

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA24FA310

MULTIPLE ELECTRONIC DEVICES

Specialist's Factual Report

September 25, 2024

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A. ACCIDENT SUMMARY

Location: Geneva, Ohio
Date: July 21, 2024
Time: 1754 eastern daylight time (EDT)
2154 coordinated universal time (UTC)
Aircraft: Experimental Titan T-51 Mustang, N751TX

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:	Garmin GPSMAP 496
Serial Number:	19729220
Manufacturer/Model:	Dynon EFIS D10A
Serial Number:	004148
Manufacturer/Model:	Link Engine Management G4+ Xtreme
Serial Number:	27857

1.0 Garmin GPSMAP 496 Description

The Garmin GPSMAP 496 is a battery-powered portable 12-channel GPS receiver with a 256-color thin-film transistor (TFT) liquid-crystal display (LCD) display screen. The unit includes a built-in Jeppesen database and is capable of receiving XM satellite radio for flight information including NEXRAD radar, lightning, METARs, TAFs, and TFRs. A built-in AOPA Airport Directory and SafeTaxi Airport Diagrams are included for selected fields. The unit stores date, route-of-flight, and flight-time information for up to 50 flights. A flight record is triggered when groundspeed exceeds 30 knots and altitude exceeds 250 feet, and it ends when groundspeed drops below 30 knots for 10 minutes or more. A detailed track log, including latitude, longitude, date, time, and GPS altitude information is stored within the unit when the receiver has a lock on the GPS navigation signal. Position is updated within the track log as a function of time or distance moved, depending on how the unit has been configured. Once the current track log memory becomes full, new information either overwrites the oldest information or recording stops, depending on how the unit is configured. The current track log can be saved to long-term memory and 15 saved track logs can be maintained in addition to the current track log. Track log storage

may be activated or de-activated at user discretion. All recorded data is stored in non-volatile memory (NVM).¹ The unit contains hardware and software permitting the download of recorded waypoint, route, and track log information to a PC via a built-in serial port. The unit can also communicate with external devices such as a computer using a built-in USB port. An internal button battery is used to back up power to the internal memory and real-time clock during those periods when main power is removed.

1.1 Garmin GPSMAP 496 Condition and Data Recovery

Figure 1 shows the Garmin GPSMAP 496 as received at the NTSB Vehicle Recorders Laboratory. The device powered up normally, and the internally stored track logs were downloaded using laboratory tools.



Figure 1. Garmin GPSMAP 496 as received.

1.2 Garmin GPSMAP 496 Recording Description

The downloaded data contained 165 sessions, from May 25 to July 21, 2024. The last session was identified to be associated to the accident event. The duration of this recording was approximately 7 minutes and 14 seconds, from 21:48:34 to 21:54:24 UTC, July 21, 2024. The recording rate ranged from 1-13 seconds per sample.

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

1.2.1 Garmin GPSMAP 496 Parameters Provided

Table 1 lists the Garmin GPSMAP 496 parameters verified and provided in this report.

Table 1. Garmin GPSMAP 496 data parameters provided.

Parameter Name (unit)	Parameter Description (unit)
GPS Alt (ft)	Altitude above Mean Sea Level (feet)
Groundspeed (mph/kts)	Calculated average groundspeed between current and previous data point (miles per hour/knots)
Latitude (deg)	Geographic latitude (degrees)
Longitude (deg)	Geographic longitude (degrees)
Track (deg)	Derived path on the surface of the Earth directly below aircraft with reference to the true north (degrees)

1.3 Garmin GPSMAP 496 Time Correlation

The Garmin GPSMAP 496 data was recorded in UTC, and was converted to EDT, the local time of the event. EDT is 4 hours behind UTC.

2.0 Dynon EFIS D10A Description

The Dynon Electronic Flight Information System (EFIS) D10A is a 7-inch wide screen display mounted in the cockpit of non-type certificated aircraft. The instrument integrates multiple flight instruments including airspeed, altitude, gyro-stabilized magnetic compass, turn rate, slip/skid ball, bank angle, pitch angle and vertical speed. The unit also has other functions that include a clock/timer, g-meter, voltmeter and a density altitude/true airspeed calculator. The unit contains an Air Data, Attitude and Heading Reference System (ADAHRS) to provide air data, attitude and heading information to the display.

Depending on the installation in the aircraft certain parameters might not be displayed, for example angle-of-attack. Depending on the firmware version on the unit, the ability to log data to internal memory exists. According to the manufacturer, firmware versions 5.0 and later contain the ability to log certain EFIS and GPS parameters. The data logging must be configured by the operator to enable logging and set the data log interval. The unit can also be configured to start logging data automatically at boot-up. The data logging interval can be set to store at 1, 3, 5, 10, 30 and 60 second intervals. The internal memory can store at least 2 hours of cumulative data at a 1 second recording interval or at least 120 hours at a 60 second data recording interval. When the recording limit in the internal memory is reached, the oldest record is dropped, and a new record is added.

2.1 Dynon EFIS D10A Condition and Data Recovery

Figure 2 shows the Dynon EFIS D10A as received at the NTSB Vehicle Recorders Laboratory. The device powered up normally, and its stored data were extracted by following the manufacturer's procedures.



Figure 2. Dynon EFIS D10A as received.

2.2 Dynon EFIS D10A Recording Description

The data recovered from the Dynon EFIS D10A included 30 boot cycles. The 23rd boot cycle was identified to be associated with the accident. The duration of the recording was 10 minutes and 26 seconds. The sampling rate was 1 Hz.

2.2.1 Dynon EFIS D10A Parameters Provided

Table 2 lists the Dynon EFIS D10A parameters verified and provided in this report.

Table 2. Dynon EFIS D10A data parameters provided.

Parameter Name (unit)	Parameter Description (unit)
airspeed (mph/kts)	Indicated airspeed (miles per hour/knots)
altitude (ft)	Indicated pressure altitude ² (feet)
pitch (deg)	Aircraft pitch angle (degrees)
roll (deg)	Aircraft roll angle (degrees)
vert spd (fpm)	Vertical speed (feet per minute)

² The Dynon EFIS D10A showed the altimeter was set at 30.05 inches of mercury upon powering up at the NTSB laboratory.

2.3 Dynon EFIS D10A Time Correlation

The times recorded on Dynon EFIS D10A were invalid. The data were timestamped with derived EDT based on the same parameters recorded on the Garmin GPSMAP 496 – altitude and speed.

3.0 Link Engine Management G4+ Xtreme Description

The Link Engine Management G4+ Xtreme is an engine control unit (ECU). The unit contains a 512Mb internal NVM for data logging. The amount of engine parameters available for the operator to select for logging depends on the installation. The rate at which the data is recorded is selected by the operator from 1 to 50 samples per second. With 7 engine parameters logged at 10 samples per second, the memory can store approximately 2.5 hours of data. When the recording limit in the internal memory is reached, the oldest record is overwritten by new record. The data can be downloaded by the operator using Link Engine Management software.

3.1 Link Engine Management G4+ Xtreme Condition and Data Recovery

Figure 3 shows the Link Engine Management G4+ Xtreme as received at the NTSB Vehicle Recorders Laboratory. All stored data log was extracted by following the manufacturer's procedure.



Figure 3. Link Engine Management G4+ Xtreme as received.

3.2 Link Engine Management G4+ Xtreme Recording Description

The downloaded log file contained 2 hours and 39 minutes of recording. The sampling rate was 10 Hz. The recording towards the end of the log file was identified to be associated with the event flight. The duration was 9 minutes and 30 seconds.

3.2.1 Link Engine Management G4+ Xtreme Parameters Provided

Table 3 lists the Link Engine Management G4+ Xtreme parameters verified and provided in this report.

Table 3. Link Engine Management G4+ Xtreme data parameters provided.

Parameter Name (unit)	Parameter Description (unit)
ECT (F)	Engine coolant temperature (degrees Fahrenheit)
Engine Speed (RPM)	Engine speed (revolutions per minute)
IAT (F)	Intake air temperature (degrees Fahrenheit)
Ign Angle (BTDC) (deg)	Ignition angle before top dead center (degrees)
Inj Actual PW (ms)	Injection actual pulse width (milliseconds)
MGP (psi)	Manifold gauge pressure (pounds per square inches)
TP (%)	Linearized throttle position (percent)

3.3 Link Engine Management G4+ Xtreme Time Correlation

The downloaded data were recorded in elapsed time. A time correlation of the data to EDT was not conducted, instead, the times in the report are presented in elapsed time from the start of the engine of the event flight.

D. FIGURES AND TABULAR DATA

Figure 4 and Figure 5 are basic flight data parameters plots of the accident flight recording from the Garmin GPSMAP 496 and Dynon D10A. 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.

Figure 6 to Figure 8 are engine data parameters plots of the accident flight recording from the Link Engine Management G4+ Xtreme.

Figure 9 and Figure 10 are Google Earth overlays of the accident flight recording from the Garmin GPSMAP 496. Figure 9 shows the entire flight recording, and Figure 10 shows the final portion of the accident flight. Note that the groundspeeds shown on the two figures are in the unit of knots instead of miles per hour. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

The recorded data indicated that the accident aircraft took off Germack Airport (7D9), Geneva, OH, at around 17:48:34 EDT. The accident aircraft was circling around the airport. At 17:54:24 EDT, the last recorded GPS data point showed the accident aircraft was near the recorded wreckage location, with an altitude of 1,184 feet above mean seal level (approximately 300 feet above ground level) and with a groundspeed of 85 knots. The engine data showed that the engine speed and linearized throttle position were 6,613 RPM and 70.3% at the last recorded data point.

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, 2, and 3 are data sets recovered from Garmin GPSMAP 496, Dynon D10A, and Link Engine Management G4+ Xtreme, respectively.

Submitted by:

W. Deven Chen
Electrical Engineer - Recorder Specialist

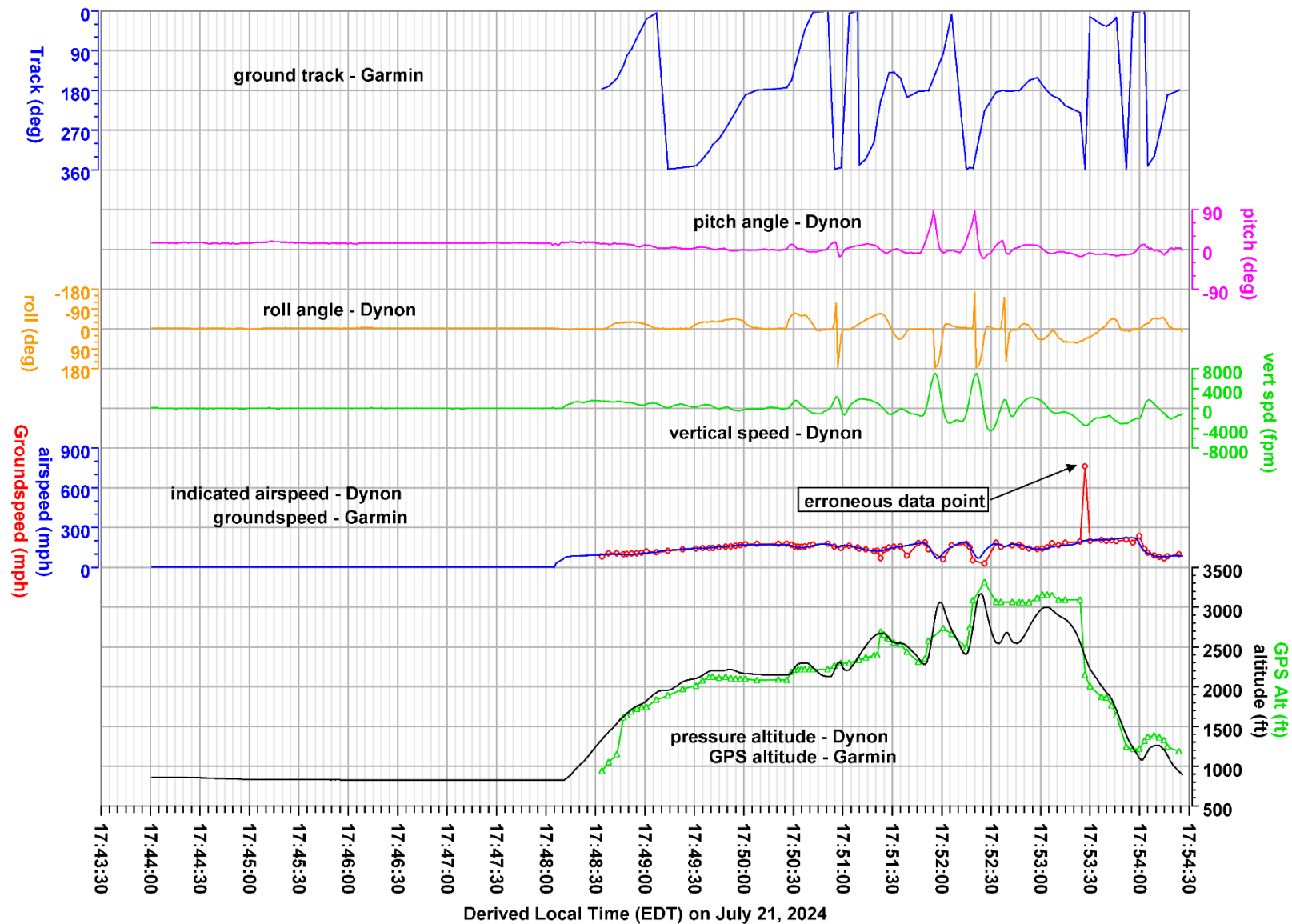


Figure 4. Plot of basic data parameters of the entire accident flight. Note that the groundspeeds from Garmin device were calculated.

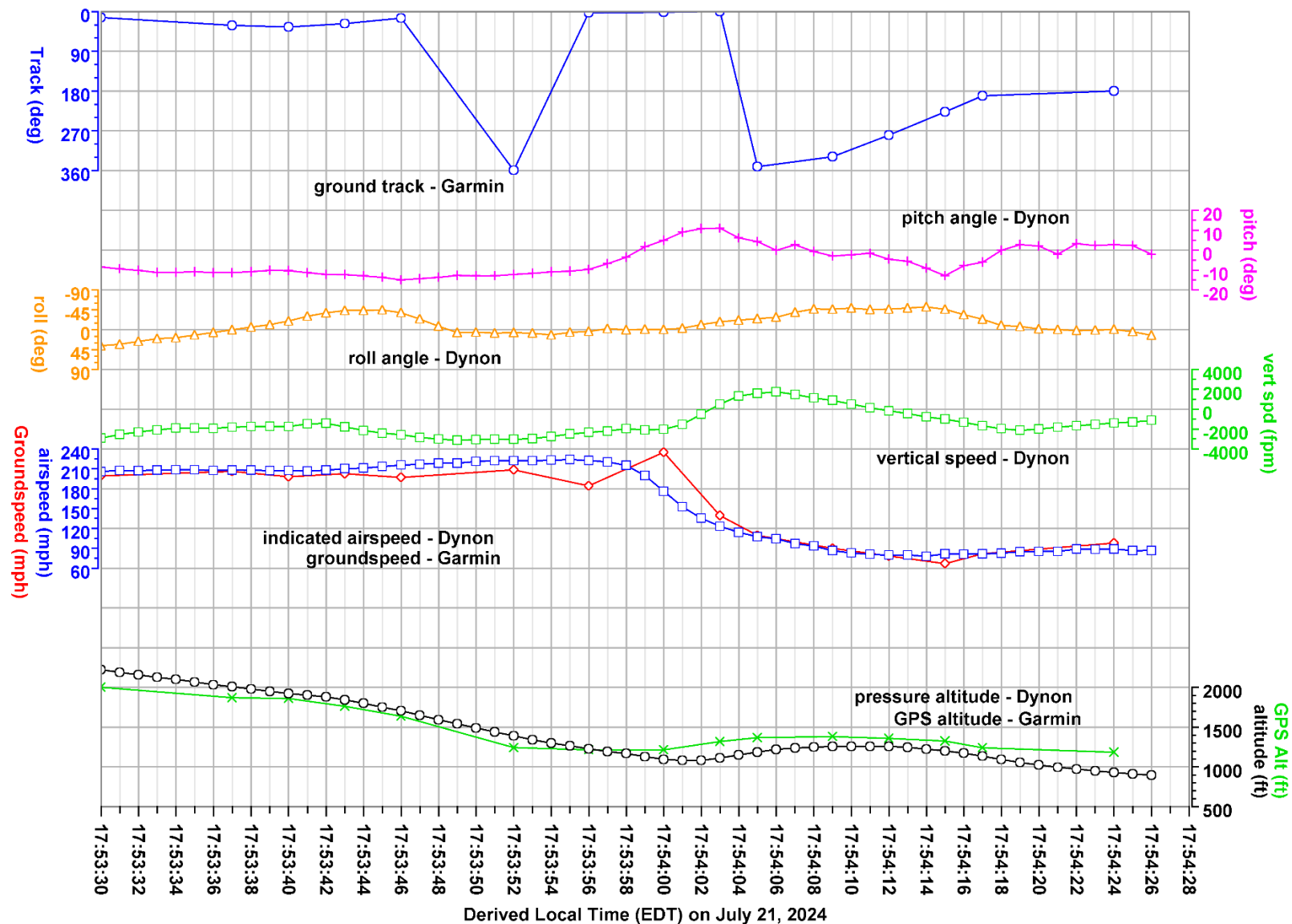


Figure 5. Plot of basic data parameters of the final portion of the accident flight recording. Note that the groundspeeds from Garmin device were calculated.

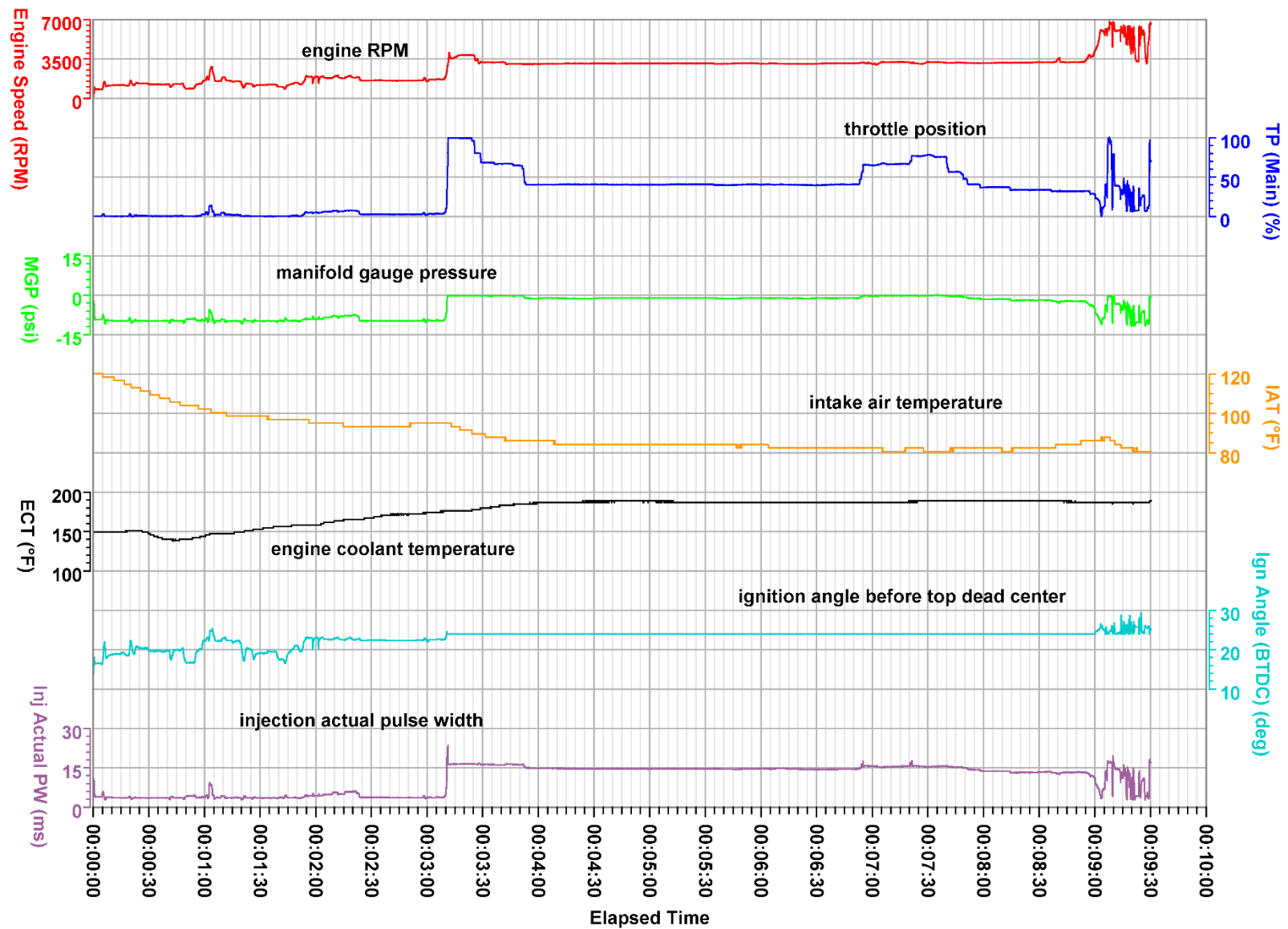


Figure 6. Plot of engine data parameters of the entire accident flight.

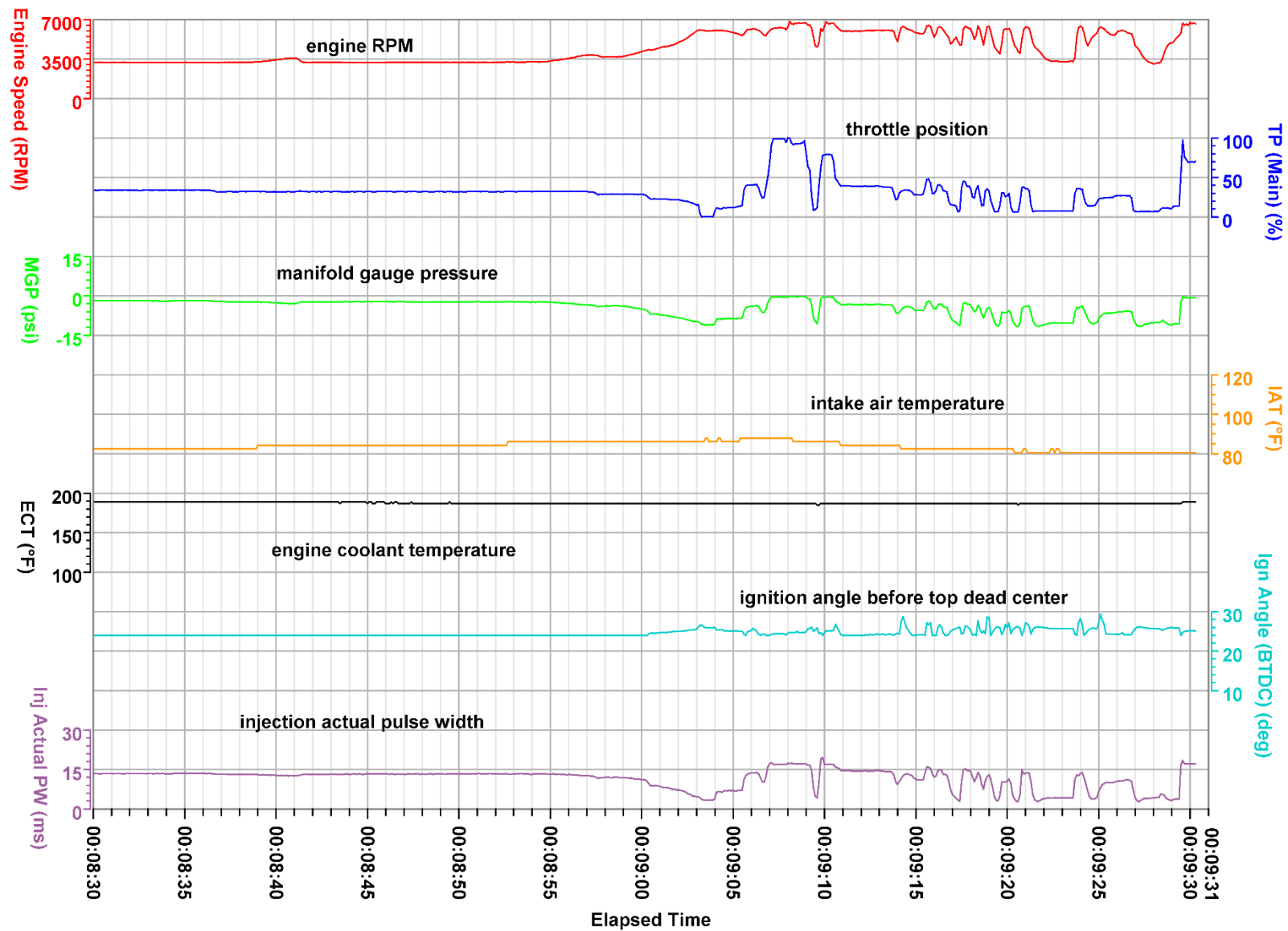


Figure 7. Plot of engine data parameters of the final portion of the accident flight.

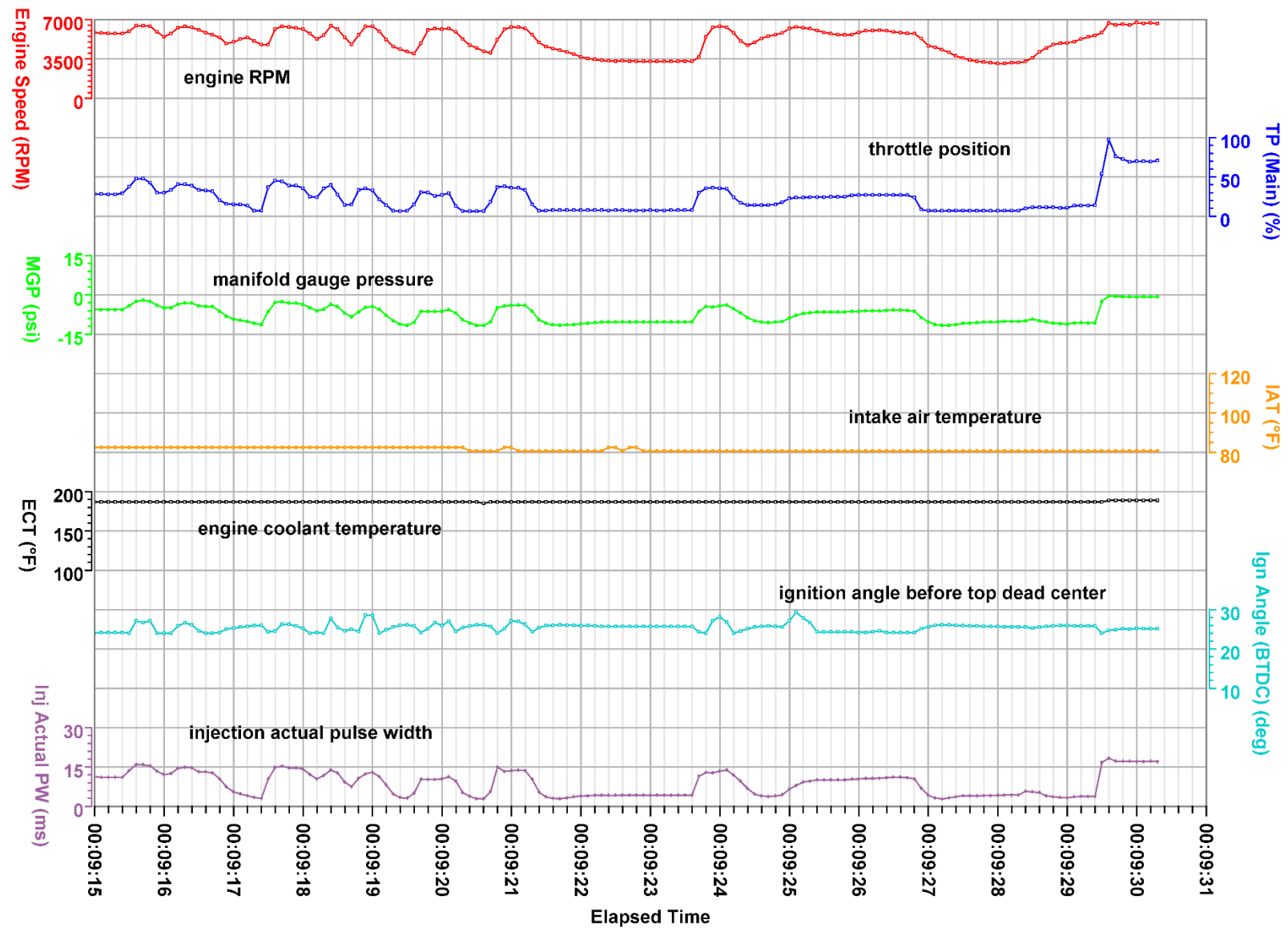


Figure 8. Plot of engine data parameters of the final 15 seconds of recording.



Figure 9. Google Earth overly of the entire accident flight recording on July 21, 2024. Note that the groundspeed in this figure is shown in the unit of knots.

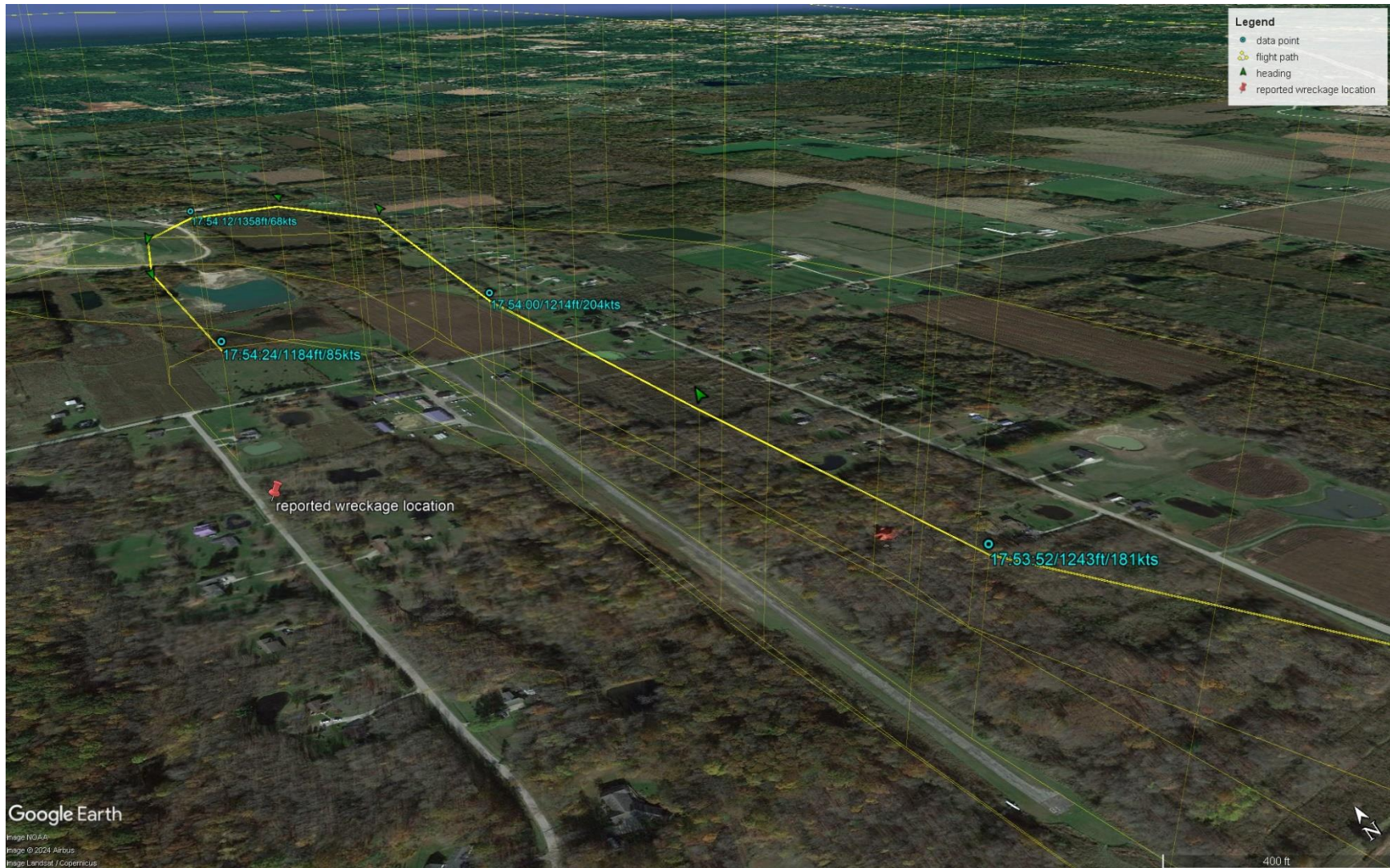


Figure 10. Google Earth overlay of the final portion of the accident flight recording on July 21, 2024. Note that the groundspeed in this figure is shown in the unit of knots.