

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, D.C. 20594

May 11, 2021

Cockpit Display – Recorded Flight Data

Specialist's Factual Report
By Sean Payne

1. EVENT SUMMARY

Location: Ogden, UT
Date: December 10, 2020
Aircraft: Cirrus SR22
Registration: N577CP
Operator: Private
NTSB Number: WPR21LA068

2. DETAILS OF INVESTIGATION

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

Recorder Manufacturer/Model: **Garmin SD Cards (recovered from Garmin flight display)**
Recorder Serial Number: **N/A**

2.1. Garmin G1000 Description

The Garmin G1000 Integrated Flight Deck is a collection of multiple avionics units which include flight displays, air data computers, attitude/heading reference system (AHRS), communications and other systems. A typical installation includes a primary flight display (PFD) and a multi-function display (MFD). Each display includes two SD card slots, an upper and a lower slot. The lower SD card slot is used by the system for software updates and various databases.¹

Depending on the display unit software, the aircraft can include a data logging feature. The data logging feature must be enabled by the aircraft operator. If the data logging feature is available and enabled, a SD card must be installed in the upper slot of the MFD. Depending on the airframe and engine combination, as many as 64 parameters can be stored at a rate of one sample per second (1Hz). According to the manufacturer of the display unit, one flight hour can be stored in approximately 2 MB. The SD card typically used is 2 GB in size and can store approximately 1,000 flight hours.

2.1.1. Data Recovery

There were three SD cards received by the Vehicle Recorder Division, as shown in Figure 1. The three cards were in good condition and the data were extracted normally from the

¹ Databases can include terrain data, obstacle data, SafeTaxi charts, flight charts and airport terrain databases

SanDisk SD card. The other two cards contained system and chart data and were not included in this investigation.

Figure 1. Garmin SD Cards as received.



2.1.2. Data Description

The extracted data contained 448 log files. The accident flight recording was identified, and was approximately 16 minutes 25 seconds in duration.

2.1.3. Engineering Units Conversions

The flight log data stored in the log files were converted to engineering units by the display unit.

Appendix A lists the parameters verified and provided in this report.

2.2. Time Correlation

The Garmin G1000 records time with the first data sample based on the unit's internal clock. This clock is set and updated by the unit and is based off GPS time. The data set for the accident flight appeared to correspond to mountain standard time (MST), and no further time offsets were made. Therefore, for the rest of this report, all times are referenced as MST, not recorded time.

2.3. Plots and Corresponding Tabular Data

The following three figures contain data recorded during the December 10, 2020, event. These figures 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.

There was no GPS information contained on the dataset provided to the NTSB, thus a plot of the aircraft's position was unable to be constructed.

There were eleven ground power cycles between the previous flight to the accident (November 22, 2020) and the accident flight (December 10, 2020). Of these eleven power cycles, some power cycles were associated with engine runs and contained recorded valid engine data.

Figure 2 is a plot of a previous flight to the accident that was recorded on November 22, 2020. The time was not offset to local time. The duration of the plotted time interval is approximately 2 hours and 15 minutes. In general, values for TIT1 and TIT2 tracked together. Values for manifold pressure appeared nominal. The data did not reveal any anomalies for this previous flight.

Figure 3 is a plot of data for the relevant portion of the accident recording on December 10, 2020. The plotted time interval is from 15:30 to 15:48 MST. The data show the engine was started around 15:32 MST. Recorded data for TIT1 and TIT2 showed a divergence. Data consistent with an engine runup occurred around 15:42 MST. Around this time values for TIT1 and TIT2 tracked more closely in line with one another. The takeoff roll appeared to begin around 15:45:20 MST. The aircraft climbed and the heading changed to the right and roll values showed the aircraft was in a right turn. During this time values for TIT1 diverged from TIT2. Values for EGT and CHT appeared nominal, values for RPM remained around 2700 RPM and fuel flow around 35 gph, while manifold pressure spiked to about 35 in/Hg. The Cirrus pilot's operating handbook denotes that the normal operating range for an aircraft of this configuration is 15.0 to 29.6 in/Hg, with a maximum of 32 in/Hg. The aircraft climbed about 4,695 feet MSL (around 220 feet AGL) before data showed a descending turning the aircraft back to an altitude roughly consistent with the takeoff elevation and landing on a runway alternate to that of the departure runway. Data ended just after 15:47 MST. Airspeed at this time was last recorded at 100 knots. Values for fuel flow and manifold pressure had decreased.

Figure 4 is an expanded time scale plot of the same data from the accident flight. The plotted time interval is from 15:44:30 MST to 15:47:30 MST.

Figure 5 is a Google Earth depiction of the GPS tracklog associated with the accident flight. Note, Google Earth does not accurately depict the weather and lighting conditions at the time of the accident. The GPS tracklog originated in the ramp area of Ogden-Hinckley Airport (KOGD), Ogden, Utah at 15:31:32. By 15:40:13, the aircraft was at the runup area for runway 16. By 15:45:10, the aircraft had begun a takeoff roll on runway 16. Tracklog data shows the aircraft taking an immediate right turn upon departure from runway 16. A maximum GPS altitude of 4,695 feet MSL (about 220 feet AGL) was obtained at 15:46:30. At that time the aircraft was on a return track toward the center of the airport. By 15:46:57, the aircraft had lined up with runway 3 about the mid-field point. Data came to an end at 15:47:10 with the GPS tracks showing the last recorded location on runway 3.

The corresponding tabular data used to create the plot of the aircraft's previous flight to the accident are provided in electronic (*.csv²) format as Attachment 1 to this report. The corresponding tabular data used to create the two plots of the aircraft's accident flight are provided in electronic (*.csv) format as Attachment 2 to this report. Note that Attachment 2 contains parameters that have been validated but not included in the plots for this report.

² Comma Separated Value format.

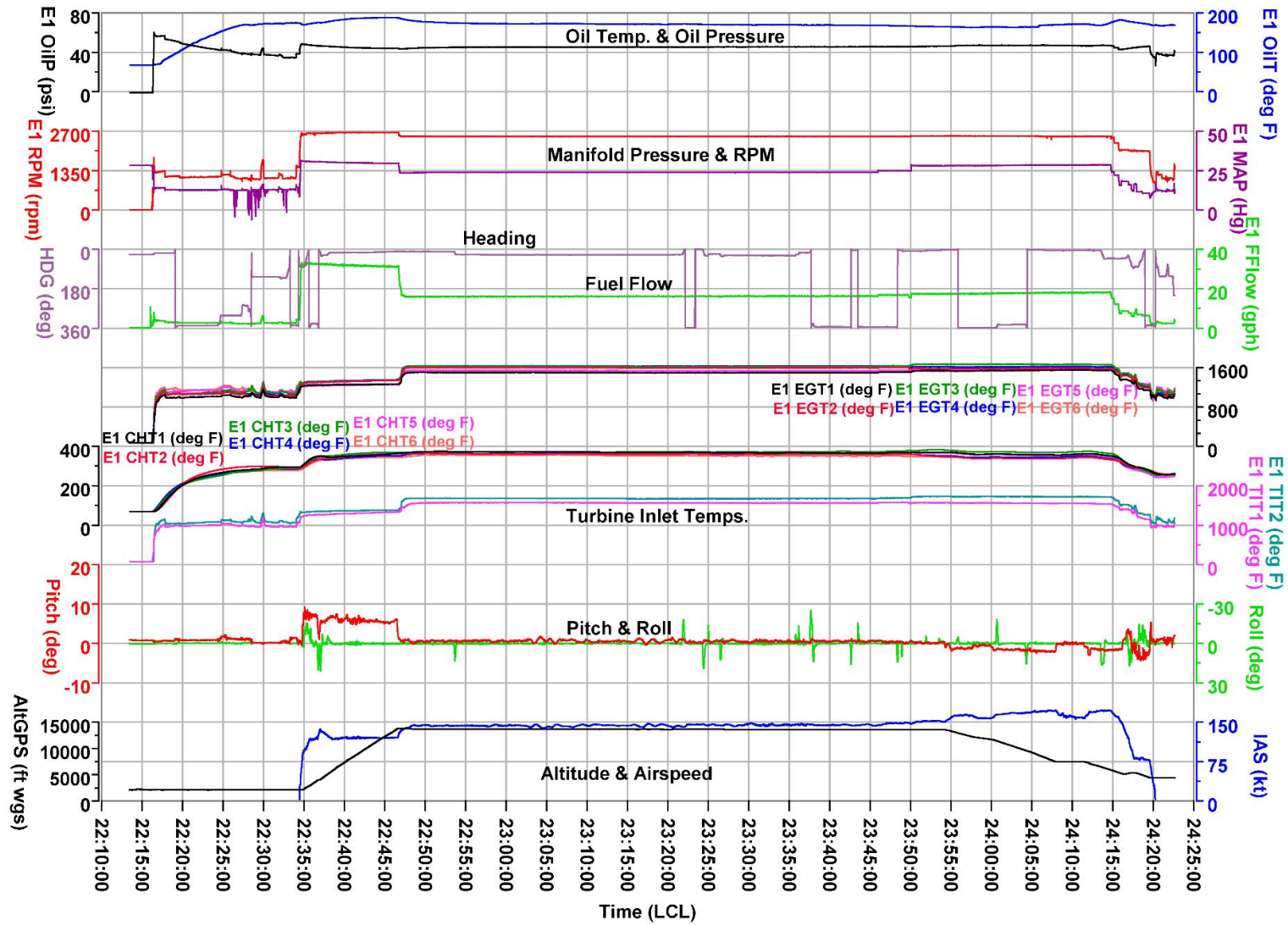


Figure 2. A plot of select parameters for a flight previous to the accident which occurred on November 22, 2020.

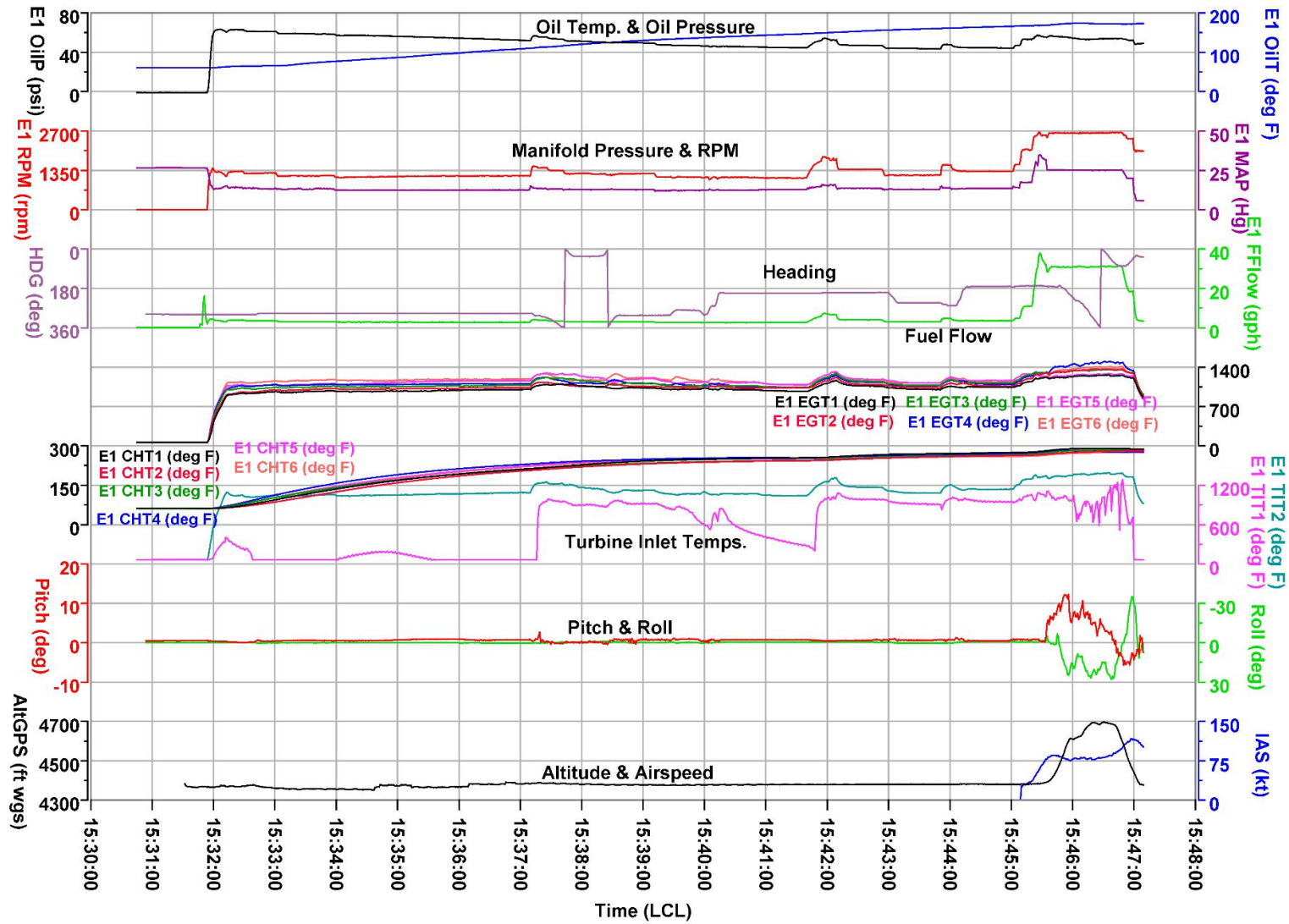


Figure 3. A plot of select parameters for the entire accident flight.

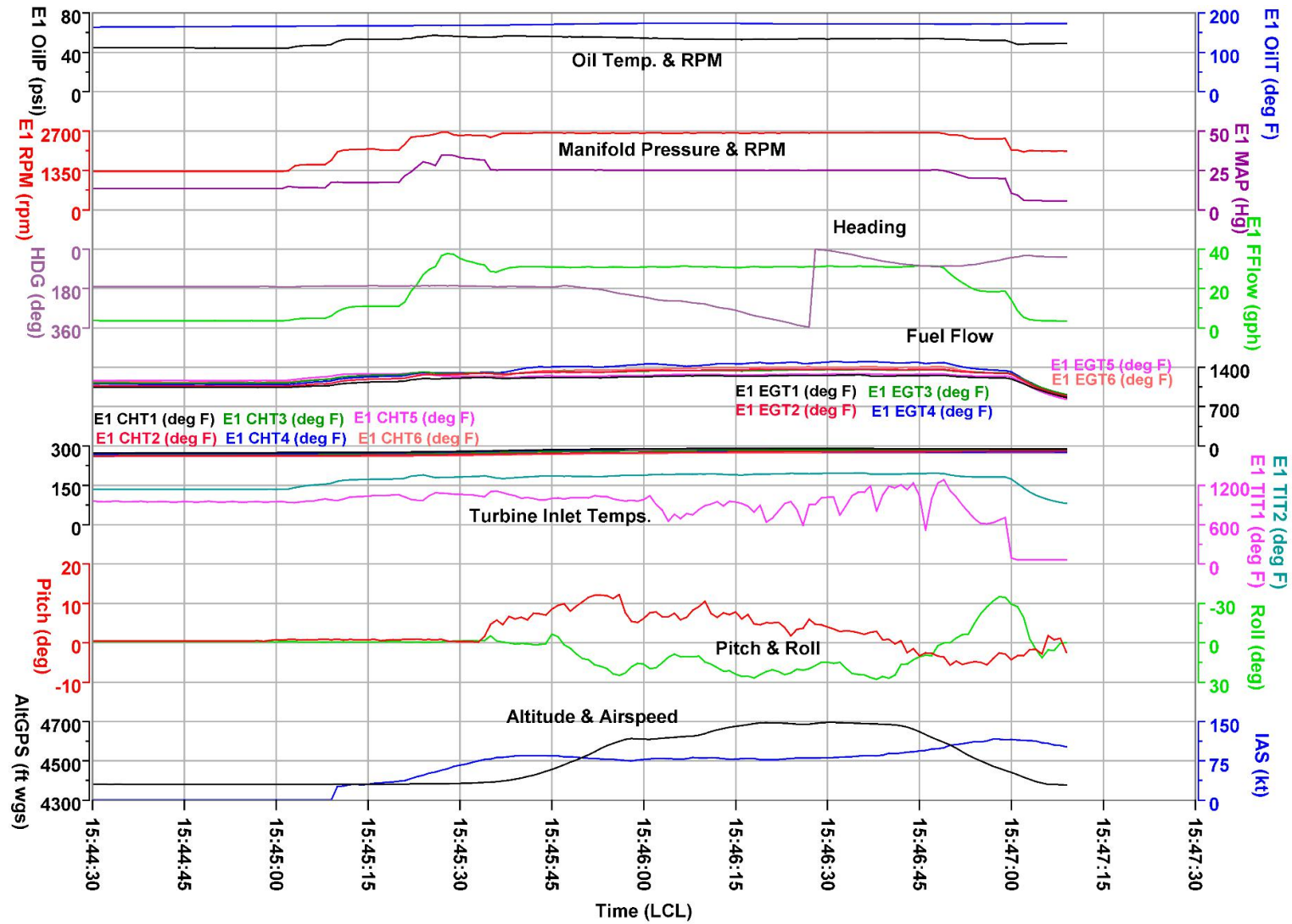


Figure 4. A plot of select parameters for the end portion of the accident recording.



Figure 5. A north up view of the GPS tracklog for the accident flight.

APPENDIX A

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. AfcsOn (discrete)	Automatic Flight Control System On
2. AltBaro (ft)	Barometric Corrected Altitude
3. AltGPS (ft)	GPS Altitude
4. AtvWpt (identifier)	Active Waypoint
5. BaroA(inHg)	Barometric Correction Setting
6. COMM1 (MHz)	VHF Radio 1 (Comm) Tuned Frequency
7. COMM2 (MHz)	VHF Radio 2 (Comm) Tuned Frequency
8. CRS (deg)	Course
9. E1 CHT-# (deg)	Cylinder Head Temperature Cylinder # ³
10. E1 EGT-# (deg)	Exhaust Gas Temperature Cylinder #
11. E1 FFlow (gph)	Engine Fuel Flow
12. E1 ITT-1 (deg)	Engine Inter Turbine Temperature-1 (left side)
13. E1 ITT-2 (deg)	Engine Inter Turbine Temperature-2 (right side)
14. E1 MAP (inHg)	Engine Manifold Pressure
15. E1 OilP (psi)	Engine Oil Pressure
16. E1 OilT (deg)	Engine Oil Temperature
17. E1 RPM (rpm)	Engine Revolutions per minute
18. Fuel Qty-L (gal)	Left Fuel Quantity
19. Fuel Qty-R (gal)	Right Fuel Quantity
20. GndSpd (kts)	Ground Speed
21. GPSFix (discrete)	GPS Fix Type
22. HAL (m)	Horizontal Alert Limit
23. Hdg (deg)	Magnetic Heading
24. HPLfd (m)	Flight Director Horizontal Protection Limit
25. HPLwas (m)	Wide Area Augmentation System Horizontal Protection Limit
26. HSIS (discrete)	Horizontal Situation Indicator Source
27. IAS (kts)	Indicated Airspeed
28. LatAc (g)	Lateral Acceleration
29. Latitude (deg)	Latitude
30. LCL Date (MM/DD/YYYY)	Date
31. Lcl Time (HH:MM:SS)	Recorded Time
32. Longitude (deg)	Longitude
33. NAV1 (MHz)	Navigation Radio 1 Tuned Frequency
34. NAV2 (MHz)	Navigation Radio 2 Tuned Frequency
35. NormAc (g)	Vertical Acceleration
36. OAT (deg C)	Outside Air Temperature

³ Depending on aircraft configuration number of cylinders that are instrumented varies. In the data plots the '#' is replaced with the appropriate cylinder ID.

Parameter Name	Parameter Description
37. Pitch (deg)	Pitch
38. Roll (deg)	Roll
39. TAS (kts)	True Airspeed
40. TRK (deg)	Ground Track
41. UTCOfst (hr)	UTC Time Offset
42. VAL (m)	Vertical Alert Limit
43. Volt1 (V)	Bus 1 Voltage
44. Volt2 (V)	Bus 2 Voltage
45. VPLwas (m)	Wide Area Augmentation System Vertical Protection Limit
46. VSpd (fpm)	Vertical Speed
47. VSpdG (fpm)	GPS Vertical Speed
48. Wind Direction (deg)	Wind Direction
49. Wind Spd (kts)	Wind Speed

Table A-2. Unit abbreviations.

Units Abbreviation	Description
%	percent
%rpm	percent revolutions per minute
A	Amperes
deg	degrees
deg/min	degrees per minute
degC	degrees Celsius
degF	Degrees Fahrenheit
discrete	discrete
ft	feet
gal	gallons
gph	gallons per hour
hrs	hours
in	inches
inHg	inches of Mercury
kts	knots
psi	pounds per square inch
sec	seconds
V	Volts DC

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.