



# 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

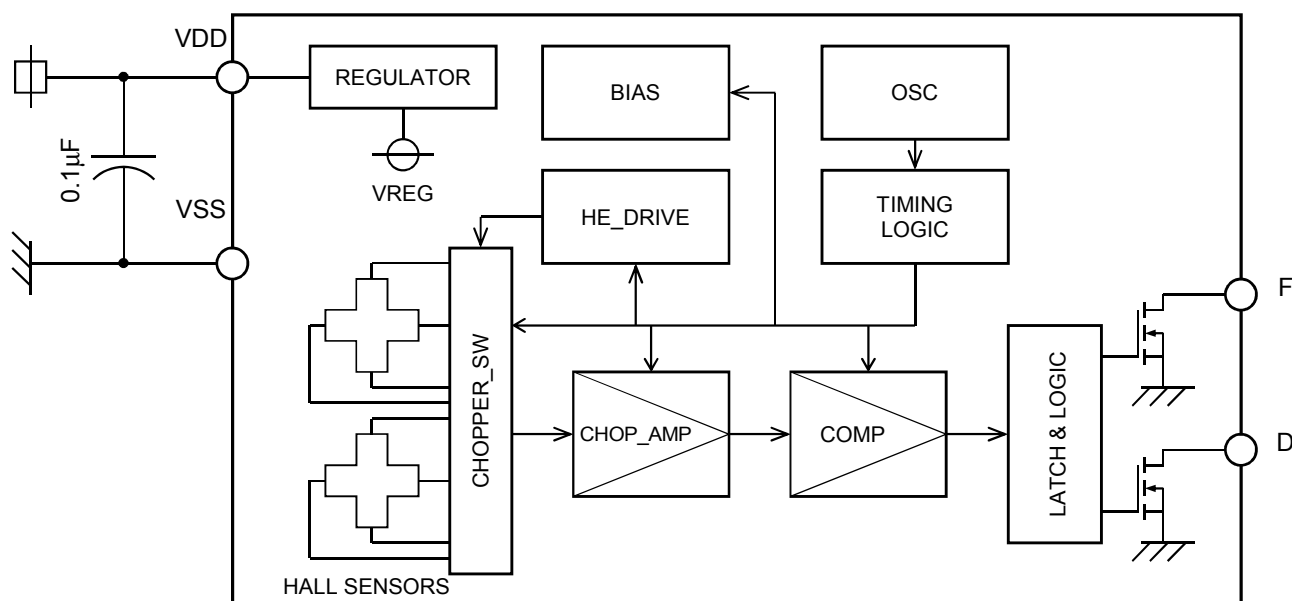


Figure 1. Block diagram

## 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	$\mu A$	F, D= $V_{DD}$
Output refresh period	$T_P$	12.0	16.7	30.5	$\mu s$	

## 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.

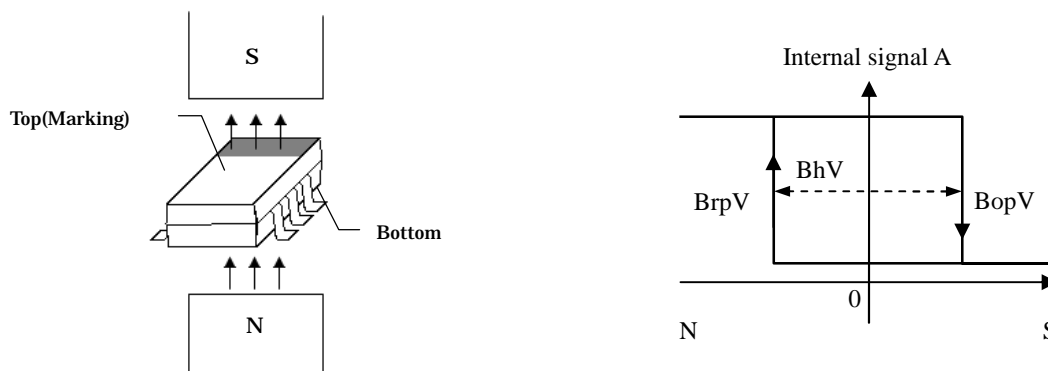


Figure 2. Switching behavior of the internal signal A when vertical magnetic field is applied

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.

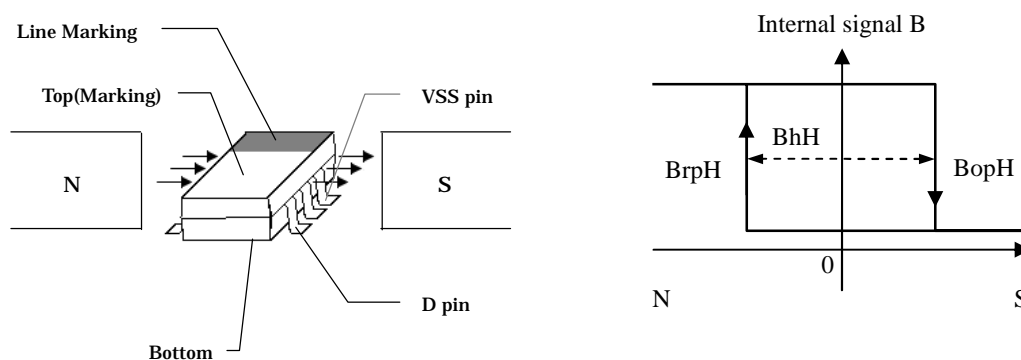


Figure 3. Switching behavior of the internal signal B when horizontal magnetic field is applied

### 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.

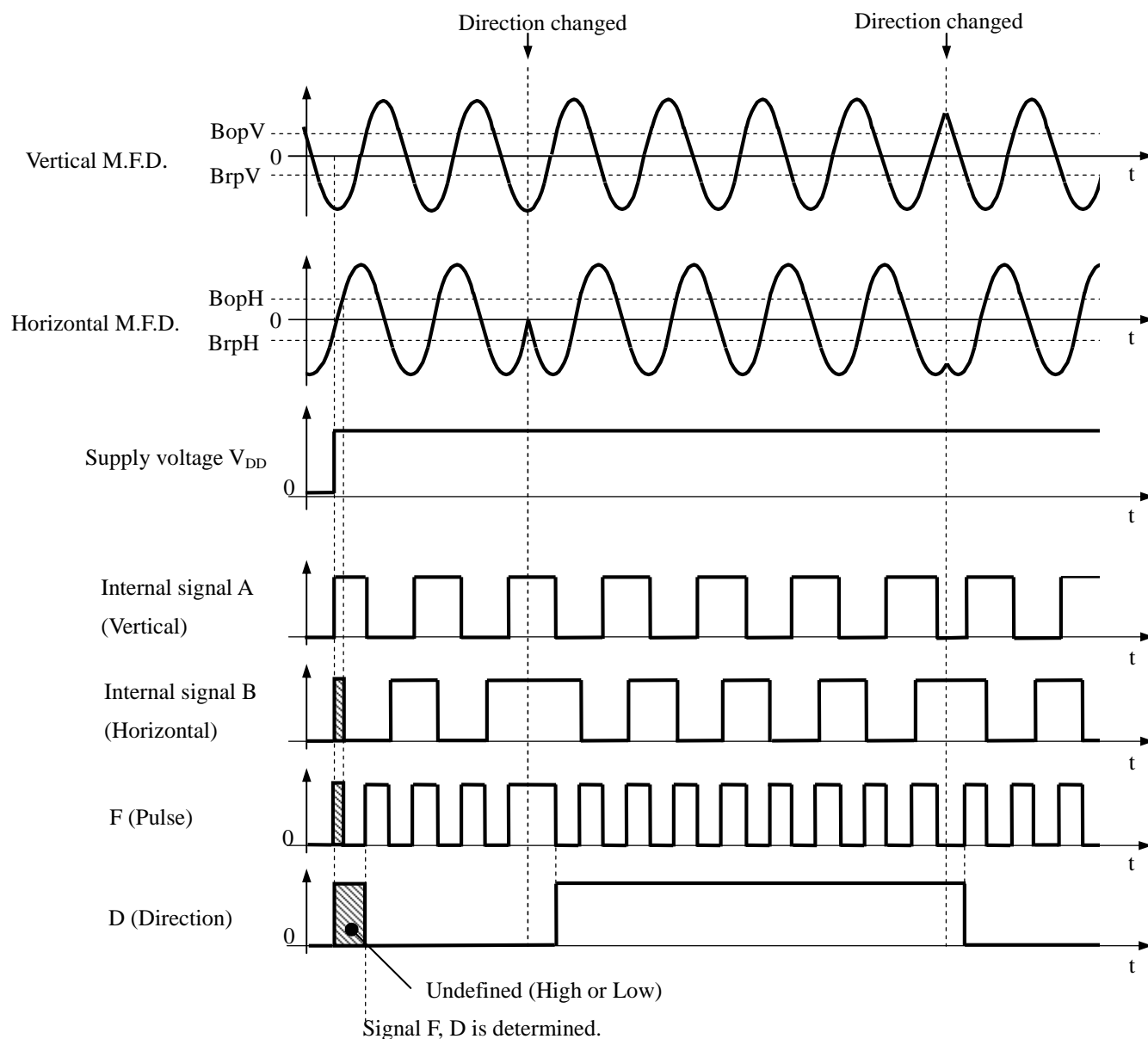


Figure 4. Behaviors of internal signal A,B and signal F, D when a rotating magnetic field is applied on AK8778B

\*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

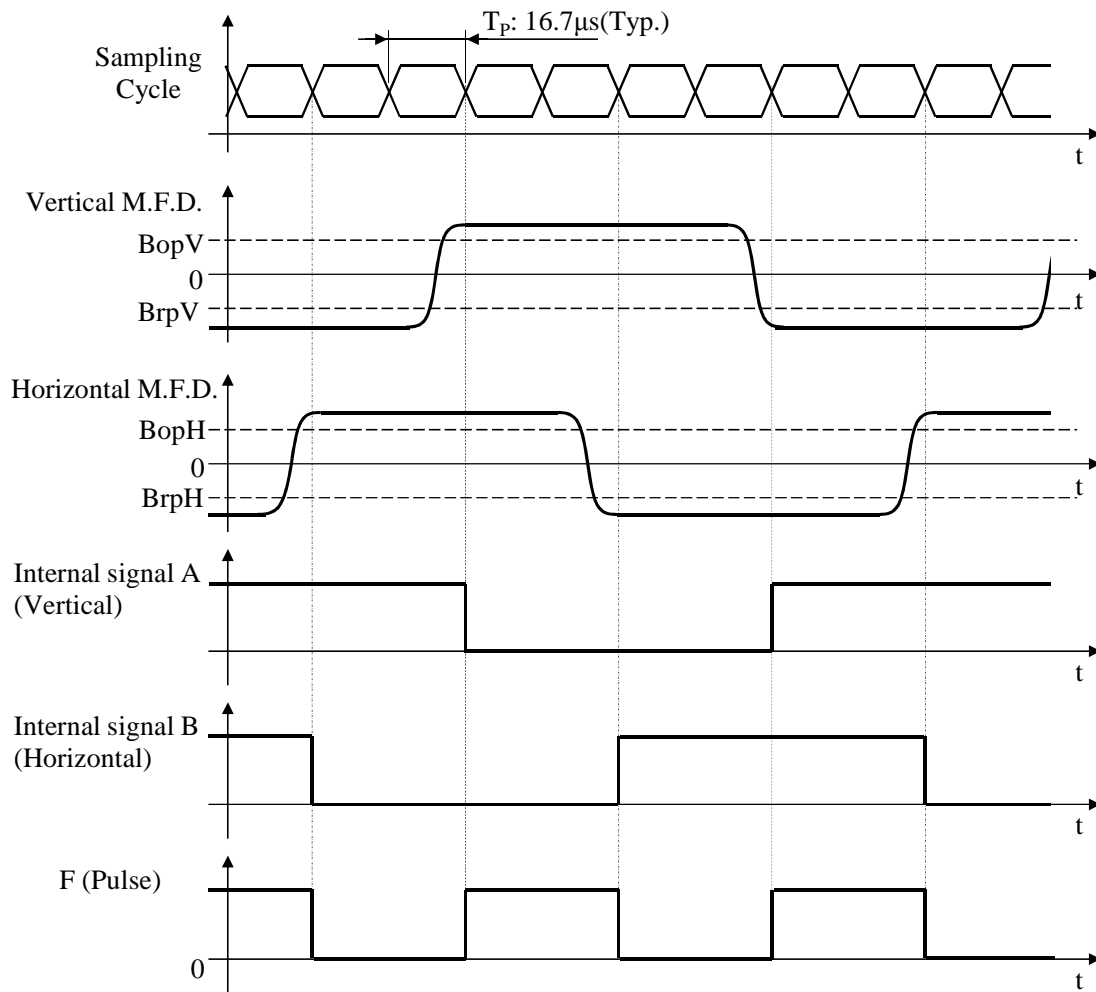


Figure 5. Timing diagram

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

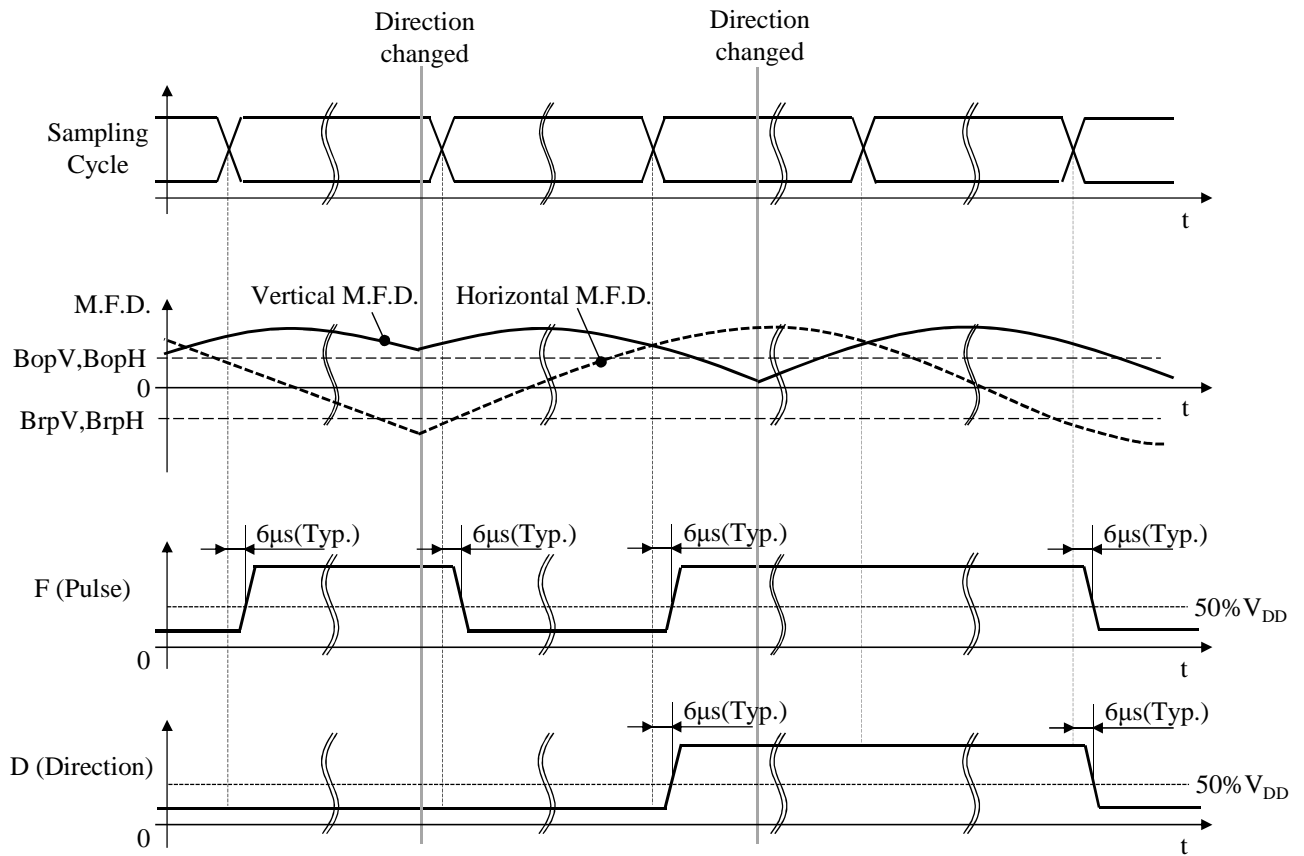


Figure 6. Timing diagram (in detail)

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

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



# Typical Characteristic Data (for reference)

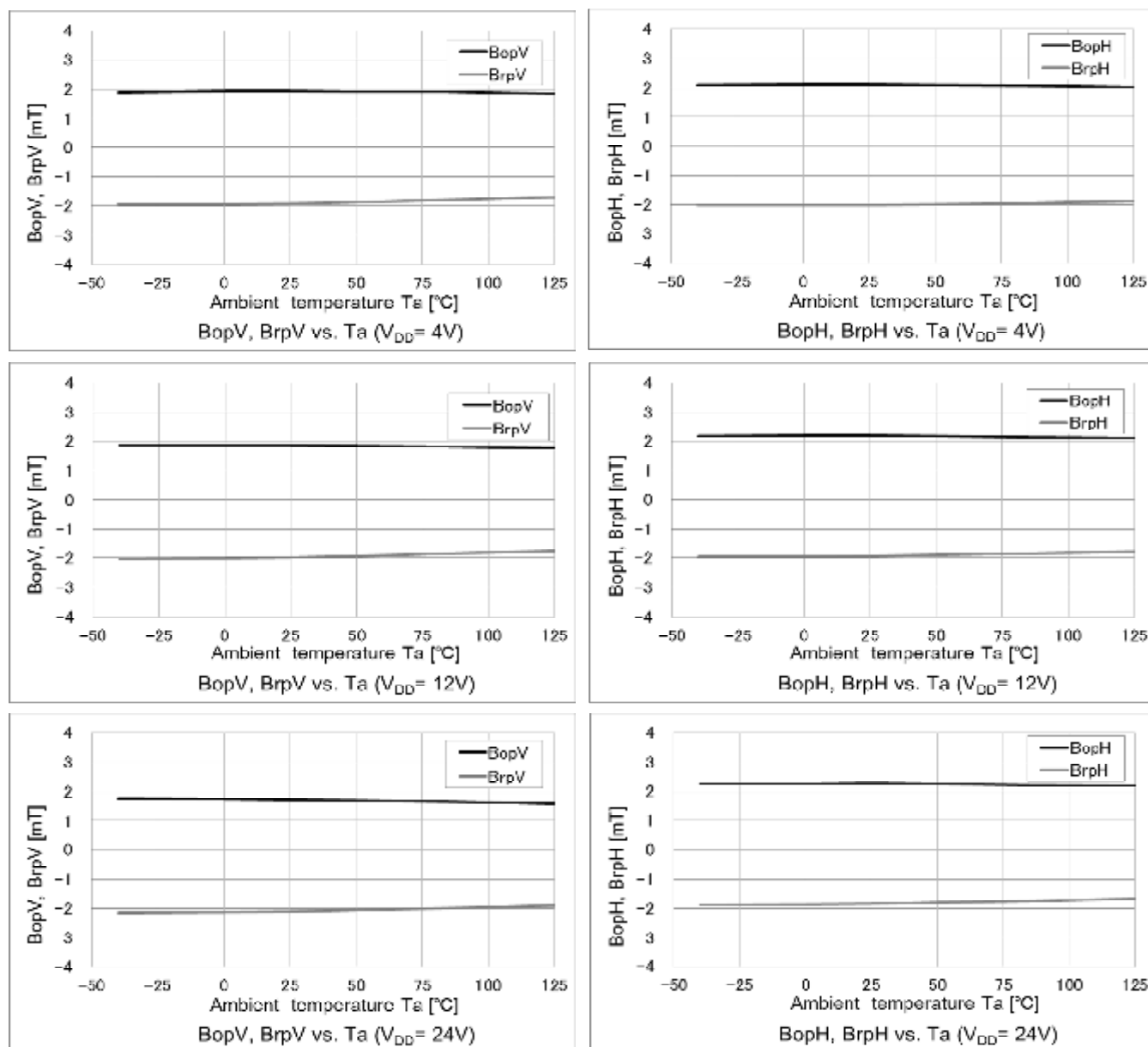


Figure 7. Temperature dependence of sensitivity

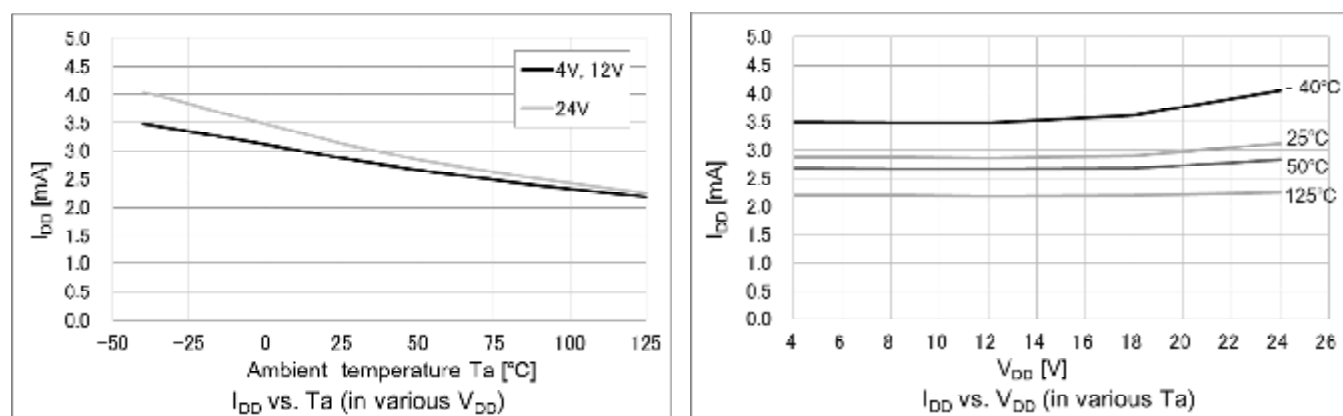


Figure 8. Temperature dependence of current consumption

## Package

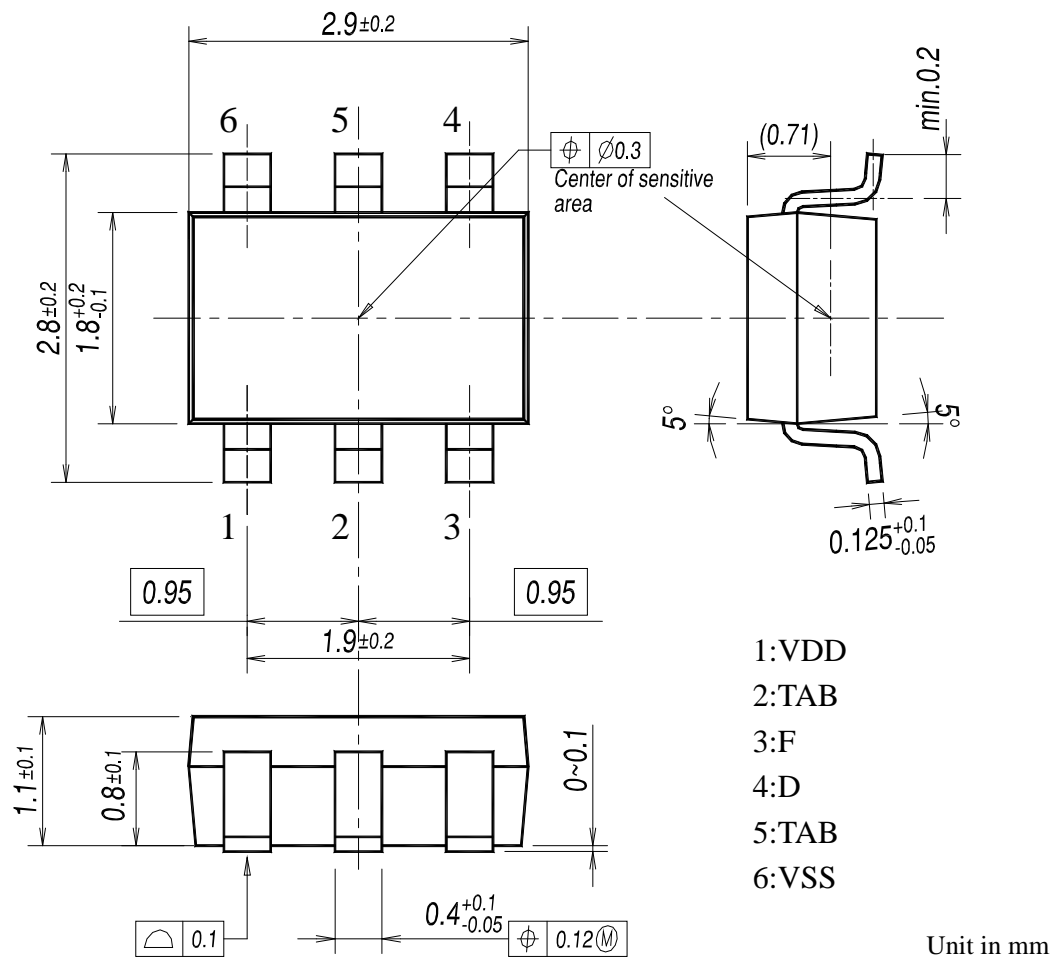


Figure 9. Package dimensions

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

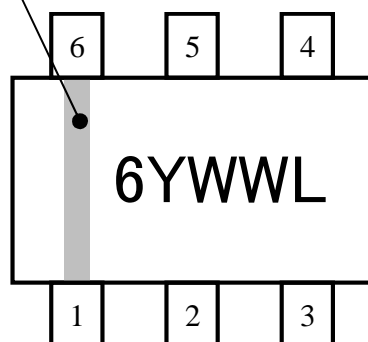
Material of terminals: Cu alloy

Material of plating for terminals: Sn 100%

Thickness of plating for terminals: 10μm (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

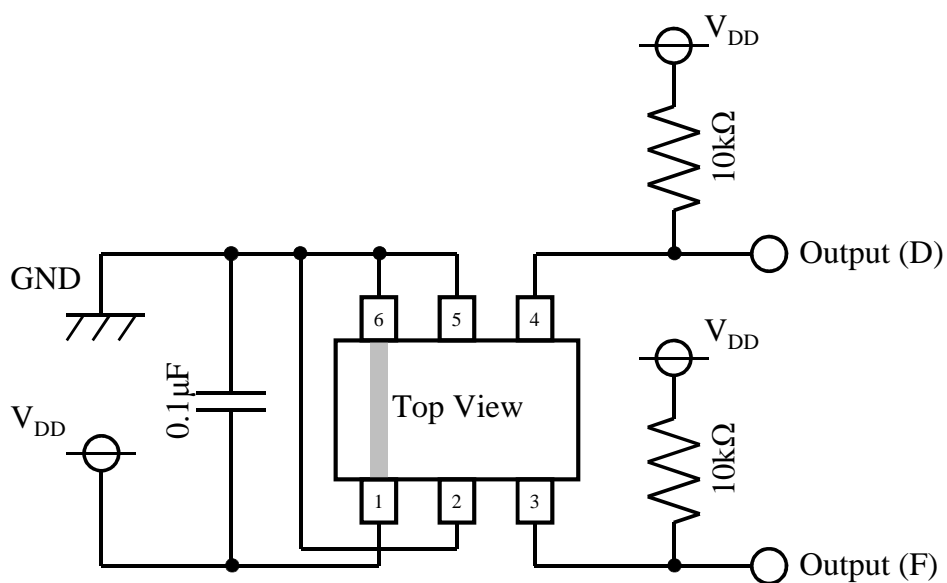


Figure 11. Recommended external circuit

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