

## Analog Output Linear Hall Sensor

### 1. Features

- 3.3 to 10.5V wide supply voltage range
- Output voltage proportional to magnetic flux density
- Analog output linear Hall sensor
- Fast power-on time
- -40°C to 150°C wide ambient temperature range
- Resistant to mechanical stress
- PKG Type
  - TO-92S(UA)
  - SOT23-3L(SO)
  - SOT89-3(BU)

### 2. Applications

- Electric Vehicle handlebars
- Angular sensing
- Position sensing
- Over-current detection
- BLDC motor current monitoring
- Weigh and liquid level sensing

### 3. Description

The SC400X are high performance small versatile linear Hall-Effect devices which are operated by the magnetic field from a permanent magnet or an electromagnet. The radiometric output voltage is set by the supply voltage and varies in proportion to the strength of the magnetic. The quiescent output voltage of the SC4002 and SC4003 is 50% of the supply voltage, The sensitivity of 5V power supply is 3.125mV/Gs, 5.0mV/Gs, and 2.5 mV/Gs, respectively.

The SC4002/SC4003/SC4005 provide low-noise output with temperature compensation. The linear position sensor ICs have an operating temperature range of -40°C to 150°C, appropriate for industrial environments These devices are available in a 3-pin SIP / SOT23 / SOT89 packages. Both packages are lead(Pb) free, with 100% matte tin lead frame plating.

Not to scale

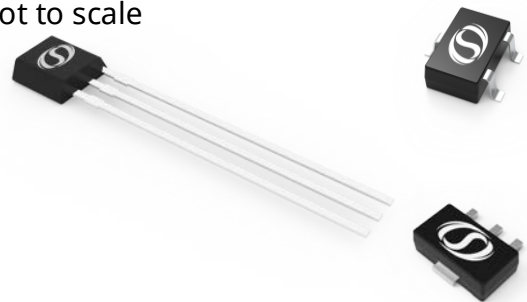


Fig.1 TO-92S(Left) & SOT23-3L & SOT89-3(Right) PKG Outline

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## 4. Terminal Configuration

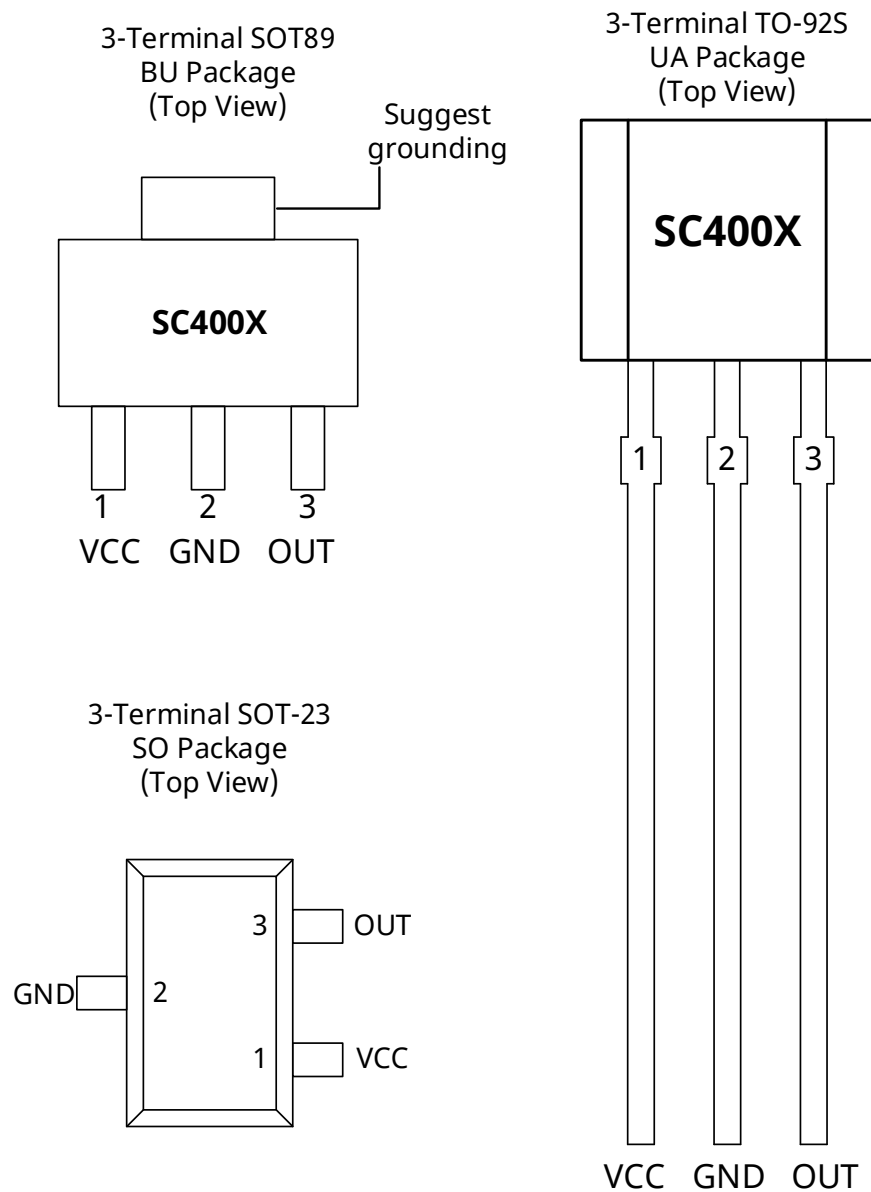


Fig.2 SOT23-3L & SOT89-3(Left) and TO-92S(Right)Pin Description

| Name | SOT89-3 & SOT23-3L & TO-92S |              |
|------|-----------------------------|--------------|
|      | Number                      | Description  |
| VDD  | 1                           | Power supply |
| GND  | 2                           | Ground       |
| OUT  | 3                           | Output       |

## 5. Ordering Information

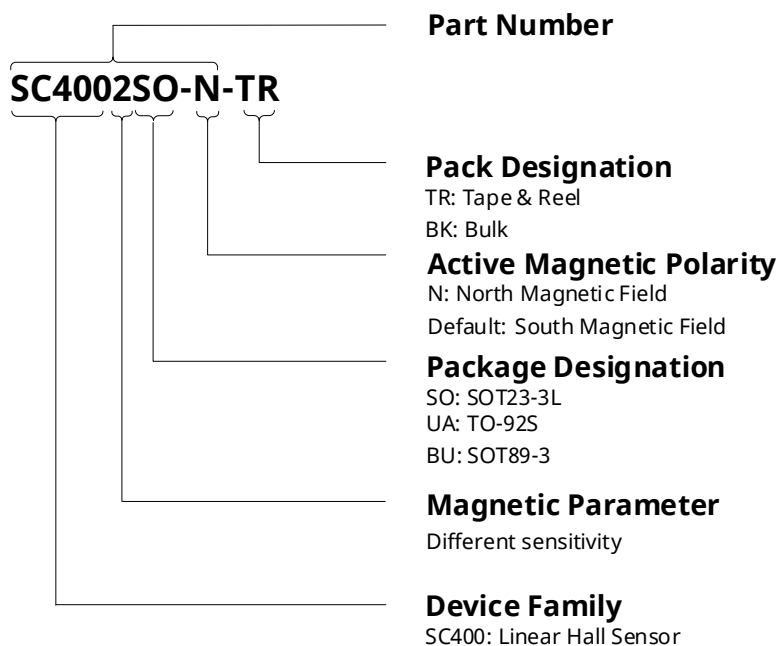
| Ordering Information       | Sens(mV/Gs) <sup>(1)</sup> | Ambient, T <sub>A</sub> (°C) | Package  | Packing | Quantity |
|----------------------------|----------------------------|------------------------------|----------|---------|----------|
| SC4002UA-BK <sup>(2)</sup> | 3.125                      | -40-150                      | TO92S-UA | BK      | 1000     |
| SC4002BU-TR                | 3.125                      | -40-150                      | SOT89-3  | TR      | 3000     |
| SC4002SO-N-TR              | 3.125                      | -40-150                      | SOT23-3L | TR      | 3000     |
| SC4003UA-BK                | 5                          | -40-150                      | TO92S-UA | BK      | 1000     |
| SC4005UA-BK                | 2.5                        | -40-150                      | TO92S-UA | BK      | 1000     |
| SC4005CUA-BK-Q             | 2.5                        | -40-150                      | TO92S-UA | BK      | 1000     |

Note:

(1) This sensitivity data is available under 5v application conditions

(2) TR: Tape & Reel; BK: Bulk

### Order information format description



## 6. Absolute Maximum Ratings

| Symbol    | Parameter                    | Notes                                       | Min. | Max. | Units            |
|-----------|------------------------------|---------------------------------------------|------|------|------------------|
| $V_{CC}$  | Power End Withstand Voltage  | $B = 0\text{mT}$ , $T_A = 25^\circ\text{C}$ | -0.5 | 30.0 | V                |
| $V_{OUT}$ | Output Withstand Voltage     | -                                           | -0.3 | 30.0 | V                |
| $I_{CC}$  | Supply Current               | $V_{CC} = 5.0\text{V}$ , $B = 0\text{mT}$   | -    | 20   | mA               |
| $I_{OUT}$ | Current Output               | -                                           | -    | 2    | mA               |
| $T_A$     | Operating Temperature Range  | -                                           | -40  | 150  | $^\circ\text{C}$ |
| $T_J$     | Storage Temperature Range    | -                                           | -50  | 165  | $^\circ\text{C}$ |
| $T_{STG}$ | Maximum Junction Temperature | -                                           | -65  | 175  | $^\circ\text{C}$ |

Note :

Stresses above those listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## 7. ESD Protection

| Symbol         | Parameter | Test conditions                                         | Min. | Max. | Units |
|----------------|-----------|---------------------------------------------------------|------|------|-------|
| $V_{ESD\_HBM}$ | HBM       | Refer to ANSI/ESDA/JEDEC JS-001 standard <sup>(1)</sup> | -4   | +4   | kV    |
| $V_{ESD\_CDM}$ | CDM       | Refer to ANSI/ESDA/JEDEC JS-002 standard <sup>(2)</sup> | -750 | +750 | V     |

Note :

(1) JEDEC document JEP155 states that 4000V HBM allows safe manufacturing using standard ESD control processes.

(2) JEDEC document JEP157 states that 740V CDM allows safe manufacturing using standard ESD control processes.

## 8. Thermal characteristics

| Symbol          | Parameter | Test conditions                                                               | Value <sup>(1)</sup> | Units              |
|-----------------|-----------|-------------------------------------------------------------------------------|----------------------|--------------------|
| $R_{\theta JA}$ | TO-92S    | Single-layer PCBS, JEDEC 2s2p and 1s0p are defined in JESD 51-7 and JESD 51-3 | 177                  | $^\circ\text{C/W}$ |
|                 | SOT23-3L  |                                                                               | 313                  |                    |
|                 | SOT89-3   |                                                                               | 250                  |                    |

Note :

(1) The maximum operating voltage must meet the requirements of power consumption and junction temperature, refer to thermal characteristics

## 9. Operating Characteristics

( $T_A = -40^{\circ}\text{C} \sim 105^{\circ}\text{C}$ ,  $V_{DD} = 2.5\text{V} \sim 5.5\text{V}$ , unless otherwise noted)

| Symbol              | Parameter              | Test Condition                                                         | Min  | TYP   | MAX  | Unit          |
|---------------------|------------------------|------------------------------------------------------------------------|------|-------|------|---------------|
| $V_{CC}$            | Operating Voltage      | $T_J < T_{J(\text{Max})}$                                              | 3.3  | 5.0   | 10.5 | V             |
| $I_{CC}$            | Operating Current      | $V_{CC} = 5.0\text{V}$ , $T_A = 25^{\circ}\text{C}$                    | -    | 4.5   | 10.0 | mA            |
| $R_L$               | Output load resistance | OUT to VCC                                                             | 2    | -     | -    | k $\Omega$    |
| $V_{\text{OUT(H)}}$ | Output Voltage Range   | $T_A = 25^{\circ}\text{C}$ , $B = 1000\text{Gs}$                       | 2    | -     | -    | V             |
| $V_{\text{OUT(L)}}$ |                        | $T_A = 25^{\circ}\text{C}$ , $B = -1000\text{Gs}$                      | 4.8  | 4.9   | -    | V             |
| $V_{\text{OUT(Q)}}$ | Static Output Voltage  | $V_{CC} = 3.3\text{V}$ , $B = 0\text{Gs}$ , $T_A = 25^{\circ}\text{C}$ | -    | 0.1   | 0.2  | V             |
|                     |                        | $V_{CC} = 5\text{V}$ , $B = 0\text{Gs}$ , $T_A = 25^{\circ}\text{C}$   | 1.55 | 1.65  | 1.75 | V             |
| S                   | Sensitivity            | $V_{CC} = 5\text{V}$ , $T_A = 25^{\circ}\text{C}$                      | 1.9  | 2.4   | 2.9  | mV/Gs         |
|                     |                        | $V_{CC} = 3.3\text{V}$ , $T_A = 25^{\circ}\text{C}$                    | 1.1  | 1.4   | 1.7  | mV/Gs         |
|                     |                        | SC4005, $V_{CC} = 3.3\text{V}$ , $T_A = 25^{\circ}\text{C}$            | 1.7  | 1.875 | 2    | mV/Gs         |
|                     |                        | SC4002, $V_{CC} = 5\text{V}$ , $T_A = 25^{\circ}\text{C}$              | 2.75 | 3.125 | 3.5  | mV/Gs         |
|                     |                        | SC4003, $V_{CC} = 5\text{V}$ , $T_A = 25^{\circ}\text{C}$              | 4.0  | 5.0   | 6.0  | mV/Gs         |
|                     |                        | SC4005, $V_{CC} = 5\text{V}$ , $T_A = 25^{\circ}\text{C}$              | 2.0  | 2.5   | 3.0  | mV/Gs         |
| Lin                 | Linearity              | -                                                                      | -1   | -     | +1   | %             |
| $\Delta\text{Sens}$ | Sensitivity            | $T_A = -40^{\circ}\text{C}$ to $105^{\circ}\text{C}$                   | -10  | -     | +10  | %             |
| $T_{\text{RESP}}$   | Step response time     | The delayed output signal reaches 90%                                  | -    | 1     | -    | $\mu\text{s}$ |

## 10. Block Diagram

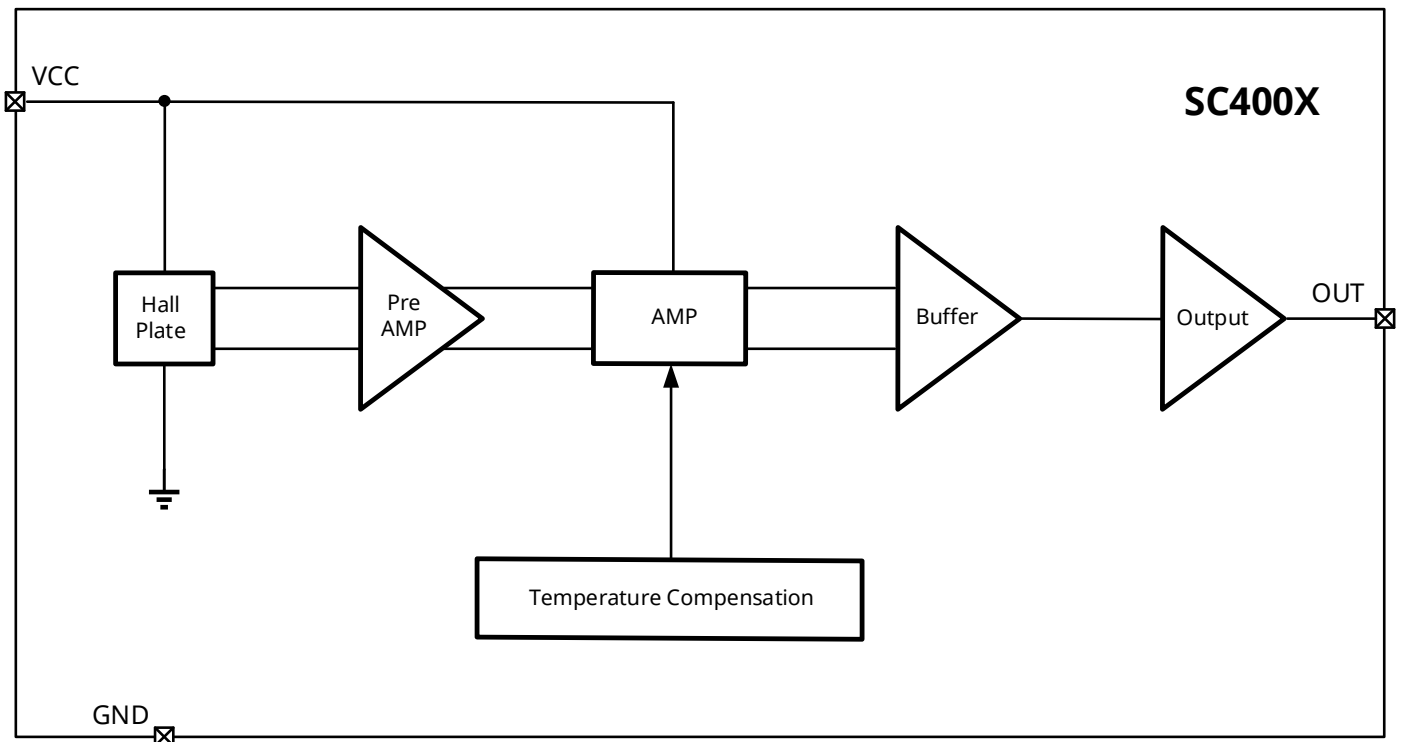


Fig.3 Block Diagram

## 11. Function Description

**Magnetic Field Direction Definition:** TO-92S(UA) & SOT89-3(BU) package, the magnetic field S pole is defined as the positive magnetic field on the chip screen; SOT23-3L(SO) package, the magnetic field S pole is defined as a negative magnetic field on the marking.

**Quiescent Output Voltage ( $V_{OUTQ}$ ):** Quiescent Output Voltage indicates the output voltage of the IC when there is no magnetic field.

**Sensitivity(S)**

$$Sens = [VOUT(B1) - VOUT(B2)] / (B1 - B2)$$

When the South Pole magnetic field perpendicular to the chip tagged side approaches, the output voltage increases proportionally, until it reaches supply voltage. Conversely, when the North Pole magnetic field perpendicular to the chip tagged side approaches, the output voltage decreases proportionally, until it reaches ground level. Sensitivity is defined as the specific value of the output voltage variation and the magnetic field variation, commonly in mV/Gs or mV/mT.

## 12. Typical Application

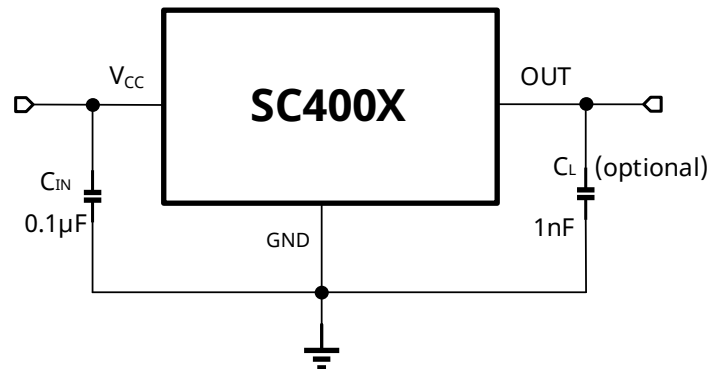


Fig.4 Typical Application Circuit

The static (zero field strength) output voltage of the chip, V<sub>Q</sub>, is usually half of the power supply voltage in the operating voltage range of the power supply. When the S-pole magnetic field perpendicular to the screen surface of the chip increases, the output voltage of the chip increases proportionally. In contrast, when the N electrode is applied to the silkscreen surface of the chip, the output voltage drops synchronously in the same proportion. These devices are available in three magnetic sensitivities, 3.125mV/Gs, 5.0mV/Gs, and 2.5 mV/Gs.

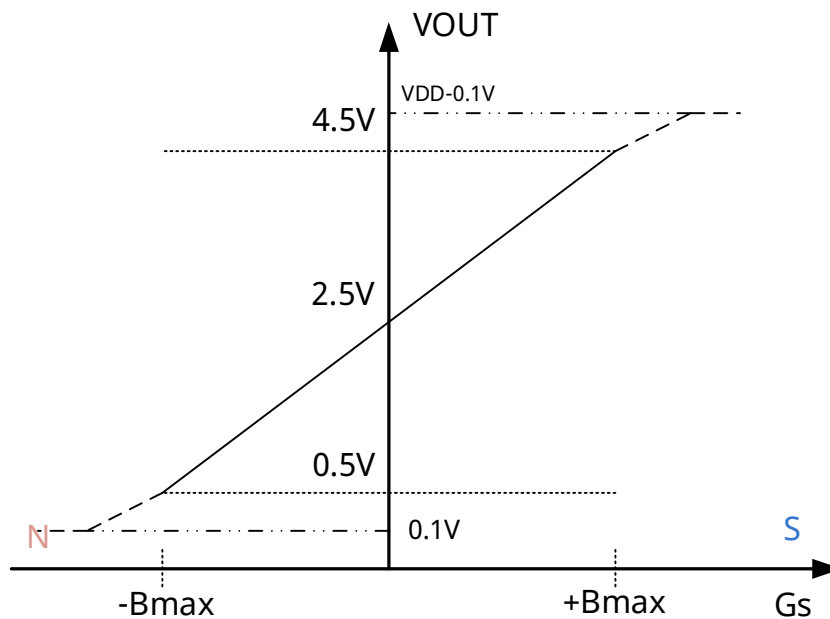


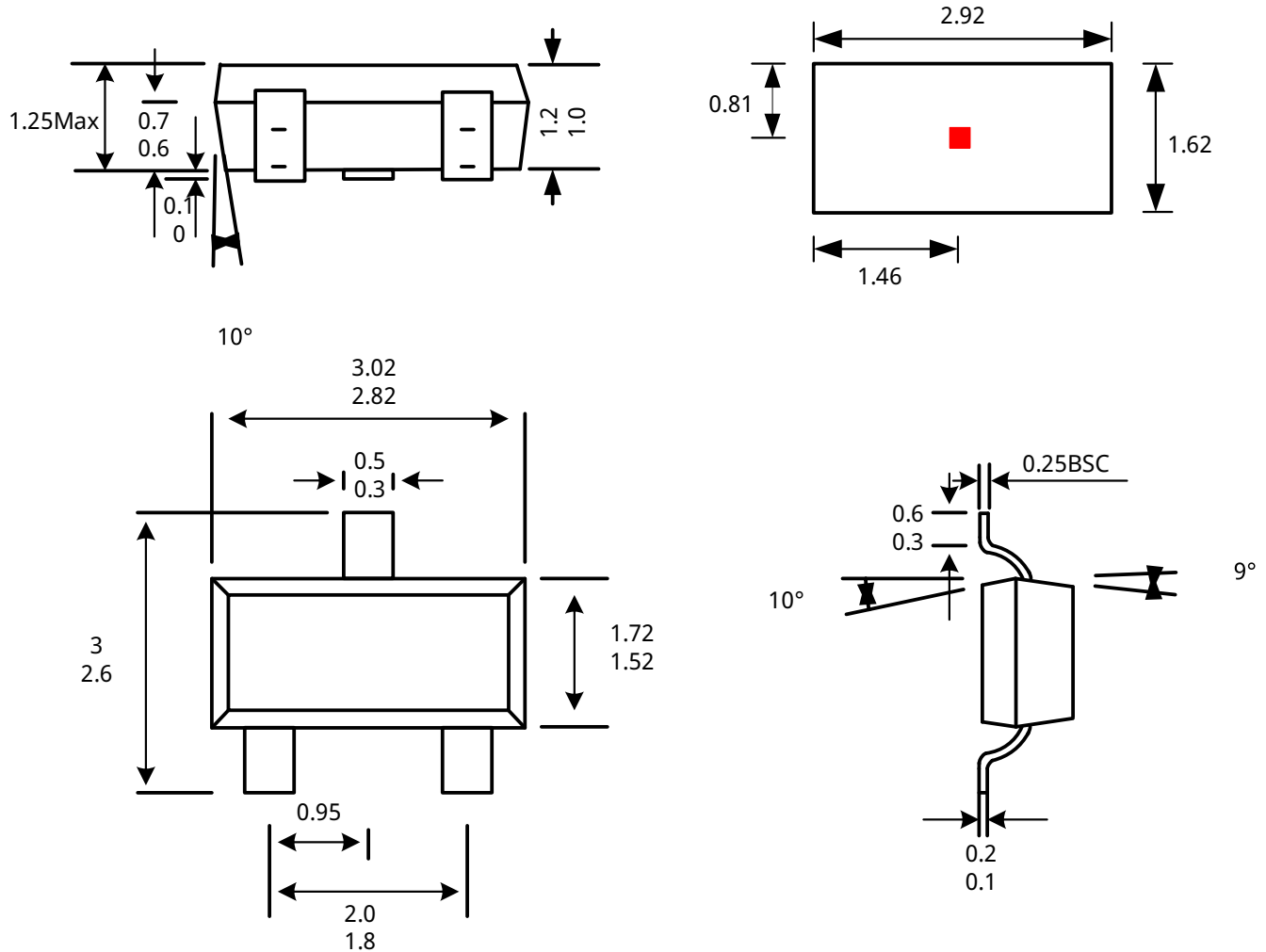
Fig.5 Output function



### 13. Package Information “SOT23-3L(SO)”

**3-PIN  
SOT23-3L  
Package**

Unit: mm



**Notes:**

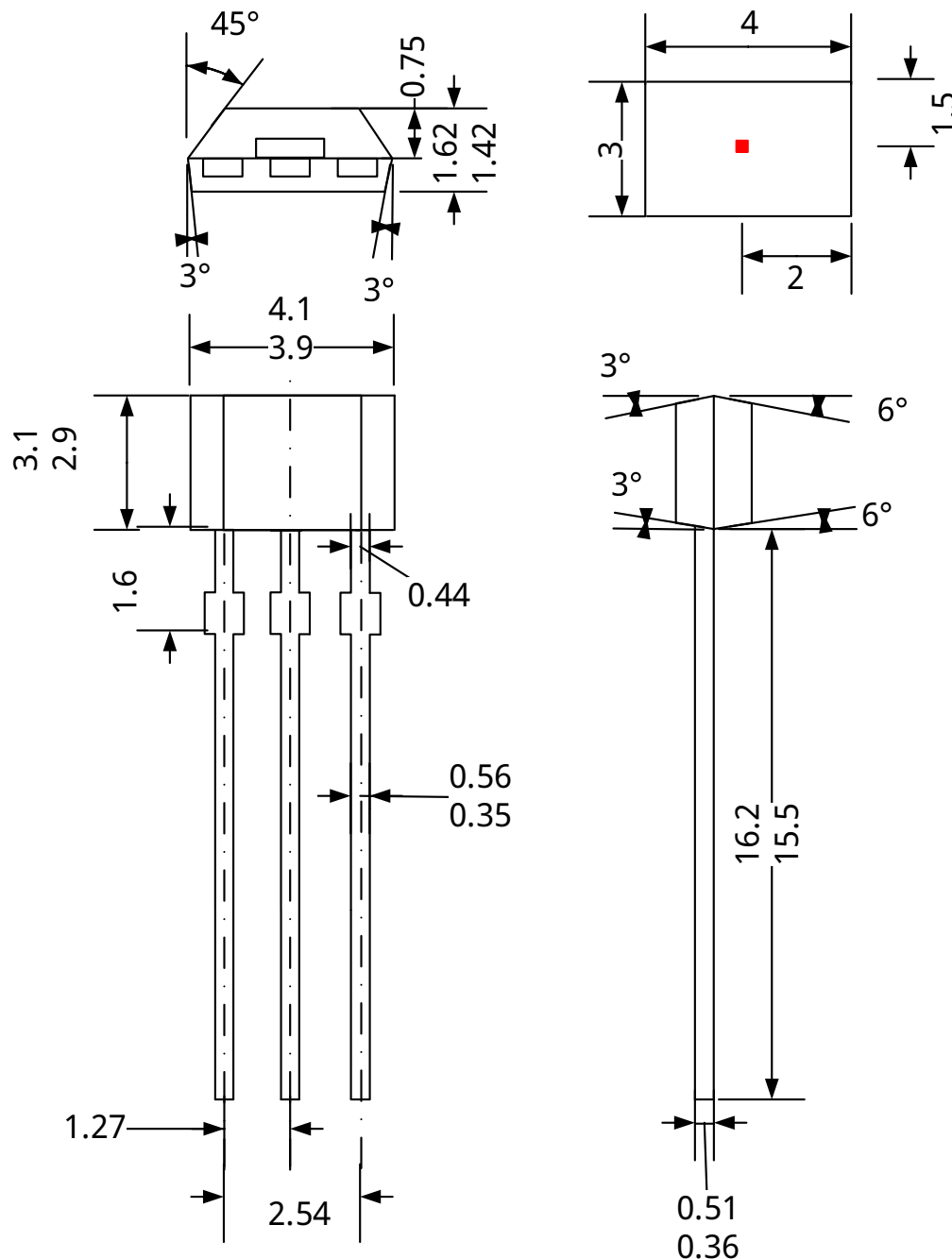
1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

## 14. Package Information “TO-92S(UA)”

TO-92S PKG

Unit: mm

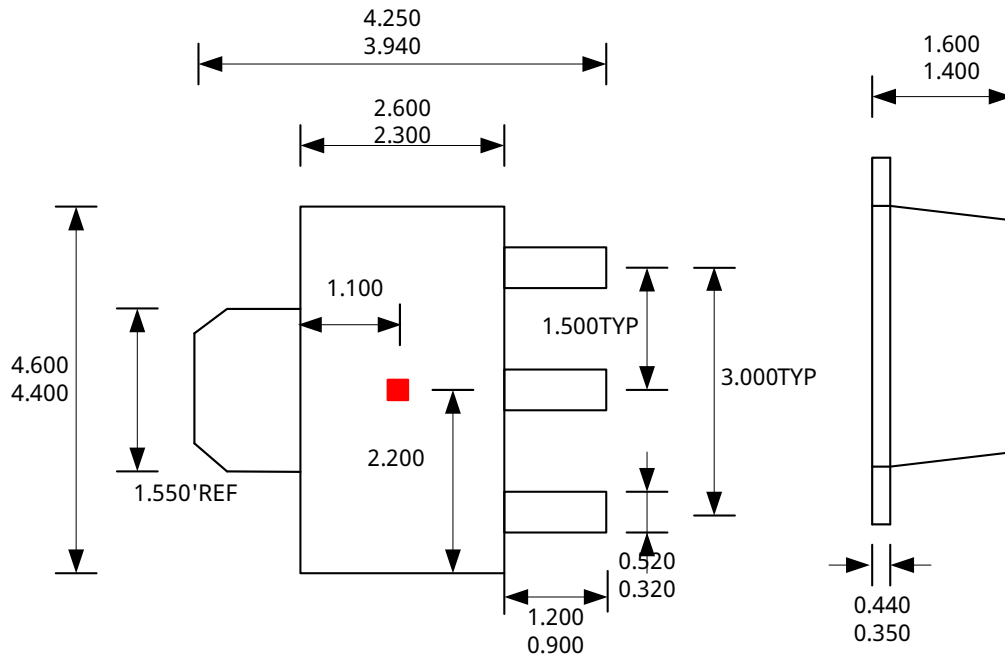


### Notes:

1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

## 15. Package Information “SOT89-3(BU)”

**TO-92S PKG****Unit: mm****Notes:**

1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

## 16. Revision History

| Revision | Date       | Description              |
|----------|------------|--------------------------|
| Rev.0.1  | 2019-07-06 | Preliminary datasheet    |
| Rev.A1.0 | 2020-11-19 | Unified datasheet format |
| Rev.A1.1 | 2024-07-08 | Add SOT23-3L PKG         |
| Rev.A1.2 | 2024-11-27 | Add order information    |