

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



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BRAKE CONTROL UNIT

Specialist's Factual Report

March 6, 2023

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A. ACCIDENT

Location: Orlando, FL
Date: October 22, 2021
Time: 1750 (EDT)
2150 (UTC)
Airplane: Embraer EMB-500

B. BRAKE CONTROL UNIT SPECIALIST

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C. SUMMARY

The Brake Control Unit (BCU) from the accident airplane was functionally tested and its non-volatile memory (NVM) was downloaded on 12/7/2022 at the Projects Unlimited Inc. (PUI) facility located in Dayton, Ohio. PUI is a supplier for Meggitt Aircraft Braking Systems Corporation (Meggitt) and has the testing equipment required for this examination. Representatives from Meggitt (now owned by Parker Aerospace), Embraer, and the NTSB attended the examination virtually. The unit passed all tests and there were no faults recorded in the NVM from the accident flight leg (including the accident landing).

D. DETAILS OF THE EXAMINATION

The EMB-500 has a brake-by-wire system for the main brakes that is controlled by either the pilot or co-pilot via the rudder pedals. The rudder pedals actuate the pedal transducers that send the brake inputs to the BCU, which controls both left and right brakes independently. The BCU receives all brake interface signals and controls the shutoff valve and both brake control valves for braking capability.

Manufacturer: Meggitt Aircraft Braking Systems Corporation
Part Number: 90005034-7
Serial Number: SEP11-1400 [Manufacturer Date (MMYY) - Sequence Number]

The BCU was visually inspected with no anomalies noted. The connector pins were straight and clean. The unit was tested per Meggitt's Functional Test Instructions (FTI) FTI90005034-7, Rev D. The NVM was downloaded immediately after the Power

Up Test (step 4.6.1) was completed. The FTI was completed in its entirety with no faults found and the BCU passed all tests.

Meggitt software was used to decode and analyze the NVM data obtained during the FTI. Meggitt reported that there were no faults recorded in the NVM from the accident flight (including the accident landing). In addition, there were no repeated fault entries in the entire NVM that would indicate there was a common intermittent fault condition with the braking system.

Meggitt stated that the most recent fault entry in the NVM occurred at power up cycle 2245 (see Figure 1). A complete power up cycle is when the OFF voltage level and ON voltage level and timing is such that the micro controller in the BCU performs a power on reset. At this time the BCU runs initialization code that will read and increment a register in the NVM, effectively keeping track of the amount of power up cycles the BCU has had. The NVM does not contain a time stamp, so the power up counter must be used to determine fault timing. To determine the power up counter cycle associated with the accident flight, Meggitt performed a second NVM download after running the FTI. The FTI will itself create faults that are logged in the NVM. The NVM download after running the FTI showed that a new fault was logged during the FTI that was recorded at power up cycle 2413 (see Figure 2). It is unknown when during the FTI this fault was recorded, but the FTI had approximately 61 power up cycles associated with it.¹ Therefore, the accident flight power up cycle would have been in the approximate range of (2413 minus 1) to (2413 minus 61 minus 1), or 2412-2351. Using this same logic, the fault that occurred at power up cycle 2245 would have occurred between approximately 167 and 106 power up cycles before the accident flight. It is noted here that the BCU power up cycle does not necessarily correlate to flight legs, as it is possible that the aircraft/BCU power may be cycled for maintenance or other reasons.

The fault associated with power up cycle 2245 was a left and right "Pressure Control Low Error" fault that occurred 9 minutes after the BCU was powered on. This fault occurs when the pressure transducer reading is 200 psi less than commanded for 750 milliseconds, and other criteria are met. Meggitt stated that this fault is commonly observed during production testing or in maintenance testing when the shutoff valve may be forced closed during a maintenance test/check. When this fault occurs in service, a *Brake Fail* indication is set and alerted to the crew.

¹ Counting power up cycles during the FTI is not a requirement. The power up cycle count of 61 is an approximation based on Meggitt's review of the FTI procedure and does not include any additional power up cycles that might have been performed during the test. According to Meggitt, additional power up cycles can be performed during the test without affecting the FTI results.

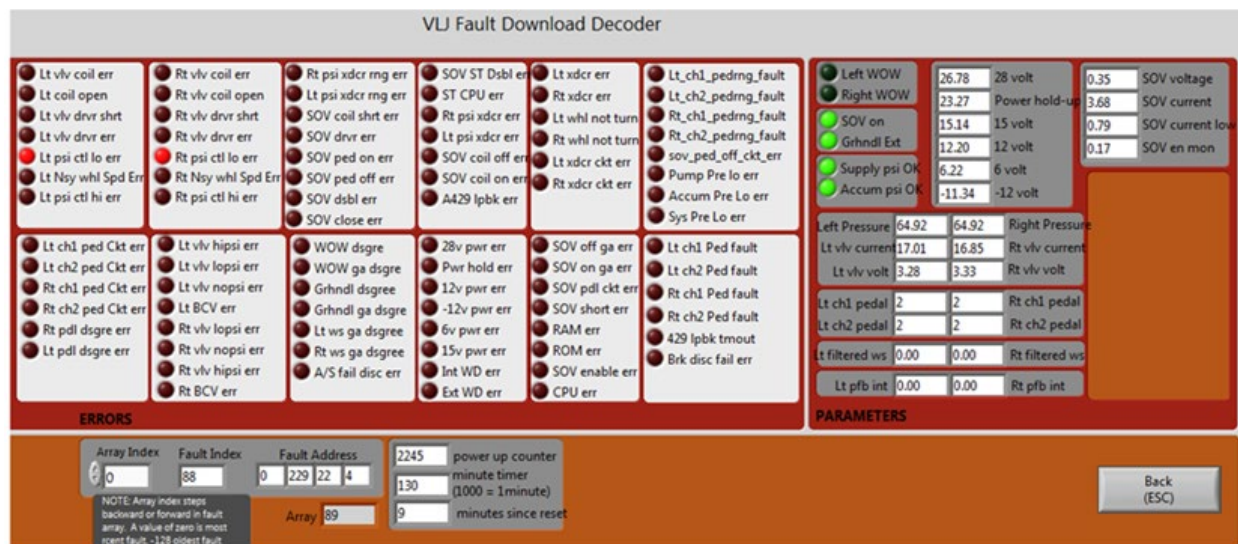


Figure 1: Fault recorded in NVM at power up cycle = 2245 (from NVM download obtained at the beginning of the FTI)

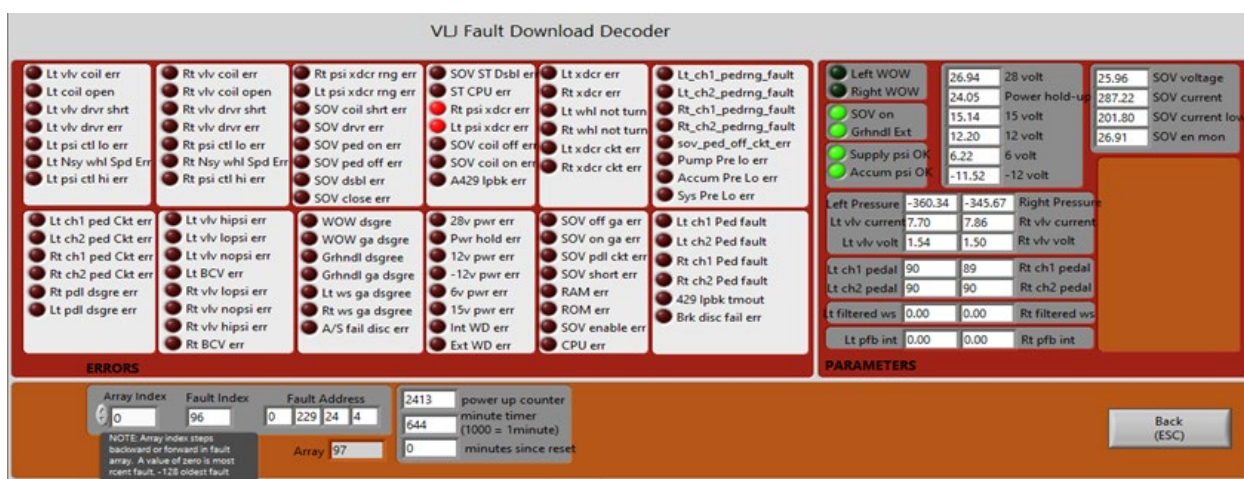


Figure 2: Fault recorded in NVM at power up cycle = 2413 (from NVM download obtained after running the FTI)

Submitted by:

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