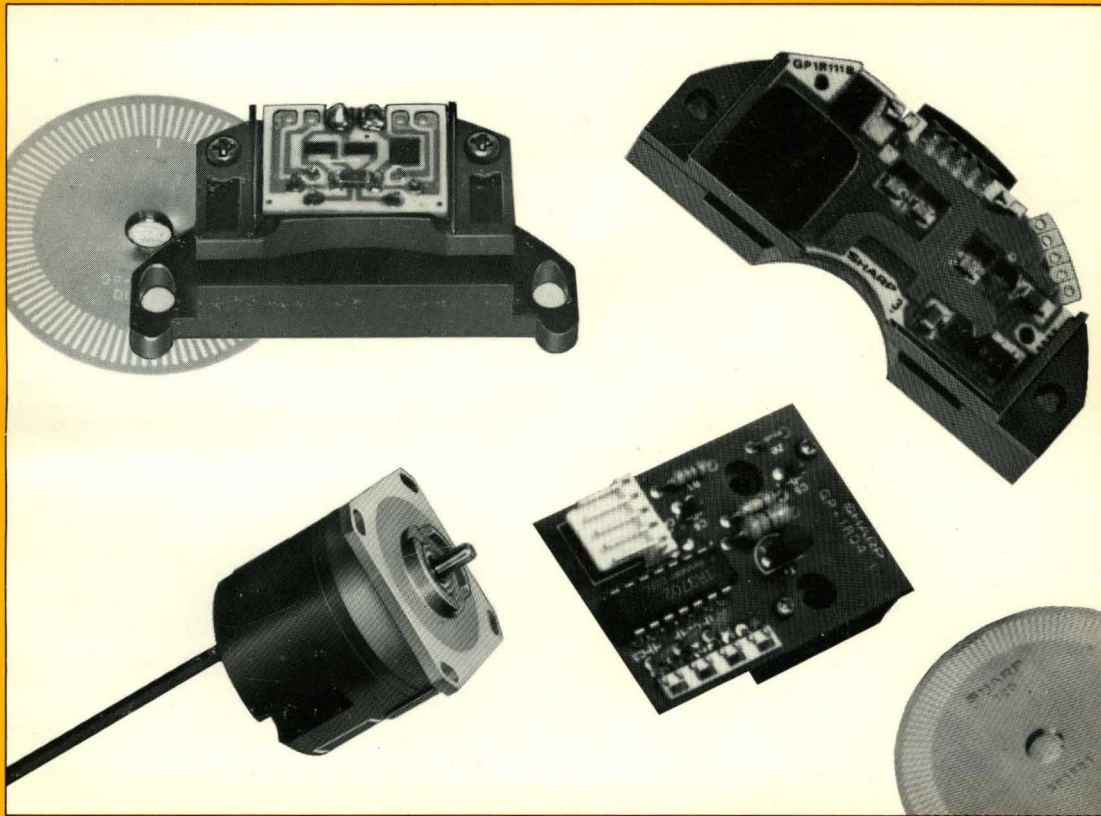


SHARP

ROTARY ENCODERS



SHARP ELECTRONIC COMPONENTS

《ROTARY ENCODERS》

1. General Description	1
2. Signal Processing Circuit of Analog Output Type Rotary Encoders	2
3. Signal Processing Circuit of Digital Output Type Rotary Encoders	4
4. Applications	6
5. Examples of Application Circuits	7
6. Systematic Diagram of SHARP Optical Rotary Encoders	9
7. Performance List for SHARP Optical Rotary Encoders	10
8. Data	
GP1R04 Series.....	11
GP1R14 Series.....	15
GP1R11	19
GP1R21	23
GP1R111 Series.....	27
GP1R23	33
GP1R52 Series.....	37
GP1A13R	41
GP1A16R	45
GP1A30R	49
GP1A33R	53



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.

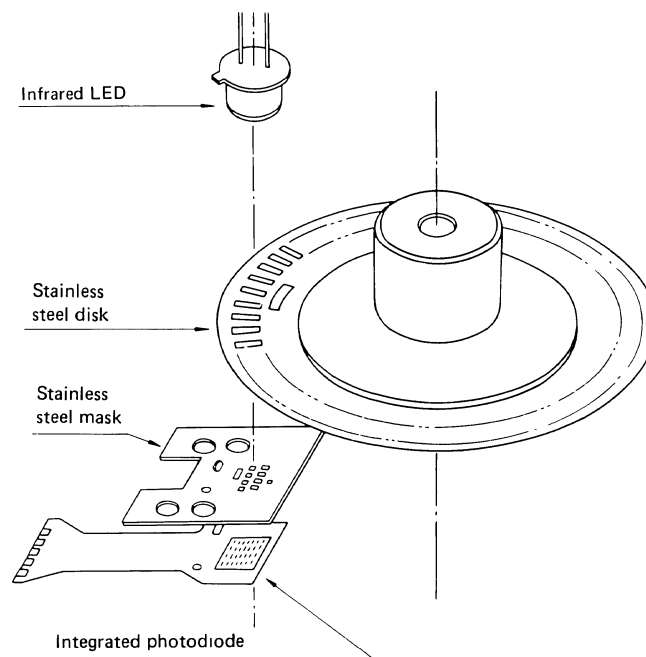


Fig. 1 Structures of optical rotary encoder

(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.

$$\text{Output A: } V_A \cong V_{AP} \sin(N \times \theta) \qquad \text{Output B: } V_B \cong V_{BP} \cos(N \times \theta)$$

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.

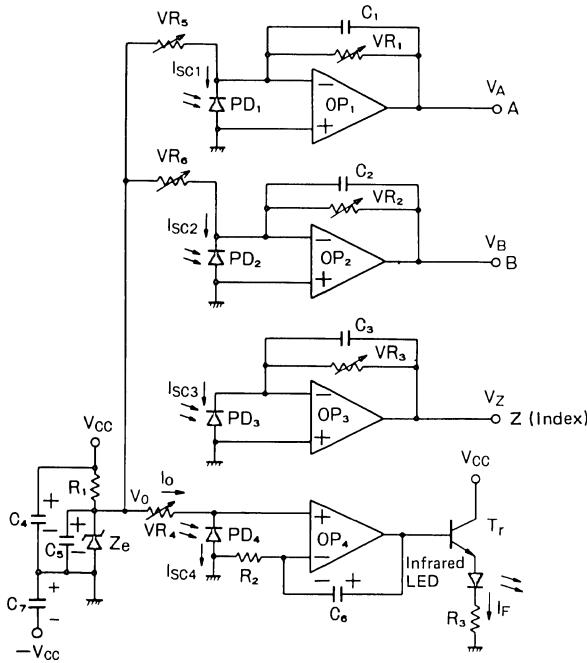


Fig. 2 Signal processing circuit of GP1R14

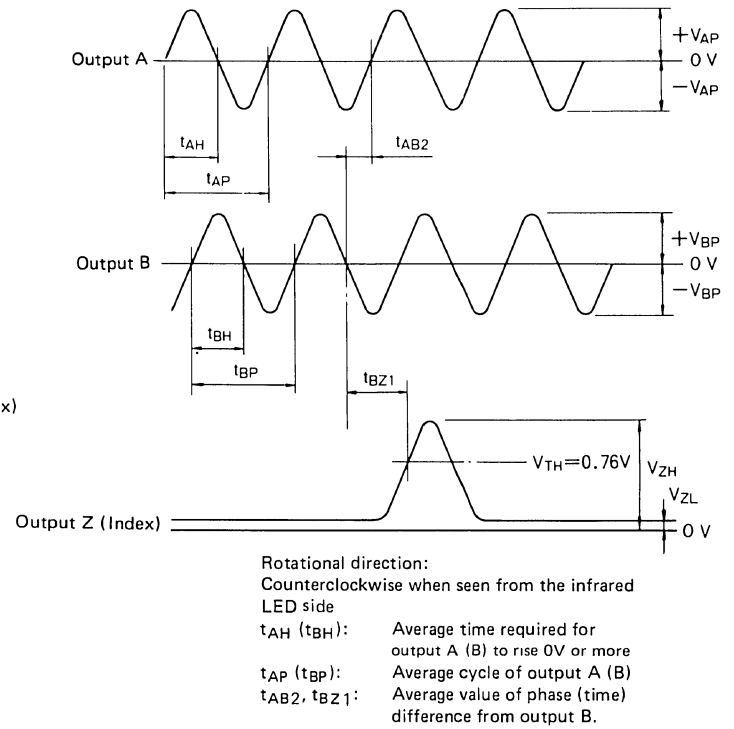


Fig. 3 Output waveforms of GP1R14

(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.

$$V_A \cong V_{AP} \cdot N \cdot \theta$$

$$V_B \cong V_{BP} \cdot N \cdot \theta$$

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 , $V_{\bar{B}}$, V_{outA} and V_{outB} 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.

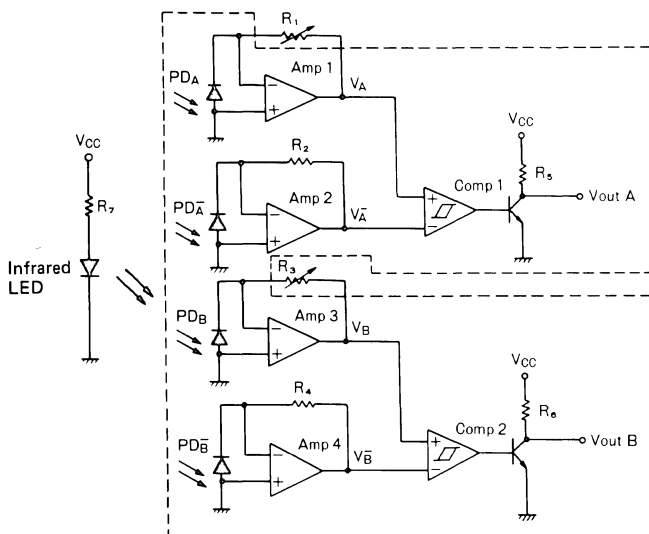


Fig. 4 Signal processing circuit of GP1R11

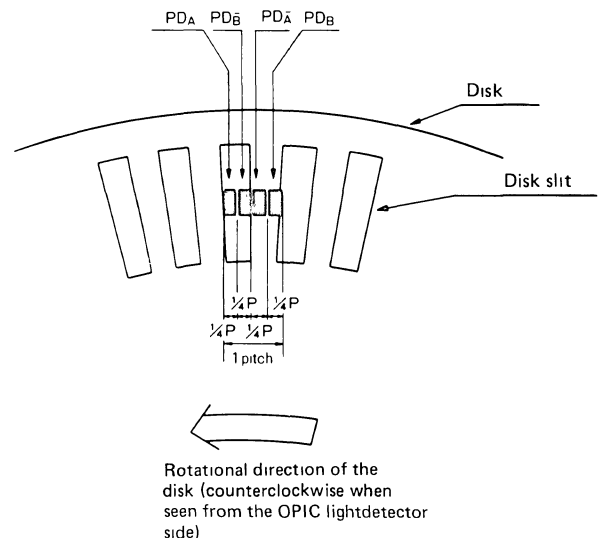


Fig. 5 Relative position of the disk slits and the photodiodes

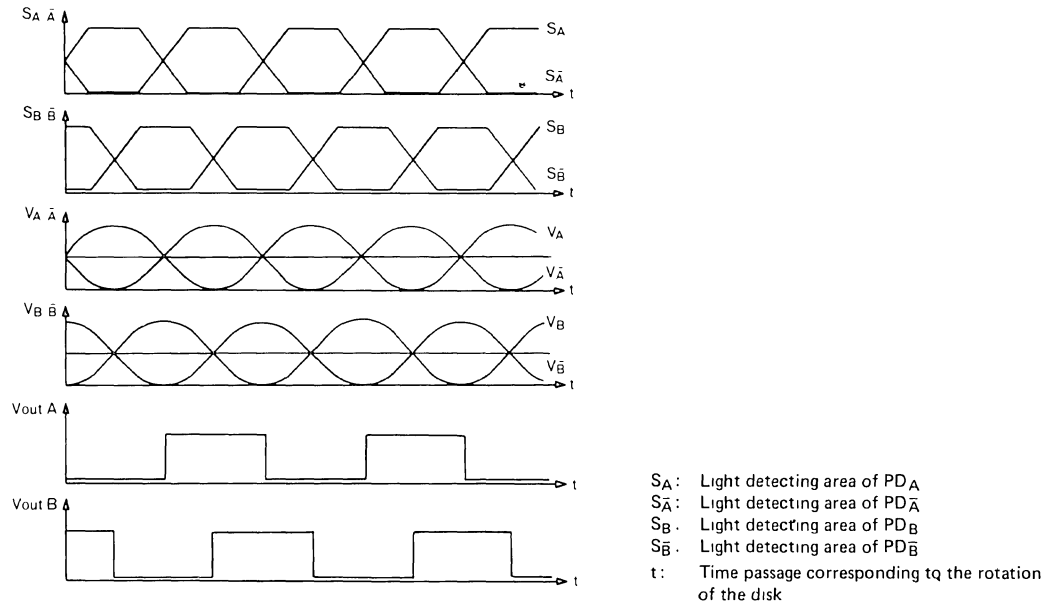


Fig. 6 Variations in the light detecting areas of the photodiode (PD) and voltage waveforms

(2) Output waveforms

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

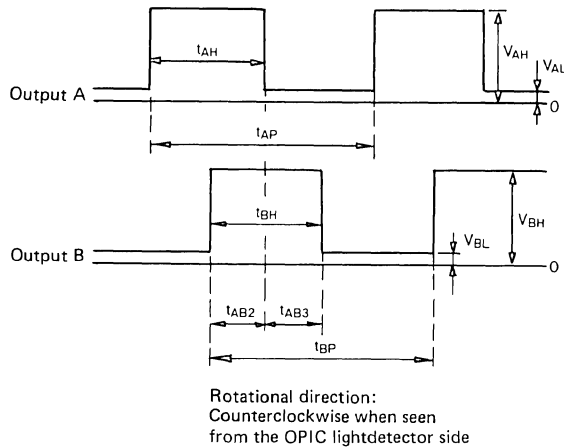


Fig. 7 Output waveforms of GP1R11

(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.

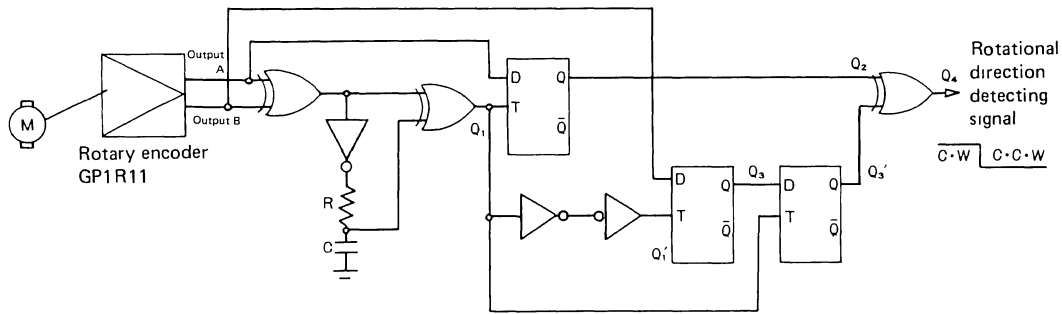


Fig. 8(a) Rotational direction detecting circuit using a rotary encoder

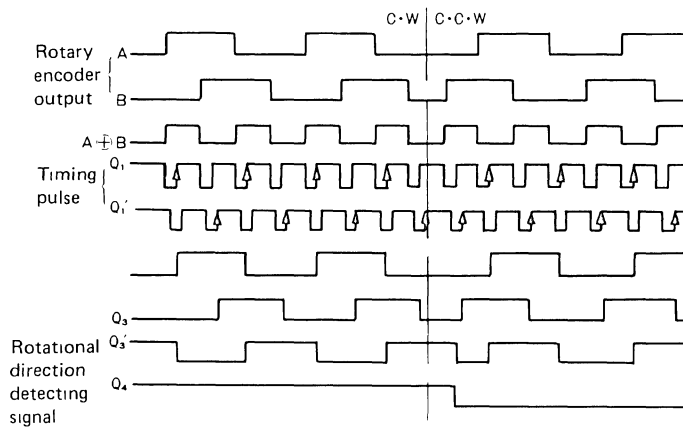


Fig. 8(b) Time chart

(2) DC servo motor control by rotary encoder

In the angle, the position or rotational speed control for mechatronic systems, which requires high speed responses, the DC servo 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 servo motor control system using the rotary encoder. Table 1 shows the general specifications of the board computer LH8H21 (designed exclusively for DC servo motor) which can be directly interface with the GP1R14 rotary encoder.

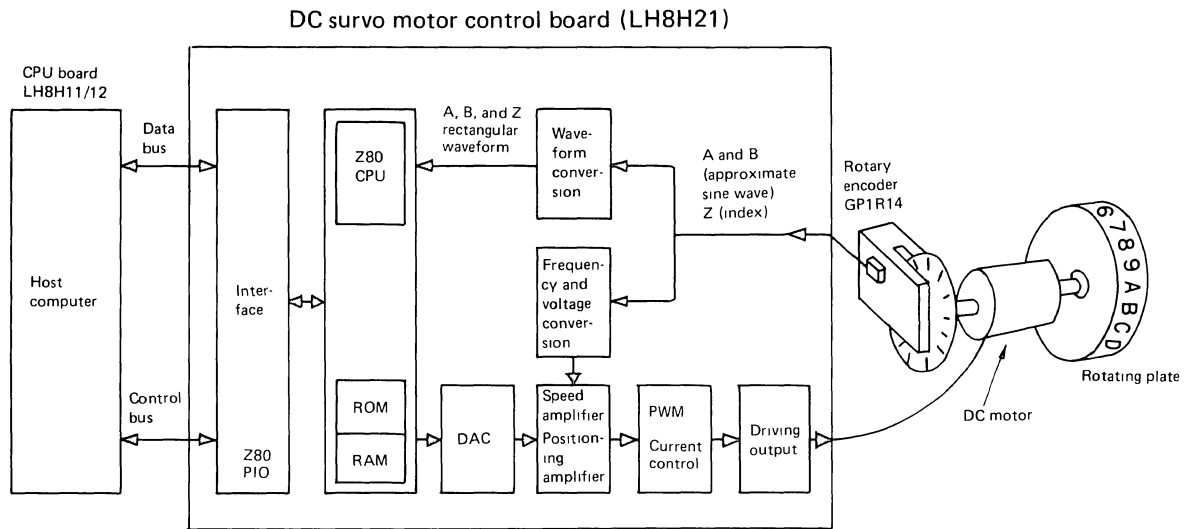
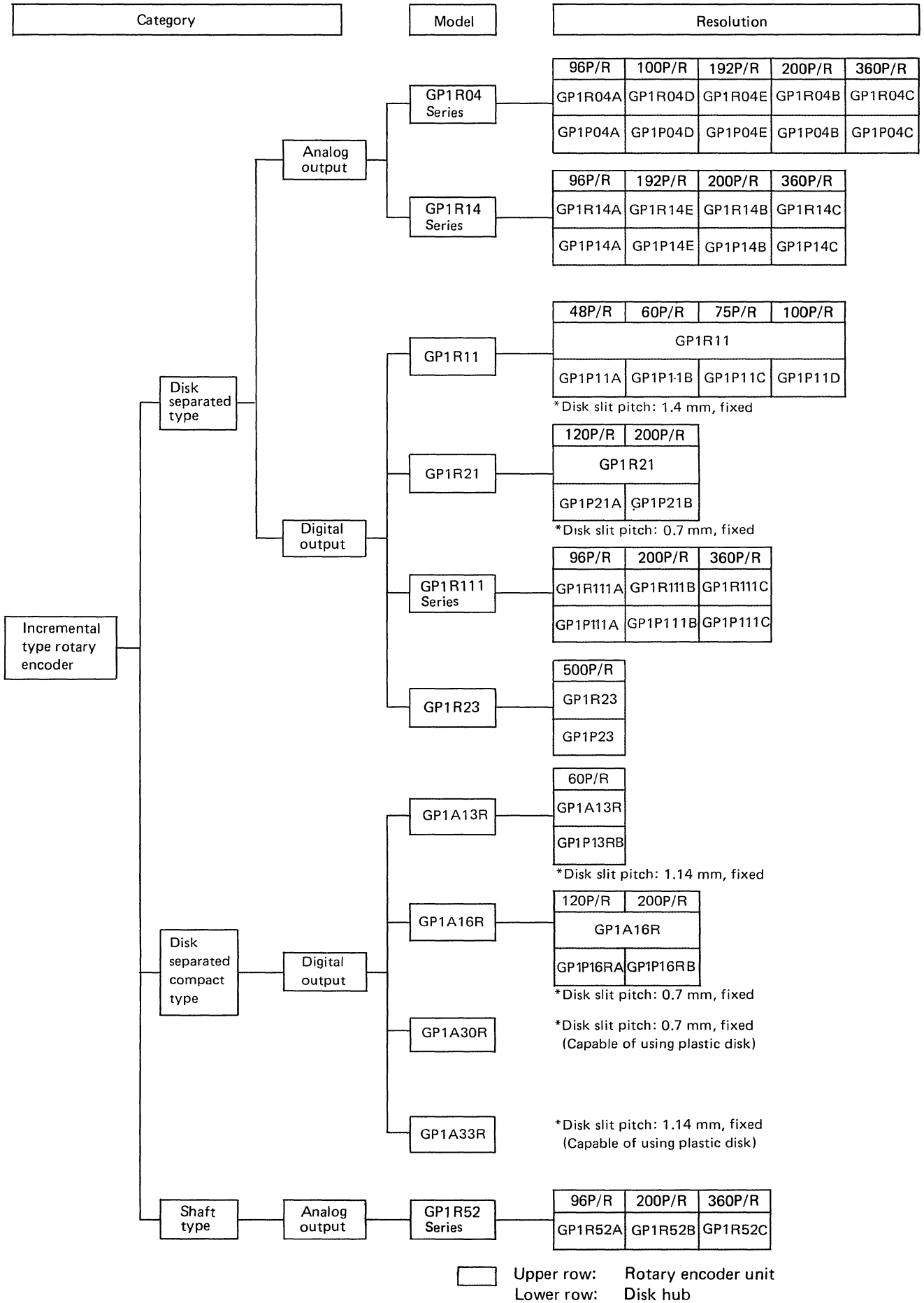


Fig. 9 Composition of the DC servo motor control system

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

Item	Specification	
Control method	Analog servo 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	

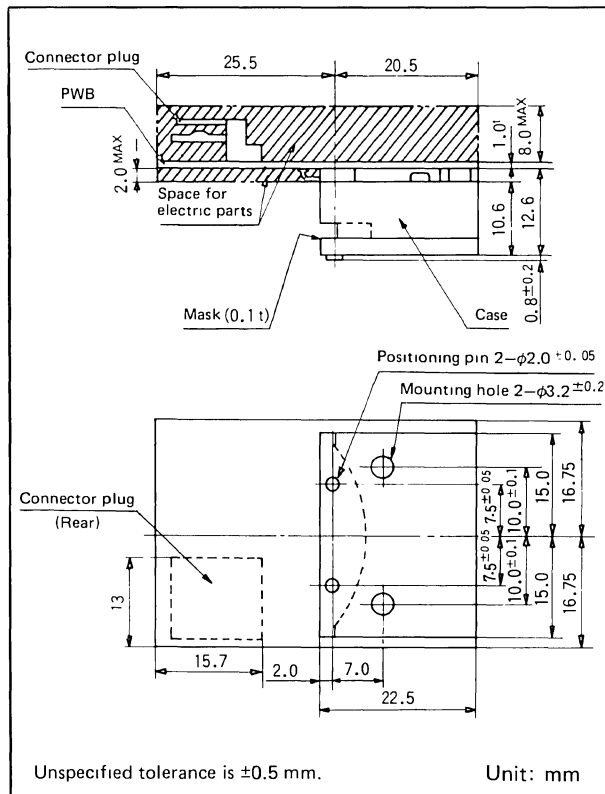
6. Systematic Diagram of SHARP Optical Rotary Encoders



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} ($^{\circ}$ C)	Storage temperature T_{stg} ($^{\circ}$ C)	Operating voltage V_{CC} (V)	Output waveforms	Frequency response (kHz)	R_L (k Ω)	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	$I_F = 20\text{mA}$	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	$I_F = 20\text{mA}$	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	$I_F = 30\text{mA}$	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	$I_F = 30\text{mA}$	MAX. 20

Outline Dimensions



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 frequency 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

($T_a = 25^\circ\text{C}$)

Parameter	Symbol	Rating	Unit
*1 Supply voltage	V_{CC}	8	V
Min. load resistance on output side	R_L	5.0	$k\Omega$
Operating temperature	T_{opr}	0 ~ +70	$^\circ\text{C}$
Storage temperature	T_{stg}	-40 ~ +80	$^\circ\text{C}$

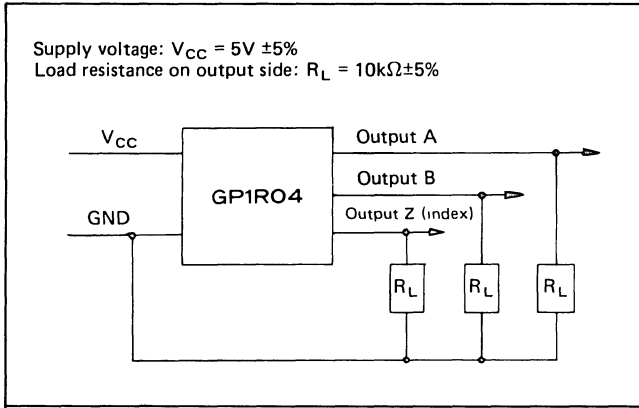
*1 Power must not be turned on when the feedback cell is optically shut off.

Electrical Characteristics

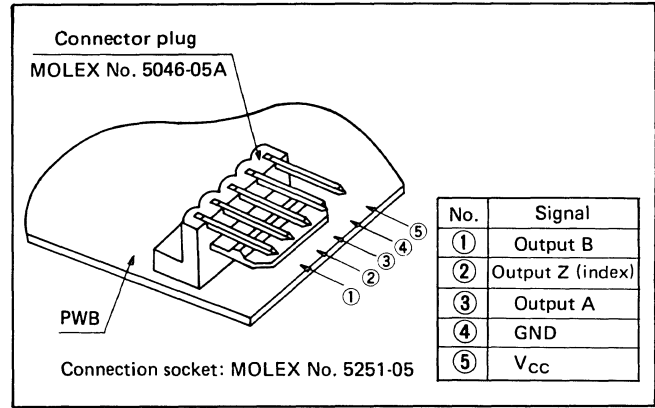
($V_{CC} = 5\text{V}$, $R_L = 10k\Omega$, $T_a = 25^\circ\text{C}$)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark
Duty ratio	D_A	0.45	0.50	0.55		$t_{AP} = DC \sim 0.5$ ms $V_{TH} = 1.5\text{V}$	$\frac{t_{AH}}{t_{AP}}$
	D_B	0.45	0.50	0.55		$t_{BP} = DC \sim 0.5$ ms $V_{TH} = 1.5\text{V}$	$\frac{t_{BH}}{t_{BP}}$
Phase difference	GP1R04A	75	90	105	deg.	$t_{AP} = DC \sim 0.5$ ms	$\frac{t_{AB1}}{t_{AP}} \times 360^\circ$
	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	$t_{AP} = DC \sim 5$ ms	
	V_{ZL}	-	-	0.6	V		
•Dissipation current	I_{TOT}	-	-	70	mA		

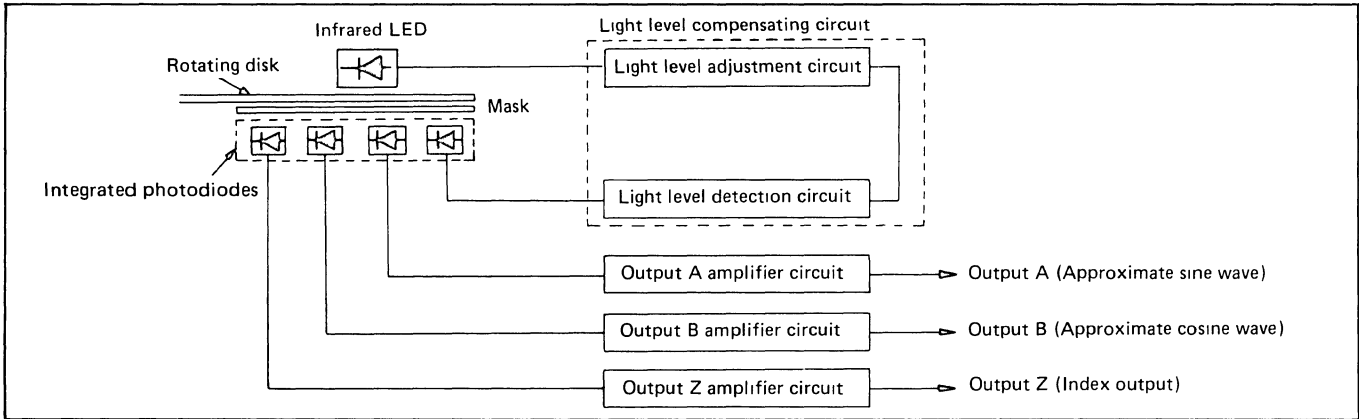
Test Circuit for Electrical Characteristics



Connector Pin Configuration



Block Diagram



Output Waveforms

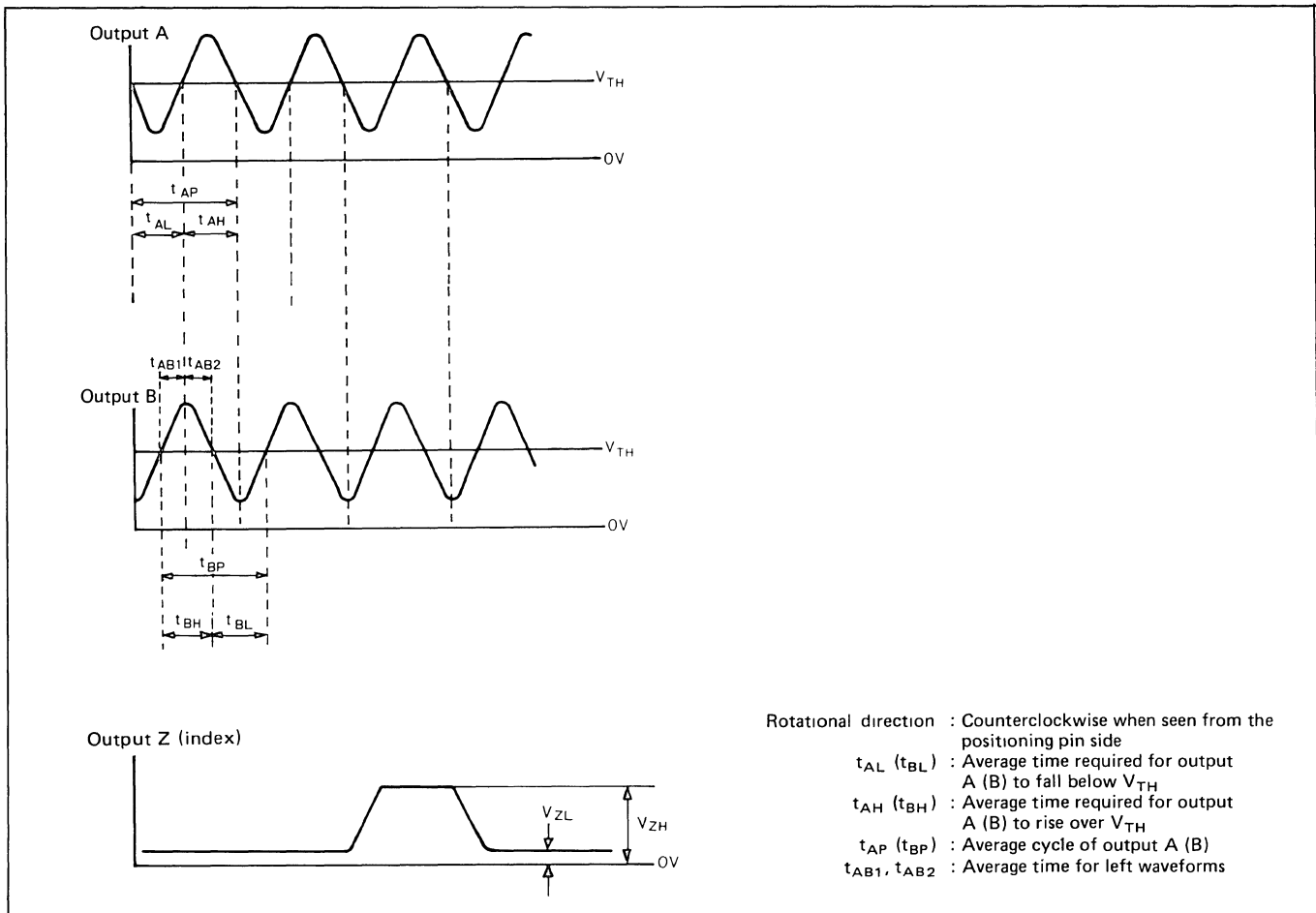


Fig. 1 Supply voltage vs. relative output

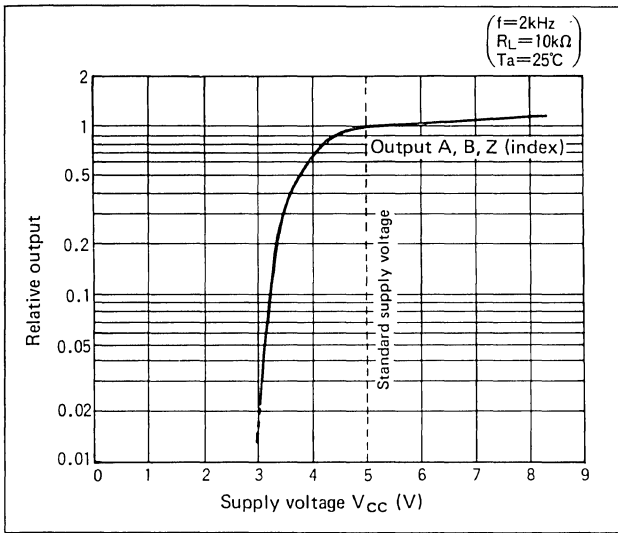


Fig. 2 Frequency response

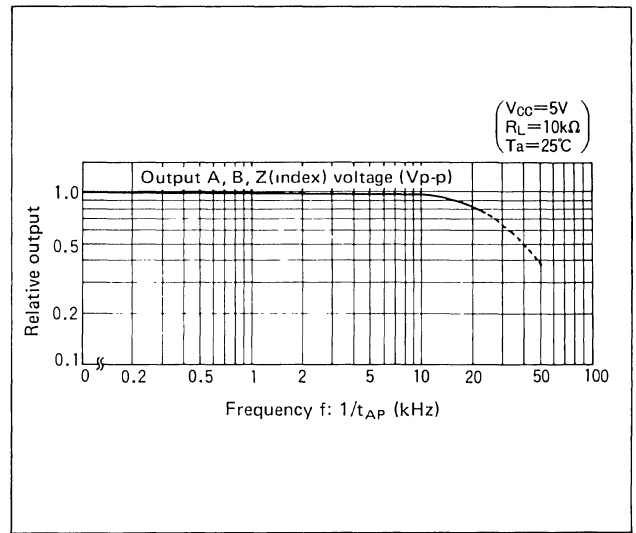


Fig. 3 Frequency vs. duty ratio

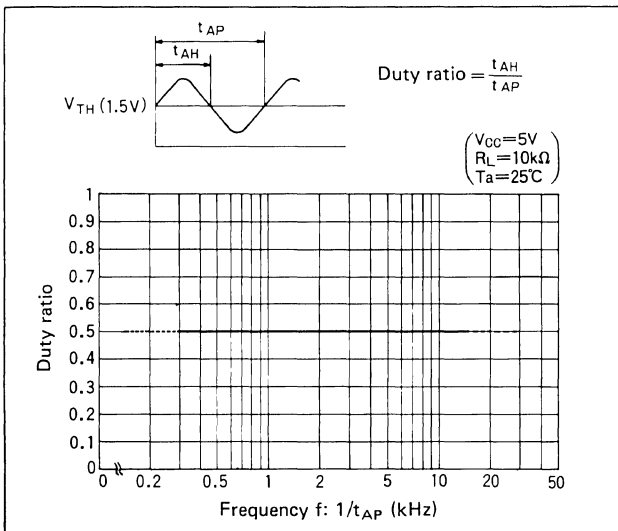
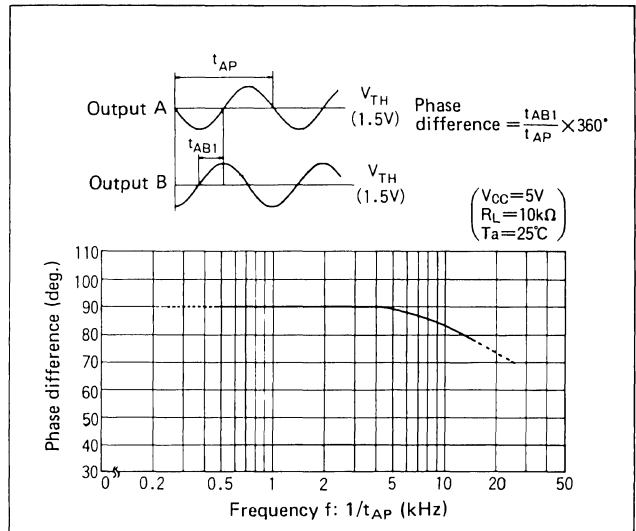
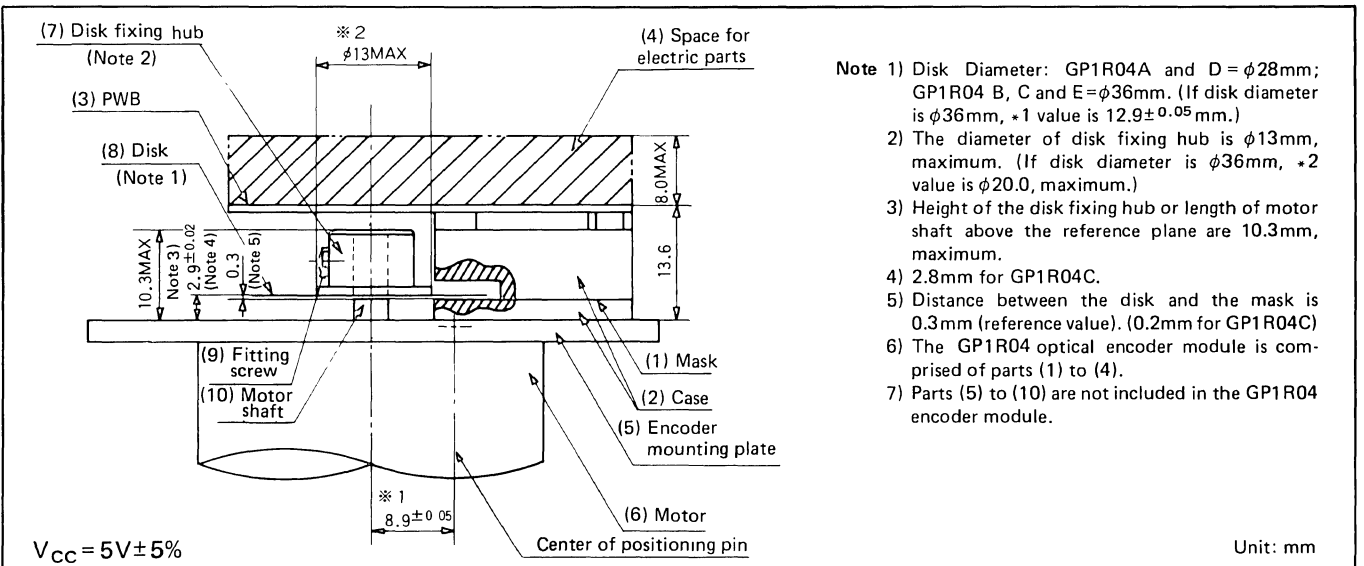


Fig. 4 Frequency vs. phase difference



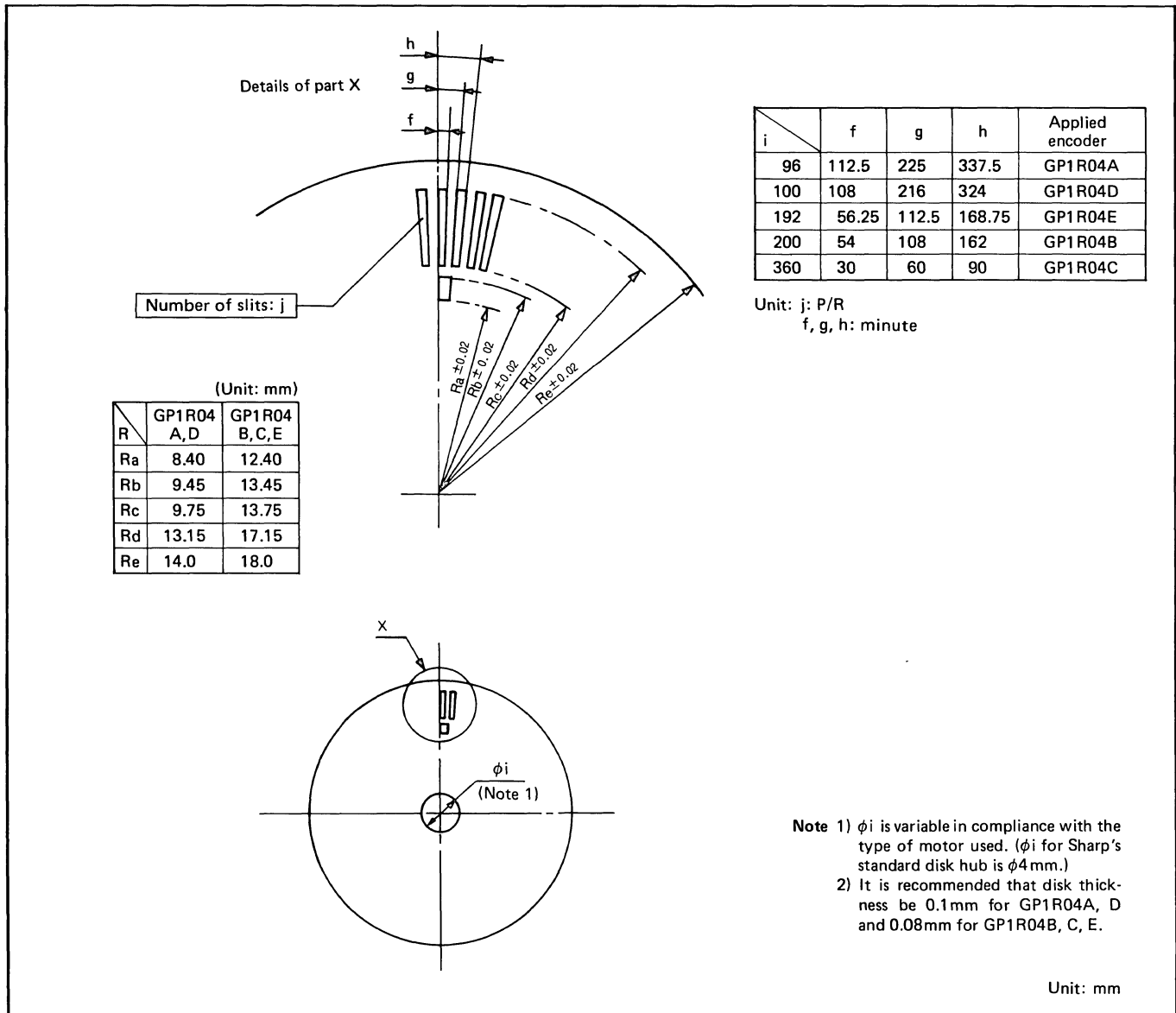
□ Suggestion for Use

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



Disk Design

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



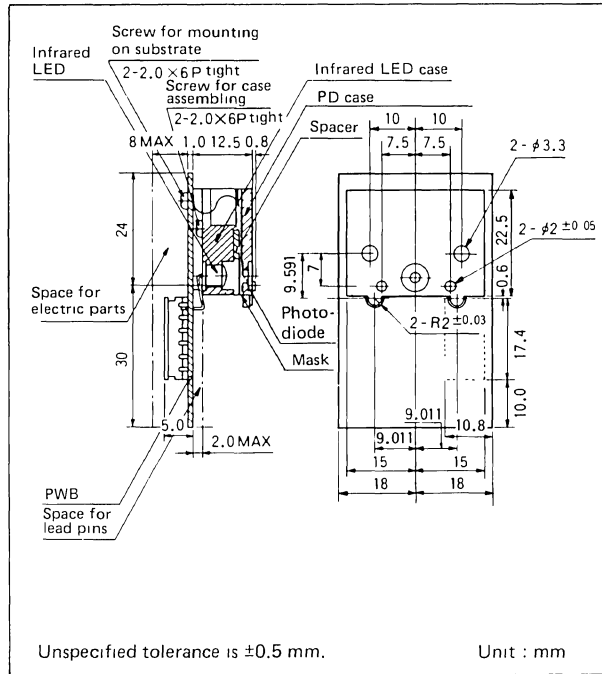
The disks shown below are available as optional parts.

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 encoder to be used with.

Specifications are subject to change without notice.

Outline Dimensions



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.	Resolution (P/R)
GP1R14A	96
GP1R14B	200
GP1R14C	360
GP1R14E	192

Features

- (1) Easily interfaced with an analog circuit due to the $\pm 12V$ 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

($T_a = 25^\circ C$)

Parameter	Symbol	Rating	Unit
*1 Supply voltage	V_{CC}	± 15	V
Min. load resistance on output side	R_L	5.0	$k\Omega$
Operating temperature	T_{opr}	$0 \sim +70$	$^\circ C$
Storage temperature	T_{stg}	$-40 \sim +80$	$^\circ C$

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

Electrical Characteristics

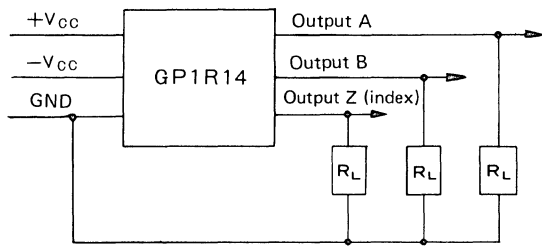
($V_{CC} = \pm 12V$, $R_L = 10k\Omega$, $T_a = 25^\circ C$)

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

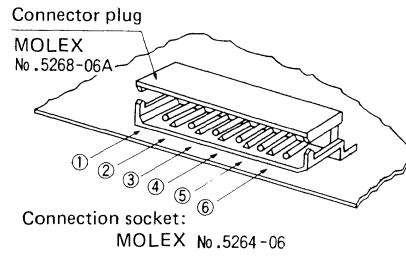
*2. Ripples shall be absolute values measured under the following conditions; Disk pitch tolerance : $\pm 10\mu m$
Disk slit tolerance : $\pm 20\mu m$
Disk deflection range : $\pm 60\mu m$

Test Circuit for Electrical Characteristics

Supply voltage $V_{CC} = \pm 12V \pm 5\%$
 Load resistance on output side $R_L = 10k\Omega \pm 5\%$

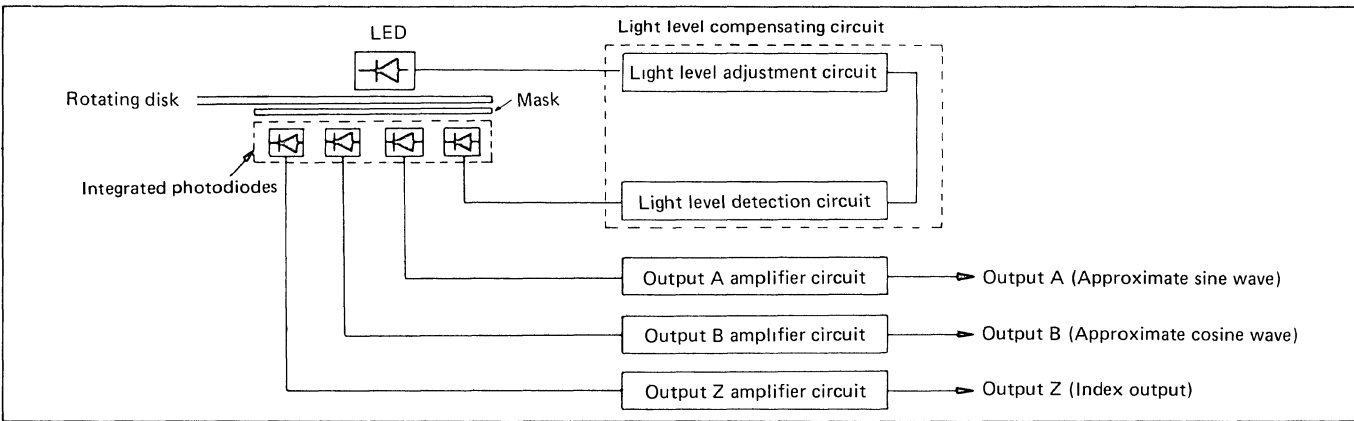


Connector Pin Configuration

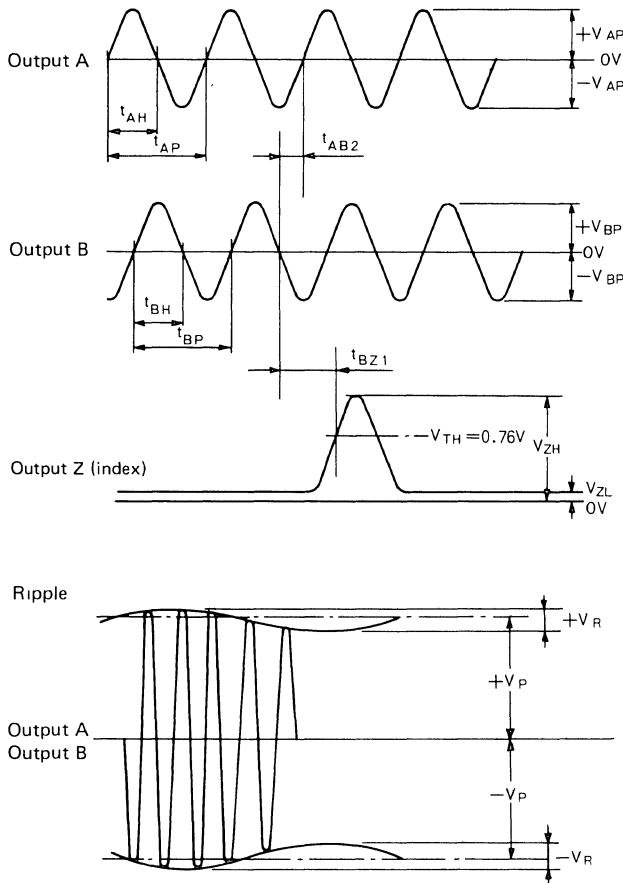


No.	Signal
①	V_{CC} (+12V)
②	GND (0V)
③	V_{CC} (-12V)
④	Output A
⑤	Output B
⑥	Output Z (index)

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

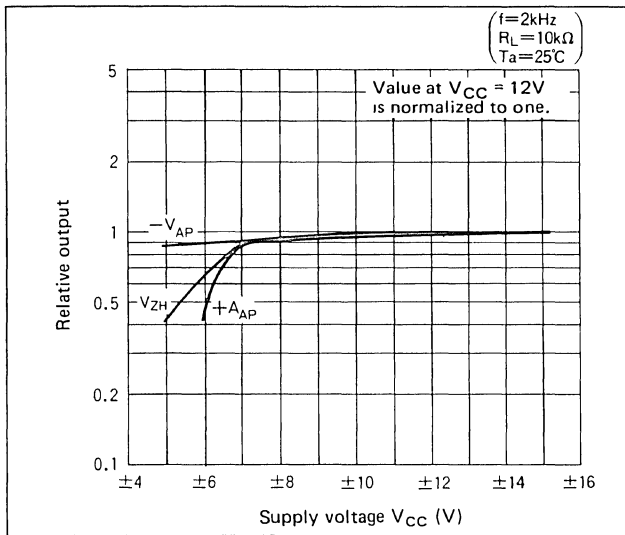


Fig. 2 Frequency response

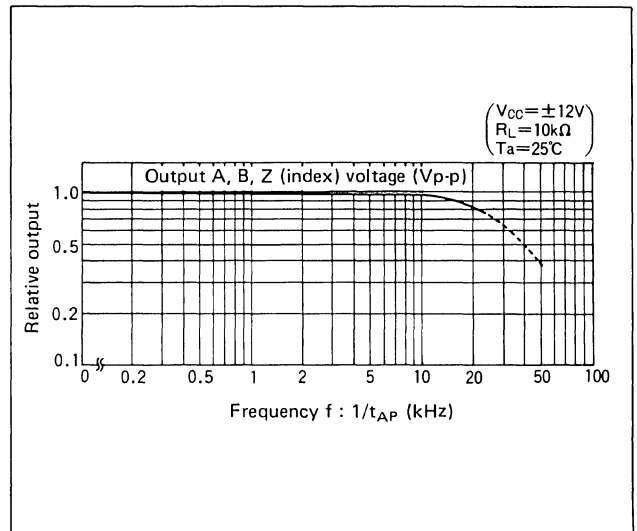


Fig. 3 Frequency vs. duty ratio

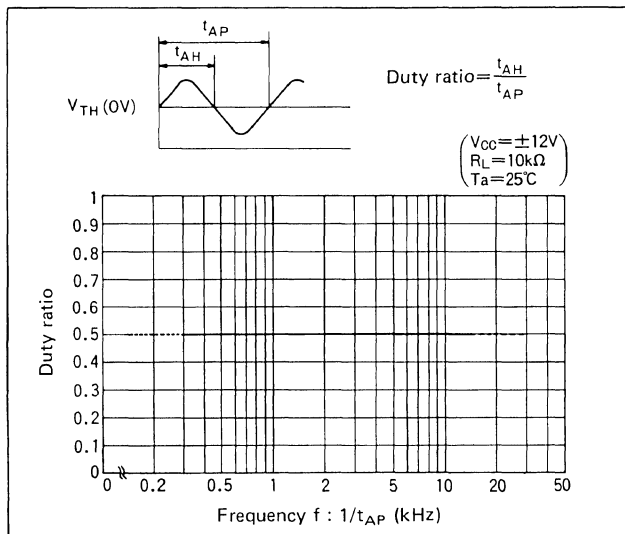
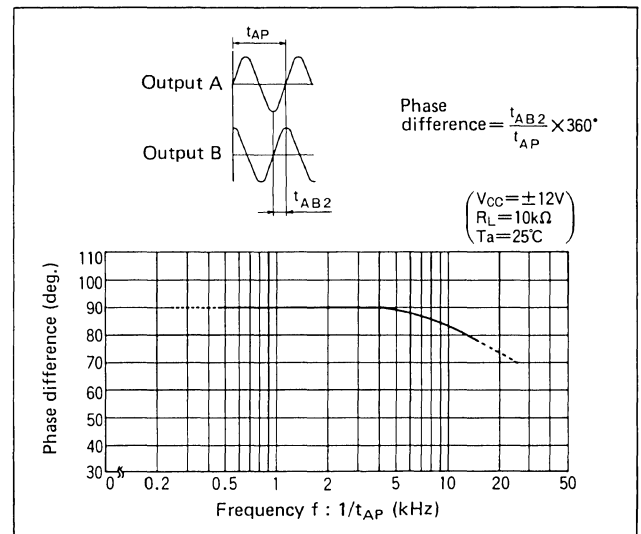
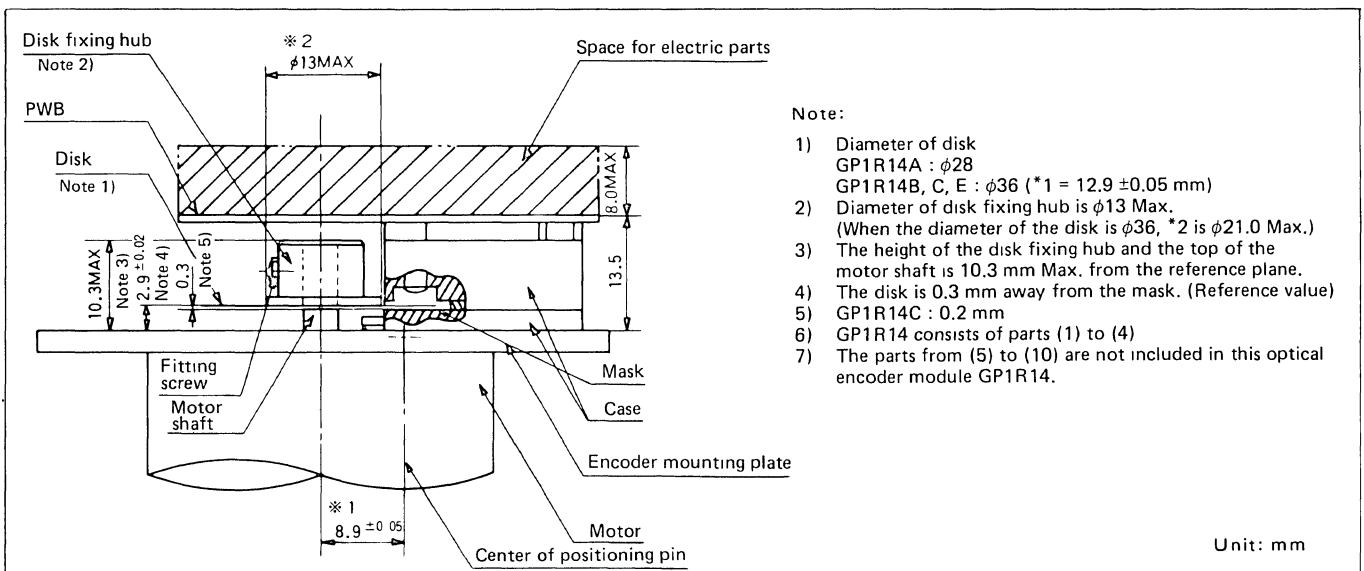


Fig. 4 Frequency vs. phase difference



☐ Suggestion for Use

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



Disk Design

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

Details of part X

Number of slits: j

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

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

Note 1) ϕ_i is variable in compliance with the type of motor used. (ϕ_i for Sharp's standard disk hub is $\phi 4$ 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

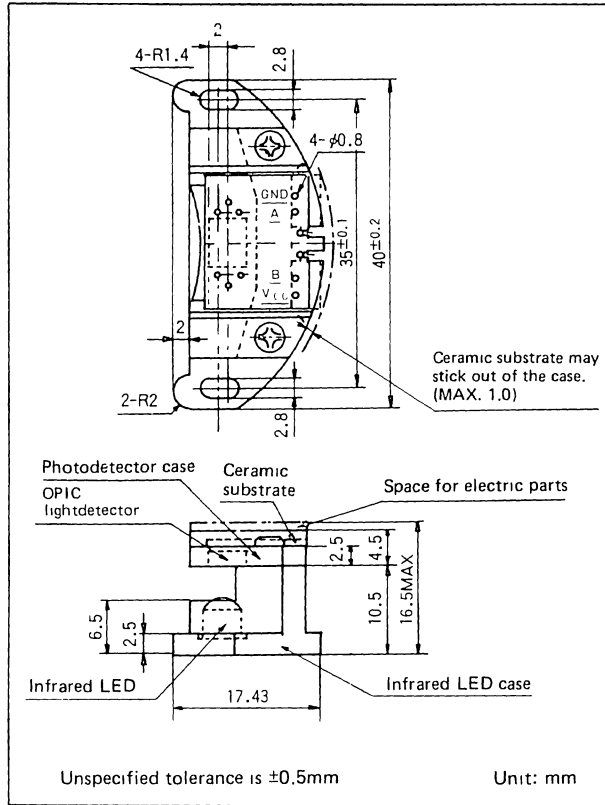
The disks shown below are available as optional parts.

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.

Outline Dimensions



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 light detector (light detector 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 light detector
- (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

($T_a = 25^\circ\text{C}$)

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

Electrical Characteristics

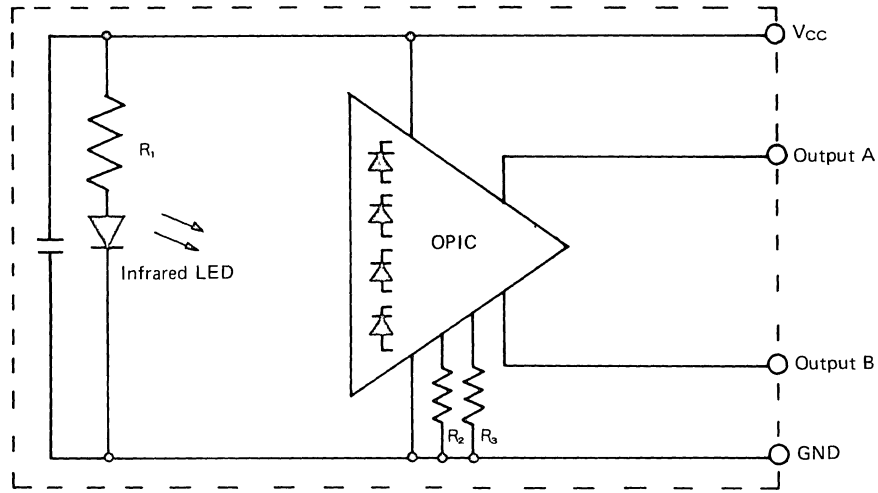
($V_{CC} = 5\text{V}$, $T_a = 0 \sim +70^\circ\text{C}$ unless specified)

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	$V_{CC} = 4.5\text{V}$, $I_{OH} = -200\mu\text{A}$	
	Low level	V_{AL}, V_{BL}	—	0.2	0.4	V	$I_{OL} = 16\text{mA}$	
*1 Duty ratio	D_A	0.45	0.50	0.55		$f = \text{DC} \sim 2.5\text{kHz}$	$\frac{V_{AH}}{V_{AP}}$	
	D_B	0.45	0.50	0.55			$\frac{V_{BH}}{V_{BP}}$	
*1 Phase difference	θ_{AB2}	60	90	120	deg.	$f = \text{DC} \sim 2.5\text{kHz}$	$\frac{V_{AB2}}{V_{AP}} \times 360^\circ$	
	θ_{AB3}						$\frac{V_{AB3}}{V_{AP}} \times 360^\circ$	
Response time	t_r	—	0.2	0.5	μs	$T_a = 25^\circ\text{C}$		
	t_f	—	0.1	0.5				
Response frequency	f_{max}	—	—	10	kHz	$T_a = 25^\circ\text{C}$		
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.

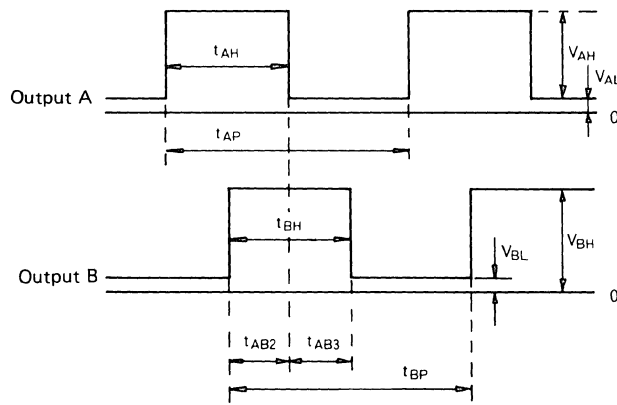
OPIC is a registered trademark of Sharp and stands for Optical IC. It has a light detecting element and signal processing circuitry integrated into a single chip.

Block Diagram

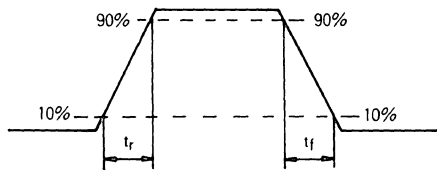


Supply voltage $V_{CC} = 5.0V \pm 5\%$
 Output pull-up resistance = $2k\Omega$ (incorporated in the encoder)

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)

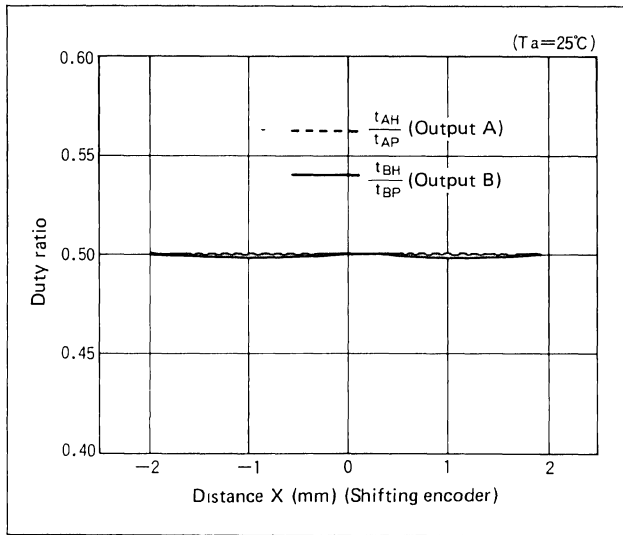


Fig. 2 Phase difference vs. distance (X direction)

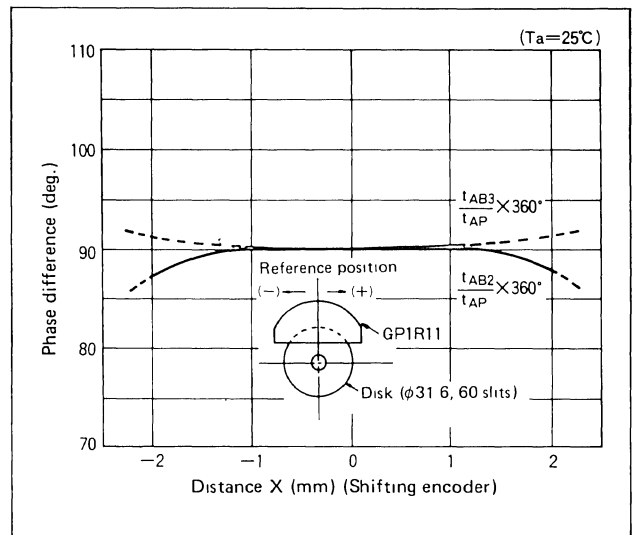


Fig. 3 Duty ratio vs. distance (Y direction)

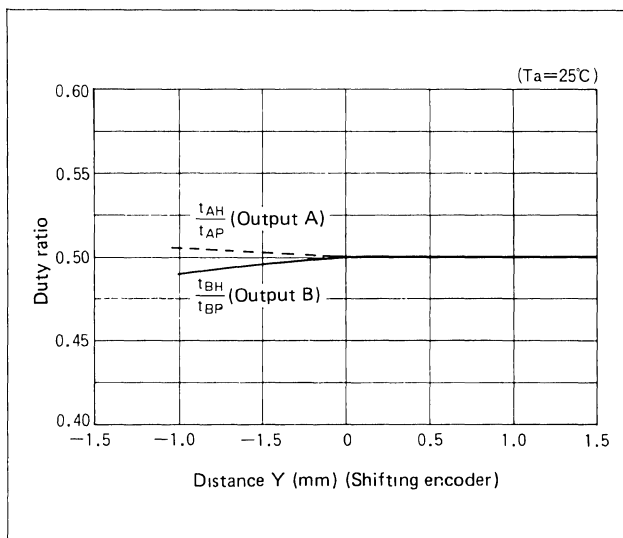


Fig. 4 Phase difference vs. distance (Y direction)

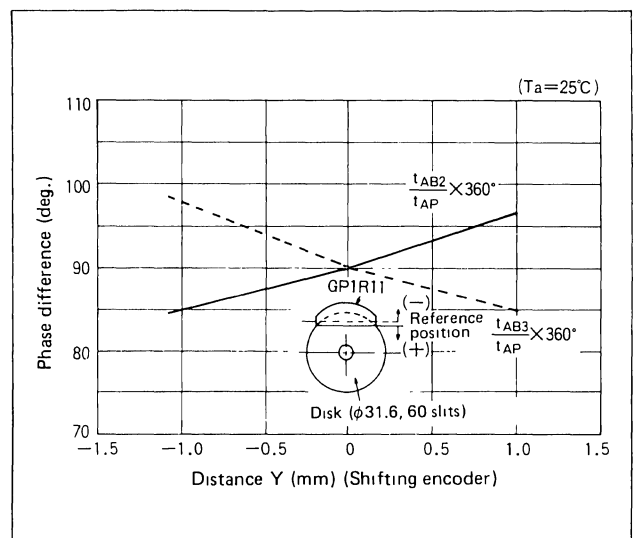


Fig. 5 Duty ratio vs. distance (Z direction)

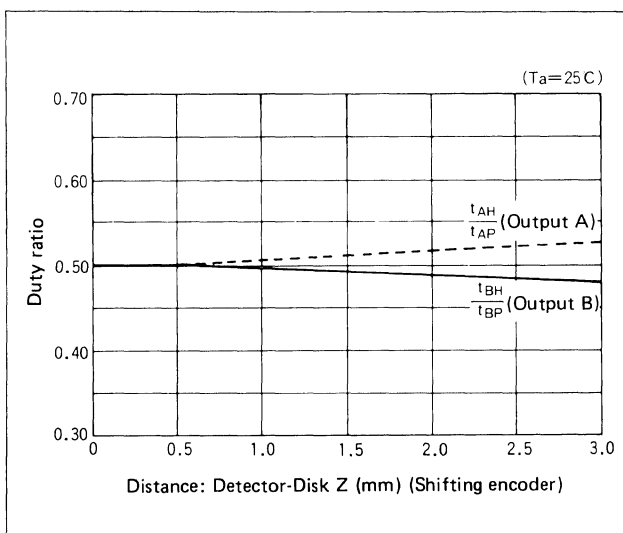
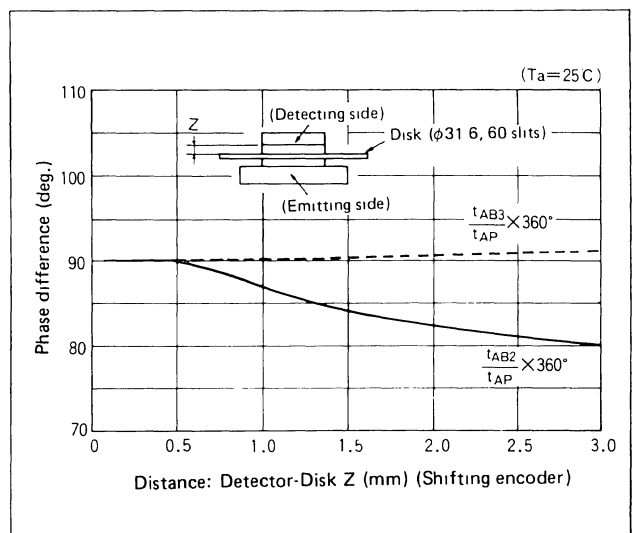
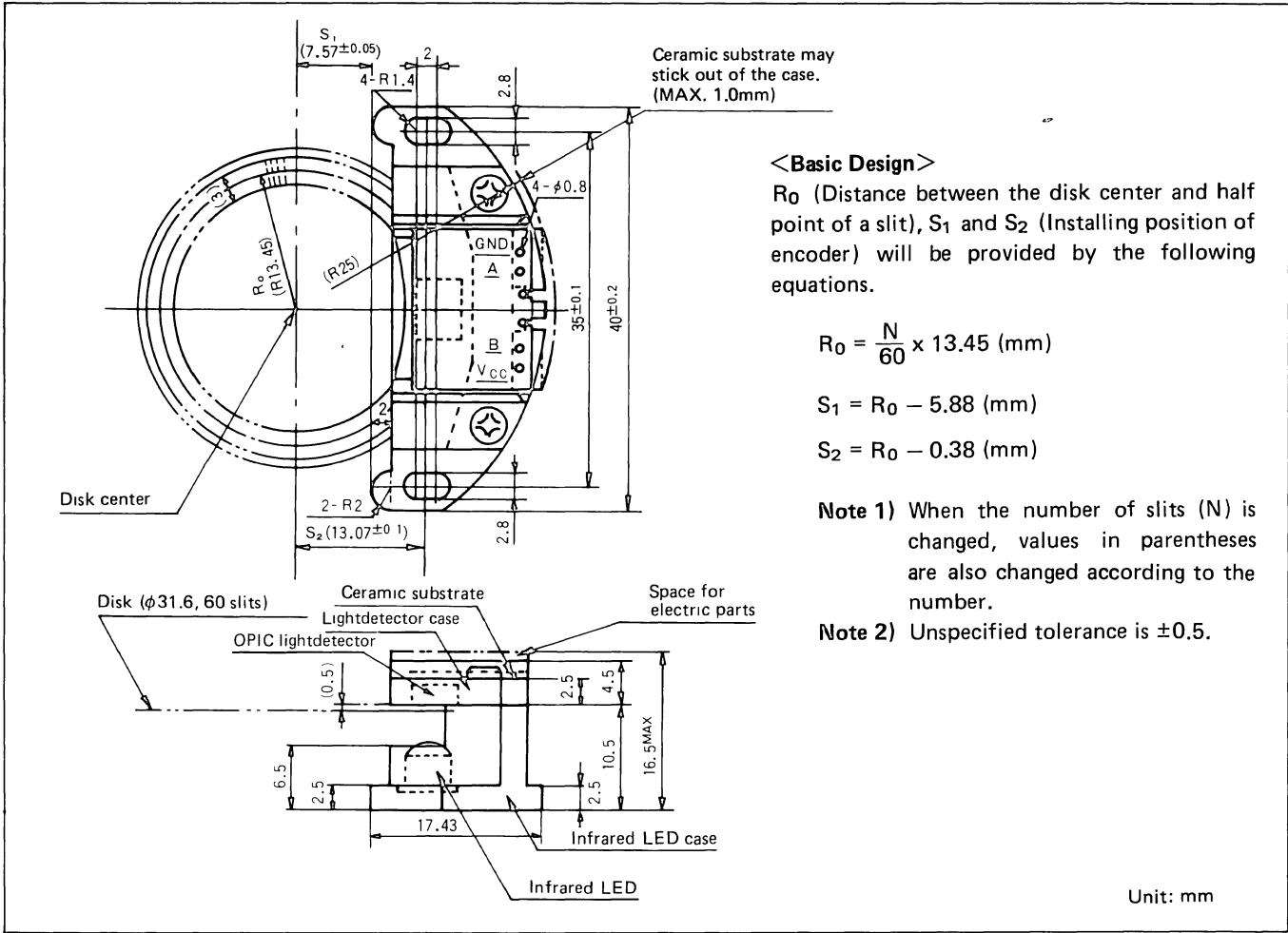


Fig. 6 Phase difference vs. distance (Z direction)



Suggestion for Use

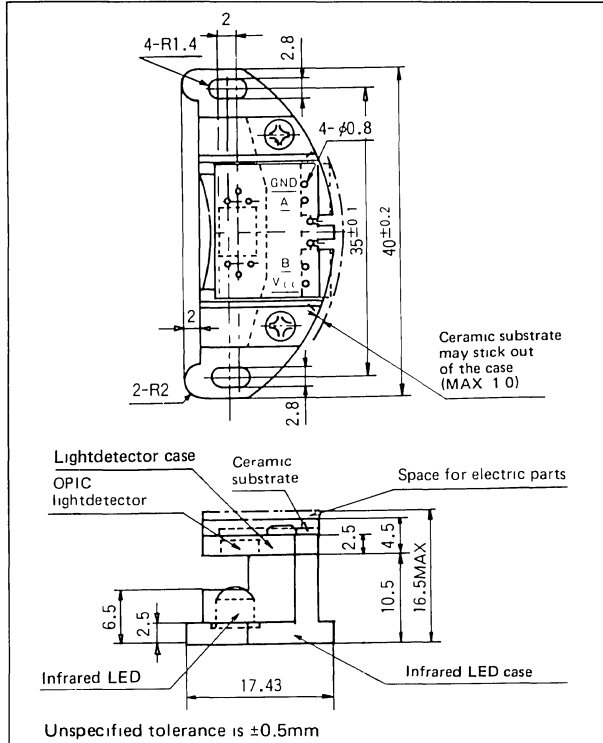


The disks shown below are available as optional parts.

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

Specifications are subject to change without notice.

Outline Dimensions



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

($T_a = 25^\circ\text{C}$)

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

Electrical Characteristics

($V_{CC} = 5\text{V}$, $T_a = 0 \sim +70^\circ\text{C}$ 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	$V_{CC} = 4.5\text{V}$ $I_{OH} = -200\mu\text{A}$	
	Low level	V_{AL}, V_{BL}	—	0.2	0.4	V	$I_{OL} = 8\text{mA}$	
*1 Duty ratio	D_A D_B	0.45	0.50	0.55		$f = \text{DC} \sim 2.5\text{kHz}$	$\frac{t_{AH}}{T_{AP}}$ $\frac{t_{BH}}{T_{BP}}$	
*1 Phase difference	θ_{AB2} θ_{AB3}	50	90	130	deg.	$f = \text{DC} \sim 2.5\text{kHz}$	$\frac{t_{AB2}}{T_{AP}} \times 360^\circ$ $\frac{t_{AB3}}{T_{AP}} \times 360^\circ$	
Response time	t_r	—	0.2	0.5	μs	$T_a = 25^\circ\text{C}$		
	t_f	—	0.1	0.5				
Response frequency	$f_{max.}$	—	—	10	kHz	$T_a = 25^\circ\text{C}$		
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

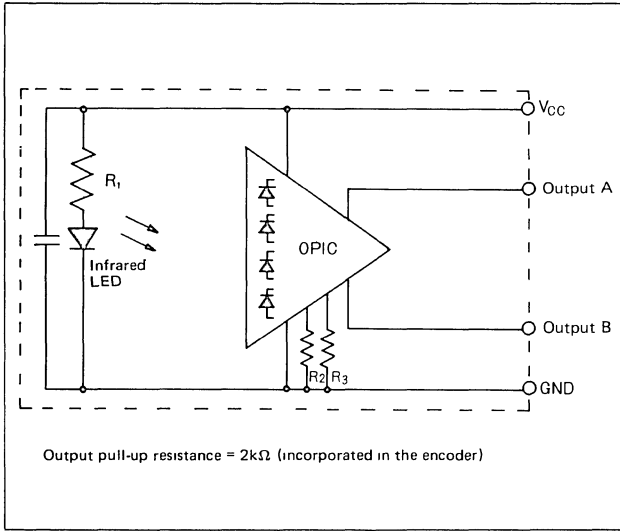


Fig. 1 Duty ratio vs. frequency

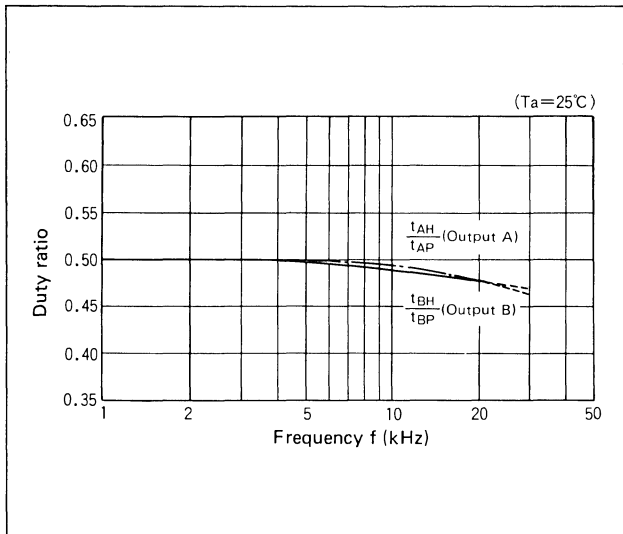
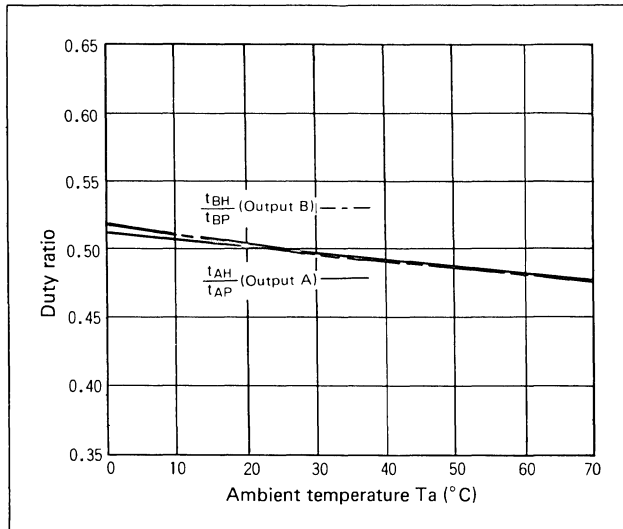


Fig. 3 Duty ratio vs. ambient temperature



□ Output Waveforms

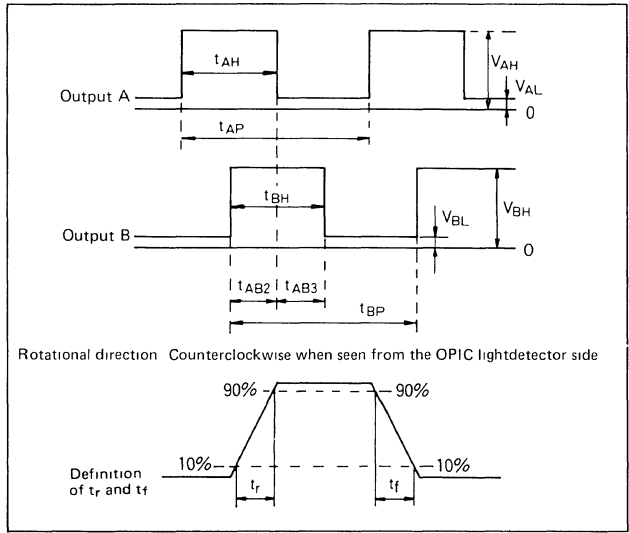


Fig. 2 Phase difference vs. frequency

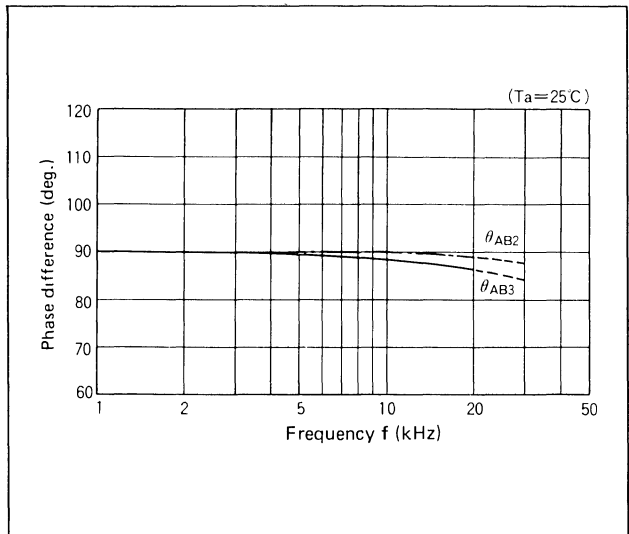


Fig. 4 Phase difference vs. ambient temperature

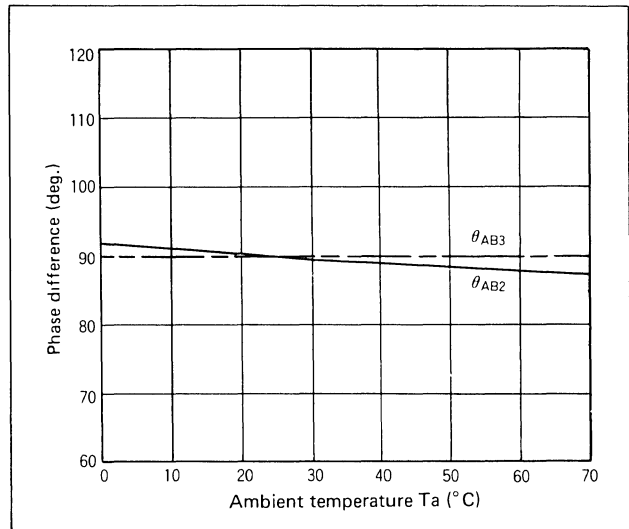


Fig. 5 Duty ratio vs. distance (X direction)

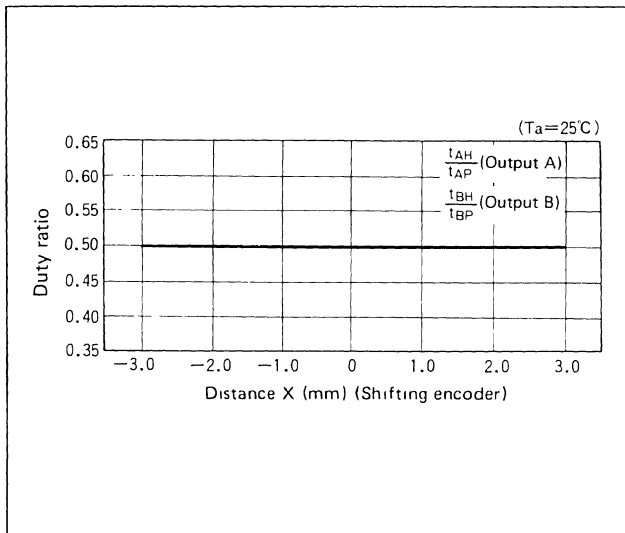


Fig. 6 Phase difference vs. distance (X direction)

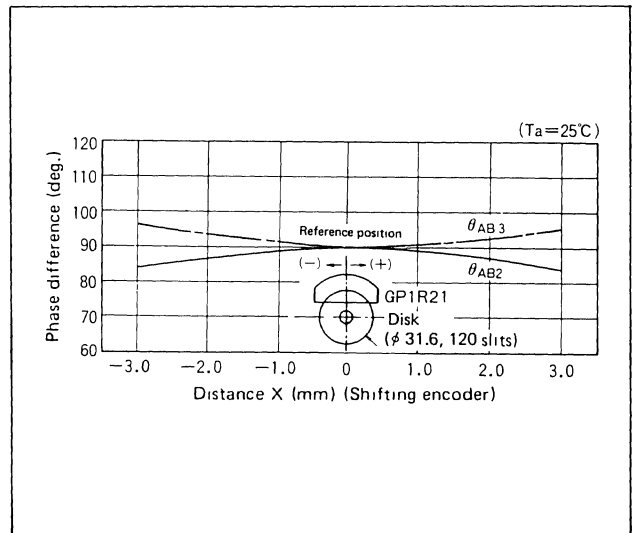


Fig. 7 Duty ratio vs. distance (Y direction)

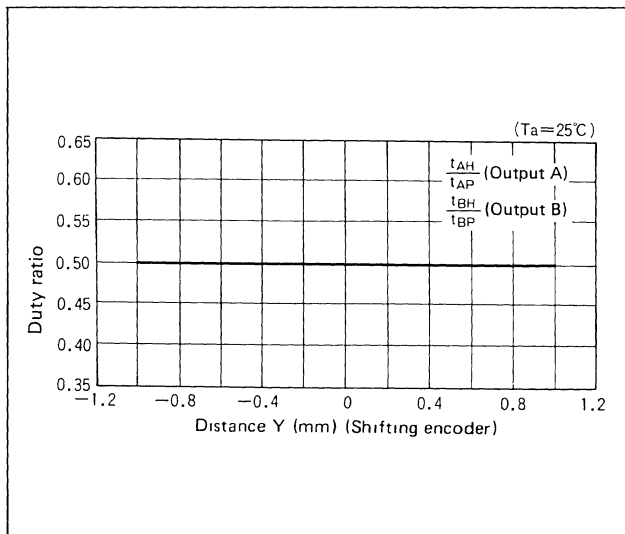


Fig. 8 Phase difference vs. distance (Y direction)

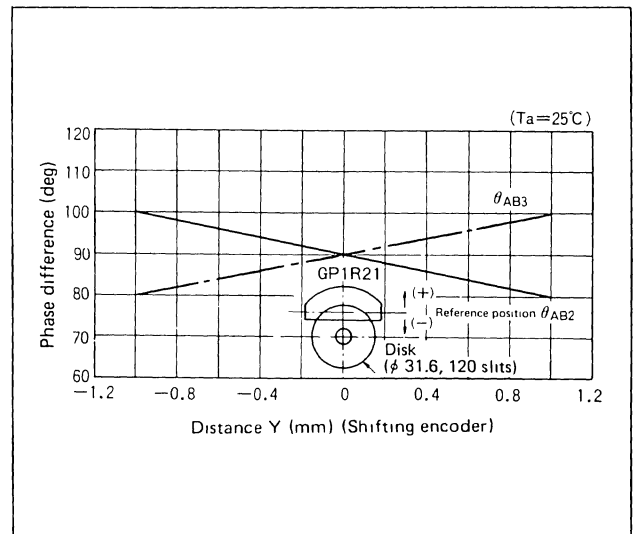


Fig. 9 Duty ratio vs. distance (Z direction)

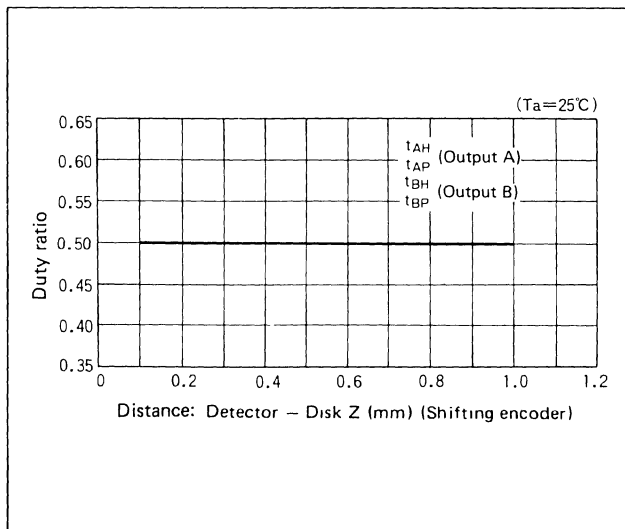
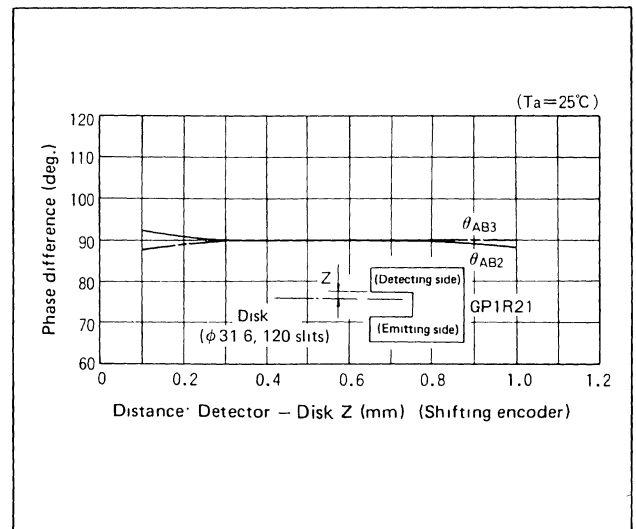
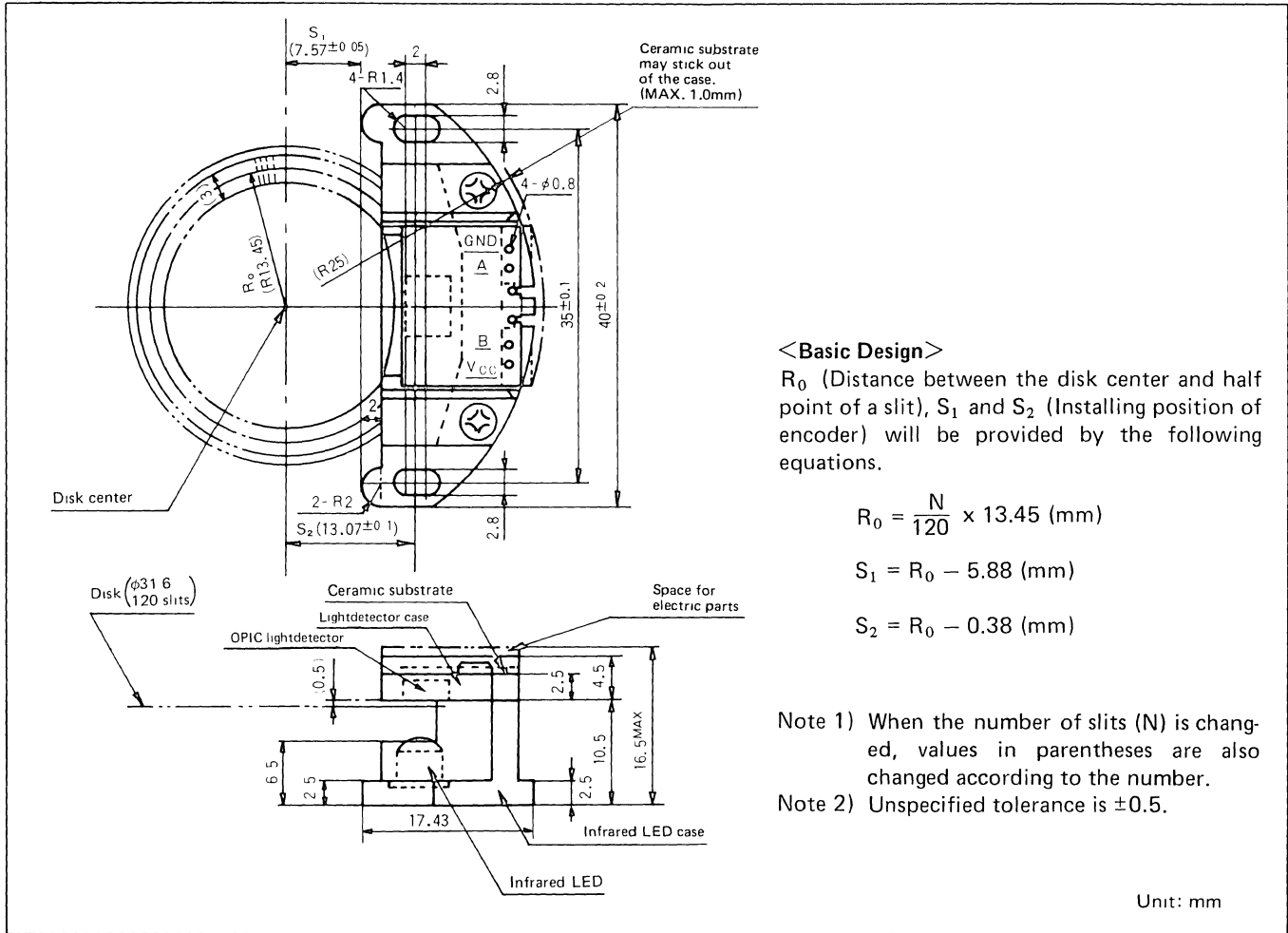


Fig. 10 Phase difference vs. distance (Z direction)



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 .

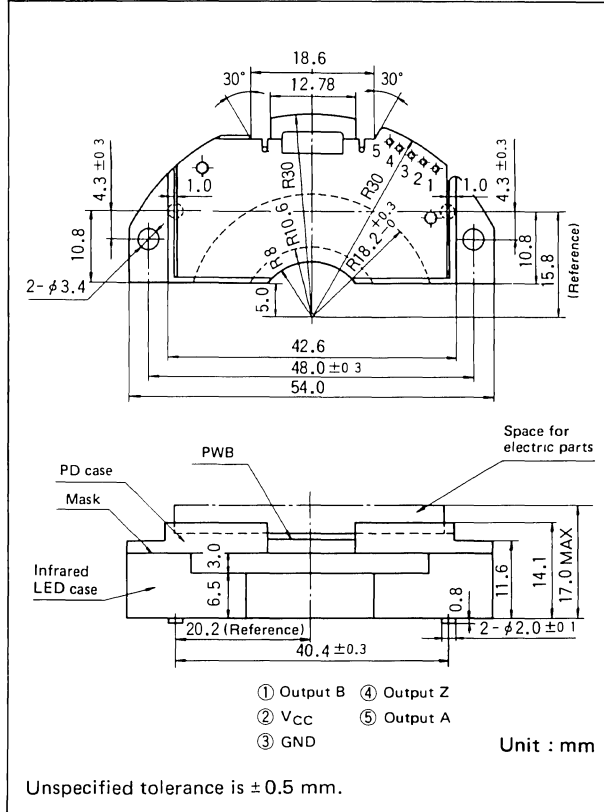
Unit: mm

The disks shown below are available as optional parts.

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

Specifications are subject to change without notice.

□ Outline Dimensions



□ General Description

The Sharp GP1R111 Series is an incremental type rotary encoder consisting of an infrared light emitting diode, integrated photo-diode 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) A, B, Z (index) 3-phase digital outputs (open collector)
- (2) Built-in light level compensating circuit
- (3) Easily interface with TTL
- (4) Easy attachment to a motor due to the disk separated type

□ Applications

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

□ Absolute Maximum Ratings

($T_a = 25^\circ\text{C}$)

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

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

□ Electrical Characteristics

($V_{CC} = 5\text{V}$, $T_a = 25^\circ\text{C}$)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Condition	
Output A, B, Z voltage	High level	V_{AH}, V_{BH}, V_{ZH}	2.4	—	—	V	$R_{up} = 680 \Omega$
	Low level	V_{AL}, V_{BL}, V_{ZL}	—	—	0.4		
*2 Phase difference	GP1R111A	$\theta_{AB1}, \theta_{AB2}$	75	90	105	deg.	$f = 0 \sim 5 \text{ kHz}$ $R_{up} = 680 \Omega$
	GP1R111B		70	90	110		
	GP1R111C		50	90	130		
	GP1R111A	$\theta_{BZ1}, \theta_{BZ2}$	-45	0	45		
	GP1R111B		-60	0	60		
	GP1R111C		-90	0	90		
Response time	t_r	—	0.3	1.5	μs	$R_{up} = 680 \Omega$	
	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

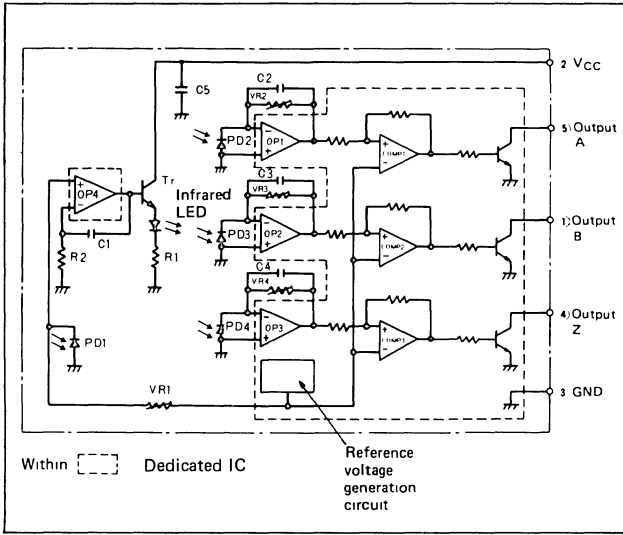


Fig. 1 Phase difference vs. frequency (1) (GP1R111A)

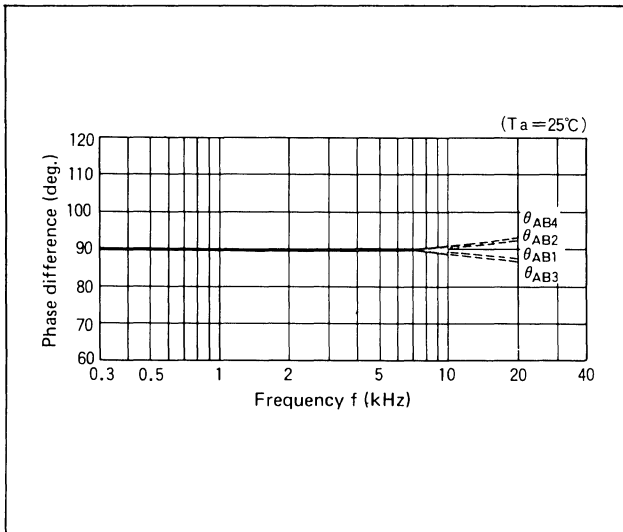
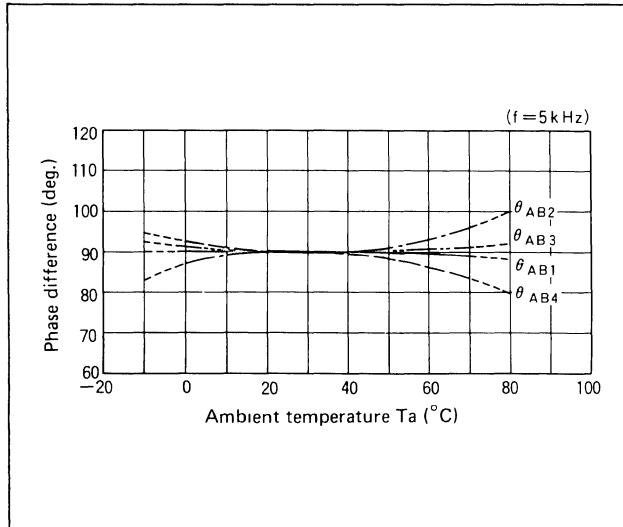


Fig. 3 Phase difference vs. ambient temperature (1) (GP1R111A)



Output Waveforms

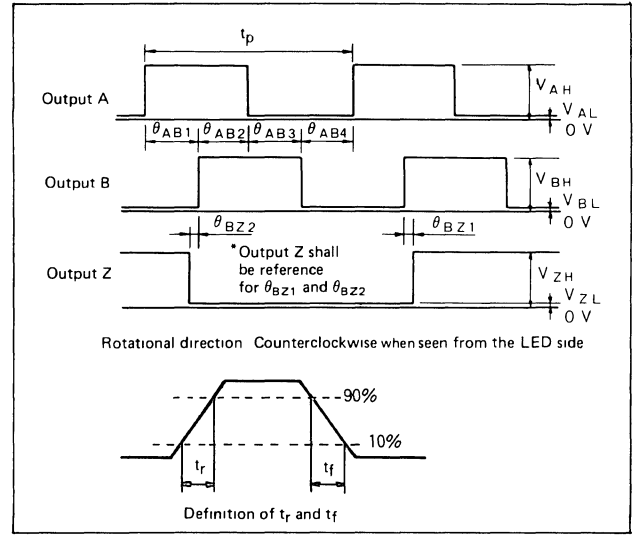


Fig. 2 Phase difference vs. frequency (2) (GP1R111A)

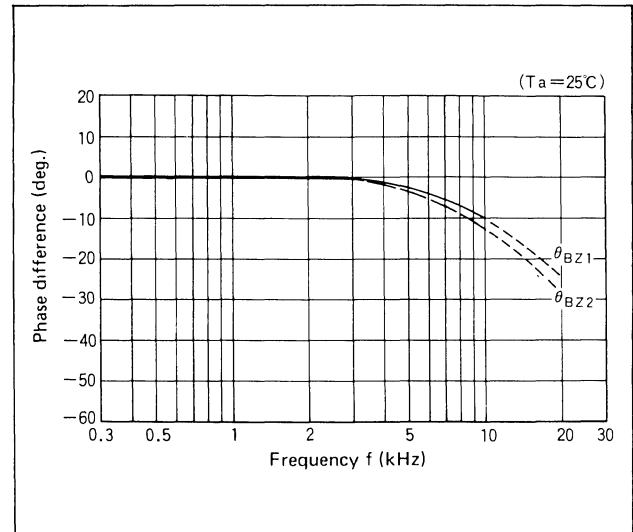


Fig. 4 Phase difference vs. ambient temperature (2) (GP1R111A)

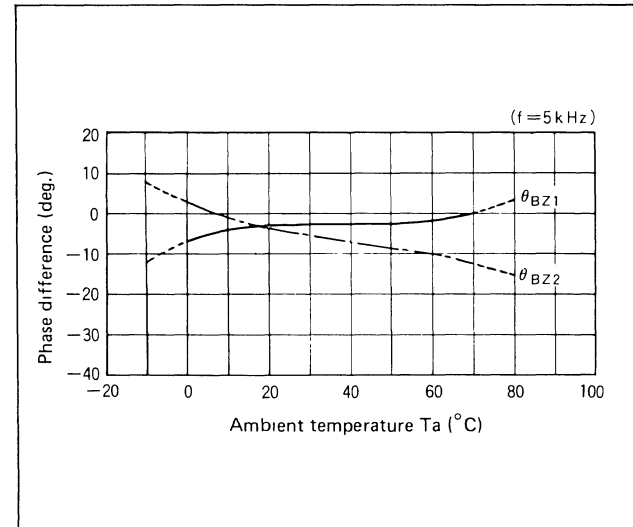


Fig. 5 Phase difference vs. distance (1) (GP1R111A)

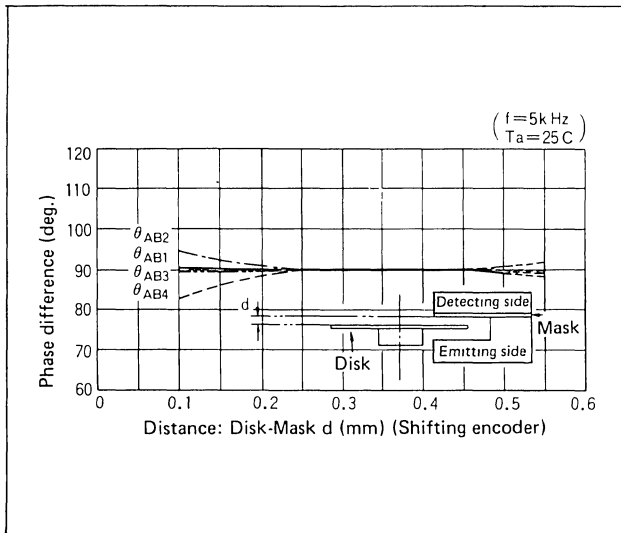


Fig. 6 Phase difference vs. distance (2) (GP1R111A)

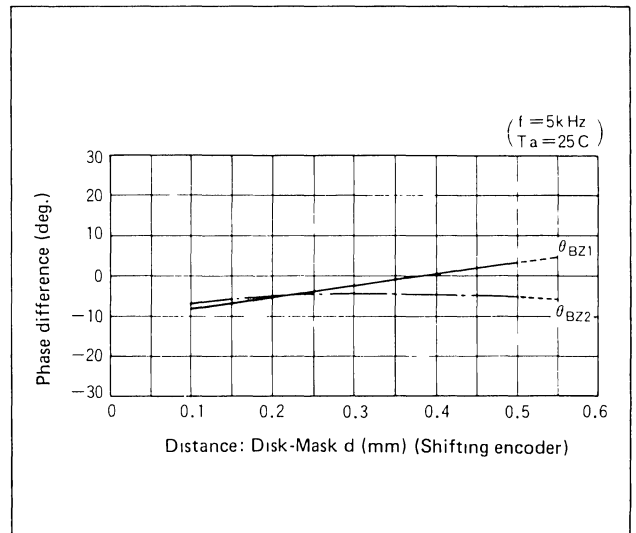


Fig. 7 Phase difference vs. frequency (1) (GP1R111B)

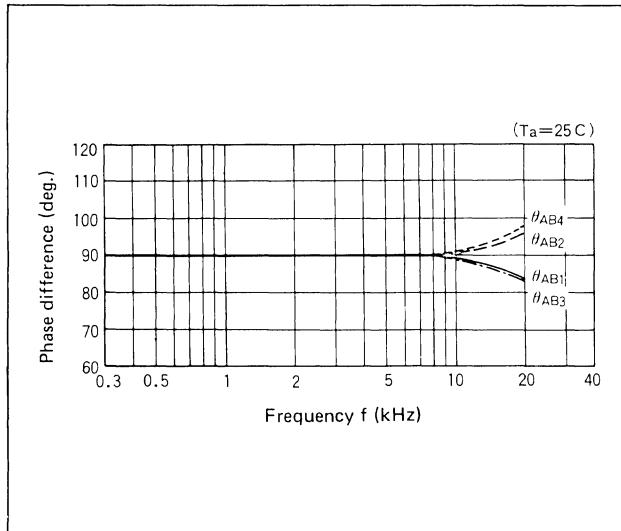


Fig. 8 Phase difference vs. frequency (2) (GP1R111B)

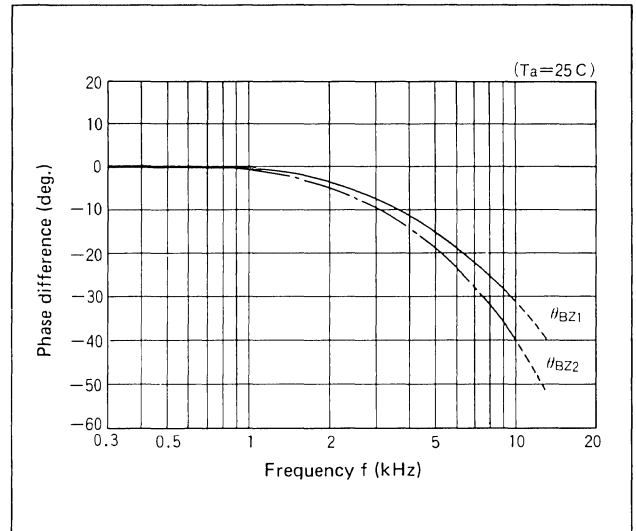


Fig. 9 Phase difference vs. ambient temperature (1) (GP1R111B)

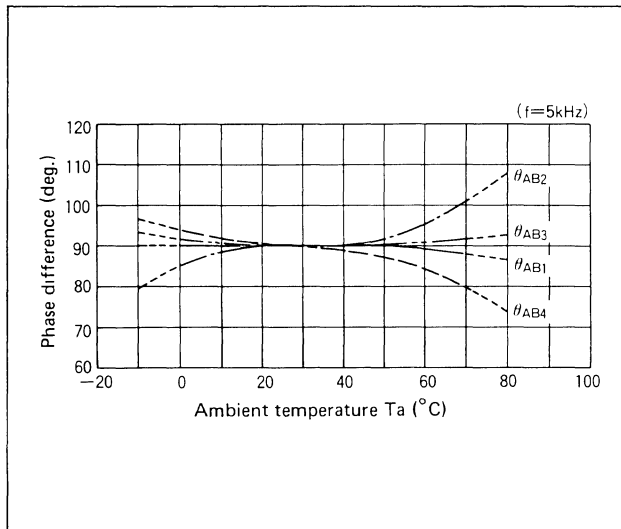


Fig.10 Phase difference vs. ambient temperature (2) (GP1R111B)

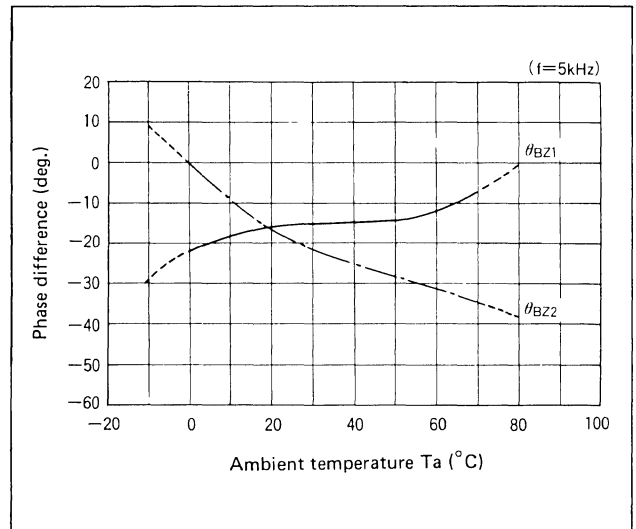


Fig.11 Phase difference vs. distance (1) (GP1R111B)

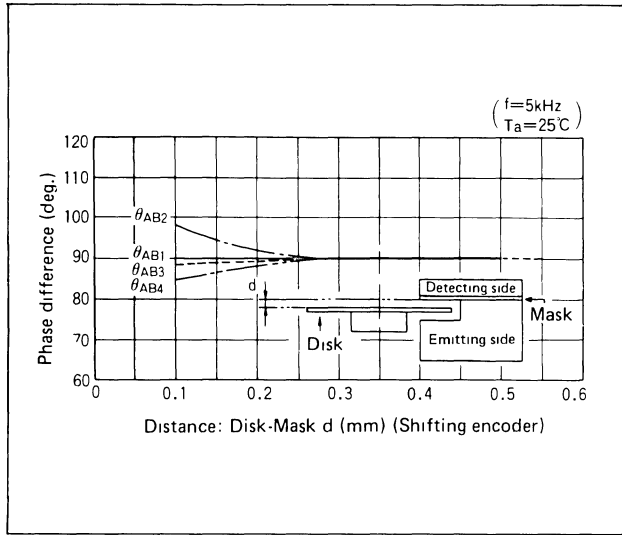


Fig.12 Phase difference vs. distance (2) (GP1R111B)

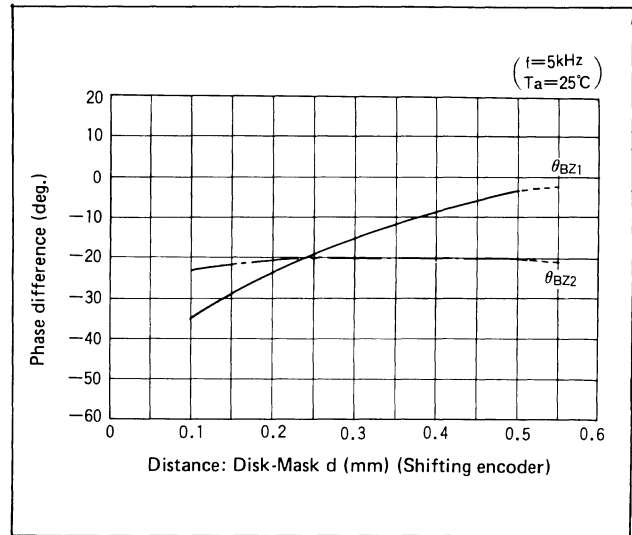


Fig.13 Phase difference vs. frequency (1) (GP1R111C)

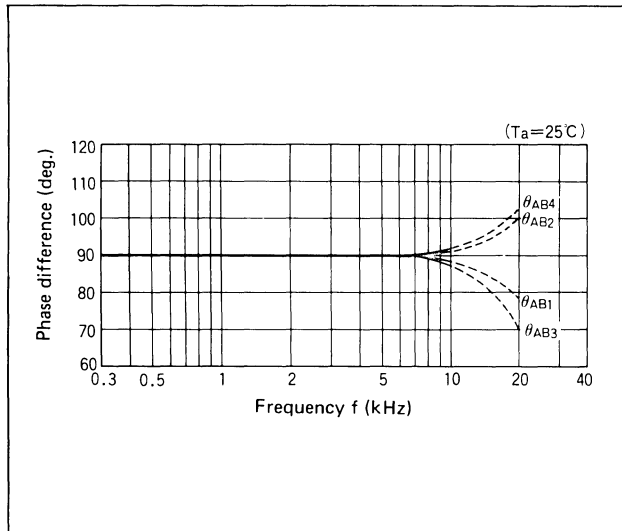


Fig.14 Phase difference vs. frequency (2) (GP1R111C)

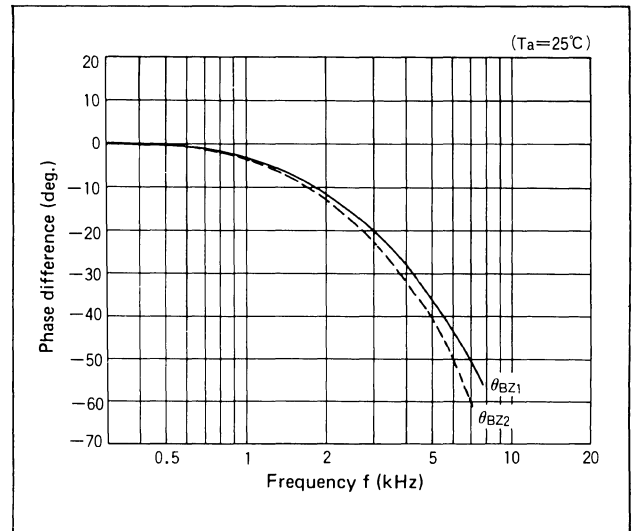


Fig.15 Phase difference vs. ambient temperature (1) (GP1R111C)

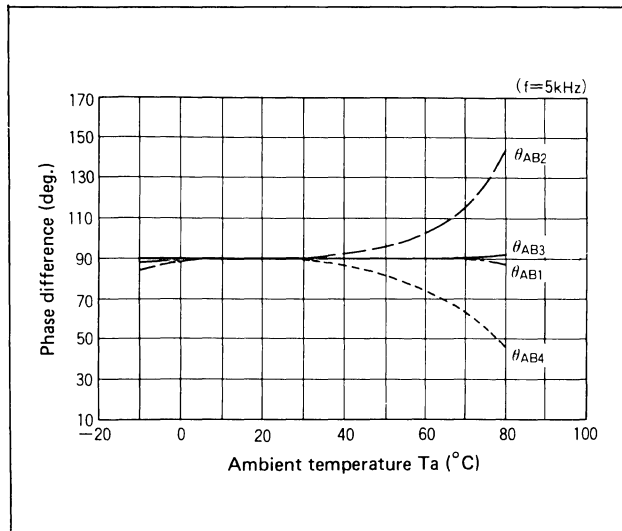


Fig.16 Phase difference vs. ambient temperature (2) (GP1R111C)

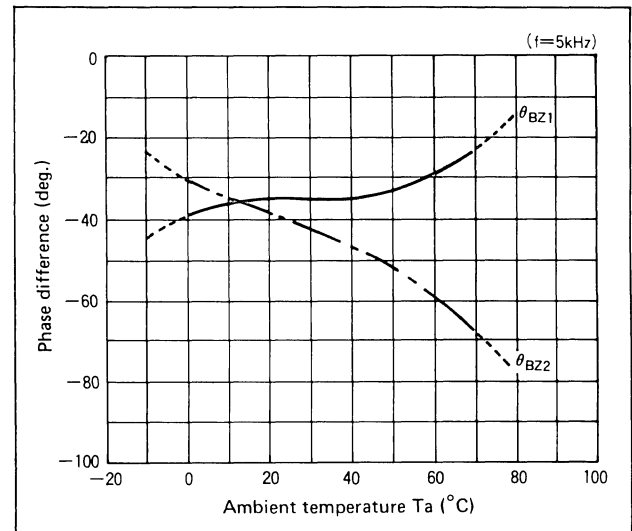


Fig.17 Phase difference vs. distance (1) (GP1R111C)

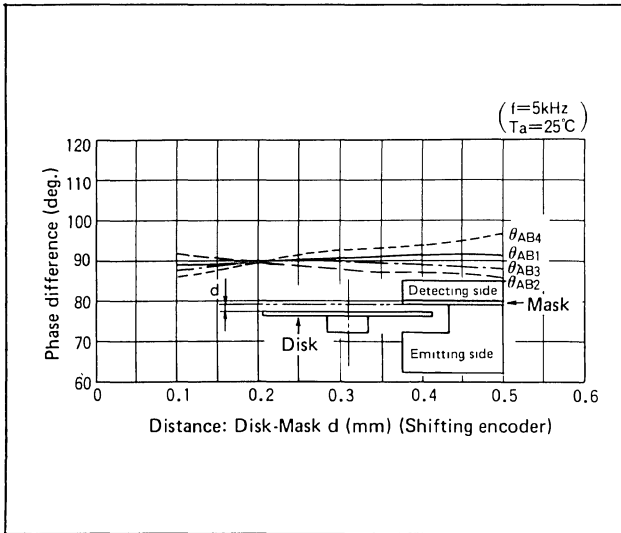
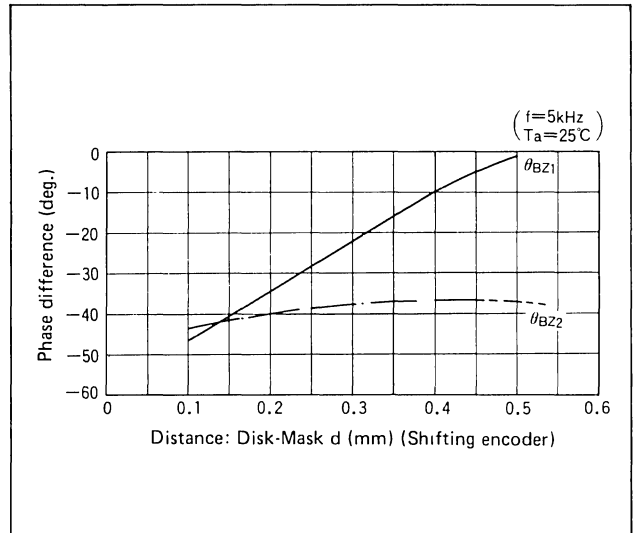
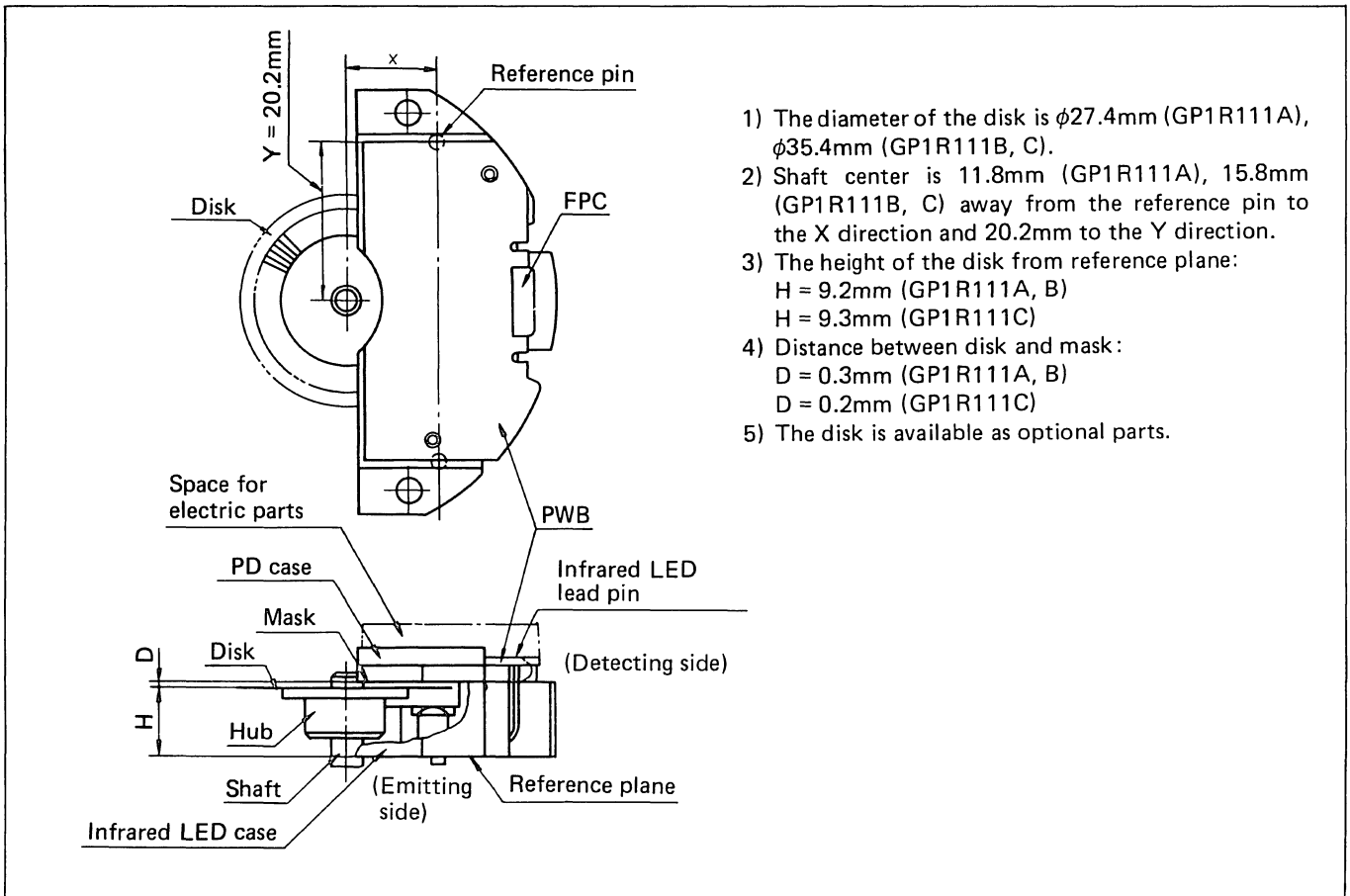


Fig.18 Phase difference vs. distance (2) (GP1R111C)



Suggestion for Use



- 1) The diameter of the disk is $\phi 27.4\text{mm}$ (GP1R111A), $\phi 35.4\text{mm}$ (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:
 $H = 9.2\text{mm}$ (GP1R111A, B)
 $H = 9.3\text{mm}$ (GP1R111C)
- 4) Distance between disk and mask:
 $D = 0.3\text{mm}$ (GP1R111A, B)
 $D = 0.2\text{mm}$ (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.

Details of part X

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 $\phi 4$ mm.)
- 2) It is recommended that disk thickness be 0.1mm for GP1R111A and 0.08mm for GP1R111B, C.

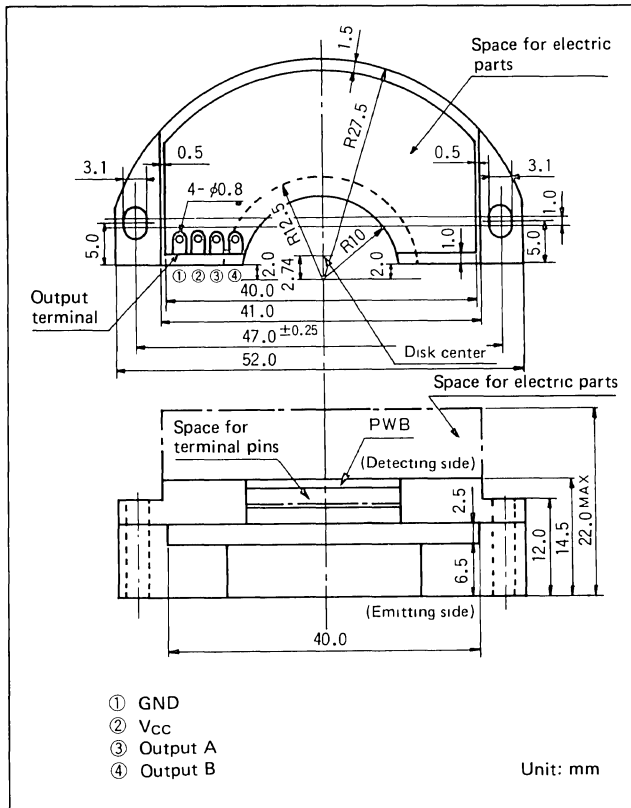
The disks shown below are available as optional parts.

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.

Outline Dimensions



General Description

The Sharp GP1R23 is a high resolution type optical rotary encoder (incremental type), consisting of an infrared 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

($T_a = 25^\circ\text{C}$)

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

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

Electrical Characteristics

($T_a = 0 \sim +70^\circ\text{C}$ unless specified)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark	
Supply voltage	V_{CC}	4.75	5.0	5.25	V	$T_a = 25^\circ\text{C}$		
Output A, B voltage	High level	V_{AH}, V_{BH}	$V_{CC} - 0.3$	V_{CC}	V	$R_{up} = 4.7\text{k}\Omega$		
	Low level	V_{AL}, V_{BL}	—	0.25	0.4	V	$R_{up} = 1\text{k}\Omega$	
*2 Duty ratio	Output A	D_A	0.45	0.50	0.55		$f = 5\text{kHz}, T_a = 25^\circ\text{C}$	$\frac{I_{AH}}{I_{AP}}$
	Output B	D_B	0.45	0.50	0.55		$f = 5\text{kHz}, T_a = 25^\circ\text{C}$	$\frac{I_{BH}}{I_{BP}}$
*2 Phase difference	θ_{AB1}	45	90	135	deg.	$f = 5\text{kHz}, T_a = 25^\circ\text{C}$		
Response time	t_r	—	1.0	2.0	μs	$f = 5\text{kHz}, T_a = 25^\circ\text{C}$ $R_{up} = 4.7\text{k}\Omega$		
	t_f	—	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

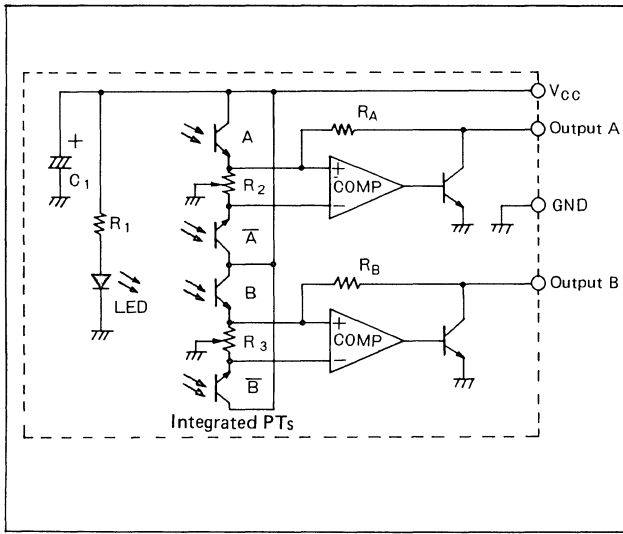
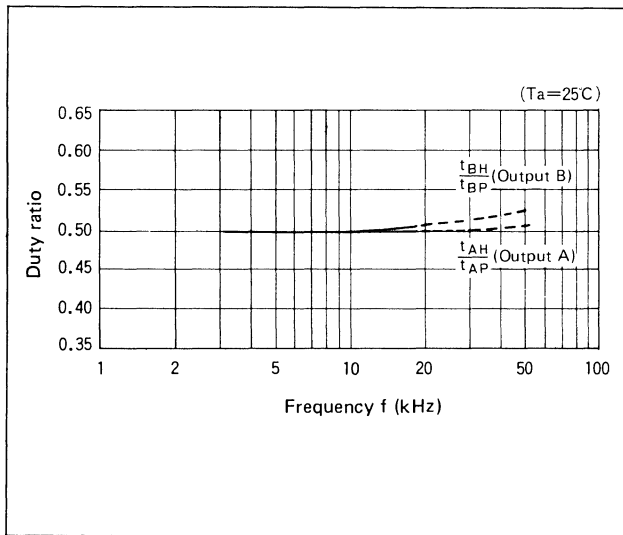


Fig. 1 Duty ratio vs. frequency



Output Waveforms

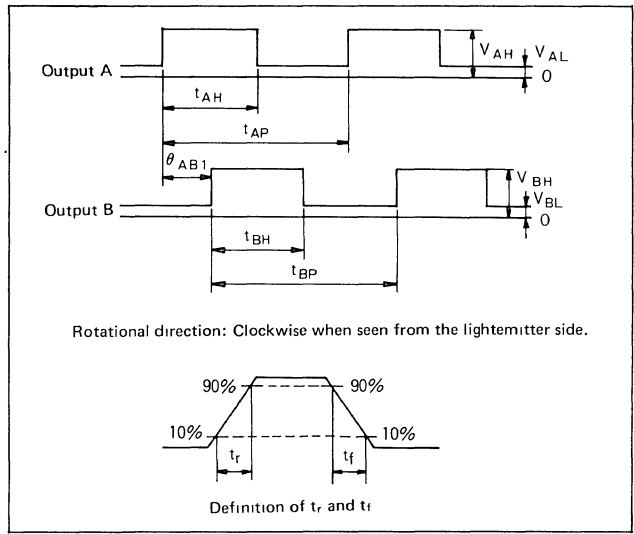


Fig. 2 Phase difference vs. frequency

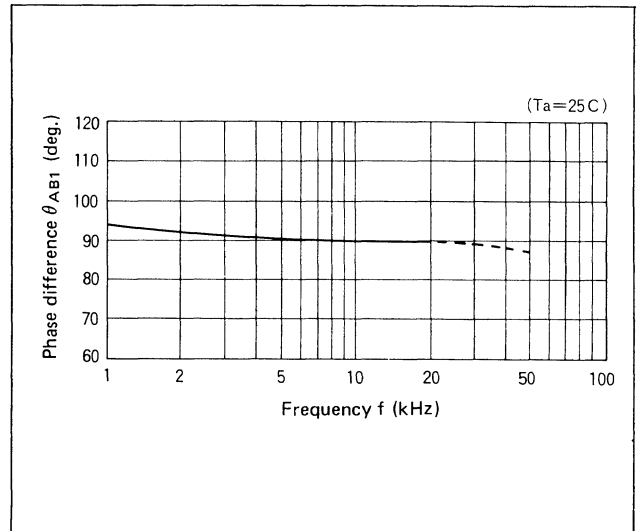


Fig. 3 Duty ratio vs. ambient temperature

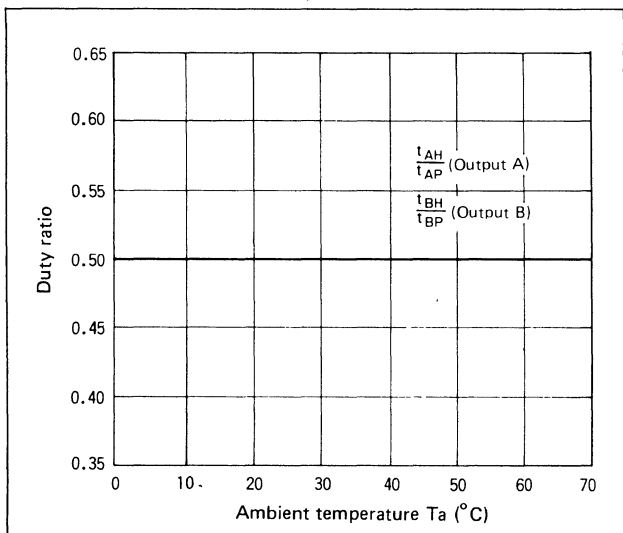


Fig. 4 Phase difference vs. ambient temperature

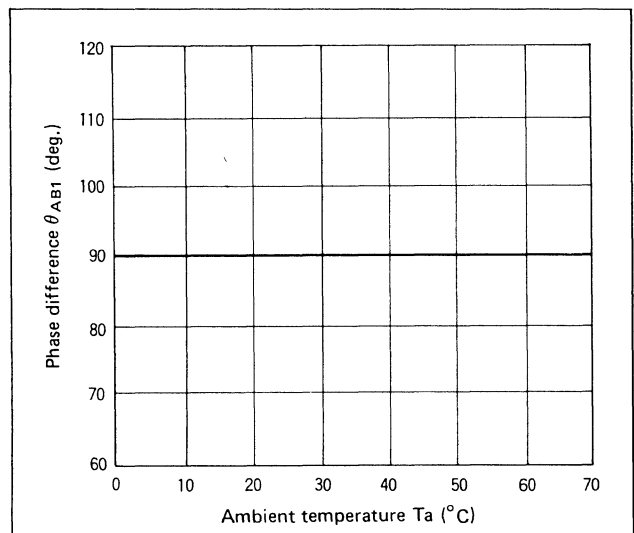


Fig. 5 Duty ratio vs. distance (X direction)

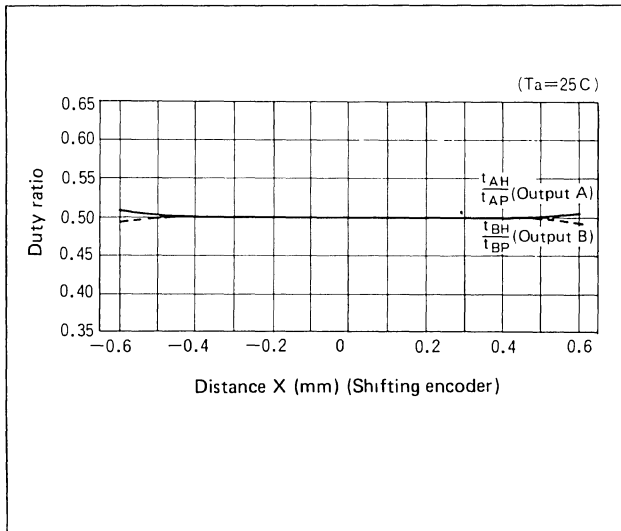


Fig. 6 Phase difference vs. distance (X direction)

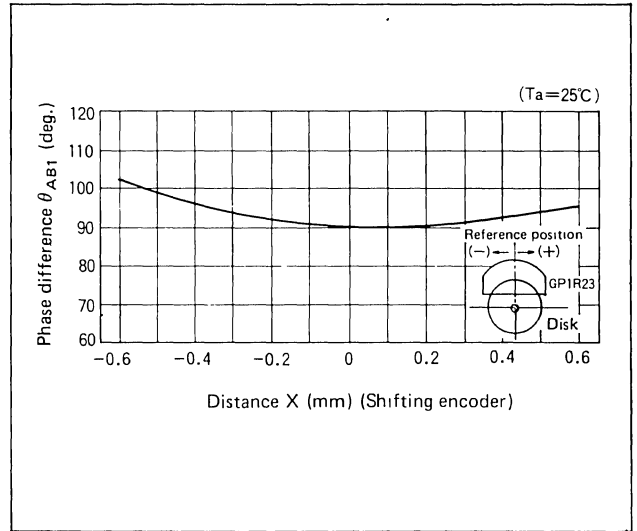


Fig. 7 Duty ratio vs. distance (Y direction)

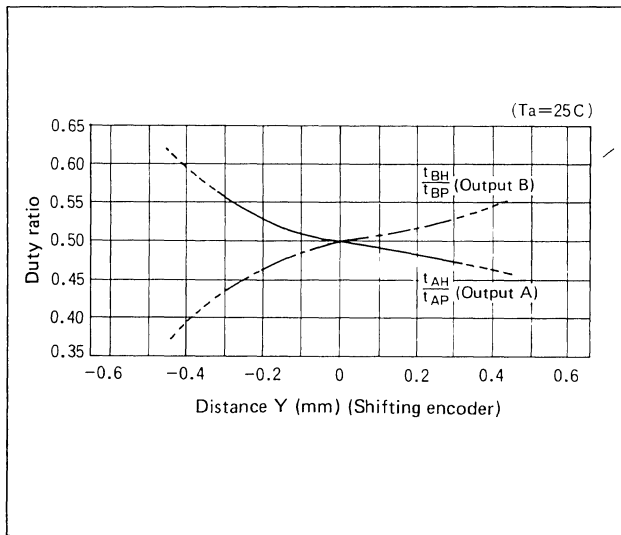


Fig. 8 Phase difference vs. distance (Y direction)

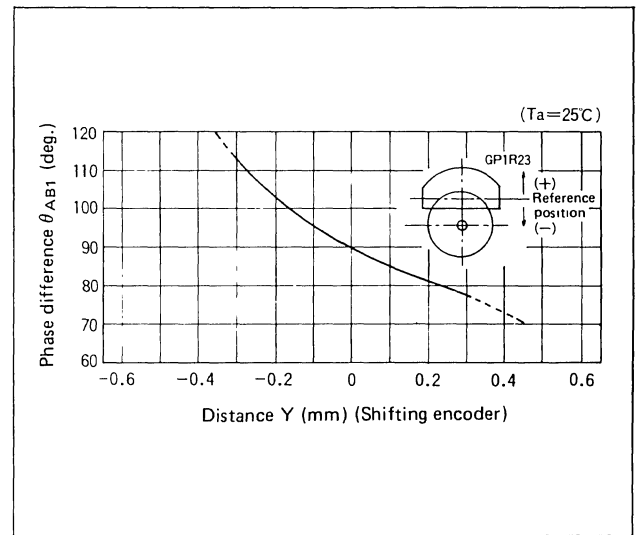


Fig. 9 Duty ratio vs. distance (Z direction)

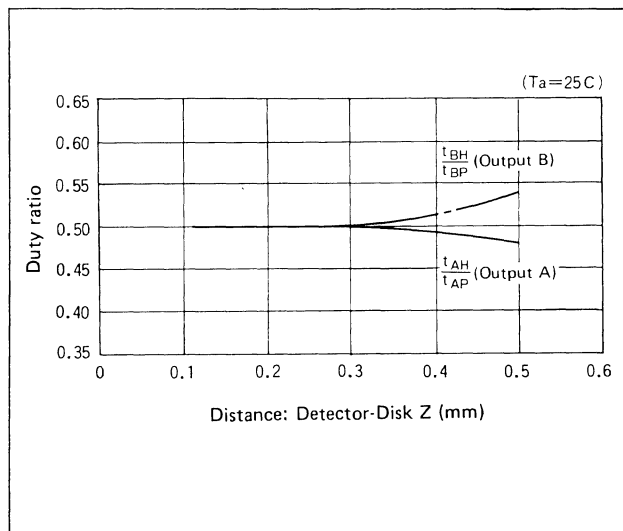
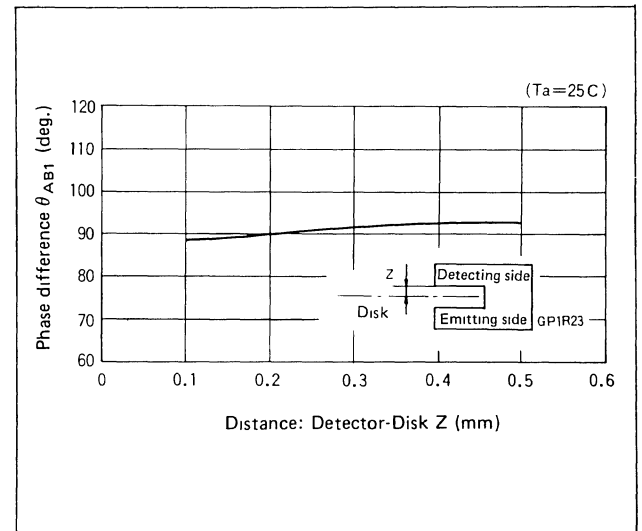
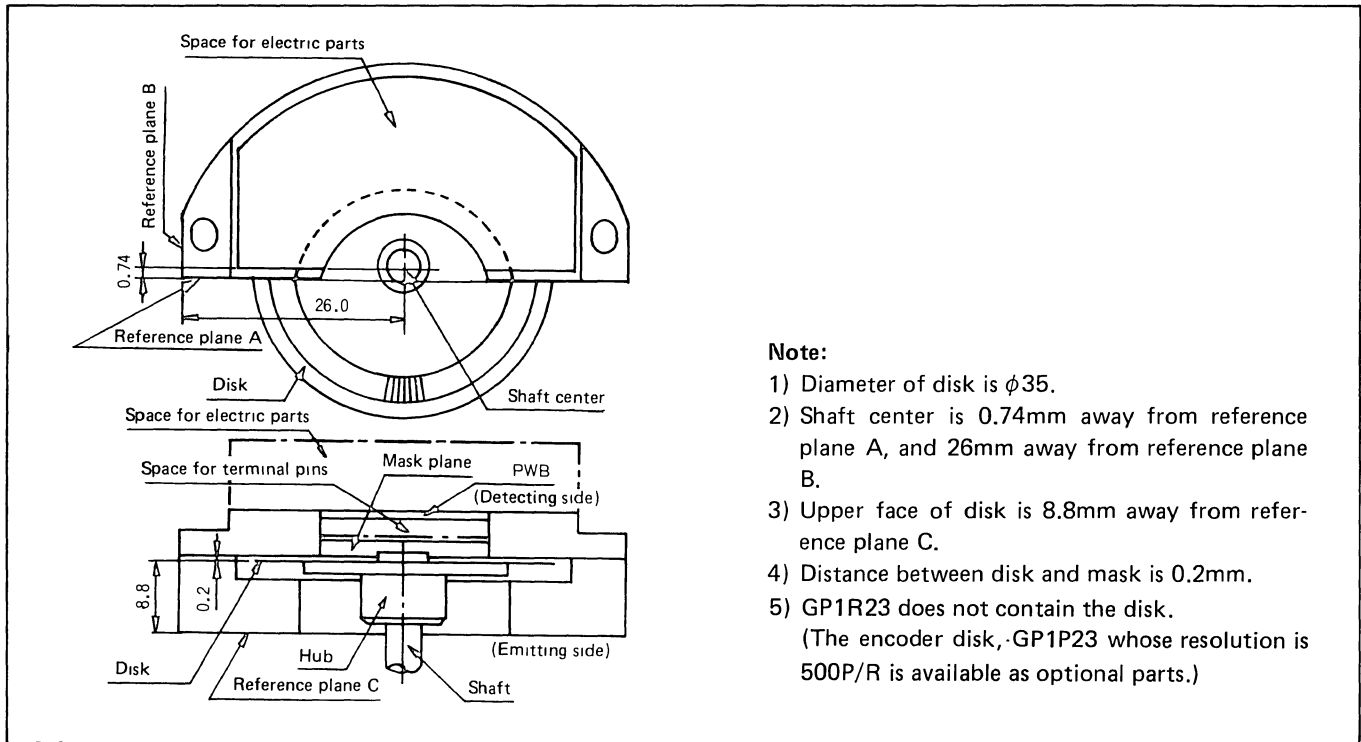


Fig. 10 Phase difference vs. distance (Z direction)

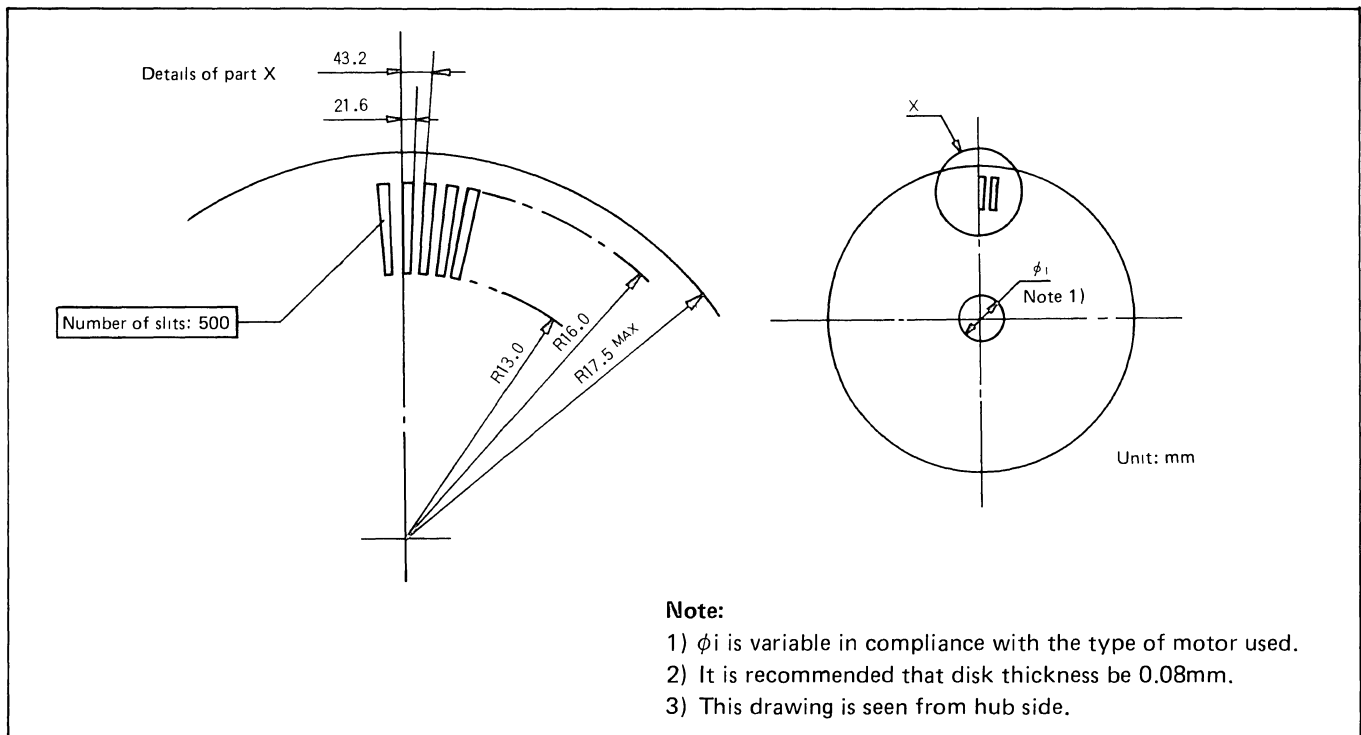


Suggestion for Use



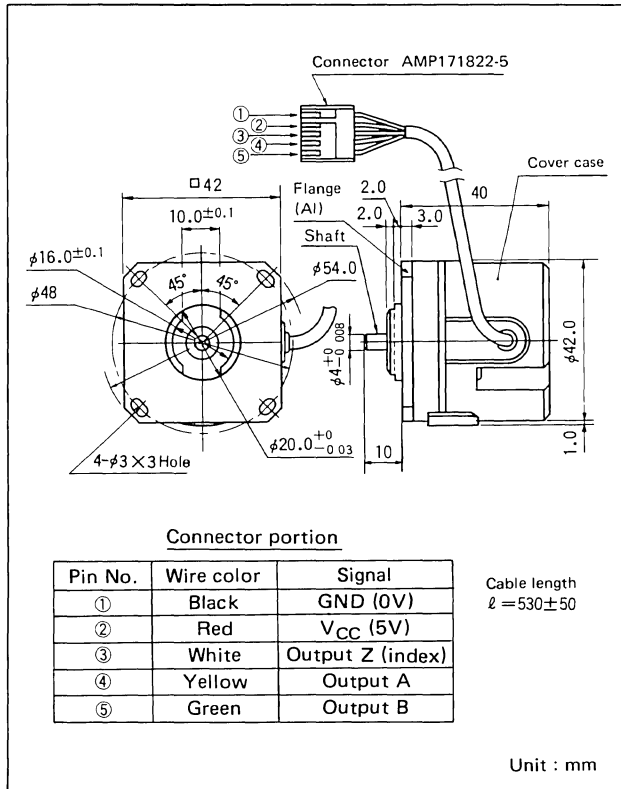
Disk Design

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



Specifications are subject to change without notice.

Outline Dimensions



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

(T_a = 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

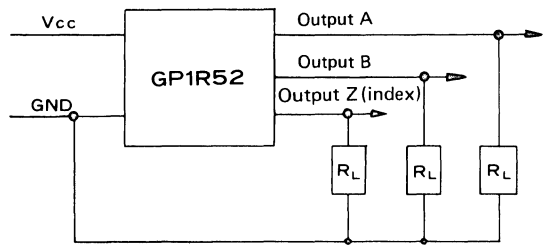
Electrical Characteristics

(V_{CC} = 5V, R_L = 10kΩ, T_a = 25°C)

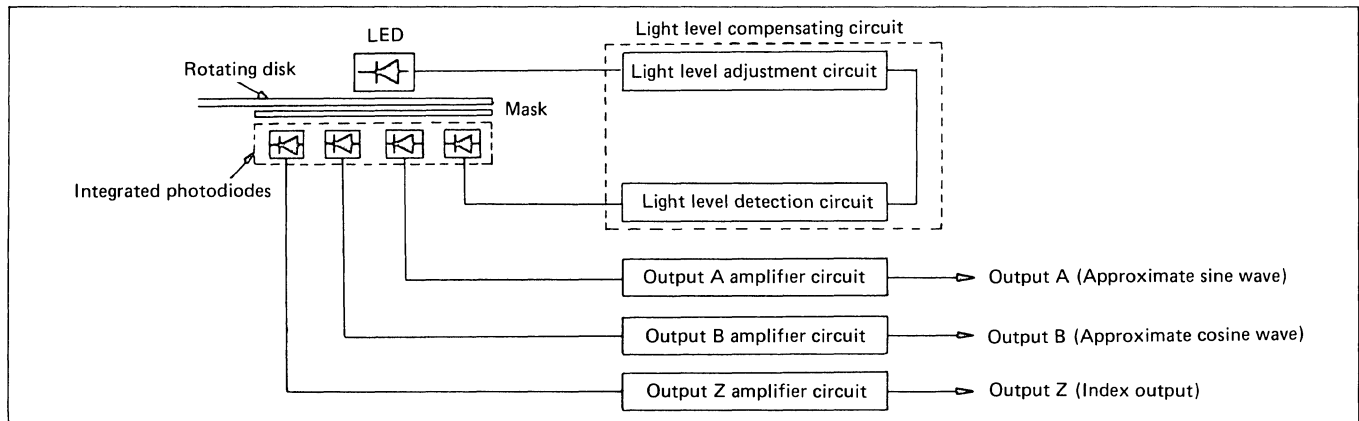
Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Condition	Remark	
Duty ratio	D _A	0.45	0.50	0.55		t _{AP} =DC~0.5ms, V _{TH} =1.5V	t _{AH} /t _{AP}	
	D _B	0.45	0.50	0.55		t _{BP} =DC~0.5ms, V _{TH} =1.5V	t _{BH} /t _{BP}	
Phase difference	GP1R52A	θ _{AB1}	75	90	105	t _{AP} =DC~5ms	deg.	t _{AB1} t _{AP} × 360
	GP1R52B		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

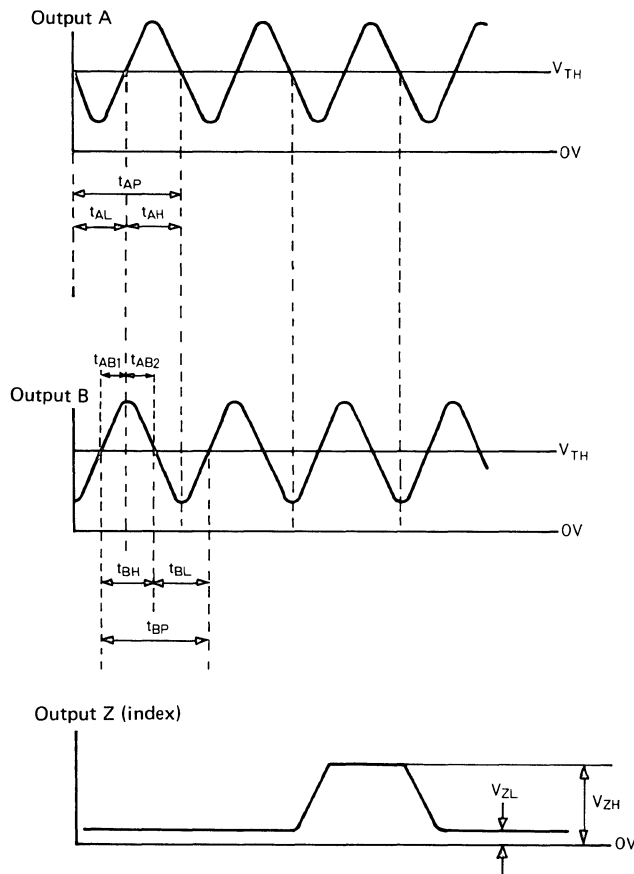
Supply voltage $V_{CC} = 5V \pm 5\%$
 Load resistance on output side $R_L = 10k\Omega \pm 5\%$



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 wave-forms

Fig. 1 Supply voltage vs. relative output

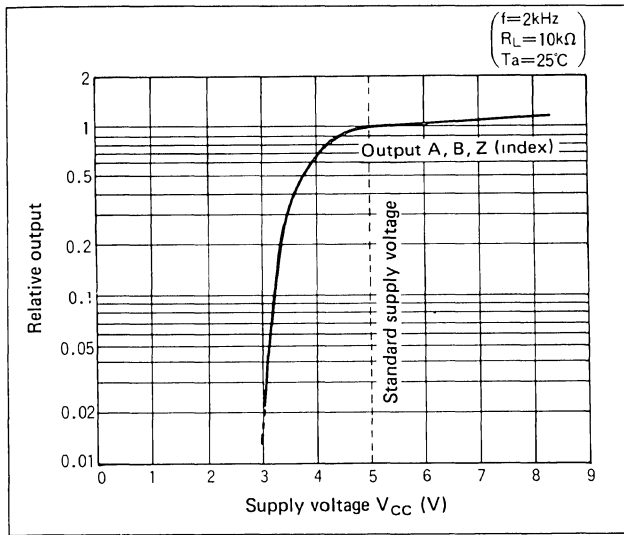


Fig. 2 Frequency response

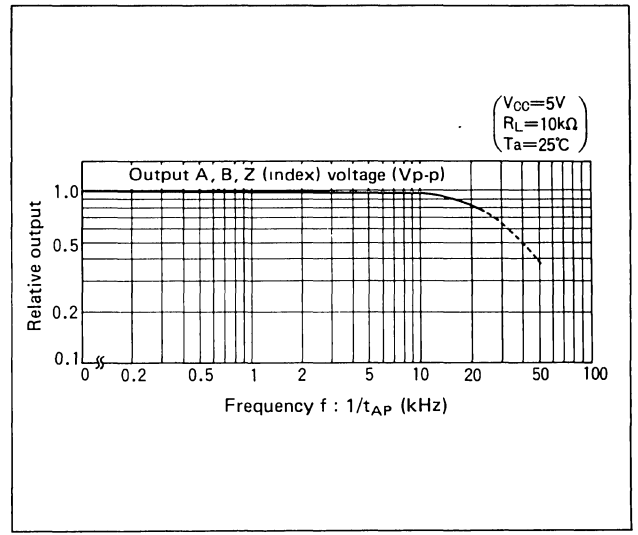


Fig. 3 Frequency vs. duty ratio

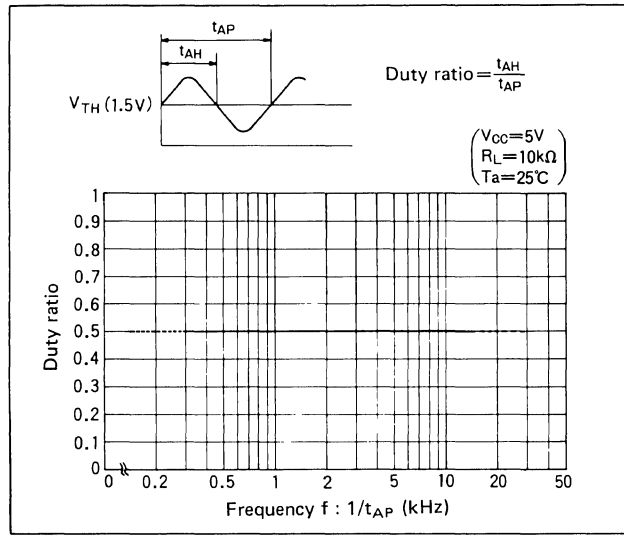
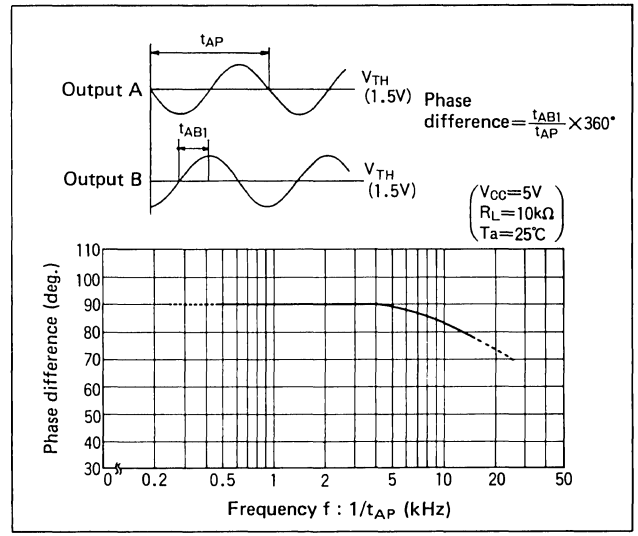
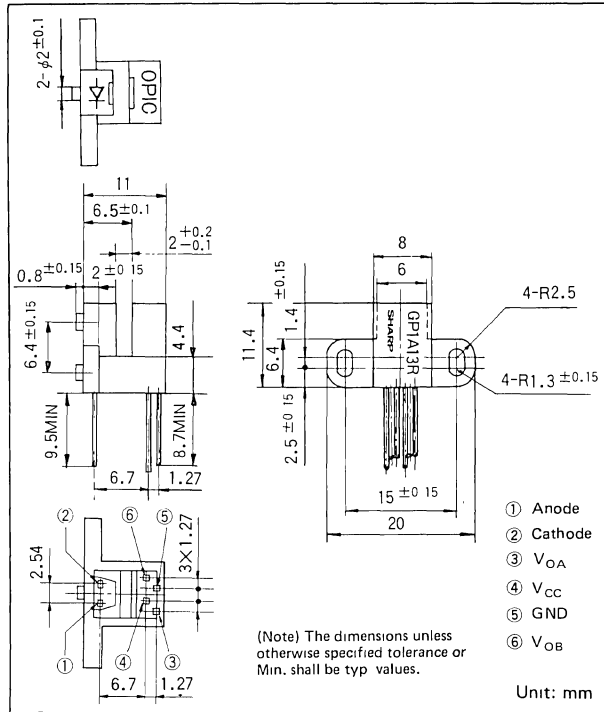


Fig. 4 Frequency vs. phase difference



Specifications are subject to change without notice.

Outline Dimensions



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 light detector (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 $\leq 100\mu s$, 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	0.25	0.50	0.75		$V_{CC} = 5V, I_F = 20mA$ $f = 2.5kHz$	$\frac{L_{AH}}{L_{AP}}$ *4
		D_B	0.25	0.50	0.75	$\frac{L_{BH}}{L_{BP}}$ *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

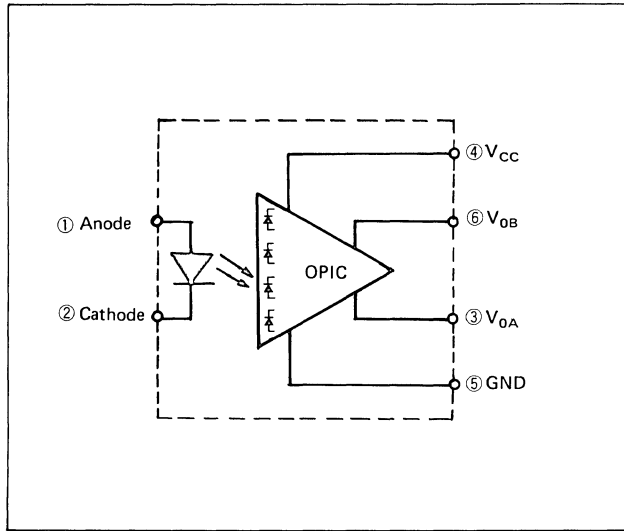


Fig. 1 Forward current vs. ambient temperature

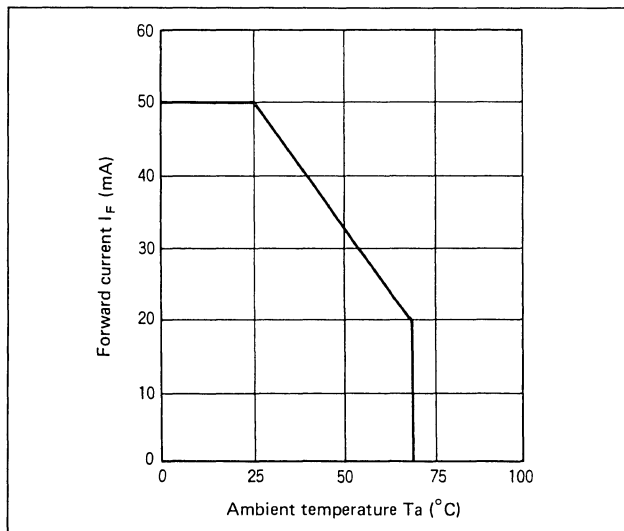
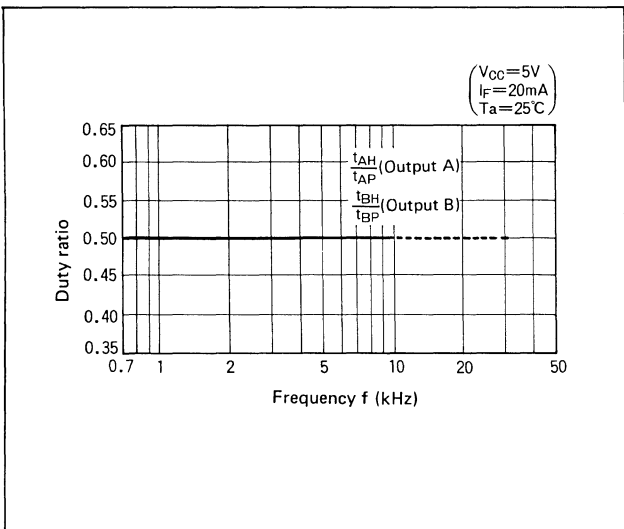


Fig. 3 Duty ratio vs. frequency



Output Waveforms

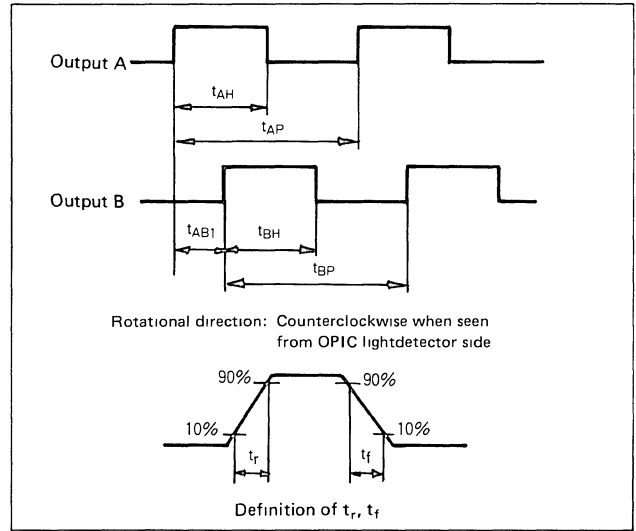


Fig. 2 Output power dissipation vs. ambient temperature

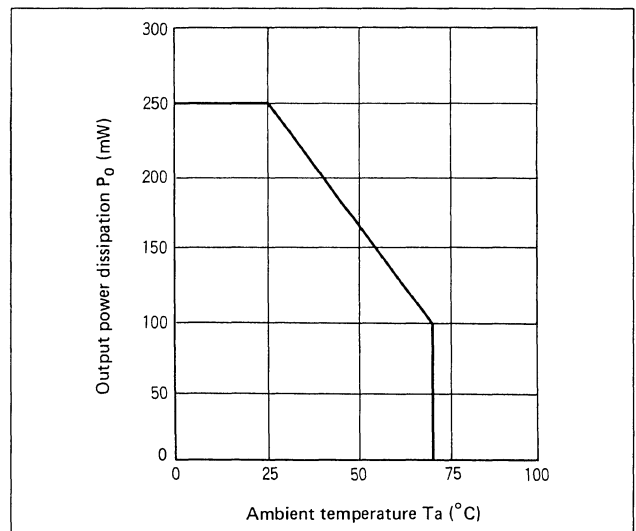


Fig. 4 Phase difference vs. frequency

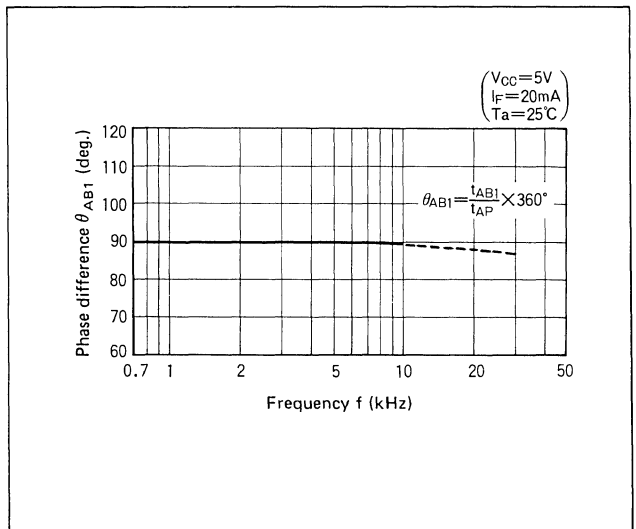


Fig. 5 Duty ratio vs. ambient temperature

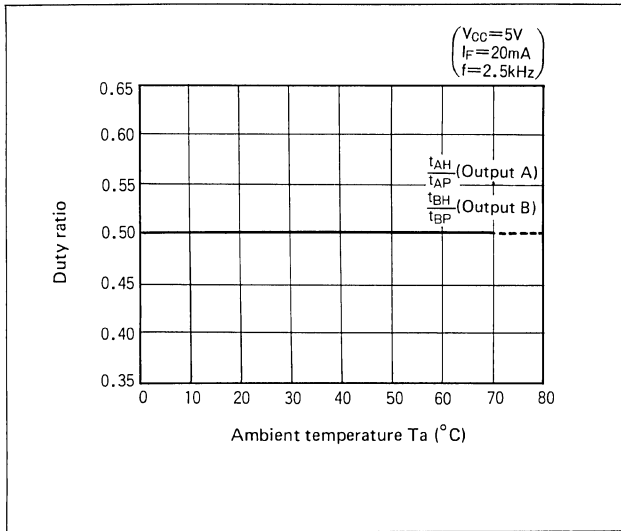


Fig. 6 Phase difference vs. ambient temperature

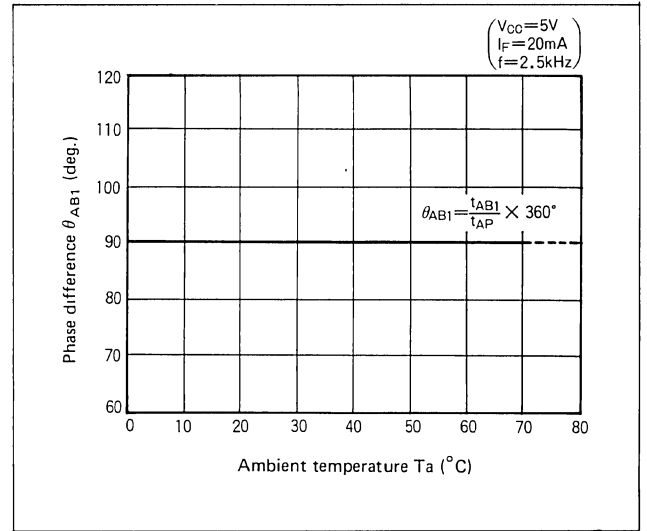


Fig. 7 Duty ratio vs. distance (X direction)

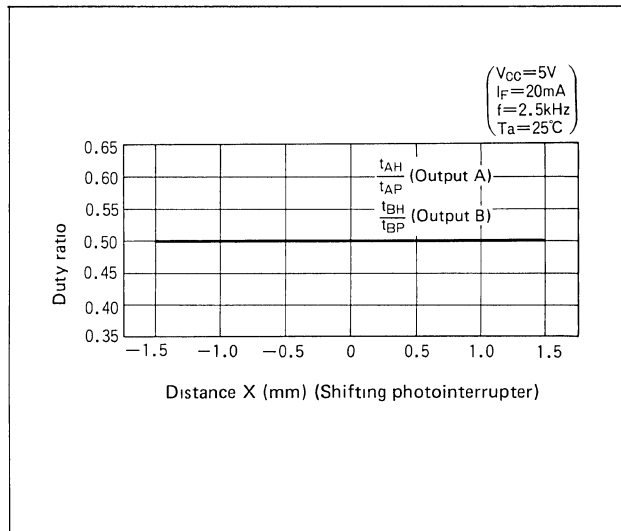


Fig. 8 Phase difference vs. distance (X direction)

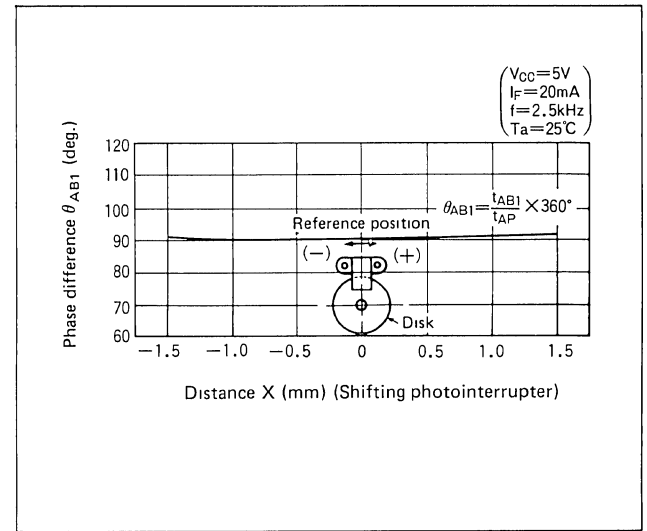


Fig. 9 Duty ratio vs. distance (Y direction)

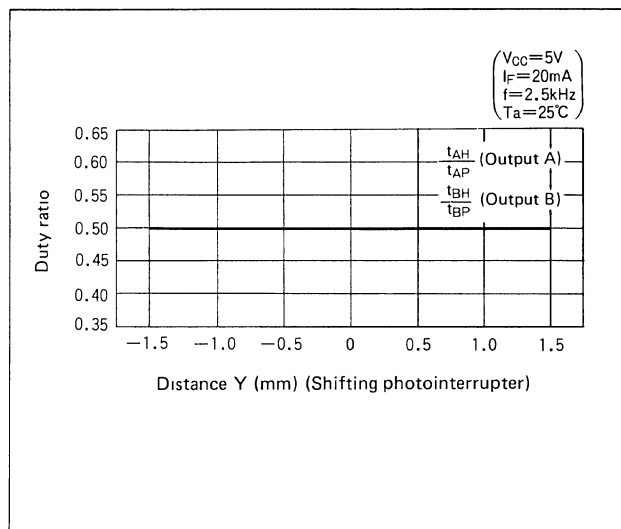


Fig. 10 Phase difference vs. distance (Y direction)

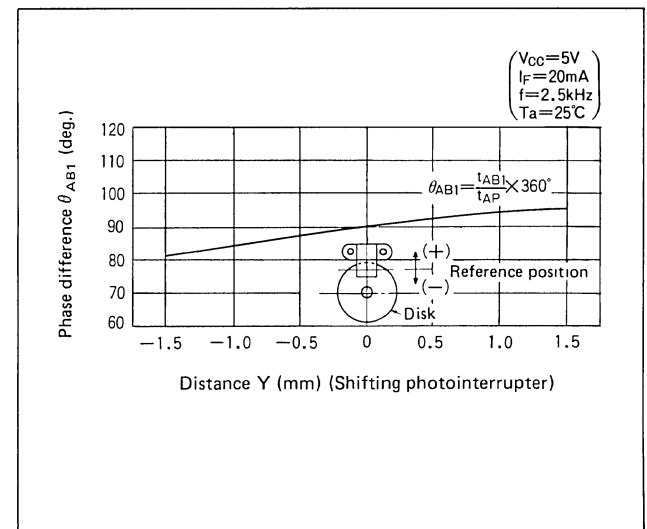


Fig. 11 Duty ratio vs. distance (Z direction)

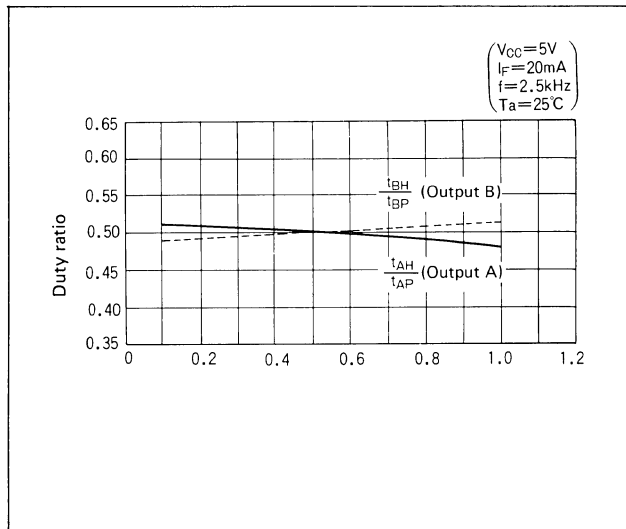
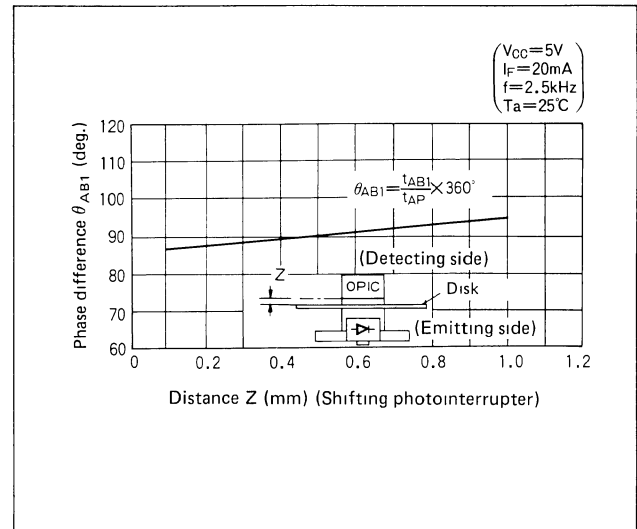


Fig. 12 Phase difference vs. distance (Z direction)



<Measurement Condition>

Disk center
Disk (φ26.48) (60 slits)

<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)

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

N : Number of slits

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

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

$$S_2 = S_1 + 6.7 \text{ (mm)}$$

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:

$$R_O = \frac{100}{60} \times 10.89$$

$$= 18.15 \text{ (mm)}$$

$$P = \frac{2 \times \pi \times 18.15}{100}$$

$$= 1.14 \text{ (mm)}$$

$$S_1 = 18.15 - 1.765$$

$$= 16.385 \text{ (mm)}$$

$$S_2 = 16.385 + 6.7$$

$$= 23.085 \text{ (mm)}$$

The disk shown below is available as optional part.

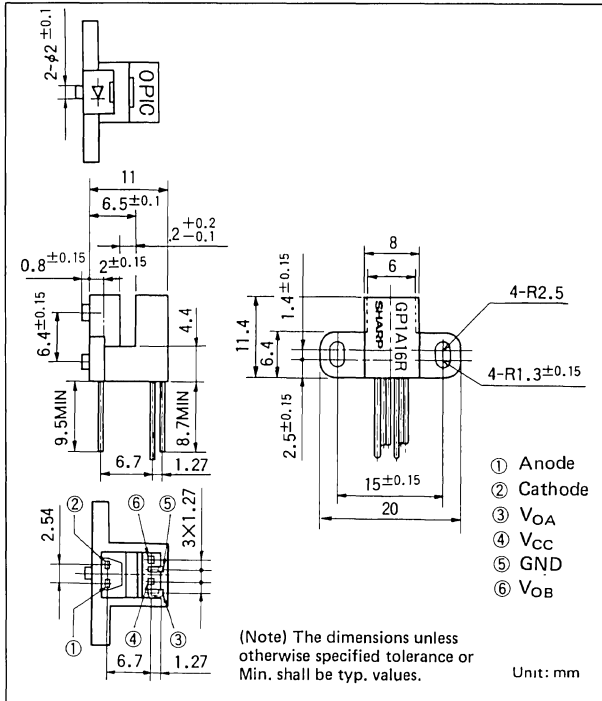
Model No.	Resolution (P/R)
GP1P13RB	60

Suggestion for Use

- 1) In order to stabilize power supply line, connect a by-pass capacitor of more than $0.01\mu F$ 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

Outline Dimensions



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 light detector (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 $\leq 100\mu s$, 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		$V_{CC}=5V$, $I_F=20mA$	$\frac{t_{AH}}{TAP}$ *4
		D_B	0.20	0.50	0.80		$f = 2.5kHz$	$\frac{t_{BH}}{TBP}$ *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

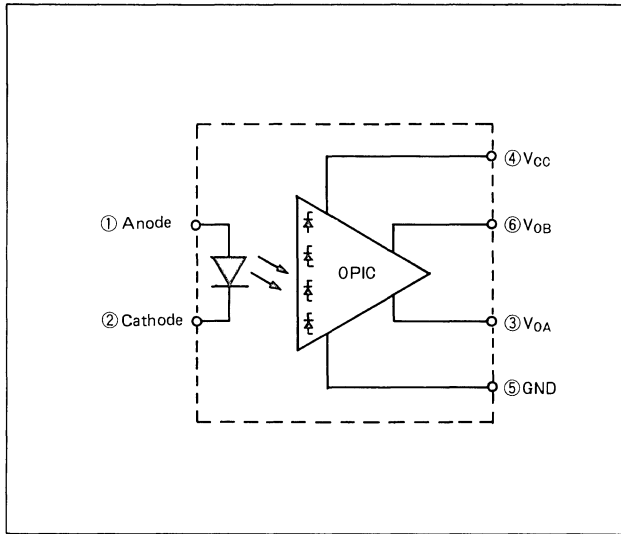
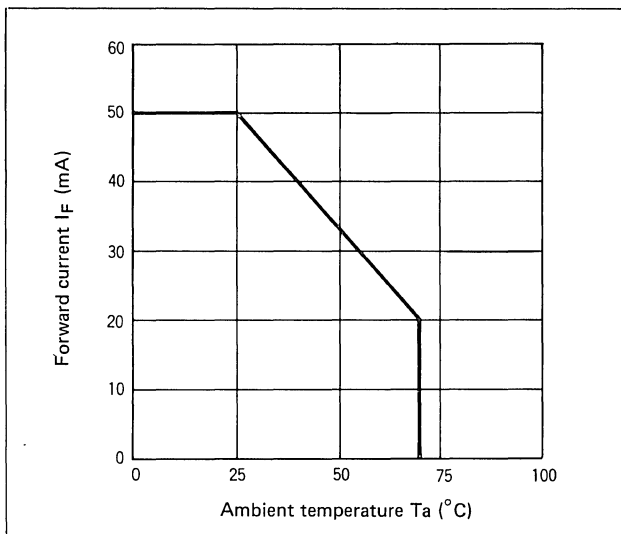


Fig. 1 Forward current vs. ambient temperature



Output Waveforms

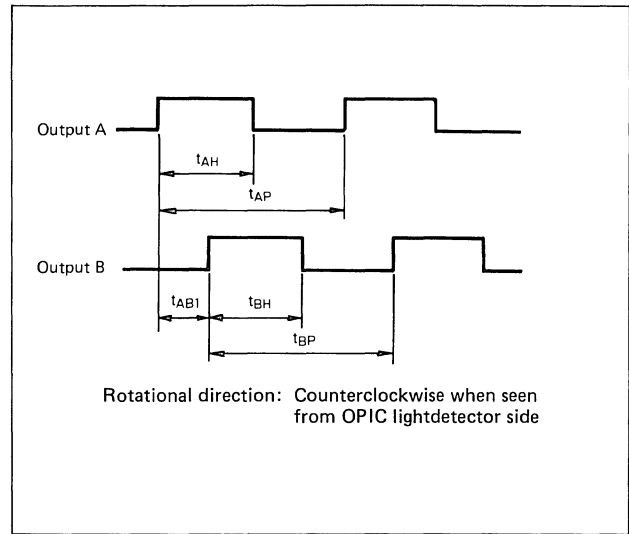


Fig. 2 Output power dissipation vs. ambient temperature

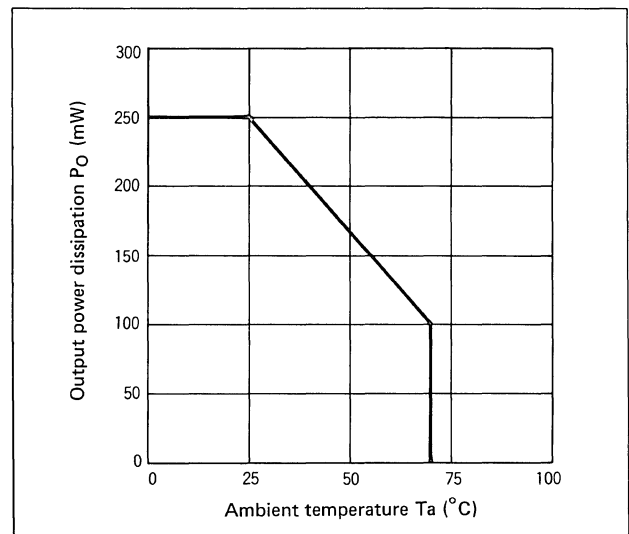


Fig. 3 Duty ratio vs. frequency

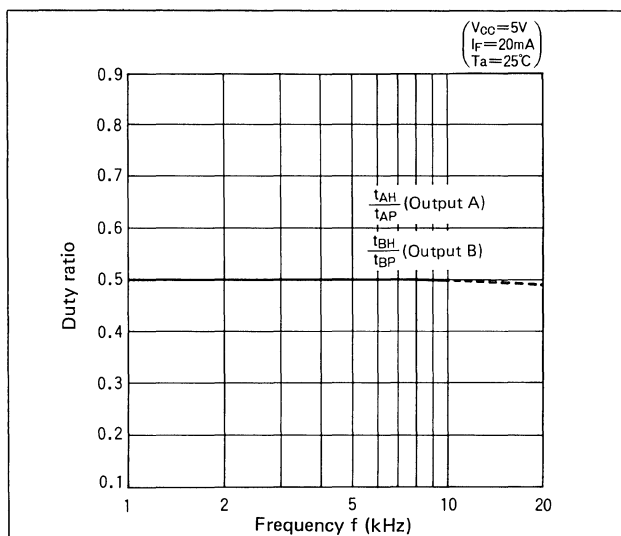


Fig. 4 Phase difference vs. frequency

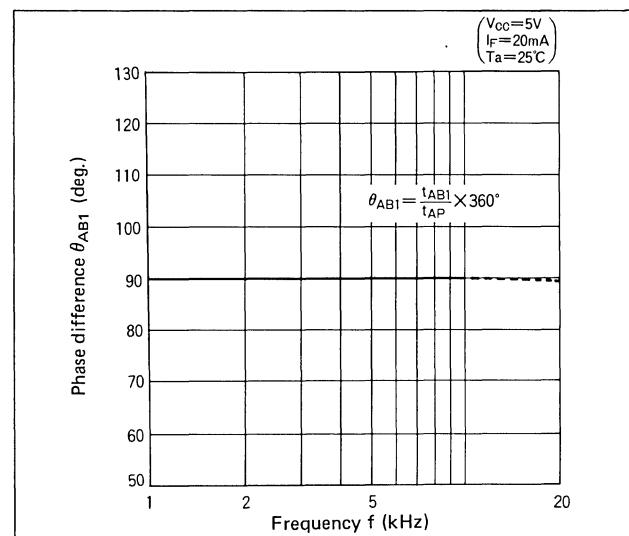


Fig. 5 Duty ratio vs. ambient temperature

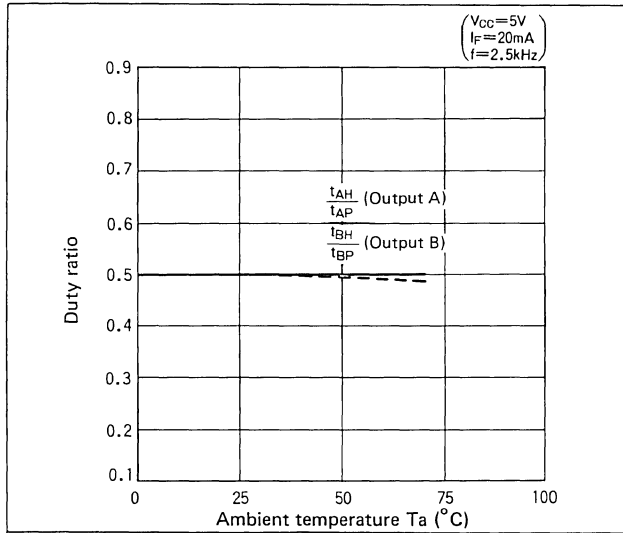


Fig. 6 Phase difference vs. ambient temperature

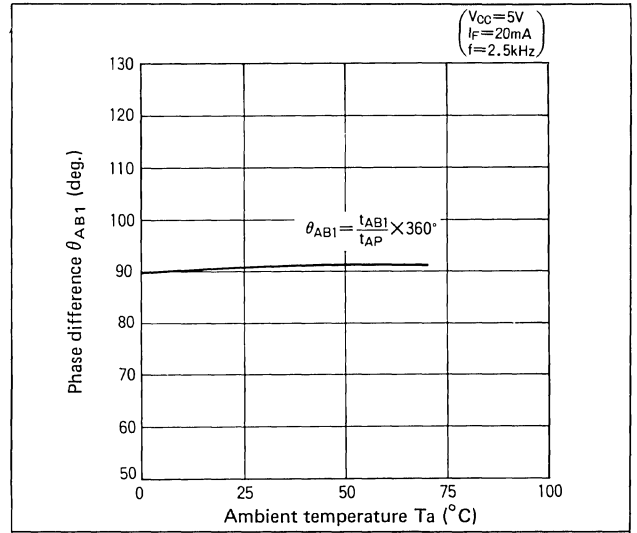


Fig. 7 Duty ratio vs. distance (X direction)

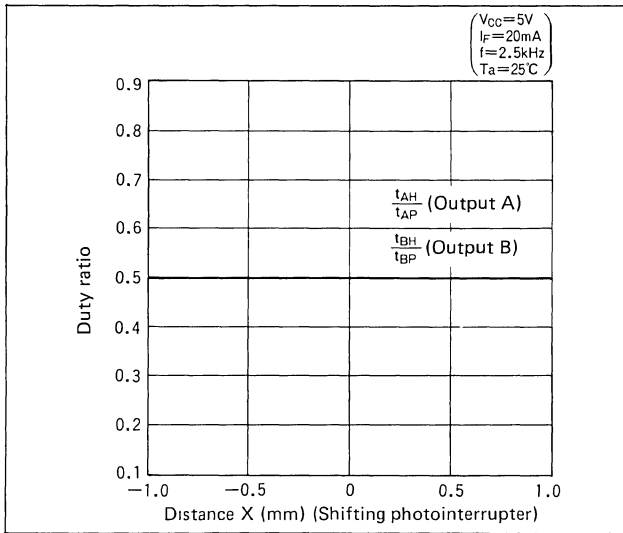


Fig. 8 Phase difference vs. distance (X direction)

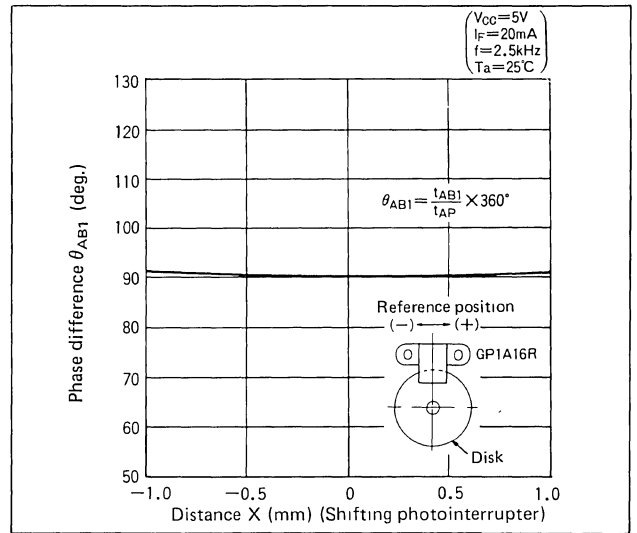


Fig. 9 Duty ratio vs. distance (Y direction)

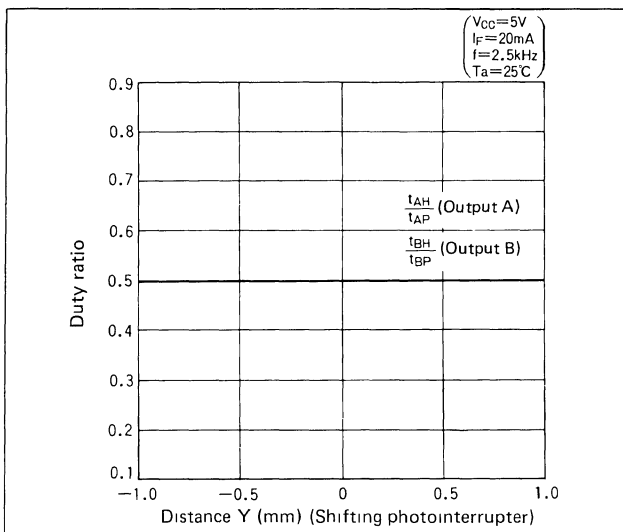


Fig. 10 Phase difference vs. distance (Y direction)

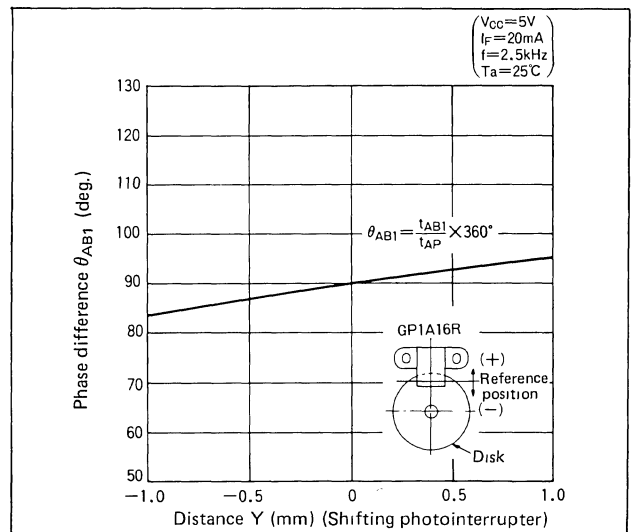


Fig. 11 Duty ratio vs. distance (Z direction)

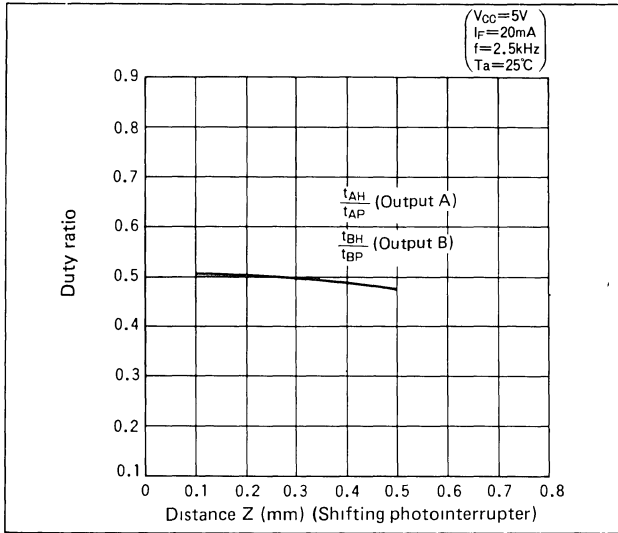
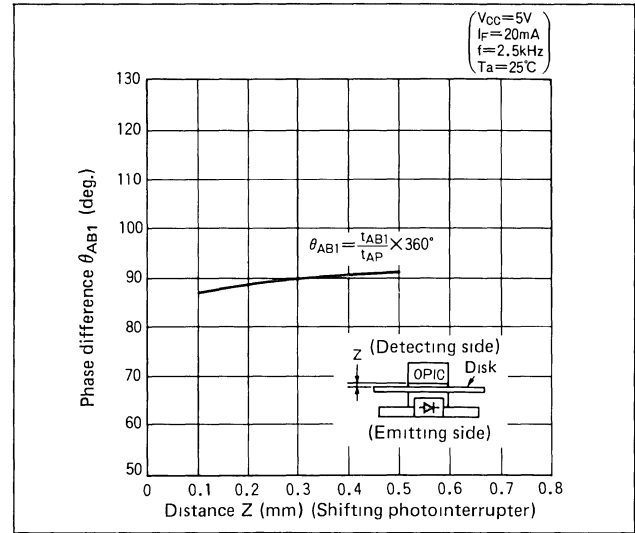


Fig. 12 Phase difference vs. distance (Z direction)



<Measurement Condition>

Disk center
 Disk ($\phi 31.6$, 120 slits)
 GP1A16R SHARP
 R1.3
 1.4
 8
 6.4
 15
 20
 11.4
 0.3
 11.685
 6.4
 0.8
 2
 4.5
 11
 S₁
 S₂

<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)

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

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

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

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.

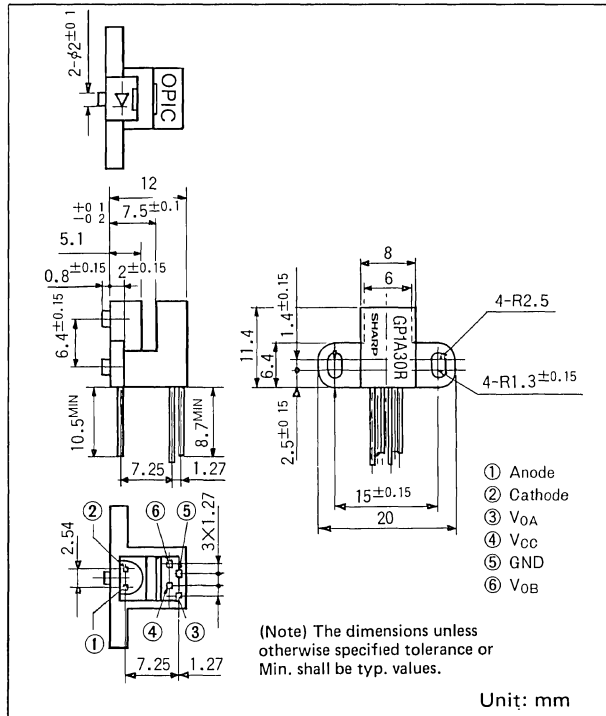
Model No.	Resolution (P/R)
GP1P16RA	120
GP1P16RB	200

Suggestion for Use

- 1) In order to stabilize power supply line, connect a by-pass capacitor of more than $0.01\mu F$ 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.

Outline Dimensions



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 light detector (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 $\leq 100\mu s$, 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		$V_{CC} = 5V$, $I_F = 30mA$ $f = 2.5kHz$	t_{AH} t_{AF}	*4
		D_B	0.20	0.50	0.80	t_{BH} t_{BF}		*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

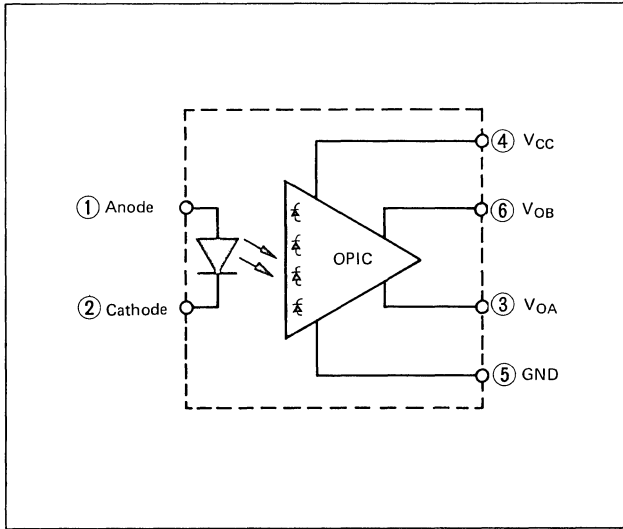
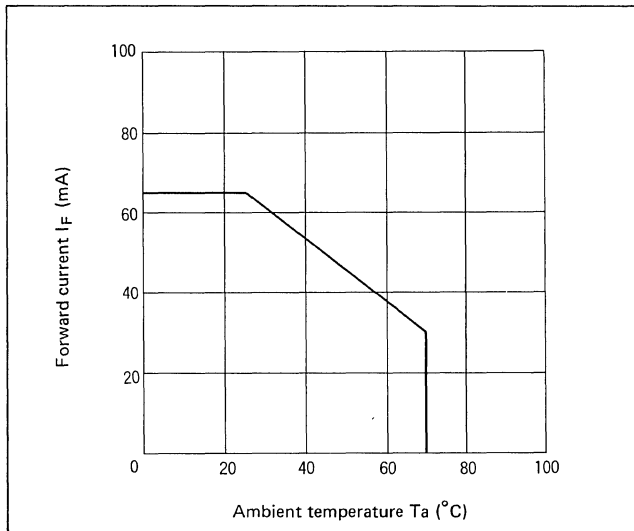


Fig. 1 Forward current vs. ambient temperature



Output Waveforms

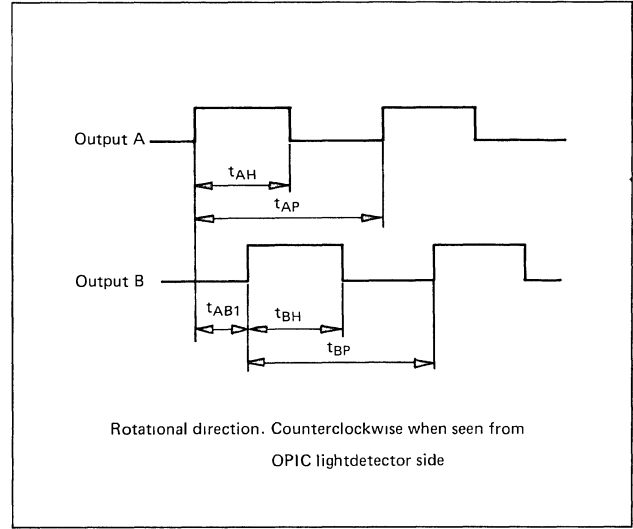


Fig. 2 Output power dissipation vs. ambient temperature

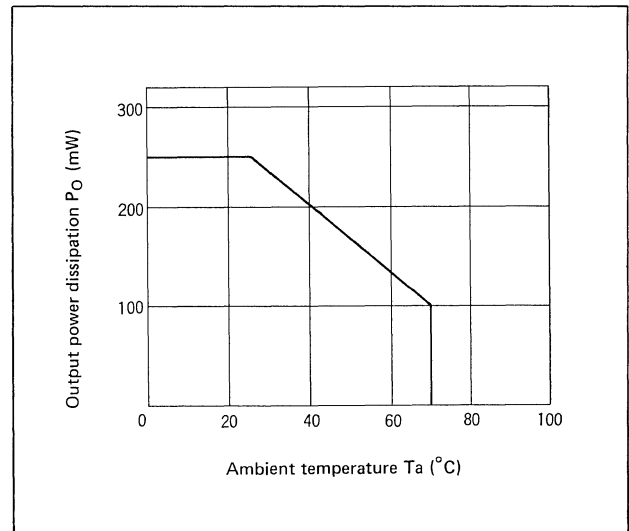


Fig. 3 Duty ratio vs. frequency

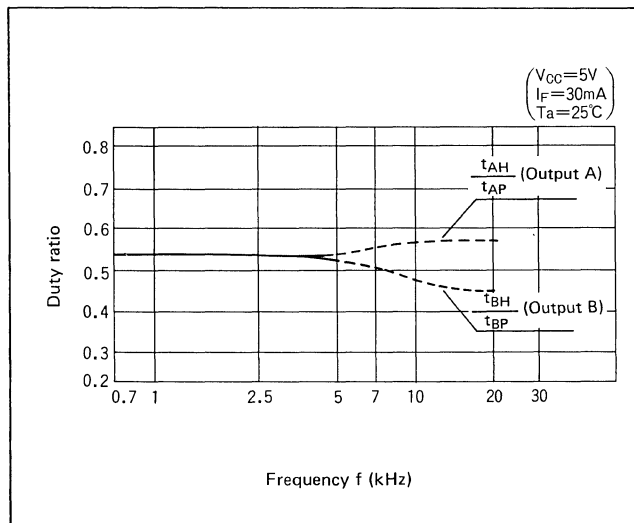


Fig. 4 Phase difference vs. frequency

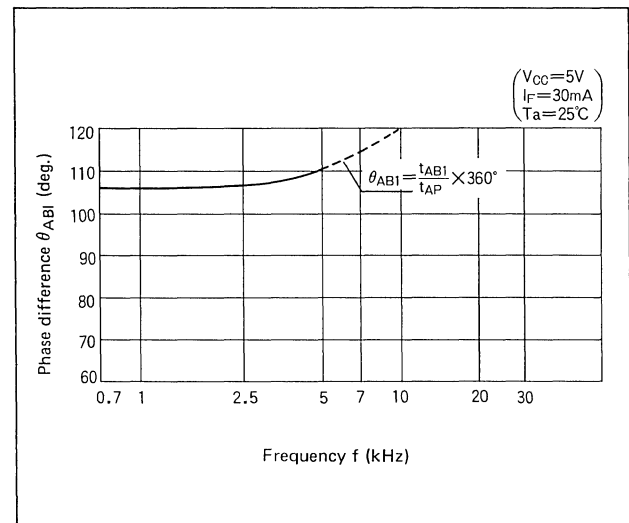


Fig. 5 Duty ratio vs. ambient temperature

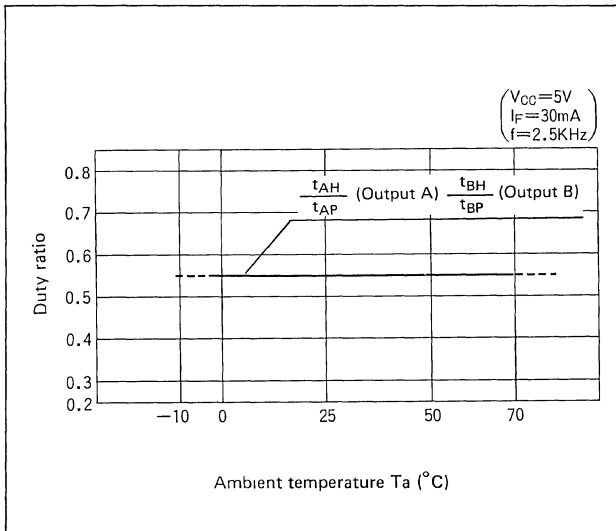


Fig. 6 Phase difference vs. ambient temperature

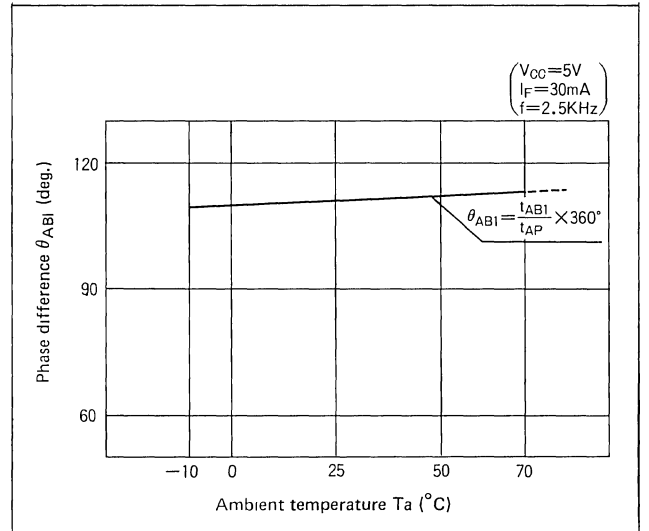


Fig. 7 Duty ratio vs. distance (X direction)

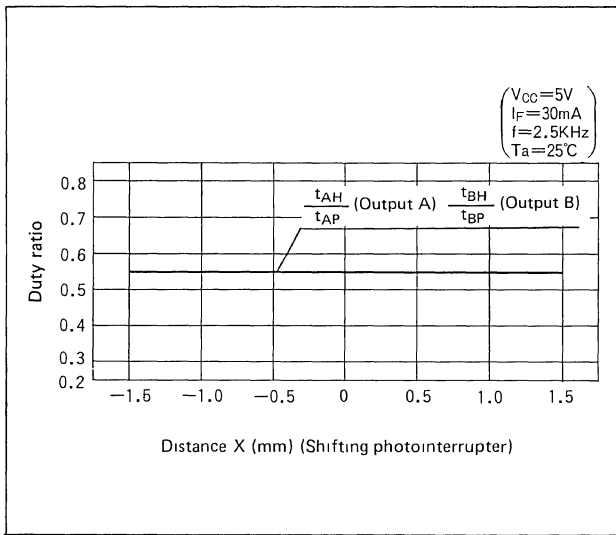


Fig. 8 Phase difference vs. distance (X direction)

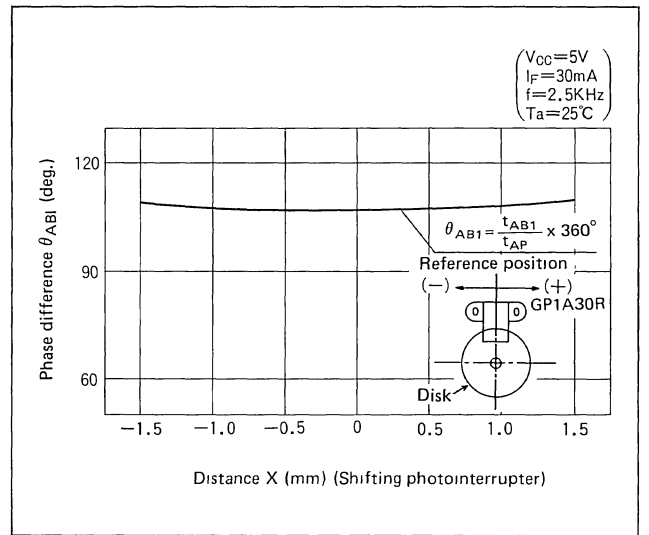


Fig. 9 Duty ratio vs. distance (Y direction)

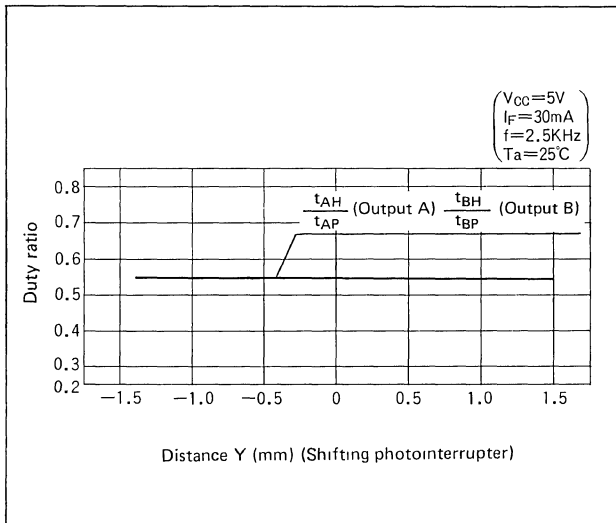


Fig. 10 Phase difference vs. distance (Y direction)

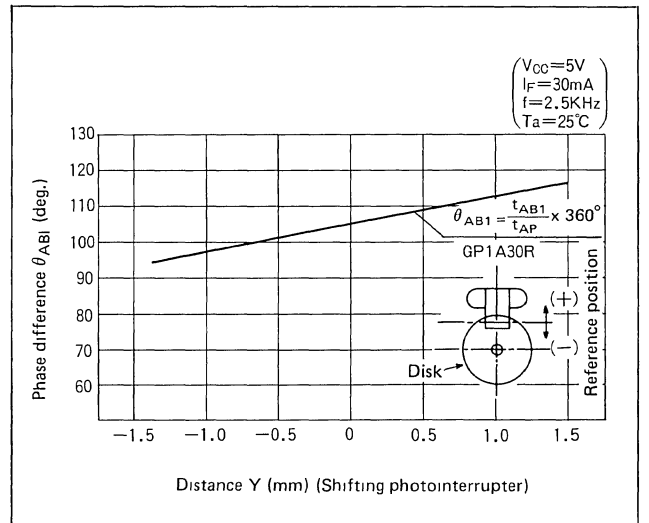


Fig. 11 Duty ratio vs. distance (Z direction)

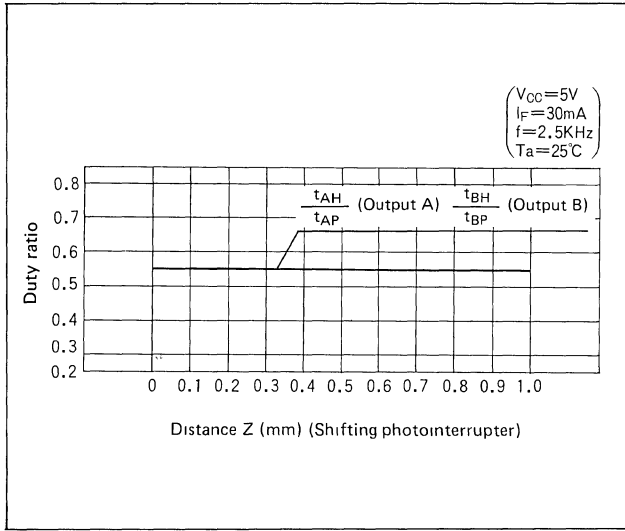
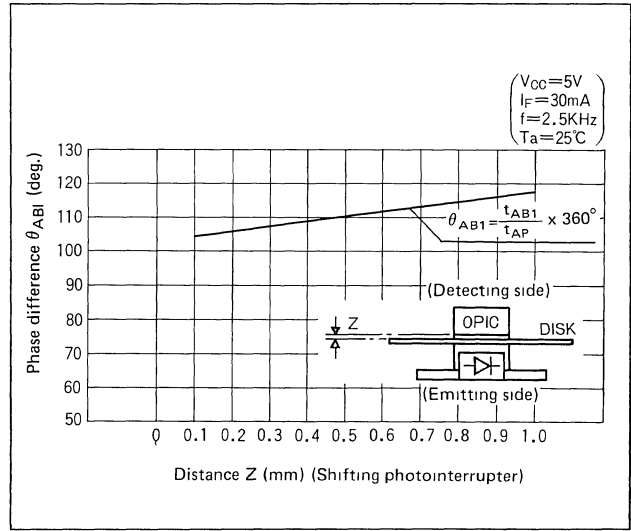


Fig. 12 Phase difference vs. distance (Z direction)



<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).

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

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

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

Enlarged drawing of A portion

Slit pitch: P Detailed drawing

Example when 200P/R disk is used:

$$R_O = \frac{200}{120} \times 13.45 = 22.42 \text{ (mm)}$$

$$P = \frac{2 \times \pi \times 22.42}{200} = 0.704 \text{ (mm)}$$

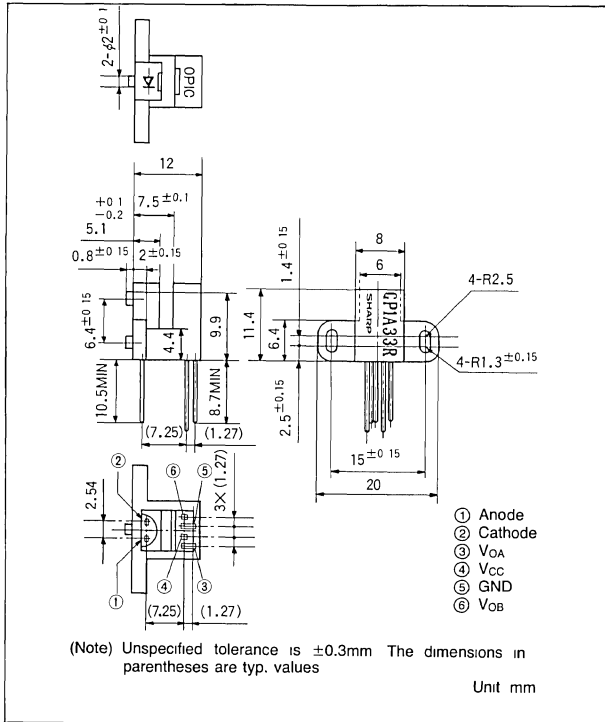
$$S = 22.42 - 1.765 = 20.655 \text{ (mm)}$$

□ Suggestion for Use

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

□ Specifications are subject to change without notice.

Outline Dimensions



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 (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 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	^{LAH} / _{LAP} *4
		D _B	0.20	0.50	0.80		f=2.5kHz	^{LBH} / _{LBP} *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

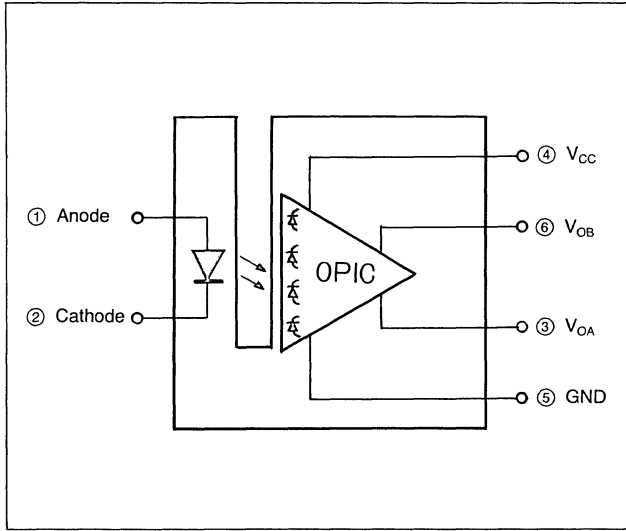


Fig.1 Forward current vs. ambient temperature

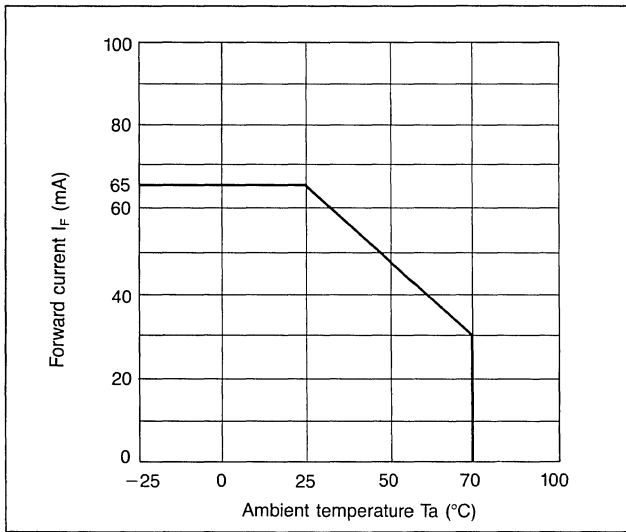
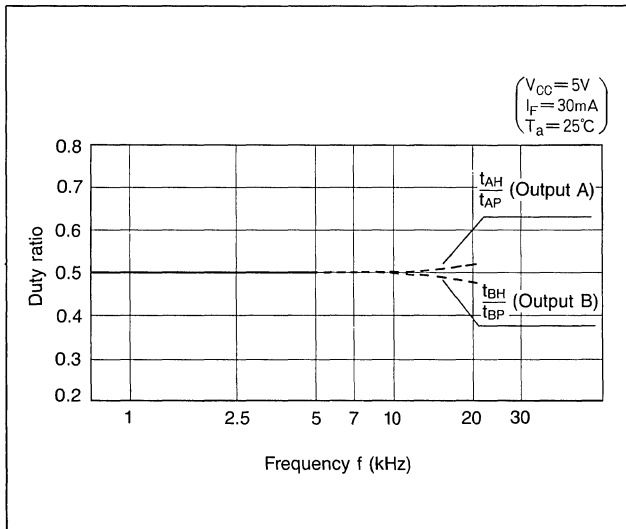
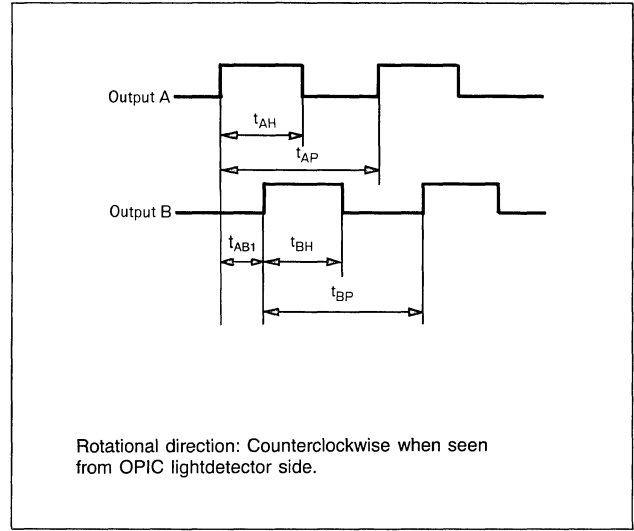


Fig.3 Duty ratio vs. frequency



Output Waveforms



Rotational direction: Counterclockwise when seen from OPIC lightdetector side.

Fig.2 Output power dissipation vs. ambient temperature

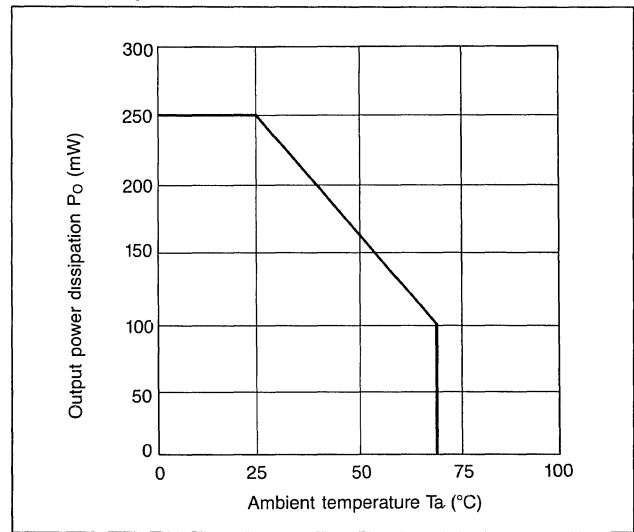


Fig.4 Phase difference vs. frequency

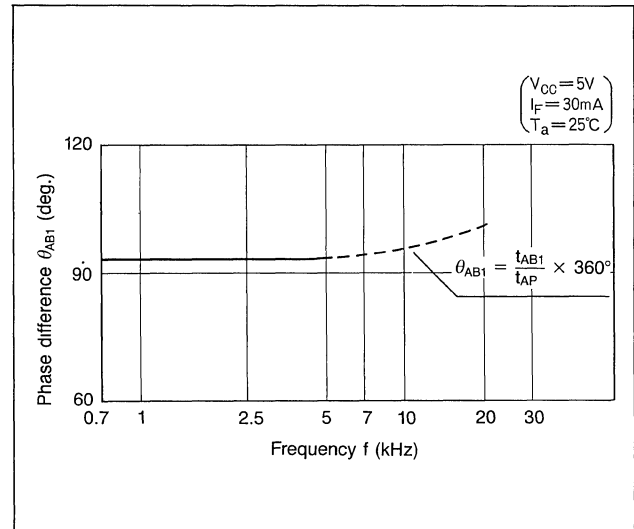


Fig.5 Duty ratio vs. ambient temperature

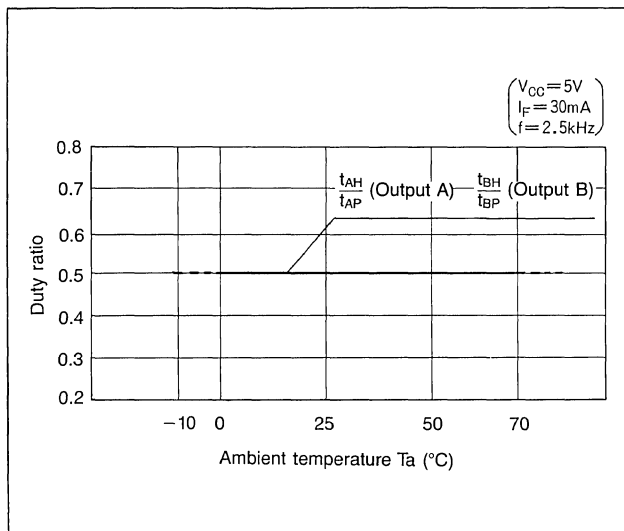


Fig.6 Phase difference vs. ambient temperature

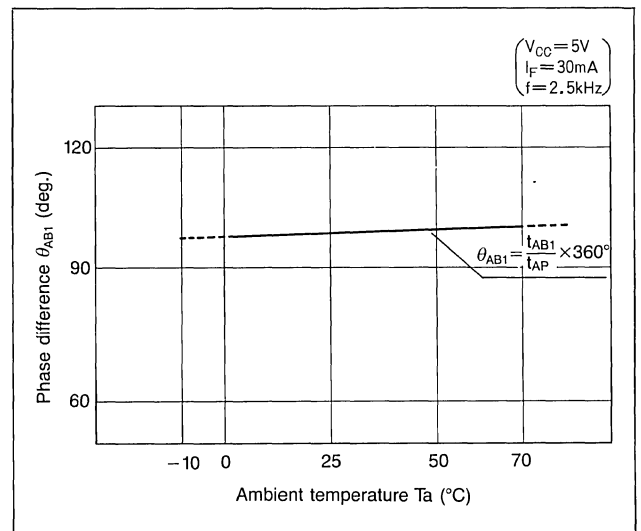


Fig.7 Duty ratio vs. distance (X direction)

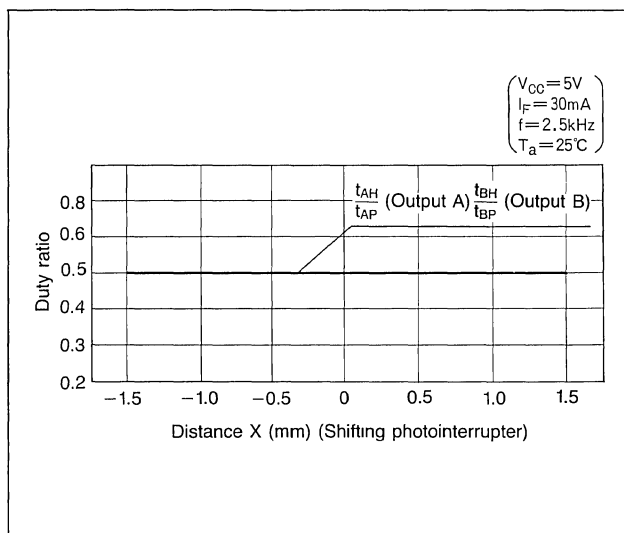


Fig.8 Phase difference vs. distance (X direction)

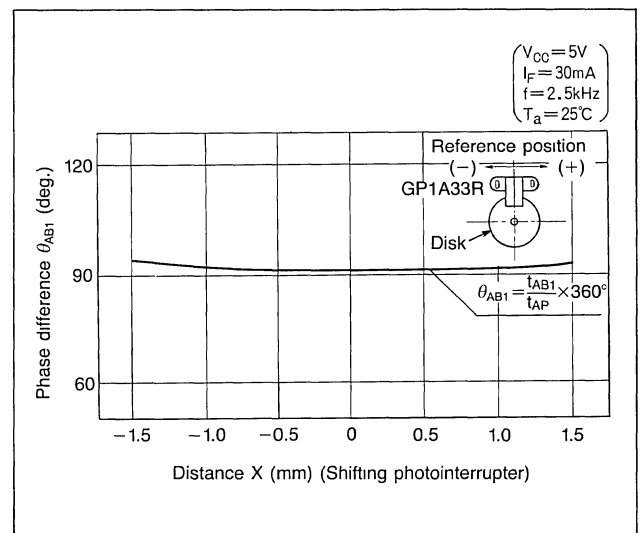


Fig.9 Duty ratio vs. distance (Y direction)

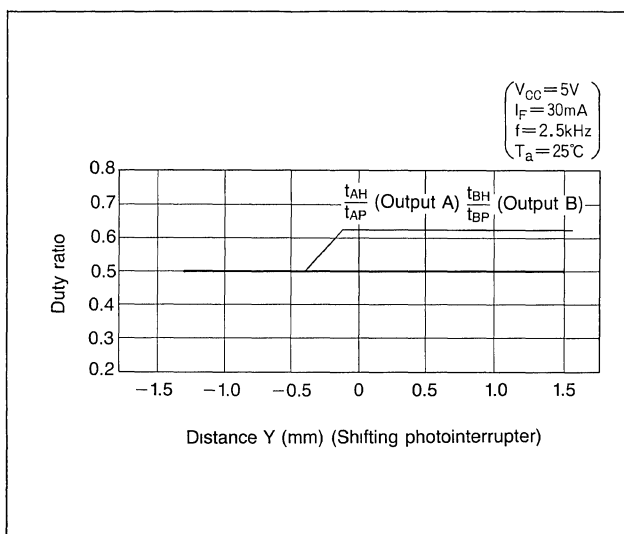


Fig.10 Phase difference vs. distance (Y direction)

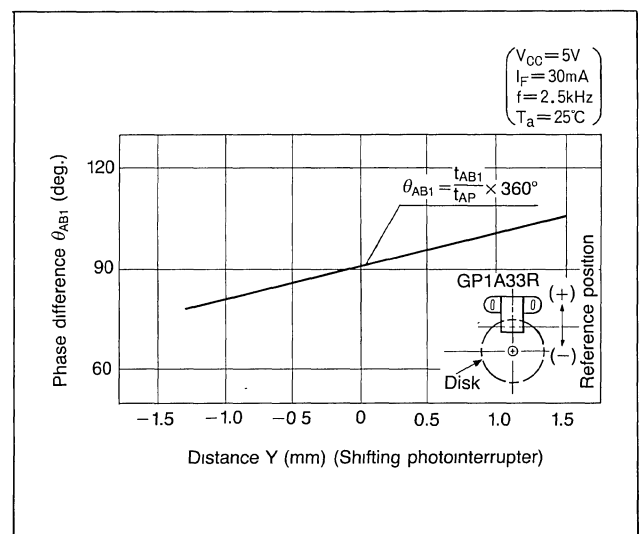


Fig.11 Duty ratio vs. distance (Z direction)

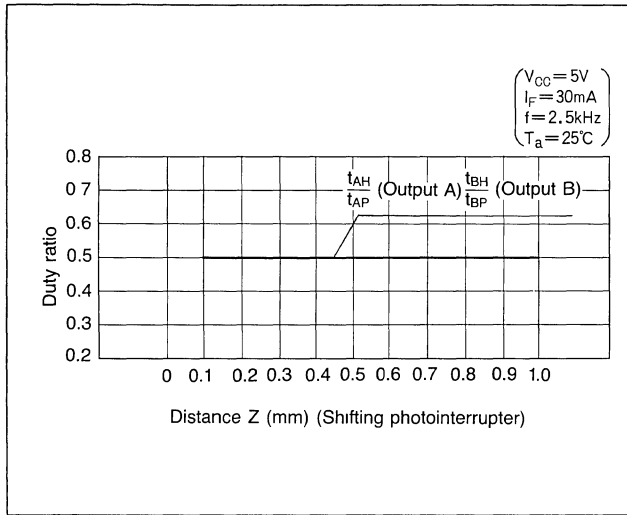
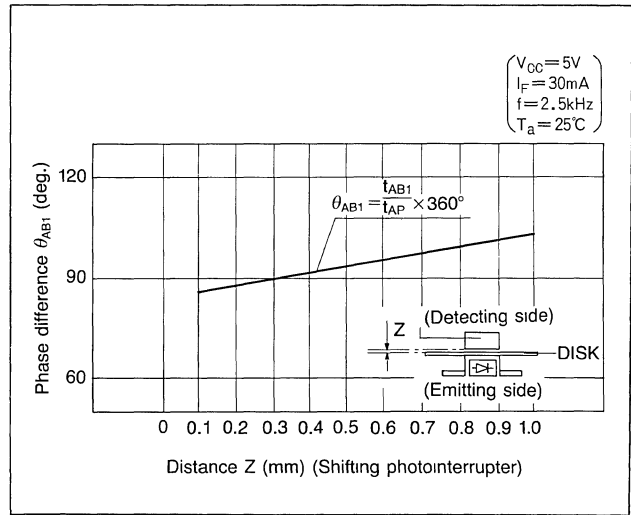


Fig.12 Phase difference vs. distance (Z direction)



<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)

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

N : Number of slits

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

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

$$S_2 = S_1 + 6.7 \text{ (mm)}$$

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

$r_1 = r_2$

Disk center

Example when 200P/R disk is used:

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

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

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

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

□ Suggestion for Use

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

□ Specifications are subject to change without notice.

■ Specifications are subject to change without notice.

SHARP

SHARP CORPORATION Japan

INTERNATIONAL SALES DEPT.
ELECTRONIC COMPONENTS GROUP
22-22, NAGAIKE-CHO, ABENO-KU, OSAKA 545, JAPAN
PHONE: (06) 621-1221
TELEX: LABOMET A-B J63428
FAX: (06) 621-8478, (06) 621-2522

NORTH AMERICA: SHARP ELECTRONICS CORPORATION

Electronic Components Division
Sharp Plaza, Mahwah, New Jersey 07430-2135, U.S.A.
PHONE: (201) 599-8757
TELEX: 426903 (SHARPAM MAWA)
FAX: (201) 529-8759

EUROPE: SHARP ELECTRONICS (EUROPE) GmbH

Electronic Components Dept.
Sonninstraße 3, 2000 Hamburg 1, F.R. Germany
PHONE: (040) 23775-0
TELEX: 2161867 (HEEG D)
FAX: (40) 231480

Distributed by: