NEW CAR ASSESSMENT PROGRAM
CRASH IMMINENT BRAKING SYSTEM CONFIRMATION TEST
NCAP-DRI-CIB-20-04

2020 Honda Odyssey EX-L

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13 May 2020

Final Report

Prepared Under Contract No. DTNH22-14-D-00333

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
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16. Abstract These tests were conducted on the subject 2020 Honda Odyssey EX-L 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. The vehicle passed the requirements of the test for all four CIB test scenarios and all speeds.		
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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) to evaluate CIB performance on the test track[1] 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).

The purpose of the testing reported herein was to objectively quantify the performance of a Crash Imminent Braking system installed on a 2020 Honda Odyssey EX-L. This test is part of the New Car Assessment Program to assess Crash Imminent Braking Systems sponsored by the National Highway Traffic Safety Administration under Contract No. DTNH22-14-D-00333.

[1] NHTSA-2015-0006-0025; Crash Imminent Brake System Performance Evaluation for the New Car Assessment Program, October 2015.

Section II

DATA SHEETS

CRASH IMMINENT BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

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2020 Honda Odyssey EX-L

SUMMARY RESULTS

VIN: *5FNRL6H77LB05xxxx*

Test Date: *3/30/2020*

Crash Imminent Braking System setting: *Normal*

Test 1 – **Subject Vehicle Encounters Stopped Principal Other Vehicle**

SV 25 mph: *Pass*

Test 2 – **Subject Vehicle Encounters Slower Principal Other Vehicle**

SV 25 mph POV 10 mph: *Pass*

SV 45 mph POV 20 mph: *Pass*

Test 3 – **Subject Vehicle Encounters Decelerating Principal Other Vehicle**

SV 35 mph POV 35 mph: *Pass*

Test 4 – **Subject Vehicle Encounters Steel Trench Plate**

SV 25 mph: *Pass*

SV 45 mph: *Pass*

Overall: ***Pass***

Notes:

CRASH IMMINENT BRAKING

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2020 Honda Odyssey EX-L

TEST VEHICLE INFORMATION

VIN: *5FNRL6H77LB05xxxx*

Body Style: *Minivan* Color: *Platinum White Pearl*

Date Received: *3/16/2020* Odometer Reading: *38 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *HONDA MFG. OF ALABAMA, LLC*

Date of manufacture: *02/20*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard:	Front:	*235/60R18 103H*
	Rear:	*235/60R18 103H*
Recommended cold tire pressure:	Front:	*240 kPa (35 psi)*
	Rear:	*240 kPa (35 psi)*

TIRES

Tire manufacturer and model: *BRIDGESTONE TURANZA EL440*

Front tire designation: *235/60R18 103H*

Rear tire designation: *235/60R18 103H*

Front tire DOT prefix: *DOT 7X45 JB2*

Rear tire DOT prefix: *DOT 7X45 JB2*

CRASH IMMINENT BRAKING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2020 Honda Odyssey EX-L

GENERAL INFORMATION

Test date: *3/30/2020*

AMBIENT CONDITIONS

Air temperature: *22.2 C (72 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: *240 kPa (35 psi)*

Rear: *240 kPa (35 psi)*

CRASH IMMINENT BRAKING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2020 Honda Odyssey EX-L

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*616.9 kg (1360 lb)*	Right Front:	*596.0 kg (1314 lb)*
Left Rear:	*497.6 kg (1097 lb)*	Right Rear:	*478.1 kg (1054 lb)*
		Total:	*2188.6 kg (4825 lb)*

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

(Page 1 of 4)

2020 Honda Odyssey EX-L

Name of the CIB option, option package, etc.

Collision Mitigation Braking System (CMBS)

Type and location of sensors the system uses:

Fusion of radar and mono camera.

The radar sensor is located in the front grille and the front sensor camera is mounted to the interior side of the windshield, behind the rear view mirror.

System setting used for test (if applicable): *Normal*

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

5 km/h (3.1 mph) (Per manufacturer supplied information)

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

No upper limit (Per manufacturer supplied information)

Does the vehicle system require an initialization sequence/procedure? **X** Yes

____ No

If yes, please provide a full description.

Initial learning (or after ignition reset) is undertaken using a section of roadway with lane markers on both sides of the vehicle.

This procedure is needed only once before all the DBS/CIB testing.

Conditions:

- *Lane markers on both sides of the vehicle 100～300 m*
- *Solid or dashed lines*
- *100 m: Three round trips*
- *300 m: Two round trips*
- *3.5 m – 4.3 m between inner parts of the lines*
- *100 mm line width*
- *25 mph*

Will the system deactivate due to repeated CIB activations, impacts, or near-misses?

X Yes

___ No

If yes, please provide a full description.

Yes, CMBS indicator in Multi-Information Display comes on if deactivated.

To avoid deactivation, turn off the ignition switch after every test and the camera calibration before every test.

How is the Forward Collision Warning system alert presented to the driver?

(Check all that apply)

X Warning light

X Buzzer or audible alarm

X 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.

Visual alert:

Location, size: Multi-Information Display in the instrument panel. Please see the Owner's Manual, Page 114 in Appendix B, Page B-6 and also Appendix A, Figure A17.

Color: Orange

Words "BRAKE"

Flashes On/Off

Audible: Repeated beep

Vibration: Steering wheel vibration for oncoming detected vehicles.

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.

A push button located to the left of the steering column can be used to deactivate CMBS (Appendix A, Figure A18).

Press and hold the button until the beeper sounds to switch the system on or off.

When the CMBS is off:

- *The CMBS indicator in the instrument panel comes on.*
- *A message on the driver information interface indicates that the system is off.*

The CMBS is turned on every time the vehicle is started, even if it was disabled during the previous ignition cycle.

Is the vehicle equipped with a control whose purpose is to adjust the range setting or otherwise influence the operation of CIB? **X** Yes

_____ No

If yes, please provide a full description.

The system settings are accessed through a touch screen in the center of the console(Appendix A, Figures A15 and A16). The menu hierarchy is:

Settings

Vehicle

Driver Assist System Setup

Forward Collision Warning Distance

Select distance: Long/Normal/Short

2020 Honda Odyssey EX-L

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.

The system limitations are described in the Owner's Manual, Pages 619 through 623. These pages are reproduced in Appendix B, Pages B-12 through B-16.

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

Four 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

Test 4. Subject Vehicle Encounters Steel Trench Plate

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.

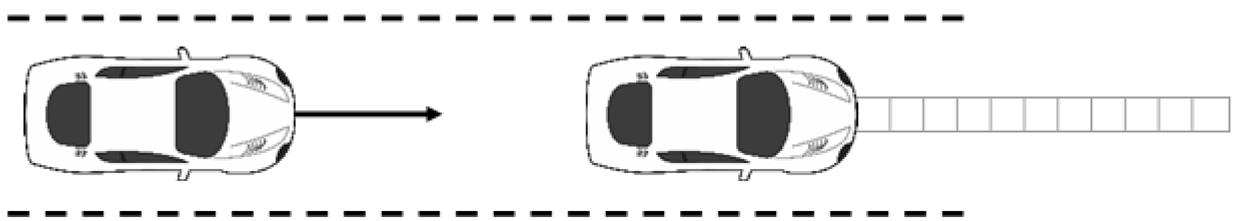


Figure 1. Depiction of Test 1

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 SV was driven at a nominal speed of 25 mph (40.2 km/h) 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}. For this test, TTC = 5.1 seconds is taken to occur at an SV-to-POV distance of 187 ft (57 m).

b. Criteria

In order to pass the test, the magnitude of the SV speed reduction attributable to CIB intervention must have been ≥ 9.8 mph (15.8 km/h) for at least five of seven 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 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. <u>TEST 2 – SUBJECT VEHICLE ENCOUNTERS SLOWER PRINCIPAL OTHER VEHICLE</u>

- 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.

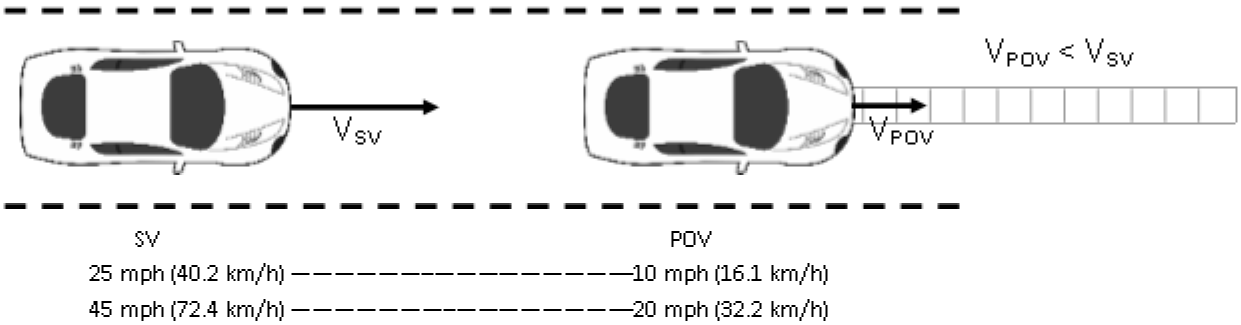


Figure 2. Depiction of Test 2

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 passing was that there be no SV-POV impact for at least five of the seven valid test trials.

In order to pass 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 five of seven 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-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 in Figure 3.

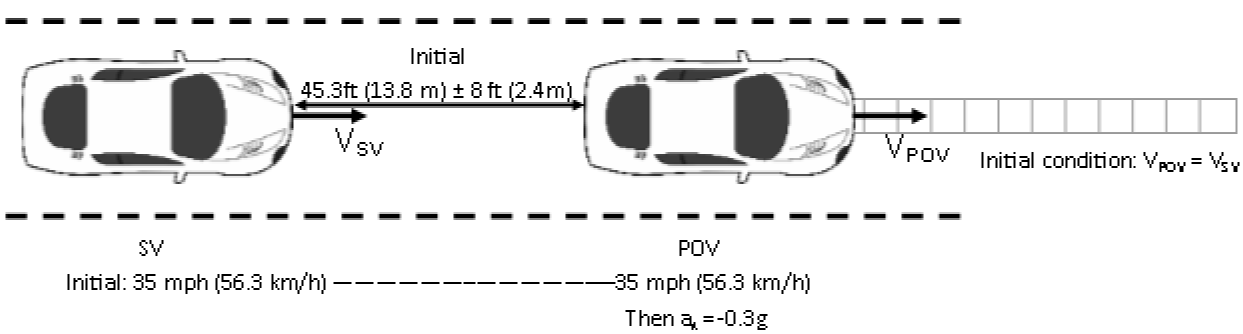


Figure 3. Depiction of Test 3 with POV Decelerating

a. Procedure

The SV ignition was cycled prior to each test run. For this test scenario, both the POV and SV were driven at a constant 35.0 mph (56.3 km/h) 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, the POV tow vehicle brakes were applied to achieve 0.3 ± 0.03 g of deceleration. The test concluded when either:

- The SV came into contact with the POV or
- For the decelerating POV, 1 second after minimal longitudinal SV-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 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

In order to pass the decelerating POV test series, the magnitude of the SV speed reduction attributable to CIB intervention must have been ≥ 10.5 mph (16.9 km/h) for at least five of seven 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 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}.

4. TEST 4 – FALSE POSITIVE SUPPRESSION

The false positive suppression test series evaluates the ability of a CIB system to differentiate a steel trench plate (STP) from an object presenting a genuine safety risk to the SV. Although the STP is large and metallic, it is designed to be driven over without risk of injury to the driver or damage to the SV. Therefore, in this scenario, the automatic braking available from CIB is not necessary and should be suppressed. The test condition is nearly equivalent to that previously defined for Test 1, the stopped POV condition, but with an STP in the SV forward path in lieu of a POV.

a. Procedure

This test was conducted at two speeds, 25 mph (40.2 km/h) and 45 mph (72.4 km/h). The SV was driven directly towards, and over, the STP, which was positioned in the center of a travel lane, with its longest sides parallel to the road edge.

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} where:
    - For SV test speed of 25 mph, TTC = 5.1 seconds is taken to occur at an SV-to-STP distance of 187 ft (57 m).
    - For SV test speed of 45 mph, TTC = 5.1 seconds is taken to occur at an SV-to-STP distance of 337 ft (106 m).
- If the SV did not present an FCW alert before the end of the validity period, SV speed could not deviate more than ±1.0 mph (±1.6 km/h) from TTC = 5.1 s to the end of the validity period.

If an FCW alert was presented, the driver released the throttle pedal within 500 ms of the alert. If no alert was presented, the driver did not release the throttle pedal until the end of the validity period. The SV driver then braked to a stop.

b. Criteria

In order to pass the False Positive test series, the magnitude of the SV deceleration reduction attributable to CIB intervention must have been ≤ 0.50 g for at least five of seven valid test trials.

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 haptic or audible, 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 1.

Table 1. 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 or STP.
- 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 0.25g.
- 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 or STP 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

Test 4: When the SV-to-STP TTC = 5.1 seconds

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-POV distance occurred.

Test 4: At the instant the front-most part of SV reached a vertical plane defined by the leading edge of the STP first encountered by the SV (i.e., just before it was driven onto the STP).

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, POV, and POV moving platform and tow vehicle were centered in the same travel lane with the same orientation (i.e., facing the same direction). For Test 4, the SV and STP were centered in the same travel lane.

For Tests 1, 2, and 3, the SV was positioned such that it just contacted a vertical plane that defines the rearmost location of the POV. For Test 4, the front-most location of the SV was positioned such that it just reached a vertical plane defined by the leading edge of the STP first encountered by the SV (i.e., just before it is driven onto the STP). 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 seven (7) valid trials were performed for each scenario. In cases where the test driver performed more than seven trials, the first seven 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 NHTSA developed Strikeable Surrogate Vehicle (SSV).

This SSV system was designed specifically for common rear-end crash scenarios which AEB systems address. The key components of the SSV system are:

- A POV shell which is a visually and dimensionally accurate representation of a passenger car.
- A slider and load frame assembly to which the shell is attached.
- A two-rail track on which the slider operates.
- A road-based lateral restraint track.
- A tow vehicle.

The key requirements of the POV element are to:

- Provide an accurate representation of a real vehicle to DBS 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 35 mph (56 km/h).
- Accurately control the lateral position of the POV within the travel lane.
- Allow the POV to move away from the SV after an impact occurs.

Operationally, the POV shell is attached to the slider and load frame which includes rollers that allows the entire assembly to move longitudinally along the guide rail. The guide rail is coupled to a tow vehicle and guided by the lateral restraint track secured to the test track surface. The rail includes a provision for restraining the shell and roller assembly in the ward direction. In operation, the shell and roller assembly engage the rail assembly through detents to prevent relative motion during run-up to test speeds and deceleration of the tow vehicle. The combination of rearward stops and forward motion detents allows the test conditions, such as relative POV-SV headway distance, speed, etc., to be achieved and adjusted as needed in the preliminary part of a test. If during the test, the SV strikes the rear of the POV shell, the detents are overcome and the entire shell/roller assembly moves forward in a two-stage manner along the rail and away from the SV. The forward end of the rail has a cushioned stop to restrain forward motion of the shell/roller assembly. After impacting the SSV, the SV driver uses the steering wheel to maintain SV position in the center of the travel lane, thereby straddling the two-rail track. The SV driver must manually apply the SV brakes after impact. The SSV system is shown in Figures A6 through A8 and a detailed description can be found in the NHTSA report: NHTSA'S STRIKEABLE SURROGATE VEHICLE PRELIMINARY DESIGN+OVERVIEW, May 2013.

D. Automatic Braking System

The POV was equipped with an automatic braking system, which was used in Test 3. The braking system consisted of the following components:

- Electronically controlled linear actuator, mounted on the seat rail and attached to the brake pedal. The actuator can be programmed for control of stroke and rate.
- PC module programmed for control of the stroke and rate of the linear actuator.
- Switch to activate actuator.

In some cases, the subject vehicle is also equipped with an automatic braking system (E-brake) for the purpose of slowing the subject vehicle 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.

E. Instrumentation

Table 2 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

Table 2. 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
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 +		By: Oxford Technical Solutions
					2258	Date: 5/3/2019 Due: 5/3/2021
					2176	Date: 4/11/2018 Due: 4/11/2020

Table 2. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
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
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
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)

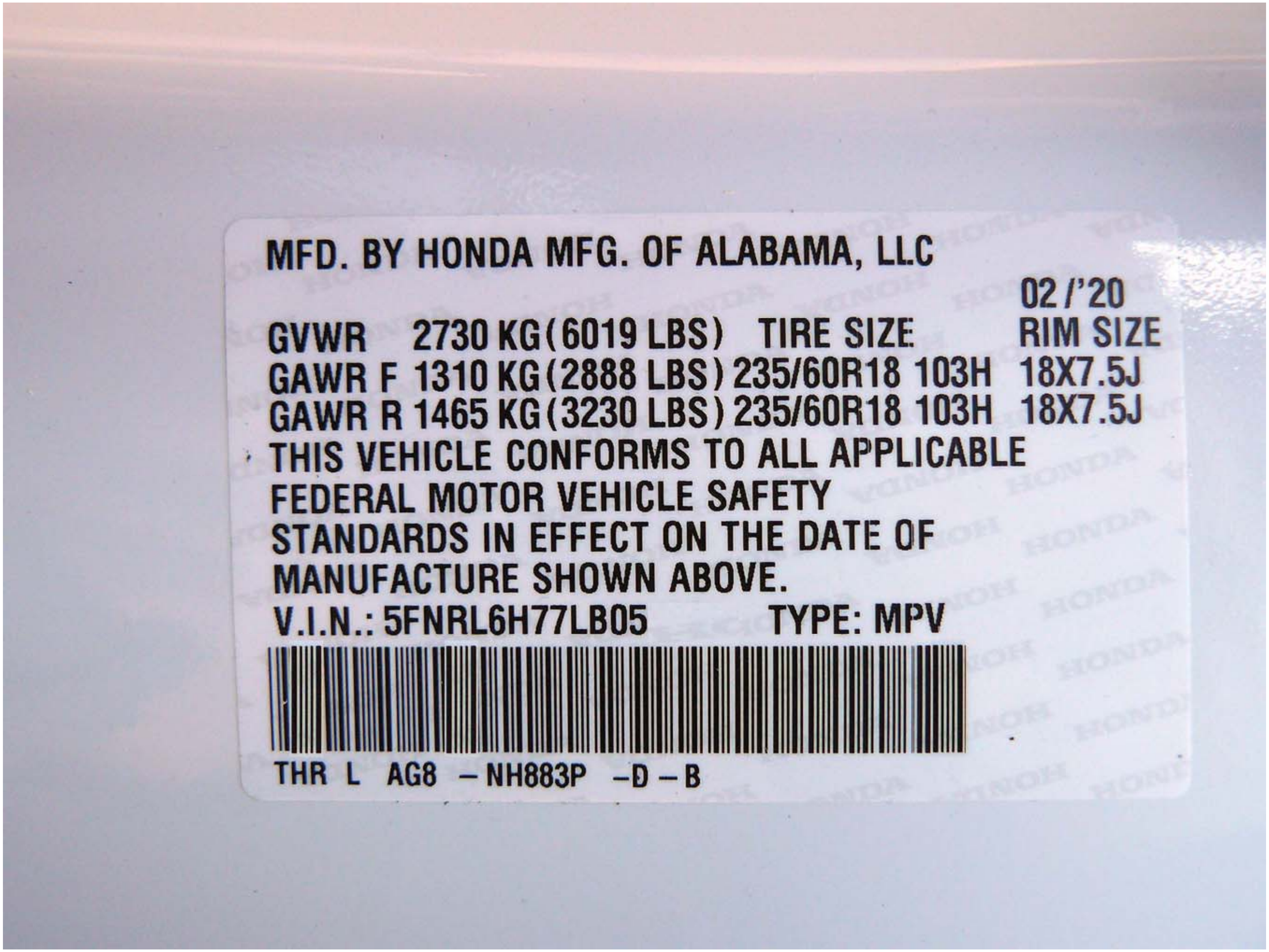


Figure A4. Vehicle Certification Label

Figure A5. Tire Placard

Figure A6. Rear View of Principal Other Vehicle (SSV)

Figure A7. Load Frame/Slider of SSV

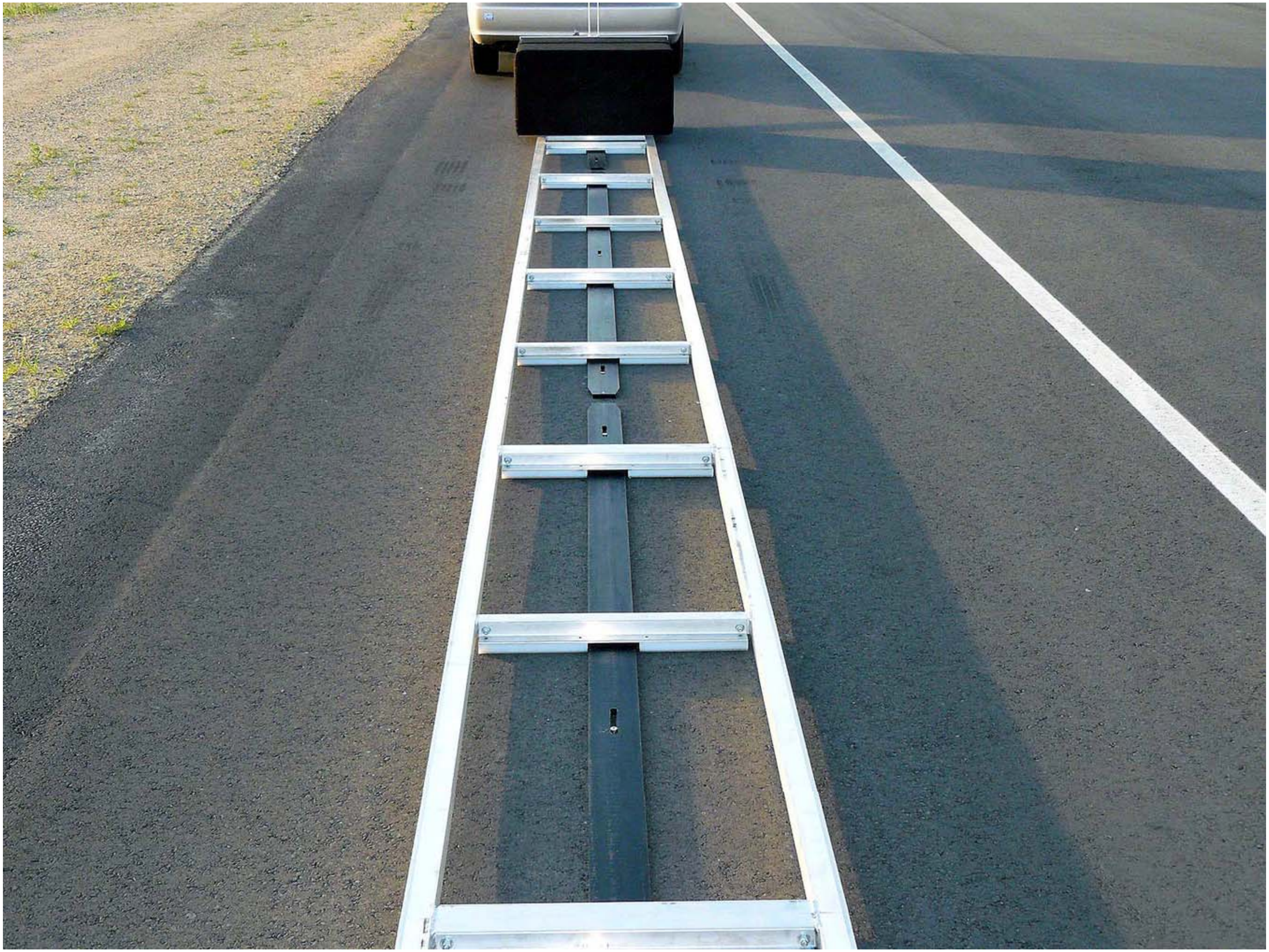


Figure A8. Two-Rail Track and Road-Based Lateral Restraint Track

Figure A9. Steel Trench Plate

Figure A10. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A11. Sensor for Detecting Auditory Alerts

Figure A12. Sensor for Detecting Visual Alerts

Figure A13. Computer Installed in Subject Vehicle

Figure A14. Brake Actuator Installed in POV System

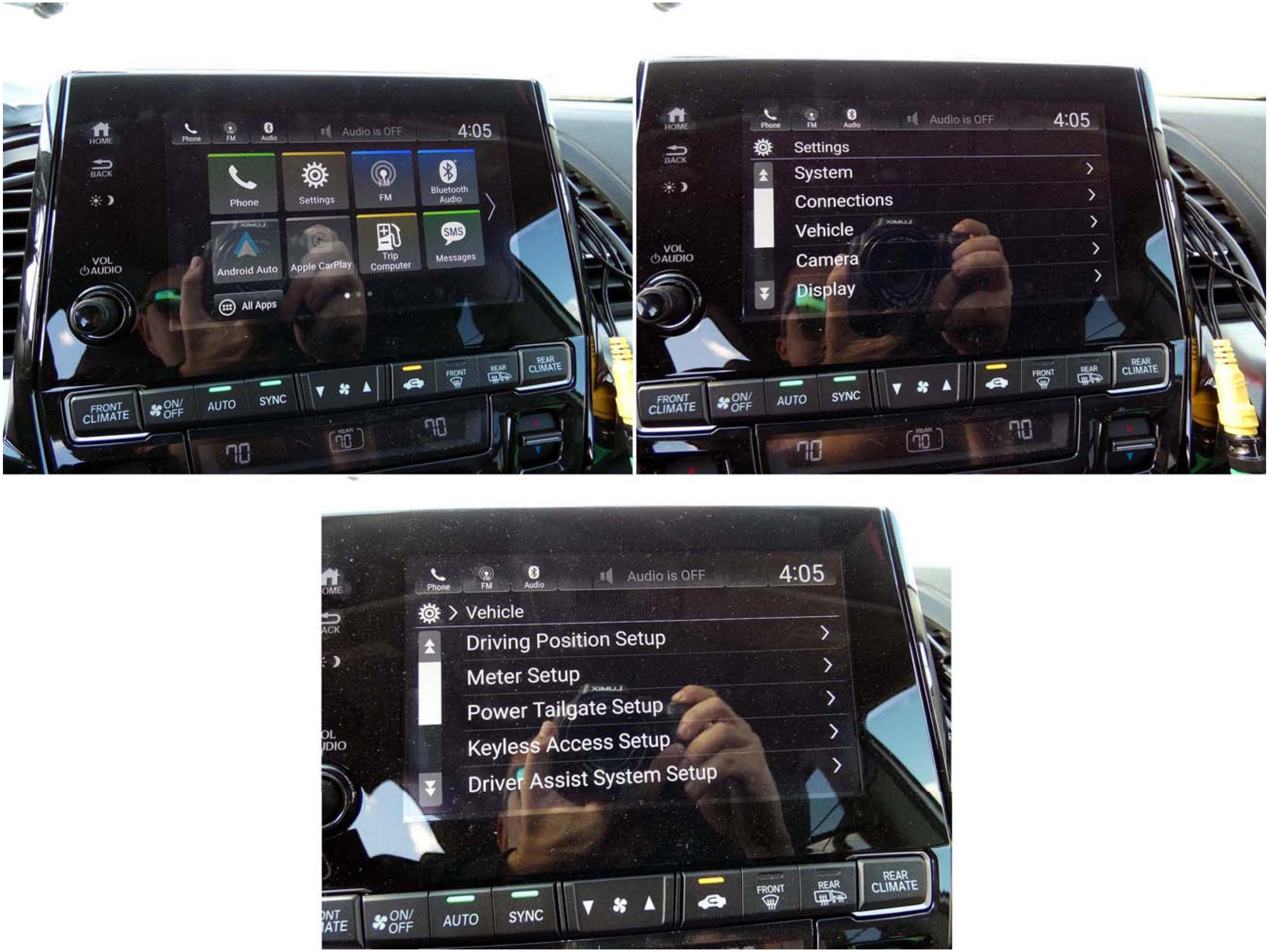


Figure A15. CMBS (AEB) Setup Menus (1/2)

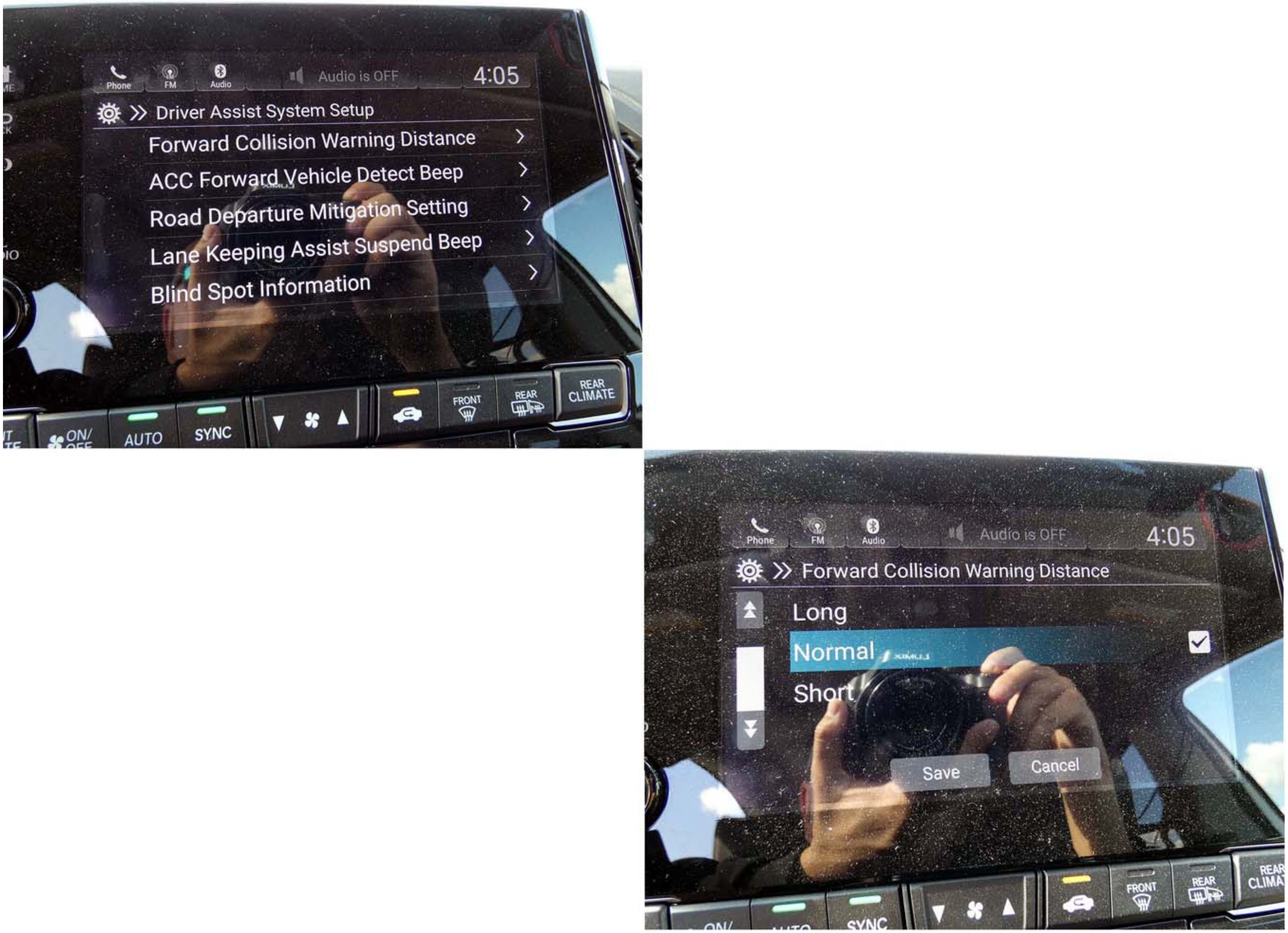


Figure A16. CMBS (AEB) Setup Menus (2/2)

Figure A17. CMBS (AEB) Visual Alert Shown as Inset in Out-the-Window View

Figure A18. CMBS (AEB) On/Off Switch

APPENDIX B

Excerpts from Owner’s Manual

Instrument Panel P. 83

Gauges P. 119/Driver Information Interface P. 120/System Indicators P. 84

System Indicators

- Malfunction Indicator Lamp
- Charging System Indicator
- Electric Power Steering (EPS) System Indicator
- Low Fuel Indicator
- Vehicle Stability Assist™ (VSA®) System Indicator
- VSA® **OFF** Indicator
- Automatic Brake Hold System Indicator
- Automatic Brake Hold Indicator (U.S. / Canada)
- Parking Brake and Brake System Indicator (Amber) (U.S. / Canada)
- Anti-lock Brake System (**ABS**) Indicator
- Blind spot information System Indicator*

M (Sequential mode) Indicator/ Sequential Mode Gear Selection Indicator

Temperature Gauge

Tachometer

Speedometer

Gear Position Indicator/ Transmission System Indicator

Driver Information Interface

Fuel Gauge

Immobilizer System Indicator/ Security System Alarm Indicator

System Indicators

- Lane Keeping Assist System (**LKAS**) Indicator (Green/ Amber)*
- Adaptive Cruise Control (**ACC**) Indicator (Green/ Amber)*

Lights Indicators

- Lights On Indicator
- High Beam Indicator
- Fog Light Indicator*
- Auto High-Beam Indicator*

System Indicators

- Turn Signal and Hazard Warning Indicators
- Low Tire Pressure/TPMS Indicator
- Parking Brake and Brake System Indicator (Red) (U.S. / Canada)
- Seat Belt Reminder Indicator
- Supplemental Restraint System Indicator
- **CRUISE MAIN** Indicator*
- **CRUISE CONTROL** Indicator*
- Econ Mode Indicator
- Auto Idle Stop System Indicator (Amber)/ Auto Idle Stop Indicator (Green)
- **Snow** Mode Indicator
- **Normal** Mode Indicator
- System Message Indicator
- Road Departure Mitigation (RDM) Indicator*
- Collision Mitigation Braking System™ (CMBS™) Indicator*

* Not available on all models

VSA® On and Off P. 597

- The Vehicle Stability Assist™ (VSA®) system helps stabilize the vehicle during cornering, and helps maintain traction while accelerating on loose or slippery road surfaces.
- VSA® comes on automatically every time you start the engine.
- To partially disable or fully restore VSA® function, press and hold the button until you hear a beep.

Cruise Control* P. 566

- Cruise control allows you to maintain a set speed without keeping your foot on the accelerator pedal.
- To use cruise control, press the **CRUISE** button, then press the **–/SET** button once you have achieved the desired speed (above 25 mph or 40 km/h).

CMBS™ On and Off*

P. 618

- When a possible collision is likely unavoidable, the CMBS™ can help you to reduce the vehicle speed and the severity of the collision.
- The CMBS™ is turned on every time you start the engine.
- To turn the CMBS™ on or off, press and hold the button until you hear a beep.

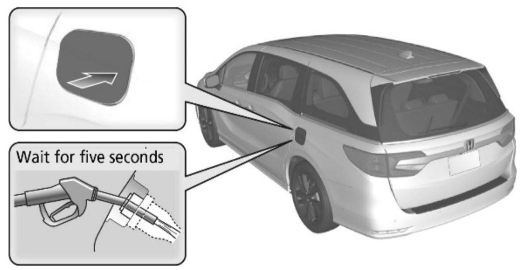
Tire Pressure Monitoring System (TPMS) with Tire Fill Assist P. 599, 726

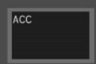
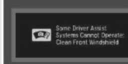
- The TPMS monitors tire pressure.
- TPMS is turned on automatically every time you start the engine.
- TPMS fill assist provides audible and visual guidance during tire pressure adjustment.

Refueling P. 637

Fuel recommendation: Unleaded gasoline, pump octane number 87 or higher
Fuel tank capacity: 19.5 US gal (73.8 L)

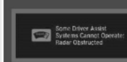
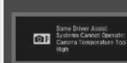
1. Unlock the driver's door.
   Locking/Unlocking the Doors from the Inside P. 156
2. Press firmly and then release the area indicated by the arrow to release the fuel filler door.
3. After refueling, wait for about five seconds before removing the filler nozzle.



Indicator	Name	On/Blinking	Explanation	Message
	Adaptive Cruise Control (**ACC**) Indicator (Green)*	• Comes on when the area around the camera is blocked by dirt, mud, etc. Stop your vehicle in a safe place, and wipe it off with a soft cloth. • May come on when driving in bad weather (rain, snow, fog, etc.)	• Have your vehicle checked by a dealer if the indicator and message come back on after you cleaned the area around the camera.	
	Collision Mitigation Braking System™ (CMBS™) Indicator*	• Comes on for a few seconds when you change the power mode to ON, then goes off. • Comes on when you deactivate the CMBS™. A driver information interface message appears for five seconds. • Comes on if there is a problem with the CMBS™.	• **Stays on constantly without the CMBS™ off** - Have your vehicle checked by a dealer. **Collision Mitigation Braking System™ (CMBS™)*** P. 615	 

Instrument Panel

* Not available on all models

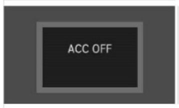
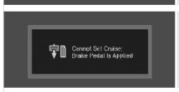
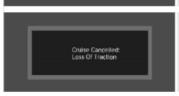
Indicator	Name	On/Blinking	Explanation	Message
	Collision Mitigation Braking System™ (CMBS™) Indicator*	• Comes on when the CMBS™ system shuts itself off.	• **Stays on** - The area around the camera is blocked by dirt, mud, etc. Stop your vehicle in a safe place, and wipe it off with a soft cloth. **Front Sensor Camera*** P. 569	
			• When the radar sensor gets dirty, stop your vehicle in a safe place, and wipe off dirt using a soft cloth. Indicator may take some time to go off after the radar sensor is cleaned. • Have your vehicle checked by a dealer if the indicator does not go off even after you clean the sensor cover. **Collision Mitigation Braking System™ (CMBS™)*** P. 615	
			• **Stays on** - The temperature inside the camera is too high. Use the climate control system to cool down the camera. The system activates when the temperature inside the camera cools down. **Front Sensor Camera*** P. 569	

* Not available on all models

Models with remote engine starter

Message	Condition	Explanation
	• Appears when you unlock and open the driver's door while the engine is running by remote engine start.	➲ **Remote Engine Start with Vehicle Feedback*** P. 544

Models with ACC

Message	Condition	Explanation
	• Flashes when the system senses a likely collision with a vehicle in front of you.	• Take the appropriate means to prevent a collision (apply the brakes, change lanes, etc.) ➲ **Collision Mitigation Braking System™ (CMBS™)*** P. 615 ➲ **Adaptive Cruise Control (ACC)*** P. 571
	• Appears when ACC has been automatically canceled.	• You can resume the set speed after the condition that caused ACC to cancel improves. Press the **RES/+** button. ➲ **Adaptive Cruise Control (ACC)*** P. 571
	• Appears when pressing the **–/SET** button while the vehicle is moving and the brake pedal is depressed.	• ACC cannot be set. ➲ **Adaptive Cruise Control (ACC)*** P. 571
	• Appears if the VSA® or traction control function operates while ACC is in operation.	• ACC has been automatically canceled. ➲ **Adaptive Cruise Control (ACC)*** P. 571

 * Not available on all models

Setup Group	Customizable Features		Description	Selectable Settings
Vehicle	**Keyless Access Setup**	**Remote Start System On/Off**	Turns the remote engine start feature on and off.	**ON**[*1]/**OFF**
		Walk Away Auto Lock	Changes the settings for the automatic locking the doors when you walk away from the vehicle while carrying the remote.	**Enable**/**Disable**[*1]
	Driver Assist System Setup*	**Forward Collision Warning Distance**	Changes at which distance CMBS™ alerts.	**Long**/**Normal**[*1]/**Short**
		ACC Forward Vehicle Detect Beep	Causes the system to beep when the system detects a vehicle, or when the vehicle goes out of the ACC range.	**ON**/**OFF**[*1]
		Road Departure Mitigation Setting	Changes the setting for the road departure mitigation system.	**Normal**[*1]/**Wide**/**Warning Only**
		Lane Keeping Assist Suspend Beep	Causes the system to beep when the LKAS is suspended.	**ON**/**OFF**[*1]
		Blind Spot Information*	Changes the setting for the blind spot information system.	**Audible and Visual Alert**[*1]/**Visual Alert**/**OFF**

*1:Default Setting

Features

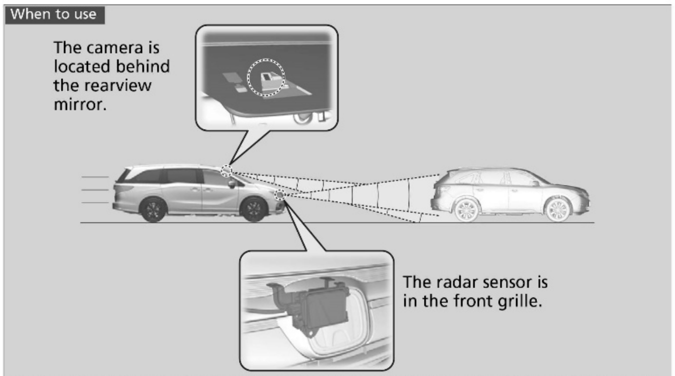
* Not available on all models

Collision Mitigation Braking System™ (CMBS™)*

Can assist you when there is a possibility of your vehicle colliding with a vehicle or a pedestrian detected in front of yours. The CMBS™ is designed to alert you when a potential collision is determined, as well as to reduce your vehicle speed to help minimize collision severity when a collision is deemed unavoidable.

■ How the system works

When to use



The system starts monitoring the roadway ahead when your vehicle speed is about 3 mph (5 km/h) and there is a vehicle in front of you.

The CMBS™ activates when:

- The speed difference between your vehicle and a vehicle or pedestrian detected in front of you becomes about 3 mph (5 km/h) and over with a chance of a collision.
- Your vehicle speed is about 62 mph (100 km/h) or less and there is a chance of a collision with an oncoming detected vehicle or a pedestrian in front of you.

▷Collision Mitigation Braking System™ (CMBS™)*

Important Safety Reminder

The CMBS™ is designed to reduce the severity of an unavoidable collision. It does not prevent a collision nor stop the vehicle automatically. It is still your responsibility to operate the brake pedal and steering wheel appropriately according to the driving conditions.

The CMBS™ may not activate or may not detect a vehicle in front of your vehicle under certain conditions:

▷ **CMBS™ Conditions and Limitations** P. 619

You can read about handling information for the camera equipped with this system.

▷ **Front Sensor Camera*** P. 569

Be careful not to have the radar sensor cover strongly impacted.

▷How the system works

Rapid vibrations on the steering wheel alert you when the your vehicle speed is between 19 and 62 mph (30 and 100 km/h) with an oncoming vehicle detected in front of you.

When the CMBS™ activates, it may automatically apply the brake. It will be canceled when your vehicle stops or a potential collision is not determined.

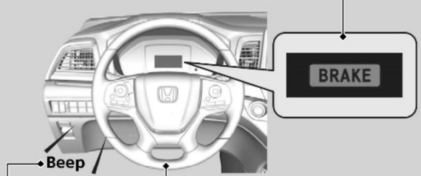
Driving

* Not available on all models

Continued

■ **When the system activates**

The system provides visual, audible and tactile alerts of a possible collision, and stops if the collision is avoided.
- Take appropriate action to prevent a collision (apply the brakes, change lanes, etc.)



At system's earliest collision alert stage, you can change the distance (**Long**/**Normal**/**Short**) between vehicles at which alerts will come on through audio/information screen setting options.

List of customizable options P. 461

■ **Vibration alert on the steering wheel**

When a potential collision to an oncoming detected vehicle is determined, the system alerts you with rapid vibration on the steering wheel, in addition to visual and audible alerts.

▶ Take appropriate action to prevent a collision (apply the brakes, operate the steering wheel, etc.).

When the system activates

The camera in the CMBS™ is also designed to detect pedestrians.
However, this pedestrian detection feature may not activate or may not detect a pedestrian in front of your vehicle under certain conditions.
Refer to the ones indicating the pedestrian detection limitations from the list.

CMBS™ Conditions and Limitations P. 619

Vibration alert on the steering wheel

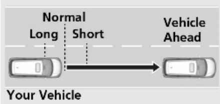
Vibration alert function is disabled when the electric power steering (EPS) system indicator comes on.

Electric Power Steering (EPS) System Indicator P. 91

Driving

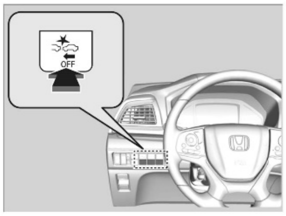
Collision Alert Stages

The system has three alert stages for a possible collision. However, depending on circumstances, the CMBS™ may not go through all of the stages before initiating the last stage.

Distance between vehicles		CMBS™			
		The sensors detect a vehicle	Audible & Visual WARNINGS	Steering Wheel	Braking
Stage one		There is a risk of a collision with the vehicle ahead of you.	When in **Long**, visual and audible alerts come on at a longer distance from a vehicle ahead than in **Normal** setting, and in **Short**, at a shorter distance than in **Normal**.	In case of an oncoming vehicle detected, rapid vibration is provided.	—
Stage two		The risk of a collision has increased, time to respond is reduced.	Visual and audible alerts.	—	Lightly applied
Stage three		The CMBS™ determines that a collision is unavoidable.		—	Forcefully applied

Driving

CMBS™ On and Off



Press and hold the button until the beeper sounds to switch the system on or off.

When the CMBS™ is off:
- The CMBS™ indicator in the instrument panel comes on.
- A message on the driver information interface reminds you that the system is off.

The CMBS™ is turned on every time you start the engine, even if you turned it off the last time you drove the vehicle.

CMBS™ On and Off

The CMBS™ may automatically shut off, and the CMBS™ indicator will come and stay on under certain conditions:

CMBS™ Conditions and Limitations P. 619

CMBS™ Conditions and Limitations

The system may automatically shut off and the CMBS™ indicator will come on under certain conditions. Some examples of these conditions are listed below. Other conditions may reduce some of the CMBS™ functions.

Front Sensor Camera* P. 569

Environmental conditions

- Driving in bad weather (rain, fog, snow, etc.).
- Sudden changes between light and dark, such as an entrance or exit of a tunnel.
- There is little contrast between objects and the background.
- Driving into low sunlight (e.g., at dawn or dusk).
- Strong light is reflected onto the roadway.
- Driving in the shadows of trees, buildings, etc.
- Roadway objects or structures are misinterpreted as vehicles and pedestrians.
- Reflections on the interior of the windshield.
- Driving at night or in a dark condition such as a tunnel.

Roadway conditions

- Driving on a snowy or wet roadway (obscured lane marking, vehicle tracks, reflected lights, road spray, high contrast).
- The road is hilly or the vehicle is approaching the crest of a hill.
- Driving on curvy, winding, or undulating roads.

CMBS™ Conditions and Limitations

Do not paint, or apply any coverings or paint to the radar sensor area. This can impact CMBS™ operation.

Have your vehicle checked by a dealer if you find any unusual behavior of the system (e.g., the warning message appears too frequently).

If the front of the vehicle is impacted in any of the following situations, the radar sensor may not work properly. Have your vehicle checked by a dealer:
- The vehicle mounted onto a bump, curb, chock, embankment, etc.
- You drive the vehicle where the water is deep.
- Your vehicle has a frontal collision.

If you need the radar sensor to be repaired, or removed, or the radar sensor cover is strongly impacted, turn off the system by pressing the CMBS™ **OFF** button and take your vehicle to a dealer.

* Not available on all models

■ Vehicle conditions

- Headlight lenses are dirty or the headlights are not properly adjusted.
- The outside of the windshield is blocked by dirt, mud, leaves, wet snow, etc.
- The inside of the windshield is fogged.
- An abnormal tire or wheel condition (wrong sized, varied size or construction, improperly inflated, compact spare tire, etc.).
- When tire chains are installed.
- The vehicle is tilted due to a heavy load or suspension modifications.
- The camera temperature gets too high.
- Driving with the parking brake applied.
- When the radar sensor in the front grille gets dirty.
- The vehicle is towing a trailer.

■ Detection limitations

- A vehicle or pedestrian suddenly crosses in front of you.
- The distance between your vehicle and the vehicle or pedestrian ahead of you is too short.
- A vehicle cuts in front of you at a slow speed, and it brakes suddenly.
- When you accelerate rapidly and approach the vehicle or pedestrian ahead of you at high speed.
- The vehicle ahead of you is a motorcycle, bicycle, mobility scooter or other small vehicle.
- When there are animals in front of your vehicle.
- When you drive on a curved, winding or undulating road that makes it difficult for the sensor to properly detect a vehicle in front of you.
- The speed difference between your vehicle and a vehicle or pedestrian in front of you is significantly large.
- An oncoming vehicle suddenly comes in front of you.
- Another vehicle suddenly comes in front of you at an intersection, etc.
- Your vehicle abruptly crosses over in front of an oncoming vehicle.
- When driving through a narrow iron bridge.
- When the lead vehicle suddenly slows down.

Limitations applicable to pedestrian detection only

- When there is a group of people in front of your vehicle walking together side by side.
- Surrounding conditions or belongings of the pedestrian alter the pedestrian's shape, preventing the system from recognizing that the person is a pedestrian.
- When the pedestrian is shorter than about 3.3 feet (1 meter) or taller than about 6.6 feet (2 meters) in height.
- When a pedestrian blends in with the background.
- When a pedestrian is bent over or squatting, or when their hands are raised or they are running.
- When several pedestrians are walking ahead in a group.
- When the camera cannot correctly identify that a pedestrian is present due to an unusual shape (holding luggage, body position, size).

Continued

■ Automatic shutoff

CMBS™ may automatically shut itself off and the CMBS™ indicator comes and stays on when:

- The temperature inside the system is high.
- You drive off-road or on a mountain road, or curved and winding road for an extended period.
- An abnormal tire condition is detected (wrong tire size, flat tire, etc.).
- The camera behind the rearview mirror, or the area around the camera, including the windshield, gets dirty.

Once the conditions that caused CMBS™ to shut off improve or are addressed (e.g., cleaning), the system comes back on.

With Little Chance of a Collision

The CMBS™ may activate even when you are aware of a vehicle ahead of you, or when there is no vehicle ahead. Some examples of this are:

When passing

Your vehicle approaches another vehicle ahead of you and you change lanes to pass.

At an intersection

Your vehicle approaches or passes another vehicle that is making a left or right turn.

On a curve

When driving through curves, your vehicle comes to a point where an oncoming vehicle is right in front of you.

Through a low bridge at high speed

You drive under a low or narrow bridge at high speed.

Speed bumps, road work sites, train tracks, roadside objects, etc.

You drive over speed bumps, steel road plates, etc., or your vehicle approaches train tracks or roadside objects [such as a traffic sign and guard rail] on a curve or, when parking, stationary vehicles and walls.

With Little Chance of a Collision

For the CMBS™ to work properly:

Always keep the radar sensor cover clean.

Never use chemical solvents or polishing powder for cleaning the sensor cover. Clean it with water or a mild detergent.

APPENDIX C

Run Log

Subject Vehicle: **2020 Honda Odyssey EX-L** Test Date: **3/30/2020**

Principal Other Vehicle: **SSV**

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Pass/Fail	Notes
1	Static Run								
2	**Stopped POV**	N							Throttle
3		Y	2.22	6.71	25.4	0.88	1.27	Pass	
4		Y	2.17	0.00	16.8	0.83	0.84	Pass	
5		Y	2.19	7.37	25.1	0.89	1.36	Pass	
6		Y	2.17	0.00	18.7	0.83	0.84	Pass	
7		Y	2.07	6.99	24.9	0.87	1.34	Pass	
8		Y	2.11	7.32	25.3	0.90	1.36	Pass	
9		Y	2.15	5.65	25.1	0.89	1.34	Pass	
10	Static Run								
11	**Slower POV, 25 vs 10**	Y	1.89	3.05	15.6	0.79	1.17	Pass	
12		Y	1.90	7.05	14.7	0.80	1.11	Pass	
13		Y	1.90	2.87	14.7	0.79	1.12	Pass	
14		Y	1.90	5.53	15.4	0.97	1.13	Pass	

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Pass/Fail	Notes
15		Y	1.87	3.29	15.3	0.81	1.17	Pass	
16		Y	1.89	2.98	14.9	0.79	1.14	Pass	
17		Y	1.87	8.07	16.0	0.98	1.22	Pass	
18	Static Run								
19	**Slower POV, 45 vs 20**	Y	1.98	8.89	24.9	0.95	1.26	Pass	
20		Y	2.00	10.49	26.3	0.94	1.29	Pass	
21		Y	2.01	9.44	25.2	0.79	1.29	Pass	
22		Y	1.98	10.85	25.4	0.98	1.32	Pass	
23		Y	2.02	12.93	25.1	0.96	1.34	Pass	
24		Y	2.04	11.38	24.9	0.99	1.30	Pass	
25		Y	1.98	10.07	24.2	0.81	1.35	Pass	
26	Static run								
27	**Decelerating POV, 35**	N							POV brakes
28		N							POV brakes
29		N							POV speed
30	Static Run								
31		N							Post processor issue
32		Y	1.81	0.00	29.2	0.99	0.81	Pass	

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Pass/Fail	Notes
33		Y	1.87	0.00	21.4	1.00	0.79	Pass	
34		Y	1.81	0.00	31.7	0.98	0.79	Pass	
35		Y	1.60	0.00	20.7	0.98	0.78	Pass	
36		Y	1.83	0.00	19.4	0.99	0.75	Pass	
37		Y	1.75	0.00	28.4	0.98	0.83	Pass	
38		Y	1.75	0.00	26.1	0.96	0.80	Pass	
39	Static Run								
40	STP - Static Run								
41	**STP False Positive, 25**	Y	1.76			0.05		Pass	FCW alert issued
42		Y	1.81			0.06		Pass	FCW alert issued
43		Y	1.89			0.05		Pass	FCW alert issued
44		Y	1.67			0.06		Pass	FCW alert issued
45		Y	1.68			0.06		Pass	FCW alert issued
46		Y	1.91			0.05		Pass	FCW alert issued
47		Y	1.86			0.06		Pass	FCW alert issued
48	STP - Static Run								

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Pass/Fail	Notes
49	**STP False Positive, 45**	Y	1.62			0.05		Pass	FCW alert issued
50		Y	1.82			0.05		Pass	FCW alert issued
51		Y	1.31			0.05		Pass	FCW alert issued
52		Y	1.80			0.05		Pass	FCW alert issued
53		Y	1.62			0.05		Pass	FCW alert issued
54		Y	0.24			0.04		Pass	FCW alert issued
55		Y	1.53			0.04		Pass	FCW alert issued
56	STP - Static Run								

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)
- 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)
- False Positive STP 25 mph (Steel trench plate run over at 25 mph)
- False Positive STP 45 mph (Steel trench plate run over at 45 mph)

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. For False Positive tests, when the FCW presents a warning “FCW” is shown in red at the right edge of the FCW plot.

- Headway (ft) – Longitudinal separation (gap) between the frontmost point of the Subject Vehicle and the rearmost point of the Strikeable Surrogate Vehicle (SSV) towed by the Principal Other Vehicle. 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. Note that for tests involving the Strikeable Surrogate Vehicle (SSV), the associated lateral restraint track is defined to be the center of the lane of travel. If testing is done with a different POV which does not have a lateral restraint track, lateral offset is defined to be the lateral offset between the SV and 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. For false positive runs a green dot, rather than a green envelope is displayed. The green dot indicates that at the end of the run the accelerator pedal had not been released. If the accelerator had been released a red asterisk would appear.

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 Figure 1 through Figure 9. Figures 1 through 6 show passing runs for each of the 6 test types. Figures 7 and 8 show examples of invalid runs. Figure 9 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 10.

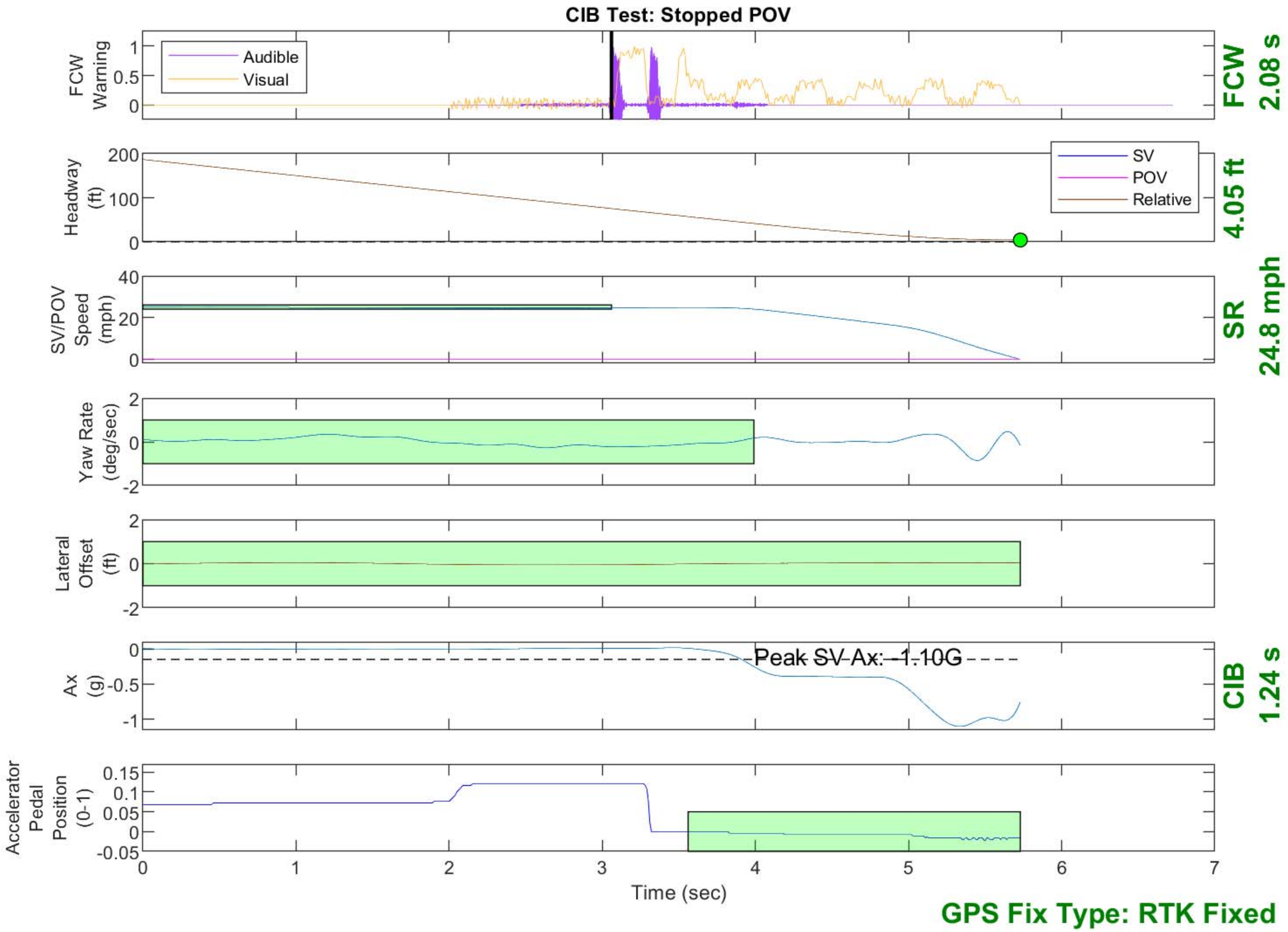


Figure D1. Example Time History for Stopped POV, Passing

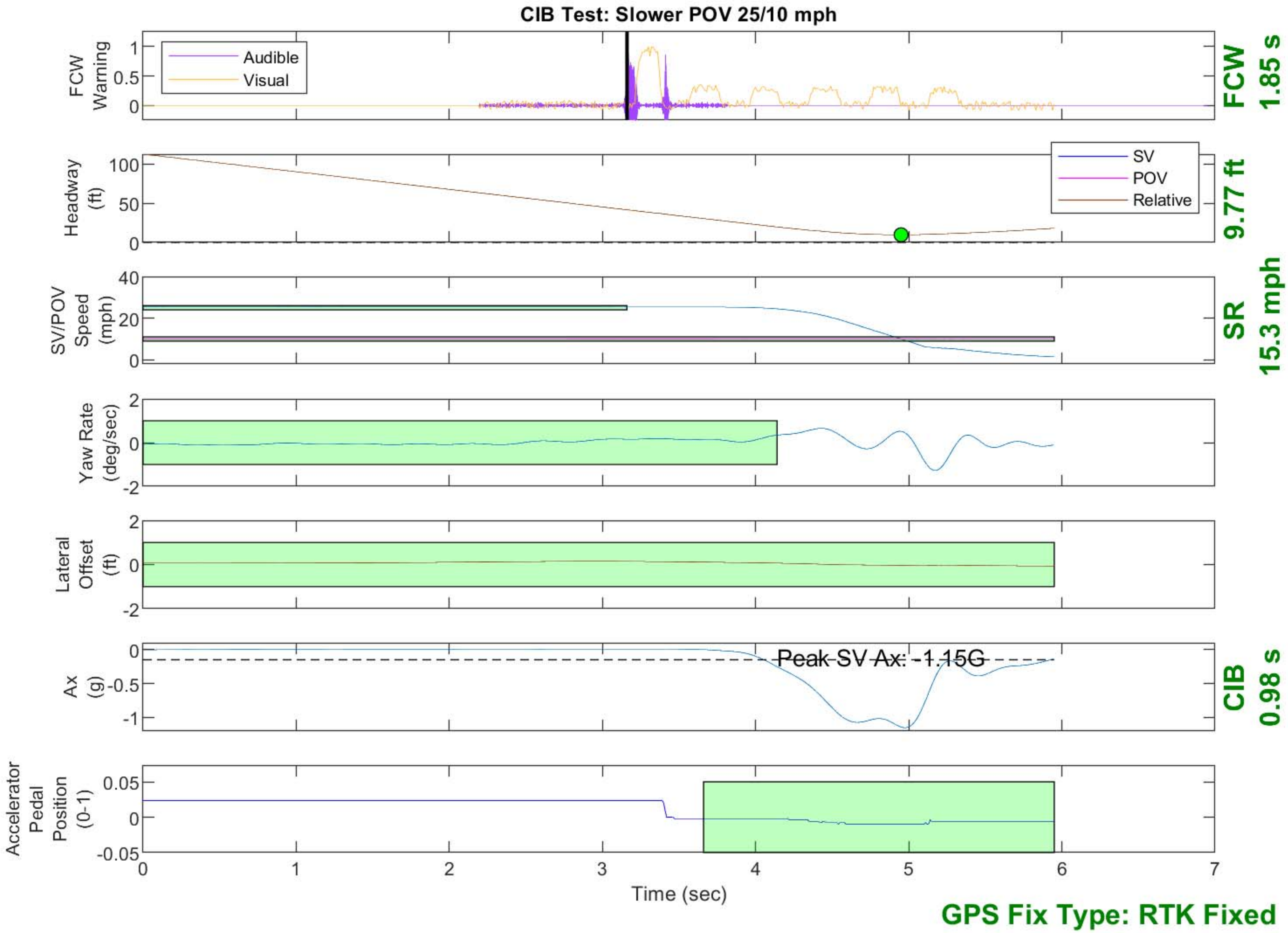


Figure D2. Example Time History for Slower POV 25 vs. 10, Passing

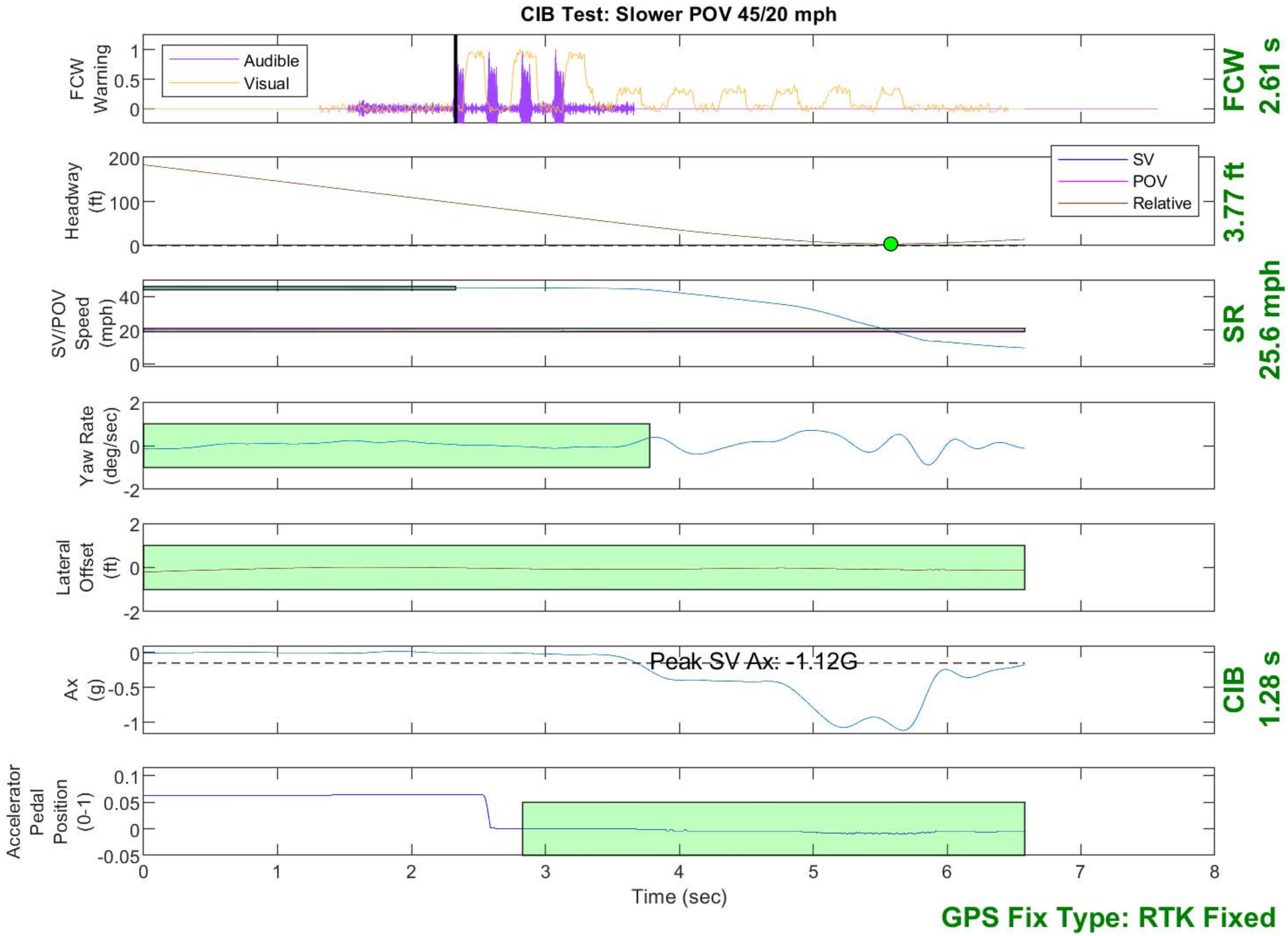


Figure D3. Example Time History for Slower POV 45 vs. 20, Passing

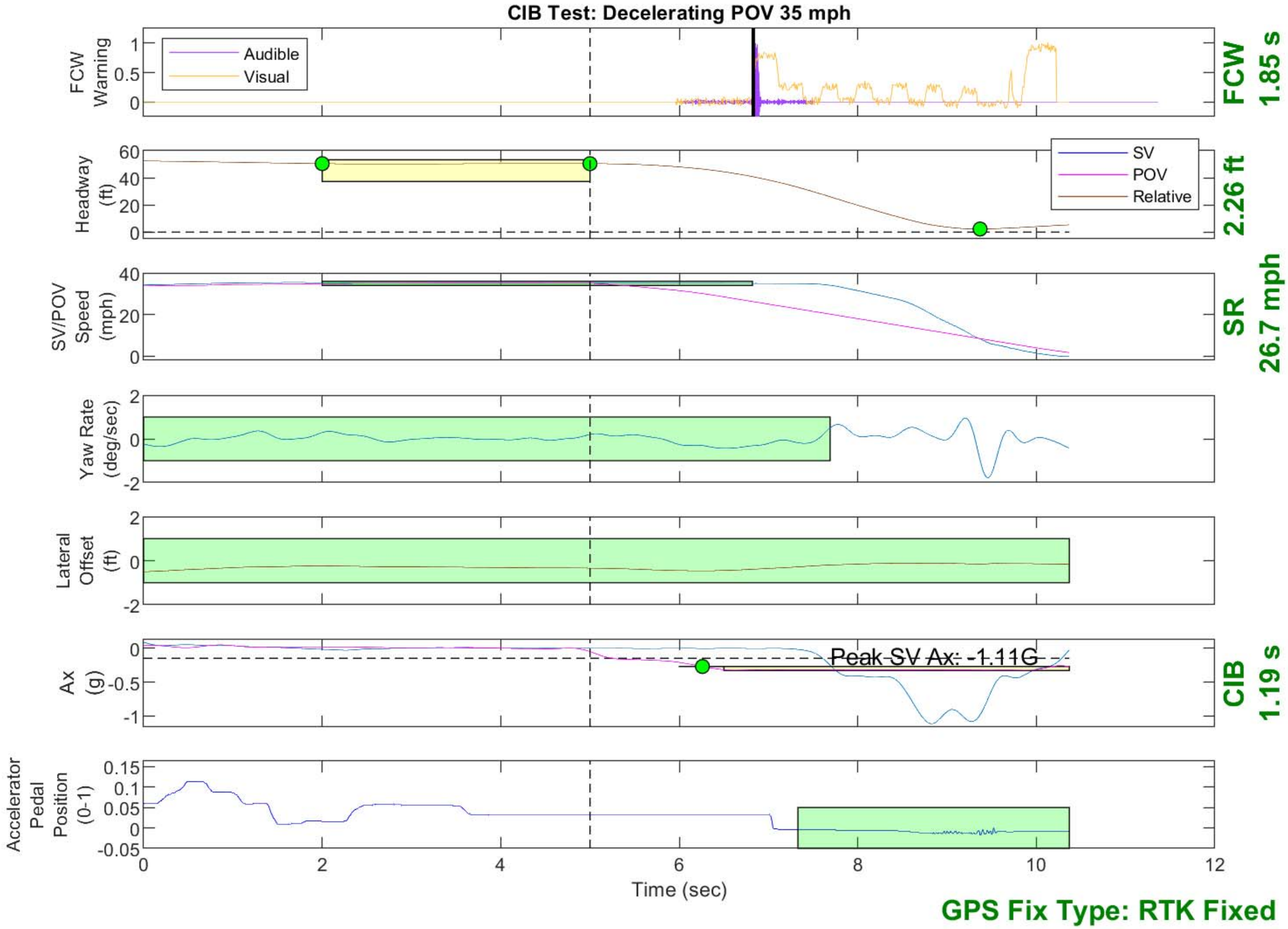


Figure D4. Example Time History for Decelerating POV 35, Passing

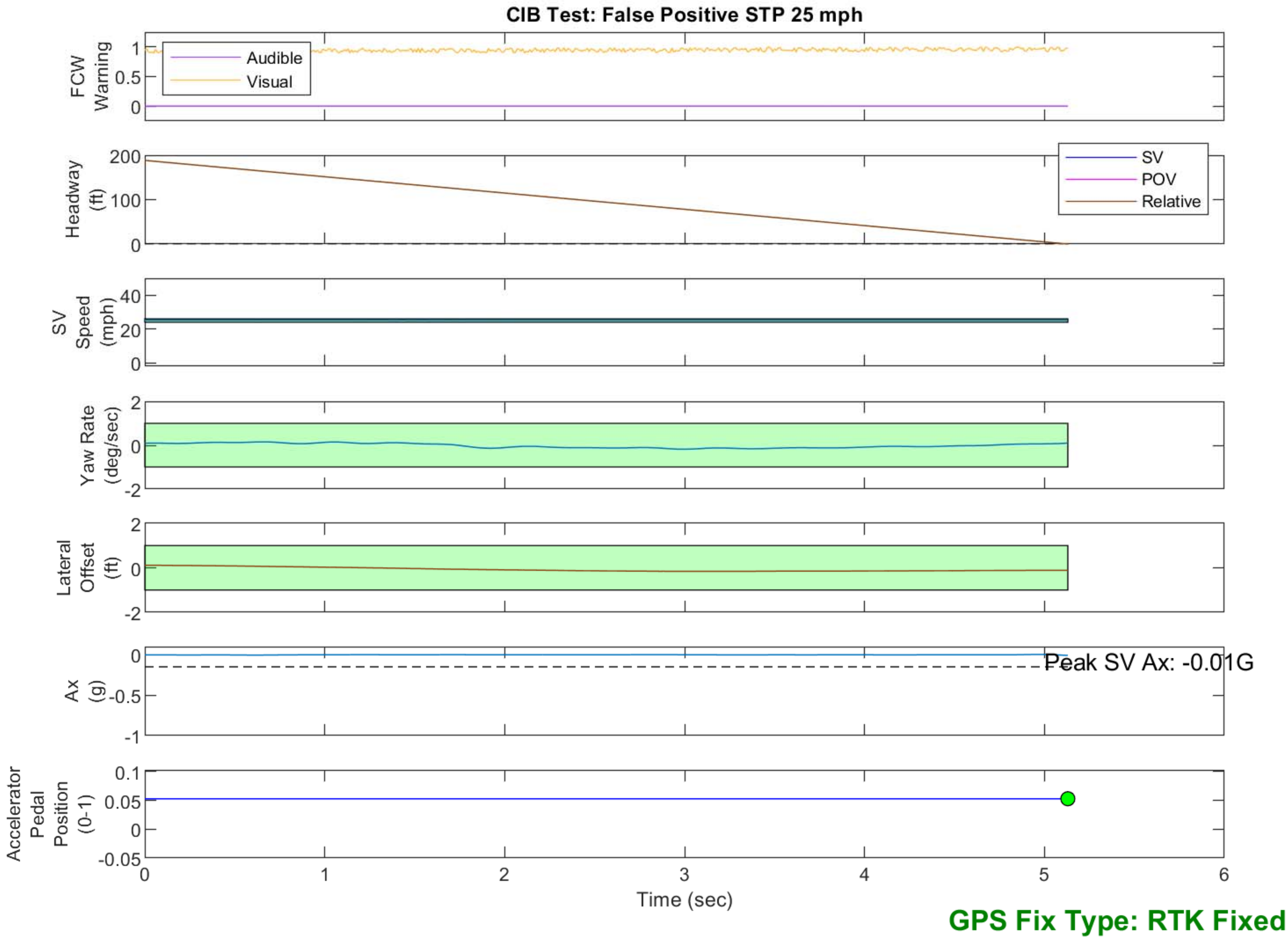


Figure D5. Example Time History for False Positive STP 25, Passing

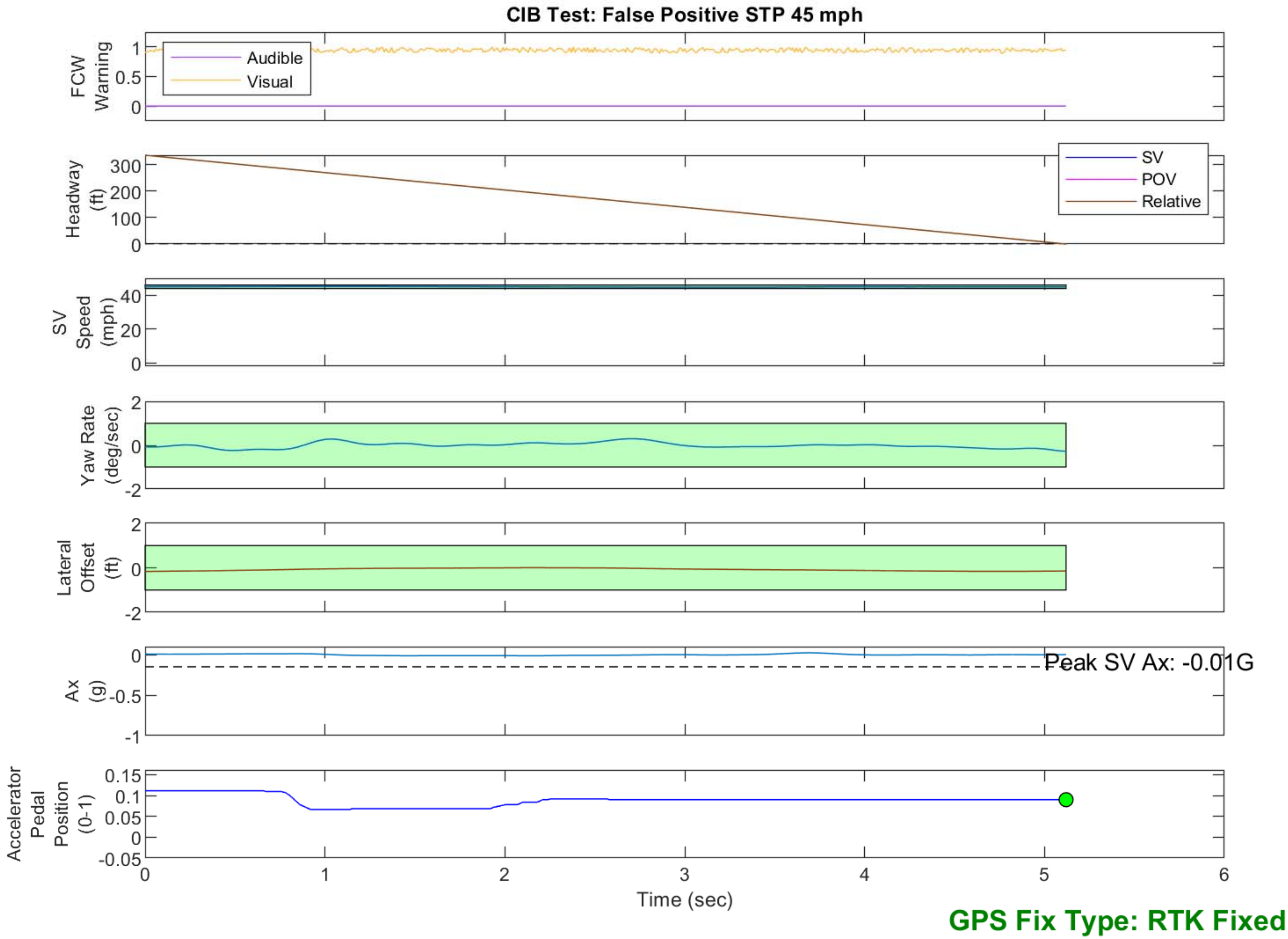


Figure D6. Example Time History for False Positive STP 45, Passing

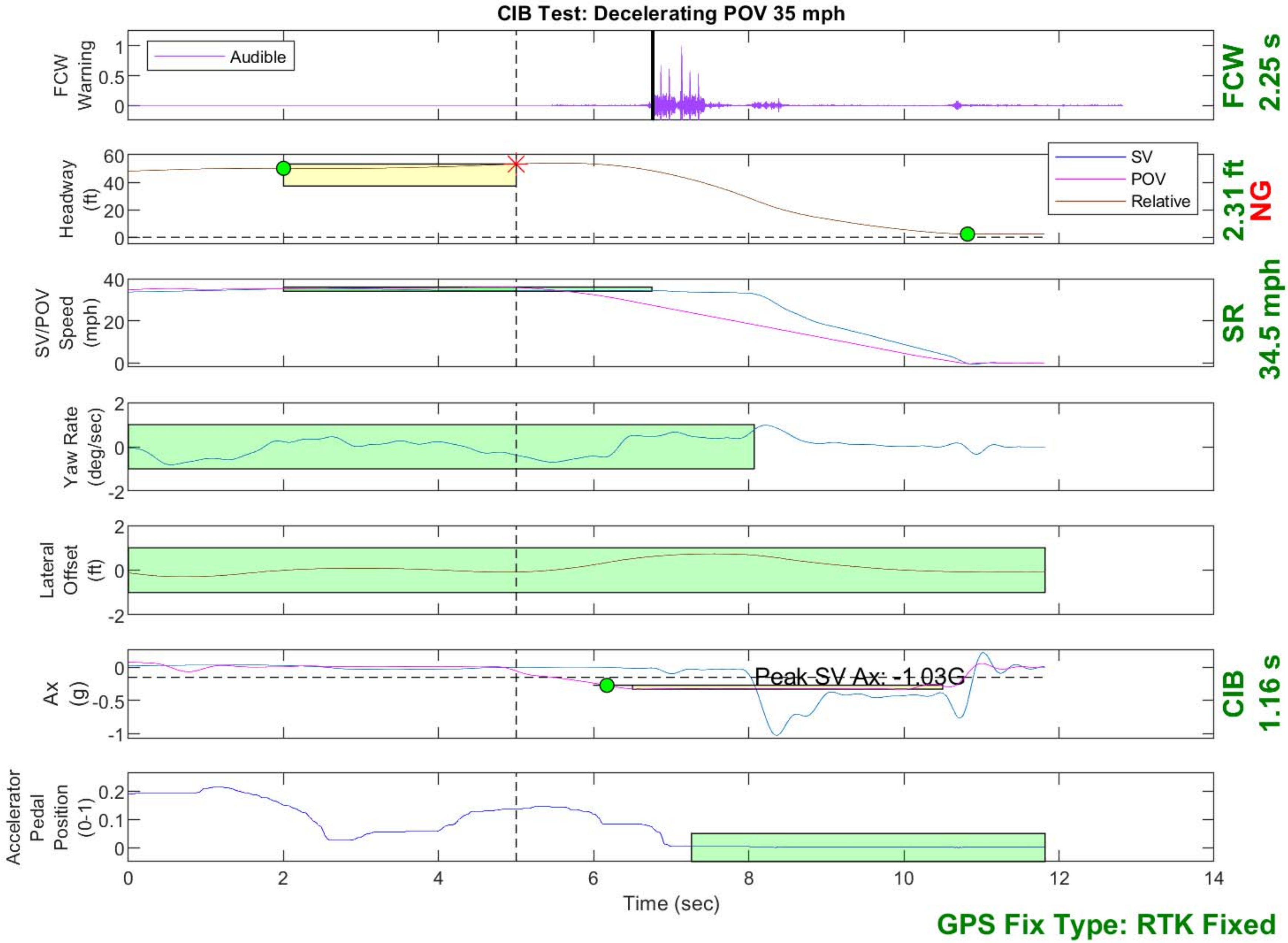


Figure D7. Example Time History Displaying Various Invalid Criteria

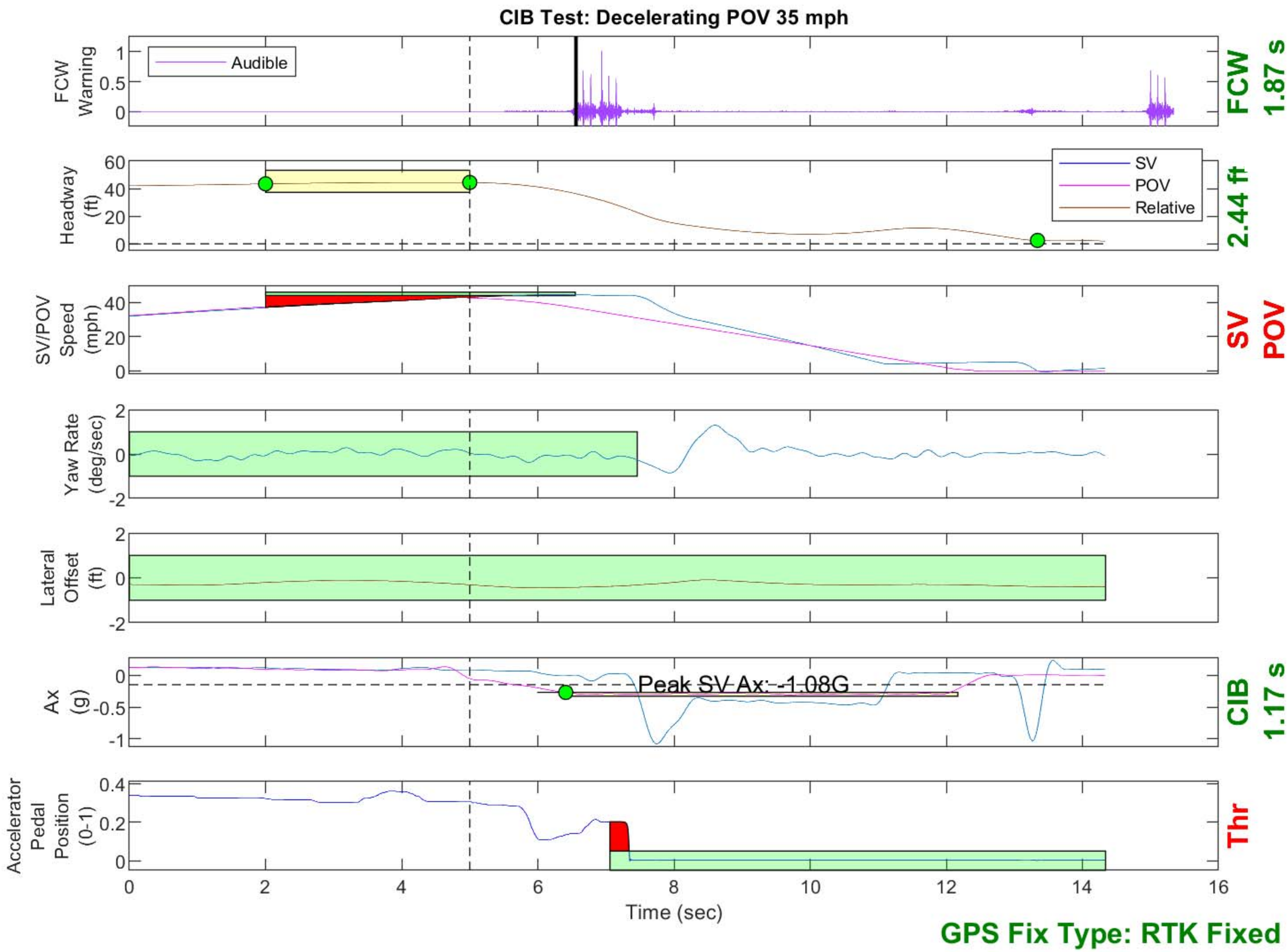


Figure D8. Example Time History Displaying Various Invalid Criteria

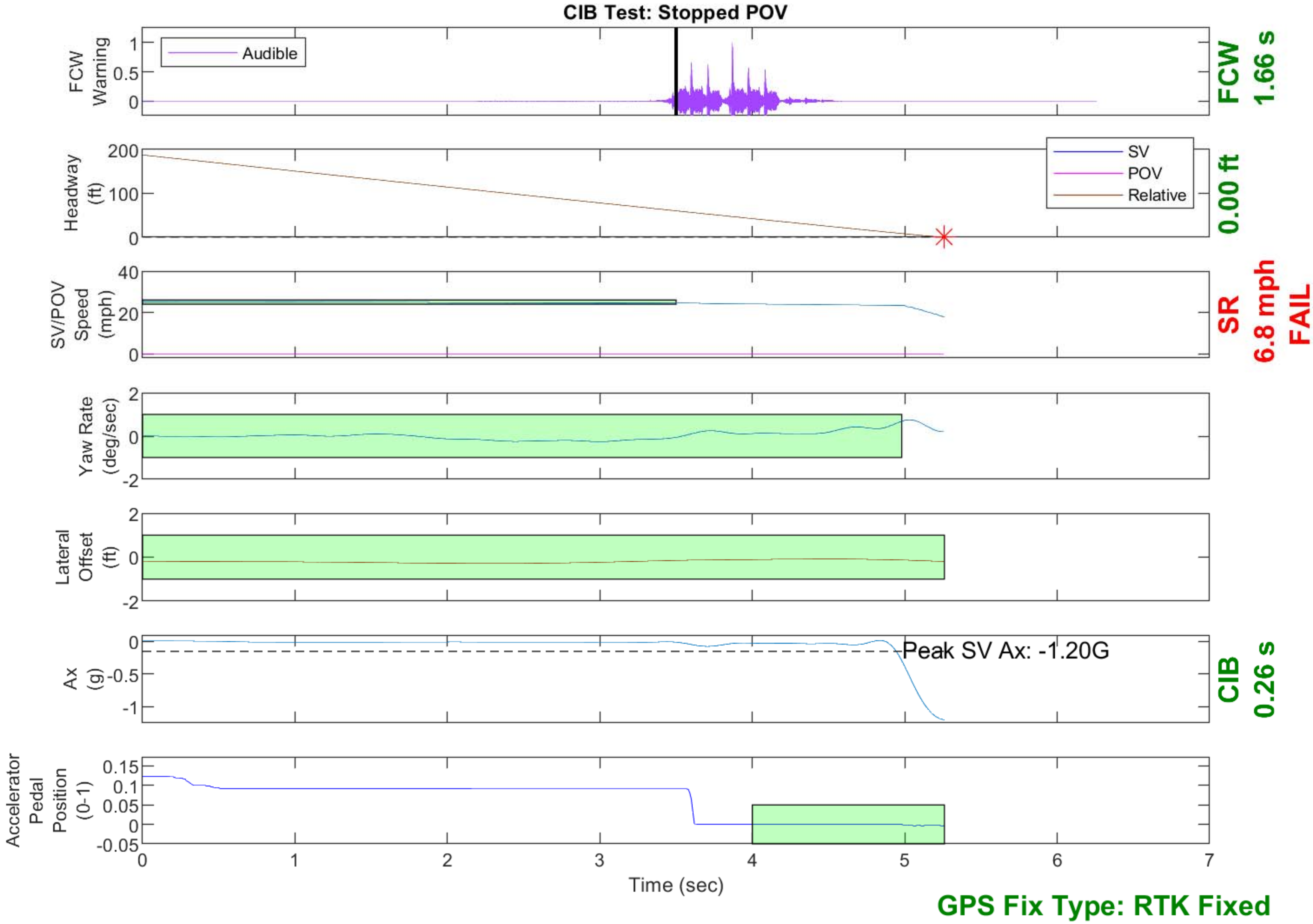


Figure D9. Example Time History for a Failed Run

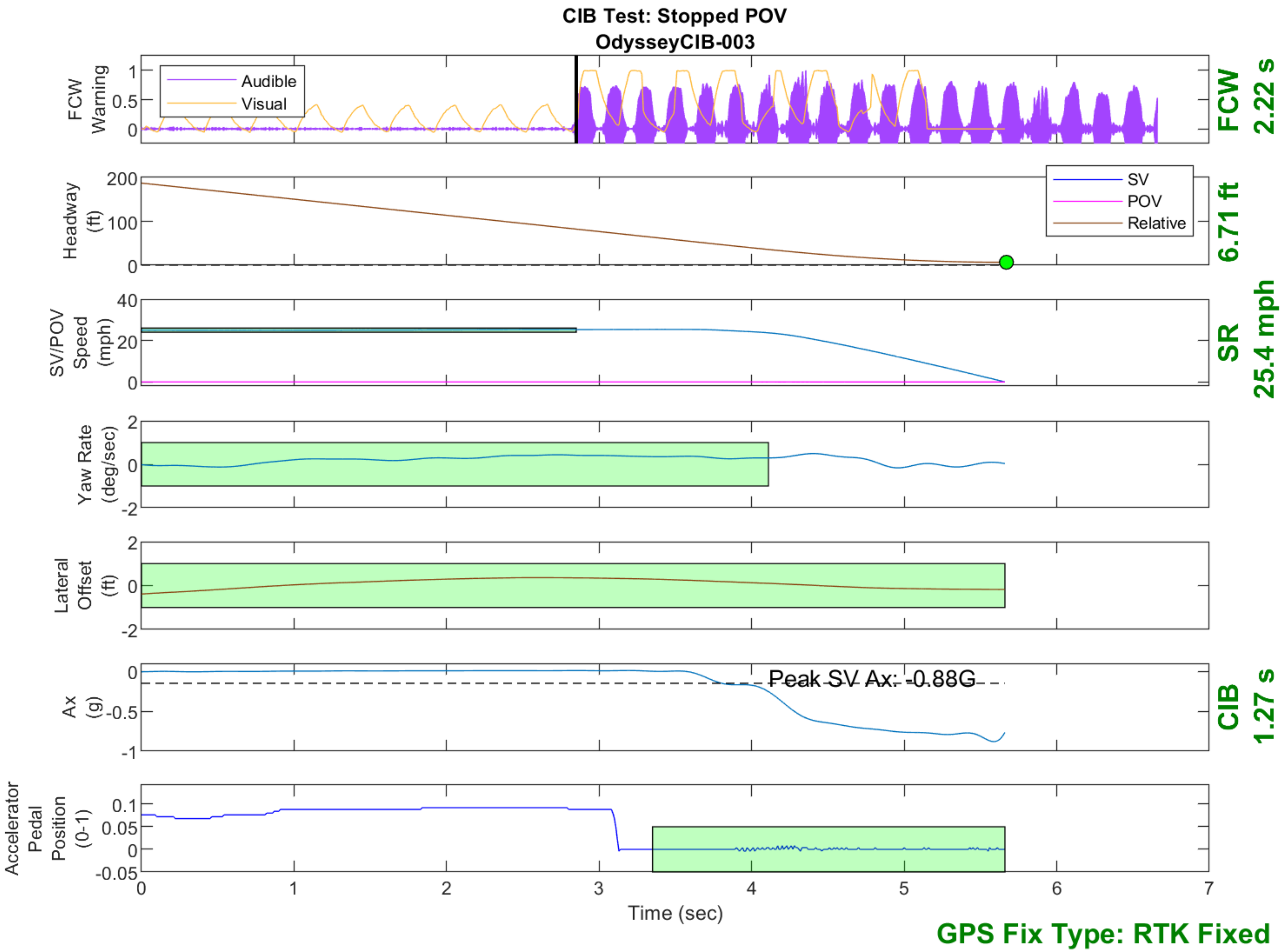


Figure D10. Time History for CIB Run 3, SV Encounters Stopped POV

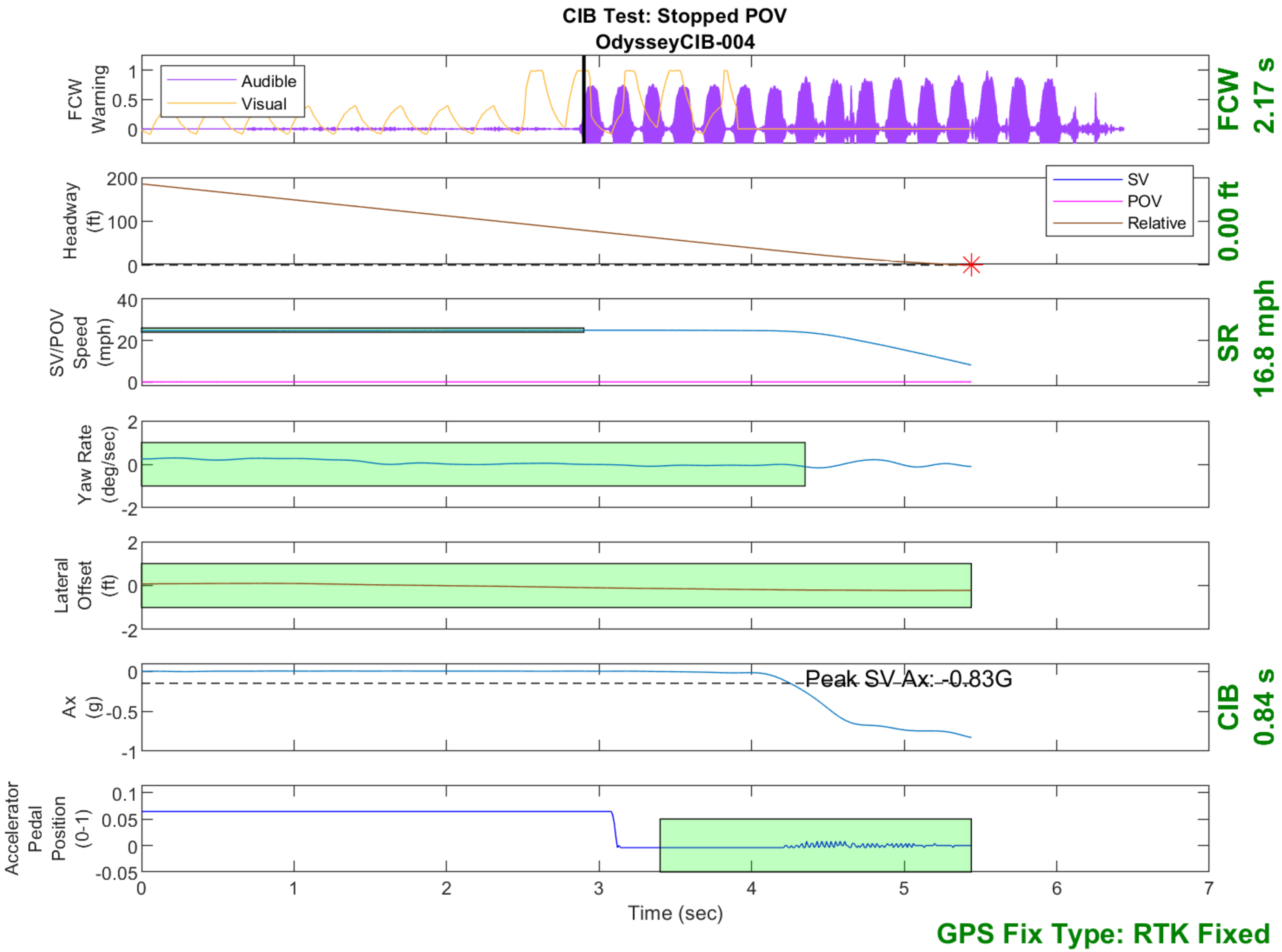


Figure D11. Time History for CIB Run 4, SV Encounters Stopped POV

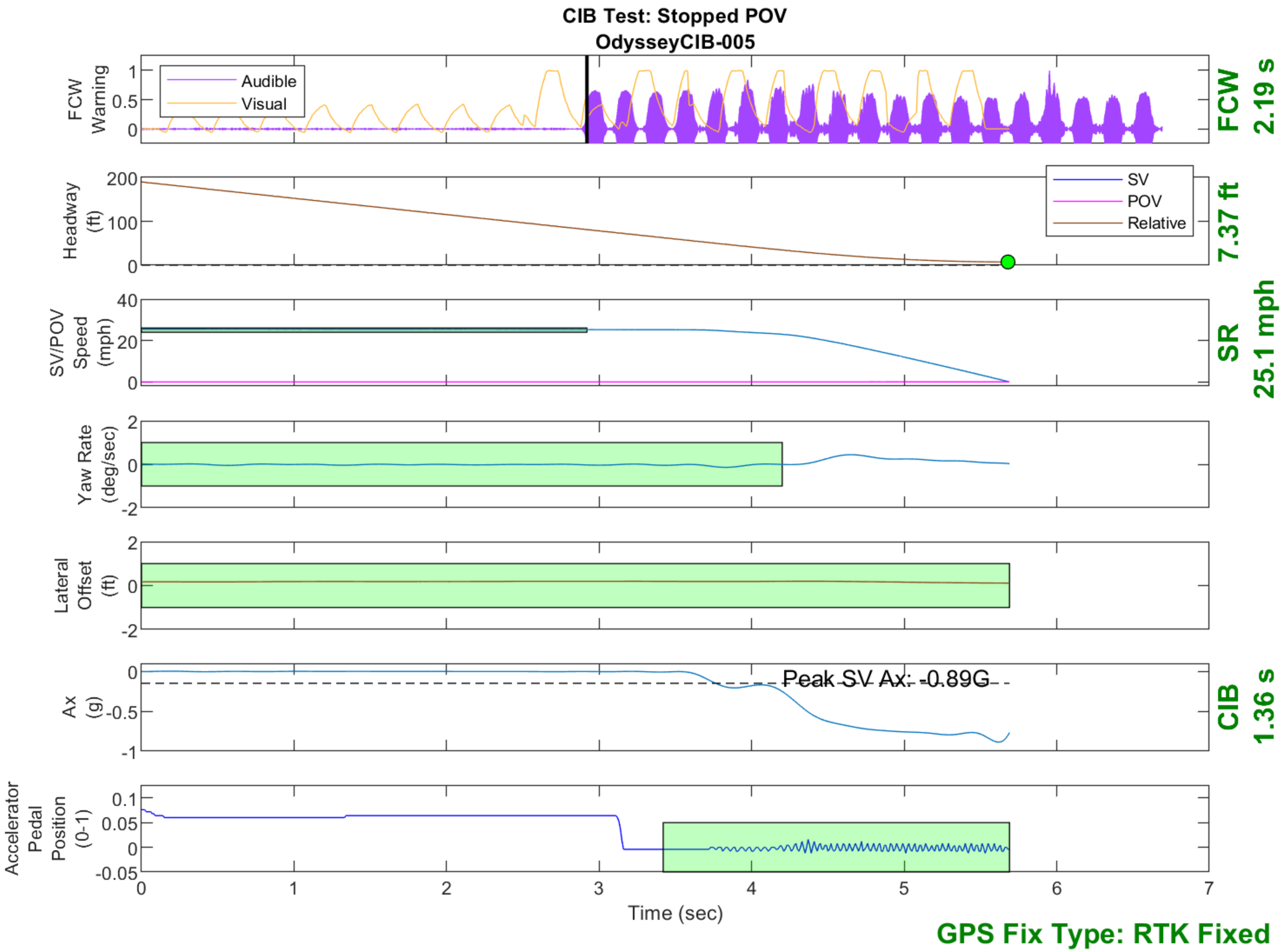


Figure D12. Time History for CIB Run 5, SV Encounters Stopped POV

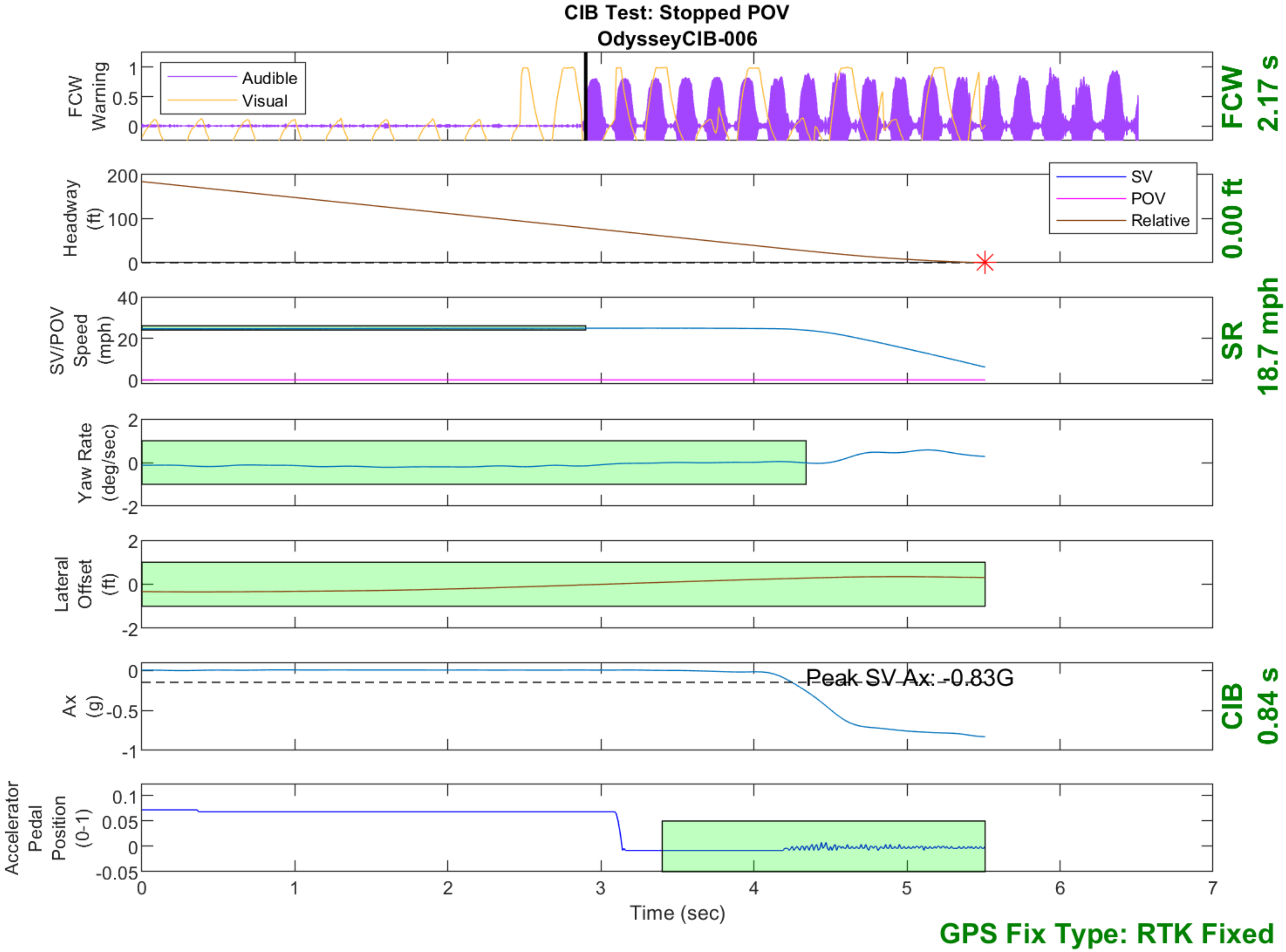


Figure D13. Time History for CIB Run 6, SV Encounters Stopped POV

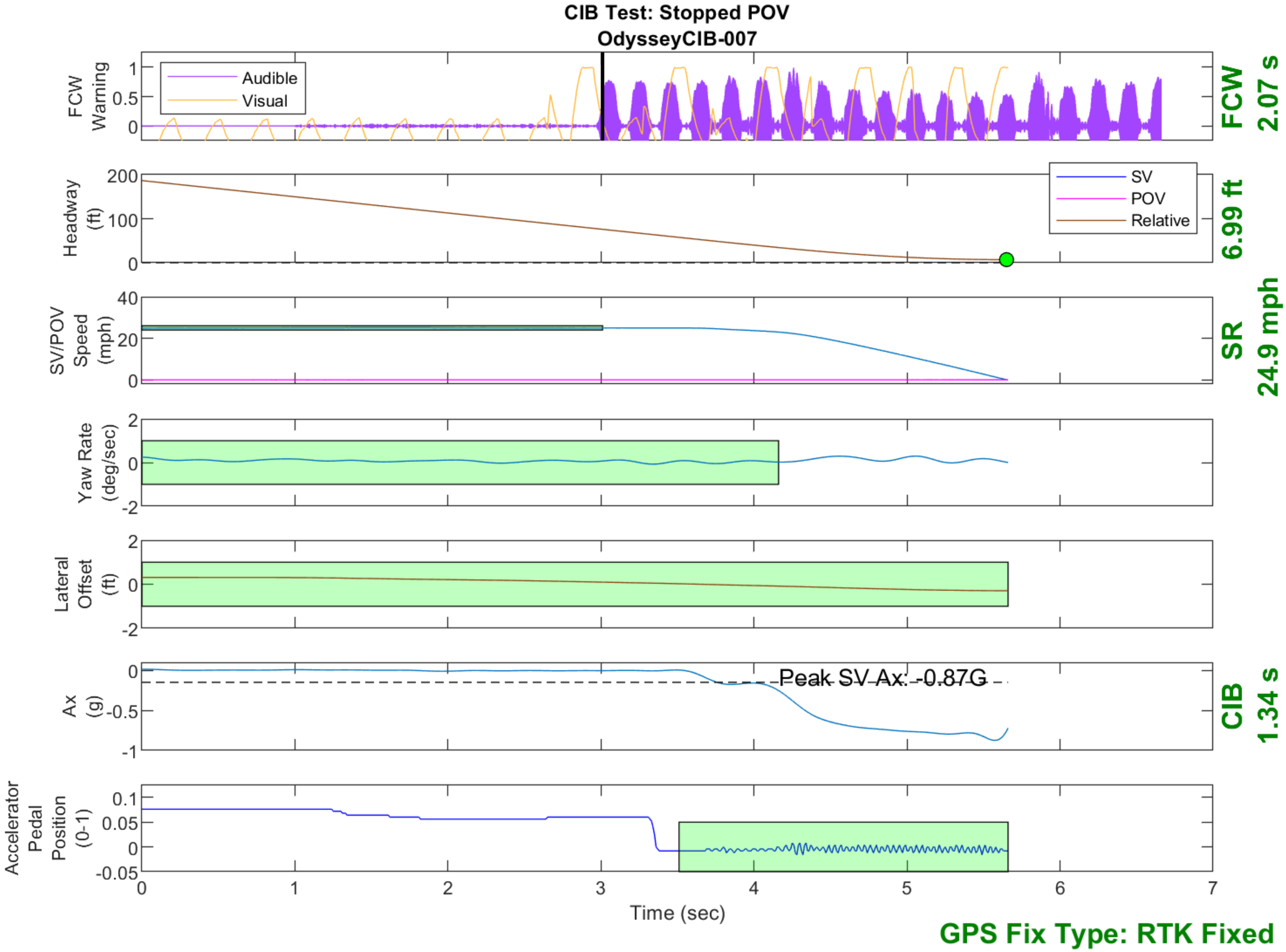


Figure D14. Time History for CIB Run 7, SV Encounters Stopped POV

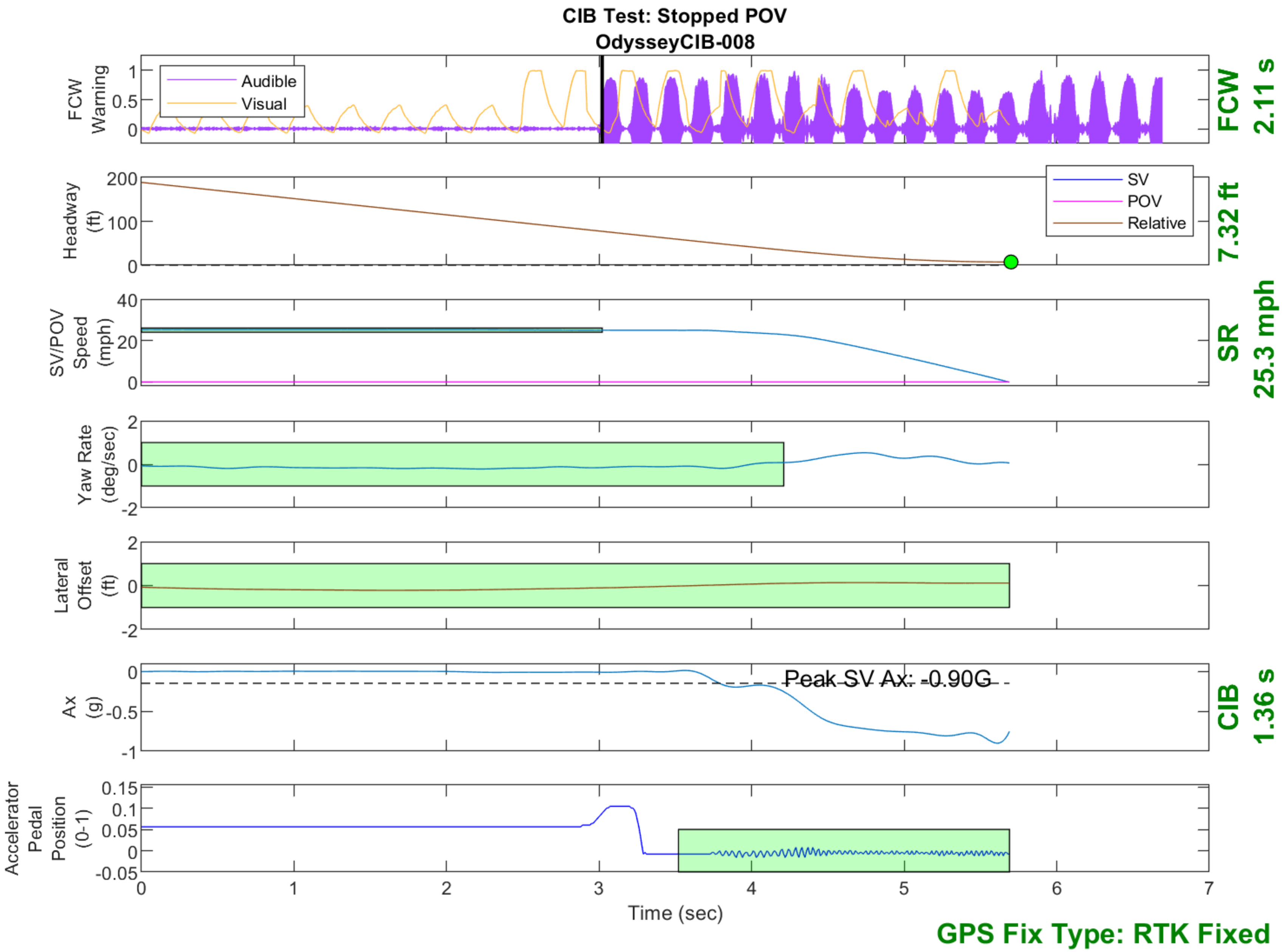


Figure D15. Time History for CIB Run 8, SV Encounters Stopped POV

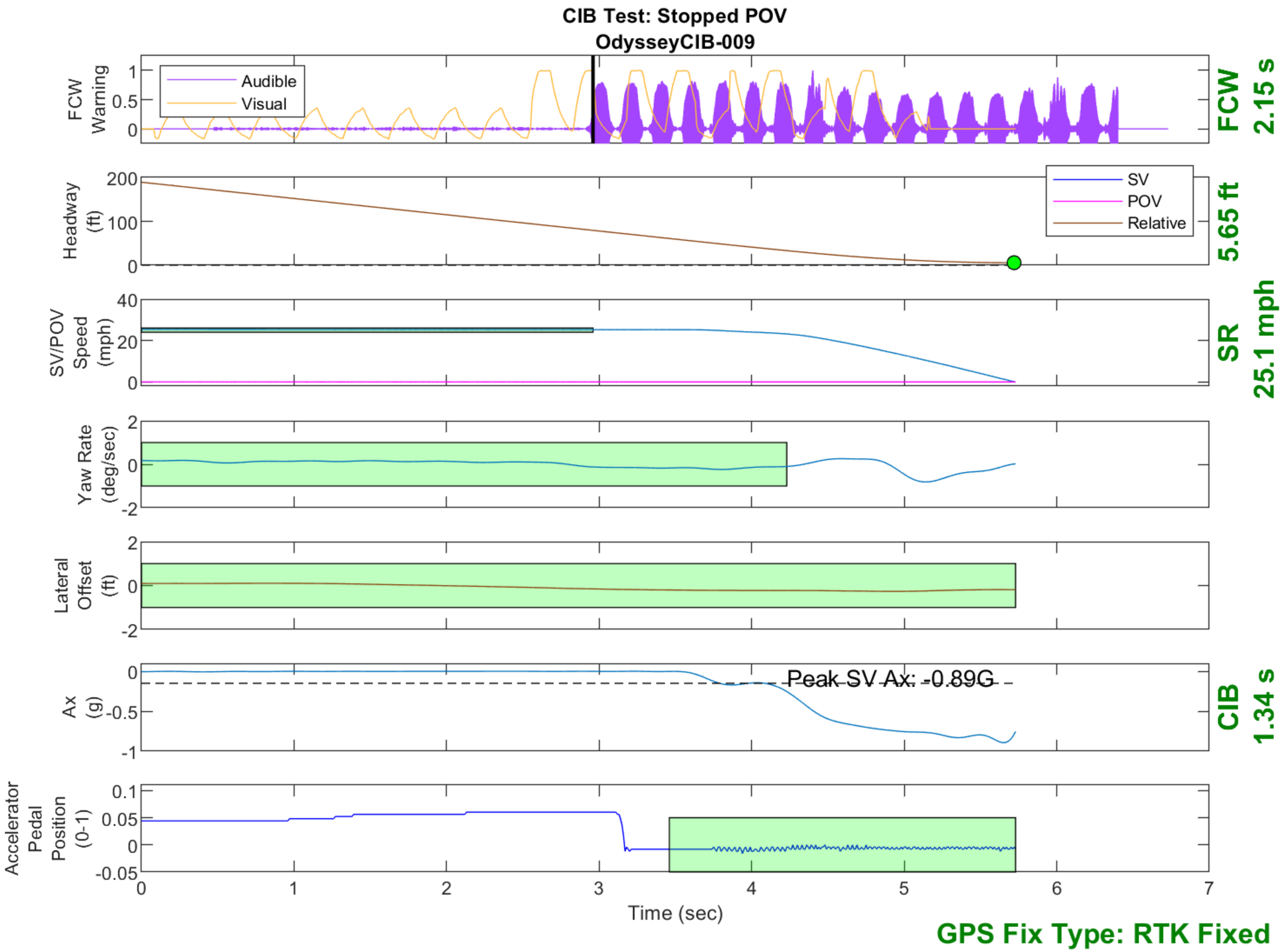


Figure D16. Time History for CIB Run 9, SV Encounters Stopped POV

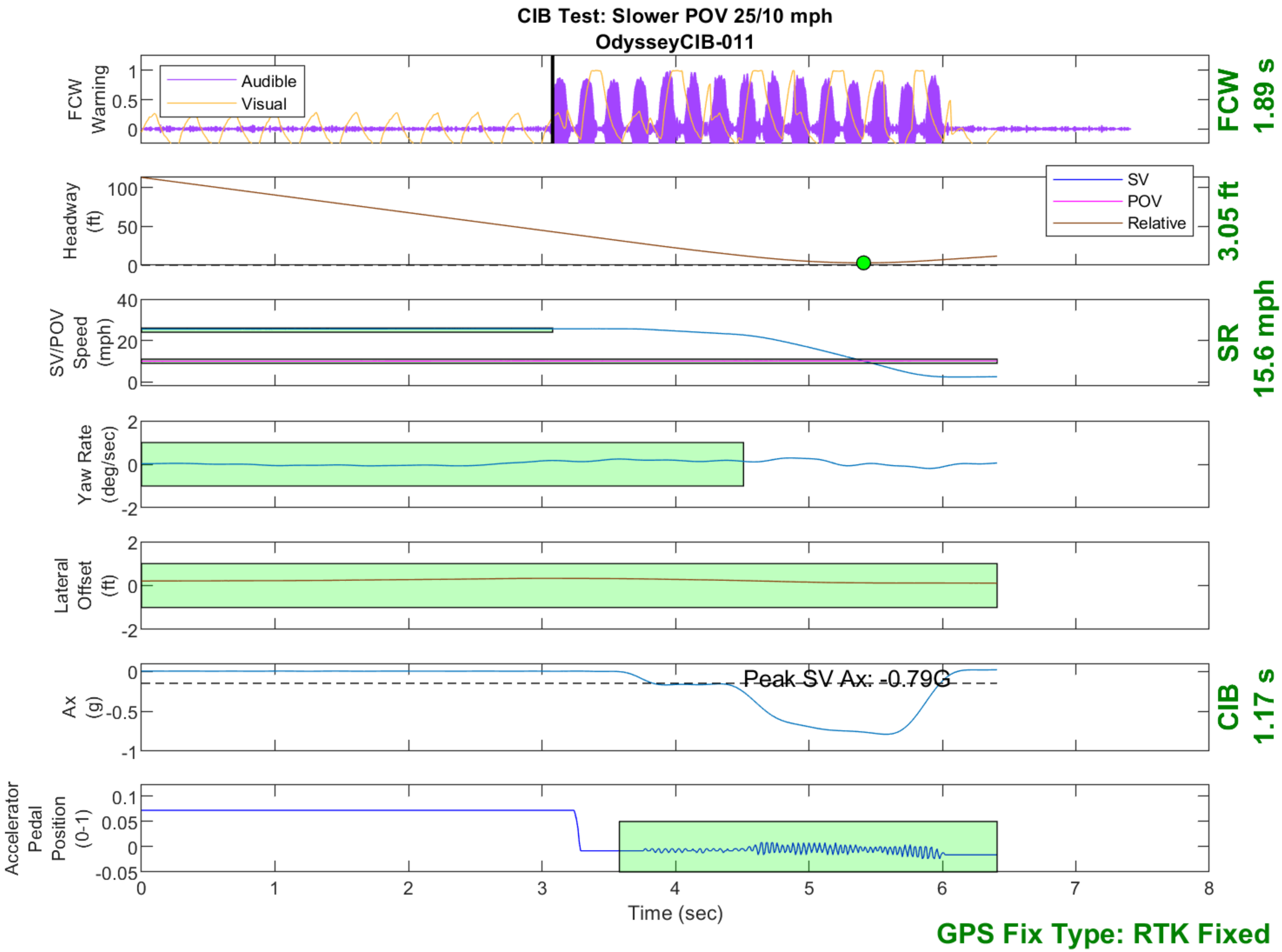


Figure D17. Time History for CIB Run 11, SV Encounters Slower POV, SV 25 mph, POV 10 mph

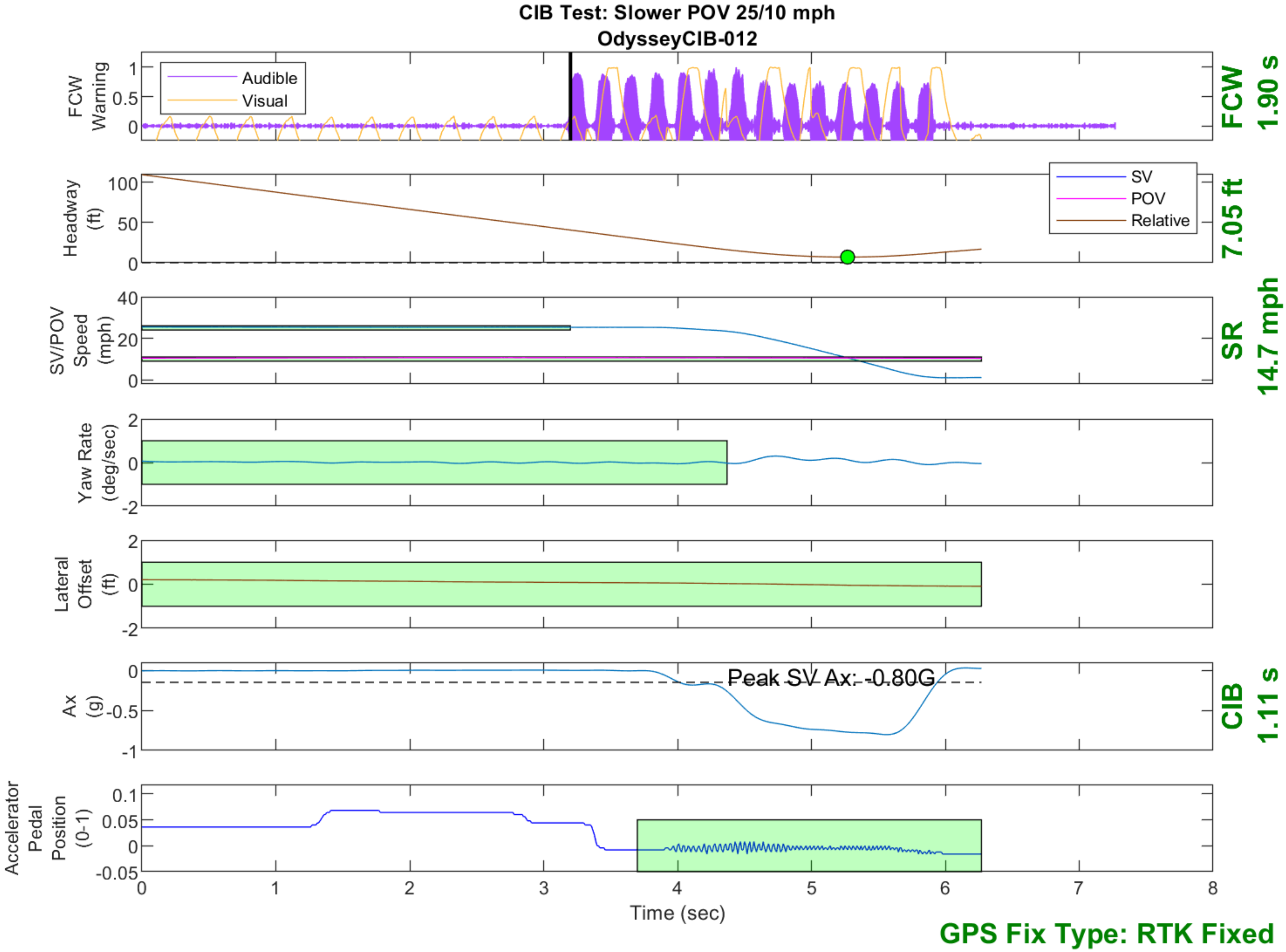


Figure D18. Time History for CIB Run 12, SV Encounters Slower POV, SV 25 mph, POV 10 mph

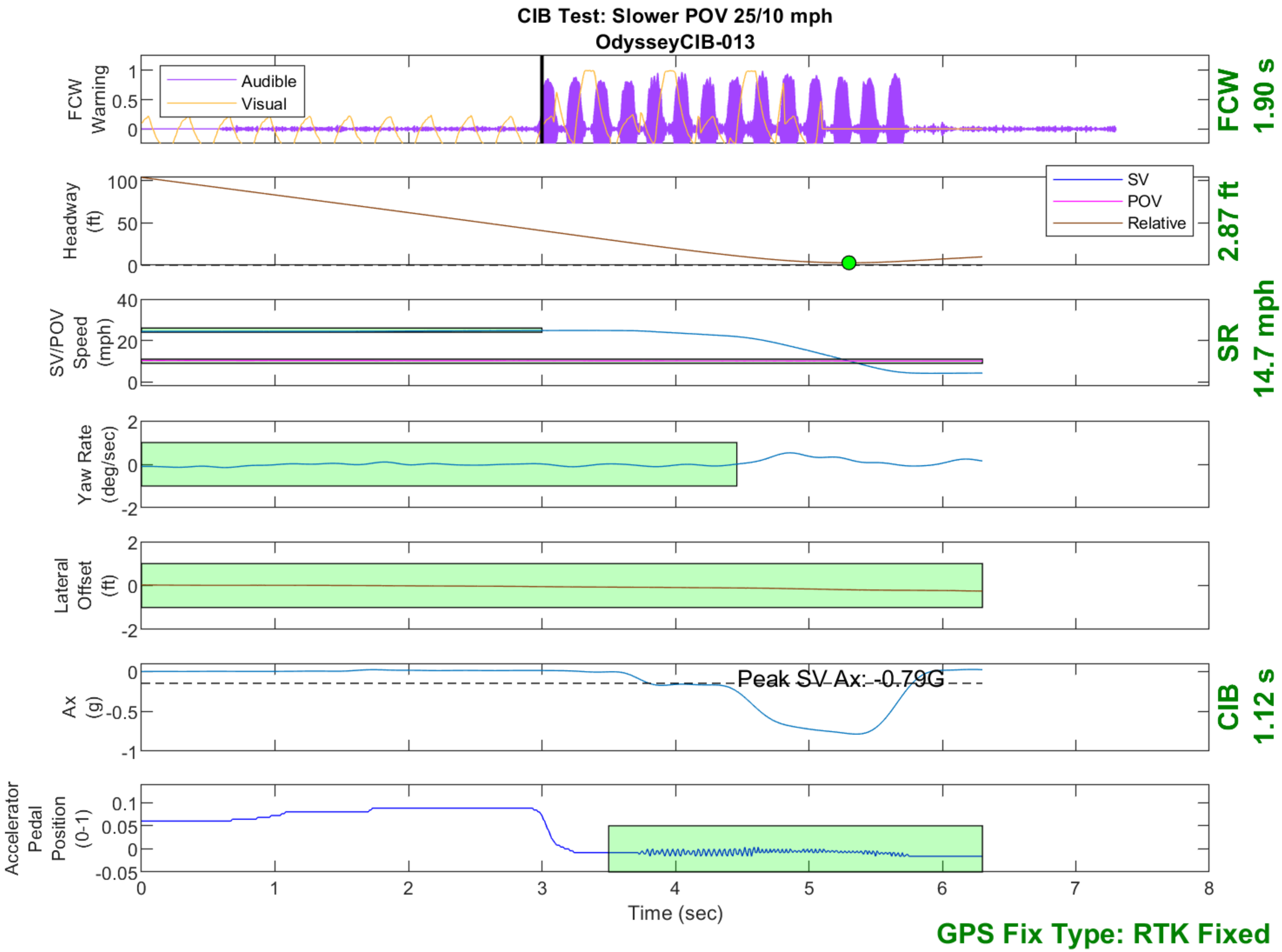


Figure D19. Time History for CIB Run 13, SV Encounters Slower POV, SV 25 mph, POV 10 mph

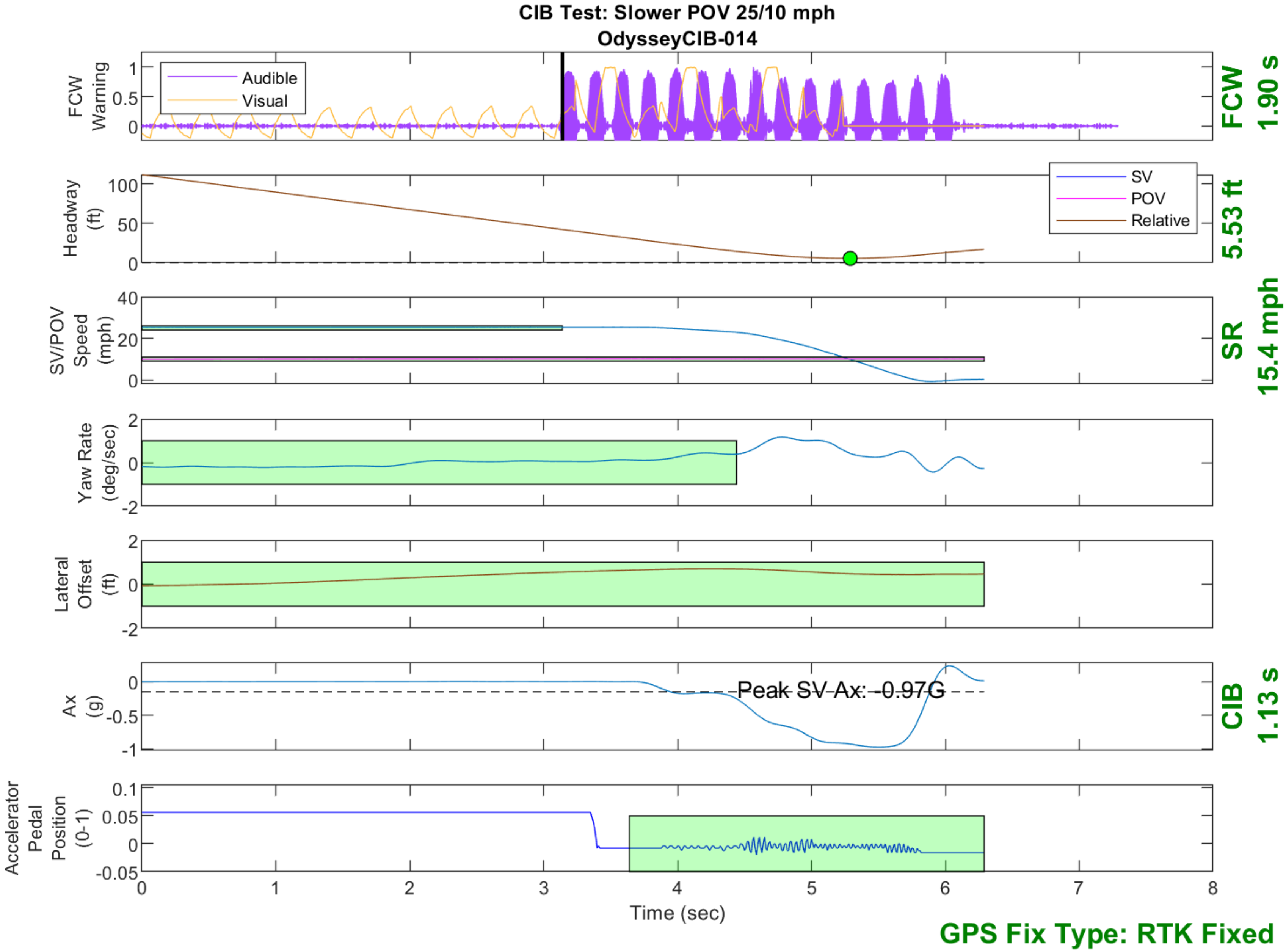


Figure D20. Time History for CIB Run 14, SV Encounters Slower POV, SV 25 mph, POV 10 mph

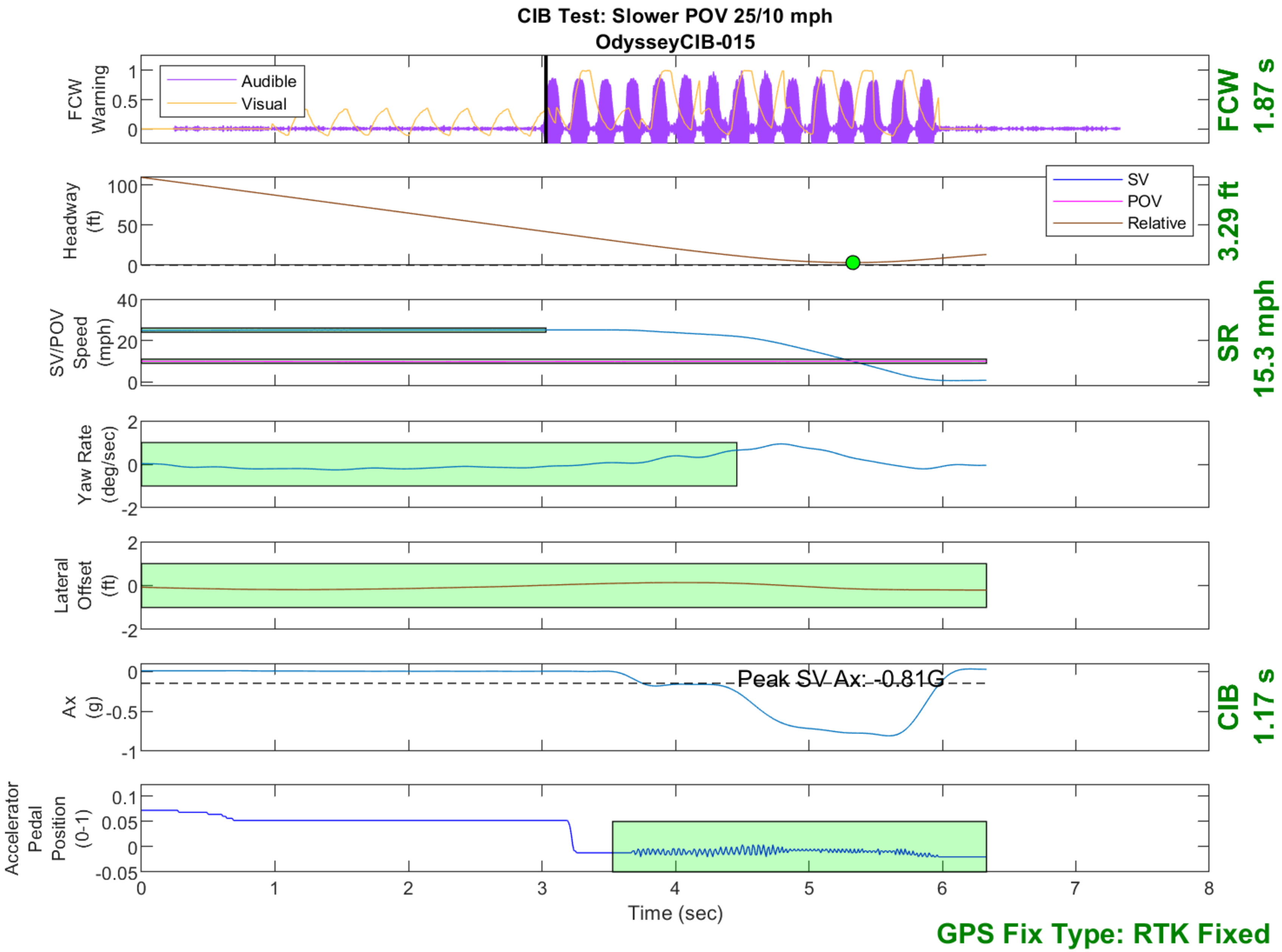


Figure D21. Time History for CIB Run 15, SV Encounters Slower POV, SV 25 mph, POV 10 mph

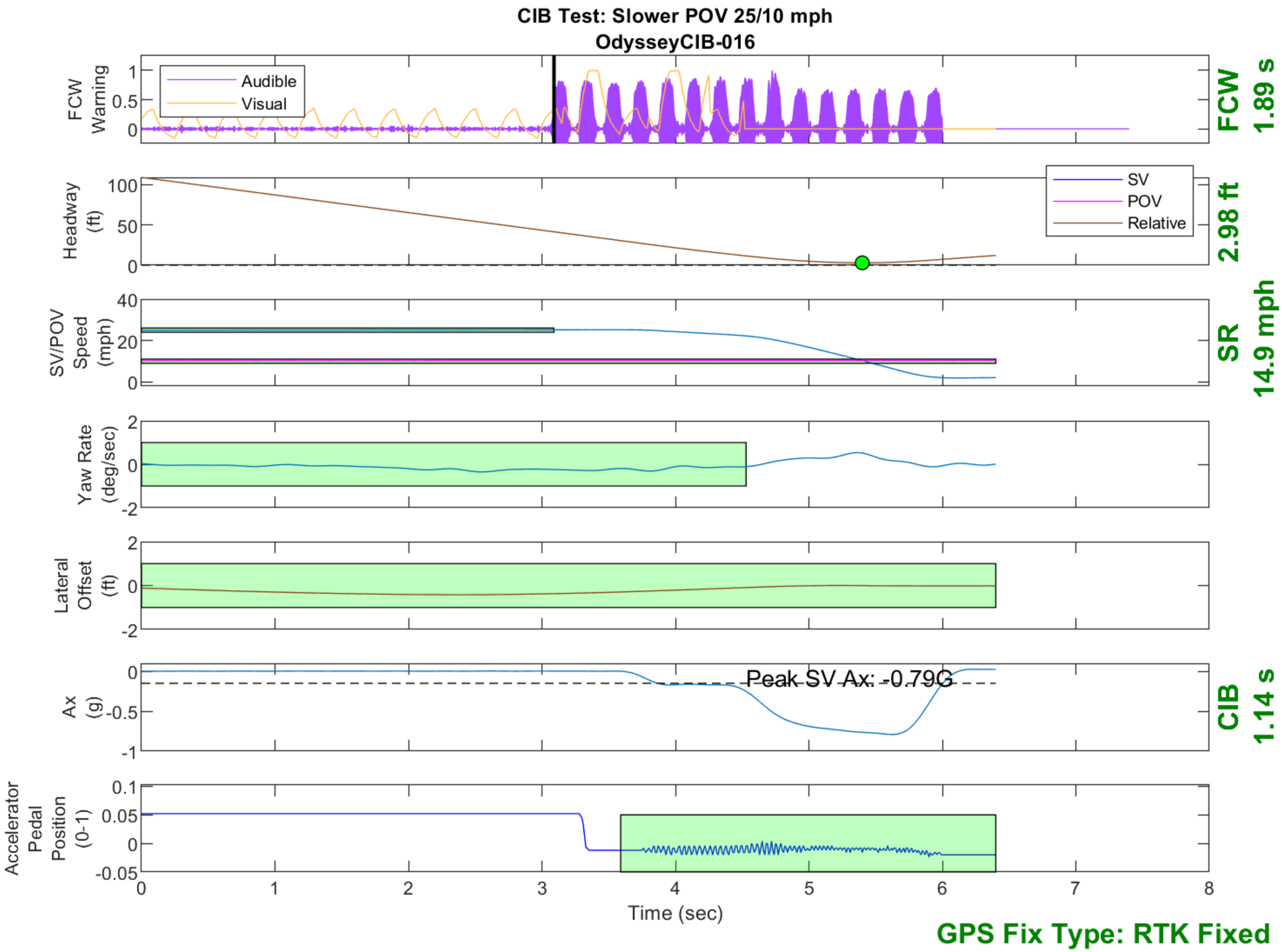


Figure D22. Time History for CIB Run 16, SV Encounters Slower POV, SV 25 mph, POV 10 mph

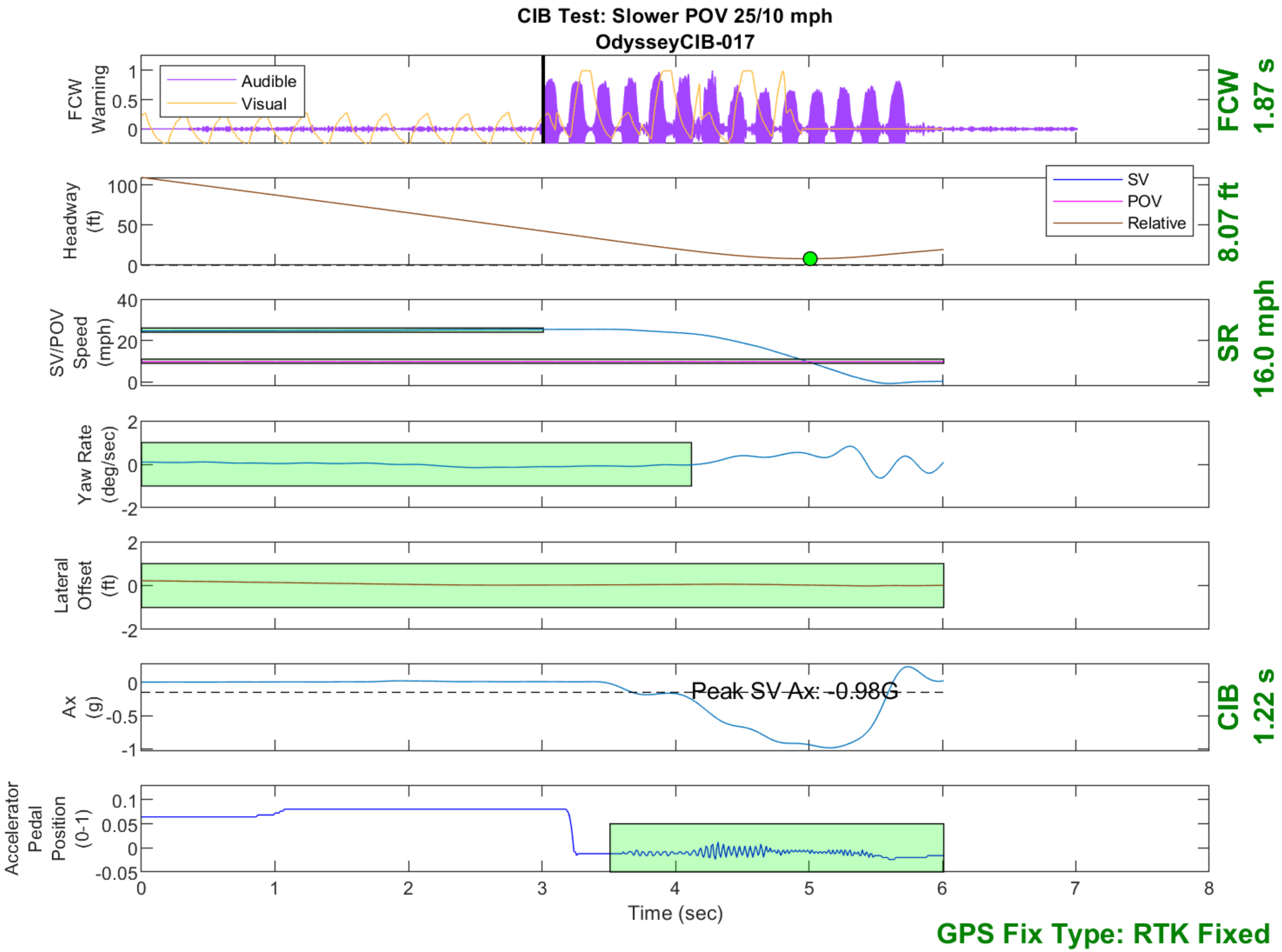


Figure D23. Time History for CIB Run 17, SV Encounters Slower POV, SV 25 mph, POV 10 mph

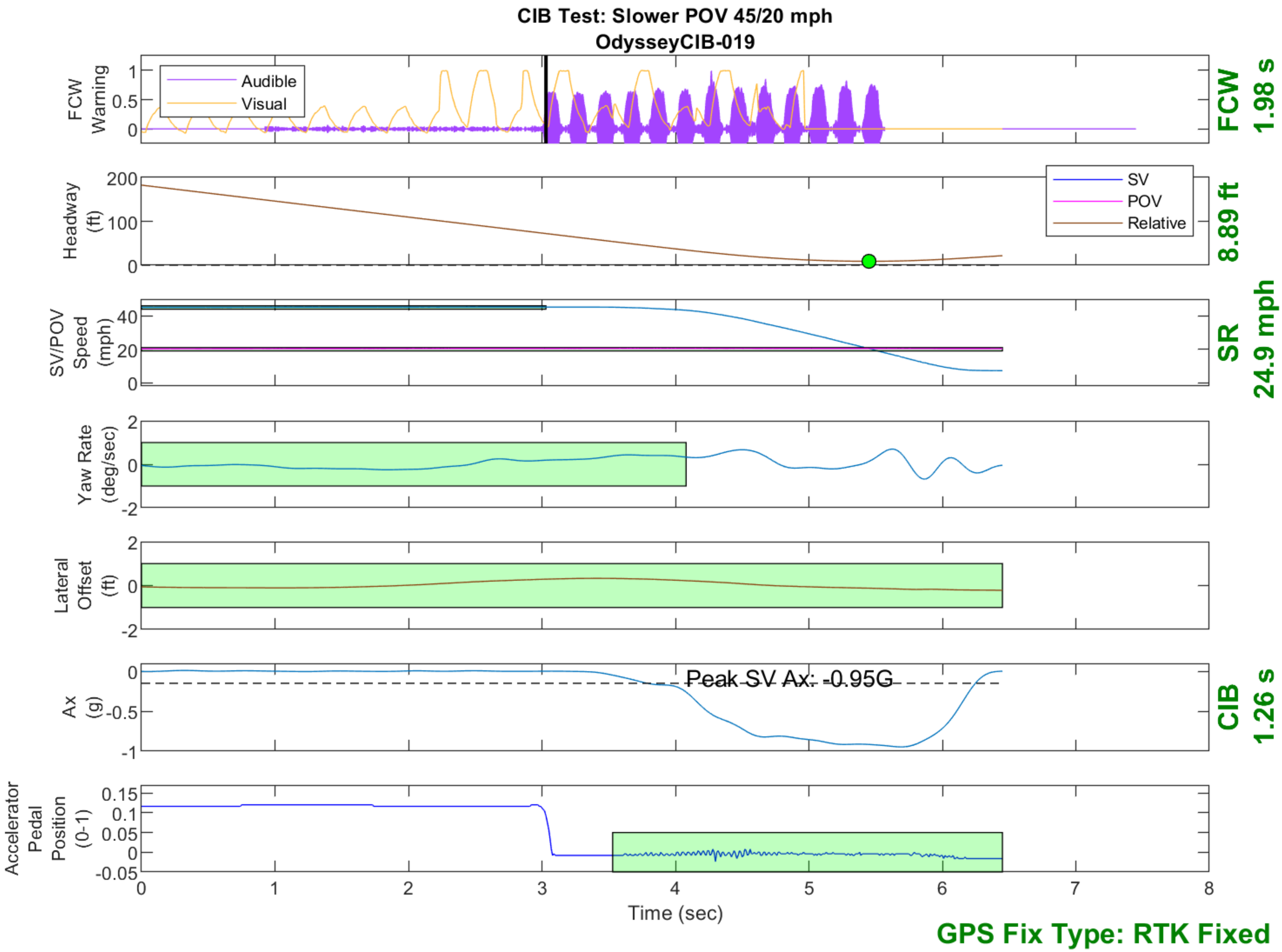


Figure D24. Time History for CIB Run 19, SV Encounters Slower POV, SV 45 mph, POV 20 mph

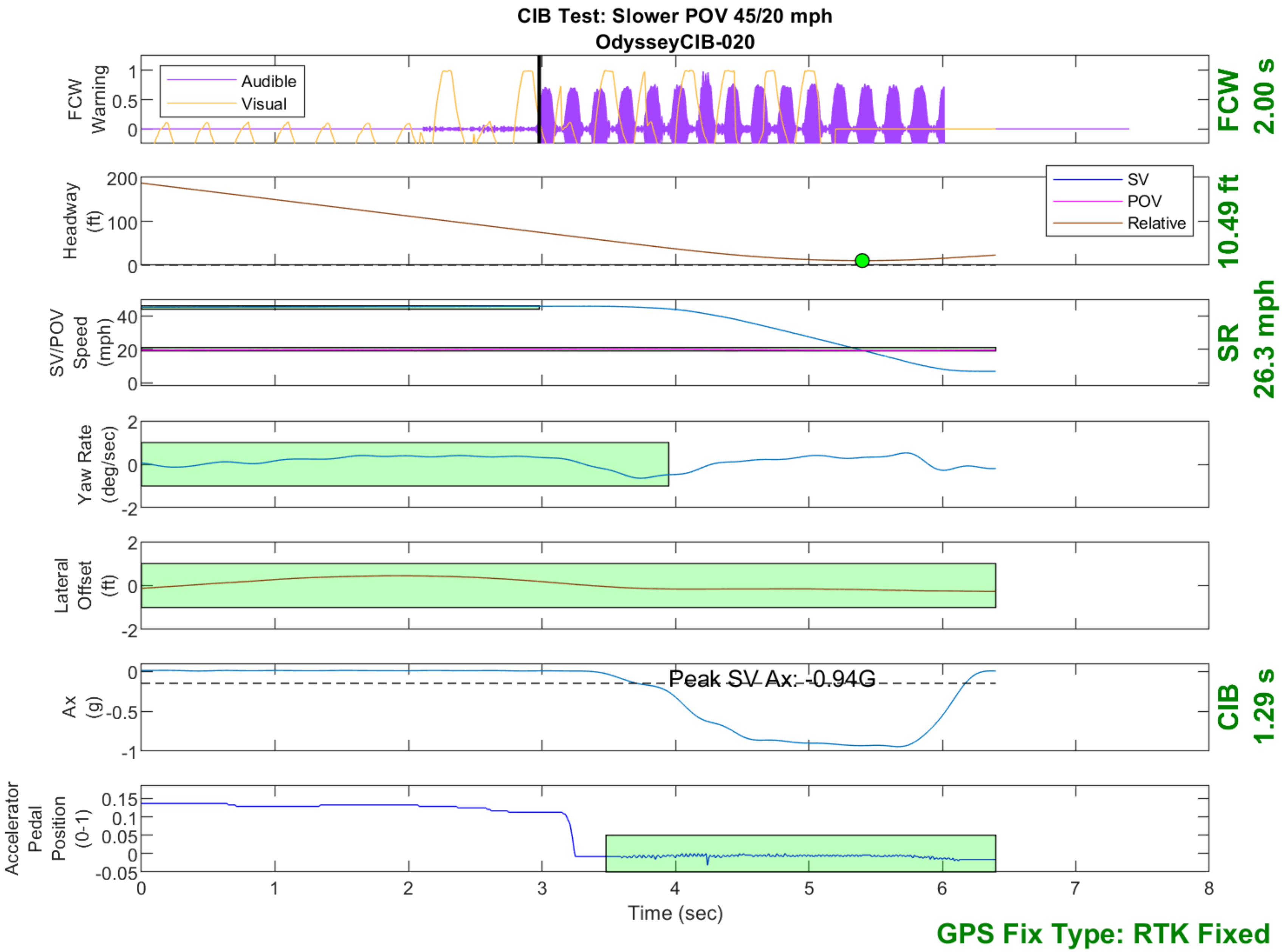


Figure D25. Time History for CIB Run 20, SV Encounters Slower POV, SV 45 mph, POV 20 mph

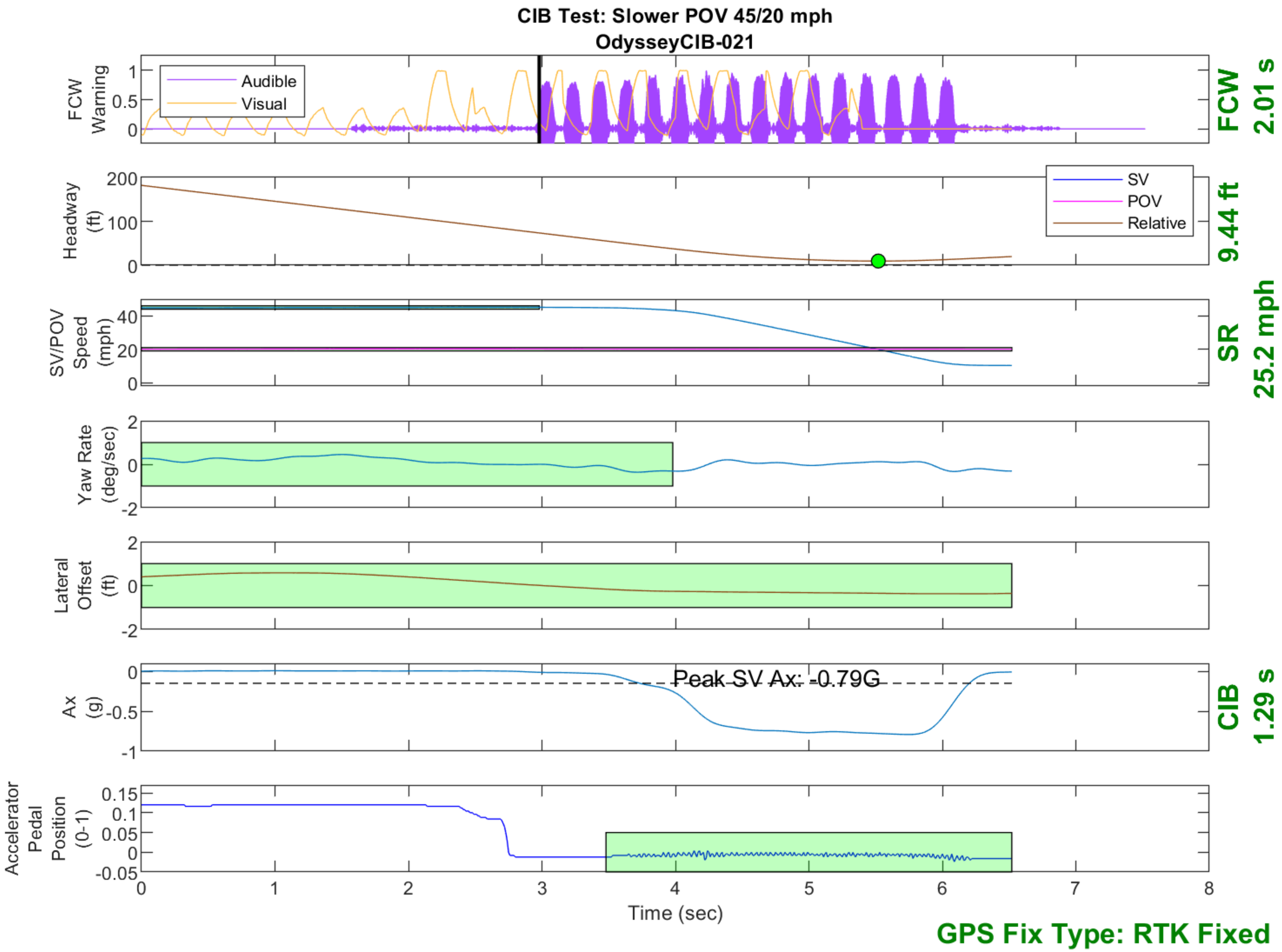


Figure D26. Time History for CIB Run 21, SV Encounters Slower POV, SV 45 mph, POV 20 mph

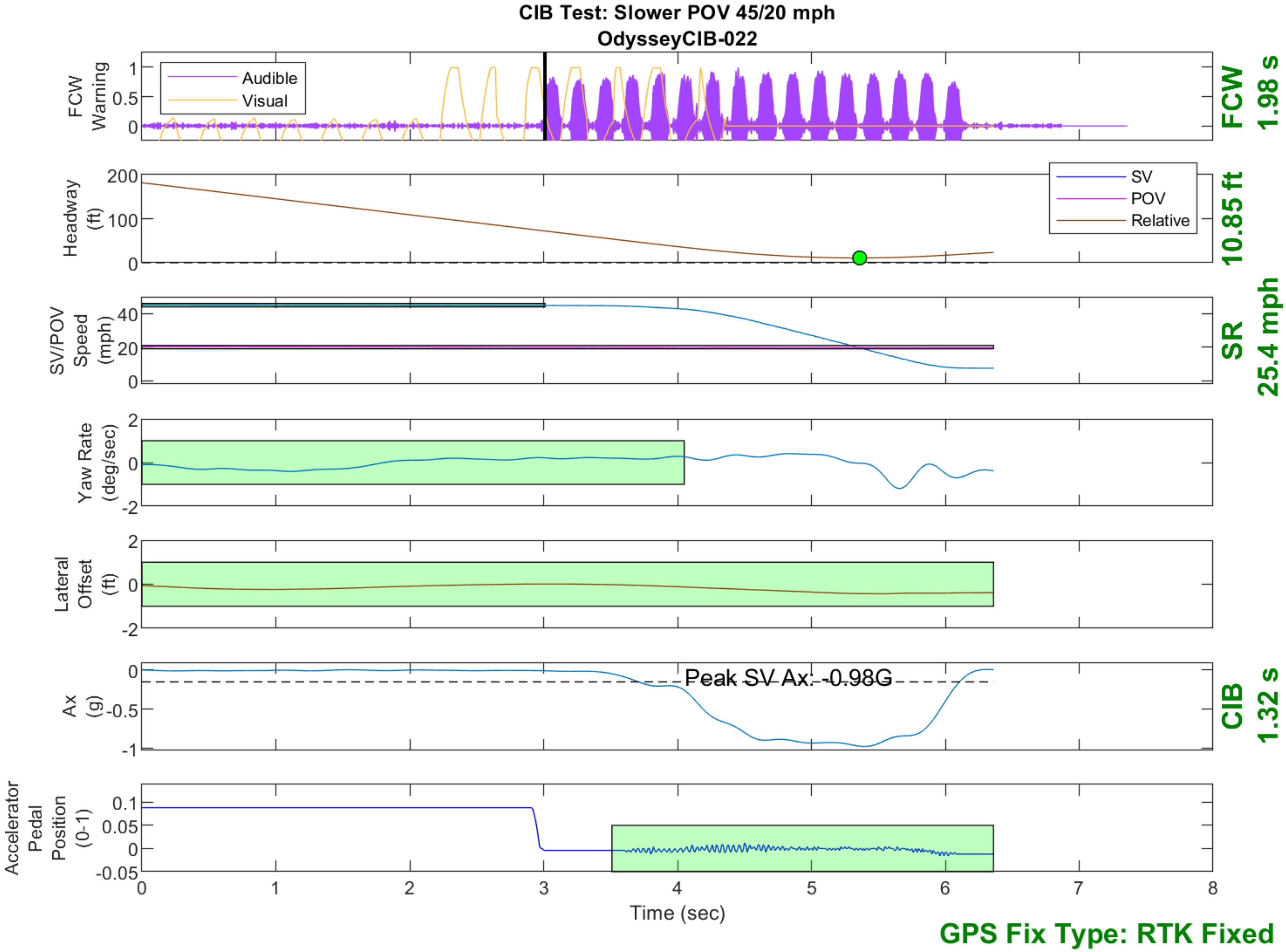


Figure D27. Time History for CIB Run 22, SV Encounters Slower POV, SV 45 mph, POV 20 mph

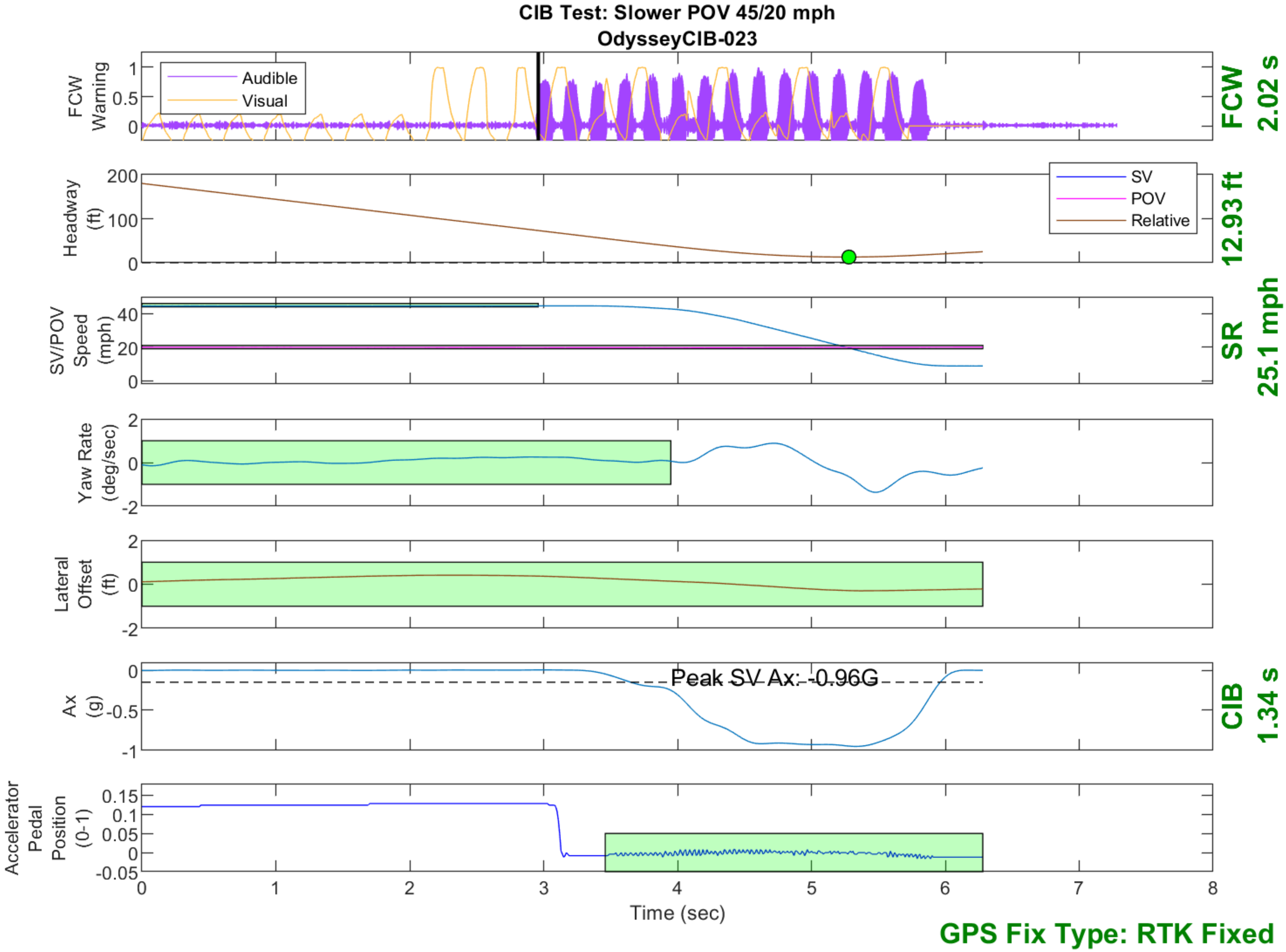


Figure D28. Time History for CIB Run 23, SV Encounters Slower POV, SV 45 mph, POV 20 mph

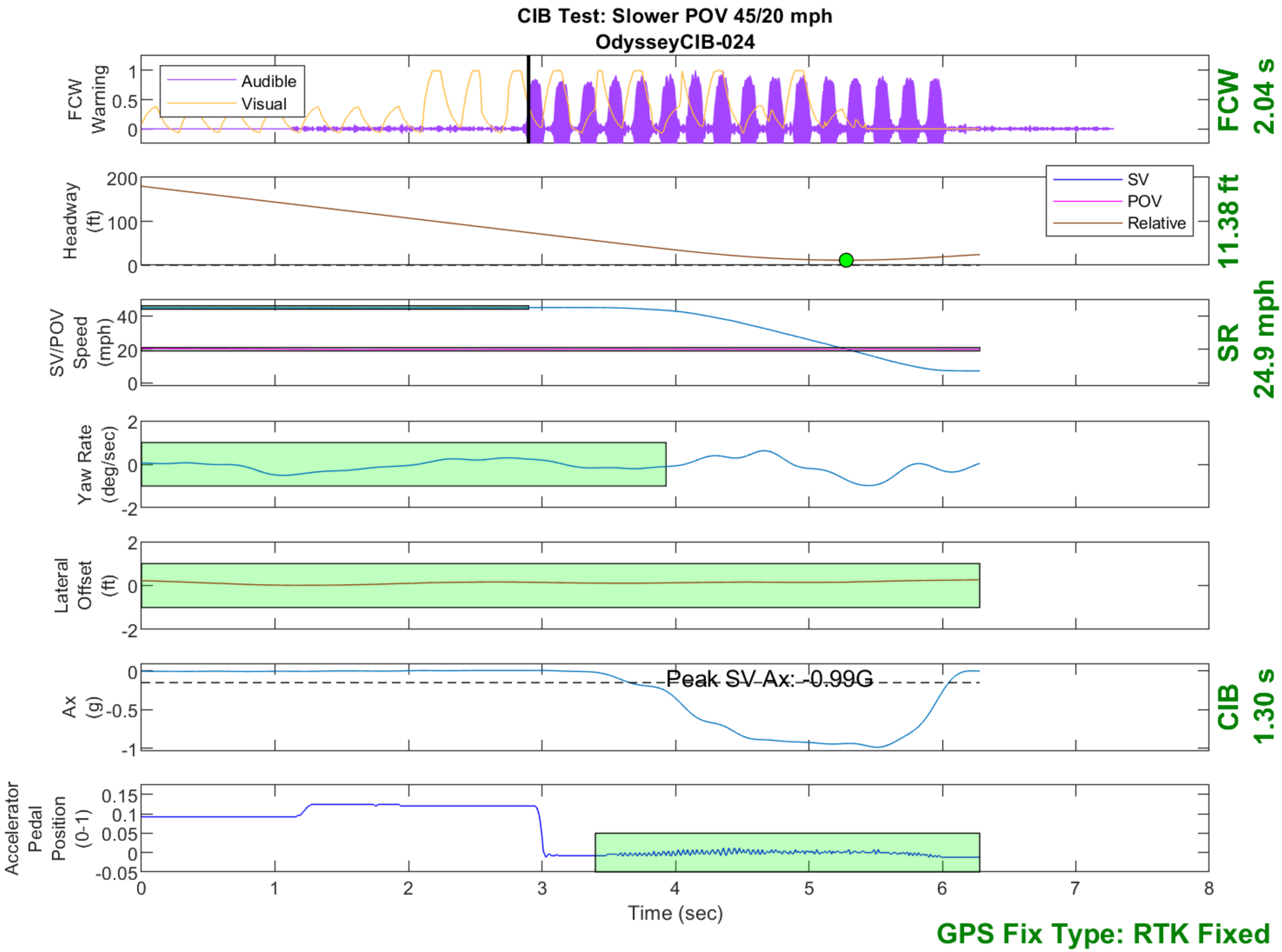


Figure D29. Time History for CIB Run 24, SV Encounters Slower POV, SV 45 mph, POV 20 mph

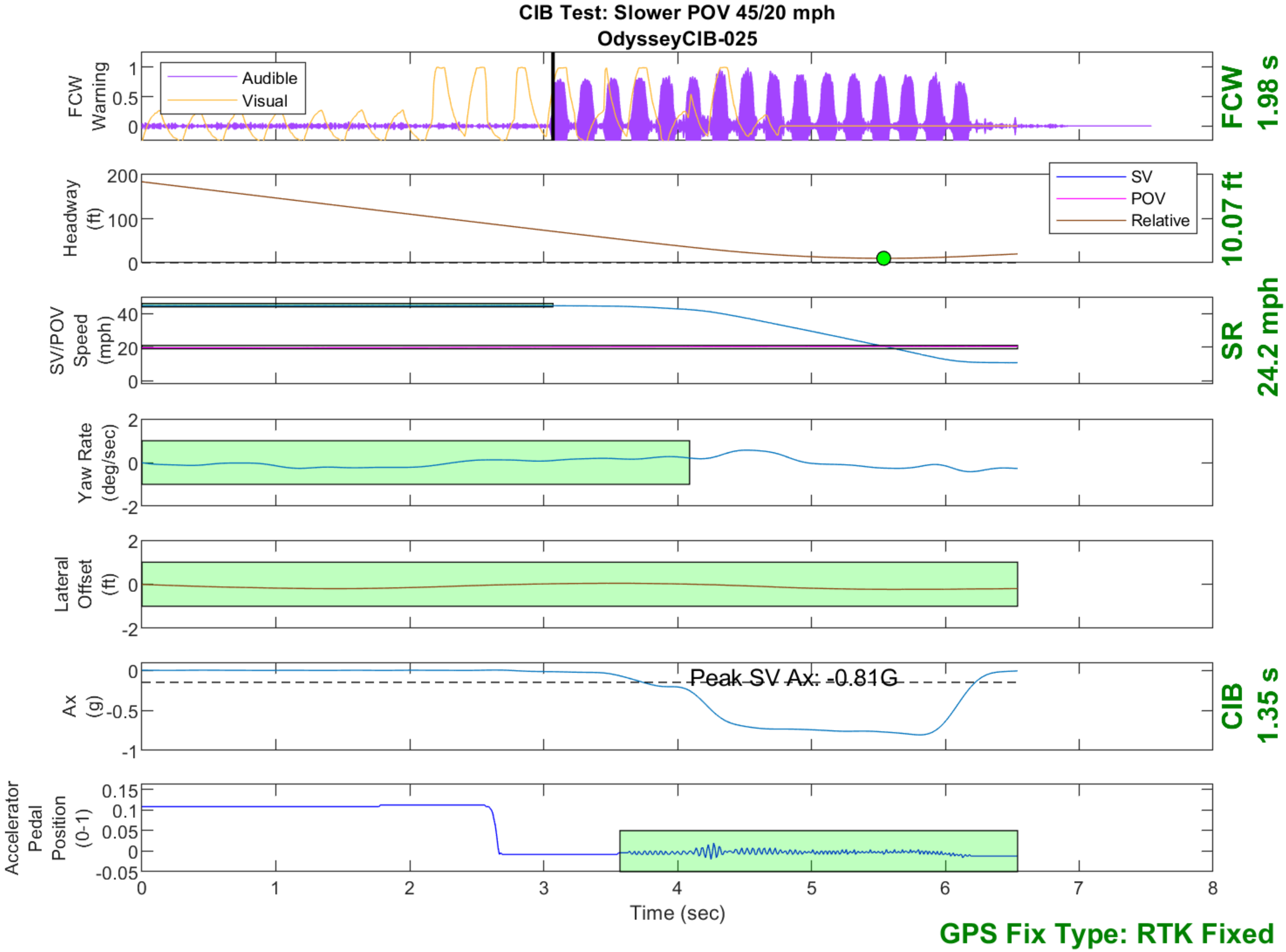


Figure D30. Time History for CIB Run 25, SV Encounters Slower POV, SV 45 mph, POV 20 mph

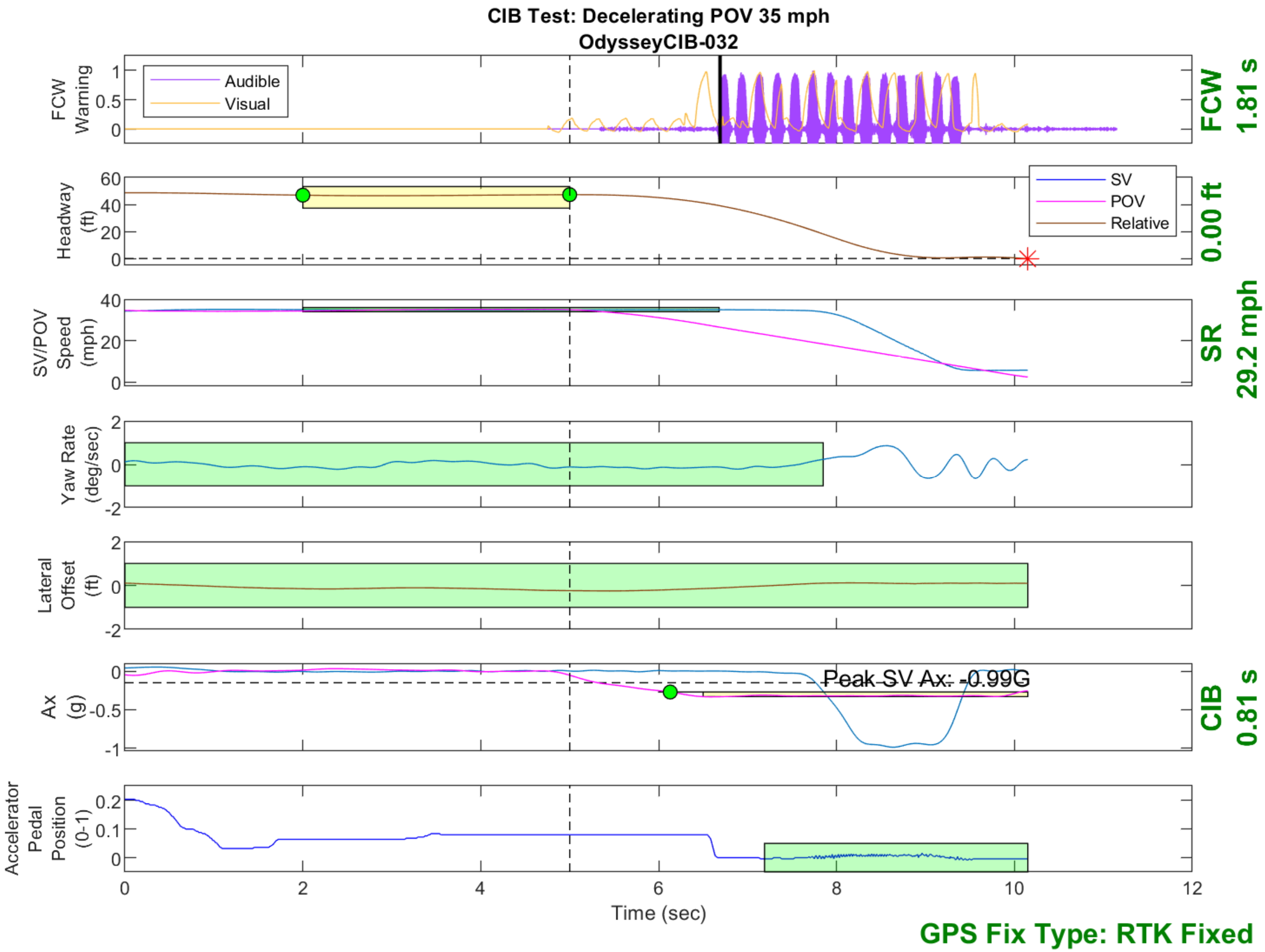


Figure D31. Time History for CIB Run 32, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

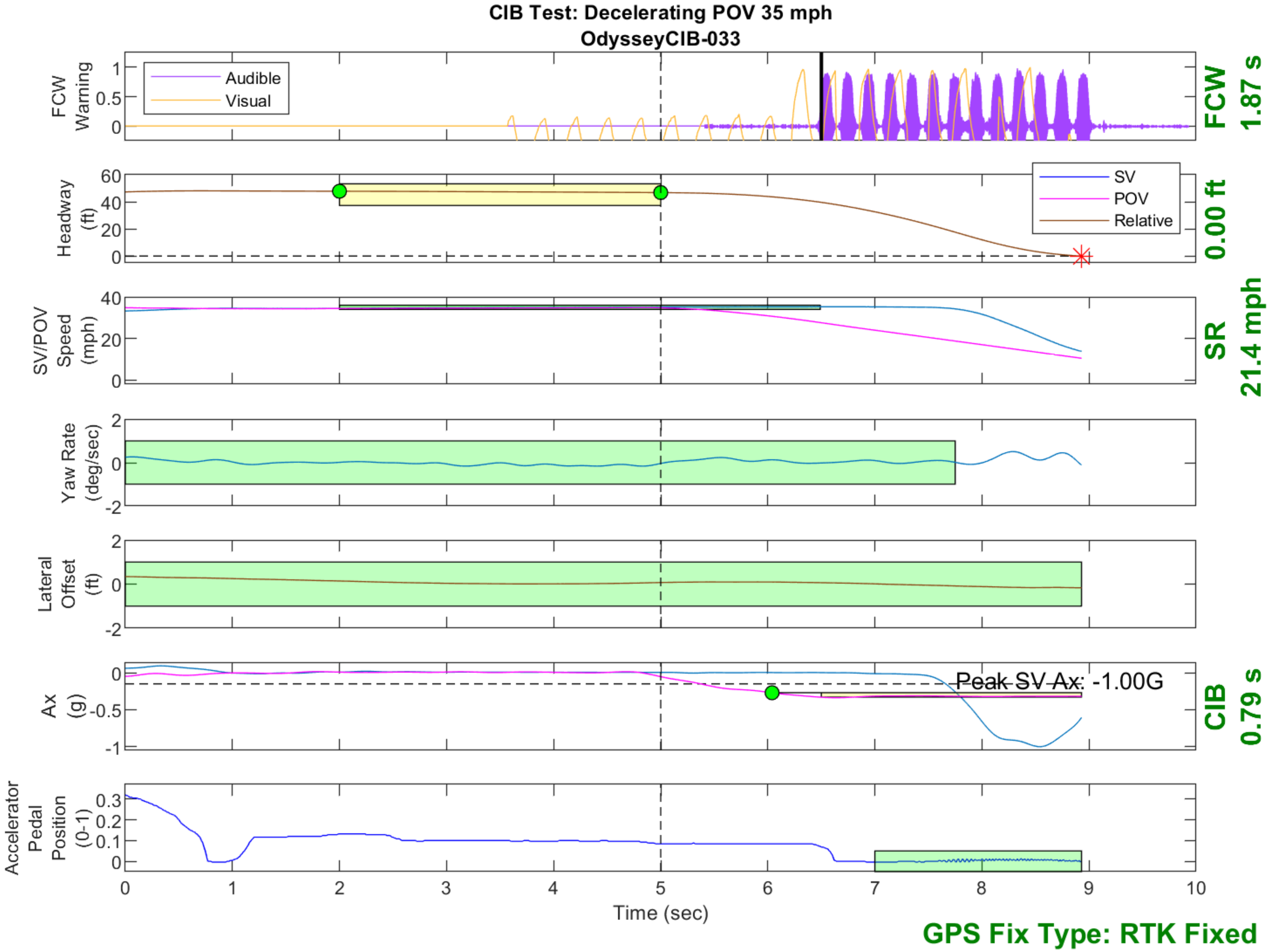


Figure D32. Time History for CIB Run 33, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

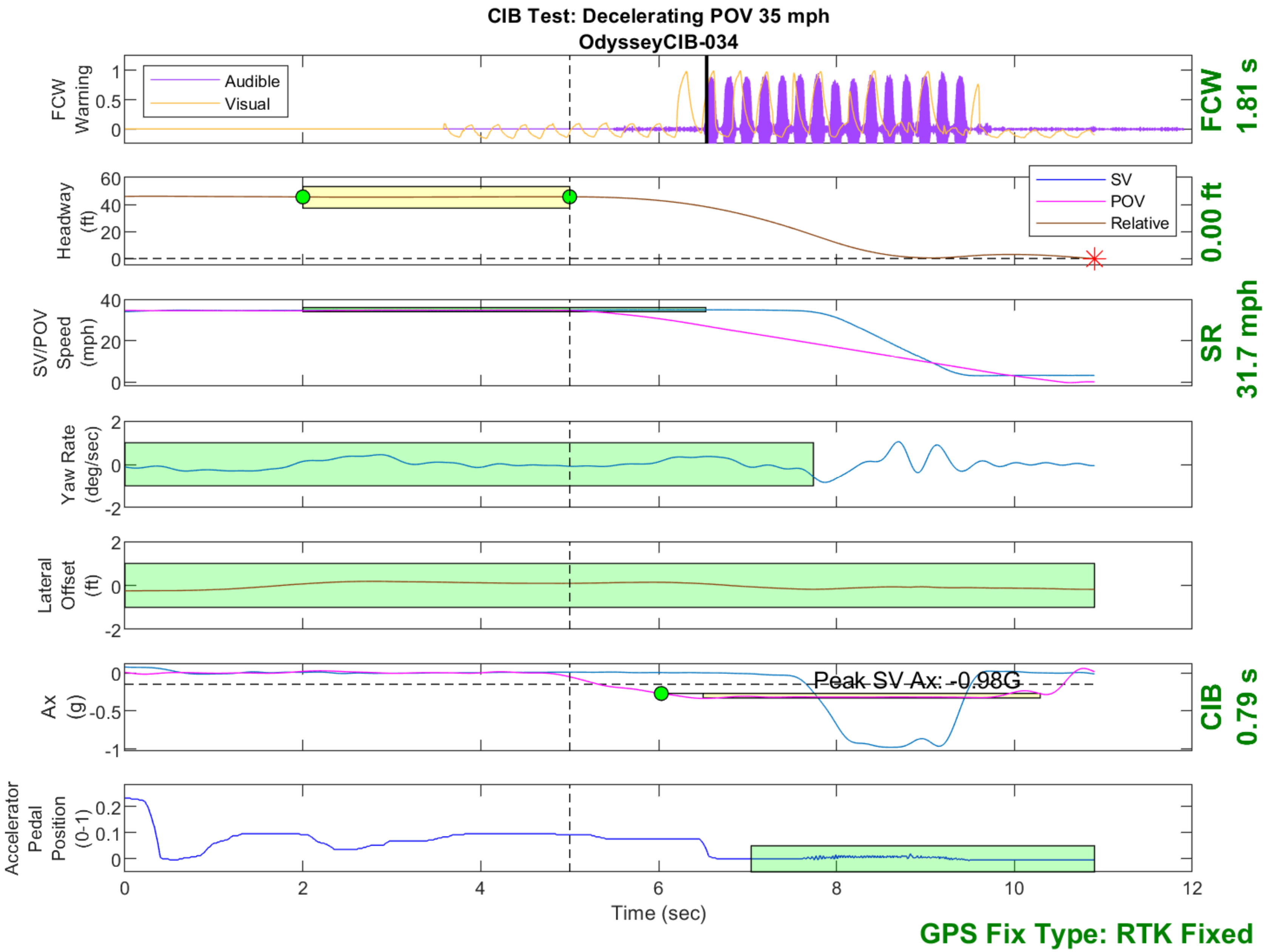


Figure D33. Time History for CIB Run 34, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

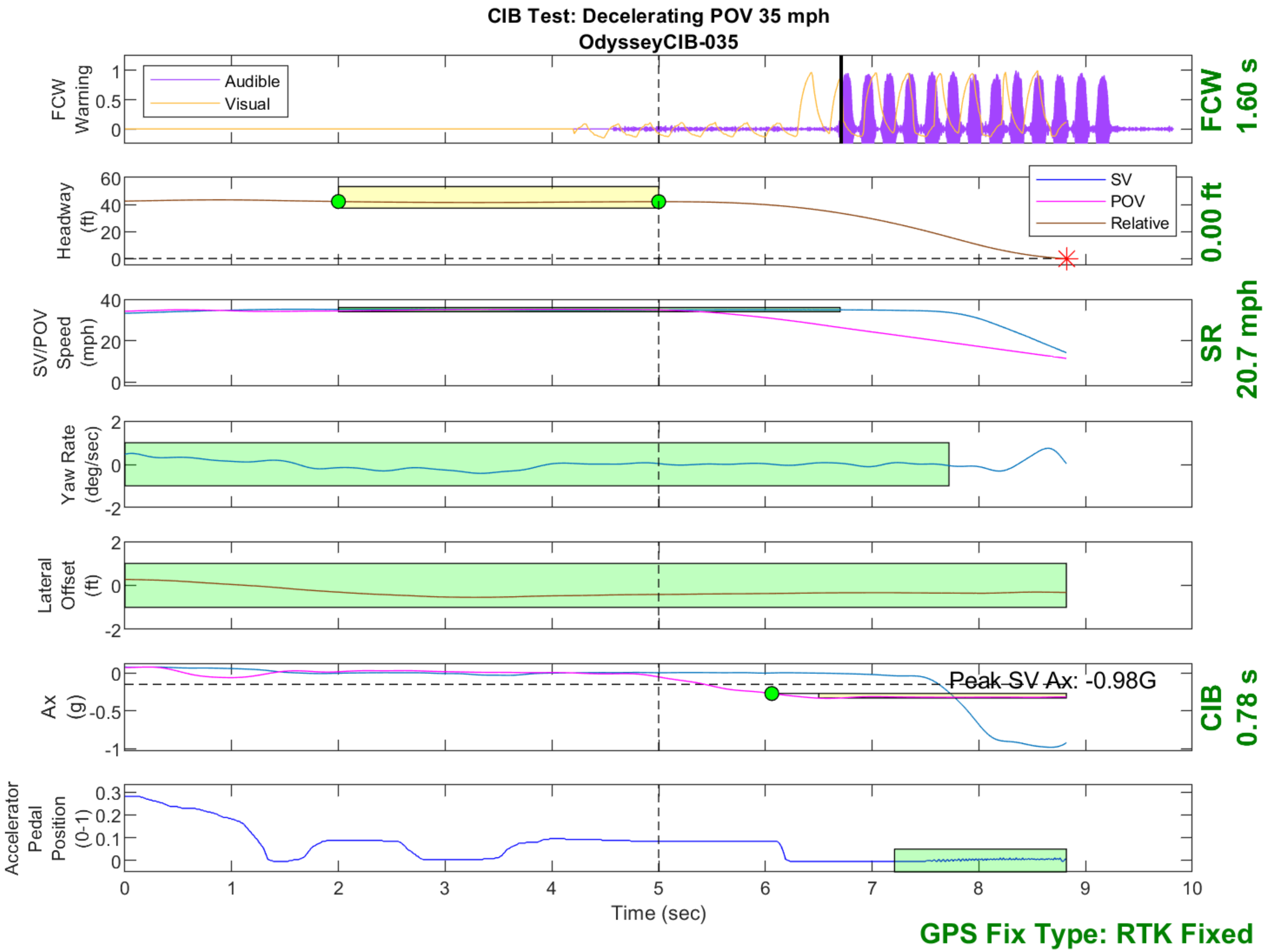


Figure D34. Time History for CIB Run 35, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

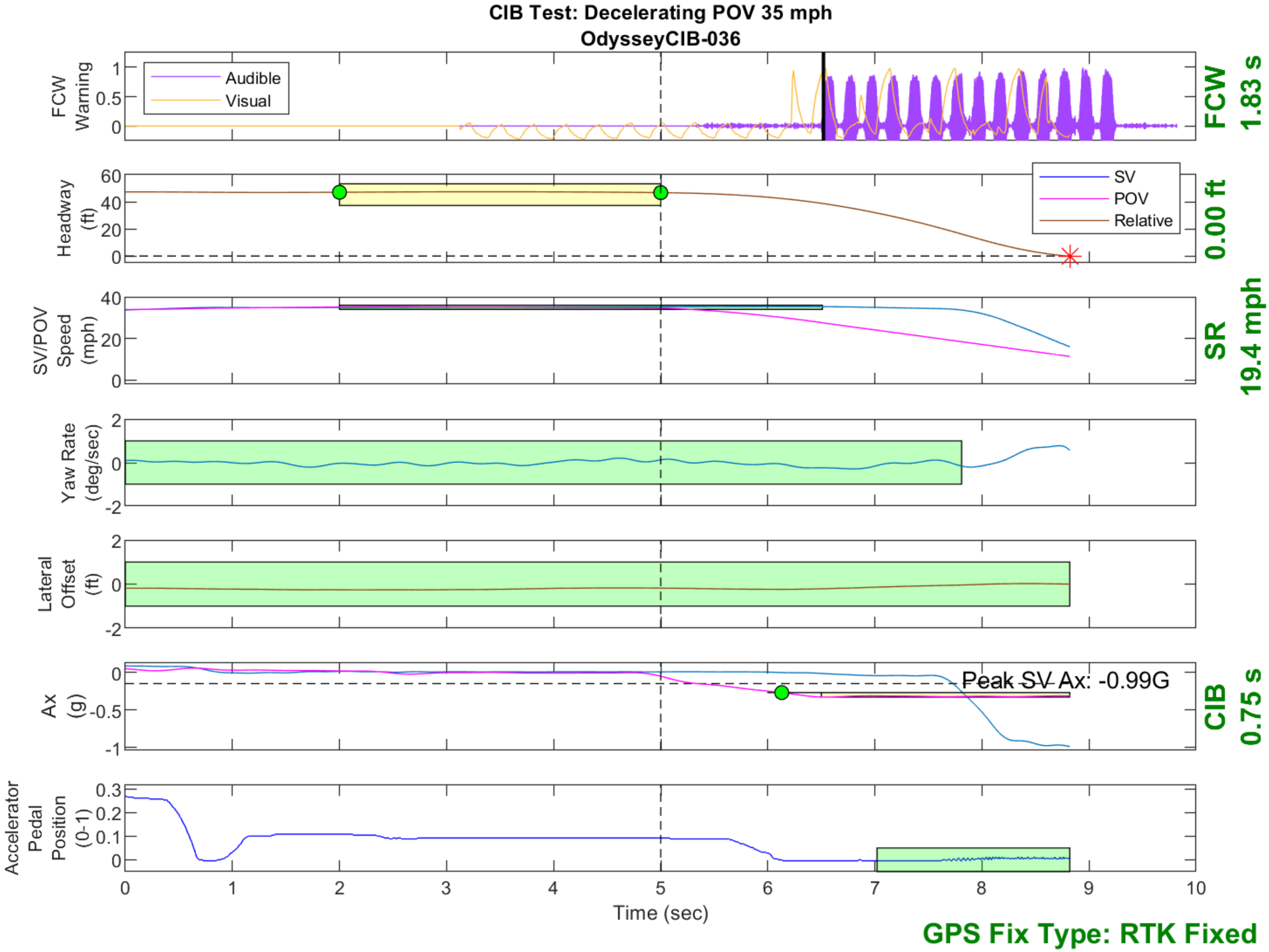


Figure D35. Time History for CIB Run 36, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

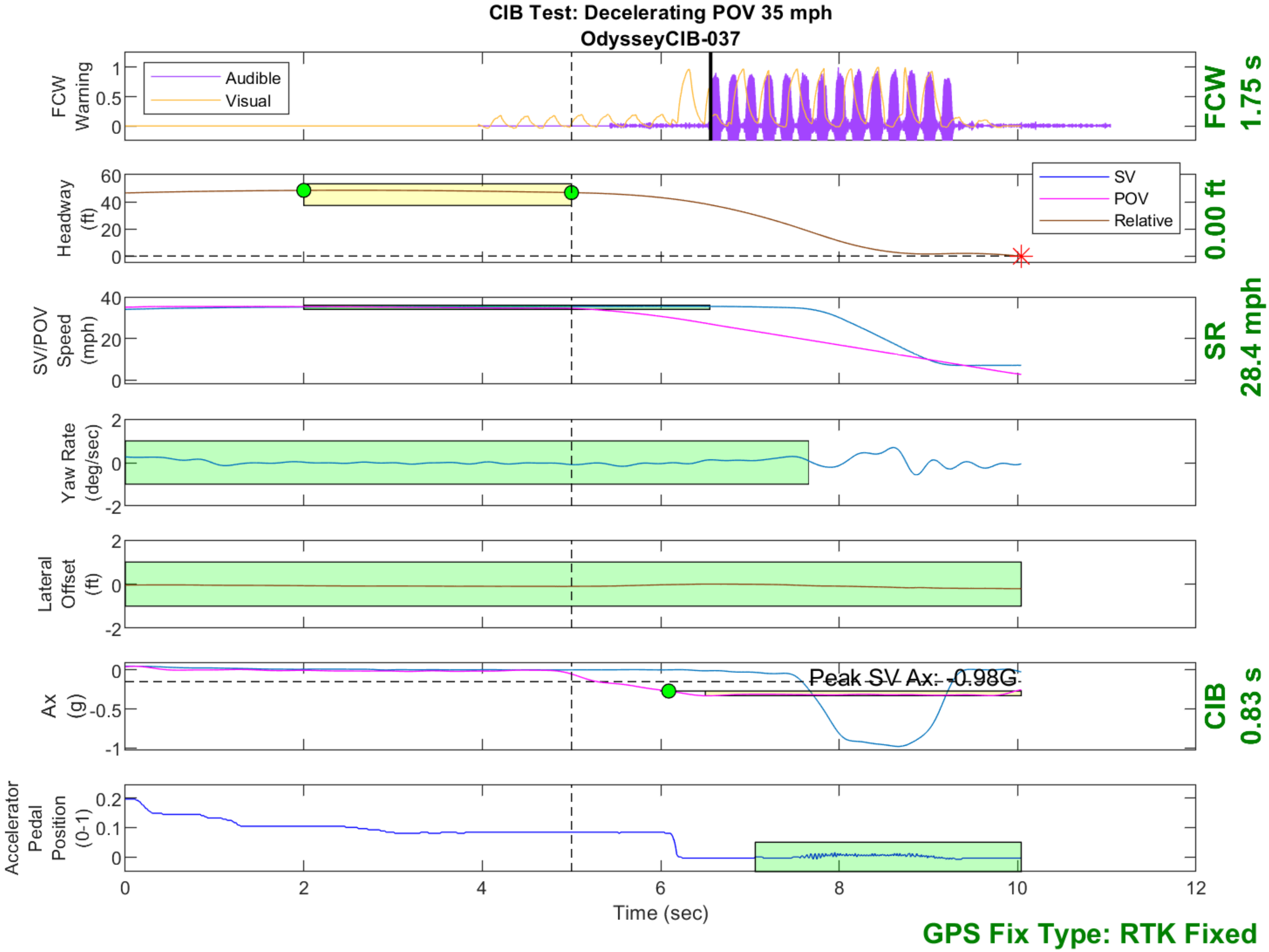


Figure D36. Time History for CIB Run 37, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

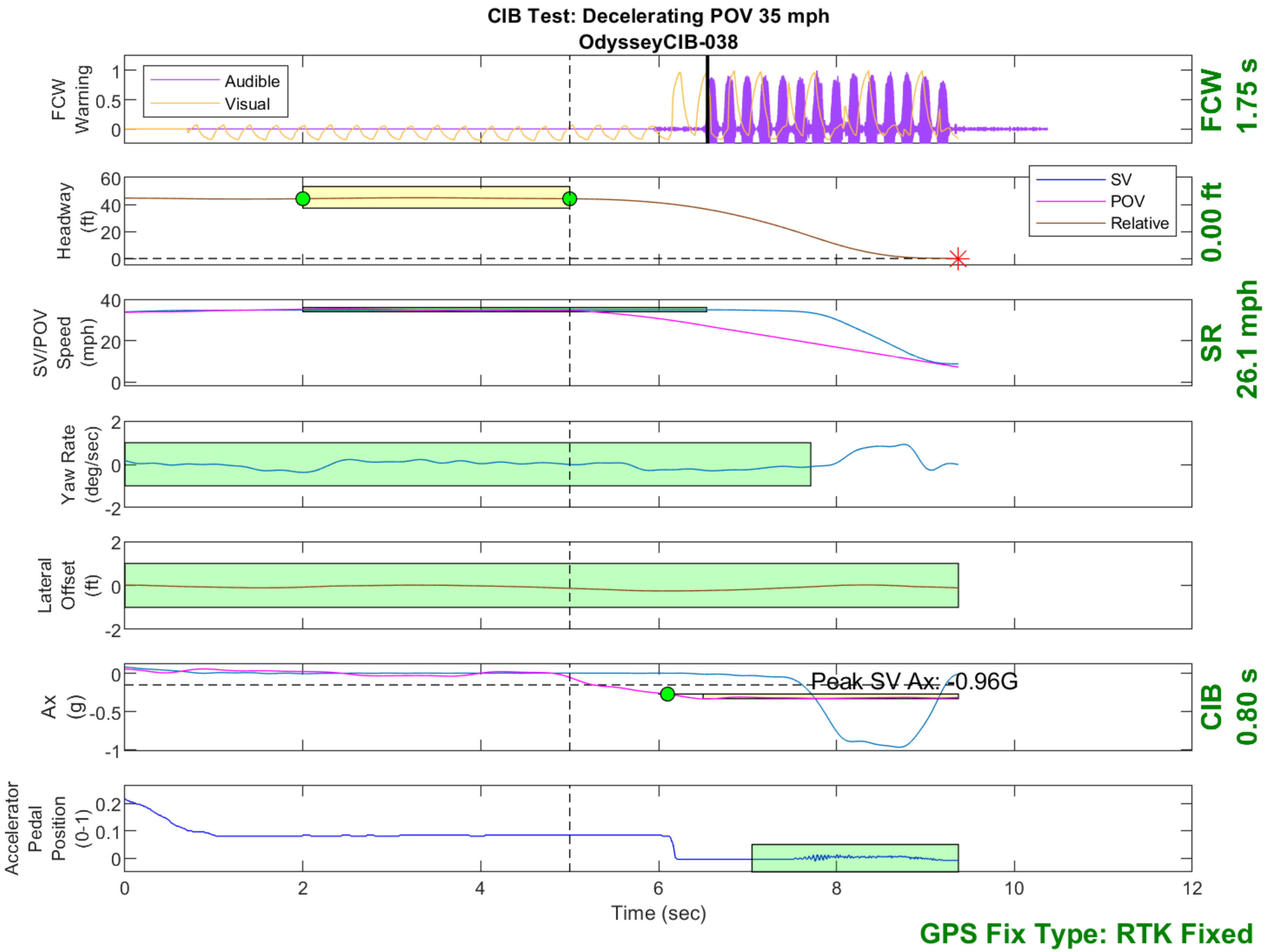


Figure D37. Time History for CIB Run 38, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

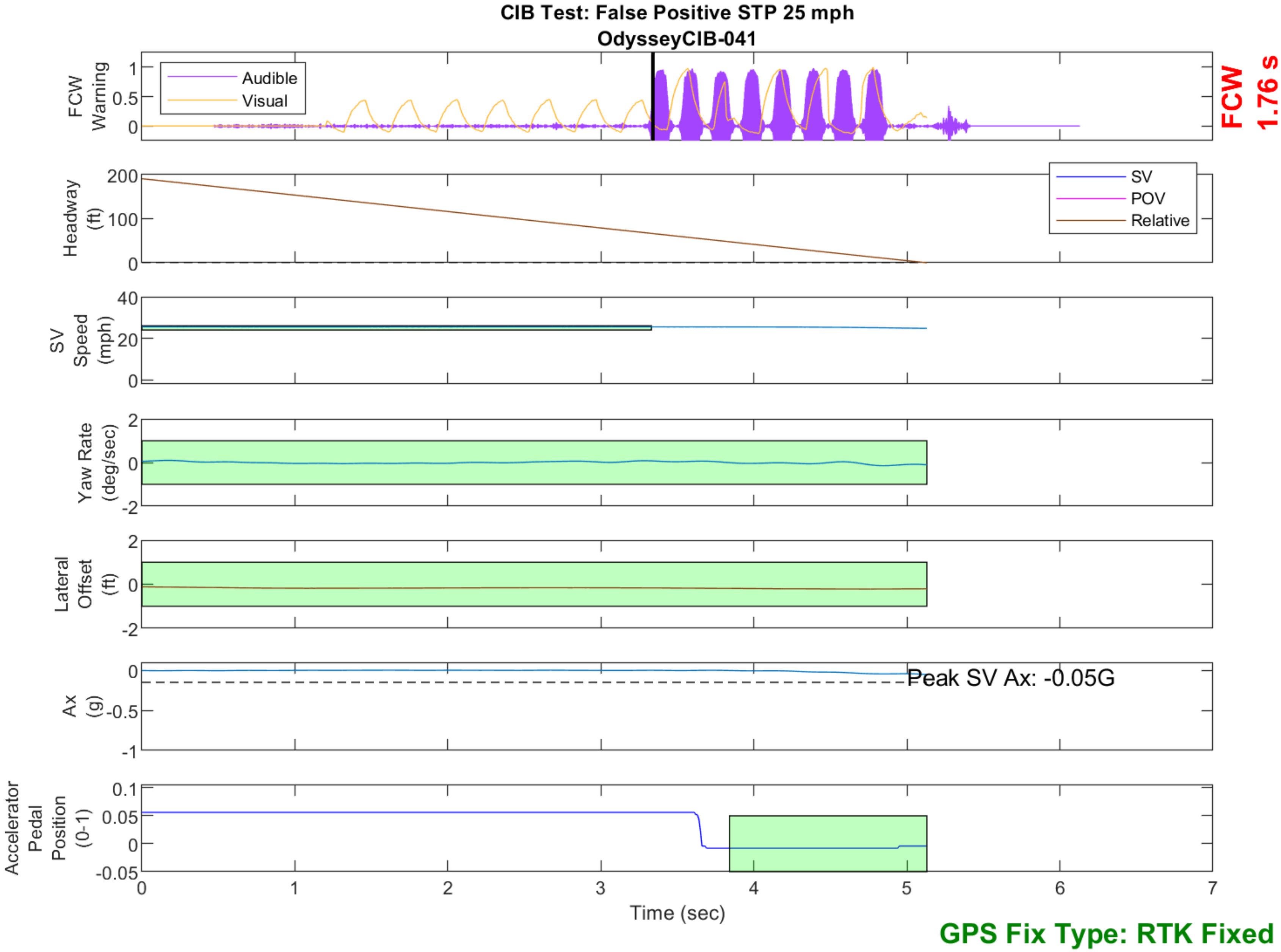


Figure D38. Time History for CIB Run 41, SV Encounters Steel Trench Plate, SV 25 mph

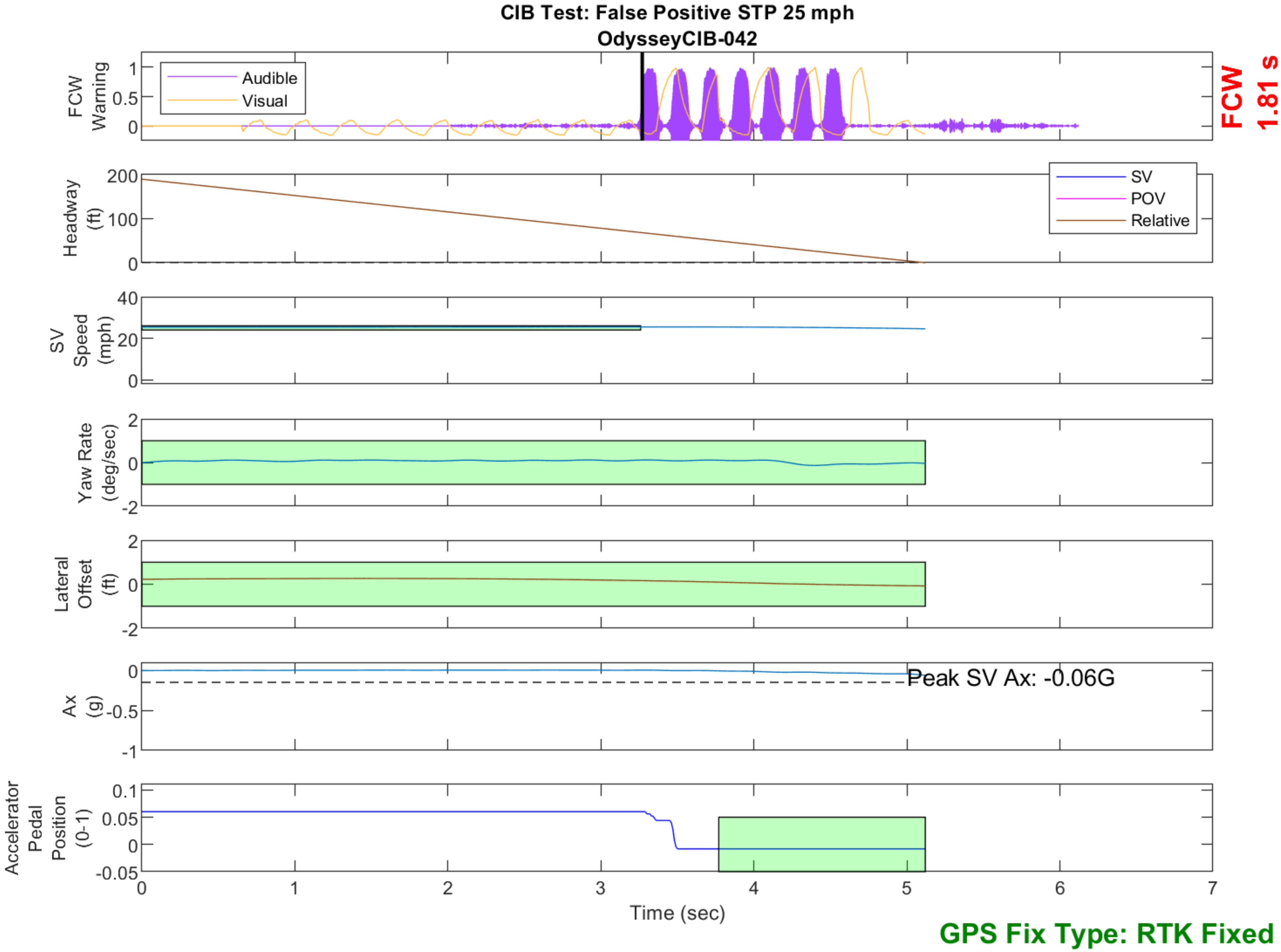


Figure D39. Time History for CIB Run 42, SV Encounters Steel Trench Plate, SV 25 mph

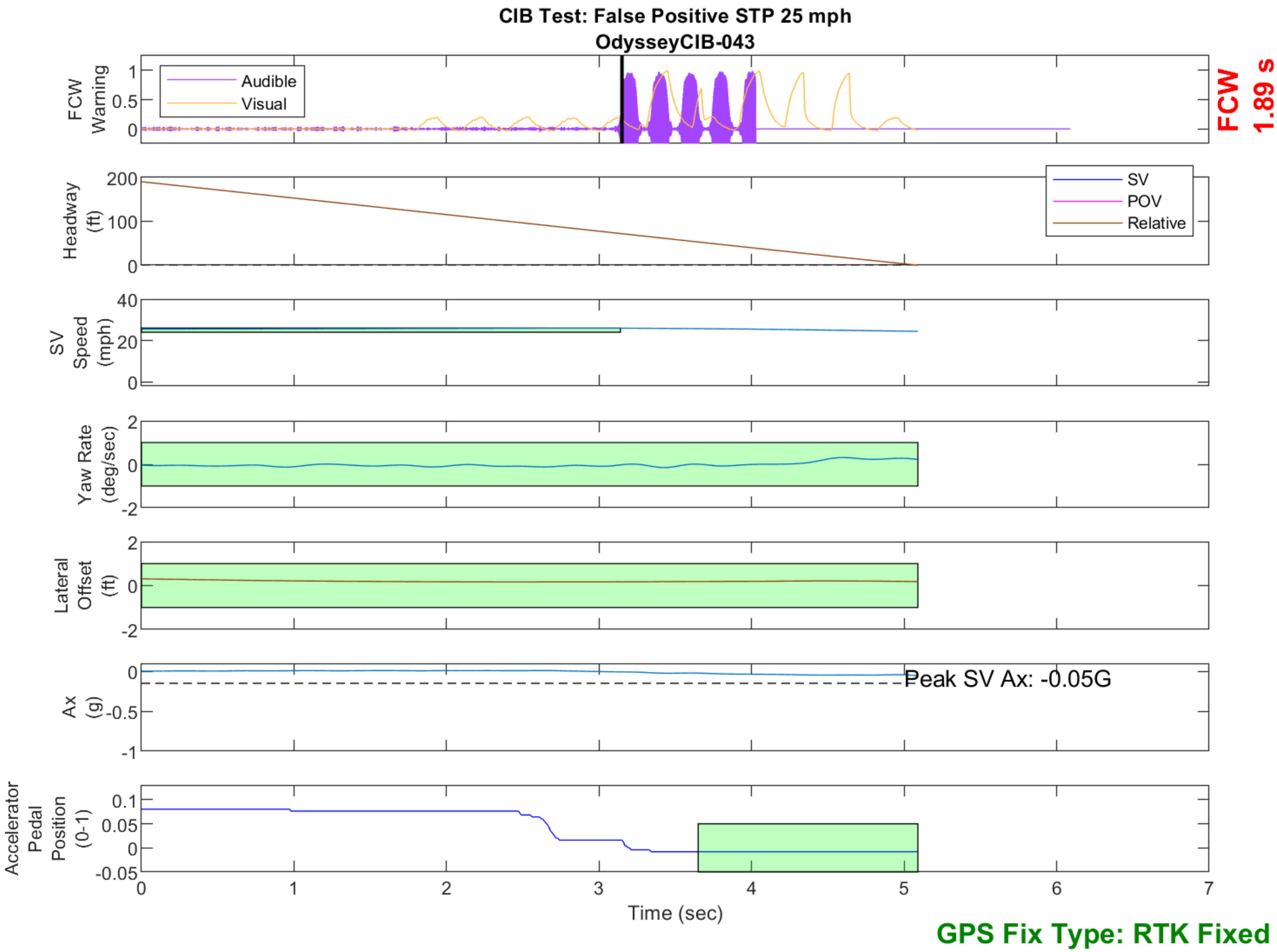


Figure D40. Time History for CIB Run 43, SV Encounters Steel Trench Plate, SV 25 mph

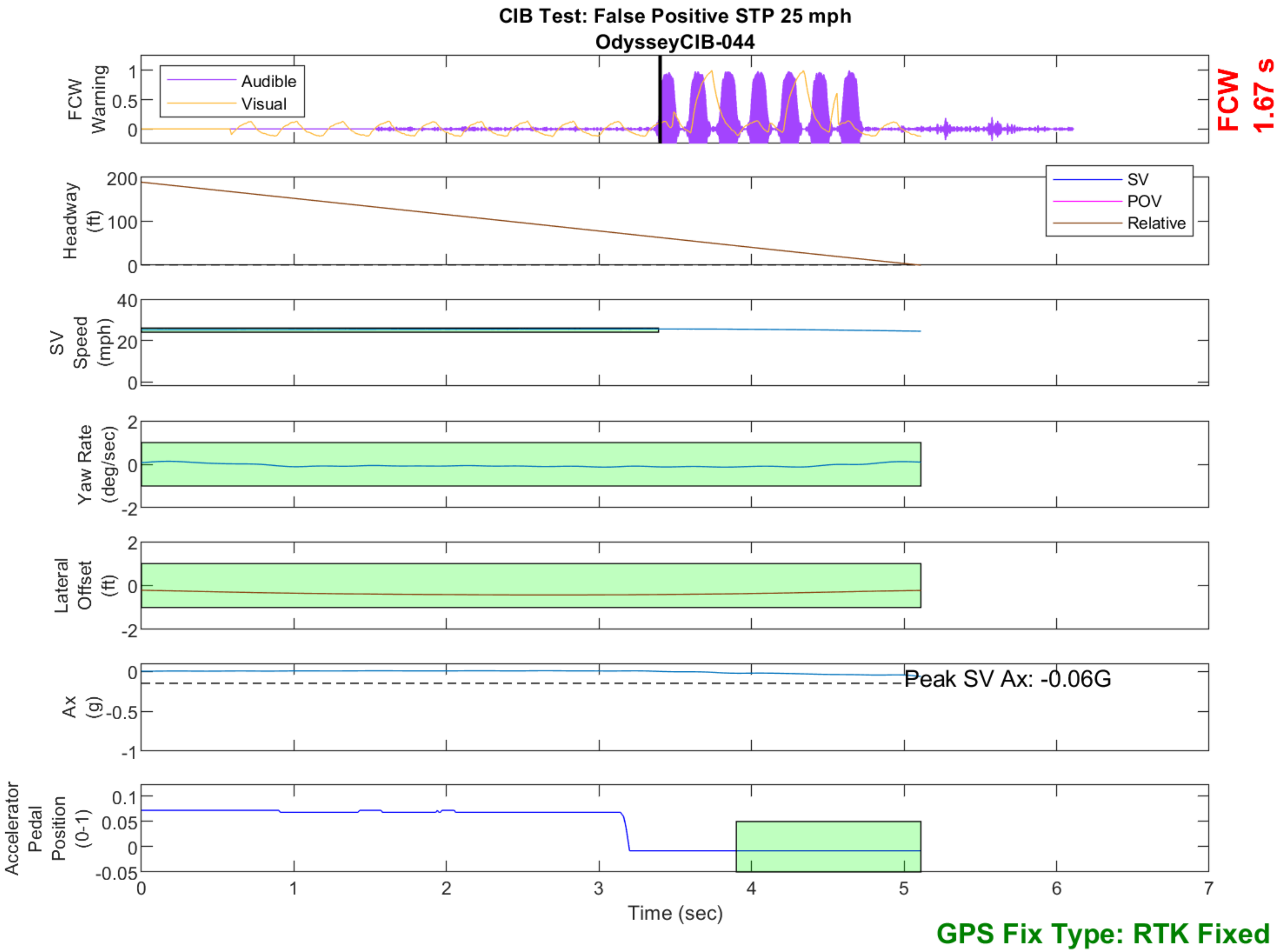


Figure D41. Time History for CIB Run 44, SV Encounters Steel Trench Plate, SV 25 mph

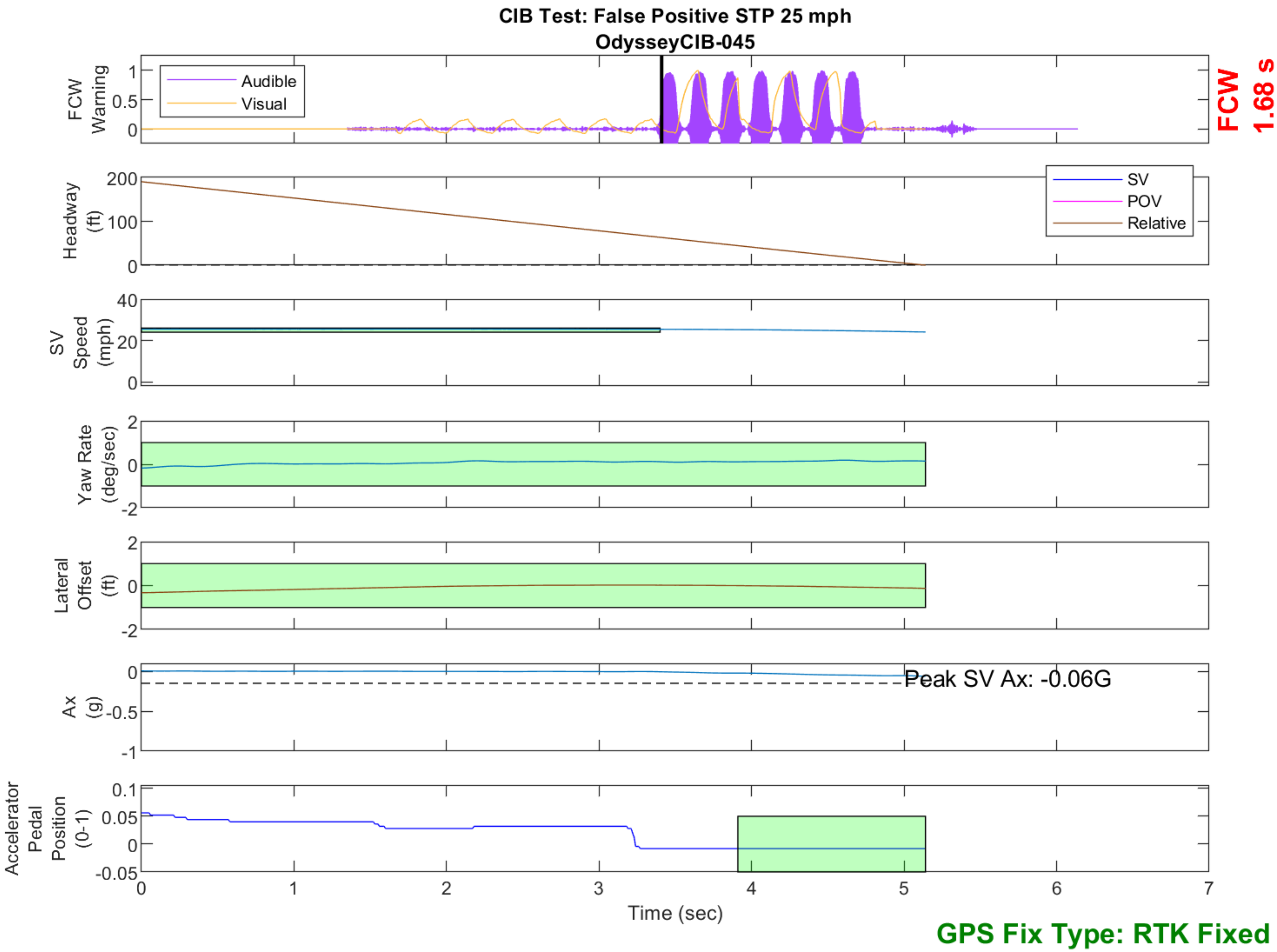


Figure D42. Time History for CIB Run 45, SV Encounters Steel Trench Plate, SV 25 mph

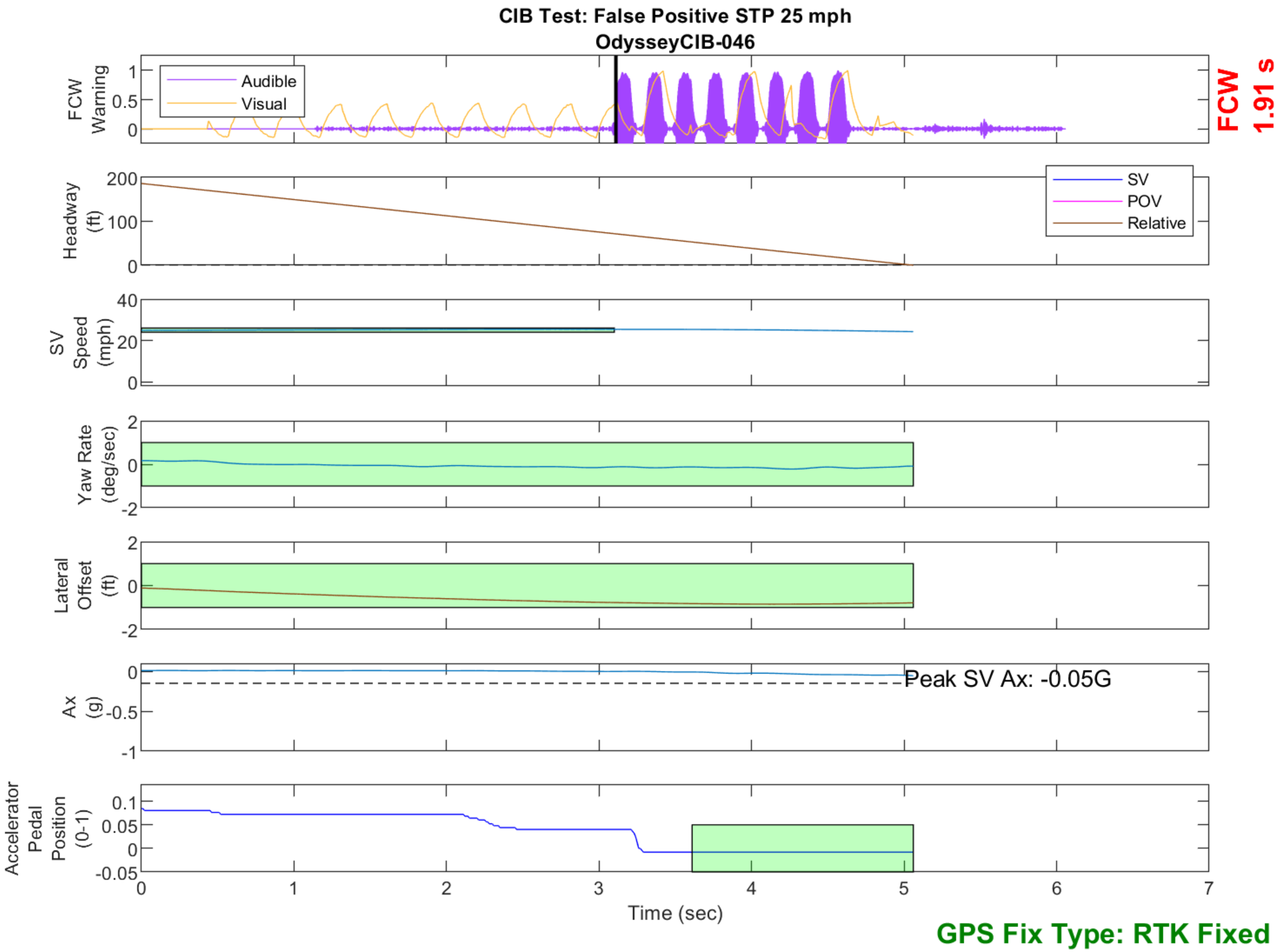


Figure D43. Time History for CIB Run 46, SV Encounters Steel Trench Plate, SV 25 mph

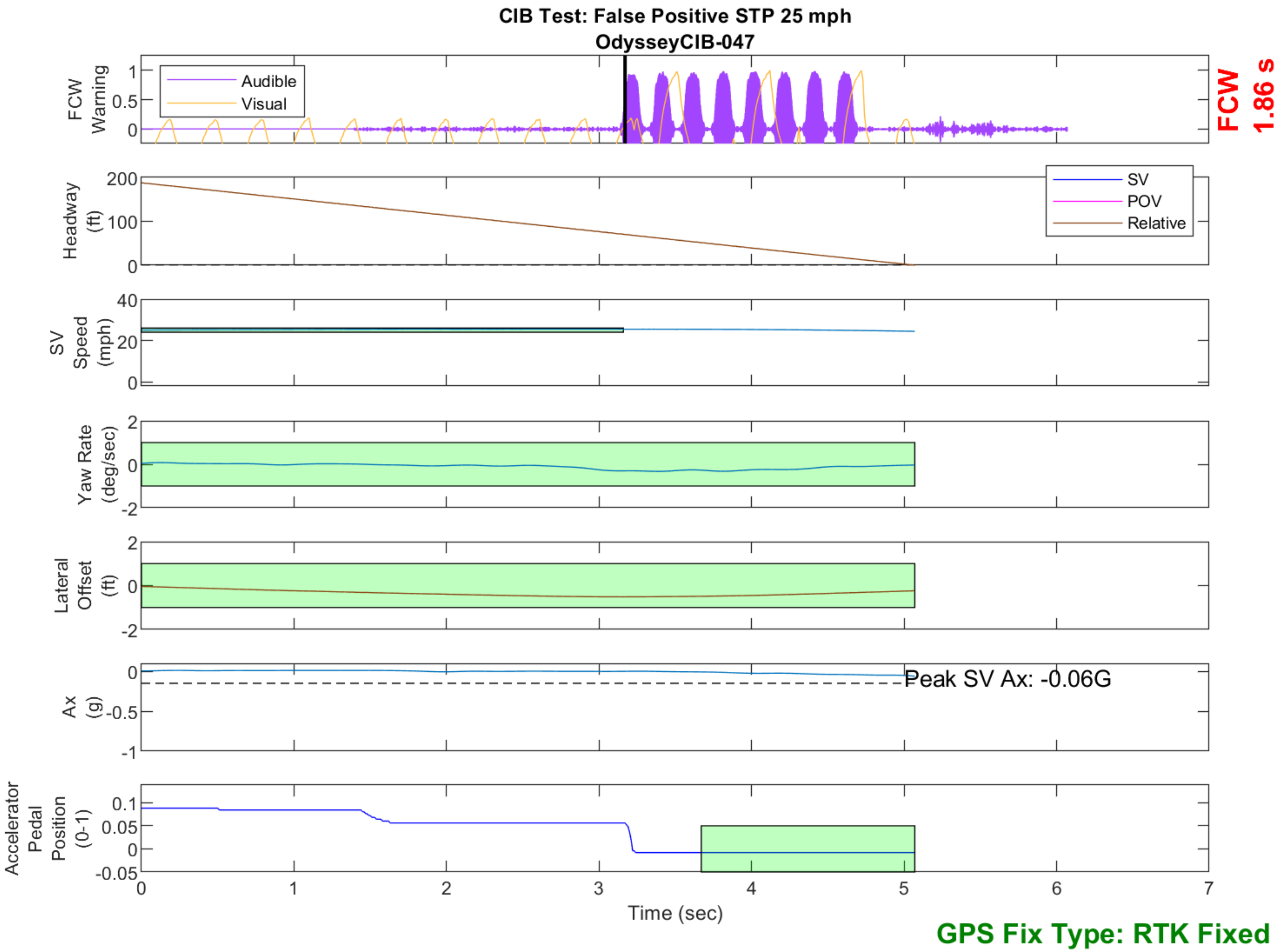


Figure D44. Time History for CIB Run 47, SV Encounters Steel Trench Plate, SV 25 mph

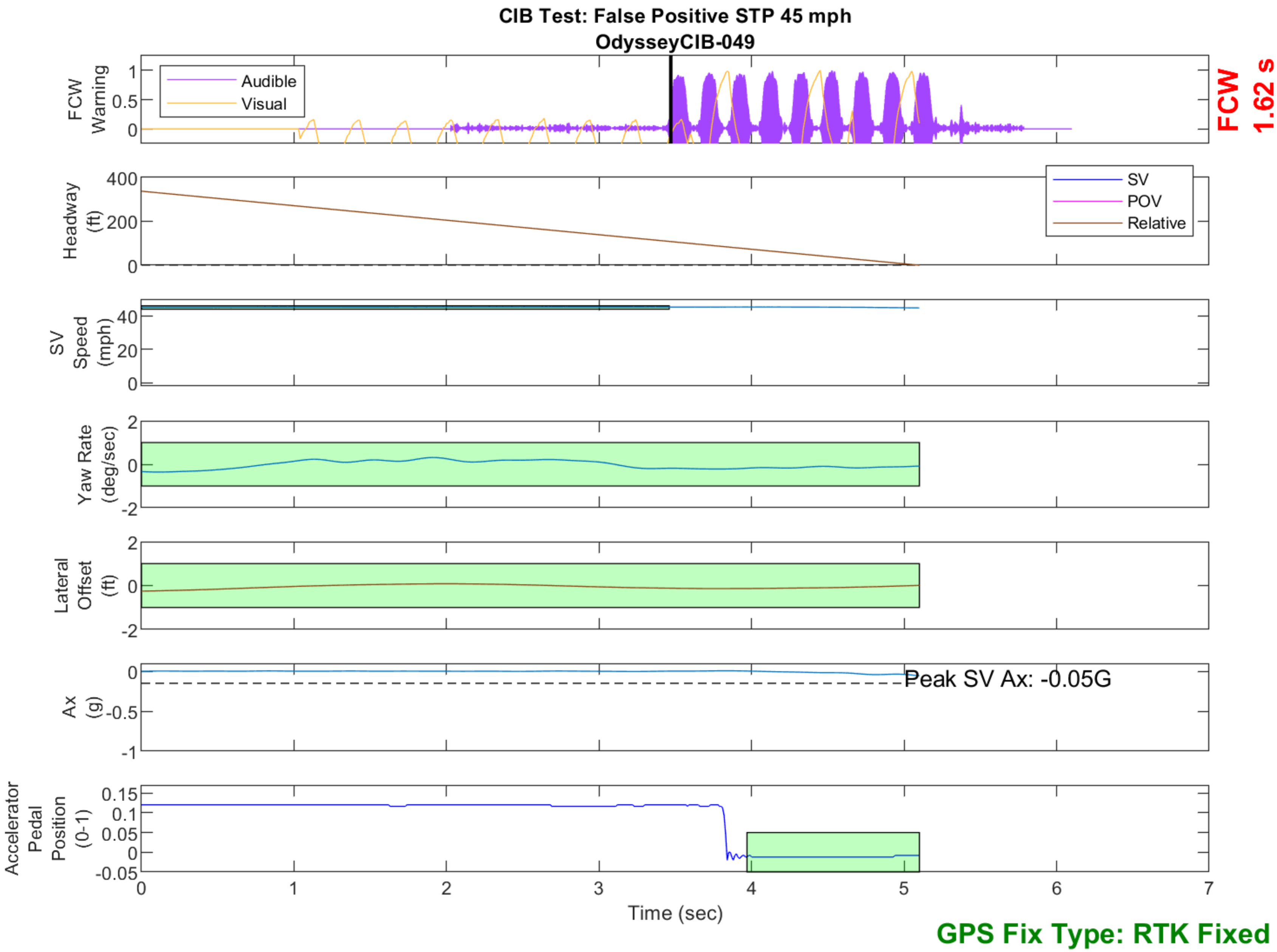


Figure D45. Time History for CIB Run 49, SV Encounters Steel Trench Plate, SV 45 mph

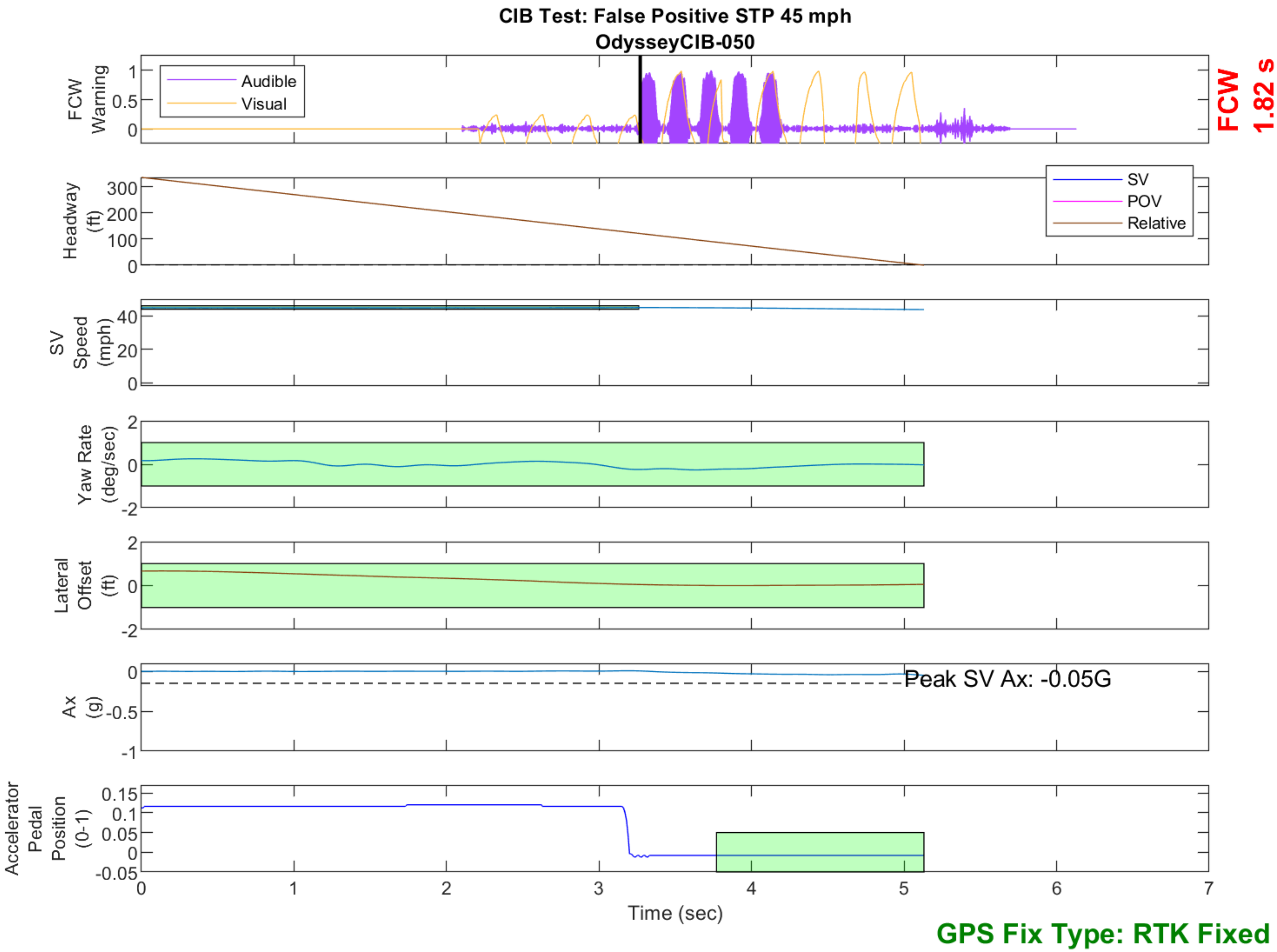


Figure D46. Time History for CIB Run 50, SV Encounters Steel Trench Plate, SV 45 mph

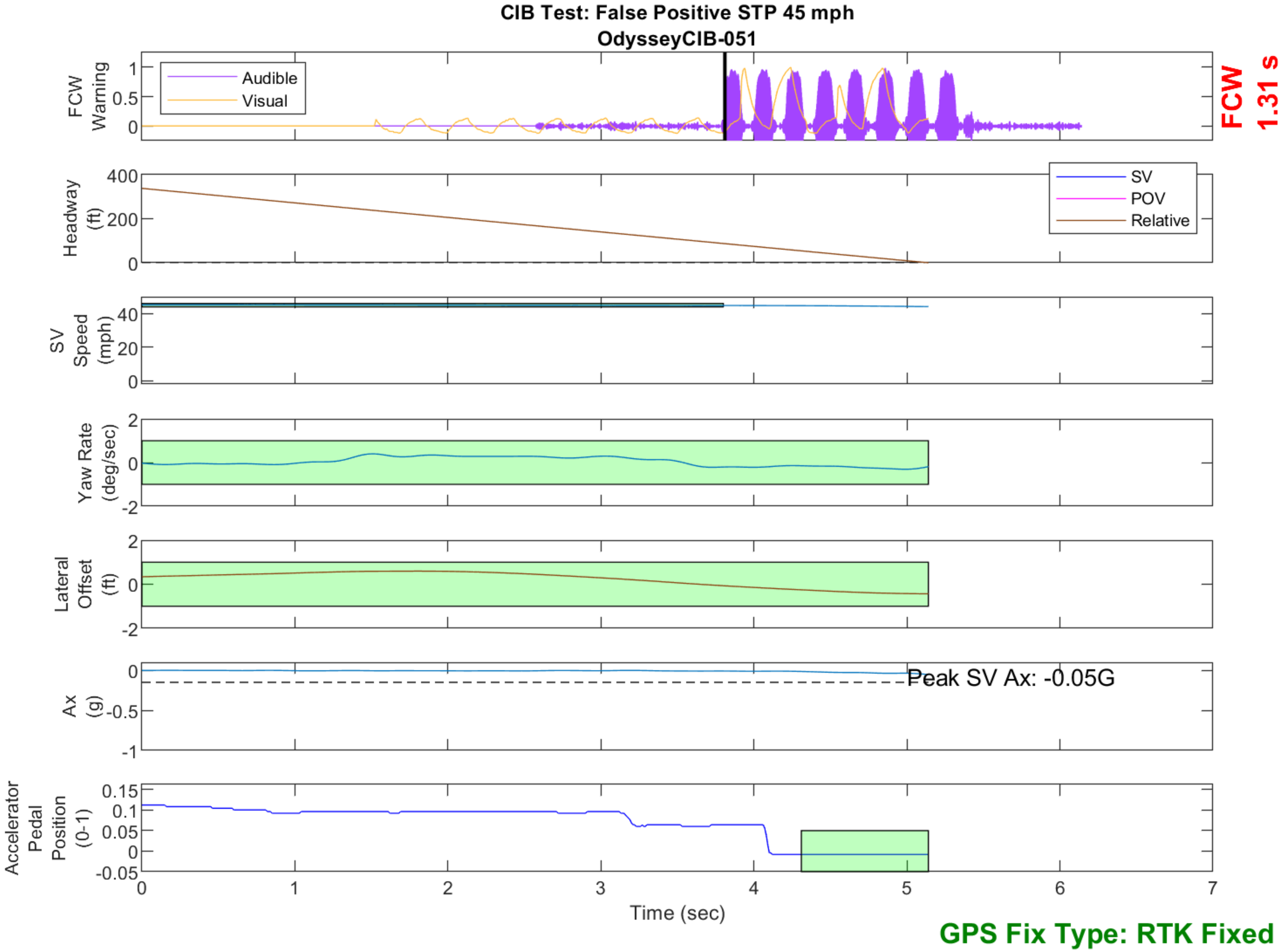


Figure D47. Time History for CIB Run 51, SV Encounters Steel Trench Plate, SV 45 mph

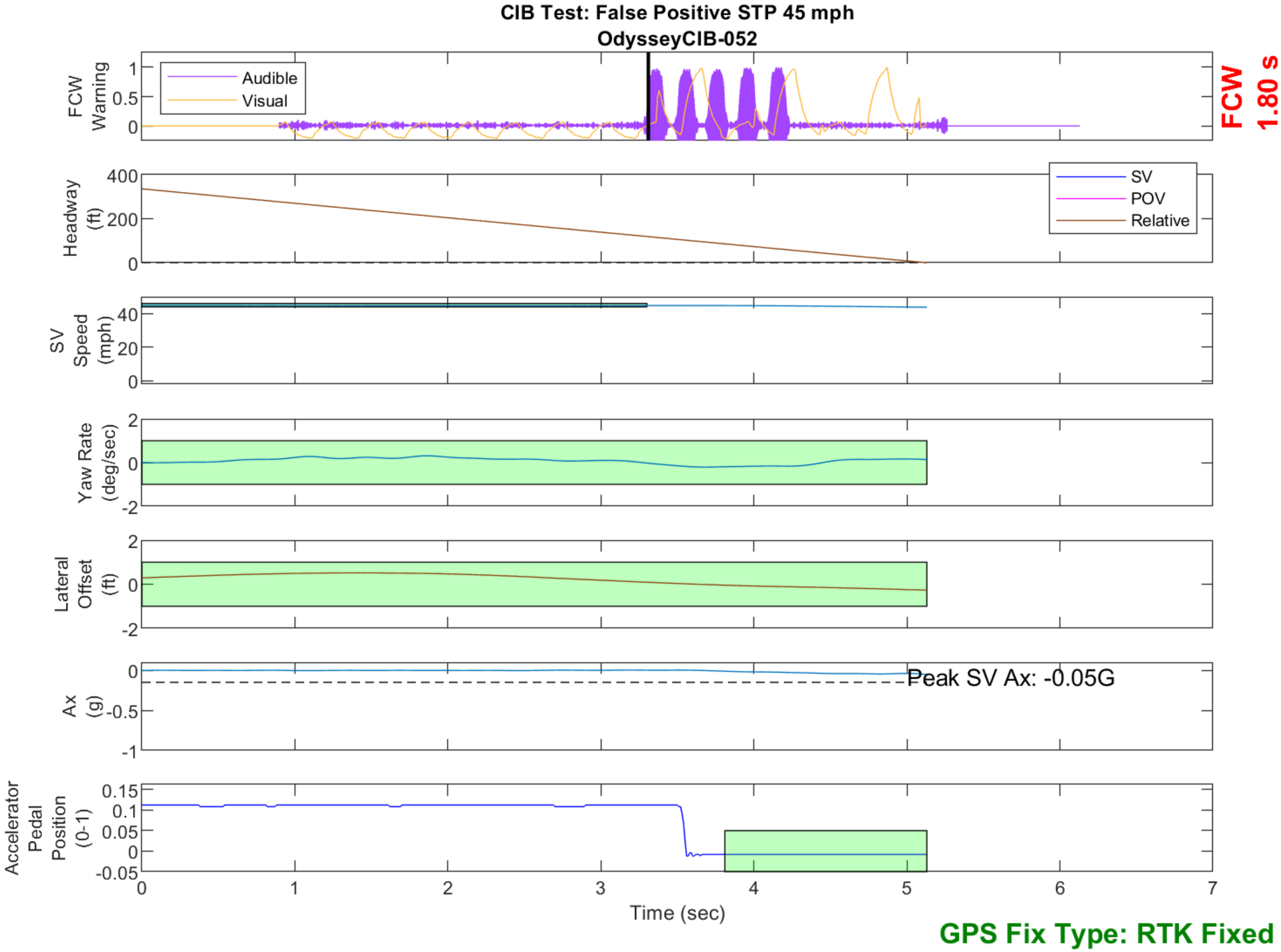


Figure D48. Time History for CIB Run 52, SV Encounters Steel Trench Plate, SV 45 mph

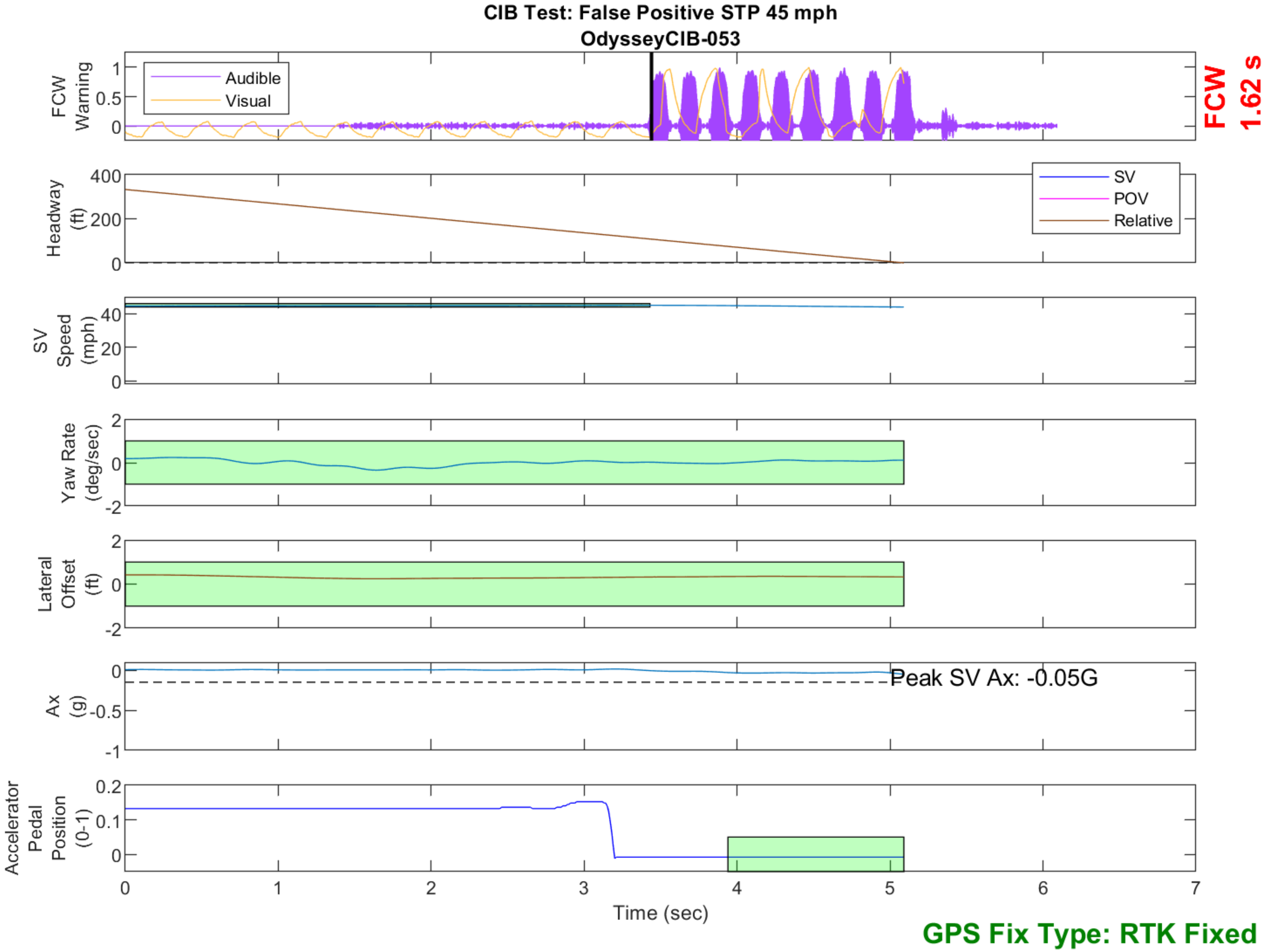


Figure D49. Time History for CIB Run 53, SV Encounters Steel Trench Plate, SV 45 mph

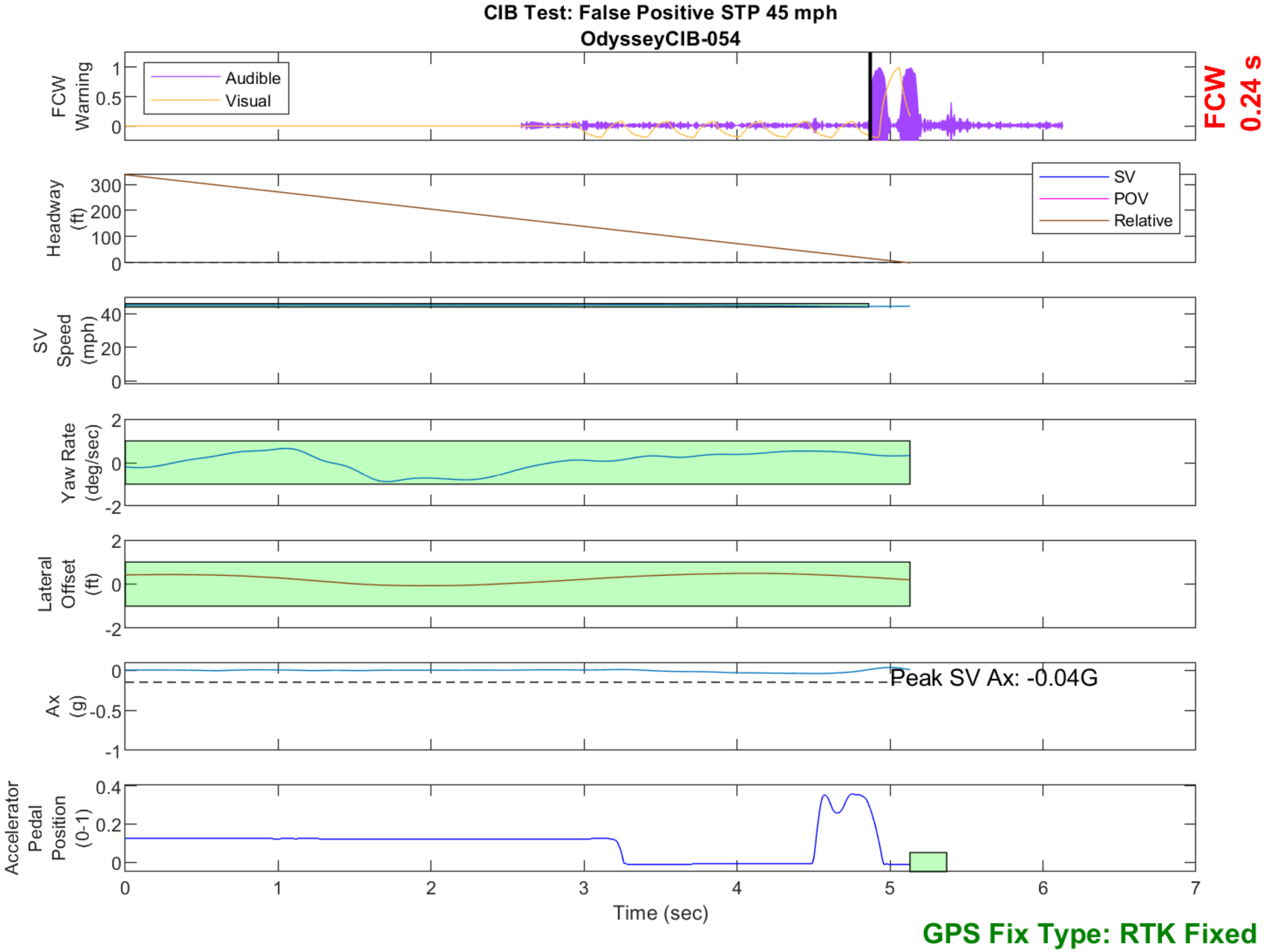


Figure D50. Time History for CIB Run 54, SV Encounters Steel Trench Plate, SV 45 mph

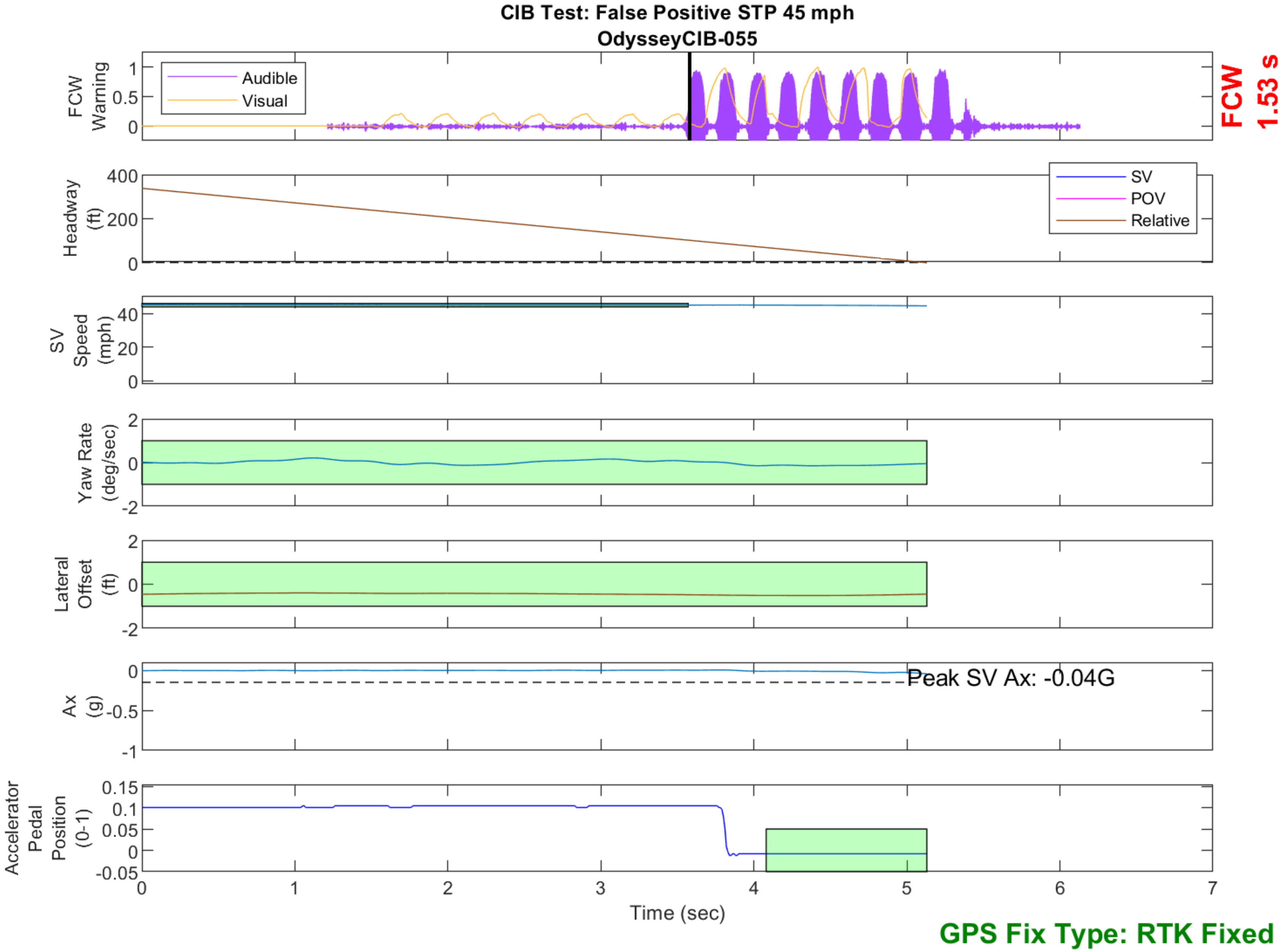


Figure D51. Time History for CIB Run 55, SV Encounters Steel Trench Plate, SV 45 mph