OMRON

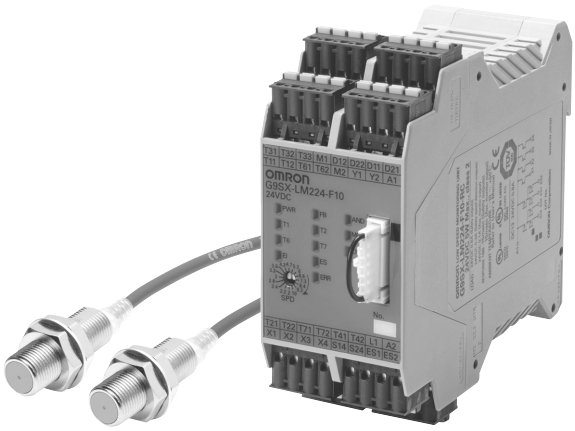
SAFETY, TECHNOLOGY & INNOVATION

Low-speed Monitoring Unit

G9SX-LM

User's Guide

Contents



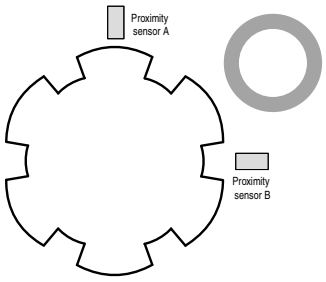
Before operating the product, be sure to read the instruction manual provided with the product thoroughly.

1. Shape of Cogwheel and Setting of Proximity Sensors

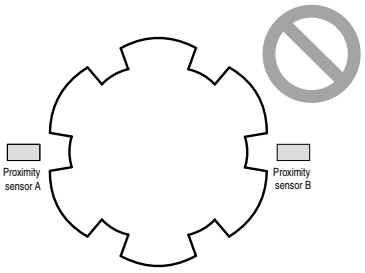
1. Installation of proximity sensors

For safe and stable detection of a rotating cogwheel, install proximity sensors according to the following description:

- To avoid interference from surrounding metal and mutual interference, specified proximity sensors should be correctly installed.
- For handling of proximity sensors, see the instruction manual for the E2E.
- Connect two proximity sensors of the same type.
- Install proximity sensors so that one of them is turned ON when the rotation of cogwheel stops.
  If neither sensor has detected any movement for more than 1 second, G9SX-LM□ will detect it as an error.



Install proximity sensors so that one of them is turned ON when the rotation of cogwheel stops.
Install one proximity sensor on the center line of the concavity width, and the other on the center of the convexity width so that one of the proximity sensors will be turned ON when the rotation of the cogwheel stops.



With this installation, both proximity sensors are turned OFF when the rotation of the cogwheel stops.
If both sensors are turned OFF for more than 1 second, G9SX-LM□ will detect it as an error.

- While operation is stopped, consideration must be given so that the cogwheel and proximity sensor do not vibrate due to vibration of the device. Otherwise the proximity sensor may detect vibration of the cogwheel, resulting in the safety outputs of G9SX-LM□ being turned OFF. Take appropriate measures to keep vibration of the cogwheel at 1Hz max.
- At the following, G9SX-LM□ diagnoses the proximity sensors. In that case, it is not abnormal though the operation indicator of the proximity sensor blinks.
  - When the rotation of the cogwheel is stopping, and both proximity sensors are turning on.

2. Relationship between the cogwheel shape and the setting of proximity sensors

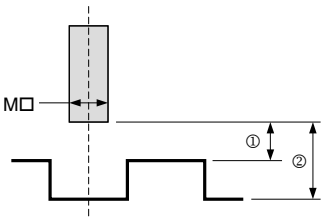
Design the cogwheel shape according to types of proximity sensors. Use the following provisions as a reference.

- Proximity sensors to be used should be selected based on the max. number of revolutions during normal operation and the number of cogwheel teeth. See the equation below.

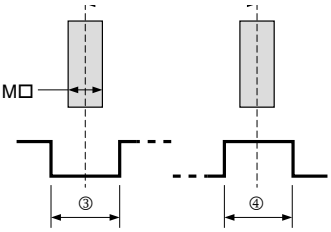
  R x 1 / 60 x N < F

  R : Max. number of revolutions during normal operation (rpm)
  N : Number of cogwheel teeth
  F : Response frequency of proximity sensor (Hz)
- Install one proximity sensor on the center line of the concavity width, and the other on the center of the convexity width so that one of the proximity sensors will be turned ON when the rotation of the cogwheel stops.
- All cogwheel teeth should be identically shaped.

The following tables show data for iron cogwheels. Use of other material will show different characteristics of operating range. See E2E Catalog for details.
"Sensing distance" on the table below shows a size when the proximity sensors are arranged in parallel.



Shielded	**Size**	**M8**	**M12**	**M18**
	Model	**E2E-X1R5F1□**	**E2E-X2F1□**	**E2E-X5F1□**
	Sensing distance	**1.5 mm**	**2 mm**	**5 mm**
①	Distance of convexity	1.2 mm max.	1.6 mm max.	4 mm max.
②	Distance of concavity	4.5 mm min.	8 mm min.	20 mm min.
Unshielded	**Size**	**M8**	**M12**	**M18**
	Model	**E2E-X2MF1□**	**E2E-X5MF1□**	**E2E-X10MF1□**
	Sensing distance	**2 mm**	**5 mm**	**10 mm**
①	Distance of convexity	1.6 mm max.	4 mm max.	8 mm max.
②	Distance of concavity	8 mm min.	20 mm min.	40 mm min.



Shielded	**Size**	**M8**	**M12**	**M18**
	Model	**E2E-X1R5F1□**	**E2E-X2F1□**	**E2E-X5F1□**
③	Concavity width	16 mm min.	24 mm min.	36 mm min.
④	Convexity width	Concavity width X 2 min. / Concavity width X 6 max.		
⑤	Sensing distance	15 mm min.	20 mm min.	35 mm min.
Unshielded	**Size**	**M8**	**M12**	**M18**
	Model	**E2E-X2MF1□**	**E2E-X5MF1□**	**E2E-X10MF1□**
③	Concavity width	24 mm min.	30 mm min.	60 mm min.
④	Convexity width	Concavity width X 2 min. / Concavity width X 6 max.		
⑤	Sensing distance	60 mm min.	100 mm min.	110 mm min.

3. Design examples

This example shows a design of cogwheel and proximity sensors when the number of motor revolutions of hazards is 3000 rpm at normal operation (high speed), and 60 rpm at low speed.

Step 1: Calculating the number of cogwheel teeth

"Input frequency range" and "Low speed detection settings" of G9SX-LM□ should be considered.

Input frequency range: 1000 max.	Set the number of cogwheel teeth such that the value of the number of rotations at normal operation (high speed) x 1 / 60 x value of the number of cogwheel teeth becomes 1000 max.
Low speed detection settings: 2 to 10 Hz	Set the number of cogwheel teeth such that the value of the number of rotations at low speed x 1 / 60 x value of the number of cogwheel teeth becomes within the range of 2 to 10.

According to the information above, when setting the number of cogwheel teeth at "6," the values will be as mentioned below. These values are frequencies input to rotation detection input of G9SX-LM□, falling within the ranges of "Input frequency range" and "Low speed detection settings".

At normal operation (high speed): 3000 rpm x 1 / 60 x 6 = 300 Hz

At low speed: 60 rpm x 1 / 60 x 6 = 6 Hz

Note: When the number of rotations between cogwheel and motor differs due to gear attachment, etc., take its rotation ratio into account.

Step 2: Selecting proximity sensors

Select proximity sensors according to the frequencies obtained in Step 1.

Since the input frequency to G9SX-LM□ at normal operation (high speed) is 300 Hz, select proximity sensors with higher response frequency performance than this value. E2E-X2F1□ (M12 shielded type, Response frequency: 1.5 kHz) is used in this example.

Step 3: Determining the arrangement of proximity sensors for cogwheel

In this example, proximity sensors are installed in the horizontal direction to the cogwheel surface.

Step 4: Determining the distance between cogwheel and proximity sensors

Determine the distance between cogwheel and proximity sensors, and the height of the cogwheel teeth according to "2. Relationship between the cogwheel shape and the setting of proximity sensors".

a. Distance of convexity: Design it to be 1.6 mm or less according to the table. In this example, a distance is set to 1 mm (50% of operating range).
b. Distance of concavity: Design it to be 8 mm or more according to the table. In this example, the height of the cogwheel is set to 20 mm, making it 21 mm by adding 1 according to "1. Distance of convexity".

Step 5: Determining the widths of convexity and concavity

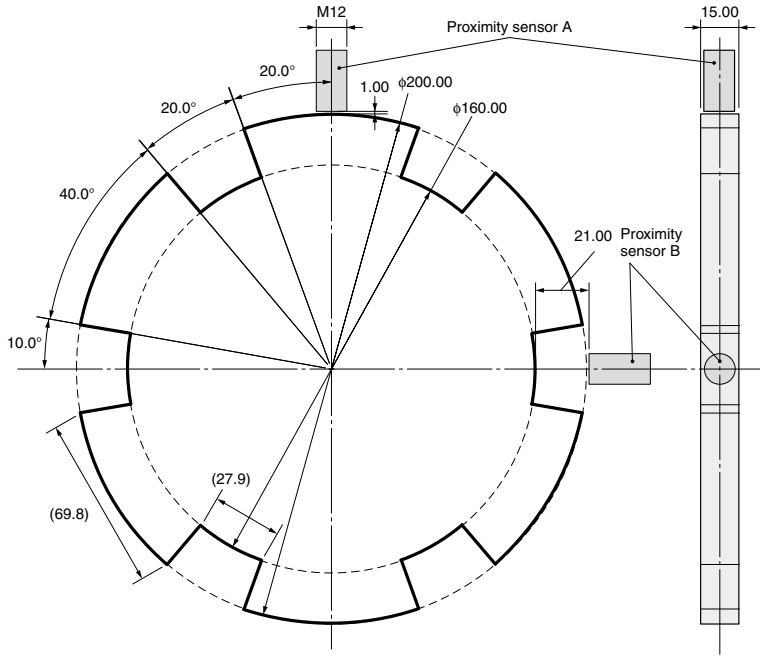
a. Because the number of cogwheel teeth obtained from Step 1 is 6, the angle of the combination of convexity and concavity is: 360°/ number of cogwheel teeth: 6 = 60°.
   According to the table of "2. Relationship between the cogwheel shape and the setting of proximity sensors", design the width of convexity as twice as the width of concavity.
   Therefore, ratio of an angle of convexity and angle of concavity is set to 2:1 = 40° : 20°.
b. Determine the diameter when concavity is assumed to be a circle.
   In this example, set the diameter to 160 mm and verify if it satisfy the provisions of the table in "2. Relationship between the cogwheel shape and the setting of proximity sensors".
   According to a. in Step 5, the concavity width is 160 mm x π x 20° / 360° $\fallingdotseq$ 27.9 mm, satisfying the concavity width of E2E-X2F1□: 24 mm or more.
c. Since the height of the cogwheel teeth is set to 20 mm according to Step 4, the diameter of the cogwheel at convexity is to be 160 mm + 20 mm x 2 = 200 mm. Verify that it satisfies the provisions of the table in "2. Relationship between the cogwheel shape and the setting of proximity sensors".
   According to a. in Step 5, the convexity width is 200 mm x π x 40° / 360° $\fallingdotseq$ 69.8 mm, satisfying twice or more of the concavity width obtained in b. in Step 5.

Step 6: Determining the thickness of the cogwheel teeth

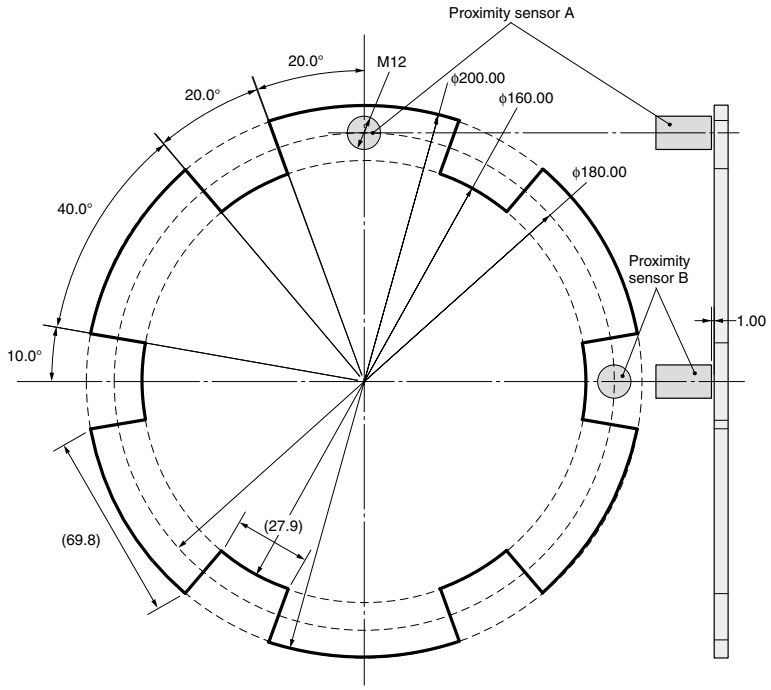
Determine the thickness according to the shape of the selected proximity sensors. Since the size of E2E-X2F1□ is M12, the thickness of the cogwheel teeth should be 15 mm (standard object width of E2E-X2F1□) to install proximity sensors in the horizontal direction according to Step 3.

1. Shape of Cogwheel and Setting of Proximity Sensors

According to the process above, an example of shape of cogwheel and arrangement of proximity sensors are shown in the diagram below. Proximity sensors are arranged to be intersecting each other. Note that the distance between proximity sensors defined in the table of "2. Relationship between the cogwheel shape and the setting of proximity sensors" must be satisfied.



The diagram below shows a design when proximity sensors are installed in the vertical direction to the cogwheel surface.



When installing proximity sensors in the vertical direction to the cogwheel surface, note that the height of cogwheel teeth should not be affected by surrounding metal products. For details in influence of surrounding metal, see the E2E Catalog.

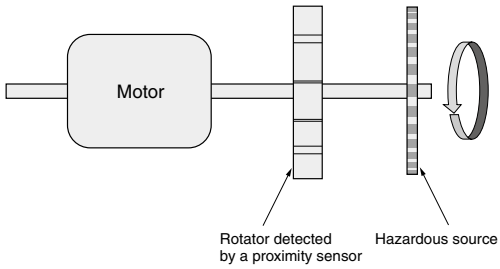
4. Example of low speed detection settings

When the number of rotations at low speed is 50 rpm and the number of cogwheel teeth detected by proximity sensors is 6, the frequency at low speed is 50 rpm x 1 / 60 x 6 = 5 Hz.
Consider the low-speed detection frequency accuracy (tolerance of -10%) such that low speed detection frequency setting is 6.0 Hz or higher.

(1)	(2)	(3)-1	(3)-2
Low speed detection settings (Hz)	Low-speed detection frequency accuracy: Hz ((1) - (1) x 10%)	Safety speed detection outputs are turned ON. No. of revolutions: rpm ∗ No. of cogwheel teeth: 6 ((2) x 60 / 6)	Safety speed detection outputs are turned ON. No. of revolutions: rpm ∗ No. of cogwheel teeth: 3 ((2) x 60 / 3)
2	1.8	18	36
2.2	1.9	19	38
2.4	2.1	21	42
2.8	2.5	25	50
3.0	2.7	27	54
3.2	2.8	28	56
3.6	3.2	32	64
4.2	3.7	37	74
4.7	4.2	42	84
5.3	4.7	47	94
6.0	5.4	54	108
6.6	5.9	59	118
7.3	6.5	65	130
8.4	7.5	75	150
9.3	8.3	83	166
10	9	90	180

5. Relationship between motor, cogwheel, and hazards

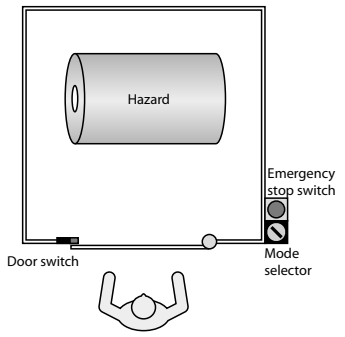
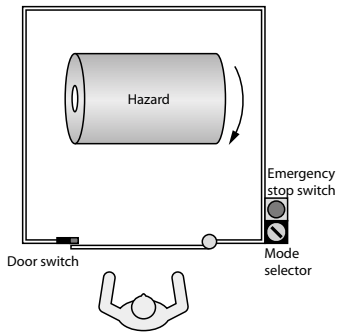
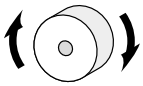
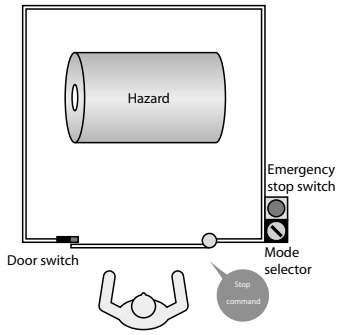
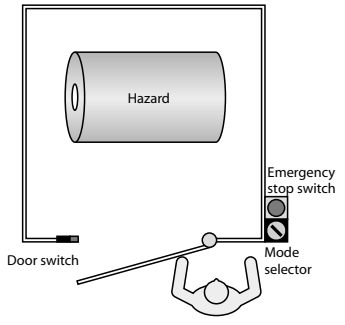
Install the cogwheel between the motor and a hazardous source.



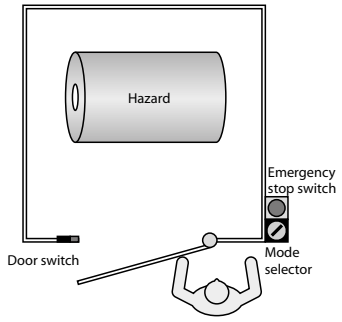
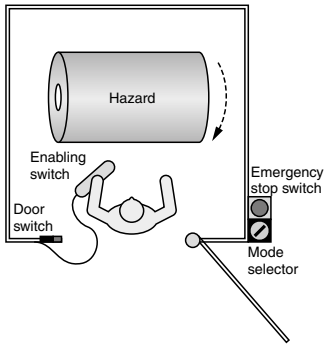
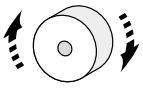
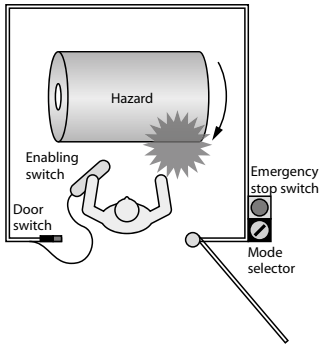
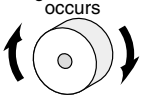
Perform a risk assessment for entire equipment including the conditions of use to implement safety measures.
(For example, attaching a protective cover around a cogwheel)

2. Operating Procedure

Normal operating mode (M1: ON, M2: OFF)

Operating status/operation	LED indicator	Machine operation (status of rotation)	Safety instantaneous output (S14, S24)	Safety speed detection output (ES1, ES2)
Before operation of the equipment (Door closed, reset switch operation) 	PWR FB AND T1 T2 MOD T6 T7 DS EI ES ERR	Standstill 	ON	ON
Operation starts, equipment operates 	PWR FB AND T1 T2 MOD T6 T7 DS EI ES ERR	Rotating 	ON	OFF
Operation stops (door closed) 	PWR FB AND T1 T2 MOD T6 T7 DS EI ES ERR	Standstill 	ON	ON
Operation stops (lock released, door open) 	PWR FB AND T1 T2 MOD T6 T7 DS EI ES ERR	Standstill 	OFF	ON

Maintenance mode (M1: OFF, M2: ON)

Operating status/operation	LED indicator	Machine operation (status of rotation)	Safety instantaneous output (S14, S24)	Safety speed detection output (ES1, ES2)
Before starting maintenance (switch to Maintenance mode) 	PWR FB AND T1 T2 MOD T6 T7 DS EI ES ERR	Standstill 	OFF	ON
Start maintenance (grip switch ON, reset switch operation, low speed operation) 	PWR FB AND T1 T2 MOD T6 T7 DS EI ES ERR	Decelerating 	ON	ON
Failure occurs (high rotation detected or grip switch is turned OFF) 	When high rotation is detected PWR FB AND T1 T2 MOD T6 T7 DS EI ES ERR When rotation stops PWR FB AND T1 T2 MOD T6 T7 DS EI ES ERR	High rotation occurs   Standstill 	OFF OFF	OFF ON

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