

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



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FLIGHT DATA RECORDER

Specialist's Factual Report

October 20, 2023

TABLE OF CONTENTS

A. INCIDENT	2
B. FLIGHT DATA RECORDER SPECIALIST	2
C. FEDERAL CARRIAGE REQUIREMENTS.....	2
D. DETAILS OF THE INVESTIGATION	2
1.0 FDR DESCRIPTIONS	2
1.1 FDR Conditions	3
1.2 Recording Descriptions	3
1.2.1 Engineering Unit Conversions	3
1.3 Time Correlations	4
1.4 Pressure Altitude.....	4
E. FIGURES AND TABULAR DATA.....	4
APPENDIX A. VERIFIED AND PROVIDED PARAMETERS	19

A. INCIDENT

Location: Austin, Texas
Date: February 4, 2023
Time: 06:30 central standard time (CST)
Airplane 1: Boeing 767-300, FedEx Express¹, N297FE
Airplane 2: Boeing 737-700, Southwest Airlines², N7827A

B. FLIGHT DATA RECORDER SPECIALIST

Specialist Kyle Garner
Aerospace Engineer - Recorder Specialist
National Transportation Safety Board (NTSB)

C. FEDERAL CARRIAGE REQUIREMENTS

The airplanes involved were operating under the provisions of Title 14 *Code of Federal Regulations* (CFR) Part 121 and were required to be equipped with a flight data recorder (FDR) that recorded, at a minimum, 88 parameters, as cited in 14 CFR Part 121.344(f).

D. DETAILS OF THE INVESTIGATION

An FDR group was not convened. The NTSB Vehicle Recorder Division received the following FDRs:

Airplane 1 (FedEx):

Recorder Manufacturer/Model: Honeywell HFR5-D
Part Number: 980-4750-003
Recorder Serial Number: FDR-05856

Airplane 2 (Southwest):

Recorder Manufacturer/Model: Honeywell 4700
Part Number: 980-4700-042
Recorder Serial Number: 4505

1.0 FDR Descriptions

An FDR records airplane flight information in a digital format using solid-state flash memory as the recording medium. FDRs receive data formatted in the ARINC

¹ Referred to as FedEx in this report.

² Referred to as Southwest in this report.

573/717/747 configurations and are required to record a minimum of 25 hours of flight data. FDRs are configured to record a set number of 12-bit words of digital information every second. Each grouping of words is called a subframe and is identified with a subframe reference number (SRN). Each subframe has a unique 12-bit synchronization (sync) word identifying it as subframe 1, 2, 3, or 4. The sync word is the first word in each subframe. Each data parameter (altitude, heading, and airspeed) has a specifically assigned word number within the subframe.

Airplane 1 (FedEx):

The Honeywell HFR5-D FDR was configured to record 512 12-bit words of digital information every second and was designed to meet the crash-survivability requirements of TSO-C124b.

Airplane 2 (Southwest):

The Honeywell 4700 FDR was configured to record 256 12-bit words of digital information every second and was designed to meet the crash-survivability requirements of TSO-C124a.

1.1 FDR Conditions

The recorders were in good condition and the data were extracted normally from the recorders using instructions provided by the recorder manufacturers.

1.2 Recording Descriptions

Airplane 1 (FedEx):

The FDR recording contained approximately 57 hours of data. The incident flight was the second to last flight of the recording, and its duration was approximately 1 hour and 31 minutes. The parameters evaluated for this report appeared to be in accordance with federal FDR carriage requirements.

Airplane 2 (Southwest):

The FDR recording contained approximately 27 hours of data. The incident flight was the second to last flight of the recording, and its duration was approximately 1 hour and 54 minutes. The parameters evaluated for this report appeared to be in accordance with federal FDR carriage requirements.

1.2.1 Engineering Unit Conversions

The engineering unit conversions used for the data contained in this report are based on documentation from the aircraft manufacturer and operators. 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=+).³

1.3 Time Correlations

Airplane 1 (FedEx):

The correlation of the FDR data to local time, CST, was established with an offset provided by the Aircraft Performance Specialist in the *Aircraft Performance Study*, which is available in the docket for this incident. The offset is provided in Table 1.

Airplane 2 (Southwest):

Correlation of the FDR data to local time, CST, was established by using the recorded Greenwich mean time (GMT) Hours, GMT Minutes, and GMT Seconds and then applying an additional 6 hours offset to change GMT to CST. The offset is provided in Table 1.

Table 1. FDR time offset.

Airplane	SRN to CST offset
1	-160755.5 seconds
2	-51788.0 seconds

For the remainder of this report, all times for both aircraft are referenced as CST.

1.4 Pressure Altitude

The FDRs record pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The altitude information presented in the FDR plots and in the tabular data has not been corrected for the local altimeter setting at the time of the incident.

E. FIGURES AND TABULAR DATA

Figures 1 to 13 contain FDR data recorded during the incident on February 4, 2023. Table 2 is a summary of the figures provided in this report.

³ 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 = +, Left Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

Table 2. Summary of figures.

Figure	Time ⁴	Data source	Summary of parameters in the figure
Figure 1 ⁵	Incident	Airplanes 1 & 2	Basic parameters for both airplanes
Figure 2	Full		Basic parameters
Figure 3			Autopilot parameters
Figure 4			Flight control input and surface movements
Figure 5			Engine and autothrottle parameters
Figure 6			Airplane 1 (FedEx)
Figure 7	Autopilot parameters		
Figure 8	Flight control input and surface movements		
Figure 9	Engine and autothrottle parameters		
Figure 10	TCAS parameters		
Figure 11	Incident	Airplane 2 (Southwest)	Basic parameters
Figure 12			Flight control input and surface movements
Figure 13			Engine and TCAS parameters

These figures are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns toward the top of the page, and nose-up attitudes toward the top of the page. A dashed line representing the time of the initiation of the go-around by Airplane 1 (FedEx) is shown on each figure for reference.

Table 3 lists the FDR parameters verified and provided in this report for Airplane 1 (FedEx). Table 4 lists the FDR parameters verified and provided in this report for Airplane 2 (Southwest). Additionally, Table 5 describes the abbreviations used in this report.

The corresponding tabular data used to create figures 1 to 10 and figures 11 to 13 are provided in electronic comma-separated value (CSV) format as attachment 1 and 2 to this report, respectively.

Submitted by:

Kyle Garner
Aerospace Engineer - Recorder Specialist

⁴ Where *Incident* = 06:39:00 to 06:42:00 CST and *Full* = full incident flight (varies for each airplane).

⁵ Parameters with the suffix *FDX* were sourced from Airplane 1's (FedEx) FDR, while those with the suffix *SWA* were sourced from Airplane 2's (Southwest) FDR.

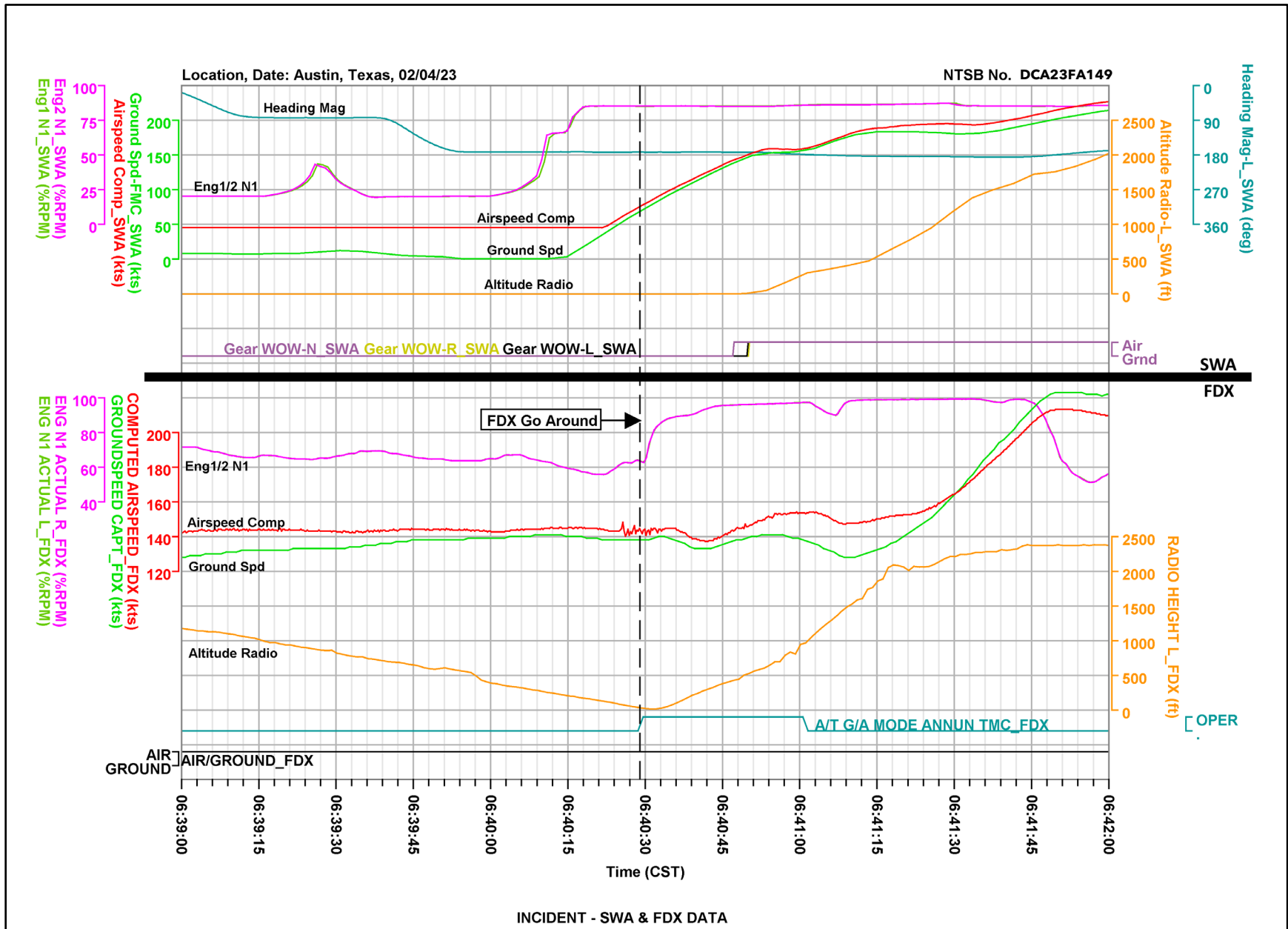


Figure 1. Basic parameters during the incident - Airplane 1 (FedEx) and Airplane 2 (Southwest).

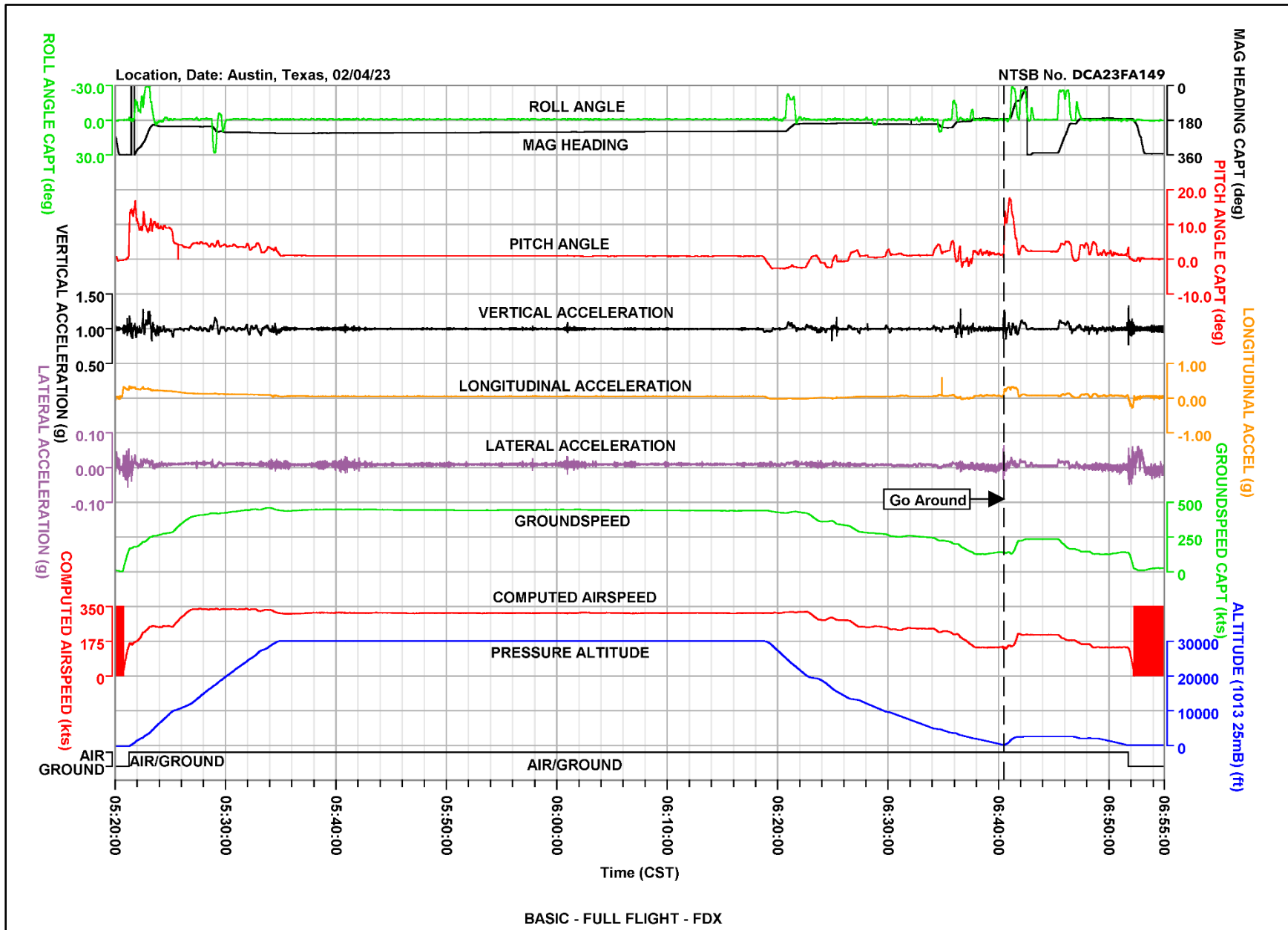


Figure 2. Basic parameters for the full incident flight - Airplane 1 (FedEx).

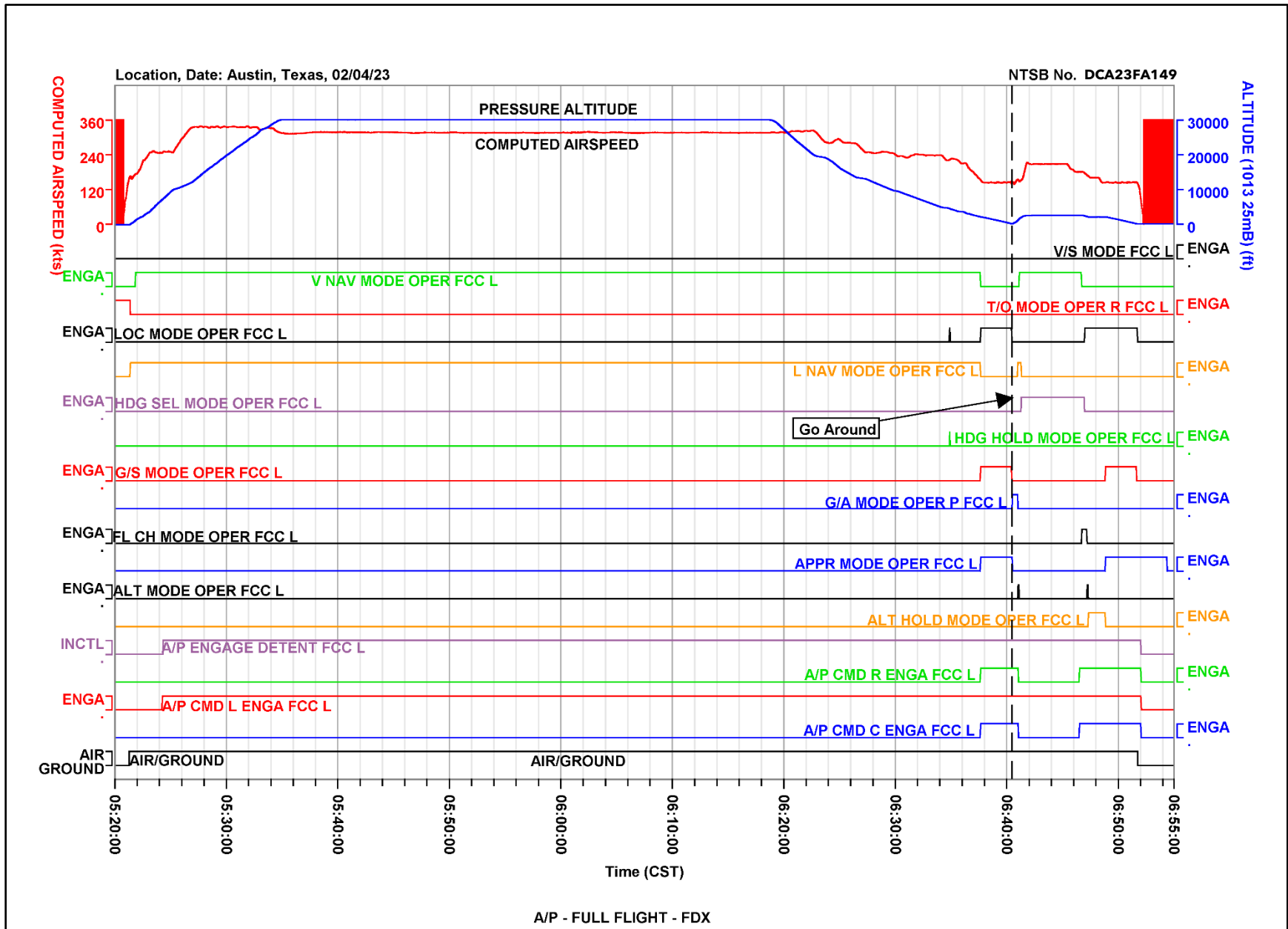


Figure 3. Autopilot parameters for the full incident flight - Airplane 1 (FedEx).

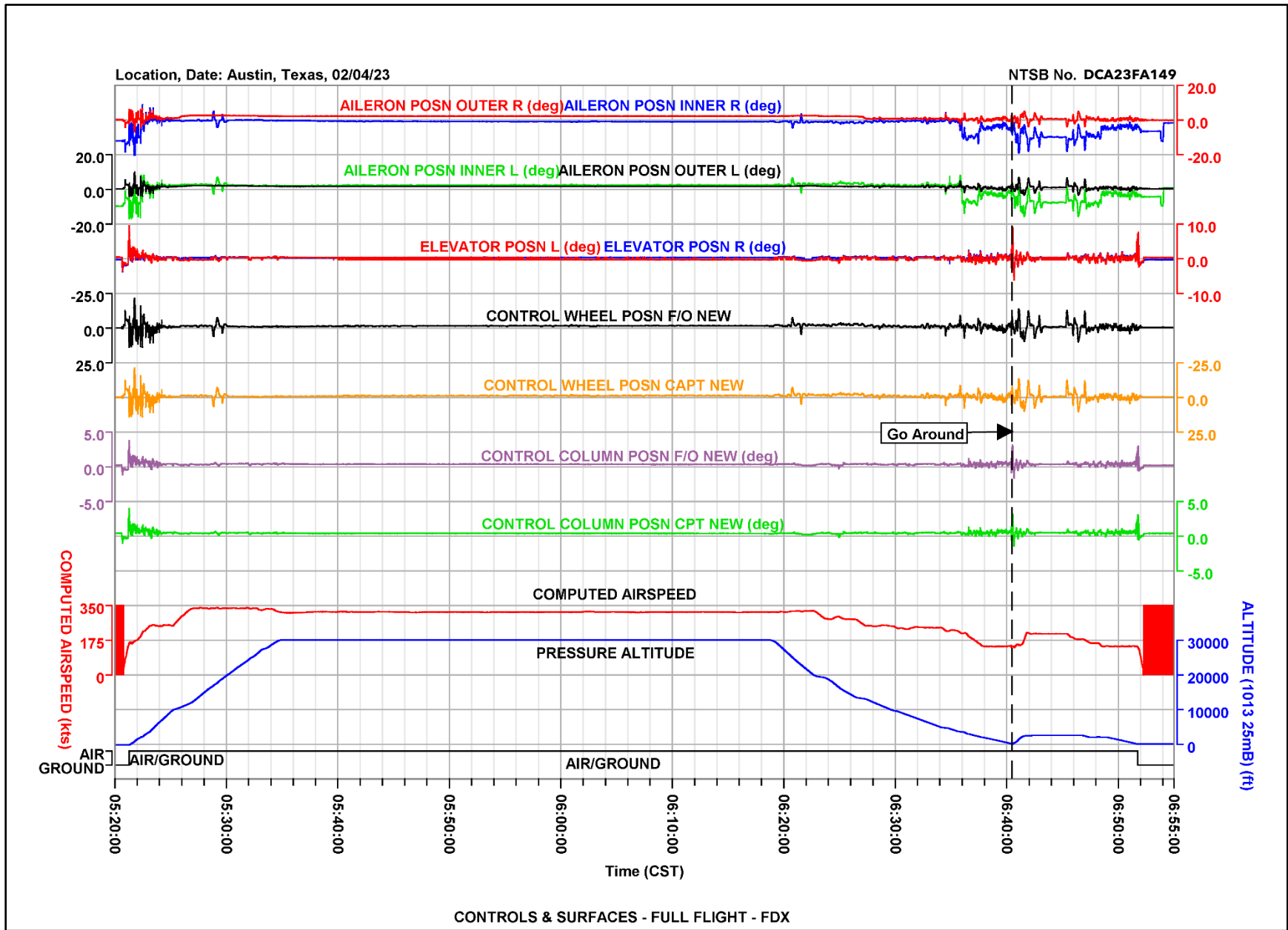


Figure 4. Flight control parameters for the full incident flight - Airplane 1 (FedEx).

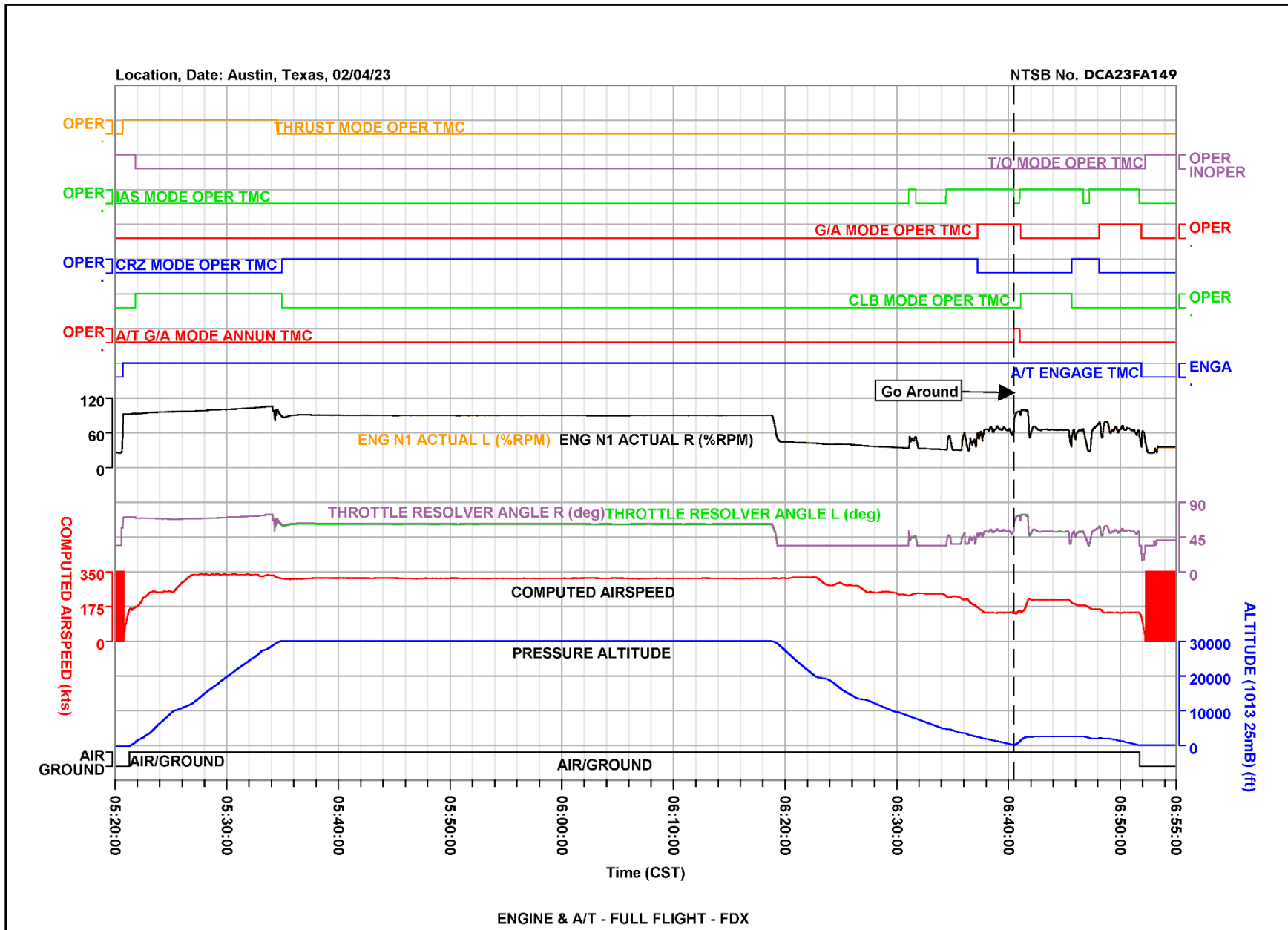


Figure 5. Engine and autothrottle parameters for the full incident flight – Airplane 1 (FedEx).

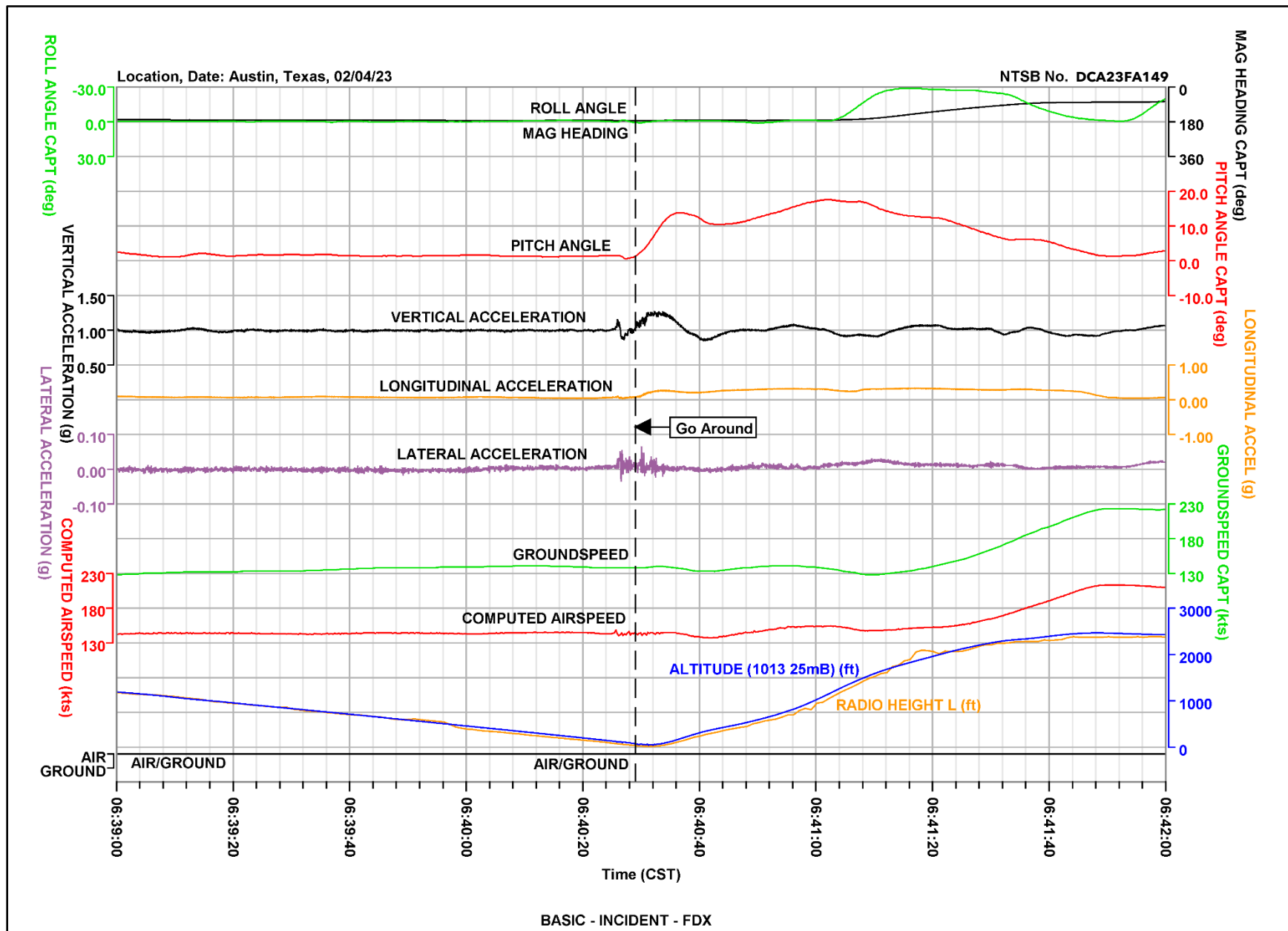


Figure 6. Basic parameters during the incident - Airplane 1 (FedEx).

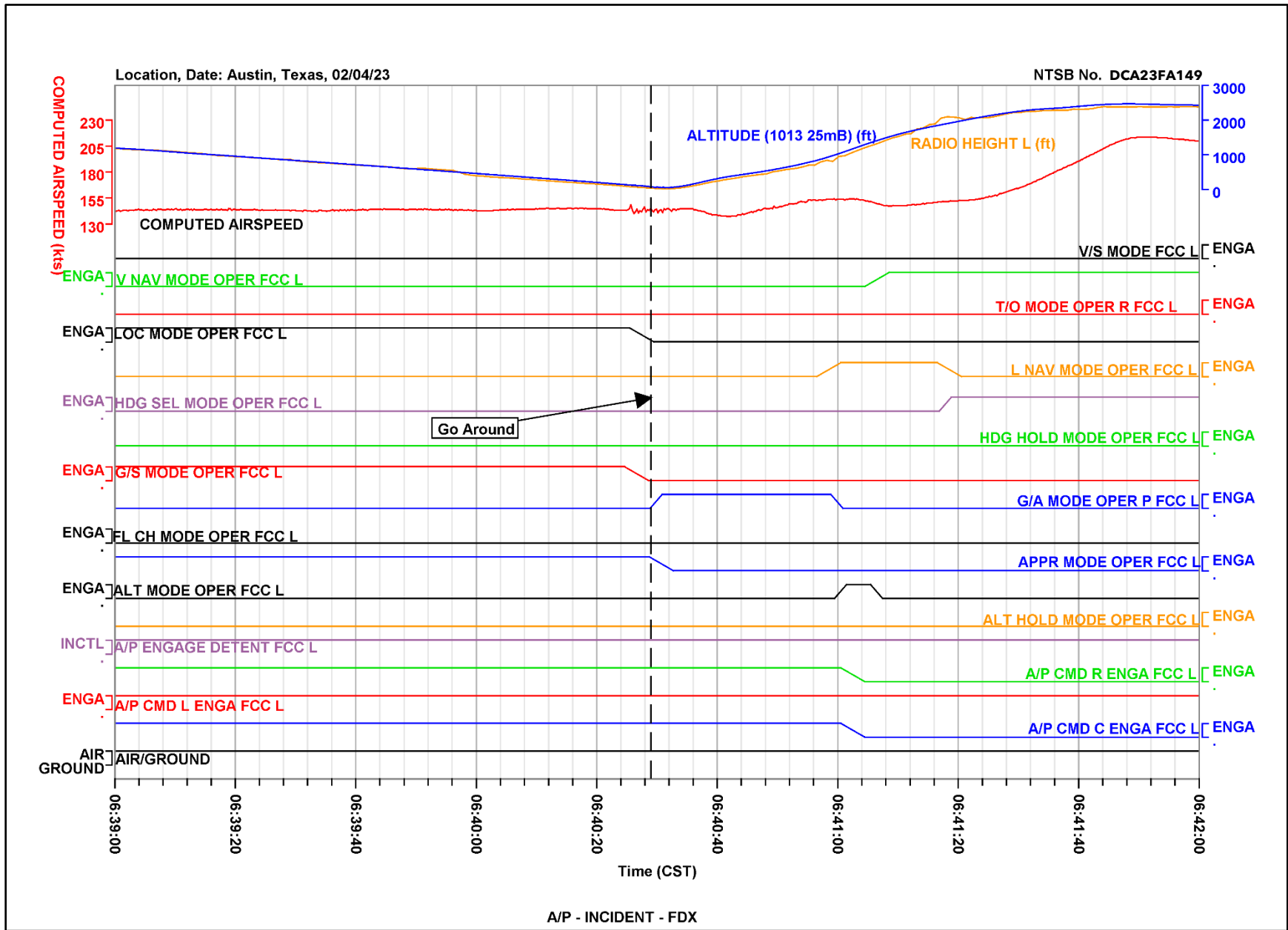


Figure 7. Autopilot parameters during the incident - Airplane 1 (FedEx).

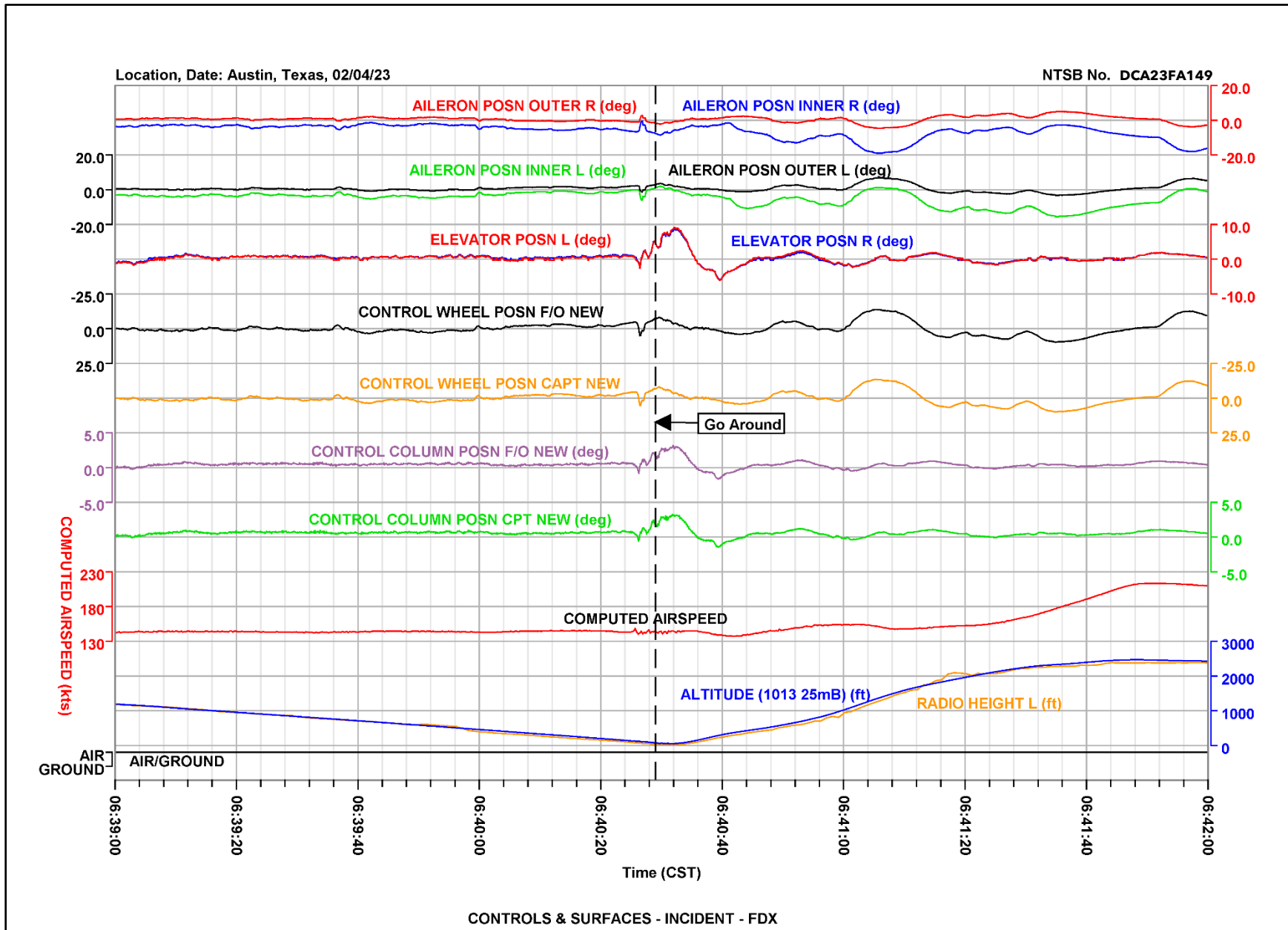


Figure 8. Flight control parameters during the incident - Airplane 1 (FedEx).

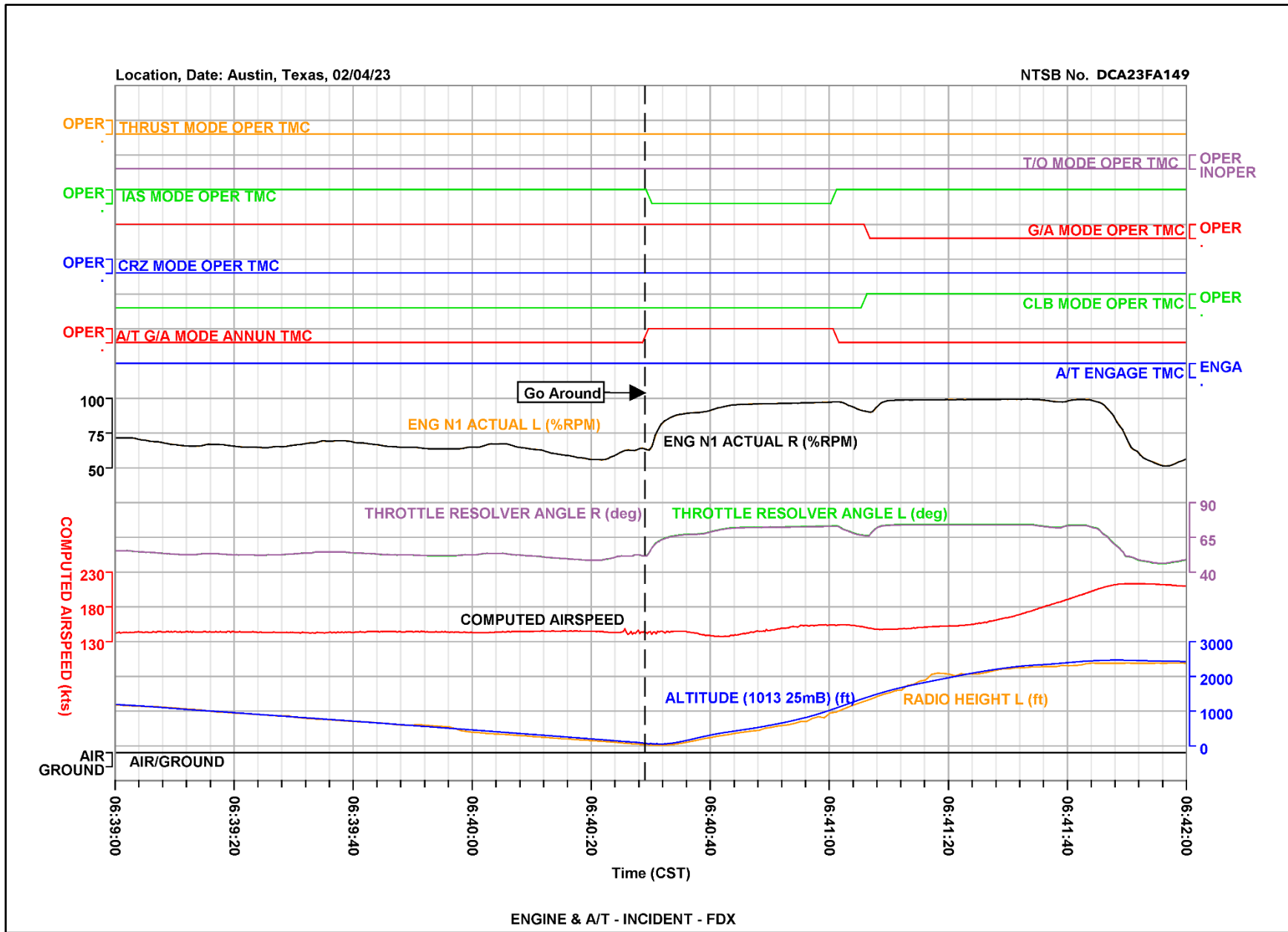


Figure 9. Engine and autothrottle parameters during the incident - Airplane 1 (FedEx).

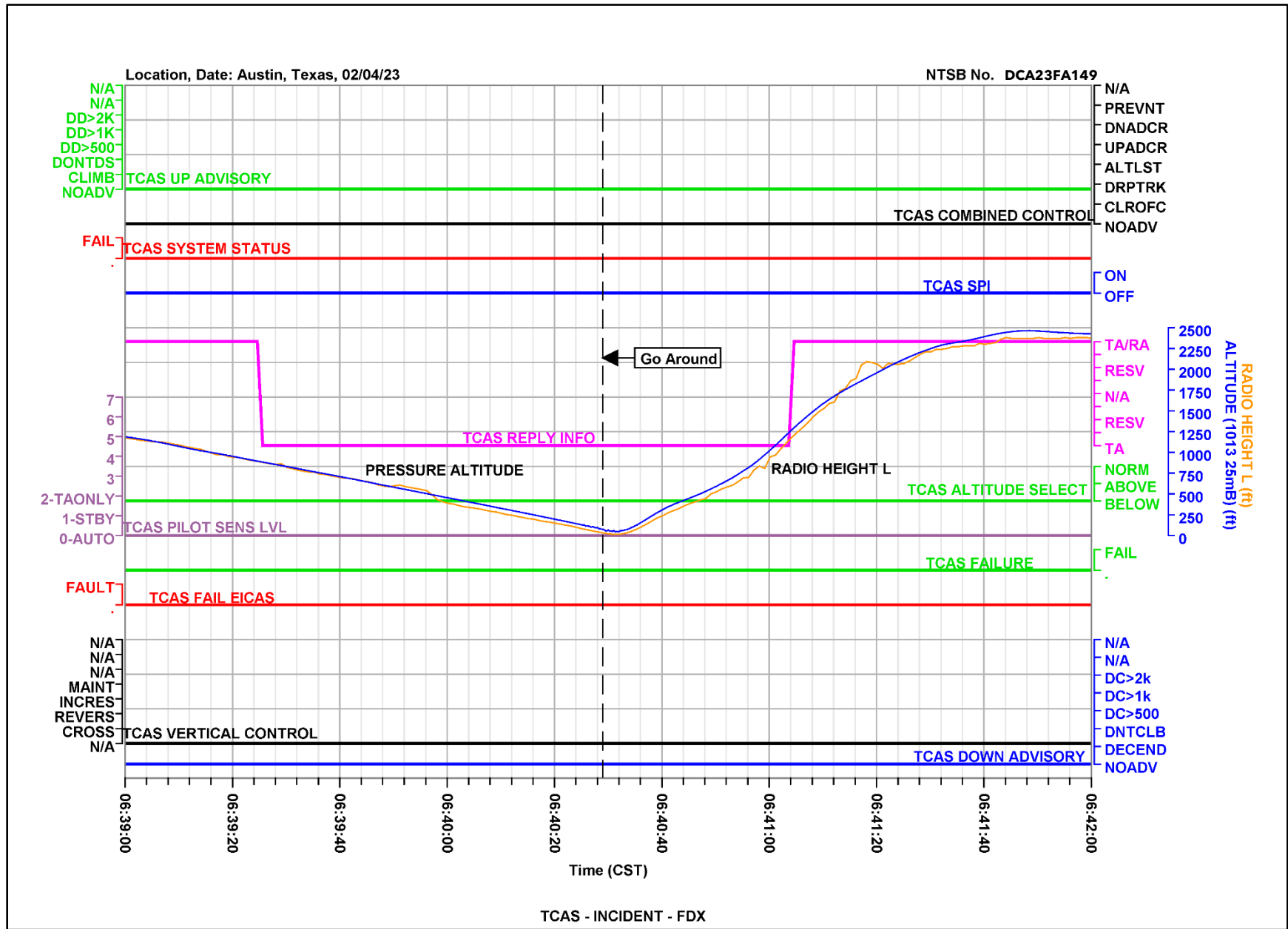


Figure 10. TCAS parameters during the incident - Airplane 1 (FedEx).

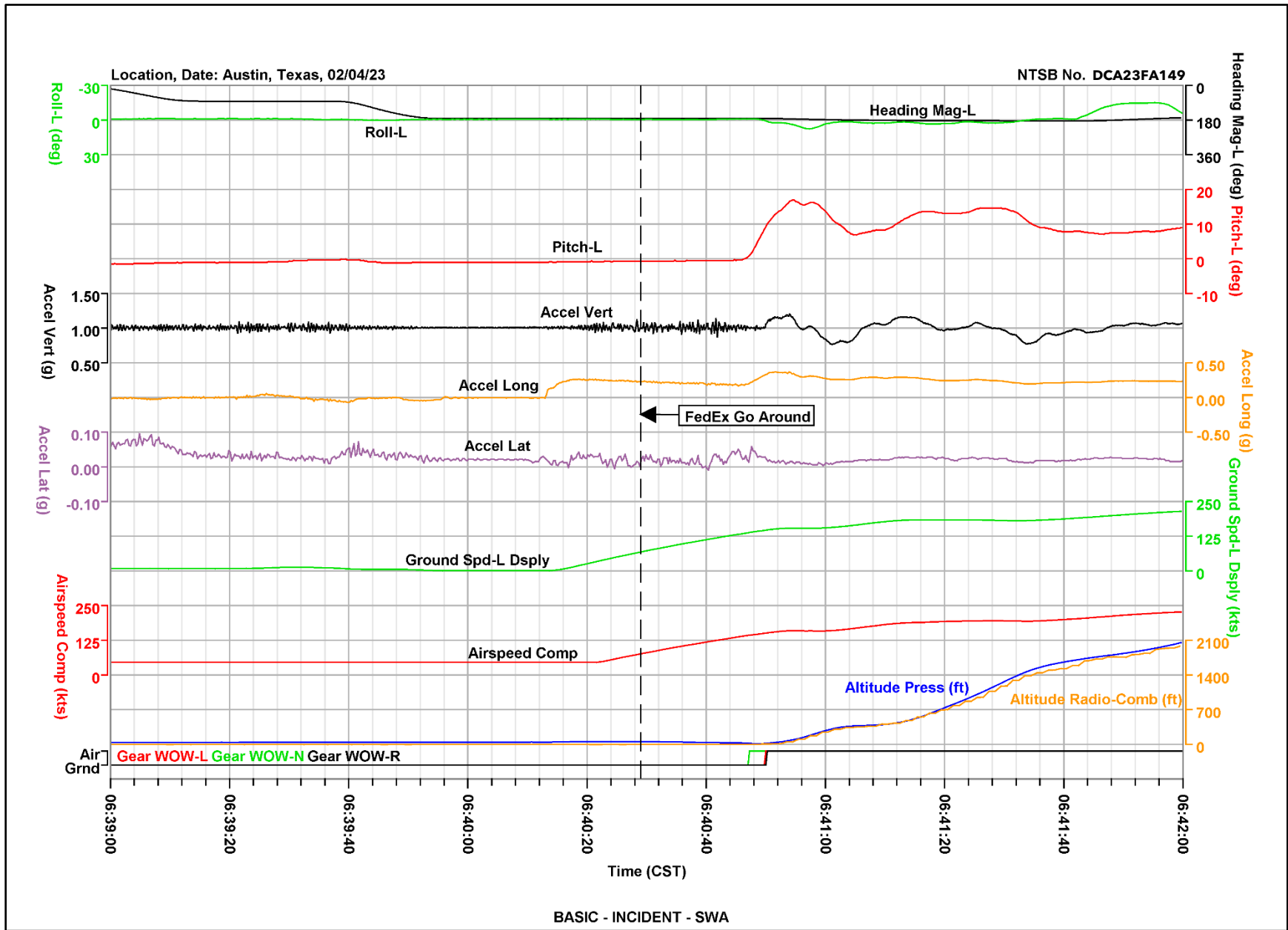


Figure 11. Basic parameters during the incident - Airplane 2 (Southwest).

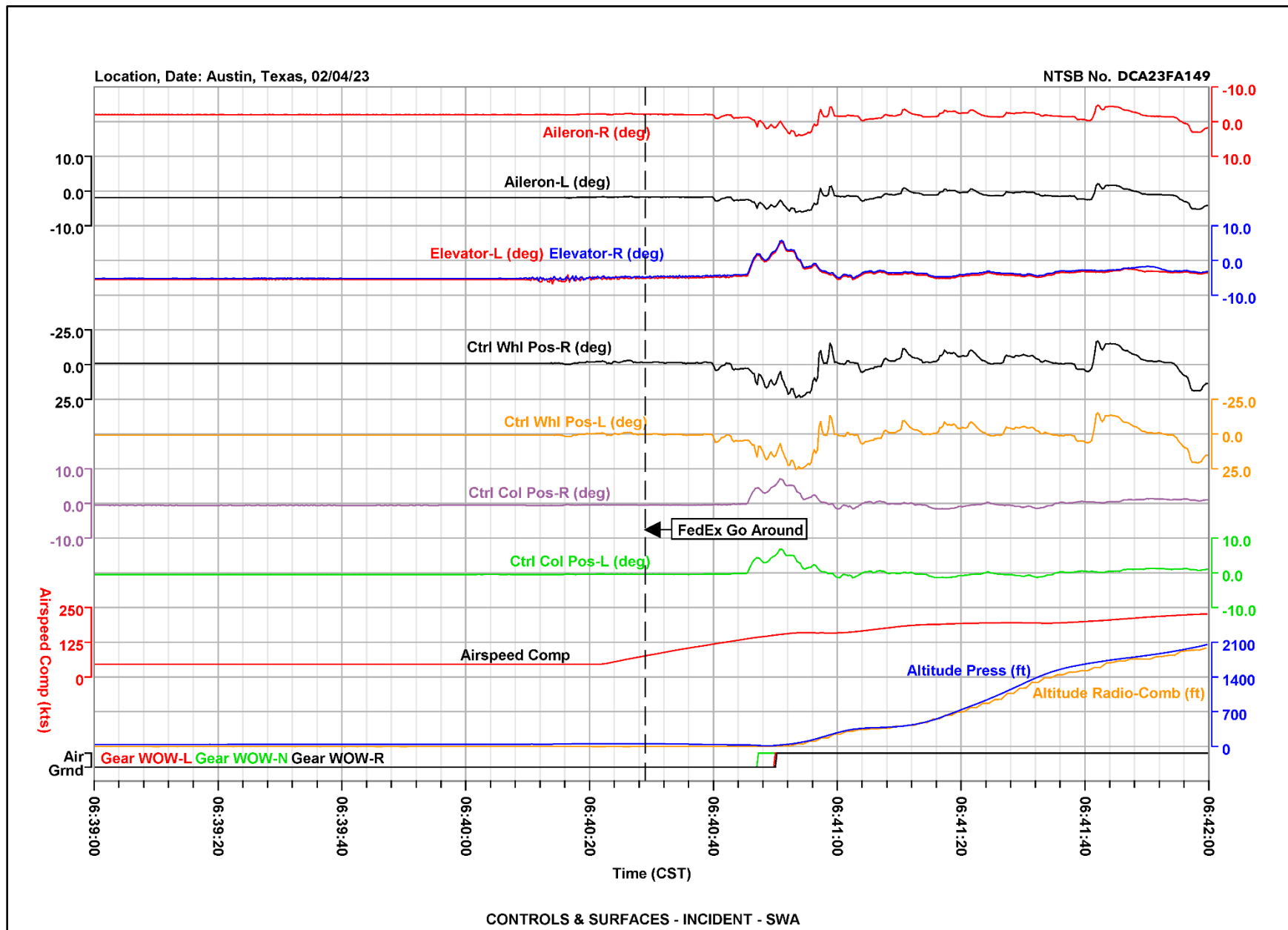


Figure 12. Flight control parameters during the incident - Airplane 2 (Southwest).

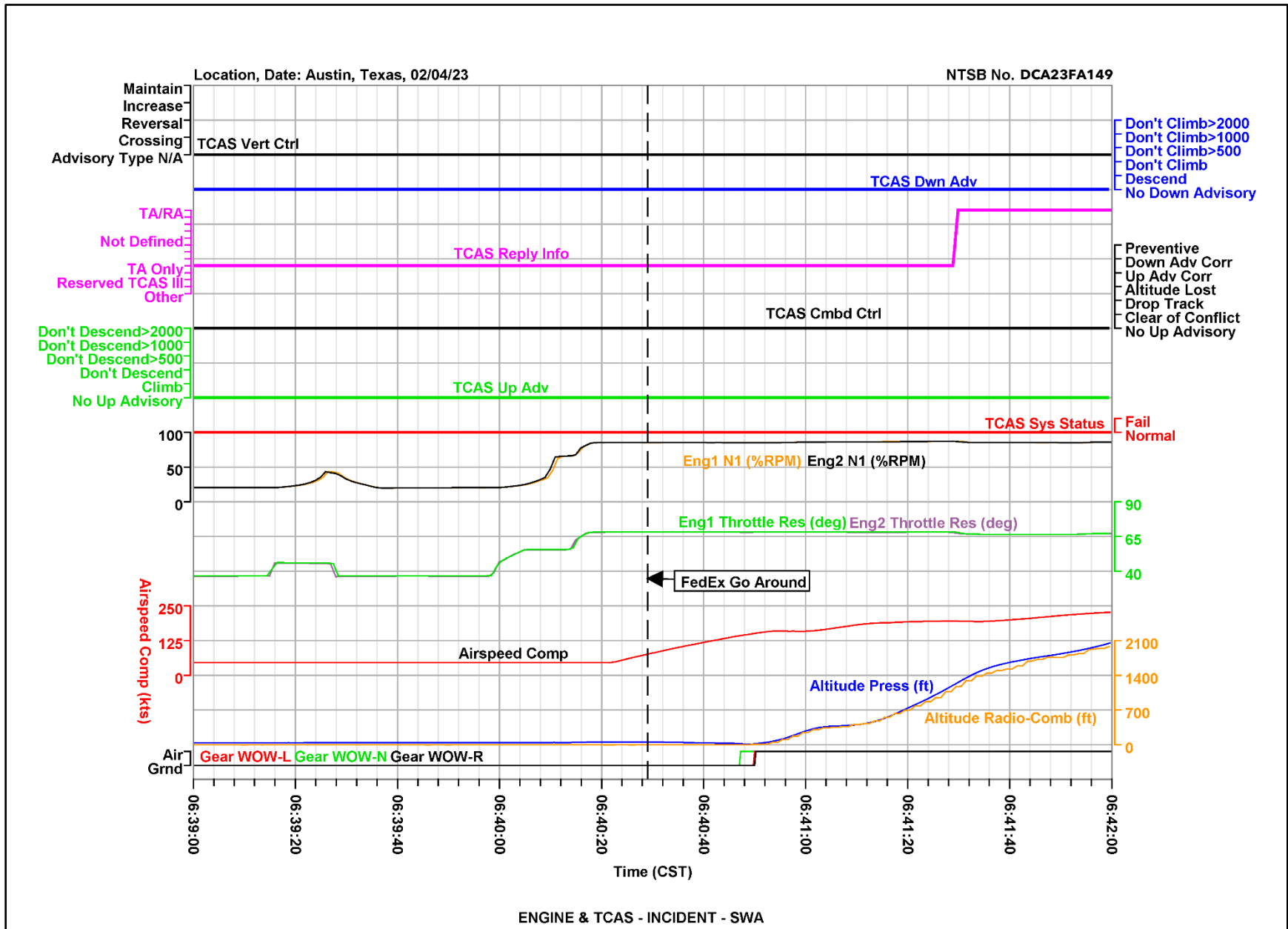


Figure 13. Engine and TCAS parameters during the incident - Airplane 2 (Southwest).

APPENDIX A. VERIFIED AND PROVIDED PARAMETERS

This appendix describes the parameters provided and verified in this report.

Table 3 and Table 4 list the plot/table labels, parameter names, and units for Airplane 1 (FedEx) and Airplane 2 (Southwest), respectively. Parameters that do not have units are discretized⁶. Not all parameters shown in Table 3 and Table 4 are plotted, however, all are provided as tabular data in attachment 1 and 2 to this report.

Table 3. Verified and provided FDR parameters for Airplane 1 (FedEx)⁷.

Plot/Table Labels	Parameter Names	Units
A/P CMD C ENGA FCC L	A/P CMD C ENGA FCC L	
A/P CMD C ENGA MCP	A/P CMD C ENGA MCP	
A/P CMD L ENGA FCC L	A/P CMD L ENGA FCC L	
A/P CMD L ENGA MCP	A/P CMD L ENGA MCP	
A/P CMD R ENGA FCC L	A/P CMD R ENGA FCC L	
A/P CMD R ENGA MCP	A/P CMD R ENGA MCP	
A/P ENGAGE DETENT FCC C	A/P ENGAGE DETENT FCC C	
A/P ENGAGE DETENT FCC L	A/P ENGAGE DETENT FCC L	
A/P ENGAGE DETENT FCC R	A/P ENGAGE DETENT FCC R	
A/T DISCONNECT TMC	A/T DISCONNECT TMC	
A/T ENGAGE TMC	A/T ENGAGED TMC	
A/T G/A MODE ANNUN TMC	A/T G/A MODE ANNUNCIATED TMC	
AILERON POSN INNER L	AILERON POSITION INNER L/R	deg
AILERON POSN OUTER L	AILERON POSITION OUTER L/R	deg
AIR/GROUND	AIR/GROUND	
ALL GEAR DOWN & LOCK	ALL LANDING GEAR DOWN AND LOCKED	
ALT HOLD MODE OPER FCC L	ALT HOLD MODE OPERATING FCC L	
ALT HOLD MODE OPER MCP	ALT HOLD MODE OPERATING MCP	
ALT MODE OPER FCC L	ALT MODE OPERATING FCC L	
ALTITUDE (1013 25mB)	PRESSURE ALTITUDE	ft
ALTITUDE SELECTED FMC	SELECTED ALTITUDE FMC	ft
ALTITUDE SELECTED MAN FCC L	ALTITUDE SELECTED MANUAL FCC L	ft
ALTITUDE SELECTED MAN MCP	ALTITUDE SELECTED MANUAL MCP	ft
APPR MODE OPER FCC L	APPROACH MODE OPERATING FCC L	
AUTOTHROTTLE DISC	AUTOTHROTTLE DISCONNECT	
CLB MODE OPER TMC	CLIMB MODE OPERATING TMC	
COMPUTED AIRSPEED	COMPUTED AIRSPEED	kts
CONTROL COLUMN POSN CPT NEW	CONTROL COLUMN POSITION CAPTAIN	deg
CONTROL COLUMN POSN F/O NEW	CONTROL COLUMN POSITION FIRST OFFICER	deg
CONTROL WHEEL POSN CAPT NEW	CONTROL WHEEL POSITION CAPTAIN	deg
CONTROL WHEEL POSN F/O NEW	CONTROL WHEEL POSITION FIRST OFFICER	deg
CRZ MODE OPER TMC	CRUISE MODE OPERATING TMC	

⁶ 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.

⁷ For parameters in this table sourced from all three FCCs (L, R, and C), only the parameter sourced from FCC L is plotted and/or provided in the tabular data. The only exception is the parameter A/P ENGAGE DETENT, which is plotted and/or provided in the tabular data for all three FCCs.

Plot/Table Labels	Parameter Names	Units
ELEVATOR POSN L/R	ELEVATOR POSITION-L/R	deg
ENG N1 ACTUAL L/R	ENG1/2 N1 ACTUAL	%RPM
ENG N1 COMMAND L/R	ENG1/2 N1 COMMANDED	%RPM
FL CH MODE OPER FCC L	FLIGHT CHANGE MODE OPERATING FCC L	
FL CH MODE OPER MCP	FLIGHT CHANGE MODE OPERATING MCP	
FLAP HANDLE POSN	FLAP HANDLE POSITION	deg
FLARE OPER FCC L	FLARE MODE OPERATING FCC L	
FLARE RETARD MODE TMC	FLARE RETARD MODE OPERATING TMC	
FLT DIR ON CAPT FCC L	FLIGHT DIRECTOR ON CAPTAIN FCC L	
FLT DIR ON CAPT MCP	FLIGHT DIRECTOR ON CAPTAIN MCP	
FLT DIR ON F/O FCC L	FLIGHT DIRECTOR ON FIRST OFFICER FCC L	
FLT DIR ON F/O MCP	FLIGHT DIRECTOR ON FIRST OFFICER MCP	
G/A MODE OPER P FCC L	G/A MODE OPERATING CAPTAIN FCC L	
G/A MODE OPER R FCC L	G/A MODE OPERATING FIRST OFFICER FCC L	
G/A MODE OPER TMC	G/A MODE OPERATING TMC	
G/S MODE OPER FCC L	G/S MODE OPERATING FCC L	
G/S MODE OPER MCP	G/S MODE OPERATING MCP	
GMT HOURS	TIME GMT HOURS	hrs
GMT MINUTES	TIME GMT MINUTES	min
GMT SECONDS	TIME GMT SECONDS	sec
GROUNDSPEED CAPT	GROUNDSPEED DISPLAYED - CAPTAIN	kts
HDG HOLD MODE OPER FCC L	HDG HOLD MODE OPERATING FCC L	
HDG HOLD MODE OPER MCP	HDG HOLD MODE OPERATING MCP	
HDG SEL MODE OPER FCC L	HDG SELECT MODE OPERATING FCC L	
HDG SEL MODE OPER MCP	HDG SELECT MODE OPERATING MCP	
HEADING SELECTED FCC L	HEADING SELECTED FCC L	deg
HEADING SELECTED MCP	HEADING SELECTED MCP	deg
IAS MODE OPER TMC	INDICATED AIRSPEED MODE OPERATING TMC	
L NAV MODE OPER FCC L	LATERAL NAVIGATION MODE OPERATING FCC L	
L NAV MODE OPER MCP	LATERAL NAVIGATION MODE OPERATING MCP	
LATERAL ACCELERATION	LATERAL ACCELERATION	g
LOC MODE OPER FCC L	LOCALIZER MODE OPERATING FCC L	
LOC MODE OPER MCP	LOCALIZER MODE OPERATING MCP	
LONGITUDINAL ACCEL	LONGITUDINAL ACCELERATION	g
MAG HEADING CAPT	MAGNETIC HEADING DISPLAYED - CAPTAIN	deg
MASTER CAUTION LIGHT	MASTER CAUTION LIGHT	
MASTER WARNING CAPT	MASTER WARNING LIGHT CAPTAIN	
MASTER WARNING F/O	MASTER WARNING LIGHT FIRST OFFICER	
NOSE GEAR SQUAT SW	NOSE LANDING GEAR SQUAT SWITCH	
PITCH ANGLE CAPT	PITCH ANGLE DISPLAYED CAPTAIN	deg
PRES POSN LAT (FMC)	LATITUDE (FMC)	deg
PRES POSN LONG (FMC)	LONGITUDE (FMC)	deg
RADIO HEIGHT C	RADIO HEIGHT C/L/R	ft
ROLL ANGLE CAPT	ROLL ANGLE DISPLAYED CAPTAIN	deg
SPD BRK HDL POSN FCC L	SPEEDBRAKE HANDLE POSITION FCC L	%
T/O MODE OPER P FCC L	T/O MODE OPERATING CAPTAIN FCC L	
T/O MODE OPER R FCC L	T/O MODE OPERATING FIRST OFFICER FCC L	
TCAS ALTITUDE SELECT	TCAS ALTITUDE SELECTED	
TCAS COMBINED CONTROL	TCAS COMBINED CONTROL	
TCAS DOWN ADVISORY	TCAS DOWN ADVISORY	

Plot/Table Labels	Parameter Names	Units
TCAS FAIL EICAS	TCAS FAIL EICAS	
TCAS FAILURE	TCAS FAILURE	
TCAS PILOT SENS LVL	TCAS PILOT SENSITIVITY LEVEL	
TCAS REPLY INFO	TCAS REPLY INFORMATION	
TCAS SPI	TCAS SAFETY PERFORMANCE INDICATOR	
TCAS SYSTEM STATUS	TCAS SYSTEM STATUS	
TCAS UP ADVISORY	TCAS UP ADVISORY	
TCAS VERTICAL CONTROL	TCAS VERTICAL CONTROL	
THROTTLE RESOLVER ANGLE L/R	ENG1/2 THROTTLE RESOLVER ANGLE	deg
THRUST MODE OPER TMC	THRUST MODE OPERATING TMC	
TRUE AIRSPEED	TRUE AIRSPEED	kts
V NAV MODE OPER FCC L	VERTICAL NAVIGATION MODE OPERATING FCC L	
V NAV MODE OPER MCP	VERTICAL NAVIGATION MODE OPERATING MCP	
V/S MODE FCC L	VERTICAL SPEED MODE OPERATING FCC L	
VERTICAL ACCELERATION	VERTICAL ACCELERATION	g
VREF AIRSPEED	REFERENCE AIRSPEED	kts

Table 4 list the plot/table labels, parameter names, and units for Airplane 2 (Southwest).

Table 4. Verified and provided FDR parameters for Airplane 2 (Southwest).

Plot/Table Labels	Parameter Names	Units
Accel Lat	Lateral Acceleration	g
Accel Long	Longitudinal Acceleration	g
Accel Vert	Vertical Acceleration	g
Aileron-L/R	Aileron Position-L/R	deg
Airspeed Comp	Computed Airspeed	kts
Altitude Press	Pressure Altitude	ft
Altitude Radio-Comb	Radio Altitude	ft
Ctrl Col Pos-L/R	Control Column Position-L/R	deg
Ctrl Whl Pos-L/R	Control Wheel Position-L/R	deg
Elevator-L/R	Elevator Position-L/R	deg
Eng1/2 N1	Eng1/2 N1	%RPM
Eng1/2 Throttle Res	Eng1/2 Throttle Resolver Angle	deg
Gear WOW-L/R/N	Landing gear WOW-L/R/N	
Ground Spd-L Dsply	Displayed Groundspeed-L	kts
Heading Mag-L	Magnetic Heading-L	deg
Latitude	Latitude	deg
Longitude	Longitude	deg
Pitch-L	Pitch-L	deg
Roll-L	Roll-L	deg
TCAS Cmbd Ctrl	TCAS Combined Control	
TCAS Dwn Adv	TCAS Down Advisory	
TCAS Reply Info	TCAS Reply Information	
TCAS Sys Status	TCAS System Status	
TCAS Up Adv	TCAS Up Advisory	
TCAS Vert Ctrl	TCAS Vertical Control	
Time Clock GMT Hrs	Time Clock GMT Hours	hrs
Time Clock GMT Min	Time Clock GMT Minutes	min

Plot/Table Labels	Parameter Names	Units
Time Clock GMT Sec	Time Clock GMT Seconds	sec

Table 5 describes the abbreviations used in this report.

Table 5. Abbreviations used in this report.

Abbreviation	Description
%	percent
%RPM	percent revolutions per minute
A/P	autopilot
A/T	autothrottle
ALT	altitude
C	center
CMD	commanded
deg	degrees
EICAS	engine indicating and crew alerting system
Eng1	Engine 1 (left)
Eng2	Engine 2 (right)
ENGA	engaged
FCC	flight control computer
FMC	flight management computer
ft	feet
G/A	go around
G/S	glideslope
GMT	Greenwich Mean Time
HDG	heading
hrs	hours
kts	knots
L	left
MCP	mode control panel
min	minutes
N	nose
R	right
sec	seconds
TCAS	Traffic Collision Avoidance System
TMC	thrust management computer
WOW	weight-on-wheels