

## 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

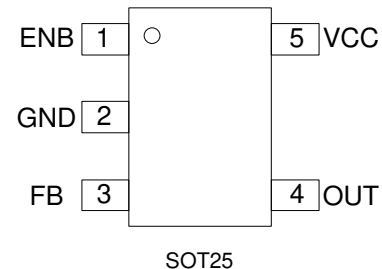
- Wide Input Voltage Range from 4.5V to 60V
- Low Reference Voltage ( $V_{FB} = 0.2V$ )
- 4% Reference Voltage Tolerance
- Up to 15mA Driver Capability for Bipolar Transistor
- Low Standby Current for AL5815
- PWM Dimming Frequency Higher than 200Hz for AL5816
- Input Under Voltage Lock-out
- Over Temperature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

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.

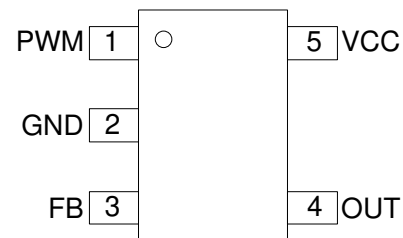
## Pin Assignments

AL5815 (Top View)



SOT25

AL5816 (Top View)

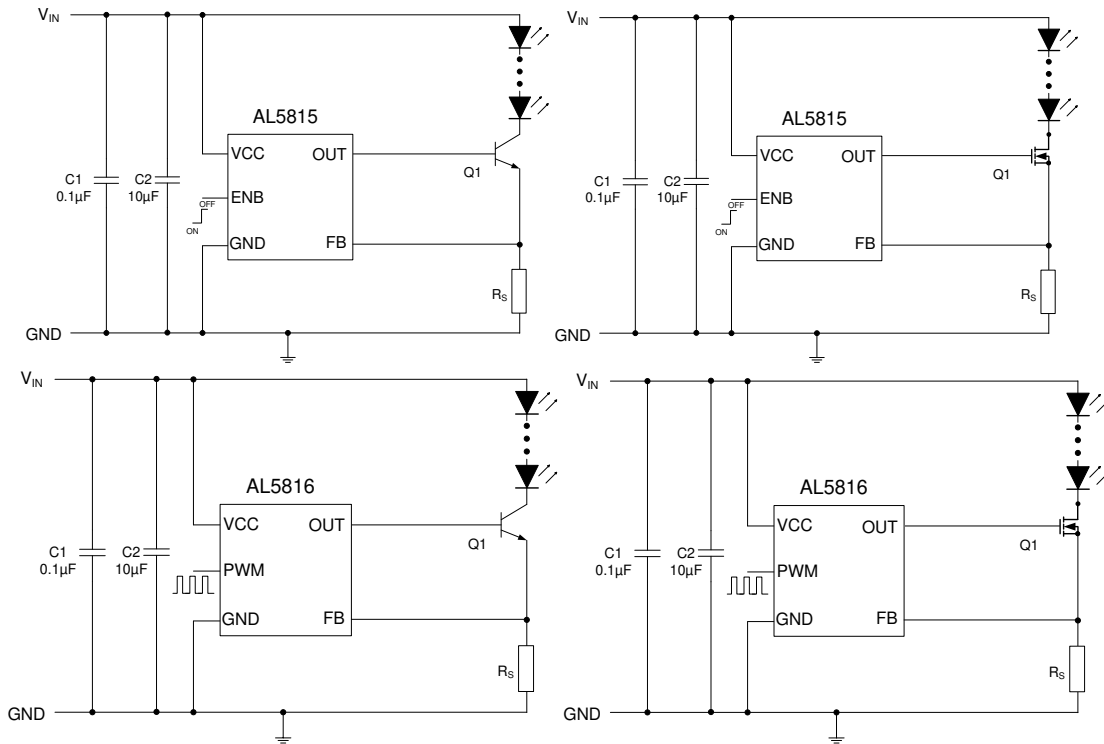


SOT25

## Applications

- Commercial and Industrial Lighting
- Exterior Lighting
- Appliance Lights

**Typical Applications Circuit**

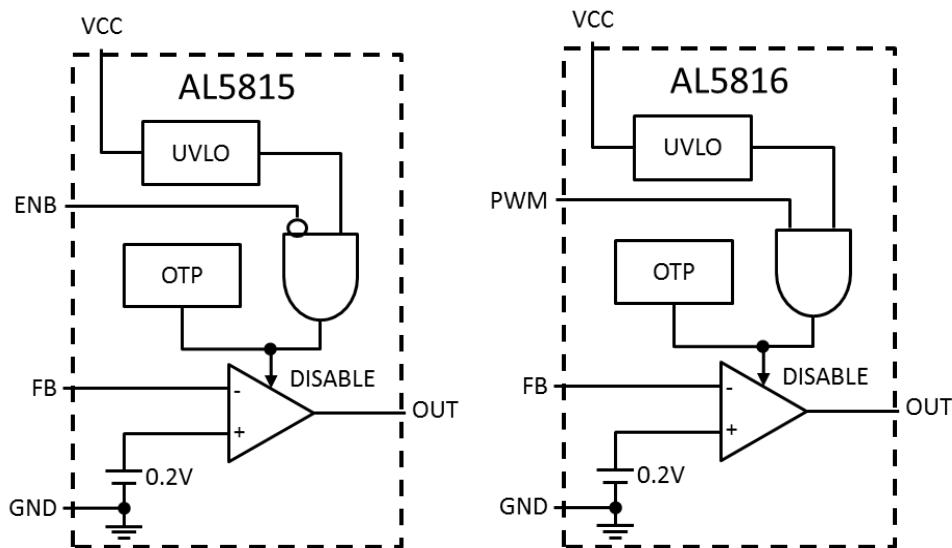


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**Pin Descriptions**

| 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**



**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 |
|---------------|--|--------|------|
| $\theta_{JA}$ | Junction-To-Ambient Thermal Resistance   | 134    | °C/W |
| $\theta_{JC}$ | 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.

**Electrical Characteristics** ( $V_{CC} = 12V$ ,  $T_A = +25^\circ C$ , unless otherwise specified.)

| Symbol                               | Parameter                                       | Condition   | Min   | Typ.  | Max   | Unit       |
|--------------------------------------|---|---|-------|-------|-------|------------|
| <b>POWER SUPPLY</b>                  |   |   |       |       |       |            |
| $V_{UVLO}$                           | 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         |
| $I_{SHDN}$<br>(AL5815)               | Shutdown Supply Current                         | $V_{ENB} > 2.5V$ , $V_{CC} = 4.5V$ to $60V$                               | -     | 3     | 20    | $\mu A$    |
| $V_{ENB\_TH}$<br>(AL5815)            | ENB Threshold Voltage                           | -   | 0.4   | 1.3   | 2     | V          |
| $R_{ENB}$<br>(AL5815)                | ENB Pin Internal Pull Down Resistor             | -   | 1.3   | 2     | 2.7   | $M\Omega$  |
| $V_{PWM\_TH}$<br>(AL5816)            | PWM Pin Threshold Voltage                       | $V_{CC} = 4.5V$ to $60V$ , $V_{PWM}$ Falling                              | 2.37  | 2.5   | 2.63  | V          |
| $V_{PWM\_TH\_HYS}$<br>(AL5816)       | PWM Pin Threshold Voltage Hysteresis            | -   | -     | 0.1   | -     | V          |
| $I_{PWM}$<br>(AL5816)                | PWM Pin Internal Pull Up Current                | $V_{PWM} = 5V$ , $V_{CC} = 4.5V$ to $60V$                                 | -20   | -15   | -11   | $\mu A$    |
| <b>FEEDBACK LOOP</b>                 |   |   |       |       |       |            |
| $V_{FB}$                             | 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         |
| <b>OUTPUT DRIVER ERROR AMPLIFIER</b> |   |   |       |       |       |            |
| $I_{OUTSOURCE}$                      | 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         |
| $I_{OUTSINK}$<br>(AL5815)            | Maximum Sink Current                            | $V_{CC} = 12V$ , $V_{ENB} = 0V$ .<br>$V_{OUT} = 4V$ , $V_{FB} = 250mV$    | 20    | -     | -     | $\mu A$    |
| $I_{OUTSINK}$<br>(AL5816)            | Maximum Sink Current                            | $V_{CC} = 12V$ , $V_{PWM} = 0V$ .<br>$V_{OUT} = 4V$ , $V_{FB} = 250mV$    | 1     | -     | -     | mA         |
| $G_m$                                | Trans-conductance of Error Amplifier (Sourcing) | $\Delta V_{FB} = 5mV$   | -     | 5     | -     | A/V        |
| $f_{BW}$                             | Bandwidth (From FB to OUT)                      | No Loading (Note 6)   | -     | 50    | -     | kHz        |
| $V_{OUT\_MAX}$                       | Maximum Output Voltage                          | $V_{CC} \geq 6V$ , $I_{OUT} = -1mA$                                       | 4     | -     | -     | V          |
| $V_{OUT\_MIN}$                       | Minimum Output Voltage                          | $V_{CC} = 12V$ , $V_{PWM} = 0V$ .<br>$I_{OUT} = 0.1mA$ , $V_{FB} = 250mV$ | -     | -     | 300   | mV         |
| $t_{ON}$<br>(AL5815)                 | Turn On Delay Time                              | ENB Active Low (Note 6)   | -     | 85    | -     | $\mu s$    |
| $t_{OFF}$<br>(AL5815)                | Turn Off Delay Time                             | ENB Active High (Note 6)  | -     | 1     | -     | $\mu s$    |
| $t_{ON}$<br>(AL5816)                 | Turn On Delay Time                              | PWM Active High (Note 6)  | -     | 1     | -     | $\mu s$    |
| $t_{OFF}$<br>(AL5816)                | Turn Off Delay Time                             | PWM Active Low (Note 6)   | -     | 1     | -     | $\mu s$    |
| <b>THERMAL SHUTDOWN</b>              |   |   |       |       |       |            |
| $T_{SHDN}$                           | Thermal Shutdown                                | (Note 6)  | -     | +160  | -     | $^\circ C$ |
| $T_{HYS}$                            | Thermal Shutdown Hysteresis                     | (Note 6)  | -     | +30   | -     | $^\circ C$ |

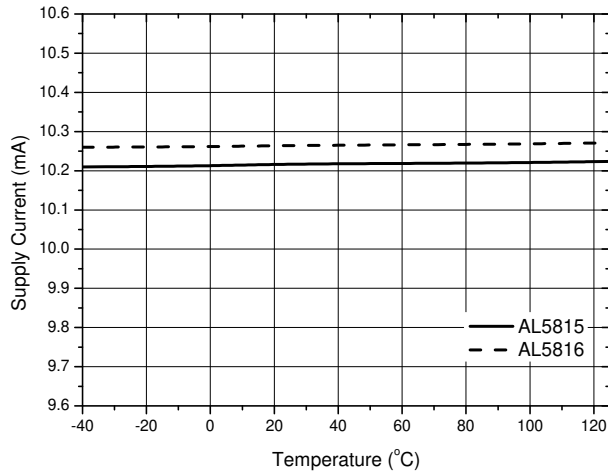
Note: 6. Not tested in production.

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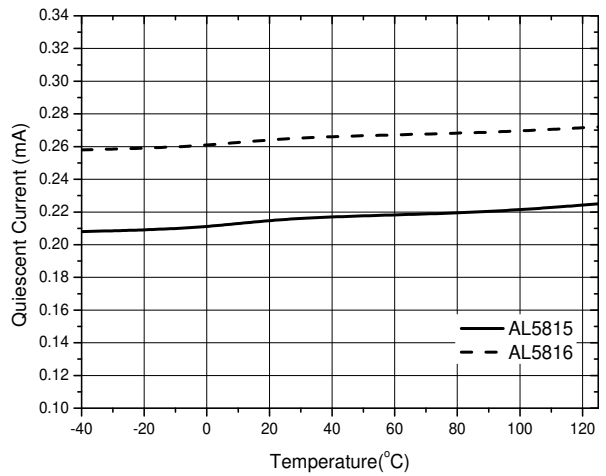
**Typical Performance Characteristics** ( $V_{CC} = 12V$ ,  $T_A = +25^\circ C$ , unless otherwise specified.)

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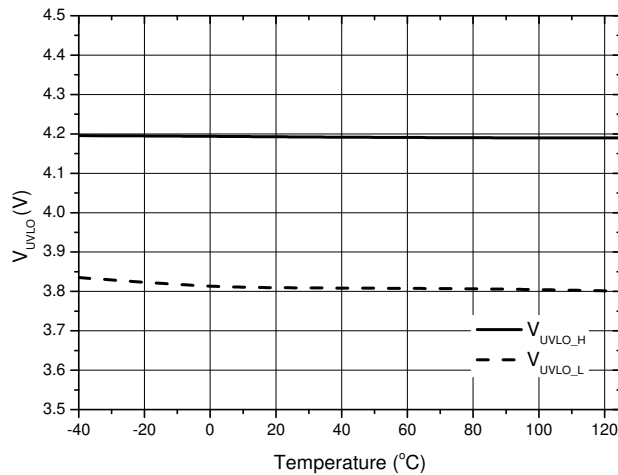
**Supply Current vs. Temperature**



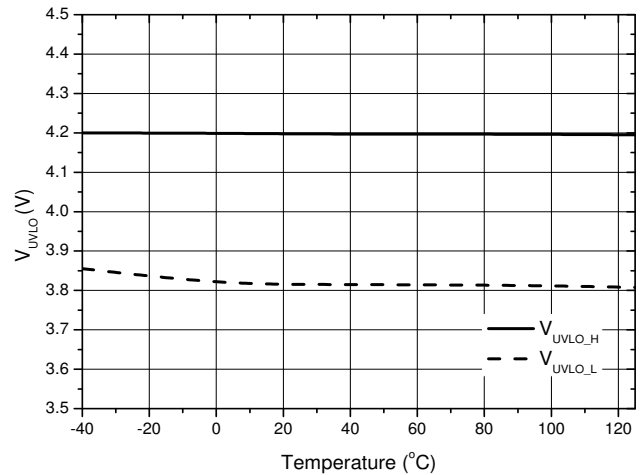
**Quiescent Current vs. Temperature**



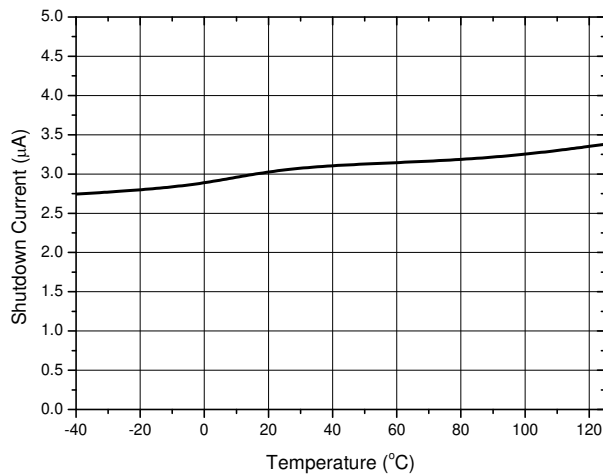
**$V_{UVLO}$  vs. Temperature (AL5815)**



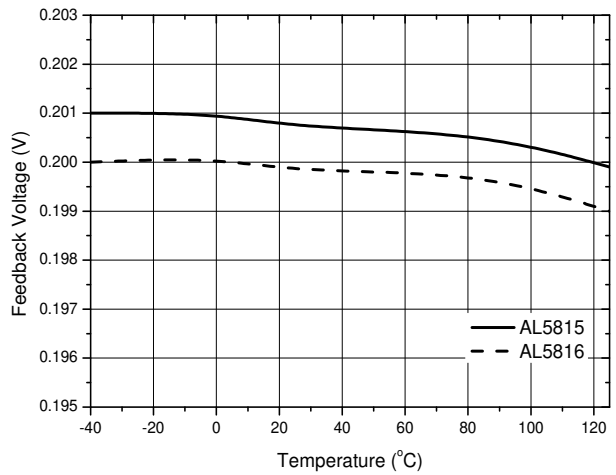
**$V_{UVLO}$  vs. Temperature (AL5816)**



**Shutdown Current vs. Temperature (AL5815)**

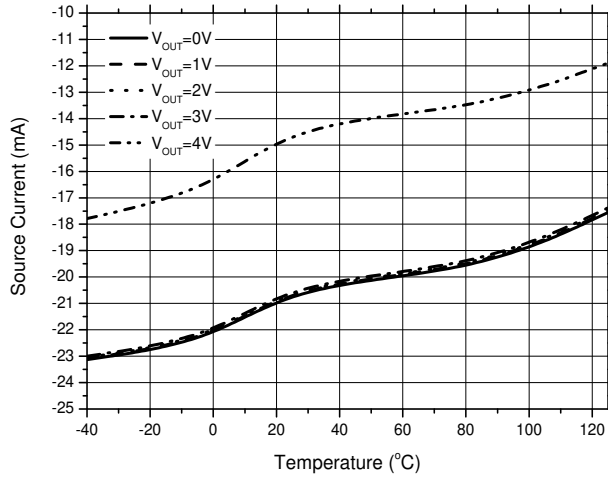


**Feedback Voltage vs. Temperature**

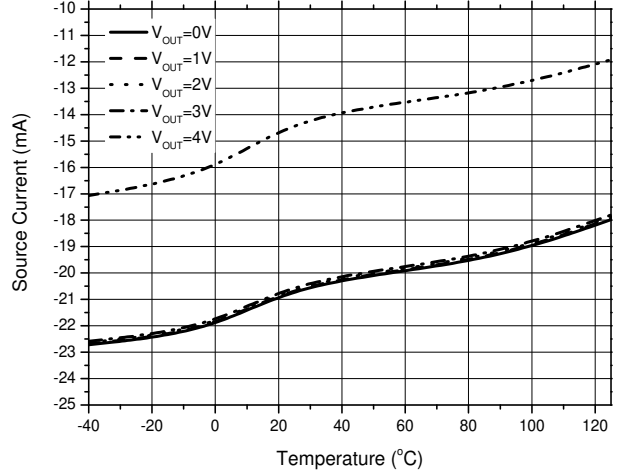


**Typical Performance Characteristics** (Cont.) ( $V_{CC} = 12V$ ,  $T_A = +25^\circ C$ , unless otherwise specified.)

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



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



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**Application Information**

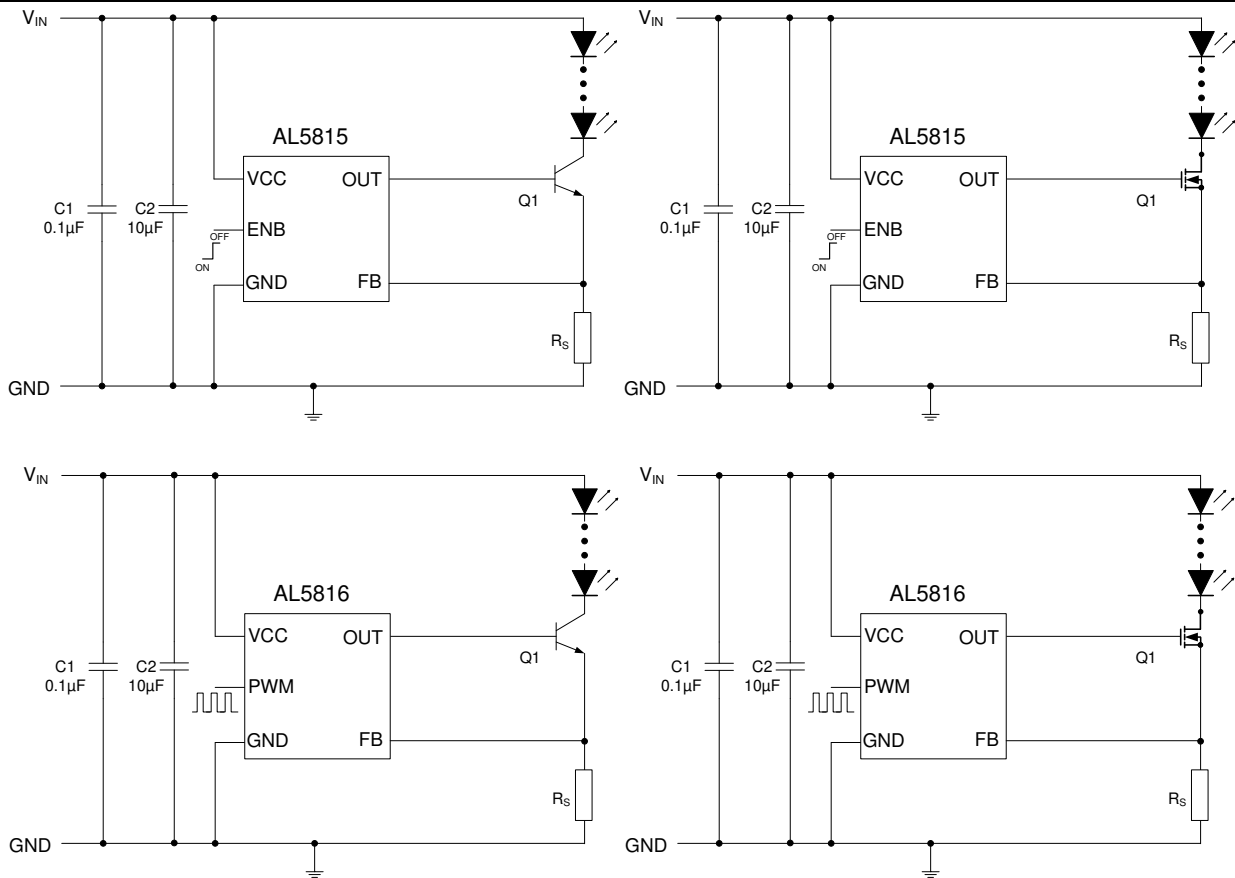


Figure 1. Typical Application Circuit Using BJT and MOSFET

**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  $R_s$  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 resistor 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.

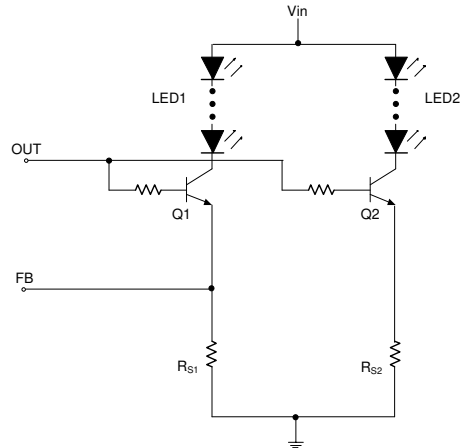


Figure 2. Two LED Strings in Parallel

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

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  $R_{S1}$  and  $R_{S2}$  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.

**LED Current (%) vs. Duty Cycle by Switching Frequency**  
 **$V_{IN}=8V$ , LED Current=200mA, 2 LEDS**

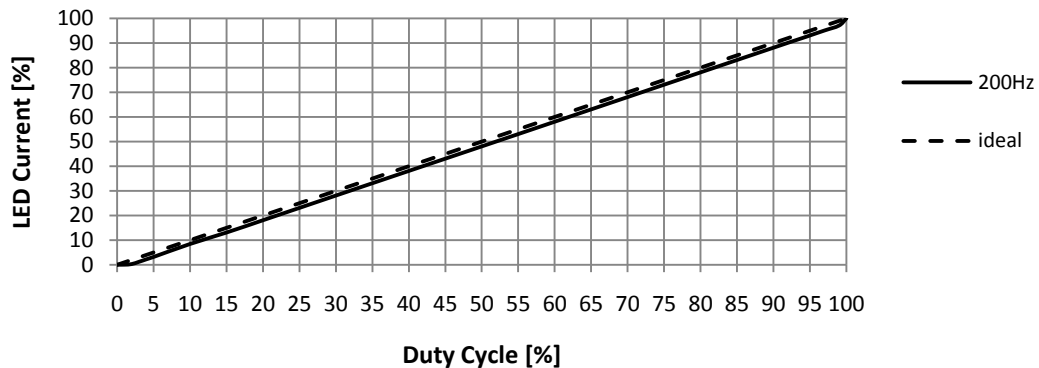


Figure 3. PWM Dimming Curve of AL5815



**Application Information** (Cont.)

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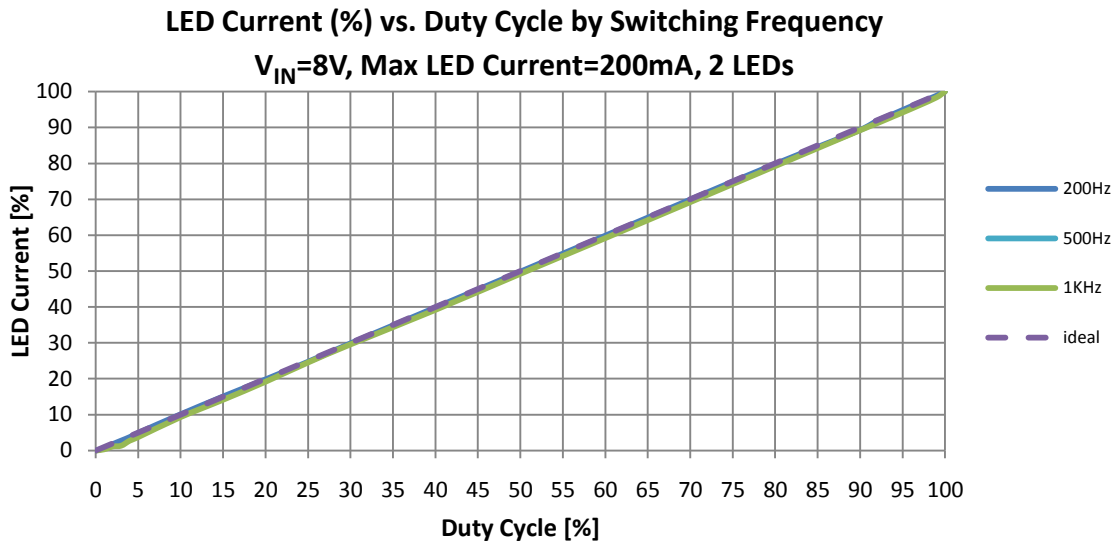


Figure 4. PWM Dimming Curve of AL5816

**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:

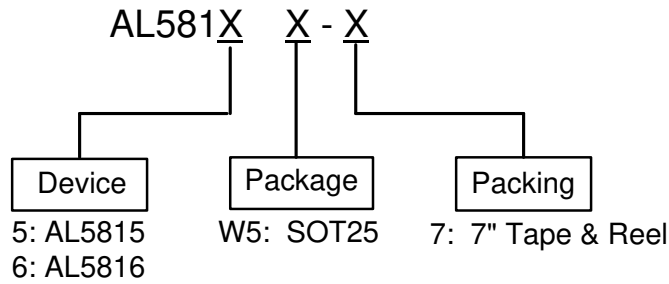
$$P = V_{DS} \cdot I_{LED}$$

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**

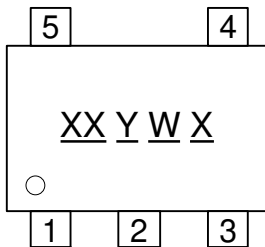


| Part Number | Package Code (Note 7) | Package | Tape and Reel    |                    |
|-------------|-----------------------|---------|------------------|--------------------|
|             |                       |         | Quantity         | Part Number Suffix |
| AL5815W5-7  | W5                    | 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

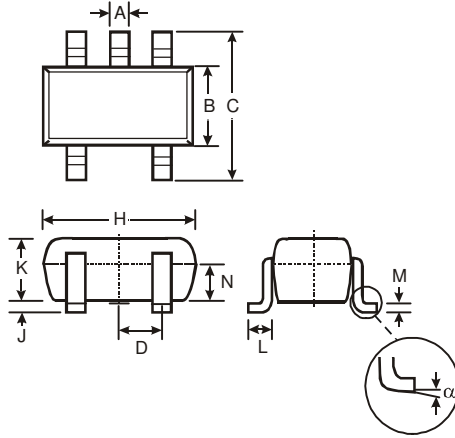
| Device     | Identification Code |
|------------|---------------------|
| AL5815W5-7 | BF                  |
| AL5816W5-7 | BJ                  |

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**Package Outline Dimensions**

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

SOT25

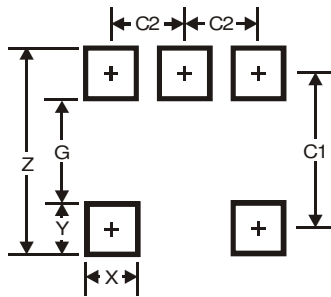


| SOT25                |       |      |      |
|----------------------|-------|------|------|
| Dim                  | Min   | Max  | Typ  |
| A                    | 0.35  | 0.50 | 0.38 |
| B                    | 1.50  | 1.70 | 1.60 |
| C                    | 2.70  | 3.00 | 2.80 |
| D                    | -     | -    | 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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