

**U3848/A/B/C****LINEAR INTEGRATED CIRCUIT****HIGH PERFORMANCE  
CURRENT MODE PWM  
CONTROLLERS****DESCRIPTION**

The UTC U3848/A/B/C 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), Over Temperature Protection (OTP) etc protection features. IC will be shutdown when either protection arise and can auto-restart. Its frequency may be defined by user through resistor  $R_T$  to external ground. UVLO featuring typical start-up current  $20\mu A$ , and  $V_{CC(ON)}$  12.6V,  $V_{CC(OFF)}$  8.1V. Lower typical operation current  $I_{CC}$  3.7mA at inactive output.

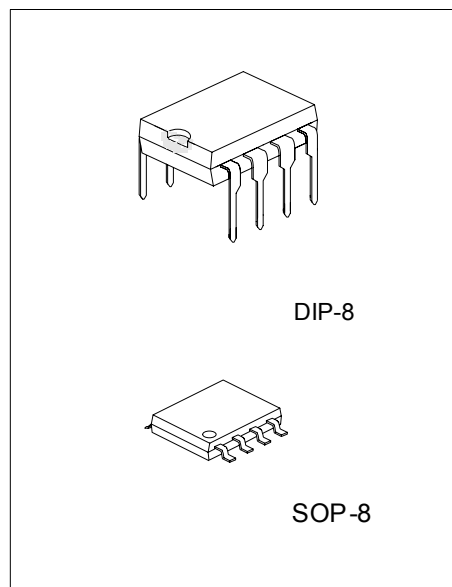
The output stage, suitable for driving N-Channel MOSFETs, can operate to duty cycles approach 70%. The U3848/A/B/C are fully pin-to-pin compatible with UC3842. But pin  $R_T$  only connected a resistor to ground to decide switch frequency, and pin FB with an  $4k\Omega$  pull up resistor to internal reference voltage. The U3848/A/B/C also have soft-start function avoiding overshoot, and controlled driver output rise edge time  $t_R$  for low EMI.

**FEATURES**

- \* Low startup and operation current
- \* User defined switching frequency(Norm is 70kHz)
- \* Max duty cycle 70%
- \* Power-saving mode for low power
- \* Under voltage lockout with hysteresis
- \* Over temperature protection
- \* Overload protection
- \* Over voltage protection
- \* Leading edge blanking
- \* Soft start

**ORDERING INFORMATION**

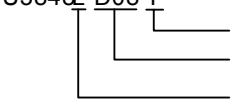
| Order Number |                   | Package | Packing   |
|--------------|-------------------|---------|-----------|
| Normal       | Lead Free Plating |         |           |
| U3848-D08-T  | U3848L-D08-T      | DIP-8   | Tube      |
| U3848-S08-R  | U3848L-S08-R      | SOP-8   | Tape Reel |
| U3848-S08-T  | U3848L-S08-T      | SOP-8   | Tube      |
| U3848A-D08-T | U3848AL-D08-T     | DIP-8   | Tube      |
| U3848A-S08-R | U3848AL-S08-R     | SOP-8   | Tape Reel |
| U3848A-S08-T | U3848AL-S08-T     | SOP-8   | Tube      |
| U3848B-D08-T | U3848BL-D08-T     | DIP-8   | Tube      |
| U3848B-S08-R | U3848BL-S08-R     | SOP-8   | Tape Reel |
| U3848B-S08-T | U3848BL-S08-T     | SOP-8   | Tube      |
| U3848C-D08-T | U3848CL-D08-T     | DIP-8   | Tube      |
| U3848C-S08-R | U3848CL-S08-R     | SOP-8   | Tape Reel |
| U3848C-S08-T | U3848CL-S08-T     | SOP-8   | Tube      |



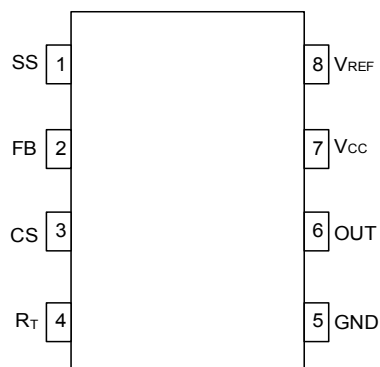
\*Pb-free plating product number:

U3848L/U3848AL/U3848BL/U3848CL

### ■ ORDERING INFORMATION(Cont.)

|                                                                                                                                                                       |                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <p>U3848-L-D08-T</p>  <p>(1)Packing Type<br/>(2)Package Type<br/>(3)Lead Plating</p> | <p>(1) R: Tape Reel, T: Tube<br/>(2) D08: DIP-8, S08: SOP-8<br/>(3) L: Lead Free Plating, Blank: Pb/Sn</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|

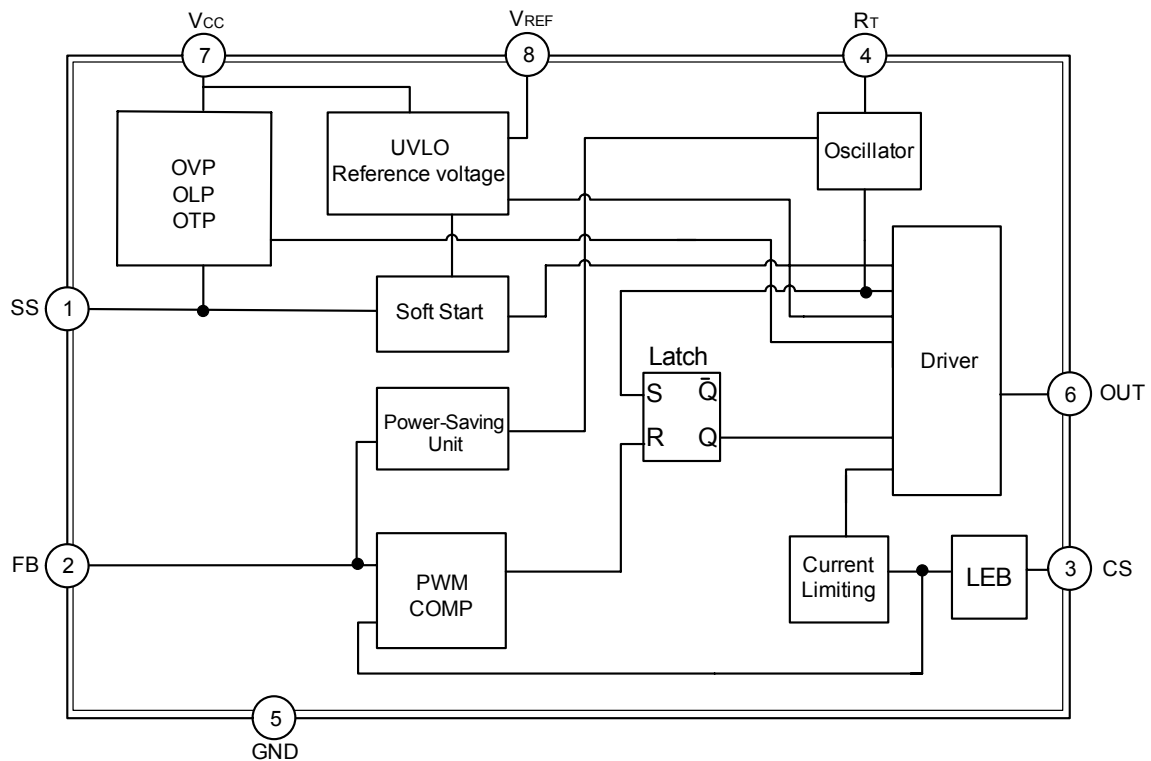
## ■ PIN CONFIGURATION



## ■ PIN DESCRIPTION

| PIN | SYMBOL           | FUNCTION                                                          |
|-----|------------------|-------------------------------------------------------------------|
| 1   | SS               | Soft-start                                                        |
| 2   | FB               | Feedback                                                          |
| 3   | CS               | Controller current sense input                                    |
| 4   | R <sub>T</sub>   | The resistor controlling switch frequency                         |
| 5   | GND              | Ground                                                            |
| 6   | OUT              | Output to the gate of external power MOS                          |
| 7   | V <sub>CC</sub>  | Supply voltage                                                    |
| 8   | V <sub>REF</sub> | Inter 6.3V reference voltage, connected with the filter capacitor |

### ■ 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<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> | 8.2 ~ 21 | 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> =12.5V                       |                | 27   | 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>REF</sub>             | 6.1            | 6.3  | 6.6  | V    |     |
| CONTROL SECTION                                         |              |                        |                                              |                |      |      |      |     |
| Switch Frequency                                        | Normal       | F <sub>(SW)</sub>      | V <sub>FB</sub> = 4V                         | U3848/B(Note1) | 85   | 95   | 105  | kHz |
|                                                         |              |                        | U3848A/C(Note2)                              | 61             | 68   | 75   | kHz  |     |
|                                                         | Power-Saving |                        | V <sub>FB</sub> = 1V                         |                | 17   | 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   |     |
| External Resistor for controlling Current Source of OSC |              | R <sub>T</sub>         |                                              |                | 75   |      | 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>        |                                              |                | 7.2  |      | μs   |     |
| CURRENT LIMITING SECTION                                |              |                        |                                              |                |      |      |      |     |
| LEB                                                     |              | t <sub>LEB</sub>       |                                              |                | 220  |      | ns   |     |

### ■ ELECTRICAL CHARACTERISTICS(Cont.)

| PARAMETER                    |         | SYMBOL   | TEST CONDITIONS              | MIN  | TYP | MAX | UNIT |
|------------------------------|---------|----------|------------------------------|------|-----|-----|------|
| <b>DRIVER OUTPUT SECTION</b> |         |          |                              |      |     |     |      |
| Output Voltage Low State     |         | $V_{OL}$ | $I_{SOURCE} = 200\text{ mA}$ |      |     | 2.5 | V    |
| Output Voltage High State    |         | $V_{OH}$ | $I_{SINK} = 200\text{ mA}$   | 12.2 |     |     | V    |
| Output Voltage Rise Time     | U3848B  | $t_R$    | $C_L = 1.0\text{ nF}$        |      | 70  | 150 | ns   |
|                              | U3848C  |          | $C_L = 1.0\text{ nF}$        |      | 200 | 300 | ns   |
|                              | U3848/A |          | $C_L = 1.0\text{ nF}$        |      | 300 | 400 | ns   |
| Output Voltage Fall Time     |         | $t_F$    | $C_L = 1.0\text{ nF}$        |      | 50  | 90  | ns   |

Note: 1.  $R_T=65k\Omega$  should be connected for U3848/ U3848B.

2. U3848A/C denote U3848A and U3848C.

## ■ 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  $T_{\text{soft-start}}$  should more than  $V_{OUT}$  start-up phase  $T_{\text{start-up}}$ , 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  $V_{CC(\text{MIN})}$  during  $V_{CC}$  power on. Otherwise, if soft-start phase remain not end before  $V_{CC}$  reach  $V_{CC(\text{MIN})}$  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  $T_{SS}$  :

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

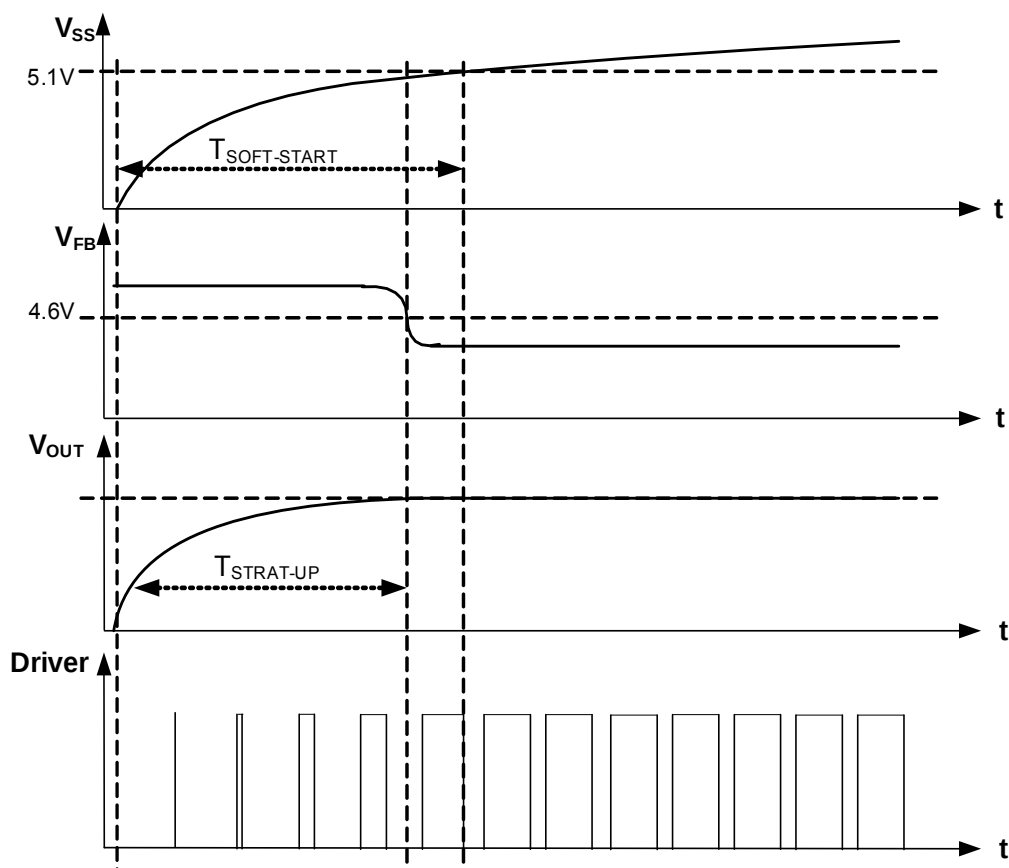


FIG.3 Soft-start phase

## ■ 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  $P_{OUT}=8W$ . The equation between  $f_{SW}$  and  $R_T$  as followed (1-2) for U3848A/C, (1-3) for U3848/B:

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

$$f_{SW} = -1.1 \cdot R_T + 167.5 \text{-----(1-3)}$$

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 U3848/B will operate at Power-Saving mode for Lower standby power. The relation curve between  $f_{SW}$  and  $P_{OUT}$  as followed FIG.4 under the condition of  $R_T=75k\Omega$ . The frequency wave of U3848A/C is similar with U3848/B's, and for them, maximum frequency point is 70kHz.

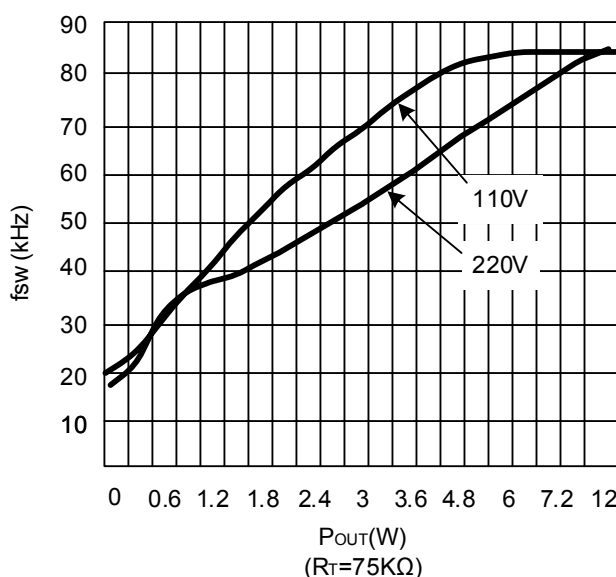


FIG.4 The relation curve between  $f_{SW}$  and output power  $P_{OUT}$

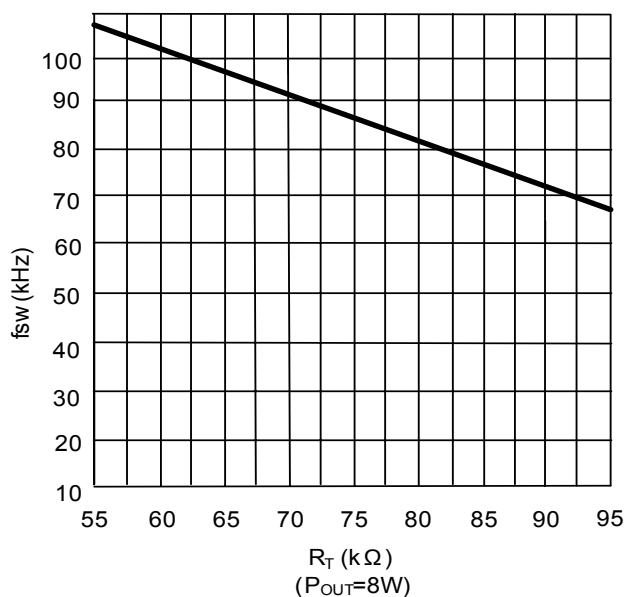


FIG.5 The relation curve between  $f_{SW}$  and  $R_T$

## ■ FUNCTIONAL DESCRIPTION(Cont.)

### (3) Protection section

U3848/A/B/C 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,  $V_{CC}$  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 7.2 $\mu$ s. OLP function will not inactive during soft-start phase. OLP case as followed FIG.6. The test circuit as followed FIG.8 for U3848/A/B/C.

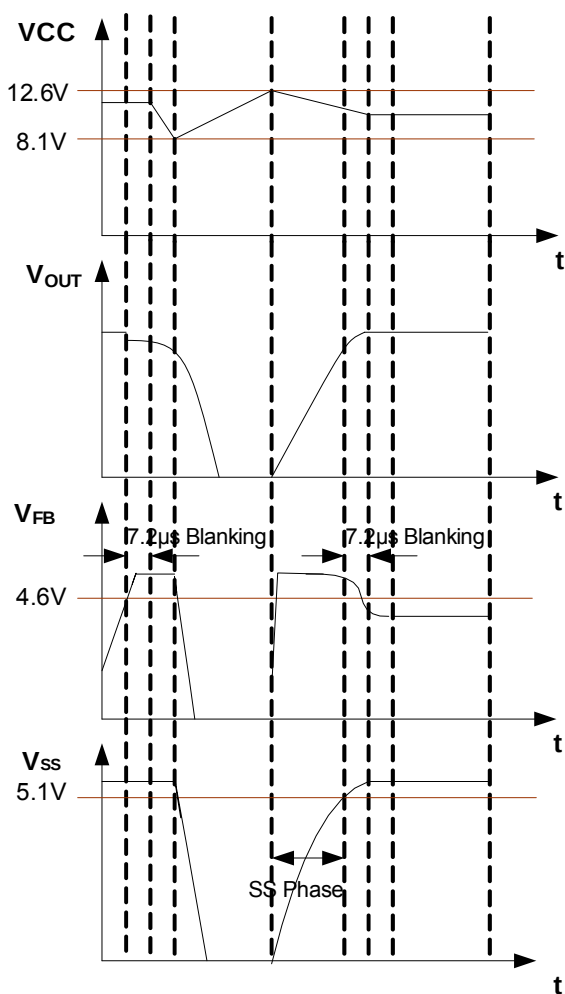


FIG.6 OLP case

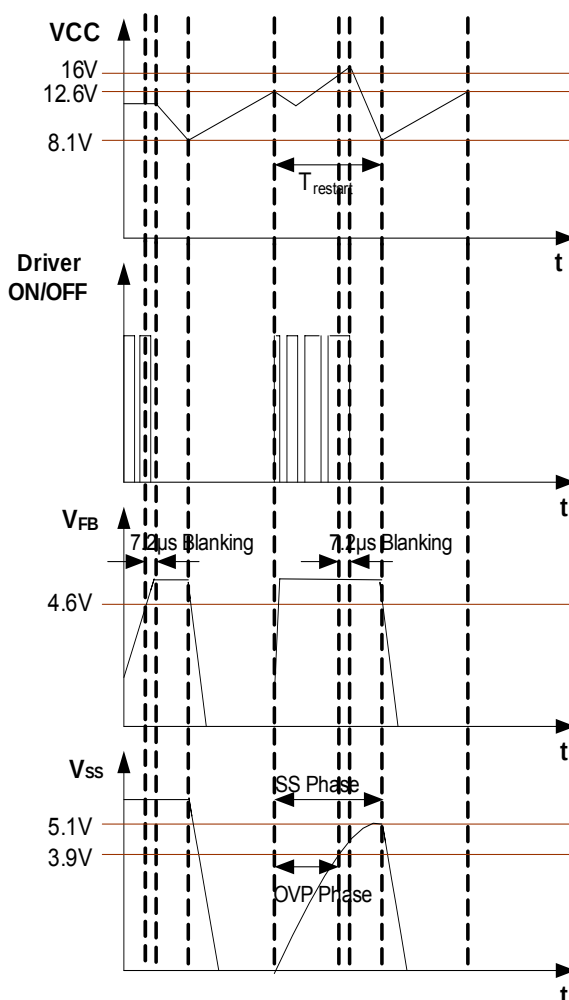


FIG.7 OVP case

#### OVP

Power supply  $V_{CC}$ 's OVP function are enabled only when  $V_{SS}<3.9V$  &  $V_{FB}>4.6V$  during soft-start phase. During above condition, driver will be shutdown if over voltage state occurs ( $V_{CC}>16V$ ) for continual 7.2 $\mu$ s. OVP function will not inactive after soft-start phase. OLP case as followed FIG.7. The test circuit as followed FIG.9 for U3848/A/B/C.

#### OTP

OTP will shut down driver when junction temperature  $T_J$  of internal circuits is more than threshold 135 $^{\circ}C$  for continual 7.2 $\mu$ s.

## ■ FUNCTIONAL DESCRIPTION(Cont.)

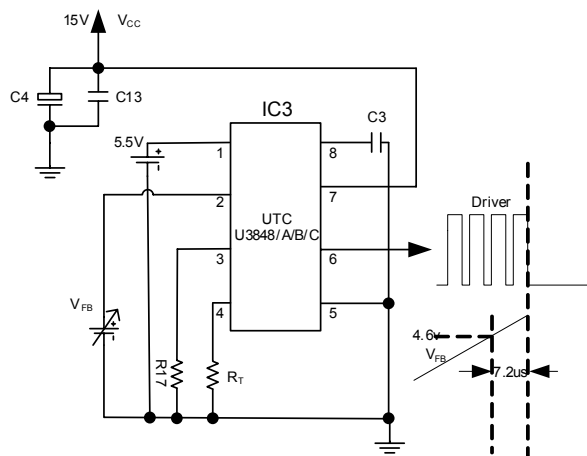


FIG.8 OLP test circuit

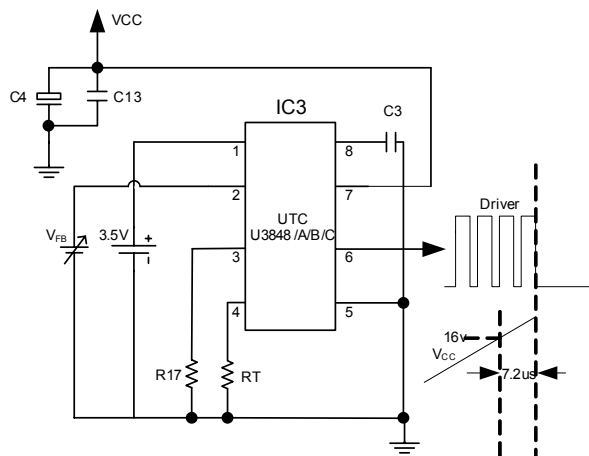


FIG.9 OVP test circuit

### (4) Driver Output Section

Rise edge time of driver output is about 200ns for avoiding Low EMI. When driver output  $V_{OL(MAX)}$  is less than 2.5V with 200mA source current, and  $V_{OH(MIN)}$  is more than 12.2V with 200mA sink current.

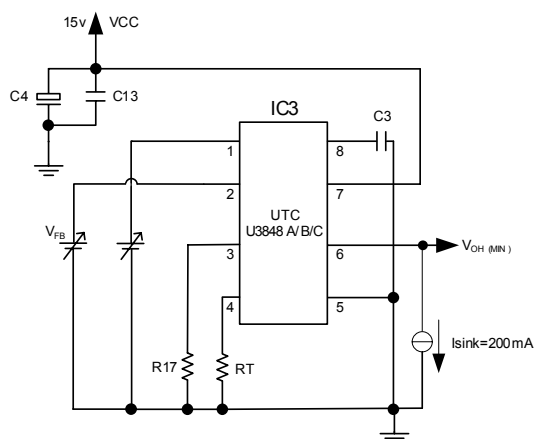


FIG.10 driver test circuit with sink current

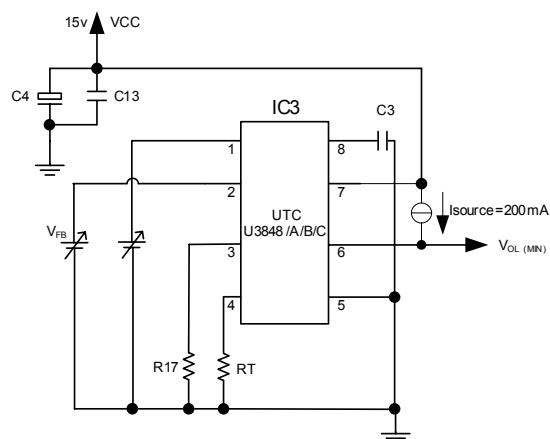
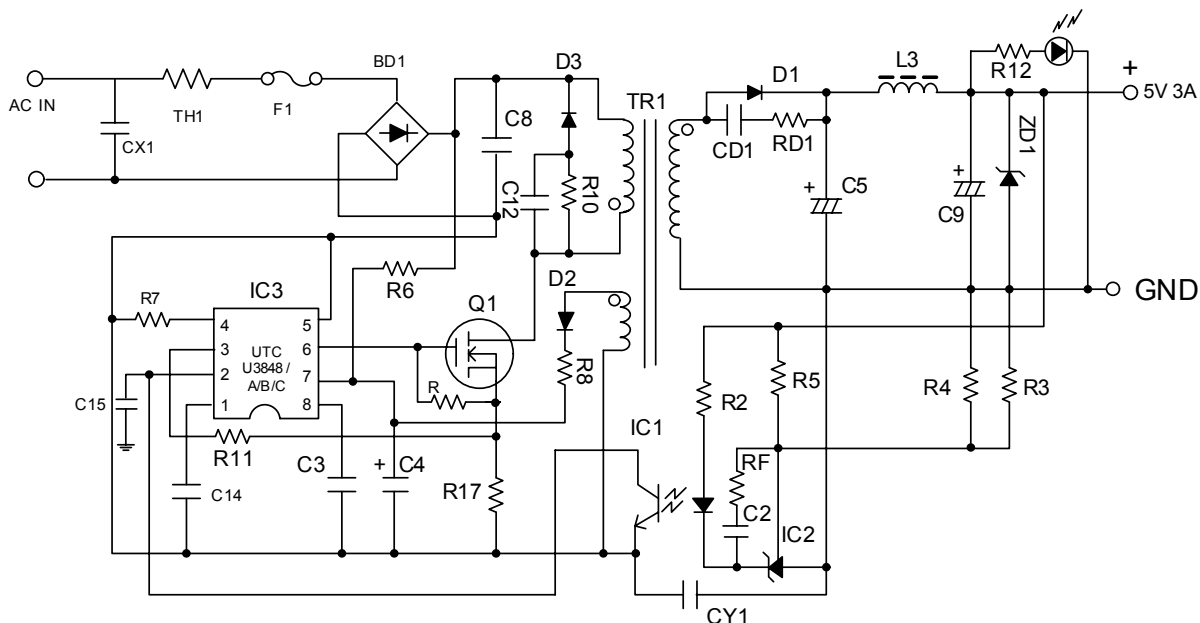


FIG.11 driver test circuit with source current

### (5) External power switch MOS transistor

Because U3848/A/B/C driver output voltage Low level threshold is about 2.5V, User may apply power MOS transistors with bigger threshold. 4N60 is recommended normally.

## ■ TYPICAL APPLICATION CIRCUIT



**FIG.12 U3848/A/B/C Typical Application Circuit**

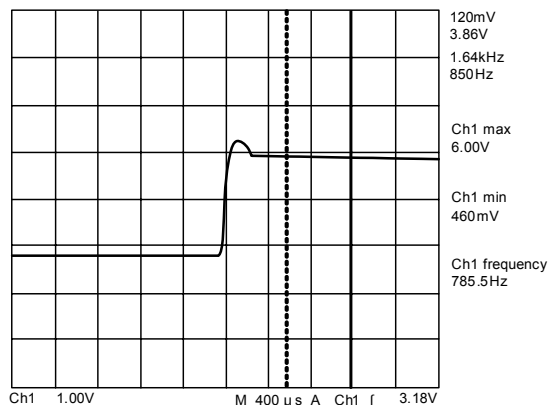
**Table1 Components Reference description for U3848/A/B/C application circuit**

|     |       |            |  |     |       |             |      |  |     |    |           |      |
|-----|-------|------------|--|-----|-------|-------------|------|--|-----|----|-----------|------|
| C12 | CC    | 10nF/1000V |  | D3  | Diode | UF1007      |      |  | R   | R  | 470KΩ     | 1/8W |
| C14 | CC    | 100nF/50V  |  | IC1 | IC    | PC817       |      |  | TH1 |    | SCK-103   |      |
| C2  | CC    | 33nF/50V   |  | IC2 | IC    | TL431CLP    |      |  | BD1 | R  | KBP-208   |      |
| CX1 |       | 104/275V   |  | IC3 | IC    | U3848/A/B/C |      |  | RD1 | R  | 10Ω       | 1/8W |
| C5  | EC    | 1000uF/15V |  | L3  | L     | 1.2uH       |      |  | R12 | R  | 3.3kΩ     | 1/8W |
| C4  | CC    | 22uF/50V   |  | Q1  | MOS   | 4N60        |      |  | TR1 |    | optional  |      |
| C8  | EC    | 68uF/400V  |  | R7  | R     | 68KΩ        | 1/8W |  | RF  | R  | 4.7kΩ     | 1/8W |
| C9  | EC    | 1000uF/16V |  | R17 | R     | 1.2Ω/1W     | 1/8W |  | C15 | CC | 0.1μF/50V |      |
| CD1 | CC    | 1nF/1KV    |  | R2  | R     | 680Ω        | 1/8W |  |     |    |           |      |
| CY1 | CC    | 4.7nF/250V |  | R3  | R     | ADJ         | 1/8W |  |     |    |           |      |
| D1  | Diode | C63-004    |  | R4  | R     | 5.6KΩ       | 1/8W |  |     |    |           |      |
| D2  | Diode | 1N4148     |  | R5  | R     | 5.6KΩ       | 1/8W |  |     |    |           |      |

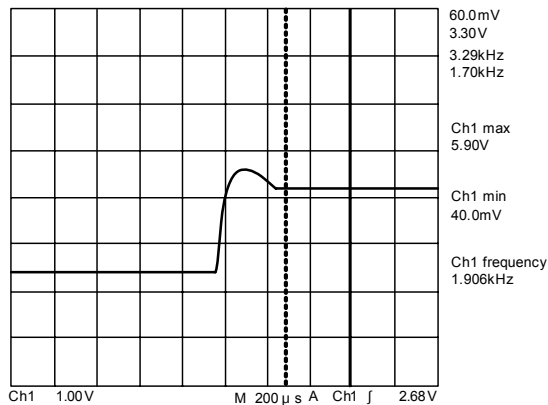
**Note:** C5 and C9 are lower ESR capacitors.

## TYPICAL CHARACTERISTICS(Cont.)

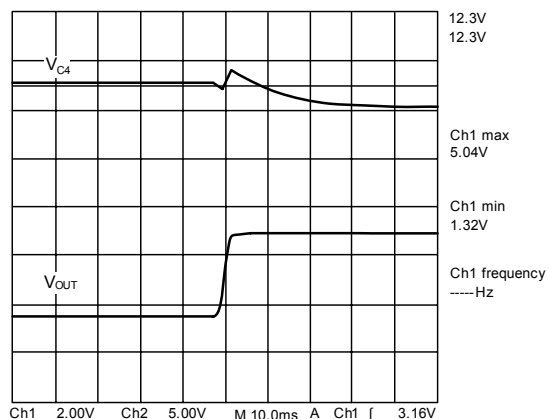
Feedback Voltage During Loadjump From10%  
Up To 100% Load ( $V_{DCIN}=120V$ )



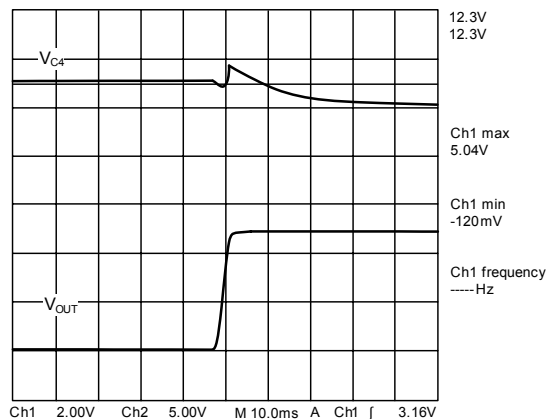
Feedback Voltage During Loadjump From10%  
Up To 100% Load ( $V_{DCIN}=350V$ )



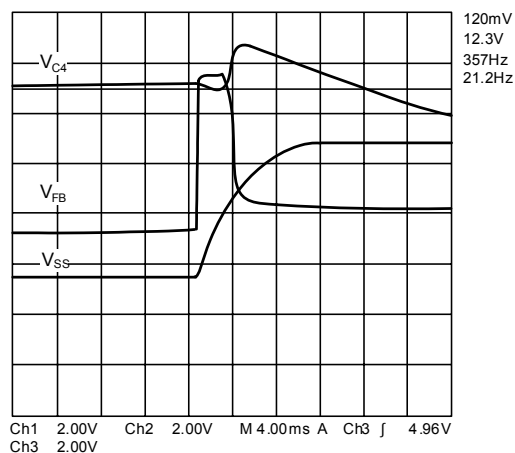
Startup With Full Load Condition At  $V_{DCIN}=120V$ ,  
 $V_{C4}$  and  $V_{OUT}$



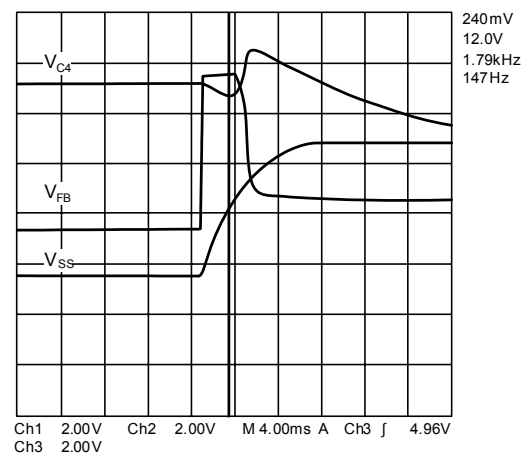
Startup With Full Load Condition At  $V_{DCIN}=350V$ ,  
 $V_{C4}$  and  $V_{OUT}$



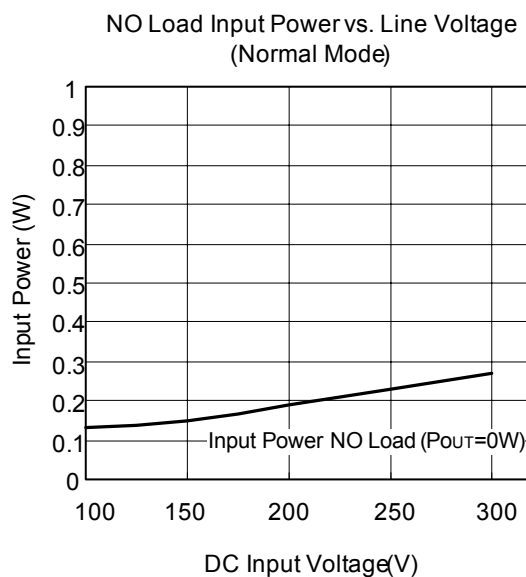
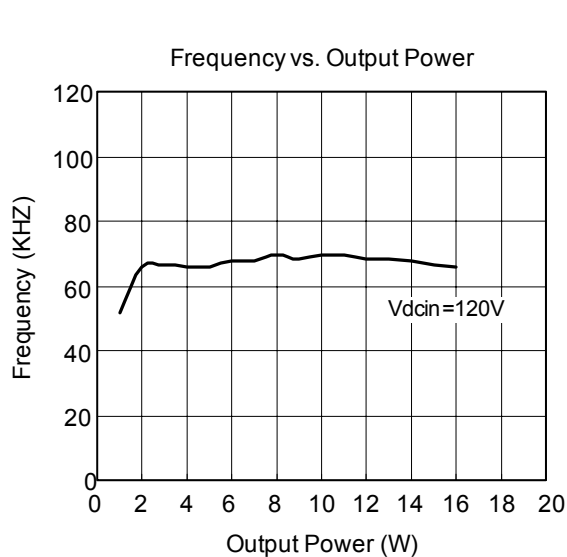
Startup Behavior At Nominal Load Condition  $V_{DCIN}=120V$



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



### ■ TYPICAL CHARACTERISTICS(Cont.)



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