QW2032

8~60V Input 1.5A deeply Dimming, Constant Current LED Driver

General Description

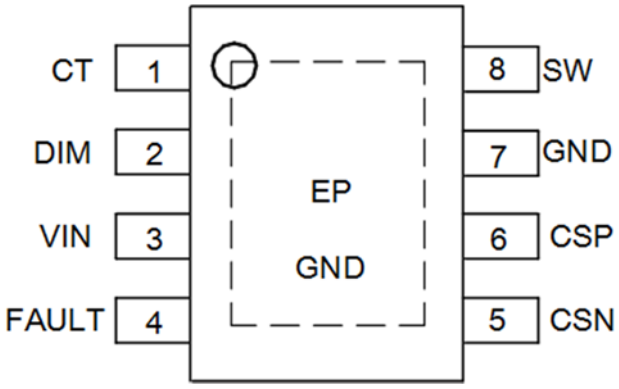
The QW2032 is a high current accuracy step-down converter designed in continuous current mode for driving the high brightness Light Emitting Diodes(LED). The QW2032 employs patent protected analog dimming LED method to regulate a high accuracy LED current and fine dimming curve. Moreover, this control scheme provides a constant switching frequency in applications. The QW2032 includes anti-stuck function for power-up and open-load check function.

The QW2032 implements frequency jitter for EMI. The QW2032 is available in ESOP-8 package.

Features

- Wide Input Range: 8V to 65V
- Internal 65V NMOSFET
- Max 1.5A Output Current
- Original analog dimming method for deeply dimming and linearity dimming curve
- Inherent Original frequency jitter for EMI
- Inherent Anti-stuck function
- Constant Switching frequency when Dimming
- High Efficiency
- Internal Protection:
  - Under Voltage Protect (UVLO)
  - Thermal Overload Protection(OTP)
  - Open LED sign (Fault PIN). Auto restart when re-load.

Package Reference

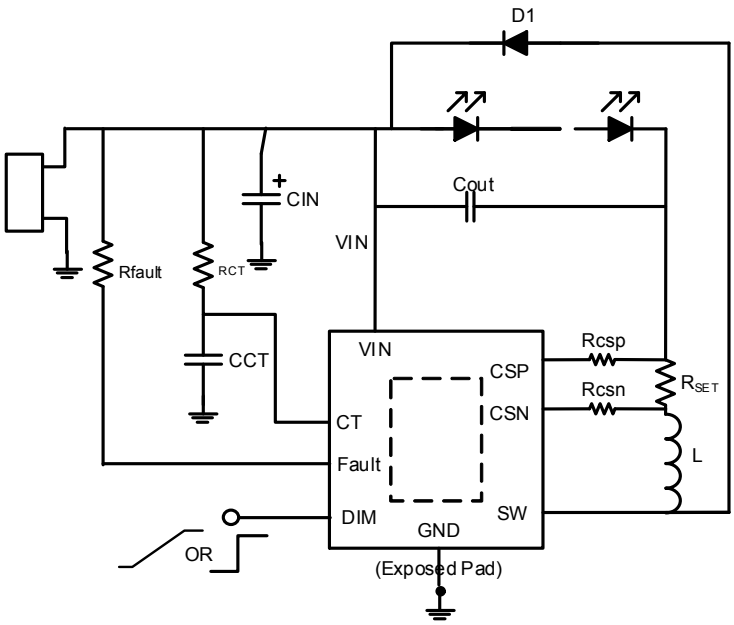


(Top View) SO-8EP

Applications

- Low Voltage LED Ceiling down Light
- Automotive/Decorative LED Lighting
- Low Voltage General Illumination/Industrial Lighting
- LED Back-up Light
- Signs/Emergency Lighting
- LED Stage Lighting

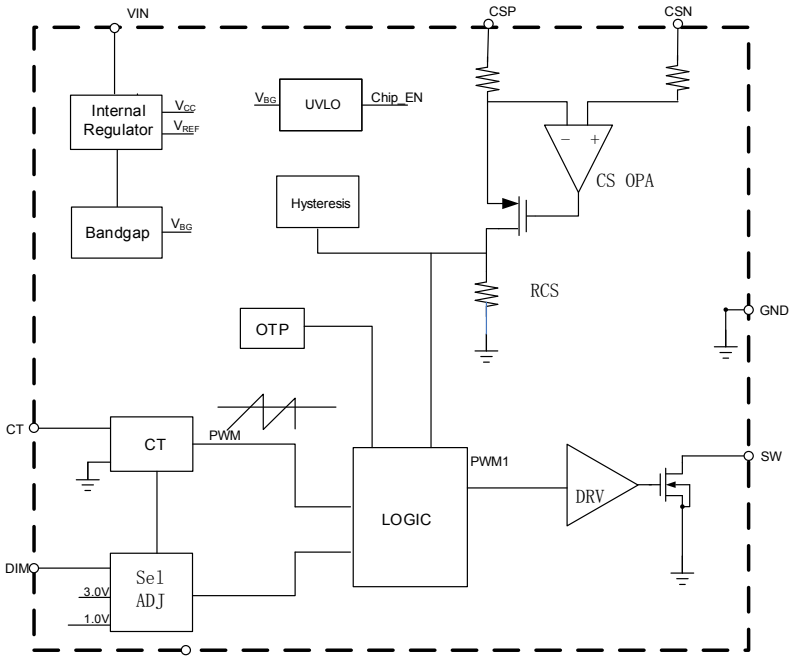
TYPICAL APPLICATION



PIN FUNCTIONS

PIN#	Name	Description
1	CT	In deep analog dimming. Analog dimming auto transforms to PWM Dimming; LED load open, after counting 128 CT duty, Fault draw low. Internal Max Clamp to 5V.
2	DIM	Analog/PWM Dimming PIN. Internal Max Clamp to 5V.
3	VIN	Input Supply Pin（8V~65V）. Connecting a proper decoupling capacitor from VIN to GND
4	Fault	LED Open-load Sign PIN. When open LED load, Fault Pin draw low.
5	CSN	LED Current Sense Input. Connecting the Current Sensing Resistor(R_{set}) that programs the LED average current between CSP and CSN. I_{out}=0.24V/R_s
6	CSP	Another terminal connecting Current Sensing Resistor(R_s) for program LED average current.
7	GND	**Ground. The Source of Internal 65V MOSFET**
8	SW	The Drain of Internal 65V MOSFET. Connecting the Common terminal of inductor and anode of Schottky to this PIN.
9	Exposed PAD	Connecting to GND

FUNCTION DIAGRAM



ABSOLUTE MAXIMUM RATINGS (@T_A= +25°C, unless otherwise specified. Note 4)

Parameter	Symbol	Value	Units
VIN	V_{IN}	-0.3 to 70	V
SW	V_{SW}	-0.3 to 70	V
Fault	V_{fault}	-0.3 to 70	V
CSP	V_{CSP}	-0.3 to 70	V
CSN	V_{CSN}	-0.3 to 70	V
CT	V_{CT}	-0.3 to 6	V
DIM	V_{DIM}	-0.3 to 6	V
Junction Temperature	T_J	+150	ºC
Storage Temperature	T_{STG}	-65 to +150	ºC
Thermal Resistance(Note 5)	θ_{JA}	66	°C/W
Lead Temperature (Soldering, 10sec)	T_{LEAD}	+300	ºC
ESD (Machine Model)	–	200	V
ESD (Human Body Model)	–	2000	V

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Units
V_{IN}	VIN	5	60	V
T_A	Ambient Temperature	-40	+105	°C

ELECTRICAL CHARACTERISTICS(@T_A = +25°C, unless otherwise specified. Note 6)

Parameter	Symbol	Condition	MIN	TYP	MAX	Units
Input Section						
Operating Input Voltage	V_{IN}	–	8	–	65	V
Quiescent Supply Current	I_Q	Output not switching	–	0.8	–	mA
Internal Regulator Start-up Threshold	V_{UVLO}	V_{IN} rising	–	7.5	–	V
Internal Regulator Hysteresis Threshold	V_{HYS}	–	–	200	–	mV
Vsense Sampling Section						
Average Sampling Voltage Threshold	V_{sense}	–	–	240	–	mV
Sampling Voltage Hysteresis Threshold	–	V_{dim} =5V	–	±15	–	%
Internal Power MOSFET Section						
Recommended Max MOS Drain Voltage	V_{DS}	–	–	60	–	V
Recommended Max MOS current	I_{DS}	–	–	2	–	A
Switch On Resistance	R_{DSON}	–	–	250	–	mΩ
DIM Analog Dimming Section						
Analog Dimming Range	–	–	0.3		3	V
CT Saw wave Voltage Range	–	–	0.2		1	V
CT internal Analog to PWM Voltage	–	–	–	0.8	–	V
DIM PWM Dimming Section						
DIM Min Voltage	V_{DIM_L}	–	–	–	0.2	V
Fault Section						
Fault PIN draw Current Energy	Ifault		10			mA
Thermal Overload Protect Section						
Thermal Overload protect	T_{OTSD}	–	–	+160	–	ºC
Thermal Protect Hysteresis	T_{HYS}	–	–	+20	–	ºC

Note: 6.These parameters, although guaranteed by design, are not 100% tested in production.

OPERATION

QW2032 operation theory

The QW2032 is a deeply dimming constant current LED driver designed in hysteretic controlled step down. Under the Analog Dimming condition, the DIM Pin voltage from 3V to 0.8V is in Linear dimming(analog dimming), and from 0.8V to 0.3V in PWM dimming by comparing with saw wave at CT PIN. And In all Analog Dimming ranges, the switching frequency is constant. According to this patented invention, The QW2032 solves deeply dimming range and switching frequency high and efficiency in deeply dimming issues.

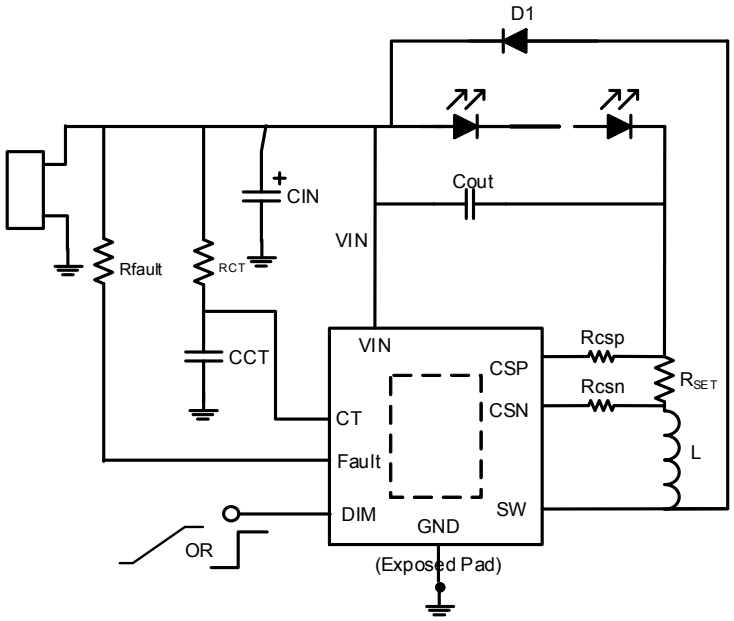


Fig 1 Typical Applications

LED current

From Figure 1. The Output LED current is decided by R_{sense}.

The output current IIED is:

$$ILED = \frac{Vsense}{Rsense}, \quad \text{Vsense = 0.24V}$$

R_{SET}

The QW2032 is Hysteretic control buck. The inductor current has upper threshold and lower threshold. The Inductor current shows in Fig.2.

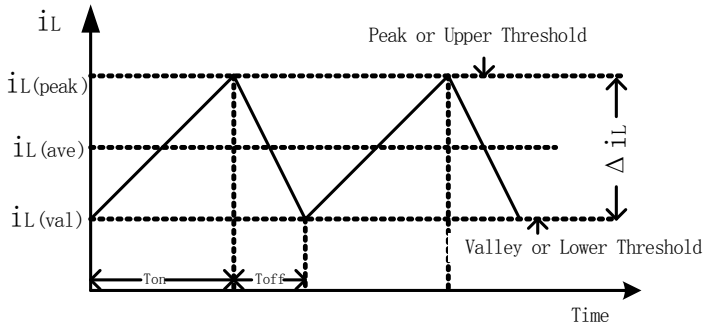


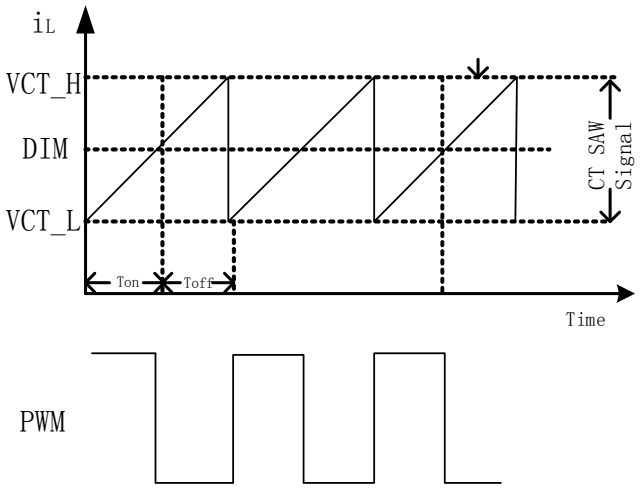
Fig 2 Inductor current waveform

Operation(Cont.)

When SW on, the inductor current flows through R_{SENSE} and increase to Il(peak) linearly. Then SW off.
When SW off, the inductor current flows through R_{SENSE} and decrease to Il(val). Then SW on. The period is repeated.
The inductor current upper and lower threshold is internal designed and don't vary with the dimming voltage.
The hysteresis threshold of inductor current is decided by V_{HYS} of Sense Voltage on Sensing Resistor.
It's recommended that Rcsp and Rcsn are used to improve the system reliability.

Analog Dimming by DC Voltage

The DIM PIN connects a DC voltage to adjust the output current of LED. And the LED current is programed by R_{SENSE}. Analog Dimming is from 0.2V to 3V.
From 0V to 0.2V, the DIM Pin make SW off and LED off.
From 0.2V to 0.3V, DIM Pin voltage internal clamps to 0.3V.
From 0.3V to 0.8V, DIM Pin compares to CT(the saw wave) PIN which creating a PWM signal. LED current is modulated by PWM.
From 0.8V to 3V, DIM Pin adjust the LED current linearly.
From 3V, DIM Pin clamps to 3V internally. The LED current is maximum.



PWM DIMMING

DPWM duty signal can connect to DIM to adjust the output LED current. The output current is linear ratio to PWM signal duty. In order to get more accuracy LED current, small bypass capacitor is recommended to DIM Pin. Otherwise PWM signal is filtered.

Jitter Making EMI Easier

The QW2302 generated 4 frequency steps. Maximum switching frequency vary is 20% average switching frequency. So the bounces of energy are diffused and EMI is improved.

Inductor selection

Operation duty cycle and switch MOSFET on time and off time should be considered in order to satisfy the input

Operation(Cont.)

voltage and whole LED current range. So:

MOSFET on time：

$$T_{ON} = \frac{L \times \Delta I}{V_{IN} - V_{LED} - I_{average} \times (R_{sense} + R_{DSL} + R_{sw_{on}})}$$

Note: if the switching frequency is too high, then internal delay time maybe not ignored. So 200KHz to 300KHz switching frequency is recommended for customers.

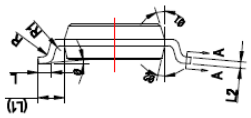
Output Capacitor: Cout

If peak to peak ripple LED current is required less than 30% of average current, add a capacitor across the LEDs. Proportionally lower ripple can be achieved with higher capacitor value. Also it is noted the output capacitor don't affect switching frequency and efficiency but affect the start-up time.

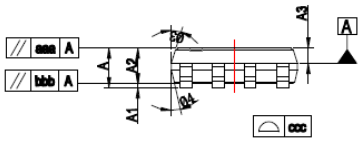
OTP

When the QW2032 junction temperature exceeded 165ºC, the OTP is triggered and SW is shutdown. When junction temperature lower than 145ºC, the QW2032 auto re-work.

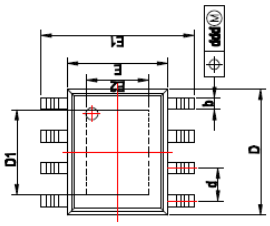
MECHANICAL DATA ESOP8



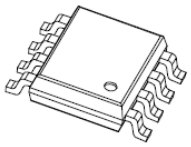
Top View



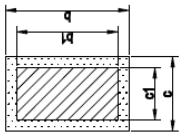
Right View



Front View



ISO View



SECTION A-A

Dimensional References unit:mm

Ref.	MIN	NOM	MAX	Ref.	MIN	NOM	MAX
A	1.35	1.55	1.75	E1	5.8	6.0	6.2
A1	0.10	0.15	0.25	L	0.45	0.60	0.80
A2	1.25	1.40	1.65	L1	1.04 REF		
A3	0.5	0.6	0.7	L2	0.25 BSC		
b	0.38	/	0.51	R	0.07	/	/
b1	0.37	0.42	0.47	R1	0.07	/	/
c	0.17	/	0.25	ø	0°	/	8°
c1	0.17	0.20	0.23	Ø1	15°	17°	19°
D	4.8	4.9	5.0	Ø2	11°	13°	15°
d	1.27 BSC			Ø3	15°	17°	19°
E	3.8	3.9	4.0	Ø4	11°	13°	15°
E2	2.3	2.4	2.5				
D1	3.2	3.3	3.4				
aaa	0.10			bbb	0.10		
ccc	0.10			ddd	0.25		

Note :

1.All dimension are in millimeter.

2.Exposed metallized leads are Cu with surface finish protection.