NEW CAR ASSESSMENT PROGRAM
DYNAMIC BRAKE SUPPORT SYSTEM CONFIRMATION TEST
NCAP-DRI-DBS-20-13

2020 Subaru Outback Premium/LDD

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7 August 2020

Final Report

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

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

Prepared for the Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DTNH22-14-D-00333.

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Date: 7 August 2020

1. Report No. NCAP-DRI-DBS-20-13	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Final Report of Dynamic Brake Support System Confirmation Test of a 2020 Subaru Outback Premium/LDD.		5. Report Date 7 August 2020	
		6. Performing Organization Code DRI	
7. Author(s) J. Lenkeit, Technical Director S. Judy, Test Engineer		8. Performing Organization Report No. DRI-TM-19-166	
9. Performing Organization Name and Address Dynamic Research, Inc. 355 Van Ness Ave, STE 200 Torrance, CA 90501		10. Work Unit No.	
		11. Contract or Grant No. DTNH22-14-D-00333	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration New Car Assessment Program 1200 New Jersey Avenue, SE, West Building, 4th Floor (NRM-110) Washington, DC 20590		13. Type of Report and Period Covered Final Test Report May - August 2020	
		14. Sponsoring Agency Code NRM-110	
15. Supplementary Notes			
16. Abstract These tests were conducted on the subject 2020 Subaru Outback Premium/LDD in accordance with the specifications of the New Car Assessment Program's (NCAP) most current Test Procedure in docket NHTSA-2015-0006-0026; DYNAMIC BRAKE SUPPORT PERFORMANCE EVALUATION CONFIRMATION TEST FOR THE NEW CAR ASSESSMENT PROGRAM**,** October 2015. The vehicle passed the requirements of the test for all four DBS test scenarios.			
17. Key Words Dynamic Brake Support, DBS, AEB, New Car Assessment Program, NCAP		18. Distribution Statement Copies of this report are available from the following: NHTSA Technical Reference Division National Highway Traffic Safety Administration 1200 New Jersey Avenue, SE Washington, DC 20590	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 177	22. Price

TABLE OF CONTENTS

Section I

INTRODUCTION

Dynamic Brake Support (DBS) systems are a subset of Automatic Emergency Braking (AEB) systems. DBS systems are designed to avoid or mitigate consequences of rear-end crashes by automatically applying supplemental braking on the subject vehicle when the system determines that the braking applied by the driver is insufficient to avoid a collision.

DBS systems intervene in driving situations where a rear-end collision is expected to be unavoidable unless additional braking is realized. Since DBS interventions are designed to occur late in the pre-crash timeline, and the driver has already initiated crash-avoidance braking, DBS systems are not required to alert the driver that a DBS intervention has occurred. In addition to sensors monitoring vehicle operating conditions, such as speed, brake application, etc., DBS systems employ RADAR, LIDAR, and/or vision-based sensors capable of detecting surrounding vehicles in traffic. Algorithms in the system's Central Processing Unit (CPU) use this information to continuously monitor the likelihood of a rear-end crash, and command additional braking as needed to avoid or mitigate such a crash.

The method prescribed by the National Highway Traffic Safety Administration (NHTSA) to evaluate DBS performance on the test track involves three longitudinal, 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 fourth scenario is used to evaluate the propensity of a DBS system to inappropriately activate in a non-critical driving scenario that does not present a safety risk to the SV occupant(s).

The purpose of the testing reported herein was to objectively quantify the performance of a Dynamic Brake Support system installed on a 2020 Subaru Outback Premium/LDD. This test to assess Dynamic Brake Support systems is sponsored by the National Highway Traffic Safety Administration under Contract No. DTNH22-14-D-00333 with the New Car Assessment Program (NCAP).

Section II

DATA SHEETS

DYNAMIC BRAKE SUPPORT

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 1)

2020 Subaru Outback Premium/LDD

VIN: *4S4BTACC3L319xxxx*

Test Date: *5/27/2020*

Dynamic Brake Support System setting: *Pre-Collision On*

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:

DYNAMIC BRAKE SUPPORT

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2020 Subaru Outback Premium/LDD

TEST VEHICLE INFORMATION

VIN: *4S4BTACC3L319xxxx*

Body Style: *SUV* Color: *Magnetite Gray Metallic*

Date Received: *5/14/2020* Odometer Reading: *114 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Subaru Corporation*

Date of manufacture: *2/20*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *225/65R17*

Rear: *225/65R17*

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

Rear: *230 kPa (33 psi)*

TIRES

Tire manufacturer and model: *Yokohama Avid GT*

Front tire specification: *225/65R17 102H*

Rear tire specification: *225/65R17 102H*

Front tire DOT prefix: *4UF5 6JK*

Rear tire DOT prefix: *4UF5 6JK*

DYNAMIC BRAKE SUPPORT

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2020 Subaru Outback Premium/LDD

GENERAL INFORMATION

Test date: *5/27/2020*

AMBIENT CONDITIONS

Air temperature: *33.9 C (93 F)*

Wind speed: *3.1 m/s (6.9 mph)*

X Wind speed ≤ 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: *230 kPa (33 psi)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2020 Subaru Outback Premium/LDD

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*518.9 kg (1144 lb)*	Right Front:	*474.9 kg (1047 lb)*
Left Rear:	*400.1 kg (882 lb)*	Right Rear:	*378.3 kg (834 lb)*
		Total:	*1772.2 kg (3907 lb)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

(Page 1 of 3)

2020 Subaru Outback Premium/LDD

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

Driver-Assist System w/ Automatic Emergency Braking, as a sub-function of Eyesight

Type and location of sensor(s) the system uses:

Stereo (2) cameras located behind the windshield near the rearview mirror.

System setting used for test (if applicable): *Pre-Collision On*

Brake application mode used for test: *Hybrid control*

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

1.6 km/h (1 mph) (Per manufacturer supplied information)

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

160 km/h (100 mph) (Per manufacturer supplied information)

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

____ No

If yes, please provide a full description.

Initialization is accomplished by operation on a public road for about 1 hour. The initialization should be performed under the following conditions and should not be performed in inclement weather:

1. Dry road surfaces

2. Daylight hours

3. Public road with both left and right lane markings

4. If traffic exists, keep a comfortable distance from a lead vehicle

5. Maintain the posted speed limit

If the vehicle ignition is turned off and the engine is restarted following each test

run, it is NOT necessary to reinitialize the system.

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

2020 Subaru Outback Premium/LDD

Will the system deactivate due to repeated AEB activations, impacts or near-misses? **X** Yes / ___ No

If yes, please provide a full description.

If the Pre-Collision Braking System OFF indicator light illuminates, AEB is NOT operational. For example, if AEB has operated 3 times in one driving cycle, AEB will NO longer operate. To reactivate, restart the engine. After the engine is restarted, it takes approximately 7 seconds for the pre-collision braking system to activate.

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

- **X** Warning light
- **X** Buzzer or audible alarm
- ___ Vibration
- ___ Other ___

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

The visual alert is alternates between two graphics, shown in Appendix A, Figure A17. The auditory alert is a tone centered at 2200 HZ and pulsed approximately 8 times per second.

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.

System settings are accessed by means of a touch screen center screen. The hierarchy is:

Settings

Driver Assistance

Pre-Collision Braking

Select: Setting On or Setting Off

The system is automatically reactivated after cycling the ignition.

Please see EyeSight Owner's Manual, Pages 126 and 127. These are shown in Appendix B, Pages B-33 and B-34. See also Appendix A, Figure A16.

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

____ Yes

X No

If yes, please provide a full description.

Are there other driving modes or conditions that render DBS inoperable or reduce its effectiveness?

X Yes

____ No

If yes, please provide a full description.

Limitations of the system are addressed at length in the EyeSight Owner's Manual, Pages 5 through 9 and Pages 27 through 35. These are shown in Appendix B, Pages B-2 through B-6 and Pages B-17 through B-25.

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 DBS system to detect and respond to a stopped lead vehicle in the immediate forward path of the SV, as depicted in Figure 1.

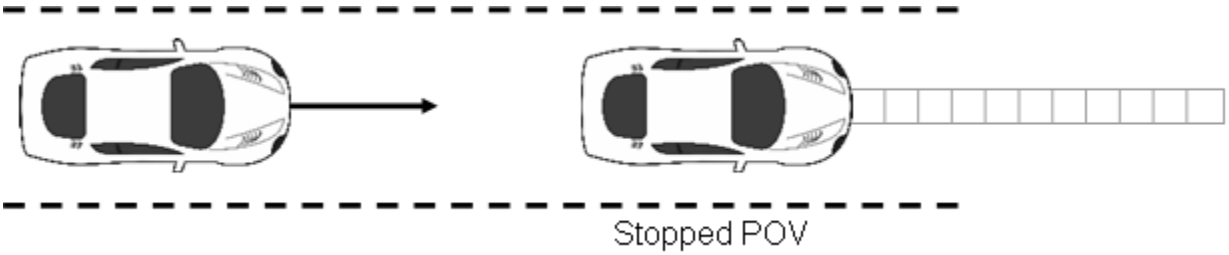


Figure 1. Depiction of Test 1

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 approaches 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 SV brakes were applied at TTC = 1.1 seconds (SV-to-POV distance of 40 ft (12 m)). The test concluded when either:

- The SV came into contact with the POV or

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

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

- The SV speed could not deviate from the nominal speed by more than 1.0 mph (1.6 km/h) during an interval defined by a Time to Collision (TTC) = 5.1 seconds to t_{FCW}. For this test, TTC = 5.1 seconds is taken to occur at an SV-to-POV distance of 187 ft (57 m).

Table 1. Nominal Stopped POV DBS Test Choreography

Test Speeds		SV Speed Held Constant		SV Throttle Fully Released By		SV Brake Application Onset (for each application magnitude)	
SV	POV	TTC (seconds)	SV-to-POV Headway	TTC (seconds)	SV-to-POV Headway	TTC (seconds)	SV-to-POV Headway
25 mph (40.2 km/h)	0	5.1 → t_{FCW}	187 ft (57 m) → t_{FCW}	Within 500 ms of FCW1 onset	Varies	1.1	40 ft (12 m)

b. Criteria

The performance requirement for this series of tests is that there be no SV-to-POV impact for at least five of the seven valid test trials.

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

This test evaluates the ability of the DBS 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.

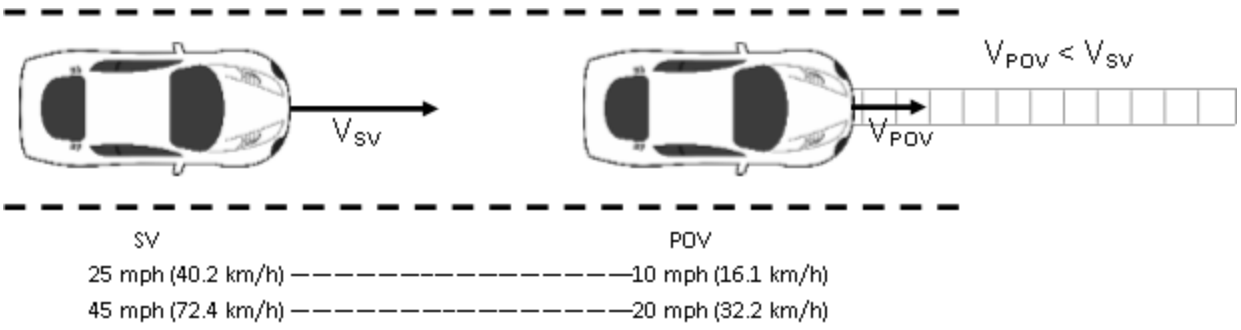


Figure 2. Depiction of Test 2

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 SV brakes were applied at TTC = 1.0 seconds, assumed to be SV-to-POV distance of 22 ft (7 m) for an SV speed of 25 mph and 37 ft (11 m) for an SV speed of 45 mph.

The test concluded when either:

- The SV came into contact with the POV or
- 1 second after the speed 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 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.

Table 2. Nominal Slower-Moving POV DBS Test Choreography

Test Speeds		SV Speed Held Constant		SV Throttle Fully Released By		SV Brake Application Onset (for each application magnitude)	
SV	POV	TTC (seconds)	SV-to-POV Headway	TTC (seconds)	SV-to-POV Headway	TTC (seconds)	SV-to-POV Headway
25 mph (40 km/h)	10 mph (16 km/h)	5.0 → t_{FCW}	110 ft (34 m) → t_{FCW}	Within 500 ms of FCW1 onset	Varies	1.0	22 ft (7 m)
45 mph (72 km/h)	20 mph (32 km/h)	5.0 → t_{FCW}	183 ft (56 m) → t_{FCW}	Within 500 ms of FCW1 onset	Varies	1.0	37 ft (11 m)

b. Criteria

The performance requirement for this series of tests is that there be no SV-to-POV impact for at least five of the seven valid test trials.

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

This test evaluates the ability of the DBS 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. Should the SV foundation brake system be unable to prevent an SV-to-POV impact for a given test condition, the DBS system should automatically provide supplementary braking capable of preventing an SV-to-POV collision.

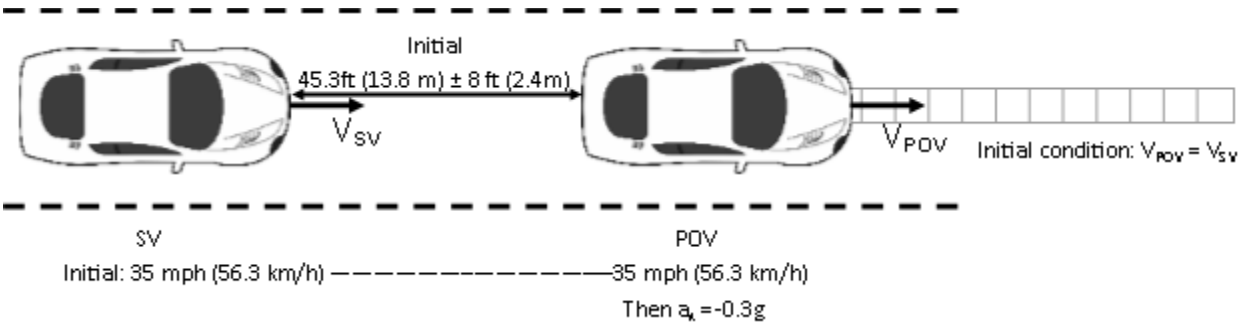


Figure 3. Depiction of Test 3 with POV Decelerating

a. Procedure

The SV ignition was cycled prior to each test run. For this 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 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. The SV throttle pedal was released within 500 ms of $t_{FCW,}$ and the SV brakes were applied when TTC was 1.4 seconds (31.5 ft (9.6 m)).

The test concluded when either:

- 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.

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 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 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.

Table 3. Nominal Decelerating POV DBS Test Choreography

Test Speeds		SV Speed Held Constant		SV Throttle Fully Released By		SV Brake Application Onset (for each application magnitude)	
SV	POV	TTC (seconds)	SV-to-POV Headway	TTC (seconds)	SV-to-POV Headway	TTC (seconds)	SV-to-POV Headway
35 mph (56 km/h)	35 mph (56 km/h)	3.0 seconds prior to POV braking → t_{FCW}	45 ft (14 m) → t_{FCW}	Within 500 ms of FCW1 onset	Varies	1.4	32 ft (10 m)

b. Criteria

The performance requirement for this series of tests is that no SV-to-POV contact occurs for at least five of the seven valid test trials.

4. TEST 4 – FALSE POSITIVE SUPPRESSION

The false positive suppression test series evaluates the ability of a DBS 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 DBS 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. The SV was driven at constant speed in the center of the lane toward the STP. If the SV did not present an FCW alert during the approach to the STP by TTC = 2.1 s, the SV driver initiated release of the throttle pedal at TTC = 2.1 s and the throttle pedal was fully released within 500 ms

of TTC = 2.1 s. The SV brakes were applied at TTC of 1.1 seconds, assumed to be 40 ft (12.3 m) from the edge of the STP at 25 mph or 73 ft (22.1 m) at 45 mph. The test concluded when the front most part of the SV reached a vertical plane defined by the edge of the STP first encountered by the SV.

b. Criteria

In order to pass the False Positive test series, the magnitude of the SV deceleration reduction attributable to DBS intervention must have been less than or equal to 1.25 times the average of the deceleration experienced by the baseline command from the braking actuator 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 haptic, visual, or audible, and the onset of the alert is determined by post-processing the test data.

For systems that implement audible or haptic alerts, part of the pre-test instrumentation verification process is 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 is accomplished in order to identify the center frequency around which a band-pass filter is 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 is a phaseless, forward-reverse pass, elliptical (Cauer) digital filter, with filter parameters as listed in Table 4.

Table 4. Audible and Tactile Warning Filter Parameters

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

2. GENERAL VALIDITY CRITERIA

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

- The SV driver seatbelt was latched.
- If any load had been placed on the SV front passenger seat (e.g., for instrumentation), the vehicle's front passenger seatbelt was latched.
- The SV was driven at the nominal speed in the center of the travel lane, toward the POV or STP.
- The driver used the least amount of steering input necessary to maintain SV position in the center of the travel lane during the validity period; use of abrupt steering inputs or corrections was avoided.
- The yaw rate of the SV did not exceed ±1.0 deg/s from the onset of the validity period to the instant SV deceleration exceeded 0.25 g.
- The SV driver did not apply any force to the brake pedal during the during the applicable validity period. All braking shall be performed by the programmable brake controller.
- 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: 2 seconds prior to the SV throttle pedal being released

The valid test interval ended:

Test 1: When either of the following occurred:

- The SV came in 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.

Test 2: 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.

Test 3: When either of the following occurred:

- The SV came in contact with the POV; or
- 1 second after minimum SV-to-POV range occurred.

Test 4: When the SV stopped.

4. STATIC INSTRUMENTATION CALIBRATION

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

For Tests 1, 2, and 3, the SV, POV, 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 defining the rearmost location of the POV. For Test 4, the front-most location of the SV was positioned such that it just reached a vertical plane defined by the leading edge of

the STP first encountered by the SV (i.e., just before it is driven onto the STP). This is the "zero position."

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

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

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

5. NUMBER OF TRIALS

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

6. TRANSMISSION

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

C. Principal Other Vehicle

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

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

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

- A road-based lateral restraint track.
- A tow vehicle.

The key requirements of the POV element are to:

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

The key requirements of the POV delivery system are to:

- Accurately control the nominal POV speed up to 35 mph (56 km/h).
- Accurately control the lateral position of the POV within the travel lane.
- Allow the POV to move away from the SV after an impact occurs.

Operationally, the POV shell is attached to the slider and load frame, which includes rollers that allow 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 rearward direction. In operation, the shell and roller assembly engages the rail assembly through detents to prevent relative motion during run-up to test speeds and minor deceleration of the tow vehicle. The combination of rearward stops and forward motion detents allows the test conditions, such as relative POV-SV headway distance and 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 soft 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. Foundation Brake System Characterization

Data collected and analyzed from a series of pre-test braking runs were used to objectively quantify the response of the vehicle's foundation brake system without the contribution of DBS. The results of these analyses were used to determine the brake pedal input magnitudes needed for the main tests.

This characterization was accomplished by recording longitudinal acceleration and brake pedal force and travel data for a variety of braking runs. For three initial brake characterization runs, the vehicle was driven at 45 mph, and the brakes were applied at a rate of 1 inch/sec up to the brake input level needed for at least 0.7 g. Linear regressions were performed on the data from each run to determine the linear vehicle deceleration

response as a function of both applied brake pedal force and brake pedal travel. The brake input force or displacement level needed to achieve a vehicle deceleration of 0.4 g was determined from the average of the three runs. Using the 0.4 g brake input force or displacement level found from the three initial runs, subsequent runs were performed at 25 mph, 35 mph, and 45 mph, with the brakes applied at a rate of 10 inch/sec to the determined 0.4 g brake input force or displacement level. For each of the three test speeds, if the average calculated deceleration level was found to be within 0.4 ± 0.025 g, the resulting force or displacement was recorded and used. If the average calculated deceleration level exceeded this tolerance, the brake input force or displacement levels were adjusted and retested until the desired magnitude was realized. Prior to each braking event, the brake pad temperatures were required to be in the range of 149° - 212°F.

E. Brake Control

1. SUBJECT VEHICLE PROGRAMMABLE BRAKE CONTROLLER

To achieve accurate, repeatable, and reproducible SV brake pedal inputs, a programmable brake controller was used for all brake applications. The controller has the capability to operate in one of two user-selectable, closed-loop, control modes:

- Constant pedal displacement. By maintaining constant actuator stroke, the position of the vehicle's brake pedal remains fixed for the duration of the input. To achieve this, the brake controller modulates application force.
- Hybrid control. Hybrid control uses position-based control to command the initial brake application rate and actuator position, then changes to force-based control to command a reduction of applied force to a predetermined force. This force is maintained until the end of the braking maneuver by allowing the brake controller to modulate actuator displacement.

2. SUBJECT VEHICLE BRAKE PARAMETERS

- Each test run began with the brake pedal in its natural resting position, with no preload or position offset.
- The onset of the brake application was considered to occur when the brake actuator had applied 2.5 lbf (11 N) of force to the brake pedal.
- The magnitude of the brake application was that needed to produce 0.4 g deceleration, as determined in the foundation brake characterization.
- The SV brake application rate was between 9 to 11 in/s (229 to 279 mm/s), where the application rate is defined as the slope of a linear regression line applied to brake pedal position data over a range from 25% to 75% of the commanded input magnitude.

3. POV AUTOMATIC BRAKING SYSTEM

The POV was equipped with an automatic braking system, which was used in Test Type 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.

F. Instrumentation

Table 5 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

Table 5. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and	Omega DPG8001	17042707002	By: DRI Date: 7/3/2019 Due: 7/3/2020
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	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
Load Cell	Force applied to brake pedal					By: DRI
		0 - 250 lb 0 -1112 N	0.1% FS	Honeywell 41A	1464391	Date: 8/30/2019 Due: 8/30/2020
		0-250 lb 1112 N	0.05% FS	Stellar Technology PNC700	1607338	Date: 8/30/2019 Due: 8/30/2020
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	NA

Table 5. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
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
					2258	Date: 5/3/2019 Due: 5/3/2021
					2182	Date: 9/16/2019 Due: 9/16/2021
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	NA
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA

Type	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

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

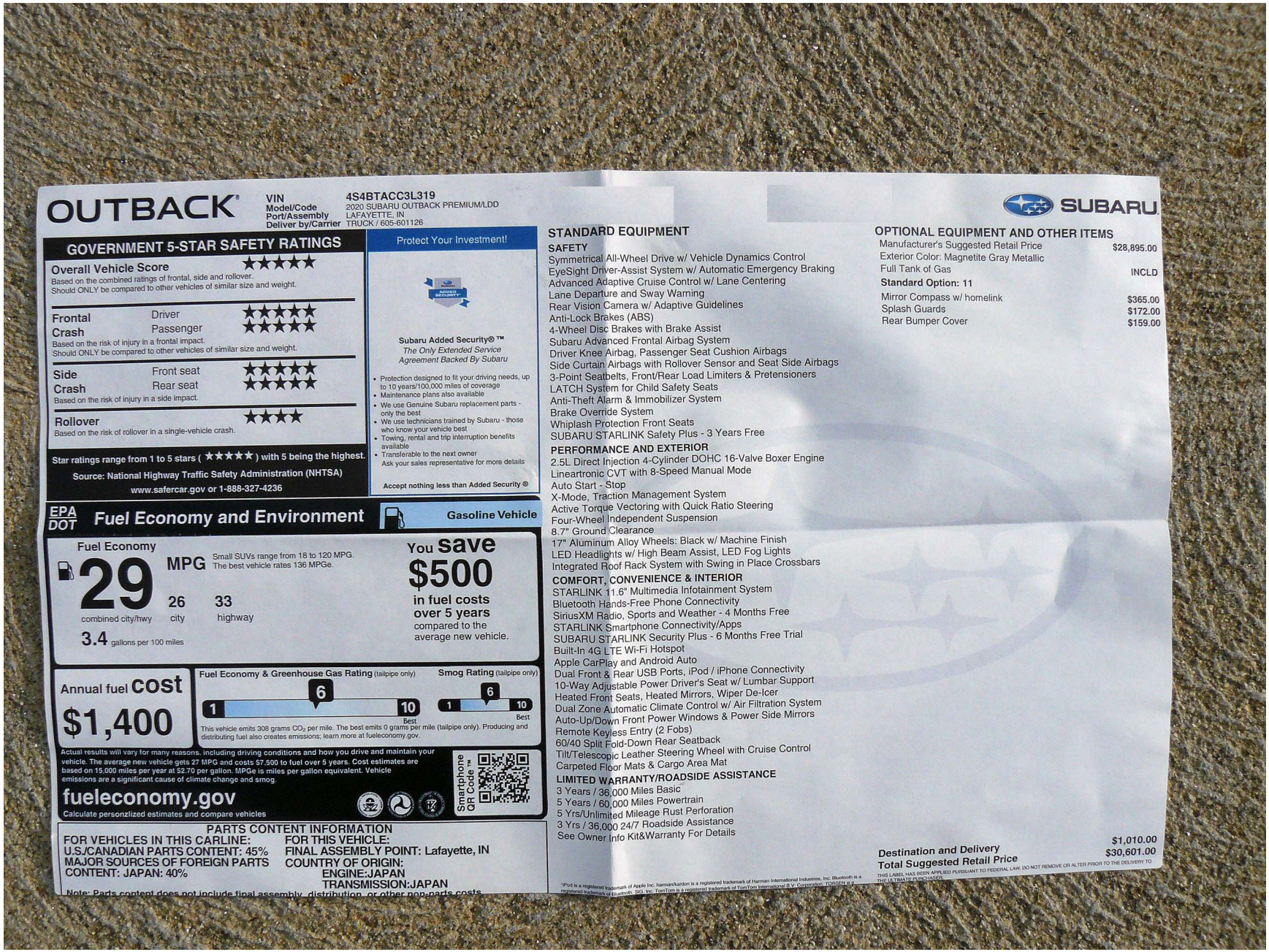
APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle



OUTBACK®

VIN 4S4BTACC3L319
Model/Code 2020 SUBARU OUTBACK PREMIUM/LDD
Port/Assembly LAFAYETTE, IN
Deliver by/Carrier TRUCK / 605-601126

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score ★★★★★
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 ★★★★★ Passenger ★★★★★
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 ★★★★★ Rear seat ★★★★★
Based on the risk of injury in a side impact.

Rollover ★★★★
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

Protect Your Investment!

Subaru Added Security® ™
The Only Extended Service Agreement Backed By Subaru

- Protection designed to fit your driving needs, up to 10 years/100,000 miles of coverage
- Maintenance plans also available
- We use Genuine Subaru replacement parts - only the best
- We use technicians trained by Subaru - those who know your vehicle best
- Towing, rental and trip interruption benefits available
- Transferable to the next owner

Ask your sales representative for more details

Accept nothing less than Added Security ®

EPA DOT Fuel Economy and Environment — Gasoline Vehicle

Fuel Economy
29 MPG
Small SUVs range from 18 to 120 MPG.
The best vehicle rates 136 MPGe.

26 city | 33 highway
combined city/hwy
3.4 gallons per 100 miles

You **save $500** in fuel costs over 5 years compared to the average new vehicle.

Annual fuel **cost** **$1,400**

Fuel Economy & Greenhouse Gas Rating (tailpipe only): 6 (1 – 10, Best)
Smog Rating (tailpipe only): 6 (1 – 10, Best)
This vehicle emits 308 grams CO_2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also creates 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 $7,500 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $2.70 per gallon. MPGe is miles per gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov
Calculate personzlized estimates and compare vehicles
Smartphone QR Code ™

PARTS CONTENT INFORMATION

FOR VEHICLES IN THIS CARLINE:
U.S./CANADIAN PARTS CONTENT: 45%
MAJOR SOURCES OF FOREIGN PARTS CONTENT: JAPAN: 40%

FOR THIS VEHICLE:
FINAL ASSEMBLY POINT: Lafayette, IN
COUNTRY OF ORIGIN:
ENGINE:JAPAN
TRANSMISSION:JAPAN

Note: Parts content does not include final assembly, distribution, or other non-parts costs

SUBARU

STANDARD EQUIPMENT

SAFETY
Symmetrical All-Wheel Drive w/ Vehicle Dynamics Control
EyeSight Driver-Assist System w/ Automatic Emergency Braking
Advanced Adaptive Cruise Control w/ Lane Centering
Lane Departure and Sway Warning
Rear Vision Camera w/ Adaptive Guidelines
Anti-Lock Brakes (ABS)
4-Wheel Disc Brakes with Brake Assist
Subaru Advanced Frontal Airbag System
Driver Knee Airbag, Passenger Seat Cushion Airbags
Side Curtain Airbags with Rollover Sensor and Seat Side Airbags
3-Point Seatbelts, Front/Rear Load Limiters & Pretensioners
LATCH System for Child Safety Seats
Anti-Theft Alarm & Immobilizer System
Brake Override System
Whiplash Protection Front Seats
SUBARU STARLINK Safety Plus - 3 Years Free

PERFORMANCE AND EXTERIOR
2.5L Direct Injection 4-Cylinder DOHC 16-Valve Boxer Engine
Lineartronic CVT with 8-Speed Manual Mode
Auto Start - Stop
X-Mode, Traction Management System
Active Torque Vectoring with Quick Ratio Steering
Four-Wheel Independent Suspension
8.7" Ground Clearance
17" Aluminum Alloy Wheels: Black w/ Machine Finish
LED Headlights w/ High Beam Assist, LED Fog Lights
Integrated Roof Rack System with Swing in Place Crossbars

COMFORT, CONVENIENCE & INTERIOR
STARLINK 11.6" Multimedia Infotainment System
Bluetooth Hands-Free Phone Connectivity
SiriusXM Radio, Sports and Weather - 4 Months Free
STARLINK Smartphone Connectivity/Apps
SUBARU STARLINK Security Plus - 6 Months Free Trial
Built-In 4G LTE Wi-Fi Hotspot
Apple CarPlay and Android Auto
Dual Front & Rear USB Ports, iPod / iPhone Connectivity
10-Way Adjustable Power Driver's Seat w/ Lumbar Support
Heated Front Seats, Heated Mirrors, Wiper De-Icer
Dual Zone Automatic Climate Control w/ Air Filtration System
Auto-Up/Down Front Power Windows & Power Side Mirrors
Remote Keyless Entry (2 Fobs)
60/40 Split Fold-Down Rear Seatback
Tilt/Telescopic Leather Steering Wheel with Cruise Control
Carpeted Floor Mats & Cargo Area Mat

LIMITED WARRANTY/ROADSIDE ASSISTANCE
3 Years / 36,000 Miles Basic
5 Years / 60,000 Miles Powertrain
5 Yrs/Unlimited Mileage Rust Perforation
3 Yrs / 36,000 24/7 Roadside Assistance
See Owner Info Kit&Warranty For Details

OPTIONAL EQUIPMENT AND OTHER ITEMS

Manufacturer's Suggested Retail Price	$28,895.00
Exterior Color: Magnetite Gray Metallic	
Full Tank of Gas	INCLD
Standard Option: 11	
Mirror Compass w/ homelink	$365.00
Splash Guards	$172.00
Rear Bumper Cover	$159.00
Destination and Delivery	$1,010.00
Total Suggested Retail Price	$30,601.00

THIS LABEL HAS BEEN APPLIED PURSUANT TO FEDERAL LAW. DO NOT REMOVE OR ALTER PRIOR TO THE DELIVERY TO THE ULTIMATE PURCHASER.

Figure A3. Window Sticker (Monroney Label)

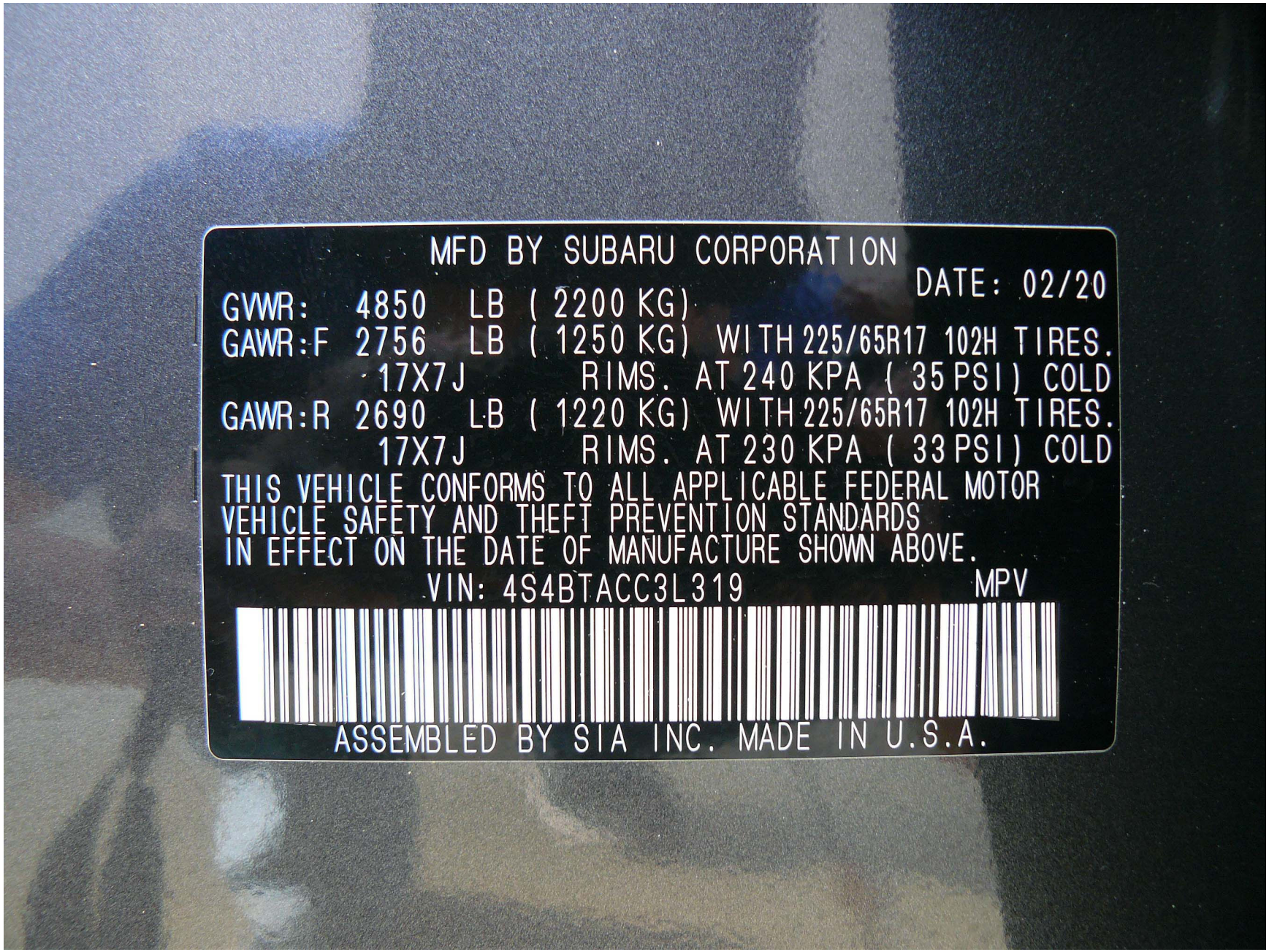


Figure A4. Vehicle Certification Label

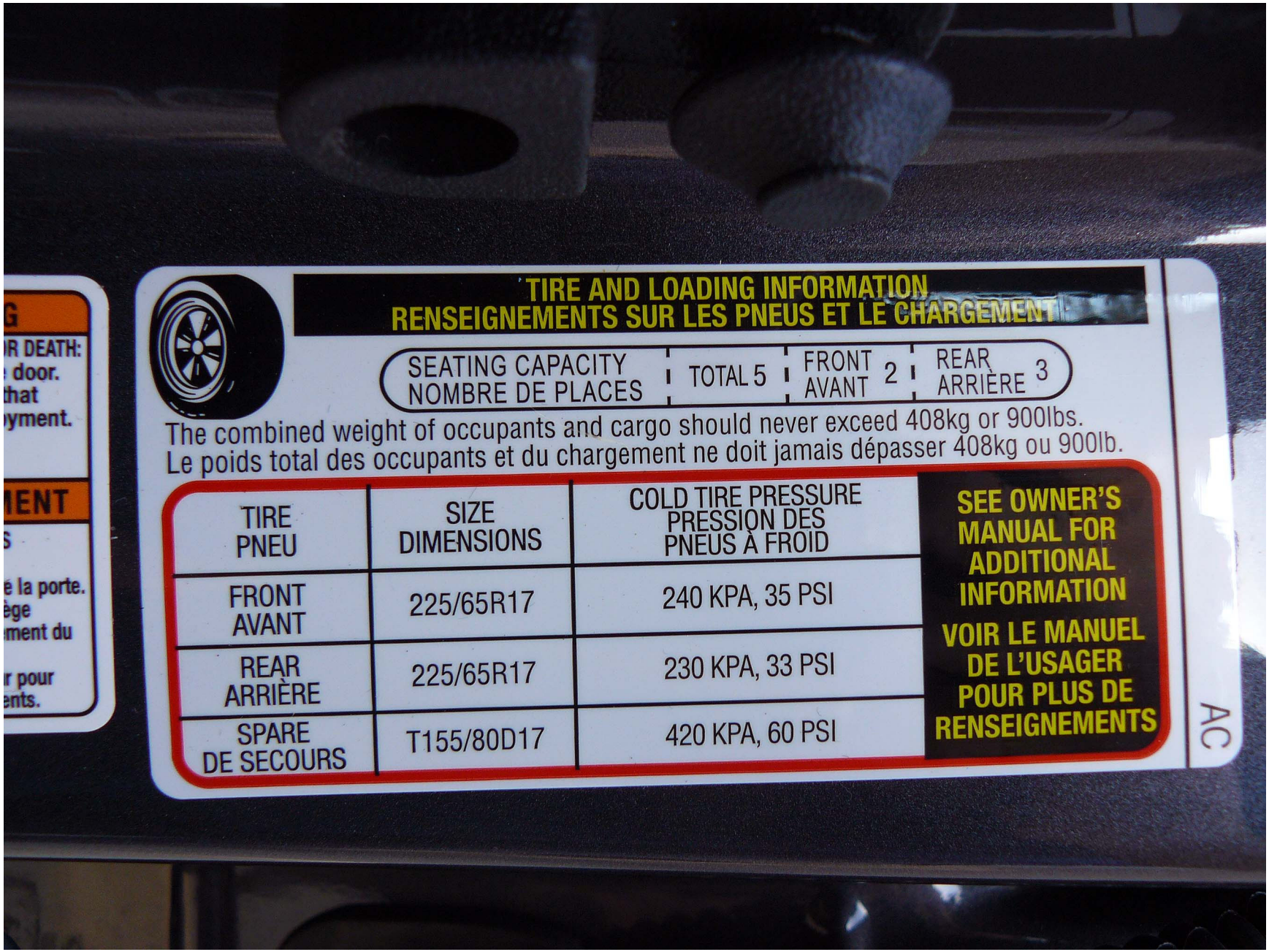


Figure A5. Tire Placard

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

Figure A7. Load Frame/Slider of SSV

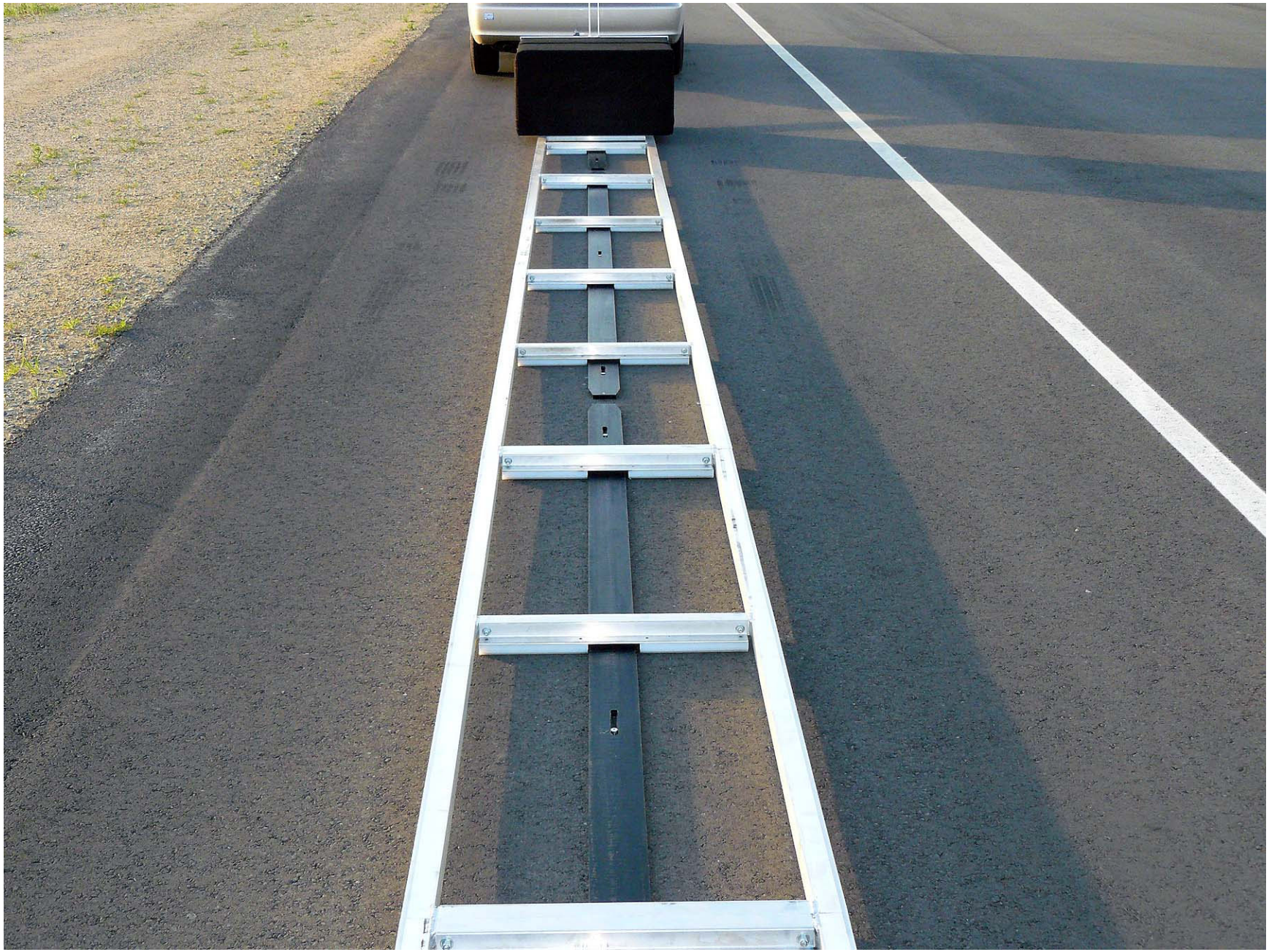


Figure A8. Two-Rail Track and Road-Based Lateral Restraint Track

Figure A9. Steel Trench Plate

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

Figure A11. Sensor for Detecting Auditory Alerts

Figure A12. Sensor for Detecting Visual Alerts

Figure A13. Computer Installed in Subject Vehicle

Figure A14. Brake Actuator Installed in Subject Vehicle

Figure A15. Brake Actuator Installed in POV System

Figure A16. System Setup Menus

Figure A17. Visual Alert

APPENDIX B

Excerpts from Owner's Manual

(Eyesight Owner's Manual)

In LHD vehicles, EyeSight is configured for driving on the right-hand side of the road. However, it can be reconfigured by changing the Driving Lane Customize setting for driving on the left-hand side.*
⇒ **Page 126**
If the setting for the traffic lane (driving side of the road) does not match the traffic lane, full EyeSight performance may not be available.
***: Characteristics and settings that are affected by specific differences between RHD and LHD vehicles cannot be changed.**

- The system may not operate correctly under the conditions listed below. When these conditions occur, turn off the Pre-Collision Braking System. Also, do not use Adaptive Cruise Control, Lane Centering Function, Lane Departure Prevention Function or Conventional Cruise Control.
  - The tire pressure is not correct.*1
  - The temporary spare tire is installed.*1
  - Tires that are unevenly worn or tires with uneven wear patterns are installed.*1
  - Tires that are the wrong size are installed.*1
  - A flat tire has been fixed temporarily with a tire repair kit.
  - The suspension has been modified (including a genuine SUBARU suspension that has been modified).
  - An object that obstructs the stereo camera's view is installed on the vehicle.
  - The headlights are dirty or they have snow and ice or dirt on them. (Objects are not correctly illuminated and are difficult to detect.)
  - The optical axes are not aligned correctly. (Objects are not correctly illuminated and are difficult to detect.)
  - The lights including headlights and fog lights have been modified.
  - Vehicle operation has become unstable due to an accident or malfunction.
  - The brake system warning light is illuminated in red.*2
  - A heavy cargo is loaded onto or inside the vehicle.
  - The maximum number of occupants is exceeded.
  - The combination meter is not operating properly; such as when the lights do not illuminate, the beeps do not sound, the display is different from when it is normal, etc.*3

Continued on next page ⇒

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- The system will not operate correctly in the following conditions. Do not use Adaptive Cruise Control, Lane Centering Function, Lane Departure Prevention Function or Conventional Cruise Control.
  - The wheels are out of balance (e.g., the balance weight is removed or misaligned).*1
  - The wheels are out of alignment.*1
  - A trailer or another vehicle, etc. is being towed.
- The system may not operate properly under the following conditions. Do not use Lane Centering Function.
  - There is an abnormal vibration in the steering wheel or the steering wheel is heavier than usual.
  - The steering wheel has been replaced with parts other than genuine SUBARU parts.

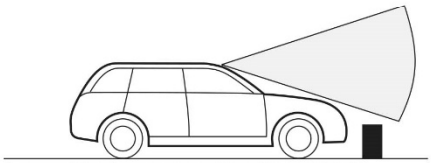
*1: The wheels and tires have functions that are critically important. Be sure to use the correct ones. For details, refer to the Owner's Manual for your vehicle.

*2: If the brake system warning light does not turn off, immediately pull the vehicle over in a safe place and contact a SUBARU dealer to have the system inspected. For details, refer to the Owner's Manual for your vehicle.

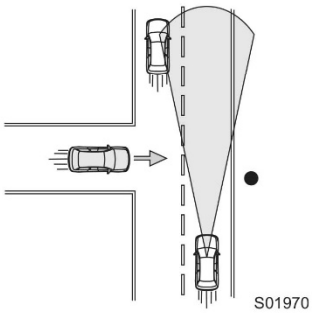
*3: For details about the combination meter, refer to the Owner's Manual for your vehicle.

CAUTION

- The characteristics of the stereo camera are similar to those of human eyes. For this reason, conditions that make it difficult for the driver to see in the forward direction have the same effect on the stereo camera. They also make it difficult for the system to detect vehicles, obstacles, and traffic lanes.
- Detection by the EyeSight system is limited to objects that are within the range of the stereo camera's field of view. Also, after an object enters the range of the camera's field of view, it may take some time for the system to detect it as a controllable target and to warn the driver.



Low objects surrounding the vehicle cannot be detected.



S01970

- Under the conditions listed below, it will become more difficult for the system to detect the vehicle in front, motorcycles, bicycles, pedestrians and obstacles on the road, and lane markers. Also, EyeSight may temporarily stop operating. However, the temporary stop will be canceled once these conditions have improved and the vehicle is driven for a short period of time.
  - Bad weather (for example heavy rain, a blizzard or thick fog). In particular, the system is more likely to temporarily stop operating when there is an oil film adhering to the windshield, a glass coating has been applied, or poorly performing wipers are used.
  - Strong light is coming from the front (sunlight or headlight beams of oncoming traffic, etc.).
  - The windshield washer is in use.
  - Raindrops, water drops, or dirt on the windshield are not wiped off sufficiently.
  - The windshield has become fogged, scratched, or snow, dirt, dust or frost has adhered to it, or it is otherwise affected. These will reduce the stereo camera's field of view.
  - The vehicle is tilted at an extreme angle due to loaded cargo or other factors.

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- Visibility is poor due to sand, smoke or water vapor blowing in the wind, or the front vision is obscured due to water splashes, snow, dirt or dust stir up generated by the vehicle in front or oncoming traffic.
- The stereo camera's field of view is obstructed (for example by a canoe on the roof of the vehicle).
- Through the entrance or exit of a tunnel
- The rear aspect of the vehicle in front is low, small or irregular (for example a low bed trailer, etc.).
- The obstacle is a fence, a wall or a shutter, etc. with a uniform pattern (a striped pattern, brick, etc.) or with no pattern in front.
- The obstacle is a wall or door made of glass or a mirror in front.
- Driving at night or in a tunnel when there is a vehicle in front that does not have its taillights on
- Driving through a banner or flag, low branches on a tree or thick/tall vegetation
- On steep uphill or downhill grades
- The stereo camera is obstructed by a hand, etc. (If even one of the lenses is obstructed, the system does not operate properly.)
- It is completely dark and no objects are detected.
- The area around the vehicle has a uniform color (such as when completely covered in snow, etc.).
- Accurate detection is not possible due to reflections in the windshield.

• Under the conditions listed below, EyeSight may temporarily stop operating. If this occurs, EyeSight will resume operating when the conditions improve.
- The temperature inside the vehicle is high, such as after the vehicle was left in bright sunshine, or the temperature inside the vehicle is low, such as after the vehicle was left in an extremely cold environment.
- Immediately after the engine starts

• Under the conditions listed below, it is difficult to recognize vehicles in front, motorcycles, pedestrians, obstacles on the road, traffic lanes, etc. Also, the EyeSight system may temporarily stop operating. If the EyeSight system repeatedly stops operating several times, contact a SUBARU dealer and have the system inspected.
- The stereo camera lenses are smeared such as from fingerprints.
- The stereo camera has become misaligned due to a strong impact.

- When there is a malfunction in the EyeSight system, turn off the Pre-Collision Braking System (⇒ page 41) and the Lane Departure Warning (⇒ page 102), and stop using the Adaptive Cruise Control, Lane Centering Function, Lane Departure Prevention Function and Conventional Cruise Control. Contact a SUBARU dealer and have the system inspected.
- When the Vehicle Dynamics Control warning light is illuminated, the Pre-Collision Braking System may not operate properly. If the indicator light is illuminated, turn off the Pre-Collision Braking System. Also, do not use the Adaptive Cruise Control or Conventional Cruise Control.

NOTE

EyeSight records and stores the following data when the Pre-Collision Braking System is operated. It does not record conversations or other audio data.

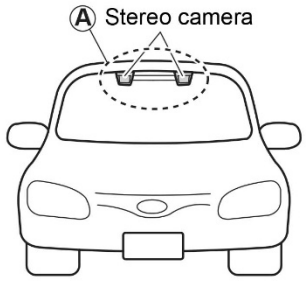
- Stereo camera image data
- Distance from the vehicle in front
- Vehicle speed
- Steering wheel turning angle
- Lateral movement with regards to the direction of travel
- Accelerator pedal operation status
- Brake pedal operation status
- Select lever position
- Odometer reading
- Data related to ABS, Vehicle Dynamics Control and Traction Control Function

SUBARU and third parties contracted by SUBARU may acquire and use the recorded data for the purpose of vehicle research and development. SUBARU and third parties contracted by SUBARU will not disclose or provide the acquired data to any other third party except under the following conditions.

- The vehicle owner has given his/her consent.
- The disclosure/provision is based on a court order or other legally enforceable request.
- Data that has been modified so that the user and vehicle cannot be identified is provided to a research institution for statistical processing or similar purposes.

Handling of the Stereo Camera

The stereo camera is located on the front map lights unit.

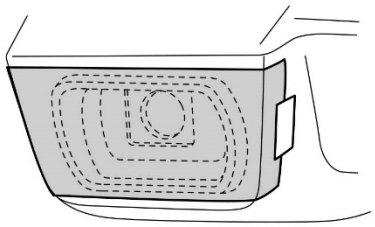


S01107

⚠ CAUTION

- The stereo camera monitors and detects smears or blurs on the front of the camera. However, detection is not 100% accurate.
  Under certain conditions, the function may fail to detect smears or blurs on the front of the stereo camera accurately. In addition, this function may not detect that there is snow or ice on the windshield close to the stereo camera. In such conditions, be sure to keep the windshield clean at all times (indicated by Ⓐ). Otherwise the system may not operate correctly. When this function detects that the front of the stereo camera is smeared or blurred, no EyeSight functions can be activated except for Conventional Cruise Control.
- The stereo camera lenses are precision components. Always observe the following precautions especially when handling them.
  - Never touch the stereo camera lenses, and do not attempt to wipe or clean the lenses. Doing so could damage or soil the lens, and lead to improper system performance.
    If you ever touch a lens for any reason, be sure to contact a SUBARU dealer.

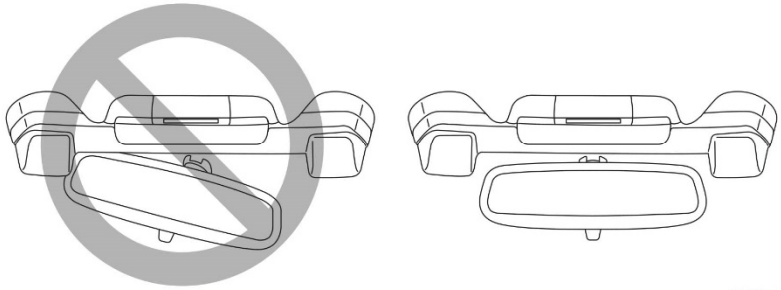
- When cleaning the windshield, cover the front of the camera casing with paper that does not collect dust, such as copy paper. Affix the paper to prevent glass cleaner from getting on the camera lenses. At this point, make sure that the tape's adhesive surface does not come in contact with the windshield or the lens. Be sure to remove the paper after cleaning.



S03066

- When having the inside of windshield cleaned at a service station, etc., be sure to request that the attendant covers the camera covers before washing the vehicle.
- Do not subject the stereo camera to a strong impact.
- Do not remove or disassemble the stereo camera.
- Do not change the positions where the stereo camera is installed or modify any of the surrounding structures.

• Do not install an interior rearview mirror other than a genuine SUBARU rearview mirror (such as a wide-type mirror) and the sun visor. Also, use the rearview mirror so that it does not obstruct the stereo camera. Failure to do so may affect the stereo camera's field of view and could prevent the EyeSight system from functioning properly.



S00509

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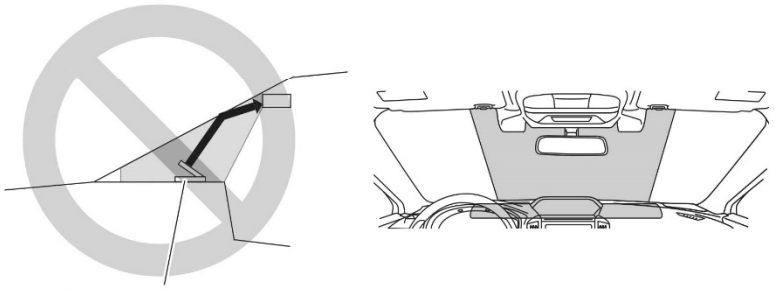
- Do not install any accessories other than the ones designated by SUBARU on the prohibited areas shown in the illustrations (gray zones).
  Even if some accessories are installed on the outside of the prohibited areas, abnormal operation of EyeSight may occur due to the reflection of the light or any objects. In this situation, move the accessories. For details, contact a SUBARU dealer.

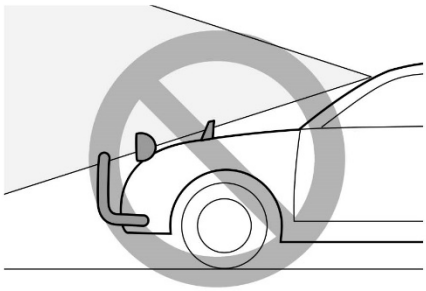
Side view **Front view**



Monitors or other accessories S02664

- Do not place any objects on top of the instrument panel. The stereo camera may not be able to detect objects accurately and the EyeSight system may not function properly due to reflections in the windshield. For details, contact a SUBARU dealer.
- If the top of the instrument panel is polished with chemicals or other substances, the stereo camera may not be able to detect objects accurately and the EyeSight system may not operate properly due to reflections in the windshield.
- Do not install any wiper blades other than genuine SUBARU wiper blades. Doing so may affect the stereo camera's field of view and could prevent the EyeSight system from functioning properly.
- Replace damaged wiper blades or worn wiper blade rubbers as soon as possible. Using damaged wiper blades or worn wiper blade rubbers may cause streaking on the windshield. The stereo camera may not be able to detect objects accurately and the EyeSight system may not function properly due to streaks or droplets remaining on the windshield.

- Do not install any accessories on the front side such as on the hood or the grille. It may affect the camera view and the system may not operate correctly.
- Make sure that the cargo loaded on the roof does not interfere in the stereo camera's field of view. Obstructing the stereo camera's view may impair the system operation. For details, contact a SUBARU dealer.



S01098

- Keep the windshield (outside and inside) clean at all times. When the windshield has become fogged, or it has a dirt or an oil film on it, the stereo camera may not detect objects accurately and the EyeSight system may not operate correctly. Never mount any device to the center air vent, as any airflow change may impact performance of the EyeSight system.
- Do not place any stickers or accessories on the windshield (outside or inside). If you have to do so (for example, legally required or electronic toll tag), avoid the area directly in front of the camera. Otherwise, it may adversely affect the field of view of the stereo camera and can cause improper operation of the system. For details, contact a SUBARU dealer.
- Do not use any glass coating agents or similar substances on the windshield. Doing so may interfere with the proper operation of the system.
- Do not install any film or an additional layer of glass on the windshield. The system may not operate correctly.
- If there are scratches or cracks on the windshield, contact a SUBARU dealer.
- To have the windshield replaced or repaired, contact a SUBARU dealer. Do not install a windshield other than a genuine SUBARU windshield. The stereo camera may not be able to detect objects accurately and the EyeSight system may not operate properly.

EyeSight Functions

EyeSight includes the following functions.

■ Pre-Collision Braking System

This function uses a following distance warning feature to warn the driver to take evasive action when there is the possibility of a collision with a vehicle or obstacle in front of you. If the driver does not take evasive action, the brakes are applied automatically to help reduce vehicle collision damage or, if possible, help prevent a collision.
⇒ Page 27

■ Advanced Adaptive Cruise Control

Adaptive Cruise Control

This function maintains the set vehicle speed and when there is a vehicle in front in the same traffic lane, it follows the speed of the vehicle in front up to the maximum of the set vehicle speed.
⇒ Page 43

Lane Centering Function

This function helps suppress lane drifting by detecting lane markings (e.g., white lines) and the lead vehicle on expressways, freeways and interstate highways, and by assisting steering operation. Lane Centering Function will work only when the Adaptive Cruise Control is activated.
⇒ Page 71

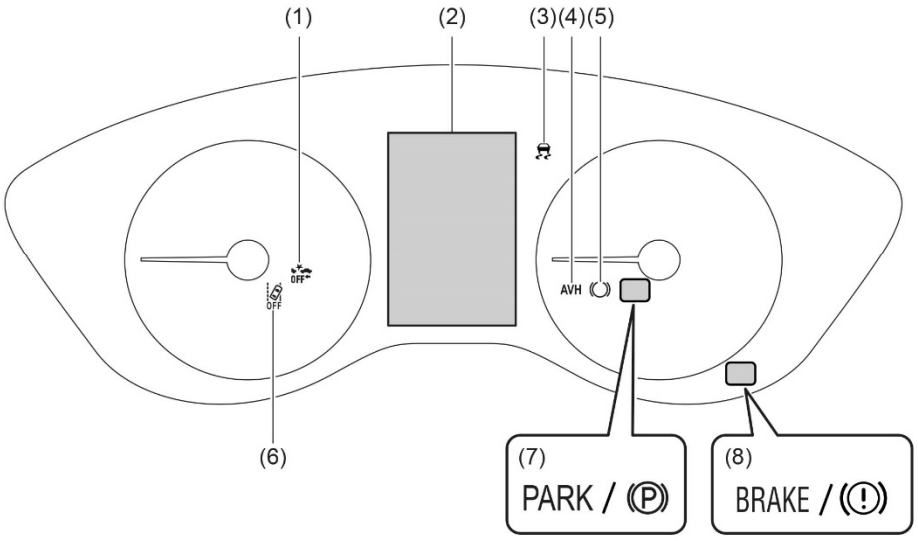
■ Lane Departure Prevention Function

When driving on expressways, freeways, or interstate highways, the system recognizes the lane markings on both sides of the vehicle. If the vehicle appears likely to depart from the lane, the system assists with steering operation in the direction that prevents the lane departure, preventing the vehicle from leaving the lane.
⇒ Page 84

■ Pre-Collision Throttle Management

This function reduces accidental forward movement caused by the select lever being placed in the wrong position or the accelerator pedal being accidentally depressed, or depressed too strongly.
⇒ Page 93

Instrument panel display layout



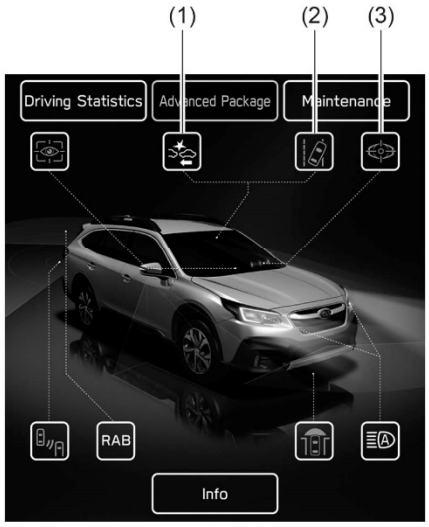
S03537

(1) Pre-Collision Braking System OFF indicator light
(2) Combination meter display
(3) Vehicle Dynamics Control warning light
(4) Auto Vehicle Hold ON indicator light
(5) Auto Vehicle Hold operation indicator light
(6) Lane Departure Warning OFF indicator light
(7) Electronic parking brake indicator light
(8) Brake system warning light

	**Select lever/gear position indicator** This indicator illuminates and shows which position the select lever or the gear is in.
	**EyeSight warning indicator (yellow)** • This indicator illuminates or flashes when a malfunction occurs in the EyeSight system. • When it is illuminated or flashing, none of the EyeSight functions can be used (including Adaptive Cruise Control and the Pre-Collision Braking System, etc.). ⇒ Page 122
	**EyeSight temporary stop indicator (white)** • This indicator illuminates when the EyeSight system is temporarily stopped. • When the ignition switch is placed in the ON position, it will illuminate if the (CRUISE) switch or (Lane Centering) switch is set to ON within approximately 7 seconds of the engine starting. It turns off when approximately 7 seconds have elapsed since the engine started. • When it is illuminated, none of the EyeSight functions can be used except for Conventional Cruise Control. ⇒ Page 124
	**Auto Start Stop indicator (green) (also used as Auto Start Stop warning indicator (yellow))** • This indicator illuminates in yellow when the ignition switch is turned to the ON position, and then it turns off after the engine starts. • It illuminates in green while the Auto Start Stop system operates. It turns off after the engine restarts. • It illuminates in yellow if a malfunction occurs in the Auto Start Stop system.
	**Auto Start Stop OFF indicator** This indicator illuminates when the Auto Start Stop system is turned off. It turns off when the Auto Start Stop system is turned on. ⇒ Refer to the vehicle Owner's Manual for details.
	**Auto Start Stop No Activity Detected indicator light** When a vehicle is stopped, the indicator light illuminates when the operating conditions of the Auto Start Stop system are not met. The light will turn off when the vehicle starts driving.
	**X-MODE indicator (if equipped)** The X-MODE indicator illuminates when the X-MODE is on. ⇒ Refer to the vehicle Owner's Manual for details.

	**Lane Departure Warning OFF indicator light** • This indicator light illuminates when the Lane Departure Warning and Lane Sway Warning are off. • It also illuminates when the ignition switch is turned to the ON position. Approximately 7 seconds after the engine starts, the Lane Departure Warning OFF indicator light will turn off or remain illuminated depending on the current status (ON or OFF). ⇒ Pages 102 and 105
	**Pre-Collision Braking System OFF indicator light** • This indicator light illuminates when the Pre-Collision Braking System and Pre-Collision Throttle Management are off. • It also illuminates when the ignition switch is turned to the ON position, and then turns off approximately 7 seconds after the engine starts. ⇒ Pages 42 and 99
	**Lane indicator** • This indicator illuminates in gray when the Lane Departure Prevention Function is turned on. • It illuminates in white under the following conditions. - The Lane Departure Prevention Function goes into the standby status. - Lane Centering Function is operating by detecting the lane markings. • It illuminates in yellow when the Lane Departure Prevention Function is operating. ⇒ Pages 80 and 89
	**Brake system warning light** If the brake system warning light illuminates when the electronic parking brake is released while driving, turn the Pre-Collision Braking System off. At this time, do not use the Conventional Cruise Control mode or Adaptive Cruise Control mode. If the brake system warning light does not turn off, immediately pull the vehicle over to a safe location. Contact a SUBARU dealer to have the system inspected. ⇒ Refer to the vehicle Owner's Manual for details.
	**Electronic parking brake indicator light** This indicator light illuminates when the electronic parking brake is applied. ⇒ Refer to the vehicle Owner's Manual for details.
	**Your vehicle indicator** When the brake pedal is depressed or the brake control function is activated, the brake indicator light illuminates in red.

Center information display



(1) Pre-Collision Braking System indicator
(2) Lane Departure/Sway Warning indicator
(3) EyeSight Assist Monitor

S03520

The settings of the on-board systems can be changed by operating the center information display.
Warning screens will be displayed on the center information display as needed.

●Pre-Collision Braking System indicator

This indicator illuminates when the Pre-Collision Braking System is on.

●Lane Departure/Sway Warning indicator

This indicator illuminates when the Lane Departure Warning and Lane Sway Warning are on.

●EyeSight Assist Monitor

This indicator illuminates when the EyeSight Assist Monitor is on.

■ Changing settings

The EyeSight settings can be changed by operating the center information display.
⇒ Page 126

The following systems can also be turned ON/OFF by operating the center information display.

- Vehicle Dynamics Control
- X-MODE (if equipped)
- Auto Vehicle Hold (AVH)

⇒ Refer to the vehicle Owner's Manual for details.

■ Warning screens

The following warning screens will be displayed on the center information display.

Item	Displayed screen
Pre-Collision Braking System warning (first braking and secondary braking)	 S03539
"Obstacle Detected" warning	
Lane Centering Function warning (no-operation of the steering wheel)	 S03540
Lane Centering Function cancellation (no-operation of the steering wheel)	 S03541

Pre-Collision Braking System

When there is the risk of a rear-end collision with an obstacle in front, the EyeSight system helps to prevent or minimize a collision by warning the driver. If the driver still does not take evasive action to avoid a collision, the brakes can be automatically applied just before the collision in order to reduce impact damage, or if possible, prevent the collision. If the driver takes evasive action to avoid a collision, Pre-Collision Braking Assist will operate in order to help the driver to prevent or minimize the collision.
This system can be effective not only with direct rear-end collisions, but also with offset rear-end collisions. This function can be activated when the select lever is in the D, M or N positions.

⚠ WARNING

- Never use the Pre-Collision Braking System and Pre-Collision Braking Assist to stop your car or avoid a collision under ordinary conditions. These functions cannot prevent collisions under all conditions. If the driver relies only on the Pre-Collision Braking System for Brake operation, collisions may occur.
- When a warning is activated, pay attention to the front of the vehicle and its surroundings, and operate the brake pedal and/or take other actions if necessary.
- The EyeSight Pre-Collision Braking System is primarily designed to prevent rear-end collisions with other vehicles when possible or to minimize damage and injuries in the event of a collision. In addition to other vehicles, things such as motorbikes, bicycles and pedestrians can also be treated as obstacles. However, there may be cases when detection is not possible depending on a variety of conditions*2. For example, when a vehicle is viewed from the side, oncoming vehicle, vehicles approaching in reverse, small animals or children, or walls or doors are not likely to be detected.
- The Pre-Collision Braking System will operate at the point when it determines that a collision cannot be avoided and is designed to apply strong braking force just before a collision. The result of this varies depending on a variety of conditions*2. Because of this, performance of this function will not always be the same.
- When the Pre-Collision Braking System is activated, it will continue to operate even if the accelerator pedal is partially depressed. However, it will be canceled if the accelerator pedal is suddenly or fully depressed.
- If the driver depresses the brake pedal or turns the steering wheel, the system may determine that this constitutes evasive action by the driver, and the automatic braking control may not activate in order to allow the driver full control.

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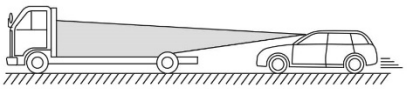
- When the difference in speed with the obstacle in front is the following figure[*1] or more, it may not be possible to avoid a collision. Even if the speed difference is the following figure[*1] or less, in cases such as when another vehicle cuts in front of you, or in other cases depending on visibility, the condition of road surface and other factors[*2], the function may be unable to stop the vehicle or may not activate. Pre-Collision Braking Assist also may not activate depending on the conditions[*2] listed below.

*1: For vehicles: approximately 30 mph (50 km/h),
For pedestrians: approximately 21 mph (35 km/h)

*2: Conditions in which the Pre-Collision Braking System cannot detect obstacles:

- Distance to obstacle in front of you, speed difference, proximity conditions, lateral displacement (the amount of offset)
- Vehicle conditions (amount of load, number of occupants, etc.)
- Road conditions (grade, slipperiness, shape, bumps, etc.)
- Visibility ahead is poor (rain, snow, fog or smoke, etc.).
- The detected object is something other than a vehicle, motorcycle, bicycle or pedestrian.
  - A domestic animal or other animal (a dog or deer, etc.)
  - A guardrail, telephone pole, tree, fence or wall, etc.
- Even if the obstacle is a motorcycle, bicycle or pedestrian, depending on the brightness of the surroundings as well as the relative movement, and aspect or angle of the object, there may be cases when the system cannot detect it.
- The system determines that operation by the driver (based on accelerator pedal operation, braking, steering wheel angle, etc.) is intended as evasive action.
- Vehicle maintenance status (brake systems, tire wear, tire pressure, whether a temporary spare tire is being used, etc.)
- A trailer or another vehicle, etc. is being towed.
- The brakes are cold due to the outside temperature being low or just after starting the engine.
- The brakes are overheated on downhill grades (braking performance is reduced).
- In rain or after washing the vehicle (the brakes are wet and braking performance is reduced)

- Recognition conditions of the stereo camera
  In particular, the function may be unable to stop the vehicle or may not activate in the following cases.
  - Bad weather (for example heavy rain, a blizzard or thick fog)
  - Visibility is poor due to sand, smoke or water vapor blowing in the wind, or the front vision is obscured due to water splashes, snow, dirt or dust stir up generated by the vehicle in front or oncoming traffic.
  - At night or in a tunnel without the headlights on
  - At night or in a tunnel when there is a vehicle in front that does not have its taillights on
  - Approaching a motorcycle, bicycle or pedestrian at night
  - Ambient light is poor in the evening or early morning.
  - A vehicle, motorcycle, bicycle or pedestrian is outside the area illuminated by the headlights.
  - Strong light is coming from the front (for example, sunlight at dawn, sunset or headlight beams, etc.).
  - The windshield has become fogged, scratched, or snow, dirt, dust or frost has adhered to it, or it is otherwise affected.
  - Fluid has not been fully wiped off the windshield during or after washer use.
  - The target cannot be correctly recognized because the stereo camera's view is obstructed by water droplets from rain or the window washer, or by the wiper blades.
  - The stereo camera's field of view is obstructed (for example by a canoe on the roof of the vehicle).
  - The rear aspect of the vehicle in front is low, small or irregular (the system may recognize another part of the vehicle as its rear and will determine operation from that).
    - There is an empty truck or trailer with no rear and/or side panels on the cargo bed.
    - With vehicles that have cargo protruding from their back ends



S02133

    - With non-standard shaped vehicles (vehicle transporters or vehicles with a sidecar fitted, etc.)
    - The height of the vehicle is low, etc.

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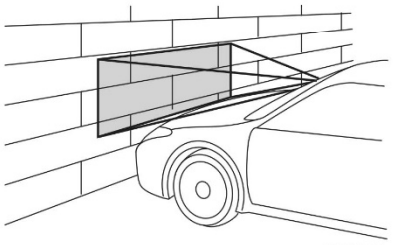
⇒ Continued from previous page

- There is a wall, etc. in front of a stopped vehicle.
- There is another object near the vehicle.
- A vehicle, etc. has its side facing you.
- With vehicles that are backing up or with oncoming vehicles, etc.
- The size and height of an obstacle is smaller than the limitations of the stereo camera's recognition capability.
  - With small animals or children, etc.
  - With pedestrians who are sitting or lying down
- The detected object is a fence or wall, etc. with a uniform pattern (a striped pattern or brick pattern, etc.).
- There is a wall or door made of glass or a mirror in front.
- The vehicle in front suddenly swerves, accelerates, or decelerates.
- A vehicle, motorcycle, bicycle or pedestrian suddenly cuts in from the side or suddenly runs in front of you.


S00653

- Your vehicle is immediately behind an obstacle after changing lanes.
- There is a vehicle, motorcycle, bicycle or pedestrian in a location close to your vehicle's bumper.
- The speed difference between your vehicle and an obstacle is 4 mph (5 km/h) or less (As braking is performed once the obstacle is in close proximity to your vehicle, depending on the shape and size of the obstacle, there may be some cases when the obstacle is outside the range of the camera's field of view.).
- On sharp curves, steep uphill grades or steep downhill grades
- On a bumpy or unpaved road
- There are changes in brightness, such as at a tunnel entrance or exit.

- Do not test Pre-Collision Braking System on its own. It may operate improperly and cause an accident.
- The system may not operate correctly under the conditions listed below. When these conditions occur, turn off the Pre-Collision Braking System.
  - The tire pressure is not correct.*1
  - The temporary spare tire is installed.*1
  - Tires that are unevenly worn or tires with uneven wear patterns are installed.*1

- Tires that are the wrong size are installed.*1
- A flat tire has been fixed temporarily with a tire repair kit.
- The suspension has been modified (including a genuine SUBARU suspension that has been modified).
- An object that obstructs the stereo camera's view is installed on the vehicle.
- The headlights are dirty or they have snow and ice or dirt on them. (Objects are not correctly illuminated and are difficult to detect.)
- The optical axes are not aligned correctly. (Objects are not correctly illuminated and are difficult to detect.)
- The lights including headlights and fog lights have been modified.
- Vehicle operation has become unstable due to an accident or malfunction.
- The brake system warning light is illuminated in red.*2
- A heavy cargo is loaded onto or inside the vehicle.
- The maximum number of occupants is exceeded.
- The combination meter is not operating properly; such as when the lights do not illuminate, the beeps do not sound, the display is different from when it is normal, etc.*3

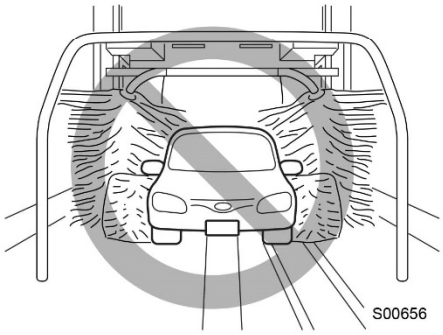
*1: The wheels and tires have functions that are critically important. Be sure to use the correct ones. For details, refer to the Owner's Manual for your vehicle.

*2: If the brake system warning light does not turn off, immediately pull the vehicle over in a safe place and contact a SUBARU dealer to have the system inspected. For details, refer to the Owner's Manual for your vehicle.

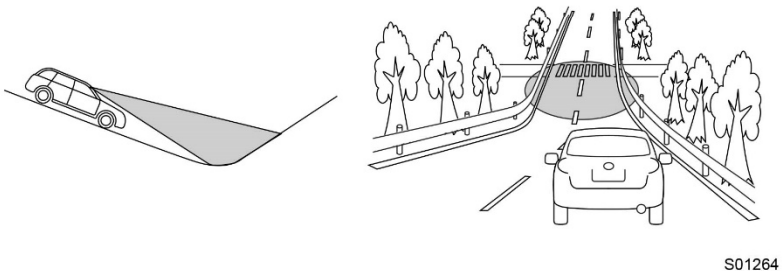
*3: For details about the combination meter, refer to the Owner's Manual for your vehicle.

CAUTION

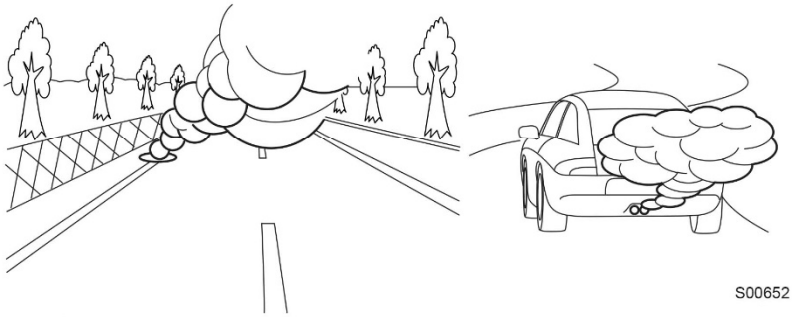
- In the following situations, turn off the Pre-Collision Braking System. Otherwise the Pre-Collision Braking System may activate unexpectedly.
  - The vehicle is being towed.
  - The vehicle is being loaded onto a carrier.
  - A chassis dynamometer, free-rollers or similar equipment is being used.
  - A mechanic lifts up the vehicle, starts the engine and spins the wheels freely.
  - Passing hanging banners, flags or branches
  - Thick/tall vegetation is touching the vehicle.
  - Driving on a race track
  - In a drive-through car wash



- The Pre-Collision Braking System may activate in the following situations. Therefore concentrate on safe driving.
  - Passing through an automatic gate (opening and shutting)
  - Driving close to the vehicle in front
  - Driving in a location where the grade of the road changes rapidly

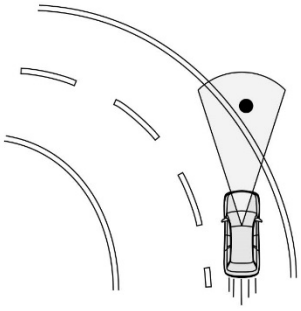


- Visibility is poor due to sand, smoke or water vapor blowing in the wind, or the front vision is obscured due to water splashes, snow, dirt or dust stir up generated by the vehicle in front or oncoming traffic.
- Passing through clouds of steam or smoke, etc.
- In adverse weather, such as heavy snow or snowstorms
- The exhaust gas emitted by the vehicle in front is clearly visible in cold weather, etc.

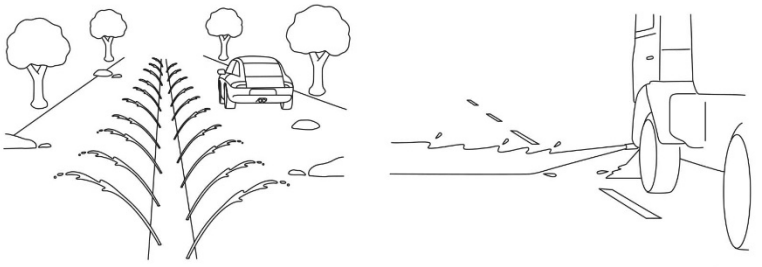


S00652

- There is an obstacle on a curve or intersection.
- A vehicle or an object is being narrowly passed.
- Stopping very close to a wall or a vehicle in front
- Passing through water spray from road sprinklers or snow clearing sprinklers on the road



S02669



S02636

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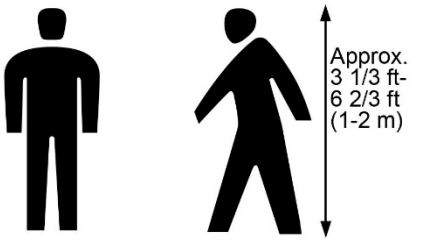
- If there is cargo or installed accessories, etc. that are protruding beyond the edge of the front bumper, the vehicle's length will increase and the system may not be able to prevent a collision.
- If the driver operates the brake pedal during automatic braking, the pedal may feel stiff; however, this is normal. By depressing the brake pedal further you can apply more braking force.

NOTE

Some unusual noises may be audible during automatic braking. This is caused by the braking control and is normal.

■ Detection of pedestrians

The EyeSight system can also detect pedestrians. The EyeSight system detects pedestrians from their size, shape and movement. The system detects a pedestrian when the contour of the head and shoulders are clear.



S02846

WARNING

The EyeSight system's Pre-Collision Braking function also identifies pedestrians as obstacles. However, depending on the conditions, there may be cases when the system cannot detect a pedestrian. In the following conditions, the possibility that the system may not be able to detect a pedestrian as an object is particularly high.

- Pedestrians are walking in a group.
- A pedestrian is next to a wall or other obstacle.
- A pedestrian is using an umbrella.
- A pedestrian is wearing clothes that are a similar color to the surrounding environment.
- A pedestrian is carrying bulky luggage.
- A pedestrian is bent over, crouching down or lying down.
- A pedestrian is in a dark location.
- A pedestrian suddenly crosses in front of you from the side or suddenly runs in front of you.

Pre-Collision Braking System operation

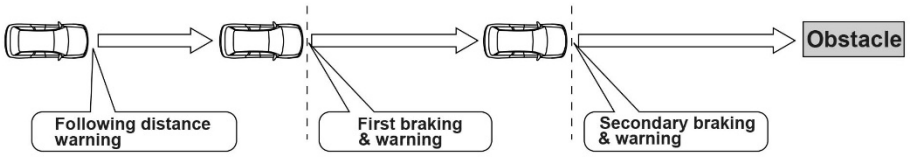
When there is an obstacle in front of you during driving, the system activates in the following sequence in order to warn the driver and to activate braking control and the brake lights.

Following Distance Warning:
When the system determines that there is a risk of collision, an alert sounds repeated short beeps and the indicators on the combination meter display illuminate to warn the driver.
The Following Distance Warning operates when Adaptive Cruise Control is not activated.
When the driver depresses the brake pedal to decelerate and achieves a suitable following distance, the warning is canceled.

First Braking and Warning:
When the system determines that there is a high risk of collision with an obstacle in front, an alert sounds repeated short beeps and the indicators on the combination meter display and the center information display illuminate to warn the driver. Braking control may be activated and in some situations, engine output may also be controlled. If the system determines that the amount of evasive action (braking, steering, etc.) taken by the driver has reduced the risk of collision, braking activation is canceled.

Secondary Braking and Warning:
If the system then determines that the risk of collision is extremely high, the alert changes to a continuous beeping sound and stronger braking control is activated. Despite any evasive action taken by the driver, if the system subsequently determines that a collision is unavoidable, braking and engine output are controlled by the system.

When the vehicle is stopped by secondary braking, the driver should depress the brake pedal in order to ensure that the vehicle stays stopped.



Operating system	Strength of Automatic Braking	Indication on the combination meter display	Alert type
Following distance warning	No brake control		Repeated short beeps
First braking	Moderate		Repeated short beeps
Secondary braking	Strong		Continuous beep

S03559

NOTE

- To release the brake control after the vehicle has come to a stop through Pre-Collision Braking System, perform the following.
  - Depress the brake pedal.
  - Depress the accelerator pedal (except when the select lever is in the N position).
  - Shift the select lever into the P position.
- After stopping with secondary braking, in the following cases, brake control will be released and the electronic parking brake will be applied.
  (For details about how to release the electronic parking brake, refer to the Owner's Manual for your vehicle.)
  - Approximately 2 minutes have elapsed since stopping and the brake pedal is not depressed.
  - Any door (except the rear gate/trunk) is opened.
  - The driver's seatbelt is unfastened.
  - The EyeSight system has a malfunction.
  - The EyeSight system has stopped temporarily.

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- Neither first braking nor secondary braking will operate in the following cases.
  - The vehicle speed is approximately 1 mph (1 km/h) or less (When the select lever is in the [N] position and your vehicle speed is approximately 2 mph (4 km/h) or less) or 100 mph (160 km/h) or more.
  - Vehicle Dynamics Control is active.
- If the system detects the brake lights of the vehicle in front, your vehicle will start decelerating earlier than if it does not.
- There are some cases where the first braking is applied for a longer period of time. One of the reasons for this is due to a large speed difference with an obstacle in front. In those cases, stronger or weaker braking control may be activated.

■ Pre-Collision Braking System operation indicator

After the Pre-Collision Braking System operation, a message appears and stays in the warning screen area of the combination meter display for a certain period of time.

▼ If the Pre-Collision Braking System stopped operating before the vehicle came to a stop

The message appears and stays in the warning screen area of the combination meter display to indicate that the Pre-Collision Braking System has activated. This screen will be displayed for 10 seconds.

S03129

▼If the Pre-Collision Braking System continued operating until the vehicle came to a stop

The screen displays the message “Apply Brake To Hold Position” to urge the driver to depress the brake pedal. At this time the alert sounds. This screen will be displayed for approximately 2 minutes until the driver depresses the brake pedal.

S02962

If the brake pedal is depressed or 2 minutes have elapsed, a message changes and stays in the warning screen area of the combination meter display to indicate that the Pre-Collision Braking System has activated. This screen will be displayed for 10 seconds.

S03130

Pre-Collision Braking Assist operation

When the Pre-Collision Braking System is activated (when the system determines that there is a high risk of collision with an obstacle in front), if the driver depresses the brake pedal, the system determines that this is emergency braking and activates braking assist automatically.

CAUTION

If the driver depresses the brake pedal while following distance warning is activated, the Pre-Collision Braking Assist will not work. The vehicle decelerates with the normal braking force operated by the driver.

NOTE

- Pre-Collision Braking Assist function does not operate when the vehicle speed is approximately 7 mph (10 km/h) or less or 100 mph (160 km/h) or more.
- For information about the brake assist function, refer to the Owner's Manual for your vehicle.

Turning on/off the Pre-Collision Braking System

Operate the center information display to turn on/off the Pre-Collision Braking System (including Pre-Collision Braking Assist).
This function is turned on by selecting “Setting ON” on the “Pre-Collision Braking” screen of the EyeSight settings.
This function is turned off by selecting “Setting OFF” on the “Pre-Collision Braking” screen of the EyeSight settings.
⇒ Page 126

The Pre-Collision Braking System on/off setting interlocks with the Pre-Collision Throttle Management setting.

- When this system is turned off, the Pre-Collision Braking System OFF indicator light illuminates.
- When this system is turned on, the Pre-Collision Braking System OFF indicator light turns off.

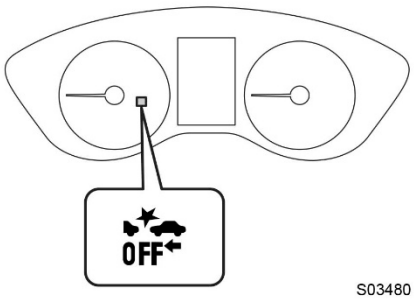
NOTE

Even when the Pre-Collision Braking System is turned off, if the engine is turned off and then restarted, the Pre-Collision Braking System will be turned on. The system default setting when the vehicle is restarted is on.

■ Pre-Collision Braking System OFF indicator light

This indicator light illuminates when the ignition switch is turned to the ON position, and remains illuminated for approximately 7 seconds after the engine starts. It turns on when the Pre-Collision Braking System and Pre-Collision Throttle Management are turned off. It also illuminates under the following conditions.

- The EyeSight system has a malfunction.
  ⇒ Page 122
- The EyeSight system has stopped temporarily.
  ⇒ Page 124



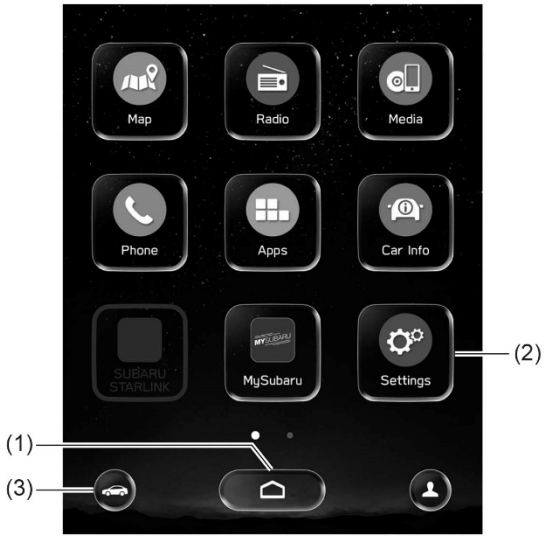
S03480

NOTE

When the Pre-Collision Braking System OFF indicator light is turned on, the Pre-Collision Braking System (including the Pre-Collision Braking Assist function) and Pre-Collision Throttle Management do not operate.

Changing settings

■ 11.6-inch display models (if equipped)



S03581

(1) HOME icon
(2) Settings icon
(3) Car settings icon

Change the EyeSight system setting as follows:
1. Touch (HOME).
2. → (Settings)
3. → “Car”
4. Select the preferred menu.

The setting adjustments to the following items can be manually changed to meet your personal requirements.

Item		Setting
EyeSight	Pre-Collision Braking	Setting ON/Setting OFF
	Lane Departure Prevention Function	All Functions/ Lane Departure Prevention Function Only/ Warning Buzzer Only/ OFF
	Cruise Control Acceleration Characteristics	Lv. 1 (Eco)/ Lv. 2 (Comfort)/ Lv. 3 (Standard)/ Lv. 4 (Dynamic)
	Select Drive on Left/Drive on Right	Right Lane/ Left Lane
	Lead Vehicle Acquisition Sound	ON/OFF
	Lead Vehicle Moving Monitor	ON/OFF
EyeSight Assist Monitor	Red Indicator	ON/OFF
	Yellow Indicator	ON/OFF
	Green Indicator	ON/OFF
Warning Volume	—	Min/Mid/Max

Touch  (Car settings icon) to display the items that are changeable while driving.
Change the EyeSight system setting as follows:
1. Touch  (Car settings icon).
2. Select the preferred menu.

Item		Setting
Driving Assistance	Pre-Collision Braking	Setting ON/Setting OFF
	Lane Departure Prevention Function	All Functions/ Lane Departure Prevention Function Only/ Warning Buzzer Only/ OFF
Others	Cruise Control Acceleration Characteristics	Lv. 1 (Eco)/ Lv. 2 (Comfort)/ Lv. 3 (Standard)/ Lv. 4 (Dynamic)
	Warning Volume	Min/Mid/Max

APPENDIX C

Run Log

Subject Vehicle: **2020 Subaru Outback Premium/LDD** Test Date: **5/27/2020**

Principal Other Vehicle: **SSV**

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
1-13	**Brake characterization and determination**						See Appendix D
14	Static Run						
15	**Stopped POV**	Y	2.71	8.76	0.94	Pass	
16		Y	2.66	5.45	0.86	Pass	
17		N					Speed low, RTK Fixed or less
18		Y	2.78	7.28	0.91	Pass	
19		N					Brake actuator did not apply force
20		Y	2.84	5.75	0.73	Pass	
21		Y	2.78	9.91	0.90	Pass	
22		Y	2.72	10.81	0.97	Pass	
23		Y	2.78	8.41	0.90	Pass	
24	Static Run						
25	**Slower POV, 25 vs 10**	N					Speed low
26		Y	2.42	6.32	0.60	Pass	
27		Y	2.38	6.37	0.64	Pass	
28		N					Speed low
29		Y	2.32	5.05	0.57	Pass	
30		Y	2.37	7.06	0.65	Pass	
31		N					Speed low

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
32		Y	2.34	7.02	0.65	Pass	
33		Y	2.28	8.94	0.80	Pass	
34		Y	2.36	7.77	0.81	Pass	
35	Static run						
36	**Slower POV, 45 vs 20**	N					Speed low
37		Y	3.01	8.90	0.91	Pass	
38		Y	3.24	8.64	0.91	Pass	
39		Y	2.97	10.36	0.96	Pass	
40		Y	3.15	8.79	0.93	Pass	
41		N					Yaw rate high
42		N					Brake force invalid
43		Y	2.93	9.04	0.91	Pass	
44		N					Throttle window
45		N					Yaw rate high
46		Y	3.13	11.22	0.99	Pass	
47		N					Yaw rate high
48		Y	3.09	8.91	0.94	Pass	
49	Static run						
50	**Decelerating POV, 35**	Y	1.98	6.04	1.01	Pass	
51		N					SV speed and POV Speed
52		N					POV brake invalid
53		N					SV Yaw
54		Y	1.90	6.39	0.53	Pass	

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
55		N					SV Yaw
56		Y	1.95	7.49	1.04	Pass	
57		N					SV Yaw
58	Static Run						
59	**Decelerating POV, 35**	N					SV speed
60		N					SV speed
61		Y	2.04	5.75	0.90	Pass	
62		Y	1.86	5.63	0.90	Pass	
63		N					SV speed
64		N					SV yaw
65		Y	1.90	5.27	0.92	Pass	
66		Y	1.84	3.01	0.97	Pass	
67	Static run						
68	STP - Static run						
69	**Baseline, 25**	Y			0.47		
70		Y			0.47		
71		Y			0.47		
72		Y			0.46		
73		N					Brake Onset
74		Y			0.48		
75		Y			0.48		
76		Y			0.49		

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
77	STP - Static run						
78	**Baseline, 45**	N					Speed
79		N					Brake onset
80		N					Speed
81		Y			0.46		
82		N					SV Speed
83		N					Braking High
84		Y			0.46		
85		Y			0.44		
86		Y			0.47		
87		Y			0.45		
88		Y			0.49		
89		Y			0.44		
90	STP - Static run						
91	**STP False Positive, 25**	Y			0.53	Pass	
92		Y			0.48	Pass	
93		Y			0.48	Pass	
94		Y			0.49	Pass	
95		Y			0.48	Pass	
96		Y			0.49	Pass	
97		Y			0.48	Pass	
98	STP - Static run						

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
99	**STP False Positive, 45**	N					Brake Onset
100		Y			0.43	Pass	
101		Y			0.45	Pass	
102		Y			0.46	Pass	
103		Y			0.44	Pass	
104		Y			0.46	Pass	
105		Y			0.48	Pass	
106		Y			0.49	Pass	
107	STP - Static run						
99	**STP False Positive, 45**	N					Brake Onset
100		Y			0.43	Pass	
101		Y			0.45	Pass	
102		Y			0.46	Pass	
103		Y			0.44	Pass	
104		Y			0.46	Pass	
105		Y			0.48	Pass	
106		Y			0.49	Pass	
107	STP - Static run						

APPENDIX D

Brake Characterization

Subject Vehicle: **2020 Subaru Outback Premium/LDD** Test Date: **5/27/2020**

DBS Initial Brake Characterization				
Run Number	**Stroke at 0.4 g (in)**	**Force at 0.4 g (lb)**	**Slope**	**Intercept**
1	2.494782	17.27817	0.485133	-0.39218
2	2.619299	17.81961	0.474597	-0.36297
3	2.503126	16.87866	0.470536	-0.35493

DBS Brake Characterization Determination								
Run	**DBS Mode**	**Speed**	**Valid Run**	**Average Decel. (g)**	**0.4 g Stroke Value (in)**	**0.4 g Force Value (lb)**	**Stroke/Force Calculator (in)**	**Notes**
4	**Displacement**	35	Y	0.406	2.54		2.50	
5		25	Y	0.404	2.54		2.51	
6		45	N					Decel High
7		45	Y	0.380	2.45		2.58	
8	**Hybrid**	35	N					Decel high
9		35	N					Decel high
10		35	N					Speed high, decel high

DBS Brake Characterization Determination								
Run	**DBS Mode**	**Speed**	**Valid Run**	**Average Decel. (g)**	**0.4 g Stroke Value (in)**	**0.4 g Force Value (lb)**	**Stroke/Force Calculator (in)**	**Notes**
11		35	Y	0.392	2.54	12.00	12.24	
12		25	Y	0.402	2.54	12.00	11.94	
13		45	Y	0.380	2.45	12.00	12.63	

Appendix E

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. Plots shown herein are grouped by test type and are presented sequentially within a given test type. The following is a description of data types shown in the time history plots, as well as a description of the color code 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 Baseline 25 mph (Baseline run at 25 mph)
False Positive Baseline 45 mph (Baseline run at 45 mph)
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)
DBS Brake Characterization Initial
DBS Brake Characterization Determination

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 between the front-most 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 the Principal Other Vehicle (if any). For DBS tests, in the case of an impact, the speed reduction experienced by the Subject Vehicle up until the moment of impact 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). The peak value of Ax for the SV is shown on the subplot.

- Pedal Position – Position of the accelerator pedal and brake pedal. The units for the brake pedal are inches and the units for the accelerator pedal are percent of full scale divided by 10.

- Brake Force (lb) – Force on the brake pedal as applied by the DBS controller. The TTC at the onset of the brake by the DBS controller is shown on the subplot. Additionally, the average force at the brake pedal while the DBS controller is active is displayed.

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 or red 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 within the envelope. Exceedances of a green envelope are indicated by red shading in the area between the measured time-varying data and the envelope boundaries.

With the exception of the brake force plots (see description below), 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 given. 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 0.27g (the upper edge of the envelope, i.e., 0.30 g ± 0.03 g). A green circle or red asterisk is displayed at the moment the POV brake level achieves 0.27g. 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 out of the appropriate interval).

For the pedal position plot, a thick black bar appears on the brake pedal position data over the DBS controller brake onset period to signify the time over which the brake application rate is determined. The calculated brake application rate is also displayed on the figure.

For the brake force plots:

- If the tests are done in Hybrid mode, the brake force plot shows a dashed black threshold line indicating a brake force of 2.5 lbs. For the time period where the DBS controller is active, the brake force at the pedal must not fall below this 2.5 lb threshold. Exceedances of this threshold are indicated by red shading in the area between the measured time-varying data and the dashed threshold line. A blue envelope represents the target average brake fore necessary to be valid
- If the tests are done in Displacement mode, there are no relevant brake force level thresholds or average brake force calculations.

In the instance of the “last second” braking applied by the brake robot, a thick vertical red line will appear on the plots at the moment the brake robot activates. Note that last second braking is only done when it has been determined by the onboard computer that test failure cannot be avoided. It is done simply to reduce the collision speed in order to minimize the likelihood of damage to the SSV and to the Subject Vehicle. Therefore, data validity checks are not performed after the red line, and certain values, such as minimum distance or peak deceleration, may not be accurate.

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
   - Blue envelope = visualized target range for the time varying data averaged over a period equal to the length of the envelope
   - 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.
   - Red threshold (Solid) = for reference only – indicates the activation of last-minute braking by the brake robot. Data after the solid red line is not used to determine test validity.

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 valid or passing time history plots for each test type (including passing, failing, and invalid runs) are shown in Figure E1 through E12. Figures E1 through E8 show passing runs for each of the 8 test types. Figure E9 shows an example of a passing brake characterization run. Figures E10 and E11 show examples of invalid runs. Figure E12 shows an example of a valid test that failed the DBS requirements. Time history data plots for the tests of the vehicle under consideration herein are provided beginning with Figure E13.

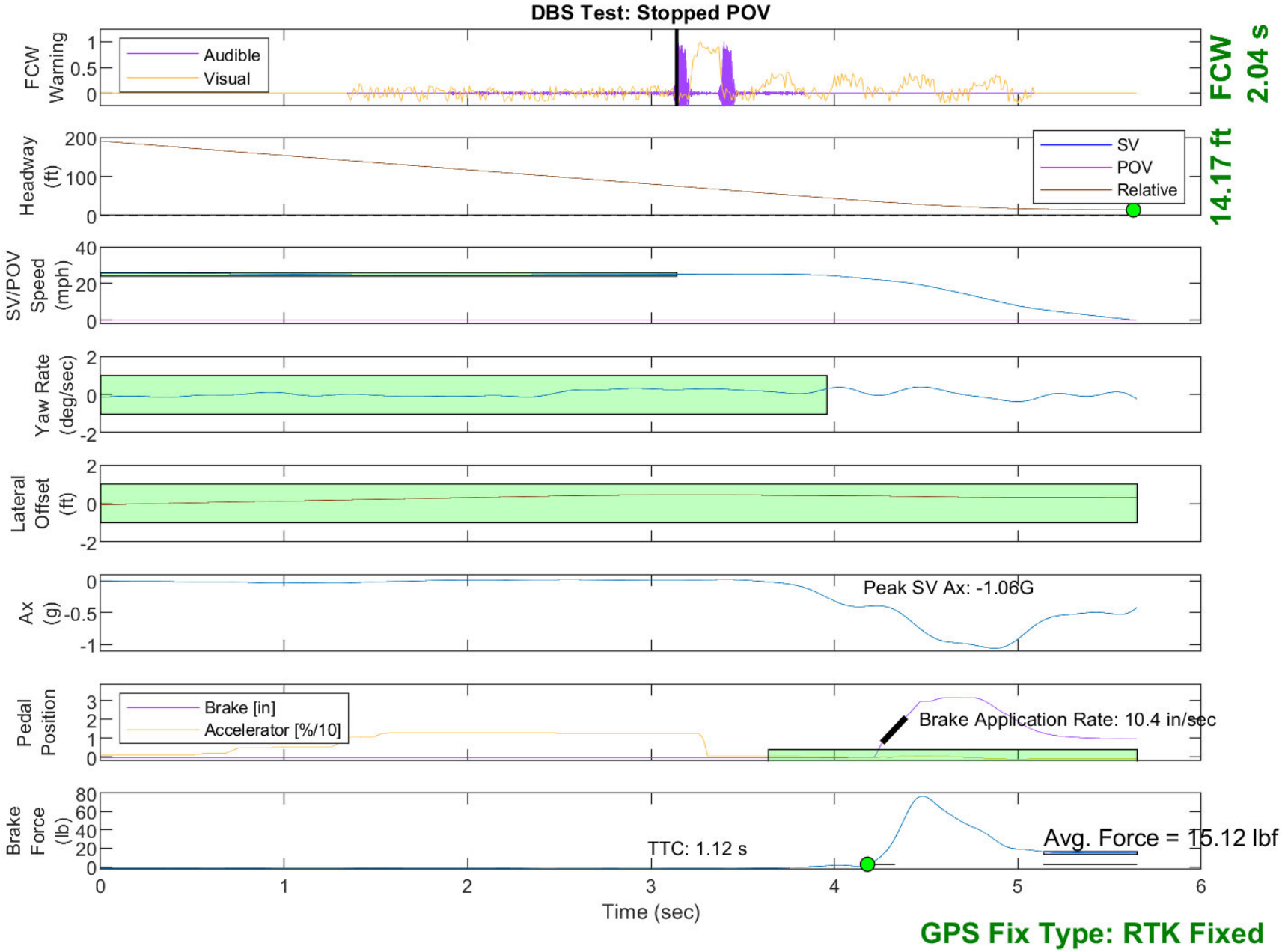


Figure E1. Example Time History for Stopped POV, Passing

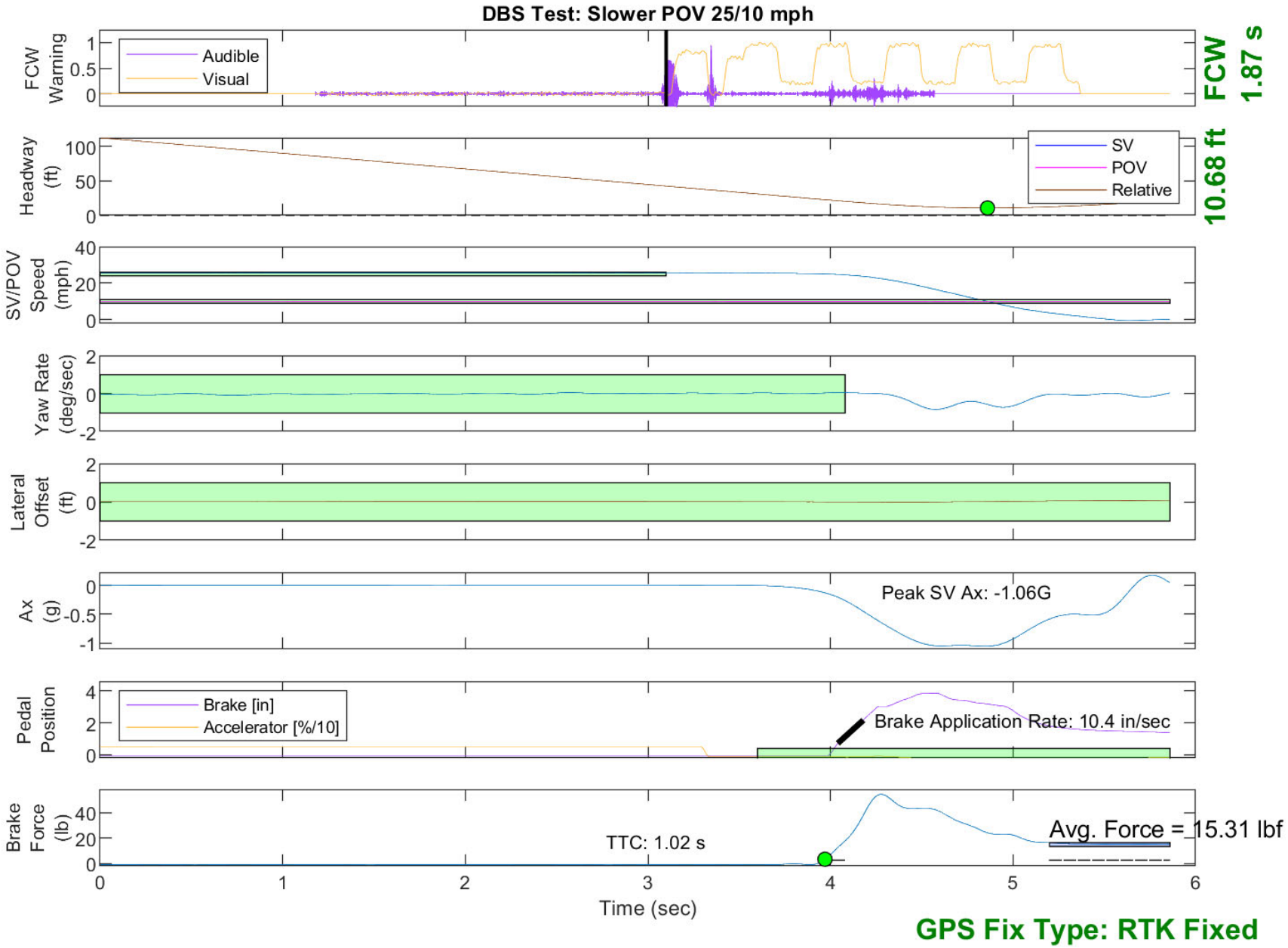


Figure E2. Example Time History for Slower POV 25 vs. 10, Passing

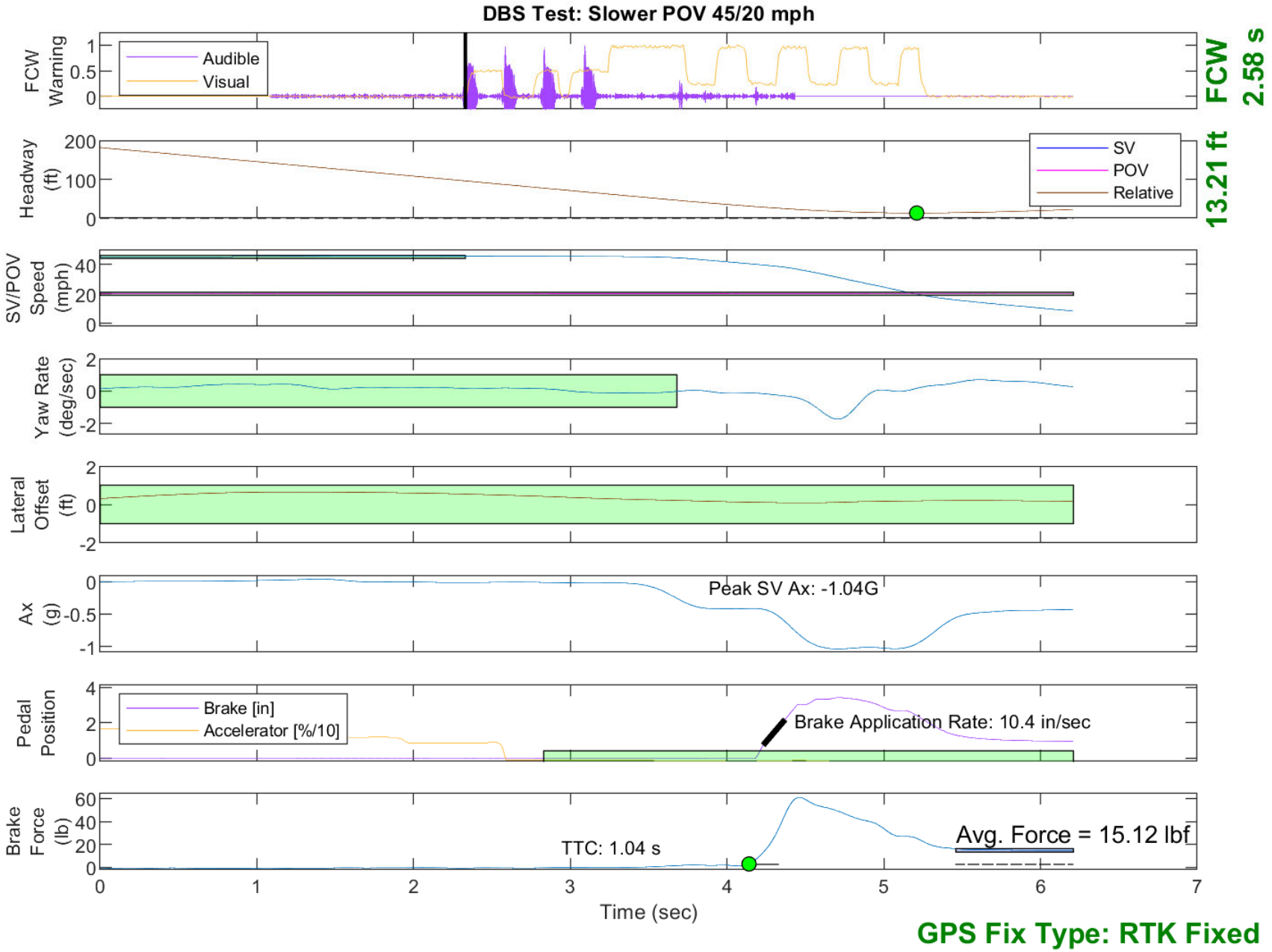


Figure E3. Example Time History for Slower POV 45 vs. 20, Passing

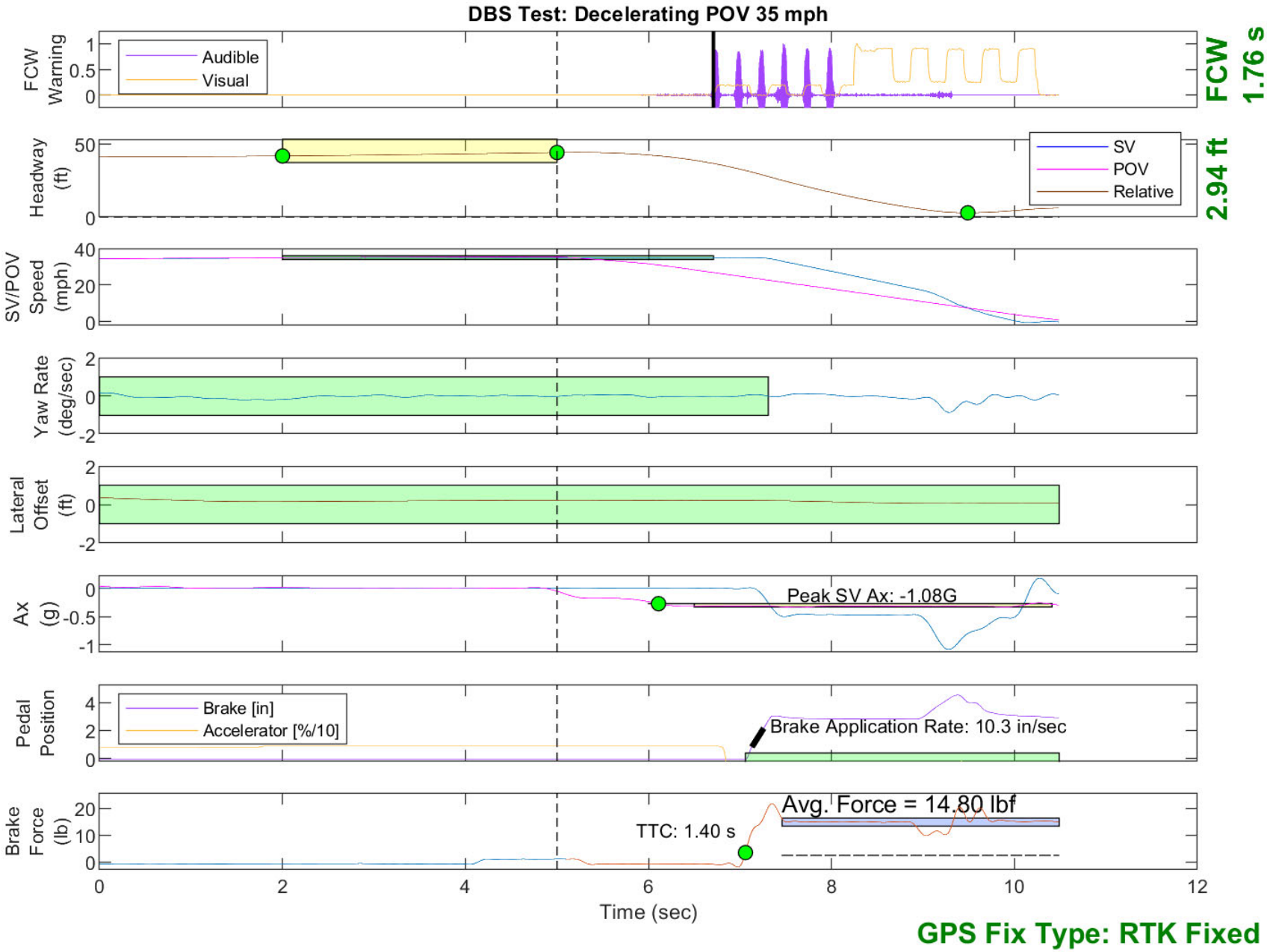


Figure E4. Example Time History for Decelerating POV 35, Passing

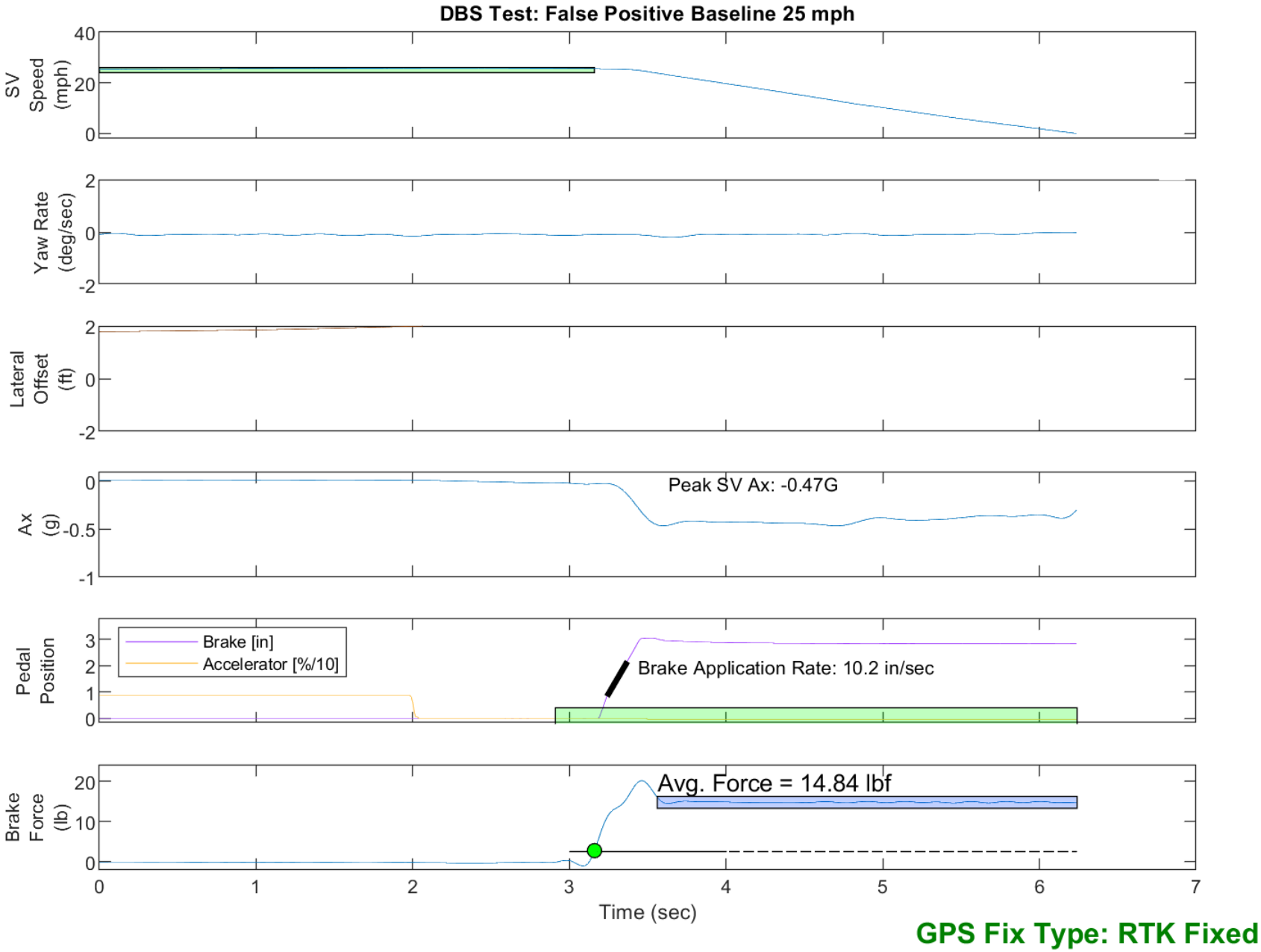


Figure E5. Example Time History for False Positive Baseline 25

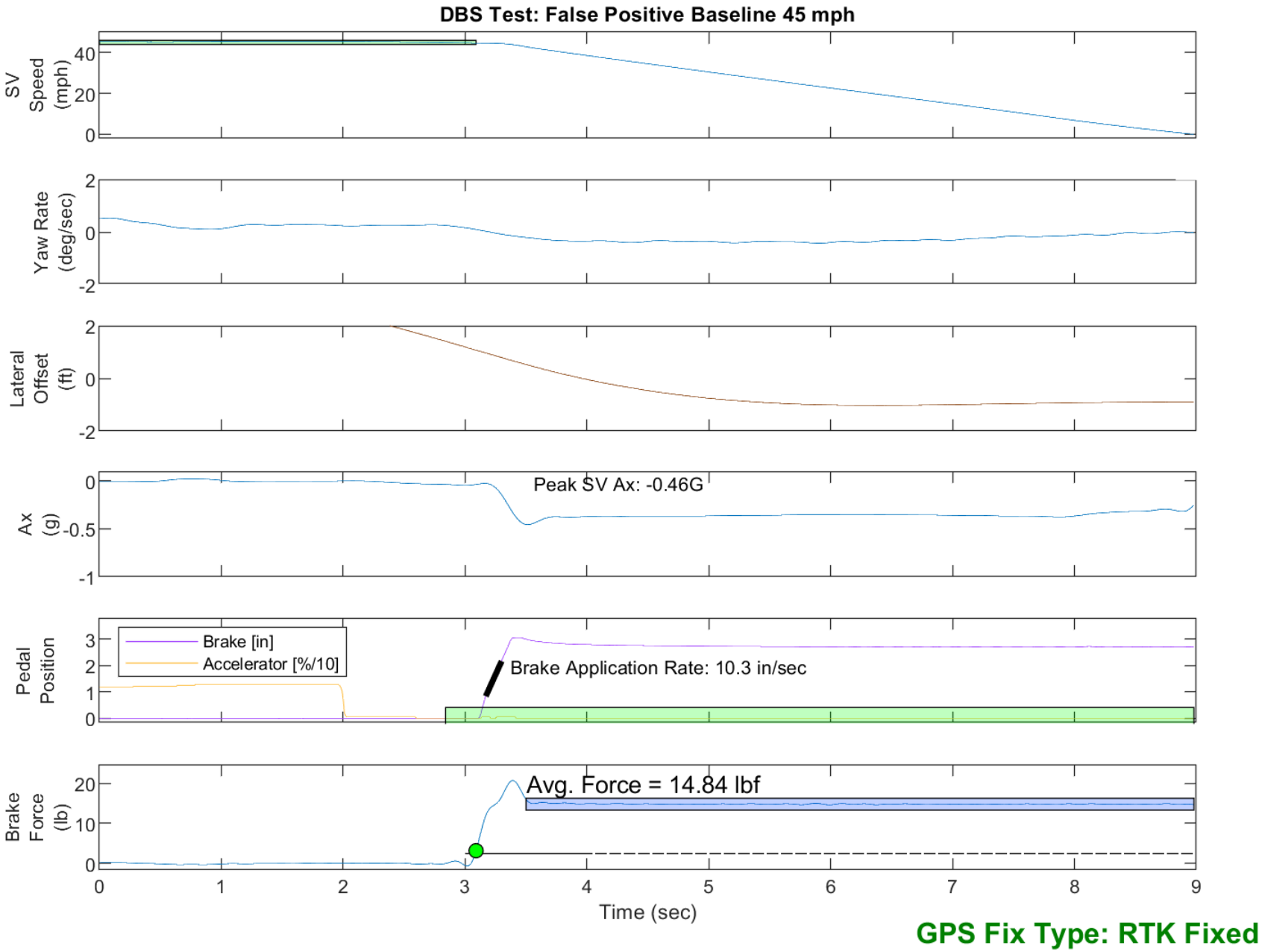


Figure E6. Example Time History for False Positive Baseline 45

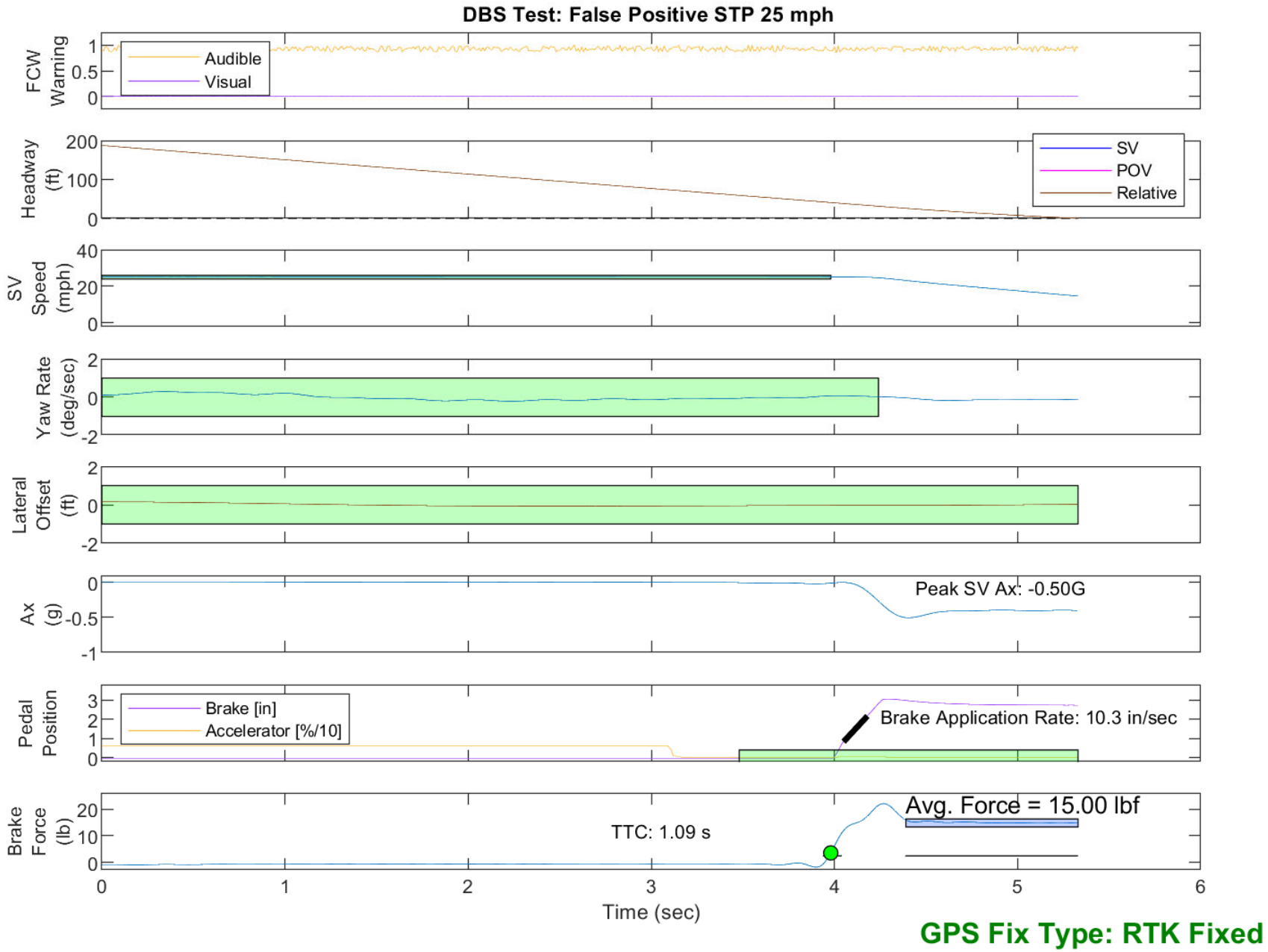


Figure E7. Example Time History for False Positive Steel Plate 25, Passing

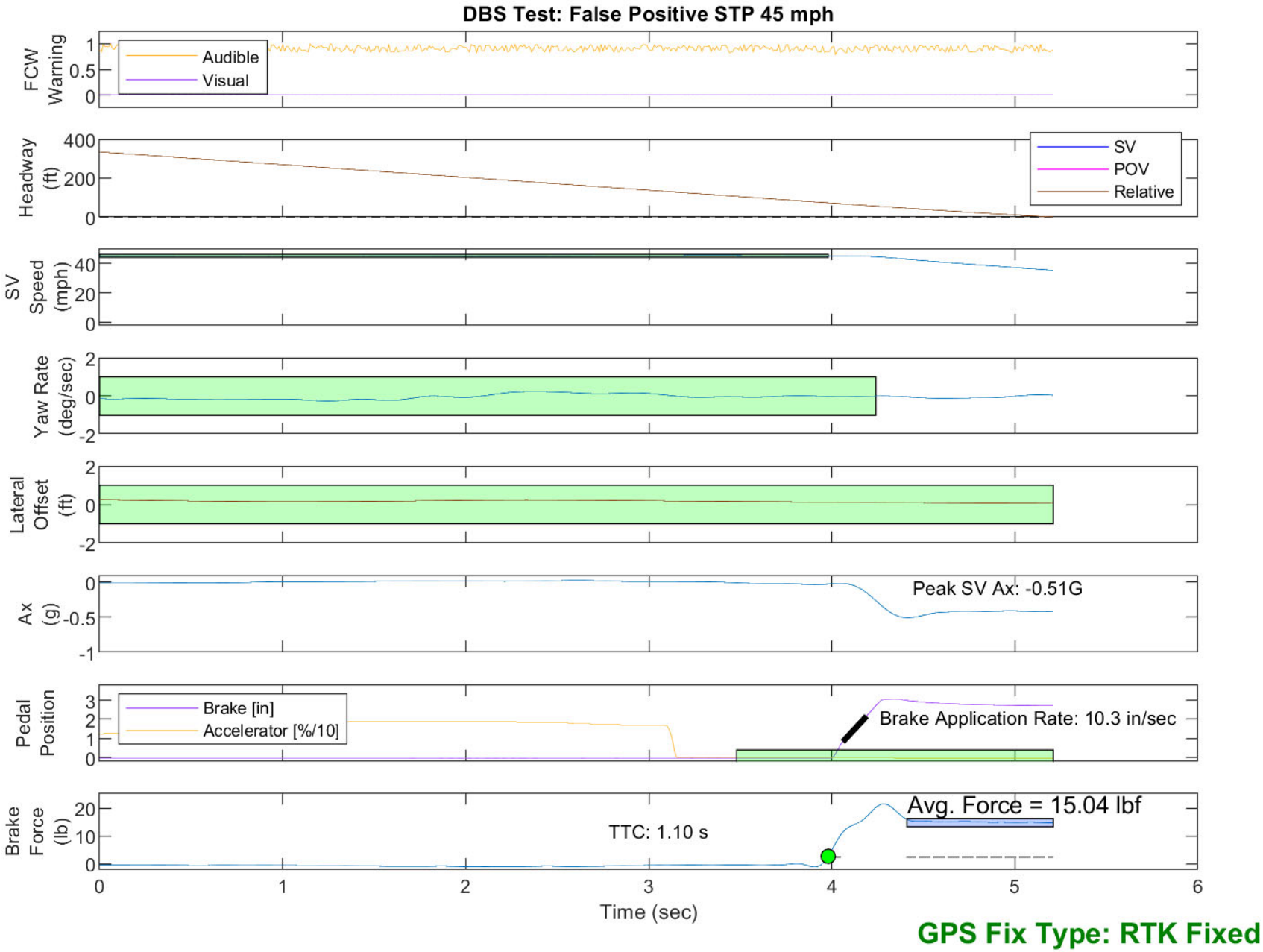


Figure E8. Example Time History for False Positive Steel Plate 45, Passing

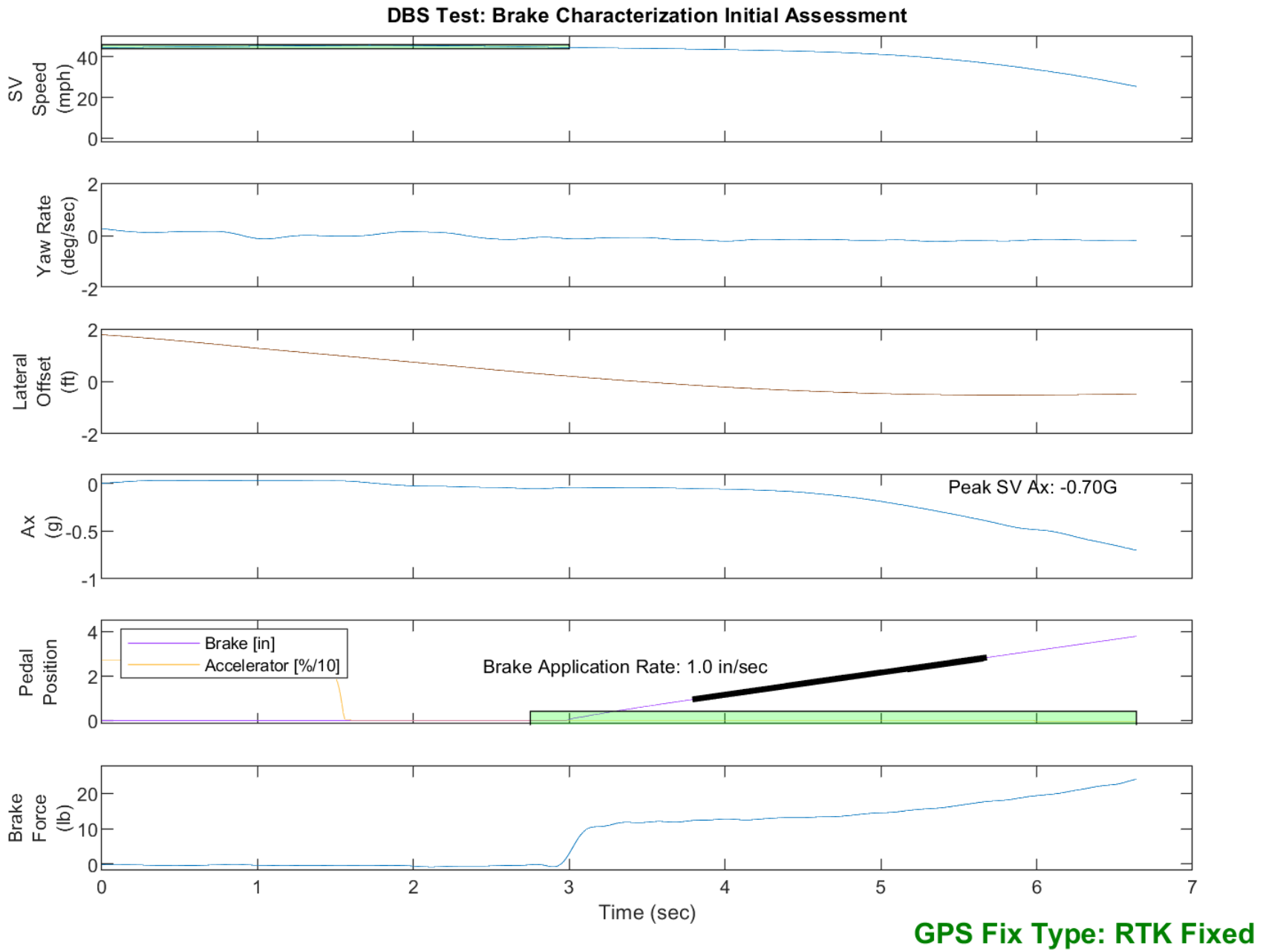


Figure E9. Example Time History for DBS Brake Characterization, Passing

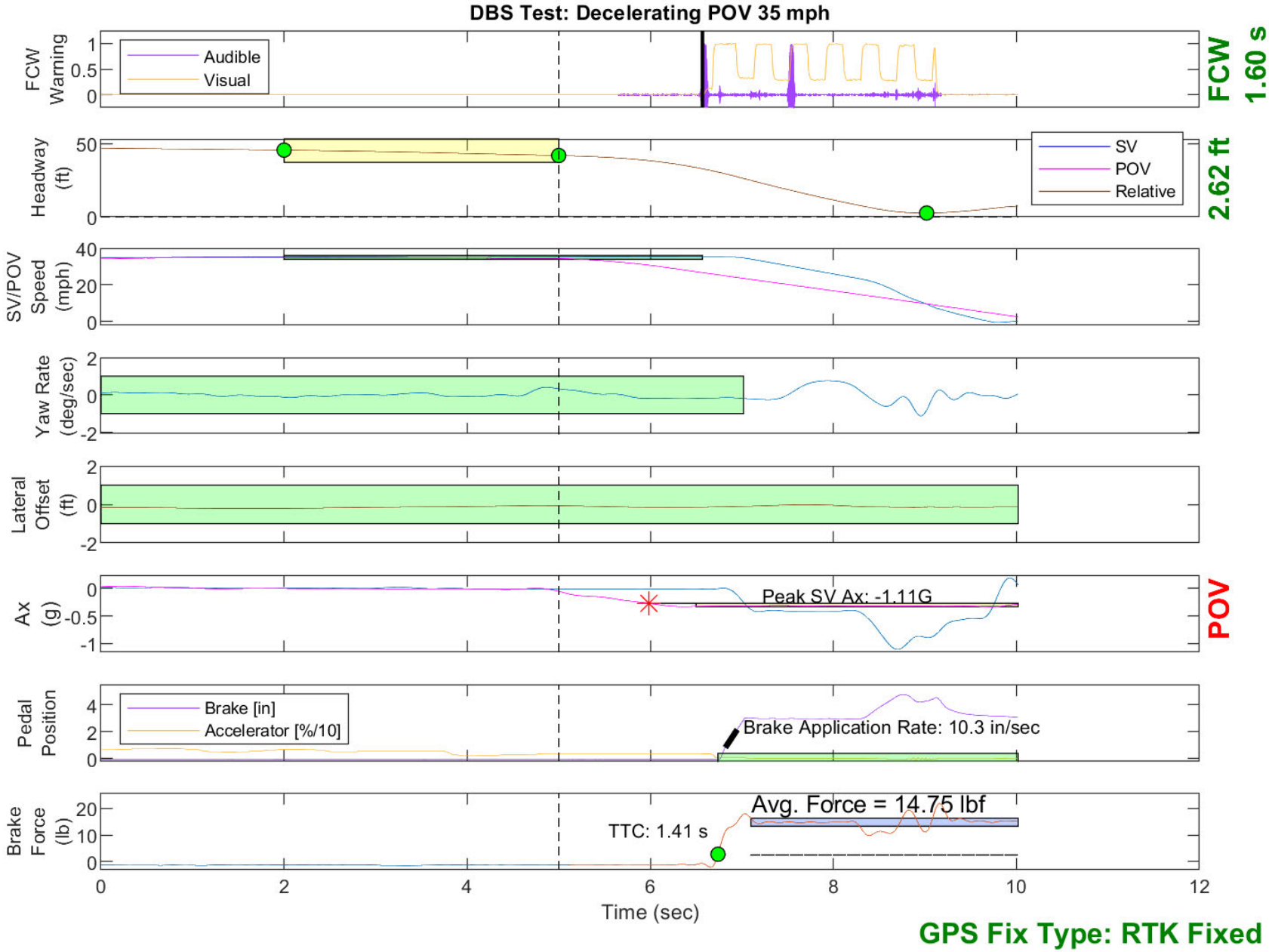


Figure E10. Example Time History Displaying Invalid POV Acceleration Criteria

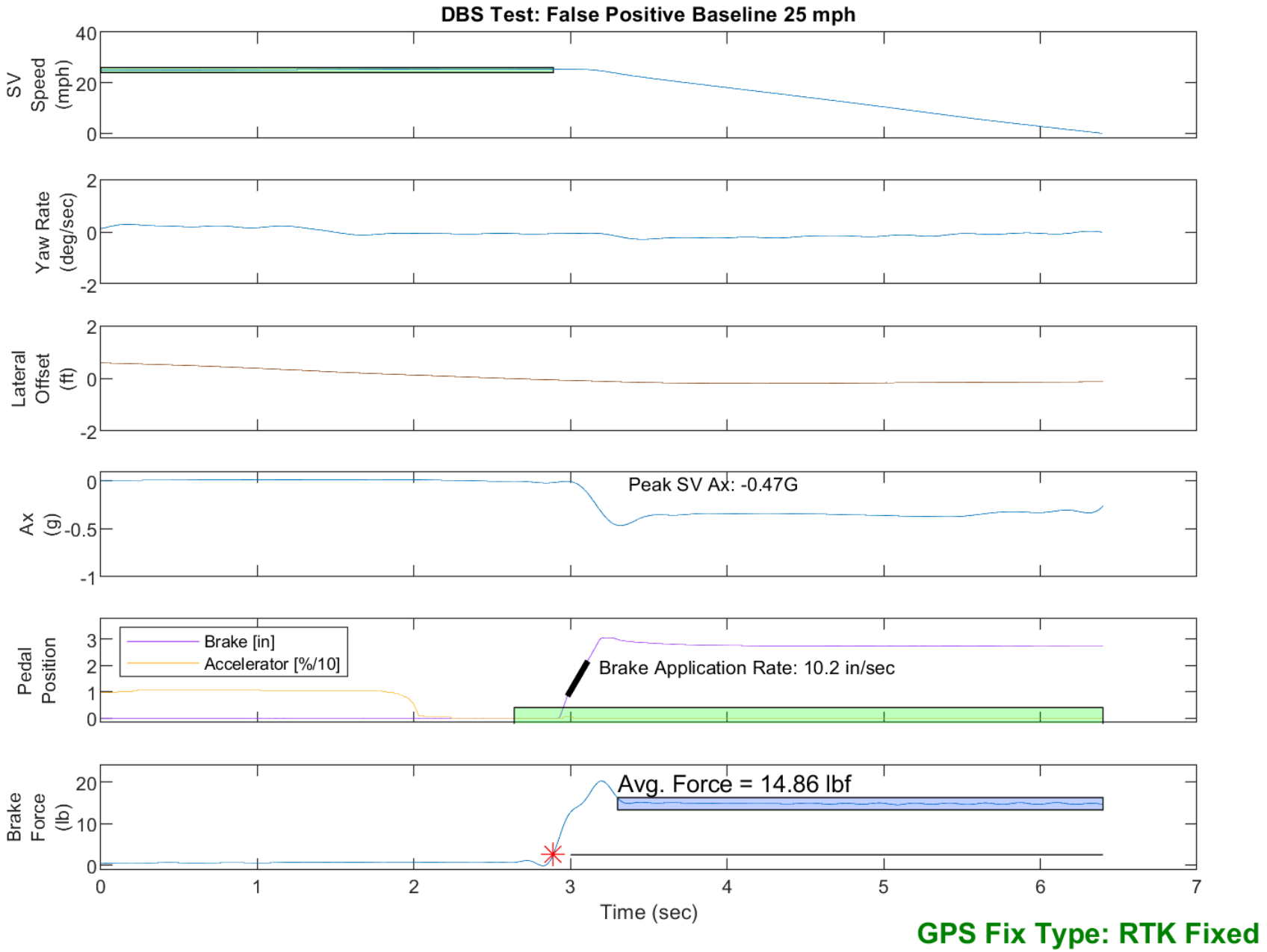


Figure E11. Example Time History Displaying Invalid Brake Force Criteria

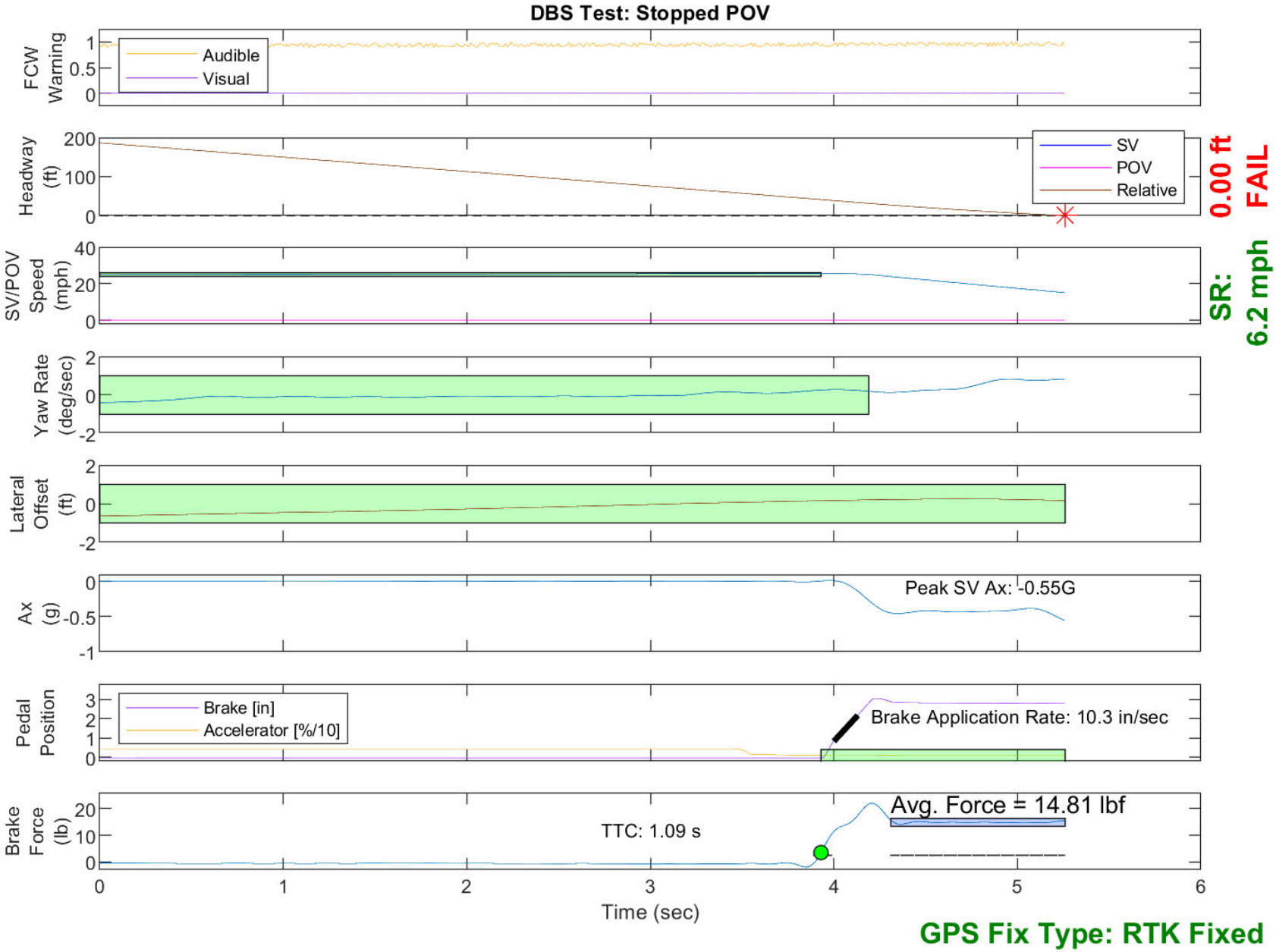


Figure E12. Example Time History for a Failed Run

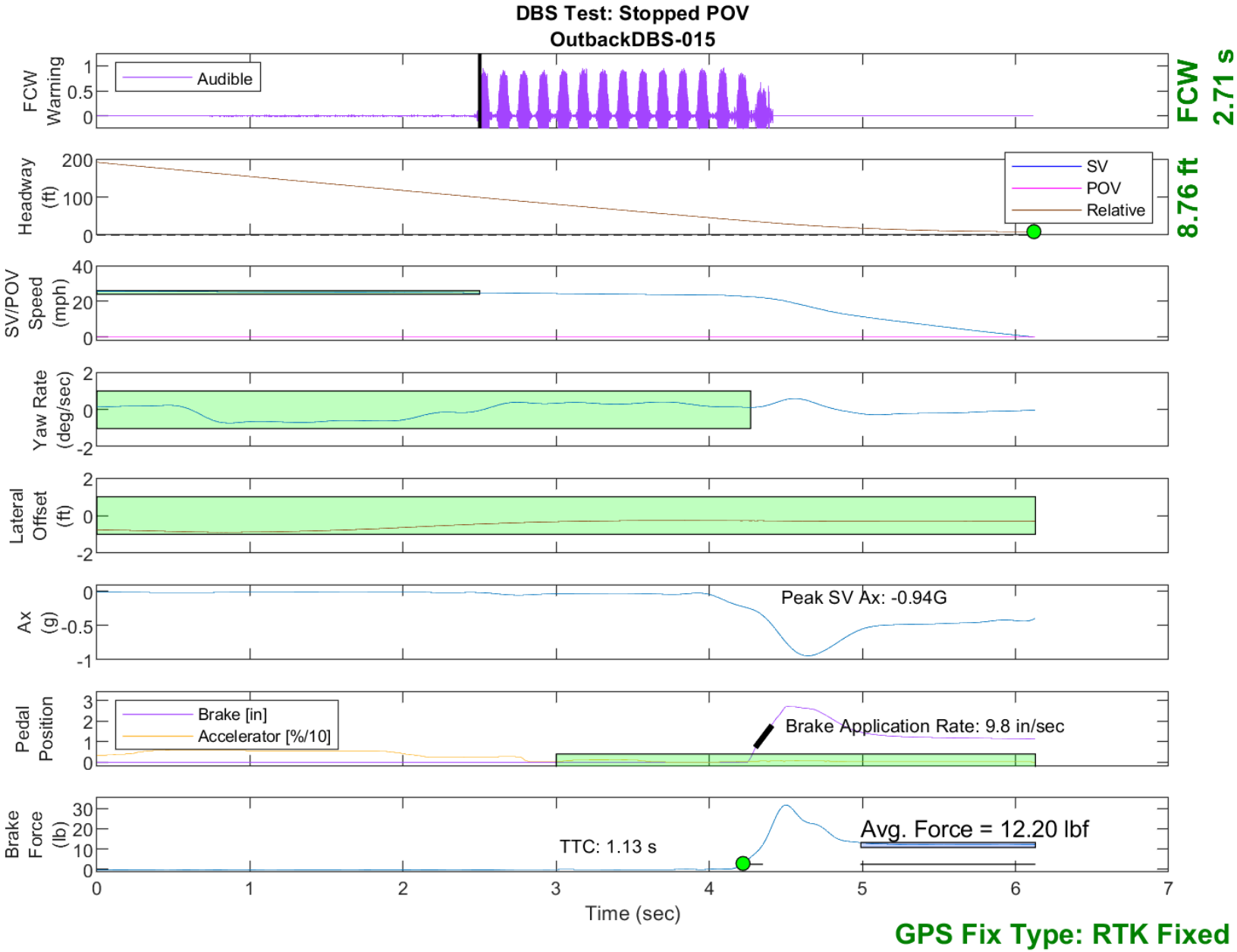


Figure E13. Time History for DBS Run 15, SV Encounters Stopped POV

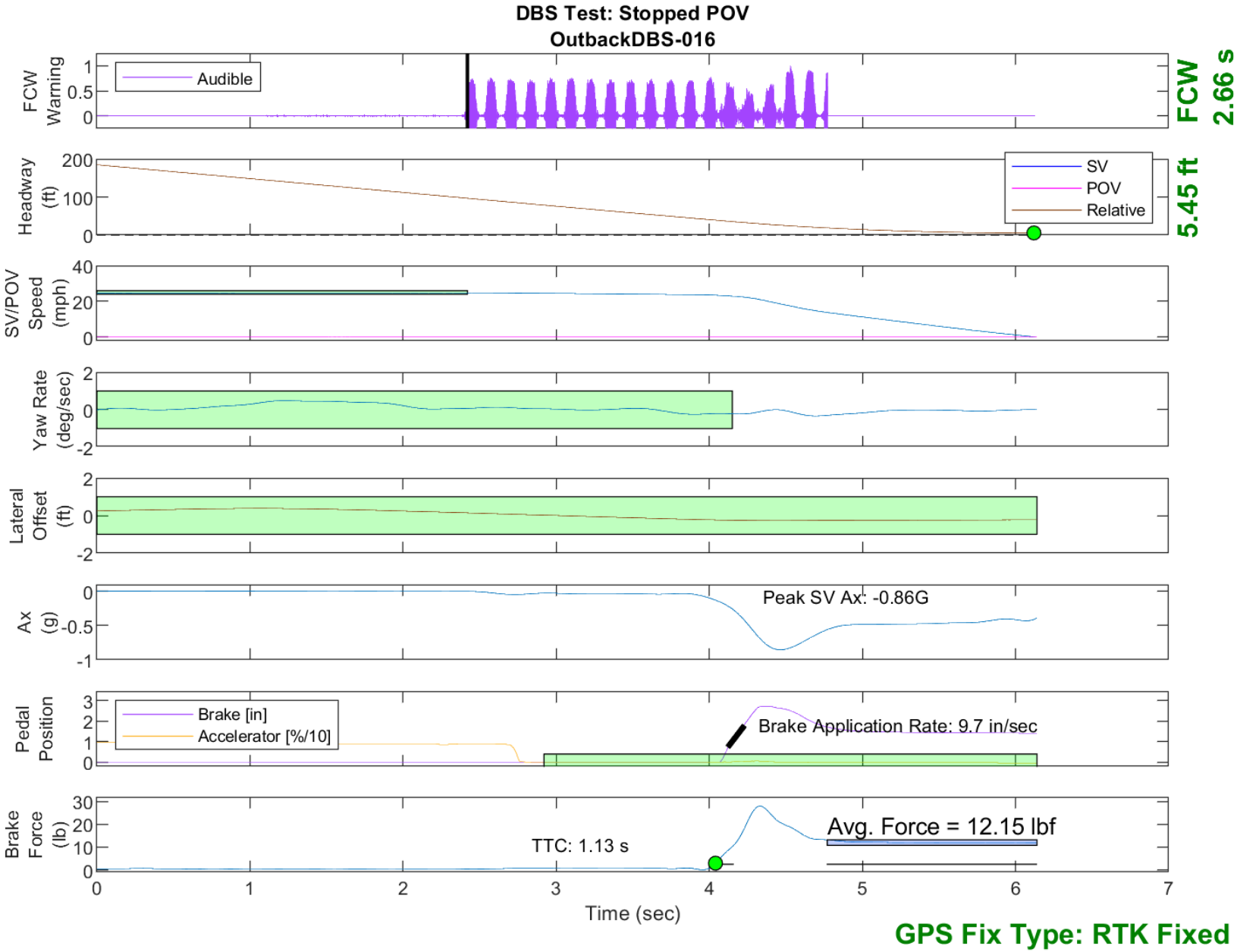


Figure E14. Time History for DBS Run 16, SV Encounters Stopped POV

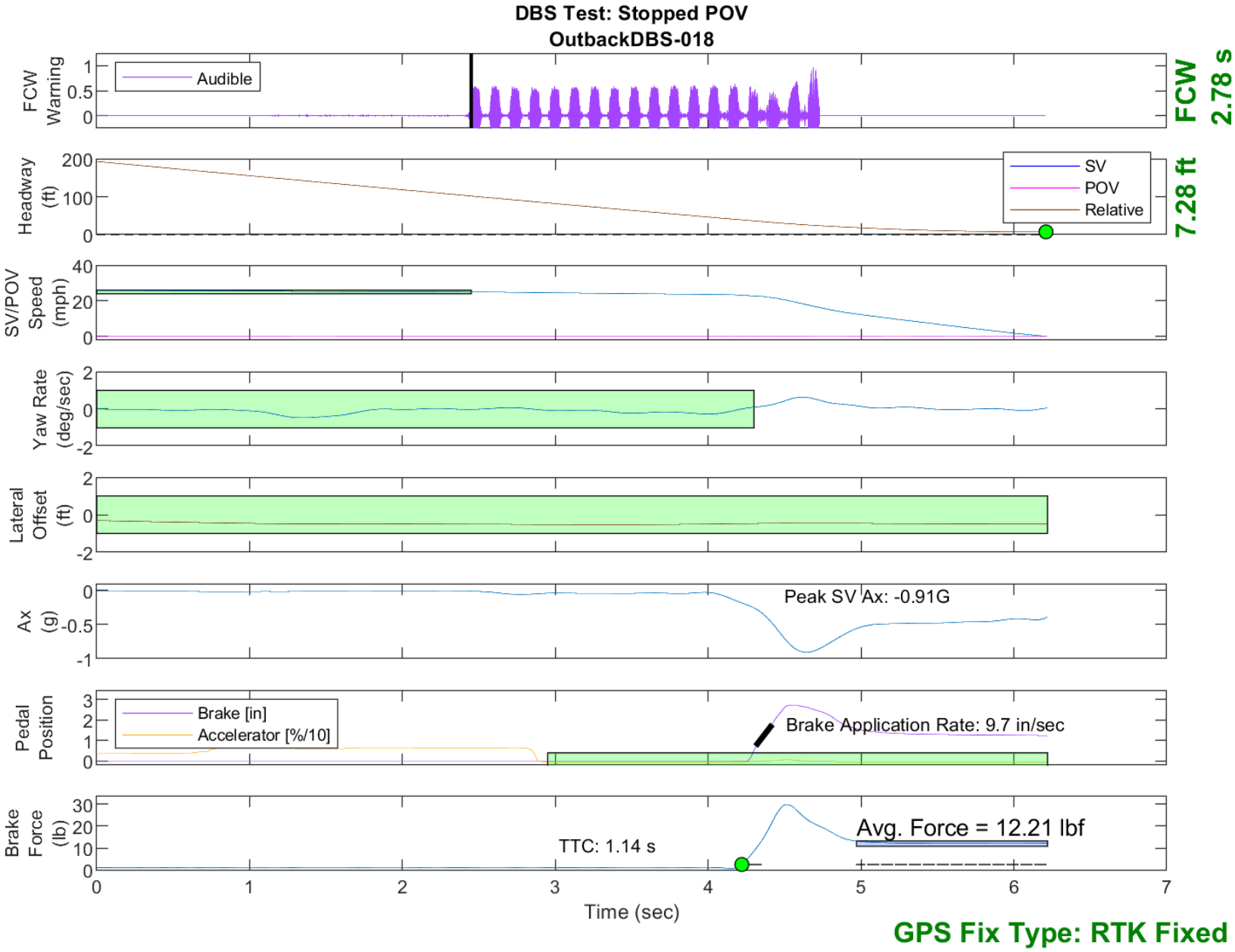


Figure E15. Time History for DBS Run 18, SV Encounters Stopped POV

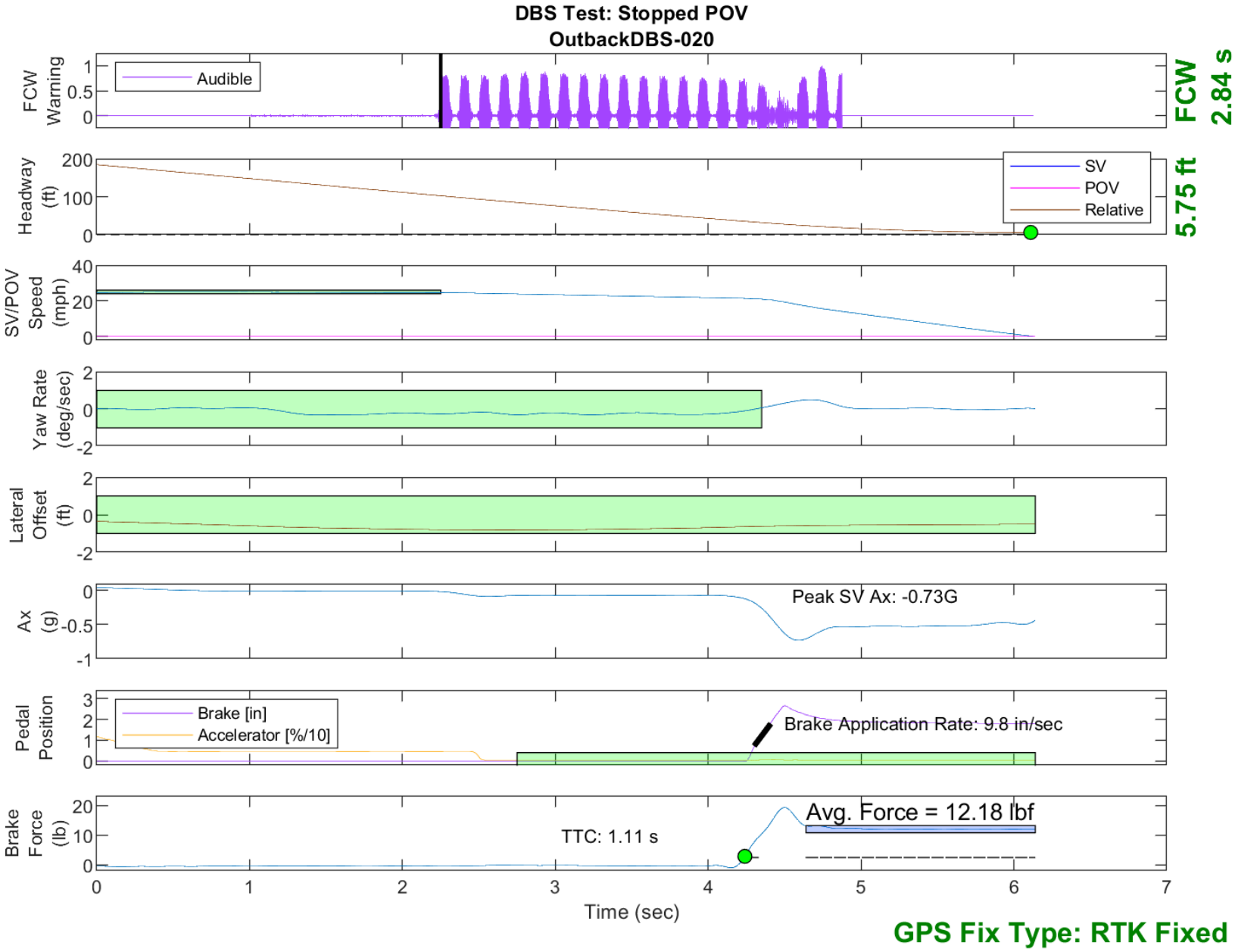


Figure E16. Time History for DBS Run 20, SV Encounters Stopped POV

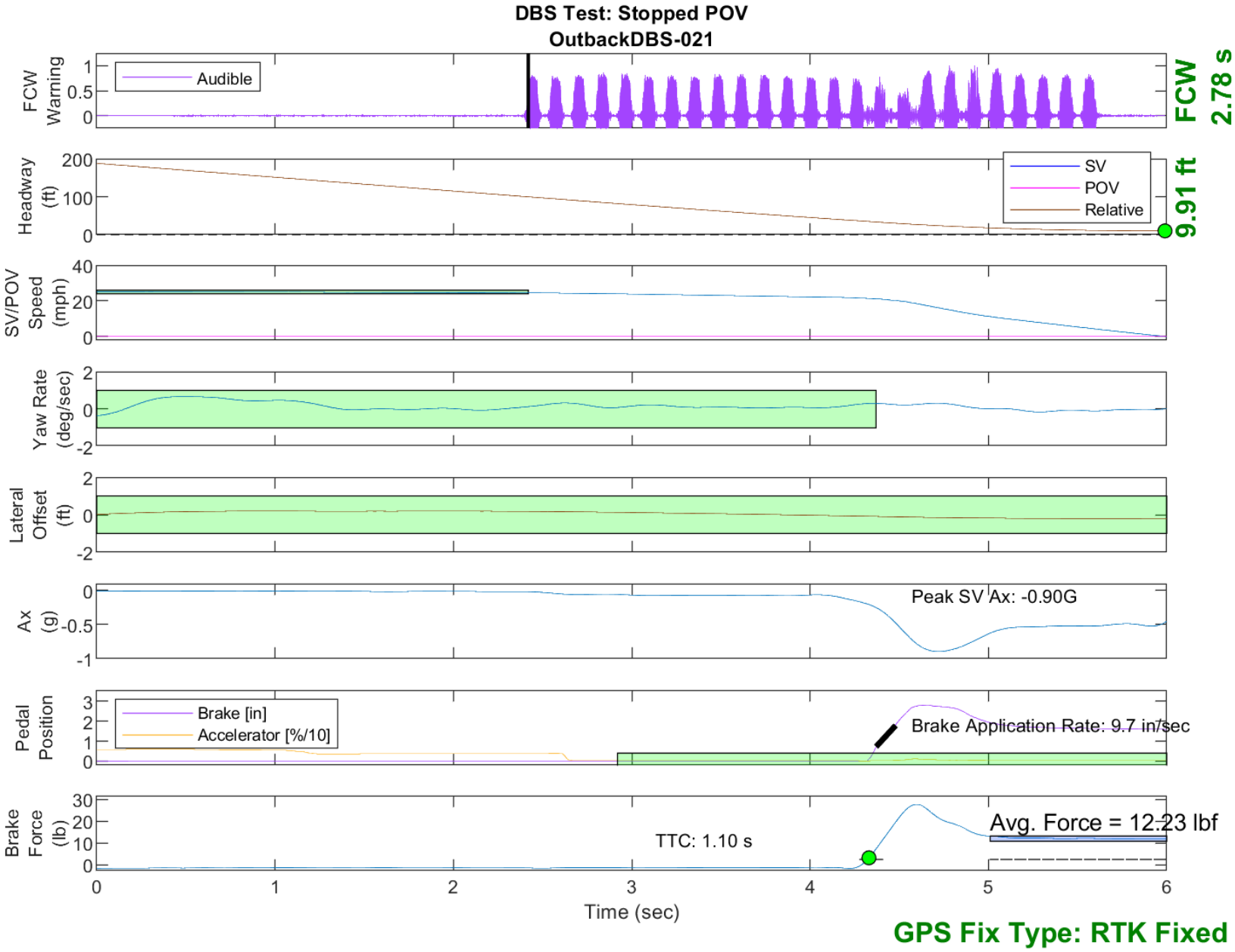


Figure E17. Time History for DBS Run 21, SV Encounters Stopped POV

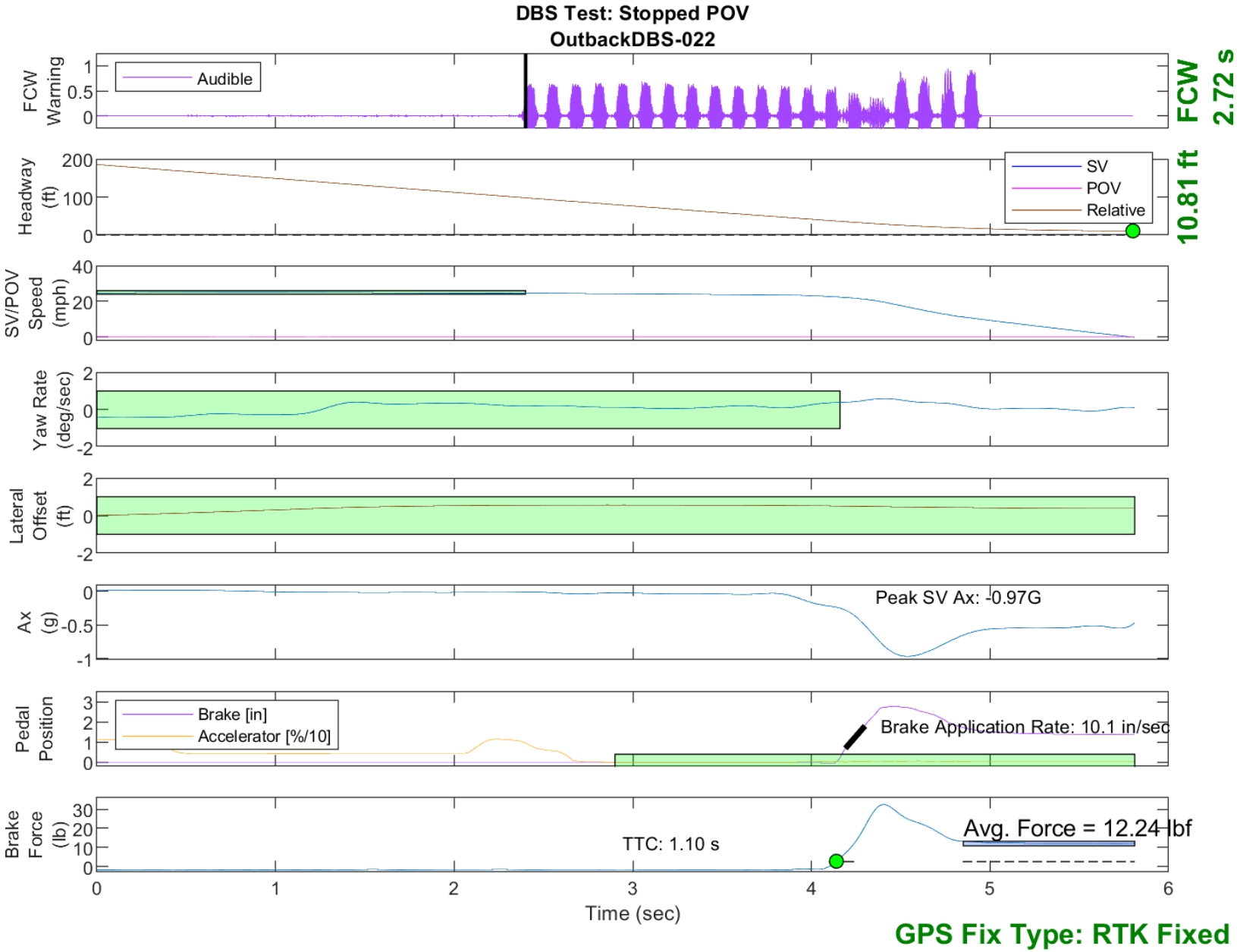


Figure E18. Time History for DBS Run 22, SV Encounters Stopped POV

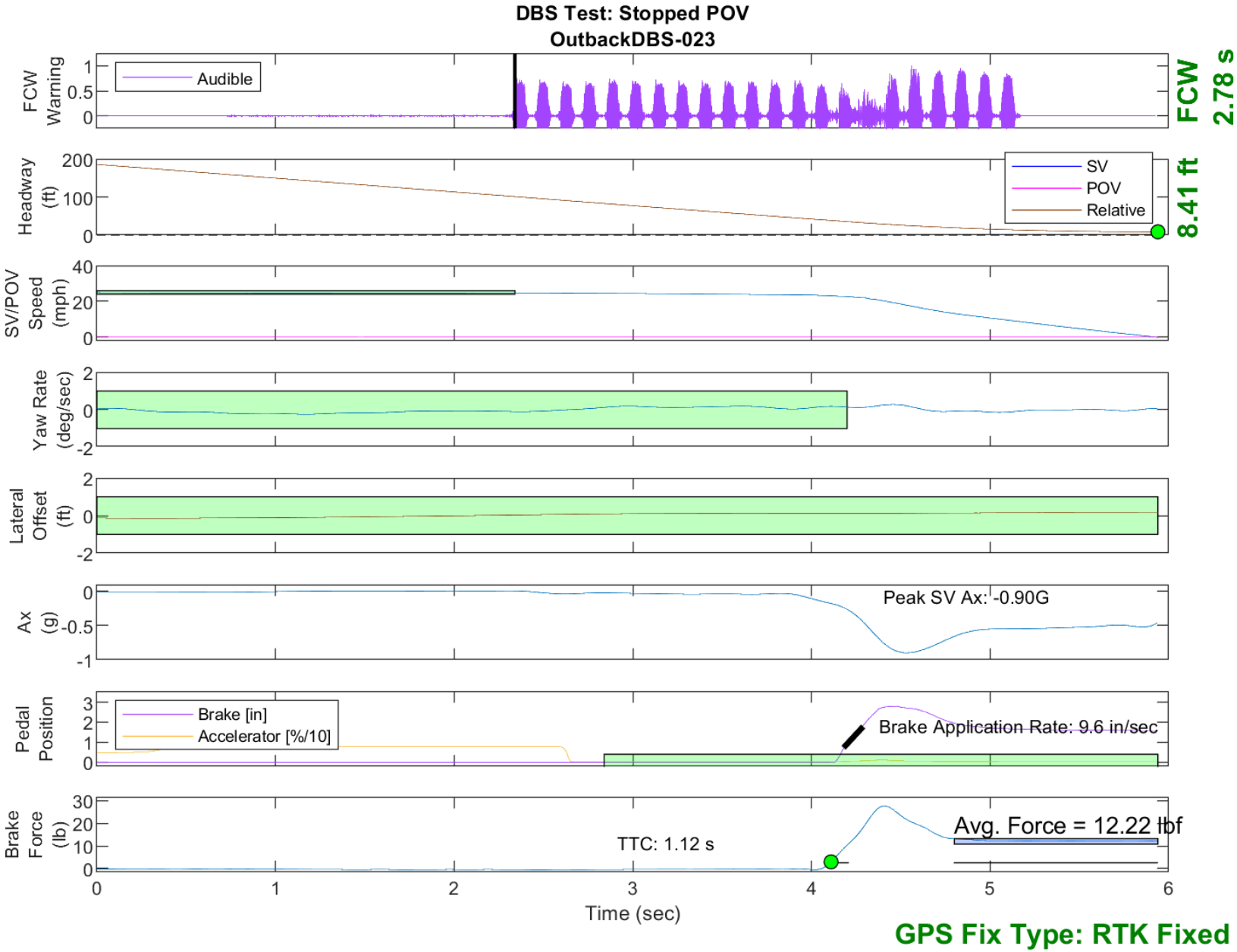


Figure E19. Time History for DBS Run 23, SV Encounters Stopped POV

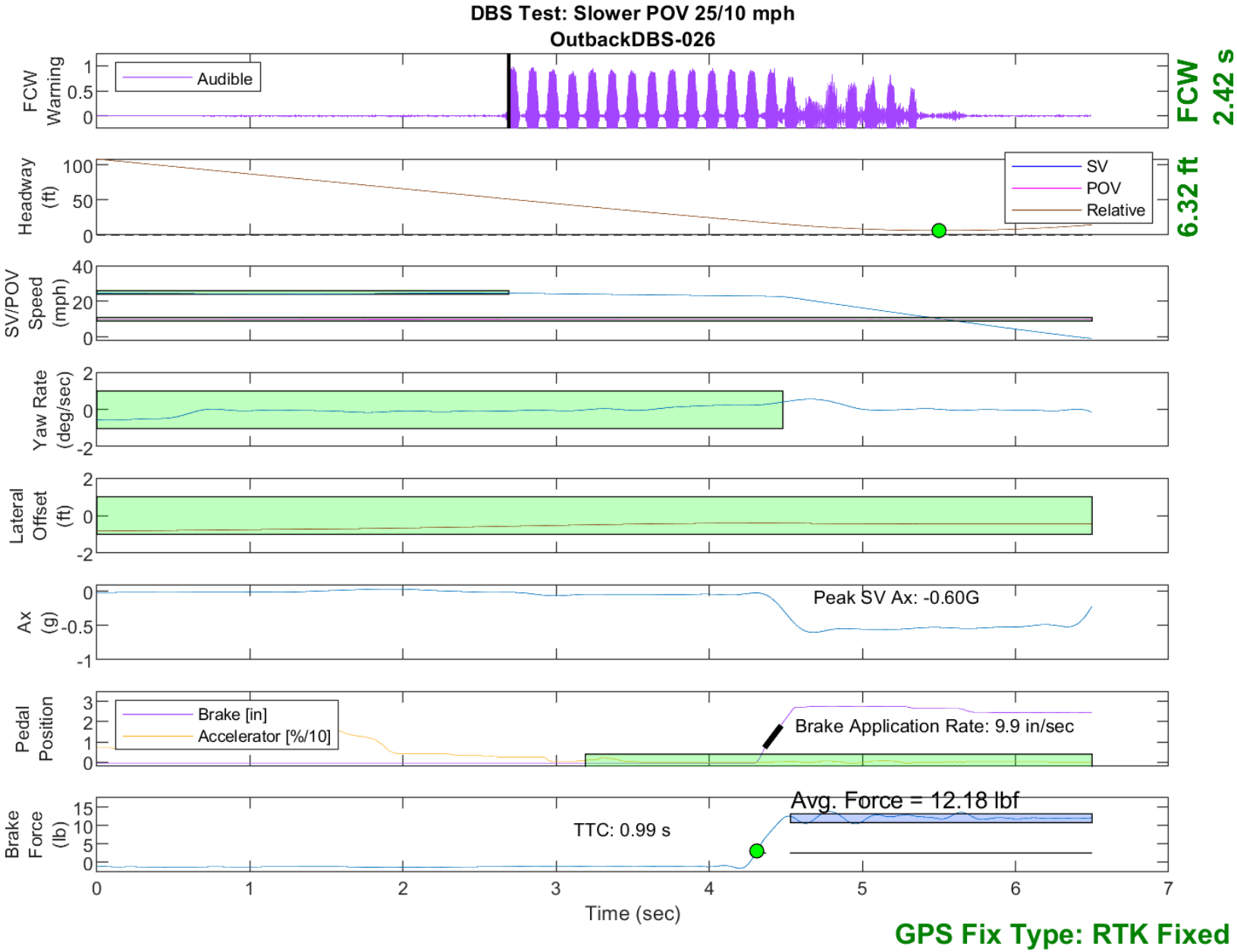


Figure E20. Time History for DBS Run 26, SV Encounters Slower POV, SV 25 mph, POV 10 mph

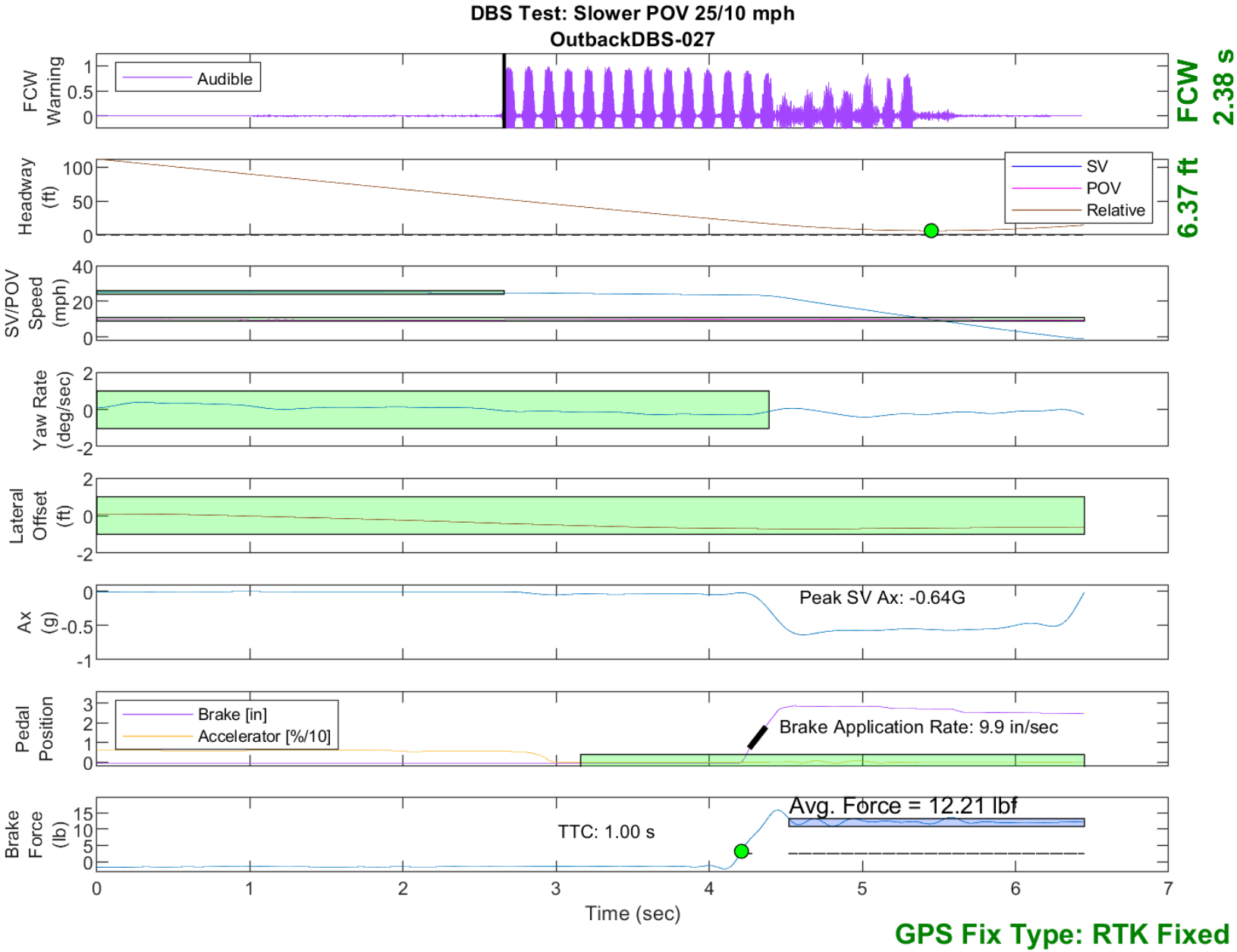


Figure E21. Time History for DBS Run 27, SV Encounters Slower POV, SV 25 mph, POV 10 mph

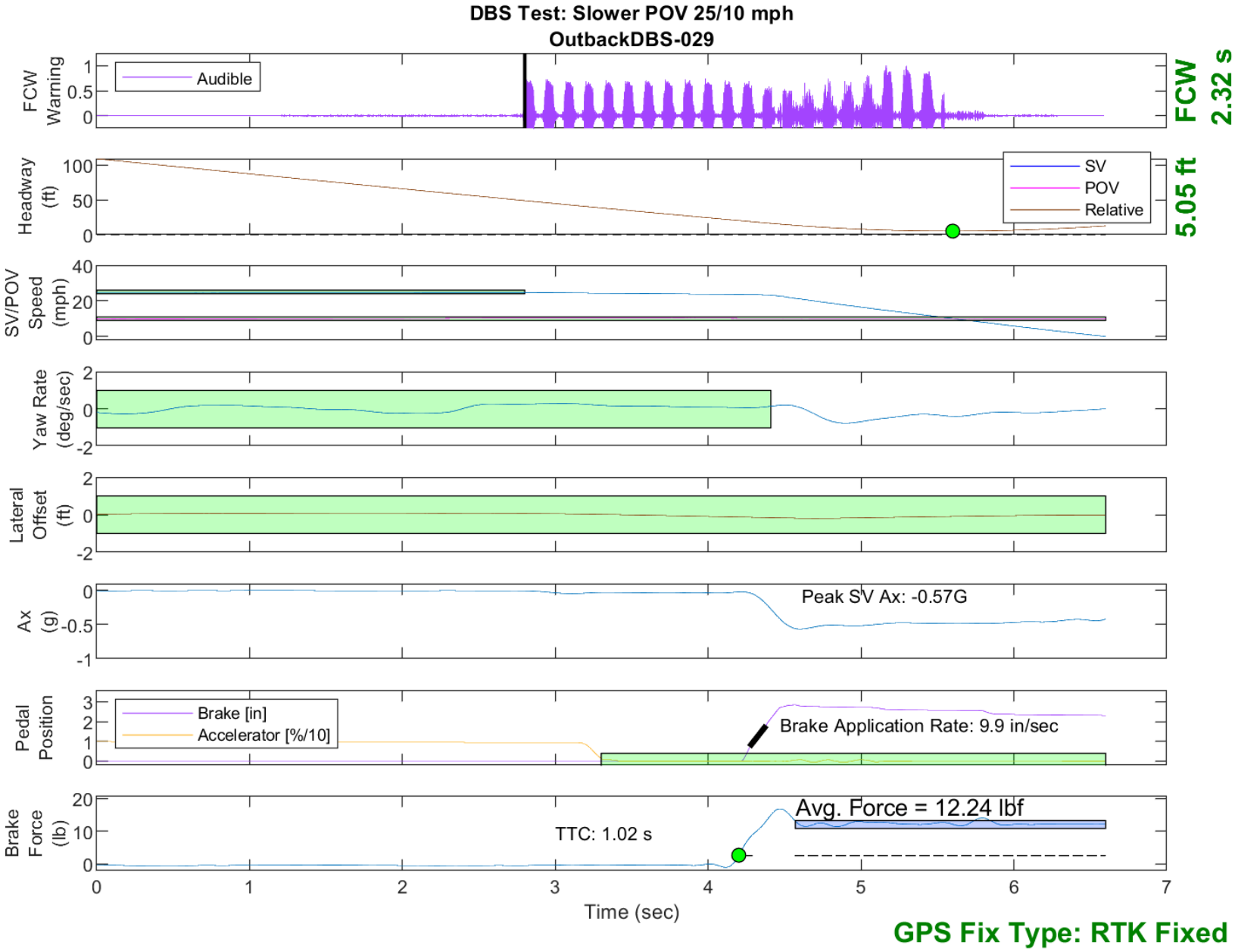


Figure E22. Time History for DBS Run 29, SV Encounters Slower POV, SV 25 mph, POV 10 mph

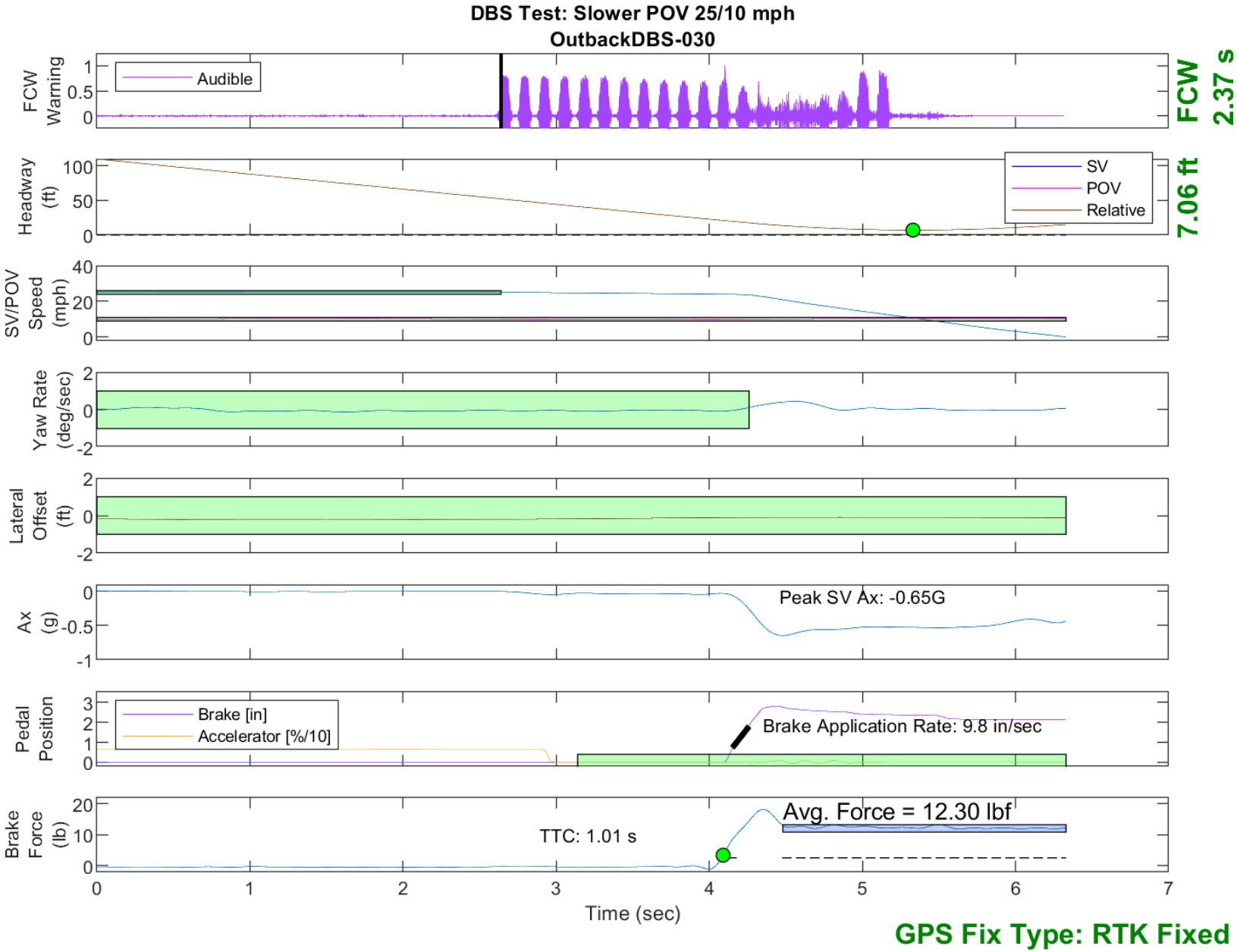


Figure E23. Time History for DBS Run 30, SV Encounters Slower POV, SV 25 mph, POV 10 mph

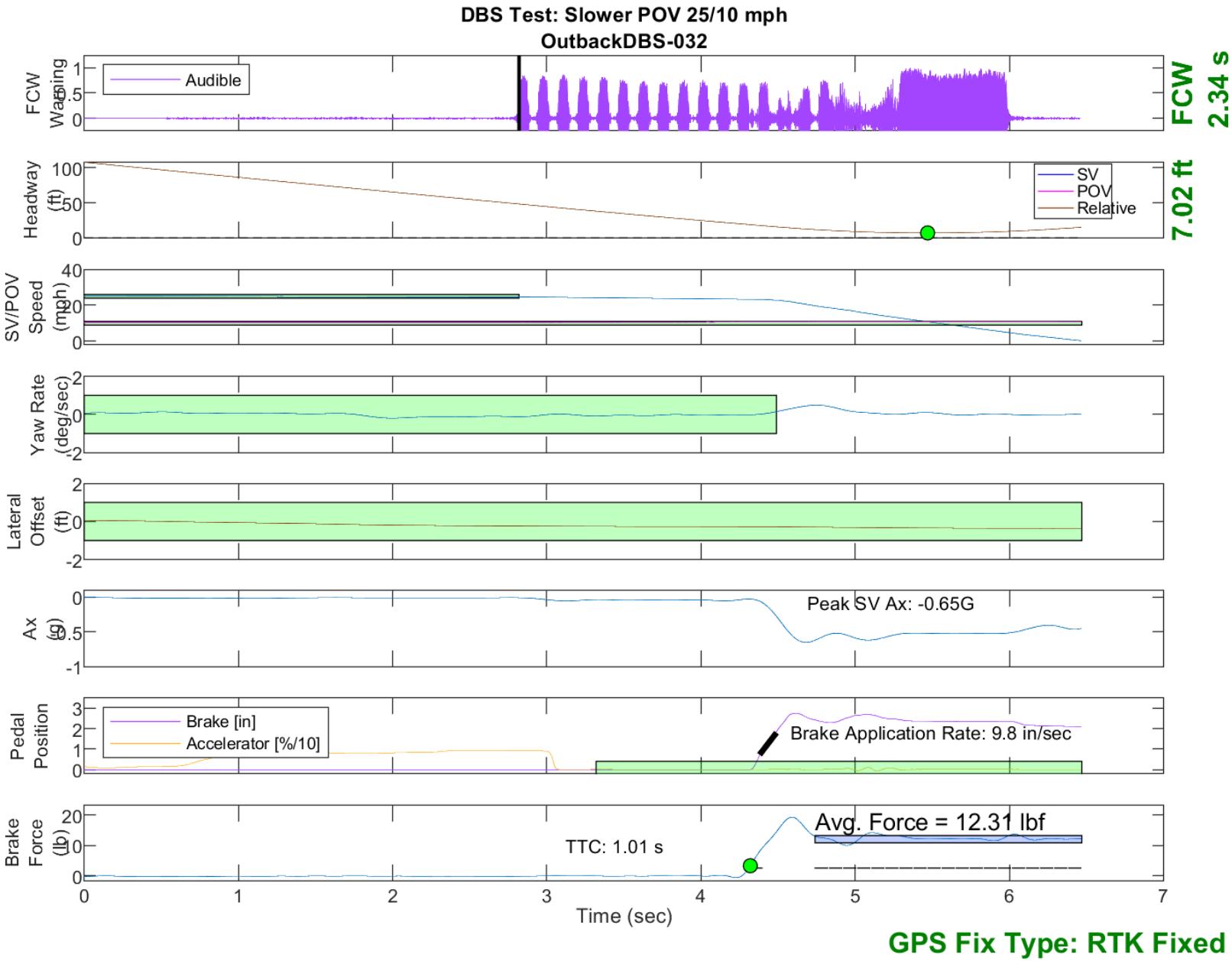


Figure E24. Time History for DBS Run 32, SV Encounters Slower POV, SV 25 mph, POV 10 mph

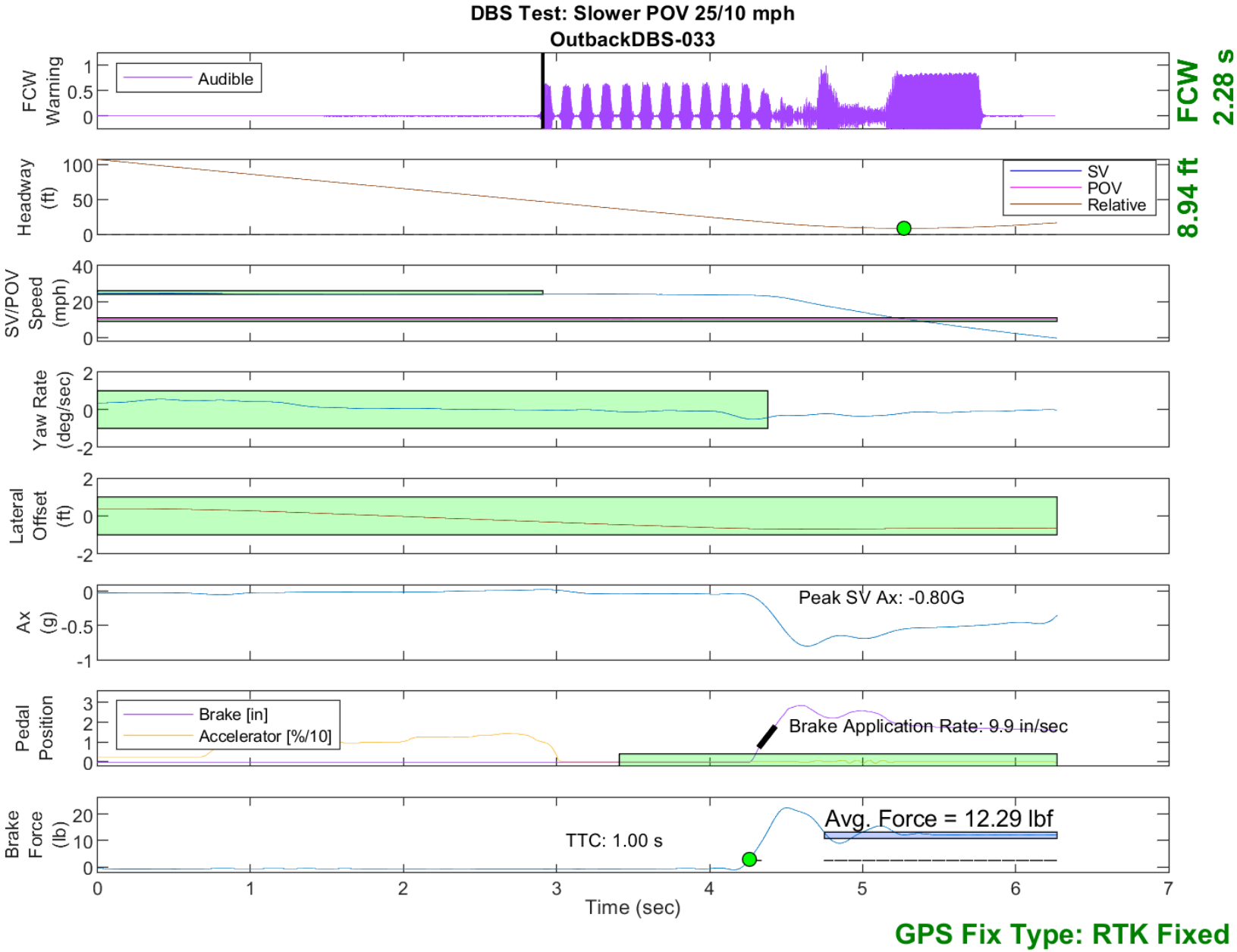


Figure E25. Time History for DBS Run 33, SV Encounters Slower POV, SV 25 mph, POV 10 mph

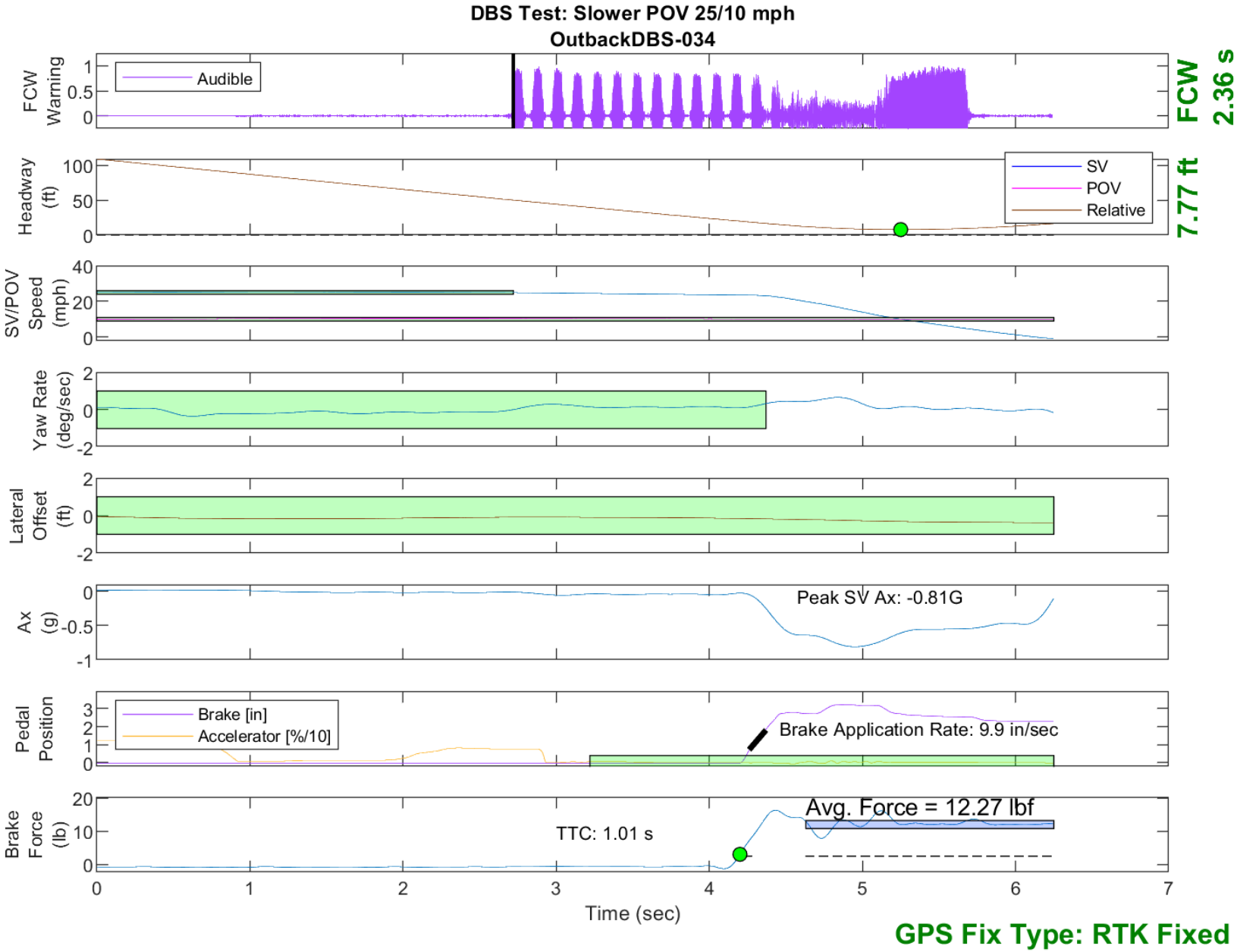


Figure E26. Time History for DBS Run 34, SV Encounters Slower POV, SV 25 mph, POV 10 mph

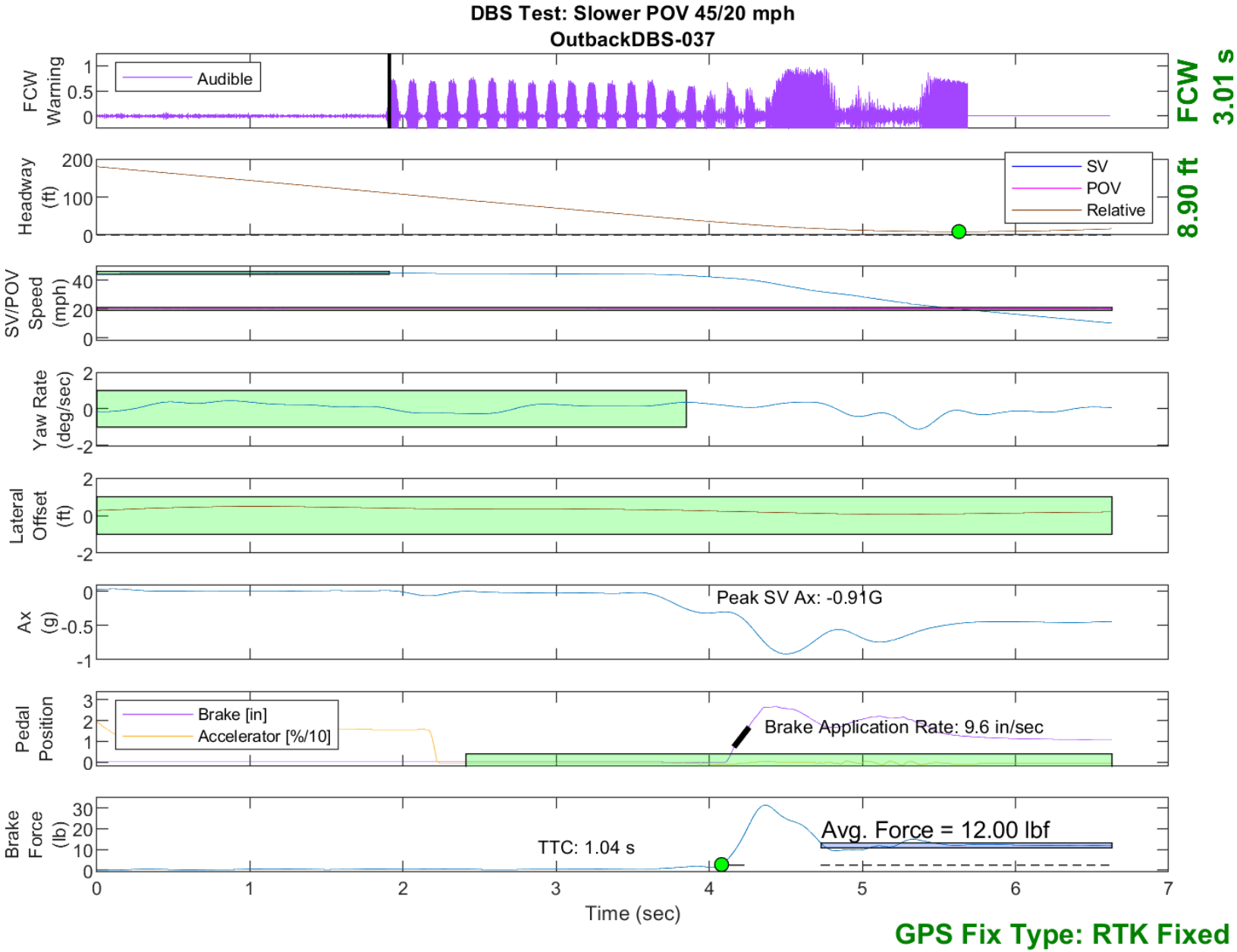


Figure E27. Time History for DBS Run 37, SV Encounters Slower POV, SV 45 mph, POV 20 mph

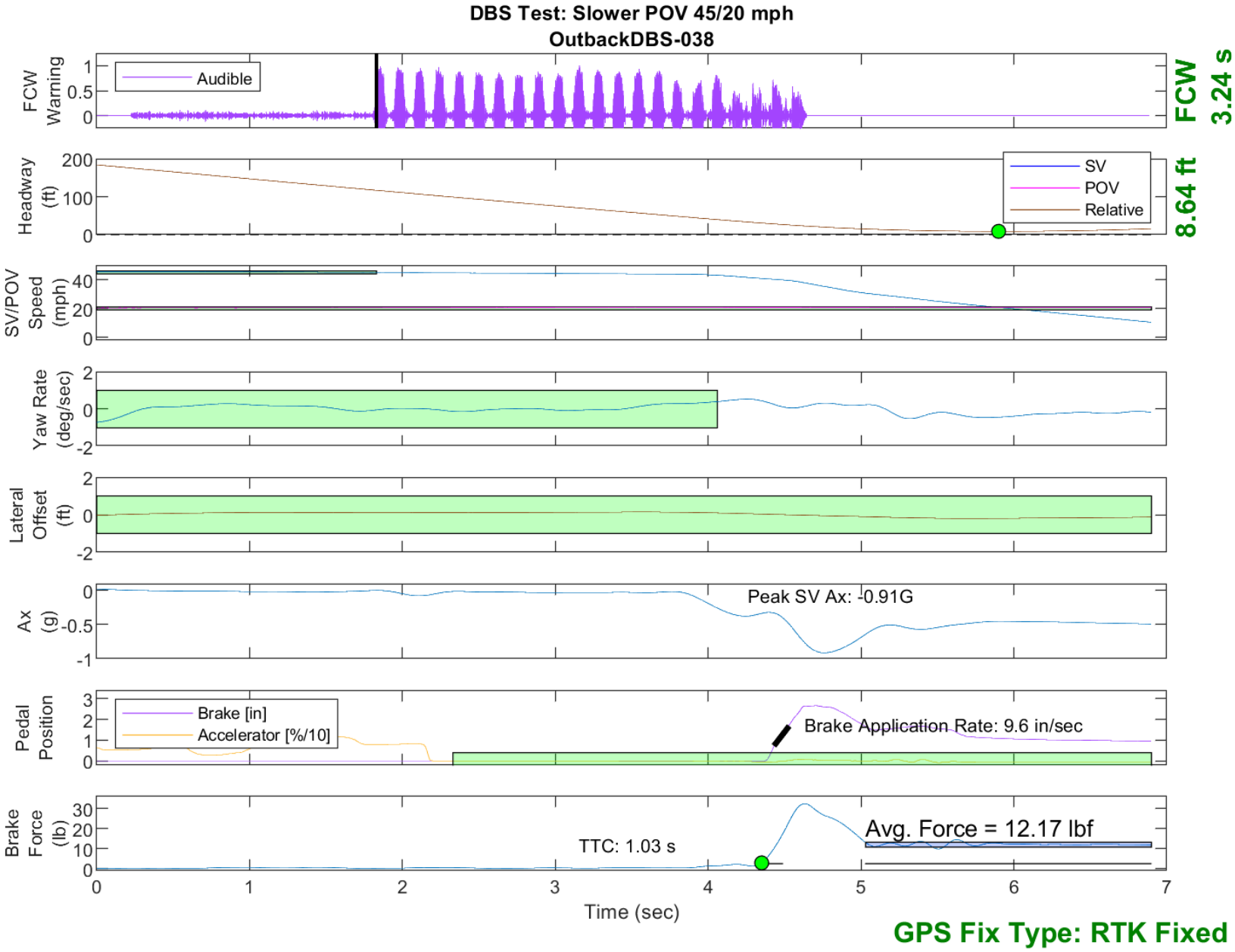


Figure E28. Time History for DBS Run 38, SV Encounters Slower POV, SV 45 mph, POV 20 mph

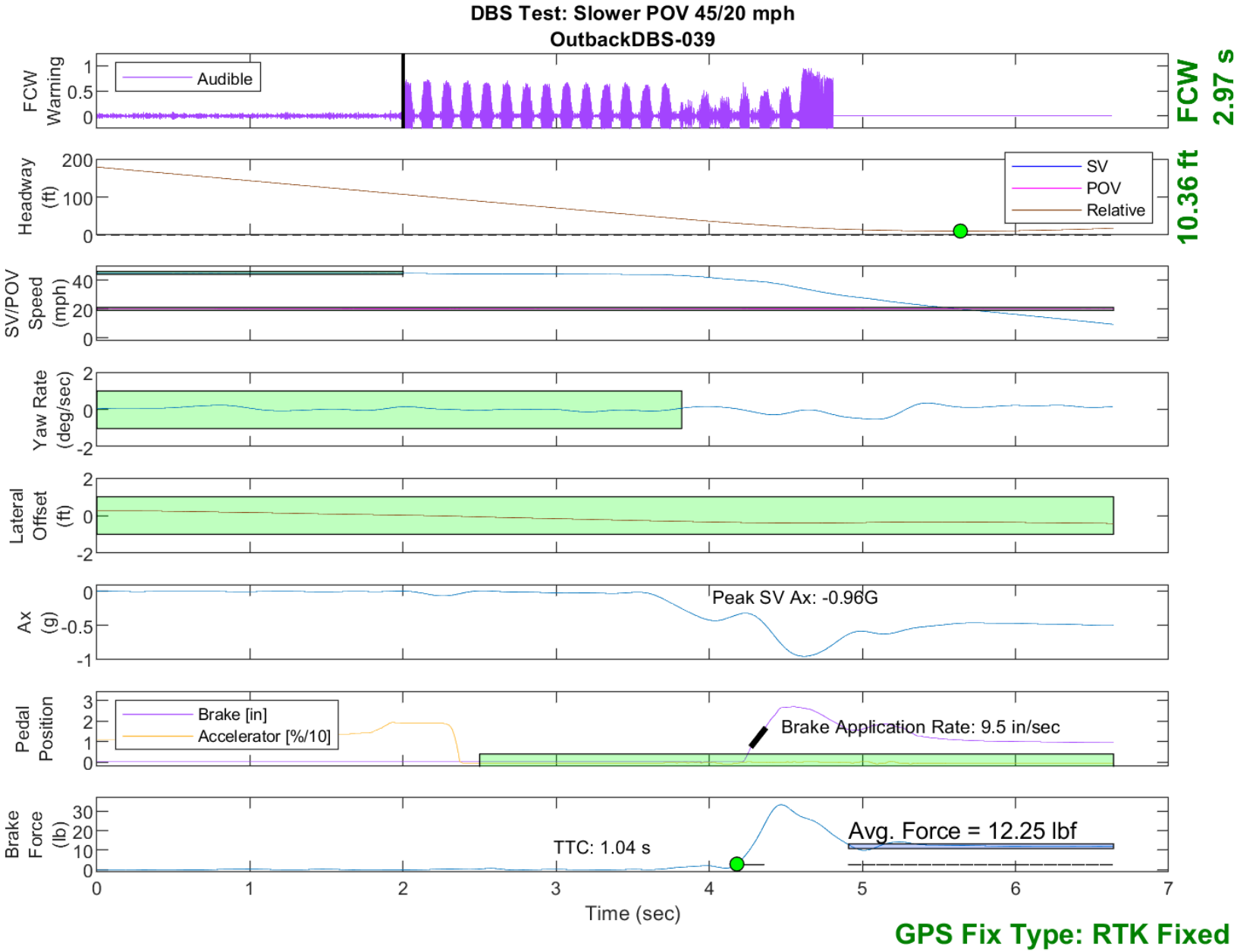


Figure E29. Time History for DBS Run 39, SV Encounters Slower POV, SV 45 mph, POV 20 mph

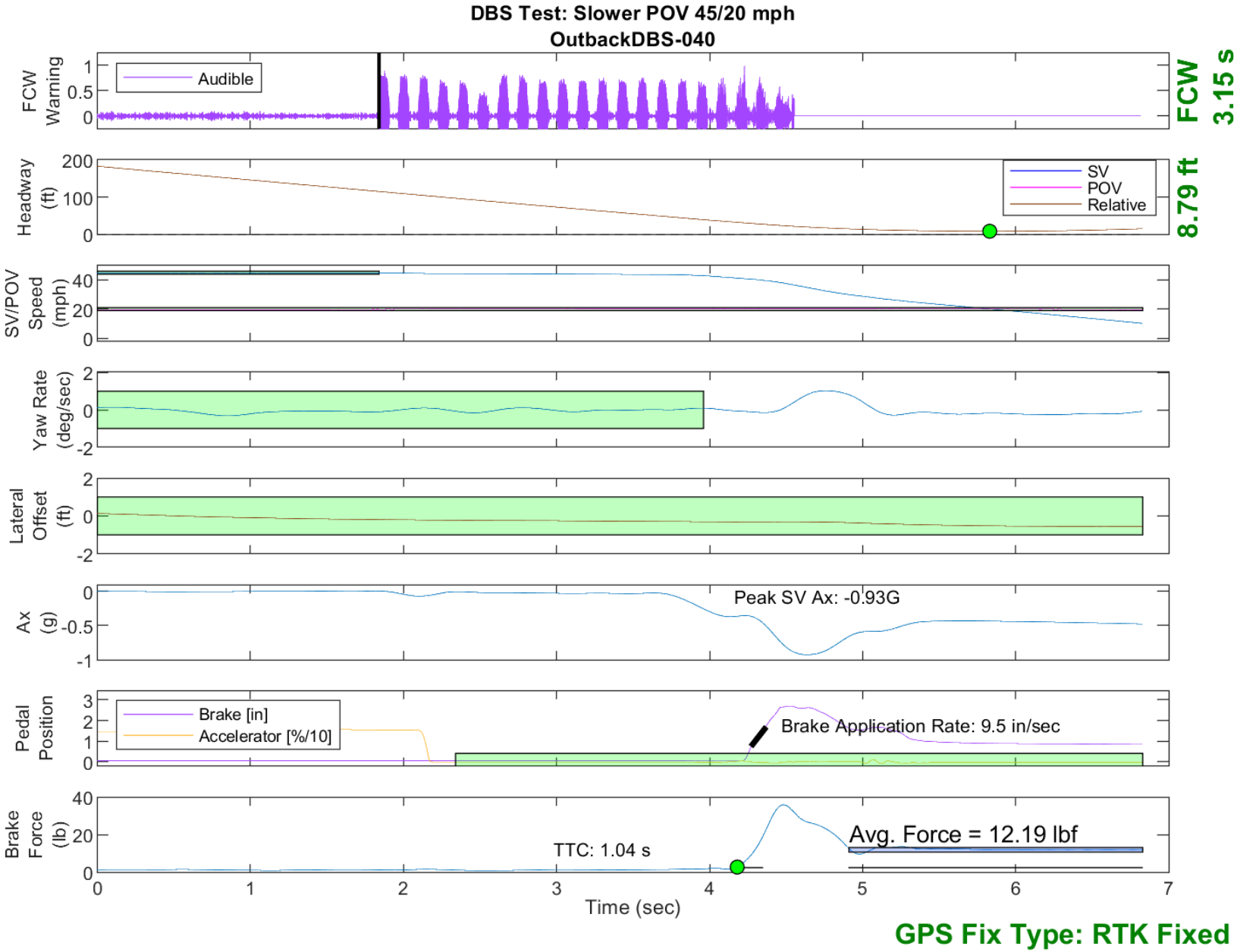


Figure E30. Time History for DBS Run 40, SV Encounters Slower POV, SV 45 mph, POV 20 mph

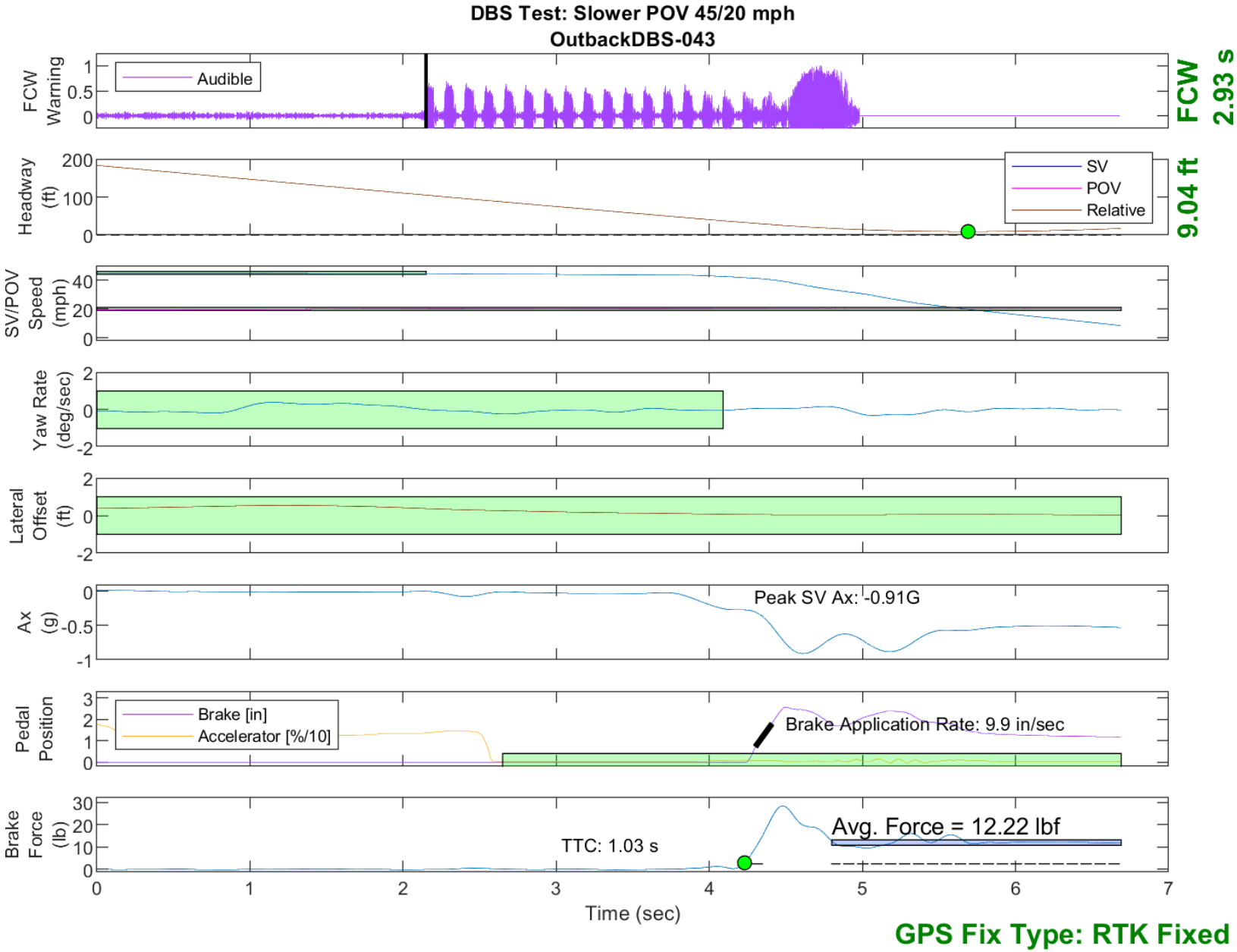


Figure E31. Time History for DBS Run 43, SV Encounters Slower POV, SV 45 mph, POV 20 mph

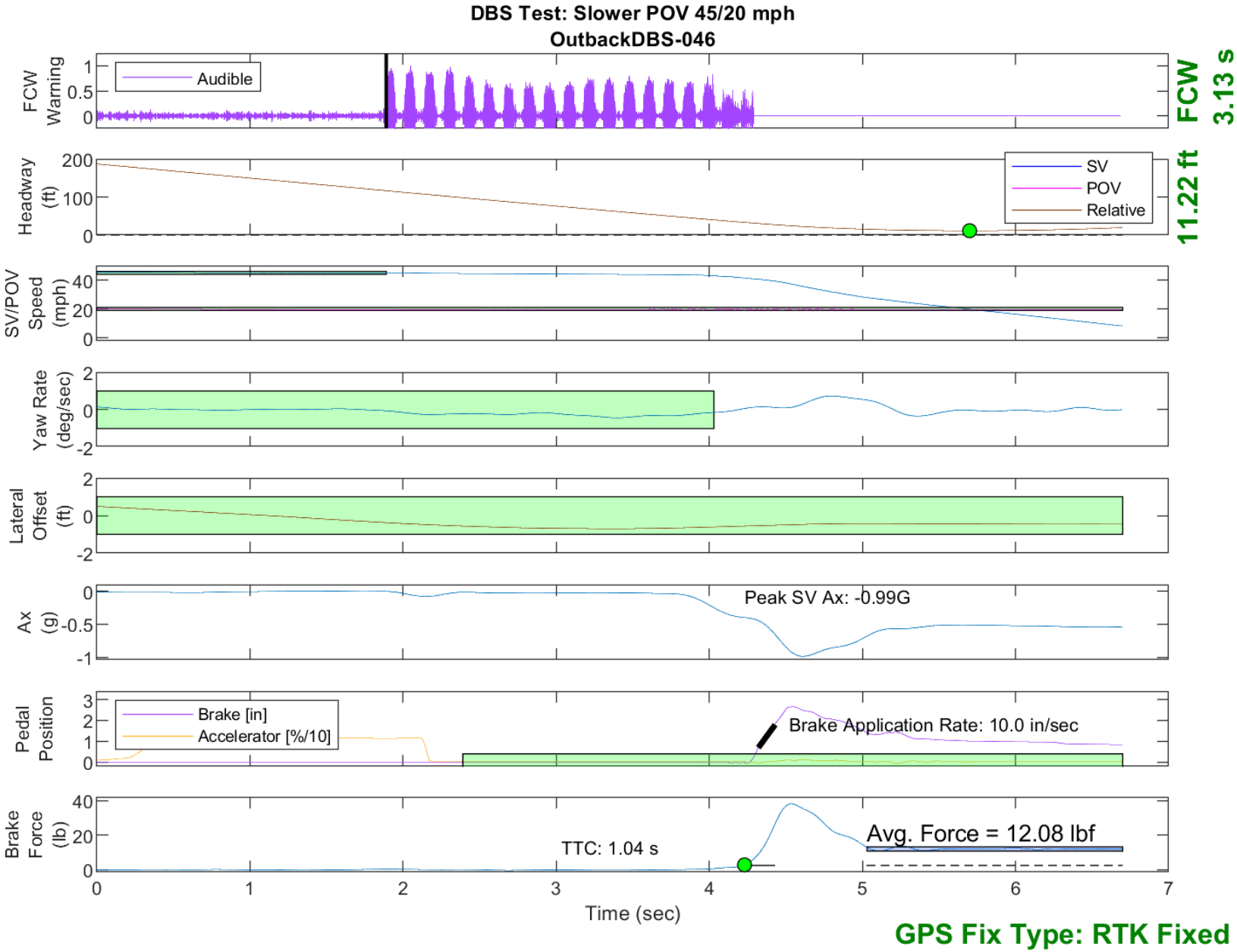


Figure E32. Time History for DBS Run 46, SV Encounters Slower POV, SV 45 mph, POV 20 mph

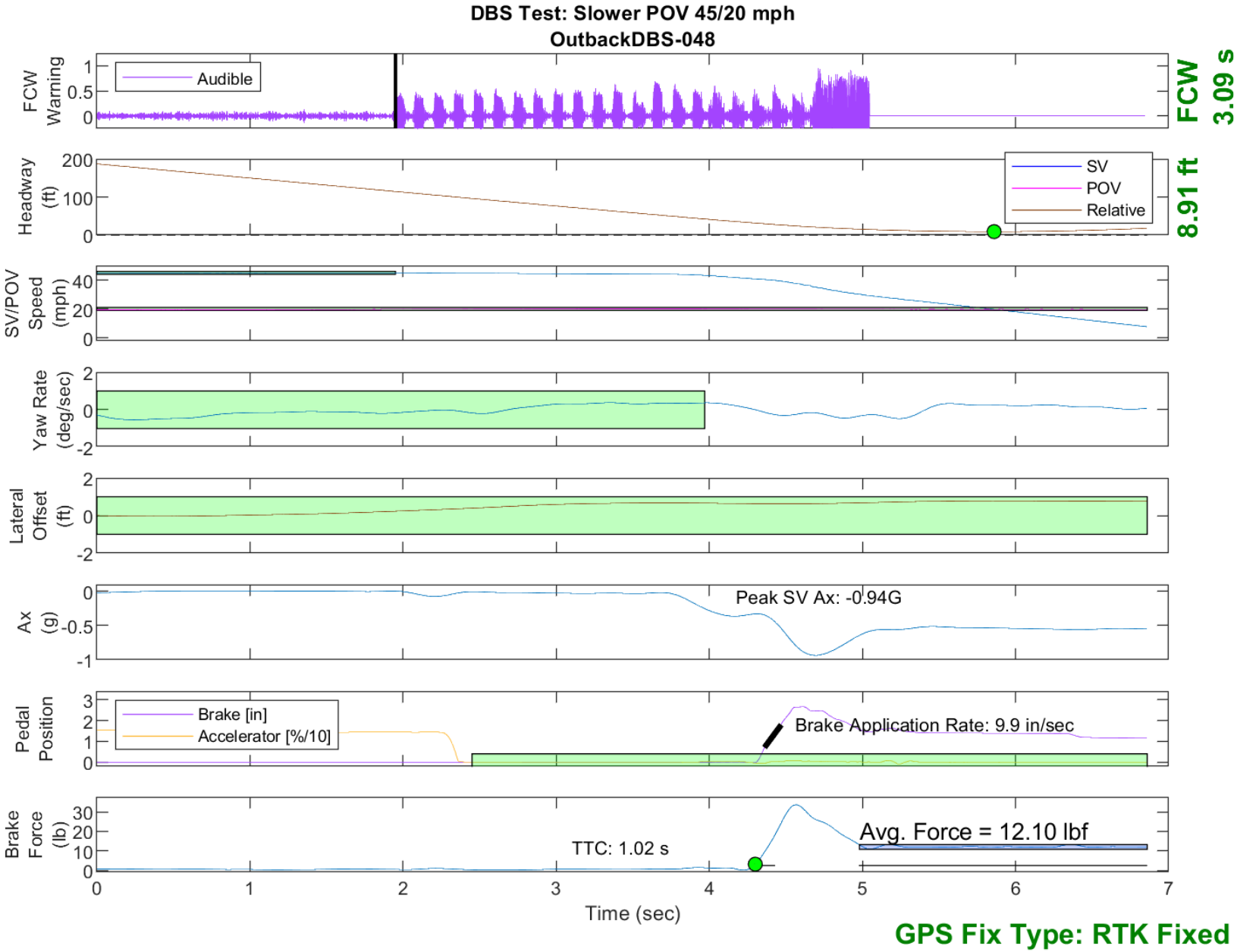


Figure E33. Time History for DBS Run 48, SV Encounters Slower POV, SV 45 mph, POV 20 mph

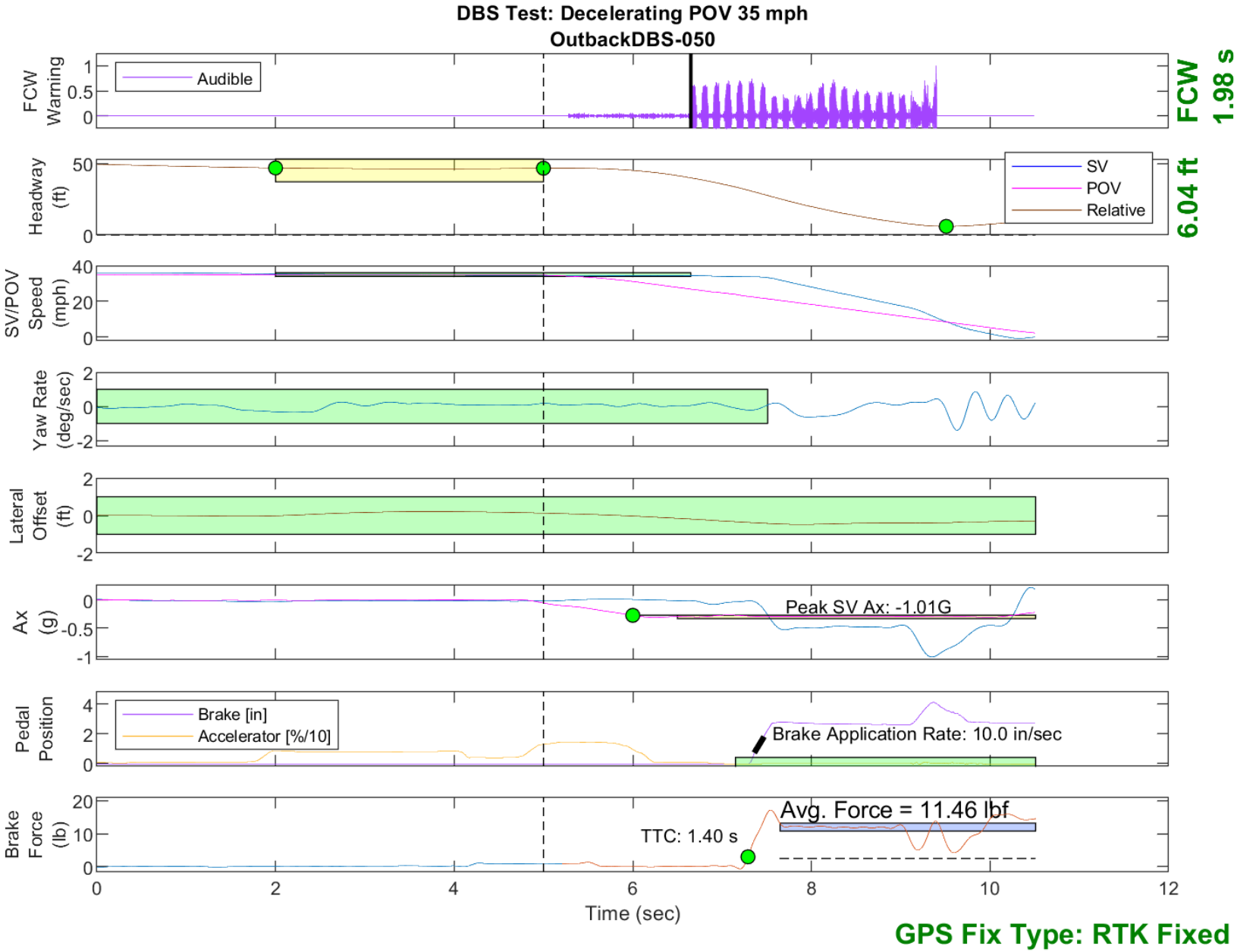


Figure E34. Time History for DBS Run 50, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

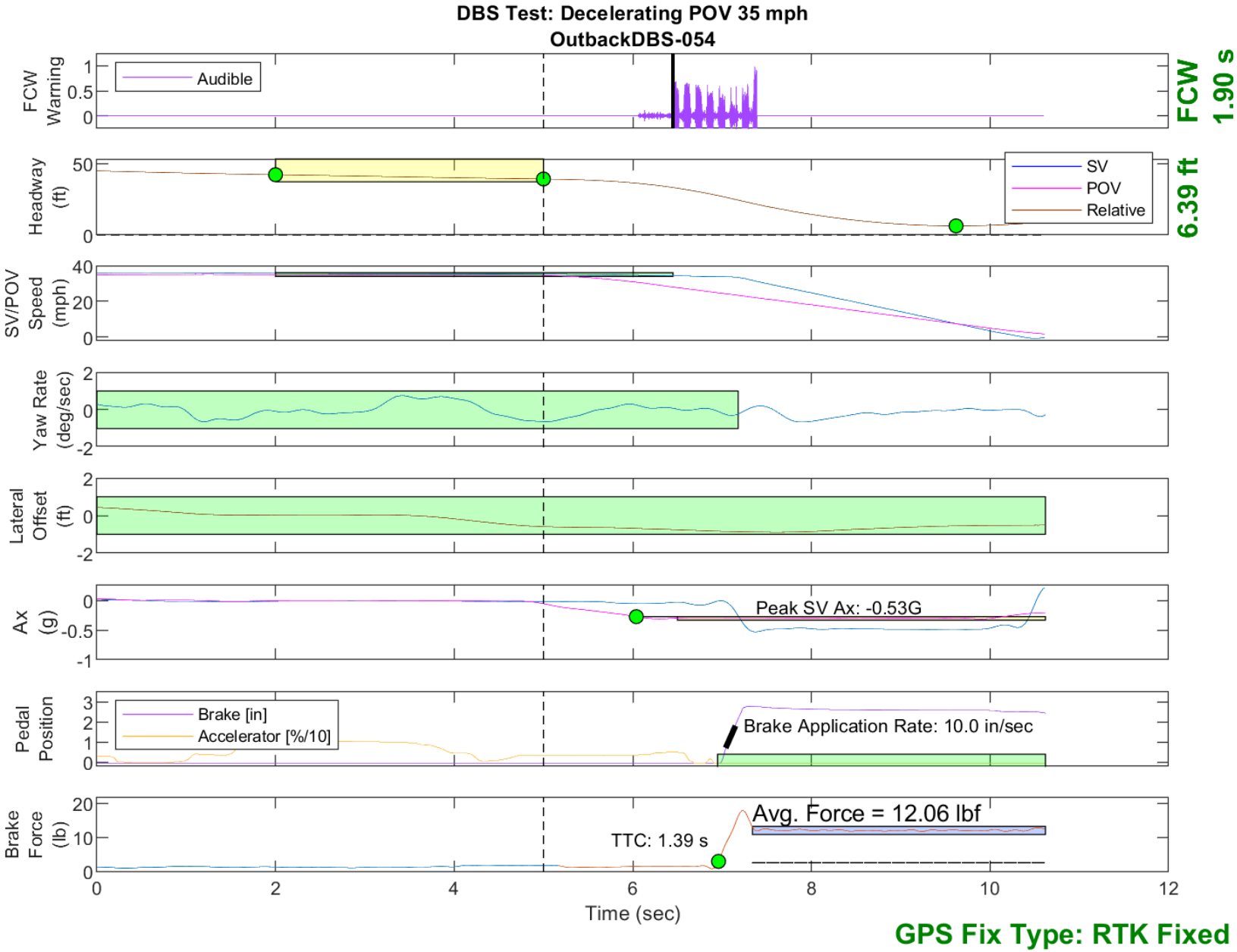


Figure E35. Time History for DBS Run 54, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

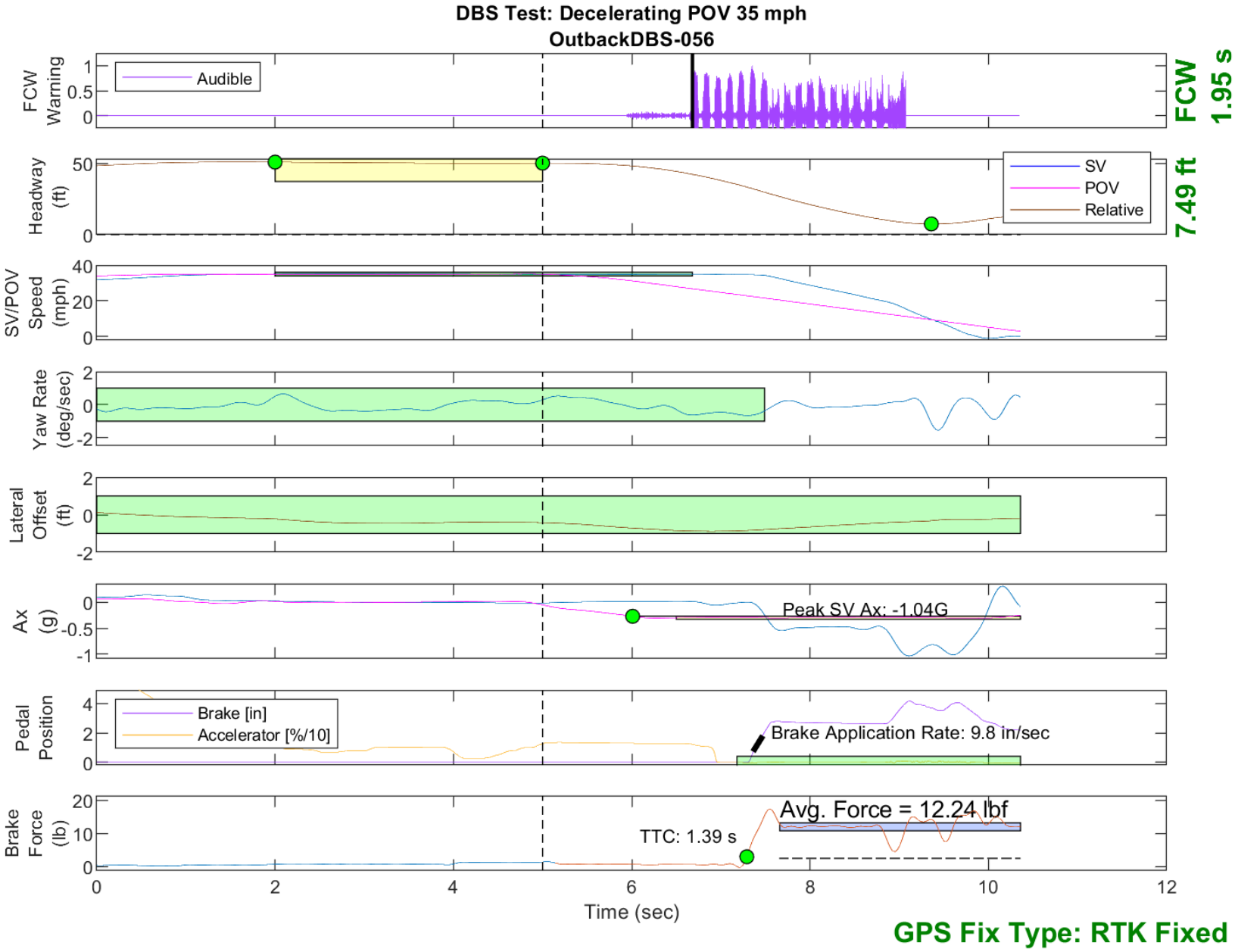


Figure E36. Time History for DBS Run 56, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

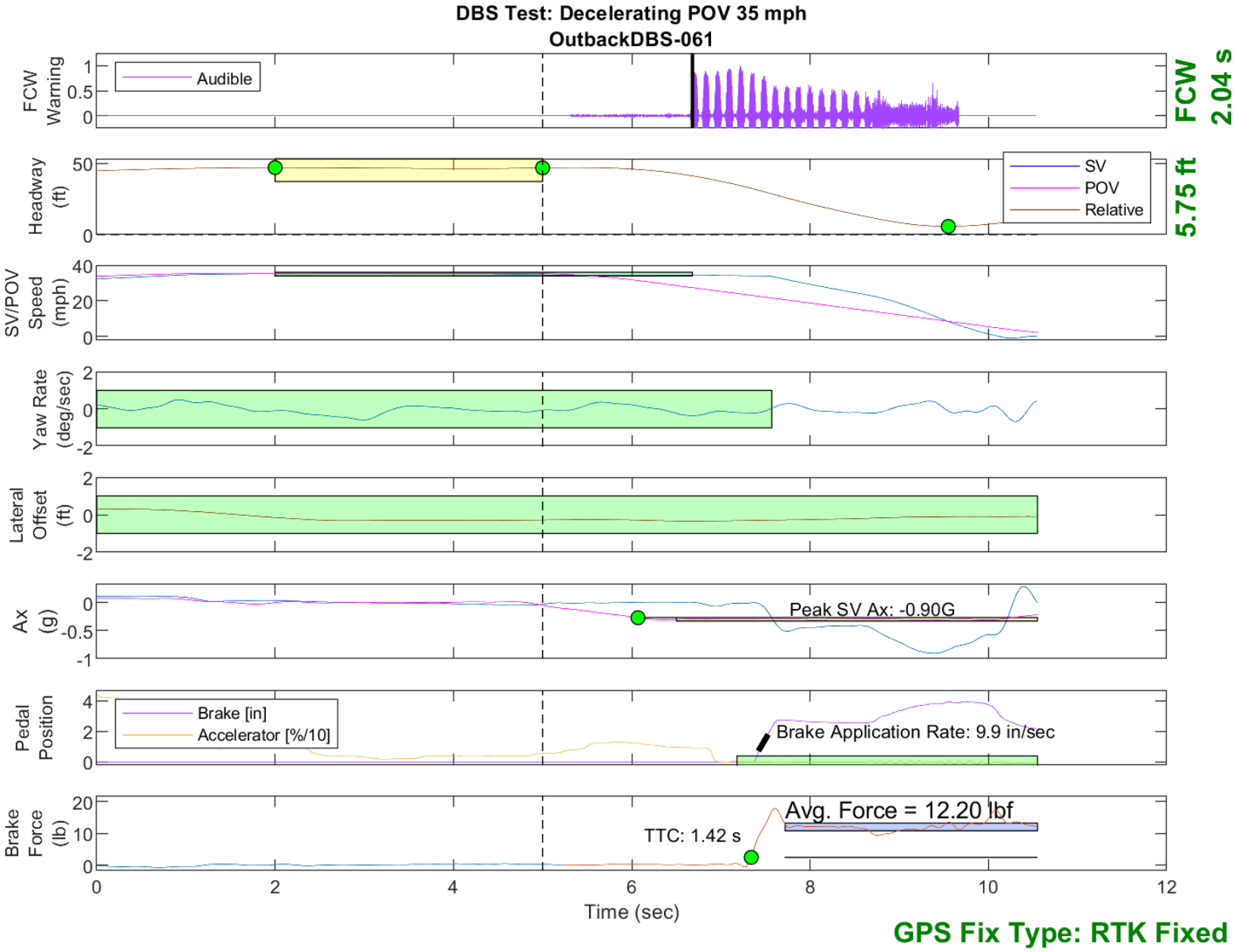


Figure E37. Time History for DBS Run 61, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

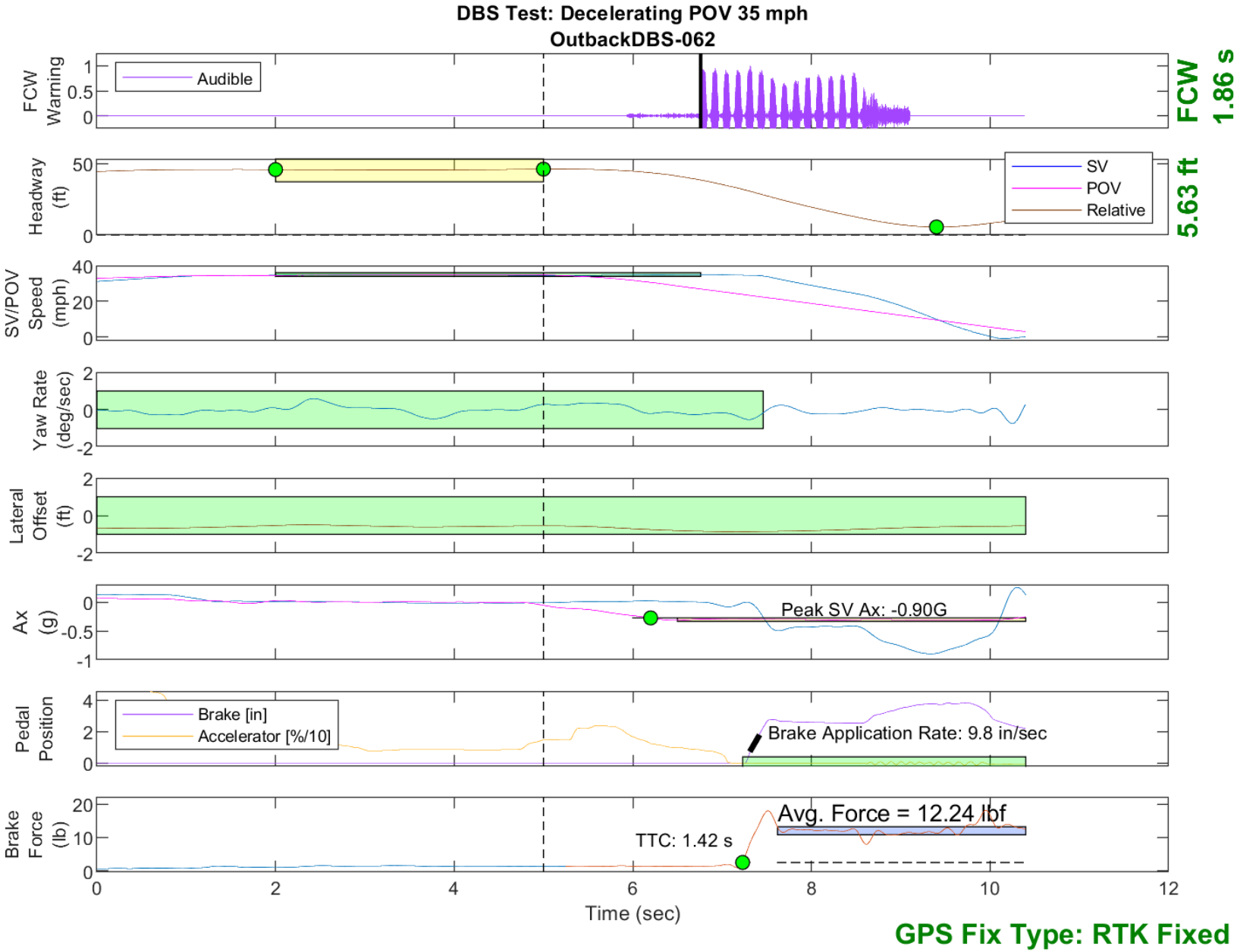


Figure E38. Time History for DBS Run 62, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

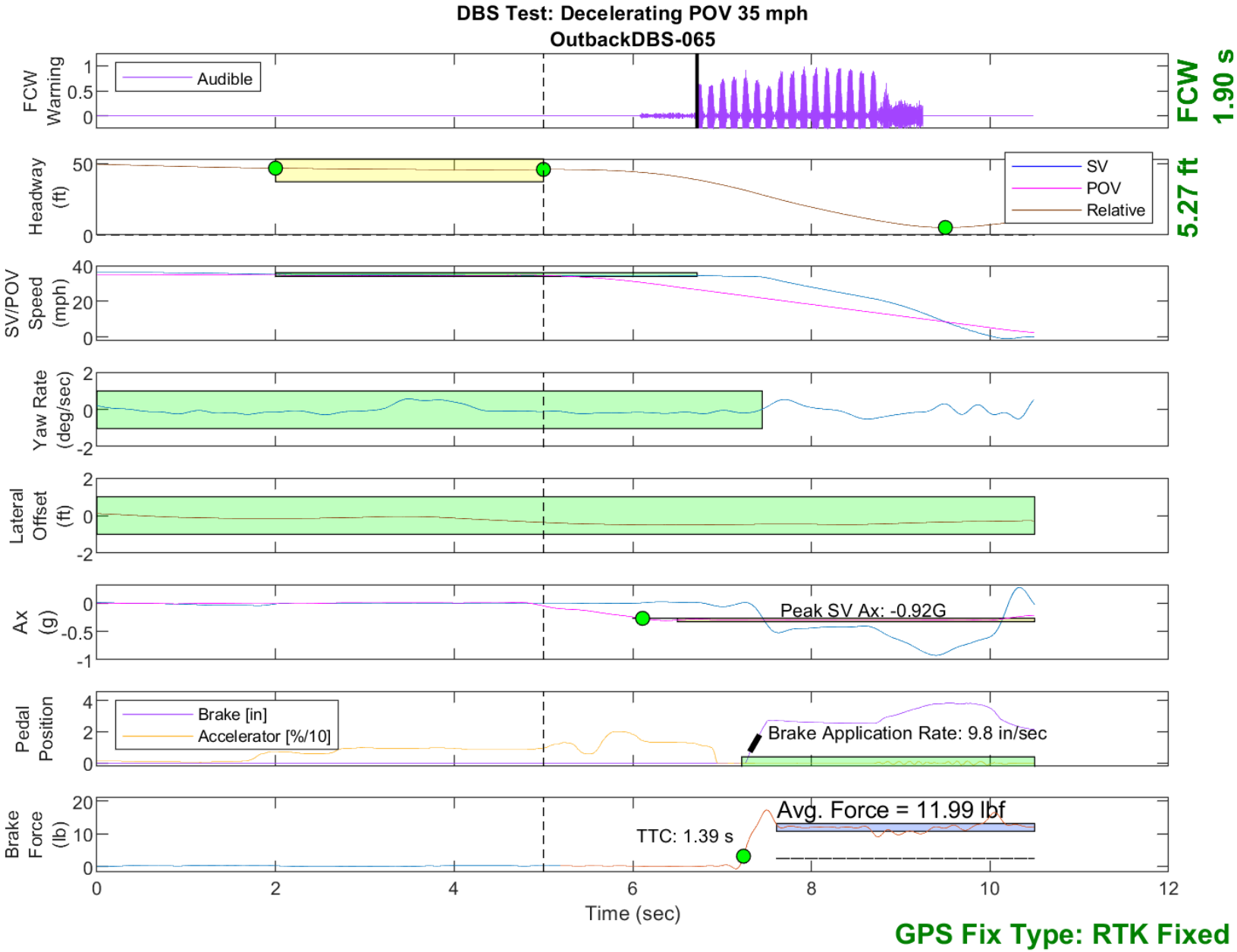


Figure E39. Time History for DBS Run 65, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

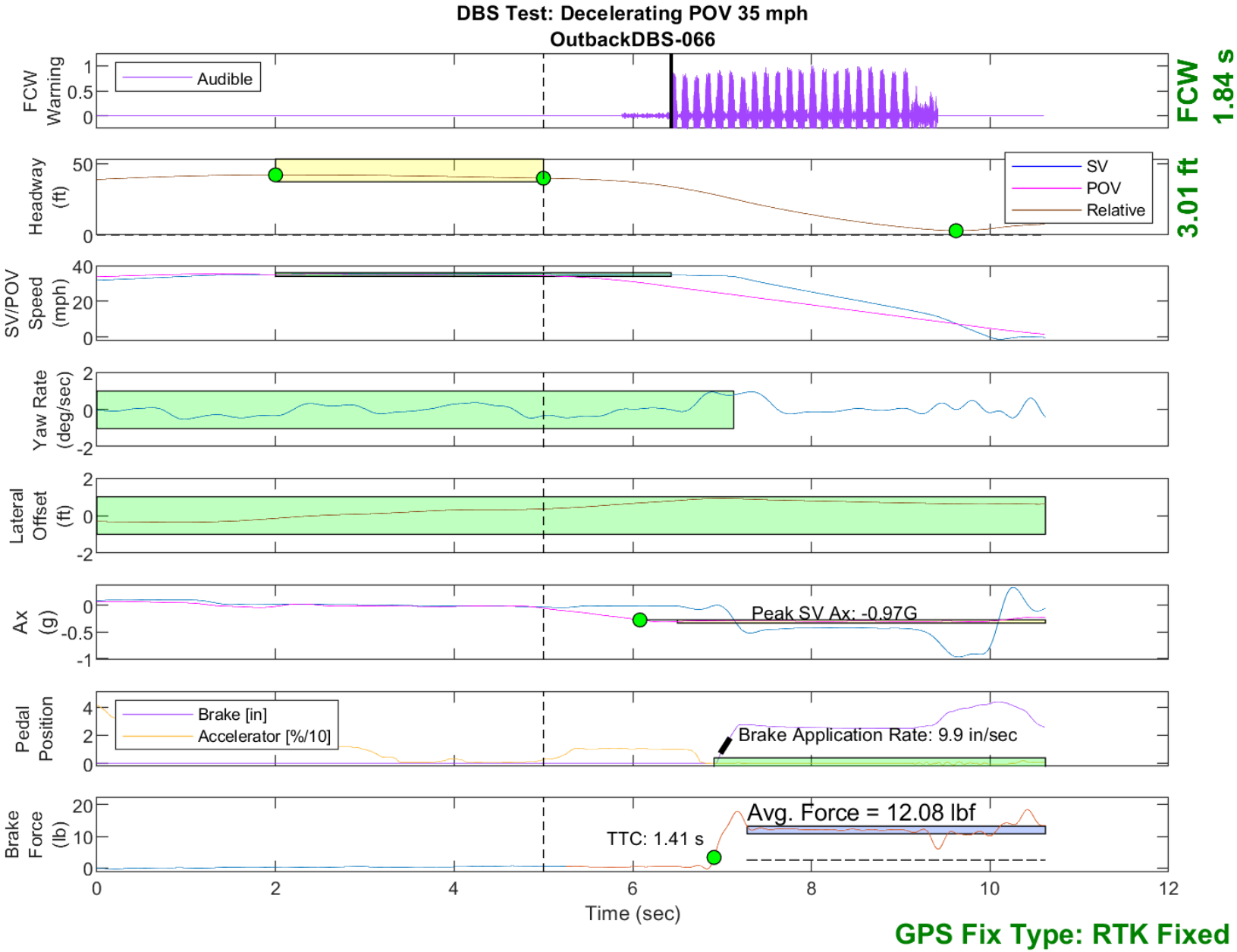


Figure E40. Time History for DBS Run 66, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

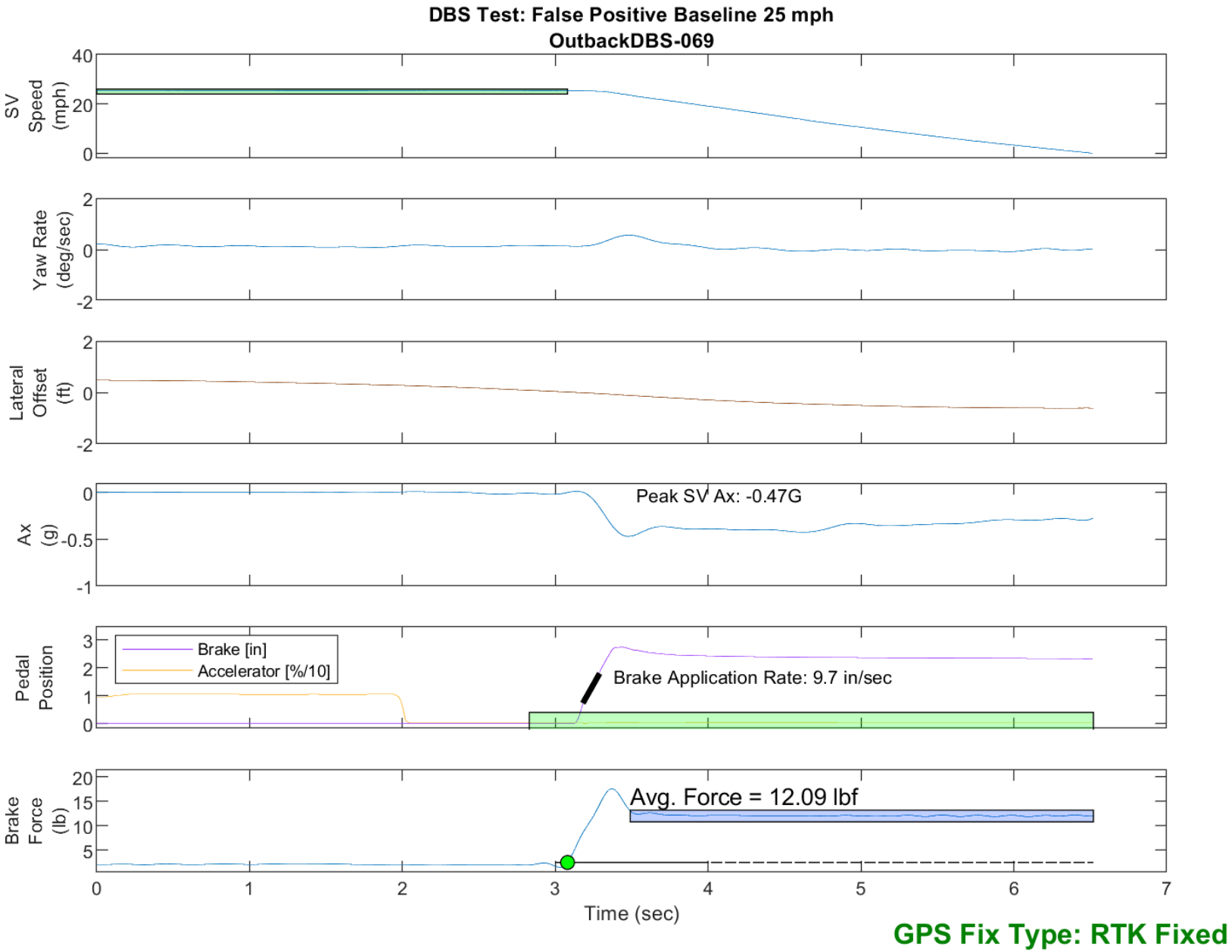


Figure E41. Time History for DBS Run 69, False Positive Baseline, SV 25 mph

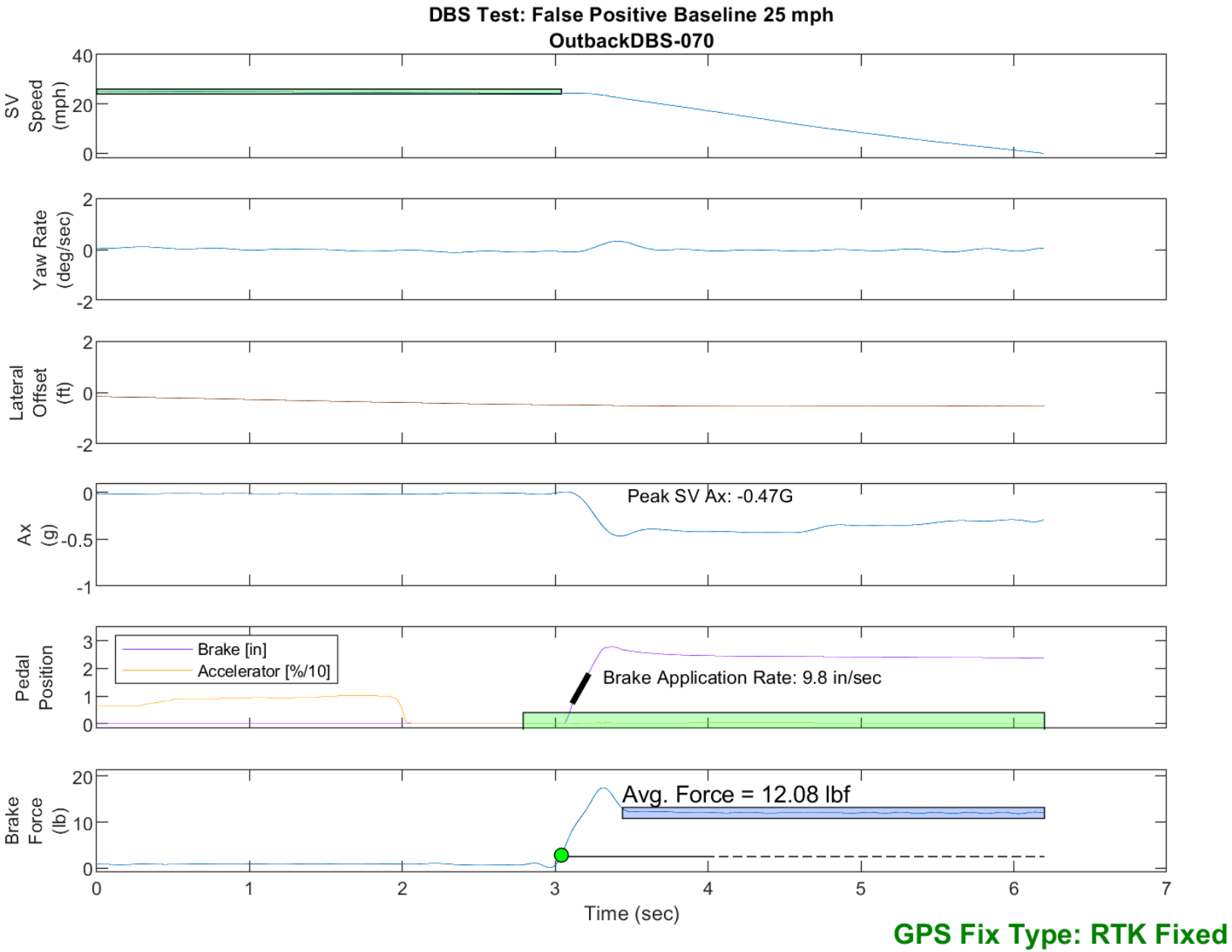


Figure E42. Time History for DBS Run 70, False Positive Baseline, SV 25 mph

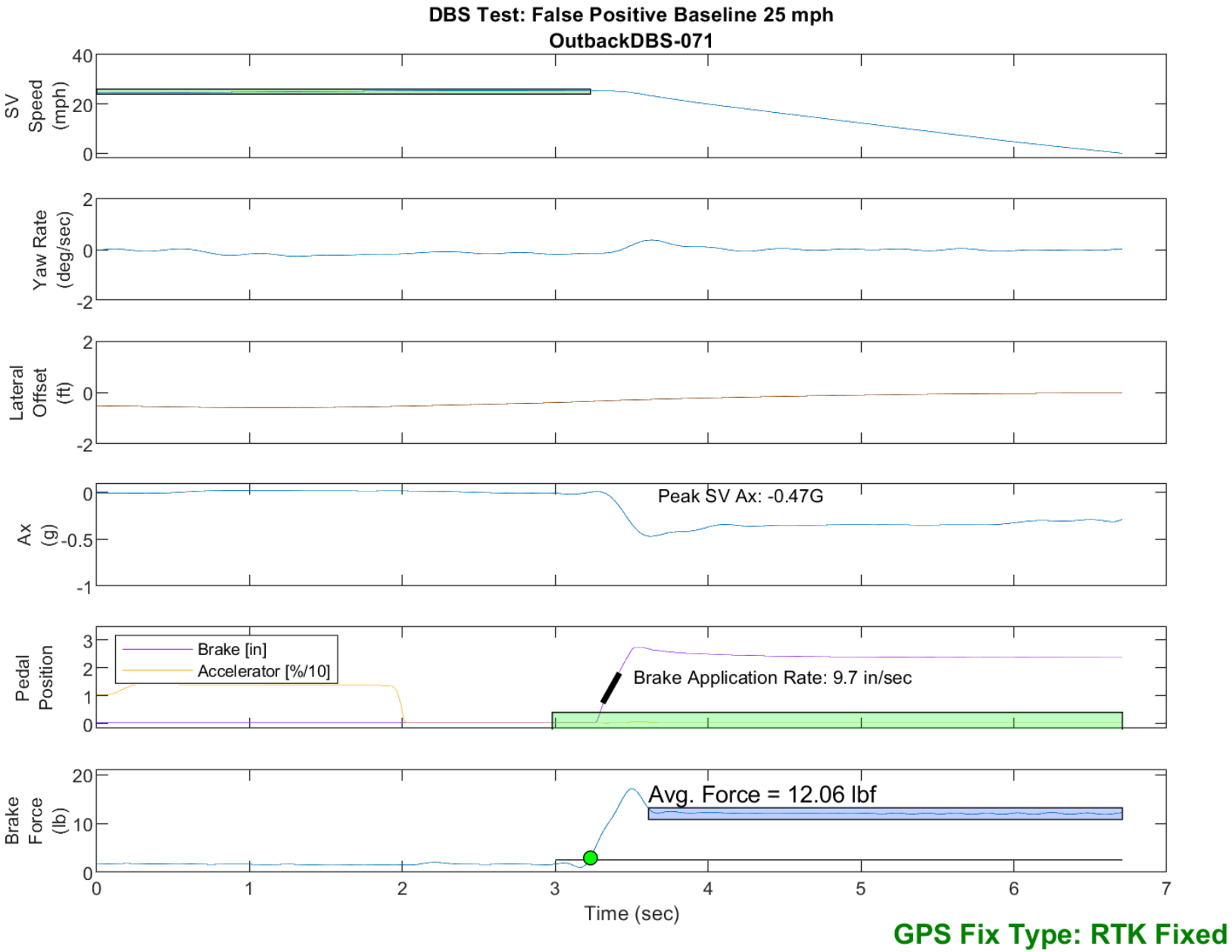


Figure E43. Time History for DBS Run 71, False Positive Baseline, SV 25 mph

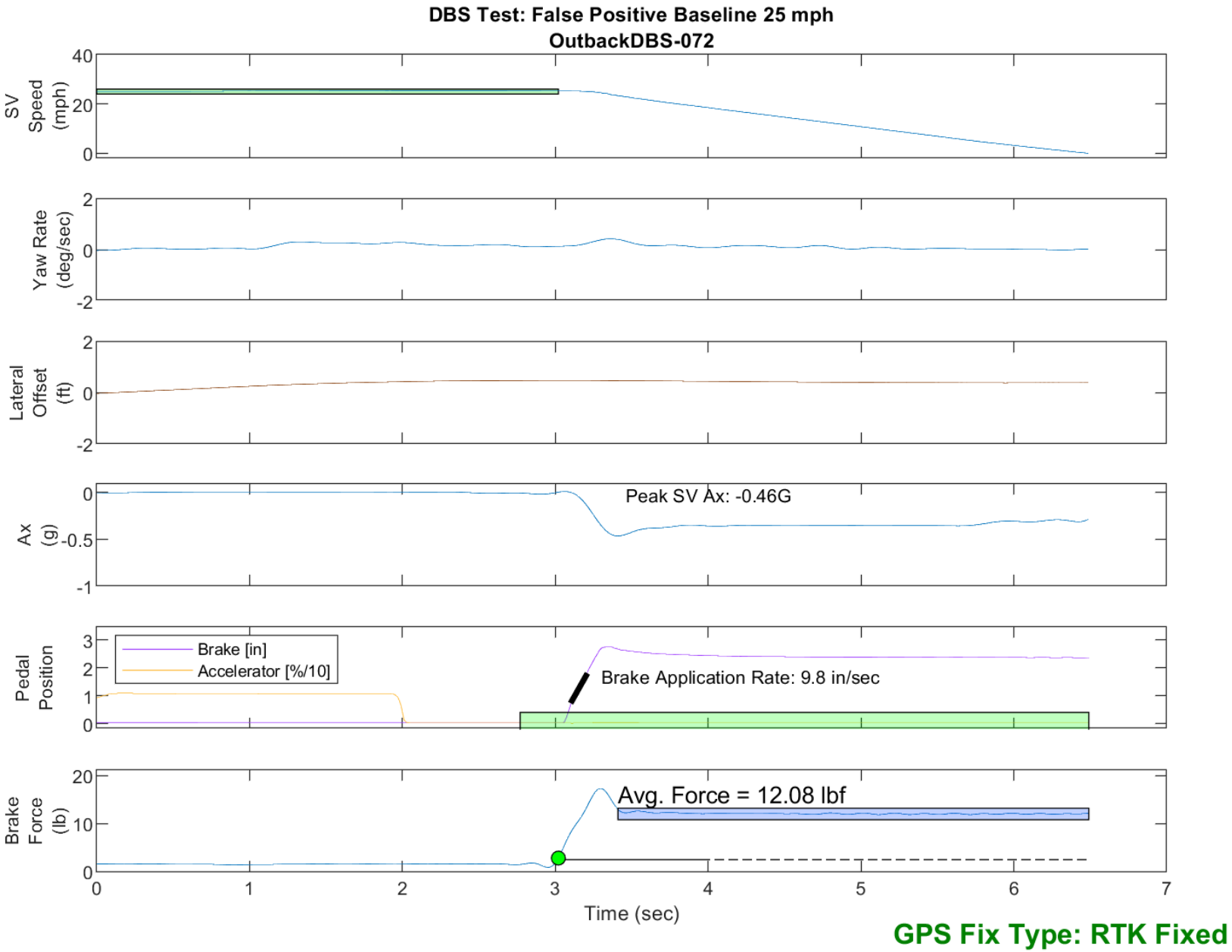


Figure E44. Time History for DBS Run 72, False Positive Baseline, SV 25 mph

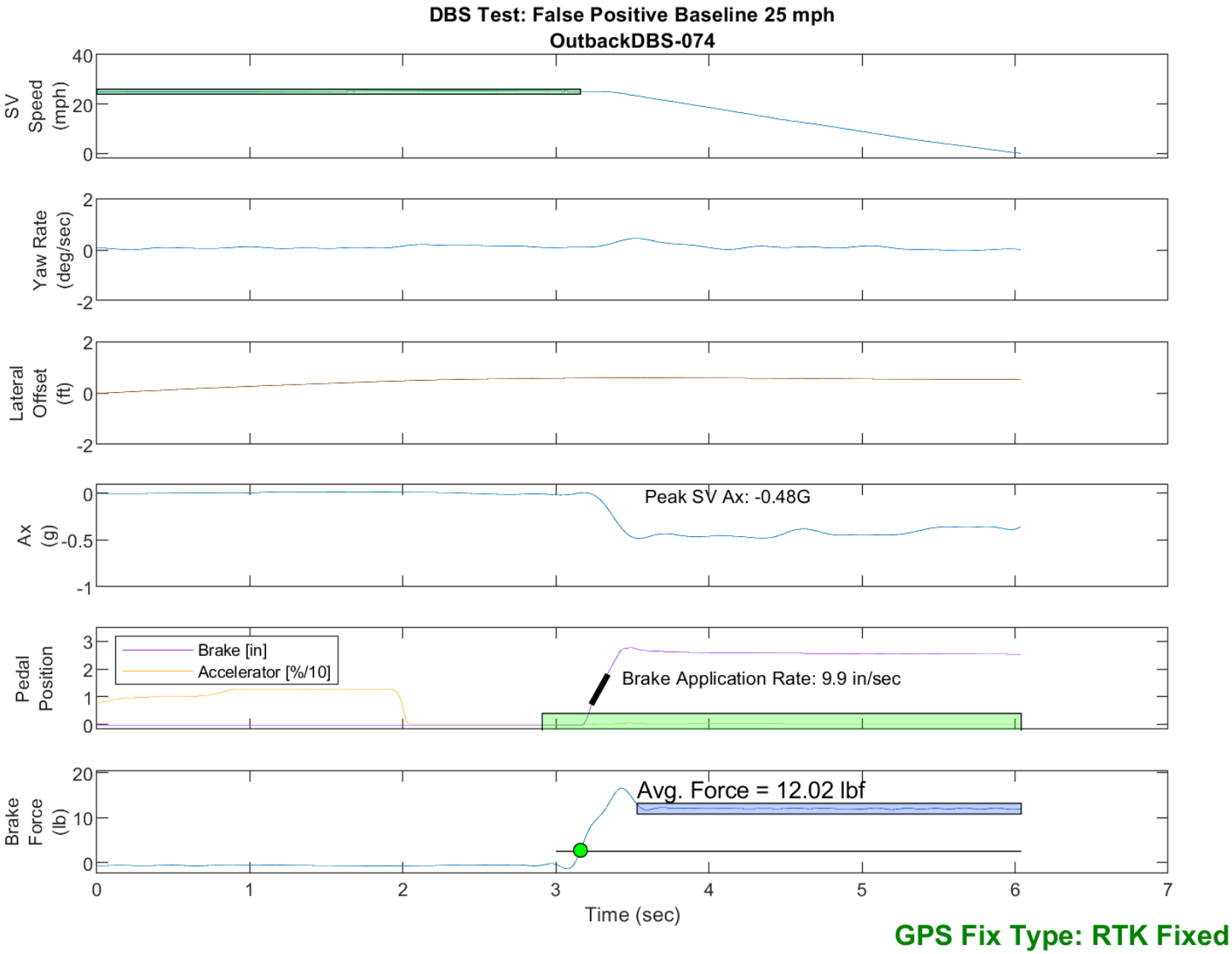


Figure E45. Time History for DBS Run 74, False Positive Baseline, SV 25 mph

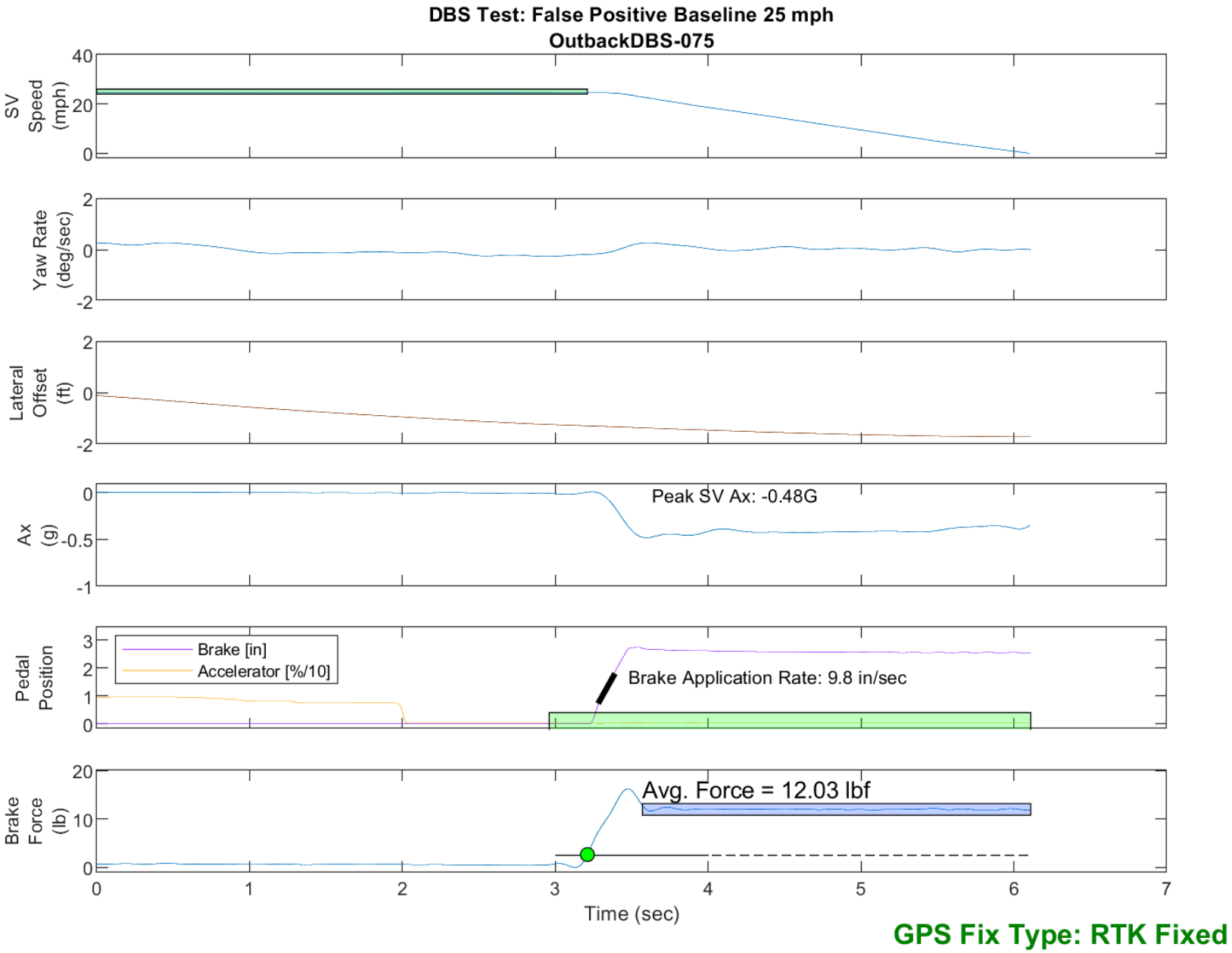


Figure E46. Time History for DBS Run 75, False Positive Baseline, SV 25 mph

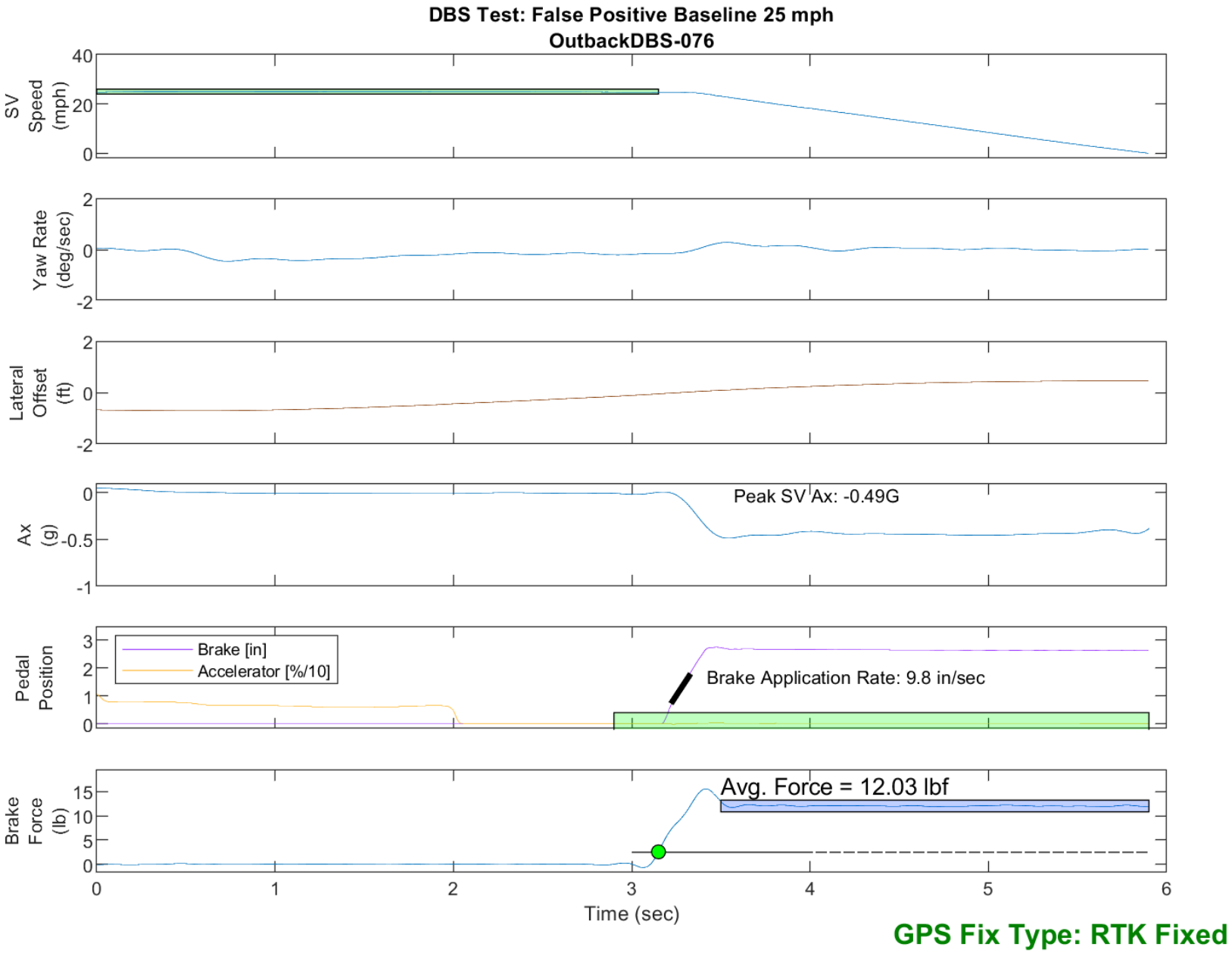


Figure E47. Time History for DBS Run 76, False Positive Baseline, SV 25 mph

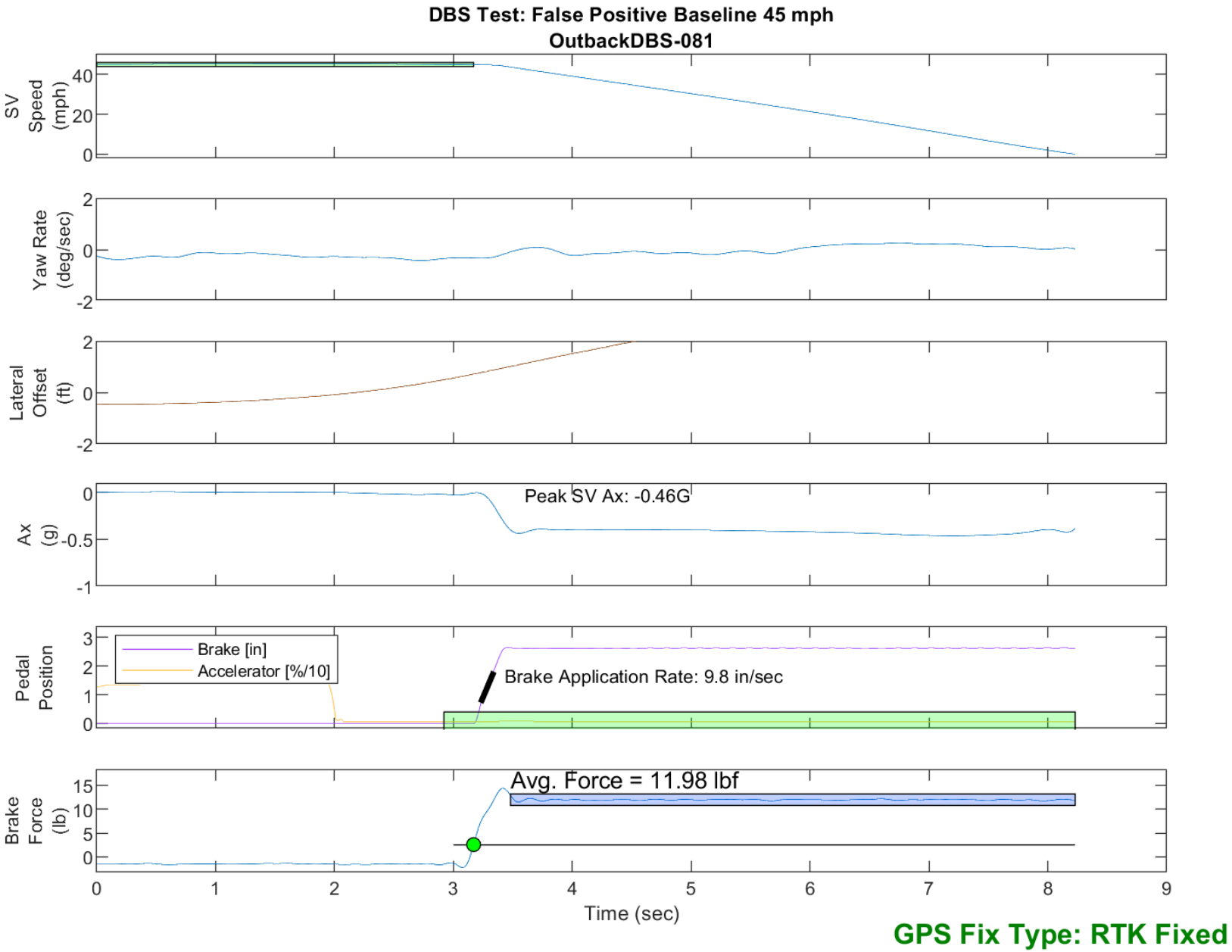


Figure E48. Time History for DBS Run 81, False Positive Baseline, SV 45 mph

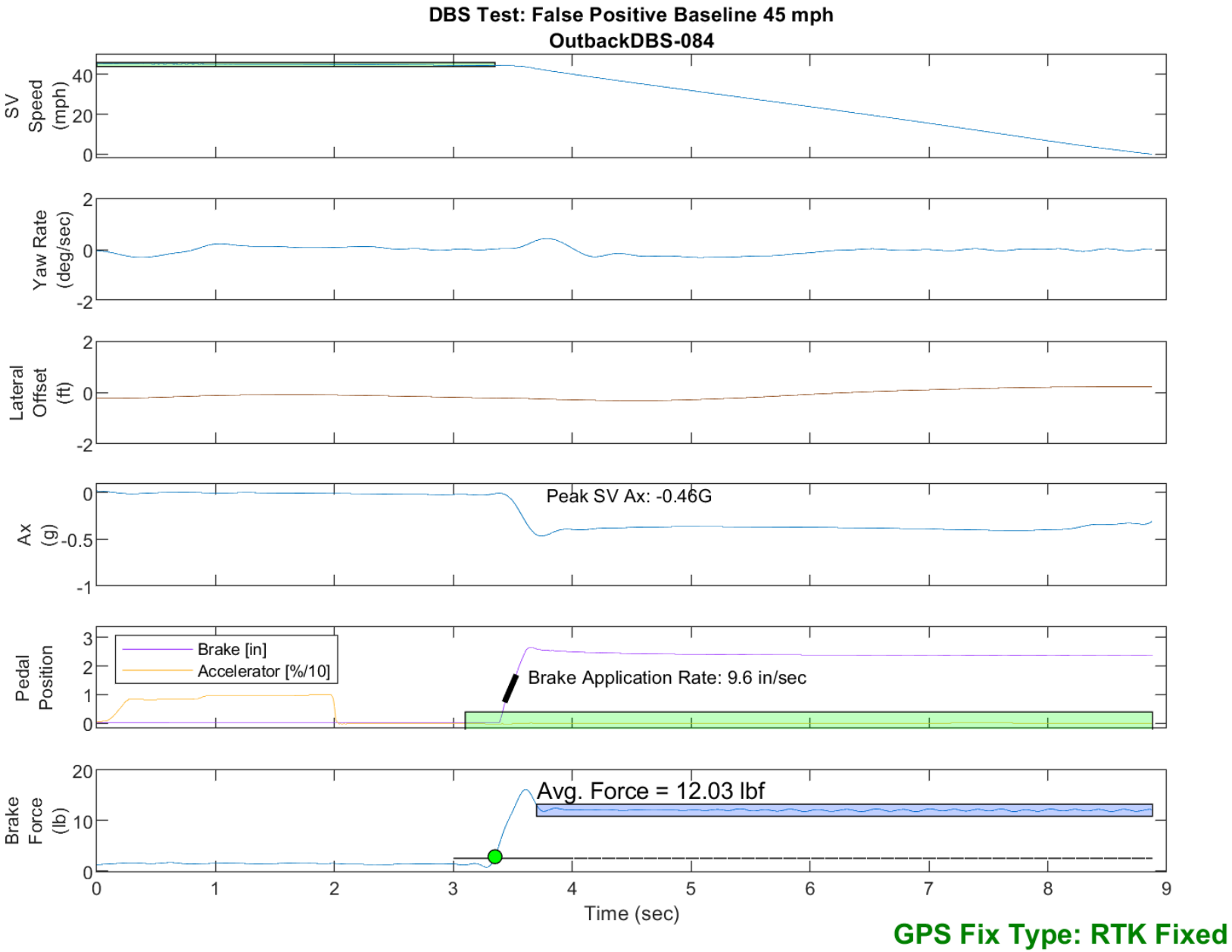


Figure E49. Time History for DBS Run 84, False Positive Baseline, SV 45 mph

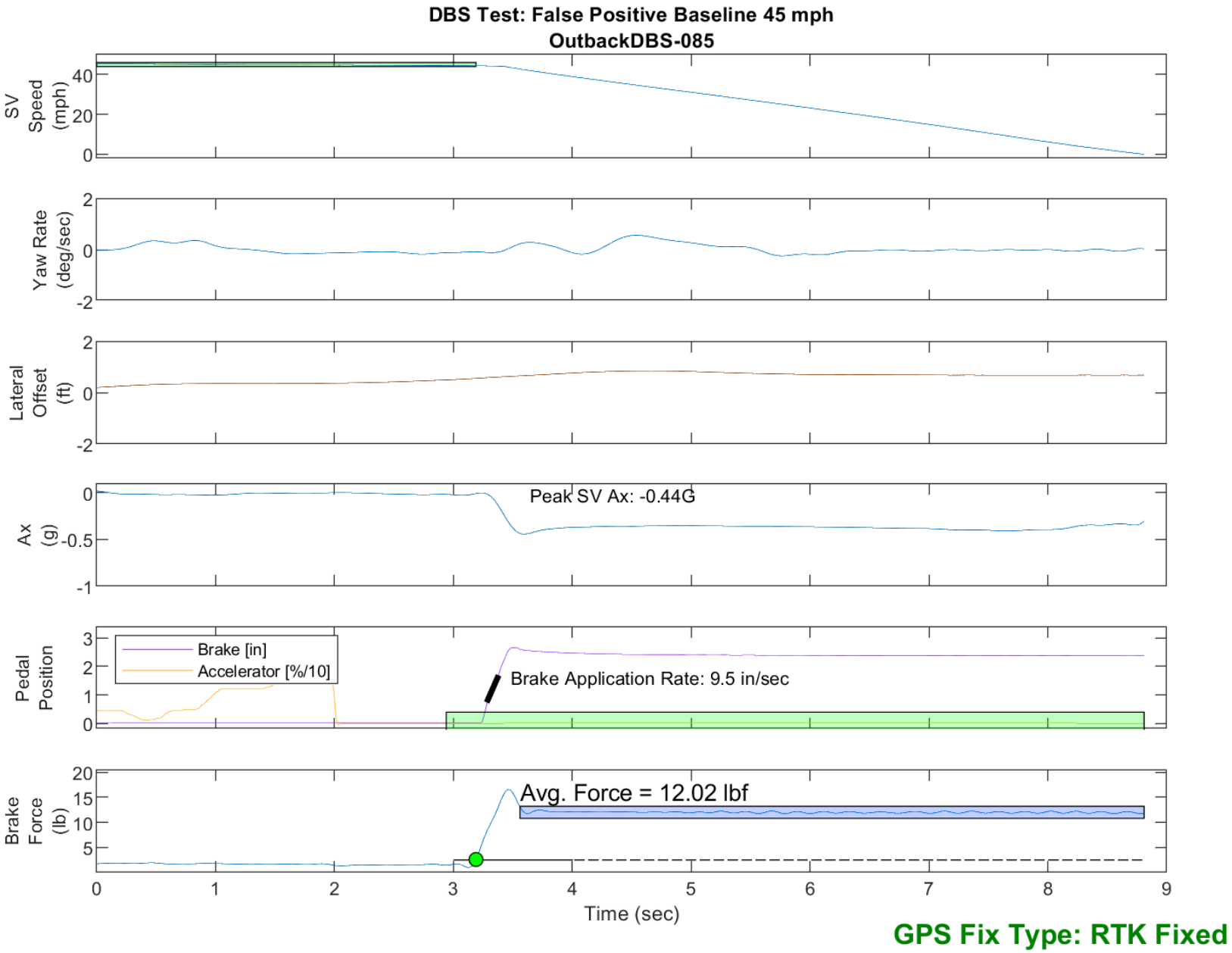


Figure E50. Time History for DBS Run 85, False Positive Baseline, SV 45 mph

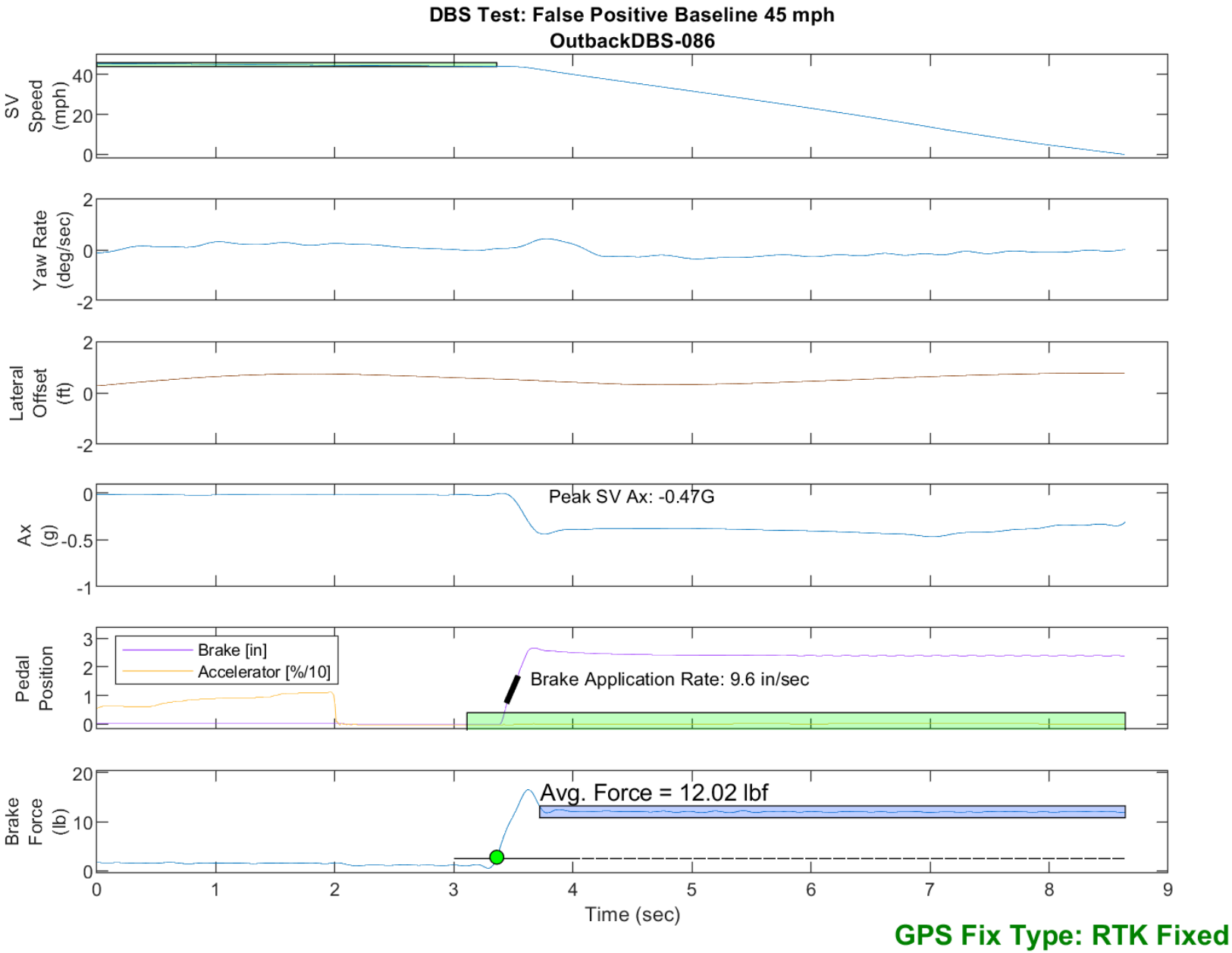


Figure E51. Time History for DBS Run 86, False Positive Baseline, SV 45 mph

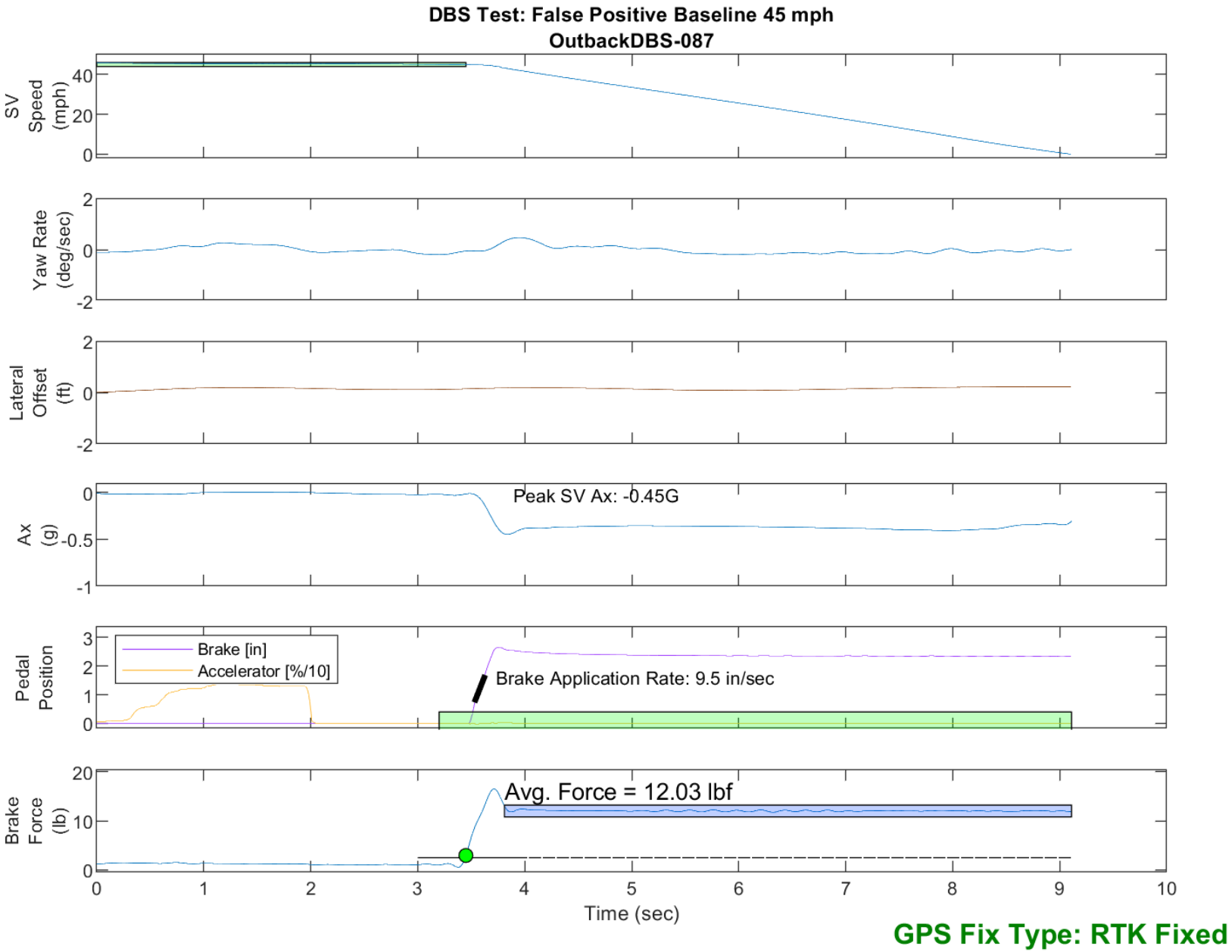


Figure E52. Time History for DBS Run 87, False Positive Baseline, SV 45 mph

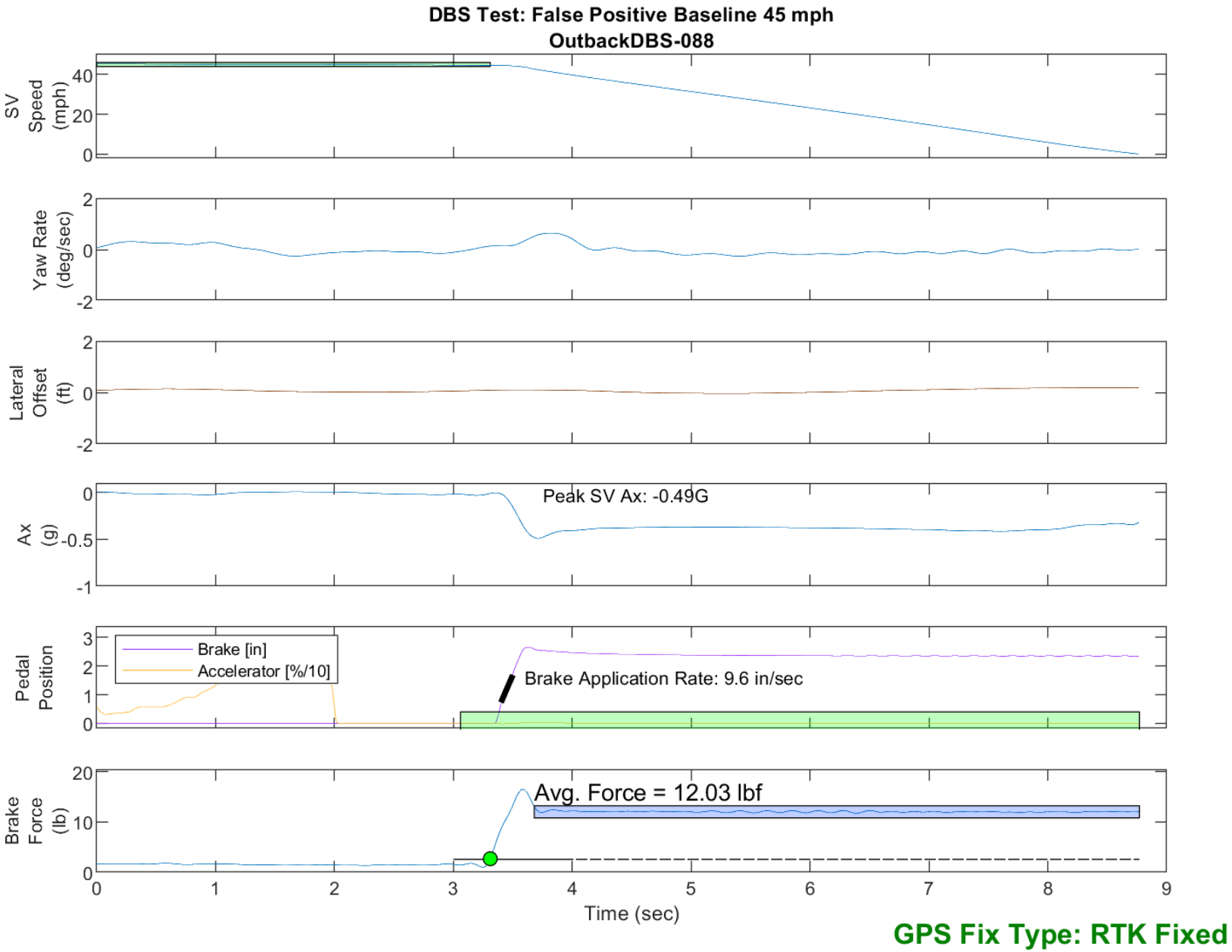


Figure E53. Time History for DBS Run 88, False Positive Baseline, SV 45 mph

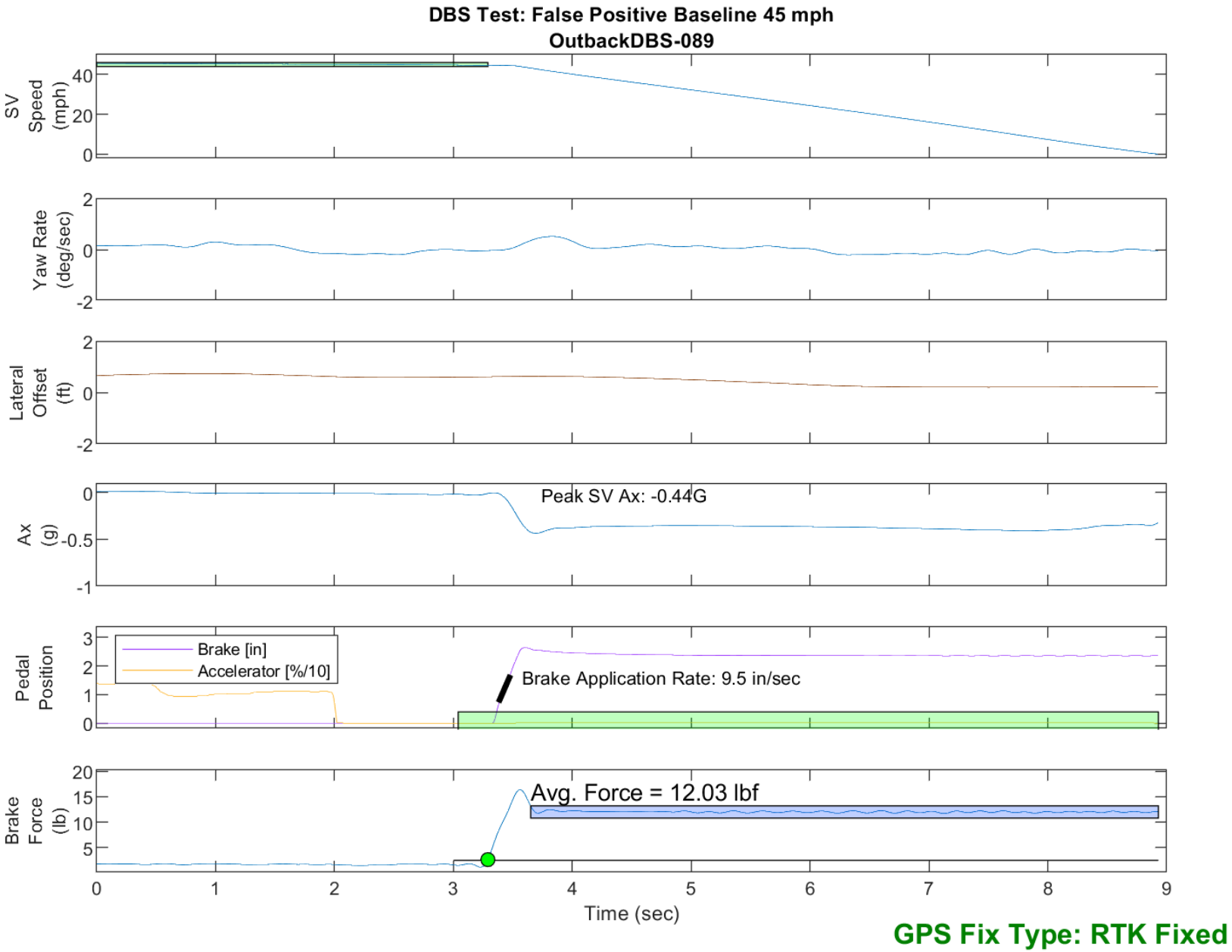


Figure E54. Time History for DBS Run 89, False Positive Baseline, SV 45 mph

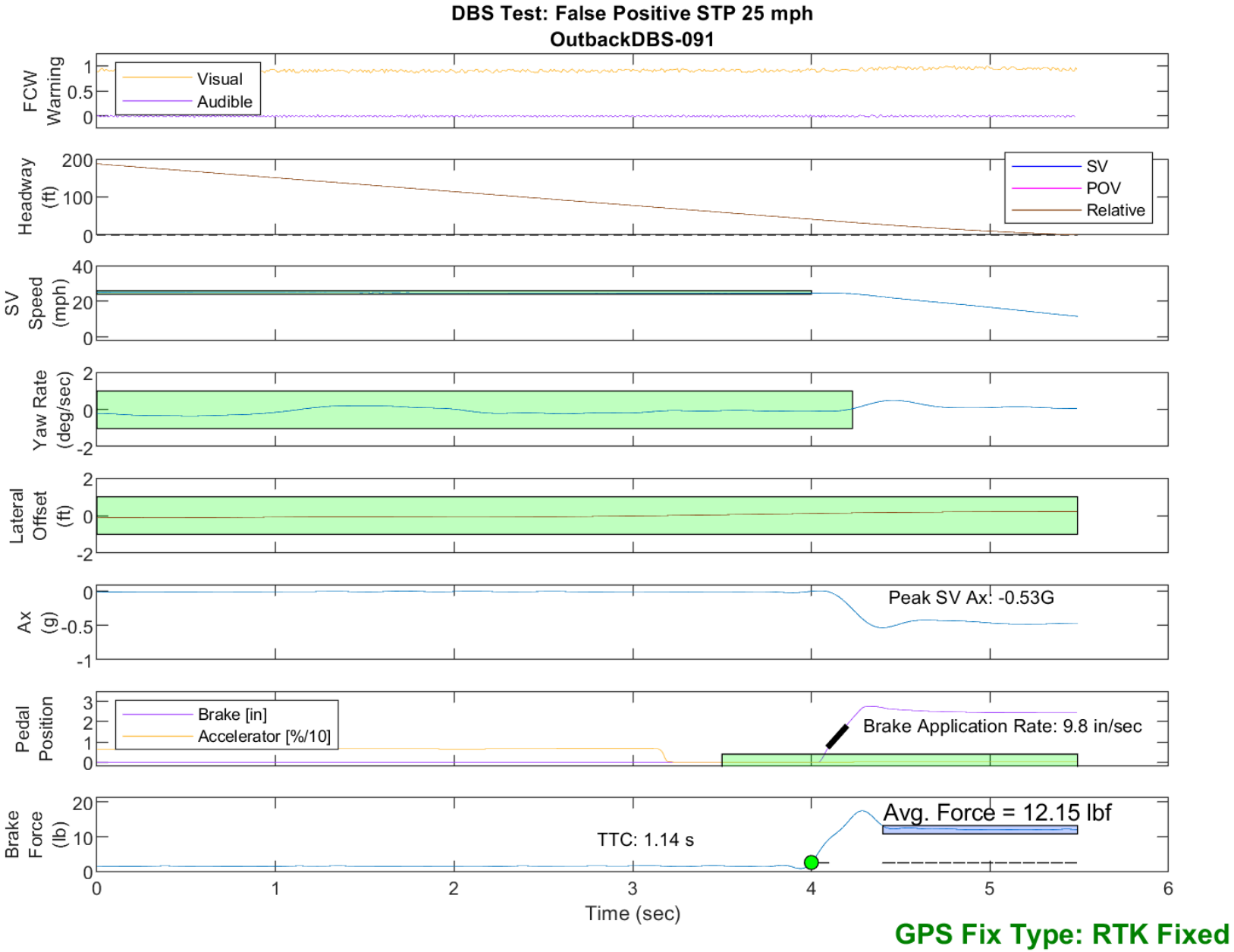


Figure E55. Time History for DBS Run 91, SV Encounters Steel Trench Plate, SV 25 mph

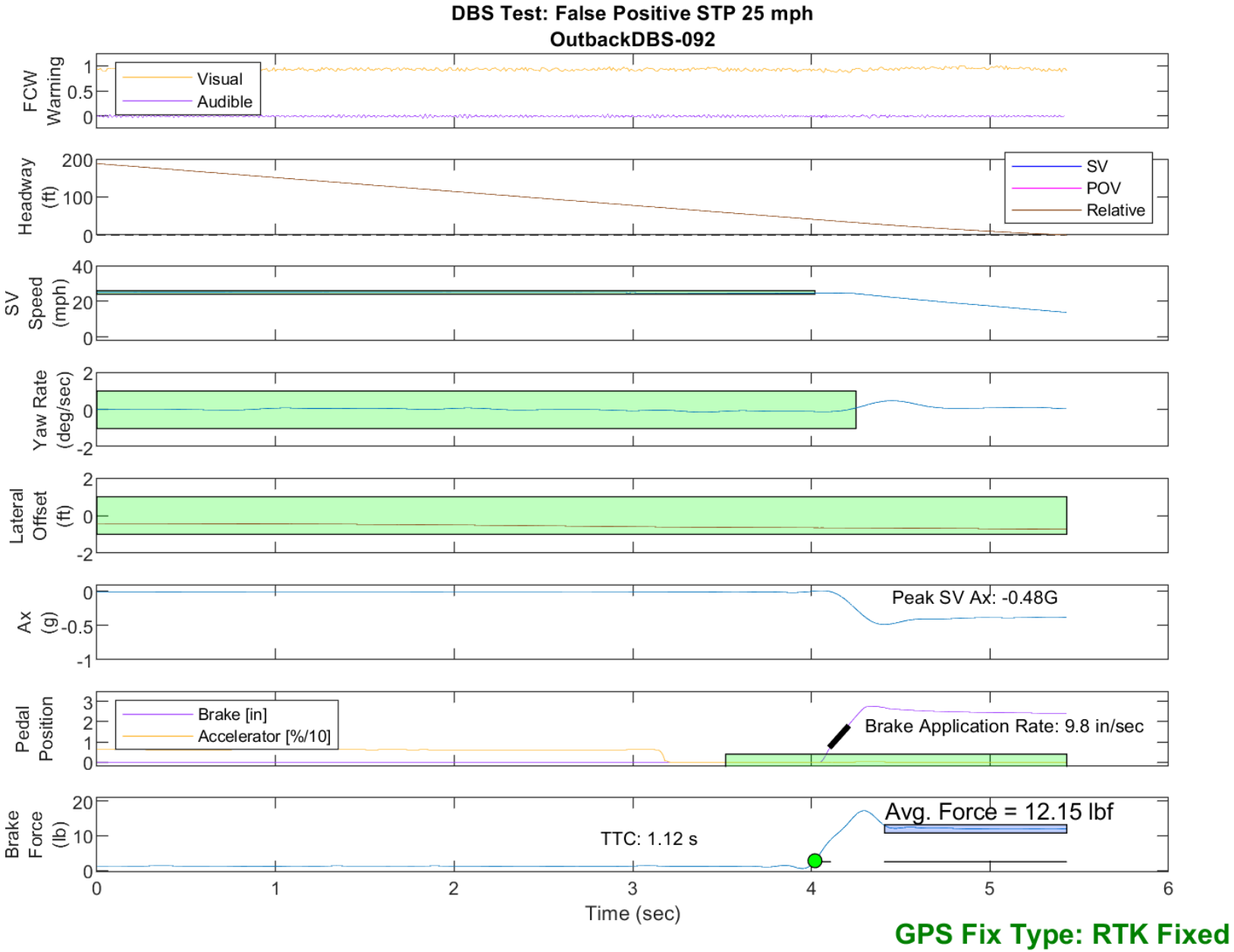


Figure E56. Time History for DBS Run 92, SV Encounters Steel Trench Plate, SV 25 mph

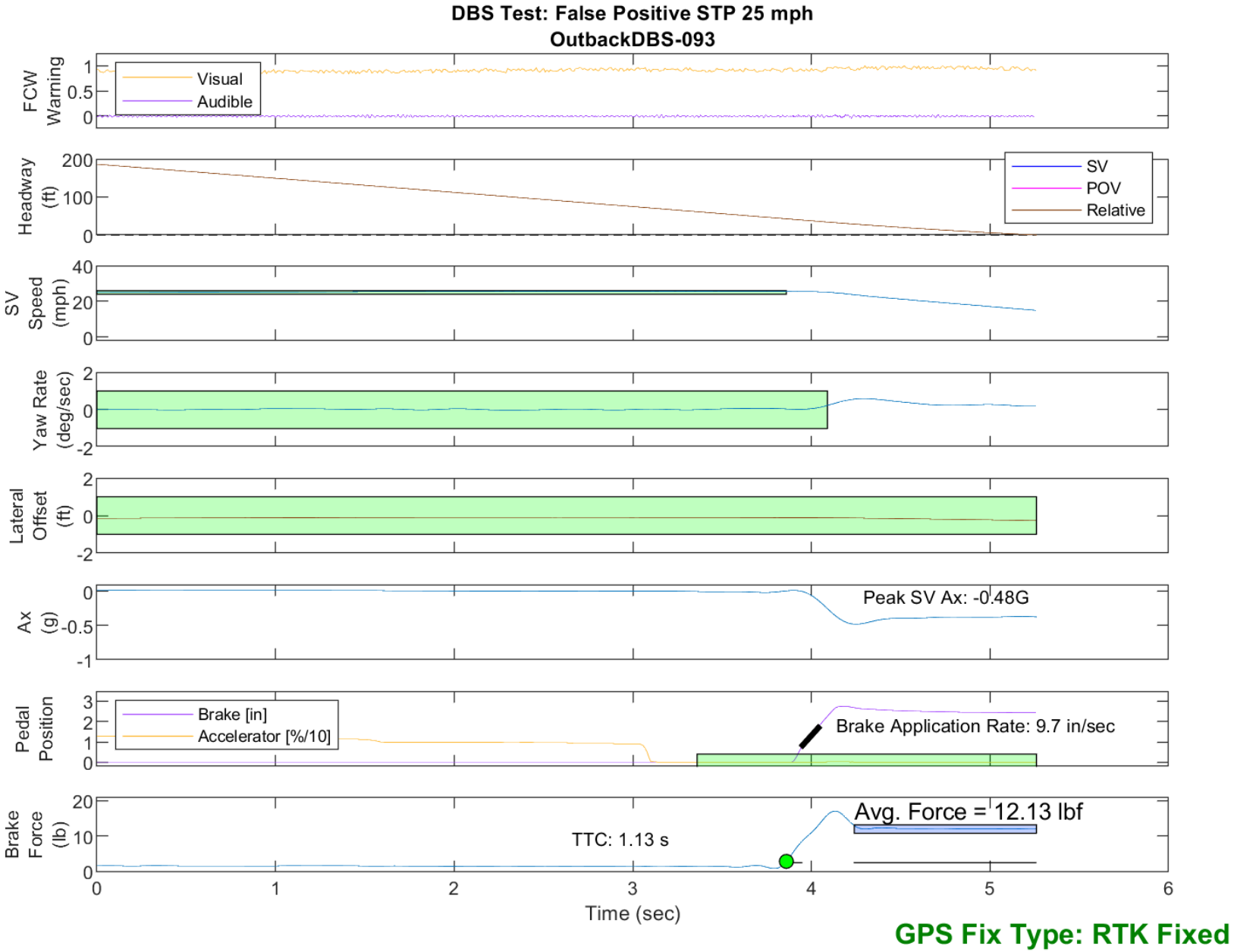


Figure E57. Time History for DBS Run 93, SV Encounters Steel Trench Plate, SV 25 mph

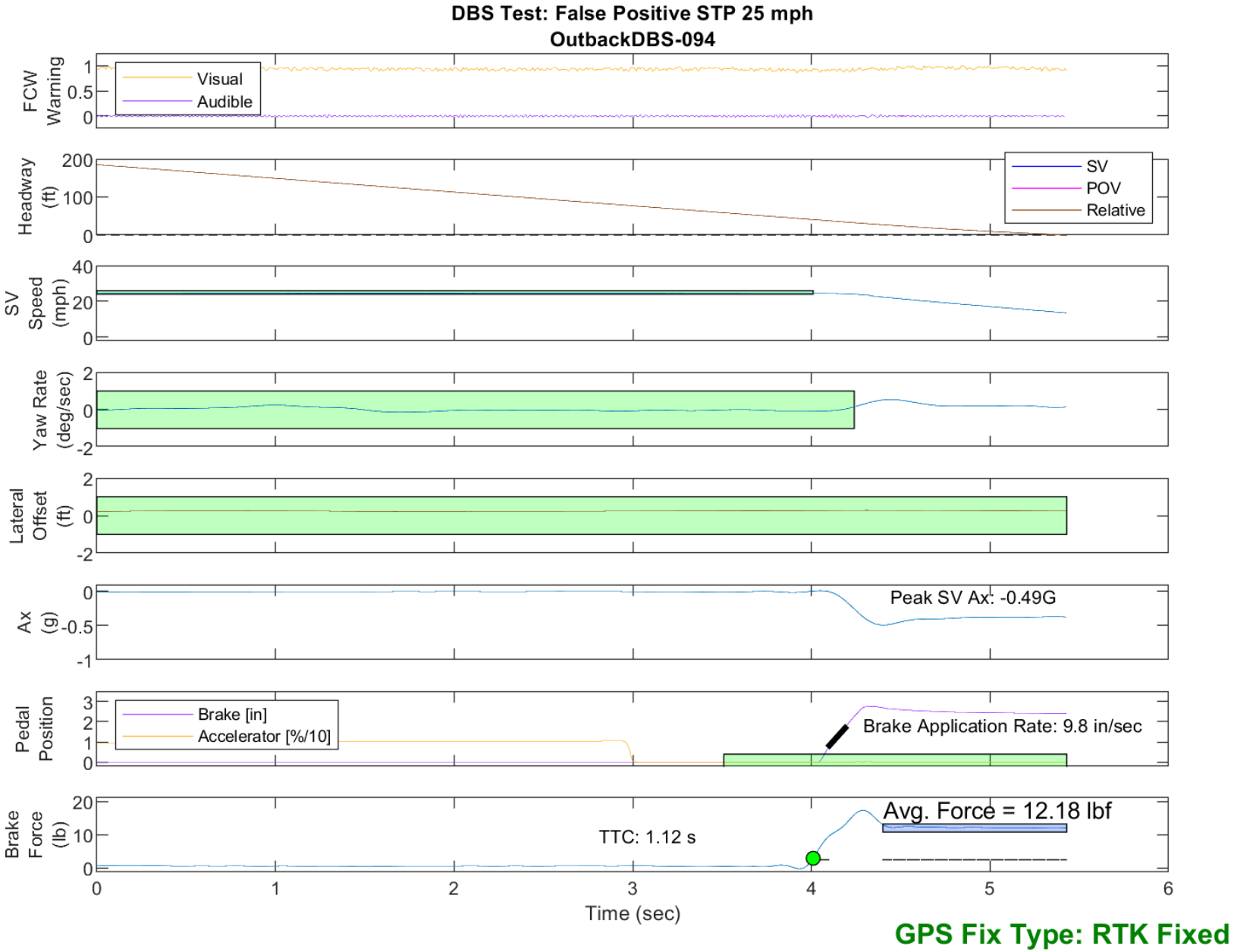


Figure E58. Time History for DBS Run 94, SV Encounters Steel Trench Plate, SV 25 mph

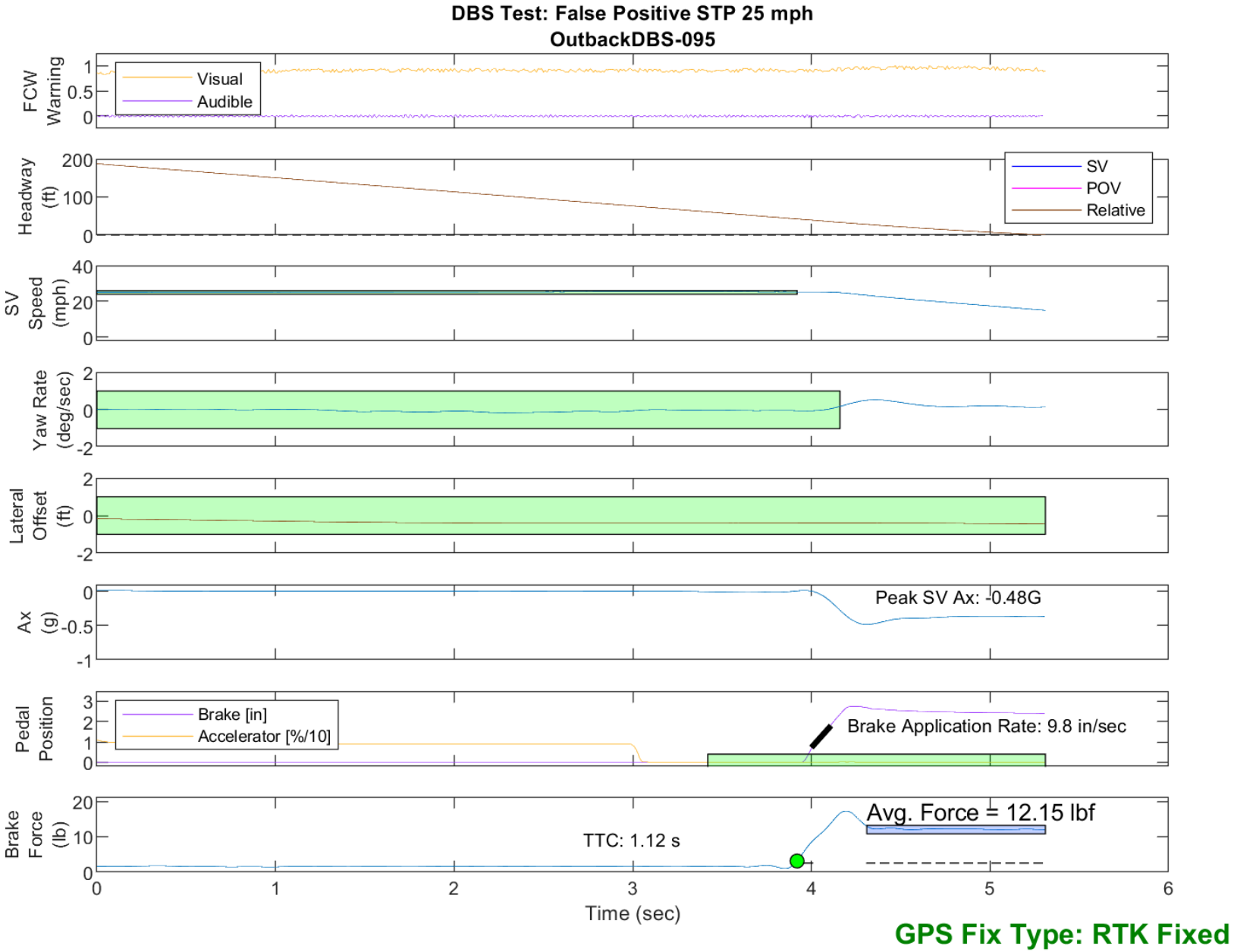


Figure E59. Time History for DBS Run 95, SV Encounters Steel Trench Plate, SV 25 mph

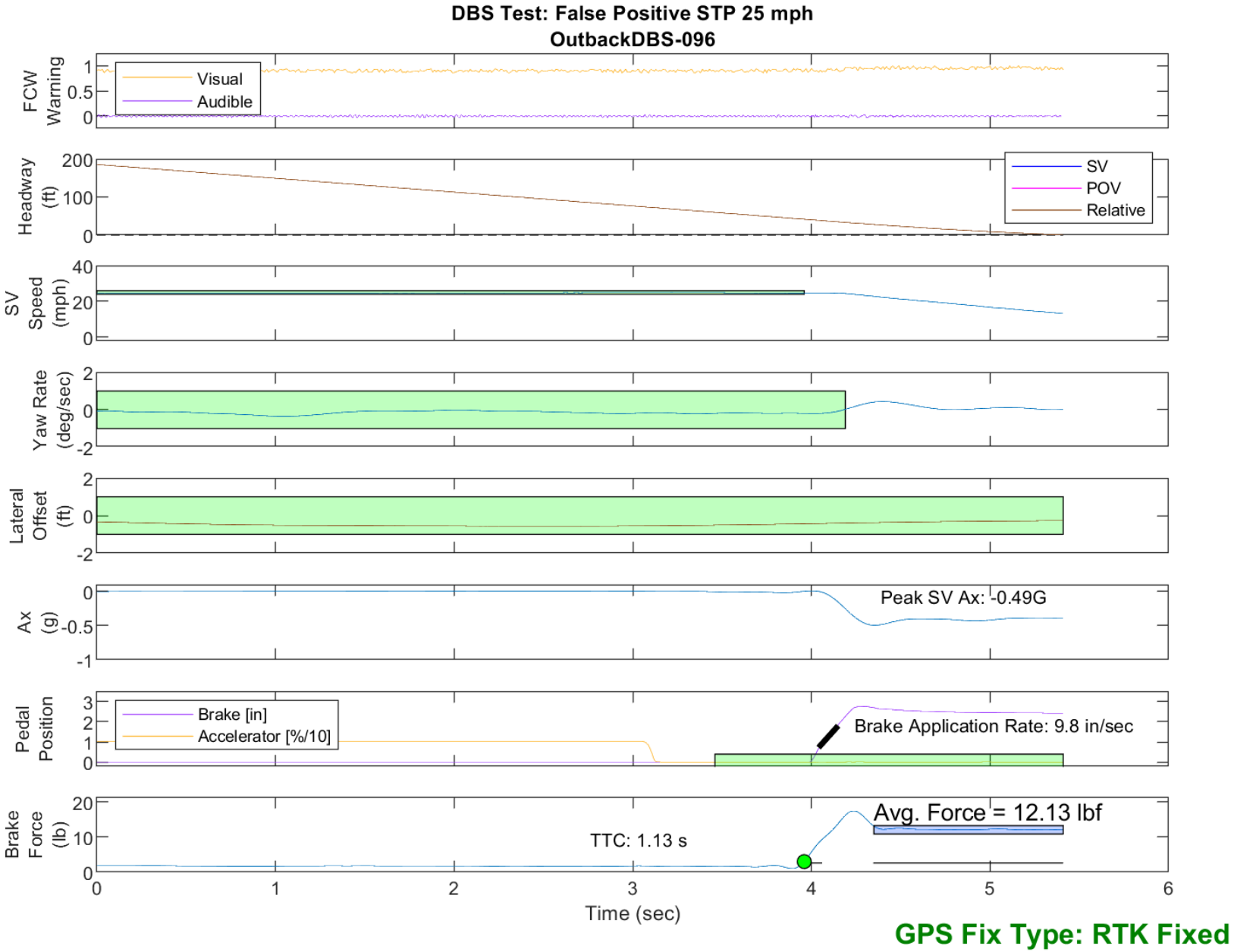


Figure E60. Time History for DBS Run 96, SV Encounters Steel Trench Plate, SV 25 mph

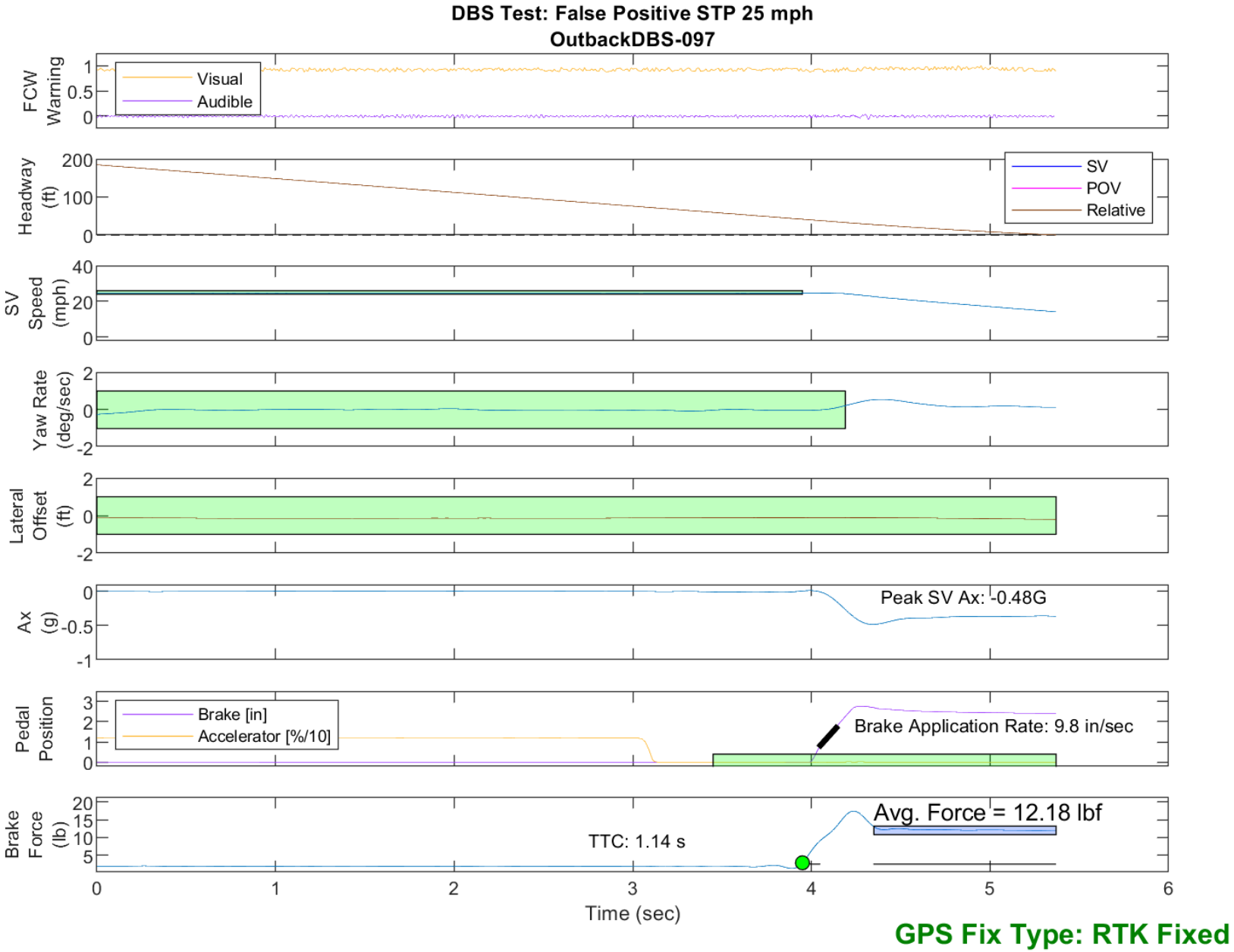


Figure E61. Time History for DBS Run 97, SV Encounters Steel Trench Plate, SV 25 mph

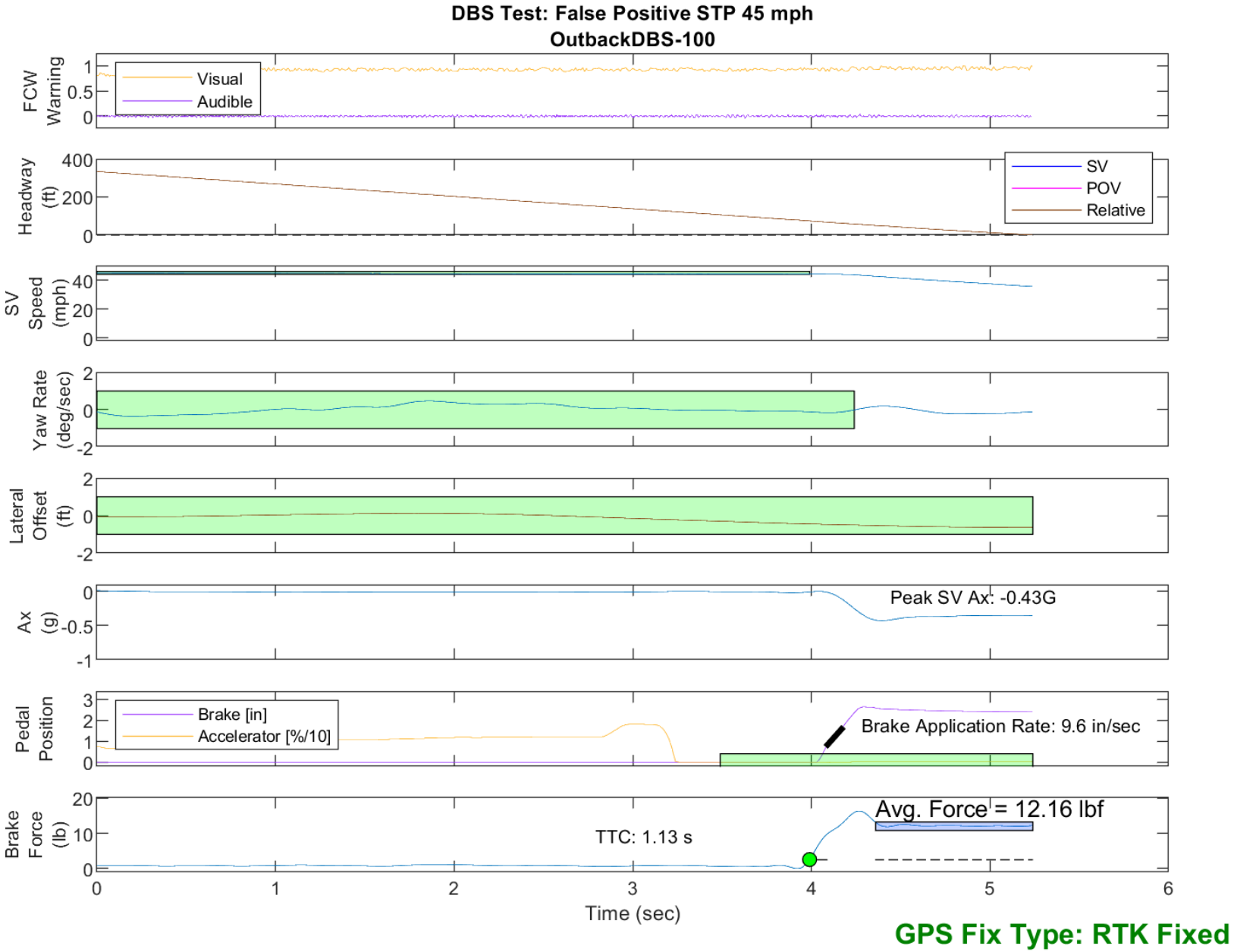


Figure E62. Time History for DBS Run 100, SV Encounters Steel Trench Plate, SV 45 mph

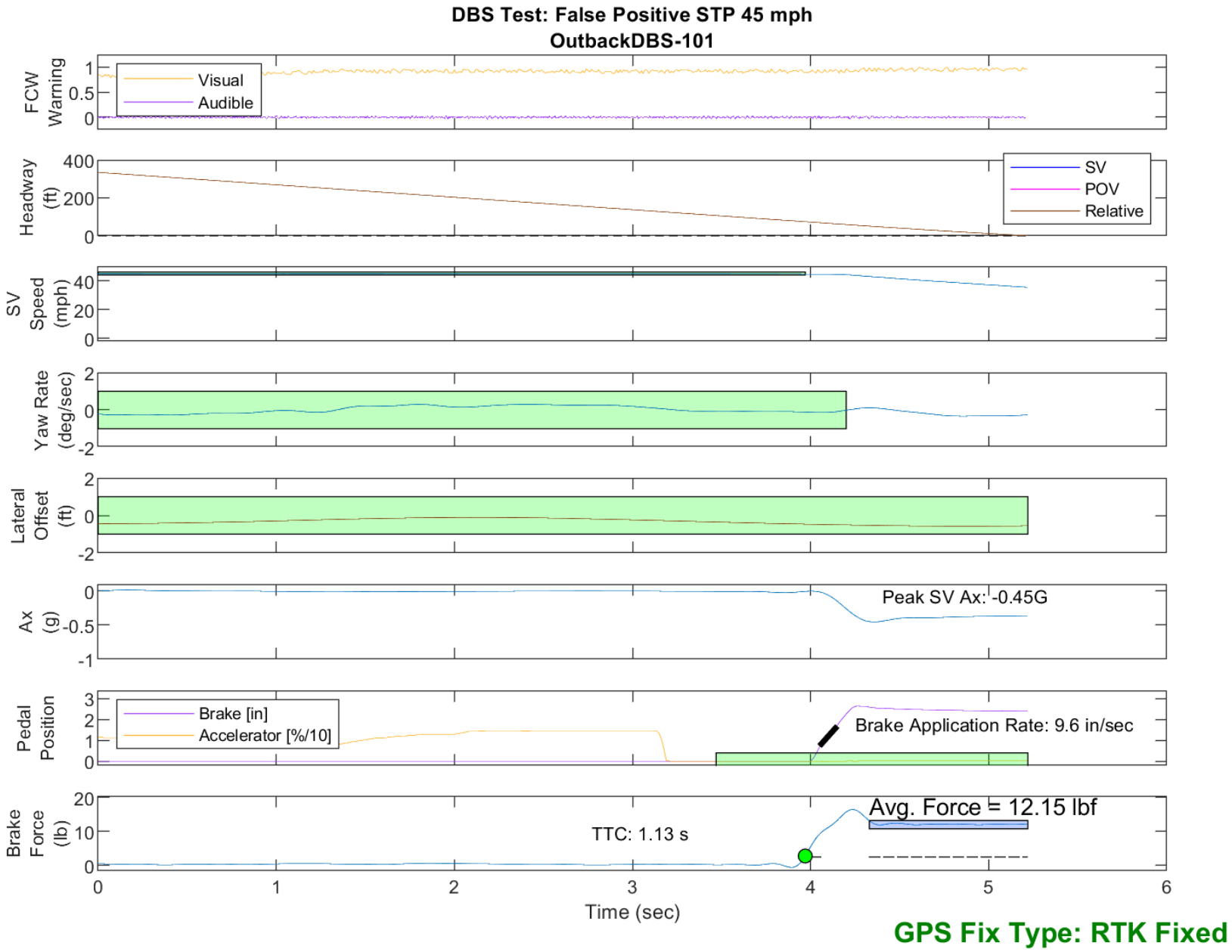


Figure E63. Time History for DBS Run 101, SV Encounters Steel Trench Plate, SV 45 mph

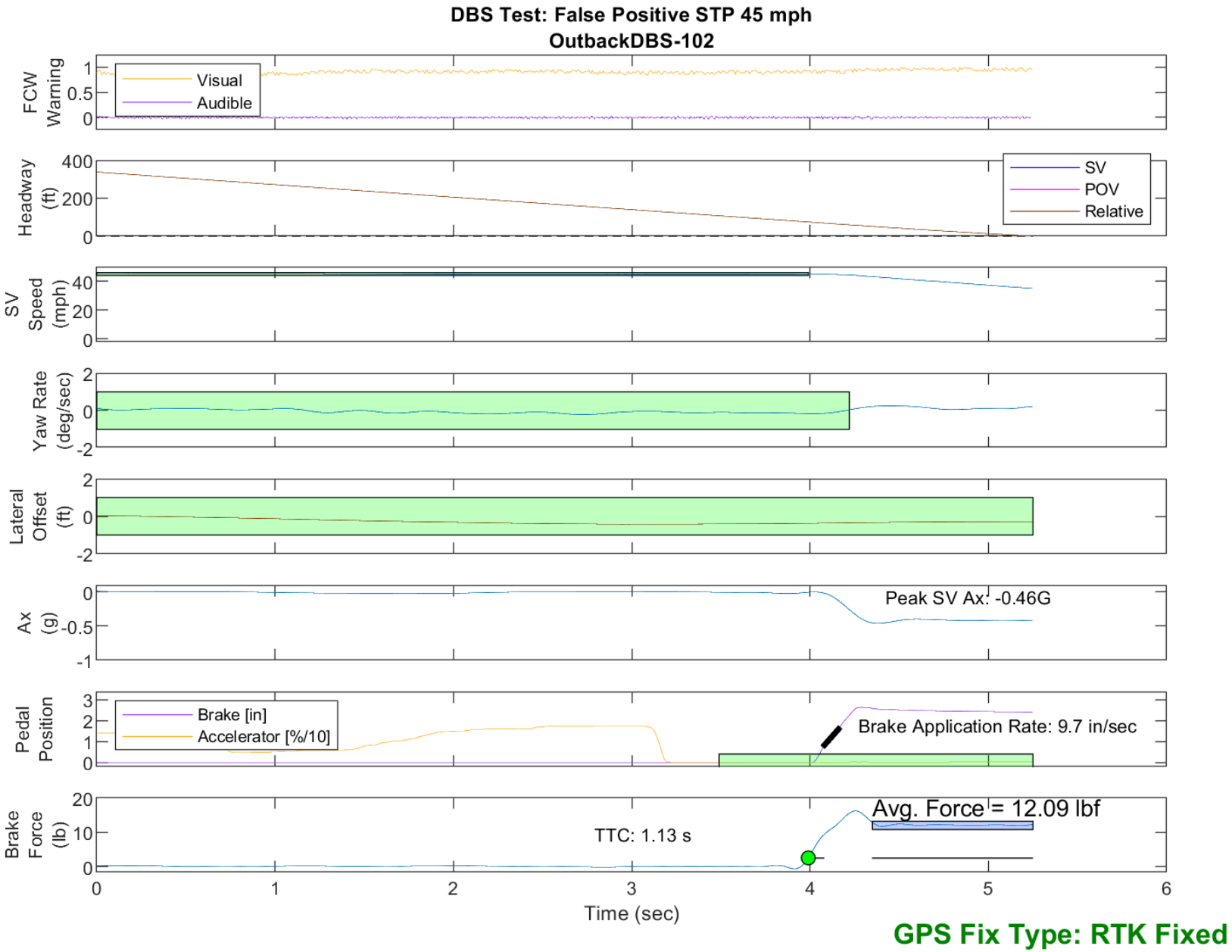


Figure E64. Time History for DBS Run 102, SV Encounters Steel Trench Plate, SV 45 mph

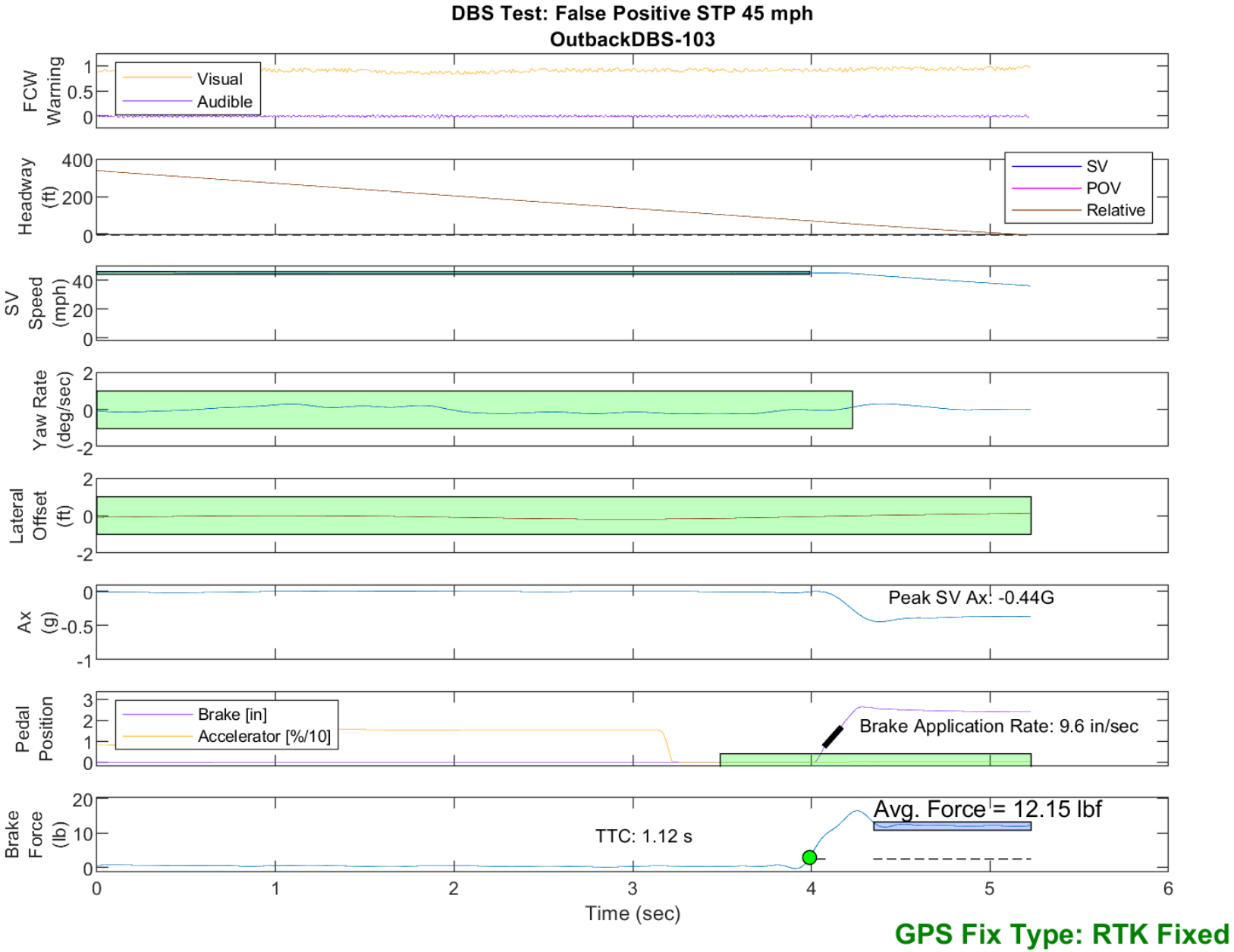


Figure E65. Time History for DBS Run 103, SV Encounters Steel Trench Plate, SV 45 mph

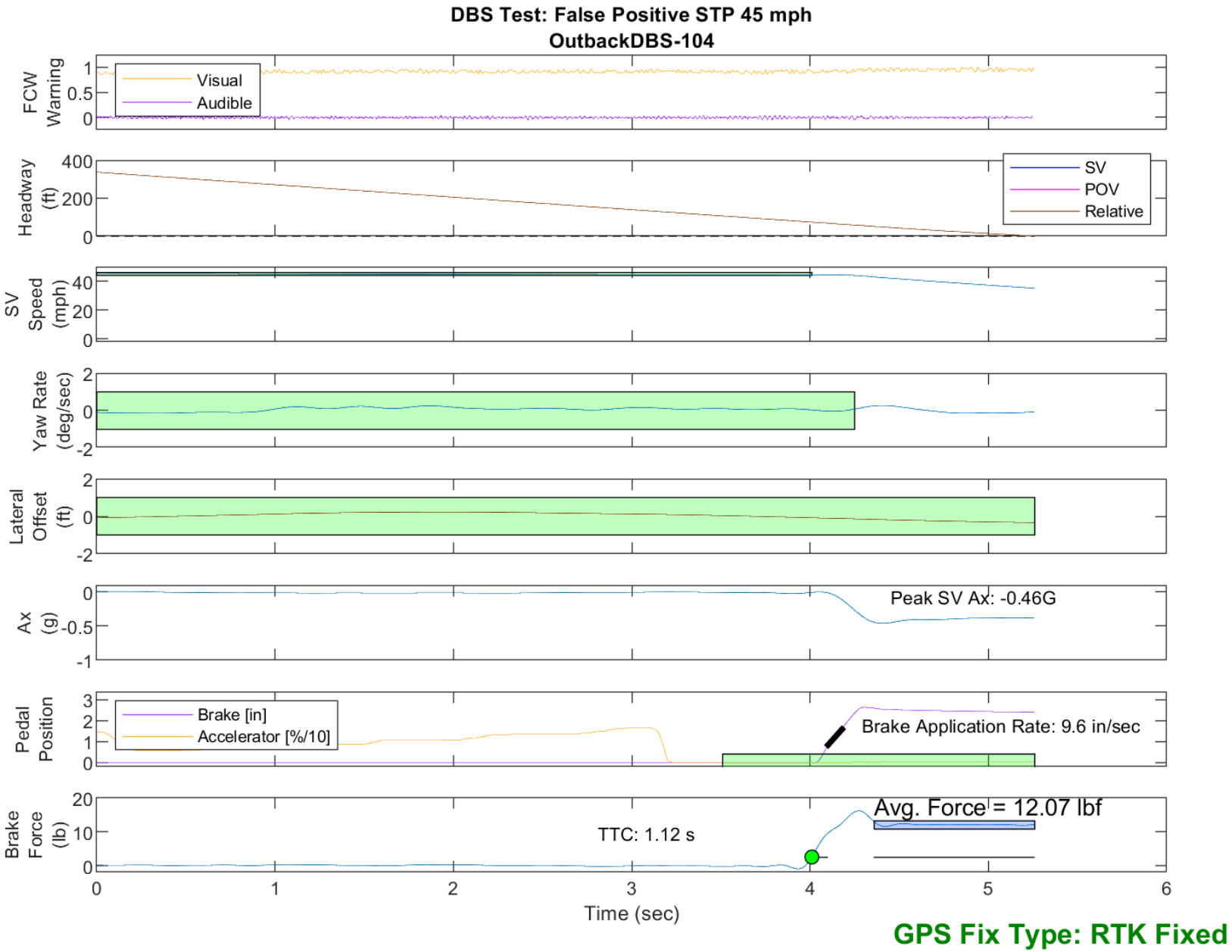


Figure E66. Time History for DBS Run 104, SV Encounters Steel Trench Plate, SV 45 mph

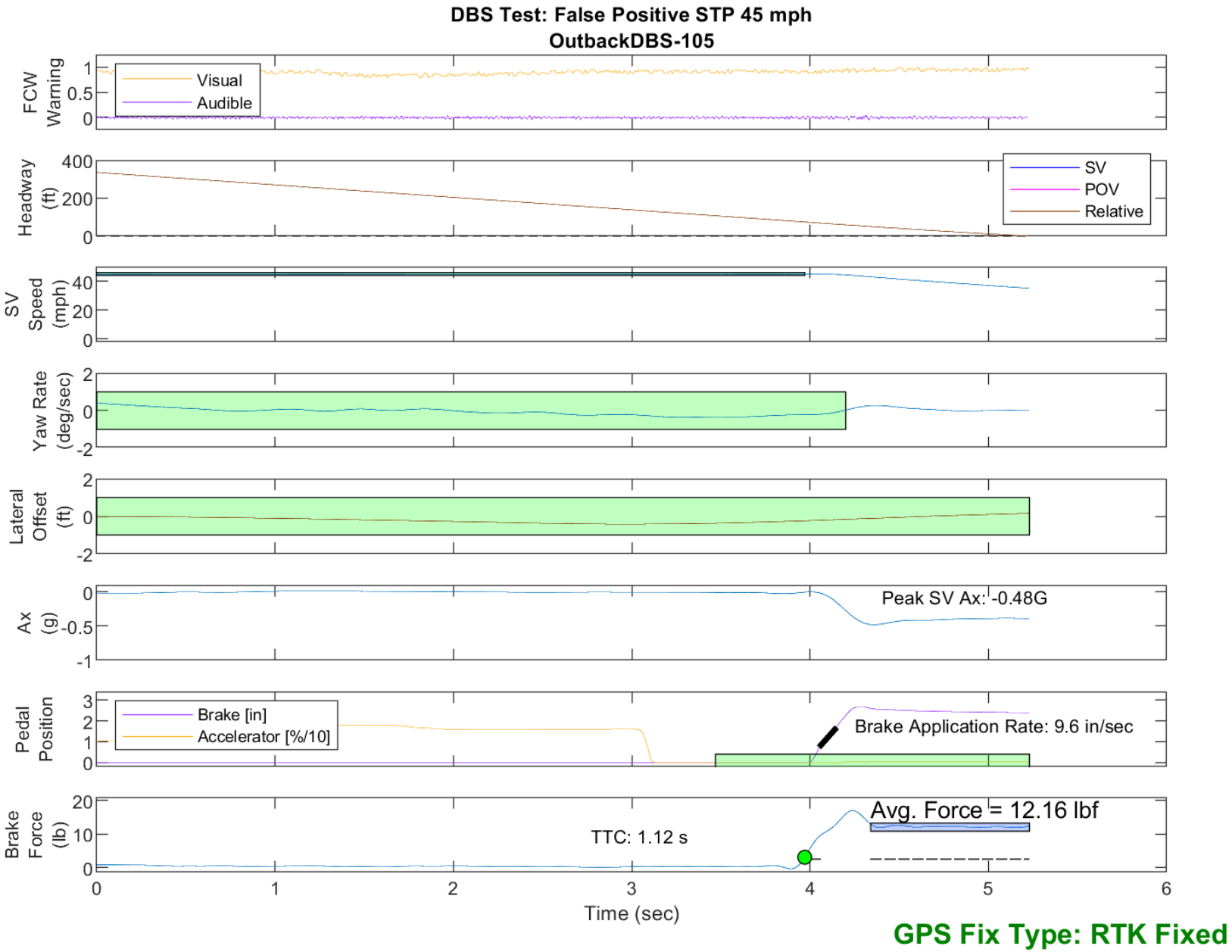


Figure E67. Time History for DBS Run 105, SV Encounters Steel Trench Plate, SV 45 mph

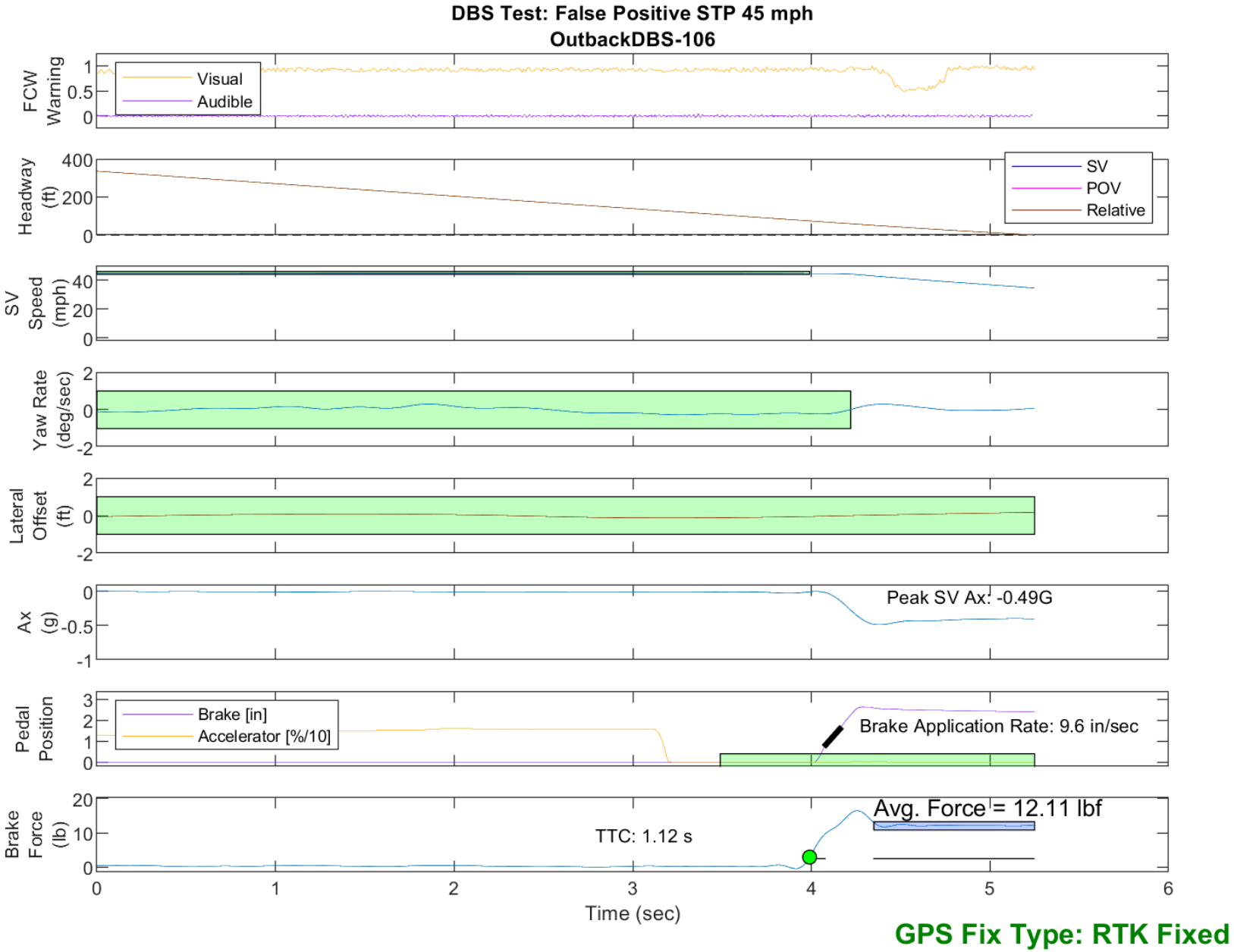


Figure E68. Time History for DBS Run 106, SV Encounters Steel Trench Plate, SV 45 mph

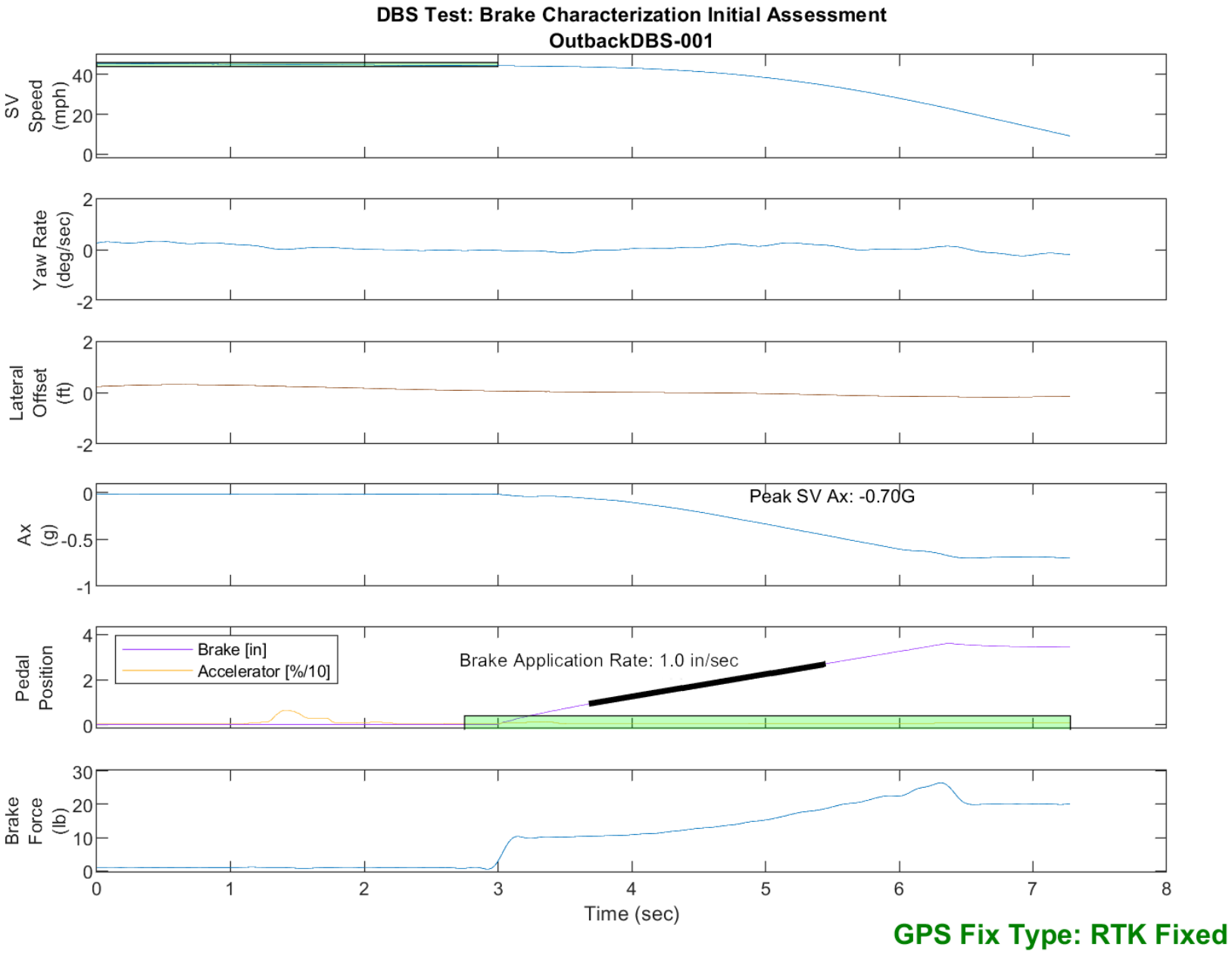


Figure E69. Time History for DBS Run 1, Brake Characterization Initial

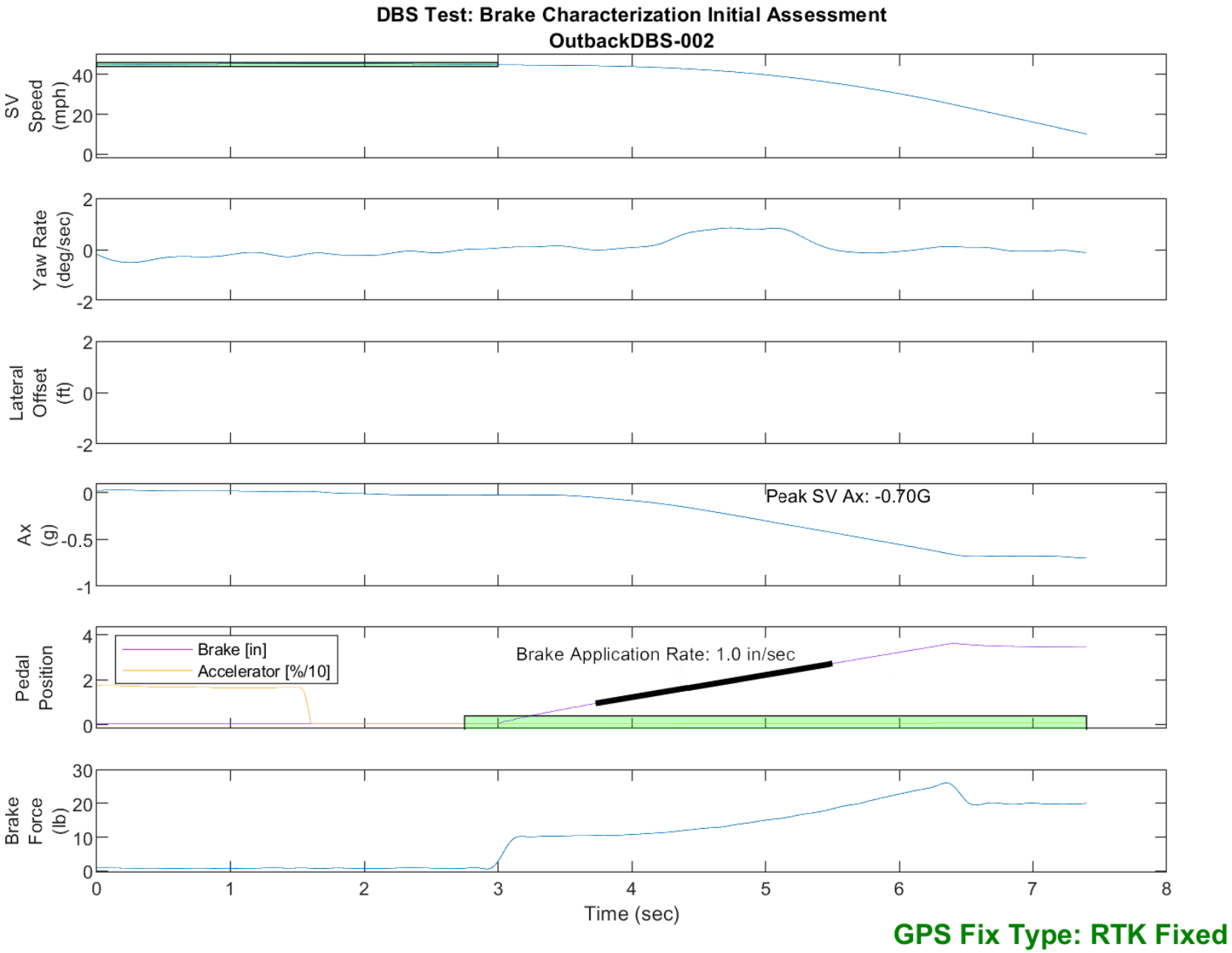


Figure E70. Time History for DBS Run 2, Brake Characterization Initial

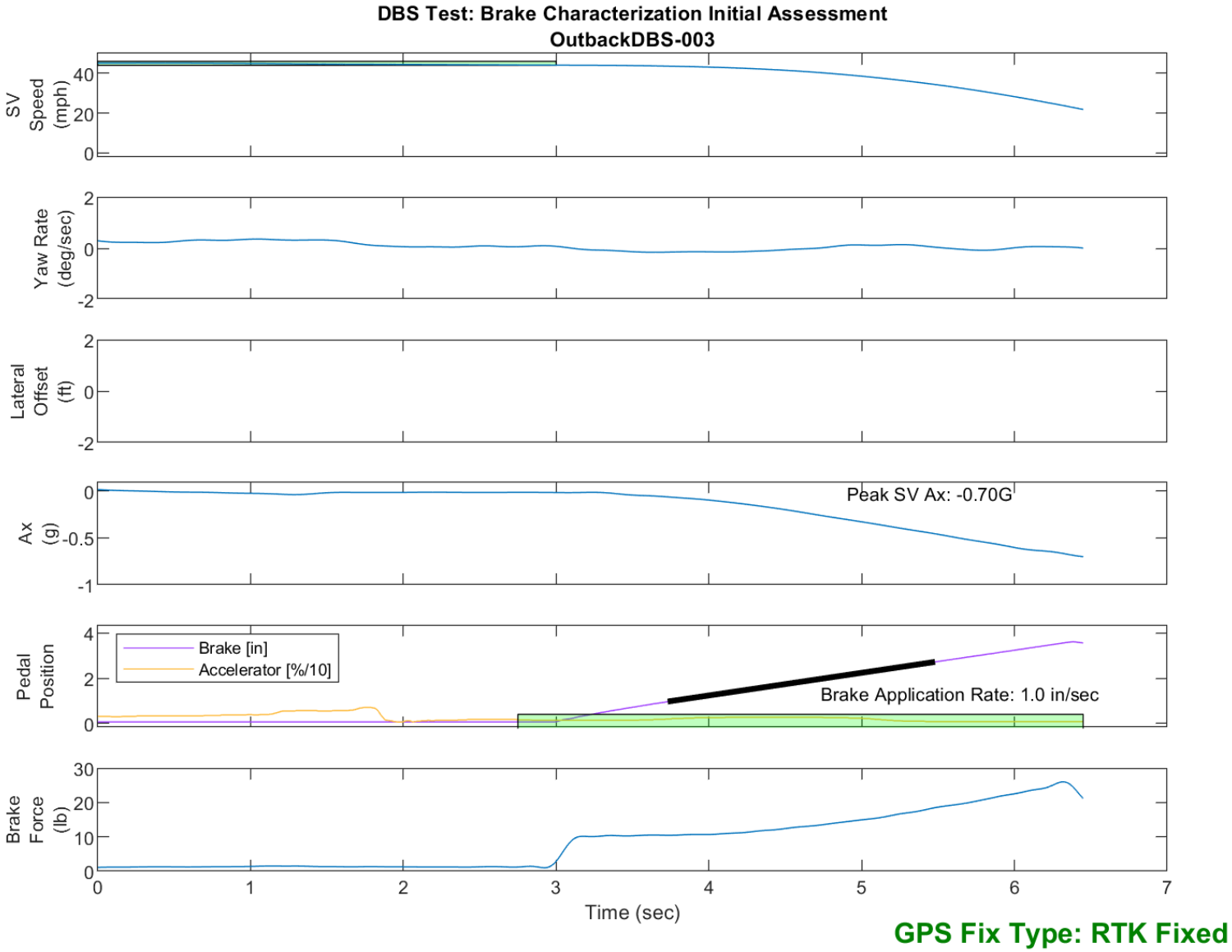


Figure E71. Time History for DBS Run 3, Brake Characterization Initial

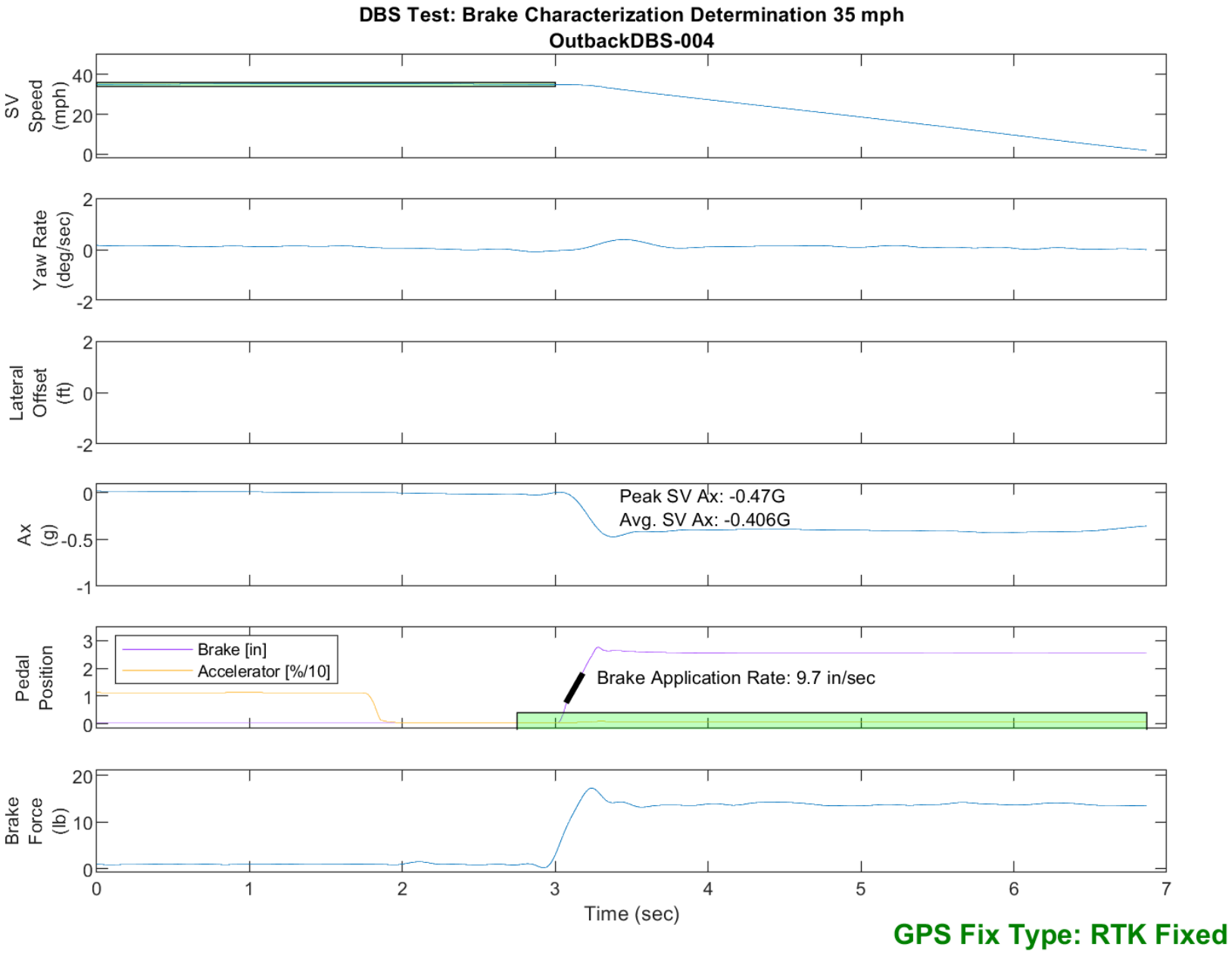


Figure E72. Time History for DBS Run 4, Brake Characterization Determination 35 mph

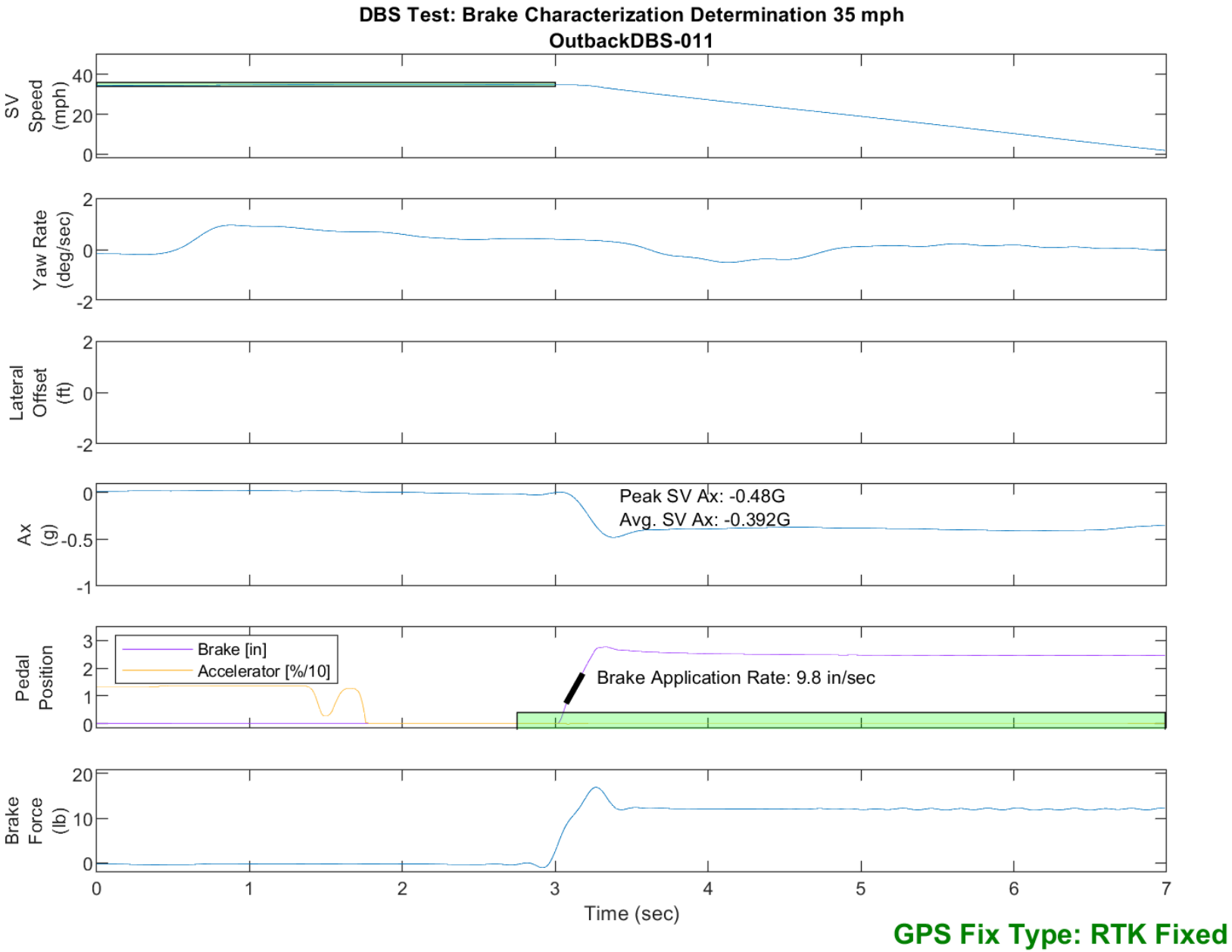


Figure E73. Time History for DBS Run 11, Brake Characterization Determination 35 mph

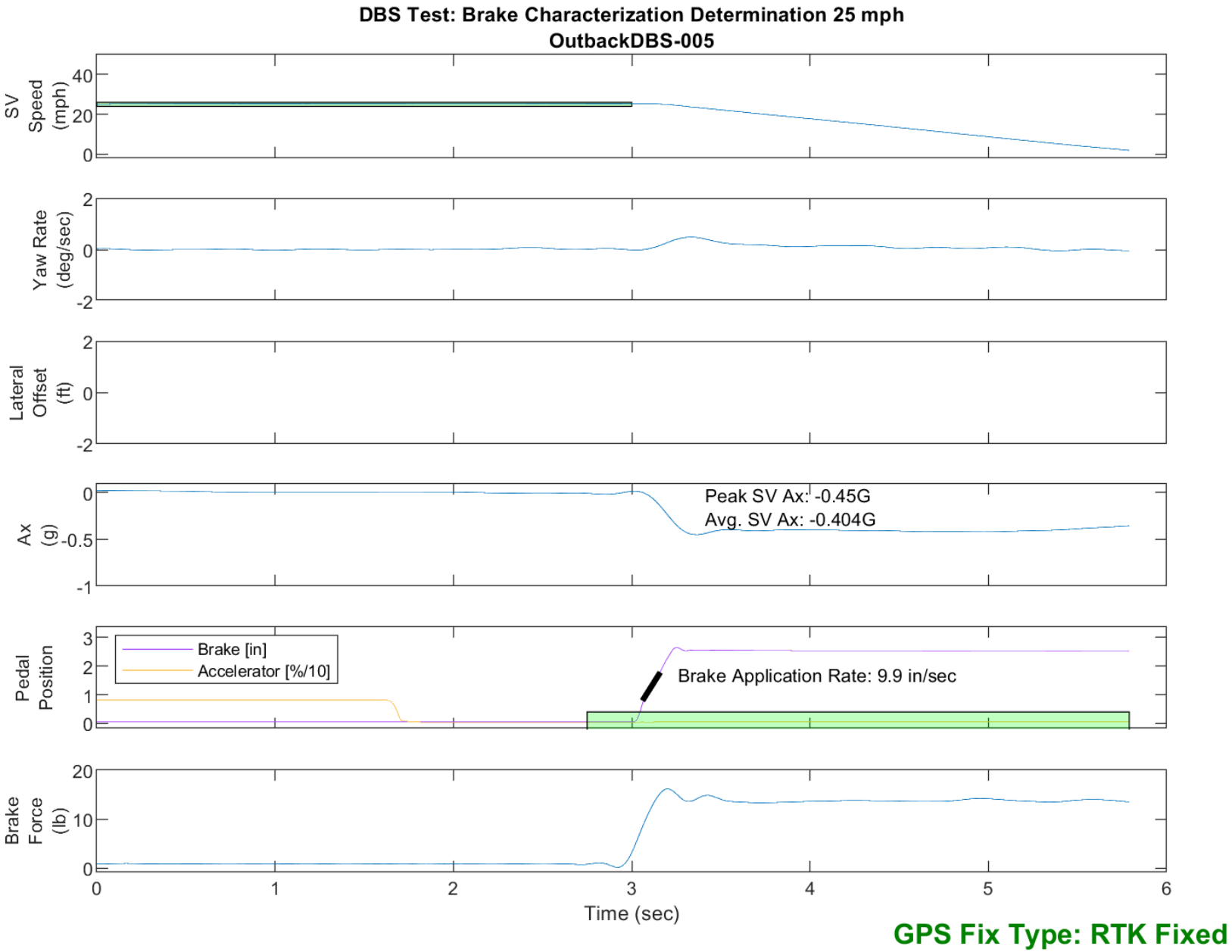


Figure E74. Time History for DBS Run 5, Brake Characterization Determination 25 mph

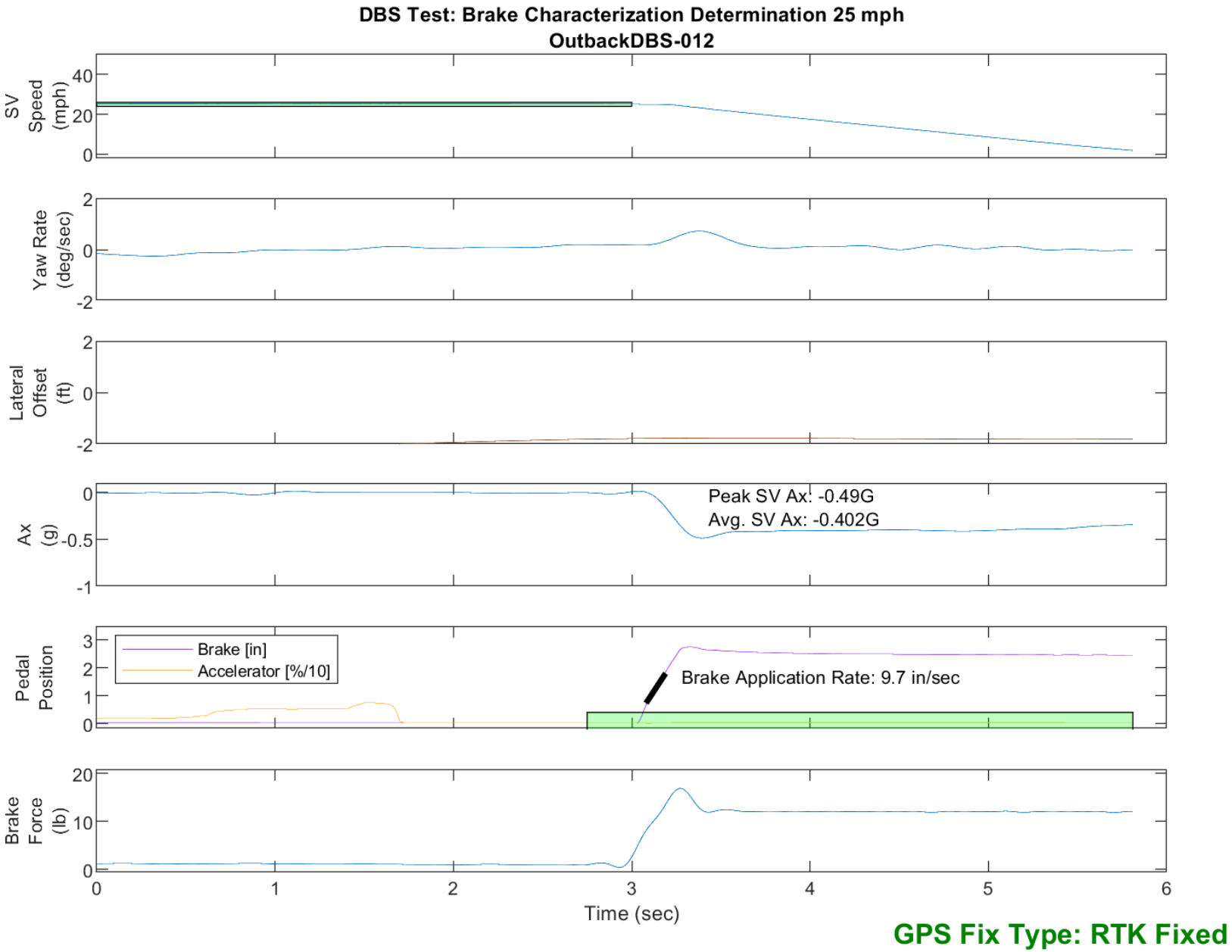


Figure E75. Time History for DBS Run 12, Brake Characterization Determination 25 mph

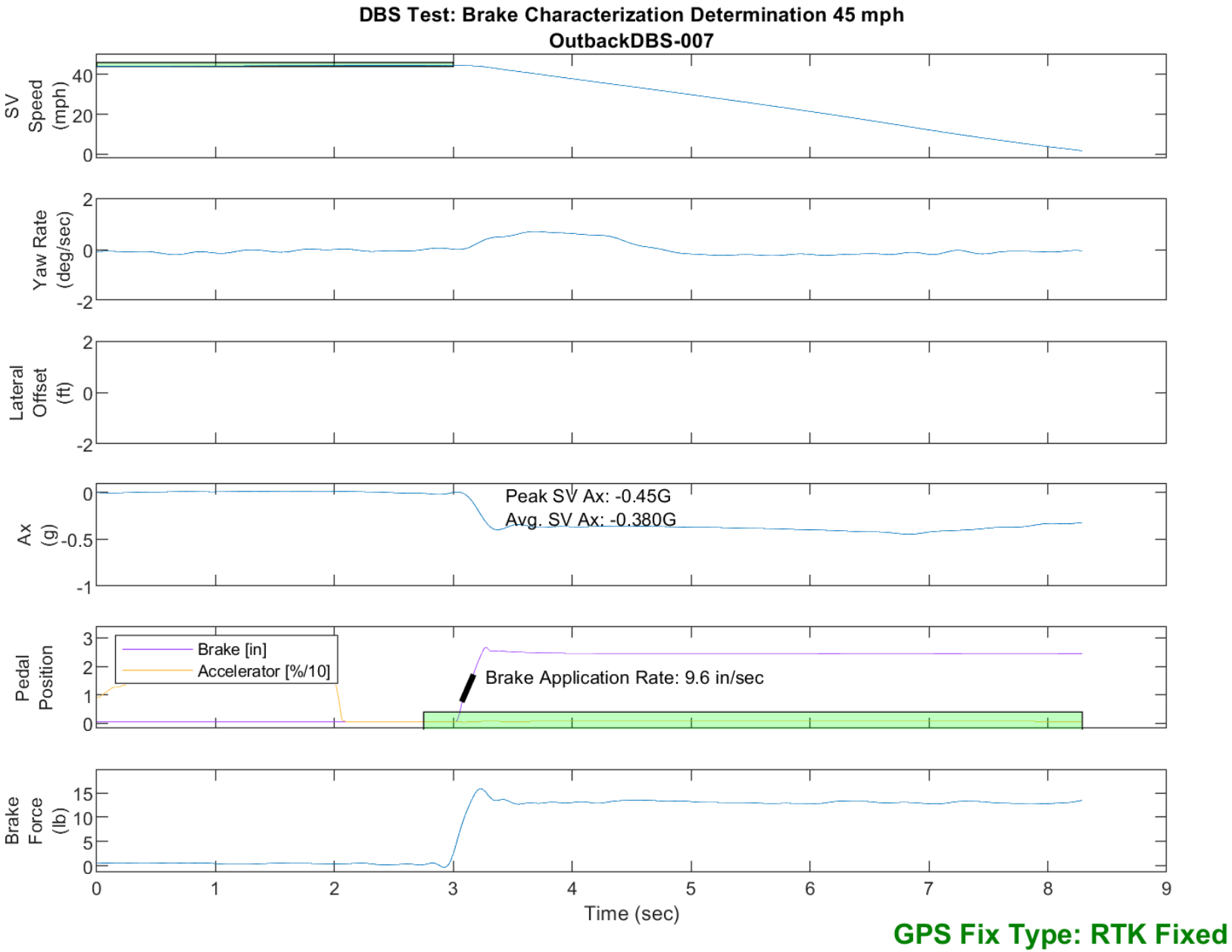


Figure E76. Time History for DBS Run 7, Brake Characterization Determination 45 mph

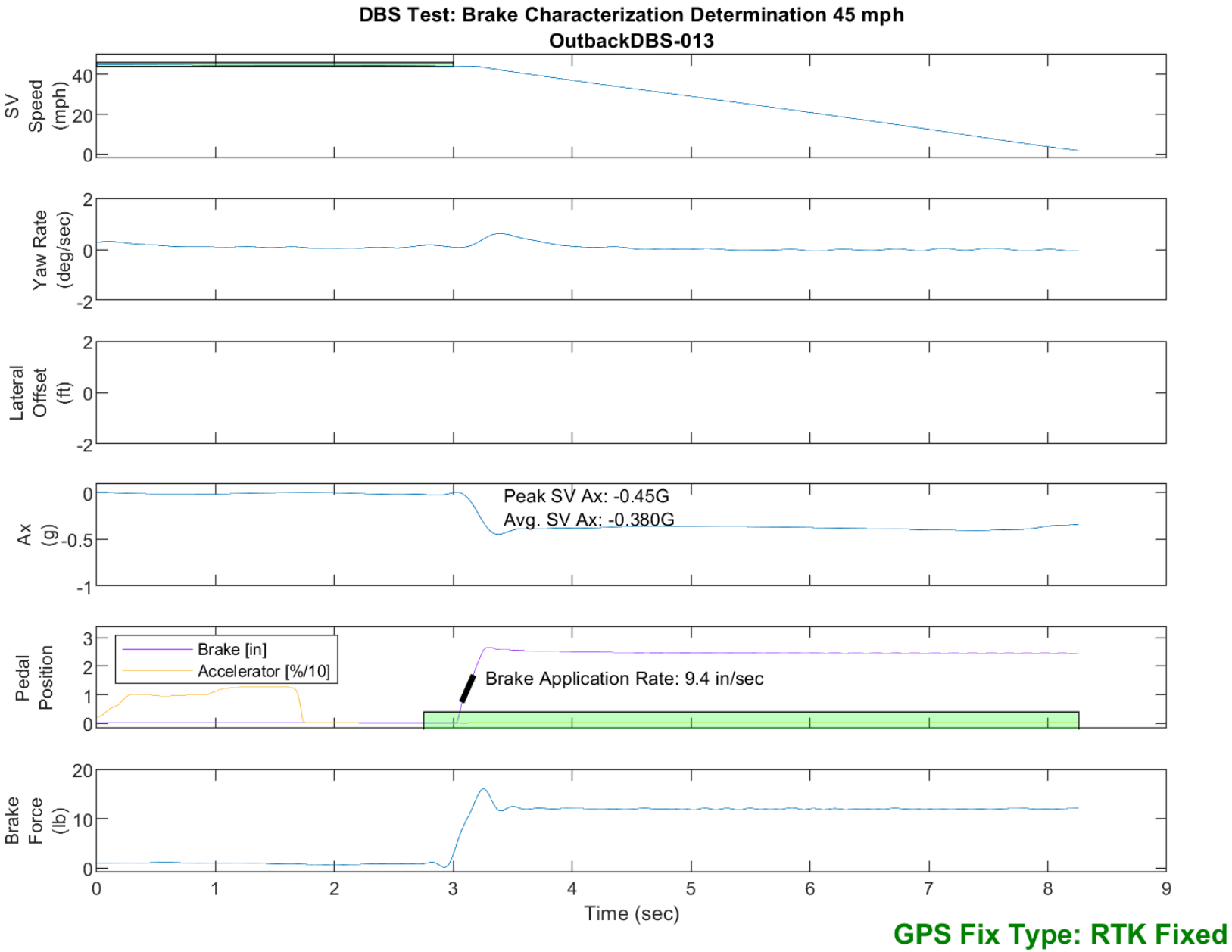


Figure E77. Time History for DBS Run 13, Brake Characterization Determination 45 mph