CONSONANCE

Switch-Mode High-Brightness LED Driver IC

CN5820

General Description：

The CN5820 is a switch-mode step-down constant-current high-brightness LED (HB LED) driver, 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.

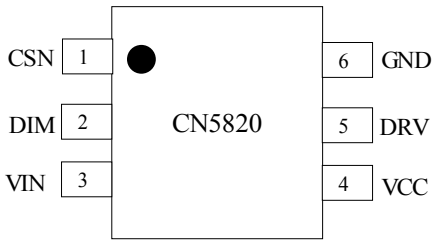
The CN5820 operates from a 4V to 28V input voltage range and features a 5V/5mA on-board regulator. A high-side current-sense resistor adjusts the LED current and a dedicated input (DIM) enables PWM dimming and analog dimming.

The CN5820 is well suited for applications requiring a wide input voltage range. The high-side current-sensing and an integrated current-setting circuitry minimize the number of external components while delivering an LED current with ±5% accuracy. A hysteretic control algorithm ensures excellent input-supply rejection and fast response during load transients and PWM dimming. The CN5820 features a 20% inductor current ripple. These devices operate up to 1MHz switching frequency, thus allowing for small component size. The CN5820 operates over the -40°C to +85°C temperature range and is available in 6-pin SOT23 package.

Features：

- High-Side Current Sense
- Dedicated Dimming Control Input
- 20kHz Maximum Dimming Frequency
- Hysteretic Control: No Compensation
- Up to 1MHz Switching Frequency
- ±5% LED Current Accuracy
- Adjustable Constant LED Current
- 4V to 28V Input Voltage Range
- Over 25W Output Power
- 5V, 5mA On-Board Regulator
- Operating Temperature Range ：－40°C to 85°C
- Lead Free, rohs-Compliant and Halogen Free

Pin Assignment：



Applications：

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

Typical Application Circuit：

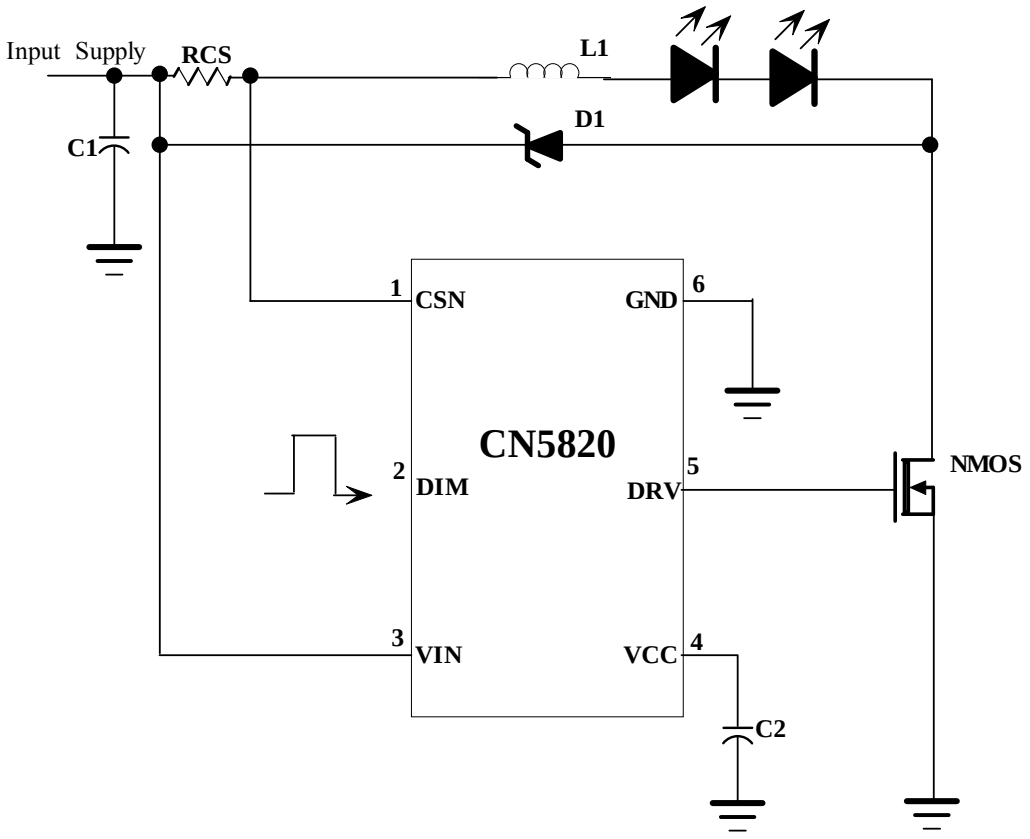


Figure 1　Typical Application Circuit

Ordering Information：

Part No.	Package	Shipping	Operating Temperature Range
CN5820	SOT23-6	Tape and Reel, 3000/Reel	－40℃ to 85℃

Block Diagram：

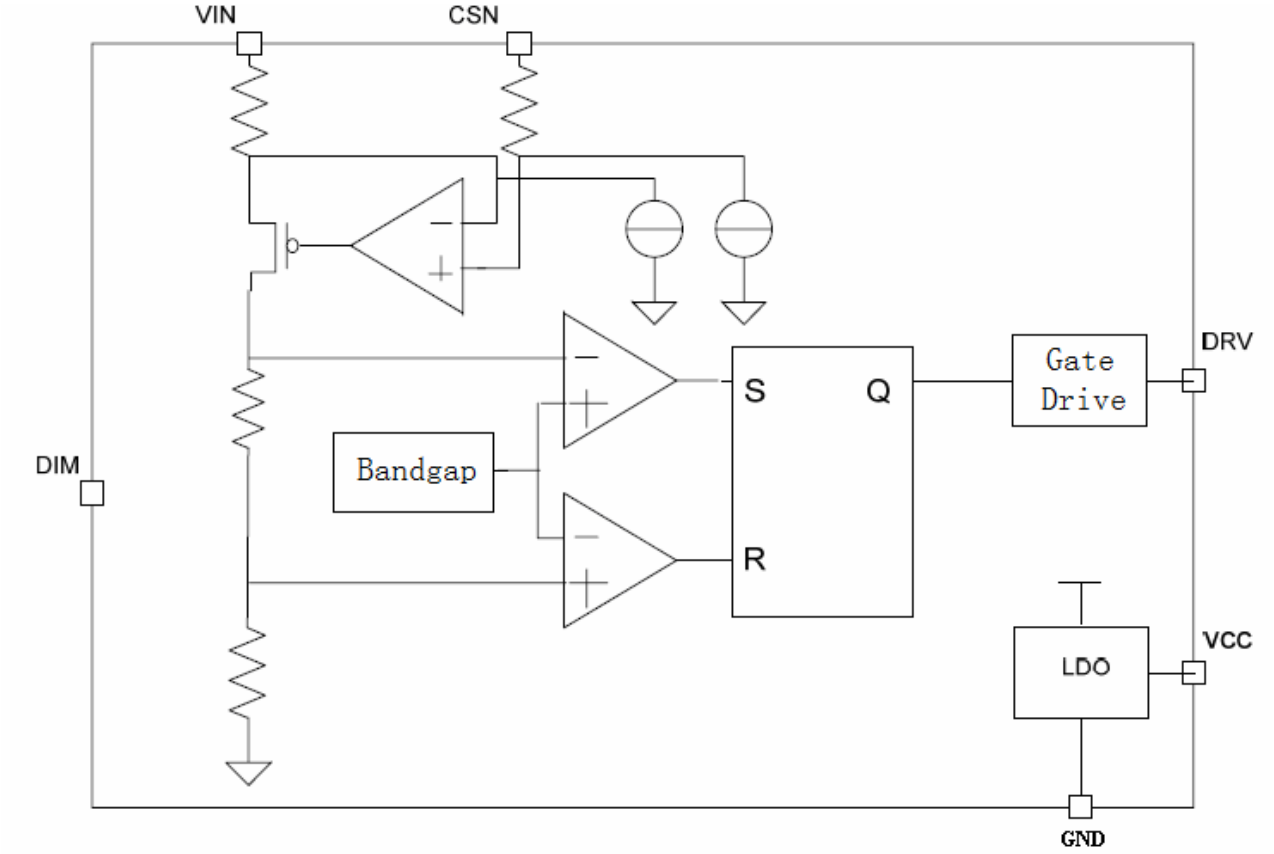


Figure 2　Block Diagram

Pin Description：

No.	Name	Description
1	CSN	**Current Sense Negative Input.** A current sense resistor R_{CS} between VIN and CSN is needed to sense the LED current.
2	DIM	**Dimming Input.** When the voltage at DIM pin is below 0.4V, DRV is driven to low, and LED is turned off. When DIM voltage is higher than 1.2V, CN5820 regulates the LED current normally, the LED average current is ($0.16V / R_{CS}$); When DIM voltage is between 0.4V and 1.2V, the LED current is controlled by DIM voltage, LED average current is ($0.133 \times V_{DIM} / R_{CS}$).
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	VCC	**5V Regulator Output.** Connect a 4.7uF or 10uF capacitor from VCC to GND, the maximum output current is 5mA.
5	DRV	**Gate Drive Output for External MOSFET.** Connect to the gate of an external N-channel MOSFET.
6	GND	**Ground(GND).**

ABSOLUTE MAXIMUM RATINGS

VIN ,CSN to GND……－0.3V to 32V
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)

Parameters	Symbol	Test Conditions	Min	Typ	max	Unit
Input Voltage Range	VIN		4		28	V
Switching Frequency	f_{SW}				1	MHz
Operating Current	I_{VIN}	V_{DIM}＜0.4V	370	475	580	uA
Current Sense Comparator						
Sense Threshold High	V_{CSHI}	(VIN－V_{CSN}) rising from 0V until V_{DRV} ＜0.5V		176		mV
Sense Threshold Low	V_{CSLO}	(VIN－V_{CSN}) falling from 0.23V until V_{DRV}＞ (VCC－0.5V)		144		mV
Propagation Delay to Output High	t_{DPDH}	(VIN－V_{CSN}) falling from 0.23V to 0V, C_{DRV}=1nF		82		nS
Propagation Delay to Output Low	t_{DPDL}	(VIN－V_{CSN}) rising from 0V to 0.23V, C_{DRV}=1nF		82		nS
CSN Input Current	I_{CSN}				1	uA
Sense Threshold Hysteresis	CS_{HYS}			32		mV
DRV Pin						
Source Current		V_{CSN}＝VIN, V_{DRV}＝0.5×VCC		0.5		A
Sink Current		V_{CSN}＝VIN－0.23V, V_{DRV}＝0.5×VCC		1		A
Output Voltage High	V_{OH}	I_{DRV}＝5mA	VCC－0.5			V
Output Voltage Low	V_{OL}	I_{DRV}＝－10mA			0.5	V
VCC Pin						
Output Voltage	VCC	I_{VCC}＝0.1mA to 5mA, VIN＝5.5V to 30V	4.7		5.3	V
Load Regulation		I_{VCC}＝0.1mA to 5mA，		5		Ohm
Line Regulation		VIN＝6V to 28V, I_{VCC}＝3mA		6		mV
PSRR	PSRR	I_{VCC}＝3mA，f_{IN}＝10kHz		-35		dB
Startup Time	t_{START}	VCC＝0 to 4.5V		350		uS

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Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
DIM Pin						
Maximum DIM Frequency	f_{DIM}				20	kHz
Input Voltage High	V_{IH}	Increase DIM voltage until V_{DRV}>(VCC－0.5V);V_{CSN}=VIN,	1.2			V
Input Voltage Low	V_{IL}	Decrease DIM voltage until V_{DRV}<0.5V; V_{CSN}=VIN			0.4	V
Turn-on Time	t_{DIMON}	V_{CSN}=VIN; C_{DRV} = 1nF; DIM rising edge to V_{DRV}=0.5VCC		100		nS
Turn-off Time	t_{DIMOFF}	V_{CSN}＝VIN; C_{DRV} = 1nF; DIM falling edge to V_{DRV}＝0.5VCC		100		nS
Leakage Current		V_{DIM} = 5V			1	uA
		V_{DIM} = 0V	-1			

Detailed Description：

The CN5820 is step-down, constant current, high-brightness LED (HB LED) drivers. The device operates from a 4V to 28V 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.

The high-side current-sensing scheme and on-board current-setting circuitry minimize the number of external components while delivering LED current with a ±5% accuracy.

Application Information

About Input Voltage Range

CN5820 operates from a 4V to 28V input voltage. When the input voltage is between 4V to 5.5V, the voltage at VCC pin may be less than 5V, though LED current is still correctly regulated.

5V Voltage Regulator

VCC is the output of a 5V regulator capable of sourcing 5mA. Bypass VCC to GND with a 4.7μF or 10μFcapacitor.

Setting LED Current

The CN5820 sets the LED current by a current sense resistor R_{CS} between VIN and CSN. LED current is decided by the following equation:

$$I_{LED} = 0.16V / R_{CS}$$

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:

$$R_{CS}= 0.16V/1A = 0.16\,\Omega$$

The average power of current sense resistor is $0.16 \times I_{LED}$.

Dimming

The CN5820 allows PWM dimming or analog dimming at DIM pin.

- When DIM voltage is below 0.4V, DRV is driven to low, and LED is turned off.
- When DIM voltage is above 1.2V, LED current is regulated normally, the average LED current is:

$$I_{LED}=0.16V / R_{CS}$$

- When the voltage at DIM pin is between 0.4V and 1.2V, DIM pin serves as the analog dimming input. The voltage at DIM pin sets the LED current, the average LED current is ($0.133 \times V_{DIM} / R_{CS}$).

If dimming function is not needed, just connect DIM to VCC.

If PWM dimming is adopted, just apply the PWM signal at DIM pin. The high level of PWM signal should be higher than 1.2V.

If analog dimming is needed, just apply a DC voltage between 0.4V and 1.2V to DIM pin. A potentiometer can also be used for analog dimming as shown in Figure 3. In Figure 3, R3 is used to set DIM's lowest voltage, and the total resistance of R1,R2 and R3 should be greater than 10Kohm.

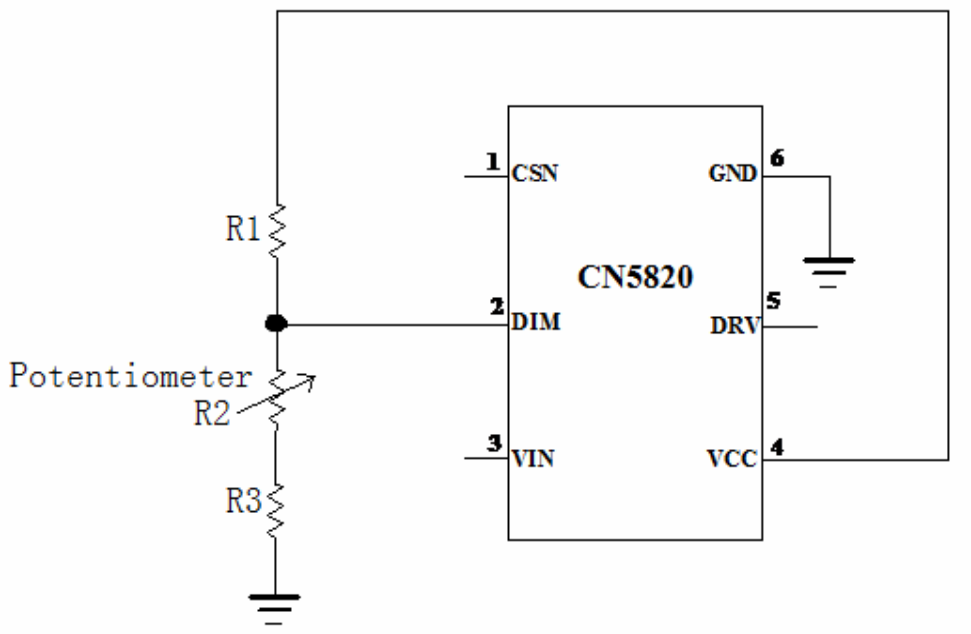


Figure 3 Analog Dimming by Using a Potentiometer

LED Current Regulation

The CN5820 regulates the LED current by using an input comparator with hysteresis (Figure 4).

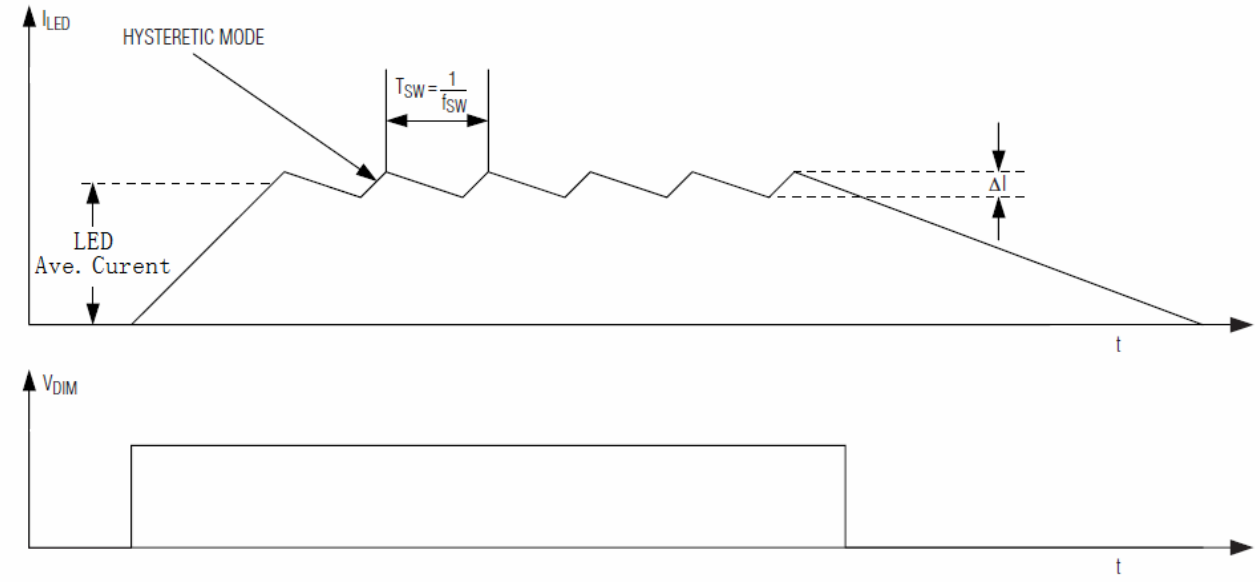


Figure 4 Current Regulation

As the current through the inductor ramps up and the voltage across the sense resistor reaches the upper threshold, the voltage at DRV 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 sense resistor equals the lower threshold. Use the following equation to determine the operating frequency:

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

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＝（V_{CSHI}-V_{CSLO}）

VIN is the input voltage

R_{CS} is the current sense resistor

MOSFET Selection

The CN5820'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 a 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 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

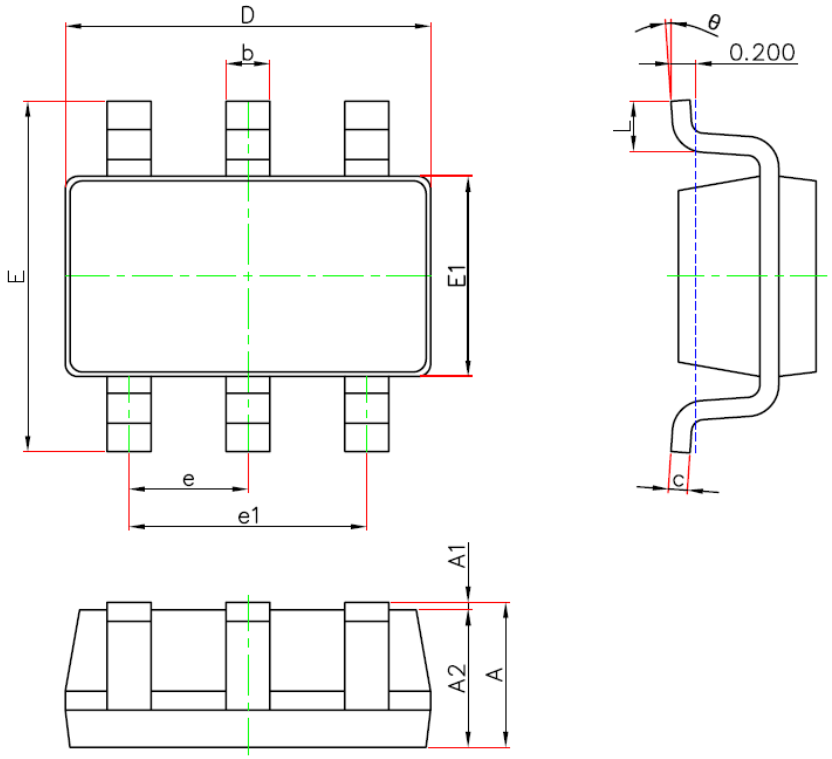
In most applications, a decoupling capacitor at VIN is needed. An at least 1uF ceramic capacitor, placed in close proximity to VIN to GND pins, works well. In some applications depending on the power supply characteristics and cable length, it may be necessary to increase the capacitor's value. The capacitor's breakdown voltage should be higher than the maximum input voltage.

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 output-filter ground lead 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 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

SOT-23-6L(12R) PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°