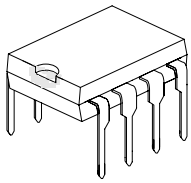
UPS601

LINEAR INTEGRATED CIRCUIT

HIGH PERFORMANCE CURRENT MODE POWER SWITCH



DIP-8

*Pb-free plating product number: UPS601L

■ DESCRIPTION

The UTC UPS601 is designed to provide several special enhancements to satisfy the needs: Power-Saving mode for low standby power, Over Current Protection (OCP), Over Voltage Protection (OVP), Over Load Protection (OLP), UVLO, Over Temperature Protection (OTP) etc protection features. IC will be shutdown when either protection arise and can auto-restart.

■ FEATURES

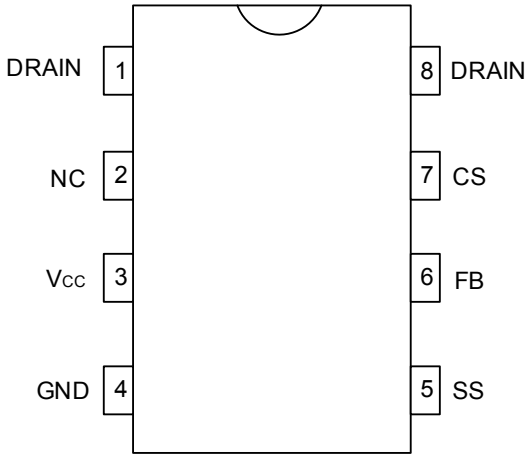
* Low startup current 20uA typ
* Fixed switching frequency(Norm is 70kHz)
* Max duty cycle 70%
* Power-saving mode for low power
* Over temperature protection
* Overload protection
* Over voltage protection
* Leading edge blanking
* Soft start

■ ORDERING INFORMATION

Order Number		Package	Packing
Normal	Lead Free Plating		
UPS601-D08-T	UPS601L-D08-T	DIP-8	Tube

UPS601L-D08-T (1)Packing Type (2)Package Type (3)Lead Plating	(1) T: Tube (2) D08: DIP-8 (3) L: Lead Free Plating, Blank: Pb/Sn

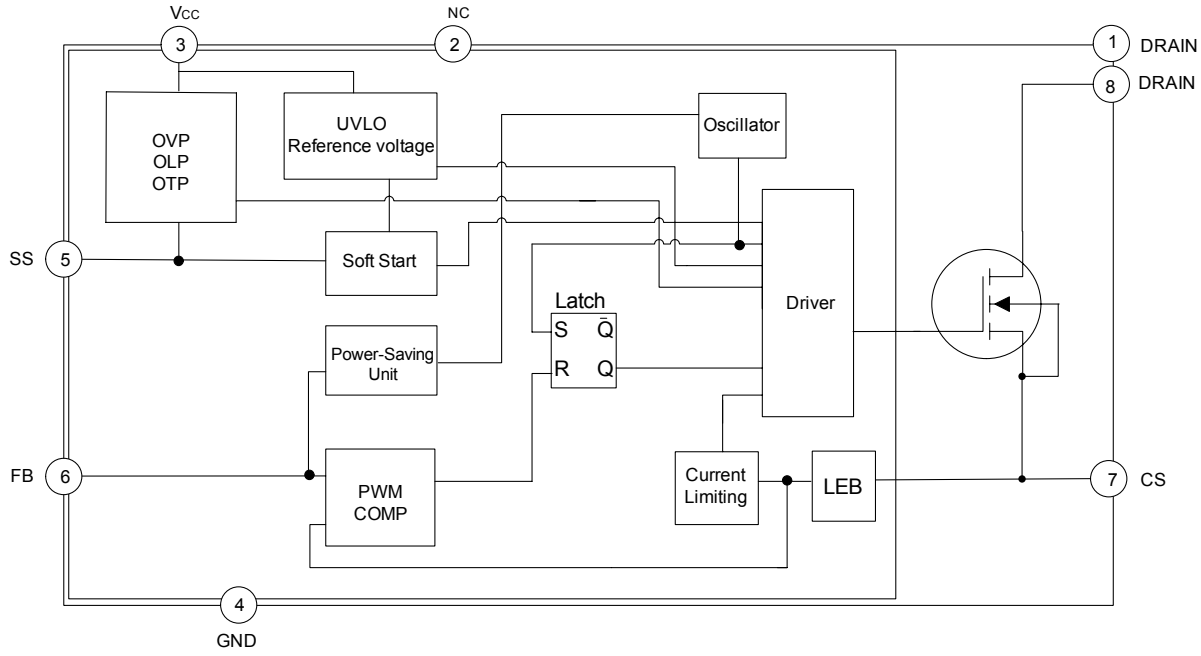
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN	SYMBOL	FUNCTION
1	DRAIN	Power MOSFET drain
2	NC	
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



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

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C, V_{CC}=15V, R_T=75kΩ, unless otherwise specified)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{CC}	26	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
Input Voltage to RT Pin	V_{RT}	-0.3 ~ 6.2	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, R_T=75kΩ, unless otherwise specified)

PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY SECTION							
Start Up Current		I_{STR}	V_{CC}=13.5		22	45	μA
Supply Current with switch	OFF	I_{OFF}	V_{SS} = 0, I_{FB} = 0		3.7	5.5	mA
	ON	I_{ON}	V_{SS} = 5V, I_{FB} = 0		4.0	6.0	mA
UNDER-VOLTAGE LOCKOUT SECTION							
Start Threshold Voltage		$V_{THD(ON)}$		11.8	12.6	13.4	V
Min. Operating Voltage		$V_{CC(MIN)}$		7.6	8.1	8.6	V
Hysteresis		$V_{CC(HY)}$			4.5		V
INTERNAL VOLTAGE REFERENCE							
Reference Voltage		V_{REF}	measured at pin V_{FB}	6.1	6.3	6.5	V
CONTROL SECTION							
Switch Frequency	Normal	$F_{(SW)}$	V_{FB} = 4V	61	68	75	kHz
	Power-Saving		V_{FB} = 1V	18	20	23	kHz
Duty Cycle	MAX	D_{MAX}		65	70	75	%
	MIN	D_{MIN}	V_{FB} < 0.5V	0			%
V_{FB} Operating Level	MIN	V_{MIN}		0.5			V
	MAX	V_{MAX}				4.4	V
Feedback Resistor		R_{FB}		2.6	3.8	5.0	kΩ
Soft-Start Time		T_{SS}	C_{SS}=0.05uF		6		ms
			C_{SS}=0.1uF		12		ms
			C_{SS}=1uF		120		ms
PROTECTION SECTION							
OVP threshold		$V_{(OVP)}$	V_{SS} < 3.5V, V_{FB} > 5V	15.2	16	16.8	V
OLP threshold		$V_{FB(OLP)}$	V_{SS} > 5.4V	4.4	4.6	4.9	V
OTP threshold		$T_{(THR)}$		120	135	150	°C
OVP Disable threshold		$V_{SS(DEACT)}$	V_{FB} > 5V, V_{CC} > 17V	3.7	3.9	4.2	V
OLP Enable threshold		$V_{SS(ACT)}$	V_{FB} > 5V	4.9	5.1	5.4	V
Spike Blanking time		T_{SB}			6.8		μs
CURRENT LIMITING SECTION							
LEB		t_{LEB}			220		ns
POWER MOS-TRANSISTOR SECTION							
Drain-Source Breakdown Voltage		V_{DSS}		600			V
Static Drain-Source On-State Resistance		$R_{DS(ON)}$				15	Ω
Output Capacitance		C_O			56		pF

■ ELECTRICAL CHARACTERISTICS(Cont.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Rise Time	t_R			21		ns
Fall Time	t_F			24		ns
Turn-Off Delay Time	$t_{d(OFF)}$			30		ns
Drain-Source Diode Continuous Source Current	I_S				1	A

■ FUNCTIONAL DESCRIPTION

The internal reference voltages and bias circuit work at V_{CC}>12.6V, and shutdown at V_{CC}< 8.1V.

(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 5.1V, 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, here soft-start phase $T_{soft-start}$ should more than V_{OUT} start-up phase $T_{start-up}$, otherwise, IC will enter false OLP protection state. Because after the soft-start phase end, if V_{OUT} remain in lower voltage, V_{FB} more than 4.6V, then IC enter false OLP state.

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}.

Finally soft-start also set OVP active phase. OVP active phase between V_{SS}=0 and V_{SS}=3.8V, OVP will not be sensed after V_{SS} reach 3.8V.The Soft-start phase T_{SS}：

$$T_{SS} = \begin{cases} 6\ ms & (C_{SS}=0.05uF) \\ 12\ ms & (C_{SS}=0.1uF) \\ 120\ ms & (C_{SS}=1uF) \end{cases}$$

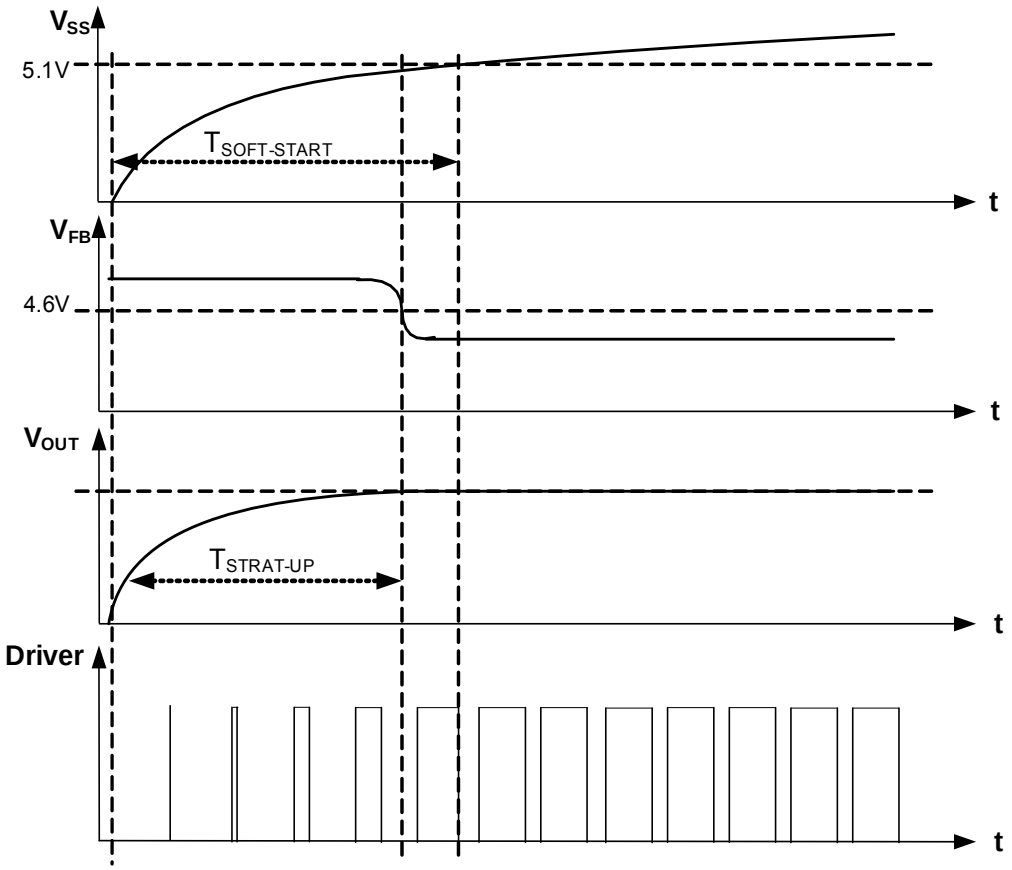


FIG.3 Soft-start phase

■ FUNCTIONAL DESCRIPTION(Cont.)

(2) Switch Frequency Set

The maximum switch frequency decided by an external resistor R_T connected between pin R_T and ground. Then the maximum switch frequency will depend on user requirement. The relation curve between f_{SW} and R_T as followed FIG.5 under the condition of P_{OUT}/P_{OUTmax}=50%. The equation between f_{SW} and R_T as followed (1-2):

$$f_{SW} = -0.61*R_T+115.7 \text{----------(1-2)}$$

After R_T connected, switch frequency is also modulated by output power P_{OUT} during IC operating. So lower switch frequency at lower load, which more and more improve IC's efficiency at light load. Switch frequency is decreased minimum at no load, then the UPS601 will operate at Power-Saving mode for Lower standby power. The relation curve between f_{SW} and P_{OUT}/P_{OUTmax} as followed FIG.4 under the condition of R_T=75kΩ.

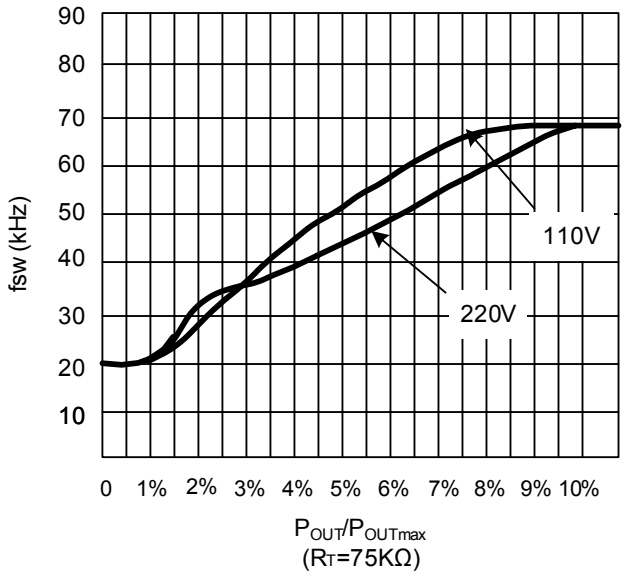


FIG.4 The relation curve between f_{SW} and output power P_{OUT}

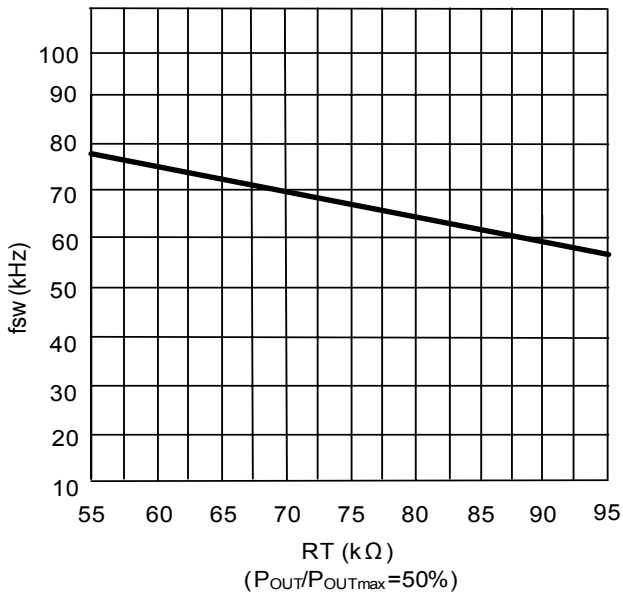


FIG.5 The relation curve between f_{SW} and R_T

■ FUNCTIONAL DESCRIPTION(Cont.)

(3) Protection section

UPS601 takes on more protection functions such as OLP, OVP and OTP etc. In case of those failure modes for continual 7.2μs (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 (V_{SS}>5.1V), IC will shutdown driver if over load state occurs (corresponding to V_{FB}>4.6V) for continual 7.2μs. OLP function will not inactive during soft-start phase. OLP case as followed FIG.6. The test circuit as followed FIG.8 for UPS601.

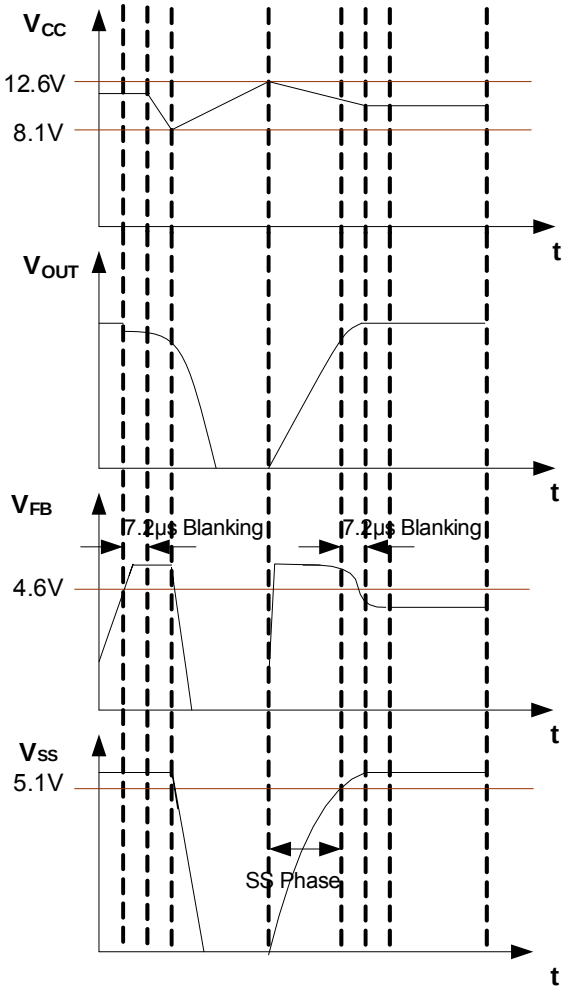


FIG.6 OLP case

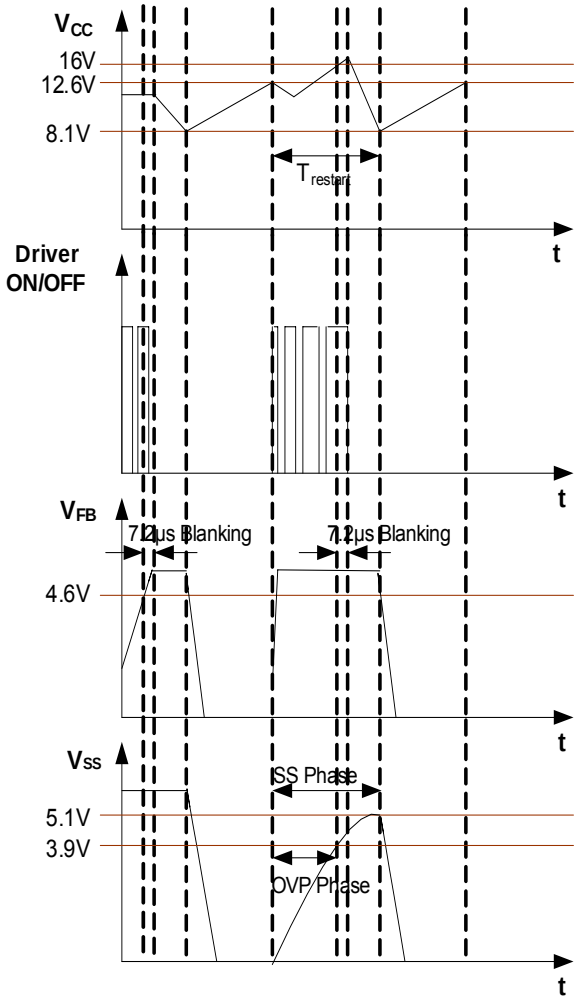


FIG.7 OVP case

OVP

Power supply V_{CC}'s OVP function are enabled only when V_{SS}<3.9 & V_{FB}>4.6V during soft-start phase. During above condition, driver will be shutdown if over voltage state occurs (V_{CC}>16v) for continual 7.2μs. OVP function will not inactive after soft-start phase. OLP case as followed FIG.7. The test circuit as followed FIG.9 for UPS601.

OTP

OTP will shut down driver when junction temperature T_J of internal circuits is more than threshold 135°C for continual 7.2μs.

■ FUNCTIONAL DESCRIPTION(Cont.)

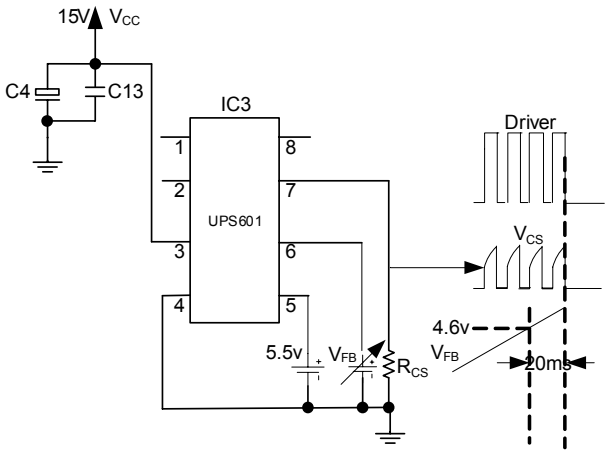


FIG.8 OLP test circuit

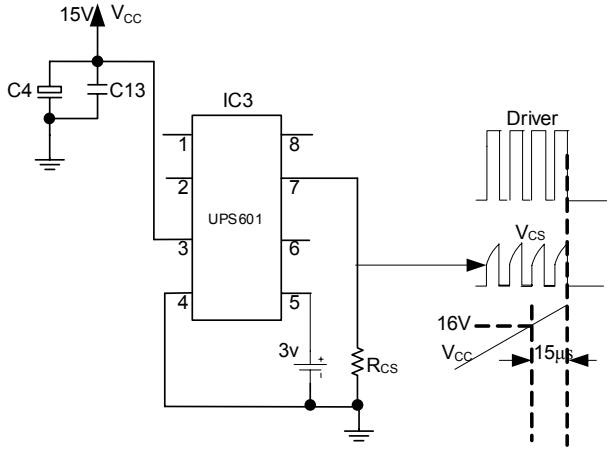


FIG.9 OVP test circuit

(4) Driver Output Section

Rise edge time of driver output is about 200ns for avoiding Low EMI.

(6) Inside power switch MOS transistor

For UPS601, it's inside power MOS transistor may load source current 1A. Specific power MOS transistor parameter is as "POWER MOS TRANSISTOR SECTION" in electrical characteristics table.

■ TYPICAL APPLICATION CIRCUIT

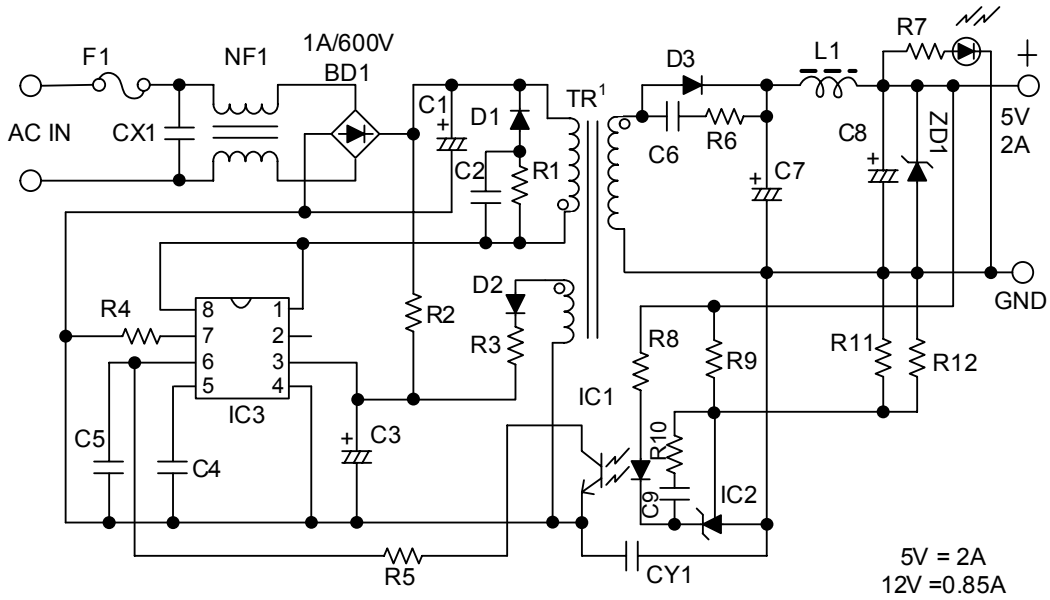


FIG.10 UPS601 Typical Application Circuit

Table1. Components reference description for UPS601 application circuit

CX	0.1uF/250V		R1	100KΩ	1/2W	D1	FR107
C1	33uF/400V		R2	2.2MΩ	1/8W	D2	1N4148
C2	103/1KV		R3	10Ω	1/8W	D3	C83-004
C3	22uF/250V		R4	0.22Ω	1/4W	IC1	PC817C
C4	104/50V		R6	10Ω	1/8W	IC2	UTC431
C5	104/50V		R7	1KΩ	1/8W	CY1	222/250V
C6	102/100V		R8	150Ω	1/8W	TR1	EF25 or EE25
C7	680uF/16V		R9	3.3KΩ	1/8W	L1	5uH
C8	680uF/16V		R10	1KΩ	1/8W	ZD1	6.2V1W
C9	104/50V		R11	3.3KΩ	1/8W	NF1	UU10.5
			R12	47KΩ	1/8W	F1	2A/250V
						IC3	UPS601
						BD1	1A/600V

■ TYPICAL CHARACTERISTICS

Fig 1. Feedback Voltage During Loadjump From 10% Up To 100% Load (V_{DCIN}=120V)

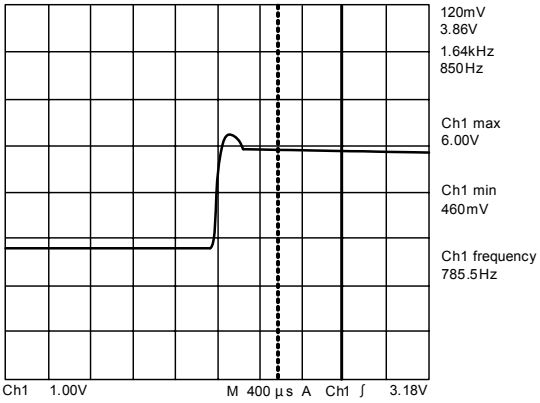


Fig 2. Feedback Voltage During Loadjump From 10% Up To 100% Load (V_{DCIN}=350V)

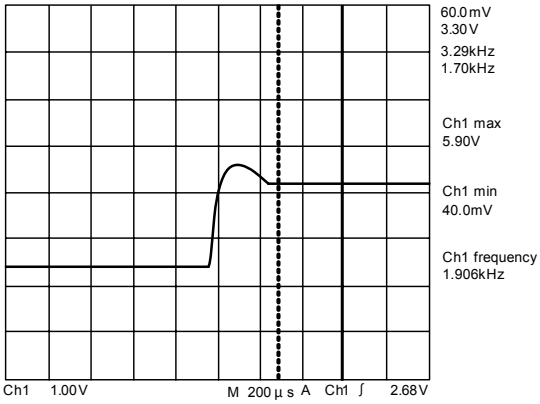


Fig 3. Startup With Full Load Condition At V_{DCIN}=120V, Vc4 and Vout

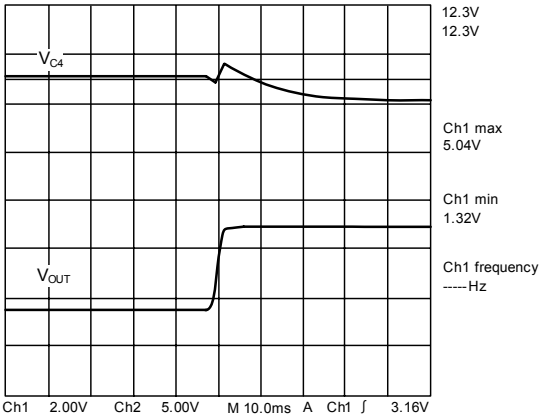


Fig 4. Startup With Full Load Condition At V_{DCIN}=350V, Vc4 and Vout

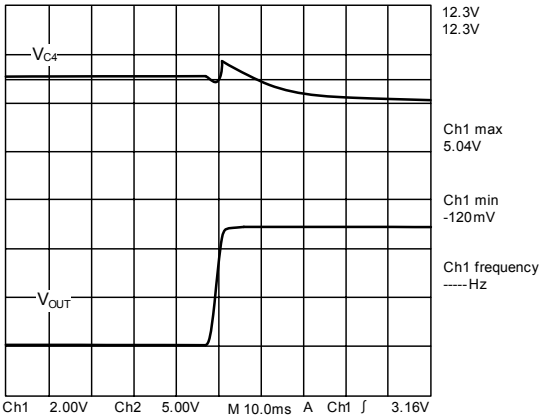


Fig 5. Startup Behavior At Nominal Load Condition V_{DCIN}=120V

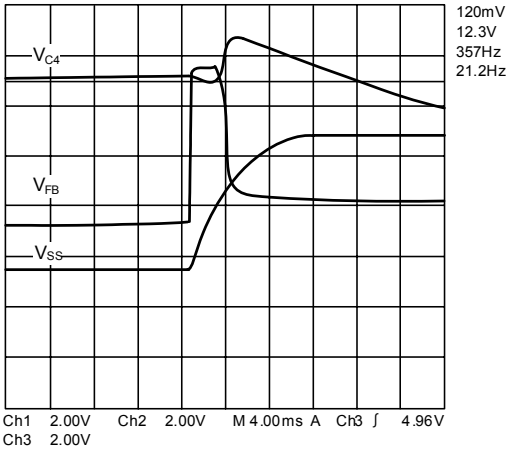
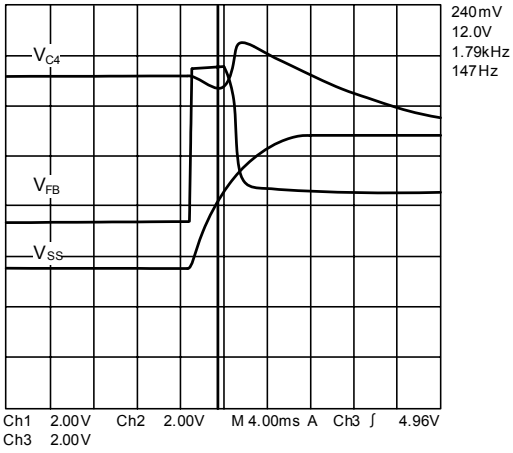


Fig 6. Startup Behavior At Nominal Load Condition V_{DCIN}=350V



■ TYPICAL CHARACTERISTICS(Cont.)

Fig 7. Frequency vs. Output Power

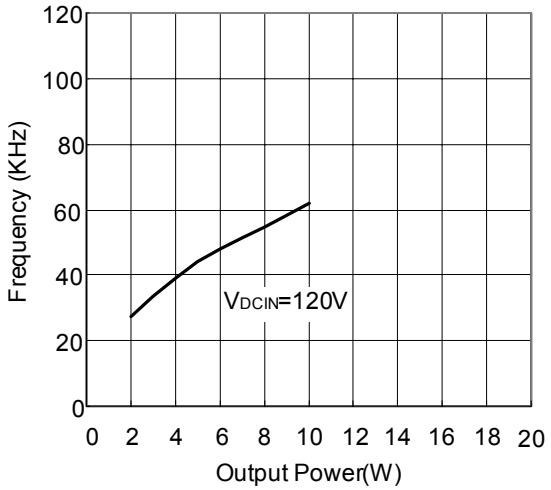


Fig 8. NO Load Input Power vs. Line Voltage (Normal Mode)