5 CHANNEL CHARGE PUMP CURRENT SINK FOR LED DRIVER

Description

The AP3615 is a step-up DC-DC converter based on 1x/1.5x charge pump and low dropout current sink, which helps it maintain the highest efficiency. The AP3615 is specially designed to drive up to 5 WLEDs in backlight display.

The AP3615 provides up to 20mA current for each WLED. There are totally 16 steps of current control, which is achieved through a digital pulse dimming function on EN pin. Additionally, 1MHz high switching frequency enables the use of small external capacitors. Internal soft-start circuitry prevents excessive inrush current during start-up and mode transition.

The supply voltage of AP3615 ranges from 2.8V to 5.5V which make it ideally suit for applications powered by Li-ion battery.

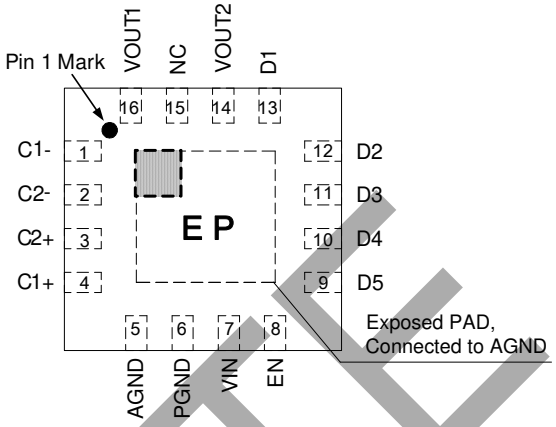
The AP3615 is available in the tiny package of QFN-3×3-16.

Features

- Regulated Output Current with ±3% Matching
- Drives up to 5 WLEDs at 20mA Each
- 16 Steps Brightness Control Using Pulse Signal Dimming
- Wide Operating Voltage Range: 2.8V to 5.5V
- High Operating Frequency: 1MHz
- Auto 1x/1.5x Charge Pump Mode Selection
- Built-in Soft-start
- Output Over Voltage Protection
- Built-in UVLO
- Built-in OTSD
- Operating Temperature Range: -40°C to +85°C

Pin Assignments

(Top View)



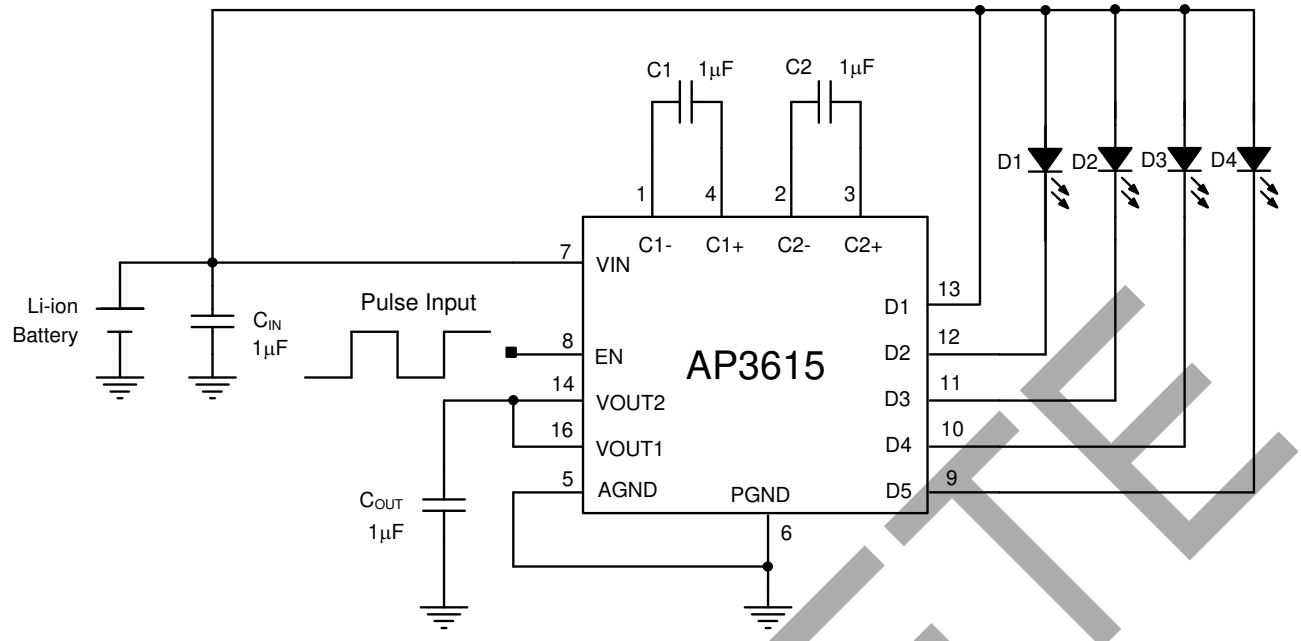
Note: Pin 14 should be connected with Pin 16 on PCB Board.

QFN-3×3-16

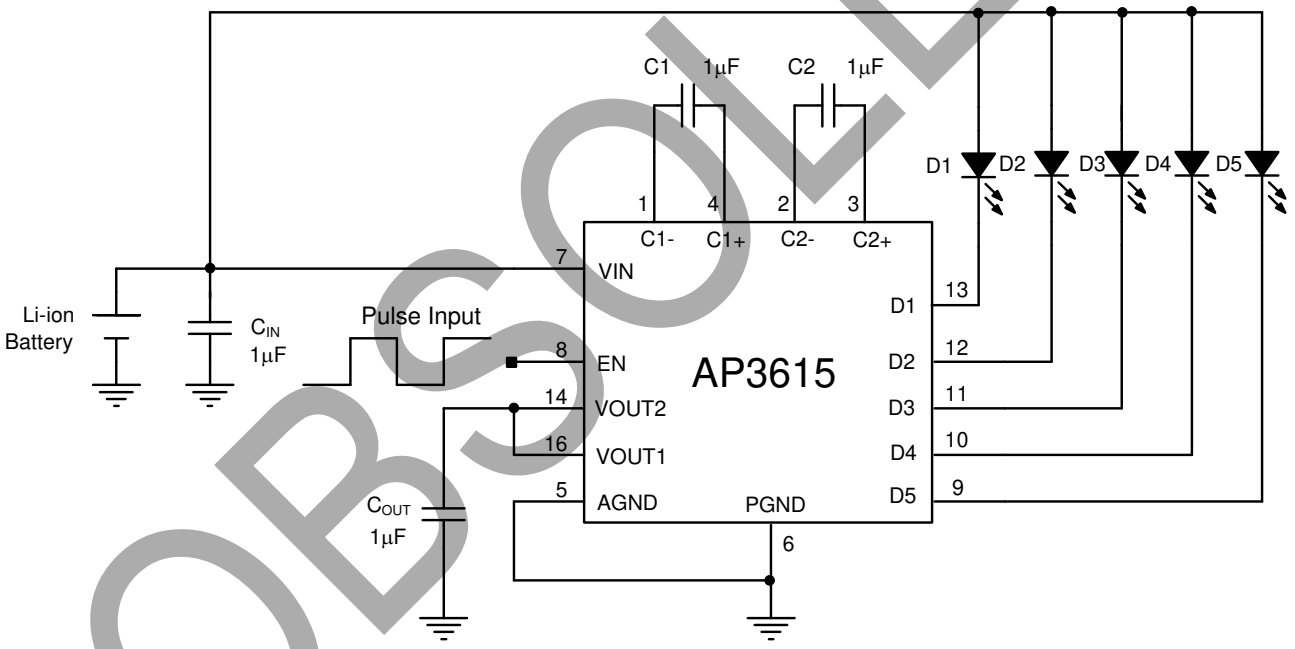
Applications

- Mobile Phone
- PDA
- MP3/4

Typical Applications Circuit



4 WLEDs



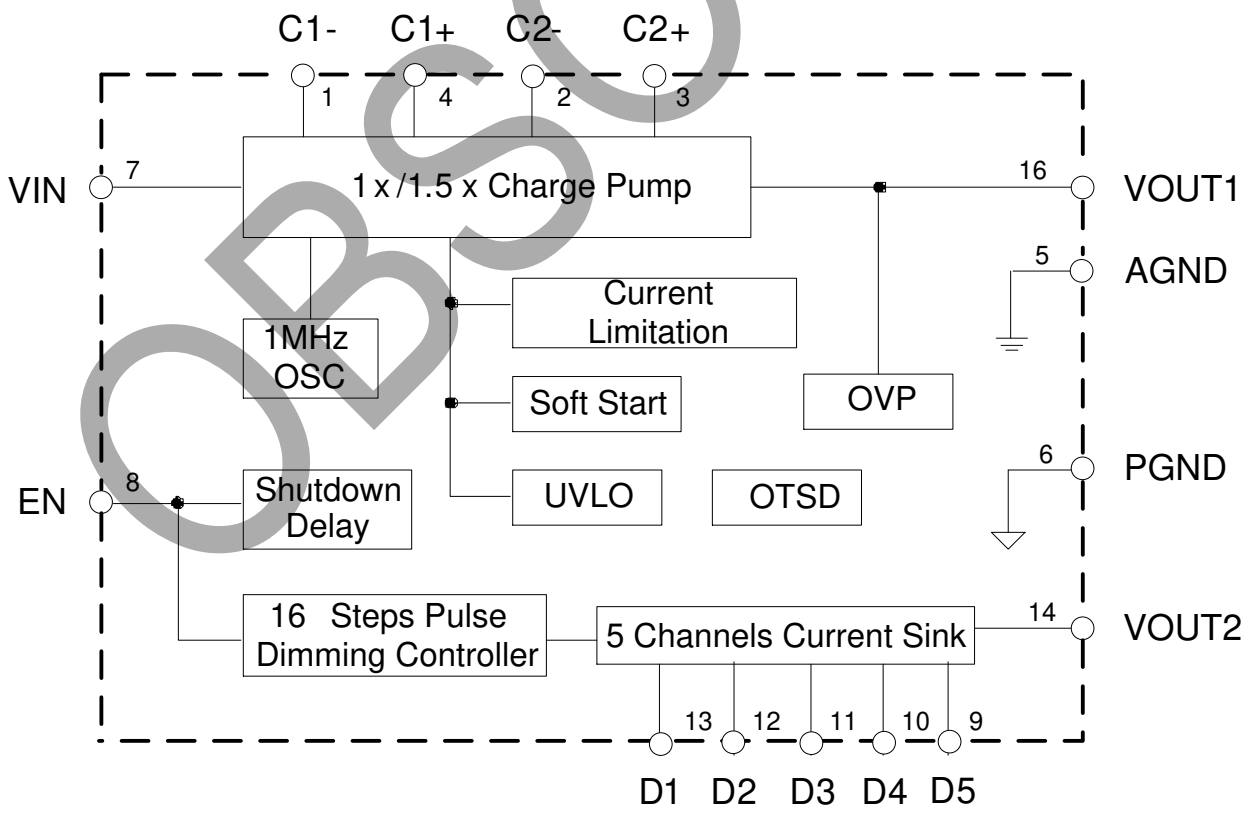
5 WLEDs

Detailed application information, please refer to AP3615 application note.

Pin Descriptions

Pin Number	Pin Name	Function
1	C1-	Flying capacitor 1 negative terminal. The flying capacitor should be connected as close to this pin as possible
2	C2-	Flying capacitor 2 negative terminal. The flying capacitor should be connected as close to this pin as possible
3	C2+	Flying capacitor 2 positive terminal. The flying capacitor should be connected as close to this pin as possible
4	C1+	Flying capacitor 1 positive terminal. The flying capacitor should be connected as close to this pin as possible
5	AGND	Analog ground
6	PGND	Power ground
7	VIN	Supply voltage input
8	EN	Enable control input. Logic high enables the IC; while logic low forces the IC into shutdown mode. It is used for digital dimming by applying a pulse signal on it.
9, 10, 11, 12, 13	D5 ~ D1	Current sink for WLED5, 4, 3, 2, 1. Connect the cathode of WLEDs to these pins. If not used, these pins must be connected with VIN
14	VOUT2	Output pin 2. It powers 5 channels current sink
15	NC	No connection
16	VOUT1	Output Pin 1. It's the charge pump output. The output capacitor should be placed closely to this pin

Functional Block Diagram



Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Value	Unit
V_{IN}	Input Voltage	-0.3 to 6	V
V_{OUT}	VOUT Pin Voltage (VOUT1 & VOUT2)	-6 to 0.3	V
V_{EN}	EN Pin Voltage	-0.3 to 6	V
V_{C+}	C1+, C2+ Pin Voltage	-0.3 to 6	V
V_{C-}	C1-, C2- Pin Voltage	-6 to 0.3	V
V_D	D1, D2, D3, D4 and D5 Pin Voltage	V_{OUT} to V_{IN}	V
θ_{JA}	Thermal Resistance (Junction to Ambient, No Heat Sink, Free Air)	60	°C/W
T_J	Operating Junction Temperature	+150	°C
T_{STG}	Storage Temperature	-65 to +150	°C
T_{LEAD}	Lead Temperature (Soldering, 10sec)	+260	°C

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Voltage	2.8	5.5	V
T_A	Operating Ambient Temperature	-40	+85	°C

Electrical Characteristics

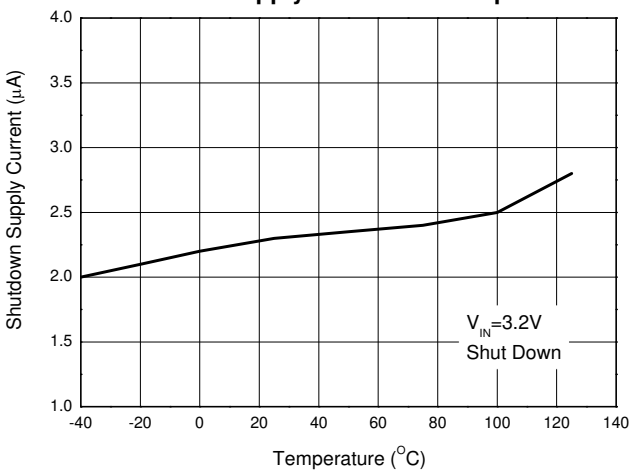
(V_{IN}=3.6V, V_{EN}=V_{IN}, T_A=+25°C, C_{IN}=C1=C2=C_{OUT}=1μF, V_F(forward voltage)=3.2V, unless otherwise noted.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Input Section						
V_{IN}	Input Voltage	I_D=0mA to 100mA	2.8	_	5.5	V
_	Under Voltage Lockout Threshold	V_{IN} Falling	_	2.2	_	V
_	Under Voltage Lockout Hysteresis	_	_	250	_	mV
I_{CC}	Supply Current	No Load	_	1.7	3	mA
I_{SHDN}	Shutdown Supply Current	V_{EN}=GND	_	3	10	μA
Charge Pump Section						
f_{OSC}	Switch Frequency	V_{IN}=3.0V, 1.5x Mode	0.7	1	1.3	MHz
$V_{1.5X}$	1x Mode to 1.5x Mode Transition Voltage (V_{IN} Falling)	V_D=3.2V, I_{D1}=I_{D2}=I_{D3}=I_{D4}=I_{D5}=20mA	_	3.5	3.6	V
V_{1X}	1.5x Mode to 1x Mode Transition Voltage (V_{IN} Rising)	V_D=3.2V, I_{D1}=I_{D2}=I_{D3}=I_{D4}=I_{D5}=20mA	_	3.7	3.8	V
Current Source Section						
I_D	WLED Current	100% Setting, 3.0V≤V_{IN}≤5.0V T_A=-40°C to+ 85°C	18.5	20	21.5	mA
$I_{D\text{-}Match1}$	Current Matching Between any Two Outputs	V_{D1}=V_{D2}=V_{D3}=V_{D4}=V_{D5}=3.2V	-3	_	3	%
$I_{D\text{-}Match2}$	Current Matching Between any Two Outputs	V_{D1}=V_{D2}=V_{D3}=V_{D4}=V_{D5}=3.0V to 4.0V V_{IN}=3.2V to 5.0V	-3.5	_	3.5	%
Enable Section						
V_{IH}	EN High Level Threshold Voltage	_	1.5	_	_	V
V_{IL}	EN Low Level Threshold Voltage	_	_	_	0.5	V
I_{EN}	EN Input Current	V_{EN}= 0V to 5V	_	1	10	μA
t_{SHDN}	EN Low to Shutdown Delay	_	1	_	_	ms
t_{LO}	EN Low Time for Dimming	_	0.1	_	0.3	ms
t_{HI}	EN High Time for Dimming	_	0.1	_	_	ms
Total Device						
t_{SS}	Soft-start Time	I_D=100mA Total	_	200	_	μs
I_{INRUSH}	Inrush Current	V_{IN}=3.2V, I_D=100mA Total	_	320	_	mA
V_{OVP}	Over Voltage Protection	(Note 2)	_	5.5	_	V
T_{OTSD}	Thermal Shutdown	_	_	+160	_	°C
T_{HYS}	Thermal Shutdown Hysteresis	_	_	+20	_	°C
θ_{JC}	Thermal Resistance (Junction to Case)	QFN-3×3-16	_	15	_	°C/W

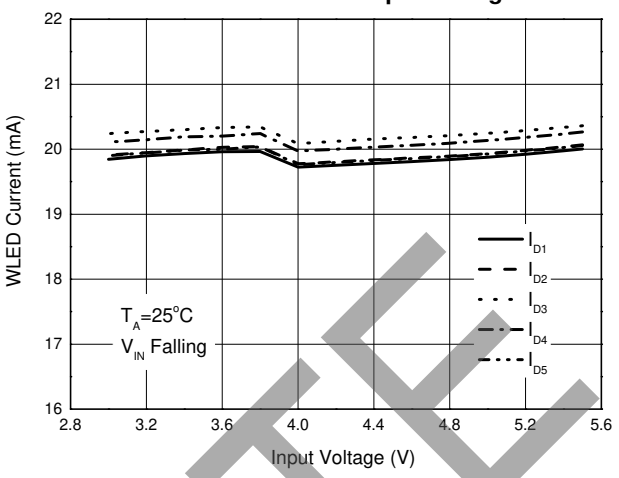
Note 2: Open circuit at any WLED that is programmed to be in the on state.

Performance Characteristics (T_A=+25°C, C_{IN}=C1=C2=C_{OUT}=1μF, V_F=3.2V, unless otherwise noted.)

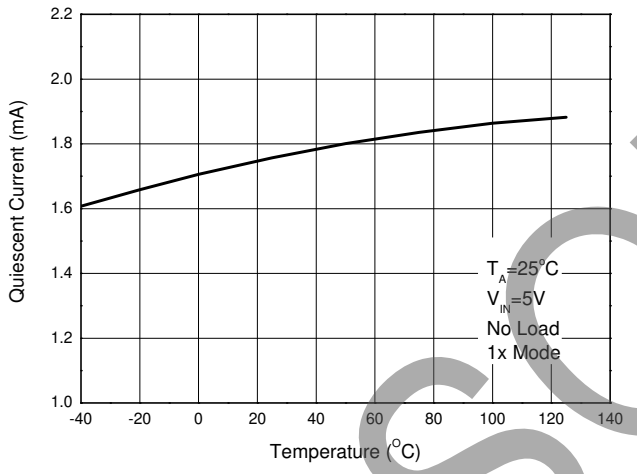
Shutdown Supply Current vs. Temperature



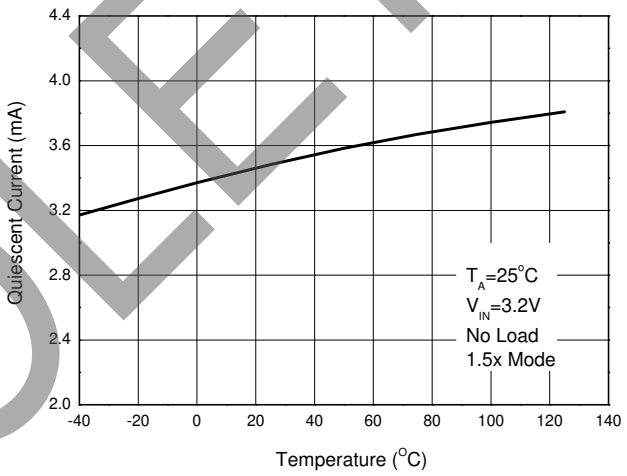
WLED Current vs. Input Voltage



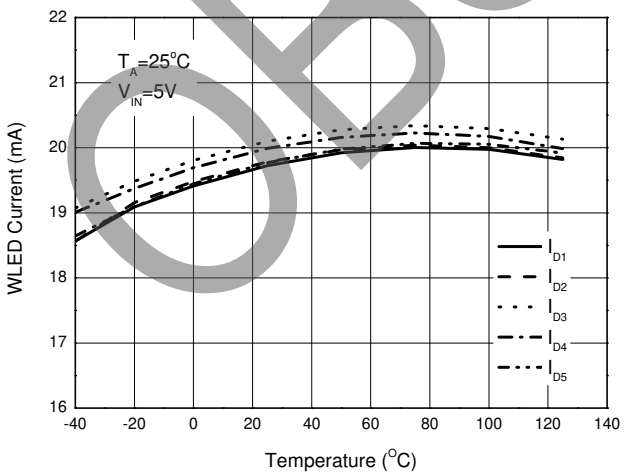
1x Mode Quiescent Current vs. Temperature



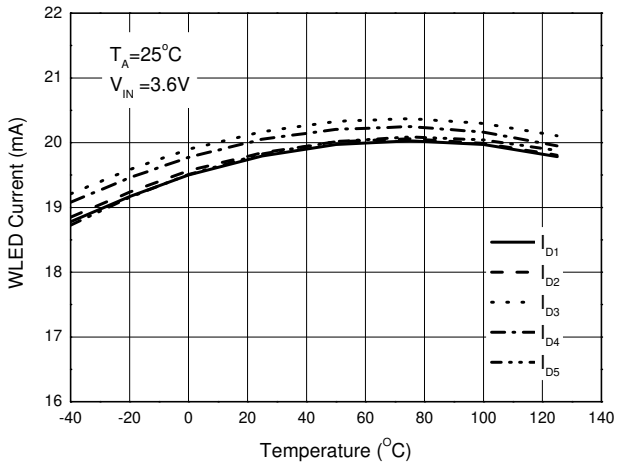
1.5x Mode Quiescent Current vs. Temperature



1x Mode WLED Current vs. Temperature

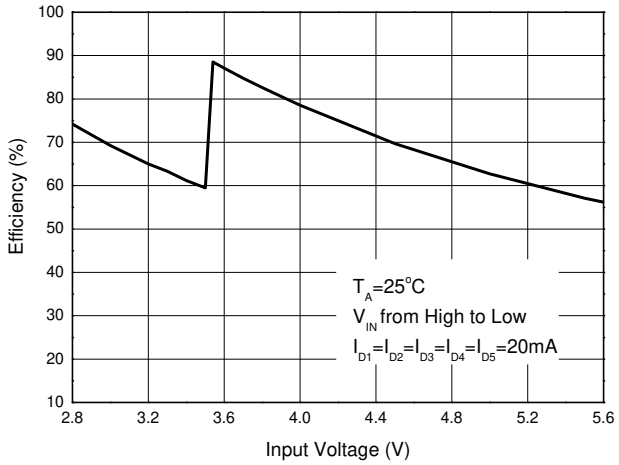


1.5x Mode WLED Current vs. Temperature

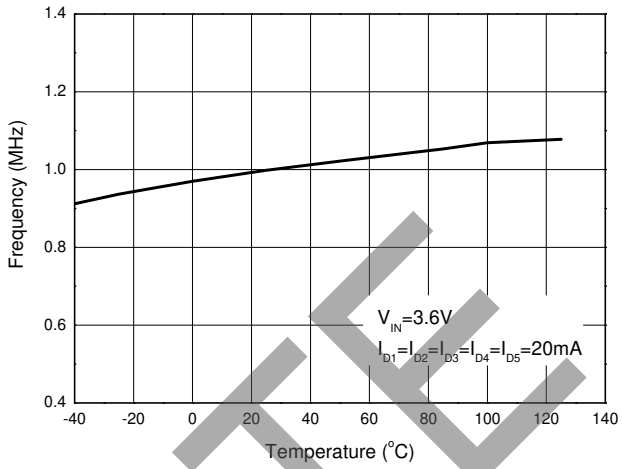


Performance Characteristics (Cont. T_A=+25°C, C_{IN}=C1=C2=C_{OUT}=1μF, V_F=3.2V, unless otherwise noted.)

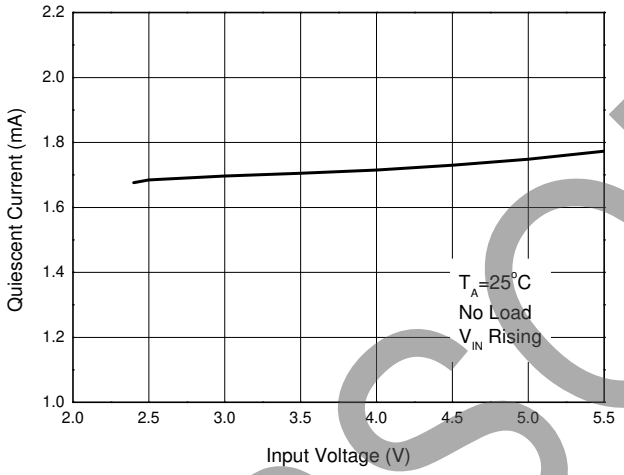
Efficiency vs. Input Voltage



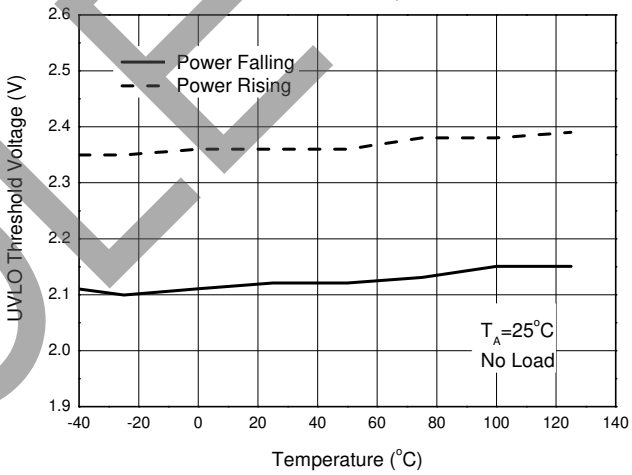
Frequency vs. Temperature



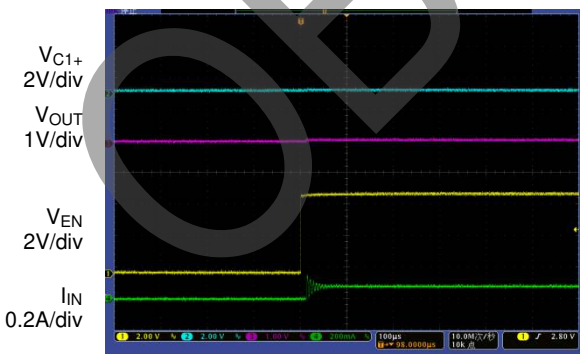
1x Mode Quiescent Current vs. Input Voltage



FUVLO Threshold Voltage vs. Temperature

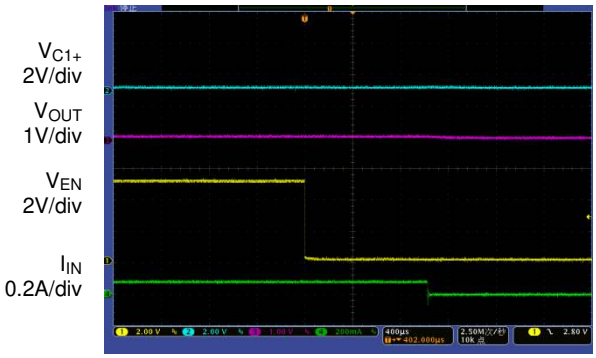


1x Mode Turn on Characteristic



Time (100μs/div)

1x Mode Turn off Characteristic



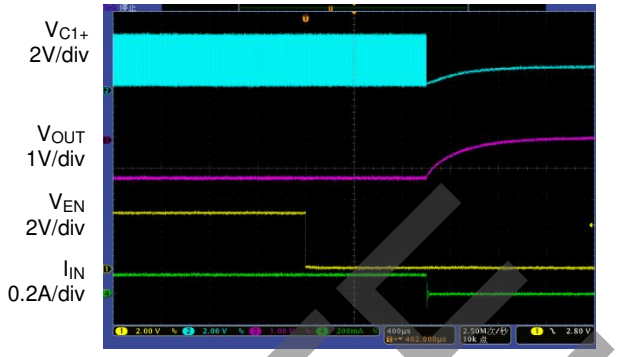
Time (400μs/div)

Performance Characteristics (Cont. T_A=+25°C, C_{IN}=C1=C2=C_{OUT}=1μF, V_F=3.2V, unless otherwise noted.)

1.5x Mode Turn on Characteristic

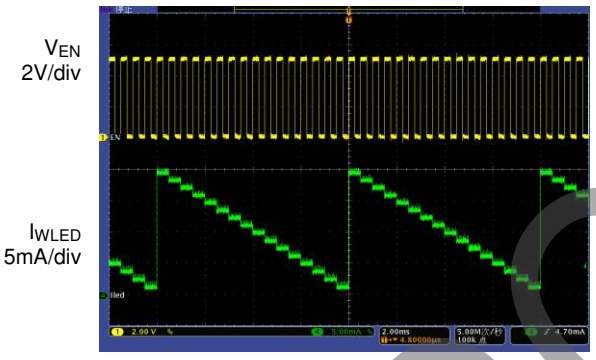
Time (100μs/div)

1.5x Mode Turn off Characteristic



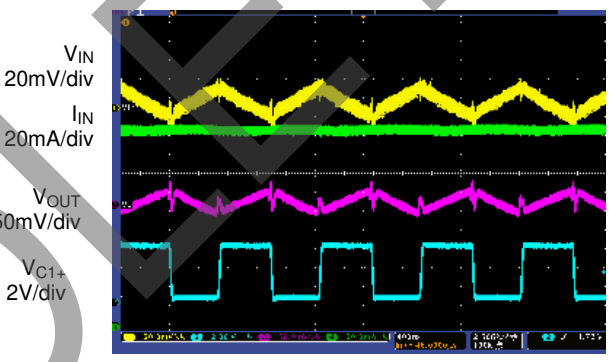
Time (400μs/div)

1x Mode Dimming Operation (V_{IN}=5V, f_{EN}=2kHz)



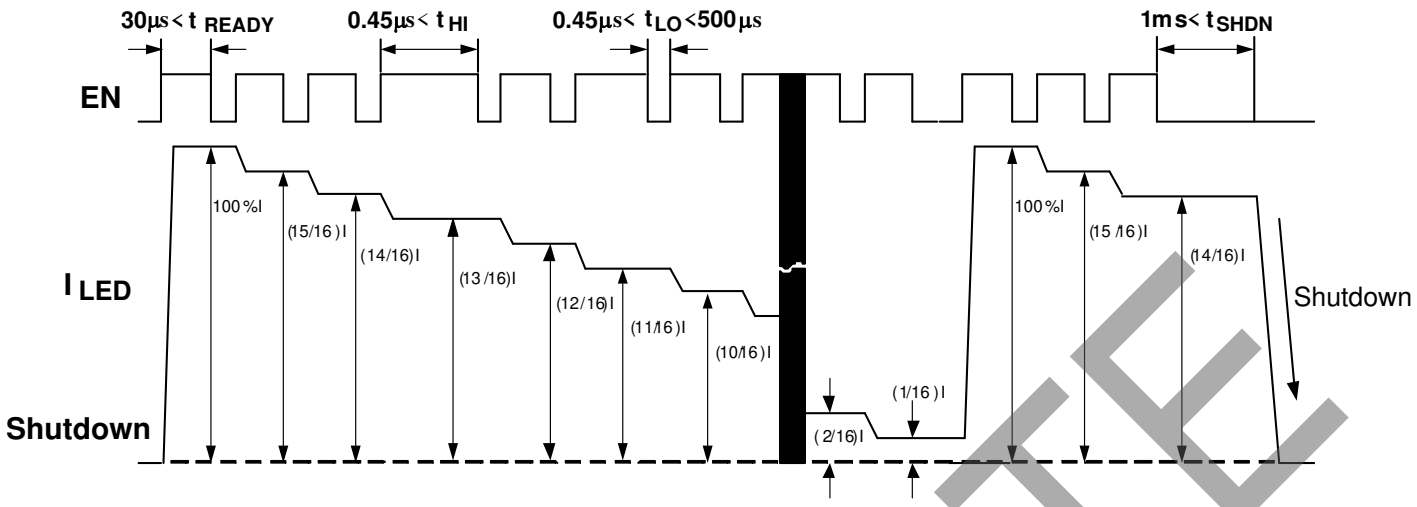
Time (2ms/div)

Output Ripple (V_{IN}=3.3V, I_D=100mA)



Time (400ns/div)

Digital Dimming Operating Diagram (Note 3)



Digital Dimming Operating Diagram of AP3615

Note: 3. The dimming control can be achieved by applying a pulse to the EN pin. When the low level duration time of pulse is between t_{LOmin} and t_{LOmax}, and the high level duration time is larger than t_{HImin}, the LED current will decrease 1/16. If the low level duration time is larger than $t_{SHDNmax}$, the IC will be turned off. When AP3615 is powered on, the WLED is in full brightness. And it will keep maximum current until the pulse is detected. After 15 pulses the WLED current decreases to 1/16 of full brightness. It will increase to full brightness if a pulse is added to EN pin then.

Ordering Information

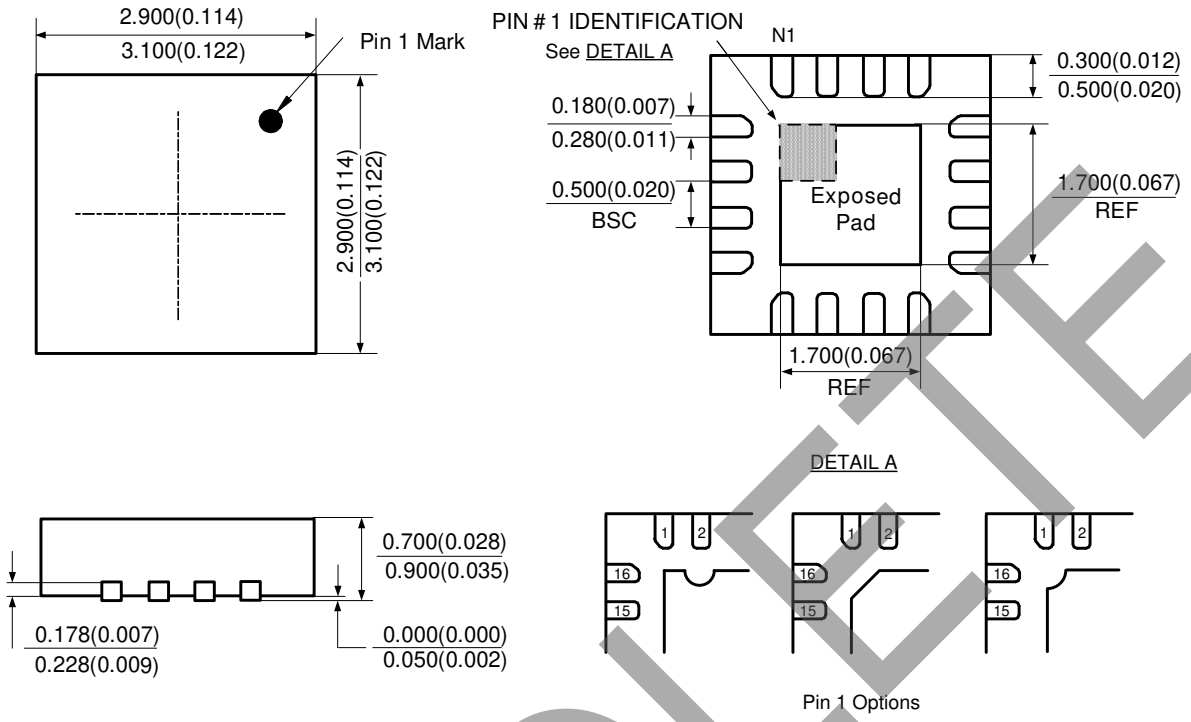
AP3615 X X - X

Product Name	Package	Packing	RoHS/Green
	FN : QFN-3x3-16	TR : Tape & Reel	G1 : RoHS Compliant and Green

Package	Temperature Range	Part Number	Marking ID	Packing
QFN-3×3-16	-40 to +85°C	AP3615FNTR-G1	B2B	Tape & Reel

Package Outline Dimensions (All dimensions in mm(inch).)

(1) Package Type: QFN-3×3-16



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