DIO302

Low Power Voltage Detector IC

Features

- Precise detection threshold：±2%
- Adjustable hysteresis to eliminate the output chatter
- Active-low and active-high CMOS outputs
- 9.5 μA supply current at V_{CC} = 3 V
- Power supply transient immunity
- Operating temperature range: -40°C to 85°C
- Available in SOT23-6
- Lead-free, RoHs-compliant and Halogen-free

Applications

- Battery-powered systems
- Multi-cell Li+ batteries monitoring
- Multi-cell Alkaline, NiCd or NiMH batteries monitoring
- Multi-cell lead acid batteries monitoring

Descriptions

The DIO302 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 DIO302 allows for wide hysteresis by adjusting the rising and falling threshold independently. The threshold accuracy is ±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.

Ordering Information

Ordering Part No.	Top Marking	MSL	RoHS	T_A	Package	
DIO302ST6	302	3	Green	-40 to 125°C	SOT23-6	Tape & Reel, 3000

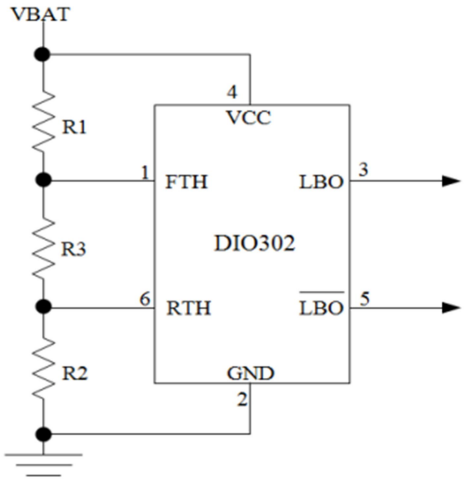


Figure 1. Monitoring battery voltage lower than 6 V

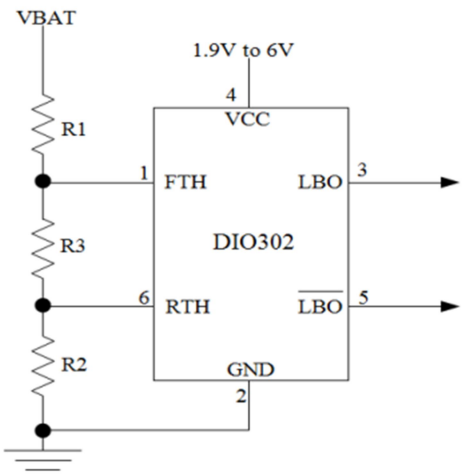
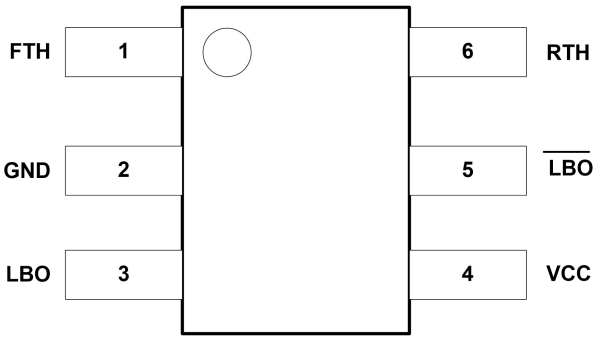


Figure 2. Monitoring battery voltage higher than 6 V

Pin Definition



Top view

Pin Descriptions

Pin No.	Pin Name	Description
1	FTH	Falling threshold input. 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	Active-high low battery output. 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	$\overline{LBO}$	Active-low low battery output. CMOS output. When the voltage at RTH pin rises above the internal reference voltage, $\overline{LBO}$ becomes high; When the voltage at FTH pin falls below the internal reference voltage, $\overline{LBO}$ becomes low.
6	RTH	Rising threshold input. Generally RTH pin should be tied to an external resistor divider to sense the battery voltage.

Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Rating" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maxim rating conditions for extended periods may affect device reliability.

Parameter		Rating	Units
Terminal Voltage (With respect to GND)	VCC	-0.3 to 6.5	V
	The other pins	-0.3 to 6.0	
Input/Output Current	All pins	20	mA
Thermal Resistance		300	°C/W
Operating Temperature		-40 to 85	°C
Lead Temperature Range (soldering 10s)		260	°C
Storage Temperature		-65 to 150	°C

DC Electrical Characteristics

Typical value: V_{CC} = 3 V, T_A = −40°C to 85°C, Typical values are at T_A = 25°C, unless otherwise noted.

Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
Operating voltage range	V_{CC}		1.9		6	V
Operating current	I_{VCC}	V_{CC} = 1.8 V	4.4	8.8	14	μA
		V_{CC} = 3.0 V	5	9.5	14	
		V_{CC} = 5.0 V	5	10	15	
RTH threshold	V_{RTH}	RTH pin voltage rising	1.187	1.211	1.235	V
FTH threshold	V_{FTH}	FTH pin voltage falling	1.187	1.211	1.235	
RTH bias current	I_{RTH}		-100	0	100	nA
FTH bias current	I_{FTH}		-100	0	100	nA
RTH to LBO delay	t_{PD1}	V_{RTH} = 1.167 V to 1.255 V		1.5		μs
FTH to LBO delay	t_{PD2}	V_{FTH} = 1.255 V to 1.167 V		1		μs
LBO or $\overline{LBO}$ low voltage	V_{OL}	V_{CC} = 2 V, I_{SINK} = 1.5 mA			0.3	V
		V_{CC} = 3 V, I_{SINK} = 3.2 mA			0.3	
		V_{CC} = 5 V, I_{SINK} = 6 mA			0.3	
LBO or $\overline{LBO}$ high voltage	V_{OH}	V_{CC} = 2 V, I_{SOURCE} = 1.5 mA	V_{CC} – 0.4			V
		V_{CC} = 3 V, I_{SOURCE} = 3 mA	V_{CC} – 0.4			
		V_{CC} = 5 V, V_{LBI} = 1.5 V, I_{SOURCE} = 5 mA	V_{CC} – 0.4			

Note:

(1) Specifications subject to change without notice.

Detailed Description

DIO302 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(1 μs 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 1.5 μs 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 DIO302 allows for wide hysteresis by adjusting the rising and falling threshold independently.

The DIO302 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.

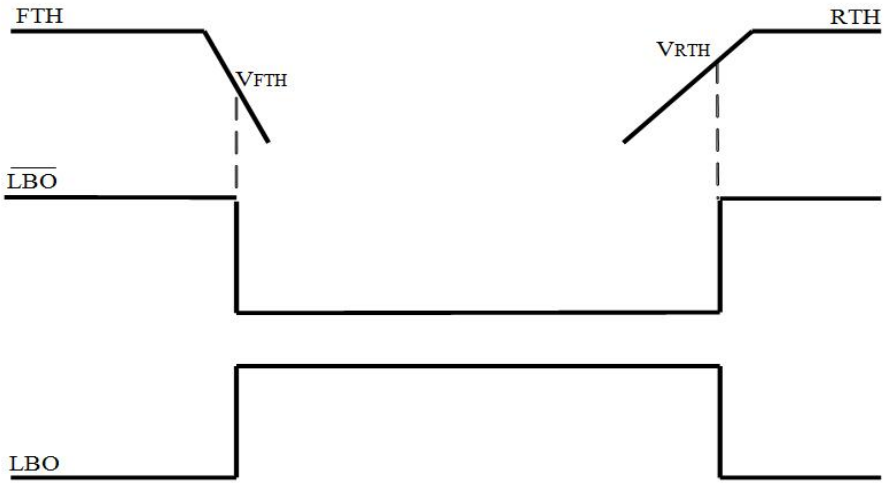


Figure 3. Timing waveform

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 5 μA to 10 μA.

The rising threshold is calculated by the following equation:

$$V_{BAT(hi)} = \frac{R1+R2+R3}{R2} \text{ X Vref}$$

The falling threshold is calculated by the following equation:

$$V_{BAT(lo)} = \frac{R1+R2+R3}{R2+R3} \text{ X Vref}$$

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

$$HYS = \frac{R1+R2+R3}{R2+R3} \text{ X } \frac{R3}{R2} \text{ X Vref}$$

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 0.1 μF 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 (< 1 nF) 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 DIO302 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 20 mV below the falling threshold and lasts 5 μs 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.

DIO302 discontinues the battery discharge

DIO302 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.

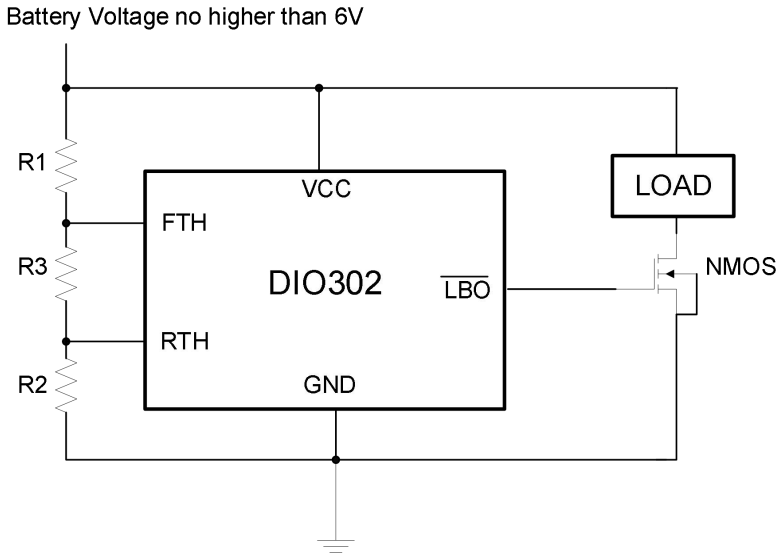


Figure 4. VBAT ≤ 6 V, DIO302 controls N channel MOSFET

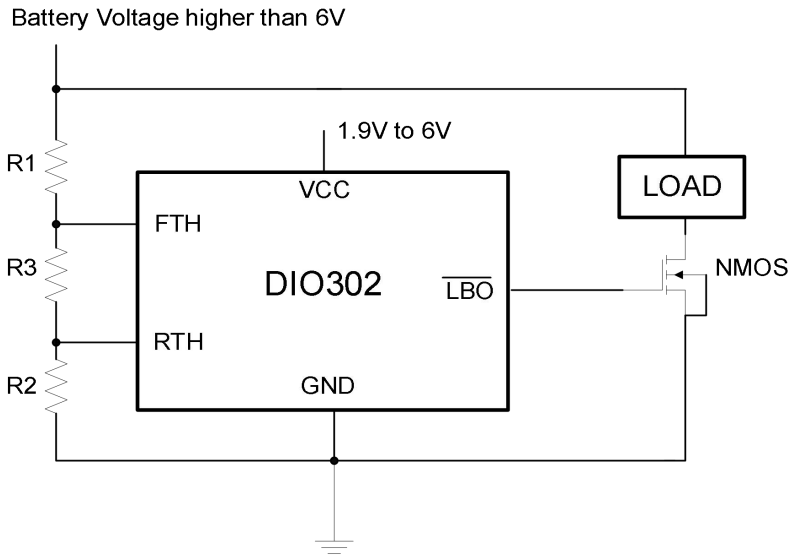


Figure 5. VBAT > 6 V, DIO302 controls N channel MOSFET

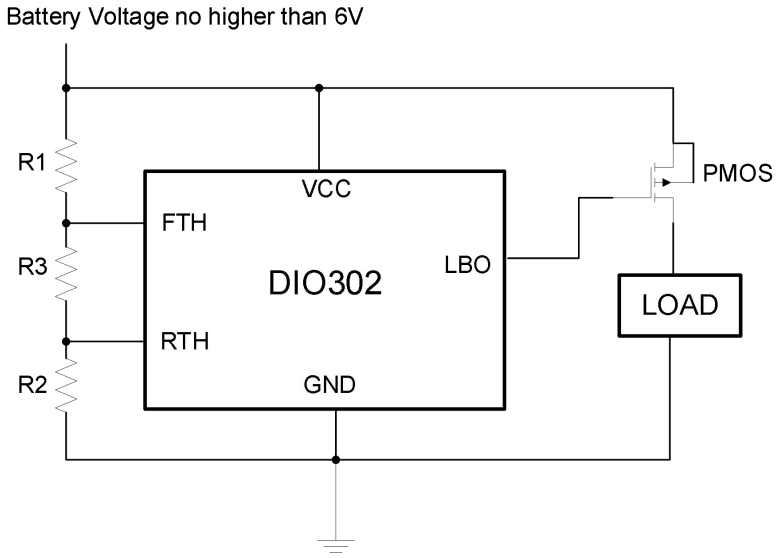


Figure 6. VBAT ≤ 6 V, DIO302 controls P channel MOSFET

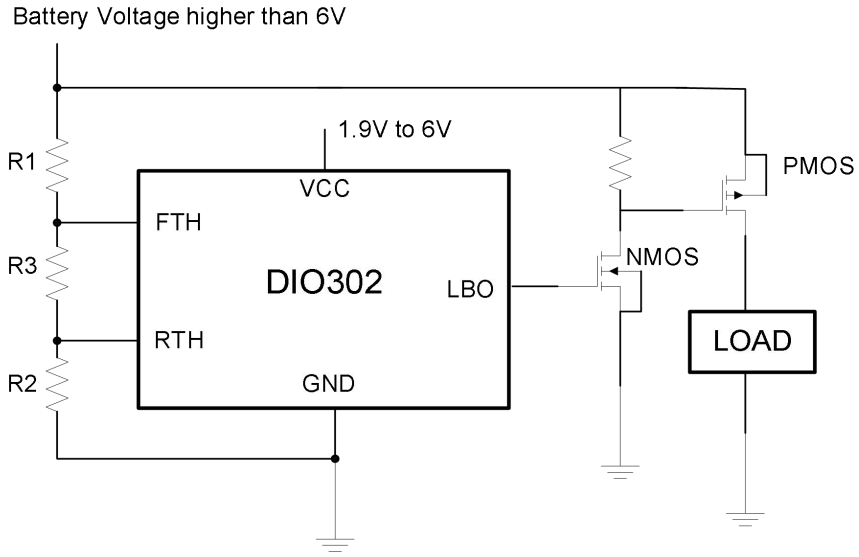


Figure 7. VBAT > 6 V, DIO302 controls P channel MOSFET

Choose the Power Supply for DIO302

If the battery voltage is greater than 6 V, the DIO302 can not be directly powered by the battery. In this case if there is a power supply from 1.9 V to 6 V in the system, then DIO302 can be powered by this power supply, otherwise the circuit in Figure 8 can be used to generate the power supply for DIO302. In Figure 8, resistor R4 and R5 are used to generate a voltage between 1.9 V to 6 V to power DIO302. R4 and R5 should be chosen in such a way that the current flowing through R4 is larger than 15 μA to meet DIO302's current consumption requirement, also R4 and R5 can not load the battery too much. A 1 μF capacitor can be chosen for C1.

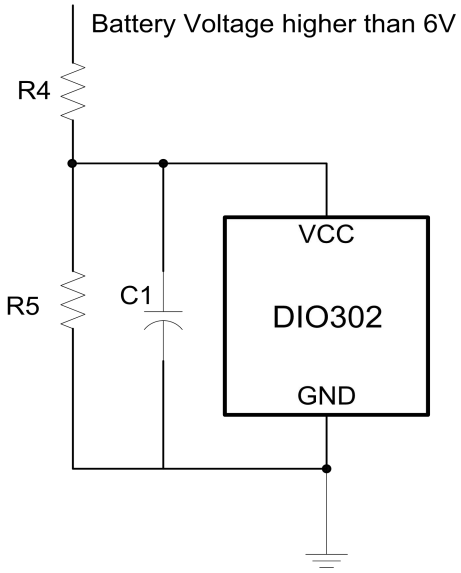
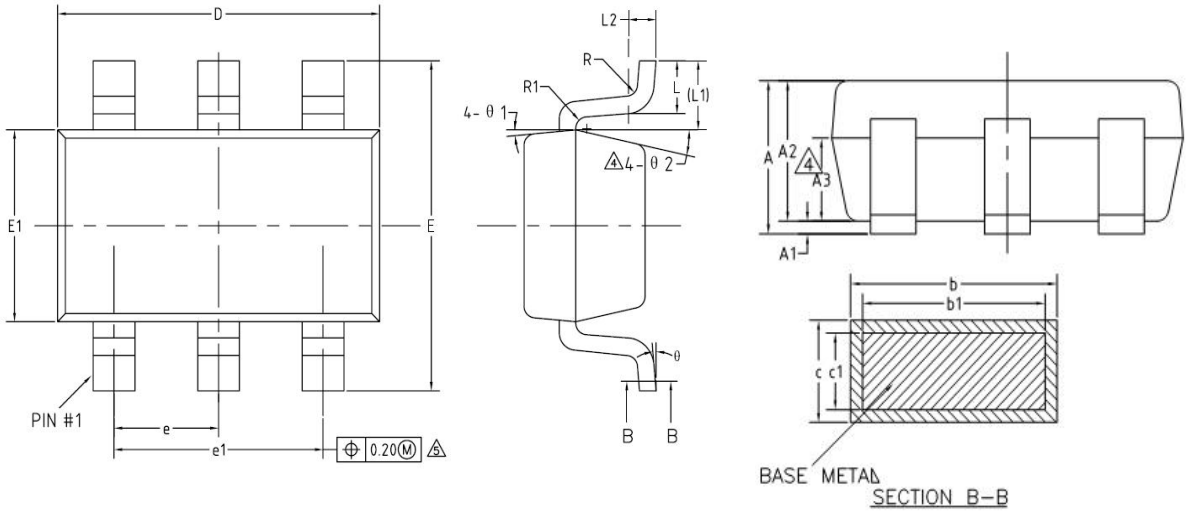


Figure 8. Power DIO302 from a resistor divider

Physical Dimensions: SOT23-6



Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	1.25
A1	0	-	0.15
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.36	-	0.50
b1	0.35	0.38	0.41
c	0.14	-	0.20
c1	0.14	0.15	0.16
D	2.826	2.926	3.026
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
L	0.30	0.45	0.60
L1	0.59 REF		
L2	0.25 BSC		
R	0.05	-	0.20
R1	0.05	-	0.20
Θ	0°	-	8°
Θ1	8°	10°	12°
Θ2	10°	12°	14°

CONTACT US

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