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

February 5, 2013

GPS Device Factual Report

Specialist's Factual Report
by Bill Tuccio

A. EVENT

Location:	Burlington, Wisconsin
Date:	November 18, 2012
Aircraft:	Grumman AA-1B
Registration:	N6273L
Operator:	Private
NTSB Number:	CEN13FA060

B. GROUP - No Group

C. SUMMARY

On November 18, 2012, about 1320 central standard time, N6273L, a Grumman AA-1B airplane, impacted terrain near Burlington, Wisconsin. The private pilot and passenger were 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 for the flight, which operated without a flight plan. The local flight originated from the Burlington Municipal Airport (KBUU), Burlington, Wisconsin, at an undetermined time.

D. DETAILS OF INVESTIGATION

The NTSB Vehicle Recorder Laboratory received the following device:

GPS Manufacturer/Model:	Lowrance AIRMAP 2000c
Serial Number:	100900149

GPS Device Description

The Lowrance AIRMAP 2000c is a WAAS[1]-capable, battery operated hand-portable 12-channel mapping GPS unit equipped with a 320 x 240 pixel color LCD display, soft key controls, and support for custom maps. The unit has the capability of performing E-6B[2] calculations. It contains a slot for a multi-media card (MMC) or Secure Digital (SD) FLASH[3] memory card. This card may be used to transfer and store custom map, waypoint[4], route[5], and trail[6] data to and from a desktop PC to the GPS unit. A serial interface using NMEA 0183[7] communication protocols is mounted in the back of the GPS unit, but the internal operating software does not support the download of saved data via this serial port.

The Lowrance AIRMAP 2000c can store up to 100 routes composed of up to 100 waypoints each. The unit can also store trail data composed of up to 10,000 latitude-longitude points per trail. Up to 100 individual trails may be named and saved by the user. Once the limit has been reached for recording continuously updated trail data, older latitude/longitude points are overwritten with new data on a first-in, first-out basis. The Lowrance AIRMAP 2000c may be programmed to update trail data in one of three ways: automatically, by time, or by distance traveled. The default 'automatic' mode only updates trail data when the GPS unit senses that position has changed by at least 0.1 miles, or that direction has changed by 2 degrees or more. Updating by time may be set to record a new latitude/longitude point every 1 to 9,999 seconds. Updating by distance may be set to record a new latitude/longitude point whenever the distance traveled from the last update exceeds anywhere from 0.01 miles to 9.99 miles. All recorded data is stored internally in non-volatile memory[8], and may be copied to a MMC or SD card inserted in a card slot in the battery compartment. The data is stored in a Lowrance proprietary *.usr file format. This card may be read using a standard desktop PC running the Microsoft Windows operating system.

GPS Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed that the unit had sustained significant impact damage, as shown in figures 1 and 2. An interior inspection revealed damage to various components, as shown in

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[1] Wide Area Augmentation System. WAAS is based on a network of approximately 25 ground reference stations used to augment the accuracy of GPS satellites. WAAS-capable receivers are capable of accuracies to approximately 7 meters vertically and horizontally.
[2] E-6B refers to mechanical and electronic tools assisting common flight related computations.
[3] FLASH Memory is a form of re-writeable, non-volatile memory that can retain data without external power - provided that the chip is not heated beyond the data retention temperature limit as stated in the datasheet.
[4] Geographical point specified by a set of latitude and longitude data along with descriptive information.
[5] An ordered list of waypoints.
[6] Linked list of latitude and longitude data representing the position of the aircraft as a function of time.
[7] NMEA, National Marine Electronics Association. NMEA Standard 0183 is an ASCII-based serial communication protocol.
[8] Non-volatile memory is semiconductor memory that does not require external power for data retention.

figure 3. The SST 39VF1601 FLASH memory chip, which contains the non-volatile memory, was identified on the printed circuit board, as shown in figure 4. The chip was removed and the binary contents read. The track history was successfully extracted from the binary contents.

Figure 1. Photo of damaged Lowrance AIRMAP 2000c - front.

Figure 2. Photo of damaged Lowrance AIRMAP 2000c - back.

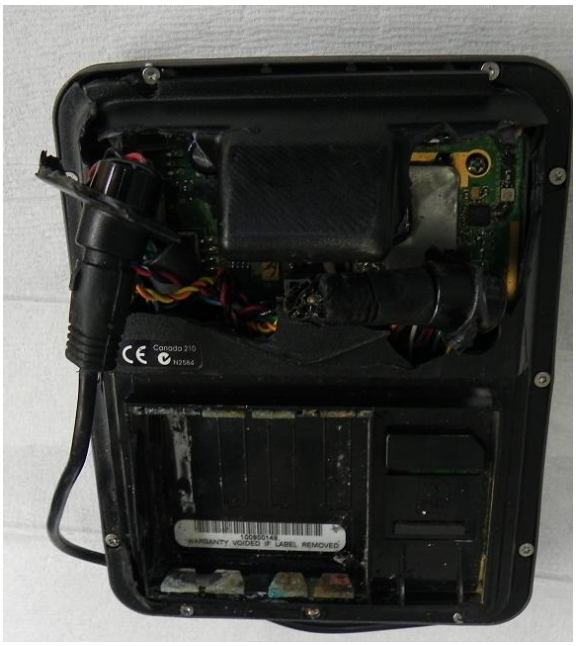
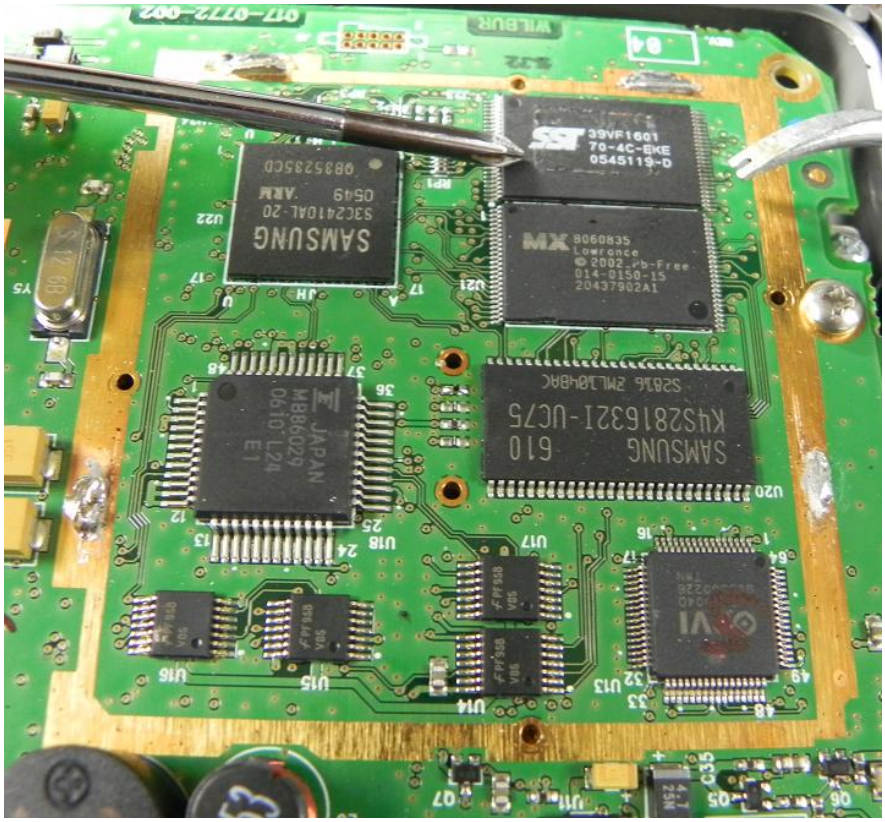


Figure 3. Photo of internal damage to Lowrance AIRMAP 2000c.

Figure 4. Photo of SST 39VF1601 FLASH memory chip in Lowrance AIRMAP 2000c.



GPS Data Description

The Lowrance AIRMAP 2000c device only records a sequential history of latitude and longitudes. A total of 1,000 points were retrieved from the device, representing approximately 5 tracks. However, none of the tracks were of the accident flight or otherwise pertinent to the investigation.