CONSONANCE

Switch-Mode High-Brightness LED Driver IC

CN5821

General Description：

The CN5821 is a switch-mode step-down constant-current high-brightness LED (HB LED) driver IC, the device provides a cost-effective solution for automotive interior/exterior lighting, architectural and ambient lighting, LED bulbs such as MR16 and other LED illumination applications.
The CN5821 operates from a 3.2V to 30V input voltage and features a 5V/15mA on-board regulator. A high-side current-sense resistor sets the LED current with 10% accuracy and a dedicated input (DIM pin) enables PWM dimming and analog dimming. Furthermore if the voltage at DIM pin is less than 0.15V for more than 8ms, CN5821 will enter shutdown mode, and consumes 0uA(Typical) current from input supply.
A hysteretic control algorithm ensures excellent input-supply rejection and fast response during load transients and PWM dimming. The CN5821 features a 15% inductor current ripple. The device operates up to 1MHz switching frequency, thus allowing for small component size.
The CN5821 is available in 6-pin SOT23 package.

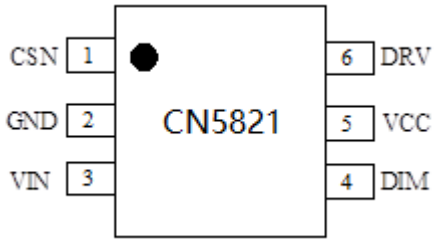
Applications：

- Architectural, Industrial, and Ambient Lighting
- Automotive RCL, DRL, and Fog Lights
- MR16 and Other LED Bulbs
- Indicators and Emergency Lighting

Features：

- Operating Voltage Range: 3.2V to 30V
- High Side Current Sense
- PWM Dimming and Analog Dimming
- PWM Dimming Frequency: 200Hz to 20kHz
- Automatic Shutdown
- Hysteretic Control: No Compensation
- Switching Frequency: Up to 1MHz
- Constant Current with ±10% accuracy
- Up to 35W Output Power
- On-chip 5V，15mA Voltage Regulator (LDO)
- Over Junction-Temperature Protection
- Operating Temperature Range:－40℃ to 85℃
- Available In 6 pin SOT23 Package
- Lead Free, rohs-Compliant and Halogen Free

Pin Assignment：



Typical Application Circuit：

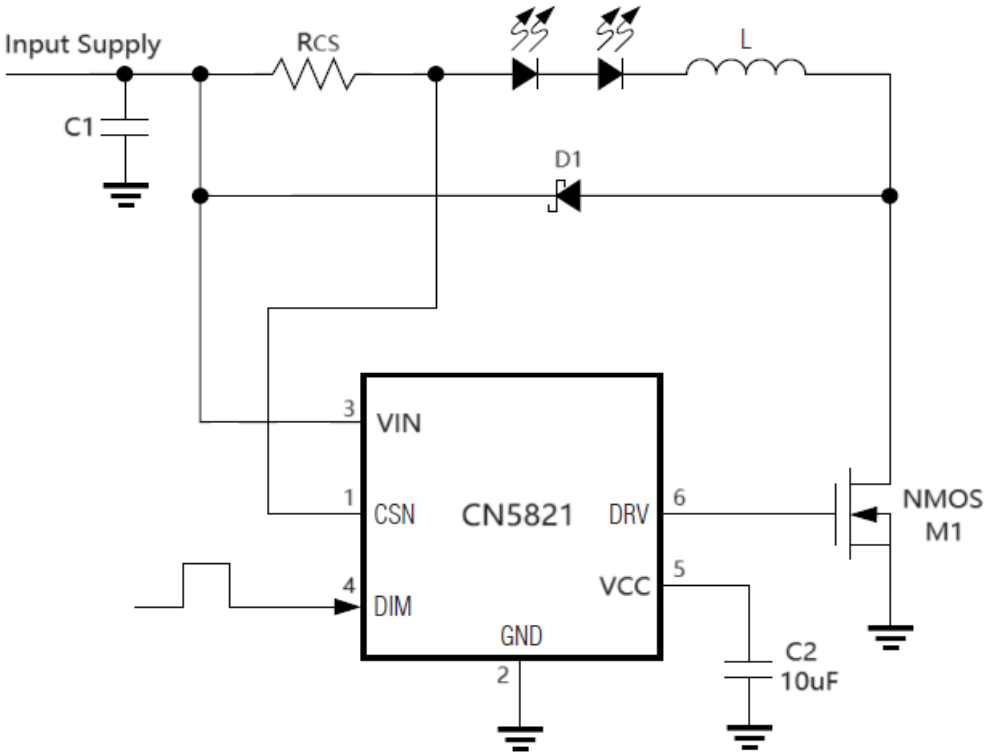


Figure 1　Typical Application Circuit

Ordering Information：

Part No.	Package	Top Marking	Shipping	Operating Temp
CN5821	SOT23-6	5821	Tape&Reel,3000pcs/Reel	－40℃ to 85℃

Block Diagram：

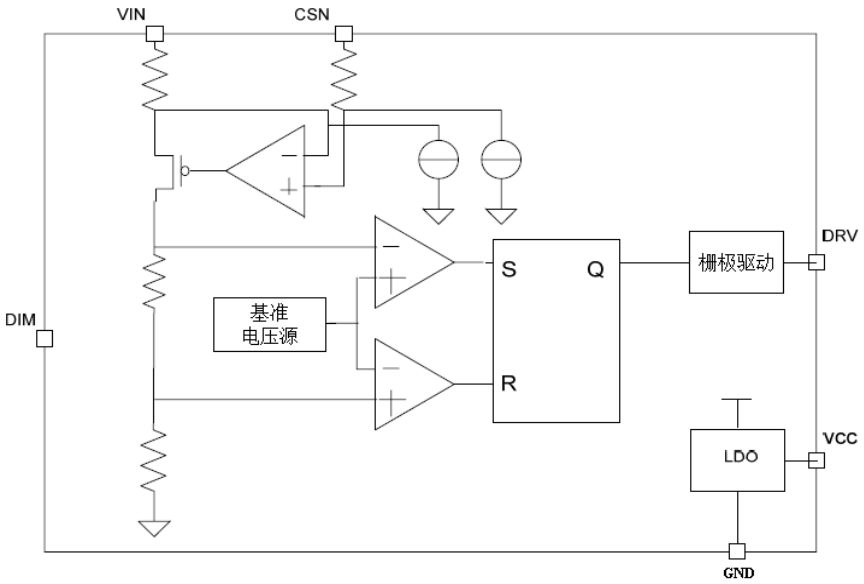


Figure 2 Block Diagram

Pin Description：：

No.	Name	Description
1	CSN	**Current Sense Negative Input.** A current sense resistor R_{CS} between VIN and CSN pin is needed to set/sense LED current. In normal operation, (VIN－CSN) is regulated at 105mV.
2	GND	**Ground(GND).** The negative terminal of input power supply.
3	VIN	**The Positive Terminal of Input Supply.** In addition to powering the internal circuits, VIN pin also serves as the positive terminal of current sense.
4	DIM	**LED Dimming Input.** Dimming signal is applied to DIM pin, dimming method can be either PWM dimming or analog dimming. There are 5 operating modes depending on DIM voltage: ● CN5821 shutdown mode (V_{DIM}<0.15V) ● CN5821 shutdown mode or LED off mode (0.15V<V_{DIM}<0.72V) ● Analog dimming mode (0.75V<V_{DIM}<1.8V) ● PWM dimming mode ● Normal operation mode (VDIM>2V) If LED dimming function is not needed, connect DIM pin to CN5821's VCC pin, or to an MCU's port, or to a voltage between 2V to 6V.
5	VCC	**5V Voltage Regulator (LDO) Output.** Connect a 10uF capacitor from VCC to GND, the maximum output current is 15mA. The 5V voltage can be used to power the external circuitry.
6	DRV	**Gate Drive Output for External MOSFET.** Connect to the gate of an external N-channel MOSFET. In certain cases such as very small PCB design, enough considerations can not be given to PCB design, a resistor between DRV pin and gate of external N-channel MOSFET can be added to reduce noise and EMI. The resistance of the resistor should be chosen so that the pulse rise time and fall time at DRV pin is between 60ns and 80ns.

ABSOLUTE MAXIMUM RATINGS

VIN ,CSN to GND……－0.3V to 36V
VCC to GND……－0.3V to 6.5V
CSN to VIN……..……－0.3V to 0.3V
DIM，DRV……..….. －0.3V to VCC

Maximum Junction Temperature. ……...150℃
Operating Temperature Range…....－40℃ to 85℃
Storage Temperature Range..... ..－65℃ to 150℃
Lead Temperature(Soldering,10S)……...260℃

Stresses beyond 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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERICS

(VIN = 12V, TA＝－40°C to +85°C, Typical values are at TA＝+25°C, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	VIN		3.2		30	V
Switching Frequency	f_{SW}				1	MHz
Operating Current	I_{VIN}	V_{DIM}>2V，VIN−V_{CSN}=0V	250	350	450	uA
Shutdown Current	I_{SHTD}	Shutdown mode		0	1	uA
Current Sense Comparator						
Current Sense Threshold High	V_{CSHI}	(VIN－V_{CSN}) rises from 0V Till V_{DRV} ＜0.5V	108	120	132	mV
Current Sense Threshold Low	V_{CSLO}	(VIN－V_{CSN}) falls from 0.18V, till V_{DRV}＞(VCC－0.5V)	80	90	100	mV
Propagation Delay High	t_{DPDH}	(VIN－V_{CSN}): 0.22V to 0V		82		nS
Propagation Delay Low	t_{DPDL}	(VIN－V_{CSN}): 0V to 0.22V		82		nS
CSN Pin Current	I_{CSN}				1	uA
VCC Pin						
Output Voltage	VCC	I_{VCC}＝0.1mA to 15mA， VIN＝5.5V to 30V	4.5		5.5	V
Load Regulation		I_{VCC}＝0.1mA to 10mA，		5		Ohm
Line Regulation		VIN＝6V to 30V，I_{VCC}＝3mA		6		mV
Power Supply Rejection Ratio	PSRR	I_{VCC}＝3mA，f_{IN}＝10kHz		－35		dB
Start Time	t_{START}	VCC＝0 to 4.5V		1		mS
DIM Pin						
Shutdown Threshold	V_{SHTD}	For over 8mS			0.15	V
Voltage Limit for Analog Dimming	$V_{analogL}$	Lower limit	0.68		0.8	V
	$V_{analogH}$	Upper limit	1.65	1.75	1.85	
PWM Input High Threshold	V_{PWMH}	V_{CSN}＝VIN, DIM voltage rises till V_{DRV} ＞(VCC－0.5V)	2			V
PWM Input Low Threshold	V_{PWML}	V_{CSN}＝VIN, DIM voltage falls till V_{DRV} ＜0.5V			0.6	V
PWM Frequency	F_{PWM}		0.2		20	kHz
PWM Turn-on Time	T_{PWMH}	Rising edge to V_{DRV}＝0.5VCC, V_{CSN}＝VIN , C_{DRV} = 1nF	100			nS
PWM Turn-off Time	T_{PWML}	Falling edge to V_{DRV}＝0.5VCC, V_{CSN}＝VIN , C_{DRV} = 1nF	100			nS
Normal-operation Threshold	V_{EN}	DIM voltage rises	2			V
DIM Leakage Current		V_{DIM} = 5V			1	uA
		V_{DIM} = 0V	-1			
Over Junction-Temperature Protection (OTP)						
OTP Threshold	T_{OTP}	Junction temperature rises		145		℃
OTP Release Threshold	T_{RLS}	Junction temperature falls		128		℃

（Continued from last page）

Parameter	Symbol	Test Conditions	min	Typ	Max	Unit
DRV Pin						
DRV Source Current		V_{CSN}＝VIN, V_{DRV}＝0.5×VCC		0.5		A
DRV Sink Current		V_{CSN}＝VIN－0.18V， V_{DRV}＝0.5×VCC		1		A
DRV Output High	V_{OH}	I_{DRV}＝5mA	VCC－0.5			V
DRV Output Low	V_{OL}	I_{DRV}＝－10mA	0.5			V
Shutdown Mode						
Shutdown Threshold	V_{SHTD}	DIM voltage falls			0.15	V
Duration Time	t_d	Duration time of DIM being low	5.8	8	10	ms
Shutdown Current	I_{SHTD}	Current into VIN pin		0	1	uA

Detailed Description：

The CN5821 is a step-down, constant current, high-brightness LED (HB LED) driver IC. The device operates from a 3.2V to 30V input voltage range and provide up to 0.5A of source and 1A of sink drive capability to the gate of an external N-channel MOSFET. A high side current-sense resistor sets the LED current and a dedicated dimming input (DIM) allows for PWM dimming and analog dimming.

When the voltage at DIM pin is less than 0.15V for a period of over 8ms(Typical), CN5821 enters shutdown mode, in which CN5821 consumes 0uA current.

The high-side current-sensing scheme and on-board current-setting circuitry minimize the number of external components while delivering LED current with a ±10% accuracy and 15% current ripple.

The on-chip 5V voltage regulator can source maximum 15mA, and can be used to power external circuitry.

A hysteretic control algorithm ensures excellent input-supply rejection and fast response during load transients and PWM dimming.

CN5821 operate up to 1MHz switching frequency, thus allowing for small component size.

Application Information：

About Input Voltage Range

CN5821 operates from a 3.2V to 30V input voltage. When the input voltage is between 3.2V to 5.35V, the voltage at VCC pin is less than 5V, though LED current is still correctly regulated.

+5V Voltage Regulator (VCC Pin)

VCC is the output of an on-chip 5V voltage regulator (LDO) capable of sourcing 15mA, which can be used to power external circuitry. Always bypass VCC to GND with a 10μF ceramic capacitor.

The 5V voltage regulator will be shut down in shut down mode or over temperature protection mode.

Setting LED Current

The CN5821 sets the LED current by a current sense resistor R_{CS} connected between VIN and CSN pin. LED current is decided by the following equation:

$$I_{LED} = \frac{0.105}{R_{CS}}$$

Where, I_{LED} is the average LED current in Ampere

R_{CS} is the current sense resistor in ohm

For example, if the LED current needs to be 1A, then:

R_{CS}= 0.105V/1A = 0.105Ω

LED Dimming

DIM pin is dedicated for LED dimming input, enables both PWM dimming and analog dimming. Depending on the voltage at DIM pin, CN5821 operates in one of the following 5 modes:

- CN5821 Shutdown Mode (V_{DIM}<0.15V)
  If the voltage at DIM pin is less than 0.15V for more than 8ms (Typical), CN5821 enters shutdown mode, and consumes 0uA (Typical) current from input supply (VIN), DRV pin outputs low, no current flows through LED.
- CN5821 shutdown mode or LED off mode (0.15V<V_{DIM}<0.72V)
  If the voltage at DIM pin is between 0.15V and 0.72V, DRV outputs low, no current flows through LED.
- Analog Dimming (0.75V<V_{DIM}<1.8V)
  When the voltage at DIM pin is between 0.75V and 1.8V, CN5821 is in analog dimming mode, LED current increases with DIM voltage's increase, and vice versa. In analog dimming mode, average LED current is determined by the following equation:

$$I_{LED} = \frac{0.105}{R_{CS}} \bullet \frac{V_{DIM} - 0.75}{1.05}$$

- PWM Dimming
  When PWM dimming is adopted, PWM signal is applied to DIM pin. PWM signal's low input should be less than 0.6V, and high input should be more than 2V. The frequency of PWM signal should be between 200Hz and 20KHz.
- Normal Operation Mode (V_{DIM}>2V)
  When the voltage at DIM pin is over 2V, CN5821 operates in normal mode. Average LED current is decided by the following equation:

$$I_{LED} = \frac{0.105}{R_{CS}}$$

If LED dimming function is not needed, connect DIM pin to CN5821's VCC pin, or to MCU's port, or to a voltage between 2V to 6V.

LED Current Regulation

The CN5821 regulates the LED current by using an input comparator with hysteresis , the operating theory is shown in Figure 3.

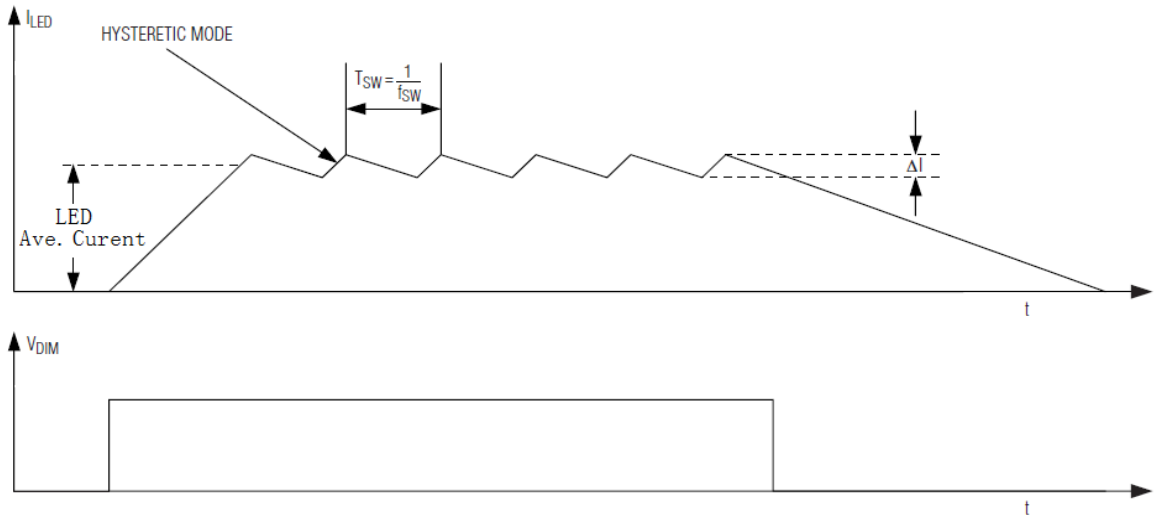


Figure 3 Current Regulation

As the current through the inductor ramps up and the voltage across the current sense resistor reaches the upper threshold (120mV typical), the voltage at DRV pin goes low, turning off the external MOSFET. The MOSFET turns on again when the inductor current ramps down through the freewheeling diode until the voltage across the current sense resistor equals the lower threshold (90mV typical). Use the following equation to determine the operating frequency:

$$f_{SW} = \frac{(VIN - n \times VLED) \times n \times VLED \times R_{CS}}{VIN \times \Delta V \times L}$$

Where:

f_{SW} is the switching frequency

L is the inductor value

N is the number of LEDs

VLED is the forward voltage drop across the LEDs

△V＝0.038V(Taking the propagation delay of internal circuit into consideration)

VIN is the input voltage

R_{CS} is the current sense resistor

Automatic Shutdown Mode

If the voltage at DIM pin is less than 0.15V(Max.) for over 8ms(Typical), CN5821 enters shutdown mode. In shutdown mode, all the internal circuits are disabled, CN5821 consumes 0uA current (Typical) from input supply (VIN), and DRV pin outputs low.

About Compact PCB Design

In certain cases, compact PCB design of CN5821 application circuit is necessary. In which enough considerations may not be able to be given to PCB design, which may lead to significant circuit noise and EMI, or even abnormal operation of CN5821. In these cases, a resistor between DRV pin and gate of external N-channel MOSFET may be needed to reduce noise and EMI, as shown in figure 4. The resistance of the resistor should be chosen so that rising time and falling time of DRV's pulse is between 60ns and 80ns.

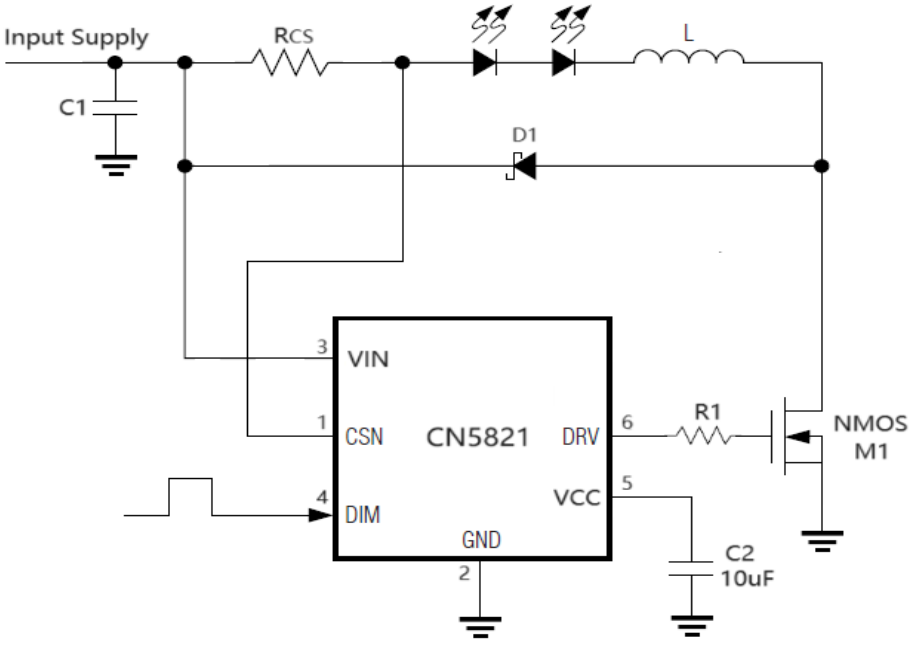


Figure 4　Reduce Noise and EMI by using R1

MOSFET Selection

The CN5821's gate driver is capable of sourcing 0.5A and sinking 1A of current. MOSFET selection is based on the maximum input operating voltage VIN, LED current and operating switching frequency. Choose an N-channel MOSFET that has a higher breakdown voltage than the maximum operation voltage, low Rds(ON), and low total gate charge(Qg) for better efficiency. MOSFET threshold voltage must be adequate if operated at the low end (3.2V) of the input-voltage operating range.

Freewheeling Diode Selection

The forward voltage of the freewheeling diode should be as low as possible for better efficiency. A Schottky diode is a good choice as long as the breakdown voltage is high enough to withstand the maximum operating voltage. The forward current rating of the diode must be at least equal to the maximum LED current.

Input Bypass Capacitor

In most applications, a decoupling capacitor at VIN is needed. An at least 10uF ceramic capacitor, placed in close proximity to VIN to GND pins, works well. In some applications depending on the power supply Characteristics, cable length and LED current, it may be necessary to increase the capacitor's value. The capacitor's breakdown voltage should be higher than the maximum input voltage.

LED Current Ripple

LED current ripple is around 15% of average LED current. In cases a lower LED current ripple is needed, a capacitor can be placed across the LED terminals.

Over Junction-Temperature Protection

CN5821's junction temperature is monitored by an internal circuit block, once the junction temperature rises above 145℃, the on-chip 5V voltage regulator is shut down, DRV pin outputs low, hence external N-channel MOSFET is turned off, no current flows through LED.

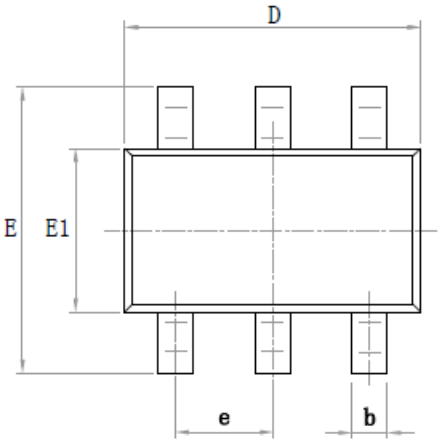
In over temperature protection mode, CN5821 will not return to normal operation until junction temperature falls below 128℃.

PCB Considerations

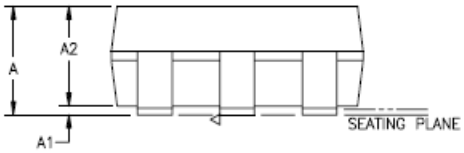
Careful PCB layout is critical to achieve low switching losses and stable operation.

- Use a multilayer board whenever possible for better noise immunity.
- Minimize ground noise by connecting high-current ground returns, the input bypass-capacitor ground lead, and the source of external N-channel MOSFET to a single point (star-ground configuration). In normal operation, there are two power loops. One is formed when the MOSFET is on and the high current flows through VIN—R_{CS}—LEDs—Inductor—MOSFET—GND. The other loop is formed when the MOSFET is off when the high current circulates through R_{CS}—LEDs—Inductor—freewheeling
- diode. To minimize noise interaction, each loop area should be as small as possible.
- Place current sense resistor R_{CS} as close as possible to the input filter and VIN. For better noise immunity, a Kelvin connection is strongly recommended between CSN and R_{CS}.

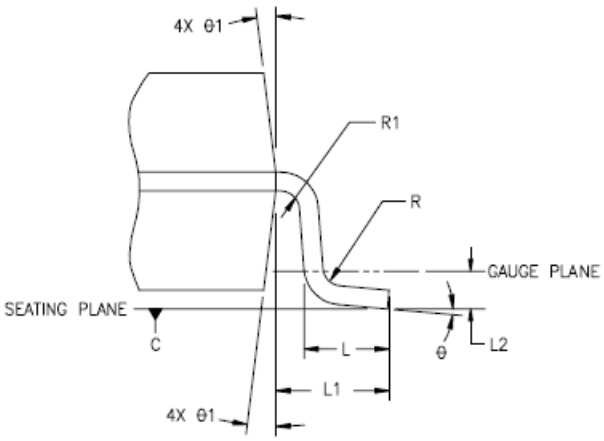
Package Information（SOT23-6）



TOP VIEW



SIDE VIEW



SYMBOL	MIN	NOM	MAX
A	--	--	1.35
A1	0	--	0.15
A2	1.0	1.1	1.2
b	0.35	--	0.45
D	2.82	2.92	3.02
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.9	0.95	1.0
L	0.35	0.45	0.6
L1	0.6REF		
L2	0.25REF		
R	0.1	--	--
R1	0.1	--	0.25
θ	0°	4°	8°
θ1	5°	10°	15°

NOTES:
1.All DIMENSIONS REFER TO JEDEC STANDARD MO-178
2.DIMENSION D DOES NOT INCLUDE MOLD FLASH
3.DIMENSION E1 DOSE NOT INCLUDE MOLD FLASH
4.FLASH OR PROTRUSION SHALL NOT EXCEED 0.25mm PER SIDE.

Important Notice

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