

## DESCRIPTION

The MT7860 is a high power factor (PF) Buck LED Driver. It works under Quasi-Resonant Mode (QRM) which reduces both of current and voltage stress greatly, helps to improve EMI performance and efficiency. The output LED current is sensed by MT7860 with Quasi-full-cycle sensing (QCS) technology, accurate LED current regulation is achieved.

The MT7860 is specially designed for intelligent dimming application. Dimming of LED current can be achieved by decoded PWM or analog signal. The accuracy and consistency of LED current, especially at low dimming level, is achieved by the internal trimming decoder. As Dimming level becomes lower, the switching control method goes from QRM to PFM (Pulse Frequency Modulation) seamlessly. Then smaller output current and lower switching loss are achieved.

MT7860 provides varies of protections to improve the system reliability, including over voltage protection (OVP), over current protection(OCP), short circuit protection (SCP) and over temperature compensation, etc.

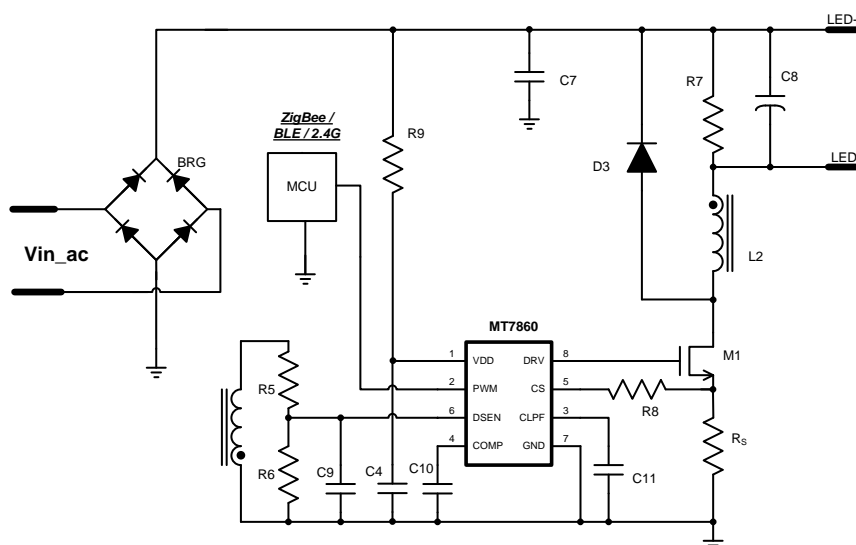
## FEATURES

- Single-stage active power factor correction (PFC > 0.90)
- High precision LED current ( $\pm 3\%$ )
- Good Line and Load Regulation ( $\pm 2\%$ )
- Quasi-Resonant mode (QRM) operation
- Various protection schemes.
- PWM Dimming/ analog Dimming (100:1)
- Available in SOP8 package

## APPLICATIONS

- Dimming lighting application
- Smart LED Lamps with 2.4G/BLE/ZigBee
- Other LED lighting application

## Typical Application Circuit



**ABSOLUTE MAXIMUM RATINGS**

VDD Pin Voltage	-0.3V to VDD Clamp
DRV Pin Voltage	-0.3V to VDD
COMP/CS/DSEN/PWM/CLPF Pins Voltage	-0.3V to 5V
Lead Temperature (soldering, 10 sec.)	260°C
Storage Temperature	-55°C to 150°C
Junction Temperature (Tj)	150°C

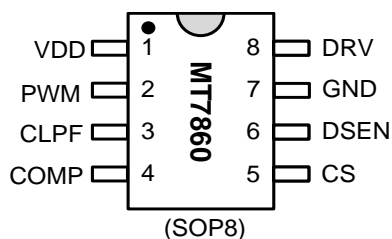
**Recommended operating conditions**

Supply voltage	9V to 28V
Operating Temperature (Environment)	-40°C to 105°C

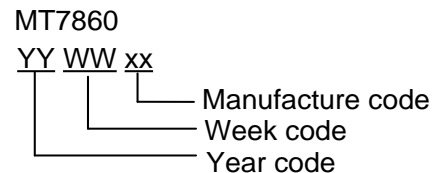
**Thermal resistance**

Junction to ambient (RθJA)	128°C/W
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**PIN CONFIGURATIONS**



**Chip Mark**



**PIN DESCRIPTION**

Name	Pin No.	Description
VDD	1	Power Supply pin.
PWM	2	Digital PWM Signal input pin.
CLPF	3	Analog Dimming Signal input pin / PWM dimming signal filtering capacitor
COMP	4	Internal EA's output pin. Connect a capacitor to ground for frequency compensation.
CS	5	Current Sense pin.
DSEN	6	Feedback pin for inductor zero current crossing detection.
GND	7	Ground pin.
DRV	8	Drive signal for external Power MOSFET.

## ELECTRICAL CHARACTERISTICS

(Test conditions: V<sub>DD</sub>=15V, T<sub>A</sub>=25°C unless otherwise stated.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Start-up (VDD Pin)</b>						
V <sub>STP</sub>	Start-up Voltage	VDD Ramp-up from 0V		14		V
UVLO	Under Voltage Lockout	VDD Ramp-down from (V <sub>STP</sub> +1V)		9		V
I <sub>STP</sub>	Start-up Current	VDD=16V		25		μA
OVP1	Over Voltage Protection of VDD			28		V
I <sub>CLAMP</sub>	Sinking Current Capability to Clamp VDD			5		mA
<b>Power Supply Current</b>						
I <sub>Q</sub>	Quiescent Current			1.0		mA
<b>Control Loop (DSEN Pin)</b>						
V <sub>REF-FB</sub>	Voltage Reference for Feedback Loop	Close the Feedback Loop	196	200	204	mV
SCP	Threshold of Short Circuit Protection at DSEN Pin			400		mV
OVP2	Over Voltage Protection at DSEN Pin			3.2		V
LEB1	Leading Edge Blank at DSEN Pin			2		us
MinT	Minimum Switching Period			10		us
MaxT	Maximum Switching Period			1		ms
DutyMin	Duty Cycle of PWM Pin when LED Current is Zero			20		%
DutyMax	Duty Cycle of PWM Pin when LED Current Reaches Maximum			80		%
T <sub>hiccup</sub>	The auto-recovery delay time of Short Circuit Protection			150		ms
<b>Current Sense (CS Pin)</b>						
OCP	Threshold of Over Current Protection at CS Pin			1.4		V
LEB2	Leading Edge Blank at CS Pin			300		ns
<b>Temperature Compensation</b>						
T <sub>Trig</sub>	Temperature Compensation Point			150		°C
<b>Driver Stage (DRV Pin)</b>						
I <sub>SINK</sub>	Sinking Capability			2		A
I <sub>SOURCE</sub>	Sourcing Capability			1		A

**APPLICATION INFORMATION**

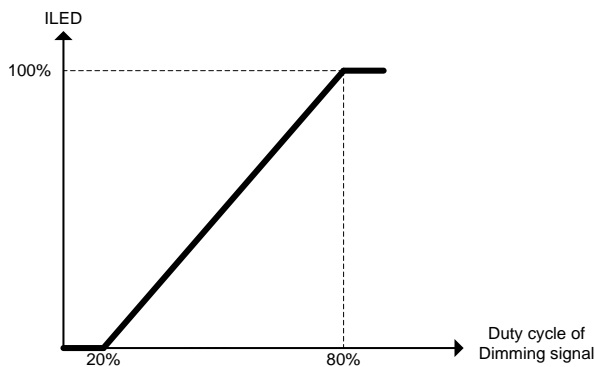
The MT7860 integrates power factor correction function and works under Quasi-Resonant Mode (QRM) at heavy loading and under Pulse Frequency Modulation (PFM) at light loading. The LED current can be accurately regulated by Maxic proprietary technology.

**Constant Current Control**

The output LED current is sensed by the MT7860 with Quasi-full-cycle sensing (QCS) technology. The LED current is set by resistor Rs (as shown in the typical application circuit).

$$I_{LED} = \frac{V_{FB}}{R_s} = \frac{200mV}{R_s}$$

For dimming application, the input PWM dimming signal is decoded by PWM pin. The LED current be set by Duty cycle of PWM dimming signal, as shown in Fig. 1.

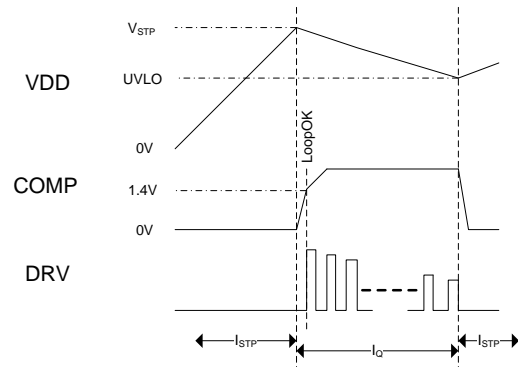


**Fig.1 ILED vs. Duty Cycle of PWM Dimming Signal**

**Start Up**

During start-up, the capacitor at VDD is charged by the start-up resistor which is connected to input voltage. The internal control logic starts to work when VDD reaches 14V (V<sub>STP</sub>). The COMP pin is, therefore, pre-charged during this process. The internal control loop is established. Once the voltage of COMP pin reaches 1.4V, the whole system would work in normal operation mode.

As the VDD goes below 9V(UVLO), the system enters UVLO, the PWM signal of DRV pin is shut down, and the voltage of COMP pin is discharged to 0V. The detailed start-up sequence is shown in Fig. 2.



**Fig.2 Start up Sequence Diagram**

**Operation Modes**

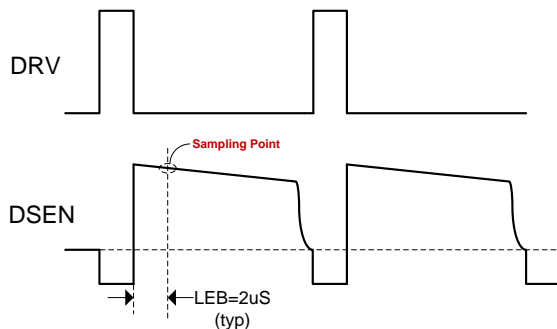
When the duty cycle of the PWM dimming signal is greater than 80%, the MT7860 works under full load condition and operates at quasi-resonant mode (QRM). As the duty cycle of the PWM dimming signal is reduced, the on-time (Ton) of the power MOSFET is reduced, so as the demagnetization time. But the minimum switching period of the chip is clamped to be 10µS. When the sum of on-time of power MOSFET and the demagnetization time of the inductor is less than 10µS, MT7860 enters the discontinuous conduction mode (DCM). When the duty cycle of the PWM dimming signal is further reduced, the on-time of power MOSFET is reduced to be the minimum turned-on time (400nS), MT7860 starts to increase the minimum switching period, and works under the pulse frequency modulation (PFM) mode.

Therefore, MT7860 automatically switches between the above three kinds of modes based on the output current value. It's recommended to choose a proper inductance to let the system work under QRM at full load condition.

### Auxiliary Sensing

The voltage waveform of the inductor is sensed during OFF period for switching logic control, over-voltage protection (OVP), short-circuit protection (SCP), etc.

The DSEN pin senses the inductor voltage through a resistor divider. The sampling strobe window is 2 $\mu$ s LEB (Leading Edge Blanking) time right after the DRV signal goes low for better noise immunity, as shown in Fig. 3.



**Fig.3 Auxiliary Signal Sensing**

### Hiccup Mode

Once detected any fault conditions, such as, over-voltage (OV), short-circuit (SC) conditions, the MT7860 goes into hiccup mode, switching signal is turned off. After waiting for  $T_{hiccup}$ , MT7860 will remove the internal protection state and initiate a start-up sequence. If the fault conditions are removed, the LED driver goes back to normal automatically.

The hiccup mode keeps the system at low power dissipation state during fault conditions, enhancing system reliability.

### Over-voltage Protection

Two kinds of over-voltage protection functions are integrated in MT7860. If DSEN voltage exceeds 3.2V three times, the MT7860 gets in hiccup mode. If VDD voltage exceeds 28V three times, the MT7860 gets in hiccup mode.

### Short-circuit Protection

The short-circuit protection is triggered if the

DSEN voltage is detected below 400mV during OFF period for a continuous time of 5 to 10ms. The MT7860 gets into hiccup mode.

During start-up, MT7860 disables the short-circuit detection within 40ms. Thereafter, if the DSEN voltage is lower than the short-circuit protection threshold (400mV), MT7860 will trigger the short-circuit protection and gets into hiccup mode.

### Over-current Protection

The MT7860 immediately turns off the power MOSFET once the voltage at CS pin exceeds 1.4V. This cycle by cycle current limitation scheme prevents the relevant components, such as power MOSFET, inductor, etc. from damage.

### Temperature Compensation

When the Junction Temperature reaches 150°C, the compensation circuit starts to reduce output current along with the temperature increasing. As the junction temperature drops below 150°C, the output current back to normal level. This thermal fold back scheme prevents the system goes into thermal runaway.

### Typical Intelligent Dimming Application

MT7860 combined with MT8801 can be used in intelligent dimming applications. MT8801 provides power to the MCU and even MT7860 itself. So MCU can also get a stable power supply when the LED is turned-off, and the system keeps low standby power dissipation. As shown in Fig. 4.

### PCB Layout

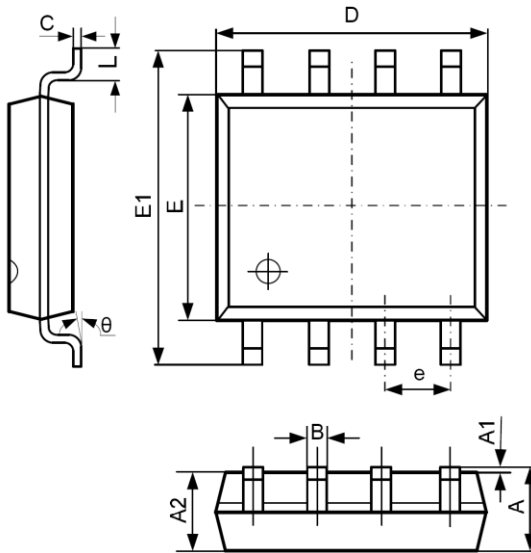
In order to improve the system noise immunity, the PCB layout should follow the rules as below (refer to Fig. 5.):

- 1) First, connect the ground paths of C9, C10, C11 and R6 to the chip ground pin GND.
- 2) Second, connect the GND pin to the ground



**PACKAGE INFORMATION**

**SOP-8 PACKAGE OUTLINE AND DIMENSIONS**



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270 TYP		0.050 TYP	
L	0.400	1.270	0.016	0.050
theta	0°	8°	0°	8°

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