

Features

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

Applications

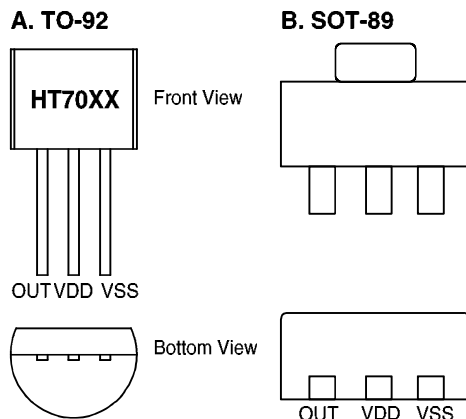
- Battery checkers
- Level selectors
- Power failure detectors
- Microcomputer reset
- Battery backup of memories
- Store non-volatile RAM signal protectors

General Description

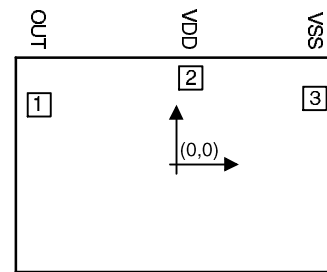
The HT70XX series is a set of three-terminal low power voltage detectors implemented in CMOS technology. Each voltage detector in the series detects a particular fixed voltage ranging from 1.5V to 7V. The voltage detectors consist of a high-precision and low power consumption standard voltage source,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

ogy ensures low power consumption. Although the HT70XX series is designed for use in fixed voltage detectors, it can be combined with external components to detect user specified threshold voltages (of the NMOS open drain type only).

Pin Assignment



Pad Assignment



Chip size: $80 \times 52 \text{ (mil)}^2$

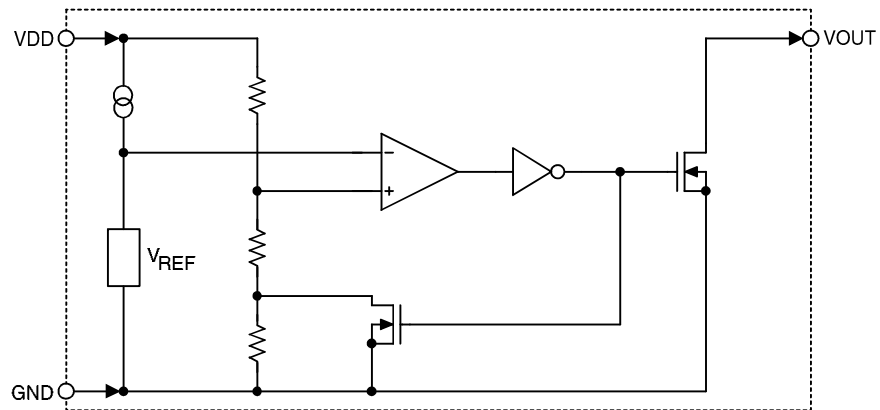
* The IC substrate should be connected to VDD in the PCB layout artwork.

Unit: mil

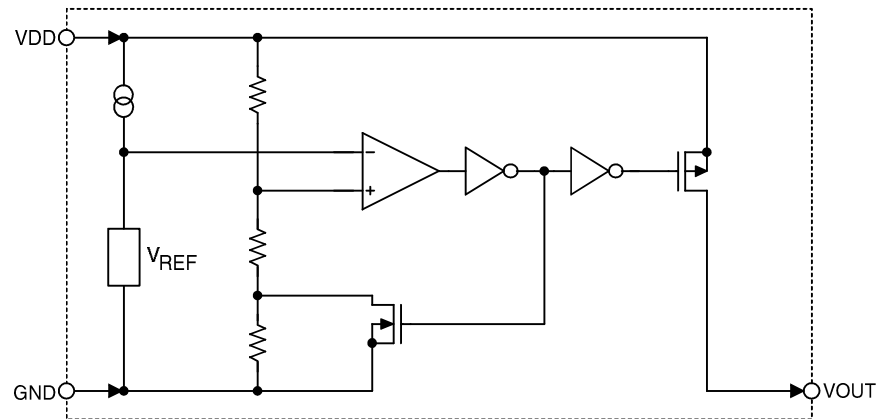
Pad No.	Symbol	X	Y
1	OUT	-17.1	15.55
2	VDD	4.75	18.15
3	VSS	30.5	16.25

Block Diagram

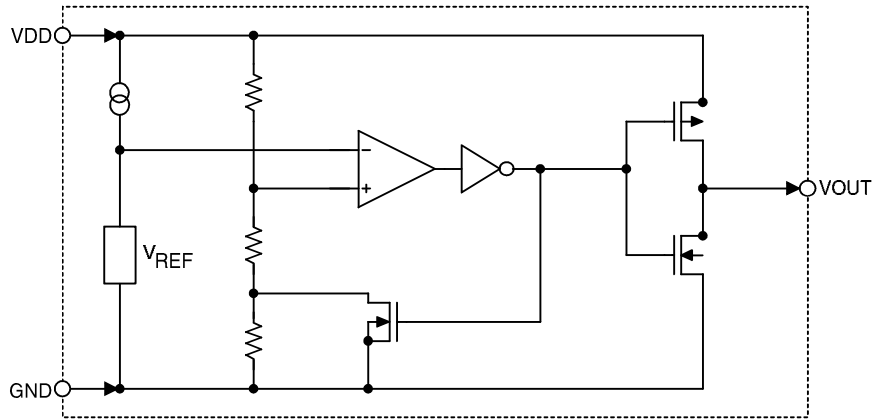
N channel open drain output (normal open; active low)



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



CMOS output (normal high, active low)



Selection Guide

Item	Detect Voltage	Hysteresis Width	Tolerance
HT7070	7V	0.35V	±2.4%, ±5%
HT7050	5V	0.25V	±2.4%, ±5%
HT7044	4.4V	0.22V	±2.4%, ±5%
HT7039	3.9V	0.195V	±2.4%, ±5%
HT7033	3.3V	0.165V	±2.4%, ±5%
HT7027	2.7V	0.135V	±2.4%, ±5%
HT7024	2.4V	0.12V	±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.

Selectable regulation voltage range from 2.4V to 9V in 0.1V increments. If custom first order 100K piece. semi-custom parts)

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		VDD	VSS

Absolute Maximum Ratings*

Supply Voltage	-0.3V to 26V	Output Current.....	50mA
Output Voltage.....	V _{SS} -0.3V to V _{DD} +0.3V	Storage Temperature.....	-50°C to 125°C
Power Dissipation.....	200mΩ	Operating Temperature.....	0°C to 70°C

*Note: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics
(HT7024)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detection 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 < T _a °C < 70°C	—	±0.9	—	mV/°C

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

(HT7027)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detection 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 < T _a °C < 70°C	—	±0.9	—	mV/°C

Note: The HT7027A has no I_{OH}.

The HT7027B has no I_{OL}.

(HT7033)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detection 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 < T _a °C < 70°C	—	±0.9	—	mV/°C

Note: The HT7033A has no I_{OH}.

The HT7033B has no I_{OL}.

(HT7039)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detection 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 < T _a °C < 70°C	—	±0.9	—	mV/°C

Note: The HT7039A has no I_{OH}.
The HT7039B has no I_{OL}.

(HT7044)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detection 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 < T _a °C < 70°C	—	±0.9	—	mV/°C

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

(HT7050)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detection 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 < T _a °C < 70°C	—	±0.9	—	mV/°C

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

(HT7070)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DET}	Detection 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 < T _a °C < 70°C	—	±0.9	—	mV/°C

Note: The HT7070A has no I_{OH}.
The 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 $V_{BH} = VDD * (RB + RC) / (RA + RB + RC)$. If VDD is decreased so that V_B falls to a value that is 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: $V_{BL} = VDD * RB / (RA + RB)$, 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 VDD falls below the minimum operating voltage, the output becomes undefined. When VDD goes from low to $VDD * RB / (RA + RB) >$

V_{REF} , the comparator output goes high and V_{OUT} goes high again.

The detection voltage is as defined:

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

The release voltage is as defined:

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

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 in the next paragraph are examples of positive output polarity (normally open, active low) unless otherwise specified.

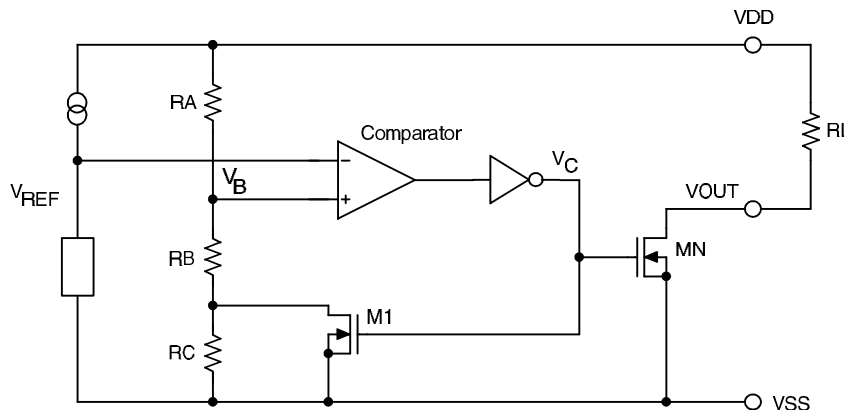


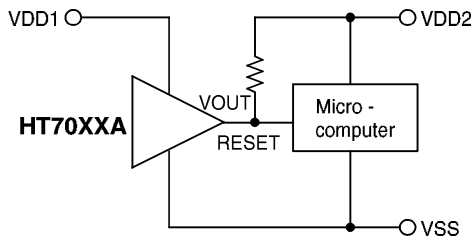
Fig. 1 NMOS output voltage detector (HT70XXA)

Application Circuit

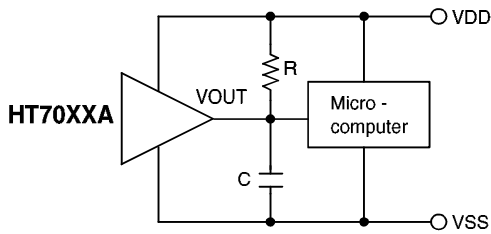
Micro-computer reset circuit

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

- NMOS open drain output application for separate power supply

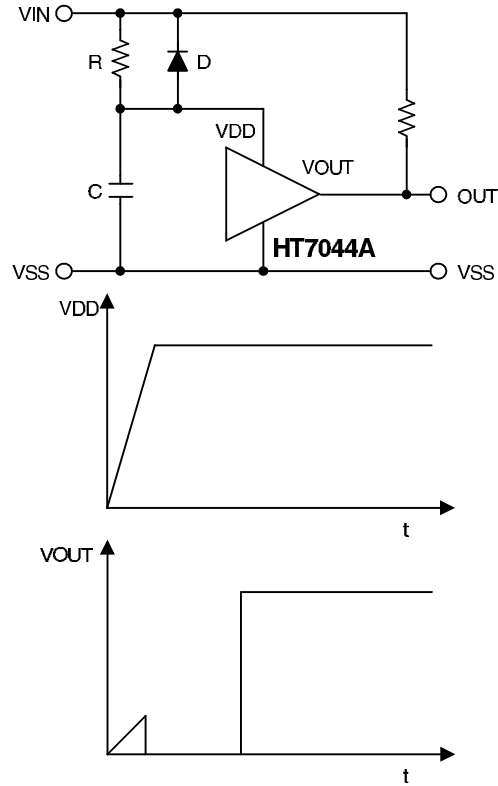


- NMOS open drain output application with R-C delay



Power-on reset circuit

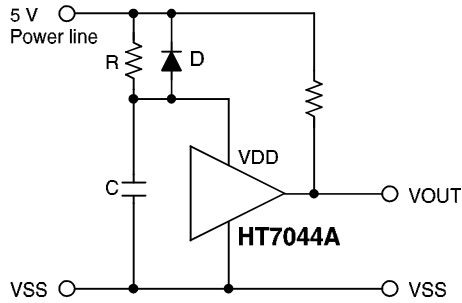
With several external components, the NMOS open drain type of the HT70XX series can be used to perform a power-on reset function as shown:



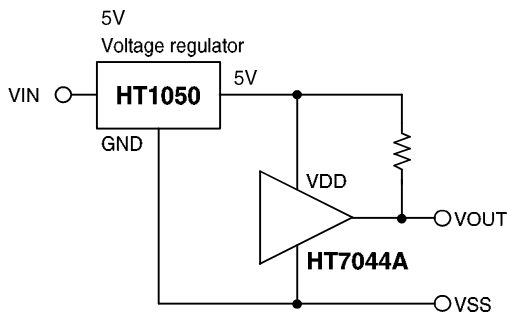
5V power line monitoring circuit

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

- 5V power line monitor with power-on reset



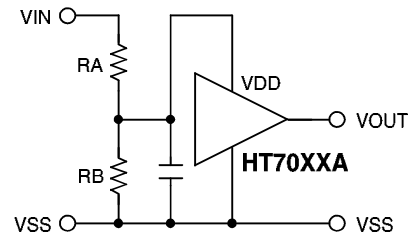
- with a 5V voltage regulator



Change of detection voltage

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

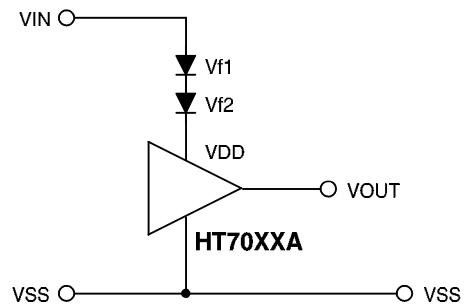
- Varying the detection voltage with a resistance divider



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

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

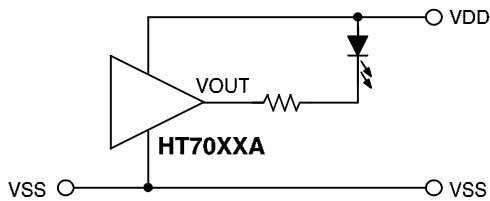
- Varying the detection voltage with a diode



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

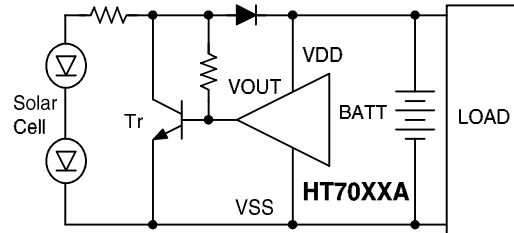
Malfunction analysis

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



Charge monitoring circuit

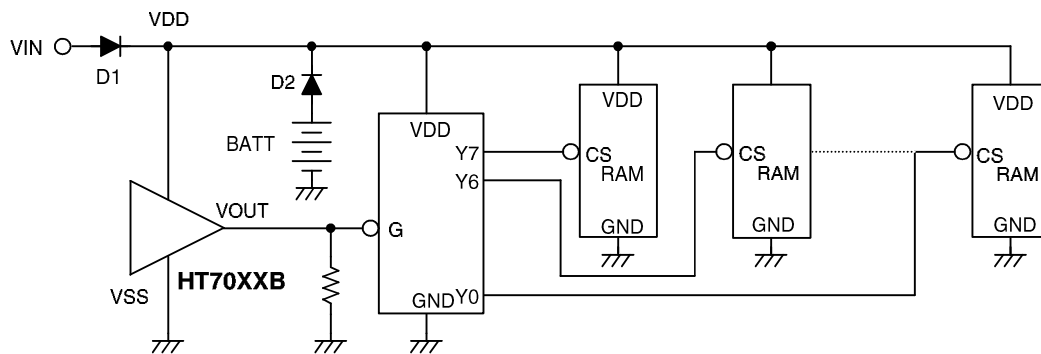
The following circuit shows a charge monitor for protection against battery deterioration by overcharging. When the voltage of the battery is higher than the set detection voltage, the transistor turns on to bypass the charge current, protecting the battery from overcharging.



Battery back up of memories

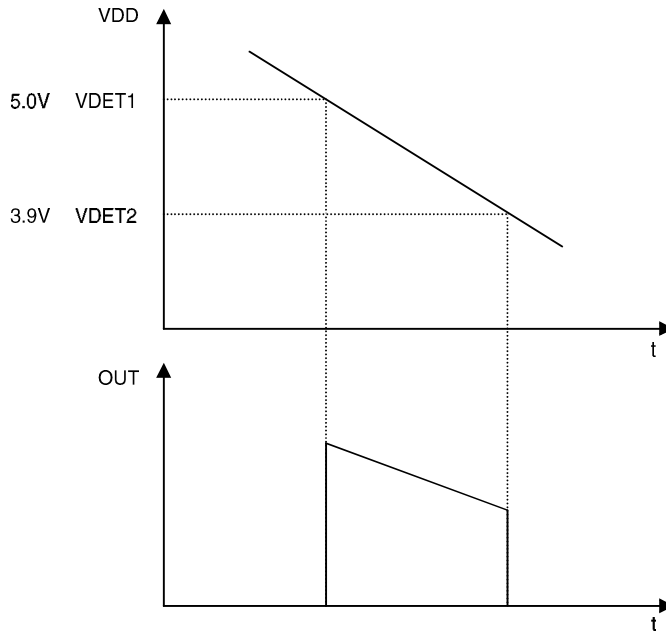
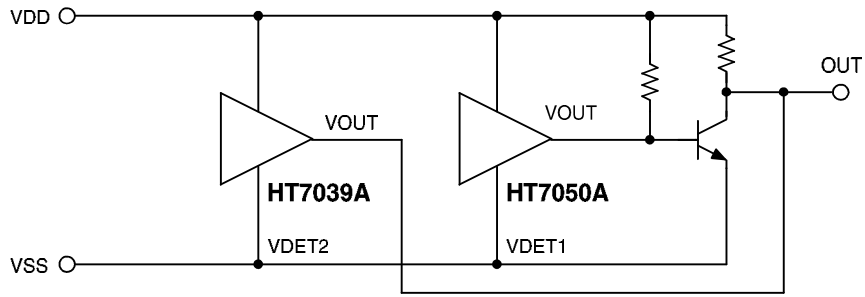
An application example of battery backup for memory data retention is shown below. During battery backup (VDD below detection voltage),

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



Level selector

The following diagram illustrates a logic level selector.

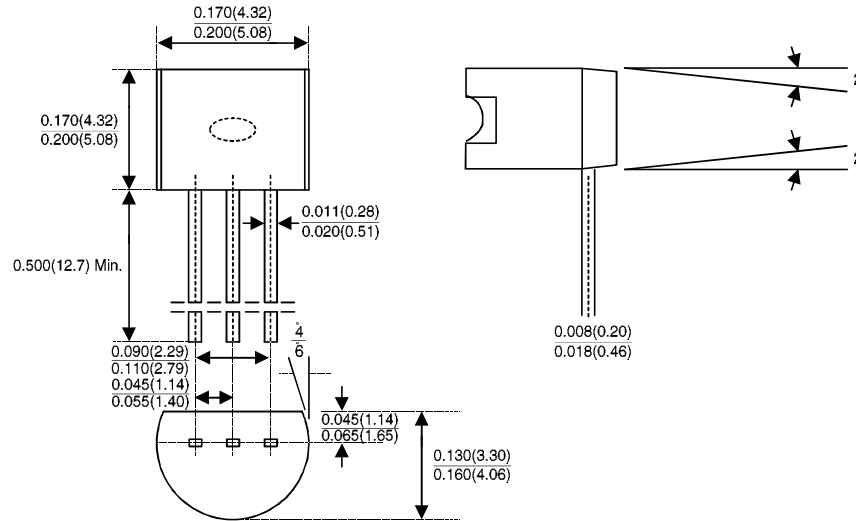


Package Information

Dimension

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

3-pin TO-92 package



SOT-89 package

