60V Two Terminal Constant Current LED Driver
PowerDI

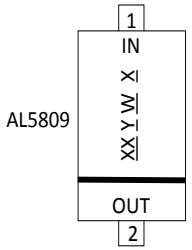
Description

The AL5809 is a constant current linear LED driver and it provides a cost-effective two pin solution. It has an excellent temperature stability of 20ppm/°C and the current accuracy ±5% regulated over a wide voltage and temperature range. The AL5809 comes in various fixed output current versions removing the need for external current setting resistors creating a simple solution for the linear driving of LEDs. It supports both the high-side and low-side driving of LED chains.

The AL5809 turns on when the voltage between IN and OUT swings from 2.5V up to 60V enabling it drive long LED chains. The floating ground, 60V Voltage rating between Input and Output pins designed to withstand the high peak voltage incurred in offline applications.

The AL5809 is available in either thermally robust package PowerDI123 or SOD-123 package.

Pin Assignments



Features

- 2.5V to 60V Operating Voltage Between Two Terminals
- Robust Power Package Up to 1.2W for PowerDI®-123
- -40°C to +125°C Temperature Range
- ±5% LED Current Tolerance Over-Temperature
- 15mA, 20mA, 25mA, 30mA, 40mA, 50mA, 60mA, 90mA, 100mA, 120mA, and 150mA Available in PowerDI123 Package
- 15mA, 20mA, 25mA, 30mA, 40mA and 50mA available in SOD-123 Package, Other Current Options Available by Request
- Constant Current with Low Temperature Drift and High Power Supply Rejection Ratio
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Applications

- Offline LED Lamps
- LED Power Supplies
- White Goods
- LED Signs
- Instrumentation Illumination

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html 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.

POWERDI is a registered trademark of Diodes Incorporated.

Absolute Maximum Ratings

Symbol	Parameters	Ratings	Unit
V_{InOut}	"In" Voltage Relative to "Out" Pin	-0.3 to +80	V
I_{InOut}	LED Current from "In" to "Out"	180	mA
ESD HBM	Human Body Model ESD Protection	4	kV
ESD MM	Machine Model ESD Protection	400	V
T_J	Operating Junction Temperature	-40 to +175	°C
T_{ST}	Storage Temperature	-55 to +150	°C

Caution: Stresses greater than the 'Absolute Maximum Ratings' specified above, may 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 may be affected by exposure to absolute maximum rating conditions for extended periods of time.
Semiconductor devices are ESD sensitive and may 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	θ_{JA} Thermal Resistance Junction-to-Ambient	P_{DIS} T_A = +25°C, T_J = +125°C
PowerDI123	27.15°C/W	148.61°C/W (Note 4)	0.68W
PowerDI123	17.81°C/W	81.39°C/W (Note 5)	1.24W
SOD-123	69.56°C/W	278.42°C/W (Note 6)	0.36W

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{InOut}	"In" Voltage Range Relative to "Out" Pin	2.5	60	V
I_{InOut}	LED Current (Note 7)	15	150	mA
T_A	Operating Ambient Temperature Range (Note 8)	-40	+125	°C

Electrical Characteristics (V_{InOut} = 3.5V) (Note 9)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{InOut}	In-Out Supply Voltage	-	T_A = -40°C to +125°C	2.5	-	60	V
I_{InOut}	I_{INOut} Current Accuracy (±5% for over temperature)	AL5809-15S1-7 AL5809-15P1-7	T_A = -40°C to +125°C	14.25	15	15.75	mA
		AL5809-20S1-7 AL5809-20P1-7	T_A = -40°C to +125°C	19	20	21	
		AL5809-25S1-7 AL5809-25P1-7	T_A = -40°C to +125°C	23.75	25	26.25	
		AL5809-30S1-7 AL5809-30P1-7	T_A = -40°C to +125°C	28.5	30	31.5	
		AL5809-40S1-7 AL5809-40P1-7	T_A = -40°C to +125°C	38	40	42	
		AL5809-50S1-7 AL5809-50P1-7	T_A = -40°C to +125°C	47.5	50	52.5	
		AL5809-60P1-7	T_A = -40°C to +125°C	57	60	63	
		AL5809-90P1-7	T_A = -40°C to +125°C	85.5	90	94.5	
		AL5809-100P1-7	T_A = -40°C to +125°C	95	100	105	
		AL5809-120P1-7	T_A = -40°C to +125°C	114	120	126	
		AL5809-150P1-7	T_A = -40°C to +125°C	142.5	150	157.5	
I_{LINE}	I_{InOut} Current Line Regulation	V_{InOut} = 2.5V to 60V (Note 10)	T_A = +25°C	-	1	-	%
V_{MIN}	Minimum Power Up Voltage	Increase V_{InOut} (Note 11)	T_A = -40°C to +125°C	-	1.5	-	V
t_{ON_MIN}	Minimum On pulse width	(Note 12, 13)	-	500	-	-	µS
t_{OFF_MIN}	Minimum Off pulse width	(Note 12, 13)	-	500	-	-	µS
T_{SHDN}	Thermal Shutdown	Junction Temperature (Note 14)	-	-	+165	-	°C
T_{HYS}	Thermal Shutdown Hysteresis	-	-	-	+30	-	°C

Notes:
4. Test condition for PowerDI-123: Device mounted on 25.4mm x 25.4mm FR-4 PCB (10mm x 10mm 1oz copper, minimum recommended pad layout on top layer and thermal vias to bottom layer ground plane). For better thermal performance, larger copper pad for heat-sink is needed.
5. When mounted on 50.8mm x 50.8mm GETEK PCB with 25.4mm x 25.4mm copper pads.
6. Test condition for SOD-123: Device mounted on FR-4 PCB with 50.8mm x 50.8mm 2oz copper, minimum recommended pad layout on top layer and thermal vias to bottom layer with maximum area ground plane. For better thermal performance, larger copper pad for heat-sink is needed.
7. The LED operating current is determined by the AL5809 current option index XXX, AL5809-XXXS/P1-7.
8. The 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.
9. All voltages unless otherwise stated are measured with respect to OUT pin.
10. Measured by the percentage degree of LED current variation when V_{InOut} varies from 2.5V to 60V each current option.
11. Apply the power linearly to the chip until the device starts to turn on.
12. t_{ON_MIN} time includes the delay and the rise time needed for I_{OUT} to reach 90% of its final value. t_{OFF_MIN} time is the time needed for I_{OUT} to drop below 10% of its final value.
13. This parameter only guaranteed by design, not tested in production.
14. Ambient temperature at which OTP is triggered may vary depending on application, PCB layout and material used.

Application Information

Description

The AL5809 is a constant current Linear LED driver and can be placed in series with LEDs as a High Side or a Low Side constant current regulator. The AL5809 offers various current settings from 15mA up to 150mA and different current settings available upon request (contact Diodes local sales office at http://www.diodes.com).

The AL5809 contains a Low-Dropout regulator which provides power to the internal Current regulation control block. A fixed preset LED current setting resistor sets the reference current of the Current regulation block. The LED current setting resistor varies with each variant of the AL5809. An accurate current mirror within the Current regulation control block increases the reference current to the preset LED current of the AL5809.

Simple LED String

The AL5809 can be placed in series with LEDs as a Low Side/High Side constant current regulator. The number of the LEDs can vary from one to as many as can be supported by the input supply voltage. The designer needs to calculate the maximum voltage between In and Out by taking the maximum input voltage minus the voltage across the LED string (Figures 1 & 2).

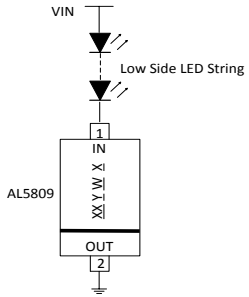


Figure 1 Low Side LED String Tapping

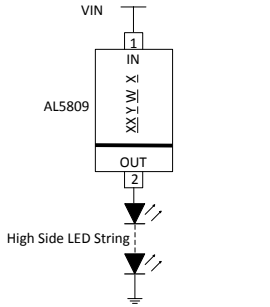
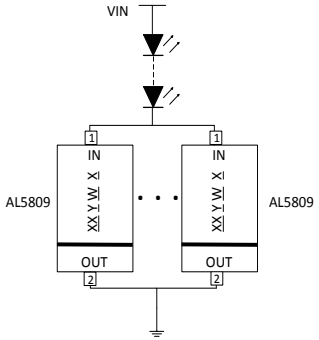


Figure 2 High Side LED String Tapping

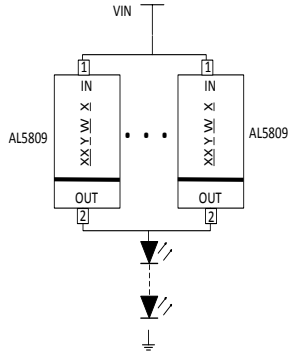
The AL5809 can also be used on the high side of the LEDs, see Figure 2. The minimum system input voltage can be calculated by:

$V_{IN(min)} = V_{LED\_CHAIN} + 2.5V$ Where V_{LED_CHAIN} is the LED chain voltage.

The LED current can be increased by connecting two or more AL5809 in parallel in Figure 3.



(a)Low Side Configuration



(b) High Side Configuration

Figure 3 Higher LED Current by Parallel Configuration of AL5809

NCR320U / NCR321U

250 mA LED driver in SOT457

Rev. 1 — 11 December 2018 Product data sheet

1. Product profile

1.1. General description

LED driver consisting of a resistor-equipped NPN transistor with two diodes on one chip in an SOT457 (SC-74; TSOP6) plastic package.

Table 1. Product overview

Type number	Package	
	Nexperia	JEITA
NCR320U	SOT457	SC-74; TSOP6
NCR321U	SOT457	SC-74; TSOP6

1.2. Features and benefits

- Stabilized output current of 10 mA without external resistor
- Stabilized output current adjustable up to 250 mA when an external resistor is used
- High current accuracy at supply voltage variation
- Low voltage overhead of 1.4 V
- Reduces component count and board space
- High power dissipation of 750 mW
- Supply voltage up to 16 V
- Digital PWM input up to 10 kHz frequency for NCR321U
- AEC-Q101 qualified

1.3. Applications

- Constant current LED driver
- Generic constant current source
- Automotive applications (for example: interior lighting, dash board, instrumentation, number plate light)
- Increase stabilized output current by paralleling drivers

1.4. Quick reference data

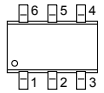
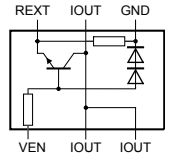
Table 2. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{EN}	enable voltage						
	NCR320U			-	-	25	V
	NCR321U			-	-	4.5	V
V_{out}	output voltage			-	-	16	V
I_{out}	stabilized output current						
	NCR320U	V_{out}= 1.4 V; V_{EN}= 12 V	[1]	9	10	11	mA
	NCR321U	V_{out}= 1.4 V; V_{EN}= 3.3 V	[1]	9	10	11	mA

[1] Pulse test: $t_p \leq 300\ \mu s$; $\delta \leq 0.02$

2. Pinning information

Table 3. Pinning

Pin	Symbol	Description	Simplified outline	Symbol
1	VEN	enable voltage	 SC-74; TSOP6 (SOT457)	
2	IOUT	output current		
3	IOUT	output current		
4	GND	ground		
5	IOUT	output current		
6	REXT	external resistor		

3. Ordering information

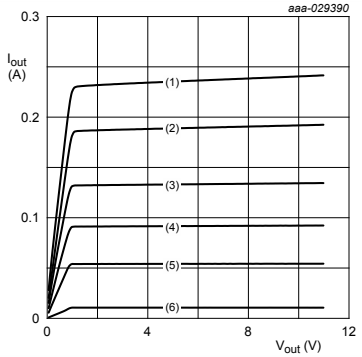
Table 4. Ordering information

Type number	Package		
	Name	Description	Version
NCR320U	SC-74; TSOP6	plastic surface-mounted package; 6 leads	SOT457
NCR321U	SC-74; TSOP6	plastic surface-mounted package; 6 leads	SOT457

4. Marking

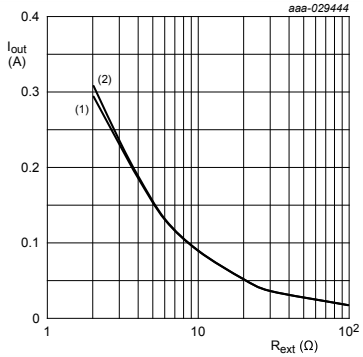
Table 5. Marking codes

Type number	Marking code
NCR320U	L4
NCR321U	L5



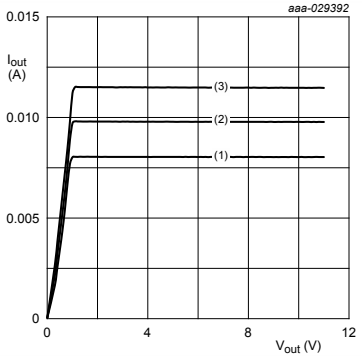
V_{EN} = 12 V; T_{amb} = 25 °C
(1) R_{ext} = 3 Ω
(2) R_{ext} = 4 Ω
(3) R_{ext} = 6 Ω
(4) R_{ext} = 10 Ω
(5) R_{ext} = 20 Ω
(6) R_{ext} = open

Fig. 4. NCR320U: Output current as a function of output voltage; typical values



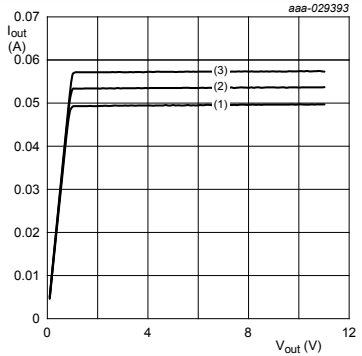
V_{EN} = 12 V; T_{amb} = 25 °C
(1) V_{out} = 1.4 V
(2) V_{out} = 5.4 V

Fig. 5. NCR320U: Output current as a function of external resistor; typical values



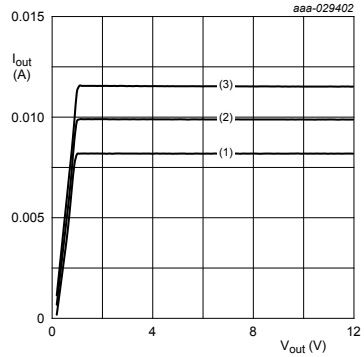
V_{EN} = 12 V; R_{ext} = open
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 6. NCR320U: Output current as a function of output voltage; typical values



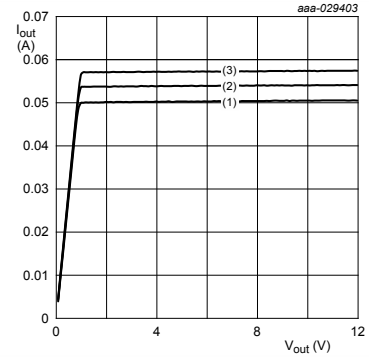
V_{EN} = 12 V; R_{ext} = 20 Ω
(1) T_{amb} = 85 °C
(2) T_{amb} = 25 °C
(3) T_{amb} = -40 °C

Fig. 7. NCR320U: Output current as a function of output voltage; typical values



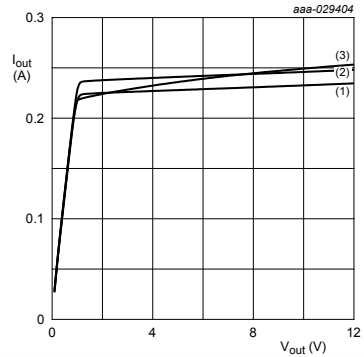
V_{EN} = 3.3 V; R_{ext} = open
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 16. NCR321U: Output current as a function of output voltage; typical values



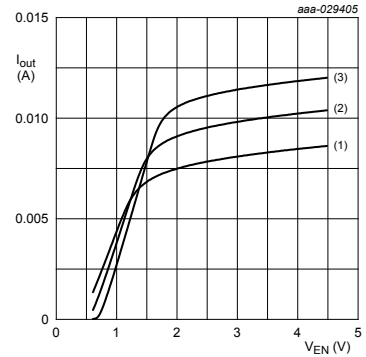
V_{EN} = 3.3 V; R_{ext} = 20 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 17. NCR321U: Output current as a function of output voltage; typical values



V_{EN} = 3.3 V; R_{ext} = 3 Ω
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 18. NCR321U: Output current as a function of output voltage; typical values



V_{out} = 2 V; R_{ext} = open
(1) R_{ext} = 85 °C
(2) R_{ext} = 25 °C
(3) R_{ext} = -40 °C

Fig. 19. NCR321U: Output current as a function of enable voltage; typical values