



## UPS602

### LINEAR INTEGRATED CIRCUIT

## HIGH PERFORMANCE CURRENT MODE POWER SWITCH

### ■ DESCRIPTION

The UTC UPS602 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

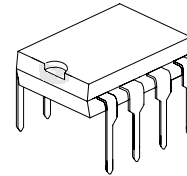
### ■ ORDERING INFORMATION

| Order Number |                   | Package | Packing |
|--------------|-------------------|---------|---------|
| Normal       | Lead Free Plating |         |         |
| UPS602-D08-T | UPS602L-D08-T     | DIP-8   | Tube    |

UPS602L-D08-T

- (1)Packing Type
- (2)Package Type
- (3)Lead Plating

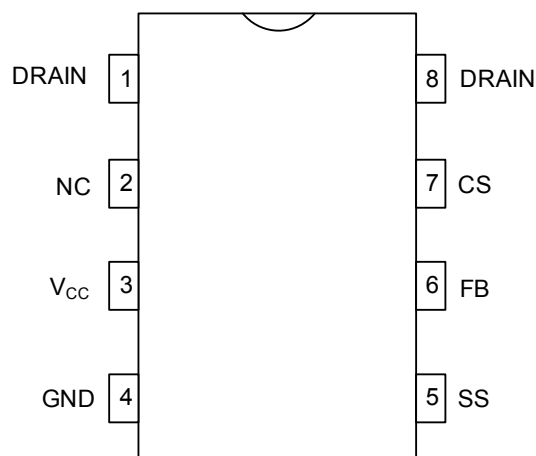
- (1) T: Tube
- (2) D08: DIP-8
- (3) L: Lead Free Plating, Blank: Pb/Sn



DIP-8

\*Pb-free plating product number: UPS602L

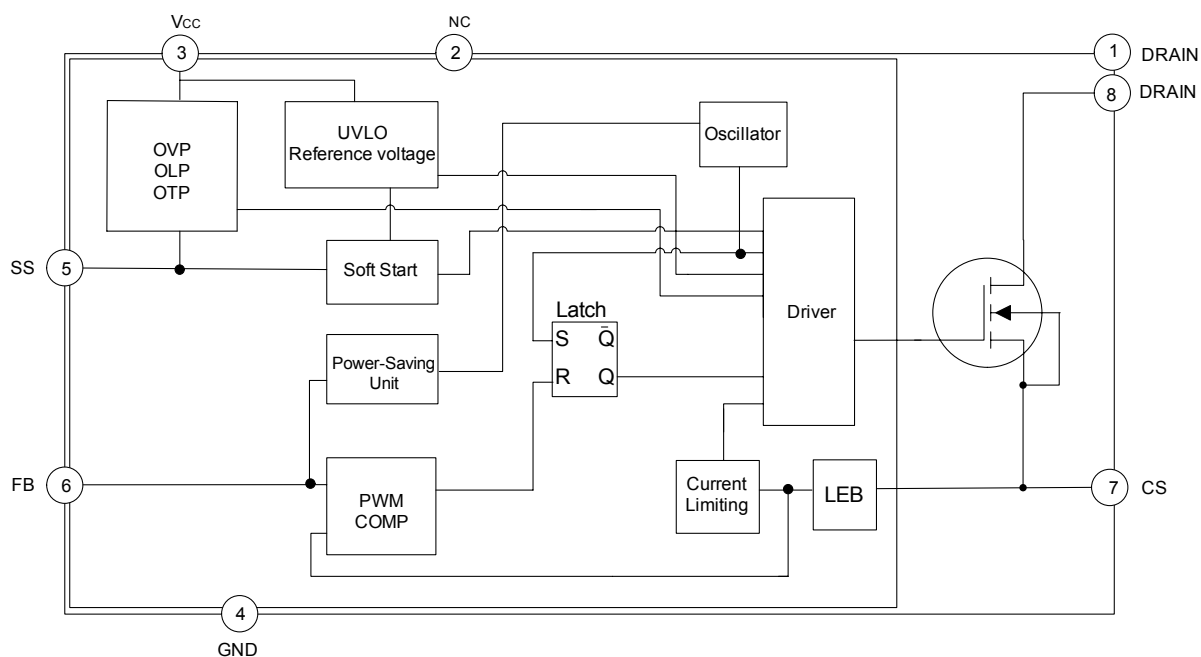
### ■ PIN CONFIGURATION



### ■ PIN DESCRIPTION

| PIN | SYMBOL          | FUNCTION                       |
|-----|-----------------|--------------------------------|
| 1   | DRAIN           | Power MOSFET drain             |
| 2   | NC              |                                |
| 3   | V <sub>CC</sub> | 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(Lid Edge Blanking)  
 SS(Soft Start)

■ ABSOLUTE MAXIMUM RATINGS (Ta = 25°C, V<sub>CC</sub>=15V, R<sub>T</sub>=75kΩ, unless otherwise specified)

| PARAMETER               | SYMBOL           | RATINGS    | UNIT |
|-------------------------|------------------|------------|------|
| Supply Voltage          | V <sub>CC</sub>  | 26         | V    |
| Input Voltage to FB Pin | V <sub>FB</sub>  | -0.3 ~ 6.2 | V    |
| Input Voltage to CS Pin | V <sub>CS</sub>  | -0.3 ~ 2.8 | V    |
| Input Voltage to RT Pin | V <sub>RT</sub>  | -0.3 ~ 6.2 | V    |
| Junction Temperature    | T <sub>J</sub>   | +150       | °C   |
| Operating Temperature   | T <sub>OPR</sub> | -40 ~ +125 | °C   |
| Storage Temperature     | T <sub>STG</sub> | -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 <sub>CC</sub> | 8.6 ~ 22 | V    |

■ ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sub>CC</sub>=15V, R<sub>T</sub>=75kΩ, unless otherwise specified)

| PARAMETER                               |              | SYMBOL                 | TEST CONDITIONS                              | MIN  | TYP  | MAX  | UNIT |
|-----------------------------------------|--------------|------------------------|----------------------------------------------|------|------|------|------|
| SUPPLY SECTION                          |              |                        |                                              |      |      |      |      |
| Start Up Current                        |              | I <sub>STR</sub>       | V <sub>CC</sub> =13.5                        |      | 22   | 45   | μA   |
| Supply Current with switch              | OFF          | I <sub>OFF</sub>       | V <sub>SS</sub> = 0, I <sub>FB</sub> = 0     |      | 3.7  | 5.5  | mA   |
|                                         | ON           | I <sub>ON</sub>        | V <sub>SS</sub> = 5V, I <sub>FB</sub> = 0    |      | 4.0  | 6.0  | mA   |
| UNDER-VOLTAGE LOCKOUT SECTION           |              |                        |                                              |      |      |      |      |
| Start Threshold Voltage                 |              | V <sub>THD(ON)</sub>   |                                              | 11.8 | 12.6 | 13.4 | V    |
| Min. Operating Voltage                  |              | V <sub>CC(MIN)</sub>   |                                              | 7.6  | 8.1  | 8.6  | V    |
| Hysteresis                              |              | V <sub>CC(HY)</sub>    |                                              |      | 4.5  |      | V    |
| INTERNAL VOLTAGE REFERENCE              |              |                        |                                              |      |      |      |      |
| Reference Voltage                       |              | V <sub>REF</sub>       | measured at pin V <sub>FB</sub>              | 6.1  | 6.3  | 6.5  | V    |
| CONTROL SECTION                         |              |                        |                                              |      |      |      |      |
| Switch Frequency                        | Normal       | F <sub>(SW)</sub>      | V <sub>FB</sub> = 4V                         | 61   | 68   | 75   | kHz  |
|                                         | Power-Saving |                        | V <sub>FB</sub> = 1V                         | 18   | 20   | 23   | kHz  |
| Duty Cycle                              | MAX          | D <sub>MAX</sub>       |                                              | 65   | 70   | 75   | %    |
|                                         | MIN          | D <sub>MIN</sub>       | V <sub>FB</sub> < 0.5V                       | 0    |      |      | %    |
| V <sub>FB</sub> Operating Level         | MIN          | V <sub>MIN</sub>       |                                              | 0.5  |      |      | V    |
|                                         | MAX          | V <sub>MAX</sub>       |                                              |      |      | 4.4  | V    |
| Feedback Resistor                       |              | R <sub>FB</sub>        |                                              | 2.6  | 3.8  | 5.0  | kΩ   |
| Soft-Start Time                         |              | T <sub>SS</sub>        | C <sub>SS</sub> =0.05uF                      |      | 6    |      | ms   |
|                                         |              |                        | C <sub>SS</sub> =0.1uF                       |      | 12   |      | ms   |
|                                         |              |                        | C <sub>SS</sub> =1uF                         |      | 120  |      | ms   |
| PROTECTION SECTION                      |              |                        |                                              |      |      |      |      |
| OVP threshold                           |              | V <sub>(OVP)</sub>     | V <sub>SS</sub> < 3.5V, V <sub>FB</sub> > 5V | 15.2 | 16   | 16.8 | V    |
| OLP threshold                           |              | V <sub>FB(OLP)</sub>   | V <sub>SS</sub> > 5.4V                       | 4.4  | 4.6  | 4.9  | V    |
| OTP threshold                           |              | T <sub>(THR)</sub>     |                                              | 120  | 135  | 150  | °C   |
| OVP Disable threshold                   |              | V <sub>SS(DEACT)</sub> | V <sub>FB</sub> > 5V, V <sub>CC</sub> > 17V  | 3.7  | 3.9  | 4.2  | V    |
| OLP Enable threshold                    |              | V <sub>SS(ACT)</sub>   | V <sub>FB</sub> > 5V                         | 4.9  | 5.1  | 5.4  | V    |
| Spike Blanking time                     |              | T <sub>SB</sub>        |                                              |      | 6.8  |      | μs   |
| CURRENT LIMITING SECTION                |              |                        |                                              |      |      |      |      |
| LEB                                     |              | t <sub>LEB</sub>       |                                              |      | 220  |      | ns   |
| POWER MOS-TRANSISTOR SECTION            |              |                        |                                              |      |      |      |      |
| Drain-Source Breakdown Voltage          |              | V <sub>DSS</sub>       |                                              | 600  |      |      | V    |
| Static Drain-Source On-State Resistance |              | R <sub>DS(ON)</sub>    |                                              |      |      | 5    | Ω    |
| Output Capacitance                      |              | C <sub>O</sub>         |                                              |      | 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 | $I_S$        |                 |     |     | 2   | 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  $T_{SS}$  :

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

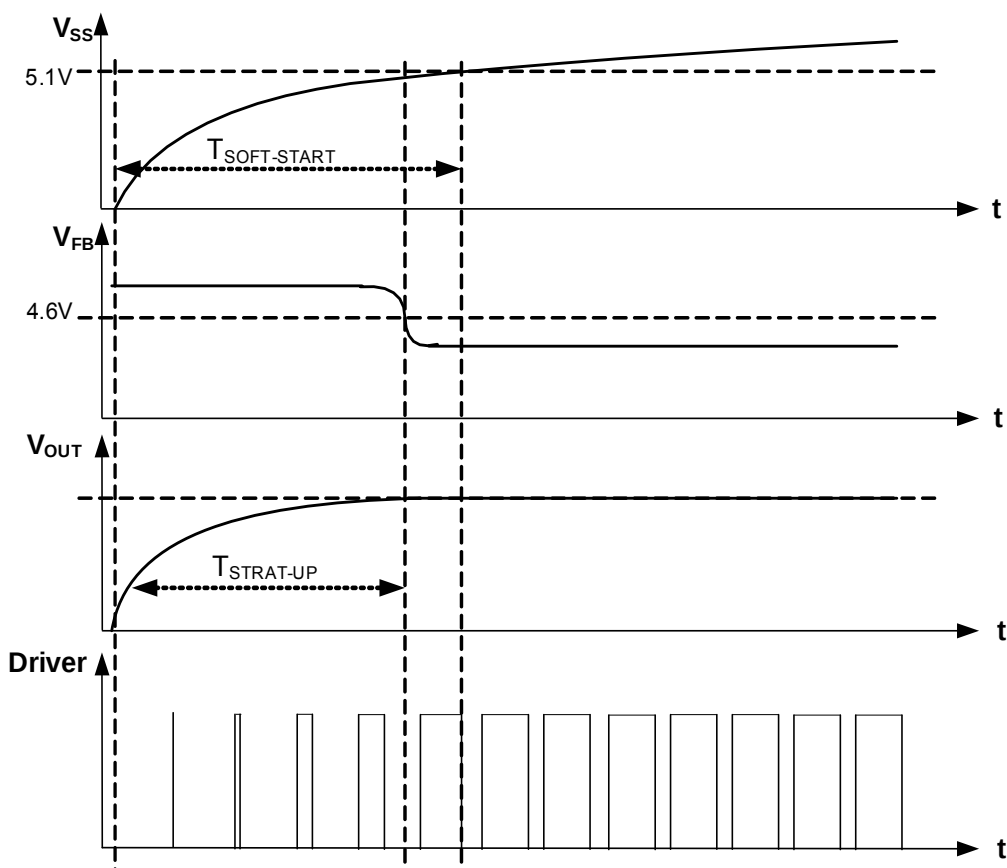


FIG.3 Soft-start phase

## ■ 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):

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

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 UPS602 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  $R_T=75k\Omega$ .

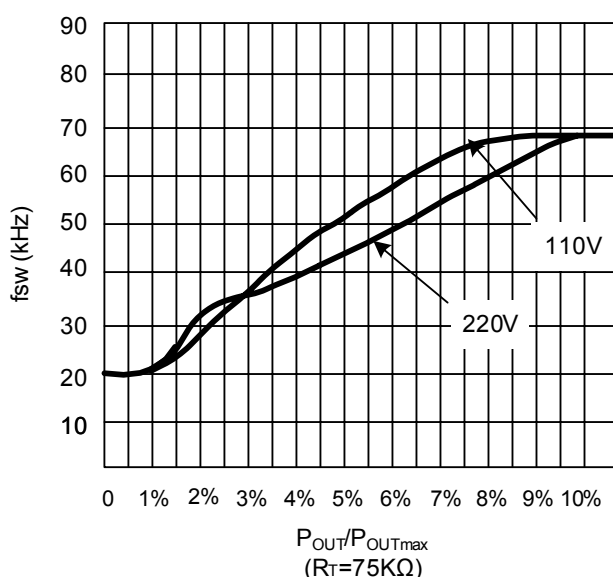


FIG.4 The relation curve between  $f_{SW}$  and relative output power  $P_{OUT}/P_{OUTmax}$

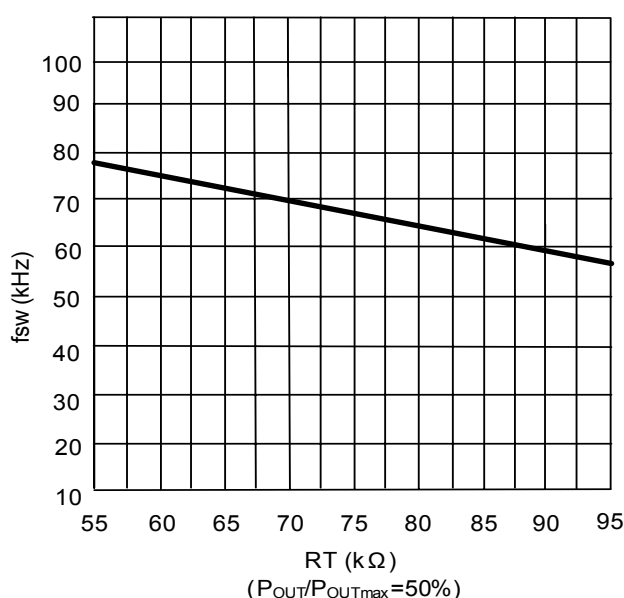


FIG.5 The relation curve between  $f_{SW}$  and  $R_T$

### ■ FUNCTIONAL DESCRIPTION(Cont.)

#### (3) Protection section

UPS602 takes on more protection functions such as OLP, OVP and OTP etc. In case of those failure modes for continual 7.2 $\mu$ s (blanking time), the driver is shut down. At the same time, IC enters auto-restart, V<sub>CC</sub> power on and driver is reset after V<sub>CC</sub> power on again.

#### OLP

After soft-start phase end (V<sub>SS</sub>>5.1V), IC will shutdown driver if over load state occurs (corresponding to V<sub>FB</sub>>4.6V) for continual 7.2 $\mu$ s. OLP function will not inactive during soft-start phase. OLP case as followed FIG. 6. The test circuit as followed FIG.8 for UPS602.

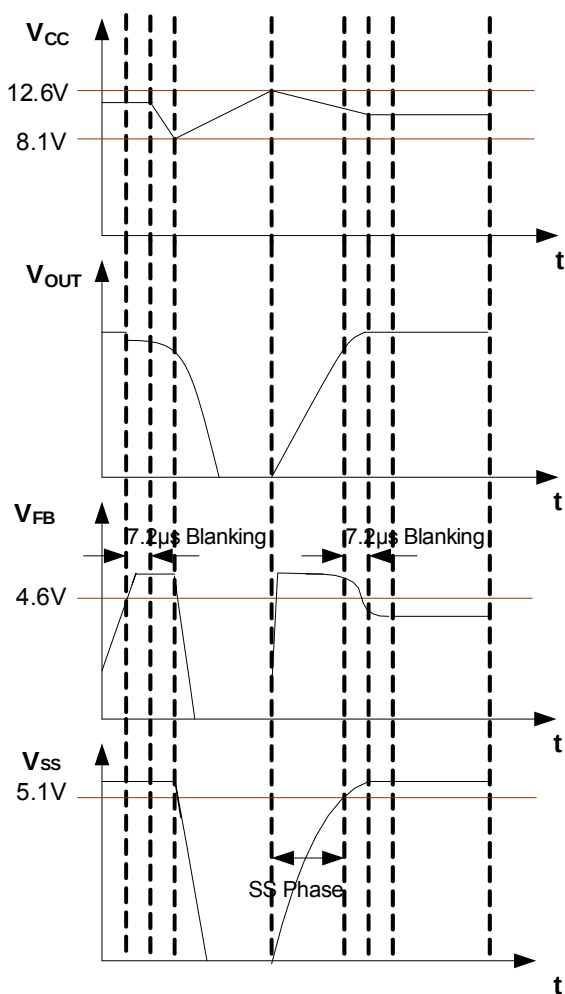


FIG.6 OLP case

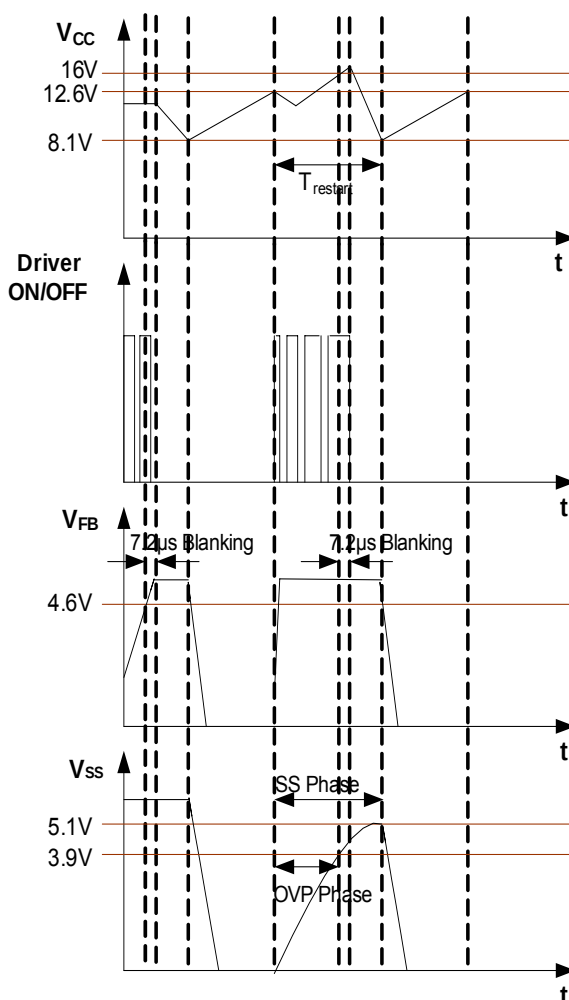


FIG.7 OVP case

#### OVP

Power supply V<sub>CC</sub>'s OVP function are enabled only when V<sub>SS</sub><3.9 & V<sub>FB</sub>>4.6V during soft-start phase. During above condition, driver will be shutdown if over voltage state occurs (V<sub>CC</sub>>16V) for continual 7.2 $\mu$ s. OVP function will not inactive after soft-start phase. OLP case as followed FIG.7. The test circuit as followed FIG.9 for UPS602.

#### OTP

OTP will shut down driver when junction temperature T<sub>J</sub> of internal circuits is more than threshold 135°C for continual 7.2 $\mu$ s.

### ■ FUNCTIONAL DESCRIPTION(Cont.)

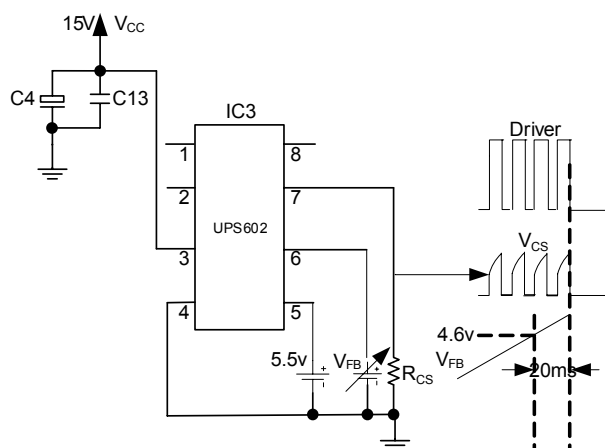


FIG.8 OLP test circuit

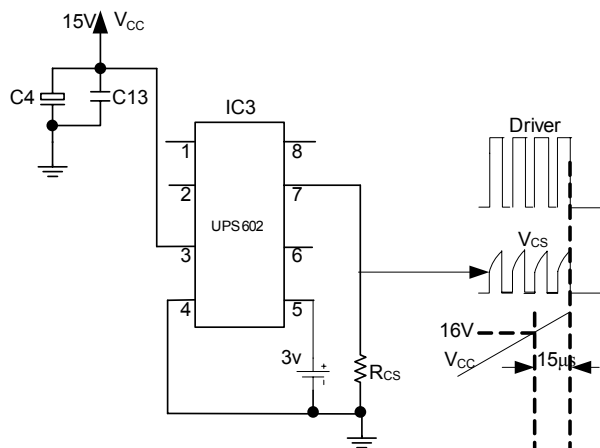


FIG.9 OVP test circuit

#### (4) Driver Output Section

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

#### (6) Inside power switch MOS transistor

For UPS602, it's inside power MOS transistor may load source current 2A. Specific power MOS transistor parameter is as "POWER MOS TRANSISTOR SECTION" in electrical characteristics table.

### ■ TYPICAL APPLICATION CIRCUIT

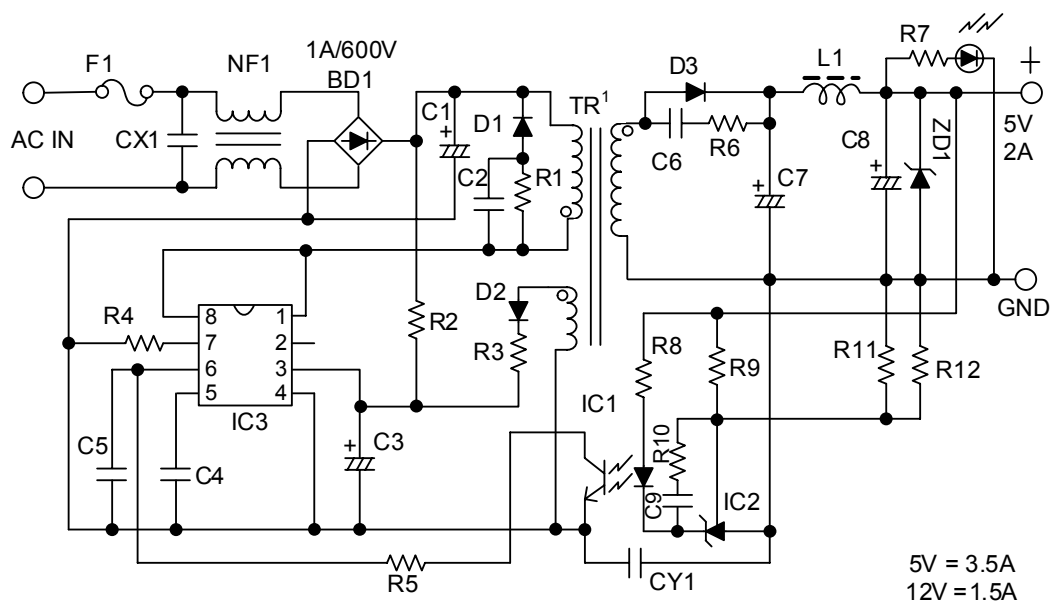


FIG.10 UPS602 Typical Application Circuit

Table1. Components reference description for UPS602 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 | UPS602       |
|    |            |     |       |      | BD1 | 1A/600V      |

## ■ TYPICAL CHARACTERISTICS(Cont.)

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

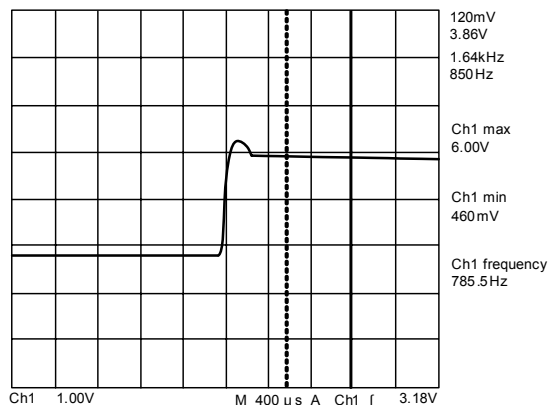


Fig 2. Feedback Voltage During Loadjump From 10% Up To 100% Load ( $V_{DCIN}=350V$ )

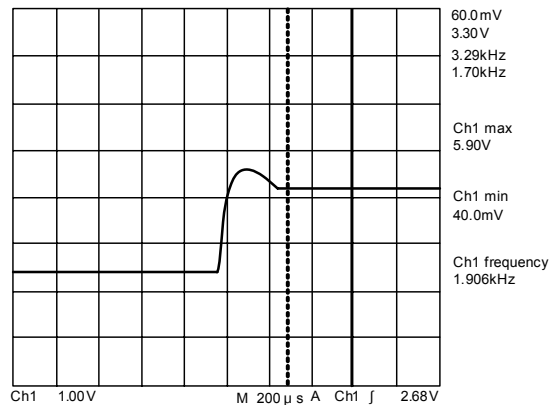


Fig 3. Startup With Full Load Condition At  $V_{DCIN}=120V$ ,  $V_{C4}$  and  $V_{out}$

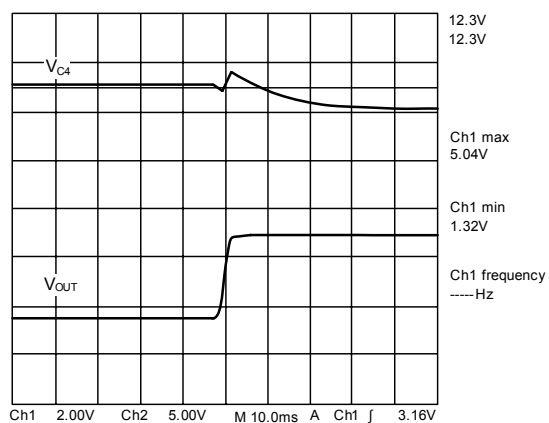


Fig 4. Startup With Full Load Condition At  $V_{DCIN}=350V$ ,  $V_{C4}$  and  $V_{out}$

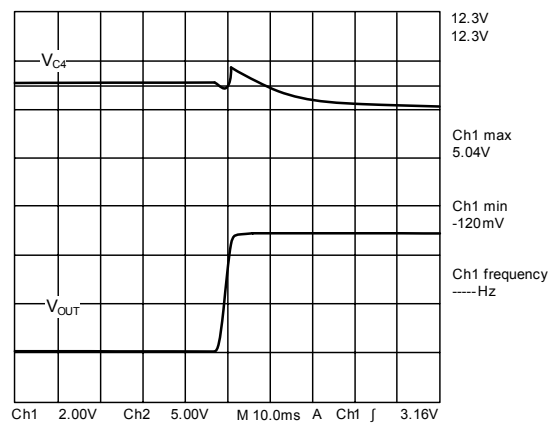


Fig 5. Startup Behavior At Nominal Load Condition  $V_{DCIN}=120V$

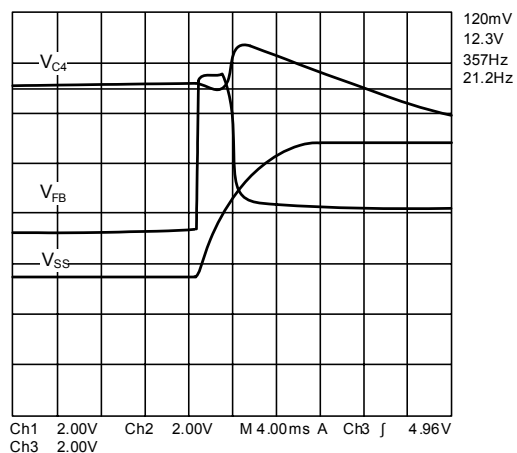
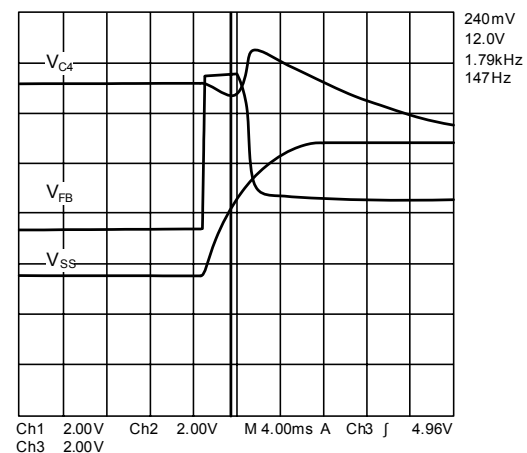


Fig 6. Startup Behavior At Nominal Load Condition  $V_{DCIN}=350V$



### ■ TYPICAL CHARACTERISTICS(Cont.)

Fig 7. Frequency vs. Output Power

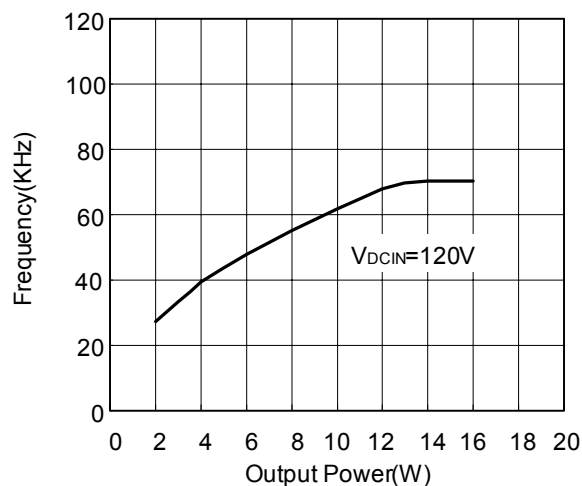
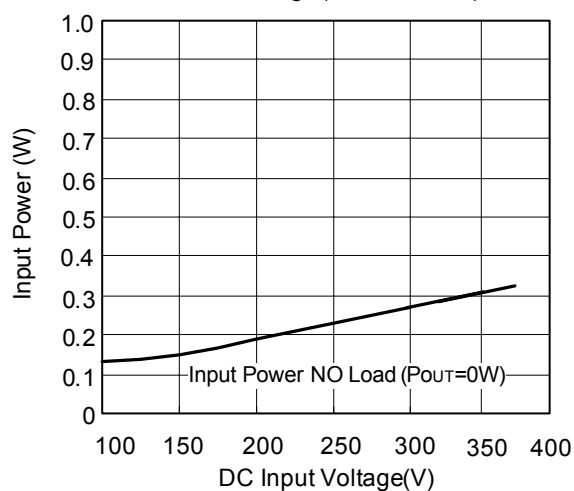


Fig 8. NO Load Input Power vs. Line Voltage(Normal Mode)



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