AsahiKASEI

Onechip Pulse Encoder IC

Application Note

ASAHI KASEI MICRODEVICES CORPORATION

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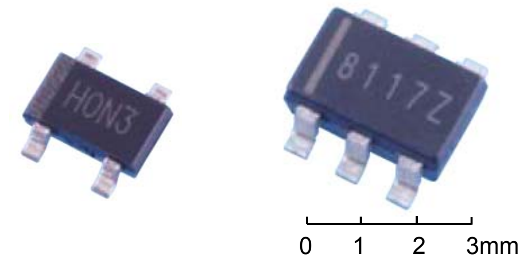
Table of Contents

§ 1. Features and Benefits

- Single chip solution with small package
- Brand-new detection principle – operating both on the vertical and horizontal magnetic fields
- Dramatically improved mounting flexibility
- 'Pitch free' – ideal two phase signal is given regardless to the magnetic pole pitch and/or air gap



(a) AK8775／AK8776 (b) AK8777B／AK8778B

Figure 1. Packages of the onechip encoder ICs

§ 2. Comparison with conventional system

In the conventional rotary incremental encoder system, two magnetic sensors such as Hall effect latches are utilized. Each output of these sensors are called A-phase signal and B-phase signal. The system detects the amount of rotation and direction by these two signals. To detect the correct rotation direction, these two pulses should have in 90 degrees out of phase relationship. This means a restriction on the mounting position of the sensors depends on the magnetic pole pitch and air gap - one sensor should be placed in front of the center of the magnetic pole and another should be placed in front of the border of N-pole and S-pole.

On the other hand, AK877x series Onechip encoder ICs are free from such a restriction if the sufficient magnetic flux density is applied. It fits with various pitches of magnets as well as dramatically improved mounting position flexibility. Single chip solution makes the mounting area as half as conventional systems and reduces current consumption drastically.

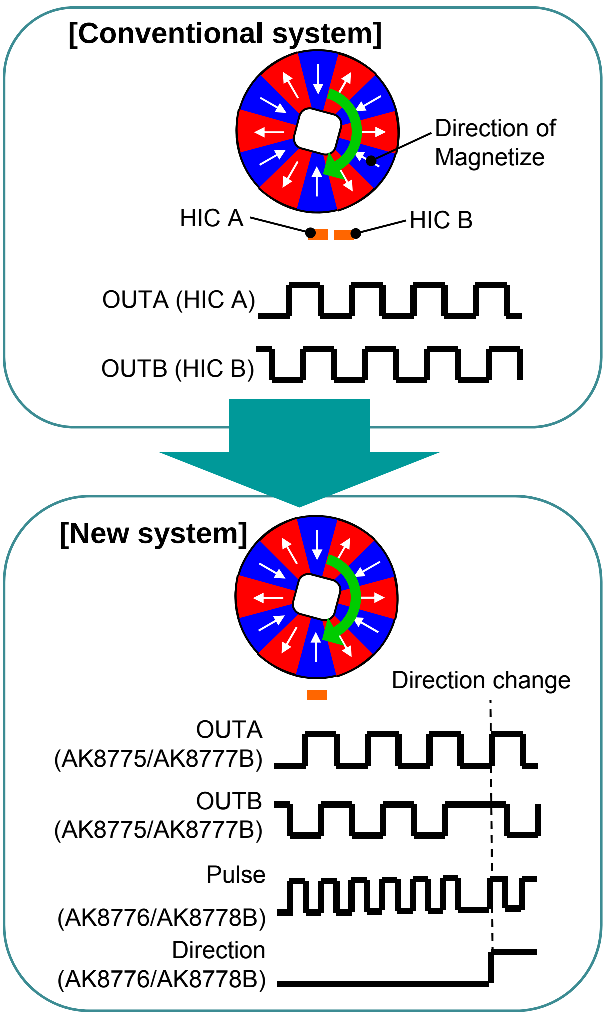


Figure 2.Rotary encoder system and its output

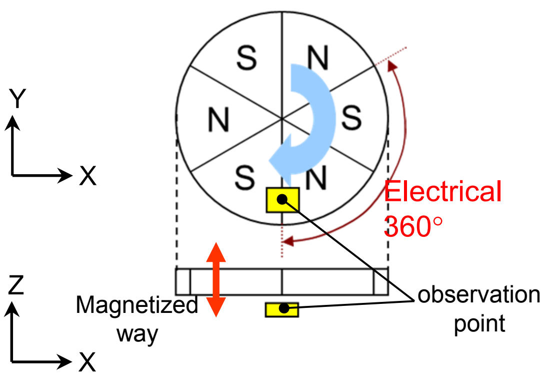
✧ Electrical angle, Mechanical (rotation) angle and 90° of phase difference

On the multipolar magnet, the electrical angle is a phase angle which is 360° constituting in one complete cycle. Electrical angle and mechanical angle are different except in case of the two pole magnet.

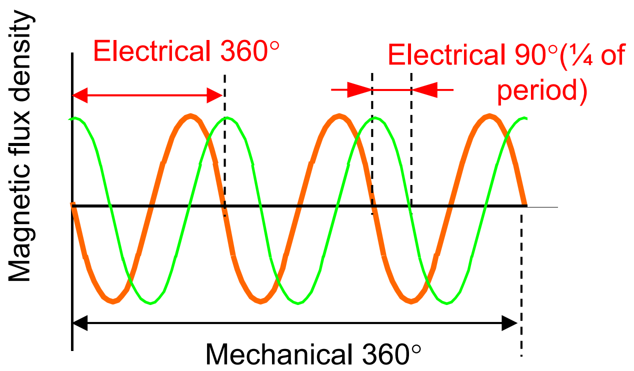
For example with six pole magnet, the magnetic flux density B_Z which is Z-axis component at the observation point where is neighboring point of its surface (Figure 3.(a)) fluctuates as shown in orange waveform of Figure.3(b). If the magnet rotates 360° from the initial position mechanically, the mechanical angle is 360° and electrical angle is 1080°. In other words, The 360° of electrical angle is equivalent to 120° in mechanical angle. Hence the electrical angle is converted by multiplying the mechanical angle by number of pole pairs or half number of poles:

electrical angle = mechanical angle × number of poles ÷ 2.

The green waveform on Figure 3.(b) has same shape but a quarter period of delay from orange waveform. They are in the '90 degree of phase difference' relationship and it is important factor in the two-phase incremental encoder system. Because in this relationship, the distance in time between two signal is maximum and it is the ideal condition in order to avoid misdetection in rotation detection.



(a)Six pole magnet and observation point



(b)Waveform of magnetic flux density against electrical angle and mechanical angle

Figure 3. Electrical angle and Mechanical angle

§ 3. Mounting flexibility of the Onechip encoder IC

AK877x series Onechip encoder IC provides not only the function of detection both of the amount of movement and direction with single chip but also dramatically improved the mounting position flexibility. As shown in Figure 4.(b), the mounting position is not restricted just underneath the magnet. Furthermore, (c) configuration is also possible. These mounting position flexibility features help in the reduction of module dimension, thickness, weight and production cost.

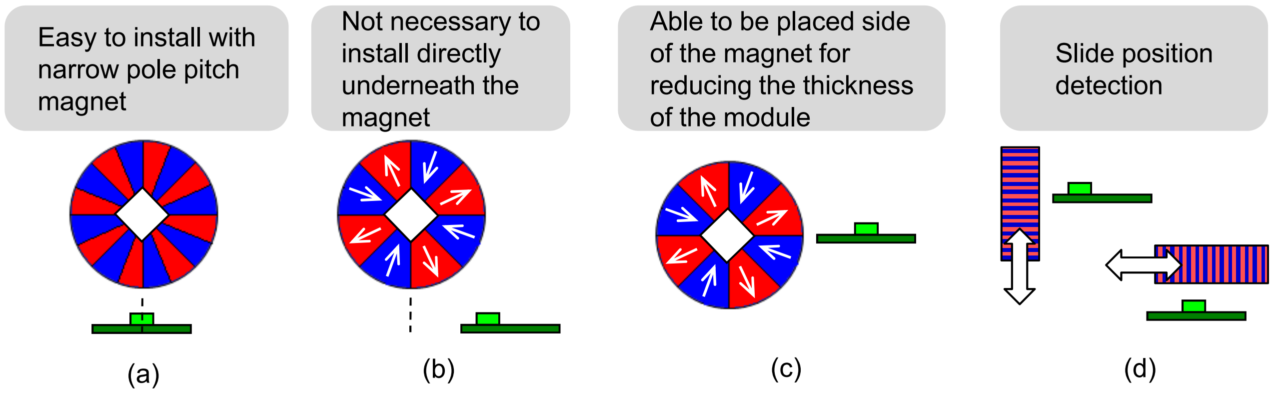
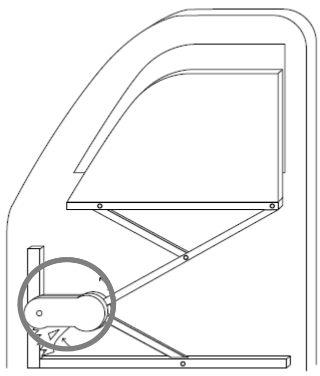


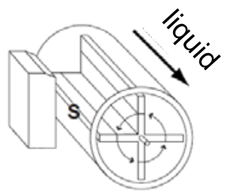
Figure 4. Example of mounting position layout

§ 4. Application of Onechip encoder IC

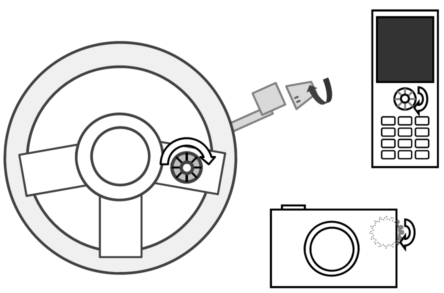
- Input devices
  DSCs, mobile equipment, Remote commanders, steering switches etc.
- Appliances and Industrial apparatus
  Washing machines, flow meters etc.
- Automotive
  Window lifters, power slide doors, sunroofs, grille shutters etc.



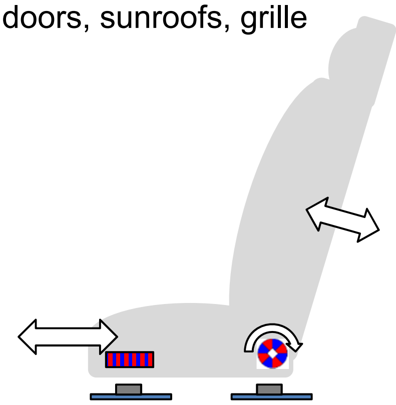
(e)Pinch control for power windows



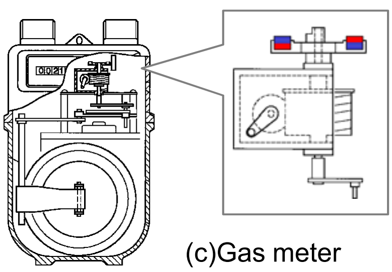
(d)Flow meter



(a)Input devices, steering switches



(b)Position sensors



(c)Gas meter

Figure 5. Application of the Onechip encoder IC

§ 5. Detection principle of One chip encoder IC

§ 5-1. Magnetic fields which are detected by One chip encoder IC

The One chip encoder IC is a Hall effect latch which detects both “vertical” and “horizontal” (perpendicular and parallel to the branded side of the package) magnetic field. As the magnet rotates, the zero-crossing point of vertical and horizontal magnetic field fluctuates by having 90 degrees of phase difference. This phase difference is independent to a magnetized pitch of the magnet. Furthermore, the phase relationship of vertical field and horizontal field depend on the direction of rotation. Hence, the two phases of pulse which is the result of the detection of vertical and horizontal field have 90 degrees out of phase in electrical angle.
The direction of rotation is given by referring the relationship of these two pulses – which pulse leads or retards – so in principle, the misdetection of direction of rotation is hardly causes.

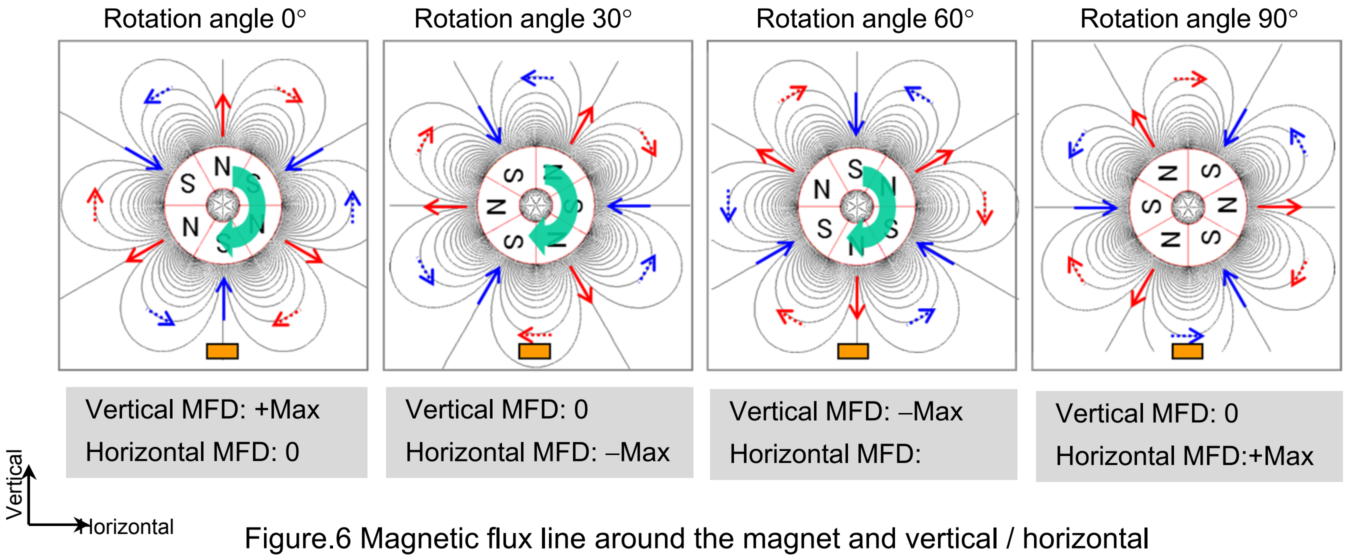


Figure.6 Magnetic flux line around the magnet and vertical / horizontal MFD

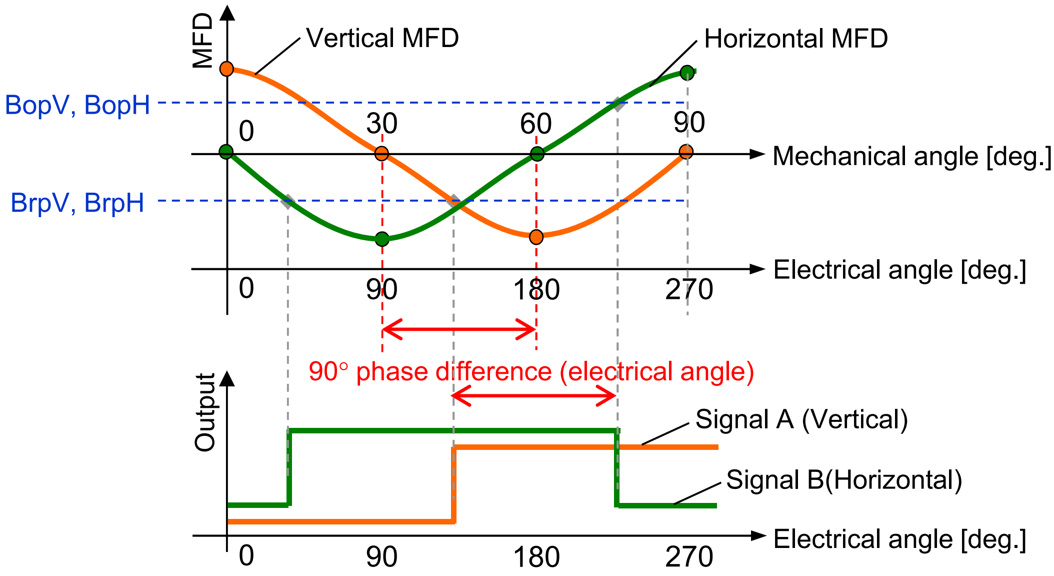


Figure 7.Vertical and Horizontal MFD, output signal vs. rotation angle

§ 5-2. The relationship between the vertical and horizontal magnetic field in CW and CCW rotation

The fluctuation behavior of vertical and horizontal magnetic field in rotation of the magnet is described in this section. The vertical and horizontal magnetic flux density at an observation point is shown in Figure 8 (CW: clockwise rotation case) and Figure 9 (CCW: counter-clockwise rotation case). Comparing these two cases, the order of the fluctuating both of the vertical and horizontal flux density is different. Initial status is same as 'vertical field : +max , horizontal field : 0.' In the CW rotation, the magnetic field is changed into 'vertical field : 0 , horizontal field : –max.' But on the contrary, in the CCW rotation the magnetic field changed into 'vertical field : 0 , horizontal field : +max.' Thus the phase relationship between the vertical and horizontal magnetic field rely on the direction of the rotation. And the order of transition of two phase pulse which is the result of the detection of the magnetic field also depends on the direction of the rotation as shown in Figure 10 and Figure 11. Therefore, the direction of the rotation is given by referring the order of transition of these pulses.

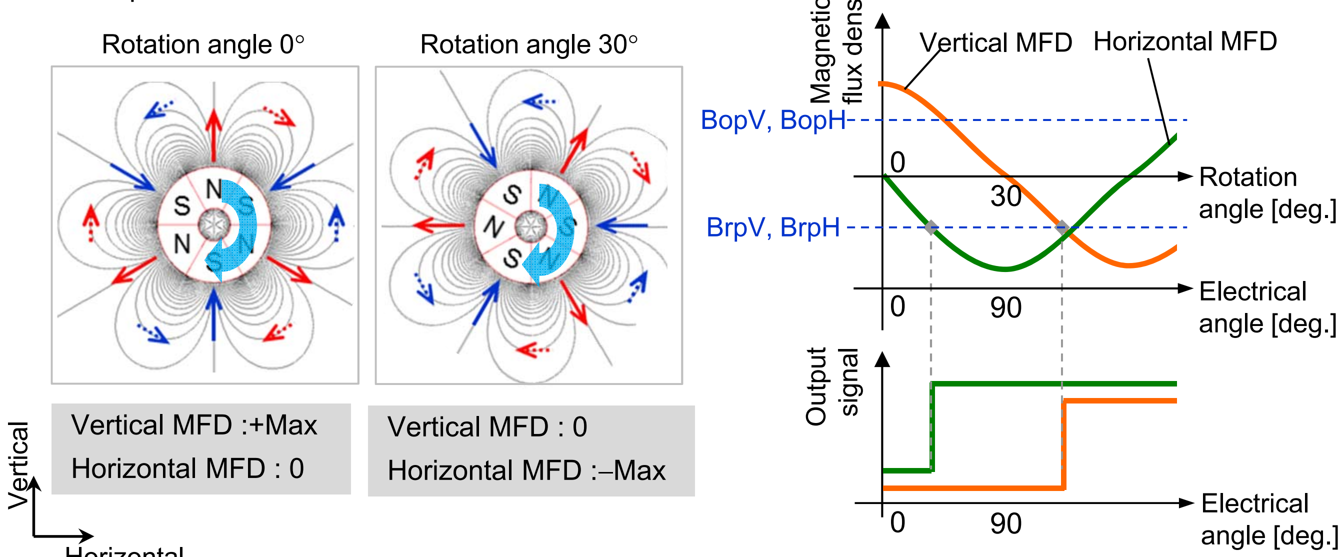


Figure 8. Fluctuation of vertical and horizontal magnetic field in CW

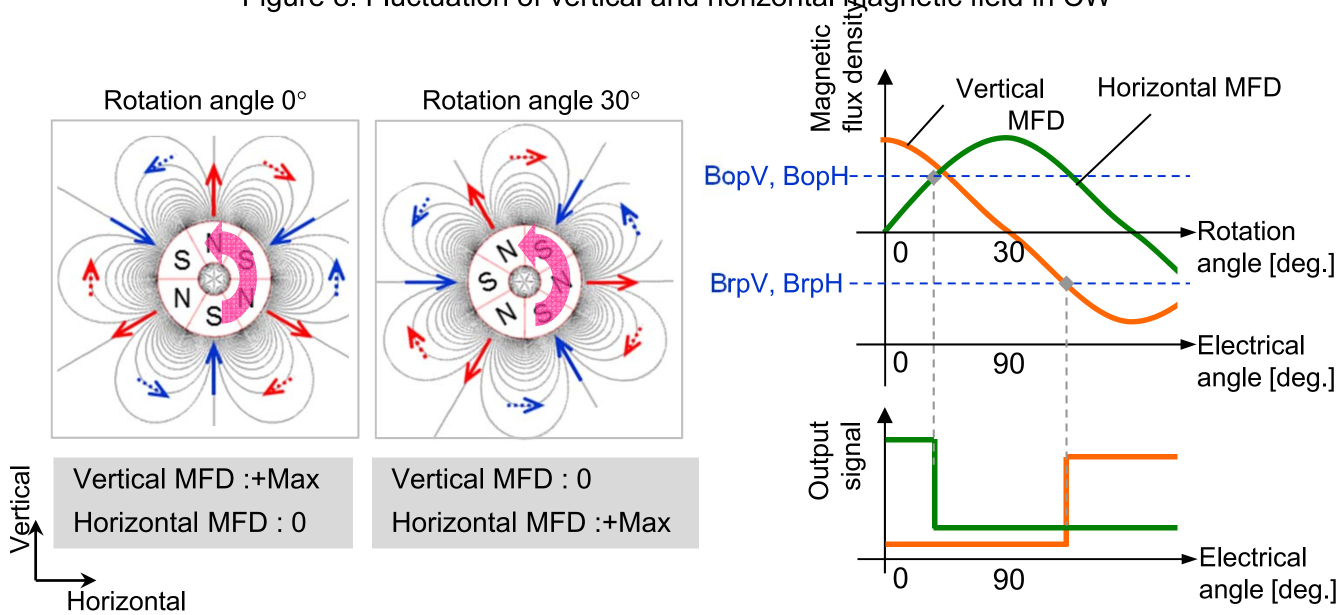


Figure 9. Fluctuation of vertical and horizontal magnetic field in CCW

§ 6. Block diagram and circuit description

- **Block diagram of AK8775 / AK8776 and circuit description**

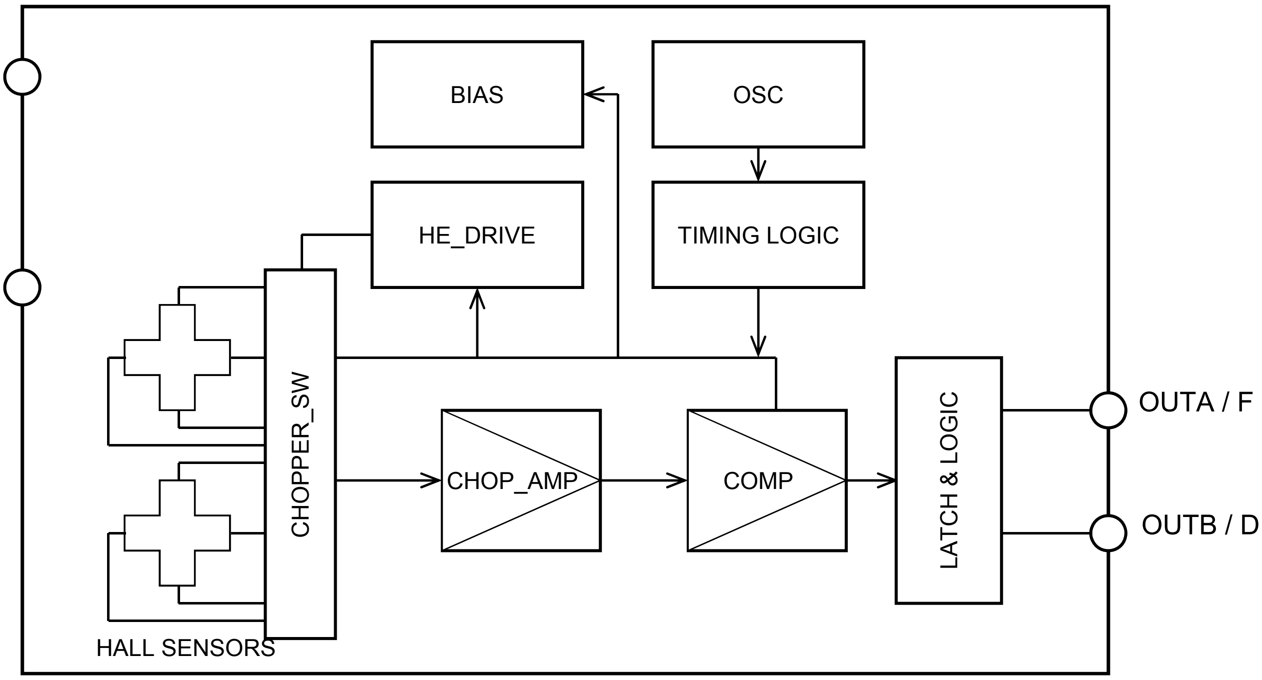


Figure 10. Block diagram of AK8775 / AK8776

Table 1. Circuit description of AK8775 / AK8776

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.

- **Block diagram of AK8777B / AK8778B and circuit description**

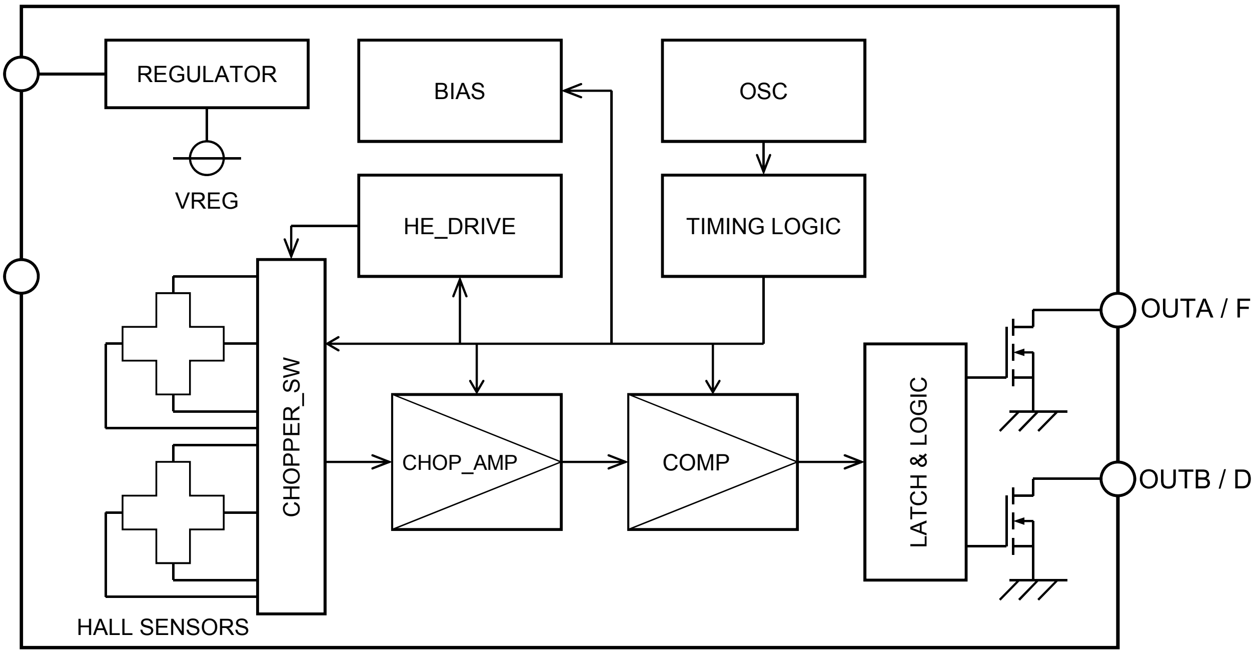


Figure 11. Block diagram of AK8777B / AK8778B

Table 2.Circuit description of AK8777B / AK8778B

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.

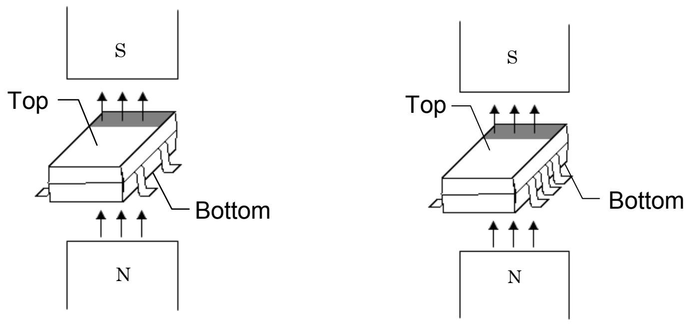
§ 7. Operating principles

§ 7-1. Operating behavior against applied magnetic field

The Onechip encoder IC outputs the result of the detection of both vertical and horizontal magnetic field. The AK8775 and AK8777B send out both of the result of detection directly to OUTA and OUTB, and the AK8776 and AK8778B send out the tachometer pulse (F) and direction of rotation (D) signal by processing of internal signal A (vertical) and B (horizontal).

As shown in Figure 12., in case of S pole vertical magnetic field is applied and the intensity of the magnetic field i.e. magnetic flux density exceeds the operating point threshold BopV (Operating Point / Vertical), the device turns on and OUTA (or internal signal A) goes low level. On the contrary, N pole vertical field which is below the releasing point threshold BrpV (Releasing Point / Vertical), the device turns off and OUTA (or internal signal A) goes high level.

Likewise, as shown in Figure 14, the device turns on and OUTB (or internal signal B) goes low level when the horizontal S pole magnetic field which exceeds the operating point threshold BopH (Operating Point / Horizontal) is applied from VSS and OUTB or F pin side. And in case of horizontal N pole magnetic field which is below the releasing point threshold BrpH (Releasing Point / Horizontal) is applied, device turns off.



(a)AK8775/AK8776 (b)AK8777B/AK8778B

Figure 12. Definition of vertical magnetic field

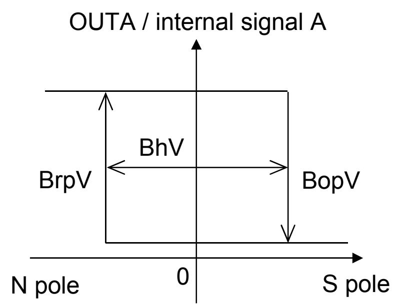
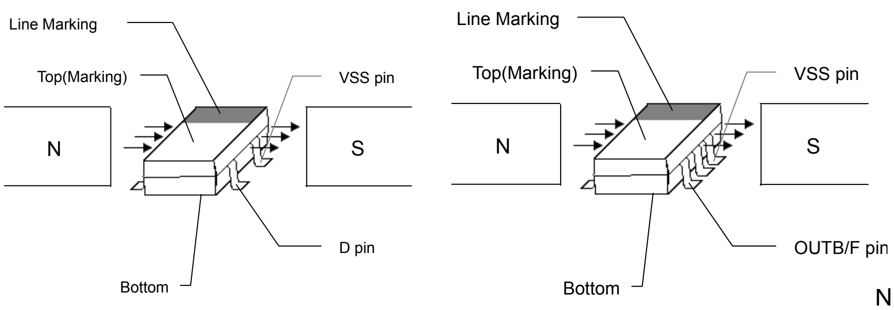


Figure 13. Switching behavior of OUTA / internal signal A



(a)AK8775/AK8776 (b)AK8777B/AK8778B

Figure 14. Definition of horizontal magnetic field

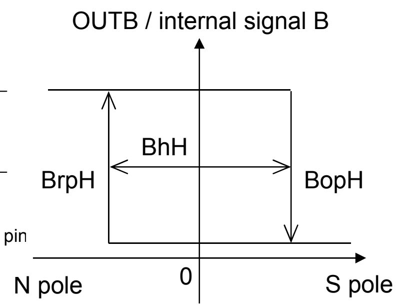


Figure 15. Switching behavior of OUTB / internal signal B

§ 7-2. Operating behavior of F (pulse) and D (direction) in AK8776 / AK8778B

The pulse signal output F in AK8776/AK8778B is generated by XORing of internal signal A and B. These internal signals A and B are also used to generate the direction of rotation signal D by assessing which signal “leads” or “retards” the other. The signal D is refreshed on every edge of F signal therefore if the direction of rotation is changed, D changes in the first transition timing of F pulse as shown in Figure 16.

Table 3. Truth table of internal signal A,B and output signal F

Internal signal A	Internal signal B	Output signal F
1	1	1
1	0	0
0	1	0
0	0	1

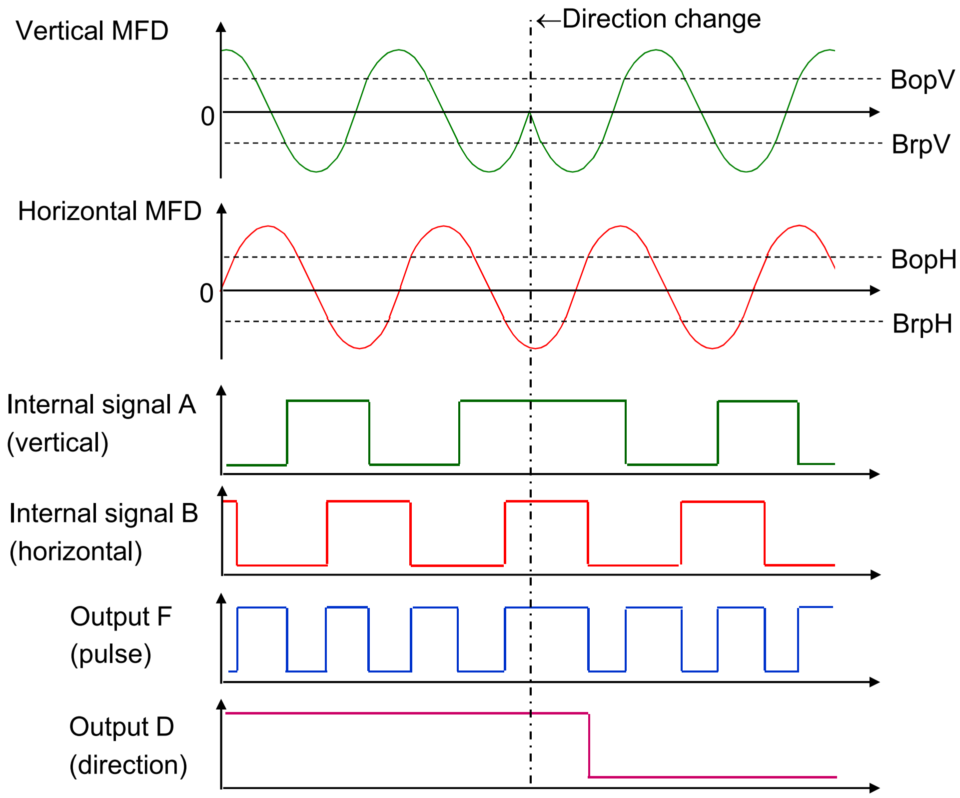


Figure 16. The transition timing chart of internal signal A,B and output F,D when the direction of rotation is changed

§ 7-3. How the direction signal is decoded?

The direction of rotation is given by referring the relationship of internal signal A and B – which pulse leads or retards – because it depends on the direction of rotation. In CW (clockwise) and CCW (counter-clockwise) rotation, the signal A and signal B transfers as shown in Figure 17 and Figure 18. Four states I to IV which is the pairs of signal A and B is presented. On the CW rotation, the state transfers as I→II→III→IV way but on the CCW rotation, the state transfers as I→VI→III→II way. Therefore the direction is given by the order of state transition in previous states and current status.

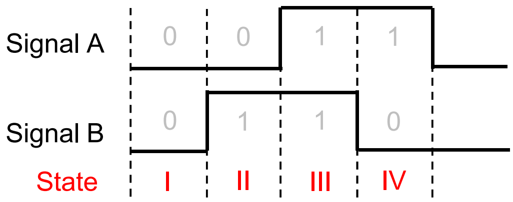


Figure 17. Transition of signal A and B in CW rotation

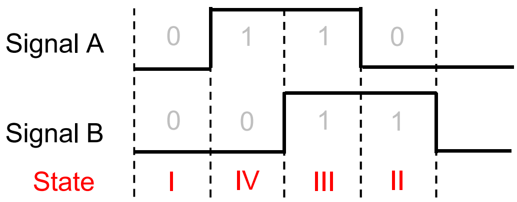


Figure 18. Transition of signal A and B in CCW rotation

Table 4. State of signal A and signal B (CW)

State	Internal signal A	Internal signal B
I	0	0
II	0	1
III	1	1
IV	1	0

Table 5.State of signal A and signal B(CCW)

State	Internal signal A	Internal signal B
I	0	0
IV	1	0
III	1	1
II	0	1

If the two phase of signal transfers simultaneously…

If the internal signal A and B transits simultaneously as shown in Figure 19., it is an invalid transition. There is no way to find out the direction of the rotation: in (0,0) → (0,1) → (1,1) or (0,0) → (1,0) → (1,1) transition. To prevent such an invalid transition, the switching timing of signal A and signal B should have large phase distance which is ideal in '90 degrees out of phase in electrical angle'.

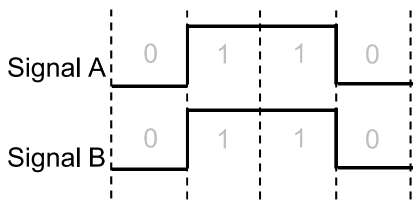


Figure 19. Simultaneous transition of two signals

§ 8. How to utilize the Onechip encoder IC

§ 8-1. Pulse encoder design flow

The typical design flow of magnetic type pulse encoder is shown in Figure 22..

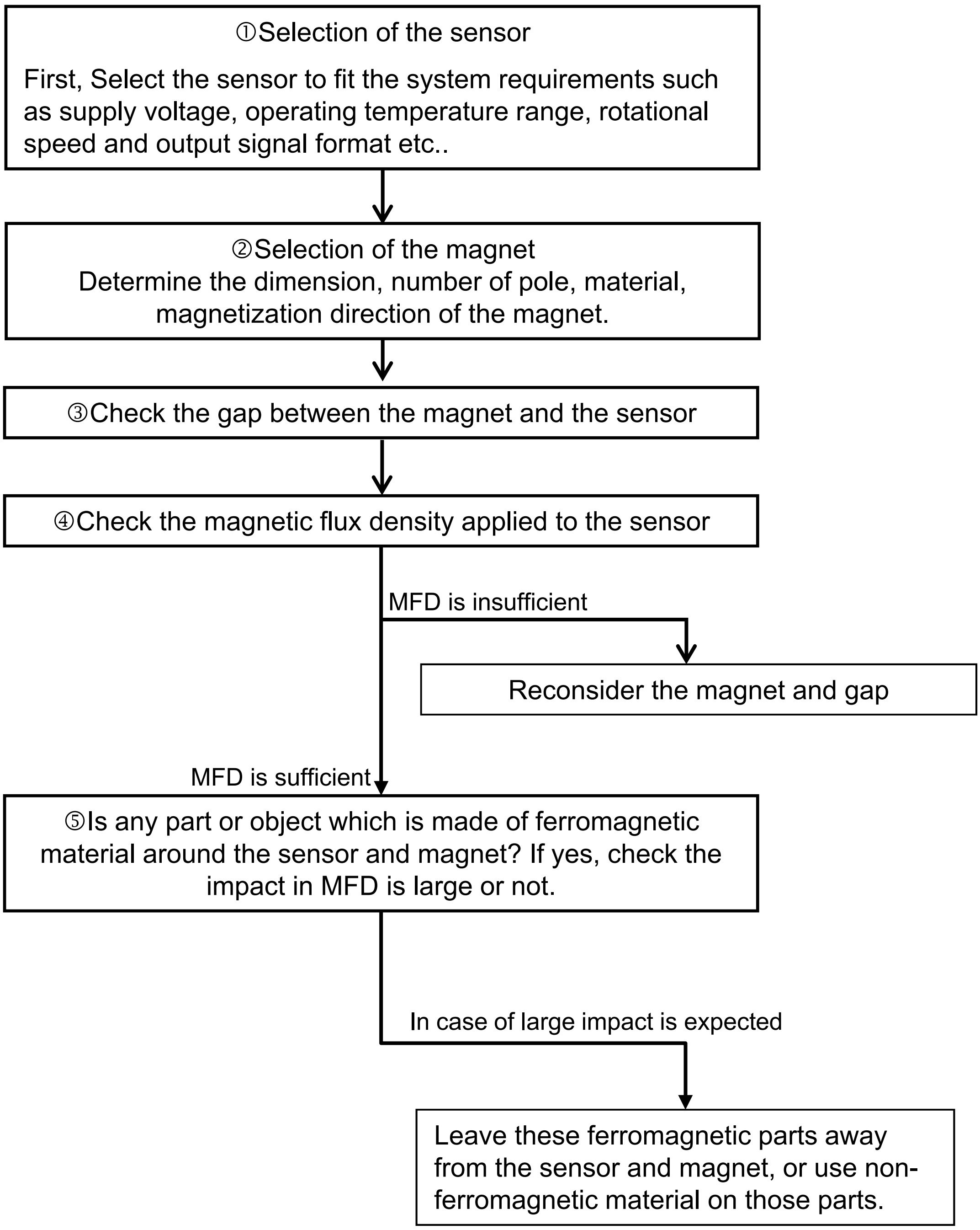
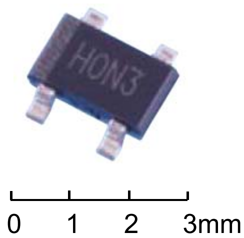
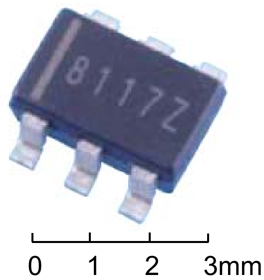


Figure 20. Design flow of pulse encoders

§ 8-2. Product line-up

The product line-up of Onechip encoder IC is shown in Table 6.

Table 6. Product line-up of Onechip encoder ICs

	AK8775	**AK8776**	**AK8777B**	**AK8778B**
Power supply voltage	1.6 to 5.5 V		4.0 to 24V	
Operating temperature	-30 to +85°C		-40 to +125°C	
Maximum magnetic field frequency	62.5 Hz		4 kHz	
Current consumption	90µA (in average)		3.0mA	
Output signal	A/B phase CMOS output	F/D CMOS output	A/B phase Open drain	F/D Open drain
Package				

§ 8- 3. Magnet

- Shape and magnetization direction

Firstly, the shape of the magnet should be determined so as to fit the application. For example, magnet should be torus e.g. disc shape, donut shape as shown in Figure 21 (a), (b) or cylinder-like shape in case of rotary encoders. Bar-shaped magnet like Figure 21 (c) is utilized for linear motion detection.

Next, the magnetizing direction should be fixed. It relies on the position of the sensor. In case of the sensor is placed beneath the magnet, the magnet should be magnetized axially (i.e. parallel to the axle) as shown in Figure 21(a). If it is impossible to place there, place the sensor on the side of the magnet which is magnetized radially (i.e. parallel to a radius) as shown in Figure 21 (b)

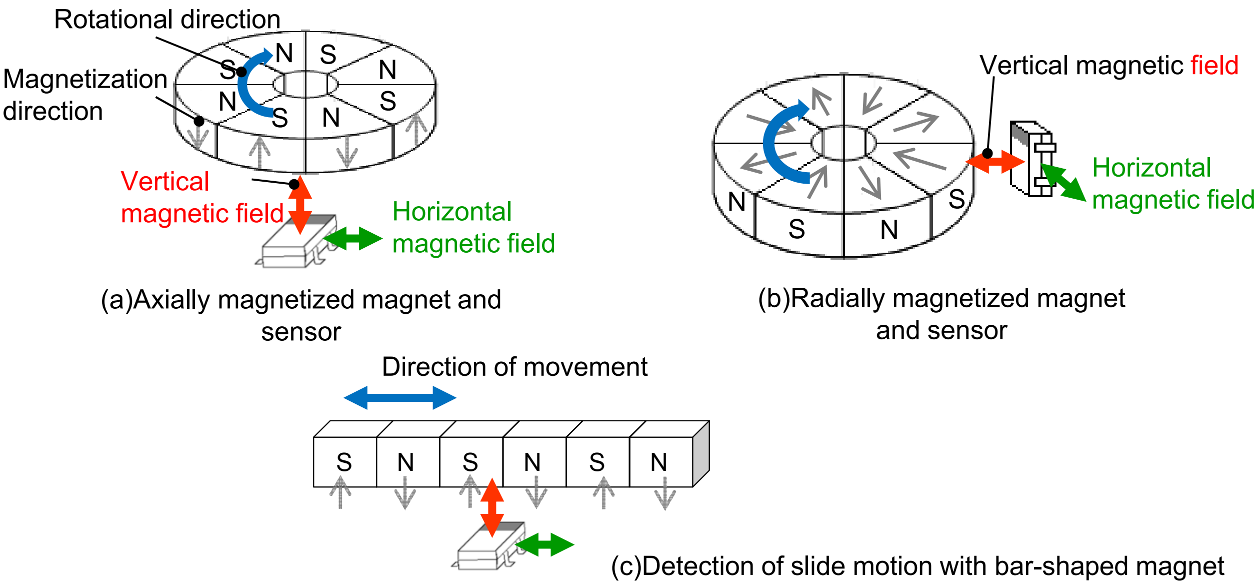


Figure 21. Example of configuration of magnet and sensor position

- Arrangement of direction of sensor

The Onechip encoder IC detects both of the vertical (perpendicular to the branded surface) and horizontal (parallel to the branded side of package) component of magnetic flux density. So that, be careful to arrange of direction of horizontal magnetic density. The horizontal magnetic flux density should be applied to the sensor from the side of the package as shown in Figure 22 and 23.

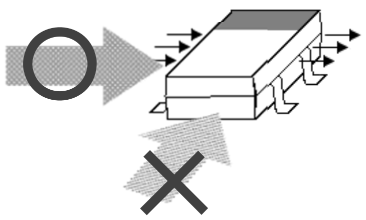


Figure 22. Horizontal magnetic field which AK8775 / AK8776 detects

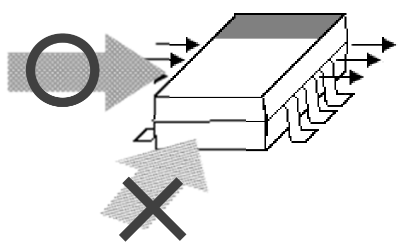


Figure 23. Horizontal magnetic field which AK8777B / AK8778B detects

- Magnetizing of the magnet – number of poles, magnetizing direction

Then the number of magnetic poles should be chosen. It depends on the system that how many pulses per rotation (PPR) are required. The AK8775/AK8777B sends out one pulse per one pair of pole i.e. a set of N pole and S pole to OUTA and OUTB. And AK8776/8778B sends out one pulse per pole i.e. on each N pole and S pole. So if four PPR is required, the magnetic ring should have two pair = four poles in case of AK8775/8777B or one pair = two poles in AK8776/8778B.

It is possible to make large PPR magnetic encoder with the magnet which has a large number of poles. However, the pole pitch which is inversely proportional to the number of poles is relevant to the magnetic flux density (MFD). In that case, some measure might be required such as utilizing much a thicker magnet, shorten the air gap between the magnet and sensor, reconsideration on the material of magnet etc. in order to apply the sufficient MFD to the sensor. Since the sensitivity of the Onechip encoder IC is ±4mT at worst case as shown in Table 7, the applied MFD in both of vertical and horizontal field should be larger than 4mT at its peak. But We recommend 8mT or above to arrow for margin on mechanical and magnetic tolerance etc.

Table 7. Magnetic characteristics of Onechip encoder IC

		AK8775／AK8776			AK8777B／AK8778B		
		Min.	Typ.	Max.	Min.	Typ.	Max.
Operating point of vertical magnetic field	BopV (mT)		1.5	4.0	0.1	1.7	4.0
Releasing point of vertical magnetic field	BrpV (mT)	-4.0	-1.5	—	-4.0	-1.7	-0.1
Operating point of horizontal magnetic field	BopH (mT)		1.5	4.0	0.1	1.7	4.0
Releasing point of horizontal magnetic field	BrpH (mT)	-4.0	-1.5	—	-4.0	-1.7	-0.1

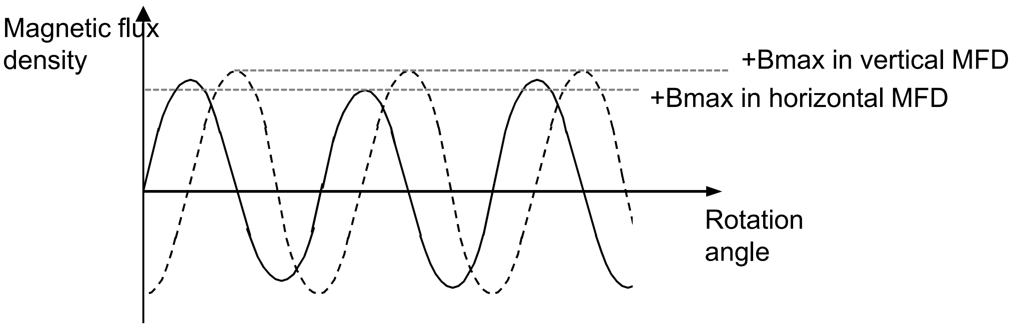


Figure 24. Peak magnetic flux density in both field

- The aspect of vertical and horizontal magnetic field around the magnet(1)

Figure 26 shows the result of measurement of magnetic flux density versus rotation angle on the torus shaped ferrite magnet which is shown in Figure 25 at 0.5mm of gap from the surface of the magnet. The dimension of the magnet is ϕ18mm in outer diameter, ϕ13mm in inside diameter and thickness is 2mm. It is magnetized in axially , eight poles. This magnet is hereinafter referred to as 'magnet A'

The peak magnetic flux density in vertical and horizontal flux density is different. The peak MFD in horizontal field BmaxH is approximately 100mT and vertical BmaxV is approximately 80mT. And both of the waveform are far from sinusoidal wave, looks distorted peaky in horizontal and saturated in vertical.

But it does not affect the accuracy in detection of Onechip encoder ICs. The sensitivity i.e. threshold level in the both of vertical and horizontal field is ±1.5mT typically on AK8775/8776 and ±1.7mT on AK8777B / AK8778B. The switching operation of Onechip encoder ICs are performed on these small levels of the magnetic field which is close to zero-cross point. So that the maximum flux density and distortion of the waveform is not relevant to its switching operation.

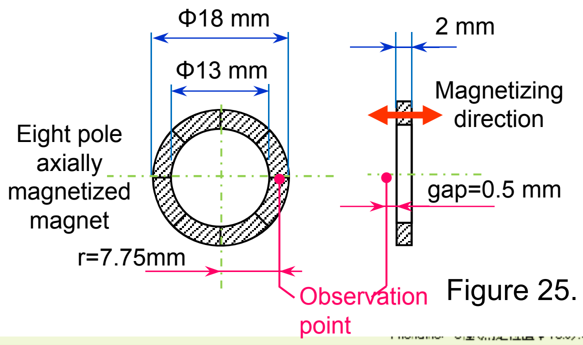


Figure 25. Measured magnet 'magnet A'

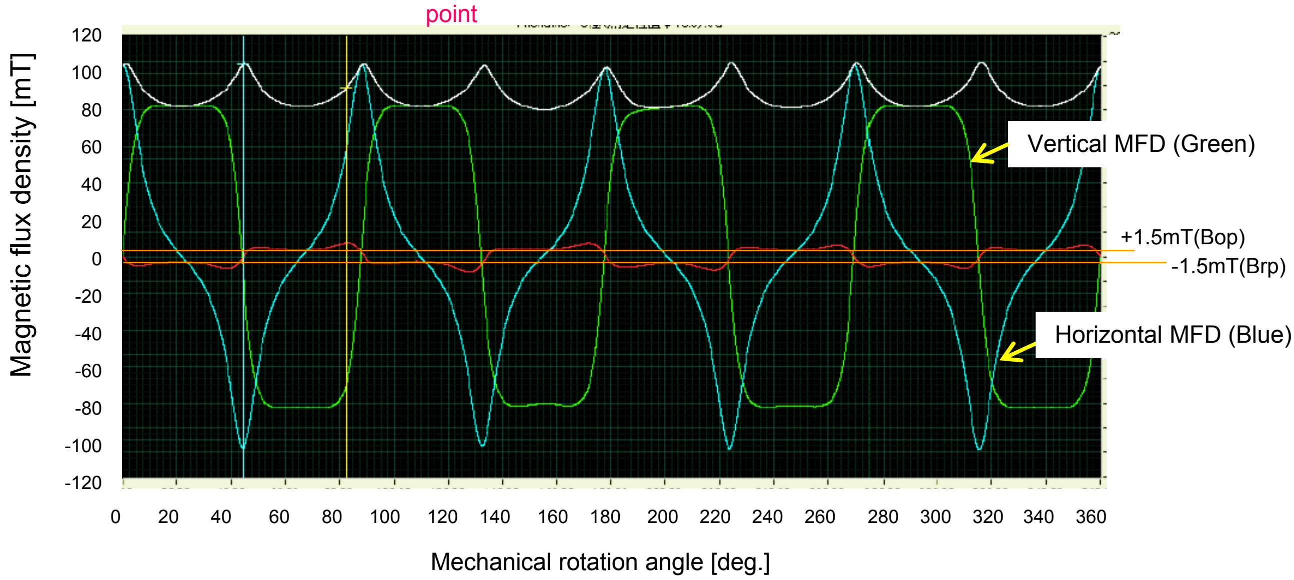


Figure 26. Measured magnetic flux density of magnet A
(R=7.75mm, gap=0.5mm)

- The aspect of vertical and horizontal magnetic field around the magnet(2)

In this section, it is discussed that the aspect of fluctuation of vertical and horizontal magnetic flux density against the variety of the shape, magnetizing pitch and direction、and the gap between the magnet and sensor.

a) Peak intensity of vertical and horizontal field and waveform on magnet A

As shown in Figure 27., the amplitude of horizontal magnetic flux density is much larger than vertical in the gap of 1.0mm. As the gap gets much large e.g. above 2.0mm of gap, vertical magnetic flux density is relatively larger than horizontal field. And the waveform is getting closer to sinusoidal form gradually.

b) On 16 poles magnet B

Figure 29 shows the waveform of vertical and horizontal magnetic flux density on magnet B which is shown in Figure 28. The difference of magnet A and magnet B is the number of poles. The dimension, magnetizing direction and the material is same in both of magnet A and magnet B. Though the peak magnetic flux density is different, the fluctuating behavior of vertical and horizontal field shows a similar aspect in both in magnet A and magnet B

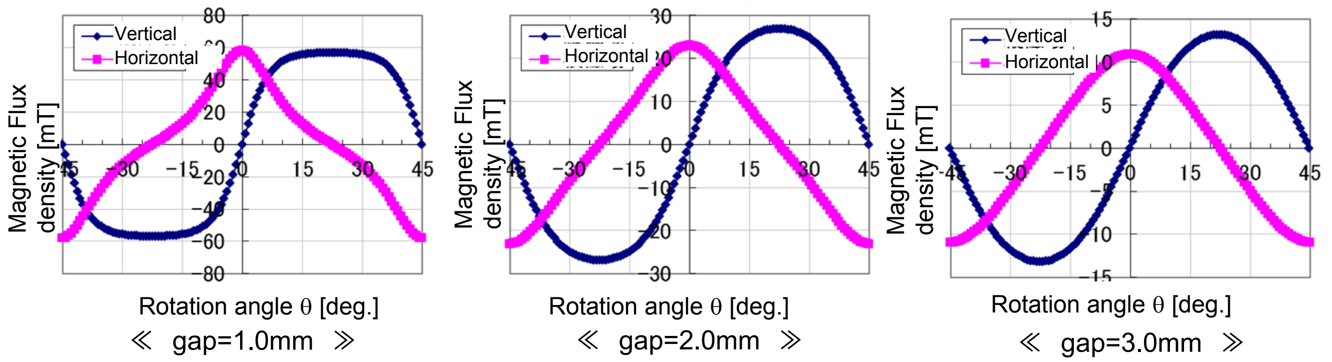


Figure 27. Air gap vs. vertical and horizontal magnetic flux density on magnet A (8 pole)

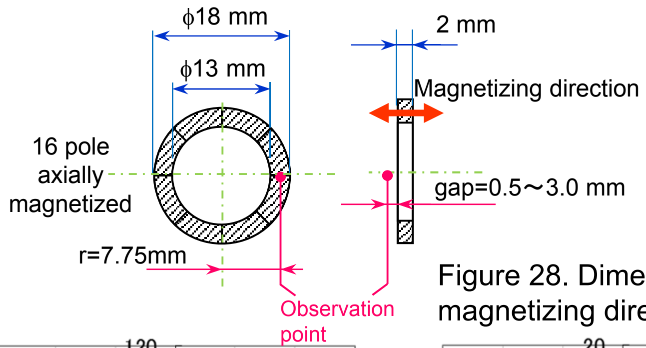


Figure 28. Dimension and magnetizing direction of magnet B

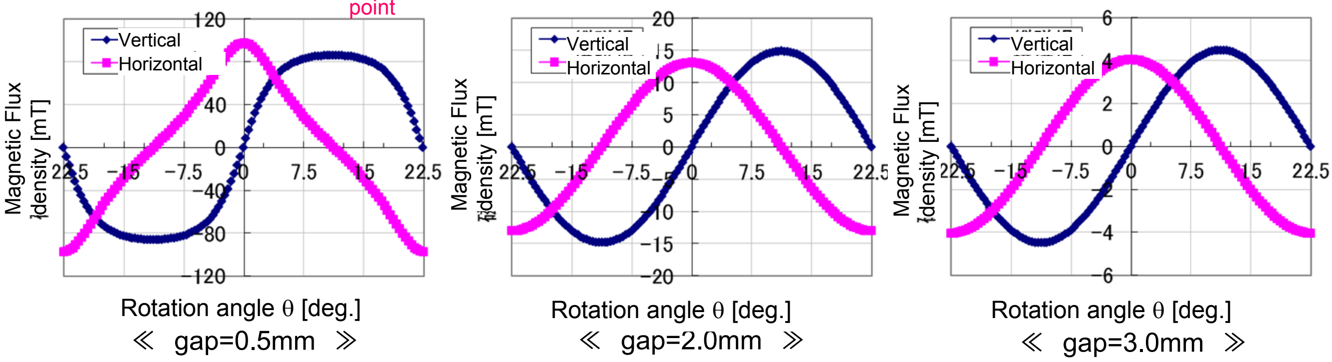


Figure 29. Air gap vs. vertical and horizontal magnetic flux density on magnet B(16 pole)

c) Other shape, magnetizing way and material

The fluctuating behavior of vertical and horizontal field on some different shape, magnetizing way and materials are shown below. Figure 31 and 33 shows that fluctuating behavior of the magnet C and magnet D which is shown in Figure 30 and 32. Unlike the magnet A or B, magnet C is magnetizing in radially. And magnet D has the completely different shape like cylinder and made of different material. But the fluctuating behavior is similar to magnet A and B in spite of these difference – the intensity of horizontal field is larger than vertical field in neighboring point of the magnet. And as gap gets larger, vertical magnetic flux density is relatively larger than horizontal field as shown and the waveform is getting closer to sinusoidal form gradually.

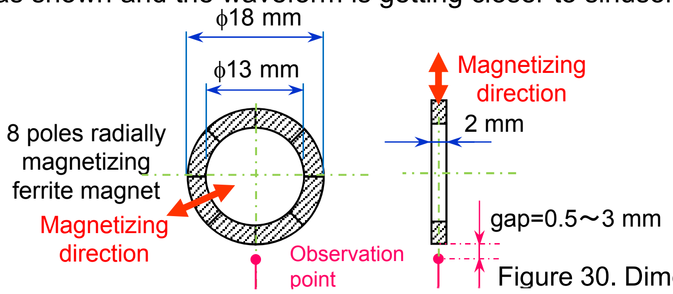


Figure 30. Dimension and magnetizing direction of magnet C

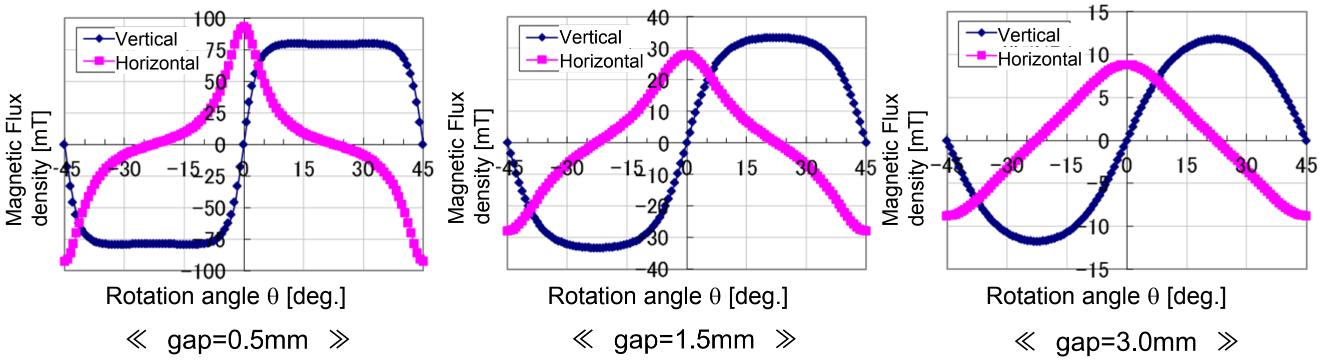


Figure 31. Air gap vs. vertical and horizontal magnetic flux density on magnet C (8 pole)

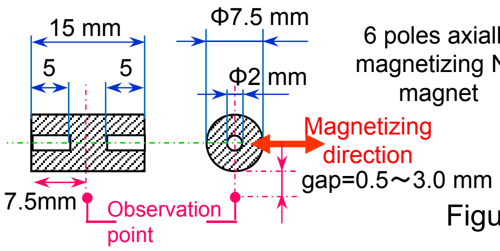


Figure 32. Dimension and magnetizing direction of magnet D

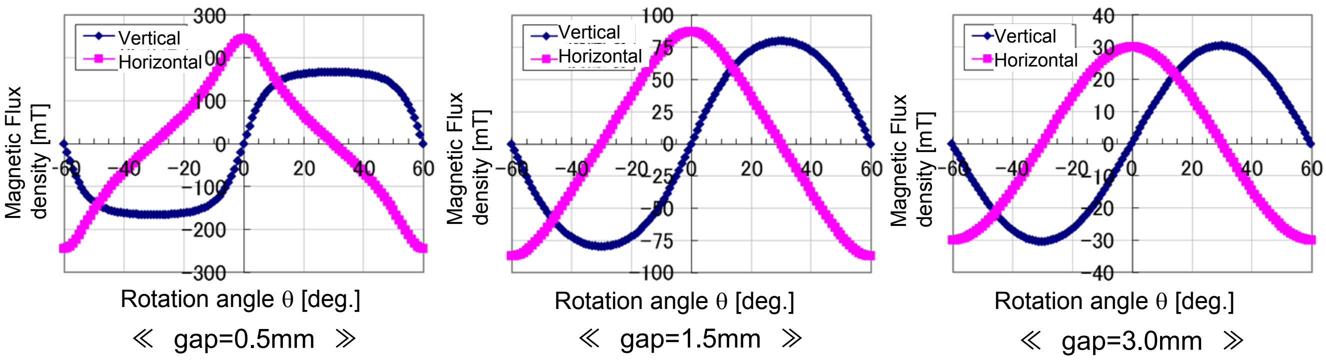


Figure 33. Air gap vs. vertical and horizontal magnetic flux density on magnet D (6 pole)

§ 9. Functional Timing

- Power on time

The Onechip pulse encoder ICs become functional when the supply voltage exceeds minimum operating voltage which is 1.6V for AK8775/8776 and 4.0V for AK8777B/8778B. After at least one time of detection, the device sends out the correct status of magnetic field.

- Output refresh timing

The AK8775/AK8776 are intermittently driven device. The device are controlled by the internal clock generator and activated on each 2.0ms (max.) period. During the awake state, device detects the applied magnetic field and output transits on the reflection of the magnetic field. The output is latched while in the sleep state. The group delay between the end of sampling and output transition is max.6.1μsec. AK8777B/AK8778s are driven continuously but the output is refreshed periodically on max.30.5μsec period. The group delay between the end of sampling and output transition* is max. 6.0μsec

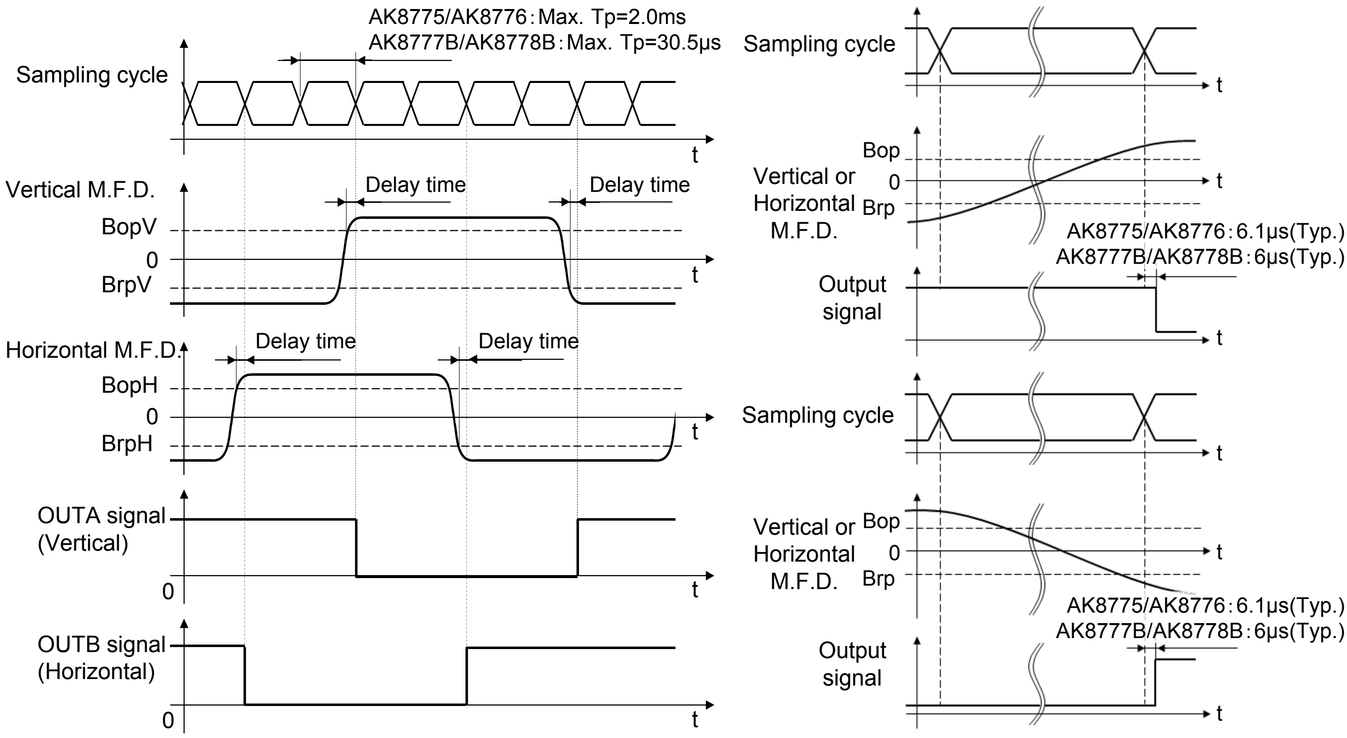


Figure 34. Timing chart

Since the external applied magnetic flux density and internal clock timing are asynchronous, the maximum response time is :

AK8775/AK8776 : Maximum intermittent period 2.0msec + 6.1μs

AK8777B/AK8778B : Maximum output refresh period 30.5μs ＋6μs*

* In case of V_{DD}=12.0V ,RL=10kΩ, CL=20pF

- Power-on state

The Onechip pulse encoder ICs become functional when the supply voltage exceeds minimum operating voltage which is 1.6V for AK8775/8776 and 4.0V for AK8777B/8778B.

a) On AK8775/AK8777B, in case of the applied magnetic flux density is larger than Bop or smaller than Brp, the output shows the correct status in relation to the magnetic flux density.

But if no magnetic field presence or Brp<B<Bop, output is 'uninitialized' state i.e. 'H' or 'L'.. Therefore the output status just after the power-on might be incorrect. In other words power-on state 'H' does not mean the actual applied field is N-pole. It means either of 1)applied magnetic field is lower than Brp (N-pole) 2)applied magnetic field is S-pole but lower then Bop.

b) On AK8776/AK8778B, it is much tricky. Both on the initial status of 'F' (rotation pulse) and 'D' (rotation direction) are 'uninitialized' i.e. 'H' or 'L.'

Since the 'F' signal is the result of XORing of 'internal A' and 'internal B' ('A' and 'B'; the same applies hereafter), the correct status is presented after both of the 'A' and 'B'. And the 'D' signal is the result of the comparison of current and previous status of 'A' and 'B' signal set.

In summary, the two consecutive determined status is needed for detection of rotation direction.

The signal transition timing chart in power-on and start-up when both of the vertical and horizontal M.F.D. are smaller than Bop and Brp is shown in Figure 35.

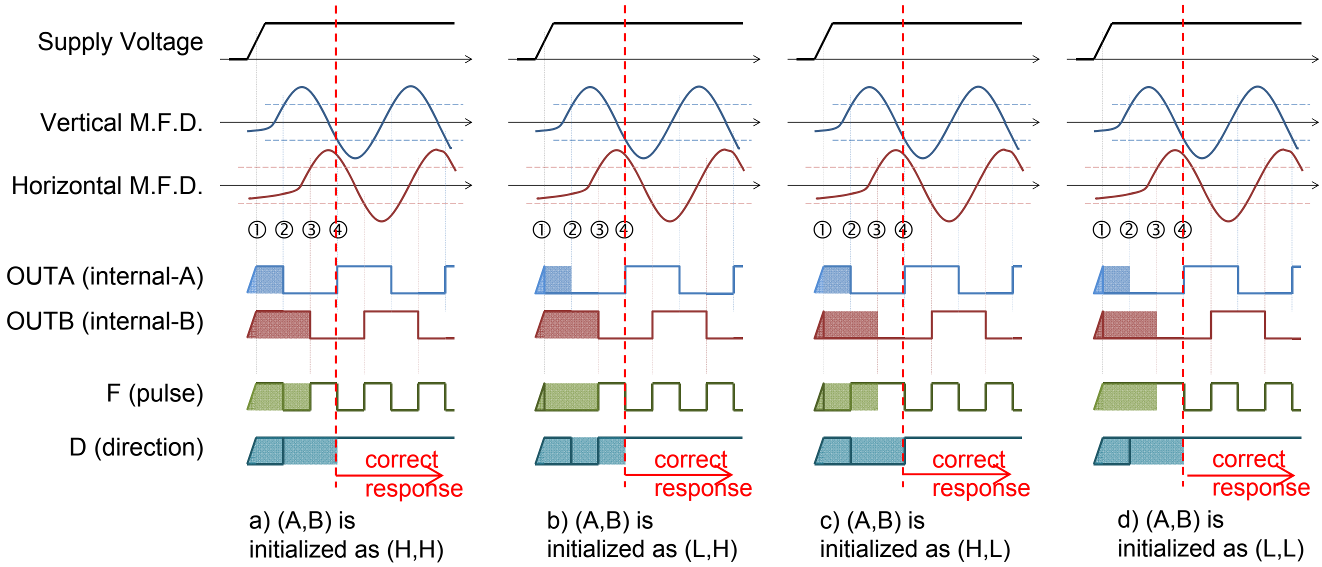


Figure 35. Signal transition timing chart at power-on without sufficient M.F.D. is applied

As the supply voltage is turned on and exceeded the minimum operating voltage, the sampling operation is began to perform. But in the Figure 37 case, at this start-up timing ①, both of the vertical and horizontal field are not sufficient to determine their status. Therefore, the result of this detection does not show the correct response but any of (H,H), (L,H), (H,L) and (L,L) at timing ①. Then, vertical M.F.D. exceeds and the OUTA (or internal-A) is determined at timing ②. Next, horizontal M.F.D. exceeds and the OUTB (or internal-B) is determined at timing ③. At this timing ③, both of OUTA and OUTB signal is correctly responded and 'F' signal is also established. However , at timing ③, 'D' signal is not established because of the previous OUTB signal might be incorrect. Finally, at timing ④, 'D' responds the correct direction since the current and previous status of both in the OUTA and OUTB is established.

§ 10. Pin and function

Table 8. Description of pin name and function (AK8775 / AK8776)

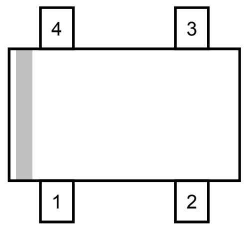
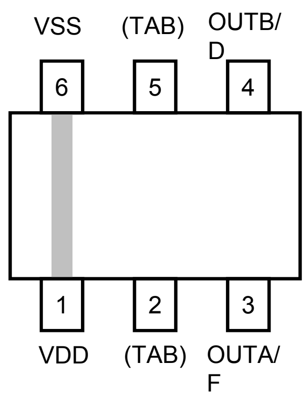
Pin No.	Name	Description	Note	Terminal diagram
1	VDD	Power supply		
2	OUTA (AK8775)	Output A pin. (Relating to the vertical magnetic field)	CMOS output	
	F (AK8776)	Output F pin (Pulse) pin		
3	OUTB (AK8775)	Output B pin. (Relating to the horizontal magnetic field)	CMOS output	
	D (AK8776)	Output F pin (Pulse) pin		
4	VSS	Ground pin		

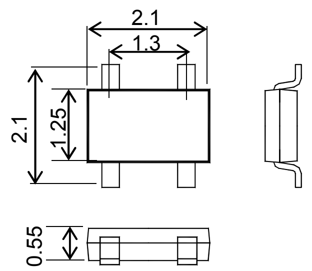
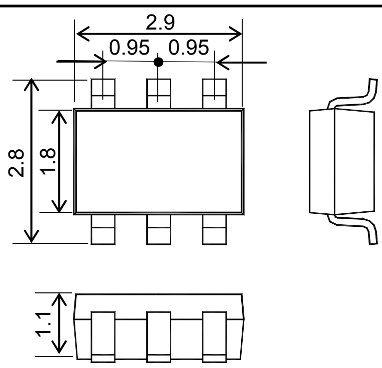
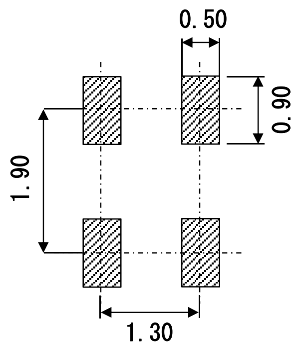
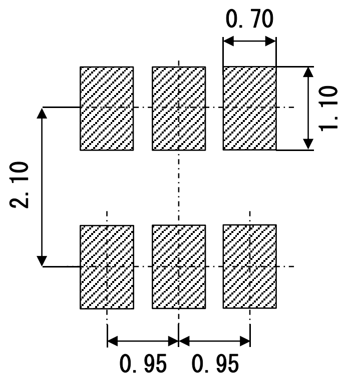
Table 9. Description of pin name and function (AK8777B / AK8778B)

Pin No.	Name	Description	Note	Terminal diagram
1	VDD	Power supply pin		
2	TAB*	(TAB pin)		
3	OUTA (AK8777B)	Output A pin. (Relating to the vertical magnetic field)	Open drain output	
	F (AK8778B)	Output F pin (Pulse) pin		
4	OUTB (AK8777B)	Output B pin. (Relating to the horizontal magnetic field)	Open drain output	
	D (AK8778B)	Output F pin (Pulse) pin		
5	TAB*	(TAB pin)		
6	VSS	Ground pin		

*TAB pin should be connected to VSS.

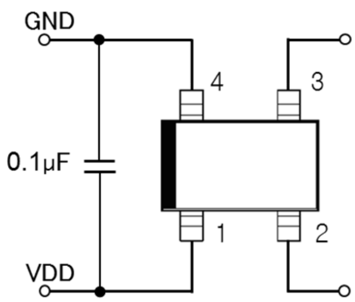
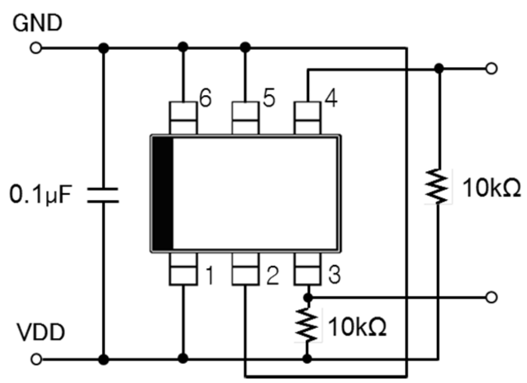
§ 11. Package outline and Land pattern

Table 10. Package outline and Land pattern

	AK8775／AK8776	AK8777B／AK8778B
Package Outline (Unit in mm)		
Land Pattern (Unit in mm, For reference only)		

§ 12. Recommended external circuit

Table 11. Recommended external circuit

AK8775／AK8776	AK8777B／AK8778B
	

§ 13. Performance graphs (for reference)

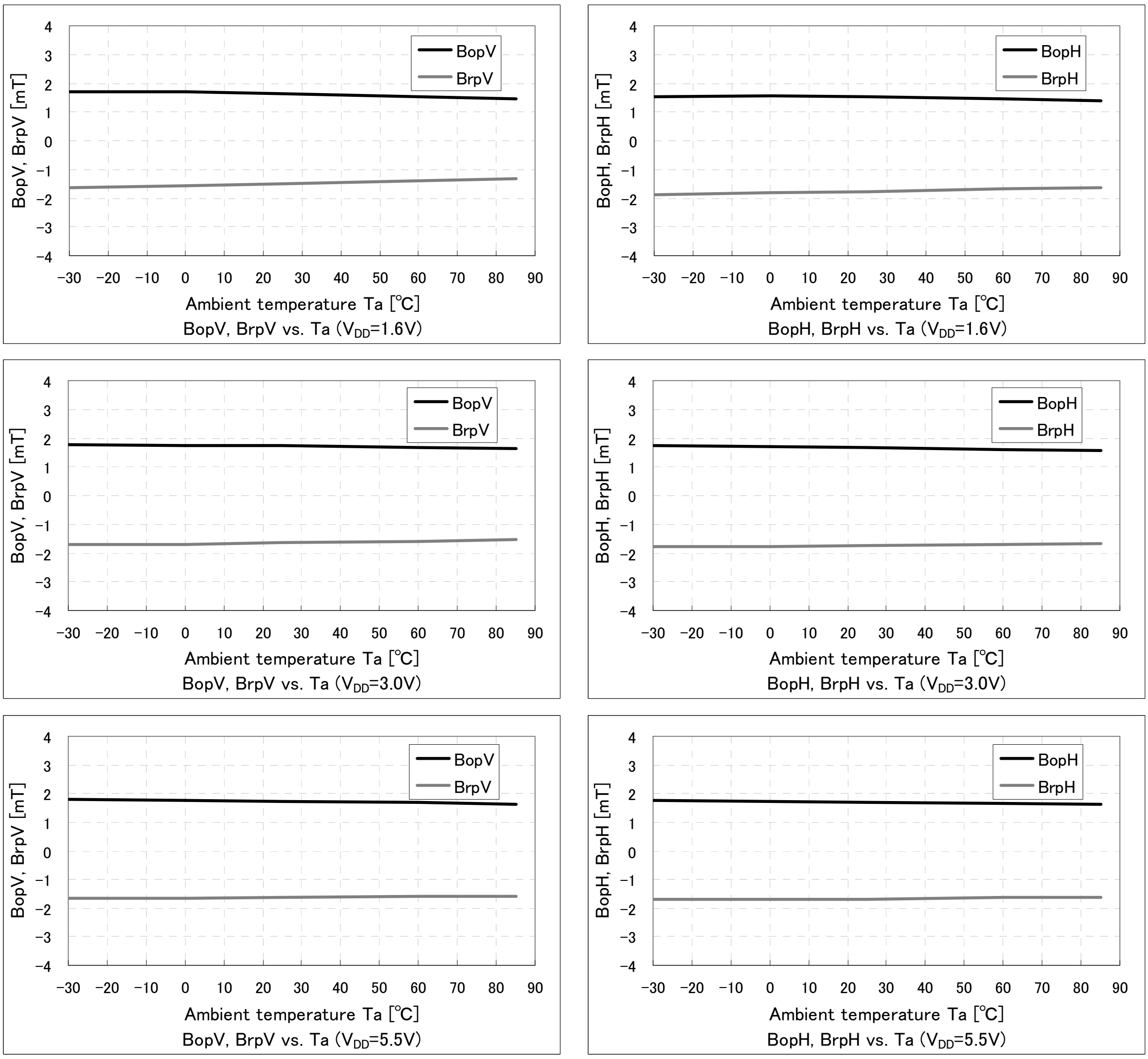


Figure 36. Typical magnetic switching point vs. temperature（AK8775 / AK8776）

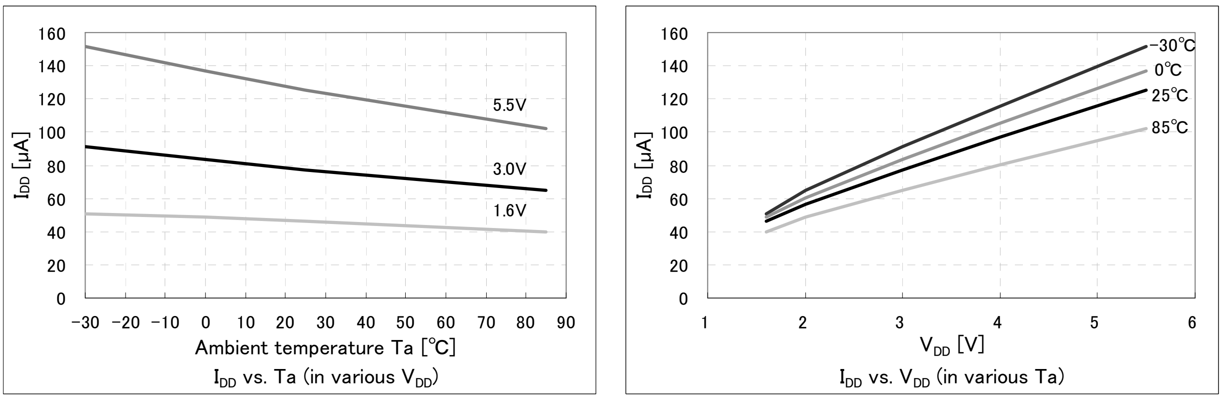


Figure 37. Typical current consumption vs. temperature and supply voltage (AK8775 / AK8776)

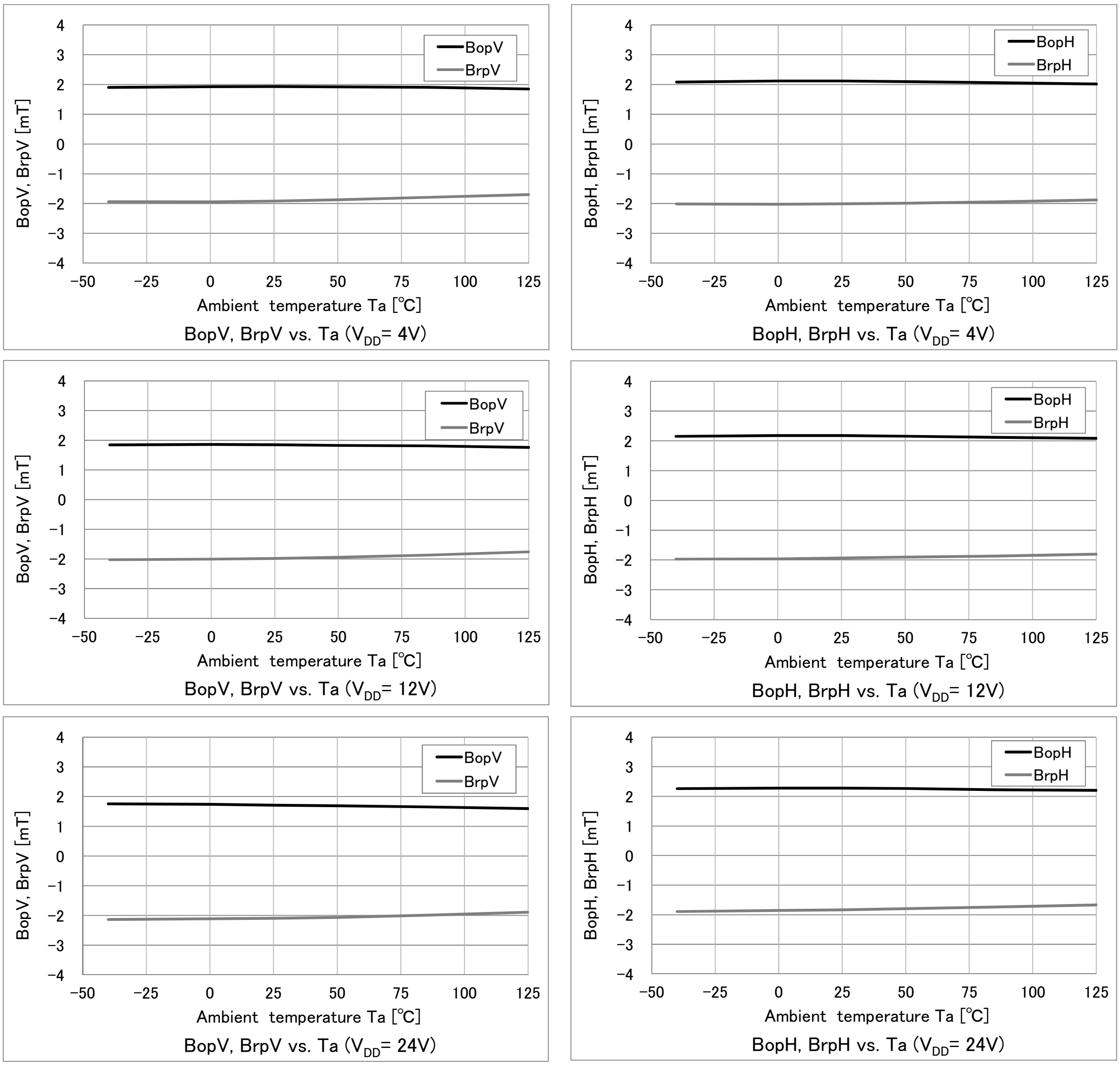


Figure 38. Typical magnetic switching point vs. temperature (AK8777B / AK8778B)

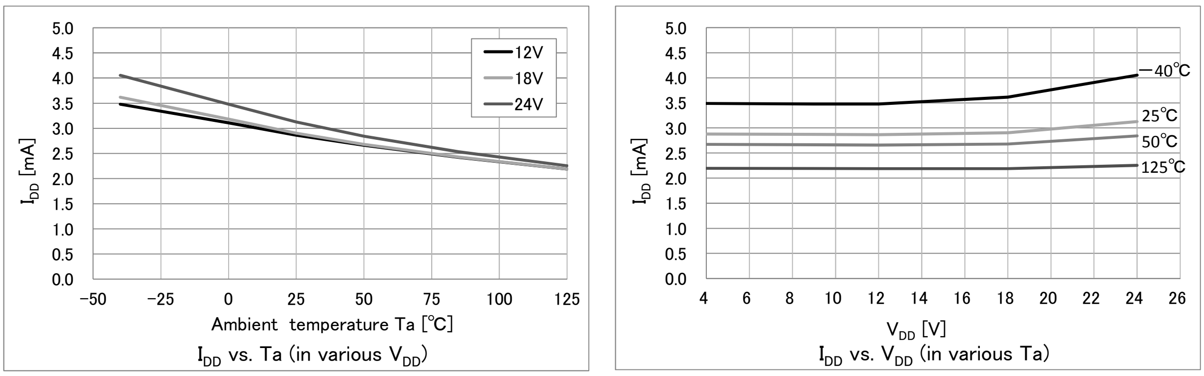


Figure 39. Typical current consumption vs. temperature and supply voltage (AK8777B / AK8778B)

§ 14. Frequently Asked Questions

Is any specially magnetized magnet needed with Onechip encoder ICs?

⇨No. As shown in §8-3, any of the magnetic ring or magnet which is commonly used in the magnetic type rotary encoder is capable.

How is the output during 'OFF (sleep)' in the pulse drive?(AK8775/8776)

⇨ During the 'OFF (sleep)' state, no sampling operation is performed and the output keeps its previous state. The output is refreshed 6.1μs after the sampling operation is finished.

What is the difference with 'F' signal of the F/D output, and OUTA/OUTB signal of the A/B phase output?

⇨ The 'F' signal of AK8776 / AK8778B is generated by XORing of internal signal A and internal signal B which is correspond to the detection result of vertical and horizontal magnetic field. Consequently, the 'F' changes twice than OUTA / OUTB on AK8775/8777B ,or the output of normal Hall effect latches. It means 'F' has twice resolution than the output of Hall effect latches.

The system needs only 'F' pin output. How should an unused 'D' pin be handled?

⇨ Unused pin should be pull-up, pull-down or leave it open. DO NOT connected to VDD, VSS or other voltage level. Or it causes permanent damage to the device

How the output signal change if the magnetic field is in the hysteresis range (less than Bop and larger than Brp)?

⇨ The output is latched. i.e. keeps its previous status until the magnetic flux density crossed either of Bop and Brp.

Is there any method for improving the resolution or accuracy of detection?

⇨Use much smaller pole pitch (distance between the consecutive poles). However, the smaller the pole pitch, the lower the magnetic flux density from the magnet is given. In case of the sufficient magnetic flux density is not given, it is needed to re-consider following items -- a) change the material of the magnet b) use much thicker magnet c) shorten the air gap between the magnet and the sensor.

What is the maximum the rotation speed the Onechip encoder IC have track it accurately?

⇨The maximum tracking frequency of Onechip encoder ICs are shown in Table 6. But the frequency of magnetic field depends on its number of poles. On Table.14, the maximum tracking rotation speed which is taking account of the number of pole (M should be even number i.e. 2, 4, 6, ….).

Table 14. Maximum tracking rotation speed in rpm

	Maximum rpm*
AK8775/AK8776	7500 / M
AK8777B/AK8778B	490000 / M

*in case of sufficient large magnetic flux density is applied

Can the large magnetic field damage the device?

⇨ No. The operation is not affected with the range of the magnetic flux density from the permanent magnet which is actually used.

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