National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

ENG22LA004

MATERIALS LABORATORY

Factual Report 23-047

May 25, 2023

(This page intentionally left blank)

A. INCIDENT INFORMATION

Location: Bellefontaine, Ohio
Date: November 12, 2021
Vehicle: Beech F33A, N9035Q
Investigator: Thomas Jacky, AS-40

B. COMPONENTS EXAMINED

Garmin GSA 28 servo.

C. EXAMINATION PARTICIPANTS

Specialist — Matthew R. Fox, Ph.D.
NTSB
Washington, DC

Specialist — Joseph Gregor
NTSB
Washington, DC

D. DETAILS OF THE EXAMINATION

An overall view of the submitted Garmin GSA 28 servo actuator, serial number 5G9001953, is shown in figure 1. The servo actuator circuits had previously been tested and disassembled at a Garmin facility where the blue thermal pad had been removed to facilitate a visual examination. Testing showed motor current measurements were out of range.

Resistors identified by Garmin as associated with the motor current circuit are shown in figure 2. Semi-spherical growths consistent with sulfuration were observed at the edges of the resistor film as shown with unlabeled arrows in figure 3.[1] The resistors were located close to the servo gears, and similar indications of sulfuration damage were observed on other resistors on the circuit board that were also located close to the servo gears. The growths appeared to be absent from resistors located at the opposite end of the circuit board.

A sample of grease was collected from the servo gears and was analyzed using energy-dispersive x-ray spectroscopy (EDS). The resulting spectrum is shown in figure 5 was analyzed using a 30 kV accelerating voltage. A peak associated with sulfur was observed as shown circled in figure 5.

[1] Sulfuration of resistors is a condition where silver electrodes on the resistor react with sulfur gas to form sulfides, which can degrade the connection and destroy the resistor.

The subject servo actuator had a serial number that was within the range of numbers affected by Garmin Service Bulletin (SB) 2063, Rev. B issued May 6, 2020. Garmin had identified premature failures due to sulfuration in the subject servo actuators, which had prompted the issuance of the SB. The stated purpose of the SB was to identify and replace failed servo actuators, and compliance was recommended at the next scheduled maintenance opportunity.

Submitted by:

Matthew R. Fox, Ph.D.
Chief Technical Advisor - Materials

Figure 1. Overall view of the submitted servo with a separate box containing the blue thermal pad.

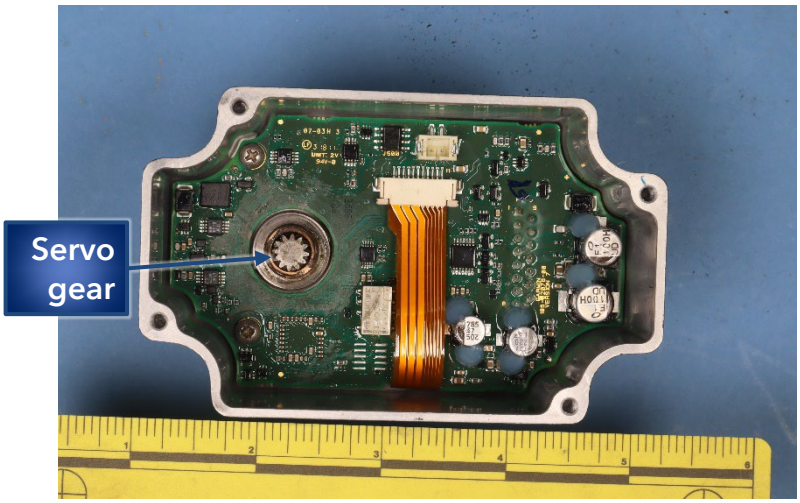

Figure 2. Circuit board after removing the cover plate. The resistors shown in figure 3 were located on the opposite side of the circuit board.

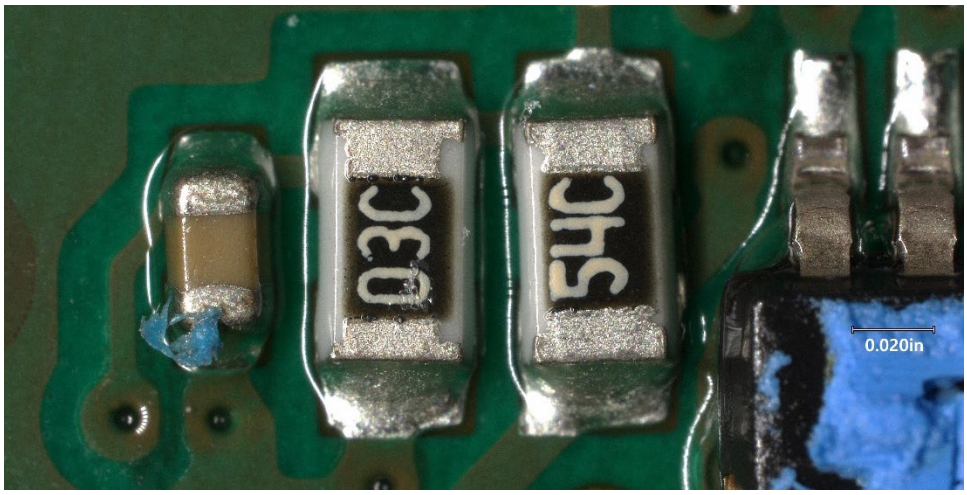

Figure 3. Resistors in the faulty motor circuit as identified by Garmin representatives.

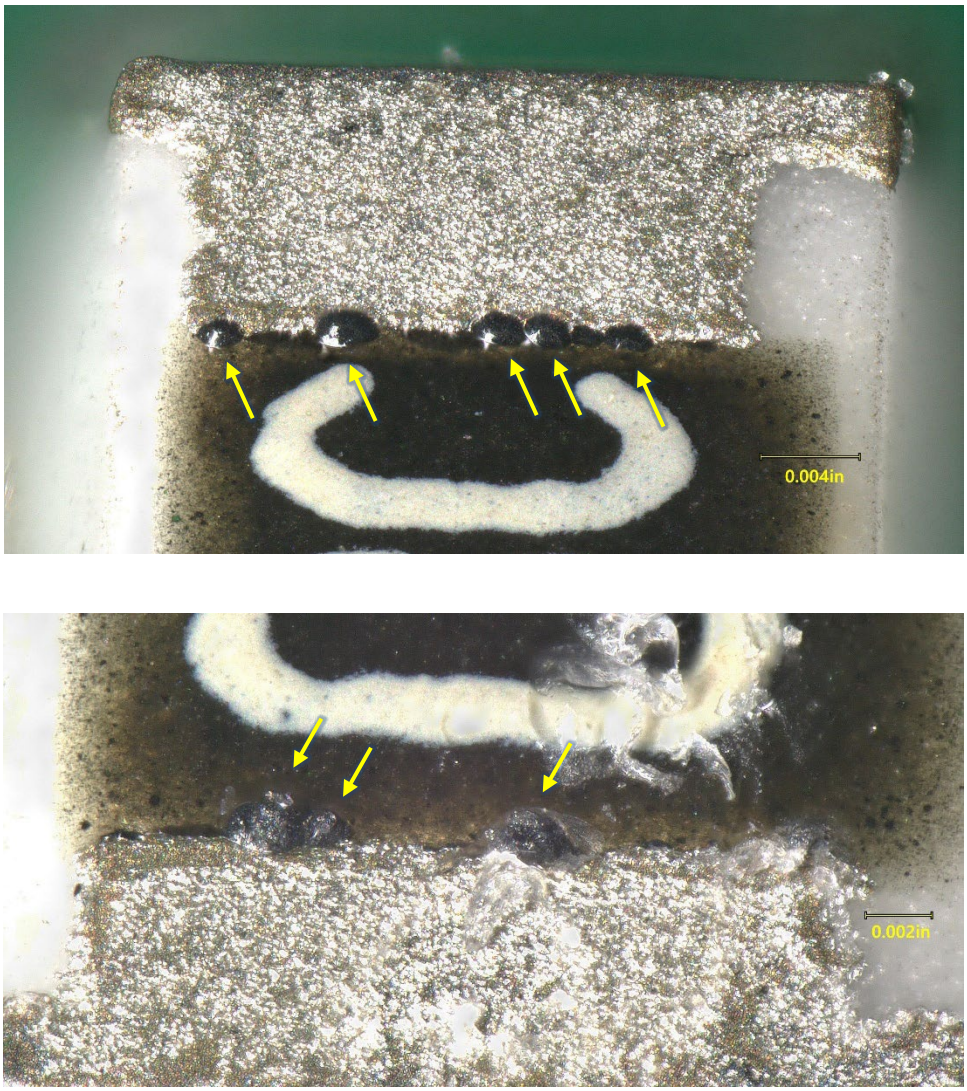

Figure 4. Semi-spherical growths at the contact edges of the resistor labeled 03C consistent with sulfuration damage.

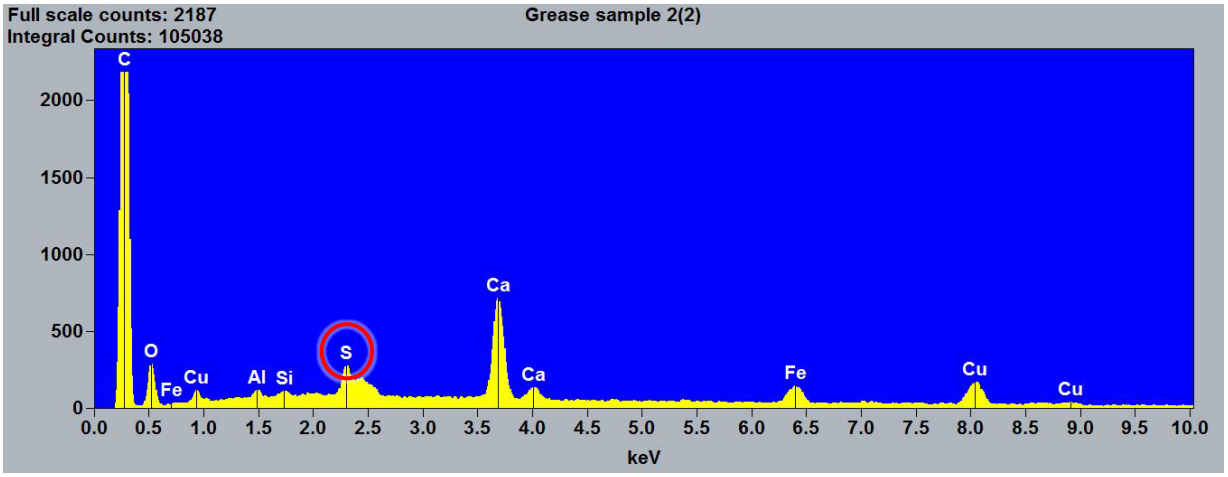

Figure 5. EDS spectrum of a grease sample from the servo showing a sulfur peak.