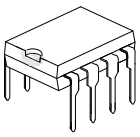
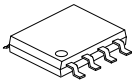
USL250X

CMOS IC

HIGH PRECISION NON-ISOLATED POWER SWITCH



DIP-8



SOP-8

■ DESCRIPTION

USL250X offers comprehensive protection coverage with auto-recovery features including LED string short circuit protection, cycle-by-cycle current limiting, built-in leading edge blanking, V_{DD} under voltage lockout (UVLO), over temperature protection(OTP), etc.

Cycle-by-Cycle current limiting is offered in **USL250X**. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial power MOSFET on state so that the external RC filtering on sense input is no longer needed.

It is a high current precision, non-isolated power switch for LED lighting. It works under transition mode. The LED lighting system design by eliminating the auxiliary winding inductance and works under low current. A 500V power switch is also integrated into the device. The LED current can be adjusted externally by the sense resistor Rs at CS pin and high precision constant current regulation is realized.

■ FEATURES

* High precision constant current regulation at universal AC input
* Support system application with PF>0.7 and no flicking
* Sense and supply without auxiliary winding inductance
* Low system cost and high efficiency
* Low operation current
* Programmable CC regulation
* Transition mode operation
* LED string short circuit protection
* Cycle-by-Cycle current limiting
* Built-in Leading Edge Blanking (LEB)
* V_{DD} Under Voltage Lockout with Hysteresis
* Over temperature protection (OTP)

■ ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
USL2500L-S08-R	USL2500G-S08-R	SOP-8	Tape Reel
USL2502L-D08-T	USL2502G-D08-T	DIP-8	Tube

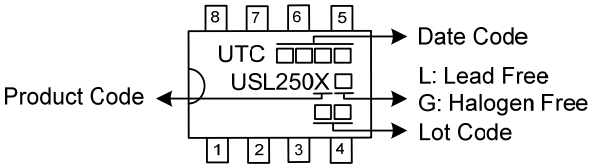
USL250XG-S08-R

(1)Packing Type
(2)Package Type
(3)Green Package
(4)Product Code

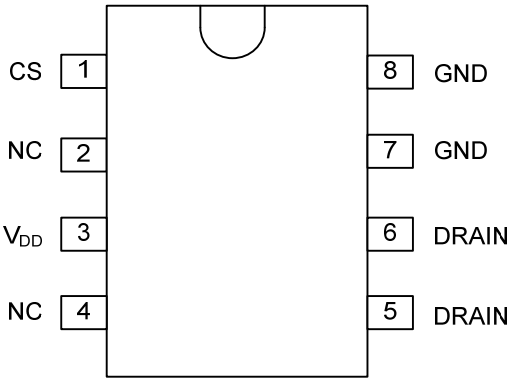
(1) R: Tape Reel, T: Tube
(2) S08: SOP-8, D08: DIP-8
(3) G: Halogen Free and Lead Free, L: Lead Free
(4) refer to ORDERING INFORMATION

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■ MARKING



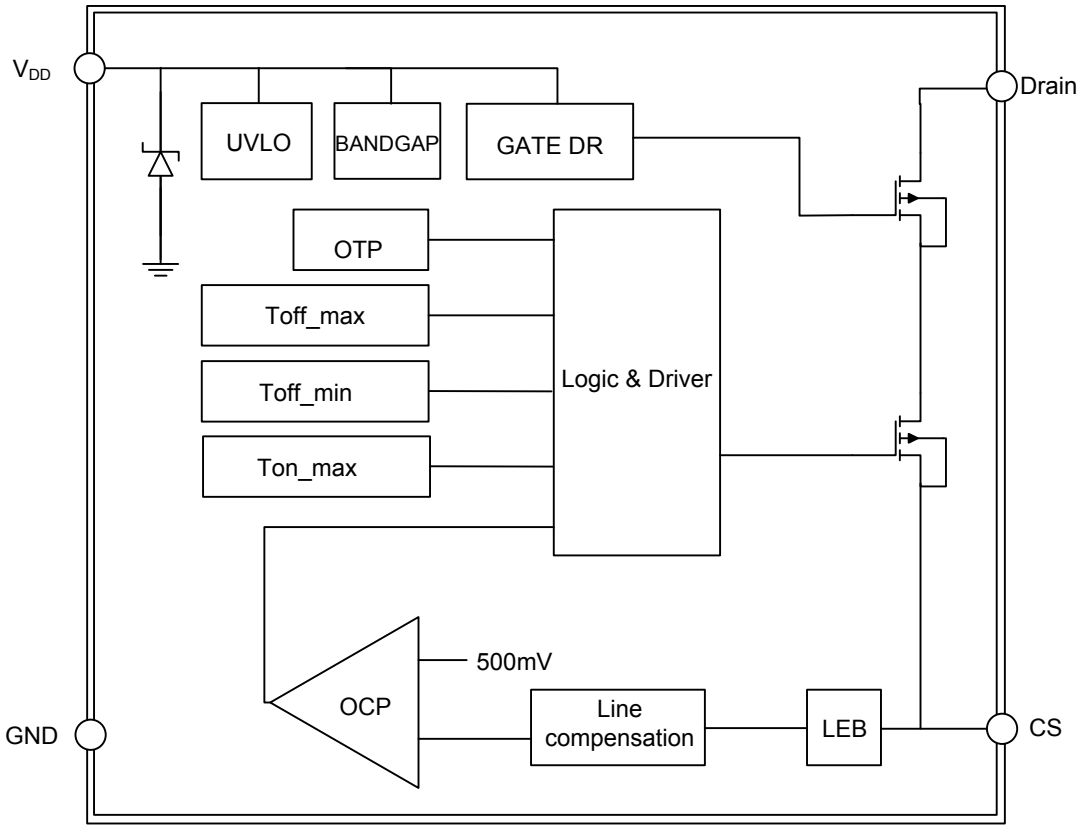
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN NO.	PIN NAME	DESCRIPTION
1	CS	Current sensing terminal
2	NC	No Connection
3	V_{DD}	Power supply Input
4	NC	No connection
5	Drain	MOSFET Drain Terminal
6	Drain	MOSFET Drain Terminal
7	GND	Power Ground, suggest to be left floating with no pad in PCB layout.
8	GND	Power Ground, suggest to be left floating with no pad in PCB layout.

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATING (T_A=25°C, unless otherwise specified)

PARAMETER	SYMBOL	RATINGS	UNIT
VDD Voltage	V_{DD}	-0.3 ~ 20	V
DRAIN Voltage	I_{DR}	-0.3 ~ 500	V
CS Input Voltage	V_{CS}	-0.3 ~ 7	V
Min/Max Operating junction Temperature T_J	T_A	-40 ~ +150	°C
Min/Max Storage Temperature T_A	T_S	-55 ~ +150	°C
Operating Ambient Temperature	T_{OPR}	-40 ~ +85	°C

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ OPERATING RANGE

PARAMETER	SYMBOL	RATINGS	UNIT
Input Voltage	V_{IN}	8 ~ 10.5	V
Ambient Temperature	T_A	-40 ~ +105	°C
Junction Temperature	T_J	-40 ~ +125	°C

■ ELECTRICAL CHARACTERISTICS (T_A=25°C, V_{CC}=12V, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY SECTION						
Start up current	$I_{START-UP}$	V_{DD}=$U_{VLO(OFF)}$-1V		170	200	uA
Operation current	I_{OPER}	V_{DD}=11.5V, No Loading		145	210	uA
V_{DD} under voltage lockout exit	$U_{VLO(ON)}$			11		V
V_{DD} under voltage lockout enter	$U_{VLO(OFF)}$			8.5		V
V_{DD} CLAMP	V_{DD_CLAMP}	V_{DD} current 1mA		12.5		V
CURRENT SENSE INPUT SECTION						
LEB time	T_{LEB}			0.4		uS
Over current threshold	V_{TH_OCP}		485	500	515	mV
OCP propagation delay	T_{D_OC}	From OCP comparator to gate drive		100		nS
Maximum off time	T_{OFF_MAX}			50		uS
Minimum off time	T_{OFF_MIN}			5		uS
Maximum on time	T_{ON_MAX}			30		uS
SOURCE DRIVE SECTION						
Source drive low side on resistor	$R_{DS(ON)_LOW}$			1.3		Ω
OTP SECTION						
Over temperature protection	OTP			150		°C
POOWER MOSFET SECTION						
MOSFET Drain-Source Breakdown Voltage	BV_{DSS}		500			V
On resistance	$R_{DS(ON)}$	USL2502		5		Ω
		USL2500		18		Ω

■ OUTPOUT POWER TABLE

PARAMETER		TEST CONDITIONS		RATINGS	UNIT
Output Power	USL2500	90Vac~264Vac Input	I_{LED}＜200mA	18	W
	USL2502		I_{LED}＜350mA	14	W
	USL2500	220Vac±20% Input	I_{LED}＜200mA	29	W
	USL2502		I_{LED}＜350mA	19	W

■ OUTPOUT DESCRIPTION

USL250X is ahigh current precision, non-isolated power switch for LED lighting working under transition mode. It significantly simplifies the LED lighting system design by eliminating the auxiliary winding inductance and works under low current. A500V power switch is also integrated into the device.

Start up Control

Startup process is realized by charging V_{DD} capacitor. When V_{DD} voltage reaches up to $U_{VLO(OFF)}$, the inner circuit works. A12.5V typical) clamp circuit is applied to clamp V_{DD} voltage. At work state, no auxiliary winding inductance is necessary.

Principle of CC Operation

For buck type operating in transition mode, the peak voltage of CS is detected cycle-by-cycle, and compared with internal reference voltage, V_{TH_OCP} (typical value 500mV). When the voltage at CS pin is up to the threshold voltage, thepower switch will be turned off.

$$I_{PK} = \frac{V_{TH_OCP}}{R_{CS}}$$

Where, RCS indicates the resistor at CS pin for primary side current sensing. Refer to the equation 1, LED output current is

$$I_{LED} = \frac{I_{PK}}{2} = \frac{V_{TH_OCP}}{2 \times R_{CS}}$$

USL250X works under transition mode and the on-time for power switch is

$$T_{ON} = \frac{L \times I_{PK}}{V_{IN} - V_{LED}}$$

Where L is the inductor of transformer at primary-side winding,Vin is line voltage after rectifying and VLED is the voltage at LED.

When power switch turns off, the current flowing in the inductor will reduce to zero and the power switch will turn on after then. The off-time for power switch is

$$T_{OFF} = \frac{L \times I_{PK}}{V_{LED}}$$

The inductor could also be calculated by

$$L = \frac{V_{LED} \times (V_{IN} - V_{LED})}{F \times I_{PK} \times V_{IN}}$$

Where, F is the working frequency. The working frequency changes with input voltage. The lowest input voltage determines the lowest working frequency and the highest input voltage determines the highest working frequency.

The minimum and maximum off-time are set in **USL250X**. Therefore, the value of inductor should be carefully designed to achieve good LED output current, according to equation4.

Inner Line Compensation

USL250X provides internal line compensation, therefore no outside sensing devices are needed. The compensated voltage is added to CS voltage cycle-by-cycle and LED output current is kept constant under different line voltage.

■ OUTPOUT DESCRIPTION (Cont.)

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in **USL250X**. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial power MOSFET on state so that the external RC filtering on sense input is no longer needed.

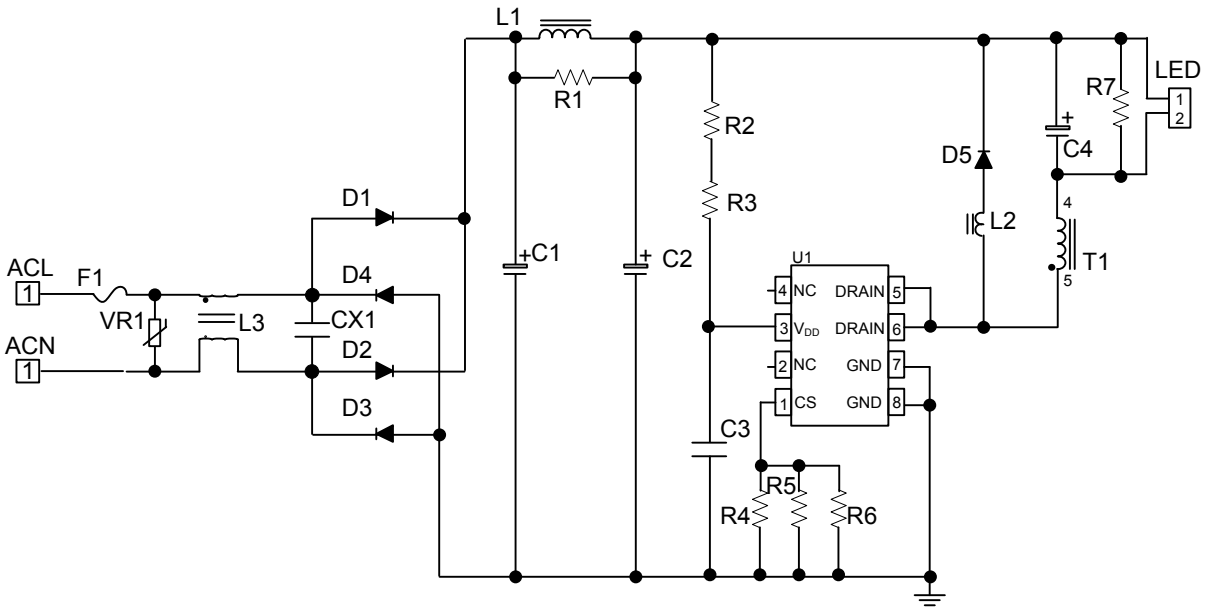
Protection

USL250X offers comprehensive protection coverage with auto-recovery features including LED string short circuit protection.

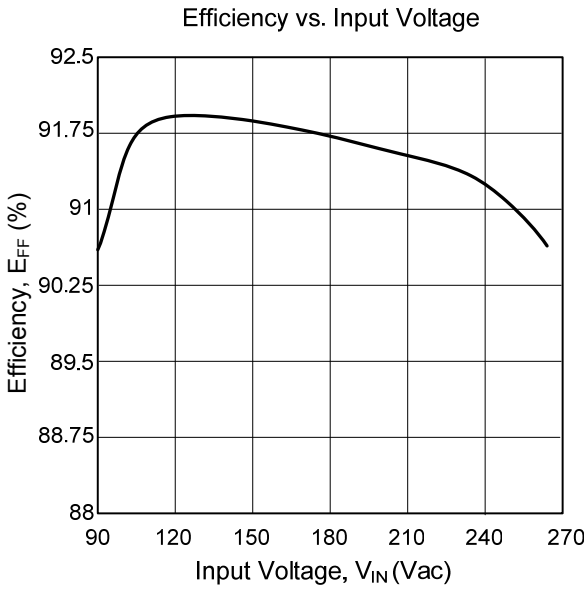
USL250X detects the states of LED. When LED string short circuit occurs, the switching frequency is reduced to the minimum switching frequency with maximum T_{OFF} time. **USL250X** resumes normal operation after the fault condition is removed.

Over temperature protection is offered in **USL250X**. When temperature rises above 150°C (typical), switching will be stopped. The normal operation is resumed until the temperature falls below 100°C (typical).

■ TYPICAL APPLICATION CIRCUIT



■ TYPICAL CHARACTERISTICS



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