CRASH IMMINENT BRAKING SYSTEM RESEARCH TEST
NCAP-DRI-CIBHS-20-02

2019 Audi A6 55 TFSI (3.0T) quattro

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Final Report

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National Highway Traffic Safety Administration
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16. Abstract These research tests were conducted on the subject 2019 Audi A6 55 TFSI (3.0T) quattro in accordance with the specifications of the New Car Assessment Program's most current Test Procedure in docket NHTSA-2015-0006-0025; CRASH IMMINENT BRAKE SYSTEM PERFORMANCE EVALUATION FOR THE NEW CAR ASSESSMENT PROGRAM, October 2015, with modifications to include use of the Global Vehicle Target (GVT) and additional test speeds or deceleration rates to assess system performance and point of failure. The vehicle met the tentative requirements for 58 out of 58 valid test runs.			
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Section I

INTRODUCTION

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

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

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

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

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

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

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

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

Section II

DATA SHEETS

CRASH IMMINENT BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

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2019 Audi A6 55 TFSI (3.0T) quattro

VIN: *WAUL2AF2XKN04xxxx* Test Date: *10/23/2020*

Crash Imminent Braking System setting: *Early*

		Number of valid test runs for which acceptability[3] criteria were:		
Test 1 –	**Subject Vehicle Encounters Stopped Principal Other Vehicle**	**Met**	**Not met**	**Valid Runs**
	SV 25 mph:	*7*	*0*	*7*
	SV 30 mph:	*5*	*0*	*5*
	SV 35 mph:	*5*	*0*	*5*
	SV 40 mph:	*5*	*0*	*5*
	SV 45 mph:	*5*	*0*	*5*
Test 2 –	**Subject Vehicle Encounters Slower Principal Other Vehicle**			
	SV 25 mph POV 10 mph:	*7*	*0*	*7*
	SV 45 mph POV 20 mph:	*7*	*0*	*7*
Test 3 –	**Subject Vehicle Encounters Decelerating Principal Other Vehicle**			
	SV 35 mph POV 35 mph, 0.3 g decel:	*7*	*0*	*7*
	SV 35 mph POV 35 mph, 0.5 g decel:	*5*	*0*	*5*
	SV 45 mph POV 45 mph, 0.3 g decel:	*5*	*0*	*5*
	Overall:	***58***		***58***

Notes:

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

CRASH IMMINENT BRAKING

DATA SHEET 2: VEHICLE DATA

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2019 Audi A6 55 TFSI (3.0T) quattro

TEST VEHICLE INFORMATION

VIN: *WAUL2AF2XKN04xxxx*

Body Style: *Sedan* Color: *Vesuvius Gray Metallic*

Date Received: *8/24/2020* Odometer Reading: *2143 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Audi AG*

Date of manufacture: *11 18*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *255/40 R20 101 H*

Rear: *255/40 R20 101 H*

Recommended cold tire pressure: Front: *250 kPa (36 psi)*

Rear: *260 kPa (38 psi)*

TIRES

Tire manufacturer and model: *Michelin Primacy MXM4*

Front tire designation: *255/40 R20 101H*

Rear tire designation: *255/40 R20 101H*

Front tire DOT prefix: *F3L2 00LX*

Rear tire DOT prefix: *F3L2 00LX*

CRASH IMMINENT BRAKING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2019 Audi A6 55 TFSI (3.0T) quattro

GENERAL INFORMATION

Test date: *10/23/2020*

AMBIENT CONDITIONS

Air temperature: *26.7 C (80 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: *250 kPa (36 psi)*

Rear: *260 kPa (38 psi)*

CRASH IMMINENT BRAKING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2019 Audi A6 55 TFSI (3.0T) quattro

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*569.3 kg (1255 lb)*	Right Front:	*580.6 kg (1280 lb)*
Left Rear:	*451.8 kg (996 lb)*	Right Rear:	*476.3 kg (1050 lb)*
		Total:	*2078.0 kg (4581 lb)*

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

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2019 Audi A6 55 TFSI (3.0T) quattro

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

Pre Sense Front comes standard on all trims.

Type and location of sensors the system uses:

Camera mounted near the inside rearview mirror

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

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

10 km/h (6 mph) (Per manufacturer supplied information)

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

250 km/h (155 mph) (Per manufacturer supplied information)

Does the vehicle system require an initialization sequence/procedure?

___ Yes

X No

If yes, please provide a full description.

No, but there is an initialization phase for a few seconds after the ignition is turned on. This is indicated by a lamp in the instrument cluster. It is not necessary to cycle the ignition.

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

___ Yes

X No

If yes, please provide a full description.

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

X Warning light

X Buzzer or audible alarm

___ Vibration

X Other Brake Jerk

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

The visual alert is presented in the center of the instrument cluster between the speedometer and tachometer. It is shown in Figure A14 in Appendix A.

The auditory alert is presented as a single pulse tone centered at 1809 Hz.

There is also a brake jerk as part of the warning cascade.

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.

Pre Sense Front (FCW) can be disabled by using the vehicle settings menus. These can be accessed by two different methods.

1. Using the touch screen select

Vehicle

Driver Assistance

2. Press the Driver assistance setting button (Appendix A, Figure A13)

From the Driver Assistance page select the gear icon in the upper right of the screen, then

Audi pre sense

Prewarning

Toggle the top radio button for on/off

See Appendix A, Figures A11 and A12.

CRASH IMMINENT BRAKING

DATA SHEET 4: CRASH IMMINENT BRAKING SYSTEM OPERATION

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2019 Audi A6 55 TFSI (3.0T) quattro

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

If yes, please provide a full description.

The Pre Sense Front (FCW) sensitivity can be adjusted by using the vehicle settings menus. These can be accessed by two different methods.

1. Using the touch screen select

Vehicle

Driver Assistance

2. Press the Driver assistance setting button (See Appendix A, Figure A13)

From the Driver Assistance page select the gear icon in the upper right of the screen, then

Audi pre sense

Prewarning

Select Early, Medium, or Late

See Appendix A Figures A11 and A12.

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

If yes, please provide a full description.

The system has a self-test algorithm, which will reduce the system performance or deactivate completely if the following conditions are observed:

- *Mud/dirt/snow accumulation on the sensor*
- *ESC Turned off or in sport mode*

If the system detects sensor blockage, FCW, DBS, CIB will not be available, and the system will show a notification in the vehicle cluster.

For a more comprehensive list of other driving modes or conditions that render FCW inoperable or reduce its effective, see Appendix B, Page B-3 (Owner's Manual, Page 114).

Section III

TEST PROCEDURES

A. Test Procedure Overview

Three test scenarios were used, as follows:

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

Test 2. Subject Vehicle Encounters Slower Principal Other Vehicle

Test 3. Subject Vehicle Encounters Decelerating Principal Other Vehicle

An overview of each of the test procedures follows.

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

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

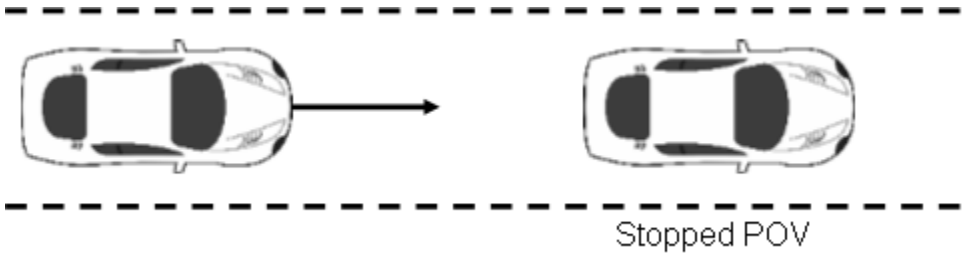

Figure 1. Depiction of Test 1

Table 2. Test Conditions for Stopped POV

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

a. Procedure

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

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

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

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

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

b. Criteria

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

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

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

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

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

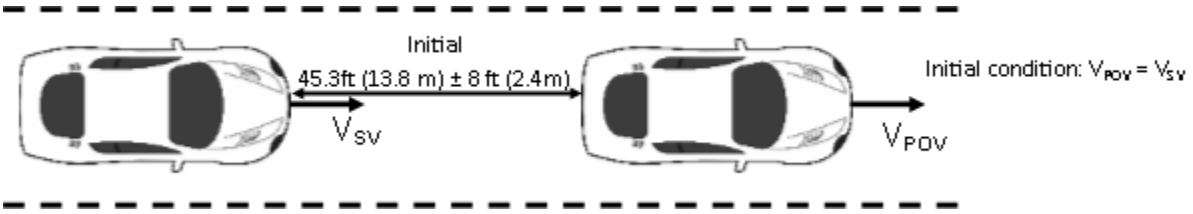

Figure 2. Depiction of Test 2

Table 3. Test Conditions for Slower POV

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

a. Procedure

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

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

The SV driver then braked to a stop.

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

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

b. Criteria

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

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

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

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

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

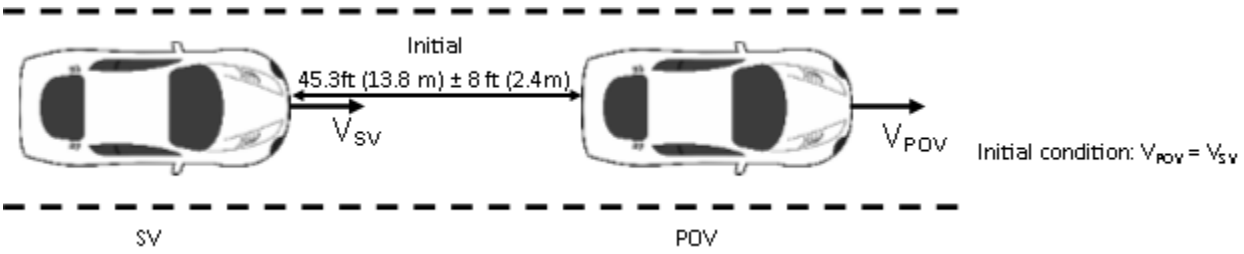

Figure 3. Depiction of Test 3 with POV Decelerating with V_0 =35 mph (56.3 km/h)

Table 4. Test Conditions for Decelerating POV

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

a. Procedure

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

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

The SV driver then braked to a stop.

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

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

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

b. Criteria

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

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

B. General Information

1. T_{FCW}

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

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

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

Table 5. Audible and Tactile Warning Filter Parameters

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

2. GENERAL VALIDITY CRITERIA

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

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

3. VALIDITY PERIOD

The valid test interval began:

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

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

Test 3: 3 seconds before the onset of POV braking

The valid test interval ended:

Test 1: When either of the following occurred:

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

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

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

4. STATIC INSTRUMENTATION CALIBRATION

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

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

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

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

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

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

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

5. NUMBER OF TRIALS

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

6. TRANSMISSION

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

C. Principal Other Vehicle

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

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

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

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

The key requirements of the POV element are to:

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

The key requirements of the POV delivery system are to:

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

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

D. Automatic Braking System

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

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

E. Instrumentation

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

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

Table 6. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and 100 psi	Omega DPG8001	17042707002	By: DRI Date: 8/18/2020 Due: 8/18/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 4/20/2020 Due: 4/20/2021
Linear (string) encoder	Throttle pedal travel	10 in 254 mm	0.1 in 2.54 mm	UniMeasure LX-EP	49041189	By: DRI Date: 5/22/2020 Due: 5/22/2021
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
SV Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal	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 +	2258	By: Oxford Technical Solutions Date: 5/3/2019 Due: 5/3/2021

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
POV Multi-Axis Inertial Sensing System	and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Latitude: ±90º Longitude: ±180º Altitude: 0-18 km Velocity: 0-1000 knots Accel: ±30g Angular Rate: ±300 º/s Angular Disp: ±180º	Position: ±2 cm Velocity: 0.1 km/h Accel: ≤ 0.05% Angular Rate: ≤ 0.05% Roll/Pitch Angle: ±0.05º Heading Angle: ±0.1º	Oxford PinPoint 2G	24504	By: Oxford Technical Solutions Date: 7/18/2019 Due: 7/18/2021

Table 6. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2020 Due: 1/6/2021
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	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

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	N/A	N/A

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

LOC: PR * Dealer Stock Status: SOLD
Exterior: Vesuvius Gray Metallic

VIN: WAUL2AF2XKN04
Interior: Black Interior

MODEL: 4A2B2Y-2019 Audi A6 55 TFSI (3.0T) quattro
2018345-ORIGINAL

2019 Audi A6 55 TFSI (3.0T) quattro

STANDARD EQUIPMENT (unless replaced by options)

TECHNICAL
- 3.0 TFSI® V6 engine
- quattro® all-wheel drive system
- 7-speed S tronic® transmission
- 19" 5-double-spoke bi color wheels, 245/45 all-season tires
- Energy recuperation with start-stop system
- Space-saving spare tire

COMFORT/TECHNOLOGY
- Audi connect® CARE (limited time subscription)
- Audi connect® PRIME & PLUS (6 month trial)
- Audi MMI Navigation w/ MMI touch response and traffic information online
- Audi smartphone interface
- Audi sound system
- Dark Brown Walnut wood inlays
- Garage door opener (HomeLink®)
- Heated, auto-dimming, exterior mirrors, w/ memory
- Heated, 8-way power front seats w/ driver memory and 4-way lumbar adjustment
- Leather seating surfaces
- LED headlights
- Parking system plus
- Preparation for mobile phone (Bluetooth®)
- Power adjustable steering column with memory
- Power sunroof
- S line exterior
- Split-folding rear seat back with pass-through (40/20/40)
- Three-zone automatic climate control
- 3-spoke multi-function steering wheel w/ shift paddles

SAFETY/CONVENIENCE
- Advanced Airbag Protection System with 8 airbags
- Anti-lock Braking System (ABS) w/ Brake Assist
- Audi pre sense basic (preventative occupant protection)
- Audi pre sense front (low speed collision assist)
- Child safety locks in rear doors, power
- Electronic Stabilization Control (ESC) w/ Sport mode
- Electronic vehicle immobilization w/ anti-theft alarm
- LED Daytime Running Lights (DRLs)
- LED taillights w/ dynamic turn signals
- Lower Anchors and Tethers for CHildren (LATCH)
- Rearview camera
- Tire Pressure Monitoring System (TPMS)

WARRANTY/MAINTENANCE
- 4 Year/50,000 mile (whichever occurs first) New Vehicle Limited Warranty*
- 12 Year Limited Warranty Against Corrosion Perforation
- 1 Year/10,000 mile (whichever occurs first) First Scheduled Maintenance Service FREE OF CHARGE
- 4 Years Roadside Assistance coverage provided by a third party supplier

*Please refer to the 2019 Audi Warranty and Maintenance Booklet for complete coverage information.

MANUFACTURER'S SUGGESTED RETAIL PRICE

2019 Audi A6 55 TFSI (3.0T) quattro	**$58,900.00**
PACKAGES / OPTIONS	
Vesuvius Gray metallic	$595.00
Black interior	Included
Premium Plus package	$3,800.00
Audi MMI Navigation w/touch response, 10.1" screen	
Audi virtual cockpit	
Bang & Olufsen® Premium 3D sound system	
Audi phone box w/wireless charging and antenna booster	
Audi advanced key	
Audi side assist, rear cross traffic,Audi pre sense rear	
Power-folding exterior mirrors	
Matrix design LED headlights	
Highbeam assist, Headlight washer system	
Top view camera system	
Driver Assistance package	$2,750.00
20" Sport package	$1,050.00
20" 5-V-spoke bi-color wheels, 255/40 all-season tires	
Sport suspension	
Cold Weather package	$600.00
Heated steering wheel	
Heated rear seats	
Audi Beam - Rings	$450.00
Interior Protection Package	$210.00
Gray/Brown Fine Grain Ash natural wood inlays	Included
Destination Charge	$995.00
Total Price:	**$69,350.00**

Fuel, license, title fees, taxes and dealer-installed accessories are not included.

MODEL: 4A2B2Y

VIN: WAUL2AF2XKN04

DEALER:

SHIP TO:

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score **Not Rated**
Based on the combined ratings of frontal, side and rollover.
Should ONLY be compared to other vehicles of similar size and weight.

Frontal Crash	Driver	**Not Rated**
	Passenger	**Not Rated**

Based on the risk of injury in a frontal impact.
Should ONLY be compared to other vehicles of similar size and weight.

Side Crash	Front Seat	**Not Rated**
	Rear Seat	**Not Rated**

Based on the risk of injury in a side impact.

Rollover **Not Rated**
Based on the risk of rollover in a single-vehicle crash.

Star ratings range from 1 to 5 stars (★★★★★) with 5 being the highest.
Source: National Highway Traffic Safety Administration (NHTSA).
www.safercar.gov or 1-888-327-4236

EPA DOT Fuel Economy and Environment

Gasoline Vehicle

Fuel Economy
25 MPG
combined city/hwy

22 city

29 highway

4 gallons per 100 miles

Mid-Size Cars range from 14 to 136 MPG.
The best vehicle rates 136 MPGe.

You **spend $2,000** more in fuel costs over 5 years compared to the average new vehicle.

Annual fuel **cost** **$1,800**

Fuel Economy & Greenhouse Gas Rating (tailpipe only): 5 (1 – 10, Best)

Smog Rating (tailpipe only): 5 (1 – 10, Best)

This vehicle emits 360 grams of CO_2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions; learn more at fueleconomy.gov.

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and costs $7,000 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $3.00 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov
Calculate personalized estimates and compare vehicles

Smartphone QR Code℠

PARTS CONTENT INFORMATION

FOR VEHICLES IN THIS CARLINE:		FOR THIS VEHICLE:	
U.S./CANADIAN PARTS CONTENT:	1%	FINAL ASSEMBLY POINT: NECKARSULM, GERMANY	
MAJOR SOURCES OF FOREIGN		COUNTRY OF ORIGIN: ENGINE: HUNGARY	
PARTS CONTENT: GERMANY:	53%	TRANSMISSION: GERMANY	
HUNGARY:	21%		

NOTE: PARTS CONTENT DOES NOT INCLUDE FINAL ASSEMBLY, DISTRIBUTION OR OTHER NON-PARTS COSTS.

Disclaimer: The Monroney describes the vehicle features when the vehicle was first sold/leased to the customer and that as of the present day the actual features on the vehicle might differ from the ones listed on the Monroney label. The Monroney label is for view only purposes and must not be used to paste on the vehicle as a Monroney sticker for resale.

Figure A3. Window Sticker (Monroney Label)

Figure A4. Vehicle Certification Label

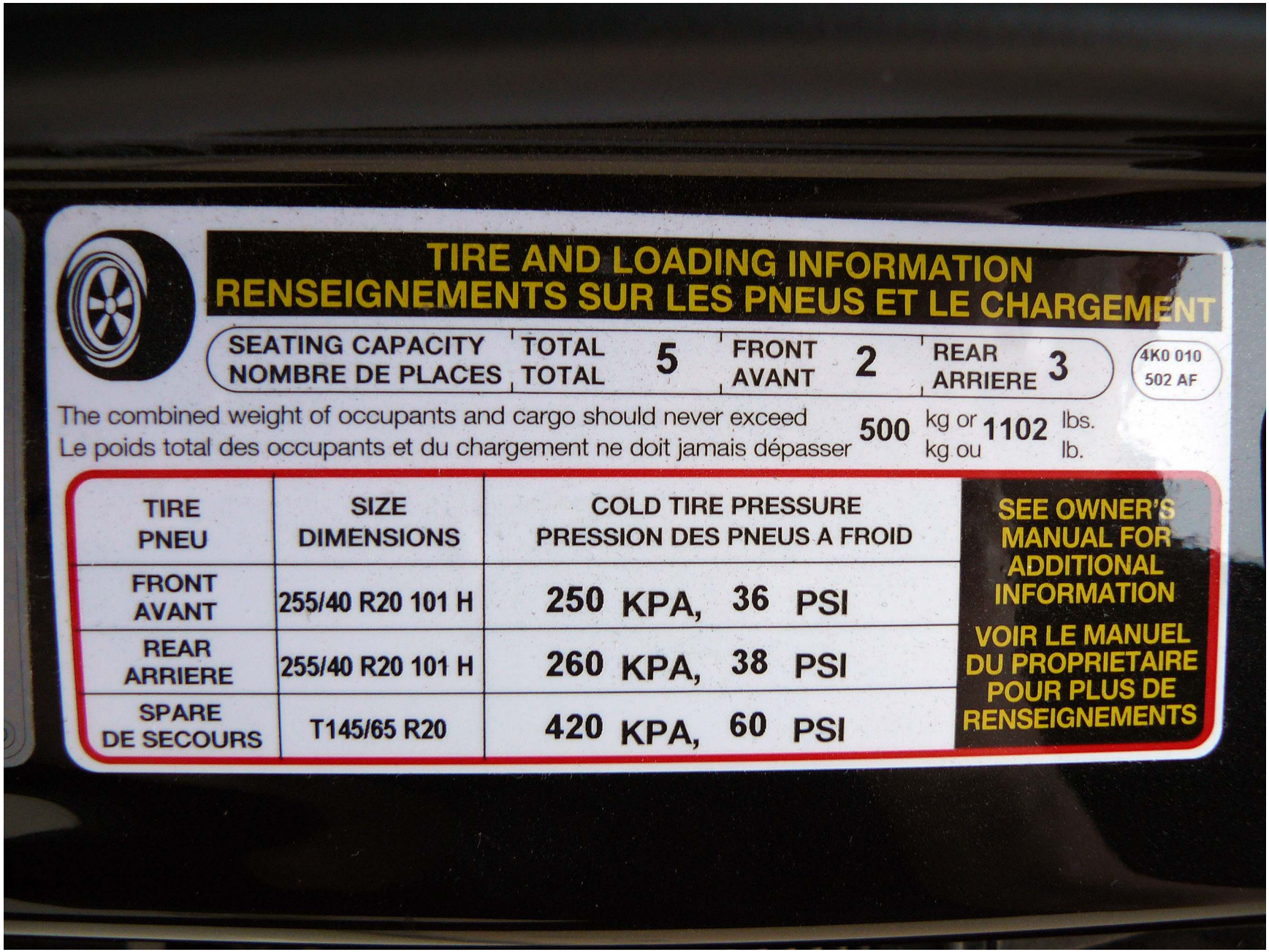

Figure A5. Tire Placard

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

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

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

Figure A9. Sensors for Detecting Auditory and Visual Alerts

Figure A10. Computer Installed in Subject Vehicle

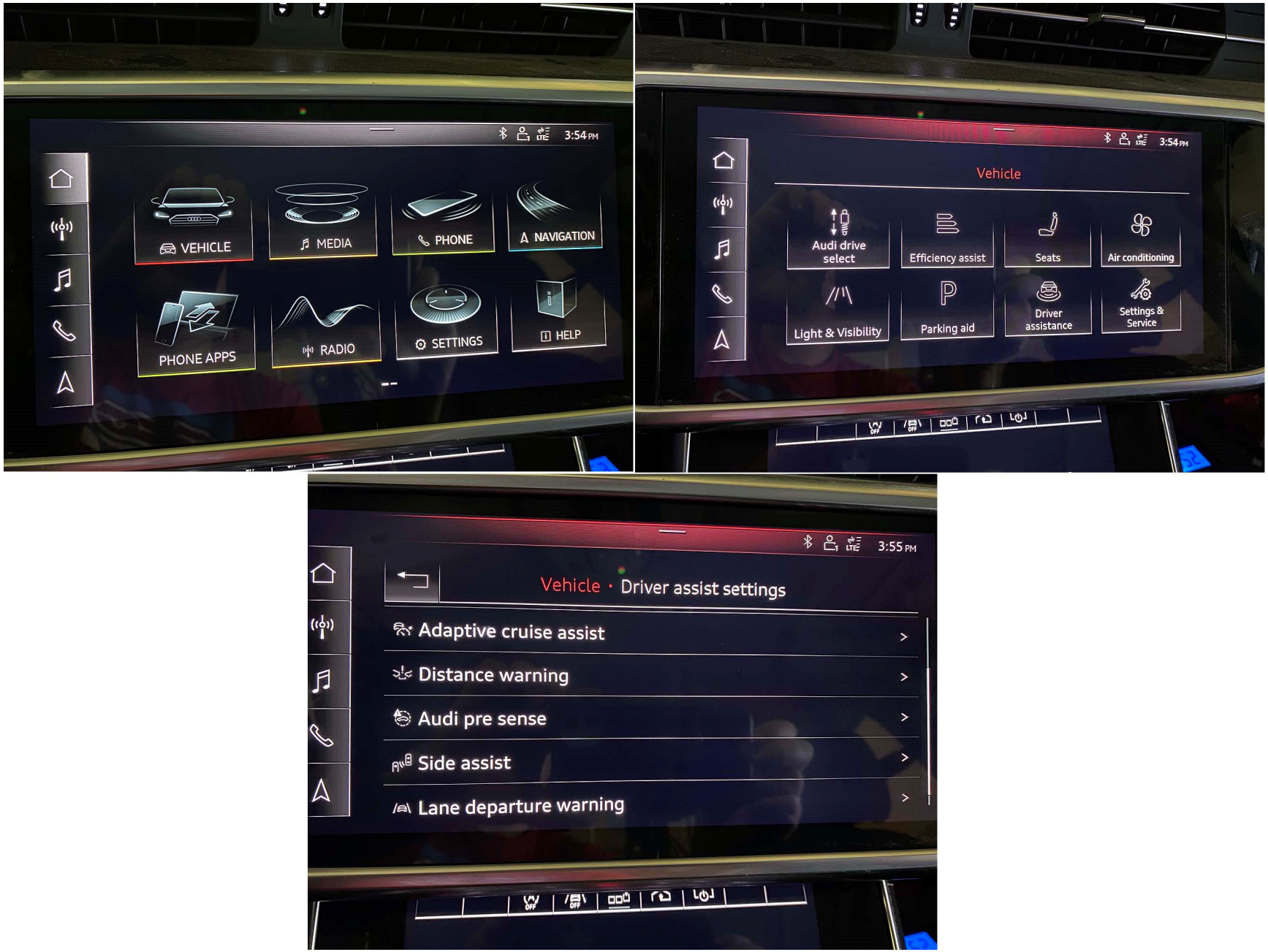

Figure A11. AEB Setup Menus (page 1 of 2)

Figure A12. AEB Setup Menus (page 2 of 2)

Figure A13. Button for Directly Accessing Driver Assistance Settings Menus

Figure A14. Visual Alert

APPENDIX B

Excerpts from Owner’s Manual

BRAKE	Brake system ✓ ⇨ *page 100*, ⇨ *page 102*, ⇨ *page 234*
	Steering ✓ ⇨ *page 106*
	Steering lock ⇨ *page 106*
	Air suspension ⇨ *page 105*
	Electrical system ⇨ *page 235*
	Engine oil level (MIN) ⇨ *page 229*
	Engine oil pressure ⇨ *page 229*
	Cooling system ⇨ *page 232*
	Hood ⇨ *page 227*
	Loose wheel warning ⇨ *page 254*
	Night vision assist ⇨ *page 124*
	Night vision assist ⇨ *page 124*
	Distance warning ⇨ *page 139*
	Steering intervention request ⇨ *page 135*
	Safe start monitor ⇨ *page 137*, Driver intervention request ⇨ *page 137*
	Lane departure warning ⇨ *page 140*
	Lane departure warning ⇨ *page 140*
	Audi pre sense ⇨ *page 143*, Intersection assist ⇨ *page 149*

Yellow indicator lights

	Central indicator light ⇨ *page 7*
	Safety systems ✓ ⇨ *page 69*
	Transmission ⇨ *page 96*
	Drive system ⇨ *page 98* Cooling system ⇨ *page 232*
	Engine start system ⇨ *page 91*
	Keys ⇨ *page 91*
	Electromechanical parking brake ⇨ *page 102*
	Brake system ⇨ *page 100*
	Electronic Stabilization Control (ESC) ✓ ⇨ *page 108*
OFF	Electronic Stabilization Control (ESC) ✓ ⇨ *page 108*
ESC OFF	Electronic Stabilization Control (ESC) ⇨ *page 109*
ABS	Anti-lock braking system (ABS) ✓ ⇨ *page 110*
	Anti-lock braking system (ABS) ✓ ⇨ *page 110*
	Steering ⇨ *page 106*
	Steering lock ⇨ *page 106*
	All wheel drive ⇨ *page 108*
	Suspension control ⇨ *page 105*
	Air suspension ⇨ *page 105*

	Engine speed limitation ⇨ *page 15*
	Tank system ⇨ *page 224*
	Electrical system ⇨ *page 235*
	Engine oil level (MIN) ⇨ *page 229*
	Engine oil level (MAX) ⇨ *page 229*
	Engine oil sensor ⇨ *page 229*
	Malfunction Indicator Lamp (MIL) ✓ ⇨ *page 226*
	Engine warm-up request ⇨ *page 229*
	Washer fluid level ⇨ *page 238*
	Windshield wipers ⇨ *page 57*
	Parking system plus ⇨ *page 153*
TPMS	Tire pressure ⇨ *page 257*
	Tire pressure ✓ ⇨ *page 257*
	Loose wheel warning ⇨ *page 254*
	Bulb failure indicator ⇨ *page 52*
	Adaptive light ⇨ *page 52*
	Light/rain sensor ⇨ *page 52*, ⇨ *page 57*
	Door lock ⇨ *page 34*
	Battery in vehicle key ⇨ *page 38*
	Night vision assist ⇨ *page 125*

	Intersection assistant ⇨ *page 149*
	Side assist ⇨ *page 147*; Exit warning ⇨ *page 148*
	Rear cross-traffic assist ⇨ *page 158*
	Adaptive cruise assist ⇨ *page 138*
	Steering intervention request ⇨ *page 135*, ⇨ *page 141*
	Lane departure warning ⇨ *page 141*
	Distance warning ⇨ *page 139*
	Audi pre sense ⇨ *page 145*
SOS	Emergency assist ⇨ *page 150*
SOS	Emergency call function ⇨ *page 180*

Other indicator lights

	Rear safety belt ✓ ⇨ *page 66*
	Start/Stop system ⇨ *page 98*
	Low beam headlight ⇨ *page 49*
	Parking light ⇨ *page 49*
	Turn signals ⇨ *page 50*
CRUISE	Cruise control system ⇨ *page 126*
	Cruise control system ⇨ *page 126*
	Efficiency assist ⇨ *page 127*
	Efficiency assist ⇨ *page 127*

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Assist systems

General information

Safety precautions

WARNING

- As the driver, you are always completely responsible for all driving tasks. The assist systems cannot replace the driver's attention. Give your full attention to driving the vehicle, and be ready to intervene in the traffic situation at all times.
- Activate the assist systems only if the surrounding conditions permit it. Always adapt your driving style to the current visual, weather, road, and traffic conditions.
- Loose objects can be thrown around the vehicle interior during sudden driving or braking maneuvers, which increases the risk of an accident. Store objects securely while driving.
- For the assist systems to be able to react correctly, the function of the sensors and cameras must not be restricted. Note the information on sensors and cameras ⇨ page 225.

Tips

- Pay attention to applicable local regulations relating to driving tasks, leaving space for emergency vehicles, vehicle distance, speed, parking location, wheel placement, etc. The driver is always responsible for following the laws that are applicable in the location where the vehicle is being operated.
- You can cancel a steering or braking intervention by the system, by braking or accelerating noticeably, steering, or deactivating the respective assist system.
- Always check the assist systems settings before driving. The settings could have been changed, for example, by other drivers or if another personal profile was used.

System limitations

WARNING

- The use of an assist system cannot overcome the natural laws of physics. A collision cannot be prevented in certain circumstances.
- Warnings, messages, or indicator lights may not be displayed or initiated on time or correctly, for example, if vehicles are approaching very fast.
- Corrective interventions by the assist systems, such as steering or braking interventions, may not be sufficient or they may not occur. Always be ready to intervene.

Tips

- Due to the system limitations when detecting the surrounding area, the systems may warn or intervene unexpectedly or too late in certain situations. The assist systems may also interpret a driving maneuver incorrectly and then warn the driver unexpectedly.
- The systems may not function as expected in unusual driving situations, such as driving offroad, on unpaved roads, on loose ground, on inclines, or on grooves in the road.
- The systems may not function correctly in unclear traffic situations, such as turning lanes, exit ramps, construction zones, rises or dips that obstruct visibility, intersections, toll stations, or city traffic.
- The detection of the surrounding area can be limited, for example by vehicles driving ahead or by rain, snow, heavy spray, or light shining into the camera.
- If accessories have been mounted on the steering wheel, the ability for the steering systems to react may be limited.

Audi pre sense rear

Applies to: vehicles with Audi pre sense rear

Within the limits of the system, **Audi pre sense rear** uses data from radar sensors in the rear area of the vehicle and calculates the probability of a rear-end collision with the vehicle behind you.

Audi pre sense preemptive safety measures can be initiated if the risk of a collision with the vehicle behind you is detected.

WARNING

- Follow the safety precautions and note the limits of the assist systems, sensors, and cameras ⇨ *page 114*.
- Audi pre sense rear does not react to pedestrians, animals, crossing objects, and objects not detected as vehicles.

Tips

Audi pre sense rear functions may also switch off if there is a malfunction in the side assist system.

Audi pre sense side

Applies to: vehicles with Audi pre sense side

Audi pre sense side uses data from the extra radar sensors installed in the front and rear areas of the vehicle, and other sensors can react to side impacts from cross-traffic and vehicles coming from the side.

Audi pre sense side is active at speeds up to approximately 35 mph (60 km/h). The Audi pre sense preemptive safety measures can be triggered when a collision risk is detected.

WARNING

- Follow the safety precautions and note the limits of the assist systems, sensors, and cameras ⇨ *page 114*.
- Audi pre sense side does not react to pedestrians, animals, and objects not detected as vehicles.

Tips

The Audi pre sense side functions may also switch off if there is a malfunction in the intersection assistant*.

Swerve assist

Applies to: vehicles with swerve assist

The swerve assist can help you to steer the vehicle around an obstacle detected in a critical area. If you avoid an obstacle after the acute warning, then swerve assist assists you by specifically braking individual wheels and applying slight steering adjustment to correct the steering wheel angle as long as you are actively steering. The swerve assist is available at speeds between approximately 20 mph and 90 mph (30 km/h - 150 km/h) [1].

WARNING

- Follow the safety precautions and note the limits of the assist systems, sensors, and cameras ⇨ *page 114*.
- Swerve assist does not react to pedestrians, animals, crossing objects, and objects not detected as vehicles.

Tips

- System functions may not be available if the ESC is limited or switched off, or if there is a malfunction.
- An indicator in the instrument cluster will inform you when there is an intervention.

[1] In preparation at the time of printing. The speed range may be within approximately 30 mph - 90 mph (50 km/h - 150 km/h) depending on the vehicle production date.

Turn assist

Applies to: vehicles with turn assist

When your vehicle is turning

The turn assist can assist you with a braking intervention when starting to drive or when driving slowly, to reduce the risk of your vehicle colliding with an oncoming vehicle when you are making a left turn[1]. The braking intervention causes your vehicle to stay in its lane. The function is only available when the turn signal is turned on and at speeds up to maximum of 6 mph (10 km/h).

WARNING

- Follow the safety precautions and note the limits of the assist systems, sensors, and cameras ⇨ *page 114*.
- The turn assist does not react to pedestrians, animals, crossing objects, and objects not detected as vehicles.

Tips

- System functions may not be available if the ESC is limited or switched off, or if there is a malfunction.
- An indicator in the instrument cluster will inform you when there is an intervention.

Adjusting Audi pre sense

Applies to: vehicles with Audi pre sense

The system can be switched on and off in the MMI ⇨ *page 117*.

You can adjust the Audi pre sense functions to your preferences. The settings depend on the vehicle equipment.

▸ Applies to MMI: Select on the home screen: **VEHICLE** > **Driver assistance** > (⚙) > **Audi pre sense**.

Possible settings:

– **Turn assist**
– **Swerve assist**

Prewarning[2] - The prewarning can be switched off or the Audi pre sense warning time can be set (**Early/Medium/Late**).

Set the warning time for the early warning to **Early** at first. If you feel that the prewarnings appear too early, then set the warning time to **Medium**. The **Late** warning time should only be set in special circumstances.

Tips

- Switch Audi pre sense off when you are not using public streets, when loading the vehicle onto a vehicle carrier, train, ship, or other type of transportation, or when towing the vehicle. This can help to prevent an undesired intervention from the Audi pre sense system.
- If the system is switched off, it switches on again automatically once the ignition is switched on again[2].
- Certain settings are stored automatically in the active personal profile.

Messages

Applies to: vehicles with Audi pre sense

If  or  is displayed when there is a malfunction, the Audi pre sense functions may be unavailable or may be limited.

A message that indicates the cause and possible solution may appear with some displays. The weather conditions may be too poor or a sensor may be covered. Clean the area in front of the sensors ⇨ *page 116, fig. 85*, ⇨ *page 116, fig. 86* and try to turn on the systems again later.

If the malfunction remains, drive to an authorized Audi dealer or authorized Audi Service Facility immediately to have the malfunction corrected.

[1] When making a right turn in countries with left-hand drive vehicles.
[2] In certain countries

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APPENDIX C

Run Log

Subject Vehicle: **2019 Audi A6 55 TFSI (3.0T) quattro** Test Date: **10/23/2020**

Principal Other Vehicle: **GVT**

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Acceptability Criteria met [5]	Notes
54	**Stopped POV 25 mph**	Y	1.56	0.88	25.0	1.11	1.36	Yes	
55		Y	1.50	1.08	24.9	1.08	1.37	Yes	
56		Y	1.55	1.23	24.9	1.09	1.37	Yes	
57		Y	1.57	1.05	25.0	1.18	1.36	Yes	
58		Y	1.53	1.40	25.0	1.08	1.35	Yes	
59		Y	1.62	1.45	24.8	1.08	1.14	Yes	
60		Y	1.45	0.32	24.7	1.06	1.37	Yes	
61	Static Run								
62	**Stopped POV 30 mph**	Y	1.69	3.66	29.6	1.08	1.43	Yes	
63		Y	1.67	3.58	29.4	1.07	1.41	Yes	
64		Y	1.62	3.85	29.4	1.12	1.40	Yes	
65		Y	1.78	3.74	29.8	1.09	1.44	Yes	
66		Y	1.61	3.47	29.8	1.10	1.43	Yes	
67	Static Run								
68	**Stopped POV 35 mph**	Y	1.92	2.26	34.7	1.10	1.48	Yes	
69		Y	1.89	3.70	34.4	1.11	1.53	Yes	
70		Y	1.90	0.00	30.0	1.07	1.57	Yes	
71		Y	1.86	2.27	34.2	1.08	1.46	Yes	
72		Y	1.86	2.44	34.3	1.11	1.53	Yes	
73	Static Run								

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

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Acceptability Criteria met [5]	Notes
74	**Stopped POV 40 mph**	Y	2.10	0.00	31.9	1.08	1.53	Yes	
75		Y	1.99	0.00	32.0	1.10	1.53	Yes	
76		Y	2.04	0.00	35.3	1.11	1.54	Yes	
77		Y	2.12	2.74	39.8	1.09	1.60	Yes	
78		Y	2.07	0.23	39.5	1.08	1.55	Yes	
79	Static Run								
80	**Stopped POV 45 mph**	Y	2.26	0.00	29.9	1.10	1.56	Yes	
81		Y	2.14	0.00	22.3	1.13	1.29	Yes	
82		Static Run							
83		Y	2.20	0.00	28.9	1.08	1.43	Yes	
84		Y	2.20	0.00	30.9	1.08	1.58	Yes	
85		N							Late throttle drop
86		Y	2.30	0.00	31.4	1.10	1.44	Yes	
87									
88	Static Run								
37	**Slower POV 25/10 mph**	Y	1.46	4.38	15.1	1.08	1.18	Yes	
38		Y	1.46	2.22	14.9	1.10	1.24	Yes	
39		Y	1.46	0.99	14.4	1.09	1.16	Yes	
40		Y	1.47	1.37	14.5	1.11	1.26	Yes	
41		Y	1.50	1.61	15.1	1.03	1.19	Yes	
42		Y	1.45	1.28	14.8	1.04	1.18	Yes	
43		N							Aborted run
44		Y	1.52	1.37	14.8	1.03	1.22	Yes	
45	Static Run								

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Acceptability Criteria met [5]	Notes
46	**Slower POV 45/20 mph**	Y	2.23	1.37	25.0	1.14	1.41	Yes	
47		Y	2.14	2.84	25.2	1.15	1.39	Yes	
48		Y	2.19	1.89	25.2	1.16	1.44	Yes	
49		Y	2.23	1.81	24.7	1.18	1.41	Yes	
50		Y	2.29	2.18	25.1	1.17	1.42	Yes	
51		Y	2.10	4.52	25.0	1.16	1.26	Yes	
52		Y	2.20	3.59	25.1	1.14	1.45	Yes	
53	Static Run								
1	Static								
2	**Decelerating POV, 0.5g 35 mph**	Y	1.45	0.00	23.8	1.13	1.19	Yes	Contact
3		Y	1.15	0.00	26.6	1.11	1.15	Yes	Contact
4		Y	1.22	0.00	24.5	1.09	1.16	Yes	Contact
5		Y	1.33	0.00	25.4	1.10	1.33	Yes	Contact
6		Y	1.44	0.00	28.5	1.12	1.31	Yes	Contact
7	Static Run								
8	**Decelerating POV, 0.3g 45 mph**	N							GPS, POV brake
9		N							POV brakes
10		N							POV brakes
11		Y	1.73	0.00	23.0	1.08	1.29	Yes	
12		N							Lateral offset
13		Y	1.59	1.83	24.9	1.06	1.26	Yes	
14		N							POV brakes
15		N							POV brakes, throttle
16		N							POV brakes
17		Y	1.78	0.00	22.3	1.10	1.20	Yes	
18		Y	1.80	0.00	17.8	1.07	1.09	Yes	
19		N							POV brakes

Run	Test Type	Valid Run?	FCW TTC (s)	Min. Distance (ft)	Speed Reduction (mph)	Peak Decel. (g)	CIB TTC (s)	Acceptability Criteria met [5]	Notes
20		N							Lateral offset
21		N							Lateral offset, throttle, POV brakes
22		Y	1.72	1.07	23.8	1.10	1.19	Yes	
23	Static Run								
24	**Decelerating POV, 0.3g 35 mph**	Y	1.53	1.18	23.2	1.13	1.18	Yes	
25		Y	1.58	2.15	23.6	1.06	1.28	Yes	
26		N							SV POV speed, lateral offset
27		N							Lateral offset
28		Y	1.48	0.00	15.7	1.06	1.19	Yes	
29		N							GPS RTK fixed or less
30		Y	1.65	2.01	23.9	1.07	1.22	Yes	
31		Static Run							
32		Y	1.39	1.84	24.7	1.18	1.33	Yes	
33		N							POV braking
34		Y	1.41	0.51	24.7	1.09	1.23	Yes	
35		Y	1.55	0.00	21.9	1.10	1.17	Yes	
36	Static Run								

APPENDIX D

Time History Plots

LIST OF FIGURES

Description of Time History Plots

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

Time History Plot Description

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

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

Time history figures include the following sub-plots:

- FCW Warning – Displays the Forward Collision Warning alert (which can be audible, visual, or haptic). Depending on the type of FCW alert or instrumentation used to measure the alert, this can be any combination of the following:
    - Filtered, rectified, and normalized sound signal. The vertical scale is 0 to 1.
    - Filtered, rectified, and normalized acceleration (i.e., haptic alert, such as steering wheel vibration). The vertical scale is 0 to 1.
    - Normalized light sensor signal. The vertical scale is 0 to 1.

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

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

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

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

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

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

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

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

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

Envelopes and Thresholds

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

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

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

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

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

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

Color Codes

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

Color codes can be broken into four categories:

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

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

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

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

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

Other Notations

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

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

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

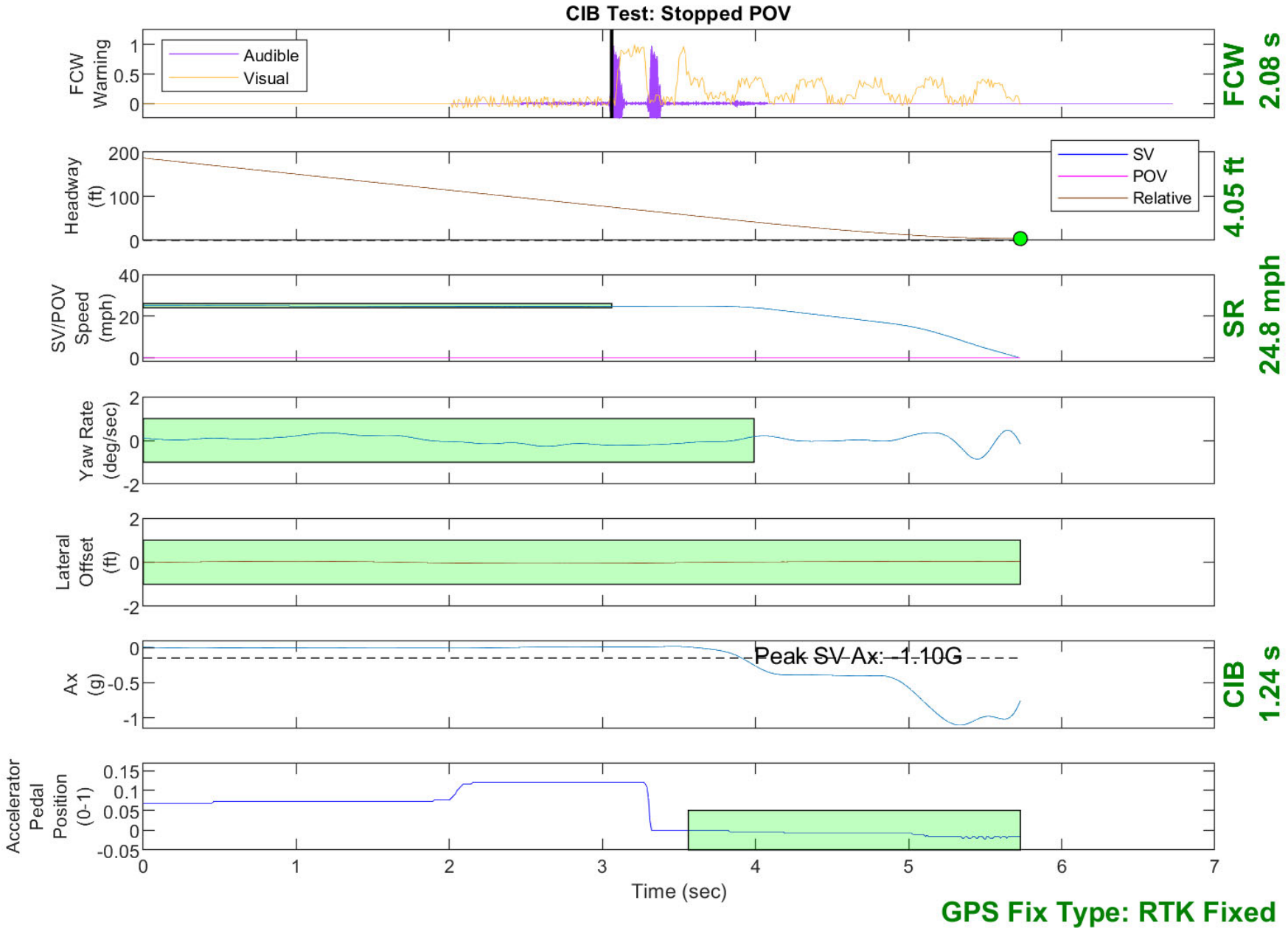

Figure D1. Example Time History for Stopped POV, Passing

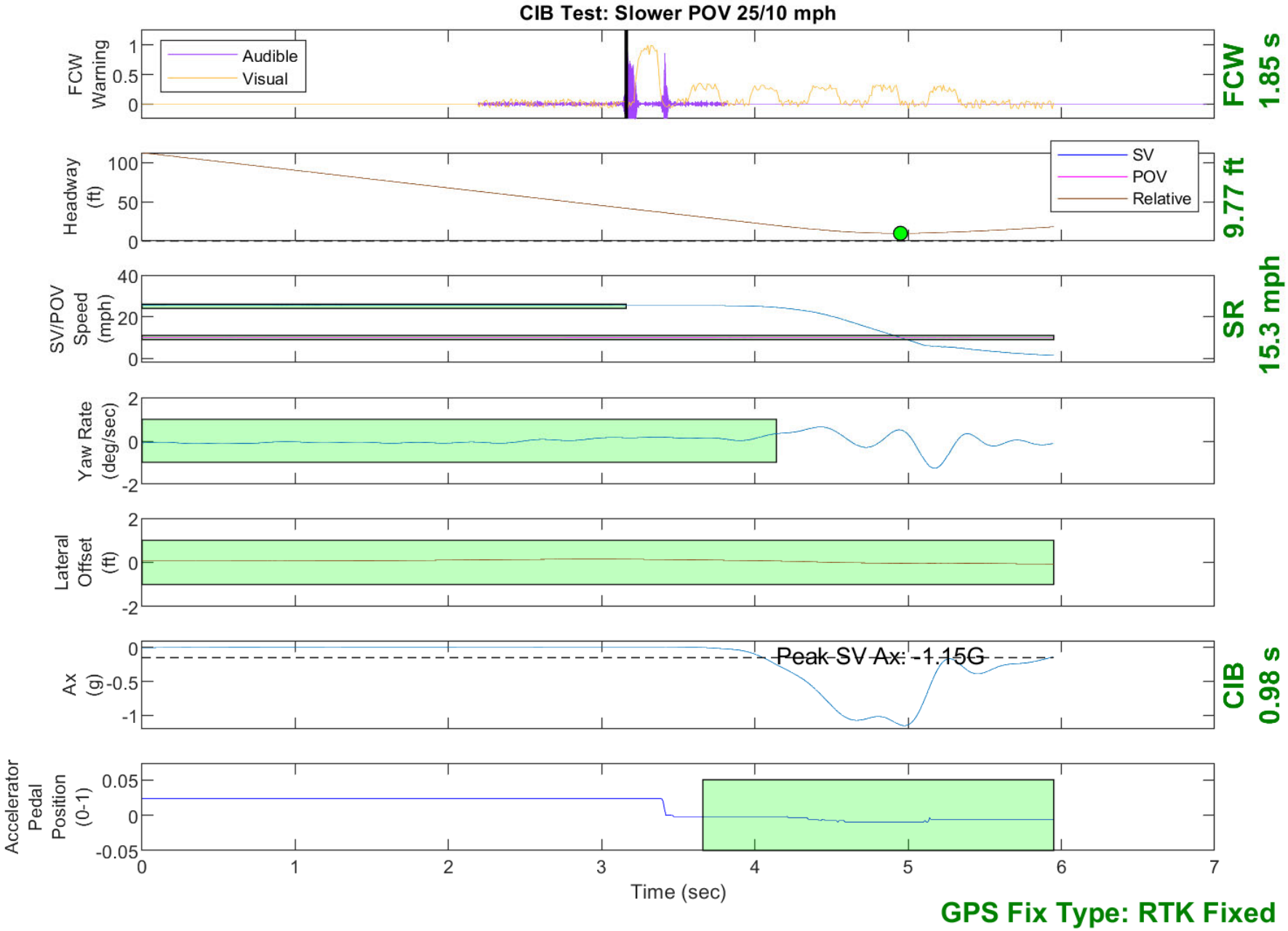

Figure D2. Example Time History for Slower POV 25 vs. 10, Passing

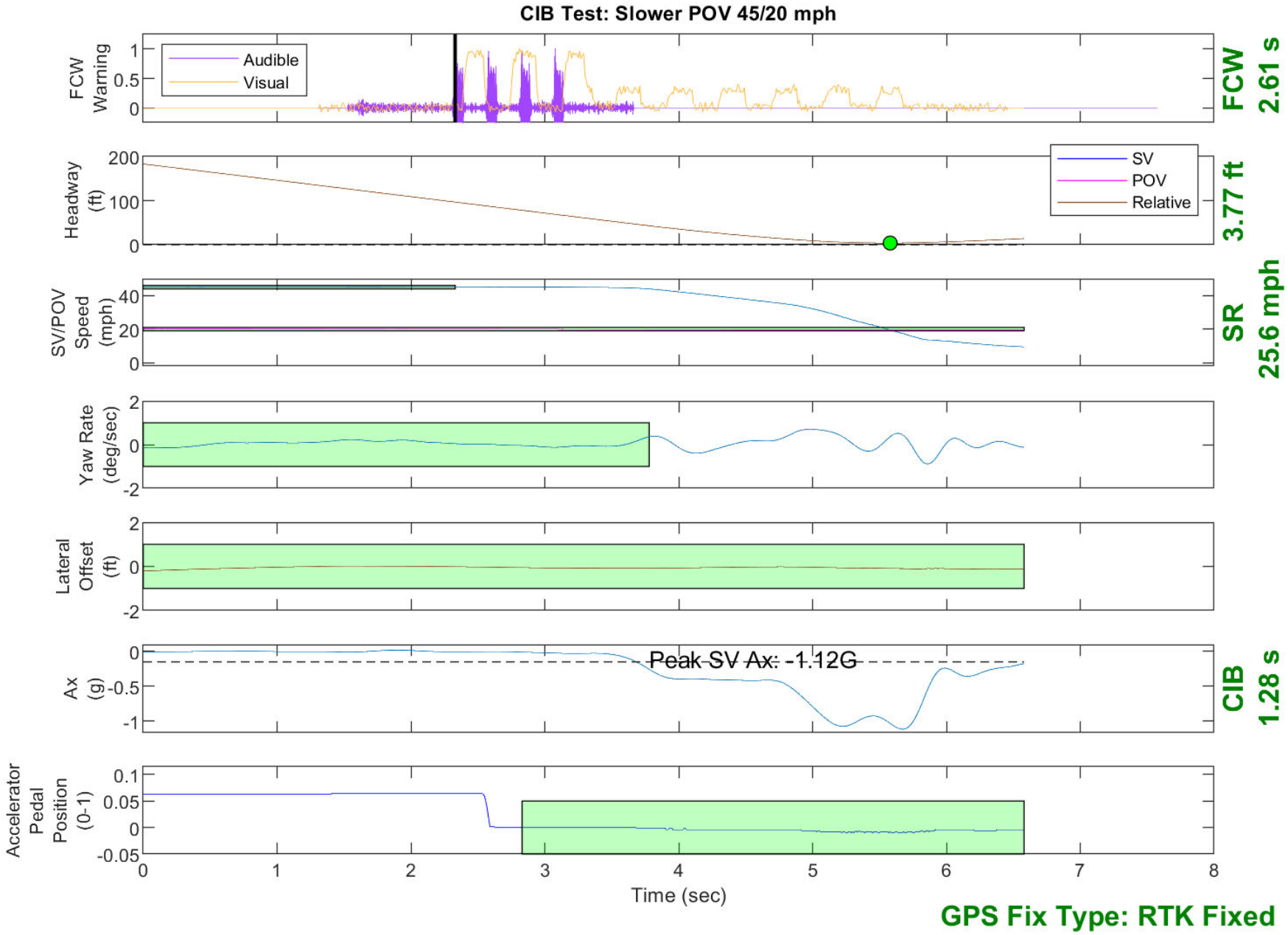

Figure D3. Example Time History for Slower POV 45 vs. 20, Passing

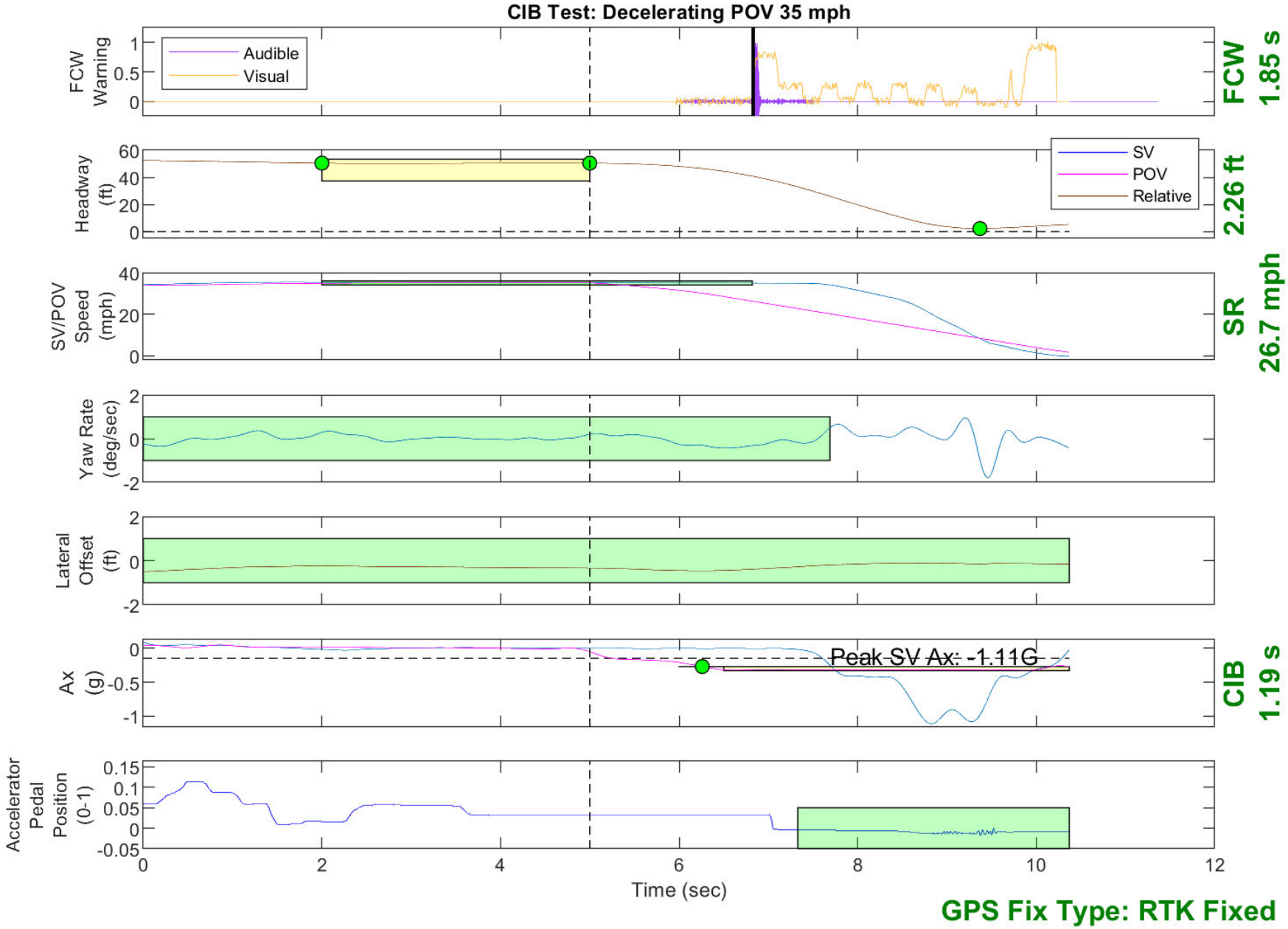

Figure D4. Example Time History for Decelerating POV 35, Passing

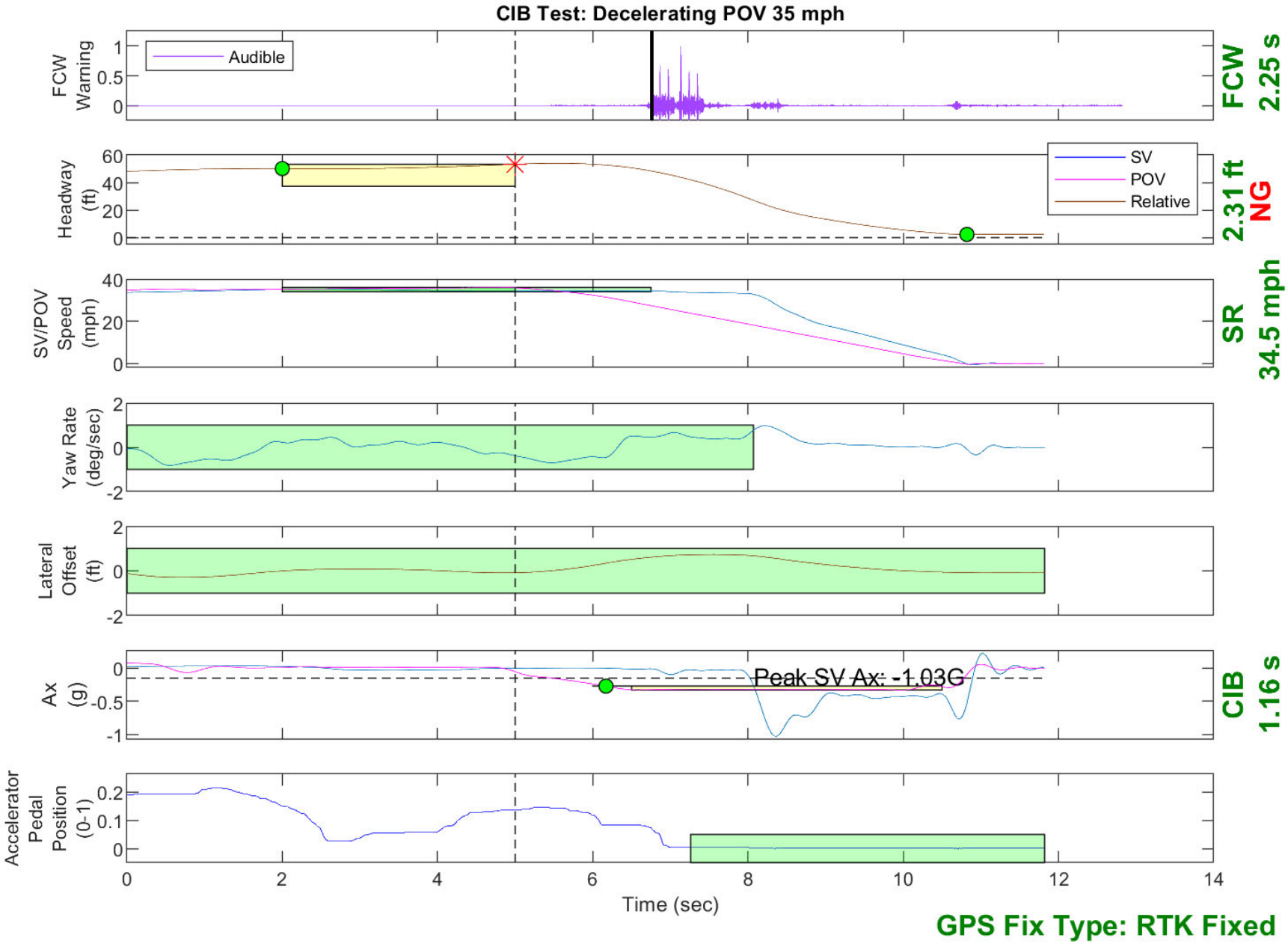

Figure D5. Example Time History Displaying Invalid Headway Criteria

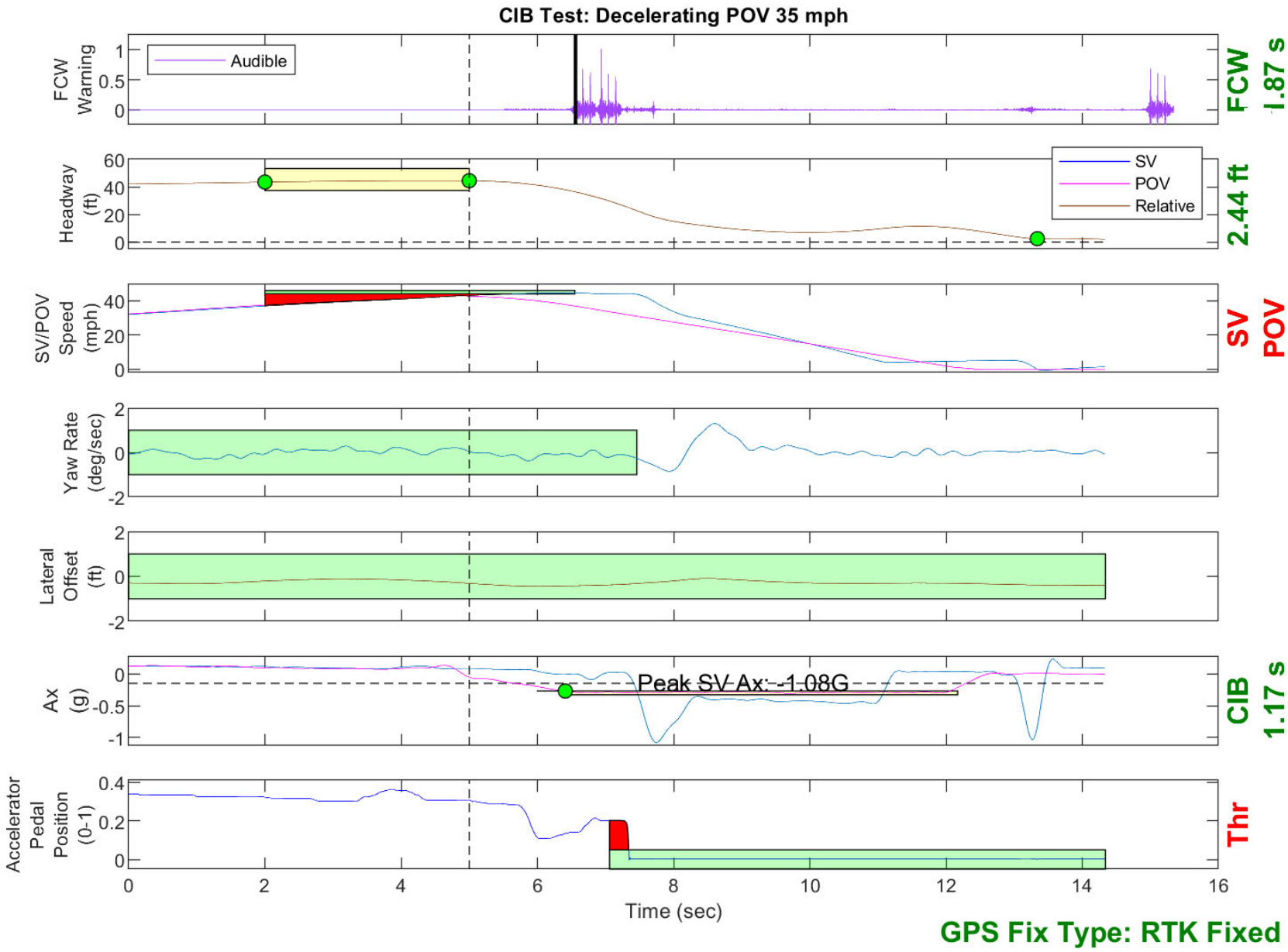

Figure D6. Example Time History Displaying Various Other Invalid Criteria

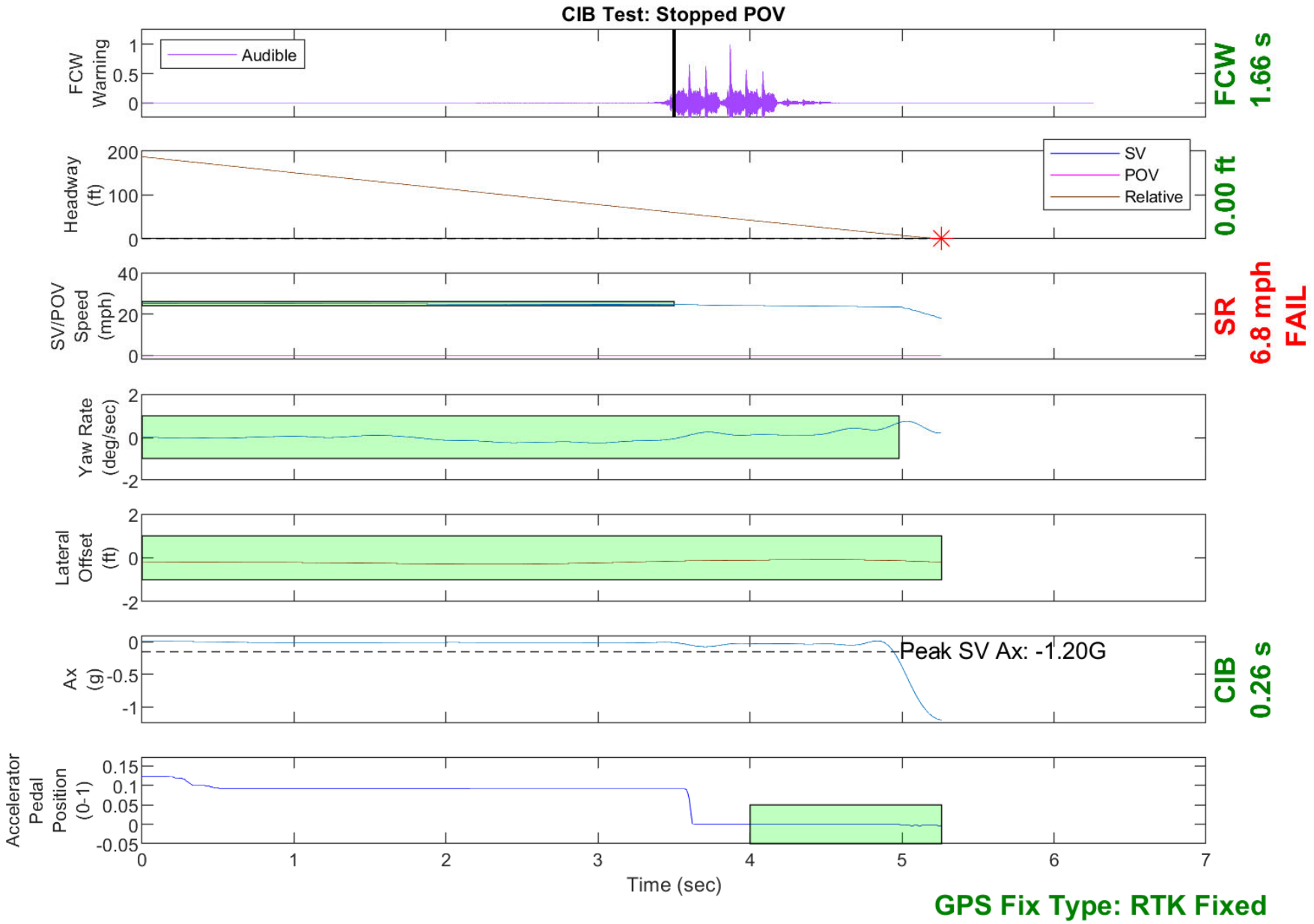

Figure D7. Example Time History for a Failed Run

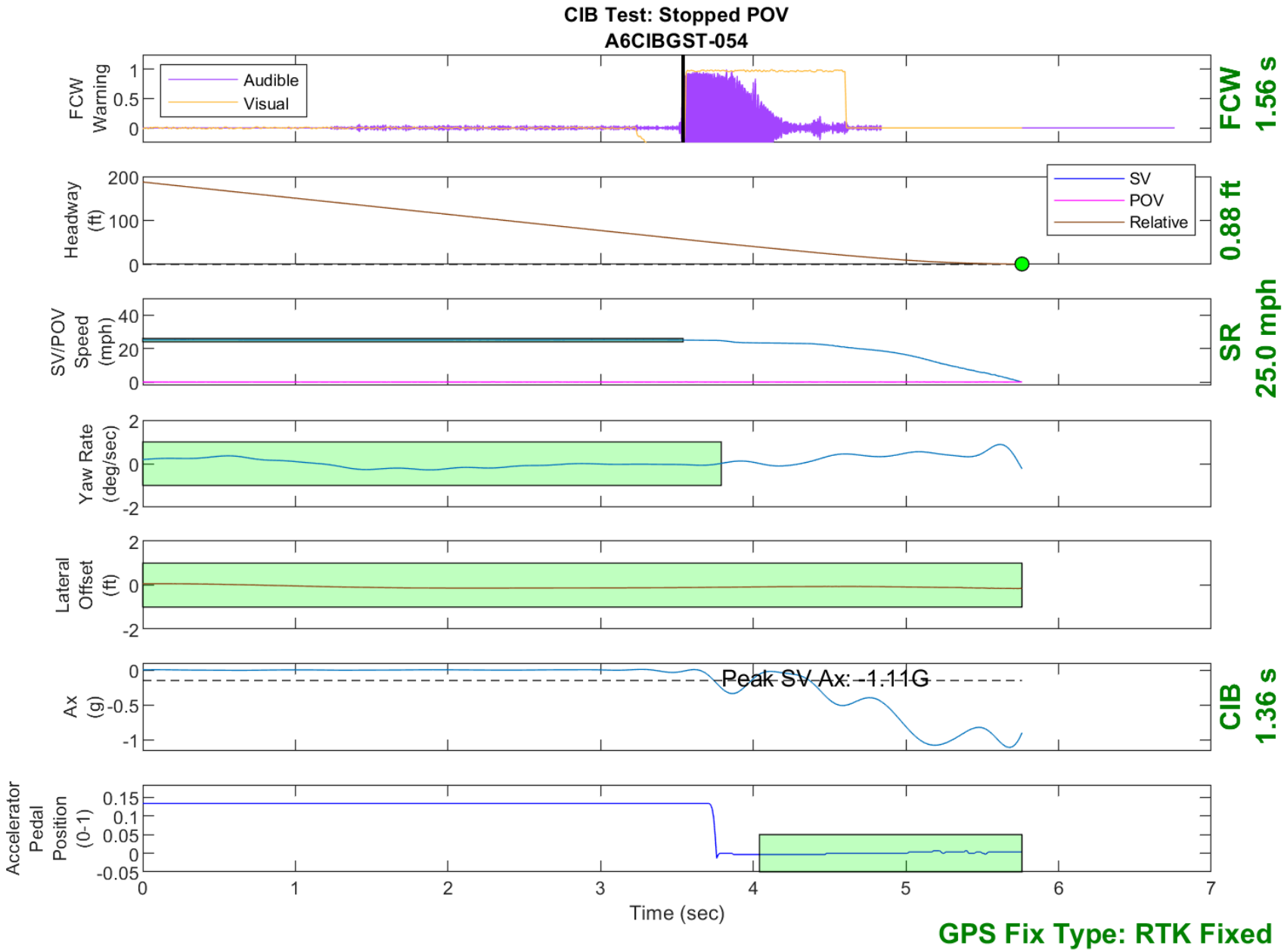

Figure D8. Time History for CIB Run 54, Stopped POV, 25 mph

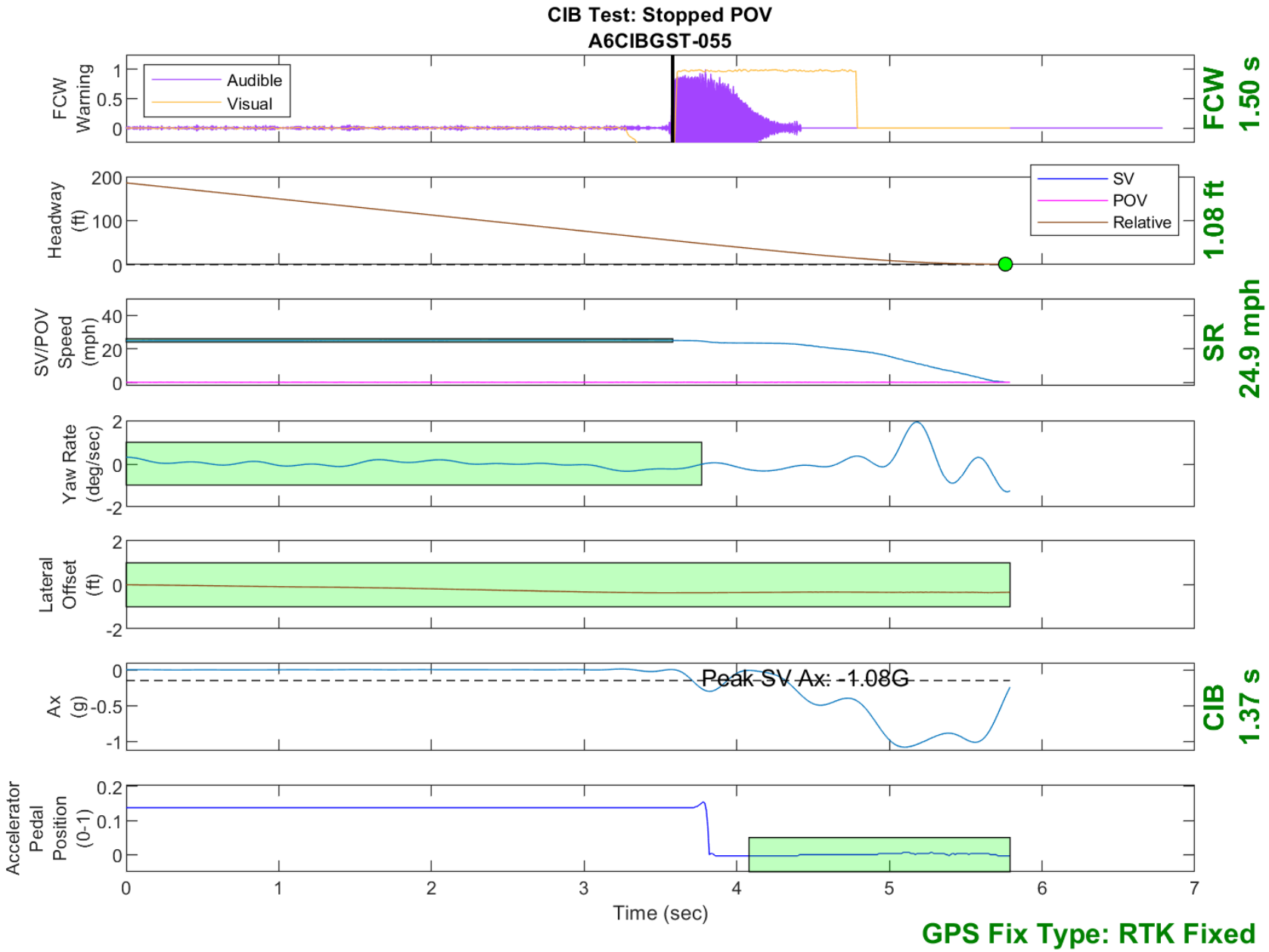

Figure D9. Time History for CIB Run 55, Stopped POV, 25 mph

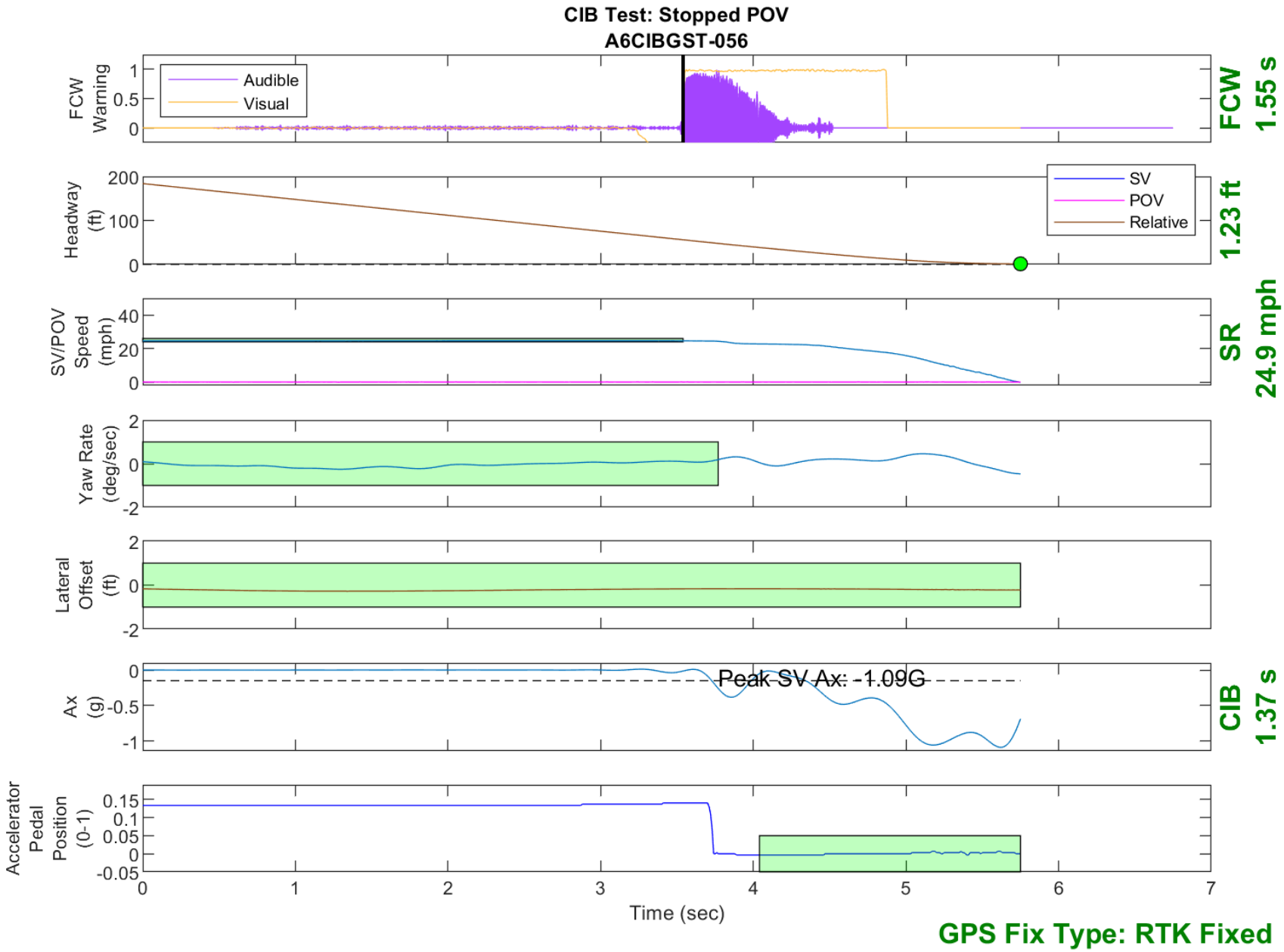

Figure D10. Time History for CIB Run 56, Stopped POV, 25 mph

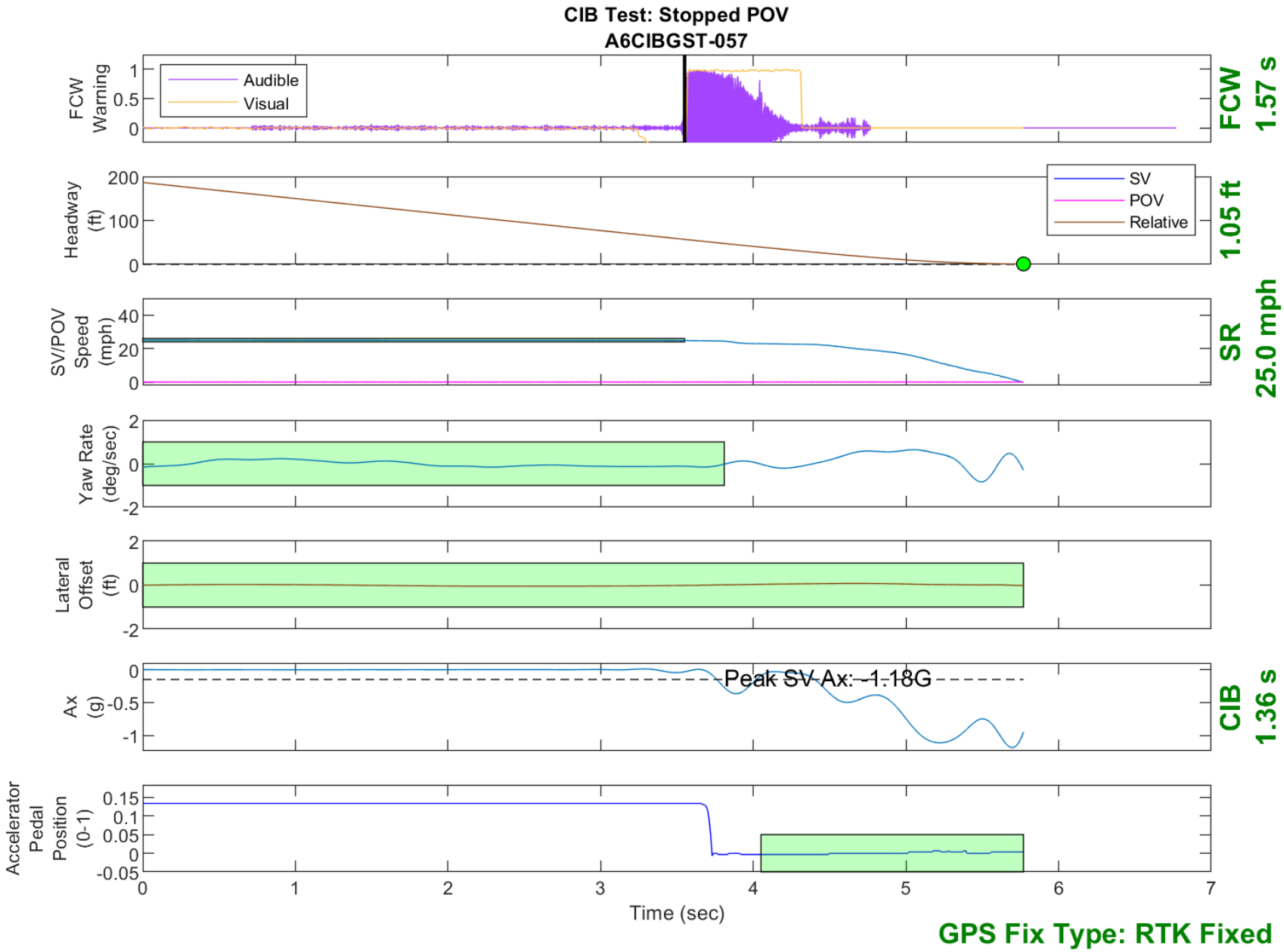

Figure D11. Time History for CIB Run 57, Stopped POV, 25 mph

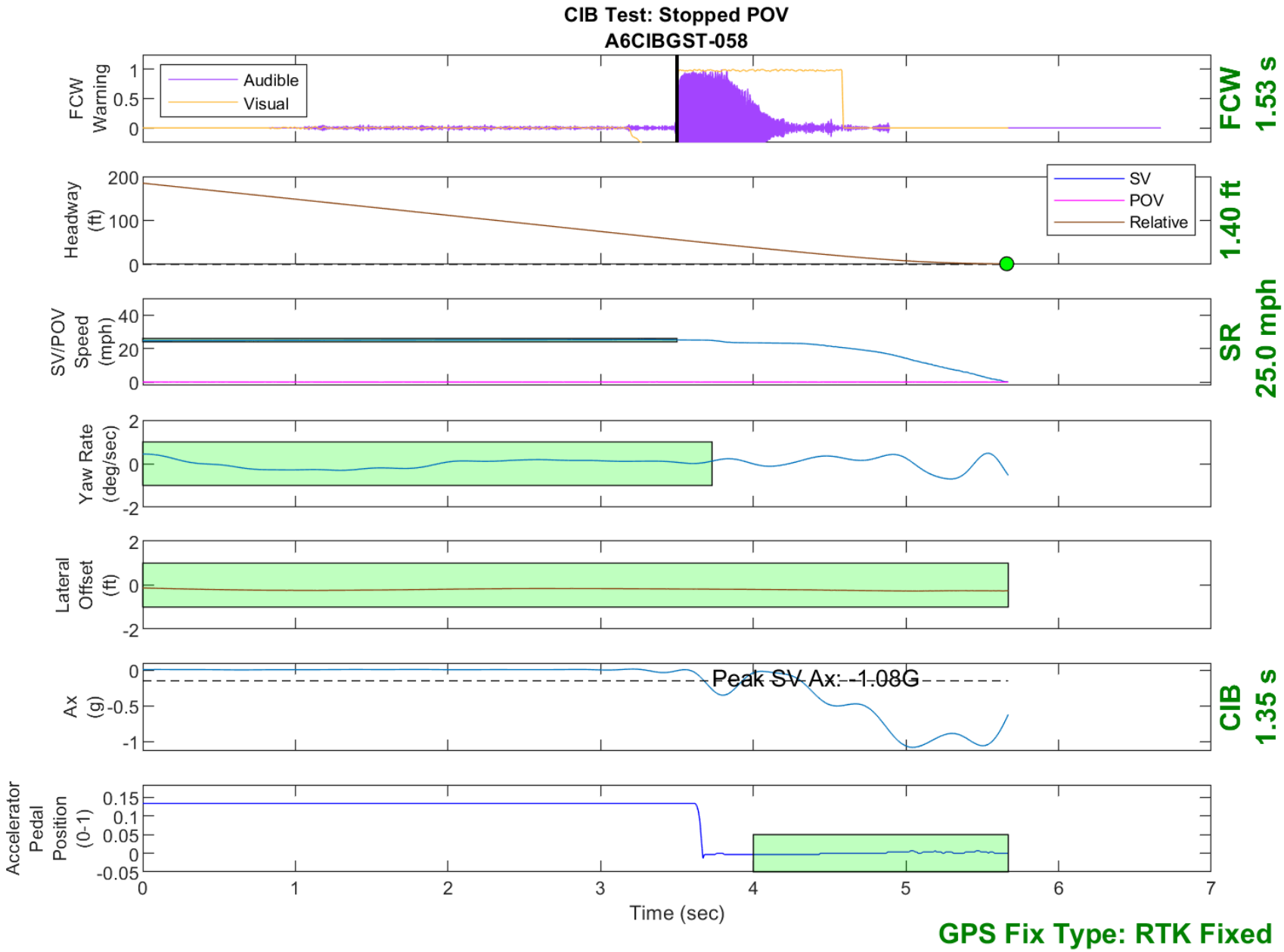

Figure D12. Time History for CIB Run 58, Stopped POV, 25 mph

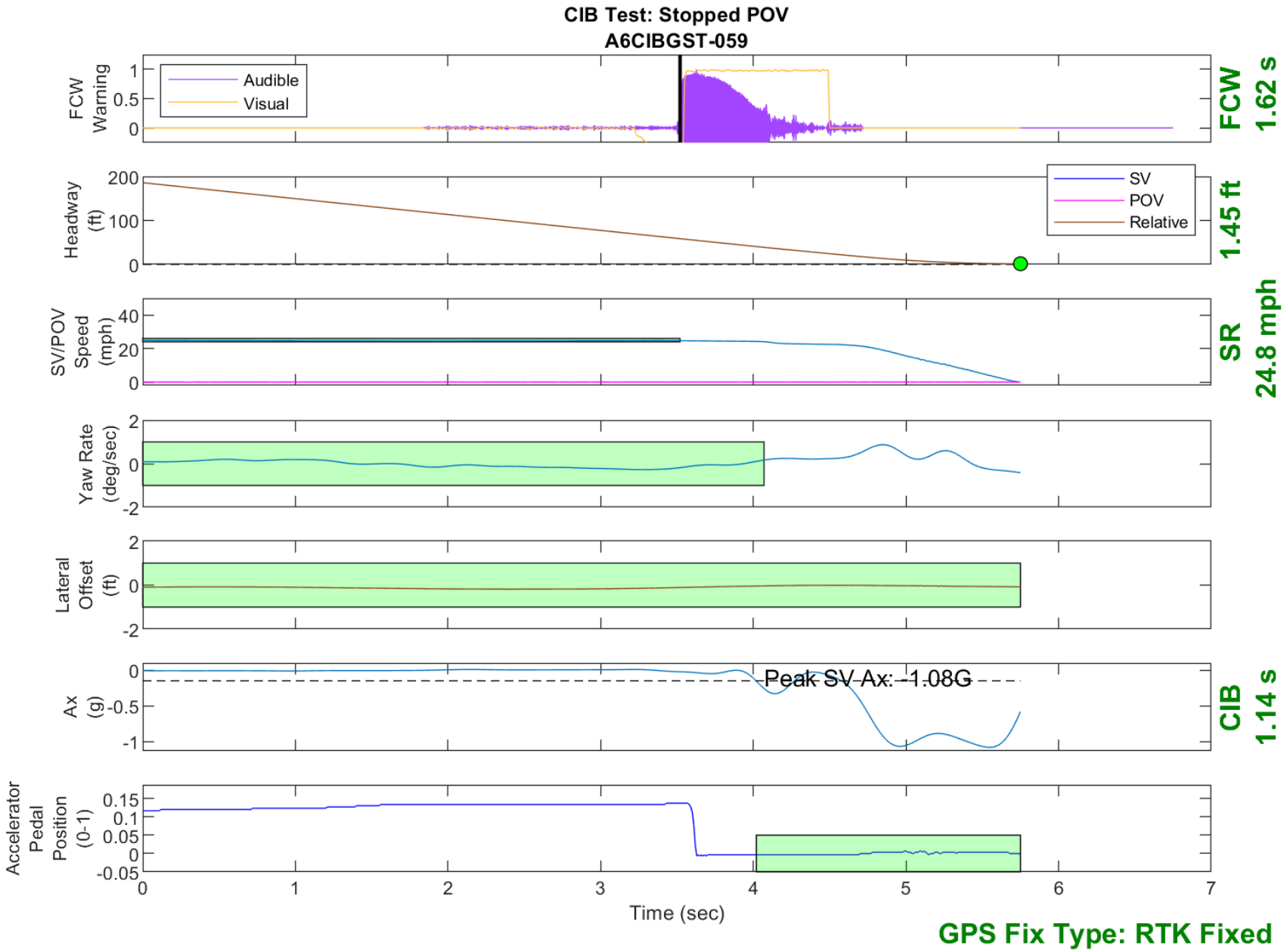

Figure D13. Time History for CIB Run 59, Stopped POV, 25 mph

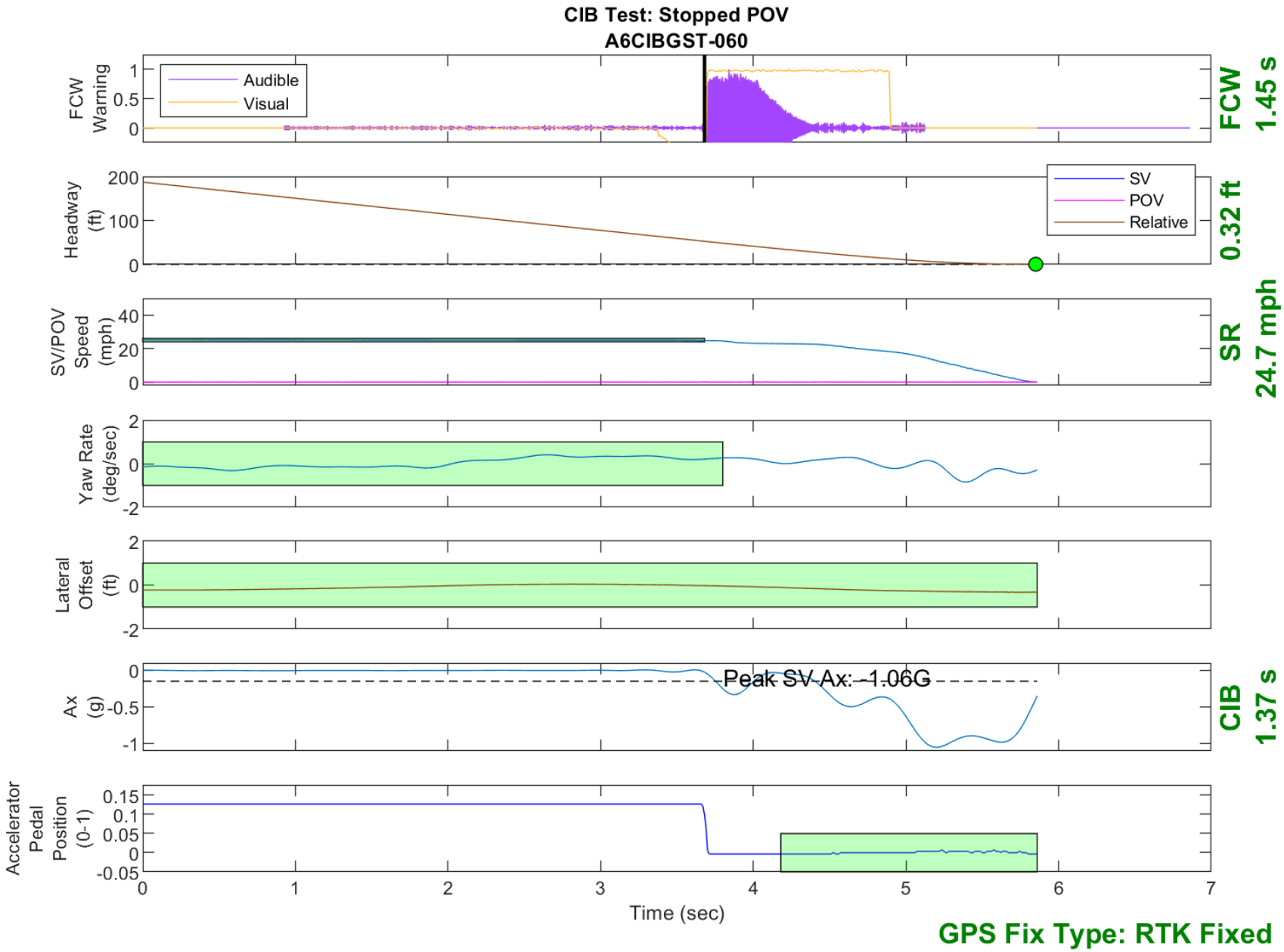

Figure D14. Time History for CIB Run 60, Stopped POV, 25 mph

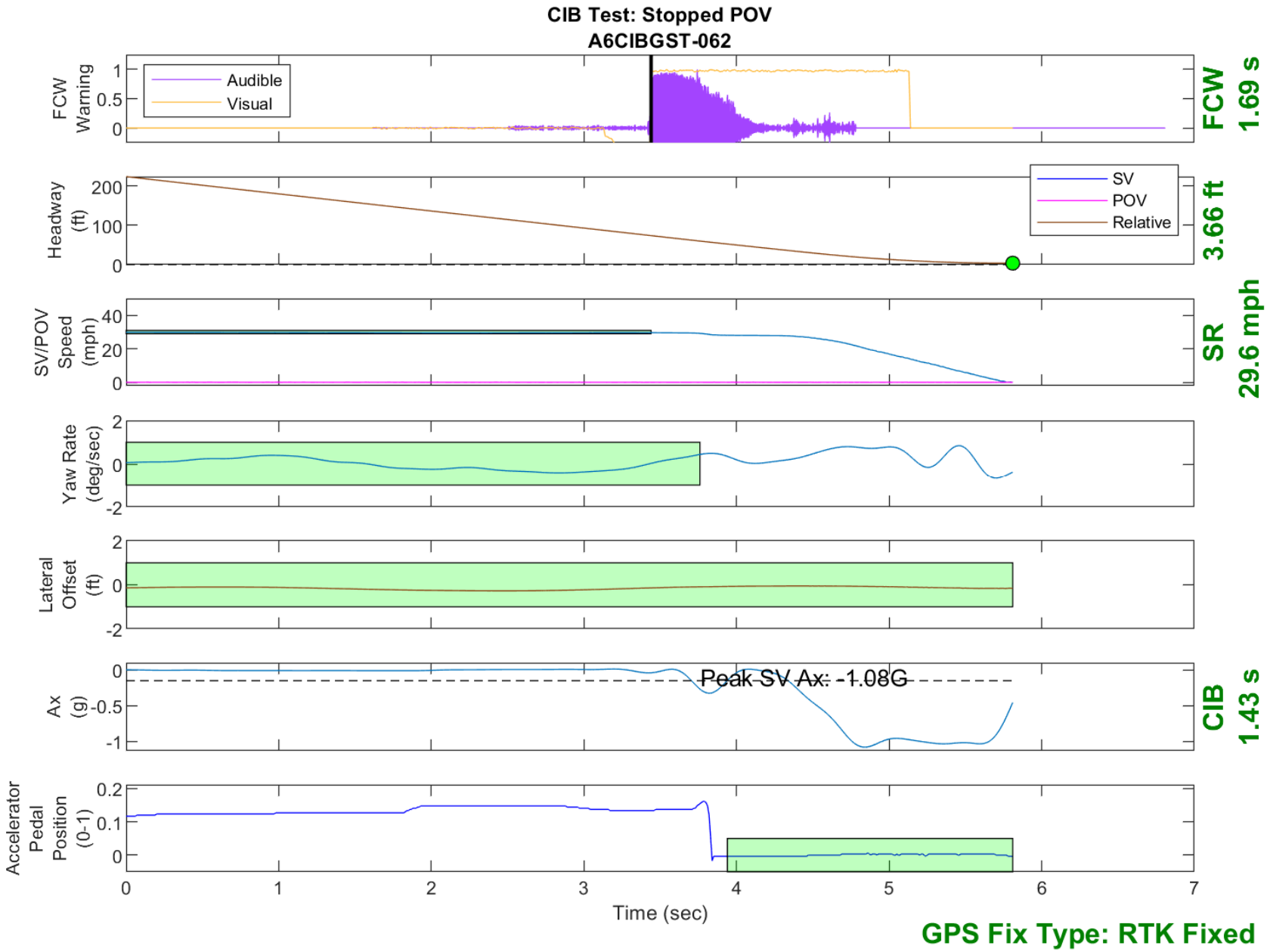

Figure D15. Time History for CIB Run 62, Stopped POV, 30 mph

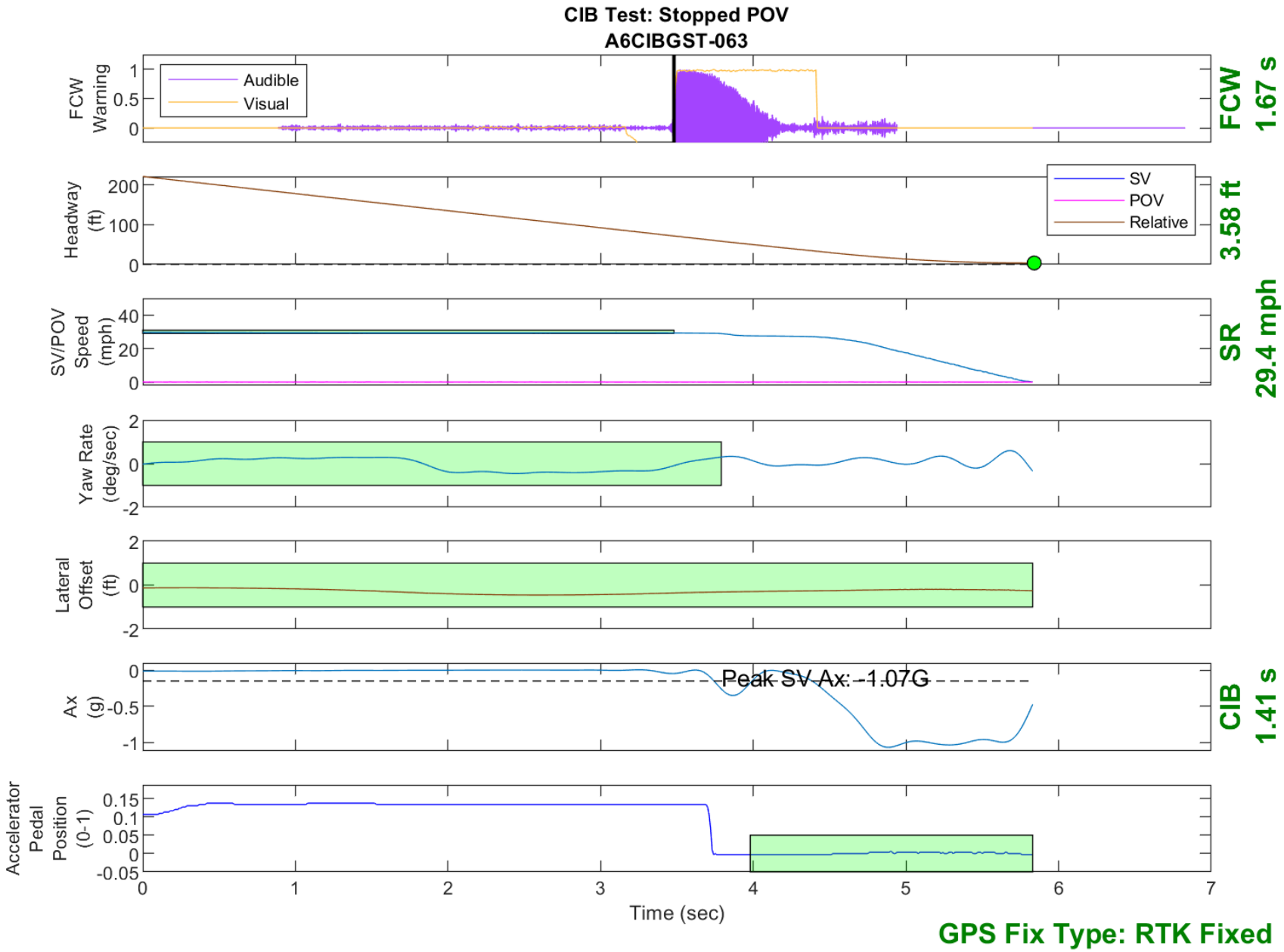

Figure D16. Time History for CIB Run 63, Stopped POV, 30 mph

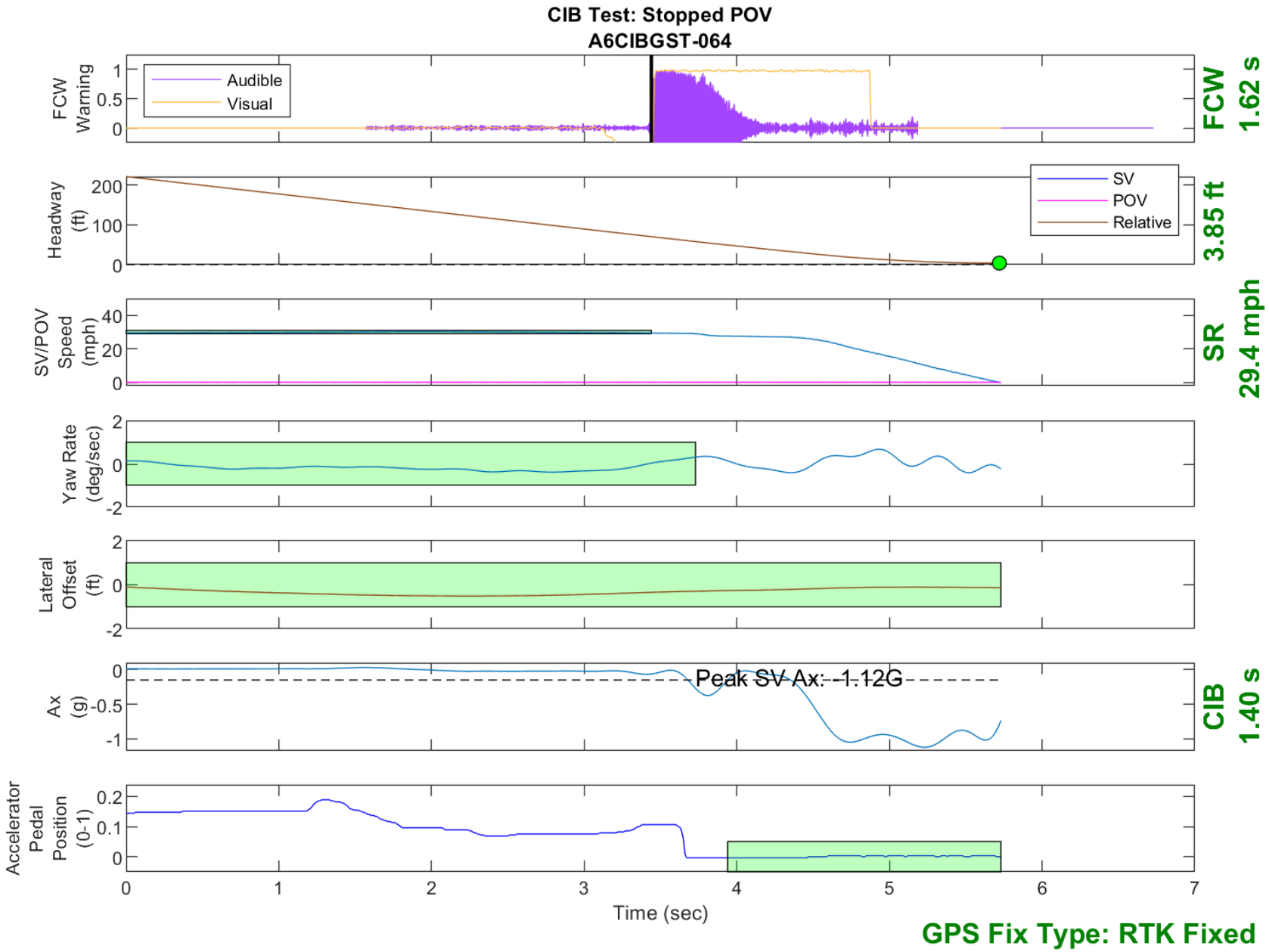

Figure D17. Time History for CIB Run 64, Stopped POV, 30 mph

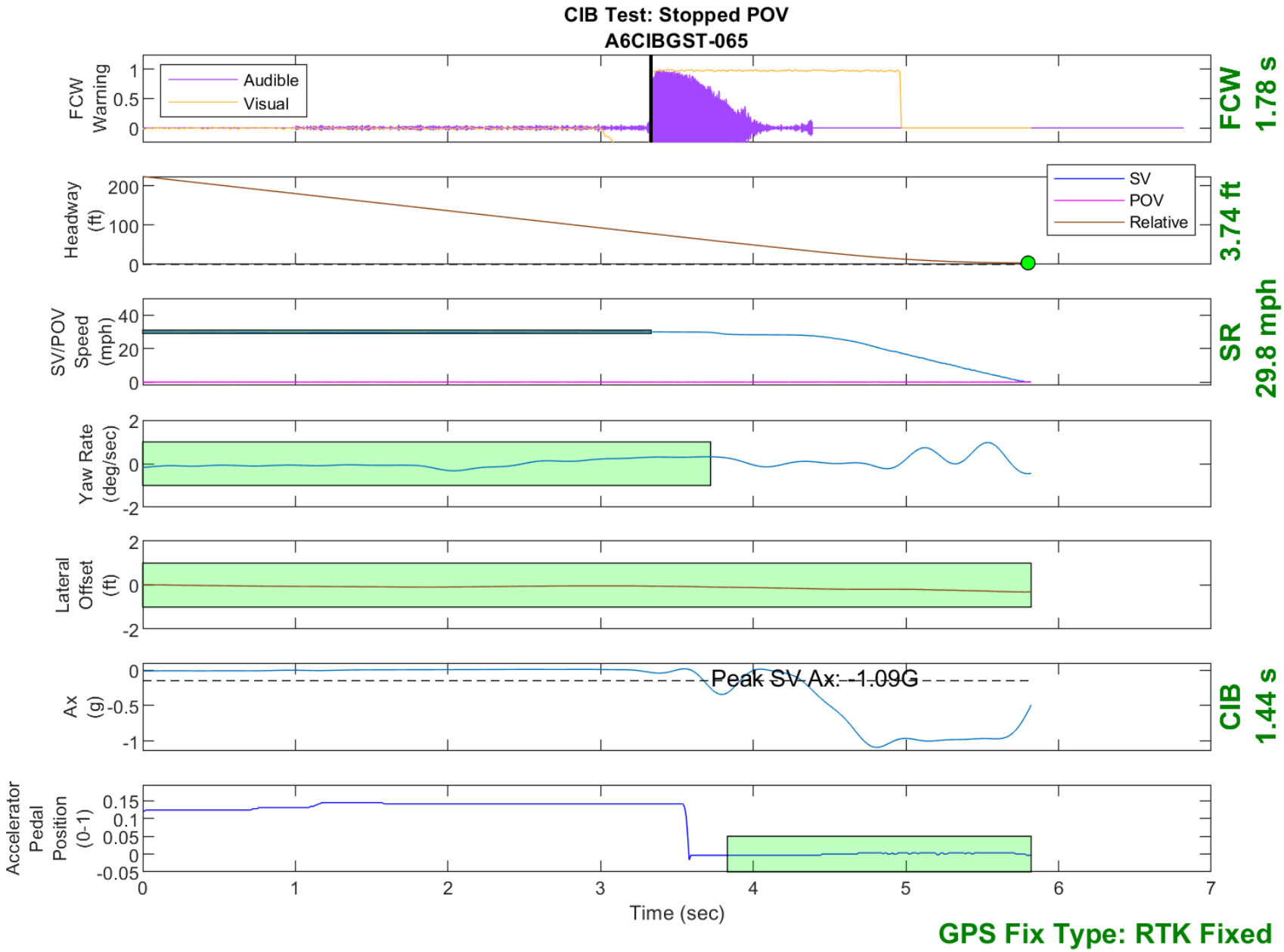

Figure D18. Time History for CIB Run 65, Stopped POV, 30 mph

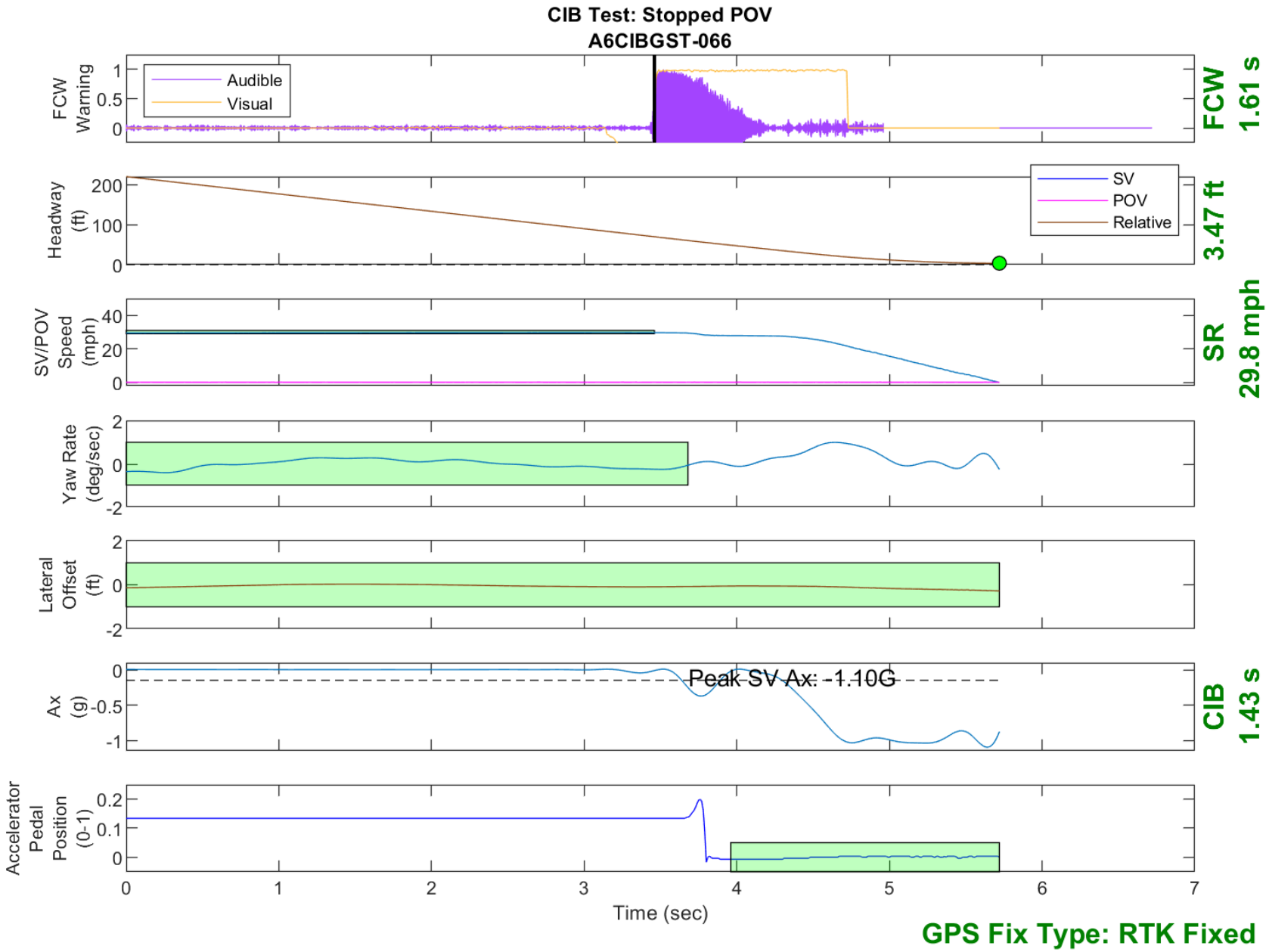

Figure D19. Time History for CIB Run 66, Stopped POV, 30 mph

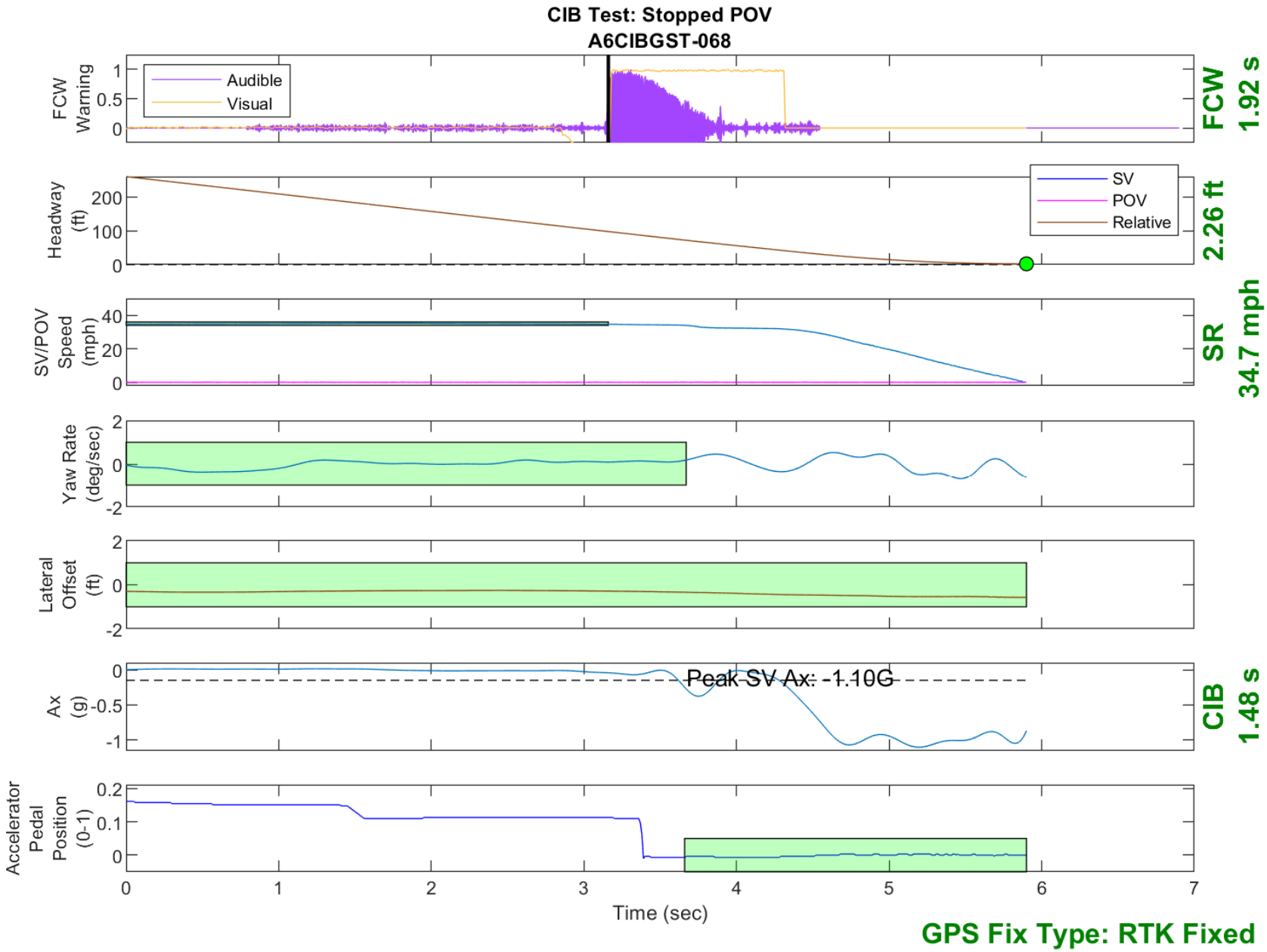

Figure D20. Time History for CIB Run 68, Stopped POV, 35 mph

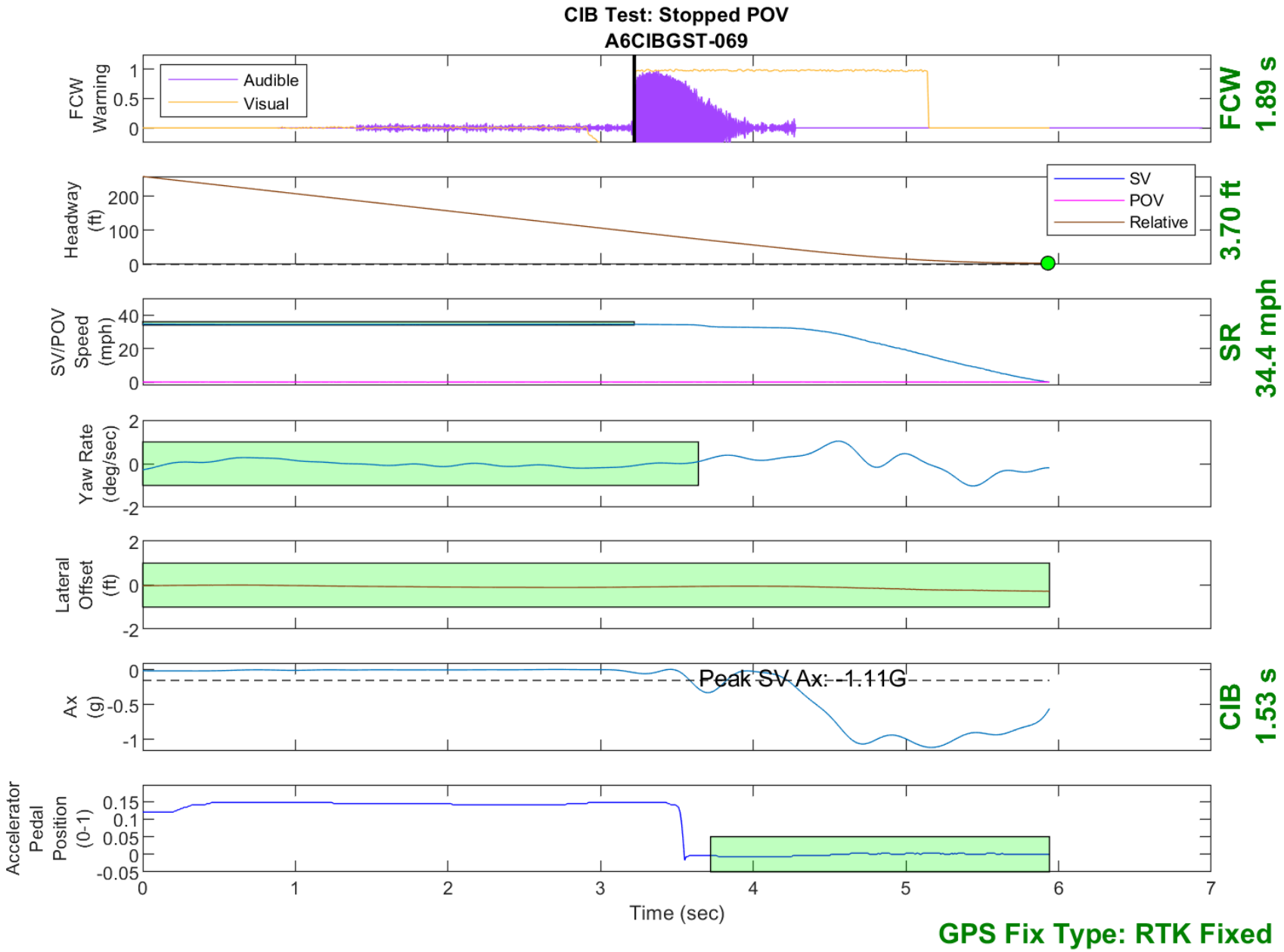

Figure D21. Time History for CIB Run 69, Stopped POV, 35 mph

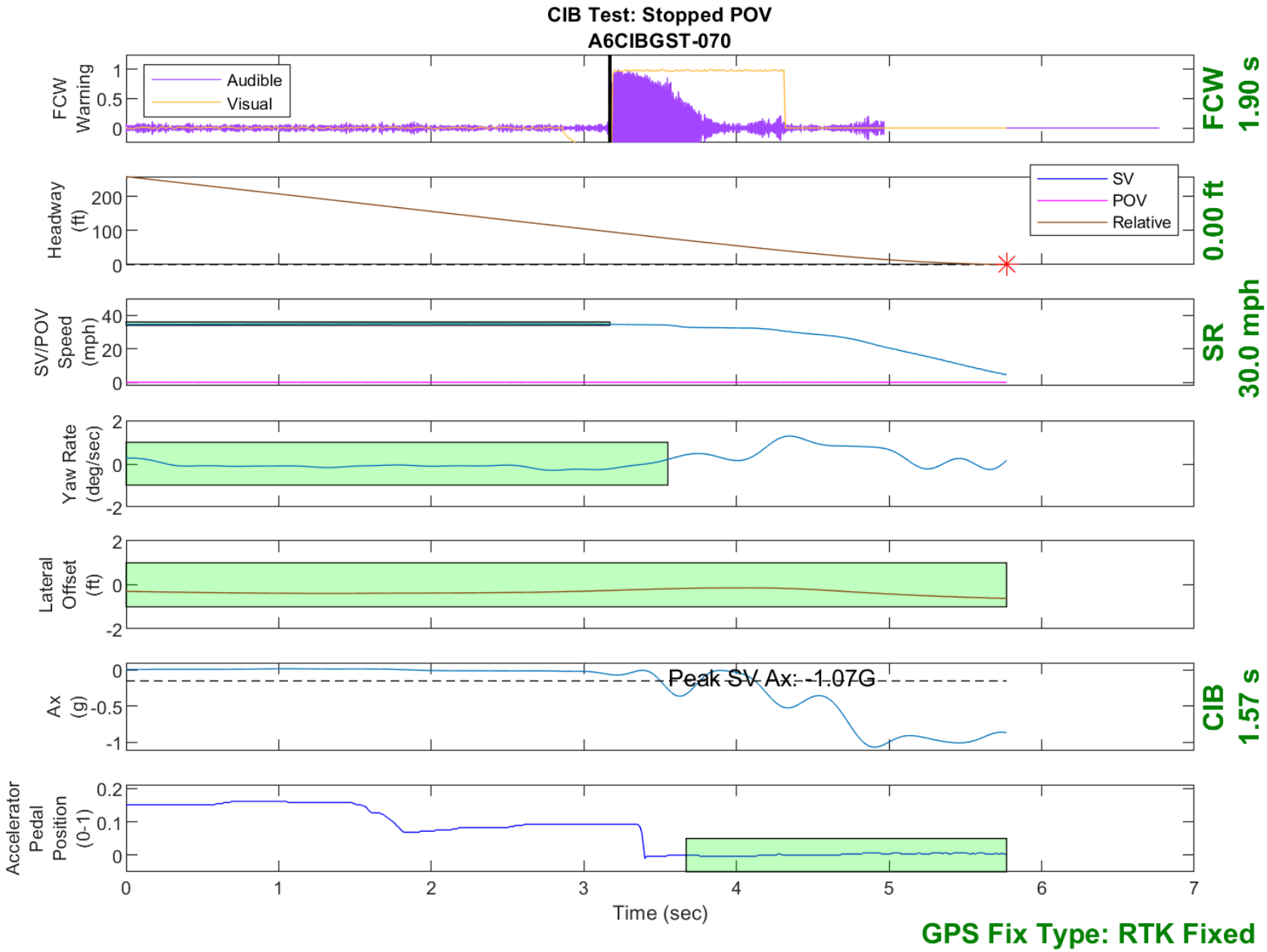

Figure D22. Time History for CIB Run 70, Stopped POV, 35 mph

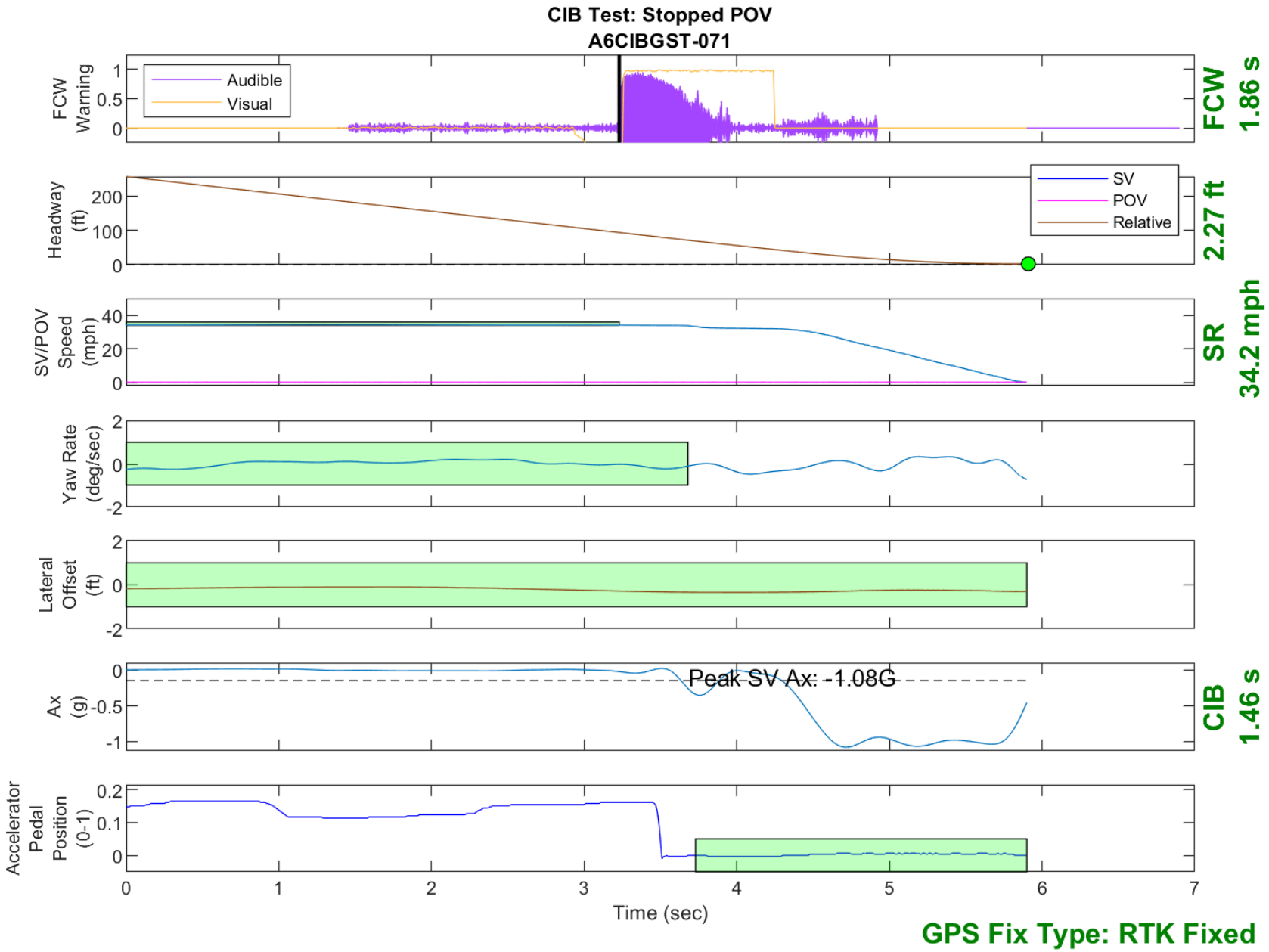

Figure D23. Time History for CIB Run 71, Stopped POV, 35 mph

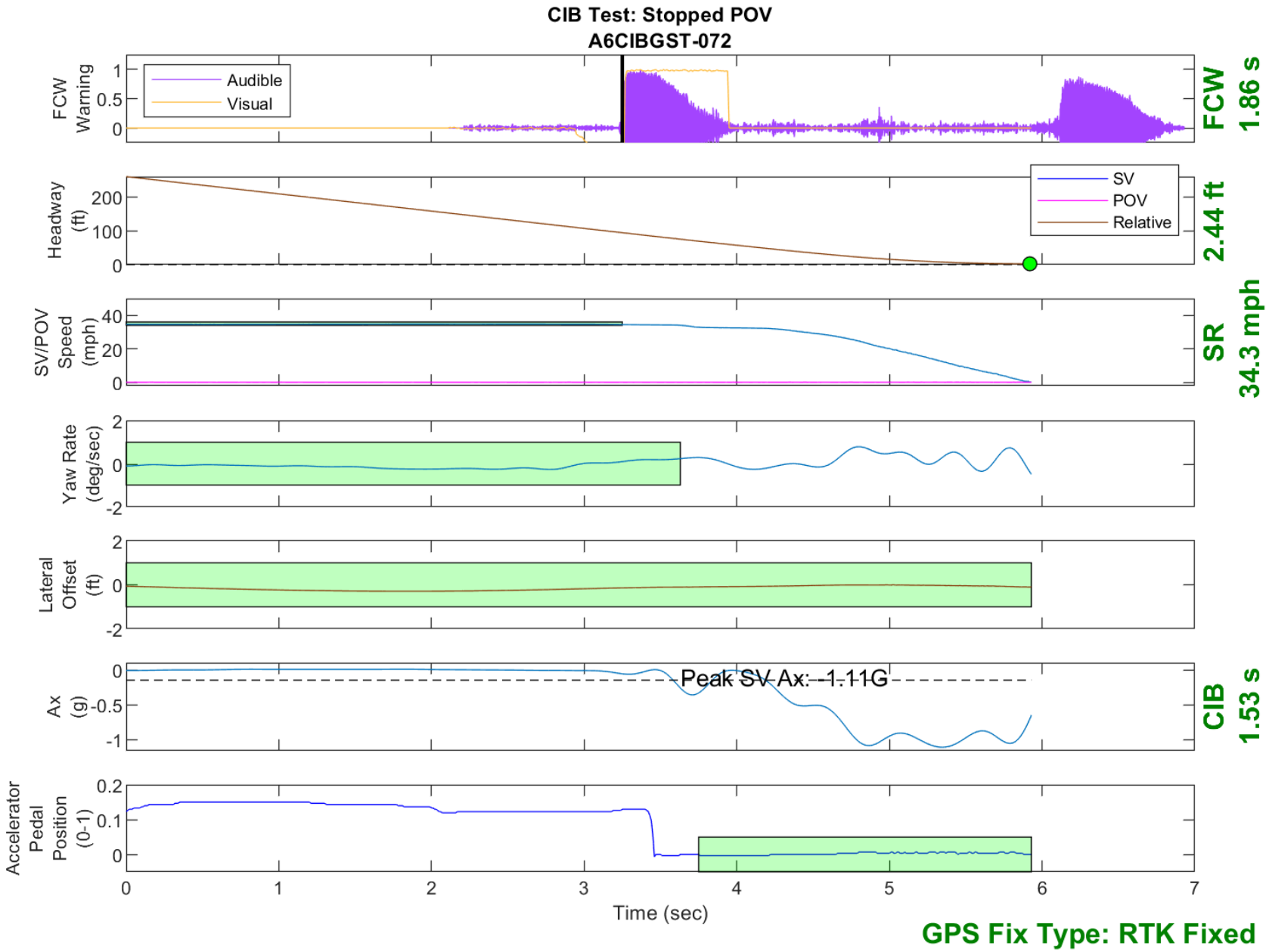

Figure D24. Time History for CIB Run 72, Stopped POV, 35 mph

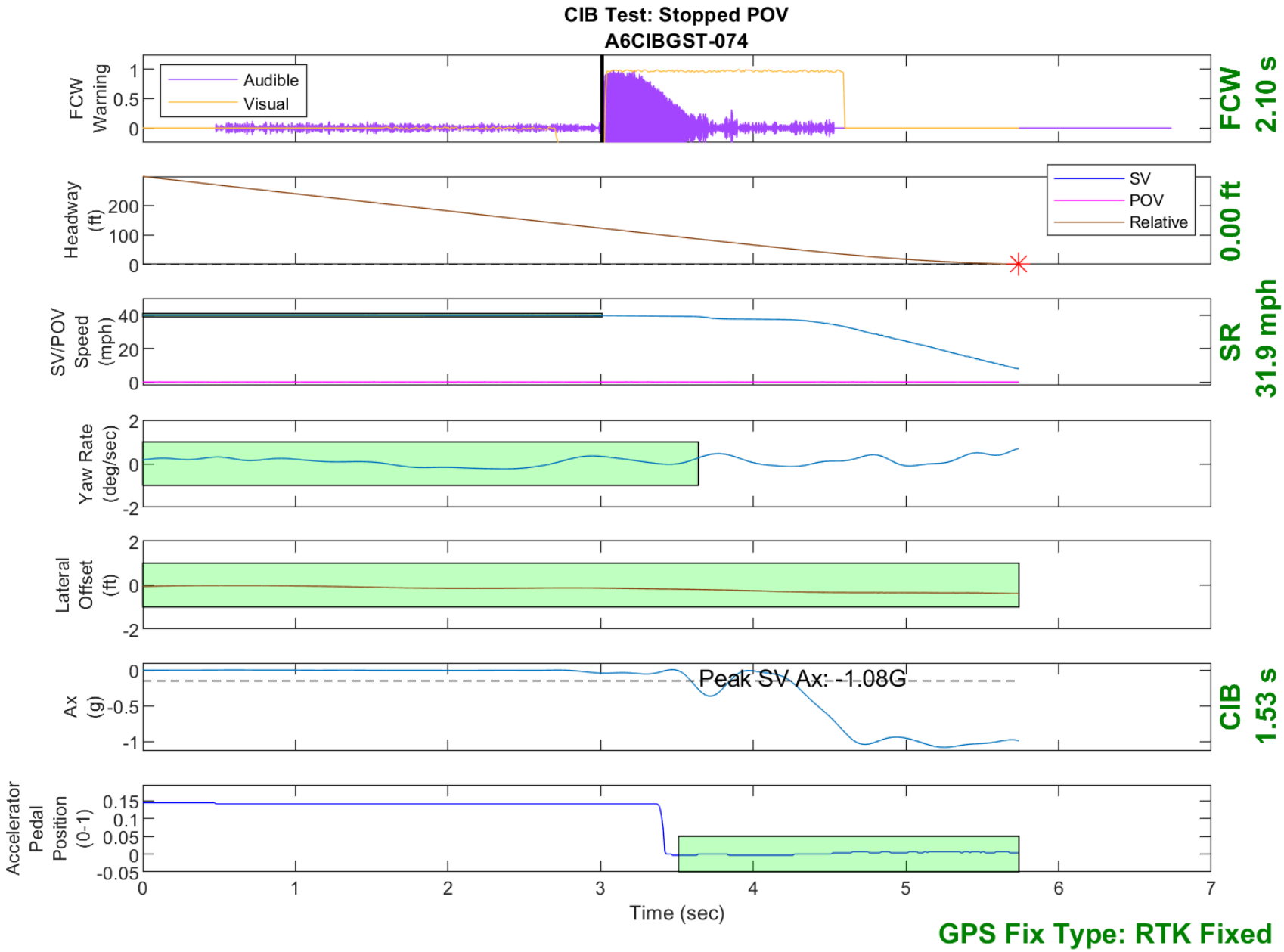

Figure D25. Time History for CIB Run 74, Stopped POV, 40 mph

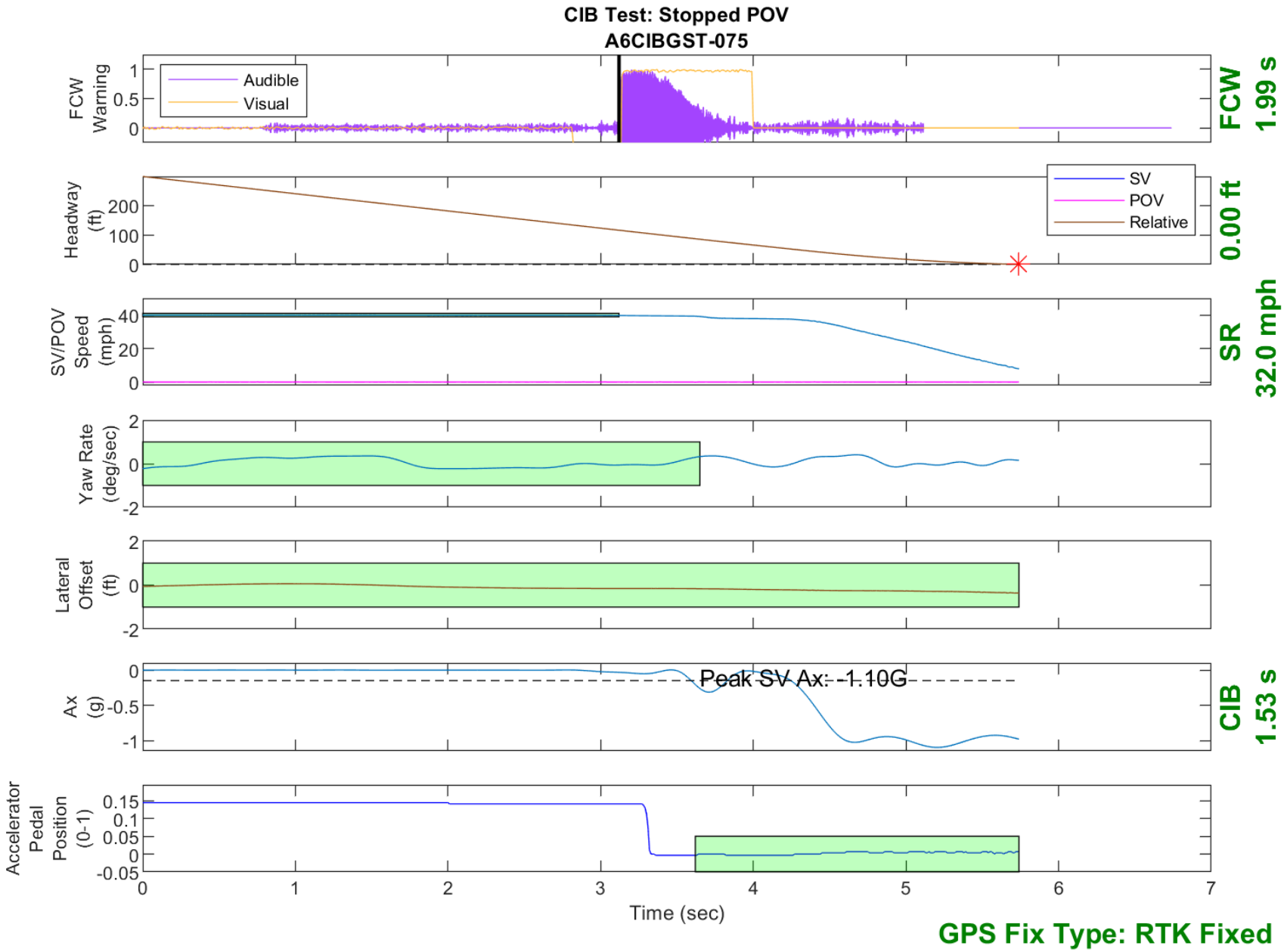

Figure D26. Time History for CIB Run 75, Stopped POV, 40 mph

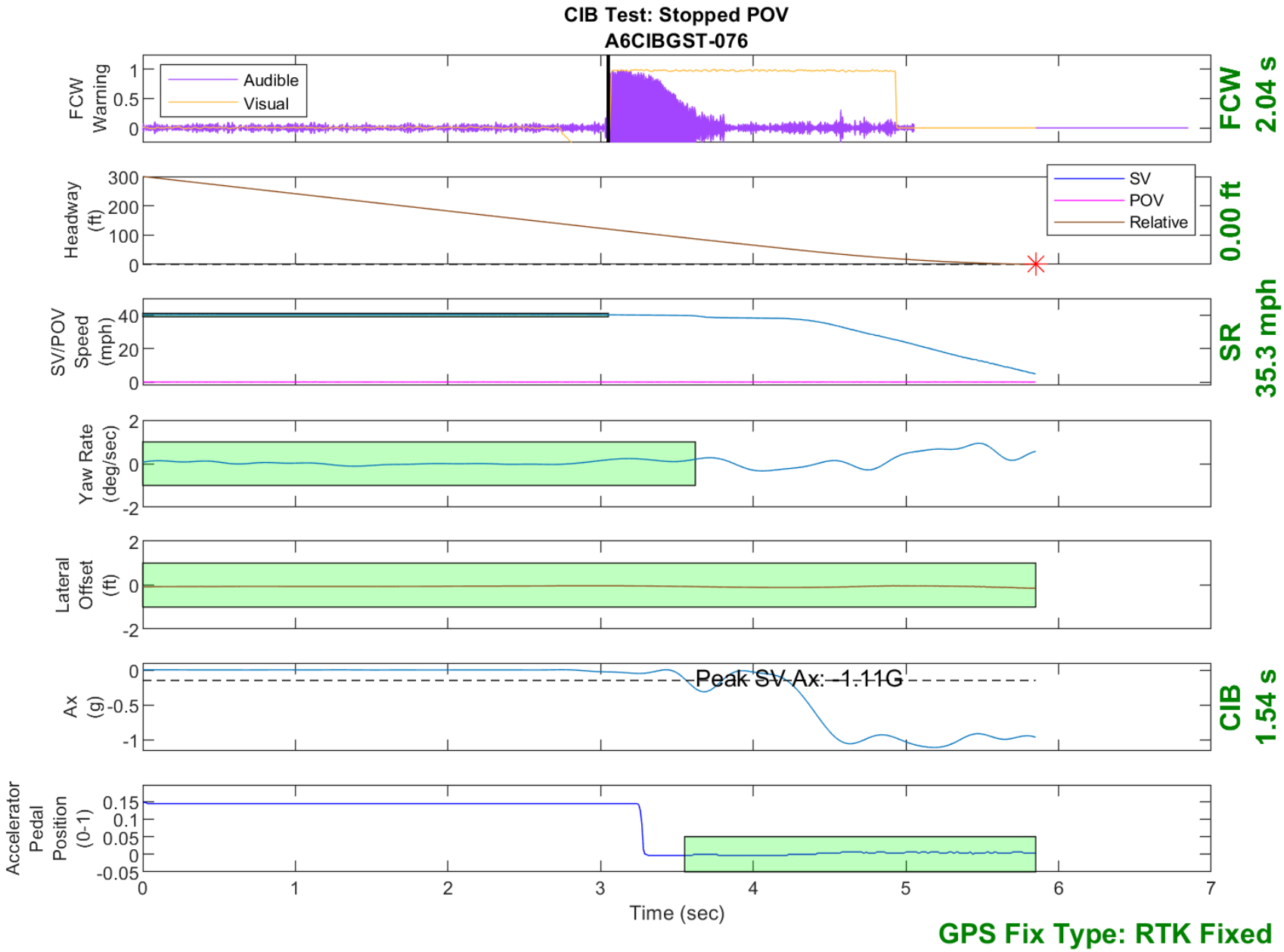

Figure D27. Time History for CIB Run 76, Stopped POV, 40 mph

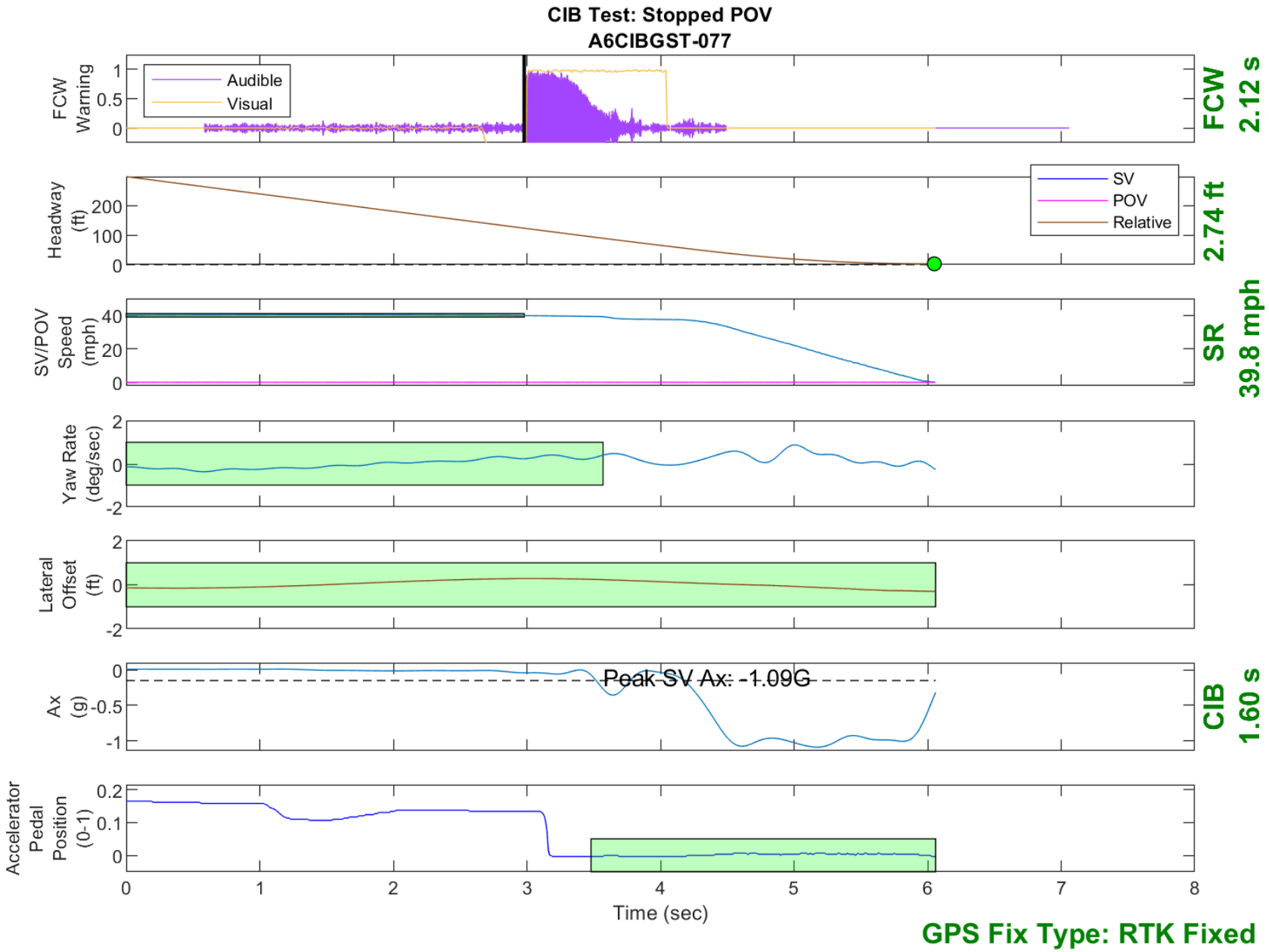

Figure D28. Time History for CIB Run 77, Stopped POV, 40 mph

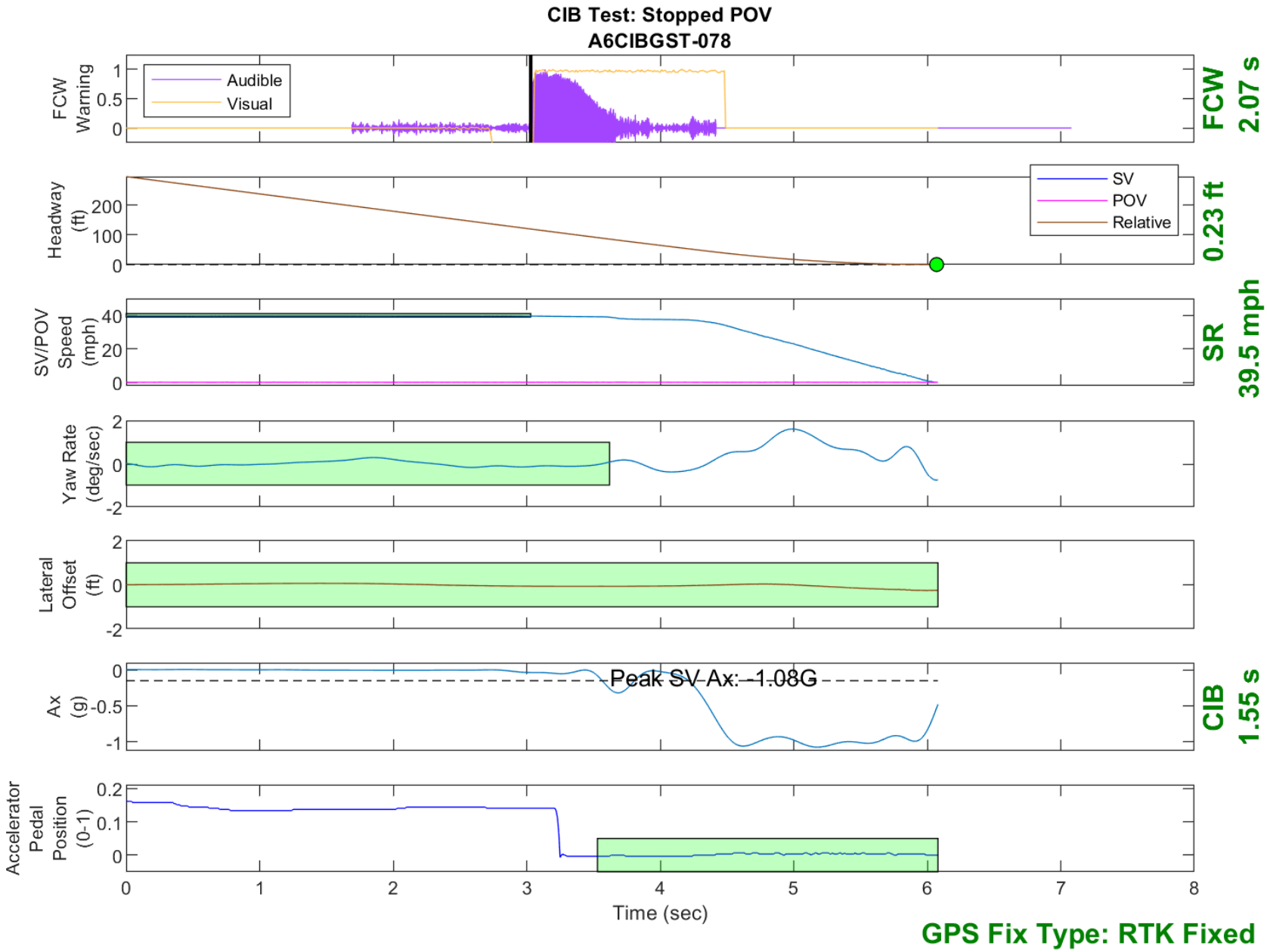

Figure D29. Time History for CIB Run 78, Stopped POV, 40 mph

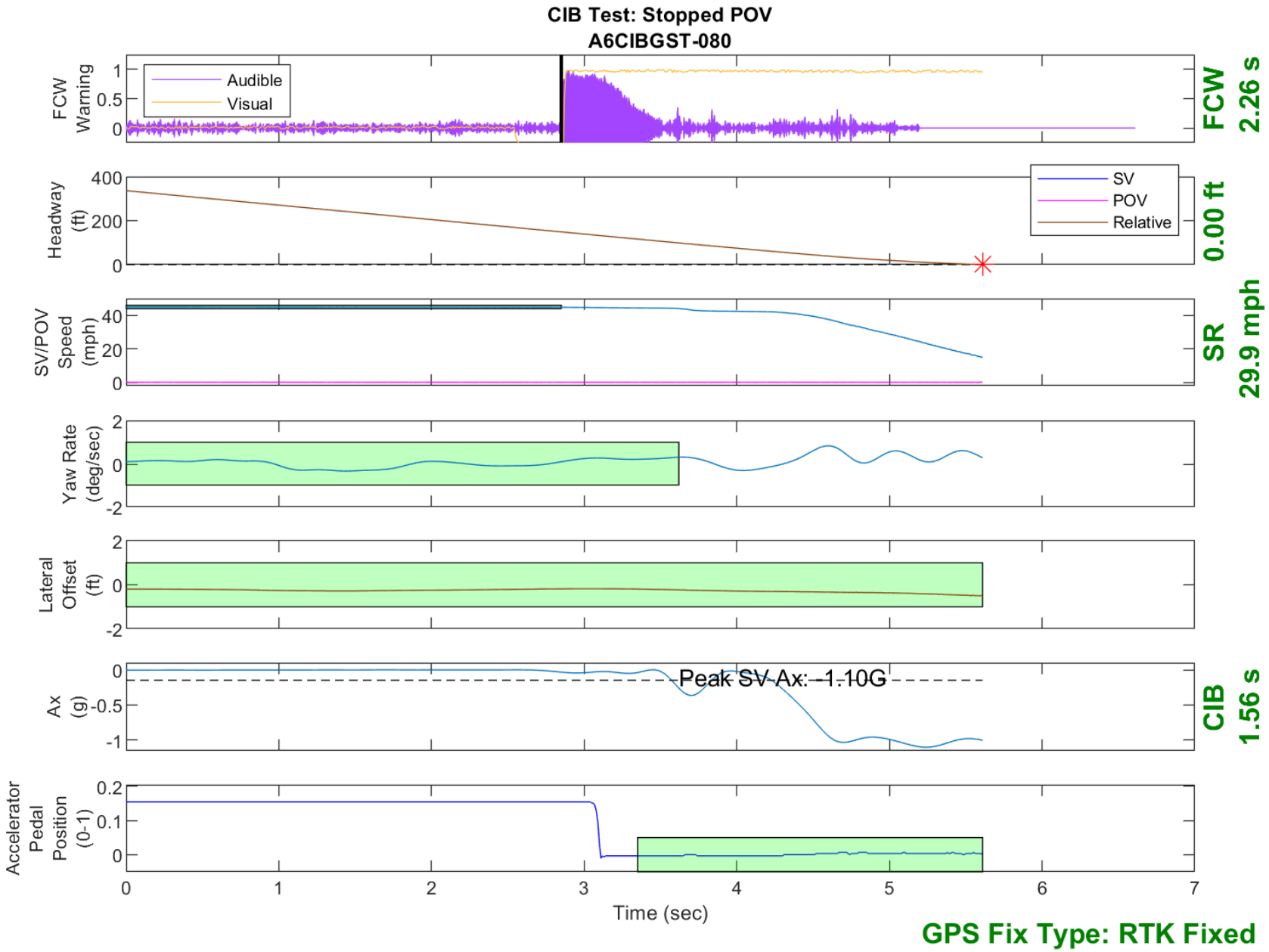

Figure D30. Time History for CIB Run 80, Stopped POV, 45 mph

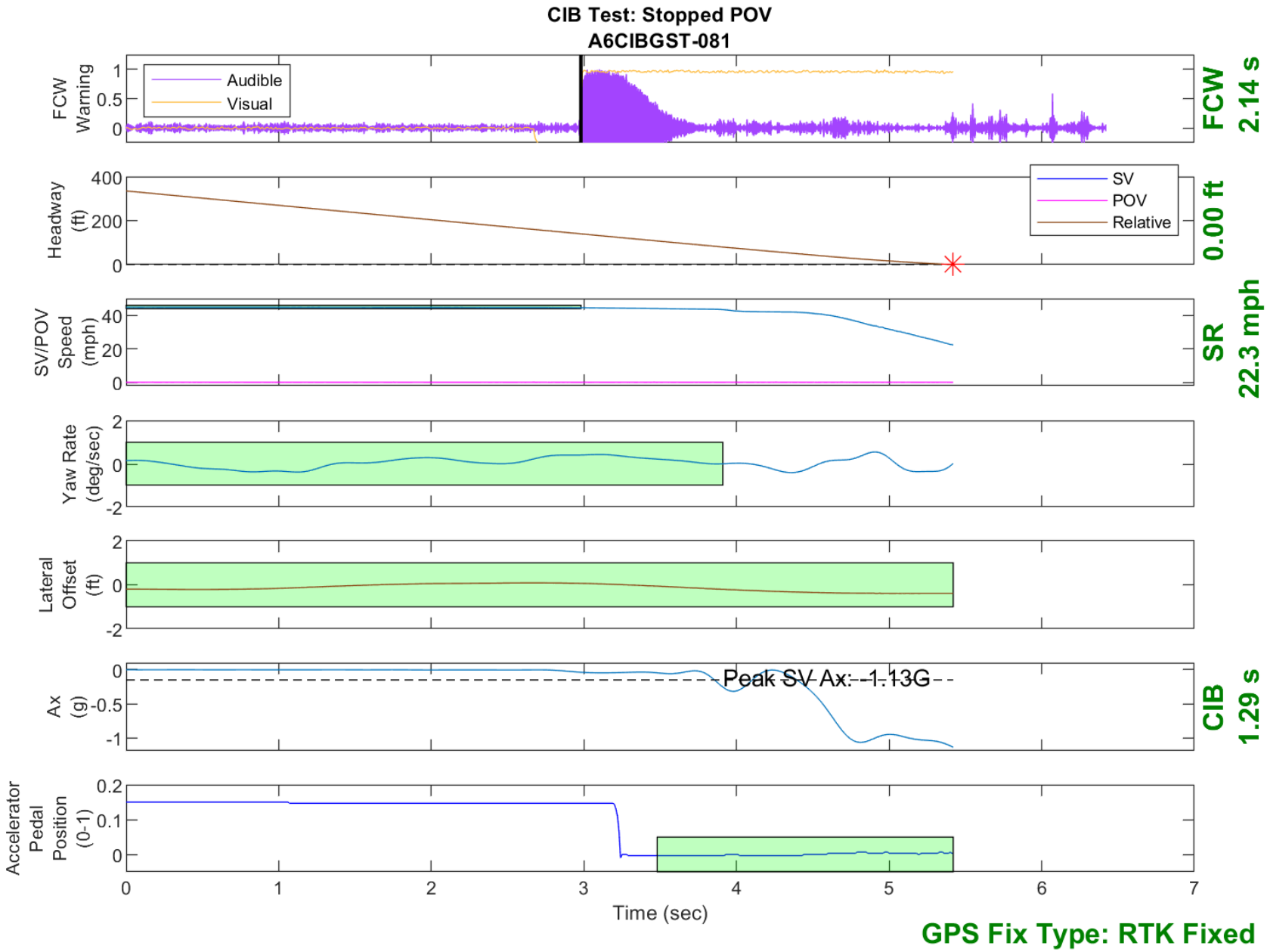

Figure D31. Time History for CIB Run 81, Stopped POV, 45 mph

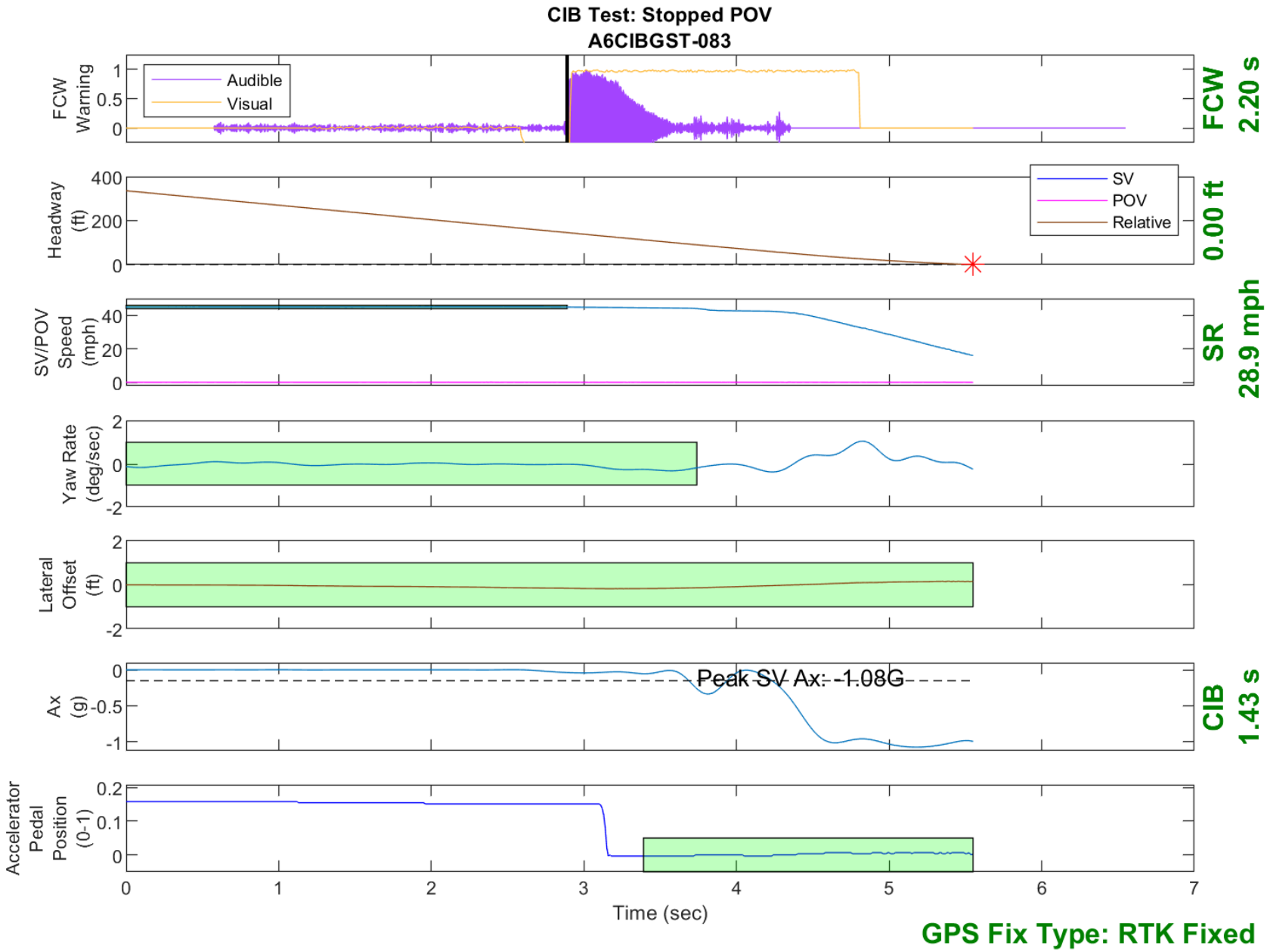

Figure D32. Time History for CIB Run 83, Stopped POV, 45 mph

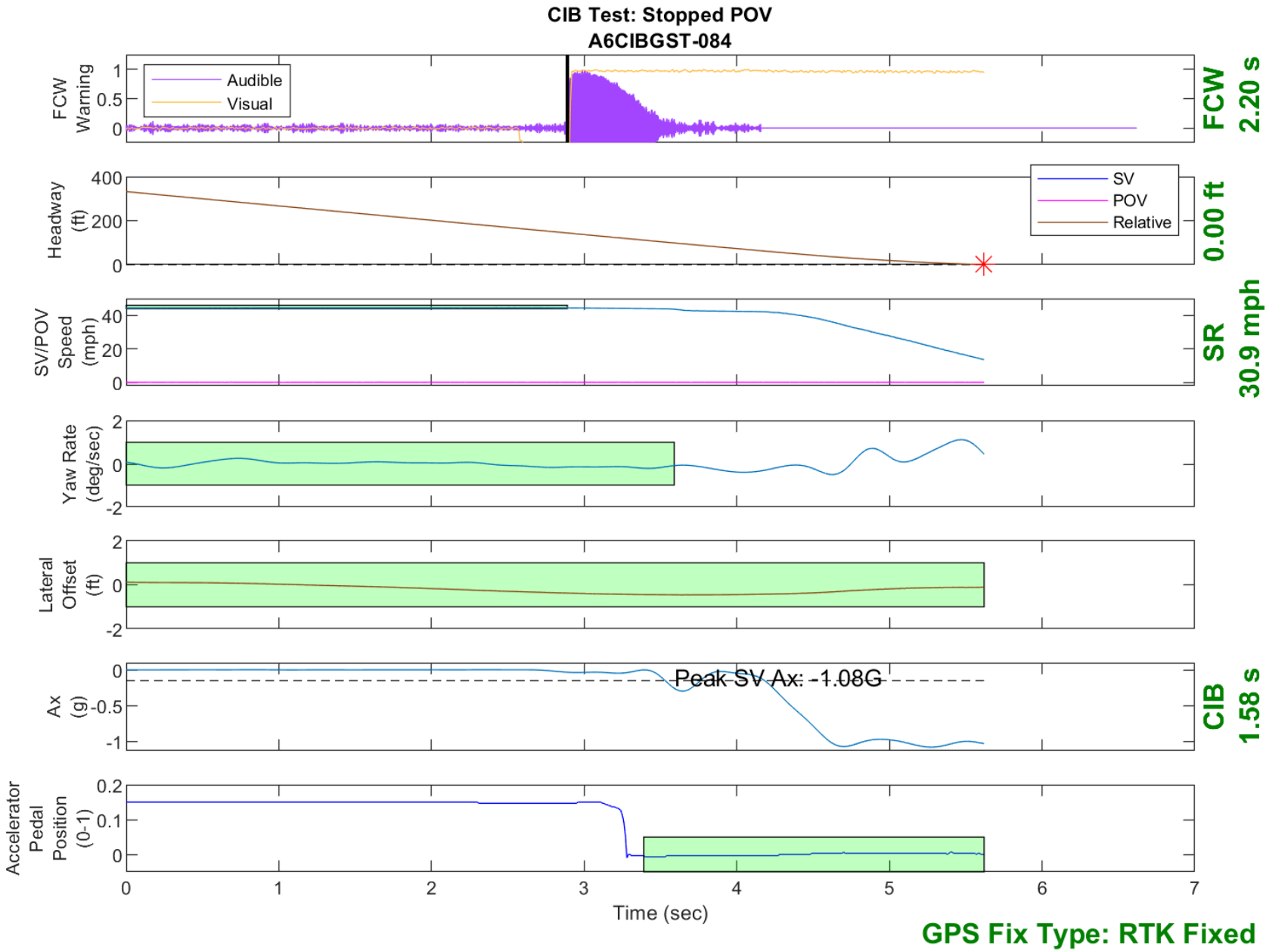

Figure D33. Time History for CIB Run 84, Stopped POV, 45 mph

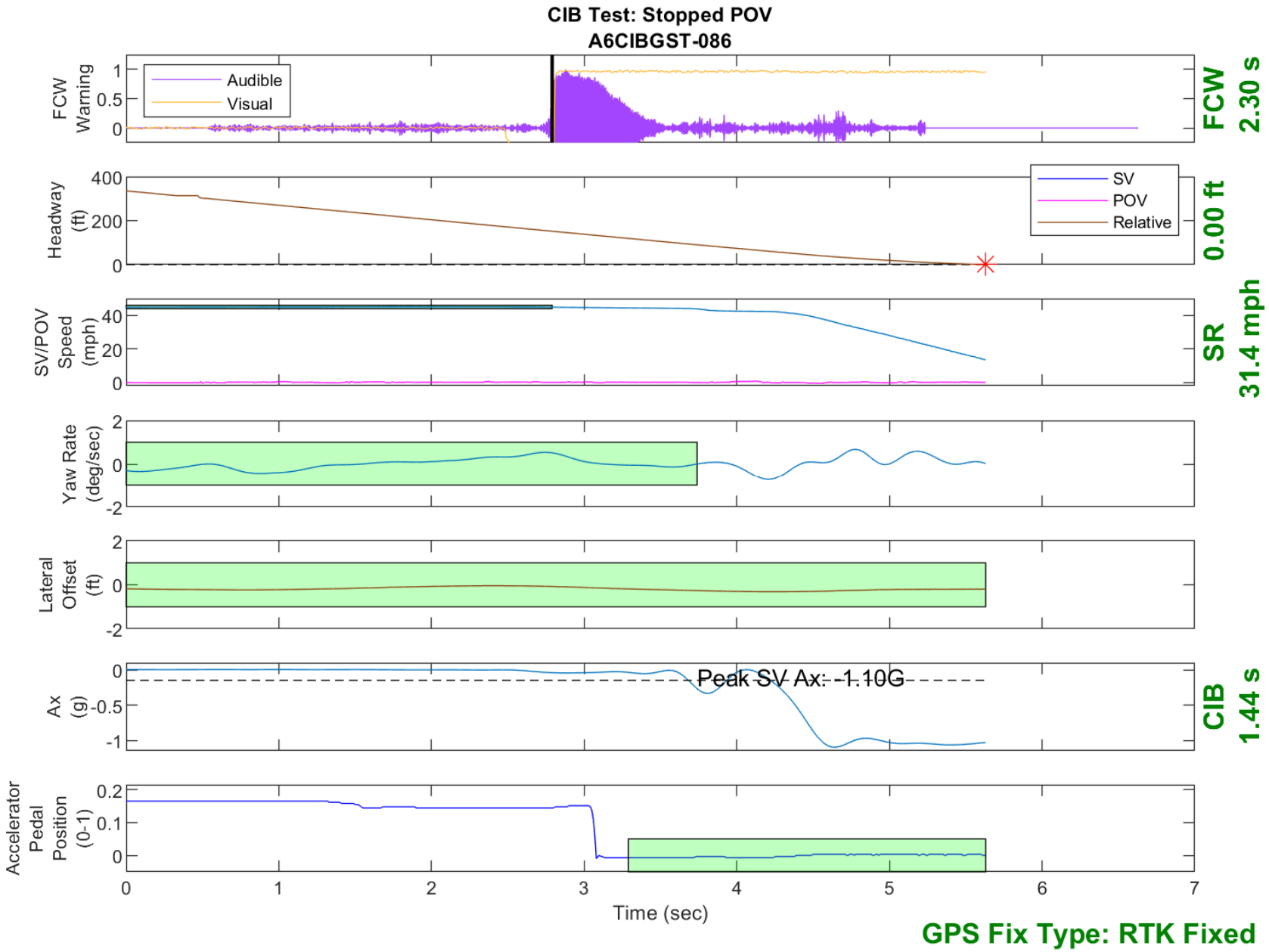

Figure D34. Time History for CIB Run 86, Stopped POV, 45 mph

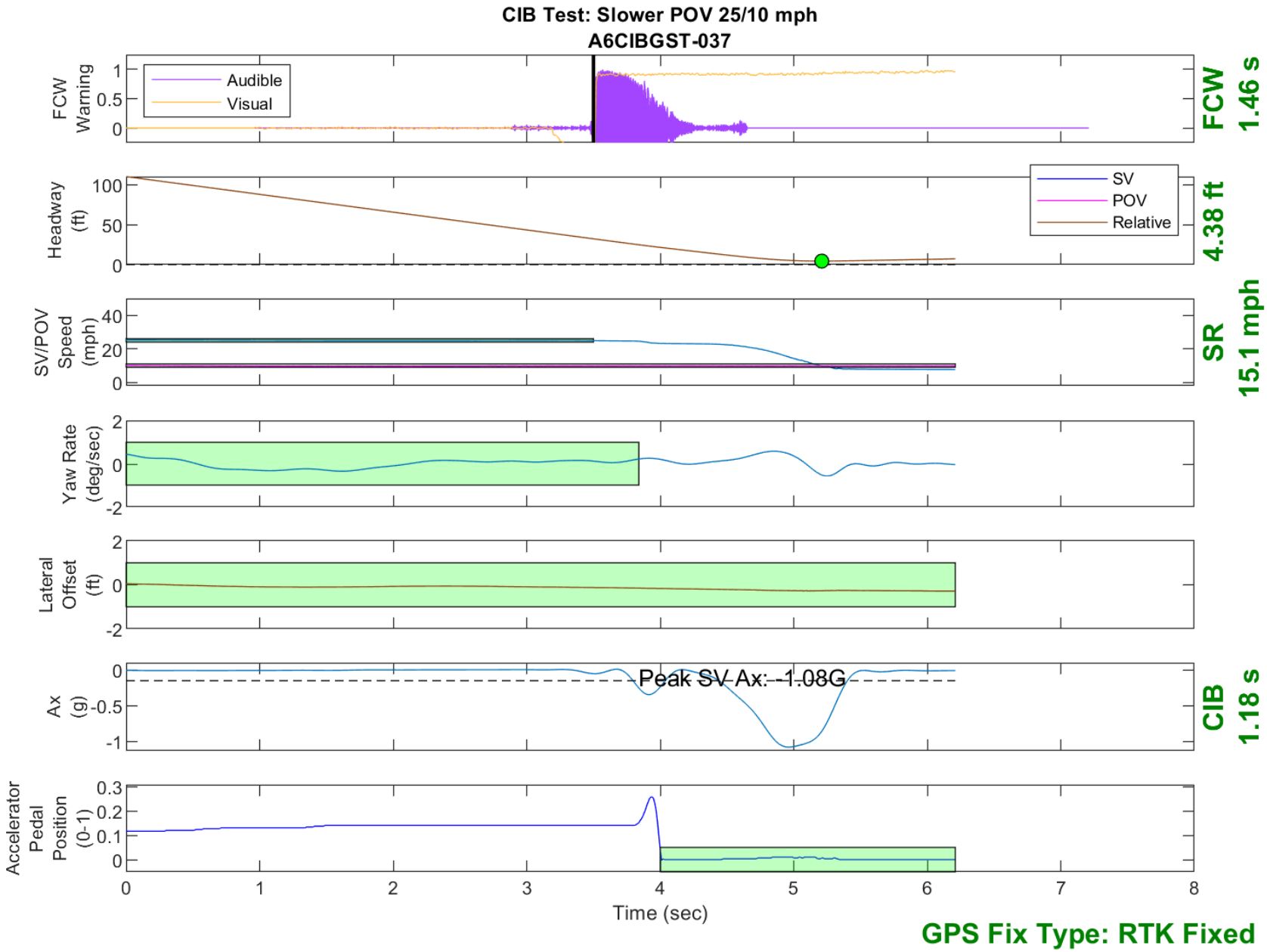

Figure D35. Time History for CIB Run 37, Slower POV, 25/10 mph

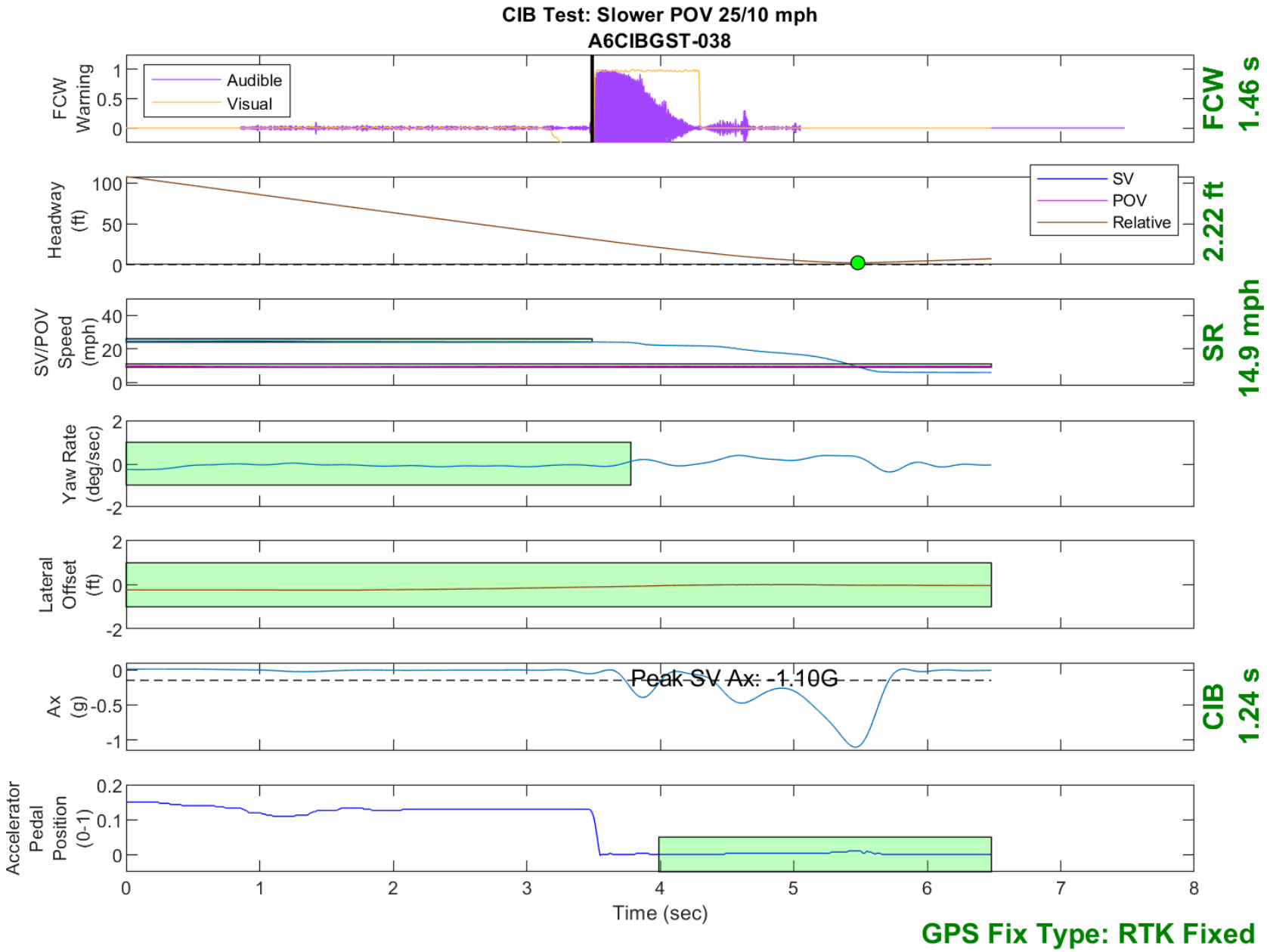

Figure D36. Time History for CIB Run 38, Slower POV, 25/10 mph

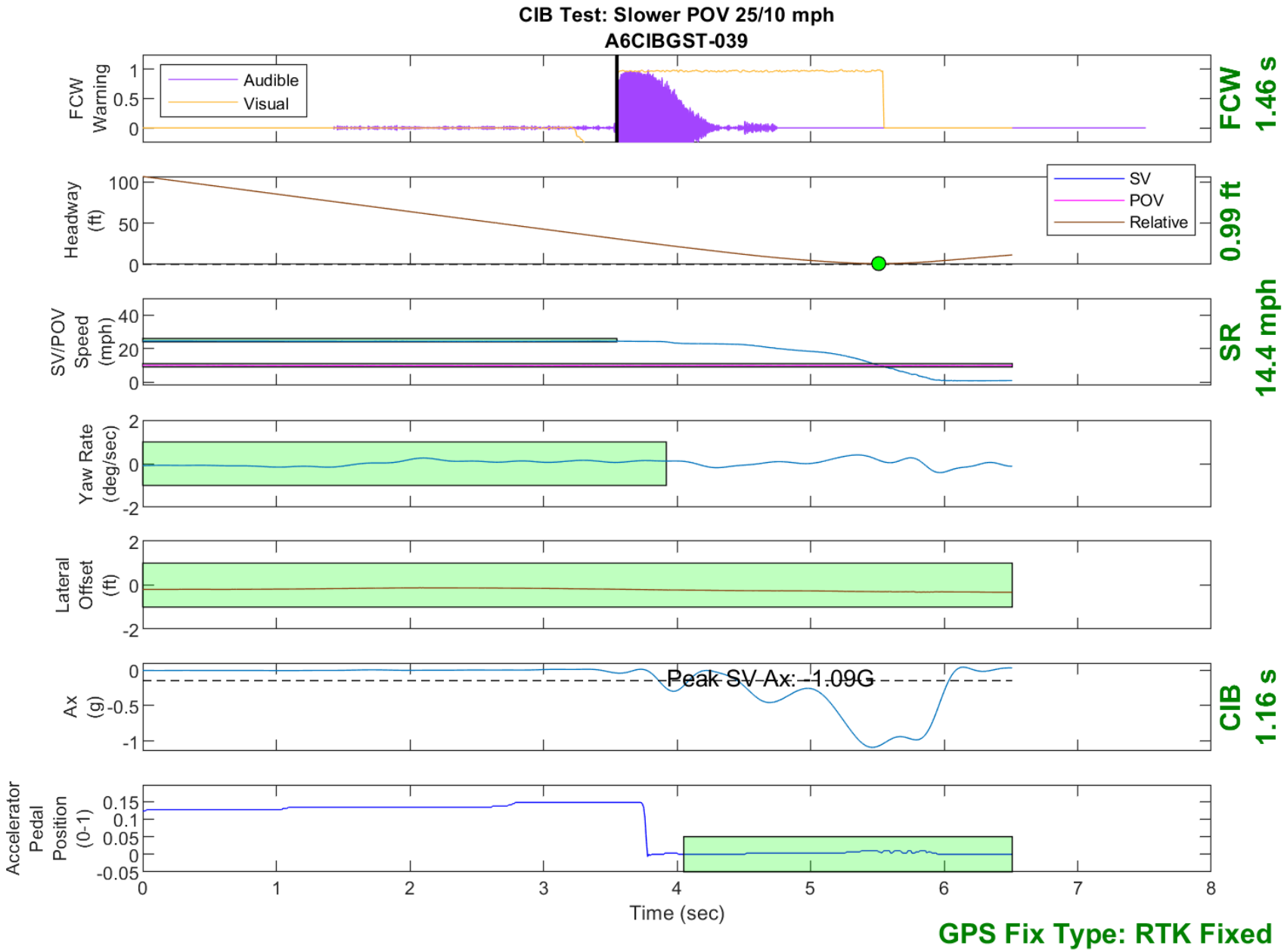

Figure D37. Time History for CIB Run 39, Slower POV, 25/10 mph

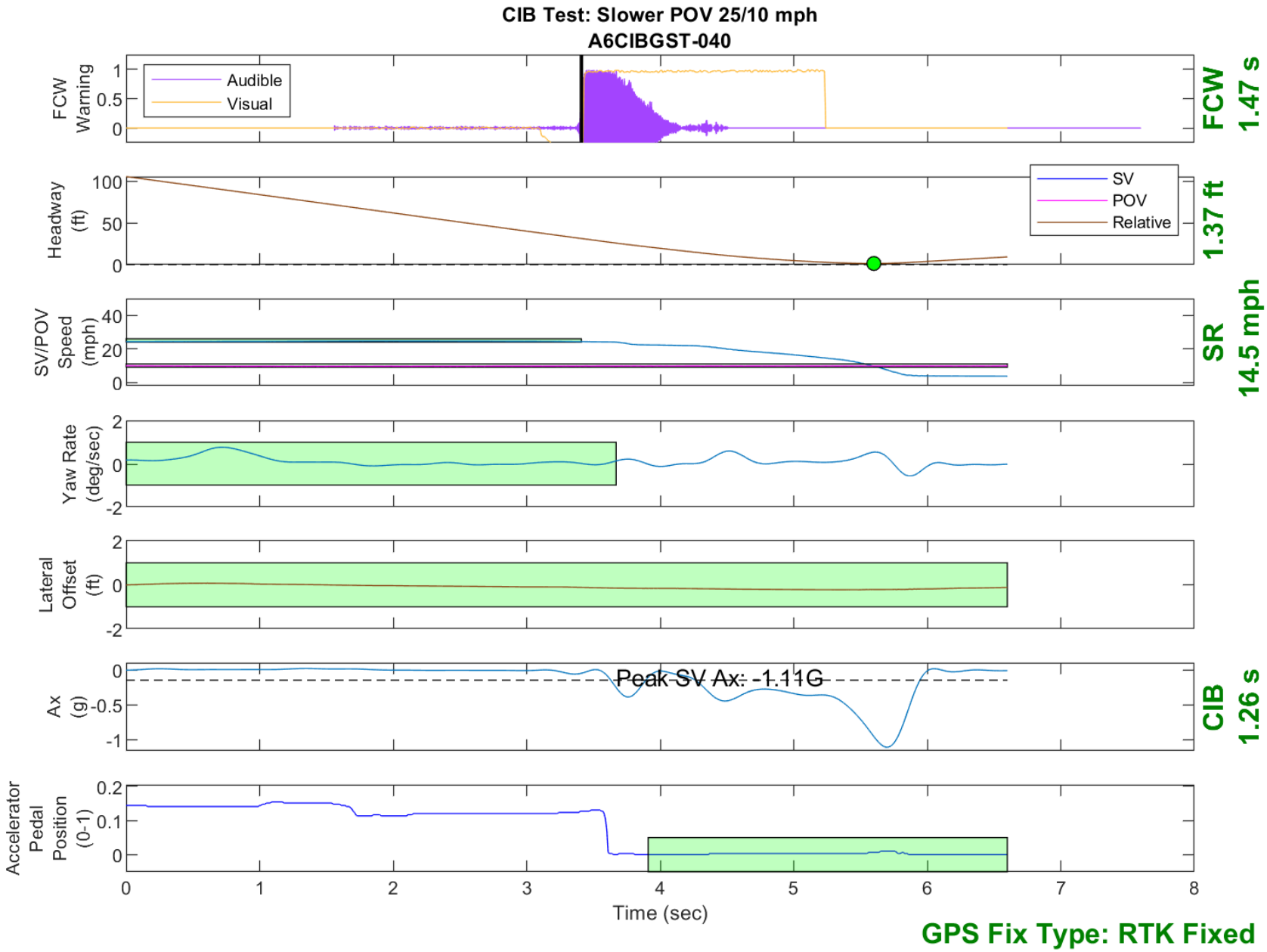

Figure D38. Time History for CIB Run 40, Slower POV, 25/10 mph

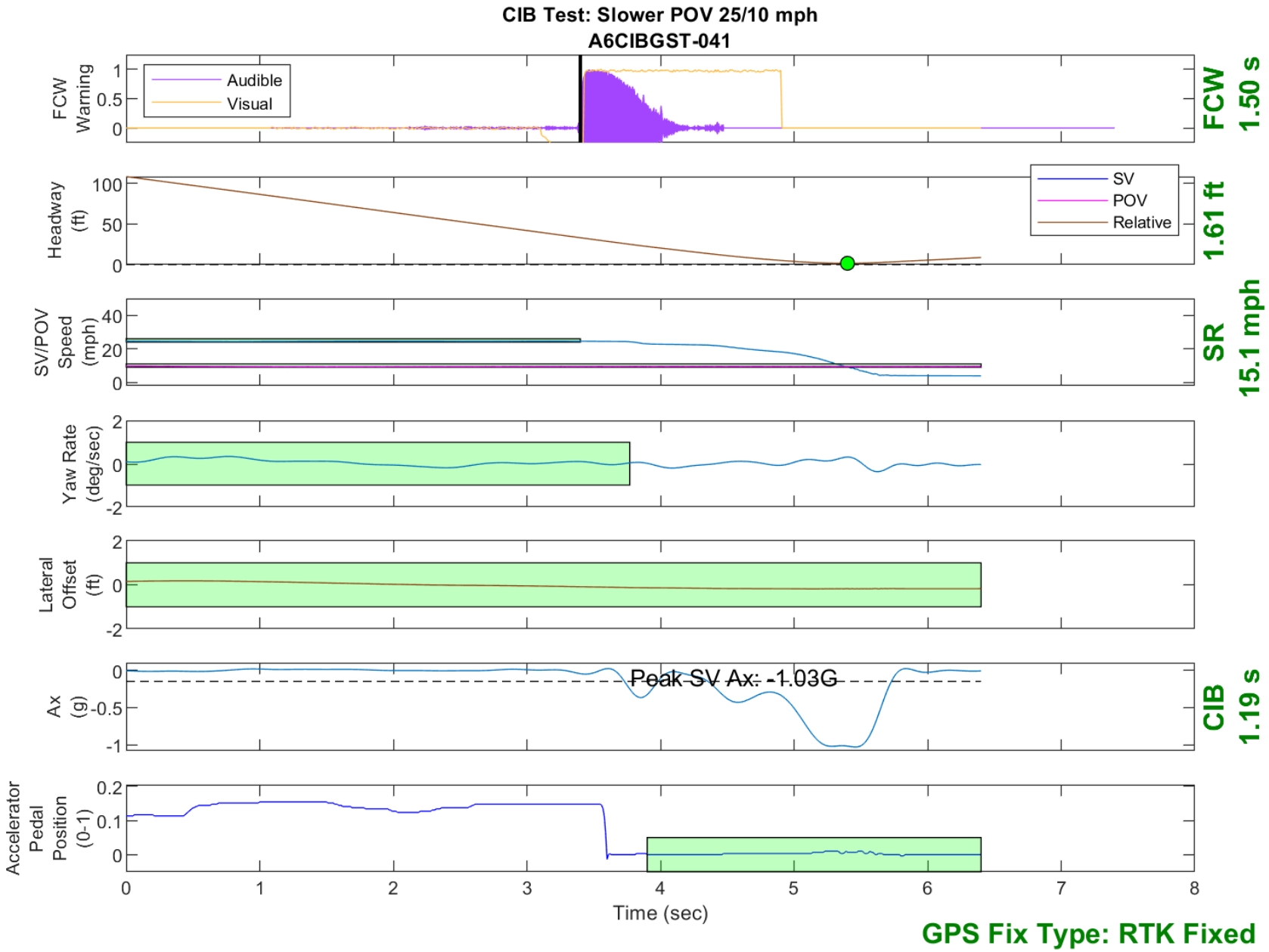

Figure D39. Time History for CIB Run 41, Slower POV, 25/10 mph

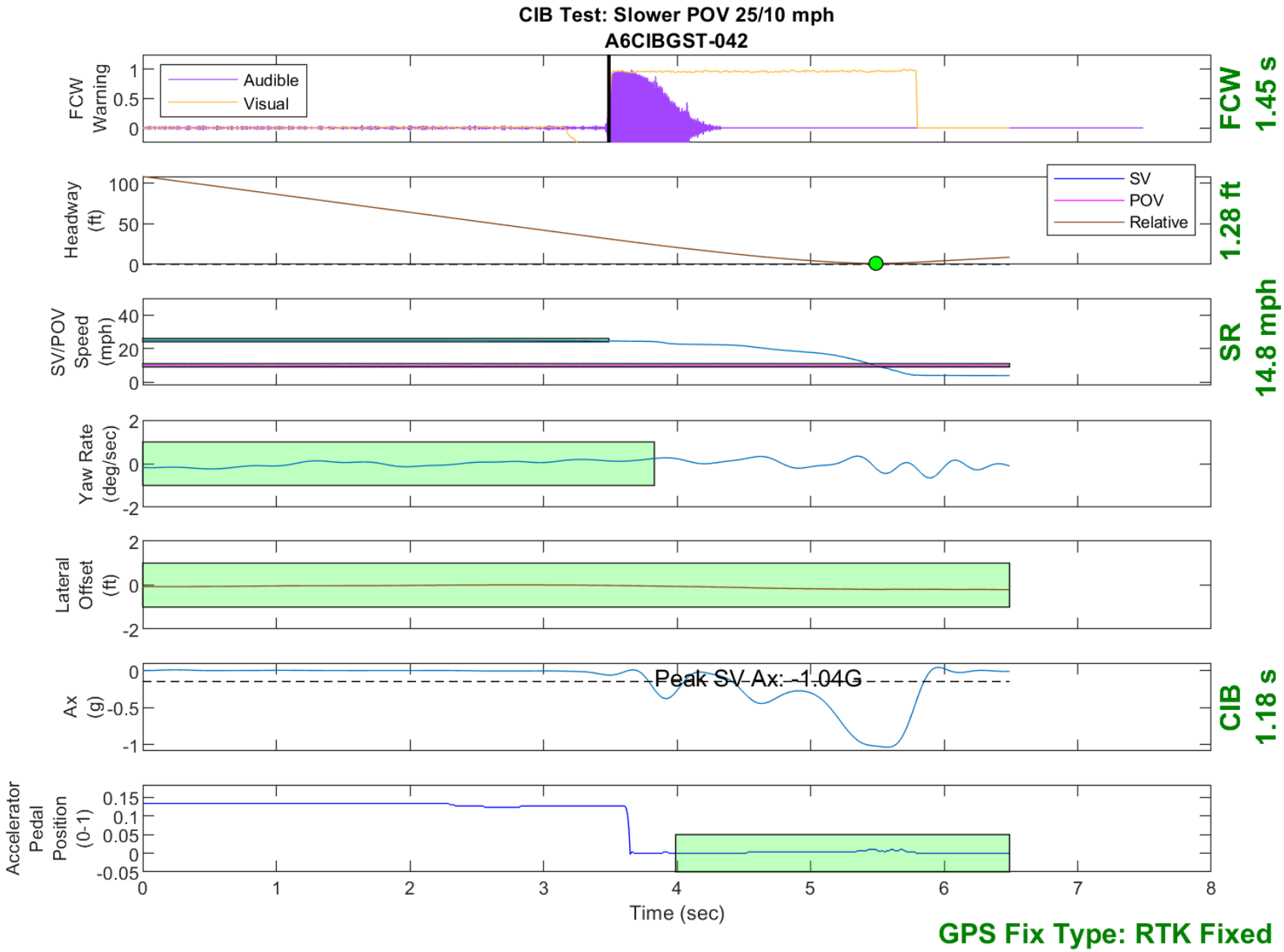

Figure D40. Time History for CIB Run 42, Slower POV, 25/10 mph

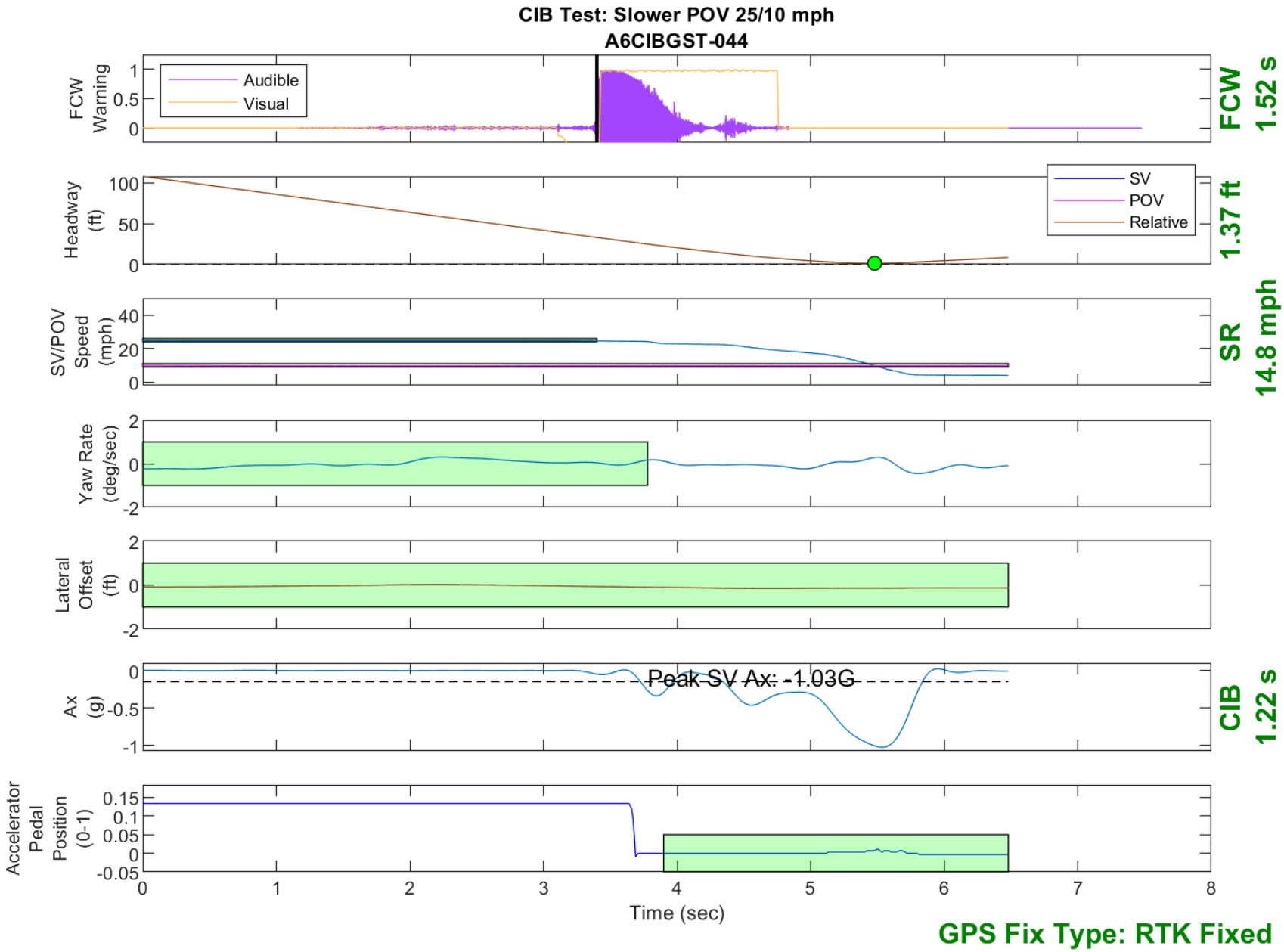

Figure D41. Time History for CIB Run 44, Slower POV, 25/10 mph

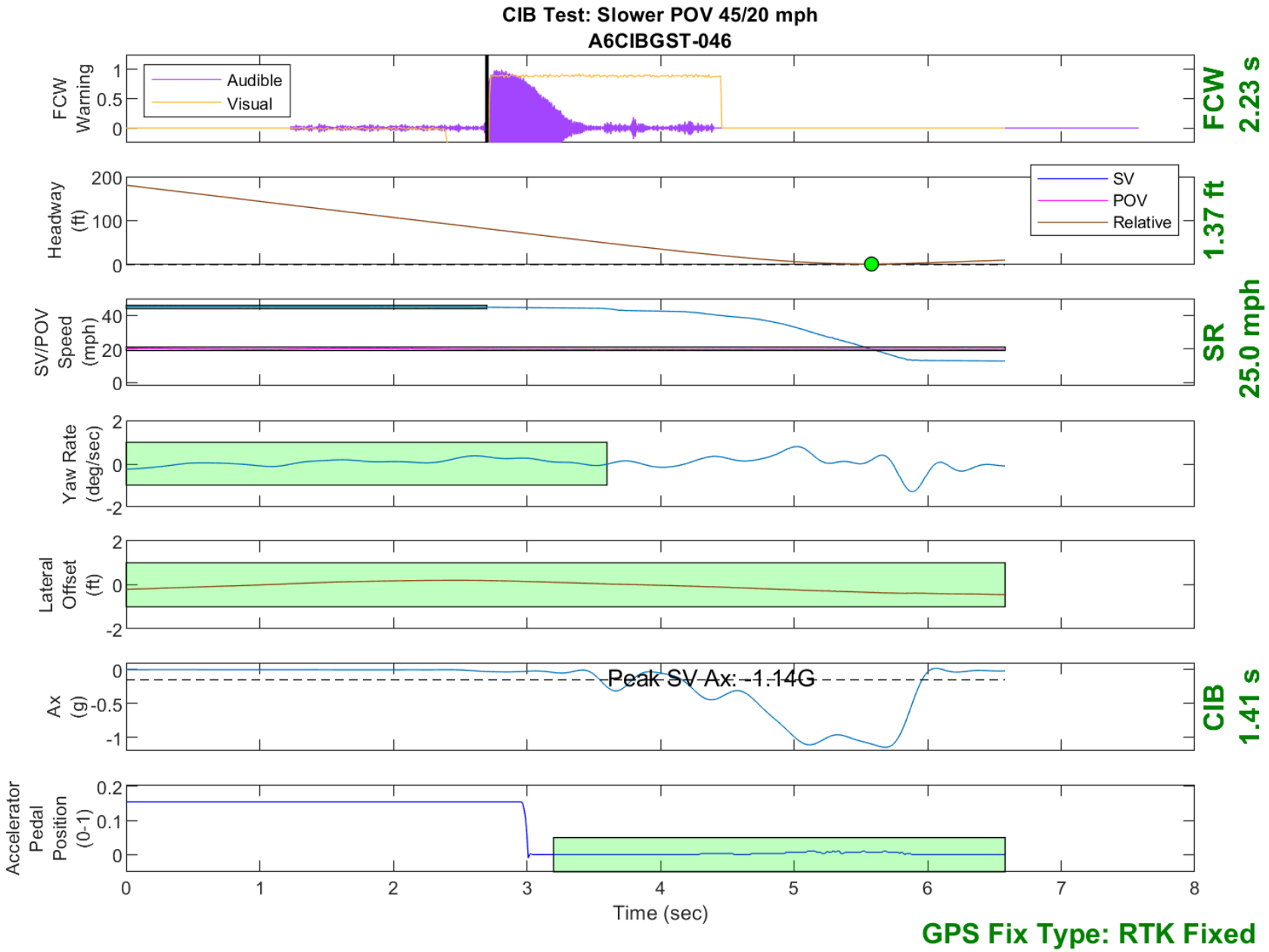

Figure D42. Time History for CIB Run 46, Slower POV, 45/20 mph

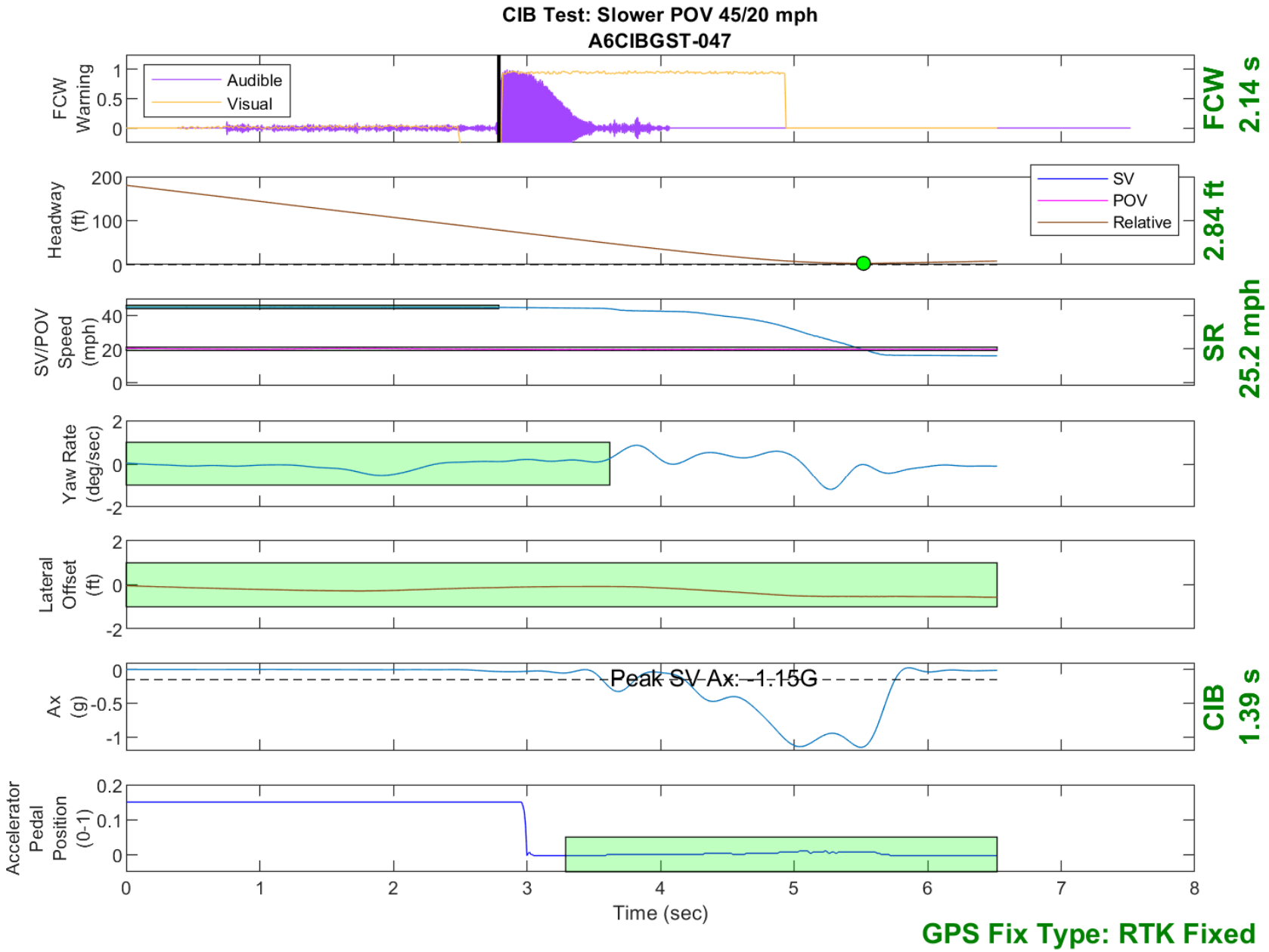

Figure D43. Time History for CIB Run 47, Slower POV, 45/20 mph

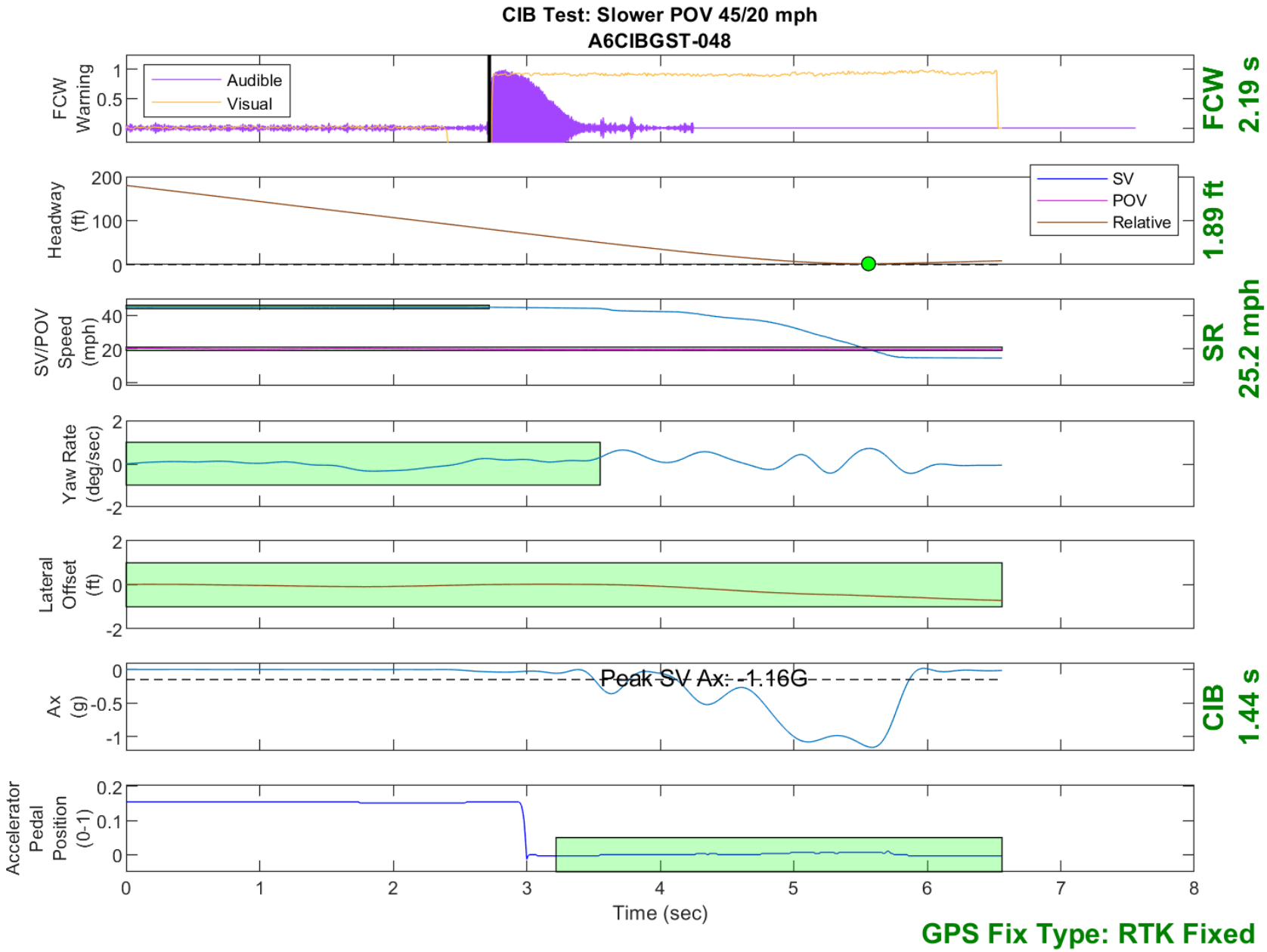

Figure D44. Time History for CIB Run 48, Slower POV, 45/20 mph

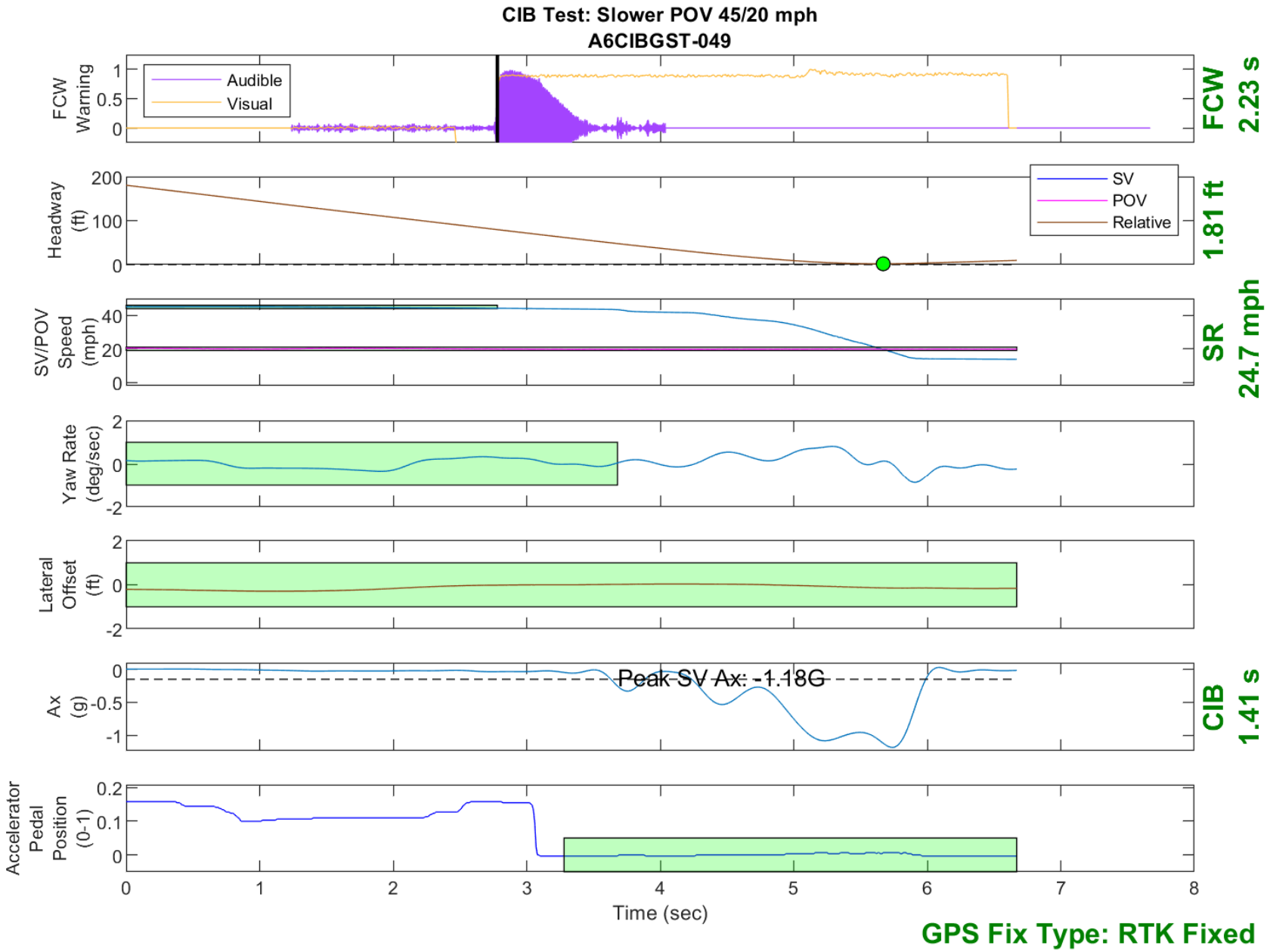

Figure D45. Time History for CIB Run 49, Slower POV, 45/20 mph

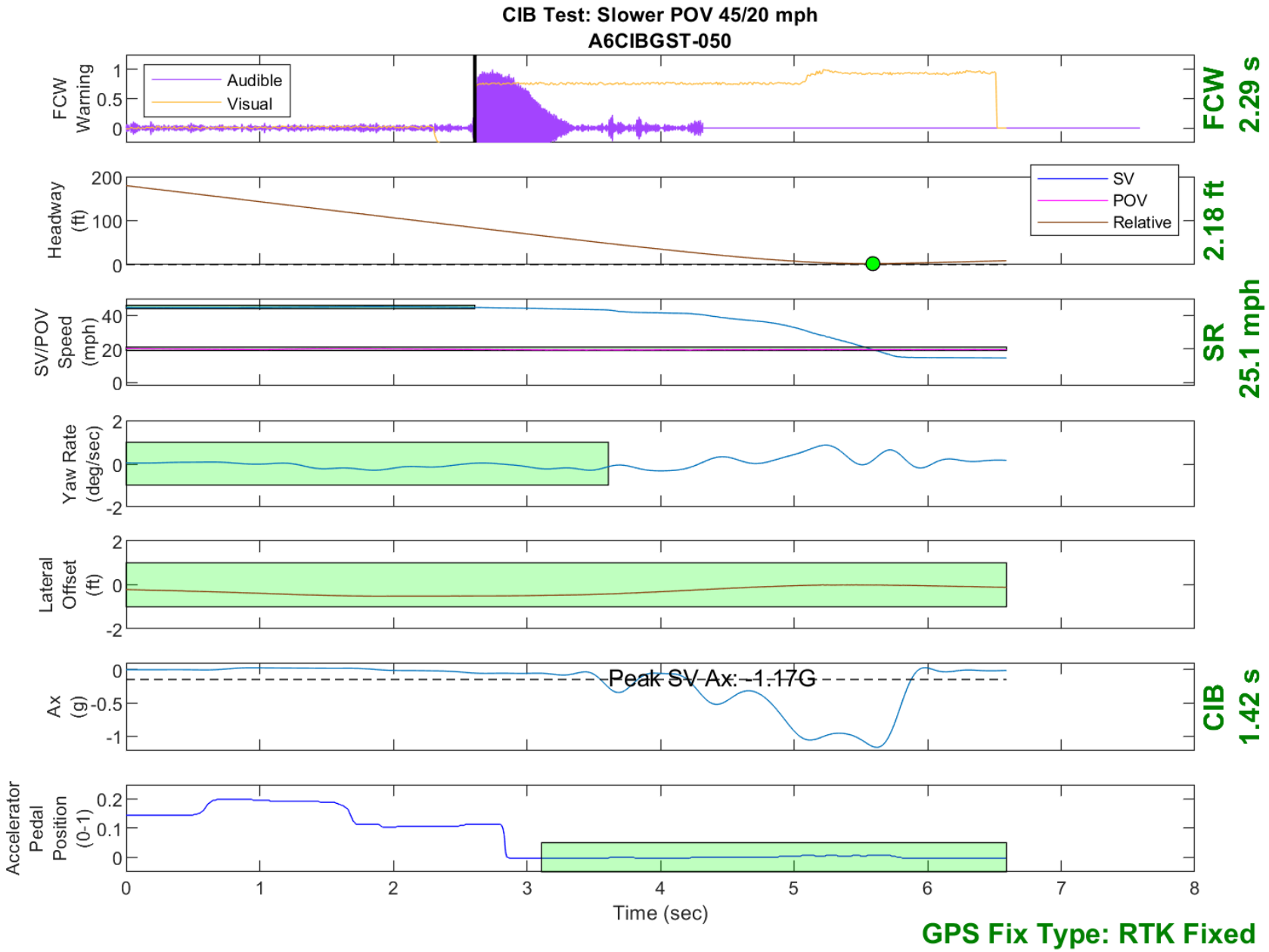

Figure D46. Time History for CIB Run 50, Slower POV, 45/20 mph

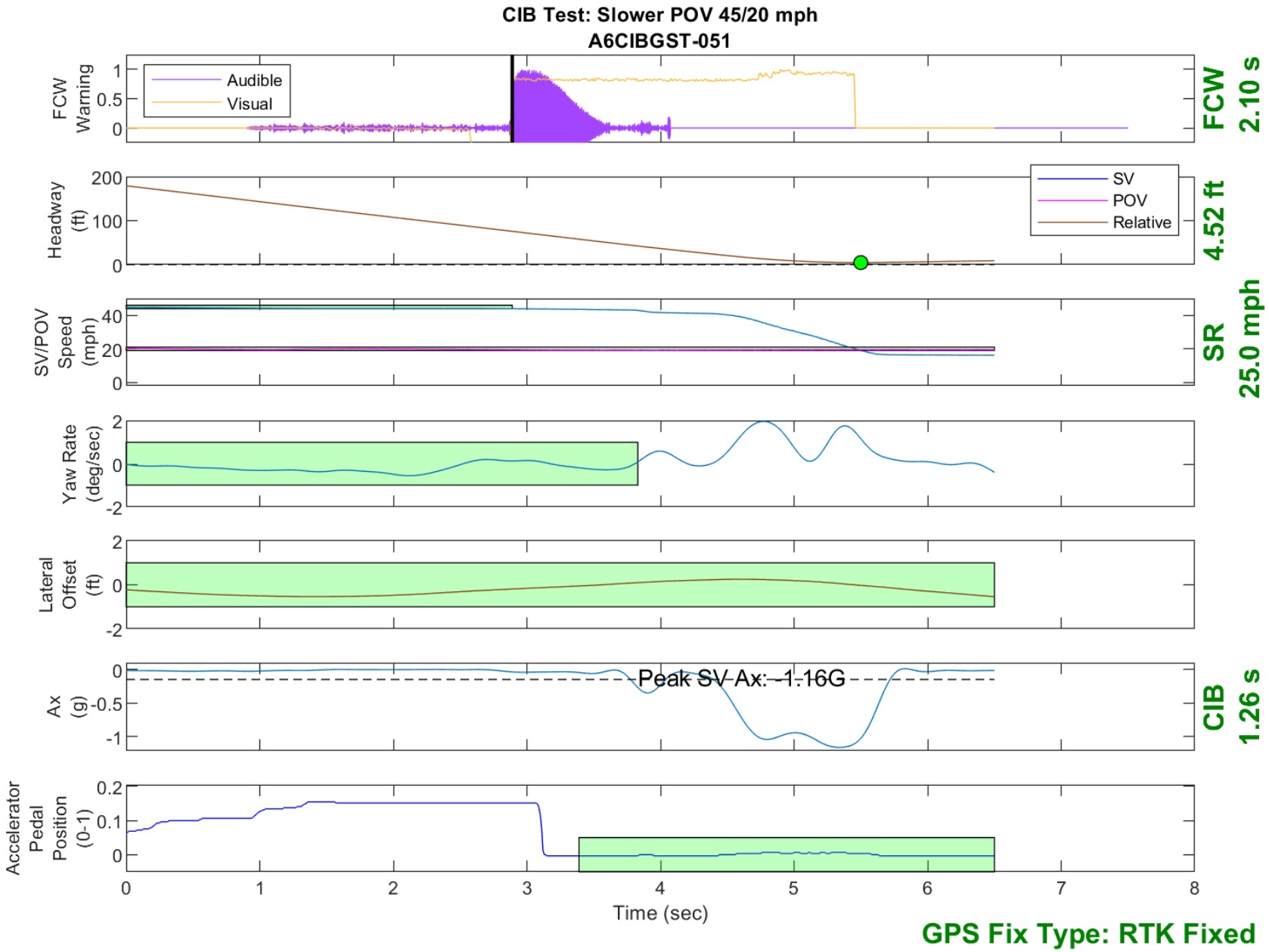

Figure D47. Time History for CIB Run 51, Slower POV, 45/20 mph

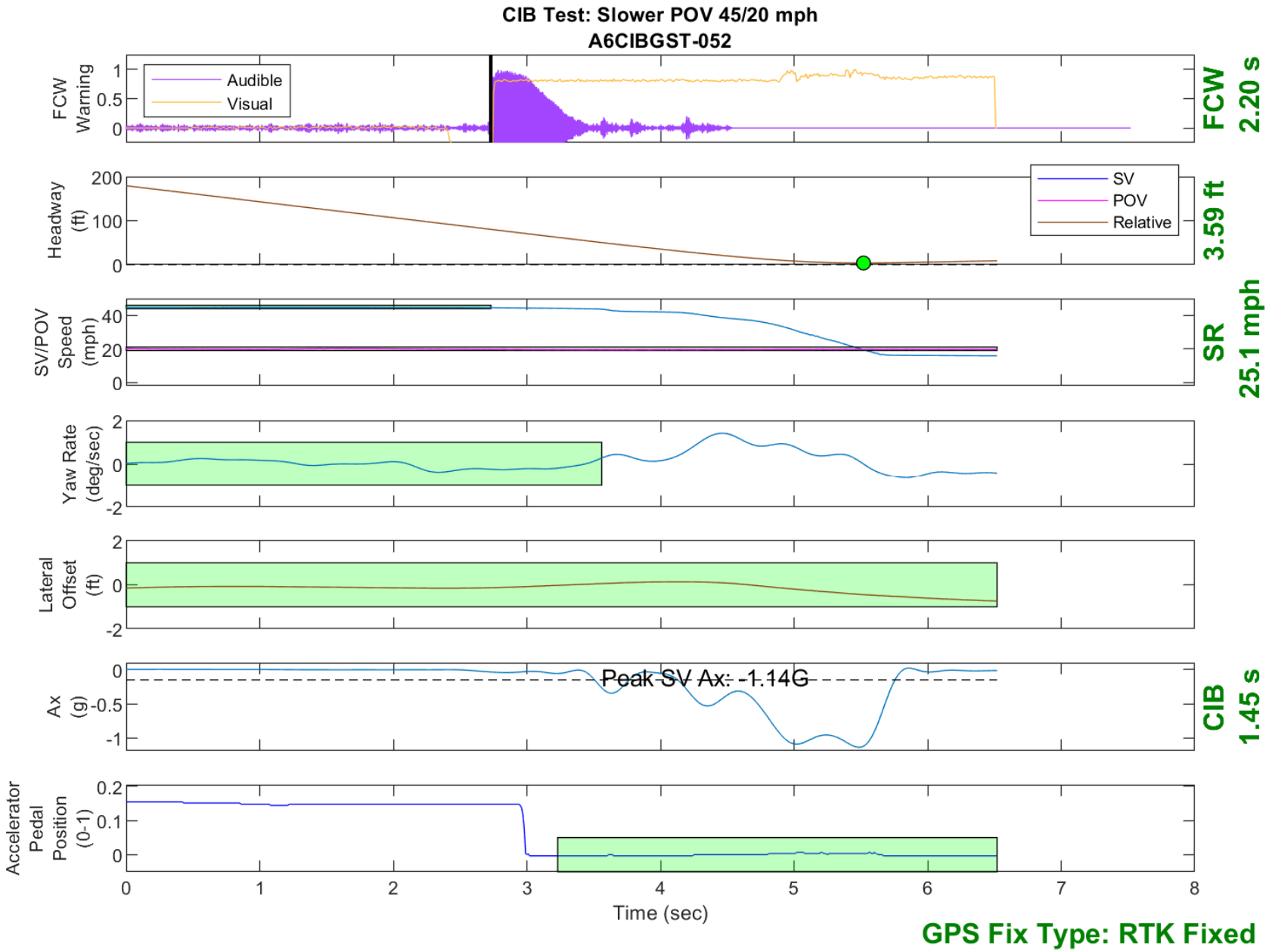

Figure D48. Time History for CIB Run 52, Slower POV, 45/20 mph

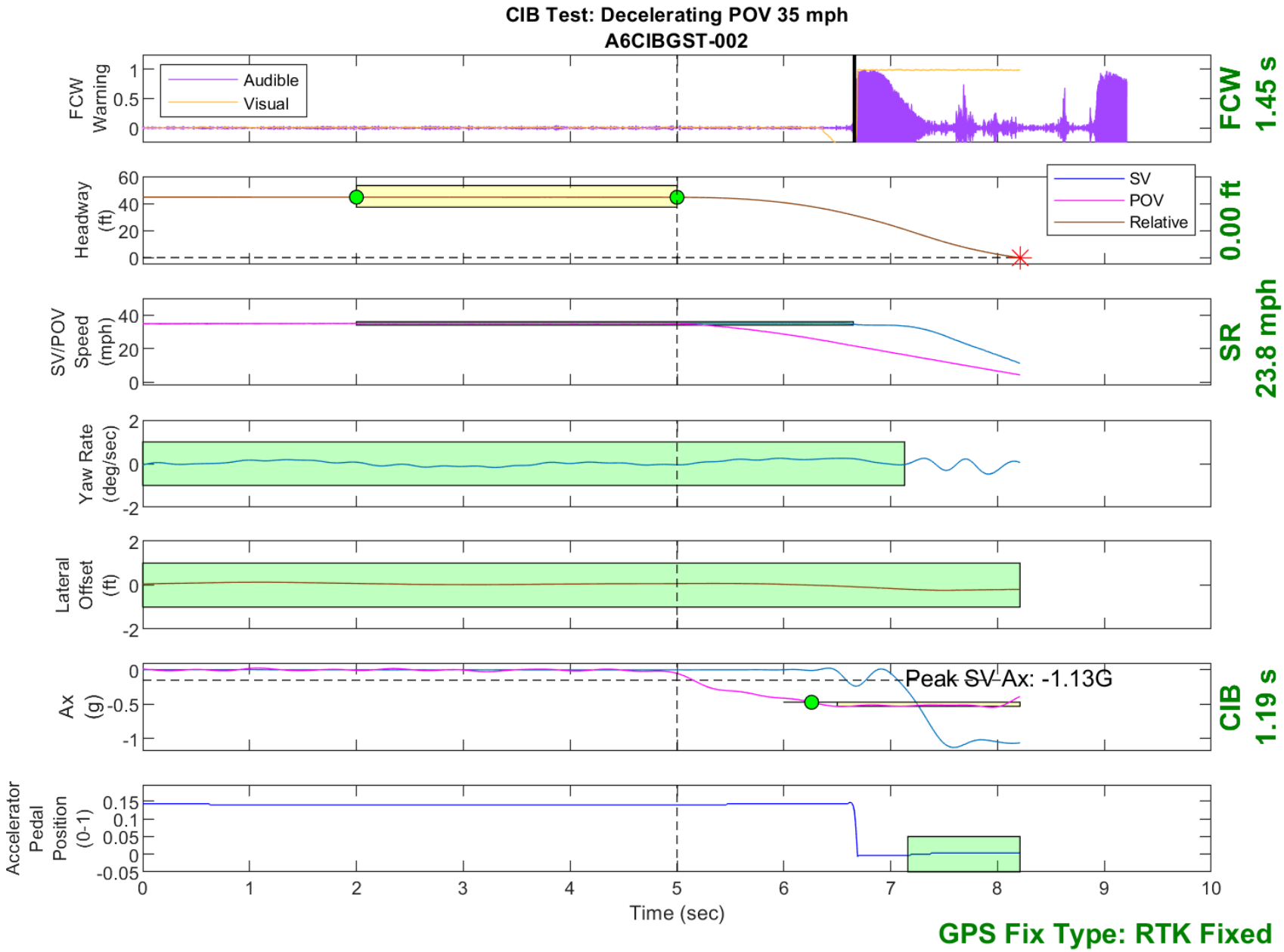

Figure D49. Time History for CIB Run 2, Decelerating POV, 35 mph 0.5g

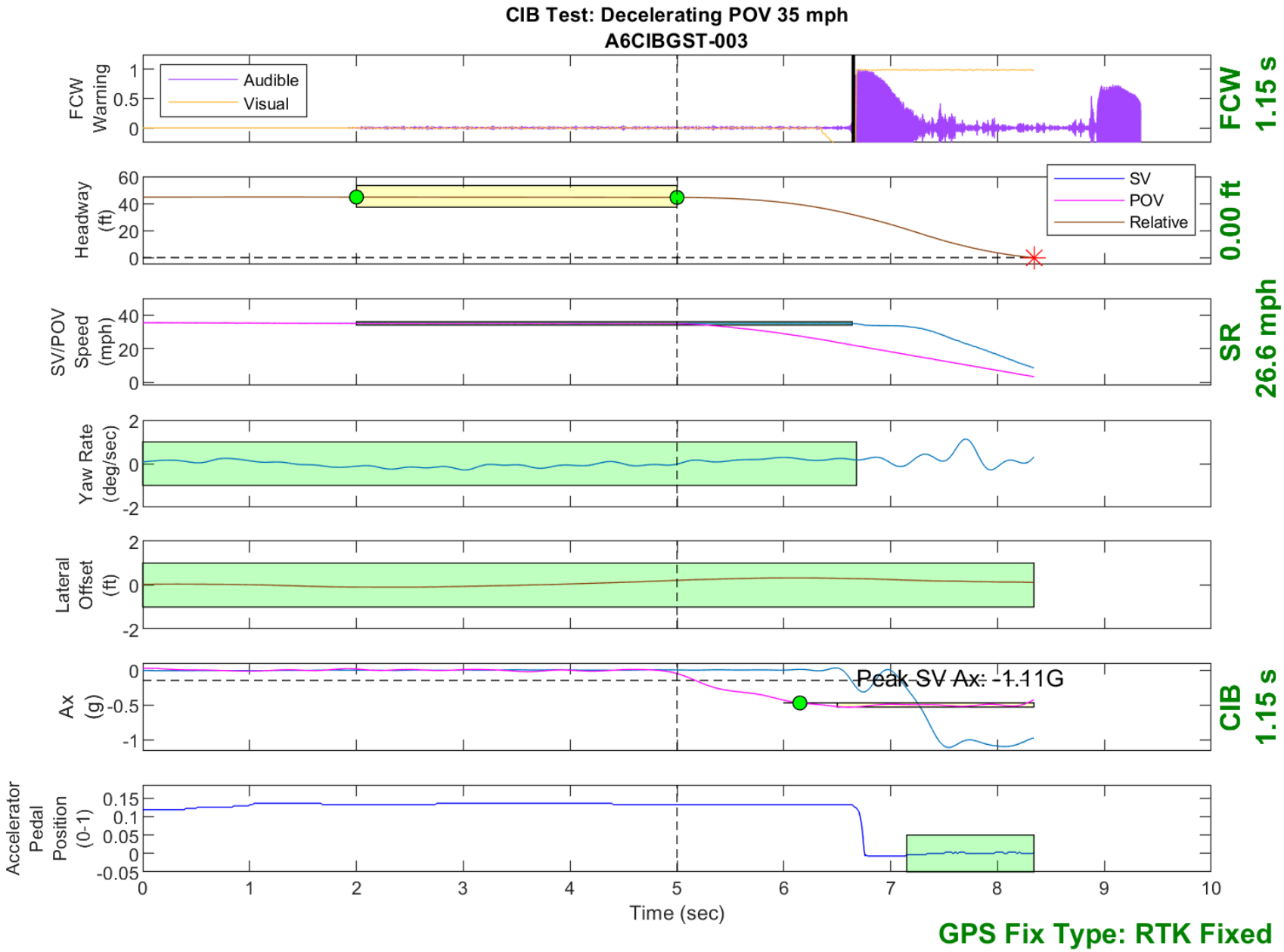

Figure D50. Time History for CIB Run 3, Decelerating POV, 35 mph 0.5g

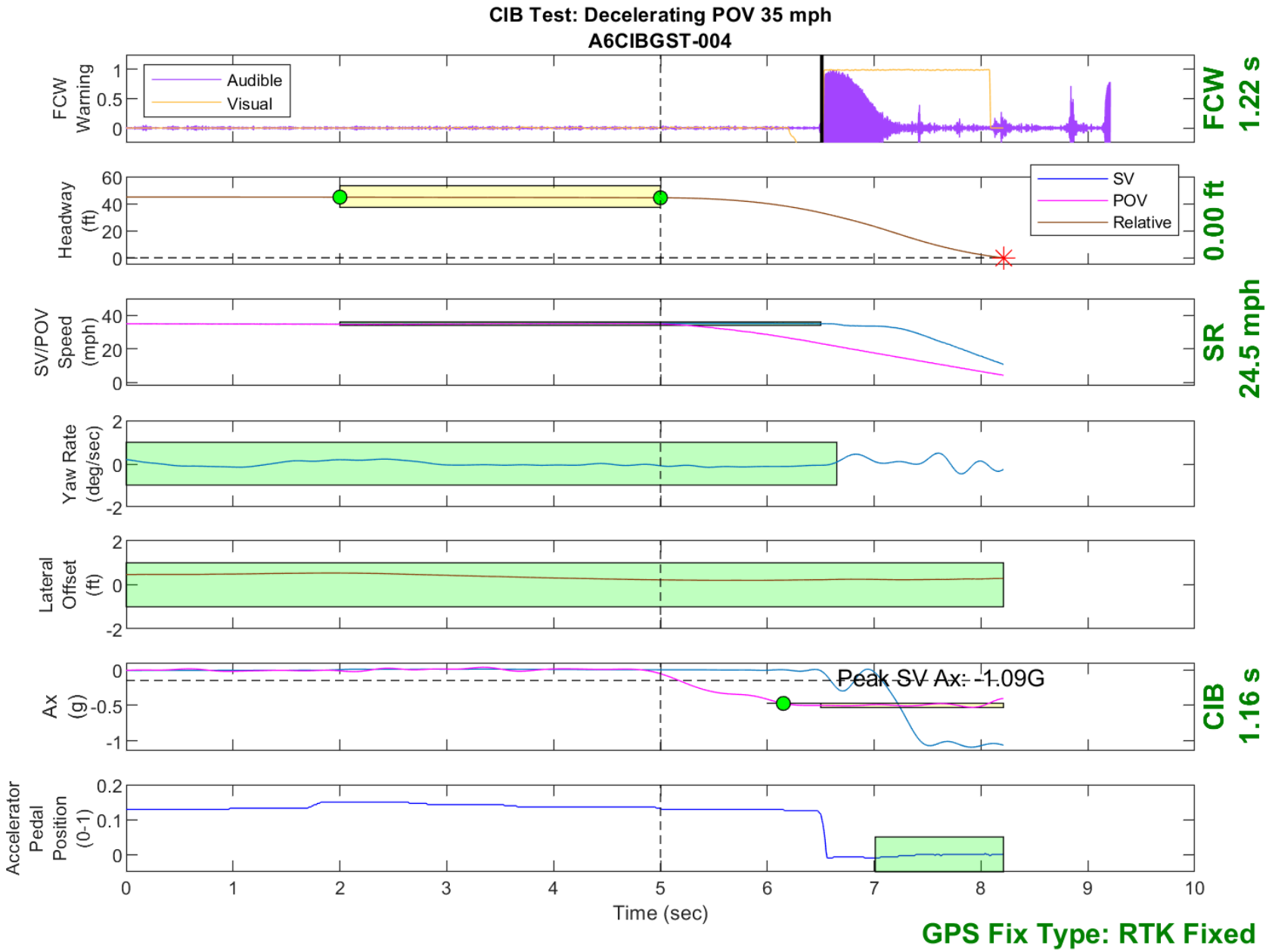

Figure D51. Time History for CIB Run 4, Decelerating POV, 35 mph 0.5g

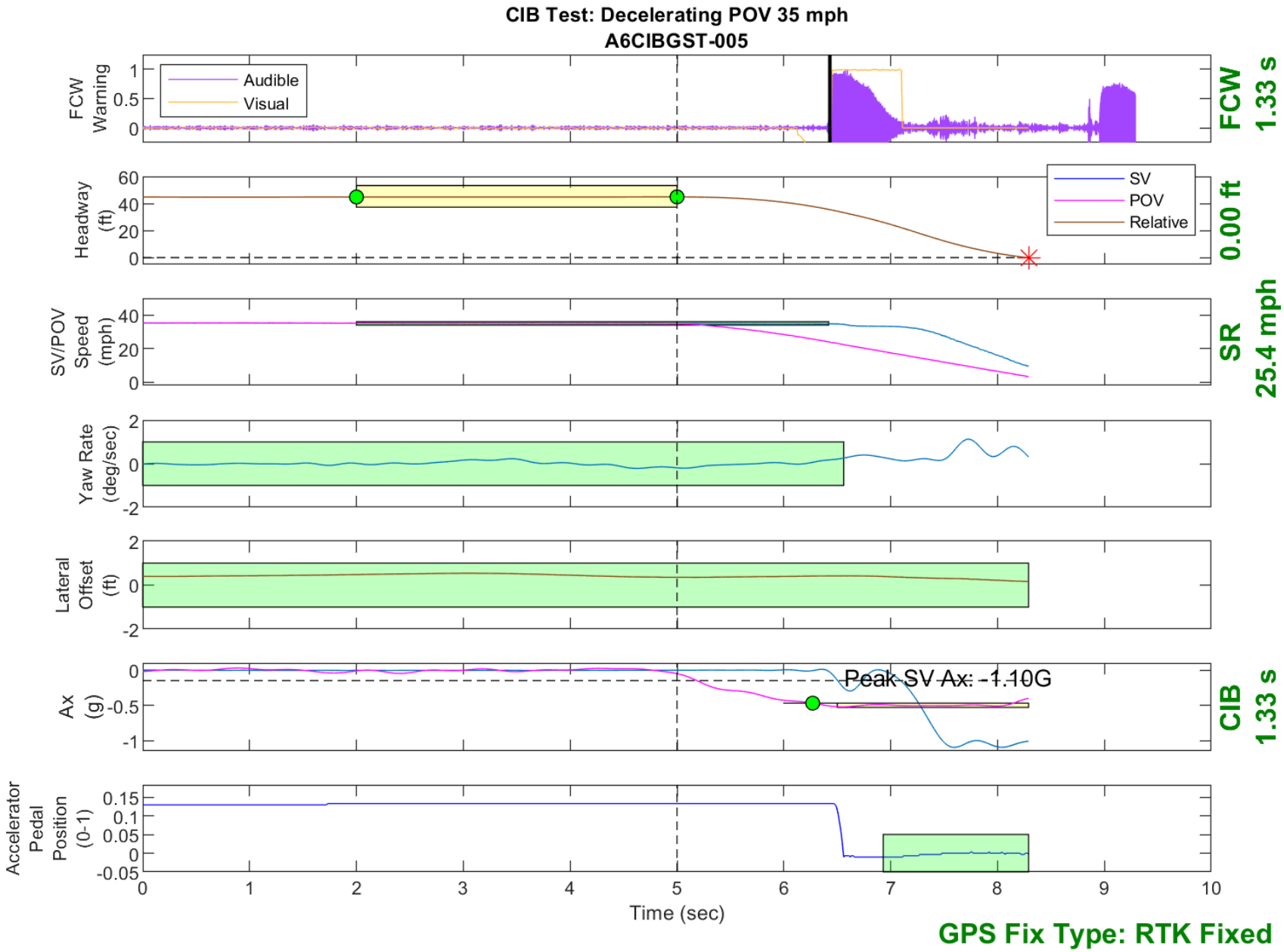

Figure D52. Time History for CIB Run 5, Decelerating POV, 35 mph 0.5g

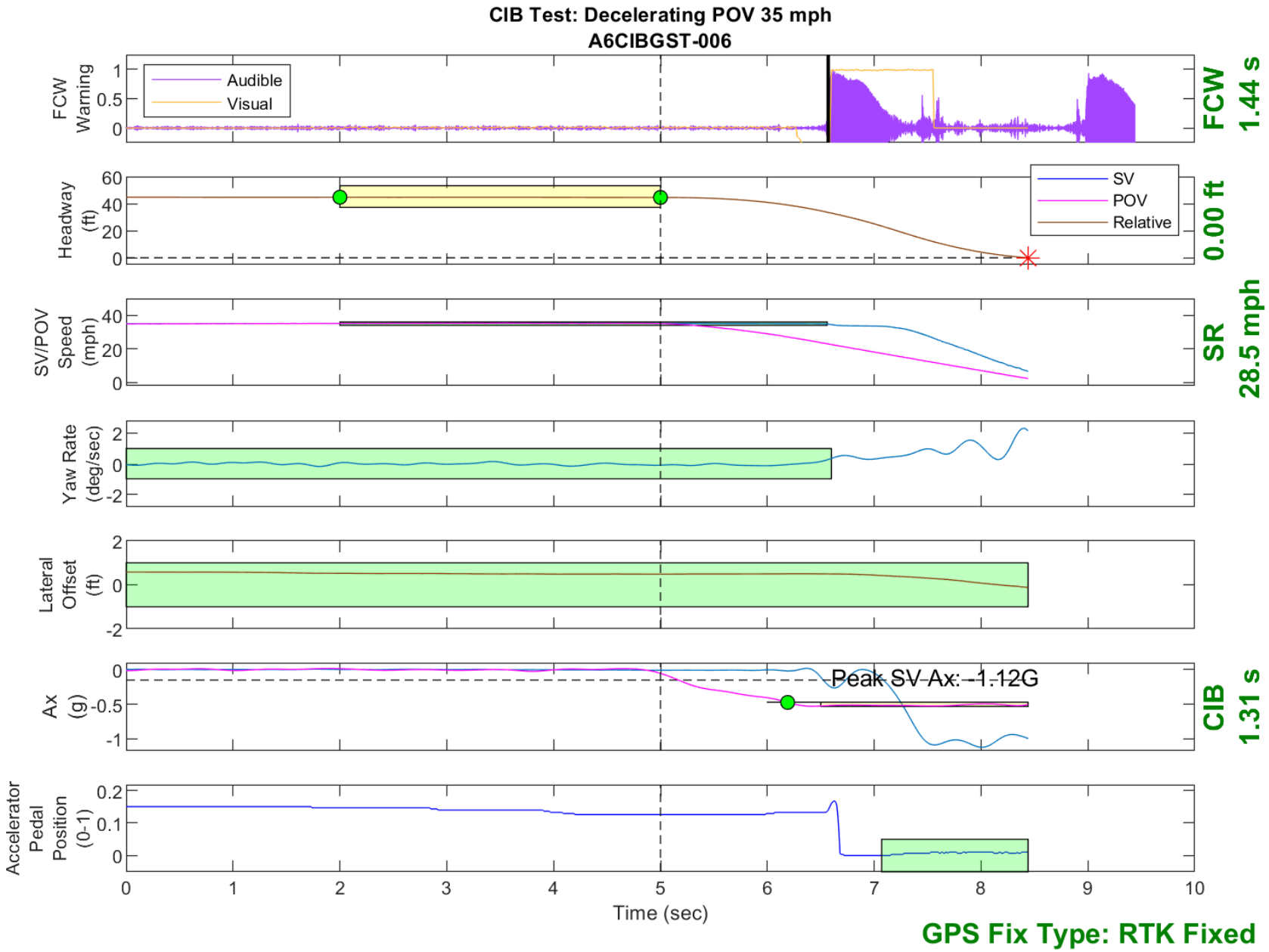

Figure D53. Time History for CIB Run 6, Decelerating POV, 35 mph 0.5g

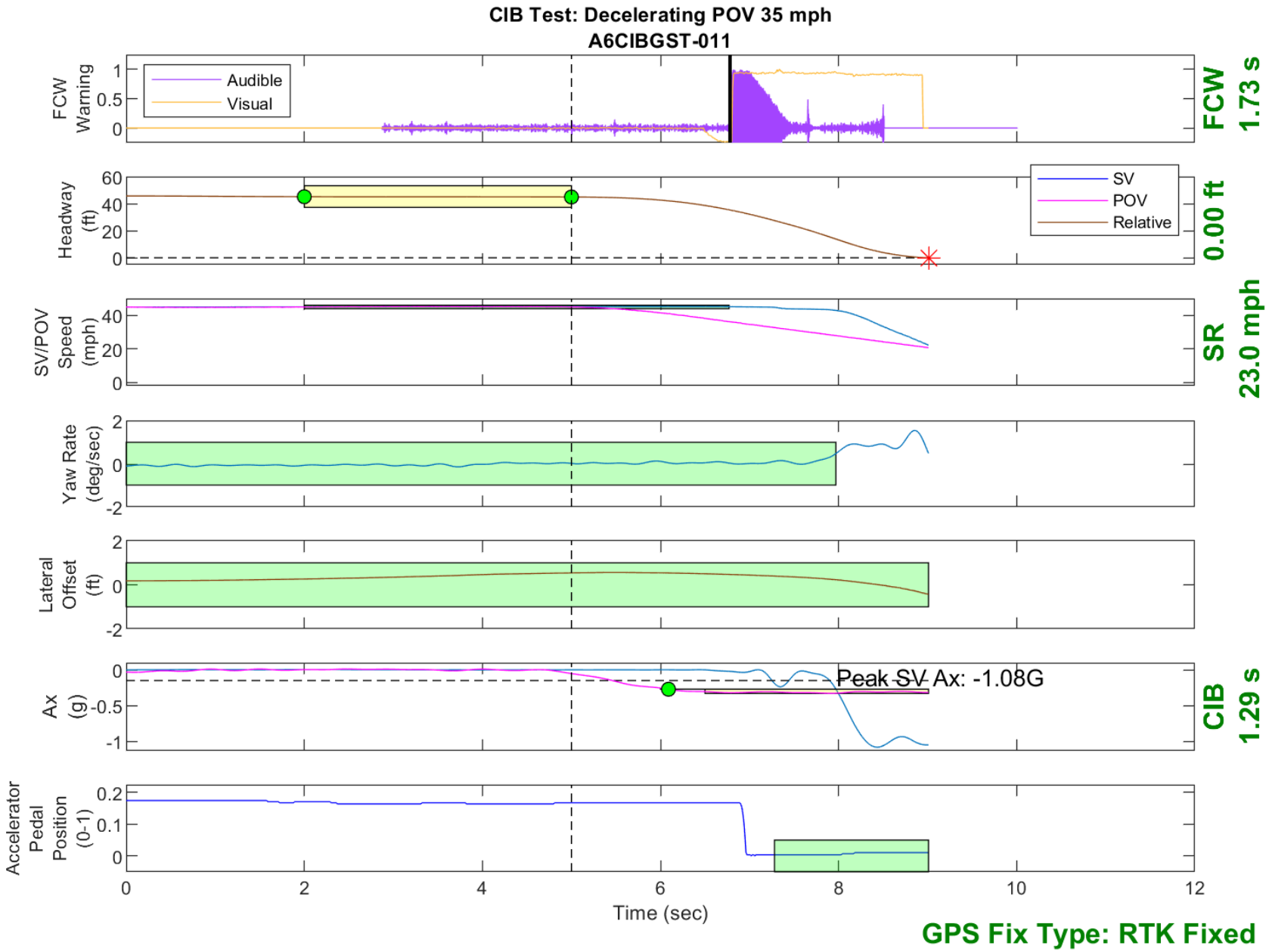

Figure D54. Time History for CIB Run 11, Decelerating POV, 45 mph 0.3g

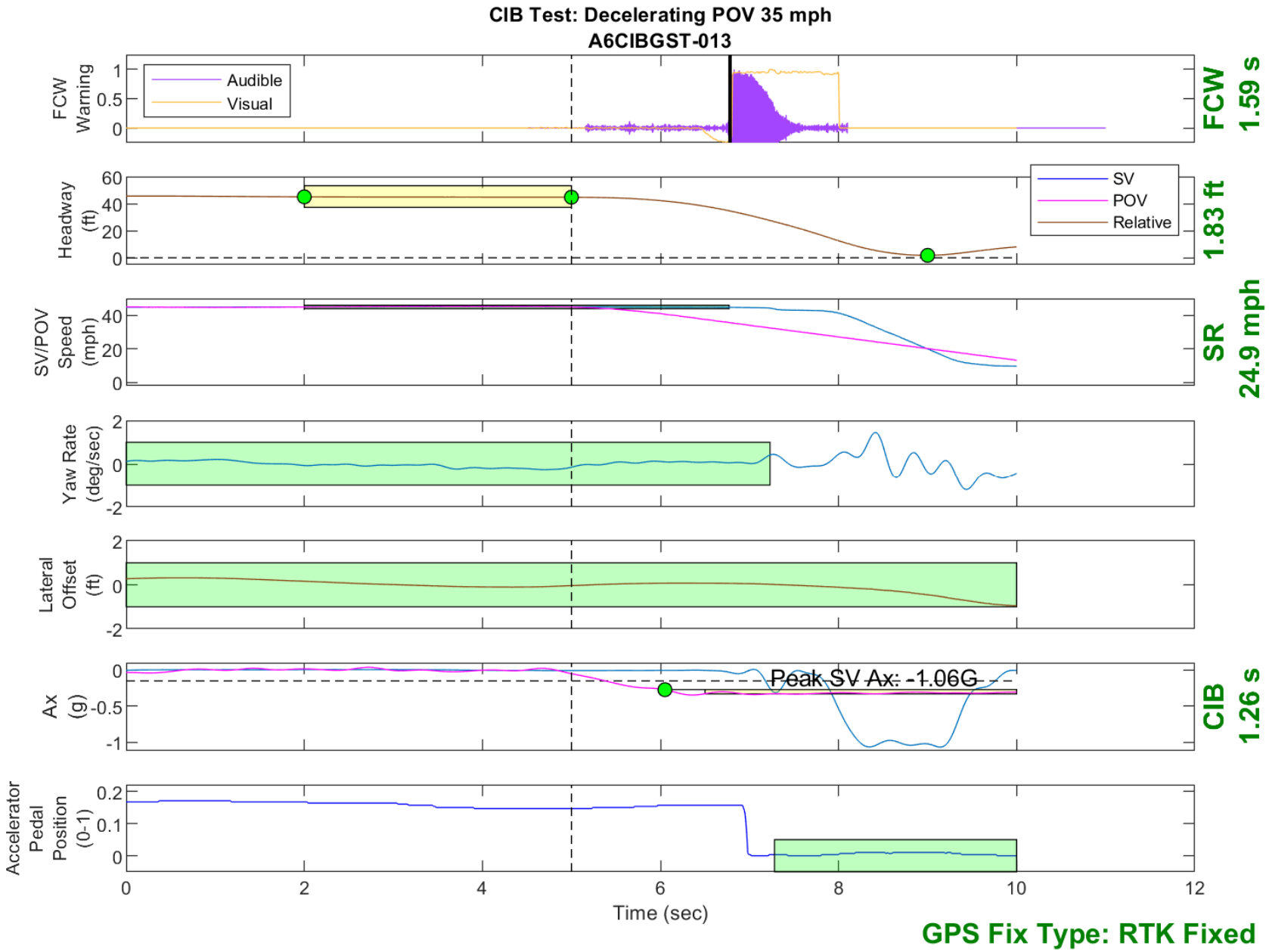

Figure D55. Time History for CIB Run 13, Decelerating POV, 45 mph 0.3g

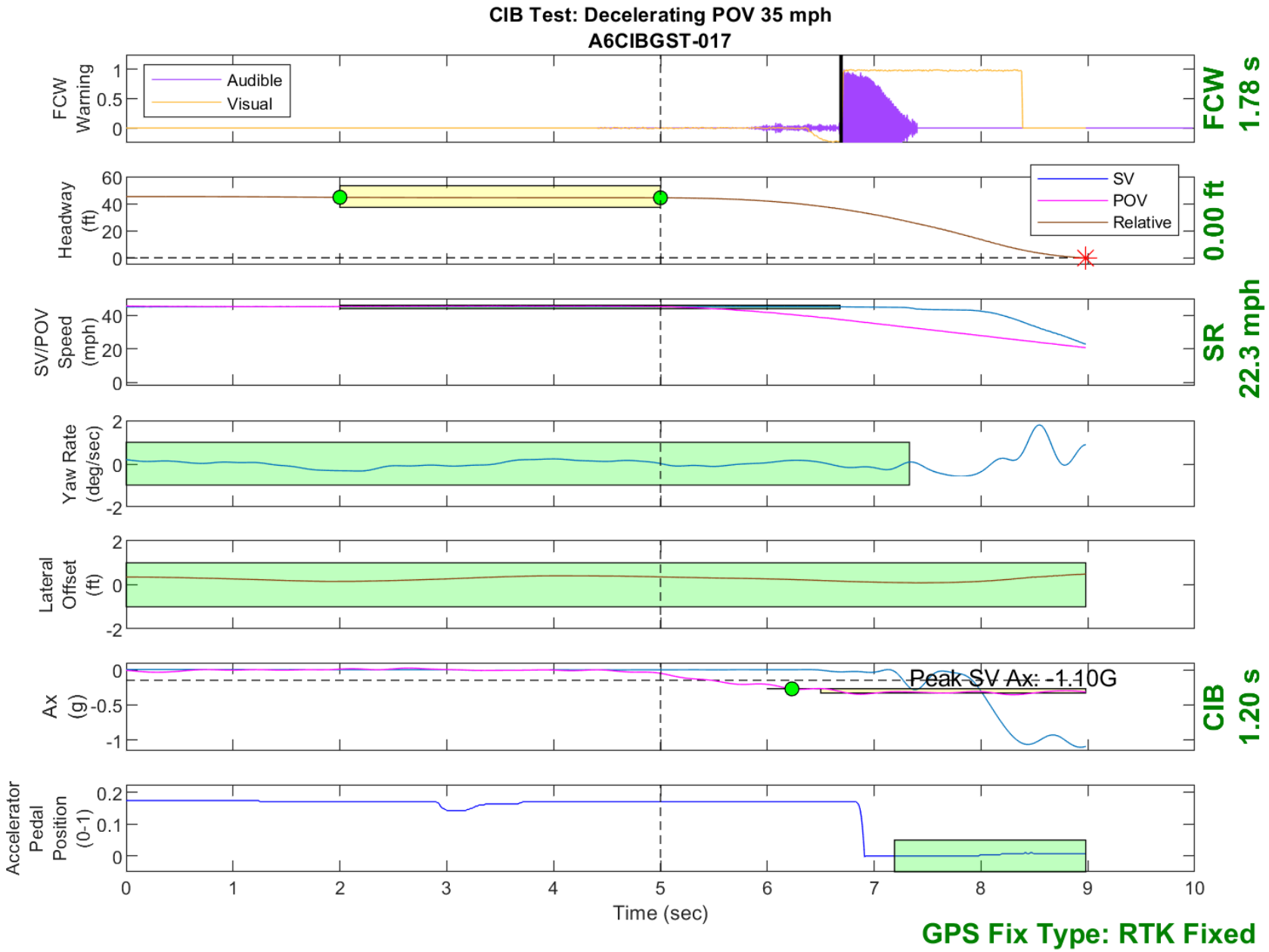

Figure D56. Time History for CIB Run 17, Decelerating POV, 45 mph 0.3g

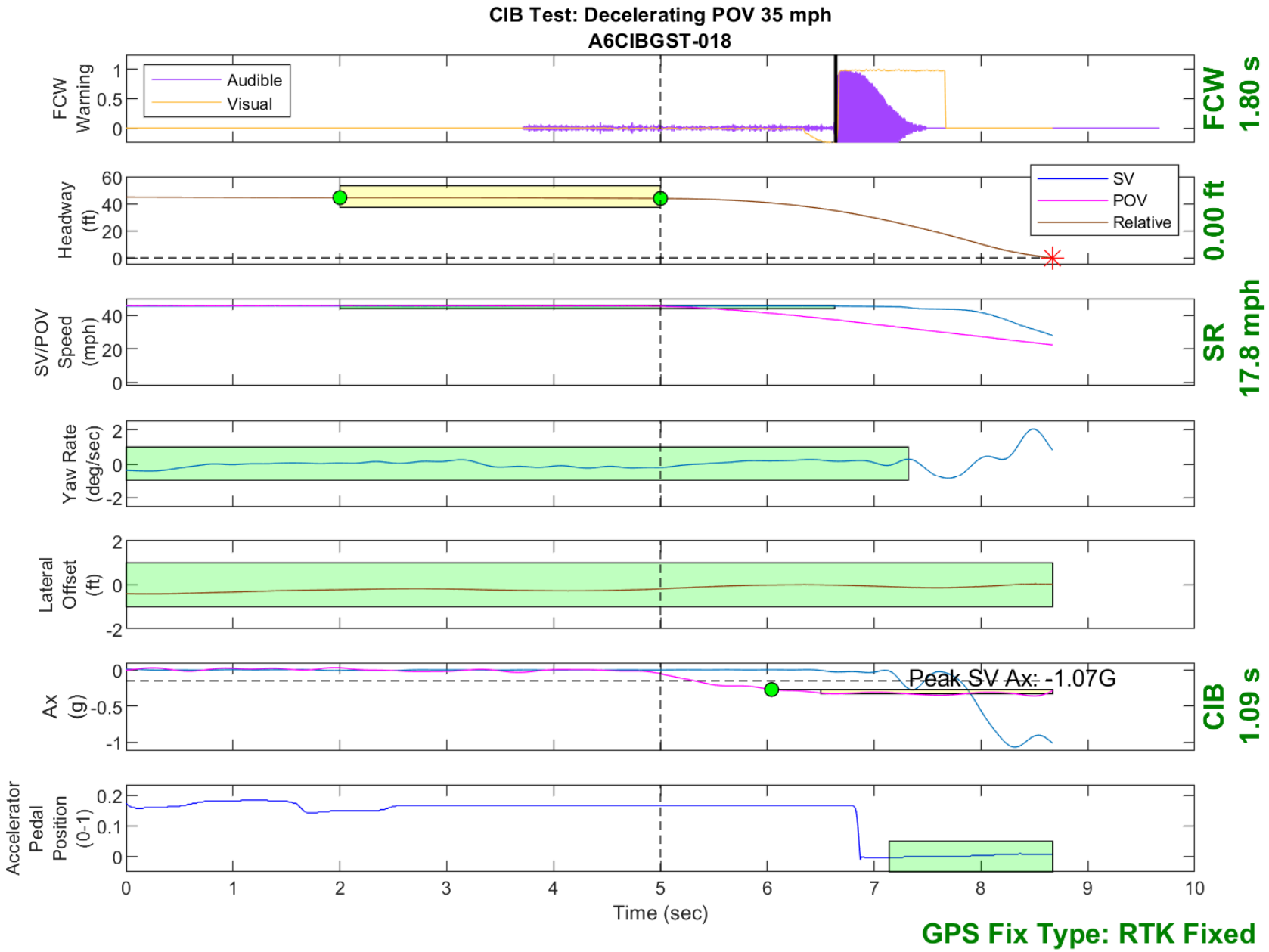

Figure D57. Time History for CIB Run 18, Decelerating POV, 45 mph 0.3g

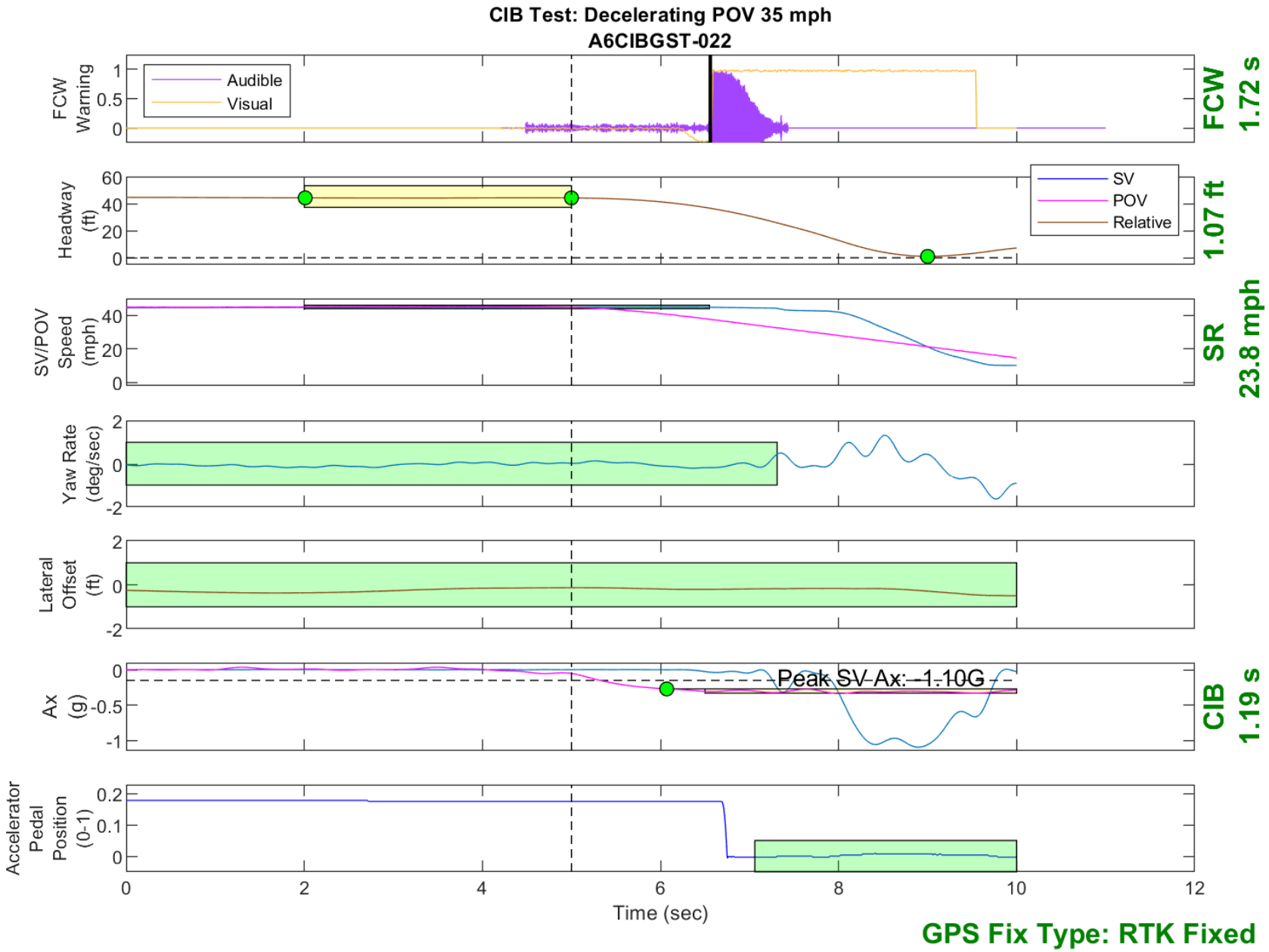

Figure D58. Time History for CIB Run 22, Decelerating POV, 45 mph 0.3g

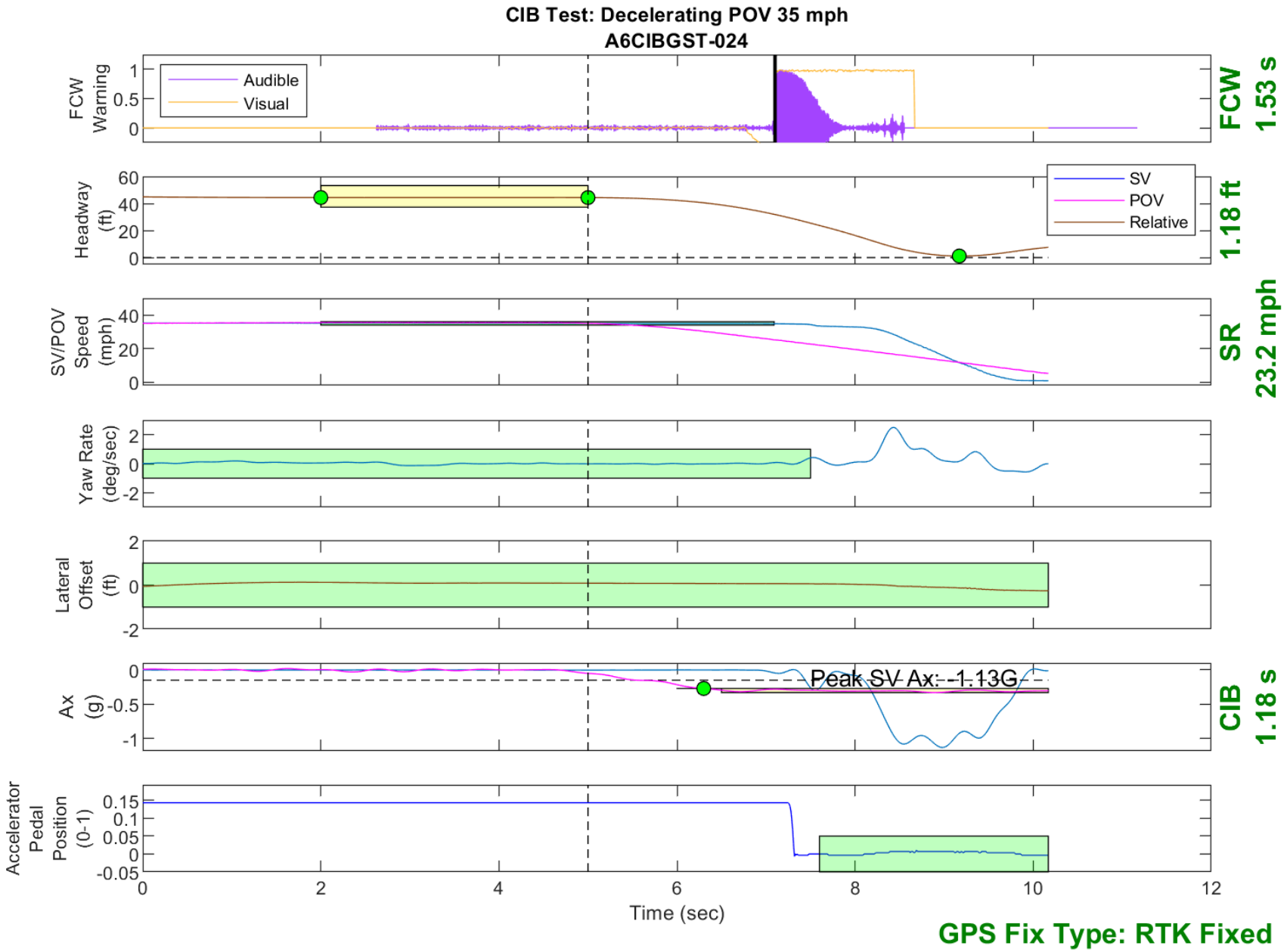

Figure D59. Time History for CIB Run 24, Decelerating POV, 35 mph 0.3g

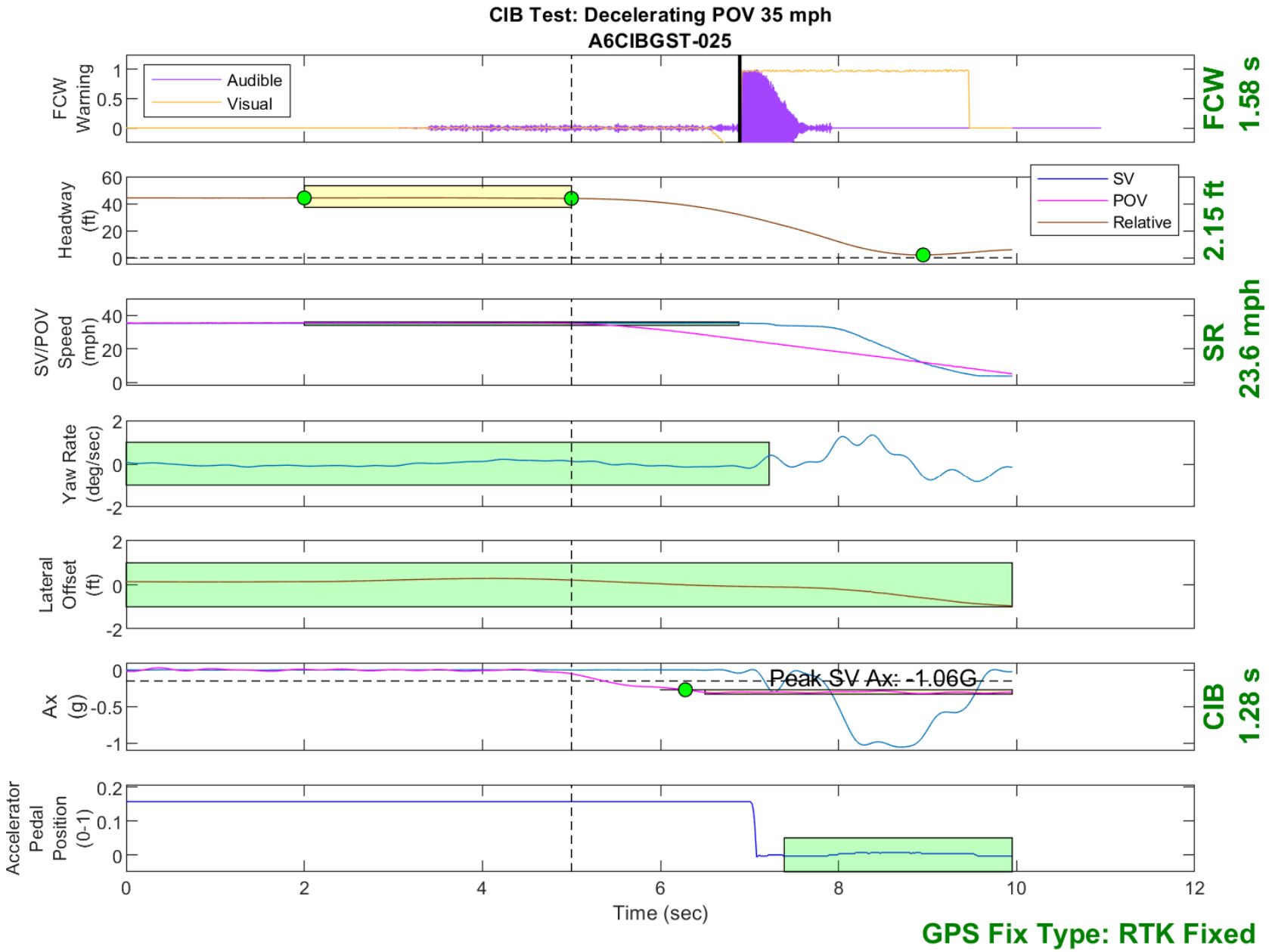

Figure D60. Time History for CIB Run 25, Decelerating POV, 35 mph 0.3g

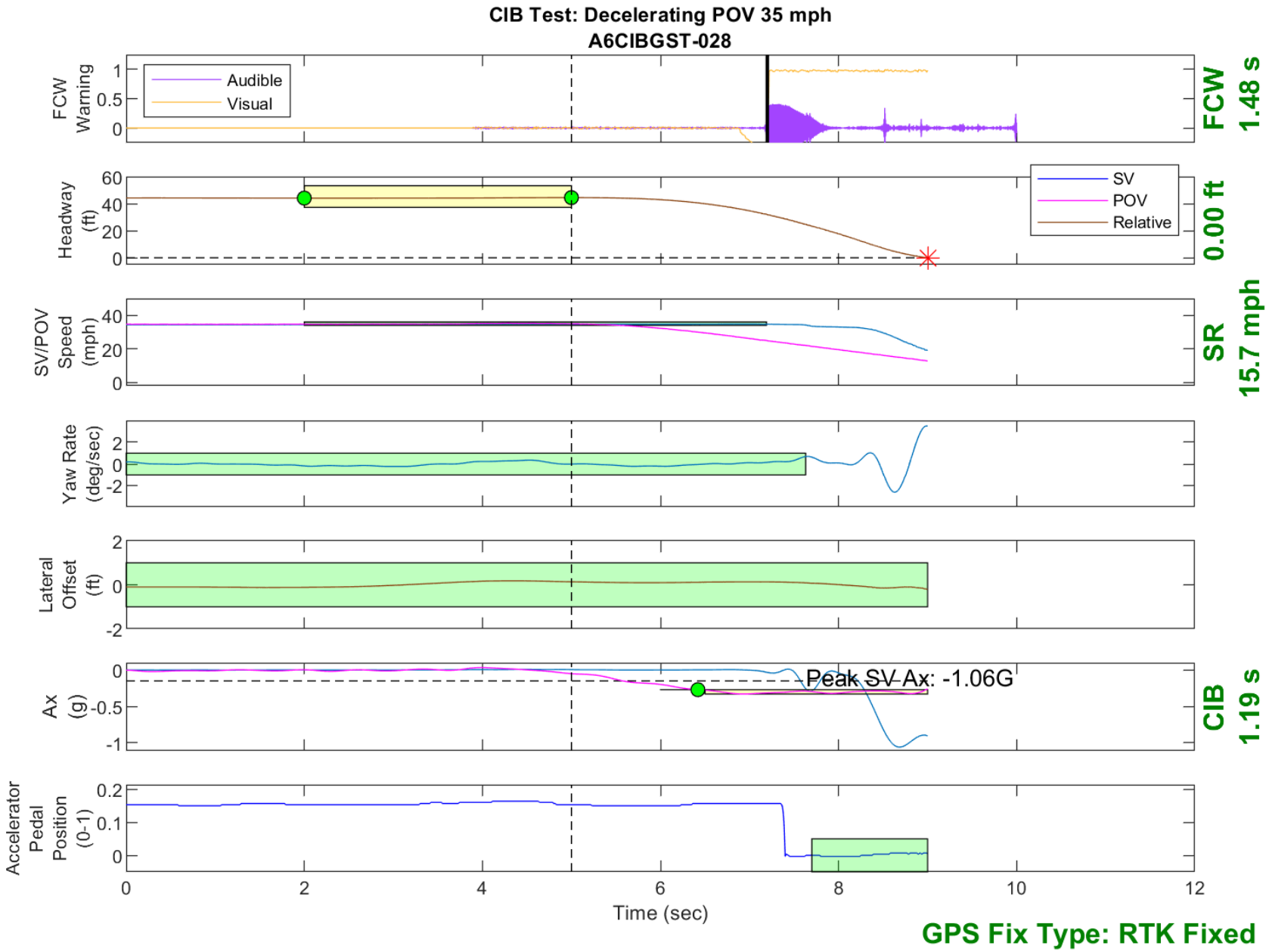

Figure D61. Time History for CIB Run 28, Decelerating POV, 35 mph 0.3g

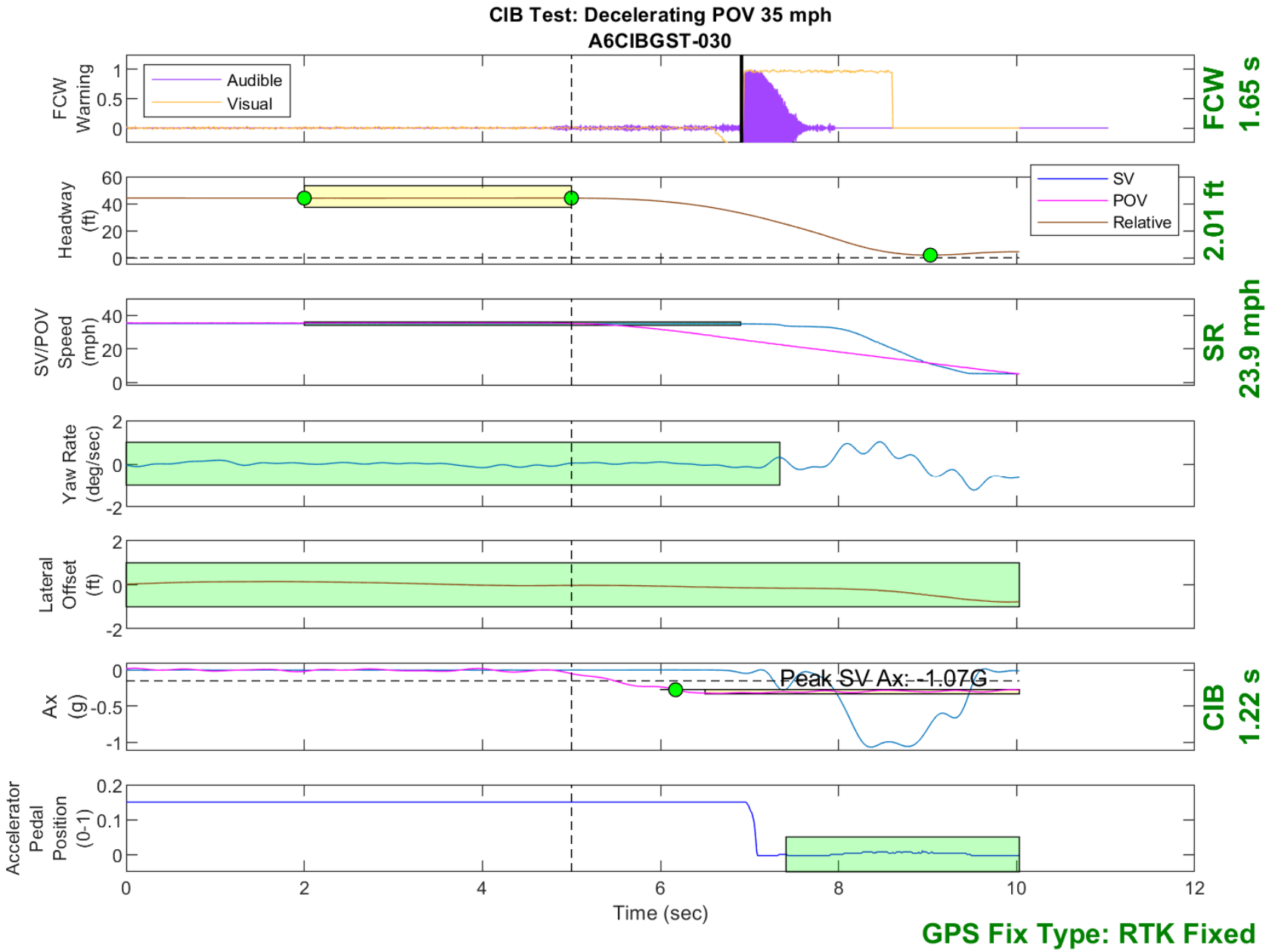

Figure D62. Time History for CIB Run 30, Decelerating POV, 35 mph 0.3g

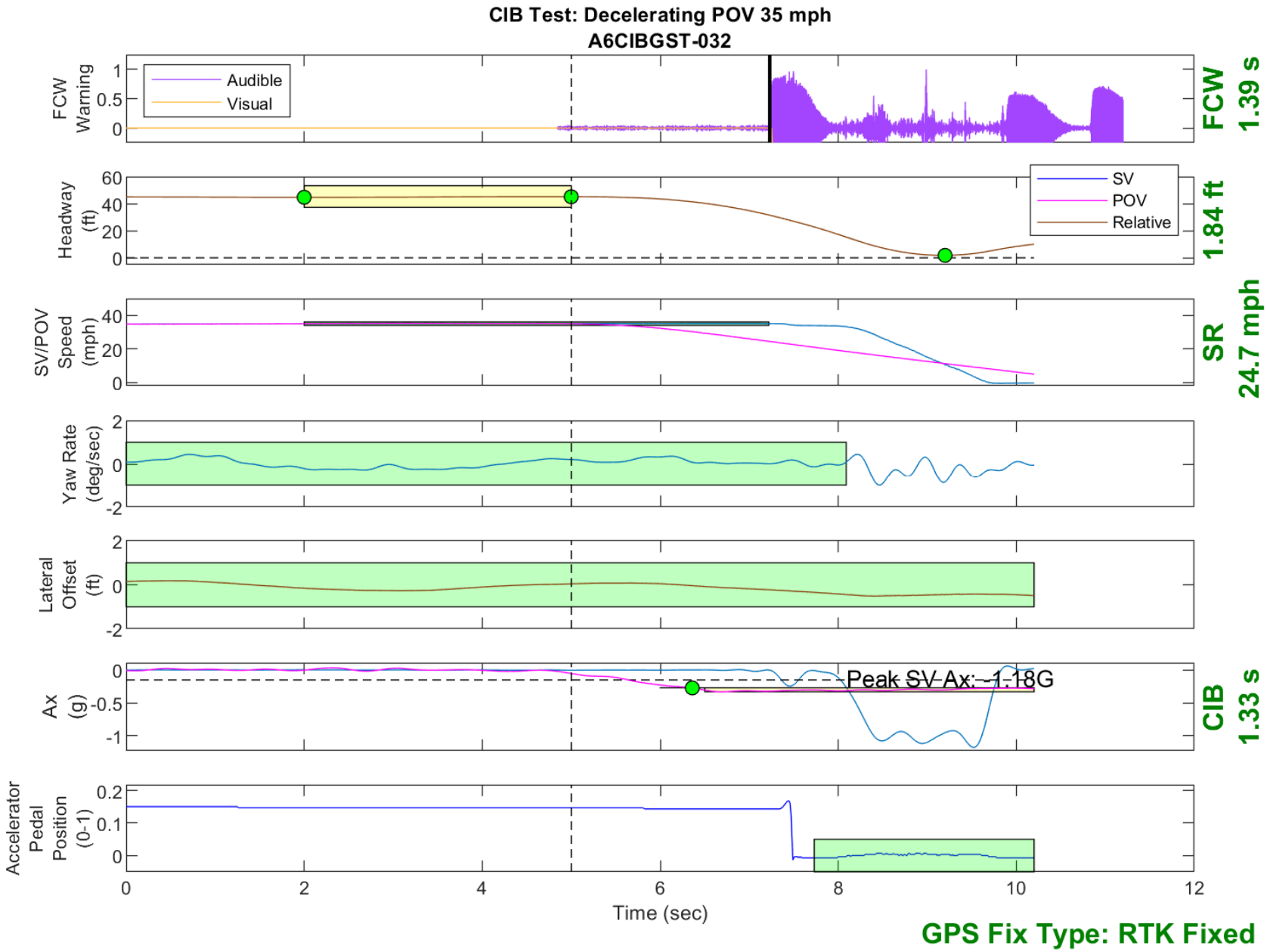

Figure D63. Time History for CIB Run 32, Decelerating POV, 35 mph 0.3g

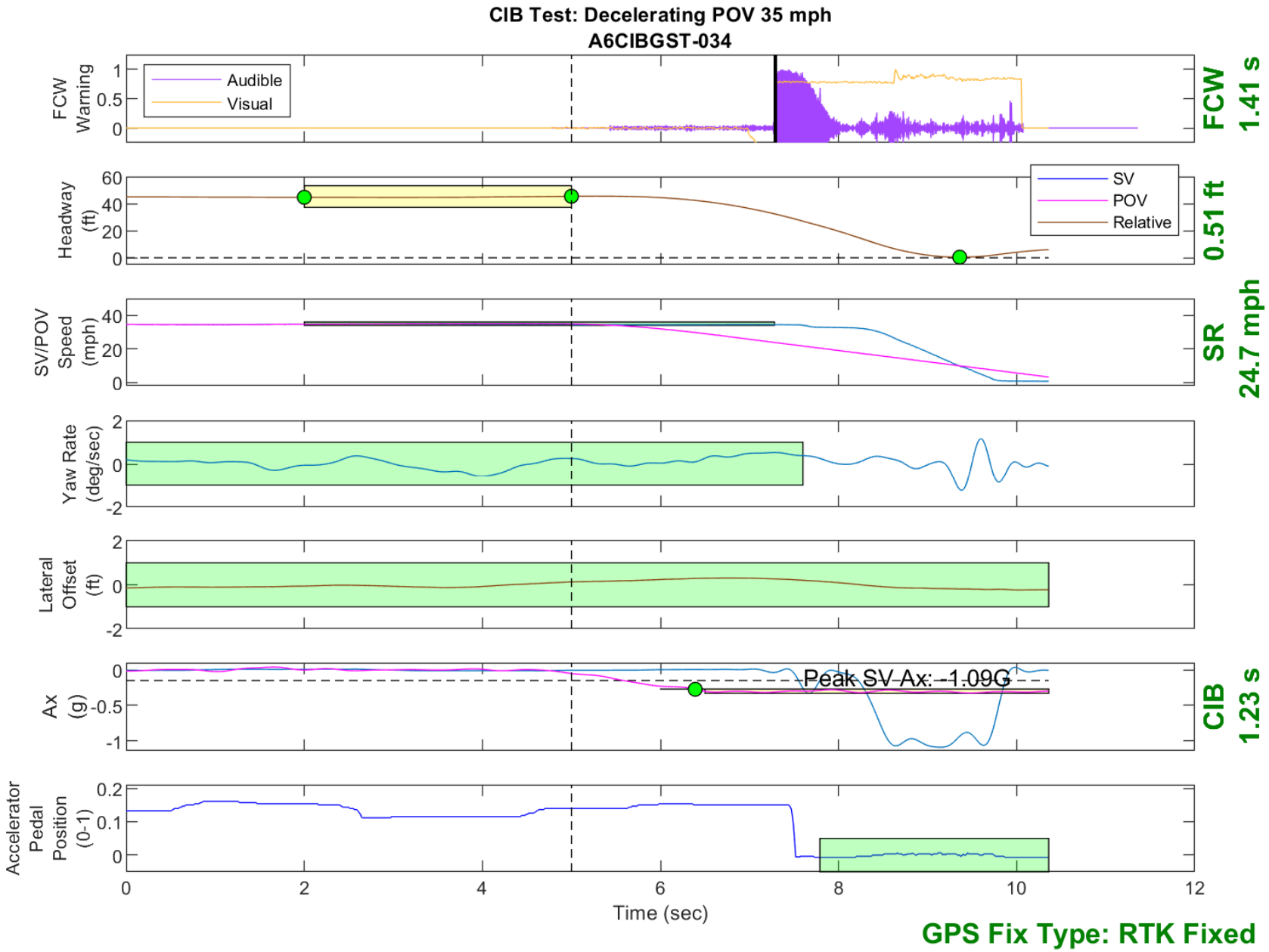

Figure D64. Time History for CIB Run 34, Decelerating POV, 35 mph 0.3g

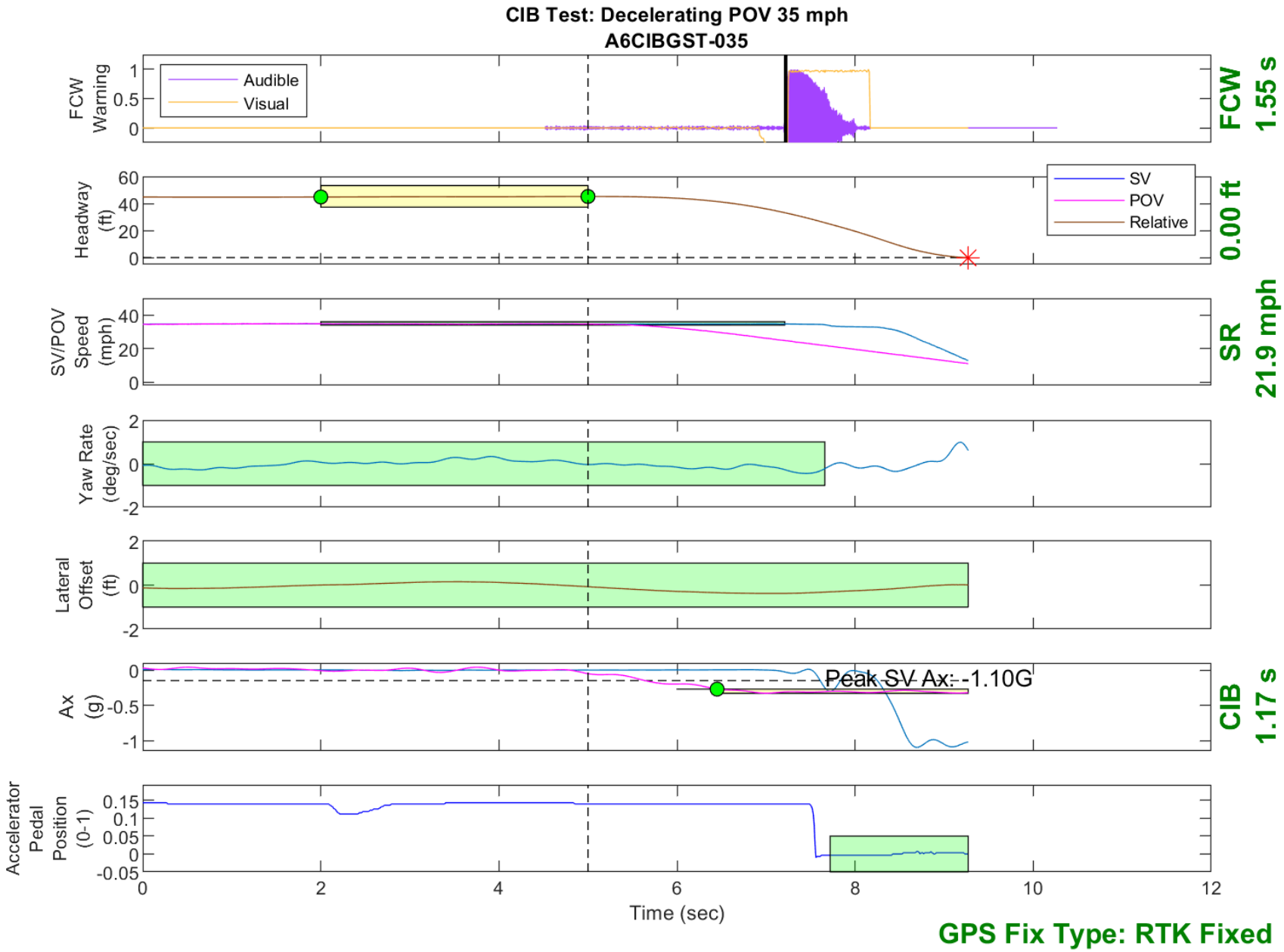

Figure D65. Time History for CIB Run 35, Decelerating POV, 35 mph 0.3g