HT70XXA-1
TinyPower™ Voltage Detector

HOLTEK

Features

- Low power consumption
- Low temperature coefficient
- High input voltage range (up to 24V)

- Output voltage accuracy: tolerance ± 3%
- Built-in hysteresis characteristic
- TO-92, SOT-89 and SOT-25 package

Applications

- Battery checkers
- Level selectors
- Power failure detectors

- Microcomputer reset
- Battery memory backup
- Non-volatile RAM signal storage protectors

General Description

The HT70XXA-1 series devices area 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 2.2V to 5V. The voltage detectors consist of a high-precision and low power consumption standard voltage source as well as 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.
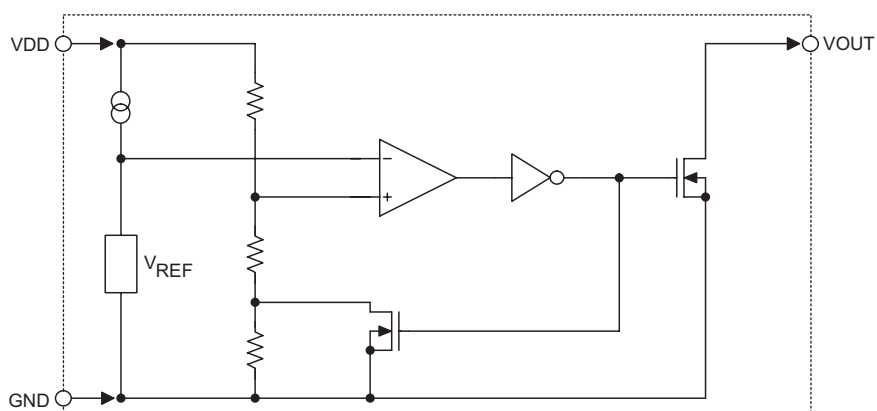
Selection Table

Part No.	Detectable Voltage	Hysteresis Width	Tolerance	Package	Marking
HT7022A-1	2.2V	0.11V	±3%	TO-92 SOT-89 SOT-25	70XXA-1 (for TO-92) 70XXA-1 (for SOT-89) 0XXA (for SOT-25)
HT7024A-1	2.4V	0.12V	±3%		
HT7027A-1	2.7V	0.135V	±3%		
HT7033A-1	3.3V	0.165V	±3%		
HT7039A-1	3.9V	0.195V	±3%		
HT7044A-1	4.4V	0.22V	±3%		
HT7050A-1	5.0V	0.25V	±3%		

Note: ″XX″ stands for output voltages.

For lead free devices, TO-92 package will add a ″#″ mark at the end of the date code, whereas SOT-89 & SOT-25 packages will add a ″#″ mark at the end of the marking.
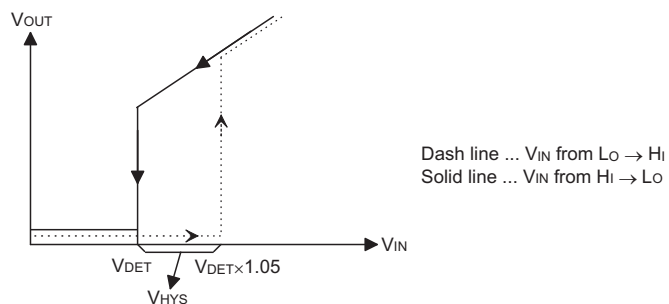
Block Diagram

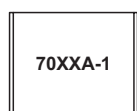**N Channel Open Drain Output (Normal Open; Active Low)**

Output Table & Curve

V_{DD}	$V_{DD} > V_{DET}(+)$	$V_{DD} \leq V_{DET}(-)$
V_{OUT}	Hi-Z	VSS
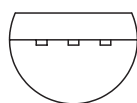
Dash line ... V_{IN} from $L_O \rightarrow H_I$
Solid line ... V_{IN} from $H_I \rightarrow L_O$

Pin Assignment
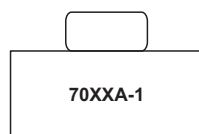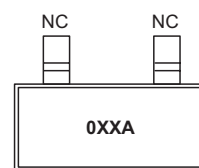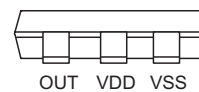
Absolute Maximum Ratings

Supply Voltage ....V_{SS}–0.3V to V_{SS}+26V

Output Voltage ....V_{SS}–0.3V to V_{DD}+0.3V   Output Current...50mA

Storage Temperature ....–50°C to 125°C   Power Consumption 200mW

Operating Temperature ....–40°C to 85°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

HT7022A-1   Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DET}	Detection Voltage	—	—	2.134	2.200	2.266	V
V_{HYS}	Hysteresis Width	—	—	0.02 V_{DET}	0.05 V_{DET}	0.1 V_{DET}	V
I_{DD}	Operating Current	8V	No load	—	4	7	μA
V_{DD}	Operating Voltage	—	—	1.5	—	24	V
I_{OL}	Output Sink Current	2V	V_{OUT}=0.2V	0.5	1	—	mA
$\frac{\Delta V_{DET}}{\Delta T_a}$	Temperature Coefficient	—	0°C<Ta<70°C	—	±1.1	—	mV/°C

HT7024A-1   Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DET}	Detection Voltage	—	—	2.328	2.400	2.472	V
V_{HYS}	Hysteresis Width	—	—	0.02 V_{DET}	0.05 V_{DET}	0.1 V_{DET}	V
I_{DD}	Operating Current	8V	No load	—	4	7	μA
V_{DD}	Operating Voltage	—	—	1.5	—	24	V
I_{OL}	Output Sink Current	2V	V_{OUT}=0.2V	0.5	1	—	mA
$\frac{\Delta V_{DET}}{\Delta T_a}$	Temperature Coefficient	—	0°C<Ta<70°C	—	±0.9	—	mV/°C

HT7027A-1   Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DET}	Detection Voltage	—	—	2.619	2.700	2.781	V
V_{HYS}	Hysteresis Width	—	—	0.02 V_{DET}	0.05 V_{DET}	0.1 V_{DET}	V
I_{DD}	Operating Current	8V	No load	—	4	7	μA
V_{DD}	Operating Voltage	—	—	1.5	—	24	V
I_{OL}	Output Sink Current	2V	V_{OUT}=0.2V	0.5	1	—	mA
$\dfrac{\Delta V_{DET}}{\Delta T_a}$	Temperature Coefficient	—	0°C<Ta<70°C	—	±0.9	—	mV/°C

HT7033A-1   Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DET}	Detection Voltage	—	—	3.201	3.300	3.399	V
V_{HYS}	Hysteresis Width	—	—	0.02 V_{DET}	0.05 V_{DET}	0.1 V_{DET}	V
I_{DD}	Operating Current	8V	No load	—	4	7	μA
V_{DD}	Operating Voltage	—	—	1.5	—	24	V
I_{OL}	Output Sink Current	2.5V	V_{OUT}=0.25V	1.2	2.5	—	mA
$\dfrac{\Delta V_{DET}}{\Delta T_a}$	Temperature Coefficient	—	0°C<Ta<70°C	—	±0.9	—	mV/°C

HT7039A-1   Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DET}	Detection Voltage	—	—	3.783	3.900	4.017	V
V_{HYS}	Hysteresis Width	—	—	0.02 V_{DET}	0.05 V_{DET}	0.1 V_{DET}	V
I_{DD}	Operating Current	8V	No load	—	4	7	μA
V_{DD}	Operating Voltage	—	—	1.5	—	24	V
I_{OL}	Output Sink Current	2.5V	V_{OUT}=0.25V	1.2	2.5	—	mA
$\dfrac{\Delta V_{DET}}{\Delta T_a}$	Temperature Coefficient	—	0°C<Ta<70°C	—	±0.9	—	mV/°C

HT7044A-1

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DET}	Detection Voltage	—	—	4.268	4.400	4.532	V
V_{HYS}	Hysteresis Width	—	—	0.02 V_{DET}	0.05 V_{DET}	0.1 V_{DET}	V
I_{DD}	Operating Current	8V	No load	—	4	7	μA
V_{DD}	Operating Voltage	—	—	1.5	—	24	V
I_{OL}	Output Sink Current	3.6V	V_{OUT}=0.36V	3	6	—	mA
$\frac{\Delta V_{DET}}{\Delta T_a}$	Temperature Coefficient	—	0°C<Ta<70°C	—	±0.9	—	mV/°C

HT7050A-1

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DET}	Detection Voltage	—	—	4.850	5.000	5.150	V
V_{HYS}	Hysteresis Width	—	—	0.02 V_{DET}	0.05 V_{DET}	0.1 V_{DET}	V
I_{DD}	Operating Current	8V	No load	—	4	7	μA
V_{DD}	Operating Voltage	—	—	2.1	—	24	V
I_{OL}	Output Sink Current	3.6V	V_{OUT}=0.36V	3	6	—	mA
$\frac{\Delta V_{DET}}{\Delta T_a}$	Temperature Coefficient	—	0°C<Ta<70°C	—	±0.9	—	mV/°C

Functional Description

The HT70XXA-1 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}, VOUT goes high, M1 turns off, and V_B is expressed as V_{BH}=V_{DD} × (R_B+R_C) / (R_A+R_B+R_C). 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} × R_B / (R_A+R_B), 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 VDD goes from low to V_{DD} × R_B / (R_A+R_B) > V_{REF}, the comparator output and V_{OUT} goes high.

The detectable voltage is defined as:

$$V_{DET} (-) = \frac{R_A + R_B + R_C}{R_B + R_C} \times V_{REF}$$

The release voltage is defined as:

$$V_{DET} (+) = \frac{R_A + R_B}{R_B} \times V_{REF}$$

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 HT70XXA-1 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.
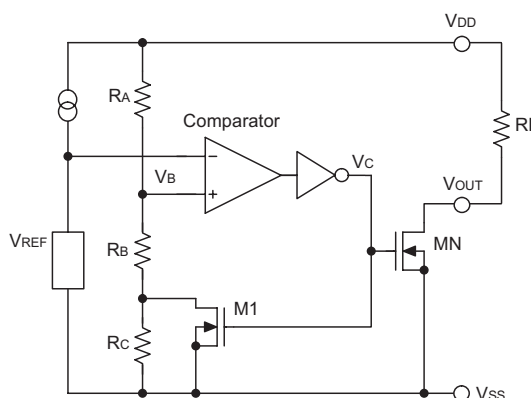

NMOS Output Voltage Detector (HT70XXA-1)

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.

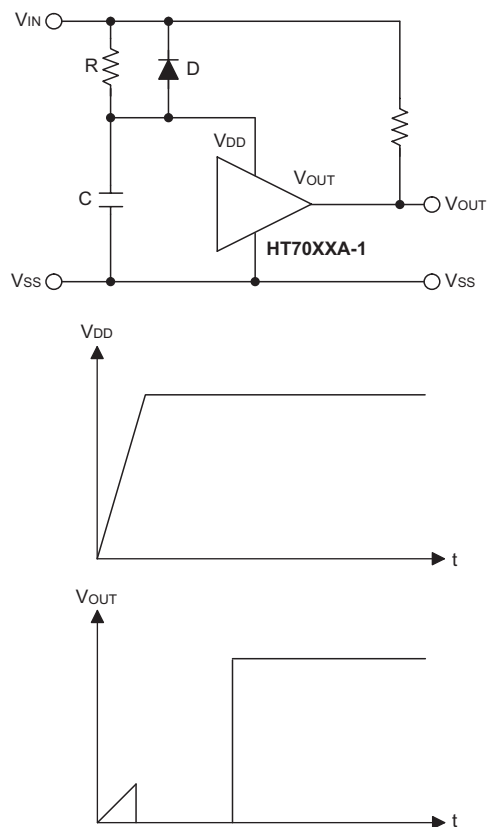- NMOS open drain output application for separate power supply
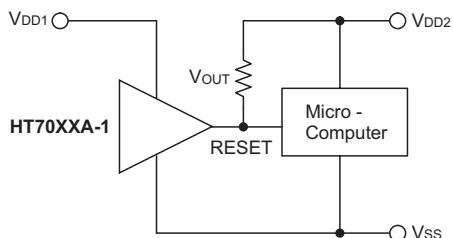
- NMOS open drain output application with R-C delay
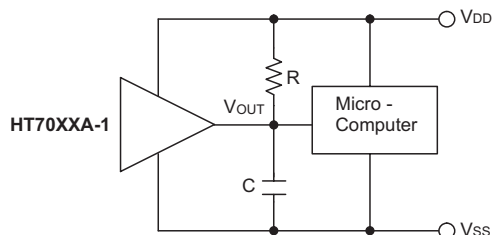
Power-on Reset Circuit

With several external components, the NMOS open drain type of the HT70XXA-1 series can be used to perform a power-on reset function as shown:
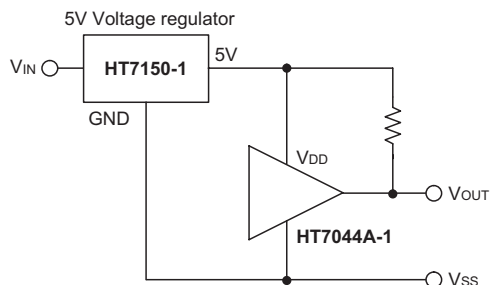
5V Power Line Monitoring Circuit

Generally, a minimum operating voltage of 4.5V is guaranteed in a 5V power line system. The HT7044A-1 is recommended for use as 5V power line monitoring circuit.
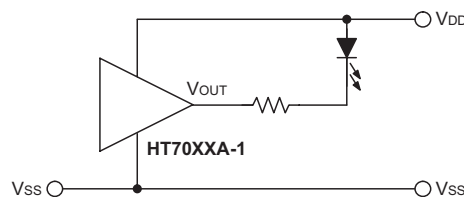
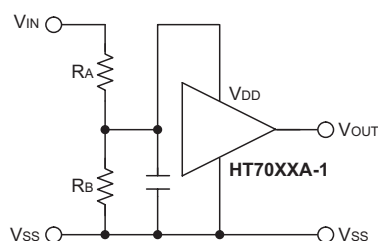- 5V power line monitor with power-on reset
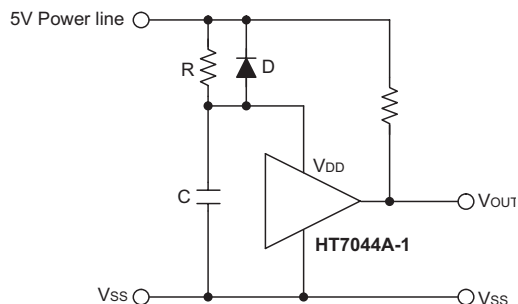
- with 5V voltage regulator

5V Voltage regulator

```
V_IN O──┤ HT7150-1 ├──5V───●────────┐
         GND                │        �
                            │        │
                         ┌──┴──┐     │
                         │ V_DD│     │
                         │     ├─────●──O V_OUT
                         │HT7044A-1  │
                         │     ├─────────O V_SS
```

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.
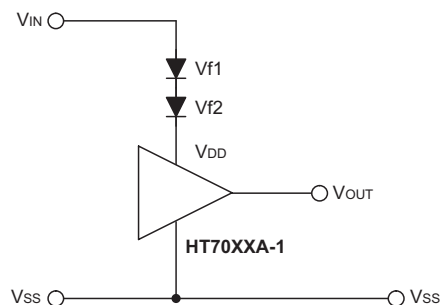
- Varying the detectable voltage with a resistance divider

```
V_IN O──┬──────┐
        R_A    │  V_DD
        │   ┌──┴──┐
        ●───│     ├──O V_OUT
        │   │HT70XXA-1
        R_B │
        │   │
V_SS O──┴───┴──O V_SS
```

$$\text{Detectable voltage} = \frac{R_A + R_B}{R_B} \times V_{DET}$$

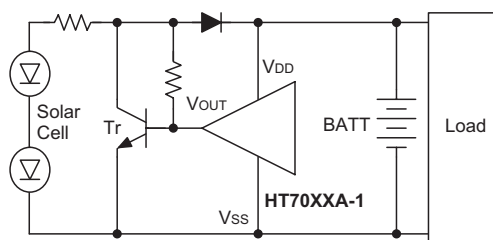$$\text{Hysteresis width} = \frac{R_A + R_B}{R_B} \times V_{HYS}$$

- Varying the detectable voltage with a diode

```
V_IN O──┬
        ▼ Vf1
        ▼ Vf2
        │   V_DD
     ┌──┴──┐
     │     ├──O V_OUT
     │HT70XXA-1
V_SS O──┴──O V_SS
```

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

Malfunction Analysis

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

```
         ┌──────────────●──O V_DD
         │              ▼LED
      ┌──┴──┐           │
      │V_OUT├──▕nR▏─────┘
      │HT70XXA-1
V_SS O─┴──────●─────────O V_SS
```

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.
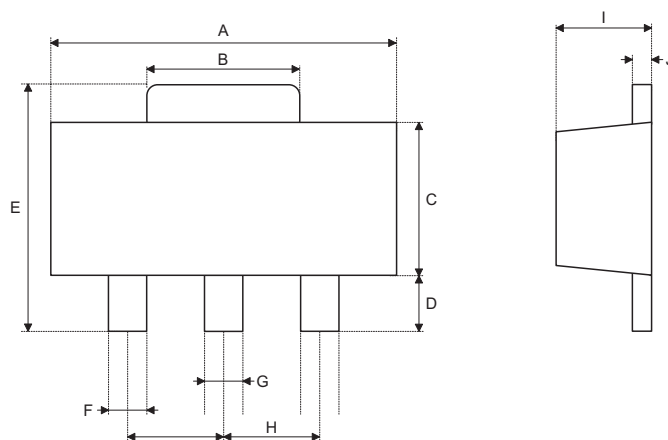
```
    ┌─▕nR▏──●────▷|────●──────●───┐
    │       │          │V_DD  │   │
  ⊽ │      ▉R      ┌──┴──┐   │  ┌─┴─┐
 Solar     │   ┌──│V_OUT│  BATT │Load│
 Cell  Tr ◁┤   │  │HT70XXA-1│  ═   │   │
  ⊽ │      ├───┘  │   V_SS  │  │   │
    └───────●──────┴────────●───┘
```

Level Selector

The following diagram illustrates a logic level selector.
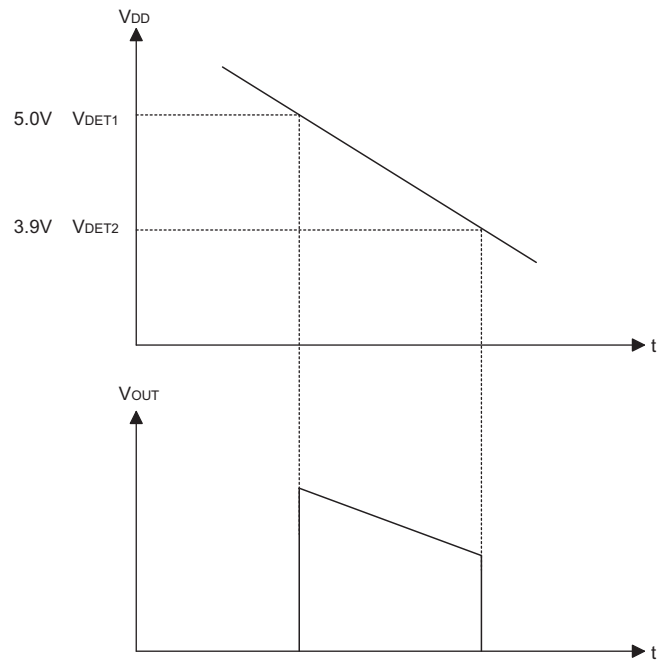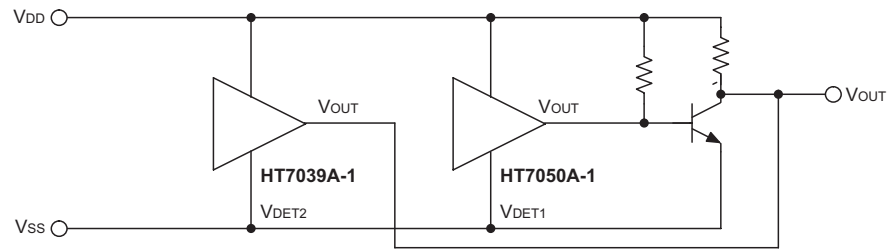
Package Information

3-Pin TO-92 Outline Dimensions
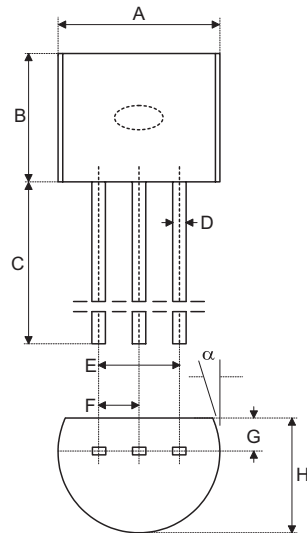
Symbol	Dimensions in mil		
	Min.	**Nom.**	**Max.**
A	170	—	200
B	170	—	200
C	500	—	—
D	11	—	20
E	90	—	110
F	45	—	55
G	45	—	65
H	130	—	160
I	8	—	18
α	4°	—	6°

3-Pin SOT-89 Outline Dimensions

Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	173	—	181
B	64	—	72
C	90	—	102
D	35	—	47
E	155	—	167
F	14	—	19
G	17	—	22
H	—	59	—
I	55	—	63
J	14	—	17

5-Pin SOT-25 Outline Dimensions
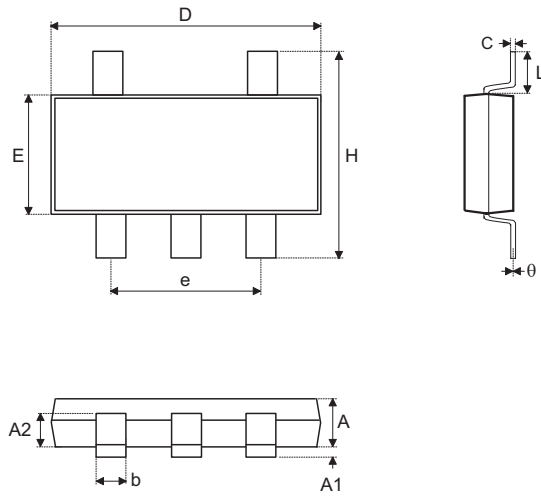
Symbol	Dimensions in mm		
	Min.	**Nom.**	**Max.**
A	1.00	—	1.30
A1	—	—	0.10
A2	0.70	—	0.90
b	0.35	—	0.50
C	0.10	—	0.25
D	2.70	—	3.10
E	1.40	—	1.80
e	—	1.90	—
H	2.60	—	3
L	0.37	—	—
θ	1°	—	9°

Product Tape and Reel Specifications

TO-92 Reel Dimensions (Unit: mm)

30

58

43

88

360

Package Up,   Flat Side Up

Package Up,   Flat Side Down
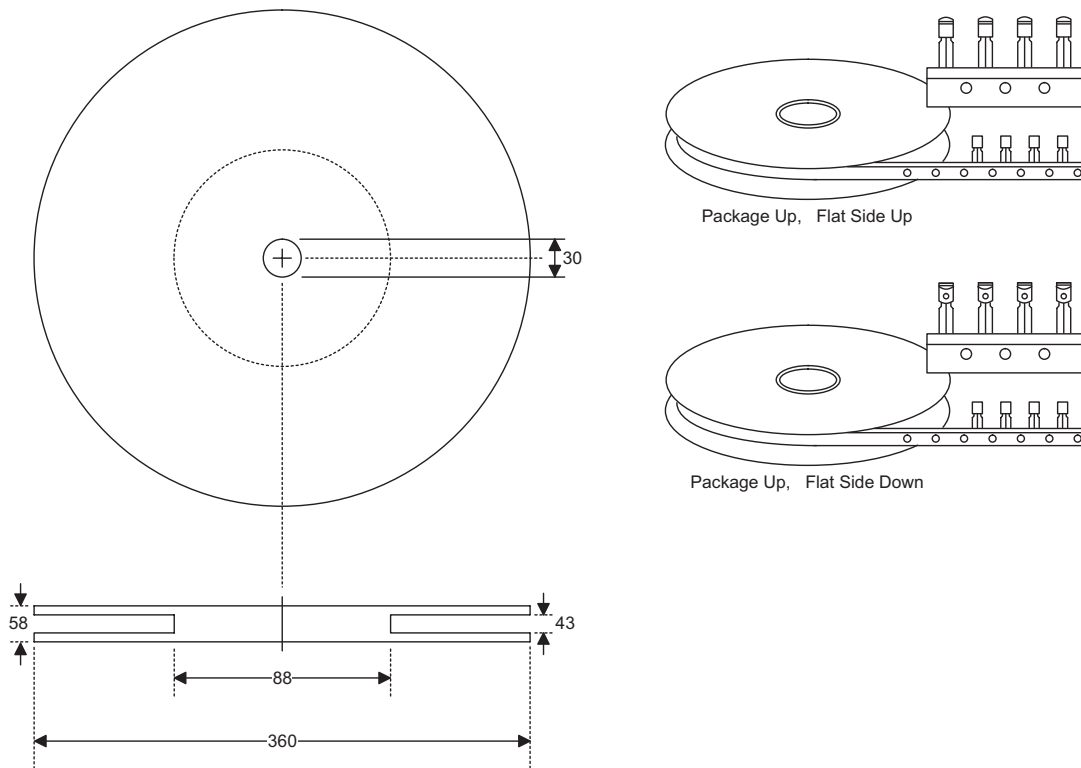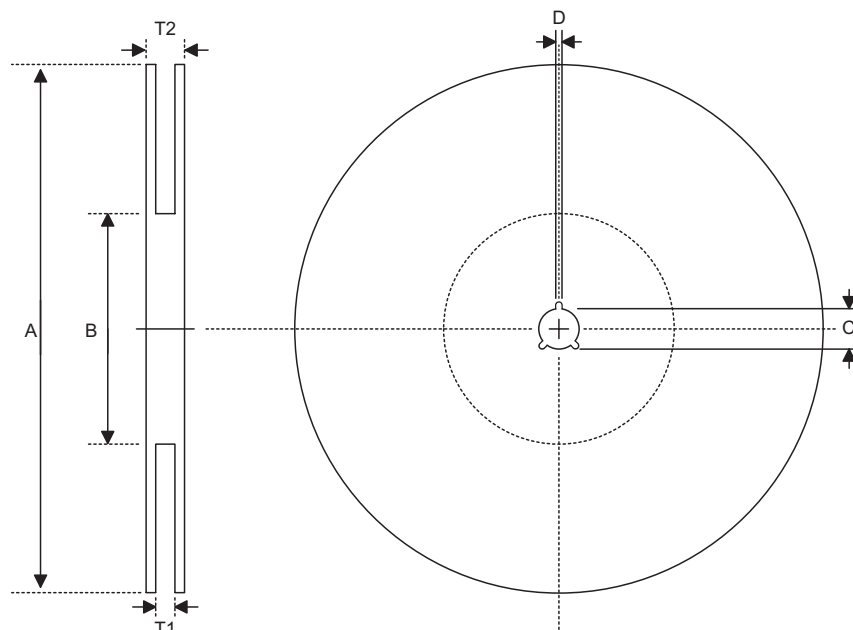
Reel Dimensions

SOT-89

Symbol	Description	Dimensions in mm
A	Reel Outer Diameter	180±1.0
B	Reel Inner Diameter	62±1.5
C	Spindle Hole Diameter	12.75+0.15
D	Key Slit Width	1.9±0.15
T1	Space Between Flange	12.4+0.2
T2	Reel Thickness	17−0.4

SOT-25

Symbol	Description	Dimensions in mm
A	Reel Outer Diameter	178±1.0
B	Reel Inner Diameter	62±1.0
C	Spindle Hole Diameter	13.0±0.2
D	Key Slit Width	2.5±0.25
T1	Space Between Flange	8.4+1.5 −0.0
T2	Reel Thickness	11.4+1.5

TO-92 Carrier Tape Dimensions
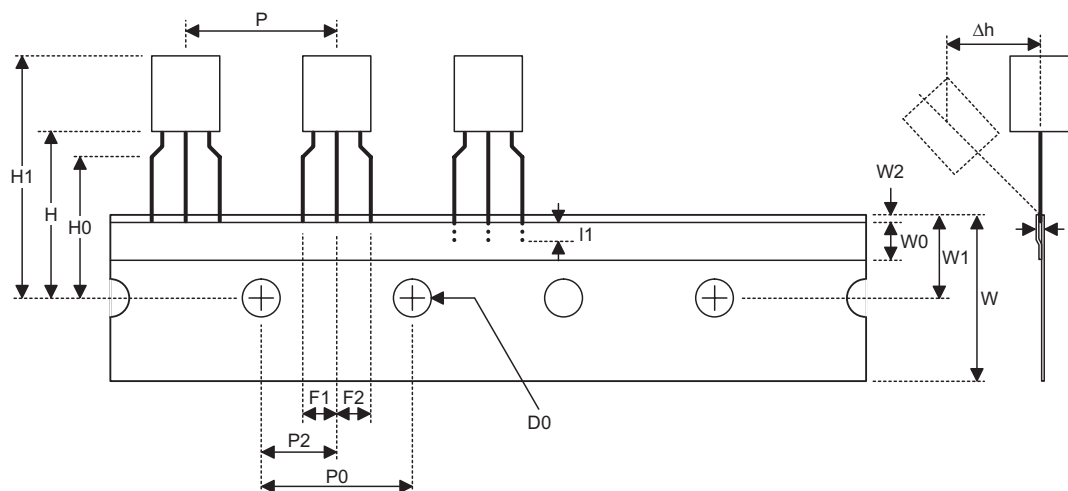
TO-92

Symbol	Description	Dimensions in mm
I1	Taped Lead Length	(2.5)
P	Component Pitch	12.7±1.0
P_0	Perforation Pitch	12.7±0.3
P_2	Component to Perforation (Length Direction)	6.35±0.4
F_1	Lead Spread	2.5+0.4 −0.1
F_2	Lead Spread	2.5+0.4 −0.1
Δh	Component Alignment	0±0.1
W	Carrier Tape Width	18.0+1.0 −0.5
W_0	Hold-down Tape Width	6.0±0.5
W_1	Perforation Position	9.0±0.5
W_2	Hold-down Tape Position	(0.5)
H_0	Lead Clinch Height	16.0±0.5
H_1	Component Height	Less than 24.7
D_0	Perforation Diameter	4.0±0.2
t	Taped Lead Thickness	0.7±0.2
H	Component Base Height	19.0±0.5

Note: Thickness less than 0.38±0.05mm~0.5mm

P0 Accumulated pitch tolerance: ±1mm/20pitches.

（ ）Bracketed figures are for consultation only

Carrier Tape Dimensions
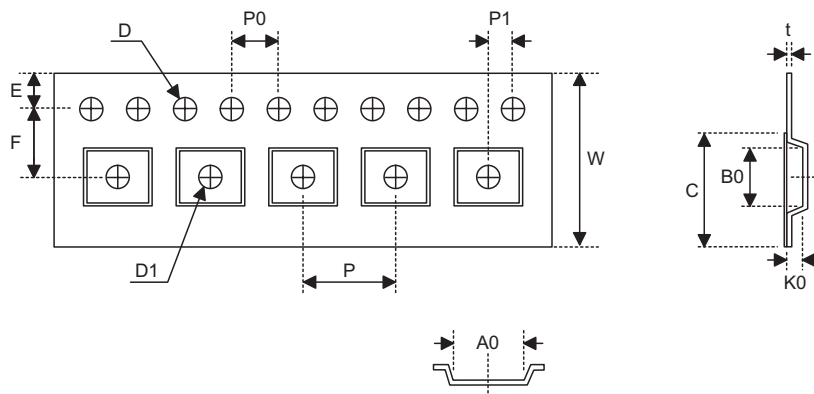
SOT-89

Symbol	Description	Dimensions in mm
W	Carrier Tape Width	12.0+0.3 −0.1
P	Cavity Pitch	8.0±0.1
E	Perforation Position	1.75±0.1
F	Cavity to Perforation (Width Direction)	5.5±0.05
D	Perforation Diameter	1.5+0.1
D1	Cavity Hole Diameter	1.5+0.1
P0	Perforation Pitch	4.0±0.1
P1	Cavity to Perforation (Length Direction)	2.0±0.10
A0	Cavity Length	4.8±0.1
B0	Cavity Width	4.5±0.1
K0	Cavity Depth	1.8±0.1
t	Carrier Tape Thickness	0.30±0.013
C	Cover Tape Width	9.3

SOT-25

Symbol	Description	Dimensions in mm
W	Carrier Tape Width	8.0±0.3
P	Cavity Pitch	4.0
E	Perforation Position	1.75
F	Cavity to Perforation (Width Direction)	3.5±0.05
D	Perforation Diameter	1.5+0.1
D1	Cavity Hole Diameter	1.5+0.1
P0	Perforation Pitch	4.0
P1	Cavity to Perforation (Length Direction)	2.0
A0	Cavity Length	3.15
B0	Cavity Width	3.2
K0	Cavity Depth	1.4
t	Carrier Tape Thickness	0.20±0.03
C	Cover Tape Width	5.3

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