UNISONIC TECHNOLOGIES CO., LTD

UPSR100   Preliminary   *CMOS IC*

HIGH PRECISION CC/CV PRIMARY SIDE REGULATOR

SOP-8

■ DESCRIPTION

The UTC **UPSR100** is a primary control unit for switch mode charger and adapter applications. The controlled variable is transferred by an auxiliary winding from the secondary to the primary side. The device uses Pulse Frequency Modulation (PFM) method to build discontinuous conduction mode (DCM) flyback power supplies.

The UTC **UPSR100** operates in primary-side sensing and regulation. Opto-coupler and TL431 could be eliminated. It also eliminates the need of loop compensation circuitry while maintaining stability.

The UTC **UPSR100** 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, output over voltage protection, feedback loop open protection, short circuit protection, leading edge blanking, V_{CC} under voltage lockout, etc.
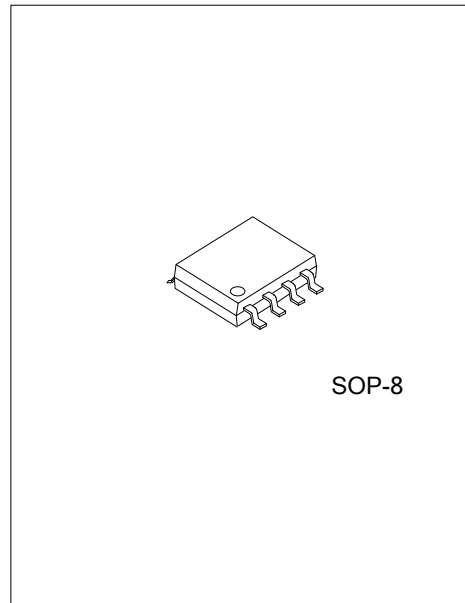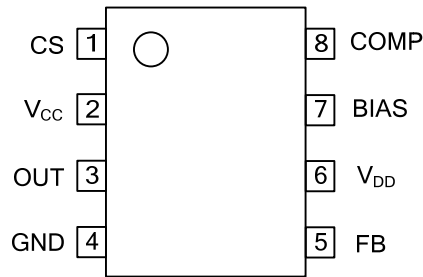
■ FEATURES

* ±5% constant voltage regulation at universal AC input
* High precision constant current regulation at universal AC input
* Primary side control without TL431 and opto-coupler
* Programmable CV and CC regulation
* Eliminates control loop compensation circuitry
* Flyback topology in DCM operation
* Random frequency modulation to reduce system EMI

* Driver BJT switch
* Built-in leading edge blanking
* Built-in primary winding inductance compensation
* Open circuit protection
* Over voltage protection
* Short circuit protection

■ ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
UPSR100L-S08-T	UPSR100G-S08-T	SOP-8	Tube
UPSR100L-S08-R	UPSR100G-S08-R	SOP-8	Tape Reel

UPSR100<u>L</u>-<u>S08</u>-<u>R</u>

    (1)Packing Type   (1) T: Tube, R: Tape Reel

    (2)Package Type   (2) S08: SOP-8

    (3)Halogen Free   (3) L: Lead Free, G: Halogen Free

■ **PIN CONFIGURATION**

CS 1	8 COMP
V_{CC} 2	7 BIAS
OUT 3	6 V_{DD}
GND 4	5 FB

■ **PIN DESCRIPTION**

PIN NO.	PIN NAME	DESCRIPTION
1	CS	Current sense input.
2	V_{CC}	Power supply.
3	OUT	Base drive for power BJT.
4	GND	Ground.
5	FB	The voltage feedback from the auxiliary winding
6	V_{DD}	The 5V output of the internal voltage regulator
7	BIAS	This pin sets the bias current inside UTC UPSR100 with an external resistor to GND
8	COMP	This pin connects a bypass capacitor

■ **BLOCK DIAGRAM**
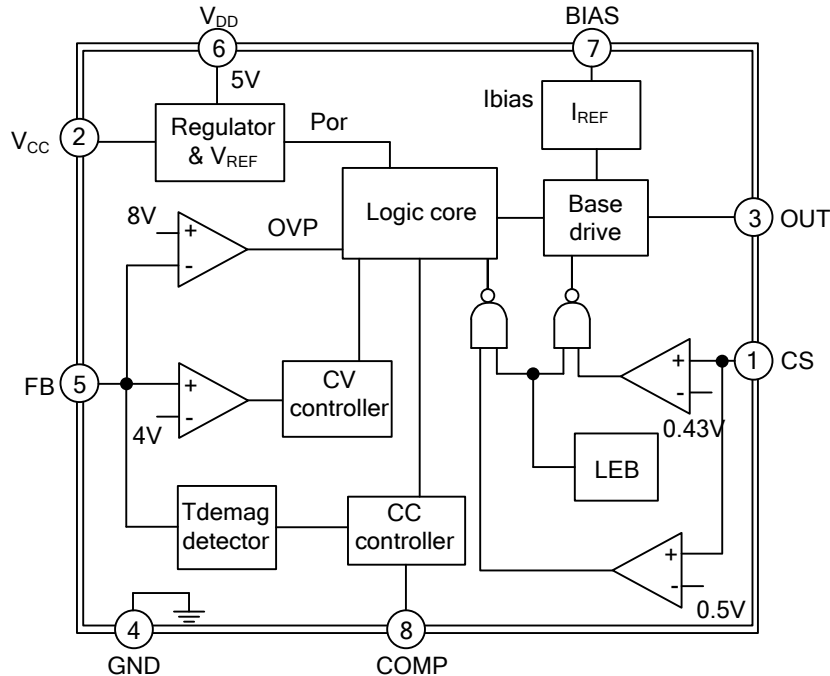
■ **ABSOLUTE MAXIMUM RATING**

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{CC}	-0.3~30	V
Voltage at CS, BIAS, OUT, V_{DD}, COMP to GND		-0.3~7	V
FB Input (Pin 5)		-40~10	V
ESD (Machine Model)		200	V
Output Current at OUT		Internally limited	A
Power Dissipation at T_A=25°C	P_D	0.657	W
Operating Junction Temperature	T_J	150	°C
Storage Temperature	T_{STG}	-65~150	°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**

DESCRIPTION	SYMBOL	RATINGS	UNIT
Junction to Ambient	θ_{JA}	190	°C/W

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

PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
UVLO SECTION							
Turn-on Threshold Voltage		$V_{TH (ON)}$		17.5	19	20.5	V
Turn-off Threshold Voltage		$V_{TH(OFF)}$		6.5	7.5	8.5	V
REFERENCE VOLTAGE SECTION							
BIAS Pin Voltage		V_{BIAS}	R_{BIAS}=200kΩ, Before Turn on	1.15	1.20	1.25	V
VDD Pin Voltage		V_{DD}		4.75	5.0	5.25	V
STANDBY CURRENT SECTION							
Start-up Current		I_{ST}	R_{BIAS}=200kΩ, Before Turn on		90	110	µA
Operating Current		I_{OP}	R_{BIAS}=200kΩ		500	700	µA
DRIVE OUTPUT SECTION							
OUT Maximum Current	$I_{OUT(SINK)}$	I_{OUT}	R_{BIAS}=200kΩ,V_{OUT}<0.2V	50			mA
	$I_{OUT(SOURCE)}$		R_{BIAS}=200kΩ	30	40		mA
CURRENT SENSE SECTION							
Current Sense Threshold		V_{CS}		505	520	545	mV
Pre-Current Sense		$V_{CS(PRE)}$		455	480	505	mV
Leading Edge Blanking					460		ns
FEEDBACK INPUT SECTION							
Feedback Pin Input Leakage Current		I_{FB}	V_{FB}=4V	11.0	13.5	15.0	µA
Feedback Threshold		V_{FB}		3.90	4.00	4.10	V
Enable Turn-on Voltage		$V_{FB(EN)}$		-1.2	-1.0	-0.9	V
COMP THRESHOLD VOLTAGE SECTION							
Turn-on Threshold Voltage		V_{COMP}		3.28	3.4	3.58	V
PROTECTION SECTION							
Over Voltage Protection		$V_{FB(OVP)}$		7	8	9	V

■ **OPERATION DESCRIPTION**

The UTC **UPSR100** is a primary control unit for switch mode charger and adapter applications. It operates in primary-side sensing and regulation. Opto-coupler and TL431 could be eliminated. Proprietary built-in CV and CC control can achieve high precision CV/CC performance. It uses Pulse Frequency Modulation (PFM) method to build discontinuous conduction mode (DCM) flyback power supplies.

Startup control

The voltage regulator provides the internal power supply V_{DD}. For V_{CC} and V_{DD} external capacitors are required. The current biasing of UTC **UPSR100** is adjustable by an external resistor. Internal time constants, thresholds and the output current depend from the value of this resistor. The startup circuit activates the IC after startup and deactivates the IC in case of UVLO.

Operating Current

The Operating current of UTC **UPSR100** is as low as 500μA. Good efficiency and very low standby power can be achieved.

Constant Voltage Operation

The output voltage is defined by the transmission ratio between the secondary and auxiliary winding. The UTC **UPSR100** captures the auxiliary winding feedback voltage at FB pin and operates in constant-voltage (CV) mode to regulate the output voltage. The auxiliary voltage reflects the output voltage is given by:

$$V_{AUX} = \frac{N_A}{N_S} \times (V_O + \Delta V) \tag{1}$$

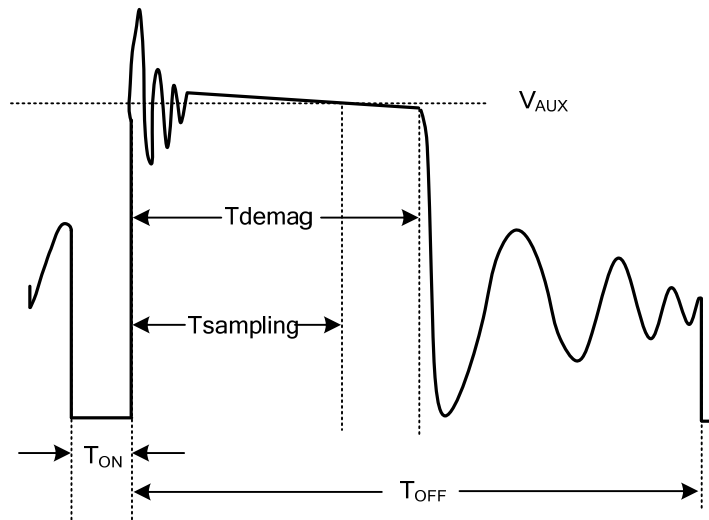Where $\triangle V$ indicates the drop voltage of the output diode.

Figure 2. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB, the V_{AUX} is sampled at the Tsampling end and it is hold until the next sampling. The sampled voltage is compared with 4V reference voltage and the error is amplified. The error amplifier output reflects the load condition and controls the Toff time to regulate the output voltage, thus constant output voltage can be achieved.

Constant Current Operation

When the sampled voltage is below 4V reference voltage and the error amplifier output reaches its maximum, thus UTC **UPSR100** operates in constant-current (CC) mode. The CC point and maximum output power can be externally adjusted by external current sense resistor Rcs. The larger Rcs, the smaller CC point is, and the smaller output power becomes.

■ **OPERATION DESCRIPTION**

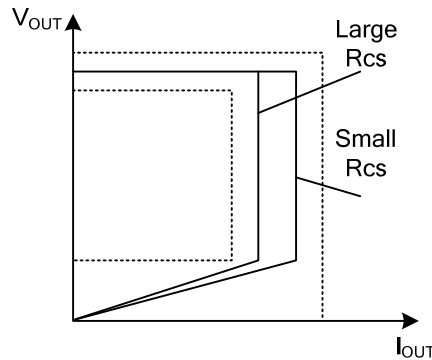
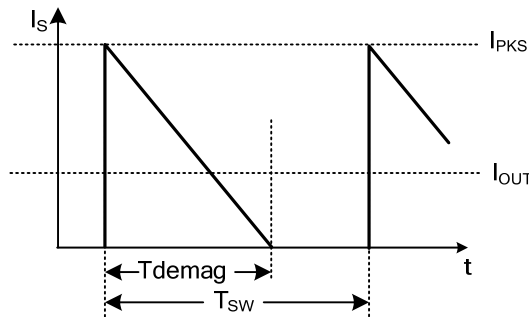**Figure 3. Adjustable output power by changing R$_{CS}$**

Figure 4. Secondary current waveform

In CC operation, the CC loop control function of UTC **UPSR100** will keep a fixed proportion between secondary inductance de-magnetization time (Tdemag) and switching cycle time (Tsw). The fixed proportion is

$$\frac{Tdemag}{Tsw} = \frac{4}{7} \tag{2}$$

Thus the output current is given by:

$$Iout = \frac{1}{2} \times \frac{N_P}{N_S} \times Ipk \times \frac{Tdemag}{Tsw} = \frac{2}{7} \times \frac{N_P}{N_S} \times Ipk \tag{3}$$

Current Sensing and Leading Edge Blanking

Cycle-by-cycle current limiting is offered in UTC **UPSR100**. 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.

Drive BJT

The driver is a push pull stage with the supply voltage V$_{CC}$. It provides the driving current for the external power bipolar transistor. The output signal is current-limited to I$_{OUT(SOURCE)}$.

Protection Control

Good power supply system reliability is achieved with its comprehensive protection features including output over-voltage protection, feedback loop open protection, Cycle-by-cycle current limiting, short circuit protection, leading edge blanking and UVLO, etc.

V$_{CC}$ is supplied by transformer auxiliary winding output. The output of UTC **UPSR100** is shutdown when V$_{CC}$ drops below V$_{TH(OFF)}$ and the power converter enters power on start-up sequence thereafter.

■ TYPICAL APPLICATION CIRCUIT
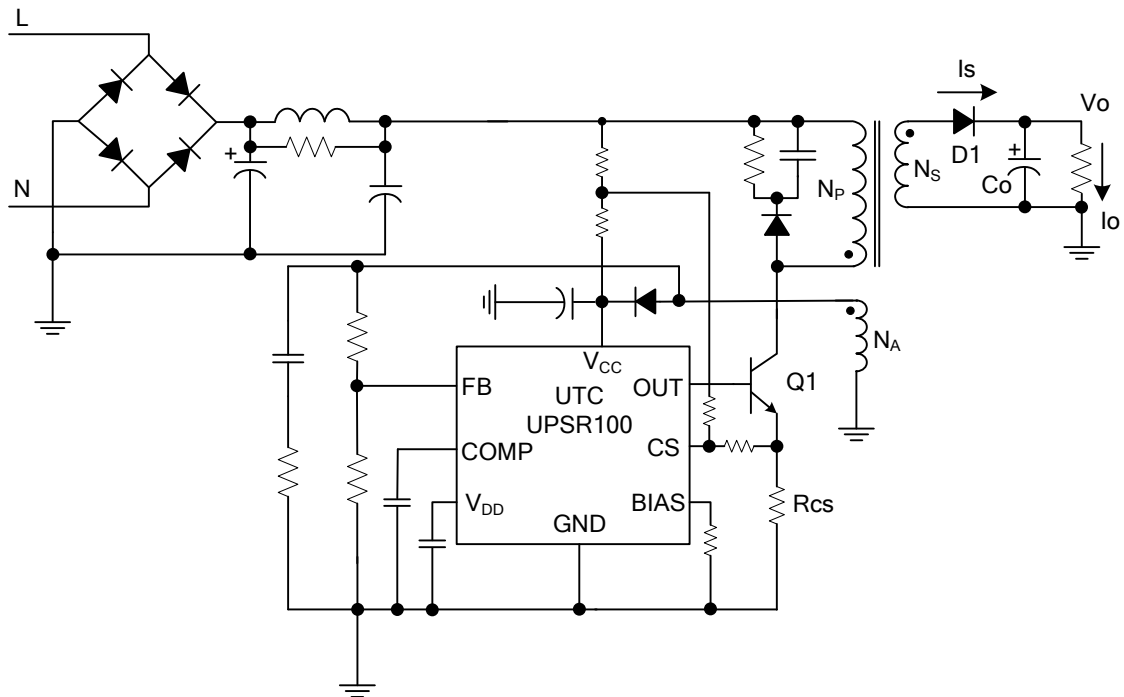
A typical flyback application by UTC UPSR100