NEW CAR ASSESSMENT PROGRAM
CRASH IMMINENT BRAKING SYSTEM CONFIRMATION TEST
NCAP-DRI-CIB-22-12

2022 Mitsubishi Outlander SE 2.5S-AWC

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Draft Report

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U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
New Car Assessment Program
1200 New Jersey Avenue, SE
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16. Abstract These tests were conducted on the subject 2022 Mitsubishi Outlander SE 2.5S-AWC in accordance with the specifications of the New Car Assessment program's most current Test Procedure in docket NHTSA-2015-0006-0025; CRASH IMMINENT BRAKE SYSTEM PERFORMANCE EVALUATION FOR THE NEW CAR ASSESSMENT PROGRAM, October 2015. The vehicle passed the requirements of the test for all four CIB test scenarios and all speeds.			
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Section I

INTRODUCTION

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

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

The purpose of the testing reported herein was to objectively quantify the performance of a Crash Imminent Braking system installed on a 2022 Mitsubishi Outlander SE 2.5S-AWC. This test is part of the New Car Assessment Program to assess Crash Imminent Braking Systems sponsored by the National Highway Traffic Safety Administration under Contract No. DTNH22-14-D-00333.

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

Section II

DATA SHEETS

CRASH IMMINENT BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

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2022 Mitsubishi Outlander SE 2.5S-AWC

VIN: *JA4J4UA85NZ04xxxx*

Test start date: *1/5/2021* Test end date: *1/5/2021*

Crash Imminent Braking System setting: *No options available*

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

SV 25 mph: *Pass*

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

SV 25 mph POV 10 mph: *Pass*

SV 45 mph POV 20 mph: *Pass*

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

SV 35 mph POV 35 mph: *Pass*

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

SV 25 mph: *Pass*

SV 45 mph: *Pass*

Overall: *Pass*

Notes:

CRASH IMMINENT BRAKING

DATA SHEET 2: VEHICLE DATA

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2022 Mitsubishi Outlander SE 2.5S-AWC

TEST VEHICLE INFORMATION

VIN: *JA4J4UA85NZ04xxxx*

Body Style: *SUV* Color: *Alloy Silver Metallic*

Date Received: *12/20/2021* Odometer Reading: *257 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Mitsubishi Motors Corporation*

Date of manufacture: *Oct 2021*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *P255/45R20*

Rear: *P255/45R20*

Recommended cold tire pressure: Front: *240 kPa (35 psi)*

Rear: *240 kPa (35 psi)*

TIRES

Tire manufacturer and model: *Bridgestone Ecopia H/L 422+*

Front tire designation: *P255/45R20 101W*

Rear tire designation: *P255/45R20 101W*

Front tire DOT prefix: *EL A9 CDJ*

Rear tire DOT prefix: *EL A9 CDJ*

CRASH IMMINENT BRAKING

DATA SHEET 3: TEST CONDITIONS

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2022 Mitsubishi Outlander SE 2.5S-AWC

GENERAL INFORMATION

Test start date: *1/5/2021* Test end date: *1/5/2021*

AMBIENT CONDITIONS

Air temperature: *11.1 C (52 F)*

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

X Windspeed ≤ 10 m/s (22 mph)

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

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

VEHICLE PREPARATION

Verify the following:

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

Fuel tank is full: **X**

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

Front: *240 kPa (35 psi)*

Rear: *240 kPa (35 psi)*

CRASH IMMINENT BRAKING

DATA SHEET 3: TEST CONDITIONS

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2022 Mitsubishi Outlander SE 2.5S-AWC

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*543.4 kg (1198 lb)*	Right Front:	*517.1 kg (1140 lb)*
Left Rear:	*420.5 kg (927 lb)*	Right Rear:	*397.8 kg (877 lb)*
		Total:	*1878.8 kg (4142 lb)*

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

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2022 Mitsubishi Outlander SE 2.5S-AWC

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

Forward Collision Mitigation System (FCM)

Type and location of sensors the system uses:

The FCM system uses a camera installed behind the windshield and a radar sensor mounted in the front bumper

System setting used for test (if applicable):

No options available

Over what speed range is the system operational?

The FCM system will function at vehicle speeds above approximately 3 mph.

For the pedestrian detection function, the FCM system operates at speeds between 6 – 37 mph (10 – 60 km/h). (Per manufacturer supplied information)

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

____ No

If yes, please provide a full description.

Run the test vehicle under the following conditions:

Vehicle Speed: 31 – 37 mph (50 – 60 km/h)

Time: 10 Minutes

Don't drive down a steep road grade and don't quickly accelerate/decelerate.

Avoid excessive yaw

The roadway should have white lines on both sides of the car and radar objects should be present (for example, telephone pole, guardrail, vehicles)

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

____ No

If yes, please provide a full description.

If AEB activates three times in same ignition cycle, cycling the ignition is needed.

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

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

(Check all that apply)

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

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

If a risk of a forward collision is detected, the FCM system will first provide the warning to the driver by flashing the vehicle ahead detection indicator (yellow) in the multi-information display and providing an auditory alert.

In addition, the system applies partial braking. If the driver applies the brakes quickly and forcefully after the warning, and the FCM system detects that there is still the possibility of a forward collision, the system will automatically increase the braking force.

If the driver does not take action, the FCM system will provide the visual warning to the driver by flashing FCM emergency warning indicator (red) in the multi-information display and providing an auditory alert. Then the system applies partial braking.

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

While the FCM system is operating, you may hear the sound of brake operation.

This is normal and indicates that the FCM system is operating properly.

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.

Arrow buttons on the left side of the steering wheel are used to turn the FCM system on and off. The procedure is as follows:

1. Press the < > button until "Settings" appears in the multi-information display and then push the scroll dial. Use the scroll dial to select "Driver Assistance" and select by pushing the scroll dial.

2. Select "Emergency Brake" and select by pushing the scroll dial.

3. Select "Front" and use the scroll dial to turn the system on or off.

When the FCM system is turned off, the FCM system OFF warning light illuminates.

The FCM system will be automatically turned ON when the engine is restarted.

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

X No

If yes, please provide a full description.

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

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2022 Mitsubishi Outlander SE 2.5S-AWC

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.

Poor visibility (conditions such as rain, snow, fog, dust storms, sandstorms, and road spray from other vehicles) and so on, can reduce system effectiveness. System limitations are described in detail on pages 5-129 to 5-133 owner's manual shown in Appendix B, pages B-16 through B-20.

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

Four test scenarios were used, as follows:

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

Test 2. Subject Vehicle Encounters Slower Principal Other Vehicle

Test 3. Subject Vehicle Encounters Decelerating Principal Other Vehicle

Test 4. Subject Vehicle Encounters Steel Trench Plate

An overview of each of the test procedures follows.

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

This test evaluates the ability of the CIB system to detect and respond to a stopped lead vehicle in the immediate forward path of the SV, as depicted in Figure 1.

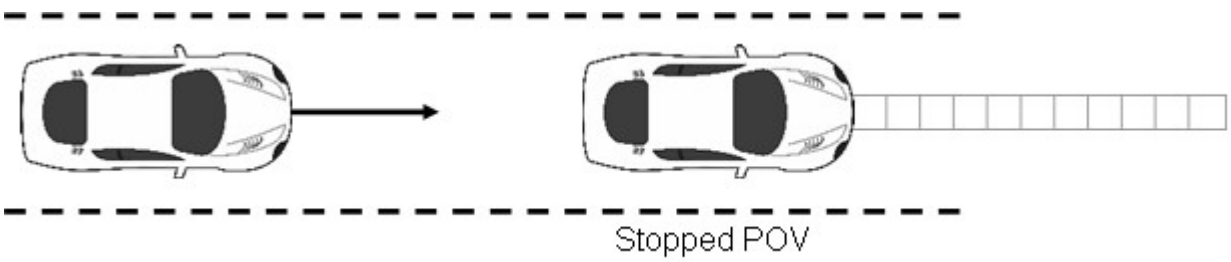


Figure 1. Depiction of Test 1

a. Procedure

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

The SV ignition was cycled prior to each test run. The SV was driven at a nominal speed of 25 mph (40.2 km/h) in the center of the lane of travel, toward the parked POV. The SV throttle pedal was released within 500 ms after t_{FCW}, i.e. within 500 ms of the FCW alert. The test concluded when either:

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

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

- The lateral distance between the centerline of the SV to the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The yaw rate of the SV could not deviate more than ±1 deg/sec during the validity period.
- 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} or impact if no FCW alert was given.

b. Criteria

In order to pass the test, the magnitude of the SV speed reduction attributable to CIB intervention must have been ≥ 9.8 mph (15.8 km/h) for at least five of seven valid test trials.

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

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

2. <u>TEST 2 – SUBJECT VEHICLE ENCOUNTERS SLOWER PRINCIPAL OTHER VEHICLE</u>

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

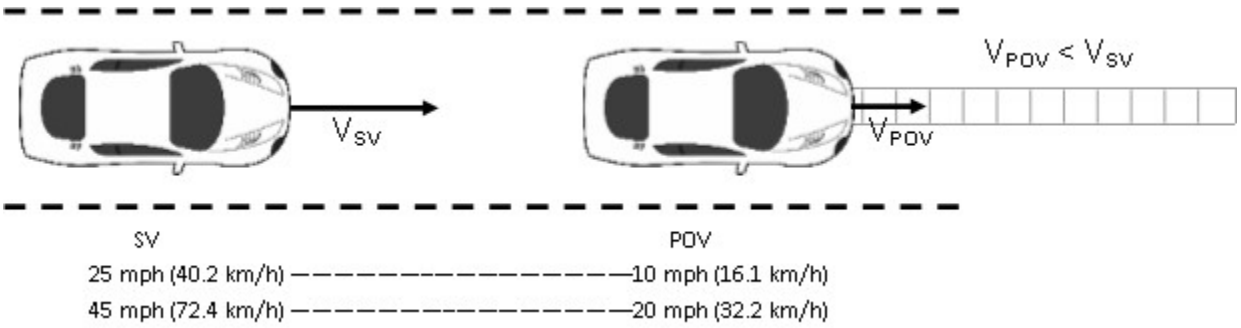


Figure 2. Depiction of Test 2

a. Procedure

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

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

The SV driver then braked to a stop.

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

- The lateral distance between the centerline of the SV and POV to the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The yaw rate of the SV and POV could not deviate more than ±1 deg/sec 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} or impact if no FCW alert was given.
- The POV speed could not deviate more than ±1.0 mph (±1.6 km/h) during the validity period.

b. Criteria

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

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

- If SV-to-POV contact occurred during a test trial, the CIB speed reduction was calculated by subtracting the SV speed at the time of SV-to-POV contact (i.e., when longitudinal range became zero) from the average SV speed calculated from 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 CIB speed reduction was calculated by subtracting the SV speed at the minimum longitudinal SV-to-POV range during the validity period from the SV speed at t_{FCW}.

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

This test evaluates the ability of the CIB system to detect and respond to a lead vehicle slowing with a constant deceleration in the immediate forward path of the SV, as depicted in Figure 3.

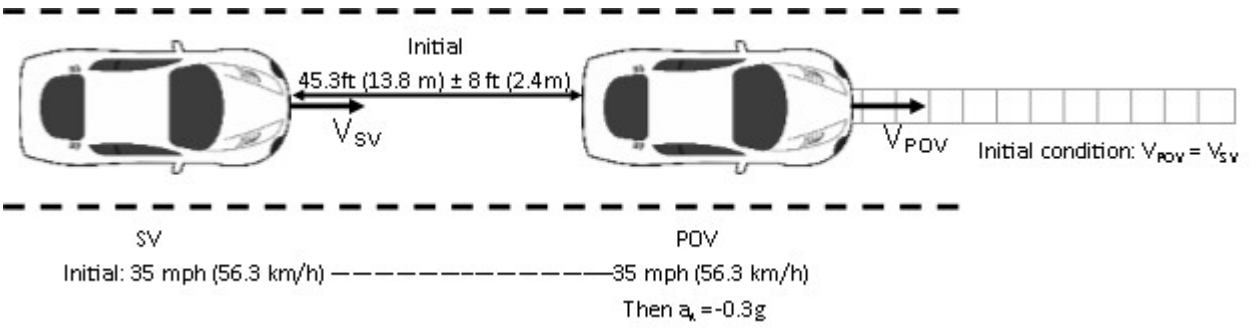


Figure 3. Depiction of Test 3

a. Procedure

The SV ignition was cycled prior to each test run. For this test scenario, both the POV and SV were driven at a constant 35.0 mph (56.3 km/h) in the center of the lane, with a headway of 45.3 ft (13.8 m) ± 8 ft (2.4 m). Once these conditions were met, the POV tow vehicle brakes were applied to achieve 0.3 ± 0.03 g of deceleration within 1.5 ± 0.1 sec. The test concluded when either:

- The SV came into contact with the POV or
- 1 second after minimum longitudinal SV-to-POV distance has occurred.

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 SV and POV to the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The yaw rate of the SV and POV could not deviate more than ±1 deg/sec during the validity period.
- The SV speed could not deviate more than ±1.0 mph (1.6 km/h) during an interval defined by 3.0 seconds before the onset of POV braking to t_{FCW} or impact if no FCW alert was given.
- The POV speed could not deviate more than ±1.0 mph (1.6 km/h) during an interval of 3.0 seconds before the onset of POV braking.
- The SV- POV headway distance could not deviate more than ±8 ft (2.4 m) during an interval defined by the onset of the validity period to the onset of POV braking.
- The average POV deceleration could not deviate by more than ±0.03 g from the nominal 0.3 g deceleration during the interval beginning at 1.5 seconds after the onset of POV braking and ending either 250 ms prior to the POV coming to a stop or the SV coming into contact with the POV.

b. Criteria

In order to pass the decelerating POV test series, the magnitude of the SV speed reduction attributable to CIB intervention must have been ≥ 10.5 mph (16.9 km/h) for at least five of seven valid test trials. The magnitude of the SV speed reduction attributable to CIB intervention was calculated in one of two ways, depending on whether a test trial concluded with the SV colliding with the POV.

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

4. TEST 4 – FALSE POSITIVE SUPPRESSION

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

with an STP in the SV forward path in lieu of a POV.

a. Procedure

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

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

- The lateral distance between the centerline of the SV to the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The yaw rate of the SV could not deviate more than ±1 deg/sec during the validity period.
- The SV speed could not deviate from the nominal speed by more than 1.0 mph (1.6 km/h) during an interval defined by a Time to Collision (TTC) = 5.1 seconds to t_{FCW} where:
    - For SV test speed of 25 mph, TTC = 5.1 seconds is taken to occur at an SV-to-STP distance of 187 ft (57 m).
    - For SV test speed of 45 mph, TTC = 5.1 seconds is taken to occur at an SV-to-STP distance of 337 ft (106 m).
- If the SV did not present an FCW alert before the end of the validity period, SV speed could not deviate more than ±1.0 mph (±1.6 km/h) from TTC = 5.1 s to the end of the validity period.

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

b. Criteria

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

B. General Information

1. T_{FCW}

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

For systems that implement auditory or haptic alerts, part of the pre-test instrumentation verification process was to determine the tonal frequency of the auditory 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 auditory or tactile warning data so that the beginning of such warnings can be programmatically determined. The band-pass filter used for these warning signal types was a phaseless, forward-reverse pass, elliptical (Cauer) digital filter, with filter parameters as listed in Table 1.

Table 1. Auditory and Tactile Warning Filter Parameters

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

2. GENERAL VALIDITY CRITERIA

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

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

3. VALIDITY PERIOD

The valid test interval began:

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

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

Test 3: 3 seconds before the onset of POV braking

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

The valid test interval ended:

Test 1: When either of the following occurred:

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

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

- The SV came into contact with the POV; or
- 1 second after minimum longitudinal SV-to-POV distance occurred.

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

4. STATIC INSTRUMENTATION CALIBRATION

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

For Tests 1, 2, and 3, the SV, POV, POV moving platform, and tow vehicle were centered in the same travel lane with the same orientation (i.e., facing the same direction). For Test 4, the SV and STP were centered in the same travel lane.

For Tests 1, 2, and 3, the SV was positioned such that it just contacted a vertical plane that defines the rearmost location of the POV. For Test 4, the front-most location of the SV was positioned such that it just reached a vertical plane defined by the leading edge of the STP first encountered by the SV (i.e., just before it is driven onto the STP). This is the “zero position.”

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 offset was adjusted to output zero ,another pre-test static calibration data file was collected, and the test series was repeated.

5. NUMBER OF TRIALS

A target total of seven (7) valid trials were performed for each scenario. In cases where the test driver performed more than seven trials, the first seven trials satisfying all test tolerances were used to assess the SV performance.

6. TRANSMISSION

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

C. Principal Other Vehicle

CIB testing requires a POV that realistically represents typical vehicles, does not suffer damage or cause damage to a test vehicle in the event of collision, and can be accurately positioned and moved during the tests. The tests reported herein made use of the NHTSA developed Strikeable Surrogate Vehicle (SSV).

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

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

The key requirements of the POV element are to:

- Provide an accurate representation of a real vehicle to 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 35 mph (56 km/h).
- Accurately control the lateral position of the POV within the travel lane.

- Allow the POV to move away from the SV after an impact occurs.

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

D. Automatic Braking System

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

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

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

E. Instrumentation

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

Table 2. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and 100 psi	Omega DPG8001	17042707002	By: DRI Date: 10/5/2021 Due: 10/5/2022
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 2/10/2021 Due: 2/10/2022
Linear (string) encoder	Throttle pedal travel	10 in 254 mm	0.1 in 2.54 mm	UniMeasure LX-EP	49041189	By: DRI Date: 4/15/2021 Due: 4/15/2022
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	N/A
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels ± 10g, Angular Rate ±100 deg/s, Angle >45 deg, Velocity >200 km/h	Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h	Oxford Inertial +		By: Oxford Technical Solutions
					2176	Date: 6/26/2020 Due: 6/26/2022
					2258	Date: 4/28/2021 Due: 4/28/2023

Table 2. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Real-Time Calculation of Position and Velocity Relative to POV	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	N/A
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	N/A	N/A
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	N/A	N/A
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	N/A	N/A
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2021 Due: 1/6/2022

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

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

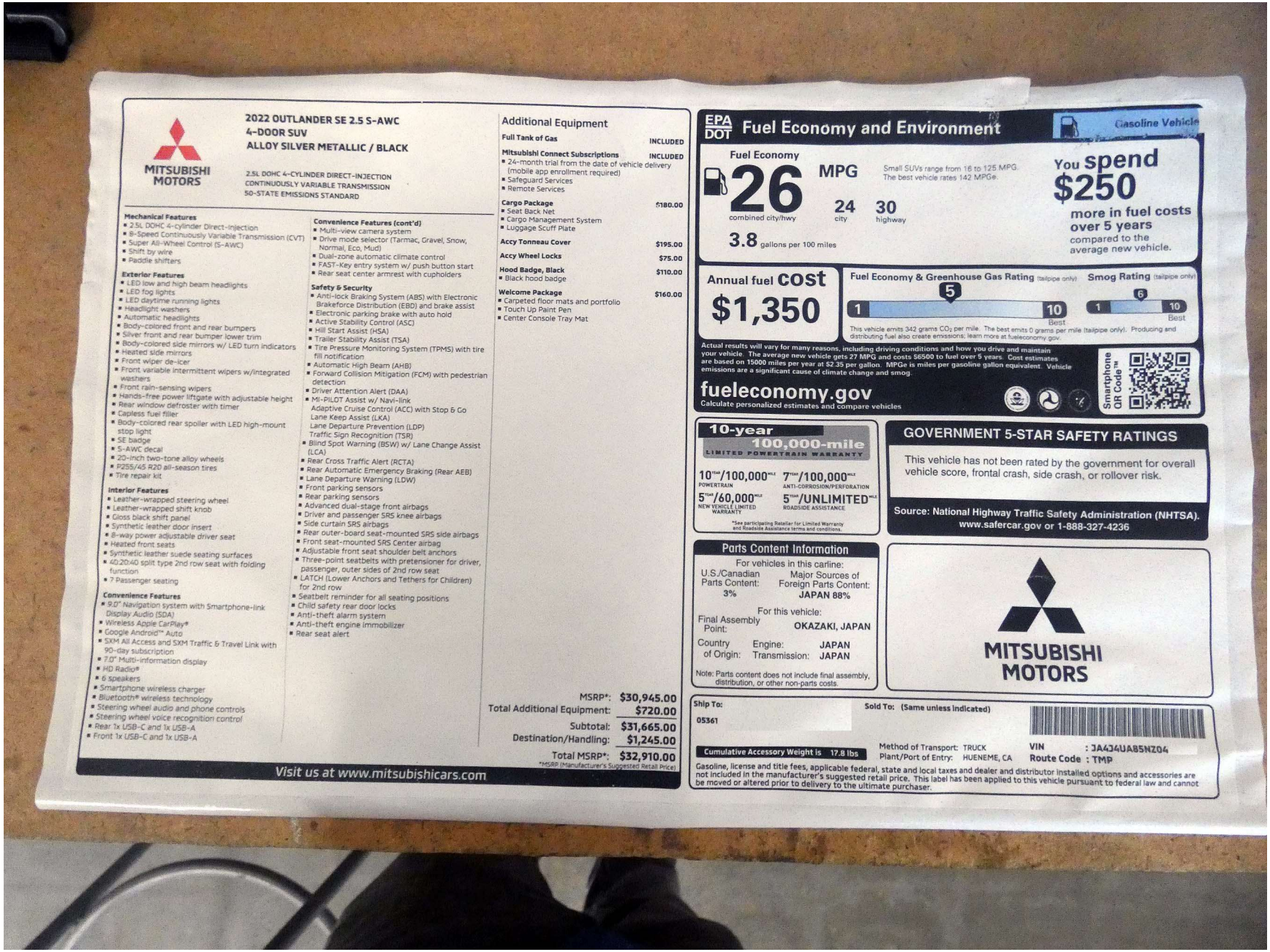


Figure A3. Window Sticker (Monroney Label)

Figure A4. Vehicle Certification Label

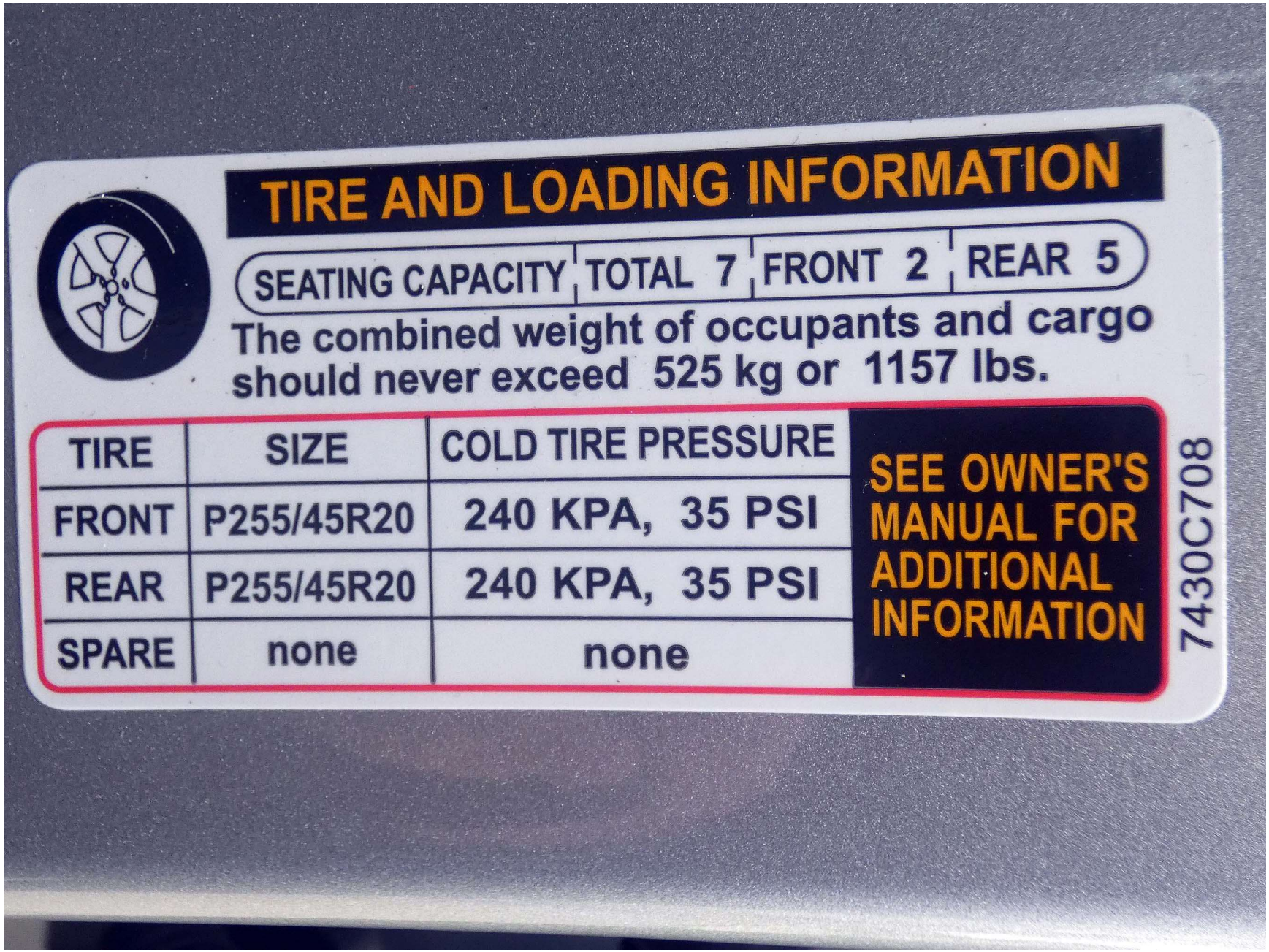


Figure A5. Tire Placard

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

Figure A7. Load Frame/Slider of SSV

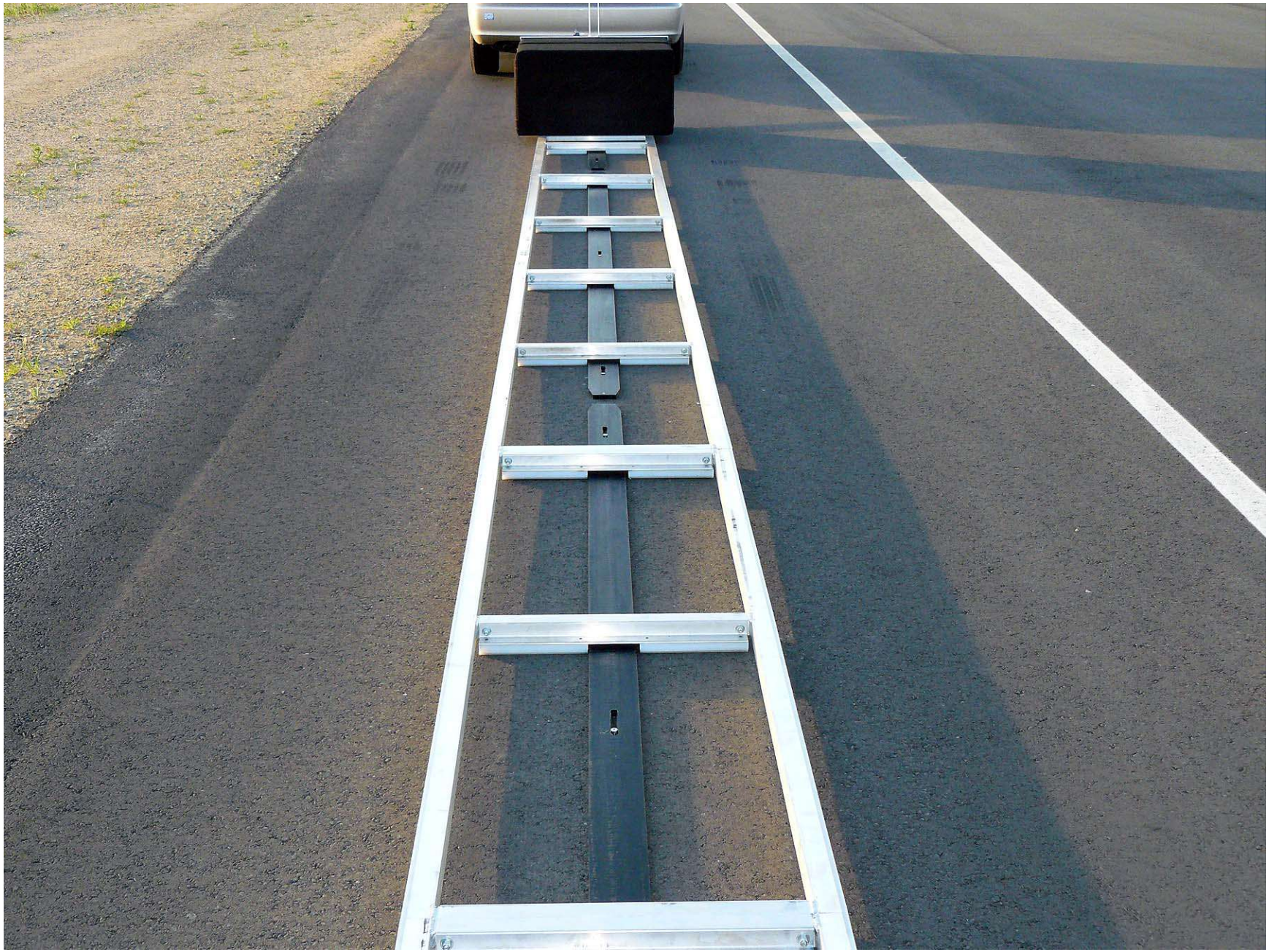


Figure A8. Two-Rail Track and Road-Based Lateral Restraint Track

Figure A9. Steel Trench Plate

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

Figure A11. Sensor for Detecting Auditory and Visual Alerts

Figure A12. Computer Installed in Subject Vehicle

Figure A13. Brake Actuator Installed in POV System

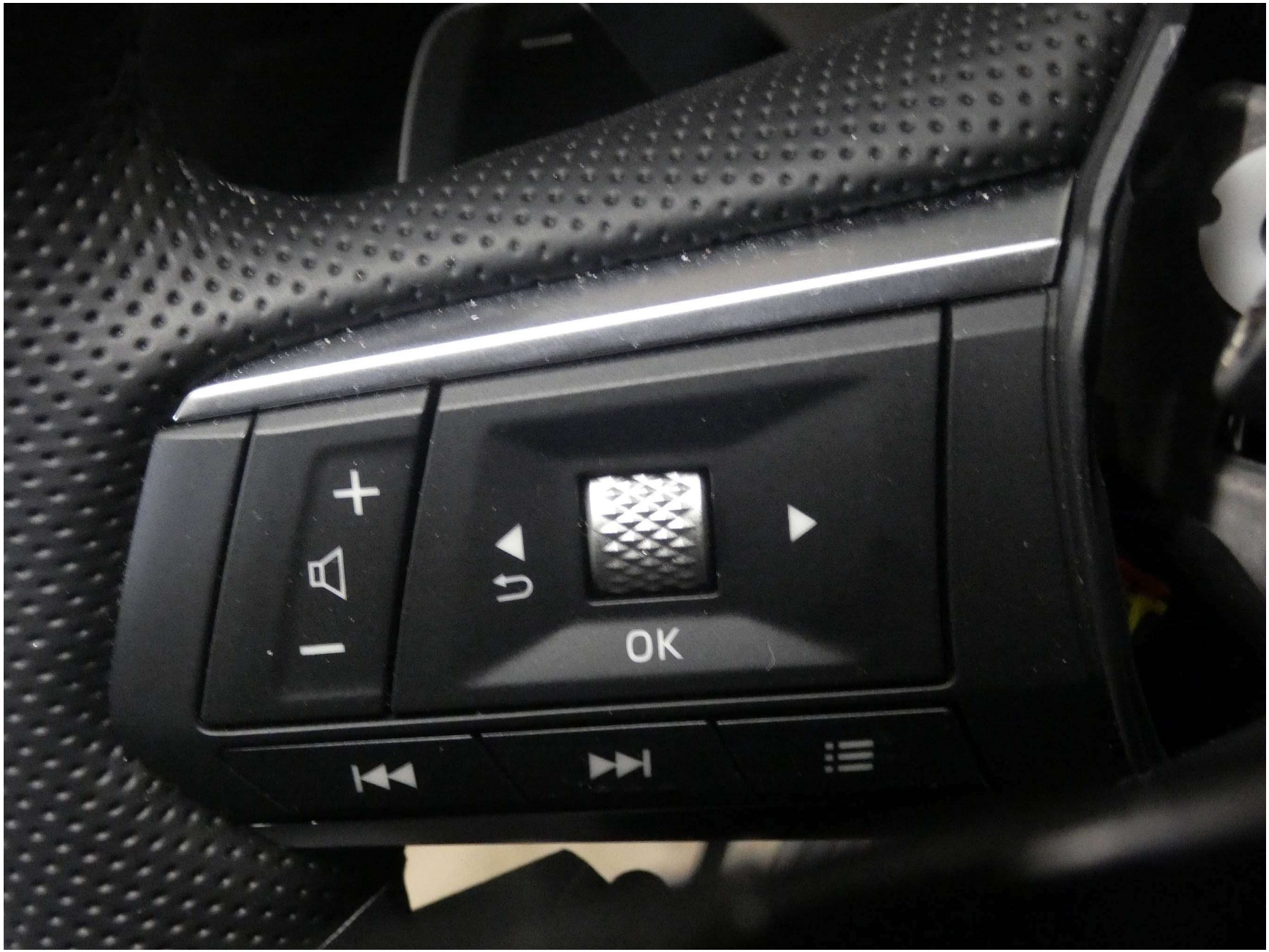


Figure A14. Button for Accessing Menus

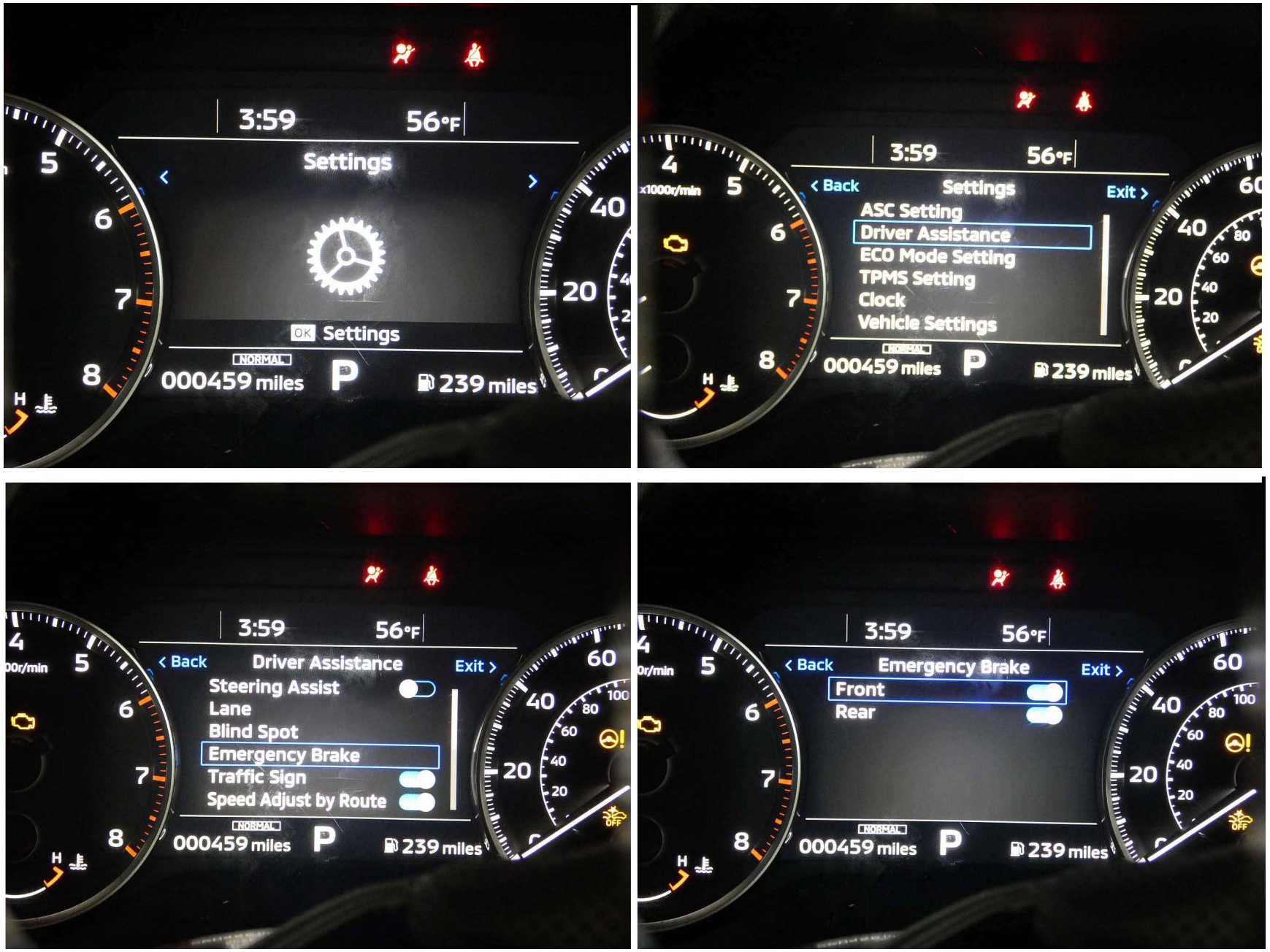


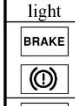
Figure A15. AEB Setup Menus

Figure A16. Visual Alert

APPENDIX B

Excerpts from Owner’s Manual

WARNING AND INDICATOR LIGHTS

Red light	Name	Page
	Brake warning light	2-13
	Charge warning light	2-14
	Electric shift control system warning light	2-14
	Electronic parking brake warning light	2-14
	Engine oil pressure warning light	2-14
	Front seat belt warning light	2-15
	Hands OFF warning light (if so equipped)	2-15
	Master warning light	2-15
	SRS airbag warning light	2-15

Yellow light	Name	Page
	Active stability control (ASC) warning light	2-16
	Active stability control (ASC) off indicator light	2-16
	Anti-lock Braking System (ABS) warning light	2-16
	Forward Collision Mitigation System (FCM) OFF warning light	2-16
	Electric power steering warning light	2-16
	Electronic parking brake warning light	2-17
	Low tire pressure warning light	2-17
	Malfunction Indicator Light (MIL)	2-18
	Master warning light	2-19
	Rear Automatic Emergency Braking (Rear AEB) system OFF warning light	2-19

Other light	Name	Page
	Automatic High Beam (AHB) indicator light	2-19
	Brake Auto Hold indicator light (white)	2-19
	Brake Auto Hold indicator light (green)	2-19
	Exterior light indicator	2-19
	Front fog light indicator light (if so equipped)	2-19
	High beam indicator light	2-20
	Turn signal/hazard indicator lights	2-20

WARNING LIGHTS, INDICATOR LIGHTS AND AUDIBLE REMINDERS

Warning/indicator lights (red)		Warning/indicator lights (yellow)		Warning/indicator lights (other)	
BRAKE	Brake warning light (red)		Active stability control (ASC) warning light		Automatic High Beam (AHB) indicator light
		OFF	Active stability control (ASC) off indicator light	AUTO HOLD	Brake Auto Hold indicator light (white)
	Charge warning light	ABS	Anti-lock Braking System (ABS) warning light	AUTO HOLD	Brake Auto Hold indicator light (green)
	Electric shift control system warning light				Exterior light indicator
PARK	Electric parking brake warning light	OFF	Forward Collision Mitigation System (FCM) OFF warning light		Front fog light indicator light (if so equipped)
			Electric power steering warning light		High beam indicator light
	Engine oil pressure warning light		Electric parking brake warning light (yellow)		Turn signal/hazard indicator lights
	Front seat belt warning light and chime		Low tire pressure warning light		
	Hands OFF warning light (if so equipped)		Malfunction Indicator Light (MIL)		
	Master warning light		Master warning light		
	SRS airbag warning light	OFF	Rear Automatic Emergency Braking (Rear AEB) system OFF warning light		

WARNING

If the SRS airbag warning light is on, it could mean that the front airbag, side airbag, curtain airbag and/or pretensioner systems will not operate in an accident. To help avoid injury to yourself or others, have your vehicle checked. It is recommended you visit an authorized Mitsubishi Motors dealer for this service.

WARNING/INDICATOR LIGHTS (yellow)

See also "Multi-information display" (P.2-21).

Active stability control (ASC) warning light

When the ignition switch is in the ON position, the Active stability control (ASC) warning light illuminates and then turns off.

The light will blink when the Active stability control (ASC) or the traction control system is operating, thus alerting the driver that the vehicle is nearing its traction limits. The road surface may be slippery.

If the ASC warning light illuminates while the ASC is on, this light alerts the driver to the fact that the ASC's fail-safe mode is operating, for example the ASC may not be functioning properly. Have the system checked. It is recommended you visit an authorized Mitsubishi Motors dealer for this service. If a malfunction occurs in the system, the ASC function will be canceled but the vehicle is still driveable. For additional information, see "Active stability control (ASC)" (P.5-159) of this manual.

Active stability control (ASC) off indicator light

When the ignition switch is in the ON position, the Active stability control (ASC) off indicator light illuminates and then turns off.

The light comes on when the Active stability control (ASC) is turned OFF. This indicates that the ASC and traction control system are not operating.

ABS or Anti-lock Braking System (ABS) warning light

When the ignition switch is in the ON position, the Anti-lock Braking System (ABS) warning light illuminates and then turns off. This indicates the ABS is operational.

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

If an ABS malfunction occurs, the anti-lock function is turned off. The brake system then operates normally, but without anti-lock assistance. (See "Brake system" (P.5-156).)

Forward Collision Mitigation System (FCM) OFF warning light

When the ignition switch is in the ON position, the FCM system OFF warning light illuminates. After starting the engine, the warning light turns off.

This light illuminates when the FCM system is set to OFF on the multi-information display.

If the light illuminates when the FCM system is ON, it may indicate that the system is unavailable. See "Forward Collision Mitigation System (FCM)" (P.5-126) or "Predictive Forward Collision Warning (PFCW)" (P.5-135).

Electric power steering warning light

When the ignition switch is in the ON position, the electric power steering warning light illuminates. After starting the engine, the electric power steering warning light turns off. This indicates the electric power steering is operational.

High beam indicator light

This light illuminates when the headlight high beam is on and goes out when the low beam is selected.

Turn signal/hazard indicator lights

The light flashes when the turn signal switch lever or hazard switch is turned on.

AUDIBLE REMINDERS

Light reminder chime

The light reminder chime will sound when the driver side door is opened with the headlight switch in the ≡D◐≡ or 🔆 position, and the ignition switch is in the OFF position.

Turn the light switch off when you leave the vehicle.

Driving aid chimes

An audible alert/chime may be heard if any of the following systems are active (if so equipped):

- Forward Collision Mitigation System (FCM)
- Predictive Forward Collision Warning (PFCW)
- Blind Spot Warning (BSW)
- Active Blind Spot Assist (ABSA)
- Rear Cross Traffic Alert (RCTA)
- Lane Departure Prevention (LDP)
- Lane Departure Warning (LDW)
- MI-PILOT Assist
- Rear Automatic Emergency Braking (Rear AEB)
- Parking sensor system

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

Door lock warning chime

When the chime sounds, be sure to check both the vehicle and the F.A.S.T.-key. See "Trouble-shooting guide" (P.3-13).

Brake pad wear warning

The disc brake pads have audible wear warnings. When a brake pad requires replacement, it will make a high pitched scraping sound when the vehicle is in motion. This scraping sound will first occur only when the brake pedal is depressed. After more wear of the brake pad, the sound will always be heard even if the brake pedal is not depressed. Have the brakes checked as soon as possible if the warning sound is heard.

Parking brake reminder chime

The parking brake reminder chime will sound if the vehicle is driven at more than 2 MPH (4 km/h) with the parking brake applied. Stop the vehicle and release the parking brake.

SETTINGS

The setting mode allows you to change the information displayed in the multi-information display. The following items are available if the vehicle is equipped with them:

- ASC Setting
- Driver Assistance
- Personal Display
- Head-Up Display
- ECO Mode Setting
- TPMS Setting
- Clock
- Vehicle Settings
- Maintenance
- Customize Display
- Units/Language
- Key- Linked Settings
- Factory Reset

ASC Setting

To change the setting, use the scroll dial to select and push it.

- System
  This allows you to turn the Active stability control (ASC) ON or OFF. By default the ASC will be turned ON. If the ASC is turned off, the ASC OFF indicator light will illuminate.

NOTE:

The vehicle should be driven with the Active stability control (ASC) ON for most driving conditions. (See "Active stability control (ASC)" (P.5-159).)

Driver Assistance

To change the status, warnings or turn on or off any of the systems/warnings displayed in the "Driver Assistance" menu, use the scroll dial to select and change a menu item. The displayed menu items vary depending on the vehicle's equipment.

- Steering Assist
- Lane
- Blind Spot
- Emergency Brake
- Traffic Sign
- Speed Adjust by Route
- Spd.Limit Assist
- Parking sensors
- Rear Cross Traffic Alert
- Driver Attention Alert
- Timer Alert
- Low Temp. Alert

Steering Assist:

- Allows user to turn the Lane Keep Assist (LKA) ON/OFF.

(See "MI-PILOT Assist" (P.5-90).)

Lane:

- Warning (LDW)
  Allows user to turn the Lane Departure Warning (LDW) system ON/OFF.
- Prevention (LDP)
  Allows user to turn the Lane Departure Prevention (LDP) system ON/OFF.

(See "Lane Departure Warning (LDW)" (P.5-33) and "Lane Departure Prevention (LDP)" (P.5-38).)

Blind Spot:

- Warning (BSW)
  Allows user to turn the Blind Spot Warning (BSW) system ON/OFF.
- Active Assist (ABSA)
  Allows user to turn the Active Blind Spot Assist (ABSA) system ON/OFF.

(See "Blind Spot Warning (BSW)" (P.5-43) and "Active Blind Spot Assist (ABSA)" (P.5-51).)

Emergency Brake:

Models without Rear Automatic Emergency Braking (Rear AEB) :

Allows user to turn the Forward Collision Mitigation System (FCM) system and Predictive Forward Collision Warning (PFCW) system ON/OFF.

Models with Rear Automatic Emergency Braking (Rear AEB) :

Allows user to turn the Forward Collision Mitigation System (FCM) system and Predictive Forward Collision Warning (PFCW) system ON/OFF

- Front
  Allows user to turn the Forward Collision Mitigation System (FCM) system and Predictive Forward Collision Warning (PFCW) system ON/OFF
- Rear
  Allows user to turn the Rear Automatic Emergency Braking (Rear AEB) system ON/OFF.

(See "Forward Collision Mitigation System (FCM)" (P.5-126), "Predictive Forward Collision Warning (PFCW)" (P.5-135) and "Rear Automatic Emergency Braking (Rear AEB)" (P.5-146).)

Traffic Sign:

This menu allows the customer to turn the Traffic Sign Recognition ON/OFF. (See "Traffic Sign Recognition (TSR)" (P.5-30).)

Speed Adjust by Route:

Allows user to turn the Speed Adjust by Route (MI-PILOT Assist with Navi-link) function ON/OFF. (See "Speed Adjust by Route - a feature of MI-PILOT Assist with Navi-link" (P.5-110).)

Spd. Limit Assist:

Allows user tocustomize the Speed Limit Assist (MI-PILOT Assist with Navi-link) options.

- OFF
- Manual
- Auto

(See "Speed Limit Assist - a feature of MI-PILOT Assist with Navi-link" (P.5-108).)

Parking sensors:

To change the status or turn on or off any of the systems displayed in the "Parking sensors" menu, use the scroll dial ① to select and change a menu item:

- Moving Object
  Push the scroll dial ① to turn the Moving Object Detection (MOD) ON/OFF.
- Auto Show Sonar
  Allows user to turn the parking sensor system display ON/OFF.
- Front
  Allows user to turn the front sensor ON/OFF.
- Rear
  Allows user to turn the rear sensor ON/OFF.
- Distance
  Allows user to select the sensor range (Long, Medium or Short).
- Volume
  Allows user to select sensor volume (High, Medium or Low).

(See "Moving Object Detection (MOD)" (P.4-23), "Parking sensor system" (P.5-164) and "Rear parking sensor system" (P.5-169).)

Rear Cross Traffic Alert:

Allows user to turn the Rear Cross Traffic Alert system ON/OFF. (See "Rear Cross Traffic Alert (RCTA)" (P.5-62).)

Driver Attention Alert:

Allows the customer to turn the Driver Attention Alert (DAA) on or off. (See "Driver Attention Alert (DAA)" (P.5-143).)

Timer Alert:

Allows user to adjust the Timer Alert or reset.

- Current Time/Set Time
- Reset

Low Temp. Alert:

Allows user to turn the Low Temperature Alert function ON/OFF.

26. Time for a Break? indicator

This indicator appears when the set "Time for a Break?" indicator activates. You can set the time for up to 6 hours.

27. Take a Break? indicator

This indicator appears when the Driver Attention Alert (DAA) system detects driver fatigue or that driver attention is decreasing. (See "Driver Attention Alert (DAA)" (P.5-143).)

28. Chassis Control System Error: See Owner's Manual warning

This warning appears if the chassis control module detects an error in the chassis control system. Have the system checked. It is recommended that you visit an authorized Mitsubishi Motors dealer for this service. (See "Chassis control" (P.5-160).)

29. Malfunction warning

This warning appears when the following systems malfunction if the vehicle is equipped with them.

- Active Blind Spot Assist (ABSA)
- Rear Cross Traffic Alert (RCTA)
- Traffic Sign Recognition (TSR)
- Forward Collision Mitigation System (FCM)
- Predictive Forward Collision Warning (PFCW)

For more details, see "Active Blind Spot Assist (ABSA)" (P.5-51), "Rear Cross Traffic Alert (RCTA)" (P.5-62), "Traffic Sign Recognition (TSR)" (P.5-30), "Forward Collision Mitigation System (FCM)" (P.5-126) or "Predictive Forward Collision Warning (PFCW)" (P.5-135).

30. Unavailable High Cabin Temperature warning

This warning appears if the interior temperature of the vehicle has reached such a high temperature that the sensor for the Active Blind Spot Assist (ABSA), Lane Departure Warning (LDW) (if so equipped), Lane Departure Prevention (LDP) (if so equipped) or Traffic Sign Recognition (TSR) (if so equipped) system can no longer function reliably. Once the interior temperature has reached normal levels, the warning should disappear.

If the warning continues to display, have the system checked. It is recommended that you visit an authorized Mitsubishi Motors dealer for this service.

For additional information, refer to "Active Blind Spot Assist (ABSA)" (P.5-51), "Lane Departure Warning (LDW)" (P.5-33), "Lane Departure Prevention (LDP)" (P.5-38) or "Traffic Sign Recognition (TSR)" (P.5-30).

31. Not Available: Poor Road Conditions warning

This message appears when Adaptive Cruise Control System (ACC) or Active Blind Spot Assist (ABSA) system becomes unavailable because the road is slippery. For additional information, refer to "Adaptive Cruise Control System (ACC)" (P.5-71), "Adaptive Cruise Control System (ACC) with Stop & Go" (P.5-103) or "Active Blind Spot Assist (ABSA)" (P.5-51).

32. Currently not available warning

This message appears when the Active Blind Spot Assist (ABSA), Lane Departure Prevention (LDP) system or the Adaptive Cruise Control System (ACC) system becomes unavailable because the ASC is turned off. For additional information, refer to "Active Blind Spot Assist (ABSA)" (P.5-51), "Lane Departure Prevention (LDP)" (P.5-38), "Adaptive Cruise Control System (ACC)" (P.5-71) or "Adaptive Cruise Control System (ACC) with Stop & Go" (P.5-103).

33. Forward Driving Aids Temporarily Disabled Front Sensor Blocked See Owner's Manual warning

If the front radar sensor area is covered with dirt or obstructed, making it impossible to detect a vehicle ahead, Forward Collision Mitigation System (FCM), Predictive Forward Collision Warning (PFCW), Adaptive Cruise Control (ACC) or MI-PILOT Assist system is automatically turned off if the vehicle is equipped with them. The warning message will appear in the multi-information display. If the warning message appears, park the vehicle in a safe location and turn the engine off.

Check to see if the front radar sensor area is blocked. If the front radar sensor area is blocked, remove the blocking material. Restart the engine. If the warning message continues to appear, have the Forward Collision Mitigation System (FCM), Predictive Forward Collision Warning (PFCW), Adaptive Cruise Control (ACC) or MI-PILOT Assist system checked. It is recommended that you visit an authorized Mitsubishi Motors dealer for this service.

For more details, see "Forward Collision Mitigation System (FCM)" (P.5-126), "Predictive Forward Collision Warning (PFCW)" (P.5-135), "Adaptive Cruise Control System (ACC)" (P.5-71) or "MI-PILOT Assist" (P.5-90).

34. Unavailable Side Radar Obstruction warning

This warning appears when the Blind Spot Warning (BSW), Active Blind Spot Assist (ABSA) or Rear Cross Traffic Alert (RCTA) system becomes unavailable because a radar blockage is detected. (See "Blind Spot Warning (BSW)" (P.5-43), "Active Blind Spot Assist (ABSA)" (P.5-51) or "Rear Cross Traffic Alert (RCTA)" (P.5-62).)

35. Press Brake Pedal warning

This indicator appears in the following situations:

- The driver tries to release the electric parking brake manually without depressing the brake pedal.
- The vehicle is stopped on a steep hill and there is a possibility of moving backward, even if the electric parking brake is applied.
- This warning appears if the vehicle moves while the Brake Auto Hold is activated.

36. Lane Keep Assist (LKA) alert

This message may appear when the Lane Keep Assist (LKA) system is engaged.

It will be displayed under the following condition:

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

Hold on the steering wheel immediately. When the steering operation is detected, the warning turns off and the Lane Keep Assist (LKA) function is automatically restored. For additional information, refer to "MI-PILOT Assist" (P.5-90).

37. Rear Seat Alert is Activated

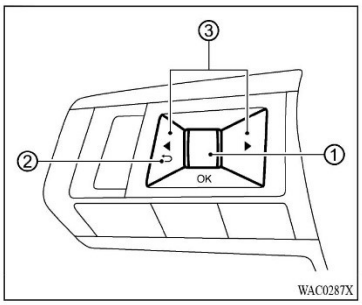
When the system is enabled, this message appears when the Rear Seat Alert system is active and can remind the driver to check the back seat.

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

For additional information, see "Rear Seat Alert" (P.2-62).

⚠ WARNING

Selecting "Dismiss Message" during a stop within a trip temporarily dismisses the message for that stop without turning the system off.



TRIP COMPUTER

Switches for the trip computer are located on the left side of the steering wheel.

① Scroll dial button - navigate through the items and change or select an item in multi-information display

② ⮌ - go back to the previous menu

③ ◀ ▶ - change from one display screen to the next (i.e. Home, Fuel economy, S-AWC)

1. Driver assistance

The driver assistance mode shows the operating condition for the following systems if the vehicle is equipped with them.

- Lane Departure Warning (LDW)
- Lane Departure Prevention (LDP)
- Blind Spot Warning (BSW)
- Active Blind Spot Assist (ABSA)
- Forward Collision Mitigation System (FCM)
- Predictive Forward Collision Warning (PFCW)

For more details, see "Lane Departure Warning (LDW)" (P.5-33), "Lane Departure Prevention (LDP)" (P.5-38), "Blind Spot Warning (BSW)" (P.5-43), "Active Blind Spot Assist (ABSA)" (P.5-51), "Forward Collision Mitigation System (FCM)" (P.5-126) and "Predictive Forward Collision Warning (PFCW)" (P.5-135).

2. Speed and Average speed (model with type 1 display)

The Speed and Average speed mode shows the current vehicle speed and the average vehicle speed since the last reset. The Speed and Average speed mode have three modes of operation. You can push the scroll dial to switch between Manual reset1, Manual reset2 or Auto Refuel.

Manual reset1 can be reset only manually by using the scroll dial.

Manual reset2 will be reset manually by using the scroll dial, or automatically reset each time the ignition is placed in the OFF position.

Auto Refuel will be reset automatically each time when refueling.

3. Drive Computer

Average fuel consumption:

The average fuel consumption shows the average fuel consumption since the last reset.

Average speed:

The average speed shows the average vehicle speed since the last reset.

Trip odometer:

The trip odometer shows the total distance the vehicle has been driven since the last reset.

Elapsed time:

The elapsed time shows the time since the last reset.

The Drive Computer mode have three modes of operation. You can push the scroll dial to switch between Manual reset1, Manual reset2 or Auto Refuel.

Manual reset1 can be reset only manually by using the scroll dial.

- Reset Settings

NOTE:

Emergency information may display even if the HUD system is turned off.

For more details, refer to the separate Smartphone-link Display Audio (SDA) Owner's Manual.

This product includes the following software.

(1) Panasonic Corporation or software developed for Panasonic Corporation

(2) Third-party software licensed to Panasonic Corporation

(3) Open source software

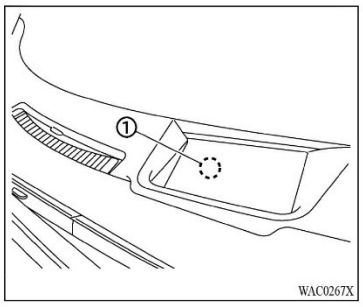
Regarding (3) Open source software, it includes open source software (OSS), including various software to which license information applies.

Refer to the license web site at: http://car.panasonic.jp/oss/i02lln39

Display brightness

The brightness of the display may be controlled in the multi-information display. The brightness will also be adjusted automatically according to the exterior ambient lighting brightness.

For more details, refer to the separate Smartphone-link Display Audio (SDA) Owner's Manual.



NOTE:

- **The HUD has a built-in sensor ① that controls the brightness of the displayed image. If you block the sensor with an object, the display will darken, making it difficult to see.**
- **Do not expose the HUD sensor to excessive light. This could cause failure or malfunction.**

DRIVER ASSISTANCE/NAVIGATION/TRAFFIC SIGN/ AUDIO/TEL/SMS LINKING

The HUD will display driver assistance and navigation information (if so equipped).

The driver assistance display will display warning situations for the following systems if the vehicle is equipped with them:

- Forward Collision Mitigation System (FCM)
- Predictive Forward Collision Warning system
- Cruise control
- Adaptive Cruise Control System (ACC)
- MI-PILOT Assist
- Lane Departure Warning (LDW) system
- Lane Departure Prevention

The Navigation System linking display will display the following items (if so equipped):

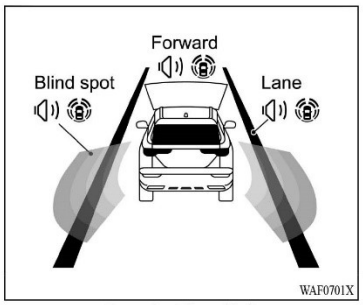
- Intersection names
- Arrows indicating turning direction
- Distance to the next intersection
- Recommended lane indicator

For the navigation system, refer to the separate Smartphone-link Display Audio (SDA) Owner's Manual.

The Traffic Signs Recognition System linking

OPERATING MI-PILOT ASSIST

1. Push the MI-PILOT Assist switch Ⓐ. This turns on the MI-PILOT Assist system.
   - The MI-PILOT Assist status indicator Ⓑ illuminates in white.
   - A screen is displayed for a period of time that indicates the status of the Driving Aid functions.



Example (all enabled)

When the Driving Aids are enabled:

Zone	Driving Aid	Display
Forward	Forward Collision Mitigation System (FCM)	Outline
	Predictive Forward Collision Warning (PFCW)	
Lane	Lane Departure Warning (LDW)	Shaded
	Lane Departure Prevention (LDP)	Shaded
Blind Spot	Blind Spot Warning (BSW)	Outline
	Active Blind Spot Assist (ABSA)	Shaded

- When any of the "Warning" systems are enabled, the " " mark is shown in each zone.
- When any of the "Intervention" systems are enabled, the " " mark is shown in each zone.
- When no system is enabled, "OFF" is shown in each zone.

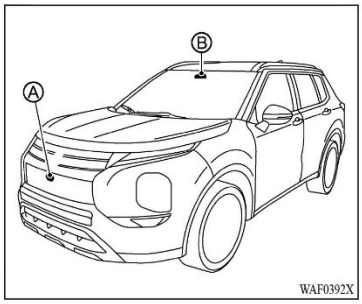
FORWARD COLLISION MITIGATION SYSTEM (FCM)

⚠ WARNING

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

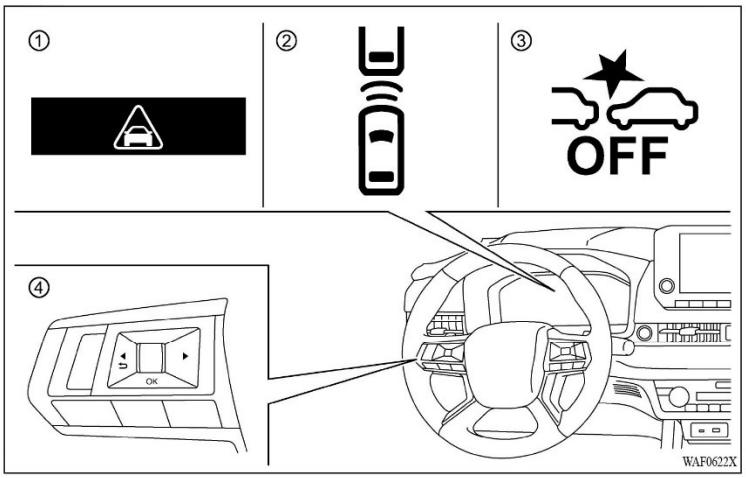
- **The FCM system is a supplemental aid to the driver. It is not a replacement for the driver's attention to traffic conditions or responsibility to drive safely. It cannot prevent accidents due to carelessness or dangerous driving techniques.**
- **The FCM system does not function in all driving, traffic,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

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



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

For pedestrians, the FCM system uses a camera Ⓑ installed behind the windshield in addition to the radar sensor.



① FCM emergency warning indicator
② Vehicle ahead detection indicator (on the multi-information display)
③ FCM system OFF warning light (on the meter panel)
④ Steering wheel remote control switches (left side)

FCM SYSTEM OPERATION

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

For the pedestrian detection function, the FCM system operates at speeds between 6 – 37 MPH (10 – 60 km/h).

If a risk of a forward collision is detected, the FCM system will firstly provide the warning to the driver by flashing the vehicle ahead detection indicator (yellow) in the multi-information display and providing an audible alert. In addition, the system applies partial braking.

If the driver applies the brakes quickly and forcefully after the warning, and the FCM system detects that there is still the possibility of a forward collision, the system will automatically increase the braking force.

If the driver does not take action, the FCM system provide the warning to the driver by flashing FCM emergency warning indicator (red) in the multi-information display and providing an audible alert. Then the system applies partial braking.

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

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

NOTE:

The vehicle's stop lights come on when braking is performed by the FCM system.

Depending on vehicle speed and distance to the vehicle or pedestrian ahead, as well as driving

and roadway conditions, the system may help the driver avoid a forward collision or may help mitigate the consequences of a collision should one be unavoidable.

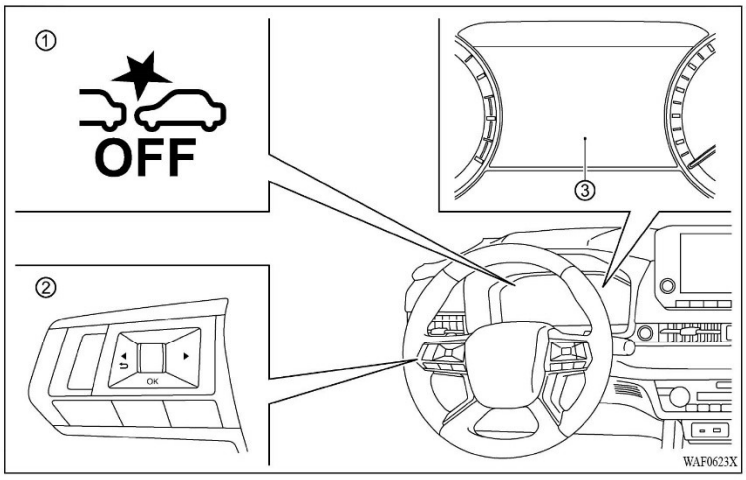
If the driver is handling the steering wheel, accelerating or braking, the FCM system will function later or will not function.

The automatic braking will cease under the following conditions:

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

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

When the brake pedal is depressed while the brake is applied by the system, you may feel the pedal effort is changed and may hear a sound and vibration noise. This is normal and does not indicate a malfunction. In addition, the braking force can be increased by adding the pedal effort.



① FCM system OFF warning light (on the meter panel)
② Steering wheel remote control switches (left side)
③ Multi-information display

TURNING THE FCM SYSTEM ON/OFF

Perform the following steps to turn the FCM system on or off.

1. Press the ◀ ▶ button until "Settings" appears in the multi-information display ③

and then push the scroll dial. Use the scroll dial to select "Driver Assistance." Then push the scroll dial.

2. Select "Emergency Brake" and push the scroll dial.
3. Select "Front" and use the scroll dial to turn the system on or off.

When the FCM system is turned off, the FCM system OFF warning light illuminates ①.

NOTE:

- **The FCM system will be automatically turned ON when the engine is restarted.**
- **The Predictive Forward Collision Warning (PFCW) system is integrated into the FCM system. There is not a separate selection in the display for the PFCW system. When the PFCW system is also turned off.**

FCM SYSTEM LIMITATIONS

⚠ WARNING

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

- **The FCM system cannot detect all vehicles or pedestrians under all conditions.**
- **The FCM system does not detect the following:**
  - **— Pedestrians that are small (for example, children), in a sitting position, operating toys/skateboards, on scooters or in wheelchairs, or not in an upright standing or walking position.**
  - **— Animals of any size.**
  - **— Obstacles (for example, cargo or debris) on the roadway or roadside.**
  - **— Oncoming or crossing vehicles.**
  - **— Vehicles where the tires are difficult to see or the shape of the rear of the vehicle is unclear or obstructed.**
  - **— Parked vehicles.**
- **The FCM system has some performance limitations.**
  - **— If a stationary vehicle is in the vehicle's path, the FCM system will not function when the vehicle is driven at speeds over approximately 50 MPH (80 km/h).**
  - **— For pedestrian detection, the FCM system will not function when the vehicle is driven at speeds over approximately 37 MPH (60 km/h) or below approximately 6 MPH (10 km/h).**
- **The FCM system may not function for pedestrians in darkness or in tunnels, even if there is street lighting in the area.**
- **For pedestrians, the FCM system will not issue the first warning.**
- **The FCM system may not function if the vehicle ahead is narrow (for example a motorcycle).**
- **The FCM system may not function if speed difference between the two vehicles is too small.**
- **The FCM system may not function properly or detect a vehicle or pedestrian ahead in the following conditions:**
  - **— Poor visibility (conditions such as rain, snow, fog, dust storms, sandstorms, and road spray from other vehicles)**
  - **— Driving on a steep downhill slope or roads with sharp curves.**
  - **— Driving on a bumpy road surface, such as an uneven dirt road.**
  - **— If dirt, ice, snow, fog or other material is covering the radar sensor area or camera area of**

the windshield.

— Interference by other radar sources.

— Strong light (for example, sunlight or high beams from oncoming vehicles) enters the front camera. Strong light causes the area around the pedestrian to be cast in a shadow, making it difficult to see.

— A sudden change in brightness occurs. (For example, when the vehicle enters or exits a tunnel or a shaded area or lightning flashes.)

— In dark or dimly lit conditions, such as at night or in tunnels, including cases where your vehicle's headlights are off or dim, or the tail lights of the vehicle ahead are off.

— When the direction of the camera is misaligned.

— When your vehicle's position or movement is changed quickly or significantly (for example, lane change, turning vehicle, abrupt steering, sudden acceleration or deceleration).

— When your vehicle or the vehicle or pedestrian ahead moves quickly or significantly such that the system cannot detect and react in time (for example, pedestrian moving quickly toward the vehicle at close range, vehicle cutting in, changing lanes, making a turn, steering abruptly, sudden acceleration or deceleration).

— When the vehicle or pedestrian is offset from the vehicle's forward path.

— If the speed difference between the two vehicles is small.

— The poor contrast of a person to the background, such as having clothing color or pattern which is similar to the background.

— The pedestrian's profile is partially obscured or unidentifiable due to the pedestrian transporting cargo, wearing bulky or very loose-fitting clothing or accessories.

— For approximately 15 seconds after starting the engine

— If the vehicle ahead has a unique or unusual shape, extremely low or high clearance heights, or unusual cargo loading or is narrow (for example, a motorcycle).

— When the vehicle or pedestrian is located near a traffic sign, a reflective area (for example, water on road), or is in a shadow.

— When multiple pedestrians are grouped together.

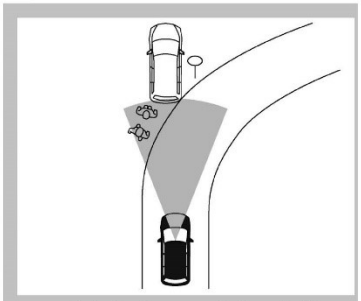
— When the view of the pedestrian is obscured by a vehicle or other object.

— While towing a trailer or other vehicle.

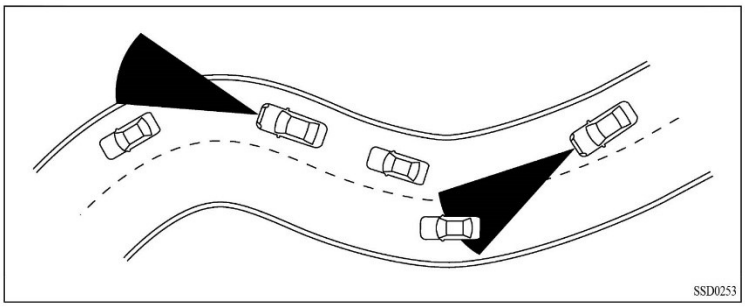
- The system performance may degrade in the following conditions:
  - — The vehicle is driven on a slippery road.
  - — The vehicle is driven on a slope.
  - — Excessively heavy baggage is loaded in the rear seat or the cargo area of your vehicle.
- The system is designed to automatically check the sensor (radar and camera)'s functionality, within certain limitations. The system may not detect blockage of

sensor areas covered by ice, snow or stickers, for example. In these cases, the system may not be able to warn the driver properly. Be sure that you check, clean and clear sensor areas regularly.

- In some road and traffic conditions, the FCM system may unexpectedly apply partial braking. When acceleration is necessary, depress the accelerator pedal to override the system.
- The FCM system may operate when a pattern, object, shadow or lights are detected that are similar to the outline of vehicles or pedestrians, or if they are the same size and position as a vehicle or motorcycle's tail lights.
- The system may keep operating when the vehicle ahead is turning right or left.
- The system may operate when your vehicle is approaching and passing a vehicle ahead.
- Depending on the road shape (curved road, entrance and exit of the curve, winding road, lane regulation, under construction, etc.), the system may operate temporarily for the oncoming vehicle in front of your vehicle.
- The FCM system may react to:
  - — objects on the roadside (traffic sign, guardrail, pedestrian, cyclist, motorcycle, vehicle, etc.)



  - — objects above road (low bridge, traffic sign, etc.)
  - — objects on the road surface (railroad track, grate, steel plate, etc.)
  - — objects in the parking garage (beam, pillar, etc.)
  - — pedestrians, cyclists or motorcycles approaching the traveling lane
  - — vehicles, pedestrians, cyclists, motorcycles or objects in adjacent lane or close to the vehicle
  - — oncoming pedestrians
  - — cyclists
  - — objects on the road (such as trees)
- Braking distances increase on slippery surfaces.
- Do not use the FCM system if you are towing a trailer. The system may not detect a vehicle ahead.
- Do not use the FCM system when driving with a tire that is not within normal tire conditions (for example, tire wear, low tire pressure, installation of tire chains, non-standard wheels).
- Excessive noise will interfere with the warning chime sound, and the chime may not be heard.


SSD0253

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

The detection of vehicles may also be affected by vehicle operation (steering maneuver or traveling position in the lane, etc.) or vehicle condition. **If this occurs, the system may warn you by blinking the system indicator and sounding the chime unexpectedly. You will have to manually control the proper distance away from the vehicle traveling ahead.**

SYSTEM TEMPORARILY UNAVAILABLE

Condition A

If the following conditions, the FCM system OFF warning light will blink (no message appears in the multi-information display).

- Strong light is shining from the front of the vehicle.
- The cabin temperature is over approximately 104°F (40°C) in direct sunlight.
- The camera area of the windshield is misted or frozen.
- The camera unit detects it's misalignment condition.
- The radar sensor picks up interference from an another radar source.

Action to take:

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

NOTE:

When the inside of the windshield on camera area is misted or frozen, it will take a period of time to remove it after air conditioner turns on. If dirt appears on this area, it is recommended you visit an authorized Mitsubishi Motors dealer.

Condition B

In the following condition, the FCM system OFF warning light will flash and the "Forward Driving Aids temporarily disabled Front Sensor blocked" warning message will appear in the multi-information display.

- The sensor area of the front of the vehicle is covered with dirt or is obstructed

Action to take:

If the warning light flashes, stop the vehicle in a safe place and turn the engine off. Clean the radar cover on the front of the vehicle with a soft cloth, and restart the engine. If the warning message continues to illuminate, check that the cover of the sensor is not covered by dirt, snow

or ice. If the warning light is still illuminated, have the FCM system checked. It is recommended that you visit an authorized Mitsubishi Motors dealer for this service.

- When driving on roads with limited road structures or buildings (for example, long bridges, deserts, snow fields, driving next to long walls).

Action to take:

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

Condition C

When the Active stability control (ASC) is OFF, the FCM brake will not operate. In this case only visible and audible warning operates. The FCM system warning light (orange) will illuminate.

Action to take:

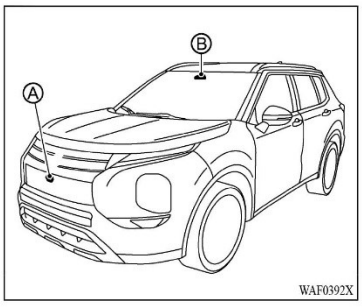
When the ASC is ON, the FCM system will resume automatically.

SYSTEM MALFUNCTION

If the FCM system malfunctions, it will be turned off automatically, a chime will sound, the FCM system warning light will (orange) will illuminate and the warning message "Malfunction" will appear in the multi-information display.

Action to take:

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



SYSTEM MAINTENANCE

The radar sensor Ⓐ is located on the front of the vehicle. The camera Ⓑ is located on the upper side of the windshield.

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

- Always keep the sensor area on the front of the vehicle and windshield clean.
- Do not strike or damage the areas around the sensors (ex. vehicle front area, windshield).
- Do not cover or attach stickers or similar objects on the front of the vehicle near the sensor area. This could cause failure or malfunction.

- Do not attach metallic objects near the radar sensor area (brush guard, etc.). This could cause failure or malfunction.
- Do not place reflective materials, such as white paper or a mirror, on the instrument panel. The reflection of sunlight may adversely affect the camera unit's detection capability.
- Do not alter, remove or paint the front of the vehicle near the sensor area. Before customizing or restoring the sensor area, it is recommended that you visit an authorized Mitsubishi Motors dealer.

Radio frequency statement

For USA

Type approval number:

FCC ID: NF3–FR5CPEC

User Manual statement according to §15.19:

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

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

User Manual statement according to §15.21:

Changes or modifications made to this equipment not expressly approved by Robert BOSCH GmbH may void the FCC authorization to operate this equipment.

User Manual statement according to §15.105:

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

RF Exposure Information according 2.1091/2.1093/OET bulletin 65:

Radiofrequency radiation exposure information:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

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

For Canada

Type approval number:

IC: 3387A-FR5CPEC

Legal warning for RF equipment:

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

APPENDIX C

Run Log

Subject Vehicle: **2022 Mitsubishi Outlander SE 2.5S-AWC** Test start date: **1/5/2021**

Principal Other Vehicle: **SSV** Test end date: **1/5/2021**

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Pass/Fail	Notes
1	Static Run								
2	**Stopped POV**	Y	2.11	1.30	25.3	1.10	1.18	Pass	
3		Y	2.09	2.62	25.0	1.10	1.31	Pass	
4		Y	2.09	2.97	25.1	1.02	1.27	Pass	
5		Y	2.15	2.50	25.2	1.21	1.40	Pass	
6		Y	2.13	1.88	25.2	1.06	1.29	Pass	
7		Y	2.14	3.23	25.5	1.00	1.44	Pass	
8		Y	2.08	3.12	25.3	1.16	1.40	Pass	
9	Static Run								
10	**Slower POV, 25 vs 10**	Y	1.88	5.03	16.1	1.03	1.11	Pass	
11		Y	1.84	5.27	15.3	1.02	1.09	Pass	
12		Y	1.81	5.71	14.7	1.07	1.03	Pass	
13		Y	1.83	4.81	15.5	1.02	1.11	Pass	
14		Y	1.77	5.51	14.6	1.09	1.08	Pass	
15		Y	1.84	4.90	15.0	1.08	1.09	Pass	
16		Y	1.82	4.99	15.5	1.04	1.09	Pass	
17	Static Run								
18	**Slower POV, 45 vs 20**	Y	2.60	4.68	24.5	1.00	1.39	Pass	
19		Y	2.55	4.92	25.1	1.03	1.36	Pass	
20		Y	2.56	3.84	24.6	1.04	1.31	Pass	

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Pass/Fail	Notes
21	**Slower POV, 45 vs 20**	Y	2.62	2.47	25.4	1.02	1.43	Pass	
22		Y	2.65	7.14	24.9	1.04	1.22	Pass	
23		Y	2.58	5.19	25.4	1.02	1.44	Pass	
24		Y	2.64	5.83	25.1	1.06	1.37	Pass	
25	Static run								
26	**Decelerating POV, 35**	Y	1.72	0.91	25.0	1.06	1.19	Pass	
27		Y	1.66	1.17	24.5	1.11	1.18	Pass	
28		Y	1.68	1.91	24.0	1.03	1.13	Pass	
29		Y	1.54	3.66	22.1	1.02	1.07	Pass	
30		N							Yaw rate
31		Y	1.65	1.34	23.9	1.05	1.18	Pass	
32		Y	1.61	0.00	28.1	1.07	1.12	Pass	
33		N							POV brakes
34		Y	1.79	0.00	31.6	1.06	1.30	Pass	
35	Static Run								
36	STP - Static Run								
37	**STP False Positive, 25**	Y				0.00		Pass	
38		Y				0.01		Pass	
39		Y				0.03		Pass	
40		Y				0.01		Pass	
41		Y				0.00		Pass	
42		Y				0.01		Pass	
43		Y				0.01		Pass	
44	STP - Static Run								

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Pass/Fail	Notes
45	**STP False Positive, 45**	Y				0.00		Pass	
46		Y				0.02		Pass	
47		Y				0.02		Pass	
48		Y				0.01		Pass	
49		Y				0.02		Pass	
50		Y				0.02		Pass	
51		Y				0.02		Pass	
52	STP - Static Run								

APPENDIX D

Time History Plots

LIST OF FIGURES

Description of Time History Plots

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

Time History Plot Description

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

- Stopped POV (SV at 25 mph)
- Slower POV, 25/10 (SV at 25 mph, POV at 10 mph)
- Slower POV, 45/20 (SV at 45 mph, POV at 20 mph)
- Decelerating POV 35 mph (Both vehicles at 35 mph with 13.8 m gap, POV brakes at 0.3 g)
- False Positive STP 25 mph (Steel trench plate run over at 25 mph)
- False Positive STP 45 mph (Steel trench plate run over at 45 mph)

Time history figures include the following sub-plots:

- FCW Warning – Displays the Forward Collision Warning alert (which can be auditory, 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 auditory or haptic alert is perceptible by the driver during a test run, the earliest of either of these alerts is used to define the onset of the FCW alert. A vertical black bar on the plot indicates the TTC (sec) at the first moment of the warning issued by the FCW system. The FCW TTC is displayed to the right of the subplot in green. For False Positive tests, when the FCW presents a warning “FCW” is shown in red at the right edge of the FCW plot.

- Headway (ft) – Longitudinal separation (gap) between the frontmost point of the Subject Vehicle and the rearmost point of the Strikeable Surrogate Vehicle (SSV) towed by the Principal Other Vehicle. The minimum headway during the run is displayed to the right of the subplot.

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

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

- Lateral Offset (ft) – Lateral offset within the lane of the Subject Vehicle to the center of the lane of travel. Note that for tests involving the Strikeable Surrogate Vehicle (SSV), the associated lateral restraint track is defined to be the center of the lane of travel. If testing is done with a different POV which does not have a lateral restraint track, lateral offset is defined to be the lateral offset between the SV and POV.

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

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

Envelopes and Thresholds

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

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

For plots with yellow envelopes, in order for the test to be valid, the time-varying data must not exceed the envelope at the beginning (left edge of the boundary) and/or end (right edge), but may exceed the boundary during the time

between the left and right edges. Exceedances at the left or right extent of a yellow envelope are indicated by red asterisks.

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

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

For the accelerator pedal position plot, a green envelope is given starting 500 ms after the onset of the FCW warning to ensure that the accelerator pedal was released at the correct time and remained off for the duration of the CIB event. For false positive runs a green dot, rather than a green envelope is displayed. The green dot indicates that at the end of the run the accelerator pedal had not been released. If the accelerator had been released a red asterisk would appear.

Color Codes

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

Color codes can be broken into four categories:

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

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

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

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

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

Other Notations

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

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

Examples of time history plots for each test type (including passing, failing and invalid runs) are shown in Figure D1 through Figure D9. Figures D1 through D6 show passing runs for each of the 6 test types. Figures D7 and D8 show examples of invalid runs. Figure D9 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 D10.

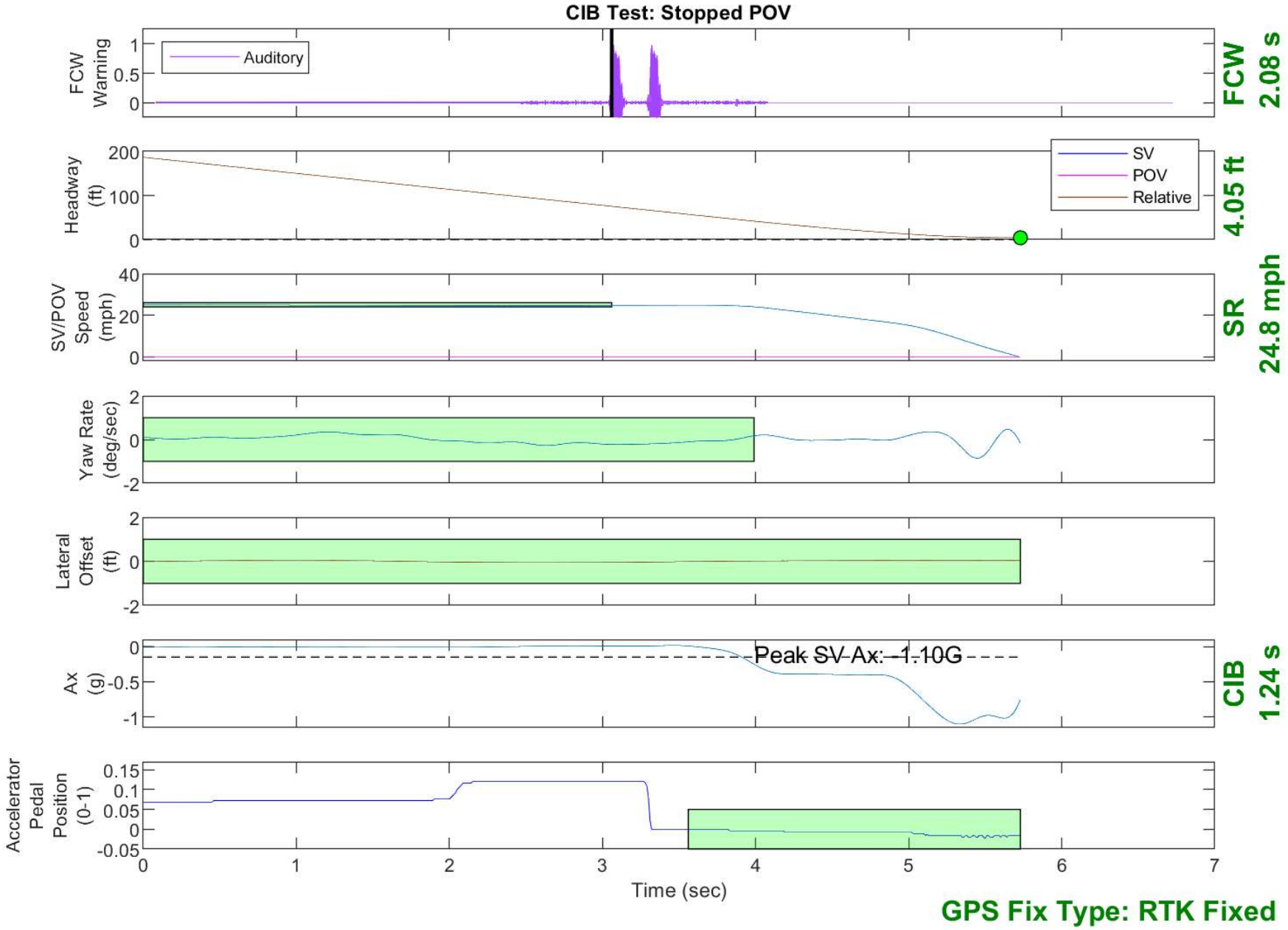


Figure D1. Example Time History for Stopped POV, Passing

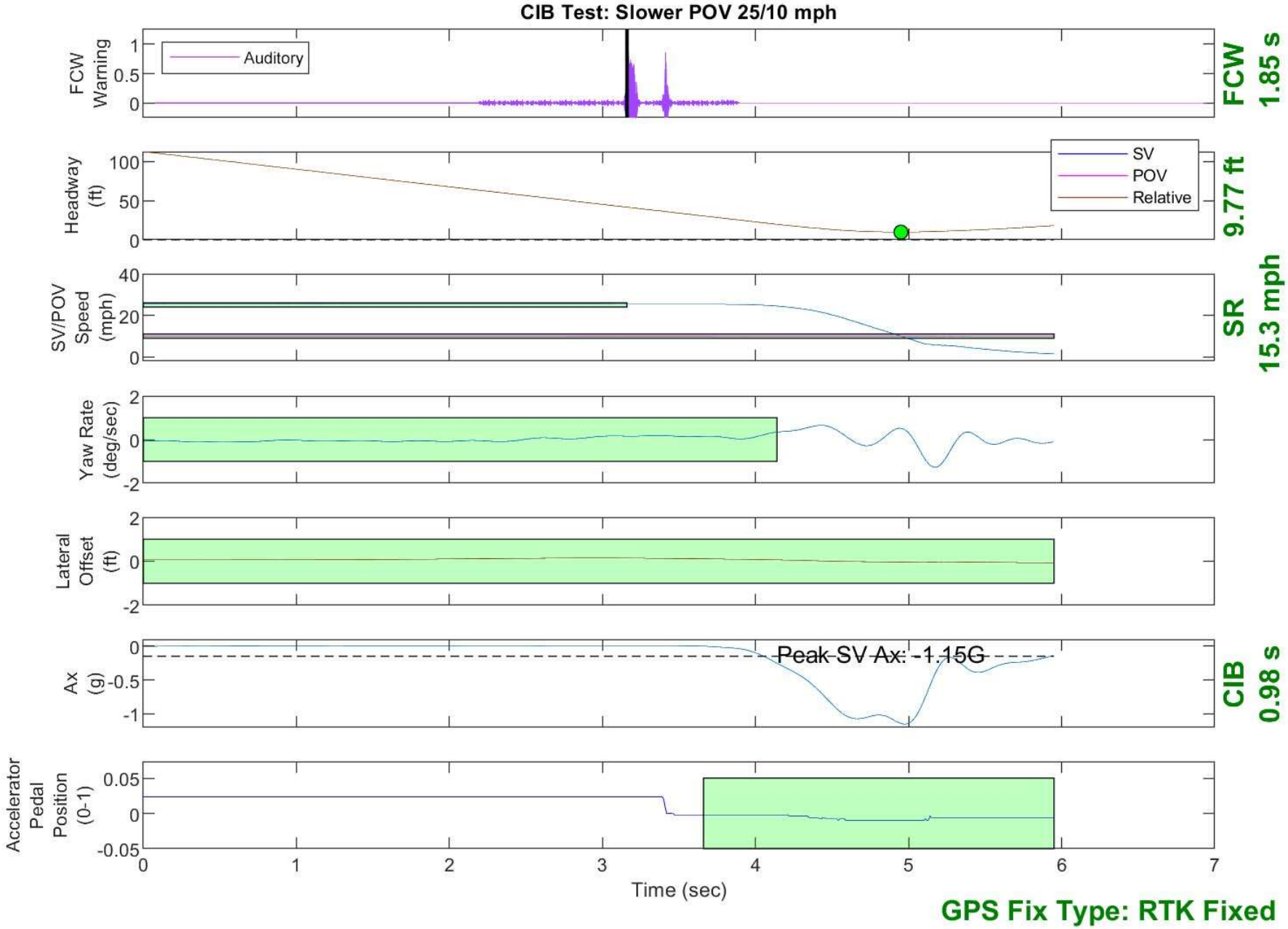


Figure D2. Example Time History for Slower POV 25 vs. 10, Passing

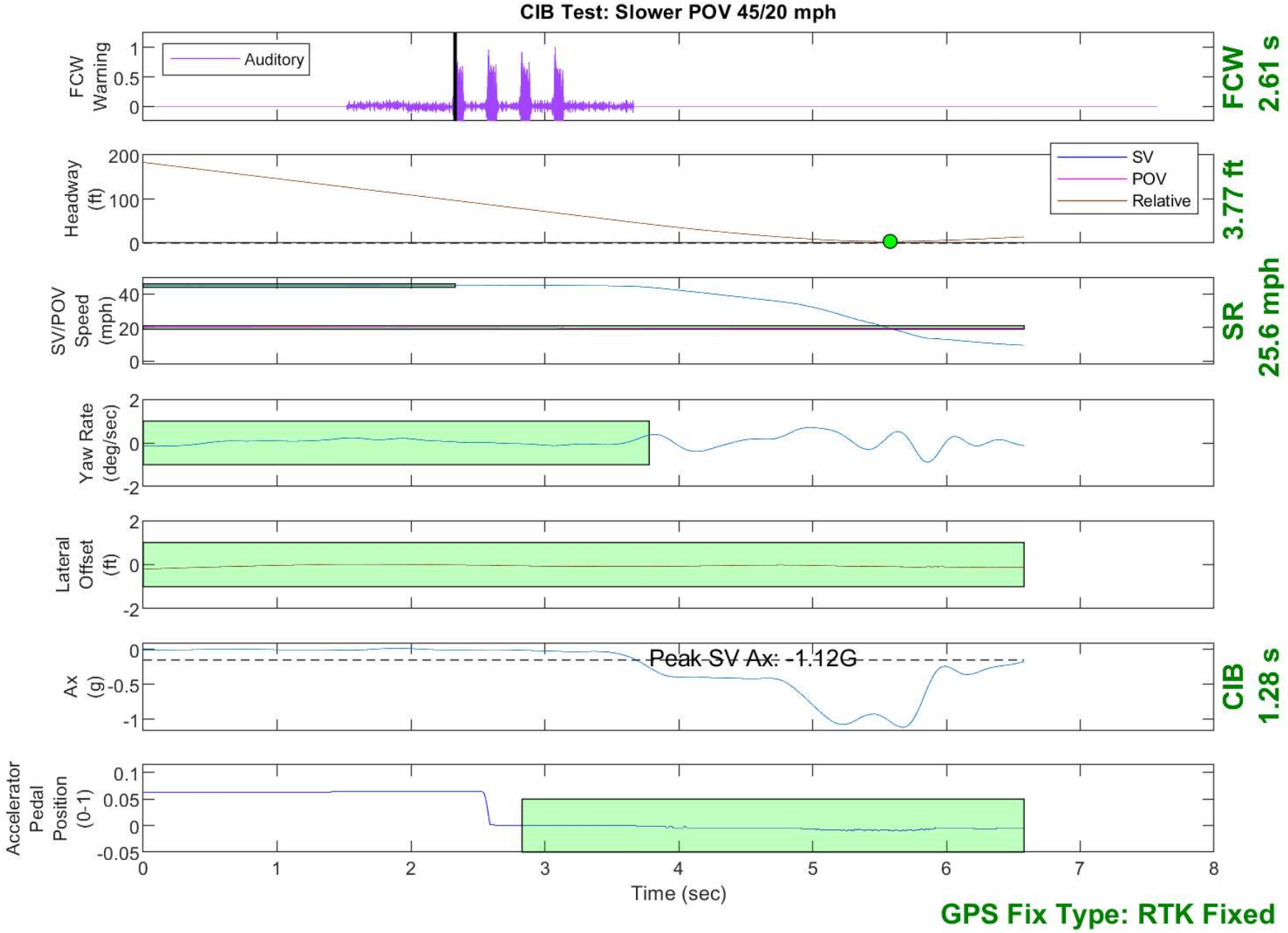


Figure D3. Example Time History for Slower POV 45 vs. 20, Passing

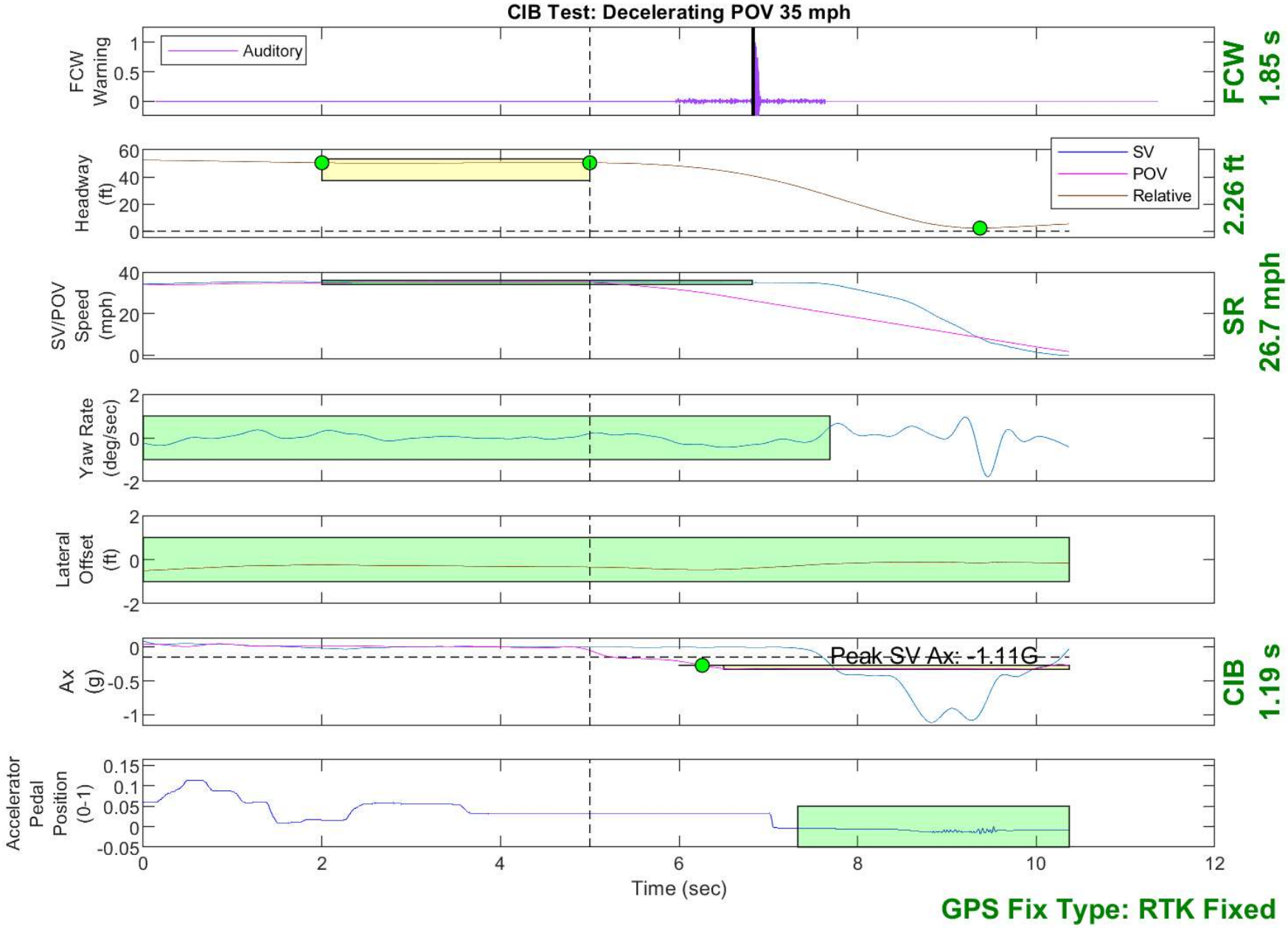


Figure D4. Example Time History for Decelerating POV 35, Passing

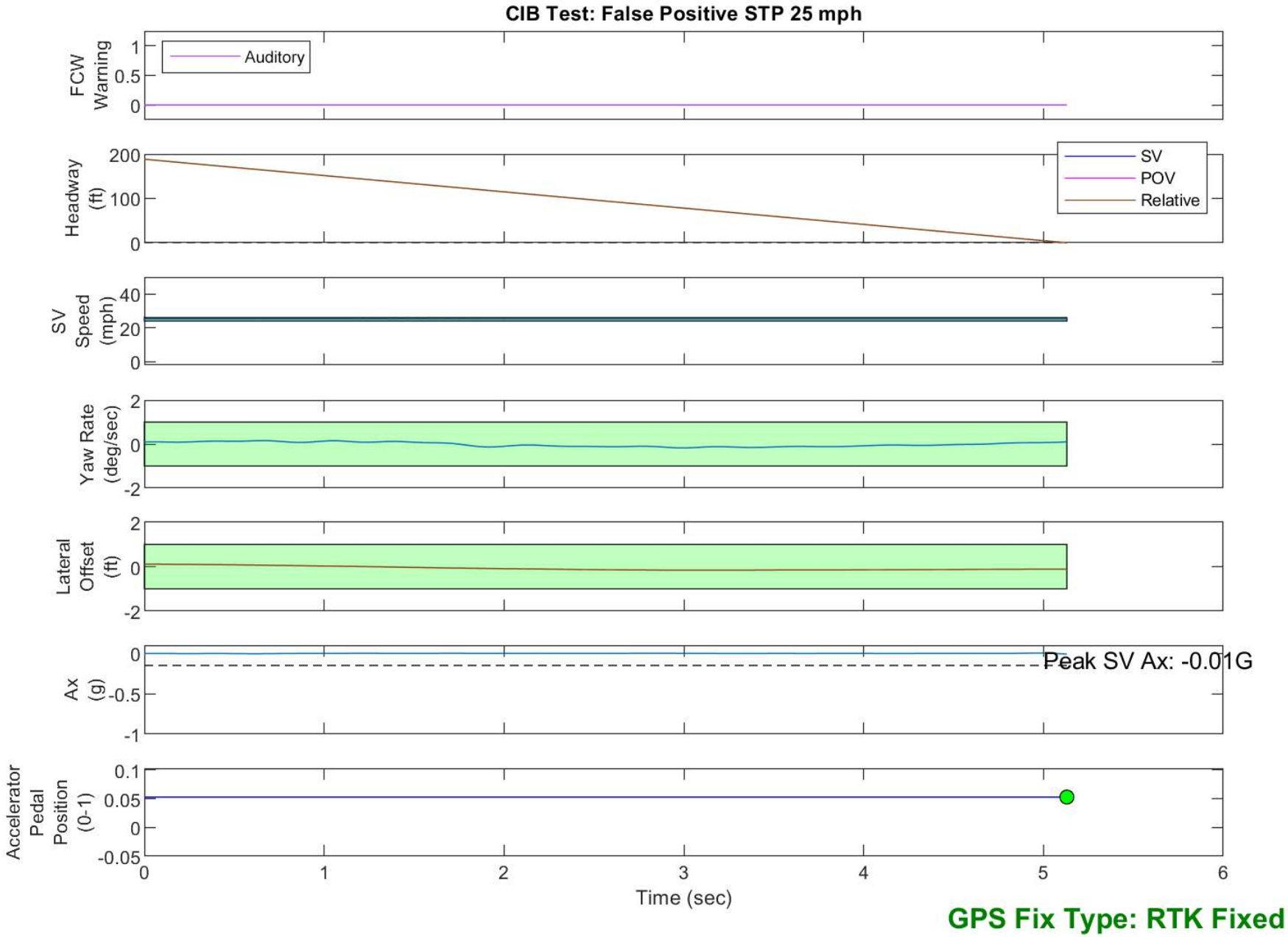


Figure D5. Example Time History for False Positive STP 25, Passing

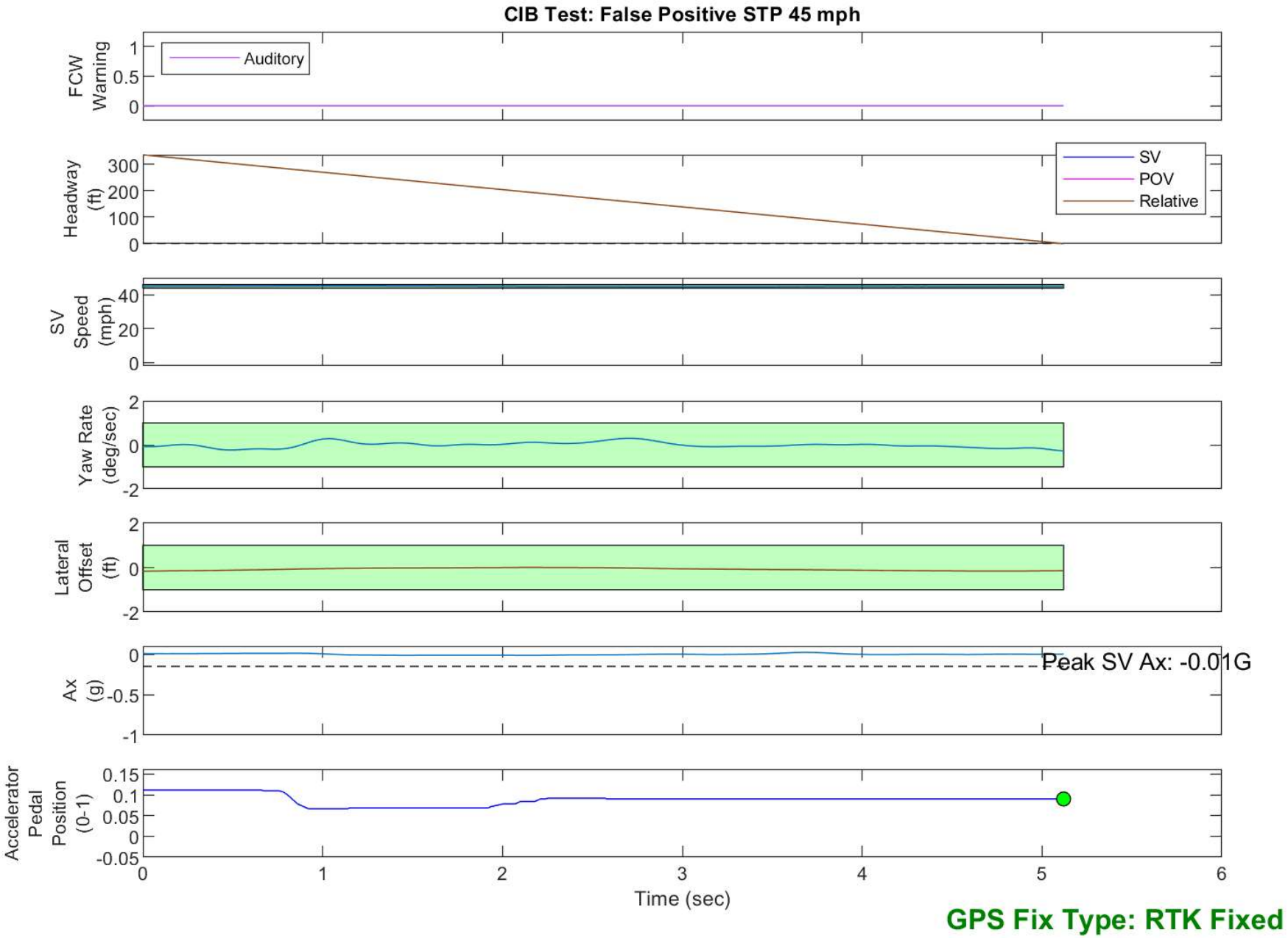


Figure D6. Example Time History for False Positive STP 45, Passing

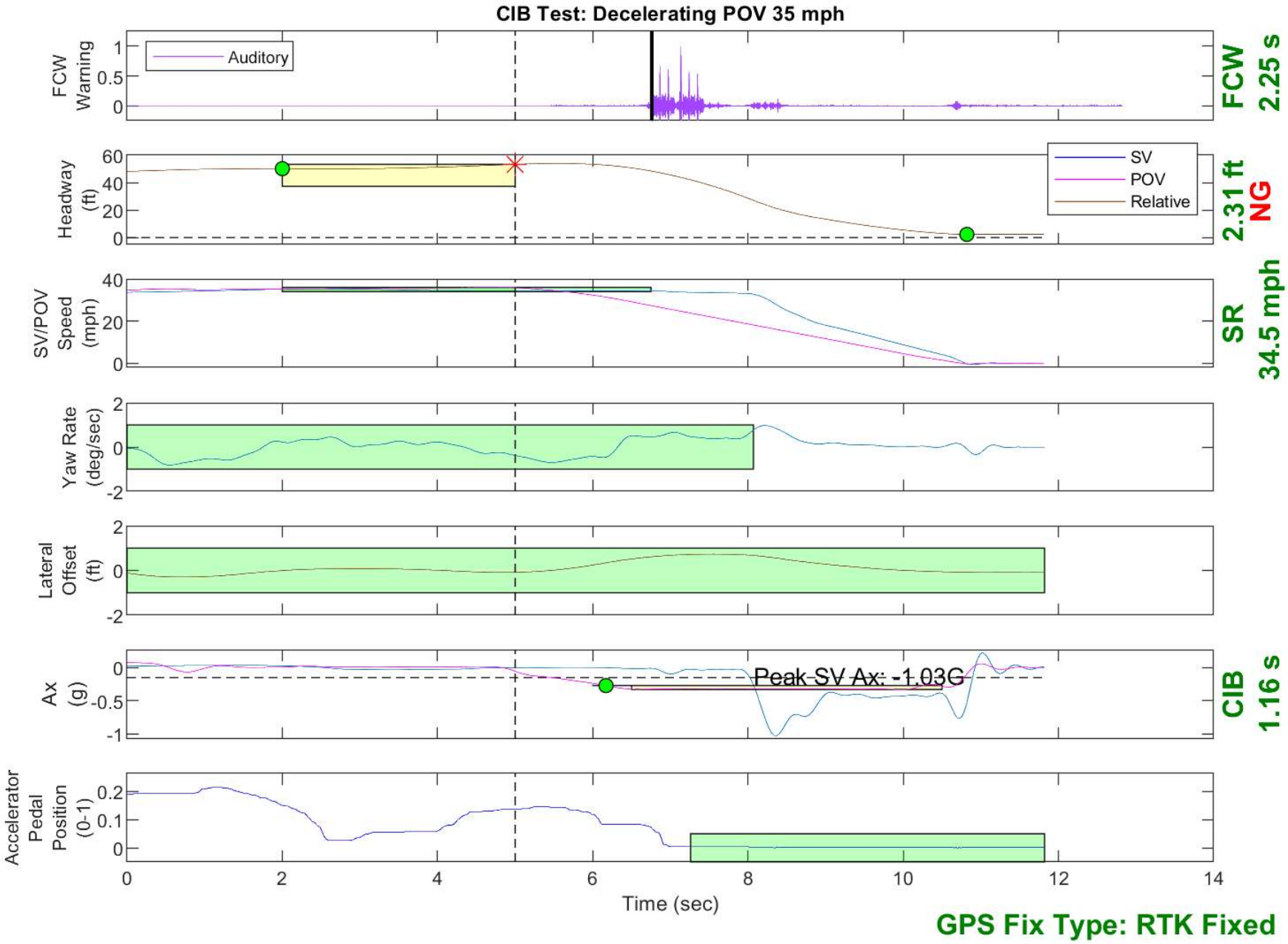


Figure D7. Example Time History Displaying Invalid Headway Criteria

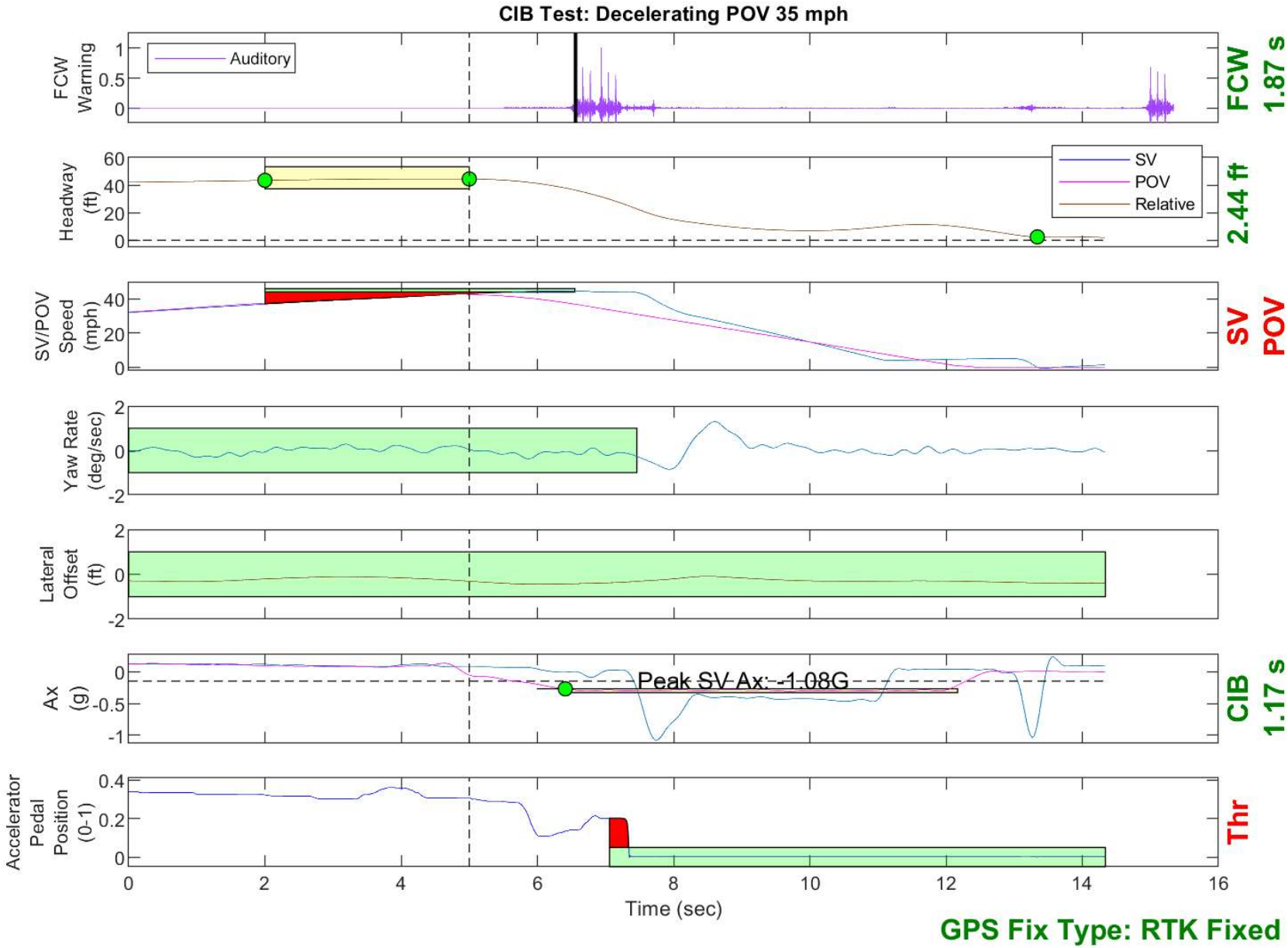


Figure D8. Example Time History Displaying Various Invalid Criteria

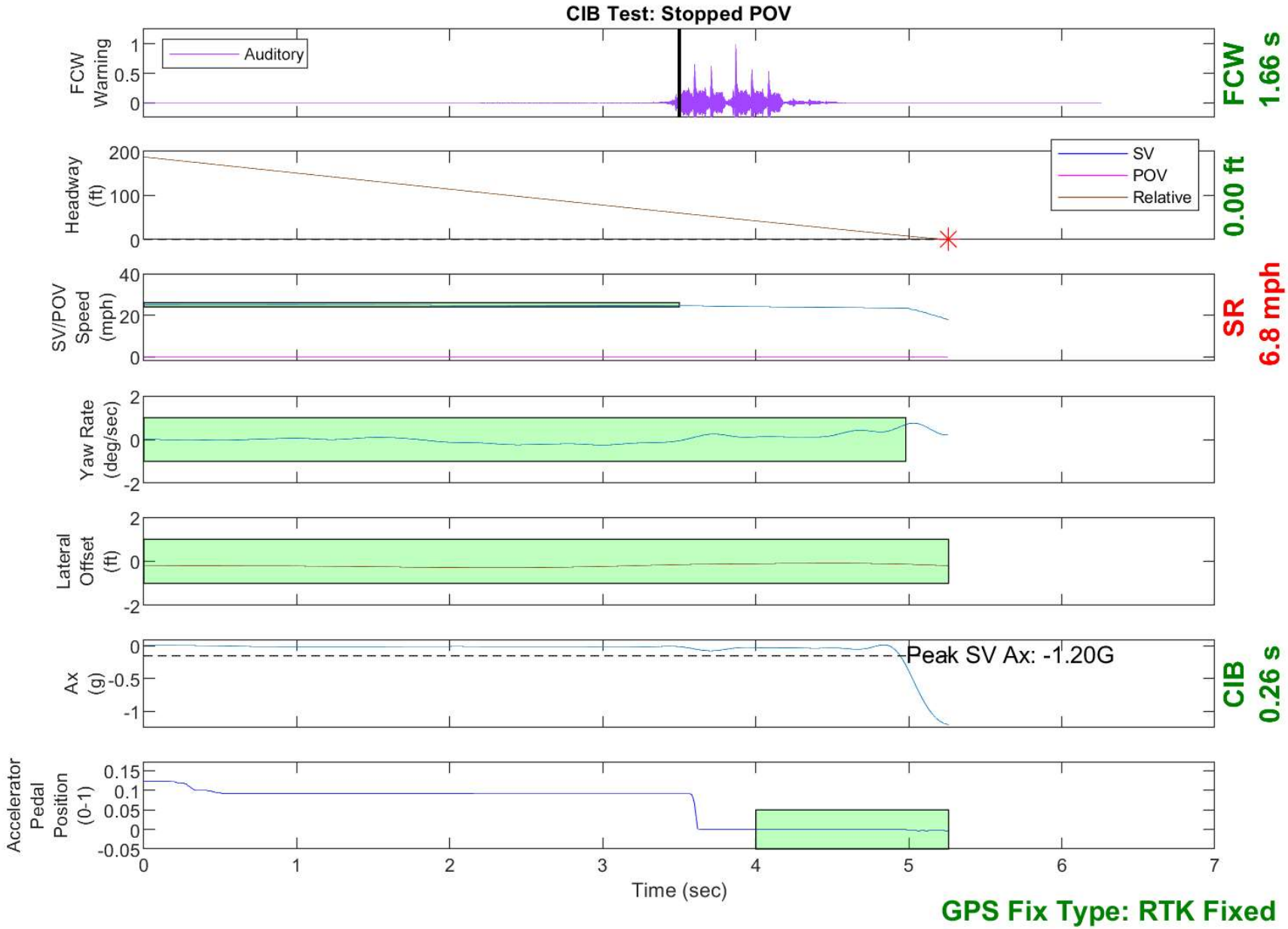


Figure D9. Example Time History for a Failed Run

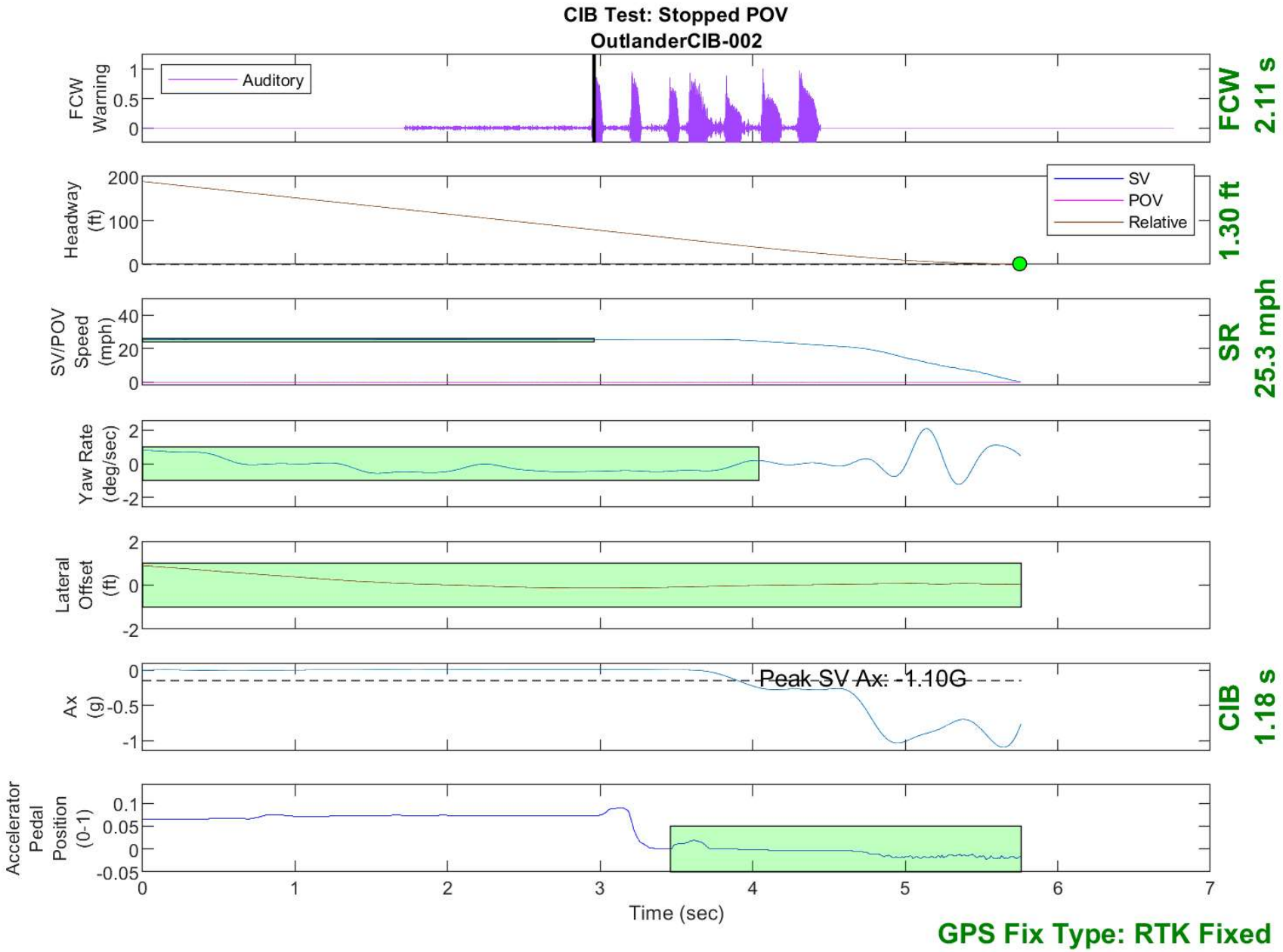


Figure D10. Time History for CIB Run 2, SV Encounters Stopped POV

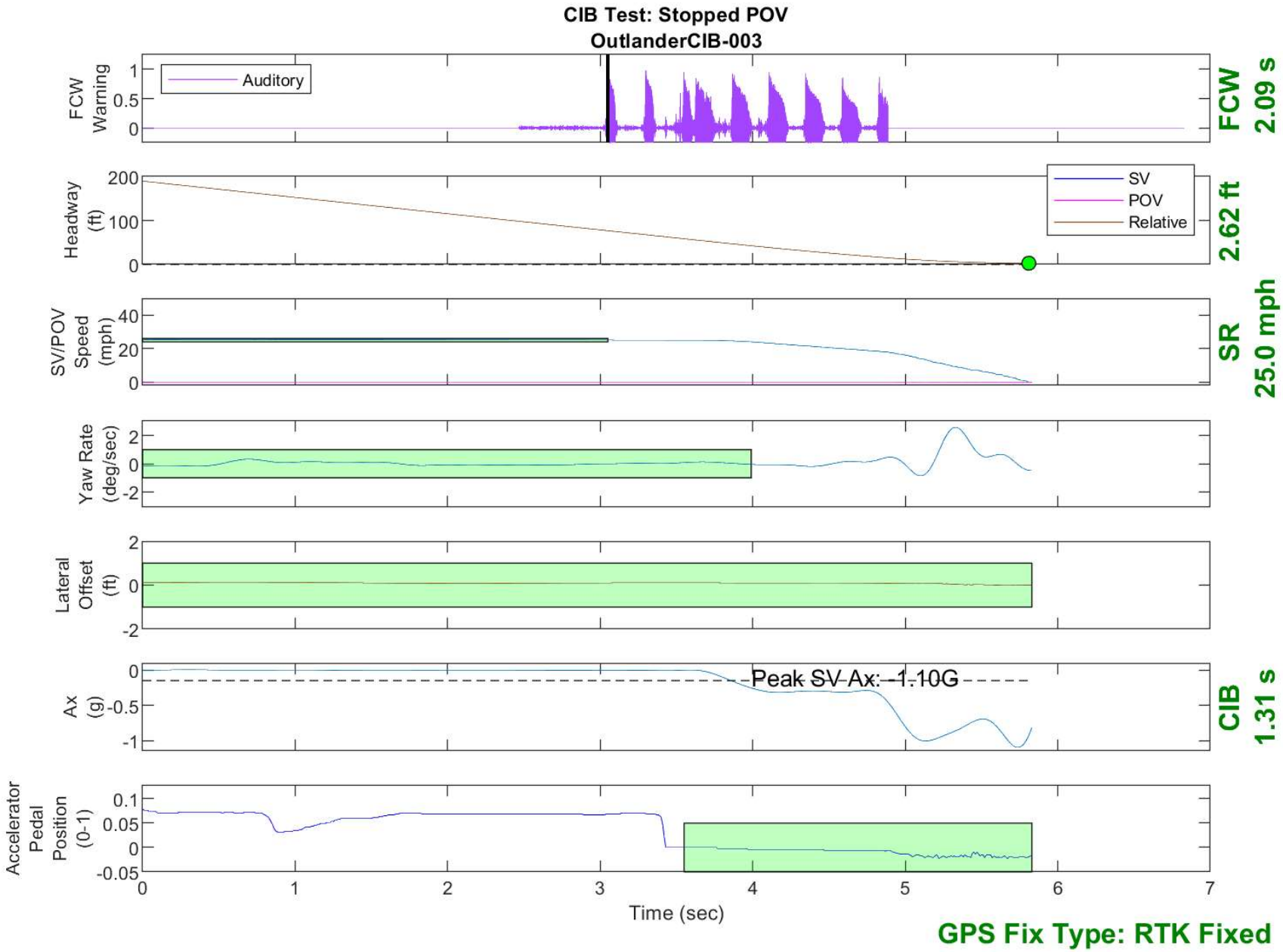


Figure D11. Time History for CIB Run 3, SV Encounters Stopped POV

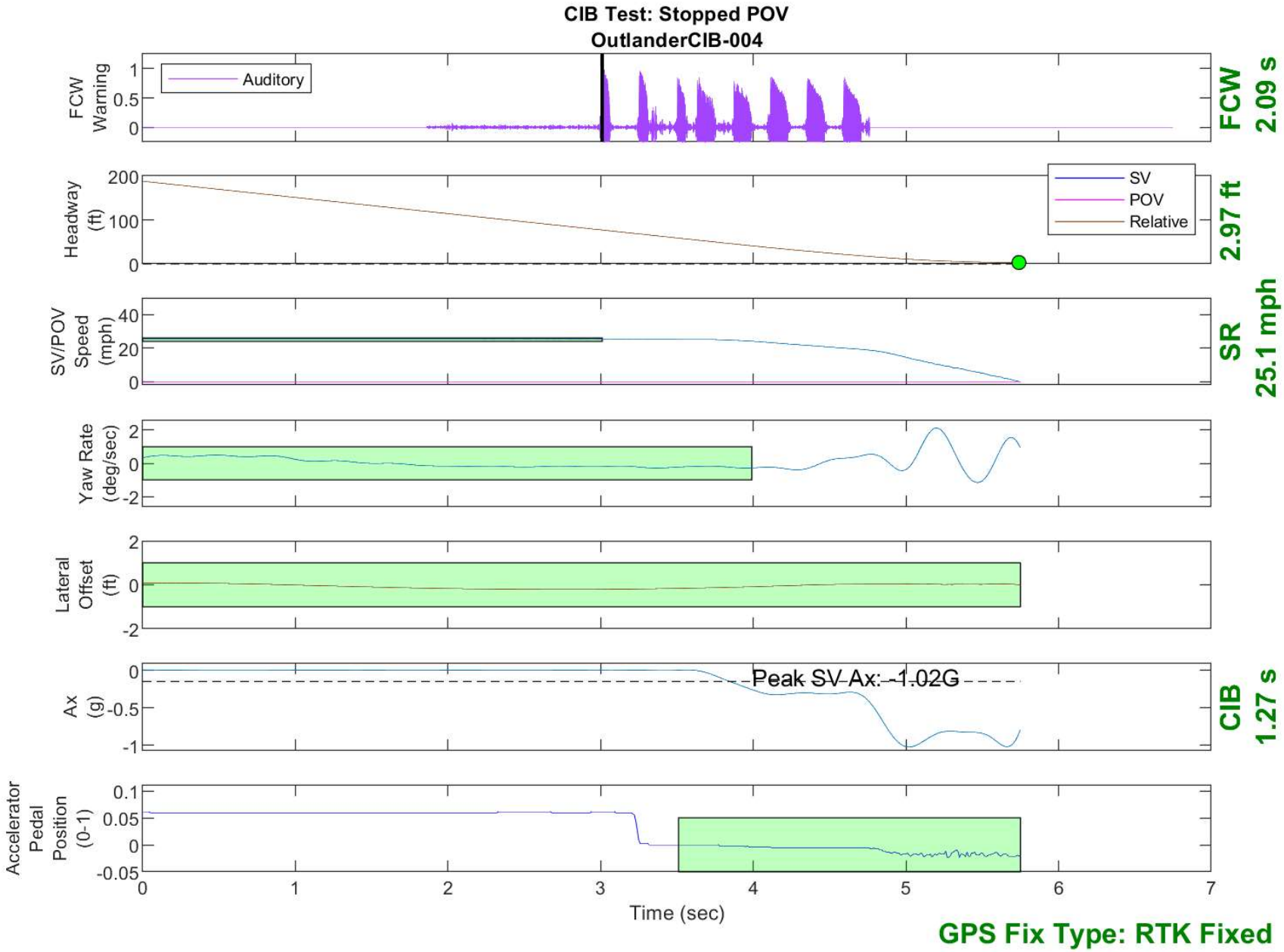


Figure D12. Time History for CIB Run 4, SV Encounters Stopped POV

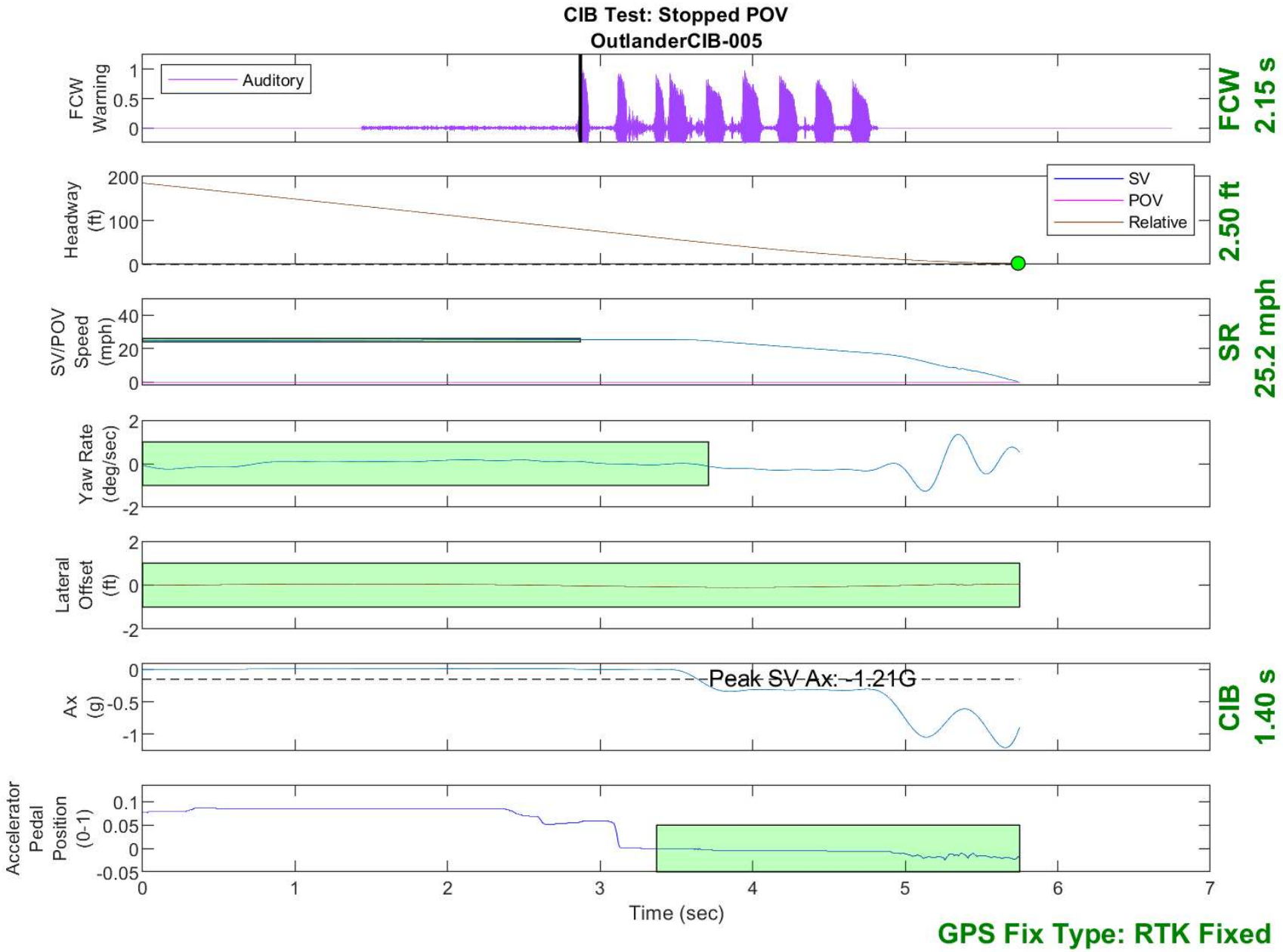


Figure D13. Time History for CIB Run 5, SV Encounters Stopped POV

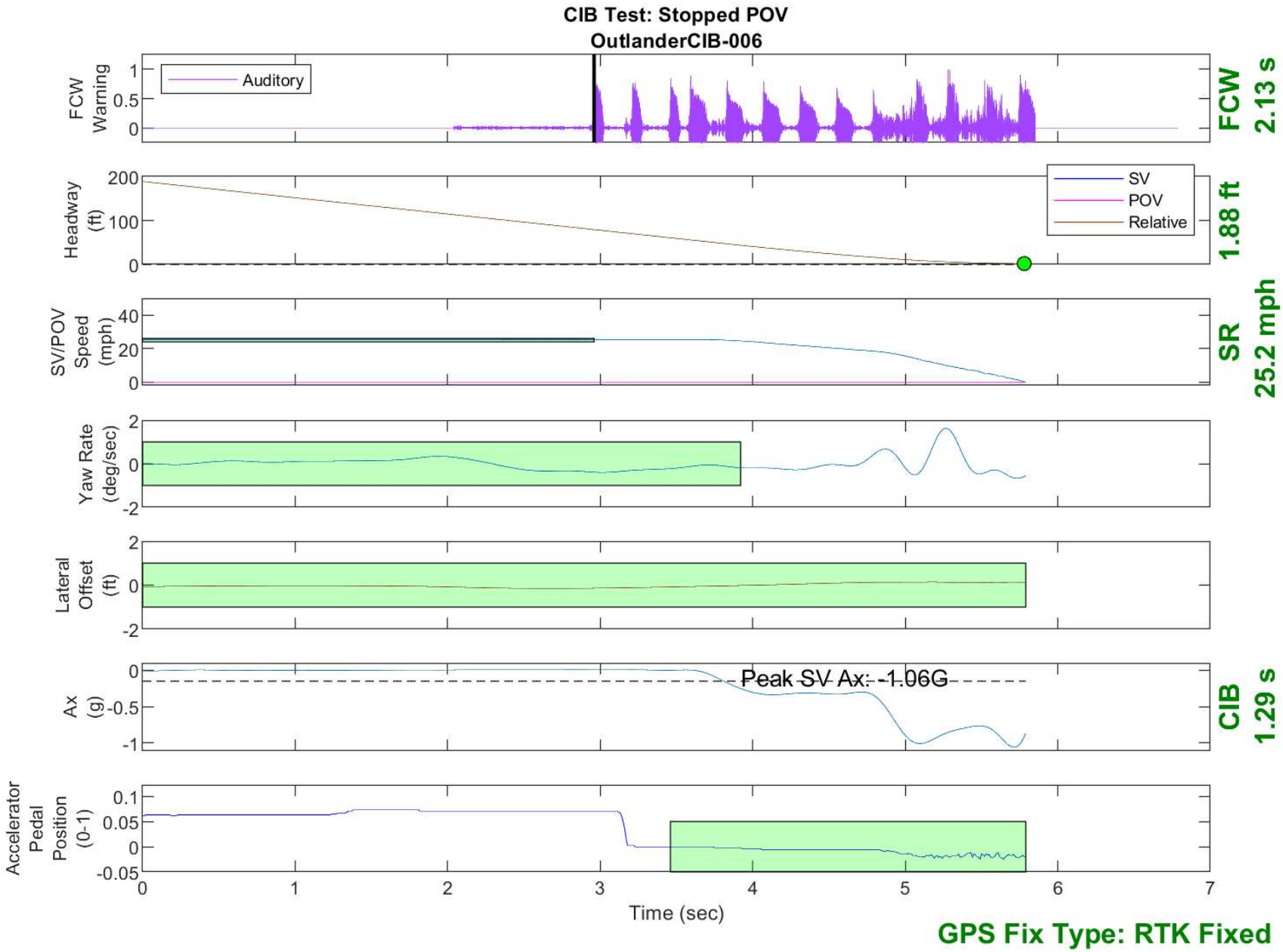


Figure D14. Time History for CIB Run 6, SV Encounters Stopped POV

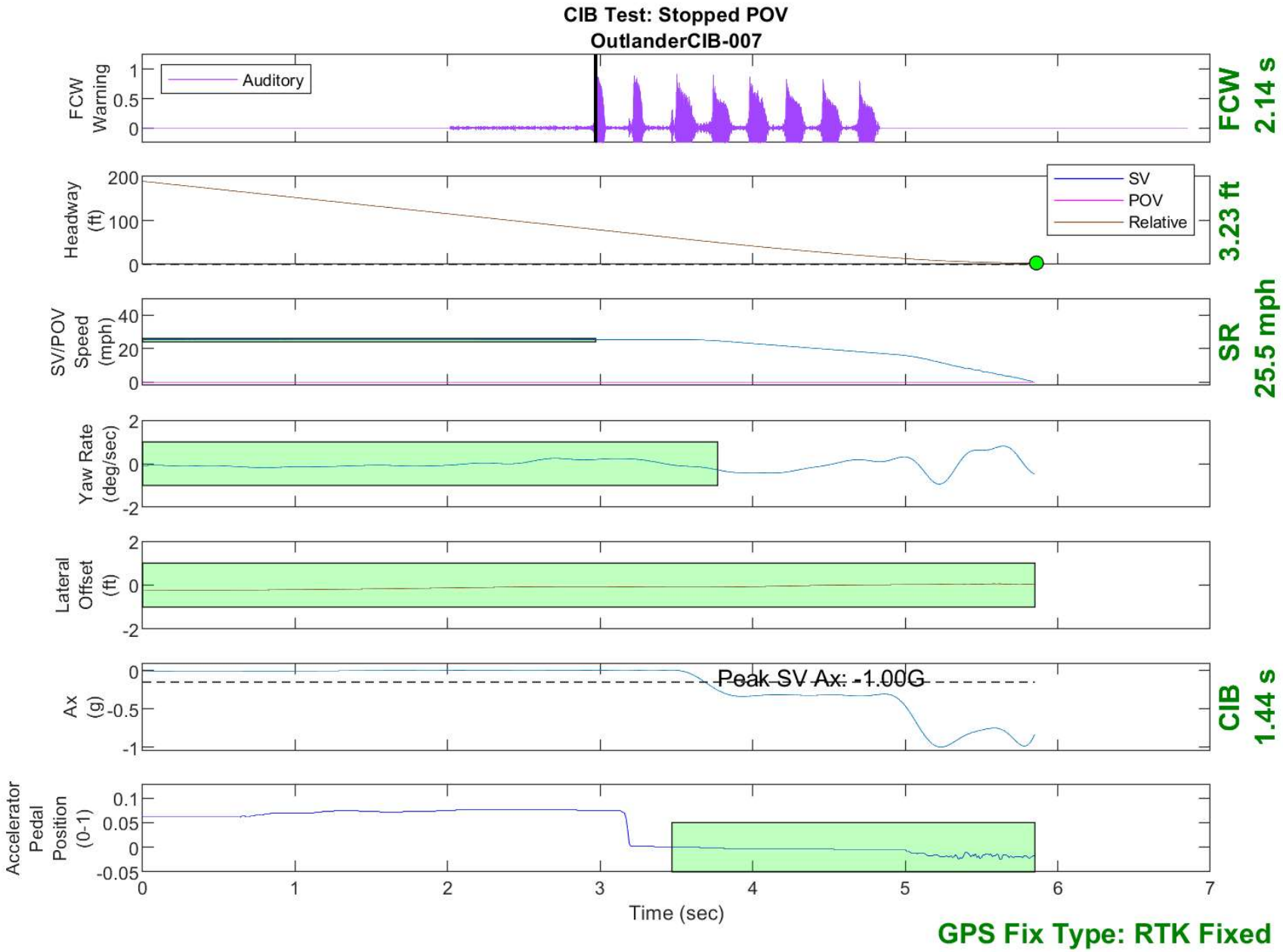


Figure D15. Time History for CIB Run 7, SV Encounters Stopped POV

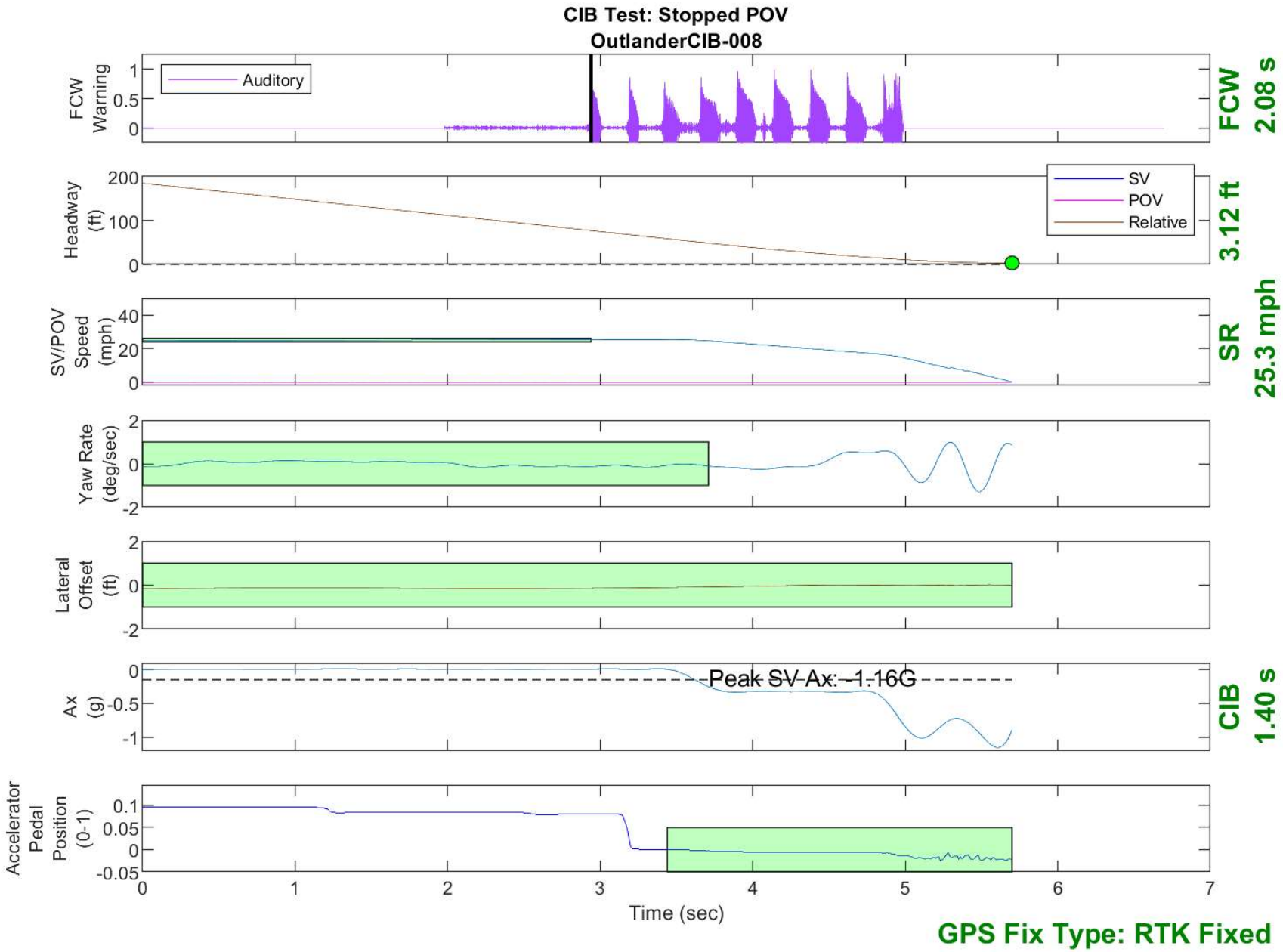


Figure D16. Time History for CIB Run 8, SV Encounters Stopped POV

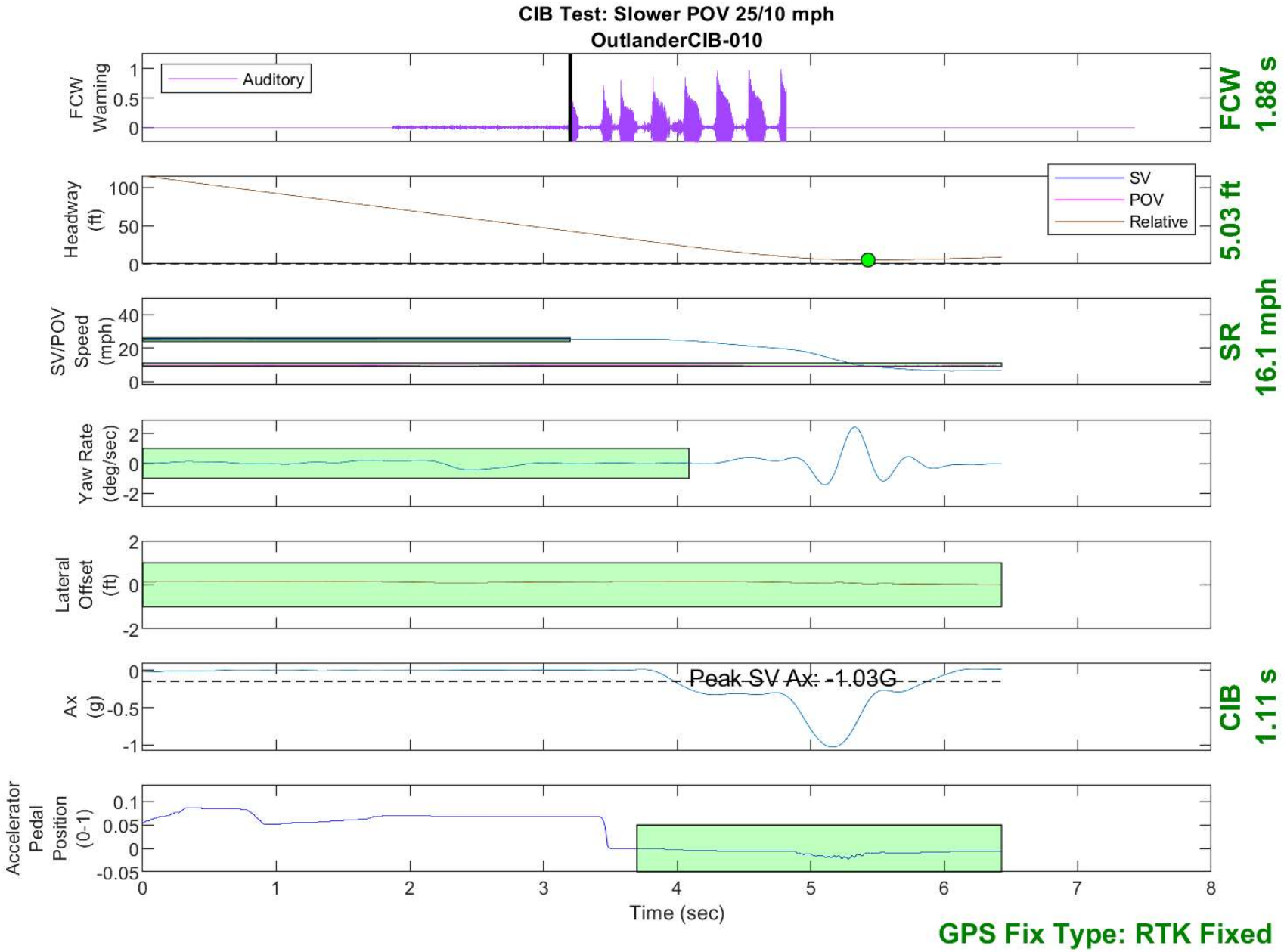


Figure D17. Time History for CIB Run 10, SV Encounters Slower POV, SV 25 mph, POV 10 mph

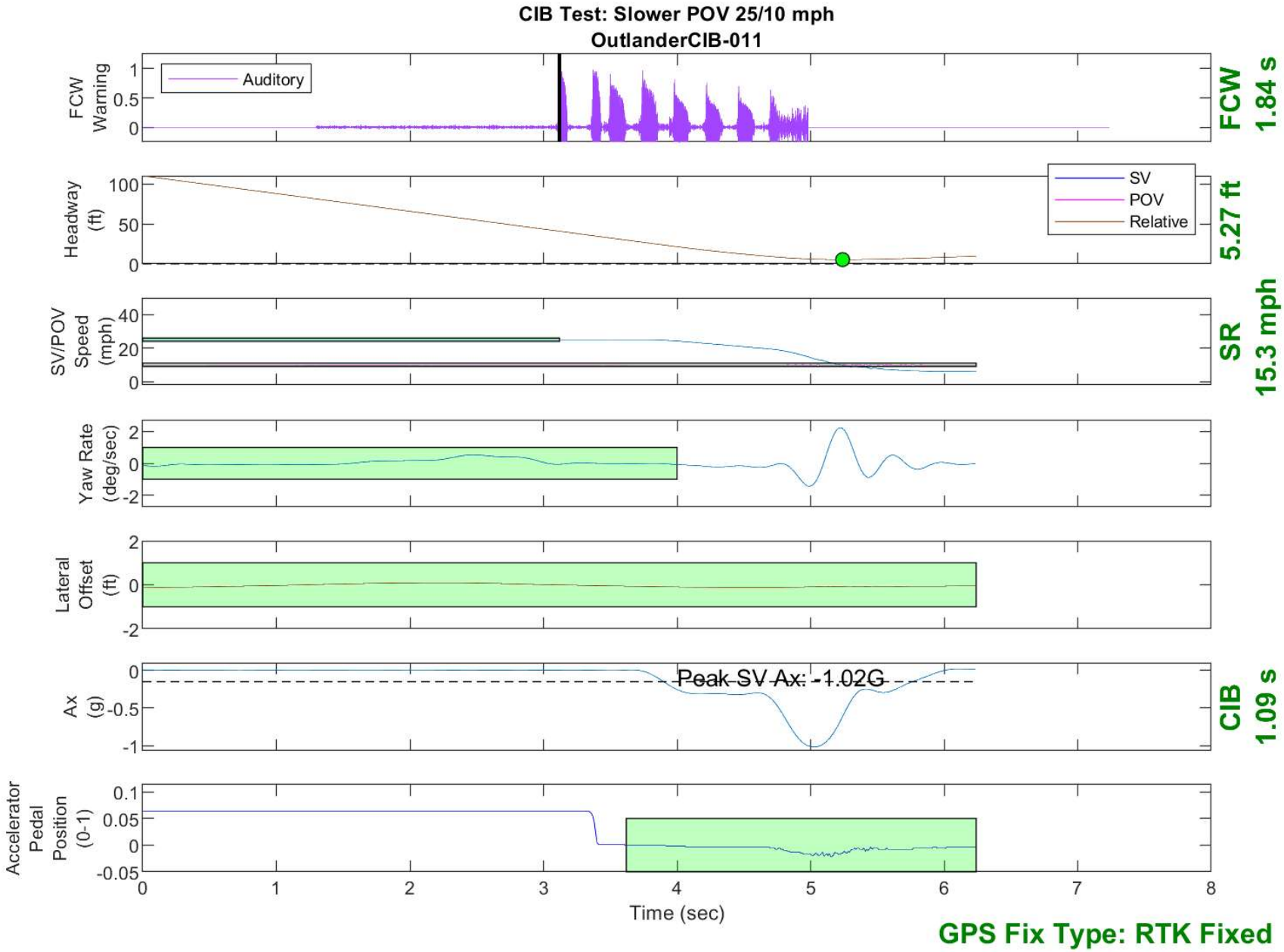


Figure D18. Time History for CIB Run 11, SV Encounters Slower POV, SV 25 mph, POV 10 mph

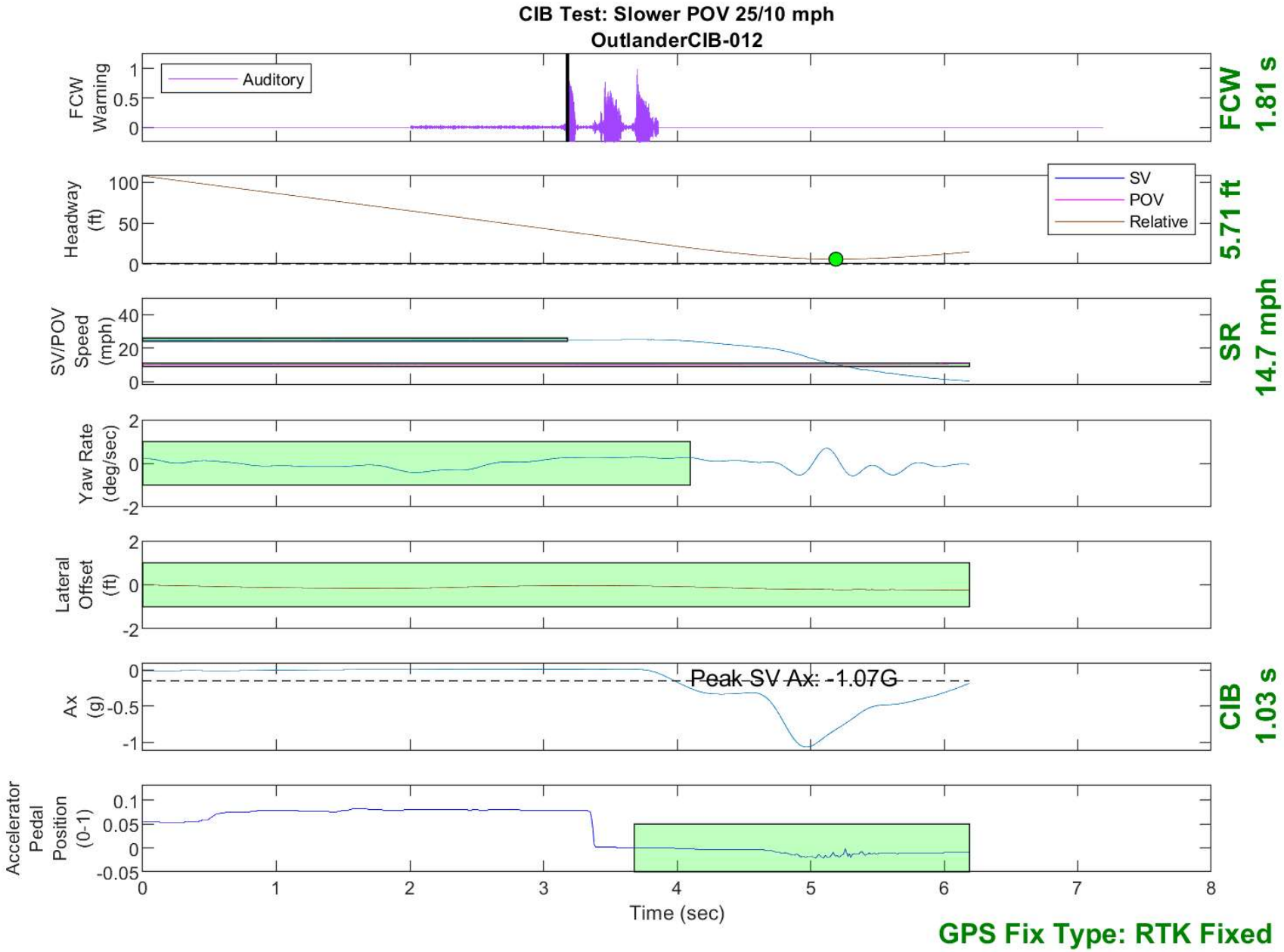


Figure D19. Time History for CIB Run 12, SV Encounters Slower POV, SV 25 mph, POV 10 mph

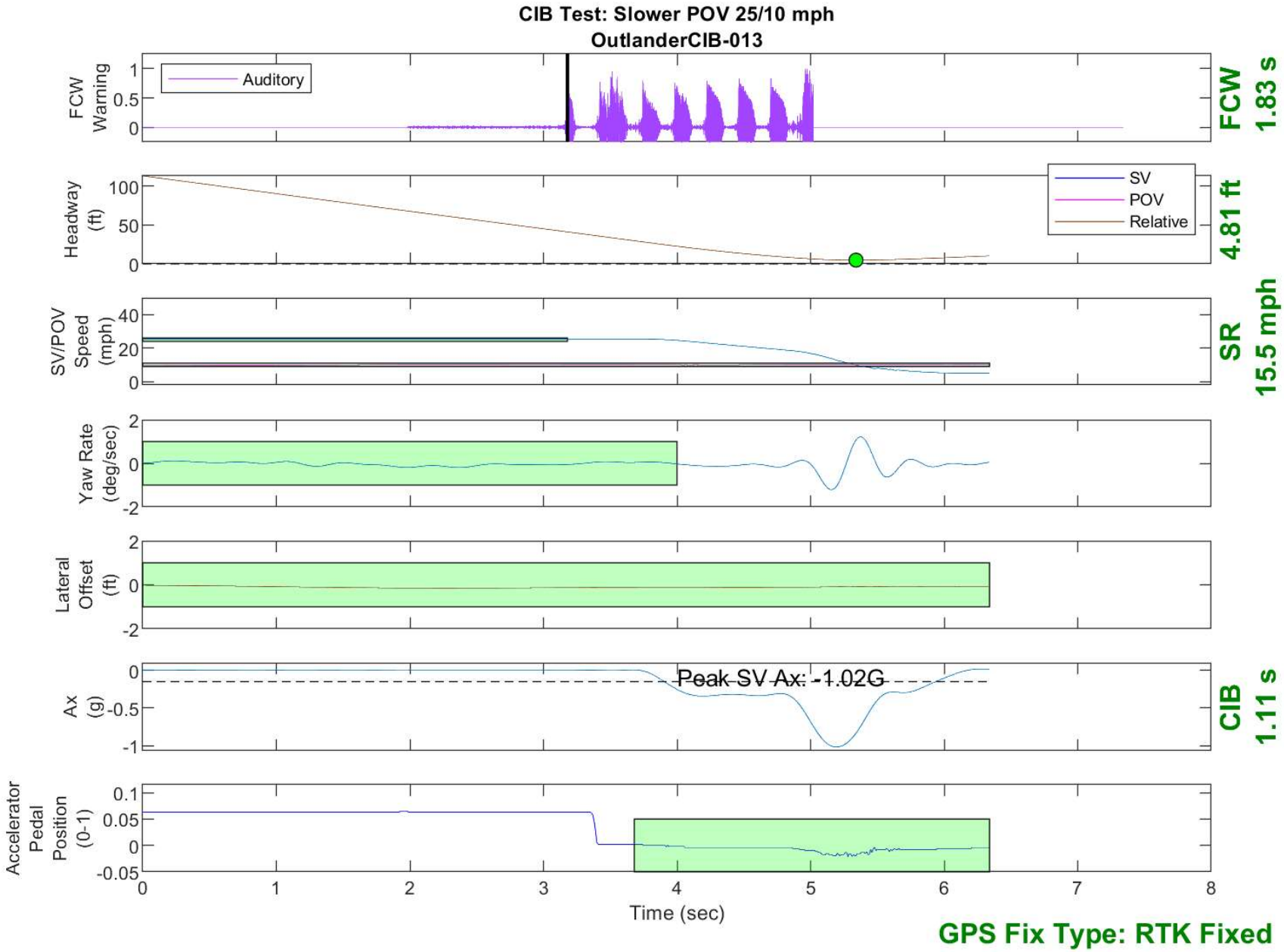


Figure D20. Time History for CIB Run 13, SV Encounters Slower POV, SV 25 mph, POV 10 mph

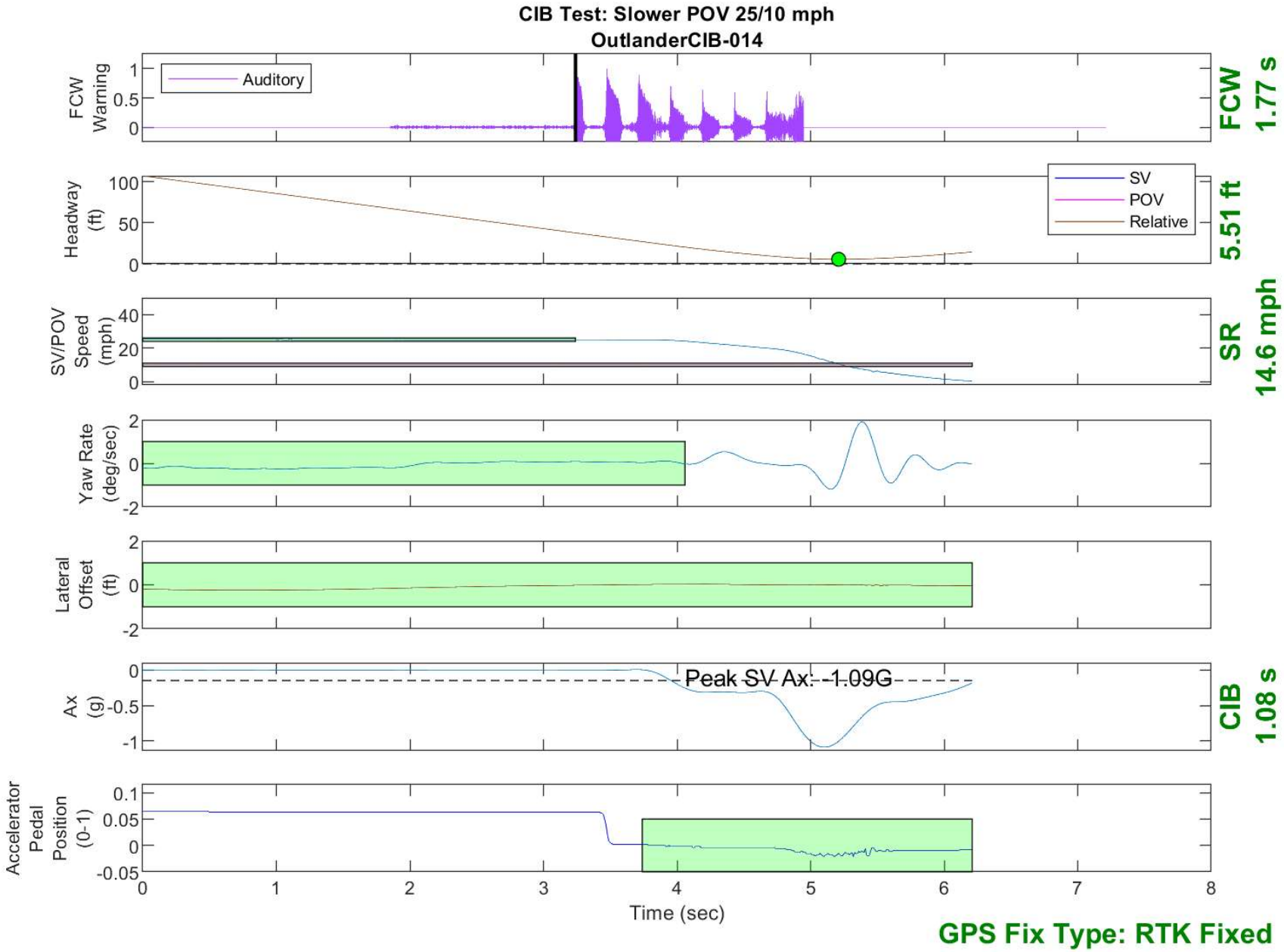


Figure D21. Time History for CIB Run 14, SV Encounters Slower POV, SV 25 mph, POV 10 mph

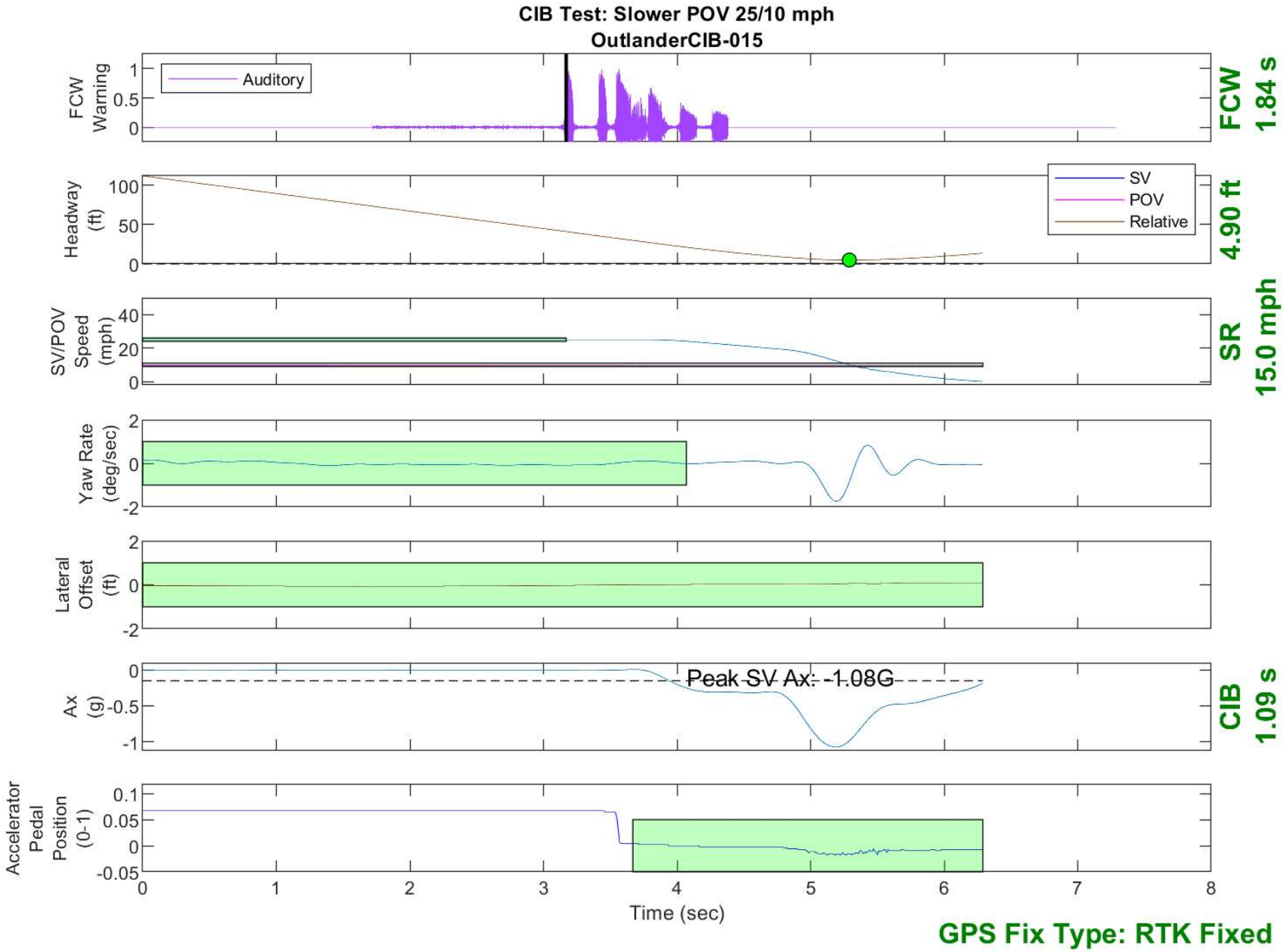


Figure D22. Time History for CIB Run 15, SV Encounters Slower POV, SV 25 mph, POV 10 mph

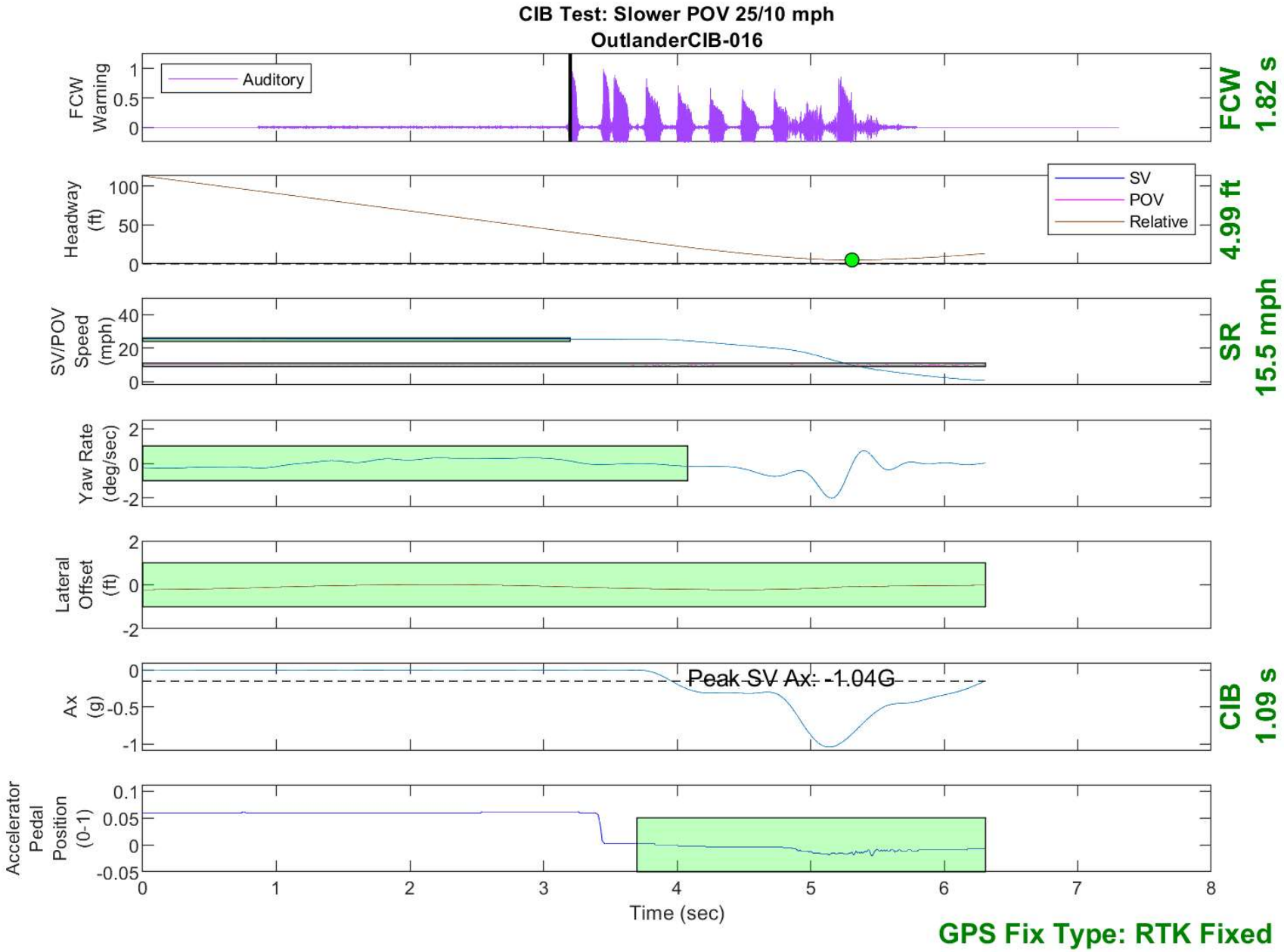


Figure D23. Time History for CIB Run 16, SV Encounters Slower POV, SV 25 mph, POV 10 mph

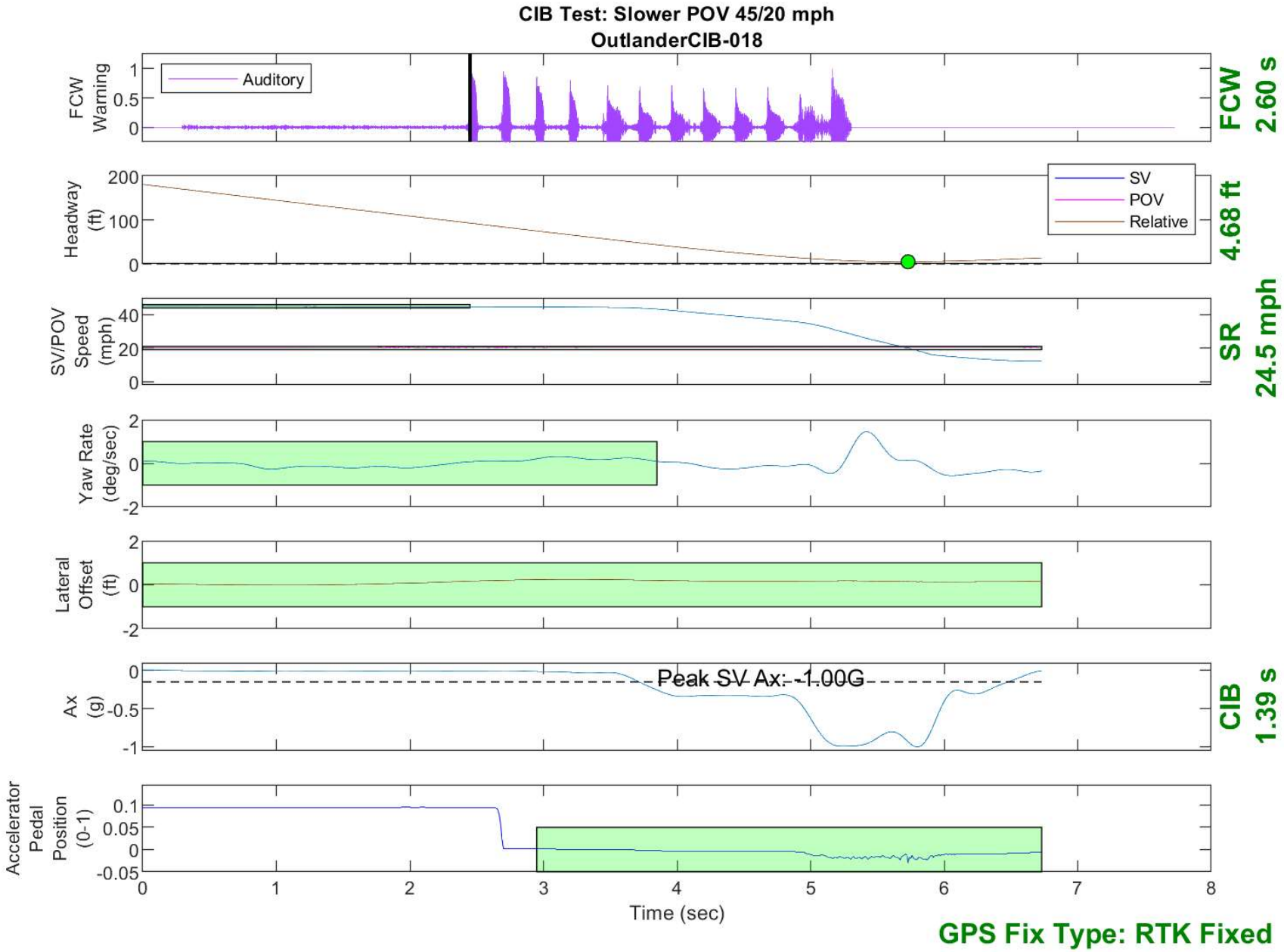


Figure D24. Time History for CIB Run 18, SV Encounters Slower POV, SV 45 mph, POV 20 mph

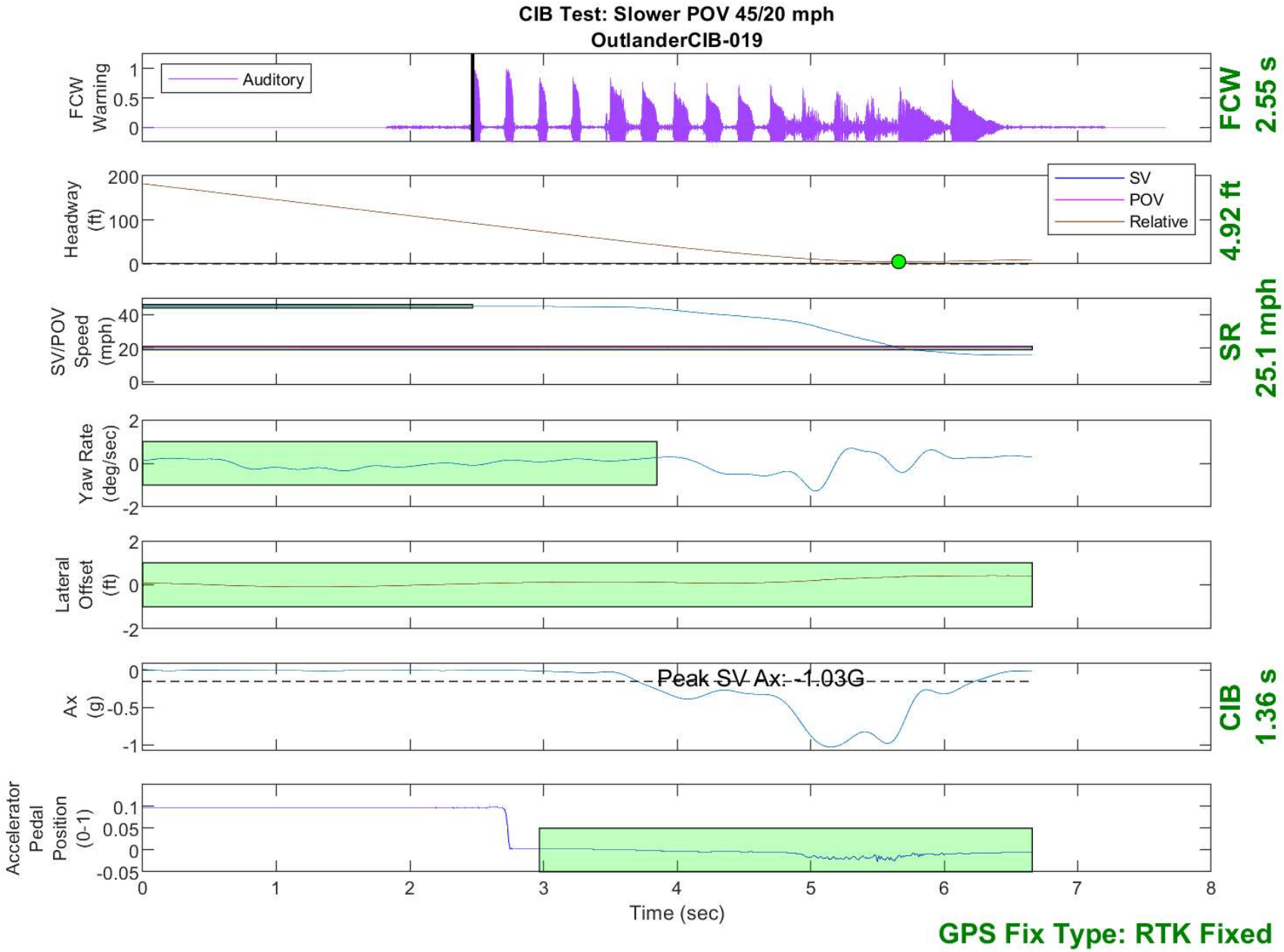


Figure D25. Time History for CIB Run 19, SV Encounters Slower POV, SV 45 mph, POV 20 mph

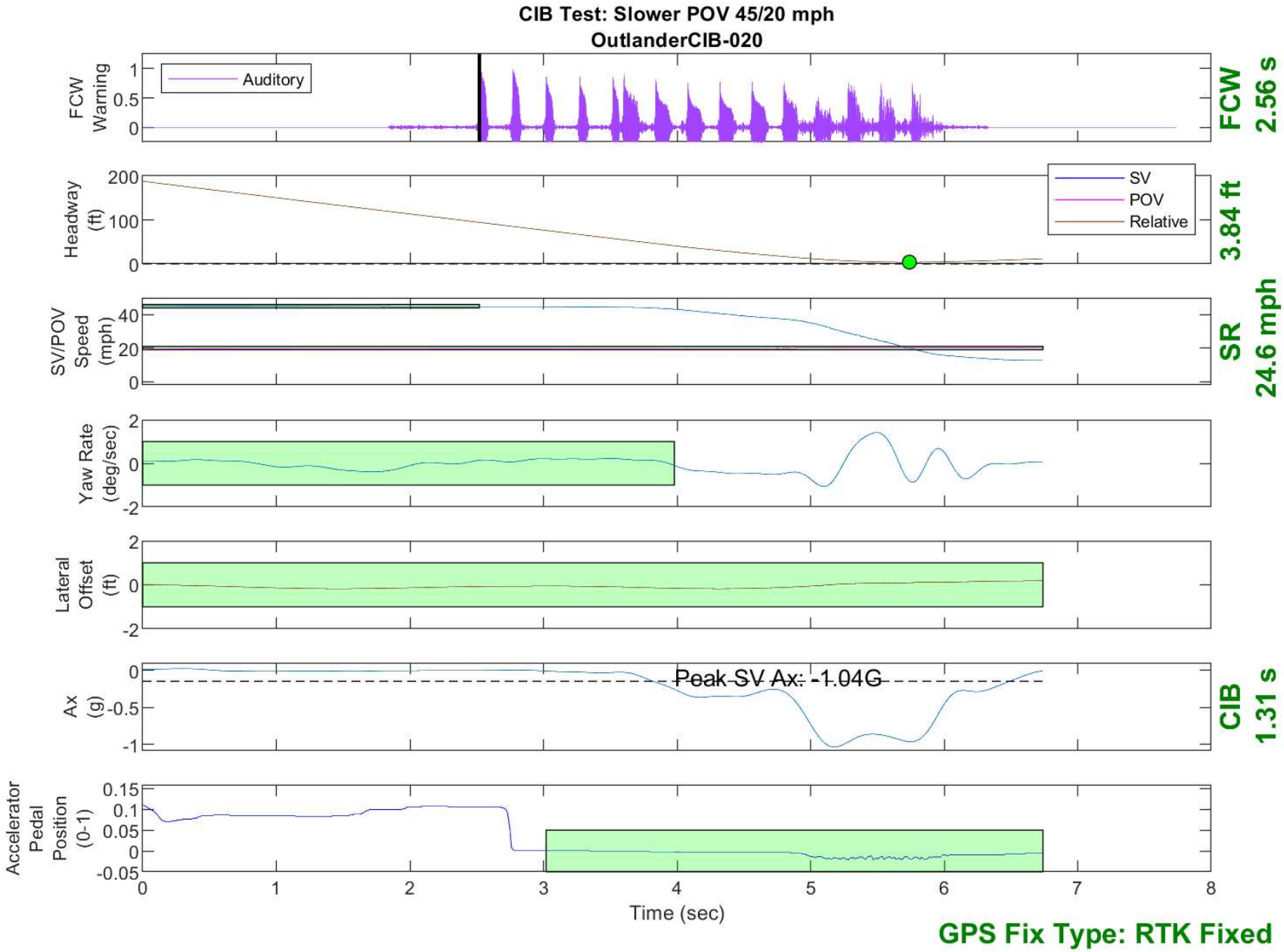


Figure D26. Time History for CIB Run 20, SV Encounters Slower POV, SV 45 mph, POV 20 mph

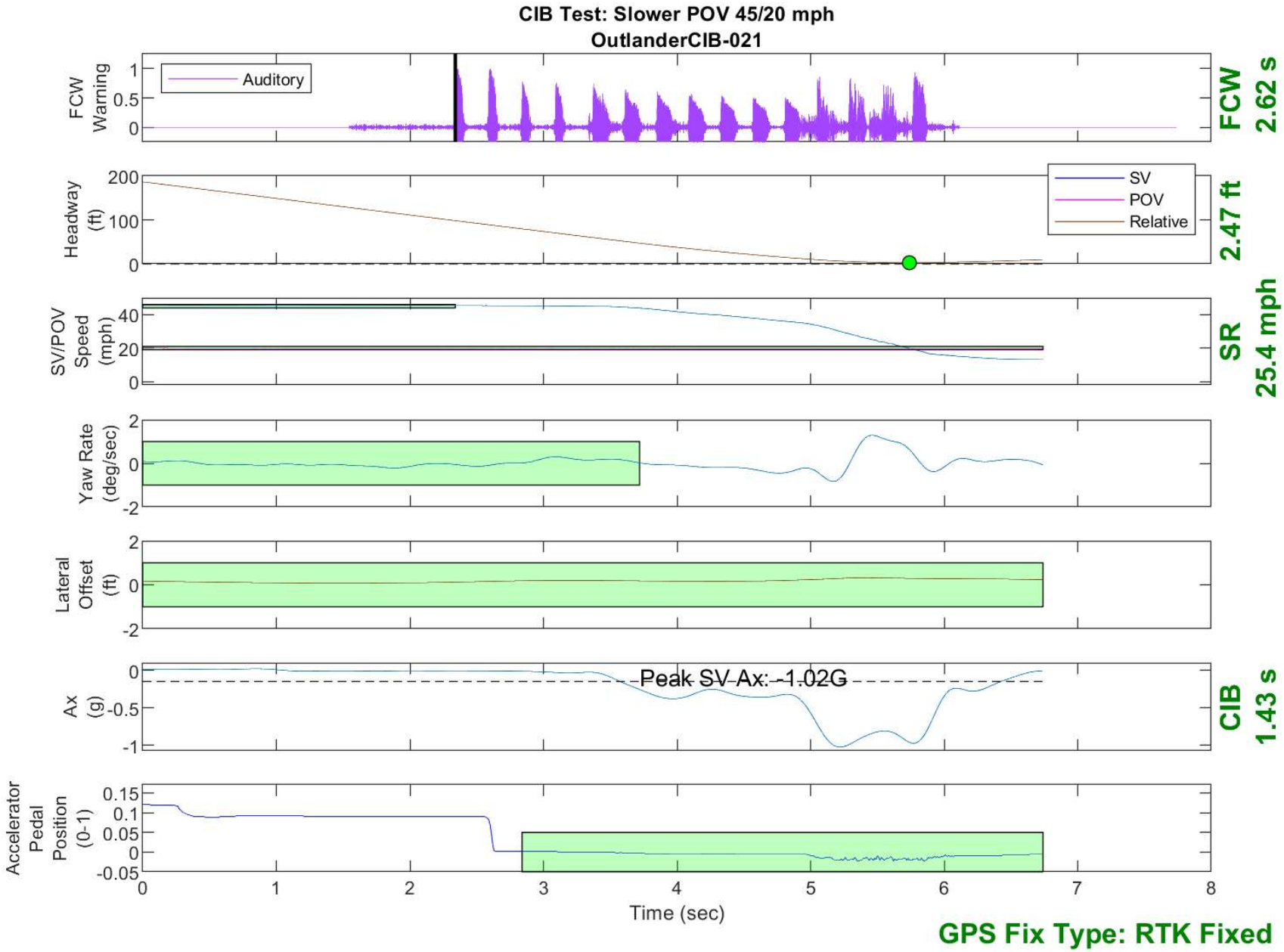


Figure D27. Time History for CIB Run 21, SV Encounters Slower POV, SV 45 mph, POV 20 mph

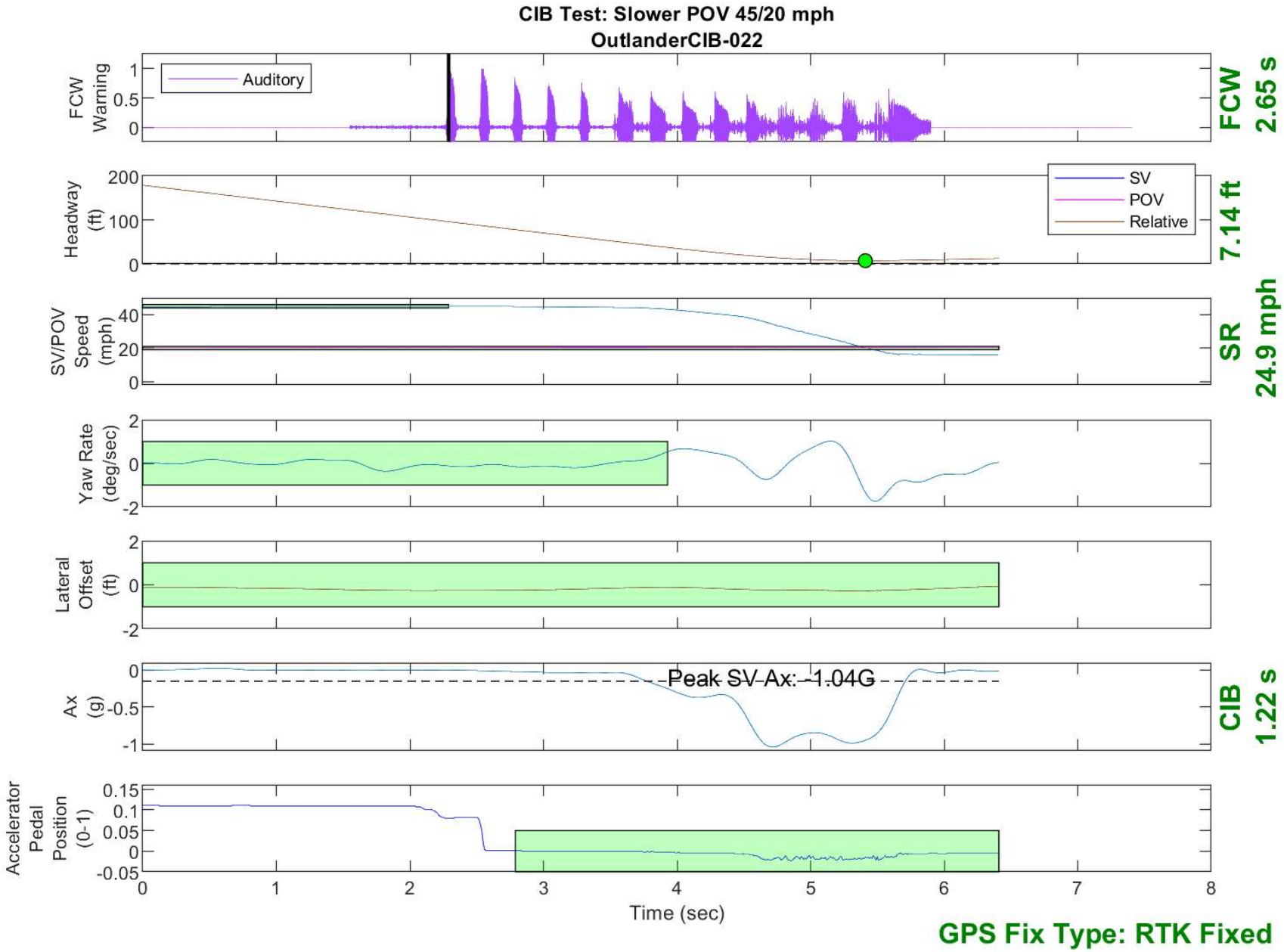


Figure D28. Time History for CIB Run 22, SV Encounters Slower POV, SV 45 mph, POV 20 mph

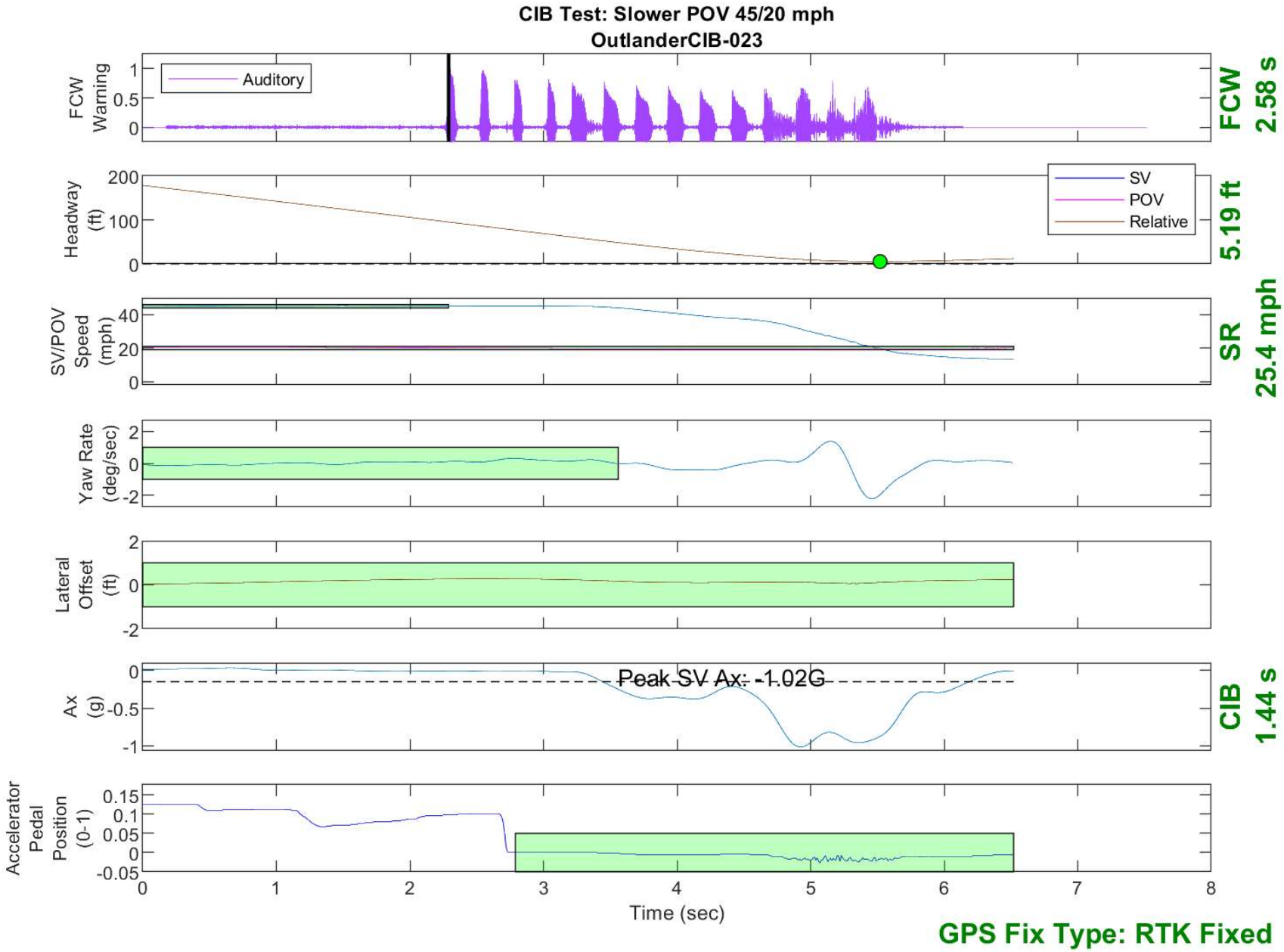


Figure D29. Time History for CIB Run 23, SV Encounters Slower POV, SV 45 mph, POV 20 mph

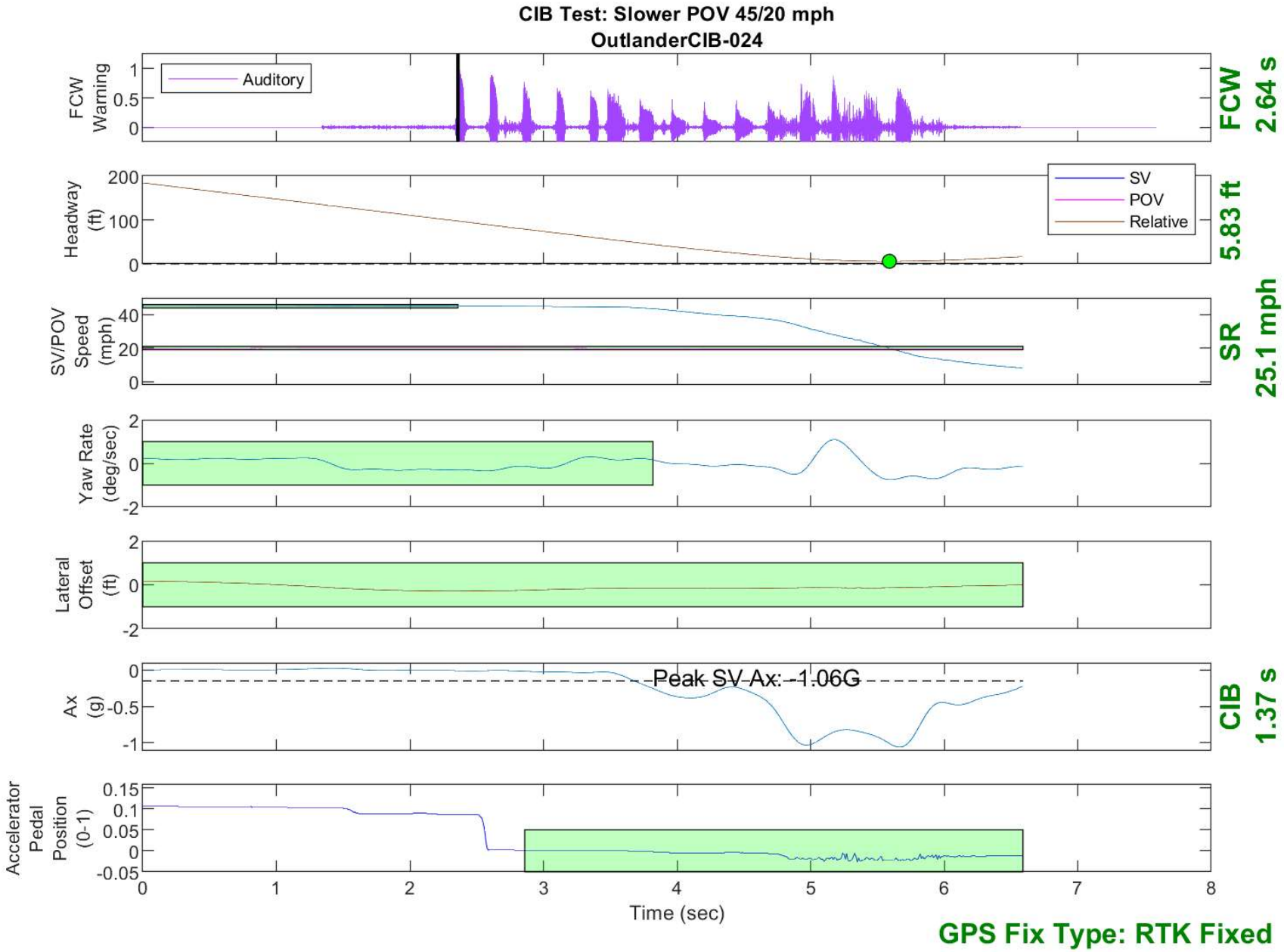


Figure D30. Time History for CIB Run 24, SV Encounters Slower POV, SV 45 mph, POV 20 mph

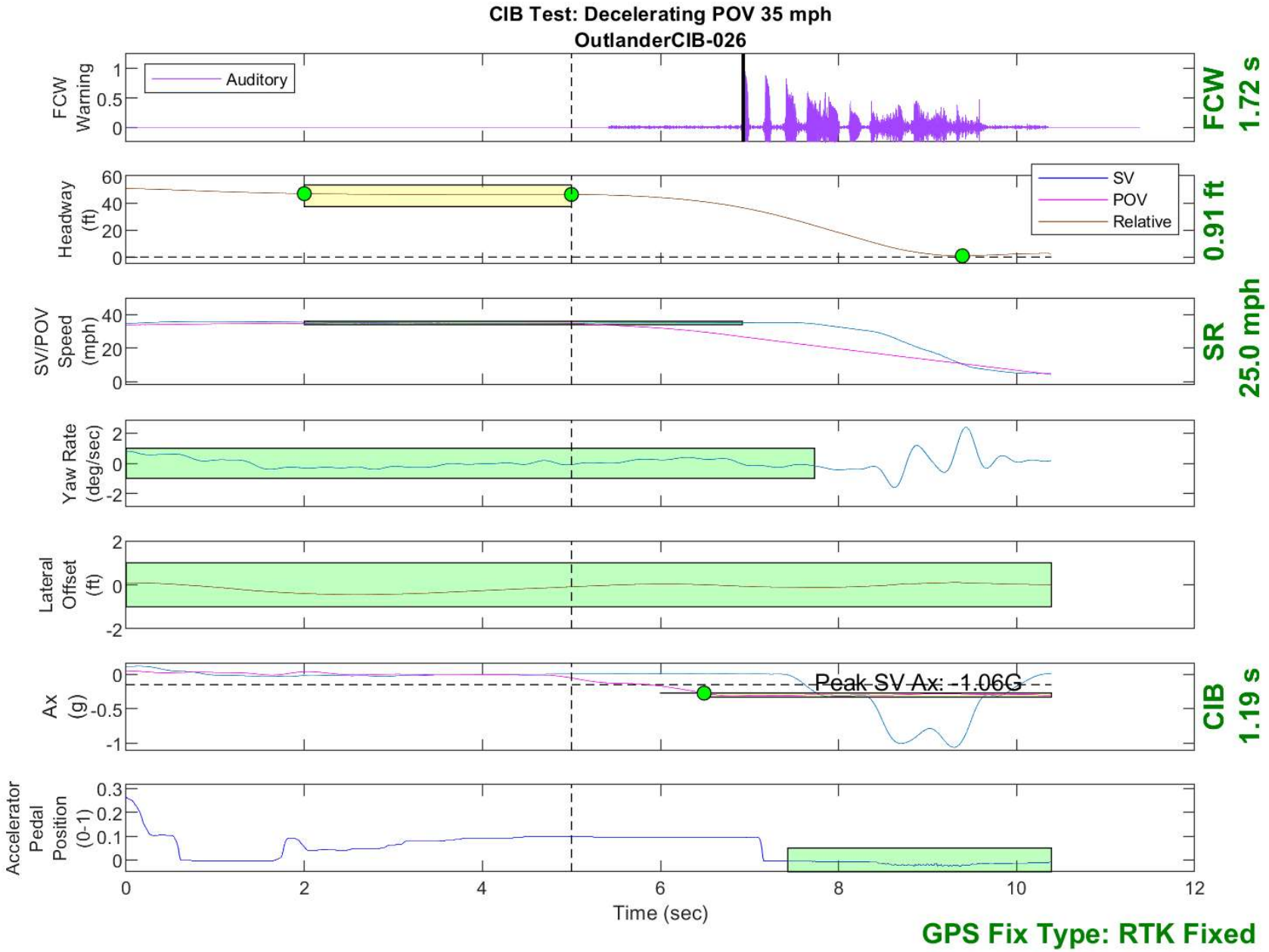


Figure D31. Time History for CIB Run 26, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

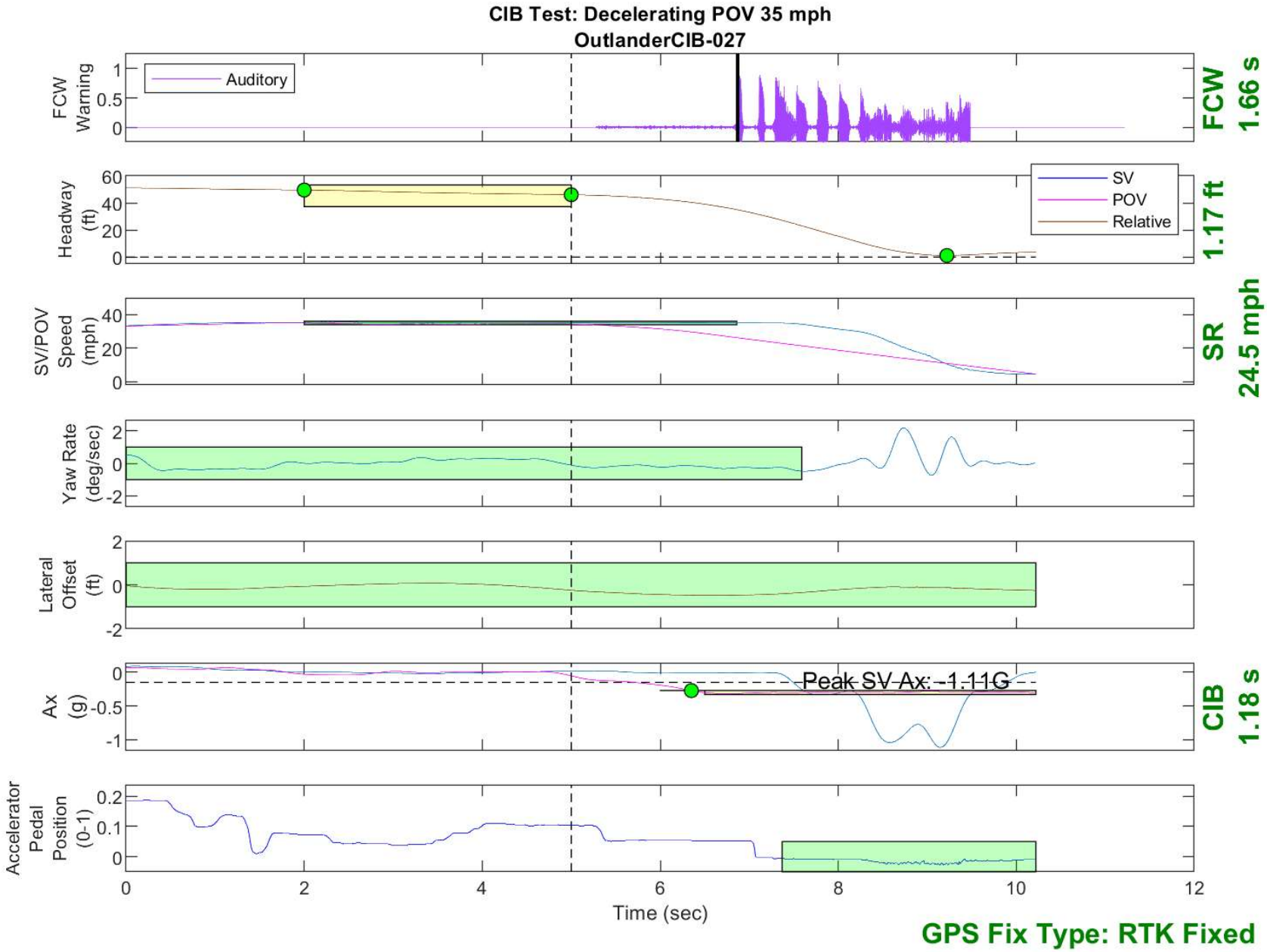


Figure D32. Time History for CIB Run 27, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

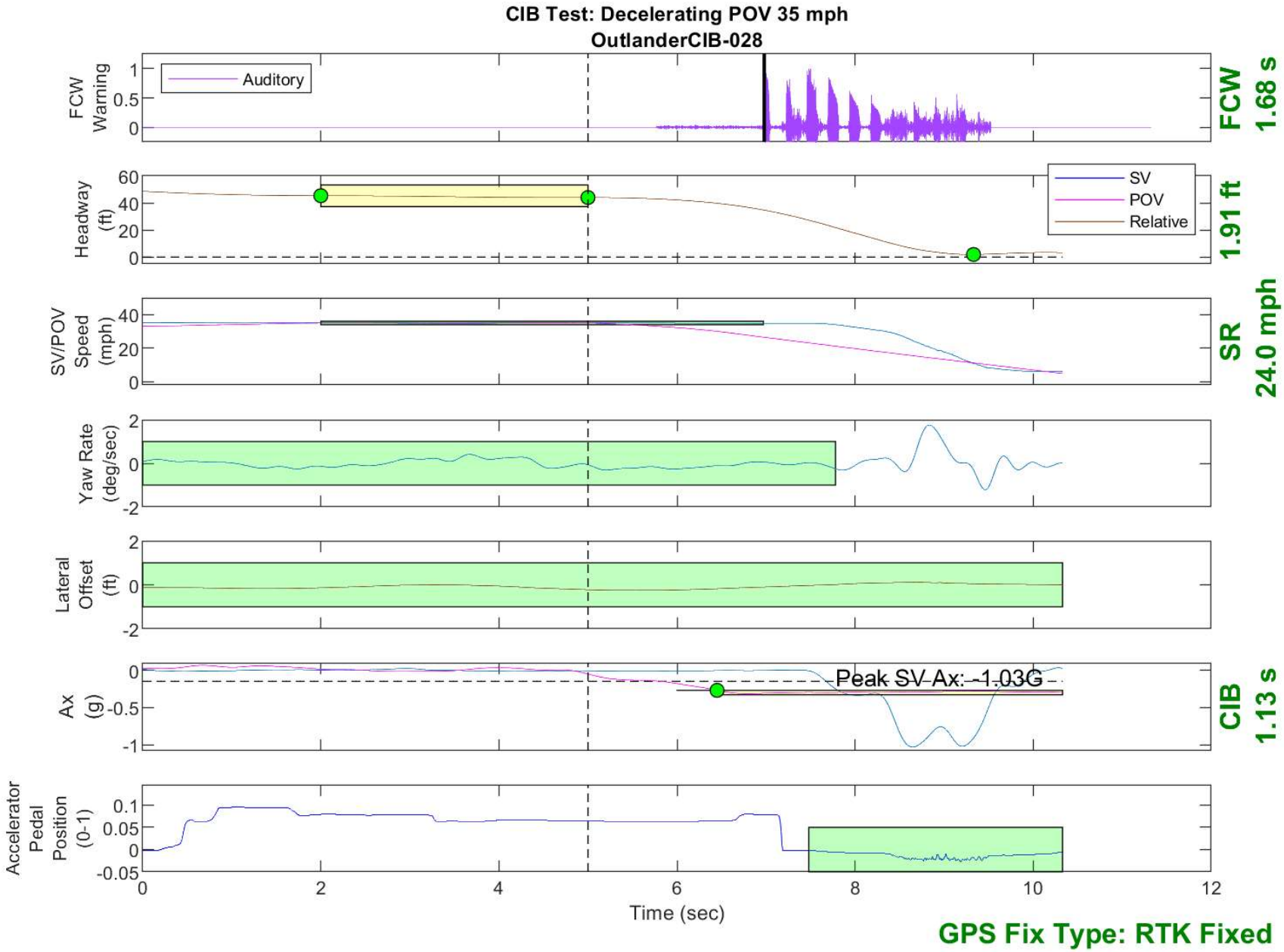


Figure D33. Time History for CIB Run 28, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

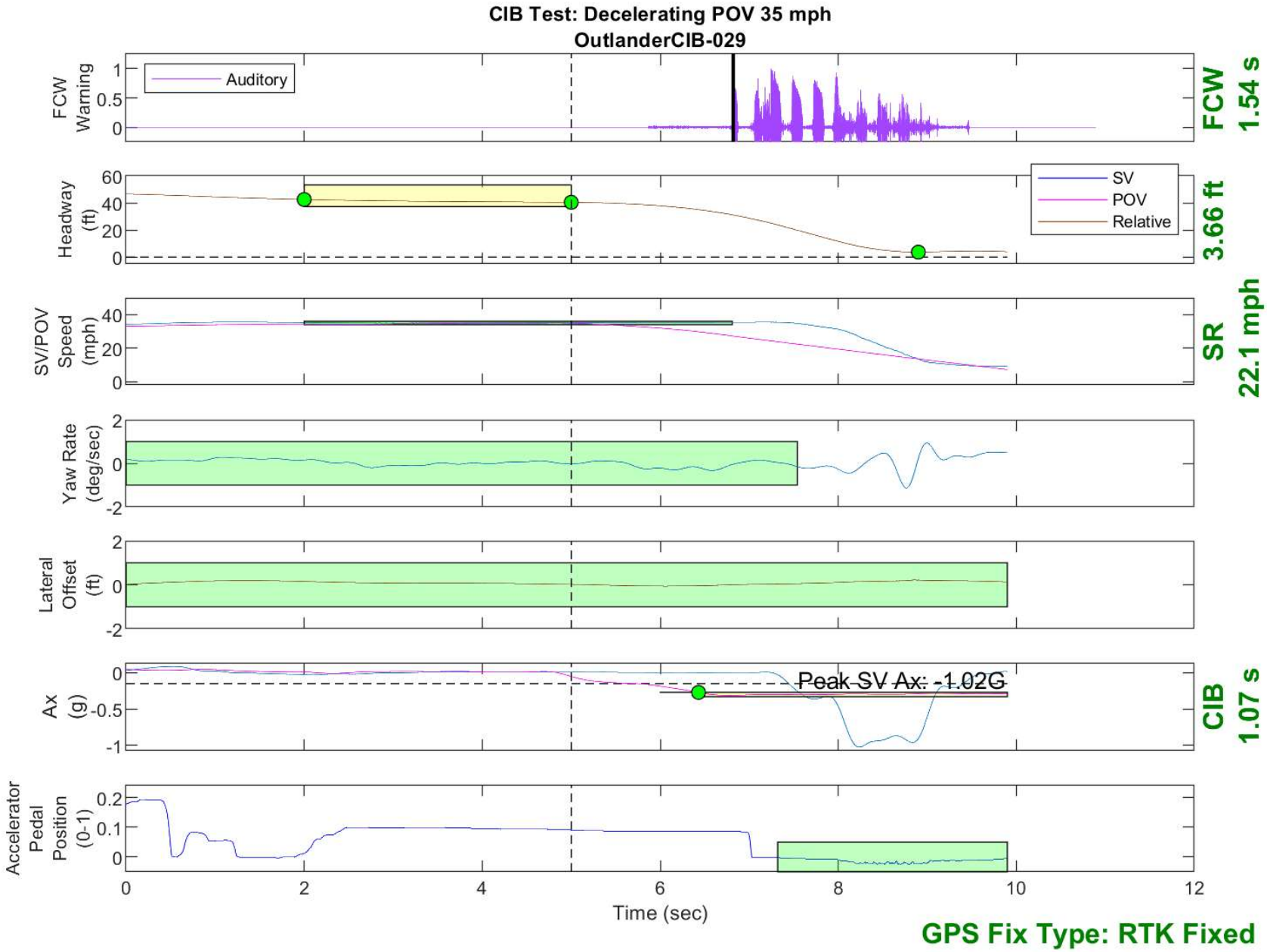


Figure D34. Time History for CIB Run 29, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

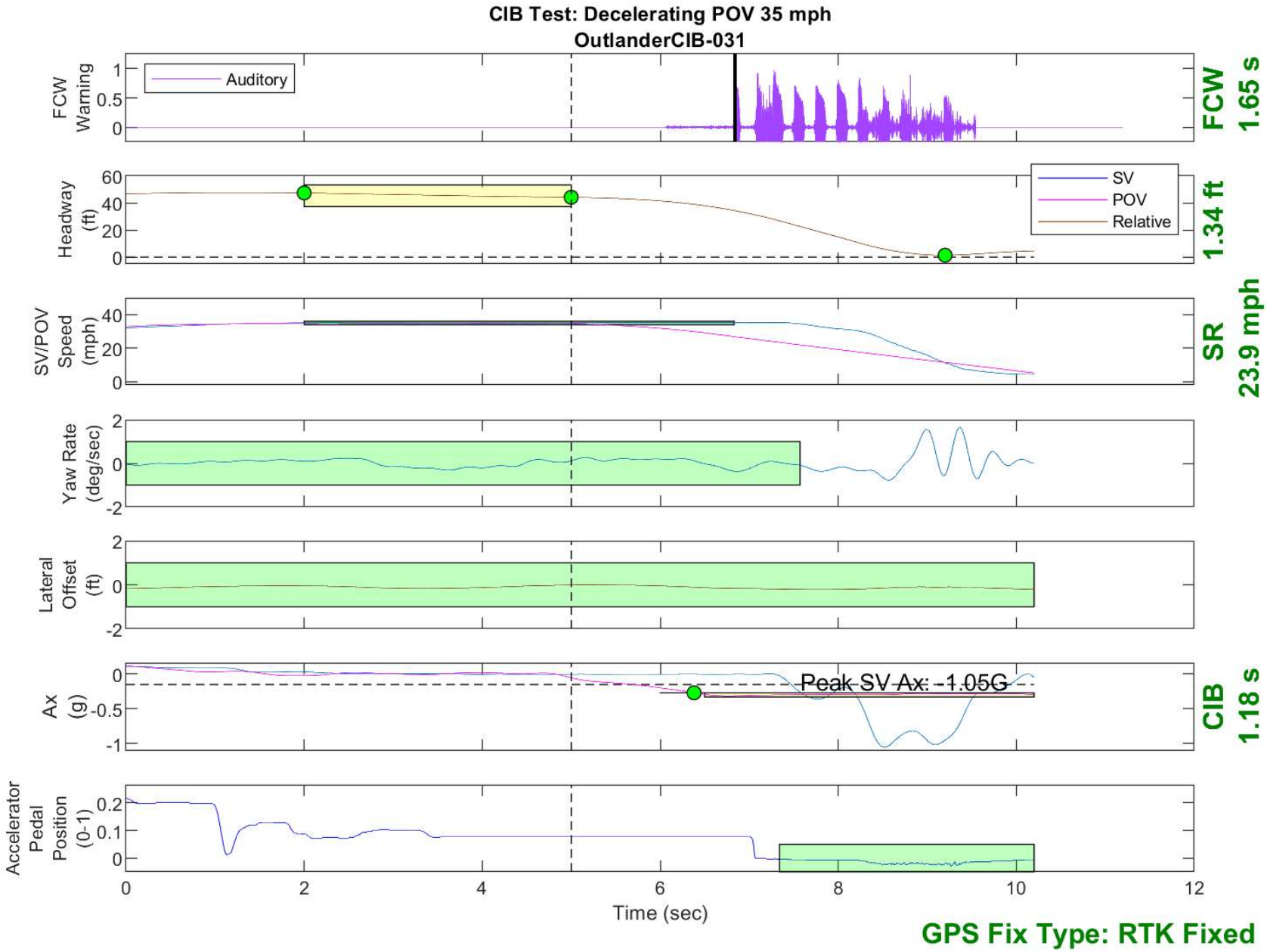


Figure D35. Time History for CIB Run 31, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

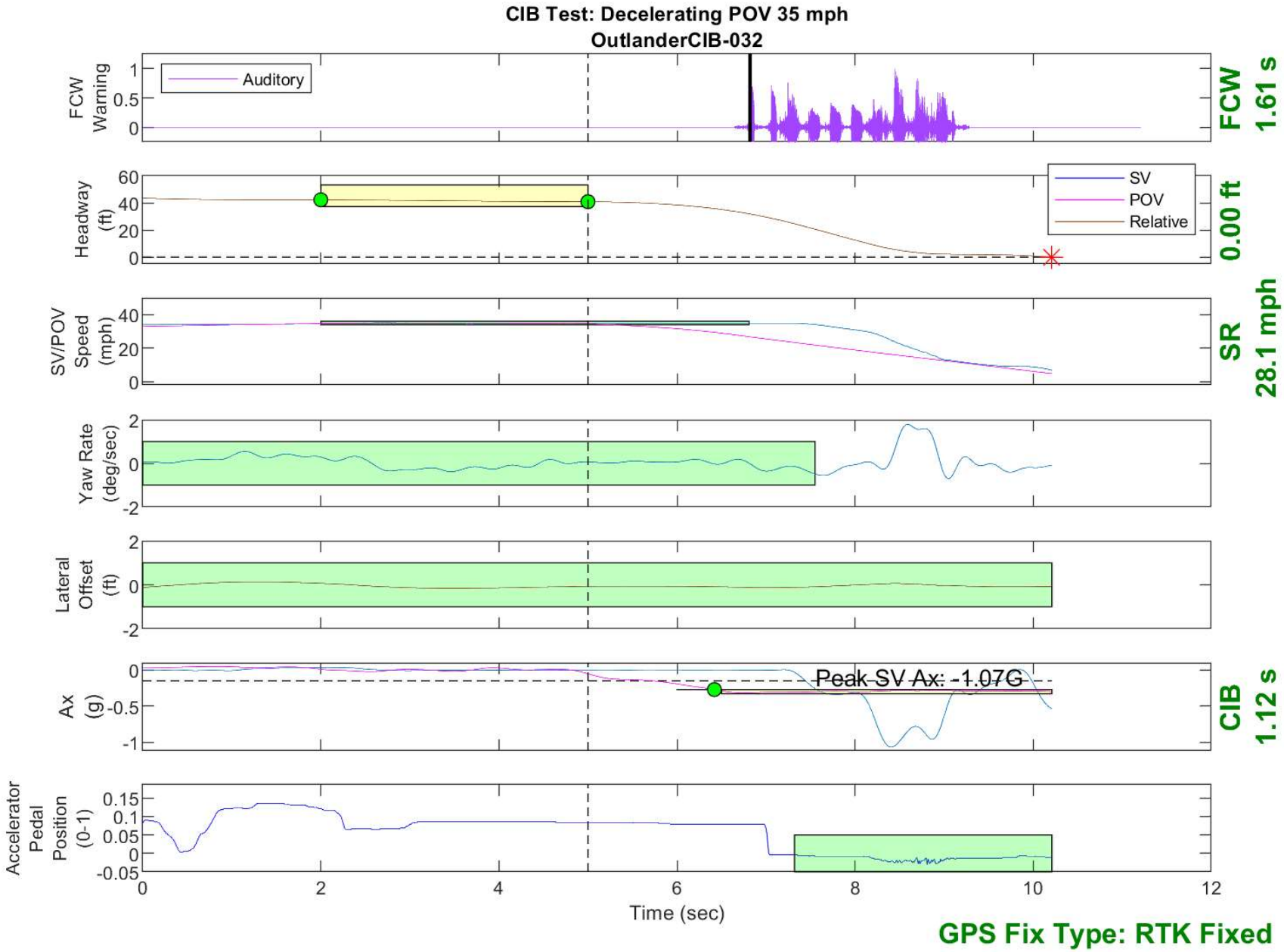


Figure D36. Time History for CIB Run 32, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

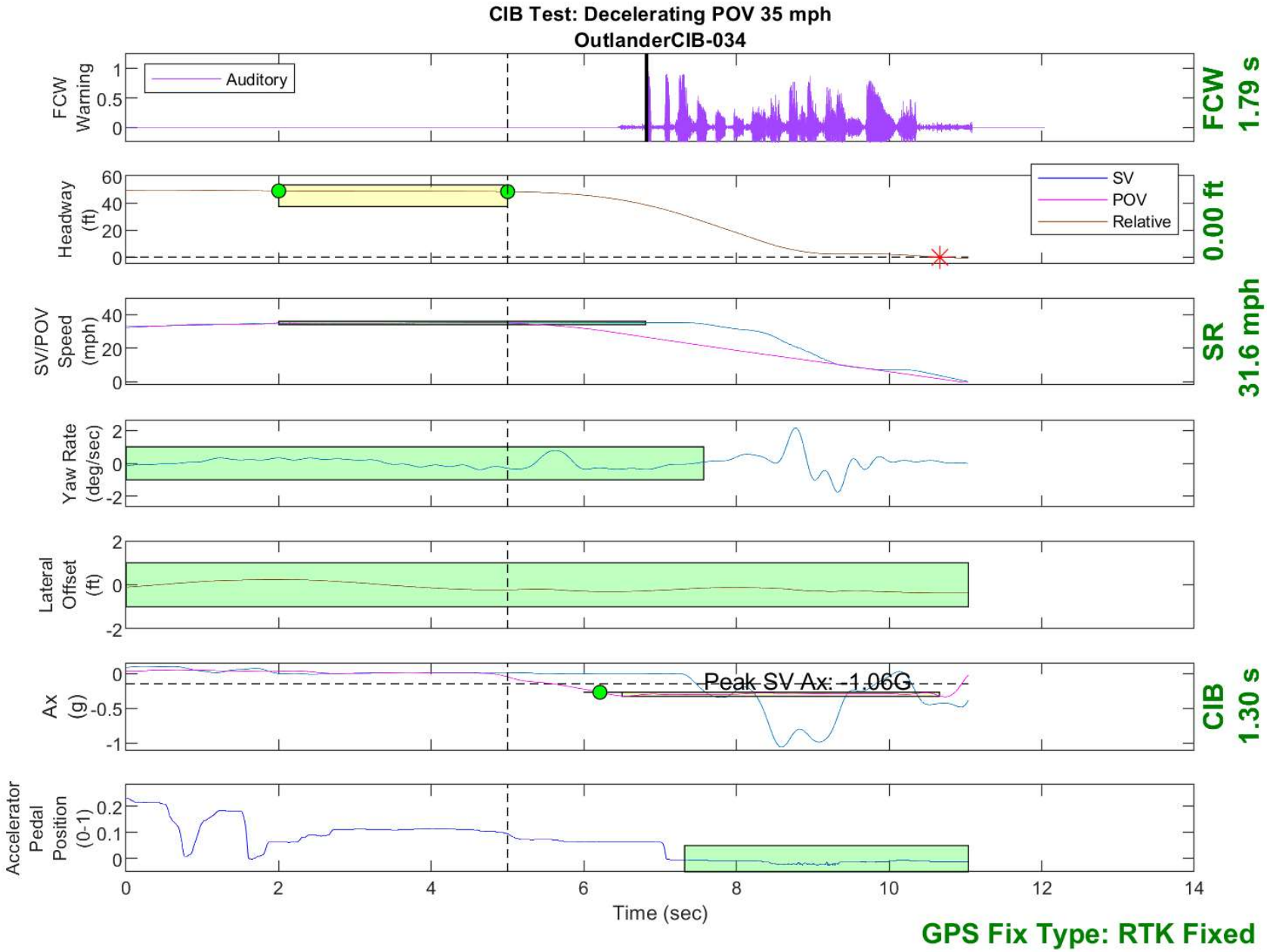


Figure D37. Time History for CIB Run 34, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

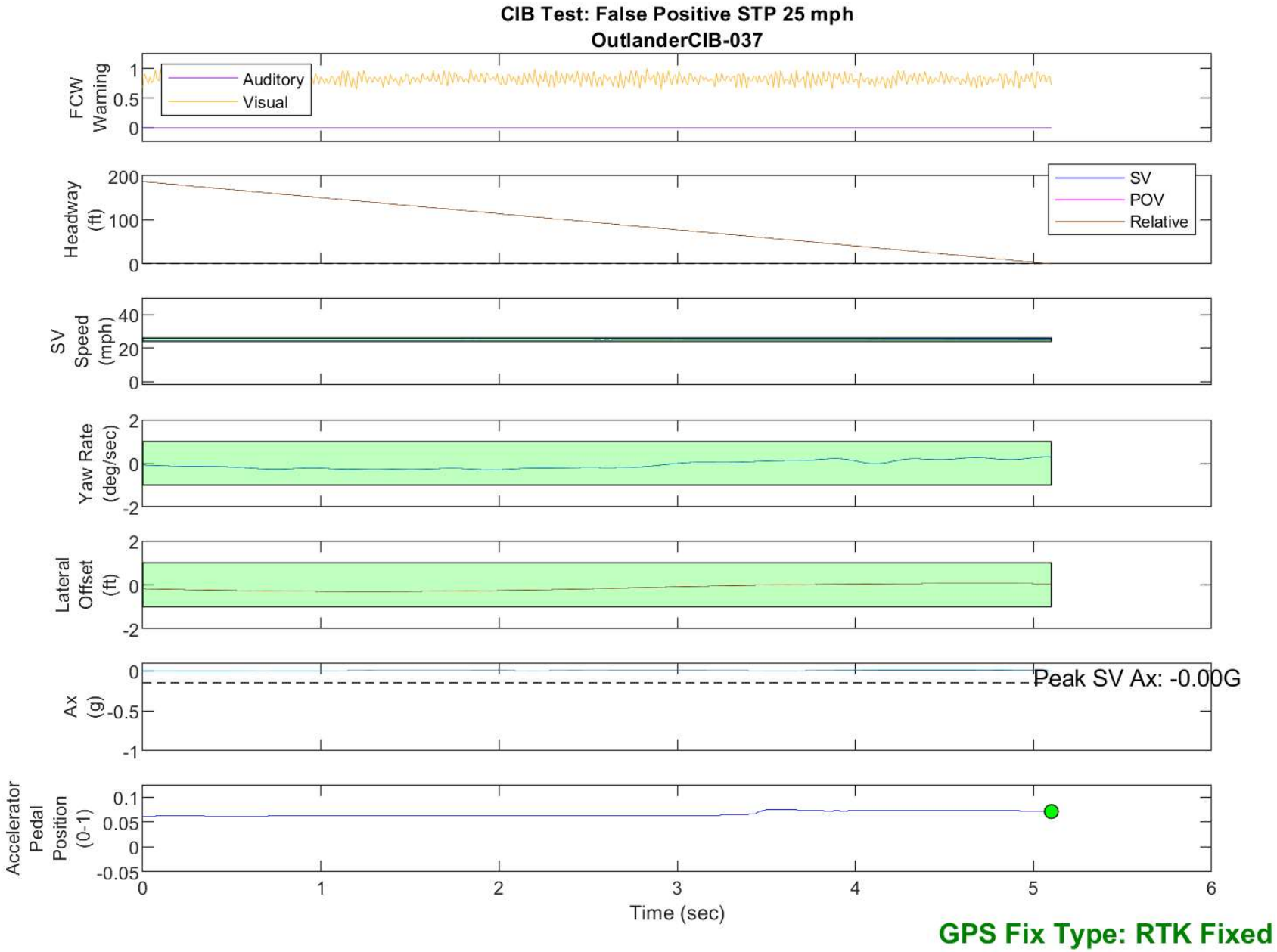


Figure D38. Time History for CIB Run 37, SV Encounters Steel Trench Plate, SV 25 mph

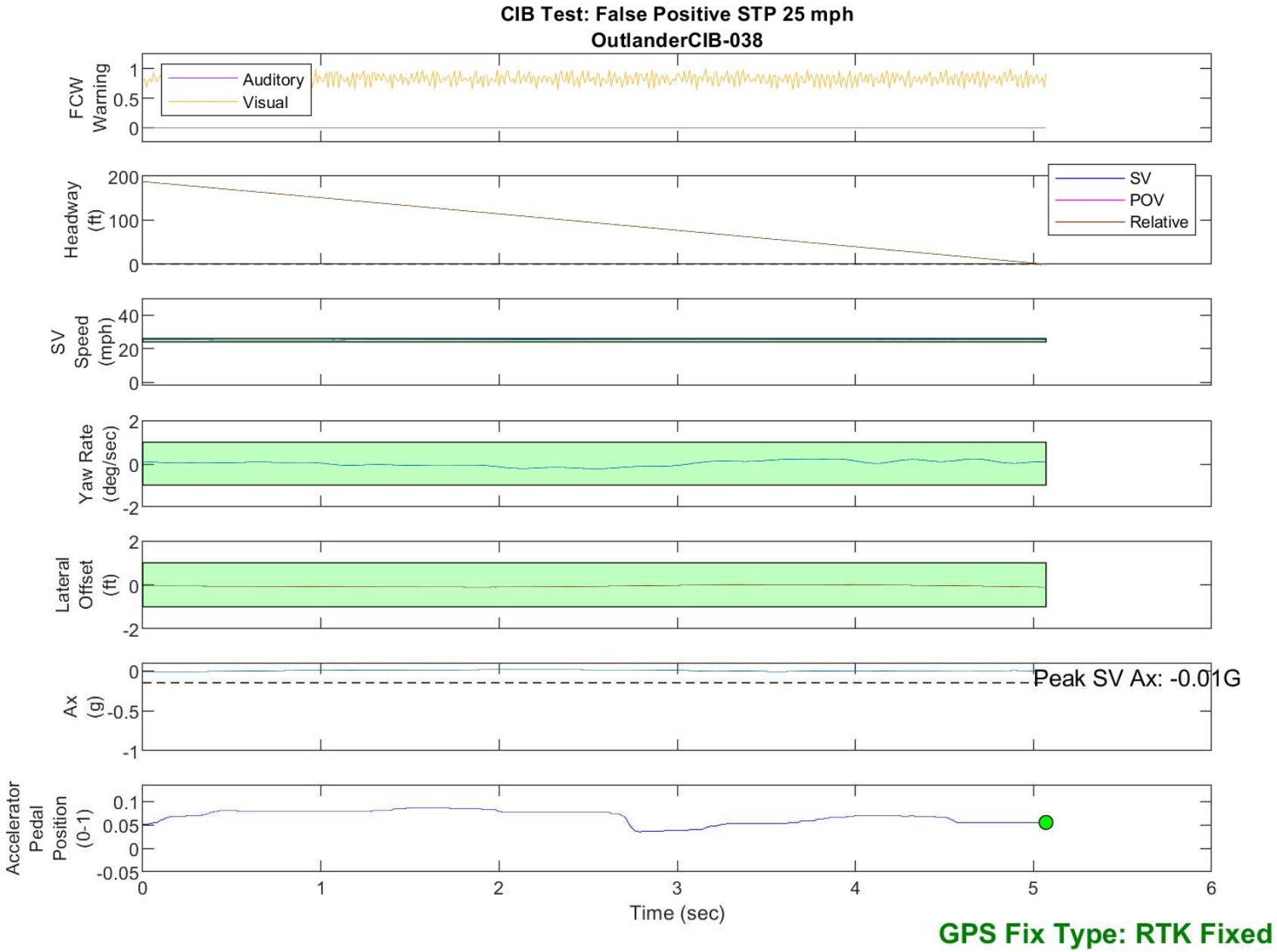


Figure D39. Time History for CIB Run 38, SV Encounters Steel Trench Plate, SV 25 mph

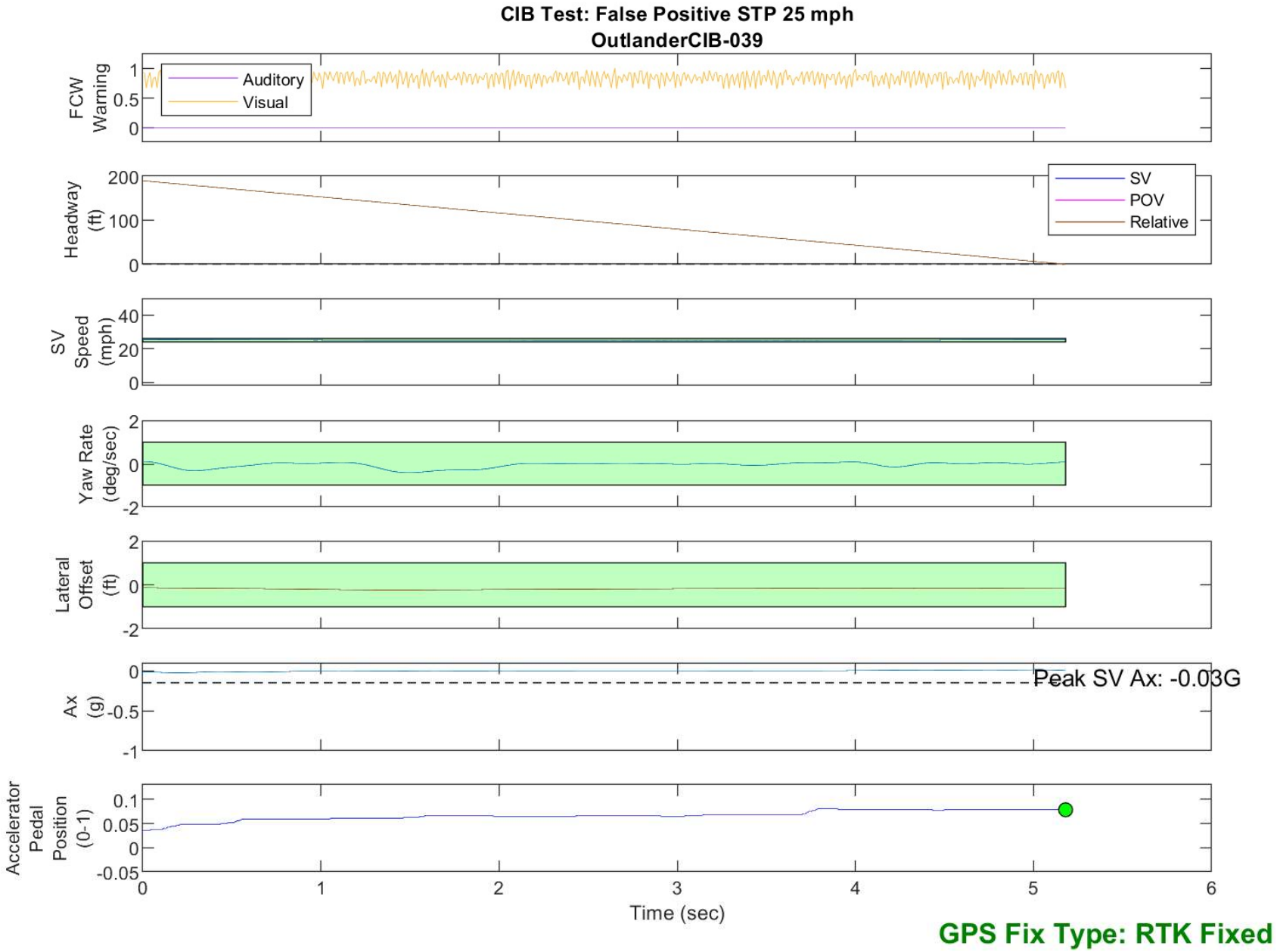


Figure D40. Time History for CIB Run 39, SV Encounters Steel Trench Plate, SV 25 mph

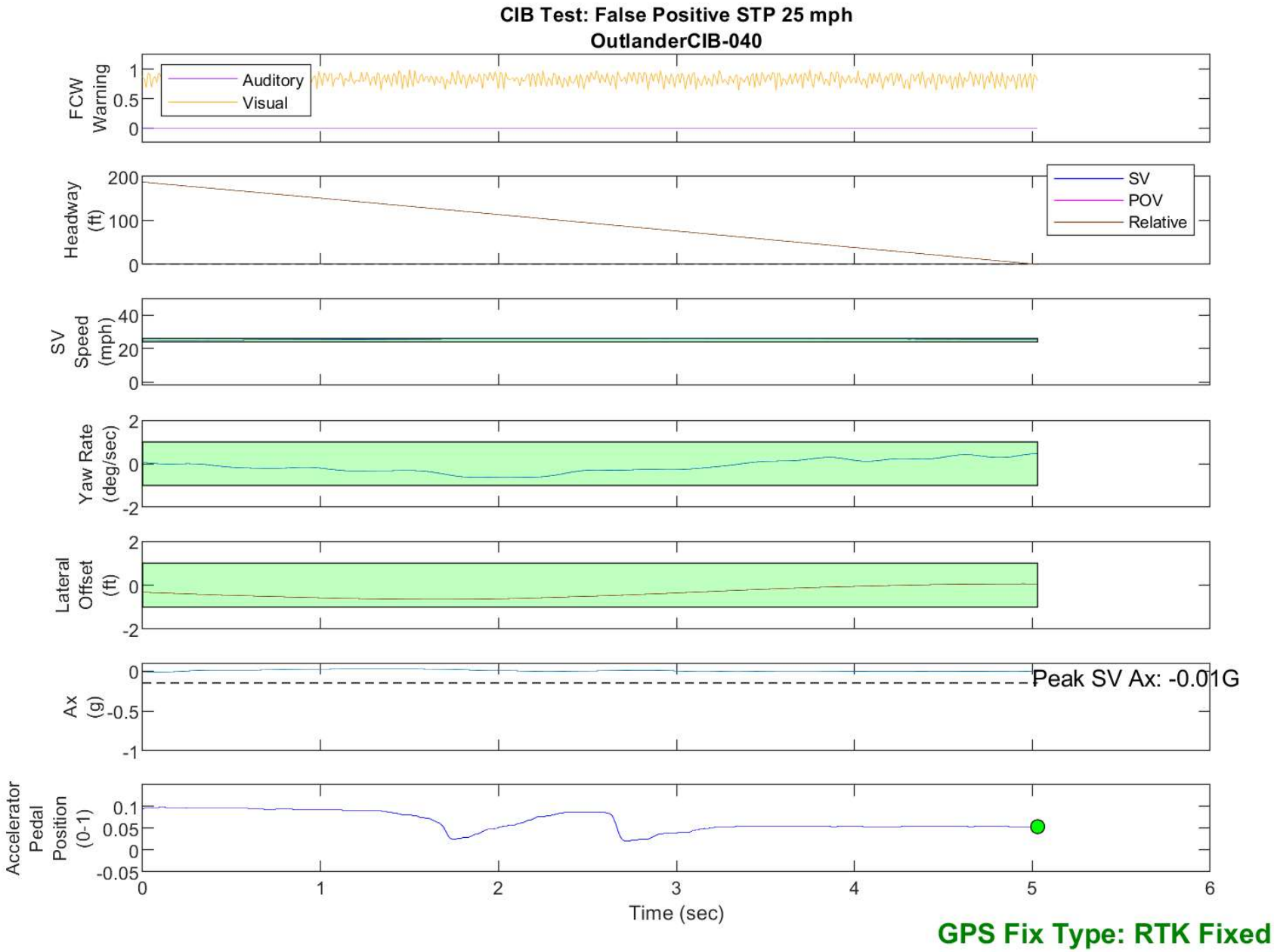


Figure D41. Time History for CIB Run 40, SV Encounters Steel Trench Plate, SV 25 mph

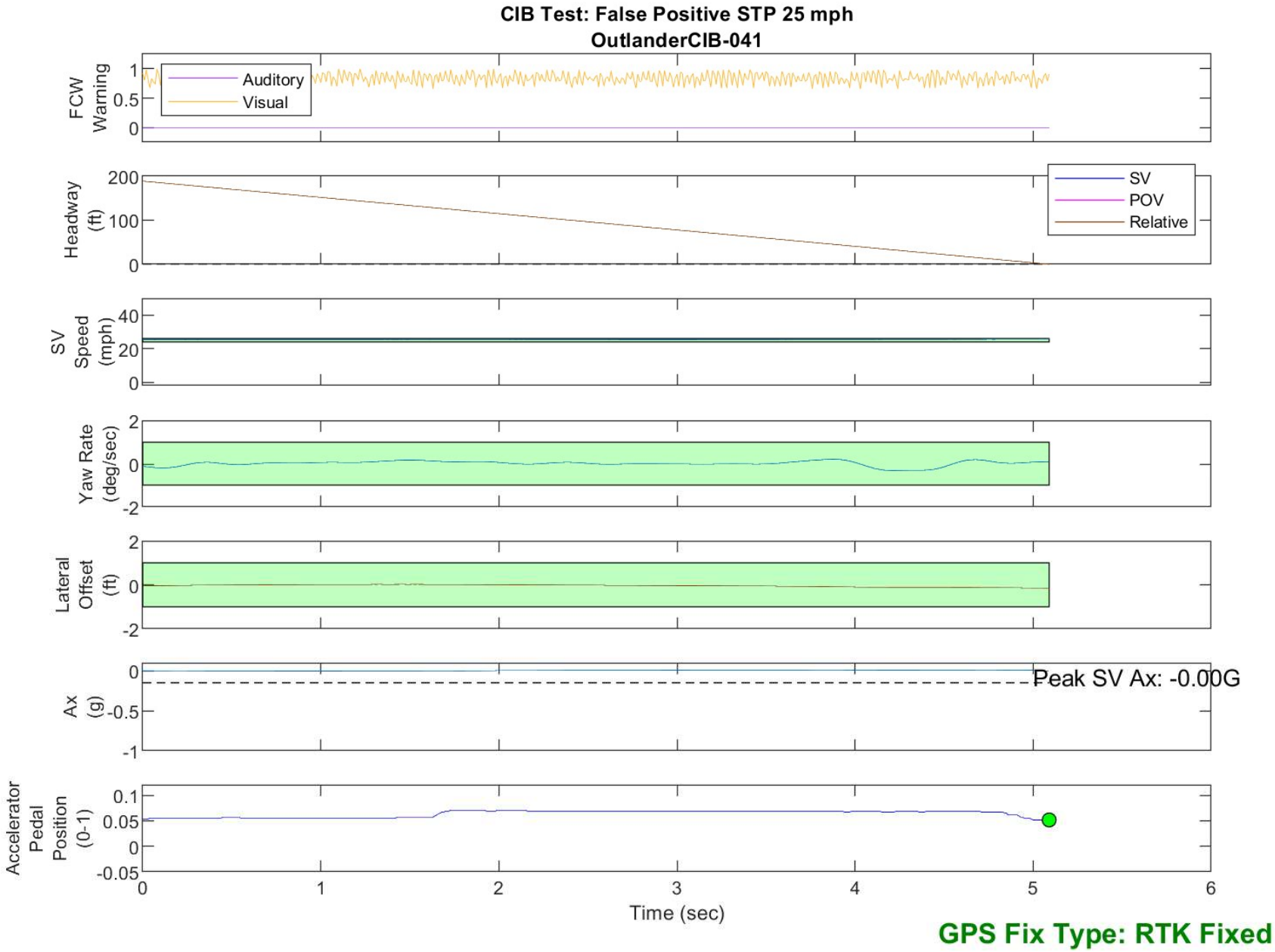


Figure D42. Time History for CIB Run 41, SV Encounters Steel Trench Plate, SV 25 mph

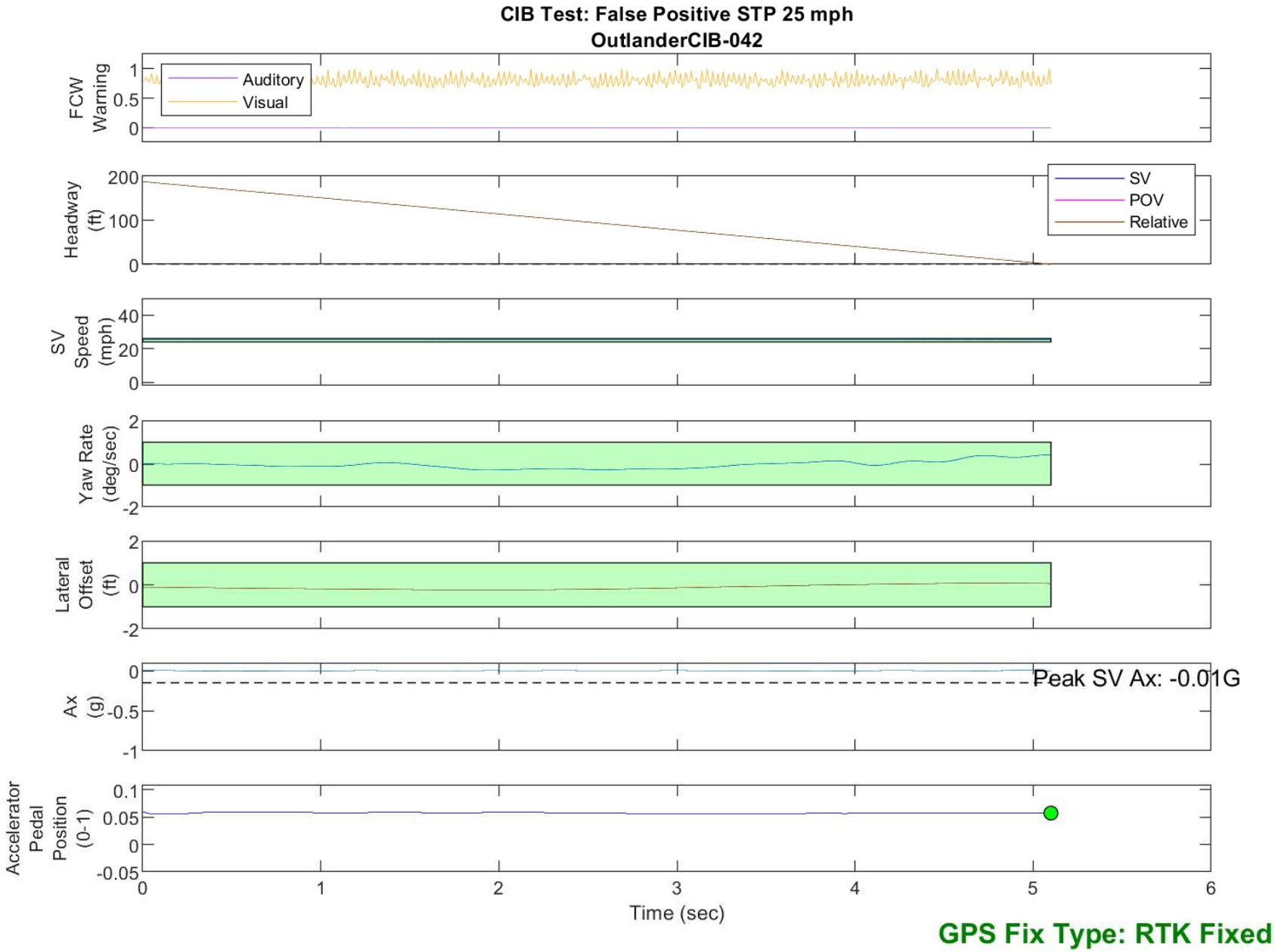


Figure D43. Time History for CIB Run 42, SV Encounters Steel Trench Plate, SV 25 mph

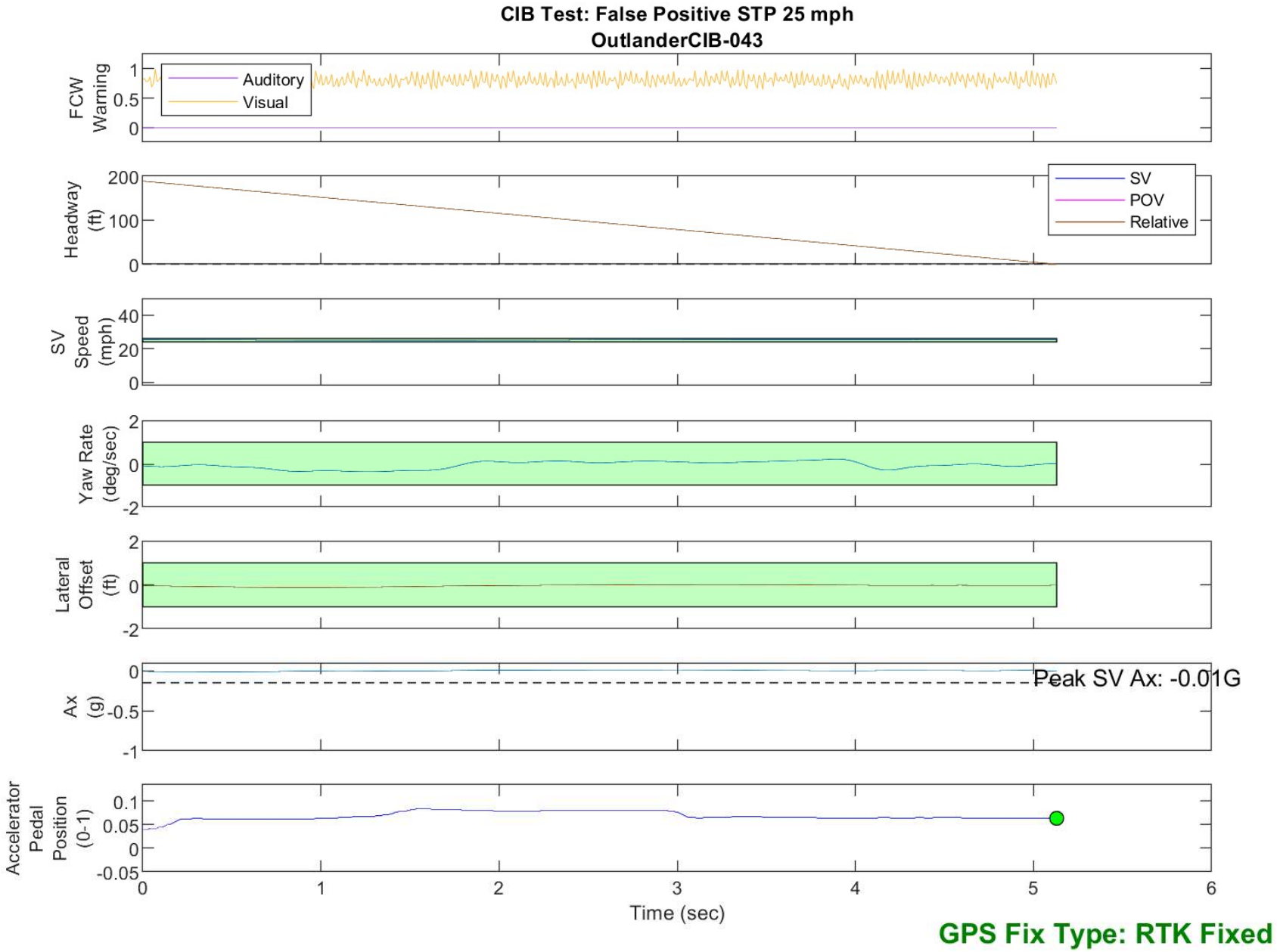


Figure D44. Time History for CIB Run 43, SV Encounters Steel Trench Plate, SV 25 mph

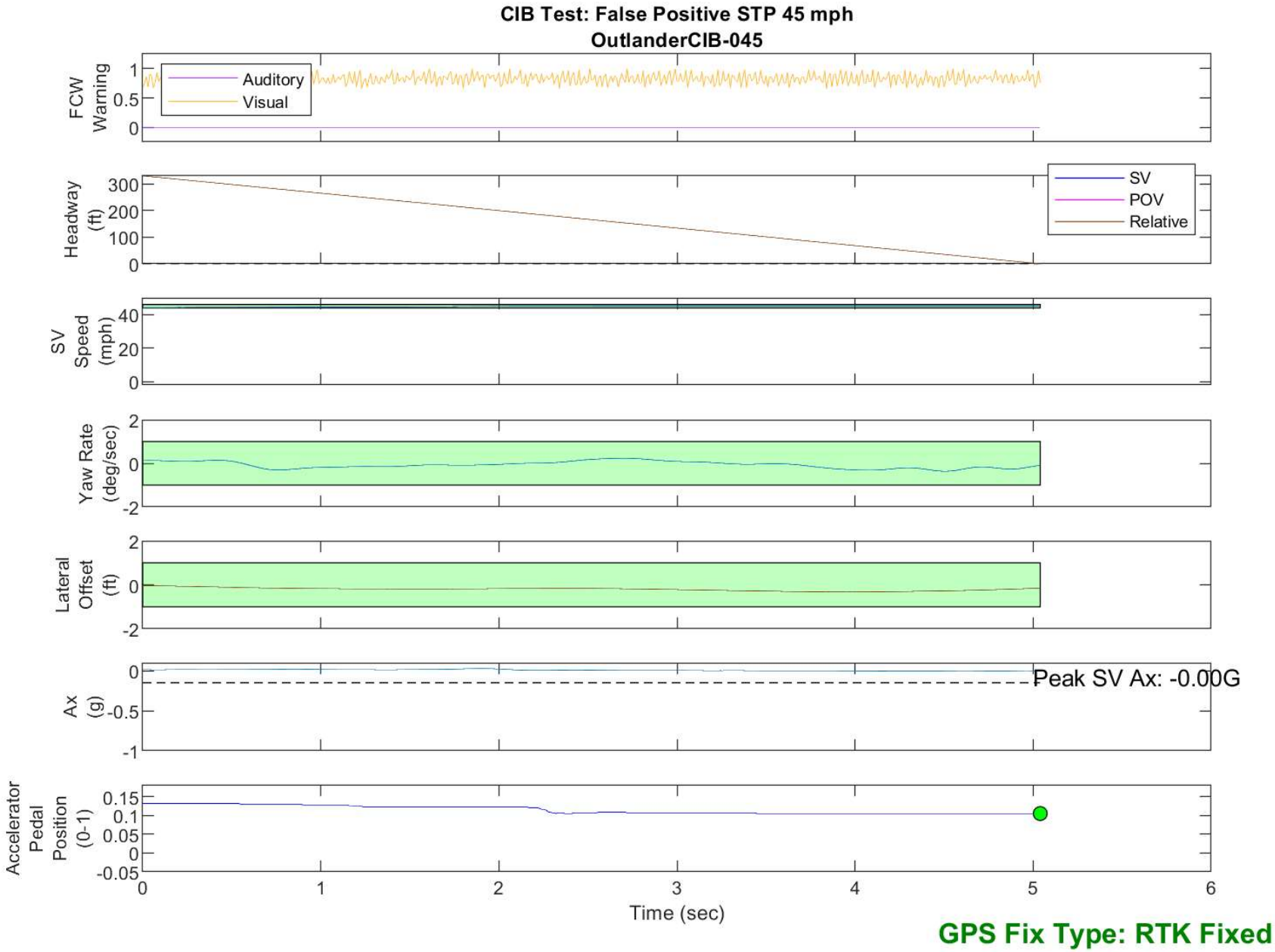


Figure D45. Time History for CIB Run 45, SV Encounters Steel Trench Plate, SV 45 mph

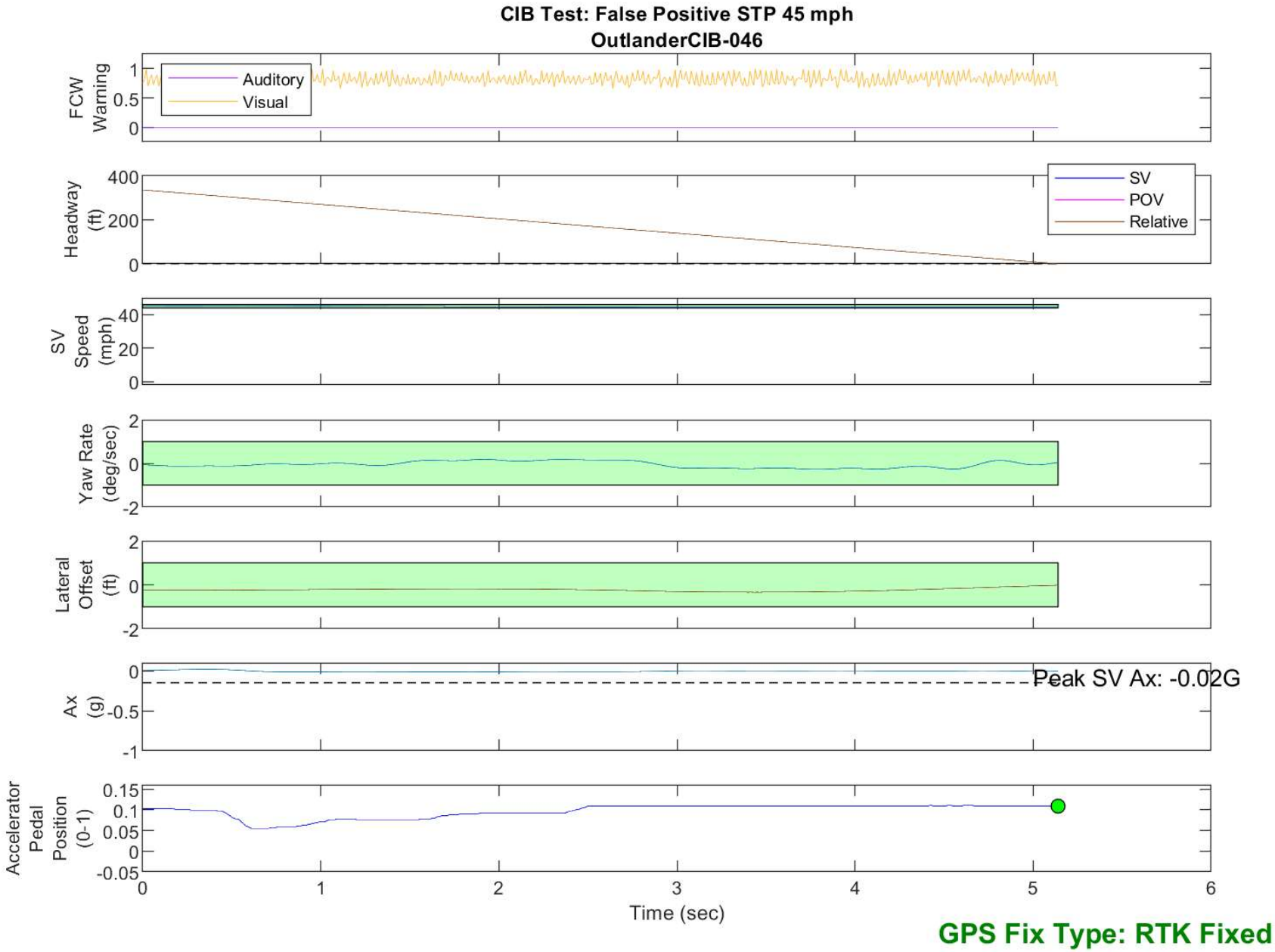


Figure D46. Time History for CIB Run 46, SV Encounters Steel Trench Plate, SV 45 mph

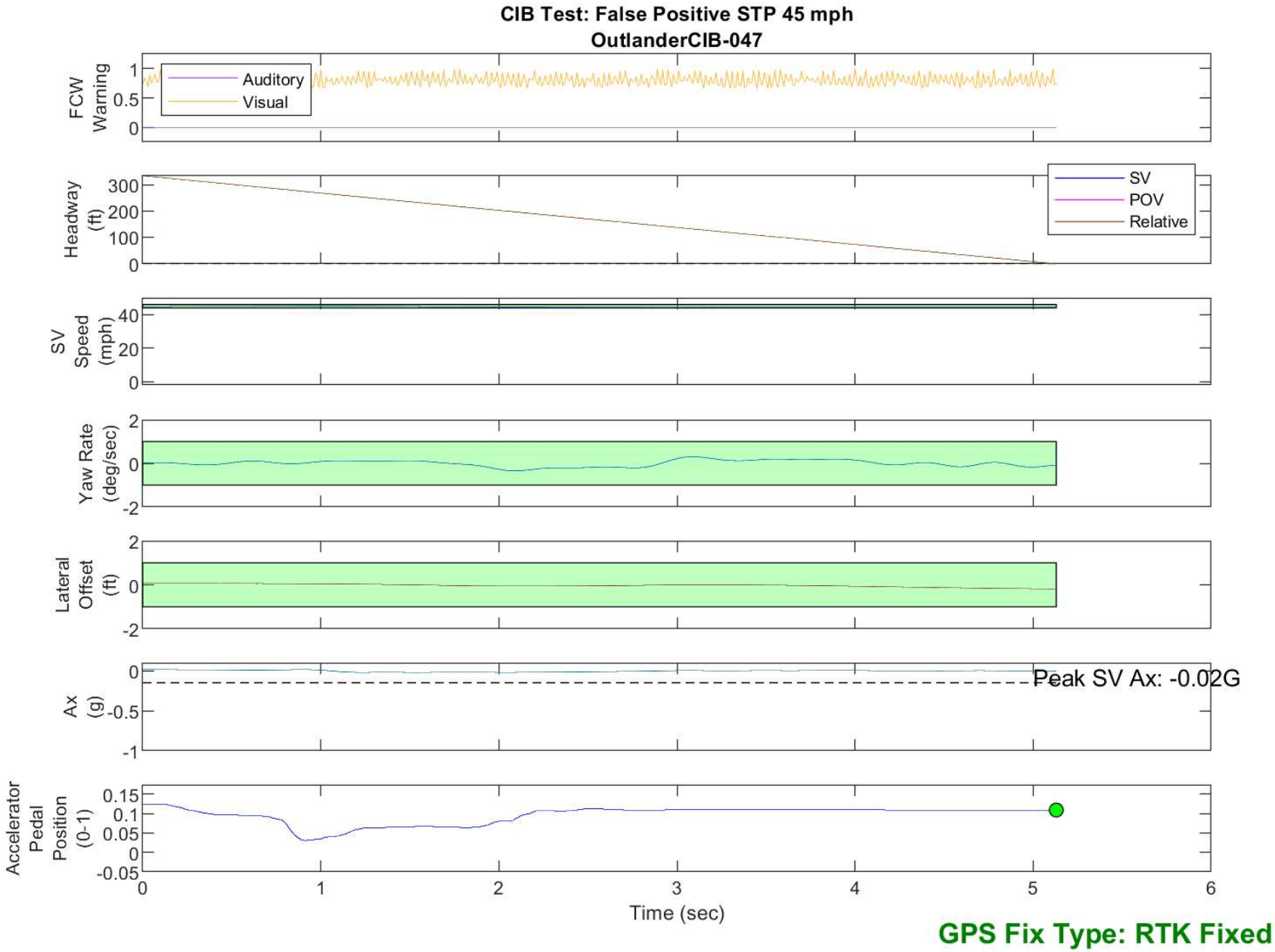


Figure D47. Time History for CIB Run 47, SV Encounters Steel Trench Plate, SV 45 mph

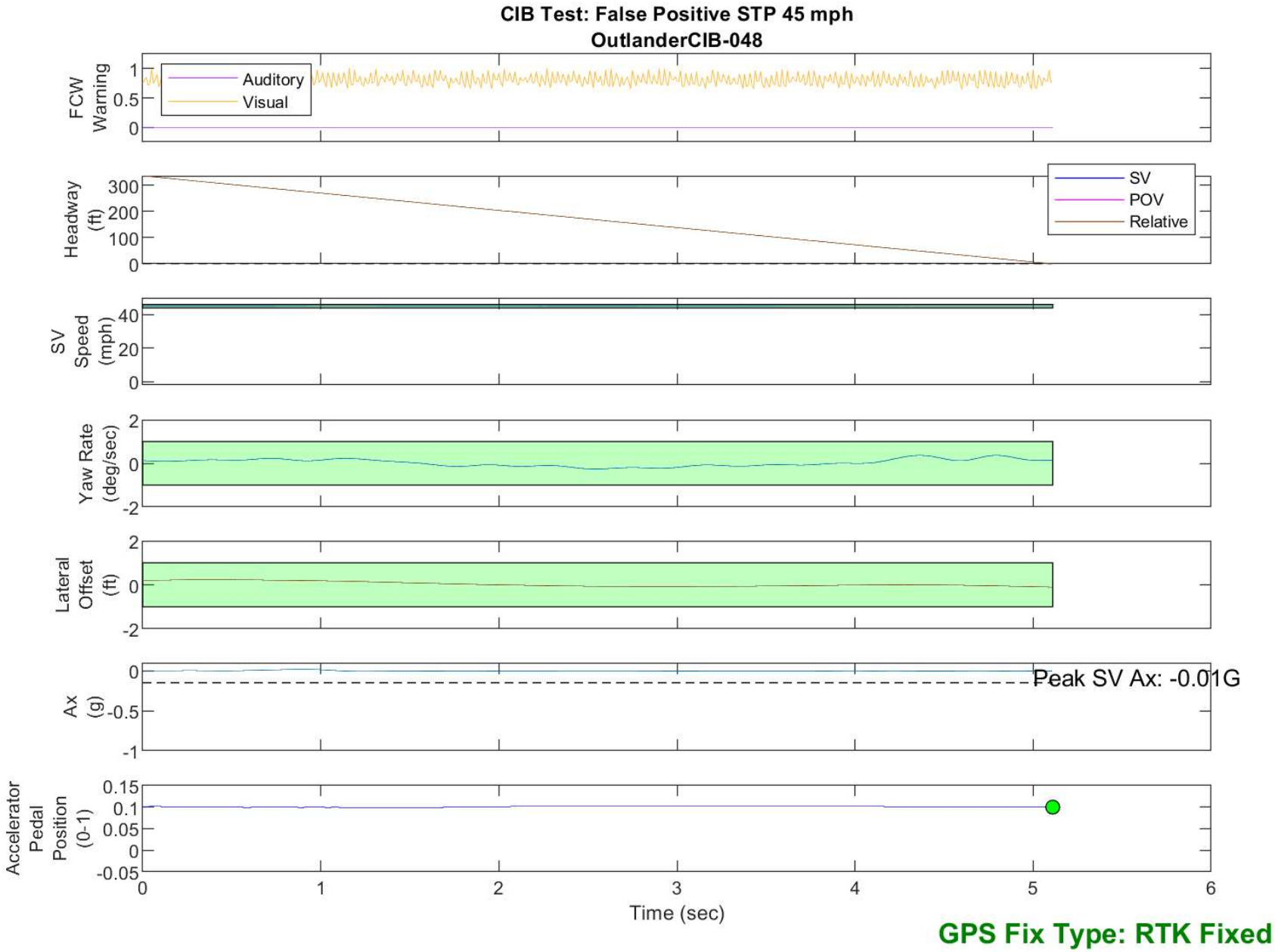


Figure D48. Time History for CIB Run 48, SV Encounters Steel Trench Plate, SV 45 mph

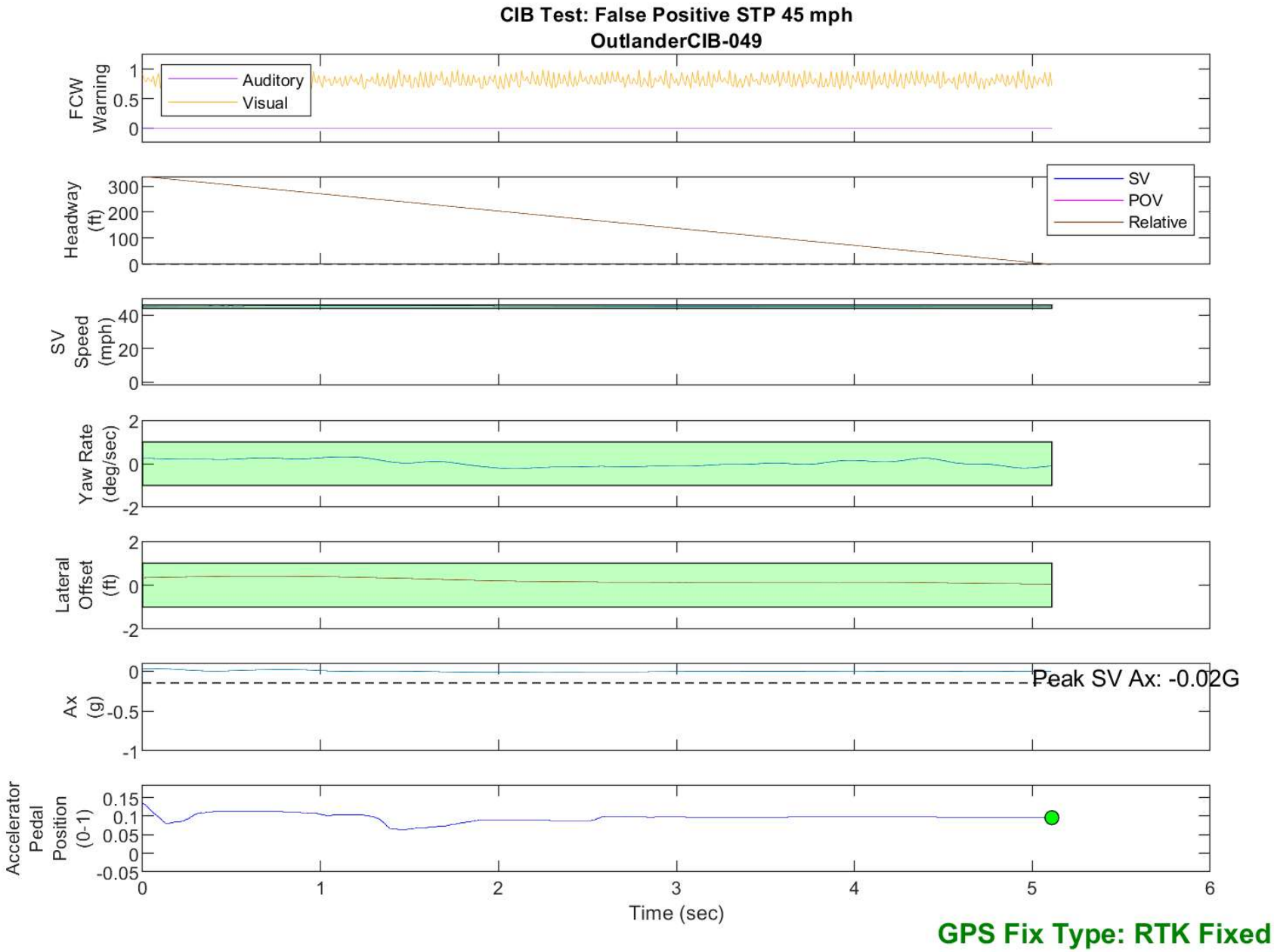


Figure D49. Time History for CIB Run 49, SV Encounters Steel Trench Plate, SV 45 mph

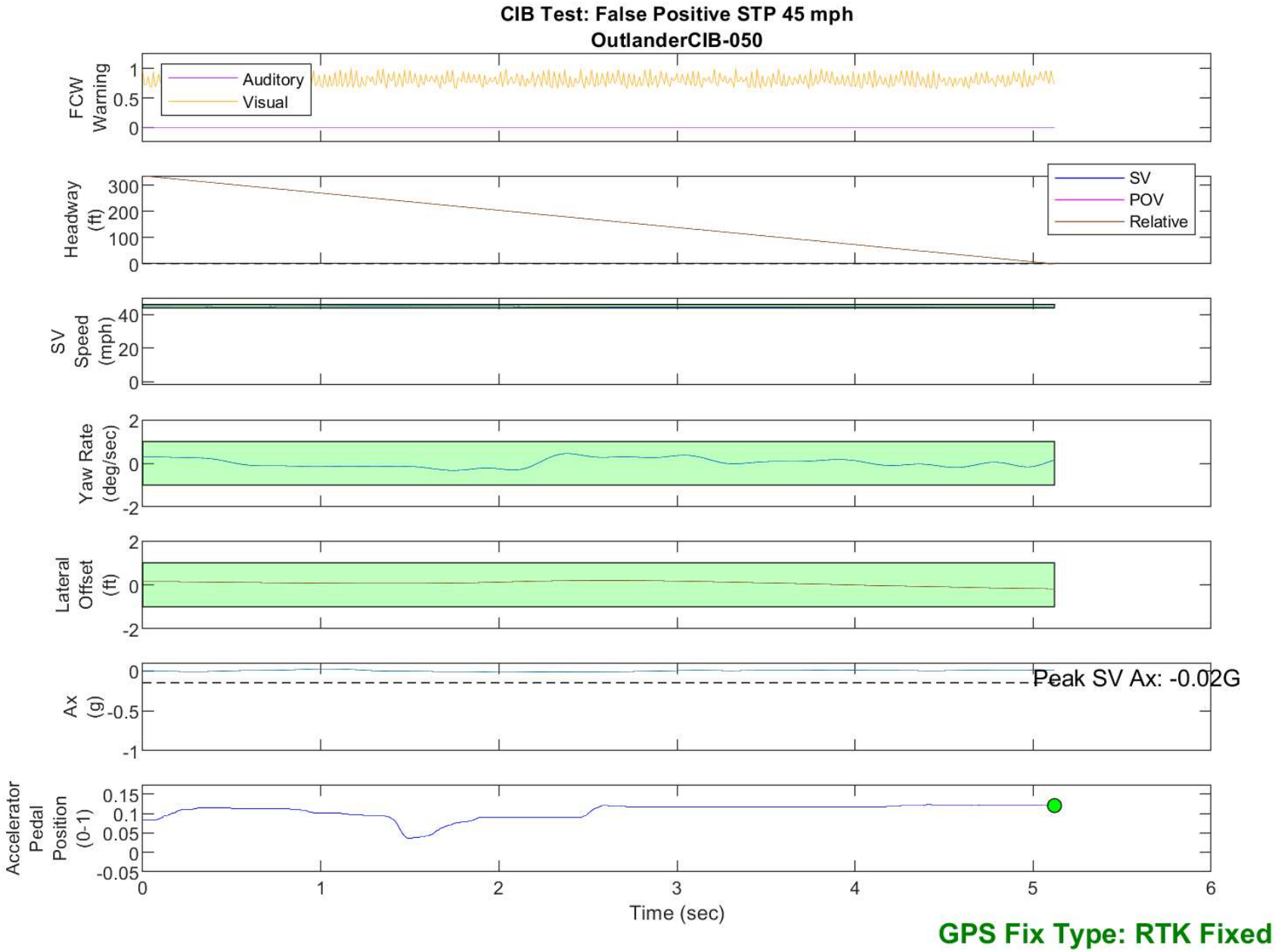


Figure D50. Time History for CIB Run 50, SV Encounters Steel Trench Plate, SV 45 mph

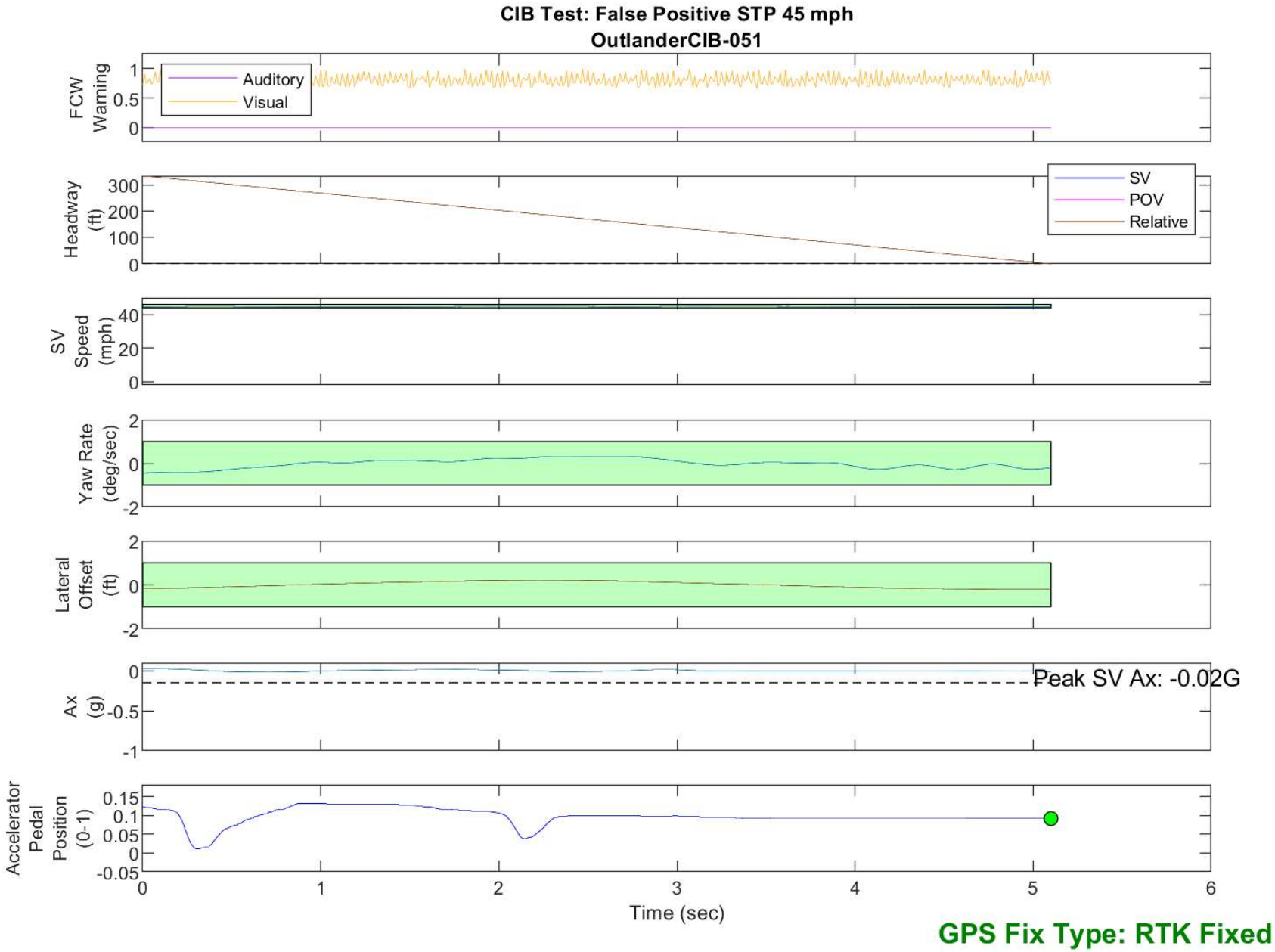


Figure D51. Time History for CIB Run 51, SV Encounters Steel Trench Plate, SV 45 mph