



## UH8615

Preliminary

CMOS IC

### HID LAMP CONTROLLER

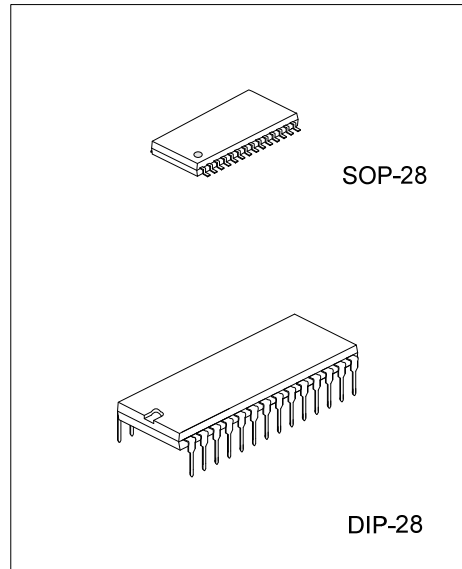
#### DESCRIPTION

The UTC **UH8615** is suit for all lighting applications where HID lamps are select, and designed for the demanding of fast turn on requirements of automobile headlamps.

It integrates all of the functions required to control and drive one HID lamp. A complete current mode pulse width modulation, total fault protection, a lamp power regulator and temperature compensation are integrated.

#### FEATURES

- \* Current Mode Control
- \* Fixed Frequency Operation
- \* Regulates Lamp Power and Temperature Compensation.
- \* High Current FET Drive Output
- \* Over-Current Protection.
- \* Over-Voltage Protection.
- \* Open and Short Protection.
- \* Operates Over Wide Battery Voltage Range: 5V ~ 18V



#### ORDERING INFORMATION

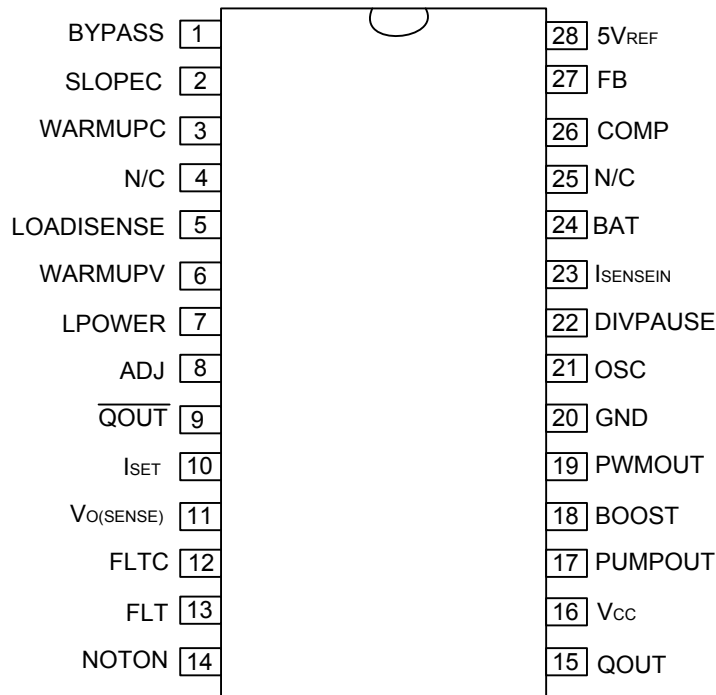
| Order Number  | Package | Packing   |
|---------------|---------|-----------|
| UH8615L-D28-T | DIP-28  | Tube      |
| UH8615L-S28-R | SOP-28  | Tape Reel |

|   |   |
|---|---|
| <p>UH8615G-D28-T</p> <p>(1) Packing Type</p> <p>(2) Package Type</p> <p>(3) Green Package</p> | <p>(1) T: Tube, R: Tape Reel</p> <p>(2) D28: DIP-28, S28: SOP-28</p> <p>(3) G: Halogen Free and Lead Free</p> |
|---|---|

#### MARKING

| DIP-28 | SOP-28 |
|--------|--------|
|        |        |

## ■ PIN CONFIGURATION



## ■ PIN FUNCTION DESCRIPTIONS

| PIN NO. | FUNCTION   | DESCRIPTION  |
|---------|------------|--|
| 1       | BYPASS     | <p>The UTC <b>UH8615</b> compensates for lamp temperature changes by varying the voltage on the WARMUPC and SLOPEC capacitors. As the lamp warms up these two voltages rises. And an internal circuit will calculate what power should be applied to the lamp. When the HID lamp is turned off, the lamp will cool down at a certain rate, the two voltage on the WARMUPC and SLOPEC capacitors should also discharge at a similarly rate. In this way, if the lamp is restarted before the lamp is fully cooled down, the controller will estimate the temperature of the lamp at the same time. So the correct power for the lamp can be calculated.</p> <p>A large capacitor connected to BYPASS supply the power for controlling the discharge of the two capacitors. The value of the capacitor can be estimated by the following formula:</p> $C = I \cdot \frac{\Delta t}{\Delta V}$ <p>Assuming a maximum BYPASS current of 5uA, a discharge time of 60s, and a maximum allowable droop of 5V, the capacitor should be 60uF.</p> |
| 2       | SLOPEC     | SLOPEC and WARMUPC is connected to capacitors to track lamp cool down and warm-up. The capacitor connected to SLOPEC charges up to 5V with a rate controlled by the resistor connected to the I <sub>SET</sub> . When V <sub>CC</sub> is power off, SLOPEC discharges at a current of 100nA.   |
| 3       | WARMUPC    | the lamp temperature is estimated not only by the capacitor from SLOPEC to GND but also by the voltage on a capacitor from WARMUPC to GND. This capacitor is charged by a 200nA current source to 4.2V and by a 100nA current source from 4.2V to 10V when the lamp is on, and discharged by 39nA current sink to 2.5V and 11nA current sink to GND when the lamp is off.  |
| 5       | LOADISENSE | Lamp current regulation to supply correct lamp power at every lamp temperature.  |

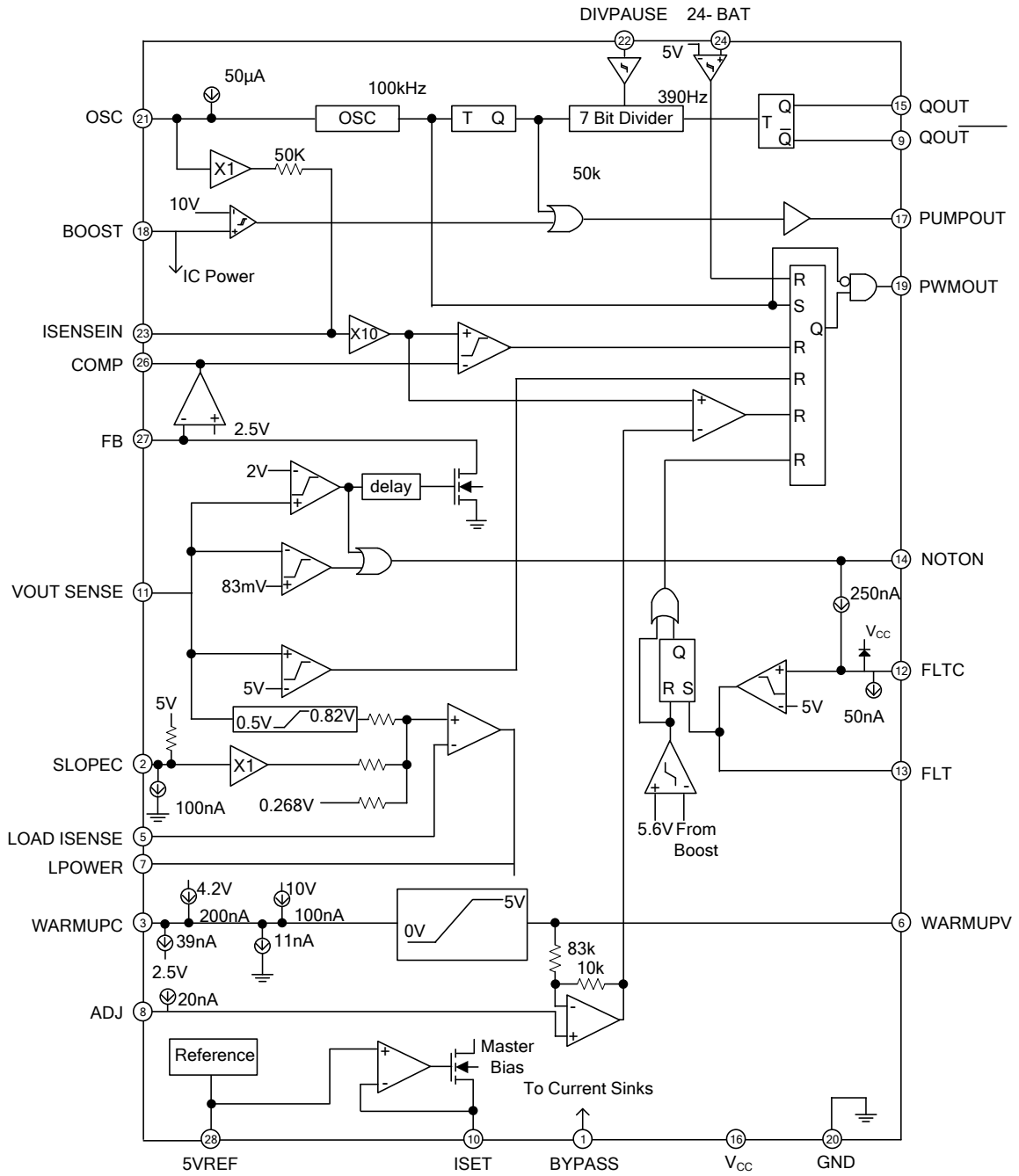
■ PIN FUNCTION DESCRIPTIONS (Cont.)

| PIN NO. | FUNCTION              | DESCRIPTION  |
|---------|-----------------------|--|
| 6       | WARMUPV               | The <b>UTC UH8615</b> inherits a buffer amplifier which buffers the voltage on WARMUPC and processes it to WARMUPV. because of the impedance on WARMUPC is too high. The voltage of WARMUPC can't be used to modulate the signal fed to the error amplifier through FB directly. So after processed by the buffer, the signal of WARMUPV is appropriate for driving FB.  |
| 7       | LPOWER                | the amplifier which amplifies the difference between the desired load current and the actual load current can generate an output signal on LPOWER. The signal feeds to the error amplifier.  |
| 8       | ADJ                   | The voltage on the pin controls the ratio of cold lamp peak current to warmed-up lamp peak current. It is selected by connecting a resistor from ADJ to GND.   |
| 9       | QOUT                  | When operated with AC HID lamps, the QOUT pin is a logic output that toggles at OSC frequency divided by 512.  |
| 10      | I <sub>SET</sub>      | Precise current is required for many functions of the <b>UH8615</b> . A resistor connected from I <sub>SET</sub> to GND can adjust the current. A resistor of 100K is for the normal operating current. Lower value increases the internal currents. The functions of WARMUPC charging and discharging, SLOPEC charging and discharging, FLTC charging and discharging, and error amplifier bandwidth are influenced by the resistor.  |
| 11      | V <sub>O(SENSE)</sub> | The V <sub>O(SENSE)</sub> is used to sense lamp voltage. The voltage across the lamp is between 60V to 110V in a normal operation. When the voltage is higher than 300V, it may break down the lamp. It is desirable to limit the voltage on the starter input to 600V maximum. And the voltage less than 10V indicates a shorted lamp.<br>The voltage of the V <sub>O(SENSE)</sub> is between 83mV and 2V corresponding to the lamp voltage is between 10V and 240V, when the lamp is in normal operation. If the V <sub>O(SENSE)</sub> voltage reaches 5V, corresponding to the lamp voltage of 600V, the <b>UTC UH8615</b> will terminate PWM output. When the V <sub>O(SENSE)</sub> voltage is outside the window of 83mV and 2V, the lamp is either shorted, open or not lit. |
| 12      | FLTC                  | the <b>UTC UH8615</b> monitors the voltage on V <sub>O(SENSE)</sub> . This voltage is proportional to lamp voltage. It is compared to an internal 83 mV lower threshold and 2V upper threshold. If it is too high or too low, the lamp is in abnormal condition. At that time, the IC will pull up on FLTC with a current of approximately 250nA. If the fault remains, the voltage on the external FLTC capacitor will over 5V. then the controller declares a catastrophic fault and shuts the circuit down. It will last until power is removed from BOOST.<br>If the fault clears before the capacitor reaches 5V, the capacitor discharge down to 0V with a current of approximately 50nA. It is five times longer than charging.   |
| 13      | FLT                   | if the voltage on the FLTC pin exceeds 5V, the FLT output goes high to V <sub>CC</sub> . And it indicates a serious system fault.  |
| 14      | NOTON                 | NOTON is pulled low When the voltage on V <sub>O(SENSE)</sub> is within the 83mV ~ 2V window. Otherwise NOTON is pulled high to V <sub>CC</sub>  |
| 15      | QOUT                  | The pin QOUT is a logic output, which toggles at the OSC frequency divided by 512, 180 degrees out of phase with the QOUT pin.   |
| 16      | V <sub>CC</sub>       | V <sub>CC</sub> is the main supply input to the <b>UTC UH8615</b> . all the functions are powered by the V <sub>CC</sub> and BOOST. V <sub>CC</sub> will be clamped to 6.8V by an external zener diode. And it will keep as close to 6.8V as practical with a low value resistor to the supply.  |
| 17      | PUMPOUT               | In normal operation, a voltage of approximately 10V which connected to BOOST supply power for many functions. This voltage is generated by a voltage doubler using the PUMPOUT pin. The out of PUMPOUT is a square wave, which swings from V <sub>CC</sub> to GND at half of the OSC frequency.  |
| 18      | BOOST                 | This pin supply a approximately 10V voltage for the functions of the device operate. And the 10v voltage is generated by a voltage doubler using PUMPOUT as an AC signal and external diodes switches.   |

■ PIN FUNCTION DESCRIPTIONS (Cont.)

| PIN NO. | FUNCTION             | DESCRIPTION   |
|---------|----------------------|---|
| 19      | PWMOUT               | The output of the PWMOUT is the signal output of the pulse width modulator. it is used to command a power MOSFET switch. In normal PWM-OUT can be directly connected to the gate of an N-channel power MOSFET. And if the lead between the UTC <b>UH8615</b> and the MOSFET is longer than a few cm. A 10 ohm resistor from PWMOUT to the MOSFET gate may be required.  |
| 20      | GND                  | Ground for IC is through this pin.  |
| 21      | OSC                  | The frequency of the PWM in the UTC <b>UH8615</b> can be generated by the pin. A 200pF capacitor from OSC to GND programs the PWM frequency at 100kHz. In fact the actual oscillator frequency is determined by both the capacitor from OSC to GND and the resistor from ISET to GND  |
| 22      | DIVPAUSE             | The QOUT and $\bar{Q}$ OUT outputs switch lamp polarity in an AC ballast. when the lamp is being lit, It is important to stop polarity switching to keep the arc across the electrodes can form in the correct place. A high voltage on DIVPAUSE can stop the internal circuit generates the QOUT and $\bar{Q}$ OUT signals.<br>Connect a resistor from NOTON to DIVPAUSE and a capacitor from DIVPAUSE to GND, will stop the divider when the lamp is being lit and start after the lamp has lit.  |
| 23      | I <sub>SENSEIN</sub> | the UTC <b>UH8615</b> HID Controller is built in a power regulation algorithm that can compute a function of the lamp current and voltage. It computes the appropriate battery current to keep lamp power constant. This current is sensed by a connection from I <sub>SENSEIN</sub> pin to a current sense resistor. This current sensed pulse width modulation scheme is often referred to as current mode control. The UTC <b>UH8615</b> also contains peak input current limiting. It is limited 0.2V across the I <sub>SENSEIN</sub> resistor during normal operation and 0.4V during starting. The period from starting to normal operation is accomplished by the rise of the WARMUPC capacitor. As the current mode control has a disadvantage that the loop will enter chaotic oscillations at high duty cycle, the UTC <b>UH8615</b> inherent the slope compensation to prevent oscillation. An external resistor from I <sub>SENSEIN</sub> to the current sense resistor creates a voltage drop proportional to OSC voltage, which gives slope compensation. |
| 24      | BAT                  | This input can detect excessively high input voltage and will shut down the IC if the input voltage exceeds a set voltage. When connect BAT to a voltage divider across the input supply, in order to protect the IC in the quite event, please keep divider impedance higher than 10k.   |
| 26      | COMP                 | COMP is driven by the amplifier which senses the difference between FB and 2.5V. a capacitor should be connected from COMP to FB to keep the system stable.   |
| 27      | FB                   | The FB pin is the inverted input of error amplifier that senses the differences between the commanded lamp power and desired lamp power. The output of the error amplifier drives the comp.   |
| 28      | 5V <sub>REF</sub>    | The output of the internal 5V reference voltage that is used for setting currents and thresholds and can also be used for other functions.  |

■ BLOCK DIAGRAM



### ■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER  | SYMBOL          | RATINGS      | UNIT |
|--|-----------------|--------------|------|
| Supply Voltage                                   | $V_{CC}$        | 8.0          | V    |
| BOOST Supply Voltage                             | $V_{CC(BOOST)}$ | 12.0         | V    |
| Input Voltage, Any Input                         | $V_{IN}$        | -0.3 ~ +10.0 | V    |
| PWMOUT Current, Peak                             | $I_{(PEAK)}$    | 1.0          | A    |
| Output Current, QOUT, QOUT, FLT                  | $I_{OUT}$       | 10.0         | mA   |
| Output Current, 5V <sub>REF</sub> , LPOWER, COMP | $I_{OUT}$       | 10.0         | mA   |
| I <sub>SET</sub> Current                         |                 | -1.0         | mA   |
| PWMOUT Energy, Capacitive Load                   |                 | 5.0          | μJ   |
| Junction Temperature                             | $T_J$           | +150         | °C   |
| Storage Temperature                              | $T_{STG}$       | -65 ~ +150   | °C   |

Note 1. All voltages with respect to GND. Currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages.

2. 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.

### ■ ELECTRICAL CHARACTERISTICS

(Unless otherwise stated,  $V_{CC} = 6.6V$ ,  $I_{SET} = 100k\Omega$  to GND,  $ADJ = 100k\Omega$  to GND,  $OSC = 200pF$  to GND,  $BAT = 4V$ ,  $LOADISENSE$  connected to LPOWER,  $V_{O(SENSE)} = 0.666V$ ,  $BOOST = 10.5V$ ,  $COMP$  connected to FB through a  $100k\Omega$  resistor,  $-40^\circ C < T_A < +105^\circ C$ , and  $T_A = T_J$ .)

| PARAMETER                               | SYMBOL      | TEST CONDITIONS                  | MIN  | TYP  | MAX  | UNIT |
|---|-------------|----------------------------------|------|------|------|------|
| <b>OVERALL SECTION</b>                  |             |                                  |      |      |      |      |
| BOOST Threshold to PUMP                 | Stop        | $V_{BOOST(STOP)}$                | 9.1  | 9.6  | 10.2 | V    |
|   | Start       | $V_{BOOST(START)}$               | 9.2  | 9.7  | 10.3 | V    |
| BOOST Threshold to PWMOUT               |             |                                  | 5.7  | 6.0  | 7.1  | V    |
| $V_{CC}$ Supply Current                 | $I_{CC}$    |                                  |      | 0.1  | 1.0  | mA   |
| BOOST Supply Current                    | $I_{CC}$    |                                  |      | 3.0  | 5.0  | mA   |
| <b>BATTERY SECTION</b>                  |             |                                  |      |      |      |      |
| BAT Threshold to PWMOUT                 | Stop        | $V_{BAT(STOP)}$                  | 4.7  | 5.0  | 5.3  | V    |
|   | Start       | $V_{BAT(START)}$                 | 4.15 | 4.8  | 5.0  | V    |
| BAT Input Current                       | $I_{(BAT)}$ | BAT = 4V                         | -1   |      | 1    | μA   |
| <b>OSCILLATOR &amp; DIVIDER SECTION</b> |             |                                  |      |      |      |      |
| DIVPAUSE Threshold                      | Pause       | $V_{PAUSE}$                      | 1.1  | 1.5  | 1.9  | V    |
|   | Divide      | $V_{DIVIDE}$                     | 0.8  | 1.2  | 1.6  | V    |
| OSC Pull - Up Current                   | $I_{(OSC)}$ | OSC = 1.5V                       | -70  | -50  | -40  | μA   |
| DIVPAUSE Input Current                  | $I_{IN}$    | 0V < DIVPAUSE < 6V               | -8   | -5   | -1   | μA   |
| OSC Frequency                           | $F_{(OSC)}$ |                                  | 80   | 100  | 120  | kHz  |
| <b>REFERENCE SECTION</b>                |             |                                  |      |      |      |      |
| 5V <sub>REF</sub> Voltage               |             |                                  | 4.85 | 5.0  | 5.1  | V    |
| I <sub>SET</sub> Voltage                |             |                                  | 4.8  | 5.0  | 5.2  | V    |
| <b>ERROR AMPLIFIER SECTION</b>          |             |                                  |      |      |      |      |
| FB Voltage                              | $V_{FB}$    |                                  | 2.4  | 2.5  | 2.6  | V    |
| FB Sink Current                         | $I_{SINK}$  | $V_{OUTSENSE} = 4V$ , FB = 4V    | 0.3  | 1.5  |      | mA   |
| COMP Current                            | Source      | $I_{SOURCE}$                     |      | -3.0 | -0.2 | mA   |
|   | Sink        | $I_{SINK}$                       |      | 0.2  | 1.0  | mA   |
| FB Input Current                        | $I_{(FB)}$  |                                  | -1   | 0    | 1    | μA   |
| FB Release Delay                        |             | $V_{OUTSENSE}$ Step from 4V ~ 1V | 15   | 30   | 43   | ms   |

■ ELECTRICAL CHARACTERISTICS(Cont.)

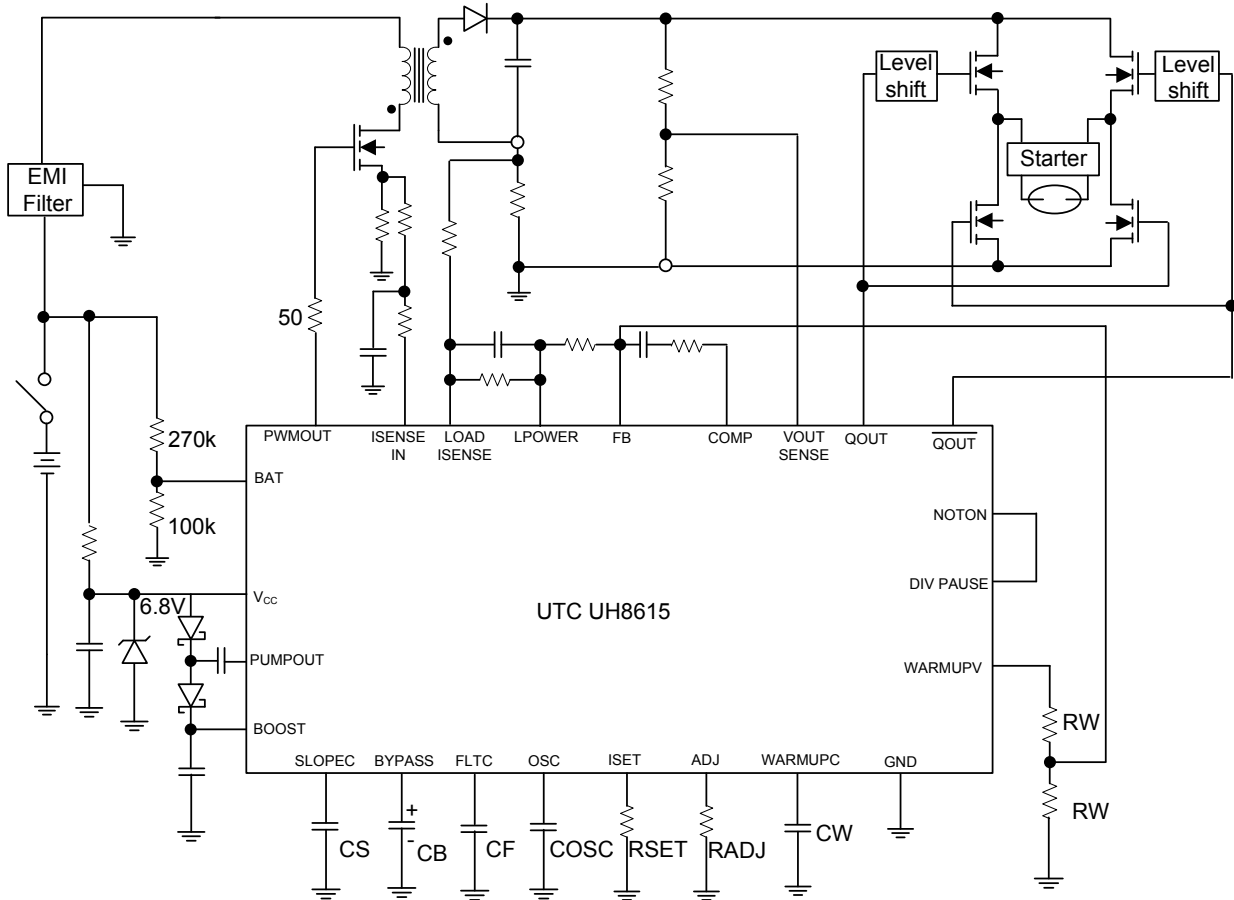
| PARAMETER                            | SYMBOL          | TEST CONDITIONS                           | MIN   | TYP   | MAX   | UNIT    |
|--------------------------------------|-----------------|---|-------|-------|-------|---------|
| <b>LOAD POWER AMPLIFIER SECTION</b>  |                 |   |       |       |       |         |
| LPOWER Voltage                       | $V_{LPOWER}$    | $V_{O(SENSE)} = 0.0V$                     | 0.32  | 0.40  | 0.48  | V       |
|                                      |                 | $V_{O(SENSE)} = 0.45V$                    | 0.32  | 0.40  | 0.48  | V       |
|                                      |                 | $V_{O(SENSE)} = 0.65V$                    | 0.41  | 0.46  | 0.51  | V       |
|                                      |                 | $V_{O(SENSE)} = 0.88V$                    | 0.43  | 0.51  | 0.59  | V       |
|                                      |                 | $V_{O(SENSE)} = 2.0V$                     | 0.43  | 0.51  | 0.59  | V       |
|                                      |                 | $V_{O(SENSE)} = 0.7V, SLOPEC = 0V$        | 0.29  | 0.34  | 0.41  | V       |
| LPOWER Source Current                | $I_{SOURCE}$    | LPOWER = 0V                               |       | -8.0  | -0.4  | mA      |
| LPOWER Sink Current                  | $I_{SINK}$      | LPOWER = 1V                               | 0.4   | 1.3   |       | mA      |
| LOADISENSE Input Current             | $I_{IN}$        |   | -2.5  | -0.1  | 2.5   | $\mu A$ |
| <b>INPUT CURRENT SENSE SECTION</b>   |                 |   |       |       |       |         |
| $I_{SENSEIN}$ Threshold              |                 | COMP = 5V, WARMUPC = 0V                   | 0.16  | 0.21  | 0.28  | V       |
|                                      |                 | COMP = 5V, WARMUPC = 10V                  | 0.10  | 0.19  | 0.27  | V       |
|                                      |                 | COMP = 1V, WARMUPC = 0V                   | 0.07  | 0.10  | 0.2   | V       |
| $I_{SENSEIN}$ Bias Current           | $I_{BIAS}$      | OSC = 0V                                  | -15   | -5    | -2    | $\mu A$ |
|                                      |                 | OSC = 2V                                  | -65   | -40   | -15   | $\mu A$ |
| <b>VOUTSENSE SECTION</b>             |                 |   |       |       |       |         |
| $V_{OUTSENSE}$ Threshold to PWMOUT   | $V_{O(PWMOUT)}$ |   | 4.2   | 5.0   | 5.2   | V       |
| $V_{OUTSENSE}$ Threshold to FB       | $V_{O(FB)}$     |   | 1.7   | 1.9   | 2.1   | V       |
| $V_{OUTSENSE}$ Threshold to NOTON    | $V_{O(NOTON)}$  |   | 0.035 | 0.083 | 0.140 | V       |
| $V_{OUTSENSE}$ Input Current         | $I_{IN}$        |   | -1    |       | 1     | $\mu A$ |
| <b>OUTPUTS SECTION</b>               |                 |   |       |       |       |         |
| PWMOUT High Voltage                  | $V_{O(H)}$      | IPWMOUT = -100mA                          | 9.15  | 10.0  |       | V       |
| PWMOUT Low Voltage                   | $V_{O(L)}$      | IPWMOUT = 100mA                           |       | 0.3   | 0.5   | V       |
| PUMPOUT High Voltage                 | $V_{O(H)}$      | IPUMPOUT = -10mA                          | 5.3   | 5.8   |       | V       |
| PUMPOUT Low Voltage                  | $V_{O(L)}$      | IPUMPOUT = 10mA                           |       | 1.0   | 1.8   | V       |
| NOTON High Voltage                   | $V_H$           | INOTON = -1mA                             | 5.0   | 6.3   |       | V       |
| NOTON Low Voltage                    | $V_L$           | INOTON = 1mA                              |       | 0.1   | 0.3   | V       |
| QOUT, $\overline{QOUT}$ High Voltage | $V_H$           | IQOUT = -1mA or $\overline{IQOUT} = -1mA$ | 5.0   | 6.3   |       | V       |
| QOUT, $\overline{QOUT}$ Low Voltage  | $V_L$           | IQOUT = 1mA or $\overline{IQOUT} = 1mA$   |       | 0.1   | 0.45  | V       |
| FLT High Voltage                     | $V_{H(FLT)}$    | IFLT = -1mA                               | 6.0   | 6.3   |       | V       |
| FLT Low Voltage                      | $V_{L(FLT)}$    | IFLT = 1mA                                |       | 0.1   | 0.3   | V       |
| PUMPOUT Frequency                    | F               | BOOST = 9.5V                              | 35    | 50    | 60    | kHz     |
| QOUT, $\overline{QOUT}$ Frequency    | F               |   | 150   | 200   | 250   | Hz      |
| <b>TIMING CAPACITOR SECTION</b>      |                 |   |       |       |       |         |
| FLTC Threshold to FAULT              | $V_{FLTC}$      |   | 4.65  | 4.9   | 5.25  | V       |
| SLOPEC Voltage                       | $V_{(SLOPEC)}$  | ISLOPEC = -125nA                          | 1.3   | 1.5   | 1.7   | V       |
|                                      |                 | ISLOPEC = -50nA                           | 2.8   | 3.0   | 3.2   | V       |
| FLTC Discharge Current               | $I_{(FLTC)}$    | FLTC = 2.5V                               | 35    |       | 250   | nA      |
| FLTC Charge Current                  | $I_{(FLTC)}$    | FLTC = 2.5V                               | -430  |       | -100  | nA      |
| SLOPEC Charge Current                | $I_{(SLOPEC)}$  | SLOPEC = 0.5V                             | -165  | -90   | -60   | nA      |
|                                      |                 | SLOPEC = 2.2V                             | -105  | -60   | -40   | nA      |
|                                      |                 | SLOPEC = 4.2V                             | -50   | -30   | -10   | nA      |

■ ELECTRICAL CHARACTERISTICS(Cont.)

| PARAMETER                               | SYMBOL            | TEST CONDITIONS   | MIN  | TYP   | MAX  | UNIT    |
|---|-------------------|---|------|-------|------|---------|
| <b>TIMING CAPACITOR SECTION (Cont.)</b> |                   |   |      |       |      |         |
| WARMUPC Voltage, Charging               | $V_{(WARMUPC)}$   | IWARMUPC = -250nA   | 2.9  | 3.8   | 3.6  | V       |
| WARMUPC Voltage, Discharging            | $V_{(WARMUPC)}$   | IWARMUPC = 25nA, $V_{CC} = 0V$ ,<br>BOOST = 0V, BYPASS = 8V | 1.5  | 1.9   | 2.3  | V       |
| WARMUPV Voltage                         | $V_{(WARMUPV)}$   | WARMUPC = 1V  | 0.05 | 0.125 | 0.25 | V       |
|   |                   | WARMUPC = 2V  | 0.09 | 1.00  | 1.5  | V       |
|   |                   | WARMUPC = 3V  | 2.3  | 2.48  | 2.66 | V       |
|   |                   | WARMUPC = 5V  | 4.5  | 4.8   | 5.25 | V       |
|   |                   | WARMUPC = 10V   | 4.5  | 4.8   | 5.25 | V       |
| BYPASS Voltage                          | $V_{(BYPASS)}$    | $V_{CC} = 0V$   | 8.8  | 9.6   |      | V       |
| BYPASS Current                          | $I_{(BYPASS)}$    | $V_{CC} = 0V$ , BOOST = 0V,<br>BYPASS = 8V                  |      | 2.5   | 7    | $\mu A$ |
| ADJ Bias Current                        | $I_{(BIAS)}$      | VADJ = 0V   | -38  | -20   | -12  | $\mu A$ |
| SLOPEC Discharge Current                | $I_{(DISCHARGE)}$ | SLOPEC = 2.2V, $V_{CC} = 0V$ ,<br>BOOST = 0V, BYPASS = 8V   | 40   |       | 300  | nA      |
| WARMUPC Charge Current                  | $I_{(CHANGE)}$    | WARMUPC = 0V  | -525 | -375  | -275 | nA      |
|   |                   | WARMUPC = 2V  | -525 | -375  | -300 | nA      |
|   |                   | WARMUPC = 6V  | -300 |       | -75  | nA      |
| WARMUPC Discharge Current               | $I_{(DISCHARGE)}$ | WARMUPC = 5V, $V_{CC} = 0V$ ,<br>BOOST = 0V, BYPASS = 8V    | 23   | 50    | 200  | nA      |
|   |                   | WARMUPC = 1V, $V_{CC} = 0V$ ,<br>BOOST = 0V, BYPASS = 8V    | 5    | 10    | 100  | nA      |



### ■ FLYBACK HID BALLAST



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