



MD70XX SERIES Voltage Detector

Features

- Low power consumption
- Low temperature coefficient
- Built-in high-stability reference source
- Built-in hysteresis characteristic
- TO-92 package
- SOT-89 package

Applications

- Battery checkers
- Level selectors
- Power failure detectors
- Microcomputer reset
- Battery memory backup
- Non-volatile RAM signal storage protectors

General Description

The MD70XX series is a set of three-terminal low power voltage detectors implemented in CMOS technology. Each voltage detector in the series detects a particular fixed voltage ranging from 1.9V to 7V. The voltage detectors consist of a high-precision and low power consumption standard voltage source, a comparator, hysteresis

circuit, and an output driver. CMOS technology ensures low power consumption.

Although designed primarily as fixed voltage detectors, these devices can be used with external components to detect user specified threshold voltages (NMOS open drain type only).

Selection Table

Part No.	Detectable Voltage	Hysteresis Width	Tolerance
MD7015A	1.5V	0.075V	±3%
MD7019A	1.9V	0.095V	±3%
MD7021A	2.1V	0.105V	±3%
MD7022A	2.2V	0.110V	±3%
MD7024A	2.4V	0.120V	±3%
MD7027A	2.7V	0.135V	±3%
MD7028A	2.8V	0.140V	±3%
MD7030A	3.0V	0.150V	±3%
MD7033A	3.3V	0.165V	±3%
MD7039A	3.9V	0.195V	±3%
MD7042A	4.2V	0.210V	±3%
MD7044A	4.4V	0.220V	±3%
MD7050A	5.0V	0.250V	±3%
MD7070A	7.0V	0.350V	±3%

NMOS open drain normal open, active low

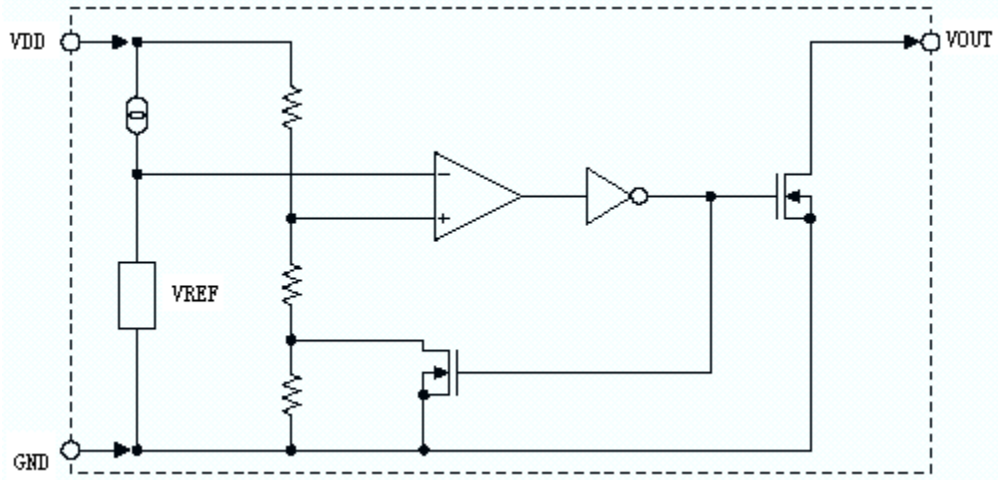
For example: The MD7044 is a 4.4V, NMOS open drain active low output

For semi-custom parts,selectable regulated voltage range is from 2.1V to 12V in 0.1V increment.

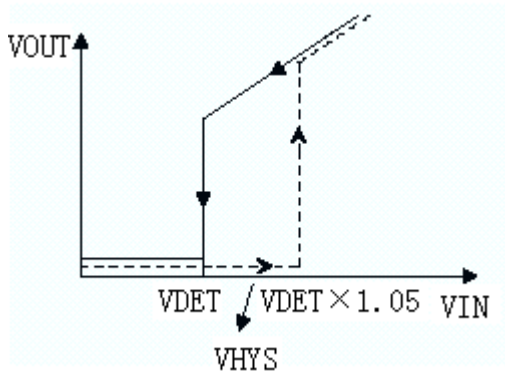
For semi-custom parts,selectable output type CMOS .

Block Diagram

N channel open drain output (normal open; active low)



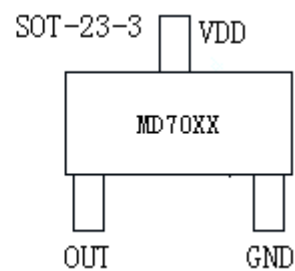
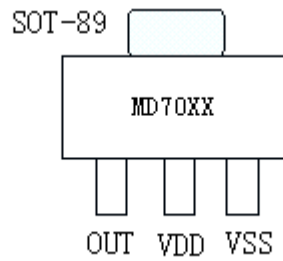
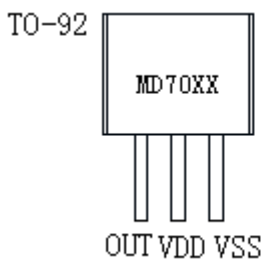
A type



Dash LineVIN from Lo→Hi

Solid LineVIN from Hi→Lo

Pin Assignment



Absolute Maximum Ratings

Supply Voltage.....0.3V to 18V
 Output VoltageV_{SS}-0.3V to V_{DD}+0.3V Output Current.....50mA
 Storage Temperature.....-50°C to 125°C Power Consumption.....200Mw TO_92
 Operating Temperature-40°C to 85°C Power Consumption.....250Mw SOT_89

Note: These are stress ratings only. Stresses exceeding the range specified under Absolute Maximum Ratings may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

Electrical Characteristic

MD7015A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	1.455	1.5	1.545	V
V _{HYS}	Hysteresis Width	--	--	0.02 V _{DET}	0.05 V _{DET}	0.07 V _{DET}	%
I _{DD}	Operating Current	2.5	No load	--	1.2	2	uA
V _{DD}	Operating Voltage	--	--	1.0	--	15	V
I _{OL}	Output Sink Current	1.45	V _{OUT} =0.2V	1	1.5	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.4	--	mV/°C

Electrical Characteristic

MD7019A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	1.843	1.9	1.957	V
V _{HYS}	Hysteresis Width	--	--	0.02 V _{DET}	0.05 V _{DET}	0.07 V _{DET}	%
I _{DD}	Operating Current	2.9	No load	--	1.2	2	uA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	1.8	V _{OUT} =0.2V	1	2	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.5	--	mV/°C

Electrical Characteristic

MD7021A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	2.037	2.1	2.163	V
V _{HYS}	Hysteresis Width	--	--	0.02 V _{DET}	0.05 V _{DET}	0.07 V _{DET}	%
I _{DD}	Operating Current	3.1	No load	--	1.2	2	uA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	2	V _{OUT} =0.2V	1	2	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.5	--	mV/°C



MD7022A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	2.134	2.2	2.266	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	3.2	No load	--	1.2	2	uA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	2	V _{OUT} =0.2V	1.5	3	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _A <70°C	--	±0.5	--	mV/°C

MD7024A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	2.328	2.4	2.472	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	3.4	No load	--	1.2	2	uA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	2.2	V _{OUT} =0.2V	1.5	3	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _A <70°C	--	±0.5	--	mV/°C

MD7027A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	2.619	2.7	2.781	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	3.7	No load	--	1.2	2	uA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	2.5	V _{OUT} =0.2V	2	4	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _A <70°C	--	±0.5	--	mV/°C

MD7028A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	2.716	2.8	2.884	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	3.8	No load	--	1.2	2	uA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	2.7	V _{OUT} =0.2V	2	4	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _A <70°C	--	±0.5	--	mV/°C



MD7030A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	2.91	3.0	3.09	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	4.0	No load	--	1.2	2	μA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	2.7	V _{OUT} =0.2V	2	4	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.5	--	mV/°C

MD7033A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	3.201	3.3	3.399	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	4.3	No load	--	1.2	2	μA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	3.1	V _{OUT} =0.2V	2	4	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.5	--	mV/°C

MD7039A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	3.783	3.9	4.017	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	4.9	No load	--	.22	2	μA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	3.7	V _{OUT} =0.2V	3	6	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.5	--	mV/°C

MD7042A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	4.074	4.2	4.326	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	5.2	No load	--	.12	2	μA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	3.8	V _{OUT} =0.2V	3	6	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.6	--	mV/°C



MD7044A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	4.368	4.4	4.532	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	5.4	No load	--	1.2	2	μA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	4.0	V _{OUT} =0.2V	4	8	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.6	--	mV/°C

MD7050A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	4.850	5.0	5.150	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.1	%
I _{DD}	Operating Current	6.0	No load	--	1.2	2	μA
V _{DD}	Operating Voltage	--	--	1.5	--	15	V
I _{OL}	Output Sink Current	4.8	V _{OUT} =0.2V	4	8	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.6	--	mV/°C

MD7070A

T_A=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Hi→Lo Detectable Voltage	--	--	6.790	7.0	7.210	V
V _{HYS}	Hysteresis Width	--	--	0.02	0.05	0.07	%
I _{DD}	Operating Current	8.0	No load	--	1.2	2	μA
V _{DD}	Operating Voltage	--	--	1.0	--	15	V
I _{OL}	Output Sink Current	6.7	V _{OUT} =0.2V	5	8	--	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	--	0°C<T _a <70°C	--	±0.8	--	mV/°C



Functional Description

The MD70XX series is a set of voltage detectors equipped with a high stability voltage reference which is connected to the negative input of a comparator---denoted as V_{REF} in the following figure for NMOS output voltage detector.

When the voltage drop to the positive input of the comparator (i.e, V_B) is higher than V_{REF} , V_{OUT} goes high, M1 turns off, and V_B is expressed as $V_{BH} = V_{DD} \times (RB+RC)/(RA+RB+RC)$.

If V_{DD} is decreased so that V_B falls to a value less than V_{REF} , the comparator output inverts from high to low, V_{OUT} goes low, V_C is high, M1 turns on, RC is bypassed, and V_B becomes: $V_{BL} = V_{DD} \times RB/(RA+RB)$, which is less than V_{BH} . By so doing, the comparator output will stay low to prevent the circuit from oscillating when $V_B \approx V_{REF}$.

If V_{DD} falls below the minimum operating voltage, the output becomes undefined. When V_{DD}

goes from low to $V_{DD} \times RB/(RA+RB) > V_{REF}$, the comparator output and V_{OUT} goes high.

The detectable voltage is defined as:

$$V_{DET} (-) = \frac{RA + RB + RC}{RB + RC} \times V_{REF}$$

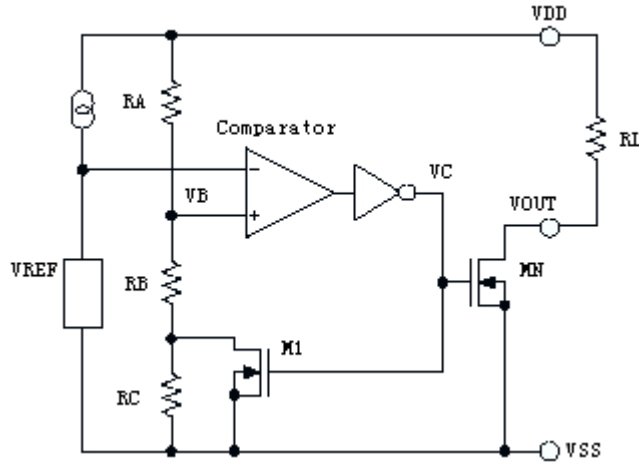
The release voltage is defined as:

$$V_{DET} (+) = \frac{RA + RB}{RB} \times V_{REF}$$

The hysteresis width is:

$$V_{HYS} = V_{DET} (+) - V_{DET} (-)$$

The figure demonstrates the NMOS output type with positive output polarity (V_{OUT} is normally open, active low). The MD70XX series also supplies options for other output types with active high outputs. Application circuits shown are examples of positive output polarity (normally open, active low) unless otherwise specified.



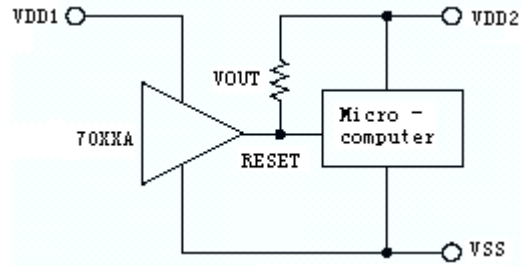
NMOS output voltage detector (MD70XXA)

Application Circuits

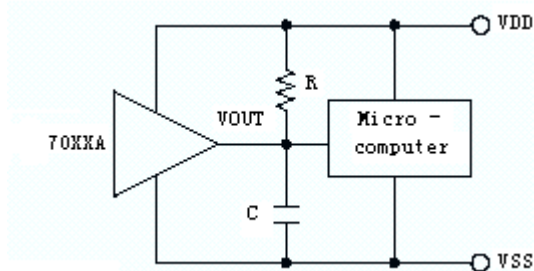
Microcomputer reset circuit

Normally a reset circuit is required to protect the microcomputer system from malfunctions due to power line interruptions. The following examples show how different output configurations perform a reset function in various systems.

- NMOS open drain output application for separate power supply

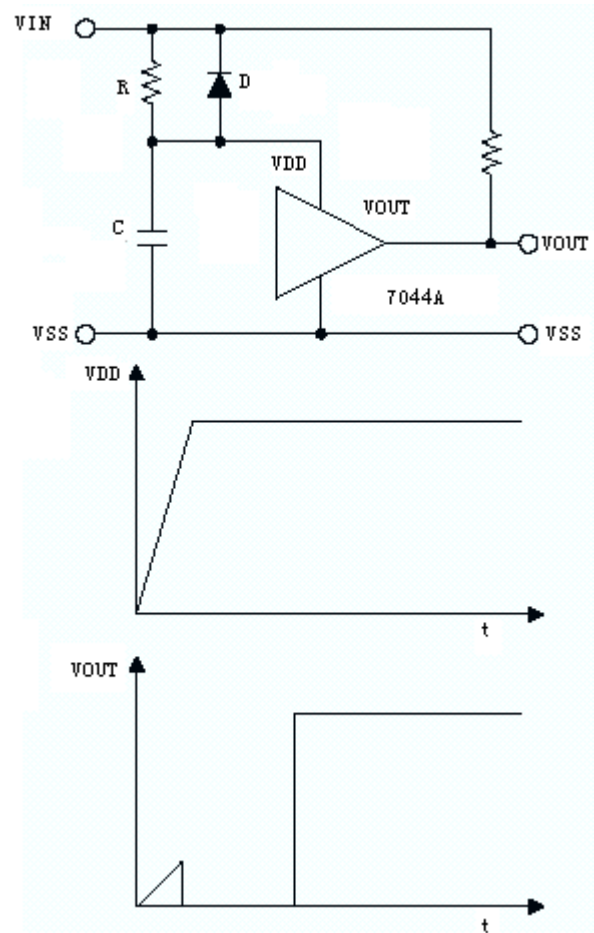


- NMOS open drain output application with R-C delay



Power-on reset circuit

With several external components, the NMOS open drain type of the MD70XX series can be used to perform a power-on reset function as shown:

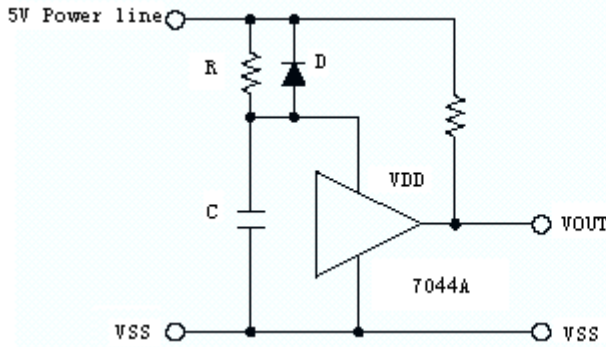




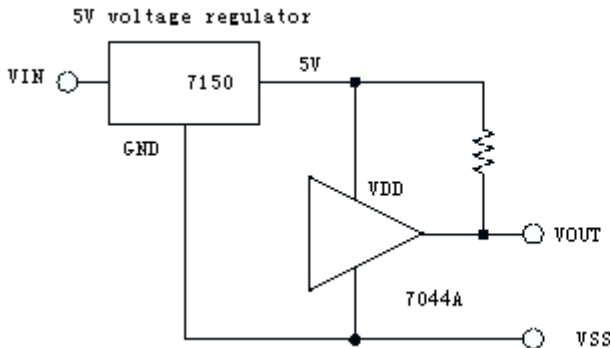
5V power line monitoring circuit

Generally, a minimum operating voltage of 4.5V is guaranteed in a 5V power line system. The MD7044A is recommended for use as 5V power line monitoring circuit.

- 5V power line monitor with power-on reset



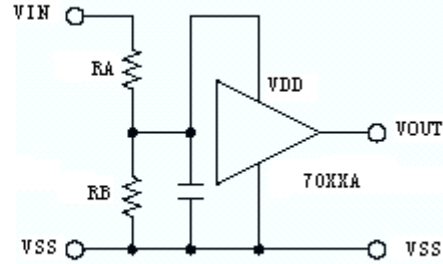
- with 5V voltage regulator



Change of detectable voltage

If the required voltage is not found in the standard product selection table, it is possible to change it by using external resistance dividers or diodes.

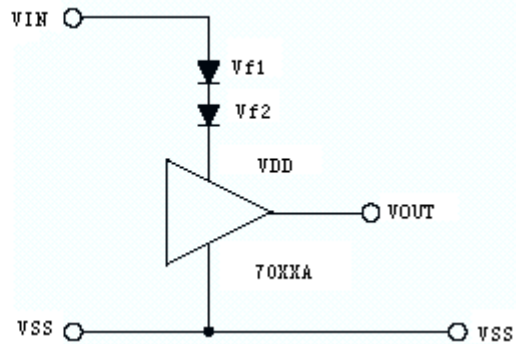
- Varying the detectable voltage with a resistance divider



$$\text{Detectable voltage} = \frac{RA \times RB}{RB} \times V_{DET}$$

$$\text{Hysteresis width} = \frac{RA \times RB}{RB} \times V_{HYS}$$

- Varying the detectable voltage with a diode

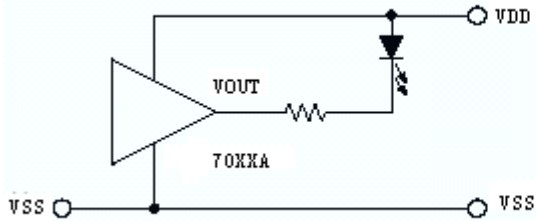


$$\text{Detectable Voltage} = V_{f1} + V_{f2} + V_{DET}$$



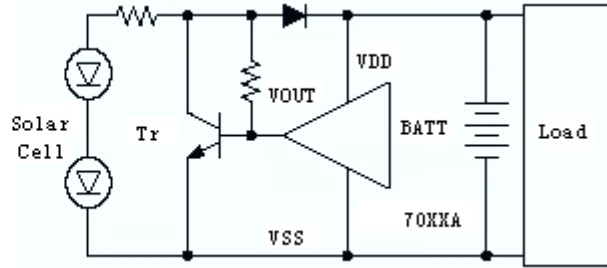
Malfunction analysis

The following circuit demonstrates the way a circuit analyzes malfunctions by monitoring the variation or spike noise of power supply voltage.



Charge monitoring circuit

The following circuit shows a charged monitor for protection against battery deterioration by overcharging. When the voltage of the battery is higher than the set detectable voltage, the transistor turns on to bypass the charge current, protecting the battery from overcharging.



Level selector

The following diagram illustrates a logic level selector.

