

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

March 9, 2022

Electronic Devices

Specialist's Factual Report by Gerald Kawamoto

1. EVENT

Location: Page, Arizona
Date: September 22, 2021
Aircraft: Piper PA-28R-200
Registration: N3906X
Operator: Private
NTSB Number: WPR21FA352

2. DETAILS OF INVESTIGATION

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

Device 1:	Appareo Stratus 3
Device 1 Serial Number:	020291
Device 2:	Apple iPad Air 2
Device 2 Serial Number:	DMPQ5A9CG5VW

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.⁴

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 is semiconductor memory that does not require external power for data retention.

2.1.1. Appareo Stratus 3 Data Recovery

Upon arrival at the Vehicle Recorder Division, an external examination revealed the device was in good condition, as shown in Figure 1. 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 14 sessions from May 12, 2021, through September 22, 2021.⁵ The last session recorded was determined to be the event flight and is included in this report. 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.

2.2. Apple iPad Air 2 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.

2.2.1. Apple iPad Air 2 Data Recovery

Upon arrival at the Vehicle Recorder Division, an external examination revealed the device had sustained impact damage, as shown in Figure 2, rendering the device

⁵ All dates and times are referenced to Coordinated Universal Time (UTC).

inoperable. The logic board was removed and was powered on using a functioning laboratory surrogate.



Figure 2. Damaged iPad Air 2 as received.

2.2.2. Apple iPad Air 2 Data Description

The content of the device was reviewed, and it was determined that there were no relevant event data stored in the non-volatile memory, thus, no data from this device are included in this report.

3. PLOTS AND TABULAR DATA

The following six figures contain data recorded during the September 22, 2021, event.

Figure 3 is a Google Earth overlay of the entire event flight tracklog recording. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

Figure 4 is a Google Earth overlay showing approximately the last 30 seconds of the event flight tracklog. The wreckage location is depicted with a yellow pin.

Figure 5 is a Google Earth overlay showing approximately the last 10 seconds of the event flight tracklog and the reported wreckage location. Based on the GPS location data, it appears that 23:24:32 UTC is the last valid timestamp representative of the aircraft's movements. The device continued to record data until 23:26:23 UTC (approximately 1 minute and 51 seconds of additional data).

Figure 6 is a plot of parameters recorded by the Appareo Stratus 3 for the entire event flight. The time interval displayed is 19:00:00 to 23:30:00 UTC.

Figure 7 is a plot of parameters recorded by the Appareo Stratus 3 for last three minutes of recorded data. 23:24:32 UTC is the last apparent valid data point representing the motion of the aircraft. The time interval displayed is 23:23:30 to 23:26:30 UTC.

Figure 8 is a plot of parameters recorded by the Appareo Stratus 3 for final minute of valid flight data. The time interval displayed is 23:23:30 to 23:24:34 UTC.

The corresponding tabular data used to create these three plots are provided in electronic (*.csv) format as Attachment 1 to this report.⁶

⁶ Comma Separated Value format.



Figure 3. Google Earth overlay of the entire event flight recorded on the Appareo Stratus 3.



Figure 4. Google Earth overlay of the end of the event flight recorded on the Appareo Stratus 3.

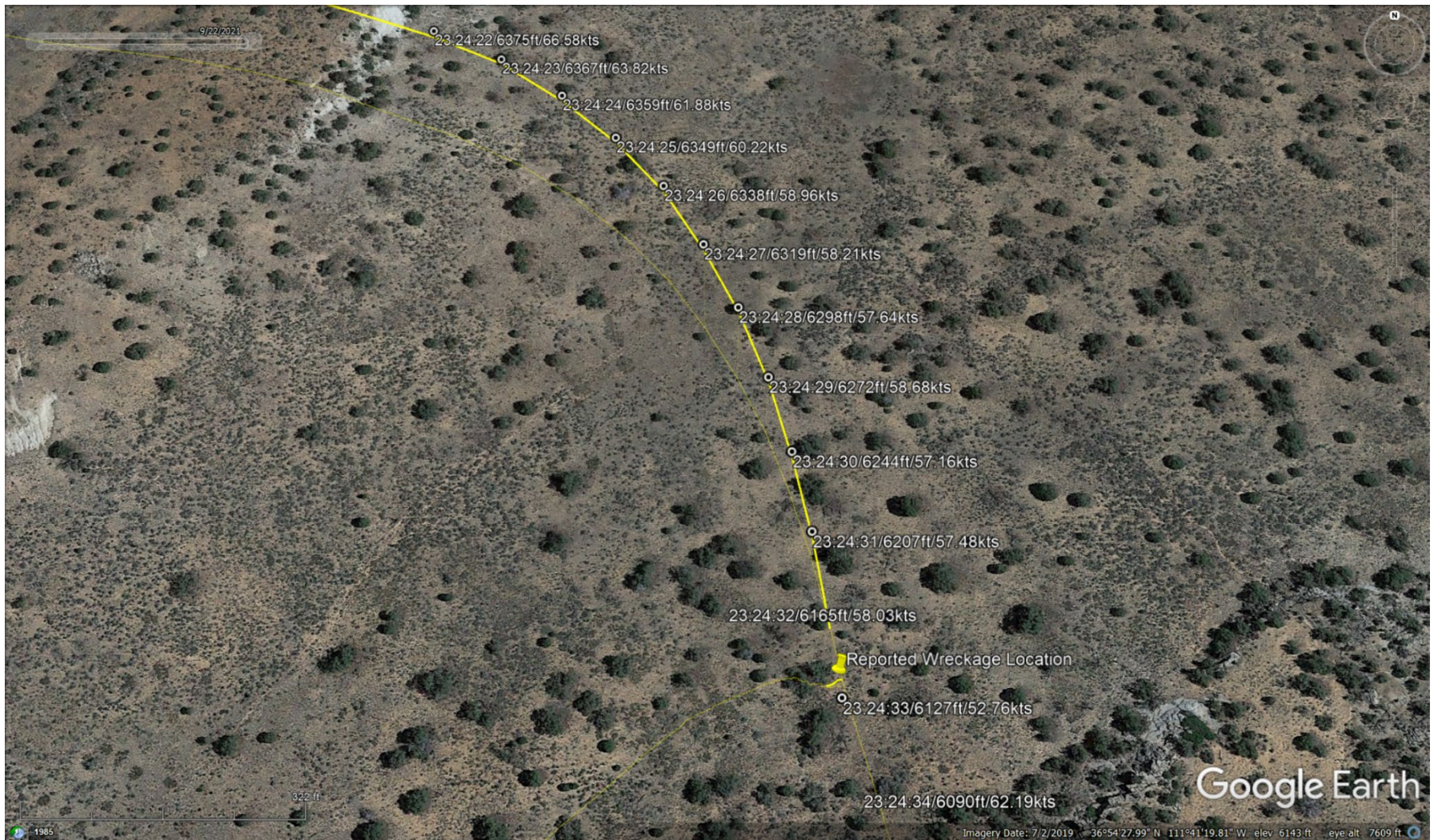


Figure 5. Google Earth overlay of the end of the event flight recorded on the Appareo Stratus 3 and the reported wreckage location.

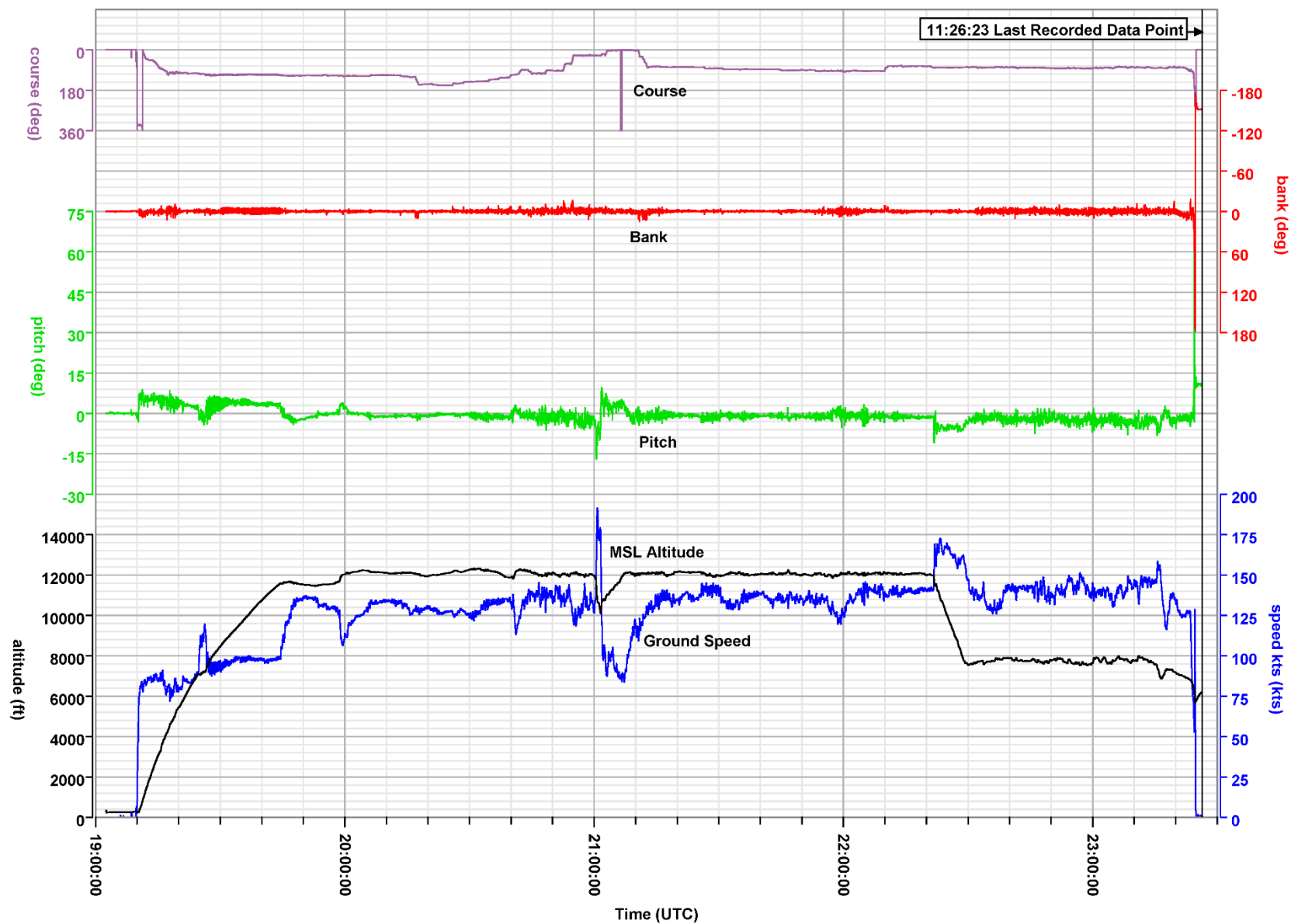


Figure 6. Plot of parameters recorded on the Appareo Stratus 3 for the entire event flight.

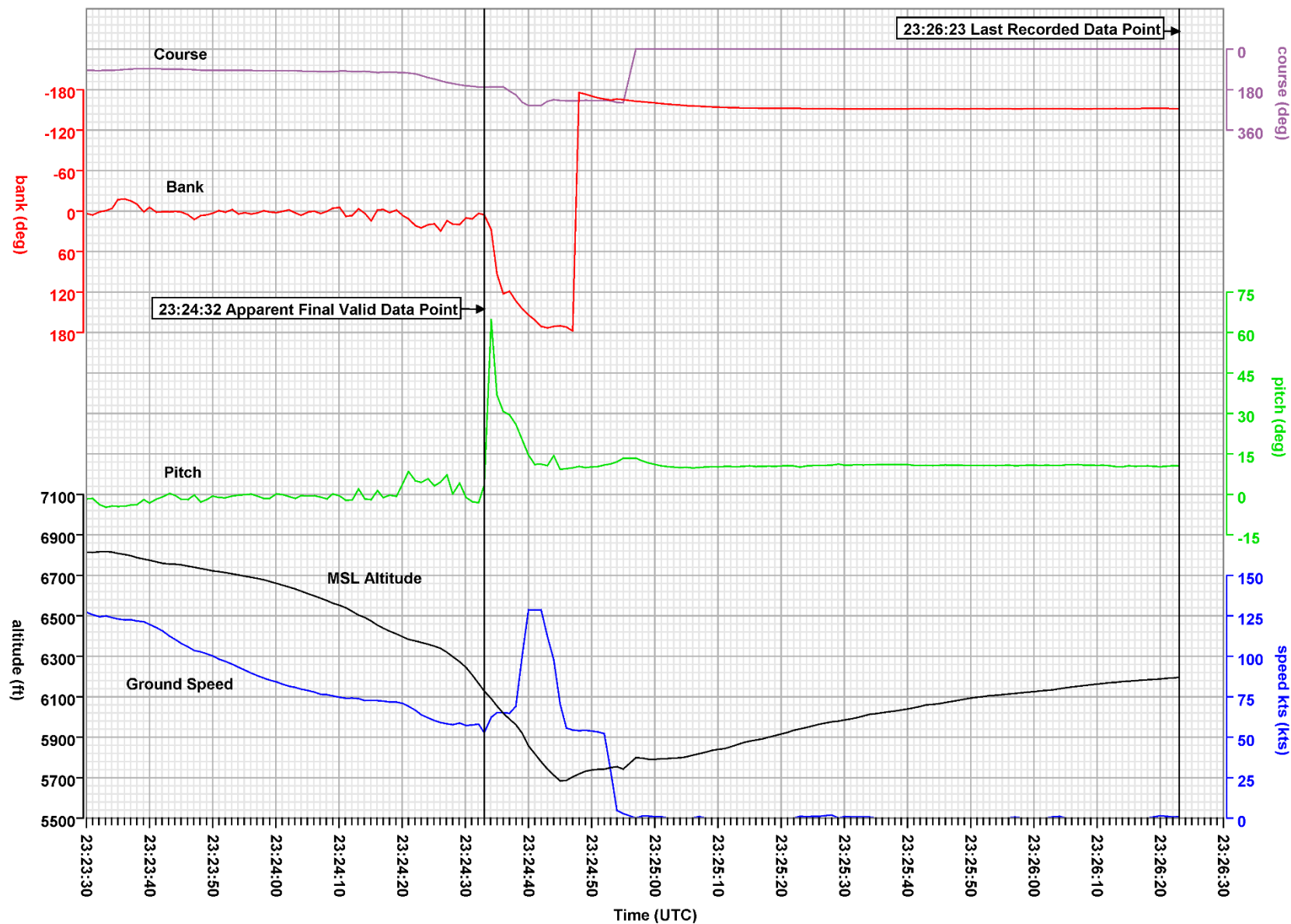


Figure 7. Plot of parameters recorded on the Appareo Stratus 3 for the last 3 minutes of recorded data.

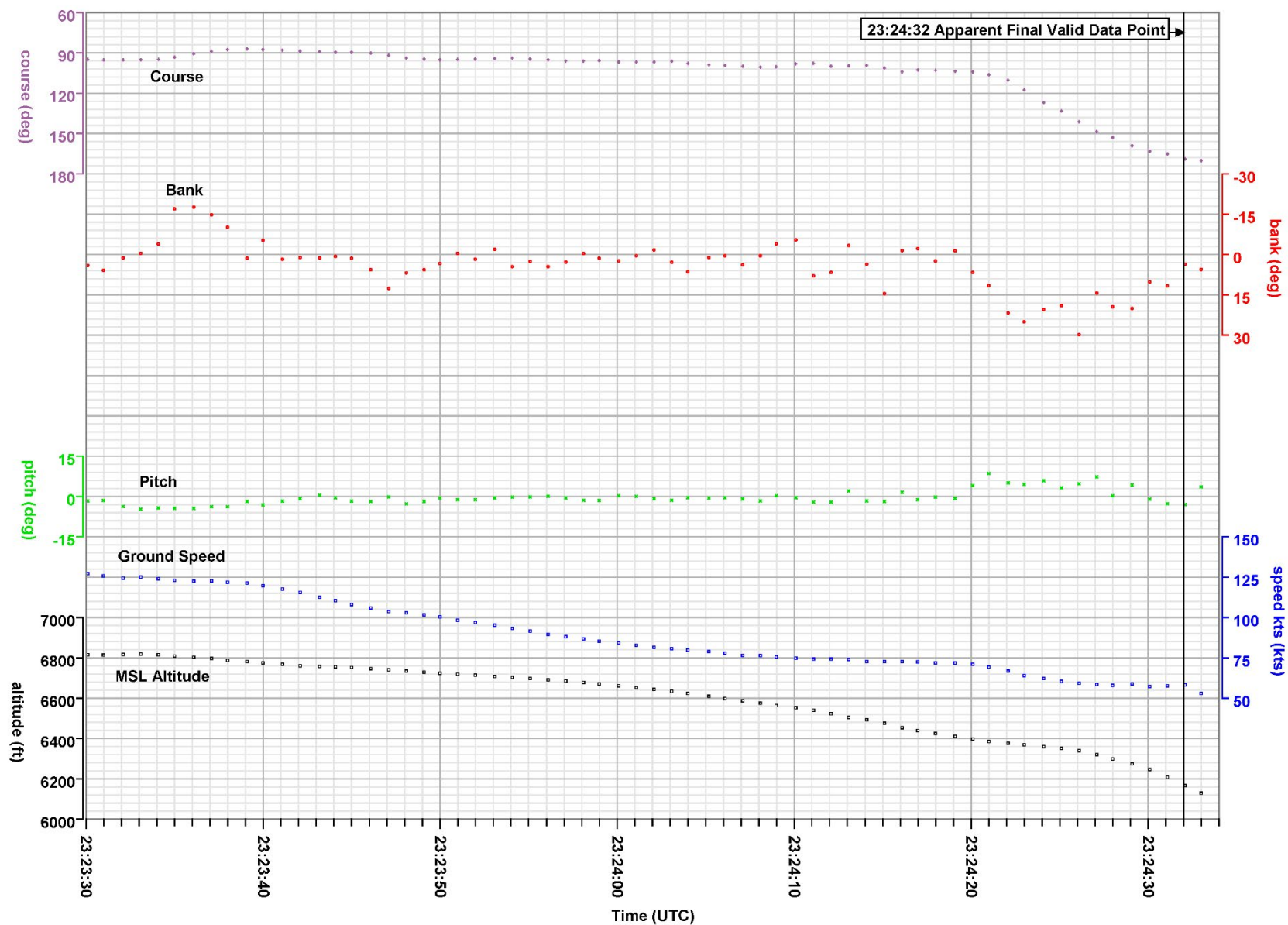


Figure 8. Plot of parameters recorded on the Appareo Stratus 3 showing the last minute of valid flight data.