



AK8778B

Hall Effect IC for Pulse Encoders

Overview

The AK8778B is a Hall effect latch which detects both “vertical magnetic field” and “horizontal magnetic field” (perpendicular and parallel to the marking side of the package) at the same time. The pulse output F and direction output D are switched according to the vertical and horizontal magnetic fields applied to the device. The direction is calculated internally and output D is switched at a rising or falling edge of output F. The AK8778B is for use in the incremental pulse encoders or rotational detection systems.

Features

- 4.0 to 24V supply voltage operation
- Sensitivity (Vertical, Horizontal) : $\pm 1.7\text{mT}$ (Typ.)
- Two outputs : F (Pulse), D (Direction)
- Small package: SOP-6pin
- Halogen free

Block Diagram

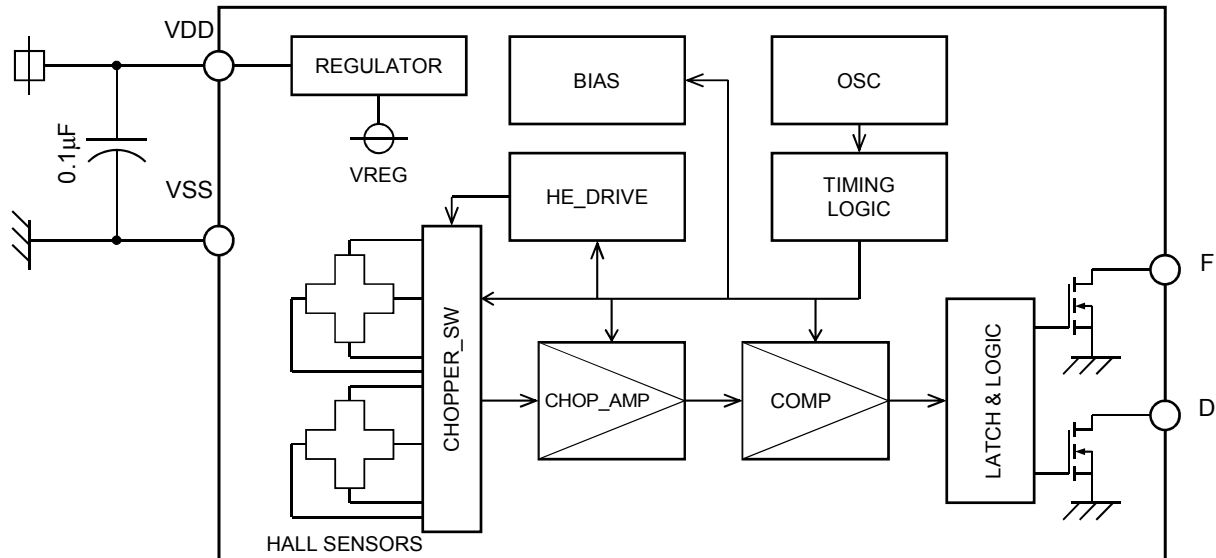


Figure 1. Block diagram

Circuit Configuration

Table 1. Circuit configuration

| Block | Function |
|---------------|--|
| REGULATOR | Generate internal operating voltage. |
| HALL SENSORS | Two Hall elements fabricated by CMOS process. |
| CHOPPER_SW | Perform chopping in order to cancel the offset of Hall sensor. |
| CHOP_AMP | Amplifies two Hall sensor output voltage with summation and subtraction circuit. |
| COMP | Hysteresis comparator. |
| BIAS | Generates bias current to internal circuits. |
| HE_DRIVE | Generates bias current for Hall sensors. |
| OSC | Generates operating clock. |
| TIMING LOGIC | Generates timing signal for internal circuits. |
| LATCH & LOGIC | Logical circuits and open drain driver. |

Pin/Function

Table 2. Description of pin name and function

| Pin No. | Pin name | I/O | Function | Note |
|---------|----------|-----|--------------------------|------------|
| 1 | VDD | | Power supply pin | |
| 2 | TAB | | (TAB pin) | |
| 3 | F | O | Output F (Pulse) pin | Open drain |
| 4 | D | O | Output D (Direction) pin | Open drain |
| 5 | TAB | | (TAB pin) | |
| 6 | VSS | | Ground pin | |

Note) TAB pins should be connected to VSS.

Absolute Maximum Ratings

Table 3. Absolute maximum ratings

| Parameter | Symbol | Min. | Max. | Unit | Note |
|---------------------|------------|------|------|------|----------------|
| Supply voltage | V_{DD} | -0.3 | +32 | V | VSS=0V |
| Output voltage | V_{OUT} | -0.3 | +32 | V | F,D pin VSS=0V |
| Output current | I_{SINK} | | 20 | mA | F,D pin |
| Storage temperature | T_{STG} | -55 | +150 | °C | |

Note) Stress beyond these listed values may cause permanent damage to the device.

Recommended Operating Conditions

Table 4. Recommended operating conditions

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|-----------------------|------------|------|------|------|------|
| Supply voltage | V_{DD} | 4.0 | 12.0 | 24.0 | V |
| Output current | I_{SINK} | | | 15 | mA |
| Operating temperature | T_a | -40 | | +125 | °C |

Electrical Characteristics

Table 5. Electrical characteristics at $V_{DD}=4.0$ to $24.0V$, $T_a=-40$ to $+125^{\circ}C$

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|---------------------------|------------|------|------|------|---------|---------------------------|
| Current consumption | I_{DD} | 1.4 | 3.0 | 5.6 | mA | |
| Output saturation voltage | V_{SAT} | | | 0.4 | V | F, D pin, $I_{SINK}=15mA$ |
| Output leak current | I_{LEAK} | | | 10 | μA | F, D= V_{DD} |
| Output refresh period | T_P | 12.0 | 16.7 | 30.5 | μs | |

Magnetic Characteristics

Table 6. Magnetic characteristics at $V_{DD}=4.0$ to $24.0V$, $T_a=-40$ to $+125^{\circ}C$

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|--|----------|------|------|------|------|------------|
| Operating point of vertical magnetic field | BopV | 0.1 | 1.7 | 4.0 | mT | (*1) |
| Releasing point of vertical magnetic field | BrpV | -4.0 | -1.7 | -0.1 | mT | (*1) |
| Operating point of horizontal magnetic field | BopH | 0.1 | 1.7 | 4.0 | mT | (*2) |
| Operating point of horizontal magnetic field | BrpH | -4.0 | -1.7 | -0.1 | mT | (*2) |
| Hysteresis | BhV, BhH | 1.5 | 3.4 | 6.8 | mT | (*1), (*2) |

(*1) Horizontal magnetic flux density is zero.

(*2) Vertical magnetic flux density is zero.

Operational Characteristics

The internal signal A switches 'Low' state when the magnetic field perpendicular to the marking side of the package exceeds B_{opV} . When the magnetic field is reduced below B_{rpV} , the internal signal A goes 'High' state. Otherwise; that is, in case of the magnetic field strength is greater than B_{rpV} and smaller than B_{opV} ; the internal signal A keeps its status.

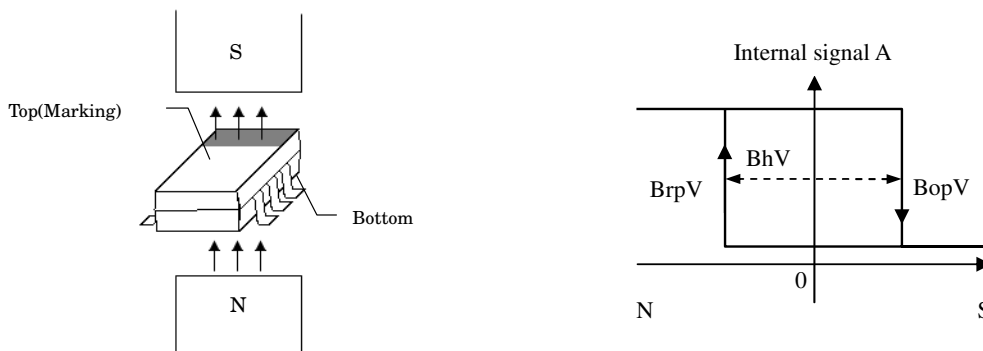


Figure 2. Switching behavior of the internal signal A when vertical magnetic field is applied

The internal signal B switches 'Low' state when the magnetic field parallel to the marking side of the package exceeds B_{opH} . When the magnetic field is reduced below B_{rpH} , the internal signal B goes 'High' state. Otherwise; that is, in case of the magnetic field strength is greater than B_{rpH} and smaller than B_{opH} ; the internal signal B keeps its status.

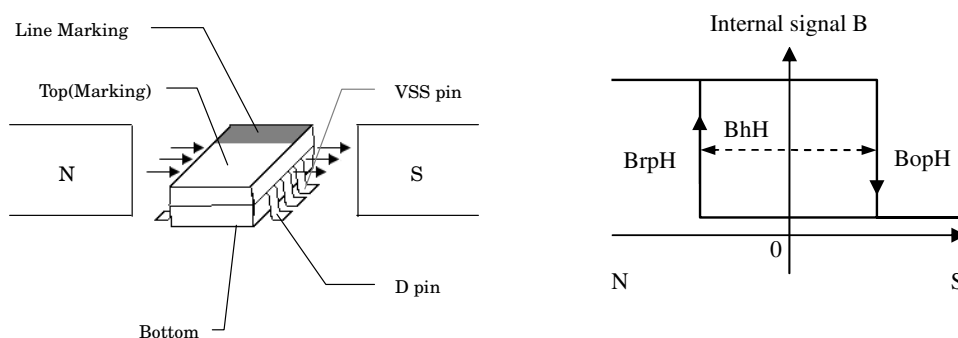


Figure 3. Switching behavior of the internal signal B when horizontal magnetic field is applied

Behaviors of internal signal A,B and output signal F, D when a rotating magnetic field is applied on AK8778B

F signal (pulse) is correspond to the result of EX-OR operation of internal signal A and B. And signal D (direction) is calculated by the state of internal signal A and B.

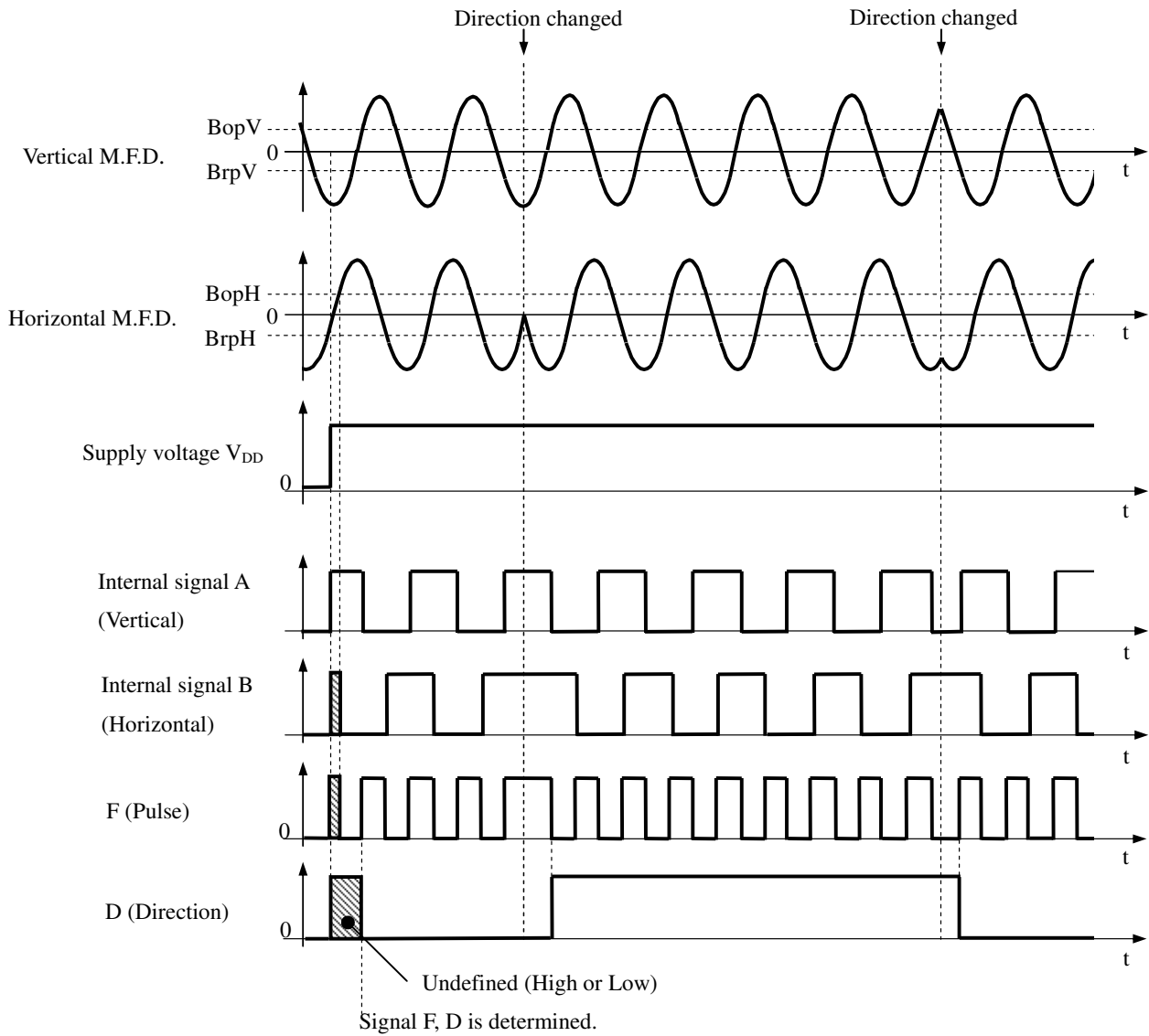


Figure 4. Behaviors of internal signal A,B and signal F, D when a rotating magnetic field is applied on AK8778B

*M.F.D. is Magnetic Flux Density.

Note) Signal D is determined after one signal F pulse is sent out. The indeterminate output state appears only in the powering up of this device.

Functional Timing

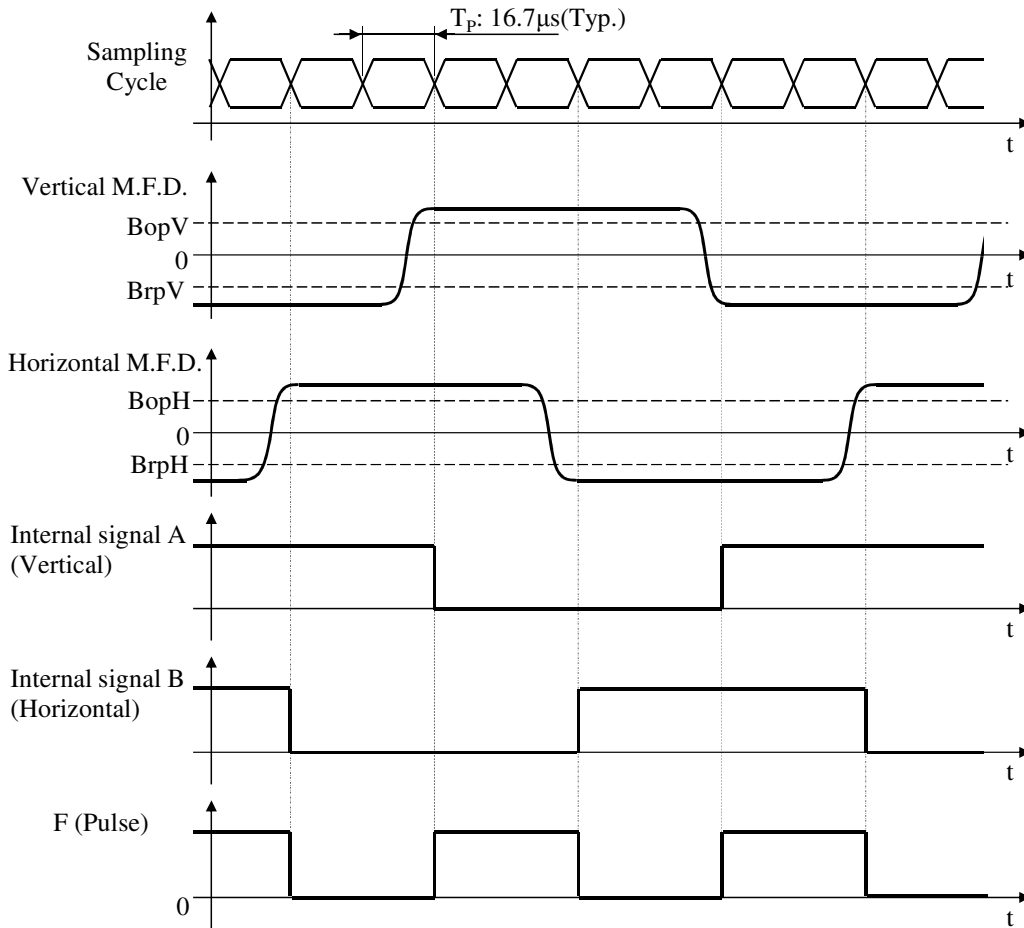


Figure 5. Timing diagram

*M.F.D. is Magnetic Flux Density.

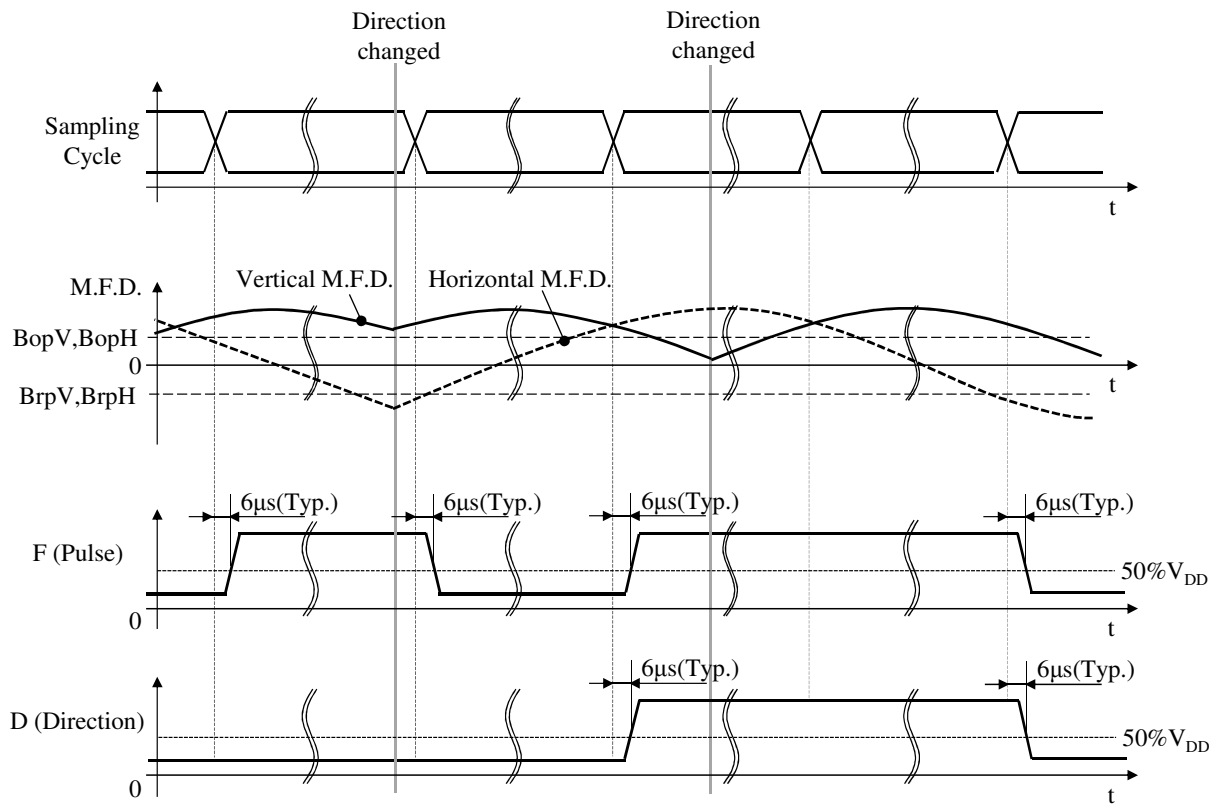


Figure 6. Timing diagram (in detail)

*M.F.D. is Magnetic Flux Density.

Note) $V_{DD}=12.0V$, $R_L=10k\Omega$, $C_L=20pF$

Typical Characteristic Data (for reference)

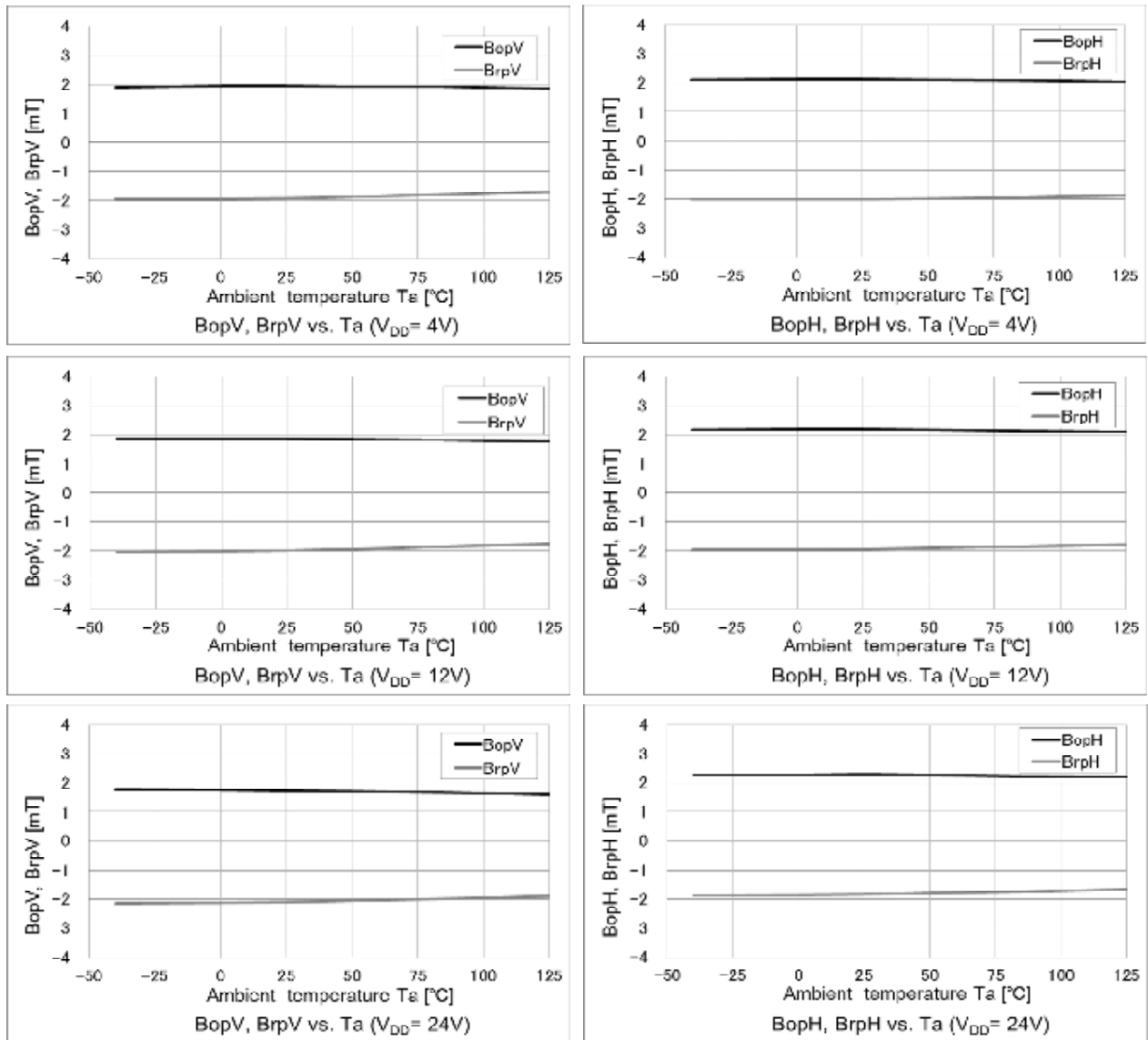


Figure 7. Temperature dependence of sensitivity

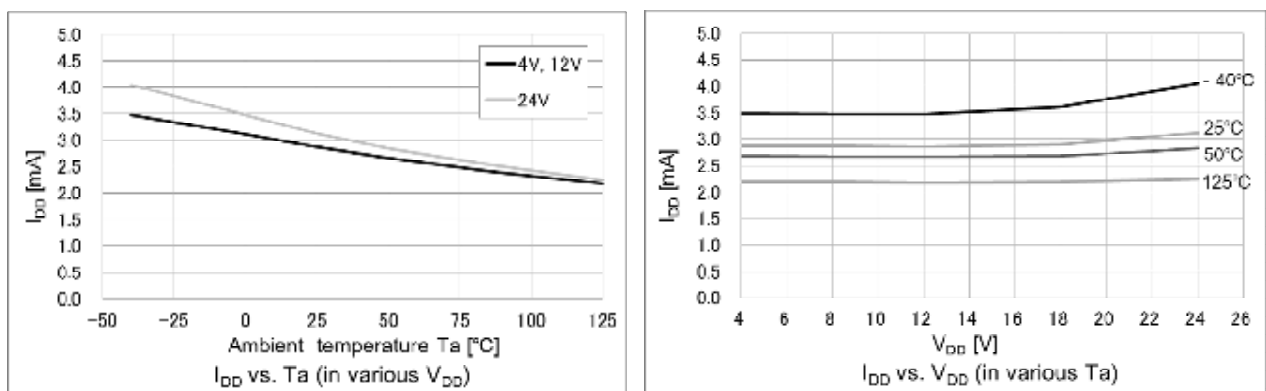


Figure 8. Temperature dependence of current consumption

Package

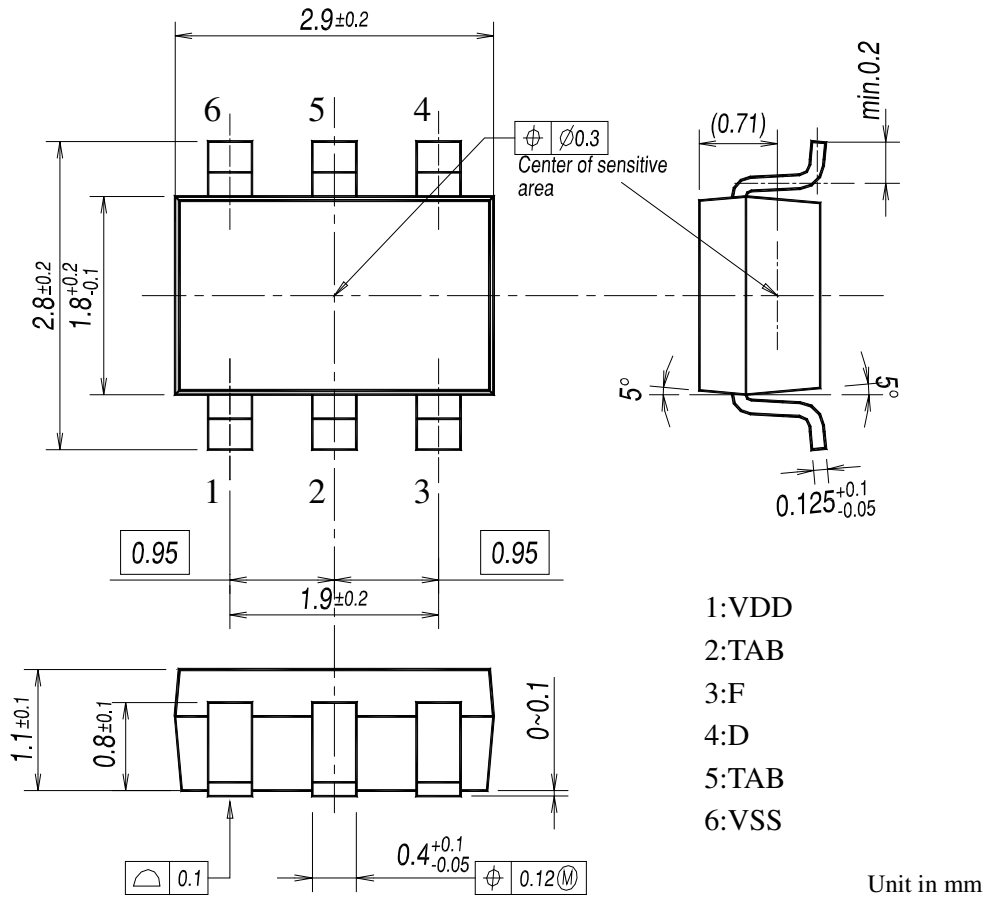


Figure 9. Package dimensions

Note 1) The center of the sensitive area is located within the $\phi 0.3$ mm circle.

Note 2) Coplanarity: The differences between standoff of terminals are max. 0.1mm.

Note 3) The sensor part is located 0.71mm(Typ.) from marking surface.

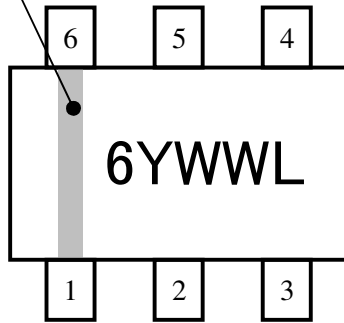
Material of terminals: Cu alloy

Material of plating for terminals: Sn 100%

Thickness of plating for terminals: 10 μ m (Typ.)

Marking

Line Marking



Marking is performed by laser

Product name : 6 (AK8778B)

Date code : YWWL

Y : Manufactured year

WW : Manufactured week

L : Lot

Figure 10. Marking

Recommended External Circuit

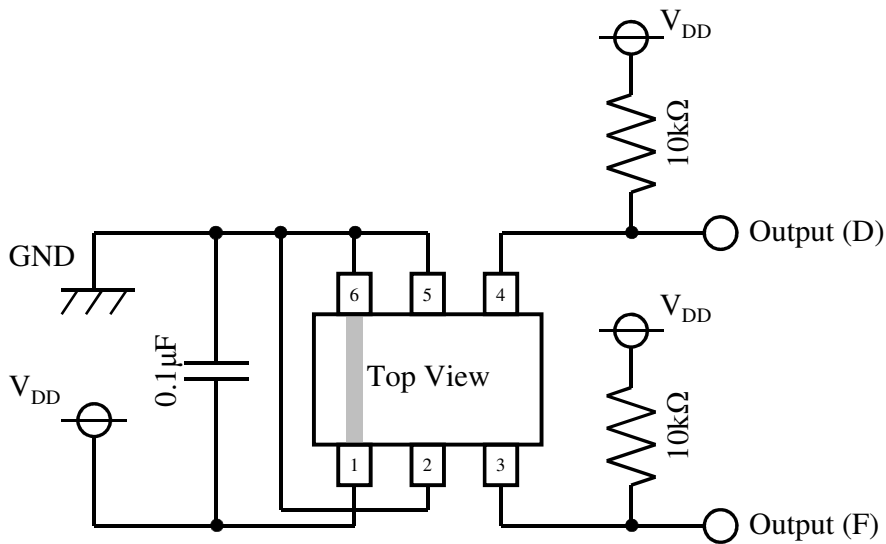


Figure 11. Recommended external circuit

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