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

REV. 00

General Description

The LD8116Q 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 LD8116Q 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 10% minimum duty on OUT pin
- Built in over temperature protection for Chip

Applications

- Dimmable LED Power Supply
- Dimming devices

Typical Application

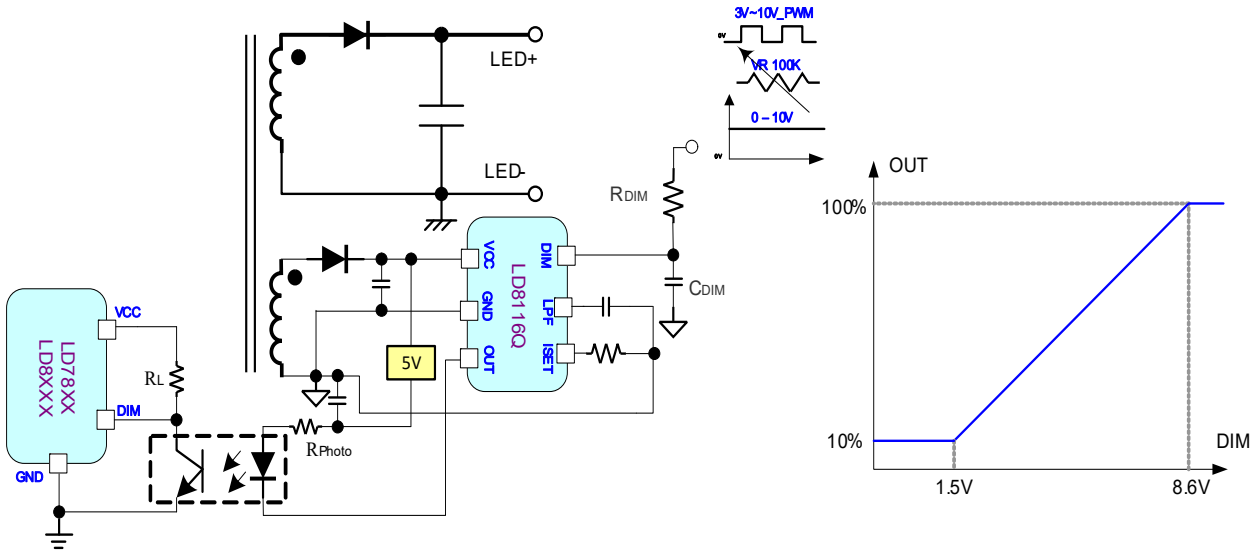
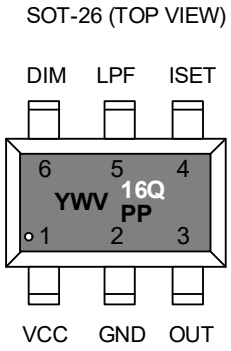


Fig. 1 Application circuit

Pin Configuration



Y : Year code (N: 2014, O: 2015…..)
W : Week code
PP : Production code
V16Q : LD8116Q

Ordering Information

Part number	Package	Top Mark	Shipping
LD8116Q GL	SOT-26	YWV/16Q/PP	3000 /tape & reel

The LD8116Q GL is ROHS compliant/ green packaged

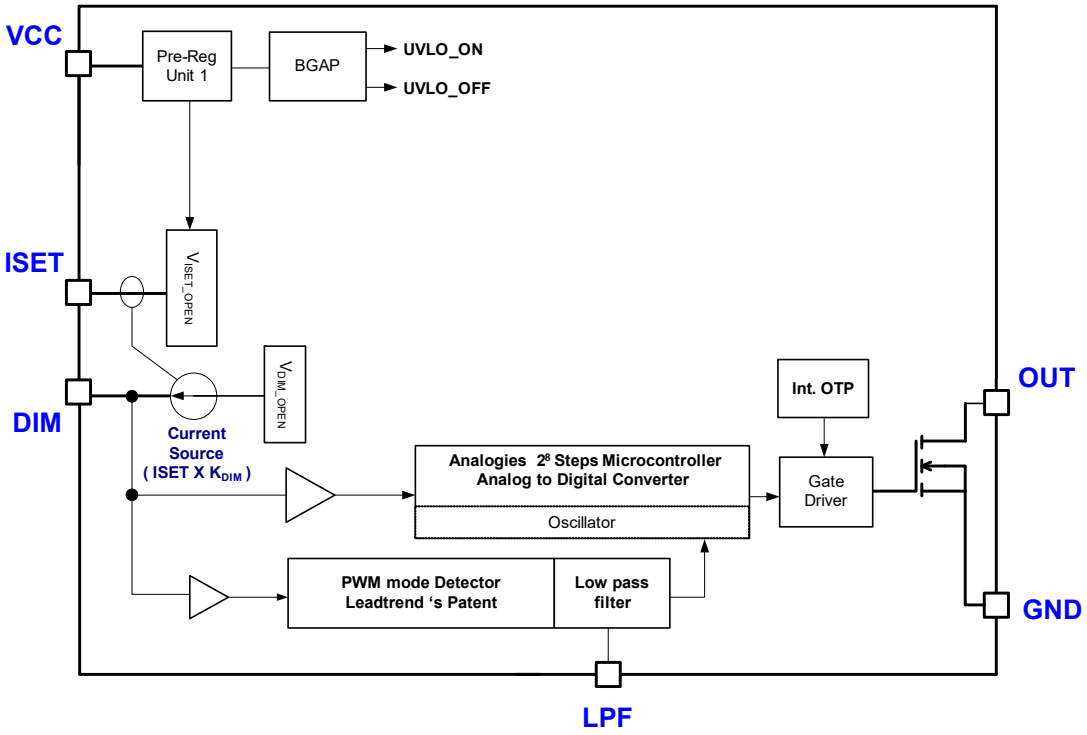
Protection Mode

Part number	Internal OTP	Cut off (Dimming to off) Function
LD8116Q GL	Auto-recovery OUT pin is open drain	None

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, LPF	-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	mA
Input voltage of DIM pin	0	13	V
Input PWM frequency of DIM pin	0.5	10	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	DIM pin is floating; R_{ISET}=100kΩ	I_{VCC}		600	850	μA
Set current source from DIM pin (ISET Pin)						
Open Voltage		V_{ISET_OPEN}	2.45	2.5	2.55	V
Current Ratio of I_{DIM} to I_{SET}	*; Calculated K_{DIM} to I_{DIM}/I_{SET}	K_{DIM}	3.8	4.0	4.2	
Dimming function (DIM Pin)						
Open Voltage	DIM pin is floating.	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	2.0	3.5	5.0	V/μS
Duty Cycles Range when PWM mode	*; When use PWM mode	D_{PWM_R}	1		99	%
Minimum Duty Cycle Clamp	When V_{DIM} ≦ 1.5V or P_{DIM}@1KHz ≦ 6%	$D_{OUT\_10\%}$	8.5	10.0	11.5	%
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
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	*	ΔOTP	20.0	32.5	45.0	°C

*: Guaranteed by design.

Typical Performance Characteristics

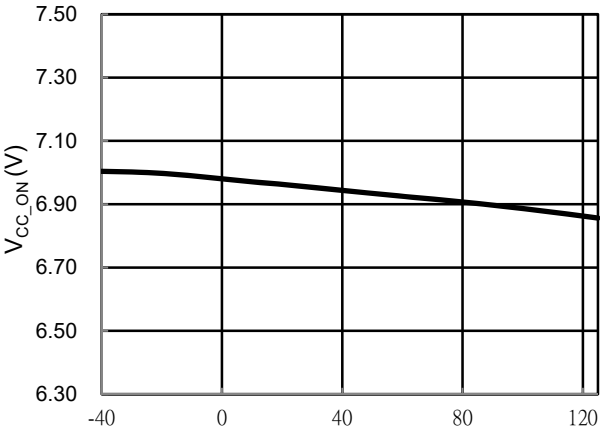


Fig.2 V_{CC_ON} VS. Temperature

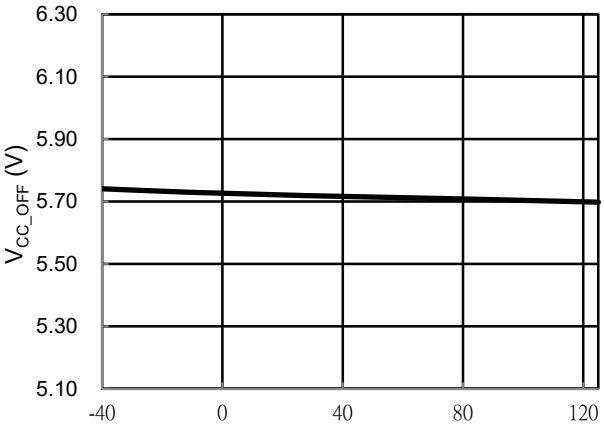


Fig.3 V_{CC_OFF} VS. Temperature

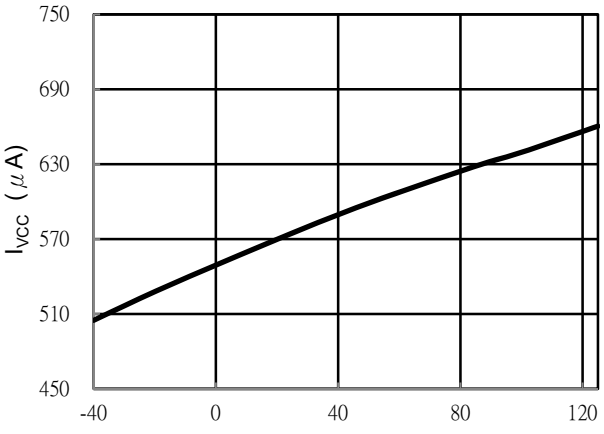


Fig.4 I_{VCC} VS. Temperature

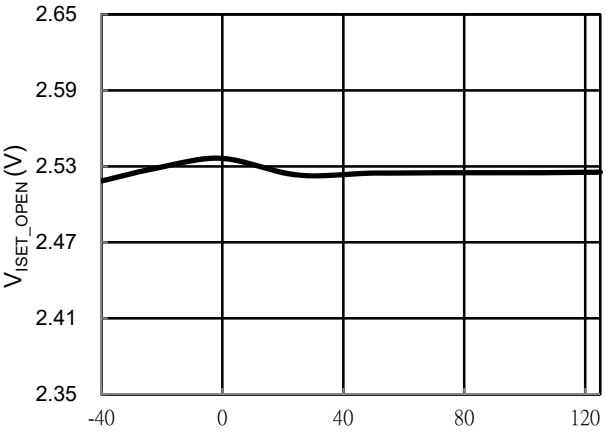


Fig.5 V_{ISET_OPEN} VS. Temperature

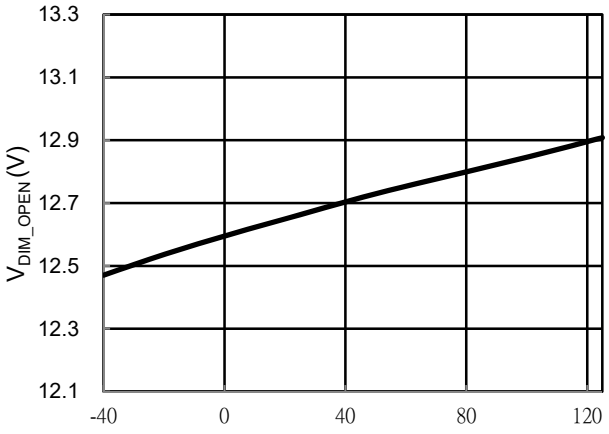


Fig.6 V_{DIM_OPEN} VS. Temperature

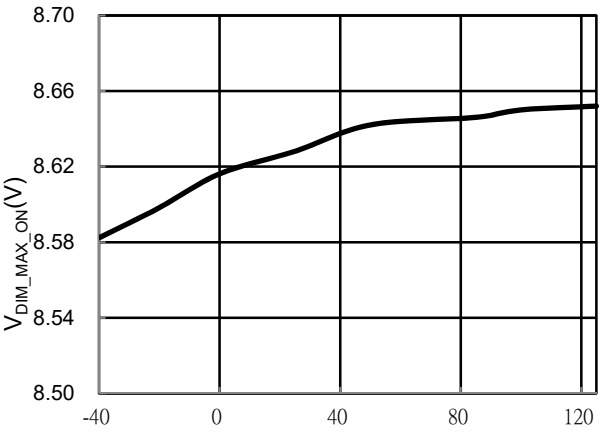


Fig. 7 $V_{DIM\_MAX\_ON}$ vs. Temperature

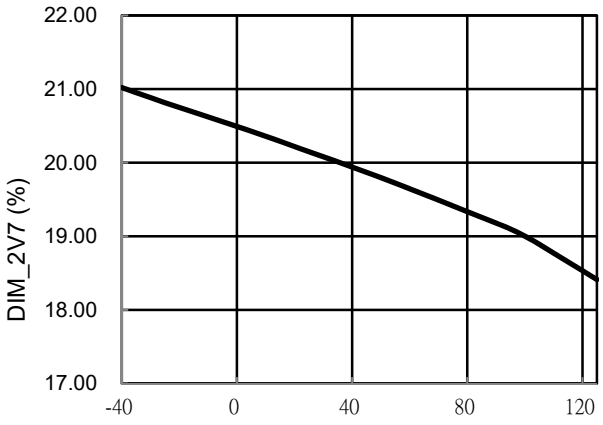


Fig. 8 DIM_2V7 vs. Temperature

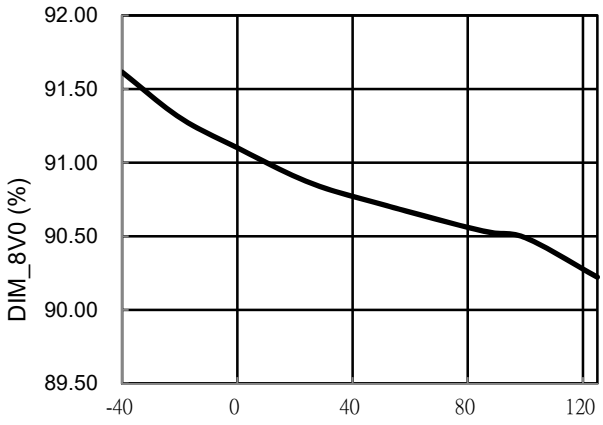


Fig. 9 DIM_8V0 vs. Temperature

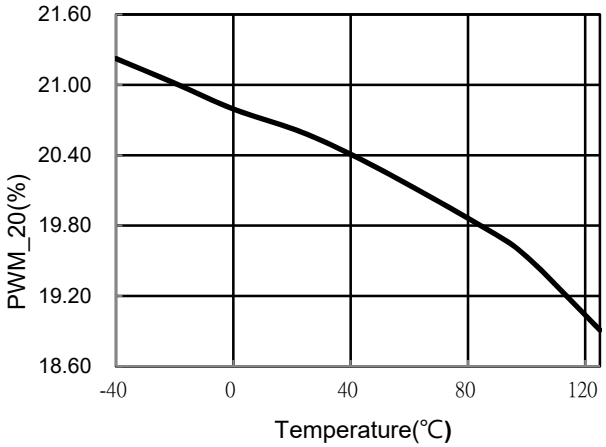


Fig. 10 PWM_20 vs. Temperature

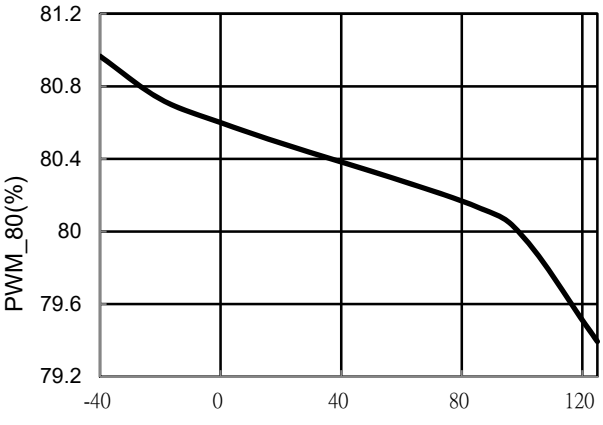


Fig. 11 PWM_80 vs. Temperature

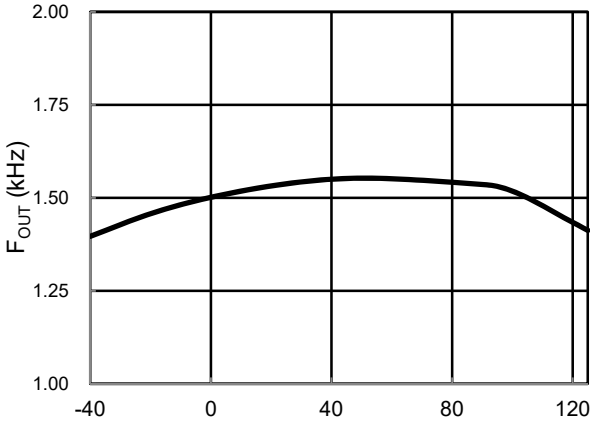


Fig.12 F_{OUT} VS. Temperature

Application Information

Operation Overview

The LD8116Q 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 LD8116Q convert input DC potential or PWM signal into PWM output. The output of LD8116Q is an open-drain configuration which can pull down any source directly to control power supply dimming. The DIM pin of LD8116Q provides an adjustable bias current for potentiometer. So LD8116Q 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 LD8116Q. The turn on and turn off threshold voltage is fixed at 7V and 6V. When the voltage of VCC pin is above 6V, the LD8116Q output PWM which is basing on input DC potential, PWM single or potentiometer.

Bias Current of DIM Pin

ISET pin of LD8116Q 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, LD8116Q 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 9.5% to 100%. When DC input on DIM pin is under 1.5V, the output duty cycles on OUT pin is clamp at ~10% around.

PWM Dimming (Leadtrend's patent)

During PWM signal input on the DIM pin, the output of LD8116Q 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 be higher than 3.2V and lower 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)	Suggestion 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, LD8116Q will transfer to PWM signal output on

OUT pin. The frequency of PWM signal on OUT pin is 1.5kHz around.

Internal Over Temperature Protection

When internal over temperature protection is occur (135°C typ.). The OUT pin of LD8116Q is open drain and auto-recovery after thermal down to normal operating temperature.

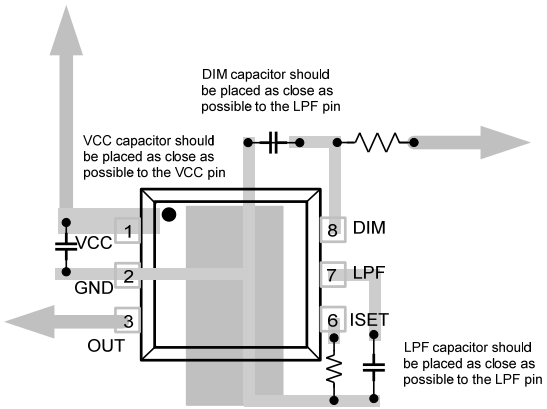
Optocouplers Selection Guide

LD8116Q 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 LD8116Q, 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 datasheet of a widely used 4-pin optocoupler.

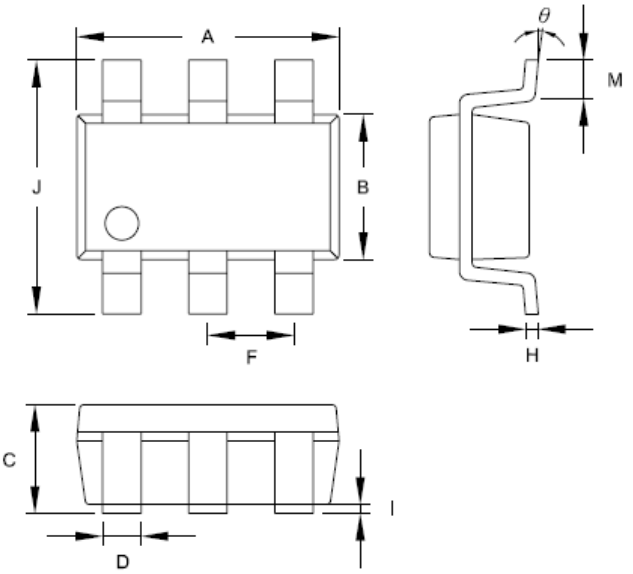
PCB Design Guideline

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	08/04/2020	Original Specification