

# CONSONANCE

## Low Power Battery Monitor with Hysteresis Control

### CN302

#### General Description

The CN302 is an low power high accuracy battery monitor with hysteresis control, and is specially designed for monitoring single or multi lithium-ion (Li+) cells, multi-cell alkaline, NiCd, NiMH and multi-cell lead acid batteries.

The CN302 allows for wide hysteresis by adjusting the rising and falling threshold independently. The threshold accuracy is  $\pm 2\%$ .

The hysteresis eliminates the output chatter sometimes associated with battery voltage monitors, usually due to input voltage noise or battery terminal voltage recovery after load removal.

The device offers both active-low and active-high battery detection outputs.

The device is available in 6 pin SOT23 package.

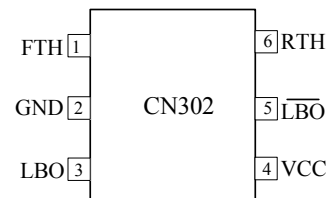
#### Applications

- Battery-powered Systems
- Multi-cell Li+ Batteries Monitoring
- Multi-cell Alkaline, NiCd or NiMH Batteries Monitoring
- Multi-cell Lead Acid Batteries Monitoring

#### Features

- Precise Threshold:  $\pm 2\%$
- Adjustable Hysteresis to Eliminate the Output Chatter
- Active-low and Active-high CMOS Outputs
- 9.5 $\mu$ A Supply Current @VCC=3V
- Power Supply Transient Immunity
- Operating Temperature Range  
-40°C to +85°C
- Available in SOT23-6
- Lead-free, Rohs-compliant and Halogen-free

#### Pin Assignment



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## Typical Application Circuit

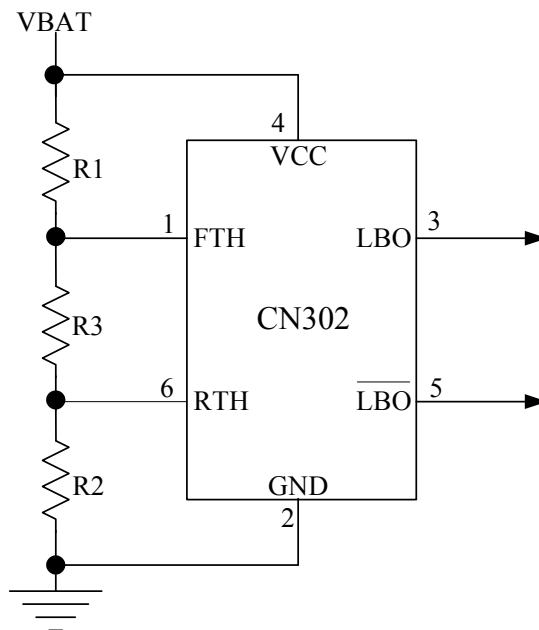


Figure 1 Monitoring Battery Voltage Lower Than 6V

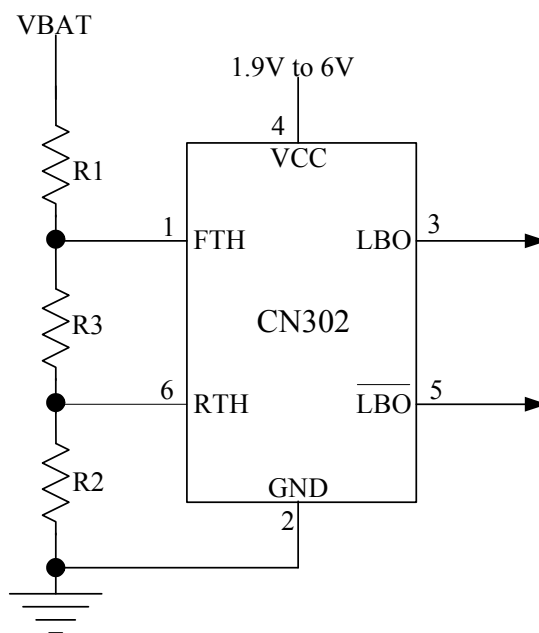


Figure 2 Monitoring Battery Voltage Higher Than 6V

### Ordering Information:

Part No.	Package	Shipping	Operating Temperature Range
CN302	SOT23-6	Tape and Reel, 3000/Reel	-40°C to 85°C

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## Pin Description

Pin No.	Symbol	Description
1	FTH	<b>Falling Threshold Input.</b> Generally FTH pin should be tied to an external resistor divider to sense the battery voltage.
2	GND	Negative Terminal of Power Supply(Ground)
3	LBO	<b>Active-High Low Battery Output.</b> CMOS output. When the voltage at RTH pin rises above the internal reference voltage, LBO becomes low; When the voltage at FTH pin falls below the internal reference voltage, LBO becomes high.
4	VCC	Positive Terminal of Power Supply. This pin is the power supply to internal circuit.
5	$\overline{\text{LBO}}$	<b>Active-Low Low Battery Output.</b> CMOS output. When the voltage at RTH pin rises above the internal reference voltage, $\overline{\text{LBO}}$ becomes high; When the voltage at FTH pin falls below the internal reference voltage, $\overline{\text{LBO}}$ becomes low.
6	RTH	<b>Rising Threshold Input.</b> Generally RTH pin should be tied to an external resistor divider to sense the battery voltage.

## ABSOLUTE MAXIMUM RATINGS

Terminal Voltage (With respect to GND)	Thermal Resistance.....300°C/W
VCC.....-0.3V to +6.5V	Operating Temperature.....-40 to +85°C
The other Pins.....-0.3V to VCC	Storage Temperature.....-65 to +150°C
Input/Output Current	Lead Temperature (soldering, 10s) .....+260°C
All Pins.....20mA	

*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

(VCC=3V, T<sub>A</sub>= -40°C to 85°C, Typical values are at T<sub>A</sub>=25°C, unless otherwise noted.)

Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
Operating Voltage Range	VCC		1.9		6	V
Operating Current	I <sub>VCC</sub>	VCC = 1.8V	4.4	8.8	14	uA
		VCC = 3.0V	5	9.5	14	
		VCC = 5.0V	5	10	15	
RTH Threshold	V <sub>RTH</sub>	RTH pin voltage rising	1.187	1.211	1.235	V
FTH Threshold	V <sub>FTH</sub>	FTH pin voltage falling	1.187	1.211	1.235	
RTH Bias Current	I <sub>RTH</sub>		-100	0	100	nA
FTH Bias Current	I <sub>FTH</sub>		-100	0	100	nA

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Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
RTH to LBO Delay	$t_{PD1}$	RTH = 1.167V to 1.255V		12		us
FTH to LBO Delay	$t_{PD2}$	FTH = 1.255V to 1.167V		13		us
LBO or $\overline{LBO}$ Low Voltage	$V_{OL}$	VCC = 2V, $I_{SINK} = 1.5mA$			0.3	V
		VCC = 3V, $I_{SINK} = 3.2mA$			0.3	
		VCC = 5V, $I_{SINK} = 6mA$			0.3	
LBO or $\overline{LBO}$ High Voltage	$V_{OH}$	VCC = 2V, $I_{SOURCE} = 1.5mA$	VCC - 0.4			V
		VCC = 3V, $I_{SOURCE} = 3mA$	VCC - 0.4			
		VCC = 5V, $V_{LBI} = 1.5V$ $I_{SOURCE} = 5mA$	VCC - 0.4			

## Detailed Description

CN302 is a low power battery monitor IC with hysteresis control, the device consists of comparator, bandgap reference and hysteresis control circuit etc.

If the voltage at FTH pin falls below the falling threshold  $V_{FTH}$ ,  $\overline{LBO}$  will become low and LBO will become high after a short delay (13us typical); If the voltage at RTH pin goes higher than the rising threshold  $V_{RTH}$ ,  $\overline{LBO}$  will become high and LBO will become low after a delay of 12us typical. The difference between rising threshold and falling threshold is also called hysteresis, which can provide noise immunity and remove the possibility of output chatter due to battery terminal voltage recovery after the load removal. The CN302 allows for wide hysteresis by adjusting the rising and falling threshold independently.

CN302 is specially designed for monitoring single or multi lithium-ion (Li+) cells, multi-cell alkaline, NiCd, NiMH and multi-cell lead acid batteries.

The operation of the device can be best understood by referring to figure 3.

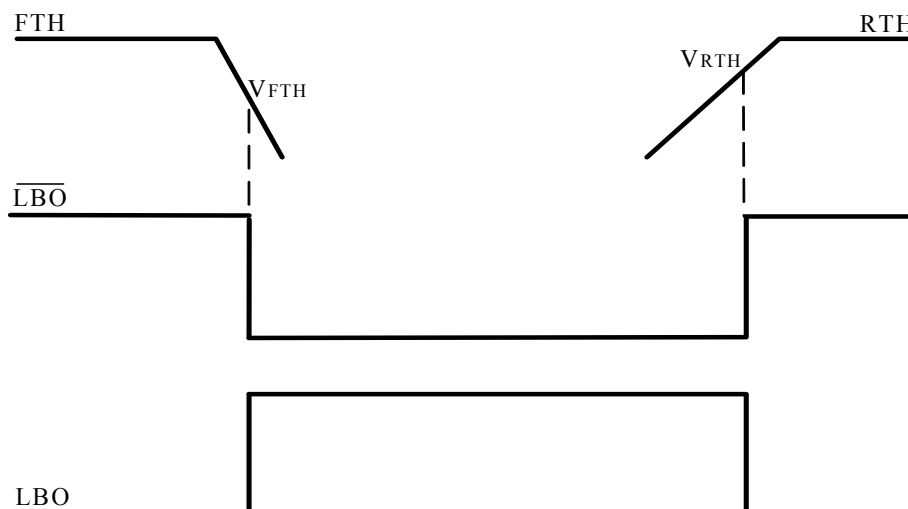


Figure 3 Timing waveform

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## Applications Information

### R1, R2 and R3 Selection

As shown in Figure 1 and Figure 2, RTH and FTH pins sense the battery voltage via the resistor divider formed by R1, R2 and R3. Choosing the proper R1, R2 and R3 values is a balance between accuracy and power consumption. The leakage currents into RTH and FTH pins travel through the resistor divider and introduce an error. If extremely high resistor values are used, the leakage current introduces a significant error; While with extremely low resistor values, the error becomes negligible, but the resistor divider draws more power from the battery than necessary and shortens battery life. Generally speaking, it is reasonable to choose the total value of R1, R2 and R3 so that the current they draw is between 5uA to 10uA.

The rising threshold is calculated by the following equation:

$$V_{BAT(hi)} = \frac{R1+R2+R3}{R2} \times V_{ref}$$

The falling threshold is calculated by the following equation:

$$V_{BAT(lo)} = \frac{R1+R2+R3}{R2+R3} \times V_{ref}$$

Where, Vref is the internal reference voltage, the typical value is 1.211V with 2% accuracy.

So, the hysteresis is:

$$HYS = \frac{R1+R2+R3}{R2+R3} \times \frac{R3}{R2} \times V_{ref}$$

It is interesting to note that:

$$\frac{HYS}{V_{BAT(hi)}} = \frac{R3}{R2+R3}$$

and

$$\frac{HYS}{V_{BAT(lo)}} = \frac{R3}{R2}$$

### Adding External Capacitance to Enhance Noise Immunity

If monitoring voltages in a noisy environment, add a bypass capacitor of 0.1μF from battery terminal to GND as close as possible to the device. For systems with large transients, additional capacitance may be required.

A small capacitor (<1nF) from RTH and FTH pin to GND may provide additional noise immunity.

### Negative-Going LBI Transients

In addition to issuing a low output at  $\overline{LBO}$  pin and a high output at LBO pin during power-up, power-down, and brownout conditions of the monitored voltage, the CN302 is relatively immune to short-duration negative-going FTH transients (glitches). As the magnitude of the transient increases (goes farther below the falling threshold), the maximum allowable pulse width decreases. Typically, a FTH transient that goes 20mV below the falling threshold and lasts 5μs or less will not cause a low  $\overline{LBO}$  output and a high LBO output. A bypass capacitor from FTH pin to GND provides additional transient immunity.

### CN302 discontinues the battery discharge

CN302 can monitor the battery voltage and discontinue the discharge by cutting off external N channel or P channel MOSFET as shown from Figure 4 to Figure 7.

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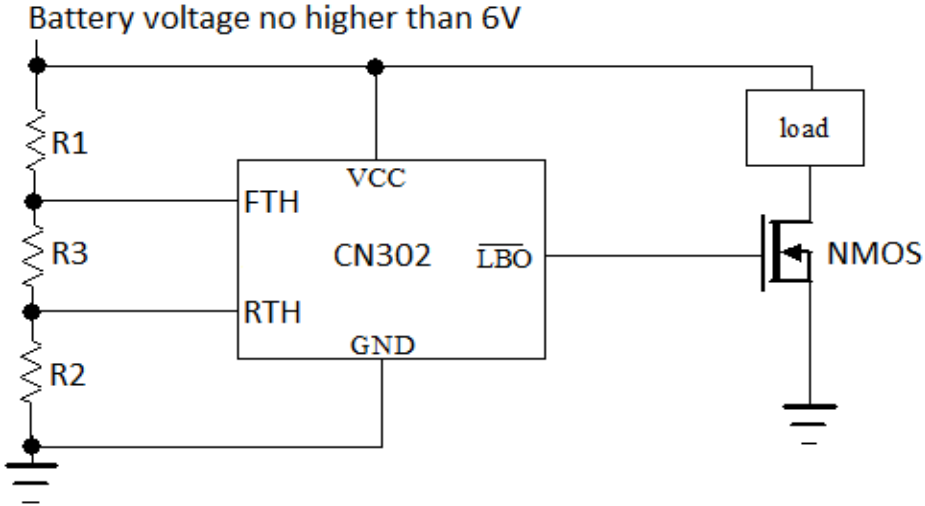


Figure 4  $V_{BAT} \leq 6V$ , CN302 controls N channel MOSFET

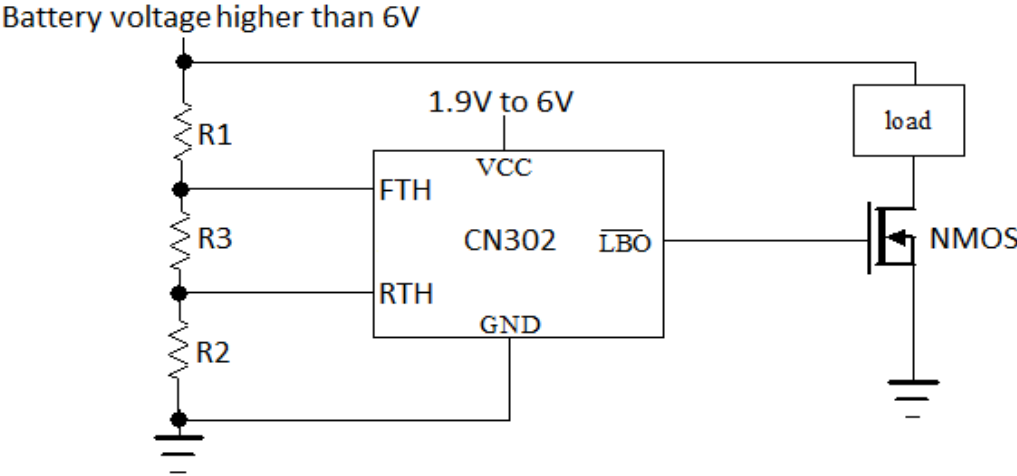


Figure 5  $V_{BAT} > 6V$ , CN302 controls N channel MOSFET

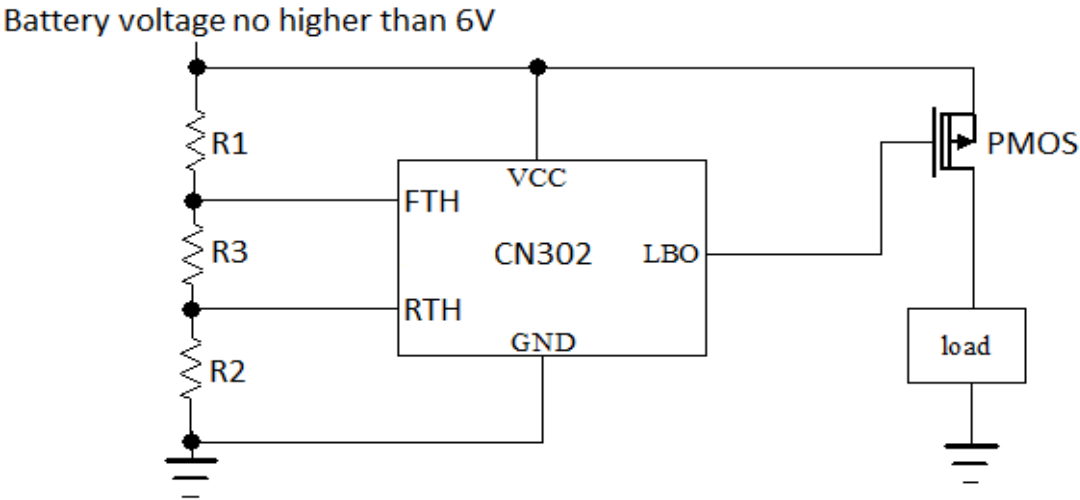


Figure 6  $V_{BAT} \leq 6V$ , CN302 controls P channel MOSFET

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Battery voltage higher than 6V

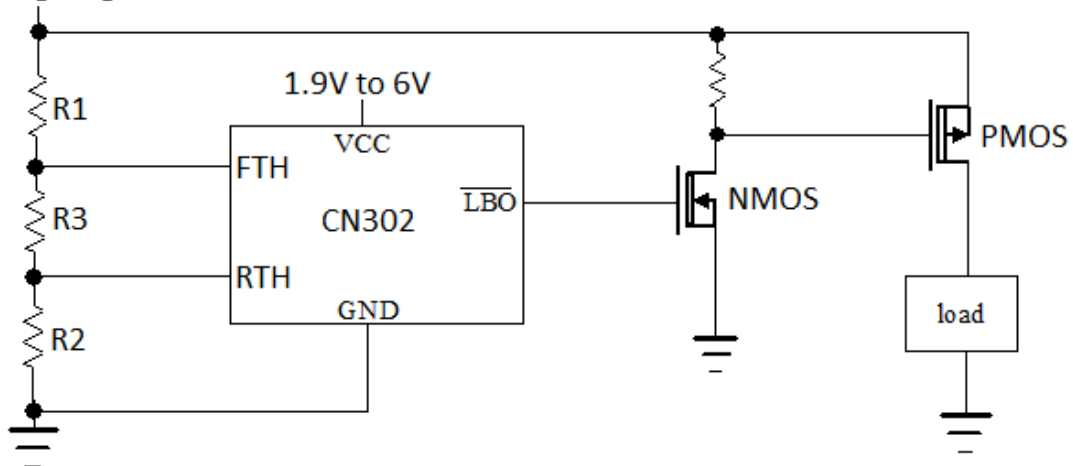


Figure 7  $V_{BAT} > 6V$ , CN302 controls P channel MOSFET

## Choose the Power Supply for CN302

If the monitored voltage is less than 6V, or there is a power supply from 1.9V to 6V in the system, then CN302 can be powered by one of the 2 power supplies. If there is glitch, ripple, etc at the power supply, a low-pass RC filter may be used as shown in Figure 8.

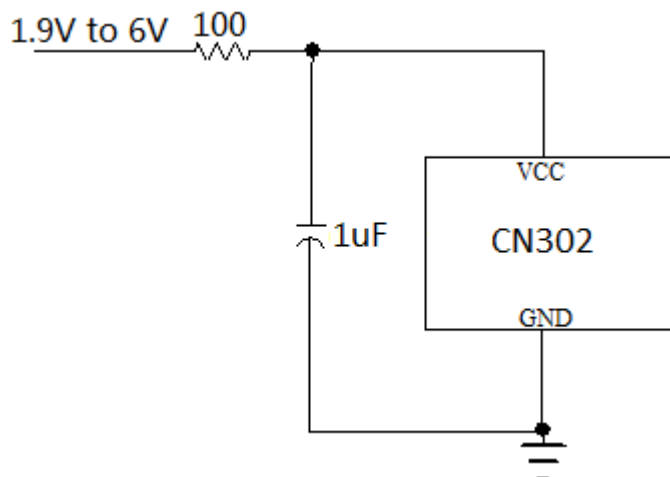


Figure 8 An RC Filter For CN302

If the monitored voltage is higher than 6V, and there is not a power supply from 1.9V to 6V, the circuit in Figure 9 can be used to generate the power supply for CN302. In Figure 9, resistor R4 and R5 are used to generate a voltage between 2.7V to 6V. R4 and R5 should be chosen in such a way that R4 and R5 can not load the battery too much. A 1uF capacitor can be chosen for C1.

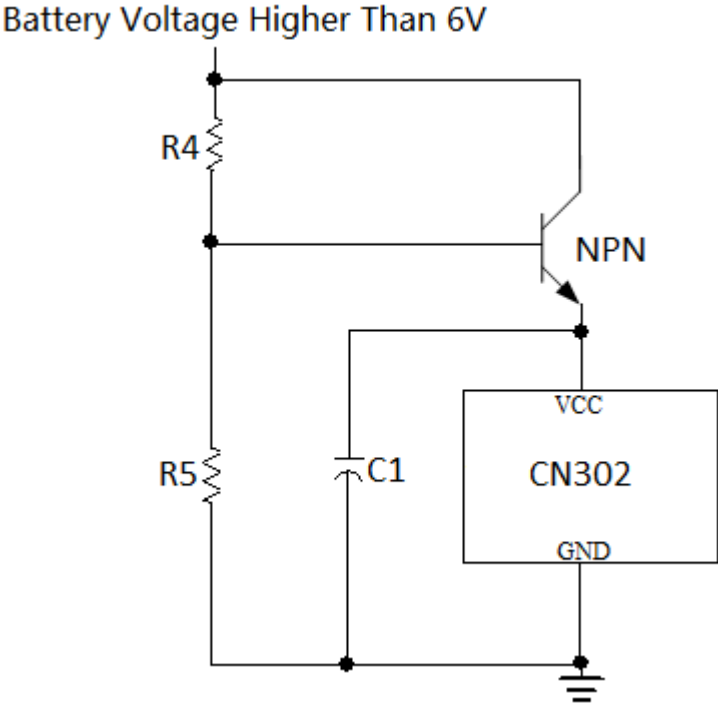


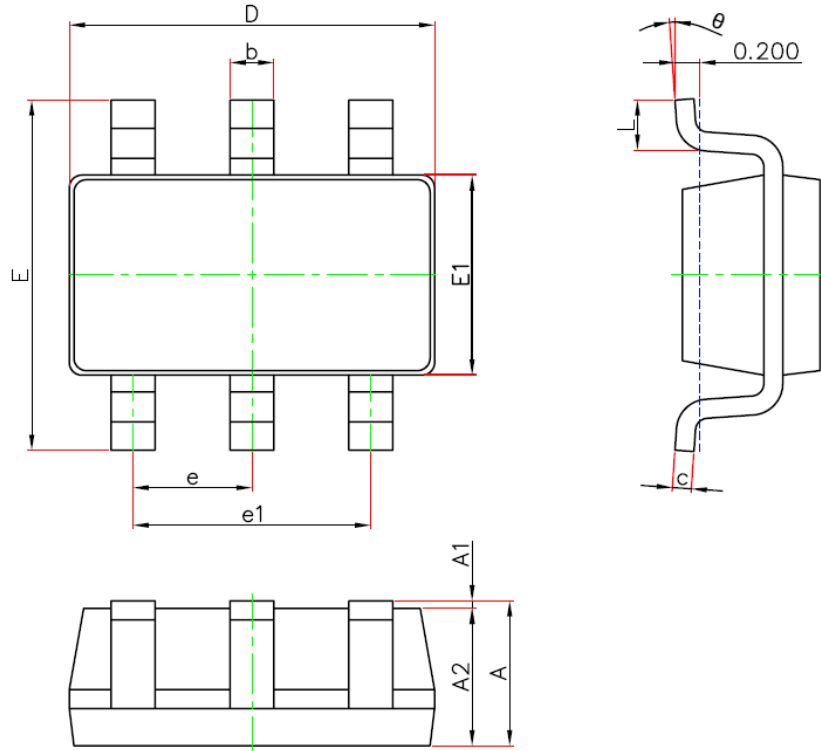
Figure 9 Power CN302 from a Resistor Divider



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## 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°

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.