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SEMICONDUCTOR

January 2012

FL6961
Single-Stage Flyback and Boundary Mode PFC Controller for Lighting

Features

- Boundary Mode PFC Controller
- Low Input Current THD
- Controlled On-Time PWM
- Zero-Current Detection
- Cycle-by-Cycle Current Limiting
- Leading-Edge Blanking Instead of RC Filtering
- Low Startup Current: 10µA Typical
- Low Operating Current: 4.5mA Typical
- Feedback Open-Loop Protection
- Programmable Maximum On-Time (MOT)
- Output Over-Voltage Clamping Protection
- Clamped Gate Output Voltage: 16.5V

Applications

- General LED Lighting
- Industrial, Commercial and Residential Fixtures
- Outdoor Lighting: Street, Roadway, Parking, Construction, and Ornamental LED Lighting

Description

The FL6961 is a general lighting power controller for low- to high-power lumens applications requiring power factor correction. It is designed for flyback or boost converter operating in Boundary Mode.

The FL6961 provides a controlled on-time to regulate the output DC voltage and achieves natural power factor correction (PFC). The maximum on-time of the external switch is programmable to ensure safe operation during AC brownouts. An innovative multi-vector error amplifier provides rapid transient response and precise output voltage clamping. A built-in circuit disables the controller if the output feedback loop is opened. The startup current is lower than 20µA and the operating current is less than 6mA. The supply voltage can be up to 25V, maximizing application flexibility.

Ordering Information

Part Number	Operating Temperature Range	Package	Packing Method
FL6961MY	-40°C to +125°C	8-Pin, Small Outline Package (SOP)	Tape & Reel

Application Diagram

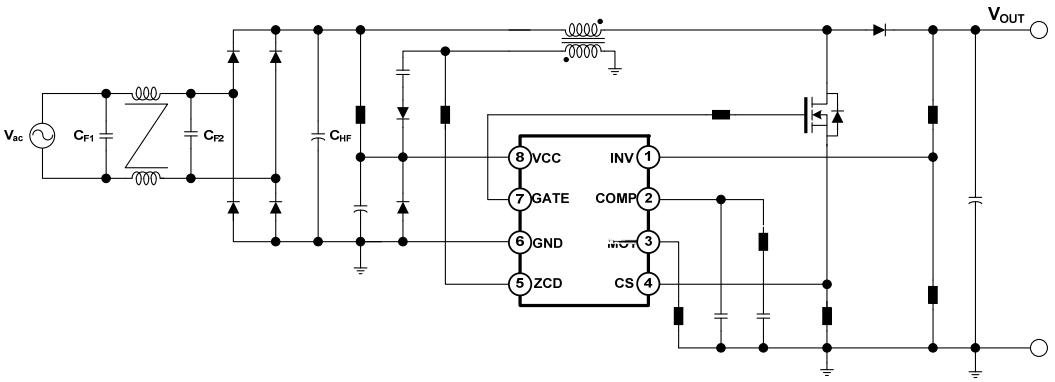
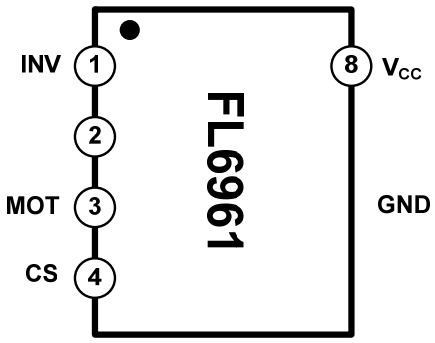


Figure 1. Typical Application Circuit for Step-up Converter

Marking Information

Figure 4. Marking Information

Pin Configuration



Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. All voltage values, except differential voltage, are given with respect to GND pin.

Symbol	Parameter	Min.	Max.	Unit
V_{VCC}	DC Supply Voltage		30	V
V_{HIGH}	Gate Driver	-0.3	30.0	V
V_{LOW}	Others (INV, COMP, MOT, CS)	-0.3	7.0	V
V_{ZCD}	Input Voltage to ZCD Pin	-0.3	12.0	V
P_D	Power Dissipation		660	mW
T_J	Operating Junction Temperature	-40	+150	C
θ_{JA}	Thermal Resistance (Junction-to-Air)		150	C/W
θ_{JC}	Thermal Resistance (Junction-to-Case)		39	C/W
T_{STG}	Storage Temperature Range	-65	+150	C
T_L	Lead Temperature (Wave Soldering or IR, 10 Seconds)		+230	C
ESD	Human Body Model: JESD22-A114		2.5	KV
	Machine Model: JESD22-A115		200	V

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_A	Operating Ambient Temperature	-40		+125	C

Electrical Characteristics

Unless otherwise noted, V_{CC}=15V and T_J=-40°C to 150°C. Current is defined as positive into the device and negative out of the device.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{CC} Section						
V_{CC-OP}	Continuous Operation Voltage				24.5	V
V_{CC-ON}	Turn-On Threshold Voltage		11.5	12.5	13.5	V
V_{CC-OFF}	Turn-Off Threshold Voltage		8.5	9.5	10.5	V
I_{CC-ST}	Startup Current	$V_{CC}=V_{CC-ON}$ – 0.16V		10	20	µA
I_{CC-OP}	Operating Supply Current	V_{CC}=12V, V_{CS}=0V, C_L=3nF, f_{SW}=60KHz		4.5	6	mA
V_{CC-OVP}	V_{DD} Over-Voltage Protection Level		26.8	27.8	28.8	V
$t_{D-VCCOVP}$	V_{DD} Over-Voltage Protection Debounce			30		µs
Error Amplifier Section						
V_{REF}	Reference Voltage		2.475	2.500	2.525	V
Gm	Transconductance			125		µmho
V_{INVH}	Clamp High Feedback Voltage			2.65	2.70	V
V_{INVL}	Clamp Low Feedback Voltage		2.25	2.30		V
$V_{OUT\ HIGH}$	Output High Voltage		4.8			V
V_{OZ}	Zero Duty Cycle Output Voltage		1.15	1.25	1.35	V
$V_{INV-OVP}$	Over-Voltage Protection for INV Input		2.70	2.75	2.80	V
$V_{INV-UVP}$	Under-Voltage Protection for INV Input		0.40	0.45	0.50	V
I_{COMP}	Source Current	V_{INV}=2.35V, V_{COMP}=1.5V	10	20		µA
		V_{INV}=1.5V	550	800		
	Sink Current	V_{INV}=2.65V, V_{COMP}=5V	10	20		
Current-Sense Section						
V_{PK}	Threshold Voltage for Peak Current Limit Cycle-by-Cycle Limit		0.77	0.82	0.87	V
t_{PD}	Propagation Delay				200	ns
t_{LEB}	Leading-Edge Blanking Time	R_{MOT}=24kΩ, V_{COMP}=5V		400	500	ns
		R_{MOT}=24kΩ, $V_{COMP}=V_{OZ}$+50mV		270	350	
Gate Section						
V_{Z-OUT}	Output Voltage Maximum (Clamp)	V_{CC}=25V	14.5	16.0	17.5	V
V_{OL}	Output Voltage Low	V_{CC}=15V, I_O=100mA			1.4	V
V_{OH}	Output Voltage High	V_{CC}=14V, I_O=100mA	8			V
t_R	Rising Time	V_{CC}=12V, C_L=3nF, 20~80%		80		ns
t_F	Falling Time	V_{CC}=12V, C_L=3nF, 80~20%		40		ns

Continued on the following page…

Electrical Characteristics

Unless otherwise noted, V_{CC}=15V and T_J=-40°C to 150°C. Current is defined as positive into the device and negative out of the device.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
Zero-Current Detection Section						
V_{ZCD}	Input Threshold Voltage Rising Edge	V_{ZCD} Increasing	1.9	2.1	2.3	V
H_{YS} of V_{ZCD}	Threshold Voltage Hysteresis	V_{ZCD} Decreasing		0.35		V
$V_{ZCD-HIGH}$	Upper Clamp Voltage	I_{ZCD}=3mA			12	V
$V_{ZCD-LOW}$	Lower Clamp Voltage	I_{ZCD}=-1.5mA	0.3			V
t_{DEAD}	Maximum Delay, ZCD to Output Turn-On	V_{COMP}=5V, f_{SW}=60KHz	100		400	ns
$t_{RESTART}$	Restart Time	Output Turned Off by ZCD	300	500	700	µs
t_{INHIB}	Inhibit Time (Maximum Switching Frequency Limit)	R_{MOT}=24kΩ		2.8		µs
V_{DIS}	Disable Threshold Voltage		130	200	250	mV
$t_{ZCD-DIS}$	Disable Function Debounce Time	R_{MOT}=24kΩ, V_{ZCD}=100mV	800			µs
Maximum On Time Section						
V_{MOT}	Maximum On Time Voltage		1.25	1.30	1.35	V
t_{ON-MAX}	Maximum On Time Programming (Resistor Based)	R_{MOT}=24kΩ, V_{CS}=0V, V_{COMP}=5V		25		µs

Typical Performance Characteristics

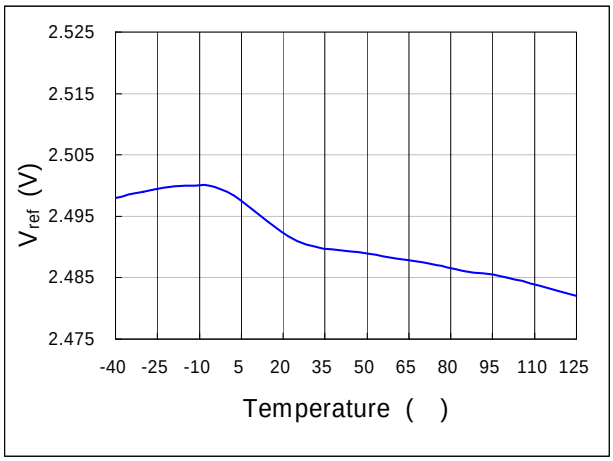


Figure 6. V_{REF} vs. T_A

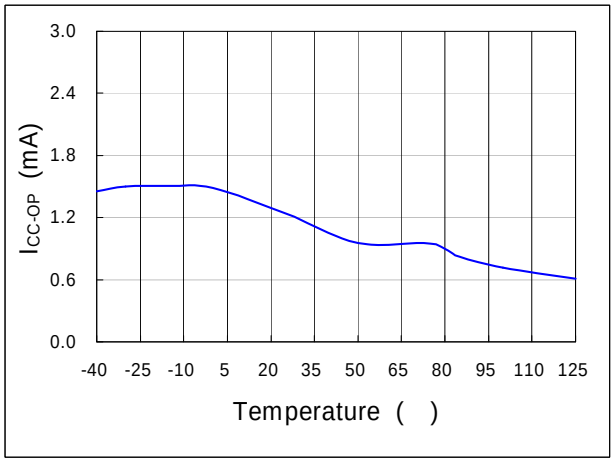
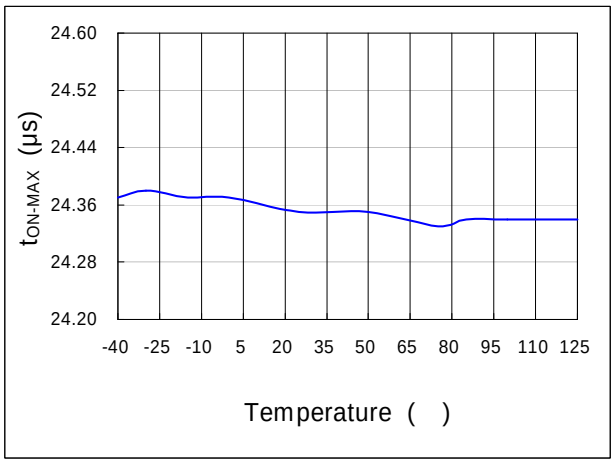
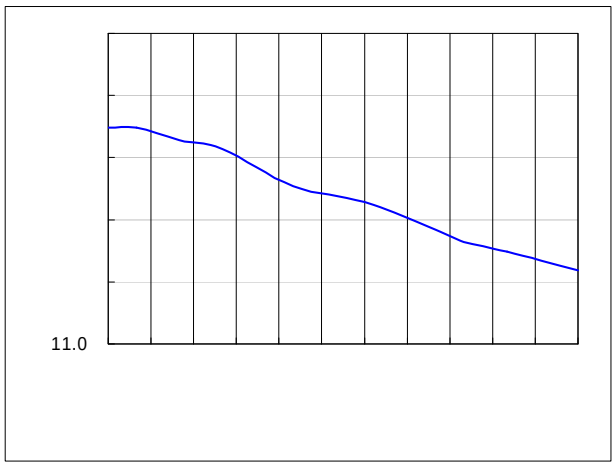
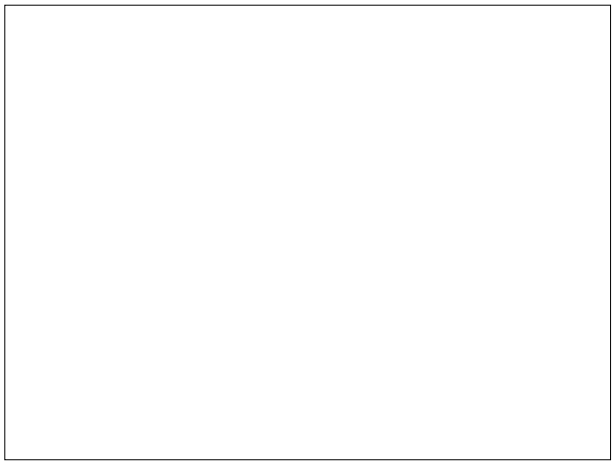


Figure 7. I_{CC-OP} vs. T_A





Typical Performance Characteristics (Continued)



Functional Description

Error Amplifier

The inverting input of the error amplifier is referenced to INV. The output of the error amplifier is referenced to COMP. The non-inverting input is internally connected to a fixed 2.5V ±2% voltage. The output of the error amplifier is used to determine the on-time of the PWM output and regulate the output voltage. To achieve a low input current THD, the variation of the on-time within one input AC cycle should be very small. A multi-vector error amplifier is built in to provide fast transient response and precise output voltage clamping.

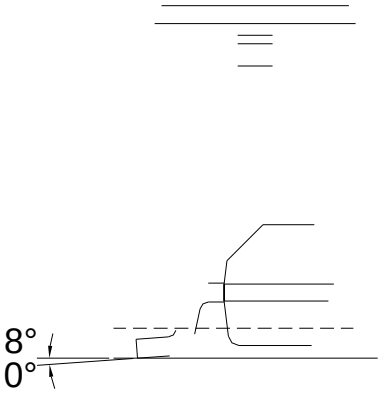
Connecting a capacitance, such as 1µF, between COMP and GND is suggested. The error amplifier is a trans-conductance amplifier that converts voltage to current with a 125µmho.

Startup Current

Typical startup current is less than 20µA. This ultra-low startup current allows the usage of a high resistance, low-wattage startup resistor. For example, 1MΩ

Physical Dimensions

SEE DETAIL A



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