80mA 4-Channel Pulse Dimming Current Source White LED Driver

General Description

The iD5213 is a 4-channel white LED driver having high performances. It supports up to 4 white LEDs and regulates a constant current for uniform intensity. Each channel supports up to 20mA output current with 1% typical current accuracy and 0.7% typical current matching.

The iD5213 provides a 16-step brightness dimming control. The LED current can be easily configured from 1.25mA to 20mA. The dimming of white LEDs' current can be achieved by applying a pulse signal to the EN pin. The LED current can be turned off by EN pin with pull low for 1.2ms or longer.

The typical leakage current is 0.1µA while shutdown condition.

Ordering Information

iD5213 - □□□ □

Taping
R: Tape and Reel

Package:
QEE:QFN-16L(3X3)
M80:MSOP-8

Features

- Ultra-Low-Noise application
- 85% Average Efficiency Over Battery Life
- 40mV Typical Current Source Dropout
- Support Up to 4 White LEDs; 80mA Output Current
- 1% Typical LED Current Accuracy
- 0.7% Typical LED Current Matching
- Soft Start Function
- Low 0.1µA Shutdown Current
- 16-Step Brightness Control
- RoHS Compliant and 100% Lead (Pb)-Free

Applications

- Mobile Phone
- DSC
- MP3/MP4
- White LED Backlighting
- LCD Display Supply

Typical Application Circuit

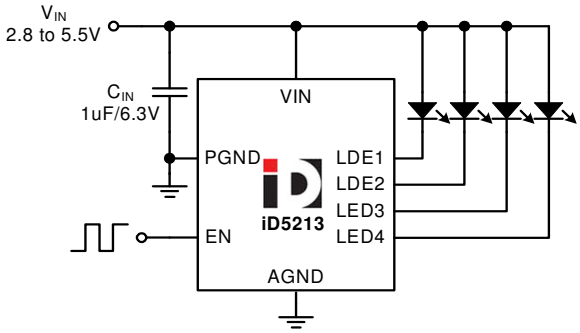


Figure 1. For 4-WLEDs Application Circuit

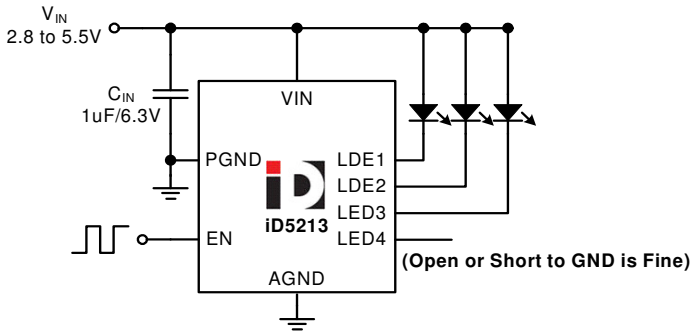


Figure 2. For 3-WLEDs Application Circuit

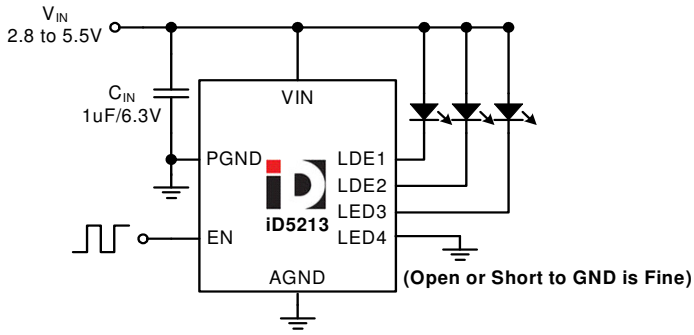


Figure 3. For 3-WLEDs Application Circuit

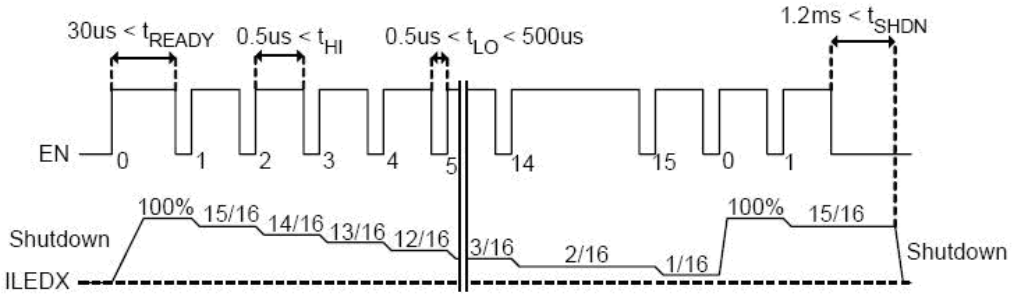


Figure 4. Brightness control by pulse Dimming

Absolute Maximum Ratings

Supply Voltage VIN 6V

Power Dissipation, PD @ TA=25°C

QFN-16 1 .47W

MSOP-8 625mW

Thermal Resistance, θ_{JA}

QFN-16 68°C/W

MSOP-8 160°C/W

Lead Temperature 260 °C

Storage Temperature -65°C to 150°C

Recommended Operating Conditions

Input Voltage VIN 2.8V to 5.5V

EN Input Voltage 0V to 5.5V

Junction Temperature Range -40°C to 125°C

Ambient Operating Temperature -40°C to 85°C

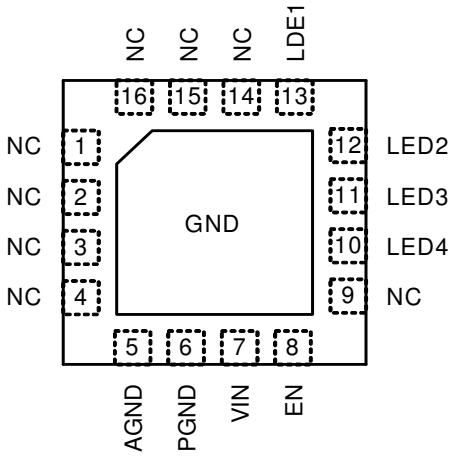
Electrical Characteristics

(Unless otherwise specified V_{IN}=3.7V, V_F=3.4V, C_{IN}= 1uF, I_{LED} =15mA, T_A=25°C)

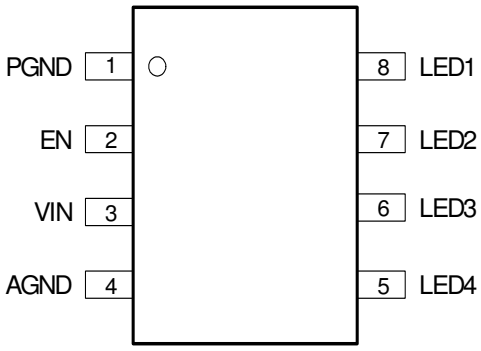
Parameter		Symbol	Test Condition	Min	Typ	Max	Units
Input							
Input Supply Voltage		V_{IN}		2.8	--	5.5	V
Under-Voltage Lockout Threshold		V_{UVLO}	V_{IN} Rising	--	2.2	--	V
Quiescent current		I_Q	V_{IN} = 5.5V, LED off	--	3	--	mA
Shutdown Current		I_{SHDN}	V_{EN} = 0V, V_{IN} = 5.5V	--	0.1	1	µA
Output							
I_{LEDx} Accuracy		$I_{LED-ERR}$	100% Setting, $I_{LED1\ to\ 4}$	-10	--	10	%
Current Matching		$I_{LED-LED-ERR}$	100% Setting, $I_{LED1\ to\ 4}$	-6	--	6	%
LED Dropout Voltage		V_{LED}	90% of full output current		40		mV
Enable							
EN Low Time for Dimming		T_{LO}	Duration of EN Logic Low for pulse dimming	0.5	--	500	µs
EN High Time for Dimming		T_{HI}	Duration of EN Logic High for pulse dimming	0.5	--	--	µs
EN Low Time for Shutdown		T_{SHDN}	From EN Low to Shutdown		1.2		ms
EN Threshold	Logic-High Voltage	V_{IH}		1.5	--	--	V
	Logic-Low Voltage	V_{IL}		--	--	0.4	V

Note 1: Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Pin Configurations (Top View)



QFN-16

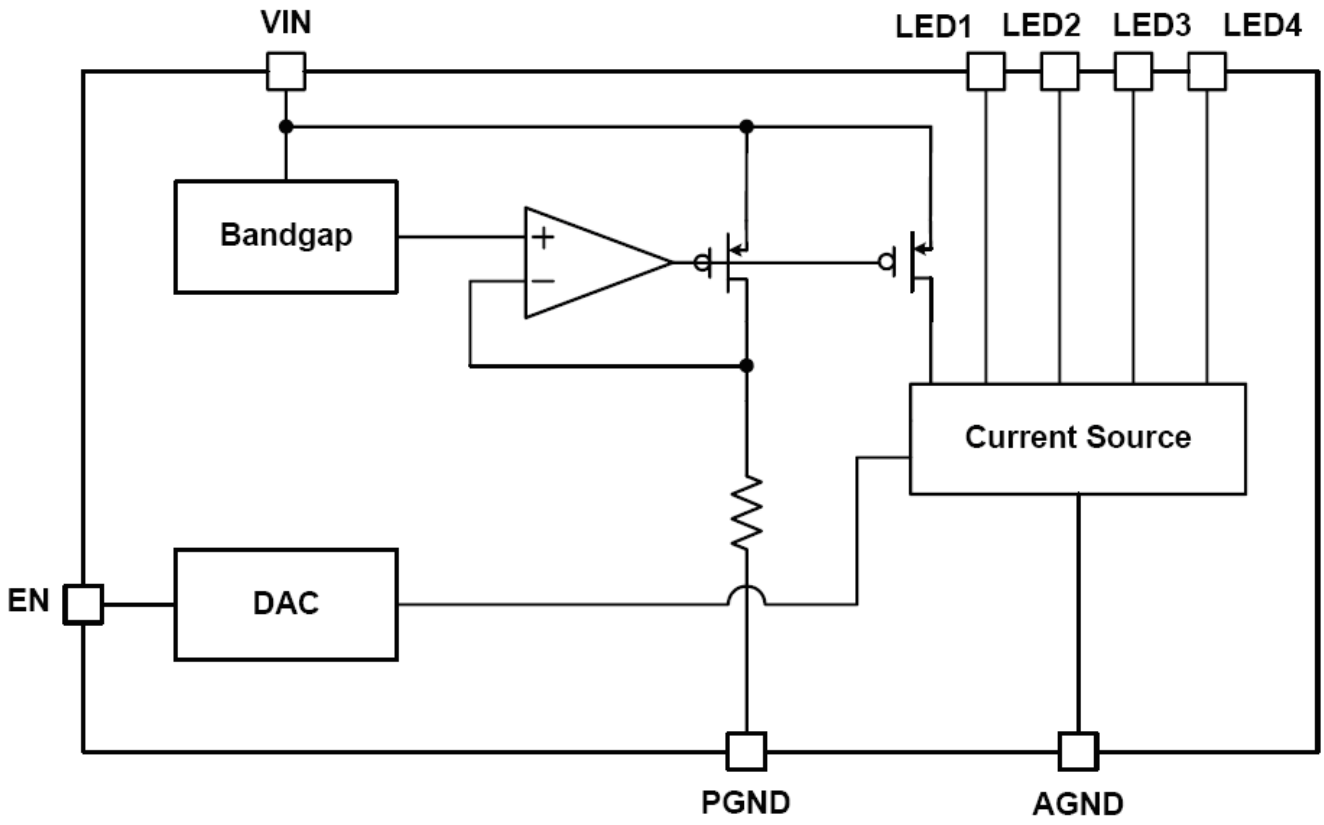


MSOP-8

Pin Description

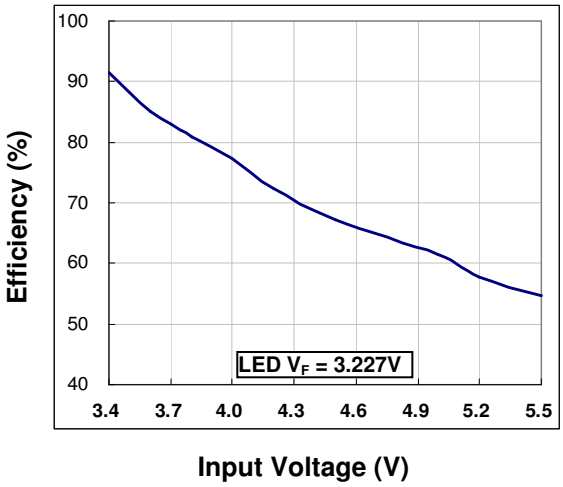
Number		Name	Description
QFN-16	MSOP-8		
1~4,9,14~16	--	NC	No Internal Connection.
5	4	AGND	Analog Ground.
6	1	PGND	Power Ground.
7	3	VIN	Input Voltage.
8	2	EN	Chip Enable. (This pin cannot be floating.)
10	8	LED4	Current Sink for LED4. (If not in use, this pin must be connected to GND or Open)
11	7	LED3	Current Sink for LED3. (If not in use, this pin must be connected to GND or Open)
12	6	LED2	Current Sink for LED2. (If not in use, this pin must be connected to GND or Open)
13	5	LED1	Current Sink for LED1. (If not in use, this pin must be connected to GND or Open)

Function Block Diagram

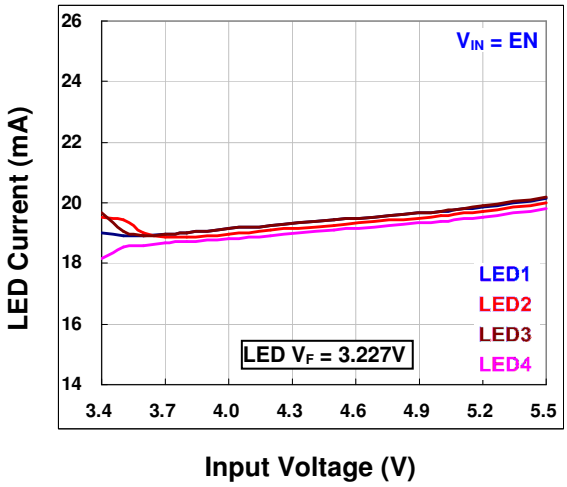


Typical Operating Characteristics

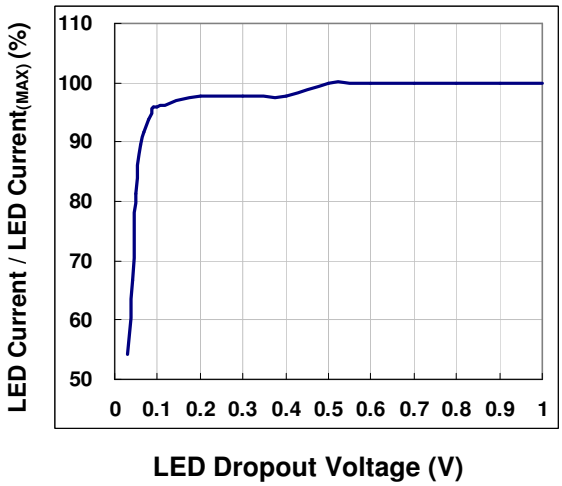
Efficiency vs. Input Voltage



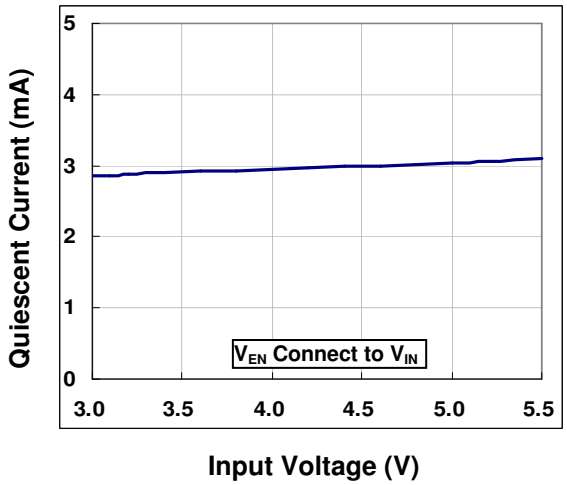
LED Current vs. Input Voltage



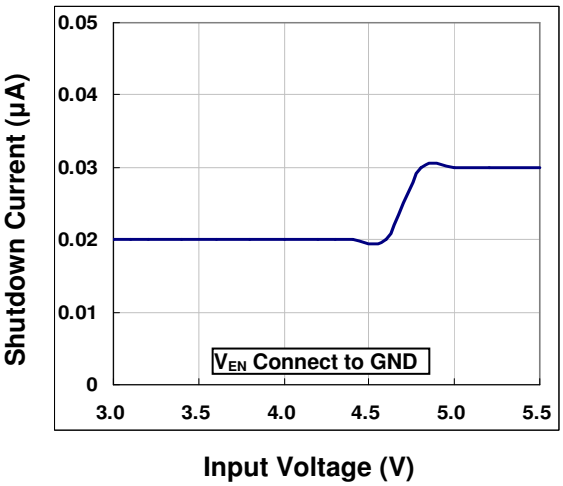
LED Current vs. Dropout Voltage



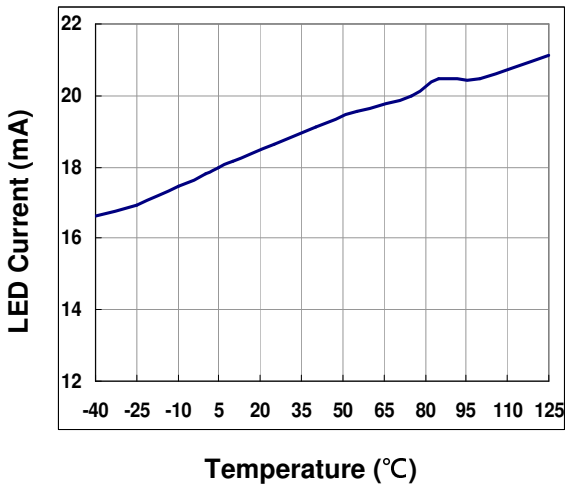
Quiescent Current vs. Input Voltage



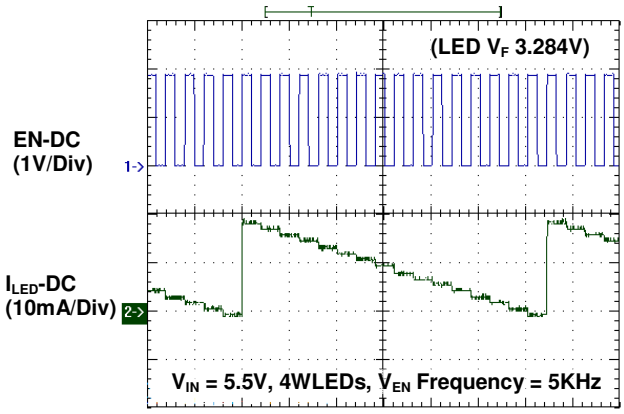
Shutdown Current vs. Input Voltage



LED Current vs. Temperature

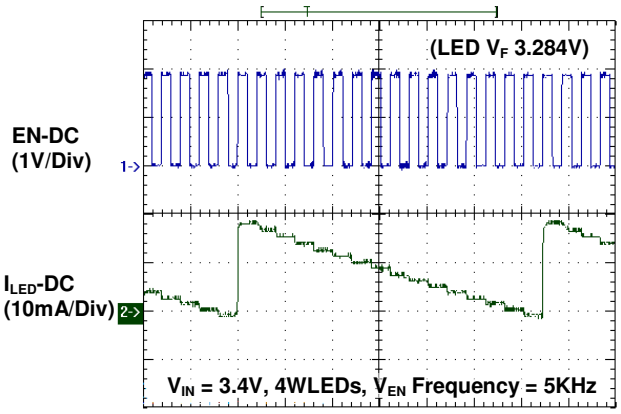


Dimming Operation



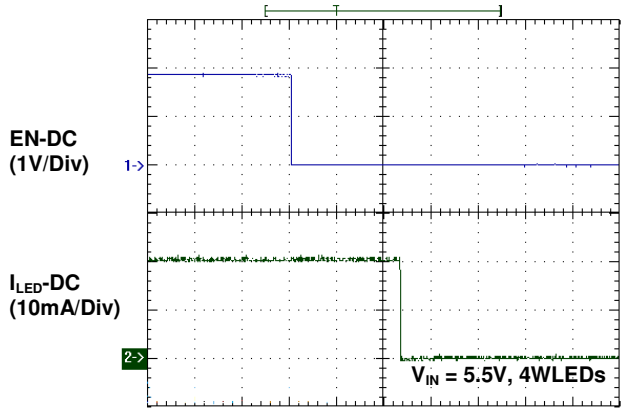
Time (500µs/Div)

Dimming Operation



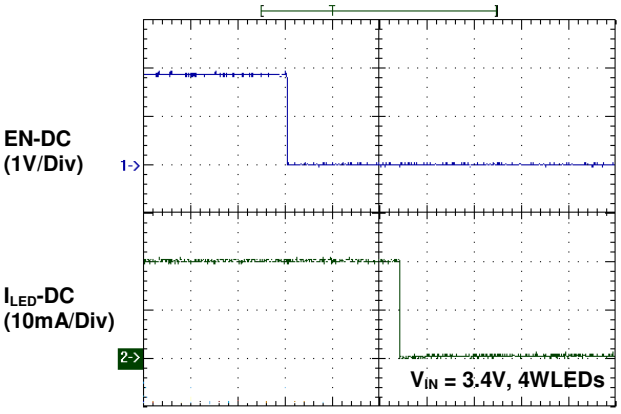
Time (500µs/Div)

Shutdown Delay Operation



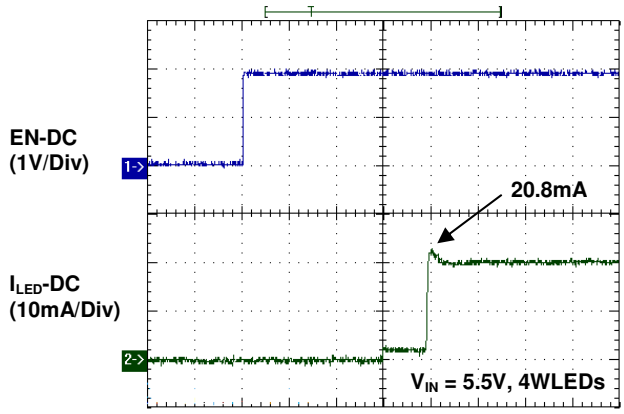
Time (500µs/Div)

Shutdown Delay Operation



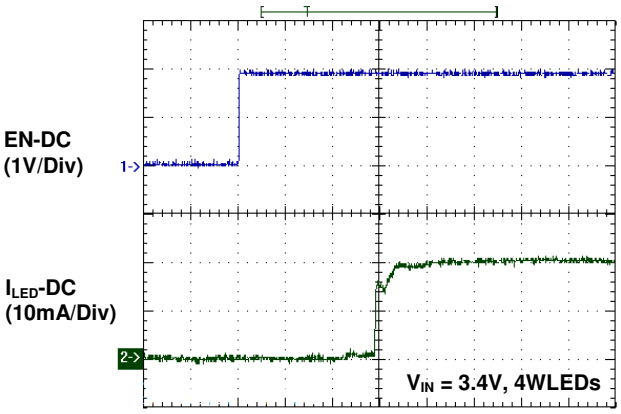
Time (500µs/Div)

Startup from EN



Time (500µs/Div)

Startup from EN



Time (500µs/Div)

Applications Information

Input UVLO

The input operating voltage range of the iD5213 is from 2.8V to 5.5V. An input capacitor at the VIN pin could reduce ripple voltage. It is recommended to use a ceramic 1μF or larger capacitance as the input capacitor. This IC provides an under voltage lockout (UVLO) function to prevent it from unstable issue when startup. The UVLO threshold of input rising voltage is set at 2.2V.

Soft Start

The iD5213 employs a soft start feature to limit the inrush current. The soft-start circuit prevents the excessive inrush current and input voltage droop. The soft-start clamps the input current over a typical period of 50μs.

LED connection

The iD5213 supports up to 4 white LEDs. If the LED is not used, the LED pin should be connected to GND or Open directly. Figure 2 & Figure 3 show the connection for 3-WLEDs application, the LED4 pin is open or shorted to GND respectively.

Selecting Capacitors

To get the better performance of iD5213, the selection of peripherally appropriate capacitor and value is very important. These capacitors determine some parameters such as input/output ripple voltage, power efficiency and maximum supply current by charge pump. To reduce the input and output ripple effectively, the low ESR ceramic capacitors are recommended. For LED driver applications, the input voltage ripple is more important than output ripple. Input ripple is controlled by input capacitor CIN, increasing the value of input capacitance can further reduce the ripple. Practically, the input voltage ripple depends on the power supply impedance.

Brightness Control

The iD5213 implements a pulse dimming method to control the brightness of white LEDs. Users can easily configure the LED current from 1.25mA to 20mA by a serial pulse. The dimming of white LEDs' current can be achieved by applying a pulse signal to the EN pin. There are totally 16 steps of current could be set by users. The detailed operation of brightness dimming is shown in the Figure 4.

Thermal Considerations

For continuous operation, do not exceed the maximum operation junction temperature 125°C. The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surroundings airflow and temperature difference between junctions to ambient. The maximum power dissipation can be calculated by following formula:

$$P_{D(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}}$$

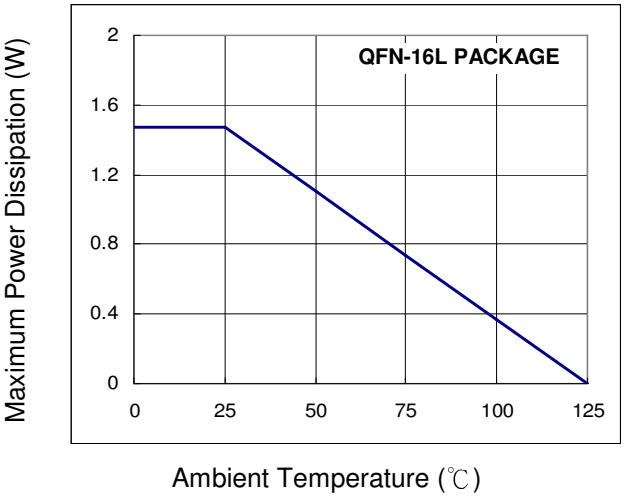
Where $T_{J(MAX)}$ is the maximum operation junction temperature 125°C, T_A is the ambient temperature and the θ_{JA} is the junction to ambient thermal resistance. For recommended operating conditions specification of iD5213 where $T_{J(MAX)}$ is the maximum junction temperature of the die (125°C) and T_A is the maximum ambient temperature. The junction to ambient thermal resistance θ_{JA} is layout dependent. For QFN-16L packages, the thermal resistance θ_{JA} is 68°C/W on the standard JEDEC 51-7 four-layers thermal test board. The maximum power dissipation at T_A = 25°C can be calculated by

following formula:

$P_{D(MAX)}$ = (125°C – 25°C) / (68°C/W) = 1.47W

for QFN-16L packages. The maximum power dissipation depends on operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance θ_{JA}. For iD5213 packages, the Figure 5 of de-rating curves allows the designer to see the effect of rising ambient temperature on the maximum power allowed.

Figure5: Maximum Power dissipation



Layout Considerations

For best performance, careful PCB layout is necessary. All peripheral components should be placed as close to the IC as possible. A short connection is highly recommended. The following guidelines should be strictly followed when designing a PCB layout for the iD5213.

1. All the traces of LED and V_{IN} running from chip to LEDs should be wide and short to reduce the parasitic connection resistance.
2. Input capacitor (C_{IN}) should be placed close to VIN and connected to ground plane. The anodes of LEDs must be connected to C_{IN}, not battery directly.
3. The exposed pad, PGND, AGND must be soldered to a large ground plane for heat sinking and noise prevention. The through-hole vias located at the exposed pad is connected to ground plane of internal layer.

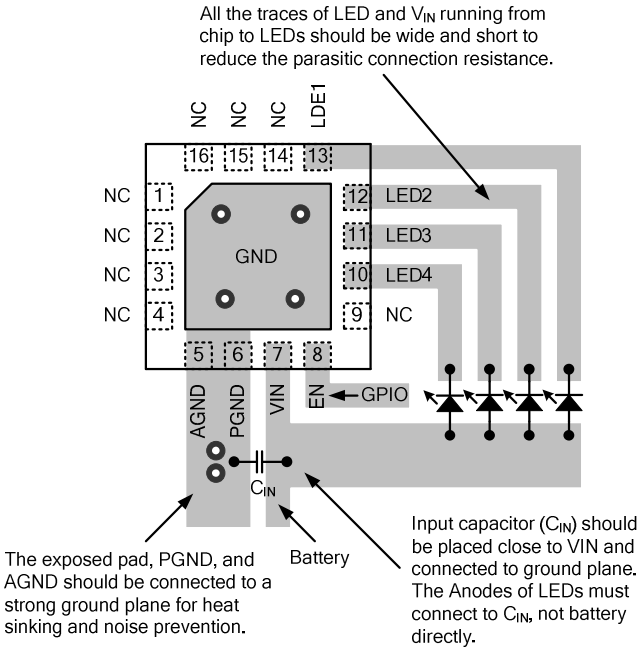
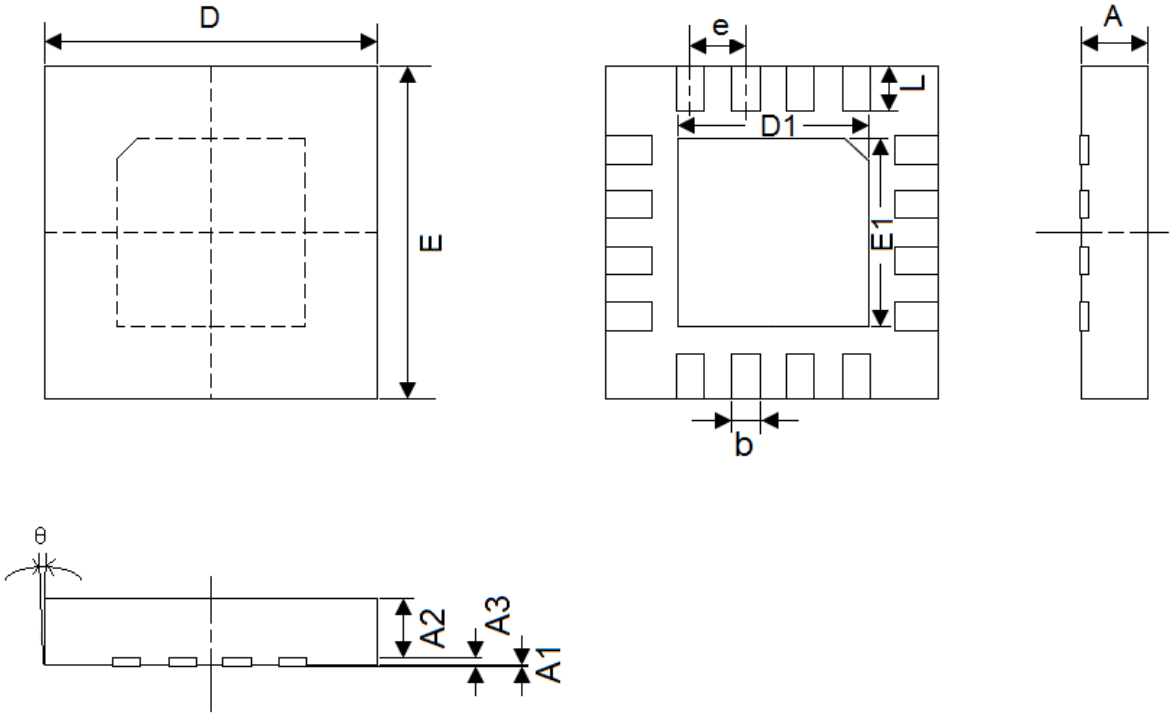


Figure 6: Layout Guide

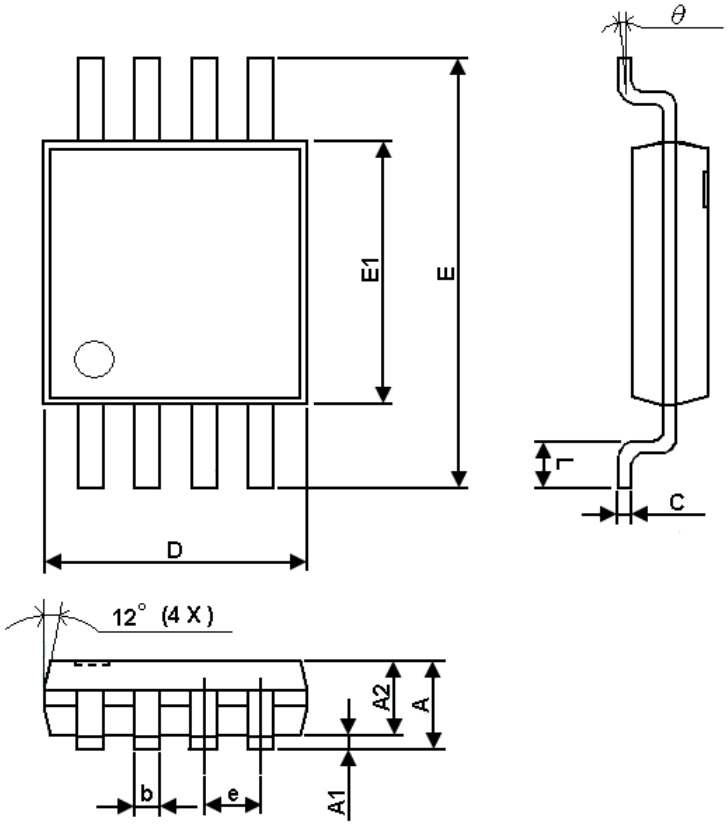
PACKAGING

QFN-16L 3x3



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.85	0.90	0.031	0.033	0.035
A1	0.00	0.01	0.03	0.000	0.00039	0.00118
A3	---	0.20 REF	---	---	0.0079REF	---
b	0.18	0.23	0.28	0.007	0.009	0.011
D	2.95	3.00	3.03	0.116	0.118	0.119
D1	---	1.60 BSC	---	---	0.063REF	---
E	2.95	3.00	3.03	0.116	0.118	0.119
E1	---	1.60 BSC	---	---	0.063BSC	---
e	---	0.50 BSC	---	---	0.0197BSC	---
L	0.35	0.40	0.45	0.0137	0.0157	0.0177
θ	-12	---	0	-12	---	0

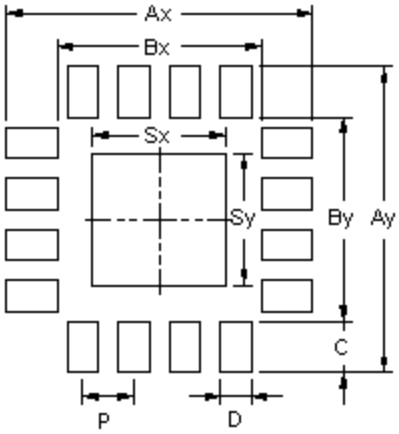
MSOP-8



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.81	0.95	1.10	0.032	0.0375	0.043
A1	0.05	0.09	0.15	0.002	0.004	0.006
A2	0.76	0.86	0.97	0.030	0.034	0.038
b	0.28	0.30	0.38	0.011	0.012	0.015
C	0.13	0.15	0.23	0.005	0.006	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.70	4.90	5.10	0.185	0.193	0.201
E1	2.90	3.00	3.10	0.114	0.118	0.122
e	---	0.65	---	---	0.026	---
L	0.40	0.53	0.66	0.016	0.021	0.026
y	---	---	0.10	---	---	0.004
θ	0°	---	6°	0°	---	6°

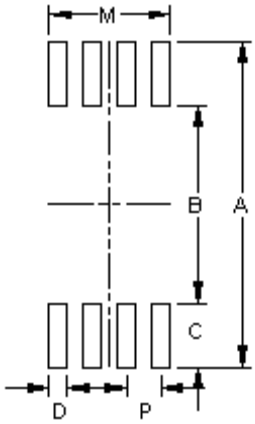
Footprints

QFN-16L 3x3



Package	Number of PIN	Footprint Dimension (mm)									Tolerance
		P	Ax	Ay	Bx	By	C	D	Sx	Sy	
QFN-16L 3x3	16	0.50	3.80	3.80	2.10	2.10	0.85	0.30	1.50	1.50	±0.030

MSOP-8



Package	Number of PIN	Footprint Dimension (mm)						Tolerance
		P	A	B	C	D	M	
MSOP-8	8	0.65	5.80	3.60	1.10	0.35	2.30	±0.10