

Features

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

Applications

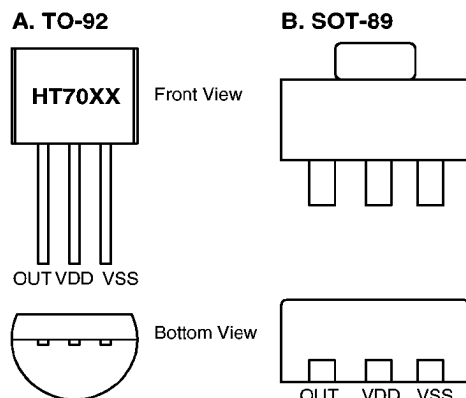
- Battery checkers
- Level selectors
- Power failure detectors
- Microcomputer reset
- Battery memory backup
- Non-volatile RAM signal storage protectors

General Description

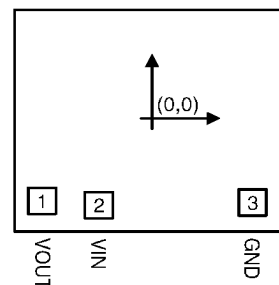
The HT70XX series is a set of three-terminal low power voltage detectors implemented in CMOS technology. Each voltage detector in the series detects a particular fixed voltage ranging from 1.5V to 7V. The voltage detectors consist of a high-precision and low power consumption standard voltage source, 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).

Pin Assignment



Pad Coordinates



Chip size: $1317 \times 1158 (\mu\text{m})^2$

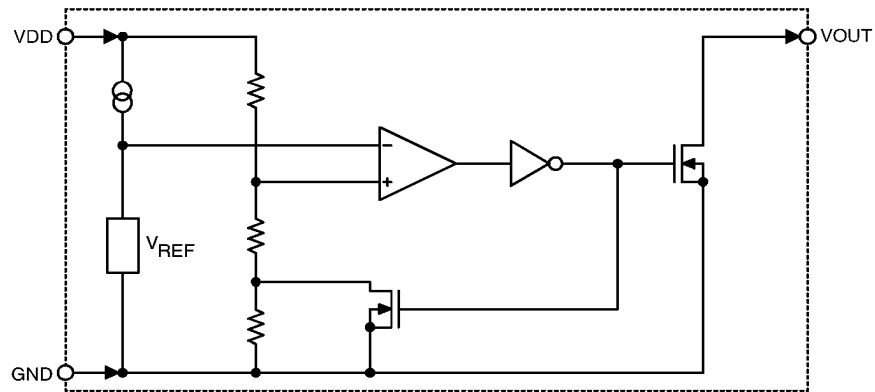
* The IC substrate should be connected to VDD in the PCB layout artwork.

Unit: μm

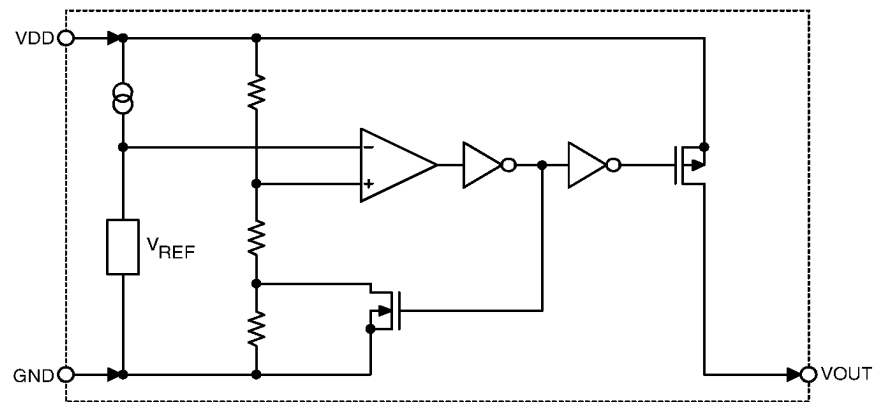
Pad No.	X	Y
1	-483.30	-379.50
2	-234.60	-399.50
3	443.90	-386.00

Block Diagram

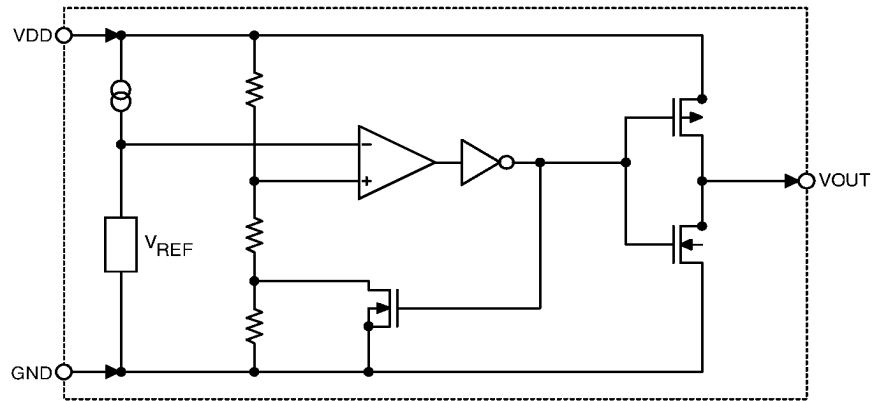
N channel open drain output (normal open; active low)



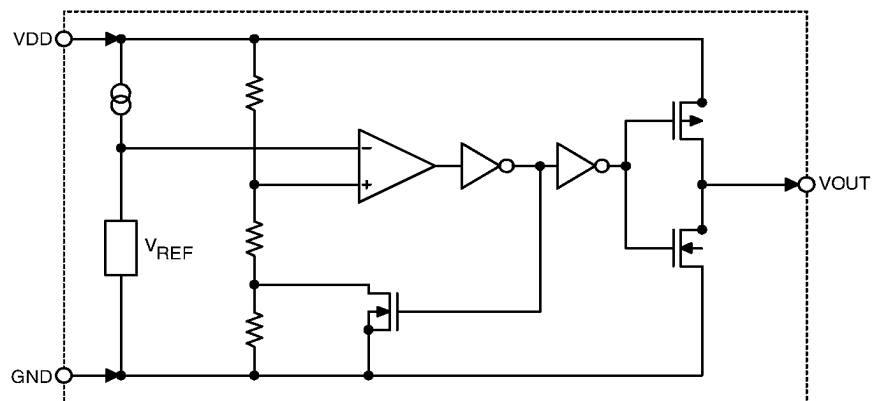
P channel open drain output (normal open; active high)



CMOS output (normal high, active low)



CMOS output (normal high, active high)



Selection Guide

Part No.	Detectable Voltage	Hysteresis Width	Tolerance
HT7024A/B	2.4V	0.12V	±2.4%, ±5%
HT7027A/B	2.7V	0.135V	±2.4%, ±5%
HT7033A/B/D	3.3V	0.165V	±2.4%, ±5%
HT7039A/B	3.9V	0.195V	±2.4%, ±5%
HT7044A/B/C	4.4V	0.22V	±2.4%, ±5%
HT7050A/B	5V	0.25V	±2.4%, ±5%
HT7070A/B	7V	0.35V	±2.4%, ±5%

Note: The output type selection codes are:

NMOS open drain normal open, active low

PMOS open drain normal open, active high

For example: The HT7070A is a 7V, NMOS open drain active low output

For semi-custom parts, selectable regulated voltage range is from 2.4V to 9V in 0.1V increment, if custom's first order is 100k pieces.

Output type selection table

Type	V _{OUT}	V _{DD}	
		V _{DD} >V _{DET} (+)	V _{DD} ≤V _{DET} (-)
	A	Hi-Z	VSS
	B	Hi-Z	VDD
	C	VSS	VDD
	D	VDD	VSS

Absolute Maximum Ratings*

Supply Voltage	-0.3V to 26V	Output Current.....	50mA
Output Voltage	VSS-0.3V to VDD+0.3V	Storage Temperature	-50°C to 125°C
Power Consumption	200mW	Operating Temperature.....	0°C to 70°C

*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 Characteristics
HT7024

(Ta=25°C)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detectable Voltage	—	—	2.28	2.4	2.52	V
V _{HYS}	Hysteresis Width	—	—	0.02 V _{DET}	0.05 V _{DET}	0.1 V _{DET}	V
I _{DD}	Operating Current	8	No load	—	4	7	μA
V _{DD}	Operating Voltage	—	—	1.5	—	24	V
I _{OL}	Output Sink Current	2	V _{OUT} =0.2V	0.5	1	—	mA
I _{OH}	Output Source Current	2	V _{OUT} =2.25V	−0.3	−0.5	—	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	—	0°C < Ta°C < 70°C	—	±0.9	—	mV/°C

Note: HT7024A has no I_{OH}
HT7024B has no I_{OL}

HT7027

(Ta=25°C)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detectable Voltage	—	—	2.565	2.7	2.835	V
V _{HYS}	Hysteresis Width	—	—	0.02 V _{DET}	0.05 V _{DET}	0.1 V _{DET}	V
I _{DD}	Operating Current	8	No load	—	4	7	μA
V _{DD}	Operating Voltage	—	—	1.5	—	24	V
I _{OL}	Output Sink Current	2	V _{OUT} =0.2V	0.5	1	—	mA
I _{OH}	Output Source Current	2	V _{OUT} =2.25V	−0.3	−0.5	—	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	—	0°C < Ta°C < 70°C	—	±0.9	—	mV/°C

Note: HT7027A has no I_{OH}
HT7027B has no I_{OL}

HT7033

(Ta=25°C)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detectable Voltage	—	—	3.135	3.3	3.465	V
V _{HYS}	Hysteresis Width	—	—	0.02 V _{DET}	0.05 V _{DET}	0.1 V _{DET}	V
I _{DD}	Operating Current	8	No load	—	4	7	μA
V _{DD}	Operating Voltage	—	—	1.5	—	24	V
I _{OL}	Output Sink Current	2.5	V _{OUT} =0.25V	1.2	2.5	—	mA
I _{OH}	Output Source Current	2.5	V _{OUT} =2.25V	-0.75	-1.5	—	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	—	0°C < Ta°C < 70°C	—	±0.9	—	mV/°C

Note: HT7033A has no I_{OH}

HT7033B has no I_{OL}
HT7039

(Ta=25°C)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detectable Voltage	—	—	3.705	3.9	4.095	V
V _{HYS}	Hysteresis Width	—	—	0.02 V _{DET}	0.05 V _{DET}	0.1 V _{DET}	V
I _{DD}	Operating Current	8	No load	—	4	7	μA
V _{DD}	Operating Voltage	—	—	1.5	—	24	V
I _{OL}	Output Sink Current	2.5	V _{OUT} =0.25V	1.2	2.5	—	mA
I _{OH}	Output Source Current	2.5	V _{OUT} =2.25V	-0.75	-1.5	—	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	—	0°C < Ta°C < 70°C	—	±0.9	—	mV/°C

Note: HT7039A has no I_{OH}

HT7039B has no I_{OL}

HT7044

(Ta=25°C)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detectable Voltage	—	—	4.18	4.4	4.62	V
V _{HYS}	Hysteresis Width	—	—	0.02 V _{DET}	0.05 V _{DET}	0.1 V _{DET}	V
I _{DD}	Operating Current	8	No load	—	4	7	μA
V _{DD}	Operating Voltage	—	—	1.5	—	24	V
I _{OL}	Output Sink Current	3.6	V _{OUT} =0.36V	3	6	—	mA
I _{OH}	Output Source Current	3.6	V _{OUT} =3.2V	–1	–2	—	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	—	0°C < Ta°C < 70°C	—	±0.9	—	mV/°C

Note: HT7044A has no I_{OH}
HT7044B has no I_{OL}

HT7050

(Ta=25°C)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detectable Voltage	—	—	4.75	5	5.25	V
V _{HYS}	Hysteresis Width	—	—	0.02 V _{DET}	0.05 V _{DET}	0.1 V _{DET}	V
I _{DD}	Operating Current	8	No load	—	4	7	μA
V _{DD}	Operating Voltage	—	—	2.1	—	24	V
I _{OL}	Output Sink Current	3.6	V _{OUT} =0.36V	3	6	—	mA
I _{OH}	Output Source Current	3.6	V _{OUT} =3.2V	–1	–2	—	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	—	0°C < Ta°C < 70°C	—	±0.9	—	mV/°C

Note: HT7050A has no I_{OH}
HT7050B has no I_{OL}

HT7070

(Ta=25°C)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detectable Voltage	—	—	6.65	7	7.35	V
V _{HYS}	Hysteresis Width	—	—	0.02 V _{DET}	0.05 V _{DET}	0.1 V _{DET}	V
I _{DD}	Operating Current	8	No load	—	4	7	μA
V _{DD}	Operating Voltage	—	—	2.1	—	24	V
I _{OL}	Output Sink Current	5	V _{OUT} = 0.5V	5	10	—	mA
I _{OH}	Output Source Current	5	V _{OUT} = 4.5 V	–2	–4	—	mA
$\frac{\Delta V_{DET}}{\Delta T_A}$	Temperature Coefficient	—	0°C < Ta°C < 70°C	—	±0.9	—	mV/°C

Note: HT7070A has no I_{OH}

HT7070B has no I_{OL}

Functional Description

The HT70XX 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 (Fig. 1).

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}*(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}*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 ≈ V_{REF}.

If V_{DD} falls below the minimum operating voltage, the output becomes undefined. When V_{DD} goes from low to V_{DD}*RB/(RA+RB) > V_{REF}, the comparator output and V_{OUT} goes high.

The detectable voltage is defined as:

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

The release voltage is defined as:

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

The hysteresis width is:

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

Figure 1 demonstrates the NMOS output type with positive output polarity (V_{OUT} is normally open, active low). The HT70XX series also supplies options for other output types with active high outputs. Application circuits shown next page are examples of positive output polarity (normally open, active low) unless otherwise specified.

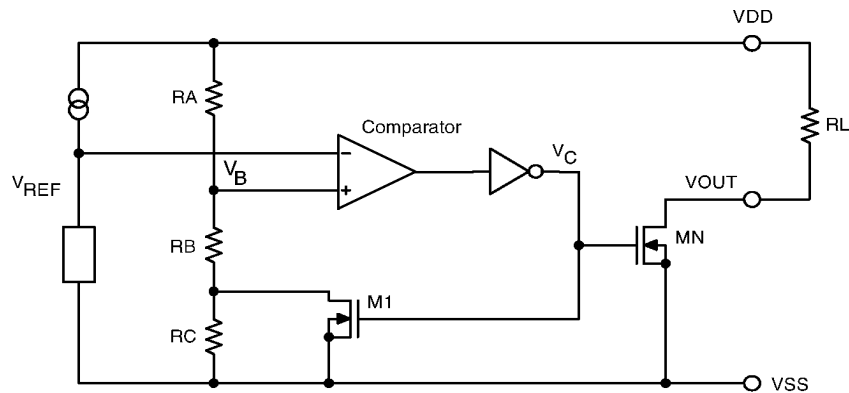


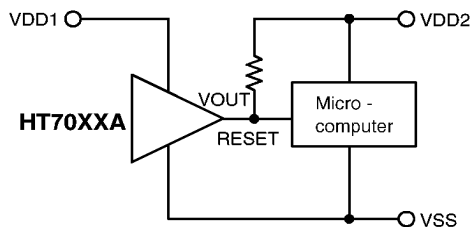
Fig. 1 NMOS output voltage detector (HT70XXA)

Application Circuit

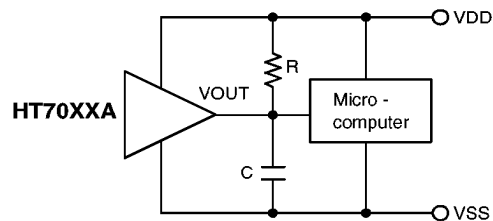
Microcomputer reset circuit

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

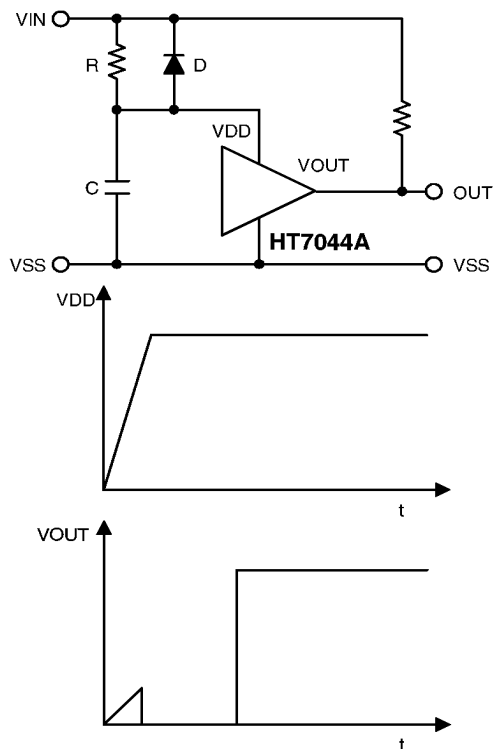


- NMOS open drain output application with R-C delay



Power-on reset circuit

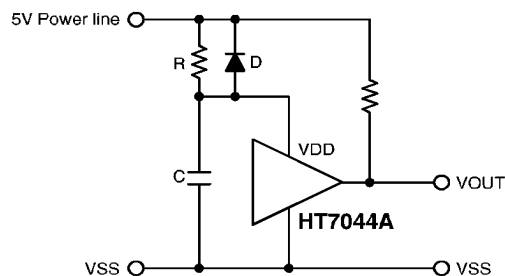
With several external components, the NMOS open drain type of the HT70XX series can be used to perform a power-on reset function as shown:



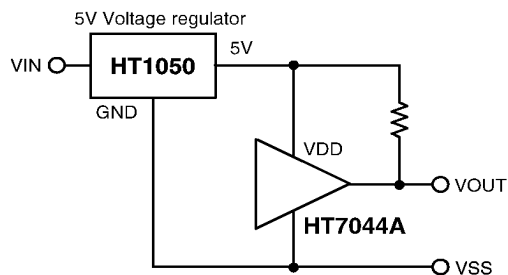
5V power line monitoring circuit

Generally, a minimum operating voltage of 4.5V is guaranteed in a 5V power line system. The HT7044A is recommended for use as 5V power line monitoring circuit.

- 5V power line monitor with power-on reset



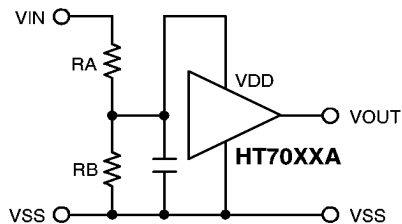
- with 5V voltage regulator



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.

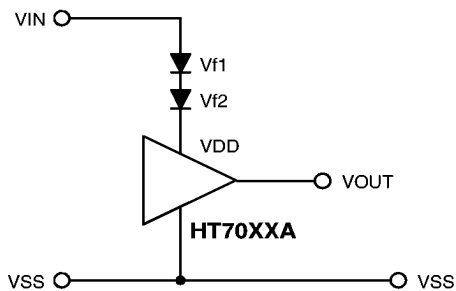
- Varying the detectable voltage with a resistance divider



$$\text{Detection voltage} = \frac{RA+RB}{RB} * V_{DET}$$

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

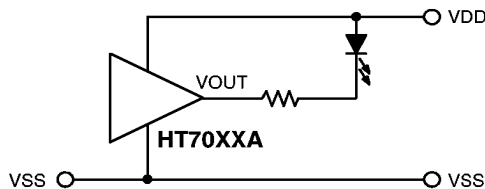
- Varying the detectable voltage with a diode



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

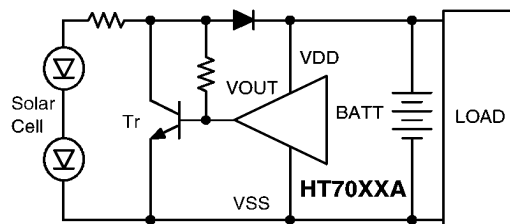
Malfunction analysis

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



Charge monitoring circuit

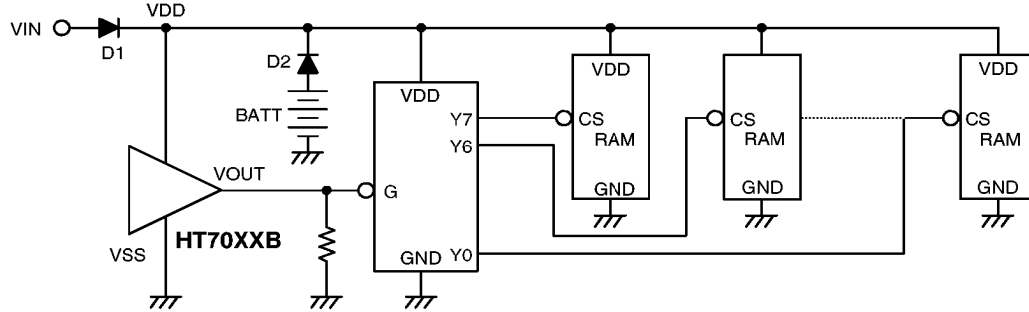
The following circuit shows a charged monitor for protection against battery deterioration by overcharging. When the voltage of the battery is higher than the set detectable voltage, the transistor turns on to bypass the charge current, protecting the battery from overcharging.



Battery backup for memories

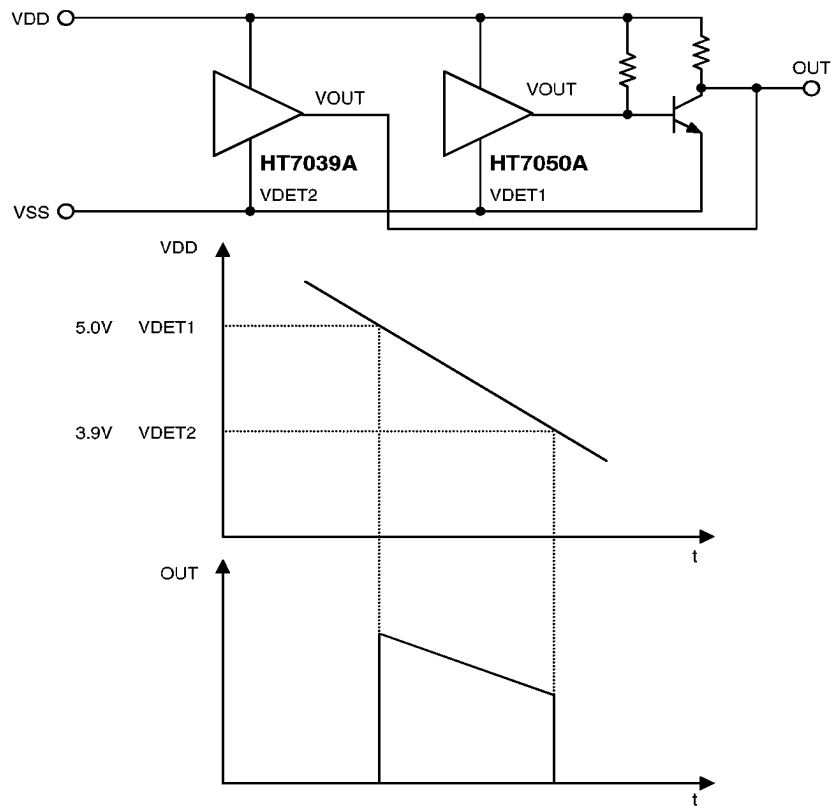
An application example of battery backup for memory data retention is shown below. During battery backup (VDD below detectable voltage),

the HT70XXB output goes high to disable the chip select decoder and to force the memory chips into a non-access state so as to retain the data.



Level selector

The following diagram illustrates a logic level selector.

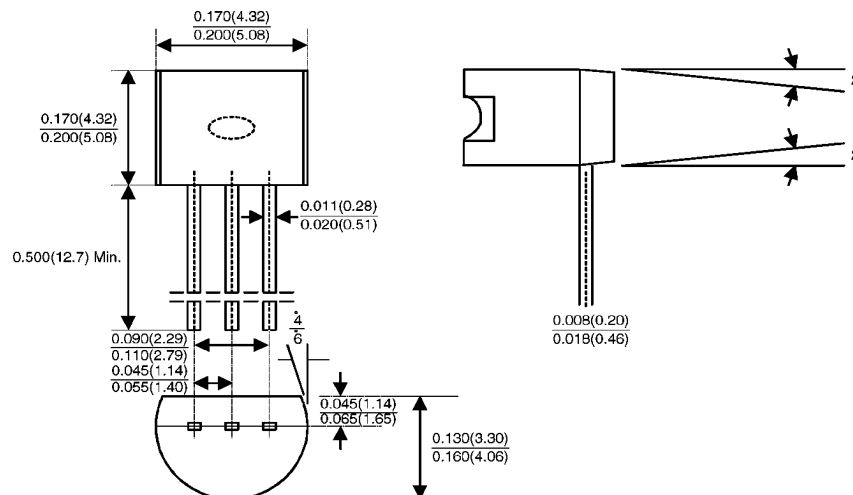


Package Information

Dimension

All linear dimensions are in inches and parenthetically in millimeters ($\frac{\text{Min.}}{\text{Max.}}$)

3-pin TO-92 package



SOT-89 package

