AK8776

Hall IC for Pulse Encoder

Overview

AK8776 is a Hall effect latch which detects both “vertical” and “horizontal” (perpendicular and parallel to the marking side of the package) magnetic field at the same time and outputs the pulse (F) and rotational direction (D). AK8776 is for use in portable devices which uses rotational detection system or incremental pulse encoder such as jog dial utilized for input devices.

Features

- 1.6 to 5.5V operation
- Bop, Brp(Vertical, Horizontal) ±1.5mT(Typ.), Highly sensitive
- Low power operation : Average 90μA(Typ.) @V_{DD}=3V
- Two Output: F-Output (Pulse count), D-Output (Direction of rotation)
- Small package: SOP-4pin, Halogen free

Block Diagram

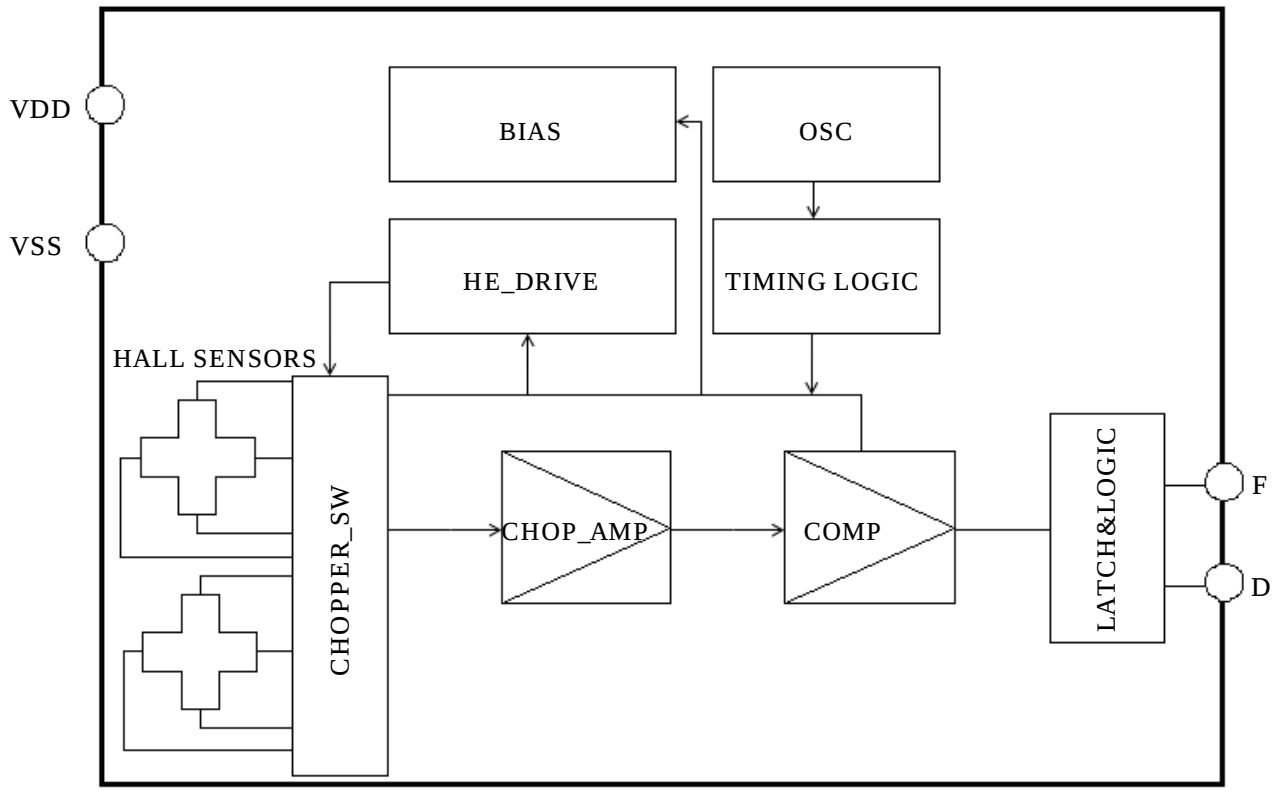

Figure 1. Block diagram

Circuit Configuration

Table 1. Circuit configuration

Block	Function
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 other circuits.
HE_DRIVE	Generates bias current for Hall sensors.
OSC	Generates operating clock.
TIMING LOGIC	Generates timing signal required for Chopper SW, AMP and COMP.
LATCH & LOGIC	Logical circuits and CMOS output buffer.

Pin/Function

Table 2. Description of pin name and function

Pin No.	Pin name	I/O	Function	Note
1	VDD	–	Power supply pin	
2	F	O	Output F (Pulse) pin	CMOS output
3	D	O	Output D (Direction) pin	CMOS output
4	VSS	–	Ground pin	

Absolute Maximum Ratings

Table 3. Absolute maximum ratings

Parameter	Symbol	Min.	Max.	Unit	Note
Power supply voltage	V_{DD}	–0.3	+6.5	V	
Output current	I_{OUT}	–0.5	+0.5	mA	F,D pin
Storage temperature	T_{STG}	–40	+125	°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
Power supply voltage	V_{DD}	1.6	3.0	5.5	V
Operating temperature	Ta	–30		+85	°C

Electrical Characteristics

Table 5. Electrical characteristics (Ta=25°C, V_{DD} = 3.0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Current consumption	I_{DD}		90	210	μA	Average
High level output Voltage	V_{OH}	V_{DD}-0.4			V	F,D pin, I_{OUT}= –0.5mA
Low level output Voltage	V_{OL}			0.4	V	F,D pin, I_{OUT}= +0.5mA
Pulse drive period	T_{PD1}	0.5	1.0	2.0	ms	
Pulse drive duration time	T_{PD2}	12.2	24.4	48.8	μs	

Note) Internal data is determined just before the internal circuit turns off. And after 6.1μs (Typ.), the output changes.

Magnetic Characteristics

The output F and D is processed signals from internal signal A and B which is determined by the applied magnetic field and threshold level BopV, BrpV, BopH and BrpH as follows.

Table 6. Magnetic characteristics(Ta = 25°C, V_{DD} = 3.0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Vertical magnetic field operating point	BopV		1.5	4.0	mT	(*1)
Vertical magnetic field releasing point	BrpV	–4.0	–1.5		mT	(*1)
Horizontal magnetic field operating point	BopH		1.5	4.0	mT	(*2)
Horizontal magnetic field releasing point	BrpH	–4.0	–1.5		mT	(*2)
Hysteresis	BhV, BhH		3.0		mT	(*1), (*2)

(*1) Horizontal magnetic flux density is zero.

(*2) Vertical magnetic flux density is zero.

Operational Characteristics

AK8776 detects the “vertical” (perpendicular to the marking side of the package) magnetic field, and the resulting internal signal A changes state. When the magnetic field is more positive than BopV, the internal signal A changes to ‘Low’ state. And it is kept while the magnetic field remains more positive than BrpV. When the magnetic field drops below BrpV, the internal signal A changes to ‘High’ state. Those threshold magnetic flux density levels are defined in Table 6.

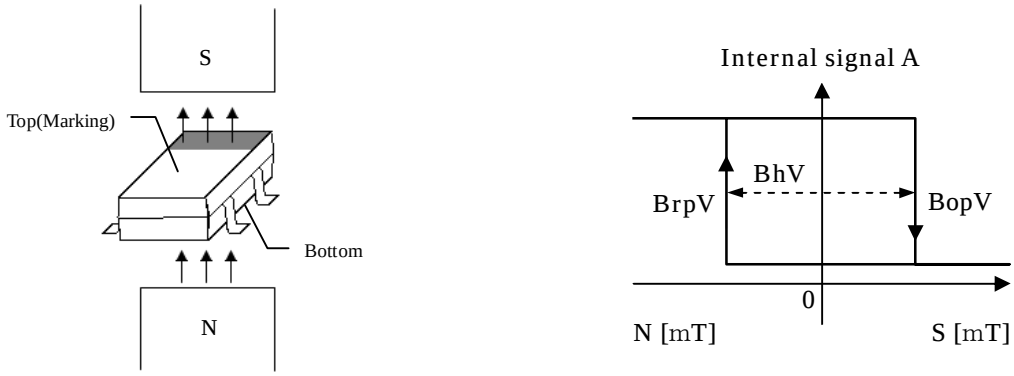

Figure 2. Switching behavior of internal signal A when vertical magnetic field is applied

AK8776 detects “horizontal “(parallel to the marking side of the package) magnetic field, and the resulting internal signal B changes state. When the magnetic field is more positive than BopH, the internal signal B changes to ‘Low’ state. And it is kept while the magnetic field remains more positive than BrpH. When the magnetic field drops below BrpH, the internal signal B changes to ‘High’ state. Those threshold magnetic flux density levels are defined in Table 6.

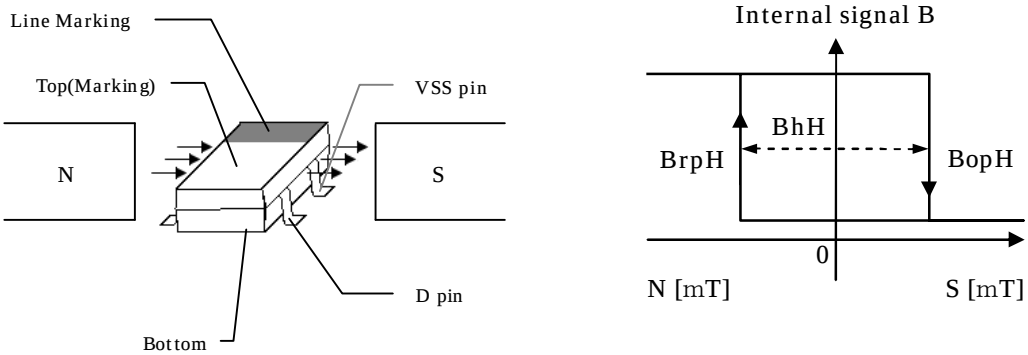

Figure 3. Switching behavior of internal signal B when horizontal magnetic field is applied

Behaviors of internal signal A,B and output signal F, D when a rotating magnetic field is applied on AK8776

F signal (pulse) is correspond to the result of internal signal A and B. And D signal (direction) is given by looking up the state of signal A and B.

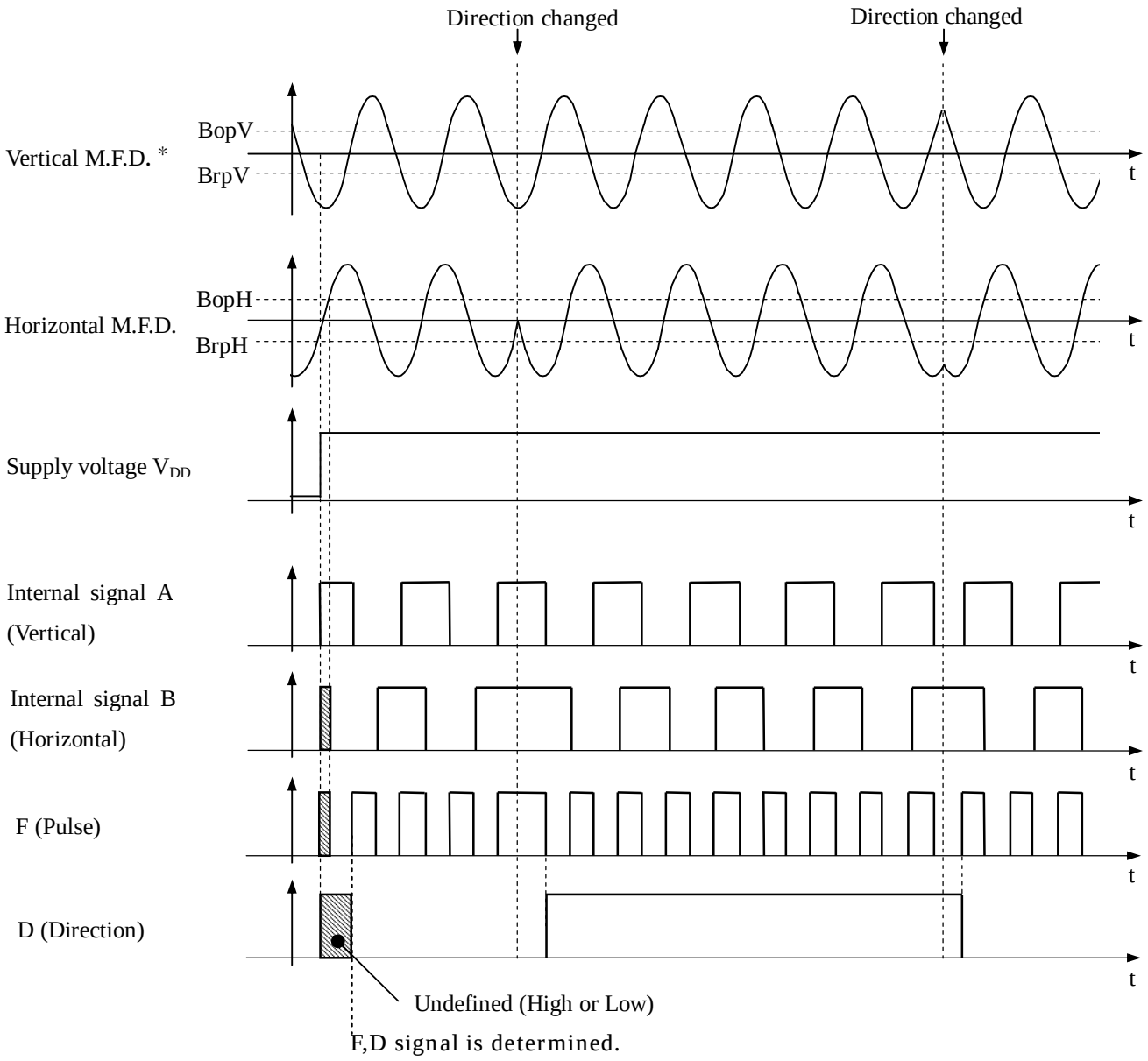

Figure 4. Behaviors of internal signal A,B and output signal F, D
when a rotating magnetic field is applied on AK8776

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

Note) D signal is determined after one pulse sent out of F signal. The section which the output status is undefined appears only in the starting up of this device.

Functional Timing

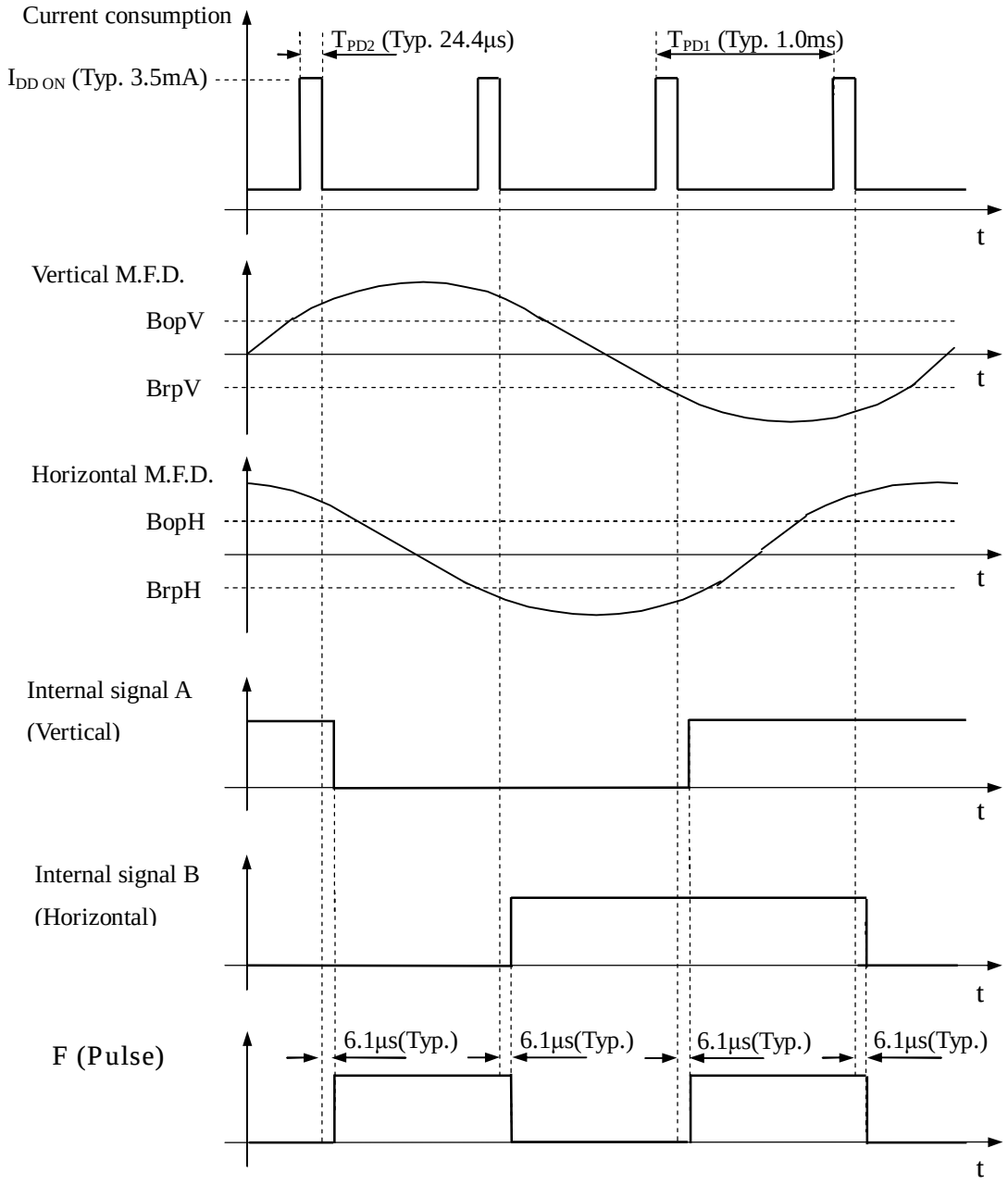

Figure 5. The timing chart of current consumption and transition timing of internal and output signal

Note)V_{DD}=3.0V. Output signal F and D are changed at the same time.

Typical Characteristic Data (for reference)

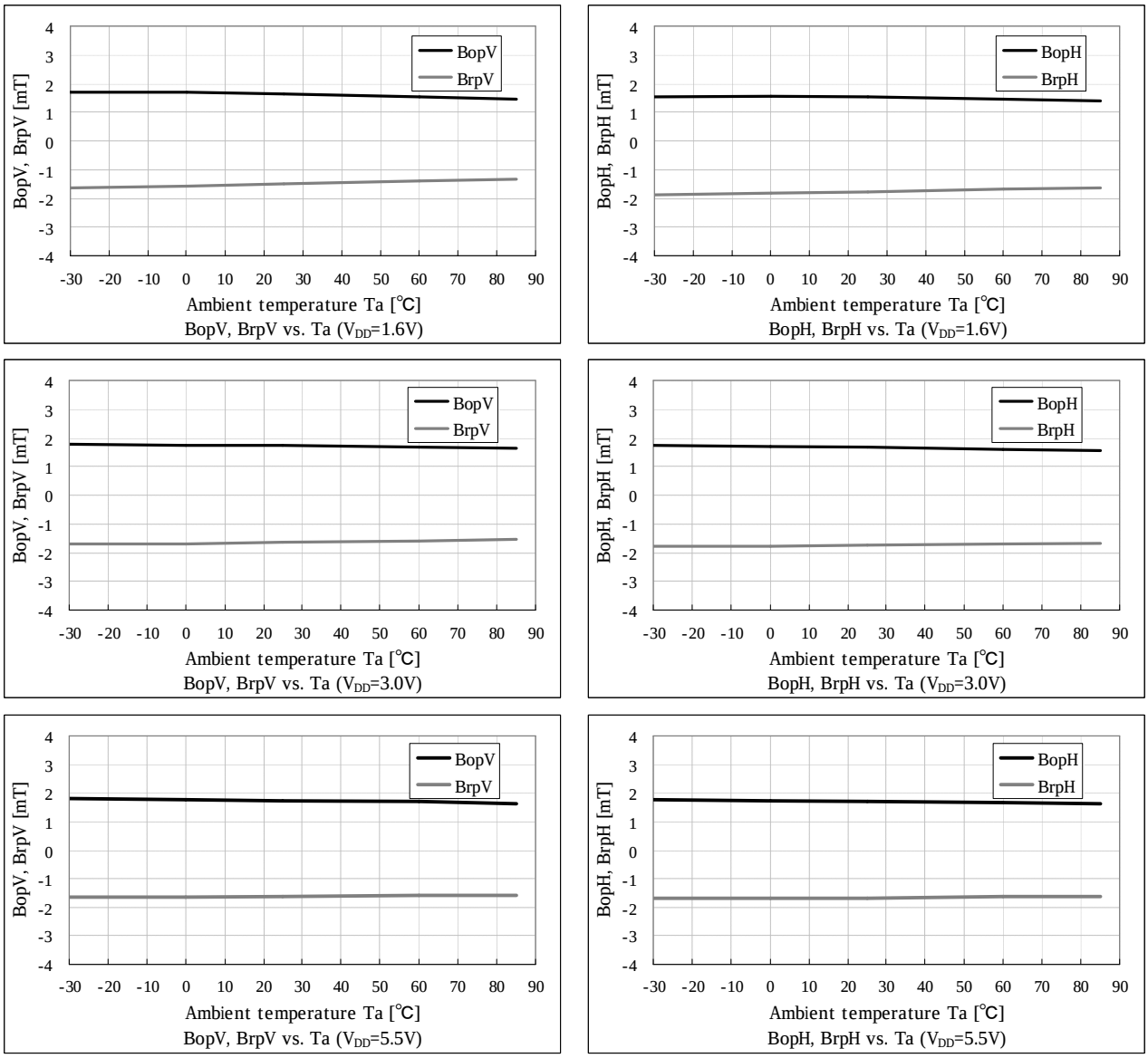

Figure 6. Temperature dependence of sensitivity

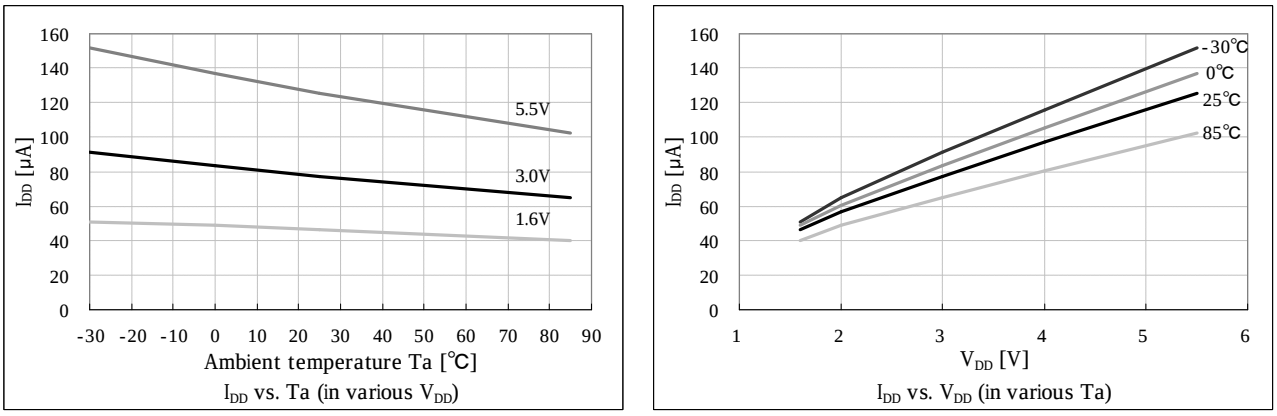

Figure 7. Temperature dependence of current consumption

Package

Unit in mm

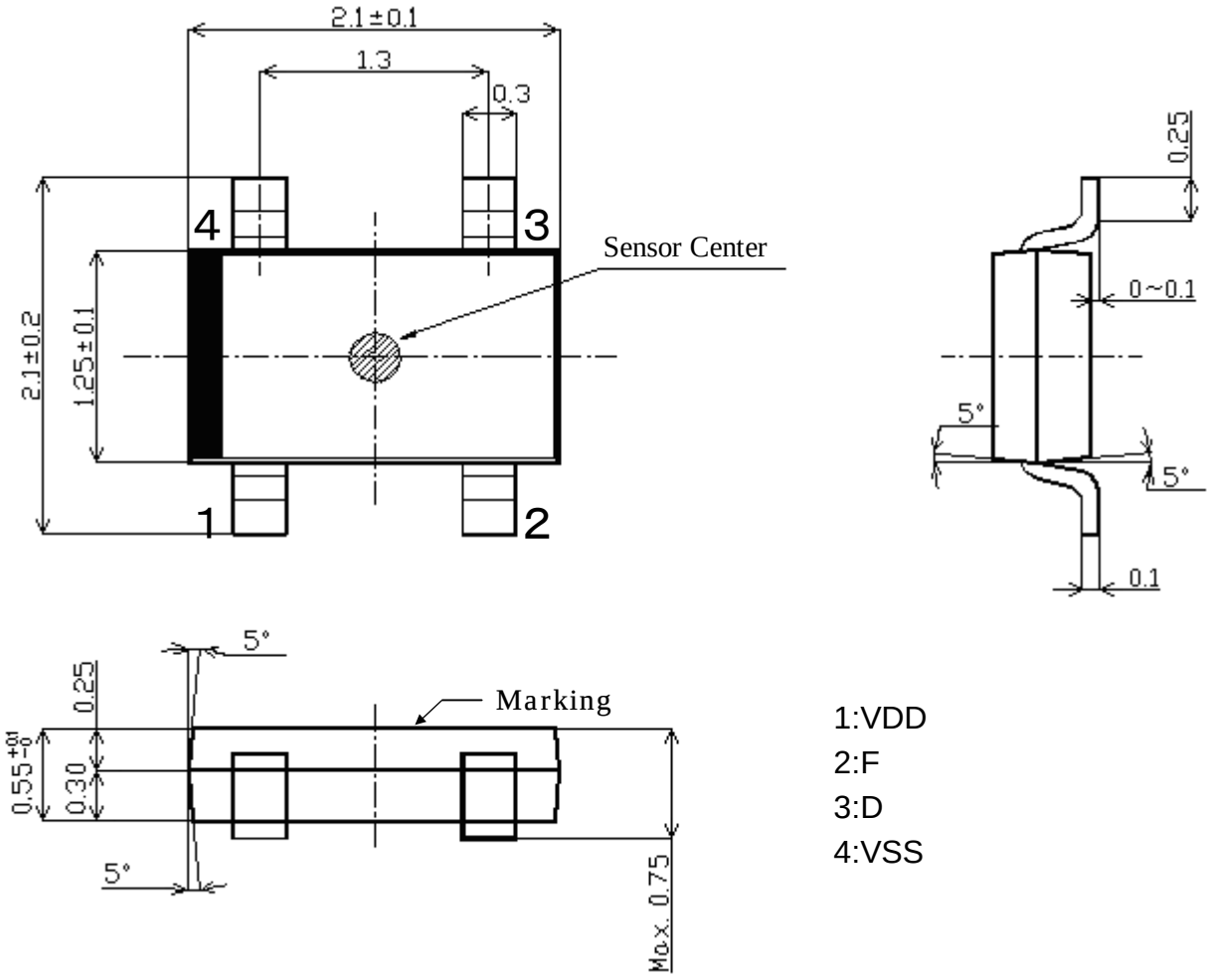

Figure 8. Package dimensions

Note 1) The center of the sensor is located within the ϕ0.3mm circle.

Note 2) The tolerances of dimensions with no mentions are ±0.1mm.

Note 3) Coplanarity: The differences between standoff of terminals are max. 0.1mm.

Note 4) The sensor part is located 0.4mm±0.1mm far from marking surface.

Material of terminals: Cu alloy

Material of plating for terminals: Sn 100%

Thickness of plating for terminals: 10μm (Typ.)

Marking

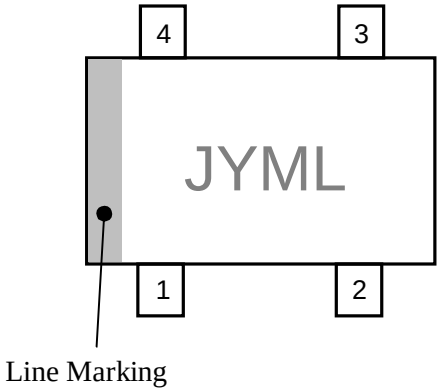

Figure 9. Marking

Marking is performed by laser

Product name : J (AK8776)

Date code : YML

Y : Last one digit of manufactured year (0~ 9)

M : Manufactured month

Jan.	C	Jul.	J
Feb.	D	Aug.	K
Mar.	E	Sept.	L
Apr.	F	Oct.	M
May.	G	Nov.	N
Jun.	H	Dec.	P

L : Lot(1~ 9,A~ Z)

Recommended External Circuit

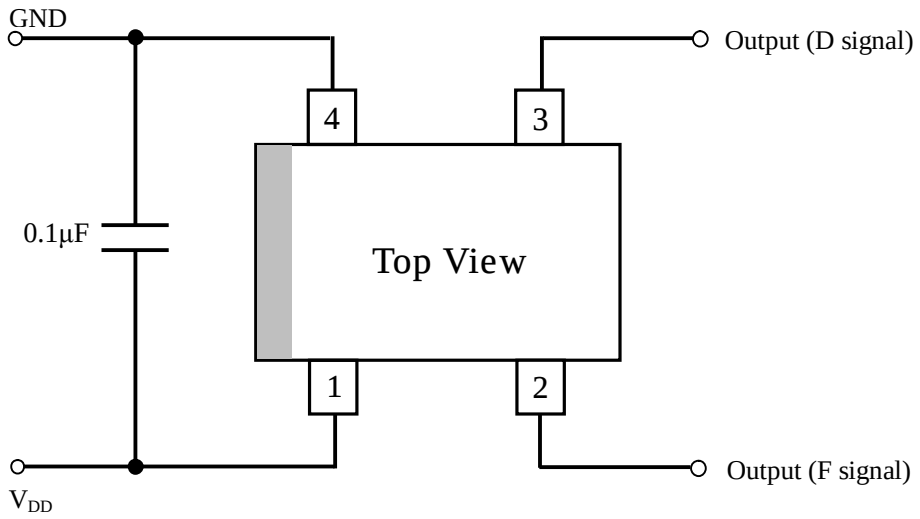

Figure 10. Recommended external circuit

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