UR3311

晶丰明源半导体

SmartPower Enabled Combo Controller for High PF LED Lighting

序号	版本	修改人	修改说明	备注
1	V130823	Sean	发起	由 Product Brief 转制
2	V140512	Ken Yi	Add EC, Block diagram, Function description Update pinout, application diagram etc	
3	V140516	Ken Yi	Update EC. FB's OCP threshold is 1.217V	
4	V140730	Sean	Format revised	
5	V141031	Ken Yi	Update the DS	
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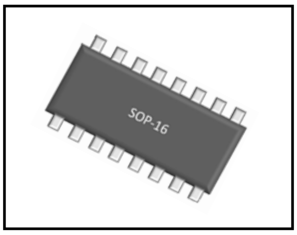
7	V150804	Ken Yi	Update the DS according to R0 version	

Data Sheet

UR3311

SmartPower Enabled Combo Controller for High PF LED Lighting

Overview:



UR3311 is a high performance AC/DC off-line power supply controller for LED luminaries. The UR3311 combines power factor correction and LED current regulation into one controller. It achieves PF>0.95 and TH<10% for 100-277Vac input voltage range.

UR3311 can be designed into an isolated two stage switching power lighting system which includes Boost and Flyback converters. It also can be designed into a non-isolated two stage switching power lighting system which includes Boost and Buck converters. This greatly simplifies customer's design for different types of lighting applications.

A patented SmartPower supply method enabled UR3311 to have fast startup and low IC supply consumption. The UR3311 operates in boundary-current and quasi-resonant modes for both switching converter stages to provide highest efficiency in the industry. With Bps's patented circuits integrated inside, the UR3311 allows customer to use single winding inductor for BOOST stage, two windings transformer for Flyback stage and single winding inductor for buck stage which greatly simplify application circuit and reduce the system cost.

The device uses Bps's advanced primary-side sensing technology to achieve excellent line and load regulation (<+/-1.5%) without secondary-feedback circuit. UR3311 is the lowest external cost and highest performance solution compared with current two-stage off-line solutions in the market.

Features:

1. isolated or non-isolated AC/DC LED driver
2. With unique patented ZCD and Smart High voltage IC power supply methods UR3311 saves great external components
3. PF>95%, THD<10%
4. <5% 100Hz/120Hz output current ripple
5. Boundary current mode and Quasi-Resonant control to achieve Ultra high conversion efficiency
6. Tight mass production current tolerance at ±3% in mass production
7. Under 0.5 second startup time
8. Excellent line/load regulation
9. CS open circuit protection
10. Cycle-cycle peak current limitation
11. LED Open/Short circuit protection
12. BOOST output over voltage protection
13. Input voltage brown out detection
14. BOOST's output voltage is using an advanced dynamic adjusting method according to AC input voltage which achieves the highest efficiency for wide input application.
15. Natural X-cap discharge function by Bps's smart power supply method which improves both the efficiency and safety.

SmartPower Enabled Combo Controller for High PF LED Lighting

Typical Application:

1. Typical isolated (Boost+Flyback) lighting application diagram

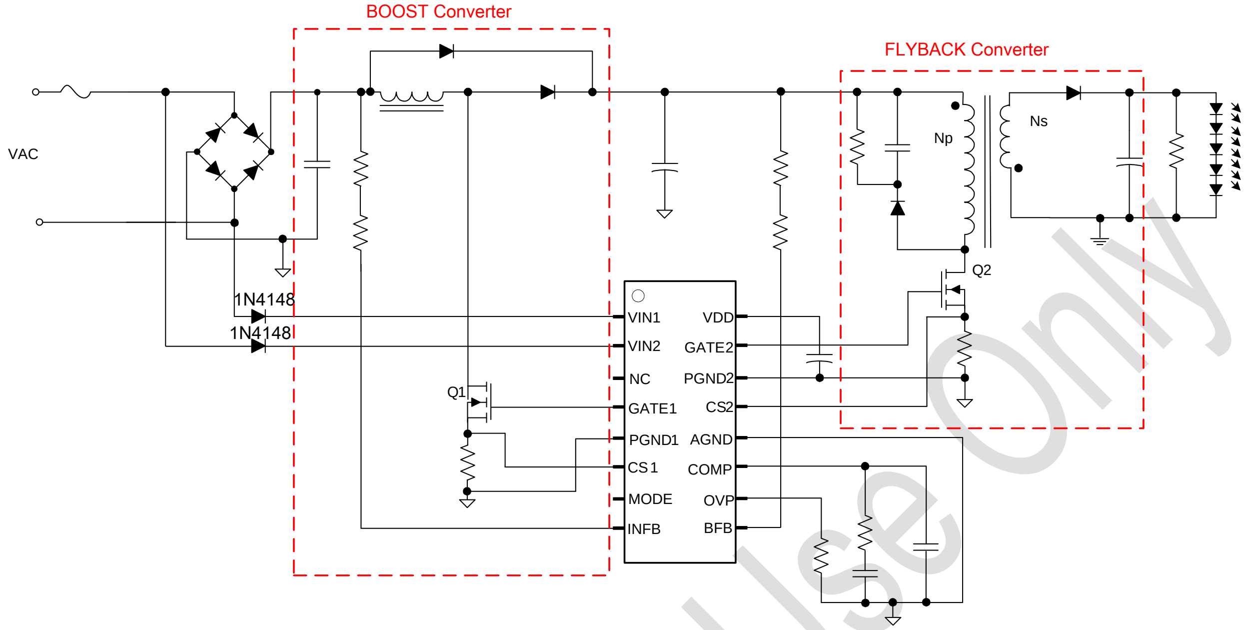


Fig.1 A typical isolated lighting application circuit

2. Typical non-isolated (Boost+Buck) lighting application diagram

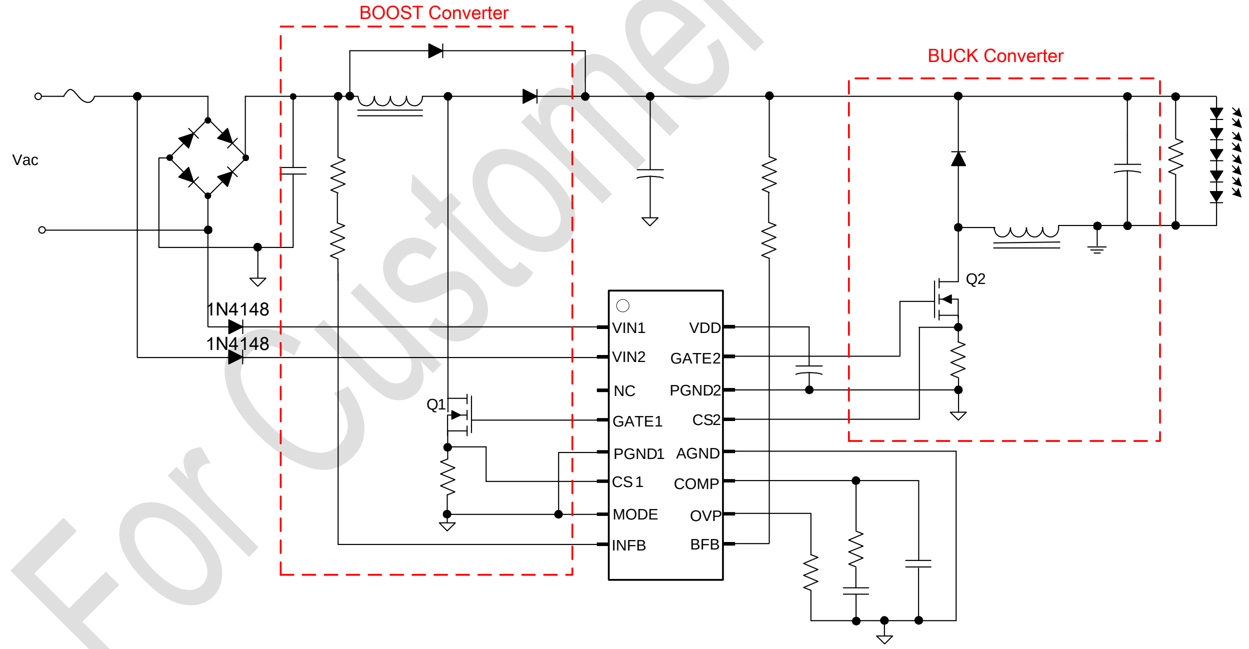
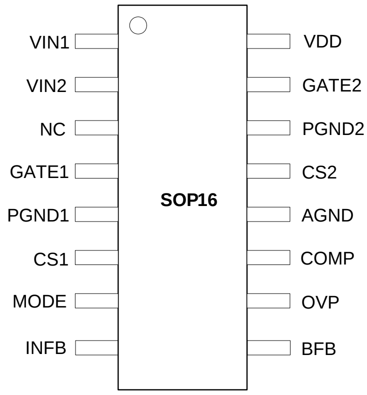


Fig.2 A typical non-isolated lighting application circuit

Pin Description:



Device	Pin Count	Package	Junction Temperature
UR3311	16	SOP-16	-40ºC - +150ºC

Pin	Symbol	Description
1	VIN1	High voltage input via a diode connected to L or N AC line. High voltage SmartPower inside to control the VIN's charge current.
2	VIN2	High voltage input via a diode connected to L or N AC line. High voltage SmartPower inside to control the VIN's charge current.
3	NC	Non-connection
4	GATE1	Gate switch for boost transistor, connected to a MOSFET's gate.
5	PGND1	Power ground for boost stage.
6	CS1	Current sense for boost transistor, used for cycle-by-cycle peak current limit.
7	MODE	Isolated or non-isolated mode selection. Mode=Float, UR3311 is used for Flyback isolated application. Mode=GND, UR3311 is used for Buck non-isolated application.
8	INFB	Input voltage sense.
9	BFB	Boost stage output voltage feedback, used to set boost output voltage.
10	OVP	Output over voltage protection pin, programmed by a resistor
11	COMP	Compensation network for Boost converter, Output of the error amplifier. Connect capacitors and resistor from this pin to ground to set the frequency response of the LED current regulation loop.
12	AGND	Analog ground.
13	CS2	Flyback primary side or Buck power switching current sense, used to set output LED current.
14	PGND2	Power ground for Flyback or Buck stage.
15	GATE2	Gate switch for Flyback or Buck transistor, connected to a MOSFET's gate.
16	VDD	Power supply, this pin provides bias power for the IC during startup and steady state operation.

Block Diagram:

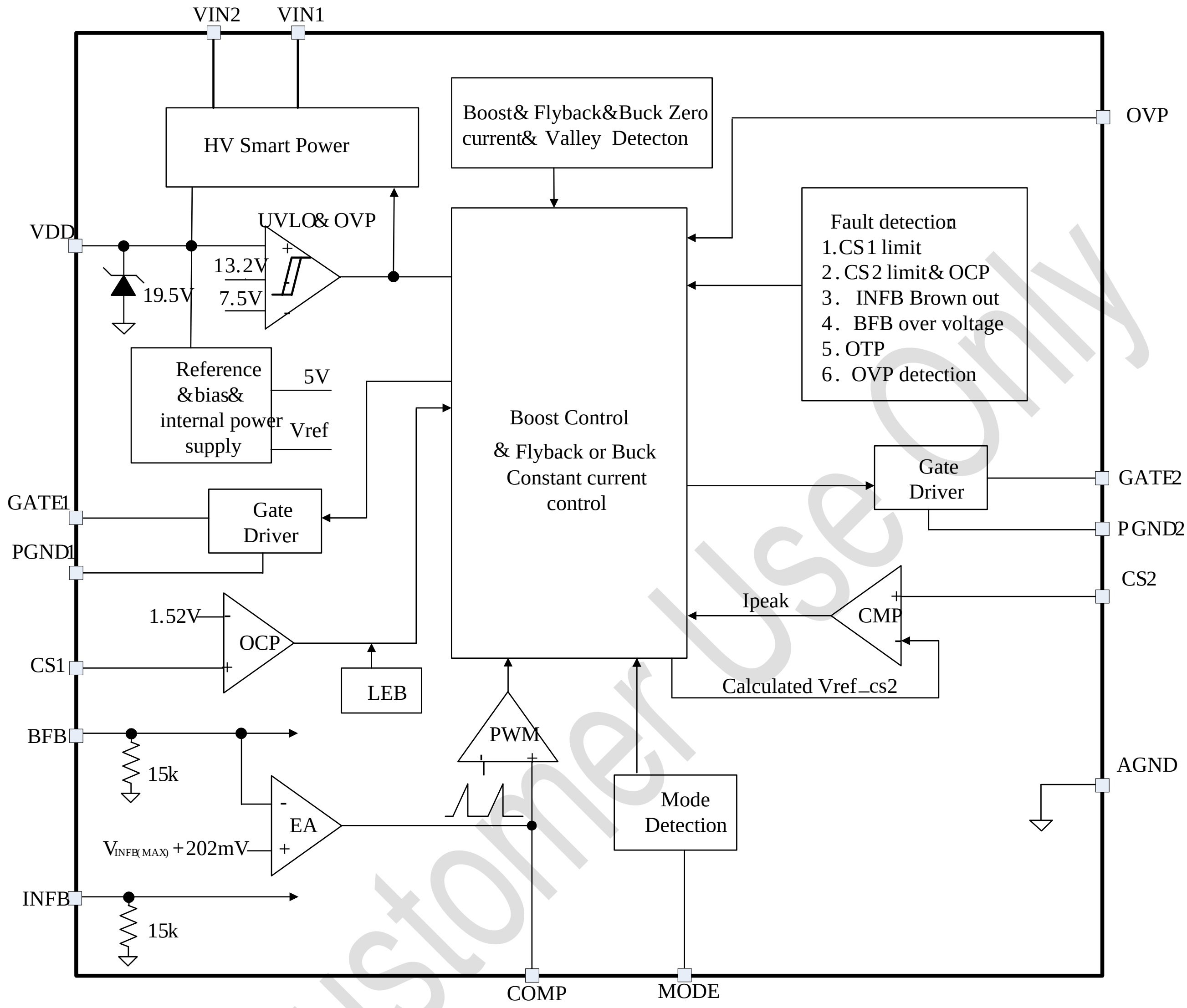


Fig.3 block diagram

Operation:

The UR3311 uses Bps's proprietary control technology, which consists of: 1) Boost control circuit. 2) Primary-side controlled flyback converter or Buck converter control circuit. It uses Bps's proprietary MOSFET boost switch control technique which achieves high power factor and low THD within wide input voltage range at high efficiency with single winding inductor. The Flyback or Buck controller operates with valley mode switching to achieve high efficiency and minimum EMI. It incorporates Bps's proprietary primary-feedback constant current control technology to achieve tight output LED current regulation.

Smart Power Supply and IC Start-up:

With two IN4148 diodes connected to bridge diodes, a fixed 5mA current will charges up VDD via VIN pins at power up. The HV startup method allows a very short startup time. For a 10uF VDD capacitor, the startup time will be around 35ms. When VDD reaches 13.2V, the internal "Enable" signal becomes active and enables the control logic. The UR3311 detects the input voltage at INFB pin. If the input voltage reaches the start-up threshold, then constant output current mode is enabled and the output-voltage starts to ramp up. During normal operation, the patented SmartPower will provide IC's supply current with a very low power consumption.
A bias winding's supply method is also doable for VDD pin. VDD's voltage will be clamped by internal 19.5V zenar.
When VDD drops below the UVLO threshold (7.5V) the IC stops switching.

Input Brown-Out Protection

After start-up, if INFB pin's voltage keeps below V_{BR_TH} for 15ms, IC will shutdown the PFC and Flyback circuit. IC will enter a re-start mode until input voltage rise up.

Boost Operation

The PFC control block provides an on-time (T_{ON}) controlled, boundary current and valley modes switching power factor correction controller. The T_{ON} is determined by the V_{INFB} and V_{BFB}. V_{BFB} is scaled down from the bus voltage. V_{INFB} is scaled down from the rectified input voltage.
The DC bus voltage is typically 45V above the peak of the line voltage. The minimum value is clamped to 280V (see INFB and BFB Resistors section for bus voltage calculation).
The powerFET source resistor provides over-current protection for boost circuit:
$I_{D(MAX)}=V_{OCP(boost)}/R_{cs1}$

INFB and BFB Resistors

The INFB and BFB pin resistors are chosen primarily to scale down the AC line voltage and input bulk capacitor voltage of the flyback circuit. The typical scale factor K_{INFB} and K_{BFB} is:

- K_{INFB} and K_{BFB}=0.0043 for 230V V_{AC} (rms)

The scale factor can be adjusted to optimize efficiency and power factor. The R_{INFB} and R_{BFB} resistance can be equated by
$R_{INFB}=Z_{INFB}/K_{INFB}-Z_{INFB}$ and $R_{BFB}=Z_{BFB}/K_{BFB}-Z_{BFB}$
The internal impedance Z_{INFB} and Z_{BFB} is 15kohm +/-6%. For example, with scale factor 0.0043, the INFB and BFB resistance should add up to
R_{INFB}=15k/0.0043-15k=3473kohm
R_{BFB}=15k/0.0043-15k=3473kohm
The relationship between INFB and BFB pin voltage for boost output voltage regulation is:
$V_{BFB}=V_{INFB(MAX)}+0.203V$
The DC bus voltage is determined by:
$V_{BUS}= V_{BFB}/K_{BFB}$
V_{BFB} also has a minimum regulation clamp is 1.214V (for example K_{BFB}=0.0043, V_{BUS} will be clamped to minimum 1.214V/0.0043=282V).

Bus Over Voltage Protection

Bus over voltage protection is realized by detecting BFB's voltage. When BFB voltage is higher than V_{BFB_OVP}, IC will halt Boost's gate driving until BFB's drop voltage is lower than $V_{BFB\_OVP\_HYS}$.

Mode selection

When Mode pin is floated, the second stage of constant current converter should be used as Flyback topology.
When Mode pin is taped to GND, the second stage of constant current converter should be used as Buck topology.

Primary Side Regulation Flyback operation for isolated application

The UR3311 uses a primary side current regulation flyback converter to eliminate the secondary side feedback components. The flyback converter turns off the external power MOSFET with a peak current control mode. Also with the boundary current and quasi-resonant modes, it achieves very high efficiency.
The real-time waveform analyzer in the UR3311 reads the switching waveform cycle by cycle. The part then generates an internal peak current's reference voltage. A patented constant current method makes sure that the output LED current to be fixed as below equation:

$$I_{LED} = \frac{1}{2} * \frac{310(mV)}{R_{CS2}(\Omega)} * N_{PS} \quad (mA)$$

Where N_{PS} is the turns ratio of the primary and

secondary windings and R_{CS2} is the CS2 resistor.
A $V_{CS2\_LIM\_FB}$ peak voltage limitation is applied to CS2's voltage.
An over current protection threshold $V_{CS2\_OCP\_FB}$ of CS2 will latch off the IC.

Constant current regulation for Buck non-isolated application

When Buck mode is selected, the internal current regulation circuit will be also set to buck mode. The output LED current will be fixed as below equation:

$$I_{LED} = \frac{1}{2} * \frac{310(mV)}{R_{CS2}(\Omega)} \quad (mA)$$

An over current protection threshold $V_{CS2\_OCP\_BK}$ of CS2 will latch off the IC.

Leading-Edge Blanking:

At the power MOSFET is switched on, a turn-on spike occurs across the sensing resistor. To avoid fault trigger, an internal leading-edge blanking time is built in. Figure 4 shows the leading-edge blanking. The LEB time of normal regulation CS detection is typically 400ns. This feature is both useful for boost and flyback stages.

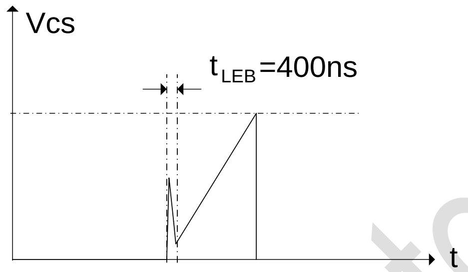


Fig.3 Leading-Edge Blanking

Output Over-Voltage/LED Open Protection:

The output over-voltage threshold is programmed by an external resister at OVP pin.
For Flyback mode, the output over-voltage protection set point will be:

$$V_{OUT\_OVP} = \frac{2.1\times10^9}{R_{CS2}} \times \frac{N_{PS} L_S}{R_{OVP}} \quad (V)$$

Where N_{PS} is the turns ratio of the primary and secondary windings, Ls is the inductance value of the secondary winding.

For Buck mode, the output over-voltage protection set point will be:

$$V_{OUT\_OVP} = \frac{2.1\times10^9}{R_{CS2}} \times \frac{L_m}{R_{OVP}} \quad (V)$$

Where Lm is the power inductor's value.

A resistor must be connected to OVP pin. If OVP function is not needed, short OVP to GND.

LED Short-Circuit Protection:

If an output short occurs, the swing of the resonant at SW will be very small. The valley point can't be detected. So the 150us auto-restart timer triggers the power MOSFET's turn-on signal which will force the switching frequency of the power converter drops to about 6.5KHz and the output current is limited to it nominal current.

Over-Temperature Protection:

To prevent from any lethal thermal damage and extend the LEDs' life, the IC will shut down operation when the IC's die temperature is higher than 150°C until the die temperature drops a 30°C hysteresis.

Other Protections:

There are other protections to make sure system more reliable, such as CS open protection, maximum operation frequency limitation, maximum and minimum T_{ON} and T_{OFF} limitation.

Absolute Maximum Ratings:

Parameters	Value	Unit
VDD, CS1, CS2,GATE1,GATE2	-0.3 to +20.0	V
INFB, BFB, OVP, COMP	-0.3 to +6.0	V
VIN1,VIN2	-0.3 to +600	V
ESD Susceptibility (HBM, JESD22-A114-F)	2	kV
Store temperature Range	-55 to 150	ºC
Operating Junction Temperature	-40 to 125	ºC
θ_{JA}(junction to Ambient temperature) of SOP14	140	ºC/W
Maximum Power Dissipation(SOP14)	1	W
Lead Temperature	260	ºC

Electrical Characteristics:

T_A=+25ºC, unless otherwise noted.

Smart Power Supply Section						
V_{DD_TH}	Startup Voltage			13.2	13.9	V
V_{DD_UVLO}	Under-voltage Lockout Threshold		7.3	7.5		V
$I_{VIN\_STARTUP\_CHRG}$	VIN charge VDD startup current	VIN=100V, VDD=6V		5		mA
V_{DD_CLAMP}	VDD's clamp voltage			19.5		V
$I_{DD\_QUSIESCENT}$	Quiescent current after startup			480		uA
BV_{DSS_ST}	ST pin's breakdown voltage	VDD=14V, I_{ST}=100uA	600			V
EA Section						
$V_{BFB\text{-}INFB(max)}$	BFB regulation voltage compared to INFB's max voltage			202		mV
V_{COMP_CLAMP}	Comp lower clamp voltage after startup			800		mV
$V_{BFB\_CLAMP\_REF}$	BFB clamp voltage reference			1.214		V
Boost Section						
$V_{INFB\_ST\_TH}$	INFB startup voltage threshold when power up			351		mV
V_{BO_TH}	INFB brown out detection threshold			351		mV
T_{BO_TH}	INFB brown out detection time after startup			15		ms
V_{CS1_TH}	CS1 current limit Threshold			1.51		V
V_{BFB_OVP}	Bus over voltage protection threshold			1.91		V
$V_{BFB\_OVP\_HYS}$	Hysteresis voltage for OVP out			100		mV
Z_{INFB}	INFB impedance			15		kohm
Z_{BFB}	BFB impedance			15		kohm
T_{LEB1}	Leading-Edge Blanking Time for normal switching			270		ns
T_{OFF1_MAX}	Maximum off time			50		us
T_{ON1_MIN}	Minimum on time			400		ns
$R_{DS\_ON\_LO1}$	Driver's pull down ability when GATE1 is low	Isink=10mA		16		ohm
$R_{DS\_ON\_HIGH1}$	Driver's pull up ability when GATE1 is high	Isource=10mA		25		ohm
Flyback Section						
V_{CS2_TH}	CS2 regulation Threshold		303	310	317	mV
$V_{CS2\_LIM\_FB}$	CS2 limitation threshold			670		mV
$V_{CS2\_OCP\_FB}$	CS2 over current threshold			1.214		V
T_{LEB1}	Leading-Edge Blanking Time for normal switching			400		ns
T_{LEB2}	Leading Edge blanking Time for OCP			270		ns

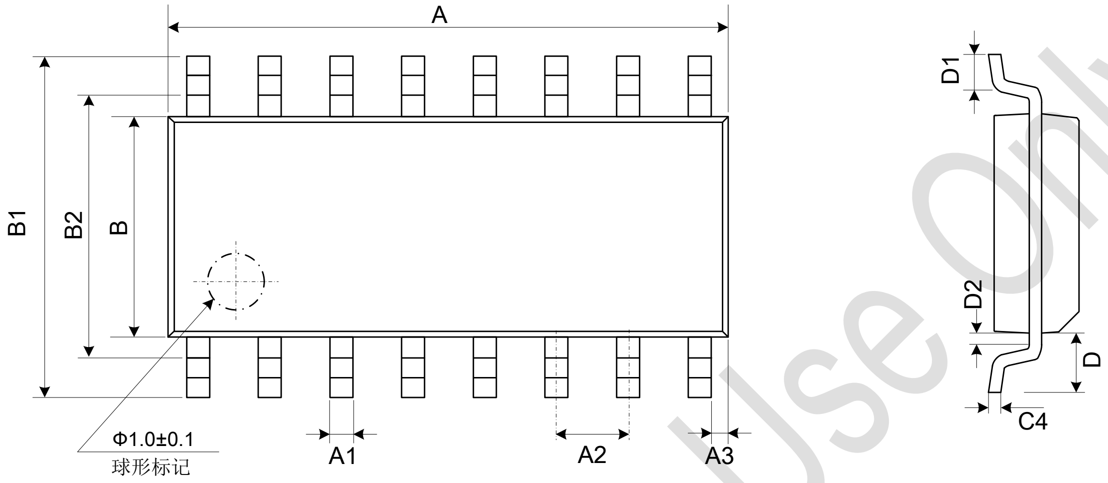
T_{ON2_MAX}	Maximum turn on time			46		us
T_{OFF2_MAX}	Maximum turn off time			156		us
V_{OVP}	OVP's regulation voltage			606		mV
$R_{DS\_ON\_LO2}$	Driver's pull down ability when GATE2 is low	Isink=10mA		16		ohm
$R_{DS\_ON\_HIGH2}$	Driver's pull up ability when GATE2 is high	Isource=10mA		25		ohm
Buck Section						
V_{CS2_TH}	CS2 regulation Threshold		303	310	317	mV
$V_{CS2\_OCP\_BK}$	CS2 over current threshold			606		mV
T_{LEB1}	Leading-Edge Blanking Time for normal switching			400		ns
T_{LEB2}	Leading Edge blanking Time for OCP			270		ns
T_{ON2_MAX}	Maximum turn on time			46		us
T_{OFF2_MAX}	Maximum turn off time			156		us
V_{OVP}	OVP's regulation voltage			606		mV
$R_{DS\_ON\_LO2}$	Driver's pull down ability when GATE2 is low	Isink=10mA		16		ohm
$R_{DS\_ON\_HIGH2}$	Driver's pull up ability when GATE2 is high	Isource=10mA		25		ohm
TEMPERATURE Protection Section						
T_{OTP}	Over temperature shutdown threshold			150		ºC
T_{OTP_HYS}	Over temperature protection hysteresis			30		ºC

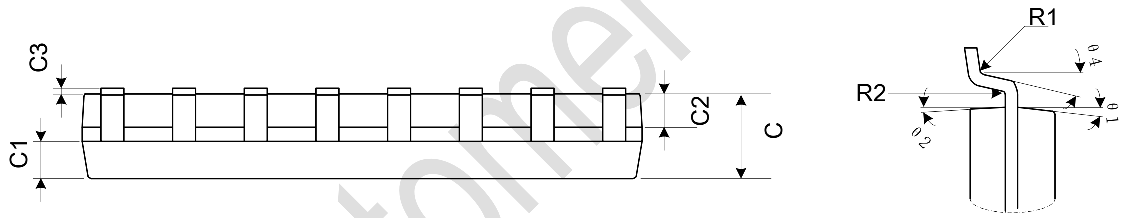
Notes: 1. the upper and lower limit is guaranteed by IC test.

SmartPower Enabled Combo Controller for High PF LED Lighting

Physical Dimensions:

SOP16





Notes:

All dimensions are in millimeters.

SmartPower Enabled Combo Controller for High PF LED Lighting

Environment Protection and RoHS Compliant：

To protect our environment, the devices in these pacakges are designed to be green. It is RoHS compatible for all 6 substances, free of Halogen, Bromine/BFR.

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