



## UPSR104A

Preliminary

CMOS IC

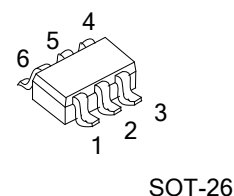
### HIGH PRECISION OFF-LINE LED CONTROLLER

#### DESCRIPTION

UTC **UPSR104A** is a primary side regulation off-line LED lighting controller which can achieve accurate LED current. It significantly simplifies LED lighting system design by eliminating the secondary side feedback circuitry. The device integrates PWM controller to enhance the performance of discontinuous conduction mode (DCM) flyback converters.

The LED current (CC control) can be adjusted externally by the resistor  $R_s$  at CS pin. Device operates in PFM in CC mode as well at large load condition and it operates in PWM with frequency reduction at light/medium load.

The UTC **UPSR104A** achieves high precision CV/CC regulation and high power efficiency. It offers comprehensive protection coverage with auto-recovery features including Cycle-by-cycle current limiting,  $V_{DD}$  over voltage protection,  $V_{DD}$  clamp, OTP, leading edge blanking,  $V_{DD}$  under voltage lockout, etc.



SOT-26

#### FEATURES

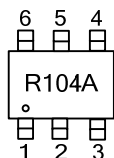
- \* High Precise Constant Current Regulation at Universal AC input
- \* Primary-side Sensing and Regulation Without TL431 and Opto-coupler
- \* Programmable CC Regulation
- \* Adjustable Constant Current and Output Power Setting
- \* Built-in Secondary Constant Current Control with Primary Side Feedback
- \* Built-in Adaptive Current Peak Regulation
- \* Built-in Primary winding inductance compensation
- \* Power on Soft-start
- \* Built-in Leading Edge Blanking (LEB)
- \* Cycle-by-Cycle Current Limiting
- \*  $V_{DD}$  Under Voltage Lockout with Hysteresis (UVLO)
- \*  $V_{DD}$  OVP
- \*  $V_{DD}$  Clamp

#### ORDERING INFORMATION

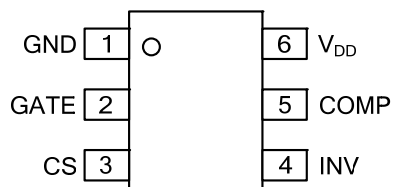
Ordering Number	Package	Packing
UPSR104AG-AG6-R	SOT-26	Tape Reel

UPSR104AG-AG6-R	
(1) Packing Type	(1) R: Tape Reel
(2) Package Type	(2) AG6: SOT-26
(3) Green Package	(3) G : Halogen Free and Lead Free

## MARKING



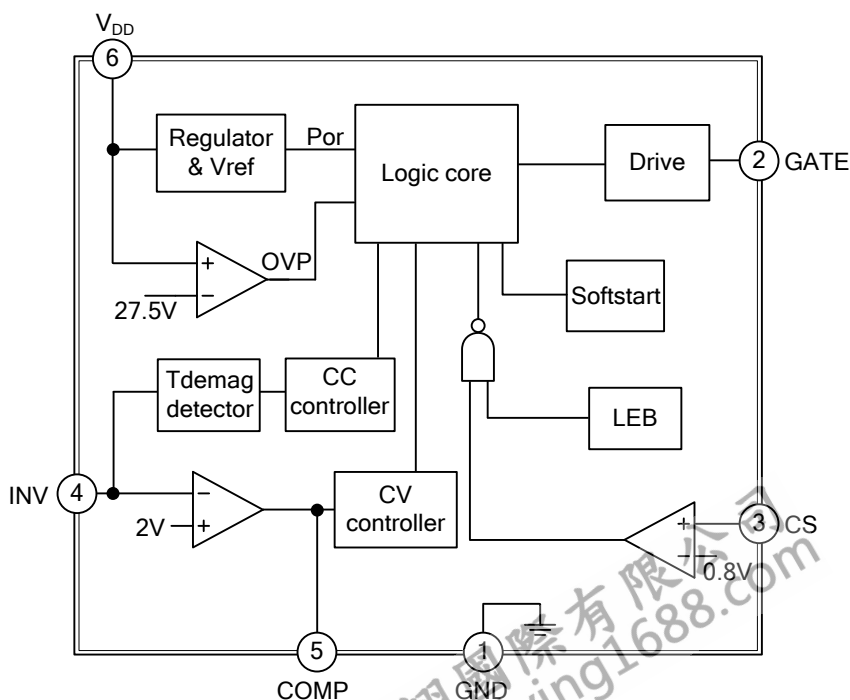
## PIN CONFIGURATION



## PIN DESCRIPTION

PIN NO.	PIN NAME	DESCRIPTION
1	GND	Ground
2	GATE	Totem-pole gate drive output for power MOSFET.
3	CS	Current sense input. Connected to MOSFET current sensing resistor node.
4	INV	The voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
5	COMP	Loop Compensation for CV Stability
6	V <sub>DD</sub>	Power Supply

## BLOCK DIAGRAM



# ■ ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	RATINGS	UNIT
V <sub>DD</sub> Voltage	V <sub>DD</sub>	-0.3~V <sub>DD</sub> clamp	V
V <sub>DD</sub> Zener Clamp Continuous Current		10	mA
COMP Voltage	V <sub>COMP</sub>	-0.3~7	V
CS Input Voltage	V <sub>CS</sub>	-0.3~7	V
INV Input Voltage	V <sub>INV</sub>	-0.3~7	V
Min/Max Operating Junction Temperature	T <sub>J</sub>	-40~150	°C
Min/Max Storage Temperature	T <sub>STG</sub>	-55~150	°C
Lead Temperature (Soldering, 10secs)	T <sub>OPR</sub>	260	°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.

# ■ ELECTRICAL CHARACTERISTICS (T<sub>A</sub>=25°C, V<sub>DD</sub>=V<sub>DDG</sub>=16V, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>Supply Voltage (V<sub>DD</sub>) Section</b>						
Standby Current	I <sub>DD ST</sub>	V <sub>DD</sub> =13V		5	20	uA
Operation Current	I <sub>DD op</sub>	Operation supply current, INV=2V, CS=0V, V <sub>DD</sub> =V <sub>DDG</sub> =20V		1.6	3	mA
V <sub>DD</sub> Under Voltage Lockout Enter	UVLO (ON)	V <sub>DD</sub> falling	8.0	9.0	10.0	V
V <sub>DD</sub> Under Voltage Lockout Exit	UVLO (OFF)	V <sub>DD</sub> rising	13.5	14.8	16.0	V
Maximum V <sub>DD</sub> Operation Voltage	V <sub>DD clamp</sub>	I <sub>DD</sub> =10mA		29		V
Over Voltage Protection Threshold	OVP	Ramp V <sub>DD</sub> until gate shut down	26	27.5	29	V
<b>Current Sense Input Section</b>						
LEB Time	T <sub>LEB</sub>			600		ns
Over Current Threshold	V <sub>TH oc</sub>		787	800	813	mV
OCP Propagation Delay	T <sub>d oc</sub>			110		ns
Soft Start Time	T <sub>SS</sub>			17		ms
<b>Frequency Section</b>						
IC Maximum Frequency	F <sub>req Max</sub> (Note 1)		55	60	65	KHz
System Nominal Switch Frequency	F <sub>req Nom</sub>			50		KHz
	F <sub>req startup</sub>	INV=0V, Comp=5V		14		KHz
Δf/Freq	Frequency shuffling range			±6		%
<b>Error Amplifier Section</b>						
Reference Voltage for EA	V <sub>REF EA</sub>		1.96	2	2.04	V
DC Gain of EA	Gain			60		dB
<b>Gate Drive Output Section</b>						
Output Low Level	V <sub>OL</sub>	V <sub>DD</sub> =16V, I <sub>O</sub> =20mA			1	V
Output High Level	V <sub>OH</sub>	V <sub>DD</sub> =16V, I <sub>O</sub> =20mA	8			V
Output Clamp Voltage Level	V <sub>clamp</sub>			16		V
Output Rising Time	T <sub>r</sub>	V <sub>DD</sub> =16V, C <sub>L</sub> =0.5nF		650		ns
Output Falling Time	T <sub>f</sub>	V <sub>DD</sub> =16V, C <sub>L</sub> =0.5nF		40		ns
<b>On chip OTP Section</b>						
Over Temperature protection	OTP			160		°C

Note: F<sub>req\_Max</sub> indicates IC internal maximum clock frequency. In system application, the maximum operation frequency of 60Khz nominal occurs at maximum output power or the transition point from CV to CC.

### ■ OPERATION DESCRIPTION

UTC **UPSR104A** is a primary side regulation off-line LED lighting controller which can achieve accurate LED current. It significantly simplifies LED lighting system design by eliminating the secondary side feedback circuitry. The device integrates PWM controller to enhance the performance of discontinuous conduction mode (DCM) flyback converters.

#### Startup control

The  $V_{DD}$  pin of UTC **UPSR104A** 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 **UPSR104A** is very low. When the  $V_{DD}$  voltage reaches  $V_{TH(ON)}$ , the internal startup circuit is disabled and the IC turns on.

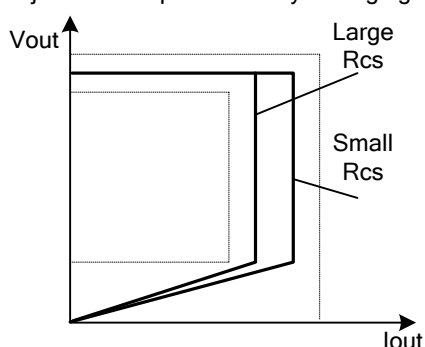
#### Operating Current

The Operating current of UTC **UPSR104A** is as low as 1.6mA. Good efficiency and very low standby power can be achieved.

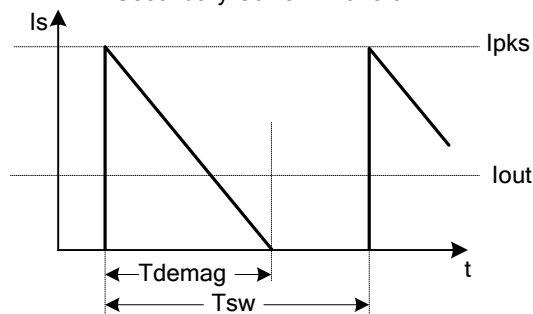
#### Constant Current Operation

When the sampled voltage is below 2.0V reference voltage and the error amplifier output reaches its maximum, thus UTC **UPSR104A** operates in constant-current (CC) mode. The CC point and maximum output power can be externally adjusted by external current sense resistor  $R_{cs}$ . The larger  $R_{cs}$ , the smaller CC point is, and the smaller output power becomes.

Adjustable Output Power By Changing  $R_{cs}$



Secondary Current Waveform



## ■ OPERATION DESCRIPTION (Cont.)

In CC operation, the CC loop control function of UTC **UPSR104A** will keep a fixed proportion between secondary inductance de-magnetization time (Tdemag) and switching cycle time (Tsw). The fixed proportion is

$$\frac{T_{demag}}{T_{sw}} = \frac{1}{2} \quad (2)$$

Thus the output current is given by:

$$I_{out} = \frac{1}{2} \times \frac{N_p}{N_s} \times I_{pk} \times \frac{T_{demag}}{T_{sw}} = \frac{1}{4} \times \frac{N_p}{N_s} \times I_{pk} \quad (3)$$

### Current Sensing and Leading Edge Blanking

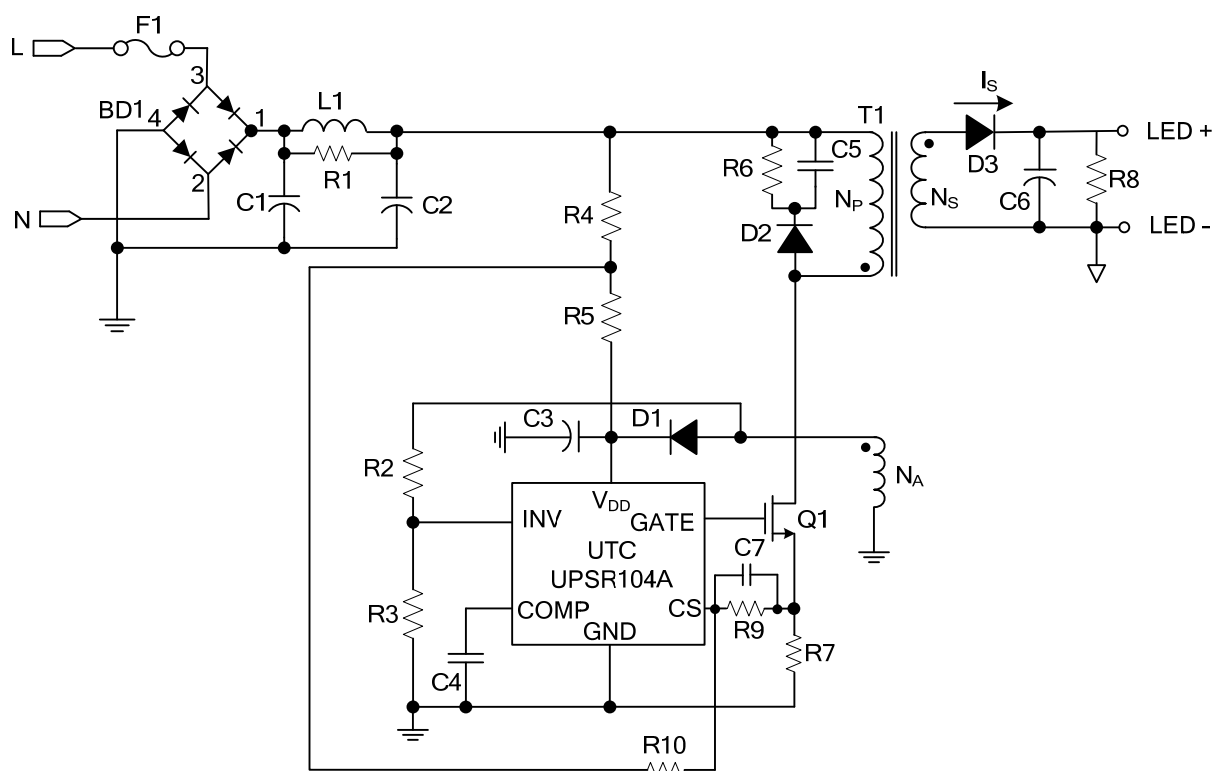
Cycle-by-cycle current limiting is offered in UTC **UPSR104A**. The switch current is detected by a sense resistor into the CS pin. When the power switch is turned on, a turn-on spike will occur on this resistor. A 600ns leading-edge blanking is built in to avoid false-termination of the switching pulse so that the external RC filtering is no longer needed.

### Protection Control

Good power supply system reliability is achieved with its comprehensive protection features including V<sub>DD</sub> over-voltage protection, V<sub>DD</sub> Clamp, GATE Clamp, Power on soft start, Cycle-by-cycle current limiting, short circuit protection, leading edge blanking, OTP and UVLO, etc.

V<sub>DD</sub> is supplied by transformer auxiliary winding output. The output of UTC **UPSR104A** is shutdown when V<sub>DD</sub> drops below V<sub>TH(OFF)</sub> and the power converter enters power on start-up sequence thereafter.

■ TYPICAL APPLICATION CIRCUIT (16V / 0.35A)



**BOM**

Reference	Component	Reference	Component
BD1	BD 1A/600V	R1	R 4.7KΩ 1206 ±5%
L1	3.3m H 1/2W	R2	R 91KΩ 0805 ±1%
C1	EC 3.3u F 400V 105°C	R3	R 7.5KΩ 0805 ±1%
C2	EC 3.3u F 400V 105°C	R4	R 1MΩ 1206 ±5%
C3	EC 10u F 50V 105°C	R5	R 1MΩ 1206 ±5%
C4	CC 47n F 50V 0805	R6	R 100KΩ 1206 ±5%
C5	CC 2.2n F 1000V 1206	R7	R 1.8Ω 1206 ±5%
C6	EC 470u F 25V 105°C Low-ESR	R8	R 10KΩ 1206 ±5%
C7	CC 33p F 50V 0805	R9	R 1KΩ 0805 ±1%
D1	Diode UTC 1N4007G	R10	R 5.1MΩ 1206 ±5%
D2	Diode UTC 1N4007G	Q1	N-MOSFET UTC 1N60
D3	Diode UTC MBR2200	T1	EE-16
		F1	FUSE 1A 250VAC

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