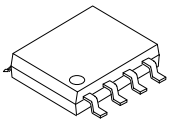
UCL2310

CMOS IC

PSR SINGLE-STAGE APFC OFFLINE LED CONTROLLER



SOP-8

■ DESCRIPTION

The UTC **UCL2310** is a high precision primary-side regulation PWM controller with single stage Active PFC, specially designed for universal input offline flyback or buck-boost constant current LED lighting. The controller with on-chip PFC circuit achieves high power factor and low THD. Operating in critical conduction mode, the power MOSFET switching loss is reduced and the inductor is fully utilized.

The UTC **UCL2310** adopts proprietary primary side current sensing scheme. It can precisely control the LED current without secondary side sense and feedback circuits. The system size and cost are optimized, as well as the system reliability.

The UTC **UCL2310** utilizes patented line and load voltage compensation method to achieve excellent line and load regulation. And the line compensation factor can also be tuned externally for flexibility.

The UTC **UCL2310** offers rich protection functions to improve the system reliability, including LED open circuit protection, LED short circuit protection, V_{CC} over voltage protection, V_{CC} under voltage protection, CS resistor open protection and cycle by cycle current limit. All the protection functions are auto-recovery. The system reliability is further improved by the thermal regulation function. The output current is reduced when the controller is over temperature.

■ FEATURES

* Single-Stage Active PFC for High Power Factor and Low THD
* Primary Side Control Constant Current Operation, No Opto-Coupler required
* ±3% LED Current Accuracy
* Excellent Line and Load Regulation
* Critical Conduction Mode Operation
* Ultra-Low (33uA) Startup Current
* High Resistance Feedback Resistor for Improved Efficiency
* LED Open and Short Circuit Protection
* CS Resistor Open Circuit Protection
* Cycle-by-Cycle Current Limit
* V_{CC} Over-voltage and Under-voltage Protection
* Auto Fault Recovery
* Thermal Regulation Function

■ ORDERING INFORMATION

Ordering Number	Package	Packing
UCL2310G-S08-R	SOP-8	Tape Reel

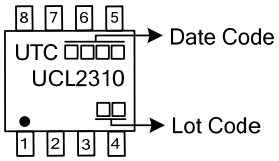
UCL2310G-S08-R

(1)Packing Type — (1) R: Tape Reel

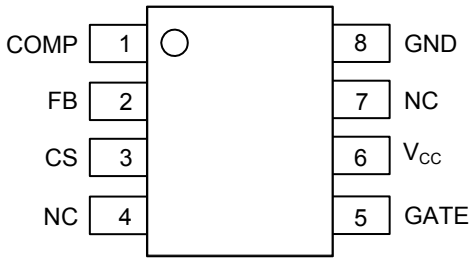
(2)Package Type — (2) S08: SOP-8

(3)Green Package — (3) G: Halogen Free and Lead Free

■ MARKING



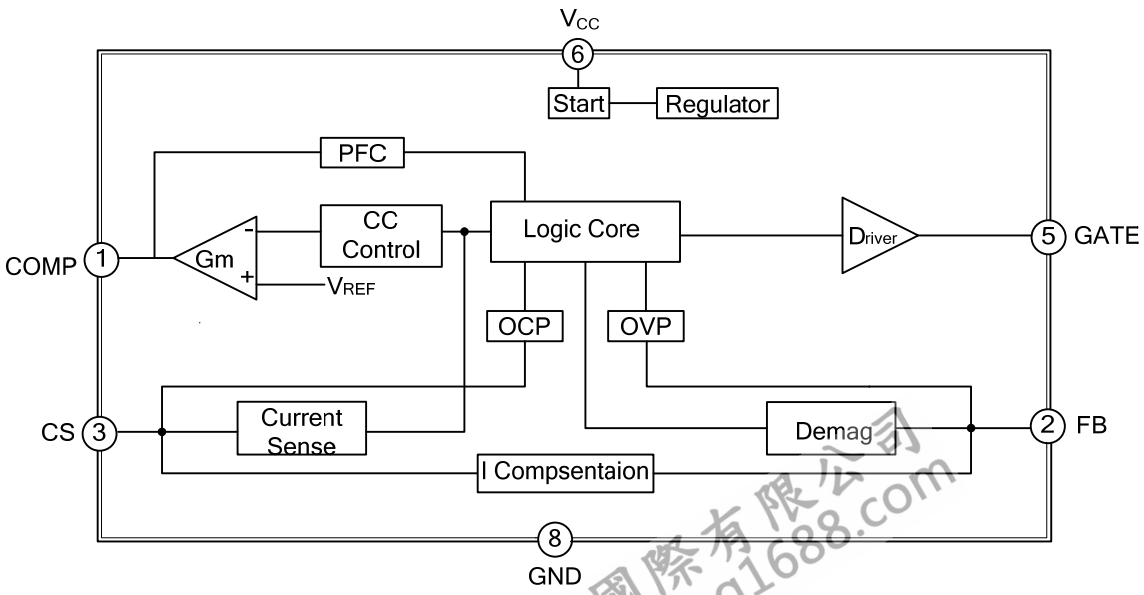
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN No.	PIN NAME	Description
1	COMP	Loop Compensation Node. This pin connects a capacitor to GND for stabilization of the control loop, achieving accurate LED current, high Power Factor and low THD.
2	FB	Feedback Voltage Input Pin. This pin detects the transformer demagnetization signal and the output voltage.
3	CS	Current Sense Pin. Connect a resistor to GND to sense the power MOSFET current.
4,7	NC	No Connect
5	GATE	Gate Driver Pin. Connect this pin to the gate of external power MOSFET.
6	V_{CC}	Power Supply Pin. Connect a bypass capacitor from this pin to GND
8	GND	Ground.

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	RATINGS	UNIT
V_{CC} pin input voltage	V_{CC}	-0.3 ~ 25	V
V_{CC} pin maximum sink current	$I_{CC\ MAX}$	5	mA
Compensation pin voltage	COMP	-0.3 ~ 6	V
Feedback pin input voltage	FB	-0.3 ~ 6	V
Current sense pin input voltage	CS	-0.3 ~ 6	V
Gate driver pin voltage	GATE	-0.3 ~ 25	V
Power dissipation	P_{DMAX}	0.45	W
Operating junction temperature	T_J	-40 ~ +150	°C
Storage temperature range	T_{STG}	-55 ~ +150	°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.

■ THERMAL DATA

PARAMETER	SYMBOL	RATINGS	UNIT
Junction to Ambient	θ_{JA}	145	°C/W

■ ELECTRICAL CHARACTERISTICS (T_A=25°C, V_{CC}=15V,unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY VOLTAGE SECTION						
V_{CC} Turn On Threshold	V_{CC_ON}	V_{CC} Rising		16.7		V
V_{CC} Turn Off Threshold	V_{CC_UVLO}	V_{CC} Falling		7.5		V
V_{CC} Over Voltage Protection threshold	V_{CC_OVP}			19		V
V_{CC} Clamp Voltage	V_{CC_CLAMP}			23		V
V_{CC} Startup Current	I_{CC_UVLO}	V_{CC} Rising V_{CC}= V_{CC_ON} - 1V		33	50	uA
V_{CC} Operating Current	I_{CC}	F_{OP}=10kHz, Load=100pF		1	2	mA
FEEDBACK SECTION						
FB Falling Edge Threshold Voltage	V_{FB_FALL}	FB Falling		0.1		V
FB Hysteresis Voltage	V_{FB_HYS}	FB Rising		0.08		V
FB Over Voltage Protection Threshold	V_{FB_OVP}			1.6		V
Maximum On Time	T_{ON_MAX}			25		us
Minimum Off Time	T_{OFF_MIN}			4.5		us
Maximum Off Time	T_{OFF_MAX}			100		us
CURRENT SENSE SECTION						
CS Peak Voltage Limitation	V_{CS_LIMIT}			1.0		V
Leading Edge Blanking Time for Current Sense	T_{LEB_CS}			350		ns
Switch off Delay Time	T_{DELAY}			200		ns
COMPENSATION SECTION						
Internal Reference Voltage	V_{REF}		0.194	0.200	0.206	V
COMP Low Clamp Voltage	V_{COMP_LO}			1.5		V
COMP Linear Operating Voltage Range	V_{COMP}		1.5		3.5	V
COMP Protection Threshold	V_{COMP_OVP}			3.6		V
DRIVER SECTION						
GATE pin Maximum Sourcing Current	I_{SOURCE_MAX}			200		mA
GATE pin Maximum Sinking Current	I_{SINK_MAX}			600		mA
THERMAL REGULATION SECTION						
Thermal Regulation Temperature	T_{REG}			150		°C

Notes: 1. production testing of the chip is performed at 25°C.
2. the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis.

■ APPLICATION INFORMATION

The UTC **UCL2310** is a high precision primary-side regulation single stage Active PFC controller for constant current LED lighting, Operating in critical conduction mode, the controller achieves high power factor, low THD and high efficiency.

Start Up

After system powered up, the V_{CC} pin capacitor is charged up by the start up resistor. When the V_{CC} pin voltage reaches the turn on threshold, the internal circuits start working. The COMP pin voltage is pulled up to 1.5V quickly, then the UTC **UCL2310** starts the MOSFET driver. The system works at 10kHz frequency at the beginning, the COMP voltage rises up gradually, and the transformer primary peak current also rises up. The LED current hence achieves a soft start without overshoot. After the output voltage is built up, the V_{CC} power is supplied by the auxiliary winding.

Constant Current Control

The UTC **UCL2310** adopts proprietary primary side current sensing scheme. It can precisely control the LED current without secondary side sense and feedback circuit. The current in LED can be calculated by the equation:

$$I_{OUT} \approx \frac{V_{REF}}{2 \times R_{CS}} \times \frac{N_P}{N_S}$$

Where,
V_{REF}: Internal reference voltage
NP: Primary winding turns of transformer
NS: Secondary winding turns of transformer
Rcs: The current sensing resistor value

Feedback Network

The UTC **UCL2310** senses the output current zero crossing information through the feedback network, the FB falling threshold voltage is set to 0.1V with 0.08V hysteresis. The FB pin is also used to detect output OVP, the threshold voltage is 1.6V. The ratio of FB upper resistor to lower resistor can be set as:

$$\frac{R_{FBL}}{R_{FBL} + R_{FBH}} = \frac{1.6V}{V_{OVP\_FB}} \times \frac{N_S}{N_A}$$

Where,
R_{FBL}: The lower resistor of the feedback network
R_{FBH}: The upper resistor of the feedback network
V_{OVP_FB}: Output over voltage setting point
NS: Secondary winding turns of transformer
NA: Auxiliary winding turns of transformer

The FB upper resistor can be set to around 330kΩ to improve the system efficiency. It is also used for fine tuning the LED current line compensation.

Thermal Regulation

The UTC **UCL2310** integrates thermal regulation function. When the system is over temperature, the output current is gradually reduced; the output power and thermal dissipation are also reduced. The system temperature is regulated and the system reliability is improved. The thermal regulation temperature is set to 150℃ internally.

■ APPLICATION INFORMATION (Cont.)

Protection Functions

The UTC **UCL2310** offers rich protection functions to improve the system reliability.

When the LED is open circuit, the output voltage will gradually rise up. The V_{CC} voltage will also rise up. When V_{CC} voltage reaches the 19V OVP threshold, it will trigger fault logic and the system stops switching. At some catastrophic fault condition, if the V_{CC} voltage continues to rise, the internal clamping circuit will limit the V_{CC} voltage to 23V, which helps improving the system reliability.

When the LED is shorted circuit, the system will work under 10kHz switching frequency. Meanwhile, the output voltage is low and the auxiliary winding cannot charge the V_{CC} pin. So the V_{CC} pin voltage will gradually decrease and finally reaches the UVLO threshold.

After the system enters into fault condition, the V_{CC} voltage will decrease until it reaches UVLO threshold, then the system will re-start again. If the fault condition is removed, the system will resume normal operation.

When the output is short circuit or the transformer is saturated, the CS peak voltage will be relatively high. When CS voltage reaches the internal limitation (1V), the power MOSFE will be turned off instantaneously. This cycle by cycle current limitation can help protecting the power MOSFET, the transformer and the output rectifying diode.

PCB Layouts

The following guidelines should be followed in UTC **UCL2310** PCB layout:

Bypass Capacitor

The bypass capacitor on V_{CC} pin should be as close as possible to the V_{CC} and GND pins.

Ground Path

The power ground path for current sense resistor should be short and wide, and it should be as close as possible to the IC ground (pin 2), otherwise the LED output current accuracy maybe affected. The IC signal ground for COMP and FB components should be connected to the IC GND pin wit short traces and should be away from the power ground path.

The Area of Power Loop

The area of main current loop should be as small as possible to reduce EMI radiation, such as the primary current loop, the snubber circuit and the secondary rectifying loop.

FB Pin

The feedback resistor divider should be as close as possible to the FB pin, and the trace must keeps away from dynamic node of the transformer and MOSFET DRAIN trace, otherwise the FB pin OVP function might have risk to be mis-triggered by the system noise.

■ TYPICAL APPLICATION CIRCUIT