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

May 11, 2015

Electronic Devices

Specialist's Factual Report
by Bill Tuccio, Ph.D.

1. EVENT

Location:	Dunnellon, Florida
Date:	April 5, 2014
Aircraft:	Fortuna Sonex
Registration:	N229P
Operator:	Private
NTSB Number:	ERA14FA464

On April 5, 2014, about 1359 eastern daylight time, a Fortuna Sonex, N229P, collided with trees then the ground about 2.0 nautical miles south-southwest of the Marion County Airport (X35) Dunnellon, Florida. The private pilot, the sole occupant, was fatally injured. The airplane was substantially damaged. The airplane was registered to and operated by a private individual under the provisions of 14 *Code of Federal Regulations* Part 91 as a personal flight. Visual meteorological conditions prevailed at the time and no flight plan was filed. The flight originated about 1357, and was destined for Zephyrhills Municipal Airport (ZPH), Zephyrhills, Florida.

2. GROUP

An electronic devices group did not convene.

3. DETAILS OF DEVICE INVESTIGATION

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

Device 1:	Garmin D2 Watch
Device 1 Serial Number:	Unknown
Device 2:	Grand Rapids Technology EIS 2000
Device 2 Serial Number:	19984
Device 3:	Electronics International R-1 Tachometer
Device 3 Serial Number:	145701
Device 4:	Garmin GPSMAP 396
Device 4 Serial Number:	28283442

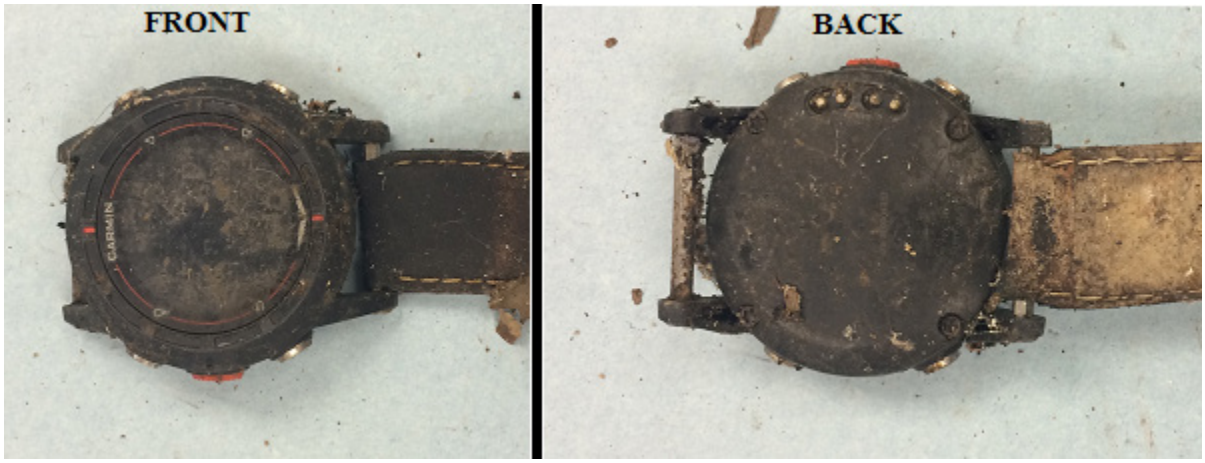
3.1. Garmin D2 Watch Device Description

The Garmin D2 Watch is a wrist-worn WAAS GPS receiver, clock, navigator, altimeter, and compass. The device is capable of interfacing with external devices via Bluetooth wireless protocols. The device contains 20MB of internal non-volatile memory[1] capable of storing custom waypoints, routes, and a track log of up to 10,000 points and 100 saved tracks. Using a proprietary cable and Garmin software, the memory contents may be downloaded.

3.1.1. Garmin D2 Watch Data Recovery

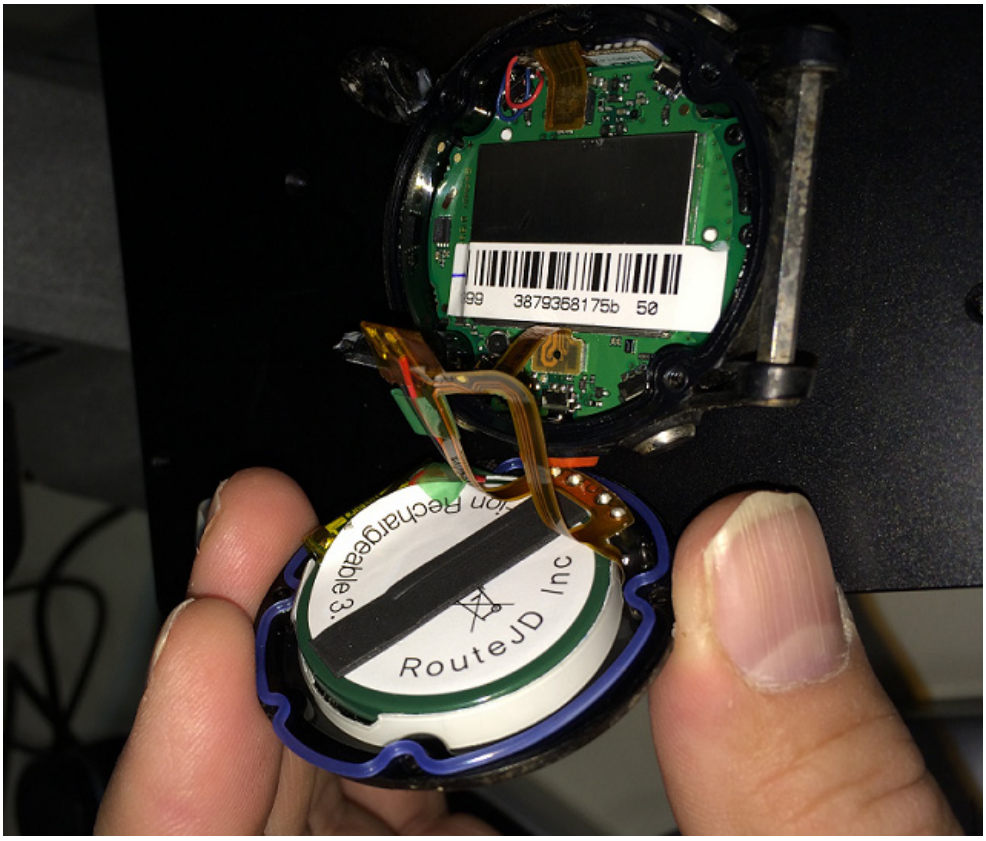
Upon arrival at the NTSB Vehicle Recorder Division, an exterior examination revealed the unit had sustained minor damage and prolonged outdoor exposure, as shown in figure 1. An internal inspection revealed the unit was intact, as shown in figure 2. Using the device's proprietary cable, information was extracted normally using the manufacturer's software.

Figure 1. Garmin D2 watch; front on left, back on right.



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

Figure 2. Garmin D2 watch, internal inspection.



3.1.2. Garmin D2 Watch Data Description

The data extracted included 5 sessions (9 total data points) from April 2, 2014 through April 5, 2014. Due to the limited number of data points, the information was not pertinent to the investigation.

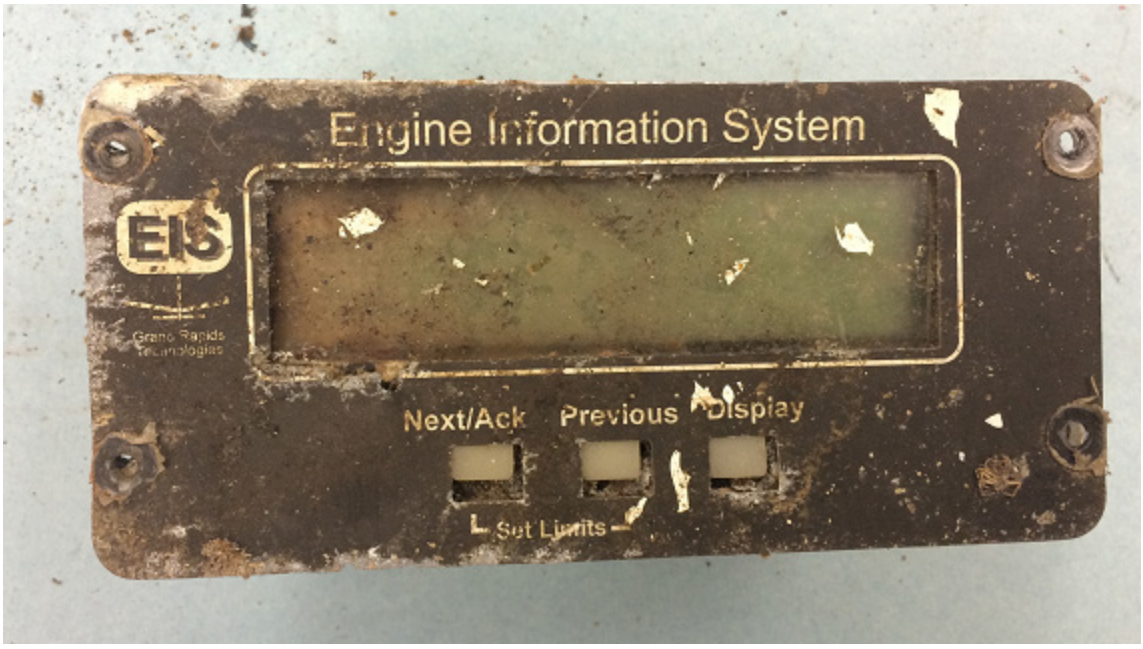
3.2. Grand Rapids Technology EIS-2000 Device Description

The GRT EIS Model 2000 is a panel mounted engine monitor. The device contains a back-lit, sunlight readable display providing the operator graphical and digital displays of various engine parameters. The device also assists the pilot to lean the engine and allows for various alarms when monitored systems exceed various settings. The device does not contain any internal memory for the recording of engine information, other than retention of total engine time.

3.2.1. Grand Rapids Technology EIS-2000 Data Recovery

Upon arrival at the NTSB Vehicle Recorder Division, an exterior examination revealed the unit had sustained minor impact damage and significant damage from outdoor exposure, as shown in figure 3. No effort was made to power the device on.

Figure 3. Grand Rapids Technology EIS-2000.



3.2.2. Grand Rapids Technology EIS-2000 Data Description

No information was retrieved from the device.

3.3. Electronics International R-1 Tachometer Device Description

The Electronics International R-1 Tachometer is a TSO'd[2] digital tachometer. The device is capable of tracking total flight and tachometer time. Additionally, the device records a limited amount of tachometer history to non-volatile memory starting approximately 2 minutes and 43 seconds after power-up and approximately every 2 minutes and 43 seconds thereafter.

3.3.1. Electronics International R-1 Tachometer Data Recovery

Upon arrival at the NTSB Vehicle Recorder Division, an exterior examination revealed the unit had sustained significant impact damage and significant damage from outdoor exposure, as shown in figure 4. The unit was disassembled and the 128-byte, non-volatile memory chip was identified, as shown in figure 5. The chip was removed and read using an EEPROM programmer. The recorded data was decoded with assistance from the manufacturer.

[2] TSO means Technical Standard Order and is a means for the FAA to approve the design of an aircraft part. See 14 CFR Part 21, Subpart and FAA Advisory Circular 20-62E "Eligibility, Quality, and Identification of Aeronautical Replacement Parts."

Figure 4. Electronics International R-1 Tachometer.

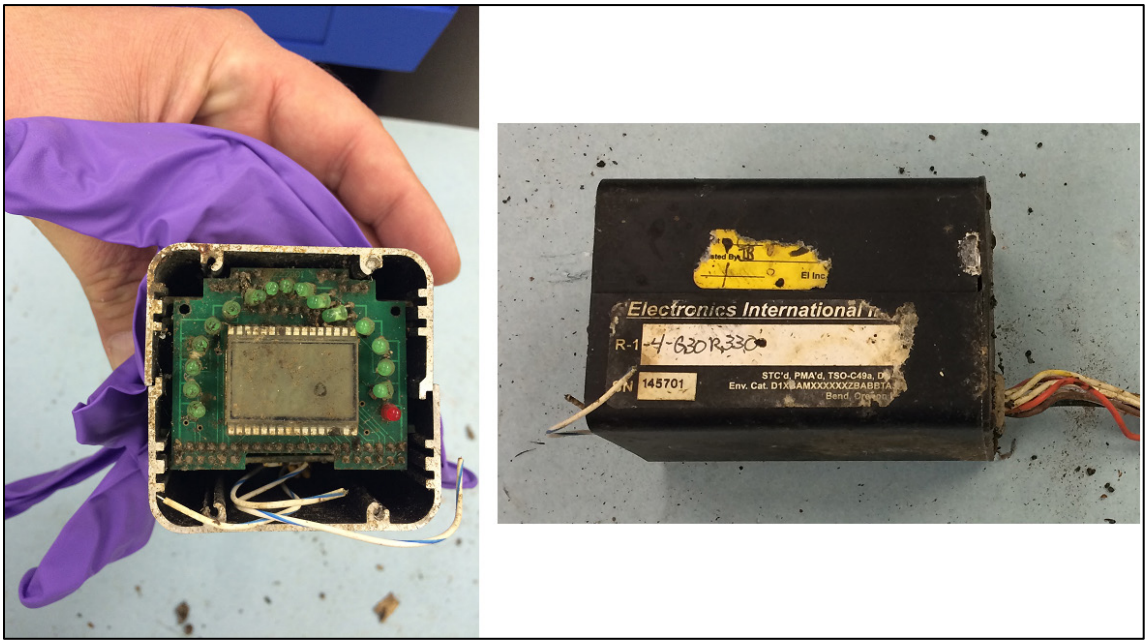
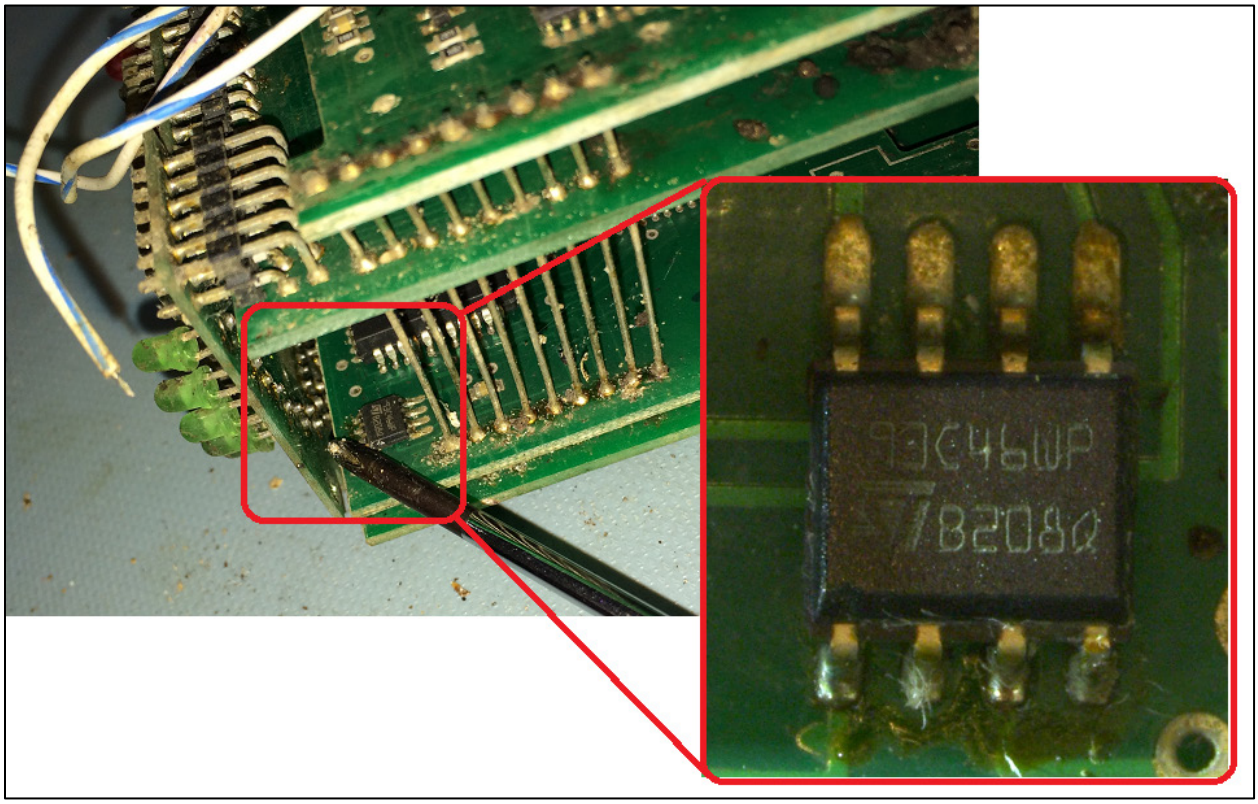


Figure 5. Non-volatile memory chip.



3.3.2. Electronics International R-1 Tachometer Data Description

Two sets of RPM history values were retrieved from the non-volatile memory, as shown in table 1. Since the non-volatile memory contains no time information, the association of RPM set with flights was confirmed in two ways: (1) the known recording order logic of the device and (2) comparison of the accident and prior flight durations to the GPS data in section 3.4 of this report. It was not possible to time correlate the RPM history with the GPS data in section 3.4 because of the large sample rate interval and the unknown time when the GPS was first powered relative to the tachometer.

Table 1. RPM history from Electronics International R-1 tachometer.

Accident Flight		Prior Flight	
Elapsed Time (mm:ss)	**RPM**	**Elapsed Time (mm:ss)**	**RPM**
02:43	1240	02:43	overwrite
05:26	1020	05:26	overwrite
08:09	2760	08:09	overwrite
		10:52	overwrite
		13:35	2950
		16:18	2540
		19:01	2720
		21:44	2720
		24:27	3000
		27:10	3000
		29:53	2920
		32:36	2920
		35:19	2840
		38:02	2650
		40:45	1540
		43:28	1010

Note: “mm:ss” means minutes:seconds; “overwrite” means the data from the accident flight overwrote the first four data samples of the prior flight.

3.4. Garmin GPSMAP 396 Device Description

The Garmin GPSMAP 396 is a battery-powered portable 12-channel GPS receiver. The unit includes a built-in Jeppesen database. 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 500 feet, and ends when groundspeed drops below 30 knots for 10 minutes or more. A detailed tracklog—including latitude, longitude, date, time, and GPS altitude information for an unspecified number of points—is stored within the unit whenever the receiver has a lock on the GPS navigation signal. Position is updated within the tracklog as a function of time or distance moved, depending on how the unit has been configured. Once the current tracklog memory becomes full, new information either overwrites the oldest information or the recording stops, depending on how the unit is configured. The current tracklog can be saved to long-term memory and 15 saved tracklogs can be maintained in addition to the current tracklog. Tracklog 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

tracklog information to a PC via a built-in serial port using the NMEA 0183 version 2.0 protocol. 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 provide back-up power to the internal memory and real-time clock when main power is removed.

3.4.1. Garmin GPSMAP 396 Data Recovery

Upon arrival at the NTSB Vehicle Recorder Division, an exterior examination revealed the unit had sustained minor impact damage and significant damage from outdoor exposure, as shown in figure 6. The unit was disassembled, all parts were rinsed with deionized water, excess water was driven off and parts de-greased using Acetone, and the unit further degreased and cleaned using Methonal. All parts and connections were then electro-washed with Cirozane spray using an acid brush. Figure 7 shows the parts after cleaning. After this treatment, the parts were dried and vacuum-baked for 12 hours at 50° C and 15 inHg. The unit was then reassembled and power applied. Although the screen did not display information, when a USB cable was connected from a PC to the unit the data were downloaded normally.

Figure 6. Garmin GPSMAP 396 as received.

Figure 7. Garmin GPSMAP 396 disassembled.

3.4.2. Garmin GPSMAP 396 Data Description

The data extracted included 47 sessions (6,227 data points) from June 4, 2009,[3] through April 5, 2014[4]. Two flights recorded on April 5, 2014, are discussed in this report.

3.4.3. Garmin GPSMAP 396 Parameters Provided

Table 2 describes data parameters provided by the GPS 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, MSL[5])

[3] The first 1,000 data points contained an invalid date expressed as 12/31/1989.
[4] All dates and times are referenced to Coordinated Universal Time (UTC).
[5] MSL means altitude above mean sea level

Parameter Name	Parameter Description
Groundspeed	Average groundspeed (knots)
Track	Average true course (degrees)

3.4.4. Garmin GPSMAP 396 Overlays and Tabular Data

All graphical overlays generated in this report were generated using Google Earth. Weather and lighting conditions depicted in Google Earth may not be representative of weather and lighting conditions at the time of the respective flights.

Figure 8 shows the prior flight on April 5, 2014, from Zephyrhills, Florida (ZPH) to X35. The recording began at 15:32:23 UTC and ended at 16:13:57 UTC (41 minutes, 34 seconds duration). Figure 9 shows data points at ZPH and X35; the aircraft departed at about 15:37:55 UTC and landed at about 16:09:38, a duration of 31 minutes, 43 seconds.

Figure 10 shows the entire accident flight recording. The recording began at 17:51:00 UTC at X35. The aircraft departed from runway 28 at about 17:57:48 UTC. At about 17:58:29 UTC, at an altitude of about 259 feet MSL, the aircraft began a left turn towards the south and continued to climb. The aircraft proceeded south and the recording ended at 17:59:53 UTC. The total duration of the recording was 8 minutes, 53 seconds. From 17:57:48 UTC until the end of recording, the total duration was 2 minutes and 5 seconds.

Figure 11 shows the start of the accident recording at X35. The recording began at 17:51:00 UTC, the aircraft reached the taxiway by 17:57:07 UTC, and began the takeoff roll at 17:57:26 UTC.

Figure 12 shows the end of the accident recording. At about 17:59:35 UTC, at an altitude of 732 feet MSL and a groundspeed of 101 knots, the aircraft track began to turn to the right about 90 degrees. Between 17:59:42 UTC and 17:59:48 UTC, the aircraft track changed from west towards the south, and the altitude decreased from about 800 feet to 312 feet MSL[6]. The aircraft continued to lose altitude and the last recorded point was 17:59:53 UTC.

Tabular data used to generate figures 8 through 12 are included as attachment 1. This attachment is provided in electronic comma-delimited (.CSV) format.

[6] Groundspeeds, track, and connecting lines are derived from the track history. Due to the sample rate and changes in aircraft track, the groundspeeds, track, and connecting lines may not be reliable during this period.

Figure 8. Prior flight as recorded by Garmin 396.

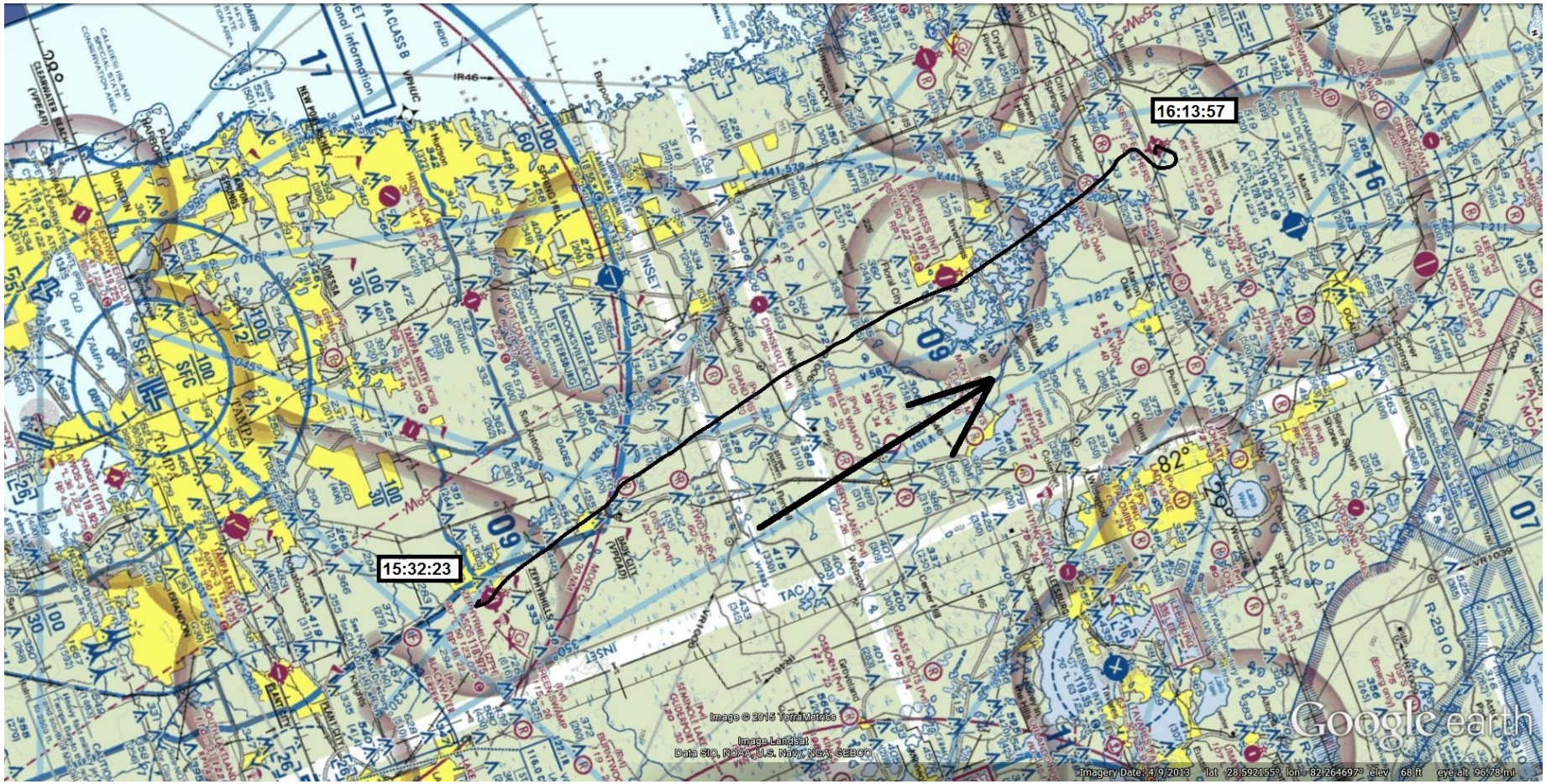


Figure 9. Prior flight, departure and arrival airport detail.

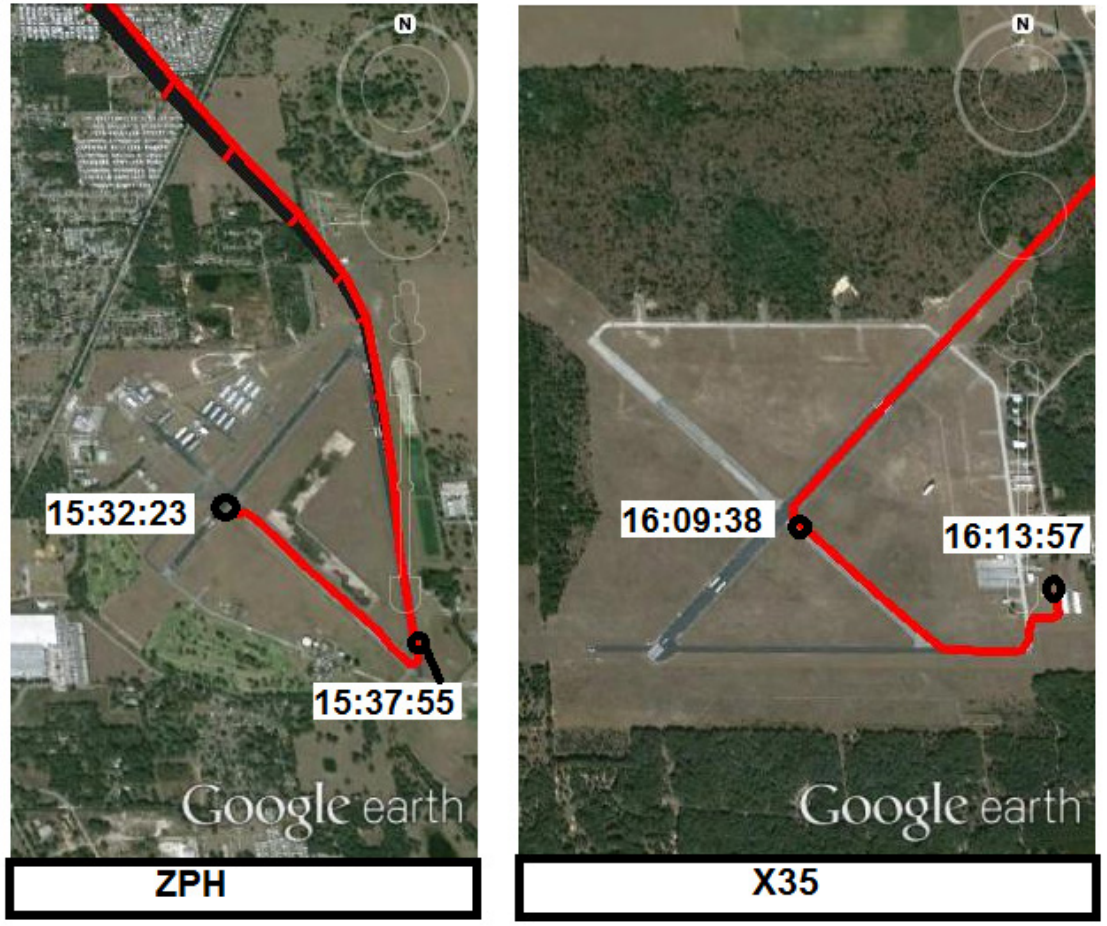


Figure 10. Accident flight as recorded by Garmin 396.

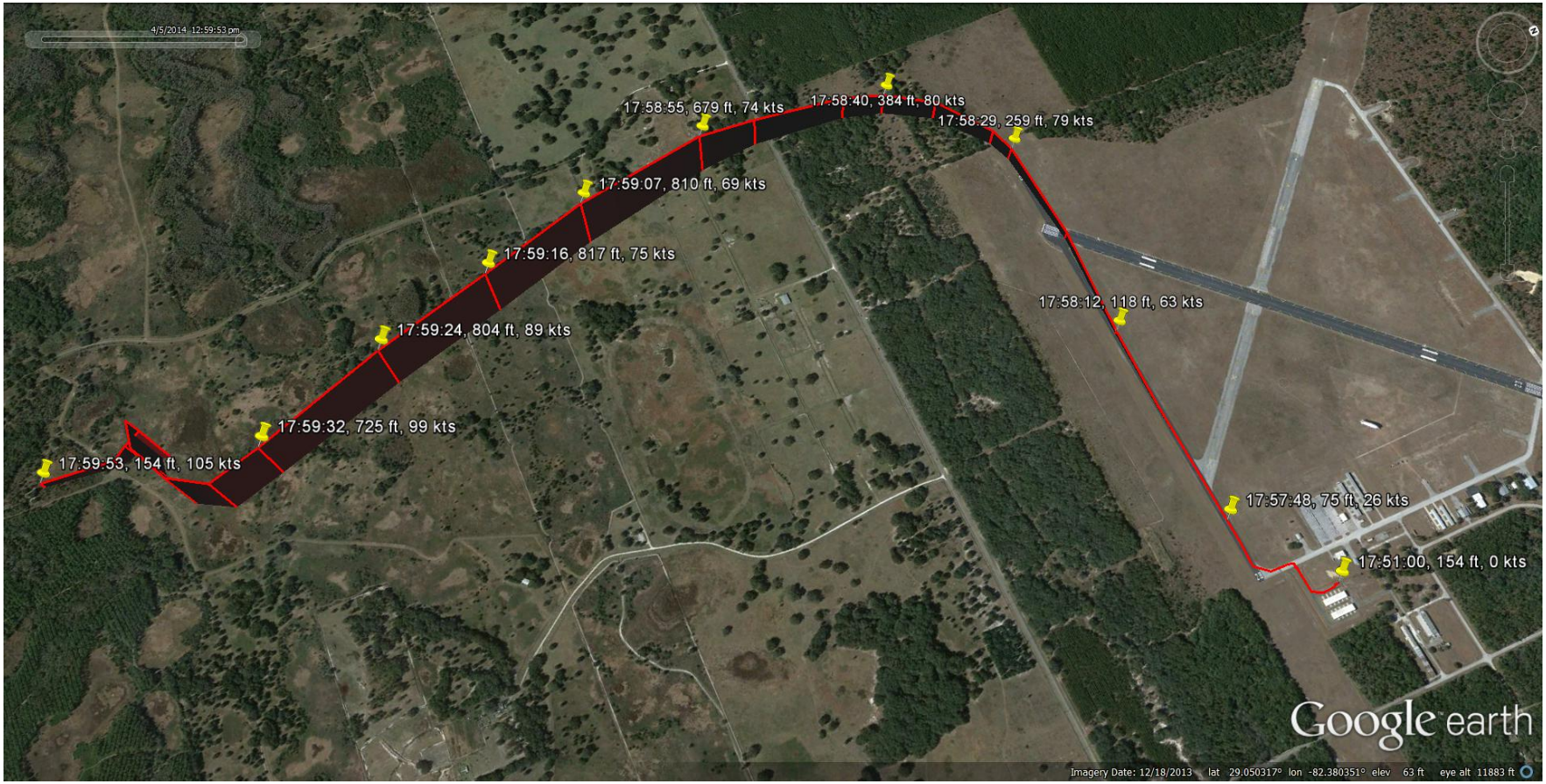


Figure 11. Accident flight, X35 start of recording, as recorded by Garmin 396.

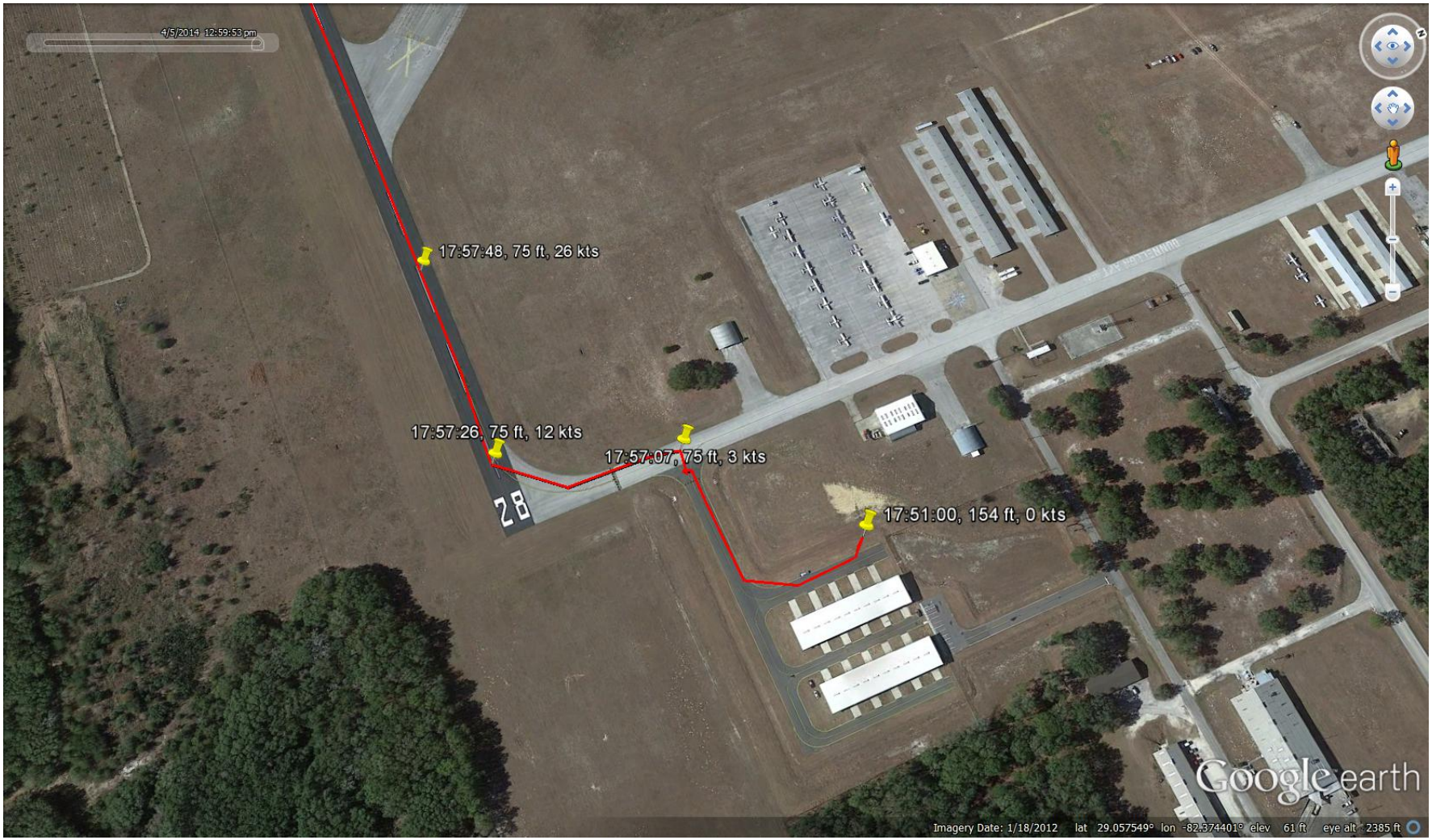


Figure 12. Accident flight, end of recording, as recorded by Garmin 396.