Flexible Dimming Solution by PWM / 0-10V / Potentiometer

REV. 00

General Description

The LD8116QL contains a processor which can convert the three different inputs of dimmer type include DC potential, PWM (Plus Width Modulation) signal and potentiometer become a PWM signal output. It is easy to provide the isolation dimming control that via opto-coupler for smart LED lighting application.

The device features include wide input voltage from 15V to 56V, adjustable bias current source for potentiometer and high precision LED dimming current.

The LD8116QL is the SOT-26 package to minimize the PCB size as well as component counts.

Features

- Wide VCC operating range
- Low operation current
- Precision dimmer type with
  - Voltage potential : 0/1V to 10V
  - PWM dimming: 500Hz to 10kHz
  - Potentiometer: 0 to 100k Ohm.
- Adjustable bias current source of DIM pin
- Clamp minimum duty 10% on OUT pin
- Built in dimming to on/off function on DIM pin
- Built in over temperature protection for Chip

Applications

- Dimmable LED Power Supply
- Dimming devices

Typical Application

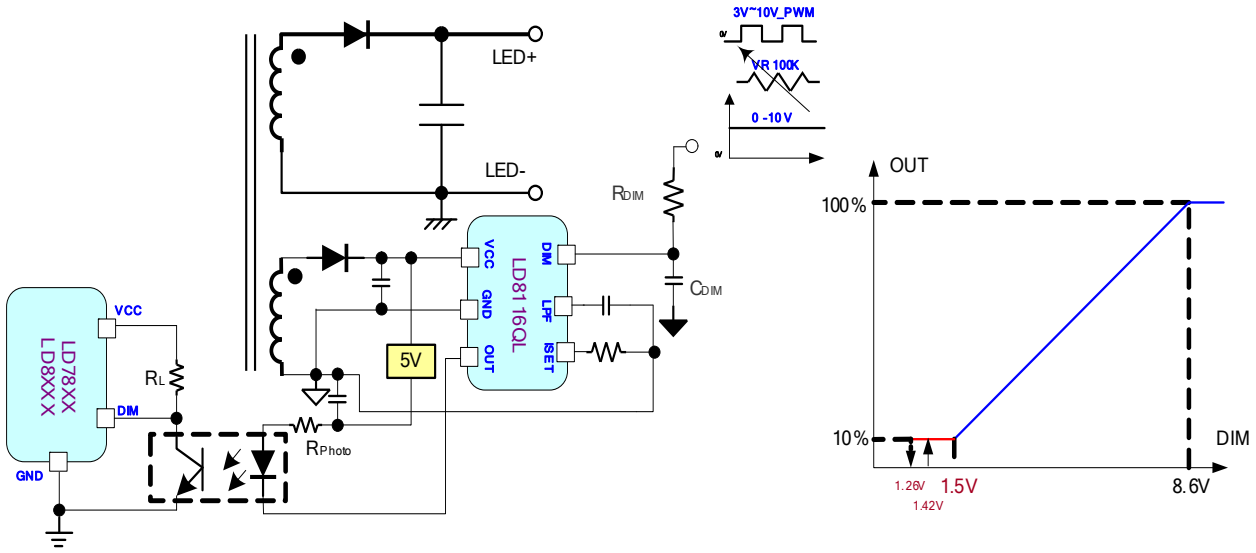
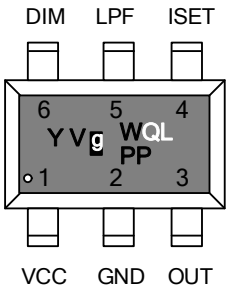


Fig. 1 Application circuit

Pin Configuration

SOT-26 (TOP VIEW)



Y : Year code (N: 2014, O: 2015.....)
W : Week code
PP : Production code
VgQL : LD8116QL

Ordering Information

Part number	Package	Top Mark	Shipping
LD8116QL GL	SOT-26	VgQL	3000 /tape & reel

The LD8116QL GL is ROHS compliant/ green packaged

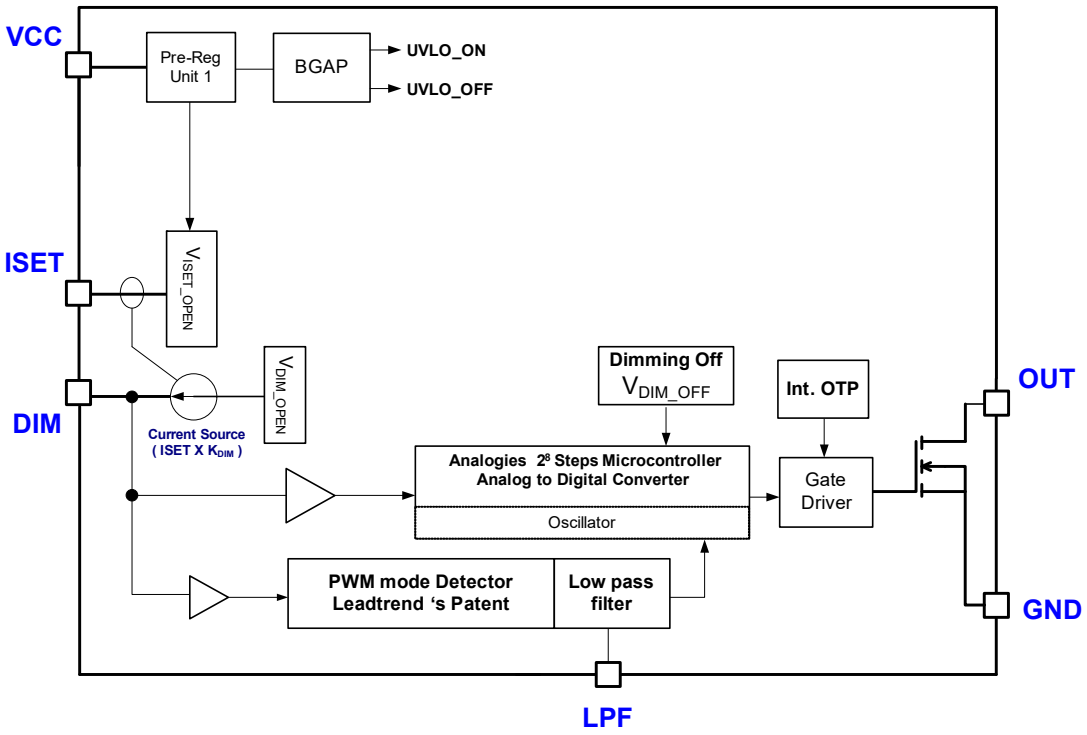
Protection Mode

Part number	Internal OTP	Cut off (Dimming to off)
LD8116QL GL	Auto-recovery OUT pin is open drain	Auto-recovery 1.26V

Pin Descriptions

Pin	NAME	FUNCTION
1	VCC	Supply voltage pin.
2	GND	Ground or Power return pin.
3	OUT	This pin is dimming output. It's an open-drain configuration. Connect this pin to power supply by a resistor.
4	ISET	This pin is used to set bias current of DIM pin by a resistor (= R_{ISET})connected between this pin and GND.
5	LPF	When chip is operated by PWM mode, PWM dimming signal filter capacitor connection. Recommend is 0.1uF.
6	DIM	Dimming signal input; - Voltage Potential : 0/1V to 10V - PWM Dimming : 500 to 10kHz and amplitude is upper 3.0V - Potentiometer : 0 to 100k ohm

Block Diagram



Absolute Maximum Ratings

VCC	-0.3V~60V
OUT	-0.3V~60V
OUT Sink Current	30mA
DIM	-0.3V~20V
ISET, CLAMP	-0.3V~6V
Maximum Junction Temperature	150°C
Storage Temperature Range	-65°C ~ 150°C
Package Thermal Resistance (SOT-26, θ_{JA})	200°C/W
Power Dissipation (SOT-26, at Ambient Temperature @ 85°C)	200mW
Lead temperature (Soldering, 10sec)	260°C
ESD Voltage Protection, Human Body Model	2.5KV
ESD Voltage Protection, Machine Model	250 V

Caution:

Stress exceeding maximum ratings may damage the device. Maximum ratings are stress ratings only. Functional operation above the recommended operating conditions is not implied. Extended exposure to stress above recommended operating conditions may affect device reliability.

Recommended Operating Conditions*Note1

Item	Min.	Max.	Unit
Supply VCC Voltage	15	56	V
Operating Junction Temperature	-20	105	°C
Resistor of ISET pin	50	100	kΩ
Source Current of DIM pin	-	1	μA
Input voltage of DIM pin	0	13	V
Input PWM frequency of DIM pin	0.5	5	kHz
Capacitor of DIM pin(C_{DIM}) *Note2	220	470	pF
Resistance of DIM pin(R_{DIM}) *Note2	5.1	7.5	kΩ
Low Pass Filter Capacitor of LPF pin(C_{LPF})	100	220	nF
PWM Signal Input Rising and Falling Time Rate	3	-	V/μs
High Voltage Level PWM Signal Input on DIM pin	3.2	12	V
Low Voltage Level PWM Signal Input on DIM pin	-	1.2	V
Sink current of OUT pin	-	20	mA

Note:

1. It's essential to connect VCC pin with a SMD ceramic capacitor (0.1μF~0.47μF) to filter out the undesired switching noise for stable operation. This capacitor should be placed close to IC pin as possible.
2. Test condition is R_{ISET}=100KOhm. (It means the I_{DIM}=100μA).
3. This application is based on system operation condition. Please refer to electrical characteristic information or contact us.

Electrical Characteristics

(V_{CC}=32.0V, T_A = 25°C unless otherwise specified.)

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
Supply Voltage (VCC Pin)						
UVLO (ON)		V_{CC_ON}	6.0	7.0	8.0	V
UVLO (OFF)		V_{CC_OFF}	5.0	6.0	7.0	V
Operating Current	R_{ISET}=100kohm, DIM pin is open	I_{VCC}		600	850	μA
ISET Pin						
Open Voltage		V_{ISET_OPEN}	2.45	2.5	2.55	V
Current Ratio of I_{DIM} to I_{SET}	*;(Calculate I_{DIM}/I_{SET})	K_{DIM}	3.8	4.0	4.2	
DIM Pin (Dimming function)						
Open Voltage	R_{ISET}=100kohm, DIM pin is open.	V_{DIM_OPEN}	12.2	13.0	13.8	V
Maximum level for 100% Output PWM duty		$V_{DIM\_MAX\_ON}$	8.4	8.6	8.8	V
Bias Current	R_{ISET}=100kΩ; at 25℃	I_{DIM_100}	97	100	103	μA
High Level of PWM input signal	*	$V_{DIM\_PWM\_H}$	3.2			V
Low Level of PWM input signal	*	$V_{DIM\_PWM\_L}$			1.2	V
PWM Dimming Mode Setting	*;Trigger rising rate and Count 4 times Still VCC ≦UVLO_OFF	Slew	2	3.5	5	V/μS
Duty Cycles Range when PWM mode	*; When use PWM mode	D_{PWM_R}	1		99	%
Minimum Duty Cycle Clamp	When VDIM=1.5V	$D_{OUT\_10\%}$	8.5	10.0	11.5	%
Cut off Threshold Level	Zero Duty when DC input	V_{DIM_OFF}	1.18	1.26	1.32	V
Cut off Recovery Voltage	*;$D_{OUT\_10\%}$ when DC input	V_{DIM_ON}	1.34	1.42	1.50	V
Cut off Duty	Zero Duty when PWM@5V,1KHz input	D_{DIM_OFF}	0.5	2	3.5	%
Cut off Recovery Duty	*;$D_{OUT\_10\%}$ when PWM@5V,1KHz input	D_{DIM_ON}	2.5	4	5.5	%
Open Drain Output (OUT Pin)						
Output Low Level	@2mA sink current	V_{OUT_LOW}		150	200	mV
Dimming Accuracy of Duty when DC input on DIM pin(Chip to Chip)	V_{DIM} = 2.0V ~ 8.0V. According to the amount of difference value, not percentage	D.A_DC	-2.0		+2.0	%
Dimming Accuracy of Duty when PWM mode (Chip to Chip)	PWM = 20~80% input when select PWM mode. According to the amount of difference value not percentage	D.A_PWM	-2.0		+2.0	%
Output Frequency		F_{OUT}	1.0	1.5	2.0	kHz

(V_{CC}=32.0V, T_A = 25°C unless otherwise specified.)

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
Low Pass Filter (LPF pin)						
Low pass filter Resistance	*	R_{LPF}		500		kΩ
Over Temp. Protection (Internal OTP)						
OTP Trip level	*; OUT pin is open drain	OTP	120	135	150	°C
OTP Hysteresis	*	△OTP	20	32.5	45	°C

*: Guaranteed by design.

Typical Performance Characteristics

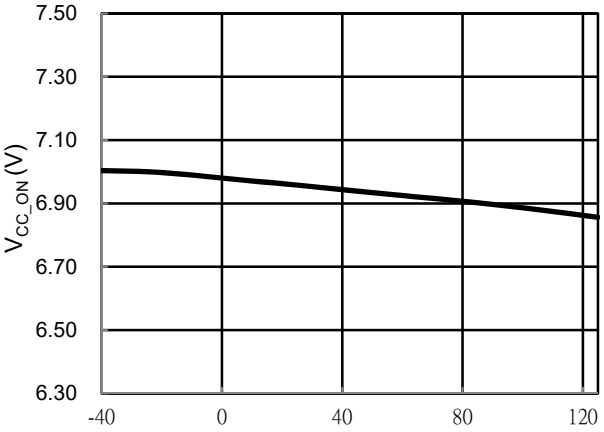


Fig.2 V_{CC_ON} VS. Temperature

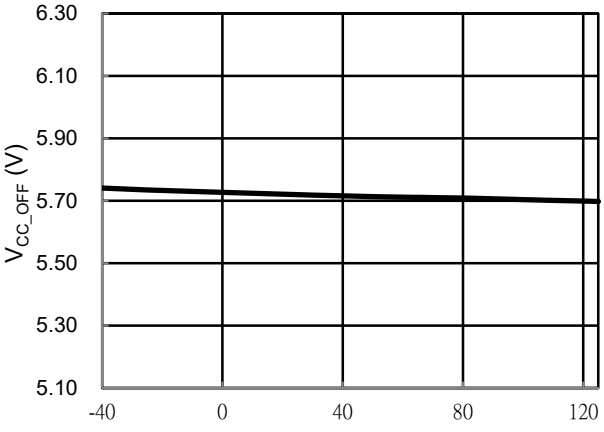


Fig.3 V_{CC_OFF} VS. Temperature

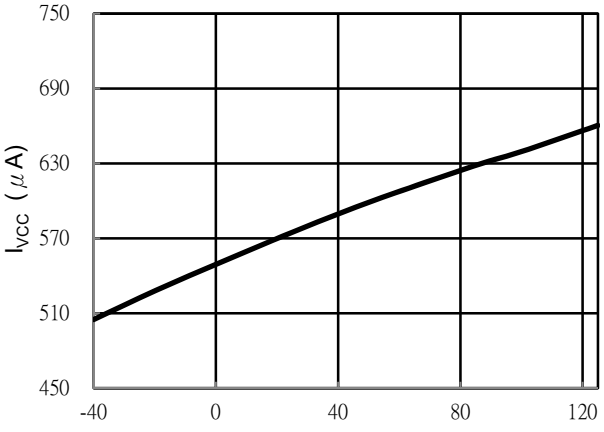


Fig.4 I_{VCC} VS. Temperature

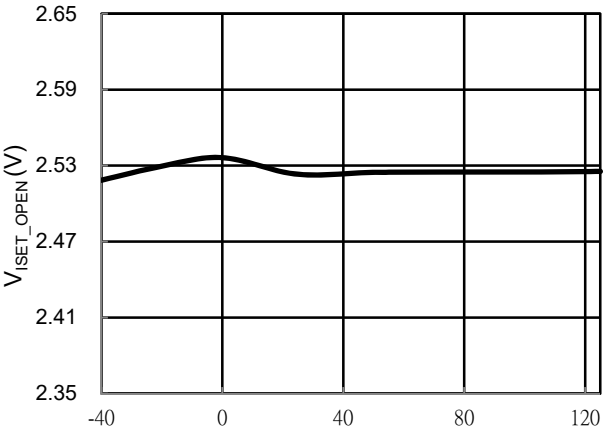


Fig.5 V_{ISET_OPEN} VS. Temperature

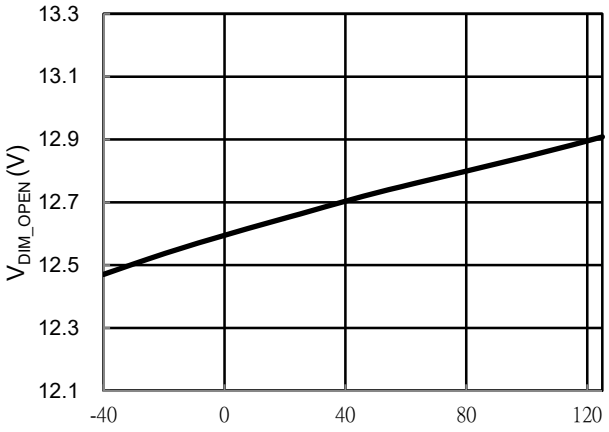


Fig.6 V_{DIM_OPEN} VS. Temperature

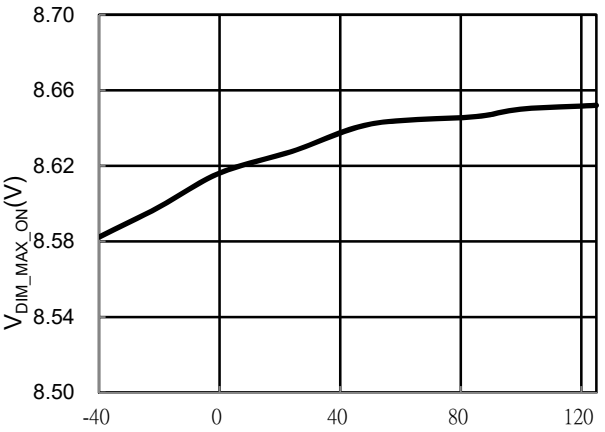


Fig. 7 $V_{DIM\_MAX\_ON}$ vs. Temperature

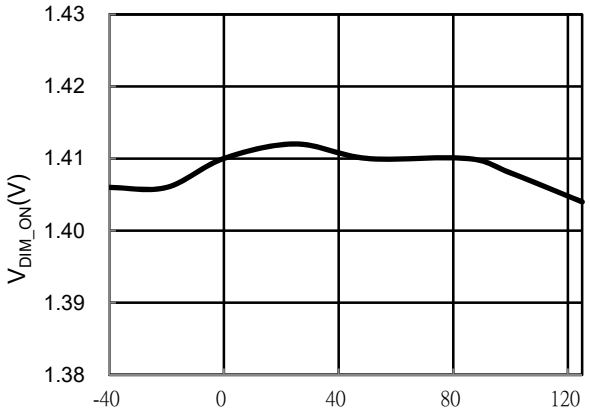


Fig. 8 V_{DIM_ON} VS. Temperature

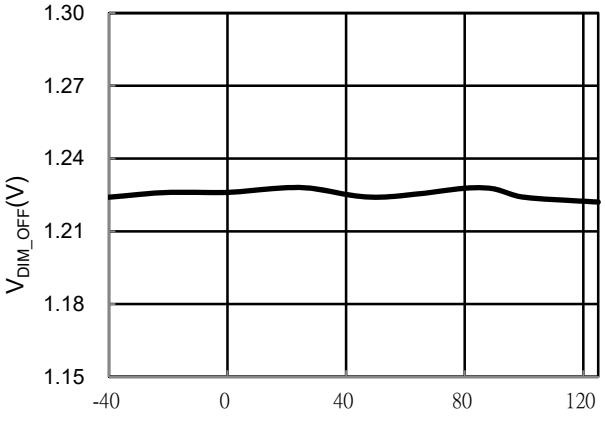


Fig. 9 V_{DIM_OFF} vs. Temperature

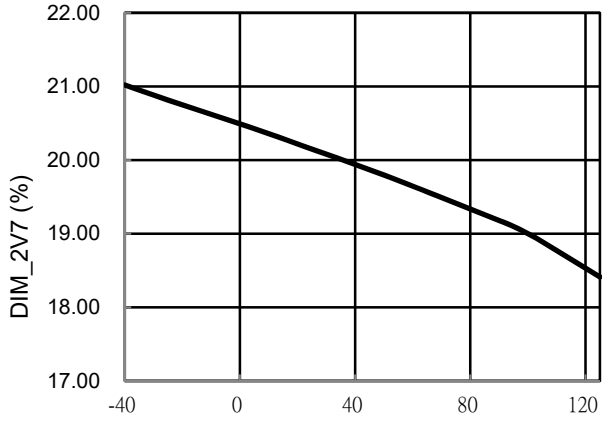


Fig. 10 DIM_2V7 vs. Temperature

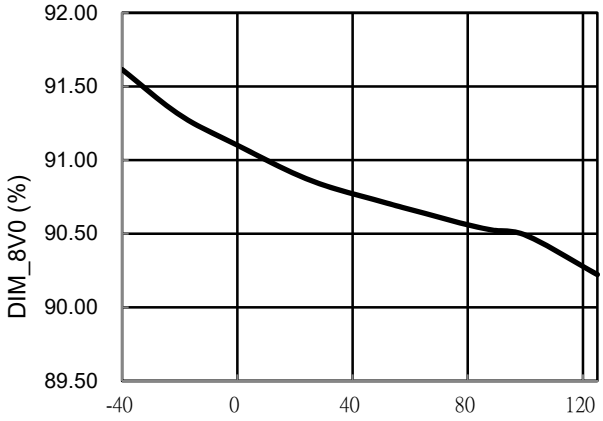


Fig. 11 DIM_8V0 vs. Temperature

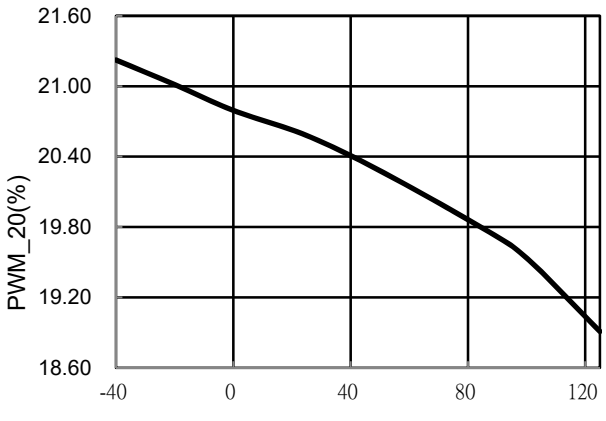


Fig. 12 PWM_20 vs. Temperature

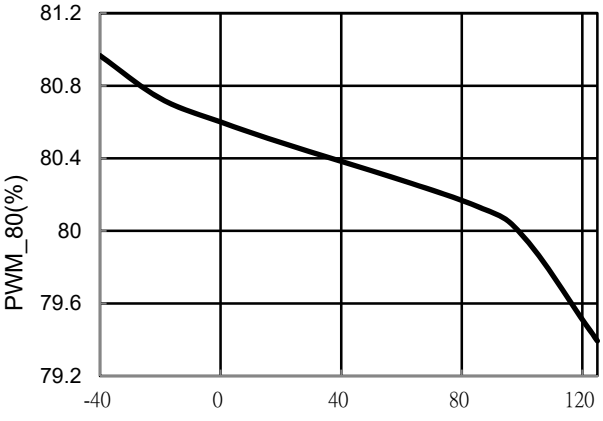


Fig. 13 PWM_80 vs. Temperature

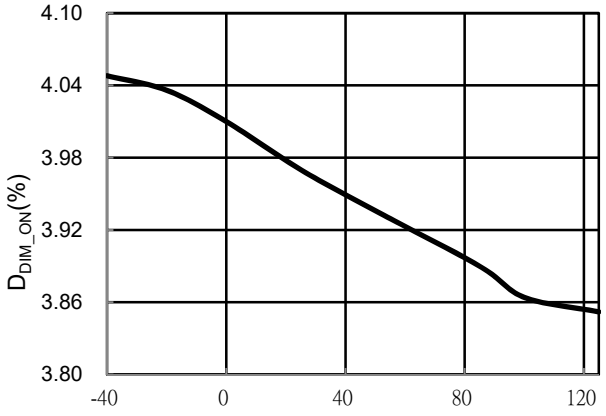


Fig. 14 D_{DIM_ON} vs. Temperature

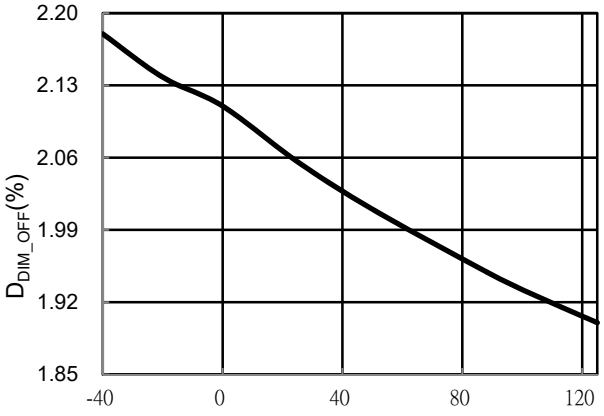


Fig. 15 D_{DIM_OFF} vs. Temperature

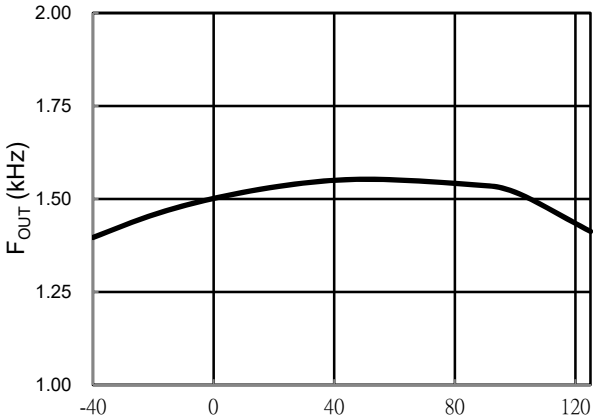


Fig.16 F_{OUT} VS. Temperature

Application Information

Operation Overview

The LD8116QL is an excellent 3 in 1 dimming controller for LED lighting applications. It integrates more functions to reduce the external components counts and the size. Its major features are described as below.

The LD8116QL convert input DC potential or PWM signal into PWM output. The output is an open-drain configuration which can pull down any source directly to control power supply dimming. The DIM pin of LD8116QL provides an adjustable bias current for potentiometer. So it can satisfy with active and passive dimmers both. It also can be used in isolation application with opto-coupler.

Startup and Under Voltage Lockout (UVLO)

An UVLO comparator is embedded to detect the voltage on the VCC pin to ensure the supply voltage enough to power on the LD8116QL. The turn on and turn off threshold voltage is fixed at 7V and 6V. When the voltage of VCC pin is above 6V, the LD8116QL output PWM which is basing on input DC potential, PWM single or potentiometer.

Bias Current of DIM Pin

ISET pin of LD8116QL is used to set bias current source of DIM pin by a resistor (= R_{ISET}) on ISET pin which is connected to GND. For the typical application, the output bias current of DIM pin is 100 μA when R_{ISET} is 100k ohm and 150 μA when R_{ISET} is 66.5k ohm. The relationship between resistor and output bias current is:

$$I_{DIM}=\frac{2.5V}{R_{ISET}} \times K_{DIM}$$

Where, K_{DIM} is a coefficient of current ratio of I_{DIM} per I_{SET}. The resistance range of R_{ISET} is recommend from 33k to 330k ohm and the range of bias current is approach to 30 μA ~ 300 μA.

Dimming Performance

0~10V Potential Dimming

When the input signal of DIM pin is DC potential, LD8116QL will transfer to PWM signal output at OUT pin. The frequency of output PWM on OUT pin is 1.5kHz around. The range of typical dimming curve is from 1.5V to 8.6V, which has the corresponding duty cycle from 10% to 100%.

PWM Dimming (Leadtrend 's patent)

During PWM signal input on the DIM pin, the output of LD8116QL OUT pin is PWM, too. And the output frequency is the same as 0-10V potential or potentiometer dimming mode. The input amplitude of PWM signal has to high level higher or equal to 3.2V and low level less than 1.2V on DIM pin. Besides, recommend PWM frequency range is from 500Hz to 10kHz and 1%~99% operation range. ICs PWM rising slew rate of DIM pin is faster than 3 V/μs through 1.2V to 3.2V and continuous 4 cycles, only in this way the PWM dimming mode can operate. Then detection of high and low voltage level on 1.8V and through LPF pin filter from PWM to DC then compare internal triangular wave. So, output duty cycle approaches input PWM duty. Once it enters PWM dimming mode, dimming mode will be kept until VCC is reset by UVLO_off. The below is suggestion for filter capacitor on LPF pin

PWM signal frequency (Hz)	Suggested C_{LPF} (nF)
500~3k	220
3k~10k	100

Potentiometer Dimming

When DIM pin has connected a potentiometer to GND, bias current source of DIM pin is pass thought this potentiometer then cause a DC voltage potential on DIM pin, LD8116QL will transfer to PWM signal on OUT pin. This frequency of OUT pin is 1.5kHz around.

Dimming Off Performance

When the DC input signal of DIM pin is up to $1.42V_{,typ.}$, PWM signal output of OUT pin is 9.5% duty cycle. But the DC input signal of DIM pin is lower to $1.26V_{DC}$, the OUT pin is pull low to GND. If dimmer signal on DIM pin is PWM condition, dimming off duty cycle is under $2\%_{,typ.}$..Then IC recover operation is higher than $4\%_{,typ.}$..

Internal Over Temperature Protection

When internal over temperature protection is occur (135°C typ.). The OUT pin of LD8116QL is open drain and auto-recovery after thermal down to normal operating temperature.

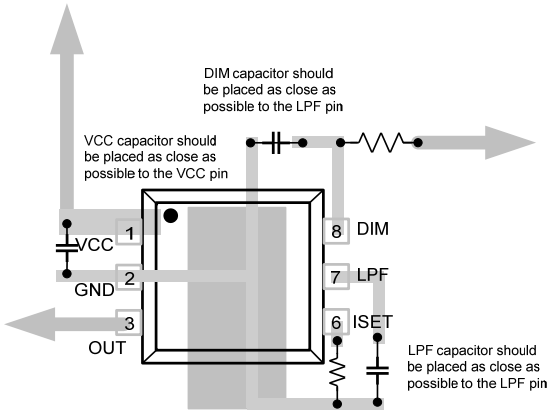
Optocouplers Selection Guide

LD8116QL converts an analog dimming signal into a PWM waveform. In the majority of applications the dimming signal needs to be isolated from the rest of the application and an optocoupler is used to implement either functional or reinforced isolation. Optocouplers are an excellent choice since they are very cost effective but nevertheless able to comply with virtually all safety standards. The most common and cost effective optocouplers are four-pin devices consisting of a LED and a photosensitive BJT. With four pin devices only collector and emitter of the BJT are connected to pins. This limits device performance, especially switching times, as will be discussed later. Six-pin devices having the base of the BJT as well connected to a pin are seen less often. With these six-pin devices bandwidth of the transmission can be improved if necessary. Finally there are high-speed digital couplers available that are designed for very high data rates and offer a buffered output with a nearly perfect PWM signal. While offering superior performance high speed couplers are considerably more expensive than simple LED-BJT couplers. There are two parameters of an optocoupler that are most important for use with LD8116QL: the **c**urrent **t**ransfer **r**atio CTR and the switching times Tr and Tf.

A typical plot of Tr and Tf vs, RL taken from the data sheet of a widely used 4-pin optocoupler.

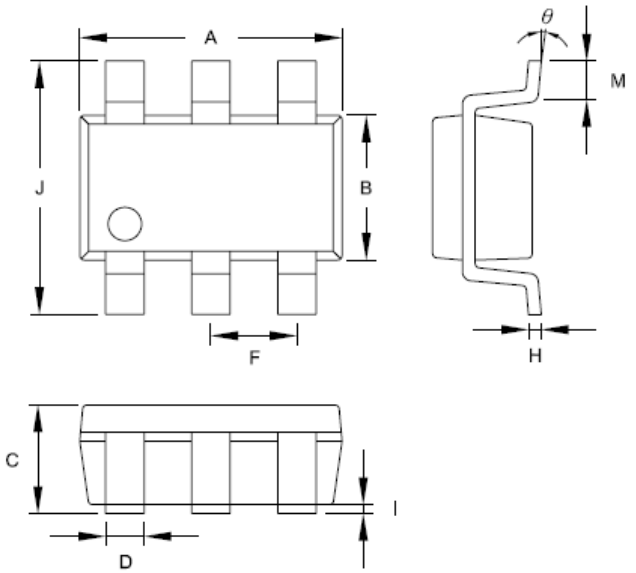
PCB Design Guideline

1. The bypass capacitor of V_{CC} should be placed as close as possible to the VCC and GND pin of IC.
2. C_{LPF} and C_{DIM} capacitors should be as short as possible to GND pin (pin 2).



Package Information

SOT-26



Symbol	Dimension in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	2.692	3.099	0.106	0.122
B	1.397	1.803	0.055	0.071
C	-------	1.450	-------	0.057
D	0.300	0.500	0.012	0.020
F	0.95 TYP		0.037 TYP	
H	0.080	0.254	0.003	0.010
I	0.050	0.150	0.002	0.006
J	2.600	3.000	0.102	0.118
M	0.300	0.600	0.012	0.024
θ	0°	10°	0°	10°

Revision History

REV.	Date	Change Notice
00	07/15/2020	Original Specification

Important Notice

Leadtrend Technology Corp. reserves the right to make changes or corrections to its products at any time without notice.

Customers should verify the datasheets are current and complete before placing order.