

High Performance Non-isolated Buck LED Driver

FEATURES

- No Auxiliary winding for sensing and supplying
- Three-level ON/OFF dimming (FT8871x only)
- Inductor current boundary conduction mode (BCM)
- Constant current control without secondary sense and feedback circuit
- Built-in 500V Power MOSFET (FT887xx)
- High efficiency with $\pm 3\%$ LED current accuracy
- Ultra low operating current for high efficiency
- Excellent line and load regulations
- Cycle-by-Cycle current limiting
- Programmable precision OVP voltage for best LED open circuit protection
- LED short circuit protection
- Over temperature compensation
- CS resistor short circuit protection.
- VCC under-voltage lockout
- Available in SOP8 and DIP8 packages

APPLICATIONS

- DC/DC or AC/DC LED Driver Applications
- Back Lighting of Flat Panel Displays

DESCRIPTION

FT887xx/FT8870 is optimized for low cost non-isolated Buck switching mode LED driver applications. It operates in inductor current boundary conduction mode. With source driving architecture, special demagnetization sensing technology and the ultra low operating current, FT887xx/FT8870 doesn't need the auxiliary winding for output current sensing and chip power supplying. FT887xx also integrates a 500V power MOSFET that further improves the system reliability and lowers the system cost and complexity. FT8871x enables three-level ON/OFF dimming function with proper capacitance choice of the Vcc capacitor.

Its highly integrated functions such as Leading Edge Blanking (LEB) and built-in line compensation offer users a high efficiency and low cost solution for constant current LED driver applications.

The multi-protection function of FT887xx/FT8870 greatly enhances the system reliability and safety. FT887xx/FT8870 offers fruitful protections like LED open and short circuit protection, over temperature compensation, CS resistor short circuit protection.

The industry leading OVP voltage accuracy ensures the best LED open circuit protection

TYPICAL APPLICATION CIRCUIT

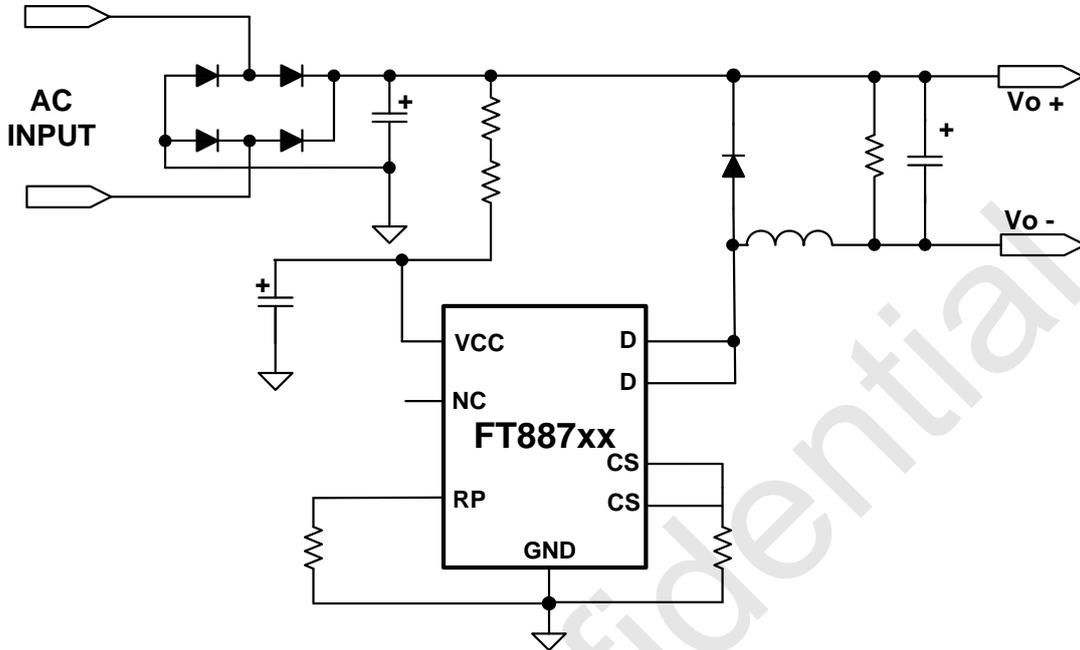


Figure 1: FT887xx Typical Application Circuit

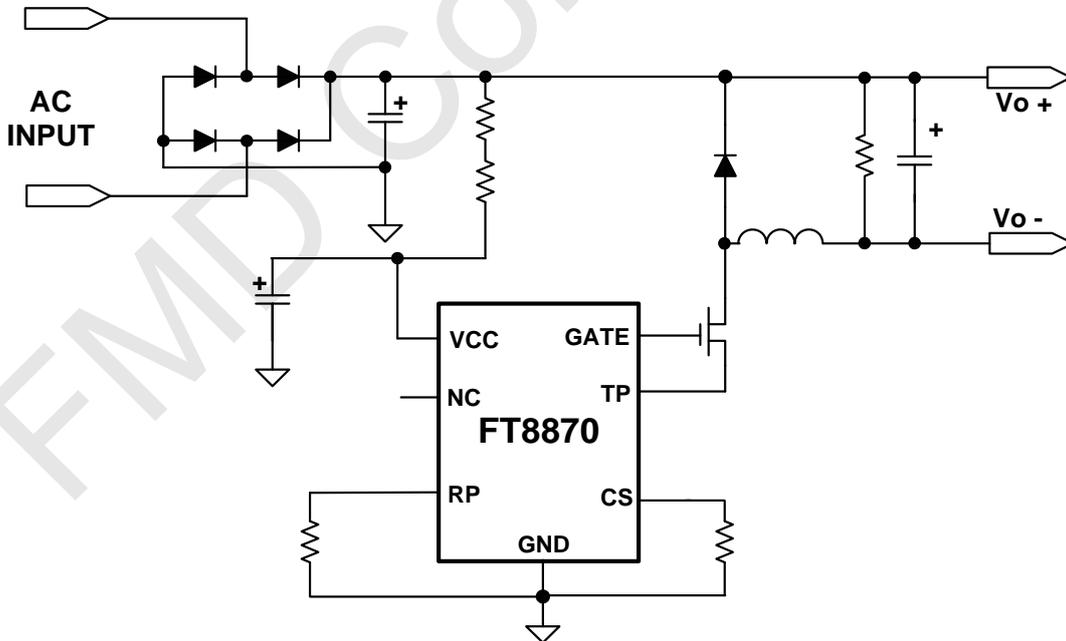


Figure 2: FT8870 Typical Application Circuit

ABSOLUTE MAXIMUM RATINGS

VCC to GND.....	-0.3V to 8V
CS Pin Inputs and Outputs.....	-0.3V to 8V
D Pin Inputs and Outputs.....	-0.3V to 500V
RP Pin Inputs and Outputs.....	-0.3V to 8V
Operating Temperature Range.....	-40°C to +125°C
Junction Temperature.....	-40°C to +150°C
Storage Temperature Range	-60°C to +150°C
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.*

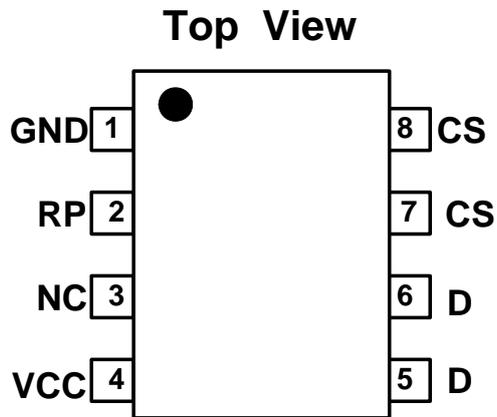
PIN CONFIGURATION

Figure 3: FT887xx Pin Assignments

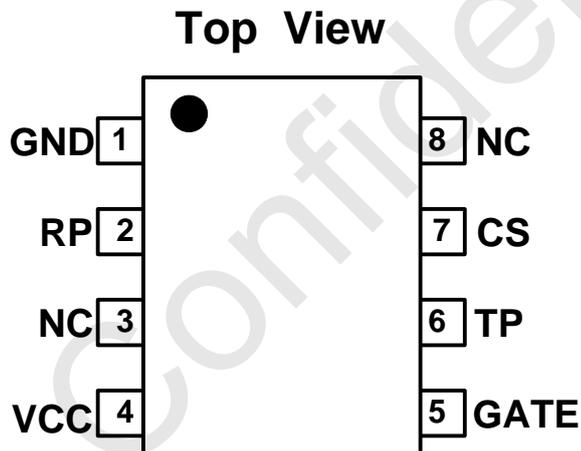


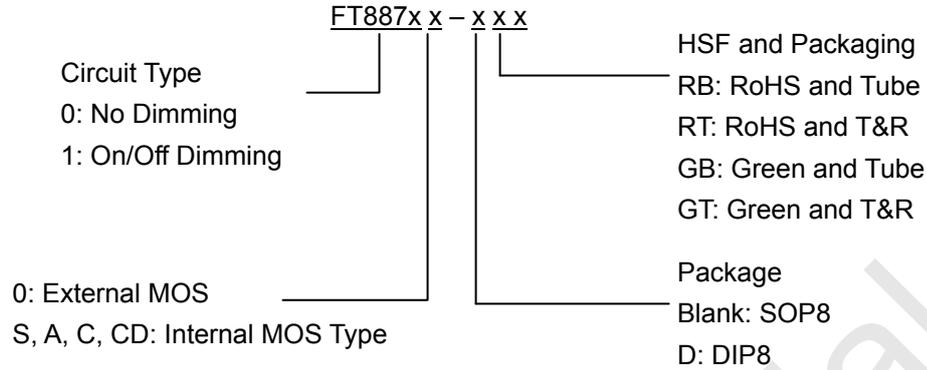
Figure 4: FT8870 Pin Assignments

TERMINAL DESCRIPTION

FT887xx		
No.	PIN	FUNCTION
1	GND	Ground
2	RP	Output OVP voltage program PIN. This pin connects a resistor to GND
3	NC	No connect
4	VCC	Power supply
5,6	D	Internal high voltage MOSFET Drain
7,8	CS	Current sense. This pin connects a current sense resistor to GND
FT8870		
No.	PIN	FUNCTION
1	GND	Ground
2	RP	Output OVP voltage program PIN. This pin connects a resistor to GND
3	NC	No connect
4	VCC	Power supply
5	GATE	Power NMOS driver output
6	TP	This pin connects to the power NMOS source
7	CS	Current sense. This pin connects a current sense resistor to GND
8	NC	No connect

Table1

ORDERING INFORMATION



Package	Max Output Current	Max Output Voltage/Power		HSF	Packaging	Ordering Code
		90V-264V	176V-264V			
SOP8	140mA	60V/7W	150V/12W	RoHS	Tube	FT887xS-RB
					T&R	FT887xS-RT
				Green	Tube	FT887xS-GB
					T&R	FT887xS-GT
SOP8	180mA	60V/10W	150V/18W	RoHS	Tube	FT887xA-RB
					T&R	FT887xA-RT
				Green	Tube	FT887xA-GB
					T&R	FT887xA-GT
SOP8	280mA	60V/15W	150V/27W	RoHS	Tube	FT887xC-RB
					T&R	FT887xC-RT
				Green	Tube	FT887xC-GB
					T&R	FT887xC-GT
DIP8	380mA	60V/22W	150V/40W	RoHS	Tube	FT887xCD-DRB
				Green	Tube	FT887xCD-DGB
SOP8	N/A	N/A	N/A	RoHS	Tube	FT8870-RB
					T&R	FT8870-RT
				Green	Tube	FT8870-RB
					T&R	FT8870-RT

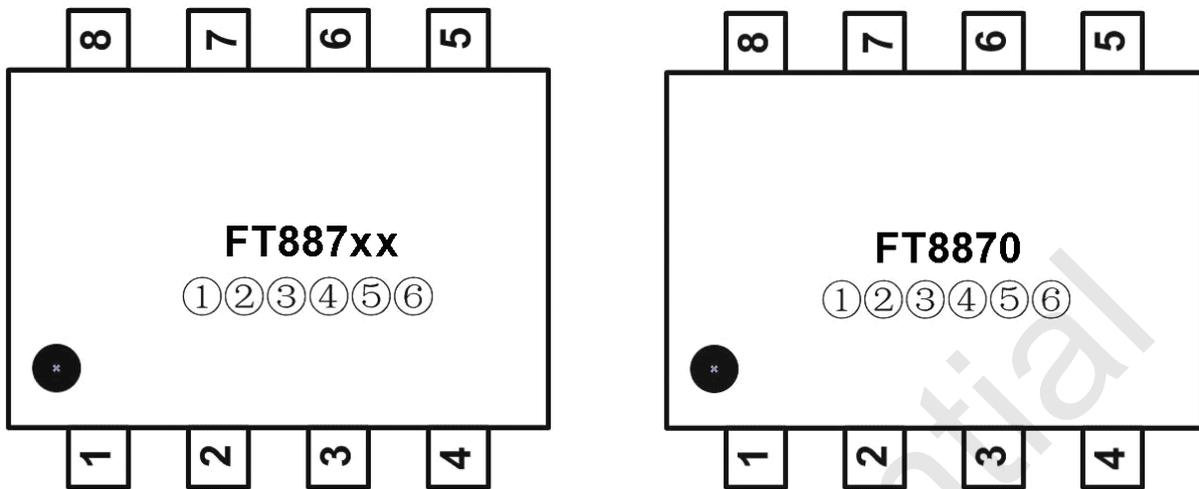
MARKING RULE

Figure 5 marking rule

①②③④⑤⑥ for internal reference

BLOCK DIAGRAM

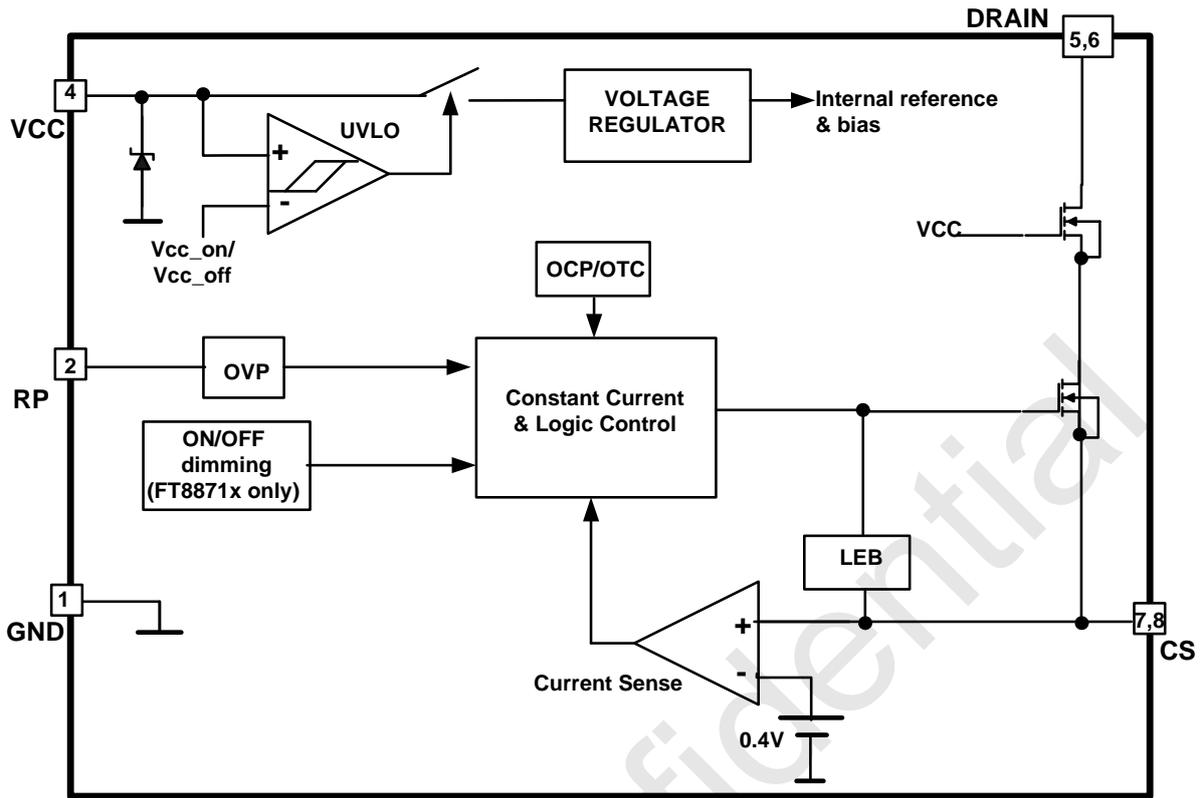


Figure 6 FT887xx Block Diagram

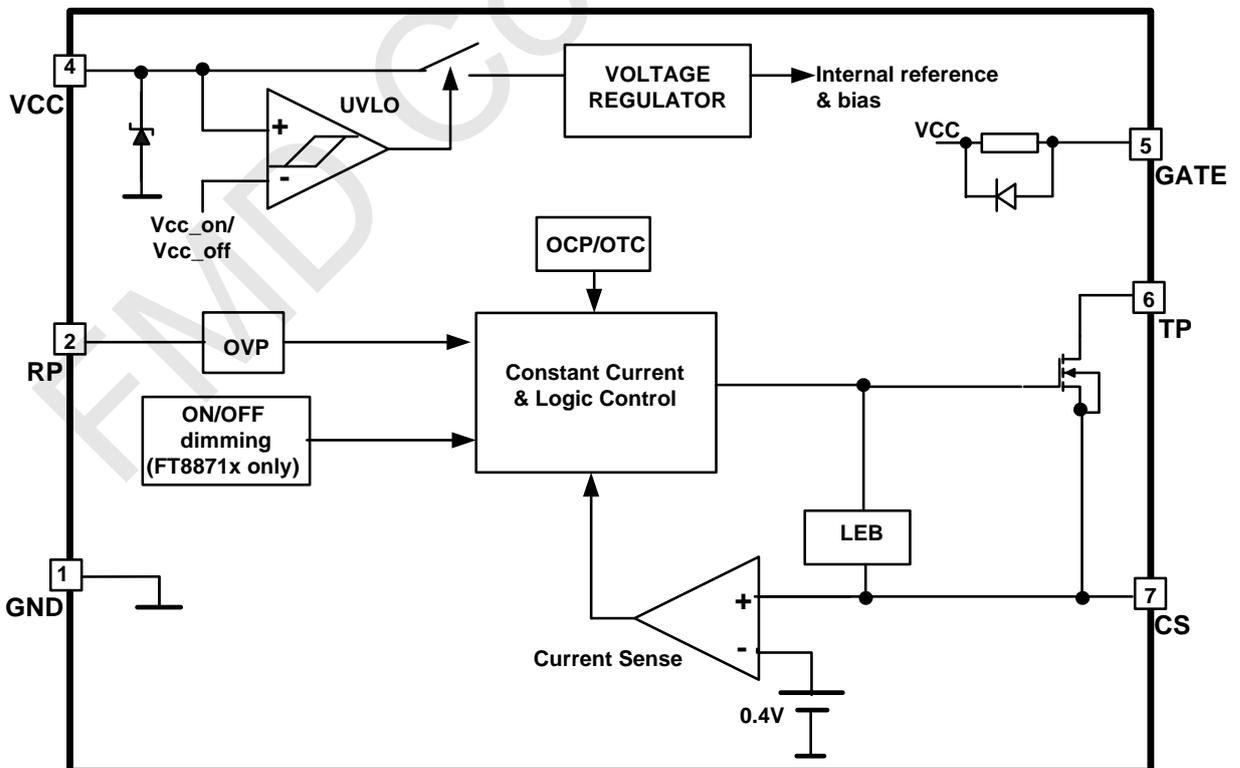


Figure 7 FT8870 Block Diagram

ELECTRICAL CHARACTERISTICS

(Tj = 25°C, VCC = 7V, unless otherwise specified)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
SUPPLY VOLTAGE						
VCC _{on}	Turn-on threshold		6.3		7.3	V
VCC _{off}	Turn-off threshold		5.3		6.3	V
VCC _{clamp}	VCC clamp voltage		6.3		7.3	V
VCC _{hys}	VCC under voltage hysteresis			1		V
SUPPLY CURRENT						
I _{start-up}	Start-up current	Before turn-on, VCC= VCC _{on} -1V		130		uA
I _q	Quiescent Current			120		uA
CURRENT SENSE						
V _{CS_TH}	Threshold voltage for peak current limit		388	400	412	mV
T _{LEB}	Leading edge blanking time for current sense			350		ns
T _{DELAY}	Switch off delay time			200		ns
SWITCH FREQUENCY						
F _{MIN}	Minimum working frequency			5		KHz
BROWNOUT PROTECTION						
TON _{MAX}	Maximum on time			48		us
ON/OFF DIMMING (For FT8871x only)						
K _{DIM}	Output current ratio	Level one		100		%
		Level two		50		
		Level three		25		
T _{DIM}	The maximum power off time for an effective dimming operation			2		s
OUTPUT OVER VOLTAGE PROTECTION						
T _{OVp}	Secondary minimum discharge time	R _p =0 Ω		10		us
		R _p floating		7.5		
		R _p =15 K Ω		11.25		
		R _p =30 K Ω		13.75		
		R _p =47 K Ω		12.5		
		R _p =82 K Ω		6.25		
		R _p =130 K Ω		8.75		
		R _p =200 K Ω		5		

MOSFET (FT887xS)						
R_{DS_ON}	Static drain-source on-resistance	$V_{GS}=10V, I_{DS}=0.5A$		17		Ω
BV_{DSS}	Drain-source breakdown voltage	$V_{GS}=0V, I_{DS}=250\mu A$	500			V
I_{DSS}	Drain-source leakage current	$V_{GS}=0V, V_{DS}=500V$			10	μA
I_{DMAX}	Maximum Drain Current	$V_d=6V$		0.35		A
MOSFET (FT887xA)						
R_{DS_ON}	Static drain-source on-resistance	$V_{GS}=10V, I_{DS}=0.5A$		9.8		Ω
BV_{DSS}	Drain-source breakdown voltage	$V_{GS}=0V, I_{DS}=250\mu A$	500			V
I_{DSS}	Drain-source leakage current	$V_{GS}=0V, V_{DS}=500V$			10	μA
I_{DMAX}	Maximum Drain Current	$V_d=6V$		0.50		A
MOSFET (FT887xC and FT887xCD)						
R_{DS_ON}	Static drain-source on-resistance	$V_{GS}=10V, I_{DS}=0.5A$		3.6		Ω
BV_{DSS}	Drain-source breakdown voltage	$V_{GS}=0V, I_{DS}=250\mu A$	500			V
I_{DSS}	Drain-source leakage current	$V_{GS}=0V, V_{DS}=500V$			10	μA
I_{DMAX}	Maximum Drain Current	$V_d=6V$		1.0		A
Over Temperature Compensation						
T_{comp}	Thermal compensation threshold			140		$^{\circ}C$
Over Temperature Protection						
T_{SD}	Thermal protection threshold			150		$^{\circ}C$
T_{HIS}	Thermo protection hysteresis			20		$^{\circ}C$

Table2

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FUNCTIONAL DESCRIPTION

Operating Description

FT887xx/FT8870 is a cost effective and high-performance non-isolated Buck LED driver. It operates in inductor current boundary conduction mode. The constant current (CC) control is achieved accurately without the secondary feedback circuit and auxiliary winding.

Startup Control

The start-up current in FT887xx/FT8870 is designed to be 130uA. The VCC capacitor will be charged through a start-up resistor when the system is powered on. Once the VCC voltage reaches the start-up threshold, FT887xx/FT8870 will start to switch. The VCC voltage of FT887xx/FT8870 is clamped at 7V. Due to the ultra-low operating current, the auxiliary winding is not needed to supply the IC, good efficiency is achieved.

ON/OFF dimming

Compare to Triac dimming, ON-OFF dimming is a simple and green solution to LED lighting applications. FT8871x enables three-level ON/OFF dimming function with proper choice of capacitance of the Vcc capacitor to maintain the VCC voltage during power off, By simply counting the number of wall switch toggling, the output power cycles through the 100%, 50% and 25% settings, in that order. If mains switch is turned off and stays off for longer than T_{DIM} , the turning off is regarded as true turning-off action, hence any subsequent turning on will output rated 100% power. If the wall switch is turned on and off or toggles in less than T_{DIM} apart, the output will go through 100%, 50%, 25% rated power levels and repeat the process.

Constant Current Control

Cycle-by-Cycle current sense is adopted in FT887xx/FT8870, and the voltage on CS will be compared with the internal 400mV reference voltage through the current sense comparator, the MOSFET will be switched off when the voltage on CS reaches the threshold.

The primary peak current is given by:
$$I_{P_PK} = \frac{400}{R_{CS}} (mA)$$

The current in LED can be calculated by the equation:
$$I_{OUT} = \frac{I_{P_PK}}{2}$$

Where, I_{P_PK} is the peak current in MOSFET,

Leading Edge Blanking (LEB)

Each time the power transistor is switched on, a turn-on spike occurs at the sense resistor. To avoid premature termination of the switching pulse, a 350ns leading edge blanking time is built in. Conventional RC filtering can therefore be omitted. During this blanking period, the current limit comparator is disabled and can not switch off the gate driver.

Over Voltage Protection (OVP)

FT887xx/FT8870 features the industry leading output OVP accuracy. Output LED open circuit will trigger the over-voltage protection logic and latch, the system stops switching immediately. VCC will be pulled down and charged up again, the system works in a hiccup mode. The output over voltage protection threshold is set by the resistance at the Rp pin according to table2.

$$V_{OVP} \approx \frac{2 \times I_{out} \times L}{T_{ovp}}$$

LED Short Circuit Protection

When LED short circuit is detected, the system works at minimum frequency (Fop=5KHz), so the power consumption is low.

CS Resistor Short or Inductor Saturation

If these catastrophic fault conditions happen, the internal fast fault detection circuit will trigger and latch, the system stops switching immediately, the system VCC will be pulled down and charged up again, system working in a hiccup mode.

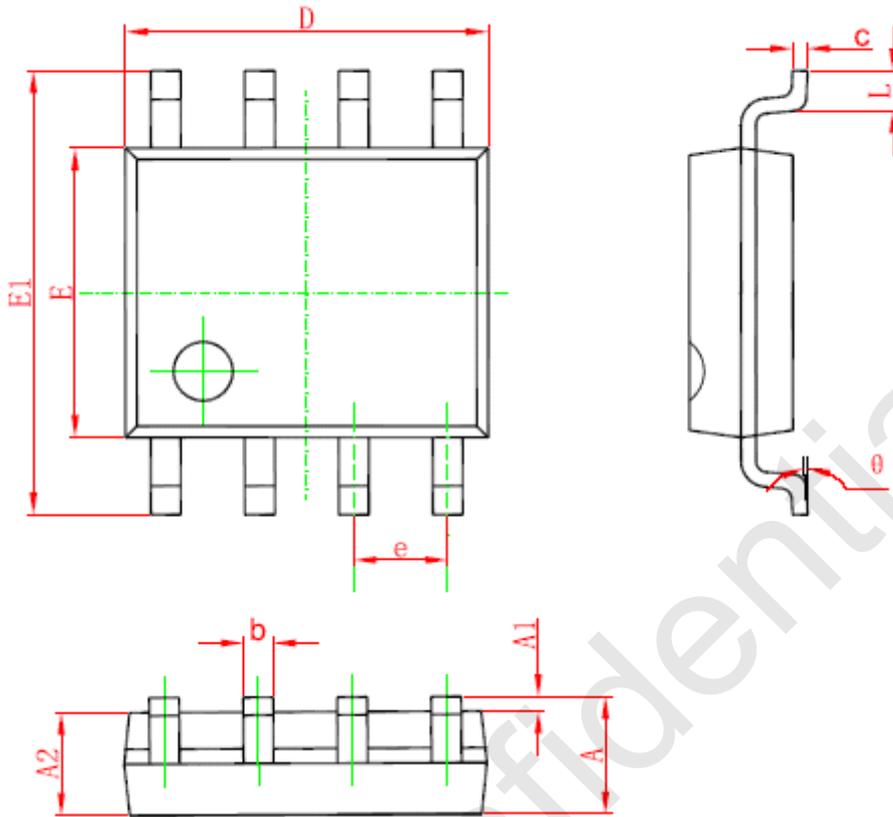
Over Temperature Compensation

FT887xx/FT8870 senses the die temperature after start up, and the thermal compensation threshold is set to 140°C. When FT887xx/FT8870 temperature rises and reaches the threshold, the output current will be reduced continually until the IC temperature stop rising. And when the IC temperature falls below the thermal compensation trigger point, the output current will recover to 100% of its designed target.

Over Temperature Protection

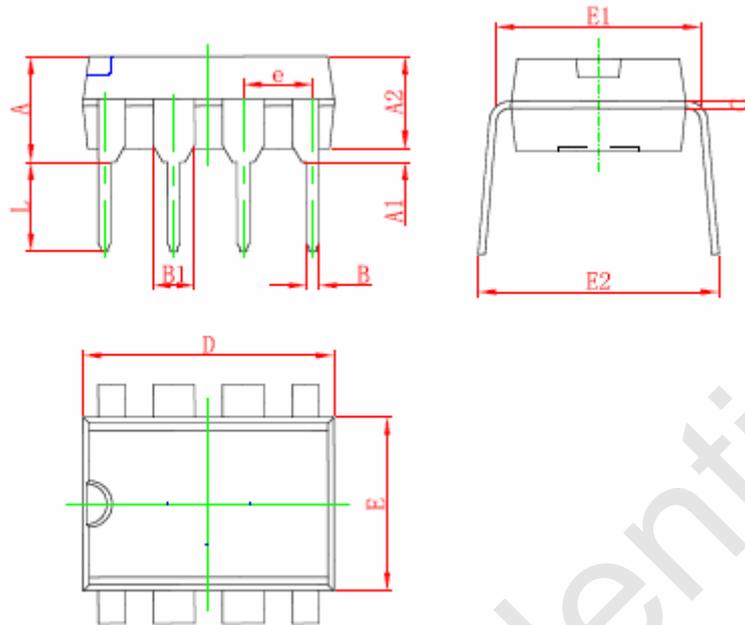
If temperature keeps rising beyond 150C even with temperature compensation described above, Over Temperature Protection will kick in. The OTP threshold is set to 150°C with 20°C hysteresis. When temperature reaches 150°C, FT887xx/FT8870 will stop switching until the IC temperature falls 20°C below the thermal protection trigger point.

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
theta	0°	8°	0°	8°

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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