

# National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA22LA404

## **RECOVERABLE DATA MODULE**

Specialist's Factual Report

November 1, 2023

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## **A. ACCIDENT**

Location: Saint Cloud, FL  
Date: September 9, 2022  
Time: 1502 eastern daylight time  
Airplane: Cirrus Design Corp SF50, N77VJ

## **B. RECOVERABLE DATA MODULE SPECIALIST**

Specialist Charles Cates  
Mechanical Engineer/Recorder Specialist  
National Transportation Safety Board (NTSB)

## **C. FEDERAL CARRIAGE REQUIREMENTS**

The event aircraft, N77VJ, was operating as Title 14 *Code of Federal Regulations* (CFR) Part 91. The event aircraft was manufactured in 2018 and was operating such that it was not required to be equipped with a flight data recorder (FDR). It was equipped with a Recoverable Data Module (RDM), a crash-hardened data storage device that records data from the avionics data bus.

## **D. DETAILS OF THE INVESTIGATION**

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received electronic files containing the raw and converted RDM data from the N77VJ aircraft.

### **1.0 Appareo RDM-300 Description**

The RDM-300 is a lightweight crash-hardened memory storage device. It is capable of recording data from sources including an aircraft's ARINC 429 high and low speed bus, RS-422 bus, or from a Universal Serial Bus (USB). It is qualified to DO-160g survivability requirements.

### **1.1 Recording Description**

The RDM recording was decoded into engineering units by the aircraft manufacturer and the accident flight was transferred to the NTSB's recorder division in comma separated variable format. The decoded file contained approximately 2 hours of data. The accident flight duration was approximately 50 minutes.

### 1.1.1 Engineering Unit Conversions

The engineering unit conversions used for the data contained in this report were done by the aircraft manufacturer under the supervision of the NTSB. Where applicable, the conversions have been changed to ensure that the parameters conform to the NTSB's standard sign convention that climbing right turns are positive (CRT=+).<sup>1</sup>

Table 1 lists the FDR parameters verified and provided in this report. Additionally, table 2 describes the unit and discrete state abbreviations used in this report.

## 1.2 Time Correlation

Correlation of the RDM data to the event local time, eastern daylight time (EDT), was established by using the recorded coordinated universal time (UTC) Hours, UTC Minutes, and UTC Seconds and then applying an additional -4 hours offset to change UTC to EDT.

## E. FIGURES AND TABULAR DATA

Figures 1 to 9 contain FDR data recorded during the event on September 9, 2022. All the parameters listed in table 1 are plotted except UTC Hours, UTC Minutes, UTC Seconds, Latitude, and Longitude.

Figures 1, 2, 8, and 9 contain data from approximately the final six minutes of the accident flight. Figures 3-7 contain data from the full accident flight.

Figures 1 and 2 are map overlays of the recorded latitude, longitude, and altitude displayed in Google Earth. Note that visibility and atmospheric conditions displayed in Google Earth are not representative of the visibility and atmospheric conditions at the time of the accident. Figure 3 is a plot of aircraft basic parameters. Figure 4 is a plot of engine parameters. Figure 5 is a plot of autoflight and stability protection system parameters. Figure 6 is a plot of autopilot parameters. Figures 7, 8, and 9 are plots of a combination of aircraft basic, engine, and autoflight parameters to clarify the conditions at the time of the accident.

In summary, the data show that the aircraft departed from Miami Opa Locka Executive Airport (KOPF) runway 27 at about 1412 EDT. The aircraft climbed to

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<sup>1</sup> CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Left Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

17,000 ft and cruised for about 8 minutes, then climbed to 18,000 ft for about 6 minutes before beginning a descent into Kissimmee Gateway Airport (KISM).

With the autopilot engaged in ALT/HDG modes at about 1457 EDT, the autopilot transitioned into VS mode, and the aircraft began a ~1,000 foot per minute (fpm) descent to 2,000 ft. During this portion of the descent the airspeed increased to 208 knots (kts) until the throttle was reduced from 9 to -9 degrees (deg). The autopilot transitioned to NAV GPS and the aircraft began a turn to the right to capture the final approach course for runway 33.

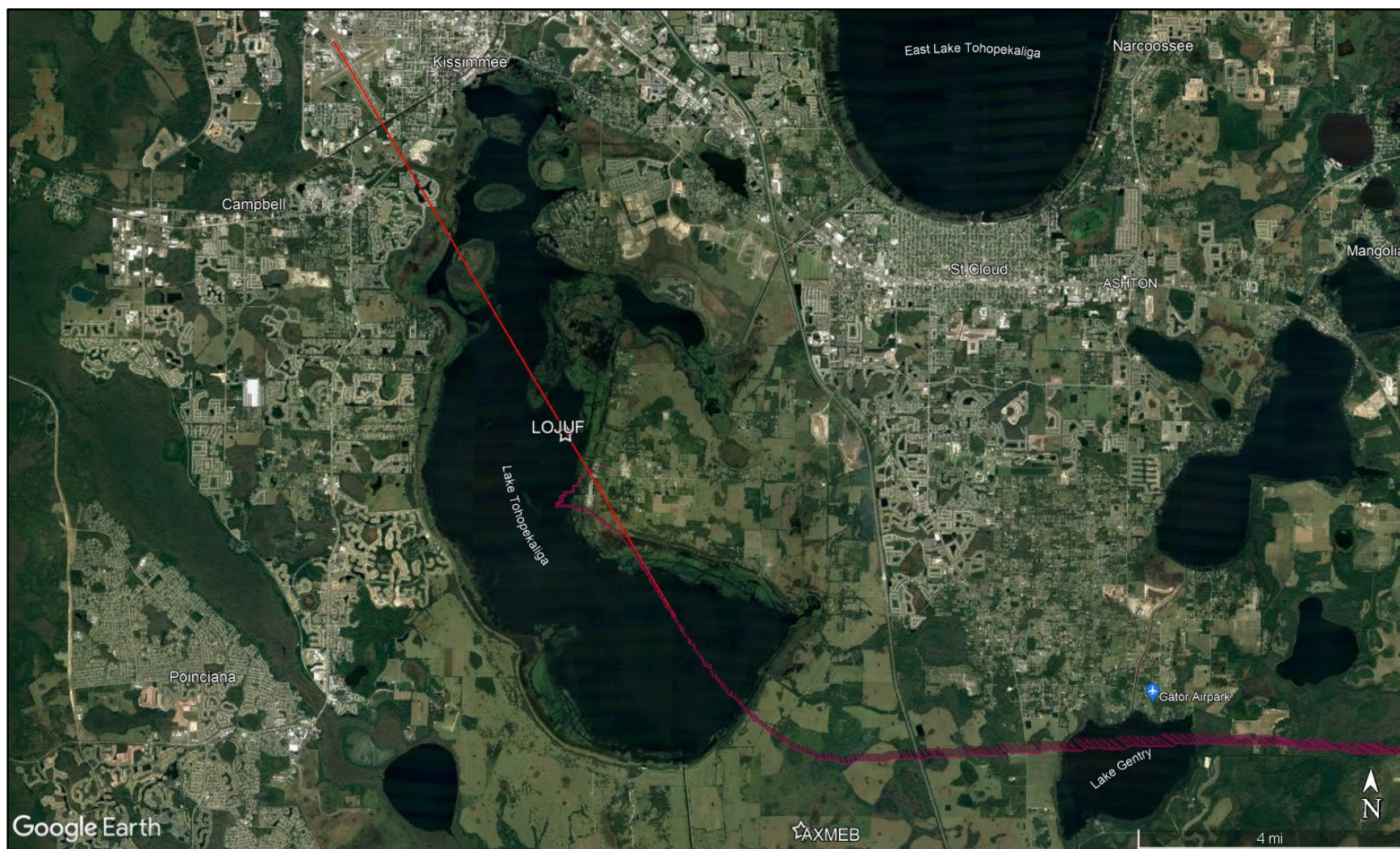
After capturing 2,000 ft, the airspeed began to decay at a rate of about 1.5-2 kts per second. The pitch began to increase as the speed decreased and autopilot pitch servos increased torque and speed allowing the aircraft to hold 2,000 ft. At 1459:11 EDT, airspeed reached a low of 100 kts, and the throttle began a gradual advance. At 1459:21 EDT with the autopilot still engaged, the aircraft pitched down from 12.8 to 1.8 degrees, and then the autopilot was disconnected at 1459:27. No faults in the autopilot or stability protection systems were recorded until the CAPS system was activated, when those recorded faults are expected.

Following autopilot disconnection, the throttle continued to increase until it reached 38 degrees, consistent with max throttle. Aircraft pitch increased until High Pitch ESP was engaged at 1459:47 at a pitch of 28 degrees nose up. The aircraft experienced variation in pitch and roll until CAPS was activated at 1459:57. The aircraft descended to the ground and the recording continued until the RDM lost power at 1601:59.

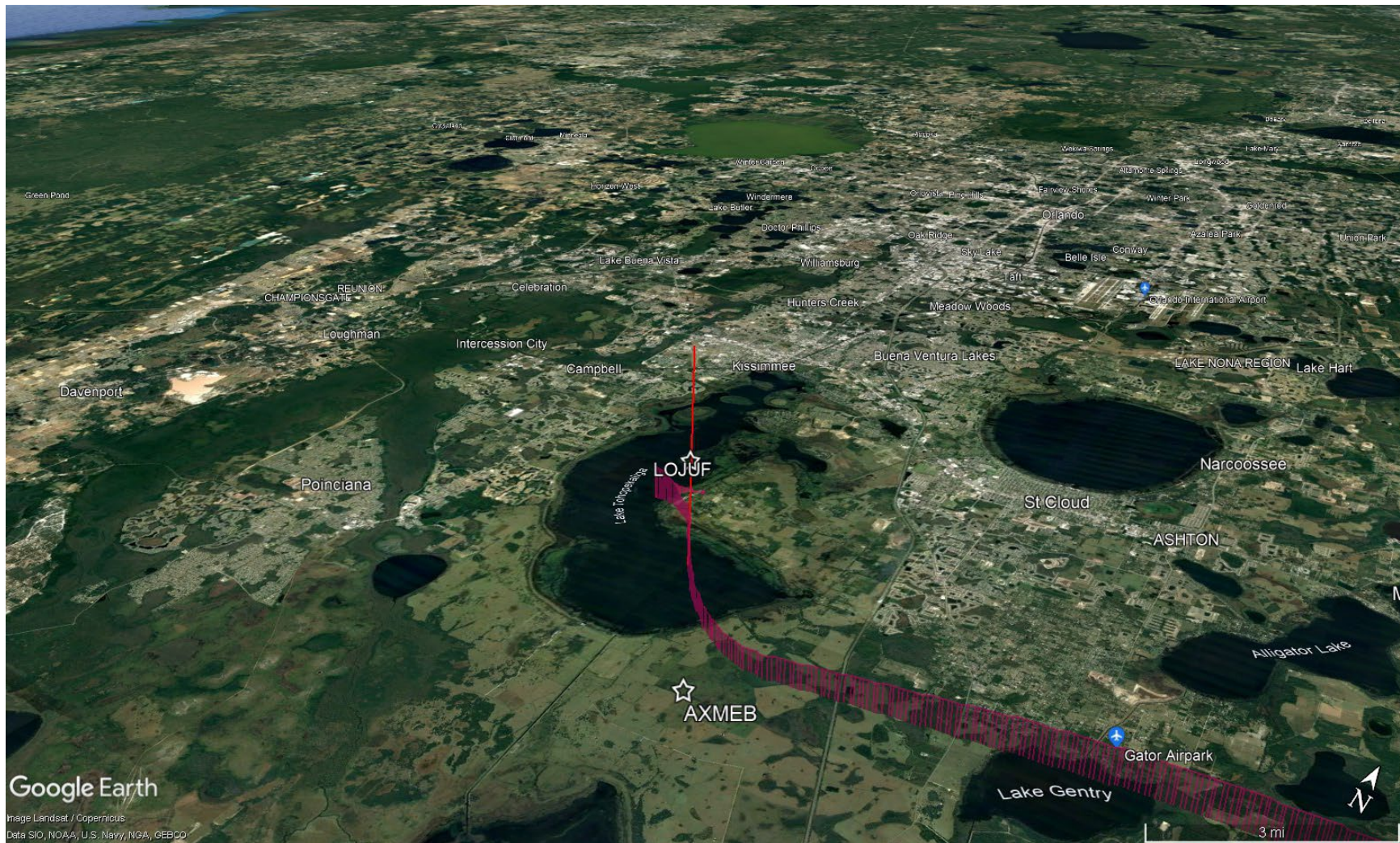
The corresponding tabular data used to create figures 1 to 9, including UTC Hours, UTC Minutes, UTC Seconds, Latitude, and Longitude, are provided in electronic comma separated value (CSV) format as attachment 1 to this report.

Submitted by:

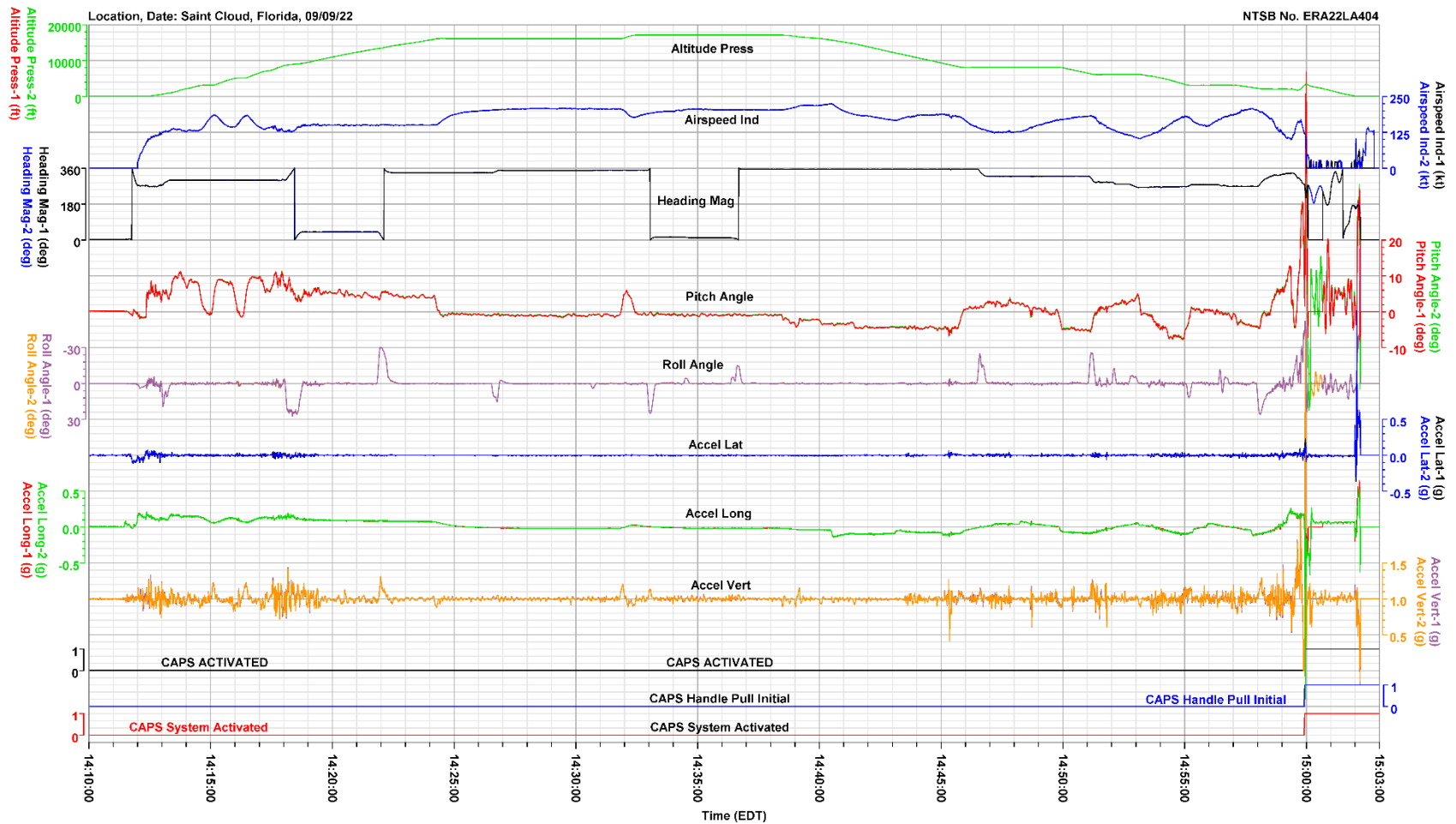
Charles Cates  
Mechanical Engineer/Recorder Specialist



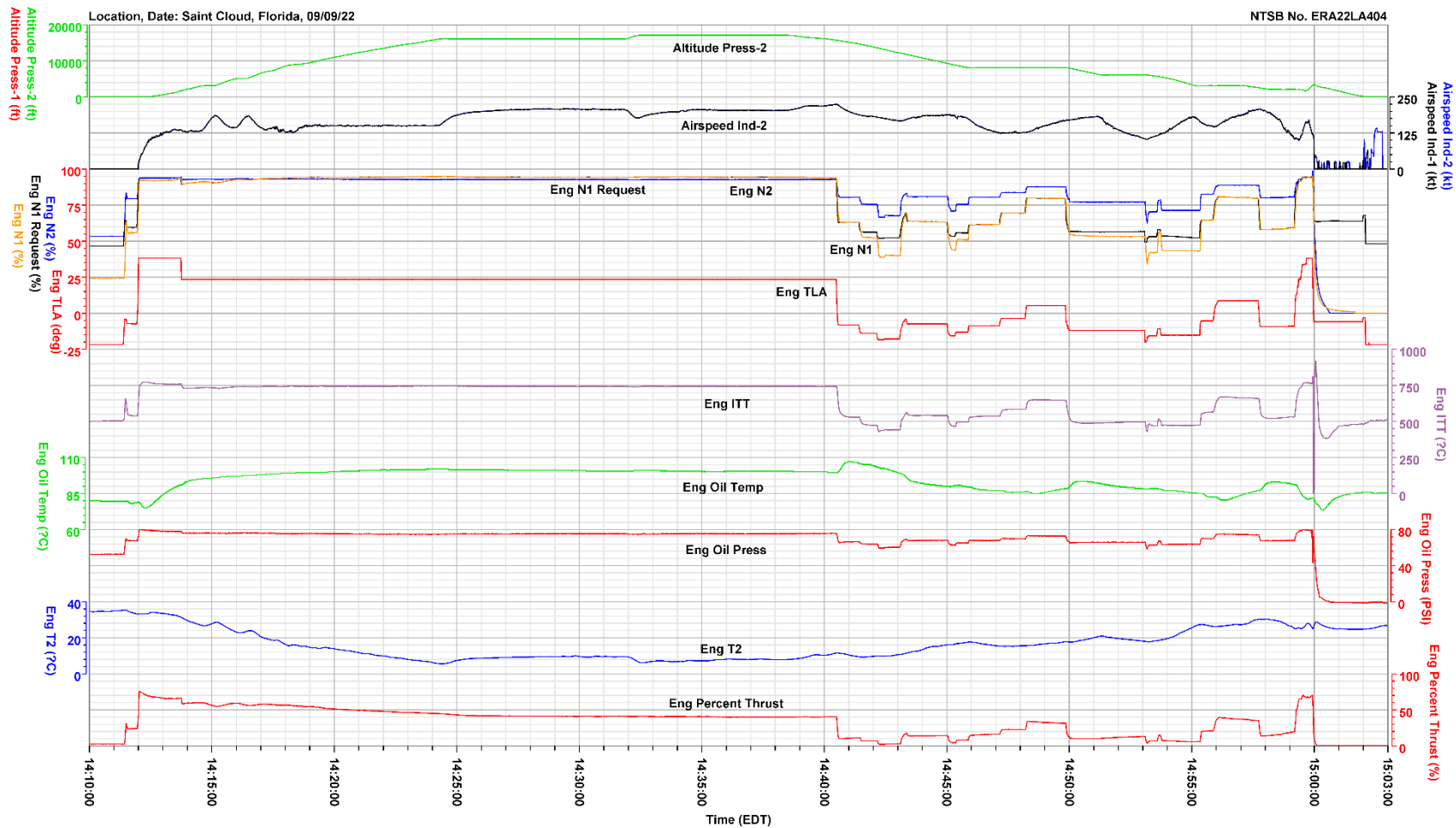
**Figure 1.** Map overlay of final 6 minutes of flight, shown in magenta. AXMEB and LOJUF waypoints annotated and extended centerline of KISM RWY 33 displayed in red.



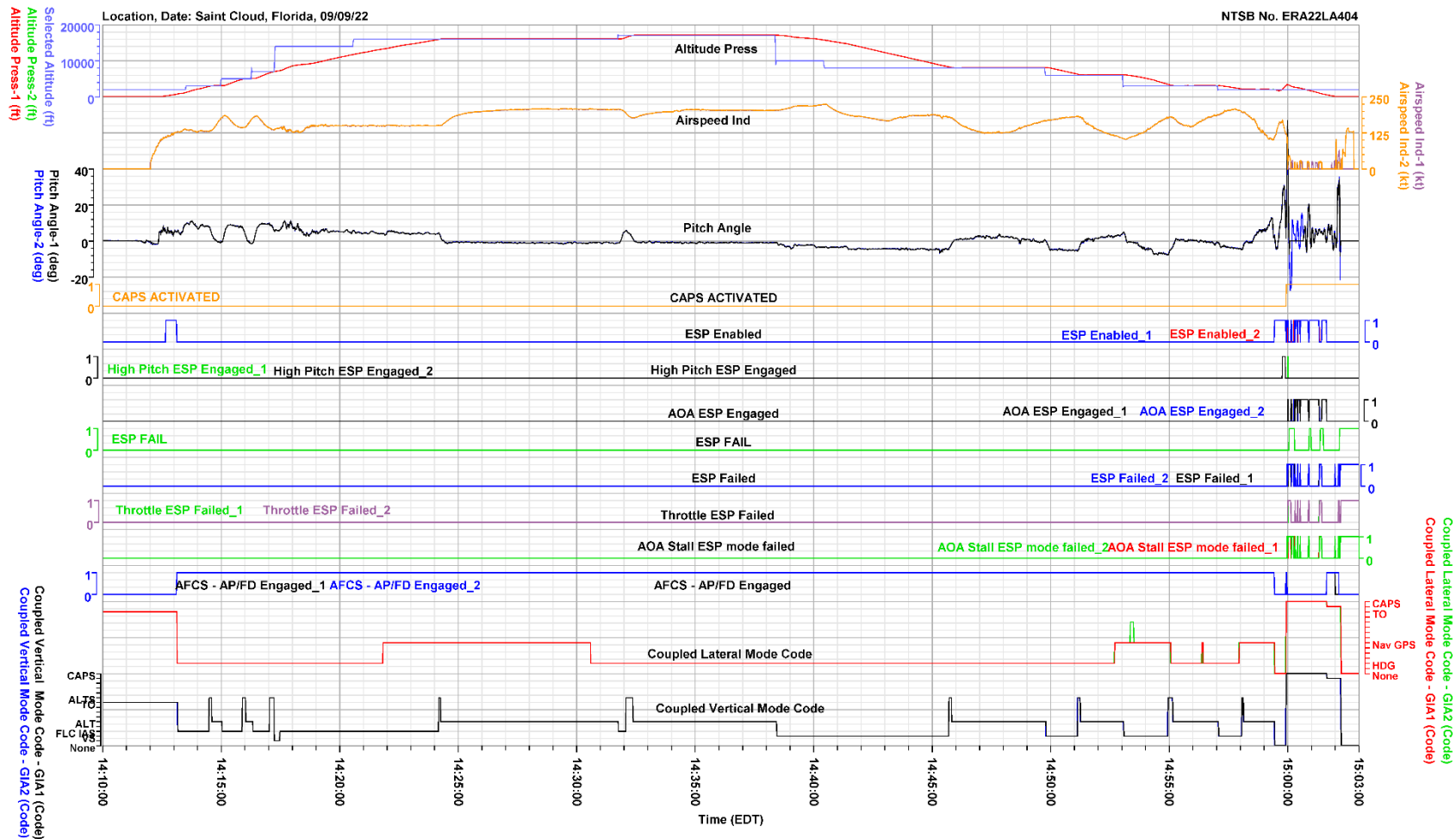
**Figure 2.** Map overlay looking in direction of KISM RWY 33. Waypoints AXMEB and LOJUF annotated and extended runway centerline shown in red.



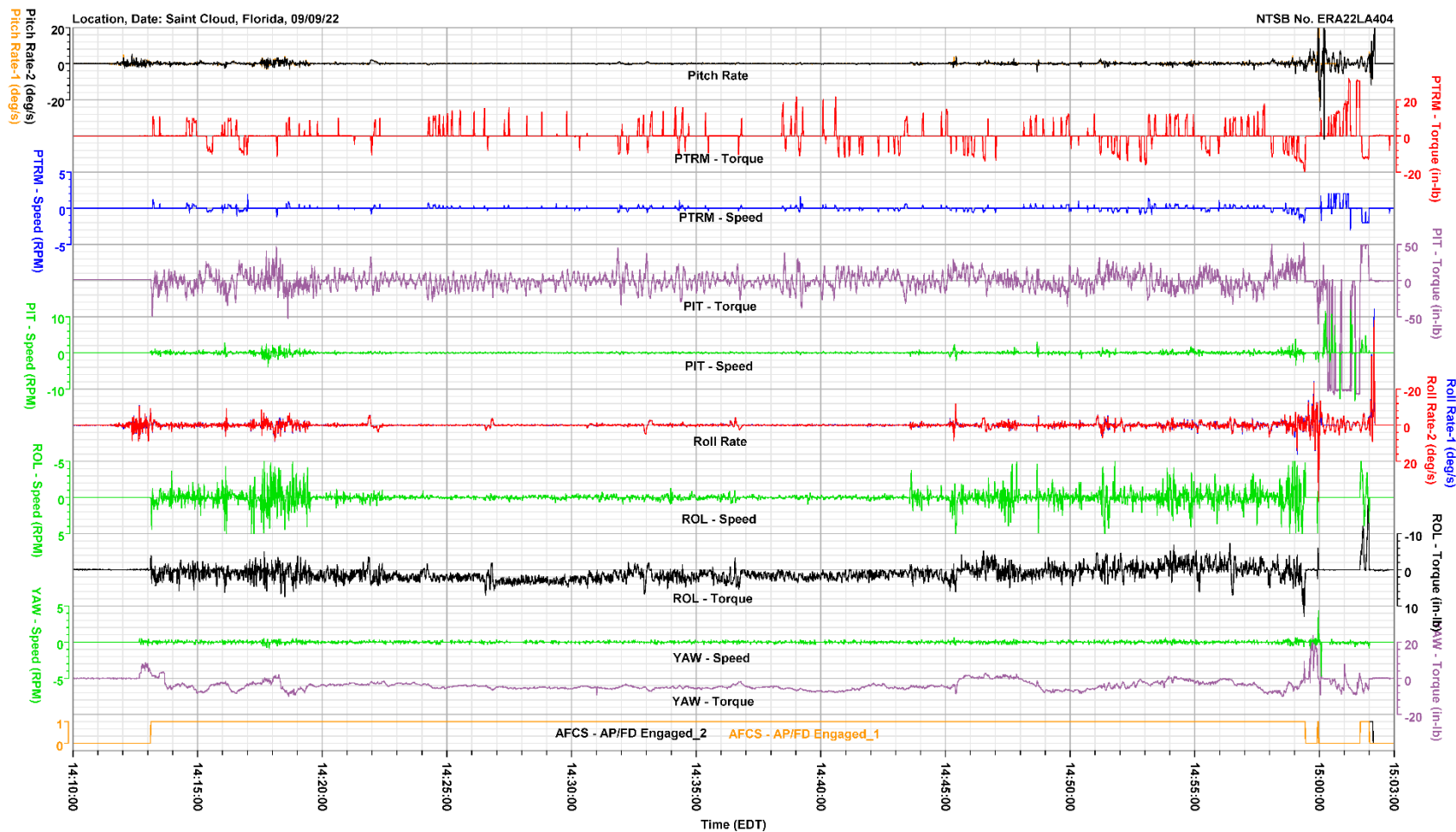
**Figure 3.** Plot of aircraft basic parameters from full accident flight.



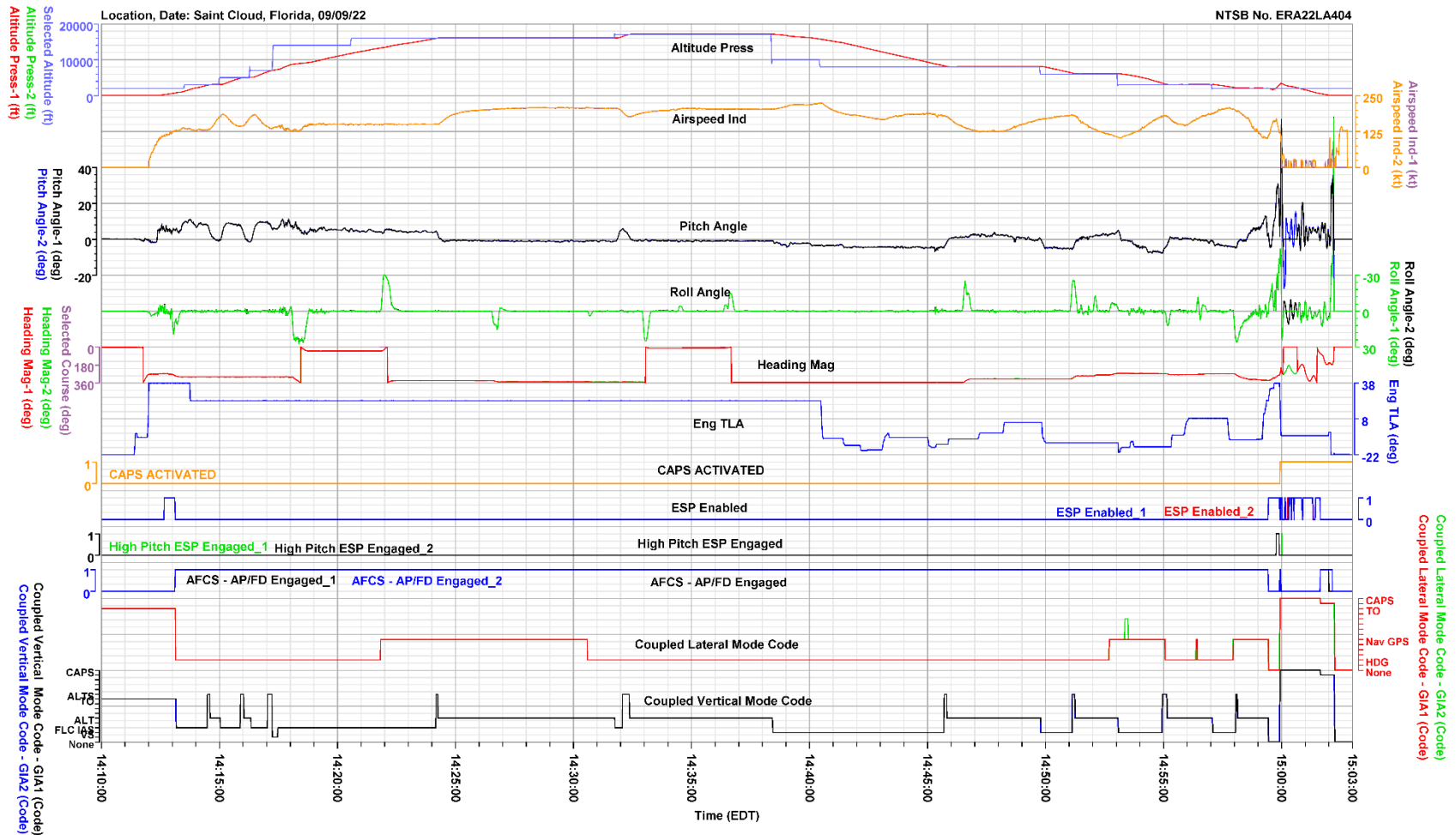
**Figure 4.** Plot of engine parameters from full accident flight.



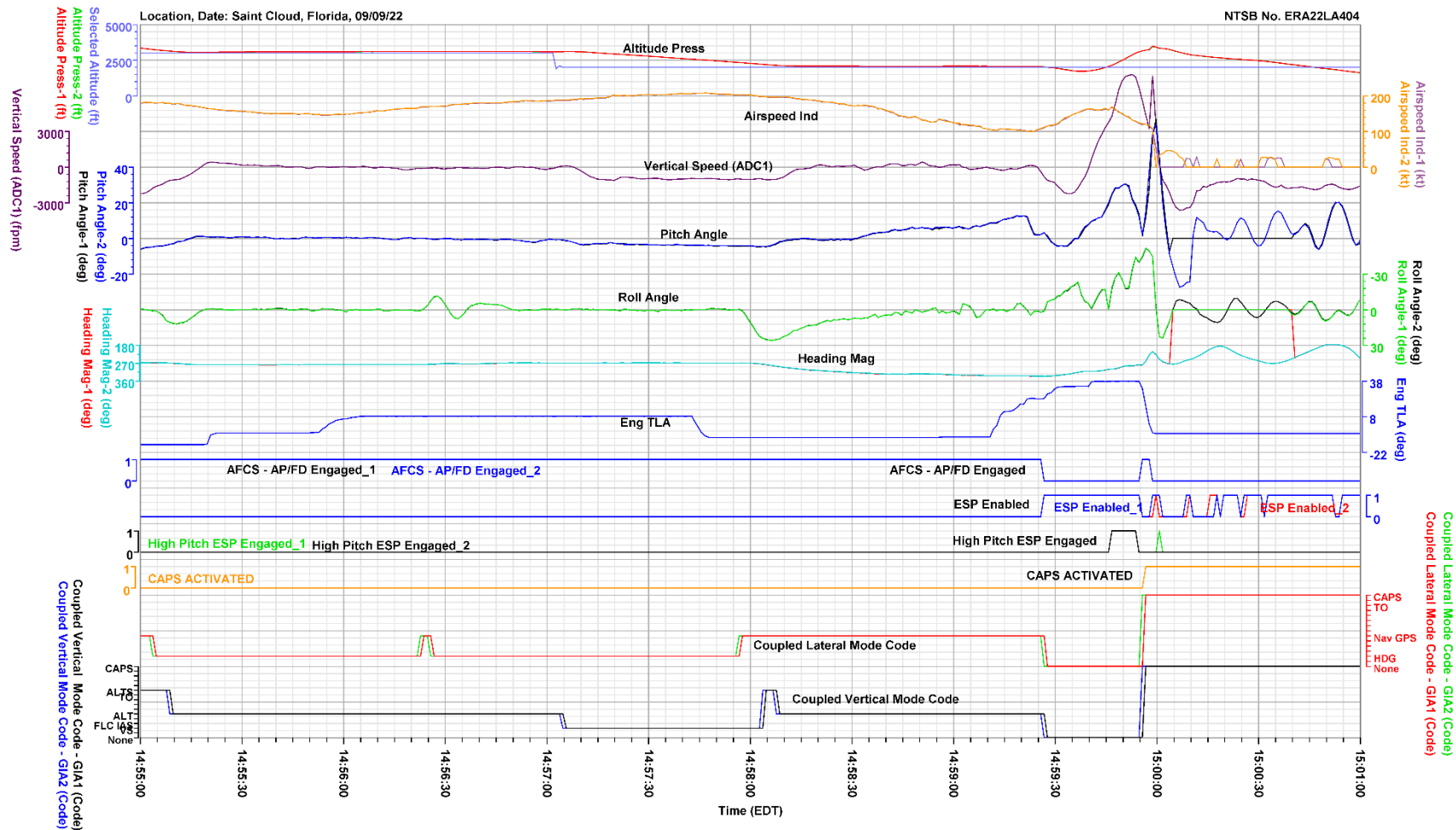
**Figure 5.** Plot of autoflight and stability protection system parameters from full accident flight.



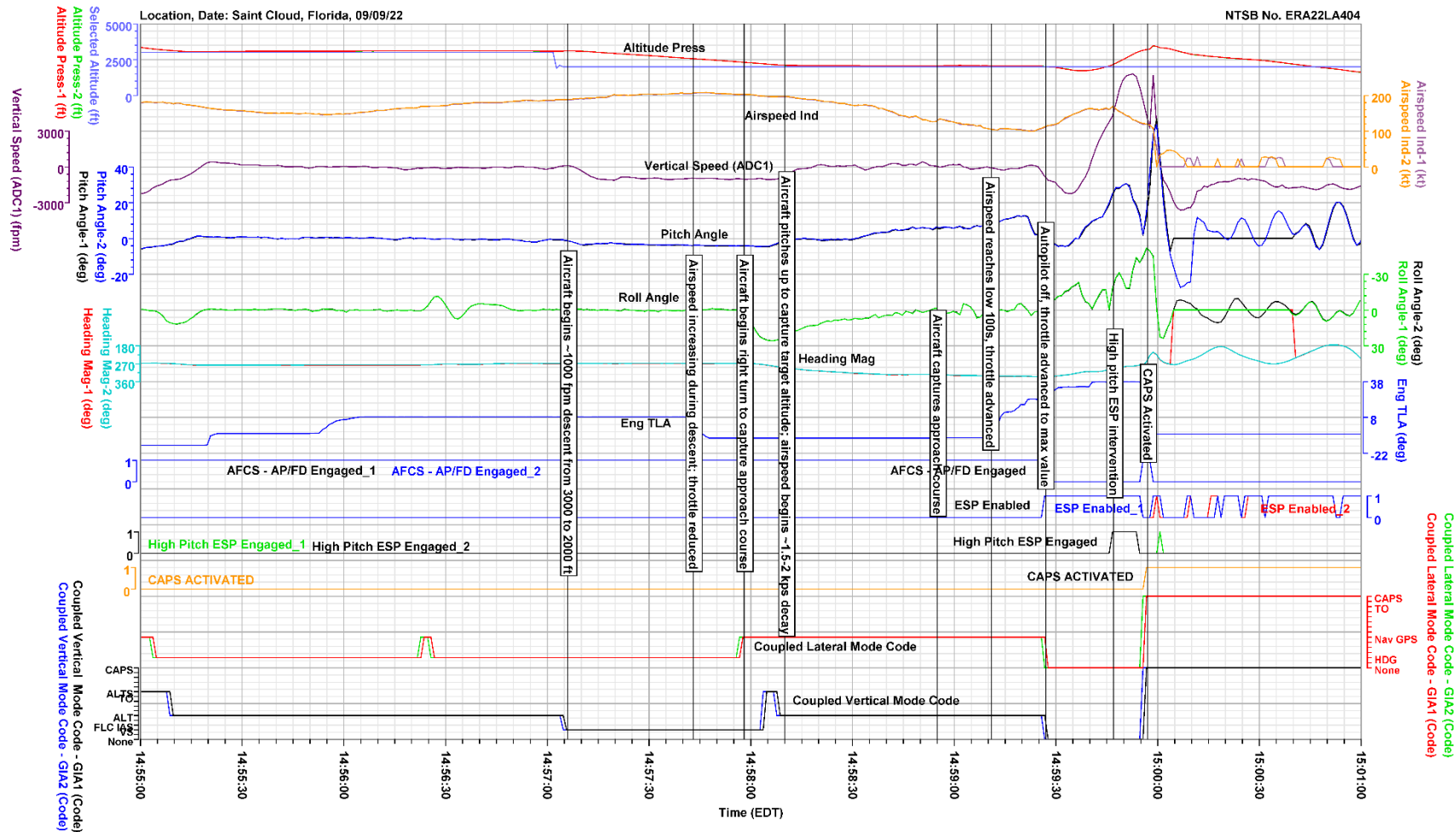
**Figure 6.** Plot of autopilot servo inputs from full accident flight.



**Figure 7.** Plot of aircraft basic, engine, and autoflight parameters from full accident flight.



**Figure 8.** Plot of aircraft basic, engine, and autoflight parameters from final six minutes of accident fight.



**Figure 9.** Plot of aircraft basic, engine, and autoflight parameters from final six minutes of accident fight with timing of events overlaid.

## APPENDIX A. VERIFIED AND PROVIDED PARAMETERS

This appendix describes the parameters provided and verified in this report. Table 1 lists the plot/table labels, parameter names, and units. Additionally, table 2 describes the unit and discrete state abbreviations used in this report.

**Table 1.** Verified and provided RDM parameters

| Parameter Name                        | Units | Parameter Description                   |
|---------------------------------------|-------|-----------------------------------------|
| 1. Accel Lat-1                        | g     | Lateral Acceleration 1                  |
| 2. Accel Lat-2                        | g     | Lateral Acceleration 2                  |
| 3. Accel Long-1                       | g     | Longitudinal Acceleration 1             |
| 4. Accel Long-2                       | g     | Longitudinal Acceleration 2             |
| 5. Accel Vert-1                       | g     | Vertical Acceleration 1                 |
| 6. Accel Vert-2                       | g     | Vertical Acceleration 2                 |
| 7. AFCS - AP/FD Engaged_1             |       | Autopilot/Flight Director Engaged 1     |
| 8. AFCS - AP/FD Engaged_2             |       | Autopilot/Flight Director Engaged 2     |
| 9. Airspeed Ind-1                     | kt    | Indicated Airspeed 1                    |
| 10. Airspeed Ind-2                    | kt    | Indicated Airspeed 2                    |
| 11. Altitude Press-1                  | ft    | Pressure Altitude 1                     |
| 12. Altitude Press-2                  | ft    | Pressure Altitude 2                     |
| 13. AOA ESP Engaged_1                 |       | AOA Stability Protection Engaged 1      |
| 14. AOA ESP Engaged_2                 |       | AOA Stability Protection Engaged 2      |
| 15. AOA Stall ESP mode failed_1       |       | AOA Stall Stability Protection Failed 1 |
| 16. AOA Stall ESP mode failed_2       |       | AOA Stall Stability Protection Failed 2 |
| 17. CAPS ACTIVATED                    |       | CAPS Activated - Master                 |
| 18. CAPS Handle Pull Initial          |       | CAPS Handle Pulled                      |
| 19. CAPS System Activated             |       | CAPS System Activated                   |
| 20. Coupled Lateral Mode Code - GIA1  | Code  | Lateral AP Mode 1                       |
| 21. Coupled Lateral Mode Code - GIA2  | Code  | Lateral AP Mode 2                       |
| 22. Coupled Vertical Mode Code - GIA1 | Code  | Vertical AP Mode 1                      |
| 23. Coupled Vertical Mode Code - GIA2 | Code  | Vertical AP Mode 2                      |
| 24. Eng ITT                           | deg C | Engine Interturbine Temperature         |
| 25. Eng N1                            | %     | Engine Fan Speed                        |
| 26. Eng N1 Request                    | %     | Engine Fan Speed Request                |
| 27. Eng N2                            | %     | Engine Core Speed                       |
| 28. Eng Oil Press                     | PSI   | Engine Oil Pressure                     |
| 29. Eng Oil Temp                      | deg C | Engine Oil Temperature                  |
| 30. Eng Percent Thrust                | %     | Engine Thrust                           |
| 31. Eng T2                            | deg C | Engine Total Temperature                |
| 32. Eng TLA                           | deg   | Engine Throttle Lever Angle             |

| Parameter Name               | Units | Parameter Description    |
|------------------------------|-------|--------------------------|
| 33. ESP Enabled_1            |       | ESP Enabled 1            |
| 34. ESP Enabled_2            |       | ESP Enabled 2            |
| 35. ESP FAIL                 |       | ESP Failed Master        |
| 36. ESP Failed_1             |       | ESP Failed 1             |
| 37. ESP Failed_2             |       | ESP Failed 2             |
| 38. GPS Altitude (GIA1)      | ft    | GPS Altitude 1           |
| 39. GPS Altitude (GIA2)      | ft    | GPS Altitude 2           |
| 40. GPS Latitude (GIA1)      | deg   | Latitude 1               |
| 41. GPS Latitude (GIA2)      | deg   | Latitude 2               |
| 42. GPS Longitude (GIA1)     | deg   | Longitude 1              |
| 43. GPS Longitude (GIA2)     | deg   | Longitude 2              |
| 44. Heading Mag-1            | deg   | Magnetic Heading 1       |
| 45. Heading Mag-2            | deg   | Magnetic Heading 2       |
| 46. High Pitch ESP Engaged_1 |       | High Pitch ESP Engaged 1 |
| 47. High Pitch ESP Engaged_2 |       | High Pitch ESP Engaged 2 |
| 48. Pitch Angle-1            | deg   | Pitch Attitude 1         |
| 49. Pitch Angle-2            | deg   | Pitch Attitude 2         |
| 50. Roll Angle-1             | deg   | Roll Attitude 1          |
| 51. Roll Angle-2             | deg   | Roll Attitude 2          |
| 52. Selected Altitude        | ft    | AP Altitude Selected     |
| 53. Selected Course          | deg   | AP Course Selected       |

Note: This FDR records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The pressure altitude information presented in the FDR plots and in the electronic data has not been corrected for the local altimeter setting at the time of the event.

Note: Parameters with a blank unit description in table 1 are discretes. A discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.

**Table 2.** Unit and discrete state abbreviations

| Unit and Discrete State Abbreviation | Description                      |
|--------------------------------------|----------------------------------|
| ALT                                  | Altitude Hold AP Mode            |
| ALTS                                 | Altitude Capture AP Mode         |
| AOA                                  | Angle of Attack                  |
| AP                                   | Autopilot                        |
| CAPS                                 | Cirrus Airframe Parachute System |
| deg                                  | degrees                          |
| deg C                                | degrees Celsius                  |
| ESP                                  | Electronic Stability Protection  |
| FD                                   | Flight Director                  |
| FLC                                  | Flight Level Change AP Mode      |

| <b>Unit and Discrete<br/>State Abbreviation</b> | <b>Description</b>     |
|-------------------------------------------------|------------------------|
| fpm                                             | feet per minute        |
| ft                                              | feet                   |
| g                                               | gravitational constant |
| HDG                                             | Heading AP Mode        |
| IAS                                             | Indicated Airspeed     |
| kt                                              | knots                  |
| Nav GPS                                         | GPS Navigation AP Mode |
| psi                                             | pounds per square inch |
| TO                                              | Takeoff AP Mode        |
| VS                                              | Vertical Speed AP Mode |