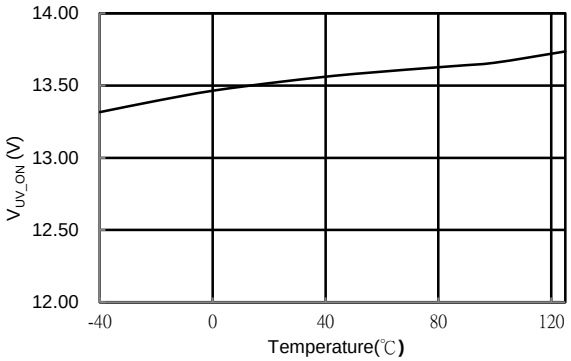


Fig. 1 V_{UV_ON} vs. Temperature

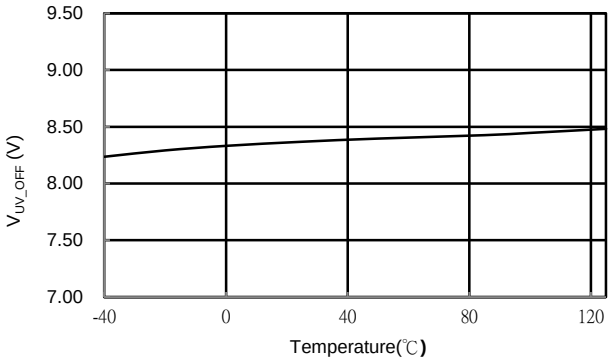


Fig. 2 V_{UV_OFF} vs. Temperature

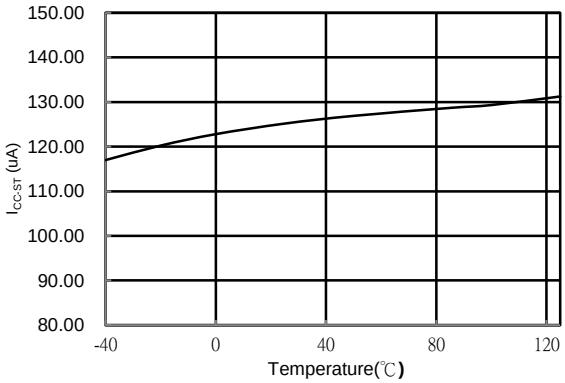


Fig. 3 I_{ST} vs. Temperature

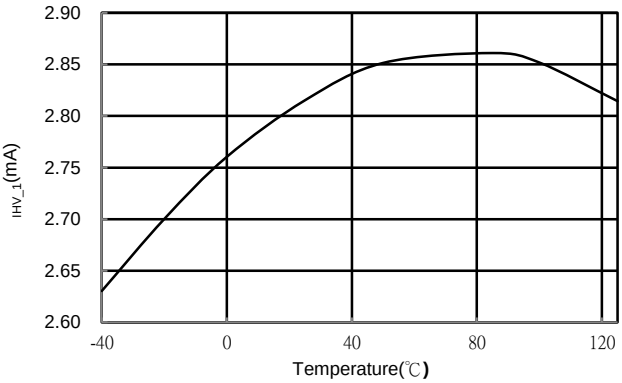


Fig. 4 IHV_1 vs. Temperature

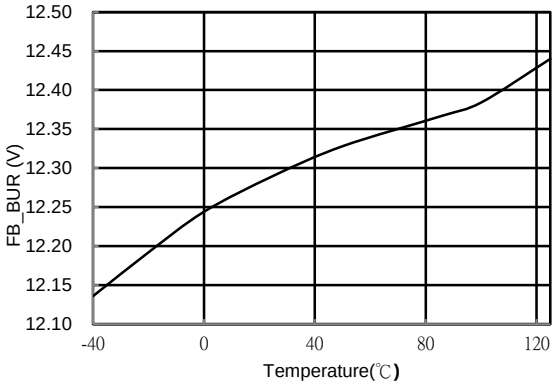


Fig. 5 FB_BUR vs. Temperature

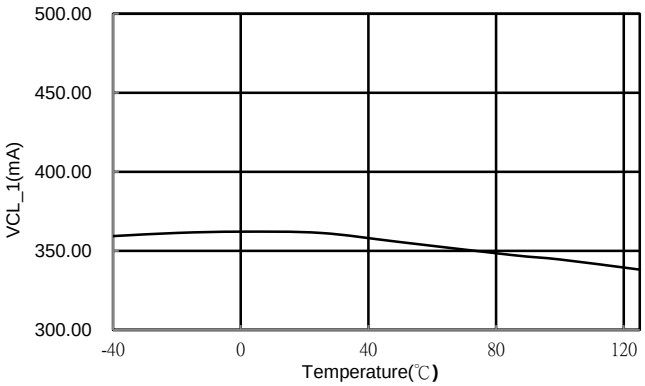


Fig. 6 V_{CL_1} vs. Temperature

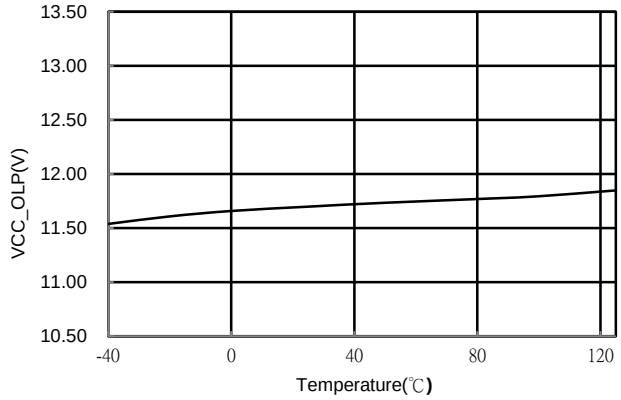


Fig. 7 V_{CC_OLP} vs. Temperature

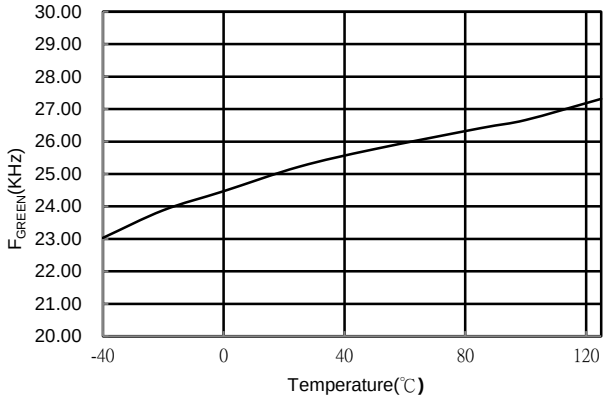


Fig. 8 F_{GREEN} vs. Temperature

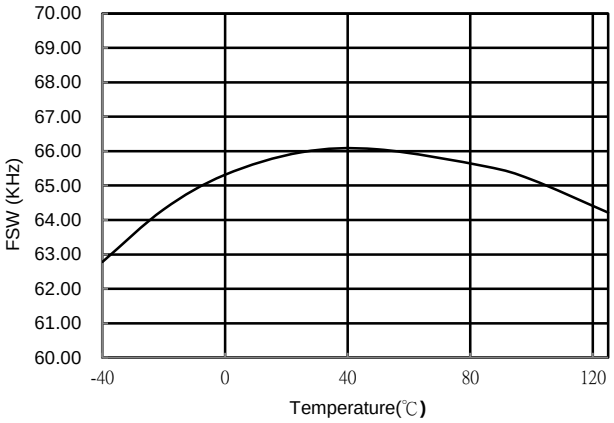


Fig. 9 FSW vs. Temperature

Application Information

Operation Overview

LD9010A is a switching power controller and is integrated with power 700V MOSFET for non-isolation power converter. It has only three function terminals to minimize the component counts and then to reduce the board size. The major features are described as below sections.

Internal Ultra High Voltage Startup Circuit and Under Voltage Lockout (UVLO)

As shown in Fig. 10, the LD9010A is implemented with a high-voltage startup circuit to minimize power loss. During startup phase, a high-voltage current source sinks a current for about 3mA from a bulk capacitor to provide the consumption in startup procedure and charge the VCC capacitor, C1.

Refer to Fig. 11, once VCC voltage rises up to reach the UVLO(ON) threshold, LD9010A starts switching to draw supply current for VCC from the inductor. At the same time, the ultra-high voltage startup circuit will also minimize the power loss in normal operation.

LD9010A is built-in HV regulator. During V_{OUT} is in rising phase, HV pin will charge the capacitor to ensure controller operating.

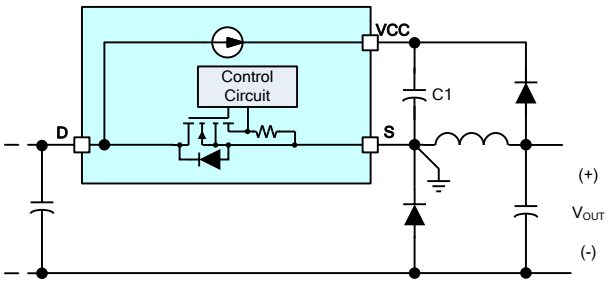


Fig.10

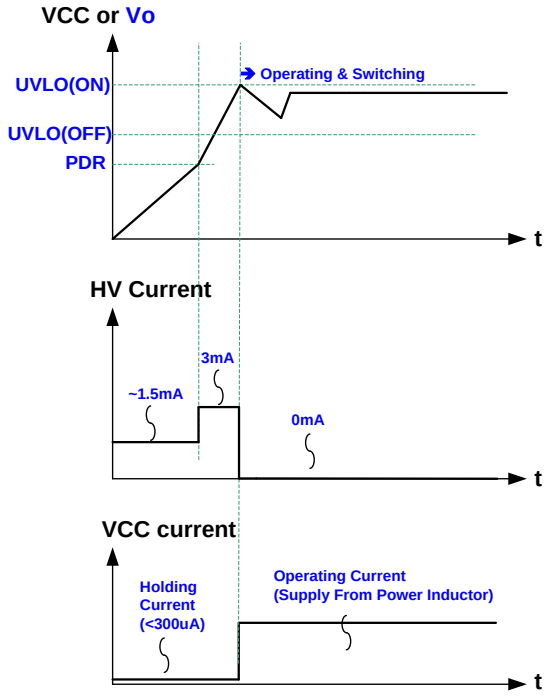


Fig. 11

Feedback Control

In order to minimize component counts, the inner feedback control signal of LD9010A is from the VCC pin. The LD9010A provides 12V output regulation and is also built in an over load protection (OLP) detection block through feedback control pin.

Types of Buck-Converter and Buck-Boost

The LD9010A can regulate the output voltage which is using an inner feedback comparator from VCC. During the internal MOSFET is in turning on phase, the inductor current ramps up and the voltage across the VCC pin feedback, will reach the upper threshold and then the voltage at GATE will be pulled low to turn off the internal MOSFET. The internal MOSFET is kept in off-state until the inductor current ramps down until the voltage across

VCC pin below or equal to the lower threshold.

Two main topologies are used to generate either positive or negative voltage with respect to the common terminal of the input voltage, buck and buck-boost topology respectively, shown in Fig. 12 and Fig.13.

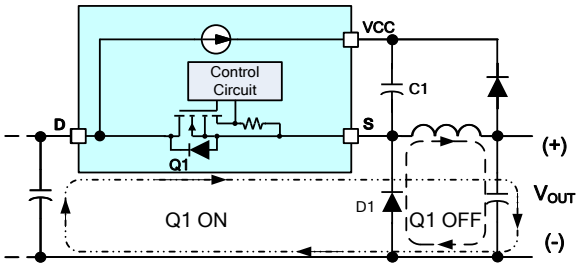


Fig.12 Buck Topology

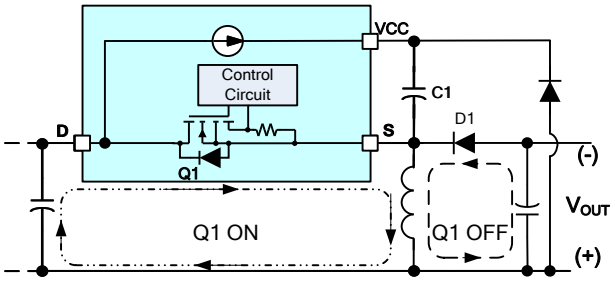


Fig.13 Buck-Boost Topology

Oscillator and Switching Frequency

The maximum switching frequency of LD9010A is 65 kHz to provide the optimized operations by considering the EMI performance, thermal treatment, component sizes and transformer design. The swapping frequency is integrated for EMI improvement.

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 patent pending from Leadtrend.

Current Sensing

LD9010A detects the MOSFET current by a sensing MOSFET, and operates with the pulse-by-pulse current limit by internal current sensing circuitry. A leading-edge blanking (LEB) time is included in the current sensing comparator to prevent the false-trigger from the current spike. Recommend using super-fast type VCC and freewheel diode which trr is less than or around 35n sec to minimize current spike period, shown as Fig. 14.

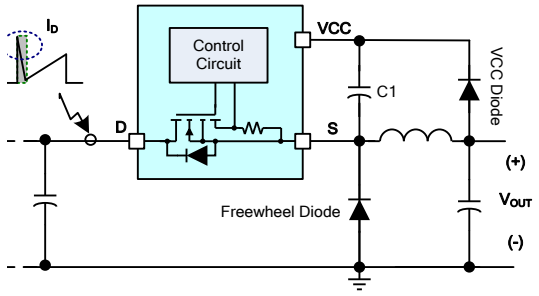


Fig.14

Over Load Protection

To protect the circuit from being damaged at over-load condition or output short-circuit condition, LD9010A is implemented with Over Load Protection (OLP) function. See Fig. 15 for the waveforms. In such fault condition, the output and VCC voltage will become lower level, when VCC drops below minimum regulation level and keeps longer than the OLP delay time, the protection will be activated to stop the switching of power converter. A divide-by-4 counter is implemented to reduce the average power under OLP behavior. Whenever OLP is activated, the output is latched off and the divide-by-4 counter starts to count the numbers of UVLO(OFF). The protection mode will not be released and the output will not be resumed until the 4th UVLO(OFF) level is tripped. With the protection mechanism, the average input power will be

reduced, so that the component temperature and stress can be controlled within the safe operating area.

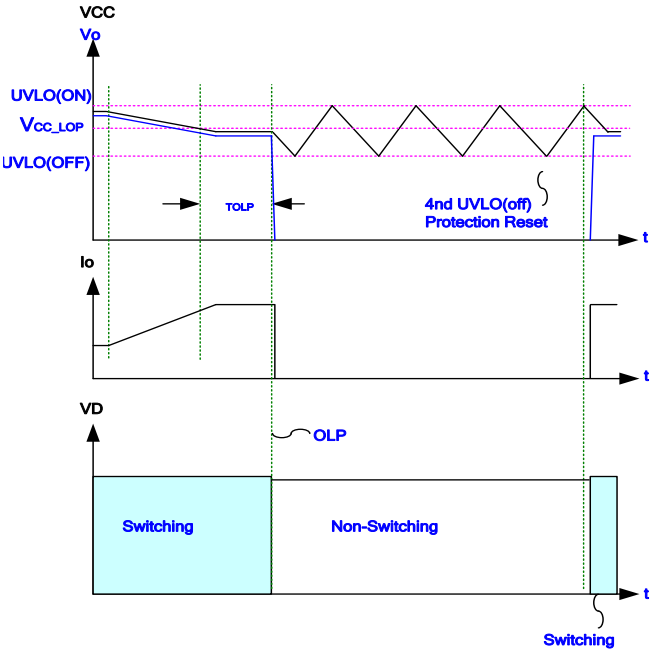


Fig.15

Pulse-by-Pulse Current Limit

The LD9010A detects the MOSFET current which is from the pulse-by-pulse current limit and output voltage feedback. The maximum voltage threshold of internal block is set to 350mA maximum. Recommend the operation current can't exceed this level.

Internal Thermal Shut Down

In order to protect control circuit of LD9010A from thermal damage, when junction temperature is above OTP level the LD9010A will shut down. While the temperature is cool down over than 30°C, the LD9010A will restart again.

Power Dissipation and Thermal management

The power supply designer should carefully consider the operating temperature on package case and the operating temperature of IC junction for the LD9010A. The maximum operating junction temperature is 125°C. The switcher should NOT operate in any condition over this temperature limitation. Please refer to the below formula to calculate the operating range.

$$T_J(\text{Junction Temperature}) = T_C\ (\text{Case Temperature}) + IC\ Power\ loss \times \theta_{JC}\ (Thermal\ resistance)$$

Output Dummy Load

In a buck converter application, it is necessary to add a dummy load from the output to maintain output regulation during no load condition. Recommend adding 3kΩ~10kΩ dummy load resistance and adjust it if necessary, shown as Fig. 16.

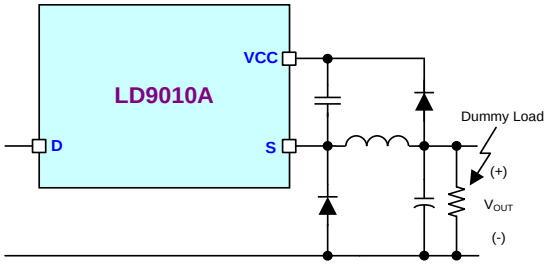
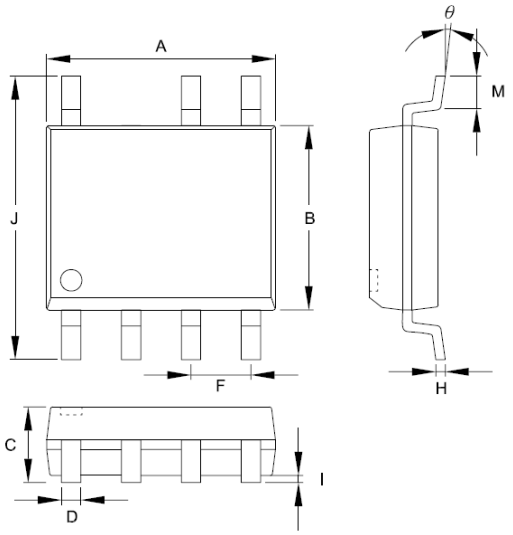


Fig.16

Package Information

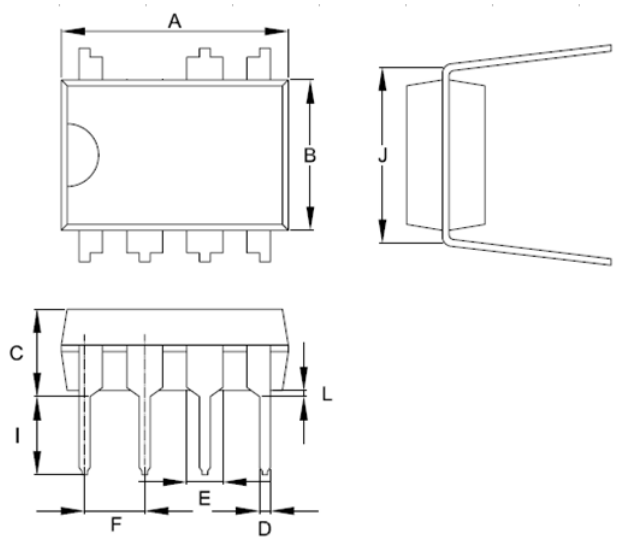
SOP-7



Symbols	Dimensions in Millimeters		Dimensions in Inch	
	MIN	MAX	MIN	MAX
A	4.801	5.004	0.189	0.197
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.178	0.254	0.007	0.010
I	0.102	0.254	0.004	0.010
J	5.791	6.198	0.228	0.244
M	0.406	1.270	0.016	0.050
θ	0°	8°	0°	8°

Package Information

DIP-7



Symbols	Dimensions in Millimeters		Dimensions in Inch	
	MIN	MAX	MIN	MAX
A	9.017	10.160	0.355	0.4
B	6.096	7.112	0.24	0.28
C	---	5.334	---	0.21
D	0.356	0.584	0.014	0.023
E	1.143	1.778	0.045	0.07
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 Corp. 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	12/08/2016	Original Specification.