Single-Stage Primary-Side-Regulation PWM Controller for PFC and Phase Cut Dimmable LED Driving

FL7734

Description

The FL7734 is a highly integrated PWM controller with advanced Primary−Side−Regulation (PSR) technology and powerful protections, such as LED open / short, sensing resistor)

onsemi 7734 Tcf
&Z = Assembly Location
&2 = 2−Digit Date Code
&K = 2−Digits Lot Run Traceability Code
7734 = Specific Device Code

APPLICATION DIAGRAM

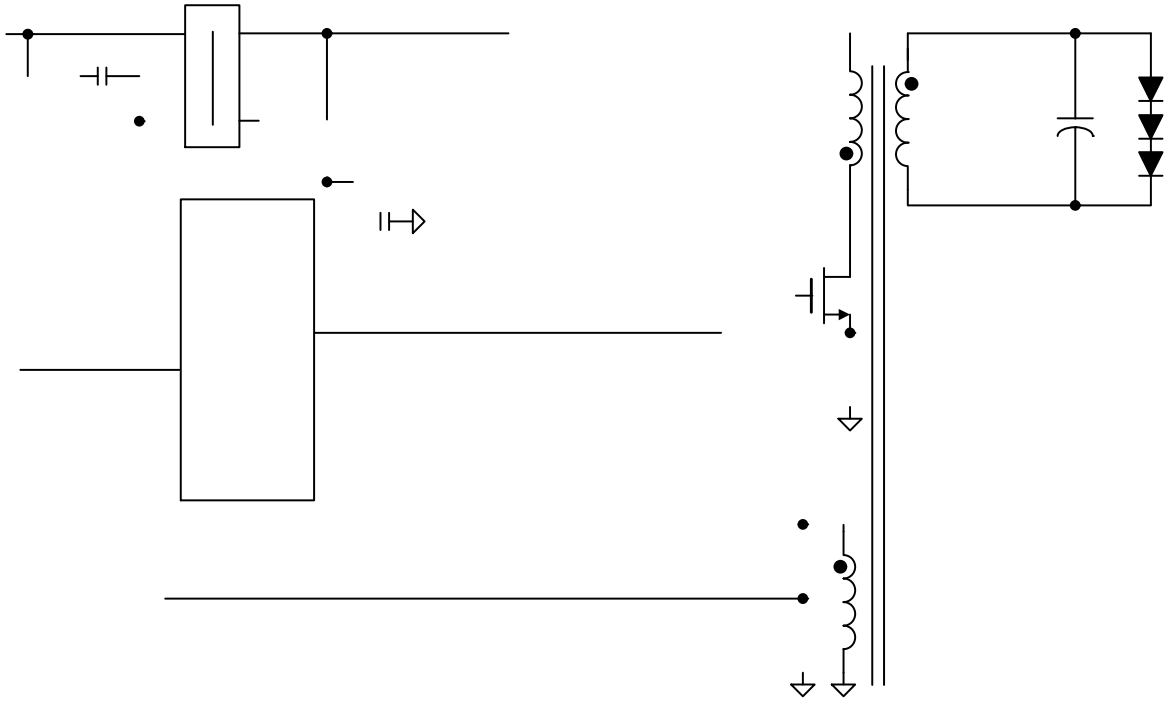


Figure 1. Typical Application

PIN CONFIGURATION

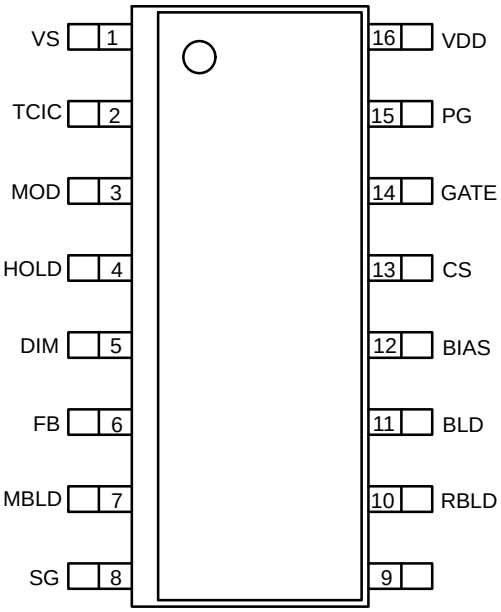


Figure 3. Pin Configuration

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Min	Max	Units
V_{VDD}				

FL7734

TYPICAL PERFORMANCE CHARACTERISTICS

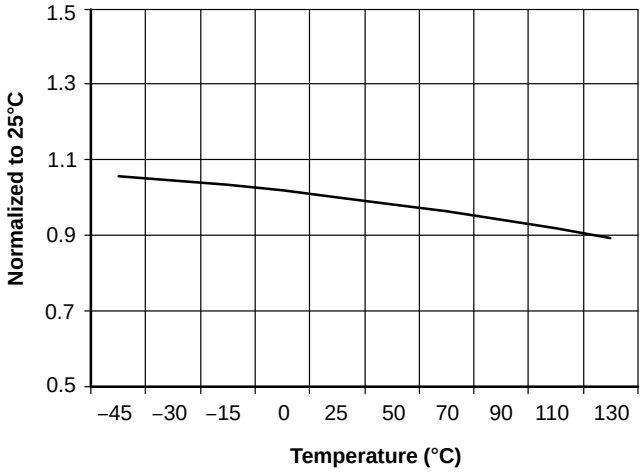


Figure 4. V_{DD-ON} vs. Temperature

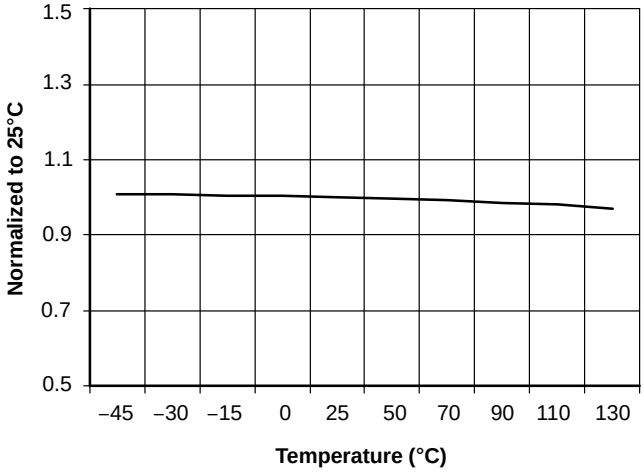


Figure 5. V_{DD-OFF} vs. Temperature

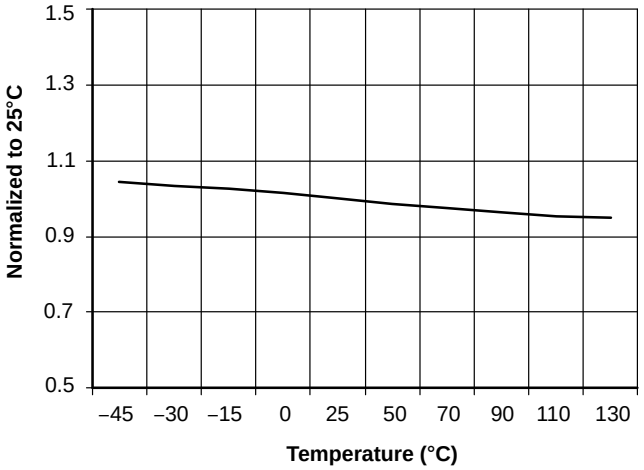


Figure 6. I_{DD-OP} vs. Temperature

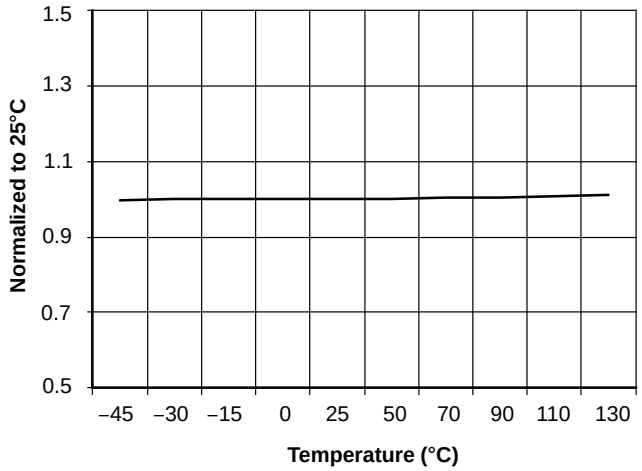


Figure 7. V_{DD-OVP} vs. Temperature

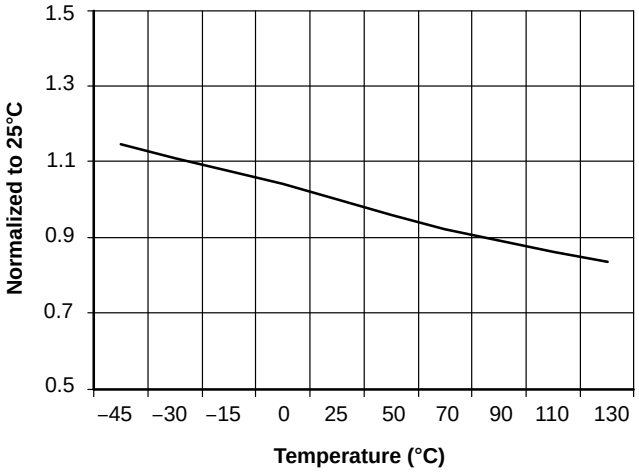


Figure 8. f_{ND-MAX} vs. Temperature

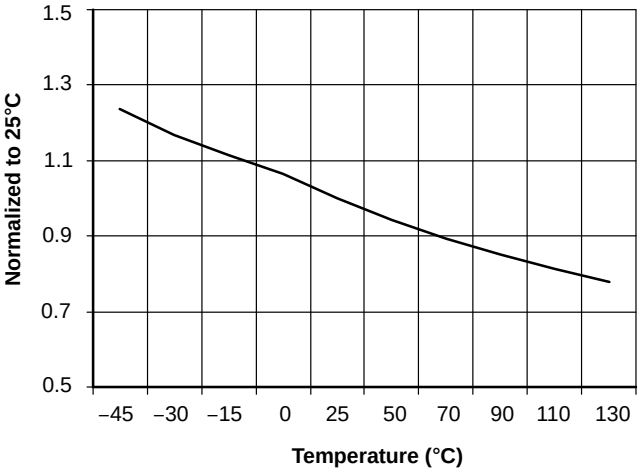


Figure 9. f_{ND-MIN} vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

FUNCTIONAL DESCRIPTION

FL7734 is a phase−cut dimmable PWM controller for LED lighting applications. Accurate LED current regulation independent of input voltage, output voltage and magnetizing inductance variations is implemented by TRUECURRENT technique. The controller features programmable dimming curve which ensures that the constant maximum LED current can be met at the various maximum phase angle conditions of each dimmer and low LED current can be set at the minimum phase angle condition with wide dimming range. **onsemi**'s proprietary constant input current control provides excellent dimmer compatibility by maintaining input current higher than TRIAC holding current. The linear frequency control and DCM operation with minimized turn−on time ripple implements best power factor and THD in a single−stage topology. A variety of protections; such as short−LED protection, open−LED protection, sensing resistor open/short protection, over−temperature protection, and cycle−by−cycle current limitation stabilize system operation and protect external components.

Startup

An external bleeding MOSFET is utilized for fast startup. Once power is on, BIAS voltage is quickly lifted to $V_{BIASVDD−OFF}$ (24.4 V) so the bleeding MOSFET can charge the VDD capacitor higher than $V_{DD−ON}$ voltage (10.6 V). Once V_{DD} is higher than $V_{DD−ON}$, Startup Sequence (SS1) begins with maximum bleeding current to stabilize dimmer operation. SS1 ends when V_{IN} reaches the line voltage zero crossing after $t_{SS1−MIN}$ (12 ms).

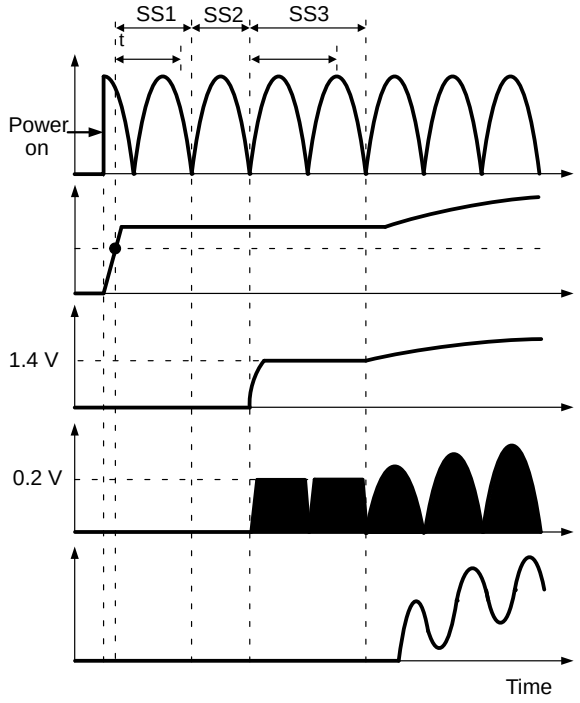


Figure 16. Startup Sequence

As a function of dimming reference modulation shown in Figure 17, output current is constantly regulated with constant V_{REF} when V_{DIM} is higher than 3 V and V_{REF} is set lower than V_{EAI} (TRUECURRENT calculation result) when V_{DIM} is lower than 2.25 V. Once V_{DIM} is less than 2.25 V, the error amplifier always pulls down current in the output and FB voltage is clamped by MOD voltage so that open loop control starts for stable LED current control at low phase angle range.

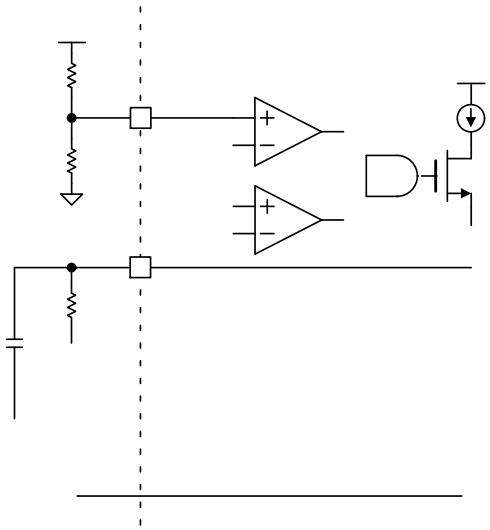


Figure 17. Dimming Control

Short−LED Protection

In a short−LED condition, the switching MOSFET and secondary diode are usually stressed by the high powering current.

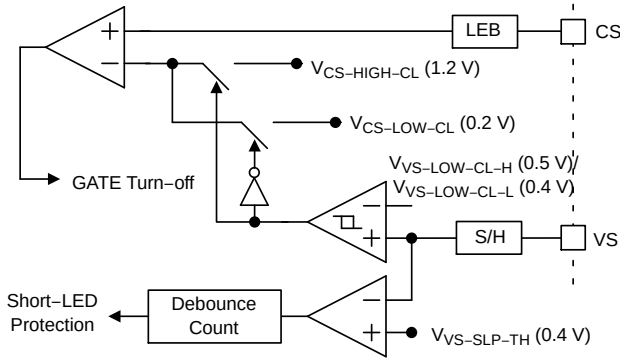


Figure 20. Short LED Protection

FL7734 changes the current−limit level in a short−LED condition. When sampled VS voltage is lower than $V_{VS-LOW-CL}$ (0.4 V), the current−limit level is reduced to 0.2 V from 1.2 V, as shown in Figure 20 so that powering is limited and external components' current stress is relieved. When the sampled VS voltage is continuously lower than $V_{VS-SLP-TH}$ (0.4 V) for 3 consecutive switching cycles, short−LED protection is triggered with gate shutdown. After all types of protection including short−LED protection is triggered, FL7734 internally counts 4 seconds for auto restart and begins startup sequence again.

Open−LED Protection

When output load is open as high impedance, the output capacitor should be protected by limiting the capacitor voltage less than its maximum rating. FL7734 can detect the output over−voltage condition by sensing both VDD and VS voltages. When VDD voltage is higher than V_{DD-OVP} (27 V typical) or sampled VS voltage is higher than V_{VS-OVP} (3 V typical), protection is triggered. The protection mode is auto restart so normal operation resumes when the fault condition is removed.

Sensing Resistor Short Protection

During SS3, the controller operates in current−mode control and the peak CS voltage is 0.2 V during switching mode. When a sensing resistor is short circuited, CS voltage cannot reach 0.2 V and turn on time is maximized with potential damage of switching MOSFET. In order to provide protection against the failure, FL7734 compares CS voltage with $V_{CS-SRSP}$ (0.1 V) during the initial two switching operation. When VCS doesn't reach 0.1 V for the two switching, Sensing Resistor Short Protection (SRSP) is triggered. In normal condition, input voltage corresponding to 1.5 V V_{VIN} is high enough to make V_{CS} higher than 0.1 V with turn−on time shorter than maximum turn−on time.

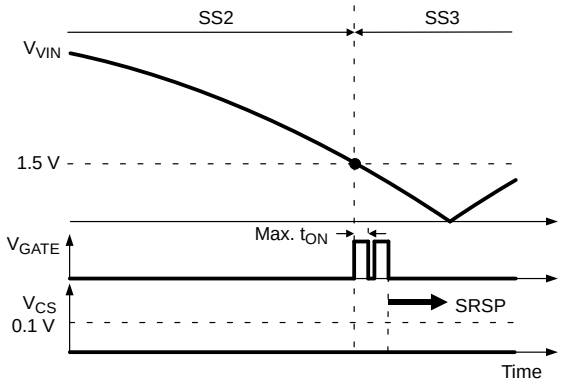


Figure 21. Sensing resistor Short Protection

Under−Voltage Lockout (UVLO)

The turn−on and turn−off thresholds are fixed internally at 10.6 V and 7.75 V, respectively. During startup, the VDD capacitor must be charged higher than 10.6 V through the external bleeding MOSFET. The bleeding MOSFET supplies VDD operating current until power can be delivered from the auxiliary winding of the main transformer. Generally at small phase angle range, V_{DD} supply time from auxiliary winding is short and V_{DD} could reach to V_{DD-OFF} (7.75 V). If V_{DD} drops below V_{DD-OFF}, VDD hiccup occurs with a certain hiccup frequency determined by VDD capacitor value and VDD supply current from auxiliary winding. This hiccup mode could cause LED flicker. In order to remove the unstable mode of operation, external bleeding circuit never allows VDD voltage to fall down less than V_{DD-OFF} (7.75 V) once input power is supplied.

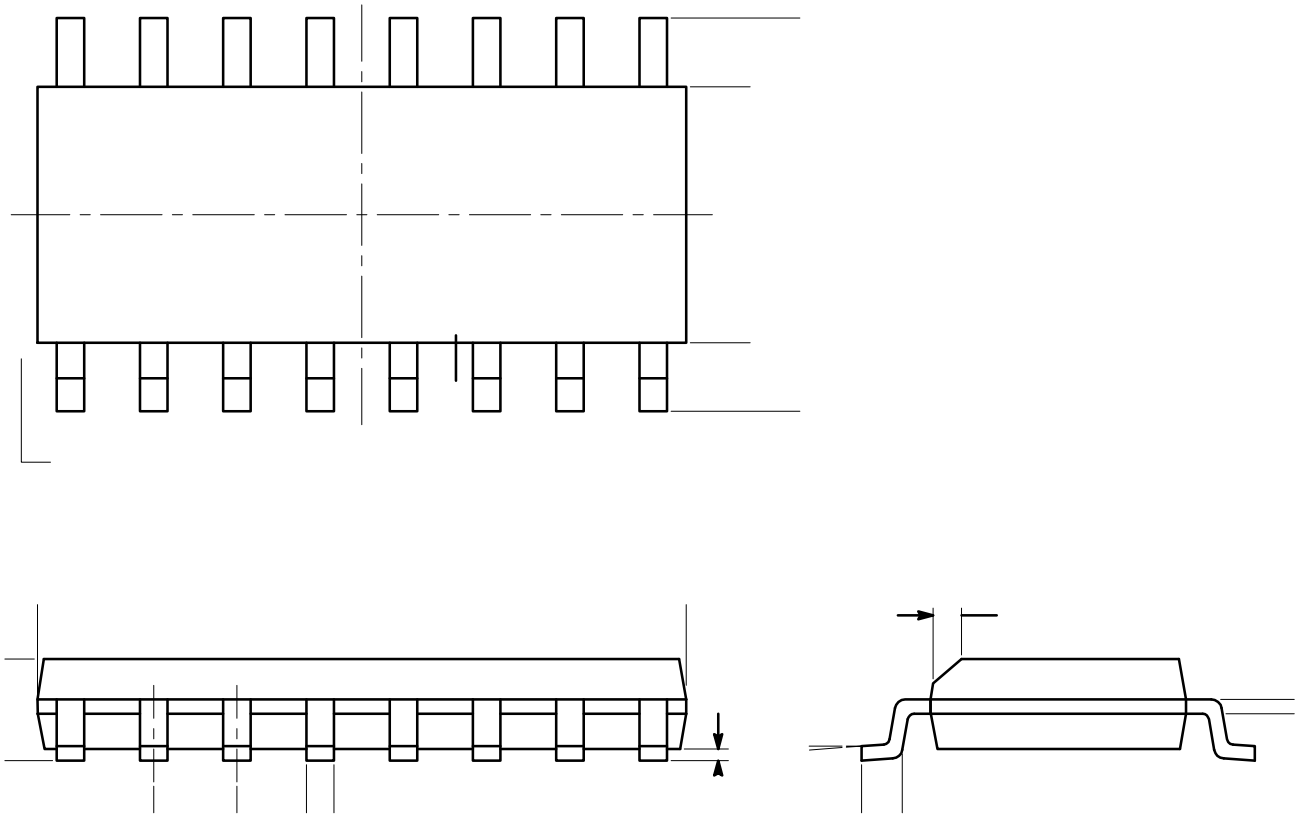
Over−Temperature Protection (OTP)

The built−in temperature−sensing circuit shuts down PWM output if the junction temperature exceeds 150 C. After Over−Temperature Protection (OTP) is triggered, FL7734 repeats auto−restart time counting until the junction temperature is lowered less than 140 C. Different from Short/Open−LED protection and SRSP, startup sequence doesn't appear every 4 seconds of auto−restart delay time because the temperature is detected by monitoring internally, not by checking external pin information. Normal startup sequence is started again when the junction temperature is out of the hysteresis temperature (140 C).

FL7734

SOIC−16, 150 mils
CASE 751BG
ISSUE O

DATE 19 DEC 2006



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