

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN24FA073

MULTIPLE ELECTRONIC DEVICES

Specialist's Factual Report

November 4, 2024

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A. ACCIDENT SUMMARY

Location: Canton, Texas
Date: December 26, 2023
Time: 1813 central standard time (CST)
0013 coordinated universal time (UTC) (December 27, 2023)
Aircraft: Cirrus SR22, N858RC

B. MULTIPLE ELECTRONIC DEVICES SPECIALIST

Specialist: W. Deven Chen
Electrical Engineer - Recorder Specialist
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A recorder group was not convened. The NTSB Vehicle Recorder Division received the following electronic devices:

Manufacturer/Model:	Aerosance RDM
Serial Number:	0743021
Manufacturer/Model:	Avidyne PFD
Serial Number:	20071087
Manufacturer/Model:	Avidyne MFD
Serial Number:	2016215
Manufacturer/Model:	Avidyne DFC-90
Serial Number:	M133905993

1.0 Aerosance RDM Description

The Aerosance recoverable data module (RDM) is a fire-resistant data recorder installed in the tail of some Cirrus aircraft to record flight data at a 1 Hz recording rate. The RDM can store approximately 200 hours of flight data on an internal 1 GB Compact Flash (CF) memory card. When the storage limit of the memory card is reached, the oldest recording is deleted.

1.1 Aerosance RDM Condition and Data Recovery

Figure 1 shows the Aerosance RDM as received at the NTSB Vehicle Recorder Laboratory. The internal CF memory card was recovered and read out normally. However, all the data files stored on the CF memory card were corrupted and could not be converted into valid engineering unit data. According to the manufacturer of the accident aircraft, data corruption was a common issue with Aerosance RDMs, and

no data can be recovered from a corrupted data module. No data pertinent to the accident was recovered from the device.



Figure 1. Aerosance RDM as received by the NTSB Vehicle Recorder Laboratory.

2.0 Avidyne PFD Description

The Avidyne primary flight display (PFD) unit includes a solid-state Air Data and Attitude Heading Reference System (ADAHRS) and displays aircraft parameter data including altitude, airspeed, attitude, vertical speed, and heading. The PFD unit has external pitot/static inputs for altitude, airspeed, and vertical speed information. Each PFD contains two flash memory devices mounted on a riser card. The flash memory stores information the PFD unit uses to generate the various PFD displays. Additionally, the PFD has a data logging function, which is used by the manufacturer for maintenance and diagnostics. Maintenance and diagnostic information recording consist of system information, event data and flight data.

The PFD samples and stores several data streams in a sequential fashion; when the recording limit of the PFD is reached, the oldest record is dropped, and a new record is added. Data from the Attitude/Heading Reference System (AHRS) is recorded at a rate of 5 Hz. Air data information such as pressure altitude, indicated airspeed, and vertical speed are recorded at 1 Hz. Global Positioning System (GPS) and navigation display and setting data are recorded at a rate of 0.25 Hz, and

information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.

2.1 Avidyne PFD Condition and Data Recovery

The Avidyne PFD was damaged in the event. The front screen was cracked. The extent of the damage is shown in figure 2. The internal circuit board on which the data were stored was removed from the device and placed into a surrogate device at the lab. The data were downloaded using the manufacturer's procedure and converted to engineering unit data using laboratory tools.



Figure 2. Avidyne PFD as received by the NTSB Vehicle Recorder Laboratory.

2.2 Avidyne PFD Recording Description

The data recovered from the Avidyne PFD contained three sessions. The last session was identified to be associated with the accident flight. The duration of the recording was 35 minutes and 4 seconds, from 23:38:24 UTC on December 26 to 00:13:28 UTC on December 27, 2023.

2.2.1 Avidyne PFD Parameters Provided

Table 1 lists the Avidyne PFD parameters verified and provided in this report.

Table 1. Avidyne PFD data parameters provided.

Parameter Name (unit)	Parameter Description (unit)
Accel Lat (g)	Lateral acceleration (gravitational acceleration)
Accel Long (g)	Longitudinal acceleration (gravitational acceleration)
Accel Vert (g)	Vertical acceleration (gravitational acceleration)

Parameter Name (unit)	Parameter Description (unit)
Airspeed Ind (kts)	Indicated airspeed (knots)
Airspeed True (kts)	True airspeed (knots)
Altitude Press (ft)	Indicated pressure altitude corrected for a non-standard altimeter setting (feet)
AP ALT Active (bin)	Autopilot altitude mode active (On or Off)
AP ALT Armed (bin)	Autopilot altitude mode armed (On or Off)
AP HDG (bin)	Autopilot heading mode (On or Off)
AP IAS Active (bin)	Autopilot indicated airspeed mode active (On or Off)
AP Pitch (bin)	Autopilot pitch mode (On or Off)
AP Roll (bin)	Autopilot roll mode (On or Off)
AP VS (bin)	Autopilot vertical speed mode (On or Off)
Ground speed (kts)	Groundspeed between current and previous data point (knots)
Heading Bug (deg)	Heading bug setting (degrees)
Heading Mag (deg)	Magnetic heading (degrees)
Latitude (deg)	Geographic latitude (degrees)
Longitude (deg)	Geographic longitude (degrees)
Pitch (deg)	Pitch angle (degrees)
Roll (deg)	Roll angle (degrees)

2.3 Avidyne PFD Time Correlation

The data were recorded in UTC and were converted to CST, the local time of the event. CST is behind UTC by 6 hours.

3.0 Avidyne MFD Description

The Avidyne multi-function flight display (MFD) unit displays aircraft checklists, terrain/map information, approach chart information and other aircraft/operational information depending on the specific configuration and options that are installed. One of the options available is a display of comprehensive engine monitoring and performance data.

Each MFD contains a compact flash (CF) memory card located in a slot on the side of the unit. This memory card contains the software that the MFD needs to operate. Additionally, it contains the checklists, approach charts, and map information that the unit uses to generate the various cockpit displays.

During operation, the MFD display receives information from several other units that are installed on the aircraft. Specifically, the MFD receives GPS position,

time, and track data from the aircraft's GPS receiver. The MFD may also receive information from the aircraft concerning altitude, outside air temperature, and engine and electrical system parameters. This data is also stored on the unit's CF memory card.

The MFD generates new data files for each MFD power-on cycle. The oldest file is dropped and replaced by a new recording once the storage limit has been reached. MFD data are sampled every six seconds and recorded to memory once every minute. If an interruption of power occurs during the minute between MFD memory write cycles, data sampled during that portion of a minute are not recorded.

3.1 Avidyne MFD Condition and Data Recovery

Figure 3 shows the Avidyne MFD as received by the NTSB Vehicle Recorder Laboratory. The internal CF card was removed, and the engineering unit data were downloaded using the manufacturer's procedure.



Figure 3. Avidyne MFD as received by the NTSB Vehicle Recorder Division.

3.2 Avidyne MFD Recording Description

The downloaded data contained 49 engine log files. The last log file was identified to be associated with the accident flight. The duration of the recording was 33 minutes and 24 seconds, from 23:39:18 UTC on December 26 to 00:12:42 UTC on December 27, 2023. The sampling rate was 1 sample per 6 seconds.

3.2.1 Avidyne MFD Parameters Provided

Table 1 lists the Avidyne MFD parameters verified and provided in this report.

Table 2. Avidyne MFD data parameters provided.

Parameter Name (unit)	Parameter Description (unit)
AMP (A)	Circuitry bus current (Amperes)
C# (degF)	Cylinder head temperature at cylinder # (degrees Fahrenheit)
E# (degF)	Exhaust gas temperature at cylinder # (degrees Fahrenheit)
FF (gph)	Fuel flow rate (gallons per hour)
LAT (deg)	Geographic latitude (degrees)
LON (deg)	Geographic longitude (degrees)
MAP (inHg)	Manifold pressure (inches of mercury)
MBUS (V)	Circuitry bus voltage (volts)
OAT (degC)	Outside air temperature (degrees Celsius)
OILP (psi)	Oil pressure (pounds per square inch)
OILT (degF)	Oil temperature (degrees Fahrenheit)
RPM (rpm)	Engine speed (revolutions per minute)
TIT (degF)	Turbine inlet temperature (degrees Fahrenheit)
USED (gal)	Fuel used (gallons)

3.3 Avidyne MFD Time Correlation

The data were recorded in UTC and were converted to CST, the local time of the event. CST is behind UTC by 6 hours.

4.0 Avidyne DFC-90 Description

The Avidyne Digital Flight Control (DFC) - 90 is a digital, attitude-based autopilot system. The DFC-90 autopilot uses the output information from the Avidyne Primary Flight Display's (PFD) ADAHRS to provide automatic aircraft control. The unit controls the aircraft in both lateral and vertical modes. The unit can also provide speed-based envelope protection. The autopilot system also has a navigation capability and will maintain a pre-programed flight track profile. In addition, the autopilot is capable of flying both precision and non-precision approaches.

The unit contains an internal microSD card which logs data and information related to the operation of the DFC90 device. The card logs various parameters at three different rates (low, medium, and high fidelity) depending on the type of information being recorded. System health parameters are logged at a slower rate when compared to acceleration information.

4.1 Avidyne DFC-90 Condition and Data Recovery

Figure 4 shows the Avidyne DFC-90 as received by the NTSB Vehicle Recorder Laboratory. The internal microSD card was recovered, and its raw data were read out. The manufacturer was contacted for assistance in converting the raw data. After viewing and analyzing the PFD engineering unit data converted with NTSB laboratory tools, the manufacturer stated that the PFD engineering unit data were "all correct",

and that the Avidyne DFC-90 would not provide additional information that were already available in PFD data. Thus, DFC-90 data conversion was not performed and is not included in this report.

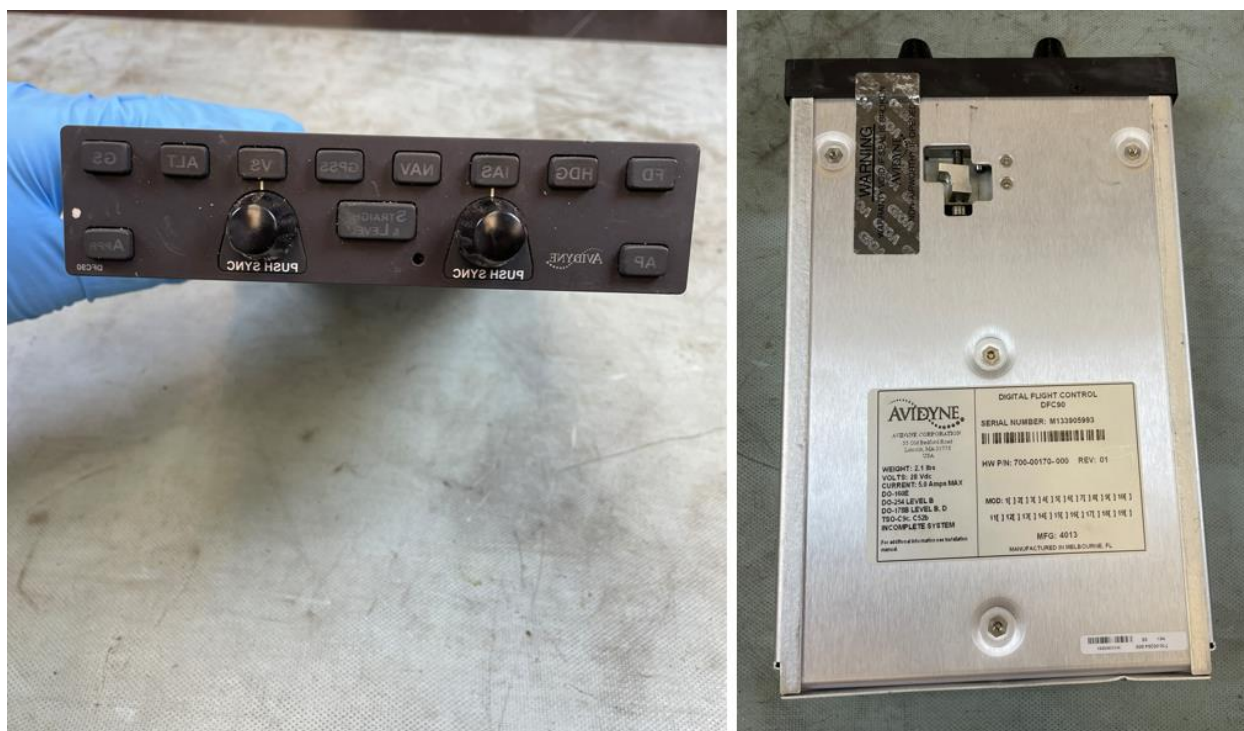


Figure 4. Front and top views of the Avidyne DFC-90 as received.

D. FIGURES AND TABULAR DATA

Figures 5 to 8 are plots of basic flight parameters and autopilot parameters of the accident flight recording from the Avidyne PFD. The plots are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

Figures 9 and 10 are plots of engine parameters of the accident flight recording from the Avidyne MFD. Figure 9 is the entire accident flight session, and figure 10 shows the final portion of the accident flight.

Figures 11 to 13 are Google Earth overlays of the accident flight recording. Figure 11 shows the entire flight recording, and figures 12 and 13 show the final portion of the accident flight. The weather and lighting conditions in Google Earth are not intended to be representative of the weather and lighting conditions present at the time of the recording.

The corresponding tabular data used to create the above figures is provided in electronic comma-separated value (CSV) format as attachments to this report. Attachments 1 and 2 are data sets recovered from Avidyne PFD and MFD,

respectively. Note that the attachments might contain additional parameters, however, not every parameter has been validated by the specialist.

Submitted by:

W. Deven Chen
Electrical Engineer – Recorder Specialist

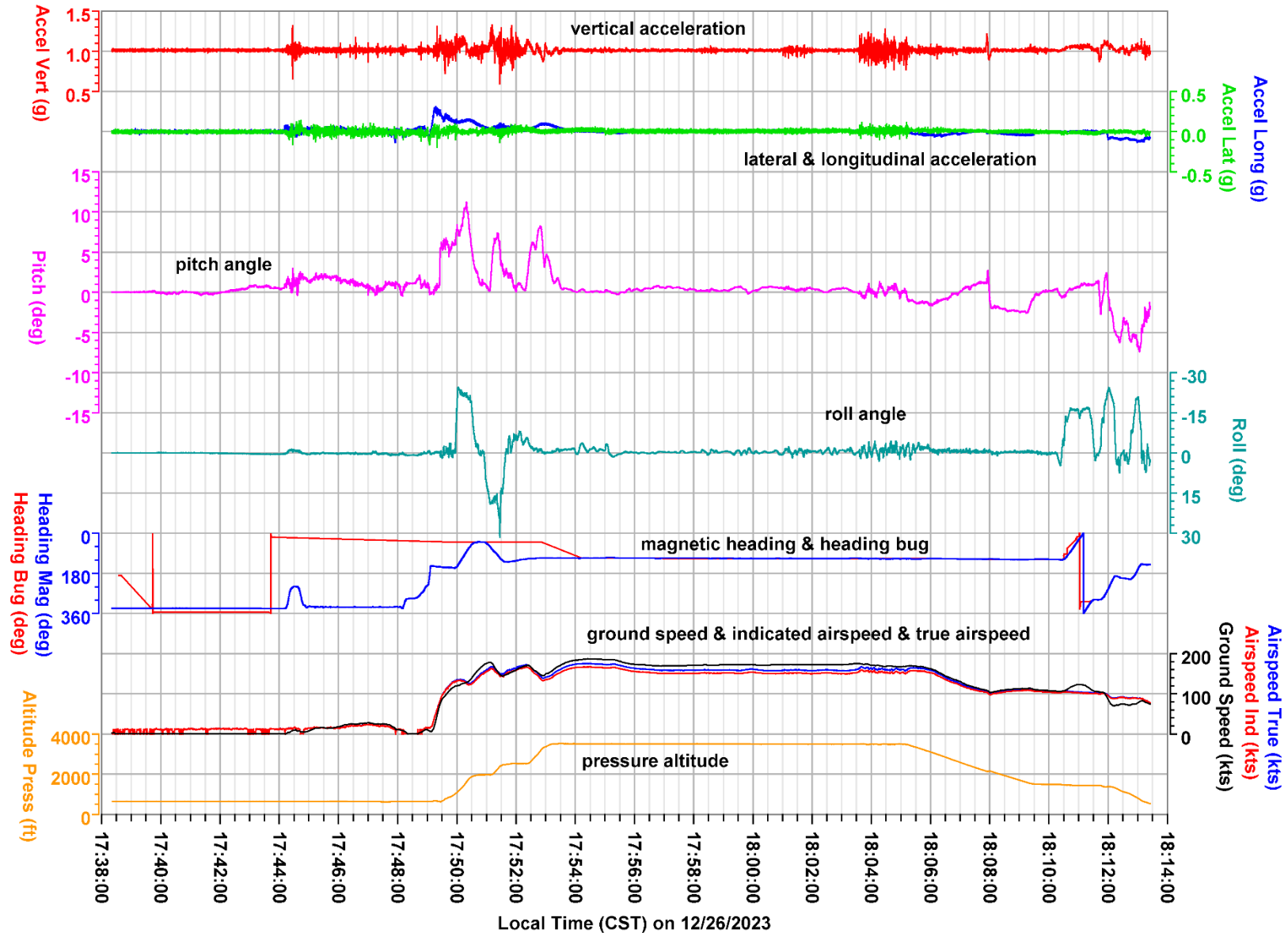


Figure 5. Plot of basic flight parameters of the entire accident flight.

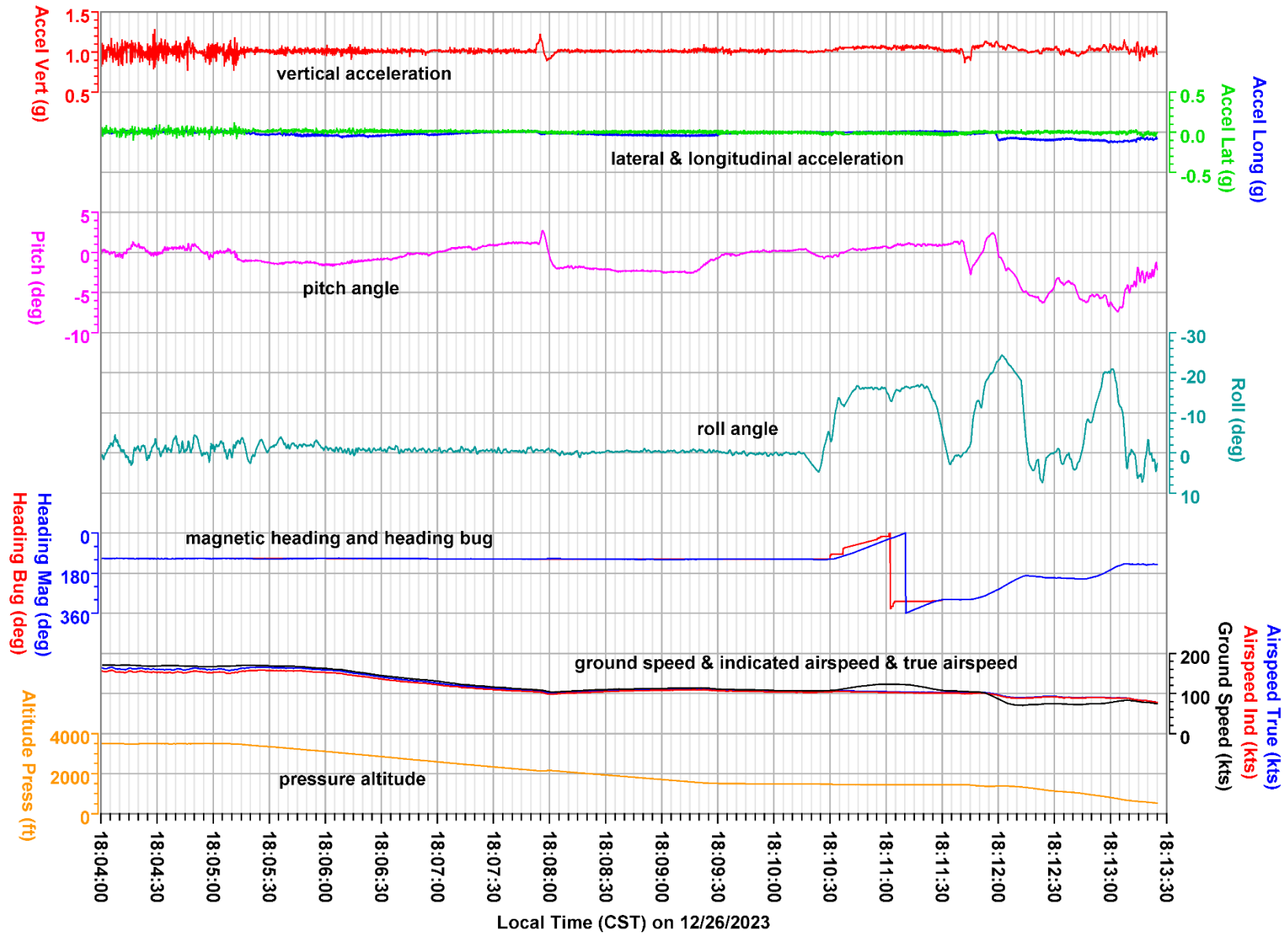


Figure 6. Plot of basic flight parameters of the final portion of the accident flight recording.

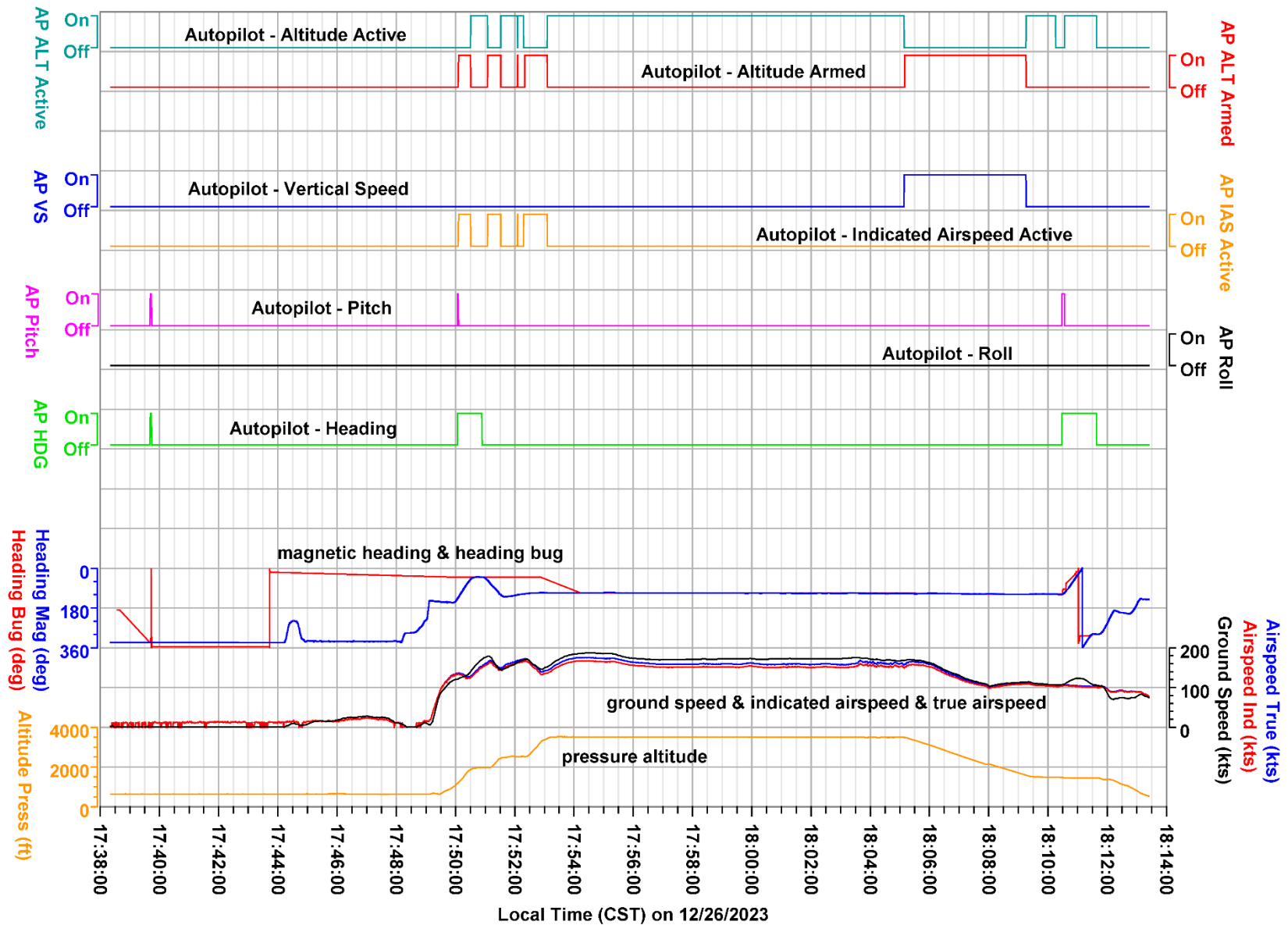


Figure 7. Plot of autopilot parameters of the entire accident flight.

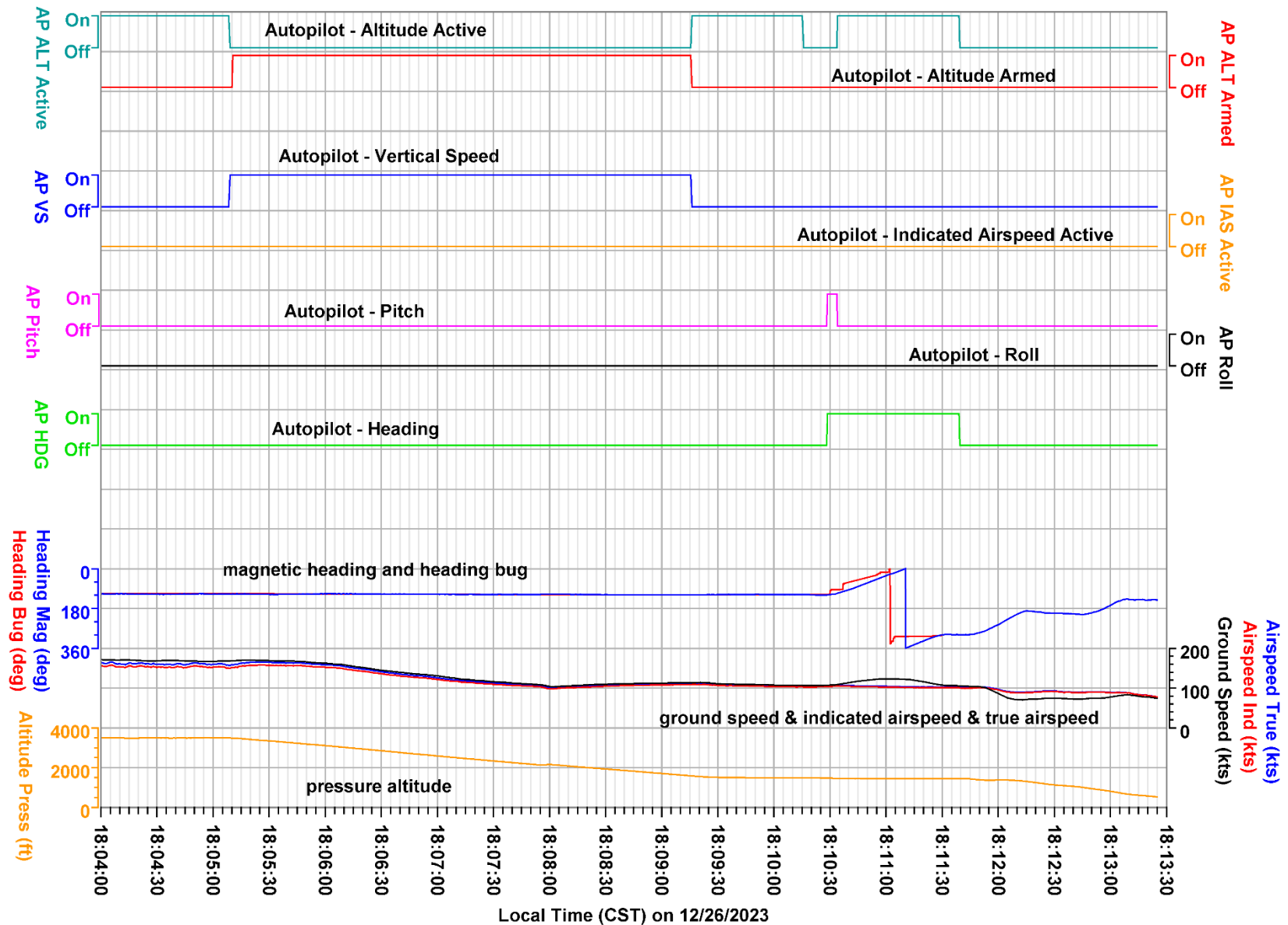


Figure 8. Plot of autopilot parameters of the final portion of the accident flight.

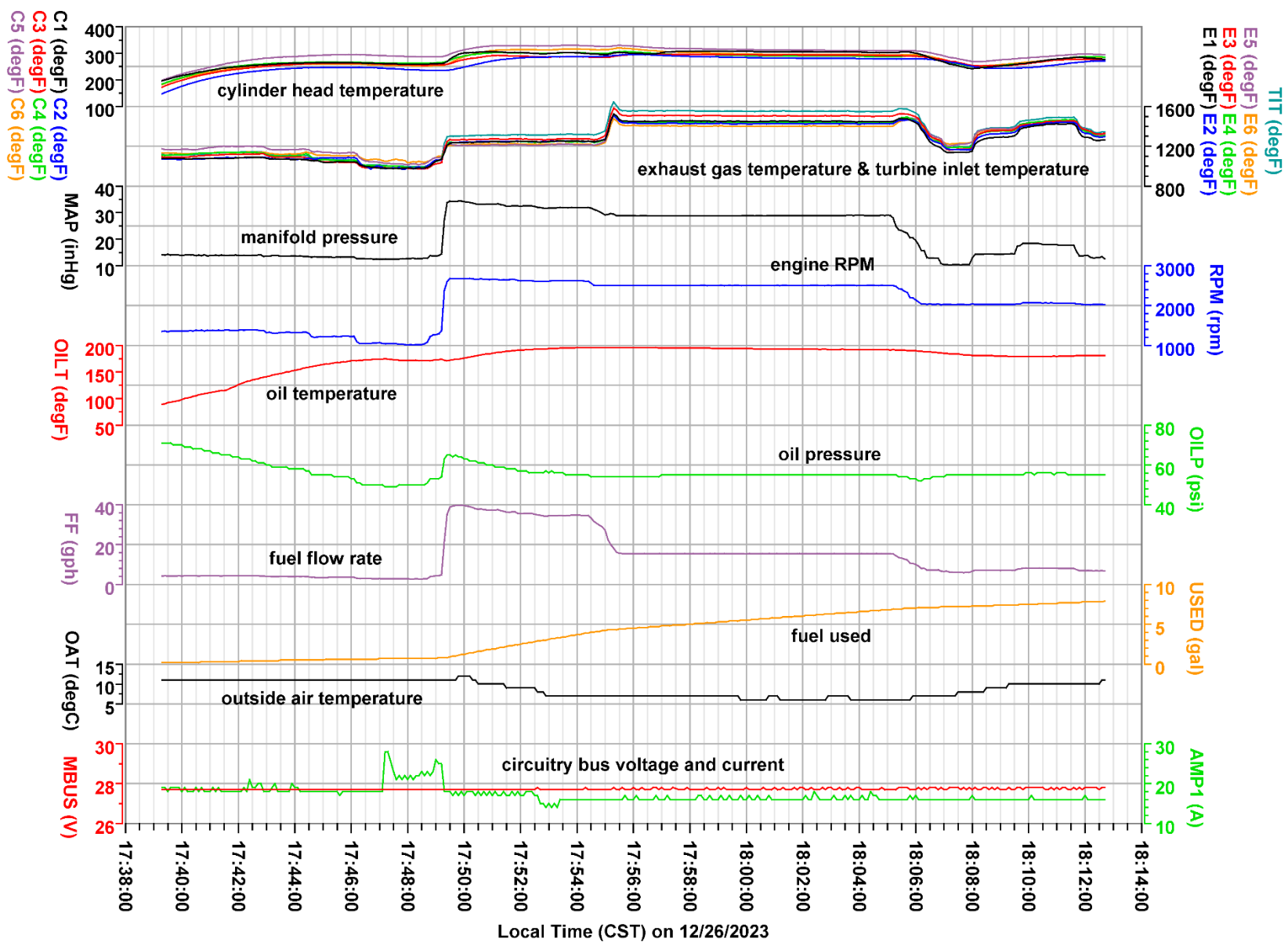


Figure 9. Plot of engine parameters of the entire accident flight.

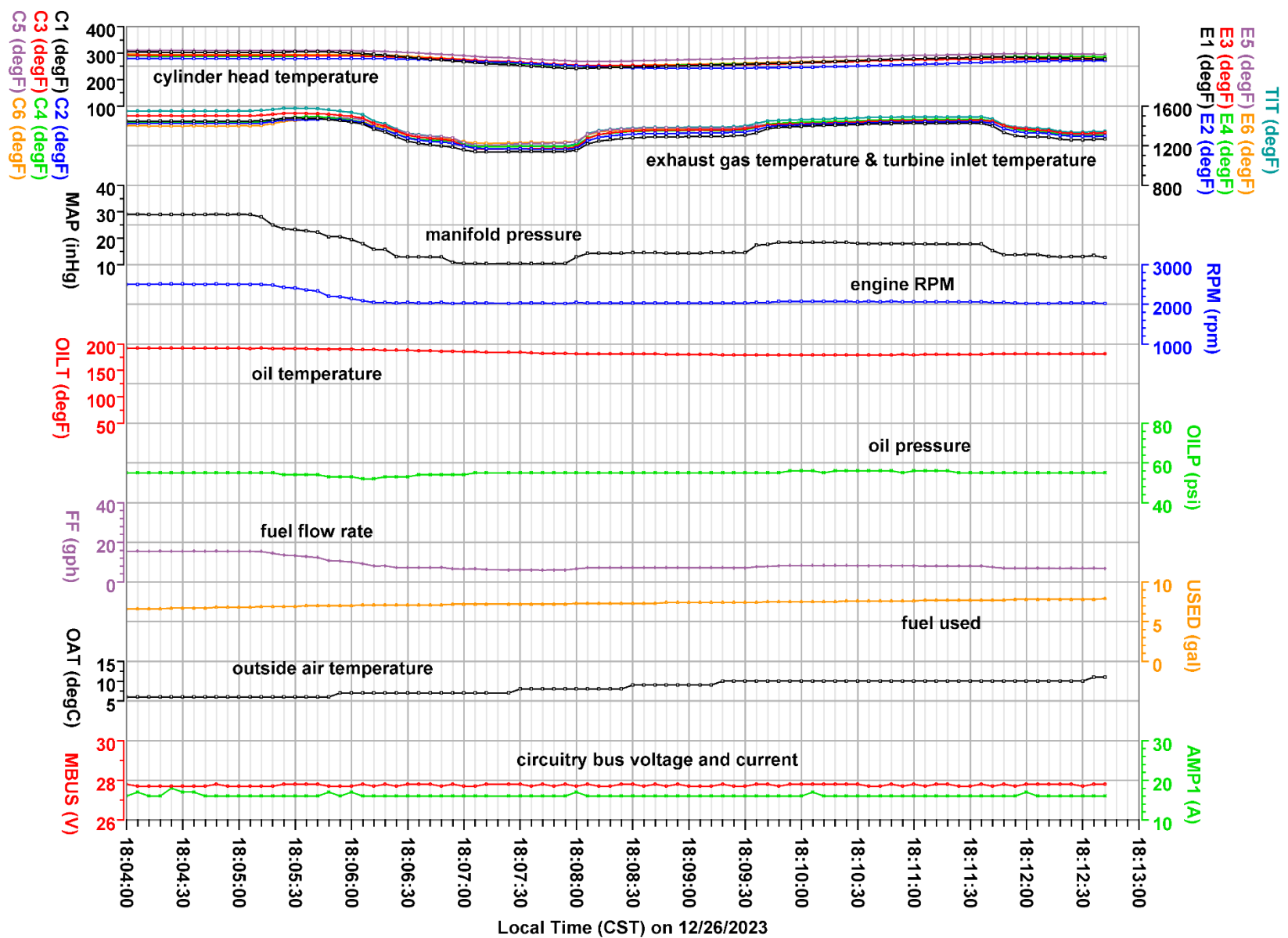


Figure 10. Plot of engine parameters of the final portion of the accident flight.

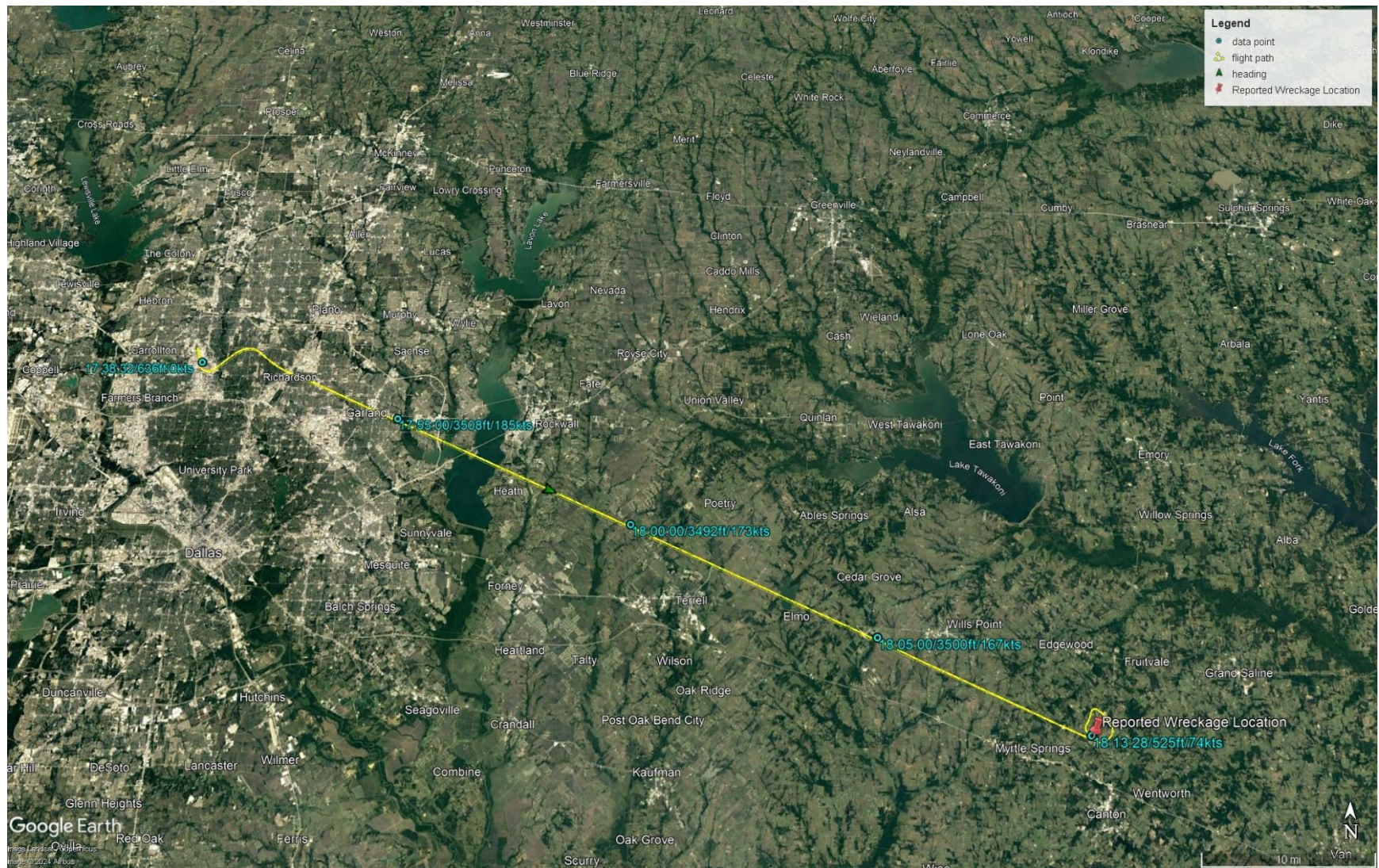


Figure 11. Google Earth overfly of the entire accident flight recording on December 26, 2023.



Figure 12. Google Earth overfly of the final portion of the accident flight recording on December 26, 2023.



Figure 13. Google Earth overfly of the final portion of the accident flight with respect to the runway 13 of Thompson Field Airport.