

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

August 15, 2019

Electronic Devices

Specialist's Factual Report By Gerald Kawamoto

1. EVENT SUMMARY

Location: Lincolnton, North Carolina
Date: July 24, 2018
Aircraft: Piper PA-32R-300
Registration: N38523
Operator: Private
NTSB Number: ERA18FA197

On July 24, 2018, about 0520 eastern daylight time, a Piper PA-32R-300, N38523, was substantially damaged when it impacted terrain shortly after takeoff from Lincolnton-Lincoln County Regional Airport (IPJ), Lincolnton, North Carolina. The private pilot and passenger were fatally injured. No flight plan was filed for the personal flight that was conducted under the provisions of Title 14 *Code of Federal Regulations* Part 91. Instrument meteorological conditions prevailed at the time of the accident. No flight was filed for the flight destined for Oshkosh, Wisconsin.

2. GROUP

A group was not convened.

3. DETAILS OF INVESTIGATION

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

Recorder Manufacturer/Model: **Appareo Stratus 2S**
Recorder Serial Number: **000511**

Recorder Manufacturer/Model: **JPI EDM-700**
Recorder Serial Number: **12757**

Recorder Manufacturer/Model: **JPI FS-450**
Recorder Serial Number: **2201**

3.1. Appareo Stratus 2S Description

The Appareo Status 2S device is a self-contained battery powered unit that contains an internal AHRS,¹ GPS/WAAS receiver,² and ADS-B³ receiver in one compact unit. 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. Internal memory has the space to store over 13 hours of flight data that is sampled at approximately 5 data records per second (5 Hz).

3.1.1. Appareo Stratus 2S Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination did not reveal any apparent damage, as shown in Figure 1. The unit, however, was unable to power on normally. The internal components and circuit board of the device were examined and corrosion was found on the battery connections. The non-volatile memory⁴ chip was removed, readout, and converted to engineering units using laboratory tools.

Figure 1. Front and back of Appareo Stratus 2 as received.



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).

⁴ Non-volatile memory (NVM) is semiconductor memory that does not require external power for data retention.

3.1.2. Appareo Stratus 2S Data Description

The data extracted included sessions from November 1, 2017⁵ through July 24, 2018. The session determined to be relevant to the accident event was parsed out and started at 09:04:45 UTC and ended at 09:21:20 UTC on July 24, 2018.

Vertical Speed and Acceleration Z were found to be reversed when compared to other data. These data were inversed in the plotted information and tabular data provided in this report. It was unclear whether the device was mounted upside down by the pilot, or if there was a conversion error in the translation of the binary data to engineering units.

3.1.3. Appareo Stratus 2S Parameters Provided

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

Table 1: Appareo Stratus 2S 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 Altitude	Recorded GPS Altitude (feet)
Ground Speed	Averaged derived ground speed (knots)
Ground Track	Averaged derived true course (degrees)
Vertical Speed	Vertical Speed (feet per minute)
Pitch	Pitch (degrees)
Roll	Roll (degrees)
Acceleration X	Acceleration in X-Axis (g)
Acceleration Y	Acceleration in Y-Axis (g)
Acceleration Z	Acceleration in Z-Axis (g)

3.2. JPI EDM-700 Description

The JPI EDM-700 is a panel-mounted gauge that allows the operator to monitor and record up to 24 parameters related to engine operations. Depending on the installation, engine parameters monitored can include: Exhaust Gas Temperature (EGT), Cylinder Head Temperature (CHT), Oil Pressure and Temperature, Manifold Pressure, Outside Air Temperature, Turbine Inlet Temperature, Engine Revolutions Per Minute (RPM), Compressor Discharge Temperature, Fuel Flow, Carburetor Temperature, and Battery Voltage.

The unit can also calculate in real time, percent of maximum horsepower, fuel used, shock cooling rate, and EGT differentials between highest and lowest cylinder temperatures. The calculations are also based on the aircraft installation.

⁵Coordinated Universal Time (UTC).

The unit contains non-volatile memory for data storage of the parameters recorded and calculated. The rate at which the data is stored is selectable by the operator from 2 to 500 seconds per sample. The memory can store up to 20 hours of data at a 6 second-per-sample rate. The data can then be downloaded by the operator using the J.P. Instruments software.

3.2.1. JPI EDM-700 Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination showed minor damage to the unit, as shown in Figure 2. The device was unable to power on normally and the non-volatile memory chips were removed. Binary images of the chips were created and converted to engineering units using laboratory tools.

Figure 2. JPI EDM-700 as received.



3.2.2. JPI EDM-700 Data Description

The data extracted included 23 sessions from July 25, 2017 through July 24, 2018. The recorded time is based on the unit's internal clock, which is set and updated by the user. The device begins recording data when power is applied and stops when power is disconnected. Due to the condition of the device, the user set time was unable to be verified and is referred to as JPI Time in this report. The last recorded session started at 10:49:10 JPI time and ended at 11:27:04 JPI time on July 24, 2018 and is included in this report. The data was recorded at a 6 second-per-sample rate.

3.2.3. JPI EDM-700 Parameters Provided

Table 2 describes data parameters recorded by the device.

Table 2: JPI EDM-700 Data Parameters

Parameter Name	Parameter Description
JPI Time	JPI Calculated Time for recorded data point (HH:MM:SS)
EGT 1-6 (degF)	Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)
CHT 1-6 (degF)	Cylinder Head Temperature Cylinder # (degrees Fahrenheit)
CLD (degF/min)	Shock Cooling Rate (degrees Fahrenheit per minute)
OilT (degF)	Oil Temperature (degrees Fahrenheit)
OAT (degC)	Outside Air Temperature (degrees Celsius)
Voltage (V)	Battery Voltage (Volts)

3.3. JPI FS-450 Description

The JPI FS-450 is a panel mounted gauge capable of displaying fuel information to the operator. The fuel status is dependent on the user to properly program the amount of fuel onboard the aircraft prior to each flight. The device stores the last remaining record of fuel used and fuel remaining in gallons.

3.3.1. JPI FS-450 Data Description

The device powered on normally and the display indicated 65.6 gallons used and 92.3 gallons remaining, as shown in Figure 3.

Figure 3. 65.6 gallons used (left image) and 92.3 gallons remaining (right image).



3.4. Plots and Corresponding Tabular Data

Figure 4 is a graphical overlay generated using Google Earth showing the entire accident flight. Data from the Appareo Stratus 2S was used to create the flight track. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

The device started recording data at 09:04:45 UTC. The flight took off from Lincoln-Lincoln County Regional Airport (IPJ) around 09:19 UTC and the last recorded parameter was at 09:21:20 UTC.

Figure 5 is a plot of parameters from the Appareo Stratus 2S for the entire accident flight. The time interval is 09:04:00 to 09:22:00 UTC.

Figure 6 is a plot of parameters from the Appareo Stratus 2S showing the final two minutes of the accident flight. The time interval is 09:19:30 to 09:21:30 UTC.

Figure 7 is a plot of parameters from the JPI EDM-700 for last session recorded on the device. The time interval is 10:49:00 to 11:29:00 JPI Time on July 24, 2018.

The corresponding tabular data used to create Figures 4 through 6 are provided in electronic comma separated value (.CSV) format as Attachment 1 to this report. The corresponding tabular data used to create Figure 7 is provided in electronic .CSV format as Attachment 2.

Figure 4. Google Earth overlay showing the entire accident flight.

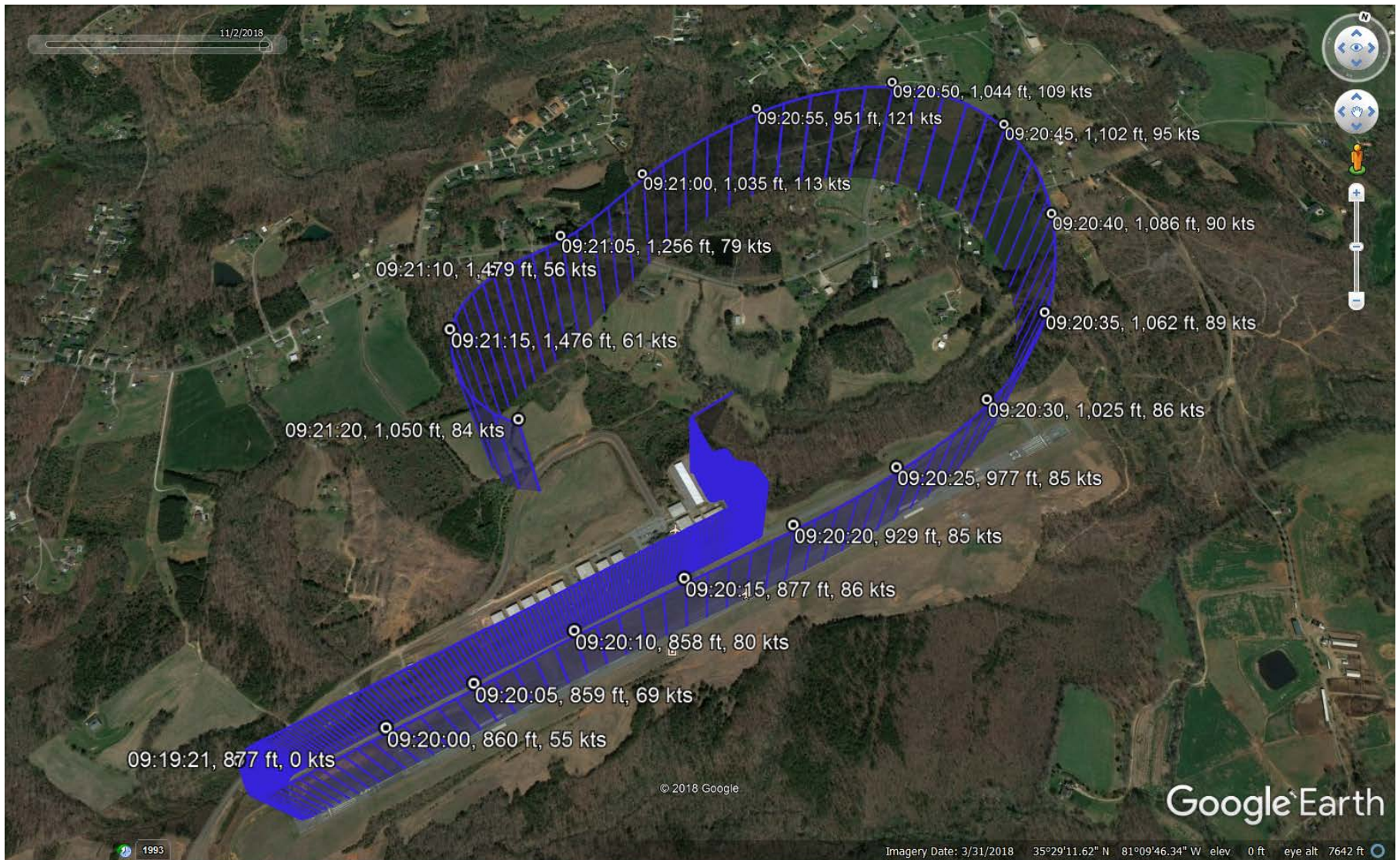


Figure 5. Plot of parameters from the Appareo Stratus 2S for the entire accident flight.

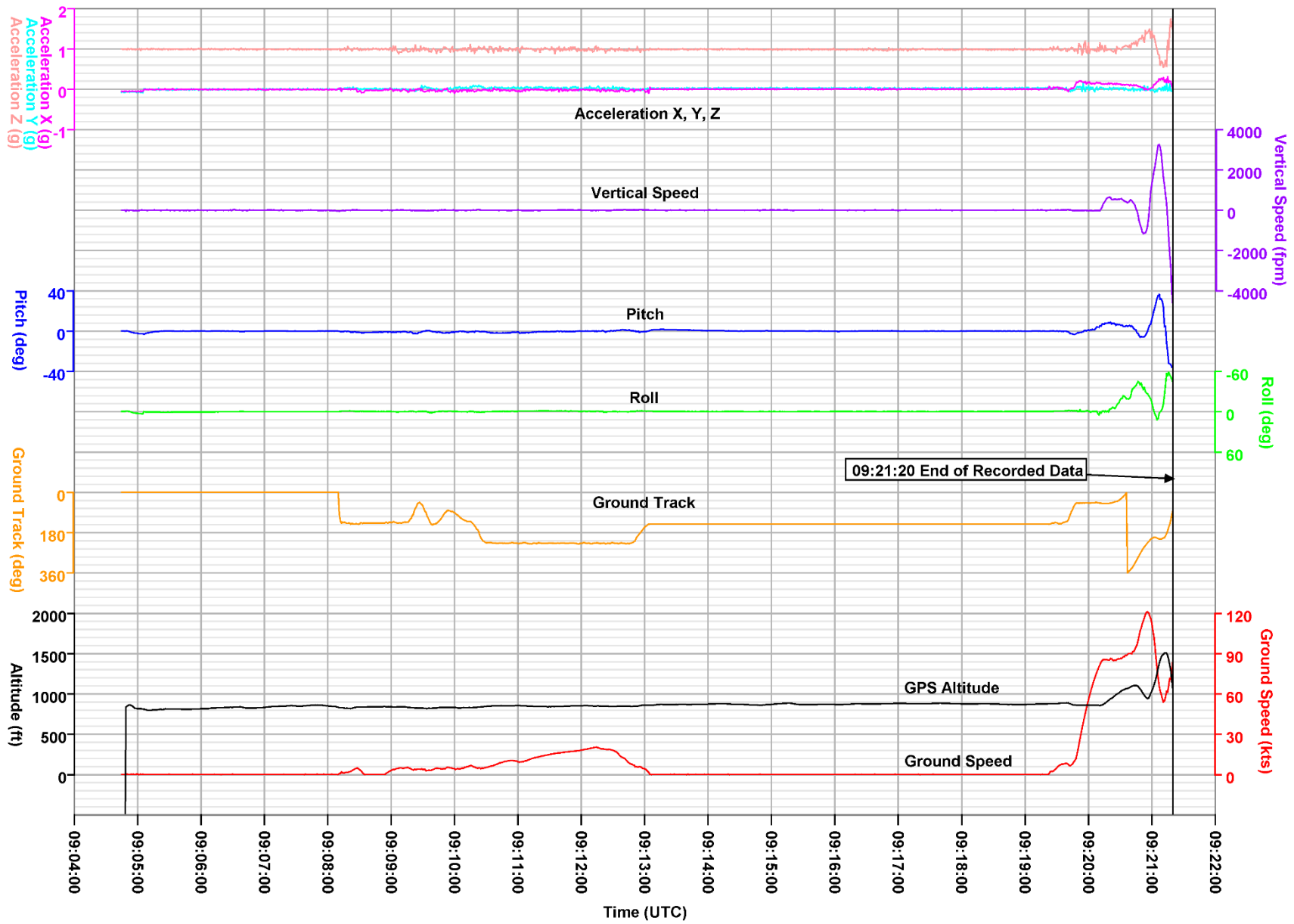


Figure 6. Plot of parameters from the Appareo Stratus 2S at the end of the accident flight.

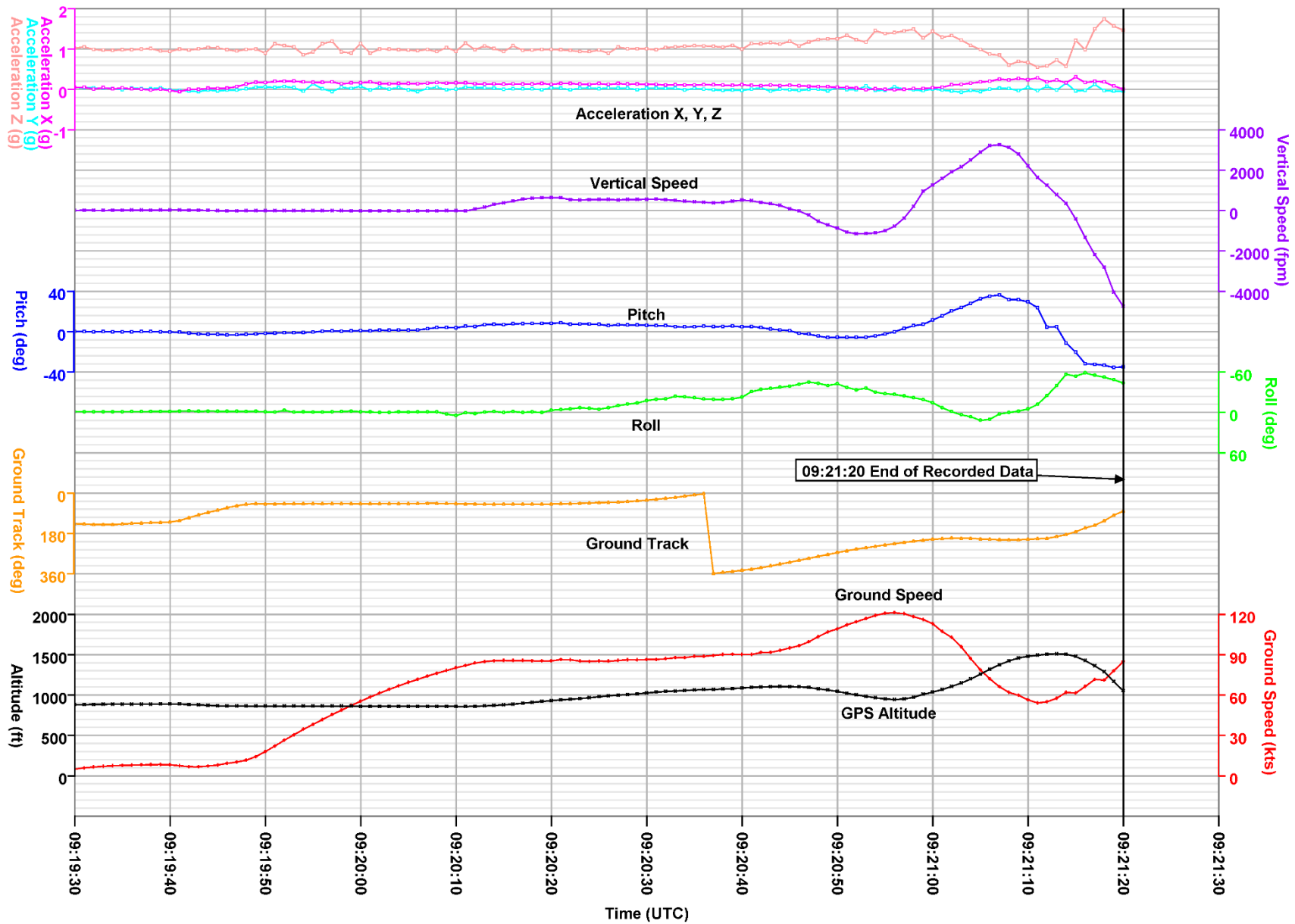


Figure 7. Plot of parameters from the last session recorded on the JPI EDM-700 on July 24, 2018.

