High PF Non-Isolated Constant Current LED Driver

FEATURES

- High Power Factor: >90%
- High Current Accuracy: ± 3%
- High Efficiency: >90%
- Low BOM Cost
- Linear Dimming (FT8902x Only)
- ON-OFF Dimming (FT8901x Only, Vin=175~264Vac)
- Fixed Frequency 45kHz(Typical) Control
- ±4% Frequency Jittering to Simplify EMI Design
- Gate Output Voltage Clamp: 13.5V
- OVP, OCP, OTP, SCP

TYPICAL APPLICATIONS

- E26/27 LED Lamp
- T5/T8 LED Lamp
- Other Non-isolated LED Lighting Application

DESCRIPTION

The FT890xx is a non-isolated, low startup current, average current mode, active PFC and fixed frequency PWM controller. These functions enable the LED driver to easily meet the average LED current accuracy and high power factor requirements.

The CS pin senses inductor current and the COMP pin controls the duty cycle, forming the closed loop feedback control to achieve high accuracy and high line/load regulation.

The integrated protection functions include the LED short/open circuit protection and over temperature protection. To protect the external power MOSFET from being damaged by supply over voltage, the FT890xx DR pin voltage is clamped at around 13.5V.

FT890xB and FT890xDD integrate a 650V power MOS to reduce the LED system design complexity.

TYPICAL APPLICATION CIRCUIT

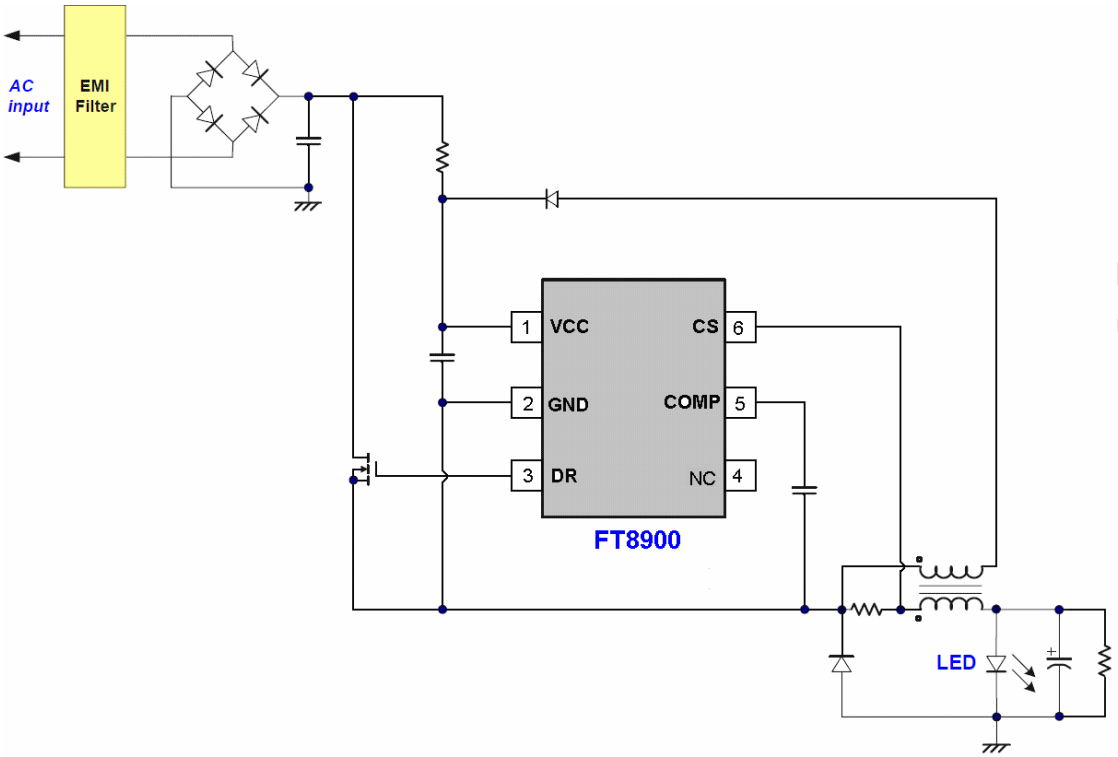


Figure 1: Typical Application Circuit for FT8900

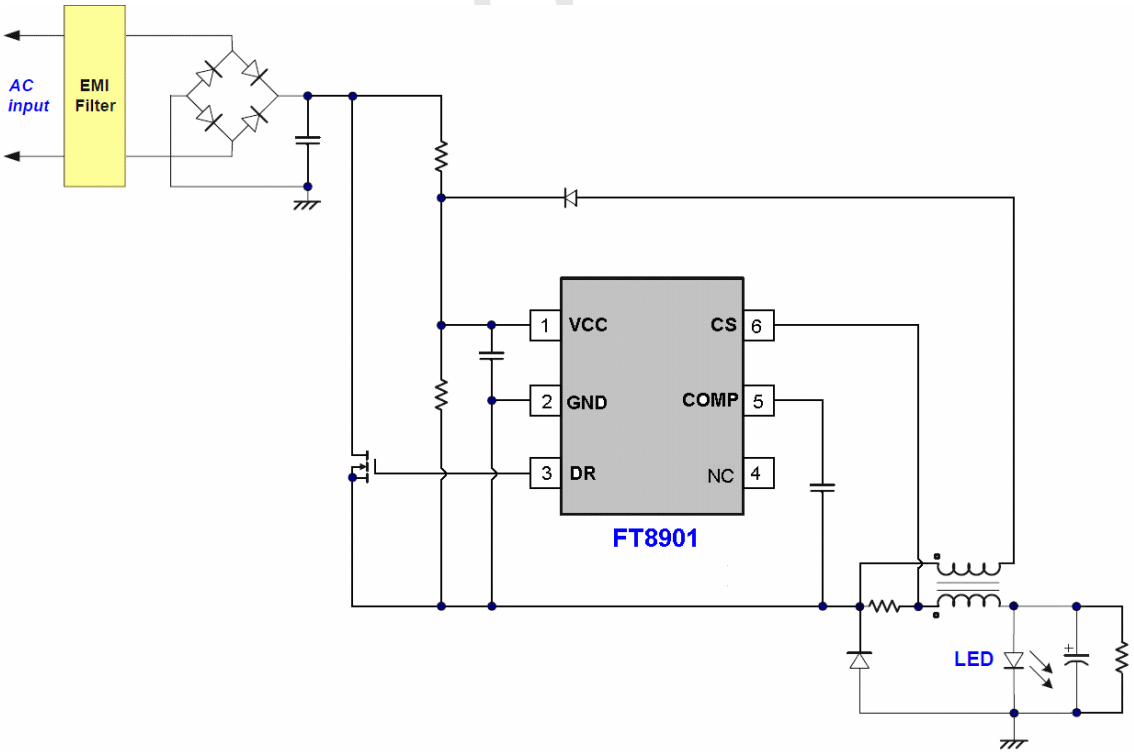


Figure 2: Typical Application Circuit for FT8901

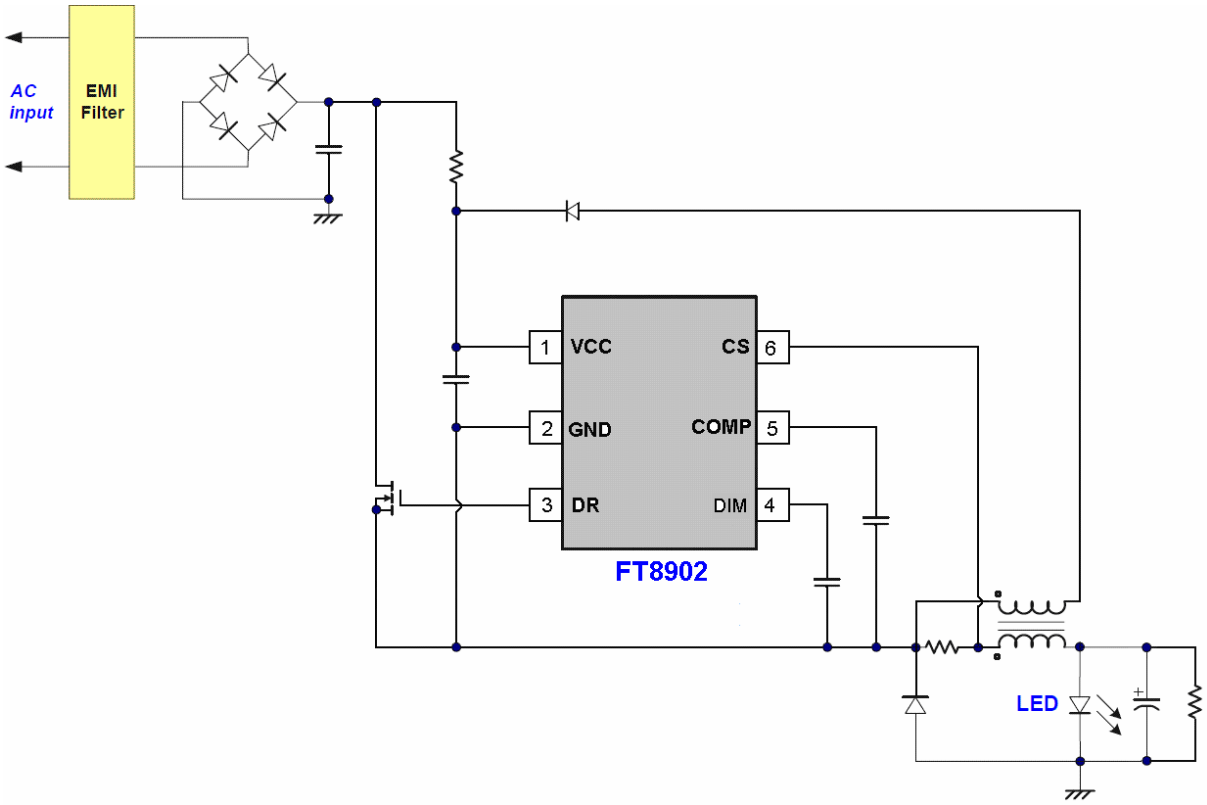


Figure 3: Typical Application Circuit for FT8902

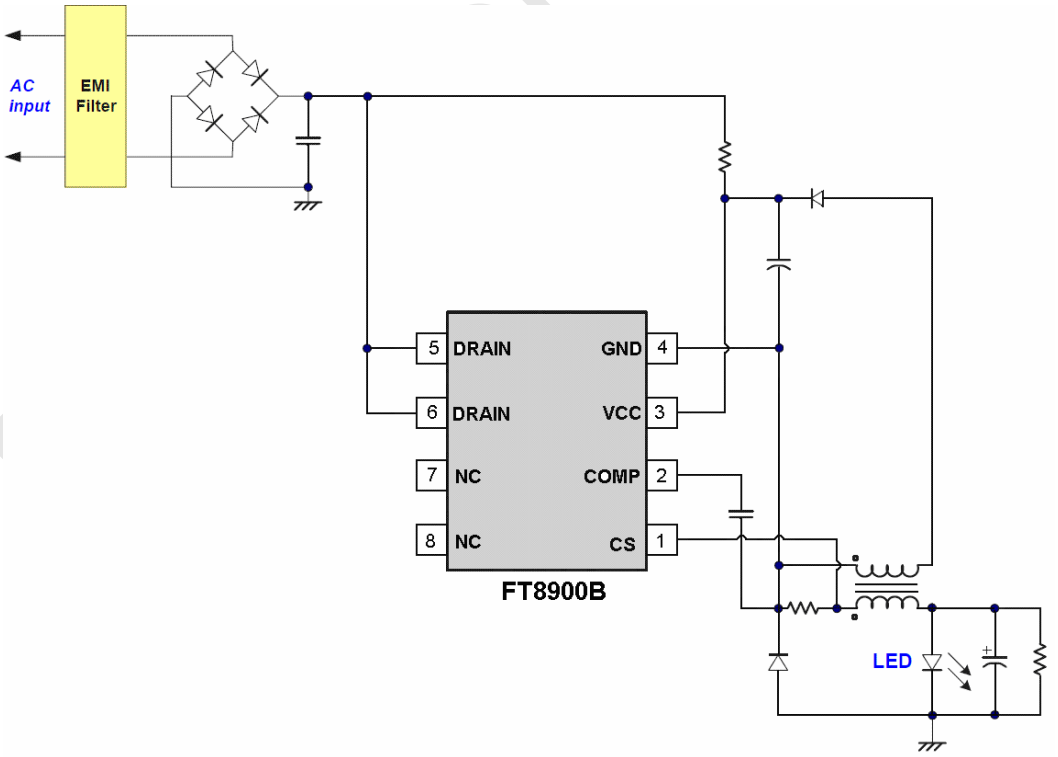


Figure4: Typical Application Circuit for FT8900B

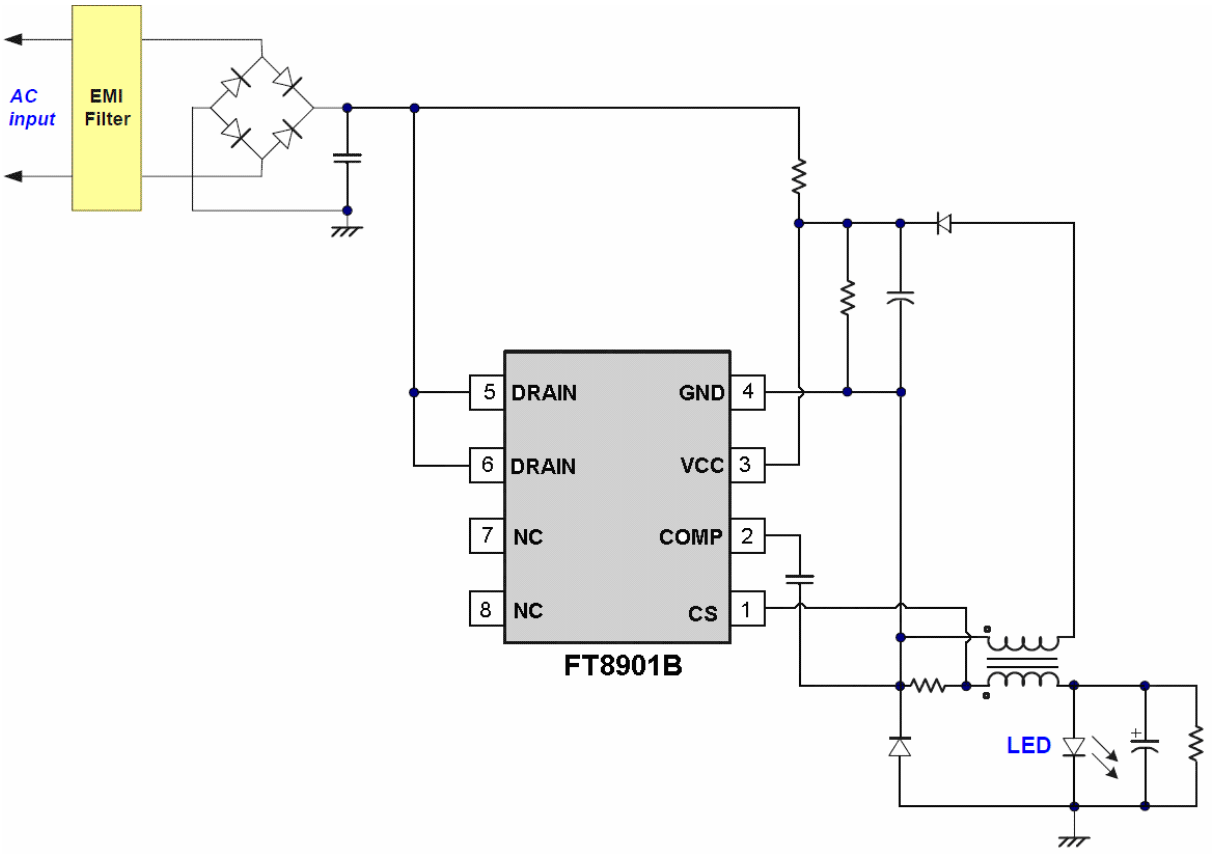


Figure5: Typical Application Circuit for FT8901B

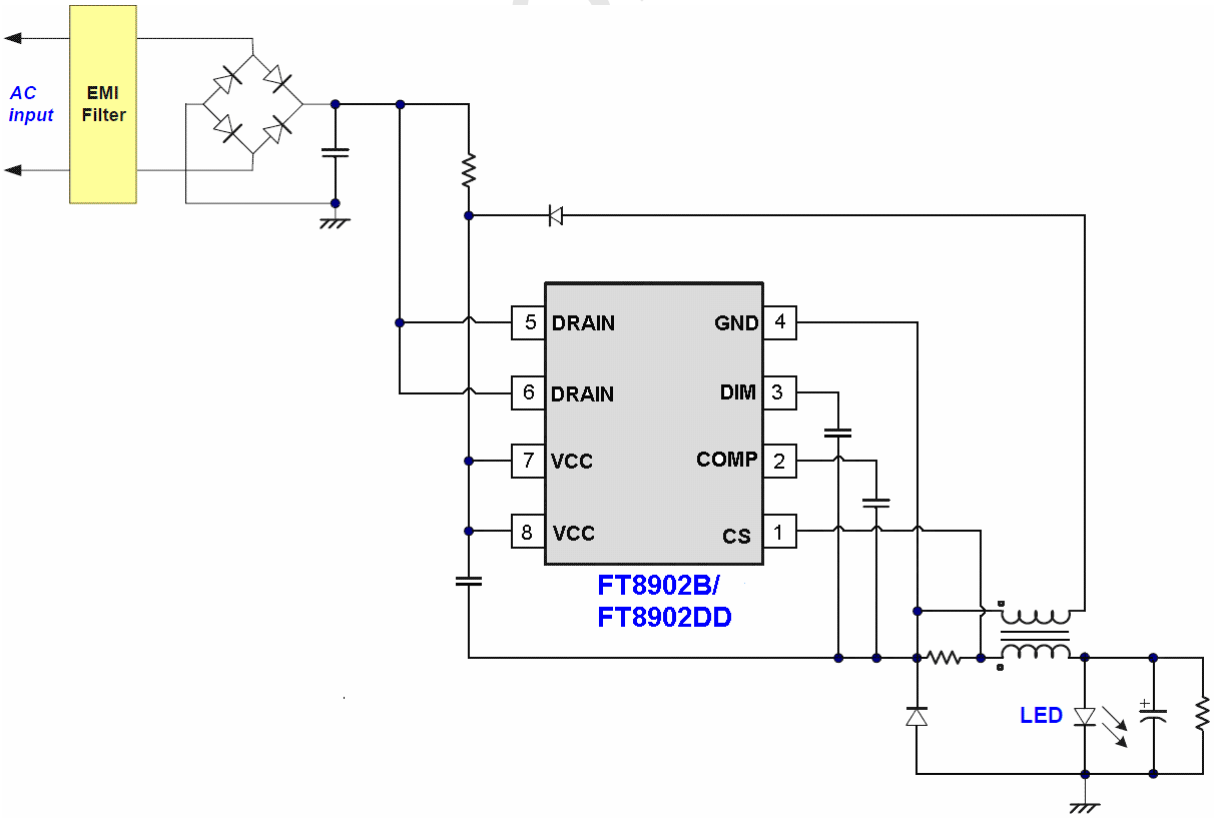


Figure6: Typical Application Circuit for FT8902B&FT8902DD

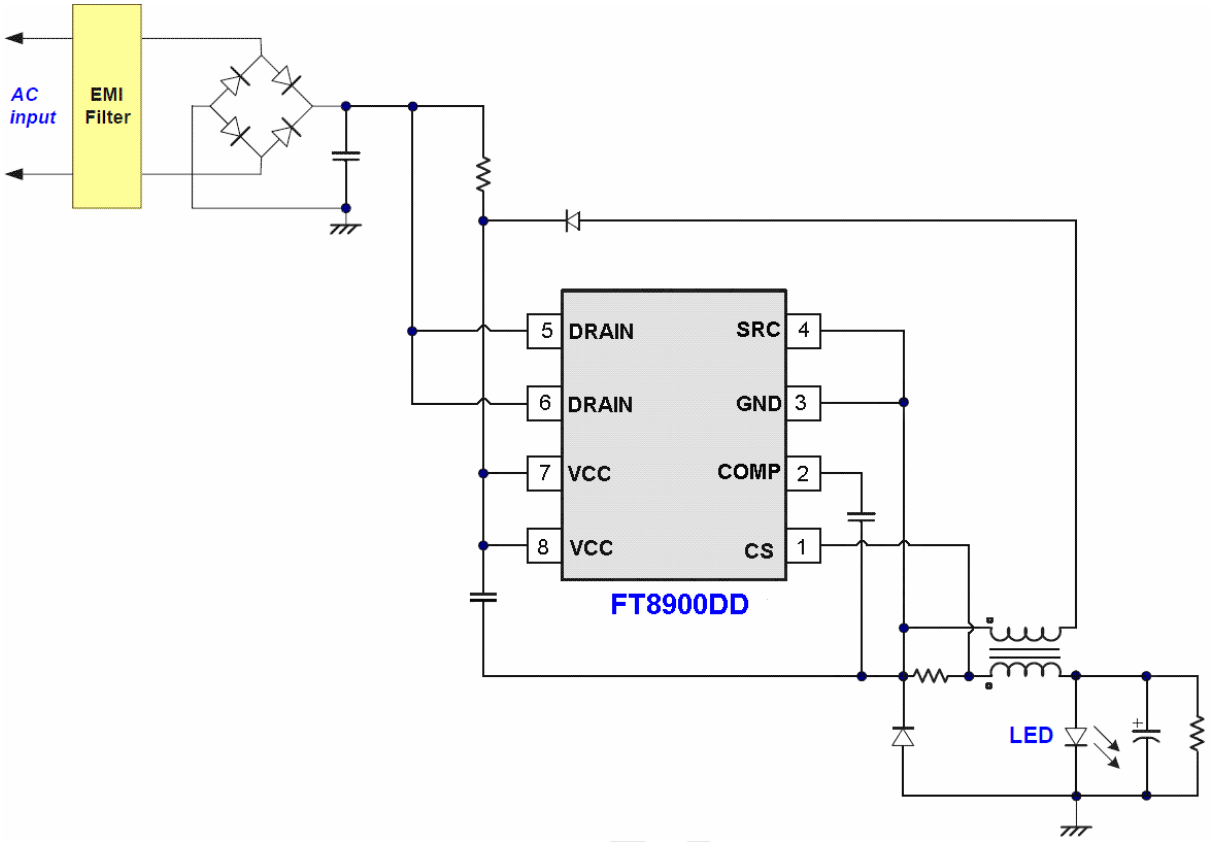


Figure7: Typical Application Circuit for FT8900DD

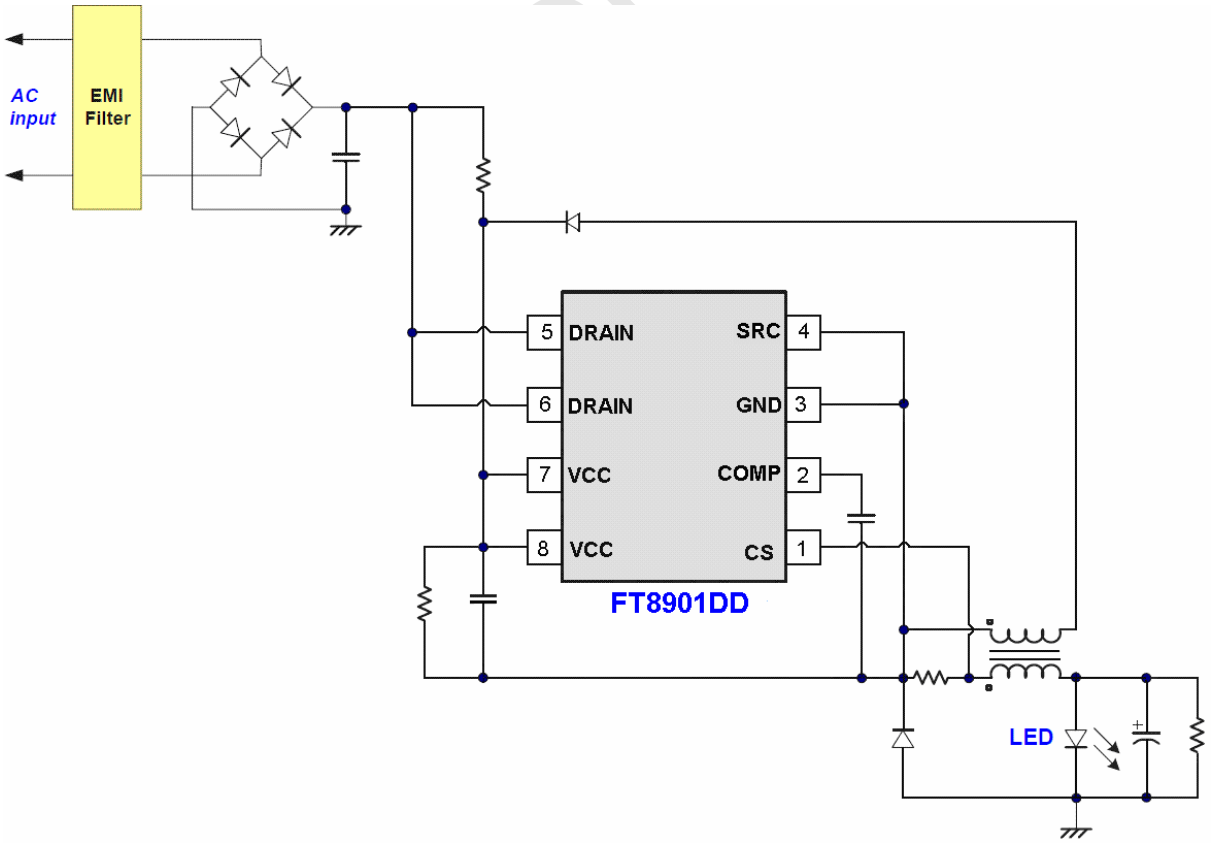


Figure8: Typical Application Circuit for FT8901DD

PIN COMFIGURATION

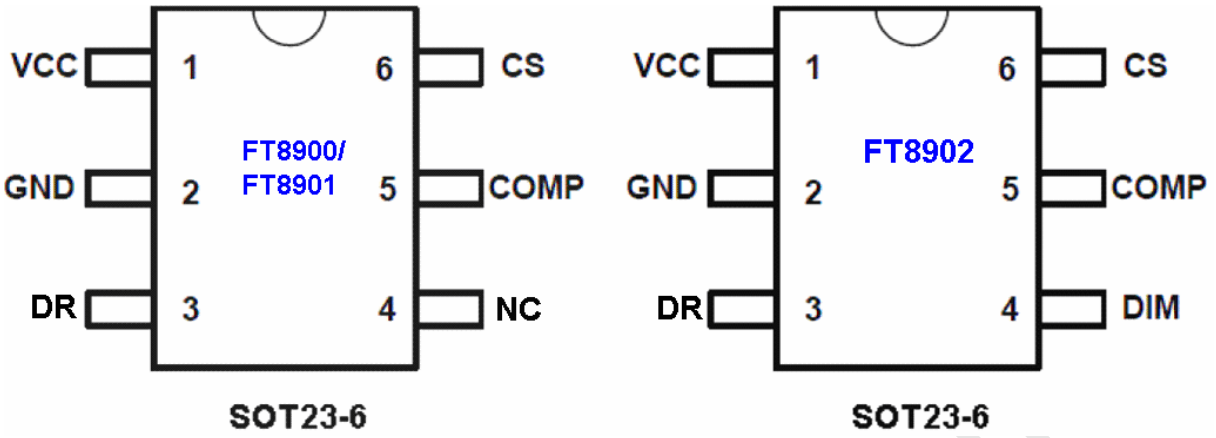


Figure9: Package Top View of FT8900/FT8901/FT8902

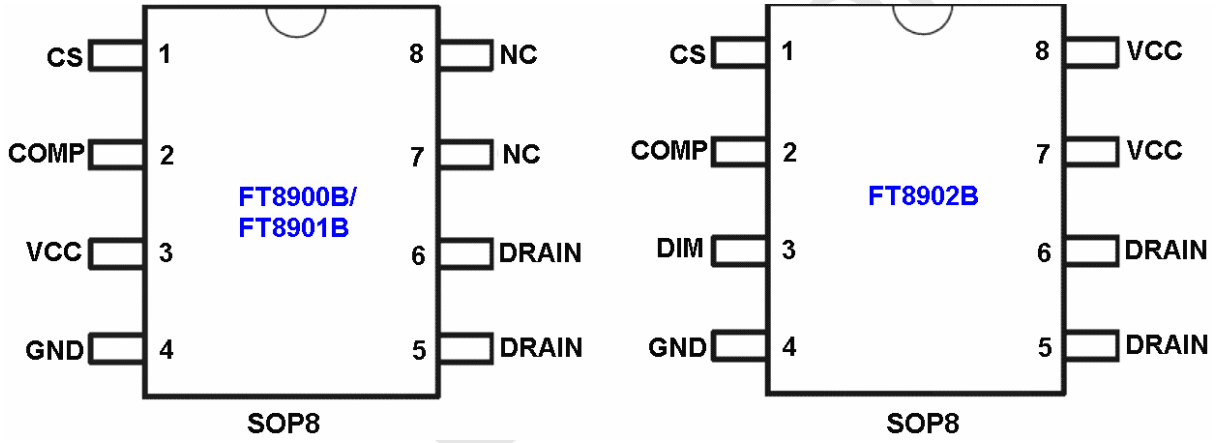


Figure10: Package Top View of FT8900B/FT8901B/FT8902B

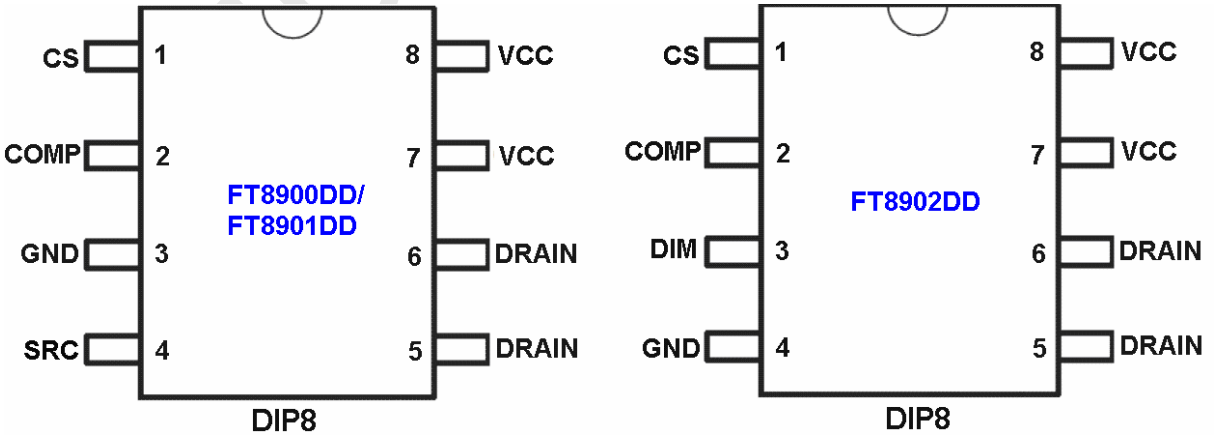


Figure11: Package Top View of FT8900DD/FT8901DD/FT8902DD

TERMINAL DEFINITION

Pin					Name	Description
FT8900/ FT8901	FT8902	FT8900B/ FT8901B	FT8902B/ FT8902DD	FT8900DD/ FT8901DD		
1	1	3	7, 8	7, 8	VCC	Power supply input
2	2	4	4	3	GND	Ground
3	3	/	/	/	DR	Output for driving the external MOSFET
/	4	/	3	/	DIM	Dimming control pin
5	5	2	2	2	COMP	Feedback loop compensation network
6	6	1	1	1	CS	Current sense pin to sense the output current
/	/	/	/	4	SRC	Source of power MOS
/	/	5, 6	5, 6	5, 6	Drain	Drain of power MOS

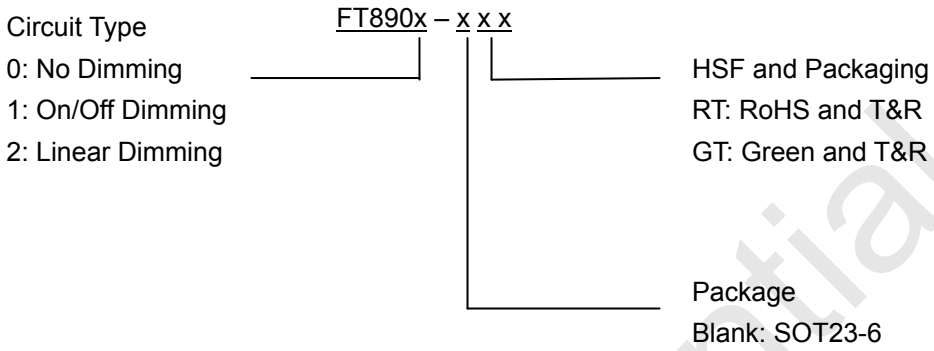
Table 1

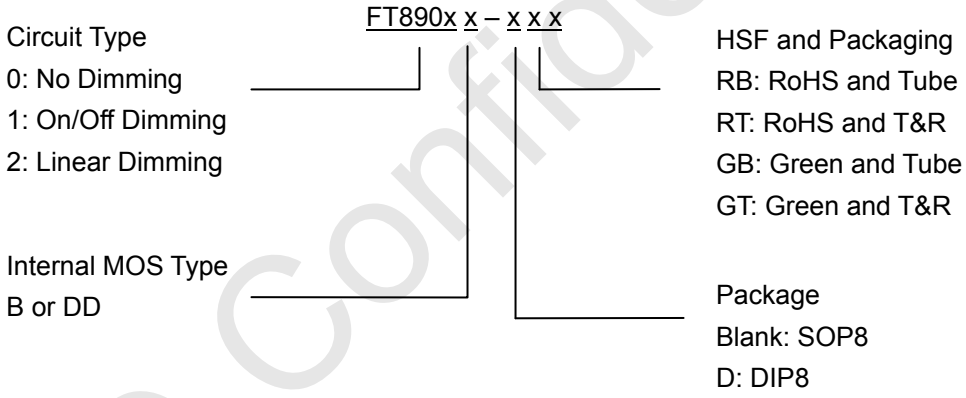
ABSOLUTE MAXIMUM RATINGS

VCC to GND……-0.3V to 27V
DIM, Comp, CS to GND…… -0.3V to 7V
SRC to GND……-0.3V to 5V
DR to GND……-0.3V to 15V
Drain to GND……-0.3V to 600V
Junction to Ambient Thermal Resistance of SOT23-6 (θ_{JA})……250℃/W
Junction to Ambient Thermal Resistance of SOP-8 (θ_{JA})…… 150℃/W
Junction to Ambient Thermal Resistance of DIP-8 (θ_{JA}). ……75℃/W
Operating Ambient Temperature Range…… -40℃ to +85℃
Junction Temperature……-40℃ to +150℃
Storage Temperature Range ……-55℃ to +150℃
ESD Voltage Protection, Human Body Model…….. 2KV
ESD Protection MM……200V
Lead Temperature (Soldering, 10sec) ……...260℃

Stresses 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 stresses above the Recommended Operating Conditions may affect device reliability.

ORDERING INFORMATION





Part No.	Dimming Method	Integrated MOS	AC Input (Vac)	Power	Package
FT8900	N/A	N/A	90~264	30W	SOT23-6
FT8901	On-Off Dimming	N/A	175~264	30W	SOT23-6
FT8902	Linear Dimming	N/A	90~264	30W	SOT23-6
FT8900B	N/A	650V, 2A	90~264	7W	SOP8
FT8901B	On-Off Dimming	650V, 2A	175~264	7W	SOP8
FT8902B	Linear Dimming	650V, 2A	90~264	7W	SOP8
FT8900DD	N/A	650V, 4A	90~264	18W	DIP8
FT8901DD	On-Off Dimming	650V, 4A	175~264	18W	DIP8
FT8902DD	Linear Dimming	650V, 4A	90~264	18W	DIP8

Table 2

MARKING RULE

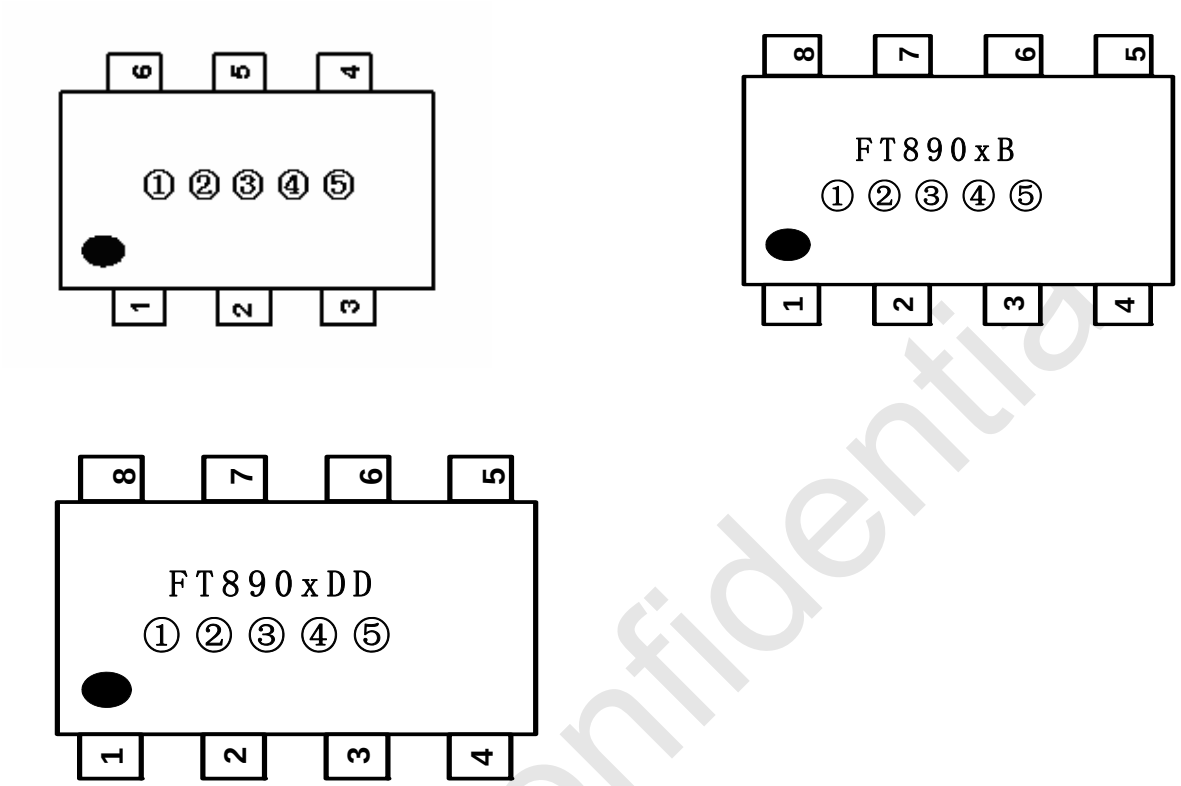


Figure 12 FT890xx marking rule

①②③④⑤ for internal reference

BLOCK DIAGRAM

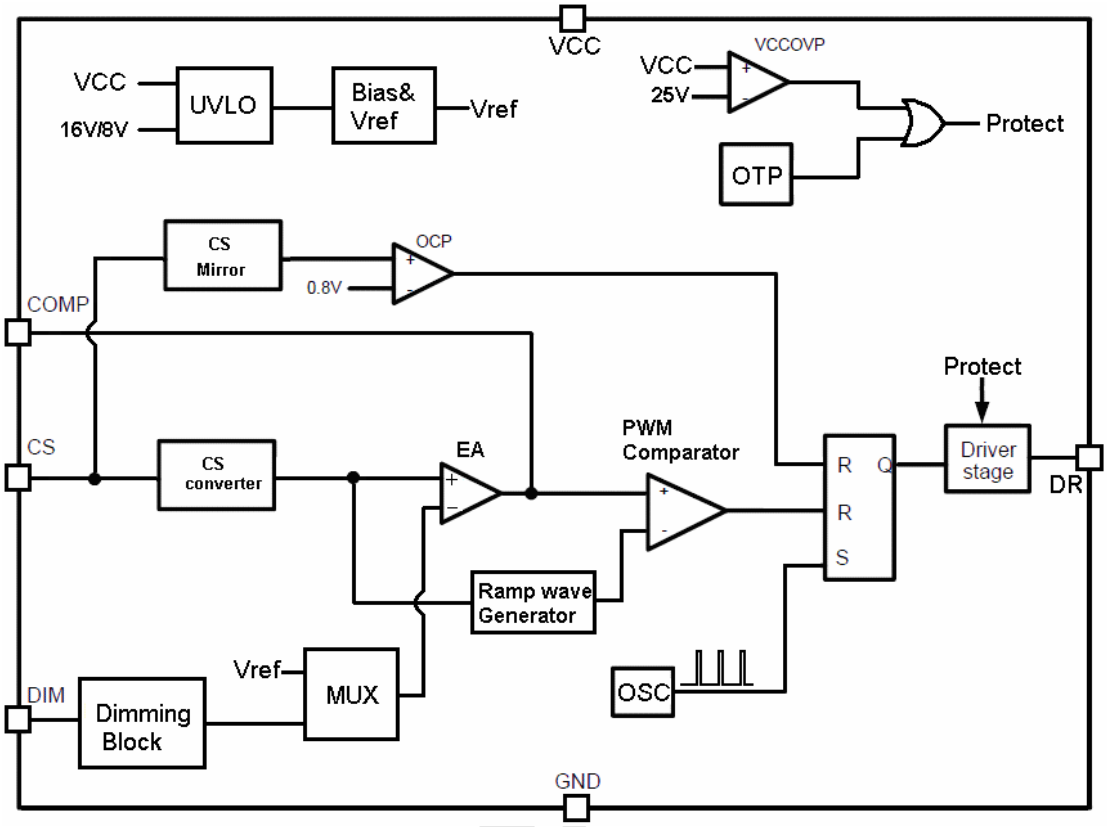


Figure 13: FT8900/FT8901/FT8902 Block Diagram

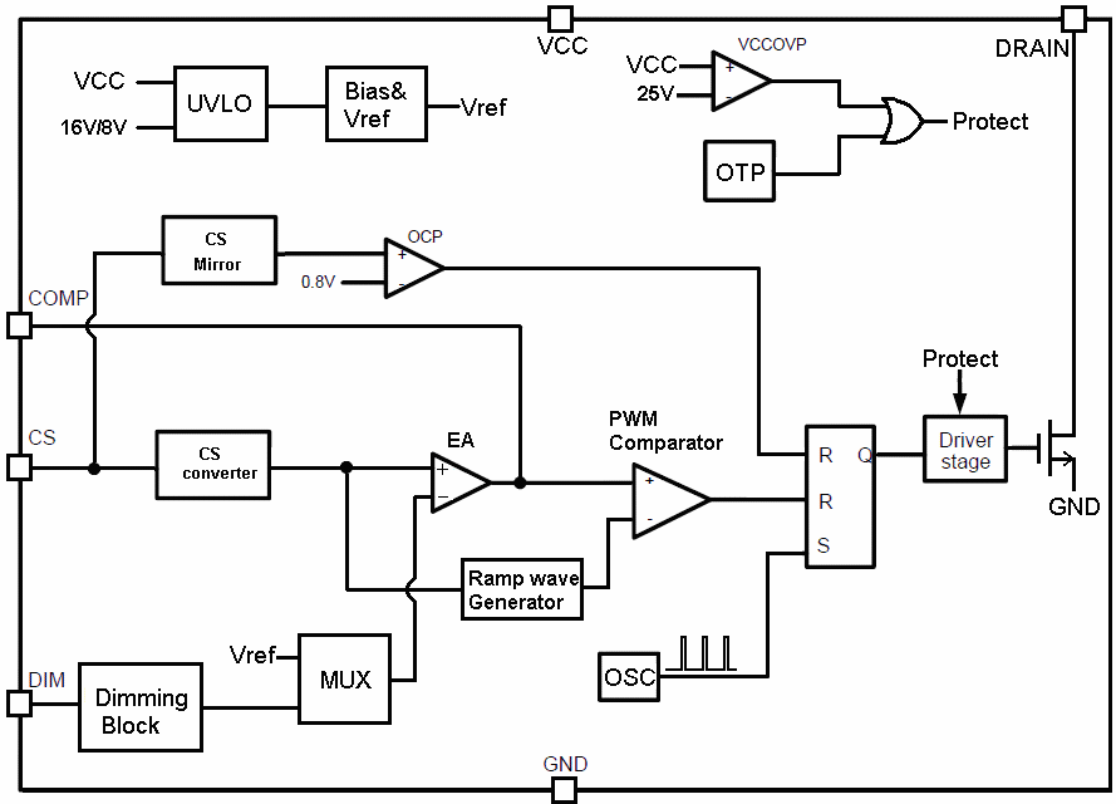


Figure 14: FT890xB/FT890xDD Block Diagram

ELECTRICAL CHARACTERISTICS

(V_{CC}= 16V, T_A = 25°C unless otherwise specified.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
SUPPLY VOLTAGE						
Startup Current	Istart	VCC=VCC_on-1		8	15	uA
Operating Current	Iop	Comp=2.5V, with 1nF load on Out pin		1.6	2.5	mA
Operating Current in protection mode (OVP, OTP, OCP)		with 1nF load on Out pin		600	750	uA
VCC off		VCC rising	7	8	9	V
VCC on		VCC falling	15	16	17	V
VCC Over Voltage Protection			23.7	25	26.3	V
CURRENT SENSE						
CS Feedback Reference Voltage	VCS		0.194	0.200	0.206	V
Tran-Conductance			60	80	100	uS
Output Sink Current				66		uA
Output Source Current				66		uA
CS Over Voltage Protection	OCP		0.72	0.8	0.88	V
Leading-Edge Blanking Time	T_{LEB}		400	500	600	nS
SWITCHING FREQUENCY						
Switching Frequency		No Jittering	42	45	48	KHz
Maximum Duty Cycle			90			%
Frequency Jitter Range				±4		%
Temperature Stability		T = -40~125			3	%
Voltage Stability		VCC = 9 ~ 22v			1	%
GATE DRIVER						
Ring Time	Trise	Load Capacitance=1nF		60	120	nS
Falling Time	Tfall	Load Capacitance=1nF		30	60	nS
DR Voltage Clamp	Vclamp	VCC=23		13.5	15	V
MOSFET (FT890xB)						
Static drain-source on-resistance	R_{DS_ON}	V_{GS}=10V,I_{DS}=0.5A		5.5		Ω
Drain-source breakdown voltage	BV_{DSS}	V_{GS}=0V,I_{DS}=250uA	650			V
Drain-source leakage current	I_{DSS}	V_{GS}=0V,V_{DS}=650V			10	uA
Maximum Drain Current	I_{DMAX}	Vd=3V	0.6	0.7		A

MOSFET (FT890xDD)						
Static drain-source on-resistance	R_{DS_ON}	V_{GS}=10V,I_{DS}=0.5A		2.6		Ω
Drain-source breakdown voltage	BV_{DSS}	V_{GS}=0V,I_{DS}=250uA	650			V
Drain-source leakage current	I_{DSS}	V_{GS}=0V,V_{DS}=650V			10	uA
Maximum Drain Current	I_{DMAX}	Vd=3V	1.0	1.1		A
Linear DIMMING SECTION						
Linear DIM Current Source		FT8902X	290	300	310	uA
Linear Dimming Range		FT8902X	0.3		3.0	V
LED Cut Off Threshold Voltage		FT8902X			0.2	V
Saturation Threshold Voltage		FT8902X	3.3			
ON-OFF DIMMING SECTION						
On-off Dimming level 2		FT8901X		50		%
On-off Dimming level 3		FT8901X		25		%
Time interval of On-off Dimming		FT8901X, Rvcc=470k, Cvcc=10uF			2	S
Time interval of Shutdown		FT8901X, Rvcc=470k, Cvcc=10uF	5			S
OTP SECTION						
Over Temperature Protection			140	150	160	℃
OTP Release Point			120	130	140	℃

Table 3

APPLICATION INFORMATION

Start-up Current

The typical start-up current is very low at around 8uA. It allows the use of high resistance value for the start-up resistor, reducing the power dissipation.

UVLO (Under Voltage Lockout)

A UVLO comparator with built-in hysteresis is implemented in FT890xx with turn-on and turn-off thresholds set at 16V and 8V respectively. The hysteresis ensures that the start-up capacitor is adequate to supply the chip during start-up. To ensure the quick startup, the start-up resistor shall be matched with the startup capacitor. The input capacitor reduces input voltage ripple to the converter; a 4.7uF~10uF ceramic capacitor is recommended for most applications.

High Accuracy Constant Current Control

The CS Pin senses inductor current and the COMP pin controls the duty cycle, forming the closed loop feedback control to achieve high current accuracy and excellent line/load regulation.

Oscillator

FT890xx works in PWM control mode with an internally set fixed frequency of 45kHz. The maximum duty-cycle of internal oscillator is up to 90% for driving high LED voltage. The built-in frequency jittering reduces EMI.

LEB (Leading-Edge Blanking)

Each time the power MOSFET is switched on, a turn-on spike will inevitably occur acorss the sense resistor. To avoid false trigger, a 500ns 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.

OVP (Over Voltage Protection) on VCC

To prevent the LED driver from being damaged, OVP on VCC is implemented. When VCC voltage is higher than the OVP threshold voltage 25V, the output gate driver circuit will be shut down immediately to stop the switching of power MOSFET. When OVP condition occurs, switching will be stopped and will recovery only when VCC voltage drops below the UVLO off level. The auto-recovery operation is illustrated in Fig.15.

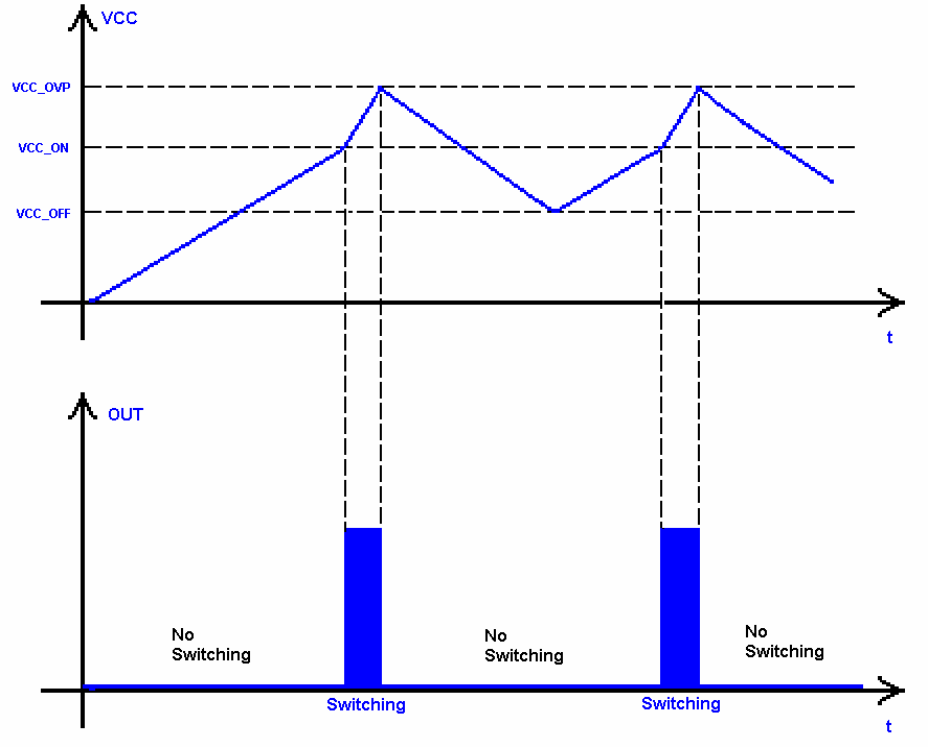


Figure 15 OVP Waveform

OCP (Over Current Protection)

The FT890xx has the over current protection function built in. An internal circuit detects the power MOS current level, when the current is larger than a threshold level, the gate output will switch off immediately until next cycle.

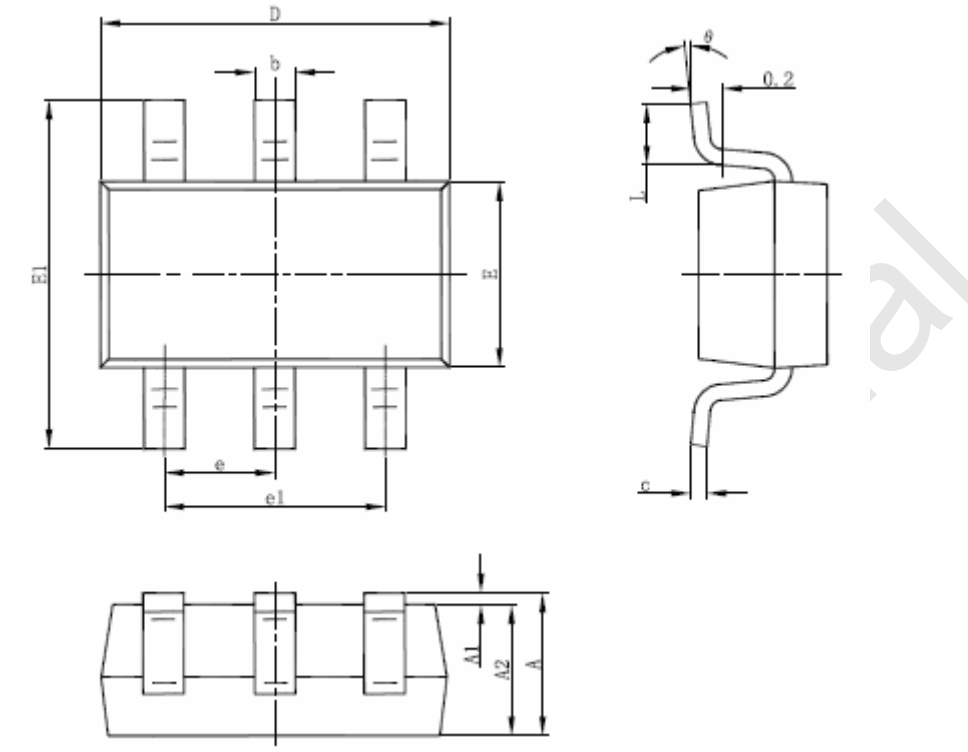
Gate Clamp/Soft Driving

Driver output is clamped at 13.5V by an internal clamping circuit, eliminating the damages that usually come from undesired over-voltage gate signals. The FT890xx's soft driving function minimizes EMI.

Dimming Function

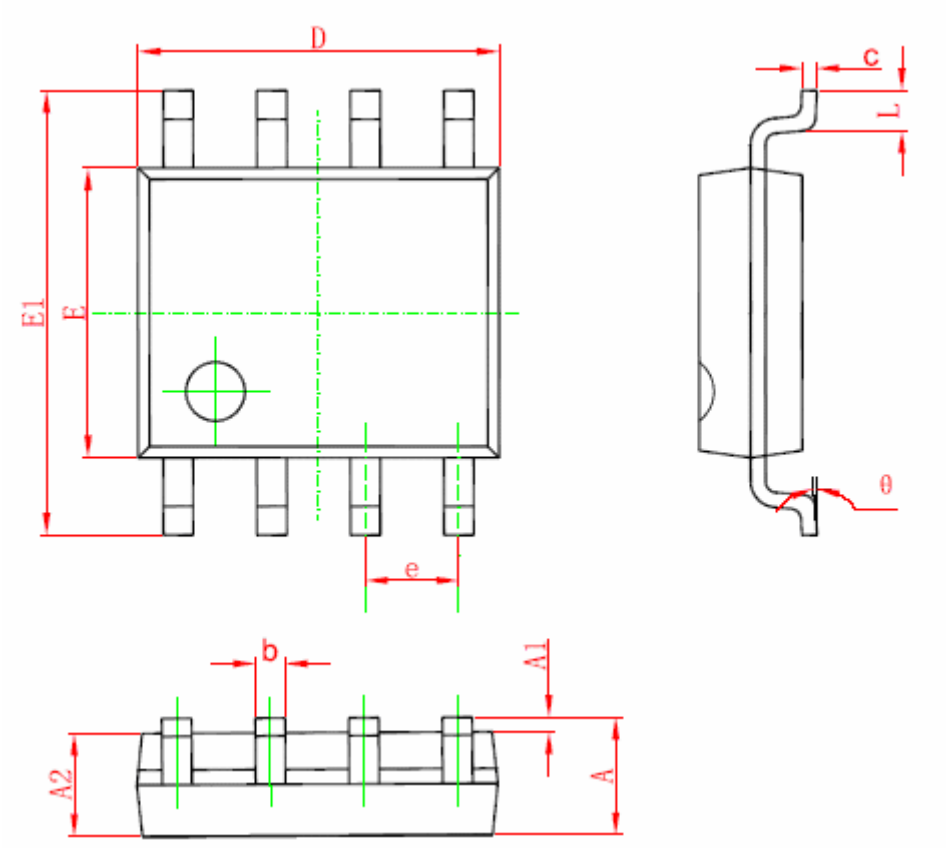
Dimming functions are optional in FT890xx. On-off dimming is available in FT8901/FT8901B/FT8901DD, including 3 dimming level: 100%, 50%, and 25%. Linear dimming is available in FT8902/FT8902B/FT8902DD. When the voltage on DIM pin is lower than 0.2V, the FT8902x will shut down. When the voltage is in the range of 0.3 to 3.0V, the FT8902X operates in the linear dimming range. When the voltage is higher than 3.3 V, the FT8902x operates on the normal status or 100% output level. The DIM Pin can be left open if the linear dimming function is not needed.

SOT23-6 Package



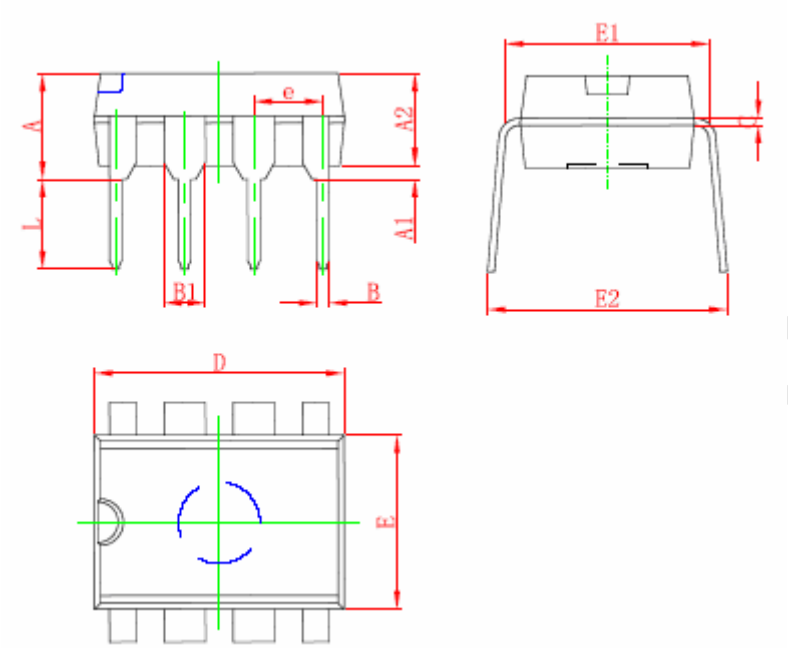
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 (BSC)		0.037（BSC）	
e1	1.800	2.000		0.079
L	0.300	0.600		0.024
θ	0°	8°	0°	8°

SOP8 Package



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°

DIP8 Package



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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