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

November 4, 2013

Cockpit Displays Factual Report

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

A. EVENT

Location:	Kernville, California
Date:	March 11, 2013
Aircraft:	Cirrus SR20
Registration:	N427GE
Operator:	Justice Aviation
NTSB Number:	WPR13LA145

B. GROUP - No Group

C. SUMMARY

On March 11, 2013, at 1450 Pacific daylight time (PDT), a Cirrus SR20, N427GE, veered off the left side of the runway and into a ditch at the Kern Valley Airport (L05), Kernville, California. The airplane was registered to East Pole Aviation, and operated by Justice Aviation as a rental under the provisions of Title 14 *Code of Federal Regulations* Part 91. The private pilot and two passengers sustained minor injuries, and the airplane was substantially damaged. Visual meteorological conditions prevailed, and no flight plan had been filed. The flight originated at Bakersfield, California, about 1438 PDT.

D. DETAILS OF INVESTIGATION

The NTSB Vehicle Recorder Laboratory received the following device:

GPS Manufacturer/Model:	Avidyne Primary Flight Display (PFD)
Serial Number:	20056048

Avidyne PFD Device Description

The Avidyne PFD unit includes a solid state Air Data and Attitude Heading Reference System (ADAHRS) and displays aircraft parameter data including altitude,

airspeed, attitude, vertical speed, and heading. The PFD unit has external pitot/static inputs for altitude, airspeed, and vertical speed information. Each PFD contains two flash memory devices mounted on a riser card. The flash memory stores information the PFD unit uses to generate the various PFD displays. Additionally, the PFD has a data logging function, which is used by the manufacturer for maintenance and diagnostics. Maintenance and diagnostic information recording consists of system information, event data and flight data.

The PFD samples and stores several data streams in a sequential fashion; when the recording limit of the PFD is reached, the oldest record is dropped and a new record is added. Data from the ADAHRS is recorded at a rate of 5 Hz. Air data information such as pressure altitude, indicated airspeed, and vertical speed are recorded at 1 Hz. Global Positioning System (GPS) and navigation display and setting data are recorded at a rate of 0.25 Hz, and information about pilot settings of heading, altitude, and vertical speed references are recorded when changes are made.

Avidyne PFD Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an exterior examination revealed the unit had not sustained any damage as shown in Figure 1. Power was applied to the accident unit and recorded data was successfully downloaded.

Figure 1. Photo of Avidyne PFD from accident aircraft.

Avidyne PFD Recorder Contents

The data extracted from the PFD contained the accident flight and other flights on March 11, 2013. The software version was 530-00214-002_REV05.

Engineering Units Conversions

Where applicable, the conversions have been changed to ensure that the parameters conform to the NTSB's standard sign convention that climbing right turns are positive (CRT=+)[1]. Appendix A lists the PFD parameters verified and provided in this report.

Time Correlation

A GPS position and Coordinated Universal Time (UTC) record is recorded in the PFD data every 4 seconds, however the time data is updated on the aircraft only every 6 seconds resulting in repeated time data. Consequently, the data may be up to 6 seconds off from true UTC. For this report, the time when the aircraft was taking off and passing through 35.3 knots and 2,510 RPM was assumed to be 2139:48 UTC. In order to convert to PDT, 7 hours was subtracted, making the assumed time when the aircraft passed through 35.3 knots and 2,510 RPM, 1439:48 PDT.

PFD Recorded Data Plots and Corresponding Tabular Data

Figure 2 shows a plot of parameters for the entire accident flight. In the plot, accelerations and roll angle scales are clipped and do not show the full scale values achieved; other figures in this report show the full scale values. Figure 3 shows a Google Earth overlay of the entire accident flight. The aircraft departed at about 1439 PDT and flew about 22 minutes to the L05 airport. The autopilot was not used during the flight.

Figure 4 shows a plot of parameters focusing on the approach and runway excursion at L05. Figure 5 shows a Google Earth overlay of the approach and landing, with select points annotated. After performing a turn over Isabella Lake, the aircraft began the final approach into L05. As the aircraft descended from about 2,700 feet pressure altitude to about 2,500 feet pressure altitude, the airspeed remained constant at 77 knots.

At about 1501:18 PDT, as the aircraft continued to descend out of 2,500 feet pressure altitude, the pitch began to increase and the airspeed decreased. Between 1501:18 PDT and 1501:22 PDT, the airspeed reduced from 77 knots to 71 knots, and the pitch increased from 4 degrees nose down to 1 degree nose down.

[1] CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

Figure 6 shows a plot of parameters focusing on the runway excursion. Figure 7 shows a Google Earth overlay of the runway excursion.

At 1501:24 PDT, the roll was 7 degrees left, the pitch was 2 degrees nose down, and the airspeed was 69 knots.

At 1501:28 PDT, the roll was 3 degrees right, the pitch was 5 degrees nose up, and the airspeed was 66 knots.

At 1501:30 PDT, the propeller RPM was 1,350, the roll was 2 degrees left, the pitch was 2 degrees nose up, and the airspeed was 62 knots.

At 1501:30 PDT and 1501:36 PDT, the propeller RPM was sampled twice at 1,350 and 2,400 RPM, respectively. During this time period, the pitch, roll, and airspeed were sampled at a higher frequency. As such, determining when power was applied relative to pitch increase is limited by the sampling rate differences. However, during this period the pitch increased from 2 degrees nose up to 12 degrees nose up, the roll increased to 9 degrees left, the airspeed decreased to 56 knots, and by 1501:32 PDT, the longitudinal acceleration began to increase. Also during this period, the magnetic heading turned to the left from 351 degrees to 335 degrees, continuing to a maximum left heading of 327 degrees at 1501:38 PDT.

At 1501:38 PDT, the pitch reached a maximum value of 17 degrees nose up when the airspeed was about 56 knots.

Between 1501:38 PDT and 1501:41 PDT, the pitch decreased to 16 degrees nose down, and the aircraft rolled to 31 degrees right, before rolling back to the left through 20 degrees.

After 1501:41 PDT, the vertical acceleration increased to a full scale value, the left roll angle increased to a full scale value of 180 degrees left, and the airspeed decreased to 0 knots.

Tabular data used to generate figures 2 through 7 are included as Attachment 1. This attachment is provided in electronic comma-delimited (.CSV) format.

Figure 2. Plot of parameters for entire accident flight.

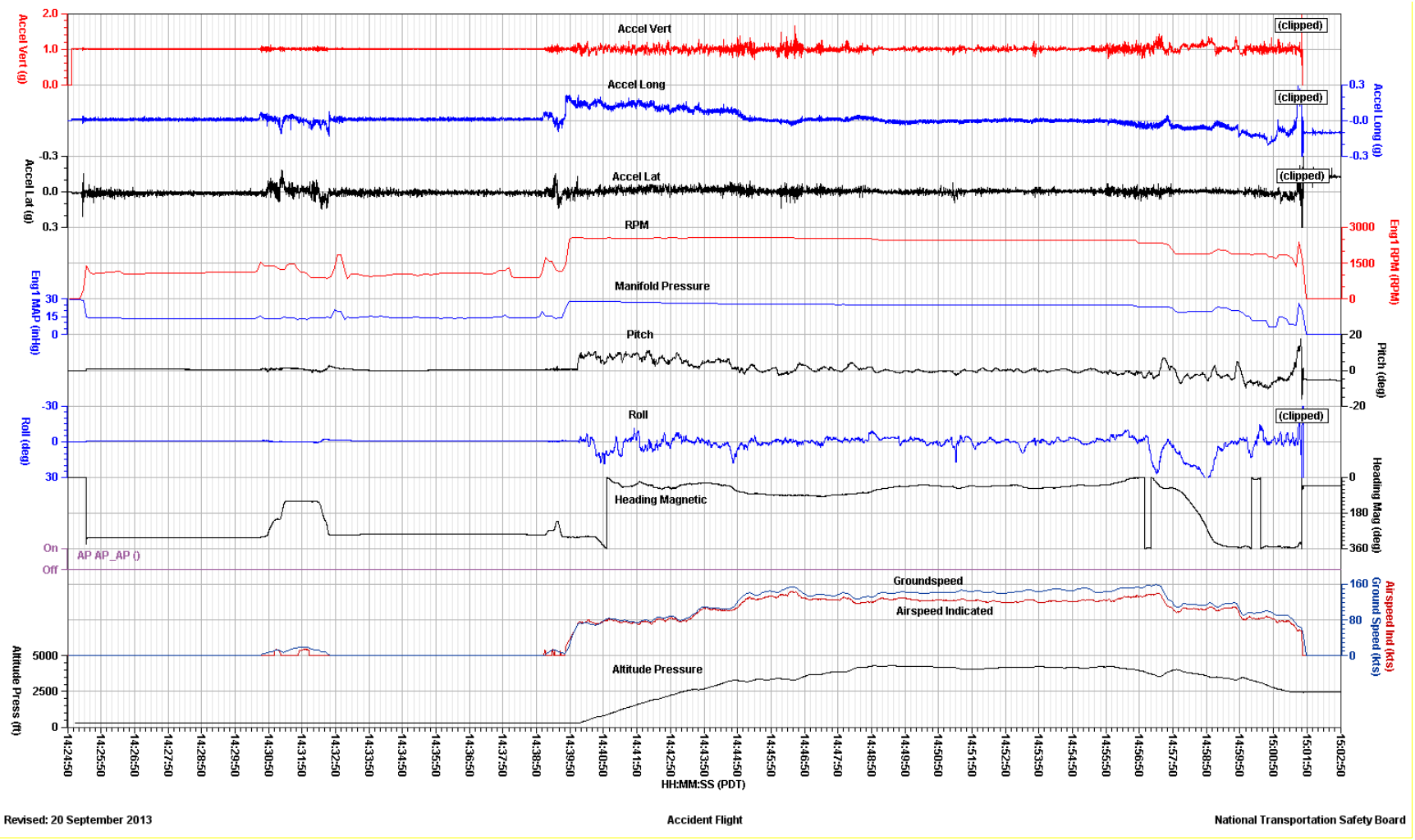

Figure 3. Google Earth overlay showing entire accident flight.

Figure 4. Plot of parameters for approach until after runway excursion.

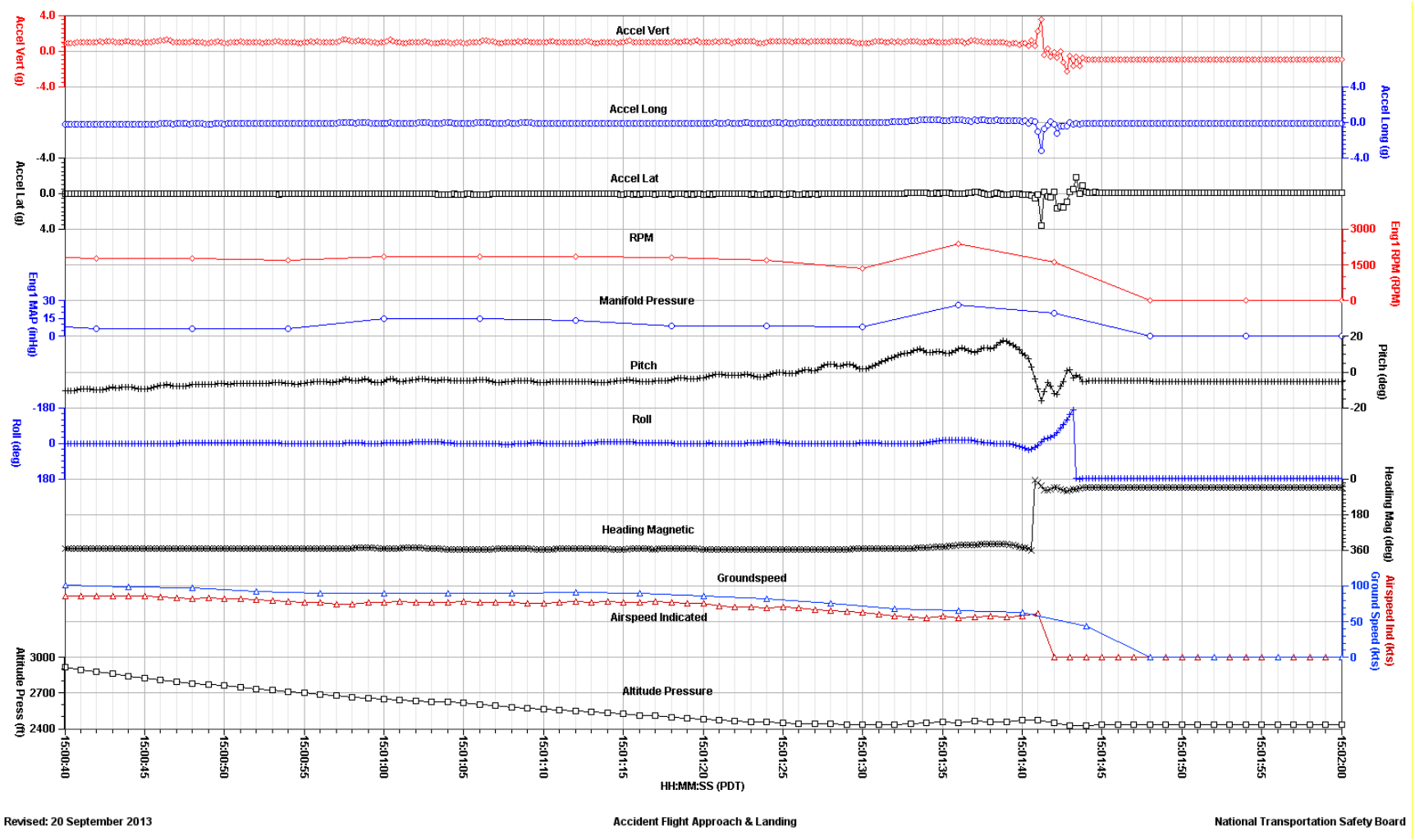

Figure 5. Google Earth overlay showing approach to landing with pressure altitude and indicated airspeed – select points annotated.

Figure 6. Plot of parameters near the time of the runway excursion.

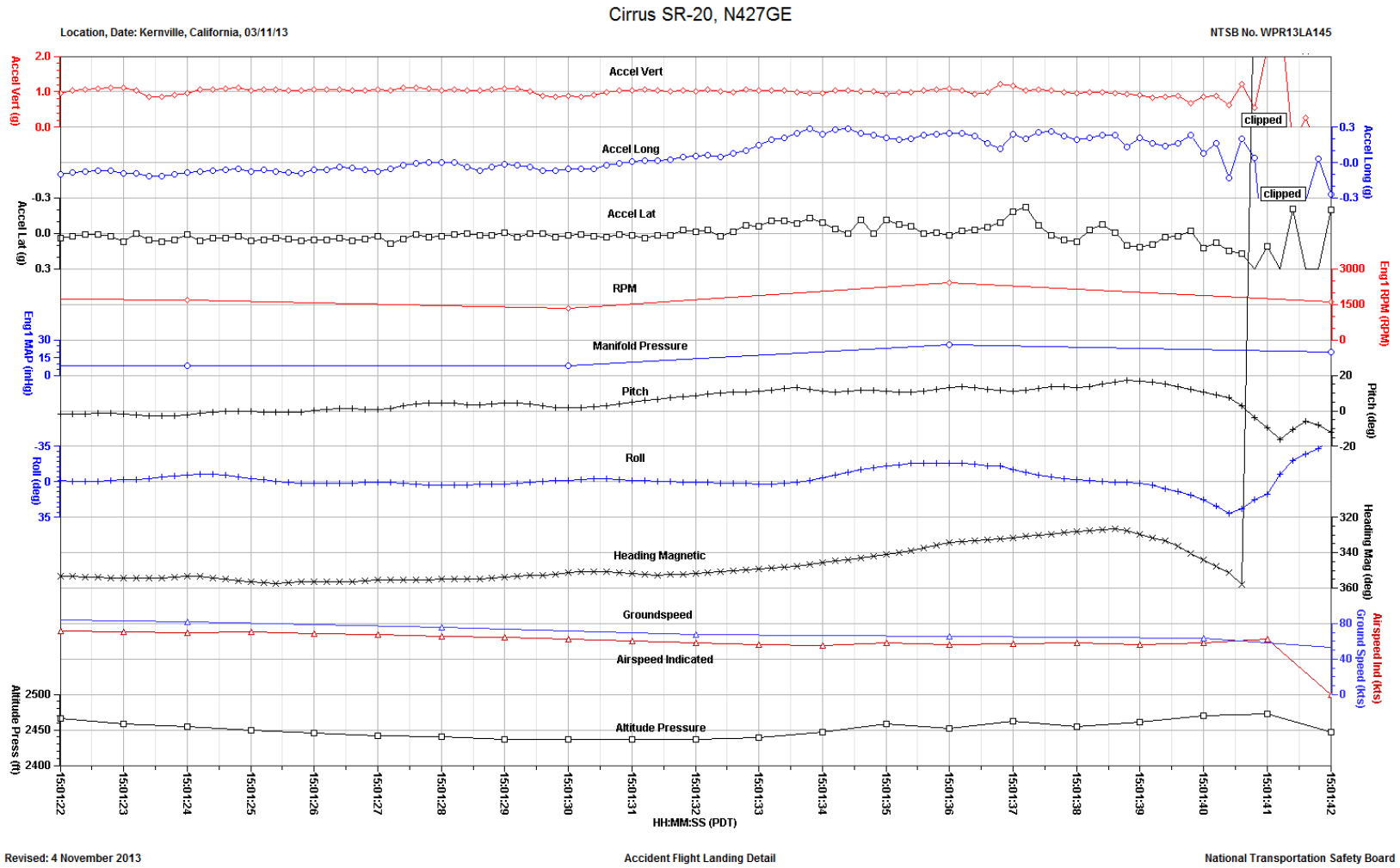

Figure 7. Google Earth overlay showing all points, pressure altitude, and indicated airspeed – short final through runway excursion.

APPENDIX A – Avidyne PFD Parameters

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameters and table A-2 describes the unit abbreviations used in this report.

Table A-1 - Verified and provided parameters.

Parameter Name	Parameter Description
1. Accel Lat (g)	Lateral Acceleration
2. Accel Long (g)	Longitudinal Acceleration
3. Accel Vert (g)	Vertical Acceleration
4. Airspeed Ind (kts)	Indicated Airspeed
5. Altitude Press (ft)	Pressure Altitude
6. AP AP_AP (discrete)	Autopilot On and Engaged
7. Eng1 MAP (inHg)	Engine Manifold Pressure
8. Eng1 RPM (rpm)	Propeller RPM
9. Heading Mag (deg)	Magnetic Heading
10. Latitude (deg)	Latitude
11. Longitude (deg)	Longitude
12. Pitch (deg)	Pitch
13. Roll (deg)	Roll
14. Time - Day (day)	UTC Time - Day
15. Time - Month (month)	UTC Time - Month
16. Time - Year (year)	UTC Time – Year
17. Time UTC Hrs (hr)	Time UTC Hours
18. Time UTC Min (min)	Time UTC Minutes
19. Time UTC Sec (sec)	Time UTC Seconds
20. Groundspeed (kts)	Groundspeed

Table A-2 - Unit abbreviations.

Units Abbreviation	Description
g	g
rpm	revolutions per minute
deg	degrees
discrete	discrete
ft	feet
hr	hour
kts	knots
sec	Seconds
inHg	Inches of Mercury

NOTE: For parameters with a unit description of discrete, 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.