

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division

Washington, D.C. 20594

June 5, 2018

Global Positioning System

Specialist's Factual Report by Alice Park

1. EVENT

Location: Thief River Falls, Minnesota
Date: September 23, 2017
Aircraft: Cessna TR182
Registration: N4777T
Operator: Private
NTSB Number: CEN17FA361

On September 23, 2017, at 0742 central daylight time, a Cessna TR182 airplane, N4777T, impacted terrain about 3 miles west of Thief River Falls Regional Airport (TVF), Thief River Falls, Minnesota. The private pilot and two passengers were fatally injured, and the airplane was destroyed. The airplane was registered to and operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. Instrument meteorological conditions prevailed at the time of the accident and no flight plan had been filed. The flight had just departed from TVF and was en route to Rawlins Municipal Airport (RWL), Rawlins, Wyoming.

2. DETAILS OF DEVICE INVESTIGATION

The National Transportation Safety Board Vehicle Recorder Division received the following Global Positioning System (GPS) device:

Device: Garmin GPSMAP 296
Device S/N: 67017031

2.1. Garmin GPSMAP 296 Device Description

The Garmin GPSMAP 296 is a hand-portable GPS unit equipped with a detachable antenna, a 256 color TFT LCD display, built in base map and an internal Jeppesen aviation database. The unit employs a parallel 12 channel receiver and can be operated using external power, or alternatively by using an internal Li-Ion rechargeable battery.

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The GPSMAP 296 can store date, route of flight, and flight time information for up to 50 individual flights in the form of a flight log. Flight logging begins when the GPS unit senses a speed increase to greater than 30 knots together with an altitude gain of greater than 500 feet. The record is saved when the speed is sensed to decrease to below 30 knots, and a new log will be started if more than 10 minutes passes from this time. 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.¹

Once the current tracklog memory becomes full, new information either overwrites the oldest information or 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 deactivated at user discretion. All recorded data is stored in *non-volatile*² memory (NVM). 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. 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.

2.1.1.1. Garmin GPSMAP 296 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed that the unit had sustained impact damage during the accident and would not power on (Figure 1 and 2). It was disassembled for further examination.

The GPSMAP 296 stores recorded data in *non-volatile* memory (FLASH).³ This model stores recorded data on an AM29SL160CB12VD FLASH memory device mounted to the main Printed Circuit Board (PCB). It was removed from the PCB (see Figure 3 in red circle) using a hot air re-work station, and then re-balled using an infrared re-work station. A raw-data binary readout of the chip⁴ was obtained using a *Xeltek SP-3000u* EEPROM programmer. Recorded track log was identified and converted to engineering units using an in-house software program.

¹ A third “Resolution” setting is available which records a new track point only when the direction and speed have changed significantly. In this mode the unit examines current 2-D position, velocity and ground track once per-second, and calculates a project position. If the unit’s actual position 1-second later differs from the projected position by a set value (25 meters, or 82 feet by default) or if the ground maneuvering flight.

² Non-volatile memory is semiconductor memory that does not require external power for data retention.

³ FLASH memory is a form of re-writable, non-volatile memory that can retain data without external power.

⁴ Chip: colloquial term for an integrated circuit device.

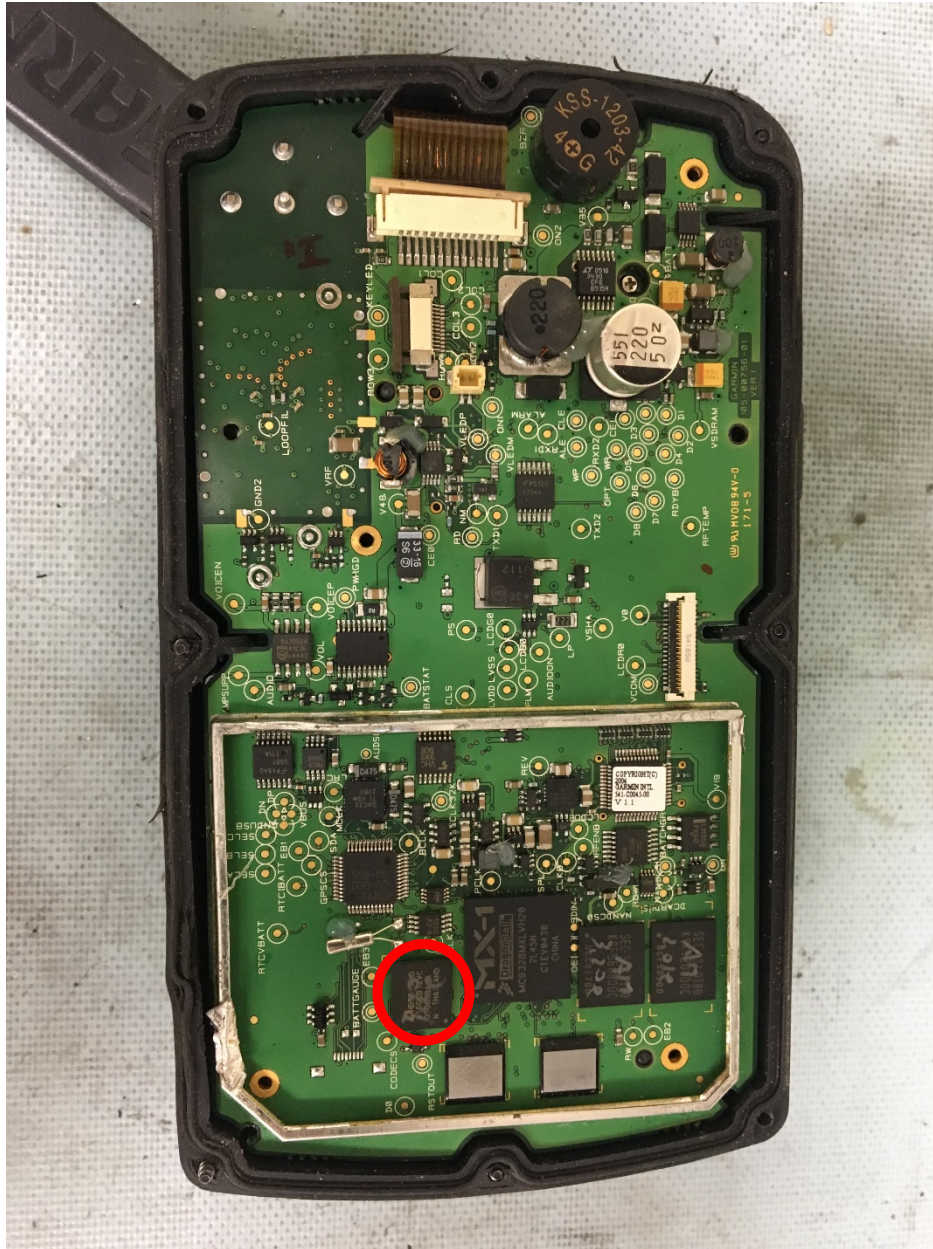
Figure 1. External view of the Garmin GPSMAP 296 - front (s/n 67017031).



Figure 2. External view of the Garmin GPSMAP 296 - back (s/n 67017031).



Figure 3. Internal view of the Garmin 296 main Printed Circuit Board (Flash memory device shows circle in red (front side))



2.1.2. Garmin GPSMAP 296 Data Description

Track log data dated from June 22, 2017, to September 23, 2017, was recovered directly from NVM chip. And the track log of the accident flight was identified with the date of the accident.

3. GPS PARAMETERS PROVIDED

Table 1 describes the data parameters provided. Date, Time, Longitude, Latitude, and GPS Altitude are recorded by the device. Groundspeed and Track are derived by the download software using recorded information. Data from the accident flight recorded is provided in tabular format as Attachment 1 to this report.

Table 1. 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 (ft)
Groundspeed	Average groundspeed between current and following data point (knots)
Track	Average true course between current and following data point (degrees)

4. OVERLAYS AND TABULAR DATA

Graphical overlays in this report were generated using Google Earth Pro. Note that the weather and lighting conditions depicted in Google Earth imagery do not necessarily reflect the conditions present during the accident flight.

The most recently recorded track log began at 1230:03 Universal Time Coordinated (UTC) on September 23, 2017, departing at Thief River Falls Regional Airport. The accident flight flew to northwest direction from the departing airport and the final position was recorded at 1242:35 UTC with an altitude about 2315 feet. Figure 4 shows an oblique overhead view of the entire flight.

Figure 4. Google Earth overlay of the accident flight

(The direction of the flight is marked by white triangles and the first and final positions of the accident flight are marked with time and altitude.)

