

Description

The DIODES™ AL5819 is 36V Low Dropout Linear LED driver offering excellent temperature stability and adjustable output current handling capability. The AL5819 simplifies the design of linear and isolated or non-isolated LED drivers by setting the LED current with standard value resistors. It is a simple and elegant solution to deliver constant current for a single LED string.

The AL5819 has an open drain output that can swing up to 36V enabling it drive long LED chains. Its R_{SET} pin is outside of the LED current path and regulated accuracy while minimizing the required overheads to regulate the LED current. This reduces its power dissipation when compared to traditional linear LED drivers.

The AL5819 is available in the SOT26 (Type SM) package.

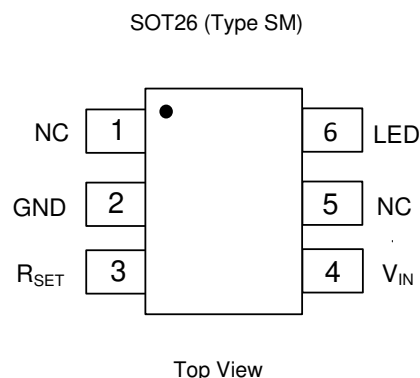
Features

- Up to 36V V_{IN} Open-Drain Output
- -40°C to +125°C Temperature Range
- 5kV ESD HBM for V_{IN} Pin, 2kV ESD HBM for All Other Pins
- No External Capacitor Required for Normal Operation
- Support LED Dimming Through Power Supply Vin
- Support LED Dimming Through R_{SET} Control
- Connect Devices in Parallel to Increase Output Current
- High LED Current Tolerance: ±5% @ 30mA
- Low Drop-out Voltage on LED Pin: 250mV Max @ 60mA
- High Power Supply Rejection
- Low Temperature Drift
- Thermal Fold Back
- Output Current up to 100mA
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](https://www.diodes.com/quality/product-definitions/) or your local Diodes representative.**

<https://www.diodes.com/quality/product-definitions/>

- 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.

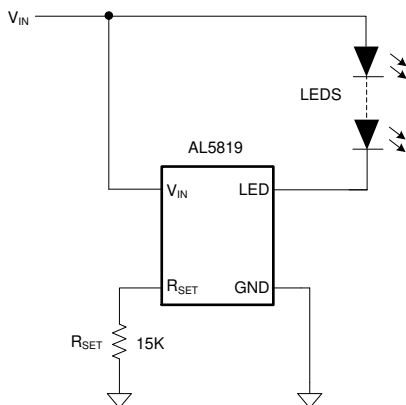
Pin Assignments



Applications

- LED strips
- LED displays and channel letters
- Architectural and landscape lighting
- Retail lighting in fridges, freezer cases and vending machines
- Signage and decorative LED lighting

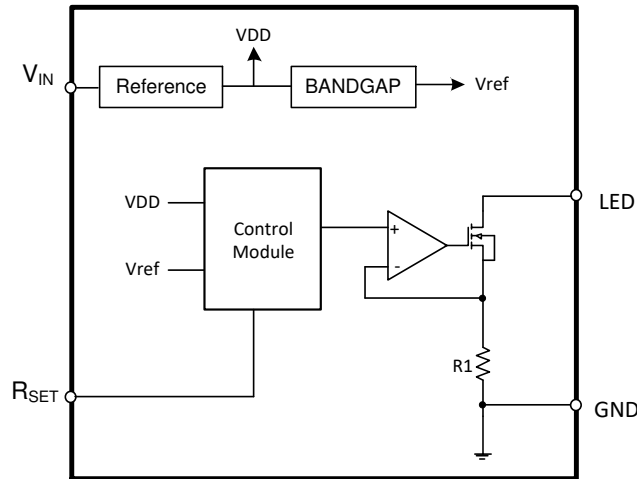
Typical Applications Circuit



Pin Descriptions

Pin Name	Pin Number SOT26 (Type SM)	Function
NC	1	No Connection.
GND	2	Ground Reference Point of Device.
RSET	3	LED Current Setting Pin. Connect a Resistor from This Pin to GND: $I_{LED} = 1500/R_{SET}$ May Also Be Used to Provide PWM Dimming Functionality.
VIN	4	Power Supply Input.
NC	5	No Connection.
LED	6	LED Current Sink Output.

Functional Block Diagram



Absolute Maximum Ratings (@TA = +25°C, unless otherwise specified.)

Symbol	Parameters	Ratings	Unit
V _{IN}	Supply Voltage Relative to GND Pin	-0.3 to +41	V
V _{LED}	LED Pin Voltage Relative to GND Pin	-0.3 to +41	V
V _{RSET}	R _{SET} Pin Voltage Relative to GND Pin	-0.3 to +6	V
I _{LED}	LED Pin Current Sink Current Range	200	mA
ESD HBM	Human Body Model ESD Protection (V _{IN})	5	kV
	Human Body Model ESD Protection (R _{SET} , LED)	2	kV
ESD CDM	Charged Device Model ESD Protection	1.0	kV
T _J	Operating Junction Temperature Range	-40 to +150	°C
T _{STG}	Storage Temperature Range	-55 to +150	°C

Caution: Stresses greater than the 'Absolute Maximum Ratings' specified above can cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability can be affected by exposure to absolute maximum rating conditions for extended periods of time. Semiconductor devices are ESD sensitive and can be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.

Package Thermal Data

Package	θ_{JC} Thermal Resistance Junction-to-Case (Note 5)	θ_{JA} Thermal Resistance Junction-to-Ambient (Note 5)	P _d TA = +25°C, TJ = +125°C (Note 5)
SOT26 (Type SM)	49°C/W	143°C/W (Note 4)	0.71W

Notes: 4. Test condition for SOT26 (Type SM): Device mounted on 1" x 1" FR-4 MPR substrate PCB (2oz copper, minimum recommended pad layout). For better thermal performance, larger copper pad for heat-sink is needed.
5. Dominant conduction path via exposed pad.

Recommended Operating Conditions (@TA = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V _{IN}	Supply Voltage Range Relative to GND Pin	5	36	V
V _{LED}	LED Pin Output Voltage Range Relative to GND Pin	0.1	36	
I _{LED}	LED Pin Current (Notes 6 & 7)	5	100	mA
T _A	Operating Ambient Temperature Range	-40	+125	°C

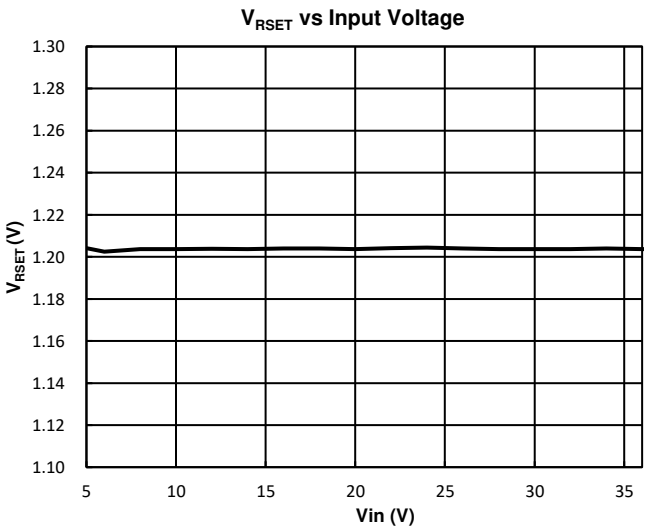
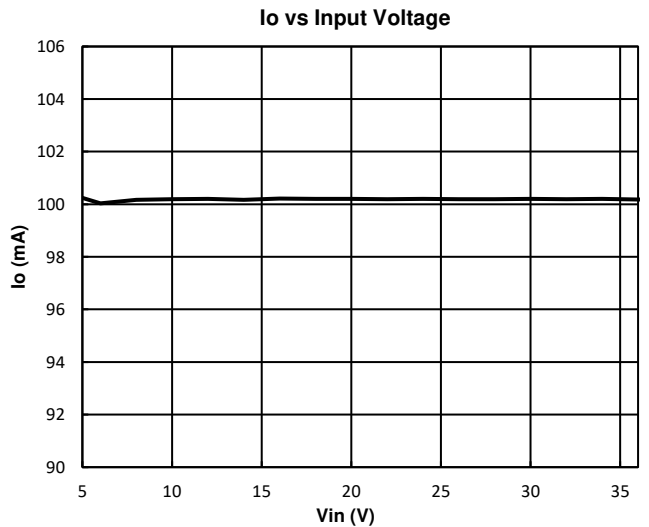
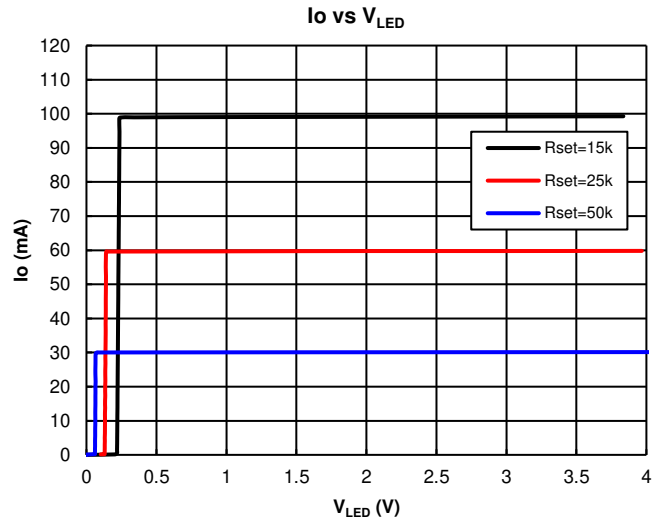
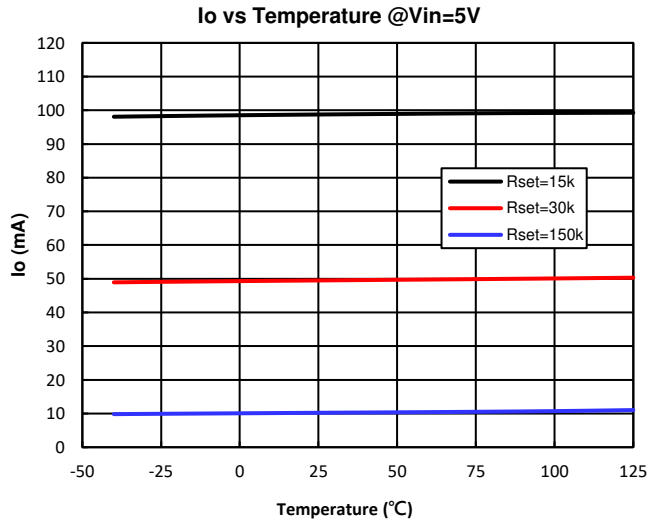
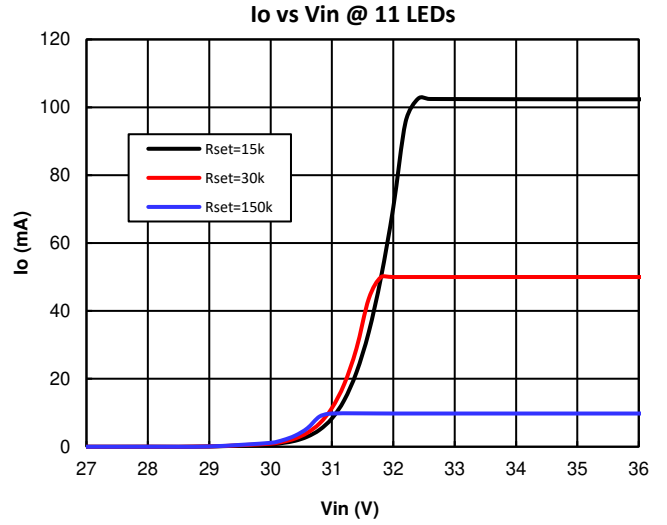
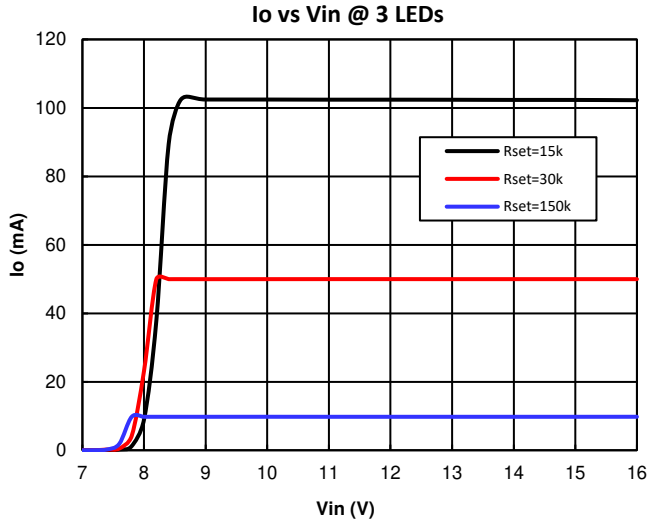
Notes: 6. For improved accuracy, LED current should be greater than 60mA.
7. Maximum LED current is also limited by ambient temperature and power dissipation such that junction temperature should be kept less than or equal to +125°C.

Electrical Characteristics (@ $T_A = +25^\circ\text{C}$, $V_{IN} = 12\text{V}$, $V_{LED} = 1\text{V}$ (Note 8), unless otherwise specified.)

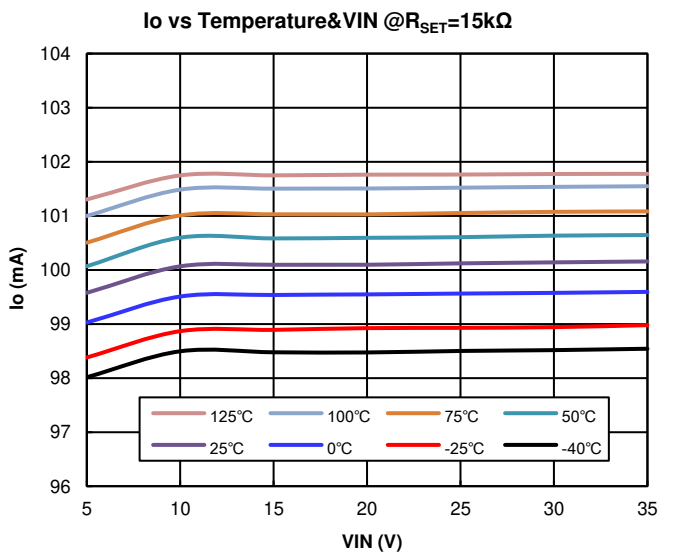
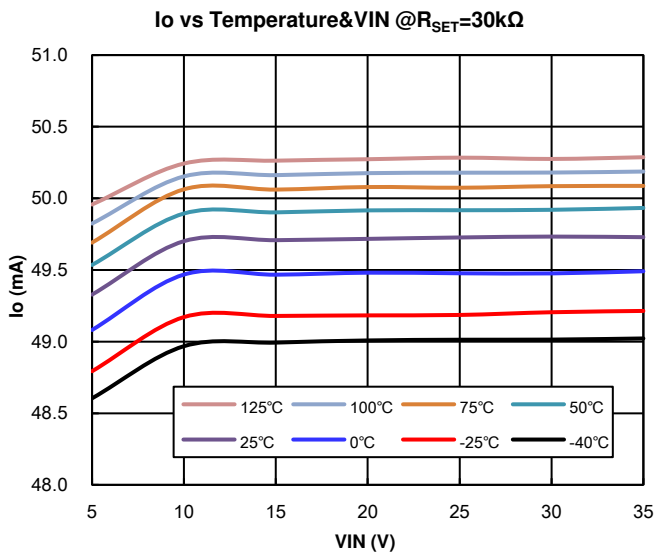
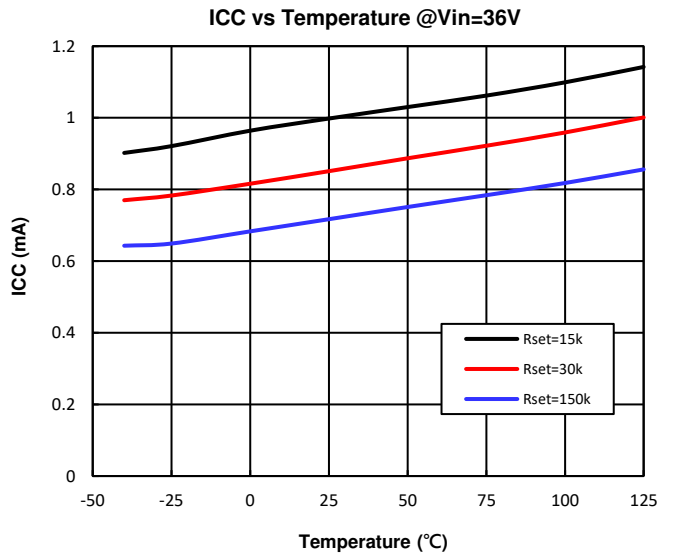
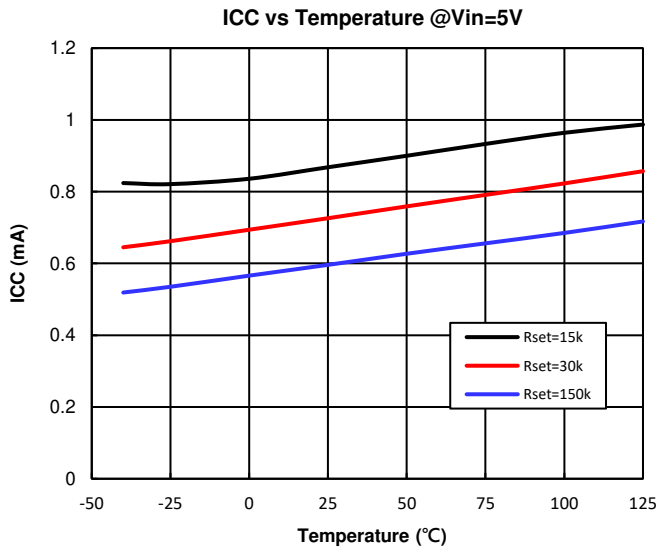
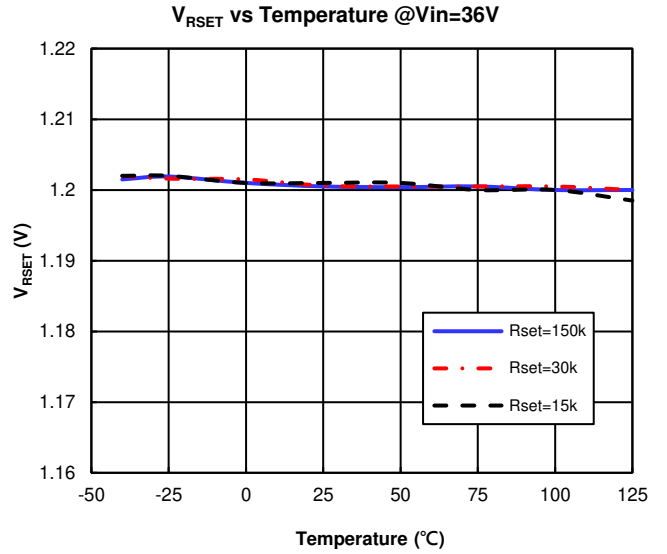
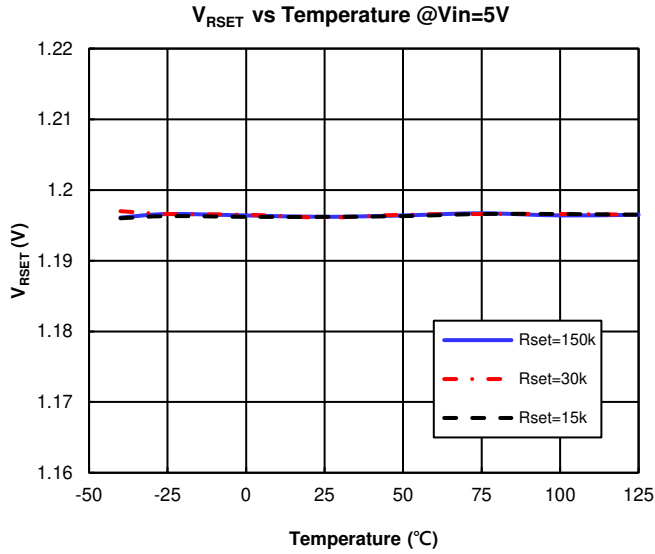
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{RSET}	R_{SET} Voltage	$R_{SET} = 50\text{k}\Omega$	—	1.2	—	V
I_{LED}	I_{LED} Current Accuracy	$R_{SET} = 50\text{k}\Omega$	28.5	30	31.5	mA
		$R_{SET} = 25\text{k}\Omega$	57	60	63	
		$R_{SET} = 15\text{k}\Omega$	95	100	105	
I_{LED_LIMIT}	Maximum Limited LED Current When R_{SET} Pin is Shorted to GND	$R_{SET} = 0\text{k}\Omega$	—	200	—	mA
V_{DROP}	LED Output Dropout Voltage	$R_{SET} = 15\text{k}\Omega$	—	—	400	mV
		$R_{SET} = 25\text{k}\Omega$	—	—	250	mV
REG_{LINE}	LED Current Line Regulation ($\Delta I_{LED} / I_{VIN=12V}$)	$R_{SET} = 25\text{k}\Omega$ $V_{IN} = 5\text{V to } 36\text{V}$	—	1	—	%
REG_{LOAD}	LED Current Load Regulation ($\Delta I_{LED} / I_{V_{LED}=1V}$)	$R_{SET} = 50\text{k}\Omega$ $V_{LED} = 1 \text{ to } 10\text{V}$	—	1	—	%
$UVLO$	Under Voltage Lockout	$R_{SET} = 50\text{k}\Omega$	—	4	—	V
	Hysteresis	$R_{SET} = 50\text{k}\Omega$	—	300	—	mV
I_{CC}	Supply Current	$V_{IN} = 5\text{V to } 36\text{V}$ $R_{SET} = 15\text{k}\Omega$	—	0.9	1.2	mA
			—	—	1.5	
I_{STBY}	Supply Current in R_{SET} Floating	$R_{SET} = \text{Floating}$	—	300	—	μA
I_{LEAK}	LED Pin Leakage Current	$V_{IN} = V_{LED} = 36\text{V}$ $R_{SET} = \text{Open Circuit}$	—	—	1	μA
t_{DELAY}	Turn on Delay Time	$R_{SET} = 25\text{k}\Omega$	—	300	—	μs
CR_T	Output LED Current Change vs. Temperature, $CR_T = \Delta I_{LED} / \Delta T_J$ (Note 9)	$R_{SET} = 150\text{k}\Omega$ $-40^\circ\text{C} < T_J < +125^\circ\text{C}$	—	8	—	$\mu\text{A}/^\circ\text{C}$
T_K	Thermal Knee Junction Temperature (Note 9)	$R_{SET} = 150\text{k}\Omega$	—	+135	—	$^\circ\text{C}$
T_{SHDN}	Thermal Shutdown (Note 9)	—	—	+165	—	$^\circ\text{C}$
T_{HYS}	Thermal Shutdown Hysteresis (Note 9)	—	—	+20	—	$^\circ\text{C}$

Notes: 8. All voltages unless otherwise stated are measured with respect to GND pin.
9. These parameters are guaranteed by design, not 100% tested in production.

Typical Performance Characteristics (@ $T_A = +25^\circ\text{C}$, $V_{IN} = 12\text{V}$, $V_{LED} = 1\text{V}$, unless otherwise specified.)



Typical Performance Characteristics (continued)



Application Information

Description

The AL5819 is a Linear LED driver and in normal operation has the LEDs connected to the same potential as its V_{IN} pin and regulates the LED current by sinking current into to its LED pin see Figure 1.

The LED current is set by an external resistor, R_{SET} , connected from the R_{SET} pin to GND. This resistor supplies the bias current of the AL5819 together with current regulator to set the LED current.

The nominal LED current is determined by this equation:

$$I_{LED} = 1250 \times \frac{V_{RSET}}{R_{SET}} \text{ Where 1250 is the current ratio between the LED pin current and } R_{SET} \text{ pin current.}$$

With $R_{SET} = 15k$

$$I_{LED} = 1250 \times \frac{1.2}{15k} = 100mA$$

The AL5819 with its 36V capability on its supply pin, V_{IN} , and its LED drive pin allows it to operate from supply rails up to 36V and/or directly drive LED chains up to 36V as shown in Figures 1 and 2. The voltage applied to the V_{IN} pin can be greater or lower than the voltage applied to the LED string. Figure 2 shows where you might control it from a 5V rail but power the rails from a 12V rail.

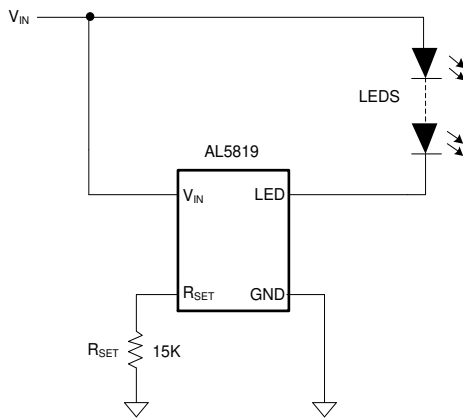


Figure 1. Single Power Supply

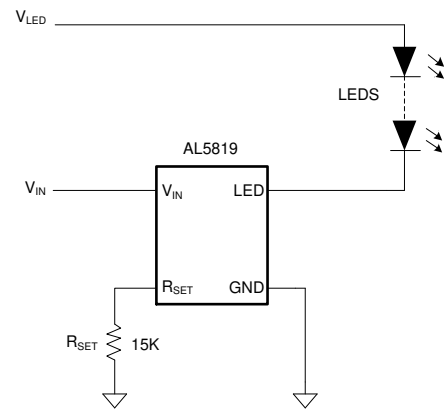
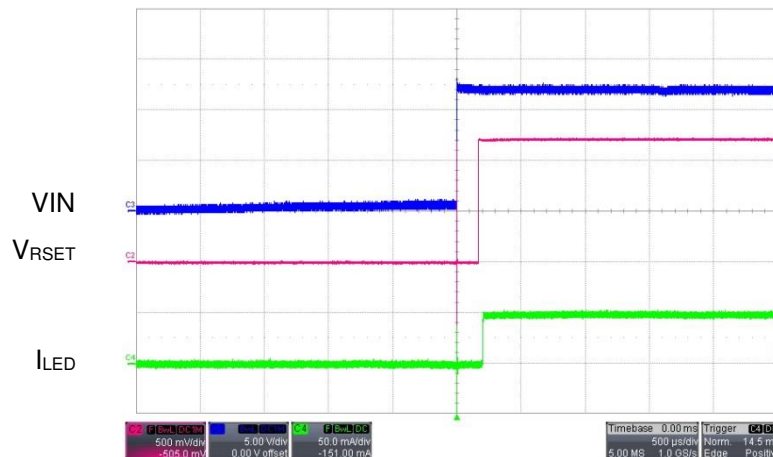


Figure 2. Separated Power Supplies

Startup Delay Time Waveform



Application Information (continued)

High Voltage Operation

An extension of Figure 2 is to derive the power for the AL5819 from the LED chain itself, see Figure 3. LED chains greater than 36V can be driven in this manner as long as PWM dimming is not utilized.

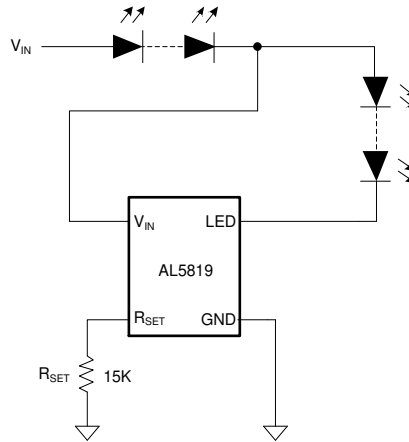


Figure 3. Single Power Supply for High Voltage LED String Connection

Figure 3 shows the use of RC delay to match the power time delay between V_{IN} and LED pin.

PWM Dimming

The AL5819 can be used to provide LED current dimming driving the R_{SET} pin via the current setting resistor (R_{SET}) and a series MOSFET switch to ground (Figure 4). The R_{SET} pin current is then effectively switched on and off causing the LED current to turn on and off. The linearity is shown in Figure 5.

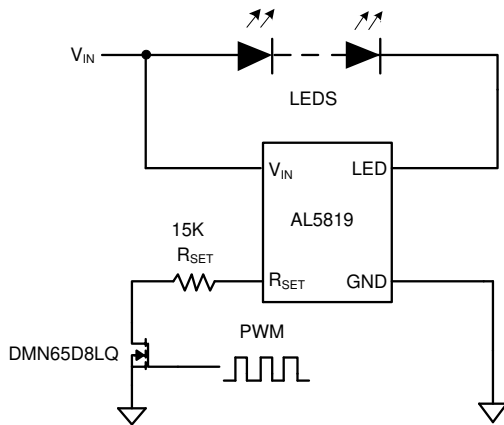


Figure 4. PWM Dimming

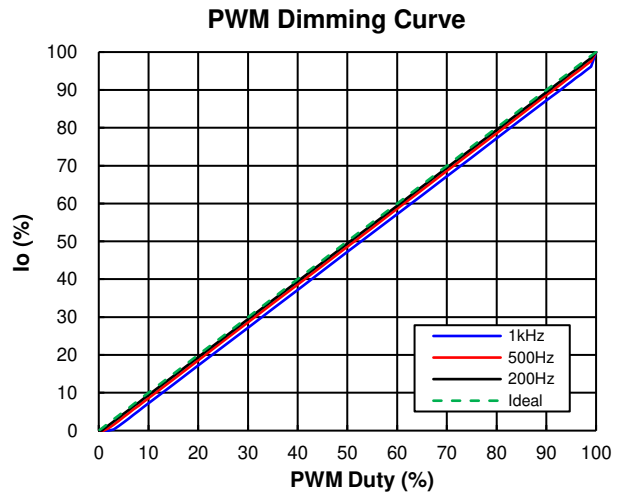


Figure 5. PWM Dimming Curve

Thermal Fold Back Operation and Over Temperature Protection (OTP)

The AL5819 employs an advanced thermal protection feature. Up to a junction temperature T_J of +135°C the regulated current keeps its set value, while it is gradually reduced above that temperature. At $T_J = +160^\circ\text{C}$ the current is reduced to 37.5 percent of set value, and output current keeps 37.5 percent of set value until T_J reached +165°C. When the junction temperature reaches +165°C, the device will enter OTP in which all current sinks are shut down and no current flows to LED strings. The device will restart from OTP when the junction temperature is cooled down below +145°C. Thermal protection prevents the IC from being damaged when the die temperature exceeds safe margins.

Application Information (continued)

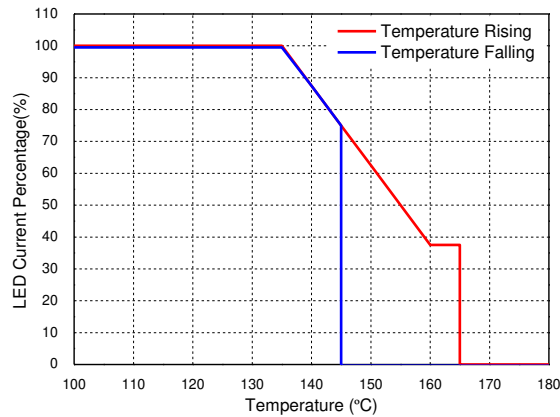


Figure 6. Thermal Fold-Back Diagram

Thermal Considerations

When designing linear LED drivers, careful consideration must be given to:

1. The power dissipation within the LED driver and
2. PCB layout/heat sinking

A Linear LED driver has to be able to handle the large potential input voltage variations due to the supply voltage tolerance and also the variation in LED forward voltage due to binning and temperature.

This can result in a large potential difference across the LED driver resulting in a larger than anticipated power dissipation.

For example, in a 12V powered system with a 5% output voltage tolerance, the input voltage could typically vary from 12.6V down to 11.4V driving 3 LEDs with a voltage varying from 3V to 3.5V at 100mA. This means that the LED driver has to cope with a voltage drop across varying from approximately 3.6V to 0.9V. This means that the power dissipation of the AL5819 could be as much as 366mW.

Figure 7 below shows how the AL5819's power dissipation capability varies with package; these values will vary with PCB size and area of metal associated with the ground plane used for heat sinking. By increasing the area on the top layer, the thermal impedance of both packages could be improved.

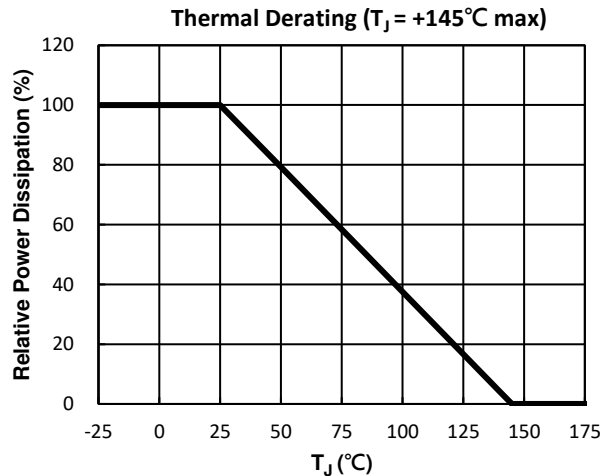
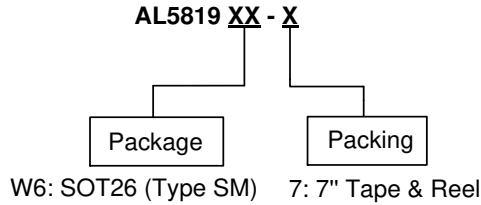


Figure 7. Power Dissipation Along with Temperature

Ordering Information

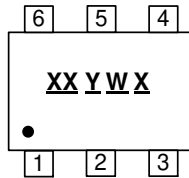


Part Number	Part Number Suffix	Package	Package Code	Packing	
				Qty.	Carrier
AL5819W6-7	-7	SOT26 (Type SM)	W6	3,000	Tape and Reel

Marking Information

SOT26 (Type SM)

(Top View)



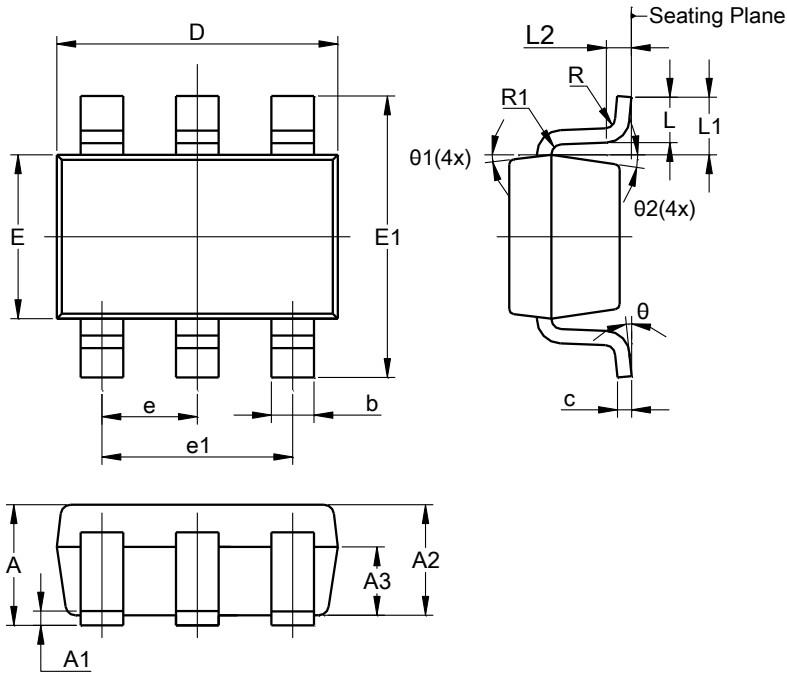
- XX : Identification Code
- Y : Year 0 to 9 (ex: 2 = 2022)
- W : Week : A to Z : Week 1 to 26;
a to z : Week 27 to 52; z Represents Week 52 and 53
- X : Internal Code

Part Number	Package	Identification Code
AL5819W6-7	SOT26 (Type SM)	F2

Package Outline Dimensions

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

SOT26 (Type SM)

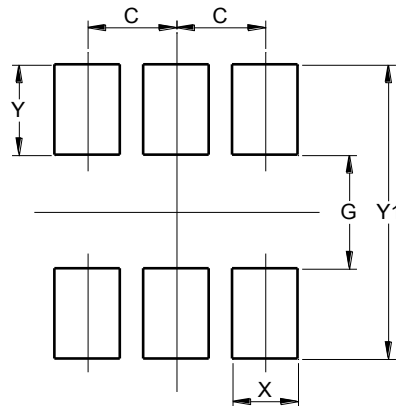


SOT26 (Type SM)			
Dim	Min	Max	Typ
A	--	1.45	--
A1	0.00	0.15	--
A2	0.90	1.30	1.10
A3	0.60	0.70	0.65
b	0.39	0.49	--
c	0.12	0.19	--
D	2.85	3.05	2.95
E	1.55	1.75	1.65
E1	2.60	3.00	2.80
e	0.85	1.05	0.95
e1	1.80	2.00	1.90
L	0.35	0.60	0.45
L1	0.59REF		
L2	0.25BSC		
R	0.05	--	--
R1	0.05	0.20	--
theta	0°	8°	--
theta1	8°	12°	10°
theta2	8°	12°	10°
All Dimensions in mm			

Suggested Pad Layout

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

SOT26 (Type SM)



Dimensions	Value (in mm)
C	0.950
G	1.250
X	0.700
Y	0.975
Y1	3.200

Mechanical Data

- Moisture Sensitivity: MSL3 per JESD22-A113
- Terminals: Finish – Matte Tin Plated Leads, Solderable per JESD22-B102 (G3)
- Weight: 0.018336 grams (Approximate)

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