CRASH IMMINENT BRAKING SYSTEM RESEARCH TEST
NCAP-DRI-CIBHS-20-05

2020 Nissan Altima

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15 July 2020

Final Report

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16. Abstract These research tests were conducted on the subject 2020 Nissan Altima in accordance with the specifications of the New Car Assessment Program's most current Test Procedure in docket NHTSA-2015-0006-0025; CRASH IMMINENT BRAKE SYSTEM PERFORMANCE EVALUATION FOR THE NEW CAR ASSESSMENT PROGRAM, October 2015, with modifications to include use of Global Vehicle Target (GVT) and additional test speeds or deceleration rates to assess system performance and point of failure. The system met the acceptability criteria for 47 out of 49 valid test runs.			
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Section I

INTRODUCTION

Crash Imminent Braking (CIB) systems are a subset of Automatic Emergency Braking (AEB) systems. CIB systems are designed to avoid, or mitigate rear-end crashes, by automatically applying subject vehicle brakes when the system determines that, without intervention, a rear-end crash will occur. CIB systems typically work as an extension of Forward Collision Warning (FCW) systems, which alert the driver to the possibility of a collision unless driver action is taken. CIB systems employ sensors capable of detecting vehicles in the forward path. Current CIB technology typically involves RADAR, LIDAR, or vision-based (camera) sensors, and measurement of vehicle operating conditions such as speed, driver steering and brake application, etc. Algorithms in the system's Central Processing Unit (CPU) use this information to continuously monitor the likelihood of a rear-end crash and command a brake actuator to apply the brakes when necessary.

The method prescribed by the National Highway Traffic Safety Administration (NHTSA) in the New Car Assessment Program's (NCAP's) Crash Imminent Brake System Test Procedure (dated October 2015)[1] to evaluate CIB performance on the test track involves three rear-end type crash configurations and a "false positive" test. In the rear-end scenarios, a subject vehicle (SV) approaches a stopped, slower-moving, or decelerating principal other vehicle (POV) in the same lane of travel. For these tests, the POV is a strikeable object with the characteristics of a compact passenger car. The false positive scenarios are used to evaluate the propensity of a CIB system to inappropriately activate in a non-critical driving scenario that does not involve a forward vehicle or present a safety risk to the SV occupant(s).

This report describes the results of research tests conducted in accordance with the NHTSA test procedure, but several modifications were made to the specified test matrix and an alternative POV was used.

The modified test matrix replaces the "false positive" test condition in the standard CIB confirmation test with additional test speeds or deceleration rates, as indicated in Table 1.

The NHTSA test procedure does not specify a particular strikeable POV, but the New Car Assessment Program (NCAP) has been using the Strikeable Surrogate Vehicle (SSV) for the CIB confirmation tests.[2] However, the Global Vehicle Target (GVT) system, which is in general use worldwide, was used in these research tests instead of the SSV. A detailed description of the GVT system is given in Section III C.

[1] NHTSA-2015-0006-0025; Crash Imminent Brake System Performance Evaluation for the New Car Assessment Program, October 2015.
[2] A detailed description of the SSV system can be found in the NHTSA report: NHTSA'S STRIKEABLE SURROGATE VEHICLE PRELIMINARY DESIGN+OVERVIEW, May 2013.

Table 1. Comparison of NCAP CIB Confirmation Test and Research Test Conditions

Test Scenario	Initial SV Speed mph (km/h)	Initial POV Speed mph (km/h)	POV Deceleration (g)	Standard NCAP CIB Confirmation Test Condition	Research Test Condition (Evaluated Herein)
1. Stopped POV	25 (40.2)	0	0	Yes	Yes
	30 (48.3)	0	0	Not Applicable	Yes
	35 (56.3)	0	0	Not Applicable	Yes
	40 (64.4)	0	0	Not Applicable	Yes
	45 (72.4)	0	0	Not Applicable	Yes
2. Slower Moving POV	25 (40.2)	10 (16.1)	0	Yes	Yes
	45 (72.4)	20 (32.2)	0	Yes	Yes
3. Decelerating POV	35 (56.3)	35 (56.3)	0.3	Yes	Yes
	35 (56.3)	35 (56.3)	0.5	Not Applicable	Yes
	45 (72.4)	45 (72.4)	0.3	Not Applicable	Yes
4. Steel Trench Plate	25 (40.2)	Not Applicable	Not Applicable	Yes	No
	45 (72.4)	Not Applicable	Not Applicable	Yes	No

Section II

DATA SHEETS

CRASH IMMINENT BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

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2020 Nissan Altima

VIN: *1N4BL4DV2LC19xxxx* Test Date: *2/20/2020*

Crash Imminent Braking System setting: *On (only On and Off are available)*

		Number of valid test runs for which acceptability[3] criteria were:		
Test 1 –	**Subject Vehicle Encounters Stopped Principal Other Vehicle**	**Met**	**Not met**	**Valid Runs**
	SV 25 mph:	*5*	*0*	*5*
	SV 30 mph:	*5*	*0*	*5*
	SV 35 mph:	*5*	*0*	*5*
	SV 40 mph:	*5*	*0*	*5*
	SV 45 mph:	*3*	*1*	*4*
Test 2 –	**Subject Vehicle Encounters Slower Principal Other Vehicle**			
	SV 25 mph POV 10 mph:	*5*	*0*	*5*
	SV 45 mph POV 20 mph:	*5*	*0*	*5*
Test 3 –	**Subject Vehicle Encounters Decelerating Principal Other Vehicle**			
	SV 35 mph POV 35 mph, 0.3 g decel:	*5*	*0*	*5*
	SV 35 mph POV 35 mph, 0.5 g decel:	*5*	*0*	*5*
	SV 45 mph POV 45 mph, 0.3 g decel:	*4*	*1*	*5*
	Overall:	***47***	***2***	***49***

Notes:
The system met the acceptability criteria for 47 out of 49 valid test runs.

[3] The acceptability criteria listed herein are used only as a guide to gauge vehicle performance, and are identical to the Pass/Fail criteria given in the of the New Car Assessment Program's most current Test Procedure in docket NHTSA-2015-0006-0025; CRASH IMMINENT BRAKE SYSTEM PERFORMANCE EVALUATION FOR THE NEW CAR ASSESSMENT PROGRAM, October 2015,

CRASH IMMINENT BRAKING

DATA SHEET 2: VEHICLE DATA

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2020 Nissan Altima

TEST VEHICLE INFORMATION

VIN: *1N4BL4DV2LC19xxxx*

Body Style: *Sedan* Color: *Gun Metallic*

Date Received: *2/3/2020* Odometer Reading: *22 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Nissan Motor Co., LTD*

Date of manufacture: *10/19*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD:

Tires size as stated on Tire Placard: Front: *215/55R17 94V*

Rear: *215/55R17 94V*

Recommended cold tire pressure: Front: *230 kPa (33 psi)*

Rear: *230 kPa (33 psi)*

TIRES

Tire manufacturer and model: *Continental Procontact TX*

Front tire designation: *215/55R17 V94*

Rear tire designation: *215/55R17 V94*

Front tire DOT prefix: *VY3R WCN5*

Rear tire DOT prefix: *VY3R WCN5*

CRASH IMMINENT BRAKING

DATA SHEET 3: TEST CONDITIONS

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2020 Nissan Altima

GENERAL INFORMATION

Test date: *2/20/2020*

AMBIENT CONDITIONS

Air temperature: *18.3 C (65 F)*

Wind speed: *1.5 m/s (3.5 mph)*

X Windspeed ≤ 10 m/s (22 mph)

X Tests were not performed during periods of inclement weather. This includes, but is not limited to, rain, snow, hail, fog, smoke, or ash.

X Tests were conducted during daylight hours with good atmospheric visibility (defined as an absence of fog and the ability to see clearly for more than 5000 meters). The tests were not conducted with the vehicle oriented into the sun during very low sun angle conditions, where the sun is oriented 15 degrees or less from horizontal, and camera “washout” or system inoperability results.

VEHICLE PREPARATION

Verify the following:

All non-consumable fluids at 100% capacity: **X**

Fuel tank is full: **X**

Tire pressures are set to manufacturer's recommended cold tire pressure: **X**

Front: *230 kPa (33 psi)*

Rear: *230 kPa (33 psi)*

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DATA SHEET 3: TEST CONDITIONS

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2020 Nissan Altima

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*490.3 kg (1081 lb)*	Right Front:	*469.5 kg (1035 lb)*
Left Rear:	*344.7 kg (760 lb)*	Right Rear:	*316.2 kg (697 lb)*
		Total:	*1620.7 kg (3573 lb)*

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

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2020 Nissan Altima

Name of the CIB option, option package, etc.:

Intelligent Forward Collision Warning (i-FCW), which is integrated into Automatic Emergency Braking

Type and location of sensors the system uses:

The system uses a mono(1) front camera installed behind the windscreen near the rearview mirror and a radar sensor located behind the front grille.

System setting used for test (if applicable): *On (only On and Off are available)*

What is the minimum vehicle speed at which the CIB system becomes active?

5 km/h (3 mph) (Per manufacturer supplied information)

What is the maximum vehicle speed at which the CIB system functions?

For moving lead vehicle: 200km/h (125 mph)

For stationary lead vehicle: 80km/h (50 mph) (Per manufacturer supplied information)

Does the vehicle system require an initialization sequence/procedure? **X** Yes ____ No

If yes, please provide a full description.

Initialization is needed. Drive straight above 20kph and drive past other vehicles for sensor initialization every ignition reset.

Will the system deactivate due to repeated CIB activations, impacts or near-misses? **X** Yes ____ No

If yes, please provide a full description.

The system becomes unavailable after the autonomous braking activates three times during the same ignition cycle. In this case, a warning light appears in the center of combination meter. Recommend ignition OFF and ON after each test.

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

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How is the Forward Collision Warning System alert presented to the driver? (Check all that apply)

- **X** Warning light
- **X** Buzzer or audible alarm
- ____ Vibration
- ____ Other _____

Describe the method by which the driver is alerted. For example, if the warning is a light, where is it located, its color, size, words or symbol, does it flash on and off, etc. If it is a sound, describe if it is a constant beep or a repeated beep. If it is a vibration, describe where it is felt (e.g., pedals, steering wheel), the dominant frequency (and possibly magnitude), the type of warning (light, audible, vibration, or combination), etc.

The visual alert is presented in the space between the speedometer and tachometer. As shown in Appendix A Figure A14, the visual alert is presented as a staged series of images as the vehicle gets closer to the vehicle ahead.

The auditory warning is presented as pulsed beeps at a rate of approximately 4 beeps/second. There are two types of auditory warning; the FCW warning is centered at 1828 Hz and the AEB warning is centered at 2445 Hz.

Is there a way to deactivate the system?

- **X** Yes
- ____ No

If yes, please provide a full description including the switch location and method of operation, any associated instrument panel indicator, etc.

Controls on the left side of the steering wheel are used to access the system menus (See Appendix A, Figure A12). The hierarchy is:

Settings

Driver Assistance

Emergency Brake

Front - select On or Off

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

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Is the vehicle equipped with a control whose purpose is to adjust the range setting or otherwise influence the operation of CIB?	____	Yes
	X	No

If yes, please provide a full description.

Are there other driving modes or conditions that render CIB inoperable or reduce its effectiveness?	**X**	Yes
	____	No

If yes, please provide a full description.

System limitations are described on pages 5-134 through 5-136 of the Owner's Manual. These pages are reproduced on pages B-19 through B-21 of Appendix B.

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

Three test scenarios were used, as follows:

Test 1. Subject Vehicle (SV) Encounters Stopped Principal Other Vehicle (POV)

Test 2. Subject Vehicle Encounters Slower Principal Other Vehicle

Test 3. Subject Vehicle Encounters Decelerating Principal Other Vehicle

An overview of each of the test procedures follows.

1. TEST 1 – SUBJECT VEHICLE ENCOUNTERS STOPPED PRINCIPAL OTHER VEHICLE ON A STRAIGHT ROAD

This test evaluates the ability of the CIB system to detect and respond to a stopped lead vehicle in the immediate forward path of the SV, as depicted in Figure 1. Test conditions for Test 1 are shown in Table 2.

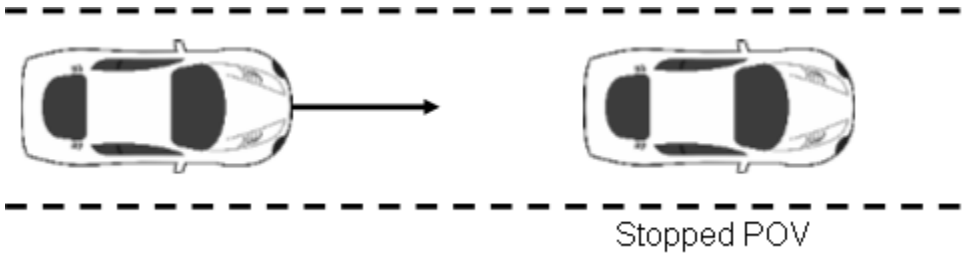


Figure 1. Depiction of Test 1

Table 2. Test Conditions for Stopped POV

Initial SV Speed mph (km/h)	**Initial POV Speed** mph (km/h)	**POV Deceleration** g
25 (40.2)	0	0
30 (48.3)	0	0
35 (56.3)	0	0
40 (64.4)	0	0
45 (72.4)	0	0

a. Procedure

The POV was parked in the center of a travel lane, with its longitudinal axis oriented parallel to the roadway edge and facing the same direction as the SV so that the SV approached the rear of the POV.

The SV ignition was cycled prior to each test run. The tests were conducted at five different SV nominal speeds. The nominal speeds were 25 mph (40.2 km/h), 30 mph (48.3 km/h), 35 mph (56.3 km/h), 40 mph (64.4 km/h), and 45 mph (72.4 km/h). The guideline for test speed was to start at the lowest speed and increase the test speed incrementally until a speed was reached at which the system performance was no longer acceptable. If the system performance became unacceptable before all the nominal speeds were completed, an additional series of tests was then conducted at a speed 2.5 mph less than the speed at which unacceptable performance was observed. The SV was driven at the nominal speed in the center of the lane of travel, toward the parked POV. The SV throttle pedal was released within 500 ms after t_{FCW}, i.e. within 500 ms of the FCW alert. The test concluded when either:

- The SV came into contact with the POV or
- The SV came to a stop before making contact with the POV.

In addition to the general test validity criteria described below, for an individual test trial to be valid, the following was required throughout the test:

- The SV speed could not deviate from the nominal speed by more than 1.0 mph (1.6 km/h) during an interval defined by a Time to Collision (TTC) = 5.1 seconds to t_{FCW}.

b. Criteria

If, at each nominal speed, the magnitude of the SV speed reduction attributable to CIB intervention was ≥ 9.8 mph (15.8 km/h) for at least three of five valid test trials the system performance was considered acceptable.

The magnitude of the SV speed reduction attributable to CIB intervention was calculated in one of two ways, depending on whether a test trial concluded with the SV colliding with the POV.

- If SV-to-POV contact occurred during a test trial, the CIB speed reduction was calculated by subtracting the SV speed at the time of SV-to-POV contact (i.e., when longitudinal range became zero) from the average SV speed calculated from t_{FCW}-100 ms to t_{FCW}.
- If SV-to-POV contact did not occur during a test trial (i.e., CIB intervention prevented the crash), the SV speed at a time of SV-to-POV contact was taken to be zero. The speed reduction is therefore equal to the SV speed at t_{FCW}.

2. TEST 2 – SUBJECT VEHICLE ENCOUNTERS SLOWER PRINCIPAL OTHER VEHICLE

This test evaluates the ability of the CIB system to detect and respond to a slower-moving lead vehicle traveling at a constant speed in the immediate forward path of the SV, as depicted in Figure 2. Test conditions for Test 2 are shown in Table 3.

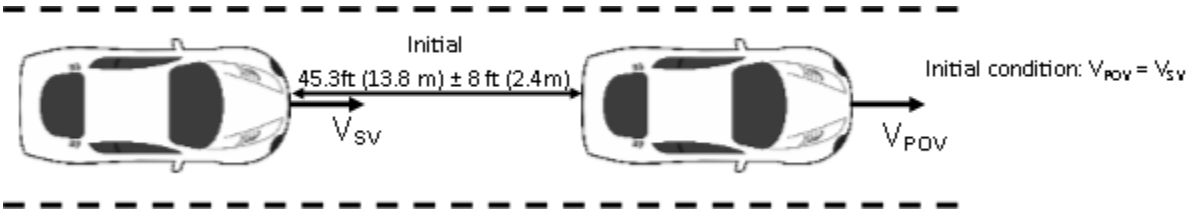


Figure 2. Depiction of Test 2

Table 3. Test Conditions for Slower POV

Initial SV Speed mph (km/h)	Initial POV Speed mph (km/h)	POV Deceleration g
25 (40.2)	10 (16.1)	0
45 (72.4)	20 (32.2)	0

a. Procedure

The SV ignition was cycled prior to each test run. The tests were conducted two ways. In the first, the POV was driven at a constant 10.0 mph (16.1 km/h) in the center of the lane of travel while the SV was driven at 25.0 mph (40.2 km/h), in the center lane of travel, toward the slower-moving POV. In the second, the POV was driven at a constant 20.0 mph (32.2 km/h) in the center of the lane of travel while the SV was driven at 45.0 mph (72.4 km/h), in the center lane of travel, toward the slower-moving POV. In both cases, the SV throttle pedal was released within 500 ms after t_{FCW}, i.e. within 500 ms of the FCW alert. The test concluded when either:

- The SV came into contact with the POV or
- 1 second after the speed of the SV becomes less than or equal to that of the POV.

The SV driver then braked to a stop.

In addition to the general test validity criteria described below, for an individual test trial to be valid, the following was required throughout the test:

- The lateral distance between the centerline of the POV and the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The lateral distance between the centerline of the SV and the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The SV speed could not deviate more than ±1.0 mph (±1.6 km/h) during an interval defined by TTC = 5.0 seconds to t_{FCW}.
- The POV speed could not deviate more than ±1.0 mph (±1.6 km/h) during the validity period.

b. Criteria

For the test series in which the initial SV speed was 25 mph, the condition for acceptability was that there be no SV-to-POV impact for at least three of five valid test trials.

To be considered acceptable for the test series for which the initial speed of the SV was 45 mph, the magnitude of the SV speed reduction attributable to CIB intervention must have been ≥ 9.8 mph (15.8 km/h) for at least three of five valid test trials. The magnitude of the SV speed reduction attributable to CIB intervention was calculated in one of two ways, depending on whether a test trial concluded with the SV colliding with the POV.

- If SV-to-POV contact occurred during a test trial, the CIB speed reduction was calculated by subtracting the SV speed at the time of SV-to-POV contact (i.e., when longitudinal range became zero) from the average SV speed calculated from tFCW-100 ms to t_{FCW}.
- If SV-to-POV contact did not occur during a test trial (i.e., CIB intervention prevented the crash), the CIB speed reduction was calculated by subtracting the SV speed at the minimum longitudinal SV-to-POV range during the validity period from the SV speed at t_{FCW}.

3. TEST 3 – SUBJECT VEHICLE ENCOUNTERS DECELERATING PRINCIPAL OTHER VEHICLE

This test evaluates the ability of the CIB system to detect and respond to a lead vehicle slowing with a constant deceleration in the immediate forward path of the SV, as depicted by the example in Figure 3. Test conditions for Test 3 are shown in Table 4.

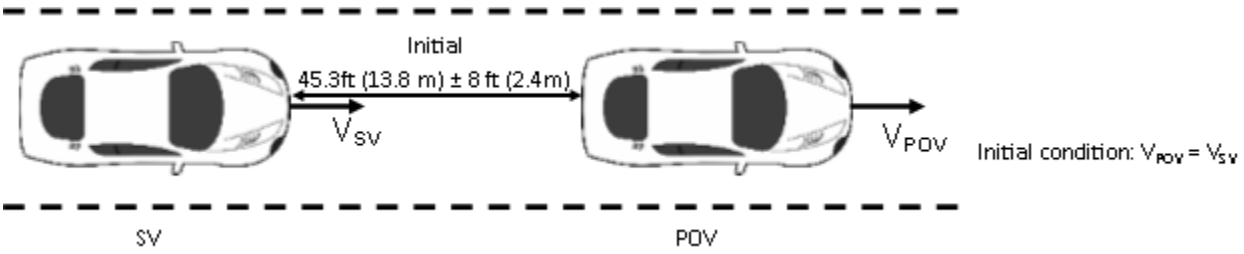


Figure 3. Depiction of Test 3 with POV Decelerating with V_0 =35 mph (56.3 km/h)

Table 4. Test Conditions for Decelerating POV

Initial SV Speed mph (km/h)	Initial POV Speed mph (km/h)	POV Deceleration g
35 (56.3)	35 (56.3)	-0.3
35 (56.3)	35 (56.3)	-0.5
45 (72.4)	45 (72.4)	-0.3

a. Procedure

The SV ignition was cycled prior to each test run. This test scenario was conducted at three different combinations of nominal initial speeds (V_0) and deceleration levels ($-a_x$). The first two combinations comprised V_0 = 35.0 mph (56.3 km/h) with a_x = -0.3 ± 0.03 g and -0.5 ± 0.03 g respectively. The third combination comprised V_0 = 45 mph (72.4 km/h) and a_x = 0.3 ± 0.03 g. Both the POV and SV were driven at a constant V_0 in the center of the lane, with a headway of 45.3 ft (13.8 m) ± 8 ft (2.4 m). Once these conditions were met for at least three seconds, the POV (GVT) brakes were applied to achieve the nominal level of deceleration ($-a_x$). The test concluded when either:

- The SV came into contact with the POV or
- For the decelerating POV, 1 second after minimal longitudinal SV-to-POV distance occurred or
- For the POV decelerating to stop case, 1 second after the velocity of the SV became less than or equal to that of the POV.

The SV driver then braked to a stop.

In addition to the general test validity criteria described below, for an individual test trial to be valid, the following was required throughout the test:

- The lateral distance between the centerline of the POV and the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.

- The lateral distance between the centerline of the SV and the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The headway between the SV and POV must have been constant from the onset of the applicable validity period to the onset of POV braking.
- The SV and POV speed could not deviate more than ±1.0 mph (1.6 km/h) during an interval defined by the onset of the validity period to the onset of POV braking.
- The SV- POV headway distance could not deviate more than ±8 ft (2.4 m) during an interval defined by the onset of the validity period to the onset of POV braking.
- The average POV deceleration could not deviate by more than ±0.03 g from the nominal 0.3 g deceleration or 0.5 g deceleration, during the interval beginning at 1.5 seconds after the onset of POV braking and ending either 250 ms prior to the POV coming to a stop or the SV coming into contact with the POV.

b. Criteria

For the decelerating POV test series, in order to be considered acceptable, the magnitude of the SV speed reduction attributable to CIB intervention must have been ≥ 10.5 mph (16.9 km/h) for at least three of five valid test trials, for each combination of initial speeds and deceleration levels. The magnitude of the SV speed reduction attributable to CIB intervention was calculated in one of two ways, depending on whether a test trial concluded with the SV colliding with the POV.

- If SV-to-POV contact occurred during a test trial, the CIB speed reduction was calculated by subtracting the SV speed at the time of SV-to-POV contact (i.e., when longitudinal range becomes zero) from the average SV speed calculated from t_{FCW} - 100 ms to t_{FCW}.
- If SV-to-POV contact did not occur during a test trial (i.e., CIB intervention prevents the crash), the CIB speed reduction was calculated by subtracting the SV speed at the minimum longitudinal SV-to-POV range during the applicable validity period from the SV speed at t_{FCW}.

B. General Information

1. T_{FCW}

The time at which the Forward Collision Warning (FCW) activation flag indicates that the system has issued an alert to the SV driver is designated as $t_{FCW.}$ FCW alerts are typically either audible, visual, or haptic and the onset of the alert was determined by post-processing the test data.

For systems that implement audible or haptic alerts, part of the pre-test instrumentation verification process was to determine the tonal frequency of the audible warning or the vibration frequency of the tactile warning through use of the PSD (Power Spectral

Density) function in Matlab. This was accomplished in order to identify the center frequency around which a band-pass filter was applied to subsequent audible or tactile warning data so that the beginning of such warnings can be programmatically determined. The band-pass filter used for these warning signal types was a phaseless, forward-reverse pass, elliptical (Cauer) digital filter, with filter parameters as listed in Table 5.

Table 5. Audible and Tactile Warning Filter Parameters

Warning Type	Filter Order	Peak-to-Peak Ripple	Minimum Stop Band Attenuation	Passband Frequency Range
Audible	5th	3 dB	60 dB	Identified Center Frequency ± 5%
Tactile	5th	3 dB	60 dB	Identified Center Frequency ± 20%

2. GENERAL VALIDITY CRITERIA

In addition to any validity criteria described above for the individual test scenarios, for an individual trial to be valid, it must have met the following criteria throughout the test:

- The SV driver seatbelt was latched.
- If any load had been placed on the SV front passenger seat (e.g., for instrumentation), the vehicle's front passenger seatbelt was latched.
- The SV was driven at the nominal speed in the center of the travel lane, toward the POV.
- The driver used the least amount of steering input necessary to maintain SV position in the center of the travel lane during the validity period; use of abrupt steering inputs or corrections was avoided.
- The yaw rate of the SV did not exceed ±1.0 deg/s from the onset of the validity period to the instant SV deceleration exceeded 0.25 g.
- The SV driver did not apply any force to the brake pedal during the applicable validity period.
- The lateral distance between the centerline of the SV and the centerline of the POV did not deviate more than ±1 ft (0.3 m) during the applicable validity period.

3. VALIDITY PERIOD

The valid test interval began:

Test 1: When the SV-to-POV TTC = 5.1 seconds

Test 2: When the SV-to-POV TTC = 5.0 seconds

Test 3: 3 seconds before the onset of POV braking

The valid test interval ended:

Test 1: When either of the following occurred:

- The SV came into contact with the POV (SV-to-POV contact was assessed by using GPS-based range data or by measurement of direct contact sensor output); or
- The SV came to a stop before making contact with the POV.

Tests 2 and 3: When either of the following occurred:

- The SV came into contact with the POV; or
- 1 second after the velocity of the SV became less than or equal to that of the POV.
- 1 second after minimal longitudinal SV-to-POV distance occurred.

4. STATIC INSTRUMENTATION CALIBRATION

To assist in resolving uncertain test data, static calibration data was collected prior to each of the test series.

For Tests 1, 2, and 3, the SV and POV (i.e., GVT and LPRV) were centered in the same travel lane with the same orientation (i.e., facing the same direction).

For these tests, the SV was also positioned such that it just contacted a vertical plane that defines the rearmost location of the POV. This is the “zero position.”

The zero position was documented prior to, and immediately after, conduct of each test series.

If the zero position reported by the data acquisition system was found to differ by more than ±2 in (±5 cm) from that measured during collection of the pre-test static calibration data file, the pre-test longitudinal offset was adjusted to output zero and another pre-test static calibration data file was collected. If the zero position reported by the data acquisition system was found to differ by more than ±2 in (±5 cm) from that measured during collection of the post-test static calibration data file, the test trials performed

between collection of that post-test static calibration data file and the last valid pre-test static calibration data file were repeated.

Static data files were collected prior to, and immediately after, conducting each of the test series. The pre-test static files were reviewed prior to test conduct to confirm that all data channels were operational and were properly configured.

5. NUMBER OF TRIALS

A target total of five (5) valid trials were performed for each scenario. In cases where the test driver performed more than five trials, the first five trials satisfying all test tolerances were used to assess the SV performance.

6. TRANSMISSION

All trials were performed with SV automatic transmissions in ‘‘Drive’’ or with manual transmissions in the highest gear capable of sustaining the desired test speed. Manual transmission clutches remained engaged during all maneuvers. The brake lights of the POV were not illuminated.

C. Principal Other Vehicle

CIB testing requires a POV that realistically represents typical vehicles, does not suffer damage or cause damage to a test vehicle in the event of collision, and can be accurately positioned and moved during the tests. The tests reported herein made use of the GVT secured to a low profile robotic vehicle (LPRV).

This GVT system was designed for a wide range of crash scenarios including scenarios that AEB systems address. The key components of the GVT system are:

- A soft Global Vehicle Target (GVT), which is visually and dimensionally similar to a 2013 Ford Fiesta hatchback. It is designed to appear realistic to the sensors used by automotive safety systems and automated vehicles: radar, camera, and lidar. Appropriate radar characteristics are achieved by using a combination of radar-reflective and radar-absorbing material enclosed within the GVT’s vinyl covers. Internally, the GVT consists of a vinyl-covered foam structure. If a test vehicle impacts the GVT at low speeds, it is designed to separate, and is typically pushed off and away from the supporting LPRV platform. At higher impact speeds, the GVT breaks apart as the SV essentially drives through it. The GVT can be repeatedly struck from any approach angle without harm to those performing the tests or the vehicles being evaluated. Reassembly of the GVT occurs on top of the robotic platform and takes a team of 3 to 5 people approximately 7 to 10 minutes to complete.
- An LPRV platform that supports the GVT and provides for precisely controlled GVT motion. The LPRV contains the batteries, drive motors, GPS receiver, and the control electronics for the system. It has a top speed of 50 mph (80 km/h); a maximum longitudinal acceleration and deceleration of 0.12g (1.18 m/s^2) and

0.8g (7.8 m/s^2), respectively; and a maximum lateral acceleration of 0.5 g (4.9 m/s^2). The LPRV is preprogrammed and allows the GVT's movement to be accurately and repeatedly choreographed with the test vehicle and/or other test equipment required by a pre-crash scenario using closed-loop control. The LPRV is designed to be safely driven over by the SV without damage if the GVT is struck by the SV.

The key requirements of the POV element are to:

- Provide an accurate representation of a real vehicle to CIB sensors, including cameras and radar.
- Be resistant to damage and inflict little or no damage to the SV as a result of repeated SV-to-POV impacts.

The key requirements of the POV delivery system are to:

- Accurately control the nominal POV speed up to 45 mph (72.4 km/h).
- Accurately control the lateral position of the POV within the travel lane.

Operationally, the GVT body is attached to LPRV using Velcro hook and loop fasteners. The GVT and LPRV are designed to separate if the GVT is struck by the SV. The GVT/LPRV system is shown in Figures A6 and A7 in Appendix A and a detailed description can be found in the NHTSA report: "A Test Track Comparison of the Global Vehicle Target (GVT) and NHTSA's Strikeable Surrogate Vehicle (SSV)".[4]

D. Automatic Braking System

The LPRV includes an automatic braking system, which was used in Test 3. The braking system can provide for pre-programmed controlled deceleration up to 0.5 g (4.9 m/s^2).

In some cases, the SV is also equipped with an automatic braking system (E-brake) for the purpose of slowing the SV before impact with the SSV in cases where the subject vehicle is likely to fail a test. The system fires when TTC is below 0.7 sec. It is typically enabled when an SV has already impacted the SSV one or two times in prior runs of the same test.

E. Instrumentation

Table 6 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

[4] Snyder, A.C., Forkenbrock, G.J., Davis, I.J., O'Harra, B.C., and Schnelle, S.C., A Test Track Comparison of the Global Vehicle Target (GVT) and NHTSA's Strikeable Surrogate Vehicle (SSV), DOT HS 812 698, Vehicle Research and Test Center, National Highway Traffic Safety Administration, Washington, DC, July 2019.

Table 6. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and	Omega DPG8001	17042707002	By: DRI Date: 7/3/2019 Due: 7/3/2020
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform 5338 N/	0.5% of applied load	Intercomp SWI	1110M206352	By: DRI Date: 1/6/2020 Due: 1/6/2021
Linear (string) encoder	Throttle pedal travel	10 in 254 mm	0.1 in 2.54 mm	UniMeasure LX-EP	45040532	By: DRI Date: 5/10/2019 Due: 5/10/2020
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	NA
SV Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels ± 10g, Angular Rat	Accels .01g, Angular Rate	Oxford Inertial +	2258	By: Oxford Technical Solutions Date: 5/3/2019 Due: 5/3/2021
POV Multi-Axis Inertial Sensing System		Accels ± 10g, Angular Rat	Position (RTK) 0.02m, Rol	Oxford PinPoint 2G	24504	By: Oxford Technical Solutions Date: 7/18/2019 Due: 7/18/2021

Table 6. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2020 Due: 1/6/2021
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	NA
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA

Type	Description	Mfr, Model	Serial Number
Data Acquisition System	Data acquisition is achieved using a dSPACE MicroAutoBox II. Data from the Oxford IMU, including Longitudinal, Lateral, and Vertical Acceleration, Roll, Yaw, and Pitch Rate, Forward and Lateral Velocity, Roll and Pitch Angle are sent over Ethernet to the MicroAutoBox. The Oxford IMUs are calibrated per the manufacturer's recommended schedule (listed above).	dSPACE Micro-Autobox II 1401/1513	
		Base Board	549068
		I/O Board	588523

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

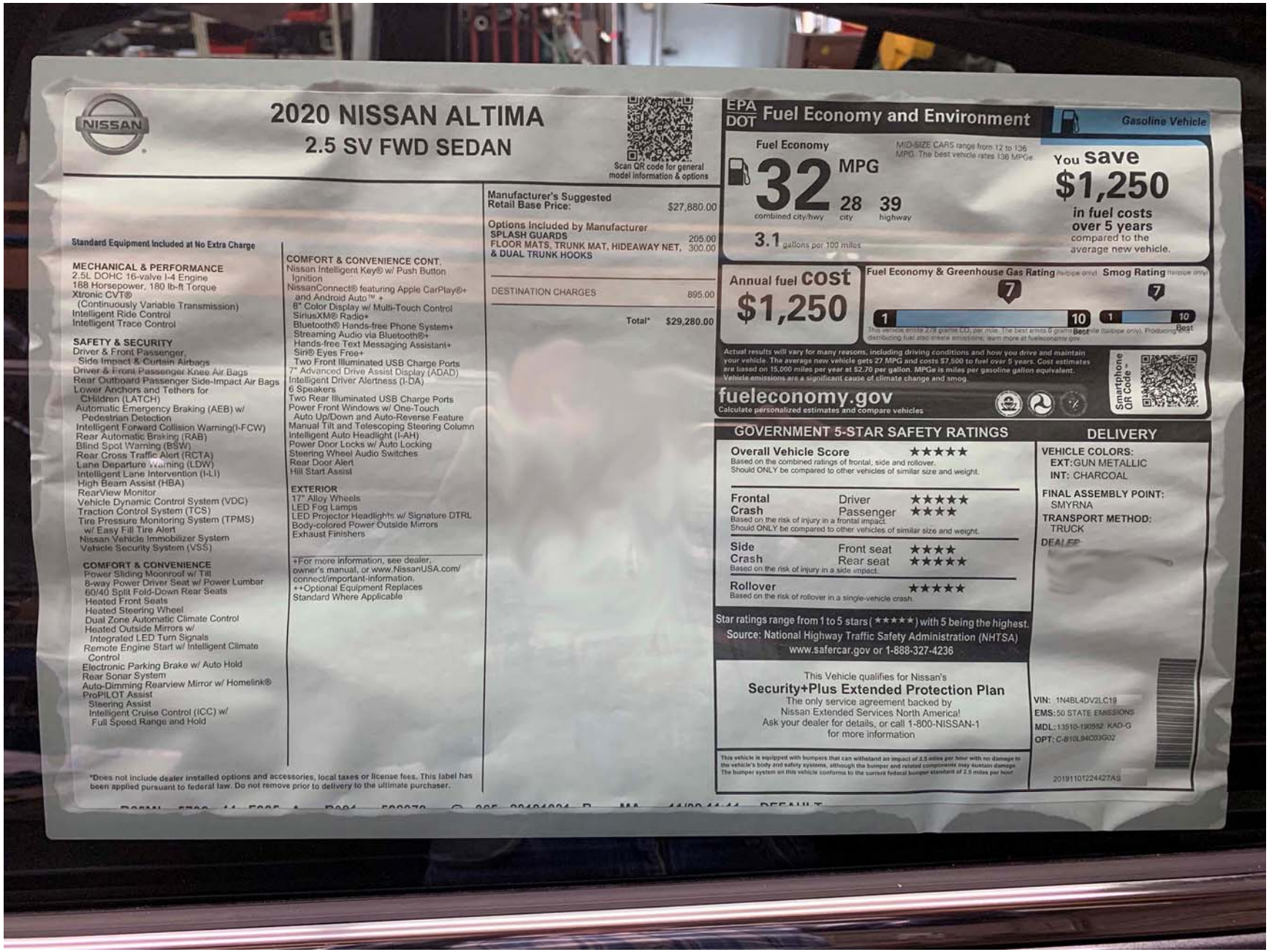


Figure A3. Window Sticker (Monroney Label)

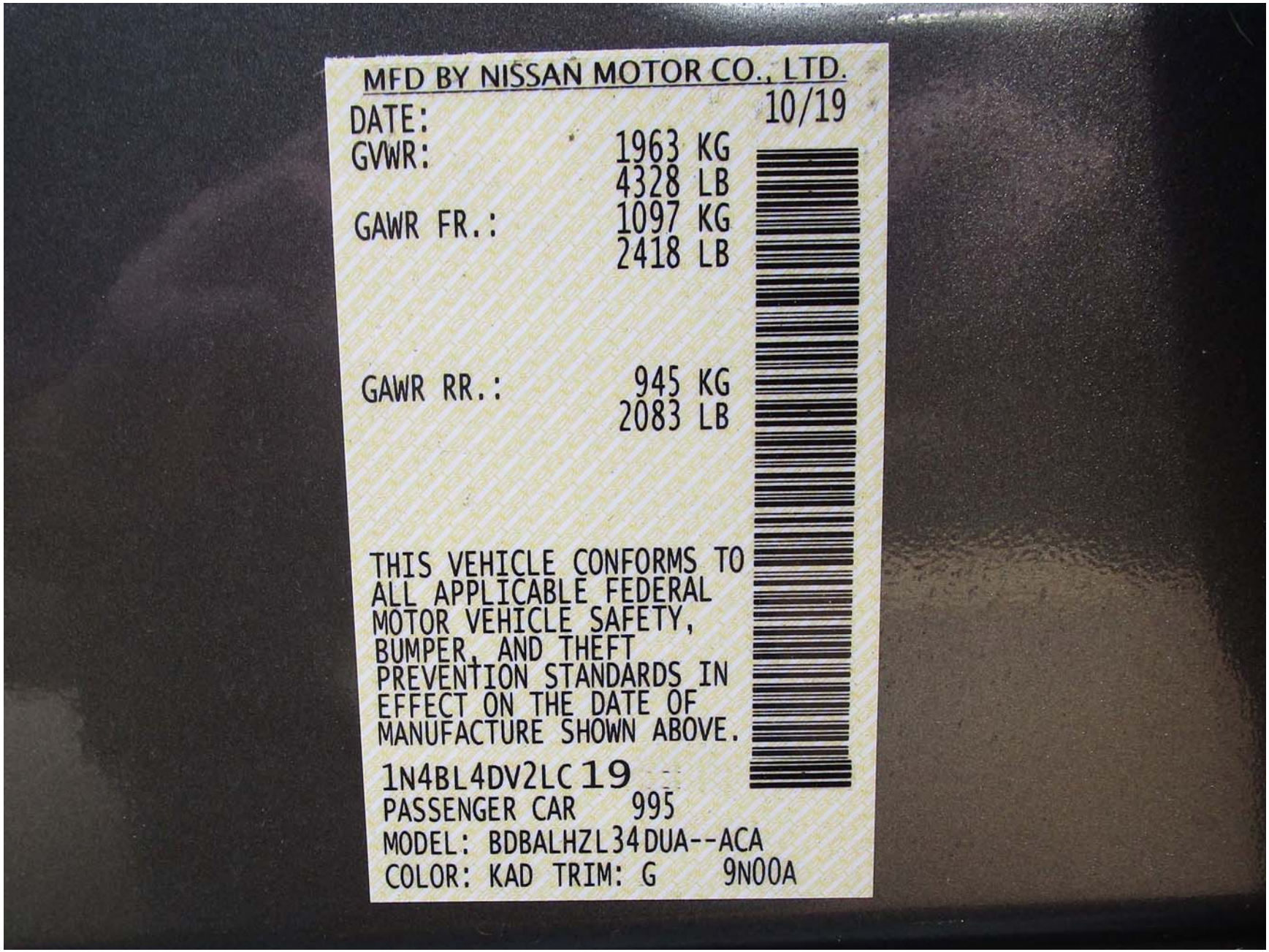


Figure A4. Vehicle Certification Label

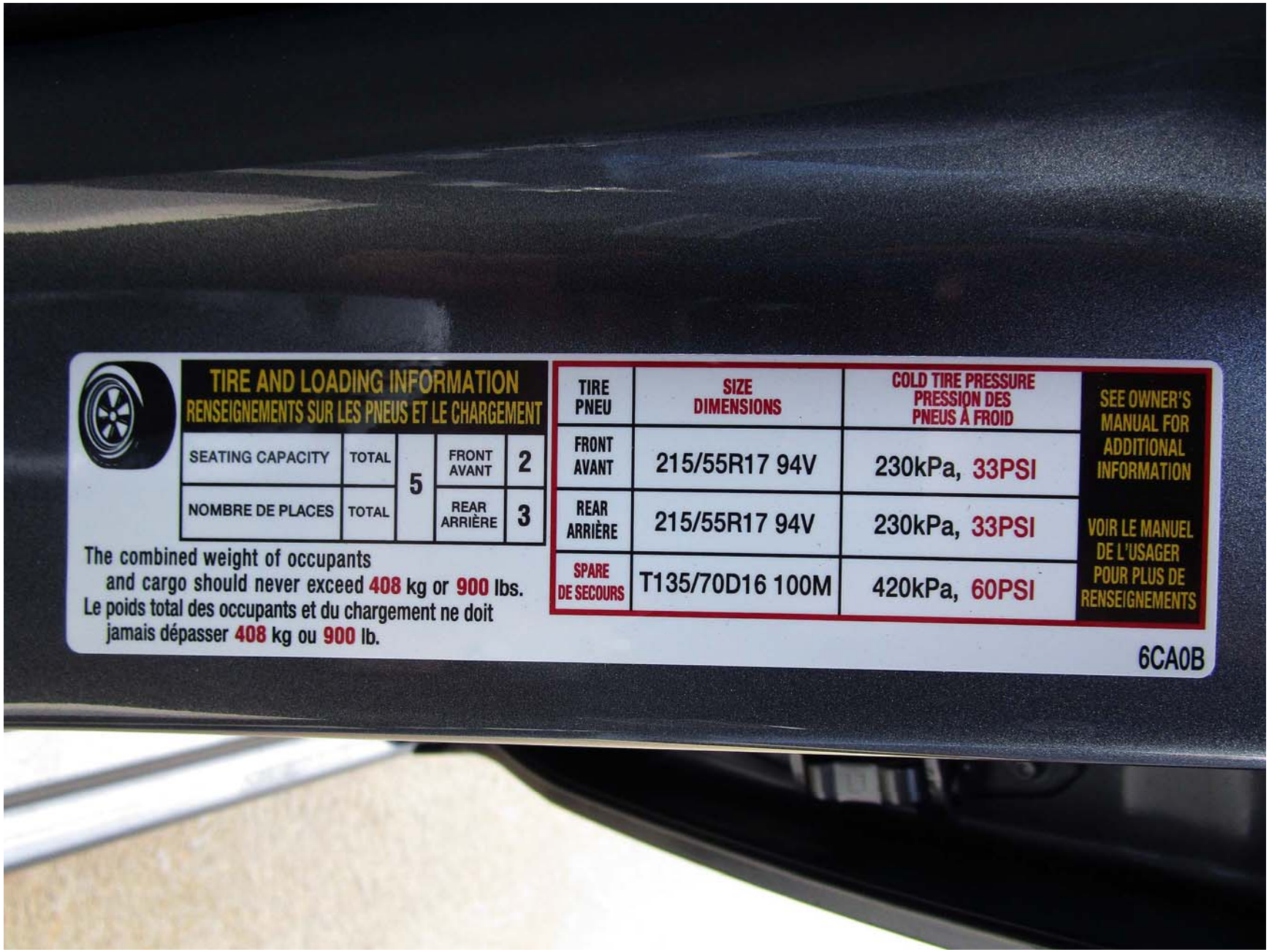


Figure A5. Tire Placard

Figure A6. Front View of Principal Other Vehicle: Global Vehicle Target

Figure A7. Rear View of Principal Other Vehicle: Global Vehicle Target

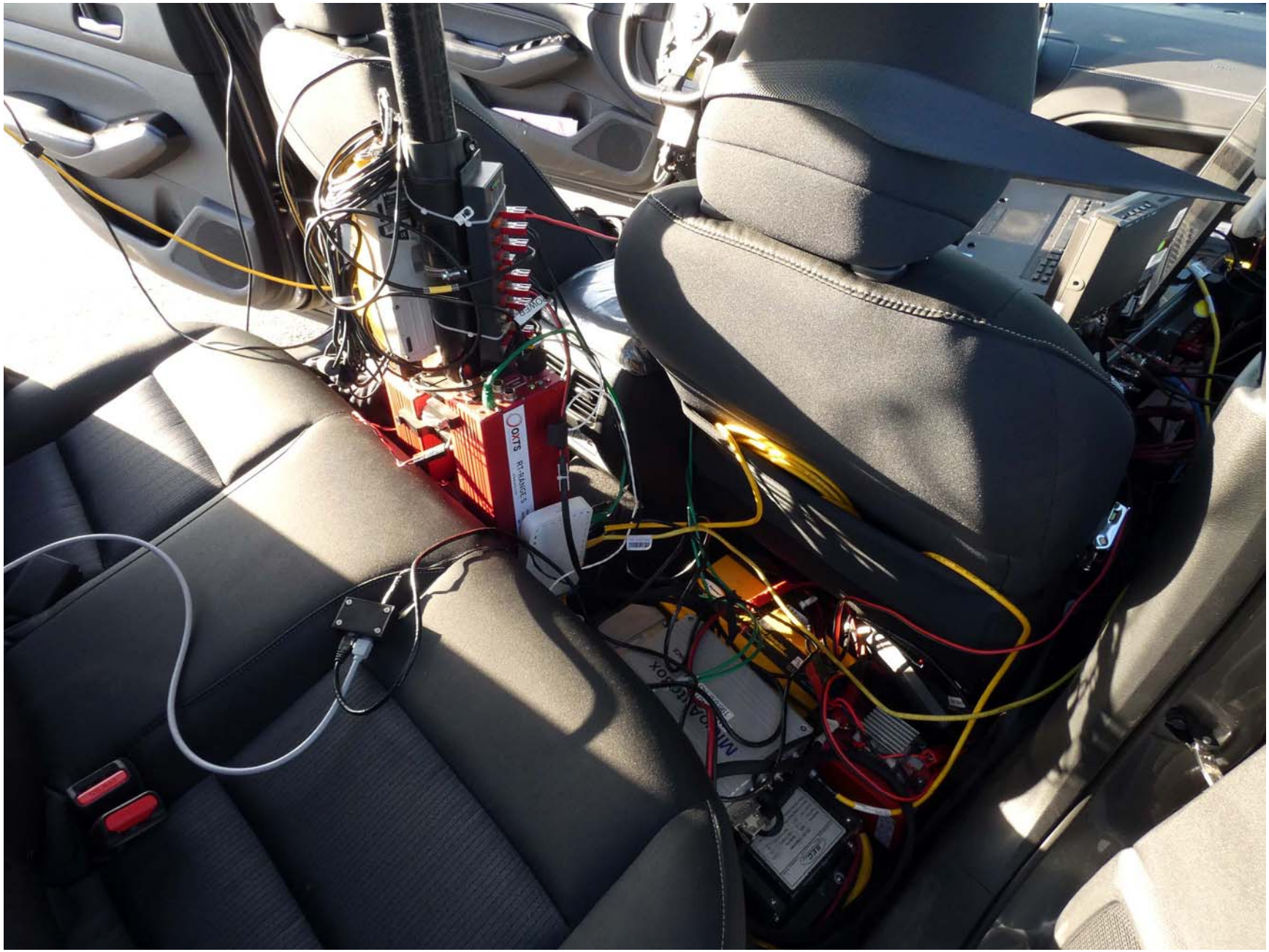


Figure A8. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A9. Sensor for Detecting Visual Alerts

Figure A10. Sensor for Detecting Auditory Alerts

Figure A11. Computer Installed in Subject Vehicle

Figure A12. AEB Setup Menus

Figure A13. Control for Changing Vehicle Parameters

Figure A14. Staged Visual Alerts

APPENDIX B

Excerpts from Owner’s Manual

WARNING AND INDICATOR LIGHTS

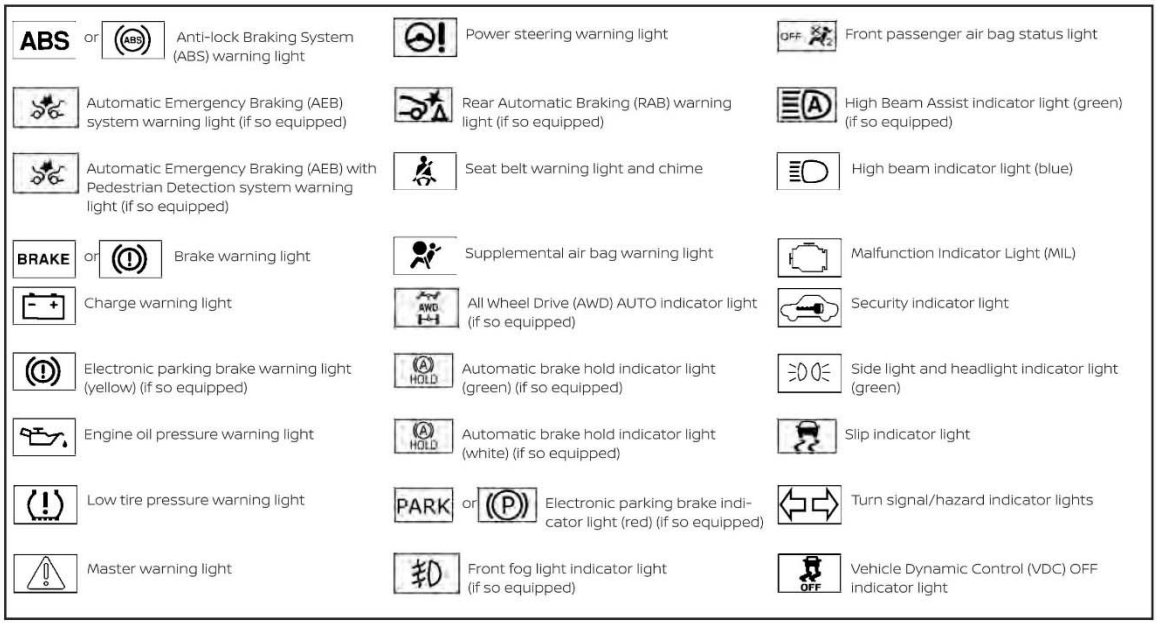
Warning light	Name	Page
	Anti-lock Braking System (ABS) warning light	2-10
	Automatic Emergency Braking (AEB) system warning light (if so equipped)	2-10
	Automatic Emergency Braking (AEB) with Pedestrian Detection system warning light (if so equipped)	2-11
	Brake warning light	2-11

Warning light	Name	Page
	Charge warning light	2-11
	Electronic parking brake warning light (yellow) (if so equipped)	2-12
	Engine oil pressure warning light	2-12
	Low tire pressure warning light	2-12
	Master warning light	2-14
	Power steering warning light	2-14
	Rear Automatic Braking (RAB) warning light (if so equipped)	2-15

Warning light	Name	Page
	Seat belt warning light and chime	2-15
	Supplemental air bag warning light	2-15

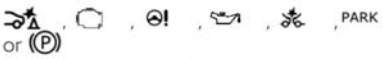
Indicator light	Name	Page
	All Wheel Drive (AWD) AUTO indicator light (if so equipped)	2-15
	Automatic brake hold indicator light (green) (if so equipped)	2-16
	Automatic brake hold indicator light (white) (if so equipped)	2-16

WARNING LIGHTS, INDICATOR LIGHTS AND AUDIBLE REMINDERS



CHECKING LIGHTS

With all doors closed, apply the parking brake, fasten the seat belts and place the ignition switch in the ON position without starting the engine. The following lights (if so equipped) will come on:



The following lights (if so equipped) come on briefly and then go off:

If any light fails to come on or operate in a way other than described, it may indicate a burned-out bulb and/or a system malfunction. Have the system checked. It is recommended that you visit a NISSAN dealer for this service.

Some indicators and warnings are also displayed in the vehicle information display between the speedometer and tachometer. For additional information, refer to "Vehicle information display" in this section.

WARNING LIGHTS

For additional information on warnings and indicators, refer to "Vehicle information display" in this section.

Anti-lock Braking System (ABS) warning light

When the ignition switch is placed in the ON position, the ABS warning light illuminates and then turns off. This indicates the ABS is operational.

If the ABS warning light illuminates while the engine is running or while driving, it may indicate the ABS is not functioning properly. Have the system checked. It is recommended that you visit a NISSAN dealer for this service.

If an ABS malfunction occurs, the anti-lock function is turned off. The brake system then operates normally but without anti-lock assistance. For additional information, refer to "Brake system" in the "Starting and driving" section of this manual.

Automatic Emergency Braking (AEB) system warning light (if so equipped)

This light comes on when the ignition switch is placed in the ON position. It turns off after the vehicle is started.

This light illuminates when the AEB system is set to OFF on the meter display.

If the light illuminates when the AEB system is on, it may indicate that the system is unavailable. For additional information, refer to "Automatic Emergency Braking (AEB)" and "Intelligent Forward Collision Warning (I-FCW)" in the "Starting and driving" section of this manual.

Automatic Emergency Braking (AEB) with Pedestrian Detection system warning light (if so equipped)

This light comes on when the ignition switch is placed in the ON position. It turns off after the engine is started.

This light illuminates when the AEB with Pedestrian Detection system is set to OFF in the vehicle information display.

If the light illuminates when the AEB with Pedestrian Detection system is on, it may indicate that the system is unavailable. For additional information, refer to "Automatic Emergency Braking (AEB) with Pedestrian Detection" and "Intelligent Forward Collision Warning (I-FCW)" in the "Starting and driving" section of this manual.

BRAKE or Brake warning light

This light functions for both the parking brake and the foot brake systems.

Parking brake indicator (if so equipped)

When the ignition switch is placed in the ON position, the light comes on when the parking brake is applied.

Low brake fluid warning light

When the ignition switch is placed in the ON position, the light warns of a low brake fluid level. If the light comes on while the engine is running with the parking brake not applied, stop the vehicle and perform the following:

1. Check the brake fluid level. Add brake fluid as necessary. For additional information, refer to "Brake fluid" in the "Do-it-yourself" section of this manual.
2. If the brake fluid level is correct, have the warning system checked. It is recommended that you visit a NISSAN dealer for this service.

⚠ WARNING

- **Your brake system may not be working properly if the warning light is on. Driving could be dangerous. If you judge it to be safe, drive carefully to the nearest service station for repairs. Otherwise, have your vehicle towed because driving it could be dangerous.**
- **Pressing the brake pedal with the engine stopped and/or a low brake fluid level may increase your stopping distance and braking will require greater pedal effort as well as pedal travel.**
- **If the brake fluid level is below the MINIMUM or MIN mark on the brake fluid reservoir, do not drive until the brake system has been checked. It is recommended that you visit a NISSAN dealer for this service.**

Charge warning light

If this light comes on while the engine is running, it may indicate the charging system is not functioning properly. Turn the engine off and check the generator belt. If the belt is loose, broken, or missing, or if the light remains on, have the system checked.

Driver Assistance

The driver assistance menu allows the user to change the settings for driving, parking, and braking aids.

Menu item		Result
Steering Assist (if so equipped)		Allows user to turn the Steering Assist of the ProPILOT Assist system on or off. For additional information, please refer to "ProPILOT Assist" in the "Starting and driving" section of this manual.
Emergency Brake		Displays available emergency braking options.
	Front	Allows user to turn the front emergency braking system on or off. For additional information, refer to "Automatic Emergency Braking (AEB)" , "Automatic Emergency Braking (AEB) with Pedestrian Detection" and "Intelligent Forward Collision Warning (I-FCW)" in the "Starting and driving" section of this manual.
	Rear (if so equipped)	Allows user to turn the rear emergency braking system on or off. For additional information, refer to "Rear Automatic Braking (RAB)" in the "Starting and driving" section of this manual.
Lane (if so equipped)		Displays available lane options.
	Lane Departure Warning	Allows user to turn the Lane Departure Warning (LDW) system on or off. For additional information, refer to "Lane Departure Warning (LDW)" in the "Starting and driving" section of this manual.
	Lane Departure Prevention (if so equipped)	Allows user to turn Intelligent Lane Intervention (I-LI) system on or off. For additional information, refer to "Intelligent Lane Intervention (I-LI)" in the "Starting and driving" section of this manual.
Blind Spot (if so equipped)		Displays available blind spot options.
	Blind Spot Warning	Allows user to turn the Blind Spot Warning (BSW) system on or off. For additional information, refer to "Blind Spot Warning (BSW)" in the "Starting and driving" section of this manual.
	Side Indicator Brightness	Allows user to change the brightness of the side indicator.
Speed Limit Sign (if so equipped)		Allows user to turn the Speed Limit Sign recognition on or off. For additional information, refer to "Traffic Sign Recognition" in the "Starting and driving" section of this manual.
Parking Aids (if so equipped)		Displays available parking aids.
	Auto Show Sonar	Allows user to auto display the sonar. For additional information, refer to "Rear Sonar System (RSS)" in the "Starting and driving" section of this manual.
	Rear	Allows user to turn the rear sonar on or off.
	Distance	Allows user to set the distance sensor range to Long/Medium/Short.

VEHICLE INFORMATION DISPLAY INDICATORS

Indicator	Name
	Automatic Emergency Braking (AEB) emergency warning indicator
	Blind Spot Warning (BSW) indicator (if so equipped)
	Cruise control indicator (if so equipped)
	Drive sport mode indicator (if so equipped)
	Intelligent Lane Intervention (I-LI) indicator (if so equipped)
	Lane Departure Warning indicator (if so equipped)

Indicator	Name
	Rear Automatic Braking (RAB) indicator (if so equipped)
	Steering Assist Alert (if so equipped)
	Steering Assist indicator (if so equipped)
	Transmission Shift position indicator
	Vehicle ahead detection indicator

Automatic Emergency Braking (AEB) emergency warning indicator

This indicator illuminates along, with an audible warning, when the system detects the possibility of a forward collision.

For additional information, refer to "Automatic Emergency Braking (AEB)" and "Automatic Emergency Braking (AEB) with Pedestrian Detection" in the "Starting and driving" section of this manual.

Blind Spot Warning (BSW) indicator (if so equipped)

This indicator shows when the BSW system is engaged.

For additional information, refer to "Blind Spot Warning (BSW)" in the "Starting and driving" section of this manual.

Cruise control indicator (if so equipped)

This indicator shows the cruise control system status.

When cruise control is activated, a green circle will illuminate to indicate it is set. The vehicle information display will also display the speed the cruise control was set at. If you accelerate past the set speed, the speed will blink until you either cancel cruise control or go back to the set speed. If cruise control is on and canceled, the speed will be displayed to show the speed the vehicle will return to if the resume button is activated.

Drive sport mode indicator (if so equipped)

A small "S" appears to the right of the Transmission Shift Position indicator in the vehicle information display when the drive sport mode is engaged.

Activate the drive sport mode by pushing the switch on the shift lever while the shift lever is in the D (Drive) position.

For additional information, refer to "Driving the vehicle" in the "Starting and driving" section of this manual.

Intelligent Lane Intervention (I-LI) indicator (if so equipped)

This indicator shows when the I-LI system is engaged.

For additional information, refer to "Intelligent Lane Intervention (I-LI)" in the "Starting and driving" section of this manual.

Lane Departure Warning (LDW) indicator (if so equipped)

This indicator shows when the LDW system is engaged.

For additional information, refer to "Lane Departure Warning (LDW)" and "Intelligent Lane Intervention (I-LI)" in the "Starting and driving" section of this manual.

Rear Automatic Braking (RAB) indicator (if so equipped)

This indicator illuminates to indicate the status of the Rear Automatic Braking (RAB) system. For additional information, refer to "Rear Automatic Braking (RAB)" in the "Starting and driving" section of this manual.

Steering Assist Alert (if so equipped)

This message may appear when the Steering Assist system is engaged.

It will be displayed under the following condition:

- When not holding the steering wheel or when there is no steering wheel operation

Please hold on the steering wheel immediately. When the steering operation is detected, the warning turns off and the steering assist function is automatically restored.

Steering Assist indicator (if so equipped)

This indicator appears when the Steering Assist system is engaged.

For additional information, refer to "ProPILOT Assist" in the "Starting and driving" section of this manual.

Transmission Shift Position indicator

This indicator shows the transmission shift position.

Vehicle ahead detection indicator

This indicator shows when the Automatic Emergency Braking (AEB) system is engaged and has detected a vehicle.

For additional information, refer to "Automatic Emergency Braking (AEB)" or "Automatic Emergency Braking (AEB) with Pedestrian Detection" in the "Starting and driving" section of this manual.

Malfunction (if so equipped)

This warning appears when one or more of the following systems (if so equipped) is not functioning properly:

- Automatic Emergency Braking (AEB)
- Automatic Emergency Braking (AEB) with Pedestrian Detection
- Intelligent Forward Collision Warning (I-FCW)

If one or more of these warning appears, have the system checked. It is recommended that you visit a NISSAN dealer for this service.

For additional information, refer to "Automatic Emergency Braking (AEB)", "Automatic Emergency Braking (AEB) with Pedestrian Detection" or "Intelligent Forward Collision Warning (I-FCW) in the "Starting and driving" section of this manual.

Shipping Mode On Push Storage Fuse

This warning may appear if the extended storage switch is not pushed in. When this warning appears, push in the extended storage switch to turn off the warning. For additional information, refer to "Extended storage switch" in this section.

Not Available Parking Brake On (if so equipped)

This message may appear when the Intelligent Cruise Control (ICC) (for vehicles with ProPILOT Assist) is engaged.

Under the following condition, the ICC (for vehicles with ProPILOT Assist) system is automatically canceled:

- The electronic parking brake is applied.

The above system cannot be used when the electronic parking is activated.

For additional information, refer to "Intelligent Cruise Control (ICC) (for vehicles with ProPILOT Assist)" and "Parking brake" in the "Starting and driving" section of this manual.

Rear Door Alert is activated

When the system is enabled, this message appears when the Rear Door Alert system is active and can remind the driver to check the back seat.

- Using the steering wheel switch, a driver can select "Dismiss Message" to clear the display for a period of time. If no selection is made, this message automatically turns off after a period of time.
- Using the steering wheel switch, a driver can select "Disable Alert" to disable the horn alert for the remainder of the current trip.

⚠ WARNING

Selecting "Dismiss Message" during a stop within a trip temporarily dismisses the message for that stop without turning the system off. Alerts can be provided for other stops during the trip. Selecting "Disable Alert" turns off the Rear Door Alert system for the remainder of a trip and no audible alert will be provided.

NOTE:

This system is disabled until a driver enables it using the vehicle information display. For additional information, refer to "How to use the vehicle information display" in this section.

For additional information, refer to "Rear Door Alert" in this section.

Check Rear Seat For All Articles

When the system is enabled, this message appears when the vehicle comes to a complete stop, the vehicle is transitioned from

The above system cannot be used when the driver's seat belt is not fastened.

Not Available: Front Radar Blocked (if so equipped)

This message appears when the Intelligent Cruise Control (ICC) systems, the Automatic Emergency Braking (AEB) system, the Automatic Emergency Braking (AEB) with Pedestrian Detection system, or the Intelligent Forward Collision Warning (I-FCW) system becomes unavailable because the front radar is obstructed. For additional information, refer to "Intelligent Cruise Control (ICC) (for vehicles without ProPILOT Assist)", "Intelligent Cruise Control (ICC) (for vehicles with ProPILOT Assist)", "Automatic Emergency Braking (AEB)", "Automatic Emergency Braking (AEB) with Pedestrian Detection" or "Intelligent Forward Collision Warning (I-FCW)" in the "Starting and driving" section of this manual.

Currently not available (if so equipped)

This message may appear when the Intelligent Cruise Control (ICC) (with ProPILOT Assist) system , the ICC system or the Intelligent Lane Intervention (I-LI) system is engaged.

Under the following conditions, the ICC (with ProPILOT Assist) , the ICC system or the Intelligent Lane Intervention (I-LI) system is automatically canceled:

- When the VDC operates
- When a wheel slips
- When the VDC system is turned off

The above system cannot be used in some situations (VDC operates, wheel slip and VDC system is off.)

Not Available Poor Road Conditions (if so equipped)

This message may appear when the Intelligent Cruise Control (ICC) (with ProPILOT Assist) system , the ICC system or the Intelligent Lane Intervention (I-LI) system is engaged.

Under the following conditions, the ICC (with ProPILOT Assist) , the ICC system or the Intelligent Lane Intervention (I-LI) system is automatically canceled:

- When the VDC operates
- When a wheel slips

The above system cannot be used in some situations (VDC operates and wheel slip.)

AWD Error: See Owner's Manual (if so equipped)

This warning appears when the all-wheel drive system is not functioning properly while the engine is running.

AWD High Temp. Stop vehicle (if so equipped)

This warning may appear while trying to free a stuck vehicle due to increased oil temperature. The driving mode may change to 2-Wheel Drive (2WD). If this warning is displayed, stop the vehicle with the engine idling, as soon as it is safe to do so. Then if the warning turns off, you can continue driving.

AWD Tire Size Incorrect: See Owner's Manual (if so equipped)

This warning may appear if there is a large difference between the diameters of the front and rear wheels. Pull off the road in a safe area, with the engine idling. Check that all the tire sizes are the same, that the tire pressure is correct and that the tires are not excessively worn.

⚠ CAUTION

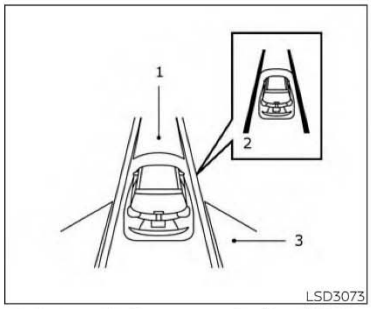
- **Except in an emergency, do not shift to the N (Neutral) position while driving. Coasting with the transmission in the N (Neutral) position may cause serious damage to the transmission.**
- **To avoid possible damage to your vehicle, when stopping the vehicle on an uphill grade, do not hold the vehicle by depressing the accelerator pedal. The foot brake should be used for this purpose.**

The CVT in your vehicle is electronically controlled to produce maximum power and smooth operation.

Follow these procedures for maximum vehicle performance and driving enjoyment.

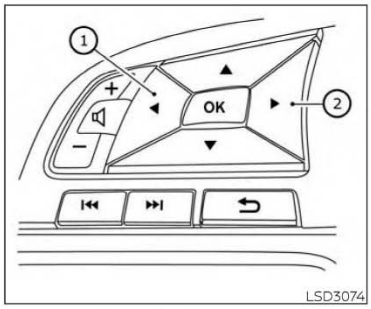
NOTE:

Engine power may be automatically reduced to protect the CVT if the engine speed increases quickly when driving on slippery roads or while being tested on some dynamometers.



LSD3073

1. Automatic Emergency Braking (AEB)
2. Lane Departure Warning (LDW) when shaded and Intelligent Lane Intervention (I-LI) when solid
3. Blind Spot Warning (BSW)



LSD3074

Starting the vehicle

1. After starting the engine, fully depress the foot brake pedal before moving the shift lever out of the P (Park) position. **The Continuously Variable Transmission is designed so the foot brake pedal MUST be depressed before shifting from P (Park) to any drive position while the ignition switch is in the ON position.The shift lever cannot be moved out of P (Park) and into any of the other gear positions if the ignition switch is placed in the LOCK position.**

- **Vehicle-to-vehicle distance control mode:** The ICC system maintains a selected distance from the vehicle in front of you within the speed range of 0 to 90 mph (0 to 144 km/h) up to the set speed. The set speed can be selected by the driver between 20 to 90 mph (32 to 144 km/h). When the vehicle ahead slows to a stop, your vehicle gradually decelerates to a standstill. When the vehicle is stopped, the ICC system maintains braking force to keep your vehicle stopped.

NOTE:

When your vehicle is stopped for less than 3 seconds and the vehicle ahead begins to move, your vehicle will start moving again automatically.

- When your vehicle is at a standstill for more than 3 seconds and the vehicle ahead begins to accelerate, push the RES+ switch or lightly depress the accelerator pedal. The ICC system starts to follow the vehicle ahead.
- When no vehicle is detected ahead within the driver selected distance, the vehicle travels at the speed set by the driver. The speed must be above 20 mph (32 km/h) to use this function.

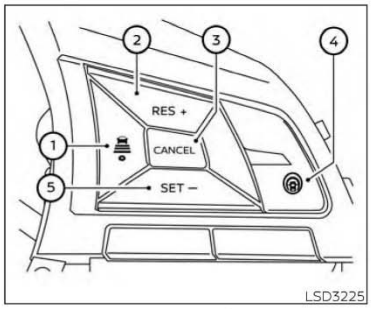
NOTE:

Even if the Automatic Emergency Braking (AEB) setting is turned off by the driver using the "Settings" menu in the vehicle information display, AEB will be automatically turned on when ICC is used.

2. **Steering Assist**

   The Steering Assist function controls the steering system to help keep your vehicle within the traveling lane.

   When there is no vehicle ahead, Steering Assist is not available at speeds under 37 mph (60 km/h).



ProPILOT Assist switches

① **DISTANCE switch:**

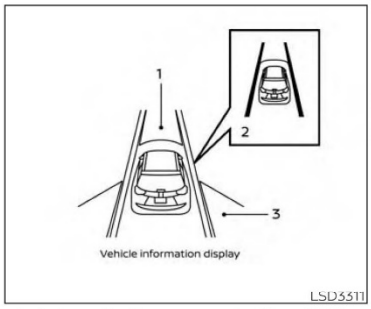
- Long
- Middle
- Short

② **RES+ switch:**

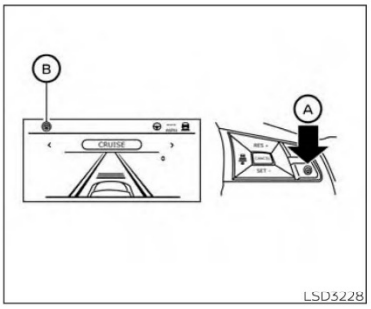
Resumes set speed or increases speed incrementally

③ **CANCEL switch:**

Deactivates the ProPILOT Assist system

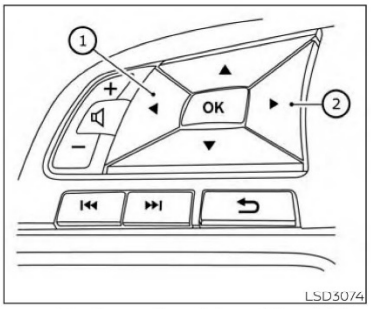


1. Automatic Emergency Braking (AEB)
2. Lane Departure Warning (LDW) when shaded and Intelligent Lane Intervention (I-LI) when solid
3. Blind Spot Warning (BSW)

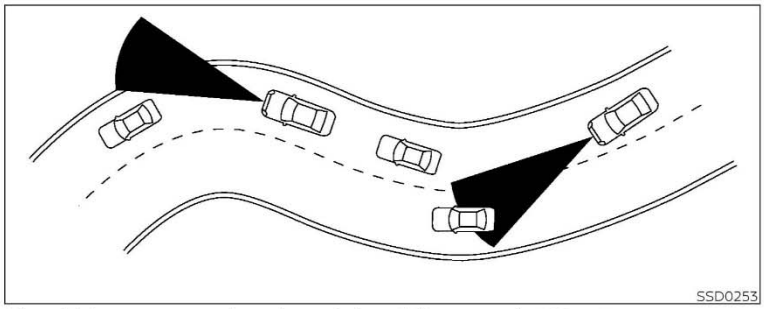


OPERATING PROPILOT ASSIST

1. Push the ProPILOT Assist switch Ⓐ. This turns on the ProPILOT Assist system.
2. A screen is displayed for a period of time that indicates the status of the driving aid functions.
   - AEB, LDW, and BSW are enabled when the specified driving aid is shaded.
   - I-LI is enabled when the driving aid is solid.



   - To change the status of the driving aids, use the ① ◄ or ② ► button to navigate the settings screen. For additional information, refer to "How to use the vehicle information display" in the "Instruments and controls" section of this manual.
3. The status of the ProPILOT Assist system is displayed in the vehicle information display Ⓑ.
4. Accelerate or decelerate your vehicle to the desired speed.


SSD0253

When driving on some roads, such as winding, hilly, curved, narrow roads, or roads which are under construction, the radar sensor may detect vehicles in a different lane, or may temporarily not detect a vehicle traveling ahead. This may cause the radar system to decelerate or accelerate the vehicle.

The detection of vehicles may also be affected by vehicle operation (steering maneuver or traveling position in the lane, etc.) or vehicle condition.

If this occurs, the ICC system may warn you by blinking the system indicator and sounding the chime unexpectedly. You will have to manually control the proper distance away from the vehicle traveling ahead.

Automatic cancellation

The following are conditions in which the ICC system may be temporarily unavailable. In these instances, the ICC system may not cancel and may not be able to maintain the selected following distance from the vehicle ahead.

Condition A

Under the following conditions, the ICC system is automatically canceled. A chime will sound and the system will not be able to be set:

- Any door is open.
- The driver's seat belt is not fastened.
- The vehicle ahead is not detected and your vehicle is traveling below the speed of 15 mph (24 km/h).
- Your vehicle has been stopped by the ICC system for approximately 3 minutes or longer.
- The shift lever is not in the D (Drive) position or manual shift mode.
- The electronic parking brake is applied.
- The VDC system is turned off.
- The AEB applies harder braking.
- VDC (including the traction control system) operates.
- A wheel slips.
- When distance measurement becomes impaired due to adhesion of dirt or obstruction to the sensor.

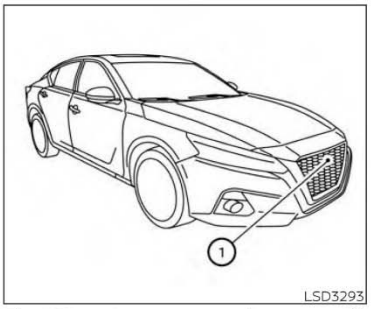
AUTOMATIC EMERGENCY BRAKING (AEB) (if so equipped)

⚠ WARNING

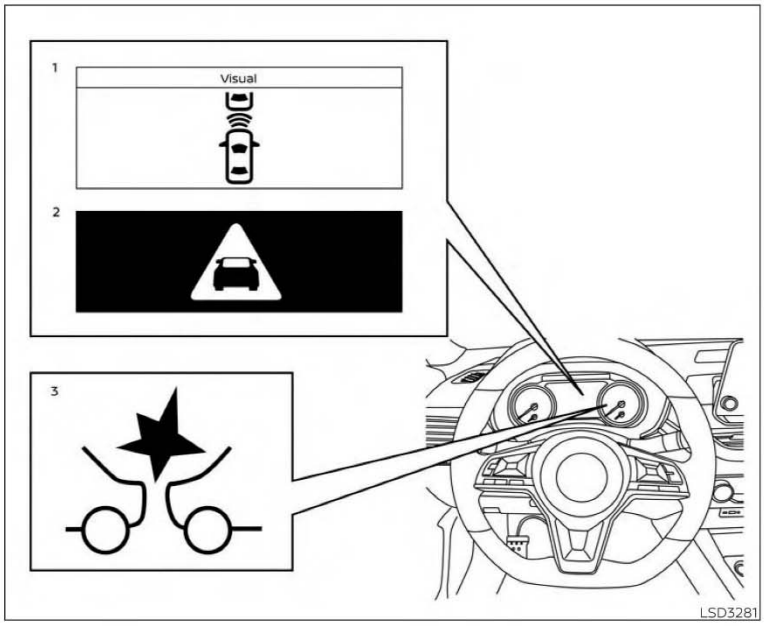
Failure to follow the warnings and instructions for proper use of the AEB system could result in serious injury or death.

- **The AEB system is a supplemental aid to the driver. It is not a replacement for the driver's attention to traffic conditions or responsibility to drive safely. It cannot prevent accidents due to carelessness or dangerous driving techniques.**
- **The AEB system does not function in all driving, traffic, weather and road conditions.**

The AEB system can assist the driver when there is a risk of a forward collision with the vehicle ahead in the traveling lane.



The AEB system uses a radar sensor ① located on the front of the vehicle to measure the distance to the vehicle ahead in the same lane.



1. Vehicle ahead detection indicator
2. AEB emergency warning indicator
3. AEB system warning light

AEB SYSTEM OPERATION

The AEB system will function when your vehicle is driven at speeds above approximately 3 mph (5 km/h).

If a risk of a forward collision is detected, the AEB system will provide an initial warning to the driver by both a visual and audible alert.

If the driver applies the brakes quickly and forcefully after the warning, and the AEB system detects that there is still the possibility of a forward collision, the system will automatically increase the braking force. If the driver does not take action, the AEB system issues the second visual warning and audible warning and also applies partial braking.

If the risk of a collision becomes imminent, the AEB system applies harder braking automatically.

While the AEB system is operating, you may hear the sound of brake operation. This is normal and indicates that the AEB system is operating properly.

NOTE:

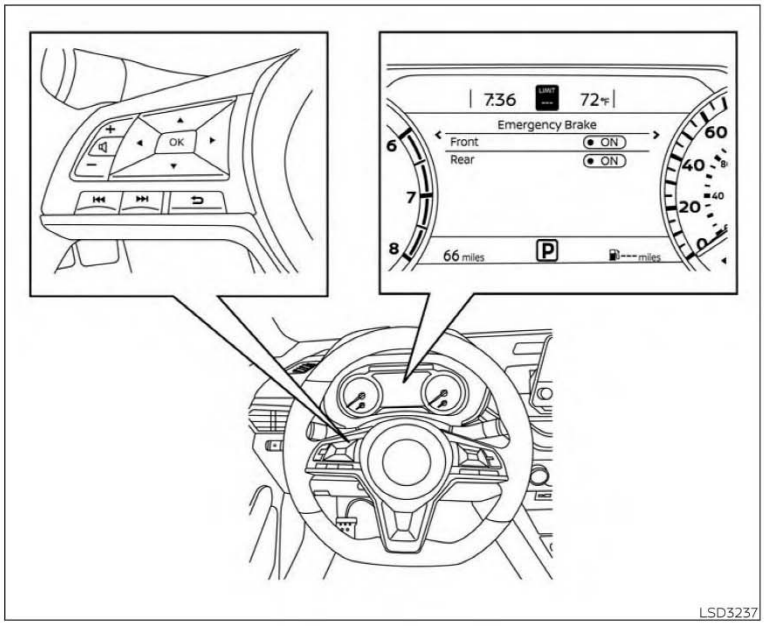
The vehicle's brake lights come on when braking is performed by the AEB system.

Depending on vehicle speed and distance to the vehicle ahead, as well as driving and roadway conditions, the system may help the driver avoid a forward collision or may help mitigate the consequences of a collision, should one be unavoidable. If the driver is handling the steering wheel, accelerating or braking, the AEB system will function later or will not function.

The automatic braking will cease under the following conditions:

- When the steering wheel is turned as far as necessary to avoid a collision.
- When the accelerator pedal is depressed.
- When there is no longer a vehicle detected ahead.

If the AEB system has stopped the vehicle, the vehicle will remain at a standstill for approximately 2 seconds before the brakes are released.



TURNING THE AEB SYSTEM ON/OFF

Perform the following steps to turn the AEB system ON or OFF.

1. Press the ◀▶ button until "Settings" displays in the vehicle information display. Use the ▲▼ button to select "Driver Assistance." Then press the OK button.
2. Select "Emergency Brake" and press the OK button.
3. Select "Front" and press the OK button to turn the system on or off.

When the AEB system is turned off, the AEB system warning light illuminates.

NOTE:

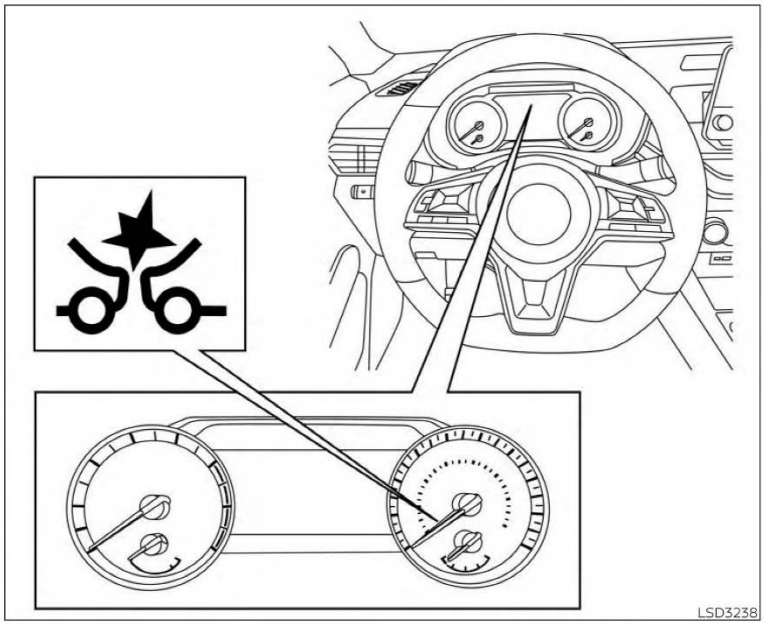
- **The AEB system will be automatically turned on when the engine is restarted.**
- **The I-FCW system is integrated into the AEB system There is not a separate selection in the vehicle information display for the I-FCW system. When the AEB is turned off, the I-FCW system is also turned off.**

AEB SYSTEM LIMITATIONS

⚠ WARNING

Listed below are the system limitations for the AEB system. Failure to operate the vehicle in accordance with these system limitations could result in serious injury or death.

- **The AEB system cannot detect all vehicles under all conditions.**
- **The radar sensor does not detect the following objects:**
  - **Pedestrians, animals or obstacles in the roadway.**
  - **Oncoming vehicles.**
  - **Crossing vehicles.**
- **The radar sensor has some performance limitations. If a stationary vehicle is in the vehicles's path, the AEB system will not function when the vehicle is driven at speeds over approximately 50 mph (80 km/h).**
- **The radar sensor may not detect a vehicle ahead in the following conditions:**
  - **Dirt, ice, snow or other material covering the radar sensor.**
  - **Interference by other radar sources.**
  - **Snow or road spray from traveling vehicles.**
  - **If the vehicle ahead is narrow (e.g. motorcycle).**
  - **When driving on a steep downhill slope or roads with sharp curves.**
- **In some road or traffic conditions, the AEB system may unexpectedly apply partial braking. When acceleration is necessary, continue to depress the accelerator pedal to override the system.**
- **Braking distances increase on slippery surfaces.**
- **The system is designed to automatically check the sensor's functionality, within certain limitations. The system may not detect some forms of obstructions of the sensor area such as ice, snow, stickers, etc. In these cases, the system may not be able to worn the driver properly. Be sure that you check, clean and clear the sensor area regularly.**
- **Excessive noise will interfere with the warning chime sound, and the chime may not be heard.**



SYSTEM TEMPORARILY UNAVAILABLE

Condition A

When the radar sensor picks up interference from another radar source, making it impossible to detect a vehicle ahead, the AEB system is automatically turned off.

The AEB system warning light (orange) will illuminate.

Action to take:

When the above conditions no longer exist, the AEB system will resume automatically.

Condition B

When the radar sensor of the front bumper is covered with dirt or is obstructed, the AEB system will automatically be canceled. The chime will sound and the "Not Available: Front Radar Blocked" warning message will appear in the vehicle information display.

Action to take:

If the warning message appears, stop the vehicle in a safe place, place the shift lever in the P (Park) position, and turn the engine off. When the radar signal is temporarily interrupted, clean the sensor area of the

front bumper and restart the engine. If the "Not Available: Front Radar Blocked" warning message continues to be displayed, have the system checked. It is recommended that you visit a NISSAN dealer for this service.

Condition C

When driving on roads with limited road structures or buildings (for example, long bridges, deserts, snowfields, driving next to long walls), the system may illuminate the system warning light and display the "Not Available: Front Radar Blocked" message.

Action to take:

When the above driving conditions no longer exist, turn the system back on.

NOTE:

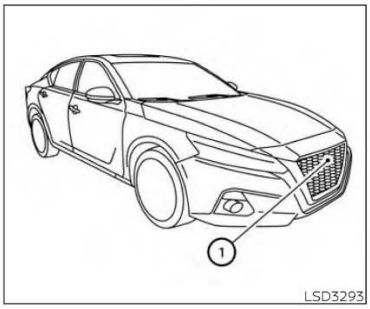
If the AEB system stops working, the I-FCW system will also stop working.

SYSTEM MALFUNCTION

If the AEB system malfunctions, it will be turned off automatically, a chime will sound, the AEB warning light (orange) will illuminate and the warning message [Malfunction] will appear in the vehicle information display.

Action to take

If the warning light (orange) comes on, stop the vehicle in a safe location, turn the engine off and restart the engine. If the warning light continues to illuminate, have the AEB system checked. It is recommended that you visit a NISSAN dealer for this service.



SYSTEM MAINTENANCE

The sensor ① for the AEB is located on the front of the vehicle.

To keep the system operating properly, be sure to observe the following:

- Always keep the sensor area of the front bumper clean.
- Do not strike or damage the areas around the sensor.
- Do not cover or attach stickers or similar objects on the front bumper near the sensor area. This could cause failure or malfunction.

- Do not attach metallic objects near the sensor area (brush guard, etc.). This could cause failure or malfunction.
- Do not alter, remove or paint the front bumper. Before customizing or restoring the front bumper, it is recommended that you visit a NISSAN dealer.

Radio frequency statement

For USA

FCC ID OAYARS4B

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

FCC Warning

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Radio frequency radiation exposure information:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

The transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

For Canada

Model: ARS4-B

IC: 4135A-ARS4B

FCC ID: OAYARS4B

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause interference,
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage, et
2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Radio frequency radiation exposure information:

This equipment complies with FCC and IC radiation exposure limits set forth for an uncontrolled environment.

This equipment should be installed and operated with minimum distance of 30 cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé.

Cet équipement doit être installé et utilisé avec un minimum de 30 cm de distance entre la source de rayonnement et votre corps.

FCC Notice

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

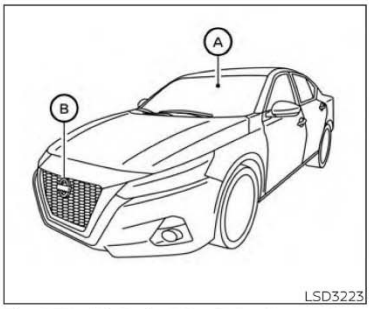
AUTOMATIC EMERGENCY BRAKING (AEB) WITH PEDESTRIAN DETECTION (if so equipped)

⚠ WARNING

Failure to follow the warnings and instructions for proper use of the AEB with Pedestrian Detection system could result in serious injury or death.

- **The AEB with Pedestrian Detection system is a supplemental aid to the driver. It is not a replacement for the driver's attention to traffic conditions or responsibility to drive safely. It cannot prevent accidents due to carelessness or dangerous driving techniques.**
- **The AEB with Pedestrian Detection system does not function in all driving, traffic, weather and road conditions.**

The AEB with Pedestrian Detection system can assist the driver when there is a risk of a forward collision with the vehicle ahead in the traveling lane or with a pedestrian ahead in the traveling lane.



The AEB with Pedestrian Detection system uses a radar sensor located on the front of the vehicle Ⓑ to measure the distance to the vehicle ahead in the same lane. For pedestrians, the AEB with Pedestrian Detection system uses a camera installed behind the windshield Ⓐ in addition to the radar sensor.

APPENDIX C

Run Log

Subject Vehicle: **2020 Nissan Altima** Test Date: **2/20/2020**

Principal Other Vehicle: **GVT**

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Acceptability Criteria met [5]	Notes
35	Static Run								
36	**Stopped POV 25 mph**	Y	2.04	5.25	25.4	1.09	1.35	Yes	
37		Y	2.08	5.49	25.6	1.10	1.36	Yes	
38		Y	2.09	4.52	24.9	1.20	1.36	Yes	
39		Y	2.04	5.14	24.8	1.11	1.27	Yes	
40		Y	2.07	5.13	25.2	1.16	1.30	Yes	
41	Static Run								
42	**Stopped POV 30 mph**	Y	2.23	5.95	29.4	1.16	1.33	Yes	
43		Y	2.22	5.55	30.4	1.13	1.28	Yes	
44		Y	2.26	6.93	30.2	1.20	1.27	Yes	
45		Y	2.29	4.91	30.2	1.23	1.36	Yes	
46		Y	2.29	5.11	30.3	1.19	1.37	Yes	
47	Static Run								
48	**Stopped POV 35 mph**	Y	2.43	5.83	35.4	1.16	1.35	Yes	
49		Y	2.47	4.99	34.9	1.15	1.40	Yes	
50		Y	2.43	4.16	35.2	1.11	1.35	Yes	
51		Y	2.47	4.92	35.1	1.20	1.35	Yes	
52		Y	2.45	5.35	35.0	1.14	1.40	Yes	

5 The acceptability criteria listed herein are used only as a guide to gauge vehicle performance, and are identical to the Pass/Fail criteria given in the New Car Assessment Program's most current Test Procedure in docket NHTSA-2015-0006-0025; CRASH IMMINENT BRAKE SYSTEM PERFORMANCE EVALUATION FOR THE NEW CAR ASSESSMENT PROGRAM, October 2015.

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Acceptability Criteria met [5]	Notes
53	Static Run								
54	Static Run								
55	**Stopped POV 40 mph**	Y	2.61	0.00	35.2	1.12	1.38	Yes	
56		Y	2.64	1.29	40.1	1.15	1.40	Yes	
57		Y	2.63	1.01	40.0	1.16	1.34	Yes	
58		Y	2.63	0.28	39.9	1.16	1.34	Yes	
59		Y	2.60	0.00	34.8	1.11	1.34	Yes	
60	Static Run								
61	**Stopped POV 45 mph**	N							Throttle Drop
62		Y	2.68	0.00	29.2	1.13	1.32	Yes	
63		Y	2.64	0.00	28.6	1.10	1.28	Yes	
64		Y	2.66	0.00	28.5	1.10	1.35	Yes	
65		Y	2.61	0.00	1.6	0.30	0.02	No	No Braking, Radar Bracket Bent after run
1	Static Run								
2	**Slower POV, 25 vs 10**	Y	1.93	9.89	15.5	1.06	1.02	Yes	
3		Y	1.92	4.97	15.0	0.46	1.07	Yes	
4		Y	1.88	5.73	15.2	0.48	1.06	Yes	
5		Y	1.88	10.47	15.5	1.07	1.03	Yes	
6		Y	1.91	6.17	15.7	0.49	1.10	Yes	

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Acceptability Criteria met [5]	Notes
7	Static Run								
8	**Slower POV, 45 vs 20**	N							POV Speed
9		Y	2.65	4.70	25.1	1.10	1.34	Yes	
10		N							POV Speed
11		Y	2.64	4.48	25.4	1.10	1.36	Yes	
12		N							POV Speed
13		Y	2.63	4.68	25.2	1.06	1.33	Yes	
14		Y	2.57	4.62	25.2	1.10	1.37	Yes	
15		Y	2.64	4.37	25.2	1.05	1.32	Yes	
16	Static run								
17	**Decelerating POV, 35**	Y	1.80	3.71	23.6	1.13	1.26	Yes	
18		Y	1.72	3.38	23.7	1.11	1.24	Yes	
19		Y	1.71	3.95	23.9	1.09	1.28	Yes	
20		Y	1.92	3.66	24.3	1.13	1.32	Yes	
21		Y	1.72	3.39	23.9	1.11	1.25	Yes	
22	Static Run								
23	**0.5 G Decelerating POV, 35**	Y	1.53	3.78	35.6	1.11	1.02	Yes	2445 Hz Warning[6]
24		Y	1.52	3.76	34.9	1.11	1.02	Yes	2445 Hz Warning
25		Y	1.55	5.13	33.8	1.14	1.03	Yes	1828 Hz Warning
26		Y	1.57	4.97	34.3	1.13	1.06	Yes	2445 Hz Warning
27		Y	1.53	5.86	34.0	1.11	1.05	Yes	2445 Hz Warning

[6] There are two levels of warning. 1828 is the FCW, and 2445 is the AEB warning. Sometimes the FCW warning does not activate, and the AEB warning is the first alert

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Acceptability Criteria met [5]	Notes
28	Static Run								
29	Static Run								
30	**Decelerating POV, 45**	Y	1.84	0.00	14.0	1.06	0.69	Yes	
31		Y	1.77	0.00	10.4	1.02	0.64	No	
32		Y	1.69	0.00	14.0	1.09	0.69	Yes	
33		Y	1.89	0.00	10.9	1.11	0.60	Yes	
34		Y	1.80	0.00	15.8	1.08	0.69	Yes	

APPENDIX D

Time History Plots

LIST OF FIGURES

Description of Time History Plots

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from both the Subject Vehicle (SV) and the Principal Other Vehicle (POV), as well as pass/fail envelopes and thresholds. The following is a description of data types shown in the time history plots, as well as a description of the color codes indicating to which vehicle the data pertain.

Time History Plot Description

Each time history plot consists of data relevant to the test type under consideration, and therefore the data channels plotted vary according to test type. The test types (shown in the plot titles) include:

- Stopped POV (SV at 25 mph)
- Stopped POV (SV at 30 mph)
- Stopped POV (SV at 35 mph)
- Stopped POV (SV at 40 mph)
- Stopped POV (SV at 45 mph)
- Slower POV, 25/10 (SV at 25 mph, POV at 10 mph)
- Slower POV, 45/20 (SV at 45 mph, POV at 20 mph)
- Decelerating POV 35 mph (Both vehicles at 35 mph with 13.8 m gap, POV brakes at 0.3 g)
- Decelerating POV 35 mph (Both vehicles at 35 mph with 13.8 m gap, POV brakes at 0.5 g)
- Decelerating POV 45 mph (Both vehicles at 45 mph with 13.8 m gap, POV brakes at 0.3 g)

Time history figures include the following sub-plots:

- FCW Warning – Displays the Forward Collision Warning alert (which can be audible, visual, or haptic). Depending on the type of FCW alert or instrumentation used to measure the alert, this can be any combination of the following:

    - Filtered, rectified, and normalized sound signal. The vertical scale is 0 to 1.
    - Filtered, rectified, and normalized acceleration (i.e., haptic alert, such as steering wheel vibration). The vertical scale is 0 to 1.
    - Normalized light sensor signal. The vertical scale is 0 to 1.

    As only the audible or haptic alert is perceptible by the driver during a test run, the earliest of either of these alerts is used to define the onset of the FCW alert. A vertical black bar on the plot indicates the TTC (sec) at

the first moment of the warning issued by the FCW system. The FCW TTC is displayed to the right of the subplot in green.

- Headway (ft) – Longitudinal separation (gap) between the front-most point of the Subject Vehicle and the rearmost point of the Global Vehicle Target (GVT). The minimum headway during the run is displayed to the right of the subplot.

- SV/POV Speed (mph) – Speed of the Subject Vehicle and Principal Other Vehicle (if any). For CIB tests, the speed reduction experienced by the Subject Vehicle is displayed to the right of the subplot.

- Yaw Rate (deg/sec) – Yaw rate of the Subject Vehicle and Principal Other Vehicle (if any).

- Lateral Offset (ft) – Lateral offset within the lane of the Subject Vehicle to the center of the lane of travel. The lateral offset is defined to be the lateral distance between the centerline of the SV and the centerline of the POV.

- Ax (g) – Longitudinal acceleration of the Subject Vehicle and Principal Other Vehicle (if any). For CIB tests, the TTC (sec) at the moment of first CIB activation is displayed to the right of the subplot in green. Also, the peak value of Ax for the SV is shown on the subplot.

- Accelerator Pedal Position (0-1) – Normalized position of the accelerator pedal.

Note that the minimum (worst) GPS fix type is displayed in the lower right corner of each page. The only valid fix type is RTK fixed (displayed in green). If the fix type during any portion of the test was anything other than RTK fixed, then “RTK Fixed OR LESS!!” is displayed in red.

Envelopes and Thresholds

Some of the time history plot figures contain either green or yellow envelopes and/or black threshold lines. These envelopes and thresholds are used to programmatically and visually determine the validity of a given test run. Envelope and threshold exceedances are indicated with either red shading or red asterisks, and red text is placed to the right side of the plot indicating the type of exceedance. Such exceedances indicate either that the test was invalid or that the requirements of the test were not met (i.e., failure of the AEB system).

For plots with green envelopes, in order for the test to be valid, the time-varying data must not exceed the envelope boundaries at any time. Exceedances of a green envelope are indicated by red shading in the area between the measured time-varying data and the envelope boundaries.

For plots with yellow envelopes, in order for the test to be valid, the time-varying data must not exceed the envelope at the beginning (left edge of the boundary) and/or end (right edge), but may exceed the boundary during the time between the left and right edges. Exceedances at the left or right extent of a yellow envelope are indicated by red asterisks.

For the headway plot, a dashed black threshold line indicating a relative headway of zero is displayed. If no impact occurs, a green circle is displayed at the moment of minimum distance. If impact occurs, a red asterisk is displayed at the moment of impact.

For the Ax plot, if the scenario is an AEB brake-to-stop scenario, a vertical dashed black line is displayed for all plots indicating the moment of first POV braking. The yellow envelope in this case is relevant to the POV braking only. The left edge of the envelope is at 1.5 seconds after the first POV braking. A solid black threshold line extends horizontally 0.5 seconds to the left of the envelope. This threshold line represents the time during which the Ax of the Principal Other Vehicle must first achieve 0.27 g (the upper edge of the envelope). A green circle or red asterisk is displayed at the moment the POV brake level achieves 0.27 g. A green circle indicates that the test was valid (the threshold was crossed during the appropriate interval) and a red asterisk indicates that the test was invalid (the threshold was crossed outside of the appropriate interval). Additionally, for the CIB tests, a dashed black threshold line indicating an Ax of -0.15 g is given to define the onset of CIB activation. When the Subject Vehicle’s Ax crosses this threshold, the CIB TTC is calculated and displayed.

For the accelerator pedal position plot, a green envelope is given starting 500 ms after the onset of the FCW warning to ensure that the accelerator pedal was released at the correct time and remained off for the duration of the CIB event.

Color Codes

Color codes have been adopted to easily identify which data correspond to which vehicle, as well as to indicate the types of envelopes and thresholds used in the plots.

Color codes can be broken into four categories:

1. Time-varying data
2. Validation envelopes and thresholds
3. Individual data points
4. Text

1. Time-varying data color codes:
   - Blue = Subject Vehicle data
   - Magenta = Principal Other Vehicle data
   - Brown = Relative data between SV and POV (i.e., TTC, lateral offset and headway distance)

2. Validation envelope and threshold color codes:
   - Green envelope = time varying data must be within the envelope at all times in order to be valid
   - Yellow envelope = time varying data must be within limits at left and/or right ends
   - Black threshold (Solid) = time varying data must cross this threshold in the time period shown in order to be valid
   - Black threshold (Dashed) = for reference only – this can include warning level thresholds, TTC thresholds, and acceleration thresholds

3. Individual data point color codes:
   - Green circle = passing or valid value at a given moment in time
   - Red asterisk = failing or invalid value at a given moment in time

4. Text color codes:
   - Green = passing or valid value
   - Red = failing or invalid value

Other Notations

- NG – Indicates that the value for that variable was outside of bounds and therefore “No Good”.
- No Wng – No warning was detected.
- POV – Indicates that the value for the Principal Other Vehicle was out of bounds.
- SV – Indicates that the value for the Subject Vehicle was out of bounds.
- SR – Shows the speed reduction value.
- Thr – Indicates that the requirements for the throttle were not met.

The minimum (worst) GPS fix type is displayed in the lower right corner of each page. The only valid fix type is RTK fixed (displayed in green). If the fix type during any portion of the test was anything other than RTK fixed, then “RTK Fixed OR LESS!!” is displayed in red.

Examples of time history plots for each test type (including passing, failing and invalid runs) are shown in Figures D1 through Figure D7. Figures D1 through D4 show passing runs for each of the 4 test types. Figures D5 and D6 show examples of invalid runs. Figure D7 shows an example of a valid test that failed the CIB requirements.

Time history data plots for the tests of the vehicle under consideration herein are provided beginning with Figure D8.

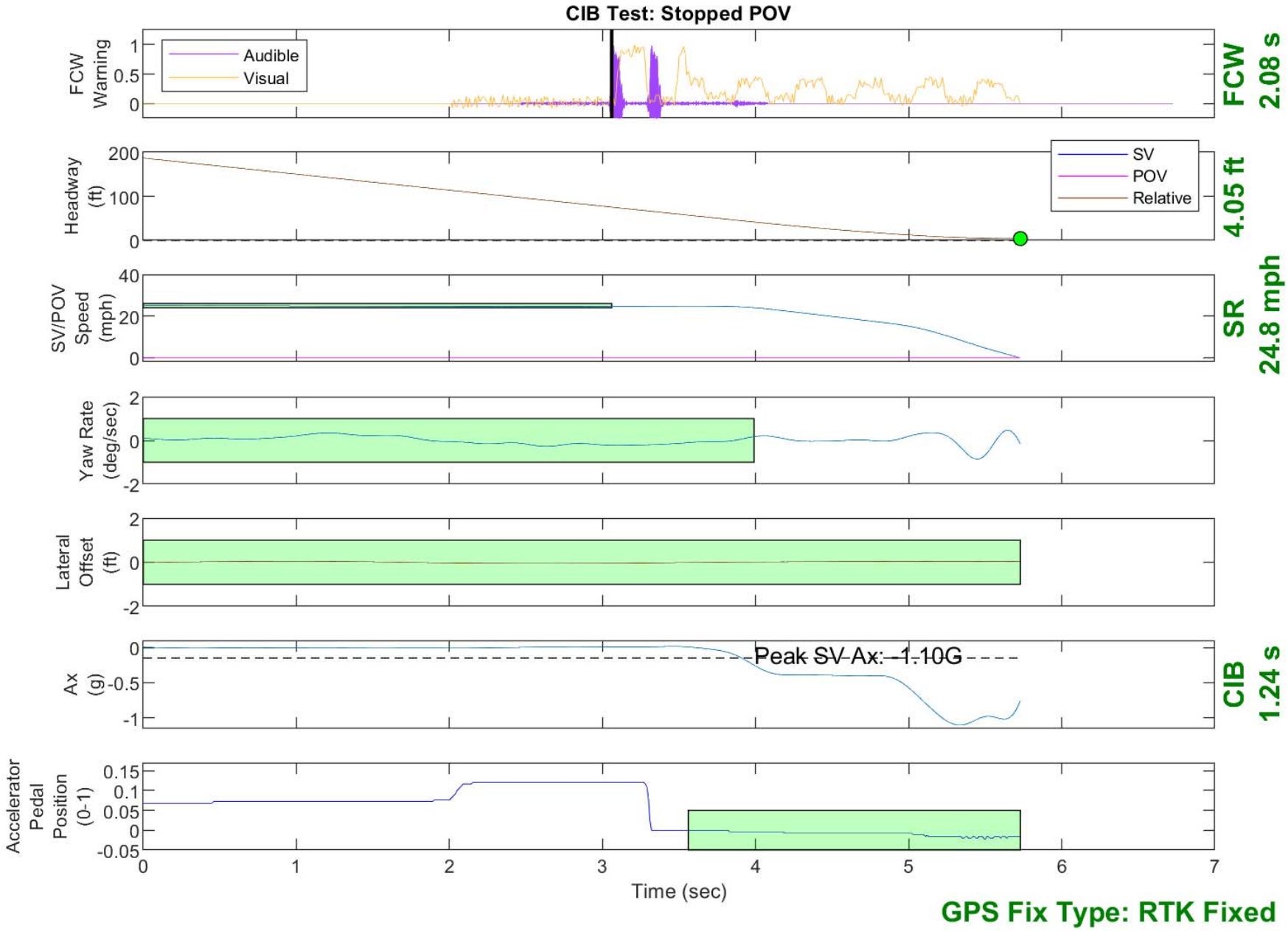


Figure D1. Example Time History for Stopped POV, Passing

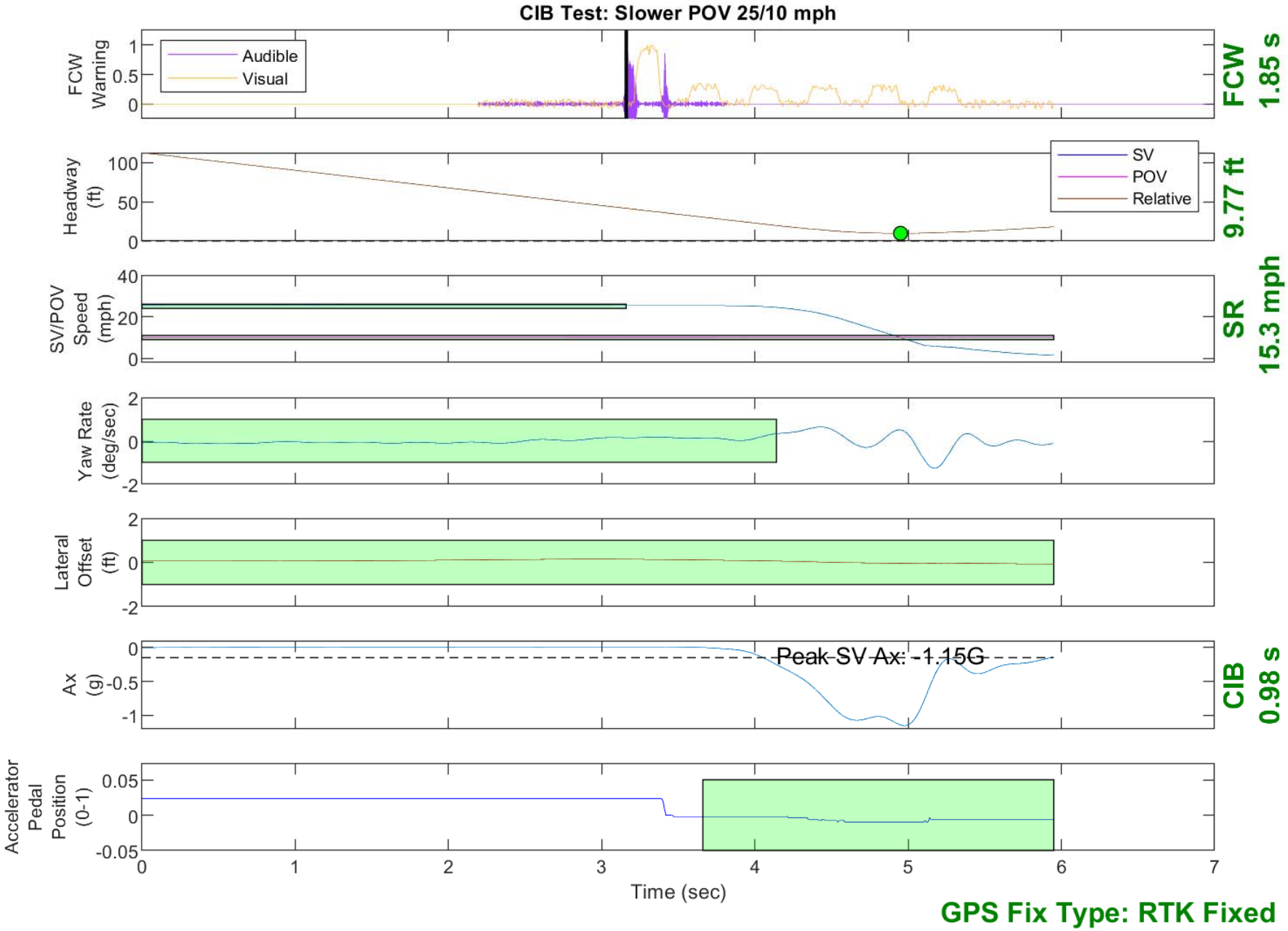


Figure D2. Example Time History for Slower POV 25 vs. 10, Passing

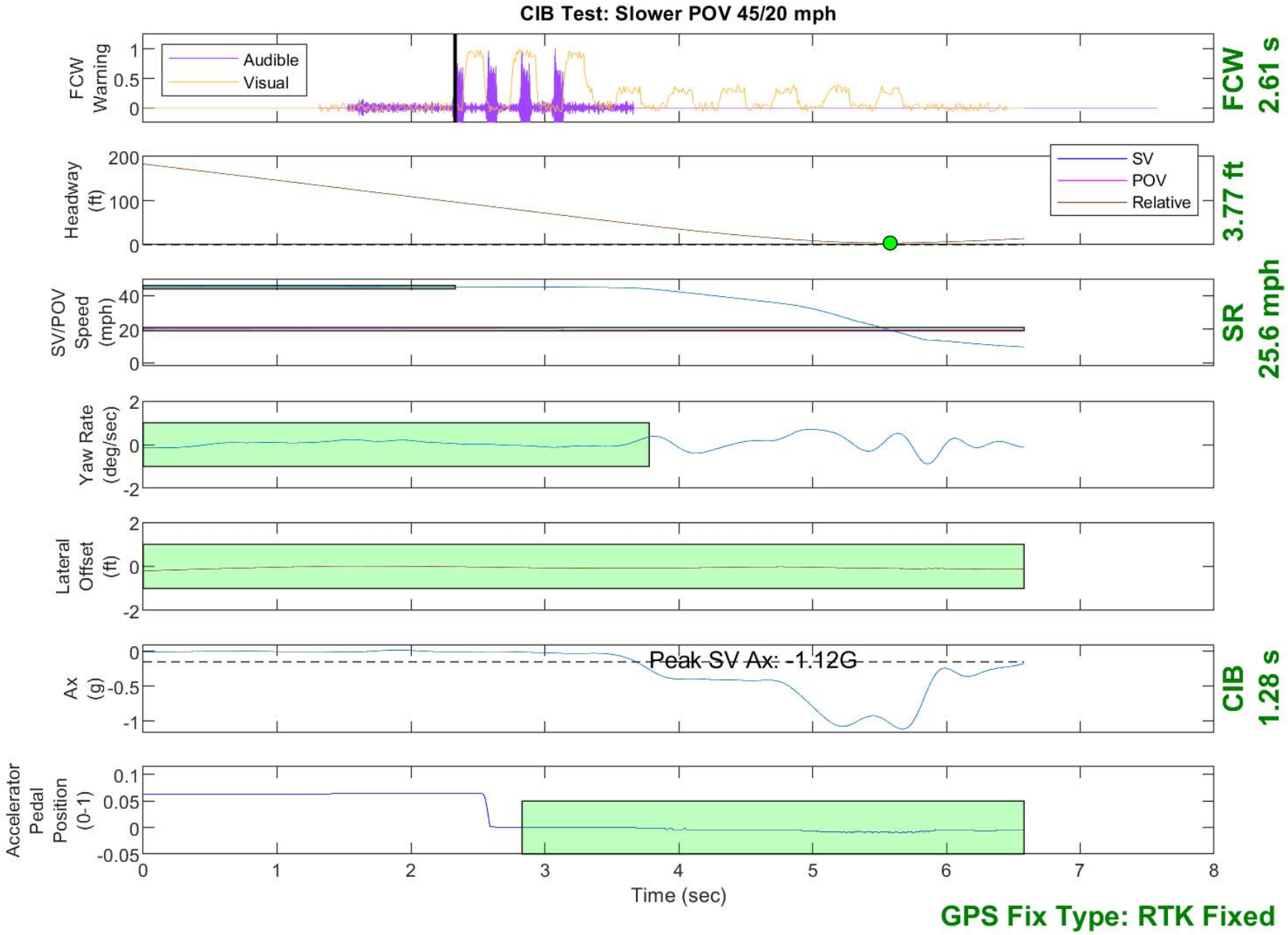


Figure D3. Example Time History for Slower POV 45 vs. 20, Passing

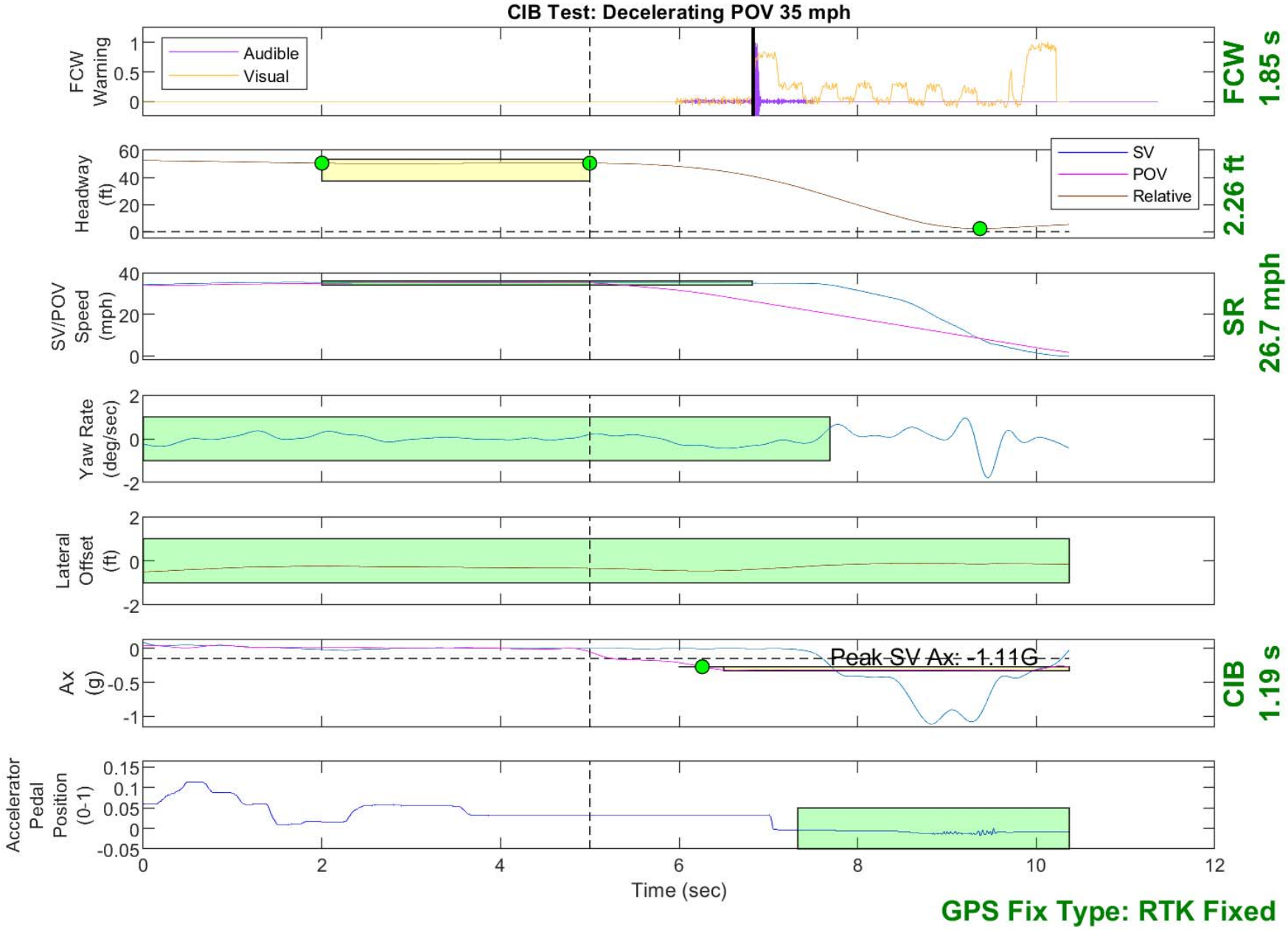


Figure D4. Example Time History for Decelerating POV 35, Passing

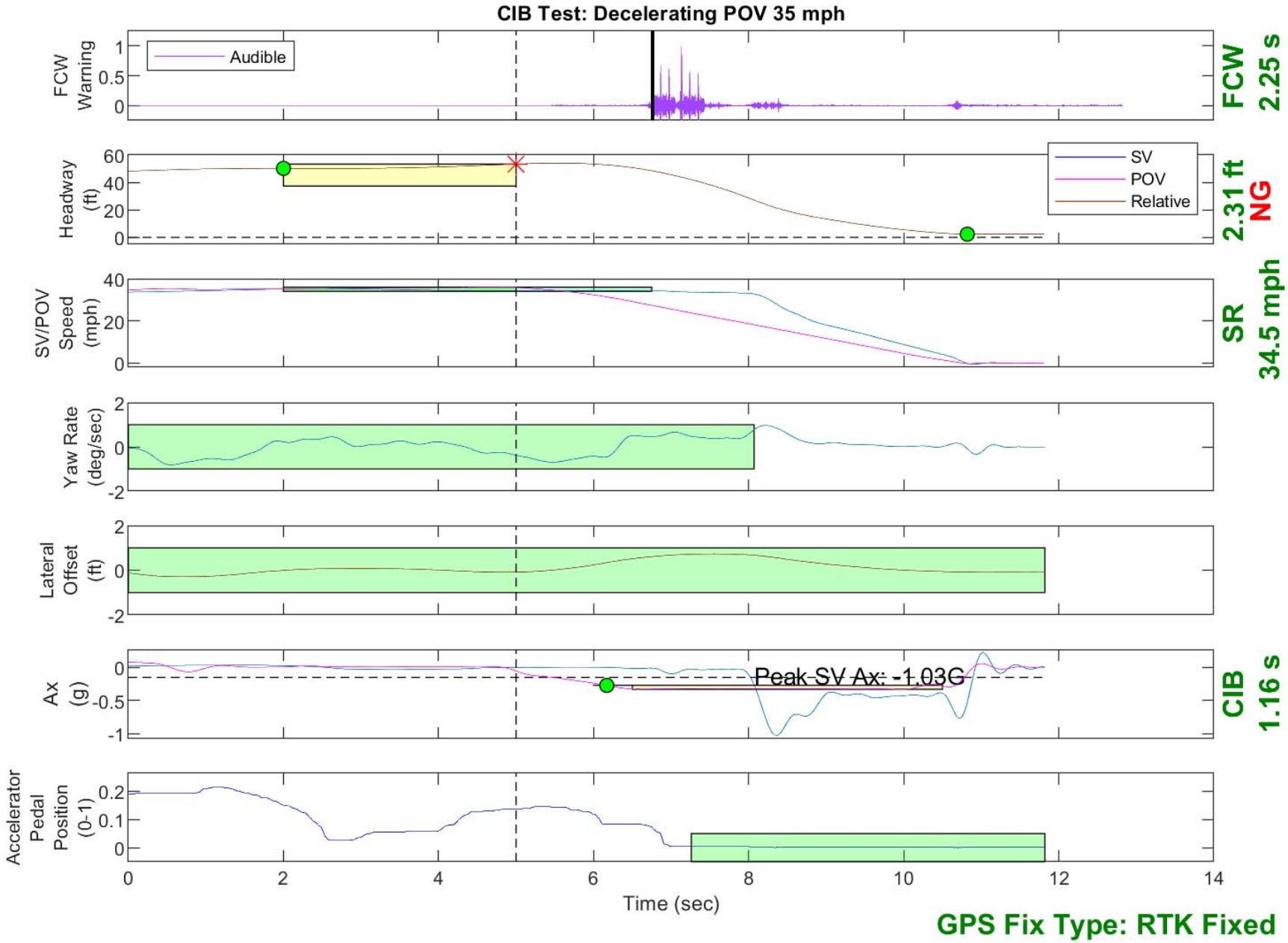


Figure D5. Example Time History Displaying Invalid Headway Criteria

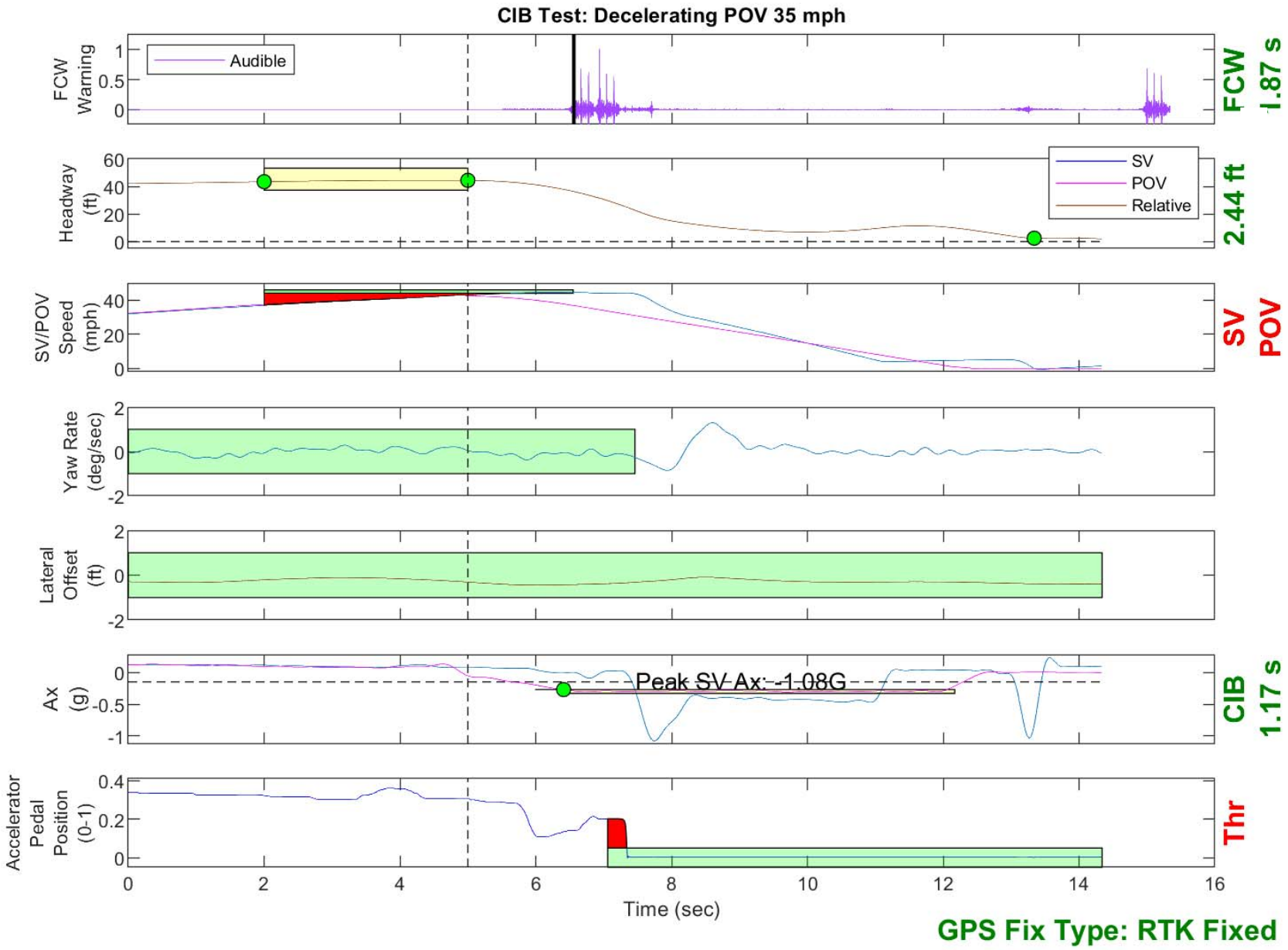


Figure D6. Example Time History Displaying Various Other Invalid Criteria

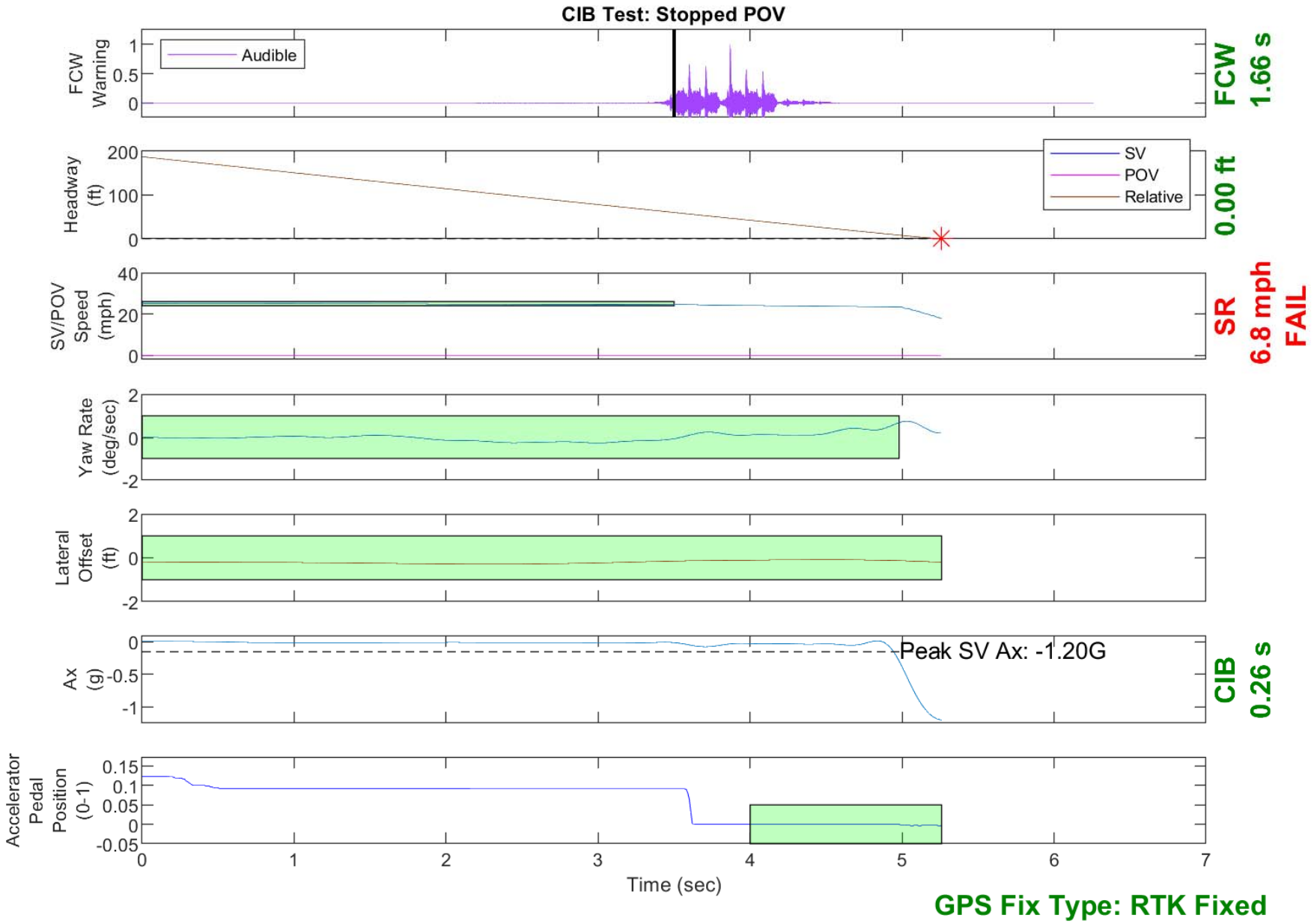


Figure D7. Example Time History for a Failed Run

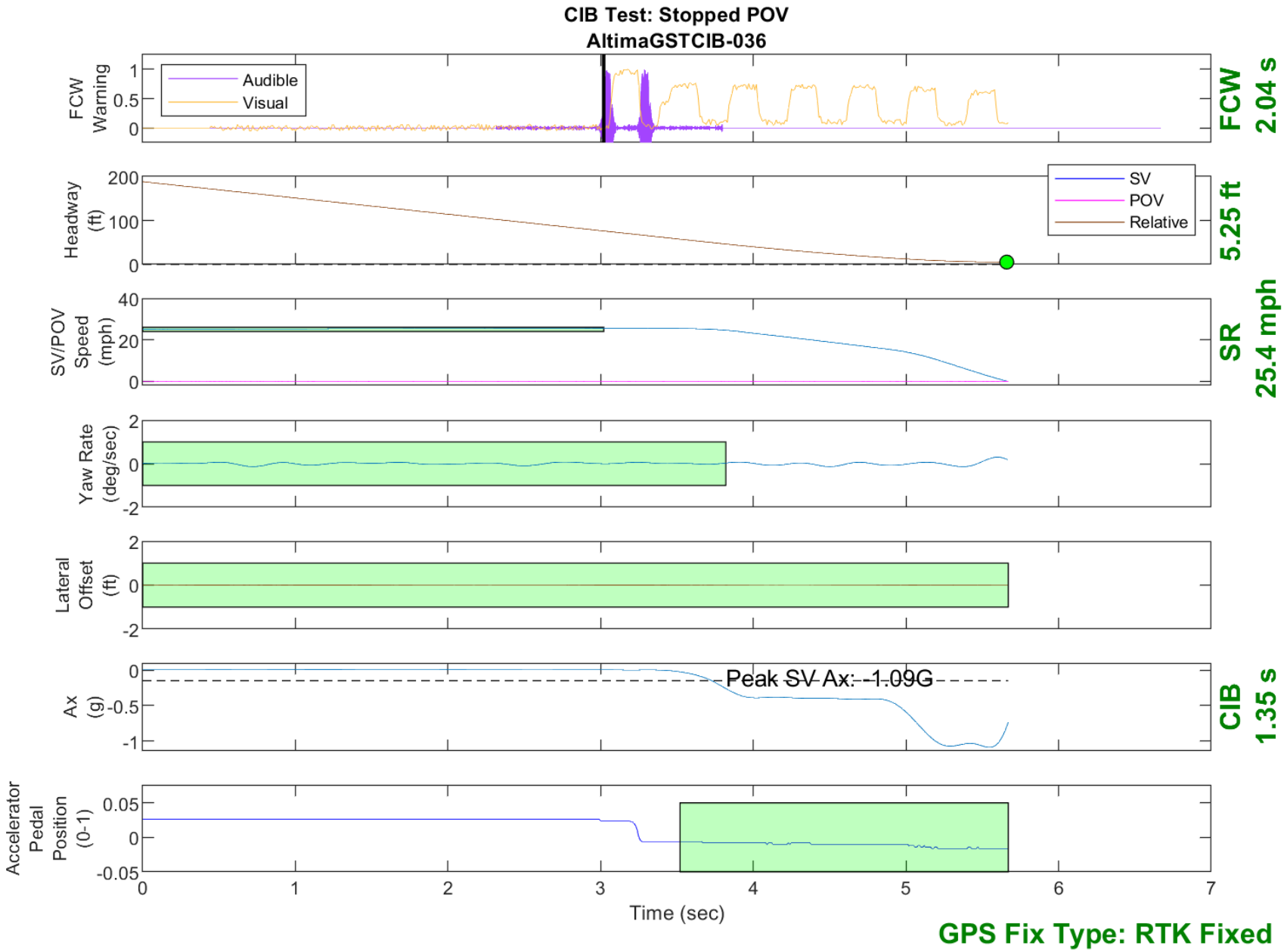


Figure D8. Time History for CIB Run 36, Stopped POV, 25 mph

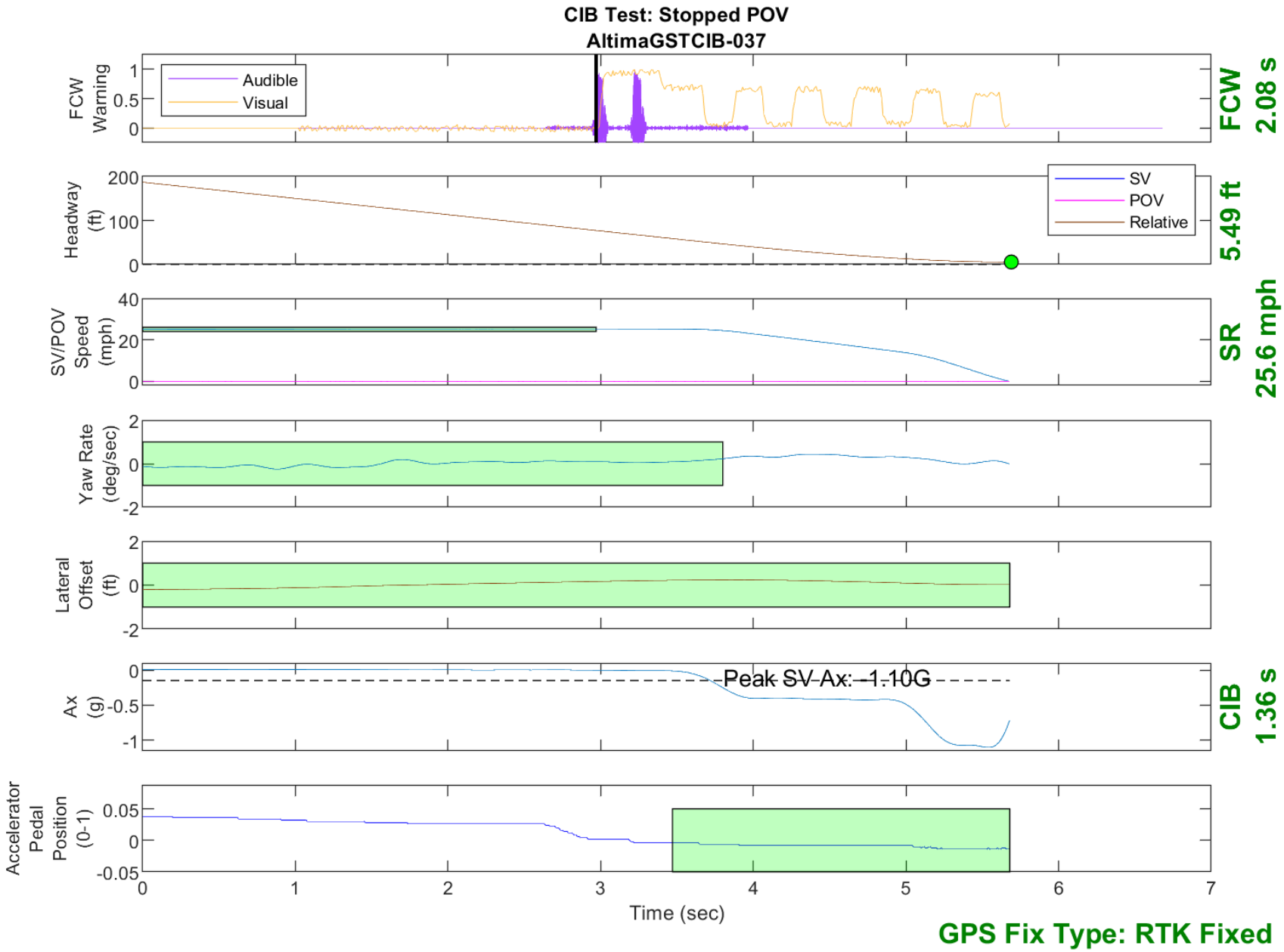


Figure D9. Time History for CIB Run 37, Stopped POV, 25 mph

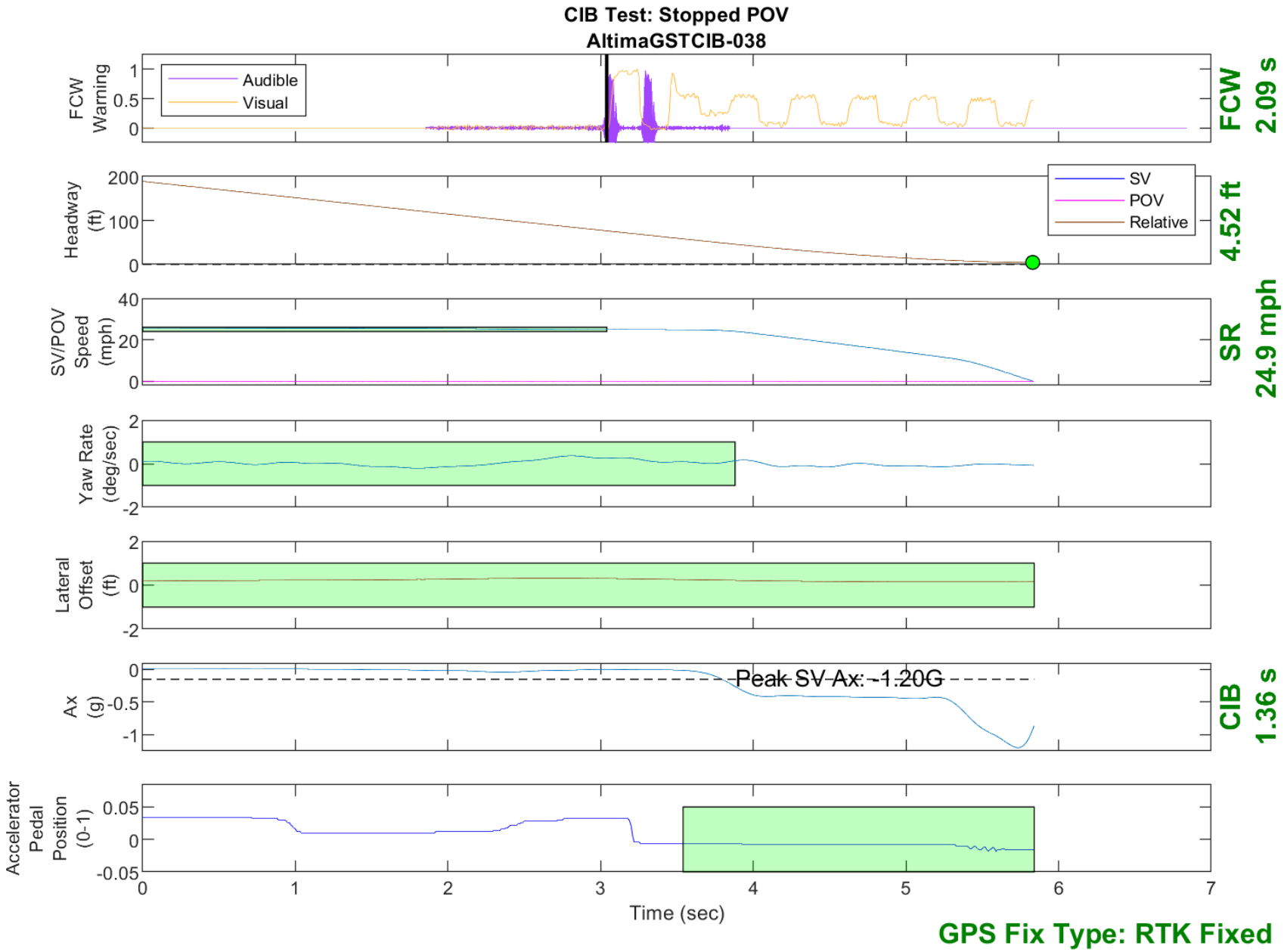


Figure D10. Time History for CIB Run 38, Stopped POV, 25 mph

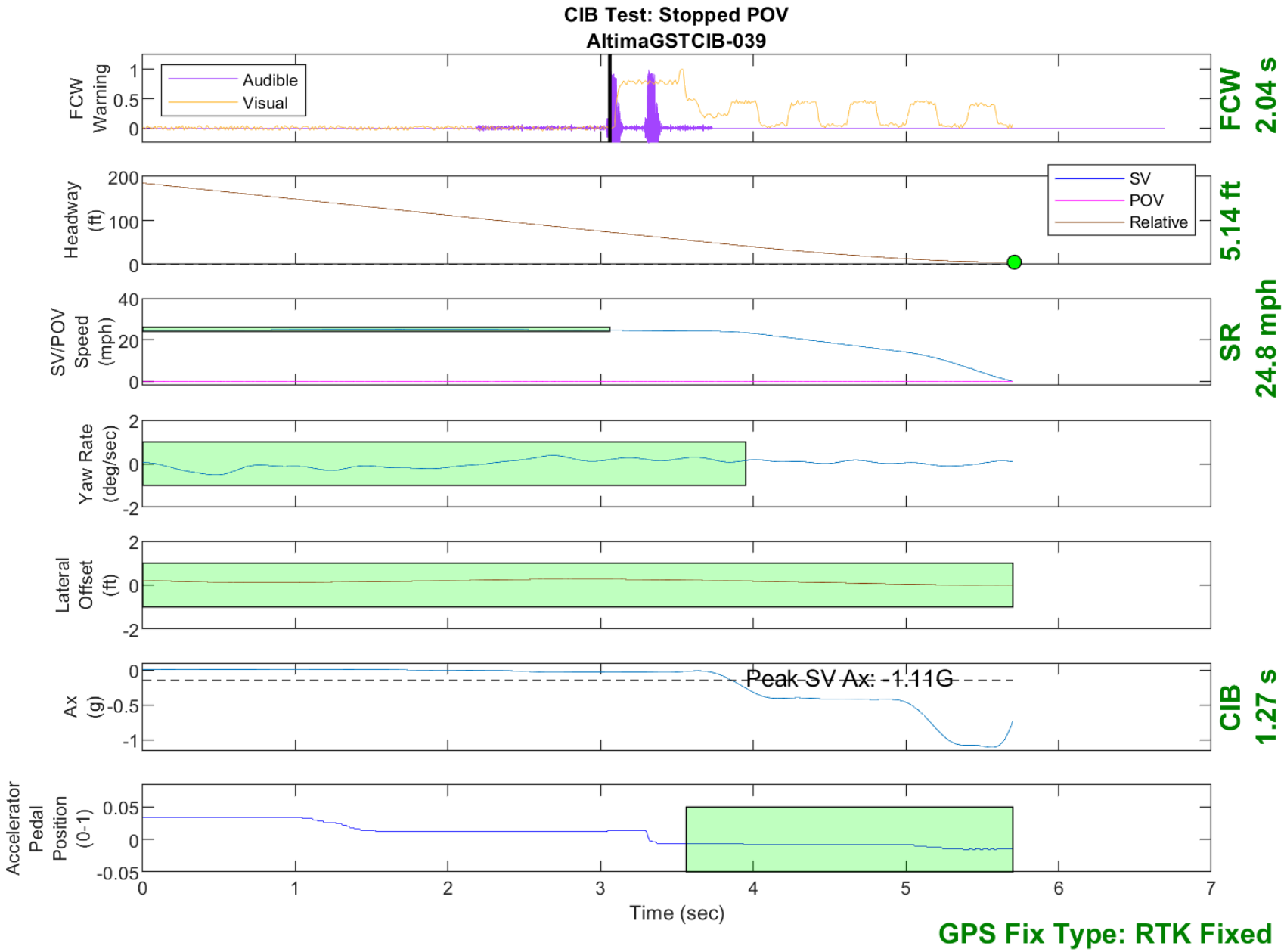


Figure D11. Time History for CIB Run 39, Stopped POV, 25 mph

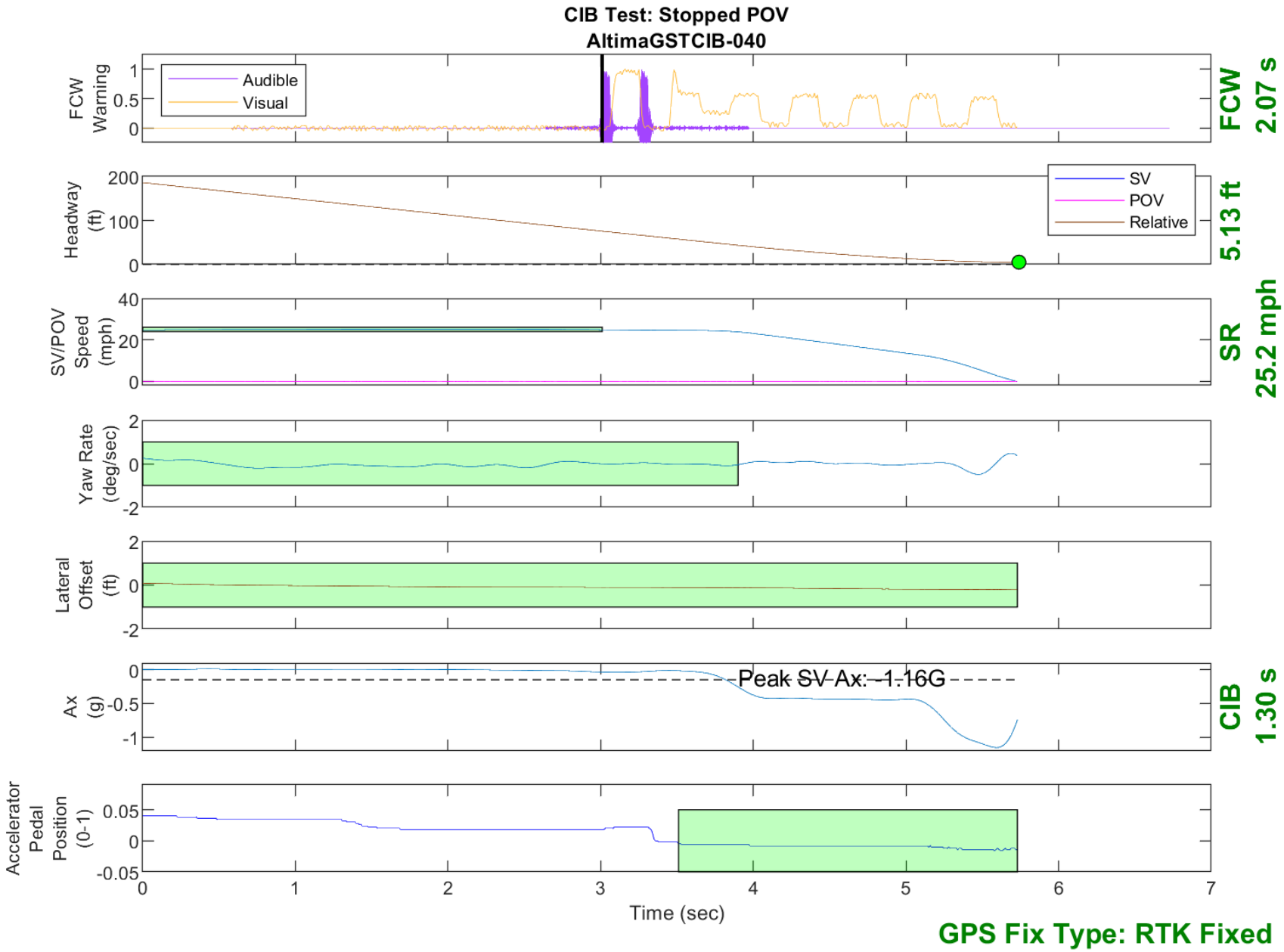


Figure D12. Time History for CIB Run 40, Stopped POV, 25 mph

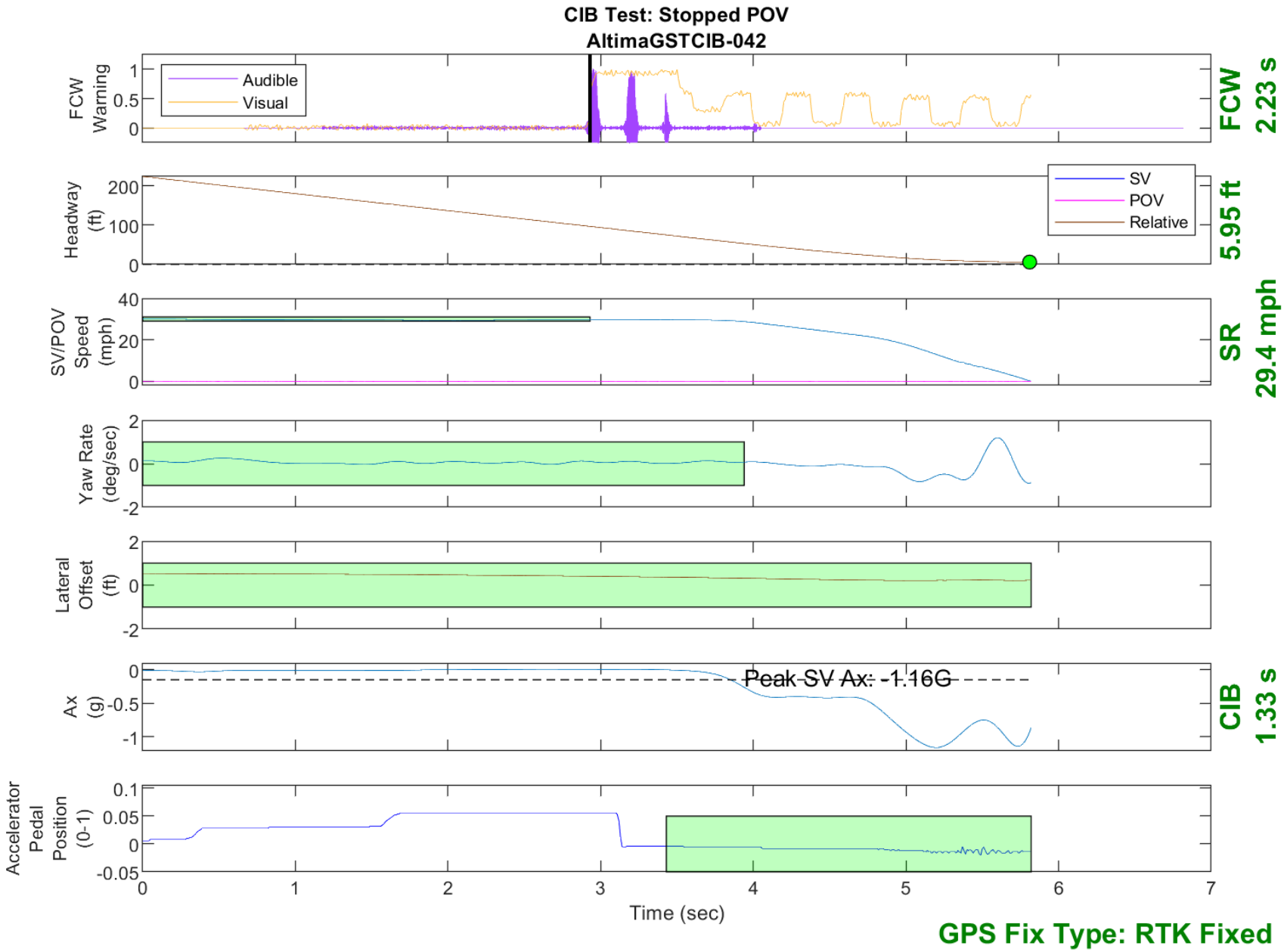


Figure D13. Time History for CIB Run 42, Stopped POV, 30 mph

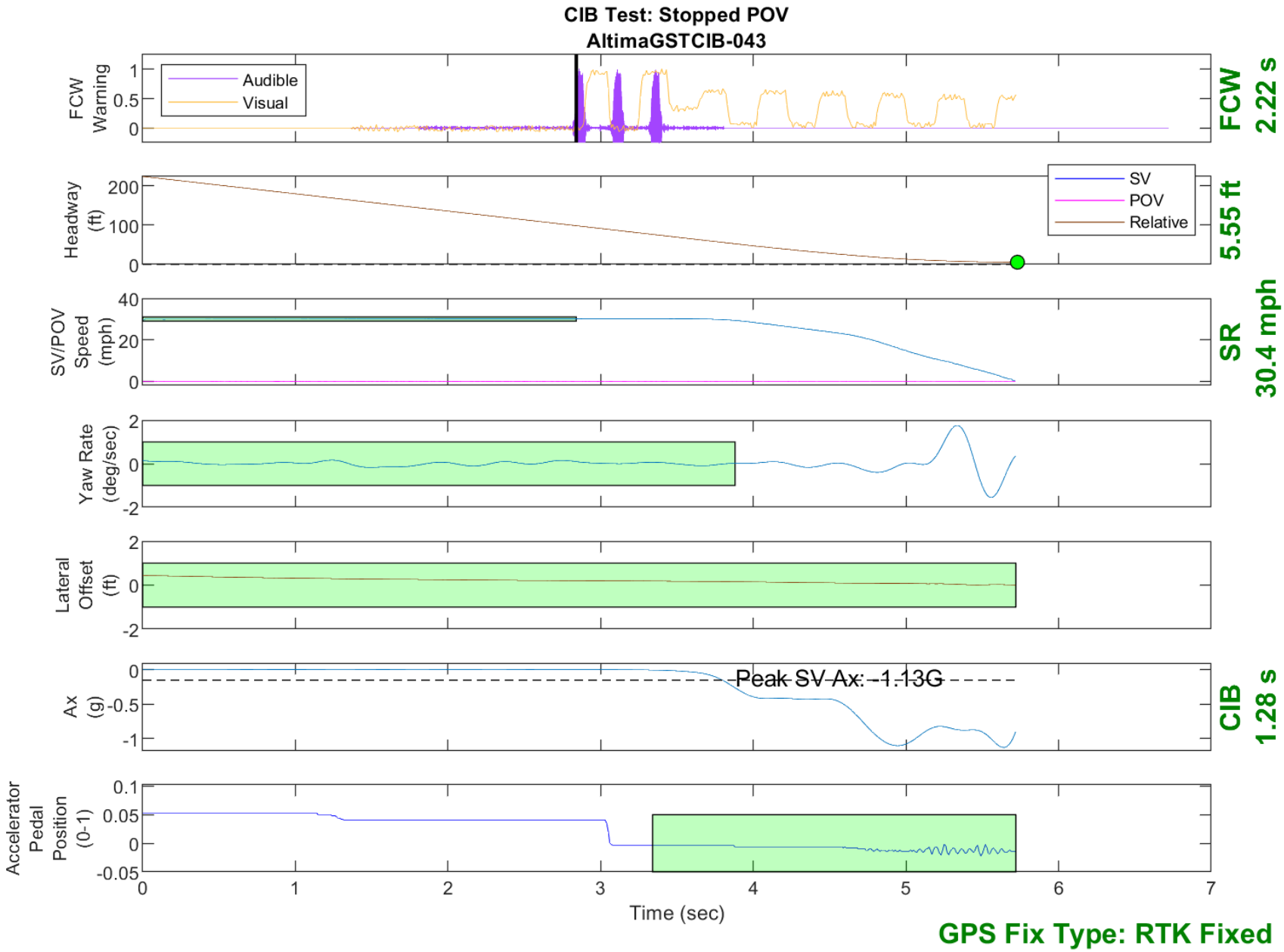


Figure D14. Time History for CIB Run 43, Stopped POV, 30 mph

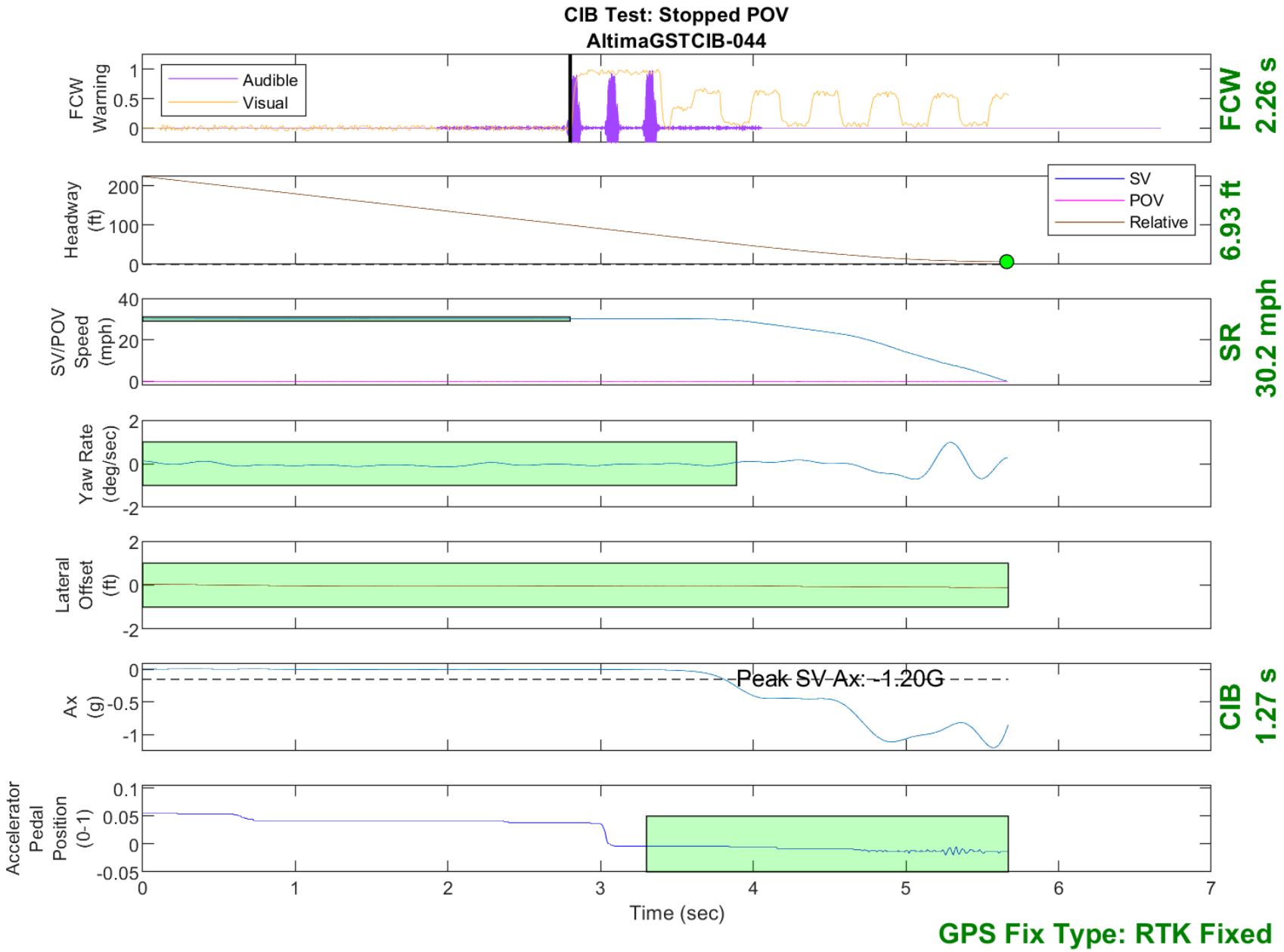


Figure D15. Time History for CIB Run 44, Stopped POV, 30 mph

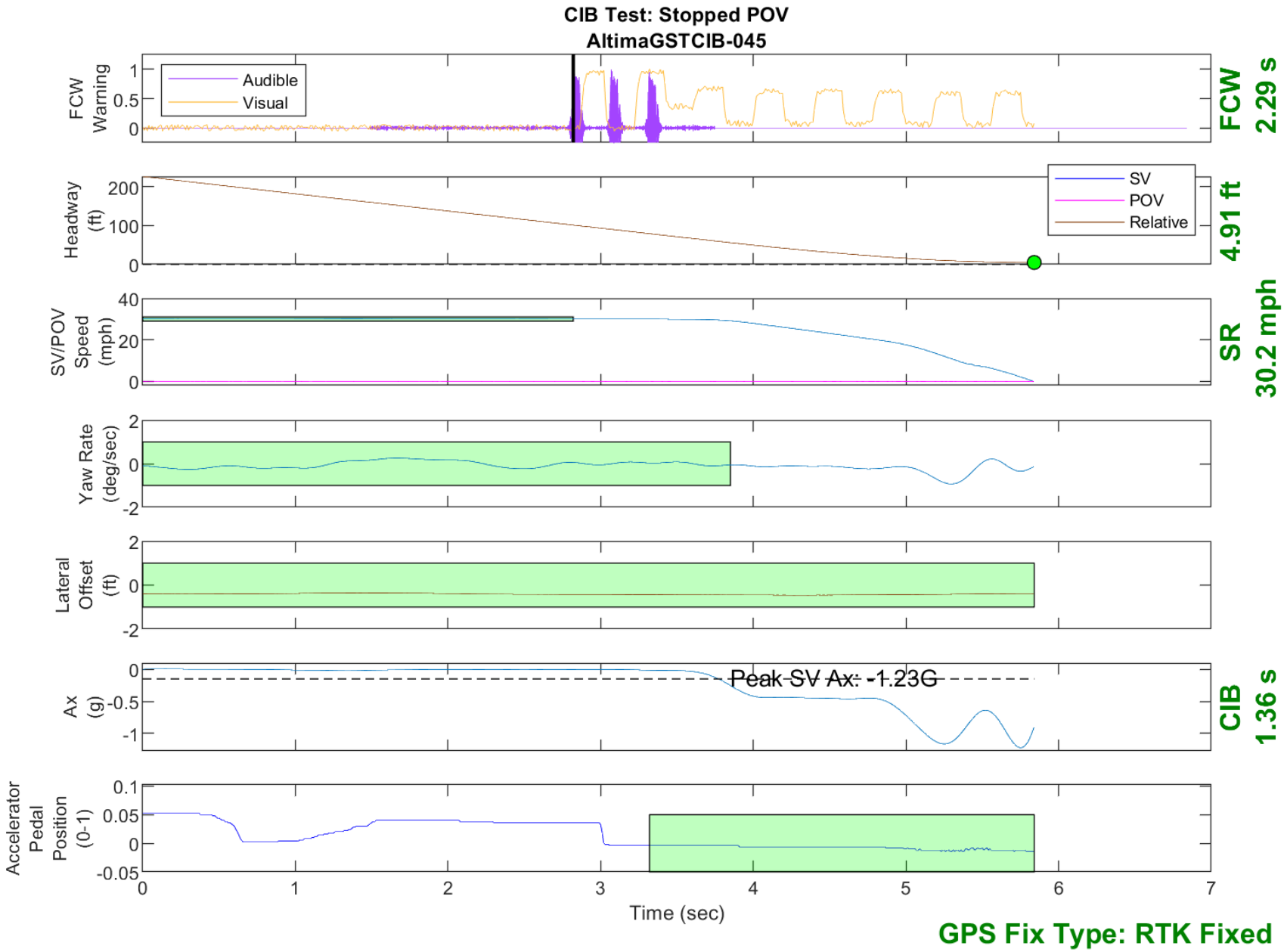


Figure D16. Time History for CIB Run 45, Stopped POV, 30 mph

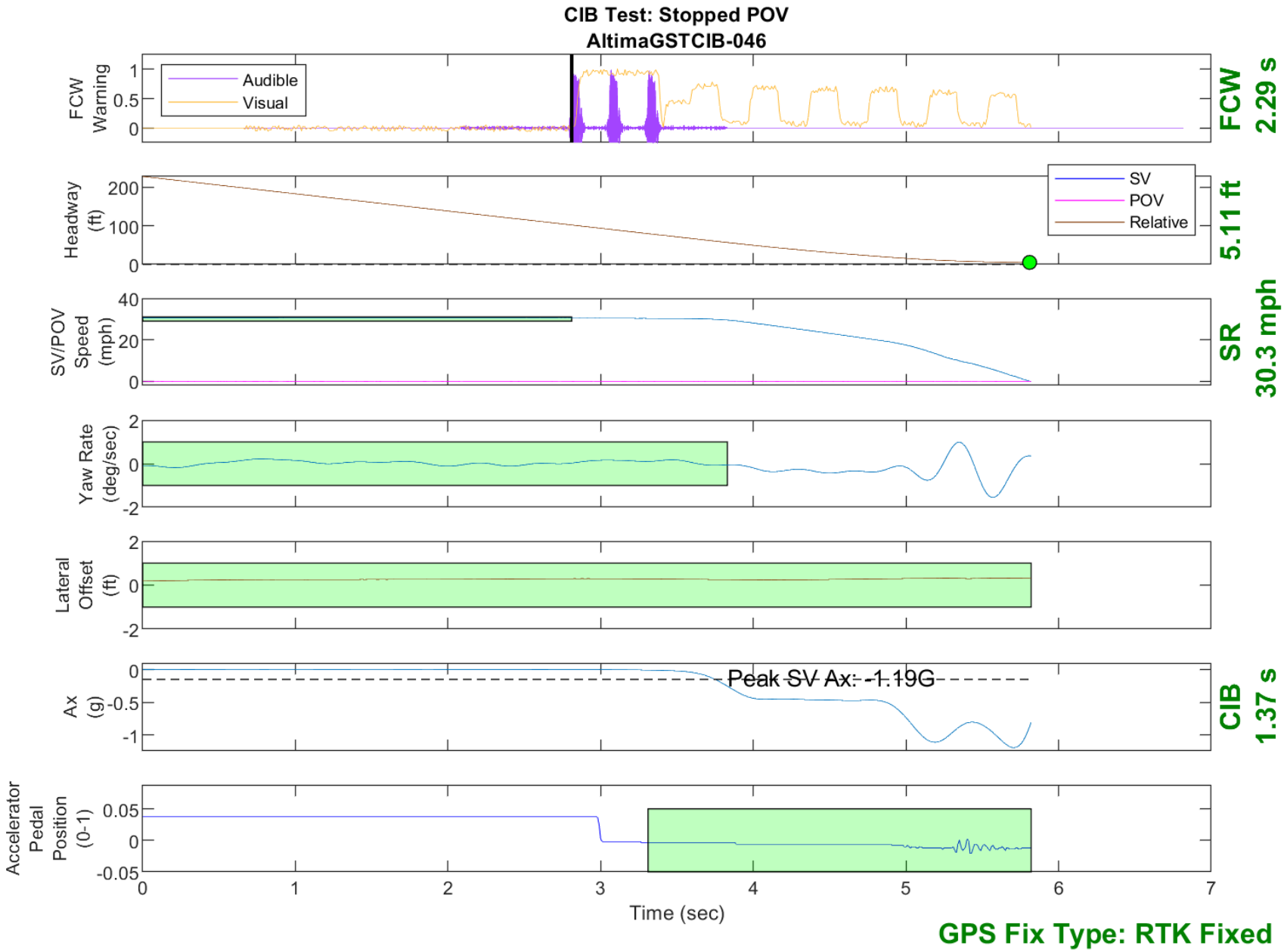


Figure D17. Time History for CIB Run 46, Stopped POV, 30 mph

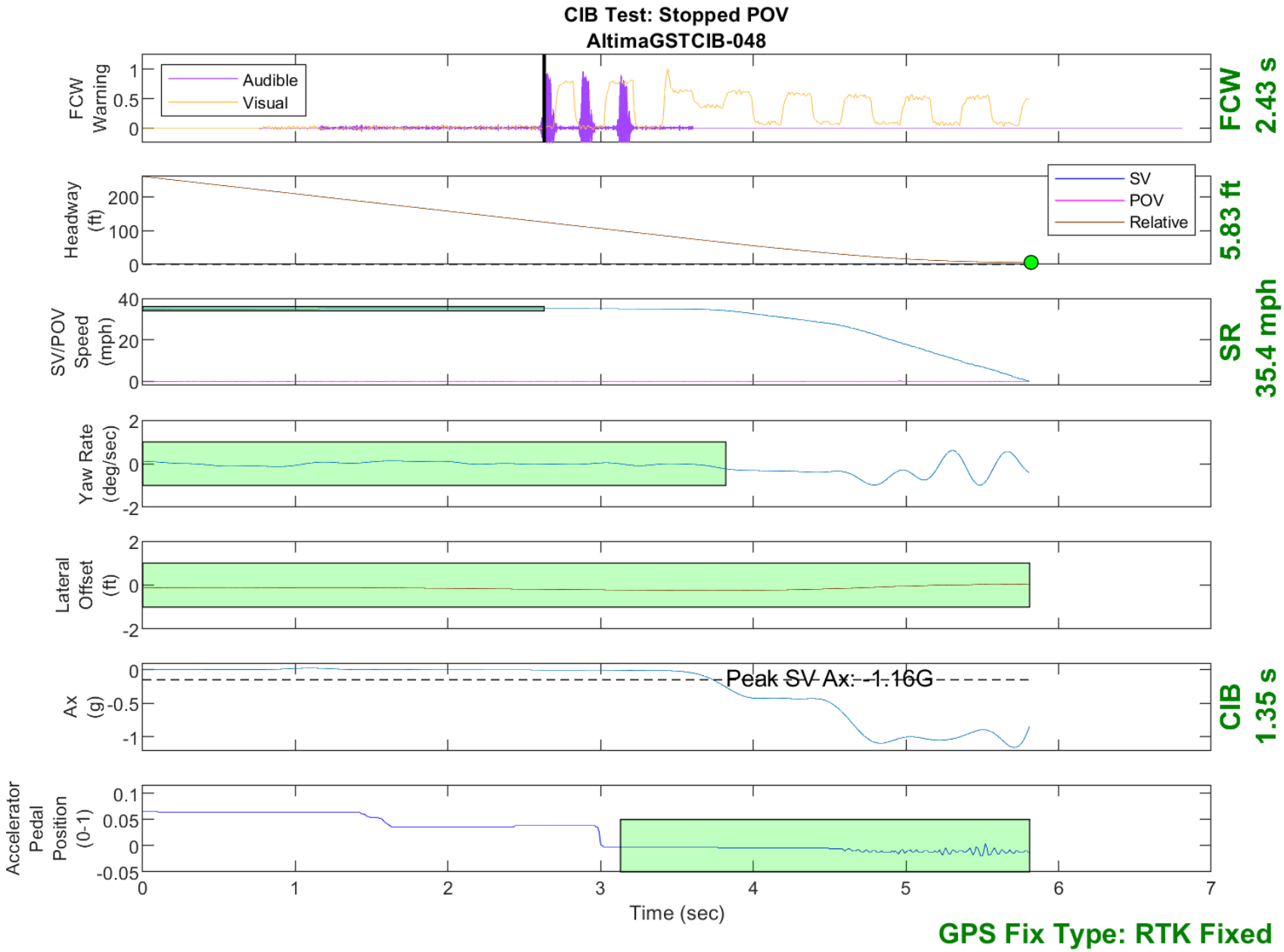


Figure D18. Time History for CIB Run 48, Stopped POV, 35 mph

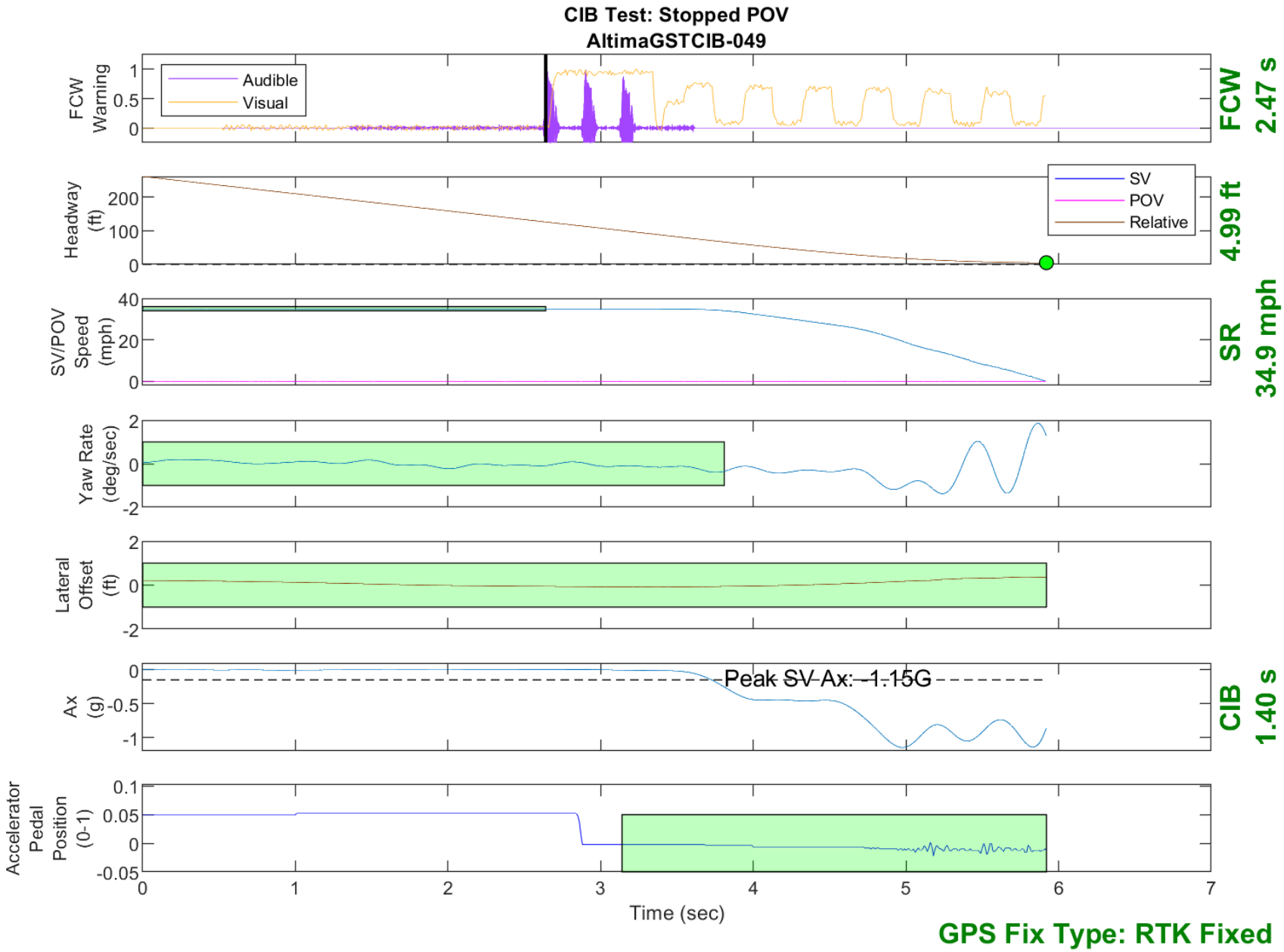


Figure D19. Time History for CIB Run 49, Stopped POV, 35 mph

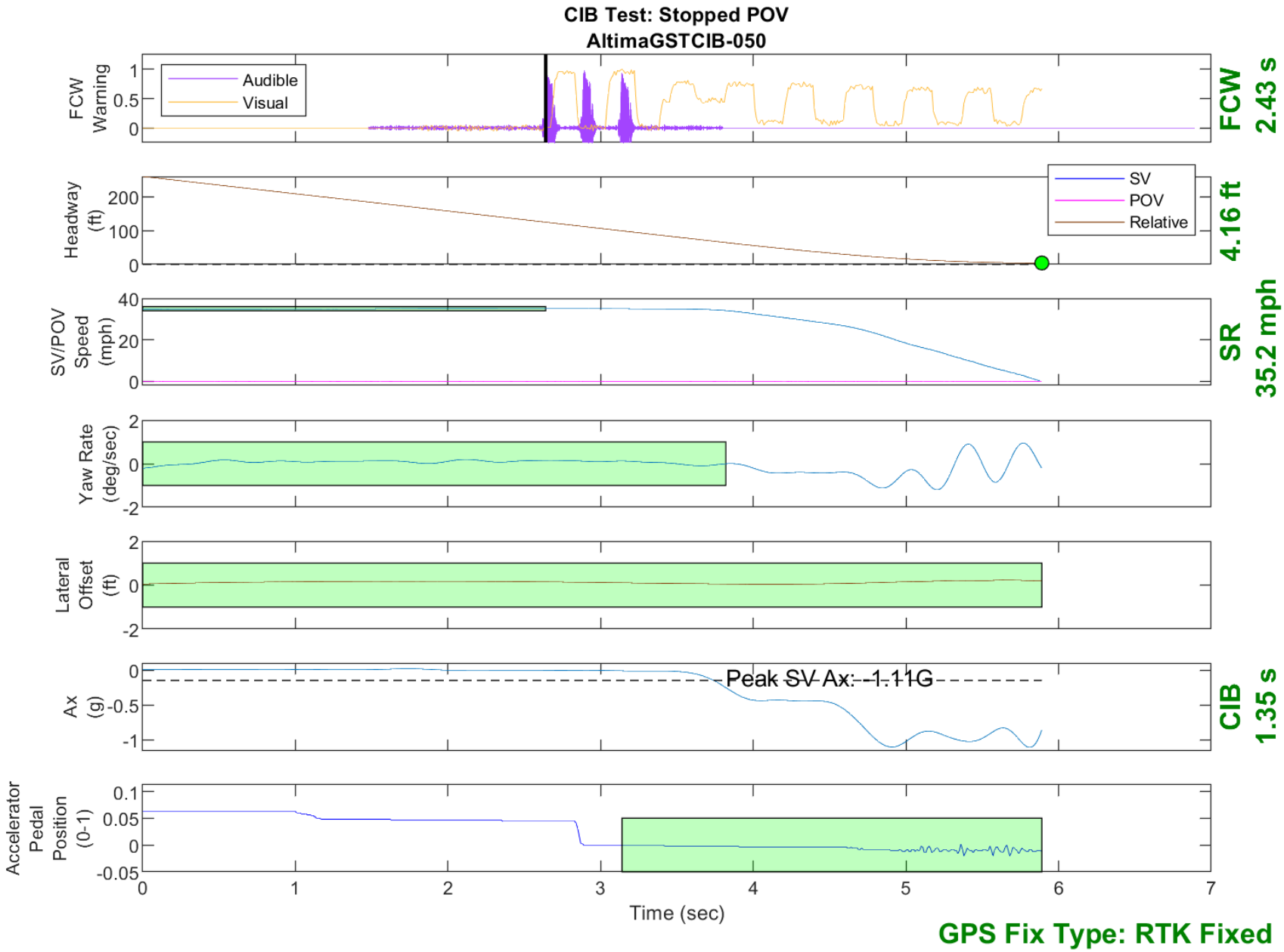


Figure D20. Time History for CIB Run 50, Stopped POV, 35 mph

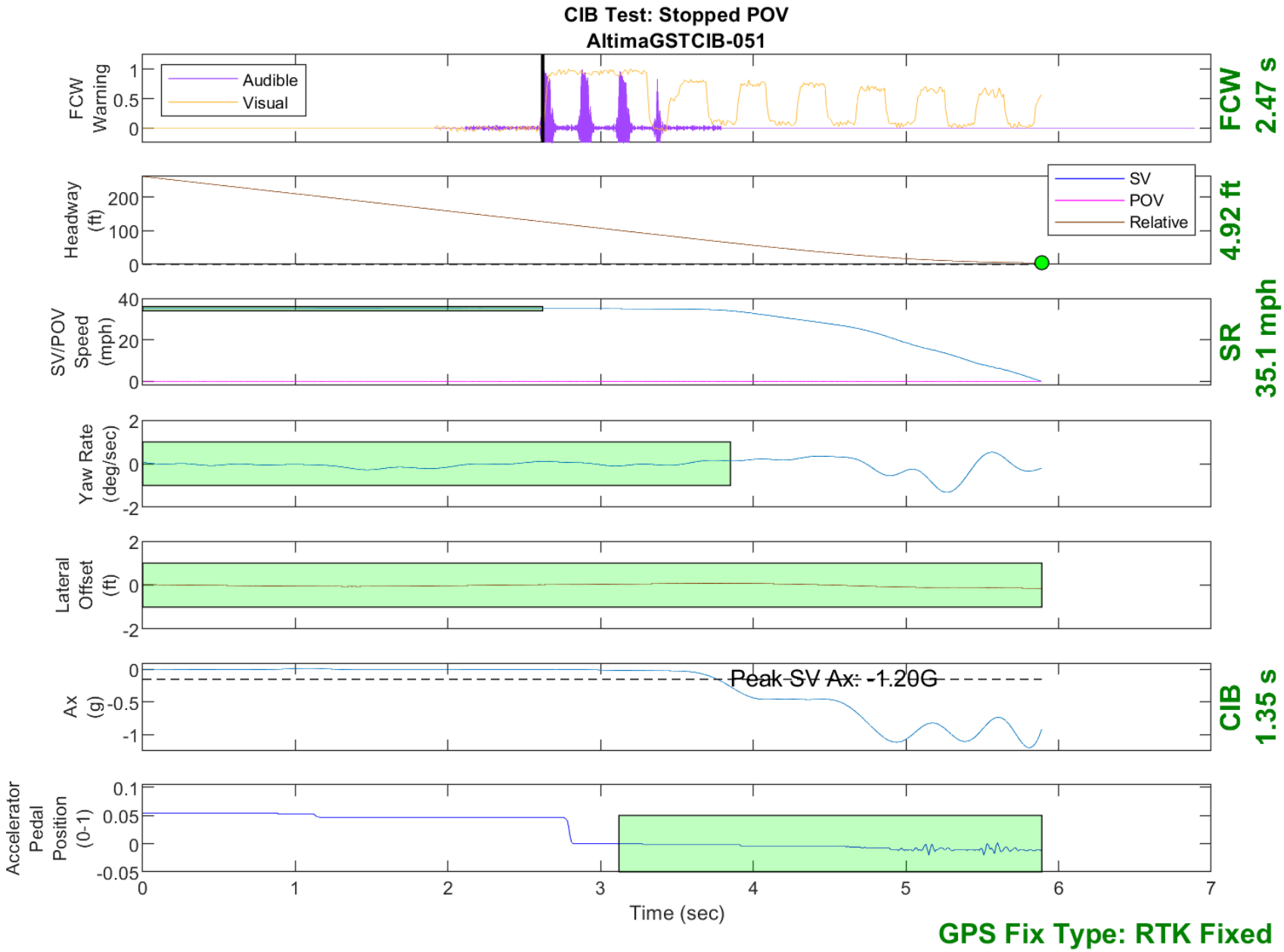


Figure D21. Time History for CIB Run 51, Stopped POV, 35 mph

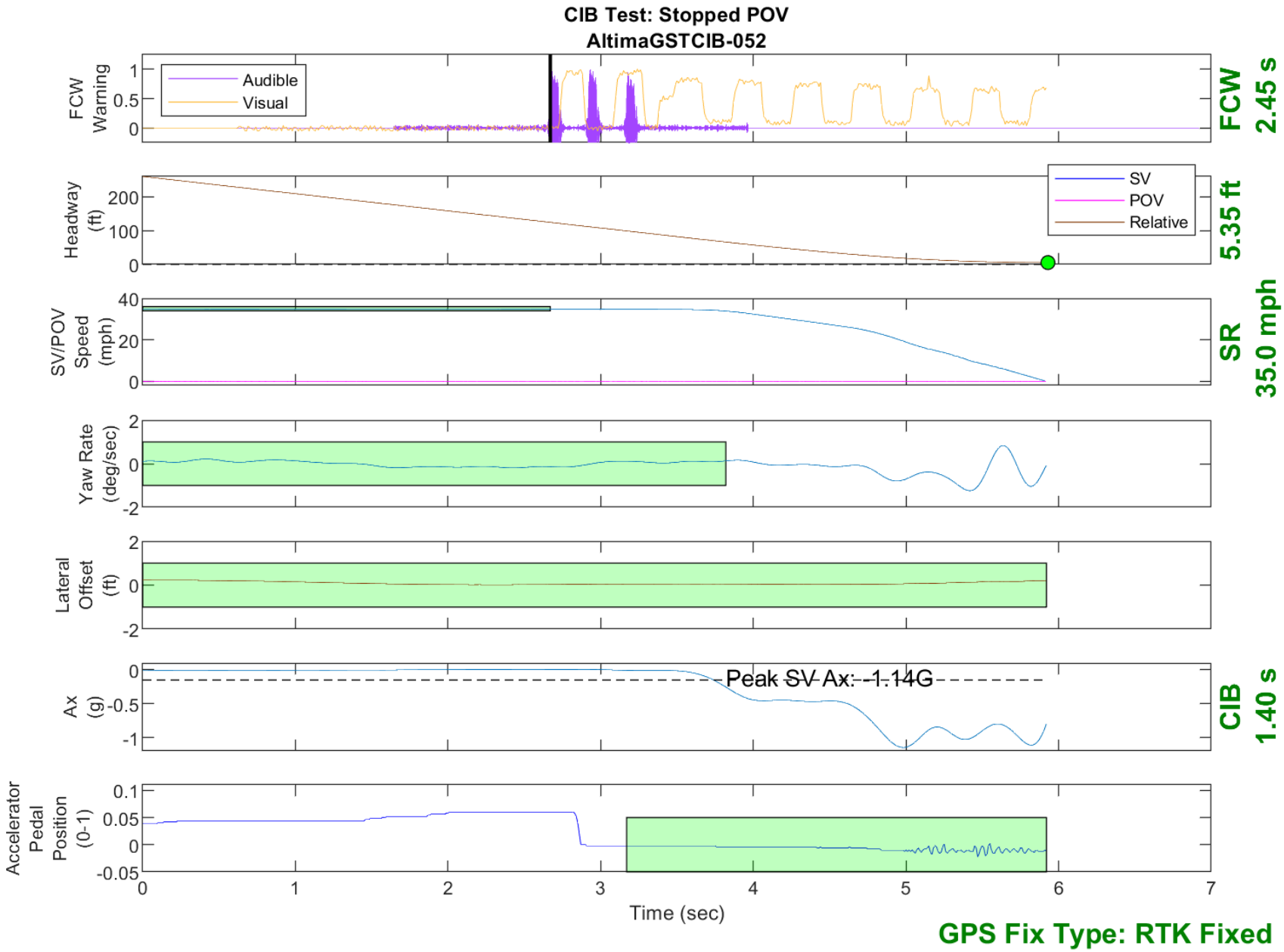


Figure D22. Time History for CIB Run 52, Stopped POV, 35 mph

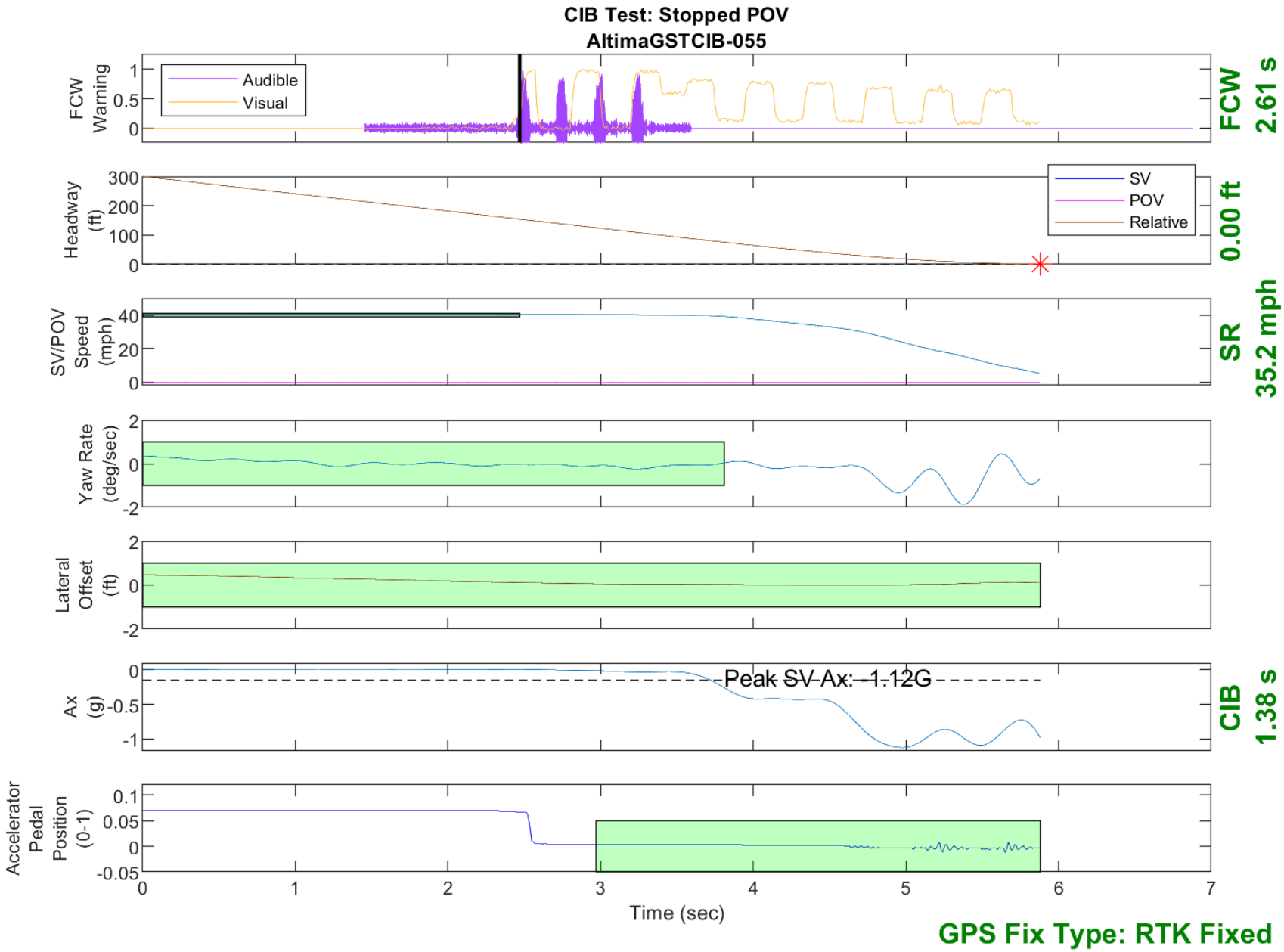


Figure D23. Time History for CIB Run 55, Stopped POV, 40 mph

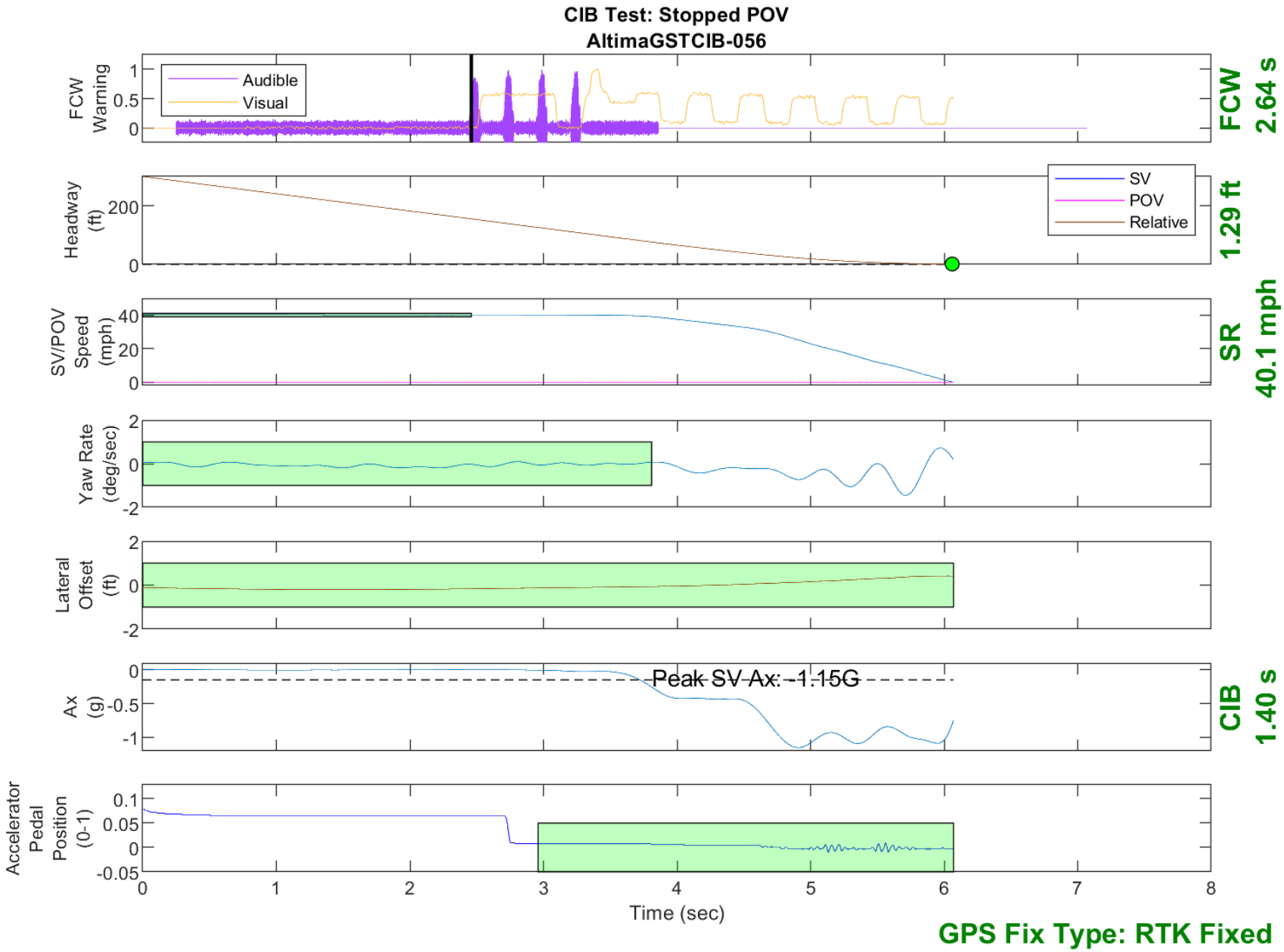


Figure D24. Time History for CIB Run 56, Stopped POV, 40 mph

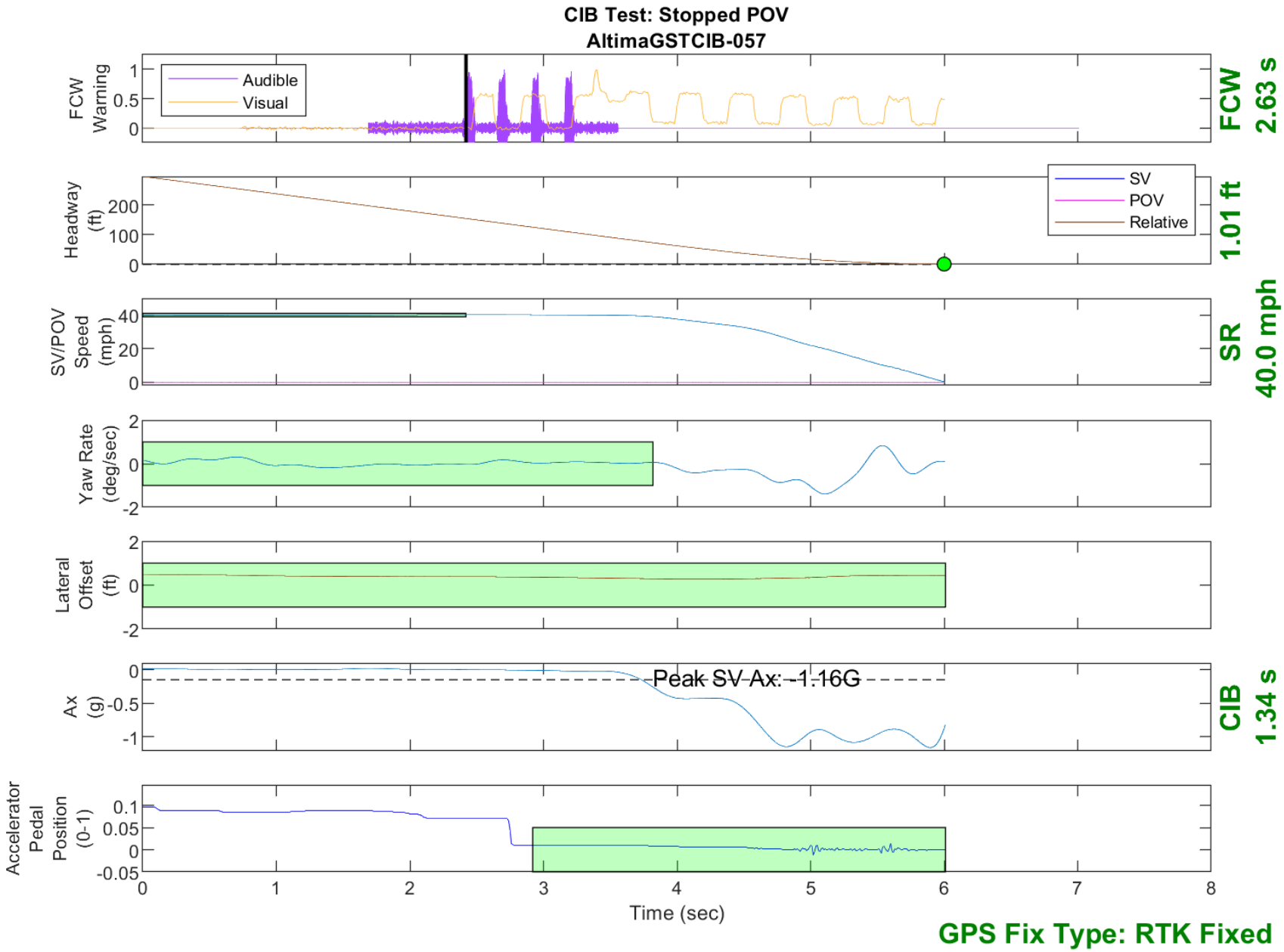


Figure D25. Time History for CIB Run 57, Stopped POV, 40 mph

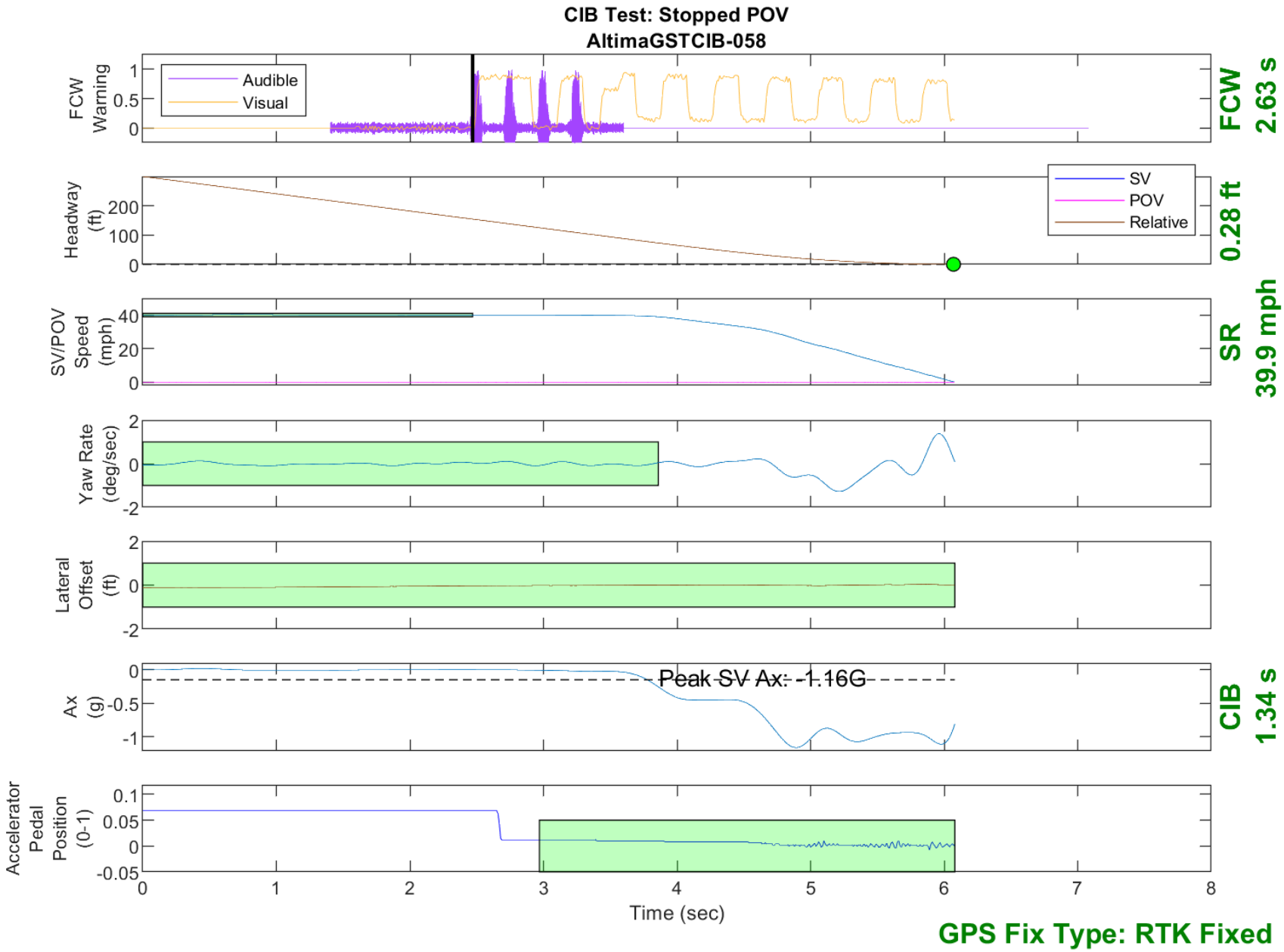


Figure D26. Time History for CIB Run 58, Stopped POV, 40 mph

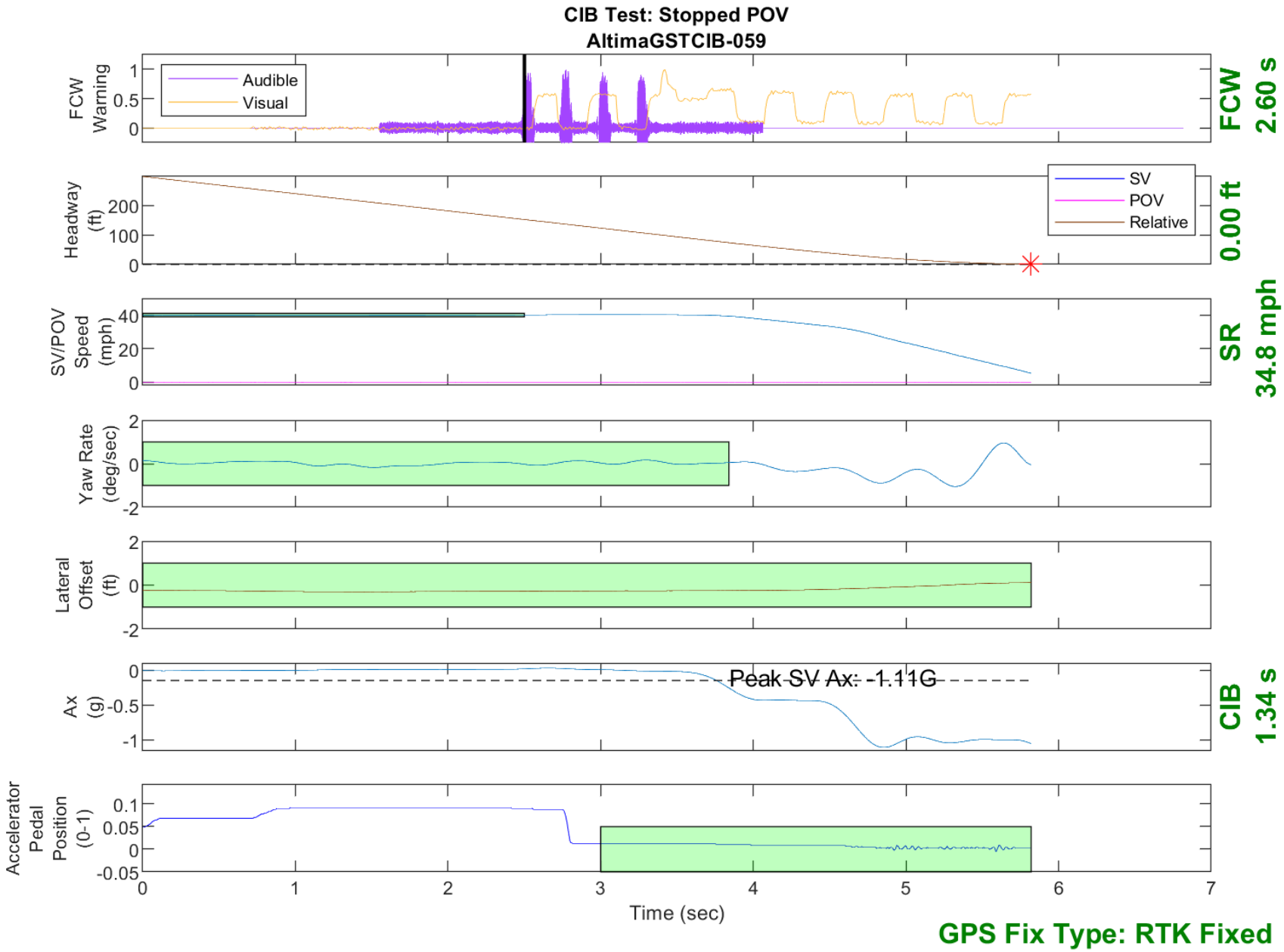


Figure D27. Time History for CIB Run 59, Stopped POV, 40 mph

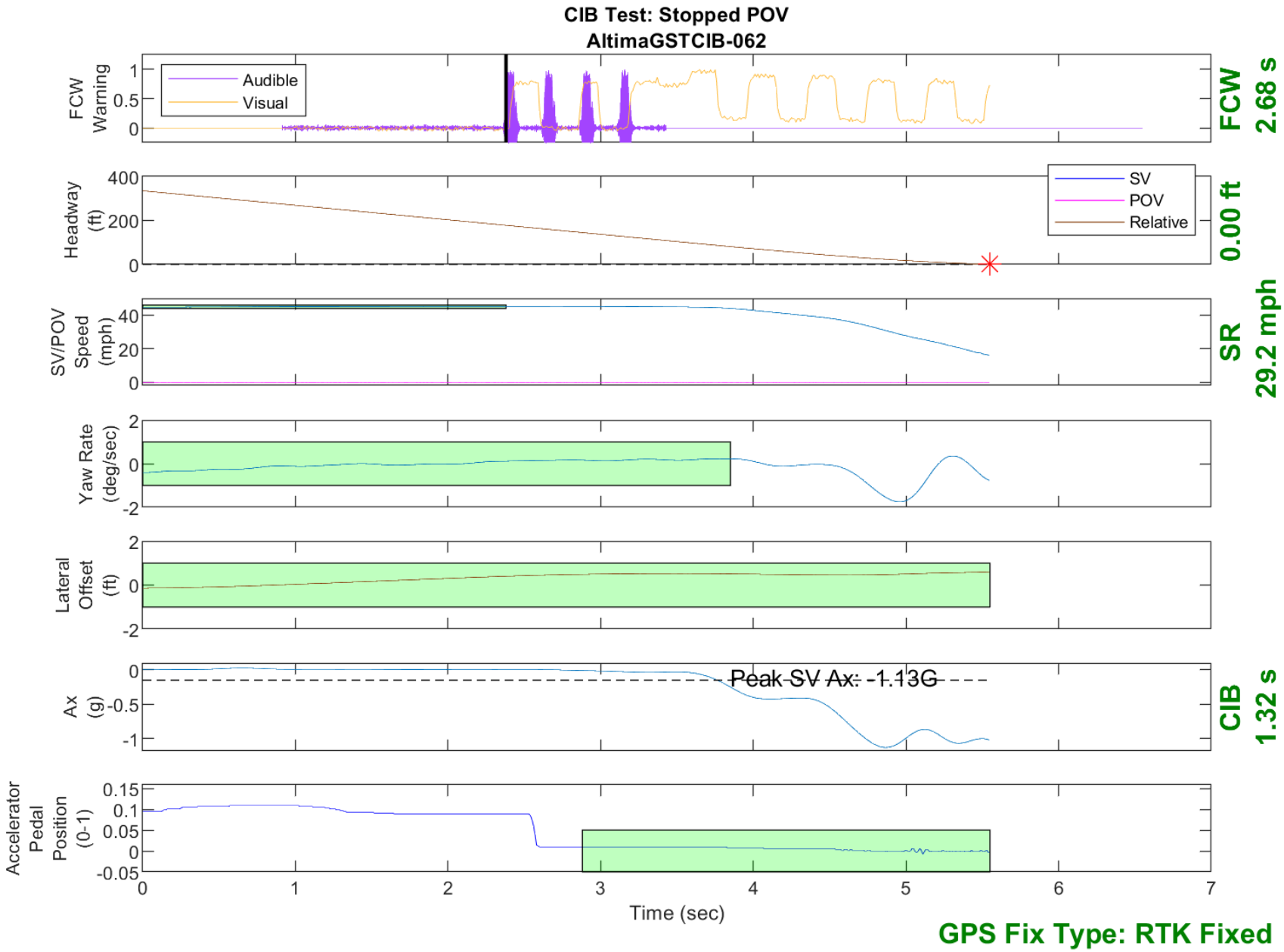


Figure D28. Time History for CIB Run 62, Stopped POV, 45 mph

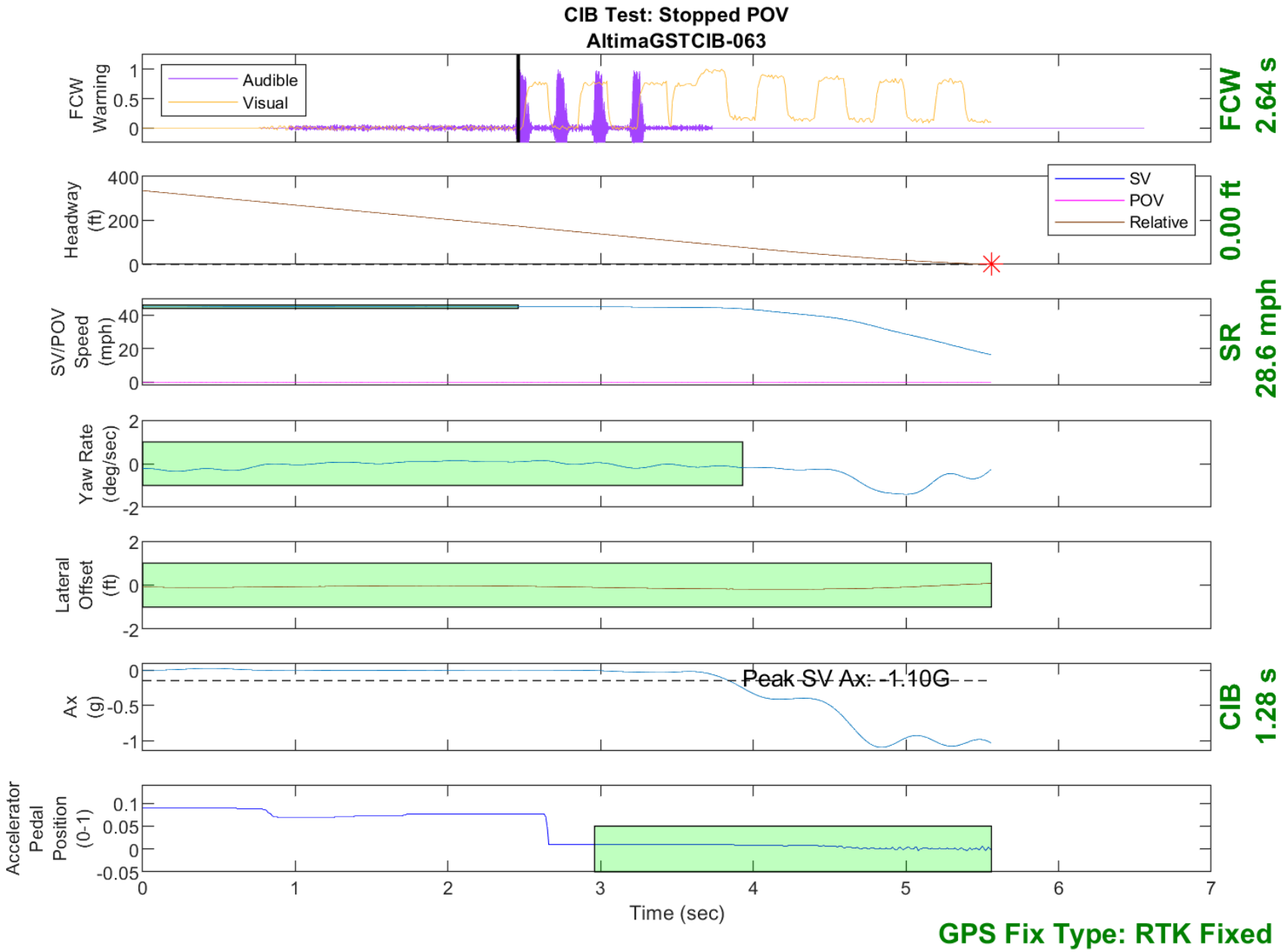


Figure D29. Time History for CIB Run 63, Stopped POV, 45 mph

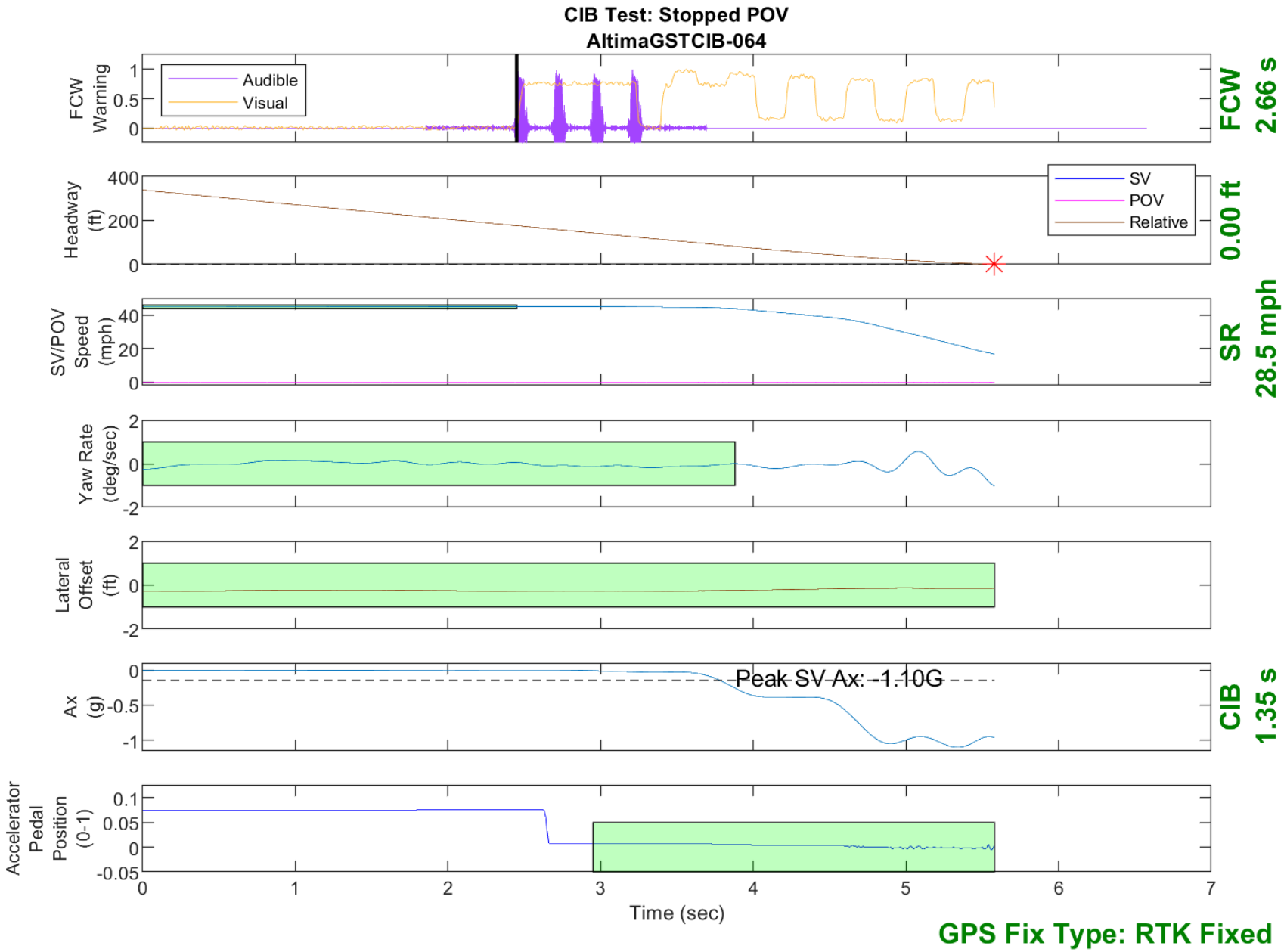


Figure D30. Time History for CIB Run 64, Stopped POV, 45 mph

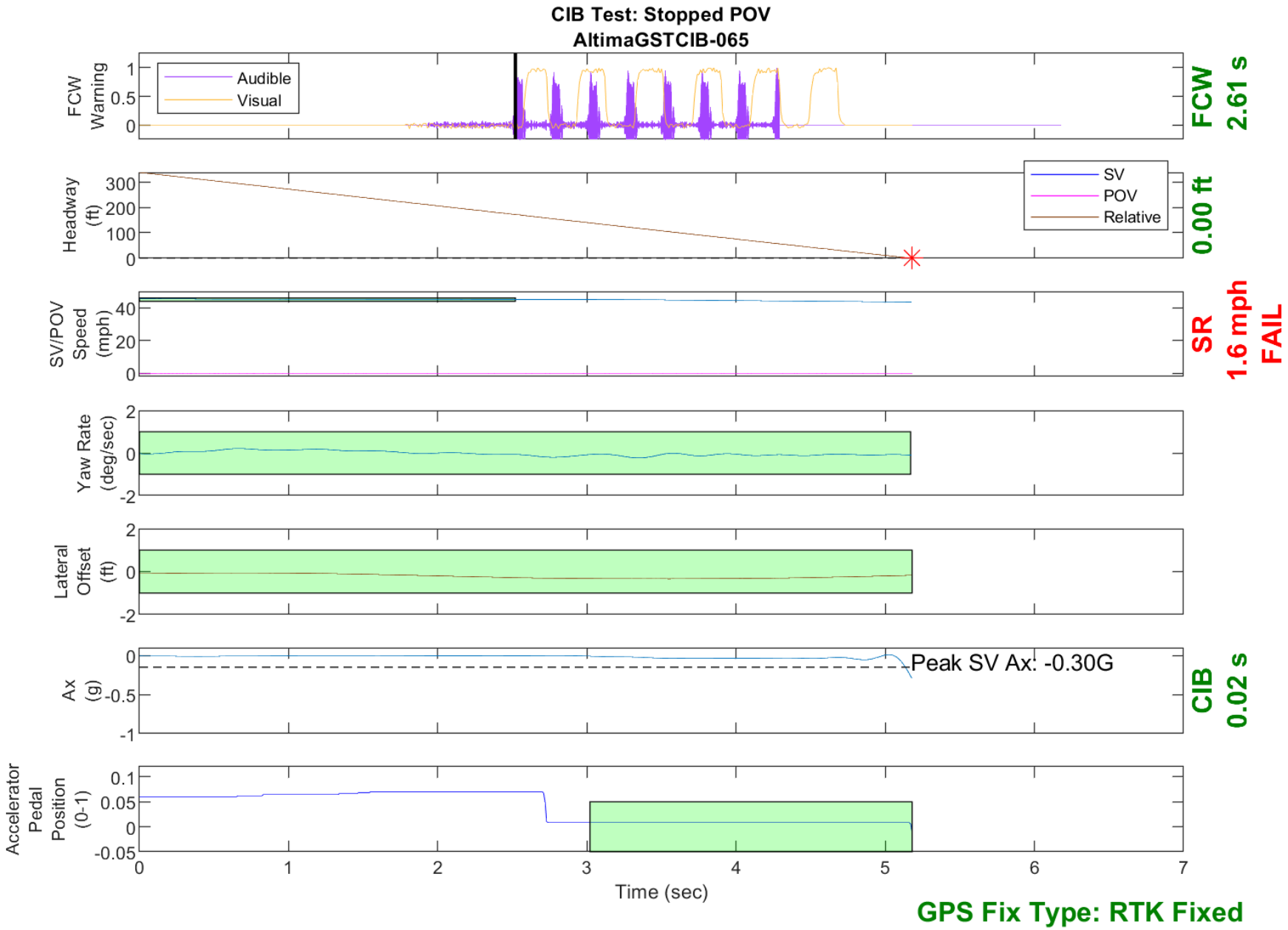


Figure D31. Time History for CIB Run 65, Stopped POV, 45 mph

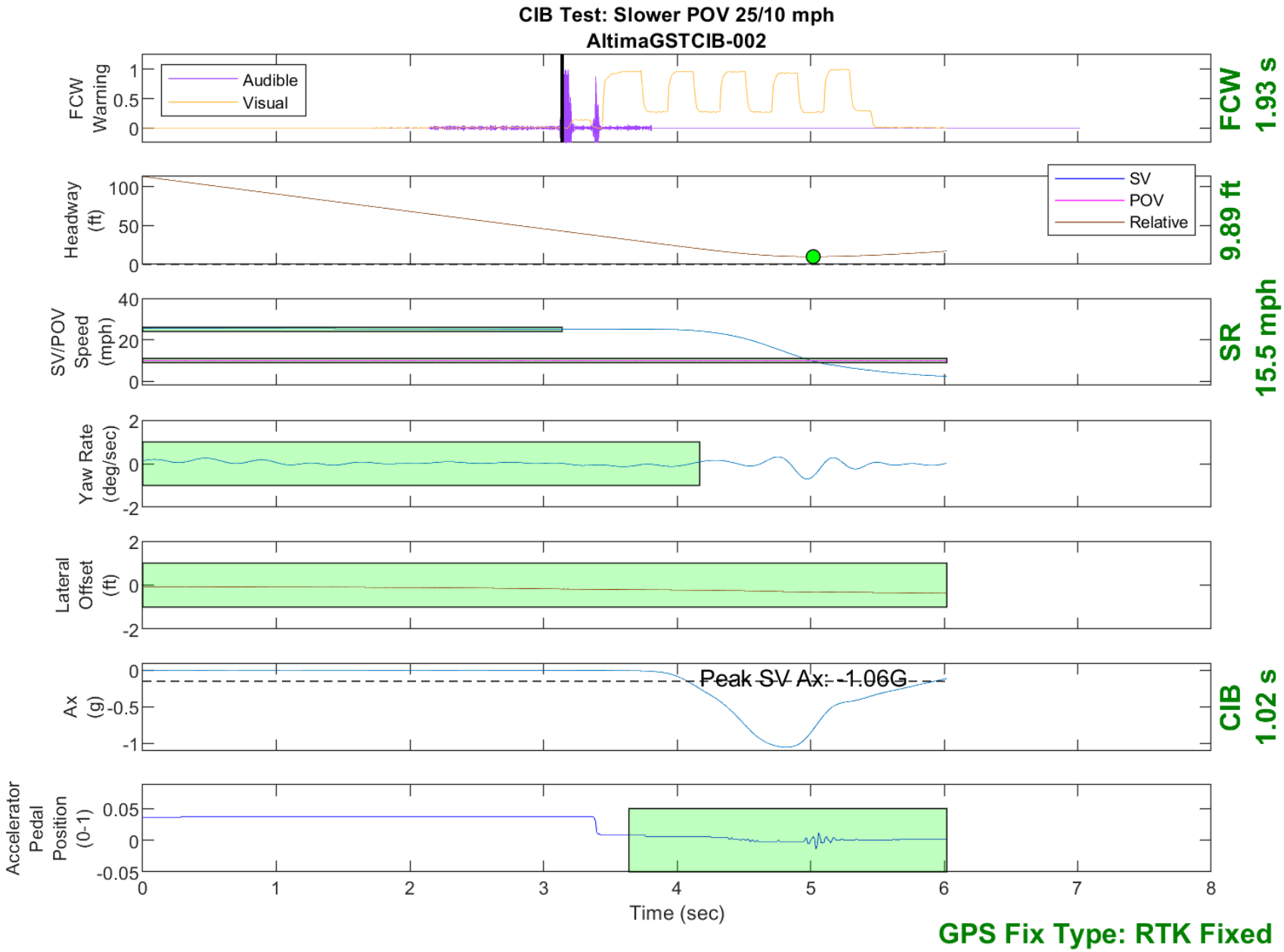


Figure D32. Time History for CIB Run 2, Slower POV, 25/10 mph

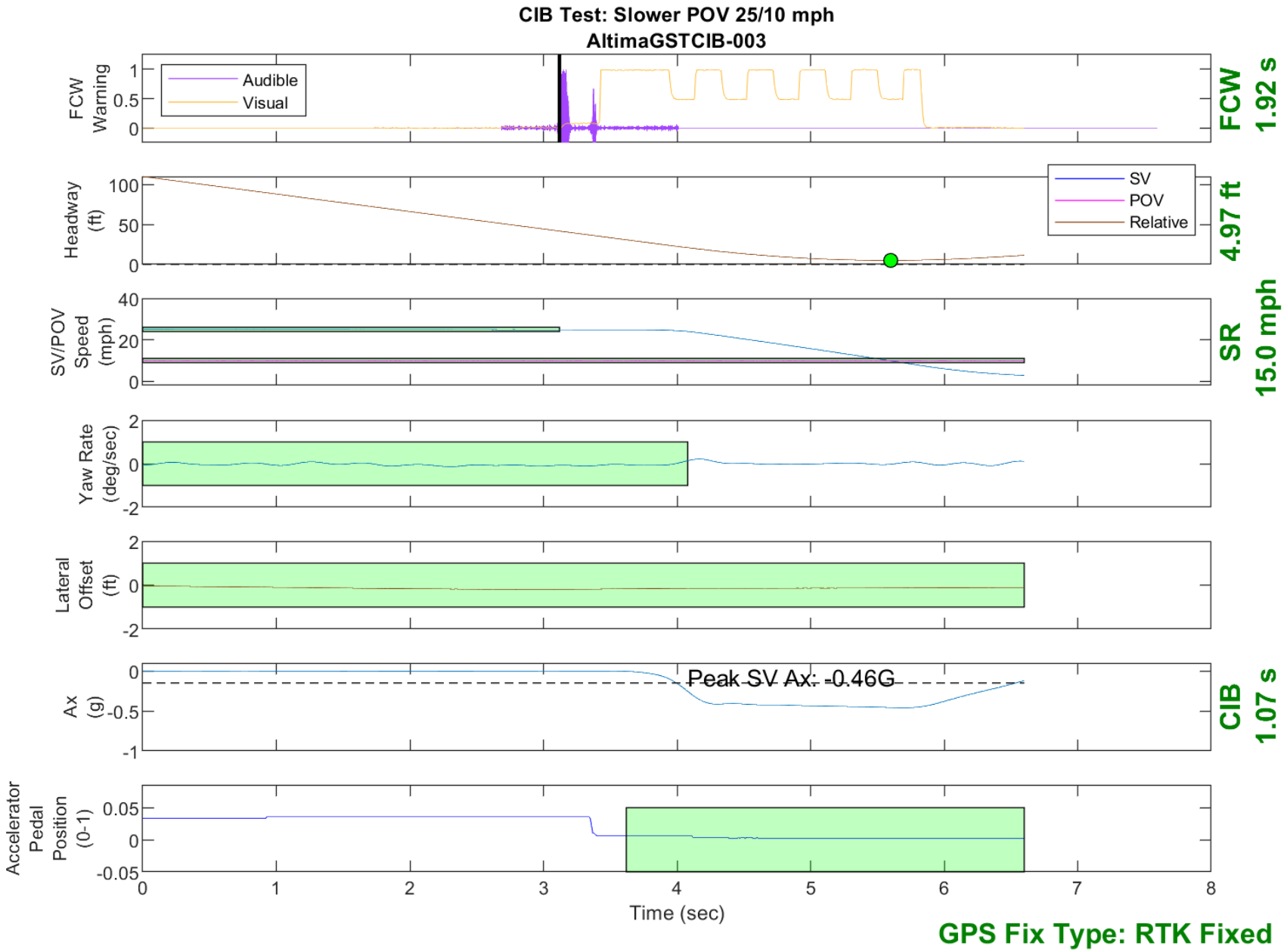


Figure D33. Time History for CIB Run 3, Slower POV, 25/10 mph

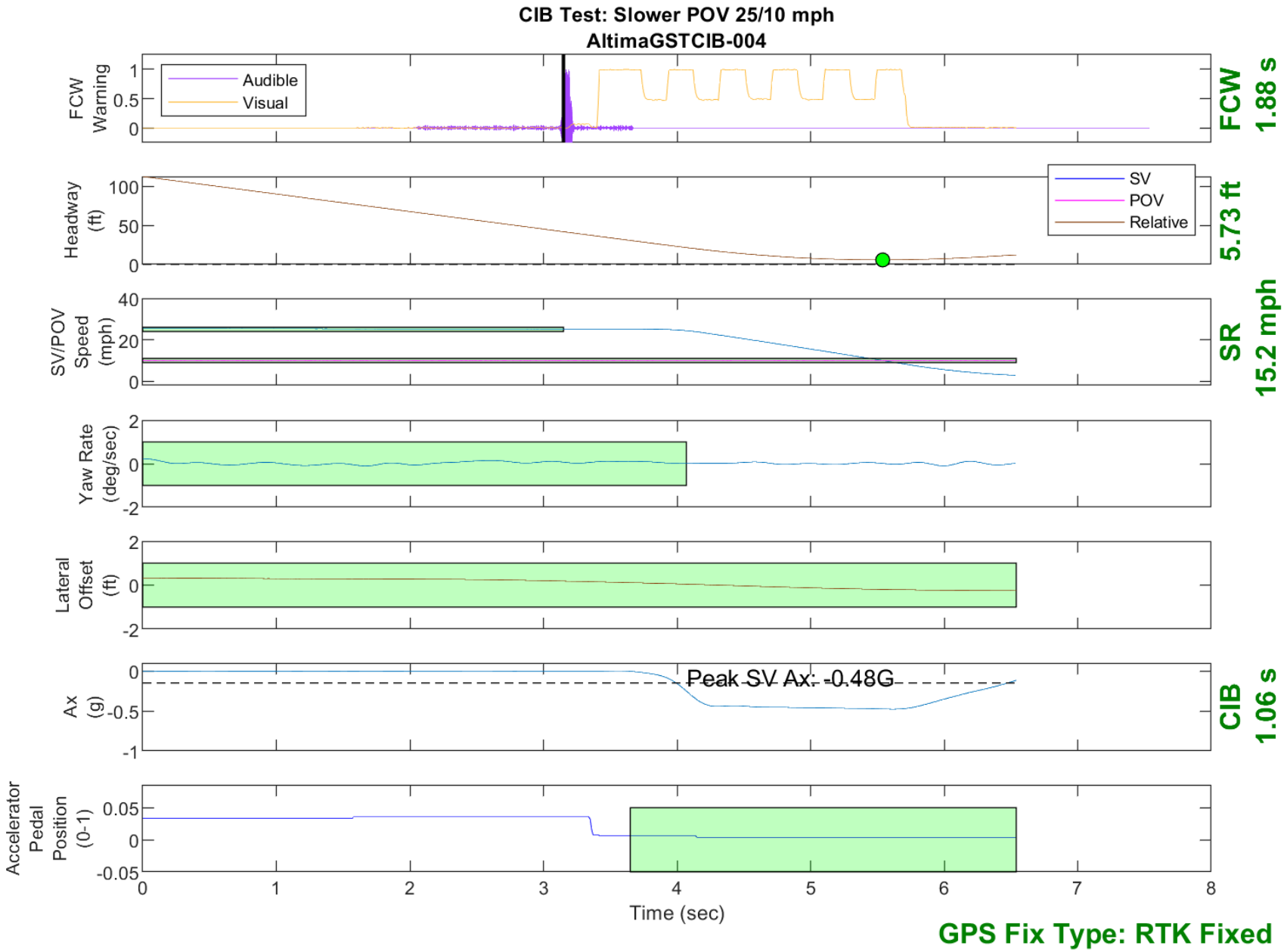


Figure D34. Time History for CIB Run 4, Slower POV, 25/10 mph

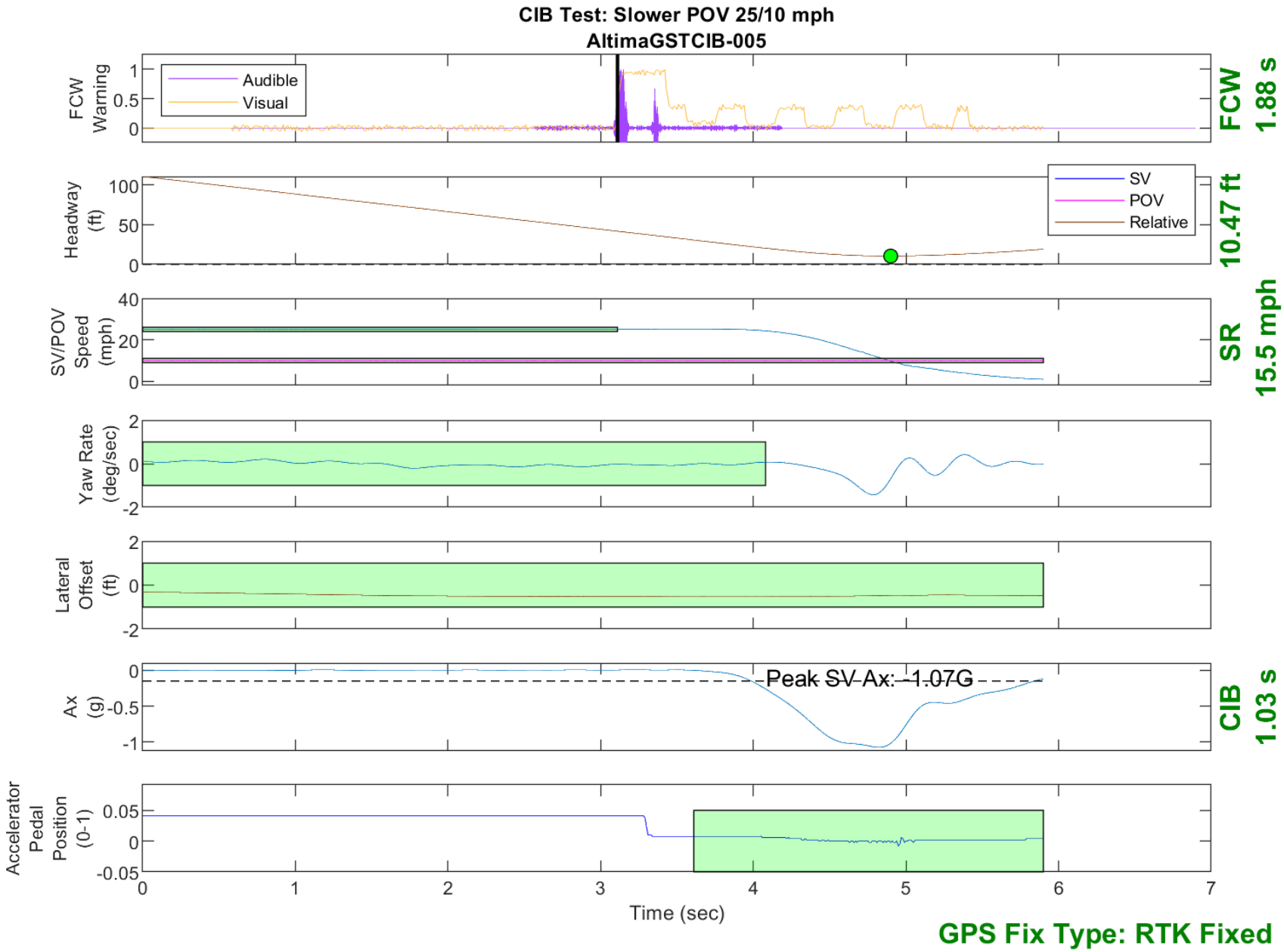


Figure D35. Time History for CIB Run 5, Slower POV, 25/10 mph

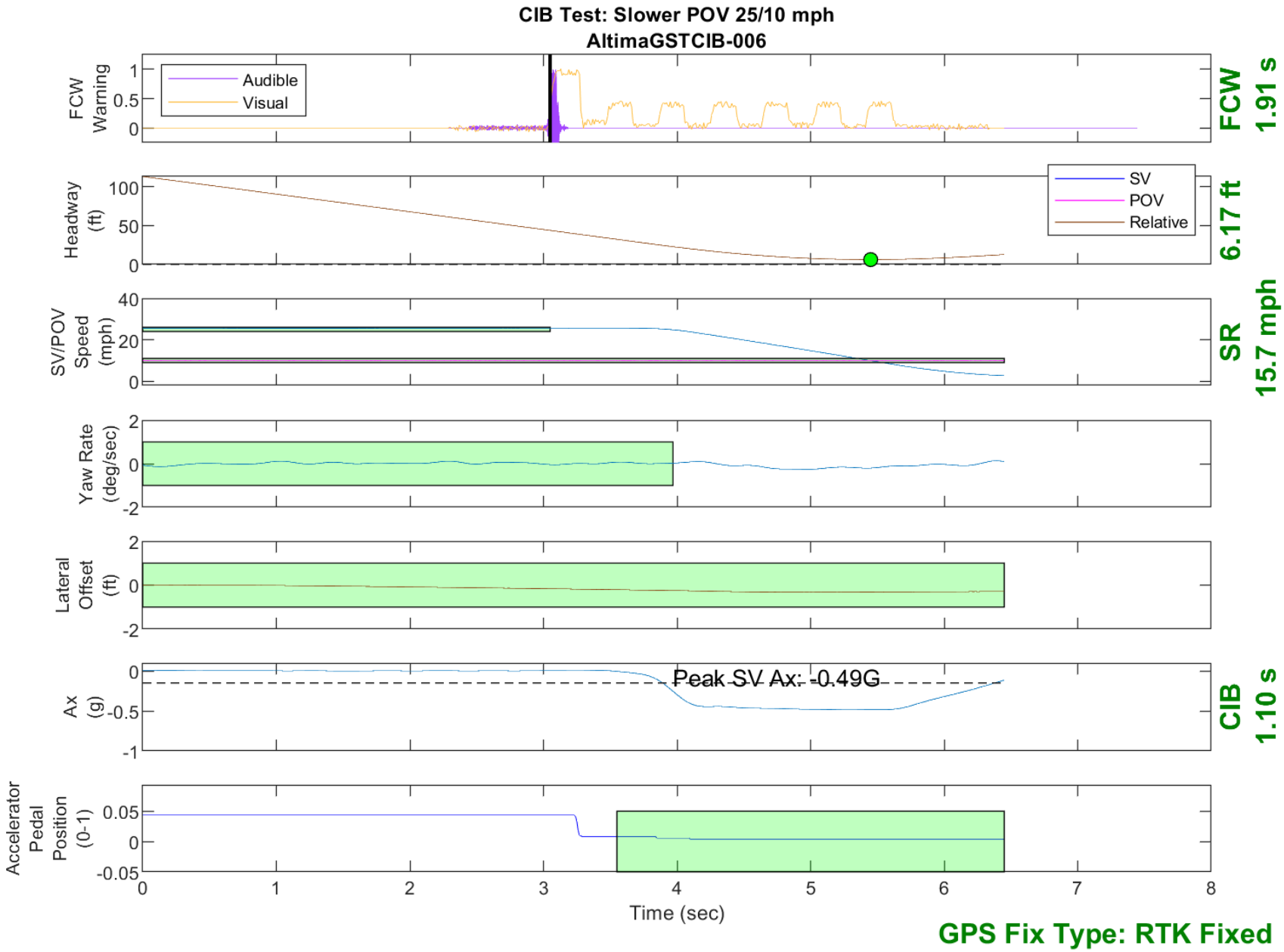


Figure D36. Time History for CIB Run 6, Slower POV, 25/10 mph

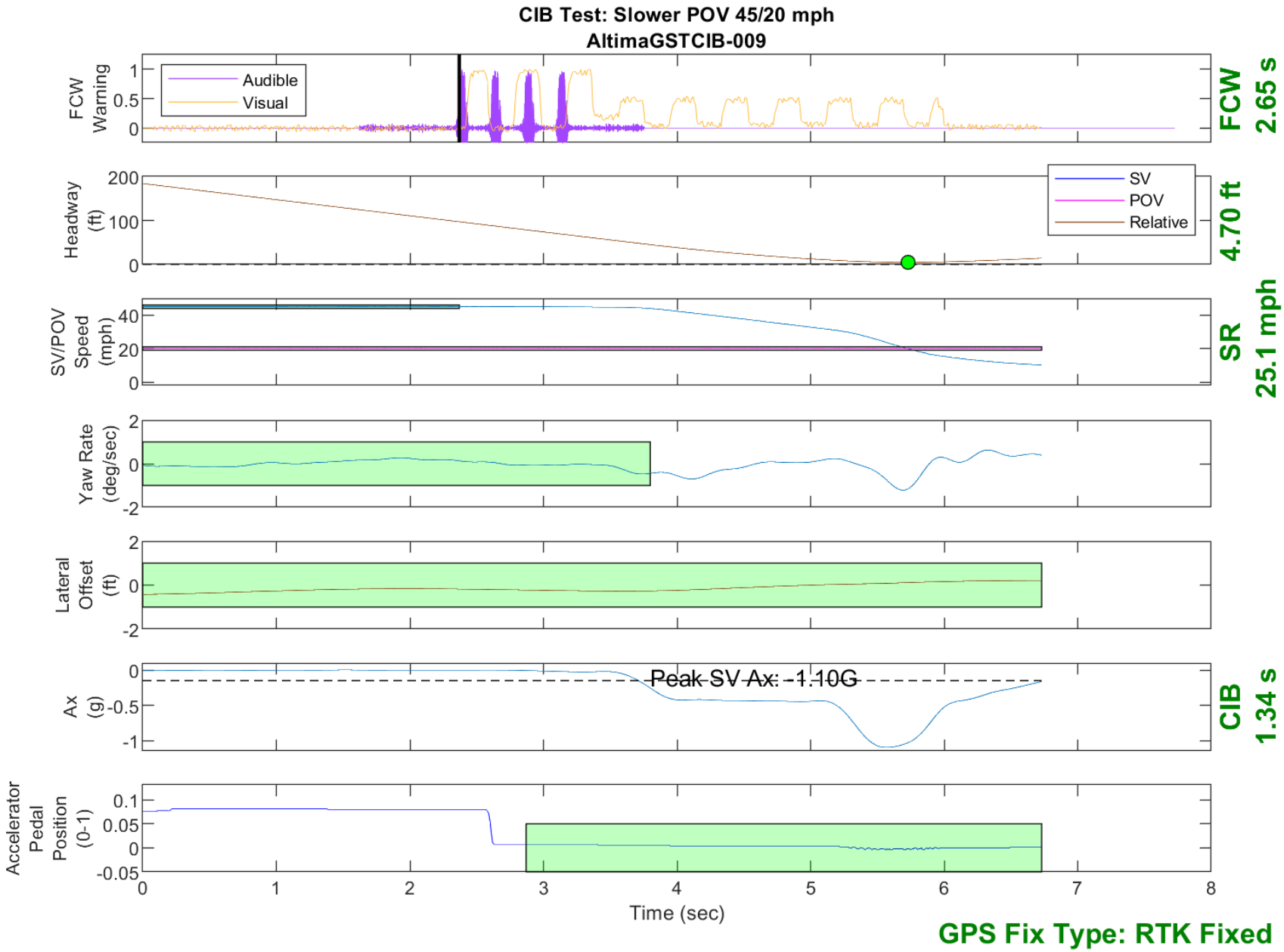


Figure D37. Time History for CIB Run 9, Slower POV, 45/20 mph

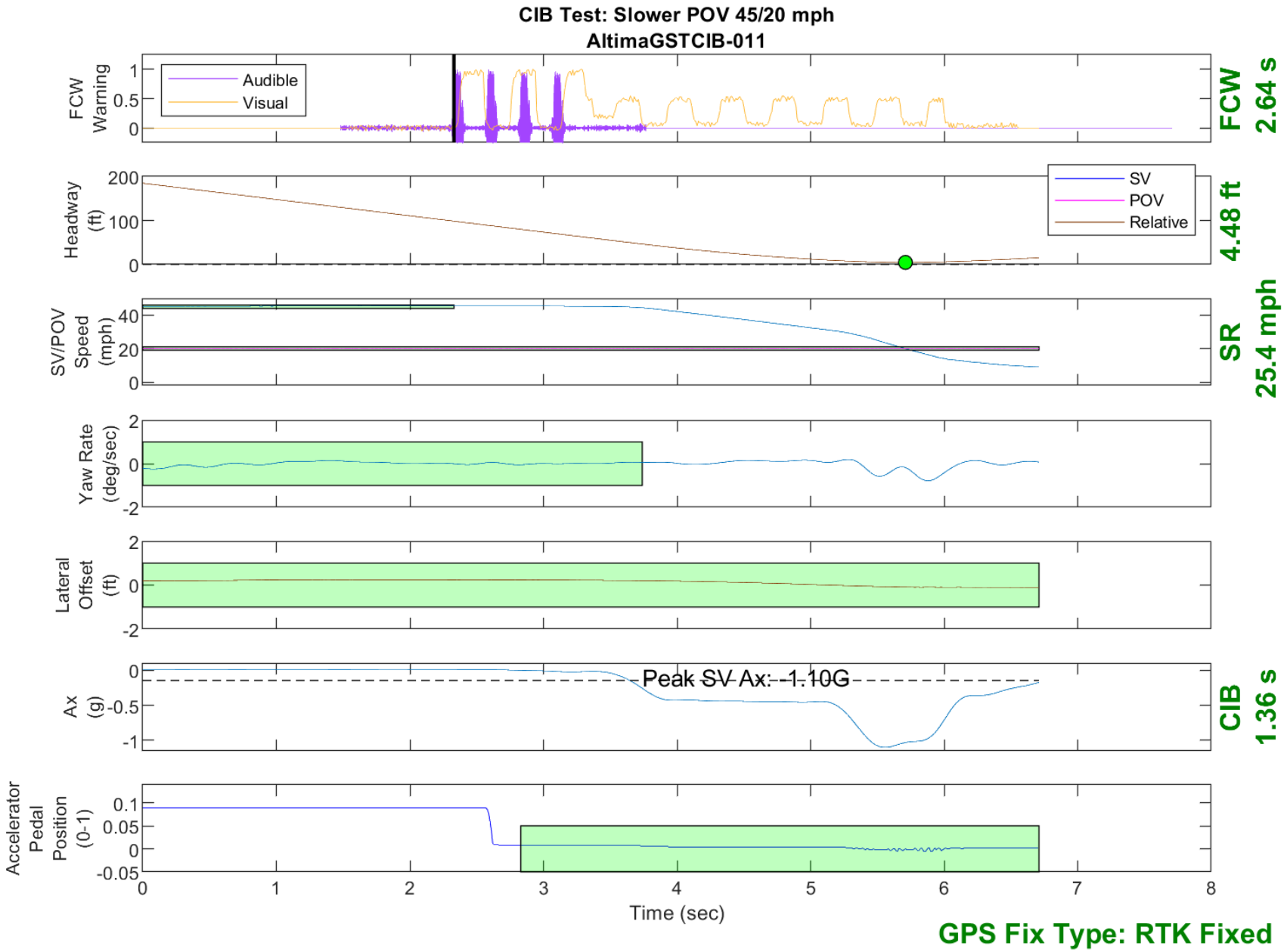


Figure D38. Time History for CIB Run 11, Slower POV, 45/20 mph

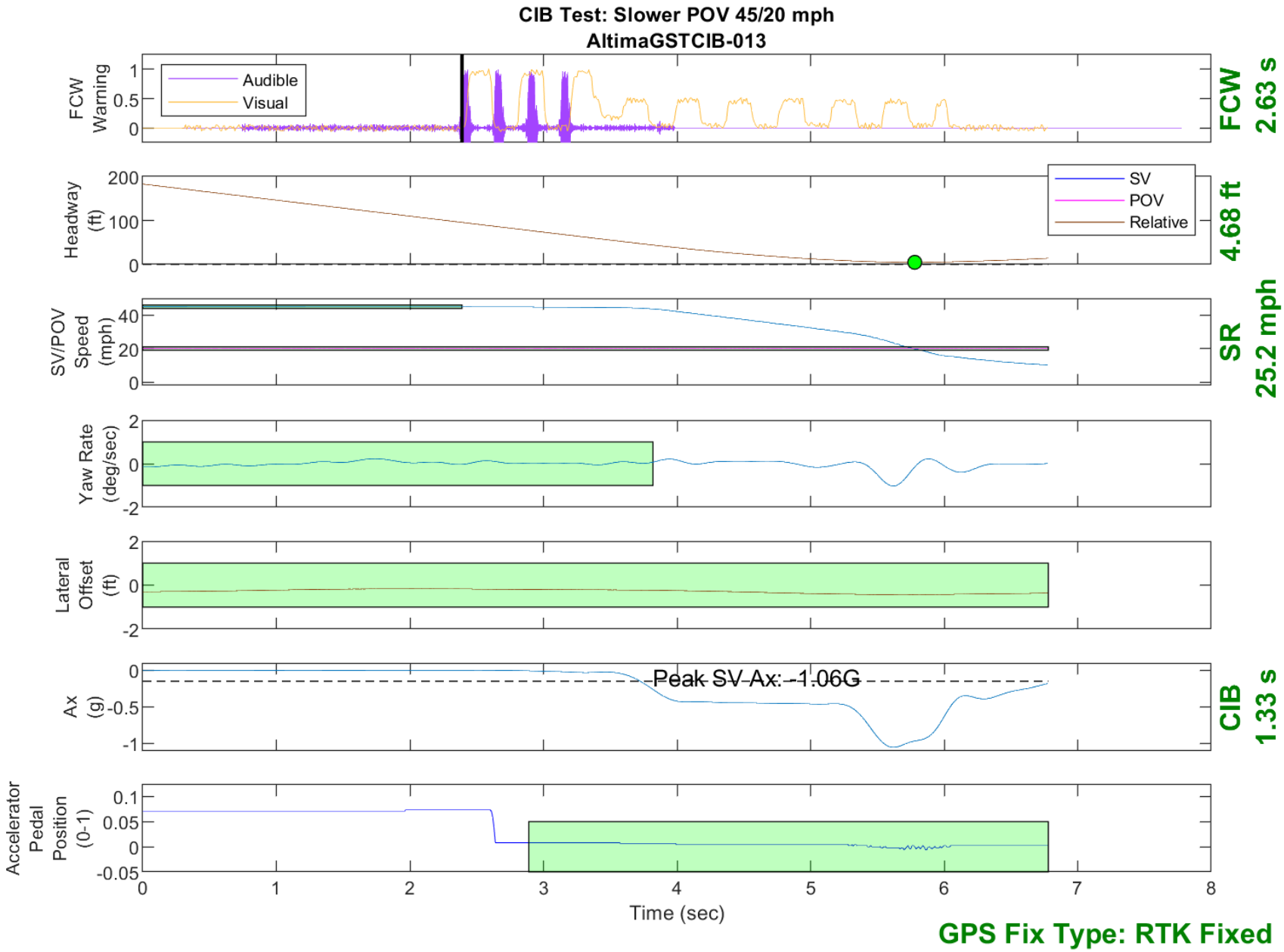


Figure D39. Time History for CIB Run 13, Slower POV, 45/20 mph

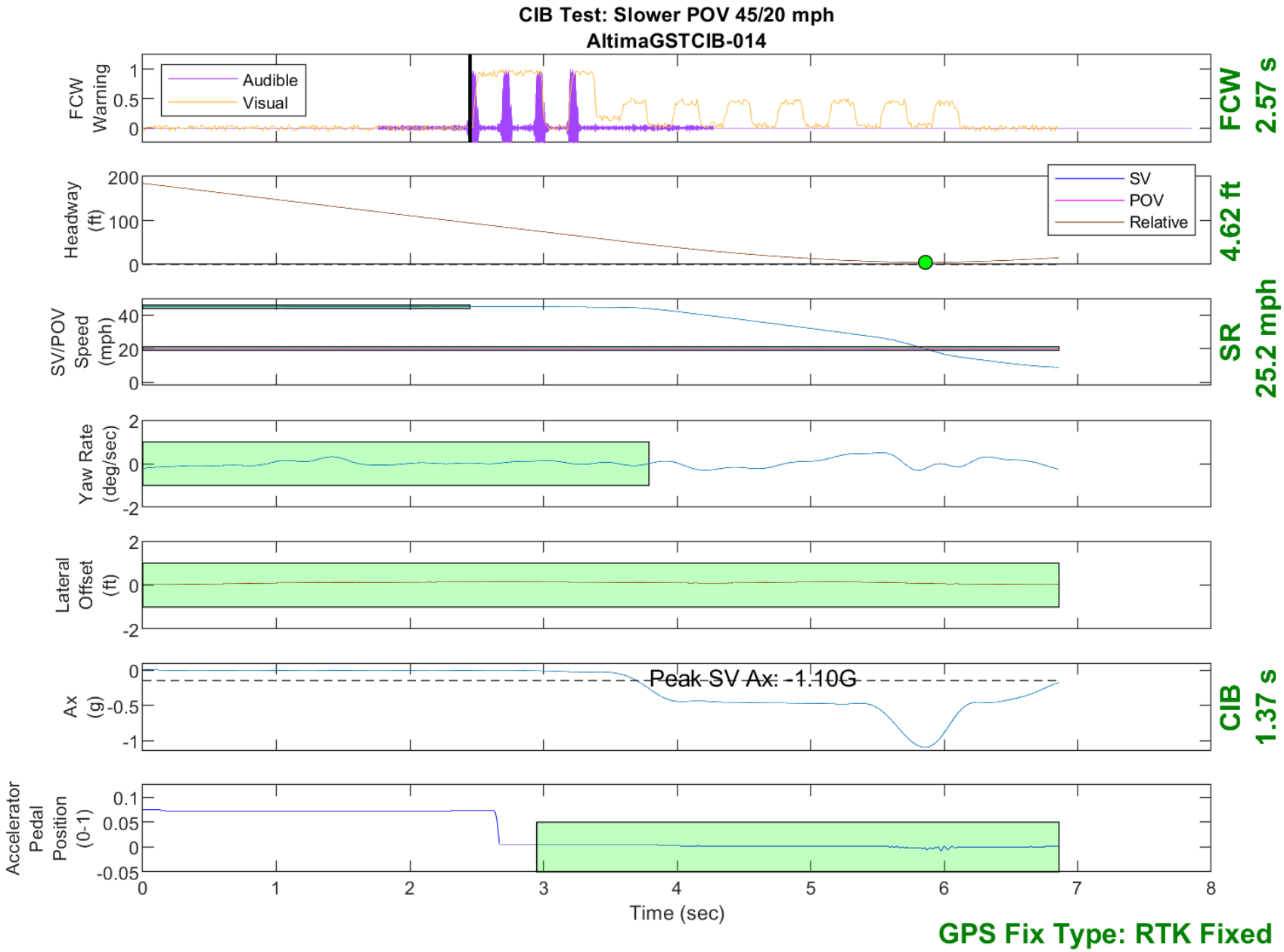


Figure D40. Time History for CIB Run 14, Slower POV, 45/20 mph

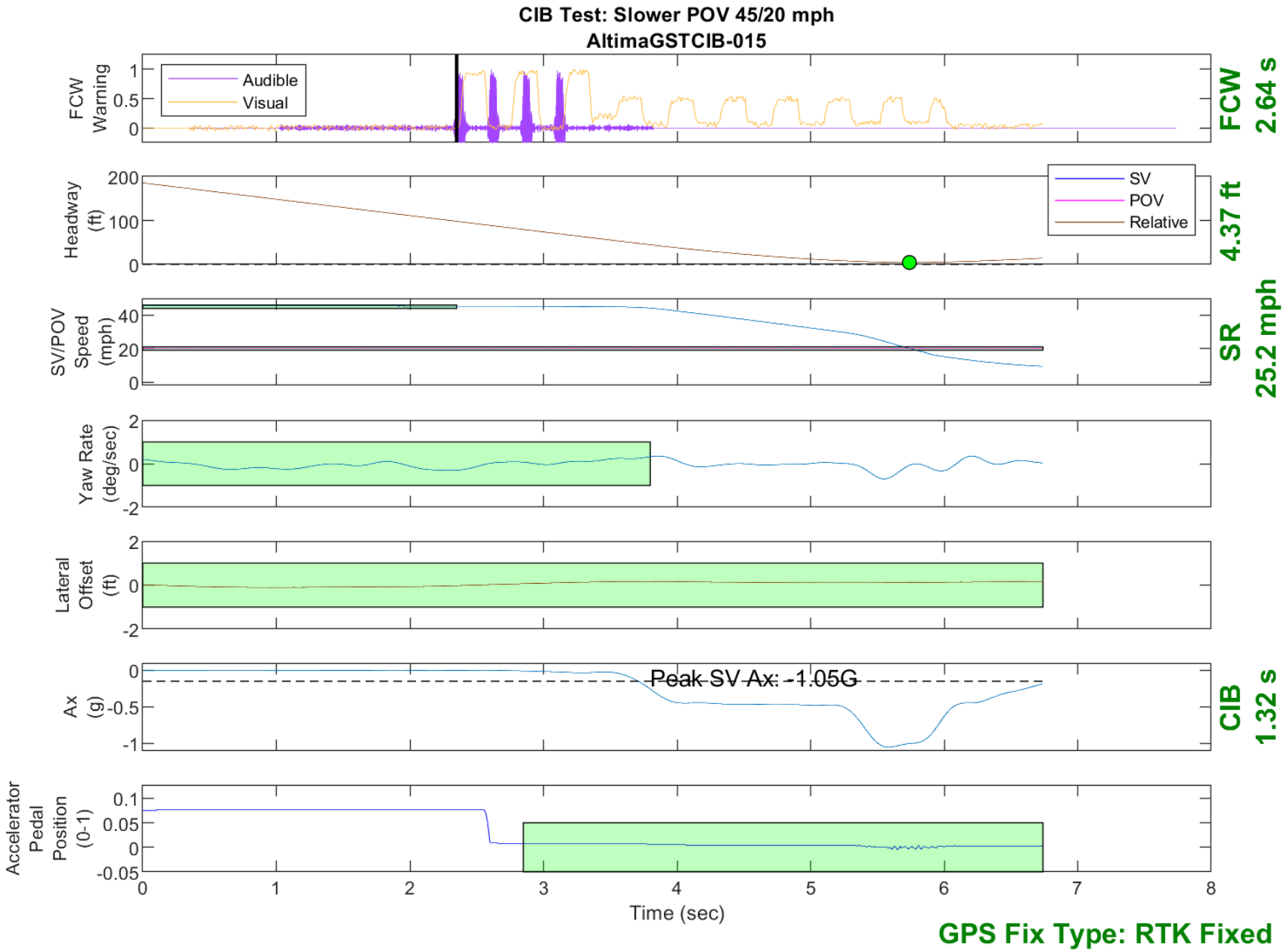


Figure D41. Time History for CIB Run 15, Slower POV, 45/20 mph

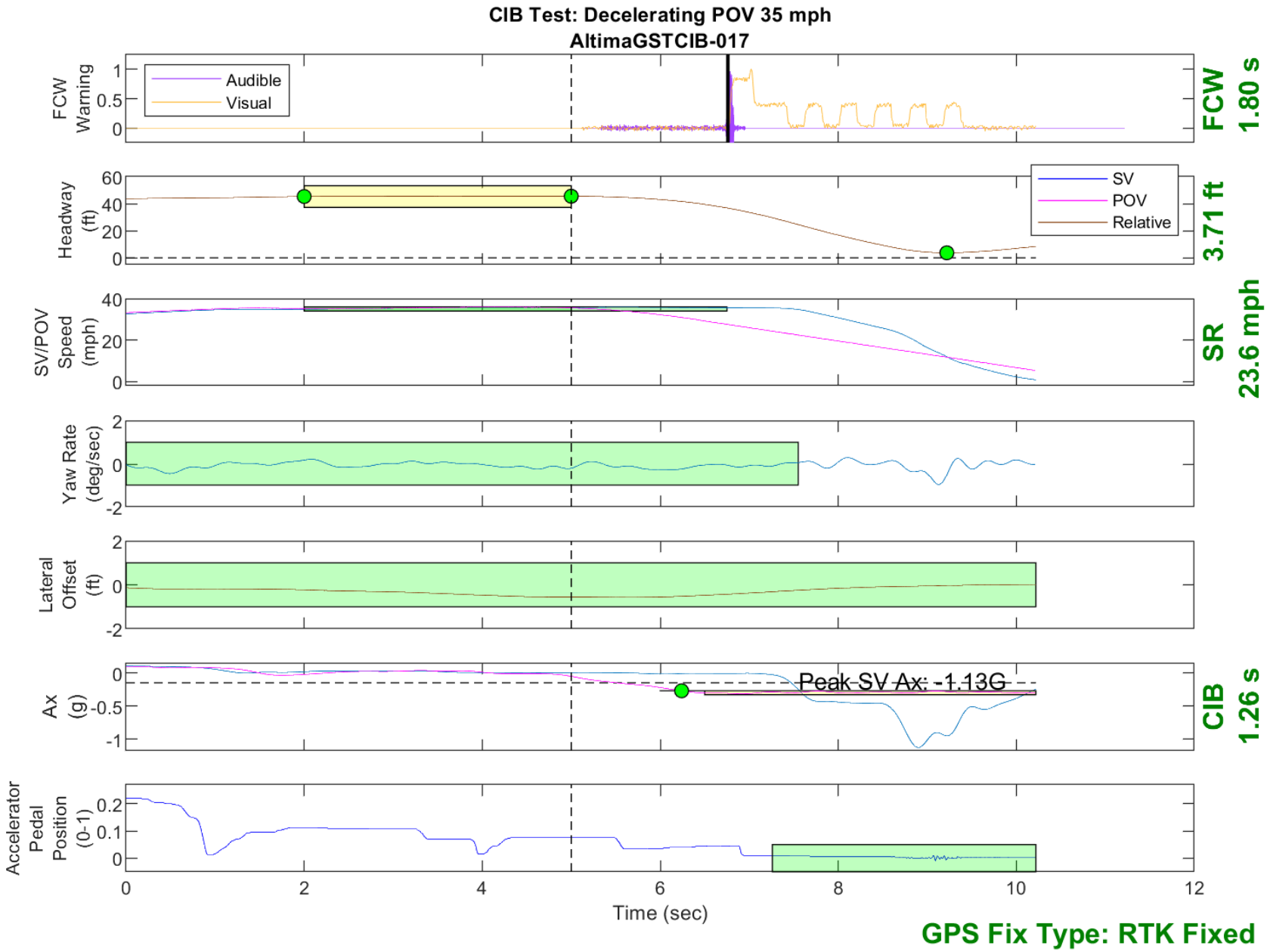


Figure D42. Time History for CIB Run 17, Decelerating POV, 35 mph 0.3g

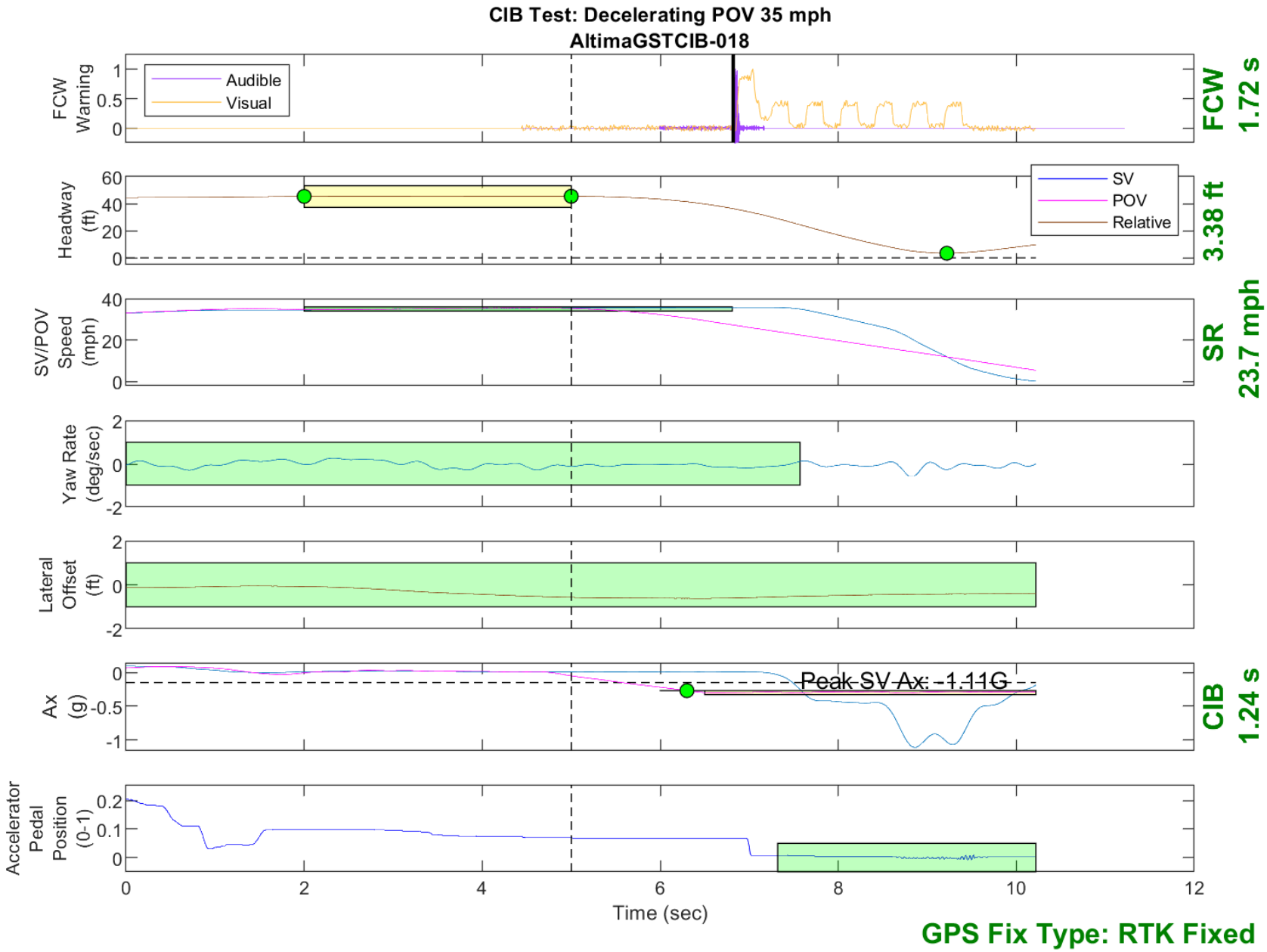


Figure D43. Time History for CIB Run 18, Decelerating POV, 35 mph 0.3g

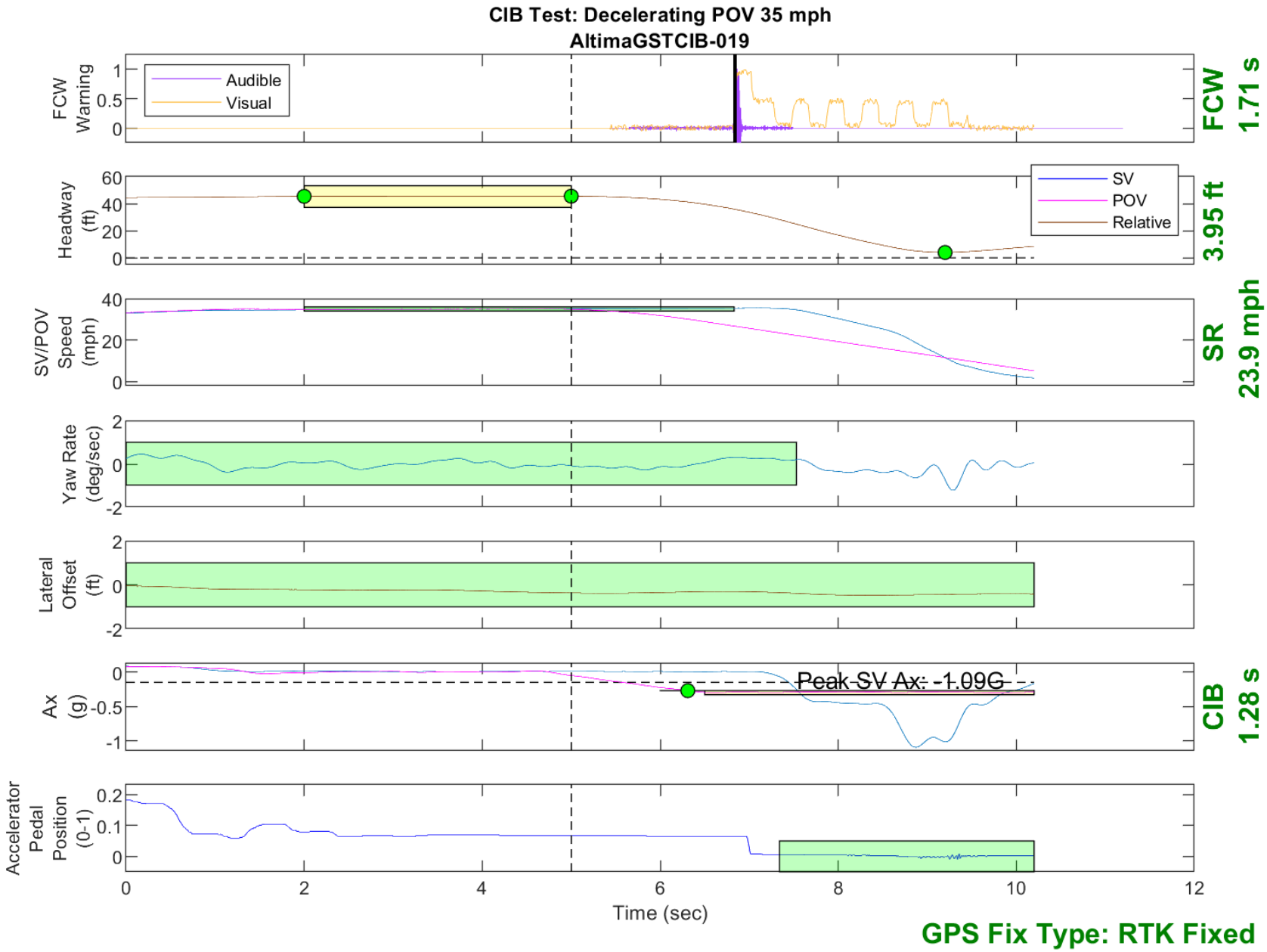


Figure D44. Time History for CIB Run 19, Decelerating POV, 35 mph 0.3g

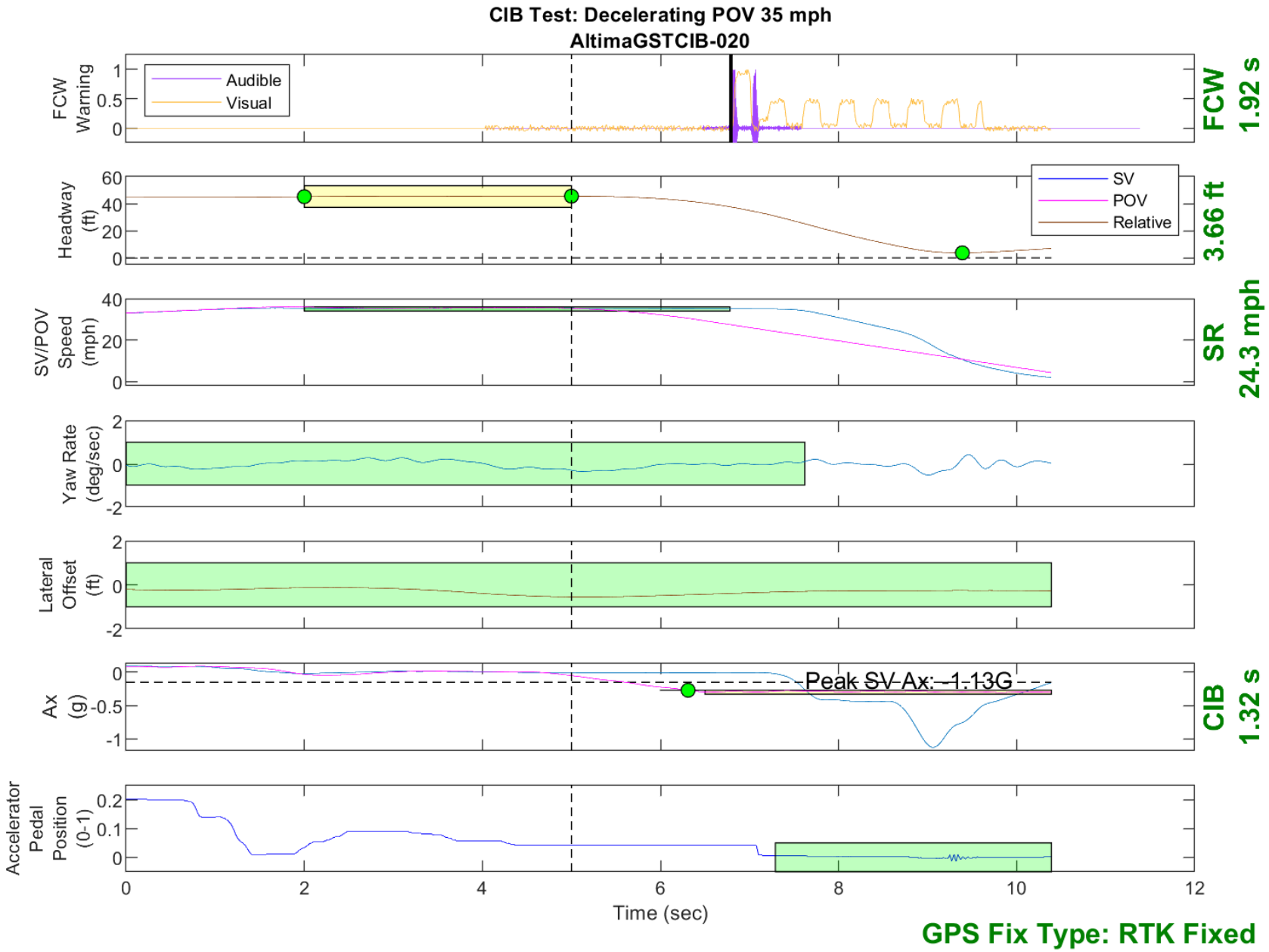


Figure D45. Time History for CIB Run 20, Decelerating POV, 35 mph 0.3g

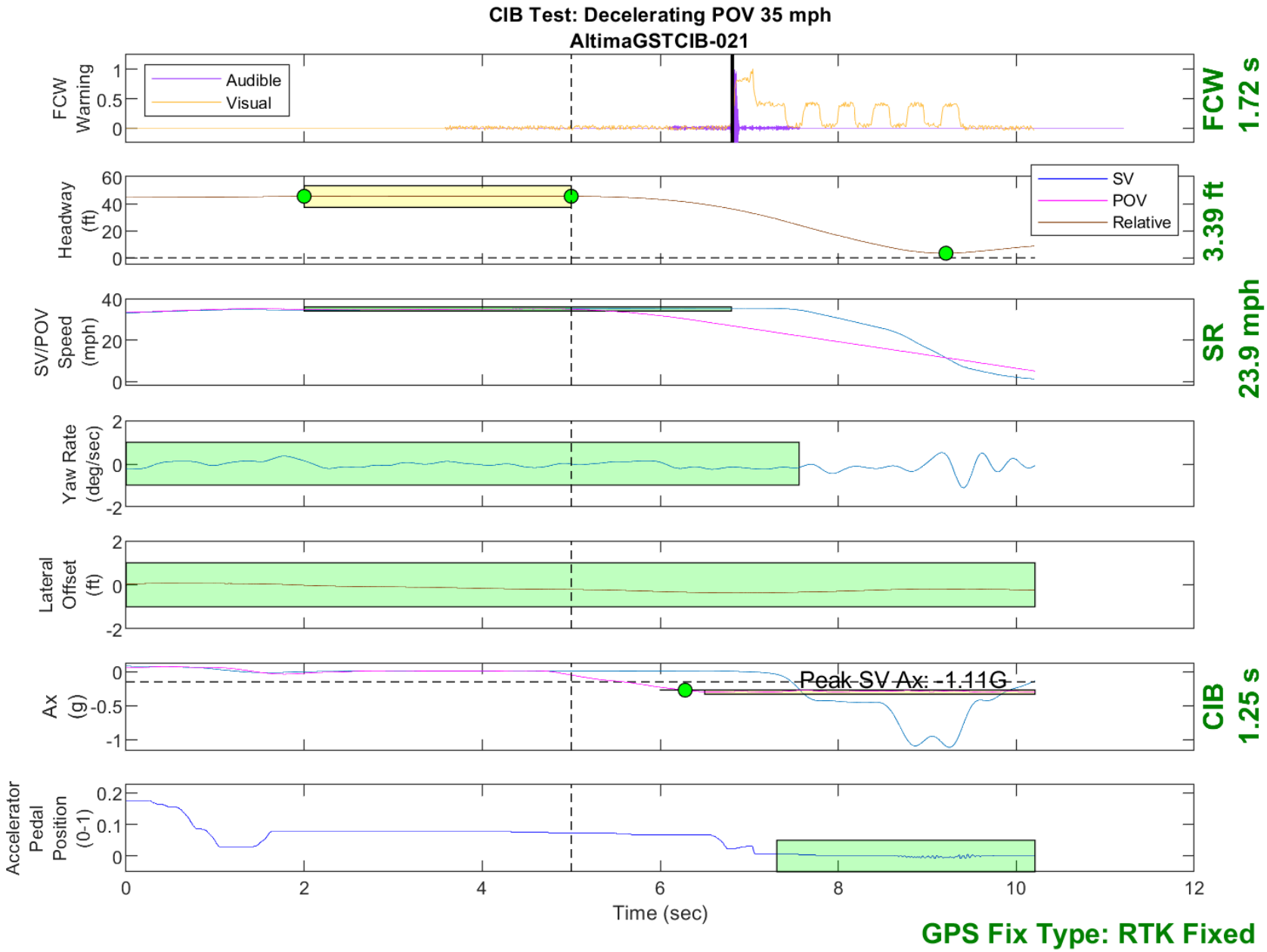


Figure D46. Time History for CIB Run 21, Decelerating POV, 35 mph 0.3g

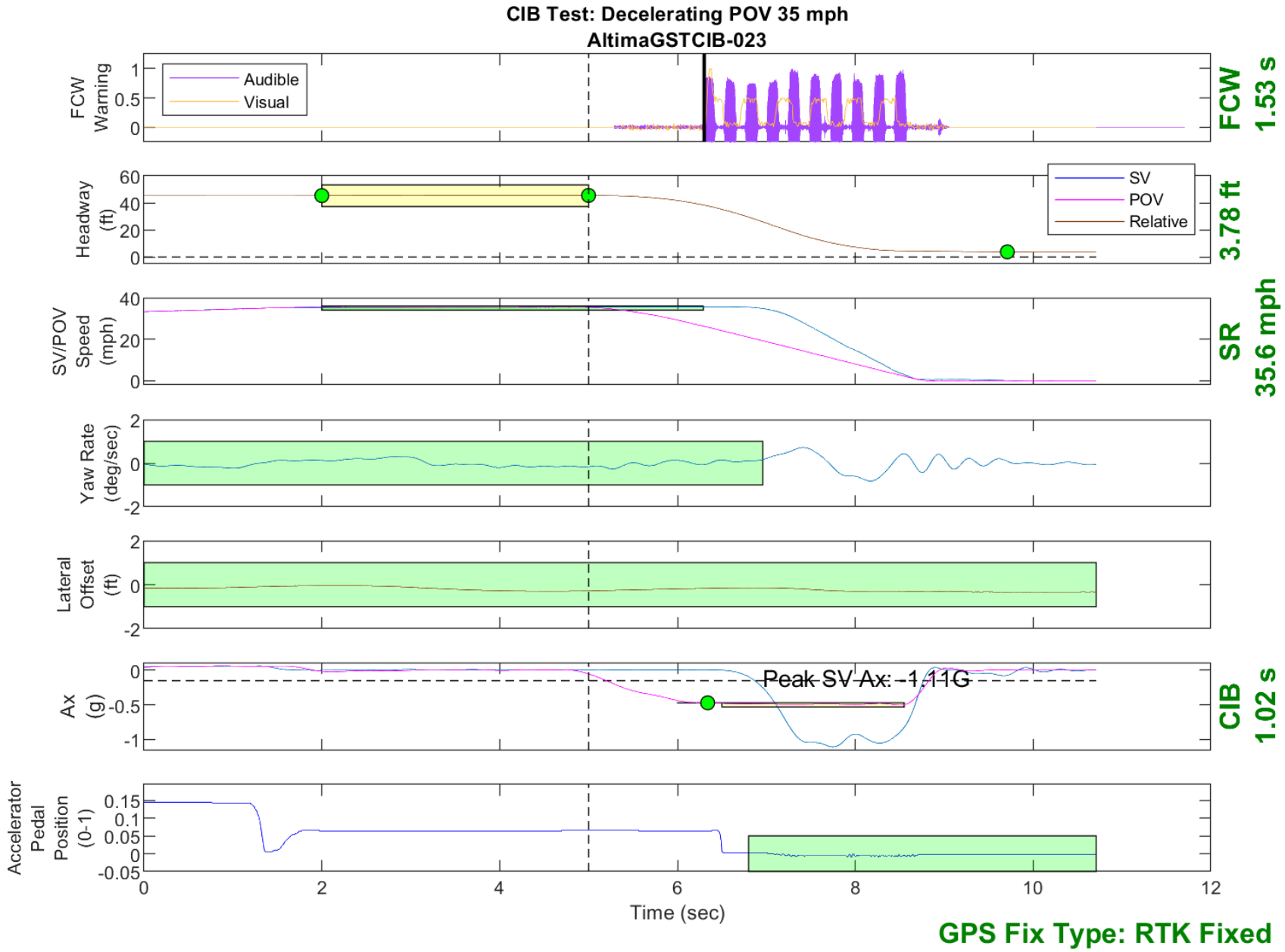


Figure D47. Time History for CIB Run 23, Decelerating POV, 35 mph 0.5g

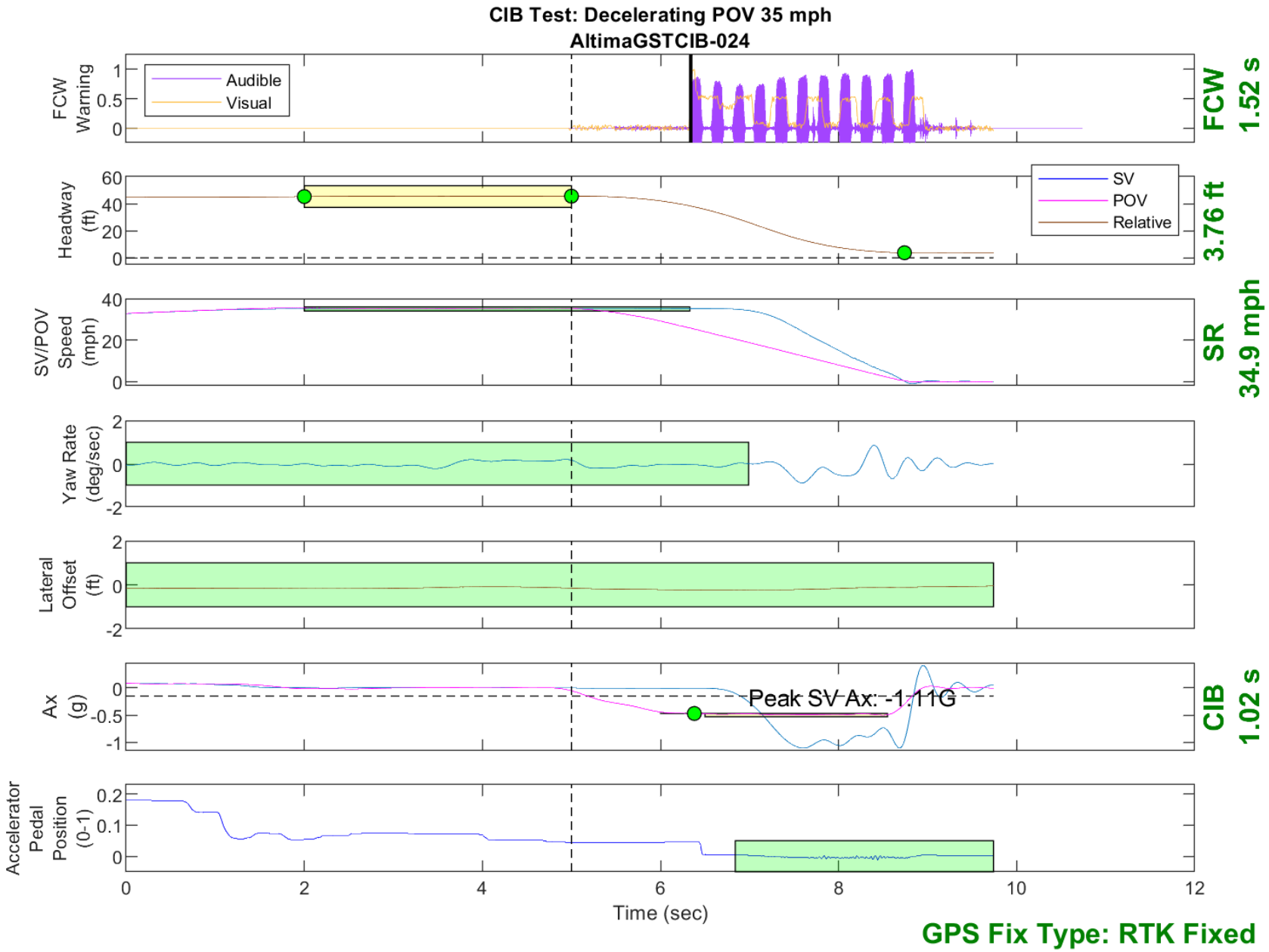


Figure D48. Time History for CIB Run 24, Decelerating POV, 35 mph 0.5g

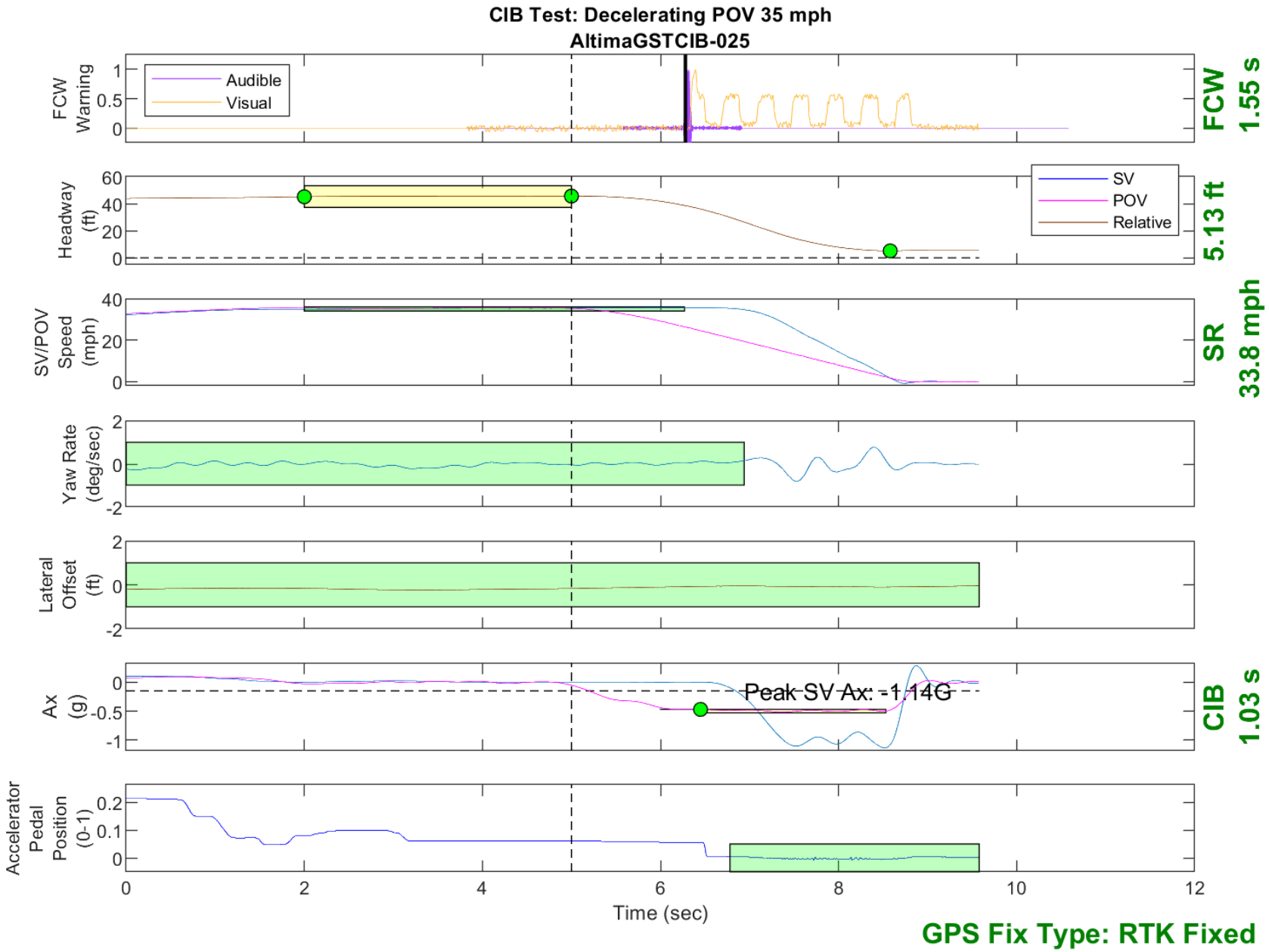


Figure D49. Time History for CIB Run 25, Decelerating POV, 35 mph 0.5g

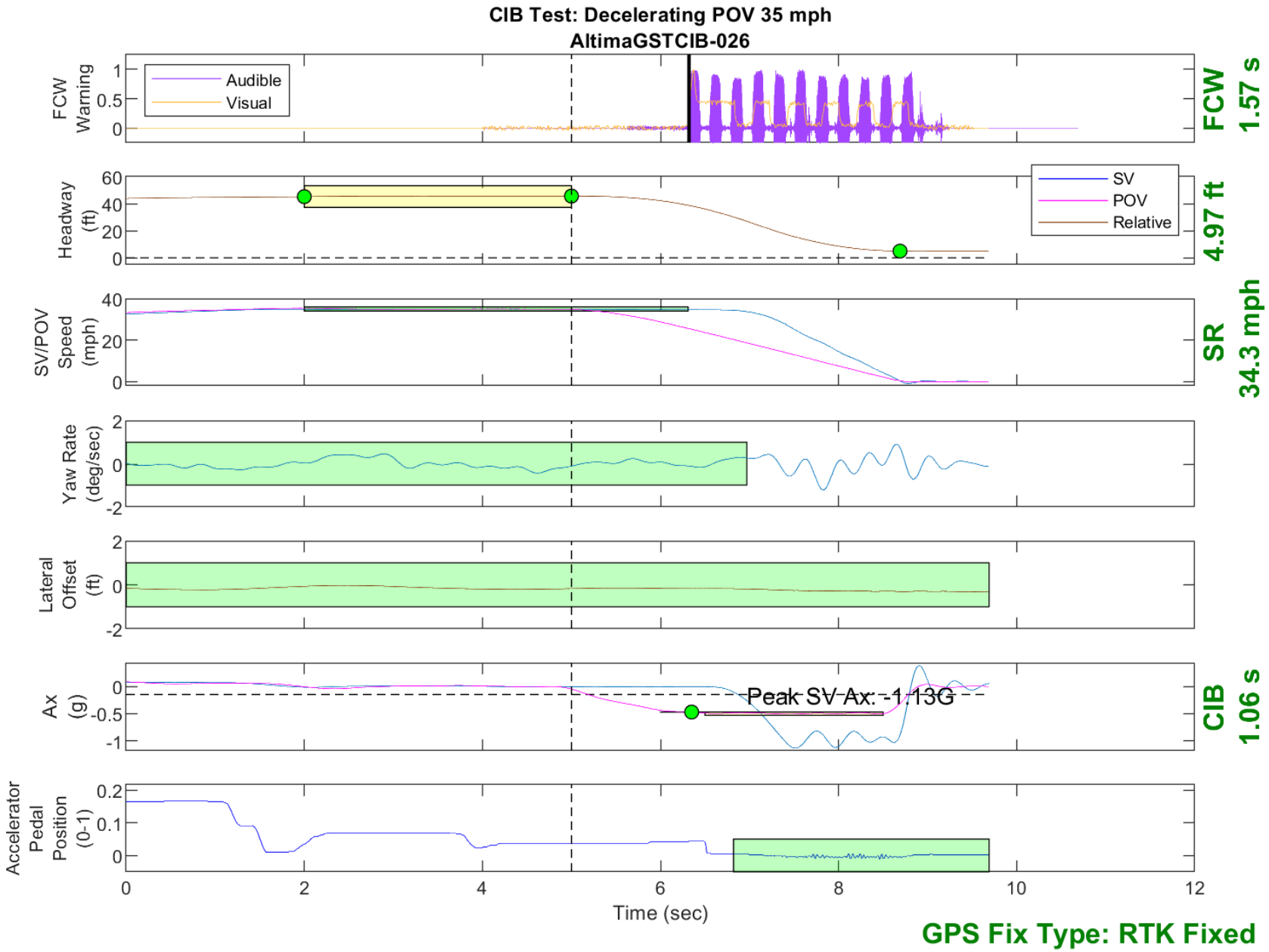


Figure D50. Time History for CIB Run 26, Decelerating POV, 35 mph 0.5g

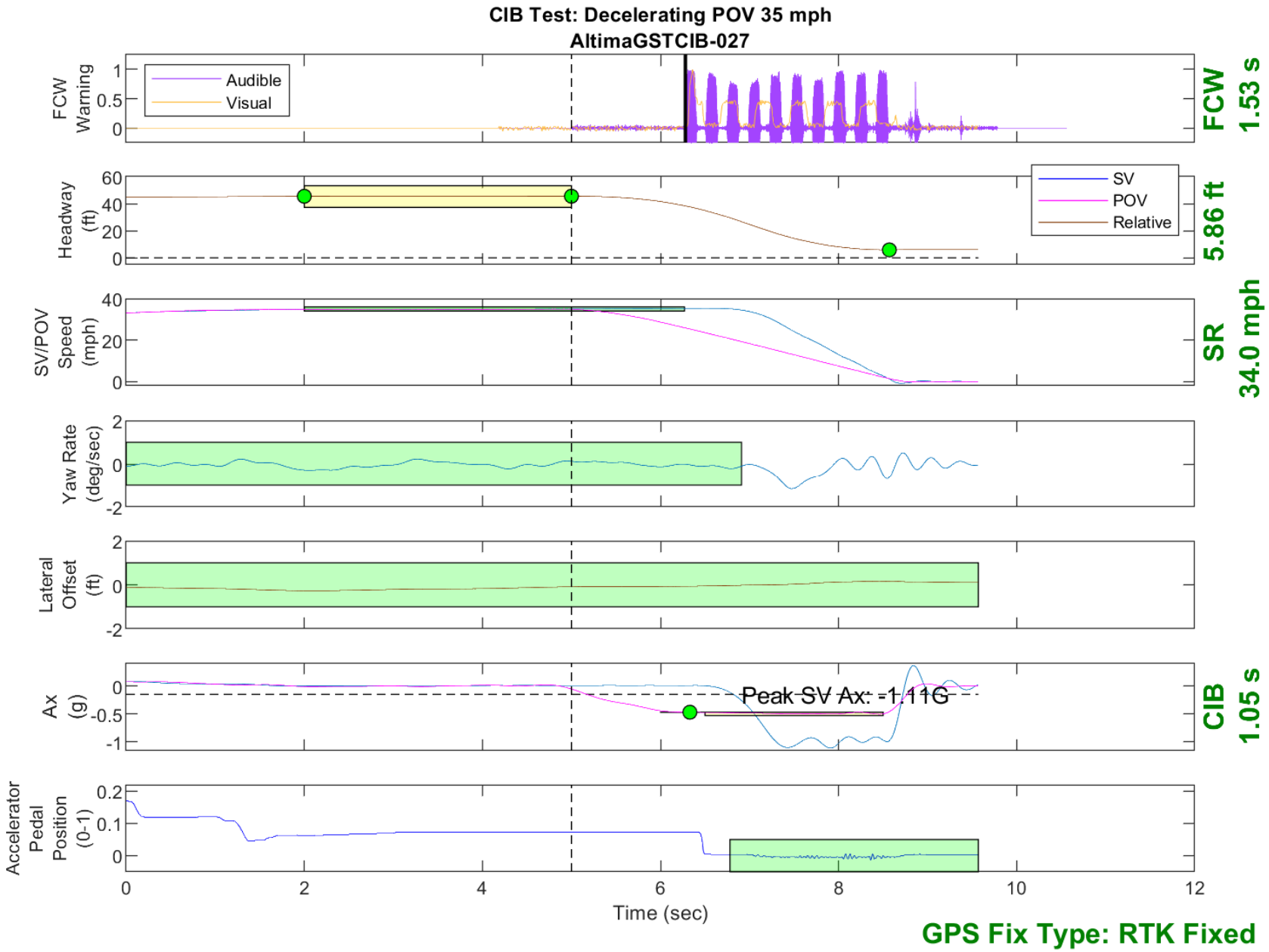


Figure D51. Time History for CIB Run 27, Decelerating POV, 35 mph 0.5g

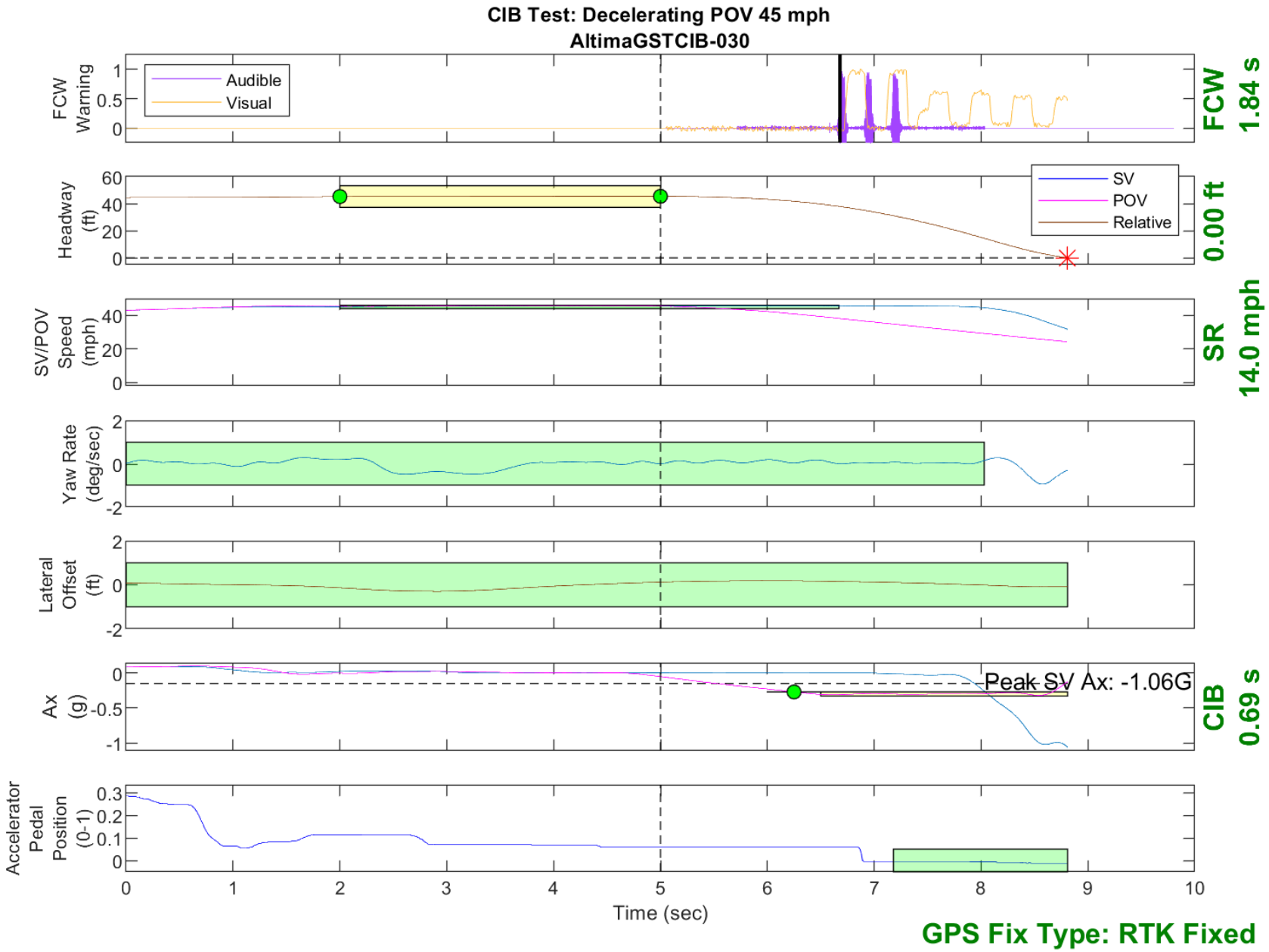


Figure D52. Time History for CIB Run 30, Decelerating POV, 45 mph 0.3g

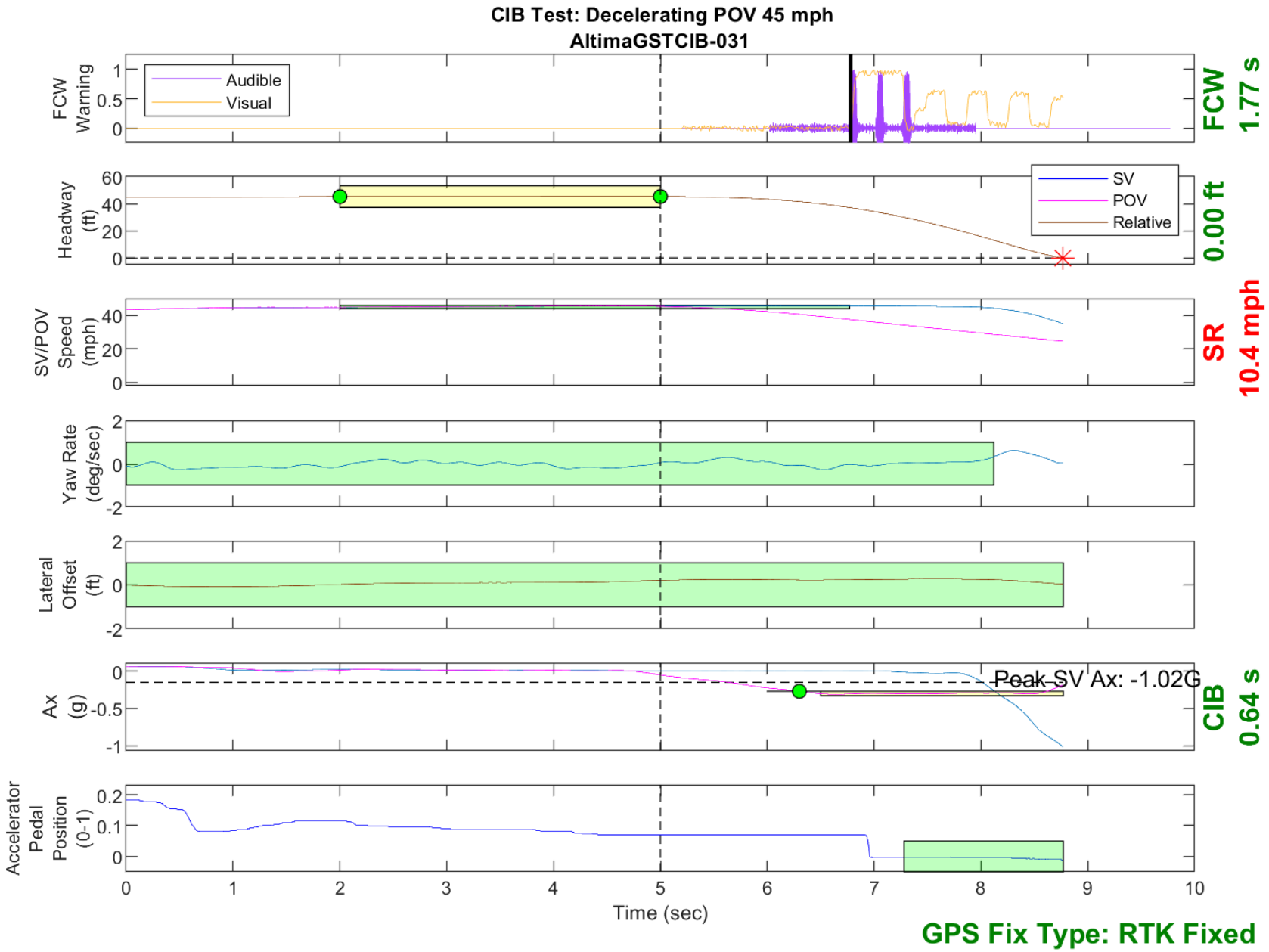


Figure D53. Time History for CIB Run 31, Decelerating POV, 45 mph 0.3g

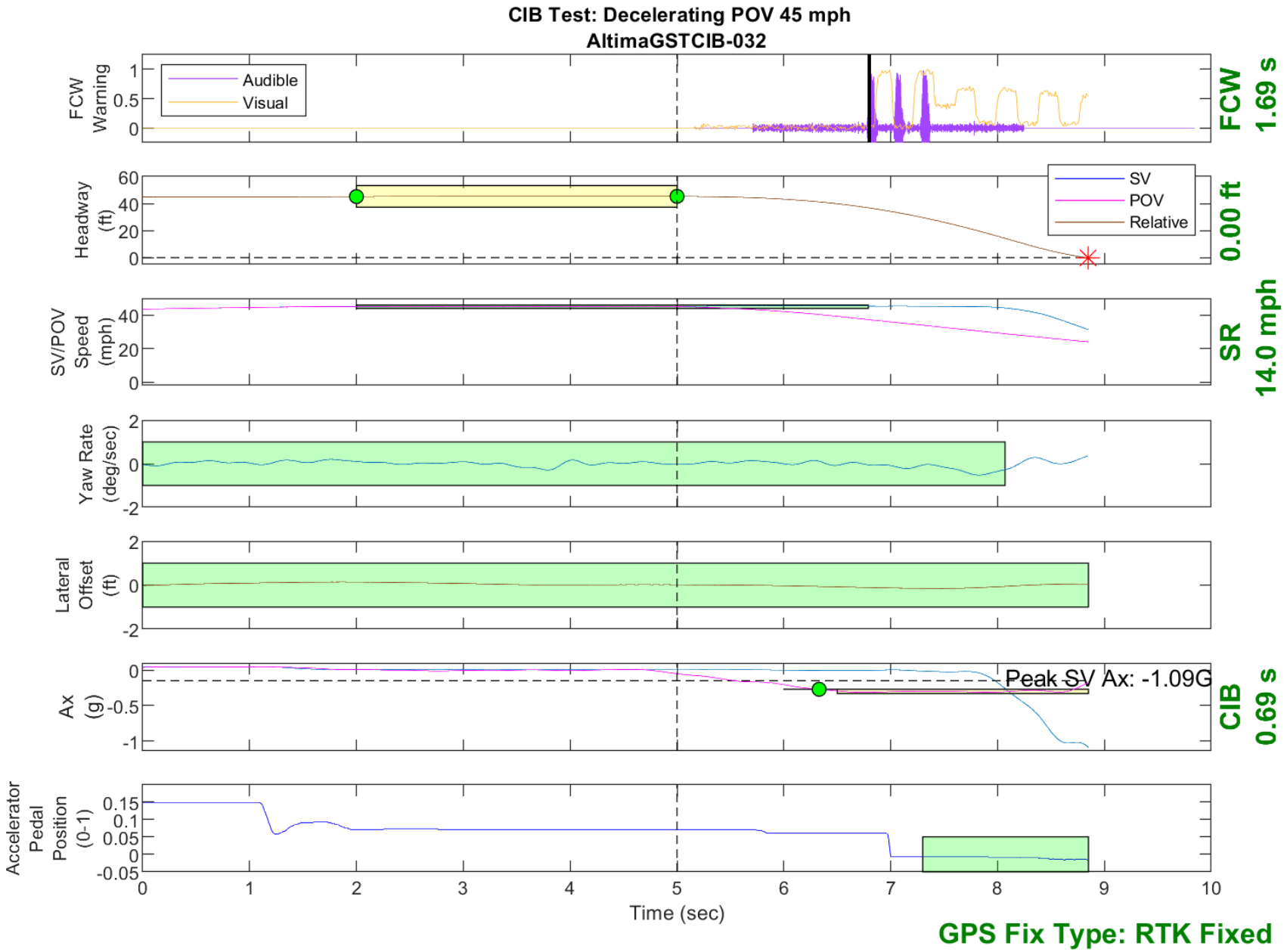


Figure D54. Time History for CIB Run 32, Decelerating POV, 45 mph 0.3g

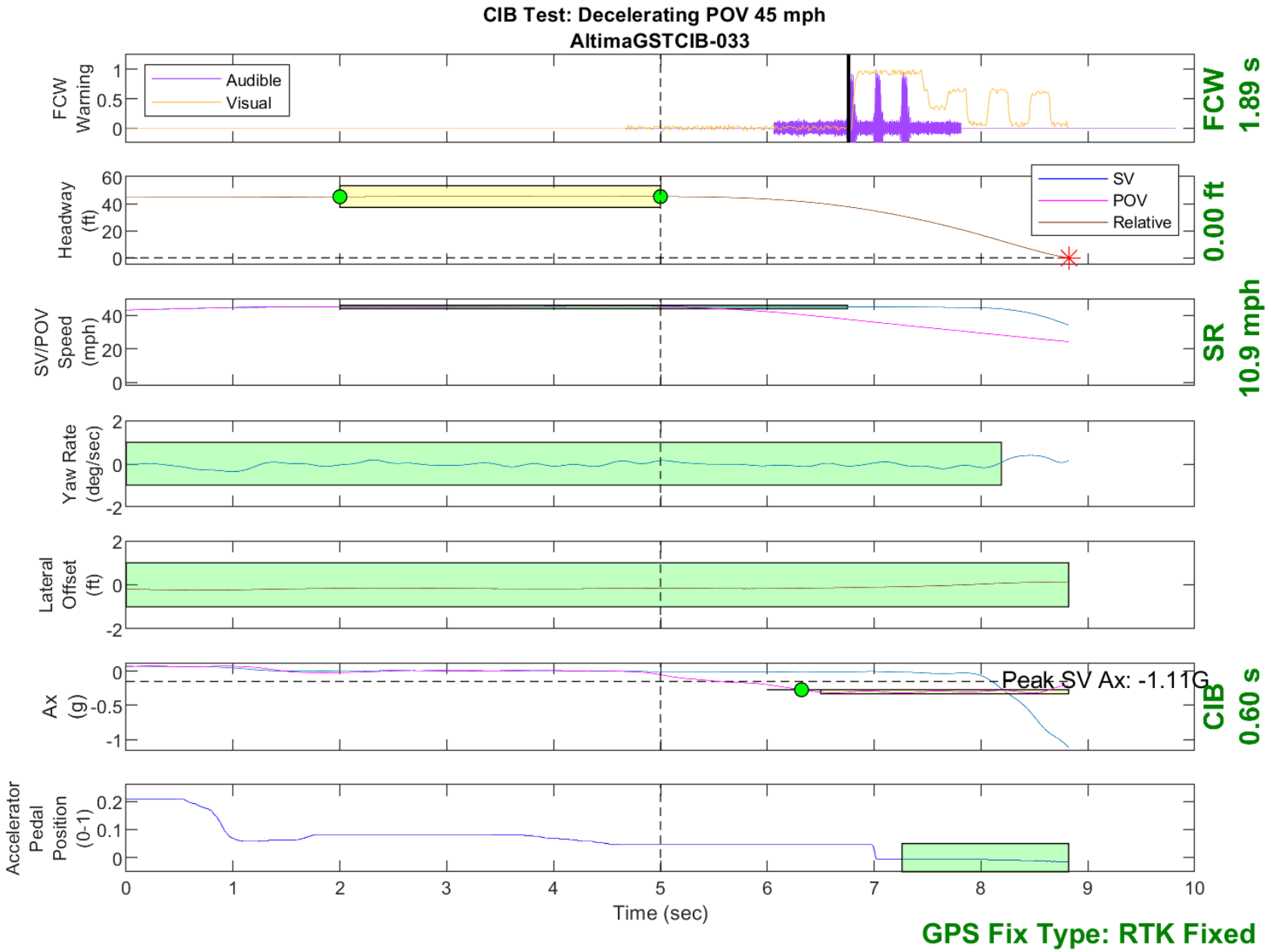


Figure D55. Time History for CIB Run 33, Decelerating POV, 45 mph 0.3g

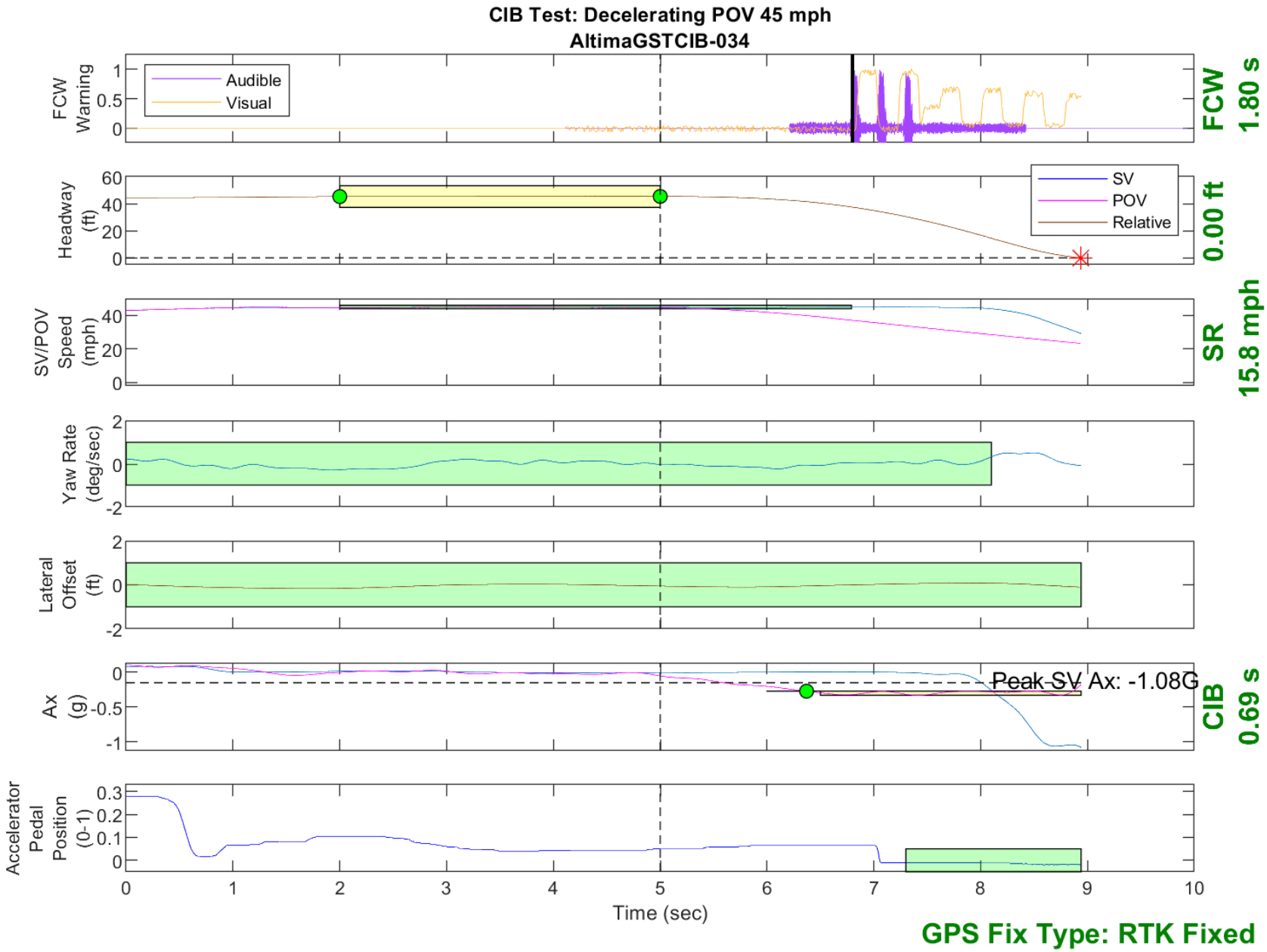


Figure D56. Time History for CIB Run 34, Decelerating POV, 45 mph 0.3g