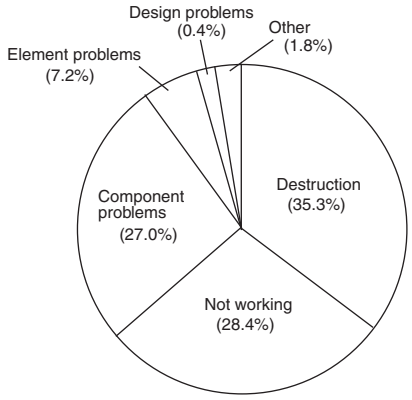
Reliability

Market Product Quality

OMRON is making efforts so that OMRON's Photomicrosensors can achieve a failure rate of only 10^{-7}/h.
OMRON will continue improving the quality of its products to comply with OMRON Photomicrosensors users' demand for product quality while actively providing good after-sales service.
OMRON's Photomicrosensors achieved a failure rate of 10 ppm. Figure 5 shows the reasons for the return of OMRON Photomicrosensors. The reasons for approximately two-thirds of the products sent back were that they were not working or they were destroyed. It is possible that they were not working or they were destructed because excessive voltages were imposed on them or they were not operated properly according to their specifications. To solve such problems, OMRON is actively holding preliminary meetings with customers who will use OMRON products and advise them of the operating conditions required by the products while actively providing them with after-sales service.

Figure 5. Reasons for Products Sent Back



Reliability

The life of any Photomicrosensor depends on the secular changes of the optical output of the LED built into the Photomicrosensor. The following are the output characteristics of the Photomicrosensor, all of which depend on the optical output of the LED.

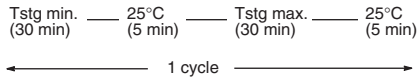
Phototransistor output	Light current (I_L)
Photo IC output	LED current I_{FT} with the photo IC output ON and OFF
Amplifier output (reflective sensor)	Sensing distance d

OMRON has been conducting reliability tests of each type of Photomicrosensor to check the secular changes of the optical output of the LED built into the Photomicrosensor.

Reliability Tests

In principle, Photomicrosensors conform to JEITA standards. The following table shows the details of the reliability tests of Photomicrosensors conducted by OMRON.

Figure 6. Details of Reliability Tests

Classification	Test	Detail	Conforming standard	
Thermal condition test	Soldering heat resistivity	Evaluates the soldering heat resistivity of products. Usually, this test is conducted under the following conditions. Soldering temperature: 260±5°C Soldering time:10±1 s	JEITA ED-4701/300 ED-8121 JIS C7021: A1 IEC Pub68-2-20	
	Thermal shock	Evaluates the resistivity of products to radical temperature changes. Usually, this test is conducted under the following conditions. Ta: 0°C to 100°C (liquid bath) or TstgMIN to TstgMAX (liquid bath)	JEITA ED-4701/300 JIS C7021: A3 IEC Pub68-2-14	
	Temperature cycle	Evaluates the low- and high-temperature resistivity of products. 	JEITA ED-4701/100 JIS C7021: A4 IEC Pub68-2-14	The five-minute storage periods at a temperature of 25°C in the test may be omitted.
Mechanical test	Soldering ease	Evaluates the terminal soldering ease of the products. Usually, this test is conducted under the following conditions. Soldering temperature: 230±5°C Soldering time: 5±0.5 s	JEITA ED-4701/300 ED-8121 JIS C7021: A2 IEC Pub68-2-20	
	Terminal strength	Evaluates the resistivity of the terminals of products to the force imposed on the terminals while the products are mounted, wired, or operated. **1.** Tension test On each terminal of products, a specified load is imposed for 10±1 s in the direction of the terminal. **2.** Bending test On the tip of each terminal of products, a specified load is imposed to bend the terminal by 90° and to change it back.	JEITA ED-4701/400 ED-8121 JIS C7021: A11 IEC Pub68-2-21	
	Shock resistance	Judges the structural resistivity and mechanical resistivity of products. The conditions of this test vary with the product structure. Usually, this test is conducted under the following conditions. Impact acceleration:14,700 m/s^2 Pulse width: 0.5 ms	JEITA ED-4701/400 ED-8121 JIS C7021: A7 IEC Pub68-2-27	A product may be subjected to this test after it is packed up.
	Vibration resistance	Evaluates the vibration resistivity of products while they are transported or operated. Usually, this test is conducted under the following conditions. Frequency: 100 to 2000 Hz/4 min 200 m/s^2	JEITA ED-4701/400 ED-8121 JIS C7021: A10 IEC Pub68-2-21	A product may be subjected to this test after it is packed up.
	Natural drop	Evaluates the irregular shock resistivity of products while they are handled, transported, or operated. Usually, this test is conducted under the following conditions. Height: 75 cm No. of times: 3	JEITA EIAJ-8121 JIS C7021: A8 IEC Pub68-2-32	A product may be subjected to this test after it is packed up.

Classification	Test	Detail	Conforming standard	
Life expectancy test	Continuous operation	Evaluates the resistivity of products to a continuous, long-time electrical stress and temperature stress. Usually, this test is conducted under the following conditions. Ta: 25±5°C Bias: I_{FMAX} or P_{CMAX}	EIAJ-EDX-8121 EIAJ-SD-121: 201 JIS C7021: B4	A product may be subjected to this test at a high temperature, low temperature, or high temperature and humidity.
	High-temperature storage	Evaluates the resistivity of products to a high-storage temperature for a long time. Usually, this test is conducted under the following conditions. Ta: TstgMAX Time: 1,000 hrs	EIAJ-EDX-8121 EIAJ-SD-121: 115 JIS C7021: B10 IEC Pub68-2-2	
	Low-temperature storage	Evaluates the resistivity of products to a low-storage temperature for a long time. Usually, this test is conducted under the following conditions. Ta: TstgMIN Time: 1,000 hrs	EIAJ-EDX-8121 EIAJ-SD-121: 116 JIS C7021: B12 IEC Pub68-2-1	
	High-temperature and high-humidity storage	Evaluates the resistivity of products to a high-storage temperature and high storage humidity for a long time. Usually, this test is conducted under the following conditions. Ta: 60°C Humidity: 90% Time: 1,000 hrs	EIAJ-EDX-8121 EIAJ-SD-121: 117 JIS C7021: B11 IEC Pub68-2-3	
	High-temperature reverse bias	Evaluates the resistivity of products to a continuous electrical stress and temperature stress.	EIAJ-SD-121: 203 JIS C7021: B8	A product may be subjected to this test at a low temperature, high temperature, or high humidity.

Note: The above testing conditions and testing times depend on the features of each product.

Data from Reliability Tests

The following tables show the results of the reliability tests of typical Transmissive Photomicrosensors with an Infrared LED conducted by OMRON. Providing this data does not imply that OMRON guarantees the specified reliability level.

Typical Failure Rates (MTTF Data)

EE-SX1041 (Transmissive Phototransistor Output)

Failure Criteria

Item	Symbol	Measuring conditions	Failure criteria	
			General test (see note)	Life test
Forward voltage	V_F	I_F = 30 mA	1.5 V max.	1.8 V max.
Reverse current	I_R	V_R = 4 V	10 μA max.	20 μA max.
Dark current	I_D	V_{CE} = 10 V 0lx	200 nA max.	400 nA max.
Light current	I_L	I_F = 20 mA V_{CE} = 10 V	0.5 mA min. 14 mA max.	Initial value × 0.7 min.

Note: Except life test.

Test Results

Test item	Test conditions (see note 1)	Number of samples	Component hours (h)	Number of failures	Failure rate (1/h) (see note 2)
Continuous operation	Ta = 25°C, I_F = 50 mA 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
High-temperature storage	Ta = 100°C 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
Low-temperature storage	Ta = –30°C 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
High-temperature and high-humidity storage	Ta = 60°C, 90% 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
High-temperature reverse bias	Ta = 85°C, V_{CE} = 30 V 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
Temperature cycle	–30°C (30 min) to 100°C (30 min) 10 times	22 pcs	---	0	---
Shock resistance	14,700 m/s^2, 0.5 ms, 3 times each in ±X, ±Y, and ±Z directions	11 pcs	---	0	---
Vibration resistance	20 to 2,000 Hz, 1.5 mm or 98 m/s^2 each in X, Y, and Z directions	11 pcs	---	0	---

Note: 1. The tests after 1001 hours are for reference only.

2. Confidence level of 90%.

EE-SX1235A-P2 (Transmissive Phototransistor Output)

Failure Criteria

Item	Symbol	Measuring conditions	Failure criteria	
			General test (see note)	Life test
Forward voltage	V_F	I_F = 30 mA	1.5 V max.	1.8 V max.
Reverse current	I_R	V_R = 4 V	10 μA max.	20 μA max.
Dark current	I_D	V_{CE} = 10 V 0lx	200 nA max.	400 nA max.
Light current	I_L	I_F = 20 mA V_{CE} = 5 V	0.5 mA min. 14 mA max.	Initial value × 0.7 min.

Note: Except life test.

Test Results

Test item	Test conditions (see note 1)	Number of samples	Component hours (h)	Number of failures	Failure rate (1/h) (see note 2)
Continuous operation	Ta = 25°C, I_F = 50 mA 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
High-temperature storage	Ta = 100°C 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
Low-temperature storage	Ta = –40°C 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
High-temperature and high-humidity storage	Ta = 60°C, 90% 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
High-temperature reverse bias	Ta = 85°C, V_{CE} = 30 V 2000 h	22 pcs	4.4×10^4	0	5.22×10^{-5}
Temperature cycle	–40°C (30 min) to 100°C (30 min) 10 times	22 pcs	---	0	---
Shock resistance	294 m/s^2, 0.5 ms, 3 times each in ±X, ±Y, and ±Z directions	11 pcs	---	0	---
Vibration resistance	5 to 50 Hz, 1.5 mm or 9.8 m/s^2 each in X, Y, and Z directions	11 pcs	---	0	---

Note: 1. The tests after 1001 hours are for reference only.

2. Confidence level of 90%.

EE-SX398 (Transmissive Photo-IC Output)

Failure Criteria

Item	Symbol	Measuring conditions	Failure criteria	
			General test (see note)	Life test
Forward voltage	V_F	I_F = 20 mA	1.5 V max.	1.8 V max.
Reverse current	I_R	V_R = 4 V	10 μA max.	20 μA max.
Low-level output voltage	V_{OL}	V_{CC} = 16 V I_{OL} = 16 mA I_F = 0 mA	0.4 V max.	0.48 V max.
High-level output current	I_{OH}	V_{CC} = 16 V V_{OUT} = 28 V I_F = 5 mA	100 μA max.	200 μA max.
Current consumption	I_{CC}	V_{CC} = 16 V	10 mA max.	12 mA max.
LED current when output is OFF	I_{FT}	V_{CC} = 16 V I_{OL} = 16 mA	5 mA max.	Initial value × 1.3 max.

Note: Except life test.

Test Results

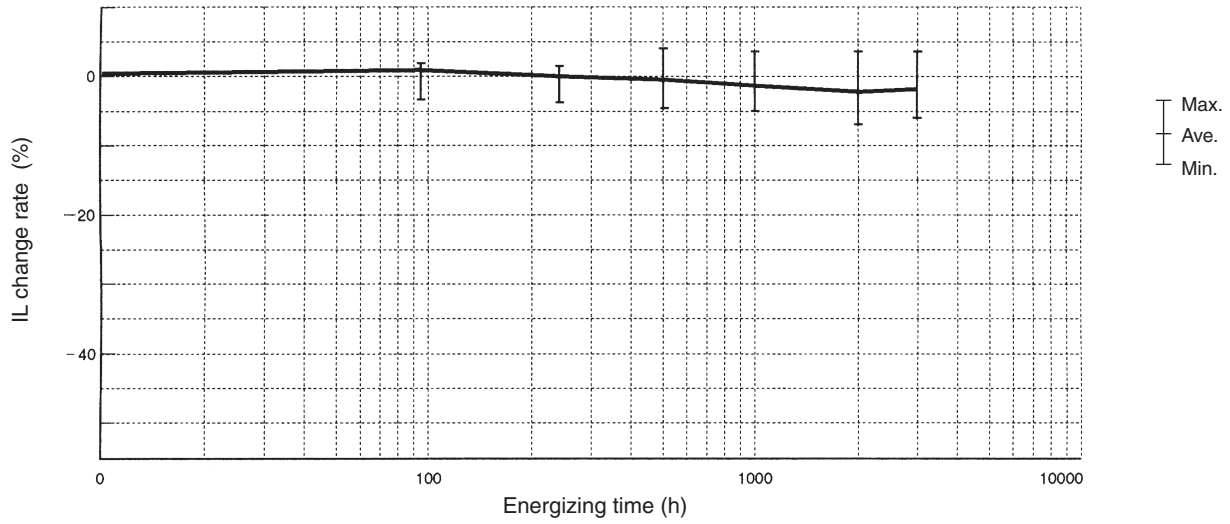
Test item	Test conditions (see note 1)	Number of samples	Component hours (h)	Number of failures	Failure rate (1/h) (see note 2)
Continuous operation	Ta = 25°C, I_F = 20 mA, V_{CC} = 5 V 1500 h	22 pcs	3.3×10^4	0	6.96×10^{-5}
High-temperature storage	Ta = 100°C 2000 h	22 pcs	3.3×10^4	0	6.96×10^{-5}
Low-temperature storage	Ta = –40°C 2000 h	22 pcs	3.3×10^4	0	6.96×10^{-5}
High-temperature and high-humidity storage	Ta = 60°C, 90% 2000 h	22 pcs	3.3×10^4	0	6.96×10^{-5}
High-temperature reverse bias	Ta = 85°C, V_{CE} = 30 V 2000 h	22 pcs	3.3×10^4	0	6.96×10^{-5}
Temperature cycle	–40°C (30 min) to 100°C (30 min) 10 times	22 pcs	---	0	---
Shock resistance	14,700 m/s^2, 0.5 ms, 3 times each in ±X, ±Y, and ±Z directions	11 pcs	---	0	---
Vibration resistance	20 to 2,000 Hz, 1.5 mm or 98 m/s^2 each in X, Y, and Z directions	11 pcs	---	0	---

Note: 1. The tests after 1001 hours are for reference only.
2. Confidence level of 90%.

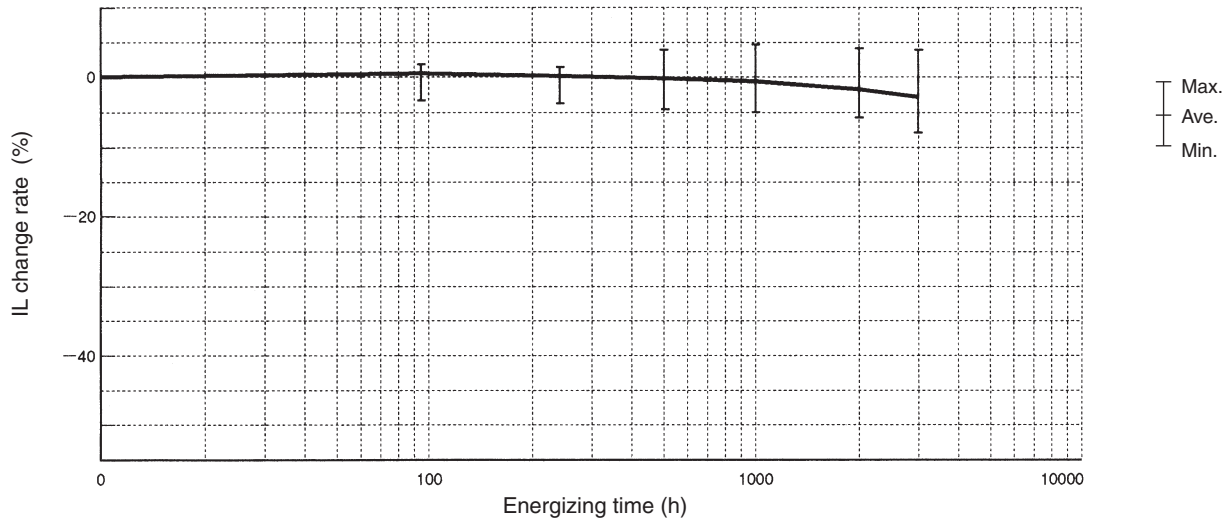
Light Current (I_L) Secular Changes of Phototransistor Output Photomicrosensor

Note: Secular changes in Photomicrosensor light current (with a phototransistor output circuit) and LED current (with a photo IC output circuit) during output ON/OFF are generally due to reductions in the LED emission intensity.
The emission intensity of a GaAs infrared LED is shown in the graphs below. The information in these graphs applies to most of the GaAs infrared LEDs manufactured by OMRON. Because reductions in the emission intensity of an ordinary red LED tend to be larger than those of an infrared LED, the information in these graphs cannot be applied to ordinary red LEDs. For detailed information, consult your OMRON representative.

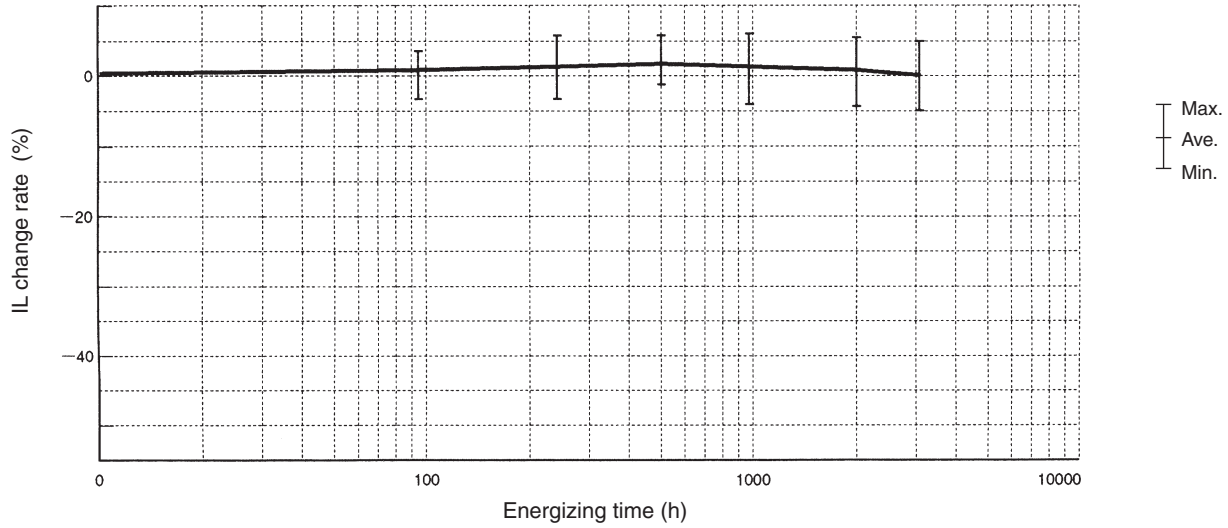
Ta = 25°C, I_F = 20 mA, n = 22



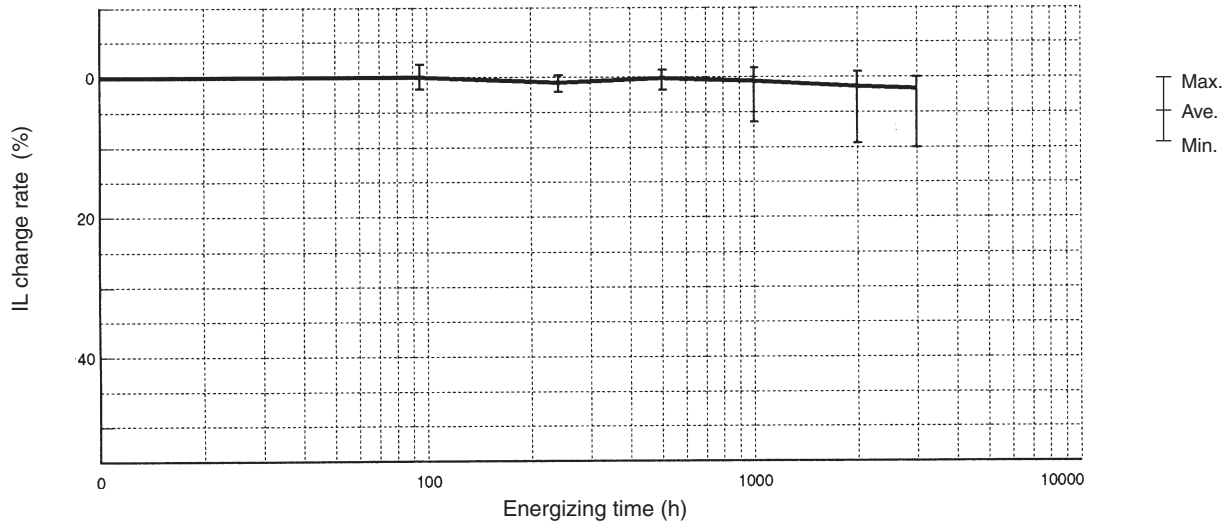
Ta = 25°C, I_F = 50 mA, n = 22



Ta = 85°C, I_F = 10 mA, n = 22



Ta = −25°C, I_F = 50 mA, n = 22



- Application examples provided in this document are for reference only. In actual applications, confirm equipment functions and safety before using the product.
- Consult your OMRON representative before using the product under conditions which are not described in the manual or applying the product to nuclear control systems, railroad systems, aviation systems, vehicles, combustion systems, medical equipment, amusement machines, safety equipment, and other systems or equipment that may have a serious influence on lives and property if used improperly. Make sure that the ratings and performance characteristics of the product provide a margin of safety for the system or equipment, and be sure to provide the system or equipment with double safety mechanisms.

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