Primary-Side Control LED Driver with High PFC

FEATURES

- Primary Feedback Control Without Secondary feedback Circuit
- High Power Factor >0.9 Over the Universal Input
- High Current Accuracy ±3%
- Boundary Conduction Mode Operation
- Ultra-low Start Up Current
- Cycle-by-cycle Current Limit
- Over-voltage Protection
- Short-circuit Protection
- Under Voltage Lock Out
- Available in a SOP8/DIP8 Package

APPLICATIONS

- Isolated, Solid State Lighting
- Industrial and Commercial Lighting
- Residential Lighting

DESCRIPTION

The FT825 is a primary-side-control offline LED lighting controller which can achieve high power factor and accurate LED current for an isolated lighting application in a single stage converter.

The real current control method can control the LED current accurately from the primary side information. It can significantly simplify the LED lighting system design by eliminating the secondary side feedback components and the opto-coupler.

The FT825 works in boundary conduction mode for reducing the MOSFET switching losses. The extremely low start-up current and the quiescent current can reduce the power consumption thus lead to an excellent efficiency performance.

The multi-protection function of FT825 can greatly enhance the system reliability and safety. The FT825 features over-voltage protection, short-circuit protection, cycle-by-cycle current limit, VCC UVLO protection.

The FT825 is available in SOP8/DIP8 Package.

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TYPICAL APPLICATION CIRCUIT

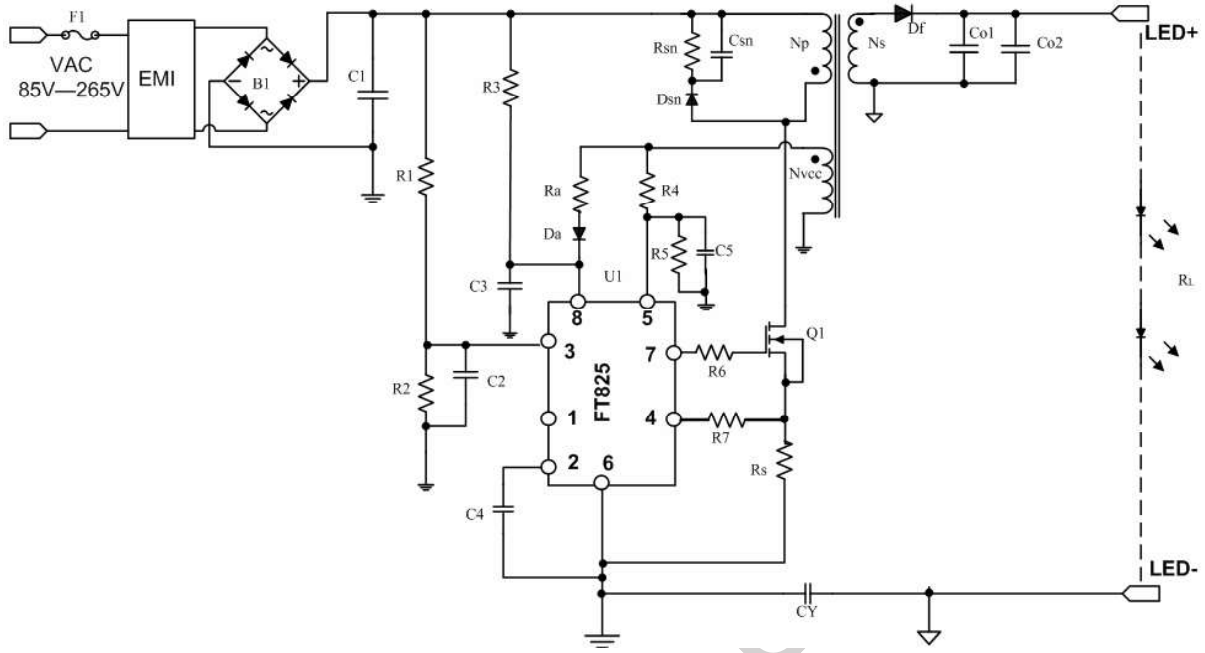


Figure 1: Typical Application Circuit

ABSOLUTE MAXIMUM RATINGS

VCC to GND……-0.3V to +27V
Analog Inputs and Outputs…….. -0.3V to 7V
ZCD Pin Maximum Current……-5mA (source) / 5mA(sink)
Max. Gate Source Current……1.0A
Max. Gate Sink Current……-1.2A
Operating Temperature Range……-40℃ to +125℃
Junction Temperature…….....-40℃ to +150℃
Storage Temperature Range ……-60℃ to +150℃
ESD Protection HBM……2000V
ESD Protection MM…….. ……..... 200V

*** Stresses exceed those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Functional operation of the device at conditions beyond those listed in the specification is not guaranteed. Prolonged exposure to extreme conditions may affect device reliability or functionality.**

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PIN CONFIGURATION

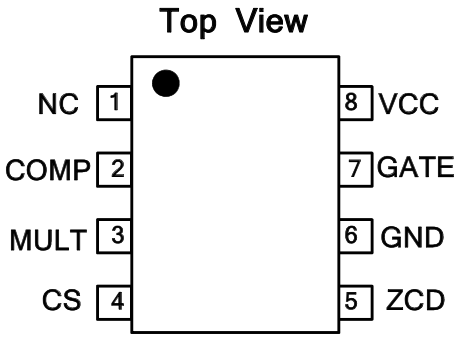


Figure 2: Pin Assignments

TERMINAL DESCRIPTION

No.	PIN	FUNCTION
1	NC	This pin can be NC or connects to GND.
2	COMP	Loop Compensation pin. Connects a compensation network to stabilize the LED driver and get an accurate LED current of the LED driver.
3	MULT	Main input to the multiplier. This pin is connected to the rectified mains voltage via a resistor divider and provides the sinusoidal reference to the current loop.
4	CS	Current sense pin. The MOSFET current is sensed via a resistor, the resulting voltage compared to the internal sinusoid shaped current reference signal to determine when the MOSFET turns off.
5	ZCD	Zero current detection pin. A negative going edge triggers the turn on signal of the external MOSFET, connects this pin through a resistor divider from the auxiliary winding to GND. Over-voltage condition is detected through ZCD, if ZCD voltage is higher than the Over-voltage protection (OVP) threshold after a blanking time 1us, the over-voltage condition is detected.
6	GND	Ground.
7	GATE	Gate drive output pin. The totem pole output stage is able to drive high power MOSFET with a peak current of 1A source capability and 1.2A sink capability. The high level voltage of this pin is clamped to 13V to avoid excessive gate drive voltage.
8	VCC	Supply Voltage of both the signal part of the IC and the gate driver.

Table1

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ORDERING INFORMATION

FT825 x - XX

Circuit Type

HSF and Packaging
RB: RoHS and Tube
RT: RoHS and T&R
GB: Green and Tube
GT: Green and T&R

Package
Blank: SOP8
a: DIP8

Package	Temperature Range	HSF	Packaging	Ordering Code
SOP8	-40℃-125℃	RoHS	Tube	FT825-RB
			T&R	FT825-RT
		Green	Tube	FT825-GB
			T&R	FT825-GT
DIP8	-40℃-125℃	RoHS	Tube	FT825a-RB
		Green	Tube	FT825a-GB

Table 2

MARKING RULE

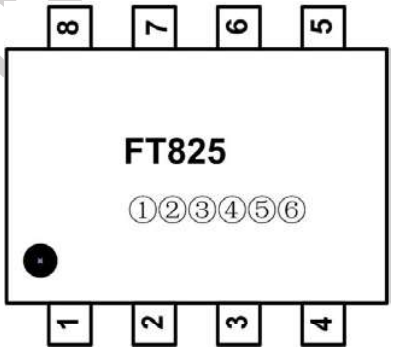
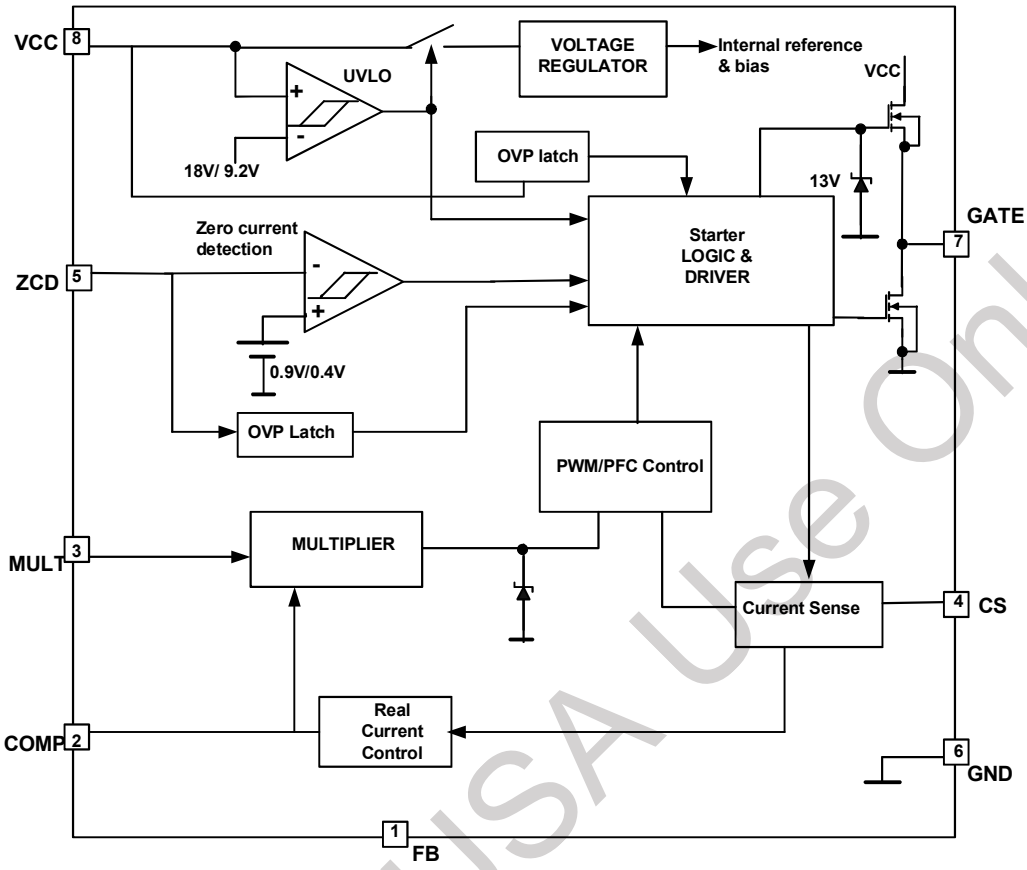


Figure 3 marking rule

①②③④⑤⑥ for internal reference

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BLOCK DIAGRAM



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ELECTRICAL CHARACTERISTICS

(Tj = 25°C, VCC = 16V, unless otherwise specified)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
SUPPLY VOLTAGE						
VCC	Operating Range	After turn-on	9.5		20	V
VCC_{on}	Turn-on Threshold			17.8		V
VCC_{off}	Turn-off Threshold			9.2		V
VCC_{OVP}	VCC over Voltage			24		V
SUPPLY CURRENT						
Istart-up	Start-up Current	Before turn-on,VCC= 16V		6		uA
Iq	Quiescent Current	After turn-on, No switch		1.3		mA
Icc	Operating Supply Current	@ 70 kHz		1.8		mA
MULTIPLIER INPUT						
I_{MULT}	Input Bias Current	V_{MULT} = 0 to 3 V			-1	uA
V_{MULT}	Linear Operation Range			0 to 3		V
$\triangle V_{CS}/\triangle V_{MULT}$	Output Max Slope	V_{MULT} = 0 to 1V V_{COMP} = Upper clamp		2.4		V/V
K	Gain (1)	V_{MULT} = 1 V, V_{COMP} = 3 V		0.72		1/V
ERROR AMPLIFIER						
V_{FB}	Voltage Feedback Input Threshold			0.4		V
V_{EA}	Voltage Gain			400		V/V
G_{EA}	Transconductance			100		100uA/V
I_{COMP}	Source Current			45		uA
	Sink Current			-65		uA
V_{COMP}	Upper Clamp Voltage			5.2		V
	Lower Clamp Voltage			1.2		V
CURRENT SENSE COMPARATOR						
$t_{d\ (H-L)}$	Delay to Output			100		ns
$V_{CS\ clamp}$	Current Sense Reference Clamp			2.4		V

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ELECTRICAL CHARACTERISTICS

(Tj = 25°C, VCC = 16V, unless otherwise specified)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
ZERO CURRENT DETECTOR						
V_{ZCD_T}	Zero Current Detect Threshold	(2)		0.4		V
V_{ZCD_Hy}	Zero Current Detect Hysterestic	(2)		0.5		V
V_{ZCD_OVP}	Output over Voltage Threshold	1us delay after turn-off		5.3		V
LOGIC						
t_{START}	Start Timer Period			130		us
t_{LEB}	Leading Edge Blanking Time			300		ns
T_{off_min}	Minimum off Time			3.5		us
GATE DRIVER						
Igate-source	Max Source Current			1		A
Igate-sink	Max Sink Current			-1.2		A
Voclamp	Output Clamp Voltage			12		V

Table 4

(1) The multiplier output is given by: $Vcs = K * V_{MULT} * (V_{COMP} - 1.2)$

(2) Parameters guaranteed by design, functionality tested in production.

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FUNCTIONAL DESCRIPTION

Under-Voltage Lockout(UVLO)

The turn-on and turn-off threshold voltages are fixed internally at 17.8V and 9.2V respectively for FT825. This hysteresis behavior will guarantee a one shot start-up, as long as a proper start-up resistor and hold-up capacitor are used.

Line Compensation

An offset current proportional to instantaneous mains voltage streams out CS pin. A compensation resistor inverse proportional to the offset current is added between ZCD Pin and transformer auxiliary winding to achieve extremely low THD and line compensation, the compensation resistor can be adjusted externally.

Zero current switching

The IC is switched on when the transformer is demagnetized after MOSFET's minimum off time about 3.5us typically. Internal circuitry connected to the ZCD pin detects the end of the secondary stroke. After MOSFET's minimum off time, if no demagnetization signal is detected on the ZCD pin, the controller generates a startup signal 130us typically after the last GATE signal.

Leading Edge Blanking (LEB)

A turn on spike on CS pin will inevitably appear when the power MOSFET is switched on. At the beginning of each switching pulse, the current-limit comparator is disabled for around 300nsec to avoid premature termination. The gate driver output cannot be switched off during the blanking period. However, it is strongly recommended to add a small RC filter for higher power application to avoid the CS pin from damage by the negative turn-on spike.

Output Driver

With a low ON-resistance and a high current driving capability, the output driver can easily driver a big MOSFET or IGBT. Cross conduction currents are avoided to minimize heat dissipation, allowing the efficiency and reliability to be improved.

Over Voltage Protection (OVP)

Under steady-state condition, system output voltage is controlled by load connection, the voltage of ZCD pin set by R1, R2 and auxiliary winding (see figure 4) does not exceeds 5.3V, When system output is open, the voltage of output increases, due to the coupling polarity between auxiliary winding and secondary winding of a transformer, ZCD voltage will increase also. Once the ZCD voltage exceeds 5.3V and last for about 1us to guarantee the leakage inductance ringing has been fully damped, OVP of IC is triggered, the IC stops switching, It can be reset by re-starting the voltage on pin VCC.

The OVP voltage can be adjusted by setting R1, R2 and auxiliary winding.

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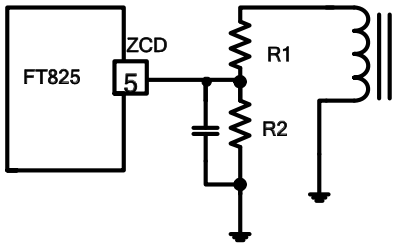


Figure4 Circuit OVP

Power Factor Correction

The MULT pin is connected to the tap of the resistor divider from the rectified instantaneous line voltage and fed as one input of the Multiplier. The output of the multiplier will be shaped as sinusoid too. This signal provides the reference for the current comparator and comparing with the primary side inductor current which sets the primary peak current shaped as sinusoid with the input line voltage, High power factor can be achieved. The maximum voltage of the multiplier output to the current comparator is clamped to 2.4V to get a cycle-by-cycle current limitation.

Minimum off time

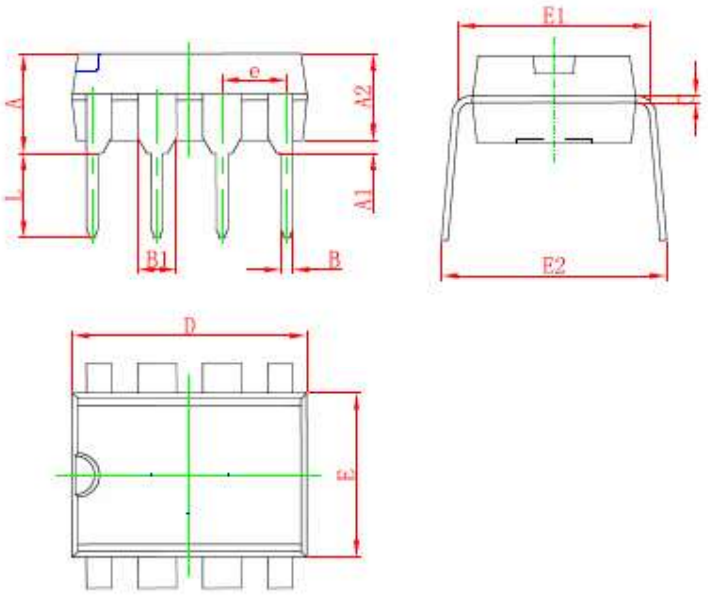
The FT825 operates with variable switching frequency, the frequency is changing with the input instantaneous line voltage. To limit the maximum frequency and get a good EMI performance, FT825 employs an internal minimum off time limiter—3.5μs.

Output Short Circuit Protection

When the output short circuit happens, the positive plateau of auxiliary winding voltage is also near zero, the VCC can not be held on and it will drop below VCC UVLO. The IC will shut down and restart again.

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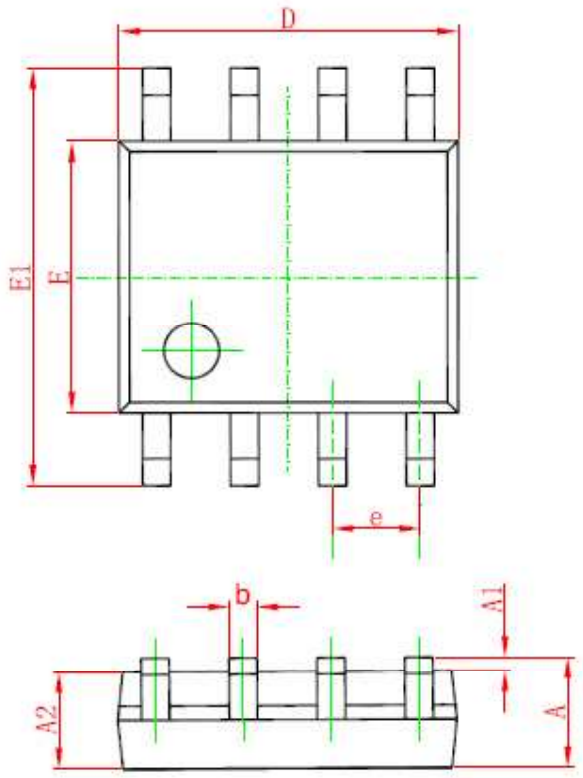
DIP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524（BSC）		0.060（BSC）	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540 (BSC)		0.100（BSC）	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354

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SOP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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