Lead-free Green

NEW PRODUCT

Description

The AL5815 and AL5816 are 5-terminal adjustable constant current linear LED controllers offering excellent temperature stability and current capability. They can work with a wide input voltage range from 4.5V to 60V. With its low 200mV current sense FB voltage, it controls the regulation of LED current with minimum power dissipation compared with traditional linear LED drivers. This makes it ideal for medium to high current LEDs.

The device has an internal output drive up to 15mA, which enables it to drive external Bipolar transistors or MOSFETs. It also provides the capability to drive longer LED chains with low drop out voltage and multiple LED channels.

AL5815 and AL5816 have their LED current adjusted and controlled by a sense resistor connected across FB pin and GND. The voltage across this resistor is controlled to a precise 0.2V thus controlling the current.

The AL5815 has an enable (ENB) pin. Bringing ENB low to enable the device and turn on external transistor. Bringing ENB high puts the device into a low quiescent current shutdown state. The AL5815 has a turn on delay built in which makes sure there is not a high current surge at startup. The average LED current can be adjusted by applying a low frequency PWM signal less than 200Hz to the ENB pin.

If PWM dimming higher than 200Hz is required the AL5816 has replaced the enable pin with a PWM pin. This device can run at frequencies greater than 200Hz.

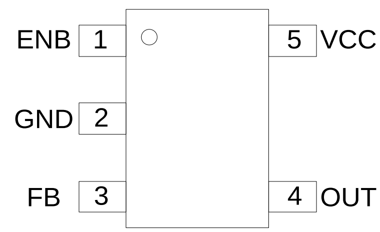
The AL5815 and AL5816 are available in SOT25 package.

Features

- Wide Input Voltage Range from 4.5V to 60V
- Low Reference Voltage (V_{FB} = 0.2V)
- 4% Reference Voltage Tolerance
- Up to 15mA Driver Capability for Bipolar Transistor
- Low Standby Current for AL5815
- PWM Dimming Frequency Higher than 200Hz for AL5816
- Input Under Voltage Lock-out
- Over Temperature Shutdown
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

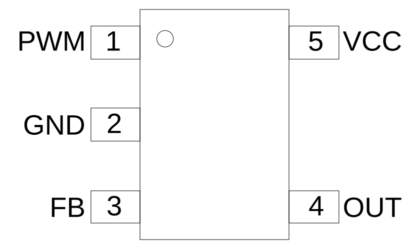
Pin Assignments

AL5815 （Top View）



SOT25

AL5816（Top View）



SOT25

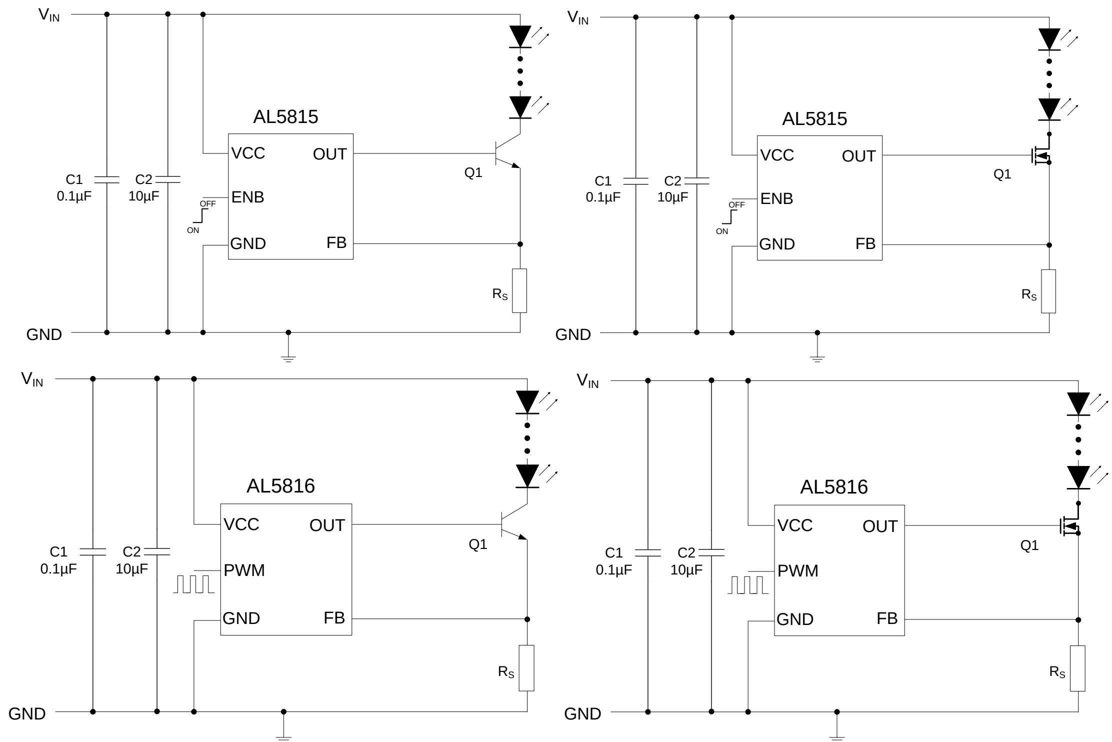
Applications

- Commercial and Industrial Lighting
- Exterior Lighting
- Appliance Lights

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and antimony-free "green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

NEW PRODUCT

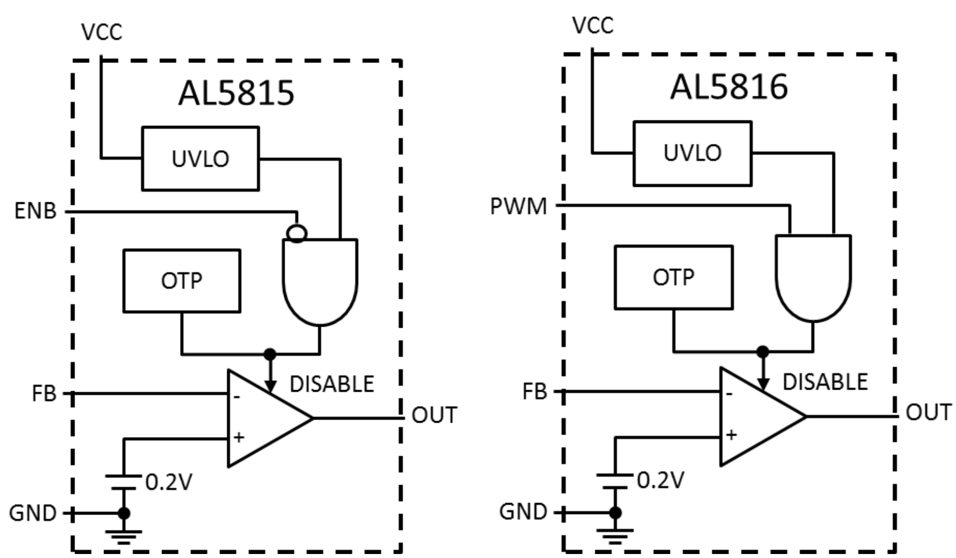
Typical Applications Circuit



Pin Descriptions

Pin Number	Pin Name	Function
1	ENB (AL5815)	Chip Enable, Active Low (Can be Used for Low Frequency Dimming)
	PWM (AL5816)	PWM Signal for High Frequency Dimming of the LED
2	GND	Ground
3	FB	Feedback Input, Regulates to 200mV Nominal
4	OUT	Driving Output to External Transistors
5	VCC	Input Supply Power

Functional Block Diagram



NEW PRODUCT

Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating	Unit
V_{CC}	Supply Voltage Relative to GND	-0.3 to +65	V
I_{VCC}	IC Supply Current	18	mA
V_{OUT}, V_{FB}	OUT, FB Relative to GND	-0.3 to +6	V
V_{ENB}	Enable Pin of AL5815 Relative to GND	-0.3 to +6	V
V_{PWM}	PWM Pin of AL5816 Relative to GND	-0.3 to V_{CC}	V
T_A	Operating Ambient Temperature	-40 to +125	°C
T_J	Operating Junction Temperature	-40 to +150	°C
T_{ST}	Storage Temperature	-55 to +150	°C

Note: 4. Stresses greater than the Absolute Maximum Ratings specified above may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at conditions between maximum recommended operating conditions and absolute maximum ratings is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.

ESD Ratings

Symbol	Parameter	Rating	Unit
V_{ESD}	Human-Body Model (HBM)	2000	V
	Charged-Device Model(CDM)	1000	

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{CC}	Supply Voltage Range Relative to GND Pin	4.5	60	V
V_{OUT}	OUT Voltage Range	0	4	V
I_{OUT}	OUT Pin Current	0	15	mA
T_A	Operating Ambient Temperature	-40	+105	°C
T_J	Operating Junction Temperature	-40	+125	°C
V_{IH}(AL5815)	High-Level Input Voltage on ENB	2.5	5.5	V
V_{IL} (AL5815)	Low-Level Input Voltage on ENB	0	0.3	V
V_{IH}(AL5816)	High-Level Input Voltage on PWM	2.7	V_{CC}	V
V_{IL}(AL5816)	Low-Level Input Voltage on PWM	0	2.3	V

Thermal Information (Note 5)

Symbol	Parameter	Rating	Unit
θ_{JA}	Junction-To-Ambient Thermal Resistance	134	°C/W
θ_{JC}	Junction-To-Case(Top) Thermal Resistance	27	°C/W

Note: 5. Device mounted on 1''x1'' FR-4 MRP substrate PC board, 2oz cooper, with minimum recommended pad layout. No thermal via and no ground plane.

NEW PRODUCT

Electrical Characteristics (V_{CC} = 12V, T_A = +25°C, unless otherwise specified.)

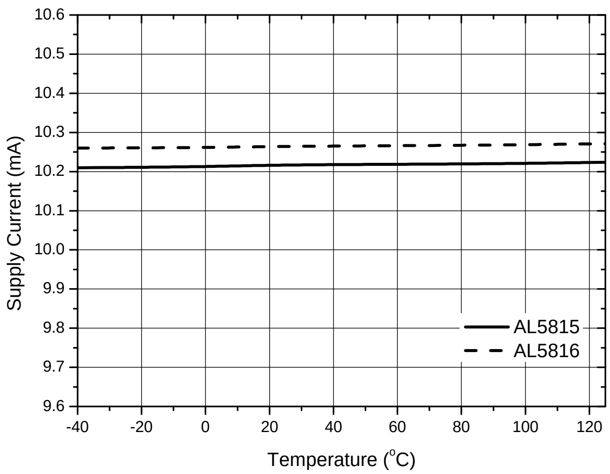
Symbol	Parameter	Condition	Min	Typ.	Max	Unit
POWER SUPPLY						
V_{UVLO}	Under-Voltage Lockout Voltage	V_{IN} Rising (1V/ms)	-	4.2	4.4	V
		V_{IN} Falling (1V/ms)	3.6	3.85	-	
I_{CC}	Supply Current	V_{CC} = 4.5V to 60V, I_{OUT} = 10mA	-	10.25	11	mA
I_Q	Quiescent Current into V_{CC}	V_{CC} = 4.5V to 60V, I_{OUT} = 0mA	-	0.25	1	mA
I_{SHDN} (AL5815)	Shutdown Supply Current	V_{ENB} > 2.5V, V_{CC} = 4.5V to 60V	-	3	20	µA
V_{ENB_TH} (AL5815)	ENB Threshold Voltage	-	0.4	1.3	2	V
R_{ENB} (AL5815)	ENB Pin Internal Pull Down Resistor	-	1.3	2	2.7	MΩ
V_{PWM_TH} (AL5816)	PWM Pin Threshold Voltage	V_{CC} = 4.5V to 60V, V_{PWM} Falling	2.37	2.5	2.63	V
$V_{PWM\_TH\_HYS}$ (AL5816)	PWM Pin Threshold Voltage Hysteresis	-	-	0.1	-	V
I_{PWM} (AL5816)	PWM Pin Internal Pull Up Current	V_{PWM} = 5V, V_{CC} = 4.5V to 60V	-20	-15	-11	µA
FEEDBACK LOOP						
V_{FB}	Feedback Voltage	V_{CC} = 4.5V to 60V	0.192	0.2	0.208	V
V_{REF_LINE}	Reference Voltage Line Regulation	V_{CC} = 4.5V to 19V	-	0.2	2	mV
I_{FB}	FB Input Bias Current	V_{FB} = 0.2V	-200	-125	-80	nA
OUTPUT DRIVER ERROR AMPLIFIER						
$I_{OUTSOURCE}$	Maximum Source Current	V_{OUT} = 0V, V_{CC} = 4.5V to 60V	-	-	-15	mA
		V_{OUT} = 1V, V_{CC} = 4.5V to 60V	-	-	-15	mA
		V_{OUT} = 2V, V_{CC} = 4.5V to 60V	-	-	-11	mA
		V_{OUT} = 4V, V_{CC} = 6.0V to 60V	-	-	-5	mA
$I_{OUTSINK}$ (AL5815)	Maximum Sink Current	V_{CC} = 12V, V_{ENB} = 0V. V_{OUT} = 4V, V_{FB} = 250mV	20	-	-	µA
$I_{OUTSINK}$ (AL5816)	Maximum Sink Current	V_{CC} = 12V, V_{PWM} = 0V V_{OUT} = 4V, V_{FB} = 250mV	1	-	-	mA
G_m	Trans-conductance of Error Amplifier (Sourcing)	ΔV_{FB} = 5mV	-	5	-	A/V
f_{BW}	Bandwidth (From FB to OUT)	No Loading (Note 6)	-	50	-	kHz
V_{OUT_MAX}	Maximum Output Voltage	V_{CC} ≥6V, I_{OUT} = -1mA	4	-	-	V
V_{OUT_MIN}	Minimum Output Voltage	V_{CC} = 12V, V_{PWM} = 0V. I_{OUT} = 0.1mA, V_{FB} = 250mV	-	-	300	mV
t_{ON} (AL5815)	Turn On Delay Time	ENB Active Low (Note 6)	-	85	-	µs
t_{OFF} (AL5815)	Turn Off Delay Time	ENB Active High (Note 6)	-	1	-	µs
t_{ON} (AL5816)	Turn On Delay Time	PWM Active High (Note 6)	-	1	-	µs
t_{OFF} (AL5816)	Turn Off Delay Time	PWM Active Low (Note 6)	-	1	-	µs
THERMAL SHUTDOWN						
T_{SHDN}	Thermal Shutdown	(Note 6)	-	+160	-	°C
T_{HYS}	Thermal Shutdown Hysteresis	(Note 6)	-	+30	-	°C

Note: 6. Not tested in production.

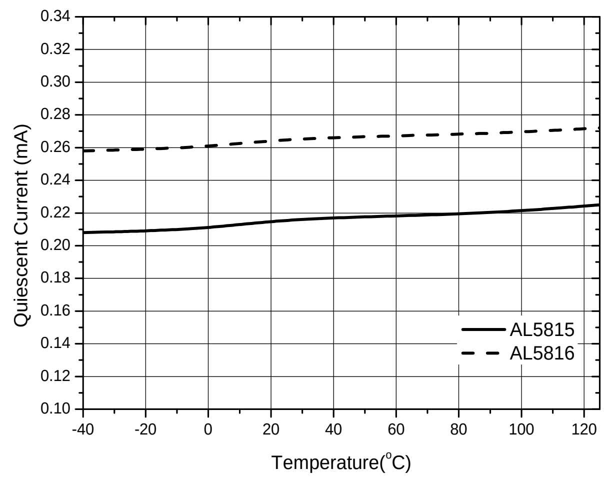
NEW PRODUCT

Typical Performance Characteristics (V_{CC} = 12V, T_A = +25°C, unless otherwise specified.)

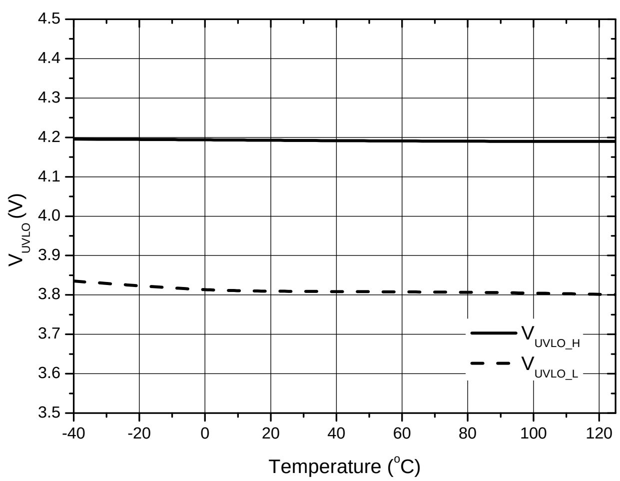
Supply Current vs. Temperature



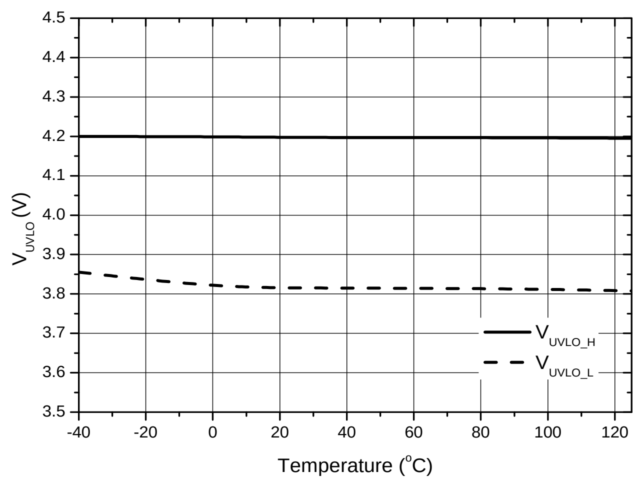
Quiescent Current vs. Temperature



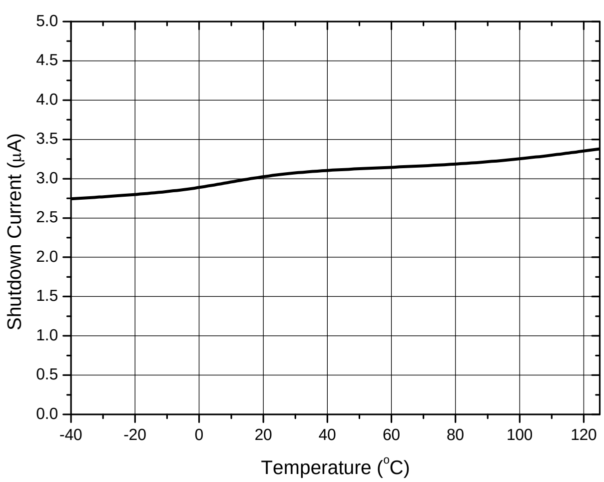
V_{UVLO} vs. Temperature (AL5815)



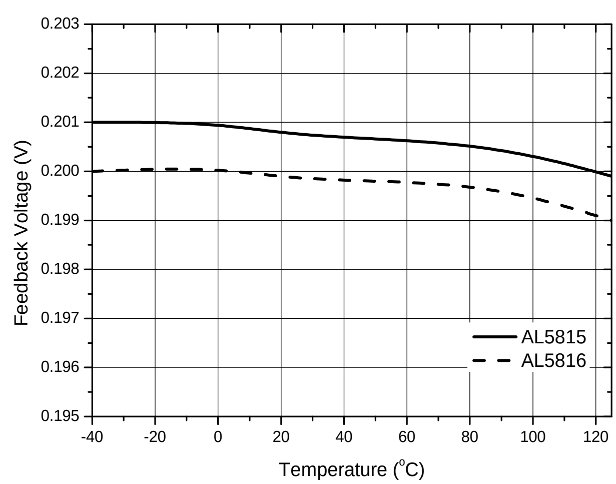
V_{UVLO} vs. Temperature (AL5816)



Shutdown Current vs. Temperature (AL5815)

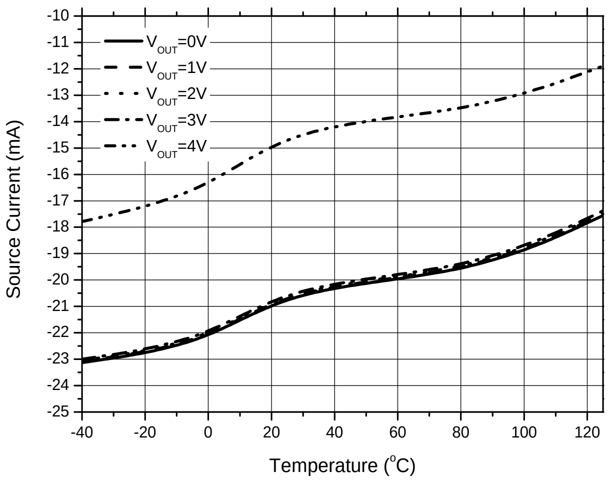


Feedback Voltage vs. Temperature

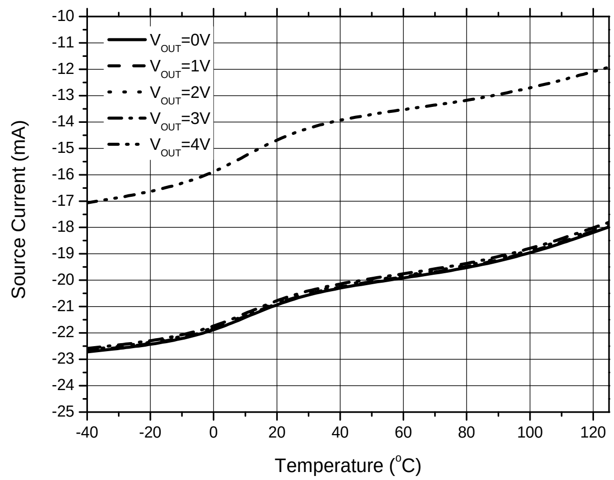


Typical Performance Characteristics (Cont.) (V_{CC} = 12V, T_A = +25°C, unless otherwise specified.)

Out Source Current (I_{OUT}) vs. Temperature (AL5815)



Out Source Current (I_{OUT}) vs. Temperature (AL5816)



Application Information

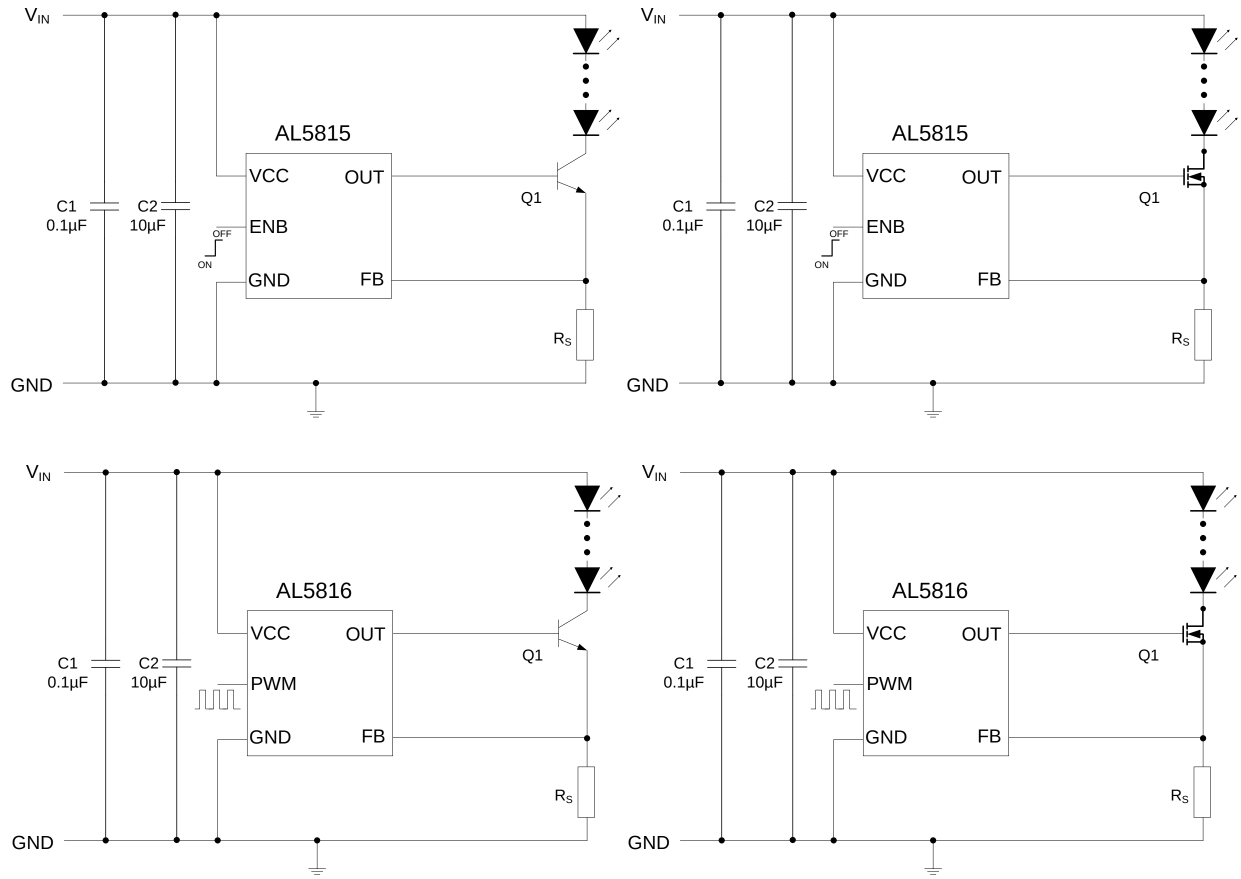


Figure 1. Typical Application Circuit Using BJT and MOSFET

Output Drive

Figure 1 shows the typical output drive configuration. The feedback loop regulates the current through the external LED. The voltage across the external sense resistor (R_S) is fed into the FB pin for sensing. When the voltage exceeds the internal reference of 0.2V, the OUT goes lower, decreasing the drive to the external transistor.

The output current can be set as following:

$$I_{LED} = \frac{V_{FB}}{R_S} \quad (1)$$

Where I_{LED} is the desired LED current, V_{FB} is the reference voltage (0.2V) and Rs is the sense resistor

The power in the resistor is calculated as:
$P = V_{SENSE} * I_{LED}$

Where V_{SENSE} = 0.2V and LED current is the desired LED string current. For a typical case of 250mA LED the power dissipation would be:
P = 0.2V * 0.25A = 0.05W

A standard 1/4W resister would work in this case. Similarly, the external transistor's power dissipation also must be considered to prevent thermal damage to the transistor, which can further damage the LED controller IC.

Application Information (Cont.)

Multiple LED Strings in Parallel

AL5815 and AL5816 can drive more than one channel of LED strings. As shown in Figure 2, the sense voltage of two channels' (or more) output current can be implemented by connecting the voltage of one sense resistor to the FB pin.

By utilizing the same type transistors, sense resistors and series base resistor, the current will match.

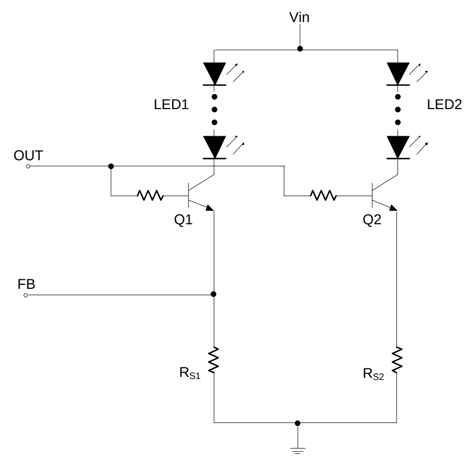


Figure 2. Two LED Strings in Parallel

The output current can be set as following: $I_{LED1} = I_{LED2} = \ldots = V_{FB} / R_{S1}$

Where I_{LED} is the desired LED current, V_{FB} is 0.2V, and R_{S1} is the sense resistor. To keep I_{LED} the same, transistors Q1 and Q2 should be matched, and Rs1 and Rs2 should be matched.

ENB/PWM Dimming

The ENB pin can be used for PWM dimming by enabling and disabling the device to turn-on and turn-off the AL5815's external transistor. A voltage higher than 2.0V will turn off OUT signal while a signal lower than 0.4V turns on the external transistor.

Due to the soft-start delay of the AL5815's ENB function, only low frequency (200Hz or lower) dimming is supported in this device. The AL5816 does not have a soft start thus its PWM pin can be driven with PWM frequency higher than 200Hz.

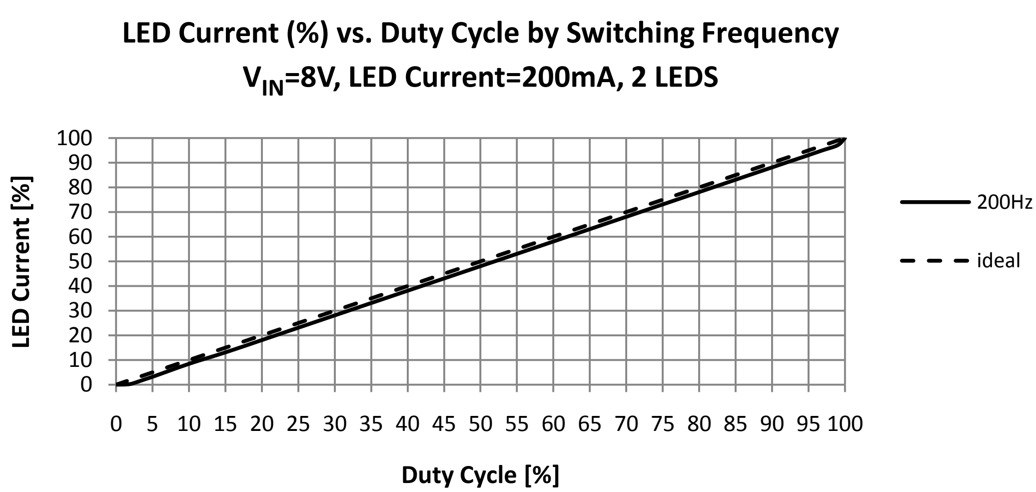


Figure 3. PWM Dimming Curve of AL5815

Application Information (Cont.)

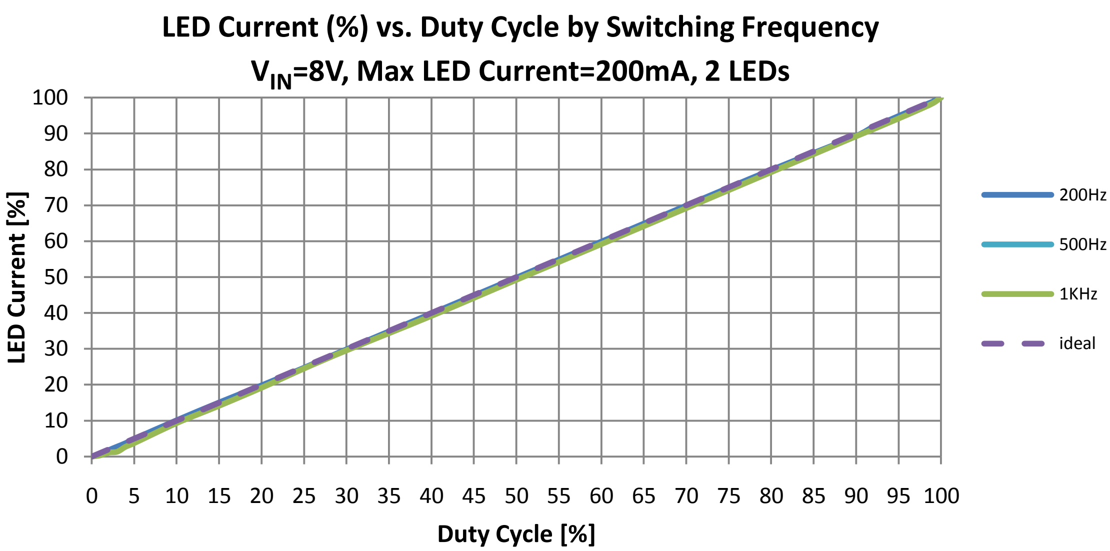


Figure 4. PWM Dimming Curve of AL5816

Thermal Protection

The AL5815 and AL5816 have internal Over Temperature Protection (OTP). When the junction temperature is over +160°C, the IC will shut down. A power cycle off and on or the junction temperature dropping by +30°C will make the IC turn back on.

Power Consideration

The power rating of the transistor (either BJT or NMOS) used in the typical application circuit is important. A correctly mounted transistor used in a typical application can dissipate a maximum of 2W. To calculate power dissipation, first calculate the voltage drop across the transistor as follows:

$V_{DS} = V_{CC} - V_{LED} – 0.2V$

Then calculate the power dissipation requirement:

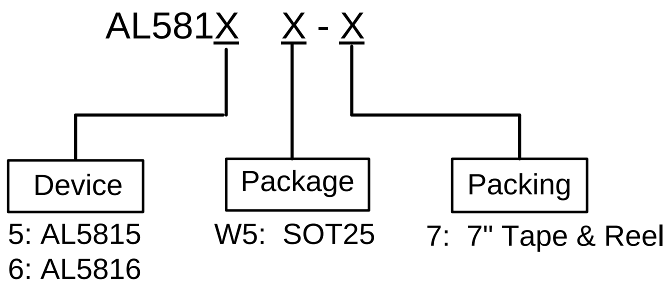
$P = V_{DS} * I_{LED}$

If power dissipation is higher than the transistor package and layout can dissipate then a higher power dissipation transistor must be selected and/or use a better PCB layout.

Feedback Loop

The device has internal compensation and therefore there’s no need to have any components in the feedback loop.

Ordering Information

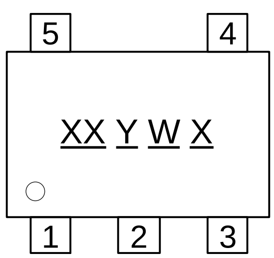


Part Number	Package Code (Note 7)	Package	Tape and Reel	
			Quantity	Part Number Suffix
AL5815W5-7	W5	SOT25	3000/Tape & Reel	-7
AL5816W5-7	W5	SOT25	3000/Tape & Reel	-7

Note: 7. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information

(Top View)



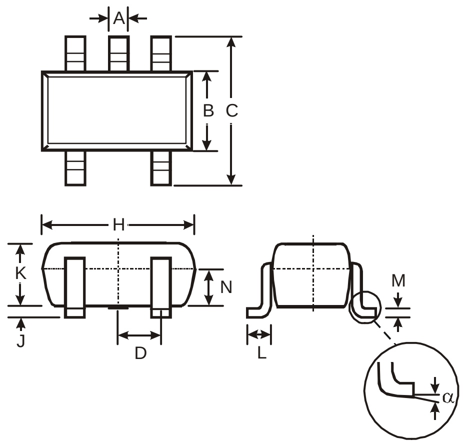
XX : Identification Code
Y : Year 0 to 9
W : Week : A to Z : 1 to 26 week;
a to z : 27 to 52 week; z represents
52 and 53 week
X : Internal Code

Device	Identification Code
AL5815W5-7	BF
AL5816W5-7	BJ

Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT25

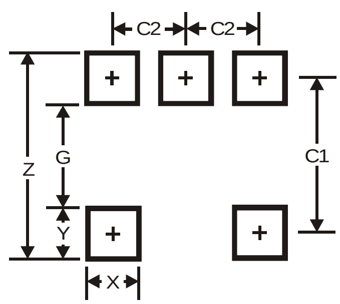


SOT25			
Dim	**Min**	**Max**	**Typ**
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	-	-	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	-
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT25



Dimensions	Value (in mm)
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

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