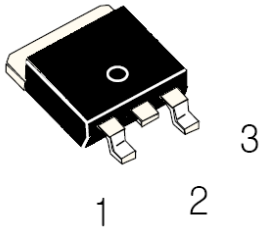
HIGH-VOLTAGE LED DRIVER WITH BUILT-IN MOSFET SWITCH AND AVERAGE-MODE CONSTANT CURRENT CONTROL

IK2312

SOT-252-2L



1.Drain
2.GND
3.V_{DD}

FEATURES

- Operating Temperature Range -40...+85 ºC
- Integrated 400V 40Ohm MOSFET Switch
- Single resistor LED current setting
- 5% accurate LED current
- Output short circuit protection with skip mode
- Over-temperature protection

APPLICATIONS

- Decorative Lighting
- Low Power Light Fixtures
- LED Signs and Displays
- Architectural Lighting
- Industrial Lighting

ORDERING INFORMATION

Device	Operating Temperature Range	Package	Packing
IK2312D0T	T_A = - 40 ... + 85 °C	TO-252-2L	Tape & Reel

PRODUCT DESCRIPTION

The IK2312 is a pulse width modulated (PWM) LED driver control IC. It allows efficient operation of low current LED strings from voltage sources ranging up to 400VDC. The IK2312 include an internal high-voltage switching MOSFET controlled with fixed off-time T_{OFF} of approximately 10,5μs. The LED string is driven at constant current, providing constant light output and enhanced reliability. The IK2312 does not produce a peak-to-average error, and therefore greatly improves accuracy of the LED current. The IK2312 designed for using low inductance value. The average current control scheme of the IK2312 provide good LED current regulation throughout the universal AC input voltage range of 85 to 264V AC or DC input voltage of 20 to 400V.

BLOCK DIAGRAM

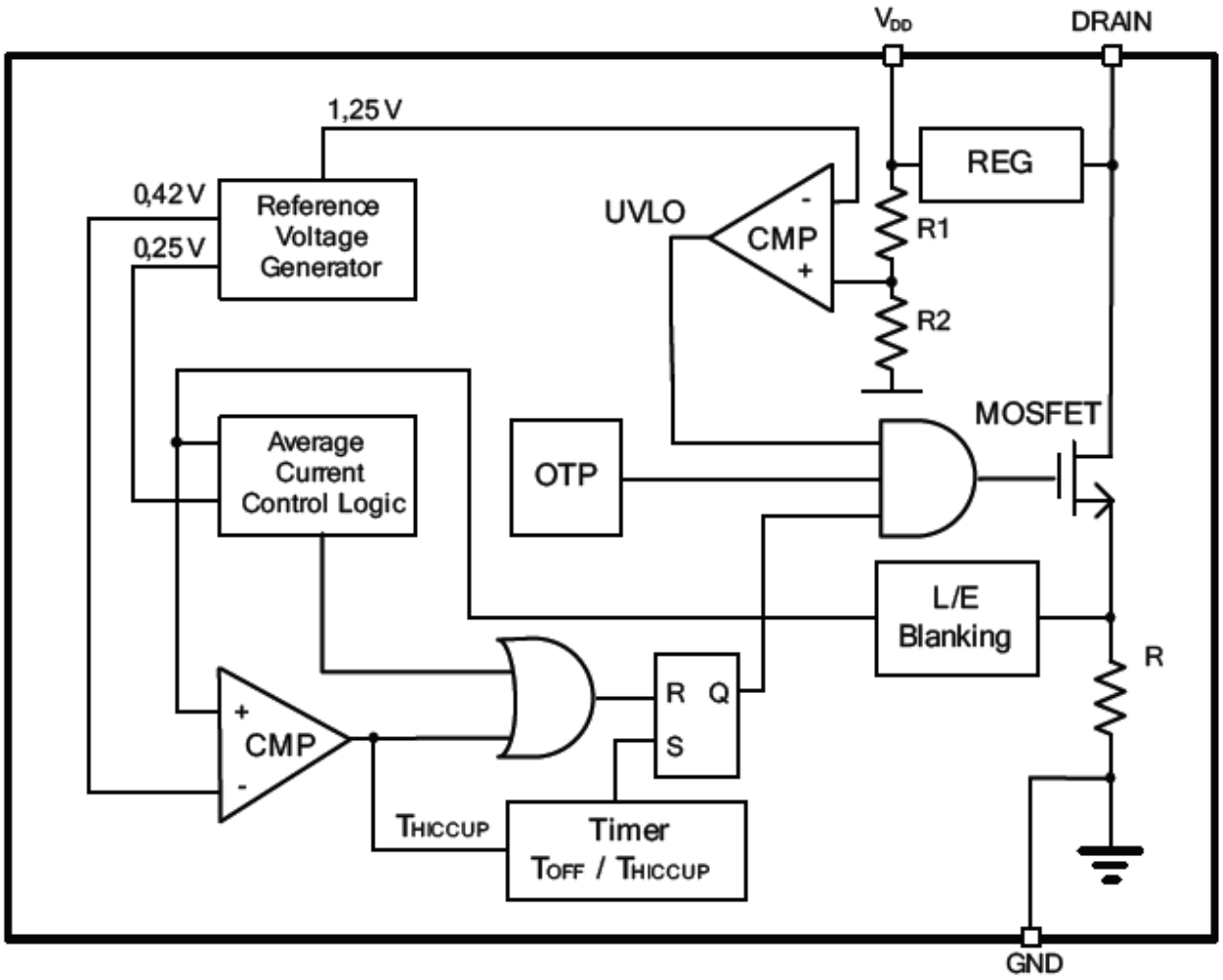


Figure 1

PIN DESCRIPTION

Pin No.	Symbol	Description
1	Drain	Drain of MOSFET Switch
2	GND	Ground
3	V_{DD}	Supply Voltage

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Min	Max	Unit
V_{DRAIN}	Input Voltage	-0.3	420	V
V_{DD}	Low-Voltage Part Supply Voltage	-0.3	10	V

Symbol	Parameter	Ratings	Unit
ΘJA	Thermal Resistance Junction-to-Ambient (TO-252)	80	°C/W
T_J	Operation Junction Temperature Range	-40 to +125	°C
T_{STG}	Operating Temperature Range	-65 to +150	°C

** Mounted on FR4 board, 25mm x 25mm x 1.57mm.*

Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATION MODE RANGE

Symbol	Parameter	Min	Max	Unit
V_{DRAIN}	Input Voltage	20	400	V

ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Max	Ambient Temperature, °C	Unit
V_{DDR}	Regulator Output Voltage	V_{DRAIN} = 20 V V_{DRAIN} = 400 V	5.5	8.5	25 ± 10	V
I_{DD}	Low-Voltage (Control) Part Of IC Consumption Current	V_{DD} = 8.5 V V_{IN} = 40 V	-	400		uA
V_{UVLO}	Under voltage Threshold	V_{DD} = V_{UVLO}	4.0	V_{DDR} – 0.3		V
R_{ON}	ON-Resistance of The Switch (DRAIN)	V_{DD} = V_{DDR} I_{DRAIN} = 120 mA V_{RSENSE} = 0 V	-	40		Ohm
V_{BR}	MOSFET switch breakdown voltage (DRAIN)	V_{DD} = 8.5V I_{DRAIN} = 0.2 mA	500	-		V
$I_{(AVG)}$	Average current	V_{DD} = V_{DDR}	114	126	25 ± 10 -40 85	mA
$I_{(SHORT)}$	Hiccup peak current	V_{DD} = V_{DDR}	160	240		mA
$T_{ON(MIN)}$	Minimum ON-time of the switch	#	-	700		ns
T_{BLANK}	Leading Edge Blanking Delay	#	200	400		ns
T_{OFF}	OFF Time	V_{DD} = V_{DDR} V_{RSENSE} = 310mV	8.0	13.0	25 ± 10	us
T_{HICCUP}	Short circuit hiccup time	V_{DD} = V_{DDR} V_{RSENSE} = 500mV	400	800		us
T_{SD}	Shut-down temperature	#	125	-		°C

Note:
 # Not production tested; guaranteed by design or characterization.

TYPICAL APPLICATION DIAGRAM

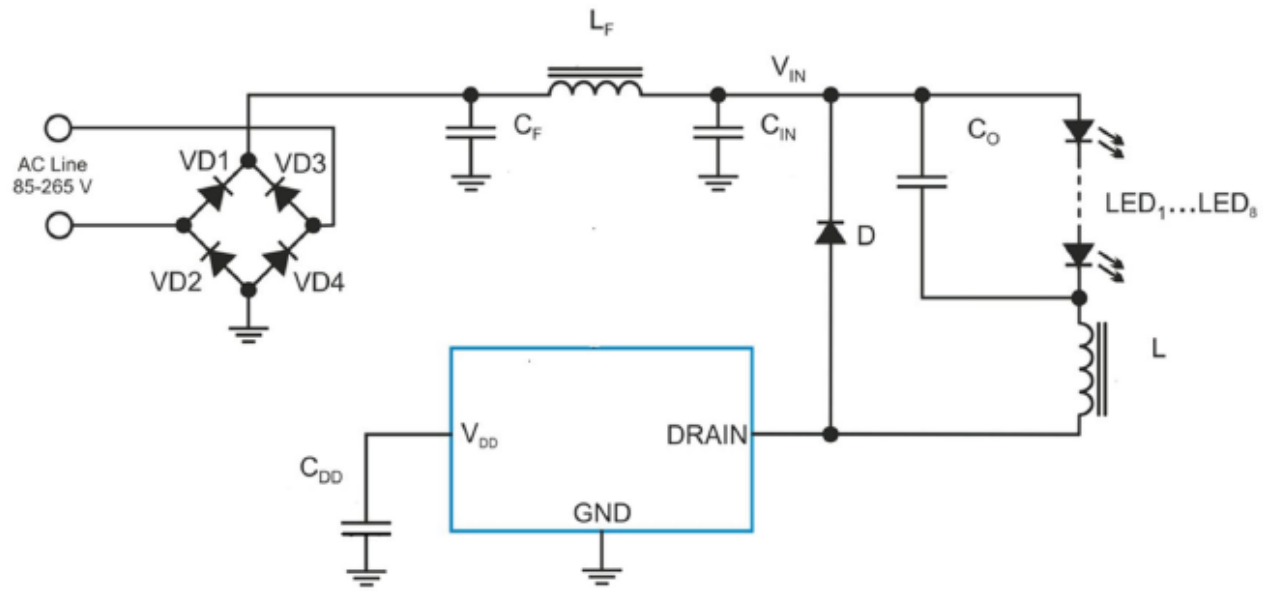


Figure 2.

FUNCTIONAL DESCRIPTION

When the input voltage of 20 to 400 V appears at the DRAIN pin, the internal high-voltage linear regulator seeks to maintain a voltage of 7 VDC at the VDD pin. Until this voltage exceeds the internally programmed under-voltage threshold, the output DRAIN is non-conductive. When the threshold is exceeded, the DRAIN turns on. The input current begins to flow into the DRAIN pin. Hysteresis is provided in the under-voltage comparator to prevent oscillation. The current through the switching MOSFET source is averaged. When the average current exceeds the internal calculated level, control logic resets an RS flip-flop, and the DRAIN turns off. At the same time, a one-shot circuit is activated that determines the duration of the off-state (10.5 μS type). As soon as this time is over, the flip-flop sets again. The new switching cycle begins. A “blanking” delay of 300 nS is provided that prevents false triggering of the current sense comparator due to the leading edge spike caused by circuit parasitic.

The constant-current control feedback derives the average current signal from the source current of the switching MOSFET. This current is detected using a sense resistor at the RSENSE pin. The feedback operates in a fast open-loop mode. No compensation is required.

The above equation is only valid for continuous conduction of the output inductor. It is a good practice to design the inductor such that the switching ripple current in it is 30~40% of its average full load DC current peak-to-peak. Hence, the recommended inductance can be calculated as:

$$L = (T_{OFF(MAX)} \bullet V_O) / (0.4 \bullet I_{LED})$$

The duty-cycle range of the current control feedback is limited to D ≤ 0.8. A reduction in the LED current may occur when the LED string voltage V_O is greater than 80% of the input voltage V_{IN}.

Reducing the output LED voltage V_O below $V_{O(MIN)} = V_{IN} \bullet D_{MIN}$,

where D_{MIN} = 0.7μs / ($T_{OFF(MAX)}$ + 0.7μs), may also result in the loss of regulation of the LED current.

This condition, however, causes increase in the LED current and can potentially trip the short-circuit protection comparator threshold. The short circuit protection comparator trips when the current at R_{SENSE} (peak value) exceeds (160 – 240) mA. When this occurs, the DRAIN off-time T_{HICCUP} = 600μs (type) is generated to prevent stair-casing of the inductor current and potentially its saturation due to insufficient output voltage.

LAYOUT CONSIDERATIONS

Single Point Grounding
Use a single point ground connection from the input filter capacitor to the area of copper connected to the GND pin.

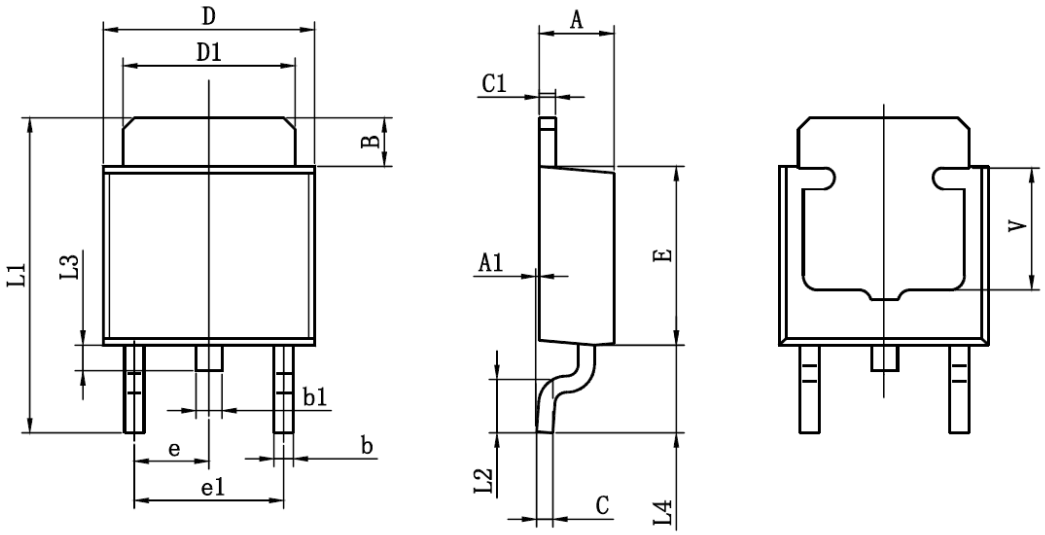
Bypass Capacitor (C_{DD})
The V_{DD} pin bypass capacitor C_{DD} should be located as near as possible to the V_{DD} and GND pins.

Switching Loop Areas
The area of the switching loop connecting the input filter capacitor C_{IN}, the diode D and the IK2312 together should be kept as small as possible. The switching loop area connecting the output filter capacitor $_{CO}$, the inductor L and the diode D together should be kept as small as possible.

Thermal Considerations vs. Radiated EMI
The copper area where GND pin is connected acts not only as a single point ground, but also as a heat sink. This area should be maximized for good heat sinking. The same applies to the cathode of the freewheeling diode D. Both nodes are quiet and therefore, will not cause radiated RF emission. The switching node copper area connected to the DRAIN pin of the IK2312, the anode of D and the inductor L needs to be minimized. A large switching node area can increase high frequency radiated EMI.

Input Filter Layout Considerations
The input circuits of the EMI filter must not be placed in the direct proximity to the inductor L in order to avoid magnetic coupling of its leakage fields. This consideration is especially important when unshielded construction of L is used. When an axial input EMI filter inductor LIN is selected, it must be positioned orthogonal with respect to L. The loop area formed by C_F, L_F and C_{IN} should be minimized. The input lead wires must be twisted together.

TO-252-2L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	2.200	2.400	0.087	0.094
A1	0.000	0.127	0.000	0.005
B	1.350	1.650	0.053	0.065
b	0.500	0.700	0.020	0.028
b1	0.700	0.900	0.028	0.035
c	0.430	0.580	0.017	0.023
c1	0.430	0.580	0.017	0.023
D	6.350	6.650	0.250	0.262
D1	5.200	5.400	0.205	0.213
E	5.400	5.700	0.213	0.224
e	2.300TYP		0.091TYP	
e1	4.500	4.700	0.177	0.185
L1	9.500	9.900	0.374	0.390
L2	1.400	1.780	0.055	0.070
L3	0.650	0.950	0.026	0.037
L4	2.550	2.900	0.100	0.114
V	3.80REF		0.150REF	