# Encoder Issue in MR-J5 HK Servo Motor

May 22, 2023

Dear Customer,

Thank you for your continued patronage of the Mitsubishi products.

We have identified a potential issue in our MR-J5, HK servo motors. The resin used to seal the encoder package may have dark spots, causing the motor encoder to report the incorrect position and velocity resulting in an alarm. Approximately 0.5% (as of September 2022) of the HK motors produced from May 2019 to February 2022 were found to have dark spots in the resin and will show alarm AL 21.1 (Encoder data error).

We are writing to inform you of the status of this issue, and we kindly ask that you remove these products from your inventory for sale or usage and contact us as soon as possible to arrange for replacements.

We are deeply sorry for any inconvenience this may cause.

## 1. Encoder Issue Symptom

Decrease in LED illuminance

The LED built in the servo motor encoder becomes faulty and its illuminance decreases. This prevents the position data from being properly generated, resulting in an alarm (AL021.1) occurrence (overrun will not occur).

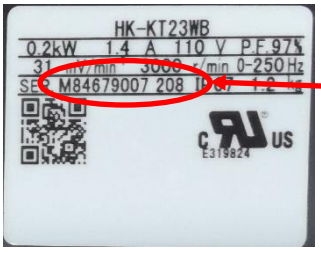
## 2. Affected Products

- Affected products: HK series
- Applicable production period: From May 2019 to February 2022

### (1) How to check on the product

Check "SER.NO." on the rating plate attached to the side of the product. (Figure 1)

Example of the rating plate




SER.NO.M84679007 208
1) 2)
1): Motor serial number M84679007
2): Production date 208 ... August 2020
(20X ... October 2020)
(20Y ... November 2020)
(20Z ... December 2020)

Figure 1. Checking on the product

## (2) How to check on the packaging box

Check the date on the label attached to the packaging box of the affected product mentioned above.

1) When the destination (contents specification) label is attached

2) When the destination (contents specification) label is not attached

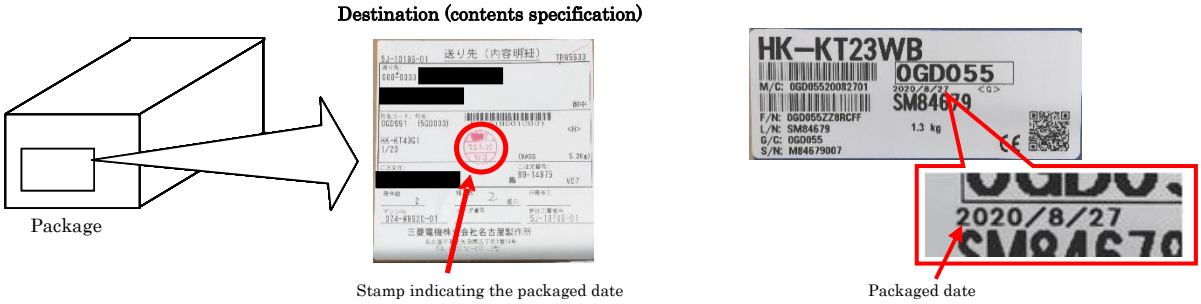



Figure 2. Checking on the packaging box

## 3. Encoder Issue Description

### 3-1. Cause of Issue

Inside the encoder, a light transmitting/receiving module is mounted on the circuit board. The light transmitting element (LED), a component part of the light transmitting/receiving module, emits light, and it reflects off the rotary disk. The position is detected by receiving the reflected light with the photodiode (image sensor).

(1) In the investigation of the faulty product, a line was found on the side of the light emitting window (Figure 3).

(2) The brightness of the LED was different from that of the normal products. In addition, a dark line was found in the light emitting window (Figure 4).

(3) From the position relation between the line on the side of the light emitting window and the dark line in the LED light emitting window, the dark line was confirmed to be aligned with the line (Figures 3 and 4).

(4) We presume that the line on the side of the light emitting window had extended inside and reached the light emitting window, causing the crystal fault. This is considered to have generated the dark line, which consequently decreased the illuminance of the LED. The decrease in the illuminance prevents the position data from being properly generated, resulting in an alarm (AL021.1) occurrence.

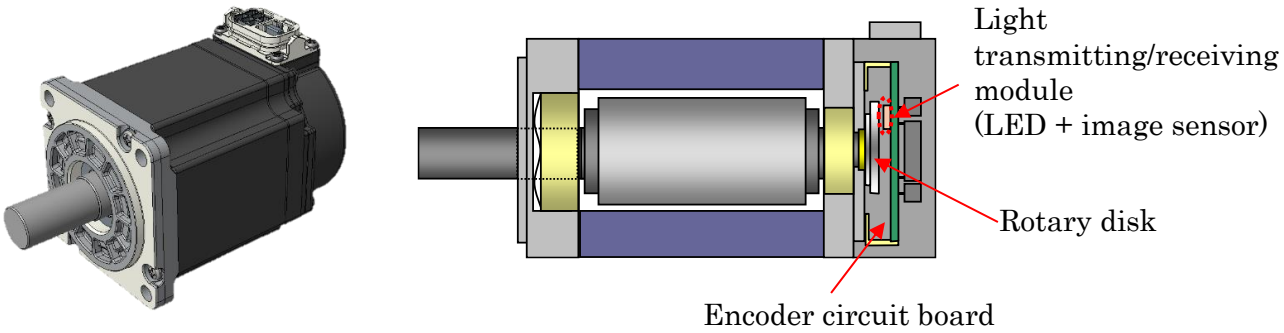



Figure 3-1 Diagrammatic sketch of a servo motor

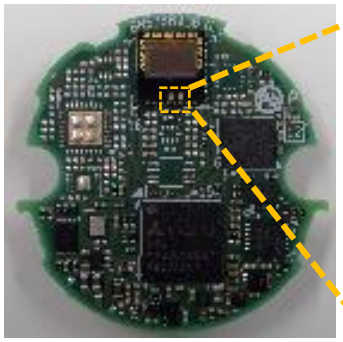


Figure 3-2 Encoder circuit board

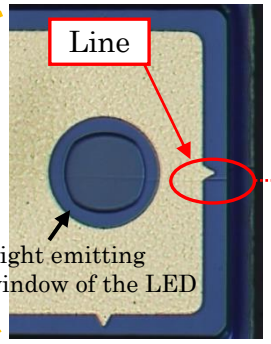



Figure 3-3 Enlarged view of the LED

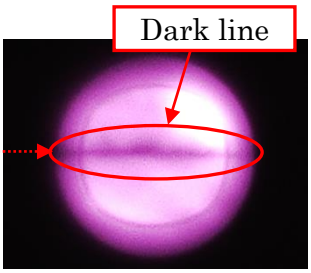



Figure 4-1 Light emitting window

Light emitting condition in which the illuminance is decreased

Figure 4-2 Light emitting window

Light emitting condition of a normal product

(5) We investigated LED chips and each process of the manufacturing process at the component manufacturer. The lines were confirmed to have occurred in the resin sealing process (Figure 5). From this result, we consider that stresses from the resins caused the lines.

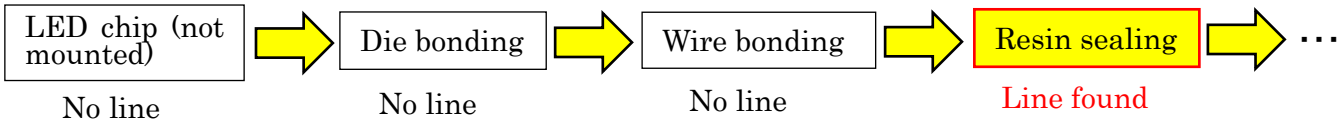



Figure 5. Investigation for the affected process at the component manufacturer

### 3-2. Occurrence mode and rate

The occurrence modes resulting in LED illuminance decrease are as follows:

(1) Line occurrence

In the manufacturing process of the light transmitting/receiving module package, compressive stress is applied to LEDs when the temperature returns to room temperature after transparent resin sealing. This causes lines in some of the products depending on the durability of the LED itself or the unevenness in the resin material.

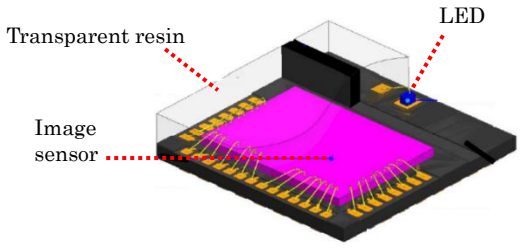
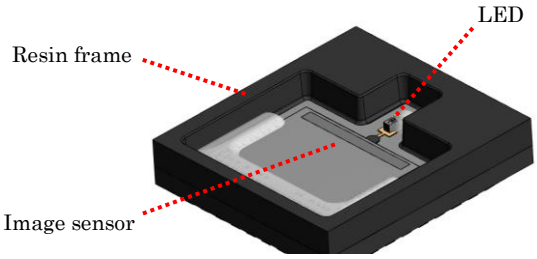
(2) Line development

In some of the products in which the lines have occurred, if the lines develop and reach the light emitting layer of the LED, a decrease in the LED illuminance occurs, resulting in alarm occurrence.

The occurrence rate of this failure is approximately 0.5 % (as of September 2022) based on our investigations in marketplace.

### 3-3. Countermeasure

As a countermeasure, the design has been sequentially changed from one whose entire part is covered with resin (Figure 6) to one without resin (Figure 7).

| Design before change | Design after change |
|---|---|
|  <br>・The LED and image sensor are entirely covered with transparent resin molding. (for protection during assembly)<br>→ A line appears in the LED (which causes the failure) due to the stress caused by temperature drop after resin molding.<br><br>Figure 6 (Light transmitting/receiving module with the design before change) |  <br>・Resin is not used for the upper parts of the LED and image sensor.<br>→ Since there is a space around the LED, the compressive stress will not be applied to the LED.<br>・The resin frame is added to the peripheral part of the LED and image sensor. (for protection during assembly)<br><br>Figure 7 (Light transmitting/receiving module with the design after change) |

### 3-4. Batteryless absolute position encoder diagnosis function for LED illuminance decrease

To detect signs of line development on the LED before LED illuminance decrease occurs causing an alarm (AL021.1), the diagnosis function has been added to the AC servo amplifier MR-J5 (with firmware version D1 or later).

As shown in Figure 8, if the line on the LED edge surface extends into the light emitting window, the LED current feedback control inside the encoder increases the LED current value to make the illuminance even. After the LED current value reaches the clamp level, the LED current value becomes even and the LED illuminance decreases. Therefore, monitoring the LED current value enables detection of signs of illuminance decrease. This diagnosis function cannot detect symptom 2 mentioned below because the function is applicable only to symptom 1. The latest firmware version of the MR-J5 is available by downloading from the Mitsubishi Electric FA site. To enable this function on servo amplifiers with firmware version D1 or later, some of the undisclosed parameters need to be changed. Please contact your local sales office when introducing this function.

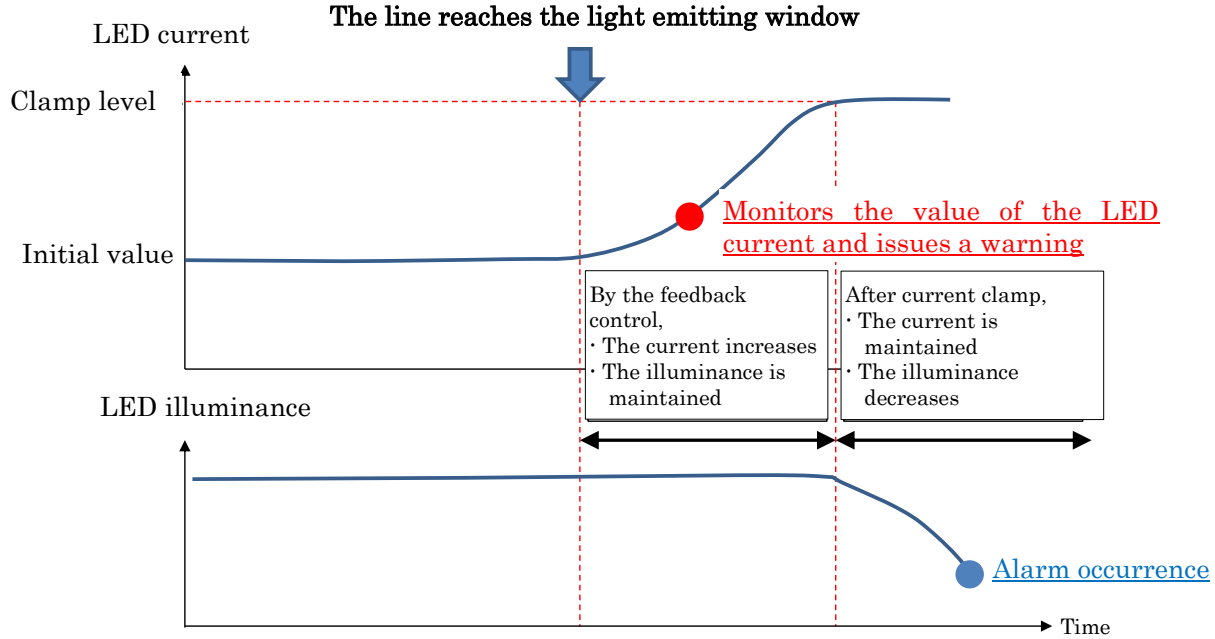



Figure 8. Conceptual figure of the diagnosis function in the batteryless absolute position encoder

There are three levels of warning to go off according to the LED current value (Table 1).

Table 1. Warning level

| Warning number | Detail warning number | Roughly estimated period from warning issue to AL021.1 occurrence * |
|---|---|---|
| Warning 1 | 1F6.1 | Approximately three months |
| Warning 2 | 1F6.3 | Approximately three months |
| Warning 3 | 1F6.5 | Approximately one and a half months |

*1: Warning 1 is detected with the amount of the change in the LED current value. Warning 2 and 3 are detected with the LED current value.

*2: The days until AL021.1 occurrence are only an estimate (assuming eight hours of operation per working day).

## 4. Remedial Measures

All customers must immediately stop selling or using the affected products as identified above. Mitsubishi Electric will replace all units at the customer's request as soon as possible.

Please contact your local supplier or Mitsubishi Electric sales representative to arrange for replacement of nonconforming products that you may currently have in inventory. We sincerely apologize for any inconvenience caused. We will continue our efforts to improve our product quality. We ask for your understanding in this matter.