

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, DC 20594

February 9, 2021

Cockpit Displays & Other Device – Recorded Flight Data

**Specialist's Factual Report
By Kyle Garner**

1. EVENT

Location: Lake Elmo, MN
Date: October 02, 2020
Vehicle: Piper PA-46-500TP
Registration: N62ZM
Operator: Private
NTSB Number: CEN21LA004

2. GROUP

A group was not convened.

3. DETAILS OF INVESTIGATION

On November 18, 2020, the National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following devices:

Device Manufacturer/Model: **Garmin GTN 750**
Serial Number: **1ZA020634**

Device Manufacturer/Model: **Garmin GTN 750**
Serial Number: **1ZA020761**

Device Manufacturer/Model: **Meggitt Data Acquisition Unit (DAU)**
Serial Number: **0106-004**

3.1. Garmin GTN 750 Device Description

The Garmin GTN 750 is a panel-mounted global positioning system (GPS) receiver featuring a 6.9-inch color liquid crystal display (LCD). It has a GPS/SBAS engine and is TSO-C146c certified for primary domestic, oceanic, and remote navigation including enroute, terminal, and non-precision approaches, and approaches with vertical guidance. The unit can simultaneously give display approach information and weather and traffic data in relation to their position on a large, color moving map display. Its color moving map features a built-in database that shows cities, highways, railroads, rivers, lakes, and coastlines.

3.1.1. Garmin GTN 750 Data Description

The Garmin GTN 750 contains an internal SD card that stores flight log data, which can be accessed through a slot on the right side of the unit. If the unit is equipped with a firmware version 6.50 or later, the internal SD card will store a limited set of flight data information.

3.1.2. Garmin GTN 750 Data Recovery

Both Garmin GTN 750 devices from the accident aircraft arrived at the Vehicle Recorder Division in good condition, with no visible damage as shown in Figures 1 and 2. Detailed information about each device is shown in Table 1.



Figure 1. Garmin GTN 750, S/N 1ZA020634, as received.



Figure 2. Garmin GTN 750, S/N 1ZA020761, as received.

Table 1. Garmin GTN 750 details.

Part Number	Serial Number	Report Designation	Plot/Tabular Designation
011-02282-00	1ZA020634	Garmin 1	_dev1
011-02282-00	1ZA020761	Garmin 2	_dev2

The SD cards containing the flight logs on both units were located and in good condition. Both SD cards were read out successfully using a forensic write blocker attached to an NTSB workstation.

The SD card from Garmin 1 contained 188,622 total data points from June 17, 2020, to the accident flight on October 02, 2020. The SD card from Garmin 2 contained 163,044 total data points from June 17, 2020, to the accident flight on October 02, 2020. Only data from the accident flight is discussed in this report.

3.1.2.1. Engineering Unit Conversions

The tabular data downloaded from each SD card was already in engineering units, thus, no further conversion was necessary.

Table A-1 lists the parameters verified and provided in this report. Additionally, Table A-2 describes the unit and discrete abbreviations used in this report.

3.1.2.2. Time Correlation

The unit was set to record data at one-second intervals. Each data point was preceded by a timestamp in the local time zone, central daylight time (CDT), thus no further time correlation was necessary.

3.1.2.3. Plots and Tabular Data

Figures 5 through 8 contain Garmin GTN 750 data recorded during the event on October 02, 2020.

Figures 5 and 6 are Google Earth presentations of the track of the accident flight generated from latitude and longitude data recorded on the Garmin GTN 750. The weather, season, and lighting conditions in Google Earth are not representative of the conditions at the time of the accident.

Figure 7 is a plot of basic parameters including vertical acceleration, lateral acceleration, indicated airspeed, groundspeed, pressure altitude, and heading from the accident flight. The data show that the aircraft started its takeoff roll at 1511:53 and lifted off the ground at approximately 1512:13. After takeoff, the aircraft continued to gain airspeed and altitude. At 1512:32, the aircraft started a gradual turn to the left and airspeed began to decrease. Shortly thereafter, the aircraft started to lose altitude and impacted the ground at approximately 1512:54.

Figure 8 is a plot of pitch, roll, and vertical speed parameters for the accident flight. Pressure altitude, airspeed, and groundspeed are also shown for reference.

Figures 7 and 8 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.

The corresponding tabular data used to create Figures 5 through 8 are provided in electronic comma-separated value (*.csv) format as attachment 1 (data from Garmin 1) and attachment 2 (data from Garmin 2) to this report.

3.2. Meggitt DAU Device Description

The Meggitt DAU is part of the Meggitt Avionics next Generation Integrated Cockpit (MAGIC) engine instrument display system that also includes dual instrument panel-mounted displays (EDU) and various engine and fuel tank sensors.

The DAU is a microprocessor-based signal-conditioning device. The unit will accept aircraft sensor data, perform signal conditioning and validation, and then present this information to the EDUs via RS-422, RS-232, and ARINC 429 compatible serial data buses. The system will also receive, via ARINC 429 compatible serial data buses, global positioning and air data information to support the exceedance and engine condition trend monitoring (ECTM) processing functions of the DAU.

The DAU supports four dual ARINC 429, two RS-422, and two RS-232 serial data buses. Information received includes altitude, airspeed, and global positioning data. Information transmitted includes engine parameters (tachometer(s), torque, inter turbine temperature, oil pressure, oil temperature, vacuum pressure, and fuel flow), fuel quantity (left and right tank groups), and global positioning data. Fuel quantity sensing and reporting functions are

accomplished by independent (isolated) fuel quantity processing electronics. Also, the DAU includes built-in test, performance, and self-test functions.

3.2.1. Meggitt DAU Data Description

The DAU records and stores up to 256 engine exceedance events in non-volatile memory. The system also provides for and automatically gathers information for ECTM. Up to three ECTM records are stored per power cycle if either "Cruise 1" or "Cruise 2" states are achieved. One record for each of the following altitude ranges is stored:

- 15,000 to 20,000 feet
- 20,000 to 25,000 feet
- Above 25,000 feet

"Cruise 1" state is achieved when one of the above-mentioned altitude ranges is reached and the altitude has stabilized within ± 300 feet, an airspeed of greater than 140 knots is reached and has stabilized within ± 10 knots, and engine torque is greater than 49.5%. If "Cruise 1" conditions are met for two minutes, an ECTM record is stored for that particular altitude range.

"Cruise 2" state is achieved when "Cruise 1" conditions are valid, the altitude variation is within ± 100 feet, the airspeed variation is within ± 8 knots, engine torque variation has stabilized to within $\pm 3.8\%$, prop tachometer variation has stabilized to within $\pm 1.25\%$, and turbine tachometer has stabilized to within $\pm 1.0\%$. If these conditions are maintained for two minutes, the "Cruise 1" data is over-written for that particular altitude range.

Each ECTM record includes the following parameters and units:

- Date/Time
- Mode ("Cruise 1" or "Cruise 2")
- Altitude – feet (ft)
- Airspeed – knots (kt)
- Static Air Temperature - degrees Celsius ($^{\circ}\text{C}$)
- Torque – pound-foot (lb-ft)
- Propeller Speed (N_p) – percent (%)
- Turbine Speed (N_g) – percent (%)
- Inter Turbine Temperature (ITT)- degrees Celsius ($^{\circ}\text{C}$)
- Fuel Flow – pounds per hour (pph)

In the event an engine parameter exceeds a preset value for a predetermined time, an exceedance is recorded. The following is a list of parameters monitored and recorded if an exceedance occurs:

- Torque
- Inter Turbine Temperature (ITT)
- Propeller Speed (N_p)
- Turbine Speed (N_g)
- Engine Oil Temperature
- Engine Oil Pressure
- Each exceedance record includes the following parameters:
- Date/Time

- Exceedance Parameter
- Duration of Exceedance
- Peak Value
- Data Bus Label

3.2.2. Meggitt DAU Data Recovery

The Meggitt DAU arrived at the NTSB's Vehicle Recorders Laboratory in good condition with no visible damage, as shown in Figures 3 and 4.



Figure 3. Top view of Meggitt DAU, as received.



Figure 4. Side view of Meggitt DAU, as received.

The ECTM and exceedance data from both channels of the DAU were downloaded using the manufacturer's download software and NTSB lab equipment.

3.2.2.1. Meggitt DAU ECTM Data

Channel A recorded 83 ECTM data events between October 18, 2019, and September 15, 2020. Channel B recorded 77 ECTM data events between November 11, 2019, and September 15, 2020. No ECTM events were recorded on either channel on the day of the accident. The most recent recorded ECTM events from channels A and B, from August 27, 2020, to September 15, 2020, are shown in Table 2. The time zone of the recorded date and time could not be determined.

Table 2. ECTM events from August 27, 2020 to September 15, 2020.

Channel	Date	Time	Mode	Altitude (ft)	Airspeed (kts)	SAT (degC)	Torque (lb-ft)	Np (%)	Ng (%)	ITT (degC)	Fuel Flow (pph)
A	9/15/2020	12:21:00	2	26004	171	-26	1168	100	94.4	678	254
B	9/15/2020	12:19:24	2	26004	171	-26	1159	100	94.4	683	253
A	9/13/2020	14:22:42	2	23994	172	-18	1183	100	94.4	685	264
B	9/13/2020	14:01:18	2	23999	168	-18	1177	100	94.4	686	262
A	9/11/2020	13:06:48	2	27003	158	-23	1065	100	94.1	681	237
B	9/11/2020	13:06:24	2	27005	158	-23	1061	100	94.1	688	237
A	8/30/2020	15:19:12	2	27001	167	-30	1092	100	93.6	665	241
B	8/30/2020	15:06:42	2	26998	164	-30	1068	100	93.3	663	237
A	8/27/2020	20:37:06	2	24008	173	-21	1198	100	94.2	676	265
A	8/27/2020	21:14:06	1	15975	178	-4	1083	100	90.5	614	275
A	8/27/2020	17:28:18	2	23997	172	-18	1165	100	94.1	676	261
A	8/27/2020	15:32:00	2	15929	175	-4	1100	100	90.7	614	277
B	8/27/2020	20:37:06	2	24002	174	-21	1197	100	94.2	683	265
B	8/27/2020	21:14:06	1	15976	179	-4	1085	100	90.5	621	275
B	8/27/2020	17:27:36	2	23989	172	-19	1168	100	94.1	683	261
B	8/27/2020	15:32:12	2	15940	176	-4	1103	100	90.8	621	277

All ECTM data events recovered from the DAU are provided in comma-separated value (CSV) format as attachment 3 to this report.

3.2.2.2. Meggitt DAU Exceedance Data

The exceedance data files for channels A and B were successfully exported from the DAU, however, no exceedances for any flight, including the accident flight, were recorded.

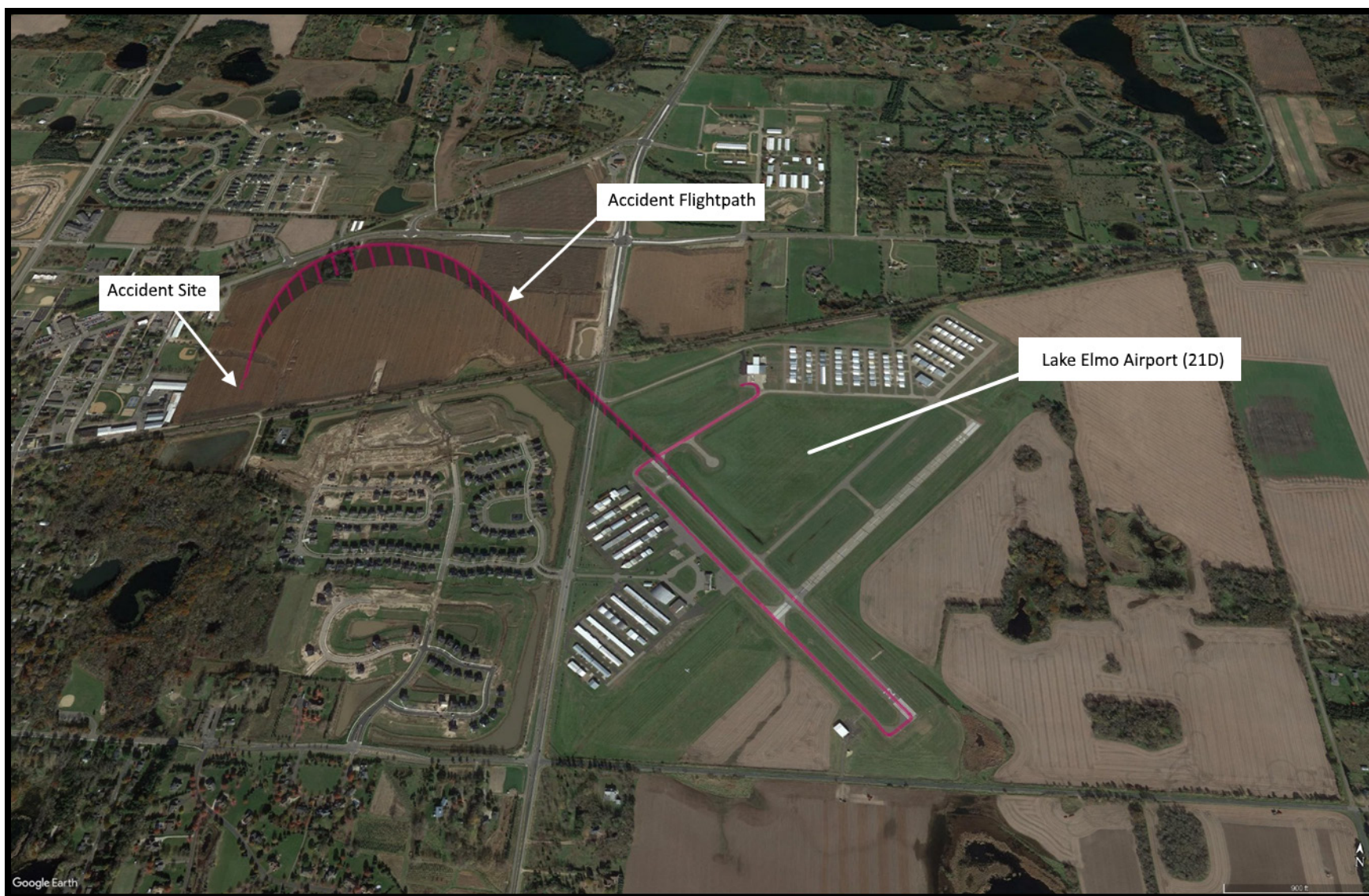


Figure 5. Google Earth overview of accident flightpath.



Figure 6. Google Earth overview of the end of accident flightpath.

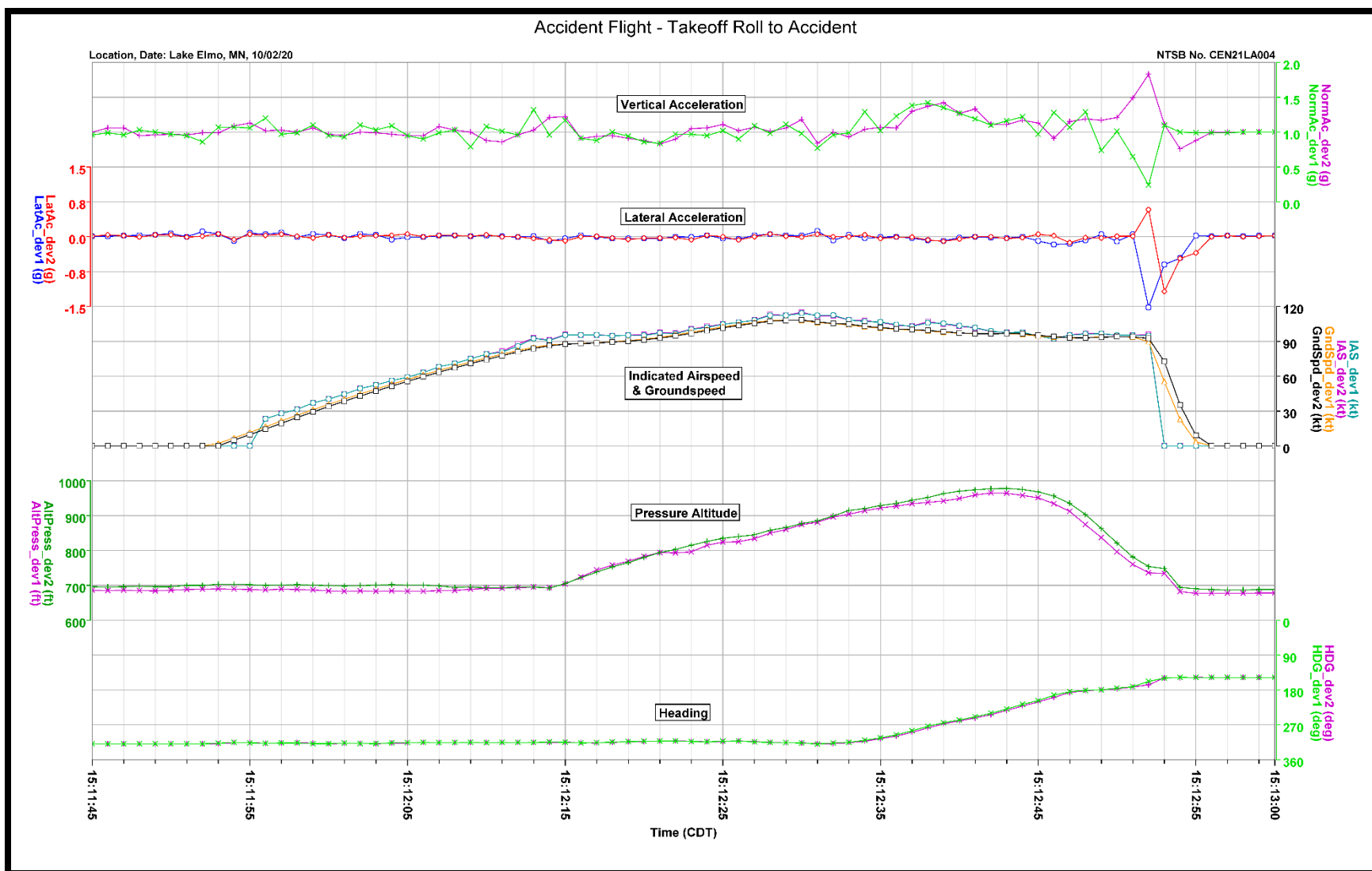


Figure 7. Garmin GTN 750 accident flight data - takeoff roll to the accident.

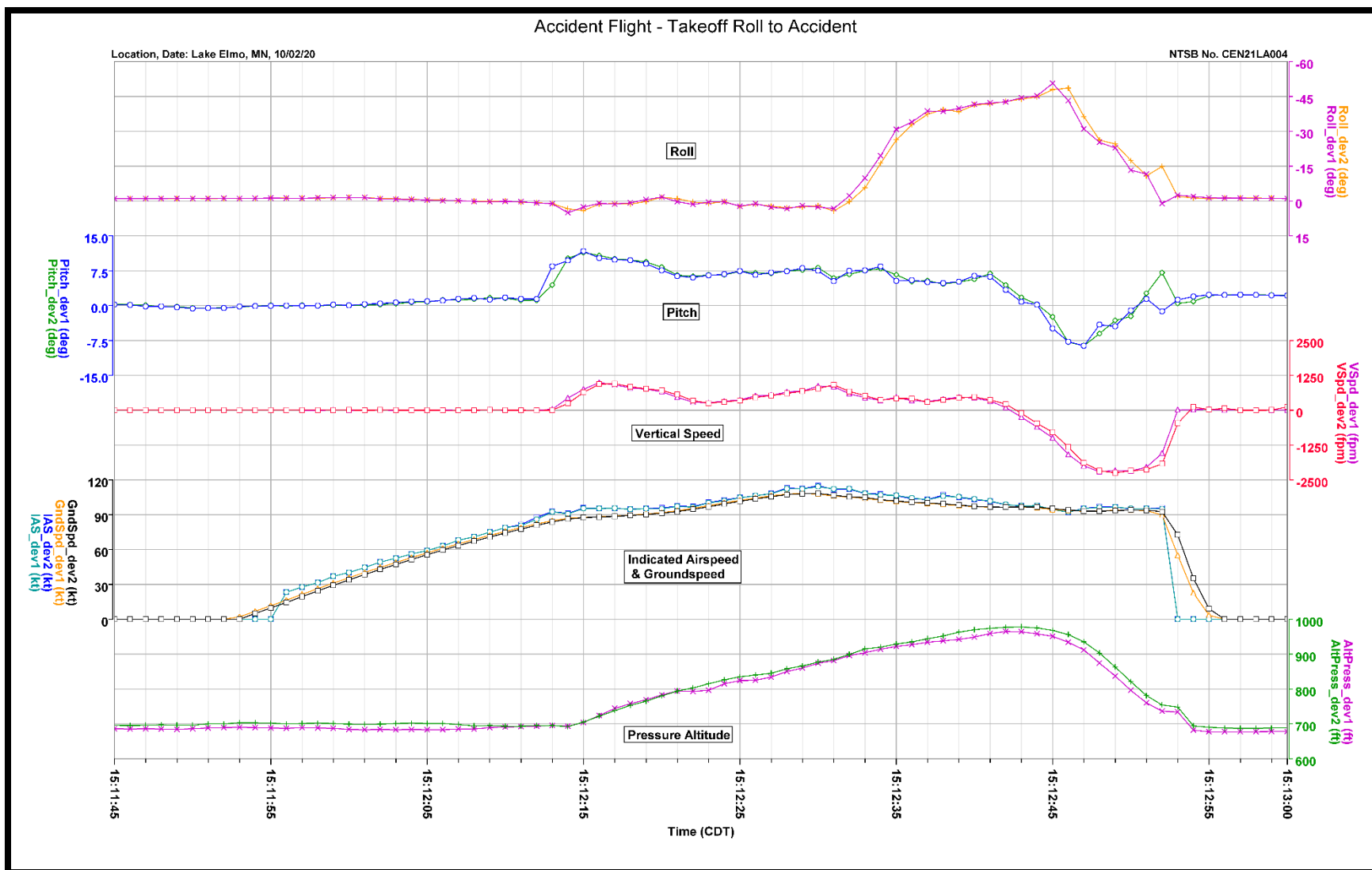


Figure 8. Garmin GTN 750 accident flight data - takeoff roll to the accident.

APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the plot/table labels, parameter names, and units. Additionally, table A-2 describes the unit and discrete abbreviations used in this report.

Table A-1. Verified and provided Garmin GTN 750 parameters.¹

Plot/Table Labels	Parameter Names	Units
AltB	Altitude – Baro	ft
AltGPS	Altitude – GPS	ft
AltMSL	Altitude – MSL	ft
AltPress	Altitude – Pressure	ft
AtvWpt	Active Waypoint Selection	-
CRS	Course	deg
FQtyC ²	Fuel Quantity	gals
GndSpd	Groundspeed	kts
HDG	Heading	deg
IAS	Indicated Airspeed	kts
LatAc	Lateral Acceleration	g
Latitude	Latitude	deg
LclDate	Local Date	MM/DD/YYYY
LclTime	Local Time	hh:mm:ss
Longitude	Longitude	deg
MagVar	Magnetic Variation	deg
NormAc	Normal/Vertical Acceleration	g
Pitch	Pitch	deg
RAIMalarm	Receiver Autonomous Integrity Monitoring – Alarm	-
RAIMfault	Receiver Autonomous Integrity Monitoring – Fault	-
Roll	Roll	deg
TAS	True Airspeed	kts
TRK	Track	deg
VSpd	Vertical Speed	fpm
WndDr	Calculated Wind Direction	deg
WndSpd	Calculated Wind Speed	kts

¹Parameters with a blank unit description in Table A-1 are discretes. A discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.

²The fuel quantity parameter was only recorded on Garmin 1. Garmin 2 contained the header information for fuel quantity, however, there was no recorded data.

Table A-2. Unit and discrete abbreviations.

Unit and discrete abbreviations	Descriptions
DD	day
deg	degrees
fpm	feet per minute
ft	feet
g	gravitational constant
gals	gallons
hh	hours
kts	knots
MM	month
mm	minutes
ss	seconds
YYYY	year