**CRASH IMMINENT BRAKING SYSTEM RESEARCH TEST**
**NCAP-DRI-CIBHS-20-04**

**2020 Honda Odyssey EX-L**


**DYNAMIC RESEARCH, INC.**
**355 Van Ness Avenue, STE 200**
**Torrance, California 90501**


**26 June 2020**

**Final Report**


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

**U.S. DEPARTMENT OF TRANSPORTATION**
**National Highway Traffic Safety Administration**
**1200 New Jersey Avenue, SE**
**West Building, 4th Floor (NRM-110)**
**Washington, DC 20590**

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| Prepared By: | J. Lenkeit | N. Wong |
| | Program Manager | Test Engineer |
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15. Supplementary Notes

16. Abstract

These research 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, 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 CIB system met the acceptability criteria for 50 out of 50 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 Honda Odyssey EX-L**

VIN: *5FNRL6H77LB05xxxx* Test Date: *4/22/2020*

Crash Imminent Braking System setting: *Normal*

| | | 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: | 5 | 0 | 5 |
| **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: | 5 | 0 | 5 |
| | **Overall:** | **50** | **0** | **50** |

Notes:
The CIB system met the acceptability criteria for 50 out of 50 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 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,

**2020 Honda Odyssey EX-L**

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## 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**

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**2020 Honda Odyssey EX-L**

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## GENERAL INFORMATION

Test date: *4/22/2020*

## AMBIENT CONDITIONS

Air temperature: *28.3 C (83 F)*

Wind speed: *5.7 m/s (12.7 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)*

## 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**

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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 rearview 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 calibrate the camera 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 and Appendix A, Figure A17.*

*Color: Orange,*

*Words "BRAKE"*

*Flashes On/Off*

*Audible: Repeated beep*

*Vibration: Steering wheel vibration for oncoming detected vehicles.*

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| | | |
|---|---|---|
| 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 A15).*

*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 A12 and A13). The menu hierarchy is:*

- *Settings*
  - *Vehicle*
    - *Driver Assist System Setup*
      - *Forward Collision Warning Distance*
        - *Select distance: Long/Normal/Short*

**CRASH IMMINENT BRAKING**

**DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION**



**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

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. <u>TEST 1 – SUBJECT VEHICLE ENCOUNTERS STOPPED PRINCIPAL OTHER VEHICLE ON A STRAIGHT ROAD</u>

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.

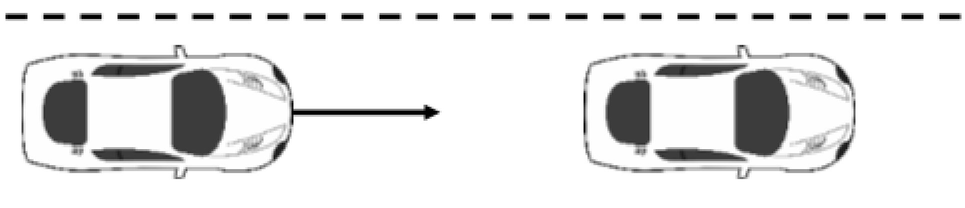



Figure 1. Depiction of Test 1

**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.

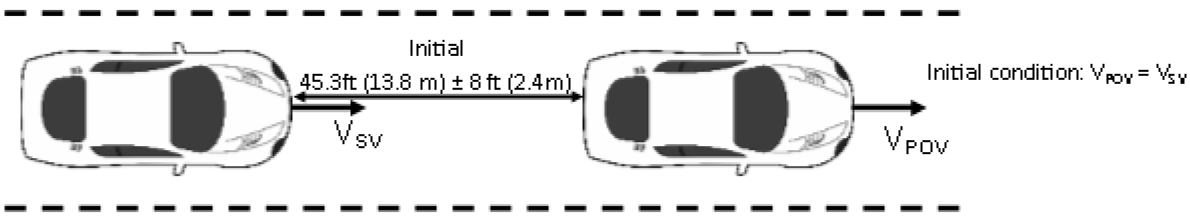



Figure 2. Depiction of Test 2

**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. <u>TEST 3 – SUBJECT VEHICLE ENCOUNTERS DECELERATING PRINCIPAL OTHER VEHICLE</u>

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.

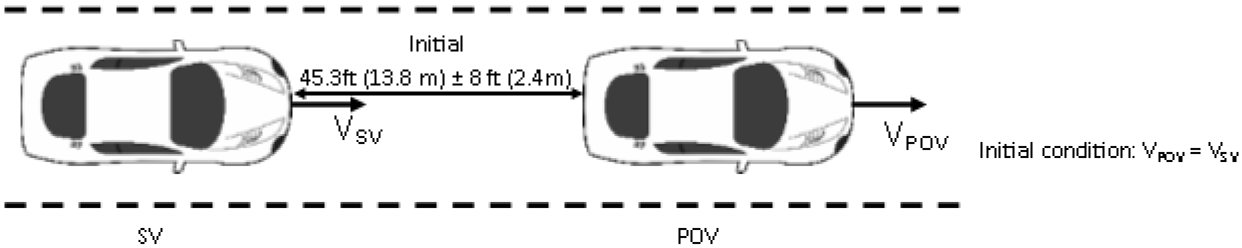



Figure 3. Depiction of Test 3 with POV Decelerating with $V_0$ =35 mph (56.3 km/h)

**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 | 5$^{th}$ | 3 dB | 60 dB | Identified Center Frequency ± 5% |
| Tactile | 5$^{th}$ | 3 dB | 60 dB | Identified Center Frequency ± 20% |

2. <u>GENERAL VALIDITY CRITERIA</u>

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 0.25g.
- 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 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 Global Vehicle Target (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 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.

- A low profile robotic vehicle (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 0.5g (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 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 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<br>0-690 kPa | < 1% error between 20 and | Omega DPG8001 | 17042707002 | By: DRI<br>Date: 7/3/2019<br>Due: 7/3/2020 |
| Platform Scales | Vehicle Total, Wheel, and Axle Load | 2200 lb/platform | 0.1% of reading | Intercomp SW wireless | 0410MN20001 | By: DRI<br>Date: 5/22/2020<br>Due: 5/22/2021 |
| Linear (string) encoder | Throttle pedal travel | 10 in<br>254 mm | 0.1 in<br>2.54 mm | UniMeasure LX-EP | 49041189 | By: DRI<br>Date: 5/10/2019<br>Due: 5/10/2020 |
| Differential Global Positioning System | Position, Velocity | Latitude: ±90 deg<br>Longitude: ±180 deg<br>Altitude: 0-18 km<br>Velocity: 0-1000 knots | Horizontal Position: ±1 cm<br>Vertical Position: ±2 cm<br>Velocity: 0.05 km/h | Trimble GPS Receiver,<br>5700 (base station and in-vehicle) | 00440100989 | NA |
| SV Multi-Axis Inertial Sensing System | Position;<br>Longitudinal, Lateral, and Vertical Accels;<br>Lateral, Longitudinal and Vertical Velocities;<br>Roll, Pitch, Yaw Rates;<br>Roll, Pitch, Yaw Angles | Accels ± 10g, Angular Rat | Accels .01g, Angular Rate | Oxford Inertial + | 2258 | By: Oxford Technical Solutions<br>Date: 5/3/2019<br>Due: 5/3/2021 |
| POV Multi-Axis Inertial Sensing System | | Latitude: ±90º<br>Longitude | Position: ±2 cm<br>Velocity | Oxford PinPoint 2G | 24504 | By: Oxford Technical Solutions<br>Date: 7/18/2019<br>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<br>0-2.4 m | ±.0020 in.<br>±.051 mm<br>(Single point articulation accuracy) | Faro Arm,<br>Fusion | UO8-05-08-06636 | By: DRI<br>Date: 1/6/2020<br>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<br>Lateral Lane Velocity: ±20 m/sec<br>Longitudinal Range to POV: ±200 m<br>Longitudinal Range Rate: ±50 m/sec | Lateral Distance to Lane Marking: ±2 cm<br>Lateral Velocity to Lane Marking: ±0.02m/sec<br>Longitudinal Range: ±3 cm<br>Longitudinal Range Rate: ±0.02 m/sec | Oxford Technical Solutions (OXTS),<br>RT-Range | 97 | NA |
| Microphone | Sound<br>(to measure time at alert) | Frequency Response:<br>80 Hz – 20 kHz | Signal-to-noise: 64 dB, 1 kHz at 1 Pa | Audio-Technica<br>AT899 | NA | NA |
| Light Sensor | Light intensity<br>(to measure time at alert) | Spectral Bandwidth:<br>440-800 nm | Rise time < 10 msec | DRI designed and developed Light Sensor | NA | NA |
| Accelerometer | Acceleration<br>(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)

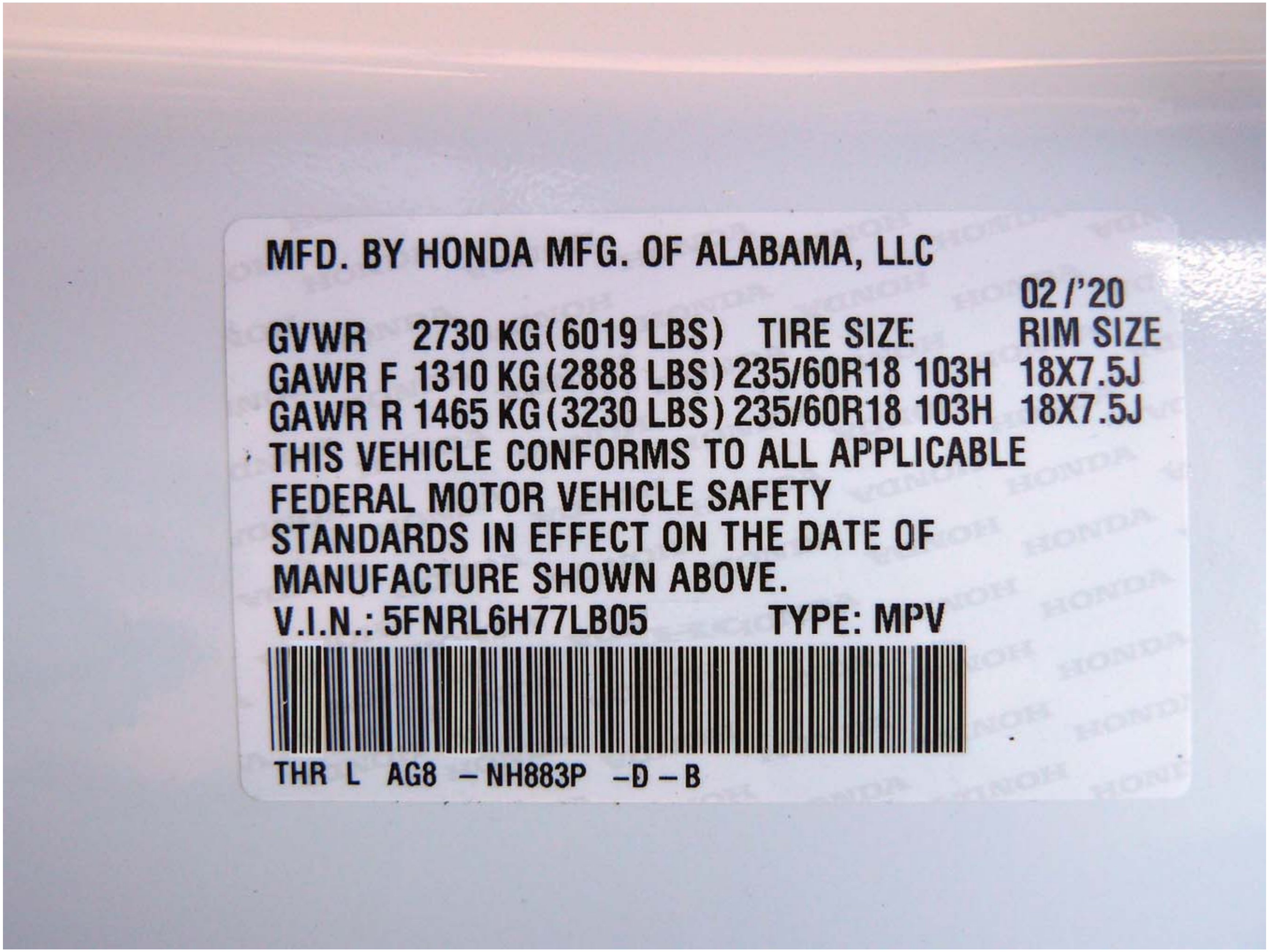



Figure A4. Vehicle Certification Label


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 Auditory Alerts


Figure A10.  Sensor for Detecting Visual Alerts

Figure A11. Computer Installed in Subject Vehicle

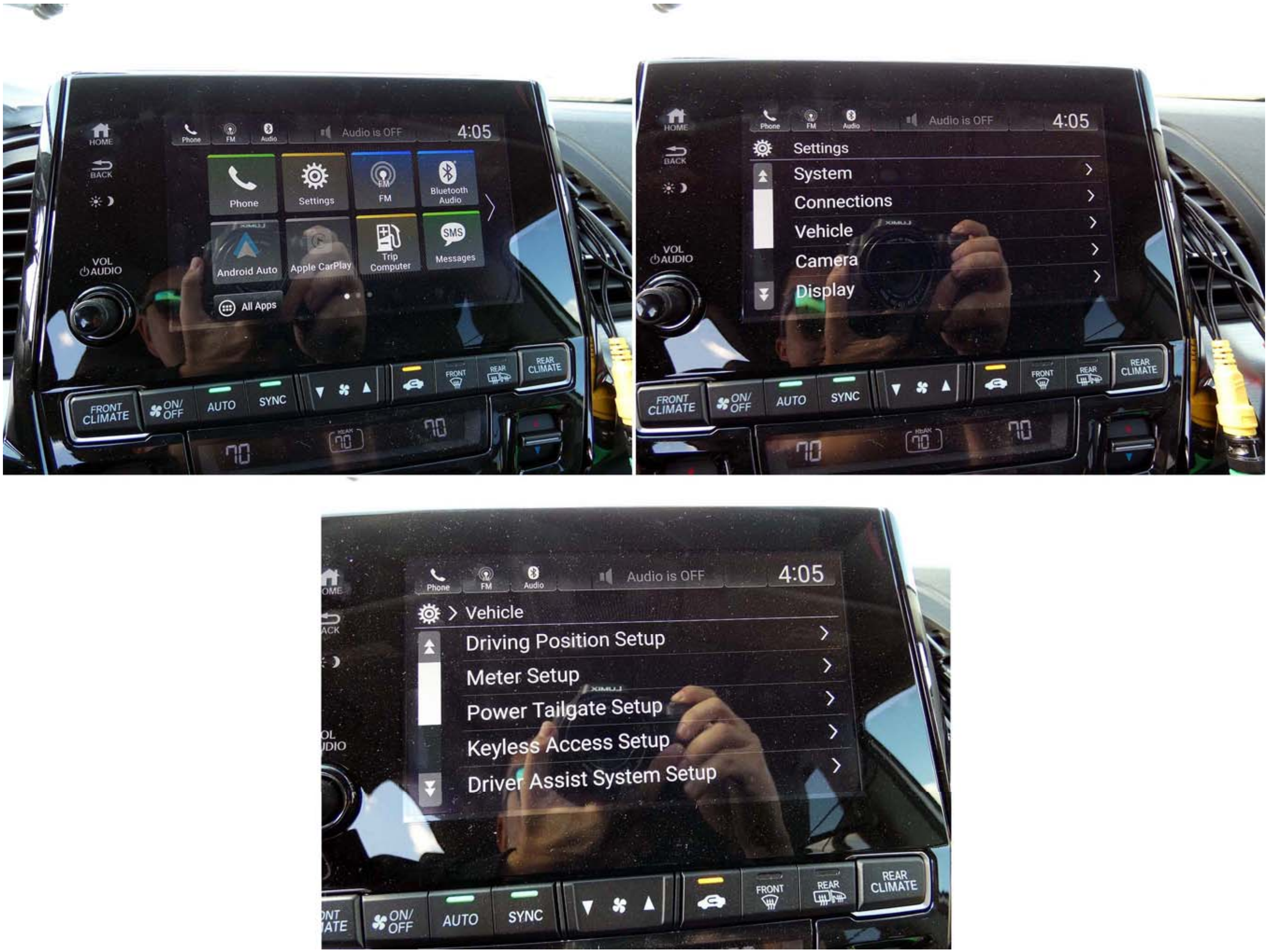



Figure A12. CIB (CMBS) Setup Menus (1/2)

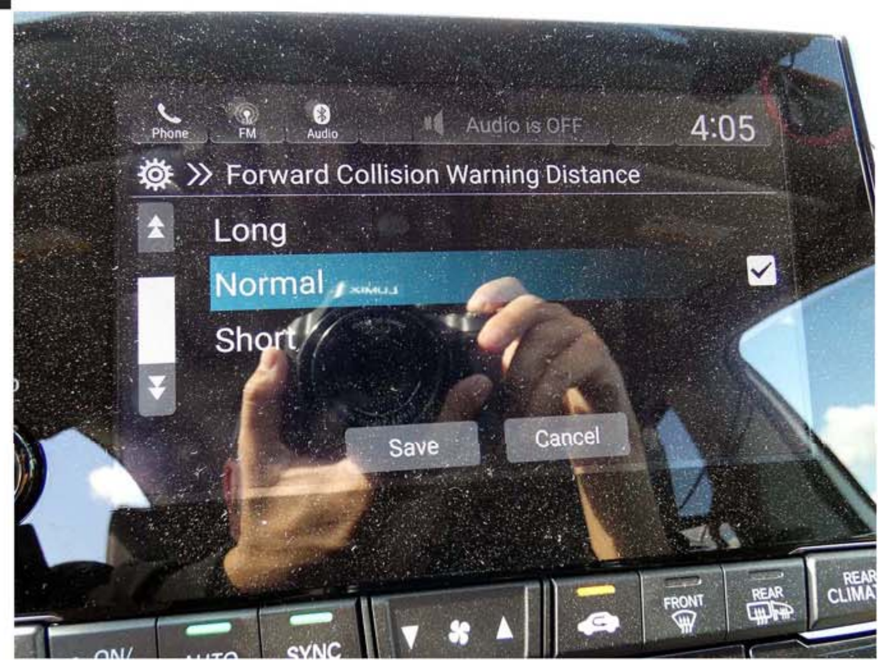




Figure A13. CIB (CMBS) Setup Menus (2/2)

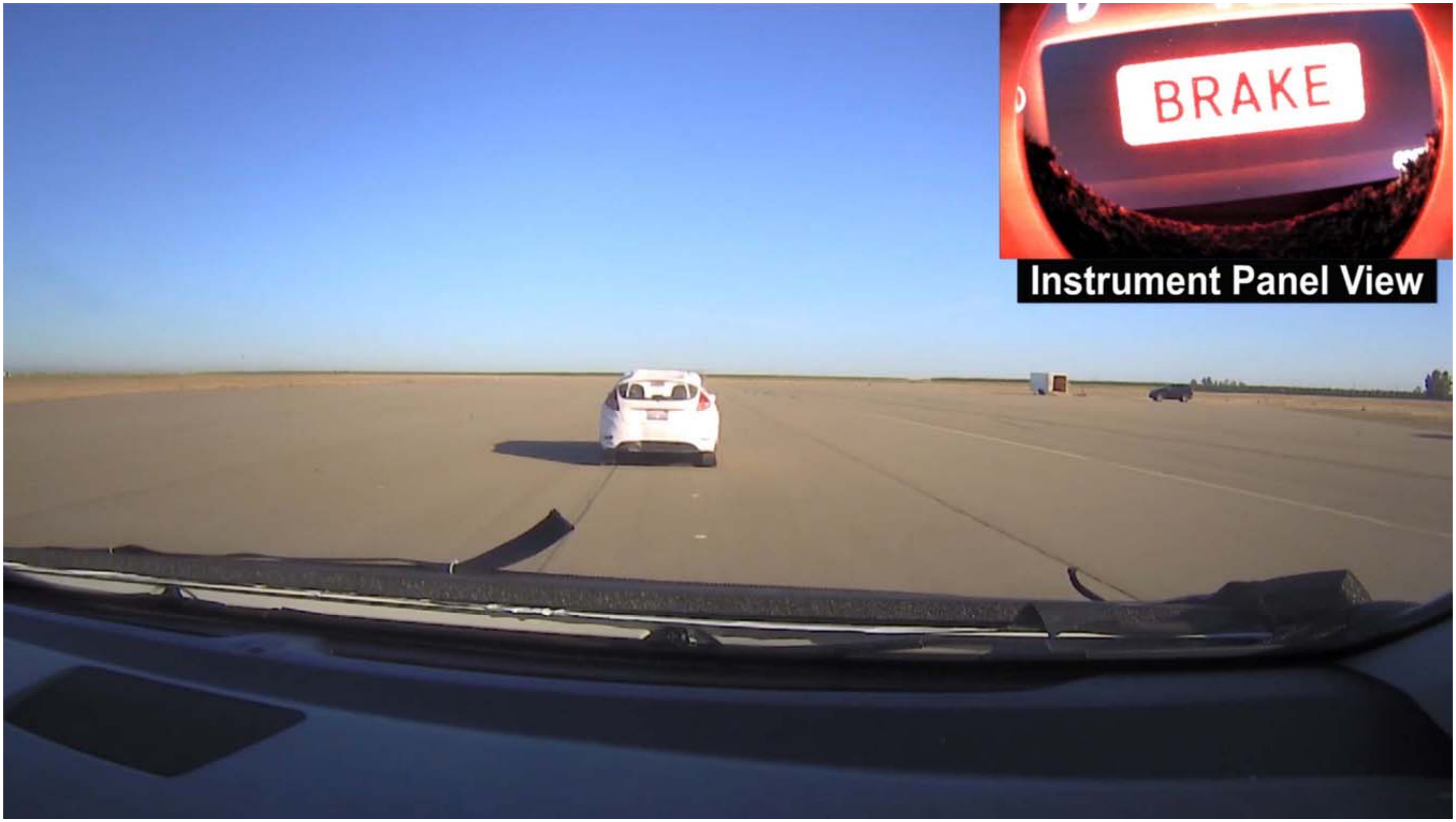



Figure A14. CIB (CMBS) Visual Alert shown as Inset in Out-the-Window View


Figure A15. CIB (CMBS) 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.

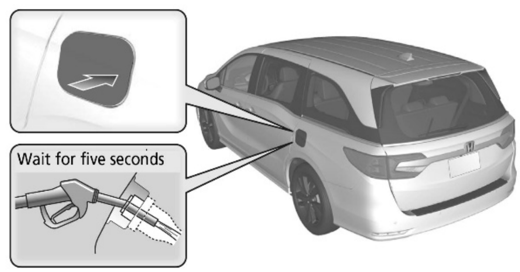
## Tire Pressure Monitoring System (TPMS) with Tire Fill Assist P. 599, 726

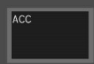
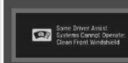
- The TPMS monitors tire pressure.
- TPMS is turned on automatically every time you start the engine.
- TPMS fill assist provides audible and visual guidance during tire pressure adjustment.

## Refueling P. 637

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

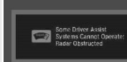
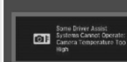
1. Unlock the driver's door.
   **Locking/Unlocking the Doors from the Inside** P. 156
2. Press firmly and then release the area indicated by the arrow to release the fuel filler door.
3. After refueling, wait for about five seconds before removing the filler nozzle.



| 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.<br>• 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.<br>• Comes on when you deactivate the CMBS™. A driver information interface message appears for five seconds.<br>• Comes on if there is a problem with the CMBS™. | • **Stays on constantly without the CMBS™ off** - Have your vehicle checked by a dealer.<br>➲ **Collision Mitigation Braking System™ (CMBS™)*** P. 615 | <br> |

Instrument Panel

* Not available on all models

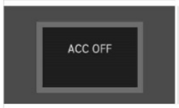
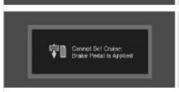
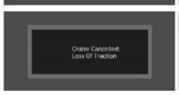
| Indicator | Name | On/Blinking | Explanation | Message |
|---|---|---|---|---|
|  | Collision Mitigation Braking System™ (CMBS™) Indicator* | • Comes on when the CMBS™ system shuts itself off. | • **Stays on** - The area around the camera is blocked by dirt, mud, etc. Stop your vehicle in a safe place, and wipe it off with a soft cloth.<br>**Front Sensor Camera*** P. 569 | <br> |
| | | | • 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.<br>• Have your vehicle checked by a dealer if the indicator does not go off even after you clean the sensor cover.<br>**Collision Mitigation Braking System™ (CMBS™)*** P. 615 | <br> |
| | | | • **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.<br>**Front Sensor Camera*** P. 569 | <br> |

 * 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

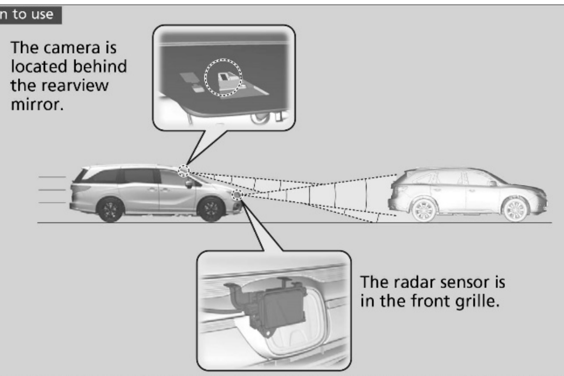
* Not available on all models

## 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.

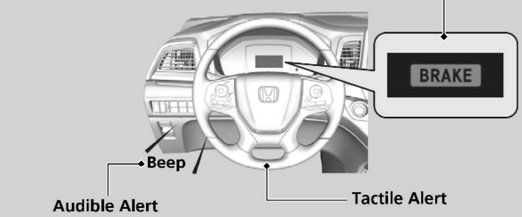
* Not available on all models

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**

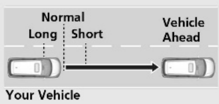
Vibration alert function is disabled when the electric power steering (EPS) system indicator comes on.

**Electric Power Steering (EPS) System Indicator** P. 91

Driving

## ■ Collision Alert Stages

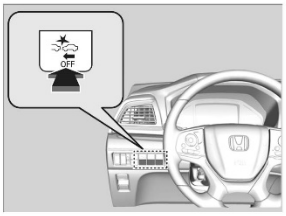
The system has three alert stages for a possible collision. However, depending on circumstances, the CMBS™ may not go through all of the stages before initiating the last stage.

| 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

Continued

## 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

Driving

## 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

*Continued*

## ■ 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: **4/22/2020**

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 |
|---|---|---|---|---|---|---|---|---|---|
| 47 | **Stopped POV, 25** | Y | 2.13 | 0.00 | 21.6 | 0.84 | 0.87 | Yes | |
| 48 | | Y | 2.06 | 8.08 | 24.5 | 0.93 | 1.44 | Yes | |
| 49 | | Y | 1.99 | 0.00 | 13.9 | 0.84 | 1.48 | Yes | |
| 50 | | Y | 2.23 | 7.42 | 24.8 | 0.92 | 1.43 | Yes | |
| 51 | | Y | 2.02 | 8.07 | 25.1 | 0.91 | 1.44 | Yes | |
| 52 | | Y | 2.16 | 11.09 | 24.7 | 0.89 | 1.48 | Yes | |
| 53 | | Y | 2.20 | 8.41 | 25.0 | 0.92 | 1.40 | Yes | |
| | | | | | | | | | |
| 54 | Static Run | | | | | | | | |
| | | | | | | | | | |
| 60 | **Stopped POV, 30** | Y | 2.36 | 3.24 | 29.5 | 0.91 | 1.52 | Yes | |
| 61 | | Y | 2.42 | 0.98 | 30.3 | 0.84 | 1.53 | Yes | |
| 62 | | Y | 2.34 | 3.67 | 29.5 | 0.92 | 1.50 | Yes | |
| 63 | | Y | 2.18 | 2.28 | 29.7 | 0.93 | 1.52 | Yes | |
| 64 | | Y | 2.23 | 4.01 | 30.5 | 0.90 | 1.52 | Yes | |
| | | | | | | | | | |
| 65 | Static Run | | | | | | | | |
| | | | | | | | | | |
| 66 | **Stopped POV, 35** | Y | 2.35 | 0.00 | 19.5 | 0.84 | 1.58 | Yes | |
| 67 | | Y | 2.39 | 0.00 | 18.1 | 0.84 | 1.52 | 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 |
|---|---|---|---|---|---|---|---|---|---|
| 68 | | Y | 2.47 | 0.00 | 17.8 | 0.83 | 1.55 | Yes | |
| 69 | | Y | 2.51 | 0.00 | 17.3 | 0.82 | 1.53 | Yes | |
| 70 | | Y | 2.24 | 0.00 | 16.6 | 0.84 | 1.52 | Yes | |
| | | | | | | | | | |
| 71 | **Stopped POV, 40** | Y | 2.47 | 0.00 | 13.6 | 0.82 | 1.49 | Yes | |
| 72 | | Y | 2.47 | 0.00 | 12.4 | 0.83 | 1.47 | Yes | |
| 73 | | Y | 2.35 | 0.00 | 13.3 | 0.83 | 1.48 | Yes | |
| 74 | | Y | 2.50 | 0.00 | 13.0 | 0.84 | 1.46 | Yes | |
| 75 | | Y | 2.49 | 0.00 | 13.3 | 0.83 | 1.50 | Yes | |
| | | | | | | | | | |
| 76 | Static Run | | | | | | | | |
| | | | | | | | | | |
| 77 | **Stopped POV, 45** | Y | 2.30 | 0.00 | 11.3 | 0.83 | 1.26 | Yes | |
| 78 | | Y | 2.29 | 0.00 | 11.8 | 0.85 | 1.19 | Yes | |
| 79 | | Y | 2.25 | 0.00 | 11.1 | 0.85 | 1.21 | Yes | |
| 80 | | Y | 2.04 | 0.00 | 10.6 | 0.86 | 1.18 | Yes | |
| 81 | | Y | 2.19 | 0.00 | 11.3 | 0.84 | 1.28 | Yes | GPS RTK error at beginning of run |
| | | | | | | | | | |
| 82 | Static Run | | | | | | | | |
| 1 | Static Run | | | | | | | | |
| | | | | | | | | | |
| 2 | **Slower POV, 25 vs 10** | Y | 1.91 | 2.97 | 15.0 | 0.77 | 1.11 | Yes | |
| 3 | | Y | 1.89 | 6.46 | 15.4 | 0.80 | 1.18 | Yes | |
| 4 | | Y | 1.94 | 7.14 | 15.5 | 0.82 | 1.19 | Yes | |
| 5 | | Y | 1.89 | 6.43 | 15.4 | 0.80 | 1.28 | Yes | |
| 6 | | Y | 1.95 | 3.61 | 14.8 | 0.82 | 1.26 | 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 | | Y | 1.93 | 4.05 | 15.2 | 0.83 | 1.22 | Yes | |
| 8 | | Y | 1.85 | 3.27 | 14.9 | 0.81 | 1.20 | Yes | |
| | | | | | | | | | |
| 9 | Static Run | | | | | | | | |
| | | | | | | | | | |
| 10 | **Slower POV, 45 vs 20** | N | | | | | | | Lateral Offset |
| 11 | | Y | 2.03 | 13.70 | 25.6 | 1.01 | 1.35 | Yes | |
| 12 | | Y | 2.03 | 14.45 | 25.5 | 0.99 | 1.37 | Yes | |
| 13 | | N | | | | | | | GPS Fix type |
| 14 | | N | | | | | | | Lateral offset |
| 15 | | Y | 1.96 | 14.22 | 25.2 | 1.02 | 1.42 | Yes | |
| 16 | | Y | 1.99 | 14.80 | 25.6 | 1.00 | 1.37 | Yes | |
| 17 | | Y | 2.08 | 16.47 | 24.5 | 1.04 | 1.40 | Yes | |
| 18 | | N | | | | | | | SV yaw |
| 19 | | Y | 2.02 | 17.64 | 25.8 | 1.00 | 1.42 | Yes | |
| 20 | | Y | 2.06 | 14.07 | 25.1 | 1.01 | 1.40 | Yes | |
| | | | | | | | | | |
| 21 | Static run | | | | | | | | |
| | | | | | | | | | |
| 22 | **Decelerating POV, 35, 0.3g** | N | | | | | | | Driver hit brakes |
| 23 | | N | | | | | | | SV yaw |
| 24 | | N | | | | | | | SV/POV Speeds |
| 25 | | Y | 1.86 | 3.29 | 22.5 | 0.97 | 0.89 | Yes | |
| 26 | | Y | 1.90 | 3.60 | 23.0 | 0.97 | 0.89 | 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 |
|---|---|---|---|---|---|---|---|---|---|
| 27 | | Y | 1.69 | 12.84 | 20.3 | 1.02 | 1.52 | Yes | |
| 28 | | Y | 1.77 | 3.33 | 23.0 | 1.04 | 0.86 | Yes | |
| 29 | | N | | | | | | | GPS fix type |
| 30 | | Y | 1.94 | 2.17 | 29.8 | 0.96 | 0.89 | Yes | |
| 31 | | Y | 1.91 | 4.69 | 22.7 | 1.01 | 0.89 | Yes | |
| 32 | | N | | | | | | | POV Brakes |
| 33 | | Y | 1.93 | 4.68 | 22.5 | 1.00 | 0.92 | Yes | |
| | | | | | | | | | |
| 34 | Static Run | | | | | | | | |
| | | | | | | | | | |
| 35 | **Decelerating POV, 35, 0.5 g** | N | | | | | | | POV Deceleration |
| 36 | | Y | 1.44 | 0.00 | 14.7 | 1.02 | 0.71 | Yes | |
| 37 | | N | | | | | | | wrong scenario loaded |
| 38 | | Y | 1.41 | 3.53 | 35.0 | 1.05 | 1.26 | Yes | |
| 39 | | Y | 1.45 | 0.00 | 16.8 | 1.03 | 0.75 | Yes | |
| 40 | | Y | 1.47 | 0.00 | 13.5 | 1.04 | 0.70 | Yes | |
| 41 | | Y | 1.39 | 0.00 | 15.6 | 1.03 | 0.74 | Yes | |
| | | | | | | | | | |
| 42 | Static Run | | | | | | | | |
| | | | | | | | | | |
| 43 | **Decelerating POV, 45, 0.3 g** | Y | 1.87 | 0.00 | 13.3 | 0.92 | 0.76 | Yes | |
| 44 | | N | | | | | | | POV deceleration |

| *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 |
|---|---|---|---|---|---|---|---|---|---|
| 45 | | N | | | | | | | POV deceleration |
| 46 | Static Run | | | | | | | | |
| | | | | | | | | | |
| 55 | | Y | 1.91 | 0.00 | 14.0 | 0.87 | 0.77 | | |
| 56 | | Y | 1.89 | 0.00 | 12.5 | 0.85 | 0.74 | | |
| 57 | | Y | 1.92 | 0.00 | 12.8 | 0.92 | 0.72 | | |
| 58 | | Y | 1.89 | 0.00 | 11.9 | 0.89 | 0.74 | | |
| 59 | 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)
- 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.

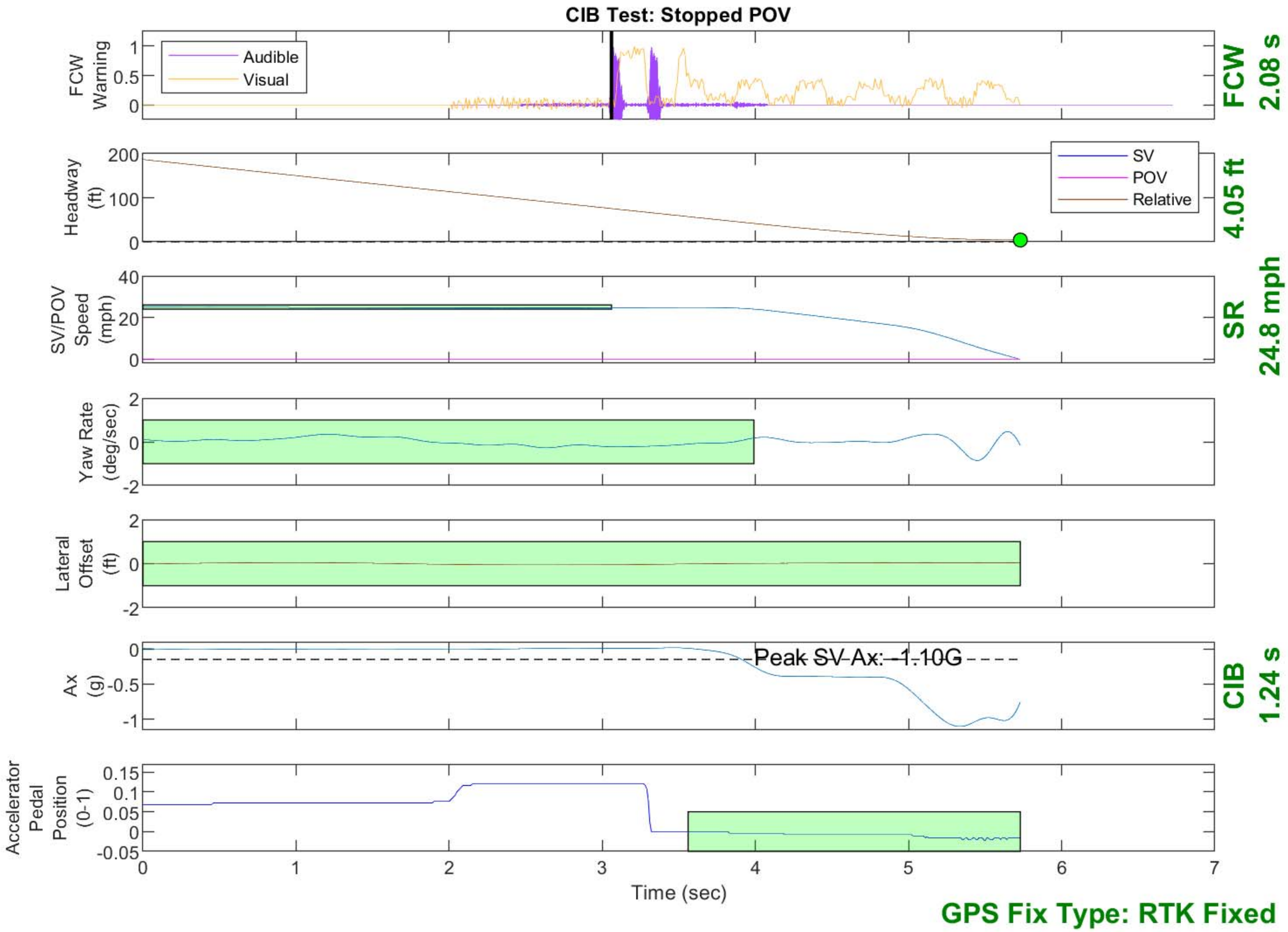



Figure D1. Example Time History for Stopped POV, Passing

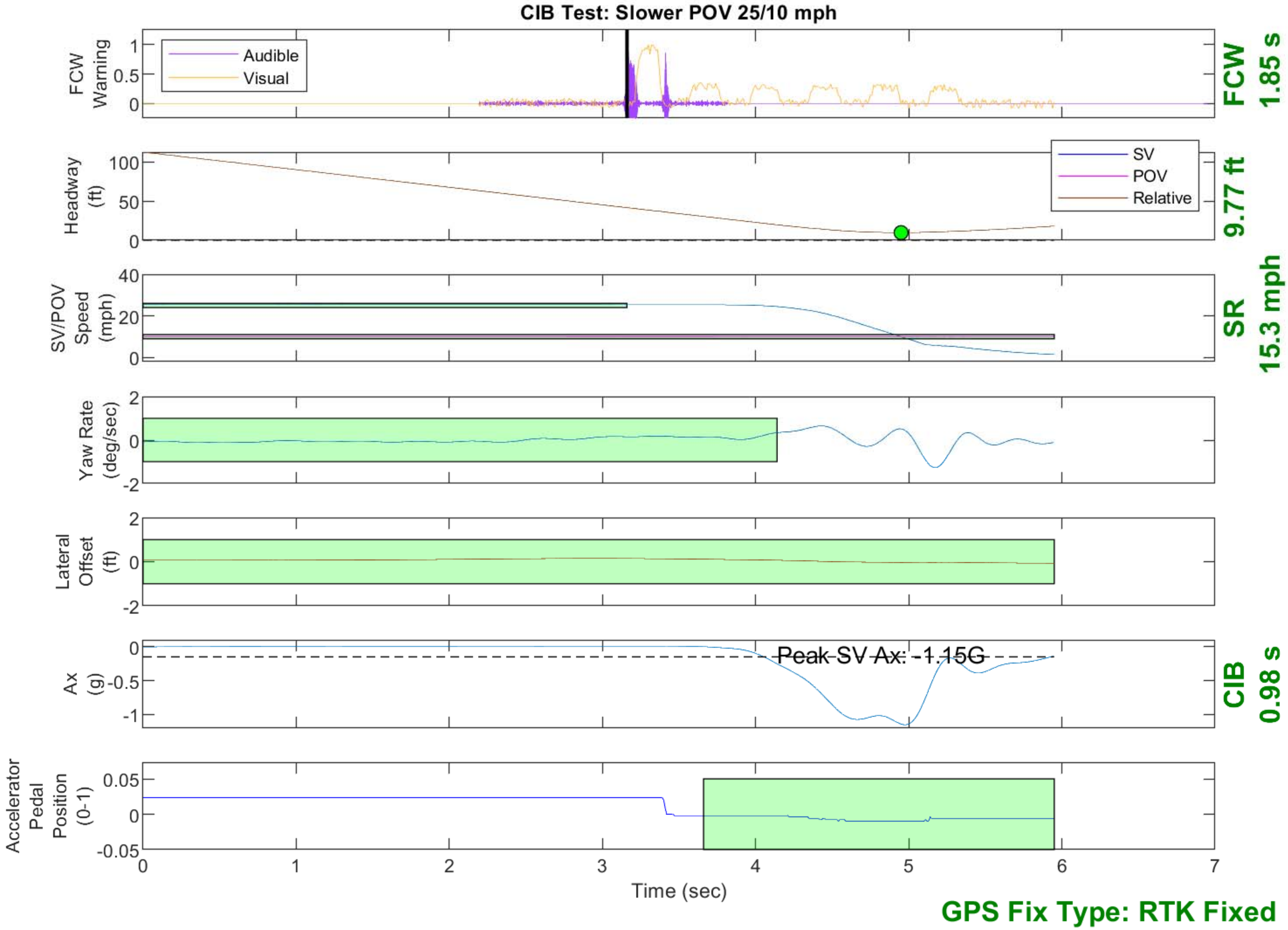



Figure D2. Example Time History for Slower POV 25 vs. 10, Passing

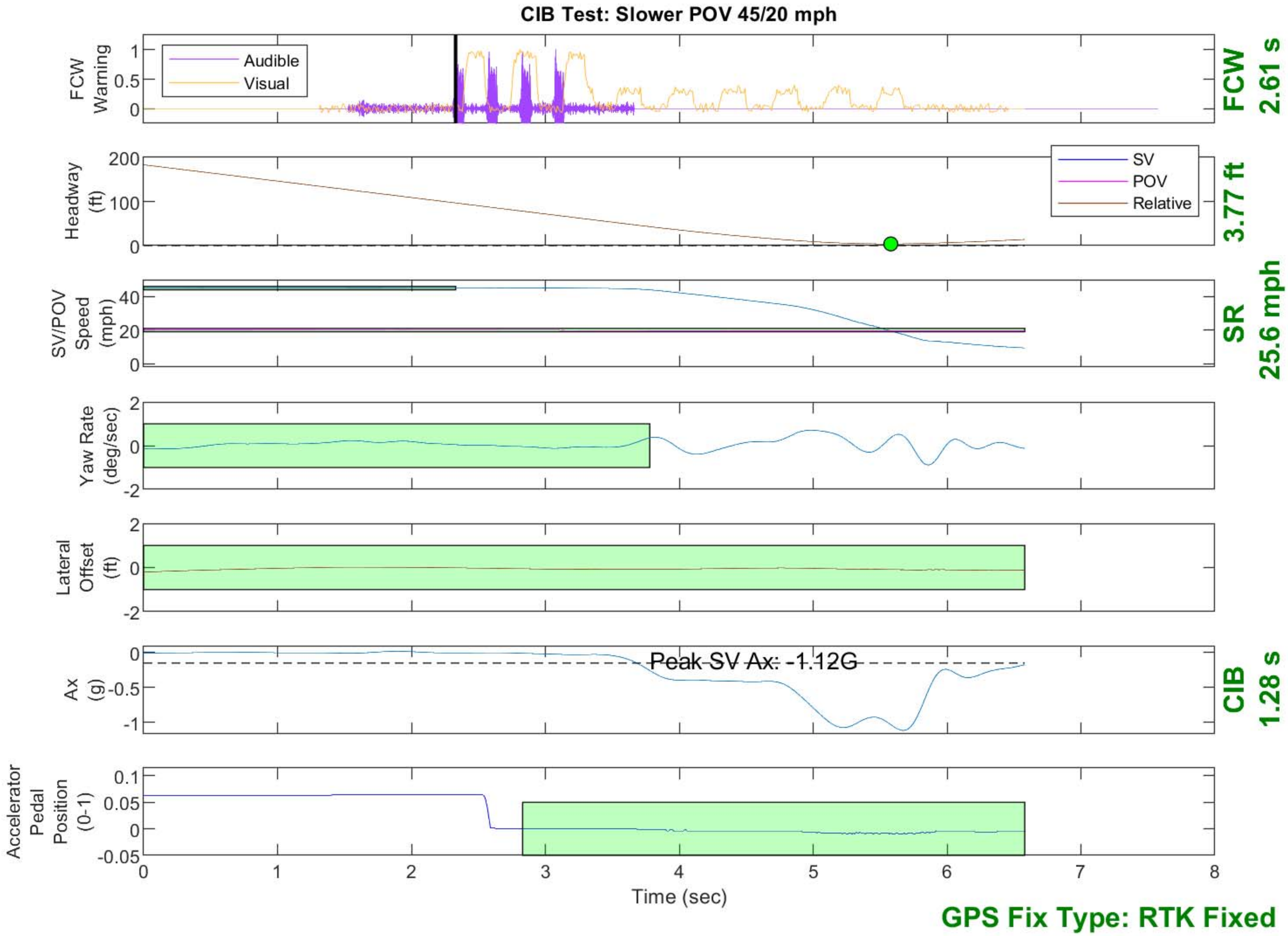



Figure D3. Example Time History for Slower POV 45 vs. 20, Passing

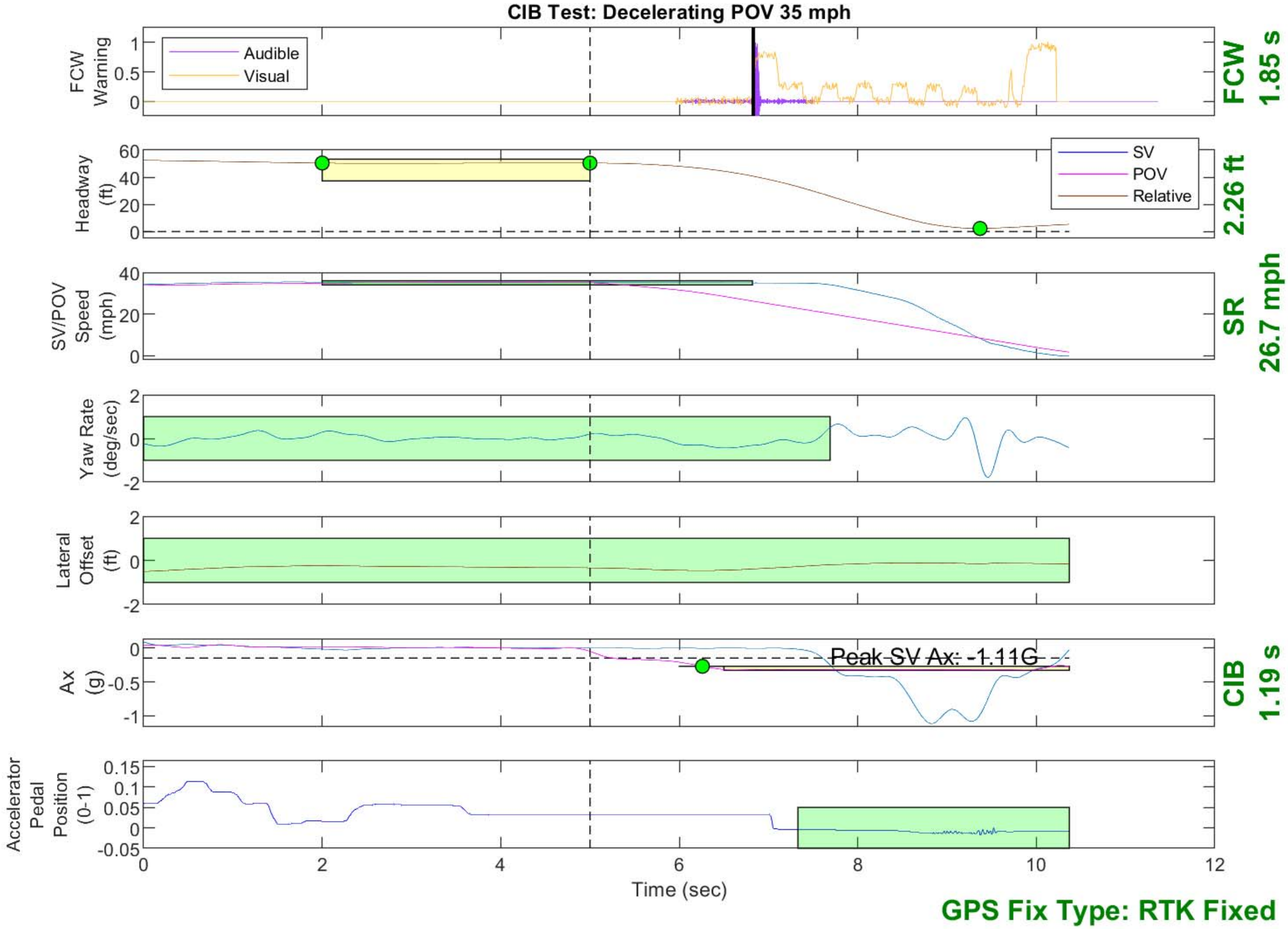



Figure D4. Example Time History for Decelerating POV 35, Passing

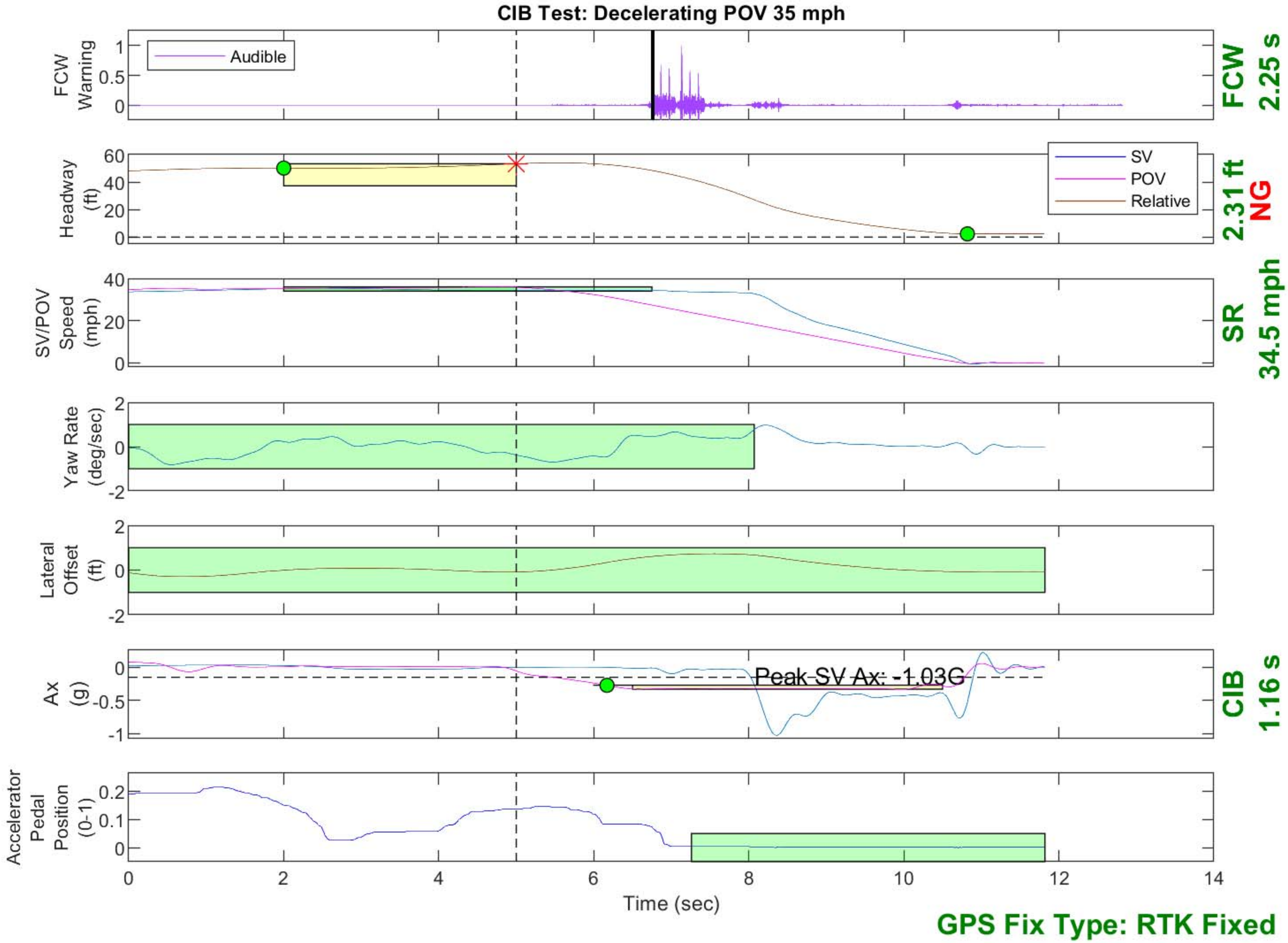



Figure D5. Example Time History Displaying Various Invalid Criteria

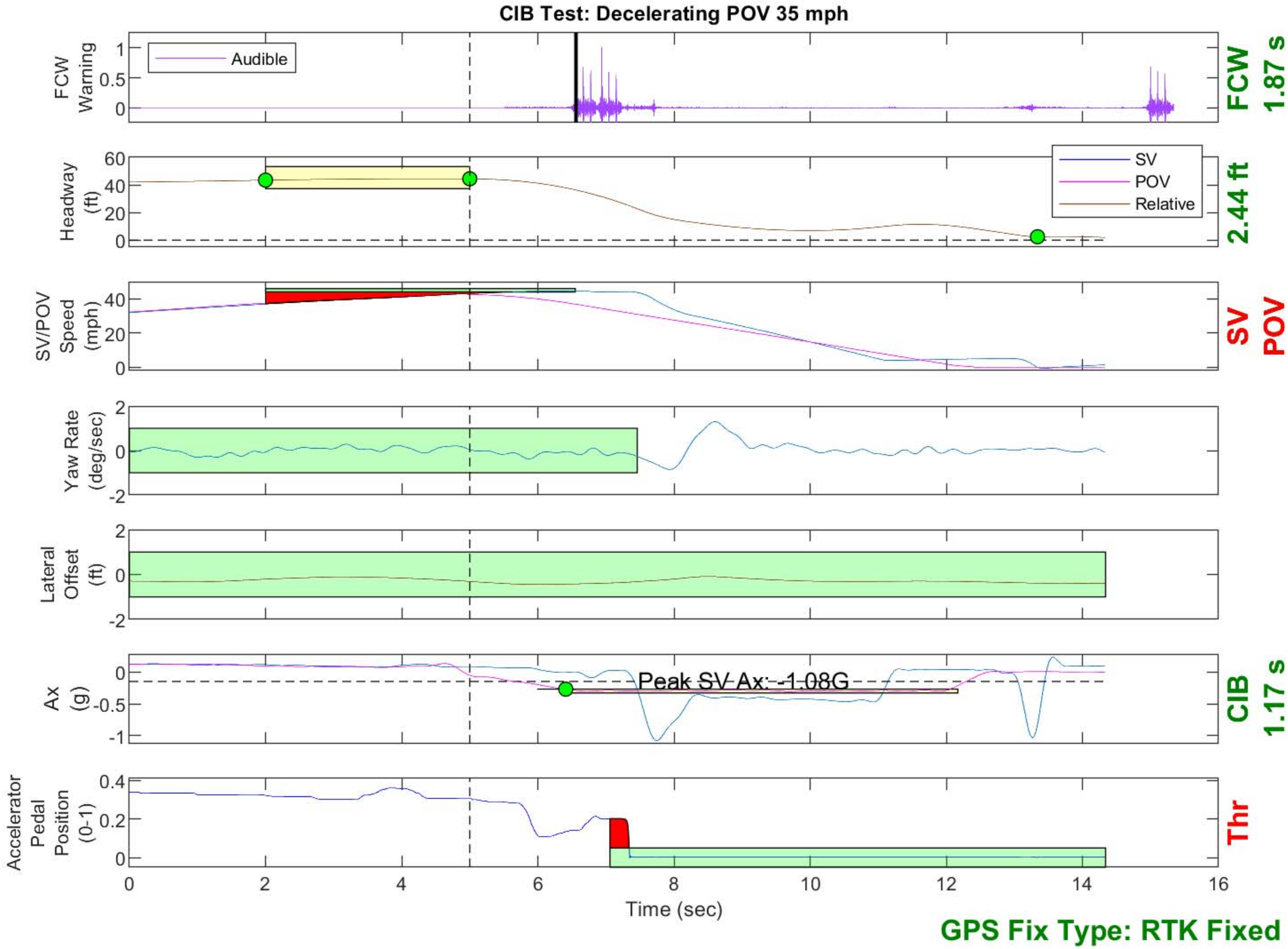



Figure D6. Example Time History Displaying Various Invalid Criteria

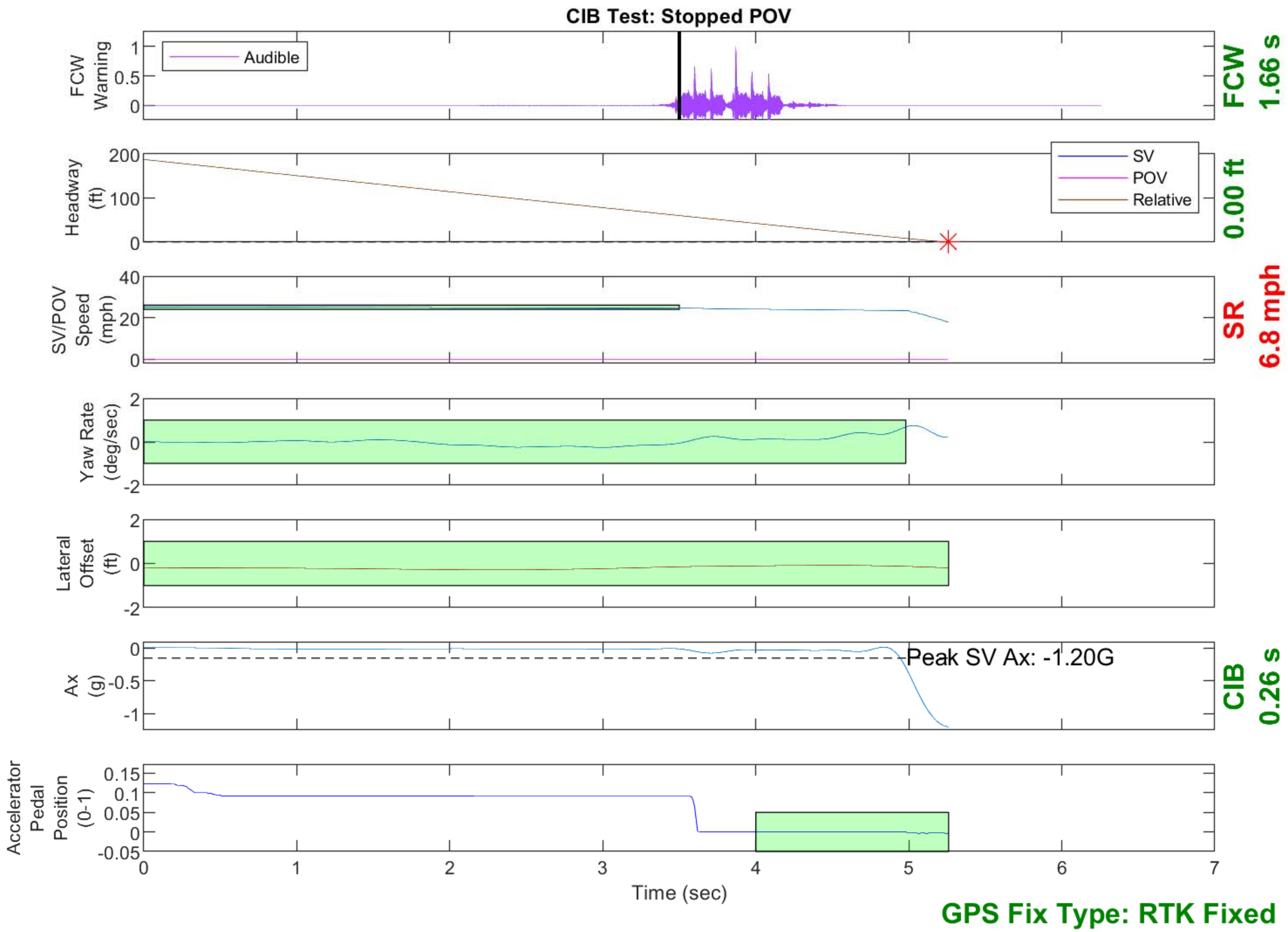



Figure D7. Example Time History for a Failed Run

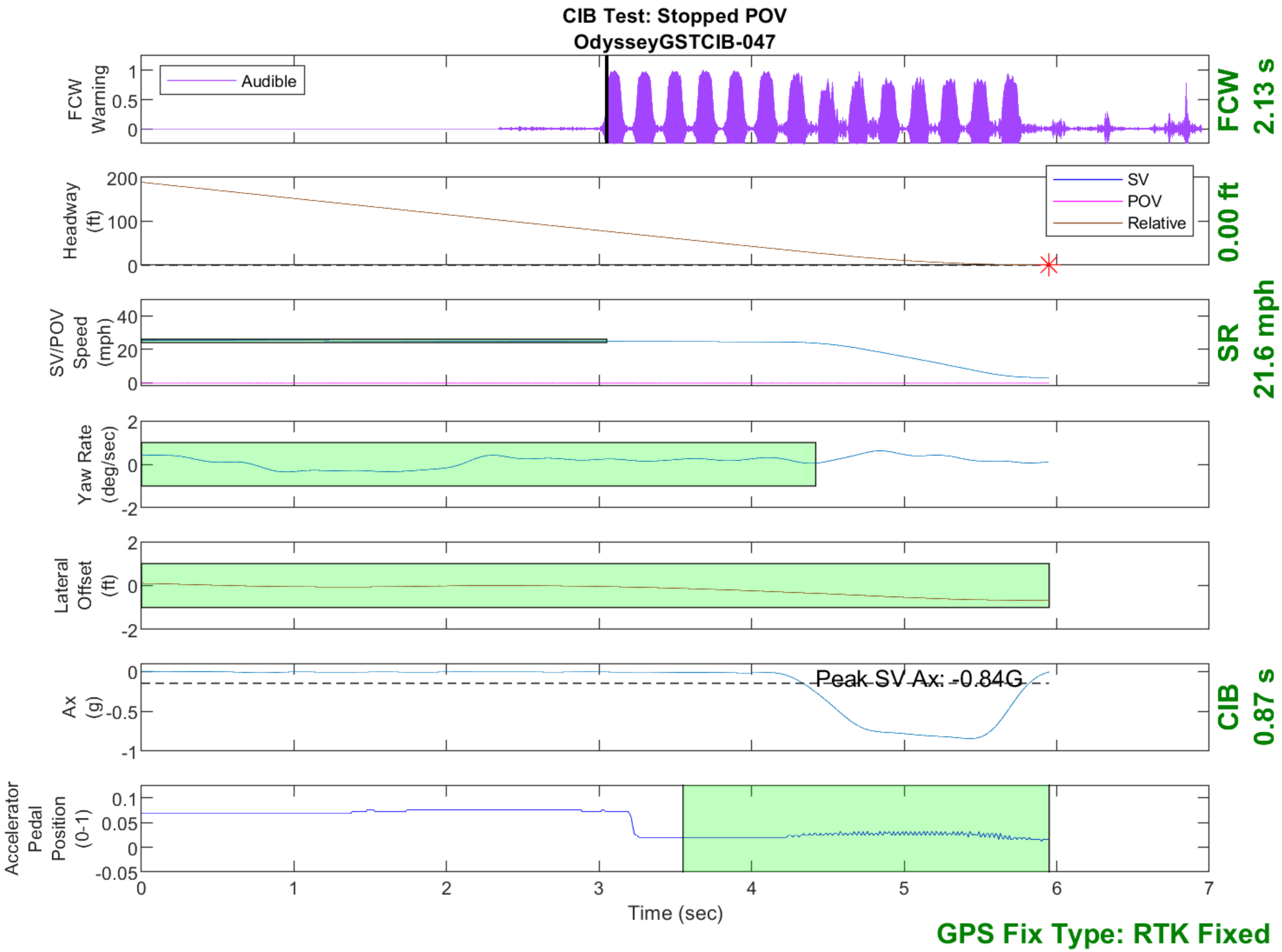



Figure D8. Time History for CIB Run 47, Stopped POV, 25 mph

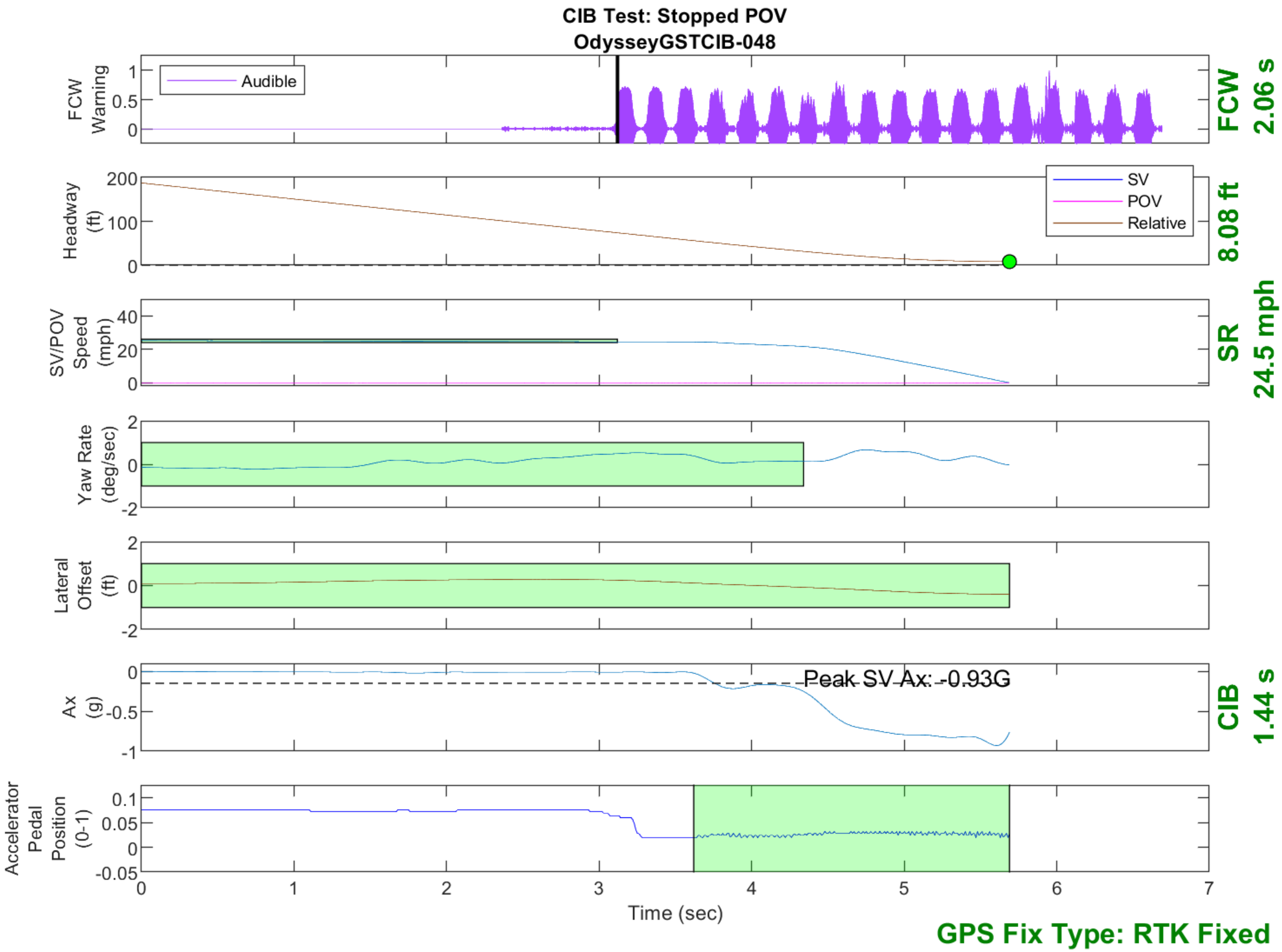



Figure D9. Time History for CIB Run 48, Stopped POV, 25 mph

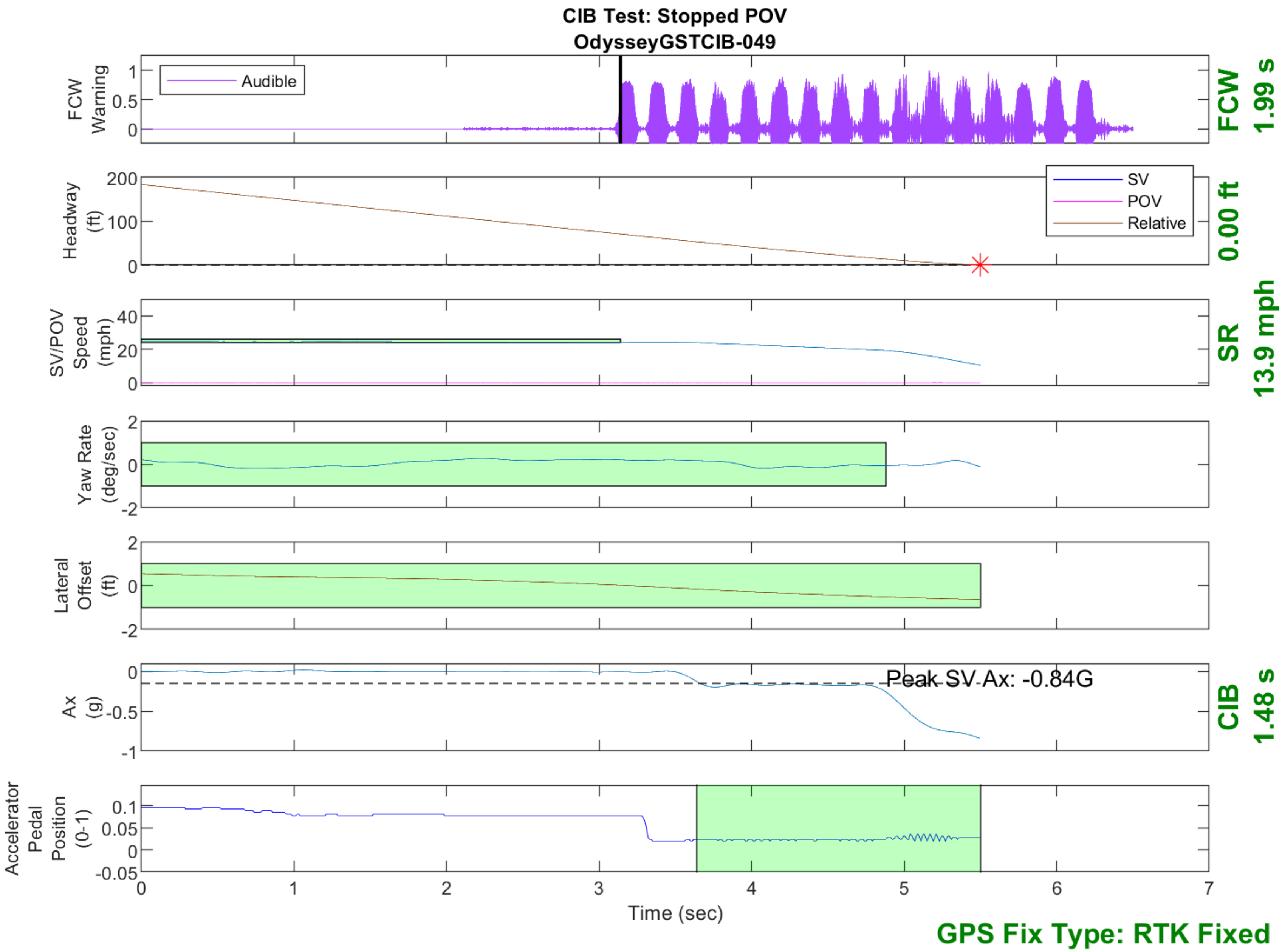



Figure D10. Time History for CIB Run 49, Stopped POV, 25 mph

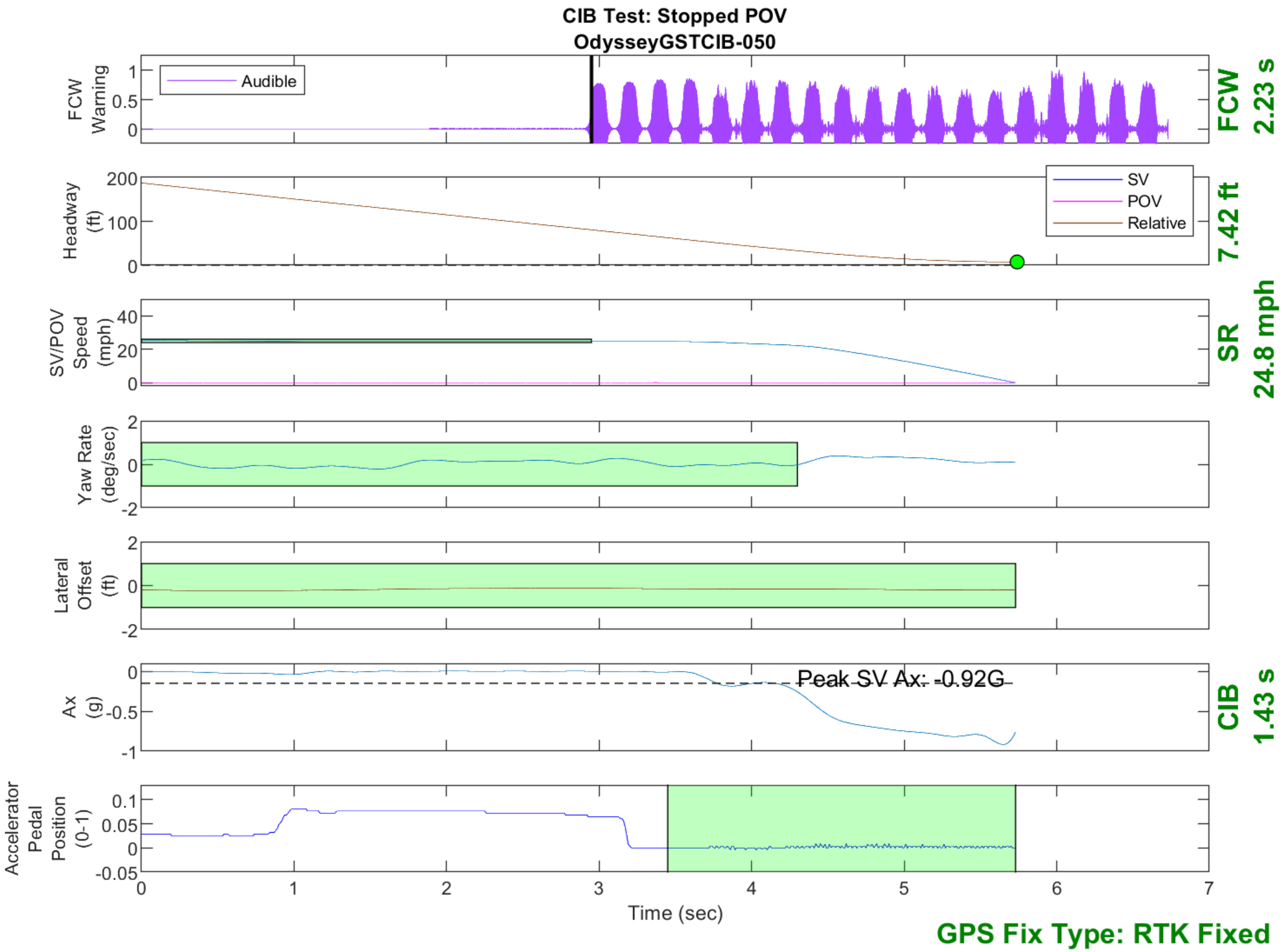



Figure D11. Time History for CIB Run 50, Stopped POV, 25 mph

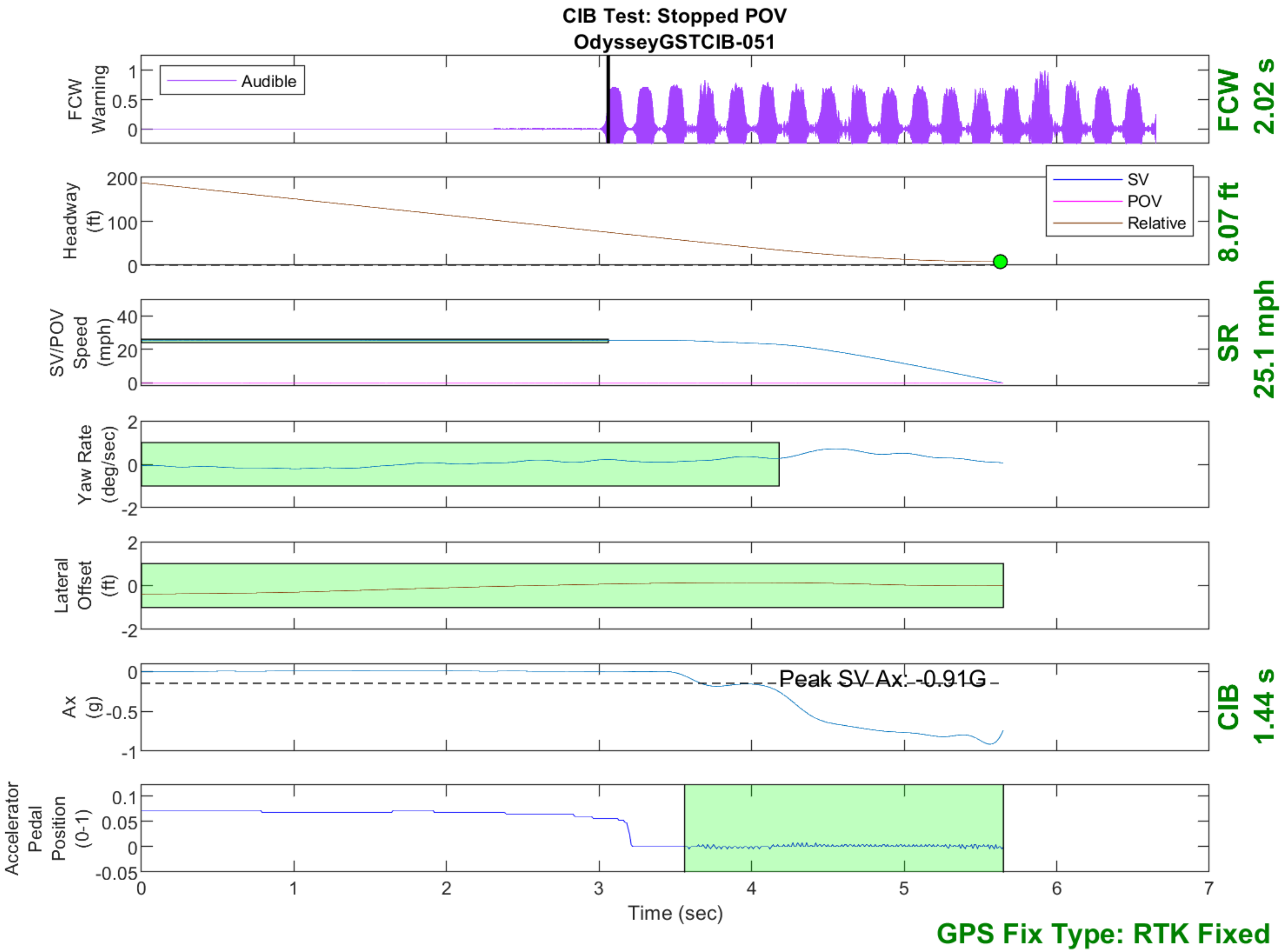



Figure D12. Time History for CIB Run 51, Stopped POV, 25 mph

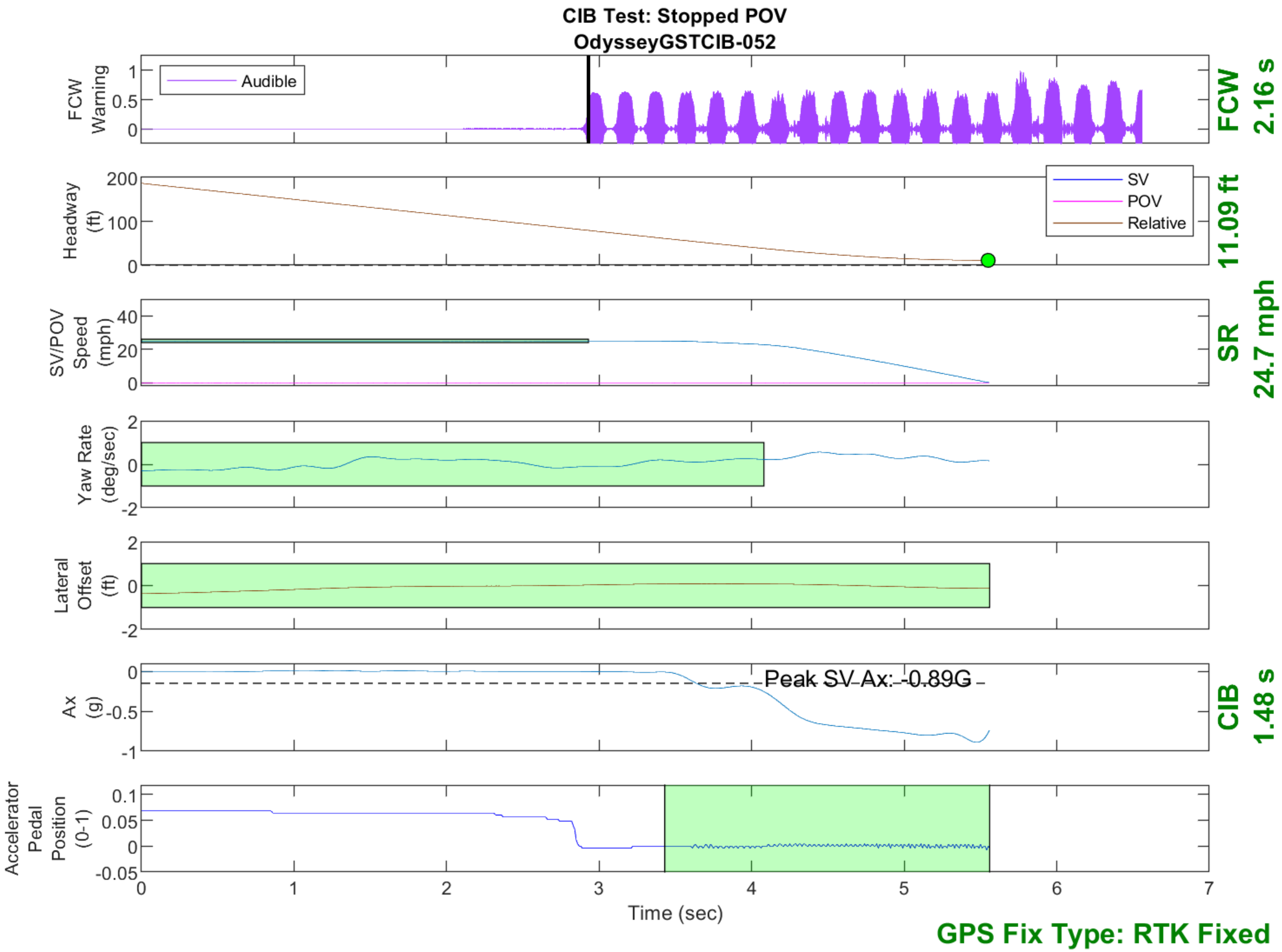



Figure D13. Time History for CIB Run 52, Stopped POV, 25 mph

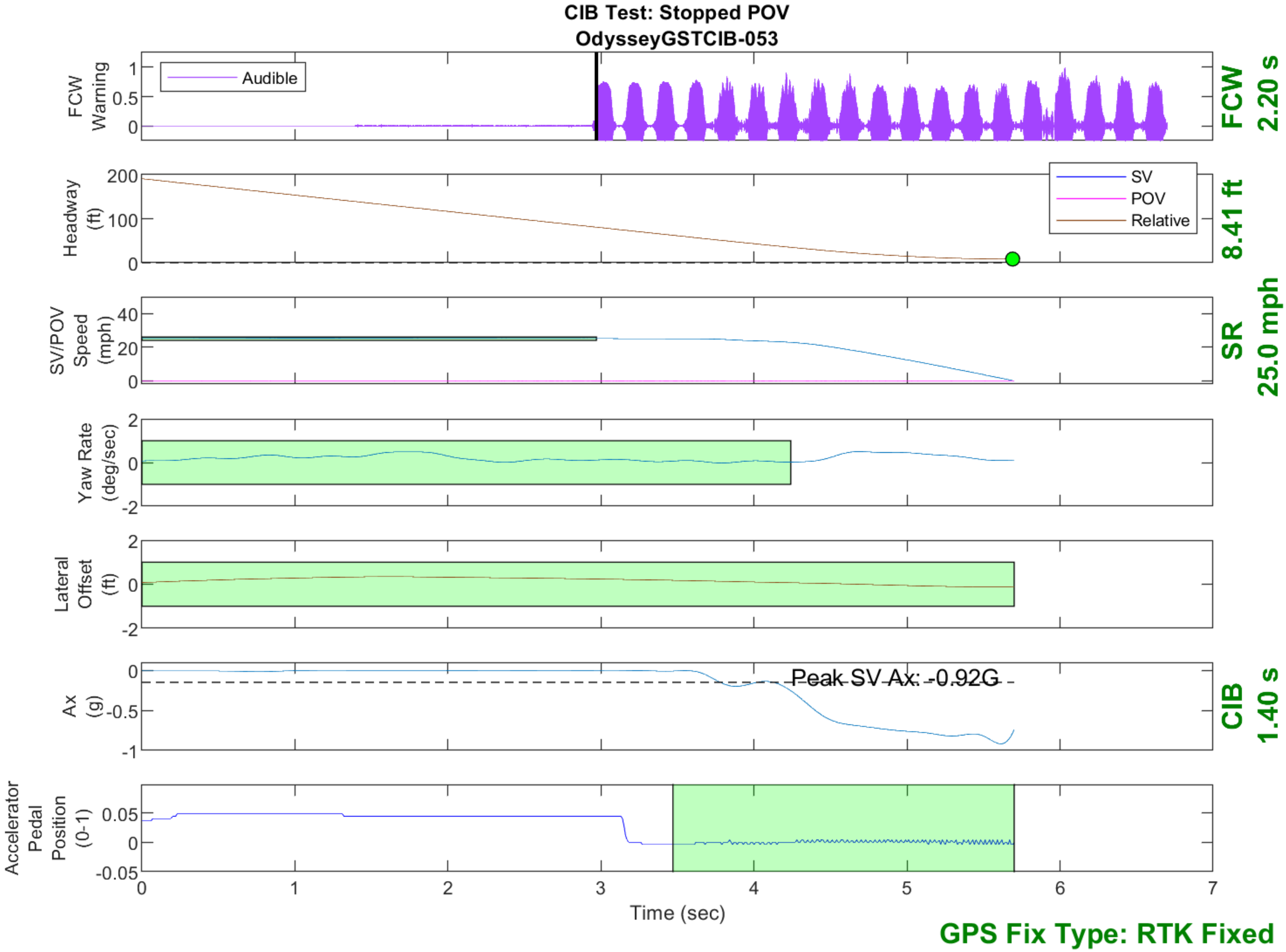



Figure D14. Time History for CIB Run 53, Stopped POV, 25 mph

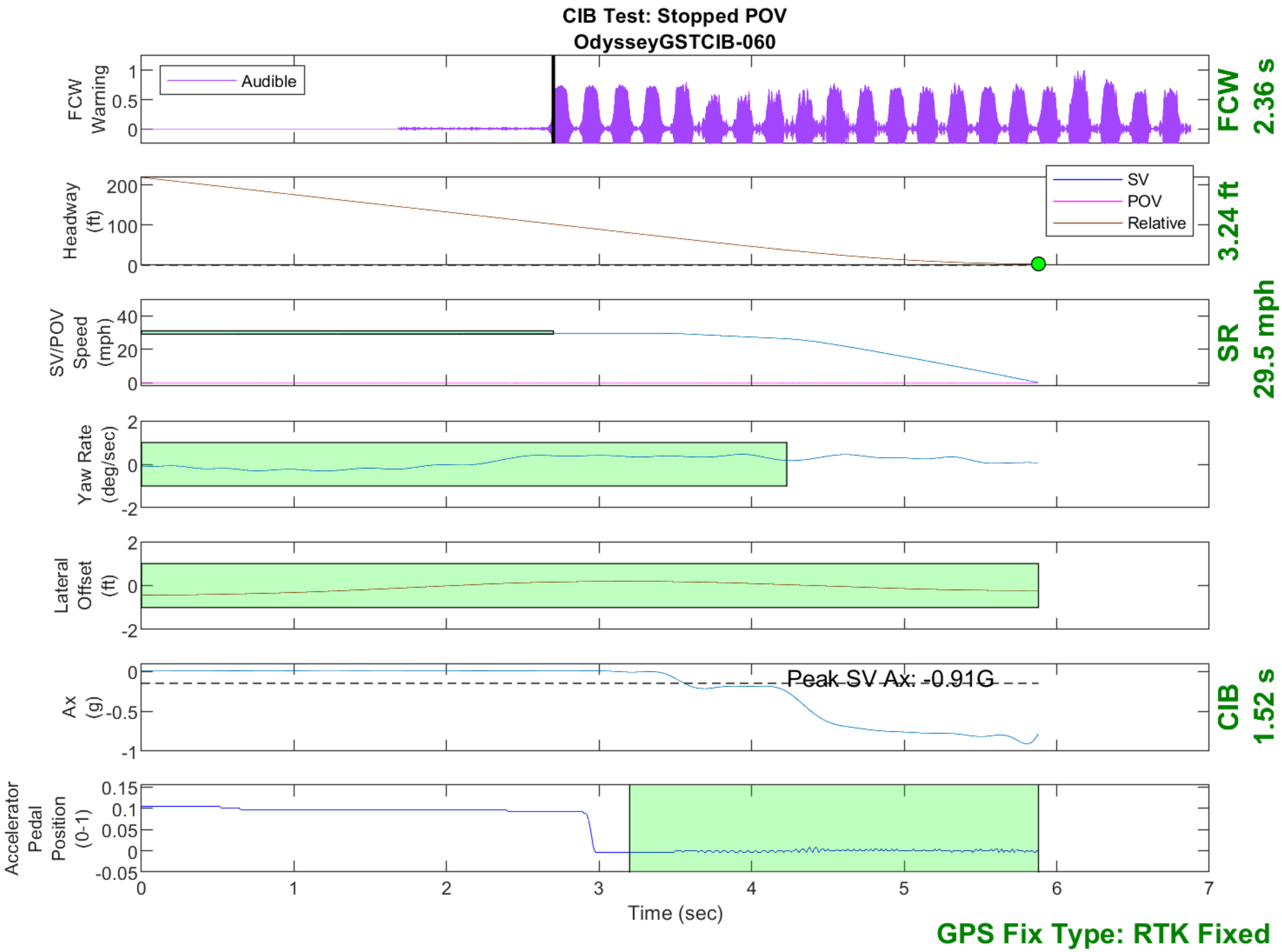



Figure D15. Time History for CIB Run 60, Stopped POV, 30 mph

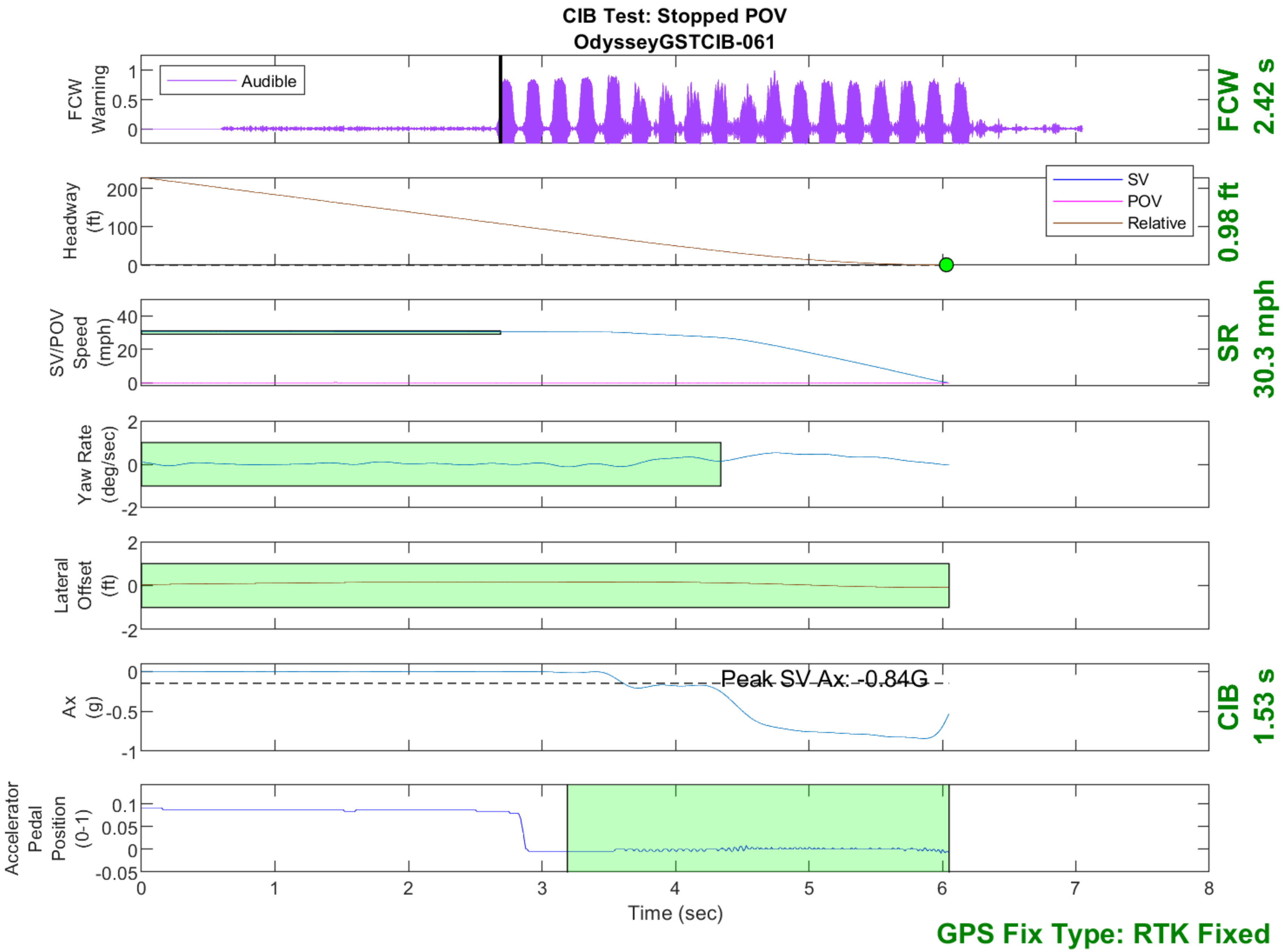



Figure D16. Time History for CIB Run 61, Stopped POV, 30 mph

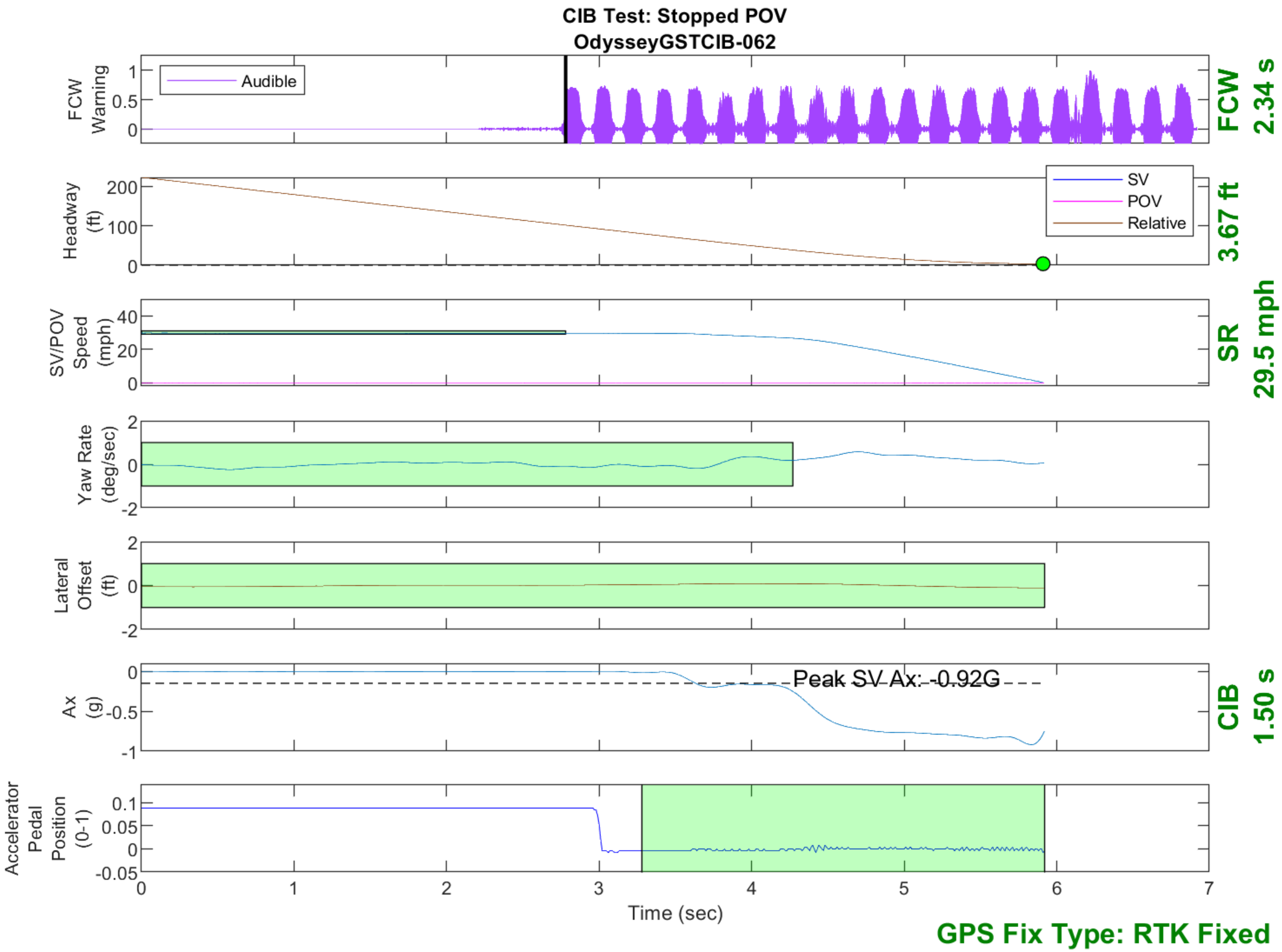



Figure D17. Time History for CIB Run 62, Stopped POV, 30 mph

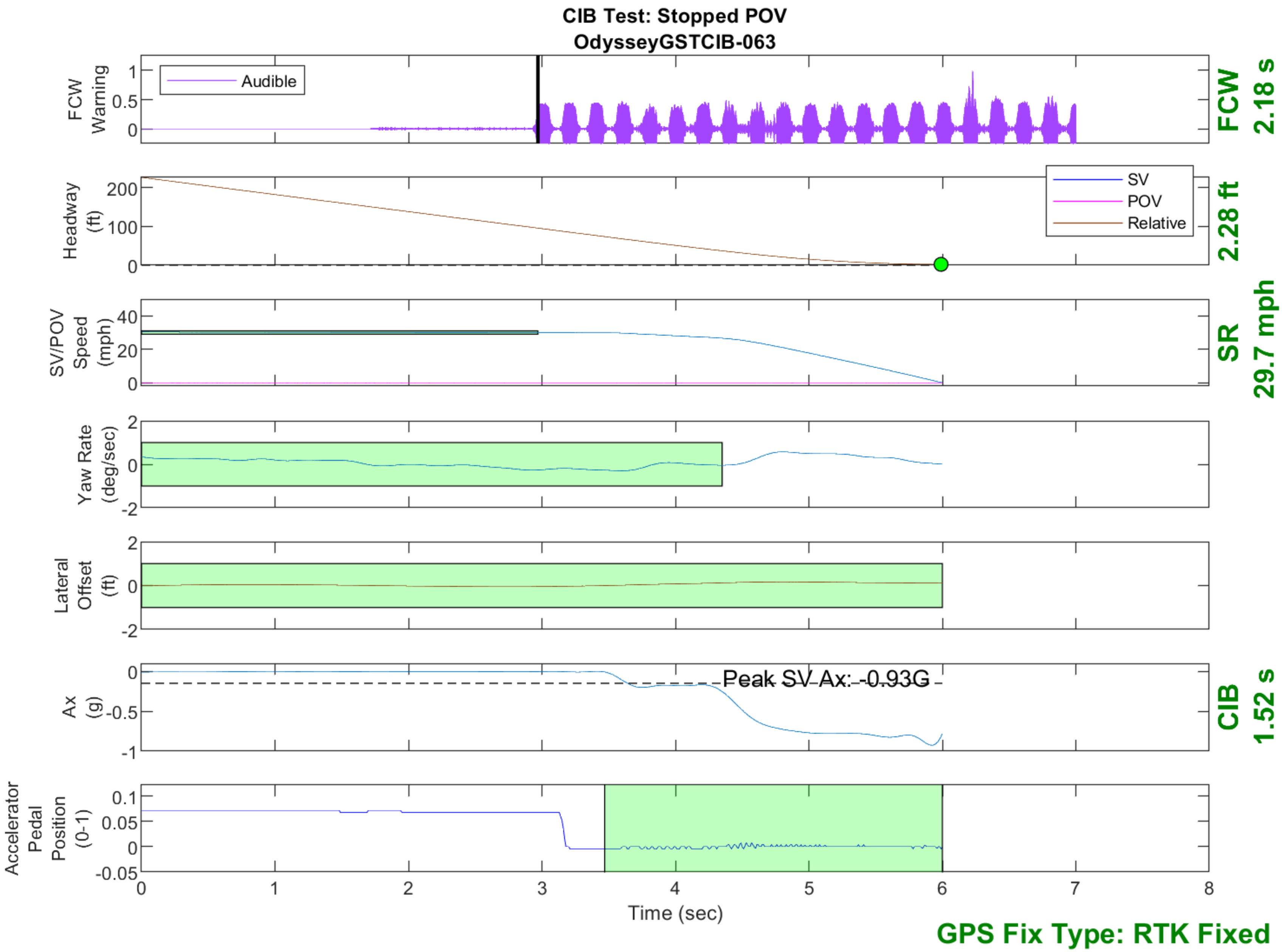



Figure D18. Time History for CIB Run 63, Stopped POV, 30 mph

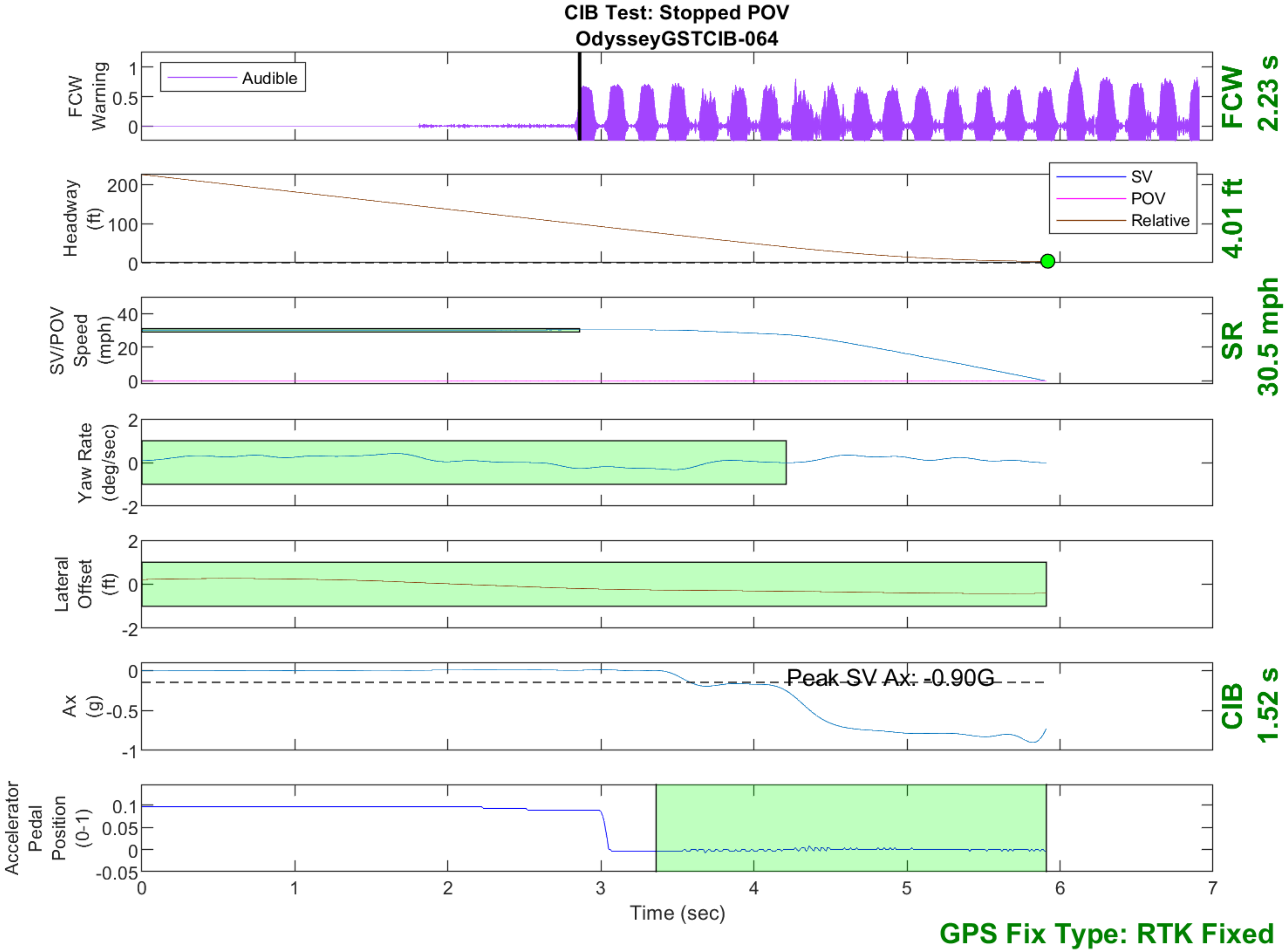



Figure D19. Time History for CIB Run 64, Stopped POV, 30 mph

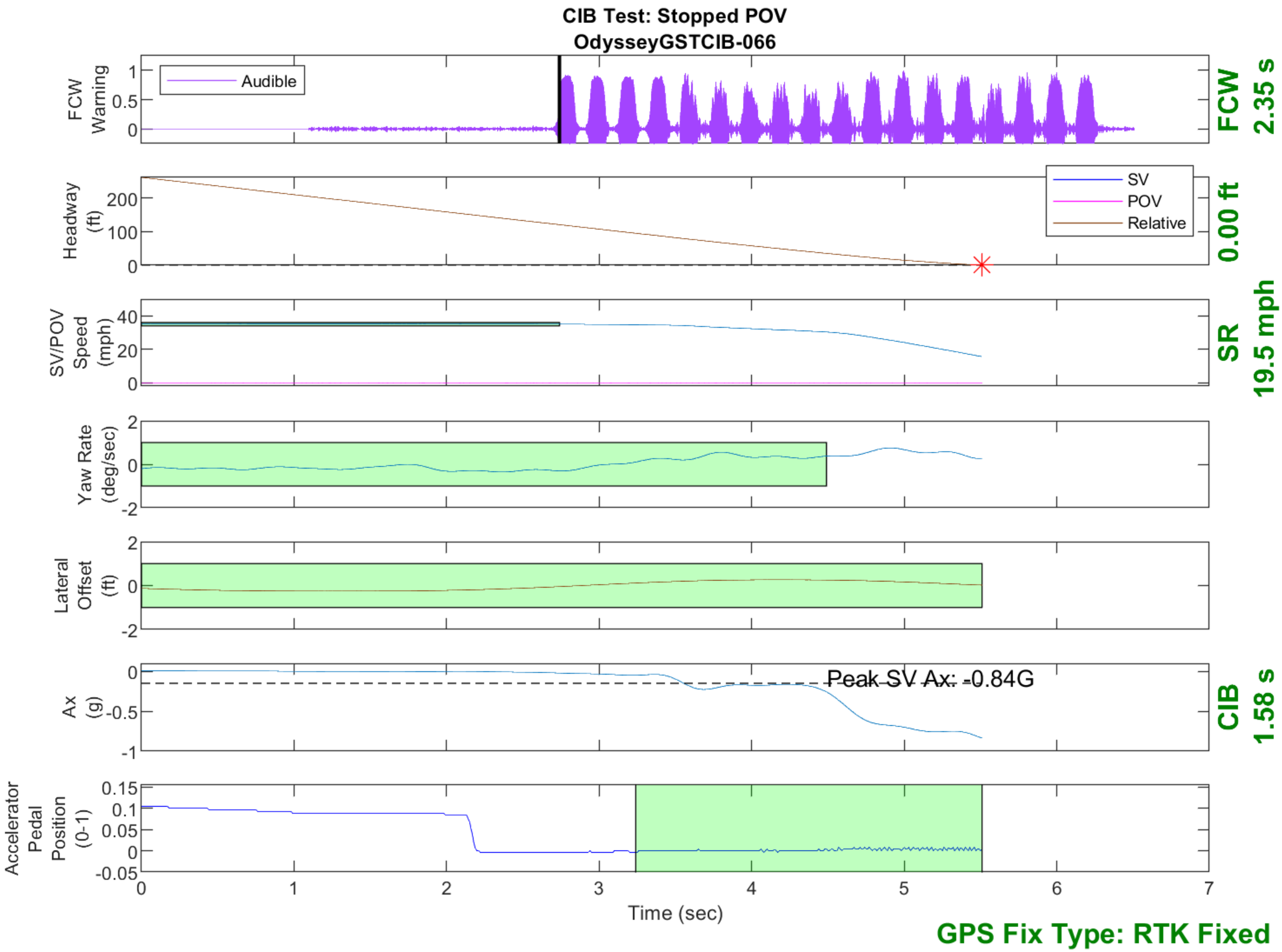



Figure D20. Time History for CIB Run 66, Stopped POV, 35 mph

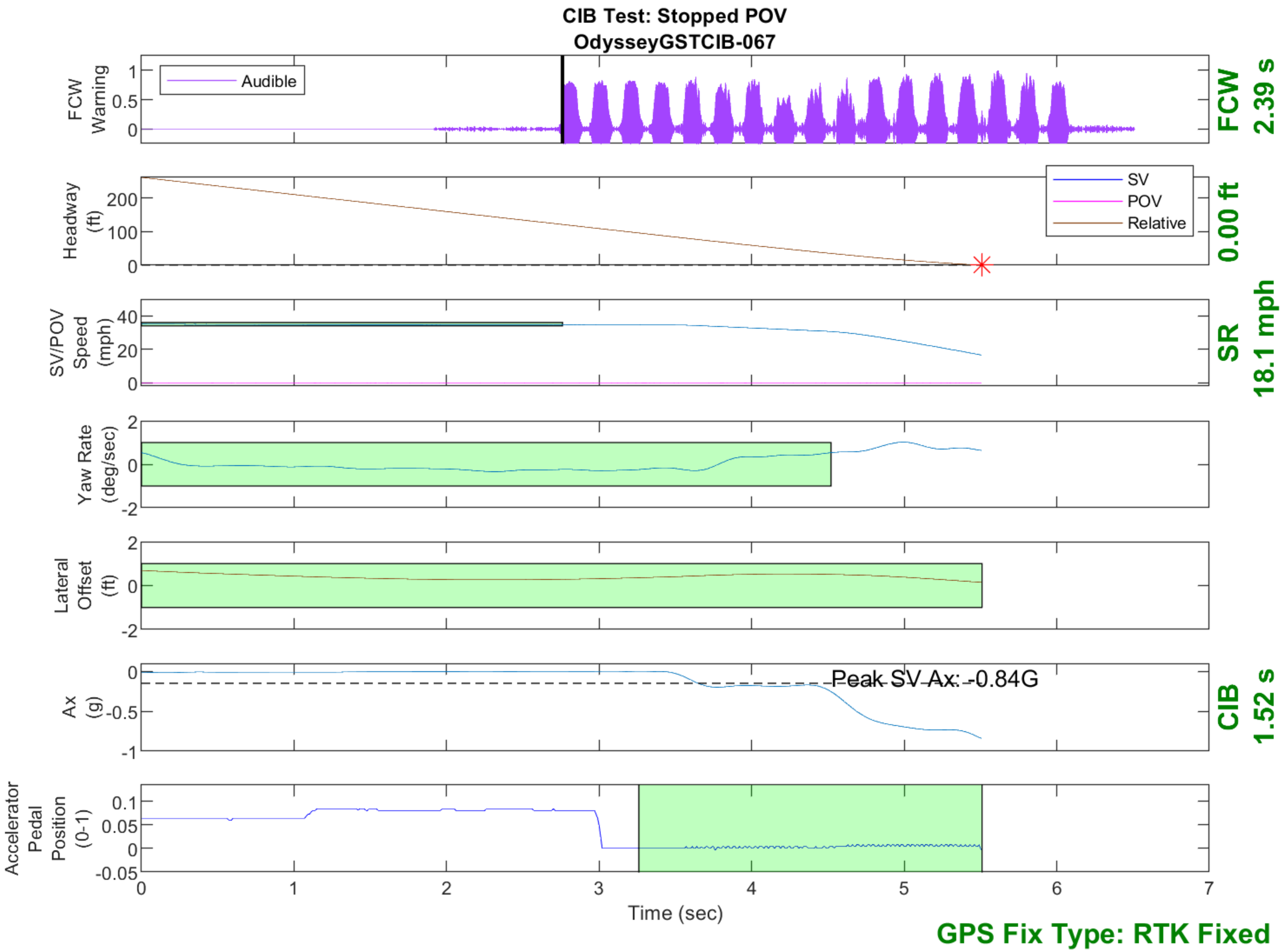



Figure D21. Time History for CIB Run 67, Stopped POV, 35 mph

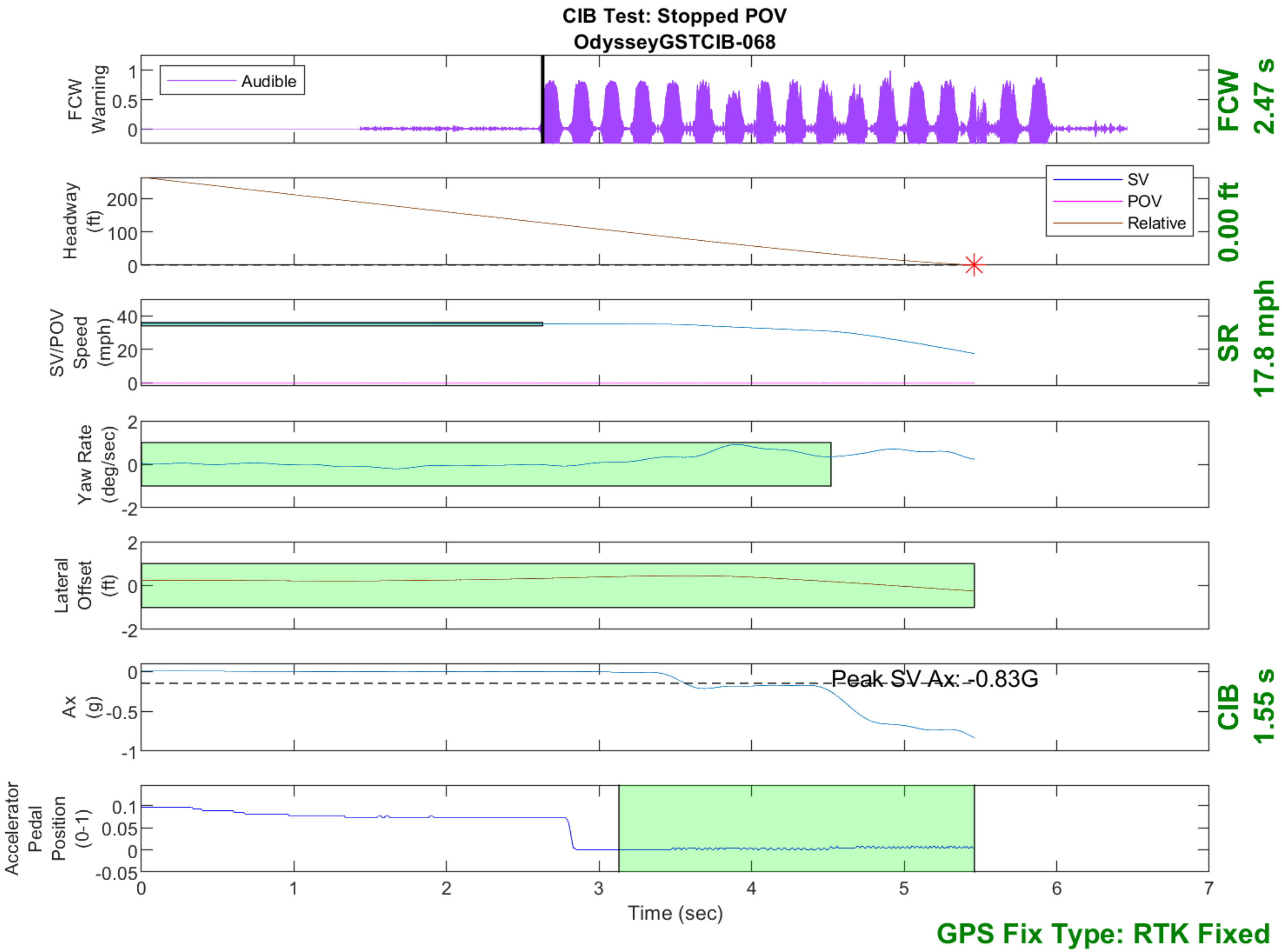



Figure D22. Time History for CIB Run 68, Stopped POV, 35 mph

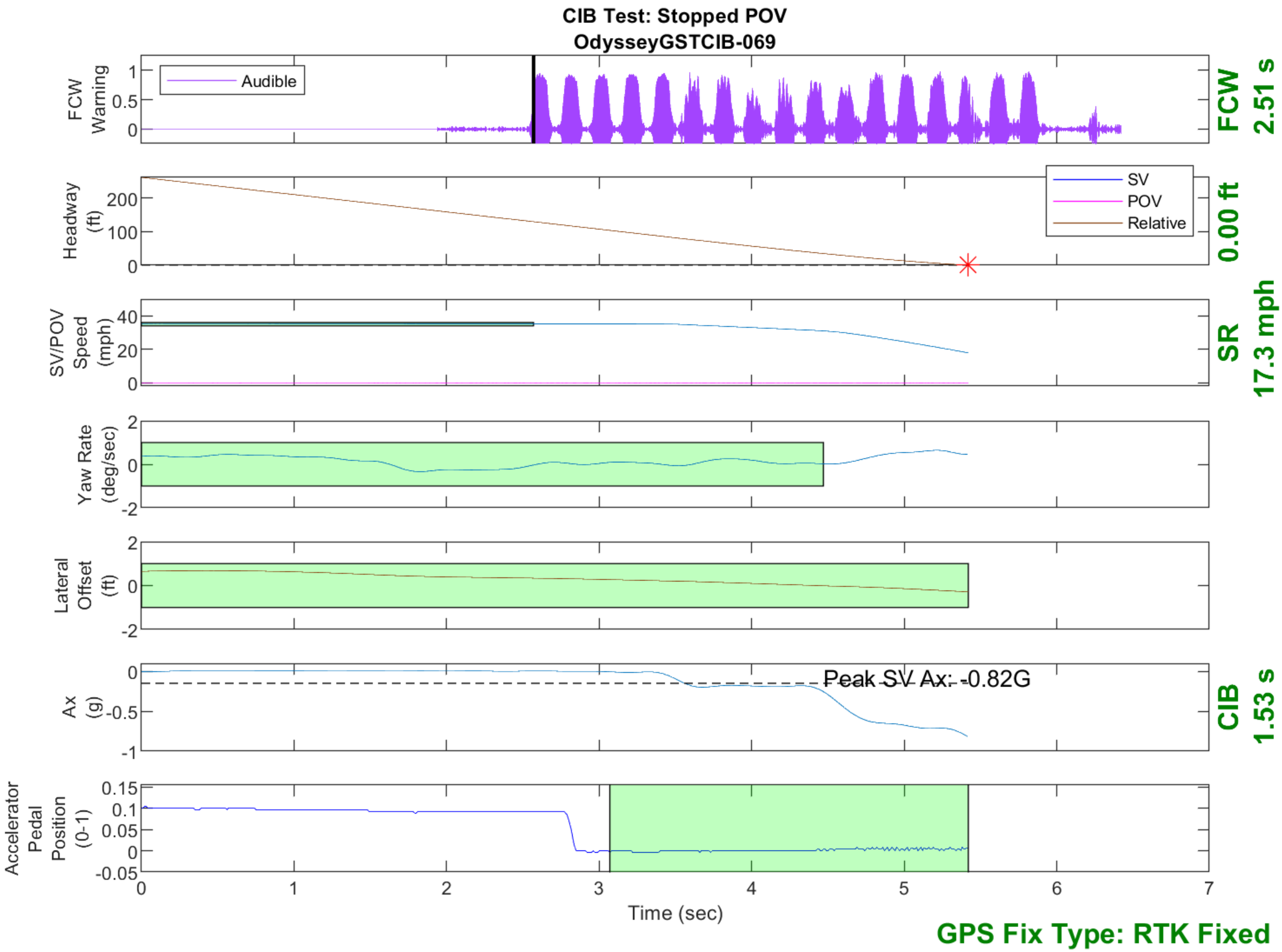



Figure D23. Time History for CIB Run 69, Stopped POV, 35 mph

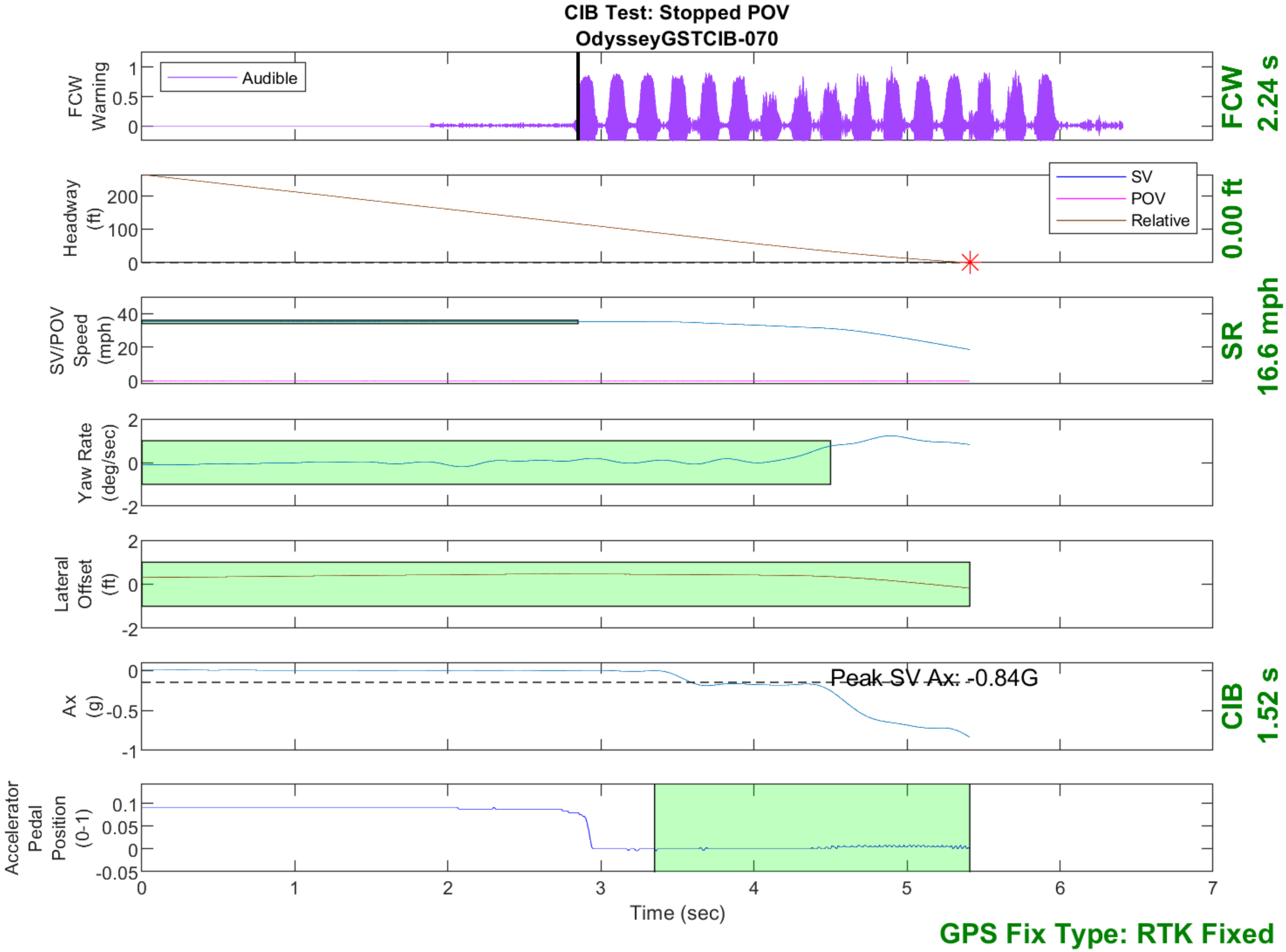



Figure D24. Time History for CIB Run 70, Stopped POV, 35 mph

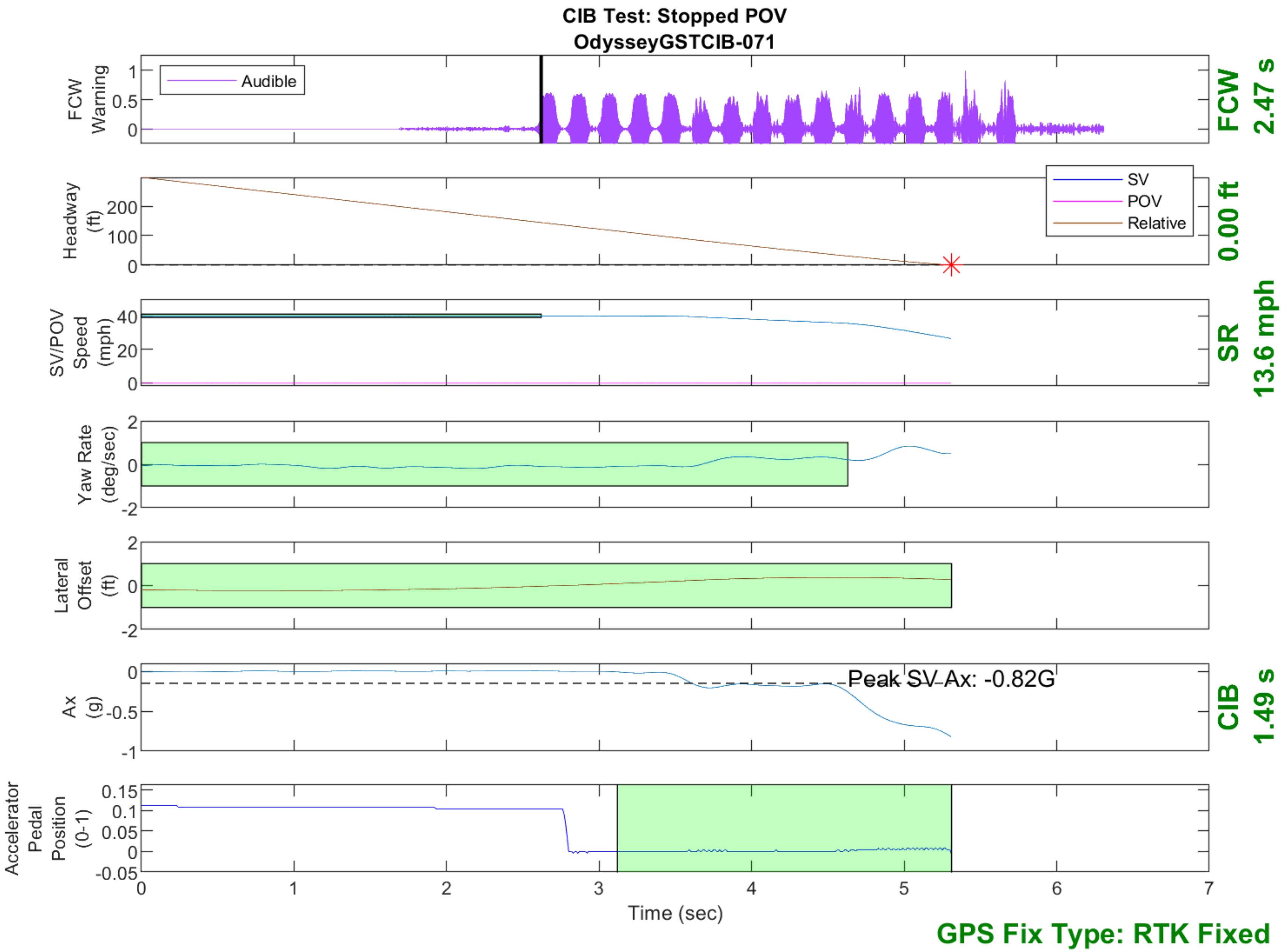



Figure D25. Time History for CIB Run 71, Stopped POV, 40 mph

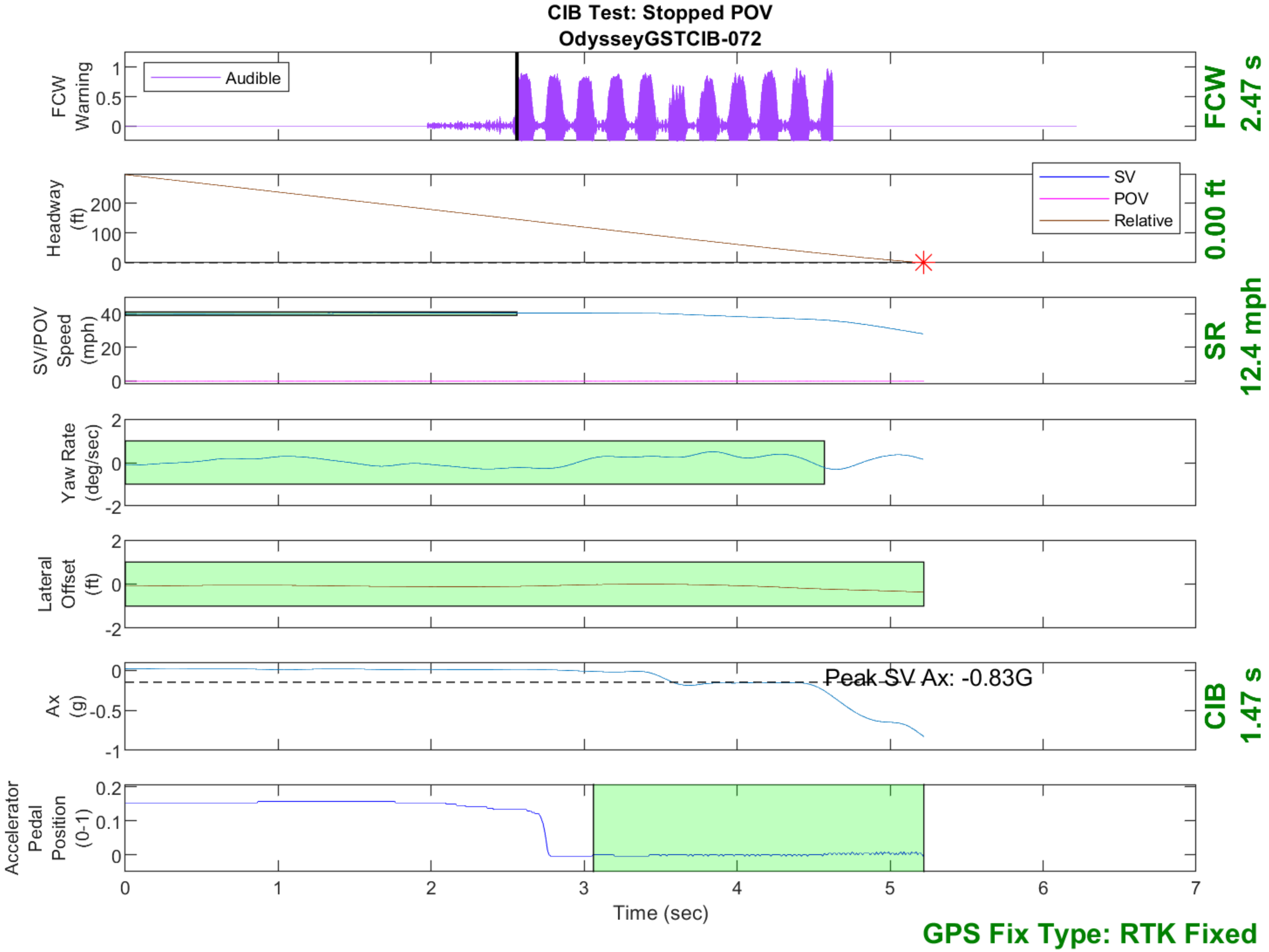



Figure D26. Time History for CIB Run 72, Stopped POV, 40 mph

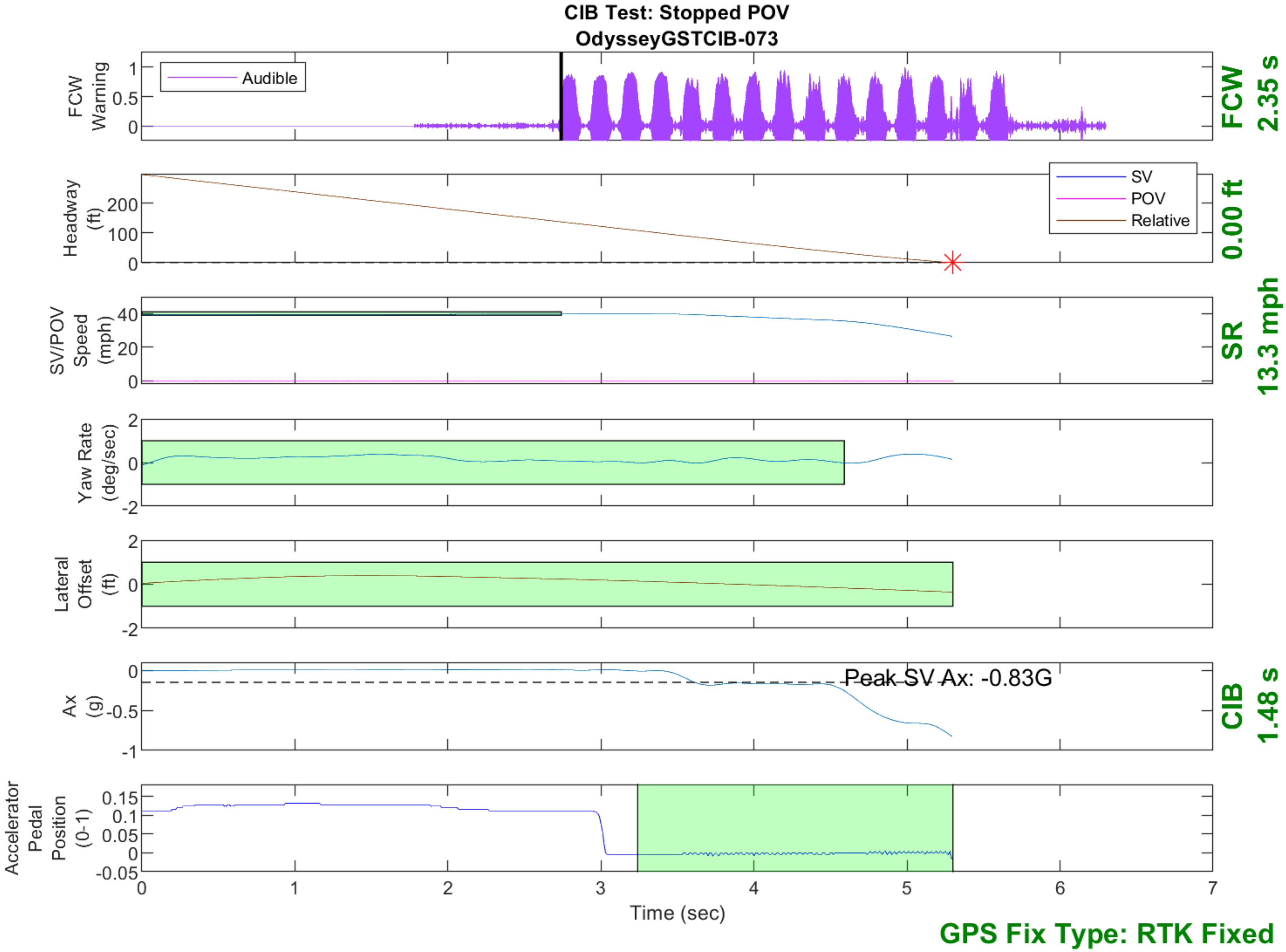



Figure D27. Time History for CIB Run 73, Stopped POV, 40 mph

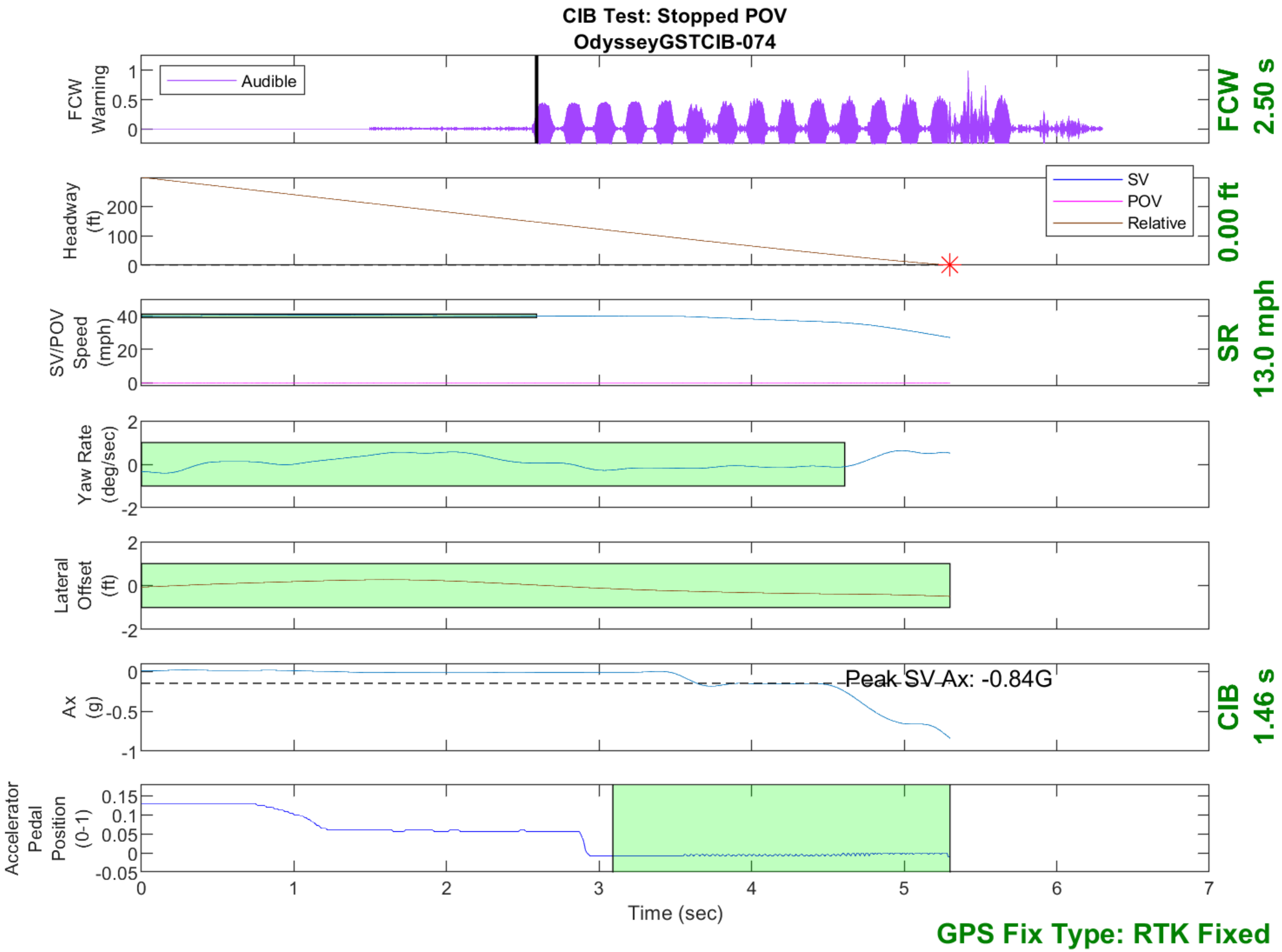



Figure D28. Time History for CIB Run 74, Stopped POV, 40 mph

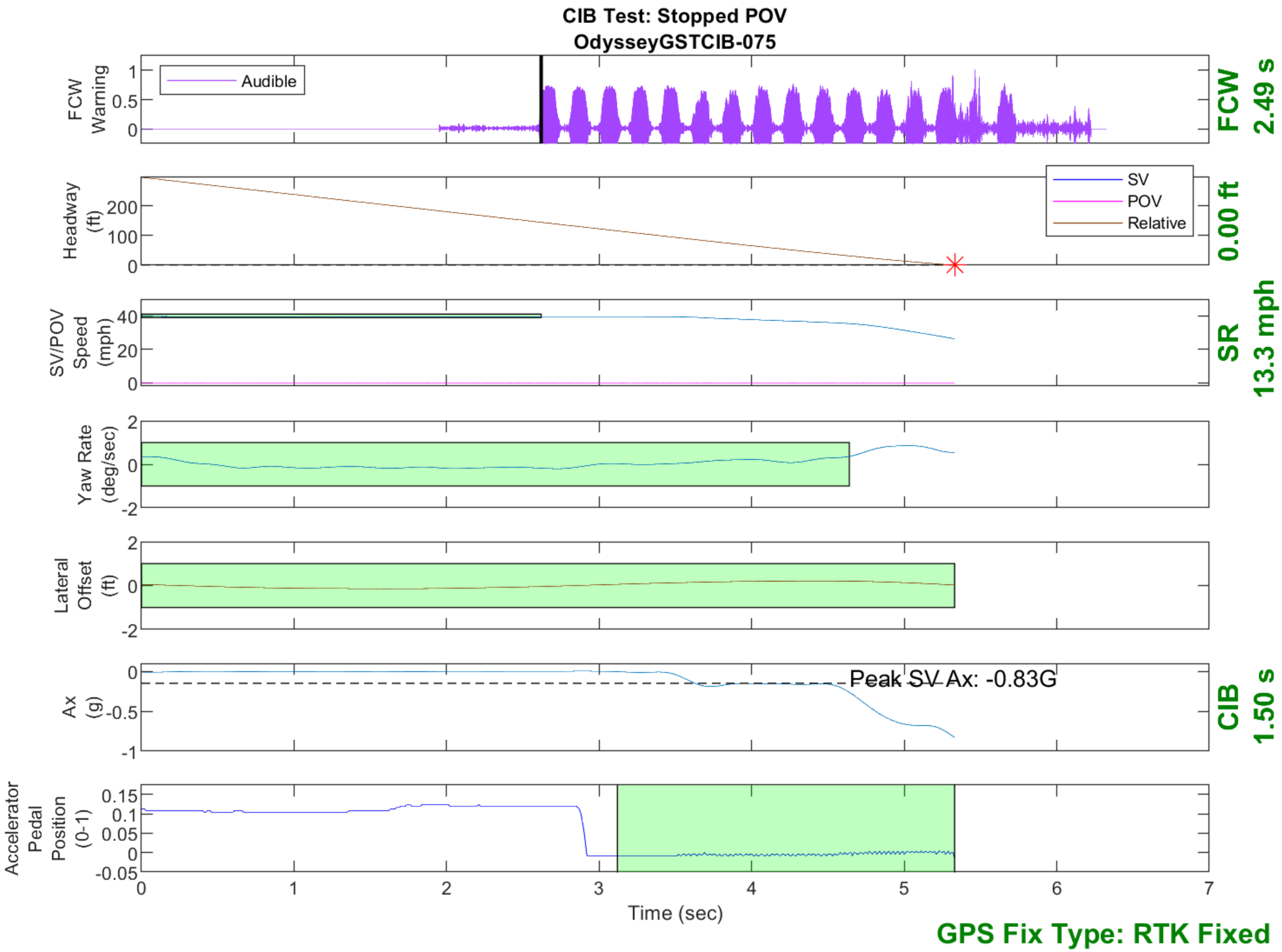



Figure D29. Time History for CIB Run 75, Stopped POV, 40 mph

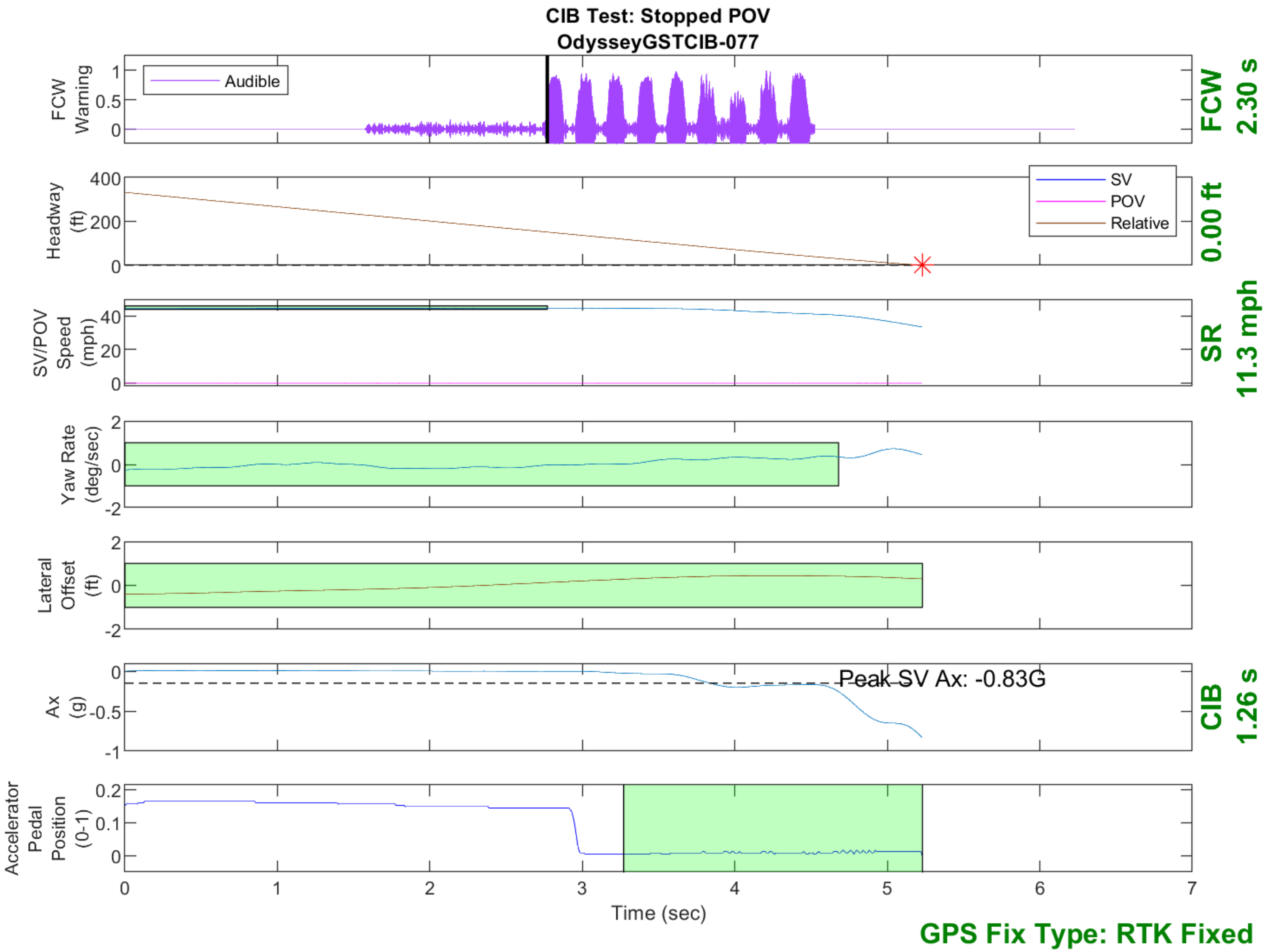



Figure D30. Time History for CIB Run 77, Stopped POV, 45 mph

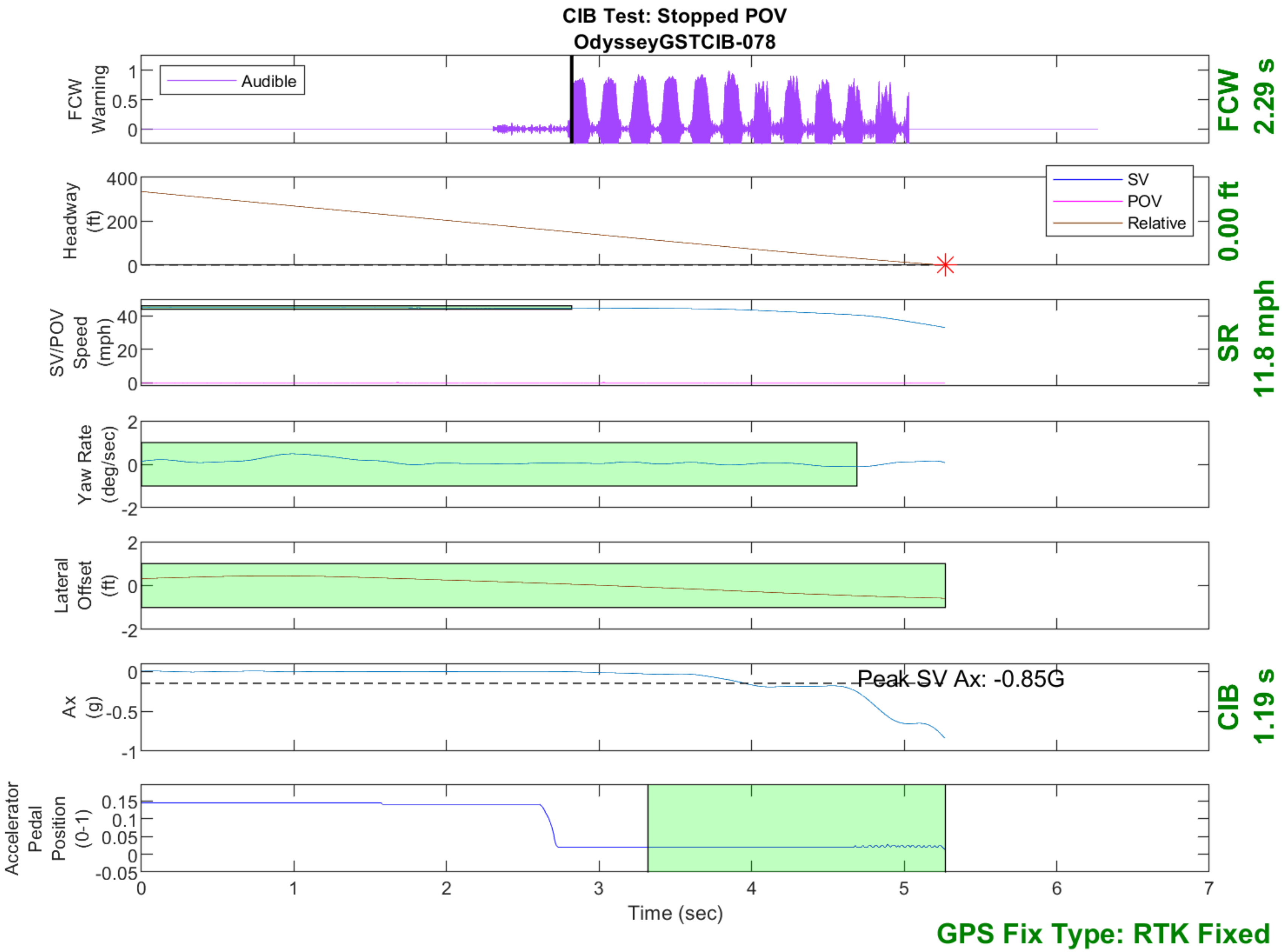



Figure D31. Time History for CIB Run 78, Stopped POV, 45 mph

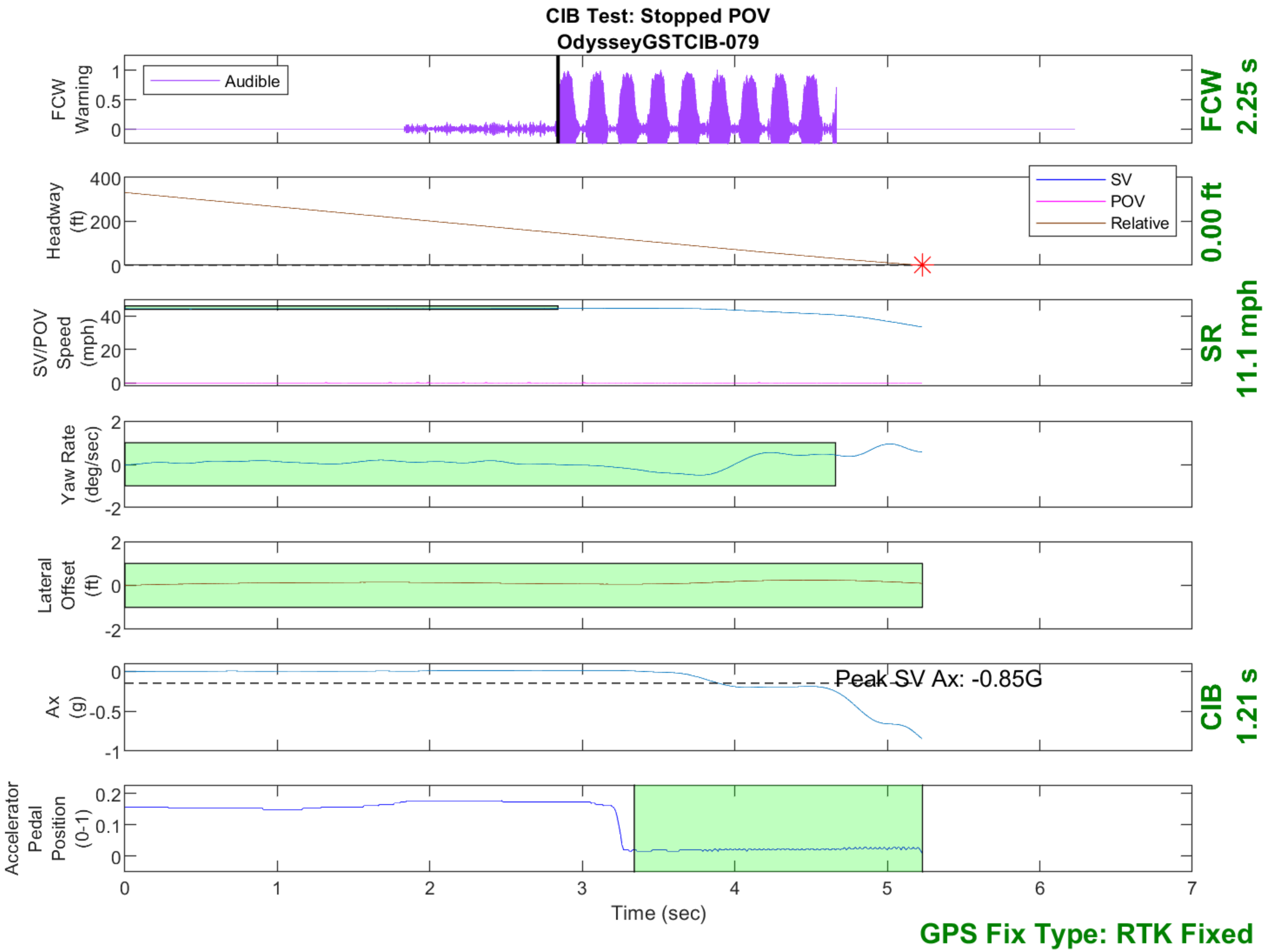



Figure D32. Time History for CIB Run 79, Stopped POV, 45 mph

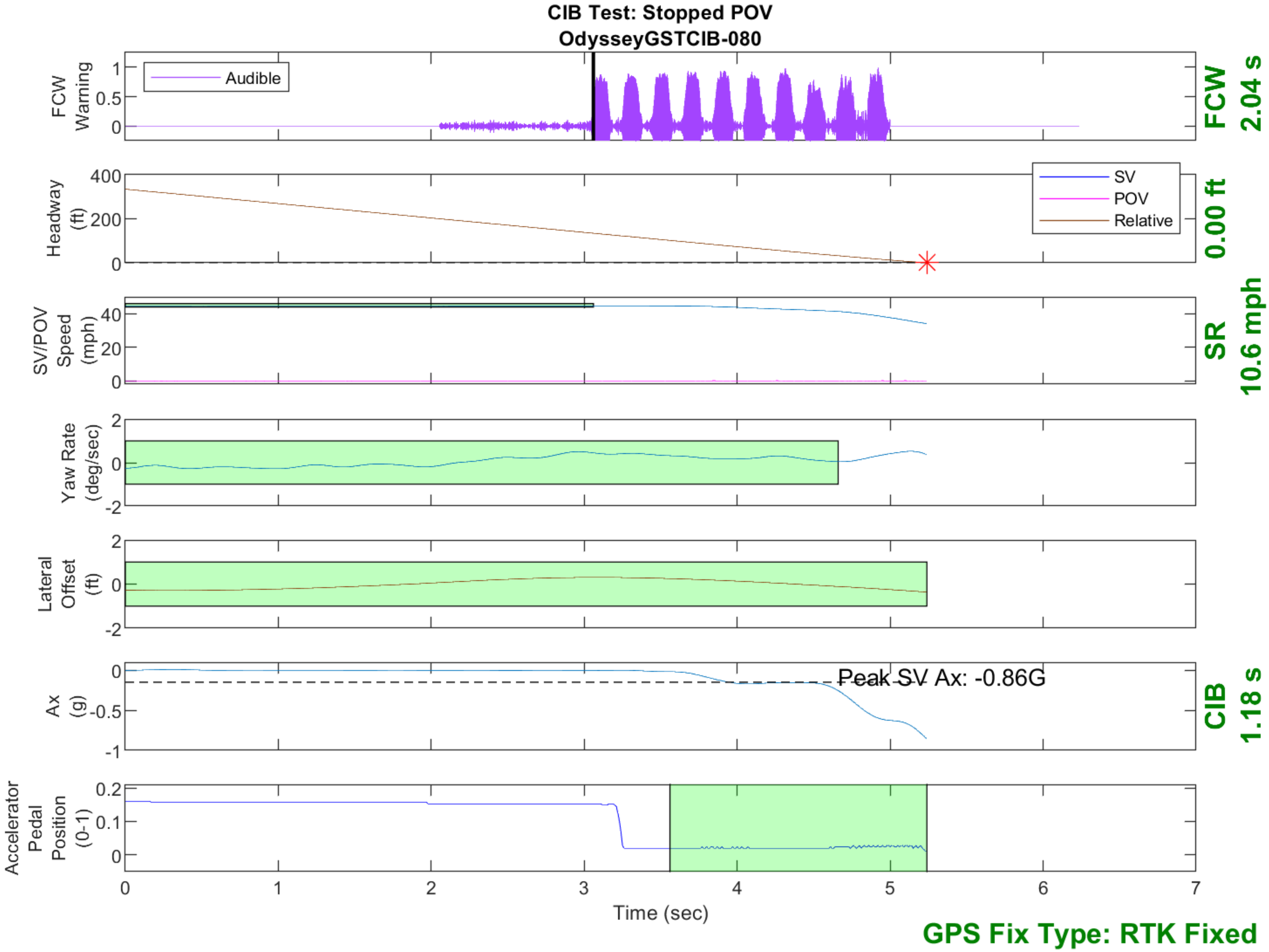



Figure D33. Time History for CIB Run 80, Stopped POV, 45 mph

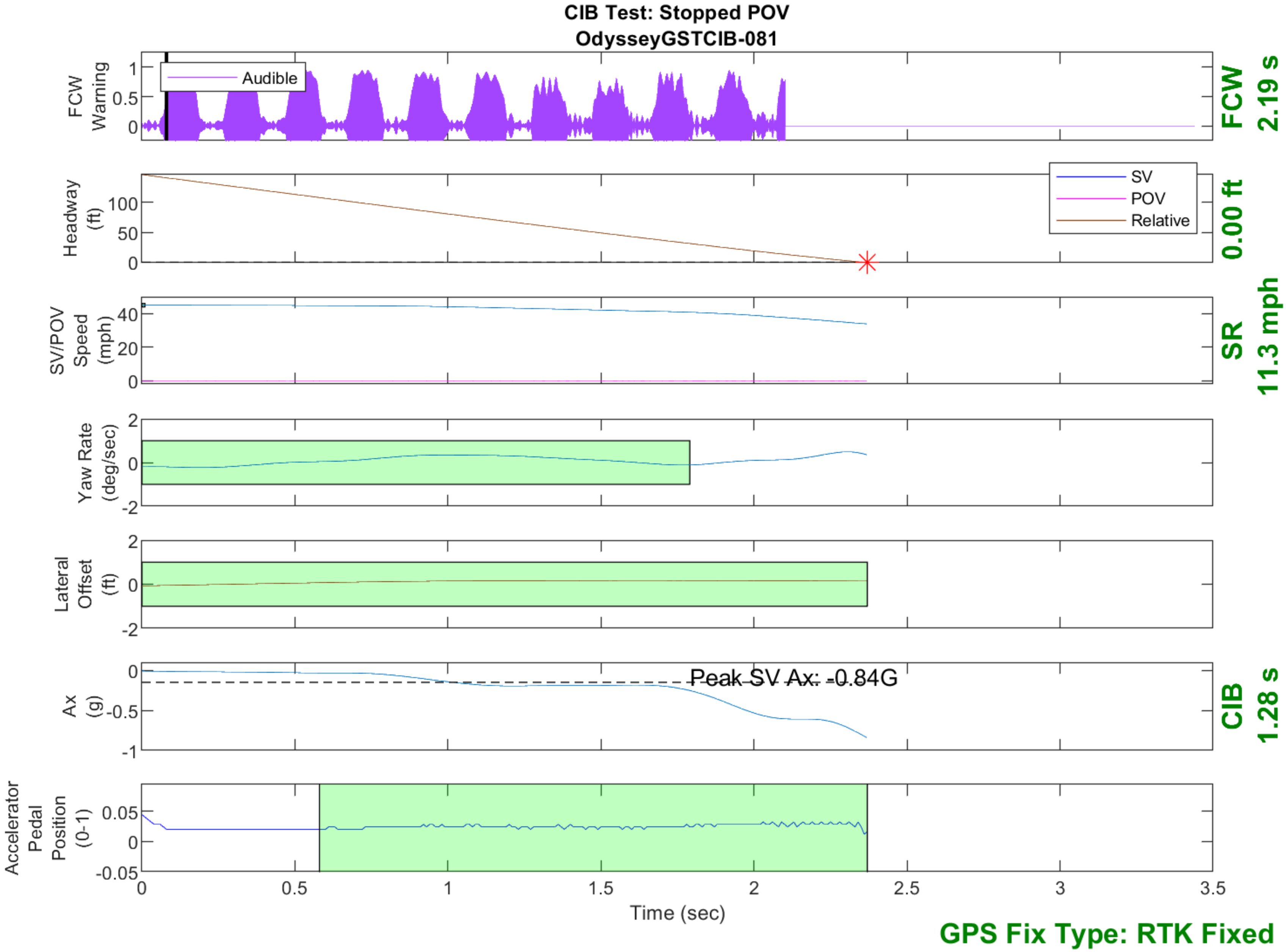



Figure D34. Time History for CIB Run 81, Stopped POV, 45 mph

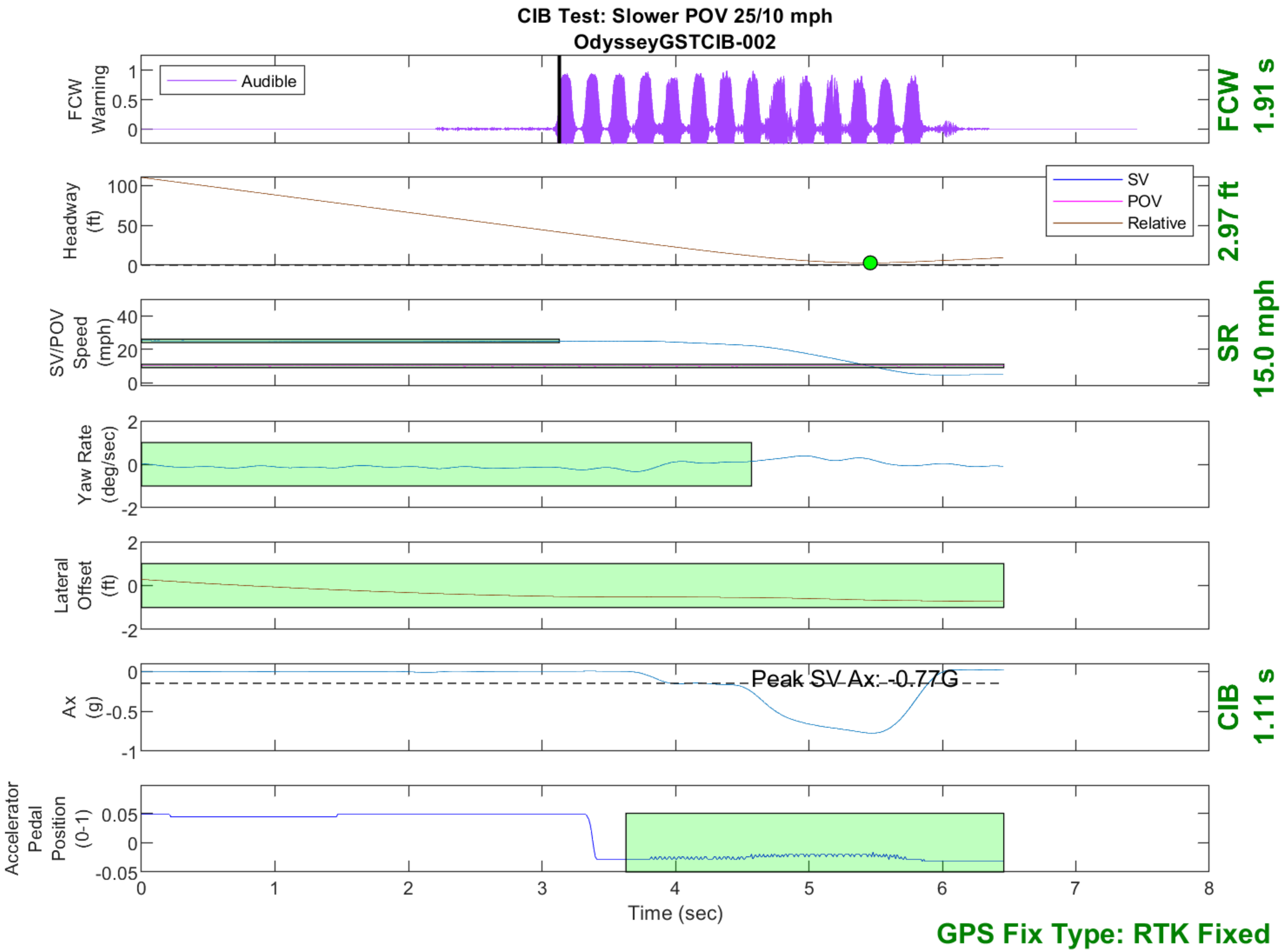



Figure D35. Time History for CIB Run 2, Slower POV, 25/10 mph

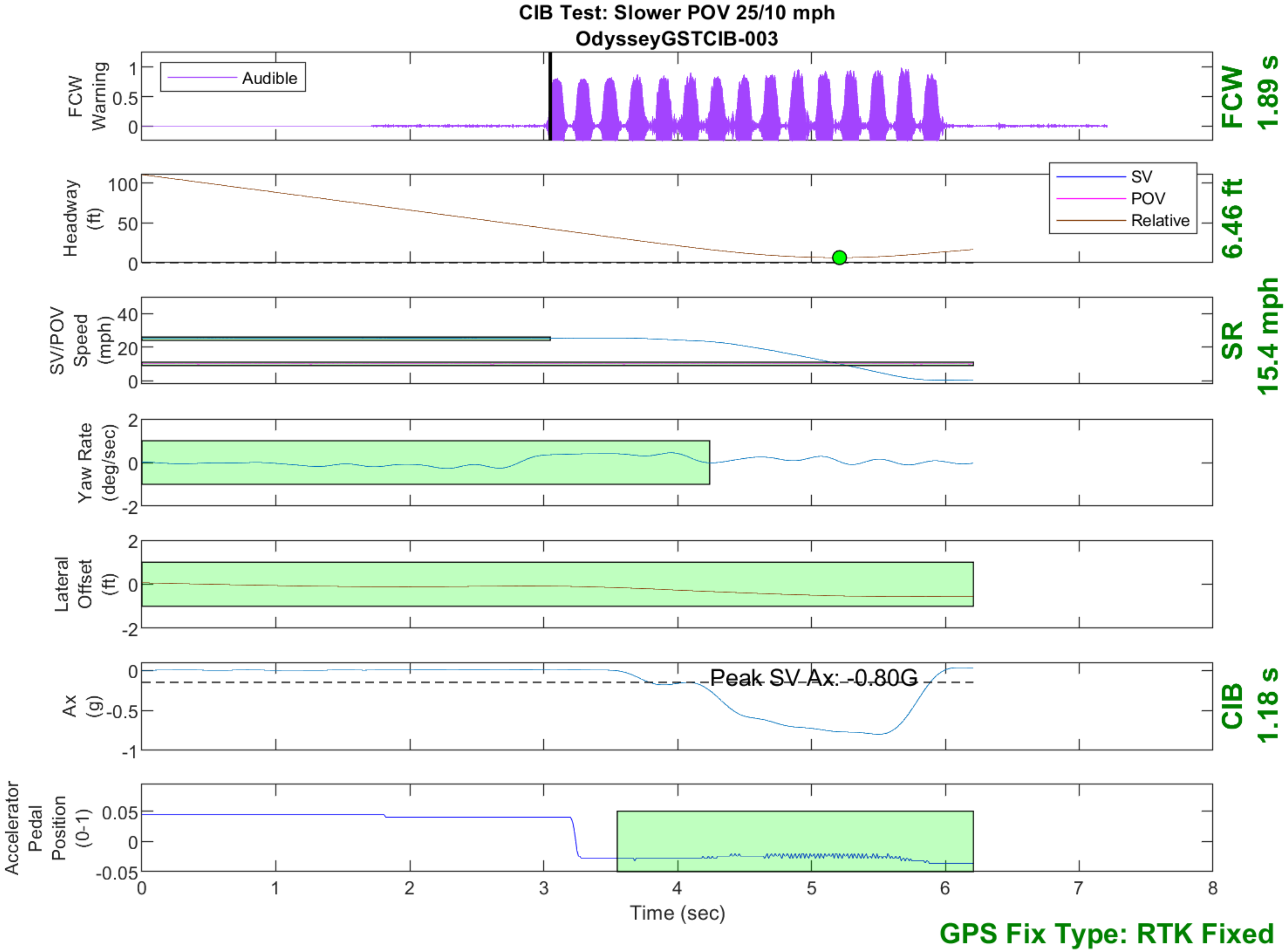



Figure D36. Time History for CIB Run 3, Slower POV, 25/10 mph

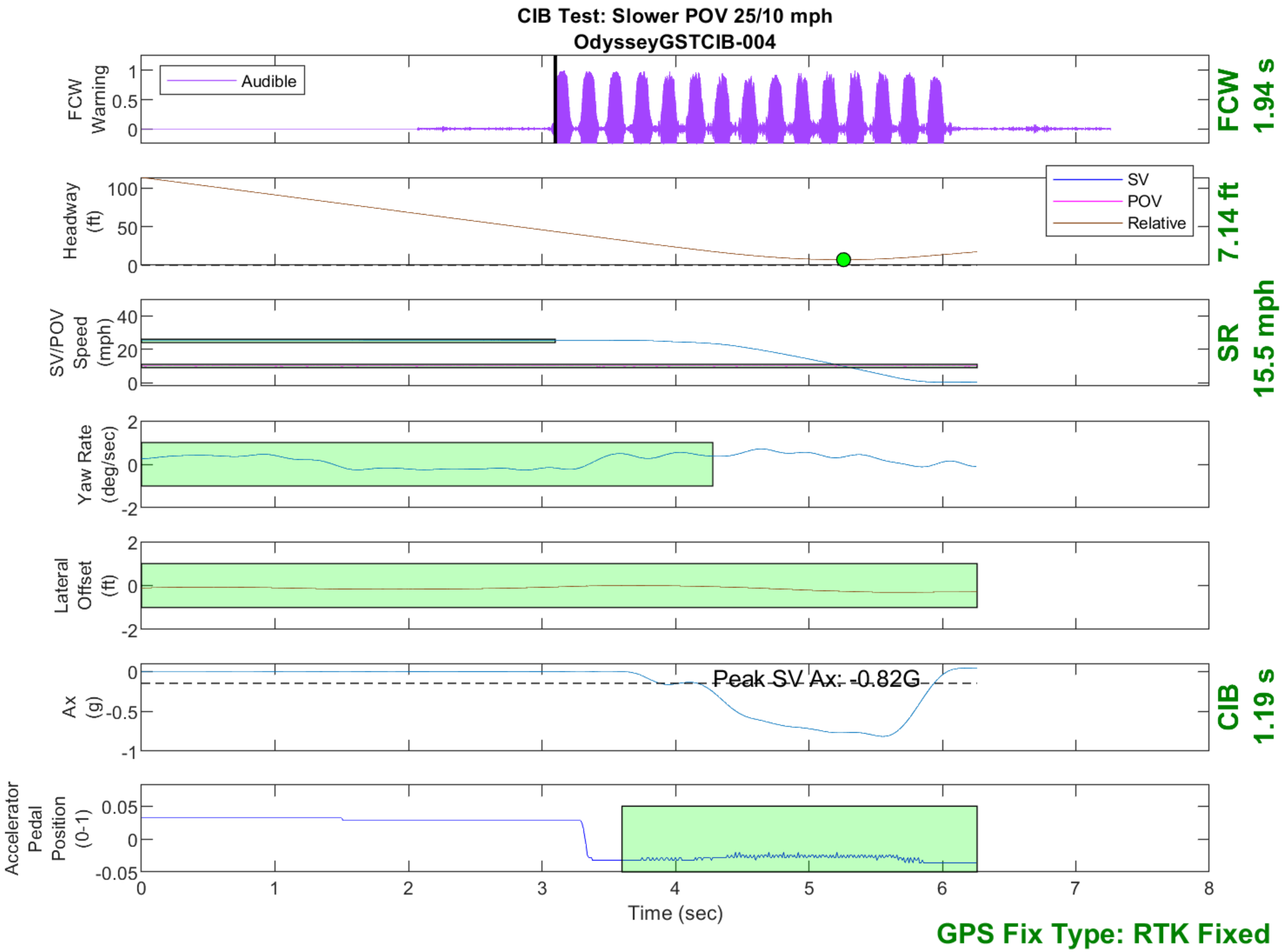



Figure D37. Time History for CIB Run 4, Slower POV, 25/10 mph

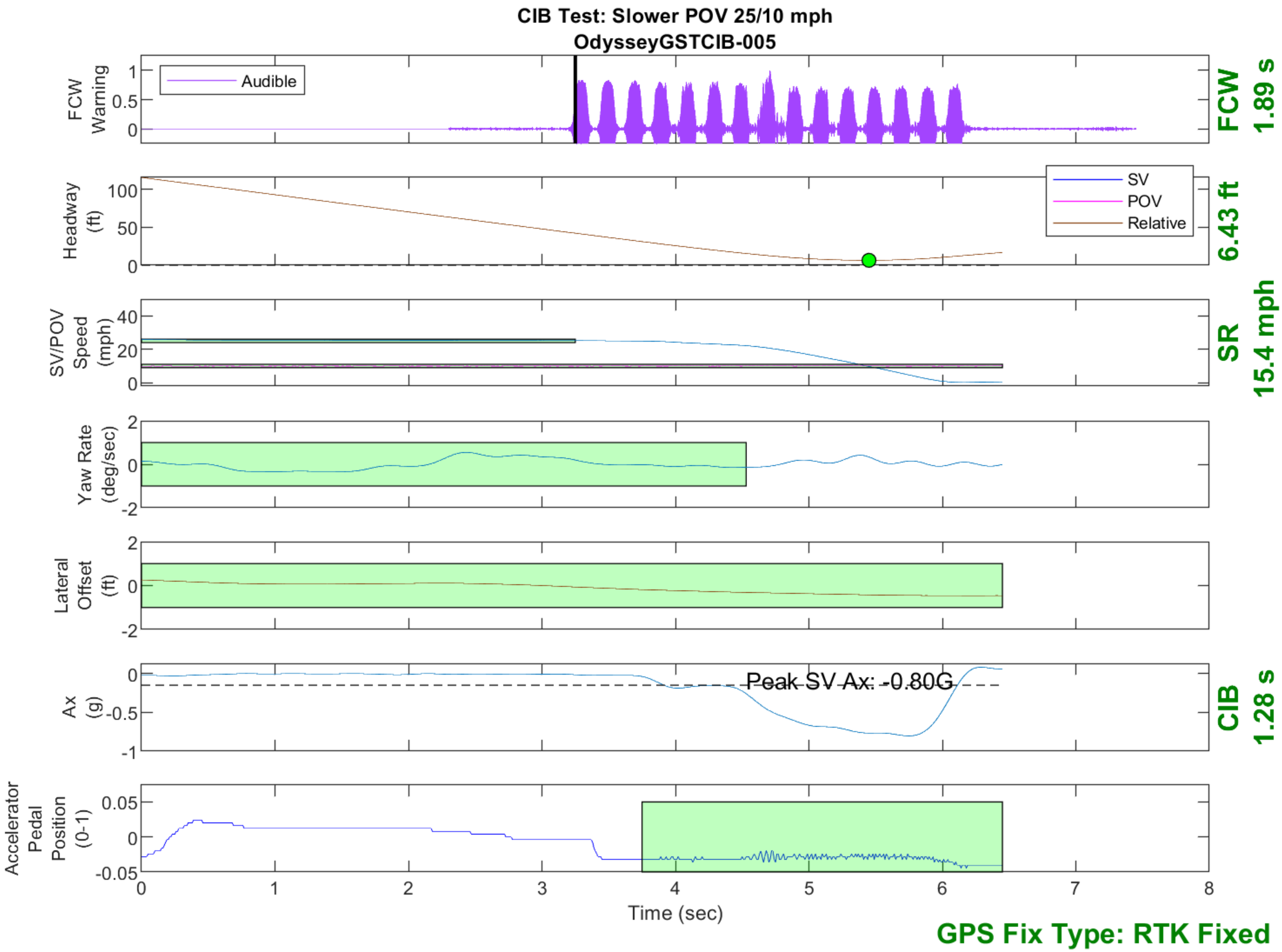



Figure D38. Time History for CIB Run 5, Slower POV, 25/10 mph

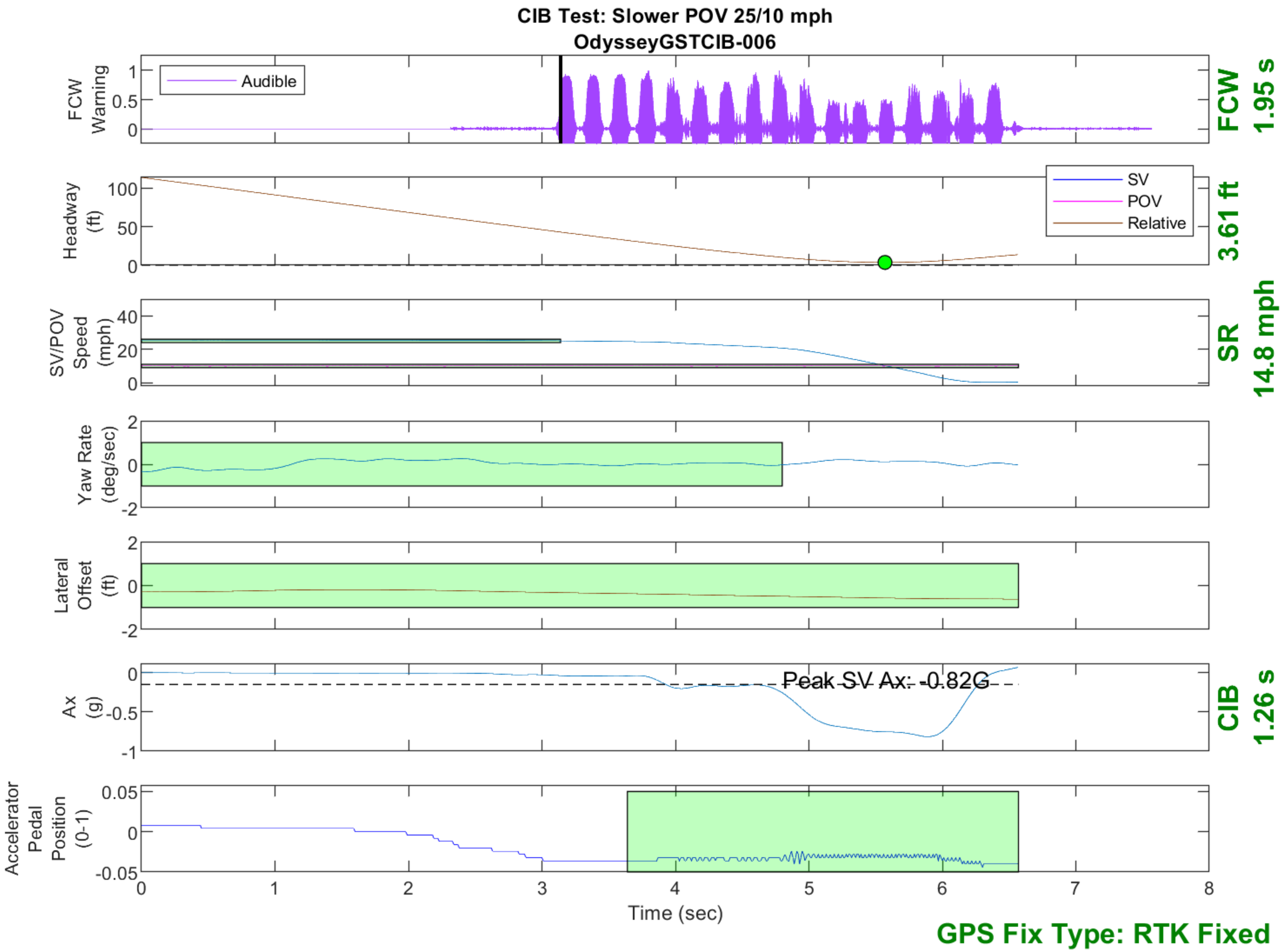



Figure D39. Time History for CIB Run 6, Slower POV, 25/10 mph

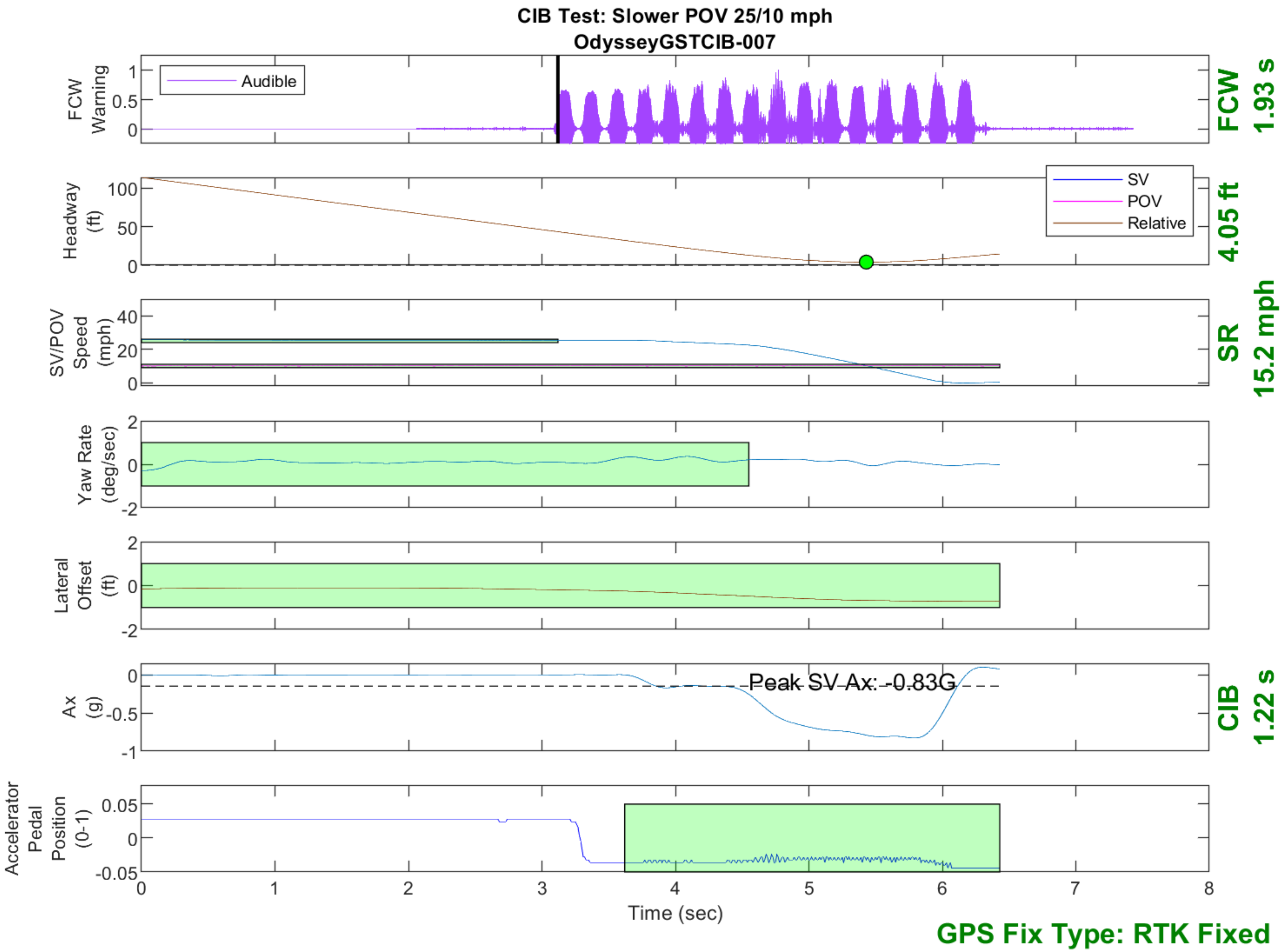



Figure D40. Time History for CIB Run 7, Slower POV, 25/10 mph

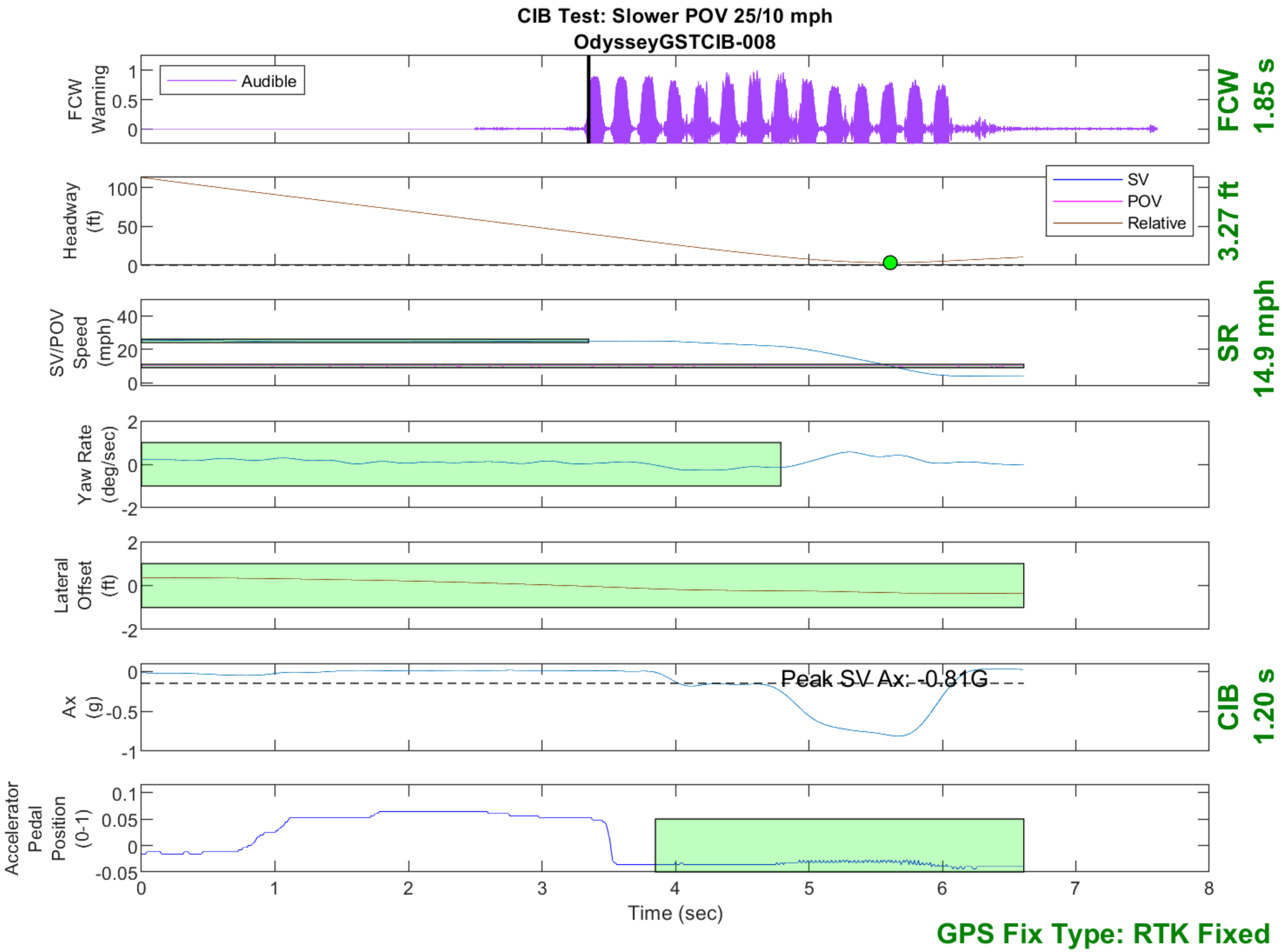



Figure D41. Time History for CIB Run 8, Slower POV, 25/10 mph

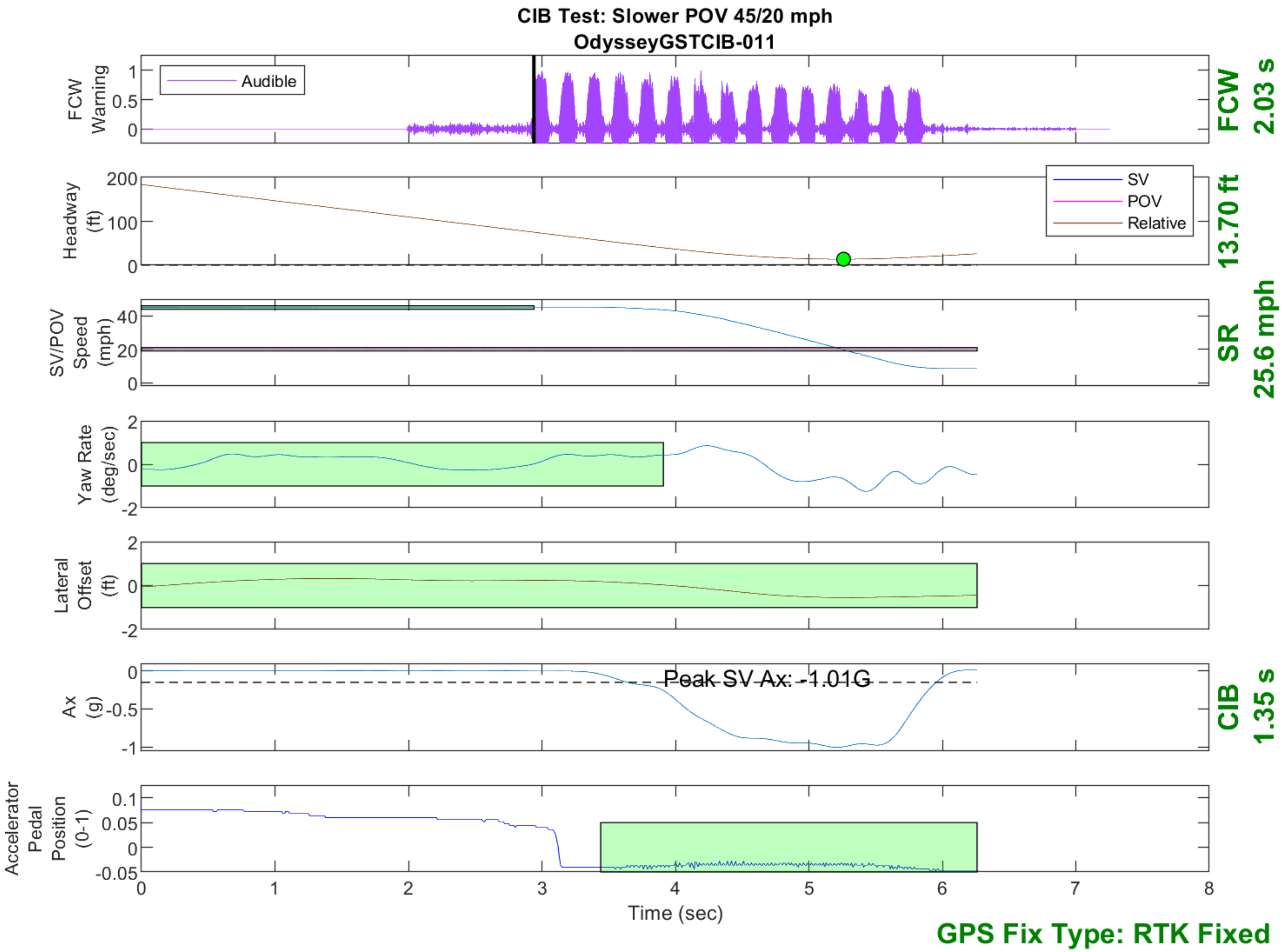



Figure D42. Time History for CIB Run 11, Slower POV, 45/20 mph

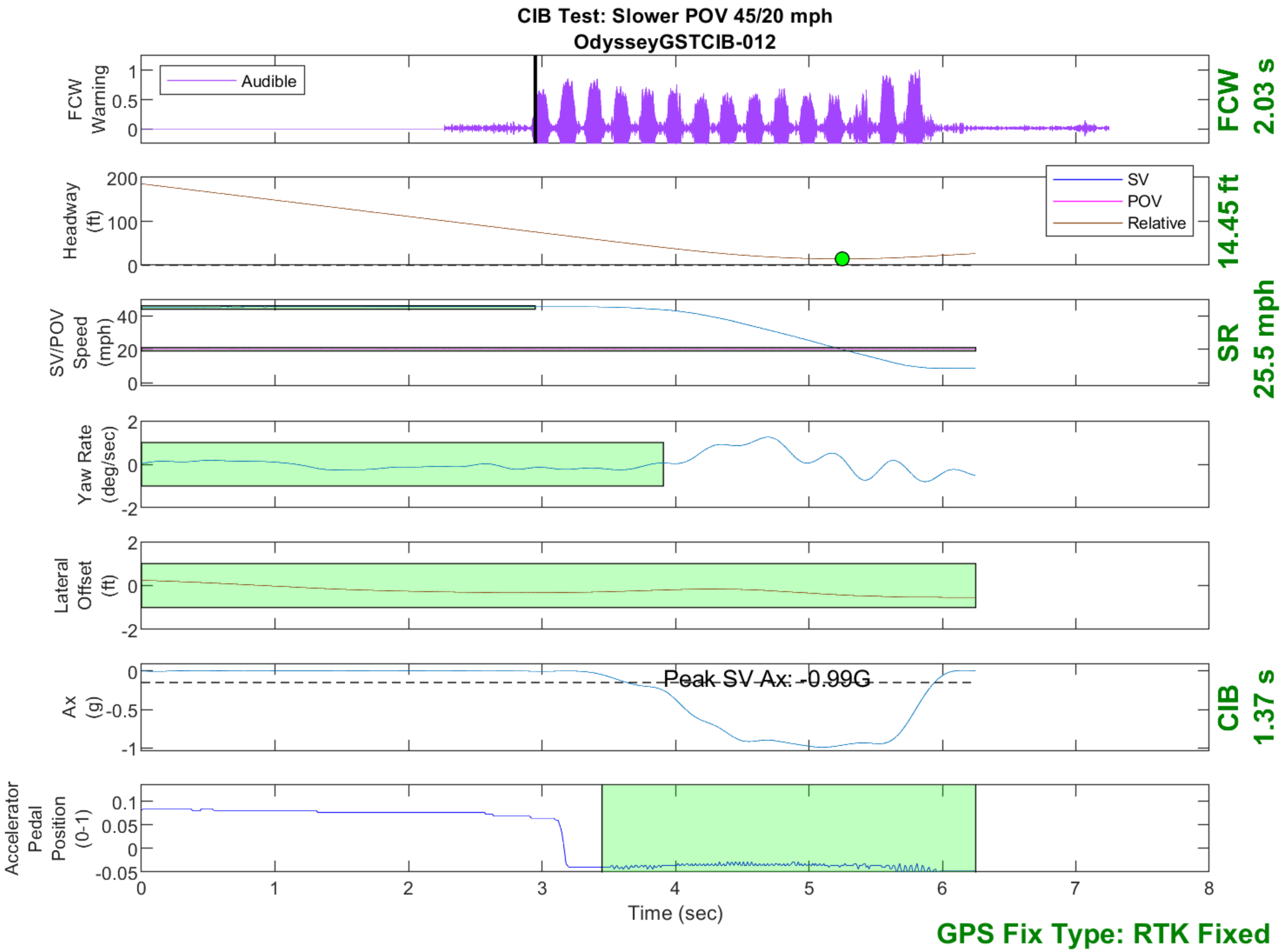



Figure D43. Time History for CIB Run 12, Slower POV, 45/20 mph

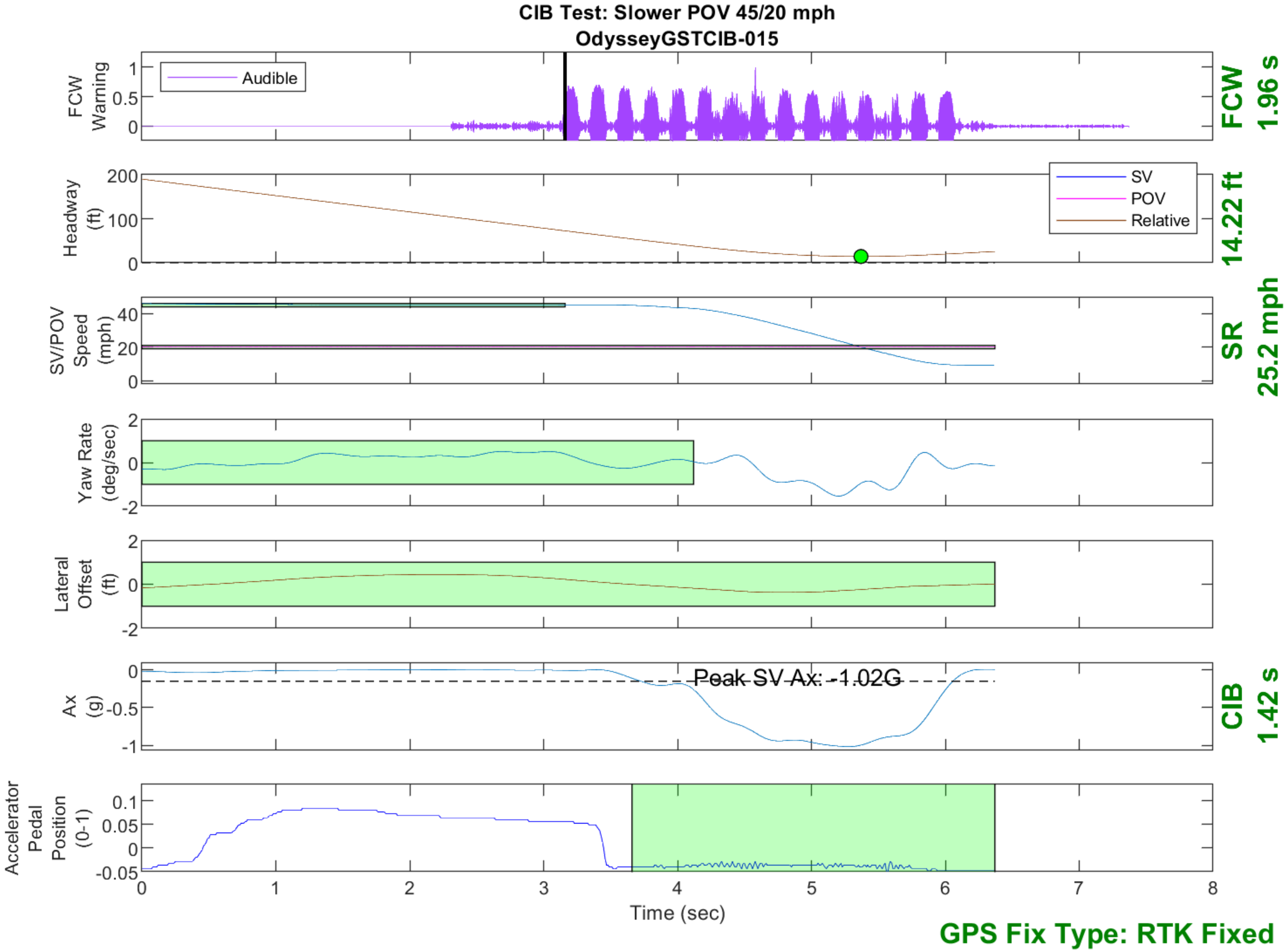



Figure D44. Time History for CIB Run 15, Slower POV, 45/20 mph

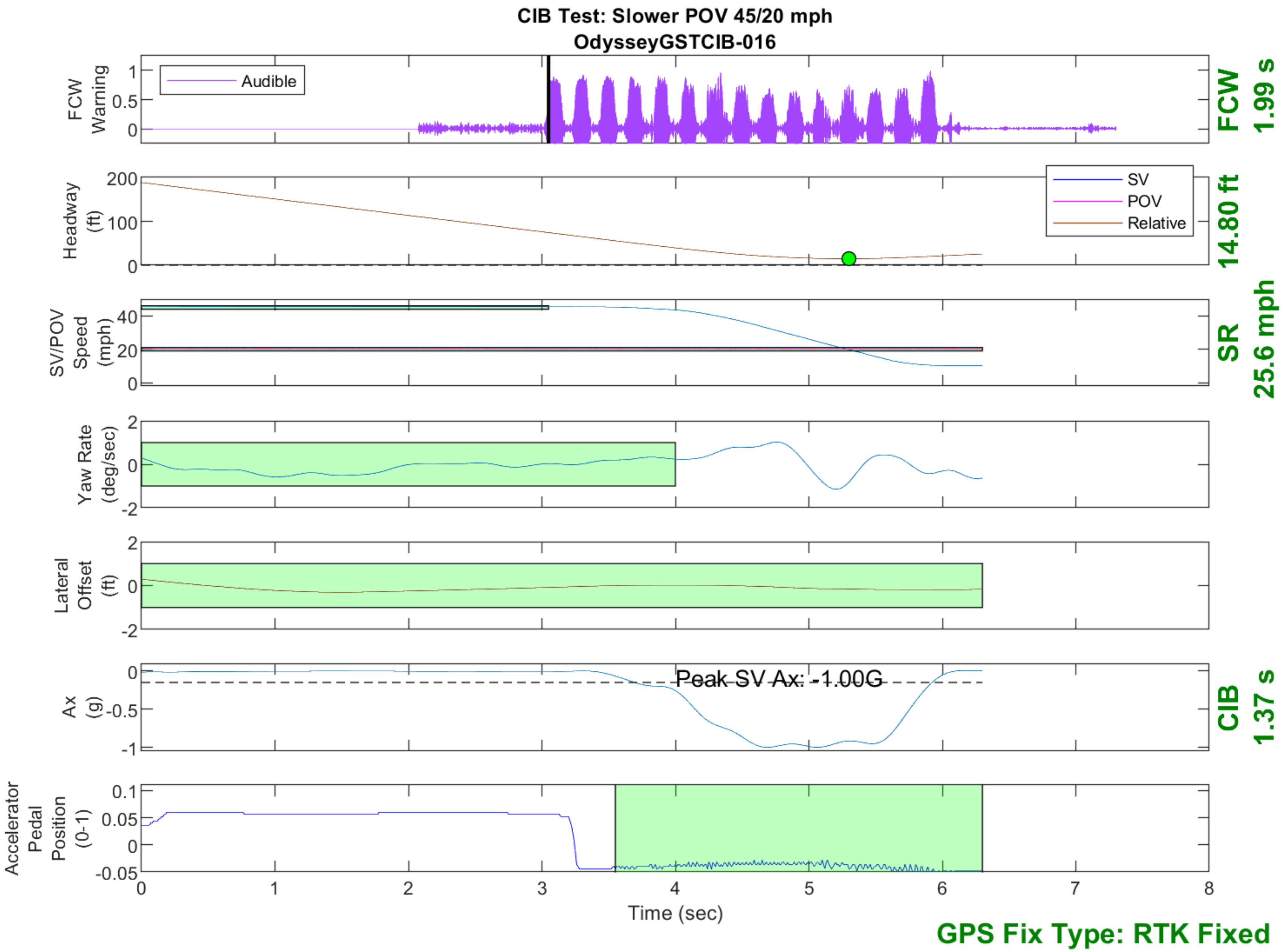



Figure D45. Time History for CIB Run 16, Slower POV, 45/20 mph

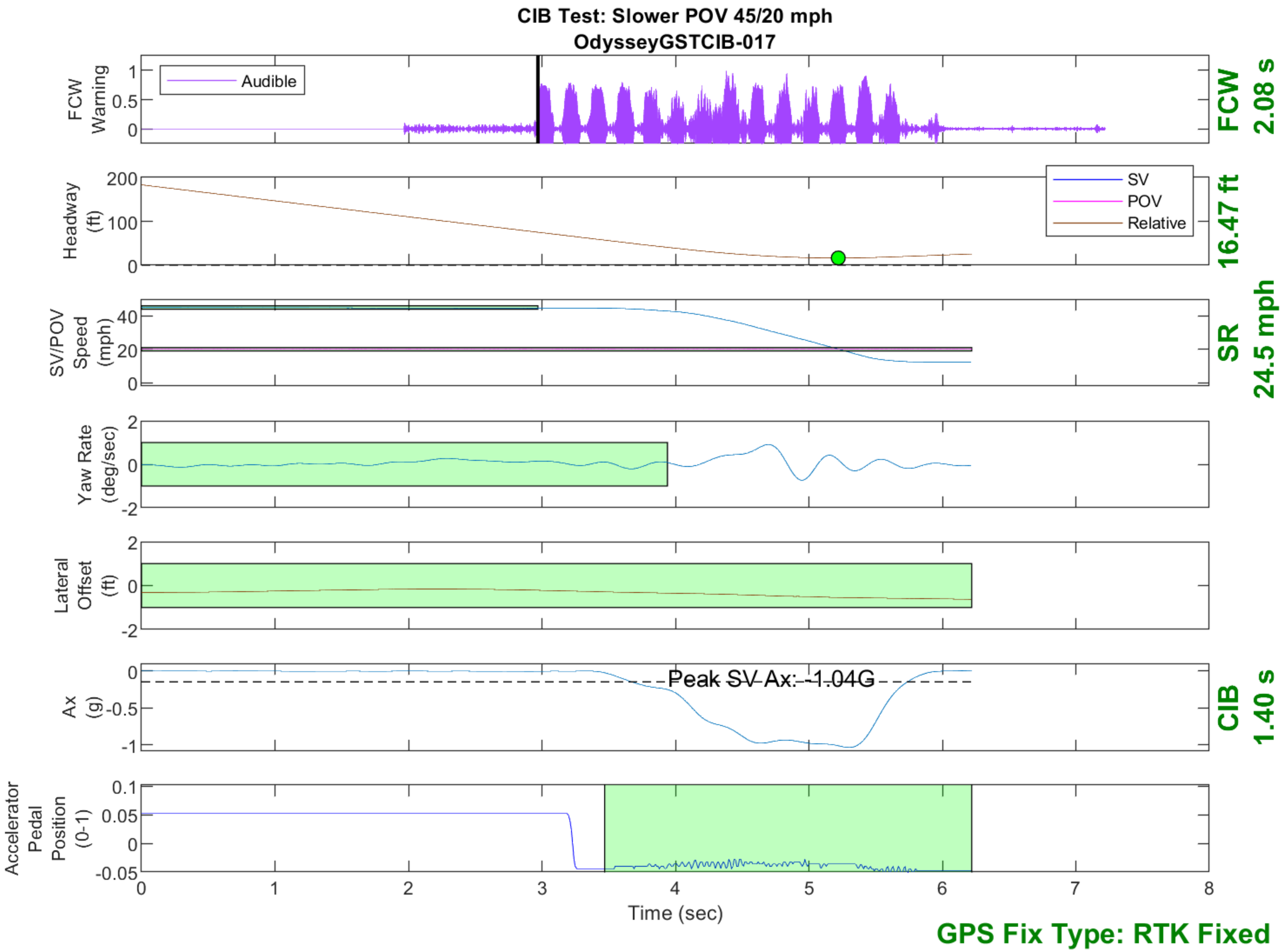



Figure D46. Time History for CIB Run 17, Slower POV, 45/20 mph

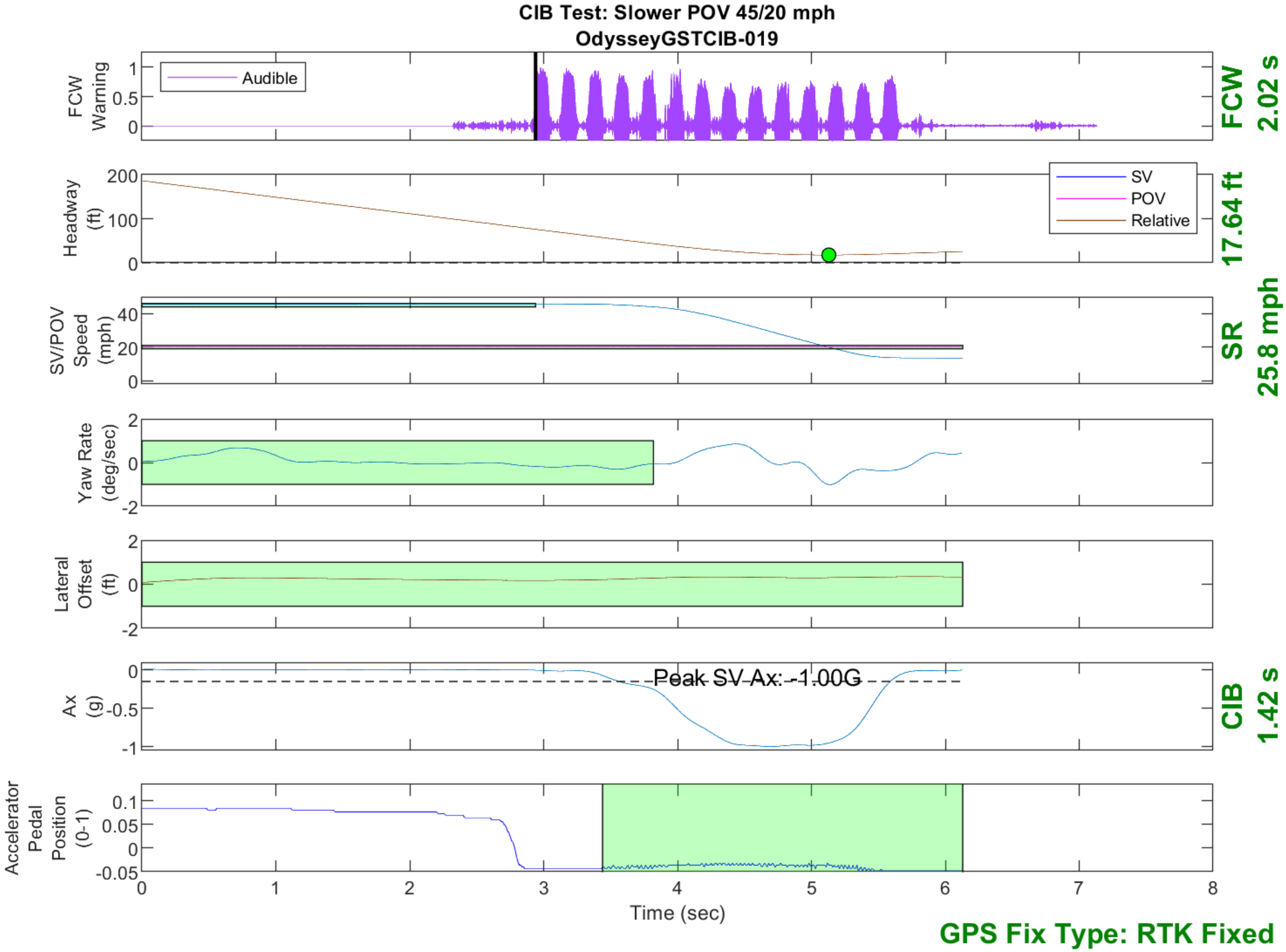



Figure D47. Time History for CIB Run 19, Slower POV, 45/20 mph

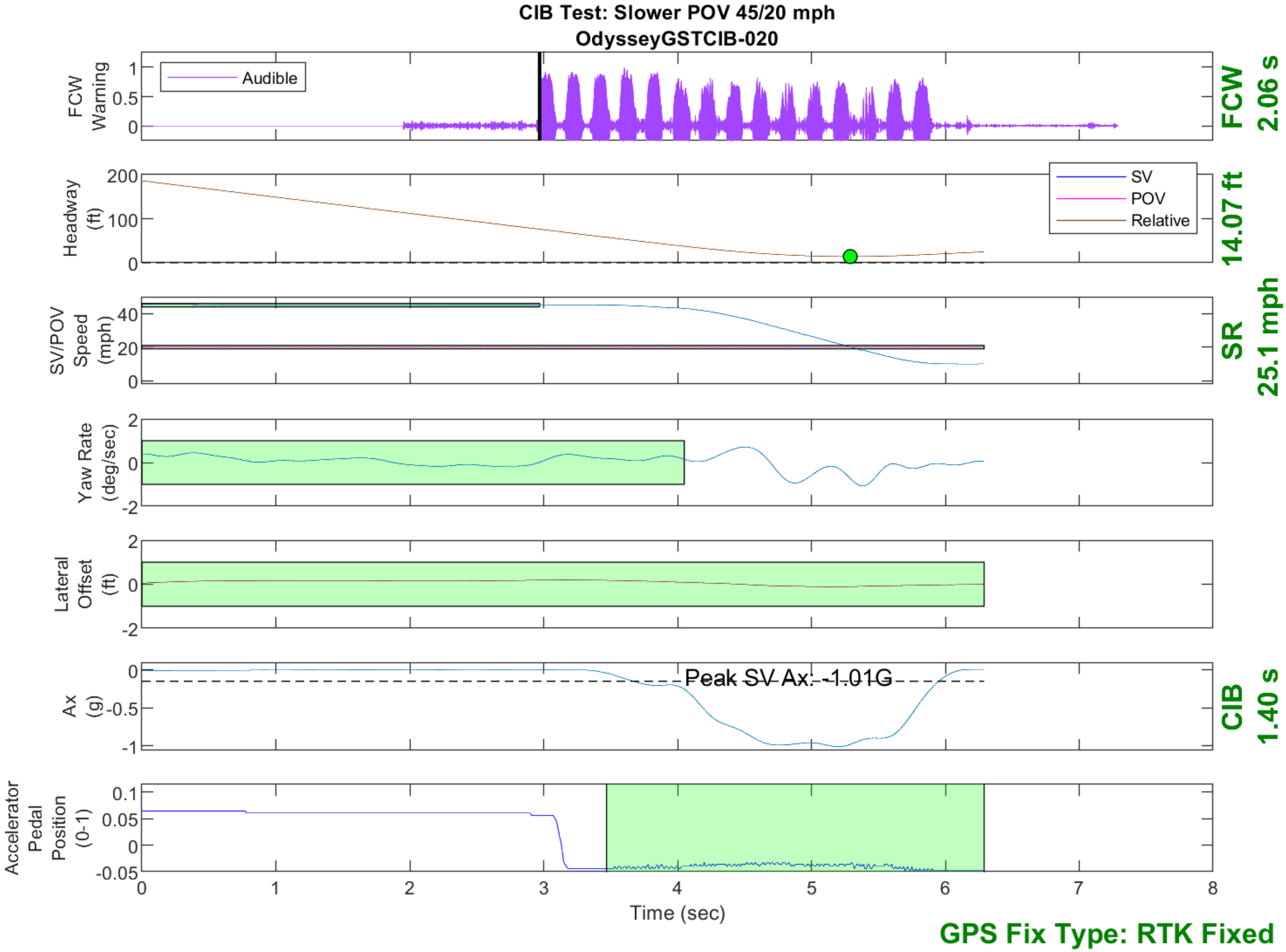



Figure D48. Time History for CIB Run 20, Slower POV, 45/20 mph

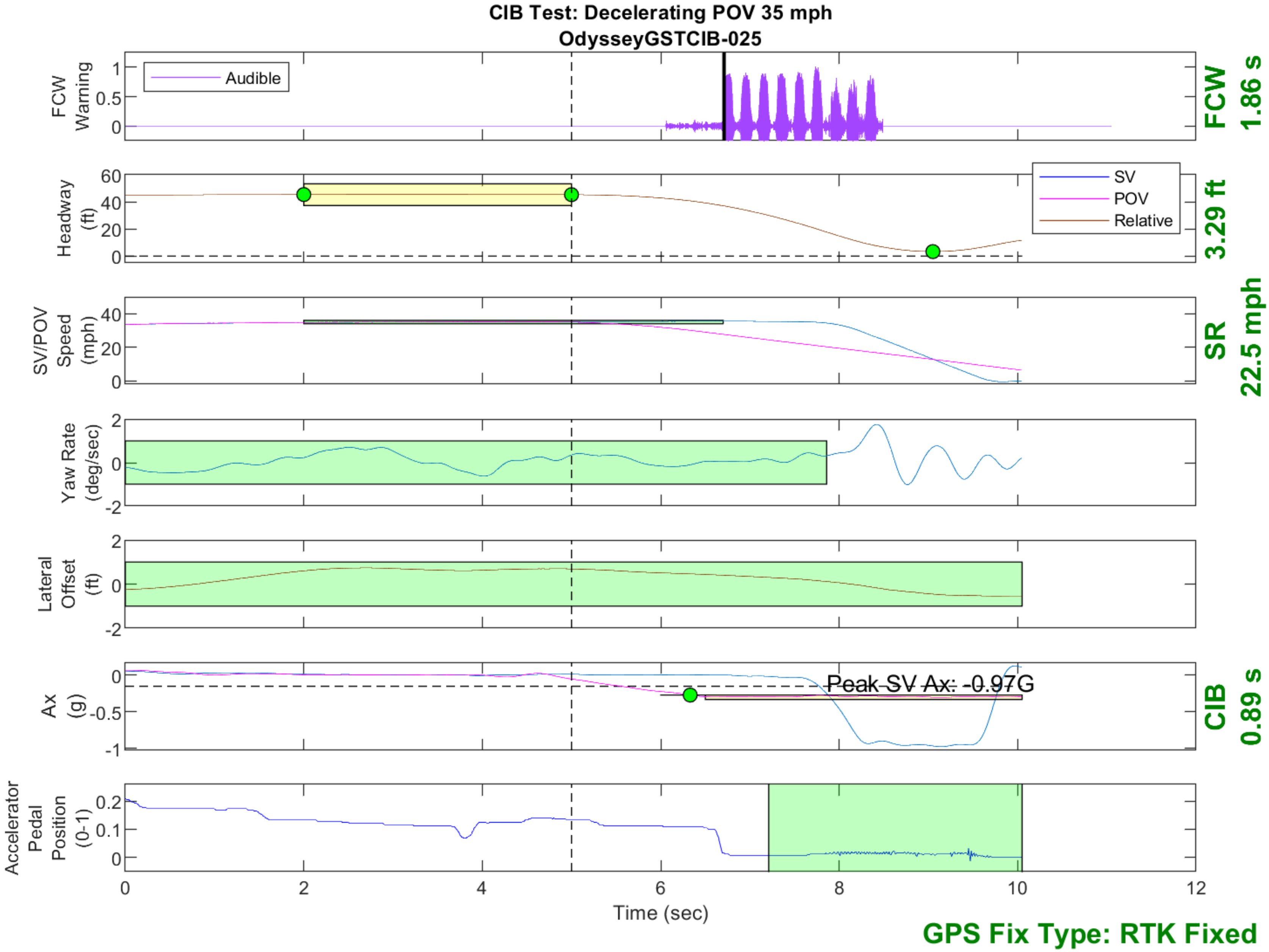



Figure D49. Time History for CIB Run 25, Decelerating POV, 35 mph 0.3g

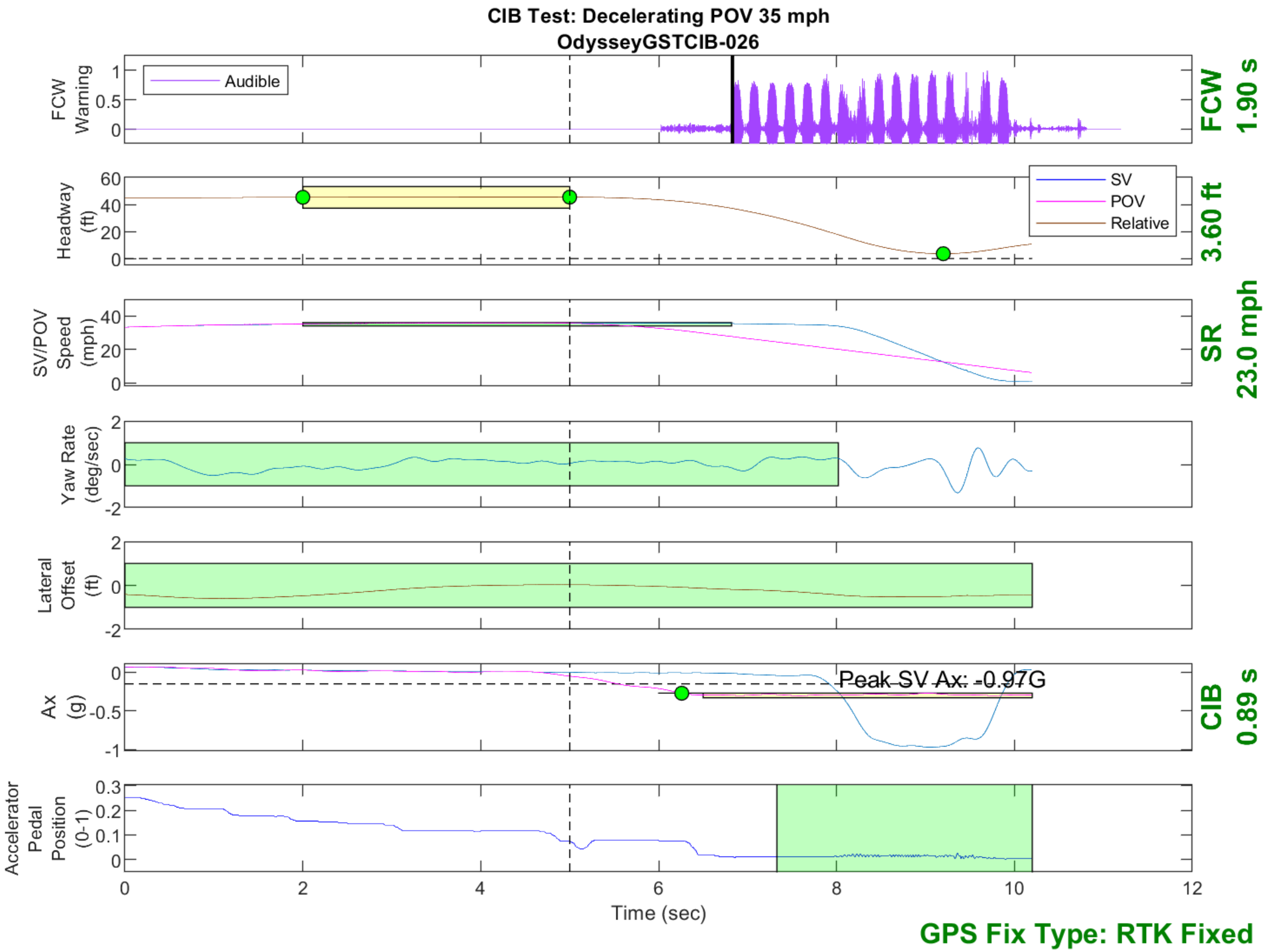



Figure D50. Time History for CIB Run 26, Decelerating POV, 35 mph 0.3g

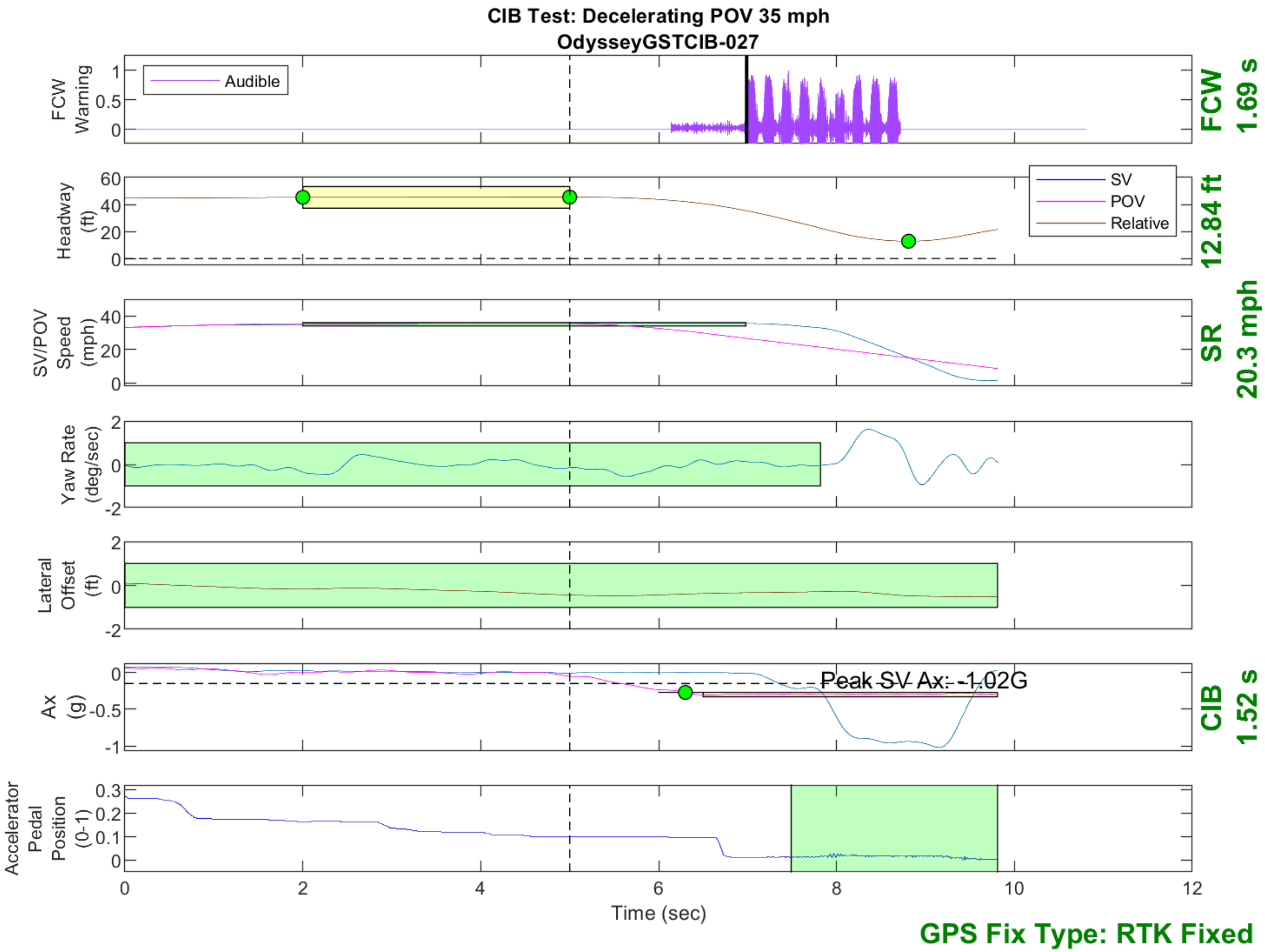



Figure D51. Time History for CIB Run 27, Decelerating POV, 35 mph 0.3g

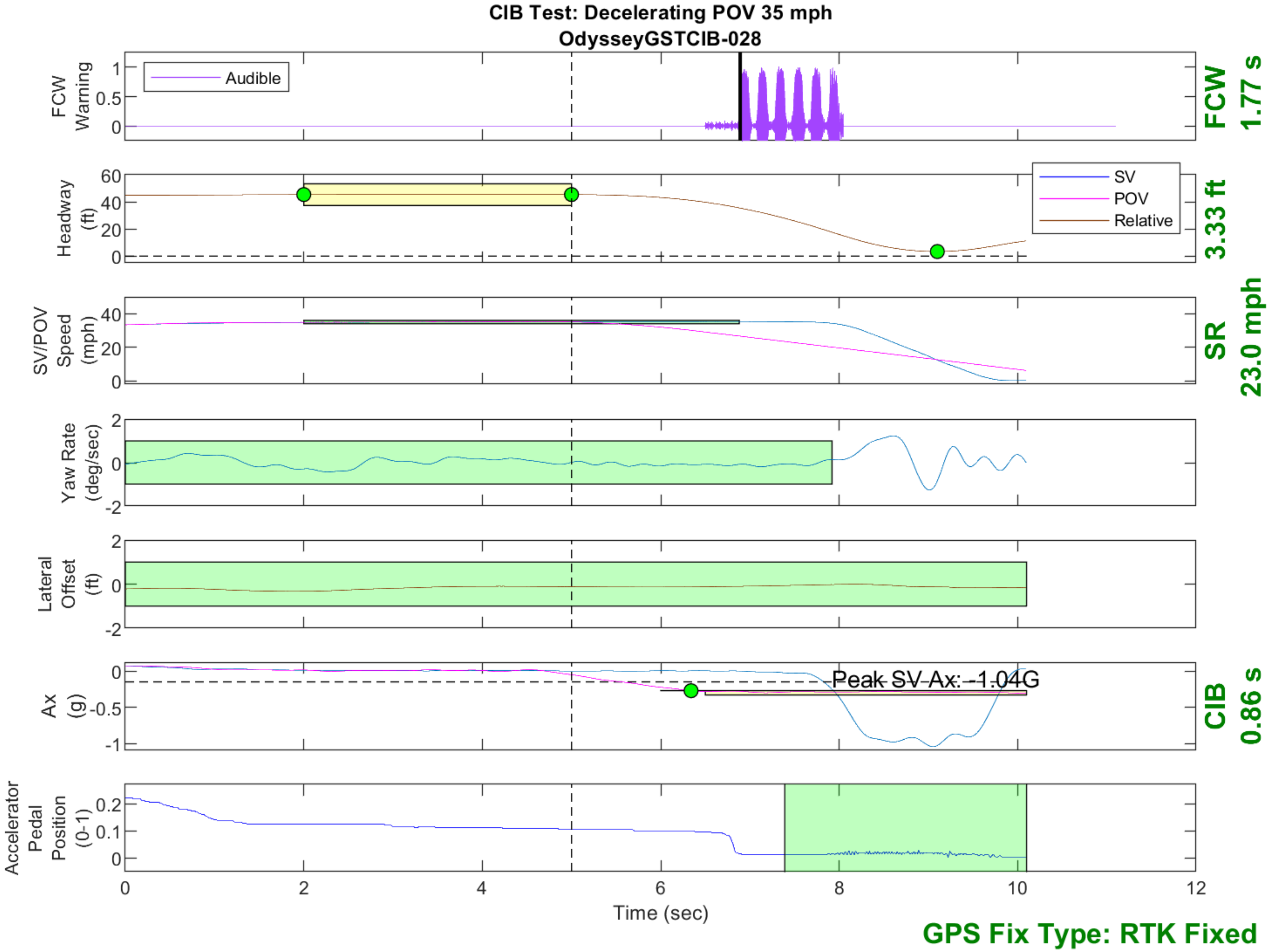



Figure D52. Time History for CIB Run 28, Decelerating POV, 35 mph 0.3g

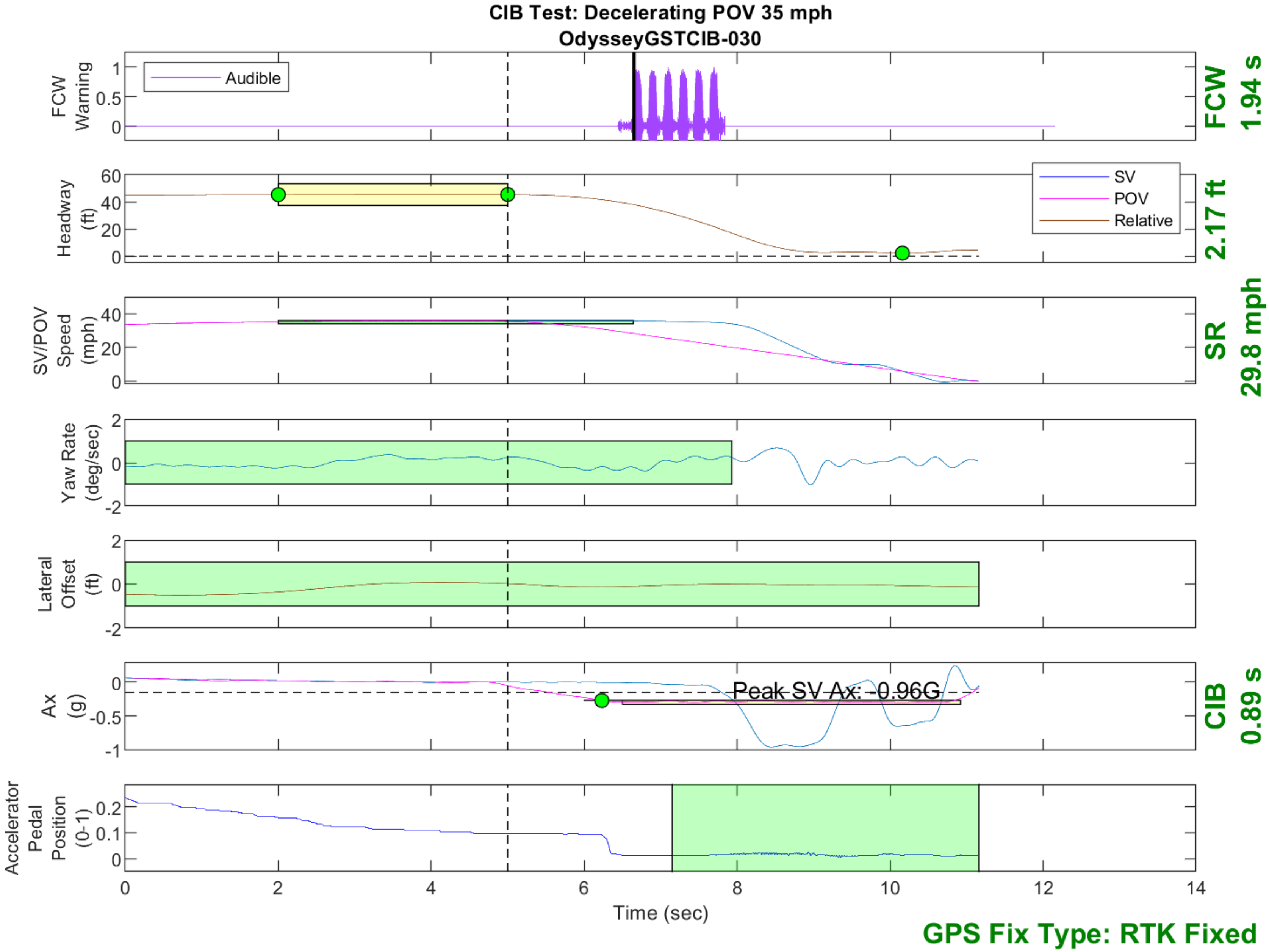



Figure D53. Time History for CIB Run 30, Decelerating POV, 35 mph 0.3g

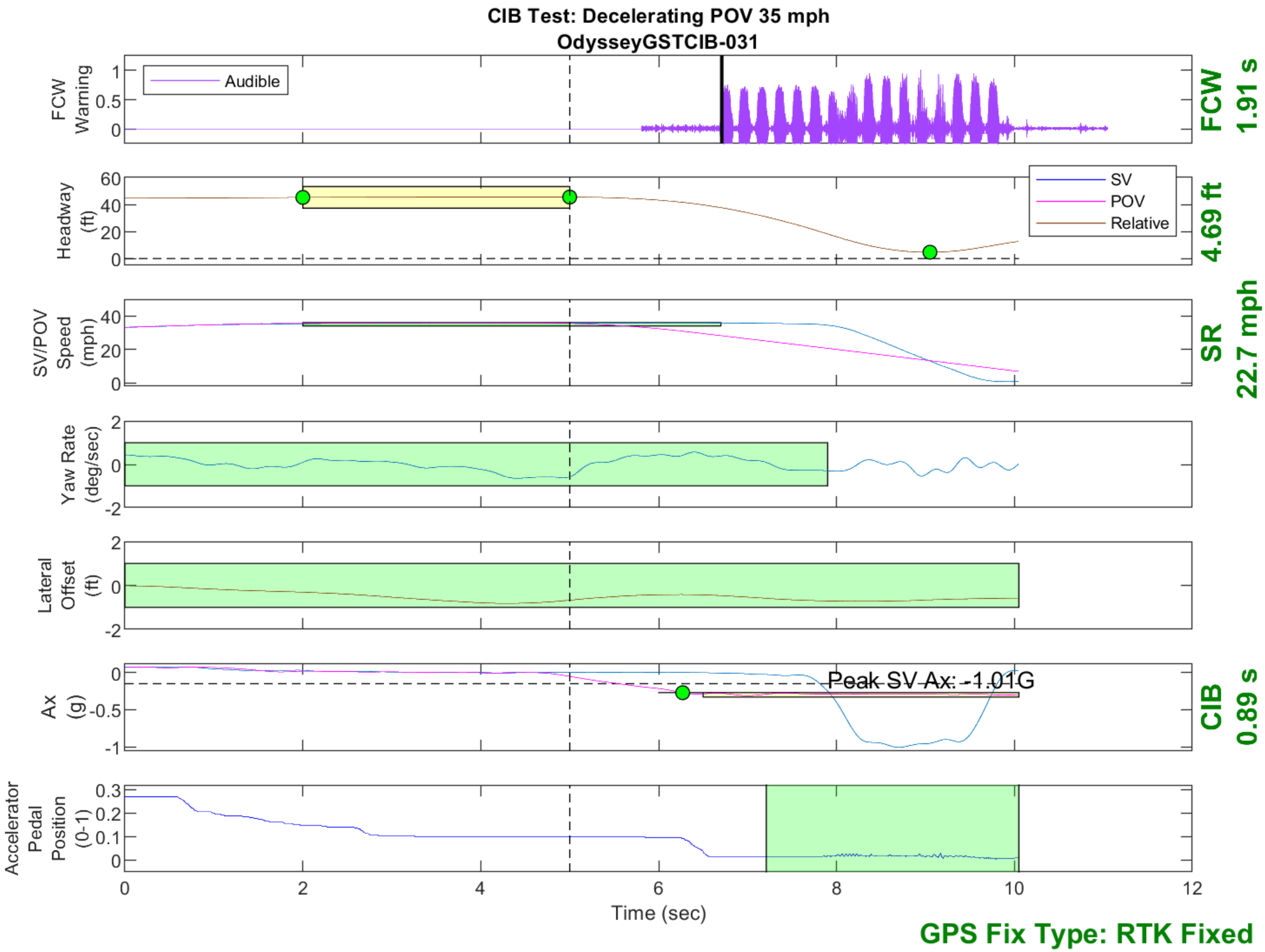



Figure D54. Time History for CIB Run 31, Decelerating POV, 35 mph 0.3g

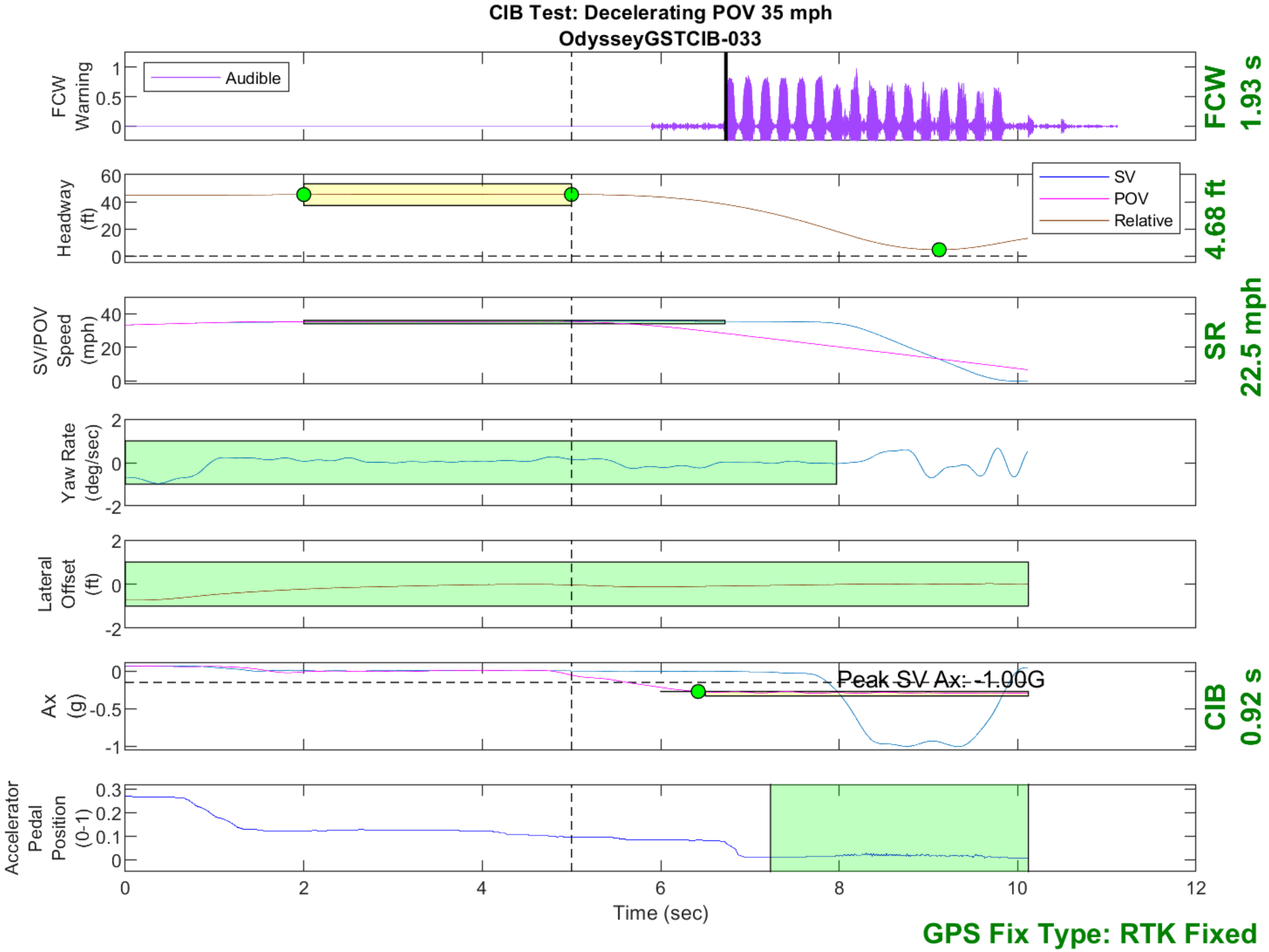



Figure D55. Time History for CIB Run 33, Decelerating POV, 35 mph 0.3g

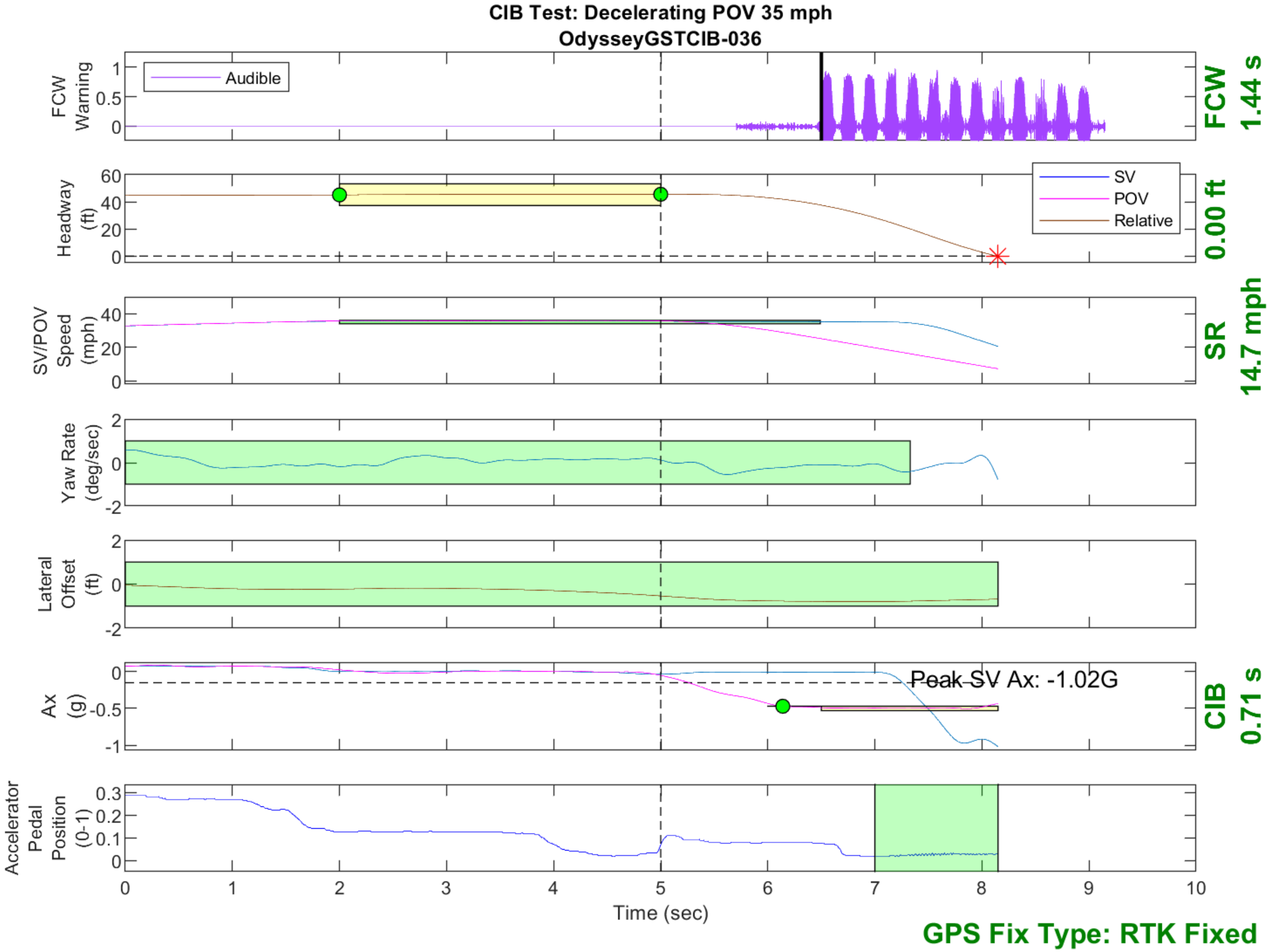



Figure D56. Time History for CIB Run 36, Decelerating POV, 35 mph 0.5g

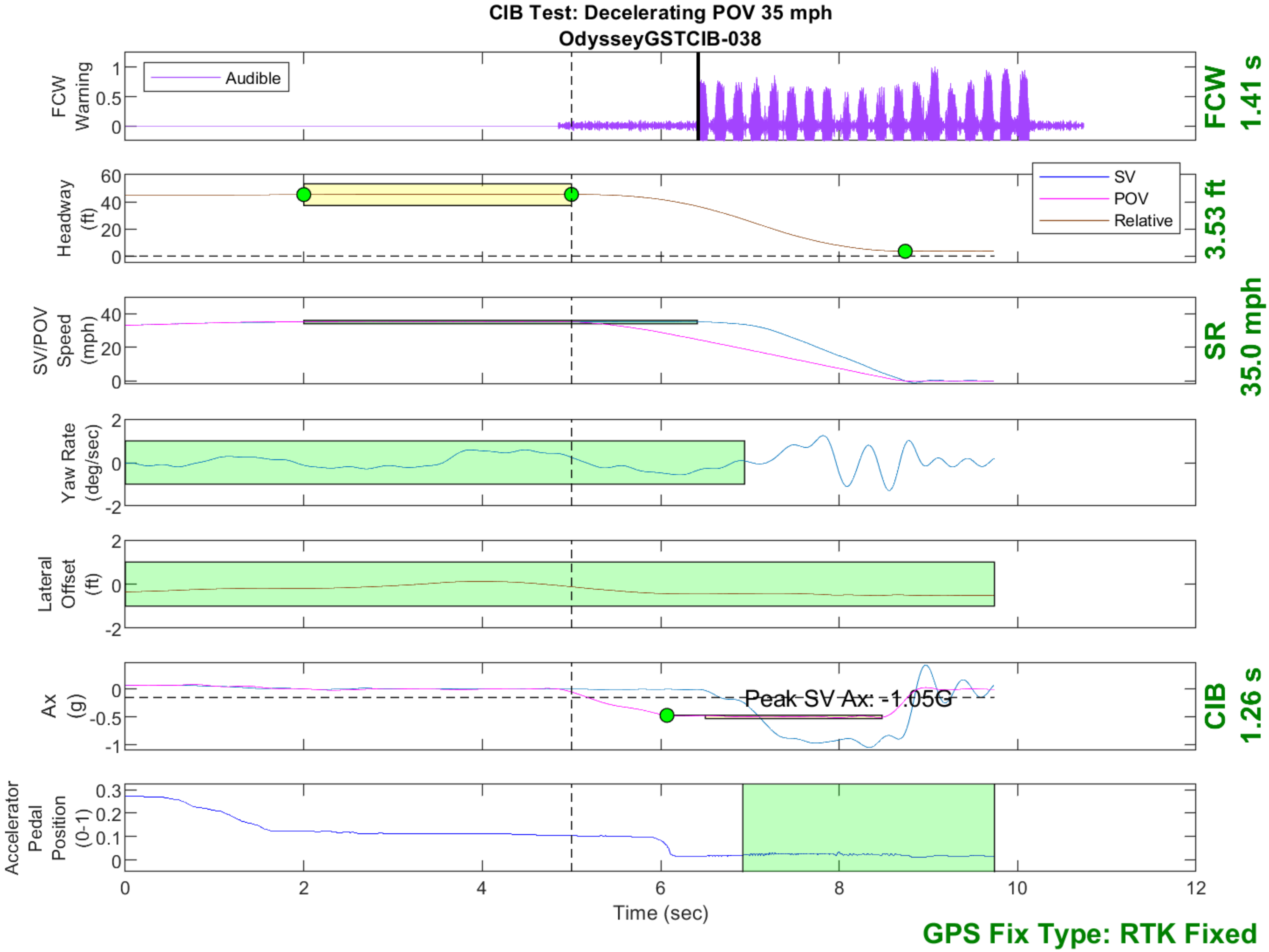



Figure D57. Time History for CIB Run 38, Decelerating POV, 35 mph 0.5g

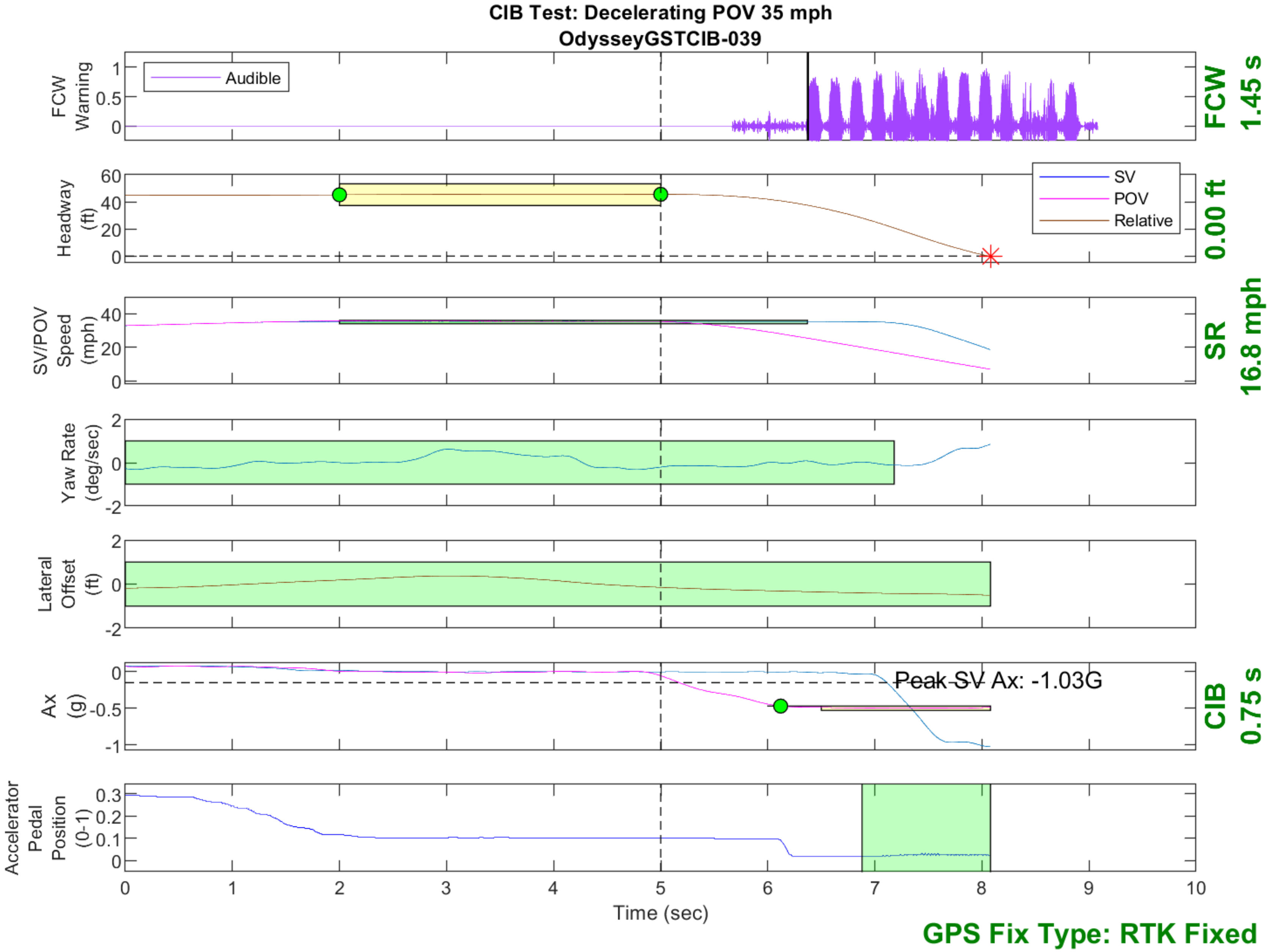



Figure D58. Time History for CIB Run 39, Decelerating POV, 35 mph 0.5g

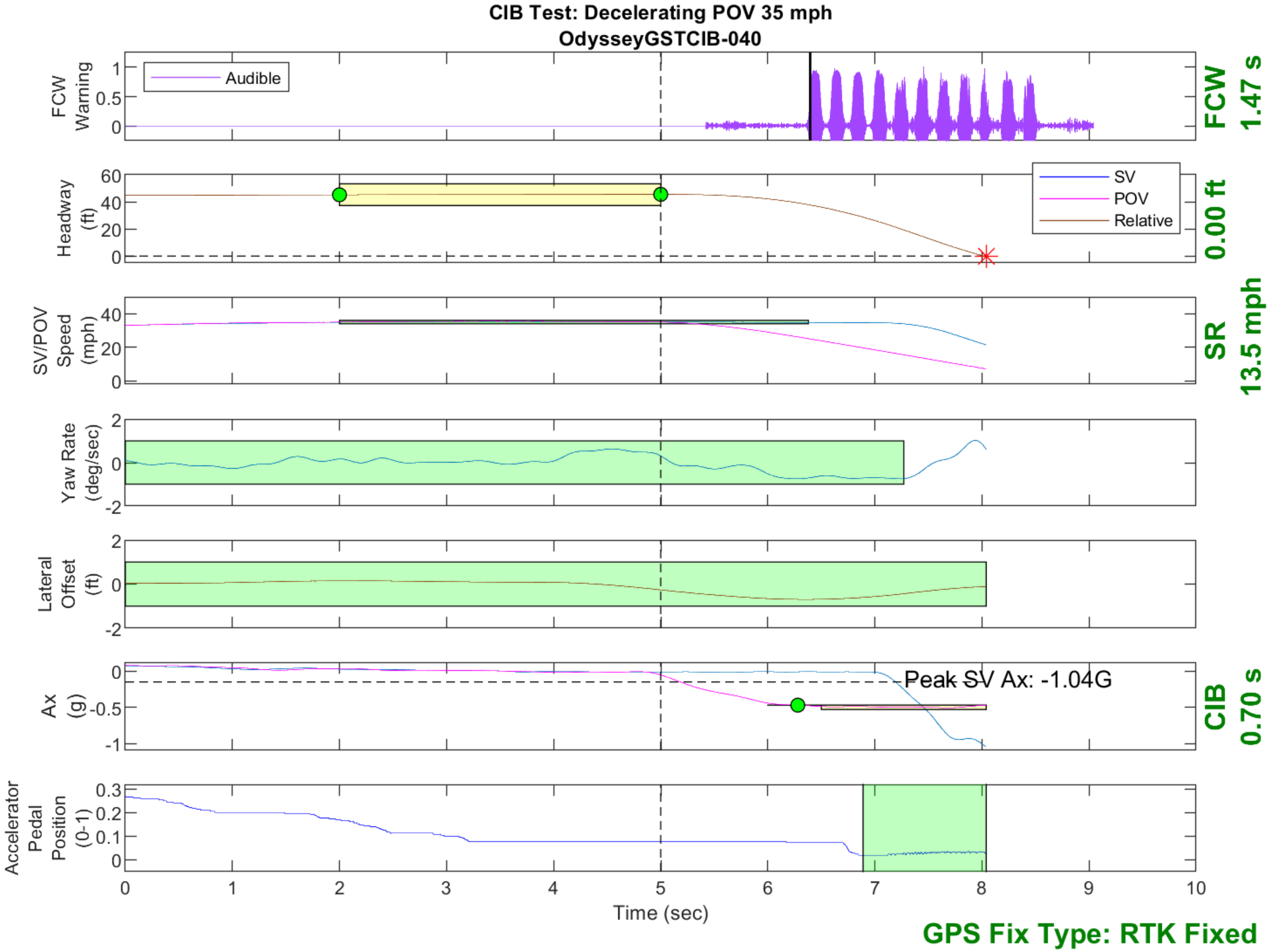



Figure D59. Time History for CIB Run 40, Decelerating POV, 35 mph 0.5g

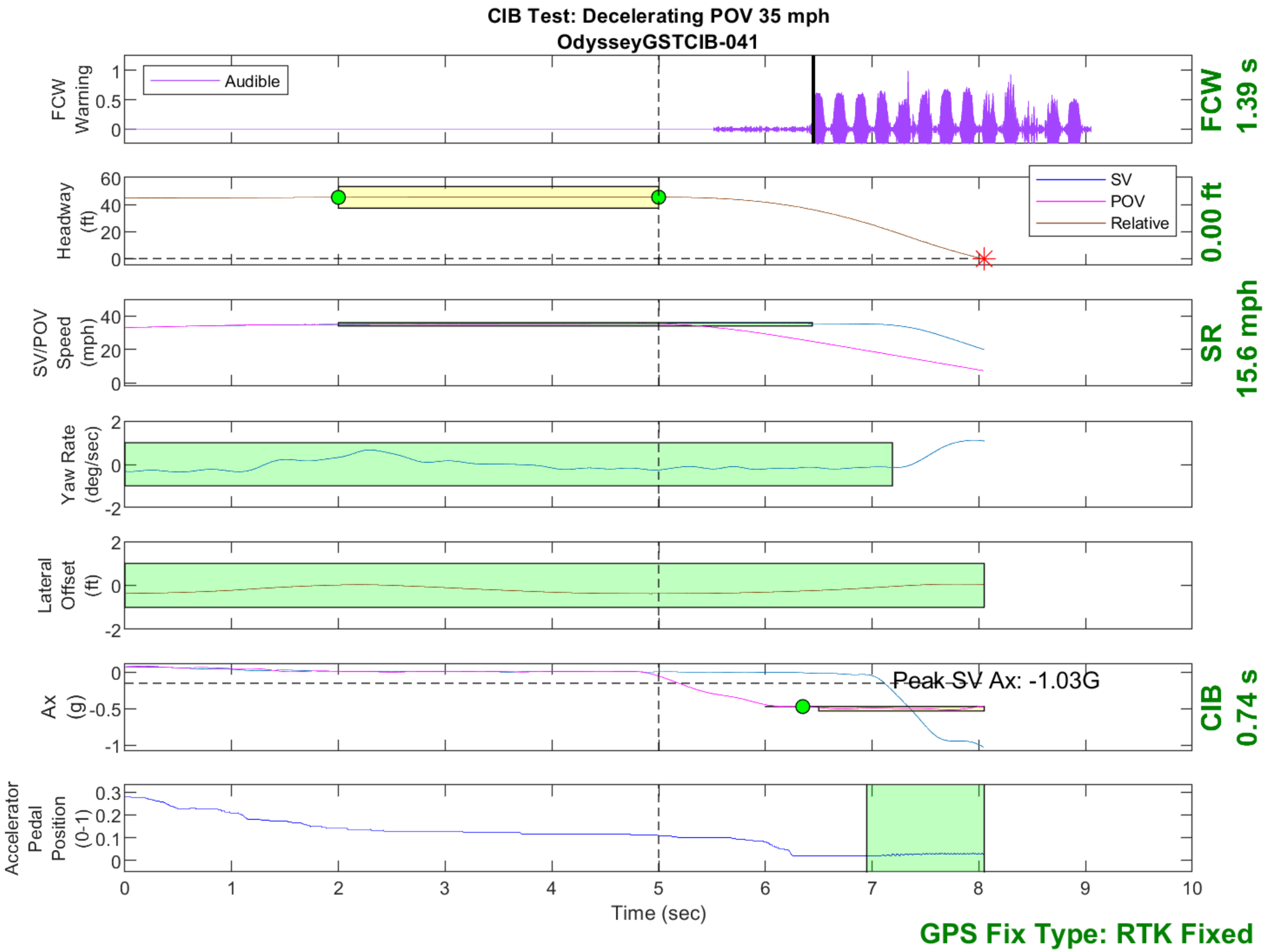



Figure D60. Time History for CIB Run 41, Decelerating POV, 35 mph 0.5g

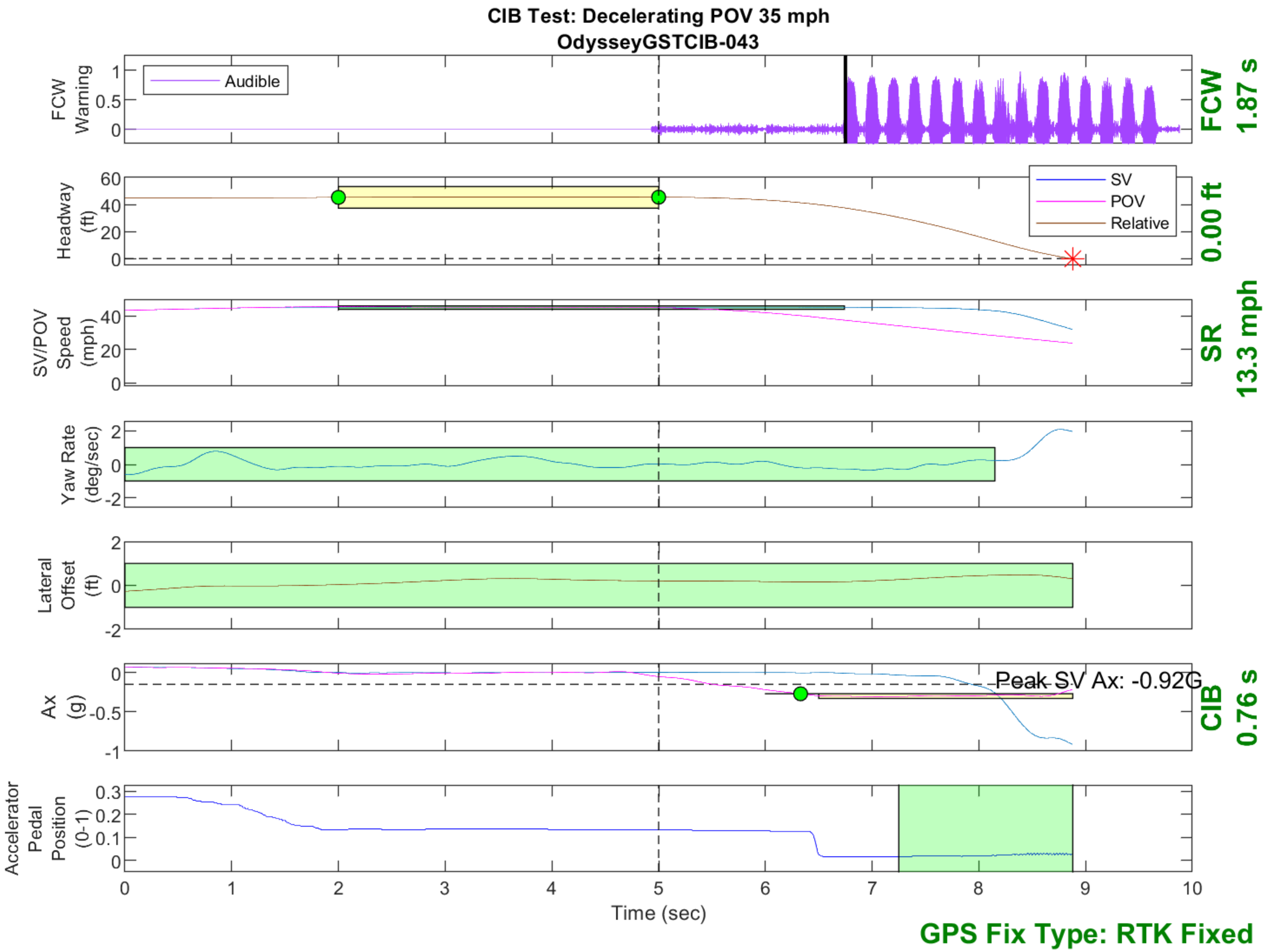



Figure D61. Time History for CIB Run 43, Decelerating POV, 45 mph 0.3g

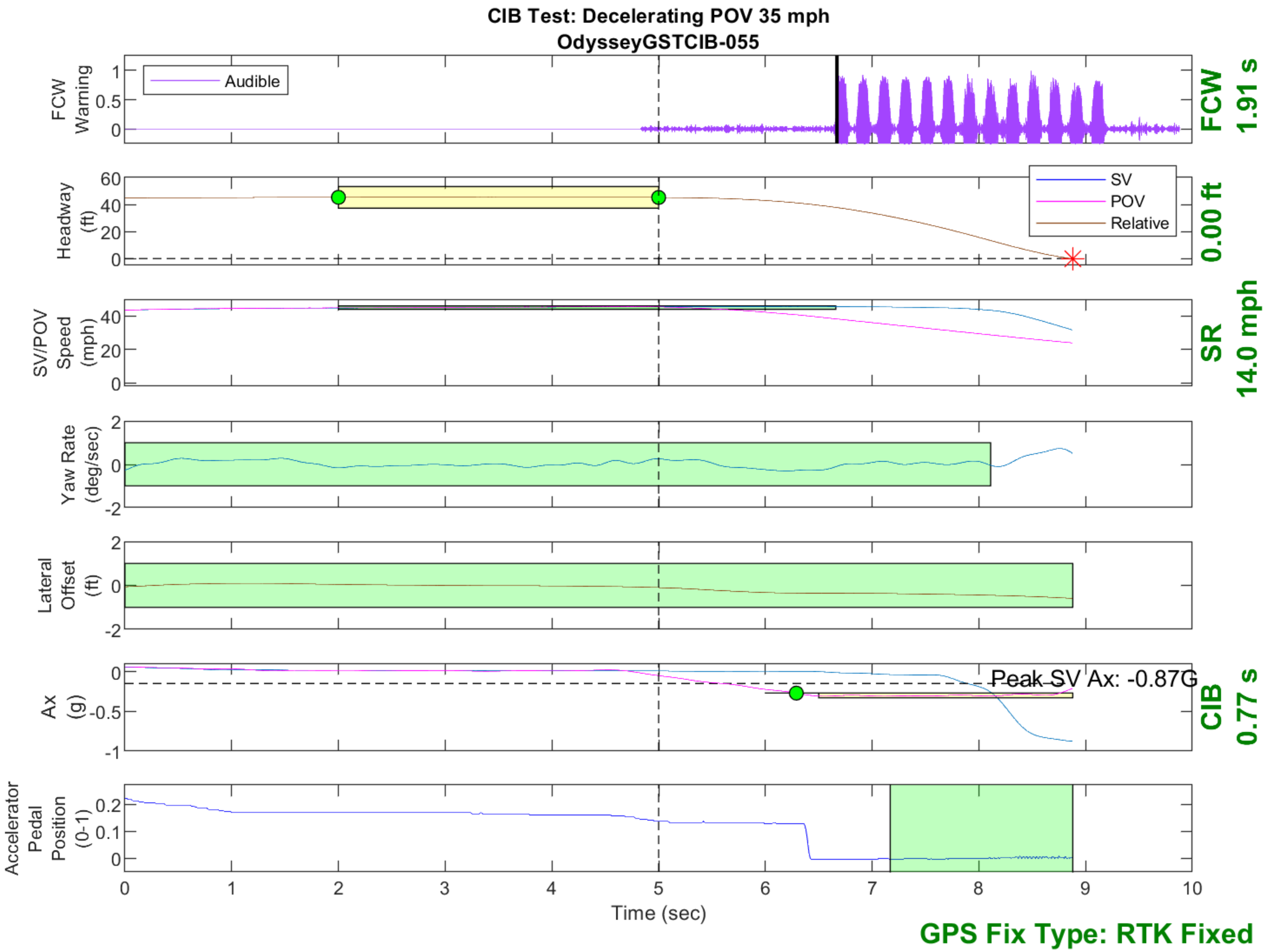



Figure D62. Time History for CIB Run 55, Decelerating POV, 45 mph 0.3g

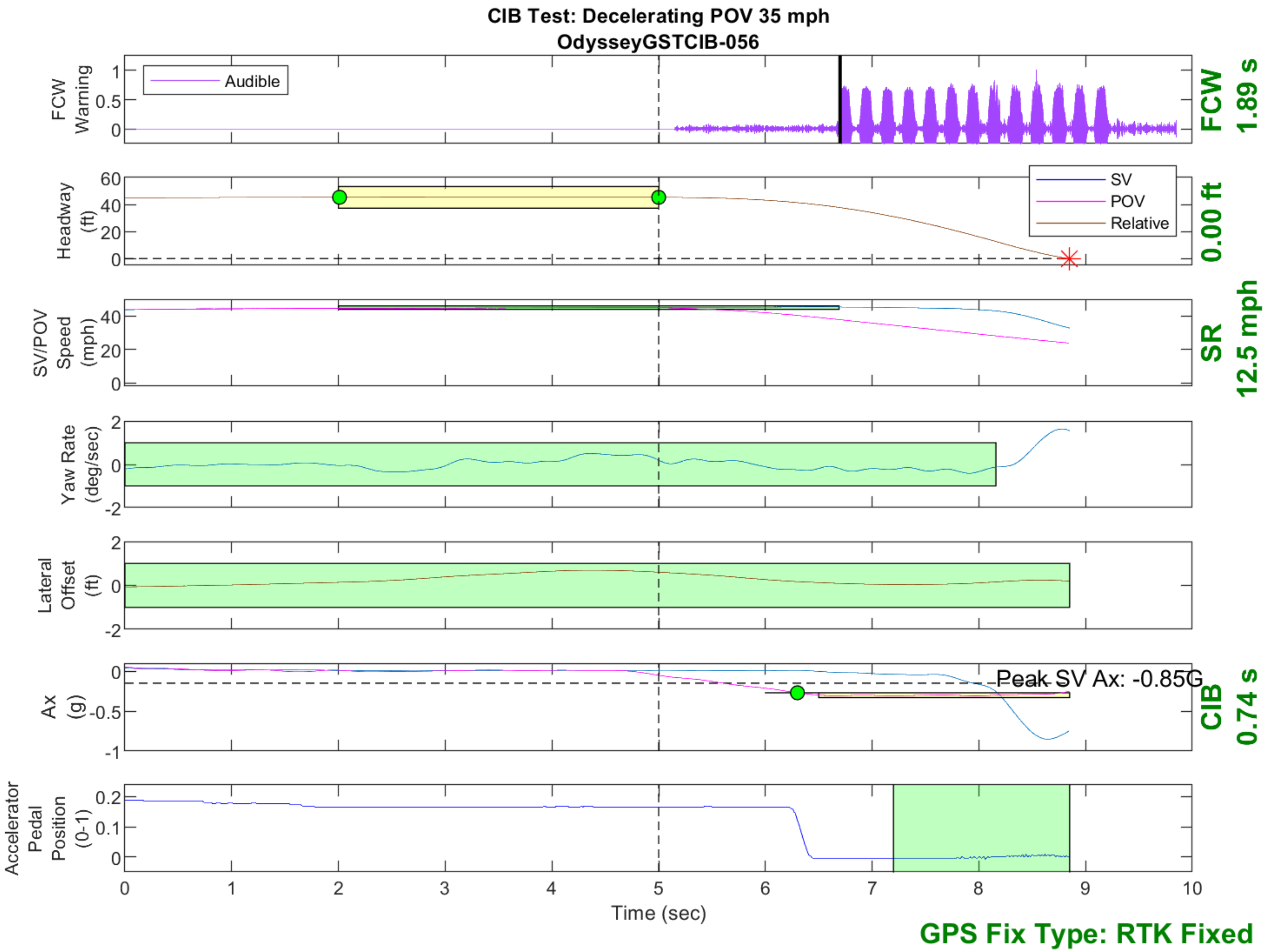



Figure D63. Time History for CIB Run 56, Decelerating POV, 45 mph 0.3g

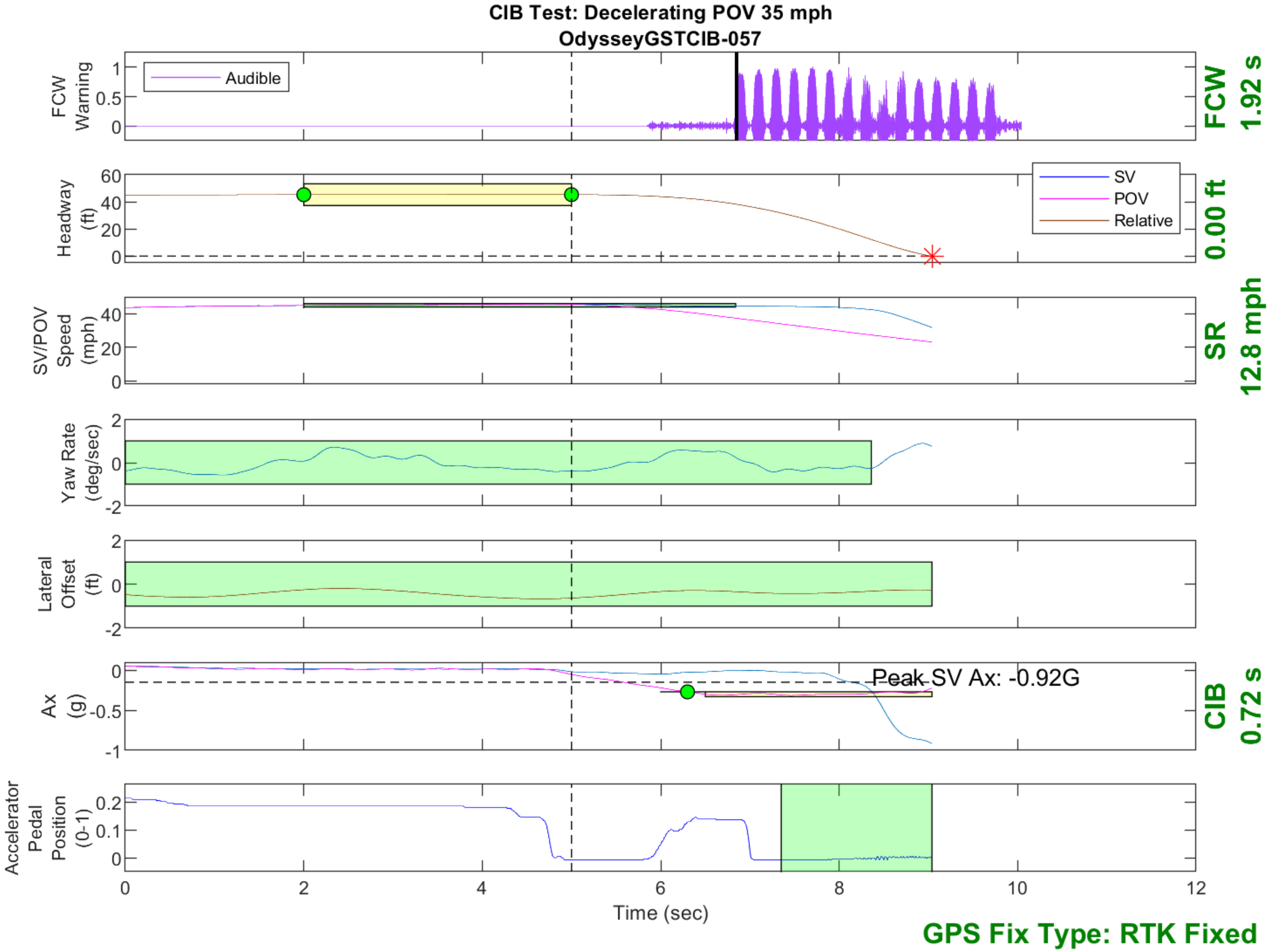



Figure D64. Time History for CIB Run 57, Decelerating POV, 45 mph 0.3g

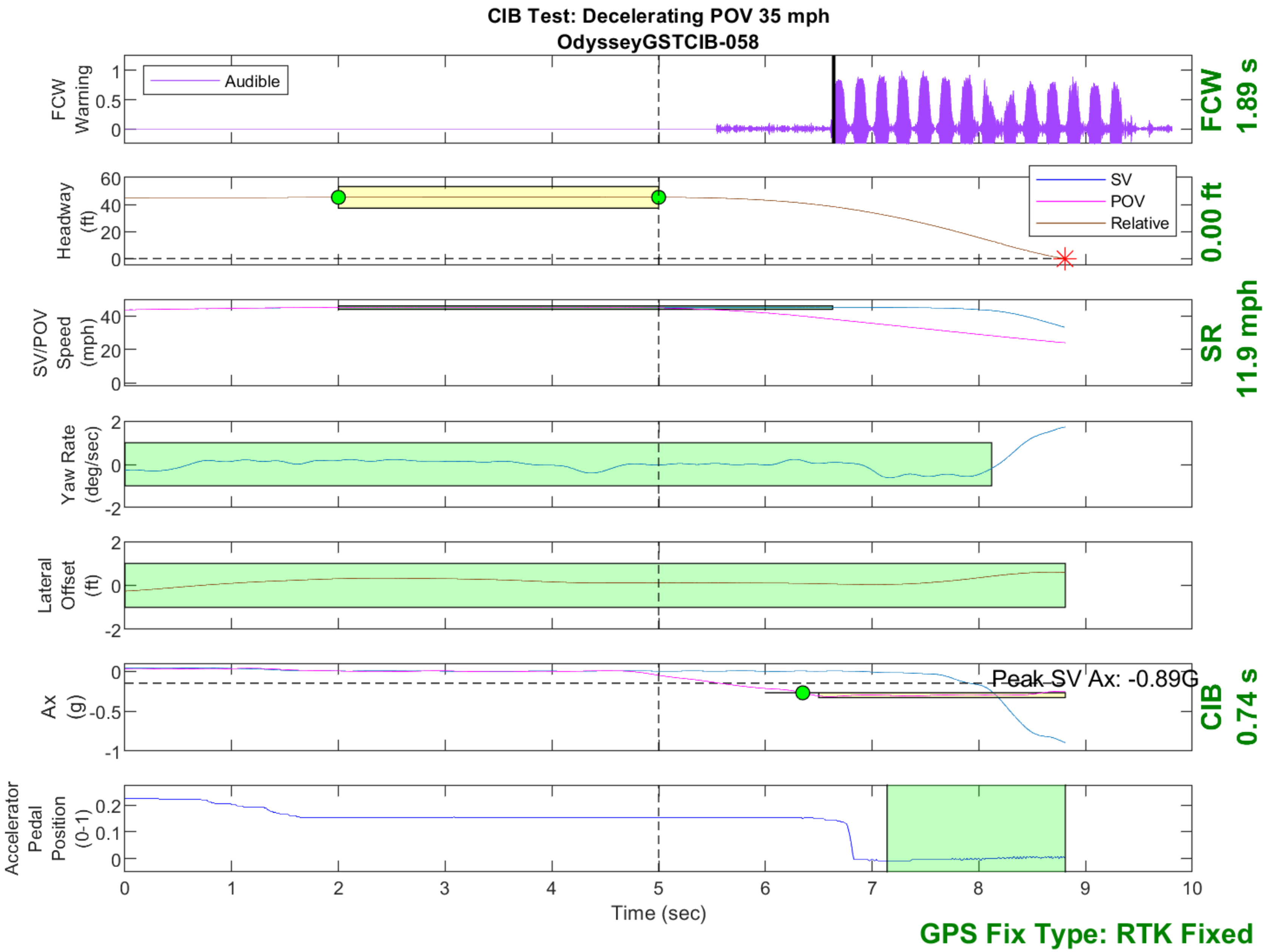



Figure D65. Time History for CIB Run 58, Decelerating POV, 45 mph 0.3g