

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, D.C. 20594

October 6, 2022

Electronic Devices

Specialist's Factual Report By Gerald Kawamoto

1. EVENT SUMMARY

Location: Katy, Texas
Date: February 11, 2022
Aircraft: Mooney M20J
Registration: N201VZ
Operator: Private
NTSB Number: CEN22LA118

2. GROUP

A group was not convened.

3. DETAILS OF INVESTIGATION

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

Device 1 Manufacturer/Model:	Avidyne Integrated Flight Display (IFD) 440
Device 1 Serial Number:	M192656464
Device 2 Manufacturer/Model:	Garmin GI 275
Device 2 Serial Number:	5MZ202068
Device 3 Manufacturer/Model:	JPI Engine Data Monitor (EDM) 930
Device 3 Serial Number:	09921

3.1. Avidyne IFD 440 Description

The Avidyne IFD 440 is a compact FMS/GPS NAV/COM whose primary function is to conduct nav-com-transponder tuning and communication and serve as the principal navigation sensor/system for all IFR VHF and GPS-based navigation and instrument flying, provided it is connected to an external navigation source selection annunciator and a CDI/HIS indicator that is installed in the required field of view.

Supplemental functions include a moving-map, flight management system (FMS), checklists, and a number of timer and calculator types of utilities. The system includes terrain alerting as well as an option for TAWS.

3.1.1. Avidyne IFD 440 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an external examination revealed the device had sustained minor impact damage, as shown in Figure 1. The device powered on normally and data were exported to a USB memory device using the manufacturer's procedures.



Figure 1. Avidyne IFD 440 as received.

3.1.2. Avidyne IFD 440 Data Description

The device contained sessions recorded from November 23, 2021, through February 12, 2022, Coordinated Universal Time (UTC). The final session started at 00:06:05 UTC and ended at 01:25:40 UTC. Parameters were recorded at various rates ranging from 0.25Hz to 5Hz, as shown in Table 1.

GPS location data were compared to corresponding data from the Garmin GI 275 to correlate offsets between recorded times. Time on the Avidyne was approximately 15 seconds ahead of Garmin GI 275 data.

3.1.3. Avidyne IFD 440 Parameters Provided

Table 1 describes data parameters recorded by the Avidyne IFD 440.

Table 1. Avidyne IFD 440 Parameters.

Parameter Name (units)	Parameter Description (units) - record frequency
Date	Date for recorded data point (MM/DD/YYYY)
Time (UTC)	Time for recorded data point (HH:MM:SS.0)
GPS Latitude (deg)	Latitude (degrees) - 5Hz
GPS Longitude (deg)	Longitude (degrees) - 5Hz
MSL Altitude (ft)	MSL Altitude (feet) - 1Hz
GPS Altitude (ft)	GPS Altitude (feet) - 1Hz
Pressure Altitude (ft)	Pressure Altitude (feet) - 5Hz
Indicated Airspeed (kts)	Indicated Airspeed (knots) - 5Hz
True Airspeed (kts)	True Airspeed (knots) - 5Hz
Ground Speed (kts)	Ground Speed (knots) - 1Hz
Magnetic Heading (deg)	Magnetic Heading (degrees) - 5Hz
Vertical Speed (ftmin)	Vertical Speed (feet per minute) - 5Hz
Fuel Flow (gph)	Fuel Flow (gallons per hour) - 0.25Hz
Fuel Remaining (gal)	Fuel Remaining (gallons) - 0.25Hz
Fuel Used (gal)	Fuel Used (gallons) - 0.25Hz
OAT (degC)	Outside Air Temperature (degrees Celsius) - 1Hz

3.2. Garmin GI 275 Description

The Garmin GI 275 is a Multi-Function Instrument (MFI) with a 2.7-inch display. The function of the device varies depending on the unit configuration. The five instrument functions are Attitude Indicator (AI/ADI), Horizontal Situation Indicator (HSI), Course Deviation Indicator (CDI), Multi-Function Display (MFD), and Engine Indication System (EIS). The instrument can relay information to and process data from compatible devices such as a Primary Flight Displays (PFDs), Air Data Computers (ADC), Attitude and Heading Reference Systems (AHRS), and more.

3.2.1. Garmin GI 275 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an external examination revealed the device had sustained minor damage, as shown in Figure 2. The device powered on normally and data were exported to an external USB memory device.



Figure 2. Garmin GI 275 as received.

3.2.2. Garmin GI 275 Data Description

The device contained sessions recorded from September 23, 2021, through February 12, 2022. Upon powering on the device, it appeared the function of the device was an Attitude Indicator, as shown in Figure 3. The final session started at 00:05:26 and ended at 01:24:50 Device Time¹. Data were recorded at a one-sample-per-second rate.



Figure 3. Garmin GI 275 powered on.

3.2.3. Garmin GI 275 Parameters Provided

Table 2 describes data parameters recorded by the Garmin GI 275.

¹ Data parameters were compared to corresponding parameters on the Avidyne IFD 440 and it was determined that the time on the Garmin GI 275 lagged the time on the Avidyne device by approximately 15 seconds. This offset has been applied to Garmin GI 275 plots such that all data in this report are represented in UTC.

Table 2. Garmin GI 275 Parameters

Parameter Name (units)	Parameter Description (units)
Date	Date for recorded data point (MM/DD/YYYY)
Time (Device Time)	Time for recorded data point (HH:MM:SS)
AltB (ft)	Barometric Altitude (feet)
AltMSL (ft)	MSL Altitude (feet)
AltGPS (ft)	GPS Altitude (feet)
AltPress (ft)	Pressure Altitude (feet)
IAS (kts)	Indicated Airspeed (knots)
GndSpd (kts)	Ground Speed (knots)
TRK (deg)	Ground Track (degrees)
Roll (deg)	Roll Angle (degrees)
Pitch (deg)	Pitch Angle (degrees)
VSpd (fpm)	Vertical Speed (feet per minute)
NormAc (G)	Normal Acceleration (G)
LatAc (G)	Lateral Acceleration (G)

3.3. JPI EDM-930 Description

The J. P. Instruments EDM-930 is a panel mounted display that the operator can monitor and record multiple engine parameters related to engine operations and GPS parameters, if connected. Depending on the installation, engine parameters monitored can include: Exhaust Gas Temperature (EGT), Cylinder Head Temperature (CHT), Oil Pressure and Temperature, Manifold Pressure, Outside Air Temperature, Turbine Inlet Temperature, Engine Revolutions per Minute, Compressor Discharge Temperature, Fuel Flow, Fuel Pressure, Fuel Level, Carburetor Temperature, and Battery Voltage.

The unit can also calculate, in real-time, horsepower, fuel used, shock cooling rate and EGT differentials between the highest and lowest cylinder temperatures. The calculations are also based on the aircraft installation.

The unit contains non-volatile memory for data storage of the parameters recorded and calculated.² The rate at which the data is stored is selectable by the operator from 1 to 500 seconds per sample. Data recording typically begins when RPM is greater than 500 rpm. The memory can typically store over 300 hours of data at a 6 second sample rate. For a non-damaged unit, the data can then be downloaded by the operator using a USB flash drive and following the instructions on the unit.

² Non-volatile memory (NVM) is semiconductor memory that does not require external power for data retention.

3.3.1. JPI EDM-930 Data Recovery

Upon arrival at the Vehicle Recorder Laboratory, an external examination revealed the device had sustained damage to the display, as shown in Figure 1, rendering it inoperable. The internal components were in good condition and the device was downloaded using procedures outlined by the manufacturer.



Figure 4. JPI EDM-930 as received.

3.3.2. JPI EDM-930 Data Description

The EDM contained sessions recorded from December 7, 2021, through February 11, 2022, JPI Time.

The final session started at 18:04:58 JPI Time and ended at 19:24:58 JPI Time. The EDM records time with the first data sample based on the unit's internal clock, which is set and updated by the operator. The internal time was unable to be observed due to the condition of the display. To correlate the device's recorded time to a standard time, the fuel flow parameter recorded was compared to the fuel flow parameter recorded on the Avidyne IFD 440. An offset of 6 hours and 49 seconds (21649 seconds) was applied to the JPI data to align the corresponding parameters. All JPI plots are represented in UTC with the applied offset.

The device recorded at a 3 second-per-sample rate. The engineering unit conversions used for the data contained in this report are based on documentation from the manufacturer of the EDM.

3.3.3. JPI EDM-930 Parameters Provided

Table 3 describes data parameters recorded by the device.

Table 3. JPI EDM-700 Parameters.

Parameter Name (units)	Parameter Description (units)
Date	Date for recorded data point (MM/DD/YYYY)
Time (JPI Time)	Time for recorded data point (HH:MM:SS)
E1-4 (degF)	Exhaust Gas Temperature Cylinder # (degrees Fahrenheit)
C1-4 (degF)	Cylinder Head Temperature Cylinder # (degrees Fahrenheit)
CLD (degF/min)	Shock Cooling Rate (degrees Fahrenheit per minute)
FF (gph)	Fuel Flow (gallons per hour)
USD (gal)	Fuel Used (gallons)
LFL (gal)	Left Fuel Level (gallons)
RFL (gal)	Right Fuel Level (gallons)
FP (psi)	Fuel Pressure (pounds per square inch)
HP (%)	Horsepower (percent)
MAP (inHg)	Manifold Pressure (inches of Mercury)
RPM	Engine Revolutions Per Minute
OilP (psi)	Oil Pressure (pounds per square inch)
OilT (degF)	Oil Temperature (degrees Fahrenheit)

3.4. Plots and Corresponding Tabular Data

Figures 5 through 13 contain data for the accident flight.

Figures 5 through 7 are graphical overlays generated using Google Earth showing the recorded data from the Avidyne IFD 440. Weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording. Flight tracks from the Garmin GI 275 data aligned with the Avidyne data. The Avidyne data provided the highest resolution flight track in addition to approximately 35 seconds of additional data beyond the final data points of Garmin. Indicated Airspeed (IAS) and Pressure Altitude values are depicted on the flight track.

Figure 8 is a plot of Avidyne IFD 440 parameters for the entire accident flight. The time interval displayed is 00:00:00 to 01:30:00 UTC.

Figure 9 is a plot of Avidyne IFD 440 parameters for the last five minutes of the accident flight. The time interval displayed is 01:21:00 to 01:25:45 UTC.

Figure 10 is a plot of Garmin GI 275 parameters for the entire accident flight. The time interval displayed is 00:00:00 to 01:30:00 UTC.

Figure 11 is a plot of Garmin GI 275 parameters for the last five minutes of the accident flight. The time interval displayed is 01:21:00 to 01:25:45 UTC.

Figure 12 is a plot of JPI EDM-930 parameters for the entire accident flight. The time interval displayed is 00:00:00 to 01:30:00 UTC.

Figure 13 is a plot of JPI EDM-930 parameters for the last five minutes of the accident flight. The time interval displayed is 01:21:45 to 01:26:00 UTC.

The corresponding tabular data used to create these nine plots are provided in electronic (*.csv) format as attachments to this report.³ Attachment 1 contains Avidyne data, Attachment 2 contains Garmin data, and Attachment 3 contains JPI data.

³ Comma Separated Value format.

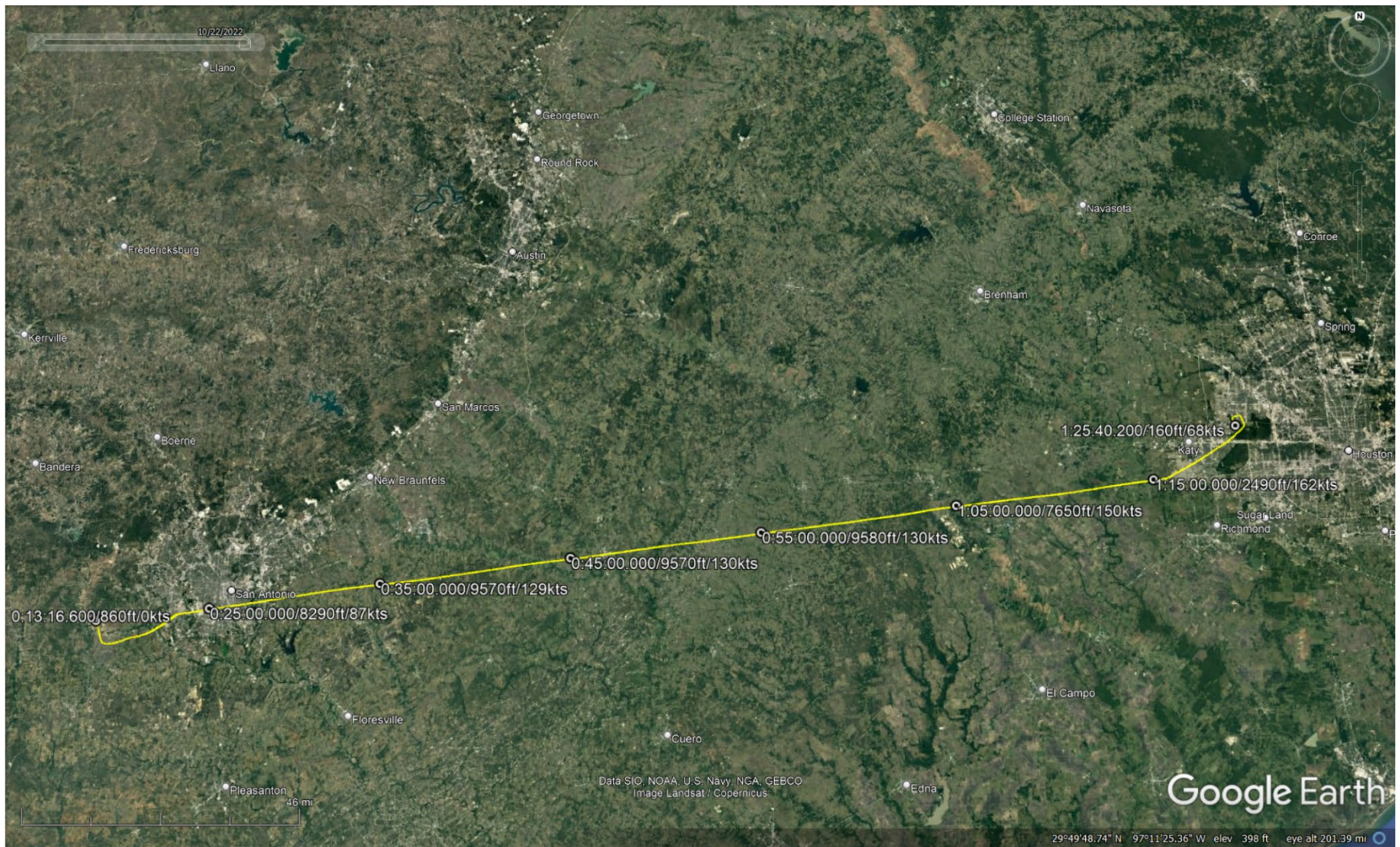


Figure 5. Google Earth overlay of the entire accident flight recorded on the Avidyne IFD 440. IAS and Pressure Altitude are shown.

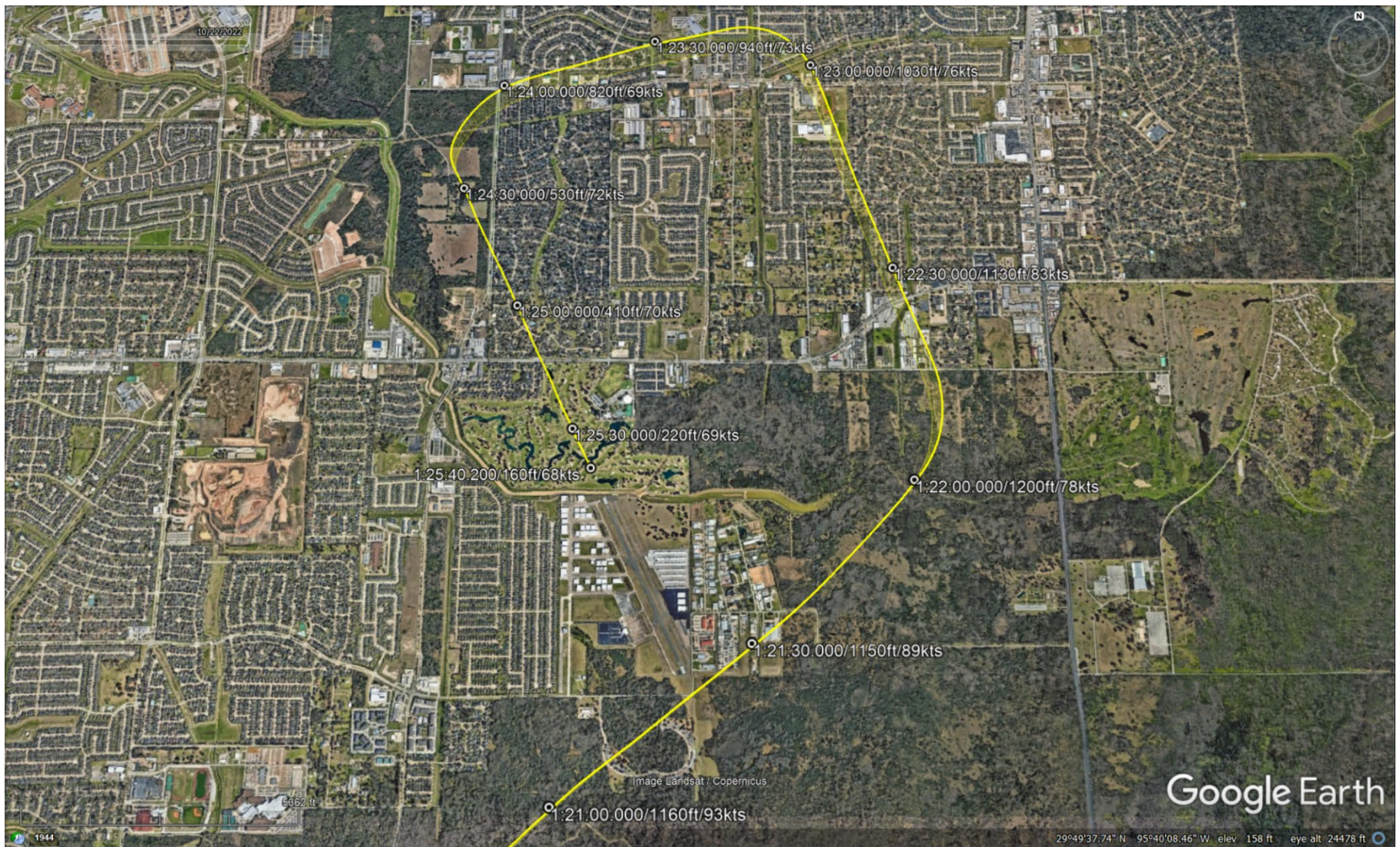


Figure 6. Google Earth overlay of the final 5 minutes of the accident flight recorded on the Avidyne IFD 440. IAS and Pressure Altitude are shown.



Figure 7. Google Earth overlay of the end of the accident flight recorded on the Avidyne IFD 440 and the reported wreckage location. IAS and Pressure Altitude are shown.

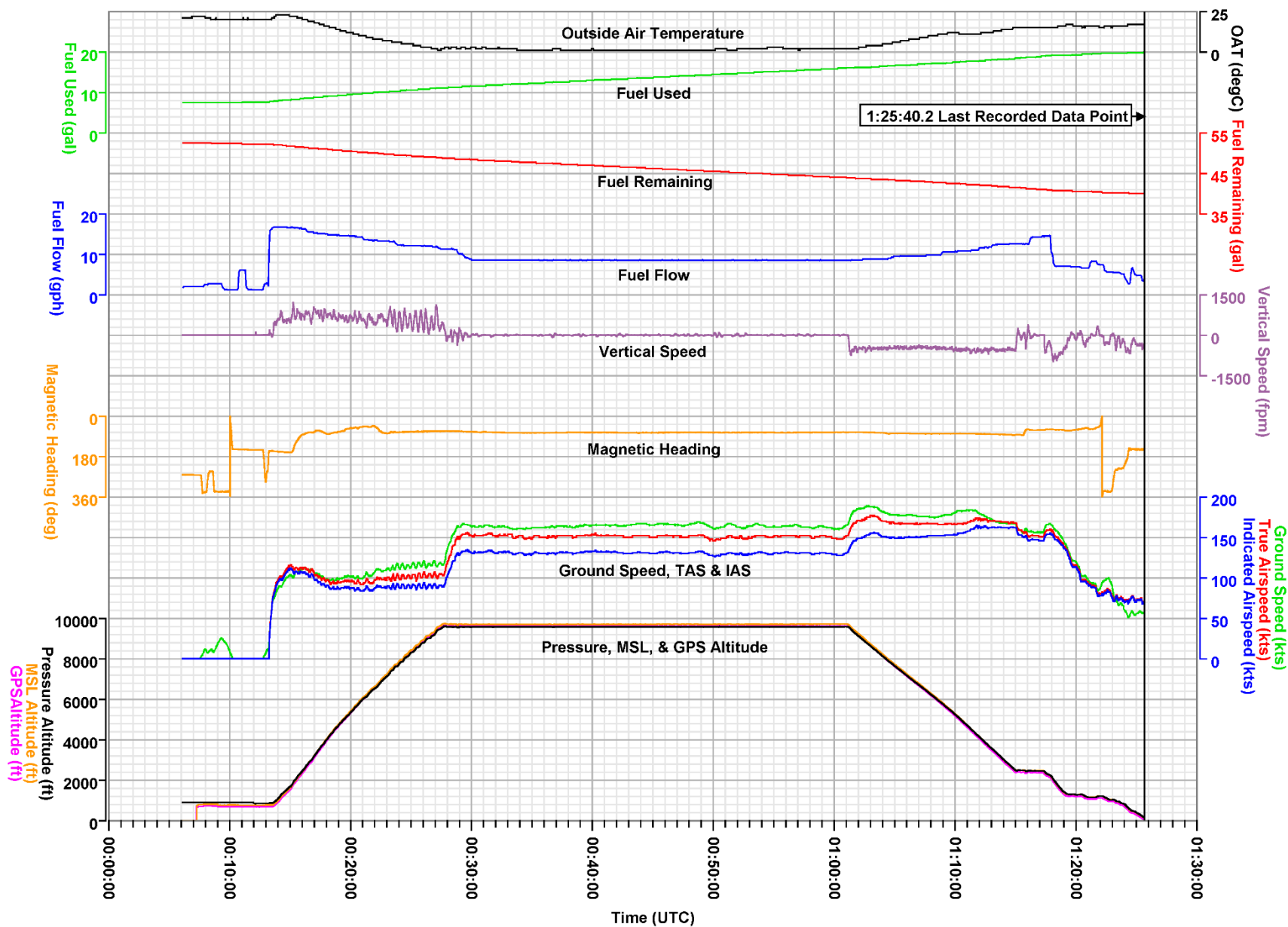


Figure 8. Plot of Avidyne IFD 440 parameters for the entire accident flight.

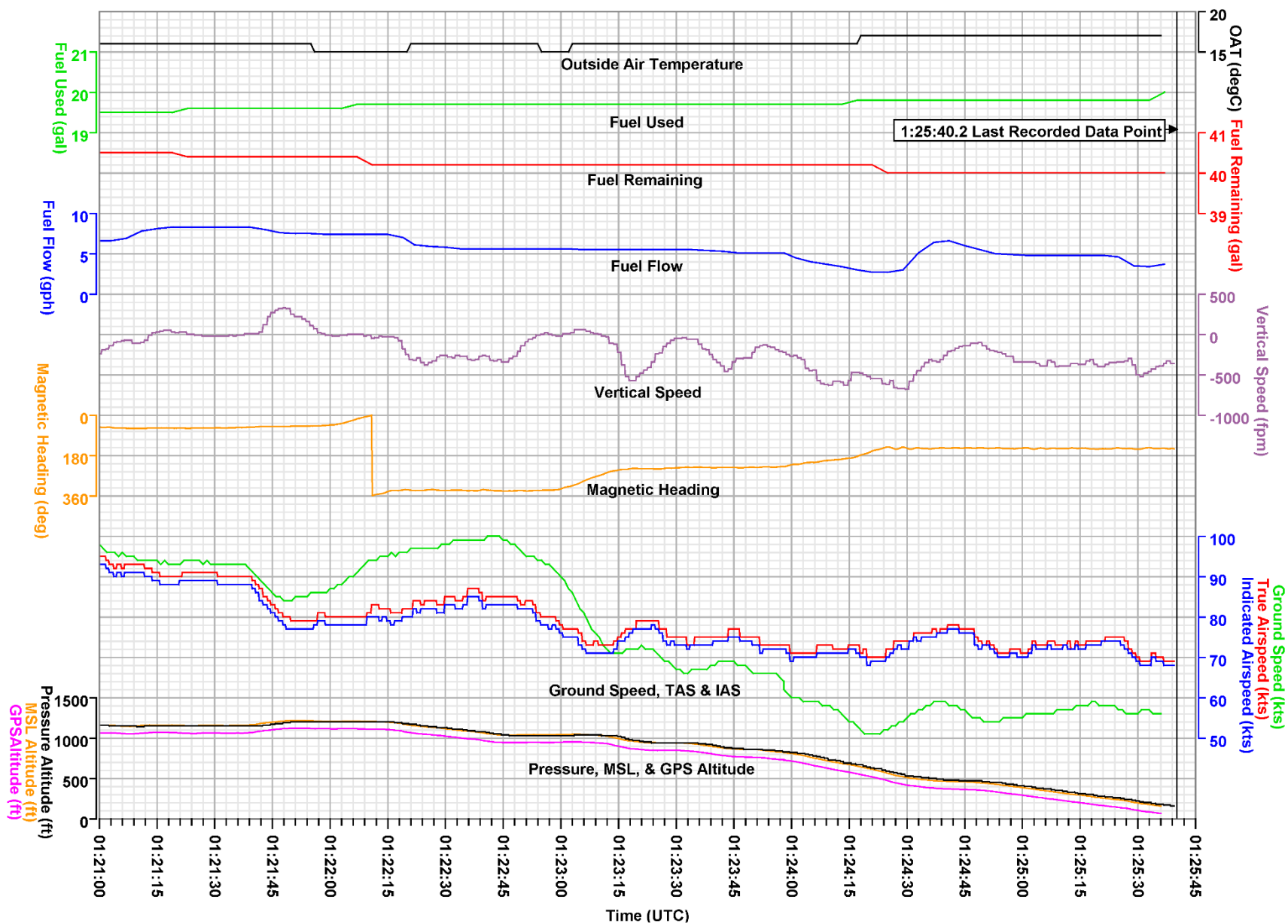


Figure 9. Plot of Avidyne IFD 440 parameters for the last five minutes of the accident flight.

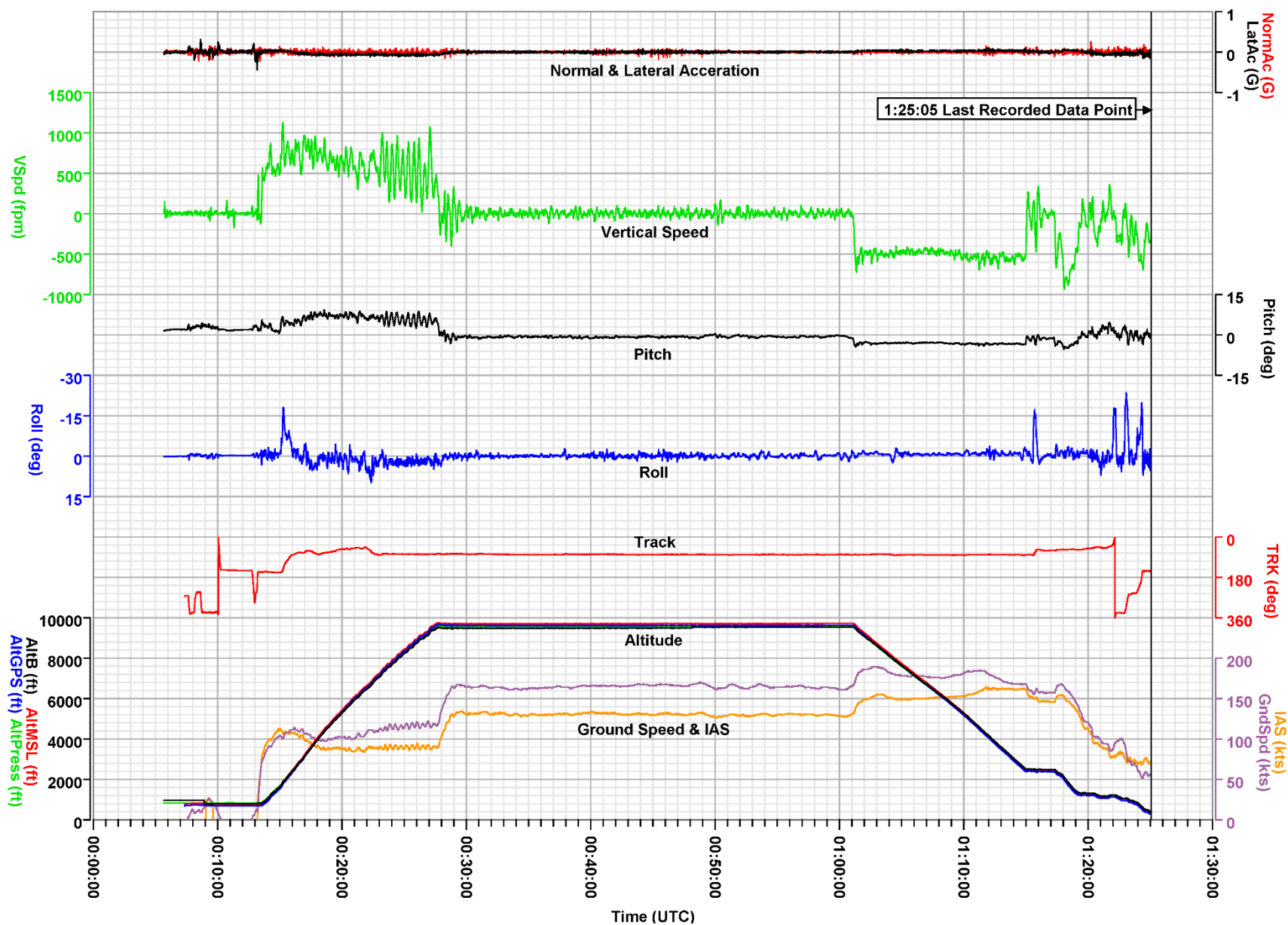


Figure 10. Plot of Garmin GI 275 parameters for the entire accident flight.

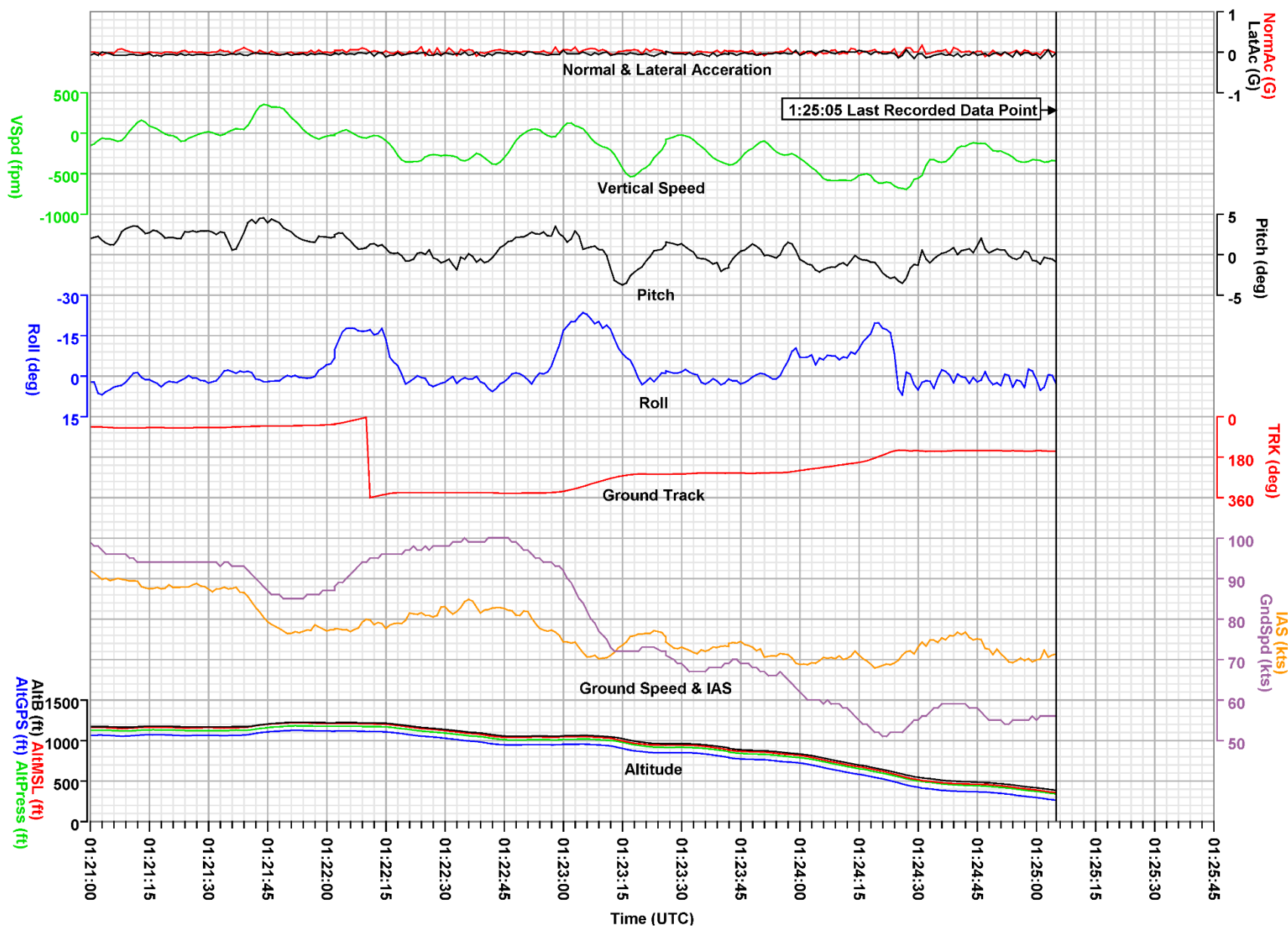


Figure 11. Plot of Garmin GI 275 parameters for the last five minutes of the accident flight.

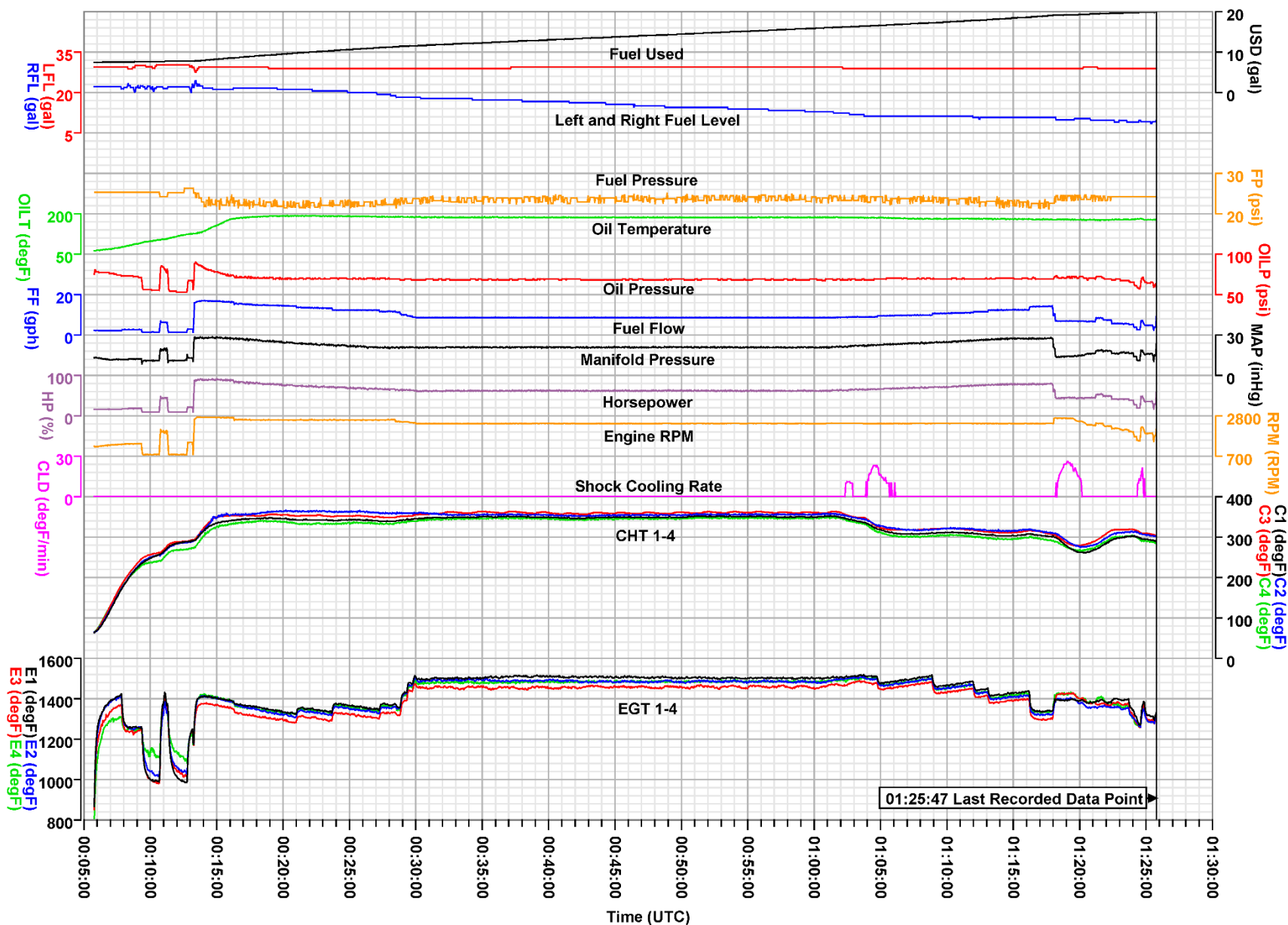


Figure 12. Plot of JPI EDM-930 parameters for the entire accident flight.

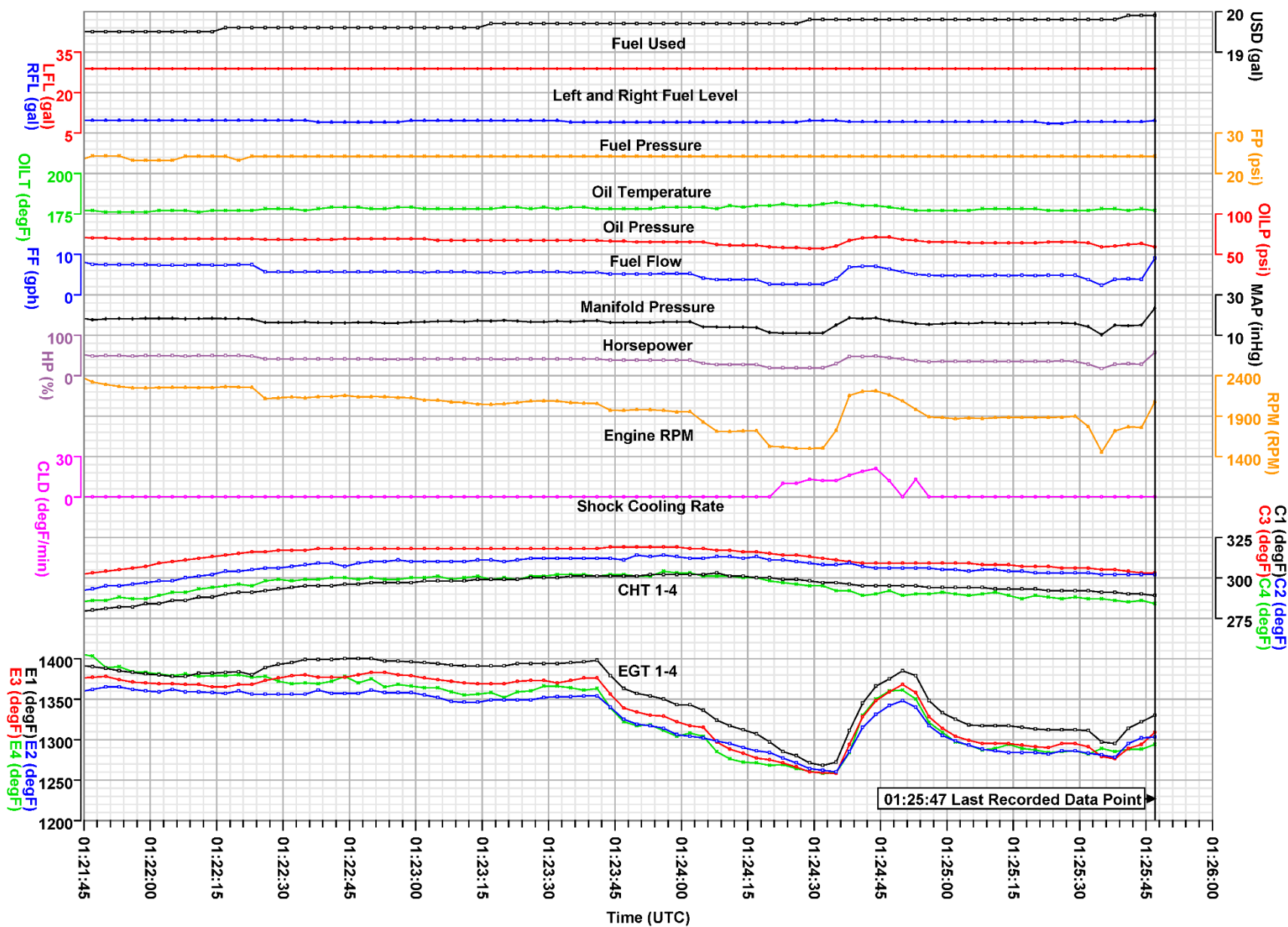


Figure 13. Plot of JPI EDM-930 parameters for the last five minutes of the accident flight.