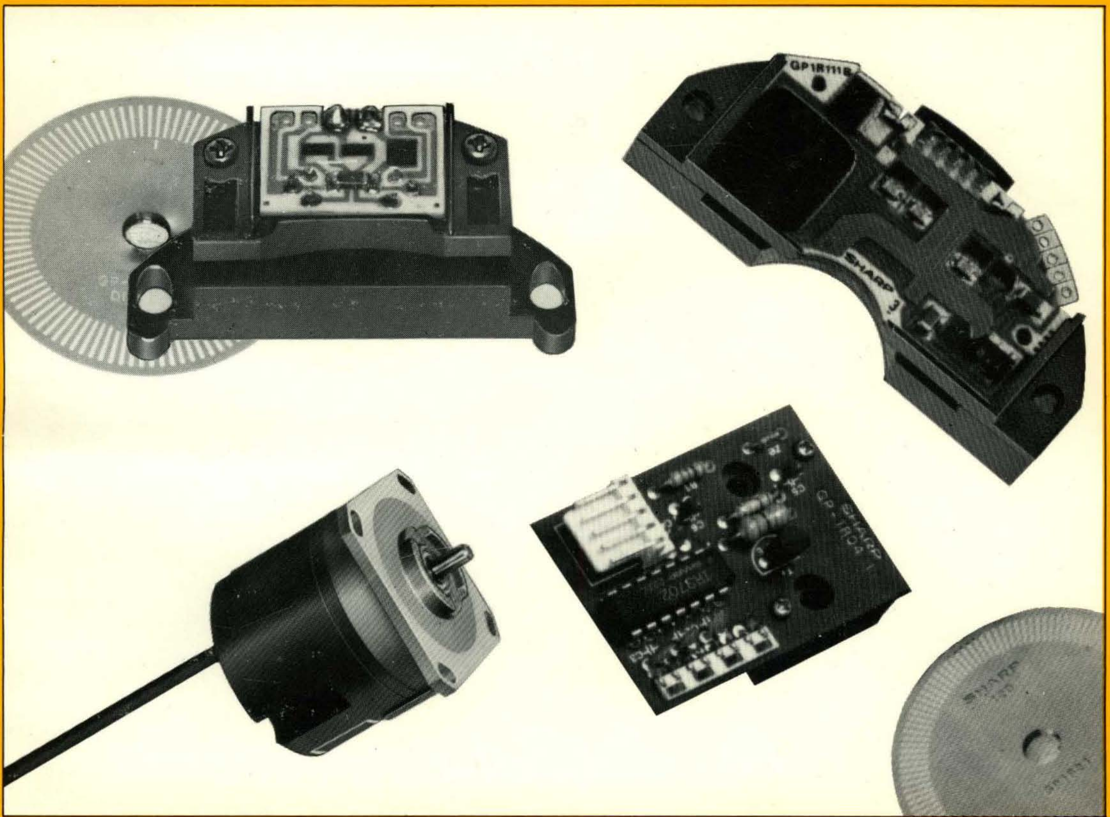
SHARP

ROTARY ENCODERS



SHARP ELECTRONIC COMPONENTS
《ROTARY ENCODERS》

1. General Description

(1) Output of the rotary encoder

Rotary encoders are position detectors which generate pulses in proportion to the rotational angles of the input shafts. They fall into two main groups: the absolute type and the incremental type.

The absolute type rotary encoders output the absolute positions of the rotational angles of the input shafts in the form of the specified pulse strings (such as BCD codes).

Incremental type rotary encoders output the pulse strings (or approximate sine wave and approximate cosine wave) of 2 phases (outputs A and B) with a phase difference of 90° corresponding to the rotation of the input shafts. The rotational direction can be determined from the relative position of these two phases. The absolute positions of the input shafts, however, cannot be output. To compensate for this, output signals (index outputs) are generated at one pulse per rotation to serve as the reference position signals. These are used to count the signals of the 2 phases by the UP/DOWN counters. Absolute positions can be obtained in this way.

(2) Structures of the rotary encoder

Rotary encoders are divided into two categories by their structures: shaft type (complete type) and disk separated type.

The shaft type is the most popular, integrating case, shaft, disk, light detecting/emitting elements and signal processing circuit. The shaft is connected to the motor shaft by a mechanical coupling method.

The disk separated type is composed of light detecting/emitting elements and a signal processing circuit. It is designed to be used with the motor, hence mechanical coupling method for connection to the motor is not needed, and dislocation between shafts can be avoided.

(3) Output waveforms of the rotary encoder

Two types of waveforms are output from the rotary encoders: analog (approximate sine wave) and digital (capable of direct interface with a TTL, or transistor open collector output). The analog output provides high speed positioning control while the digital output is optimum for high speed timing control.

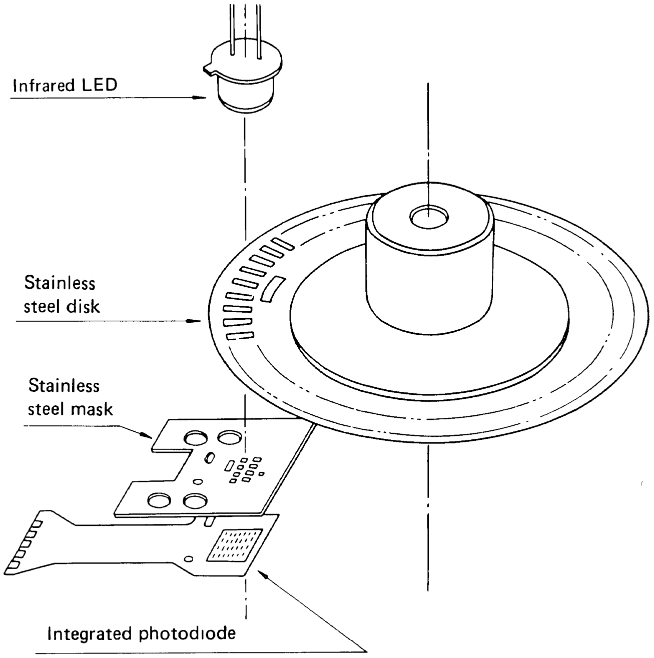


Fig. 1 Structures of optical rotary encoder

(4) Composition of the rotary encoder

Most of SHARP's optical rotary encoders are composed of infrared light emitting diodes, integrated photodiodes, masks, cases and amplifying circuits (see Fig. 1).

Slits on the mask are arranged so that the pitch corresponds to the number of slits on the disk. Slits for outputs A and B are mechanically arranged to produce a phase difference of 90°. The light that comes through the slits on the disk and the mask is detected by the integrated photodiodes, then amplified and output.

2. Signal Processing Circuit of Analog Output Type Rotary Encoders

GP1R14, the typical model of analog output type rotary encoder is described in this section.

(1) Amplifier

The signal processing circuit is shown in Fig. 2.

The short circuit current, I_{SC}, of the photodiode is proportional to the light input. As the bias voltage is reduced to 0V while the I_{SC} is being measured, dark current has no effect. Therefore, the current-voltage conversion circuit which amplifies I_{SC} at 0V bias is employed as the amplifier circuit. Using the OP amplifiers OP_1, OP_2, and OP_3; the feedback resistors VR_1, VR_2, and VR_3; and the zero point compensating resistors VR_5 and VR_6, the short circuit currents I_{SC1}, I_{SC2}, and I_{SC3} from the photodiodes PD_1, PD_2, and PD_3 are subject to current-voltage conversion and form up the output voltages V_A, V_B and V_Z. C_1, C_2, and C_3 are the anti-oscillation capacitors.

(2) Light level compensating circuitry

This circuitry compares the reference current I_O (controlled by the resistor VR_4) and the short circuit current (at the photodiode PD_4), and controls the current I_F which flows into the infrared light emitting diode so that I_O is kept equal to I_{SC4}.

(3) Adjustment

The values of I_F, V_A, V_B, and V_Z are adjusted by laser-trimming the thick film resistors VR_1, VR_2, VR_3, VR_4, VR_5, and VR_6.

(4) Output waveforms

The output waveforms of the rotary encoder GP1R14 (see Fig. 3) can be approximately expressed by the following formulas.

Output A: $V_A \fallingdotseq V_{AP}\sin(N x \theta)$　　　Output B: $V_B \fallingdotseq V_{BP}\cos(N x \theta)$

where V_{AP} and V_{BP} are the amplitudes (0.5V for GP1R14), and N is the number of pulses per rotation (200P/R for GP1R14B). θ is the rotational angle of the rotary encoder.

The DC servomotor can be controlled by these signals.

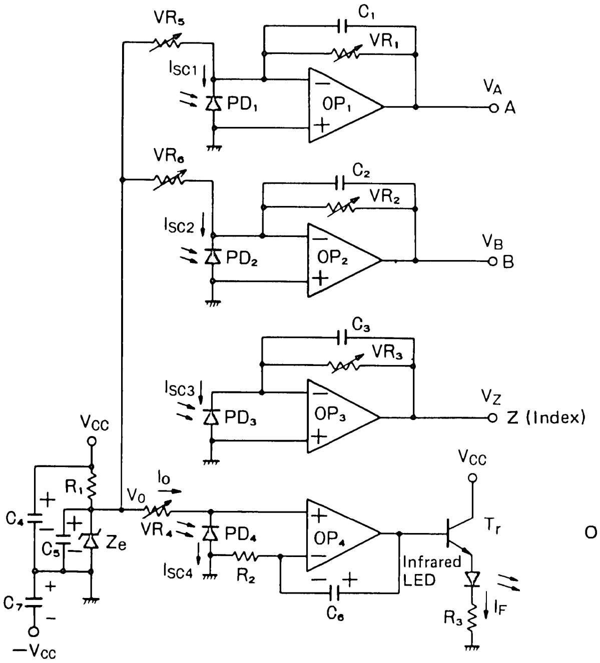
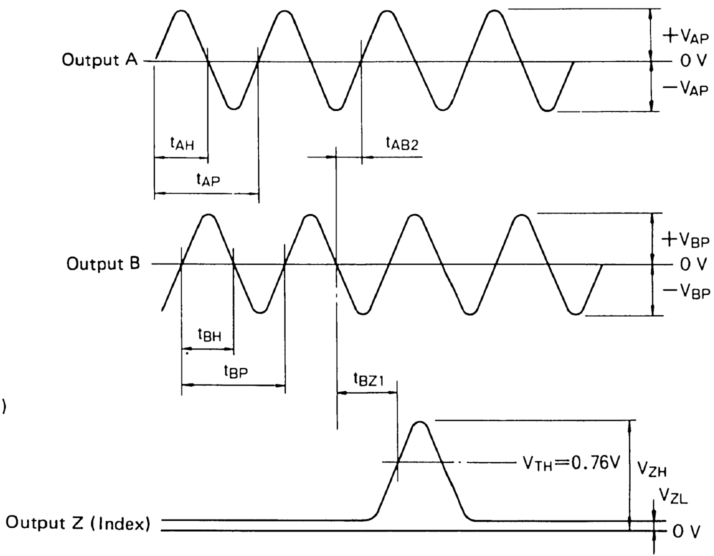


Fig. 2 Signal processing circuit of GP1R14



Rotational direction:
Counterclockwise when seen from the infrared LED side

tAH (tBH):	Average time required for output A (B) to rise 0V or more
tAP (tBP):	Average cycle of output A (B)
tAB2, tBZ1:	Average value of phase (time) difference from output B.

Fig. 3 Output waveforms of GP1R14

(5) Detection of rotational angle

The points at which $V_A = 0V$ or $V_B = 0V$ are counted by output Z as the reference.

In an area in which V_A or V_B is close to 0V, the waveforms of GP1R14 can be expressed by linear approximations against the rotational angle θ as shown in the following formulas.

$$V_A \fallingdotseq V_{AP} \cdot N \cdot \theta \qquad\qquad V_B \fallingdotseq V_{BP} \cdot N \cdot \theta$$

Thus, optimum positioning to the point where V_A or V_B is 0 is easy. Positioning can be executed by the analog output type, much faster than in the digital output type.

(6) Detection of rotational direction

The rotational direction can be detected by the phase difference of the outputs A and B.

(7) Detection of rotational speed (tacho signal)

When the motor is rotating at a constant speed (angular velocity ω), output A can be provided by differentiating the following equation:

$$V_A = V_{AP} \sin(N \cdot \omega \cdot t)$$

In other words, output A is expressed by;

$$\frac{dV_A}{dt} = V_{AP} N\omega \cos(N \cdot \omega \cdot t)$$

The angular velocity ω can be calculated from the amplitude $V_{AP}\ N\omega$.

3. Signal Processing Circuit of Digital Output Type Rotary Encoders

GP1R11, the typical model of digital output type rotary encoder, is described in this section.

(1) Signal processing

The signal processing circuit is shown in Fig. 4.

The circuit is composed of an amplifying circuit, waveform adjustment circuit and output circuit. The amplifying circuit amplifies the light signal detected at the detecting element. The waveform adjustment circuit compares the amplifier signals and transforms them into digital waveforms.

In GP1R11, the section framed in Fig. 4 composes a single chip (OPIC).

It employs an optical push-pull method in which two photodiodes are used for each output.

These four photodiodes of OPIC are arranged so that the pitch corresponds to one fourth of the slit pitch of the disk (1.6 mm pitch for GP1R11). Fig. 5 shows the relative position of the disk and the four photodiodes.

Fig. 6 shows the variations in the light detecting areas of PD_A, $PD_{\bar{A}}$, PD_B, and $PD_{\bar{B}}$ while the disk is rotating counterclockwise over the photodiodes as shown in Fig. 5. Fig. 6 also shows the voltage waveforms of V_A, $V_{\bar{A}}$, V_B, $V_{\bar{B}}$, $Vout_A$ and $Vout_B$ shown in Fig. 4. Collector current in the photodiode is proportional to the light detecting areas shown in Fig. 5. As for the relative positions, PD_A and PD_B have a phase difference of 90°. PD_A and $PD_{\bar{A}}$, PD_B and $PD_{\bar{B}}$ have a phase difference of 180° respectively. The collector current is amplified in the amplifier circuit section and subjected to current-voltage conversion before being inputted in the comparator.

The comparator provides a push-pull circuit which measures the difference between the reversed input signals with a phase difference of 180°. Therefore, the output waveforms are adjusted against the effects of the decreased output of the light emitting diode due to the rise of temperature. The output waveforms are also adjusted against the effects of the light emitting diode that change with the passage of time.

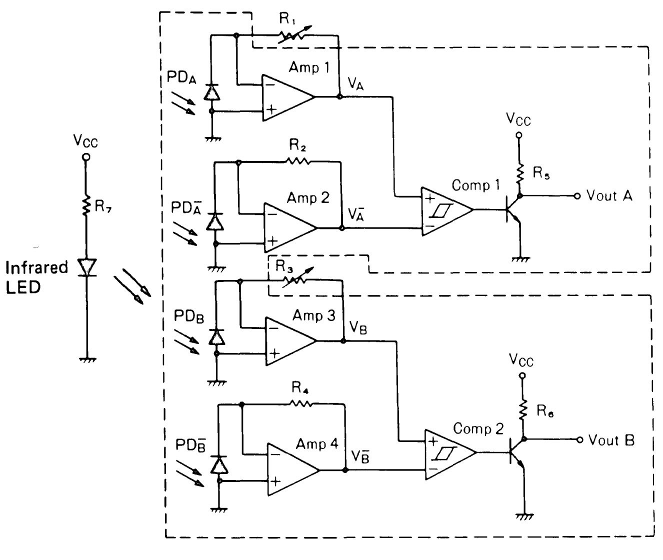
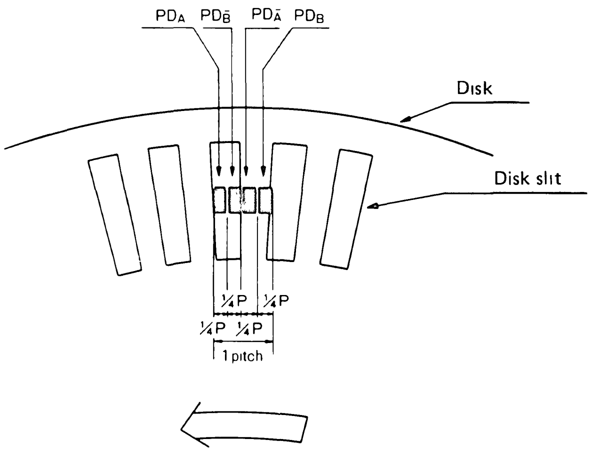
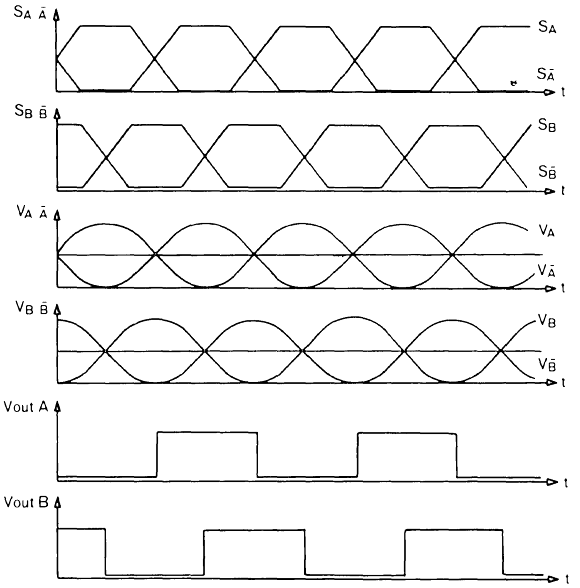


Fig. 4 Signal processing circuit of GP1R11



Rotational direction of the disk (counterclockwise when seen from the OPIC lightdetector side)

Fig. 5 Relative position of the disk slits and the photodiodes

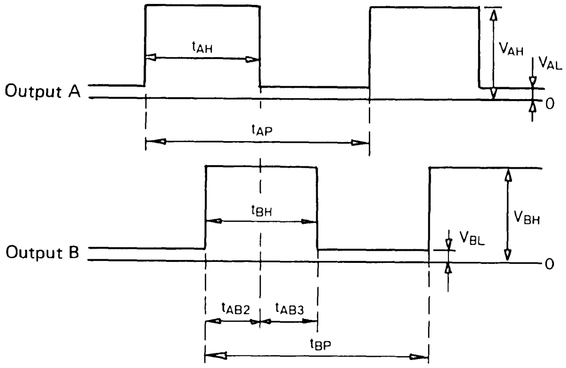


S_A : Light detecting area of PD_A
$S_{\bar{A}}$: Light detecting area of $PD_{\bar{A}}$
S_B . Light detecting area of PD_B
$S_{\bar{B}}$. Light detecting area of $PD_{\bar{B}}$
t : Time passage corresponding to the rotation of the disk

Fig. 6 Variations in the light detecting areas of the photodiode (PD) and voltage waveforms

(2) Output waveforms

Digital output waveforms of outputs A and B are obtained with a phase difference of 90°. See Fig. 7.



Rotational direction:
Counterclockwise when seen
from the OPIC lightdetector side

Fig. 7 Output waveforms of GP1R11

(3) Detection of the rotational angle

The rising and falling edges of the digital waveforms are detected and used as signals. There are three different usages according to application:

1) Only rising edges of output A (or output B) are used.

2) Rising and falling edges of output A (or output B) are used.

3) Rising and falling edges of outputs A and B are used.

The number of the output pulses is equal to (1), twice as large (2), or four times as large (3) as the number of slits (N) on the disk.

(4) Detection of rotational direction

Rotational direction is detected by the phase difference of the outputs A and B.

(5) Detection of rotational speed

The rotational speed can be detected by three methods:

1) Detection of phase difference using the reference signals (PLL method),
2) Counting of the output waveform pulses of the rotary encoder in a certain period,
3) Measurement of the width of output waveform pulses of the rotary encoder.

Each application determines which method should be used.

4. Applications

Some applications of the rotary encoder are shown in the table below.

Category	Equipment	Applications
Office equipment	Typewriters Printers Copiers Facsimiles	Daisy control for typewriters Timing control for carriage motors Daisy control for printers Carriage motor control for dot printers Control of motors for reduction/enlargement optical systems Constant rotation control for optical motors
Computer peripherals	X-Y plotters Magnetic disk system Mouse	Detection of coordinates Rotational position control for disks Detection of the moving distance and direction of the trackballs
Machine tools	Numerical control equipment Linear scales	Detection of the moving distance of the X-Y table Detection of the moving distance
Measuring instruments	Monitor TV cameras Electronic scales	Angle control of tracing turntable Detection of spring displacement
Electric appliances	VTRs Sewing machines Record players	Constant rotation control for capstan motors (for still and frame advance) Motor position control for pattern sewing Rotational control of the turntable of direct drive players
Others	Industrial robots Motors	Position and angle control of arms and joints Detection of pulse-motor step-out

5. Examples of Application Circuits

(1) Rotational direction detecting circuits using rotary encoder

This section describes a basic rotational direction detecting circuit which uses an optical rotary encoder.

Fig. 8(a) shows a rotational direction detecting circuit using the GP1R11 digital output type rotary encoder. Fig. 8(b) shows the time chart.

In this circuit, timing pulses are generated at both the rising and falling edges of the outputs A and B signals. The rotational direction detecting signals are output in synchronization with the rising edges of the timing pulses. Q_1 and Q_1' in Fig. 8(b) are timing pulses. The pulse width of the timing pulses are determined by C and R in Fig. 8(a). The number of timing pulses generated per motor rotation is four times as that of the rotary encoder output pulses (output A or B). When the motor shaft rotates clockwise, the rotational direction detecting signal is High. When it rotates counterclockwise, this signal is Low. When the rotational direction switches from clockwise to counterclockwise or from counterclockwise to clockwise the rotational direction detecting signal reverses from High to Low or from Low to High in synchronization with the first rising edge of the timing pulse following conversion of the motor rotation.

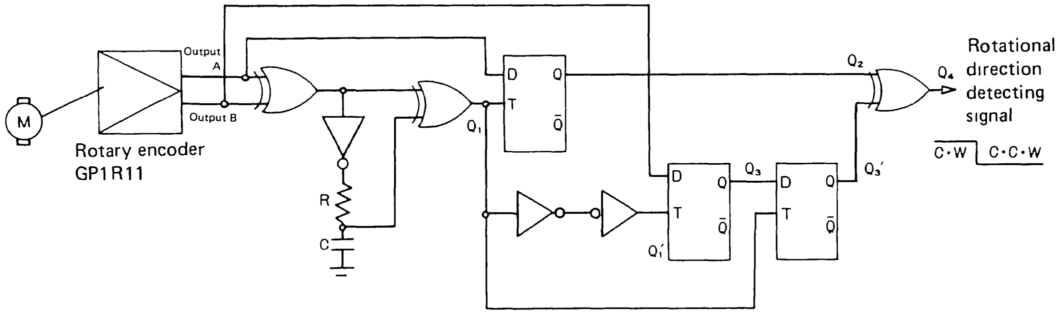


Fig. 8(a) Rotational direction detecting circuit using a rotary encoder

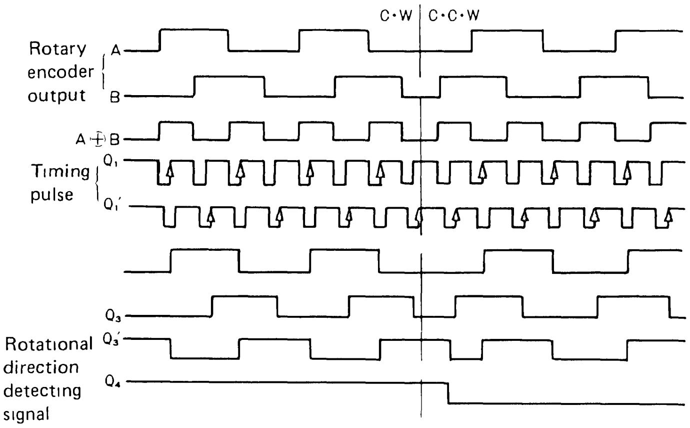


Fig. 8(b) Time chart

(2) DC survo motor control by rotary encoder

In the angle, the position or rotational speed control for mechatronic systems, which requires high speed responses, the DC survo motor which combines the DC motor and the rotary encoder is better than the pulse motor in terms of high speed response, stability and output efficiency.

Fig. 9 shows the composition of the DC survo motor control system using the rotary encoder. Table 1 shows the general specifications of the board computer LH8H21 (designed exclusively for DC survo motor) which can be directly interface with the GP1R14 rotary encoder.

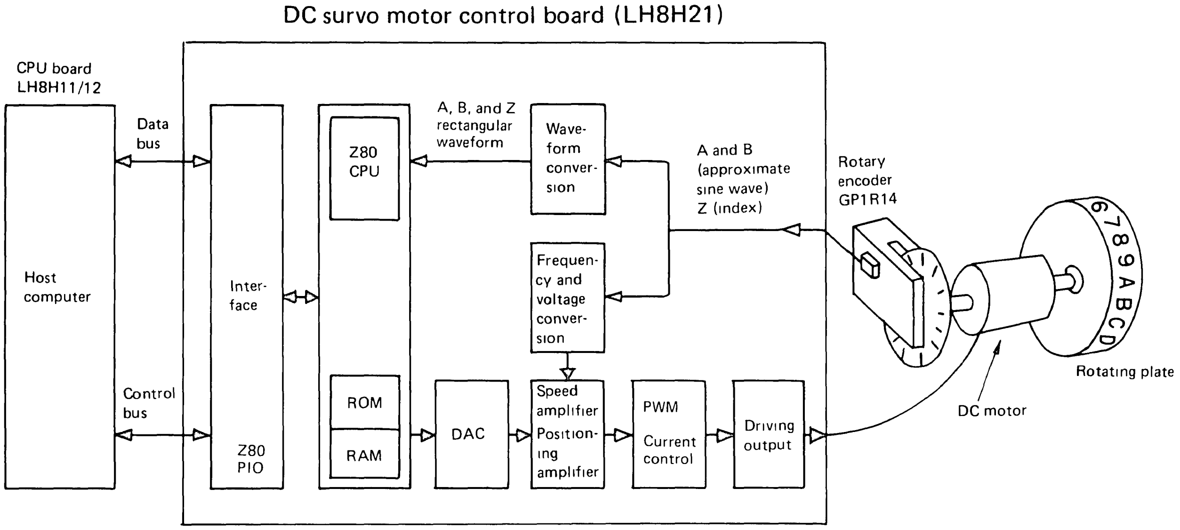
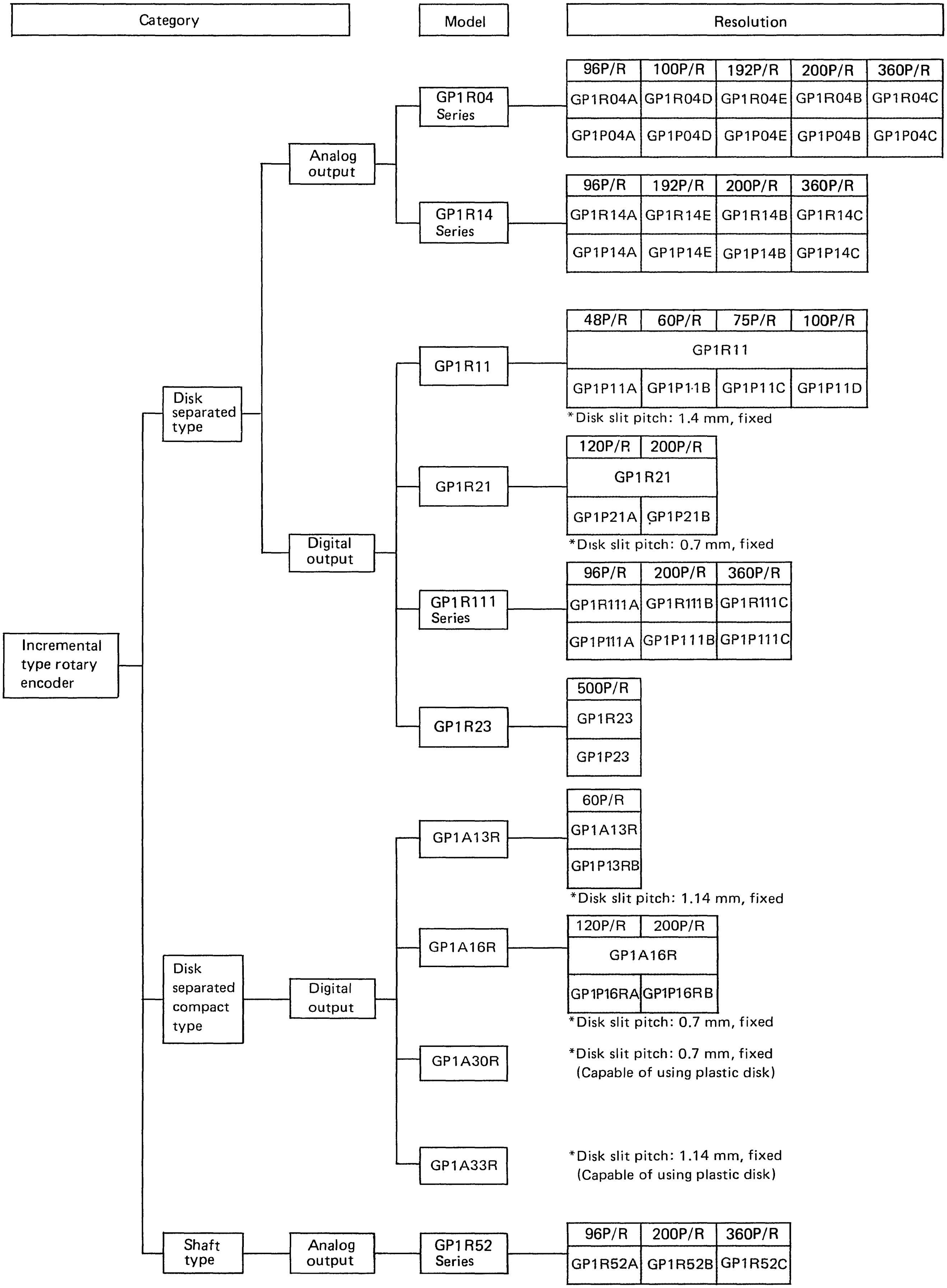


Fig. 9 Composition of the DC survo motor control system

Table 1 General specifications for the board computer LH8H21 for controlling survo motor

Item	Specification	
Control method	Analog survo method using Z80CPU and a dedicated IC	
Positioning control	Closed loop control by counting the output of the rotary encoder and using an approximate sine wave	
Speed control	Digital setting of 32 steps, speed adjustment by variable resistor	
Constant speed control	Analog feedback by rotary encoder output	
Motor driving control	PWM, Transister bridge method	
	MAX. 30VDC: recommended voltage, 24VDC: Peak current, 2A Continuation current, 0.8V	
Encoder input	Outputs A and B (with the phase difference of 90°), Z (index), (capable of interface with GP1R14).	
Control instructions	Speed instruction	Speed setting, rotational direction
	Position instruction	Rising and falling edge performance setting, displacement setting by the number of pulses and rotations.
	Motor control instruction	Drive output enable, locking at the stopping mode
Interface	8-bit parallel bus, interface with LH8H11/12 by extension connector.	
	Signal level: TTL level	
Power supply	For driving the motor, recommended voltage 24VDC: For analog circuit, ± 12V DC: For logic circuit, 5VDC	
Outline dimensions	120 x 155mm	
Operating temperature	0 ~ 55°C	
Storage temperature	–40 ~ +80°C	

6. Systematic Diagram of SHARP Optical Rotary Encoders



GP1R04 Series

96P/R	100P/R	192P/R	200P/R	360P/R
GP1R04A	GP1R04D	GP1R04E	GP1R04B	GP1R04C
GP1P04A	GP1P04D	GP1P04E	GP1P04B	GP1P04C

GP1R14 Series

96P/R	192P/R	200P/R	360P/R
GP1R14A	GP1R14E	GP1R14B	GP1R14C
GP1P14A	GP1P14E	GP1P14B	GP1P14C

GP1R11

48P/R	60P/R	75P/R	100P/R
GP1R11			
GP1P11A	GP1P11B	GP1P11C	GP1P11D

*Disk slit pitch: 1.4 mm, fixed

GP1R21

120P/R	200P/R
GP1R21	
GP1P21A	GP1P21B

*Disk slit pitch: 0.7 mm, fixed

GP1R111 Series

96P/R	200P/R	360P/R
GP1R111A	GP1R111B	GP1R111C
GP1P111A	GP1P111B	GP1P111C

GP1R23

500P/R
GP1R23
GP1P23

GP1A13R

60P/R
GP1A13R
GP1P13RB

*Disk slit pitch: 1.14 mm, fixed

GP1A16R

120P/R	200P/R
GP1A16R	
GP1P16RA	GP1P16RB

*Disk slit pitch: 0.7 mm, fixed

GP1A30R

*Disk slit pitch: 0.7 mm, fixed
(Capable of using plastic disk)

GP1A33R

*Disk slit pitch: 1.14 mm, fixed
(Capable of using plastic disk)

GP1R52 Series

96P/R	200P/R	360P/R
GP1R52A	GP1R52B	GP1R52C

☐	
Upper row:	Rotary encoder unit
Lower row:	Disk hub

7. Performance List for SHARP Optical Rotary Encoders

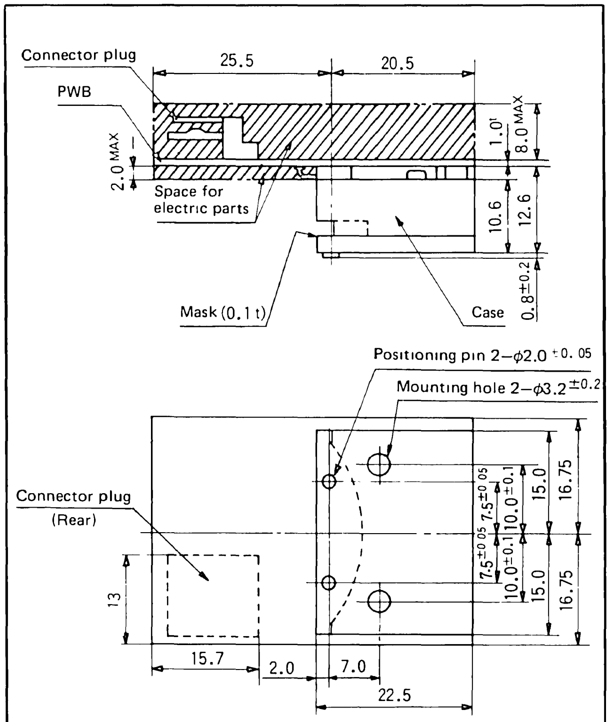
Output waveforms	Model No.	Type	Resolution (P/R)	Absolute maximum ratings			Electrical characteristics				
				Supply voltage V_{CC} (V)	Operating temperature T_{opr} (°C)	Storage temperature T_{stg} (°C)	Operating voltage V_{CC} (V)	Output waveforms	Frequency response (kHz)	R_L (kΩ)	Dissipation current (mA)
Analog output	GP1R04	Disk separated	96/100/192/ 200/360	8.0	0 ~ +70	−40 ~ +80	5	Output A (approximate sine wave) Output B (approximate cosine wave) Output Z (index output)	MAX. 20	10	MAX. 70
	GP1R14	Disk separated	96/192/ 200/360	± 15	0 ~ +70	−40 ~ +80	± 12	Output A (approximate sine wave) Output B (approximate cosine wave) Output Z (index output)	MAX. 20	10	MAX. 75
	GP1R52	Shaft	96/200/360	8.0	0 ~ +70	−40 ~ +80	5	Output A (approximate sine wave) Output B (approximate cosine wave) Output Z (index output)	MAX. 20	10	MAX. 70
Digital output	GP1R11	Disk separated	Disk slit pitch: 1.4mm, fixed	7.0	0 ~ +70	−40 ~ +80	5	Output A (digital output) Output B (digital output)	20	10	MAX. 70
	GP1R21	Disk separated	Disk slit pitch: 0.7mm, fixed	7.0	0 ~ +70	−40 ~ +80	5	Output A (digital output) Output B (digital output)	20	10	MAX. 70
	GP1R111	Disk separated	96/200/360	8.0	0 ~ +70	−40 ~ +80	5	Output A (digital output) Output B (digital output) Output Z (index output)	10	0.3	MAX. 80
	GP1R23	Disk separated	500	6.0	0 ~ +70	−40 ~ +80	5	Output A (digital output) Output B (digital output)	20	4.7	MAX. 50
	GP1A13R	Compact disk separated	Disk slit pitch: 1.14mm, fixed	7.0	0 ~ +70	−40 ~ +80	5	Output A (digital output) Output B (digital output)	10	I_F = 20mA	MAX. 20
	GP1A16R	Compact disk separated	Disk slit pitch: 0.7mm, fixed	7.0	0 ~ +70	−40 ~ +80	5	Output A (digital output) Output B (digital output)	10	I_F = 20mA	MAX. 20
	GP1A30R	Compact disk separated	Disk slit pitch: 0.7mm, fixed	7.0	0 ~ +70	−40 ~ +80	5	Output A (digital output) Output B (digital output)	5	I_F = 30mA	MAX. 20
	GP1A33R	Compact disk separated	Disk slit pitch: 1.14mm, fixed	7.0	0 ~ +70	−40 ~ +80	5	Output A (digital output) Output B (digital output)	5	I_F = 30mA	MAX. 20

SHARP

GP1R04 Series

Rotary Encoder

☐ Outline Dimensions



Unspecified tolerance is ±0.5 mm. Unit: mm

☐ General Description

The Sharp GP1R04 Series is an incremental type rotary encoder with a built-in light level compensating circuit, consisting of an infrared light emitting diode and an integrated photodiode.
It generates 2–phase outputs, A (approximate sine wave) and B (approximate cosine wave) and Z (index) output.
The Series is optimum for detection of angle, number, direction, and speed of rotation.
5 types of models are available as shown below.

Model No.	Resolution (P/R)
GP1R04A	96
GP1R04B	200
GP1R04C	360
GP1R04D	100
GP1R04E	192

☐ Features

(1) Excellent thermal characteristics
(2) High accuracy in phase difference due to laser trimming
(3) High freqeuncy response due to use of a photodiode
(4) Compact and light for its plastic case
(5) Incremental type

☐ Applications

(1) Typewriters, printers
(2) Electronic sewing machines
(3) Copiers
(4) Various types of machine tools
(5) Various types of measuring instruments

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Rating	Unit
*1 Supply voltage	V_{CC}	8	V
Min. load resistance on output side	R_L	5.0	kΩ
Operating temperature	T_{opr}	0 ~ +70	°C
Storage temperature	T_{stg}	–40 ~ +80	°C

*1 Power must not be turned on when the feedback cell is optically shut off.

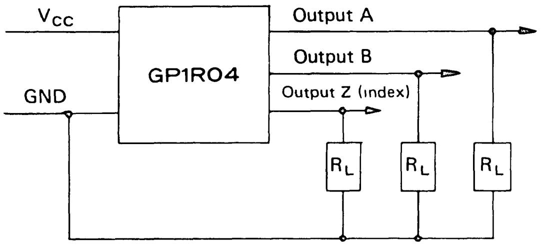
☐ Electrical Characteristics

(V_{CC} = 5V, R_L = 10kΩ, Ta = 25°C)

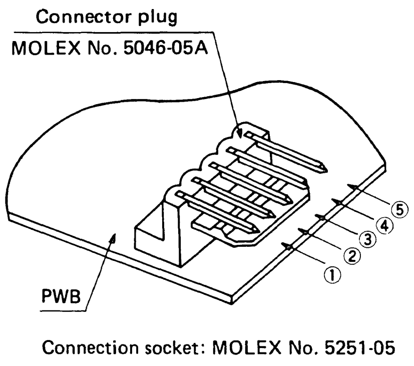
Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Duty ratio		D_A	0.45	0.50	0.55		t_{AP} = DC ~ 0.5 ms V_{TH} = 1.5V	$\frac{t_{AH}}{t_{AP}}$
		D_B	0.45	0.50	0.55		t_{BP} = DC ~ 0.5ms V_{TH} = 1.5V	$\frac{t_{BH}}{t_{BP}}$
Phase difference	GP1R04A	θ_{AB1} θ_{AB2}	75	90	105	deg.	t_{AP} = DC ~ 0.5 ms	$\frac{t_{AB1}}{t_{AP}}$ x 360° $\frac{t_{AB2}}{t_{AP}}$ x 360°
	GP1R04B		70	90	110			
	GP1R04C		50	90	130			
	GP1R04D		75	90	105			
	GP1R04E		70	90	110			
Output Z (index)voltage		V_{ZH}	1.00	1.25	1.50	V	t_{AP} = DC ~ 5 ms	
		V_{ZL}	–	–	0.6	V		
·Dissipation current		I_{TOT}	–	–	70	mA		

Test Circuit for Electrical Characteristics

Supply voltage: V_{CC} = 5V ±5%
Load resistance on output side: R_L = 10kΩ±5%

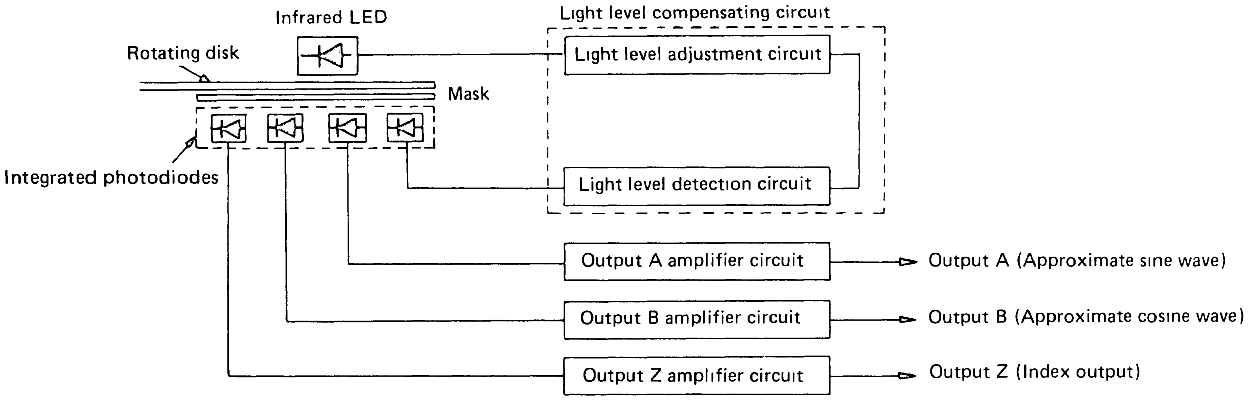


Connector Pin Configuration

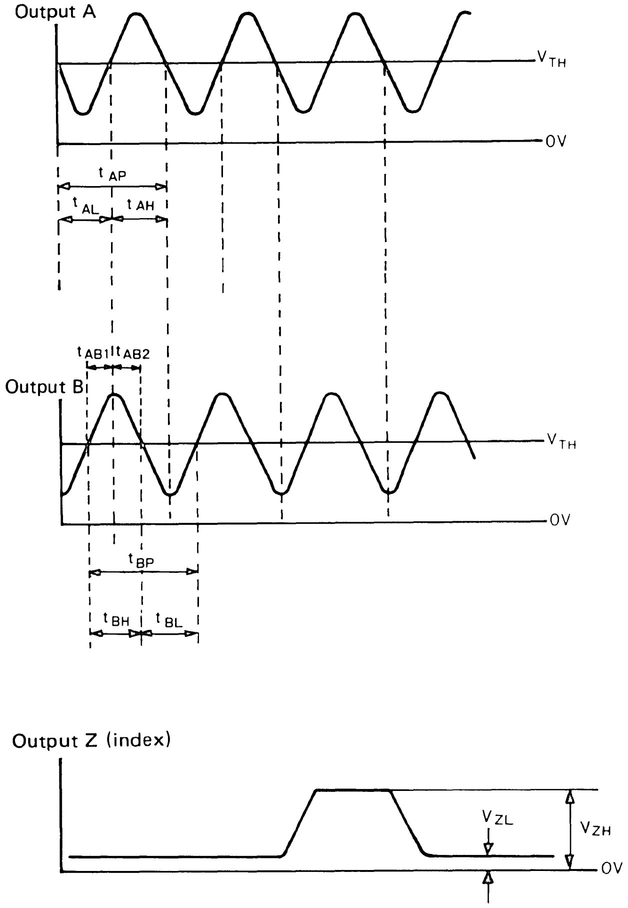


No.	Signal
①	Output B
②	Output Z (index)
③	Output A
④	GND
⑤	Vcc

Block Diagram



Output Waveforms



Rotational direction	:	Counterclockwise when seen from the positioning pin side
t_{AL} (t_{BL})	:	Average time required for output A (B) to fall below V_{TH}
t_{AH} (t_{BH})	:	Average time required for output A (B) to rise over V_{TH}
t_{AP} (t_{BP})	:	Average cycle of output A (B)
t_{AB1}, t_{AB2}	:	Average time for left waveforms

Fig. 1 Supply voltage vs. relative output

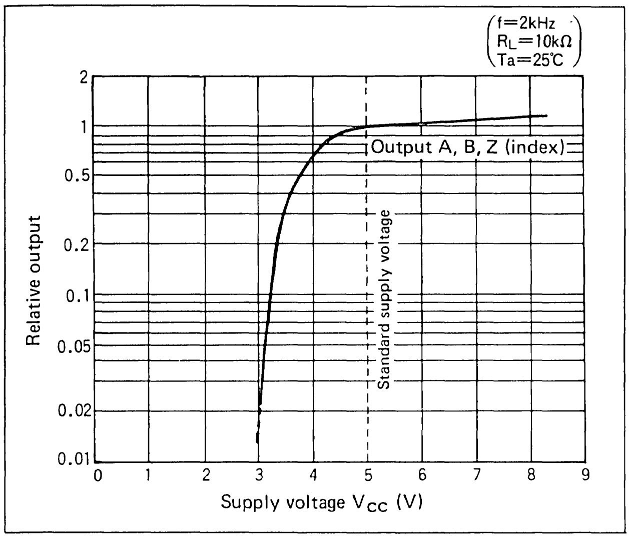


Fig. 2 Frequency response

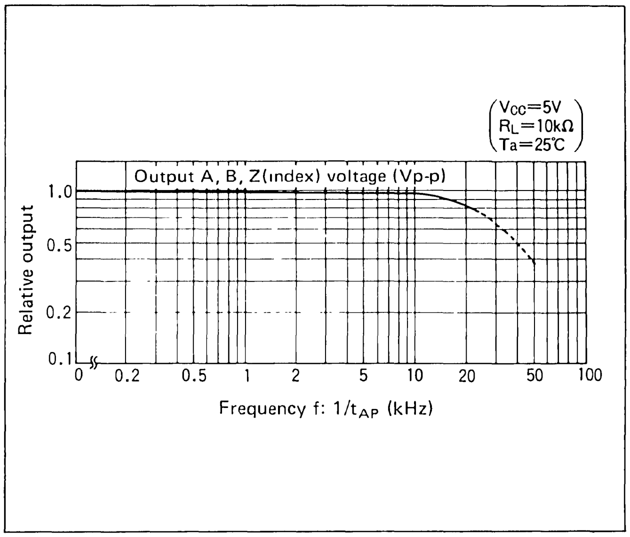


Fig. 3 Frequency vs. duty ratio

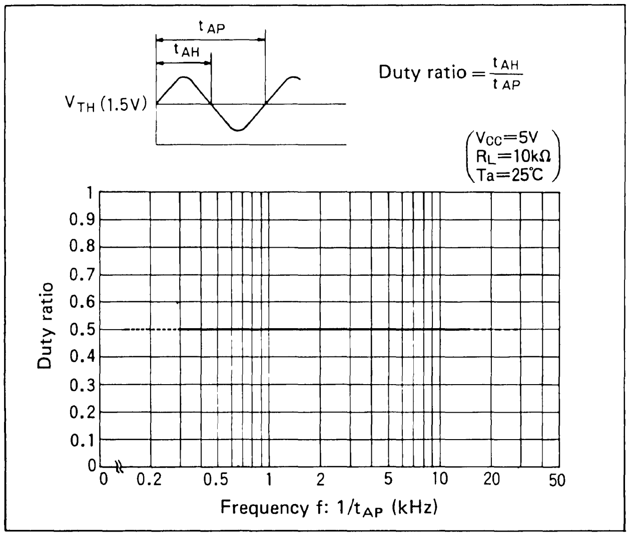
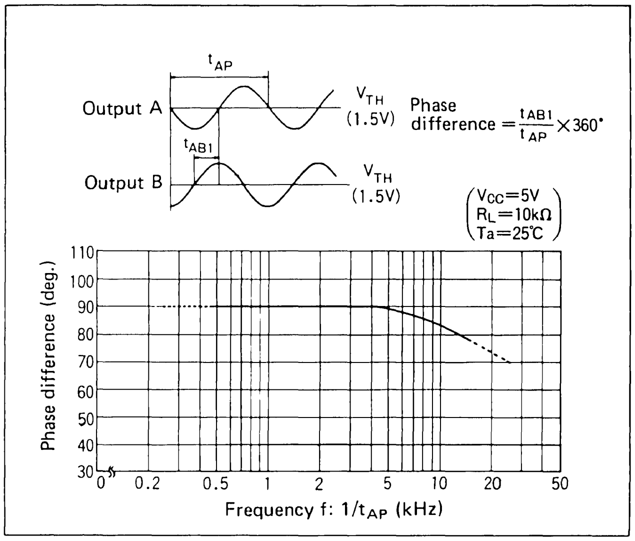
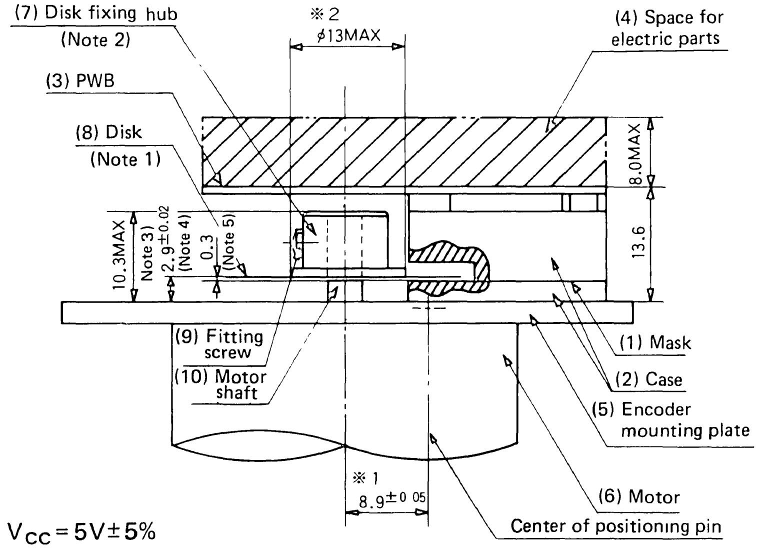


Fig. 4 Frequency vs. phase difference



☐ Suggestion for Use

It is recommended that when connected to a motor, the GP1R04 be installed as shown below.



V_{CC} = 5V±5%

Note 1) Disk Diameter: GP1R04A and D = ϕ28mm; GP1R04 B, C and E = ϕ36mm. (If disk diameter is ϕ36mm, *1 value is $12.9^{\pm0.05}$mm.)

2) The diameter of disk fixing hub is ϕ13mm, maximum. (If disk diameter is ϕ36mm, *2 value is ϕ20.0, maximum.)

3) Height of the disk fixing hub or length of motor shaft above the reference plane are 10.3mm, maximum.

4) 2.8mm for GP1R04C.

5) Distance between the disk and the mask is 0.3mm (reference value). (0.2mm for GP1R04C)

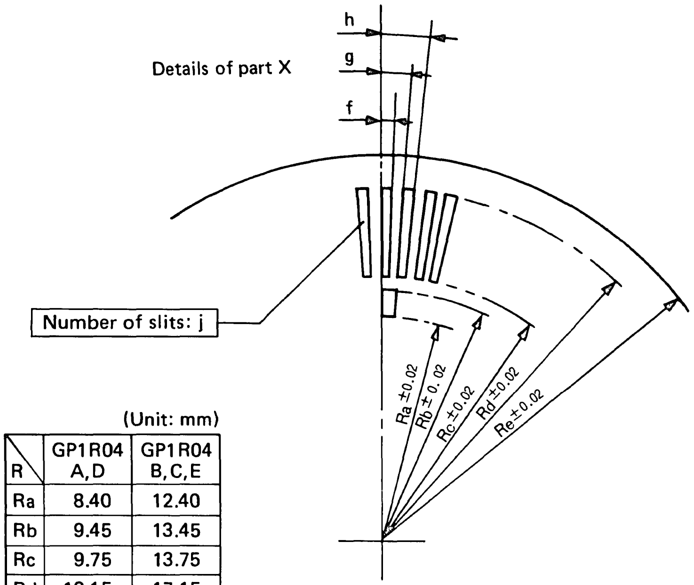
6) The GP1R04 optical encoder module is comprised of parts (1) to (4).

7) Parts (5) to (10) are not included in the GP1R04 encoder module.

Unit: mm

Disk Design

When a disk is designed for use in the GP1R04, it is suggested that the following design standard shall be utilized.

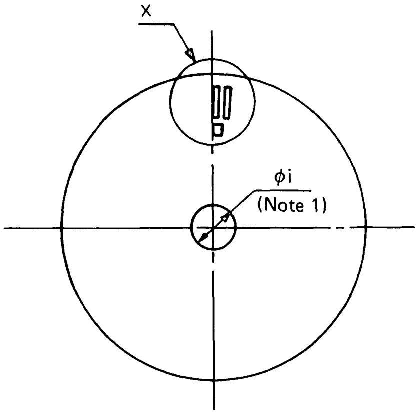


(Unit: mm)

R	GP1R04 A,D	GP1R04 B,C,E
Ra	8.40	12.40
Rb	9.45	13.45
Rc	9.75	13.75
Rd	13.15	17.15
Re	14.0	18.0

j	f	g	h	Applied encoder
96	112.5	225	337.5	GP1R04A
100	108	216	324	GP1R04D
192	56.25	112.5	168.75	GP1R04E
200	54	108	162	GP1R04B
360	30	60	90	GP1R04C

Unit: j: P/R
f, g, h: minute



Note 1) φi is variable in compliance with the type of motor used. (φi for Sharp's standard disk hub is φ4mm.)
2) It is recommended that disk thickness be 0.1mm for GP1R04A, D and 0.08mm for GP1R04B, C, E.

Unit: mm

The disks shown below are available as optional parts.

Model No.	Resolution (P/R)
GP1P04A	96
GP1P04B	200
GP1P04C	360
GP1P04D	100
GP1P04E	192

The disk must be selected according to the resolution of the encorder to be used with.

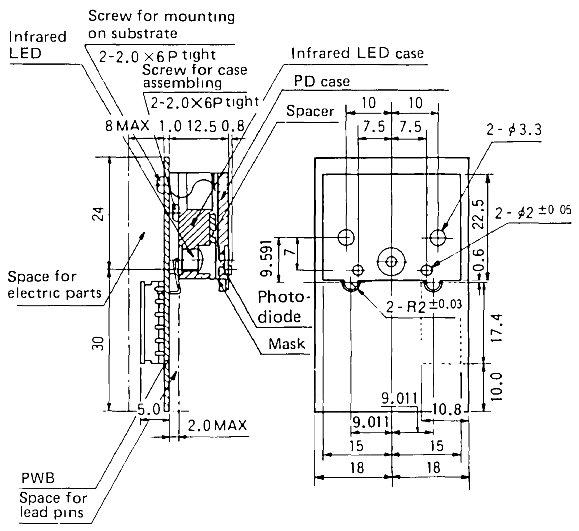
Specifications are subject to change without notice.

SHARP

GP1R14 Series

Rotary Encoder

☐ Outline Dimensions



Unspecified tolerance is ±0.5 mm. Unit : mm

☐ General Description

The Sharp GP1R14 Series is a rotary encoder which realized the compact and thin design due to use of an infrared light emitting diode and integrated photodiode array. It generates 2-phase outputs, A (approximate sine wave) and B (approximate cosine wave), and Z (index) output that are optimum for high speed position control in DC servomotor.

The GP1R14 Series constitutes a DC servomotor control system by interfacing with servo board LH8H21.

4 types of models are available as shown below.

Model No.	Rsolution (P/R)
GP1R14A	96
GP1R14B	200
GP1R14C	360
GP1R14E	192

☐ Features

(1) Easily interfaced with an analog circuit due to the ±12V power supply

(2) Stable output waveform by temperature compensating circuit

(3) Easy attachment to a motor due to the disk separated type

☐ Applications

(1) Electronic typewriters and high speed dot printers

(2) OA and FA equipment such as XY plotters, floppy disks and robots

(3) Measuring instruments, numerical control equipment

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Rating	Unit
*1 Supply voltage	V_{CC}	±15	V
Min. load resistance on output side	R_L	5.0	kΩ
Operating temperature	T_{opr}	0 ~ +70	°C
Storage temperature	T_{stg}	−40 ~ +80	°C

*1 Power must not be turned on when the feedback cell is optically shut off.

☐ Electrical Characteristics

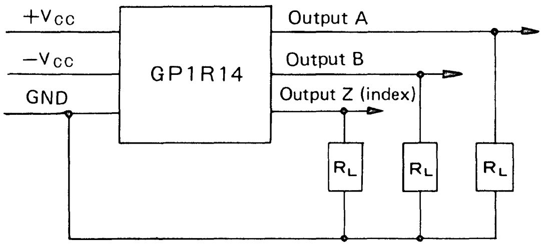
(V_{CC} = ±12V, R_L = 10kΩ, Ta = 25°C)

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Output A voltage		$+V_{AP}$	400	500	600	mV	f = DC ~ 5kHz	
		$-V_{AP}$	−400	−500	−600			
Output B voltage		$+V_{BP}$	400	500	600	mV	f = DC ~ 5kHz	
		$-V_{BP}$	−400	−500	−600			
Output Z (index) voltage		V_{ZH}	1.00	1.5	2.0	V	f = DC ~ 5kHz	
		V_{ZL}	–	–	0.5			
*2 Ripples		V_{AR}	–	–	150	mV	f = DC ~ 5kHz (Output A, B)	
		V_{BR}	–	–	150			
Duty ratio		D_A	0.45	0.50	0.55		f = DC ~ 5kHz (Output A, B)	T_{AH}/T_{AP}
		D_B	0.45	0.50	0.55			T_{BH}/T_{BP}
Phase difference	GP1R14A	θ_{AB2}	75	90	105	deg.	f = DC ~ 5kHz V_{TH} = 0V	$\frac{T_{AB2}}{T_{AP}} \times 360°$
	GP1R14B		70	90	110			
	GP1R14C		50	90	130			
		θ_{BZ1}	140	180	220		f = DC ~ 1kHz V_{TH} = 0V	$\frac{T_{BZ1}}{T_{AP}} \times 360°C$
Dissipation current		$+I_{CC}$	–	60	75	mA		
		$-I_{CC}$	–	5	20			

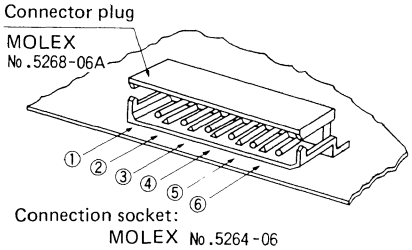
*2. Ripples shall be absolute values measured under the following conditions; Disk pitch tolerance : ±10μm
Disk slit tolerance : ±20μm
Disk deflection range : ±60μm

Test Circuit for Electrical Characteristics

Supply voltage V_{CC} = ±12V ±5%
Load resistance on output side R_L = 10kΩ±5%

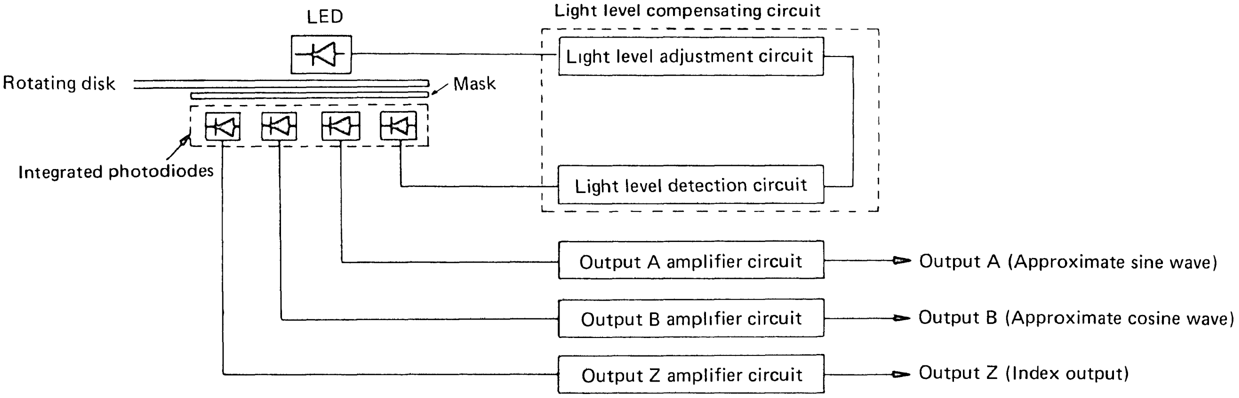


Connector Pin Configuration

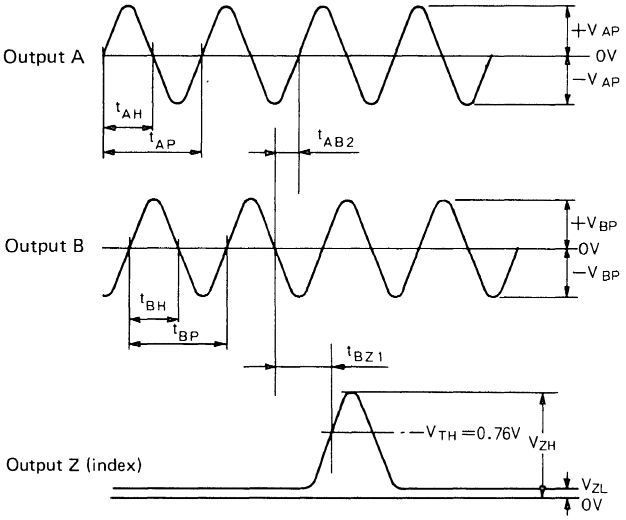


No.	Signal
①	V_{CC} (+12V)
②	GND (0V)
③	V_{CC} (−12V)
④	Output A
⑤	Output B
⑥	Output Z (index)

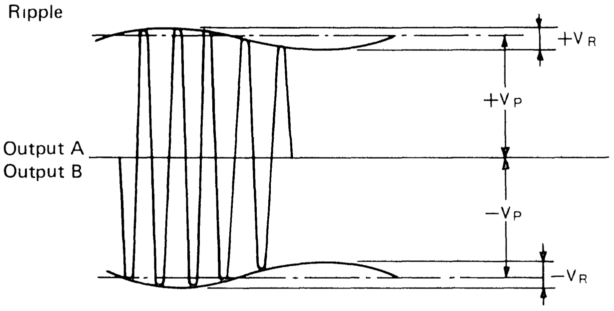
Block Diagram



Output Waveforms



Rotational direction : Counterclockwise when seen from the infrared LED side.
t_{AH} (t_{BH}) : Average time required for output A (B) to rise 0V or more.
t_{AP} (t_{BP}) : Average cycle of output A (B)
t_{AB2}, t_{BZ1} : Average time for left waveforms.



Ripple V_R = | +V_R|, | −V_R|
V_{AR} : V_R of output A
V_{BR} : V_R of output B

Fig. 1 Supply voltage vs. relative output

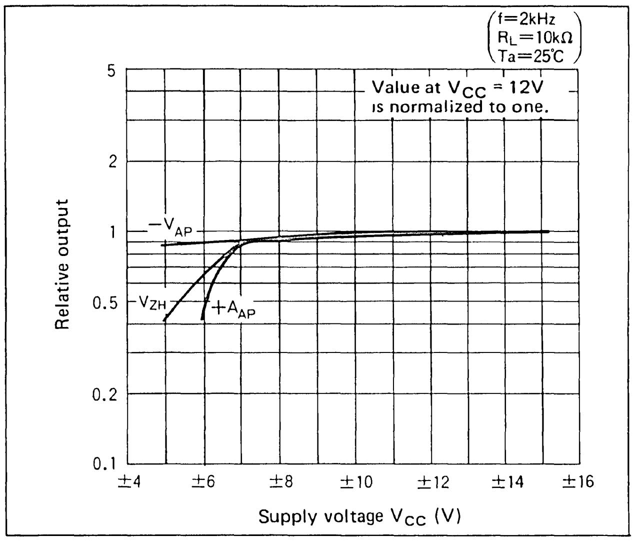


Fig. 2 Frequency response

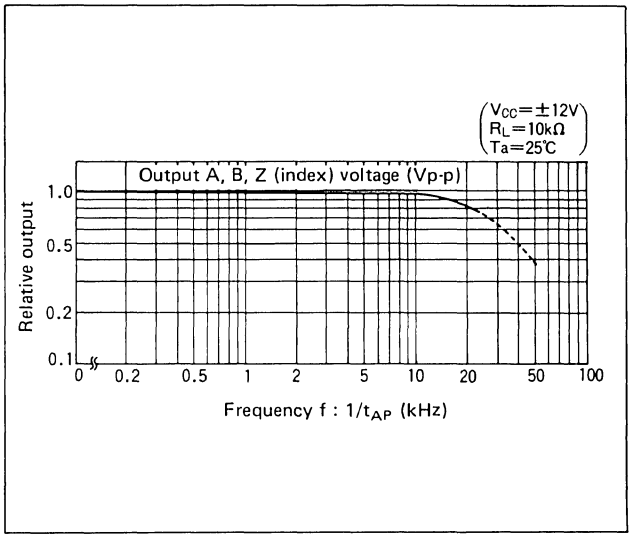


Fig. 3 Frequency vs. duty ratio

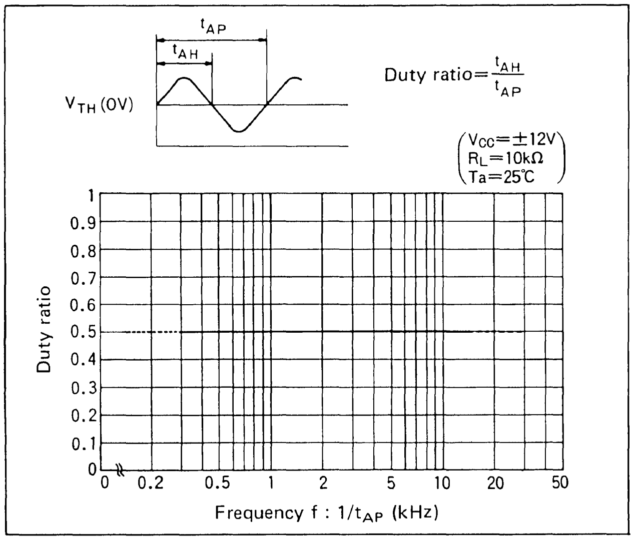
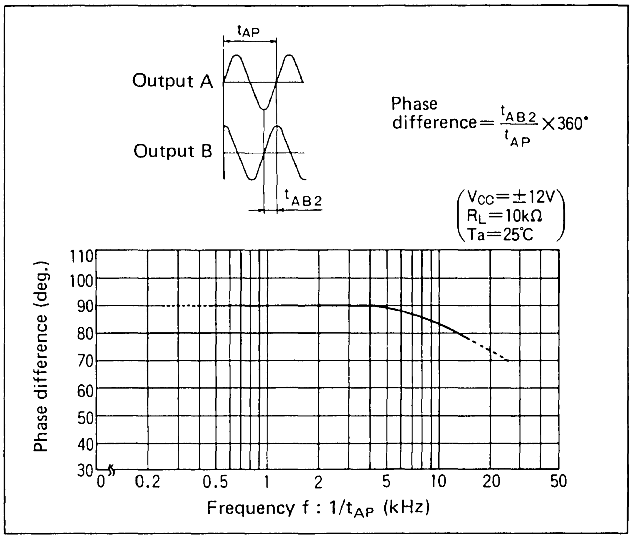
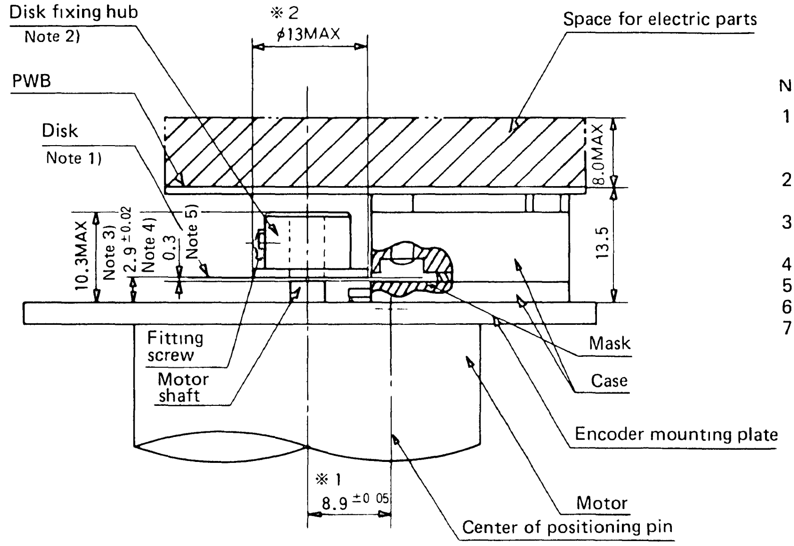


Fig. 4 Frequency vs. phase difference



☐ Suggestion for Use

It is recommended that when connected to a motor, the GP1R14 be installed as shown below.



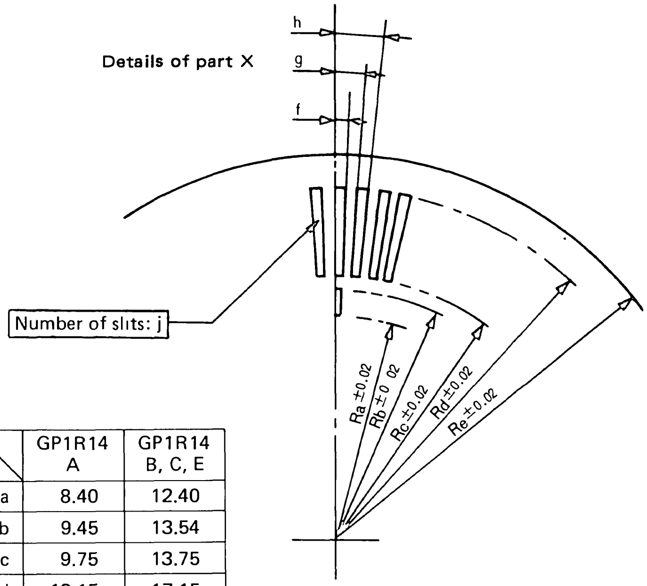
Note:

1) Diameter of disk
   GP1R14A : ϕ28
   GP1R14B, C, E : ϕ36 (*1 = 12.9 ±0.05 mm)
2) Diameter of disk fixing hub is ϕ13 Max.
   (When the diameter of the disk is ϕ36, *2 is ϕ21.0 Max.)
3) The height of the disk fixing hub and the top of the motor shaft is 10.3 mm Max. from the reference plane.
4) The disk is 0.3 mm away from the mask. (Reference value)
5) GP1R14C : 0.2 mm
6) GP1R14 consists of parts (1) to (4)
7) The parts from (5) to (10) are not included in this optical encoder module GP1R14.

Unit: mm

☐ Disk Design

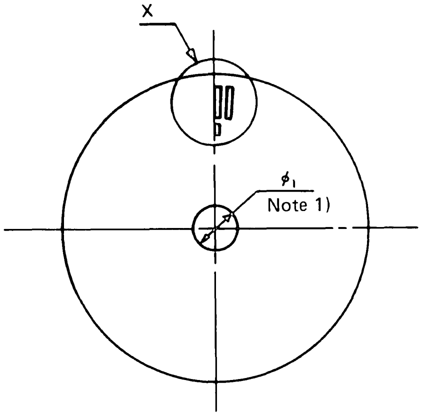
When a disk is designed for use in the GP1R14, it is suggested that the following design standard shall be utilized.



j	f	g	h	Applied encoder
96	112.5	225	337.5	GP1R14A
200	54	108	162	GP1R14B
360	30	60	90	GP1R14C
192	56.25	112.5	168.75	GP1R14E

Unit j : P/R
f, g, h : minute

R	GP1R14 A	GP1R14 B, C, E
Ra	8.40	12.40
Rb	9.45	13.54
Rc	9.75	13.75
Rd	13.15	17.15
Re	14.0	18.0



Note 1) ϕi is variable in compliance with the type of motor used.
(ϕi for Sharp's standard disk hub is ϕ4 mm.)

Note 2) It is recommended that disk thickness be 0.1 mm for GP1R14A and 0.08 mm for GP1R14 B, C, E.

Unit: mm

☐ The disks shown below are available as optional parts.

Model No.	Resolution (P/R)
GP1P14A	96
GP1P14B	200
GP1P14C	360
GP1P14E	192

The disk must be selected according to the resolution of encoder to be used with.

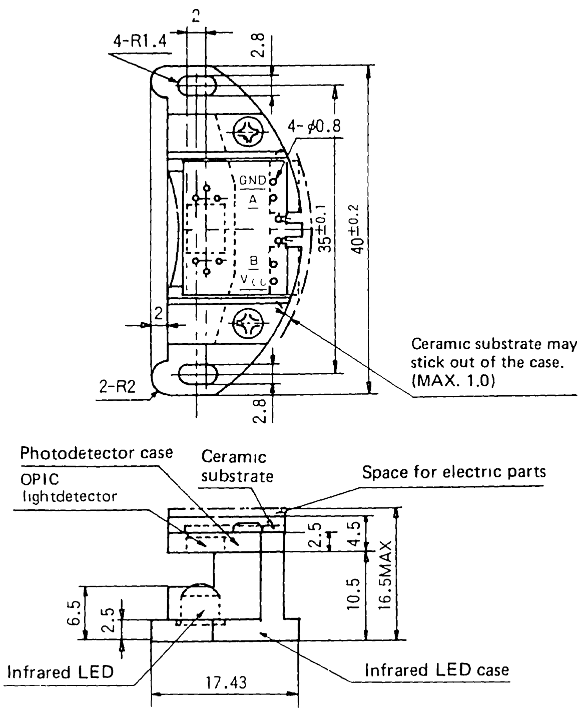
☐ Specifications are subject to change without notice.

SHARP

GP1R11

Rotary Encoder

☐ Outline Dimensions



Unspecified tolerance is ±0.5mm Unit: mm

☐ General Description

The Sharp GP1R11 is an incremental type rotary encoder which realized the light and compact design due to use of an infrared light emitting diode, and OPIC lightdetector (lightdetector that integrates photodiode array, amplifier, signal processing and output circuits into a single chip).

The GP1R11 generates 2-phase digital outputs (A and B) and enables the resolution of 1.6mm of slit pitch.

☐ Features

(1) Employs OPIC lightdetector
(2) Directly interface with TTL
(3) High accuracy in duty ratio due to laser trimming
(4) Easy attachment to a motor due to the disk separated type
(5) Compact, light, and optimum for general purposes

☐ Applications

(1) Printing head position detectors in electronic printers
(2) Joint angle detectors in robots
(3) OA and FA equipment

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	7	V
Output sink current	I_{SINK}	20	mA
Operating temperature	T_{opr}	0 ~ +70	°C
Storage temperature	T_{stg}	–40 ~ +80	°C

☐ Electrical Characteristics

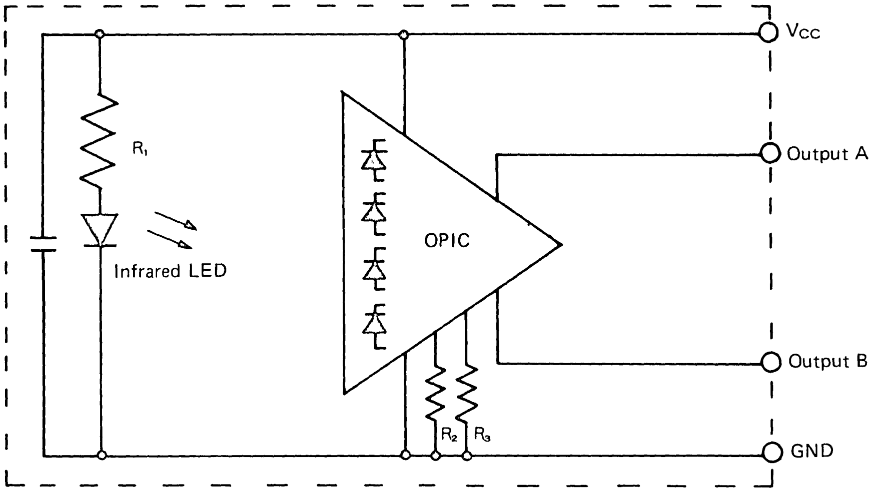
(V_{CC}=5V, Ta=0~+70°C unless specified)

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Supply voltage		V_{CC}	4.5	5.0	5.5	V		
Output A, B voltage	High level	V_{AH}, V_{BH}	2.4	3.5	–	V	V_{CC}=4.5V, I_{OH}=–200μA	
	Low level	V_{AL}, V_{BL}	–	0.2	0.4	V	I_{OL}=16mA	
*1 Duty ratio		D_A	0.45	0.50	0.55		f=DC~2.5kHz	$\frac{t_{AH}}{t_{AP}}$
		D_B	0.45	0.50	0.55			$\frac{t_{BH}}{t_{BP}}$
*1 Phase difference		θ_{AB2} θ_{AB3}	60	90	120	deg.	f=DC~2.5kHz	$\frac{t_{AB2}}{t_{AP}} \times 360°$ $\frac{t_{AB3}}{t_{AP}} \times 360°$
Response time		t_r	–	0.2	0.5	μs	Ta=25°C	
		t_f	–	0.1	0.5			
Response frequency		fmax	–	–	10	kHz	Ta=25°C	
Dissipation current		I_{TOT}	–	40	70	mA	Outputs A, B on low level	

*1 Values of phase difference and duty ratio are average ones during one rotation of the disk.

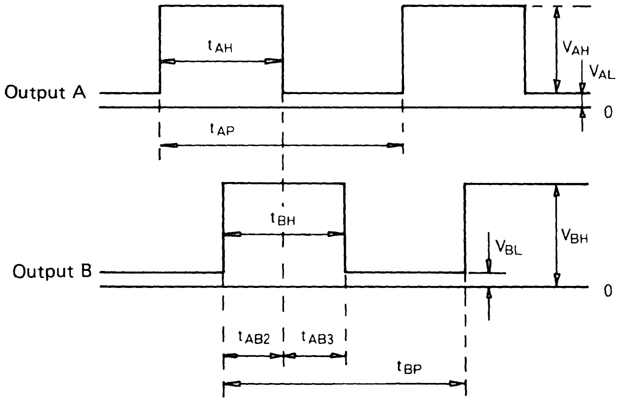
OPIC is a registered trademark of Sharp and stands for Optical IC. It has a light detecting element and signal processing circuitry integrated into a single chip.

▨ Block Diagram

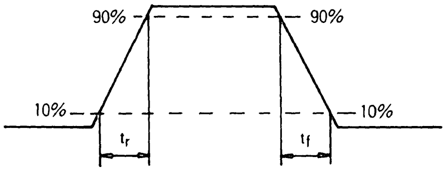


Supply voltage V_{CC} = 5.0V ± 5%
Output pull-up resistance = 2kΩ (incorporated in the encoder)

☐ Output Waveforms



Rotational direction: Counterclockwise when seen from the OPIC lightdetector side



Definition of t_r and t_f

Fig. 1 Duty ratio vs. distance (X direction)

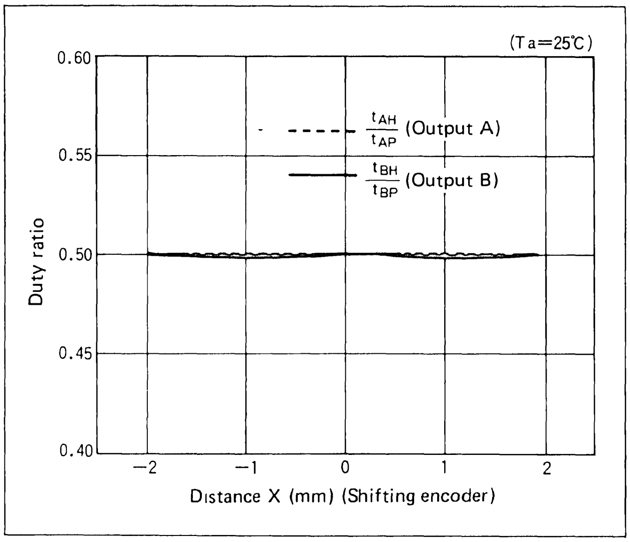


Fig. 2 Phase difference vs. distance (X direction)

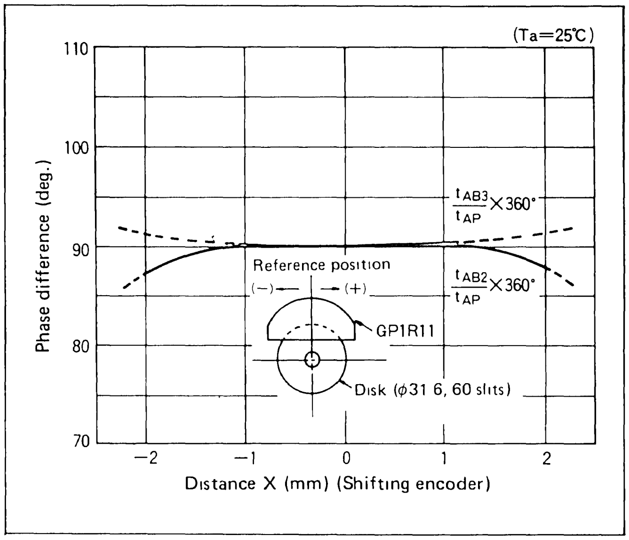


Fig. 3 Duty ratio vs. distance (Y direction)

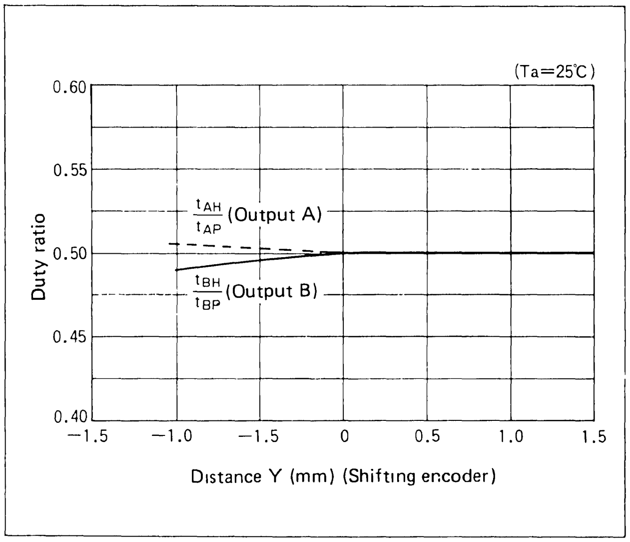


Fig. 4 Phase difference vs. distance (Y direction)

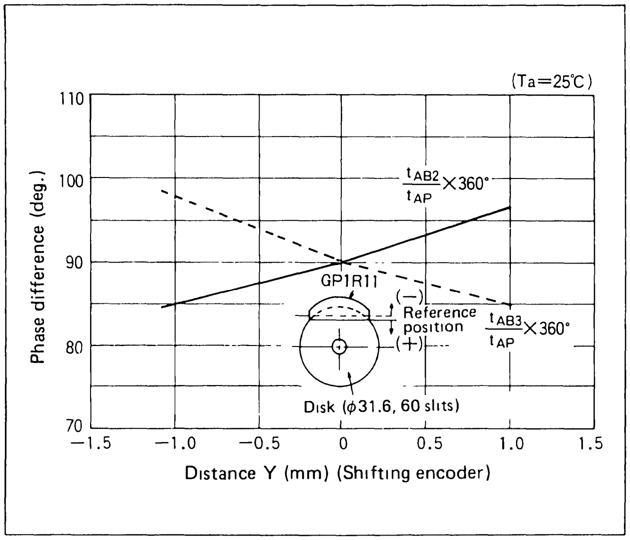


Fig. 5 Duty ratio vs. distance (Z direction)

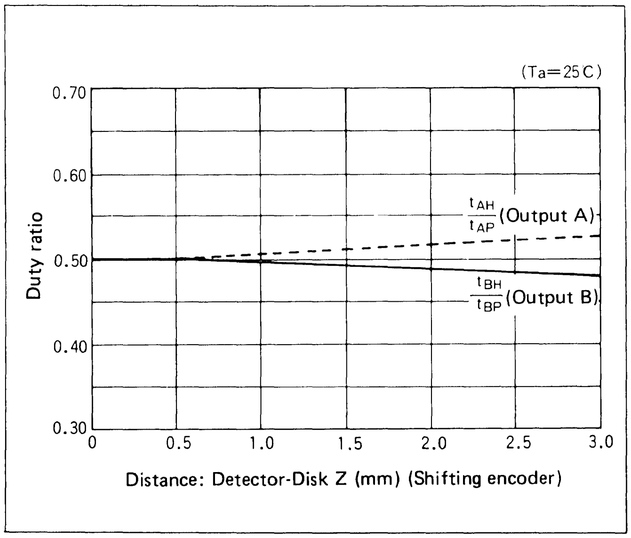
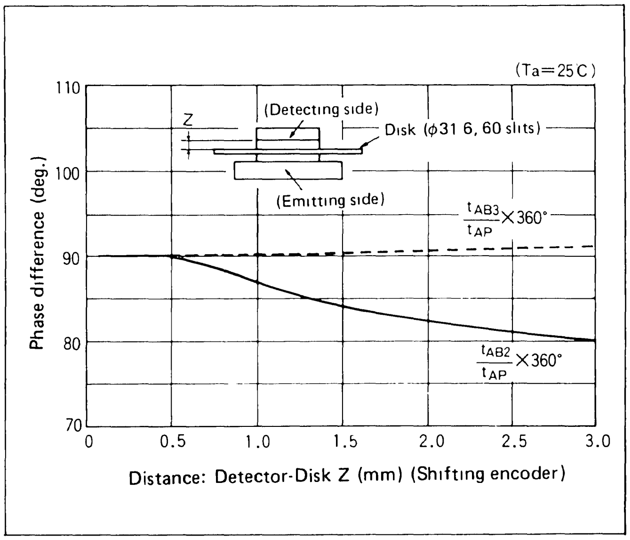
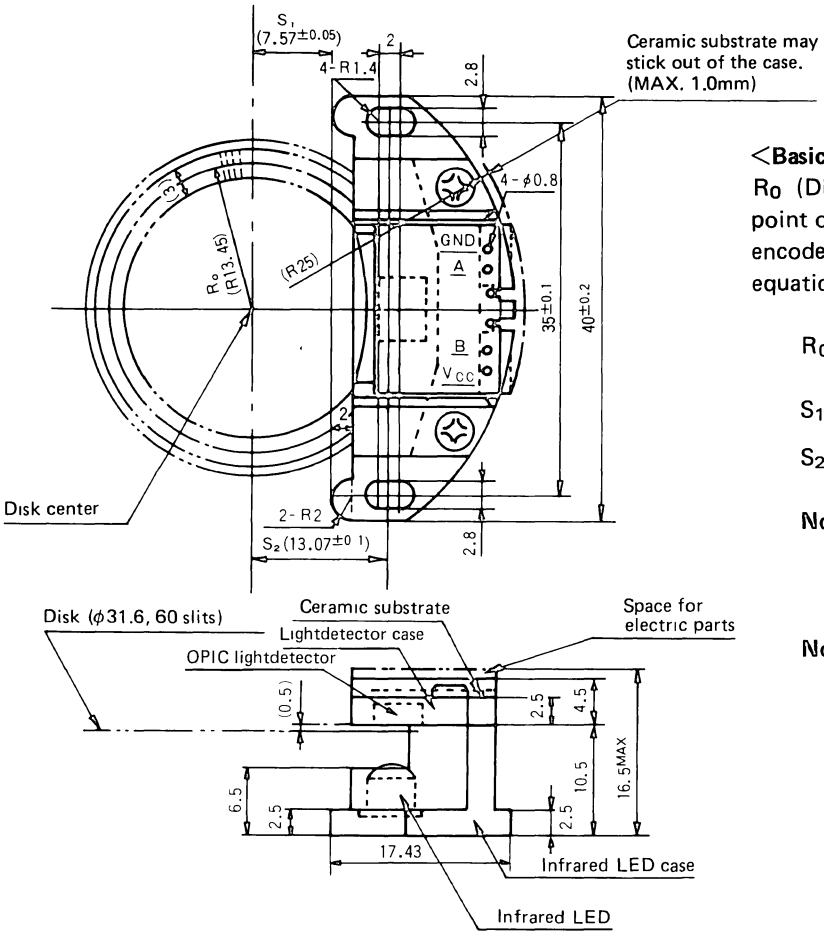


Fig. 6 Phase difference vs. distance (Z direction)



☐ Suggestion for Use



<Basic Design>

R_0 (Distance between the disk center and half point of a slit), S_1 and S_2 (Installing position of encoder) will be provided by the following equations.

$$R_0 = \frac{N}{60} \times 13.45 \text{ (mm)}$$

$$S_1 = R_0 - 5.88 \text{ (mm)}$$

$$S_2 = R_0 - 0.38 \text{ (mm)}$$

Note 1) When the number of slits (N) is changed, values in parentheses are also changed according to the number.

Note 2) Unspecified tolerance is ±0.5.

Unit: mm

☐ The disks shown below are available as optional parts.

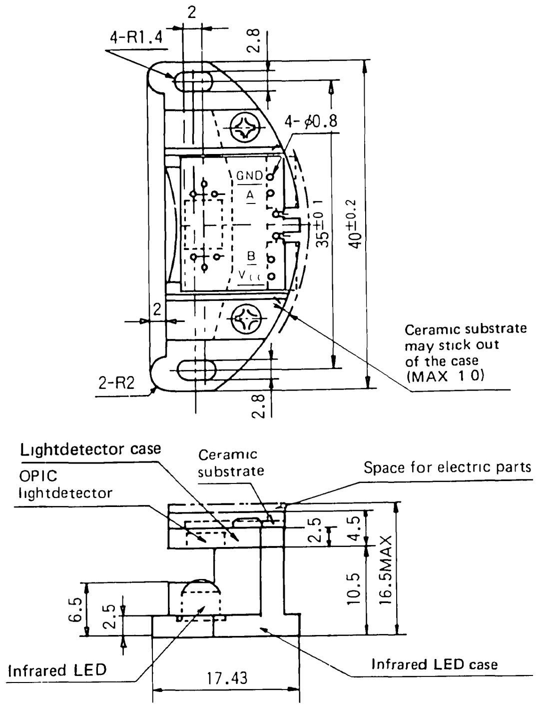
Model No.	Resolution (P/R)
GP1P11A	48
GP1P11B	60
GP1P11C	75
GP1P11D	100

SHARP

GP1R21

Rotary Encoder

☐ Outline Dimensions



Unspecified tolerance is ±0.5mm

☐ General Description

The Sharp GP1R21 is an incremental type rotary encoder which realized the light and compact design due to use of an infrared light emitting diode, and OPIC lightdetector (lightdetector that integrates photodiode array, amplifier, signal processing and output circuits into a single chip).

The GP1R21 generates 2-phase digital outputs (A and B) and enables the resolution of 0.8mm of slit pitch.

☐ Features

(1) Employs OPIC lightdetector
(2) Directly interface with TTL
(3) High accuracy in duty ratio due to laser trimming
(4) Easy attachment to a motor due to the disk separated type
(5) Compact, light, and optimum for general purposes

☐ Applications

(1) Printing head position detectors in electronic printers
(2) Joint angle detectors in robots
(3) OA and FA equipment

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	7	V
Output sink current	I_{SINK}	20	mA
Operating temperature	T_{opr}	0 ~ +70	°C
Storage temperature	T_{stg}	−40 ~ +80	°C

☐ Electrical Characteristics

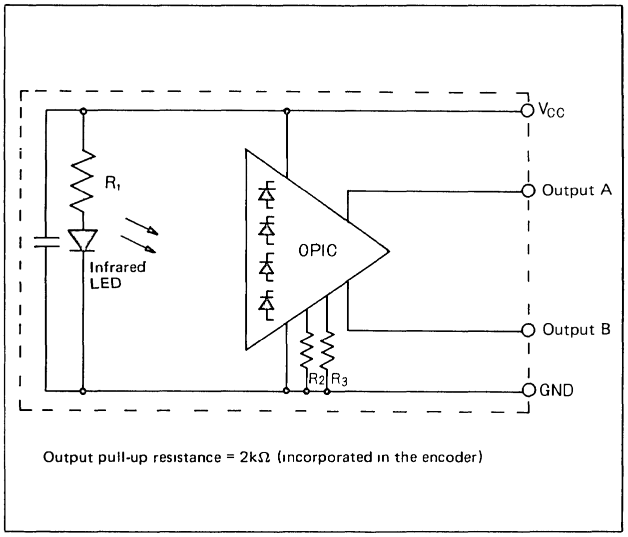
(V_{CC}= 5V, Ta = 0 ~ +70°C unless specified)

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Supply voltage		V_{CC}	4.5	5.0	5.5	V		
Phase A, B output voltage	High level	V_{AH}, V_{BH}	2.4	4.1	–	V	V_{CC}= 4.5V I_{OH} = −200μA	
	Low level	V_{AL}, V_{BL}	–	0.2	0.4	V	I_{OL} = 8mA	
*1 Duty ratio		D_A	0.45	0.50	0.55		f = DC ~ 2.5kHz	$\frac{t_{AH}}{t_{AP}}$
		D_B						$\frac{t_{BH}}{t_{BP}}$
*1 Phase difference		θ_{AB2}	50	90	130	deg.	f = DC ~ 2.5kHz	$\frac{t_{AB2}}{t_{AP}} \times 360°$
		θ_{AB3}						$\frac{t_{AB3}}{t_{AP}} \times 360°$
Response time		t_r	–	0.2	0.5	μs	Ta = 25°C	
		t_f	–	0.1	0.5			
Response frequency		fmax.	–	–	10	kHz	Ta = 25°C	
Dissipation current		I_{TOT}	–	40	70	mA	Outputs A, B on low level	

*1 Values of phase difference and duty ratio are average ones during one rotation of the disk.

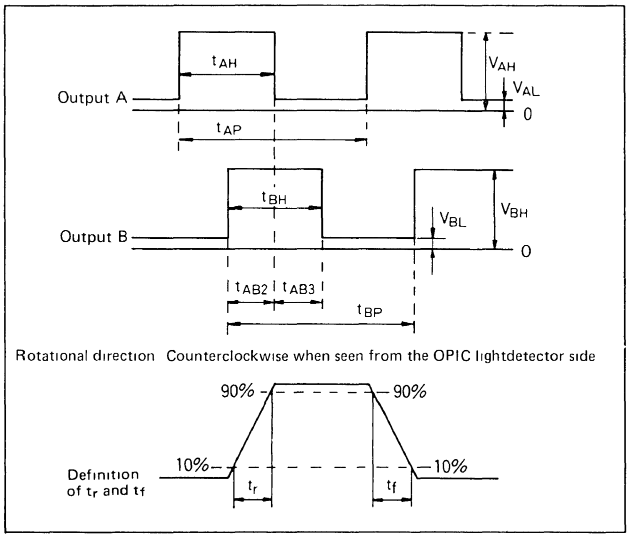
OPIC is a registered trademark of Sharp and stands for Optical IC. It has a light detecting element and signal processing circuitry integrated into a single chip.

Block Diagram



Output pull-up resistance = 2kΩ (incorporated in the encoder)

Output Waveforms



Rotational direction Counterclockwise when seen from the OPIC lightdetector side

Fig. 1 Duty ratio vs. frequency

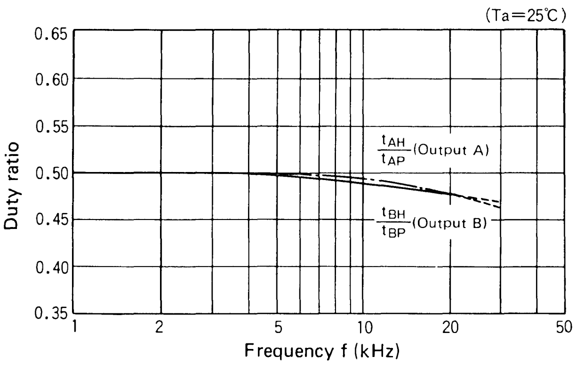


Fig. 2 Phase difference vs. frequency

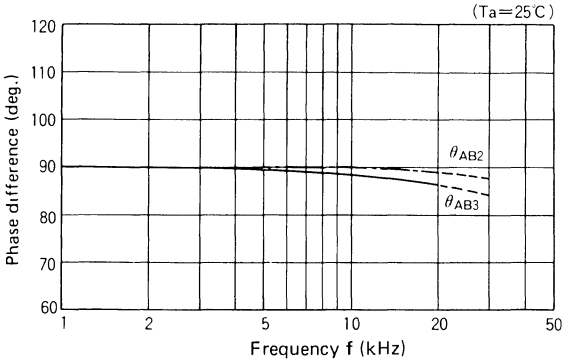


Fig. 3 Duty ratio vs. ambient temperature

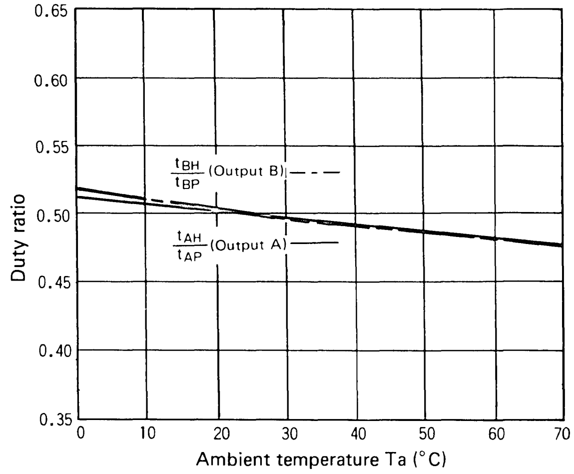


Fig. 4 Phase difference vs. ambient temperature

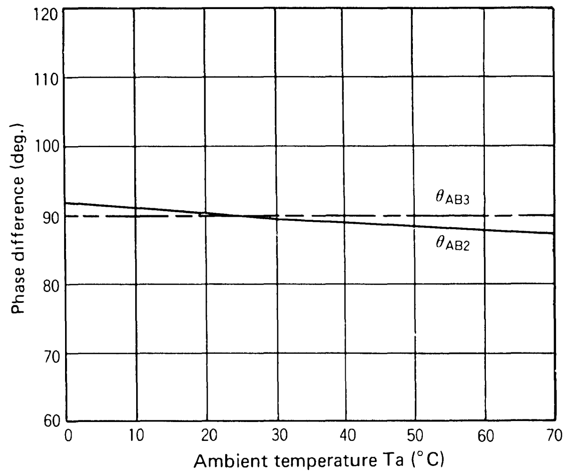


Fig. 5 Duty ratio vs. distance (X direction)

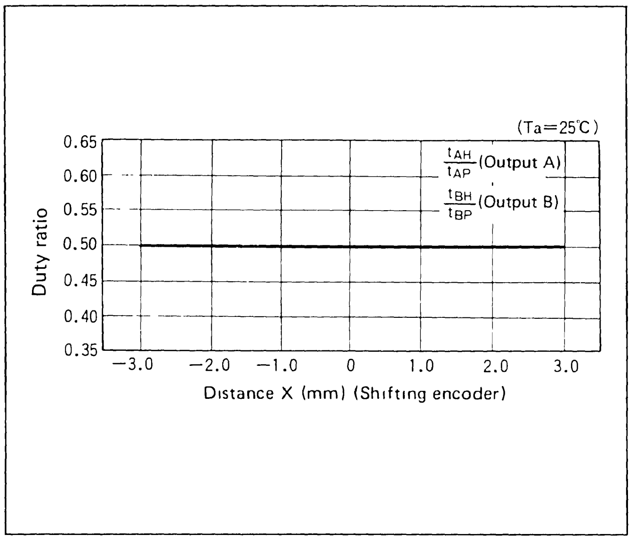


Fig. 6 Phase difference vs. distance (X direction)

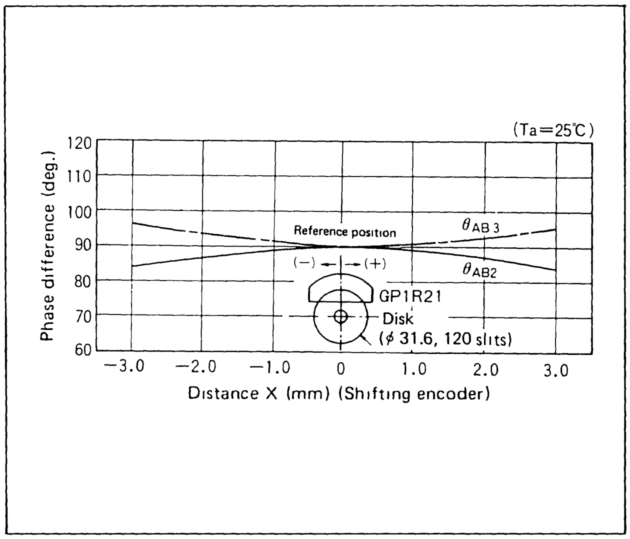


Fig. 7 Duty ratio vs. distance (Y direction)

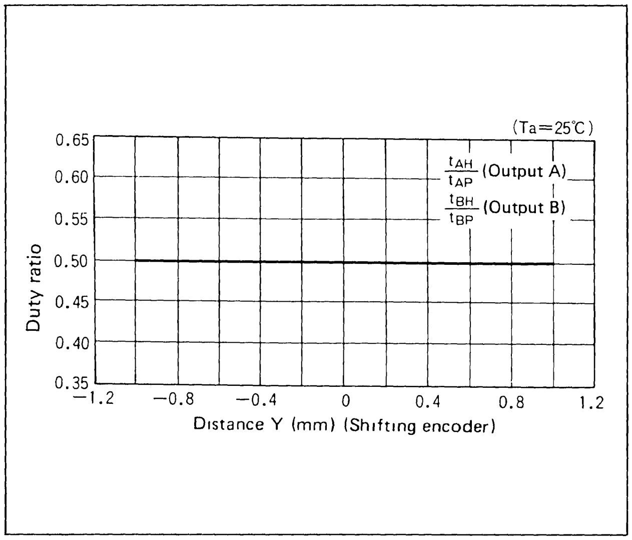


Fig. 8 Phase difference vs. distance (Y direction)

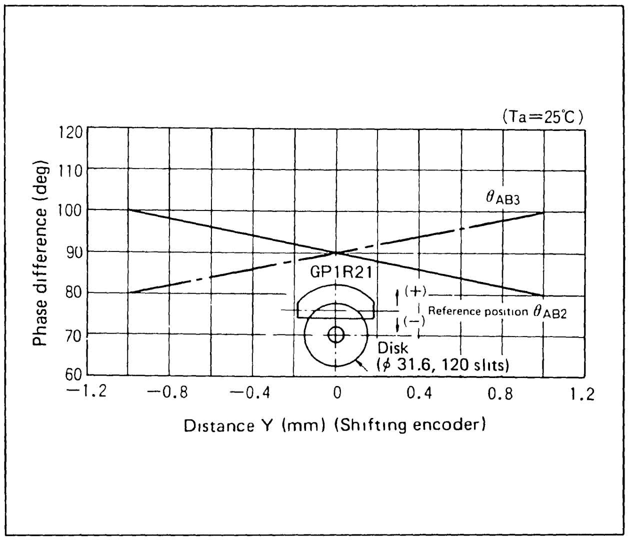


Fig. 9 Duty ratio vs. distance (Z direction)

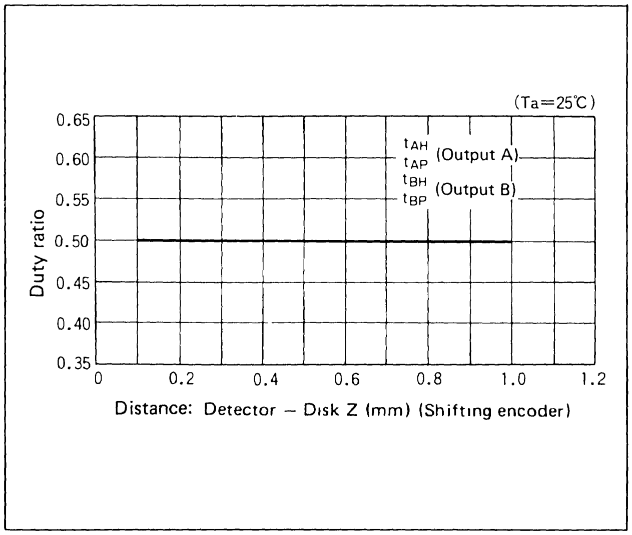
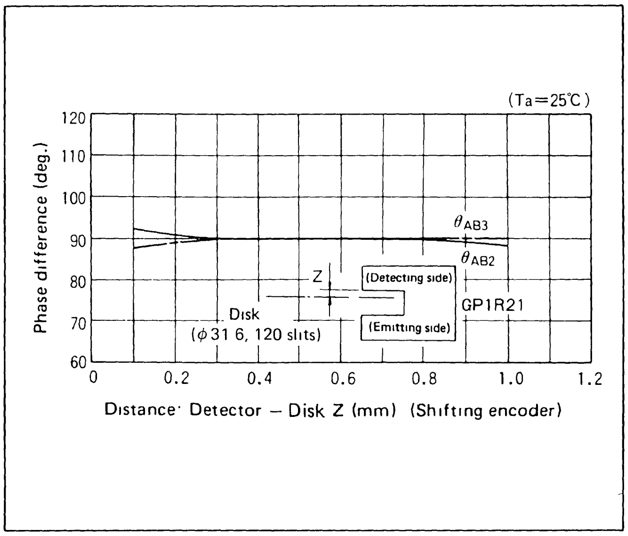
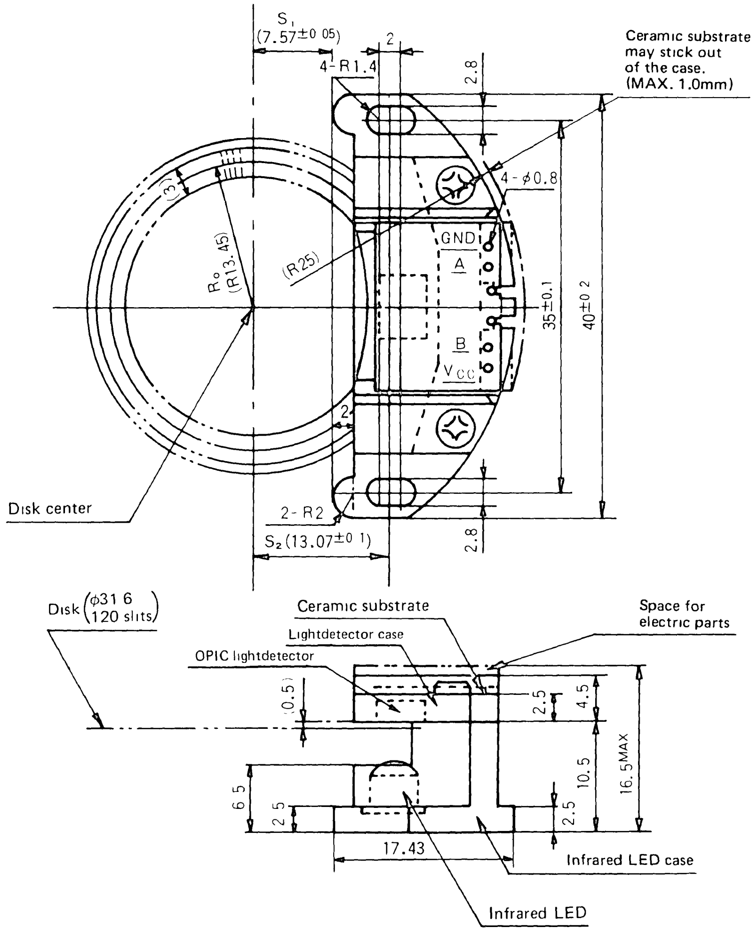


Fig. 10 Phase difference vs. distance (Z direction)



▨ Suggestion for Use



<Basic Design>

R_0 (Distance between the disk center and half point of a slit), S_1 and S_2 (Installing position of encoder) will be provided by the following equations.

$$R_0 = \frac{N}{120} \times 13.45 \text{ (mm)}$$

$$S_1 = R_0 - 5.88 \text{ (mm)}$$

$$S_2 = R_0 - 0.38 \text{ (mm)}$$

Note 1) When the number of slits (N) is changed, values in parentheses are also changed according to the number.

Note 2) Unspecified tolerance is ±0.5.

Unit: mm

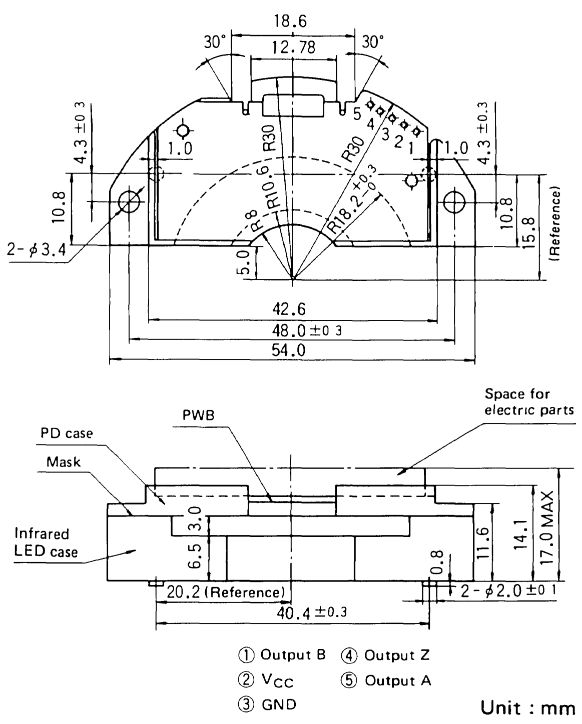
☐ The disks shown below are available as optional parts.

Model No.	Resolution (P/R)
GP1P21A	120
GP1P21B	200

SHARP GP1R111 Series

Rotary Encoder

☐ Outline Dimensions



Unspecified tolerance is ±0.5 mm.

☐ General Description

The Sharp GP1R111 Series is an incremental type rotary encoder consisting of an infrared light emitting diode, integrated photodiode array, and dedicated IC.

The GP1R111 Series generates 3-phase digital outputs A, B and Z (index).

3 types of models are available as shown below.

Model No.	Resolution (P/R)
GP1R111A	96
GP1R111B	200
GP1R111C	360

☐ Features

1. (1) A, B, Z (index) 3-phase digital outputs (open collector)
2. (2) Built-in light level compensating circuit
3. (3) Easily interface with TTL
4. (4) Easy attachment to a motor due to the disk separated type

☐ Applications

1. (1) High accurate motor position detectors in electronic printers and X-Y plotters
2. (2) Detectors for disorder of pulse motors
3. (3) Position detectors in numerical control equipment

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Rating	Unit
*1Supply voltage	V_{CC}	8	V
Output sink current	I_{SINK}	16	mA
Operating temperature	T_{opr}	0 ~ +70	°C
Storage temperature	T_{stg}	–40 ~ +80	°C

*1 Power must not turned on when the feedback cell is optically shut off.

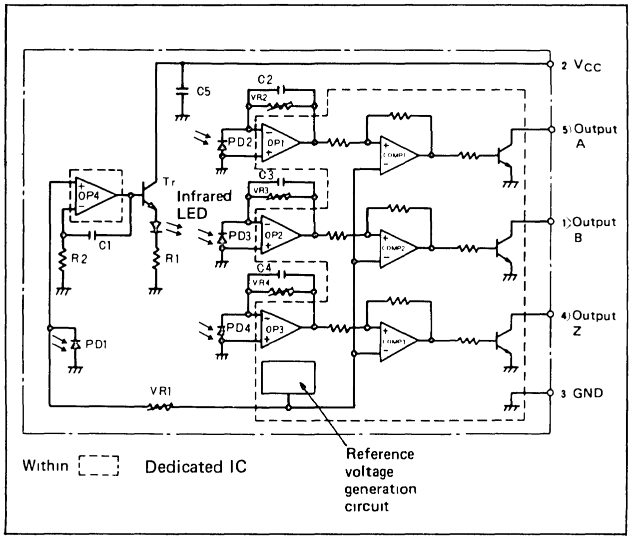
☐ Electrical Characteristics

(V_{CC} = 5V, Ta = 25°C)

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition
Output A, B, Z voltage	High level	V_{AH}, V_{BH}, V_{ZH}	2.4	–	–	V	Rup = 680 Ω
	Low level	V_{AL}, V_{BL}, V_{ZL}	–	–	0.4		
*2 Phase difference	GP1R111A	θ_{AB1}, θ_{AB2} θ_{AB3}, θ_{AB4}	75	90	105	deg.	f = 0 ~ 5 kHz
	GP1R111B		70	90	110		
	GP1R111C		50	90	130		
	GP1R111A	θ_{BZ1}, θ_{BZ2}	–45	0	45		Rup = 680Ω
	GP1R111B		–60	0	60		
	GP1R111C		–90	0	90		
Response time		t_r	–	0.3	1.5	μs	Rup = 680Ω
		t_f	–	0.3	1.5		
Dissipation current		I_{TOT}	–	–	80	mA	

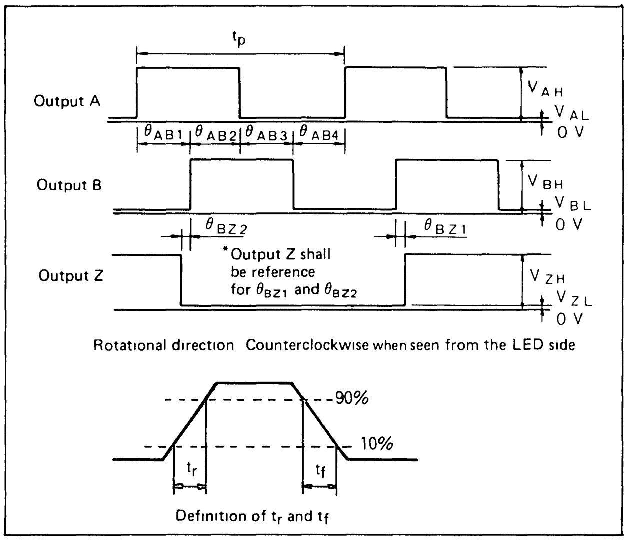
*2 Value of phase difference is an average during one rotation of the disk.

Block Diagram



Within ┌ ┐ └ ┘ Dedicated IC

Output Waveforms



*Output Z shall be reference for θ_{BZ1} and θ_{BZ2}

Rotational direction Counterclockwise when seen from the LED side

Definition of t_r and t_f

Fig. 1 Phase difference vs. frequency (1) (GP1R111A)

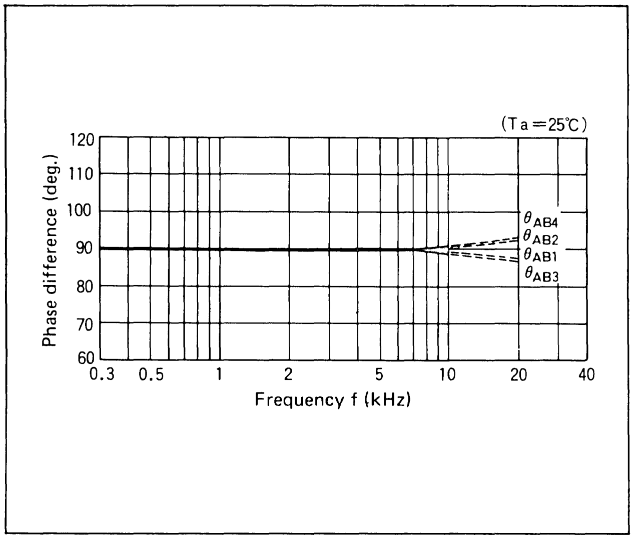


Fig. 2 Phase difference vs. frequency (2) (GP1R111A)

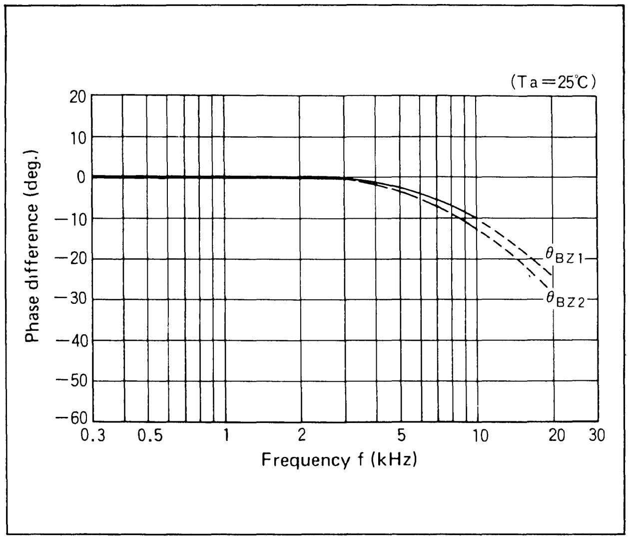


Fig. 3 Phase difference vs. ambient temperature (1) (GP1R111A)

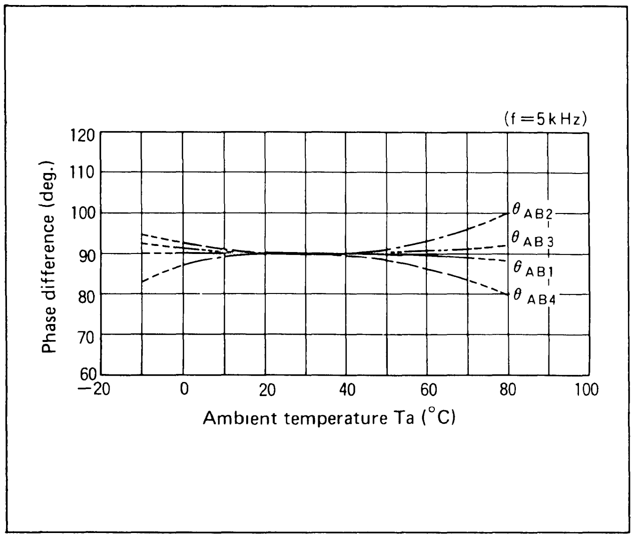


Fig. 4 Phase difference vs. ambient temperature (2) (GP1R111A)

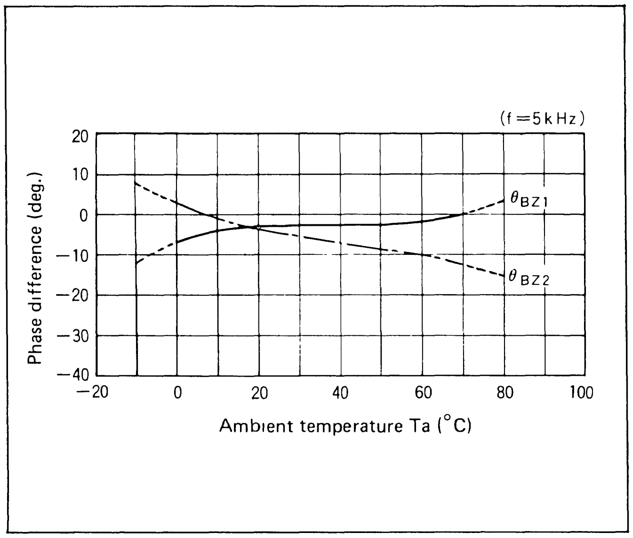


Fig. 5 Phase difference vs. distance (1) (GP1R111A)

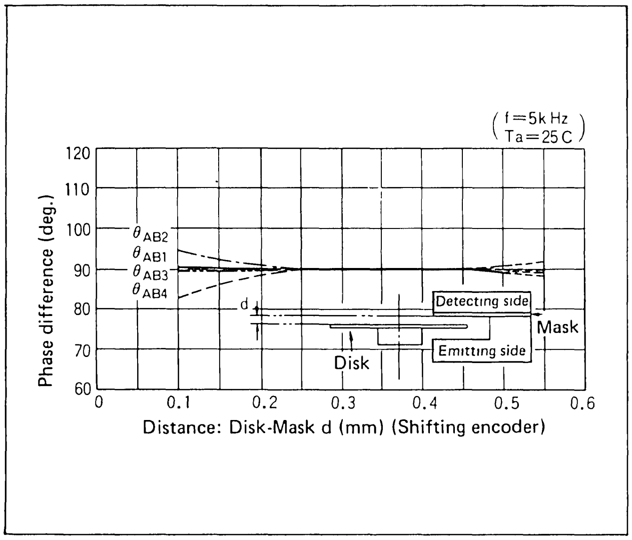


Fig. 6 Phase difference vs. distance (2) (GP1R111A)

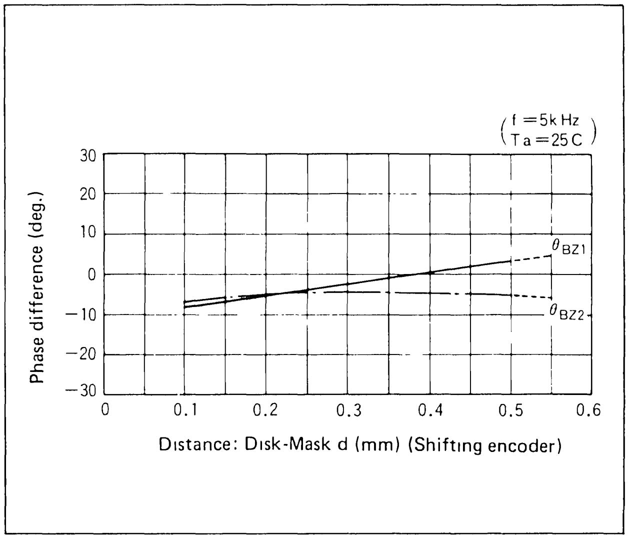


Fig. 7 Phase difference vs. frequency (1) (GP1R111B)

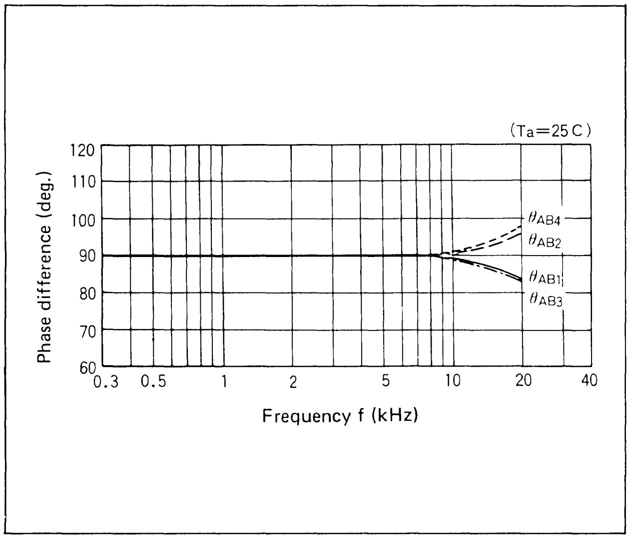


Fig. 8 Phase difference vs. frequency (2) (GP1R111B)

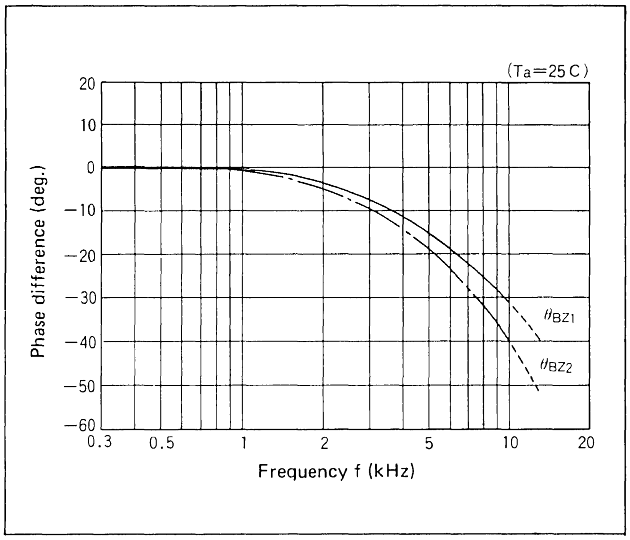


Fig. 9 Phase difference vs. ambient temperature (1) (GP1R111B)

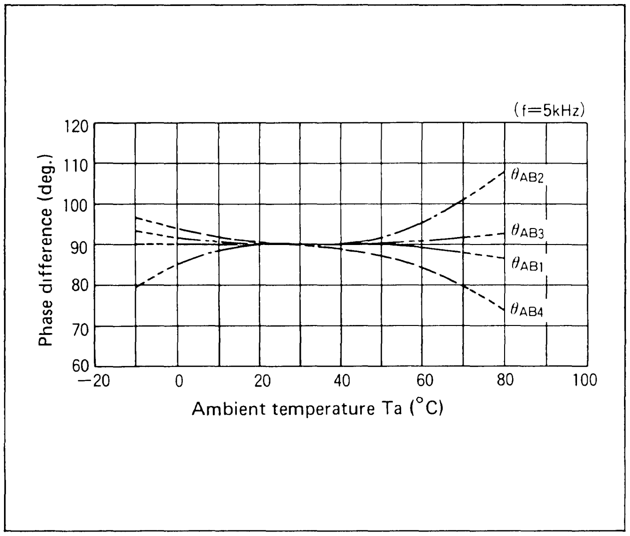


Fig.10 Phase difference vs. ambient temperature (2) (GP1R111B)

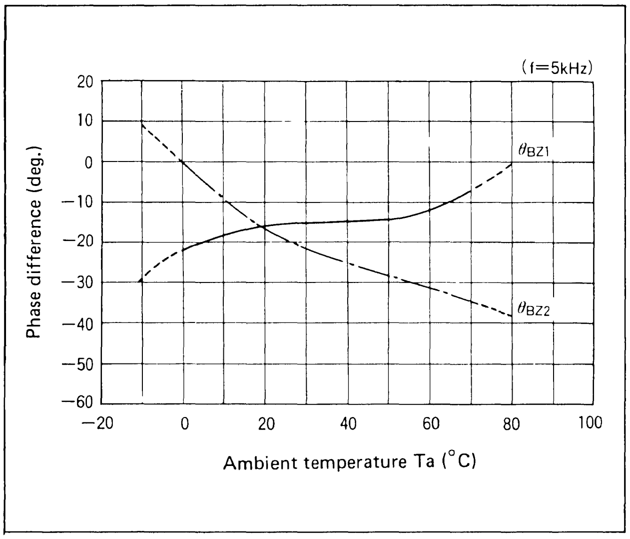


Fig.11 Phase difference vs. distance (1) (GP1R111B)

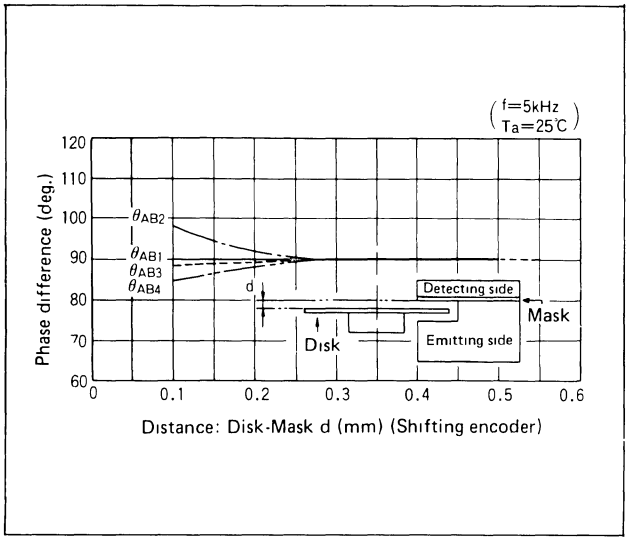


Fig.12 Phase difference vs. distance (2) (GP1R111B)

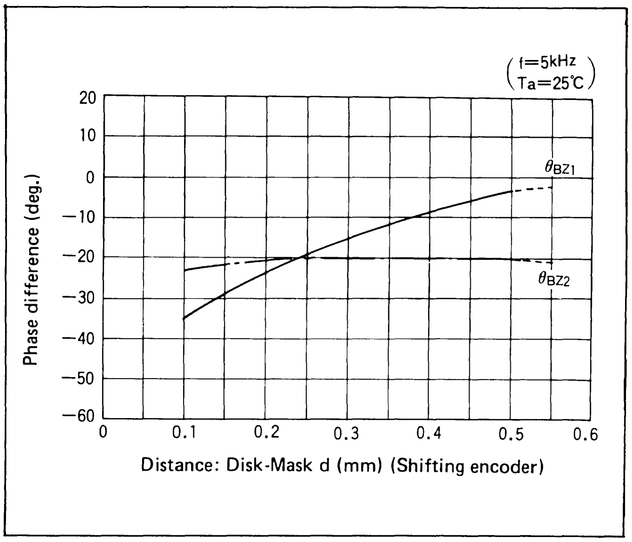


Fig.13 Phase difference vs. frequency (1) (GP1R111C)

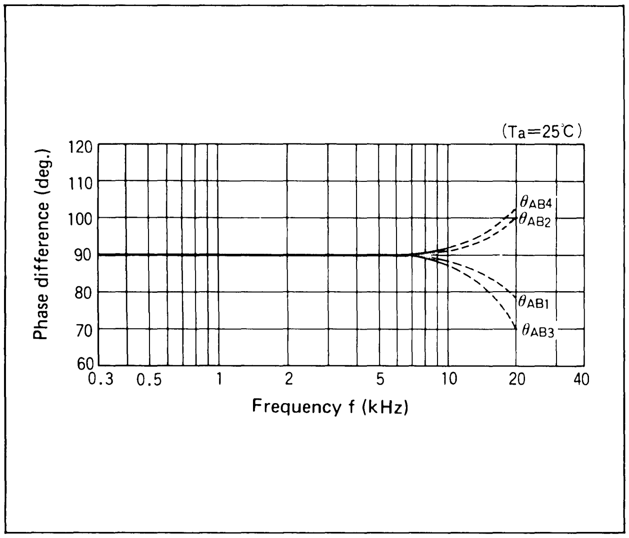


Fig.14 Phase difference vs. frequency (2) (GP1R111C)

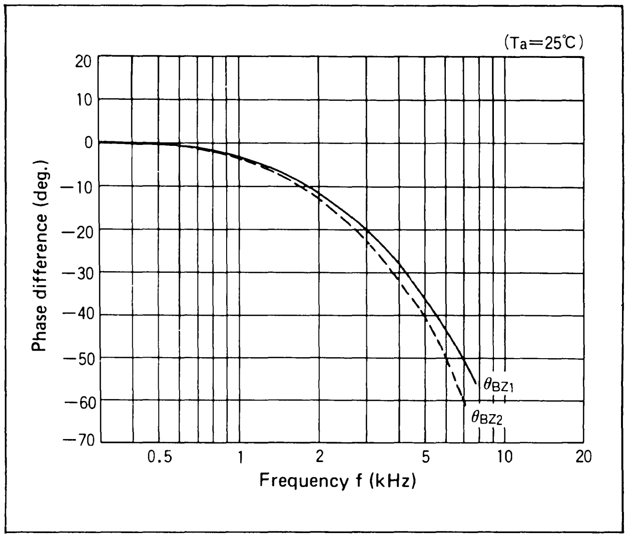


Fig.15 Phase difference vs. ambient temperature (1) (GP1R111C)

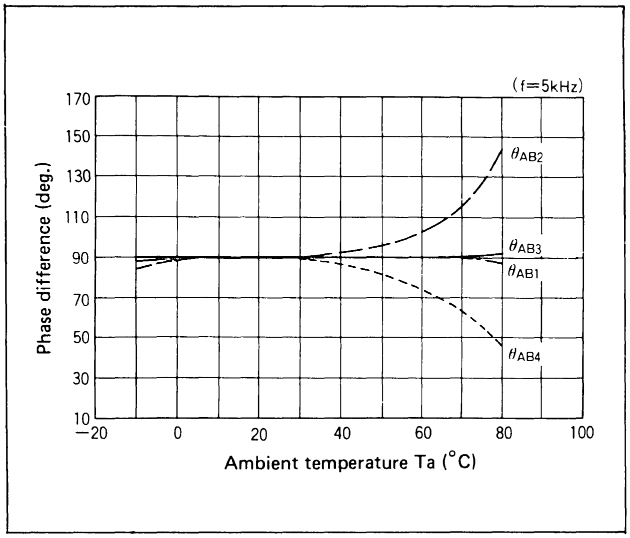


Fig.16 Phase difference vs. ambient temperature (2) (GP1R111C)

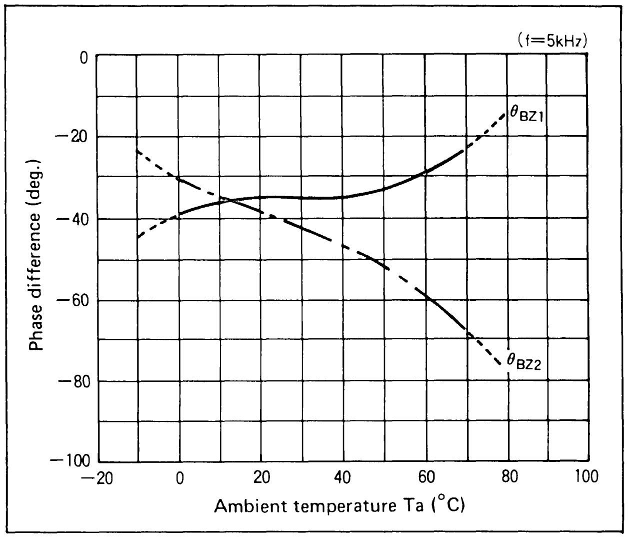


Fig.17 Phase difference vs. distance (1) (GP1R111C)

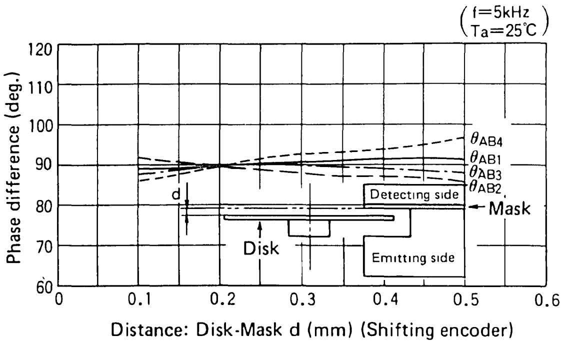
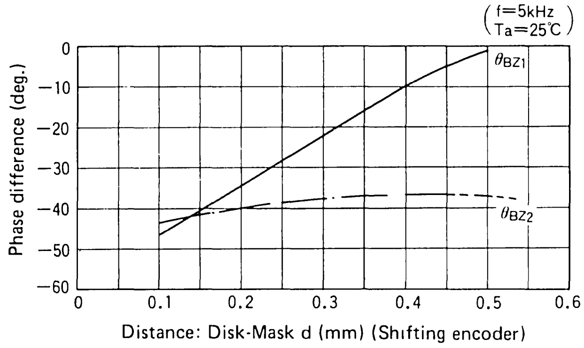
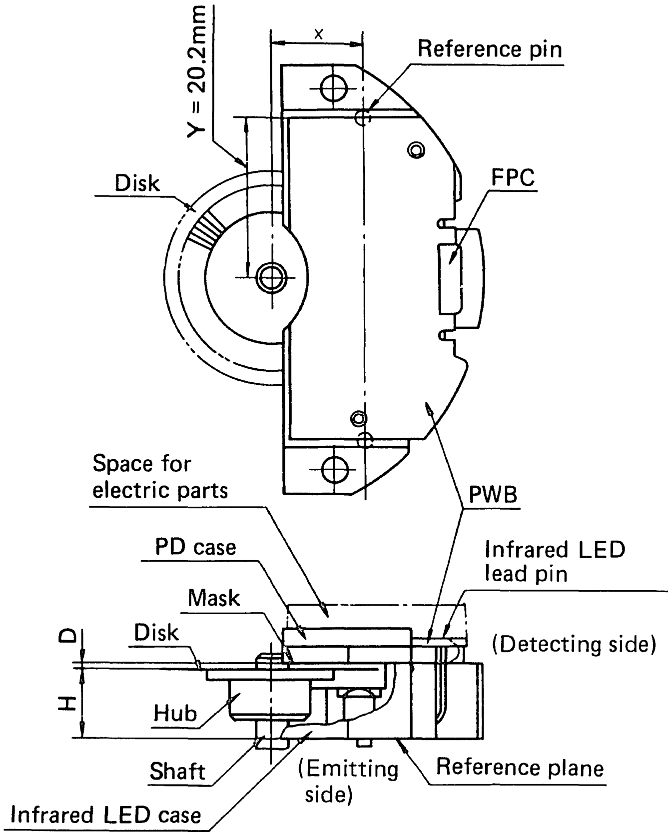


Fig.18 Phase difference vs. distance (2) (GP1R111C)



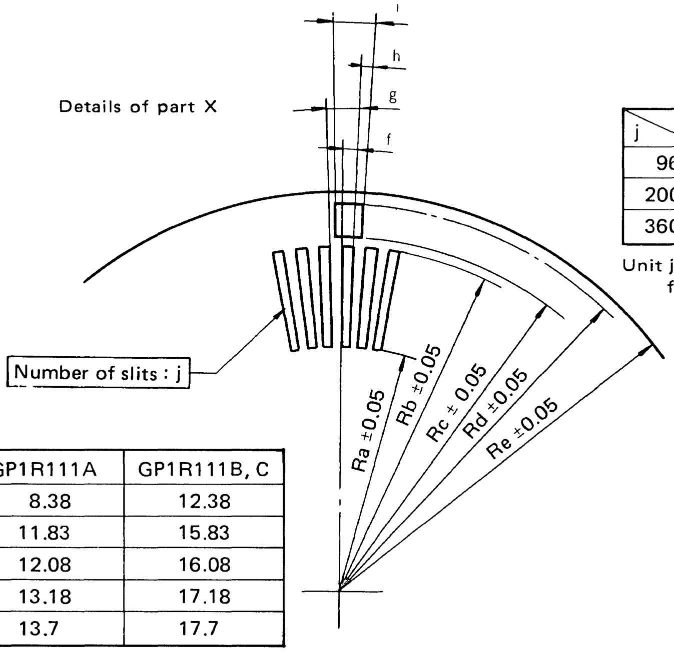
☐ Suggestion for Use



1) The diameter of the disk is ϕ27.4mm (GP1R111A), ϕ35.4mm (GP1R111B, C).
2) Shaft center is 11.8mm (GP1R111A), 15.8mm (GP1R111B, C) away from the reference pin to the X direction and 20.2mm to the Y direction.
3) The height of the disk from reference plane:
   H = 9.2mm (GP1R111A, B)
   H = 9.3mm (GP1R111C)
4) Distance between disk and mask:
   D = 0.3mm (GP1R111A, B)
   D = 0.2mm (GP1R111C)
5) The disk is available as optional parts.

▨ Disk Design

When a disk is designed for use in the GP1R111, it is suggested that the following design standard shall be utilized.

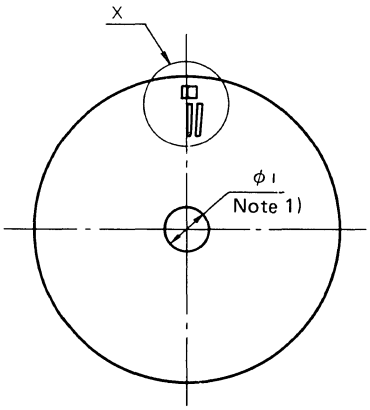


j	f	g	h	i	Applied encoder
96	112.5	225.0	56.25	225.0	GP1R111A
200	54.0	108.0	27.0	108.0	GP1R111B
360	30.0	60.0	15.0	60.0	GP1R111C

Unit j : P/R
f,g,h : minute

	GP1R111A	GP1R111B, C
Ra	8.38	12.38
Rb	11.83	15.83
Rc	12.08	16.08
Rd	13.18	17.18
Re	13.7	17.7

Unit: mm



Note:

1) φi is variable in compliance with the type of motor used. (φi for Sharp's standard disk hub is φ4mm.)
2) It is recommended that disk thickness be 0.1mm for GP1R111A and 0.08mm for GP1R111B, C.

▨ The disks shown below are available as optional parts.

Model No.	Resolution (P/R)
GP1P111A	96
GP1P111B	200
GP1P111C	360

The disk must be selected according to the resolution of the encoder to be used with.

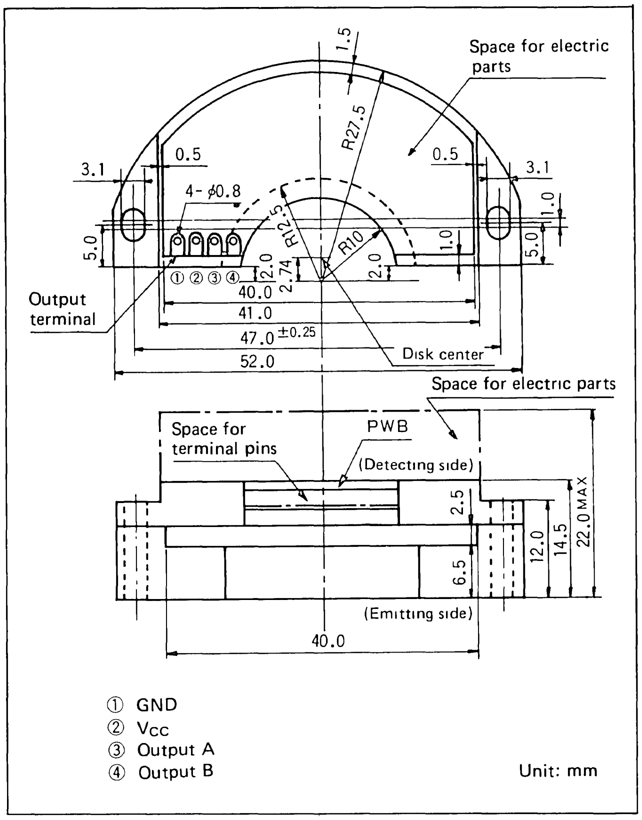
■ Specifications are subject to change without notice.

SHARP

GP1R23

Rotary Encoder

☐ Outline Dimensions



☐ General Description

The Sharp GP1R23 is a high resolution type optical rotary encoder (incremental type), consisting of an infrated light emitting diode and integrated phototransistor with optical push-pull circuit. The GP1R23 generates 2-phase digital outputs (A and B). The resolution is 500 pulses per one revolution.

☐ Features

(1) High resolution (500P/R)
(2) A, B 2-phase digital output
(3) Stable outputs due to optical push-pull circuit
(4) Easy attachment to a motor due to the disk separated type
(5) Compact and light

☐ Applications

(1) Position detectors in electronic printers and X-Y plotters
(2) Joint angle detectors in robots
(3) Rotational angle detectors for turntables
(4) OA and FA equipment

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Rating	Unit	Remark
Supply voltage	V_{CC}	6	V	
Output short-circuited time (to GND)	ts	∞	sec.	*1
Power dissipation	P	570	mW	Ta ≦ 25°C
Load reducing rate		5.7	mW/°C	Ta > 25°C
Operating temperature	T_{opr}	0 ~ +70	°C	
Storage temperature	T_{stg}	–40 ~ +80	°C	
Soldering temperature	T_{sol}	260	°C	10 sec.

*1 Short circuit to V_{CC} has possibility to damage the encoder.

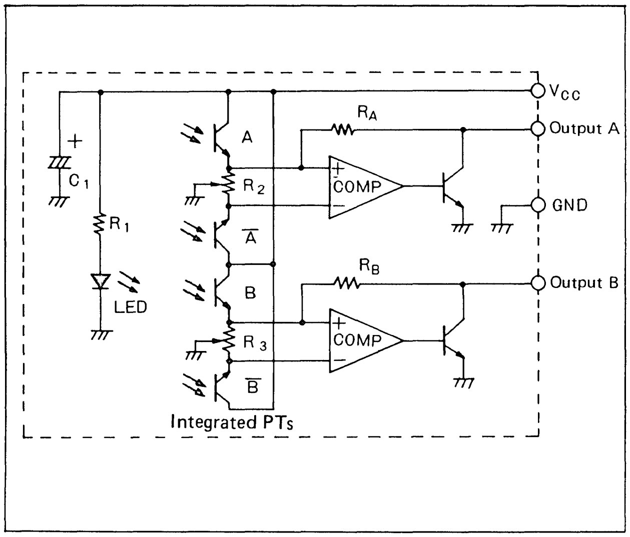
☐ Electrical Characteristics

(Ta = 0 ~ +70°C unless specified)

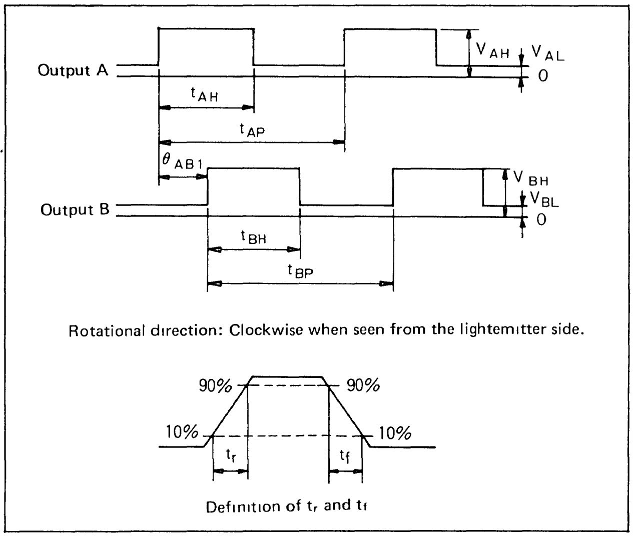
Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Supply voltage		V_{CC}	4.75	5.0	5.25	V	Ta=25°C	
Output A, B voltage	High level	V_{AH}, V_{BH}	V_{CC} –0.3	V_{CC}	–	V	Rup=4.7kΩ	
	Low level	V_{AL}, V_{BL}	–	0.25	0.4	V	Rup = 1kΩ	
*2 Duty ratio	Output A	D_A	0.45	0.50	0.55		f=5kHz, Ta=25°C	$\frac{t_{AH}}{t_{AP}}$
	Output B	D_B	0.45	0.50	0.55		f=5kHz, Ta=25°C	$\frac{t_{BH}}{t_{BP}}$
*2 Phase difference		θ_{AB1}	45	90	135	deg.	f=5kHz, Ta=25°C	
Response time		tr	–	1.0	2.0	μs	f=5kHz, Ta=25°C Rup=4.7kΩ	
		tf	–	1.0	2.0			
Dissipation current		I_{TOT}	–	35	50	mA		

*2 Values of duty ratio and phase difference are average ones during one rotation of the disk.

Block Diagram



Output Waveforms



Rotational direction: Clockwise when seen from the lightemitter side.

Definition of tr and tf

Fig. 1 Duty ratio vs. frequency

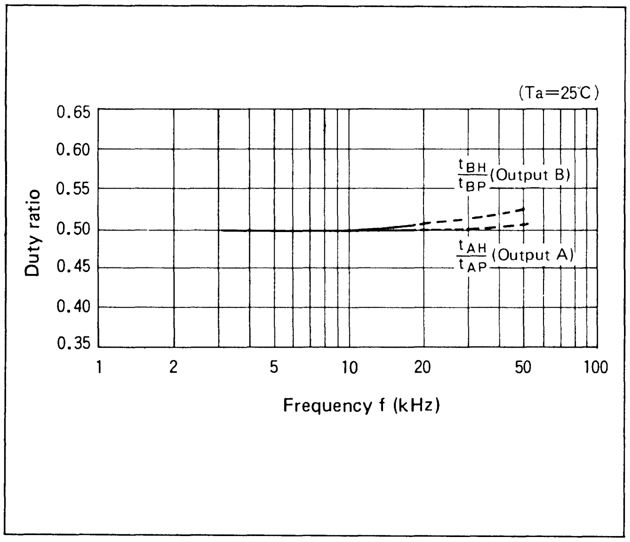


Fig. 2 Phase difference vs. frequency

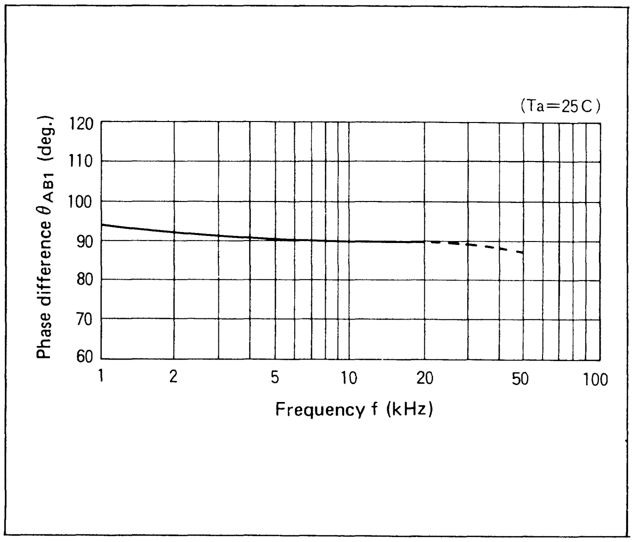


Fig. 3 Duty ratio vs. ambient temperature

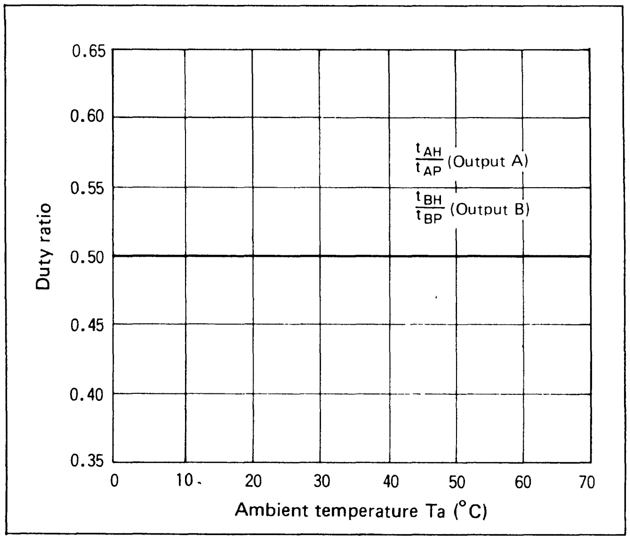


Fig. 4 Phase difference vs. ambient temperature

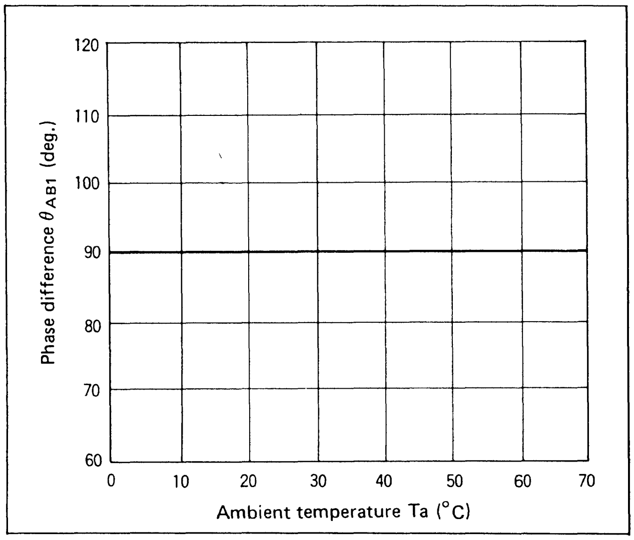


Fig. 5 Duty ratio vs. distance (X direction)

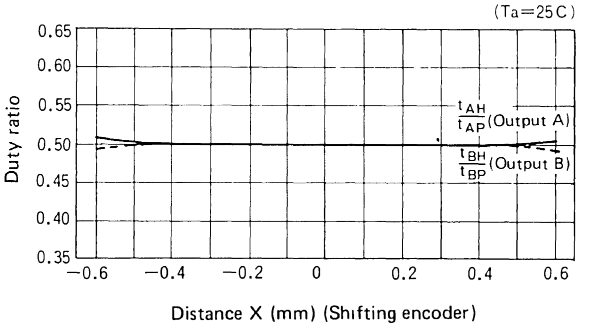


Fig. 6 Phase difference vs. distance (X direction)

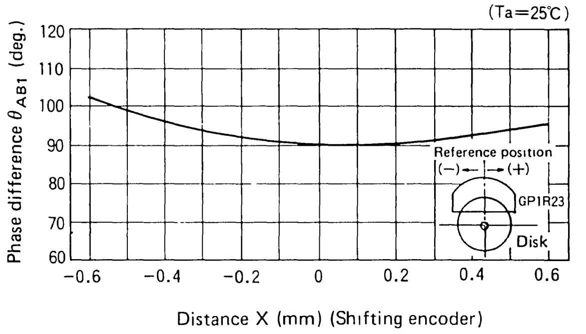


Fig. 7 Duty ratio vs. distance (Y direction)

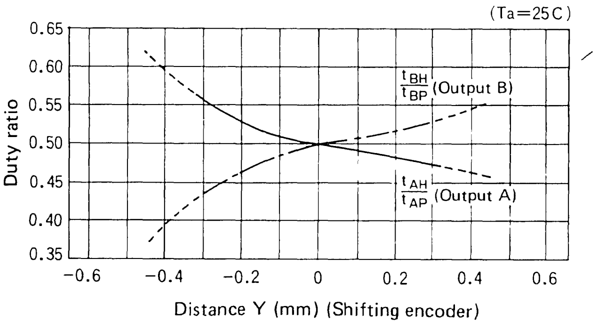


Fig. 8 Phase difference vs. distance (Y direction)

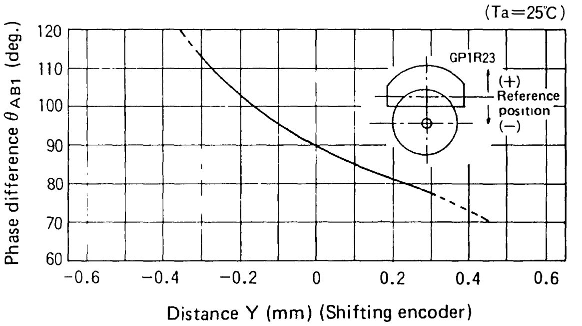


Fig. 9 Duty ratio vs. distance (Z direction)

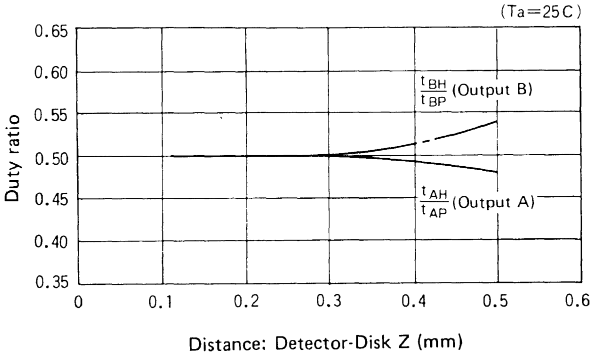
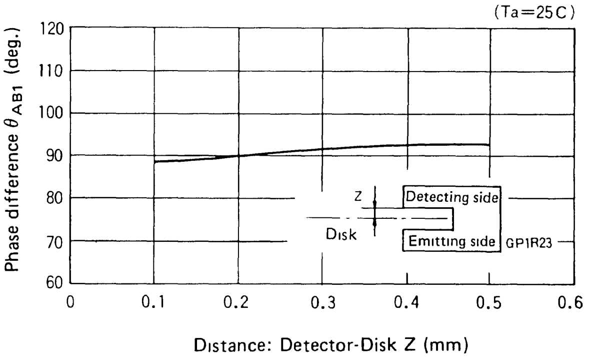
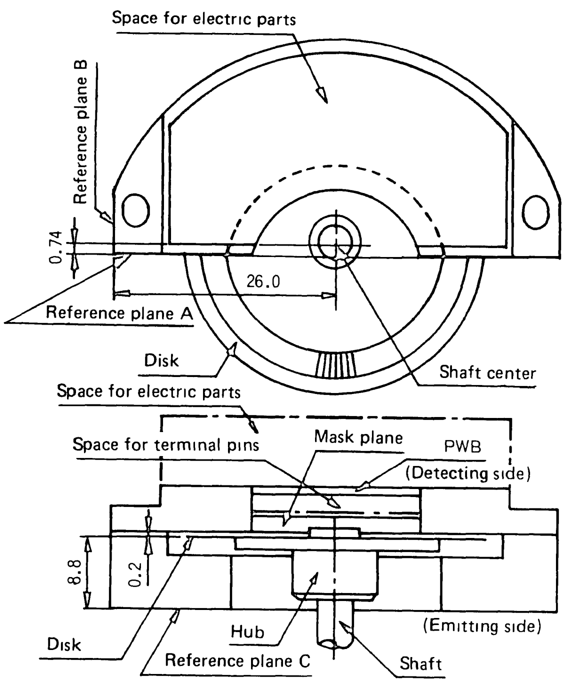


Fig. 10 Phase difference vs. distance (Z direction)



☐ Suggestion for Use

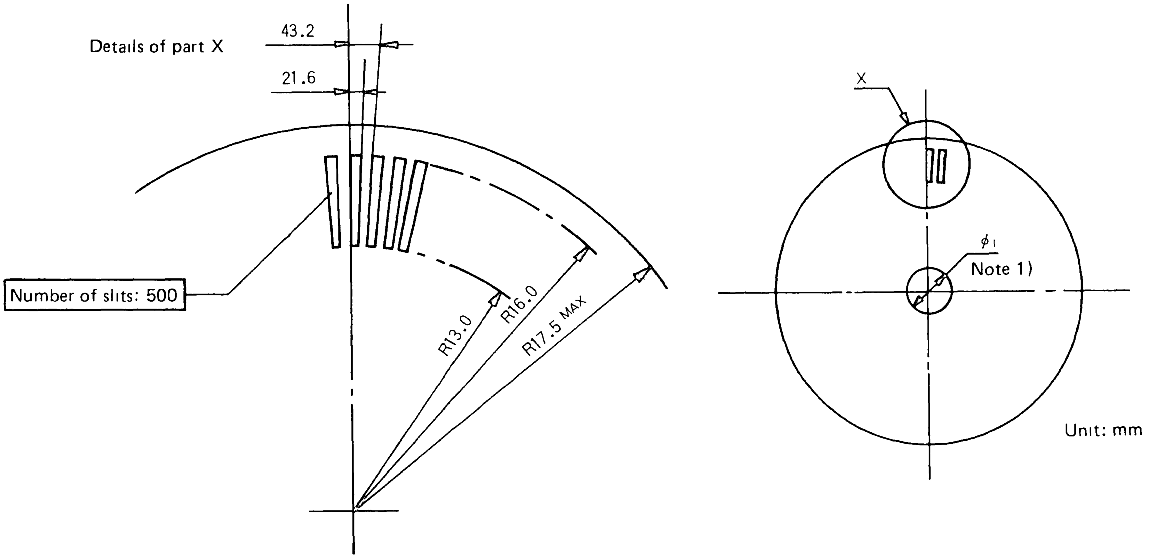


Note:

1) Diameter of disk is $\phi 35$.
2) Shaft center is 0.74mm away from reference plane A, and 26mm away from reference plane B.
3) Upper face of disk is 8.8mm away from reference plane C.
4) Distance between disk and mask is 0.2mm.
5) GP1R23 does not contain the disk.
(The encoder disk, GP1P23 whose resolution is 500P/R is available as optional parts.)

☐ Disk Design

When a disk is designed for use in the GP1R23, it is suggested that the following design standard shall be utilized.



Note:

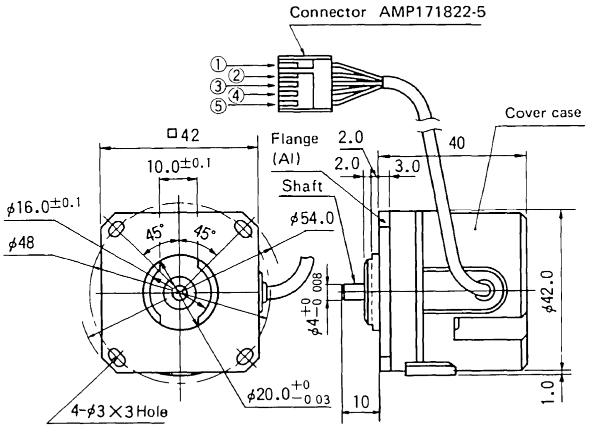
1) ϕi is variable in compliance with the type of motor used.
2) It is recommended that disk thickness be 0.08mm.
3) This drawing is seen from hub side.

☐ Specifications are subject to change without notice.

GP1R52 Series

Rotary Encoder

☐ Outline Dimensions



Connector portion

Pin No.	Wire color	Signal
①	Black	GND (0V)
②	Red	V_{CC} (5V)
③	White	Output Z (index)
④	Yellow	Output A
⑤	Green	Output B

Cable length
ℓ =530±50

Unit : mm

☐ General Description

The Sharp GP1R52 Series is a shaft type optical rotary encoder (incremental type) with a built-in light level compensating circuit, consisting of an infrared light emitting diode and integrated photodiode. It generates 3 types of outputs, 2-phase outputs, A (approximate sine wave) and B (approximate cosine wave) and output Z (index).
The GP1R52 Series is a shaft type rotary encoder which integrates disk, shaft, and bearing.
3 types of models are available as shown below.

Model No.	Resolution (P/R)
GP1R52A	96
GP1R52B	200
GP1R52C	360

☐ Features

(1) Shaft type which integrates disk, shaft, and bearing
(2) Built-in light level compensating circuit
(3) High accuracy in phase difference due to laser trimming
(4) Excellent frequency response due to use of a photodiode

☐ Applications

(1) Numerical control equipment, industrial robots
(2) Typewriters and printers
(3) Electronic sewing machines
(4) Various control equipment

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	8	V
Min. load resistance on output side	R_L	5.0	KΩ
Operating temperature	T_{opr}	0 ~ +70	°C
Storage temperature	T_{stg}	−40 ~ +80	°C
Max. allowable number of rotations	$RPM_{max.}$	5,000	rpm

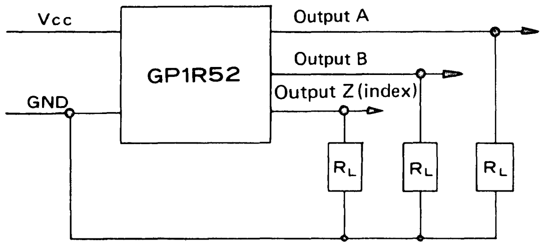
☐ Electrical Characteristics

(V_{CC} = 5V, R_L = 10kΩ, Ta = 25°C)

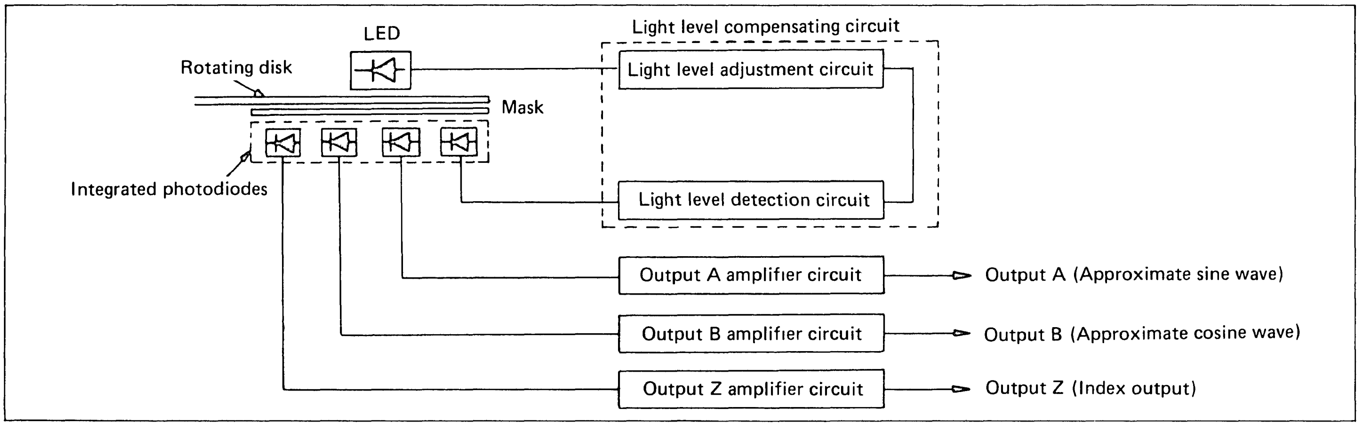
Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Duty ratio		D_A	0.45	0.50	0.55		t_{AP}=DC~0.5ms, V_{TH}=1.5V	t_{AH}/t_{AP}
		D_B	0.45	0.50	0.55		t_{BP}=DC~0.5ms, V_{TH}=1.5V	t_{BH}/t_{BP}
Phase difference	GP1R52A	θ_{AB1} θ_{AB2}	75	90	105	deg.	t_{AP}=DC~5ms	$\frac{t_{AB1}}{t_{AP}} \times 360$ $\frac{t_{AB2}}{t_{AP}} \times 360$
	GP1R52B		70	90	110			
	GP1R52C		50	90	130			
Index voltage		V_{ZH}	1.00	1.25	1.50	V	t_{AP}=DC~5ms	
		V_{ZL}	–	–	0.6			
Dissipation current		I_{TOT}	–	–	70	mA		

■ Test Circuit for Electrical Characteristics

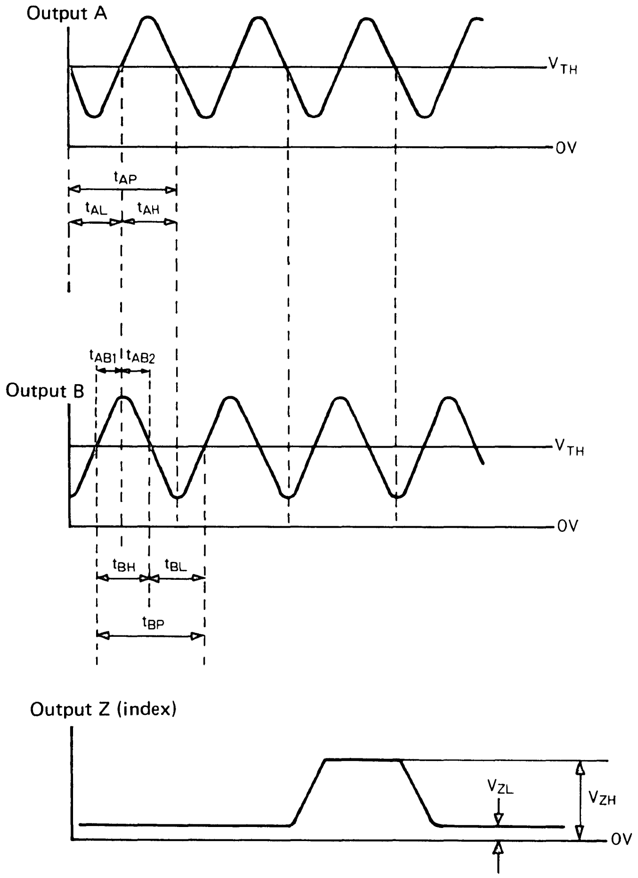
Supply voltage V_{CC} = 5V ±5%
Load resistance on output side R_L = 10kΩ ±5%



□ Block Diagram



□ Output Waveforms



Rotational direction : Counterclockwise when seen from the shaft side
t_{AL} (t_{BL}) : Average time required for output A (B) to fall below V_{TH}
t_{AH} (t_{BH}) : Average time required for output A (B) to rise over V_{TH}
t_{AP} (t_{BP}) : Average cycle of output A (B)
t_{AB1}, t_{AB2} : Average time for left waveforms

Fig. 1 Supply voltage vs. relative output

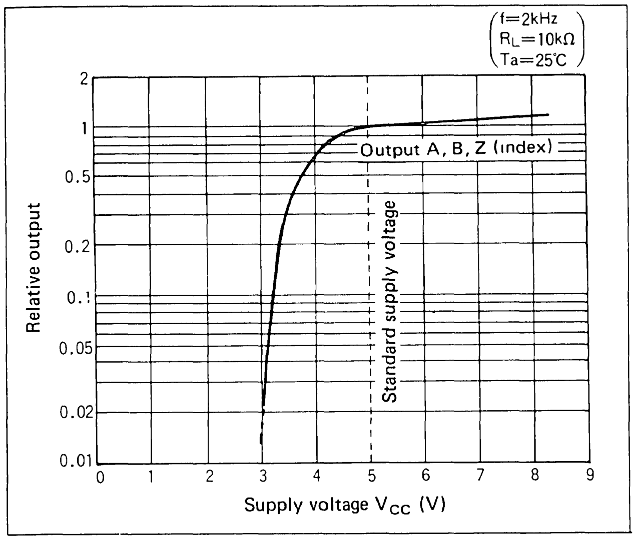


Fig. 2 Frequency response

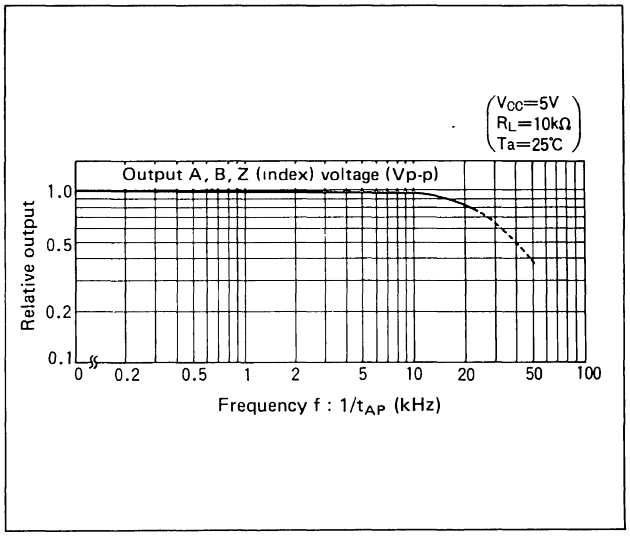


Fig. 3 Frequency vs. duty ratio

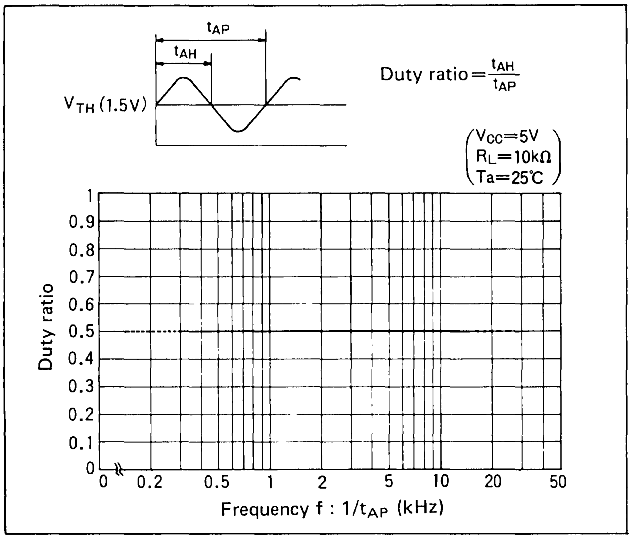
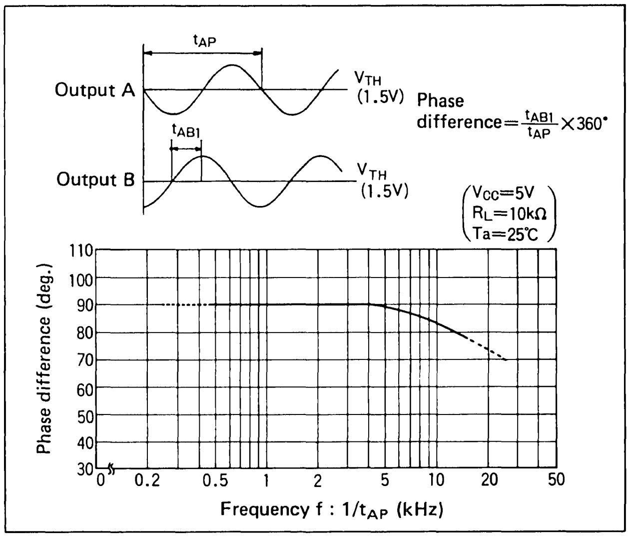


Fig. 4 Frequency vs. phase difference

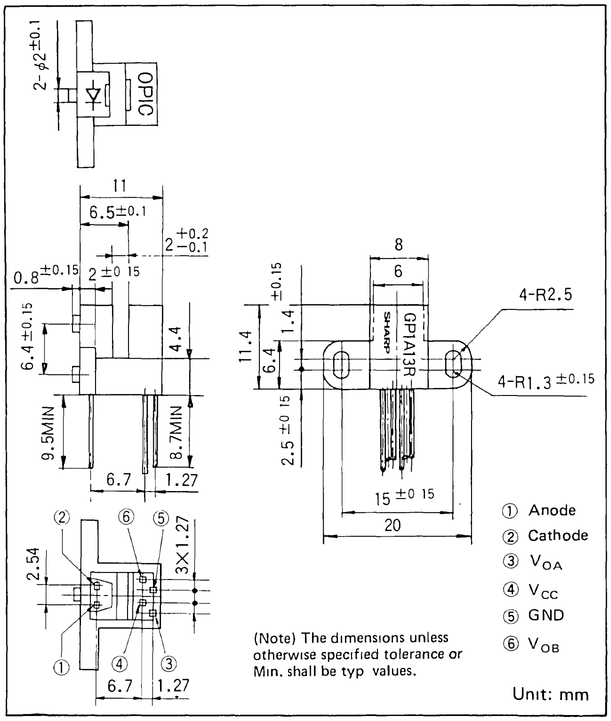


SHARP

GP1A13R

OPIC Photointerrupter

☐ Outline Dimensions



① Anode
② Cathode
③ V_{OA}
④ V_{CC}
⑤ GND
⑥ V_{OB}

(Note) The dimensions unless otherwise specified tolerance or Min. shall be typ values.

Unit: mm

☐ General Description

The Sharp GP1A13R is an A, B 2-phase digital output photointerrupter consisting of GaAs infrared light emitting diode on the emitting side and OPIC lightdetector (light detector that integrates photodiode array, amplifier, signal processing and output circuits into a single chip) on the detecting side.

2-phase output, high functional photointerrupter GP1A13R can be used as general purpose rotary encoder.

☐ Features

(1) A, B 2-phase digital output
(2) Resolution (disk slit pitch: 1.14mm)
(3) Directly interface with TTL
(4) Compact and light

☐ Applications

(1) Rotational angle detectors for DC motor of electronic printers
(2) Joint angle detectors in robots
(3) Position detectors in numerical control equipment

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter		Symbol	Rating	Unit
Input	Forward current	I_F	50	mA
	*1 Peak forward current	I_{FM}	1	A
	Reverse voltage	V_R	6	V
	Power dissipation	P	75	mW
Output	Supply voltage	V_{CC}	7	V
	Low level output current	I_{OL}	20	mA
	Power dissipation	P_O	250	mW
	Operating temperature	T_{opr}	0 ~ +70	°C
	Storage temperature	T_{stg}	−40 ~ +80	°C
	*2 Soldering temperature	T_{sol}	260	°C

*1 Pulse width ≦ 100μs, Duty ratio 0.01 *2 For 5 seconds

☐ Electro-optical Characteristics

(Ta = 0 ~ +70°C unless specified)

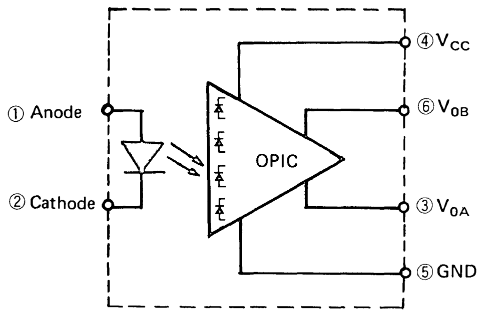
Parameter		Symobl	MIN.	TYP.	MAX.	Unit	Condition	Remark
Input	Forward voltage	V_F	–	1.2	1.4	V	Ta = 25°C, I_F = 20mA	
	Reverse current	I_R	–	–	10	μA	Ta = 25°C, V_R = 3V	
Output	Supply voltage	V_{CC}	4.5	5.0	5.5	V		
	High level output voltage	V_{OH}	2.4	4.9	–	V	V_{CC} = 5V, I_F = 20mA	*4
	Low level output voltage	V_{OL}	–	0.1	0.4	V	I_{OL} = 8mA, V_{CC} = 5V, I_F = 20mA	*4
	Supply current	I_{CC}	–	5	20	mA	I_F = 20mA, V_{CC} = 5V, *3	*4
Transfer charac-teristics	Duty ratio	D_A	0.25	0.50	0.75		V_{CC} = 5V, I_F = 20mA f = 2.5kHz	$\frac{t_{AH}}{t_{AP}}$ *4
		D_B	0.25	0.50	0.75			$\frac{t_{BH}}{t_{BP}}$ *4
	Response frequency	f_{max}	–	–	10	kHz	V_{CC} = 5V, I_F = 20mA	*4

*3 Outputs A and B on low level

*4 Measured under the condition shown in ⟨Measurement Condition⟩

OPIC is a registered trademark of Sharp and stands for Optical IC. It has a light detecting element and signal processing circuitry

□ Block Diagram



□ Output Waveforms

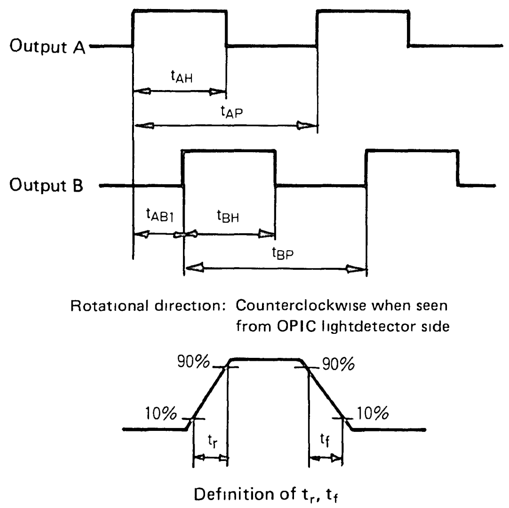


Fig. 1 Forward current vs. ambient temperature

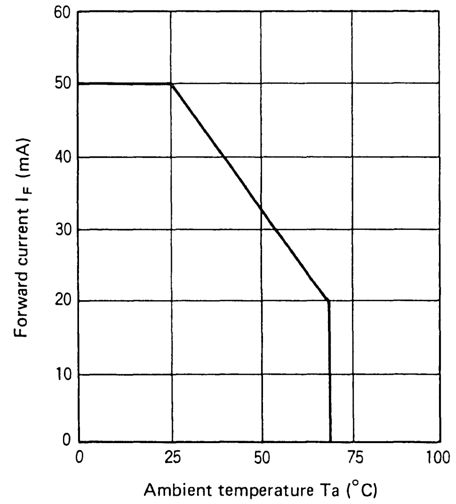


Fig. 2 Output power dissipation vs. ambient temperature

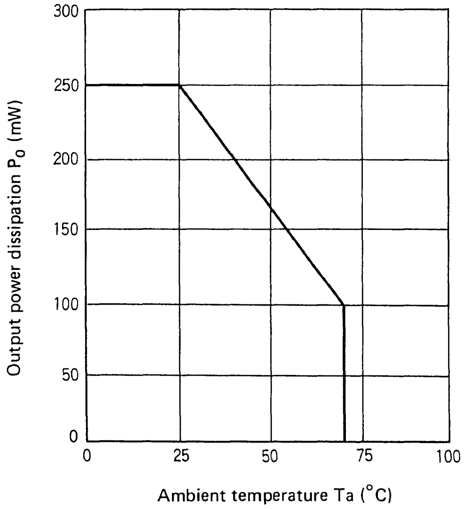


Fig. 3 Duty ratio vs. frequency

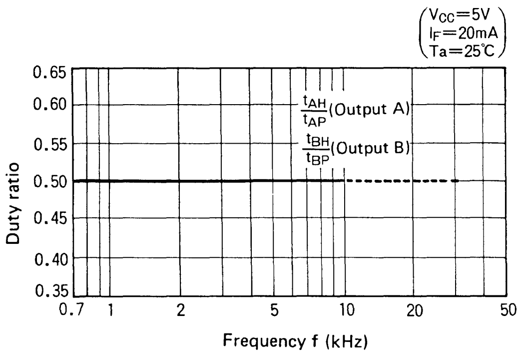


Fig. 4 Phase difference vs. frequency

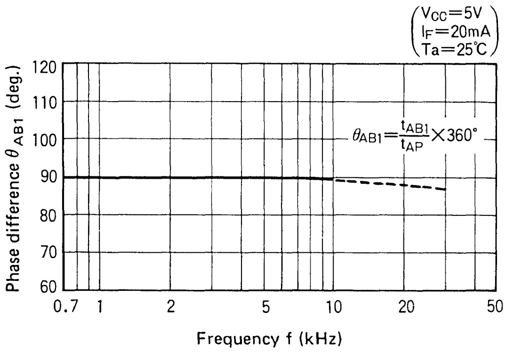


Fig. 5 Duty ratio vs. ambient temperature

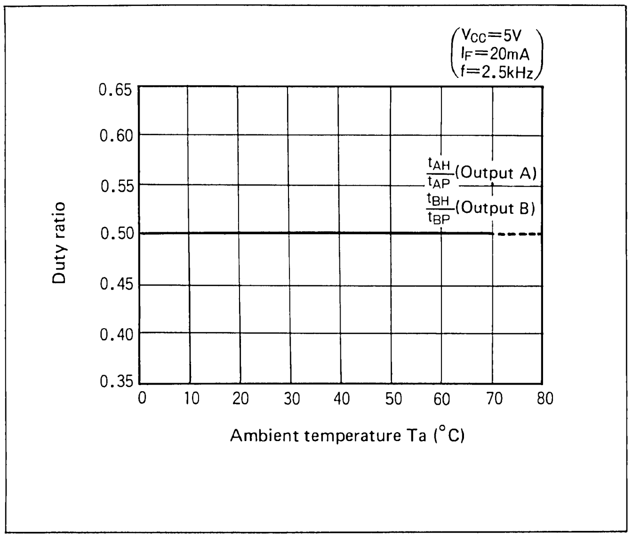


Fig. 6 Phase difference vs. ambient temperature

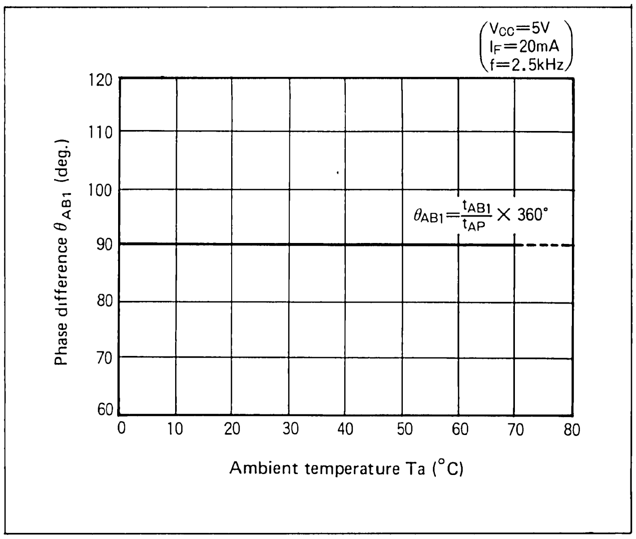


Fig. 7 Duty ratio vs. distance (X direction)

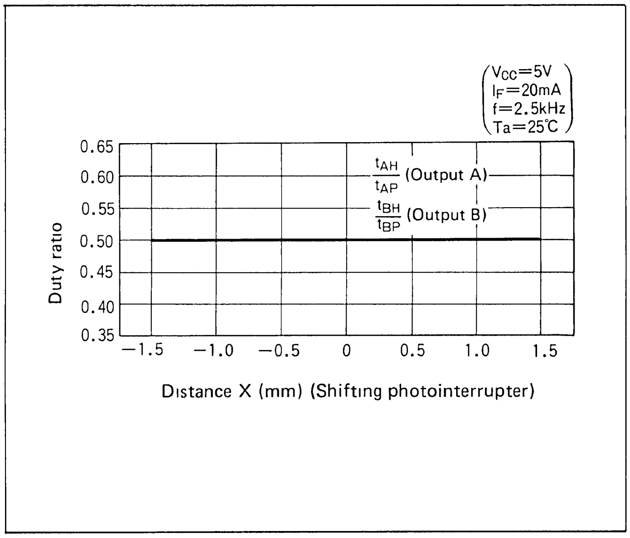


Fig. 8 Phase difference vs. distance (X direction)

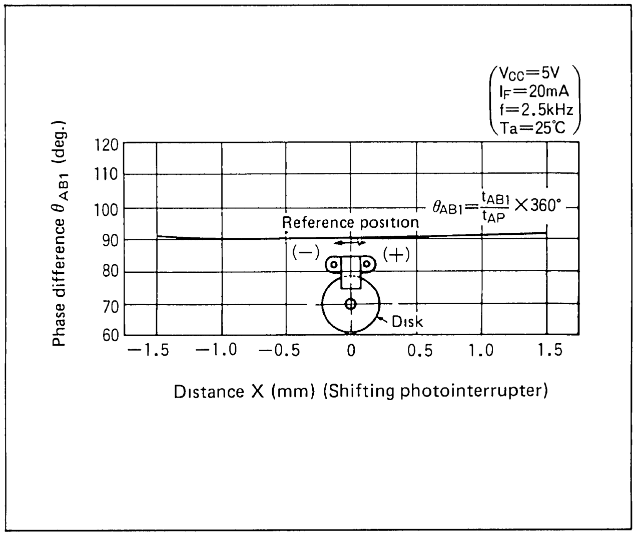


Fig. 9 Duty ratio vs. distance (Y direction)

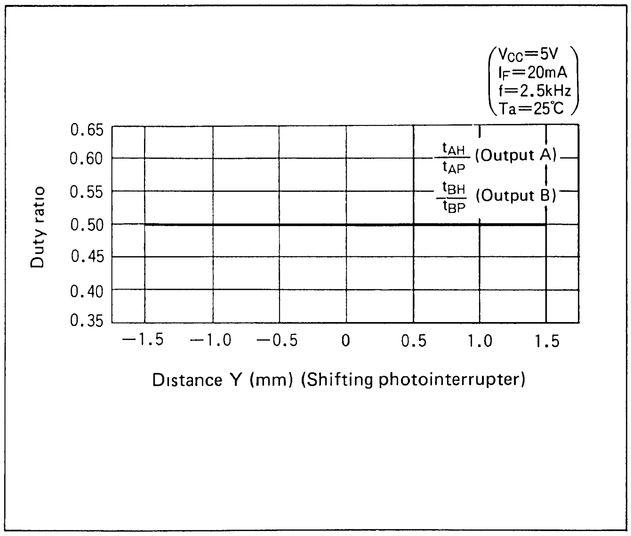


Fig. 10 Phase difference vs. distance (Y direction)

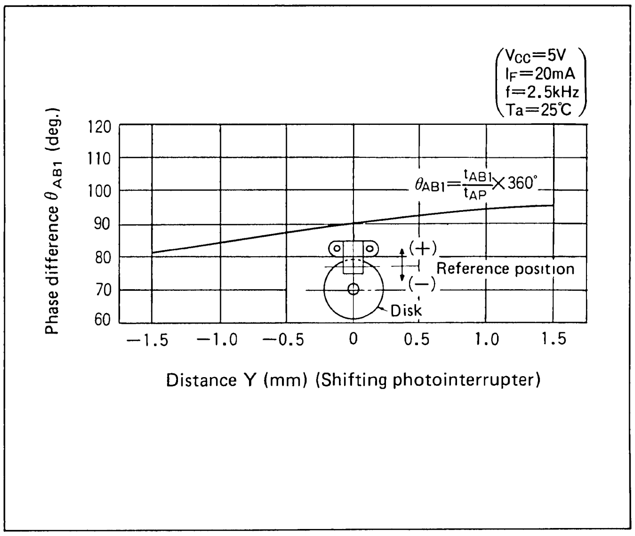


Fig. 11 Duty ratio vs. distance (Z direction)

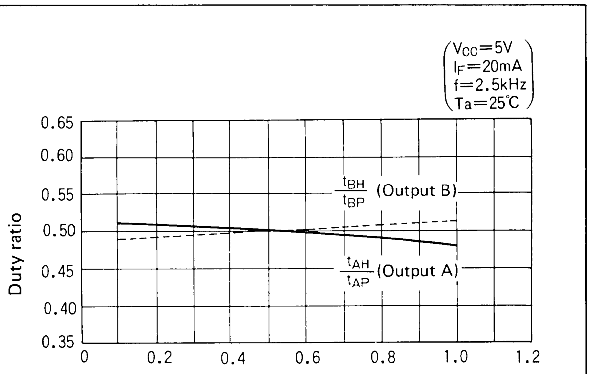
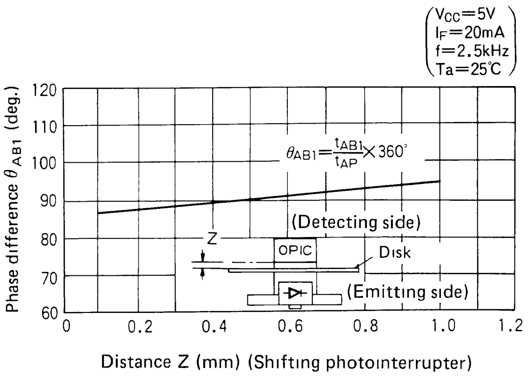
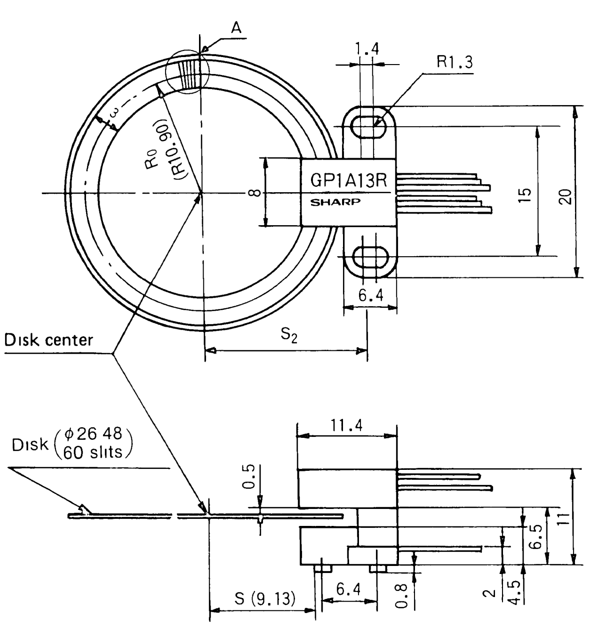


Fig. 12 Phase difference vs. distance (Z direction)



<Measurement Condition>



〈Basic Design〉

R_O (distance, between the disk center and half point of a slit), P (slit pitch) and S_1, S_2 (installing position of photointerrupter) will be provided by the following equations.

Slit pitch: P (slit center)

$R_O = \frac{N}{60} \times 10.89$ (mm) N: Number of slits

$P = \frac{2\pi R_O}{N}$

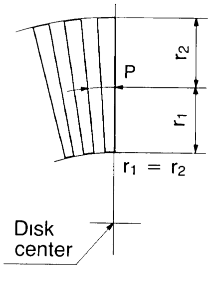
$S_1 = R_O - 1.765$ (mm)

$S_2 = S_1 + 6.7$ (mm)

Note) When the number of slits is changed, values in parentheses are also changed according to the number of slits.

Enlarged drawing of A portion

Slit pitch: P Detailed drawing



Example when 200P/R disk is used:

$$R_O = \frac{100}{60} \times 10.89 = 18.15 \text{ (mm)}$$

$$P = \frac{2 \times \pi \times 18.15}{100} = 1.14 \text{ (mm)}$$

$$S_1 = 18.15 - 1.765 = 16.385 \text{ (mm)}$$

$$S_2 = 16.385 + 6.7 = 23.085 \text{ (mm)}$$

☐ The disk shown below is available as optional part.

Model No.	Resolution (P/R)
GP1P13RB	60

☐ Suggestion for Use

1) In order to stabilize power supply line, connect a by-pass capacitor of more than 0.01μF between V_{CC} and GND near the device.
2) This product is designed to be operated at I_F = 20mA Typ.

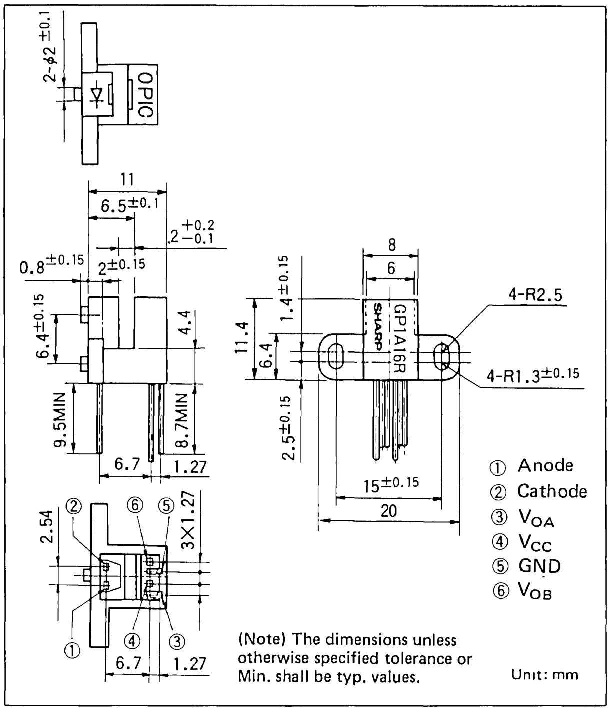
☐ Specifications are subject to change without notice

SHARP

GP1A16R

OPIC Photointerrupter

☐ Outline Dimensions



(Note) The dimensions unless otherwise specified tolerance or Min. shall be typ. values.

☐ General Description

The Sharp GP1A16R is an A, B 2-phase digital output photointerrupter consisting of GaAs infrared light emitting diode on the emitting side and OPIC lightdetector (light detector that integrates photodiode array, amplifier, signal processing and output circuits into a single chip) on the detecting side.

2-phase output, high functional photointerrupter GP1A16R can be used as general purpose rotary encoder.

☐ Features

(1) A, B 2-phase digital output
(2) High resolution (disk slit pitch: 0.7mm)
(3) Directly interface with TTL
(4) Compact and light

☐ Applications

(1) Rotational angle detectors for DC motor of electronic printers
(2) Joint angle detectors in robots
(3) Position detectors in numerical control equipment

☐ Absolute Maximum Ratings

(Ta = 25°C)

Parameter		Symbol	Rating	Unit
Input	Forward current	I_F	50	mA
	*1 Peak forward current	I_{FM}	1	A
	Reverse voltage	V_R	6	V
	Power dissipation	P	75	mW
Output	Supply voltage	V_{CC}	7	V
	Low level output current	I_{OL}	20	mA
	Power dissipation	P_O	250	mW
Operating temperature		T_{opr}	0 ~ +70	°C
Storage temperature		T_{stg}	−40 ~ +80	°C
*2 Soldering temperature		T_{sol}	260	°C

*1 Pulse width ≦ 100μs, Duty ratio 0.01 * 2 For 5 seconds

☐ Electro-optical Characteristics

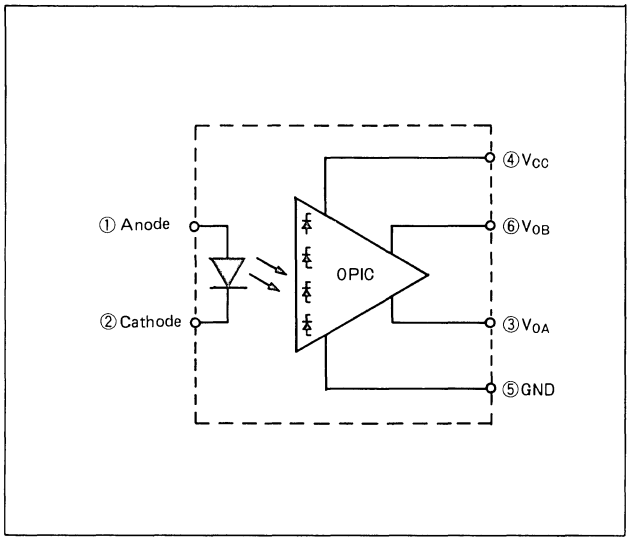
(Ta = 0 ~ +70°C unless specified)

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Input	Forward voltage	V_F	–	1.2	1.4	V	Ta=25°C, I_F=20mA	
	Reverse current	I_R	–	–	10	μA	Ta=25°C, V_R=3V	
Output	Supply voltage	V_{CC}	4.5	5.0	5.5	V		
	High level output voltage	V_{OH}	2.4	4.9	–	V	V_{CC}=5V, I_F=20mA	*4
	Low level output voltage	V_{OL}	–	0.1	0.4	V	I_{OL}=8mA, V_{CC}=5V, I_F=20mA	*4
	Supply current	I_{CC}	–	5	20	mA	I_F=20mA, V_{CC}=5V, *3	*4
Transfer characteristics	Duty ratio	D_A	0.20	0.50	0.80		V_{CC}=5V, I_F=20mA	$\frac{t_{AH}}{t_{AP}}$ *4
		D_B	0.20	0.50	0.80		f = 2.5kHz	$\frac{t_{BH}}{t_{BP}}$ *4
	Response frequency	$f_{max.}$	–	–	10	kHz	V_{CC}=5V, I_F=20mA	*4

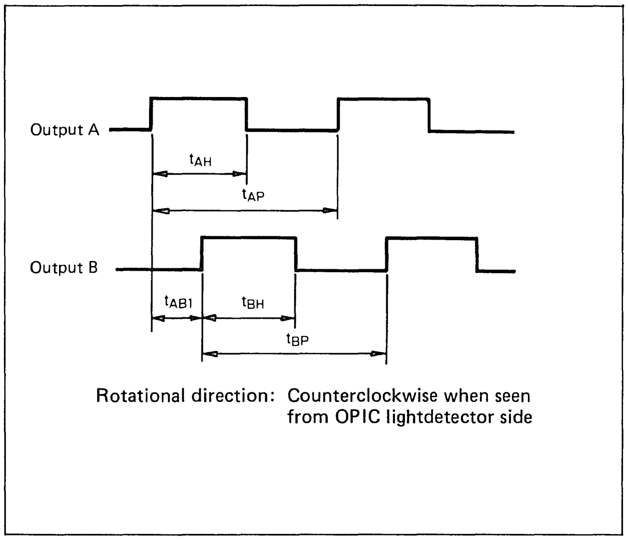
*3 Outputs A and B on low level *4 Measured under the condition shown in ⟨Measurement Condition⟩

OPIC is a registered trademark of Sharp and stands for Optical IC It has a light detecting element and signal processing circuitry integrated into a single chip.

☐ Block Diagram



☐ Output Waveforms



Rotational direction: Counterclockwise when seen from OPIC lightdetector side

Fig. 1 Forward current vs. ambient temperature

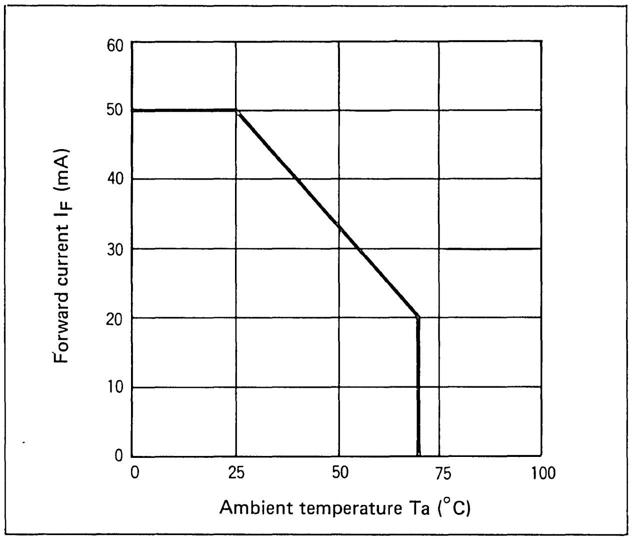


Fig. 2 Output power dissipation vs. ambient temperature

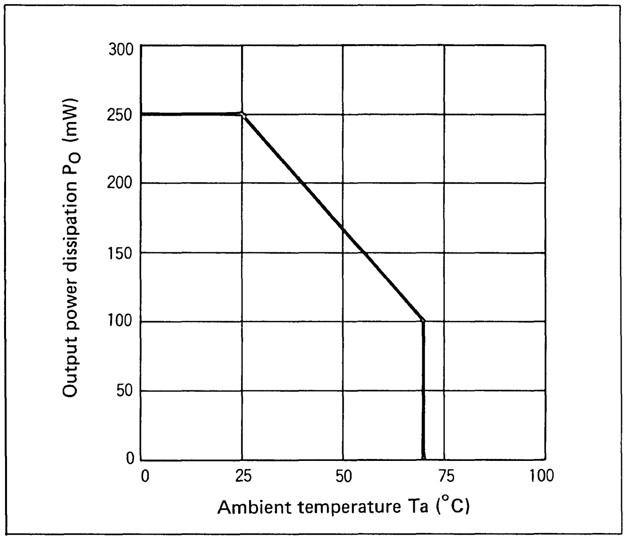


Fig. 3 Duty ratio vs. frequency

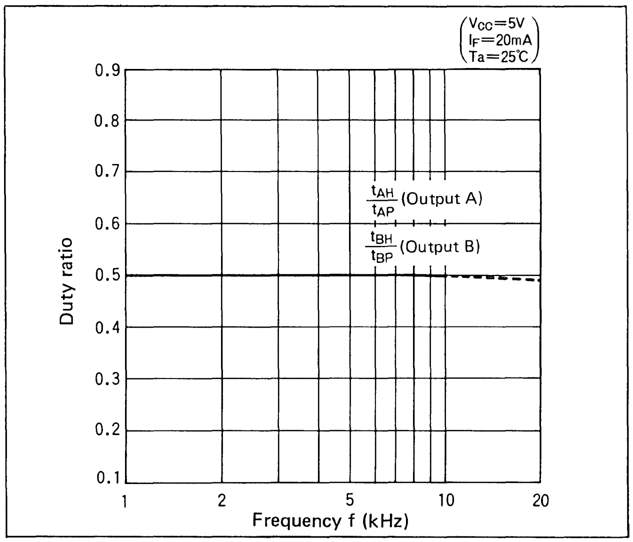


Fig. 4 Phase difference vs. frequency

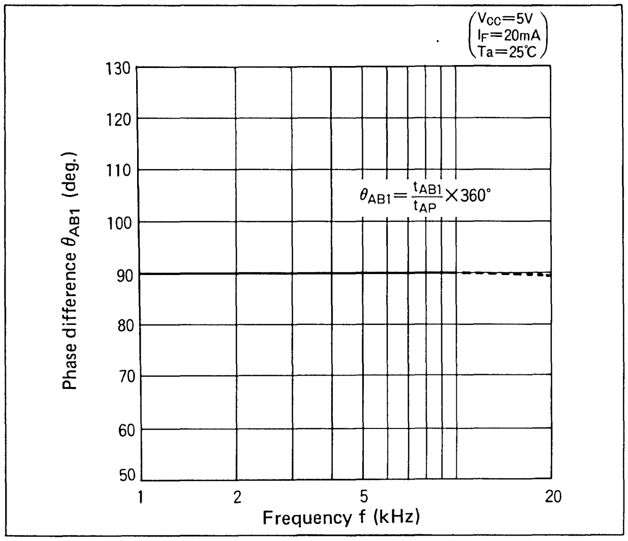


Fig. 5 Duty ratio vs. ambient temperature

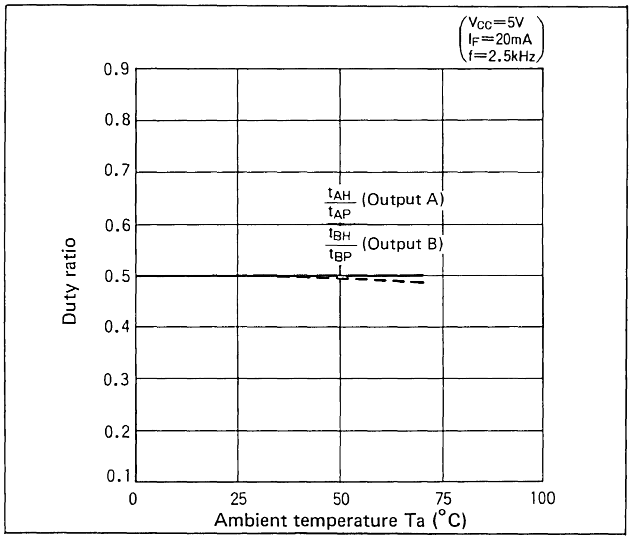


Fig. 6 Phase difference vs. ambient temperature

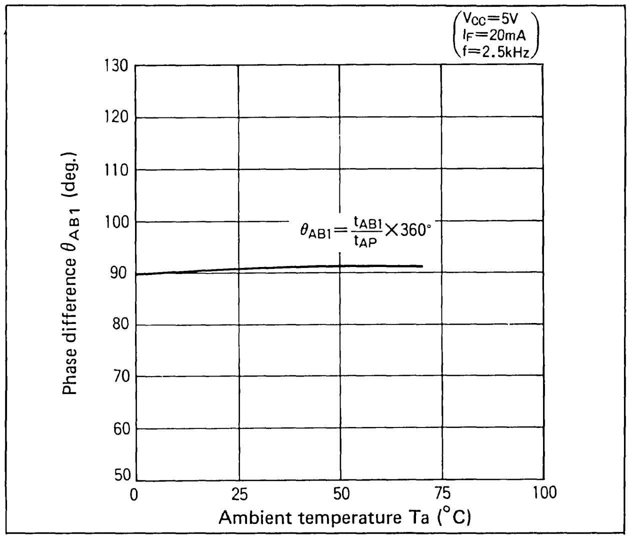


Fig. 7 Duty ratio vs. distance (X direction)

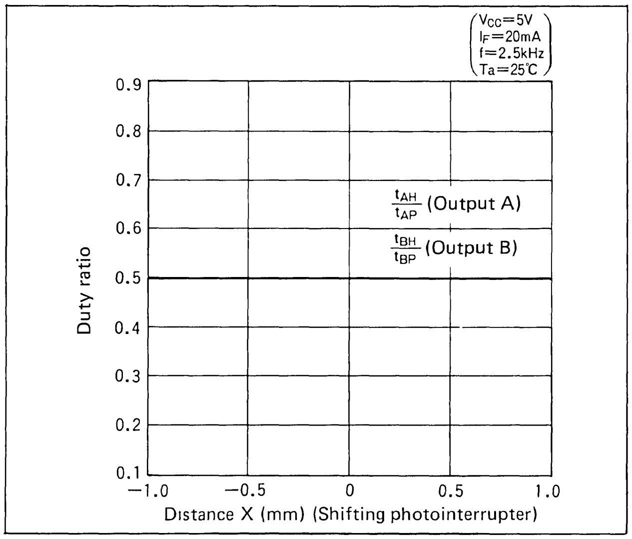


Fig. 8 Phase difference vs. distance (X direction)

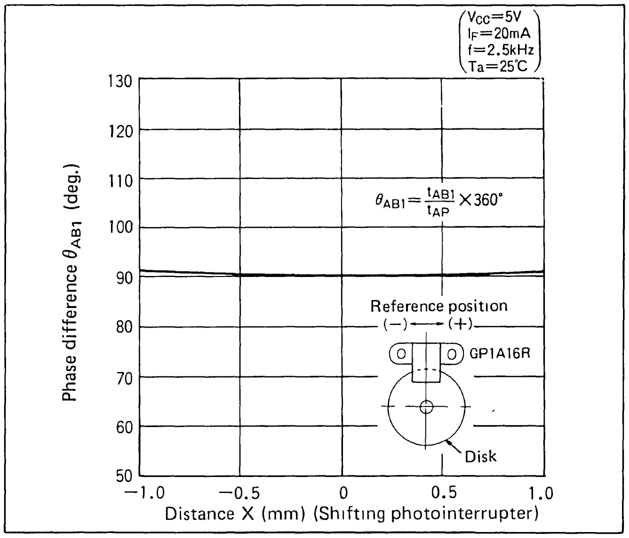


Fig. 9 Duty ratio vs. distance (Y direction)

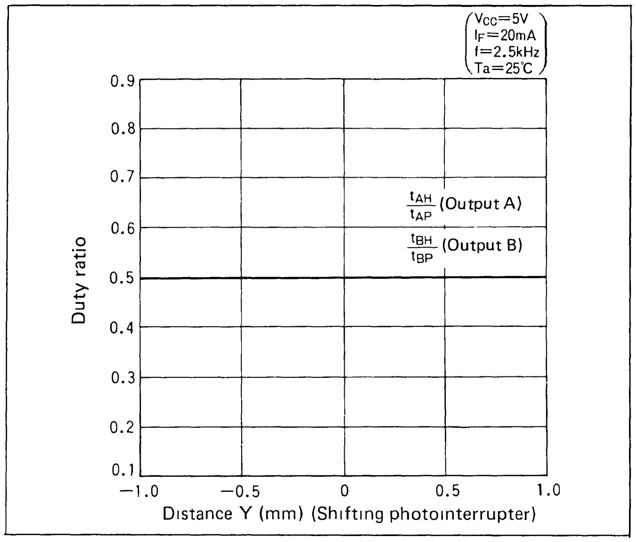


Fig. 10 Phase difference vs. distance (Y direction)

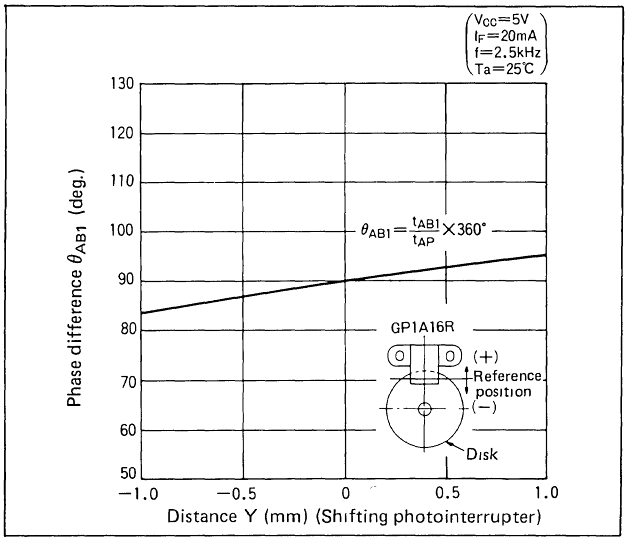


Fig. 11 Duty ratio vs. distance (Z direction)

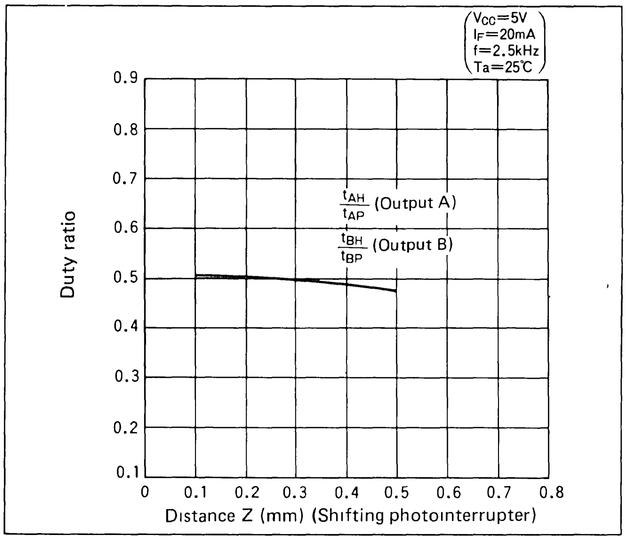
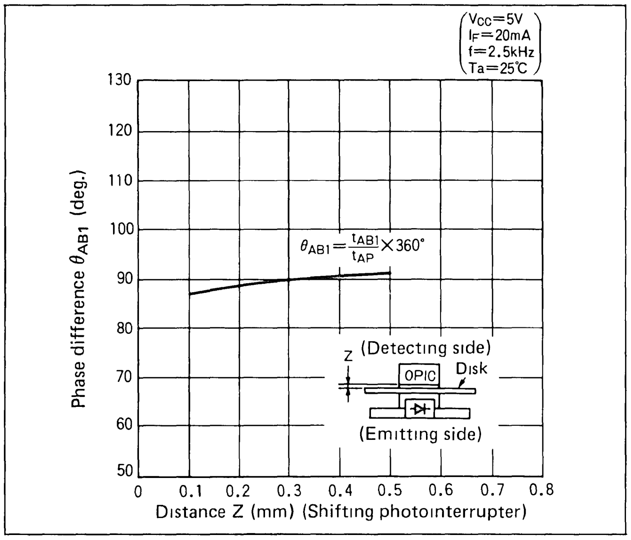
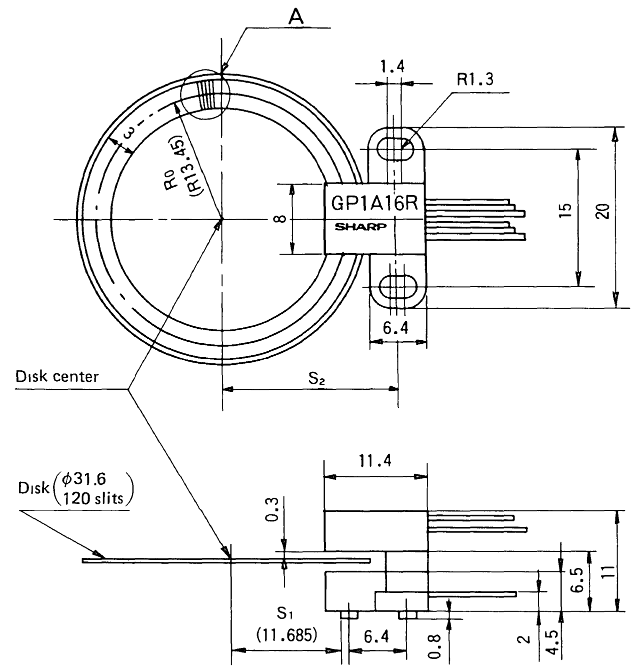


Fig. 12 Phase difference vs. distance (Z direction)



<Measurement Condition>



<Basic Design>

R_0 (distance between the disk center and half point of a slit), P (slit pitch) and S_1, S_2 (installing position of photointerrupter) will be provided by the following equations.

Slit pitch: P (slit center)

$$R_0 = \frac{N}{120} \times 13.45 \text{ (mm)} \quad \text{N: number of slits}$$

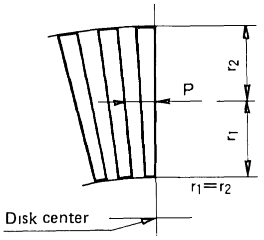
$$P = \frac{2\pi R_0}{N}$$

$$S_1 \doteqdot R_0 - 1.765 \text{ (mm)} \quad S_2 = S_1 + 6.7 \text{ (mm)}$$

Note)When the number of slits is changed, values in parentheses are also changed according to the number of slits.

Enlarged drawing of A portion

Slit pitch: P Detailed drawing



Example when 200P/R disk is used:

$$R_0 = \frac{200}{120} \times 13.45$$
$$= 22.42 \text{ (mm)}$$
$$P = \frac{2 \times \pi \times 22.42}{200}$$
$$= 0.704 \text{ (mm)}$$
$$S_1 = 22.42 - 1.765$$
$$= 20.655 \text{ (mm)}$$
$$S_2 = 20.655 + 6.7$$
$$= 27.355 \text{ (mm)}$$

☐ The disks shown below are available as optional parts.

Model No.	Resolution (P/R)
GP1P16RA	120
GP1P16RB	200

☐ Suggestion for Use

1) In order to stabilize power supply line, connect a by-pass capacitor of more than 0.01μF between V_{CC} and GND near the device.
2) This product is designed to be operated at I_F=20mA Typ.

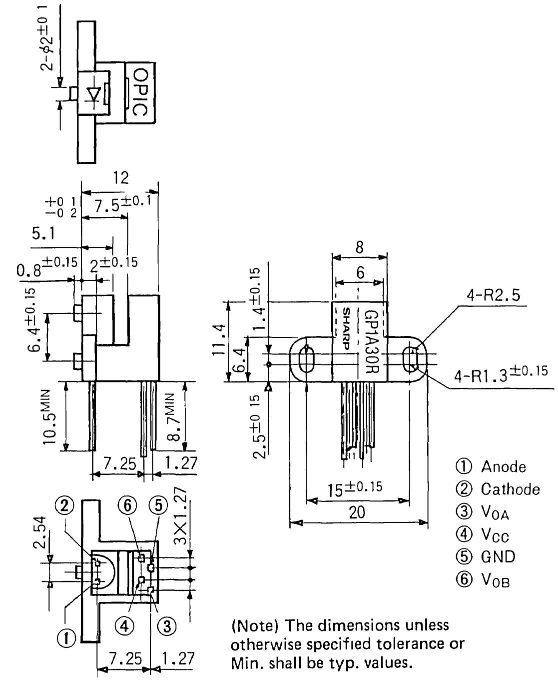
☐ Specifications are subject to change without notice.

SHARP

GP1A30R

OPIC Photointerrupter

□ Outline Dimensions



(Note) The dimensions unless otherwise specified tolerance or Min. shall be typ. values.

Unit: mm

□ General Description

The Sharp GP1A30R is an A, B 2-phase digital output photointerrupter consisting of GaAs infrared light emitting diode on the emitting side and OPIC lightdetector (light detector that integrates photodiode array, amplifier, signal processing and output circuits into a single chip) on the detecting side.

2-phase output, high functional photointerrupter GP1A30R can be used as general purpose rotary encoder.

□ Features

(1) Capable of using plastic disk
(2) Gap width: 2.4mm
(3) A, B 2-phase digital output
(4) High resolution (disk slit pitch: 0.7mm)
(5) Directly interface with TTL

□ Applications

(1) Print timing detectors in electronic typewriters and printers.
(2) Joint angle detectors in robots
(3) Rotational angle detectors in OA and FA equipment

□ Absolute Maximum Ratings

(Ta = 25°C)

Parameter		Symbol	Rating	Unit
Input	Forward current	I_F	65	mA
	*1 Peak forward current	I_{FM}	1	A
	Reverse voltage	V_R	6	V
	Power dissipation	P	100	mW
Output	Supply voltage	V_{CC}	7	V
	Low level output current	I_{OL}	20	mA
	Power dissipation	P_O	250	mW
	Operating temperature	T_{opr}	0 ~ +70	°C
	Storage temperature	T_{stg}	−40 ~ +80	°C
	*2 Soldering temperature	T_{sol}	260	°C

*1 Pulse width ≦ 100μs, Duty ratio 0.01
*2 For 5 seconds

□ Electro-optical Characteristics

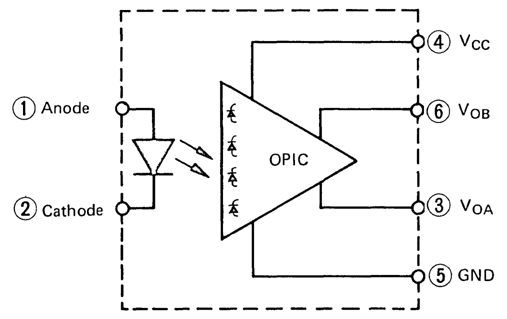
(Ta = 0 ~ +70°C unless specified)

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Input	Forward voltage	V_F	–	1.2	1.5	V	Ta = 25°C, I_F = 30mA	
	Reverse current	I_R	–	–	10	μA	Ta = 25°C, V_R = 3V	
Output	Supply voltage	V_{CC}	4.5	5.0	5.5	V		
	High level output voltage	V_{OH}	2.4	4.9	–	V	V_{CC} = 5V, I_F = 30mA	*4
	Low level output voltage	V_{OL}	–	0.1	0.4	V	I_{OL} = 8mA V_{CC} = 5V, I_F = 30mA	*4
	Supply current	I_{CC}	–	5	20	mA	I_F = 30mA V_{CC} = 5V, *3	*4
Transfer characteristics	Duty ratio	D_A	0.20	0.50	0.80		V_{CC} = 5V, I_F = 30mA f = 2.5kHz	$\frac{t_{AH}}{t_{AP}}$ *4
		D_B	0.20	0.50	0.80			$\frac{t_{BH}}{t_{BP}}$ *4
	Response frequency	$f_{max.}$	–	–	5	kHz	V_{CC} = 5V, I_F = 30mA	*4

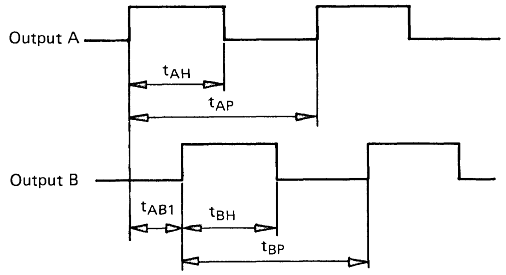
*3 Outputs A and B on low level
*4 Measured under the condition shown in ⟨Measurement Condition⟩

OPIC is a registered trademark of Sharp and stands for Optical IC. It has a light detecting element and signal processing circuitry integrated into a single chip.

□ Block Diagram



□ Output Waveforms



Rotational direction. Counterclockwise when seen from OPIC lightdetector side

Fig. 1 Forward current vs. ambient temperature

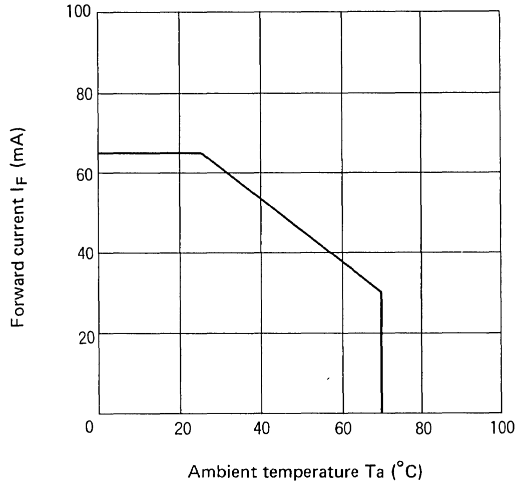


Fig. 2 Output power dissipation vs. ambient temperature

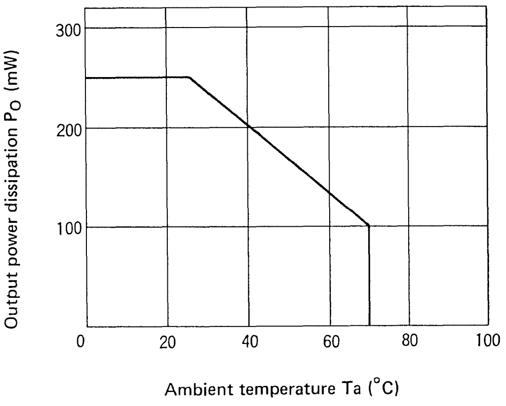


Fig. 3 Duty ratio vs. frequency

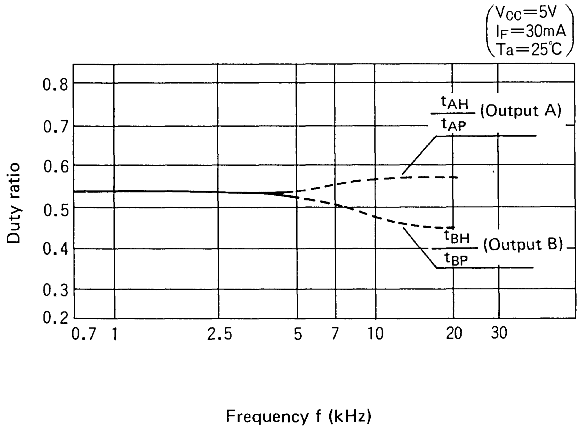


Fig. 4 Phase difference vs. frequency

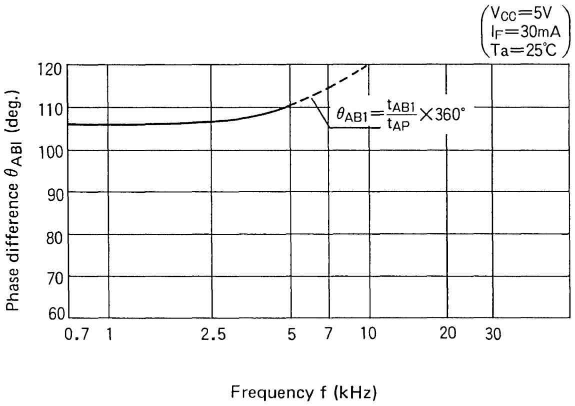


Fig. 5 Duty ratio vs. ambient temperature

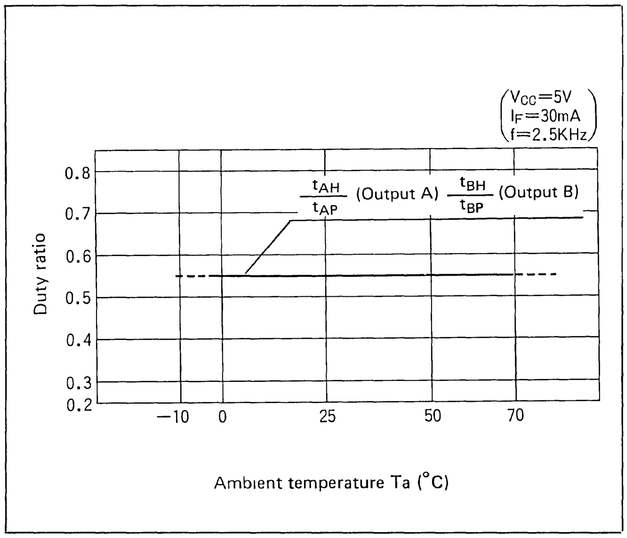


Fig. 6 Phase difference vs. ambient temperature

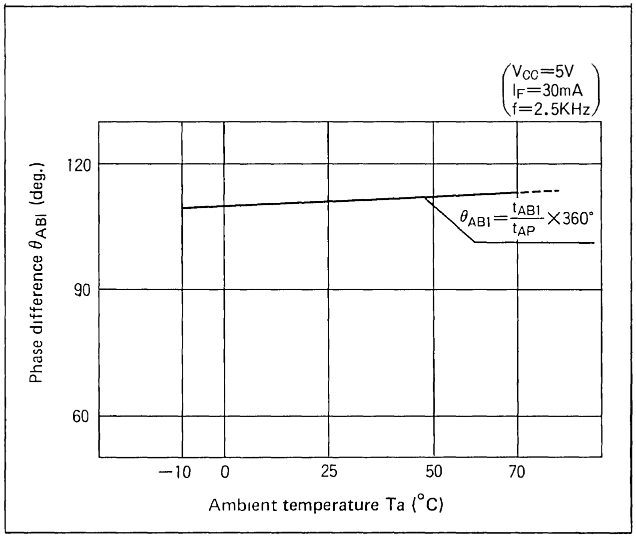


Fig. 7 Duty ratio vs. distance (X direction)

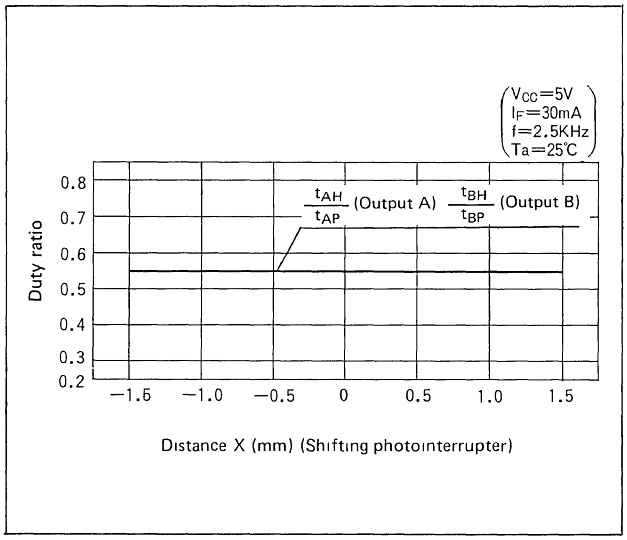


Fig. 8 Phase difference vs. distance (X direction)

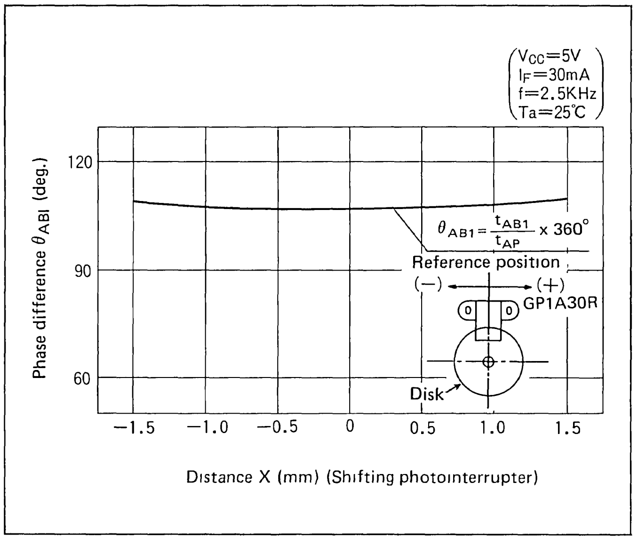


Fig. 9 Duty ratio vs. distance (Y direction)

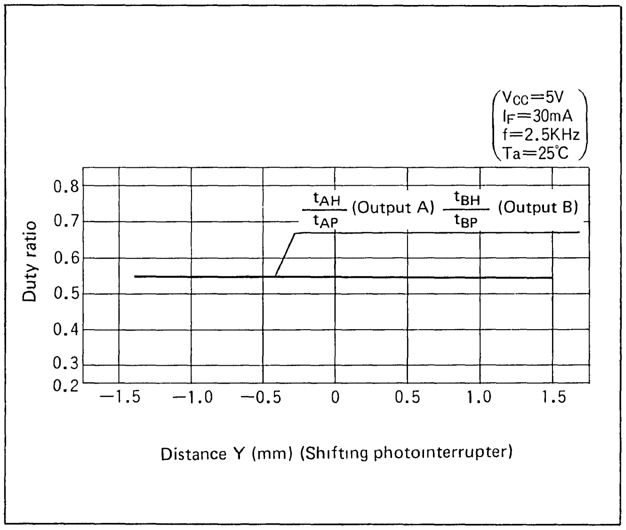


Fig. 10 Phase difference vs. distance (Y direction)

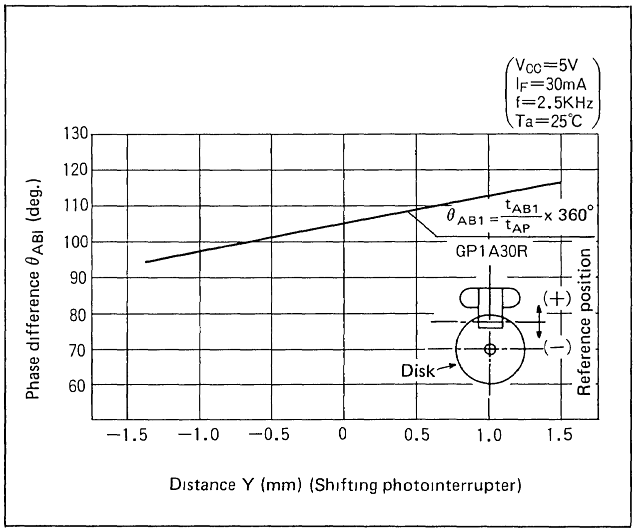


Fig. 11 Duty ratio vs. distance (Z direction)

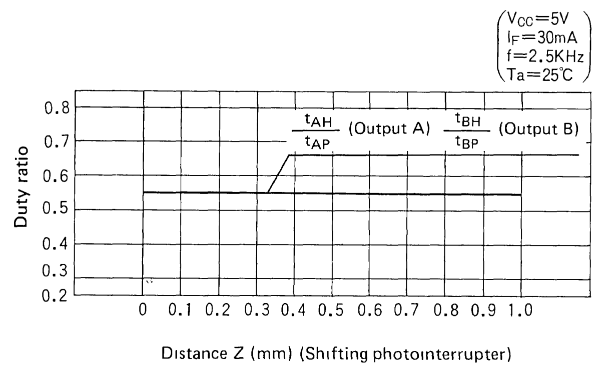
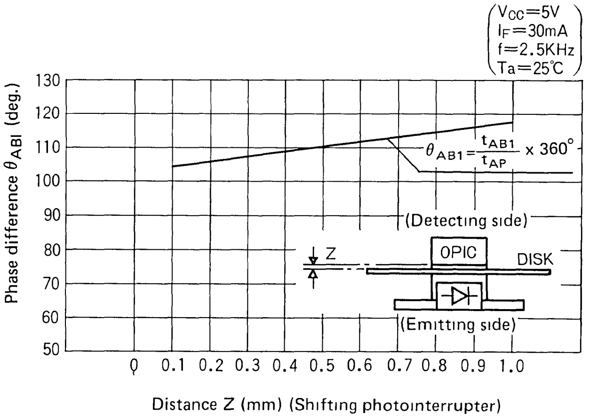
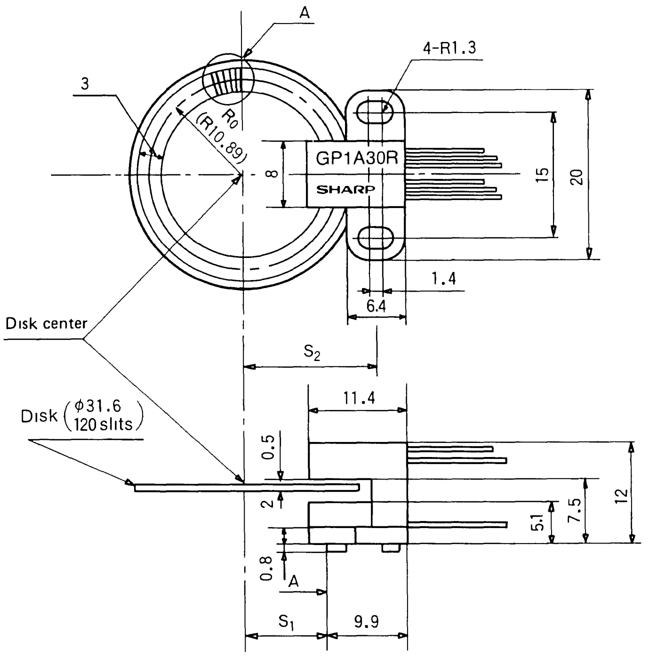


Fig. 12 Phase difference vs. distance (Z direction)



⟨Measurement Condition⟩



<Basic Design>

R_O (distance between the disk center and half point of a slit), P (slit pitch) and S_1, S_2 (installing position of photointerrupter) will be provided by the following equations.

Slit pitch: P (slit center).

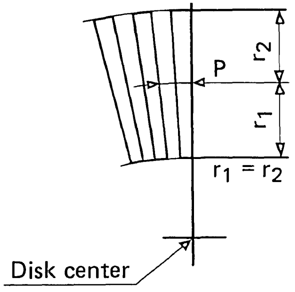
$$R_O = \frac{N}{120} \times 13.45 \text{ (mm)} \quad \text{N: number of slits}$$

$$P = \frac{2\pi R_O}{N}$$

$$S = R_O - 1.765 \text{ (mm)}$$

Enlarged drawing of A portion

Slit pitch: P Detailed drawing



Example when 200P/R disk is used:

$$R_O = \frac{200}{120} \times 13.45$$
$$= 22.42 \text{ (mm)}$$
$$P = \frac{2 \times \pi \times 22.42}{200}$$
$$= 0.704 \text{ (mm)}$$
$$S = 22.42 - 1.765$$
$$= 20.655 \text{ (mm)}$$

☐ Suggestion for Use

1) In order to stabilize power supply line, connect a by-pass capacitor of more than 0.01μF between V_{CC} and GND near the device.
2) This product is designed to be operated at I_F = 30mA Typ.

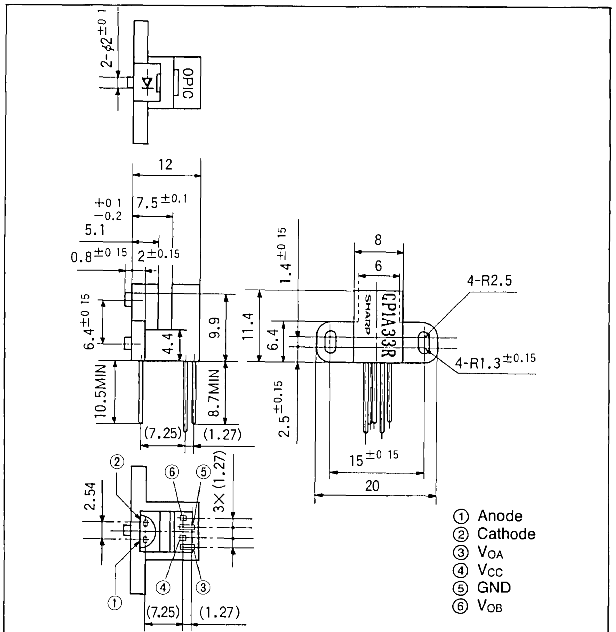
☐ Specifications are subject to change without notice.

SHARP

GP1A33R

OPIC Photointerrupter

□ Outline Dimensions



(Note) Unspecified tolerance is ±0.3mm The dimensions in parentheses are typ. values

Unit mm

□ General Description

The Sharp GP1A33R is an A, B 2-phase digital output photointerrupter consisting of GaAs infrared light emitting diode on the emitting side and OPIC light detector (lightdetector that integrates photodiode array, amplifier, signal processing and output circuits into a single chip) on the detecting side.

2-phase output, high functional photointerrupter GP1A33R can be used as general purpose rotary encoder.

□ Features

(1) Capable of using plastic disk
(2) Gap width: 2.4mm
(3) A, B 2-phase digital output
(4) High resolution (disk slit pitch: 1.14mm)
(5) Directly interface with TTL

□ Applications

(1) Print timing detectors in electronic printers
(2) Rotational angle detectors in OA and FA equipment

□ Absolute Maximum Ratings

(Ta = 25°C)

Parameter		Symbol	Rating	Unit
Input	Forward current	I_F	65	mA
	*1 Peak forward current	I_{FM}	1	A
	Reverse voltage	V_R	6	V
	Power dissipation	P	100	mW
Output	Supply voltage	V_{CC}	7	V
	Low level output current	I_{OL}	20	mA
	Power dissipation	P_O	250	mW
Operating temperature		T_{opr}	0 ~ +70	°C
Storage temperature		T_{stg}	−40 ~ +80	°C
*2 Soldering temperature		T_{sol}	260	°C

*1 Pulse width ≦ 100μs, Duty ratio 0.01 *2 For 5 seconds

□ Electro-optical Characteristics

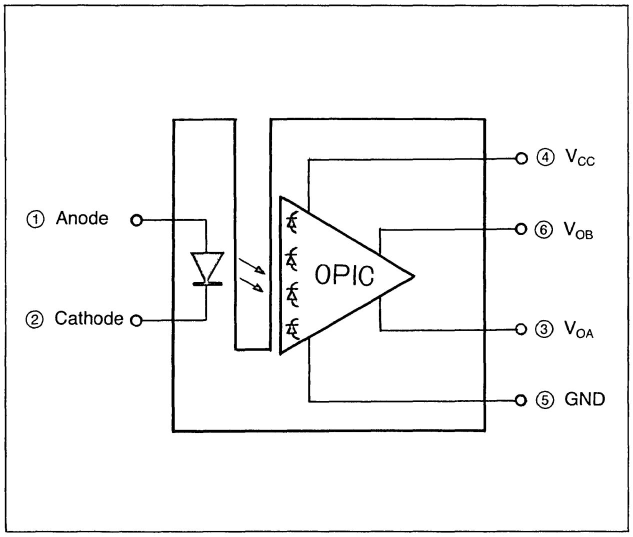
(Ta = 0 ~ +70°C unless specified)

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Input	Forward voltage	V_F	—	1.2	1.5	V	Ta=25°C, I_F=30mA	
	Reverse current	I_R	—	—	10	μA	Ta=25°C, V_R=3V	
Output	Supply voltage	V_{CC}	4.5	5.0	5.5	V		
	High level output voltage	V_{OH}	2.4	4.9	—	V	V_{CC}=5V, I_F=30mA	*4
	Low level output voltage	V_{OL}	—	0.1	0.4	V	I_{OL}=8mA V_{CC}=5V, I_F=30mA	*4
	Supply current	I_{CC}	—	5	20	mA	I_F=30mA V_{CC}=5V, *3	*4
Transfer characteristics	Duty ratio	D_A	0.20	0.50	0.80		V_{CC}=5V, I_F=30mA f=2.5kHz	$\frac{t_{AH}}{t_{AP}}$ *4
		D_B	0.20	0.50	0.80			$\frac{t_{BH}}{t_{BP}}$ *4
	Response frequency	f_{max}	—	—	5	kHz	V_{CC}=5V, I_F=30mA	*4

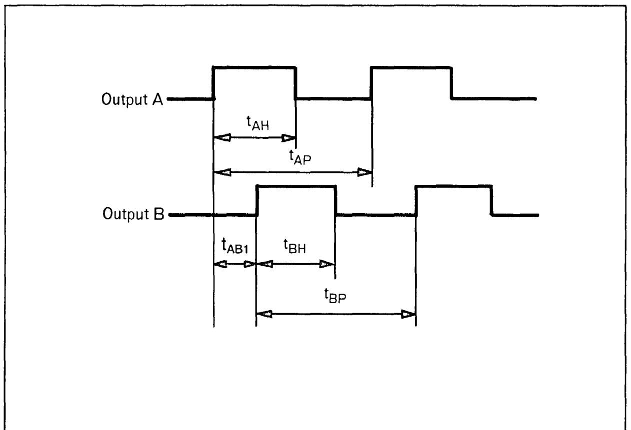
*3 Outputs A and B on low level
*4 Measured under the condition shown in 〈Measurement Condition〉

OPIC is a registered trademark of Sharp and stands for Optical IC It has a light detecting element and signal processing circuitry integrated into a single chip

□ Block Diagram



□ Output Waveforms



Rotational direction: Counterclockwise when seen from OPIC lightdetector side.

Fig.1 Forward current vs. ambient temperature

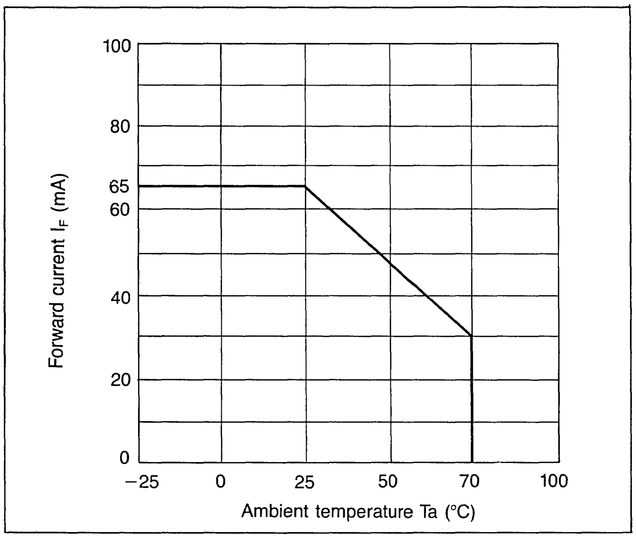


Fig.2 Output power dissipation vs. ambient temperature

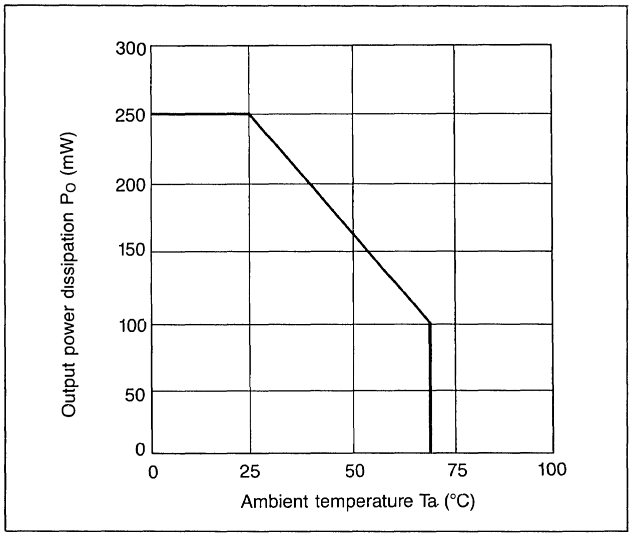


Fig.3 Duty ratio vs. frequency

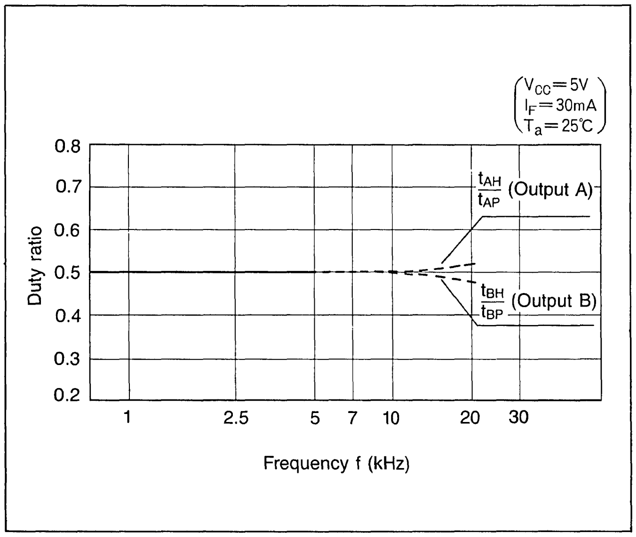


Fig.4 Phase difference vs. frequency

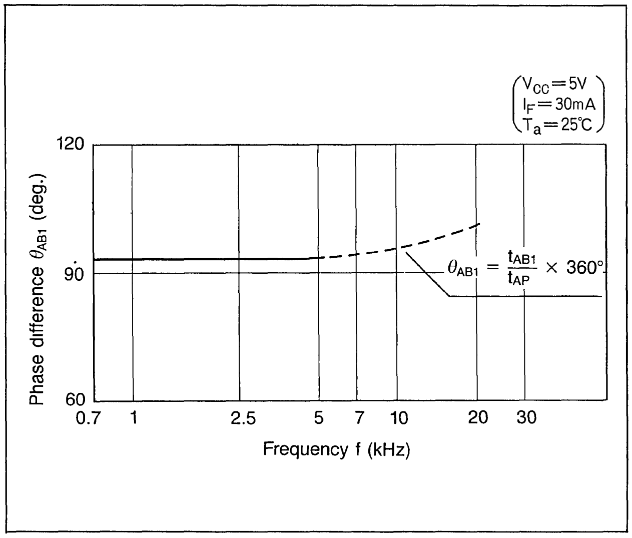


Fig.5 Duty ratio vs. ambient temperature

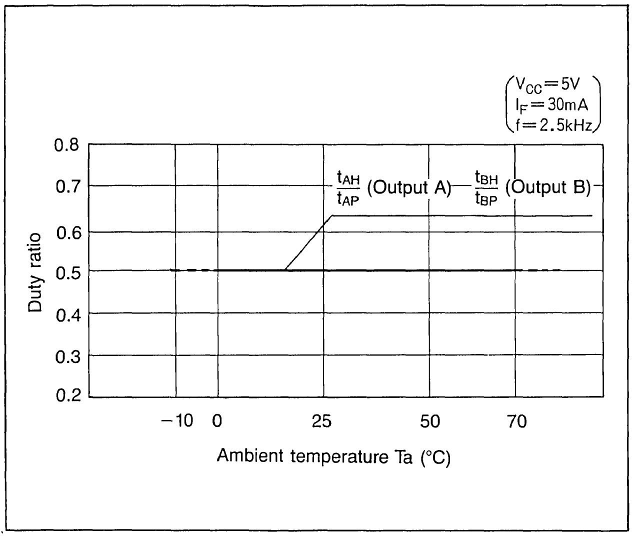


Fig.6 Phase difference vs. ambient temperature

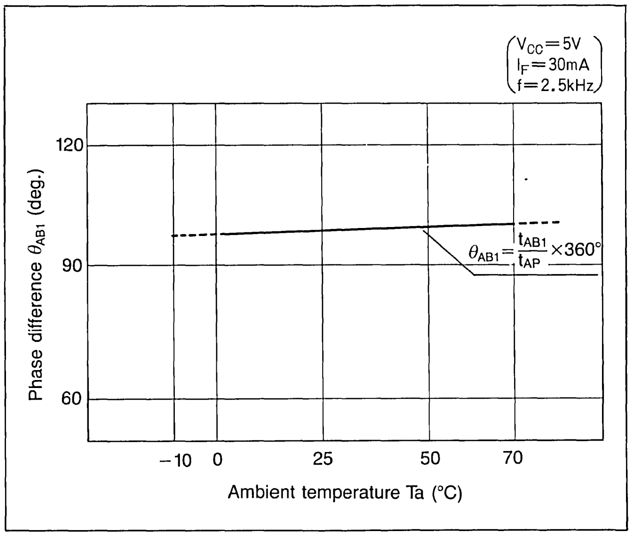


Fig.7 Duty ratio vs. distance (X direction)

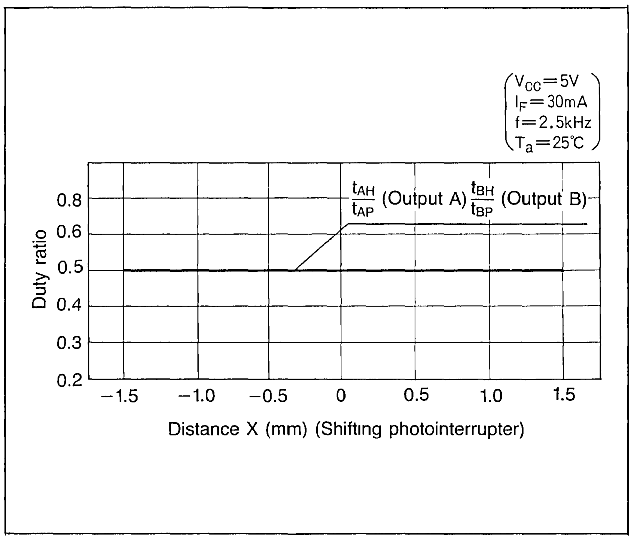


Fig.8 Phase difference vs. distance (X direction)

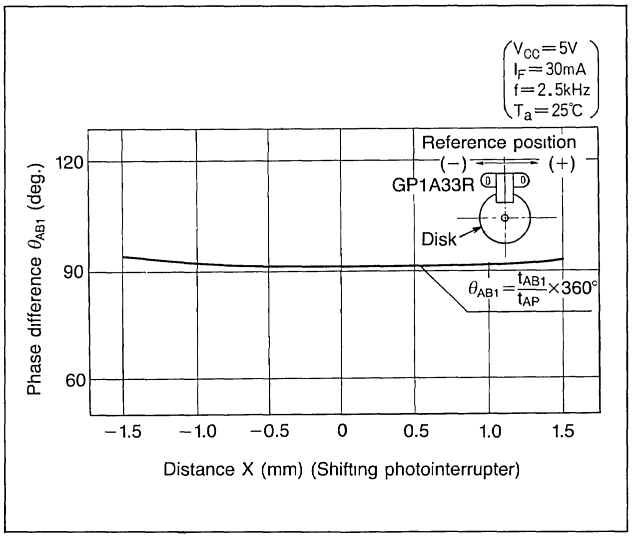


Fig.9 Duty ratio vs. distance (Y direction)

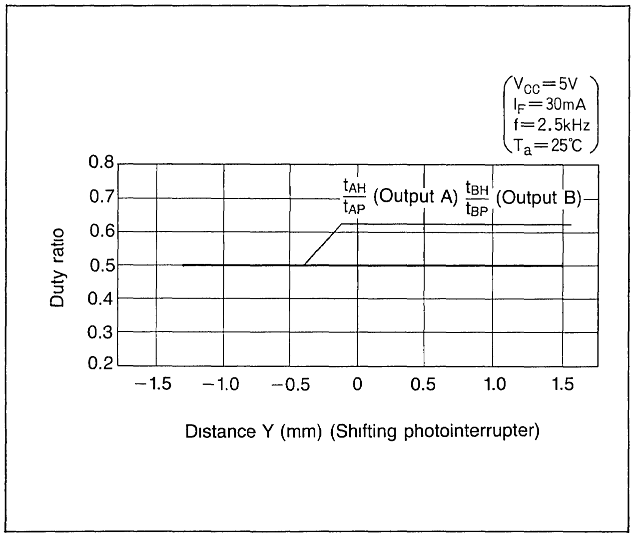


Fig.10 Phase difference vs. distance (Y direction)

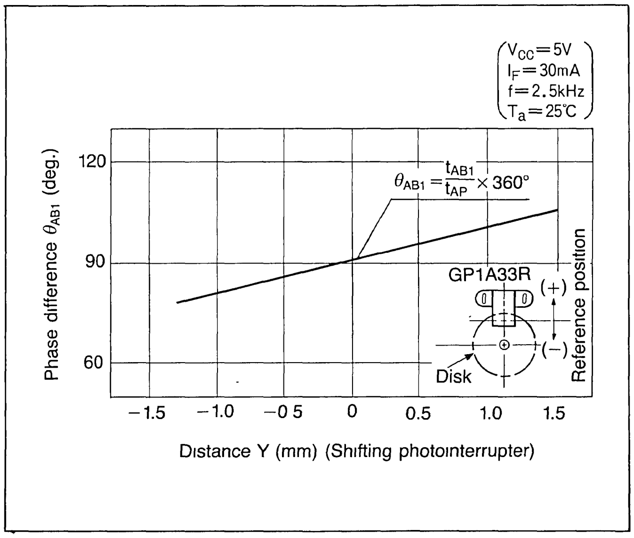


Fig.11 Duty ratio vs. distance (Z direction)

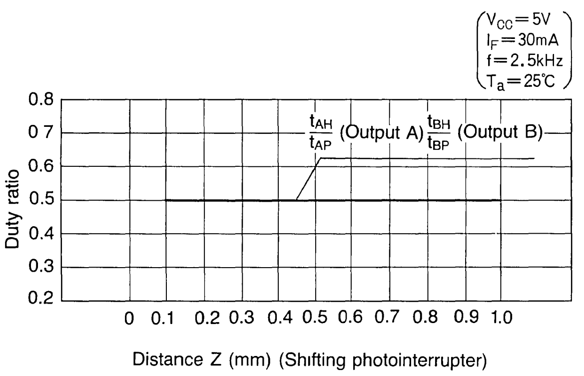
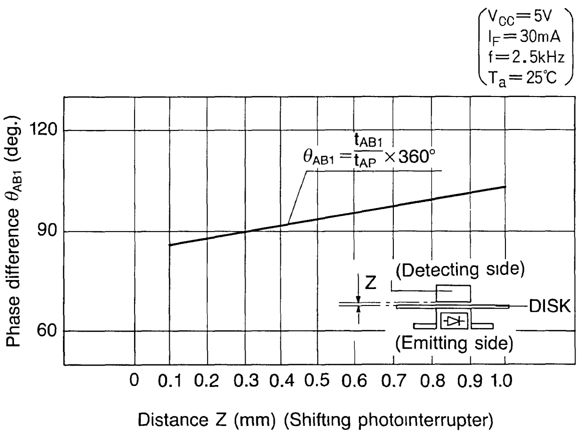
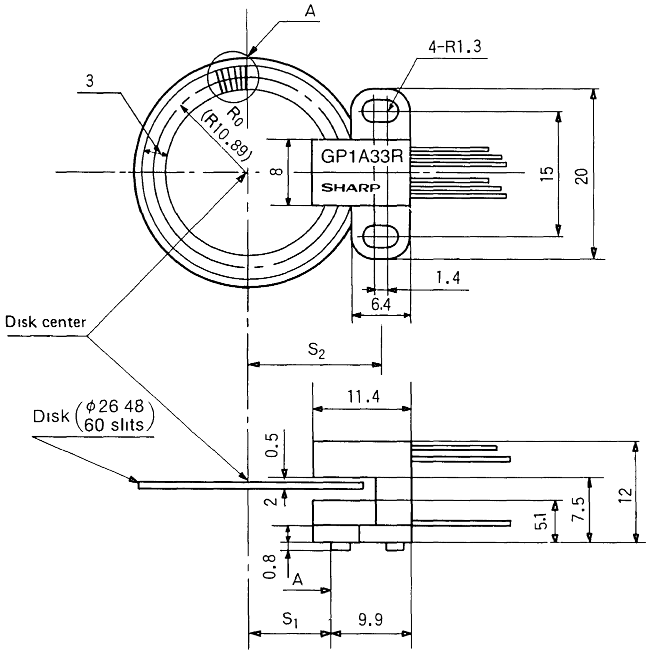


Fig.12 Phase difference vs. distance (Z direction)



<Measurement Conditon>



⟨Basic Design⟩

R_O (distance between the disk center and half point of a slit), P (slit pitch) and S_1, S_2 (installing position of photointerrupter) will be provided by the following equations.

Slit pitch: P (slit center)

$R_O = \frac{N}{60} \times 10.89$ (mm)   N: Number of slits

$P = \frac{2\pi R_O}{N}$

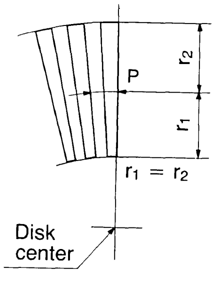
$S_1 = R_O - 1.765$ (mm)

$S_2 = S_1 + 6.7$ (mm)

Note) When the number of slits is changed, values in parentheses are also changed according to the number of slits.

Enlarged drawing of A portion

Slit pitch: P Detailed drawing



Example when 200P/R disk is used:

$R_O = \frac{100}{60} \times 10.89$
$= 18.15$ (mm)

$P = \frac{2 \times \pi \times 18.15}{100}$
$= 1.14$ (mm)

$S_1 = 18.15 - 1.765$
$= 16.385$ (mm)

$S_2 = 16.385 + 6.7$
$= 23.085$ (mm)

☐ Suggestion for Use

1) In order to stabilize power supply line, connect a by-pass capacitor of more than 0.01μF between V_{CC} and GND near the device.
2) This product is designed to be operated at I_F=30mA Typ.

☐ Specifications are subject to change without notice.

■ Specifications are subject to change without notice.

SHARP

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