

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



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ENGINE CONTROL UNIT

Specialist's Factual Report

October 17, 2024

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A. ACCIDENT

Location: Asheville, North Carolina
Date: December 14, 2023
Time: 2015 eastern standard time (EST)
0115 coordinated universal time (UTC) on December 15, 2023
Airplane: Diamond Aircraft DA40-NG, Lift Academy, N907L

B. ENGINE CONTROL UNIT SPECIALIST

Specialist: Steven Smith
Mechanical Engineer
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A group was not convened. The NTSB Vehicle Recorder Division received the following engine control unit (ECU):

Recorder Manufacturer/Model: Austro AE 300 EECU
Part Number: Unknown
Recorder Serial Number: Unknown

1.0 Austro AE300 EECU Description

The Austro Engine 300 EECU is the electronic engine control unit (EECU) of an Austro Engine 300 (known as AE300). The EECU encloses two engine control units (ECUs), ECU A and ECU B. Each ECU contains non-volatile flash memory which is used to store 16 channels of signals.¹ These signals are sampled at an interval of 1 second as long as the ECU is powered on. Both ECUs perform this task independently. These signal channels are connected to operational data parameters including Engine Oil Pressure, Coolant Temperature, Intake Air Temperature, Battery Voltage, Power Level Position, Gearbox Oil Temperature, etcetera. The unit can record these 16 channels at a 1 second sampling rate for about 90 hours of flight time. The oldest data will be overwritten when the memory is full. The unit records in UTC. In addition, the unit saves failure information into a non-volatile Fault Code Memory (FCM). This FCM can hold up to 20 different faults detected, including 9 environmental conditions (for example, timestamp, voltage, temperatures, pressures, etcetera) which are specific for each possible failure and are sampled and stored at the time the failure occurred. The full contents of the FCM will be included in the engine log file download.

¹ Non-volatile memory is semiconductor memory that does not require external power for data retention.

1.1 Austro AE300 EECU Data Recovery

Upon arrival at the NTSB Vehicle Recorder Division, an exterior examination revealed the unit had sustained damage, as shown in figure 1. Figure 2 shows that the main circuit board inside the unit was also severely damaged. The circuit board was sent to the manufacturer in Wiener Neustadt, Austria for data recovery. The manufacturer transferred the memory chips to a surrogate EECU, and the data were downloaded with the witness of an investigator from German Federal Bureau of Aircraft Accident Investigation (BFU).



Figure 1. Austro AE300 EECU as received by the NTSB Vehicle Recorder Laboratory.

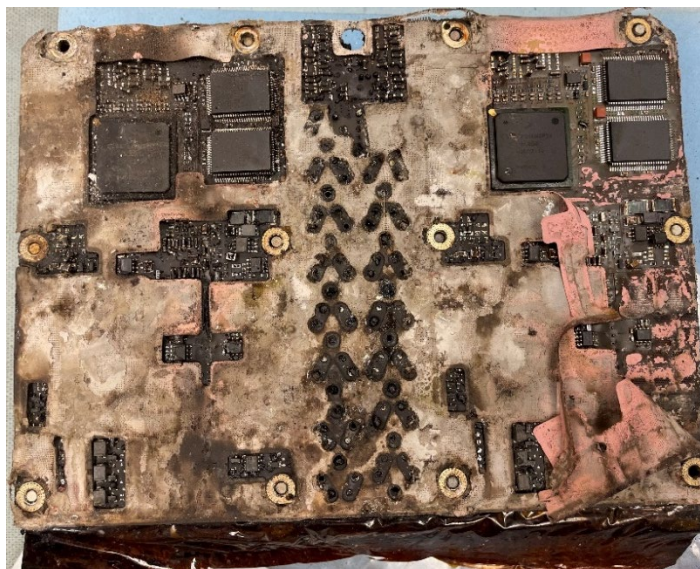


Figure 2. Memory module from the Austro AE300 EECU.

1.2 Austro AE300 EECU Recording Description

The manufacturer and German BFU provided raw data, converted engineering unit data, and a laboratory report that documented the data recovery process and their data analysis. The converted engineering unit data included numerous recording sessions from December 2, 2023, through December 15, 2023 UTC. The last recording on December 15, 2023, was identified as the accident flight.

Each of the ECU A and ECU B were supposed to store parameter data and event logger data. During the download by the manufacturer, it was noted that the chip on ECU A was significantly damaged. When the data was recovered, the parametric data was corrupt, but not the event loggers. Therefore, for this report, the parametric data is from ECU B solely. However, the manufacturer informed the NTSB that the ECU A and ECU B event loggers were not corrupt. Also observed in the parametric and event logger data was a 6-minute lapse in recorded data towards the end of the recording. The manufacturer informed the NTSB that it is possible that the engine was off or there was a data logging error. For the EECU to record, the engine must be on. The manufacturer informed the NTSB that the data logging feature is not certified and therefore is subject to recording issues.

1.2.1 Austro AE300 EECU Parameters Provided

Table 1 describes data parameters verified and proved in this report.

Table 1. AE300 EECU parameters verified and provided.

Parameter Name (unit)	Parameter Description (unit)
Amb Press (inHg)	Ambient Pressure (inches of Mercury)
Batt Volt (V)	Battery Voltage (volts)
Boost Press (inHg)	Boost Pressure (inches of Mercury)
Coolant Temp (degF)	Coolant Temperature (degrees Fahrenheit)
Date (MM/DD/YYYY)	Date for recorded data point (Month/Day/Year)
Eng Load (%)	Engine Torque (percentage)
Eng Oil Press (psi)	Oil Pressure (pounds per square inch)
Eng Oil Temp (degF)	Oil Temperature (degrees Fahrenheit)
Fuel Press (psi)	Fuel Pressure (pounds per square inch)
Gearbox Oil Temp (degF)	Gearbox Oil Temperature (degrees Fahrenheit)
Intake Air Temp (degF)	Intake Air Temperature (degrees Fahrenheit)
Power Lever Pos (%)	Power Lever Position (percentage)
Prop Act - Cyc (%)	Propeller Actuator - Duty Cycle (percentage)
Prop Spd (RPM)	Engine Speed (revolutions per minute)
Rail Press (psi)	Common Rail Pressure (pounds per square inch)
Time (HH:MM:SS)	Time (UTC) for recorded data point (Hours:Minutes:Seconds)

1.3 Austro AE300 EECU Time Correlation

The Austro AE300 data was recorded in UTC. The difference between EST and UTC is 5 hours, or 18,000 seconds. The accident flight data has been offset from the recorded Austro AE300 time to EST by subtracting 18,000 seconds.

D. FIGURES AND TABULAR DATA

Figures 3 and 4 contain ECU data recorded during the event on December 14, 2023. All the parameters listed in table 1 are plotted except Date and Time.

Figures 3 and 4 are time history plots that present the same parameters from the ECU B channel. Figure 3 presents data from the entire flight, which encompasses the 6-minute window where data was not recorded. Figure 4 presents a time history plot of data prior to the 6-minute loss in data recording.

The AE300 EECU data indicated the following sequence of events:

- **19:24:32 EST:** The ECU A event logger recorded two logs: "Indicator: set if ECU is active" and "Indicator: Weight on wheels recognized via squat switch (A/C on ground if SET)."
- **19:36:36 EST:** Ambient pressure, propeller speed, and power lever position were 29.80 inHg, 1034 RPM, and 29.05%, respectively.
- **19:36:42 EST:** Propeller speed and power lever position were 2211 RPM and 99.91%, respectively, consistent with the aircraft beginning takeoff roll.
- **19:37:12 EST:** The ambient pressure reduced to 29.74 inHg, which is consistent with the aircraft beginning to climb.
- **19:47:29 EST:** The aircraft reached a cruising altitude at an ambient pressure of 23.33 inHg. The power lever position, propeller speed, engine load, oil pressure, and boost pressure were 85.02%, 2082 RPM, 85.02%, 61.16 psi, and 73.29 inHg, respectively.
- **19:47:30 EST - 20:07:19 EST:** The aircraft flew uneventfully at an altitude with an ambient pressure of approximately 23.27 inHg.
- **19:07:20 EST:** The ECU A event logger recorded the following log: "Boost pressure governor failure (MAX: Positive governor deviation limit exceeded)." The power lever position, propeller speed, engine load, oil pressure, and boost pressure were 85.46%, 2072 RPM, 85.10%, 57.84 psi, and 73.35 inHg, respectively.
- **19:07:21 EST:** The ECU A event logger recorded the following: "Engine oil pressure failure (MIN: Engine oil pressure too low)."

- **20:07:45 EST:** The power lever position, propeller speed, engine load, oil pressure, and boost pressure were 85.45%, 2113 RPM, 86.32%, 50.57 psi, and 73.15 inHg, respectively.
- **20:08:09 EST:** Oil pressure was 1.00 psi.
- **20:09:10 EST:** The power lever position, propeller speed, engine load, oil pressure, and boost pressure were 99.99%, 0 RPM, 0.00%, 0.00 psi, and 24.10 inHg, respectively. The ambient pressure was 23.89 inHg.
- **20:10:50 EST:** Propeller speed and engine load began to increase from 0 RPM and 0.00%.
- **20:11:46 EST:** Propeller speed and engine load reduced back to 0 RPM and 0.00%.
- **20:13:08 EST:** Propeller speed and engine load began to increase from 0 RPM and 0.00%.
- **20:14:07 EST:** Propeller speed and engine load reduced back to 0 RPM and 0.00%.
- **20:14:33 EST:** The last recorded ECU B data point before a 6 minute and 5 second stop in data recording.
- **20:20:39 EST:** Data recording resumed. The ECU B event logger recorded the following: "Indicator: set if ECU is active." The ambient pressure at this time was 28.50 inHg and remained constant through the remainder of the recording.
- **20:21:00 EST:** The last recorded ECU B data point.

The corresponding tabular data used to create figures 3 and 4, including Date and Time, are provided in electronic comma-separated value (CSV) format as attachment 1 to this report.

The corresponding event loggers for both ECU A and ECU B are provided in CSV format as attachment 2 and 3 to this report, respectively.

The corresponding laboratory report provided by the German BFU has been included as attachment 4 to this report.

Submitted by:

Steven Smith
Mechanical Engineer (Recorder Specialist)

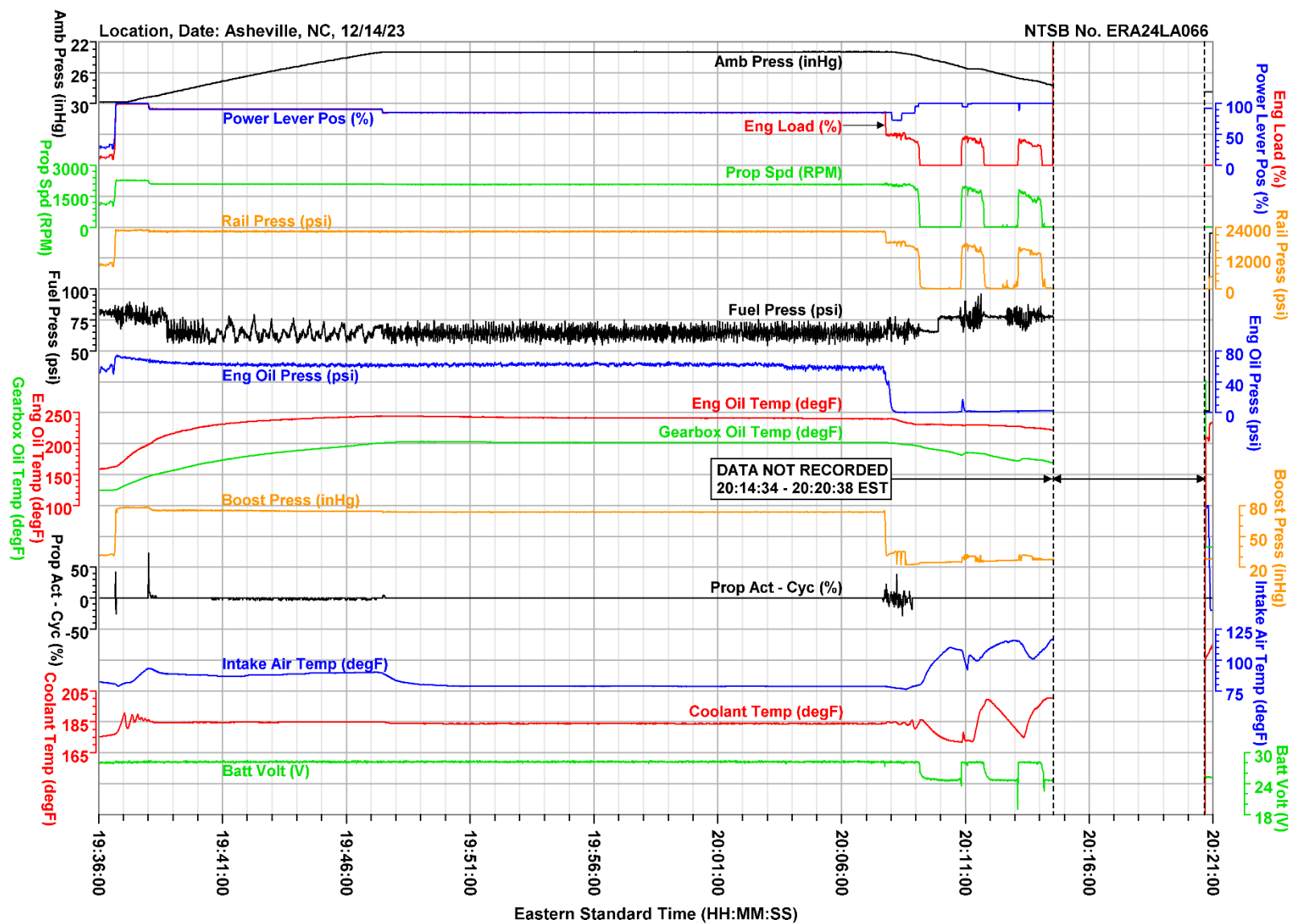


Figure 3. Time history plot of the entire accident flight.

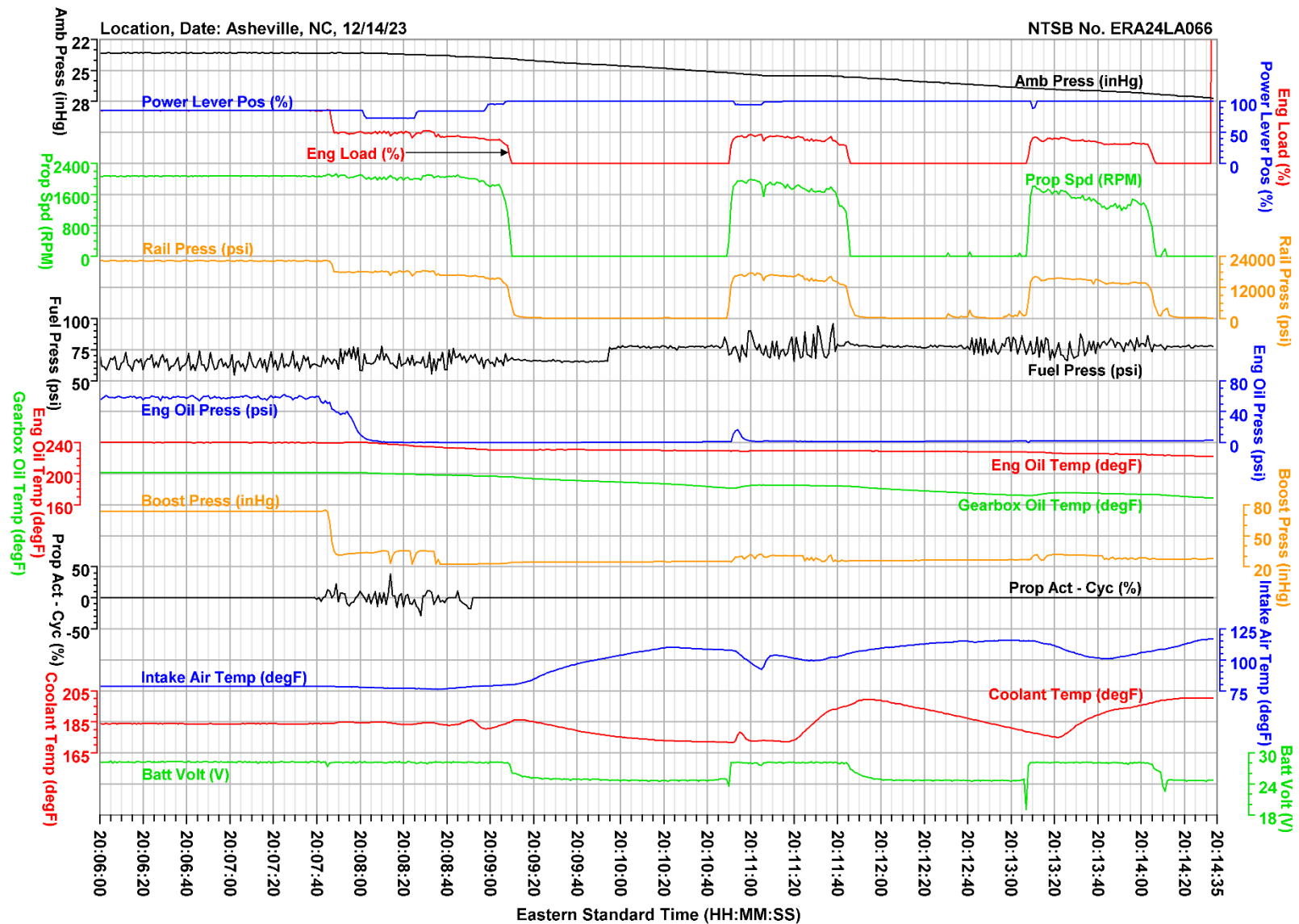


Figure 4. Time history plot of the time leading up to the 6-minute loss in data.