

# National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR23FA256

## **MULTIPLE ELECTRONIC DEVICES**

Specialist's Factual Report

January 3, 2024

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## **A. ACCIDENT SUMMARY**

Location: St. Maries, Idaho  
Date: July 6, 2023  
Time: 0917 Pacific daylight time (PDT)  
1617 coordinate universal time (UTC)  
Aircraft: Cessna 182N, N703Z

## **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: | Shadin Miniflo-L Fuel Flow Indicator |
| Serial Number:      | 9340                                 |
| Manufacturer/Model: | Appareo Stratus 3i                   |
| Serial Number:      | 005530                               |
| Manufacturer/Model: | Electronics International MUX-8A     |
| Serial Number:      | Unknown                              |
| Manufacturer/Model: | Electronics International UBG-16     |
| Serial Number:      | C74361                               |

### **1.0 Shadin Miniflo-L Fuel Flow Indicator Description**

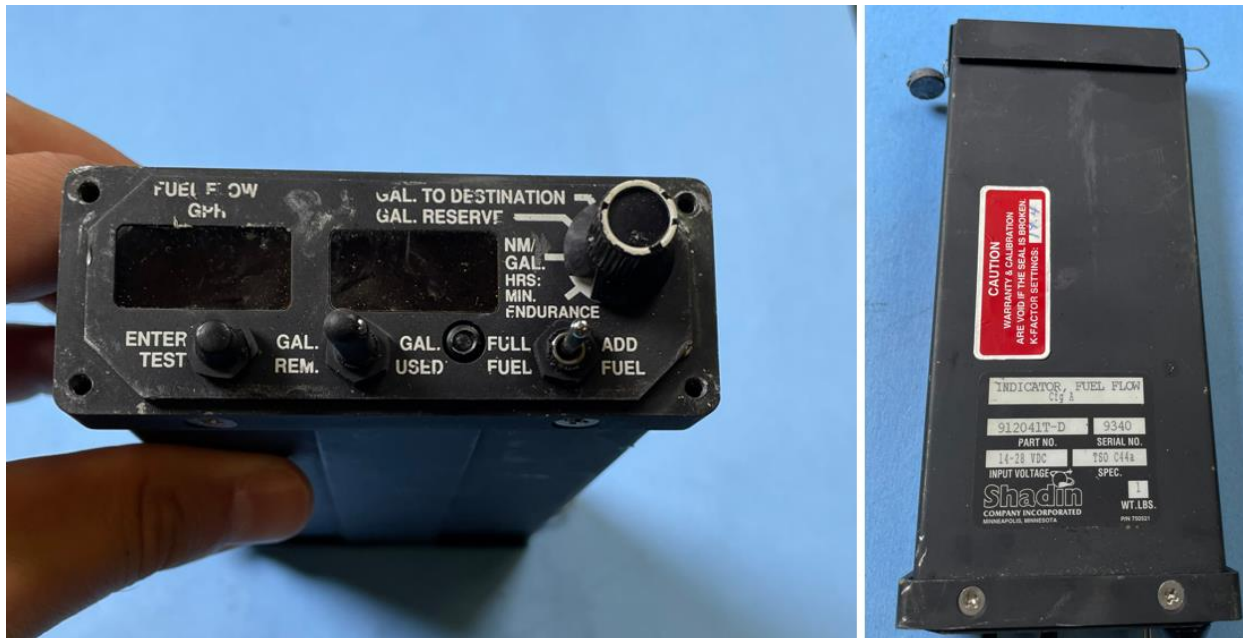
Shadin Miniflo-L is a digital fuel management system designed to provide complete fuel management information under real flight conditions after entry of the initial fuel on board. It is connected to the engine fuel flow transducer for fuel flow information and to the GPS receiver serial port for navigation data (ground speed, distance, and estimated time enroute). The system includes a non-volatile memory<sup>1</sup> that retains fuel remaining and fuel used information when the power to the unit is cut off. This system is also capable of transmitting the fuel information to navigation receivers for additional calculations and can also display fuel management data.

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<sup>1</sup> Non-volatile memory (NVM) is semiconductor memory that does not require external power for data retention.

## 1.1 Shadin Miniflo-L Fuel Flow Indicator Condition and Data Recovery

Upon arrival at the Vehicle Recorder Division, an exterior examination revealed the unit had not sustained major damage, as shown in Figure 1. The unit powered on normally, and the retained data of the fuel-used and fuel-remaining were retrieved based on the manufacturer's operating manual. Figure 2 shows the device displaying that the recorded fuel used to be 0.7 gallons and that the recorded fuel remaining to be 77.2 gallons.



**Figure 1.** Front and top views of the Shadin Miniflo-L as received.



**Figure 2.** Recorded fuel used data on the left, and fuel remaining data on the right.

## 2.0 Appareo Stratus 3i Description

The Appareo Stratus 3i is a self-contained battery-powered unit that contains an internal AHRS<sup>2</sup>, GPS/WAAS receiver<sup>3</sup>, and ADS-B<sup>4</sup> receiver in one compact unit. The unit communicates wirelessly with compatible devices (iPad, iPhone, etc.) 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 memory chip.

### 2.1 Appareo Stratus 3i Condition and Data Recovery

**Error! Reference source not found.** shows the Appareo Stratus 3i as received. The device made rattling sounds. When opened, it was found that the WiFi module was dislodged from its circuit board, as shown in Figure 4. Soldering the WiFi module back to its circuit board was attempted, but the device did not power on normally. A chip level recovery was performed, in which the memory chip was removed, read out, and converted into engineering unit data using laboratory tools.



**Figure 3.** Front and back views of the Appareo Stratus 3i as received.

<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> 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).



**Figure 4.** The WiFi module was dislodged from its circuit board as a result of the crash.

## 2.2 Appareo Stratus 3i Recording Description

The data recovered from the Appareo Stratus 3i included numerous sessions. The last session recorded on July 6, 2023, was identified to be associated with the accident. The duration of the recording was 3 minutes and 9 seconds, from 16:14:32 UTC to 16:17:41 UTC. The sampling rate was 5 Hz.

### 2.2.1 Appareo Stratus 3i Parameters Provided

Table 1 lists the Appareo Stratus 3i parameters verified and provided in this report.

**Table 1.** Appareo Stratus 3i data parameters provided.

| Parameter Name (unit)      | Parameter Description (unit)                                        |
|----------------------------|---------------------------------------------------------------------|
| Altitude HMSL (ft)         | Altitude above Mean Sea Level (feet)                                |
| Bframe Acceleration X (gs) | Device body frame acceleration in X-axis (gs)                       |
| Bframe Acceleration Y (gs) | Device body frame acceleration in Y-axis (gs)                       |
| Bframe Acceleration Z (gs) | Device body frame acceleration in Z-axis (gs)                       |
| Bframe Rotation X (deg/s)  | Device body frame rotational speed in X-axis (degrees per second)   |
| Bframe Rotation Y (deg/s)  | Device body frame rotational speed in Y-axis (degrees per second)   |
| Bframe Rotation Z (deg/s)  | Device body frame rotational speed in Z-axis (degrees per second)   |
| Ground Speed (kts)         | Average groundspeed between current and previous data point (knots) |
| Ground Track (deg)         | Path on the surface of the Earth directly below aircraft (degrees)  |

| Parameter Name (unit)   | Parameter Description (unit)               |
|-------------------------|--------------------------------------------|
| Heading (deg)           | Direction relative to true north (degrees) |
| Latitude (deg)          | Geographic latitude (degrees)              |
| Longitude (deg)         | Geographic longitude (degrees)             |
| Pitch (deg)             | Pitch angle (degrees)                      |
| Roll (deg)              | Roll angle (degrees)                       |
| Vertical Speed (ft/min) | Vertical speed (feet per minute)           |

## 2.3 Appareo Stratus 3i Time Correlation

The Appareo Stratus 3i data was recorded in GPS time (GPS week and ITOW<sup>5</sup>), which was converted to UTC, and then was converted to PDT, the local time of the event. PDT is 7 hours behind UTC.

## 3.0 Electronics International MUX-8A device Description

The MUX-8A is a data recorder designed to receive and record data from transducers produced by Electronics International, such as the UBG-16 engine bar-graph display. The MUX-8A is also capable of recording data from third-party instruments such as GPS receivers.

Data is recorded in non-volatile serial FLASH memory. Recorded data for each flight is date and time stamped and subsequently stored in a comma-delimited format. The MUX-8A can be setup to record a new data point for each supported parameter in one-, three-, or six-minutes interval. It can also be set to record in a high data-rate "Burst Mode" (usually every five to six seconds). The unit can retain between 300 and 600 hours of data at 6-minute intervals depending on the number of parameters recorded. Data may be downloaded to a standard PC running Windows using a proprietary program called DRS-1 Download which is produced by the manufacturer.

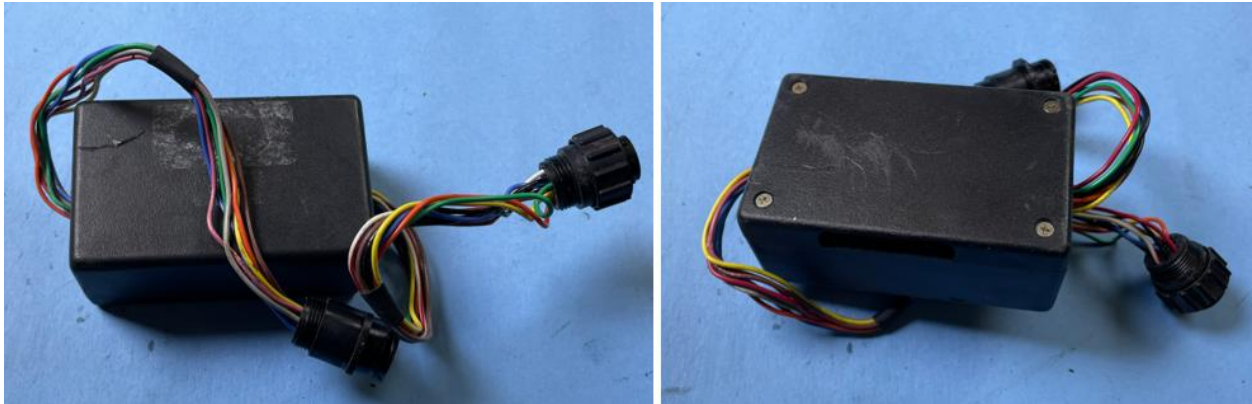
According to the manufacturer, recorded data have these features: (a) each value is recorded as transmitted by the source device, dropping any decimal point; (b) in the case of the UBG-16 source device, the value transmitted is the value displayed on the device; and (c) no record descriptor (i.e. metadata) is recorded on the MUX-8A, as such, the record descriptor must be known from the installation configuration or inferred by reviewing the recorded values.

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<sup>5</sup> Interval time of week - the number of milliseconds from beginning of the week.

### 3.1 Electronics International MUX-8A Condition and Data Recovery

The device had sustained minor impact damage, and the device label was missing from the device, as shown in Figure 5. The recorded data were downloaded using the manufacturer's software.



**Figure 5.** Top and bottom views of the Electronics International MUX-8A as received.

### 3.2 Electronics International MUX-8A Recording Description

The downloaded data were recorded at a rate of six minutes per sample. An unknown malfunction within the device caused the timestamps to be incorrectly recorded. The manufacturer was consulted, and it was determined that the last recorded data line was the only one that might be associated with the accident flight. This data line is shown in the Table 2 below. The parameters listed in Table 2 are exhaust gas temperature (EGT) and cylinder head temperature (CHT) for each of the six cylinders, and the oil temperature. All units were recorded in degrees Fahrenheit.

**Table 2.** The last recorded data line that might be associated with the accident flight.

| EGT 1 | CHT 1 | EGT 2 | CHT 2 | EGT 3 | CHT 3 | EGT 4 | CHT 4 | EGT 5 | CHT 5 | EGT 6 | CHT 6 | Oil T |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1428  | 313   | 1360  | 310   | 1375  | 278   | 1257  | 135   | 1352  | 288   | 1256  | 272   | 124   |

## 4.0 Electronics International UBG-16 Description

The Electronics International UBG-16 is a bar graph engine analyzer. Besides displaying the EGT of each cylinder, the unit incorporates a pilot programmable high and low alarm for each of its 16 channels, which allows pilots to set a high and low alarm for each cylinder in accordance with that cylinder's normal operating temperatures. The unit does not have recording functionality to retain data.

### 4.1 Electronics International UBG-16 Condition and Data Recovery

Figure 6 shows the condition of the Electronics International UBG-16 as received. Since the device does not record data, there was no data recovered from the unit.



**Figure 6.** Front and top views of the Electronics International UGB-16 as received.

## **D. FIGURES AND TABULAR DATA**

Figure 7 and Figure 8 are data parameters plots of the accident flight recording from the Appareo Stratus 3i. 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.

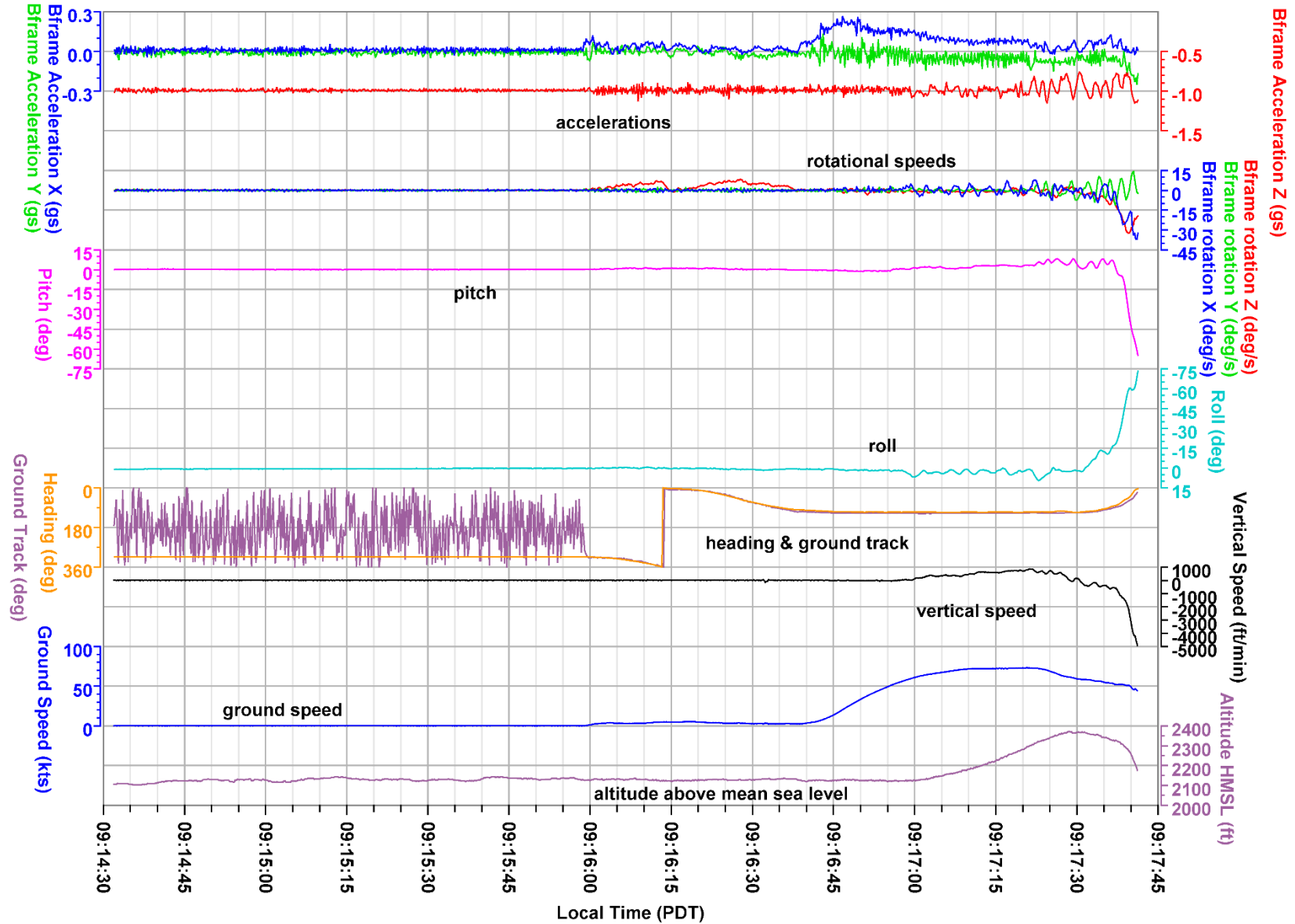
Figure 9 to Figure 11 are Google Earth overlays of the accident flight. Figure 9 shows the entire flight recording, and Figure 10 and Figure 11 show the final portion of the accident flight. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

The recorded data indicated that the accident aircraft took off from the Runway 10 at Jack A Buell Airport (S72), St. Maries, ID, at around 9:16:44 PDT. Shortly after takeoff, the accident aircraft banked left. At 9:17:41.2 PDT, the last recorded data point showed the accident aircraft was near the recorded wreckage location, with an altitude of 2,176 feet above mean seal level (approximately 51 feet above ground level) and with a groundspeed of 44.2 knots.

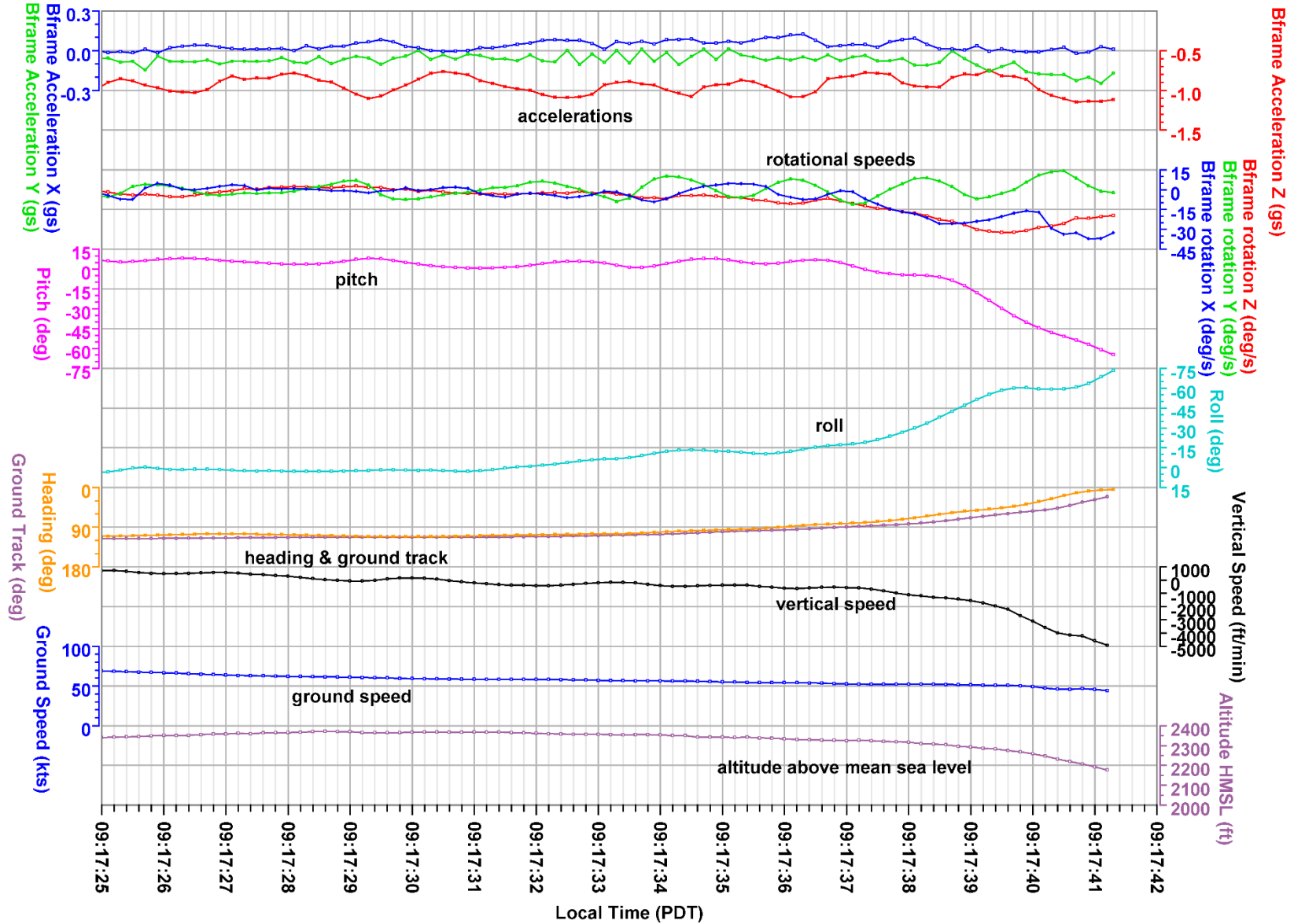
The corresponding tabular data used to create the above figures is provided in electronic comma-separated value (CSV) format as attachments to this report. Attachments 1 and 2 are GPS and AHRS data respectively from the Appareo Stratus 3i data.

Submitted by:

W. Deven Chen  
Electrical Engineer – Recorder Specialist



**Figure 7.** Plot of data parameters of the entire accident flight recording from the Appareo Stratus 3i.



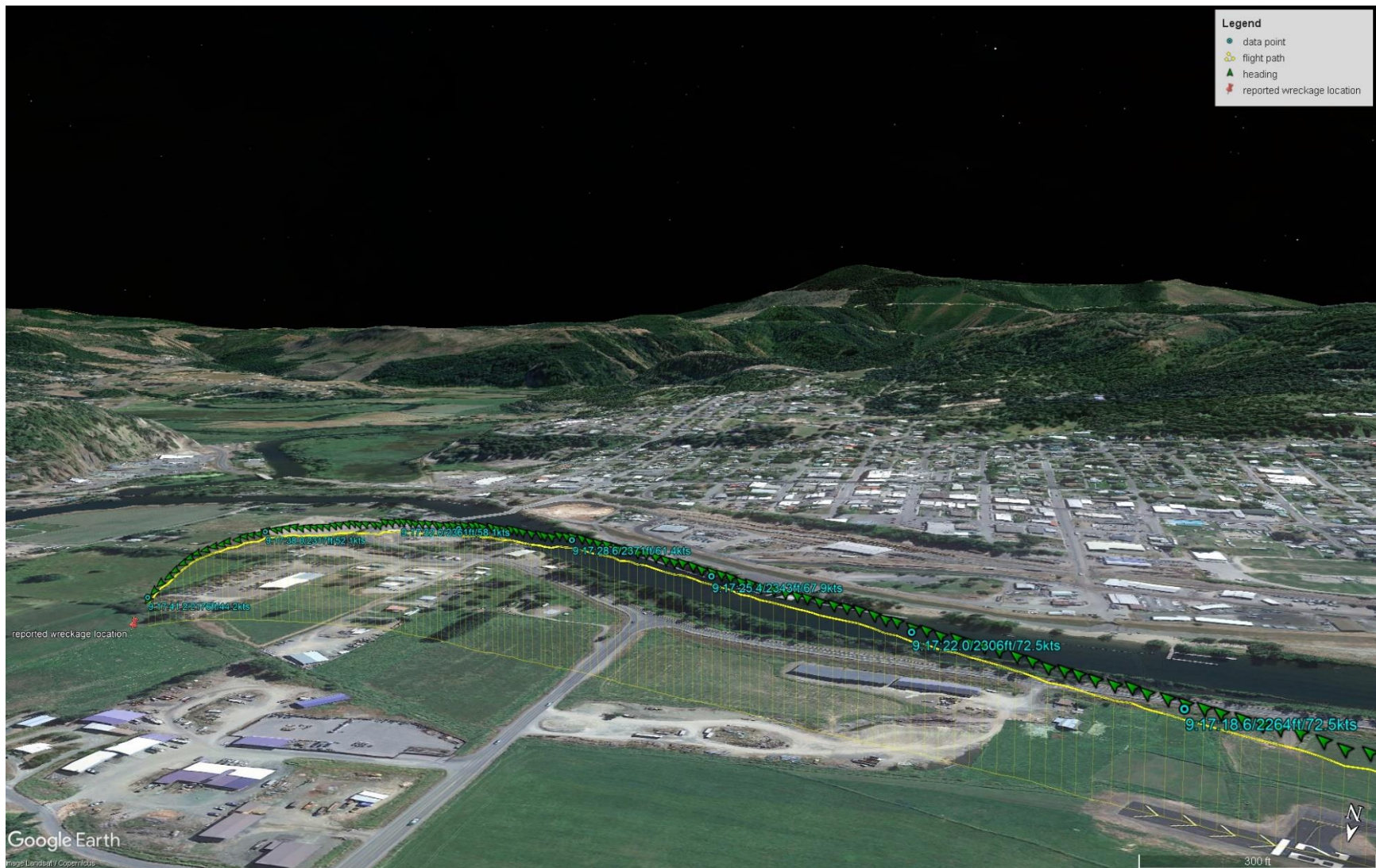
**Figure 8.** Plot of data parameters of the final portion of the accident flight recording.



**Figure 9.** Google Earth overly of the entire accident flight recording on July 6, 2023.



**Figure 10.** Google Earth overfly showing the last portion of the recording.



**Figure 11.** Google Earth overly showing the last portion of the recording at a different angle.