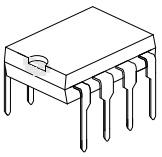
UPS604

LINEAR INTEGRATED CIRCUIT

HIGH PERFORMANCE CURRENT MODE POWER SWITCH



DIP-8

■ DESCRIPTION

The UTC **UPS604** is designed to provide several special enhancements to satisfy the needs, for example, Power-Saving mode for low standby power (<0.3W), Frequency Hopping , Constant Output Power Limiting , Slope Compensation ,Over Current Protection (OCP), Over Voltage Protection (OVP), Over Load Protection (OLP), Under Voltage Lock Out (UVLO), Short Circuit Protection (SCP) , Over Temperature Protection (OTP) etc. IC will be shutdown or can auto-restart in situations.

■ FEATURE

* Low startup current (about 22μA)
* Fixed switching frequency(Norm. is 68KHz)
* Frequency hopping for Improved EMI Performance.
* Lower than 0.3W Standby Power Design
* Linearly decreasing frequency to 26KHz during light load
* Soft start
* Internal Slope Compensation
* Constant Power Limiting for universal AC input Range
* Gate Output Maximum Voltage Clamp(15V)
* Max duty cycle 74%
* Over temperature protection
* Overload protection
* Over voltage protection
* Leading edge blanking
* Cycle-by-Cycle current limiting
* Under Voltage Lock Out
* Short Circuit Protection

■ ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
UPS604L-D08-T	UPS604G-D08-T	DIP-8	Tube

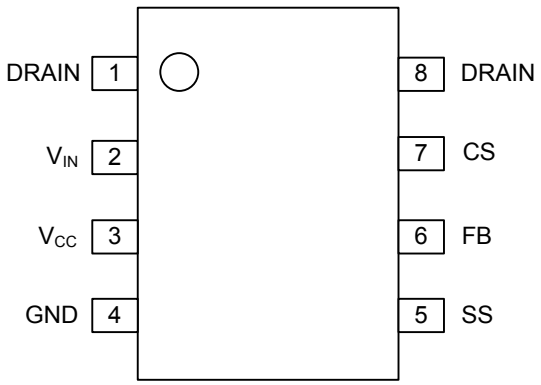
UPS604L-D08-T

(1) Packing Type
(2) Package Type
(3) Lead Free

(1) T: Tube
(2) D08: DIP-8
(3) G: Halogen Free, L: Lead Free

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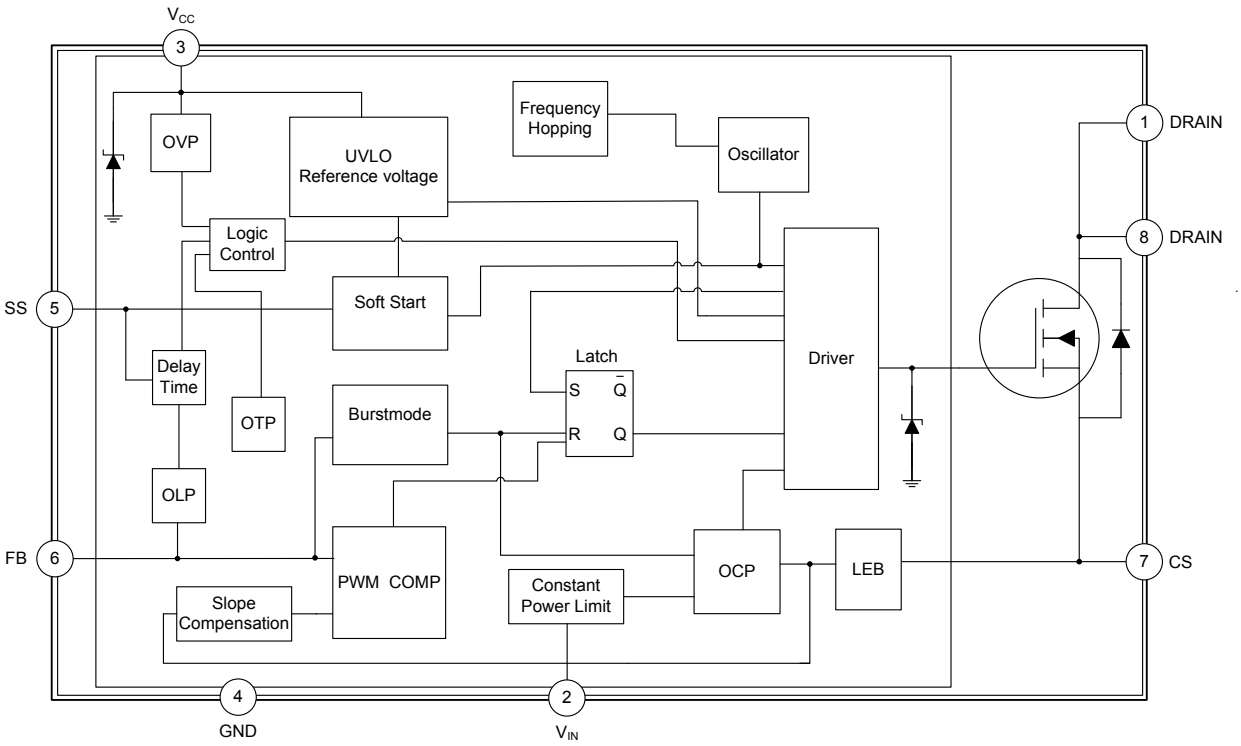
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN	NAME	FUNCTION
1	DRAIN	Power MOSFET drain
2	V_{IN}	For startup and constant power limit, this pin is pulled to the line input via resistor
3	V_{CC}	Supply voltage
4	GND	Ground
5	SS	Soft-start
6	FB	Feedback
7	CS	Controller current sense input
8	DRAIN	Power MOSFET drain

■ BLOCK DIAGRAM



Notes: OLP (Over Load Protection)
OVP (Over Voltage Protection)
OTP (Over Temperature Protection)
OCP (Over Current Protection)
UVLO (Under Voltage Latch-Out)
LEB (Led Edge Blanking)
SS (Soft Start)

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C, unless otherwise specified)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{CC}	30	V
Input Voltage to Vin Pin	Vin	30	V
Input Voltage to FB Pin	V_{FB}	-0.3 ~ 6.2	V
Input Voltage to CS Pin	V_{CS}	-0.3 ~ 2.8	V
Junction Temperature	T_J	+150	°C
Operating Temperature	T_{OPR}	-40 ~ +125	°C
Storage Temperature	T_{STG}	-50 ~ +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.

■ OPERATING RANGE

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{CC}	8.6 ~ 22	V

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

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY SECTION						
Start Up Current	I_{STR}	V_{CC} = $V_{CC(ON)}$-0.1V		22	45	μA
Supply Current with switch	I_{OFF}	V_{SS} = 0, I_{FB} = 0		7	9	mA
	I_{ON}	V_{SS} = 4.8V, I_{FB} = 0		7	9	mA
UNDER-VOLTAGE LOCKOUT SECTION						
Start Threshold Voltage	$V_{THD(ON)}$		13.5	14.2	15	V
Min. Operating Voltage	$V_{CC(MIN)}$		7.5	8.2	9	V
Hysteresis	$V_{CC(HY)}$			6		V
INTERNAL VOLTAGE REFERENCE						
Reference Voltage	V_{REF}	measured at pin V_{FB}	6.3	6.5	6.7	V
CONTROL SECTION						
V_{FB} Operating Level	V_{MIN}		0.5			V
	V_{MAX}				4.4	V
Burst-Mode Out FB Voltage	$V_{FB(OUT)}$	V_{CS} =0		1.7		V
Reduce-Frequency end FB Voltage	$V_{FB(END)}$	V_{CS} =0		1.6		V
Burst-Mode Enter FB Voltage	$V_{FB(IN)}$	V_{CS} =0		1.5		V
Switch Frequency Normal	$F_{(SW)}$	V_{FB} = 4V	61	68	75	kHz
Switch Frequency Power-Saving		Before enter burst mode	20		40	kHz
Duty Cycle	D_{MAX}	V_{FB}=4.4V, V_{CS} =0	68	74	80	%
	D_{MIN}	V_{FB}<0.5V	0			%
Frequency Hopping	$F_{J(SW)}$		±1.5	±3	±4.5	kHz
Frequency Variation VS V_{CC} Deviation	F_{DV}	V_{CC}=10 to 20V			5	%
Frequency Variation VS Temperature Deviation	F_{DT}	T=-40 to 105°C			5	%
Feedback Resistor	R_{FB}	V_{FB}=0V	16	21	26	kΩ
Soft-Start Time	T_{SS}	C_{SS}=0.47μF	9.9	11.2	12.6	ms
PROTECTION SECTION						
OVP threshold	V_{OVP1}	V_{SS}<3.5V,V_{FB}>5V		19		V
	V_{OVP2}	V_{SS}=4.8V, V_{FB}=3V		28		V
OLP threshold	$V_{FB(OLP)}$	V_{CS}=0, SS OPEN	4.7	4.9	5.1	V
Delay Time Of OLP	T_{D-OLP}	C_{SS}=0.47μF	55	62	70	ms
OTP threshold	$T_{(THR)}$		120	135	150	°C
OVP Disable threshold	$V_{SS(DEACT)}$	V_{FB}>5V, V_{CC} = 22V	3.9	4.1	4.3	V
OLP Enable threshold	$V_{SS(ACT)}$	V_{FB}>5V	5.1	5.4	5.7	V

■ ELECTRICAL CHARACTERISTICS(Cont.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
CURRENT LIMITING SECTION						
Peak Current Limitation	V_{CS}	V_{FB}=4.4V		0.86	1	V
Threshold Voltage For I_{VIN} =60μA	$V_{SENSE-L}$	I_{VIN}=60μA		0.77		V
POWER MOS-TRANSISTOR SECTION						
Drain-Source Breakdown Voltage	V_{DSS}	V_{GS}=0V, I_D=250μA	600			V
Turn-on voltage between gate and source	V_{TH}	V_{DS}=V_{GS}, I_D=250μA	2		4	V
Drain-Source Diode Continuous Source Current	I_S				4.4	A
Static Drain-Source On-State Resistance	$R_{DS(ON)}$	V_{GS}=10V,I_D=2.2A			2.5	Ω
Rise Time	t_R	V_{DD} =300V, I_D =4.0A		45	100	ns
Fall Time	t_F	RG=25Ω (Note 1,2)		35	80	ns

Notes: 1. Pulse Test: Pulse width≤300μs, Duty cycle≤2%
2. Essentially independent of operating temperature

■ FUNCTIONAL DESCRIPTION

The internal reference voltages and bias circuit work at V_{CC}> $V_{THD\ (ON)}$, and shutdown at V_{CC}<$V_{CC\ (MIN)}$.

(1) Soft-Start

When every IC power on, driver output duty cycle will be decided by voltage V_{SS} on soft-start capacitor and V_{CS} on current sense resistor at beginning. After V_{SS} reach 4.2V, the whole soft-start phase end, and driver duty cycle depend on V_{FB} and V_{CS}. The relation among V_{SS}, V_{FB} and V_{OUT} as followed FIG.3.

Furthermore, soft-start phase should end before V_{CC} reach $V_{CC\ (MIN)}$ during V_{CC} power on. Otherwise, if soft-start phase remain not end before V_{CC} reach $V_{CC\ (MIN)}$ during V_{CC} power on, IC will enter auto-restart phase and not set up V_{OUT}. So the value of C_{SS} should be between 0.1μFand 4.7μF.

Finally soft-start also set OVP1 active phase. OVP1 active phase between 0 and $V_{SS(DEACT)}$, OVP1 will not be sensed after V_{SS} reach $V_{SS(DEACT)}$.The Soft-start phase T_{SS}：T_{SS} = 23.8×C_{SS} (ms) (Example: C_{SS}=0.47μF, then T_{SS}=23.8×0.47=11.2ms).

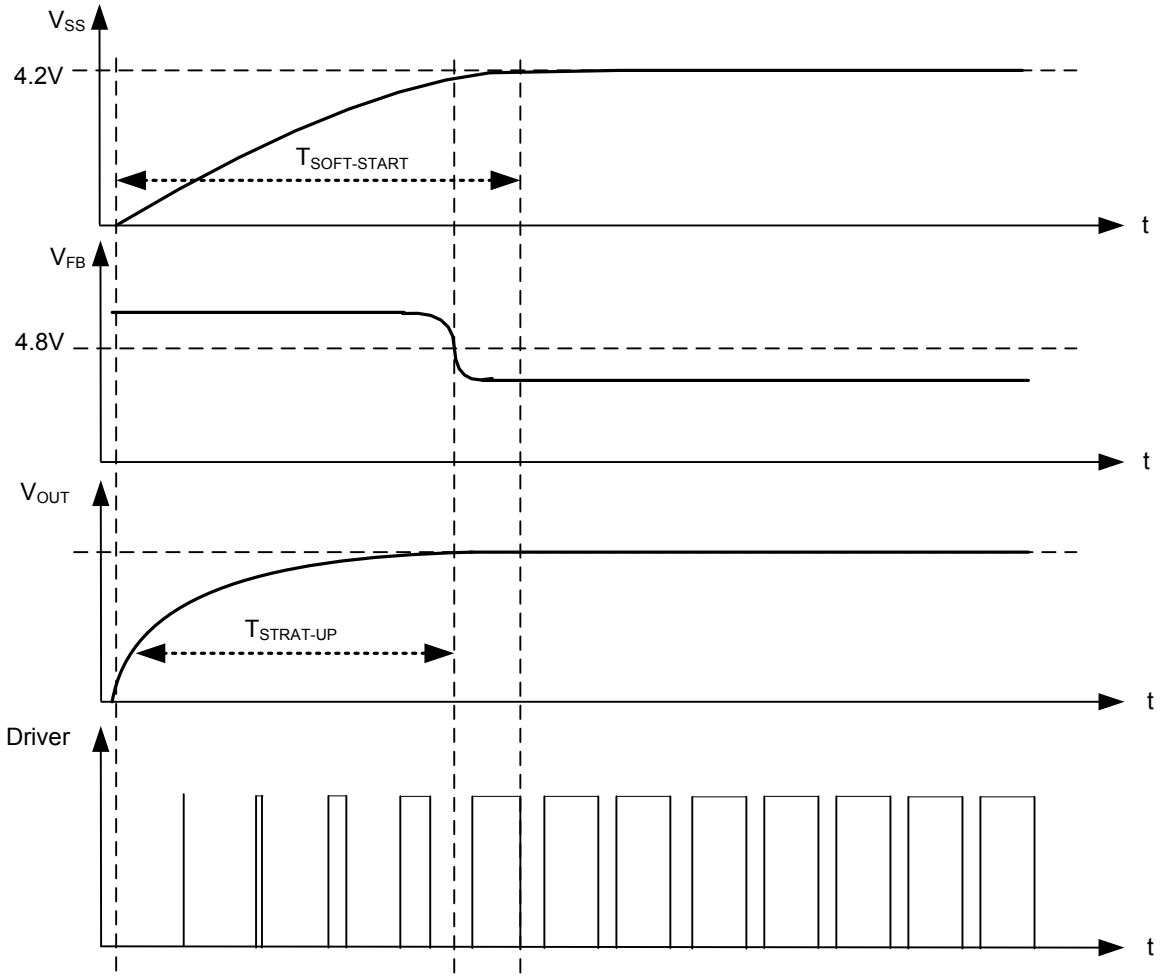


Fig.3 Soft-start phase

■ FUNCTIONAL DESCRIPTION(Cont.)

(2) Switch Frequency Set

The maximum switch frequency is set to 68kHz. Switch frequency is modulated by output power P_{OUT} during IC operating. At no load or light load condition, most of the power dissipation in a switching mode power supply is from switching loss on the MOSFET transistor, the core loss of the transformer and the loss on the subber circuit. The magnitude of power loss is in proportion to the number of switching events within a fixed period of time. So lower switch frequency at lower load, which more and more improve IC's efficiency at light load. At from no load to light load condition, The IC will operate at from Burst mode to Reducing Frequency Mode. The relation curve between f_{SW} and $P_{OUT}/P_{OUT\ (MAX)}$ as followed FIG.4.

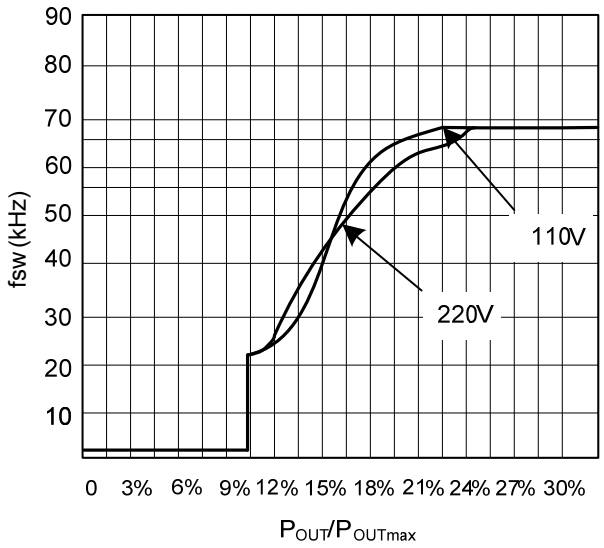


FIG.4 The relation curve between f_{SW} and relative output power $P_{OUT}/ P_{OUT\ (MAX)}$

(3) Internal Synchronized Slope Compensation

Built-in slope compensation circuit adds voltage ramp onto the current sense input voltage for PWM generation, this greatly improves the close loop stability at CCM and prevents the sub-harmonic oscillation and thus reduces the output ripple voltage.

(4) Frequency Hopping For EMI Improvement

The Frequency hopping is implemented in the IC; there are two oscillators built-in the IC. The first oscillator is to set the normal switching frequency; the switching frequency is modulated with a period signal generated by the 2nd oscillator. The relation between the first oscillator and the 2nd oscillator as followed FIG.5. So the tone energy is evenly spread out, the spread spectrum minimizes the conduction band EMI and therefore eases the system design in meeting stringent EMI requirement.

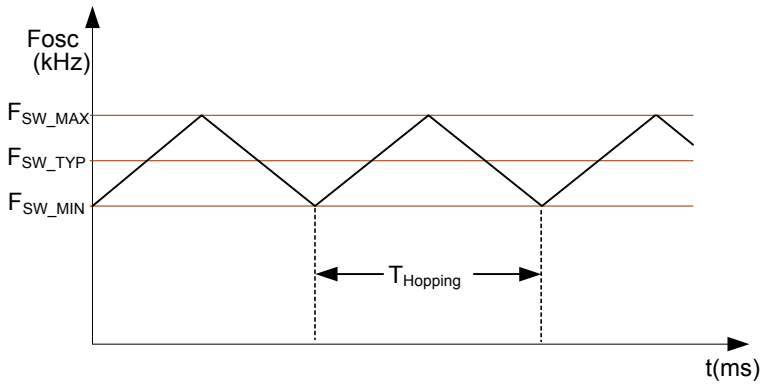


FIG.5 Frequency Hopping

■ FUNCTIONAL DESCRIPTION(Cont.)

(5) Constant Output Power Limit

When the SENSE voltage, across the sense resistor R_S, reaches the threshold voltage, around 0.8V, the output GATE drive will be turned off after a small propagation delay t_D. This propagation delay will introduce an additional current proportional to $t_D \times V_{IN}/Lp$. Since the propagation delay is nearly constant regardless of the input line voltage V_{IN}. Higher input line voltage will result in a larger additional current and hence the output power limit is also higher than that under low input line voltage. To compensate this variation for wide AC input range, the threshold voltage is adjusted by the V_{IN} current. Since V_{IN} pin is connected to the rectified input line voltage through a resistor R_{VIN}, a higher line voltage will generate higher V_{IN} current into the V_{IN} pin. The threshold voltage is decreased if the V_{IN} current is increased. Smaller threshold voltage, forces the output GATE drive to terminate earlier, thus reduce the total PWM turn-on time and make the output power equal to that of low line input. This proprietary internal compensation ensures a constant output power limit for wide AC input voltage from 90VAC to 264VAC.

(6) Protection section

The IC takes on more protection functions such as OLP, OVP and OTP etc. In case of those failure modes for continual blanking time, the driver is shut down. At the same time, IC enters auto-restart, V_{CC} power on and driver is reset after V_{CC} power on again.

OLP

After soft-start phase end, IC will shutdown driver if over load state occurs for continual $T_{D\text{-}OLP}$. OLP function will not inactive during soft-start phase. OLP case as followed FIG. 6. The test circuit as followed FIG.8. $T_{D\text{-}OLP}=5.53\times T_{SS}$.

OVP

There are two kinds of OVP circuits, the first OVP function are enabled only when $V_{SS}<V_{SS\ (DEACT)}$ & $V_{FB}>V_{FB\ (OLP)}$ during soft-start phase. During above condition, driver will be shutdown if over voltage state occurs ($V_{CC}>V_{OVP1}$) for continual a blanking time. The first OVP function will not inactive after soft-start phase. The second OVP will shutdown the switching of the power MOSFET whenever $V_{CC}>V_{OVP2}$. The first OVP case as followed FIG.7. The test circuit as followed FIG.9.

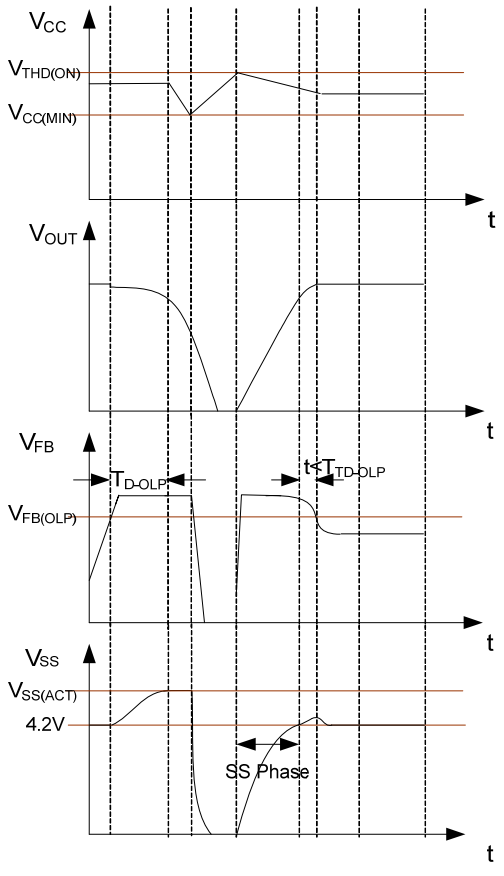


FIG.6 OLP case

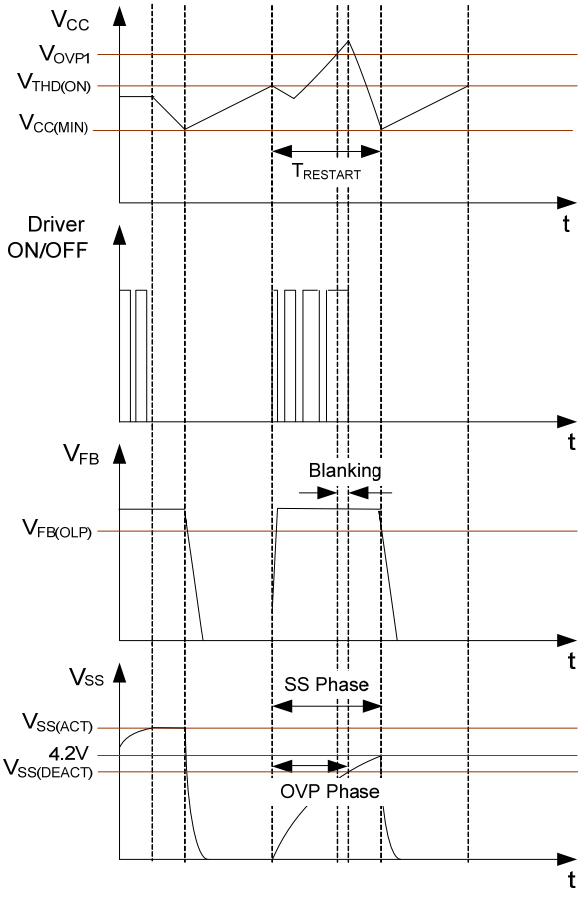


FIG.7 OVP case

■ FUNCTIONAL DESCRIPTION(Cont.)

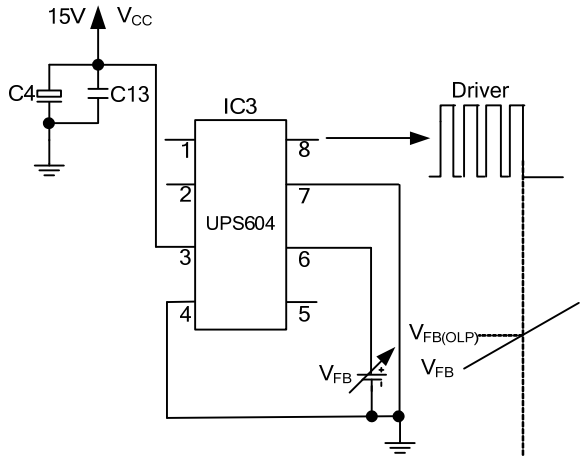


FIG.8 OLP test circuit

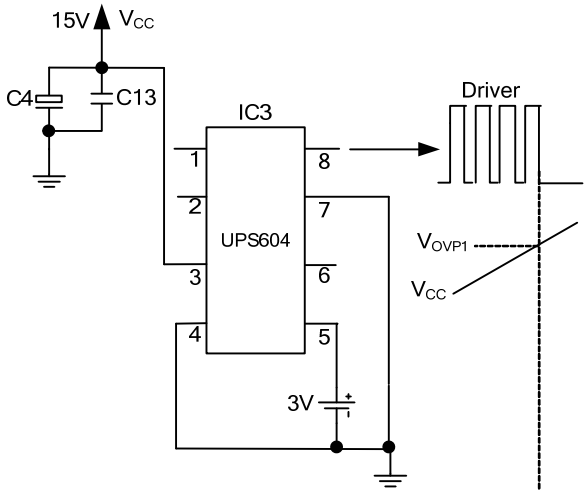


FIG.9 OVP test circuit

OTP

OTP will shut down driver when junction temperature $T_J > T_{(THR)}$ for continual a blanking time.

(7) Driver Output Section

The driver-stage drives the gate of the MOSFET and is optimized to minimize EMI and to provide high circuit efficiency. This is done by reducing the switch on slope when reaching the MOSFET threshold. This is achieved by a slope control of the rising edge at the driver's output. The output driver is clamped by an internal 15V Zener diode in order to protect power MOSFET transistors against undesirable gate over voltage.

(8) Inside power switch MOS transistor

Specific power MOS transistor parameter is as "POWER MOS TRANSISTOR SECTION" in electrical characteristics table.

■ TYPICAL APPLICATION CIRCUIT

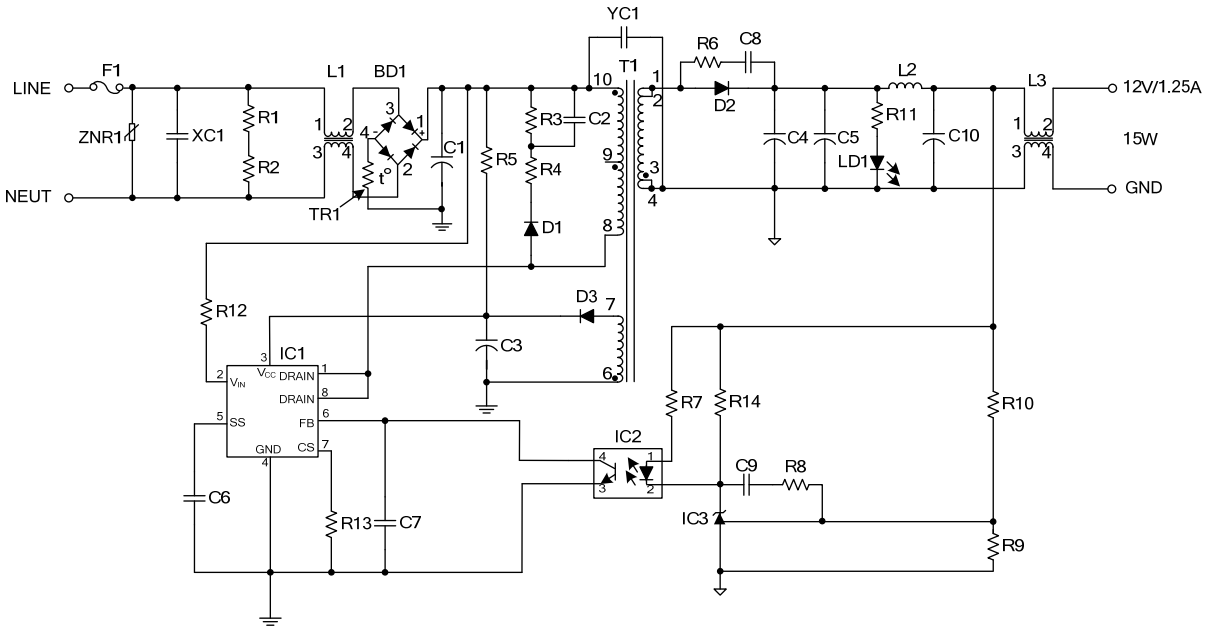


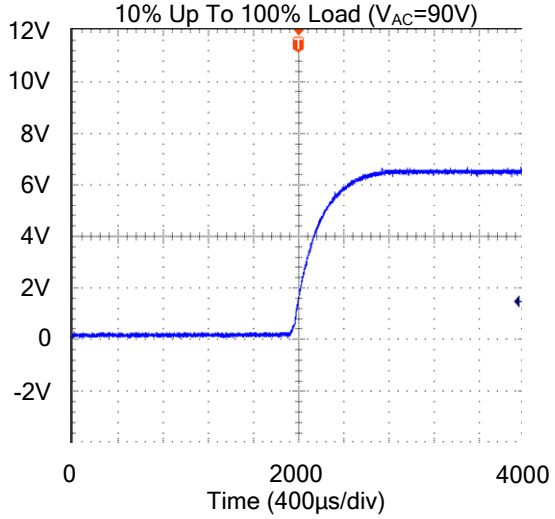
FIG.10 UPS604 Typical Application Circuit

Table1. Components reference description for UPS604 application circuit

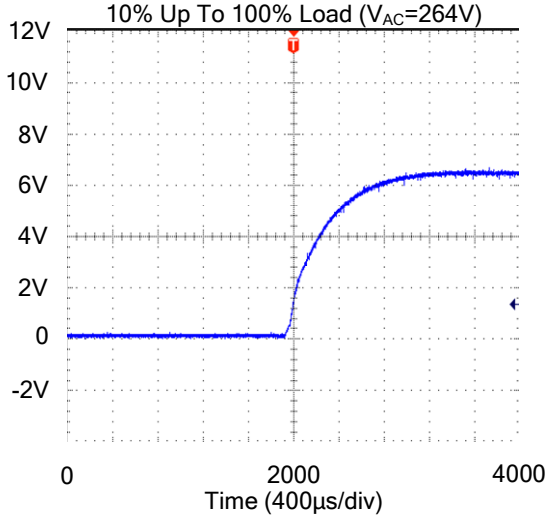
DESIGNATOR	PART TYPE		DESIGNATOR	PART TYPE		DESIGNATOR	PART TYPE
C1	33μF		R1	2.2MΩ		D1	FR107
C2	0.001μF		R2	2.2MΩ		D2	SB5100
C3	22μF		R3	68KΩ		D3	RS1D
C4	470μF		R4	100Ω		IC1	**UPS604**
C5	470μF		R5	1MΩ		IC2	PC-817
C6	0.1μF		R6	15Ω		IC3	TL431
C7	0.01μF		R7	560Ω		YC1	222
C8	0.001μF		R8	1KΩ		T1	EE25
C9	0.1μF		R9	3.9KΩ		L1	UU10.5
C10	220μF		R10	15KΩ		L2	2μH
			R11	10KΩ		L3	Ring Choke
			R12	1.5MΩ~4MΩ		LD1	LED
			R13	1.0Ω		F1	2A/250V
			R14	1.8KΩ		ZNR1	7D471K
						TR1	SCK102R55A
						XC1	334/275V
						BD1	KBP205

■ TYPICAL CHARACTERISTICS

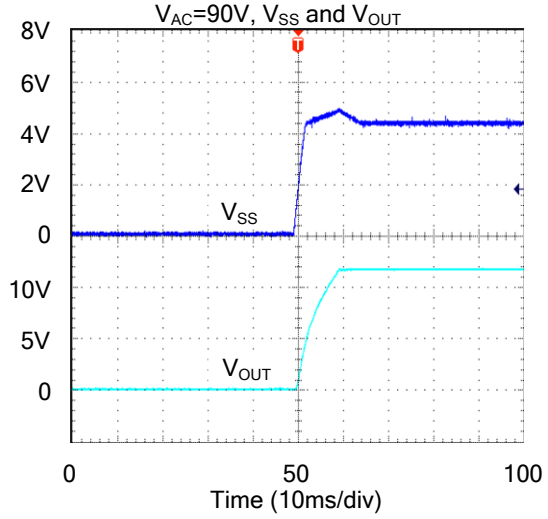
Feedback Voltage During Loadjump From 10% Up To 100% Load (V_{AC}=90V)



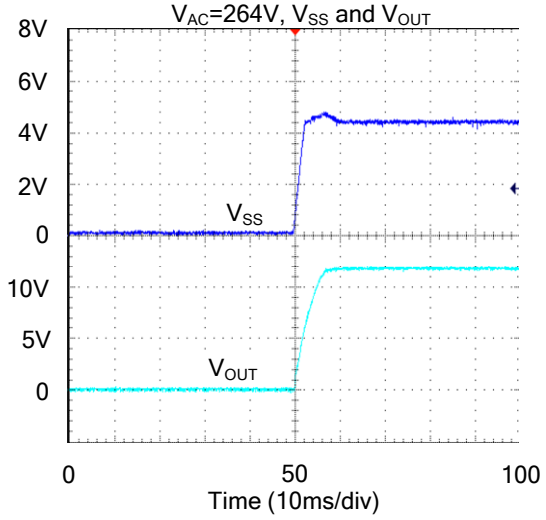
Feedback Voltage During Loadjump From 10% Up To 100% Load (V_{AC}=264V)



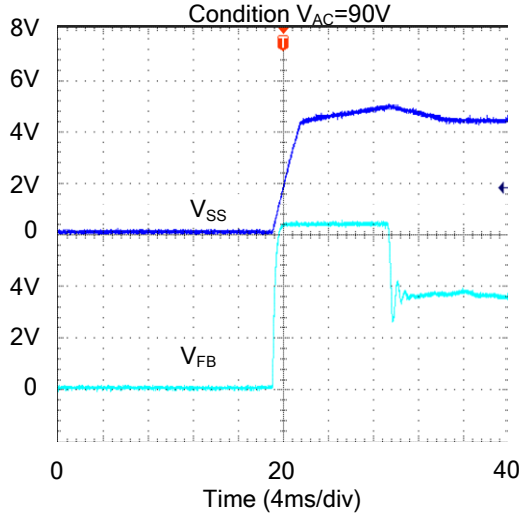
Startup With Full Load Condition at V_{AC}=90V, V_{SS} and V_{OUT}



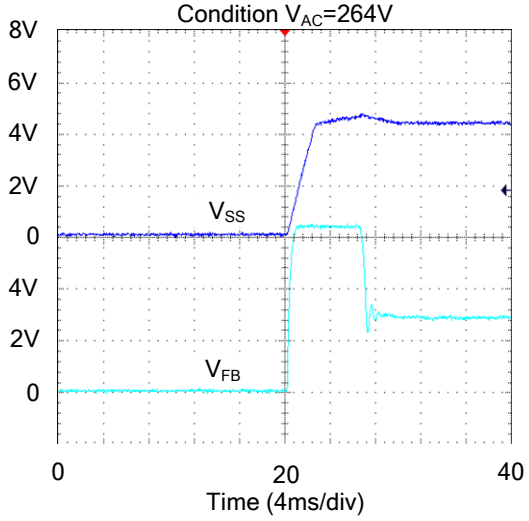
Startup With Full Load Condition at V_{AC}=264V, V_{SS} and V_{OUT}



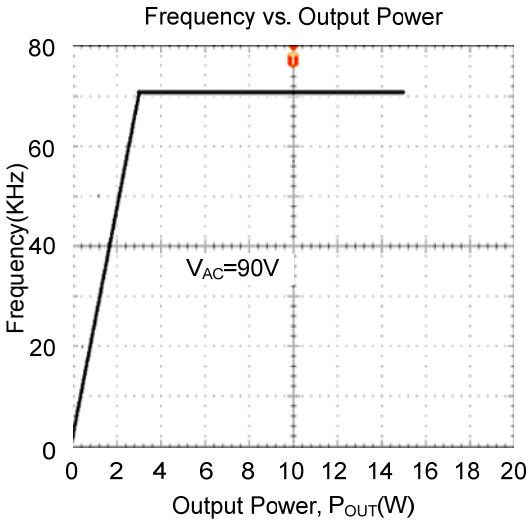
Startup Behavior At Nominal Load Condition V_{AC}=90V

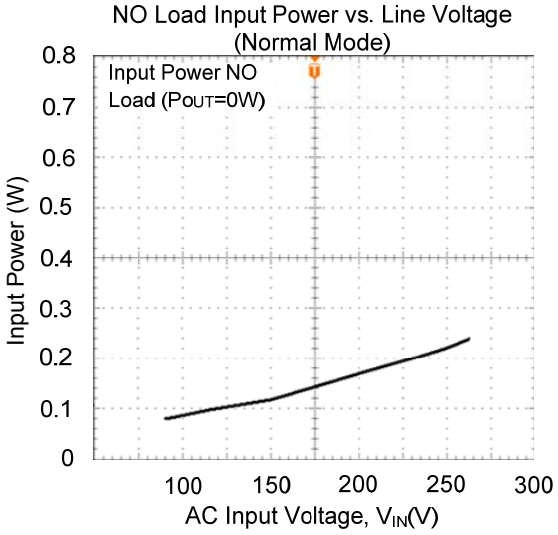


Startup Behavior At Nominal Load Condition V_{AC}=264V



■ TYPICAL CHARACTERISTICS(Cont.)





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