

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN23LA014

ELECTRONIC DEVICES

Specialist's Factual Report

May 15, 2023

Table of Contents

A. ACCIDENT SUMMARY.....	3
B. ELECTRONIC RECORDER DEVICES SPECIALIST	3
C. DETAILS OF THE INVESTIGATION	3
1.0 GARMIN COCKPIT DISPLAY - DESCRIPTION	3
1.1 Garmin Cockpit Display - Recording Description	4
1.1.1 Garmin Cockpit Display - Parameters Provided	4
1.2 Garmin Cockpit Display - Time Correlation	4
2.0 AUSTRO ENGINE EECU - DESCRIPTION	5
2.1 Austro Engine EECU - Recording Description	5
2.1.1 Austro Engine EECU - Parameters Provided	5
2.2 Austro Engine EECU - Time Correlation	6
D. FIGURES AND TABULAR DATA.....	6

A. ACCIDENT SUMMARY

Location: Dallas, Texas
Date: October 15, 2022
Time: 1448 central daylight time (CDT)
Airplane: Diamond Aircraft DA62 (N84LT)

B. ELECTRONIC DEVICES SPECIALIST

Specialist: W. Deven Chen
Electrical Engineer – Recorder Specialist
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

A recorder group was not convened. The NTSB Vehicle Recorder Division received electronic data files from the following electronic devices:

Manufacturer/Model:	Garmin G1000 NXi
Serial Number:	Unknown
Manufacturer/Model:	Austro Engine EECU
Serial Number:	Unknown

1.0 Garmin G1000 NXi – Description

The Garmin G1000 NXi is an Electronic Flight Instrument System (EFIS) that can serve as a Primary Flight Display (PFD), Multi-Function Display (MFD), Engine Information System (EIS), or a combination of all, depending on configuration. Depends on the model, the unit comes with a certain size of LCD display with certain resolution. It contains an Attitude Heading Reference System (AHRS) device and is capable of providing attitude information and air data information. The unit interfaces with a number of other compatible products and can display navigation, terrain, engine, weather, traffic and other parametric data streams. The unit is synthetic vision capable.

Depending on the display unit software, the unit can include a data logging feature. The data logging feature must be enabled by the aircraft operator and an SD card has to be installed in the upper slot of the unit to record data. 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. With a 2 GB SD card, it can store over 1,000 flight hours.

1.1 Garmin G1000 NXi - Recording Description

The received Garmin G100 NXi data contained two flights in comma-separated values (CSV) format. One was the event flight recorded on October 15, 2022, and one previous flight was recorded on October 14, 2022. The data of both flights are included in this report. The event flight on October 15th had a duration of 1 hour 25 minutes and 49 seconds and was recorded from 13:21:46 to 14:47:35, local time. Data were recorded at a rate of one sample per second.

1.1.1 Garmin G1000 NXi - Parameters Provided

Table 1 lists the Garmin G1000 NXi parameters verified and provided in this report.

Table 1. Garmin G1000 NXi data parameters provided.

Parameter Name (unit)	Parameter Description
AltB (ft)	Barometric altitude with reference to a pressure level (feet)
AltMSL (ft)	Geometric altitude above mean sea level (feet)
FQtyL/R (gals)	Fuel quantity at left/right tank (gallons)
E1/2 FFlow (gph)	Engine # fuel flow rate (gallons per hour)
E1/2 FPress (psi)	Engine # fuel pressure (pounds per square inch)
E1/2 OilP (psi)	Engine # oil pressure (pounds per square inch)
E1/2 OilT (deg F)	Engine # oil temperature (degrees Fahrenheit)
E1/2 RPM (rpm)	Engine # rotational speed (revolutions per minute)
E1/2 %Pwr (%)	Engine # linearized power output (percent)
GndSpd (kt)	Average groundspeed between current and previous data point (knots)
HDG (deg)	Aircraft heading with reference to True North (degrees)
IAS (kt)	Indicated airspeed (knots)
LatAc (G)	Lateral acceleration (G)
Latitude (deg)	Geographic latitude (degrees)
Longitude (deg)	Geographic longitude (degrees)
NormAc (G)	Normal acceleration (G)
Pitch (deg)	Pitch angle (degrees)
Roll (deg)	Roll angle (degrees)
TAS (kt)	True airspeed (knots)
TRK (deg)	Aircraft ground track (degrees)
Volts1/2 (volts)	Engine # circuitry bus voltage (volts)
VSpd (fpm)	Vertical speed (feet per minute)

1.2 Garmin G1000 NXi - Time Correlation

The Garmin G1000 NXi recorded data in CDT, the local time of the event.

2.0 Austro Engine EECU - Description

The Austro Engine EECU is the electronic engine control unit of an Austro Engine. The EECU encloses two engine control units (ECUs), ECU A and ECU B. Each ECU contains non-volatile flash memory¹ (NVM) which is used to store 16 channels of signals. These signals are sampled at an interval of 1 second as long as the ECU is powered on. Both ECUs perform this task independently. These signal channels are connected to operational data parameters including Engine Oil Pressure, Coolant Temperature, Intake Air Temperature, Battery Voltage, Power Level Position, Gearbox Oil Temperature, etc. The unit can record these 16 channels at a 1 second sampling rate for about 90 hours of flight time, depending on the number and duration of flights. The oldest data will be overwritten when the memory reach full. In addition, the unit saves failure information into a non-volatile Fault Code Memory (FCM). This FCM can hold up to 20 different detected faults, including 9 environmental conditions (e.g., timestamp, voltage, temperatures, pressures, etc.) which are specific for each possible failure and are sampled and stored at the time the failure occurred. The full contents of the FCM will be included in the engine log file download.

2.1 Austro Engine EECU - Recording Description

The received Austro Engine EECU data were in raw data format. The raw data were sent to the manufacturer for data conversion. According to the manufacturer, the received raw data were from these engines: E4P-C-00142 (right engine) and E4P-C-00143 (left engine). The converted engineering unit data sent back from the manufacturer had two data sets - one for each of the two engines. The right engine data contained 23 sessions of recording, ranging from March 11, 2019, to October 15, 2022, while the left engine data contained only 11 sessions, ranging from May 27, 2022, to October 15, 2022. For the event flight recording, the right engine data had 1 hour 25 minute and 3 seconds of recording, while the left engine data ended much earlier and had only 18 minutes and 46 seconds of recording. Since, the left engine data were very limited, and they were unremarkable, only the right engine data of the event flight is included in this report. Data were recorded at one sample per second rate.

2.1.1 Austro Engine EECU - Parameters Provided

Table 2 lists the Austro Engine EECU right engine parameters verified and provided in this report.

¹ Non-volatile flash memory - electronic memory device that does not need external power for data retention.

Table 2. Austro Engine EECU right engine data parameters provided.

Parameter Name [units]	Parameter Description
nProp [1/min]	Engine Rotational speed [revolutions per minute]
pBoost [hPa]	Boost pressure [hectopascal]
pOilEng [hPa]	Engine oil pressure [hectopascal]
posPL [%]	Linearized power output [percent]
pRail [bar]	Common rail pressure [bar]
tCoolant [degC]	Coolant temperature [degrees Celsius]
tIntakeAir [degC]	Intake air temperature [degrees Celsius]
tOilEng [degC]	Engine oil temperature [degrees Celsius]
tOilGBX [degC]	Gearbox oil temperature [degrees Celsius]
uBatt [V]	Circuitry bus voltage [volts]

2.2 Austro Engine EECU - Time Correlation

The Austro Engine EECU data set was aligned with Garmin G1000 NXi data set based on their common parameter - linearized power output. The plot of E1%Pwr (%) from Garmin G1000 NXi data set showed a dip between 13:41:14 and 13:42:16, and this exact same dip with 62 seconds of duration was shown on the plot of posPL [%] from the Austro Engine EECU data set. Based on these two points, the starting point and the end point of the dip, the two data sets were time aligned. After alignment, the Austro Engine EECU data set showed additional six seconds of recording in the end of the event flight comparing to Garmin G1000 NXi data set. The recording time was from 13:22:39 to 14:47:41, local time. All times are referred to as CDT, the local time of the event for the rest of the report.

D. FIGURES AND TABULAR DATA

Figures 1 and 2 contain Austro Engine EECU right engine data of the event flight on October 15, 2022. Figure 1 shows the entire recording, and figure 2 shows approximately the last eight minutes of recording. The data shows that the right engine circuitry bus voltage was around 27 V the entire recording until 14:47:41, when it suddenly dropped to 11.7 V, and the recording ended right after the voltage drop.

Figures 3 to 10 contain Garmin G1000 NXi data for the event flight and the previous flight.

Figure 3 is a plot of engine parameters for the entire event flight. The time displayed is from 13:20:00 to 14:50:00, CDT.

Figure 4 is a plot of engine parameters for the end of the event flight. The time displayed is from 14:40:00 to 14:48:00, CDT.

Figure 5 is a plot of basic parameters for the entire event flight. The time displayed is from 13:20:00 to 14:50:00, CDT.

Figure 6 is a plot of basic parameters for the end of the event flight. The time displayed is from 14:40:00 to 14:48:00, CDT.

Figure 7 is a plot of engine parameters for the entire previous flight recording on October 14, 2022.

Figure 8 is a plot of basic parameters for the entire previous flight recording on October 14, 2022.

Figures 9 and 10 are Google Earth overlays of the event flight. Figure 9 is a Google Earth overlay of the event flight. Figure 10 is a Google Earth overlay of the final portion of the event flight. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

The corresponding tabular data used to create figures 1 to 10 are provided in CSV format to this report. Attachment 1 is the Austro Engine EECU right engine data. Attachments 2 and 3 are the event flight recording and the previous flight recording from the Garmin G1000 NXi data set, respectively.

Submitted by:

W. Deven Chen
Electrical Engineer – Recorder Specialist

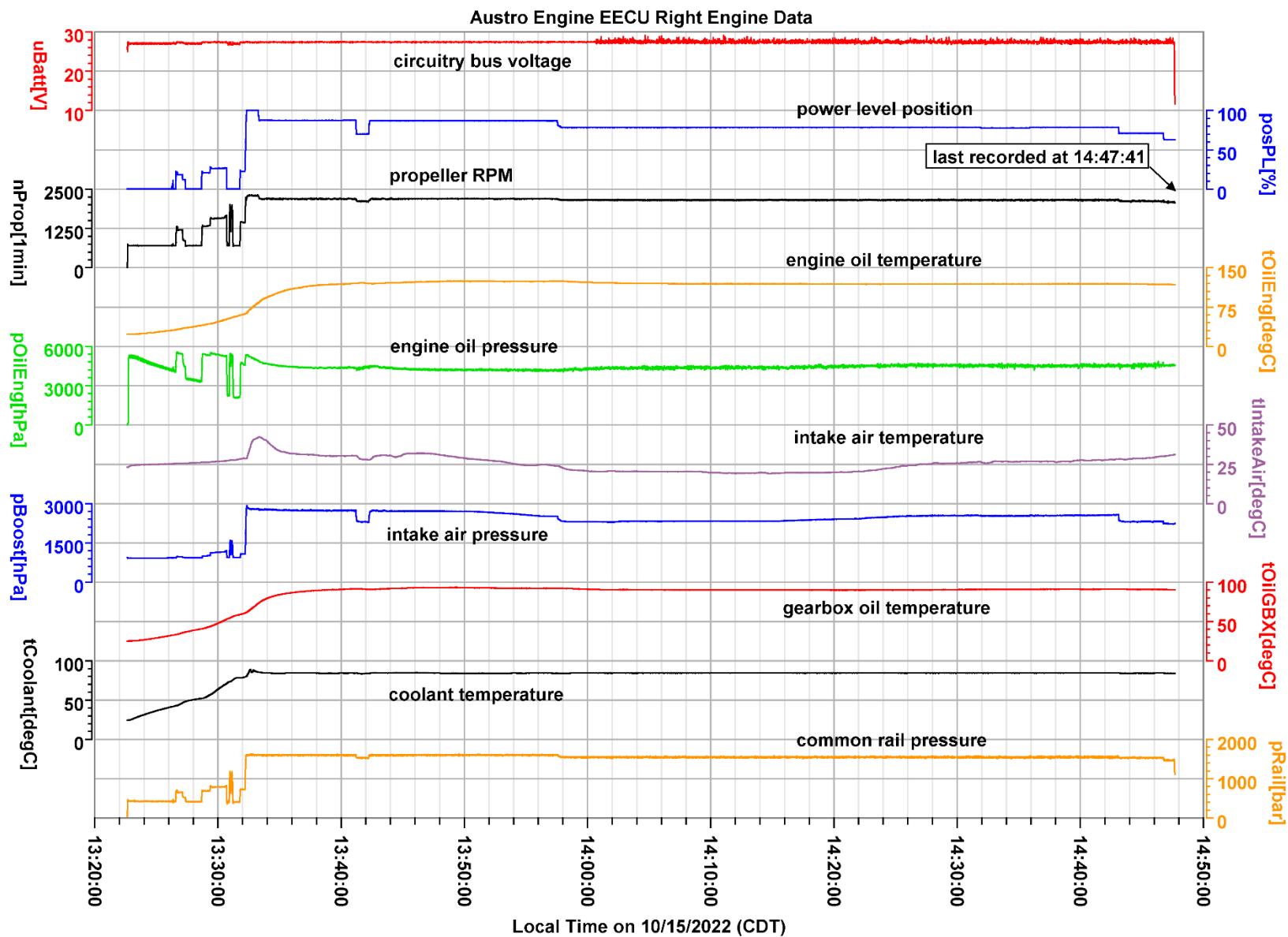


Figure 1. Plot of data parameters of the Austro Engine EECU right engine data for the entire event flight.

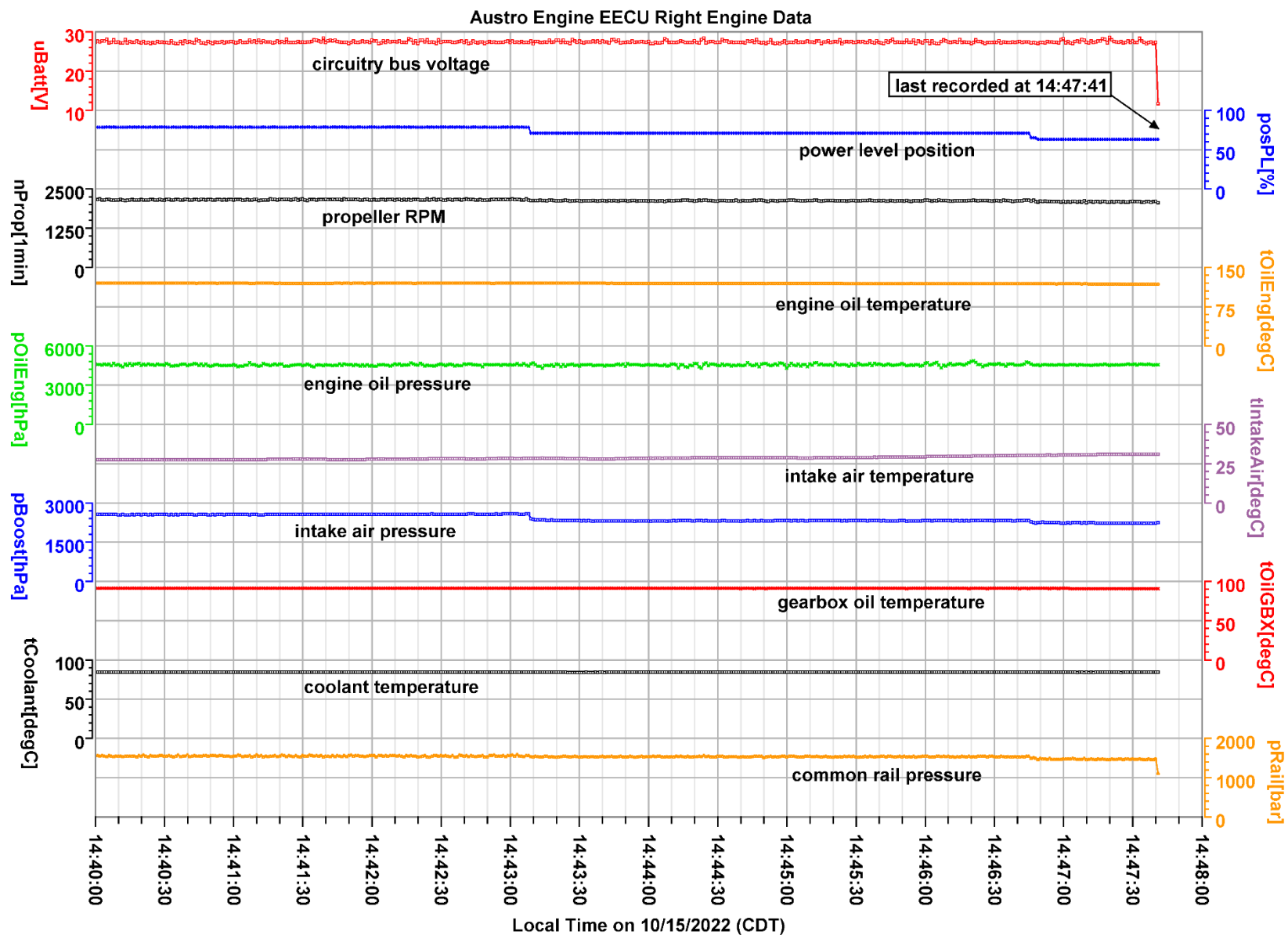


Figure 2. Plot of data parameters of the Austro Engine EECU right engine data for the end of the event flight.

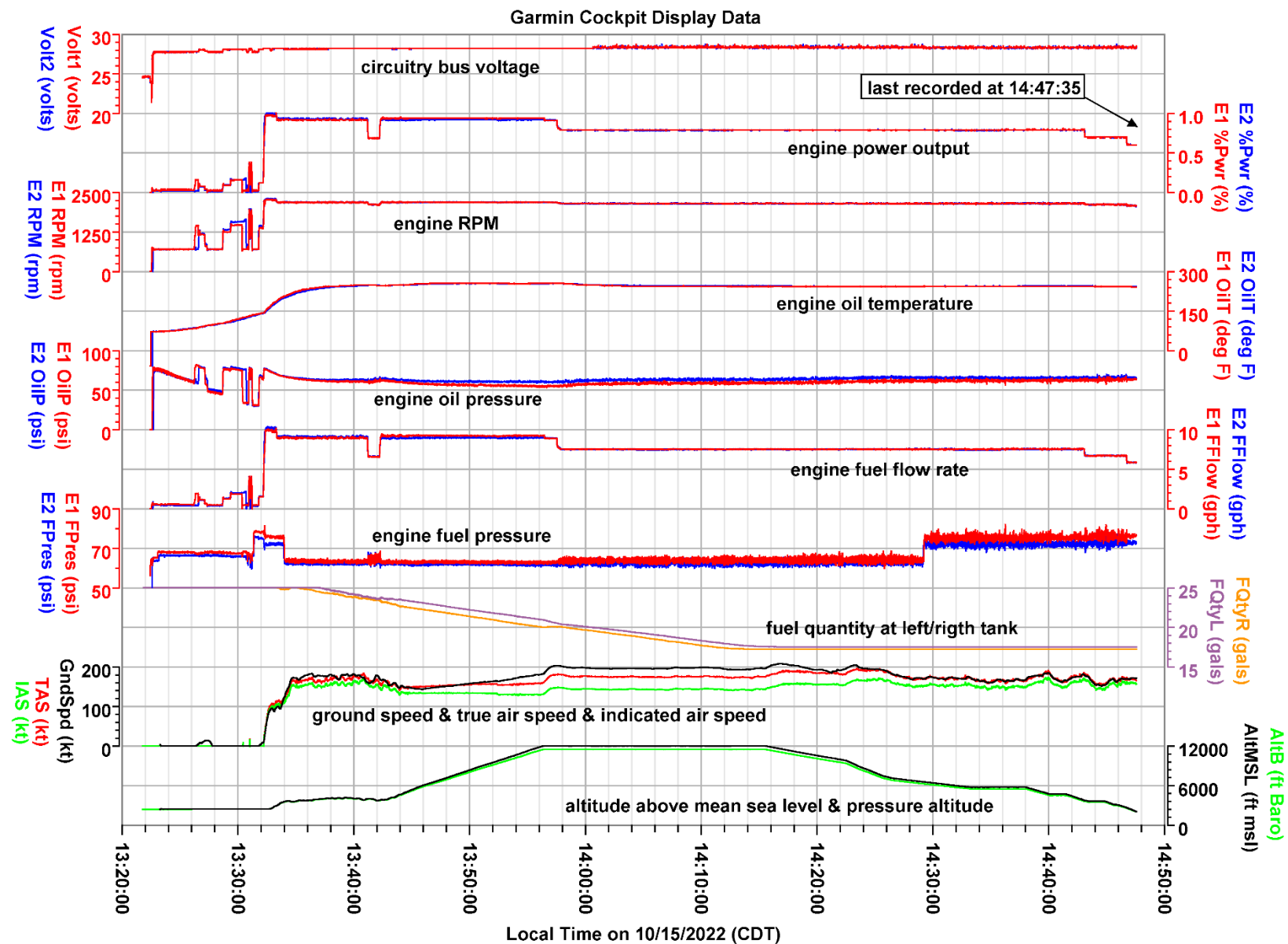


Figure 3. Plot of engine parameters of the Garmin cockpit display data for the entire event flight.

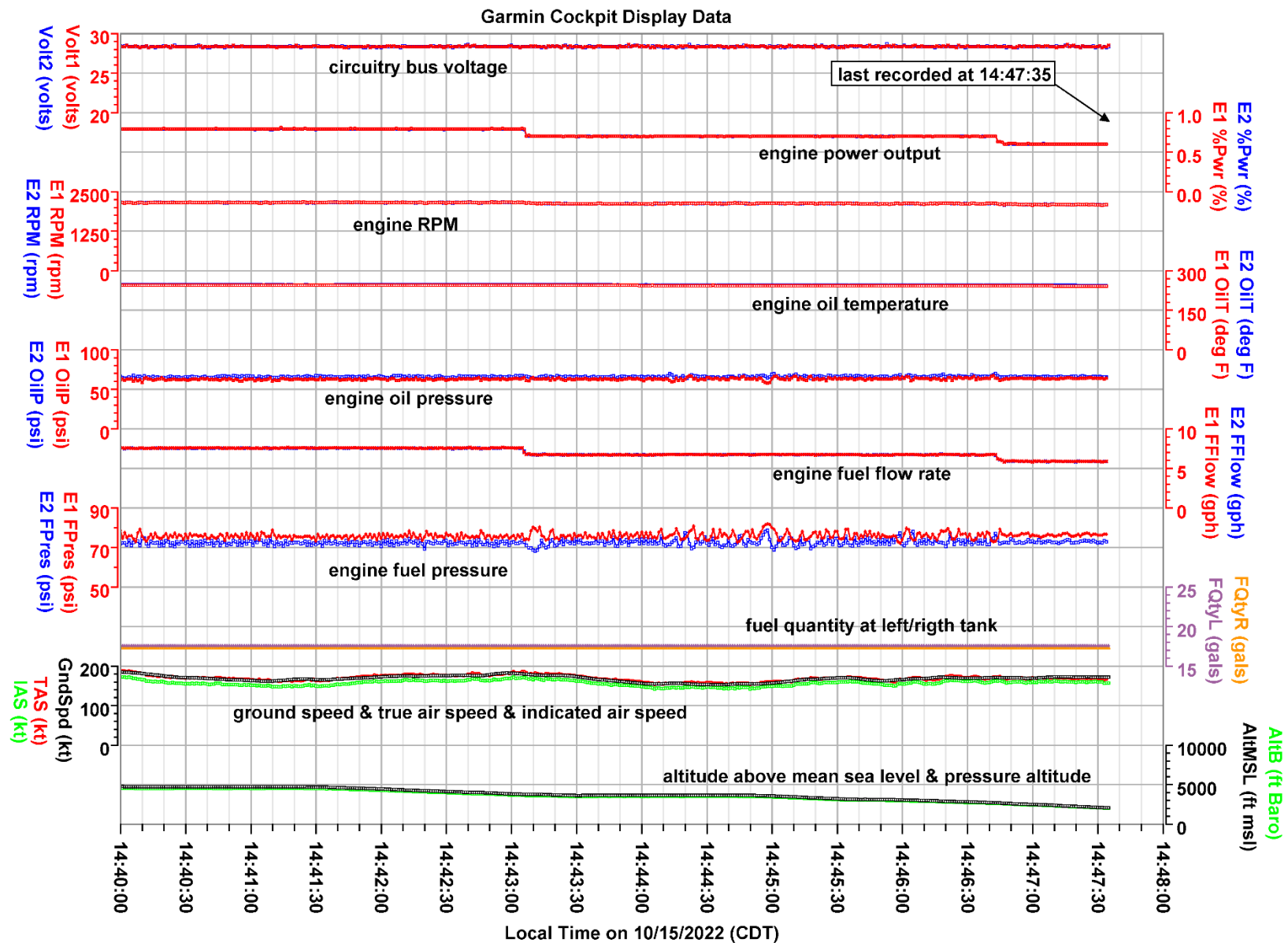


Figure 4. Plot of engine parameters of the Garmin cockpit display data for the end of the event flight.

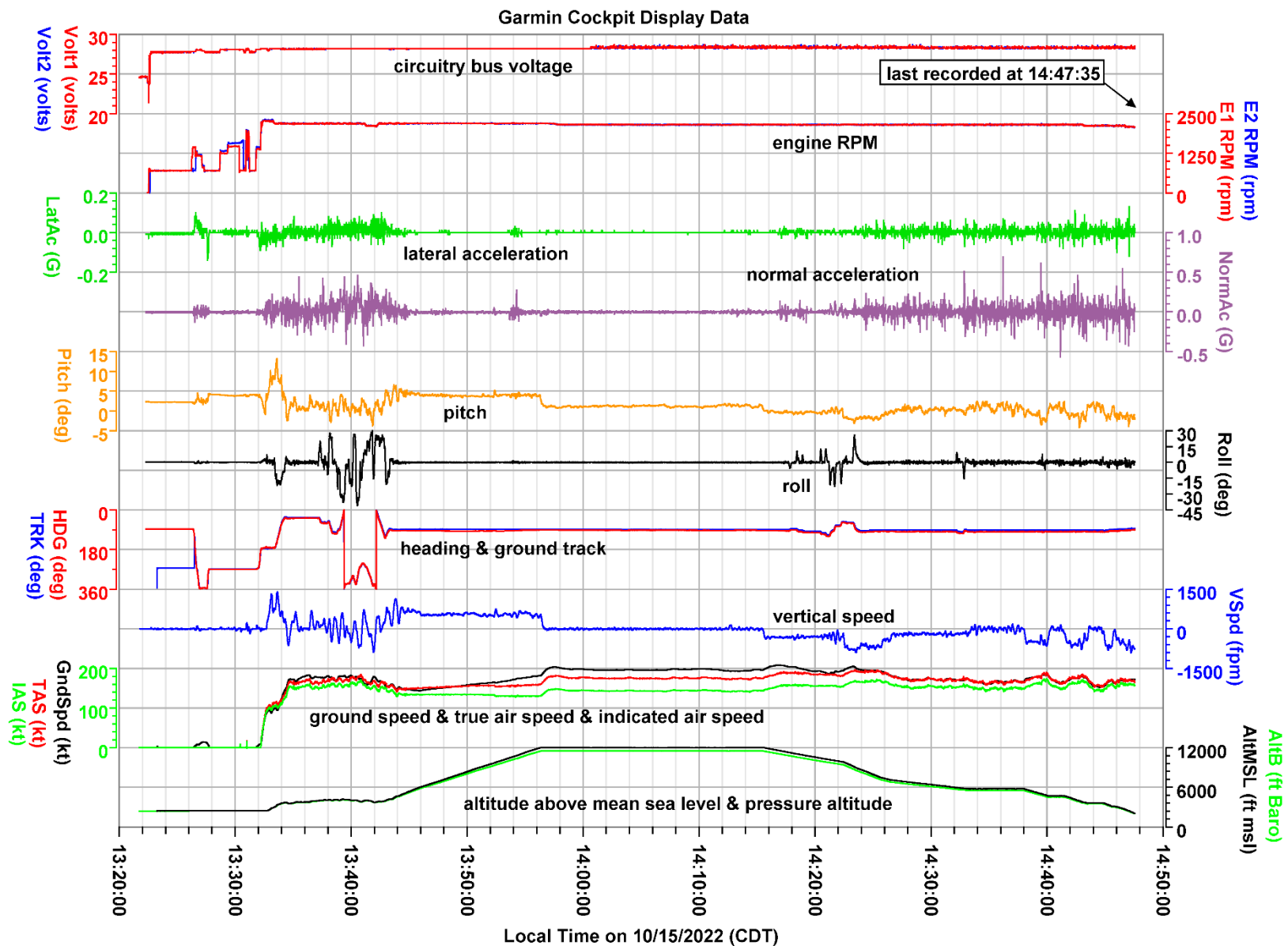


Figure 5. Plot of basic parameters of the Garmin cockpit display data for the entire event flight.



Figure 6. Plot of basic parameters of the Garmin cockpit display data for the end of the event flight.

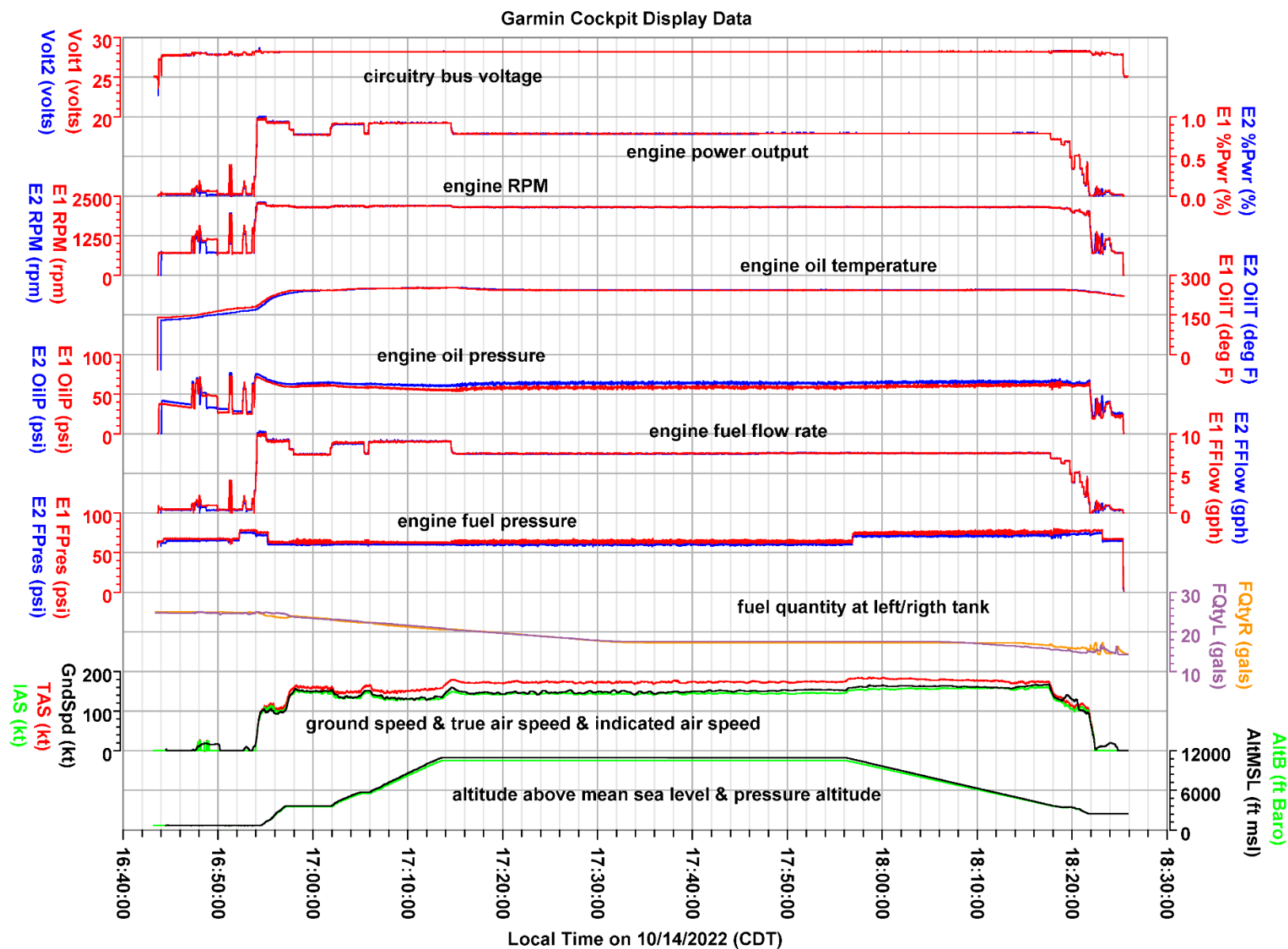


Figure 7. Plot of engine parameters of the Garmin cockpit display data for the entire previous flight on October 14, 2022.

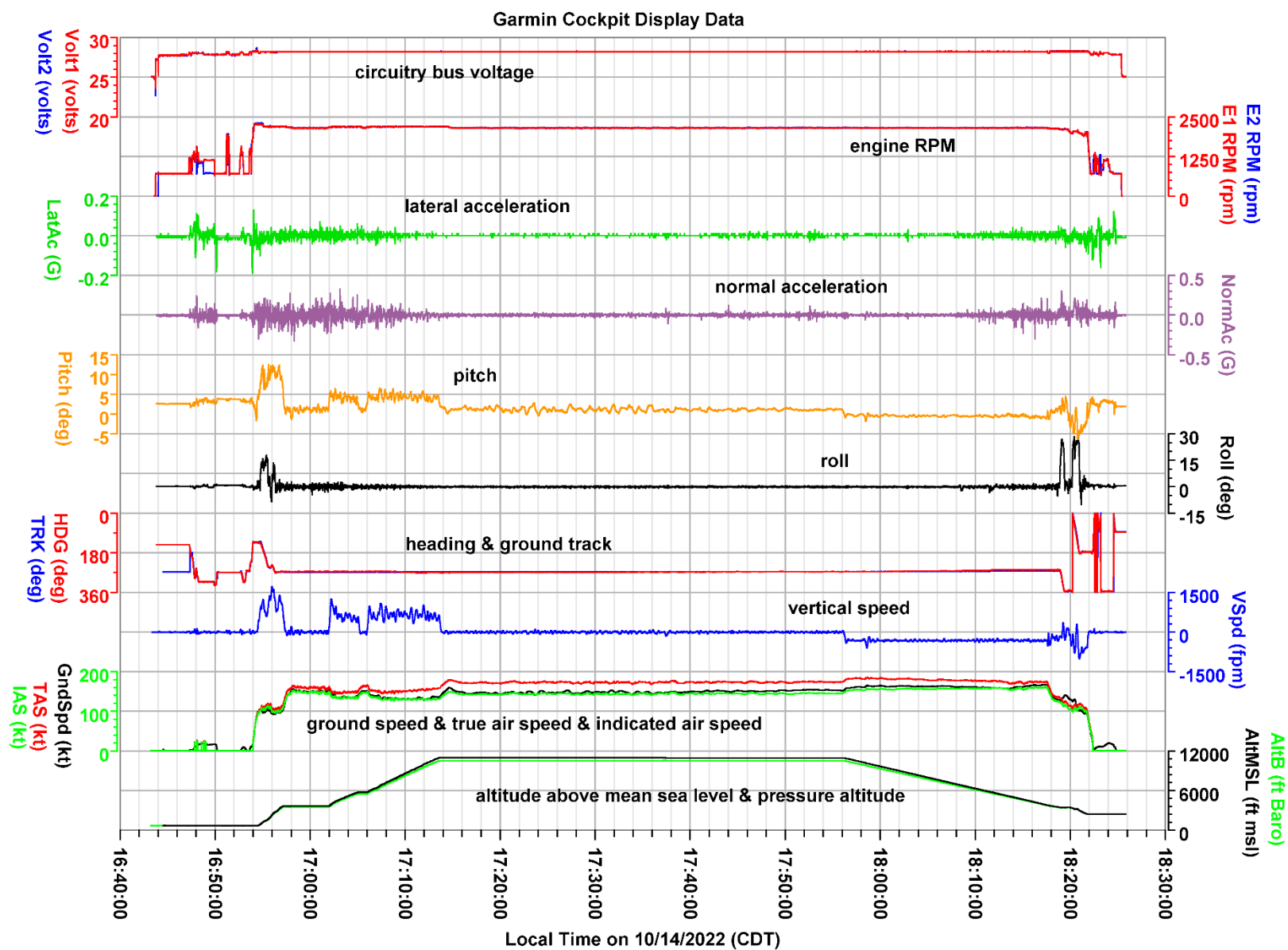


Figure 8. Plot of basic parameters of the Garmin cockpit display data for the entire previous flight on October 14, 2022.

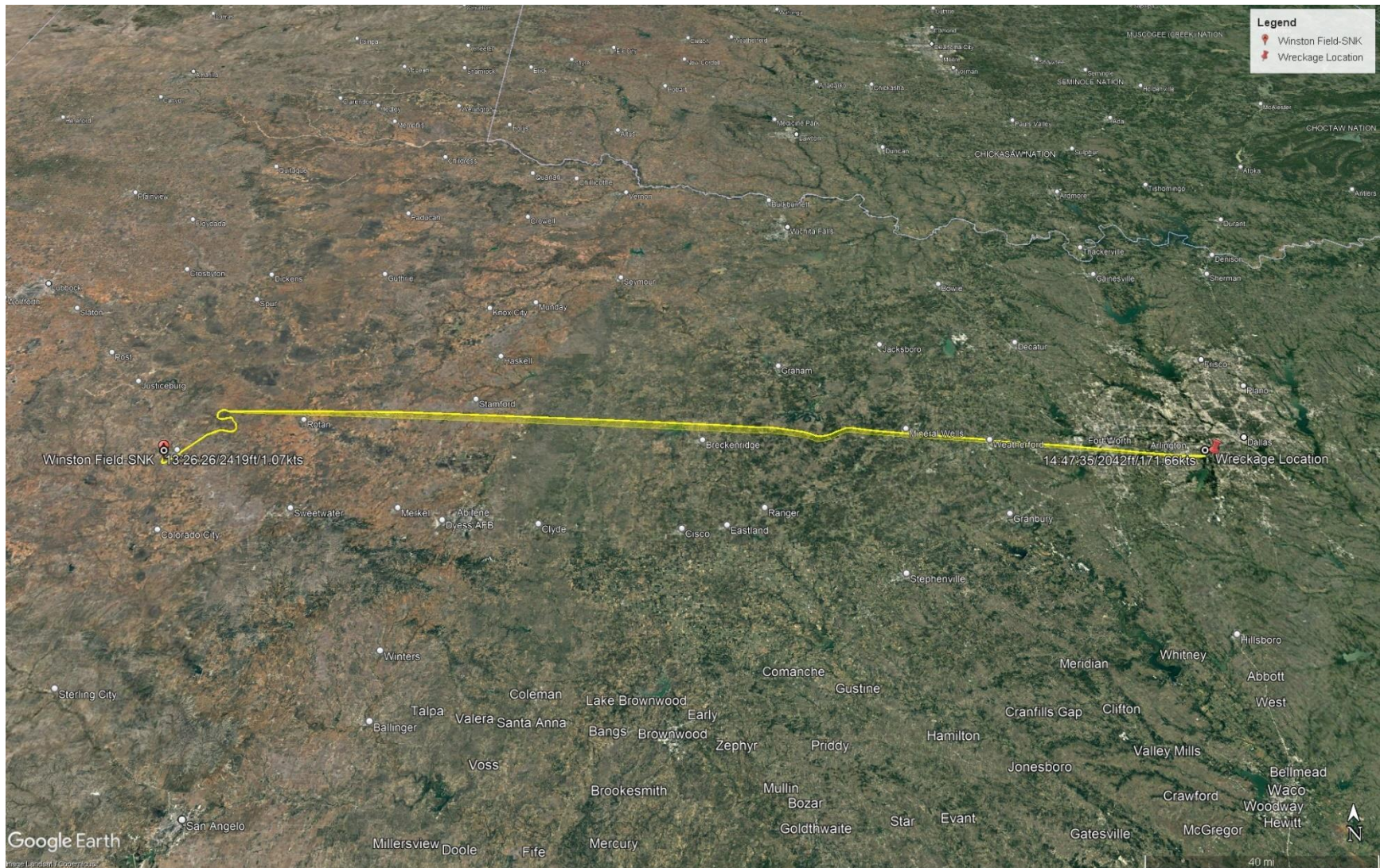


Figure 9. Google Earth overlay showing the entire event flight from the Garmin cockpit display data set.

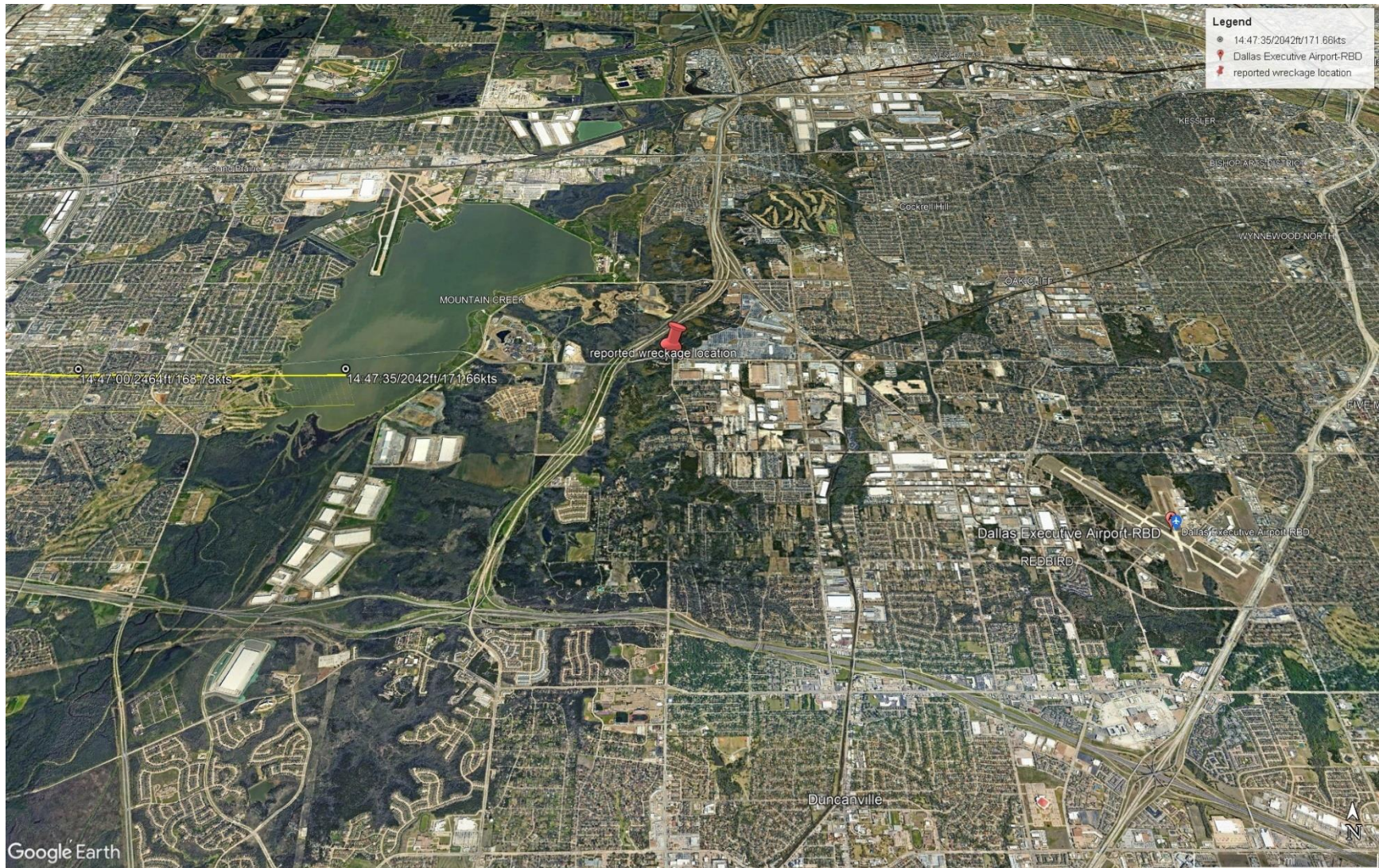


Figure 10. Google Earth overlay showing the end of the event flight from the Garmin cockpit display data set.