

## Low-Power Four Channel Voltage Monitoring Circuit

### CN1185

#### General Description

CN1185 is a low-power four-channel voltage monitoring chip, it consumes only 7.3 microamps current, very suitable for monitoring the battery voltage. The device contains four voltage comparators, each comparator's positive input received on-chip voltage reference. It can be used to monitor four different voltage source or a voltage source for monitoring different grades. Users can choose the logic input to select the comparator threshold and set the comparator hysteresis. The existence hysteresis of comparator is to eliminate the power due to interference or noise caused by the comparator output instability. Because the user can set the comparator threshold and hysteresis, making CN1185 is suitable for rough monitoring battery applications. In order to facilitate work on the same system with different voltage chip applications, CN1185 open-drain output. In order to ensure an instant system power-on work, CN1185 internal design of the 7.5 ms (minimum) start time, the comparator output high impedance state in the start time. The device is available in 16 pin TSSOP package

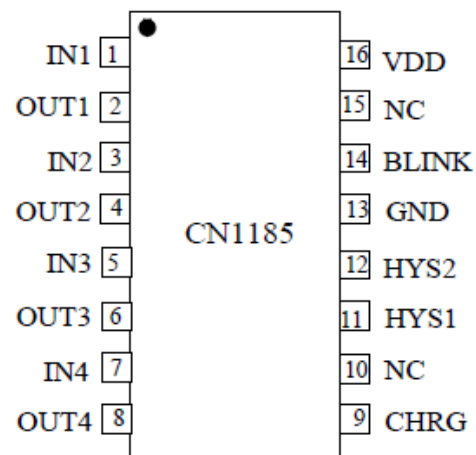
#### Applications

- Battery-powered Systems
- Mobile and cordless phones
- Portable devices and equipment
- Micro-controller system
- Monitoring and alarm applications

#### Features

- Operating supply voltage range: 2.7V-6V
- 7.3 $\mu$ A Supply Current @V<sub>CC</sub>=4V
- Guaranteed Output Valid to V<sub>CC</sub> = 1.2V
- Four-channel voltage comparator
- Open-drain output
- Start time: 15 ms (typical)
- Output can drive LED or connected with the microprocessor
- Precise Reset Threshold: 2.5%
- Comparator hysteresis can be set by two logical ports
- 60ms typical Delay to Filter out the noise
- Blink output control function
- Operating Temperature Range  
-40°C to +85°C
- Available in TSSOP16

#### Pin Assignment



## Typical Application Circuit

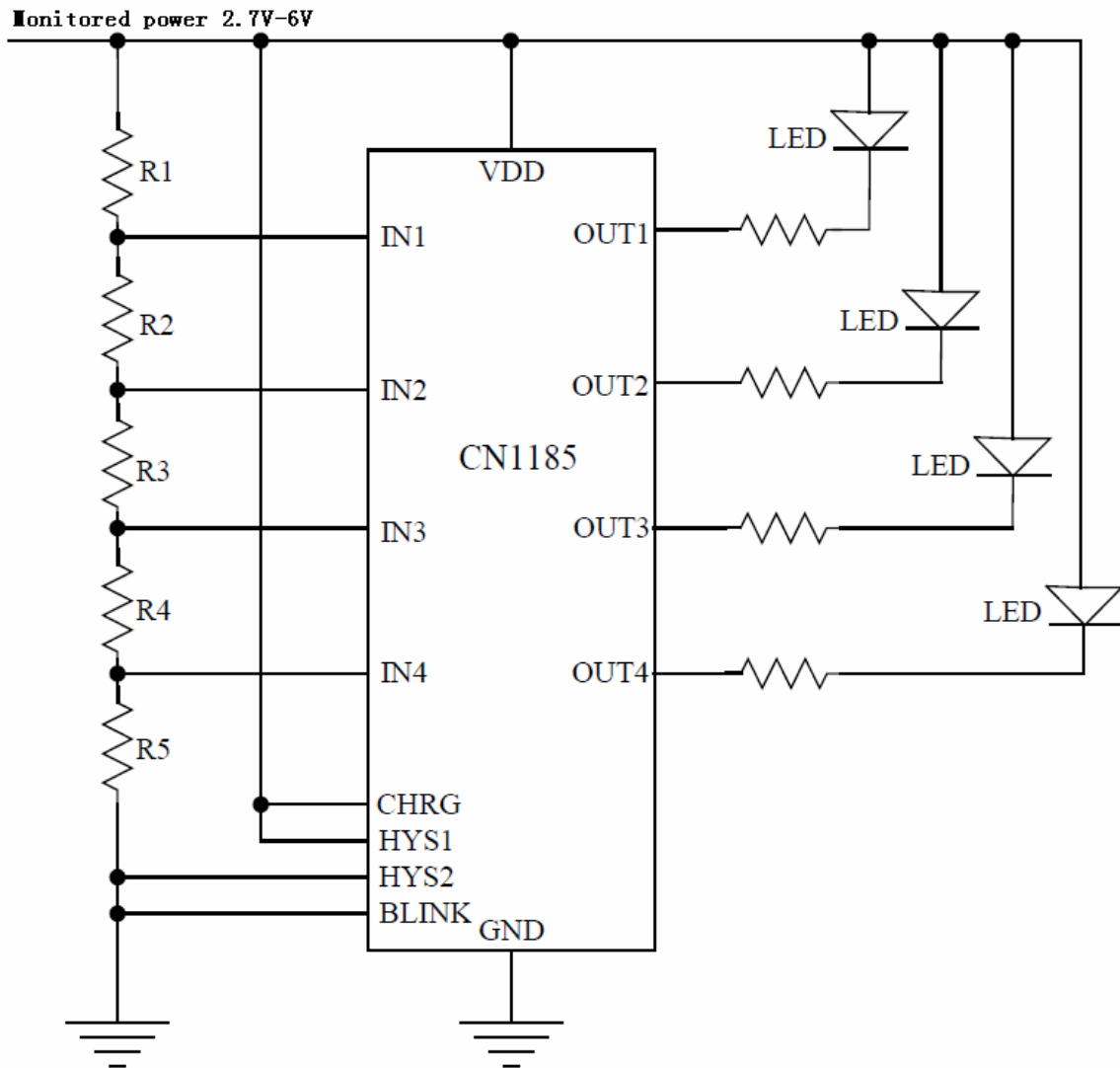


Figure 1 Typical Application Circuit

Note: CN1185 the comparator output can be pulled up to VDD through the resistor side directly

## Ordering Information:

Part No.	Operating Ambient Temperature	Package
CN1185	-40°C to +85°C	TSSOP16

# Block Diagram

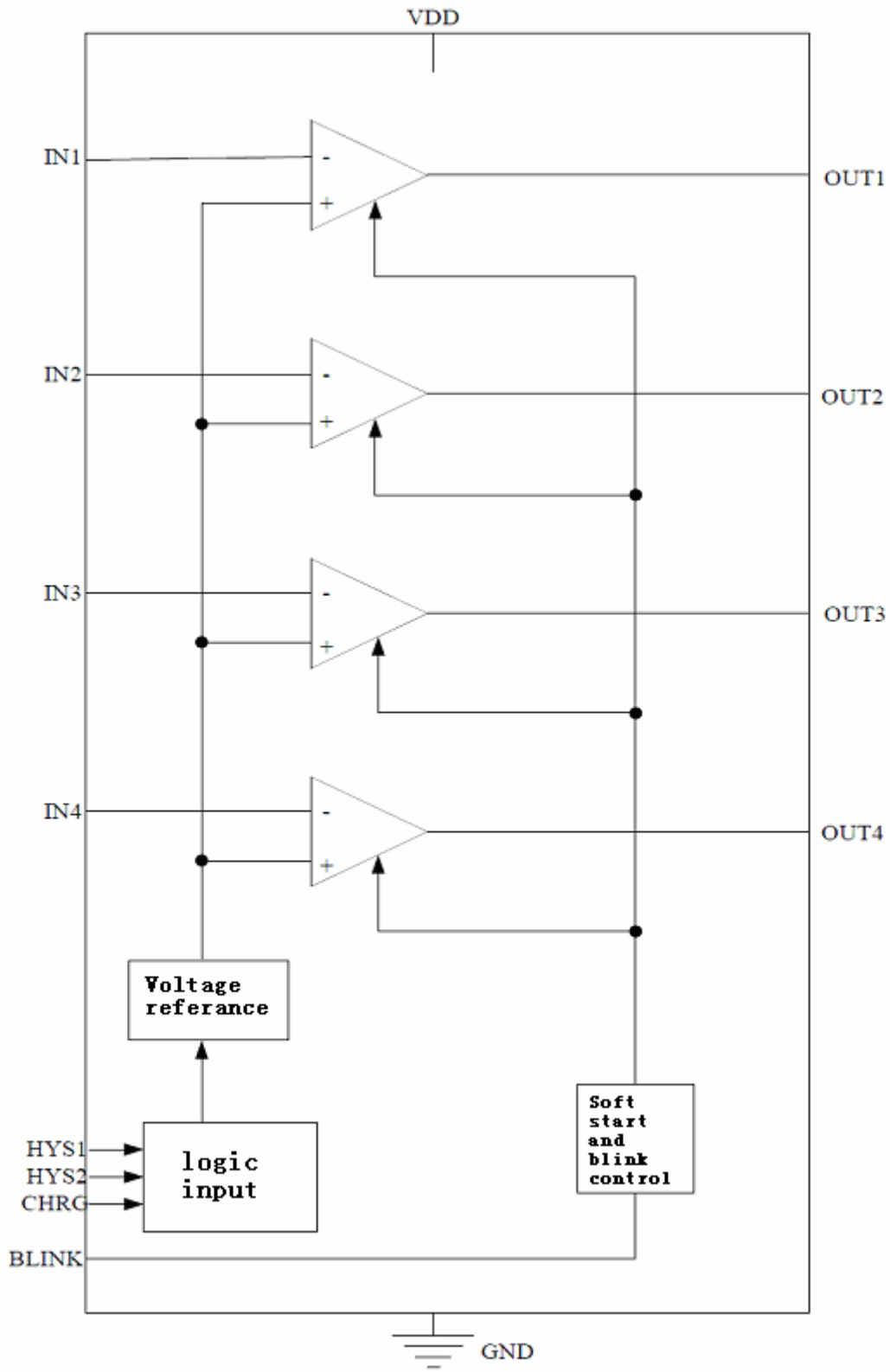


Figure 2 Block Diagram

## Pin Description

Pin No.	Symbol	Description
1	IN1	<b>The first negative input way of comparator.</b> It can be monitored directly connected or through an external resistor voltage divider network to set the flip threshold voltage.
2	OUT1	<b>The first way output of comparator.</b> Open-drain output. When IN1 rise, and exceed the comparator threshold, the device from OUT1 to GND NMOSFET on, OUT1 output low. When IN1 drops and less than the comparator threshold, the device from OUT1 to GND NMOSFET off, OUT1 output impedance.
3	IN2	<b>The second negative input way of comparator.</b> It can be monitored directly connected or through an external resistor voltage divider network to set the flip threshold voltage .
4	OUT2	<b>The second way output of comparator.</b> Open-drain output. When IN2 rise, and exceed the comparator threshold, the device from OUT2 to GND NMOSFET on, OUT2 output low. When IN2 drops and less than the comparator threshold, the device from OUT2 to GND NMOSFET off, OUT2 output impedance.
5	IN3	<b>The third negative input way of comparator.</b> It Can be monitored directly connected or through an external resistor voltage divider network to set the flip threshold voltage .
6	OUT3	<b>The third way output of comparator.</b> Open-drain output. When IN3 rise, and exceed the comparator threshold, the device from OUT3 to GND NMOSFET on, OUT3 output low. When IN3 drops and less than the comparator threshold, the device from OUT3 to GND NMOSFET off, OUT3 output impedance.
7	IN4	<b>The forth negative input way of comparator.</b> It Can be monitored directly connected or through an external resistor voltage divider network to set the flip threshold voltage .
8	OUT4	<b>The forth way output of comparator.</b> Open-drain output. When IN3 rise, and exceed the comparator threshold, the device from OUT4 to GND NMOSFET on, OUT4 output low. When IN4 drops and less than the comparator threshold, the device from OUT4 to GND NMOSFET off, OUT4 output impedance.
9	CHRG	<b>Input of the comparator flip threshold control.</b> When this pin is high, the comparator flip threshold is 1.22V typically (comparator input voltage drop); When this pin is low, the comparator flip threshold is 1.256V typically (comparator input voltage drop).
10	NC	<b>No Connection.</b>
11	HYS1	<b>Input of Comparator hysteresis (Hysteresis) to set.</b> Logic inputs, HYS1 and HYS2 set the comparator hysteresis .

12	HYS2	<b>Input of Comparator hysteresis (Hysteresis) to set.</b> Logic inputs, HYS1 and HYS2 set the comparator hysteresis .
13	GND	<b>Negative Terminal of Power Supply(Ground)</b>
14	BLINK	<b>Input of flash output control.</b> Logic input, when the comparator output is low, the comparator flip CHRГ threshold control input is low, and BLINK pin is high, the comparator output is about 500 ms conversion time at intervals , the duration of high and low the same.
15	NC	<b>No Connection.</b>
16	VDD	<b>Positive Terminal of Power Supply.</b> This pin is the power supply to internal circuit.

## ABSOLUTE MAXIMUM RATINGS

VDD Pin voltage.....	-0.3V to +6.5V	Maximum Junction Temperature...150°C
Input Pin voltage.....	-0.3V to VDD+0.3V	Operating Temperature.....-40 to +85°C
Output Pin voltage.....	-0.3V to 6.5V	Storage Temperature.....-65 to +150°C
Thermal Resistance.....	300°C/W	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 Characteristics

(V<sub>CC</sub>=3.7V, T<sub>A</sub>= 25°C, unless otherwise noted.)

Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
Operating Voltage Range	V <sub>CC</sub>		2.7		6	V
Operating Current	I <sub>VCC</sub>	V <sub>CC</sub> =3.7V		7.3		uA
Start time			7.5	15	22.5	ms
Flicker frequency		CHRГ is low, BLINK is high		2		Hz
Comparator						
The flip down comparator threshold	V <sub>trip</sub>	CHRГ is high, the comparator input voltage drops	1.189	1.22	1.25	V
		CHRГ is low, the comparator input voltage drops	1.22	1.256	1.29	
Negative input bias current	I <sub>bias</sub>	IN1, IN2, IN3, IN4		0	50	nA
Comparator delay	t <sub>PD</sub>					

Output (OUT1, OUT2, OUT3, OUT4)				
Output pull-down current	$I_{PULL}$	$IN_x > 1.3V, OUT_x = 0.3V$	10	$\mu A$
Output Leakage Current	$I_{LKG}$	$IN_x < 1.18V$	1	$\mu A$
Logic input (CHRG, BLINK, HYS1, HYS2)				
Input low level	$V_{INL}$	Logic input voltage drops	0.6	V
Input high level	$V_{CEH}$	Logic input voltage rises	$0.7 \times V_{DD}$	V
Input current	$I_{INL}$	Logic input is grounded, $V_{DD} = 6V$	-1	$\mu A$
	$I_{INH}$	Logic input is connected to $V_{DD}, V_{DD} = 6V$	+1	

## Detailed Description

CN1185 is a low-power four-channel voltage monitoring circuit chip. It has a start-up circuit, voltage reference, four voltage comparator, the comparator output hysteresis setting unit and control unit. CN1185 operating current is only 7.3 microamps (typical), which is very suit for battery powered applications. Comparator hysteresis by two logic inputs HYS1 and HYS2 programming control, allows the user to set a different delay depending on the application, and effectively inhibited the noise and the load of the output error caused by mutations. In addition, CN1185 also have comparator threshold control input CHRG, which is suitable for battery voltage monitoring applications. When the battery is charging, CHRG is set low, the comparator drops threshold will be increased by 3% to offset the connection resistance of the battery internal resistance or the battery connection terminal voltage due to the rise, this comparator is responsible for the actual battery voltage. Because the user can set the comparator threshold and hysteresis, that making CN1185 is suitable for roughly monitoring battery voltage applications.

When the CN1185 power, start-up circuit work in order to avoid voltage instability on the impact of the electric moment, start-up circuit to ensure that the 7.5 ms after power on (minimum), regardless of more the input voltage is greater than or less than the threshold comparator flip, CN1185 output are high impedance state. When after the start-up time, CN1185 output comparison results due to the actual comparator input voltage.

## Applications Information

### The comparator drops threshold set

CN1185 comparator flip down threshold is when the comparator's negative input voltage drops, the comparator output from low to high resistance state corresponds to the negative input voltage. Comparator threshold can flip down the threshold by turning the control input of the CHRG to set, as shown below.

CHRG Level	The threshold of flipping down			Explain
	Min	Typical	Max	
Low	1.22V	1.256V	1.29V	The negative comparator input voltage drops
High	1.189V	1.22V	1.251V	The negative comparator input voltage drops

Comparator set flipping down the battery voltage threshold value is mainly used in the monitoring. When the battery is charging, the battery internal resistance and connection resistance exists, may make the detection point of the actual voltage higher than the battery voltage, in this case, in order to reflect the

actual battery voltage, the CHR<sub>G</sub> pin can set low, making the comparator threshold from 1.22V flip up to 1.256V (that is, increase 3% turning down threshold), To some extent to achieve a connection to the battery's internal resistance and the resistance of the compensation. Of course, be noted that, due to user resistance and connection resistance of the battery is ever-changing, CN1185 by adjusting the threshold comparator flip down and can not accurately compensate for the specific circumstances of each user. The comparator drops threshold settings come into effect four comparators.

CN1185 comparator drops threshold can fit Shanghai Consonance with the charging chip used in conjunction. The charger has a charge status indicator pin  $\overline{\text{CHRG}}$ , with a charge-chip pull-up resistor will pull the pin  $\overline{\text{CHRG}}$  on the power supply terminal. If the charging pin  $\overline{\text{CHRG}}$  with CN1185 the CHR<sub>G</sub> pin connected together, can achieve the state of charge threshold comparator flip down automatically controlled.

**Comparator output flash control**

When CN1185 comparator suffice the following three conditions, its output will be 2 Hz flashing frequency (blink cycle 50%).

Condition 1: CN1185 the flip threshold control input CHR<sub>G</sub> pin is low;

Condition 2: CN1185 BLINK flicker control input is high;

Condition 3: The comparator output low.

Blink comparator output controls the main function is to monitor the battery voltage application and design. Generally used in battery charging, users want to indicate the battery voltage, but also continuously flashing to indicate charging in progress.

**Comparator hysteresis (Hysteresis) set**

Comparator rising threshold is when the comparator's negative input voltage rises, the comparator output goes low when the terminus of a high impedance state corresponding to the negative input voltage. In order to enhance noise immunity, the rising threshold is higher than the drops threshold. Rinsing threshold and drops threshold's difference is the comparator hysteresis. CN1185 comparator hysteresis can HYS1 and HYS2 two pins to set, as shown below.

HYS2	HYS1	Dropping Hysteresis	Rinsing Hysteresis
0	0	Dropping threshold × 1%	Dropping threshold × (1+1%)
0	1	Dropping threshold × 3%	Dropping threshold × (1+3%)
1	0	Dropping threshold × 6%	Dropping threshold × (1+6%)
1	1	Dropping threshold × 10%	Dropping threshold × (1+10%)

Comparator hysteresis is to prevent the monitored power supply or battery voltage transient caused by the comparator output disorder. In electronic systems, because they had been monitoring the power supply or battery internal resistance and connection resistance, when the load suddenly changes, the voltage sense input voltage changes suddenly which cause the comparator output change. Because in this moment, the power supply or battery by monitoring the actual voltage does not change, so the application should be monitored according to the load and the power supply or battery internal resistance and wiring resistance and other factors to set the comparator hysteresis to avoid this phenomenon.

Generally, the larger the monitored power or battery internal resistance and wiring resistance, heavier load, then the greater the hysteresis comparator to set; and conversely the opposite.

Comparator hysteresis comparator settings come into effect for four channels.

CN1185 comparator rising threshold and drops threshold will make a summary as the following table.

CHRG	HYS2	HYS1	the comparator drops threshold (typical value)	the comparator rising threshold (typical value)
1	0	0	1.22V	$1.22 \times (1 + 1\%)$
	0	1	1.22V	$1.22 \times (1 + 3\%)$
	1	0	1.22V	$1.22 \times (1 + 6\%)$
	1	1	1.22V	$1.22 \times (1 + 10\%)$
0	0	0	1.256V	$1.256 \times (1 + 1\%)$
	0	1	1.256V	$1.256 \times (1 + 3\%)$
	1	0	1.256V	$1.256 \times (1 + 6\%)$
	1	1	1.256V	$1.256 \times (1 + 10\%)$

### Resistor divider network design

In the circuit shown in Figure 1, resistors R1, R2, R3, R4 and R5 resistor divider network, the power supply voltage is monitored by the partial pressure after the on-chip reference voltage to compare. In the design of the resistor divider network of resistor values, you first need to determine the user can allow the R1, R2, R3, R4 and R5 current consumption, according to this current can determine the  $R1 + R2 + R3 + R4 + R5$ 's value, then the customer needs the voltage monitored points to determine the value of each resistor. Suppose you want to monitor a voltage, when the voltage drops, four in ascending order of the voltage detection points were Vth1, Vth2, Vth3 and Vth4, which Vth4 highest voltage value, Vth1 lowest voltage value, the design steps are as follows.

(1) to determine the  $R1 + R2 + R3 + R4 + R5$  value

Mainly based on the monitored voltage is allowed to determine the current consumed by  $R1 + R2 + R3 + R4 + R5$ 's value, the smaller the value, the greater the current consumption was monitored voltage, the more result of partial pressure from electromagnetic interference.

(2) Calculate the value of resistor R5

$$R5 = (v_{ref} / V_{th4}) \times (R1 + R2 + R3 + R4 + R5)$$

(3) Calculate the value of resistor R4

$$R4 = (v_{ref} / V_{th3}) \times (R1 + R2 + R3 + R4 + R5) - R5$$

(4) Calculate the value of resistor R3

$$R3 = (v_{ref} / V_{th2}) \times (R1 + R2 + R3 + R4 + R5) - R5 - R4$$

(5) Calculate the value of resistor R2

$$R2 = (v_{ref} / V_{th1}) \times (R1 + R2 + R3 + R4 + R5) - R5 - R4 - R3$$

(6) Calculate the value of resistor R1

$$R1 = (R1 + R2 + R3 + R4 + R5) - R5 - R4 - R3 - R2$$

The above formula, vref values following table.

CHRG	HYS2	HYS1	the comparator drops vref (typical value)	the comparator rising vref (typical value)
1	0	0	1.22V	$1.22 \times (1 + 1\%)$
	0	1	1.22V	$1.22 \times (1 + 3\%)$
	1	0	1.22V	$1.22 \times (1 + 6\%)$
	1	1	1.22V	$1.22 \times (1 + 10\%)$
0	0	0	1.256V	$1.256 \times (1 + 1\%)$
	0	1	1.256V	$1.256 \times (1 + 3\%)$
	1	0	1.256V	$1.256 \times (1 + 6\%)$



	1	1	1.256V	$1.256 \times (1 + 10\%)$
--	---	---	--------	---------------------------

### Resistor divider network design example

Suppose you want to monitor a single lithium battery voltage, battery voltage drops, four in ascending order of the voltage detection points were  $V_{th1} = 3.19V$ ,  $V_{th2} = 3.47V$ ,  $V_{th3} = 3.69V$  and  $V_{th4} = 3.99V$ . Set  $R1 + R2 + R3 + R4 + R5 = 720K\Omega$ , so the battery voltage is 3.6V, the resistor divider network consumes battery current 5uA, general portable products can be tolerated.

$$R5 = (1.22 / 3.99) \times 720 = 220K\Omega$$

$$R4 = (1.22 / 3.69) \times 720 - 220 = 18K\Omega$$

$$R3 = (1.22 / 3.47) \times 720 - 220 - 18 = 15K\Omega$$

$$R2 = (1.22 / 3.19) \times 720 - 220 - 18 - 15 = 22K\Omega$$

$$R1 = 720 - 220 - 18 - 15 - 22 = 445K\Omega$$

### Monitoring the voltage greater than 6V

If the monitored voltage greater than 6V, you can be connected to monitor voltage resistor divider network of high-end, but pay attention to any case through the resistor divider network after receiving the CN1185 partial pressure comparator input voltage is not higher than 6V. CN1185 need 2.7V to 6V power supply, the power system can be 2.7V to 6V already have the power, or voltage to be monitored or regulated through the step-down power.

### About the filter capacitor

Generally, CN1185 does not require power supply filter capacitor. However, if the CN1185 work in a relatively strong noise or electromagnetic interference environment, or be monitored power itself superimposed clutter, then add a 0.1uF capacitor between VDD and GND can effectively filter out interference. If the monitored power supply voltage transients are relatively strong, the filter capacitor value should be larger. From the comparator's negative input to ground plus a 1nF capacitor can effectively improve the noise immunity of CN1185.

### CN1185 to achieve three-color LED indicates

Some applications require the use of CN1185 to achieve three-color LED indicates when the battery voltage is higher than a certain threshold, the green light, the battery has enough energy. When the battery voltage is between a higher threshold and lower threshold, the yellow light (actually a red light and green light); when the battery voltage is below the lower threshold value, the red indicator light to alert the user needs charging the battery. Shown in Figure 3.

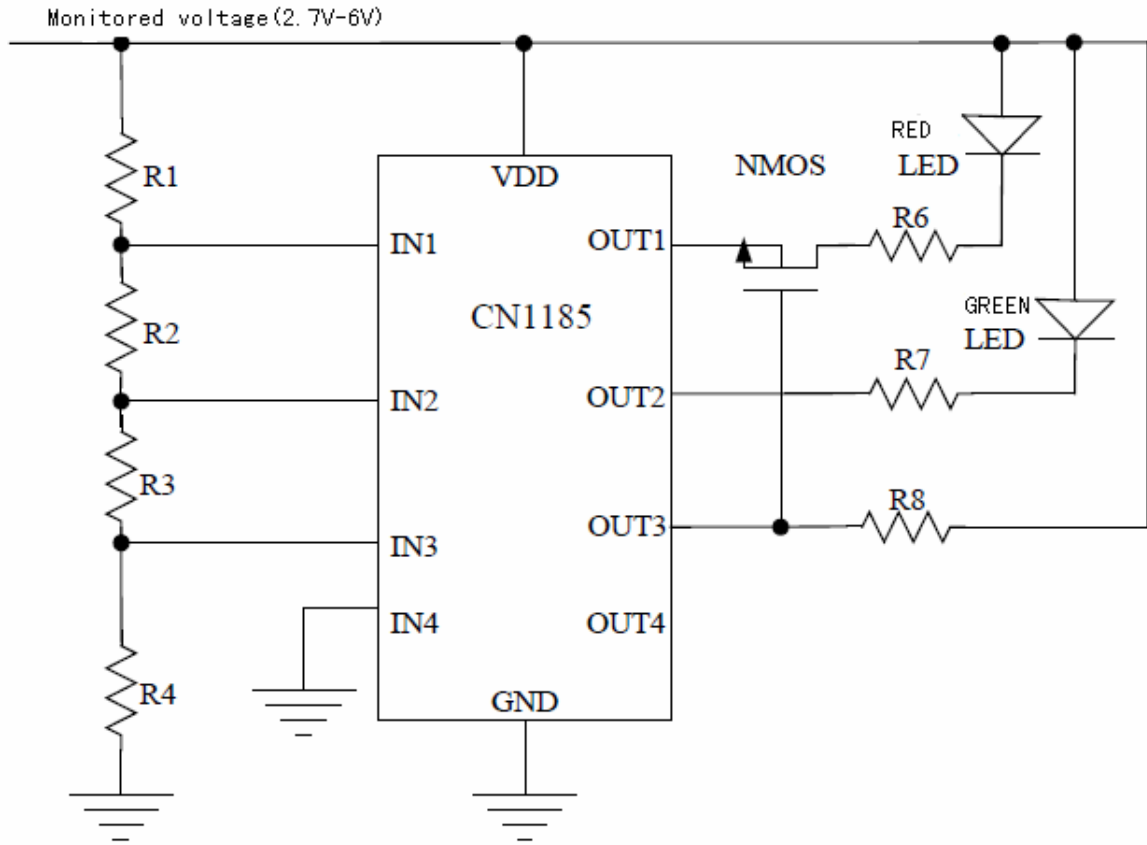


Figure 3 CN1185 to achieve three-color LED indicates

For example the lithium battery to illustrate the working principle.

Technical Requirements:

- (1) The battery voltage is greater than 3.63V, the bright green LED, that battery power sufficient;
- (2) The battery voltage is between 3.4V and 3.63V, the red LED and green LED is lit (shown in yellow), indicating that the battery energy is generally;
- (3) The battery voltage is less than 3.4V, the red LED is lit, that battery power shortage, need for battery charging.

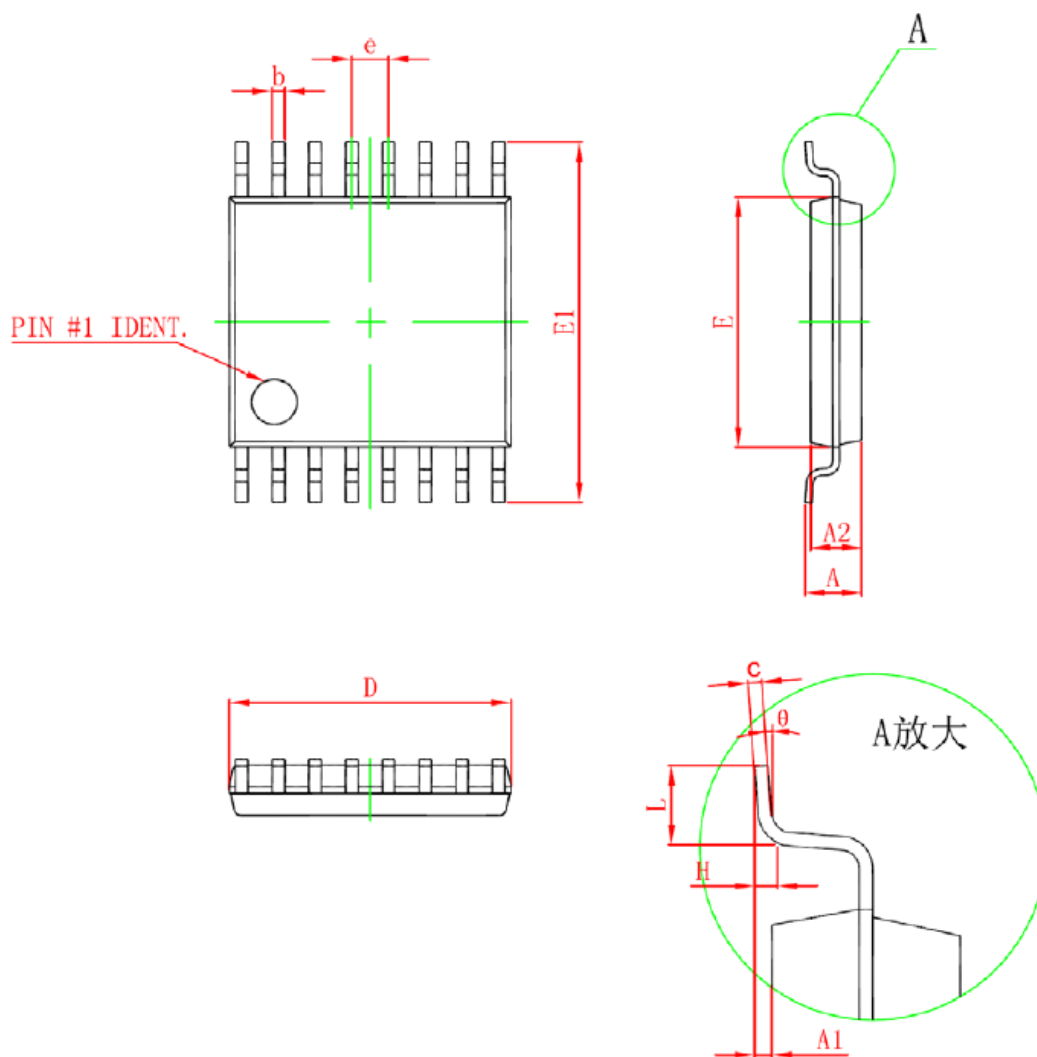
Using CN1185 three comparators,  $V_{th1}$ ,  $V_{th2}$  and  $V_{th3}$  were set to 2.5V, 3.4V and 3.63V, which is based on lithium battery 2.5V minimum voltage setting. Resistors R6 and R7 is the LED current limiting resistor, the LED brightness levels according to resistance; R8 is OUT3 pull-up resistor, the resistors according to the value of allowable power.

- When the battery voltage is 2.5V-3.4V, IN1 voltage is higher than the first comparator flip threshold, IN2 and IN3 respectively is lower than the second and third comparator flip threshold, at this time, CN1185 OUT1 output low, OUT2 and OUT3 output high, NMOS MOSFET is on, the red LED lights, green LED off.
- When the battery voltage is 3.4V-3.63V, IN1 and IN2 voltage is higher than the first and second comparator flip threshold, IN3 below the threshold of the third comparator flip, at this time, CN1185 OUT1 and OUT2 output low, OUT3 output high, NMOS MOSFET is on, while the red and green LED lights to show the effect of yellow.
- When the battery voltage is above 3.63V, IN1, IN2 and IN3 voltage respectively is higher than the first, second and third comparator flip threshold, OUT1, OUT2 and OUT3 output low, NMOS is shut off,

---

red LED off, green LED light.

## Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.100		0.043
A2	0.800	1.000	0.031	0.039
A1	0.020	0.150	0.001	0.006
e	0.65 (BSC)		0.026 (BSC)	
L	0.500	0.700	0.020	0.028
H	0.25 (TYP)		0.01 (TYP)	
$\theta$	1°	7°	1°	7°

Consonance does not assume any responsibility for use of any circuitry described. Consonance reserves the right to change the circuitry and specifications without notice at any time.