

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

April 26, 2021

Electronic Devices

Specialist's Factual Report by Gerald Kawamoto

1. EVENT

Location: Bossier City, LA
Date: December 16, 2020
Aircraft: Piper PA-28-180
Registration: N55168
Operator: Private
NTSB Number: CEN21LA089

2. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following devices:

Device 1:	Appareo Stratus 3
Device 1 Serial Number:	018067
Device 2:	Garmin GPSMAP 496
Device 2 Serial Number:	19706958
Device 3:	Apple iPhone 11 Pro
Device 3 Serial Number:	Unknown

2.1. Appareo Stratus 3 Description

The Appareo Status 3 device is a self-contained battery-powered unit that contains an internal AHRS, GPS/WAAS receiver, and ADS-B receiver in one compact unit.^{1, 2, 3} The unit communicates wirelessly with compatible devices to display all the acquired information. In addition to communicating with compatible devices, the Stratus device records GPS position and AHRS information internally on a non-volatile flash memory chip.

¹ The Attitude Heading Reference System consists of a set of 3-axis gyroscope, accelerometers and heading reference sensors that enable the unit to compute pitch, roll, and yaw motions.

² The Wide Area Augmentation System (WAAS) is an air navigation aid to augment the Global Positioning System (GPS), by improving its accuracy, integrity, and availability.

³ Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance technology deployed throughout the national airspace system. The ADS-B system is composed of aircraft avionics and a ground infrastructure. Onboard avionics determine the position of the aircraft by using the GPS and transmit its position along with additional information about the aircraft to ground stations for use by air traffic control (ATC) and other ADS-B services. This information is transmitted at a rate of approximately once per second. Operators equipped with ADS-B realize additional benefits from ADS-B broadcast services: Traffic Information Service - Broadcast (TIS-B) (traffic information) and Flight Information Service - Broadcast (FIS-B) (weather information).

2.1.1. Appareo Stratus 3 Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the unit had sustained minor impact damage, as shown in Figure 1. The device was otherwise in good condition. The device powered on normally and data were extracted using laboratory tools.



Figure 1. Front and back of the Appareo Stratus 3 as received.

2.1.2. Appareo Stratus 3 Data Description

The data extracted included 15 sessions from November 19, 2020, through December 16, 2020.⁴ The accident flight was the last session recorded, starting at 10:24:16 UTC and ending at 10:39:27 UTC on December 16, 2020. The accident recording appeared to have started while the aircraft was in motion. Accuracy of gyroscopic parameters such as pitch angle and bank angle is dependent on the orientation of the device in the aircraft and proper calibration of the device while it's stationary. GPS position data extracted from this device aligned with position data extracted from the Garmin device.

2.1.3. Appareo Stratus 3 Parameters Provided

Table 1 describes data parameters recorded and derived by the device.

⁴ All dates and times are referenced to Coordinated Universal Time (UTC).

Table 1: Appareo Stratus 3 Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time for recorded data point (HH:MM:SS.0)
Latitude (deg)	Latitude (degrees)
Longitude (deg)	Longitude (degrees)
Altitude (ft)	MSL Altitude (feet)
Ground Speed (kts)	Average derived ground speed (knots)
Course (deg)	Magnetic Heading (degrees)
Pitch (deg)	Pitch Angle (degrees)
Bank (deg)	Bank Angle (degrees)

2.2. 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 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 whenever 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. 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. 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.

2.2.1. Garmin GPSMAP 496 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination did not reveal obvious damage, as shown in Figure 2. The device powered on normally, however, the display was not functional. A functioning surrogate display was used, and data were extracted normally using laboratory tools.



Figure 2. Garmin GPSMAP 496 as received.

2.2.2. Garmin GPSMAP 496 Data Description

The data extracted included 58 sessions from June 16, 2020, through December 16, 2020. The accident flight was the last session, recorded starting at 10:16:38 UTC and ending at 10:39:25 UTC on December 16, 2020.

2.2.3. Garmin GPSMAP 496 Parameters Provided

Table 2 describes data parameters recorded and derived by the device. Date, Time, Latitude, Longitude, and GPS Altitude are recorded by the device. Groundspeed and Track are derived from the recorded parameters.

Table 2: GPS Data Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (UTC) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
GPS Alt	Recorded GPS Altitude (feet)
Groundspeed	Average derived groundspeed (knots)
Track	Average derived true course (degrees)

2.3. Apple iPhone 11 Pro Description

Personal Electronic Devices (PEDs) are a category of devices comprised primarily of portable computing devices and mobile phones. Portable computing devices are typically capable of internet access, email, messaging services, and can run user-installed applications to perform specific tasks. PED user and system data is typically stored on non-volatile memory and can be accessed through manufacturer-provided interfaces.

2.3.1. Apple iPhone 11 Pro Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage, as shown in Figure 3. The device powered on

normally and was protected by a 4-digit passcode. Passcodes to unlock the device were unable to be obtained by the investigation team, thus no data were recovered.



Figure 3. Apple iPhone 11 Pro as received.

3. PLOTS AND CORRESPONDING TABULAR DATA

Figure 4 is a Google Earth overlay of the entire accident flight recorded on the Garmin GPSMAP 496. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording. GPS data from the Garmin and Stratus aligned with each other when data were compared. The Stratus track log is not included in the Google Earth plot due to redundancy and the recording starting during flight.

Figure 5 is a Google Earth overlay of the end of the accident flight recorded on the Garmin GPSMAP 496.

Figure 6 is a plot of parameters recorded on the Appareo Stratus 3. The time interval plotted is 10:24:00 to 10:40:00 UTC. Gyroscopic parameters such as pitch and bank angle are offset due to recording starting during flight, however, the amount of offset was unable to be determined. The parameters are included for trending purposes.

Tabular Data used to generate Figures 4 through 6 are included in electronic comma-separated variable (.csv) format as Attachment 1 (Garmin) and Attachment 2 (Appareo) to this report.

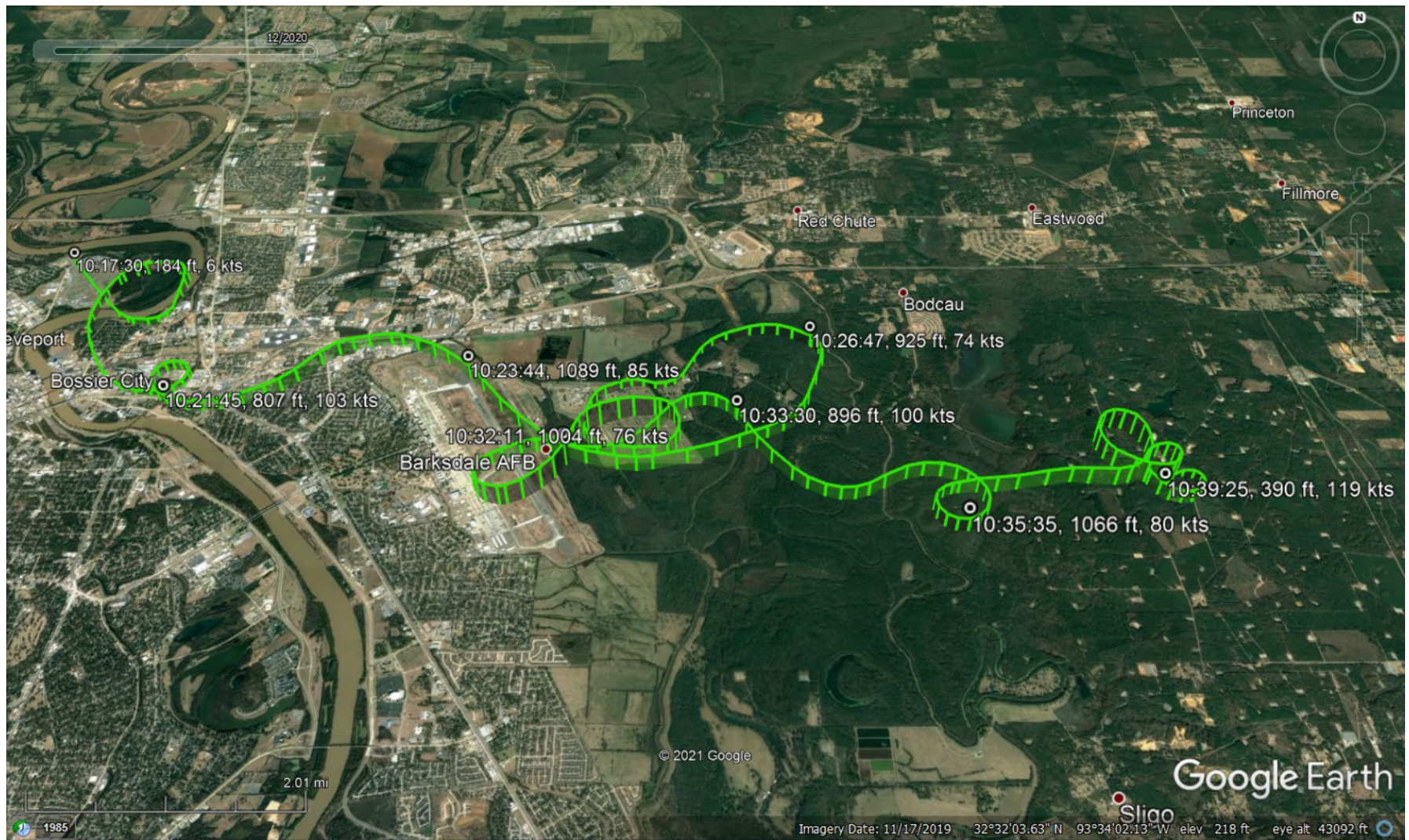


Figure 4. Google Earth overlay of the entire accident flight recorded on the Garmin.

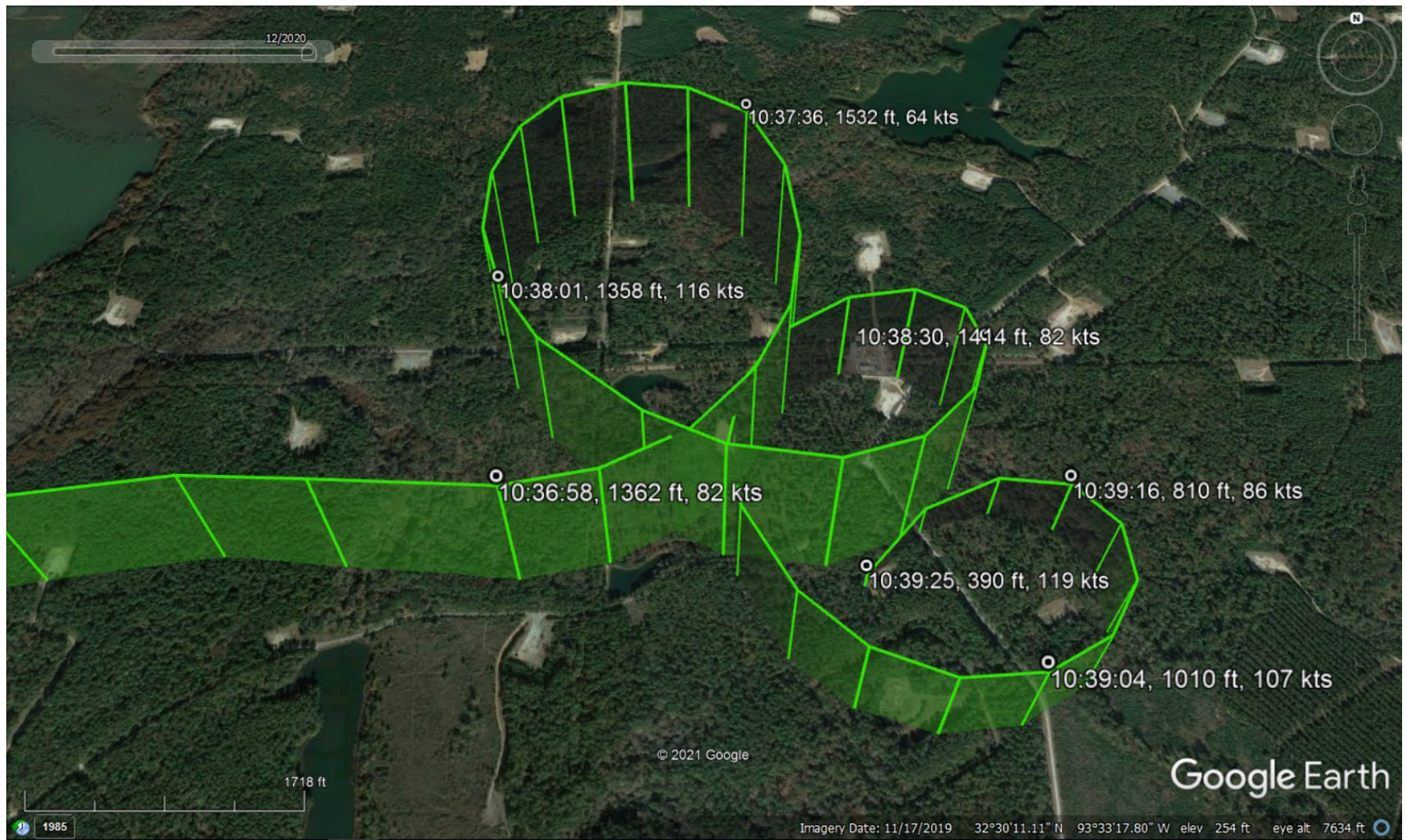


Figure 5. Google Earth overlay of the end of the accident flight recorded on the Garmin.

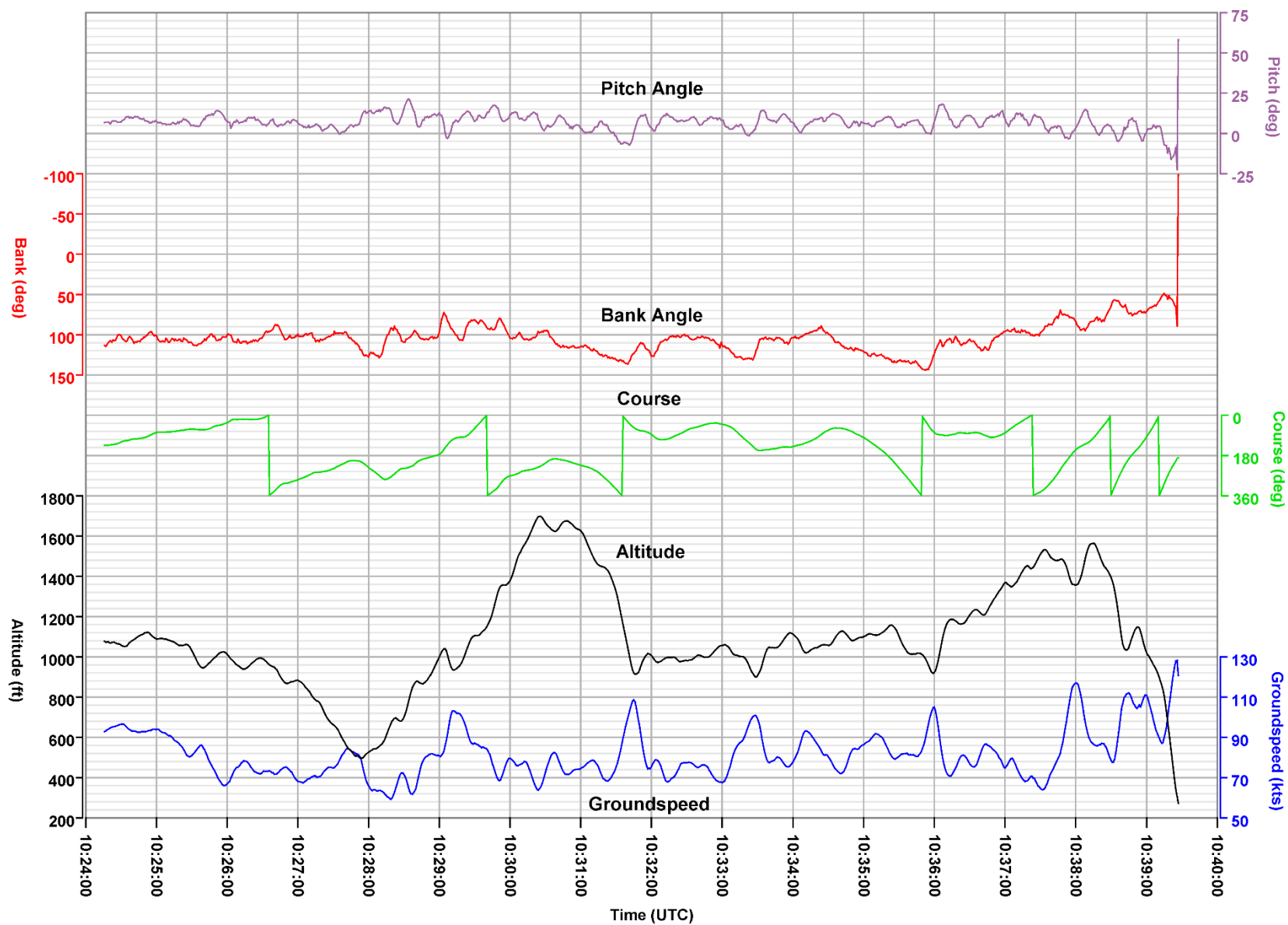


Figure 6. Plot of Stratus parameters for the accident flight.