



AK8778

## Hall Effect IC for Pulse Encoders

## Overview

The AK8778 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 AK8778 is for use in the incremental pulse encoders or rotational detection systems.

## Features

- 4.0 to 24V supply voltage operation
- Low power consumption : 1.4mA(Typ.)
- Sensitivity (Vertical, Horizontal) :  $\pm 2.5\text{mT}$ (Typ.)
- Two outputs : F (Pulse), D (Direction)
- Small package: SOP-6pin
- Halogen free

## Block Diagram

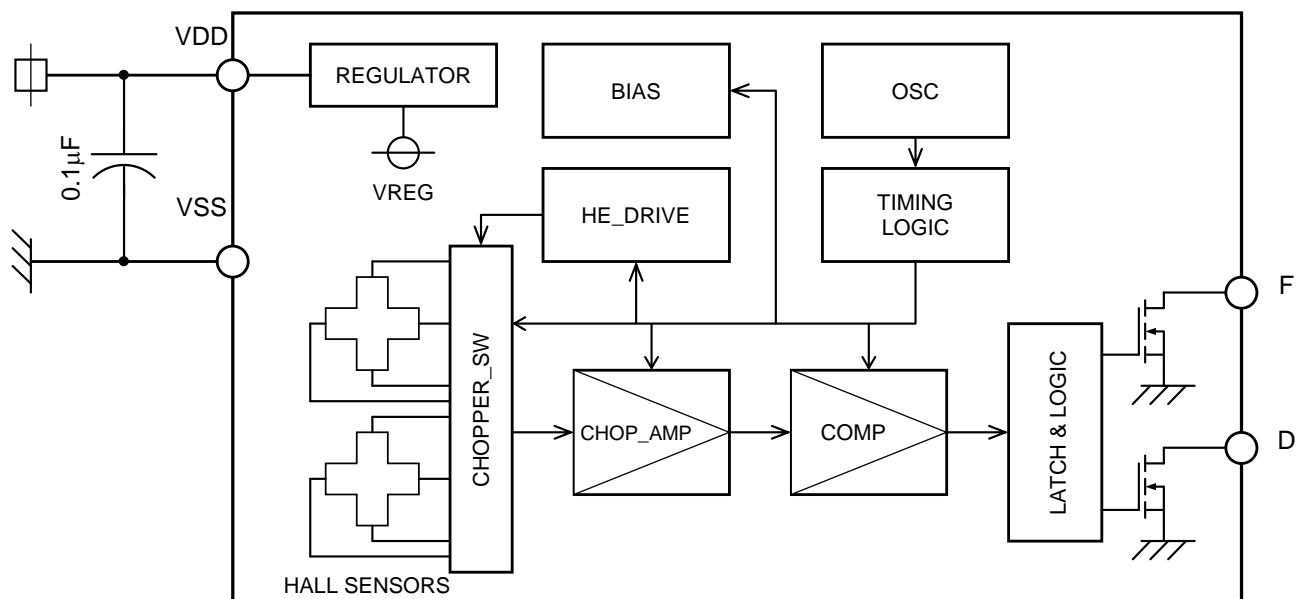


Figure 1. Block diagram

## 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		+115	°C

## Electrical Characteristics

Table 5. Electrical characteristics at  $V_{DD}=4.0$  to  $24.0V$ ,  $T_a=-40$  to  $+115^{\circ}C$ 

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Current consumption	$I_{DD}$	0.7	1.4	2.5	mA	Average
Output saturation voltage	$V_{SAT}$			0.4	V	F, D pin, $I_{SINK}=15mA$
Output leak current	$I_{LEAK}$			10	$\mu A$	F, D= $V_{DD}$
Pulse drive period	$T_{PD1}$	24.4	48.8	97.6	$\mu s$	
Pulse drive duration time	$T_{PD2}$	12.2	24.4	48.8	$\mu s$	

## Magnetic Characteristics

Table 6. Magnetic characteristics at  $V_{DD}=4.0$  to  $24.0V$ ,  $T_a=-40$  to  $+115^{\circ}C$ 

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Operating point of vertical magnetic field	BopV	0.1	2.5	6.0	mT	(*1)
Releasing point of vertical magnetic field	BrpV	-6.0	-2.5	-0.1	mT	(*1)
Operating point of horizontal magnetic field	BopH	0.1	2.5	6.0	mT	(*2)
Operating point of horizontal magnetic field	BrpH	-6.0	-2.5	-0.1	mT	(*2)
Hysteresis	BhV, BhH		5.0		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.

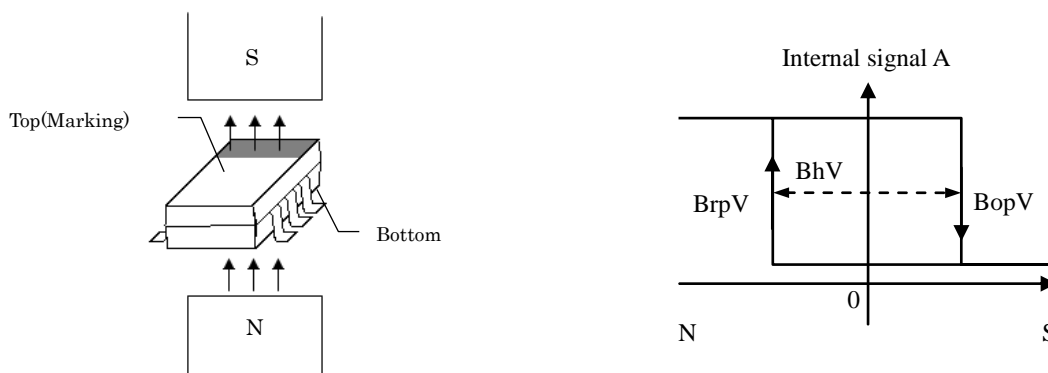


Figure 2. Switching behavior of the internal signal A when vertical magnetic field is applied

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.

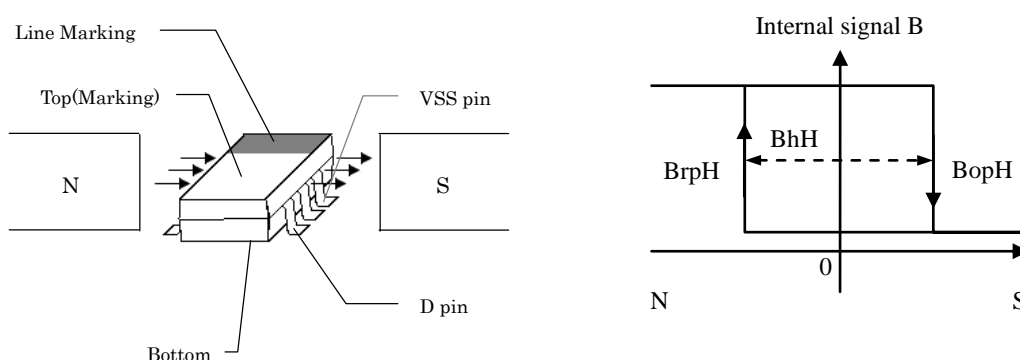


Figure 3. Switching behavior of the internal signal B when horizontal magnetic field is applied

Behaviors of internal signal A,B and output signal F, D when a rotating magnetic field is applied on AK8778

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.

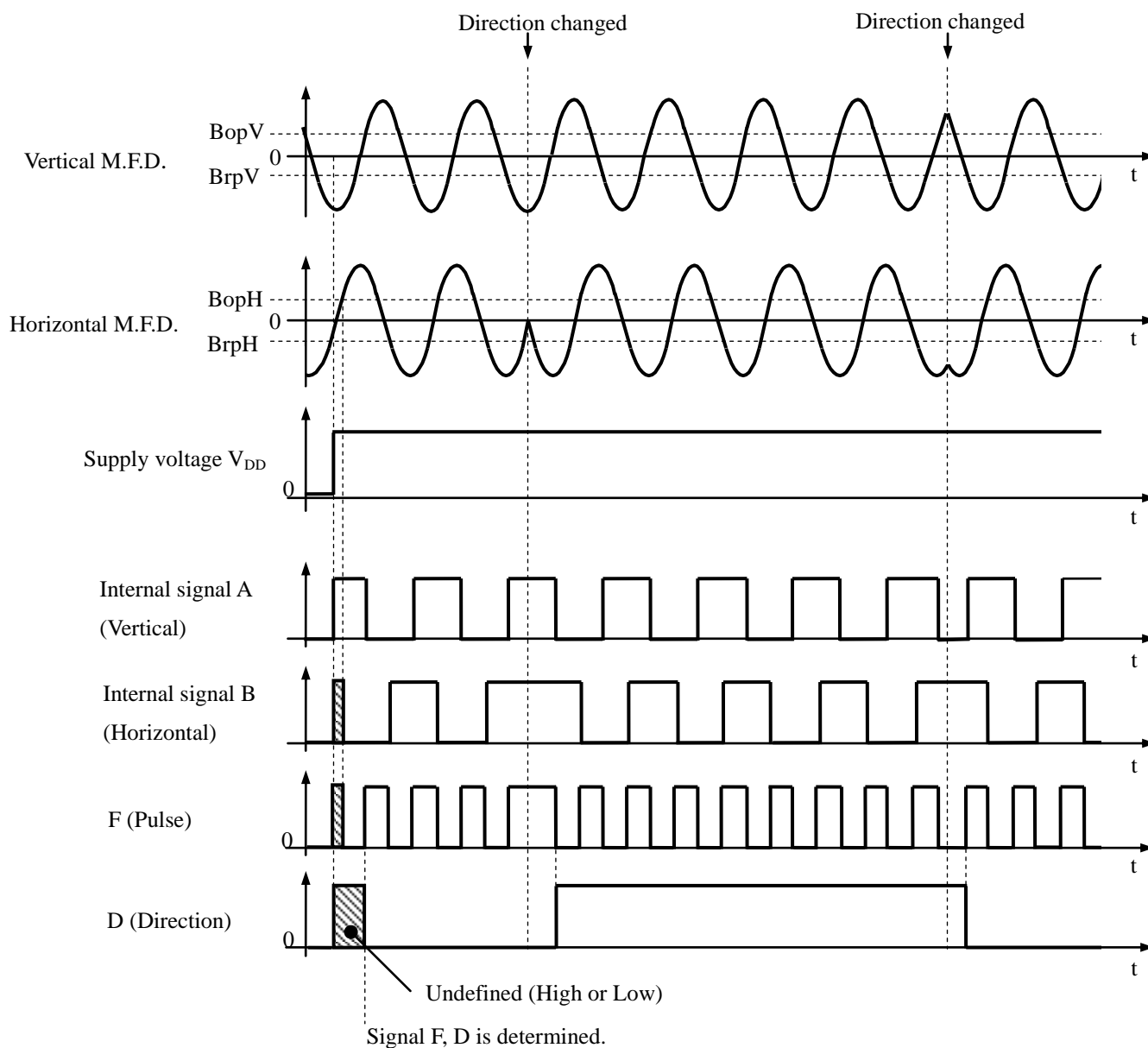


Figure 4. Behaviors of internal signal A,B and signal F, D when a rotating magnetic field is applied on AK8778

\*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

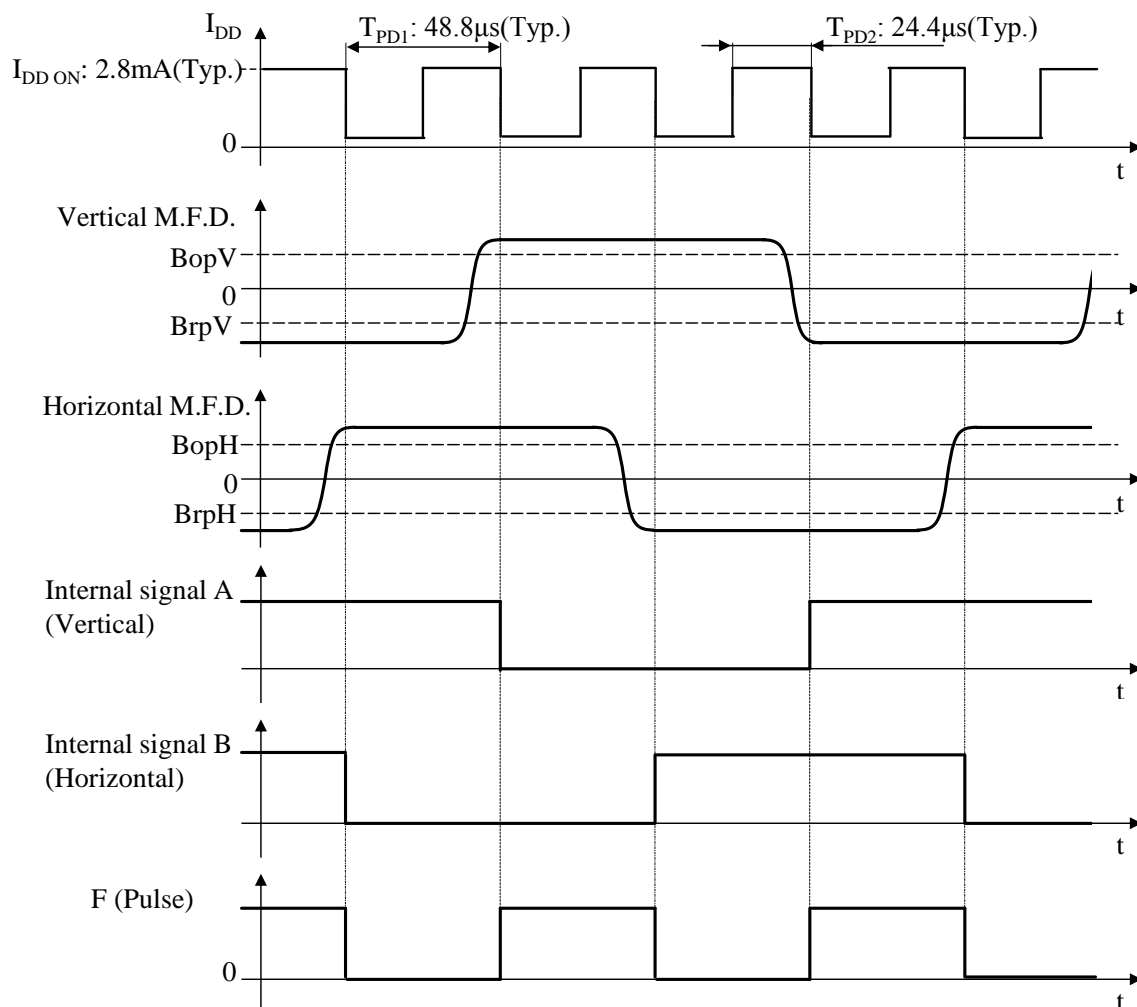


Figure 5. Timing diagram

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

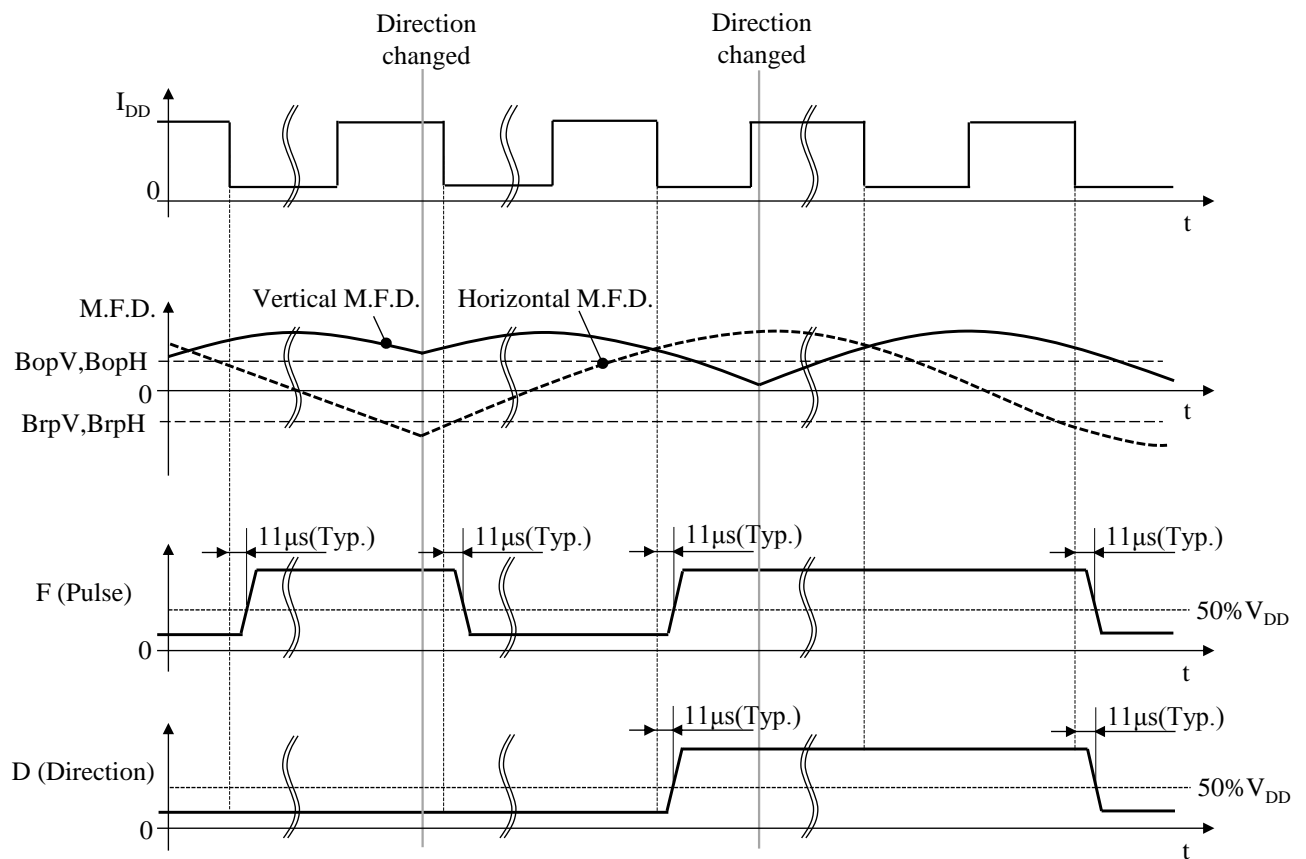


Figure 6. Timing diagram (in detail)

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

Note 1)  $V_{DD}=12.0V$ ,  $R_L=10k\Omega$ ,  $C_L=20pF$

Note 2) Signal F and D are changed at the same time.



Typical Characteristic Data (for reference)

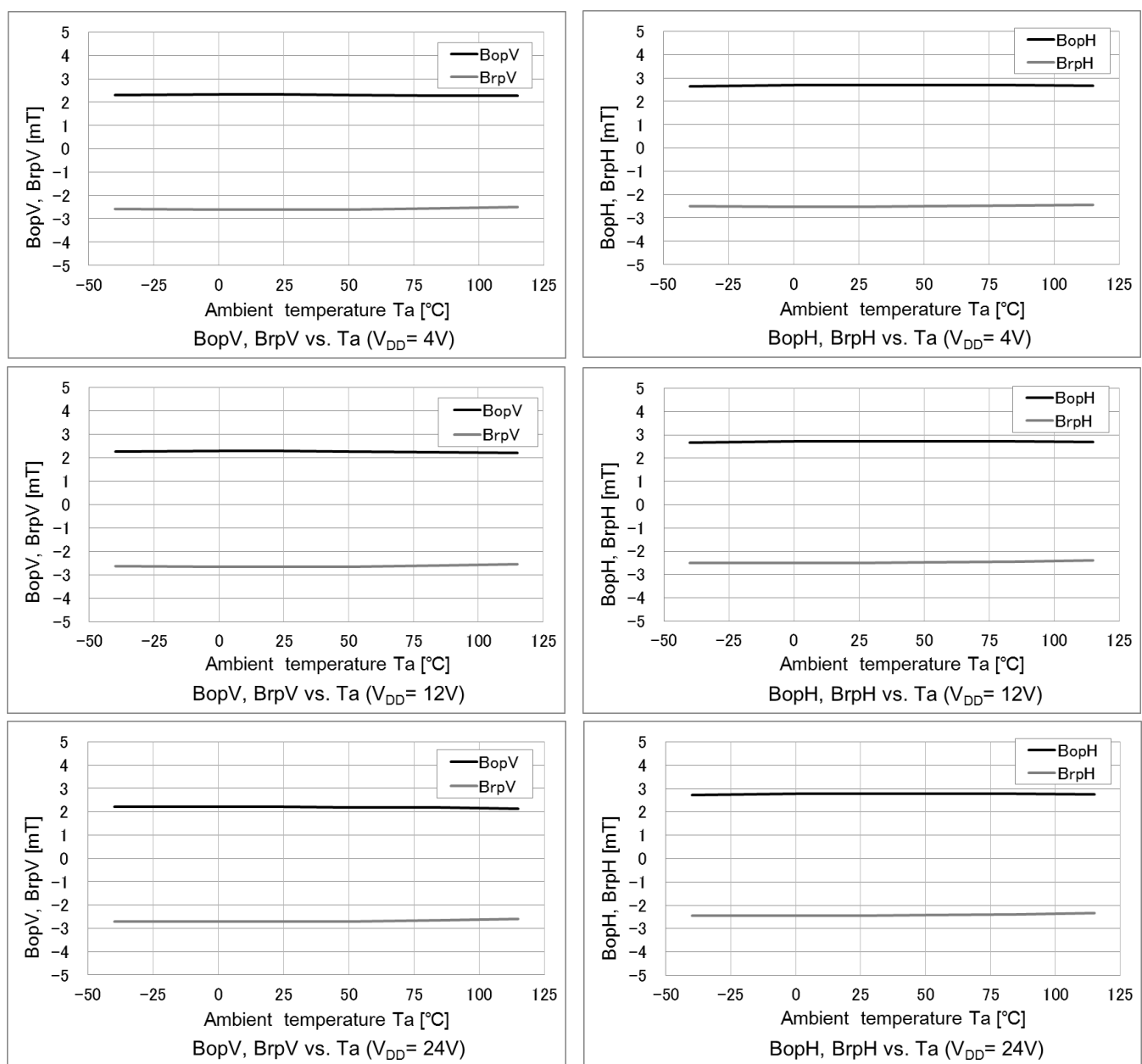


Figure 7. Temperature dependence of sensitivity

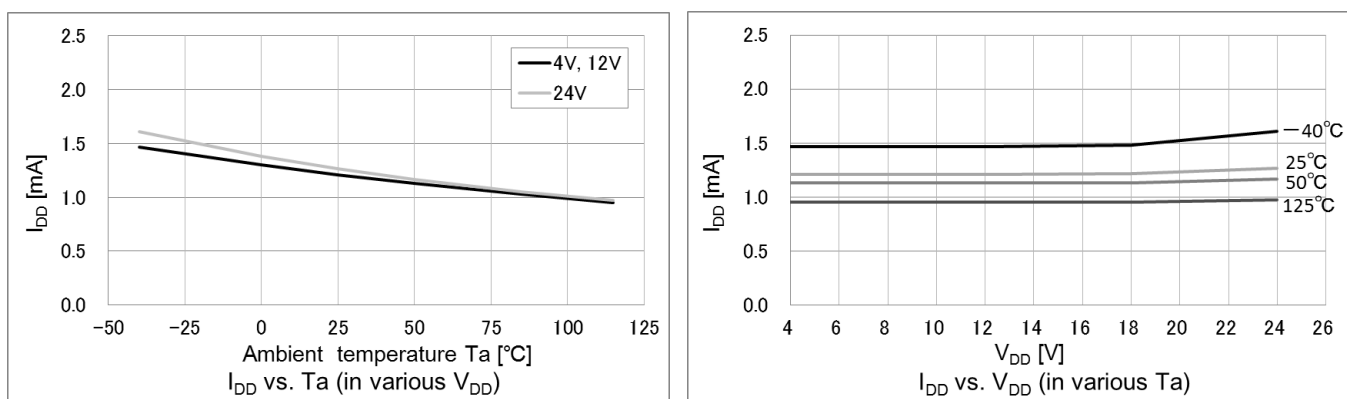


Figure 8. Temperature dependence of current consumption

Package

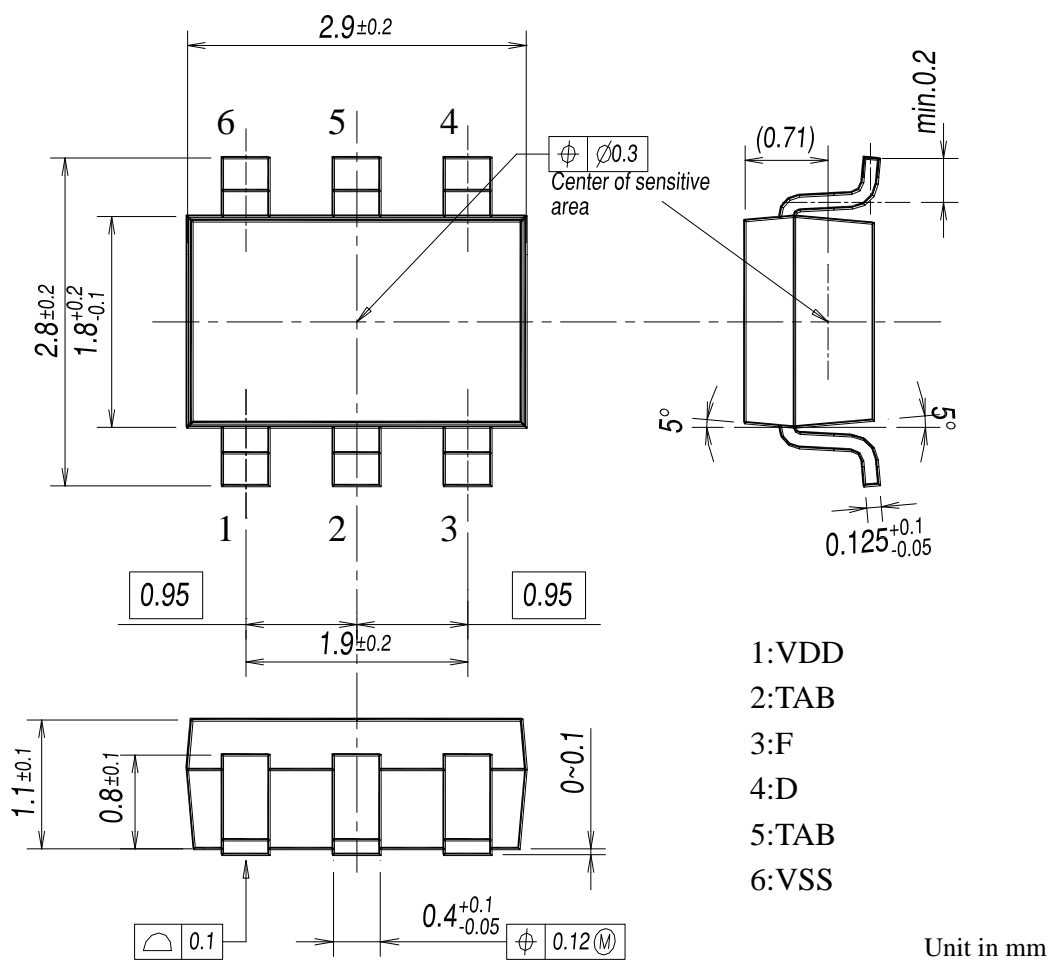


Figure 9. Package dimensions

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.

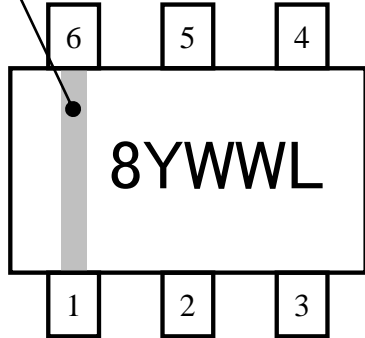
Material of terminals: Cu alloy

Material of plating for terminals: Sn 100%

Thickness of plating for terminals: 10 $\mu$ m (Typ.)

Marking

Line Marking



Marking is performed by laser

Product name : 8 (AK8778)

Date code : YWWL

Y : Manufactured year

WW : Manufactured week

L : Lot

Figure 10. Marking

Recommended External Circuit

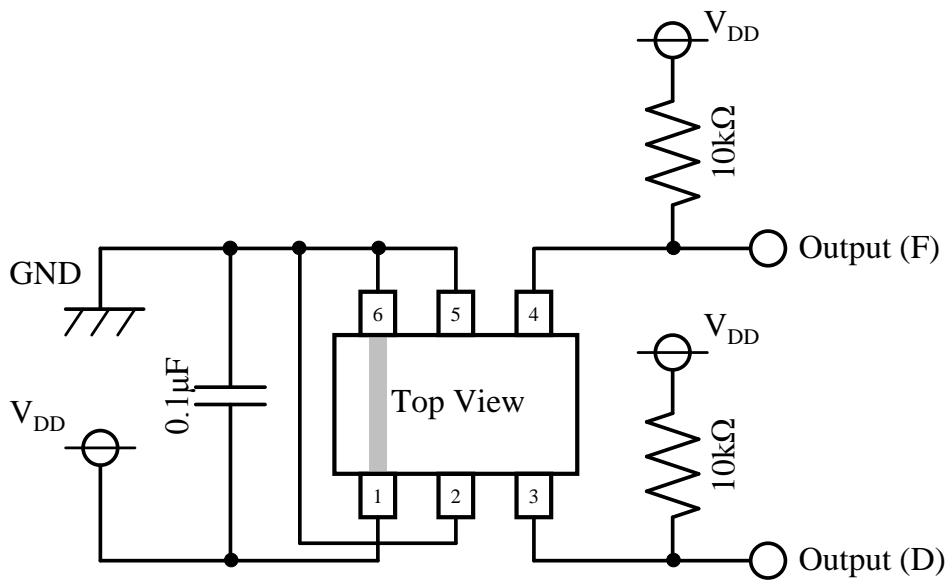


Figure 11. Recommended external circuit

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