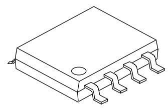
HIGH PRECISION PSR CONSTANT CURRENT LED DRIVER



SOP-8

■ DESCRIPTION

The **UTC US3602** is a primary side control offline LED lighting controller. It operates in inductor current DCM mode and can achieve accurate constant current.

The **UTC US3602** integrates 600V power MOSFET and simplifies the LED lighting system design by eliminating the secondary side feedback components and the opto-coupler. The loop compensation components are also removed while maintaining stability overall operating conditions.

The LED current can be adjusted externally by the sense resistor RCS at CS pin. The **UTC US3602** achieves ±3% accuracy of LED current along with excellent line regulation and load regulation.

The **UTC US3602** offers comprehensive protection coverage with auto-recovery features including LED short circuit protection, LED open circuit protection, Cycle-by-cycle current limiting, OTP, V_{CC} over voltage protection, leading edge blanking, V_{CC} under voltage lockout, etc.

■ FEATURES

* Built-in 600V Power MOSFET
* ±3% constant current regulation at universal AC input
* Primary side control without TL431 and opto-coupler
* Programmable CC regulation
* Flyback topology in DCM operation
* Low operating current to improve efficiency
* High resistance feedback resistor to improve efficiency
* LED short and open circuit protection
* Cycle-by-cycle current limiting
* Built-in leading edge blanking
* V_{CC} over voltage protection
* V_{CC} under-voltage lockout
* Feedback loop short circuit protection
* Current sense resistor open circuit protection

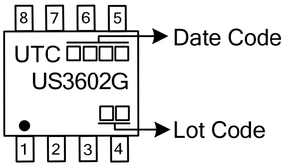
■ ORDERING INFORMATION

Ordering Number	Package	Packing
US3602G-S08-R	SOP-8	Tape Reel

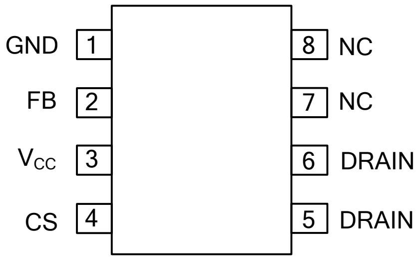
US3602G-S08-R
(1)Packing Type
(2)Package Type
(3)Green Package

(1) R: Tape Reel
(2) S08: SOP-8
(3) G: Halogen Free and Lead Free

■ MARKING



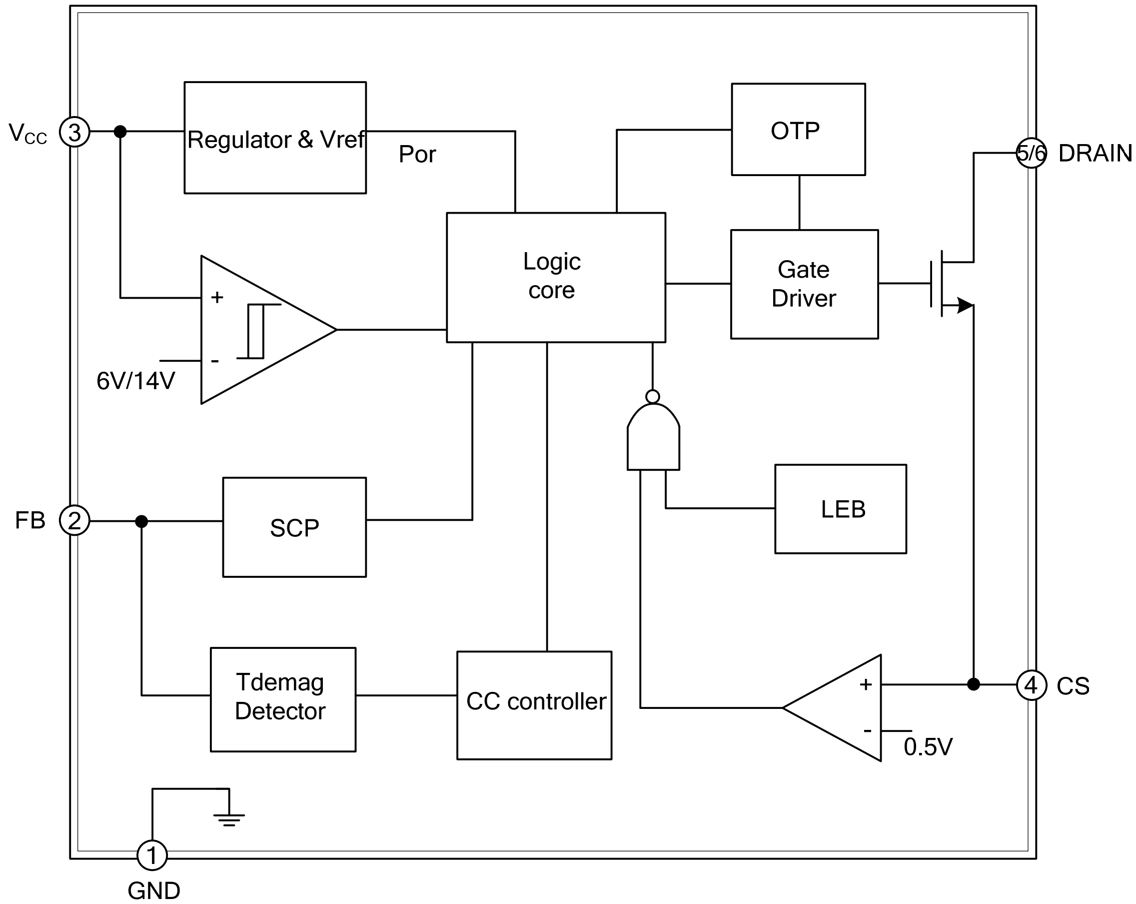
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN NO.	PIN NAME	DESCRIPTION
1	GND	Ground
2	FB	Feedback. This pin detects the output information from auxiliary winding.
3	V_{CC}	Power supply
4	CS	Current sense. This pin connects a current sense resistor to GND to adjust the LED current.
5, 6	DRAIN	Internal power MOSFET drain.
7, 8	NC	No connection, must be floated

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	RATINGS	UNIT
V_{CC} Pin Input Voltage	V_{CC}	-0.3~20	V
Feedback Pin Input Voltage	FB	-0.3~6	V
Internal MOSFET Drain Voltage	Drain	-0.3~600	V
Current Sense Pin Input Voltage	CS	-0.3~6	V
Power Dissipation (Note 2)	P_{DMAX}	0.45	W
Thermal Resistance (Junction to Ambient)	θ_{JA}	145	°C/W
Operating Junction Temperature	T_J	-40~150	°C
Storage Temperature Range	T_{STG}	-55~150	°C

Notes: 1. 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.
2. The maximum power dissipation decrease if temperature rise, it is decided by T_{JMAX}, θ_{JA}, and environment temperature (T_A). The maximum power dissipation is the lower one between $P_{DMAX}=(T_{JMAX}-T_A)/\theta_{JA}$ and the number listed in the maximum table.

■ RECOMMENDED OPERATION CONDITIONS

PARAMETER	SYMBOL	RATINGS	UNIT
Power Supply Voltage	V_{CC}	7.5~14.5	V
Output Power (Input Voltage 230V±15%)	P_{OUT1}	<5	W
Output Power (Input Voltage 85V~265V)	P_{OUT2}	<4	W

■ ELECTRICAL CHARACTERISTICS (Note 1, 2) (V_{CC}=12V, T_A=25°C, Unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Supply Voltage Section						
Turn on Threshold Voltage	$V_{TH(ON)}$		13	14	15	V
Turn off Threshold Voltage	$V_{TH(OFF)}$			6.5		V
V_{CC} OVP Protection	V_{CC_OVP}			16		V
V_{CC} Clamped Voltage	V_{CC_clamp}	I_{CC}=10mA		23		V
Start up Current	I_{ST}	$V_{CC}=V_{TH(ON)}-1V$		30	50	μA
Operating Current	I_{CC-OP}	F_{OP}=40kHz		1		mA
Current Sense Section						
Current Sense Threshold Voltage	V_{CS}		460	500	600	mV
Leading Edge Blanking Time	T_{LEB}			500		nS
OCP Propagation Delay	T_{D_OC}			300		nS
Feedback Section						
FB Voltage Sense Level	V_{FB}			1		V
Minimum Demagnetization Time	T_{DEMAG_MIN}			3.5		μS
Line Compensation Ratio (Note 3)	$\Delta V_{CS}/\Delta I_{FBUP}$			1.1		mV/μA
Maximum Duty Cycle						
Maximum Duty Cycle	D_{MAX}				50	%
Over Temperature Protection						
Thermal Shutdown Threshold	T_{SD}			150		°C
Thermal Shutdown Hysteresis	T_{SD-HYS}			25		°C
MOSFET Section						
Static Drain-Source On-Resistance	R_{DS_ON}	$V_{GS}=10V/I_{DS}=0.5A$		13		Ω
Drain-Source Breakdown Voltage	BV_{DSS}	$V_{GS}=0V/I_{DS}=250μA$	600			V
Drain-Source Leakage Current	I_{DSS}	$V_{GS}=0V/V_{DS}=600V$			100	nA

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.
3. Refer to application information.

FUNCTION DESCRIPTION

The **UTC US3602** is a primary side control offline LED lighting controller. It operates in inductor current DCM mode and can achieve accurate constant current. The **UTC US3602** integrates 600V power MOSFET and simplifies the LED lighting system design by eliminating the secondary side feedback components and the opto-coupler. The loop compensation components are also removed while maintaining stability overall operating conditions.

Startup control

The V_{CC} pin of **UTC US3602** is connected to the line input through a resistor. A large value startup resistor can be used to minimize the power loss in application because the start current of **UTC US3602** is very low. When the V_{CC} voltage reaches $V_{TH(ON)}$, the internal startup circuit is disabled and the IC turns on.

Operating Current

The operating current of **UTC US3602** is as low as 1mA. Good efficiency and very low standby power can be achieved.

Constant Current Operation

When the FB voltage is over 1.2V reference voltage and the demagnetization time is lager than 4μS, thus **UTC US3602** operates in constant-current (CC) mode. The CC point can be externally adjusted by external current sense resistor RCS.

In CC operation, the CC loop control function of **UTC US3602** will keep a fixed proportion between secondary inductance demagnetization time (Tdemag) and switching cycle time (Tsw). The fixed proportion is

$$\frac{Tdemag}{Tsw} = \frac{1}{2}$$

Thus the output current is given by:

$$Iout = \frac{1}{2} \times \frac{N_P}{N_S} \times Ipk \times \frac{Tdemag}{Tsw} = \frac{1}{4} \times \frac{N_P}{N_S} \times Ipk$$

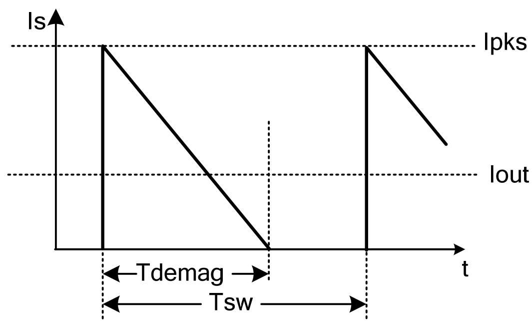


Figure4. Secondary current waveform

Current Sensing and Leading Edge Blanking

Cycle-by-cycle current limiting is offered in **UTC US3602**. The switch current is detected by a sense resistor into the CS pin. When the power switch is turned on, a turn-on spike will occur on this resistor. A 500ns leading-edge blanking is built in to avoid false-termination of the switching pulse so that the external RC filtering is no longer needed.

Programmable Line Voltage Compensation

UTC US3602 has a built-in line voltage compensation to achieve good line regulation. An offset voltage is generated at CS pin by a sense current from upper resistor at FB pin. The current is inversely proportional to the upper resistor and is proportional to the line voltage. So the line voltage is compensated by this offset voltage at CS pin. It can also be programmed by adjusting the resistance of the divider for various line voltage used.

The ratio of line compensation can be calculated by the equation:

$$\Delta V_{CS} = -1.1 \times 10^6 \times \frac{V_{AUX}}{R_{FBH}} (mV)$$

Where, R_{FBH} is the upper resistor of the FB pin.

■ FUNCTION DESCRIPTION(Cont.)

Operation Switching Frequency

The **UTC US3602** is designed to work in DCM flyback topology and no external loop compensation component is required while maintaining stability. The maximum duty cycle is limited to 50%. The maximum switching frequency should be set to less than 100KHz and the minimum switching frequency should be set to more than 20KHz. The maximum and minimum switching frequency is limited in **UTC US3602** to ensure the stability of system.

The switching frequency can be set by the formula:

$$f = \frac{Np^2 \times V_{LED}}{8 \times Ns^2 \times Lp \times I_{LED}}$$

Where, L_P is the primary winding inductance of transformer.

Protection Control

Good power supply system reliability is achieved with its comprehensive protection features including V_{CC} over-voltage protection, V_{CC} Clamp, GATE Clamp, Cycle-by-cycle current limiting, LED short circuit protection, LED open circuit protection, leading edge blanking, OTP and UVLO, etc.

V_{CC} is supplied by transformer auxiliary winding output. The output of **UTC US3602** is shutdown when V_{CC} drops below $V_{TH(OFF)}$ and the power converter enters power on start-up sequence thereafter.

■ TYPICAL APPLICATION CIRCUIT