HT70XX
Voltage Detector

Features

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

Applications

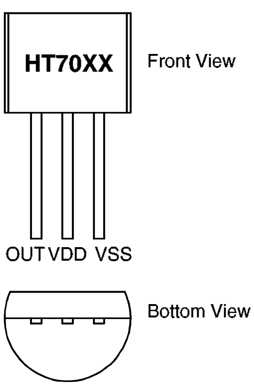
- Battery checkers
- Level selectors
- Power failure detectors
- Microcomputer reset
- Battery backup of memories
- Store non-volatile RAM signal protectors

General Description

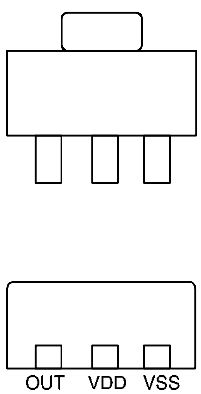
The HT70XX series is a set of three-terminal low power voltage detectors implemented in CMOS technology. Each voltage detector in the series detects a particular fixed voltage ranging from 1.5V to 7V. The voltage detectors consist of a high-precision and low power consumption standard voltage source,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

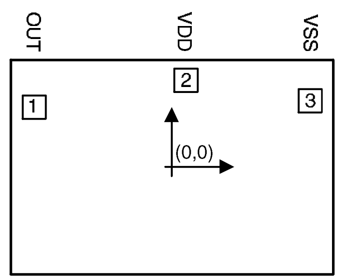
A. TO-92



B. SOT-89



Pad Assignment



Chip size: 80×52 (mil)^2

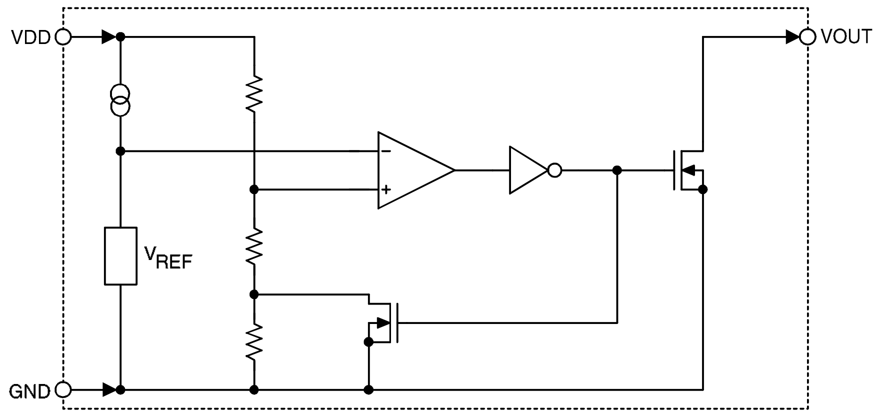
* The IC substrate should be connected to VDD in the PCB layout artwork.

Unit: mil

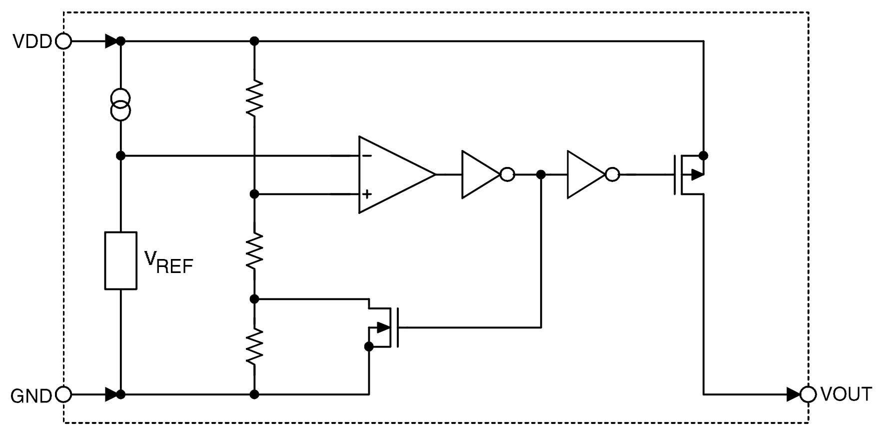
Pad No.	Symbol	X	Y
1	OUT	–17.1	15.55
2	VDD	4.75	18.15
3	VSS	30.5	16.25

Block Diagram

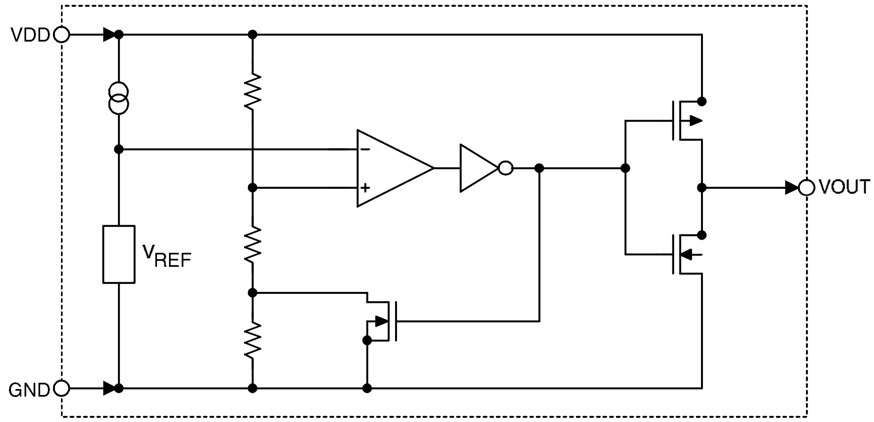
N channel open drain output (normal open; active low)



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



CMOS output (normal hign, 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.

Output type selection table

Type \ V_{DD} / V_{OUT}	$V_{DD}>V_{DET}(+)$	$V_{DD}\leq V_{DET}(-)$
A	Hi–Z	VSS
B	Hi–Z	VDD
C	VDD	VSS

Absolute Maximum Ratings

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

Electrical Characteristics

(HT7024)

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{DD}	Condition				
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 < Ta°C < 70°C	—	±0.9	—	mV/°C

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

(HT7027)

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{DD}	Condition				
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 < Ta°C < 70°C	—	±0.9	—	mV/°C

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

(HT7033)

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{DD}	Condition				
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 < Ta°C < 70°C	—	±0.9	—	mV/°C

Note: The HT7033A has no I_{OH}.
The HT7033B has no I_{OL}.

(HT7039)

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{DD}	Condition				
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 < Ta°C < 70°C	—	±0.9	—	mV/°C

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

(HT7044)

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{DD}	Condition				
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 < Ta°C < 70°C	—	±0.9	—	mV/°C

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

(HT7050)

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
		V_{DD}	Condition				
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 < Ta°C < 70°C	—	±0.9	—	mV/°C

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

(HT7070)

Symbol	Parameter	Test Condition V_{DD}	Test Condition Condition	Min.	Typ.	Max.	Unit
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 < Ta°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}, VOUT 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), VOUT 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 bellow 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 VOUT 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 (VOUT 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.

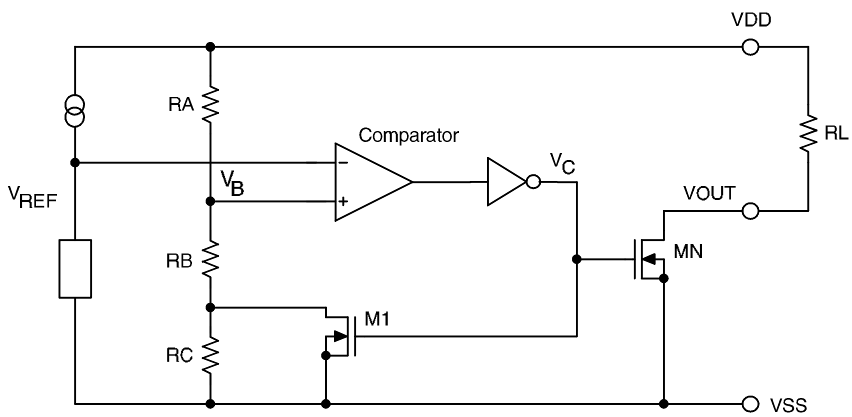


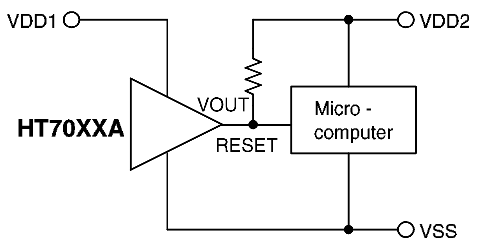
Fig. 1 NMOS output voltage detector (HT70XXA)

Application Circuit

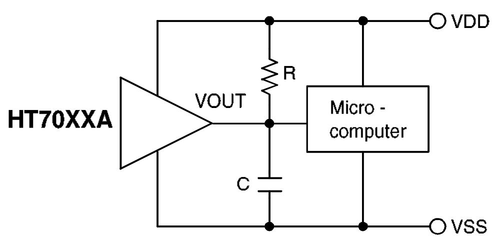
Micro-computer reset circuit

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

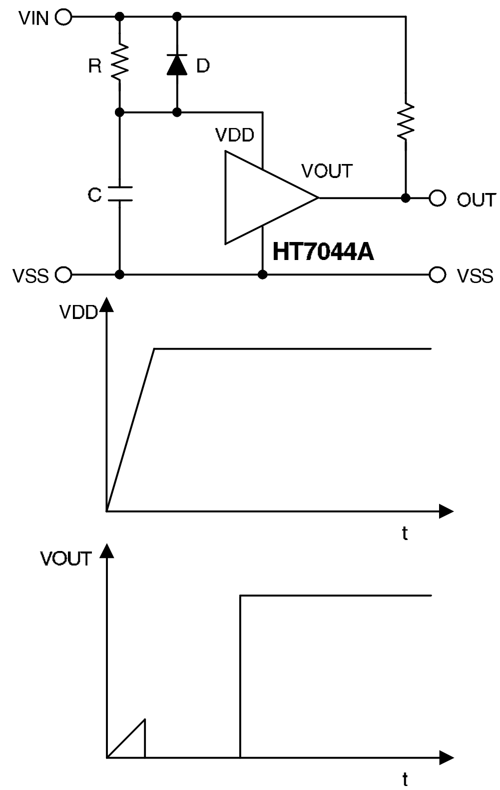


- NMOS open drain output application with R-C delay



Power-on reset circuit

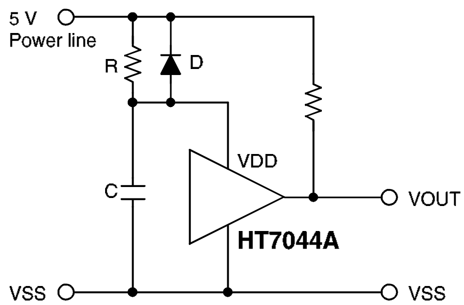
With several external components, the NMOS open drain type of the HT70XX series can be used to perform a power-on reset function as shown:



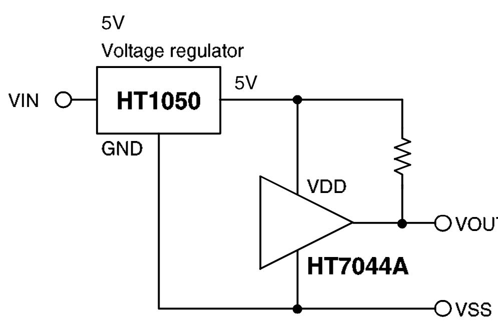
5V power line monitoring circuit

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



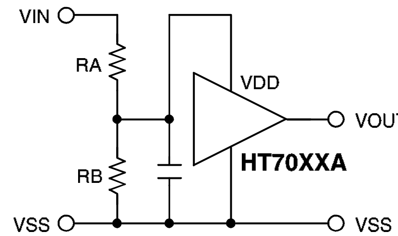
• with a 5V voltage regulator



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.

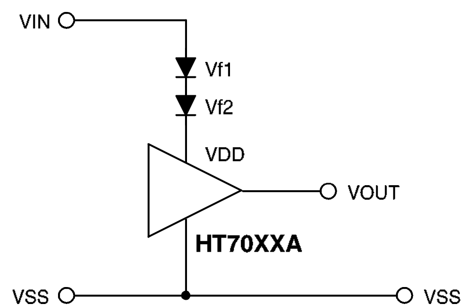
• Varying the detection voltage with a resistance divider



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

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

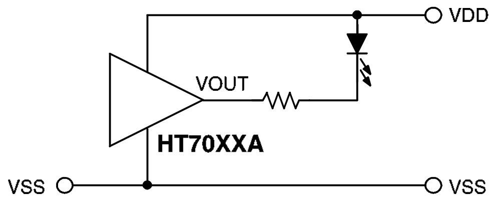
• Varying the detection voltage with a diode



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

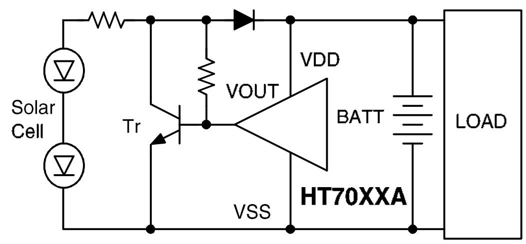
Malfunction analysis

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



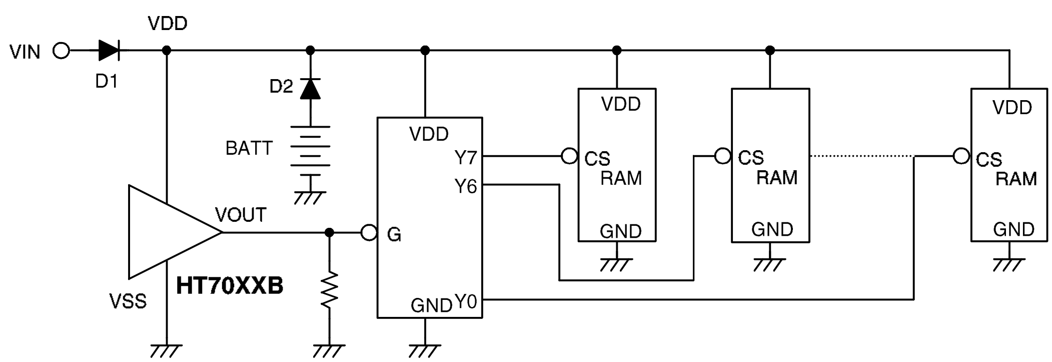
Charge monitoring circuit

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.



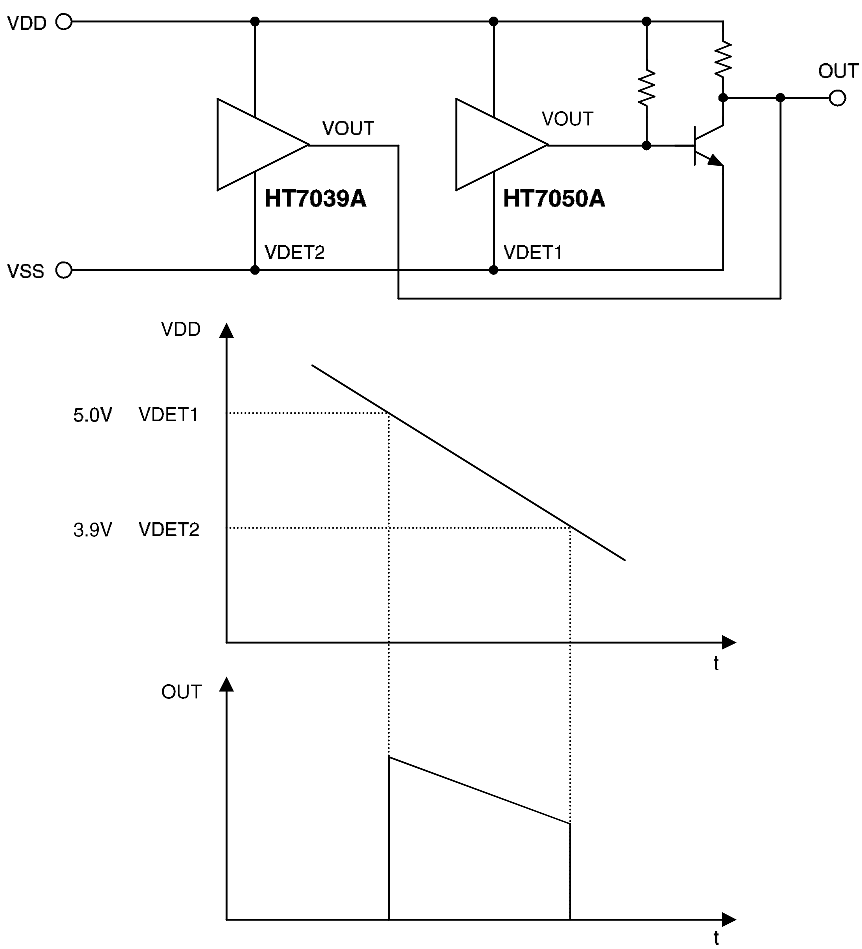
Battery back up of memories

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.



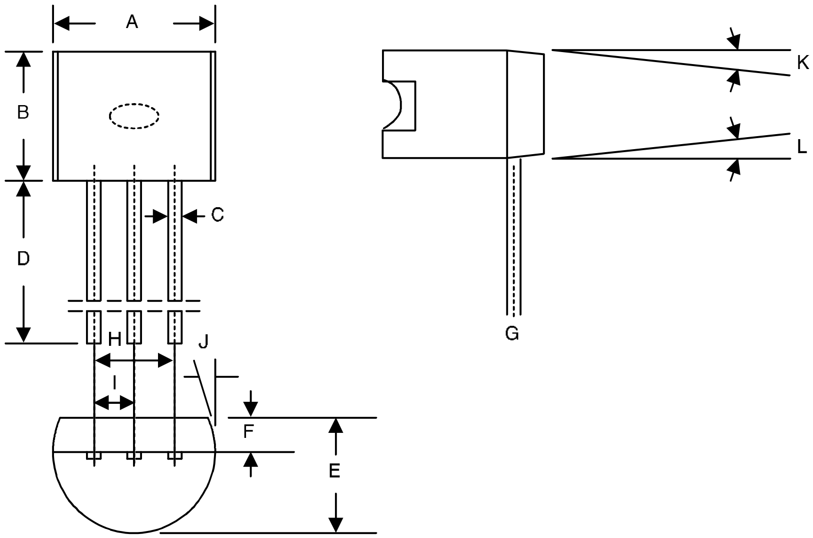
Level selector

The following diagram illustrates a logic level selector.



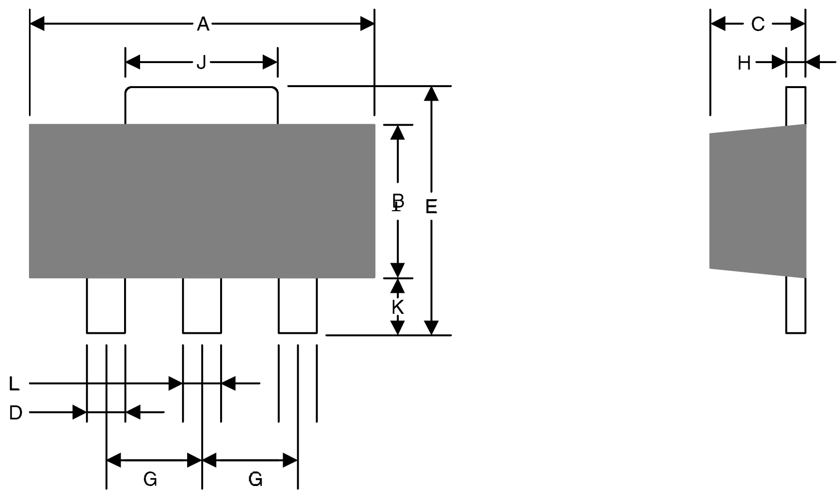
Package Information

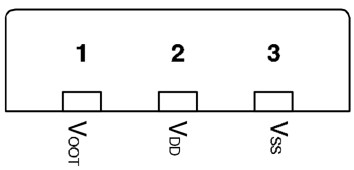
TO-92



	mm	inches	degree		mm	inches	degree
A	4.57	0.180	—	I	1.27	0.050	—
B	4.57	0.180	—	J	—	—	5
C	0.38	0.015	—	K	—	—	2
D	13.5	0.531	—	L	—	—	2
E	3.66	0.140	—				
F	1.27	0.050					
G	0.39	0.011					
H	2.54	0.100					

TO-89 Outline





	mm	inches		mm	inches
A	4.60	0.18	I		
B	2.60	0.102	J	1.70	0.669
C	1.60	0.063	K	0.80	0.031
D	0.48	0.019	L	0.53	0.021
E	4.20	0.165			
F					
G	1.50	0.059			
H	0.45	0.018			