NEW CAR ASSESSMENT PROGRAM
DYNAMIC BRAKE SUPPORT SYSTEM CONFIRMATION TEST
NCAP-DRI-DBS-20-12

2020 Nissan Altima

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

30 June 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
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Washington, DC 20590

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Prepared By: J. Lenkeit and N. Watanabe

Technical Director Test Engineer

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16. Abstract These tests were conducted on the subject 2020 Nissan Altima 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.			
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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 Nissan Altima . 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

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2020 Nissan Altima

VIN: *1N4BL4DV2LC19xxxx*

Test Date: *2/11/2020*

Dynamic Brake Support System setting: *On (only On and Off are available)*

Test 1 - Subject Vehicle Encounters Stopped Principal Other Vehicle

SV 25 mph: *Pass*

Test 2 - Subject Vehicle Encounters Slower Principal Other Vehicle

SV 25 mph POV 10 mph: *Pass*

SV 45 mph POV 20 mph: *Pass*

Test 3 - Subject Vehicle Encounters Decelerating Principal Other Vehicle

SV 35 mph POV 35 mph: *Pass*

Test 4 - Subject Vehicle Encounters Steel Trench Plate

SV 25 mph: *Pass*

SV 45 mph: *Pass*

Overall: *Pass*

Notes:

DYNAMIC BRAKE SUPPORT

DATA SHEET 2: VEHICLE DATA

2020 Nissan Altima

TEST VEHICLE INFORMATION

VIN: *1N4BL4DV2LC19xxxx*

Body Style: *Sedan* Color: *Gun Metallic*

Date Received: *2/3/2020* Odometer Reading: *22 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Nissan Motor Co., LTD*

Date of manufacture: *10/19*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *215/55R17 94V*

Rear: *215/55R17 94V*

Recommended cold tire pressure: Front: *230 kPa (33 psi)*

Rear: *230 kPa (33 psi)*

TIRES

Tire manufacturer and model: *Continental Procontact TX*

Front tire specification: *215/55R17 V94*

Rear tire specification: *215/55R17 V94*

Front tire DOT prefix: *VY3R WCN5*

Rear tire DOT prefix: *VY3R WCN5*

DYNAMIC BRAKE SUPPORT

DATA SHEET 3: TEST CONDITIONS

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2020 Nissan Altima

GENERAL INFORMATION

Test date: *2/11/2020*

AMBIENT CONDITIONS

Air temperature: *16.1 C (61 F)*

Wind speed: *1.3 m/s (2.9 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: *230 kPa (33 psi)*

Rear: *230 kPa (33 psi)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 3: TEST CONDITIONS

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2020 Nissan Altima

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*490.3 kg (1081 lb)*	Right Front:	*469.5 kg (1035 lb)*
Left Rear:	*344.7 kg (760 lb)*	Right Rear:	*316.2 kg (697 lb)*
		Total:	*1620.7 kg (3573 lb)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

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2020 Nissan Altima

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

Intelligent Forward Collision Warning (i-FCW), which is integrated into Automatic Emergency Braking

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

The system uses a mono front camera installed behind the windscreen near the rearview mirror and a radar sensor located behind the front grille.

System setting used for test (if applicable): *On (only On and Off are available)*

Brake application mode used for test: *Hybrid control*

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

5 km/h (3 mph) (Per manufacturer supplied information)

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

For moving lead vehicle: 200 km/h (125 mph)

For stationary lead vehicle: 80 km/h (50 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 needed. Drive straight above 20 km/h and drive past other vehicles for sensor initialization every ignition reset.

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

If yes, please provide a full description.

The system becomes unavailable after the autonomous braking activates three times during the same ignition cycle. In this case, a warning light appears in the center of combination meter. Recommend ignition OFF and ON after each test.

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.

Visual alert – Presented in the space between the speedometer and tachometer. As shown in Appendix A, Figure A17, the visual alert is presented as a staged series of images as the vehicle gets closer to the vehicle ahead.

Auditory warning – Presented as pulsed beeps at a rate of approximately 4 beeps/second. There are two types of auditory warning; the FCW warning is centered at 1828 Hz and the AEB warning is centered at 2445 Hz.

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.

Controls on the left side of the steering wheel are used to access the system menus. The hierarchy is:

Settings

Driver Assistance

Emergency Brake

Front - select On or Off

See Appendix A, Figure A15

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

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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
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.

System limitations are described on pages 5-134 through 5-136 of the Owner's Manual. These pages are reproduced on pages B-19 through B-21 of Appendix B.

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.

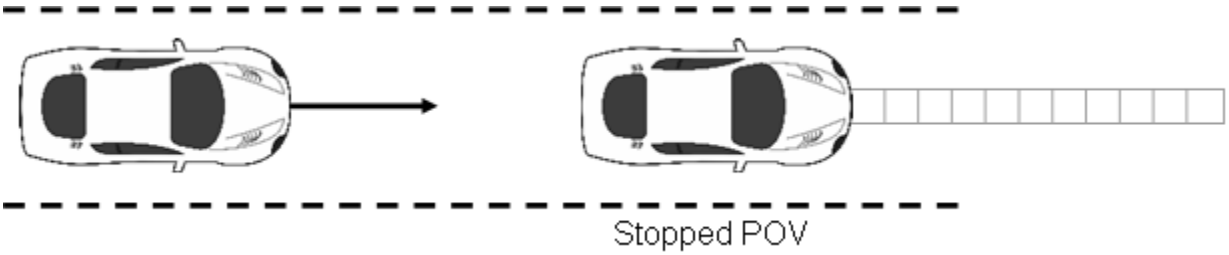


Figure 1. Depiction of Test 1

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-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.

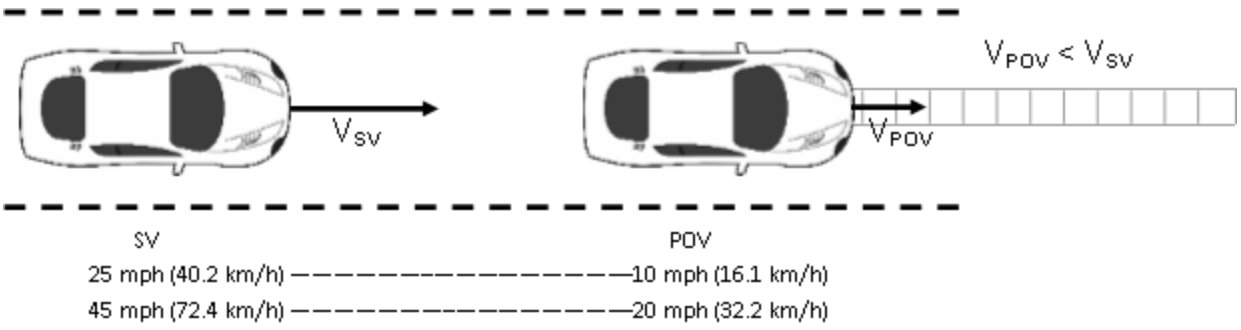


Figure 2. Depiction of Test 2

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-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.

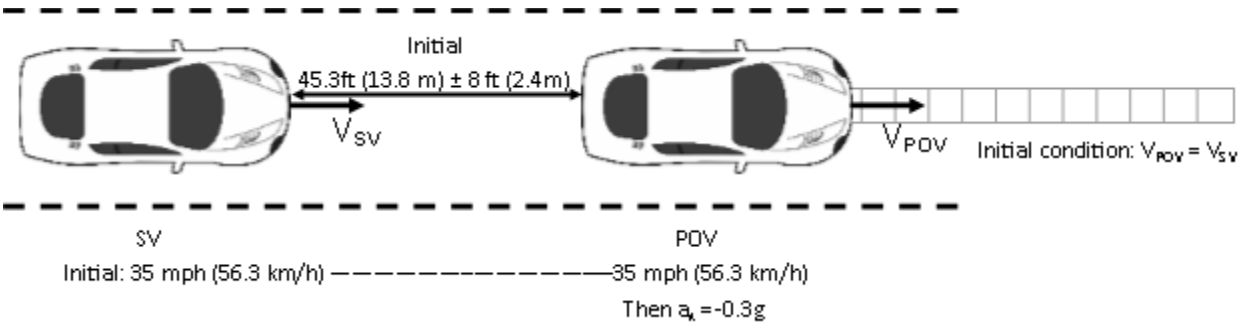


Figure 3. Depiction of Test 3 with POV Decelerating

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

For Tests 1, 2, and 3, the SV was positioned such that it just contacted a vertical plane 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 5338 N/	0.5% of applied load	Intercomp SWI	1110M206352	By: DRI Date: 1/6/2020 Due: 1/6/2021
Linear (string) encoder	Throttle pedal travel	10 in 254 mm	0.1 in 2.54 mm	UniMeasure LX-EP	45040532	By: DRI Date: 5/10/2019 Due: 5/10/2020
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 Rat	Accels .01g, Angular Rate	Oxford Inertial +		By: Oxford Technical Solutions
					2258	Date: 5/3/2019 Due: 5/3/2021
					2176	Date: 4/11/2018 Due: 4/11/2020
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

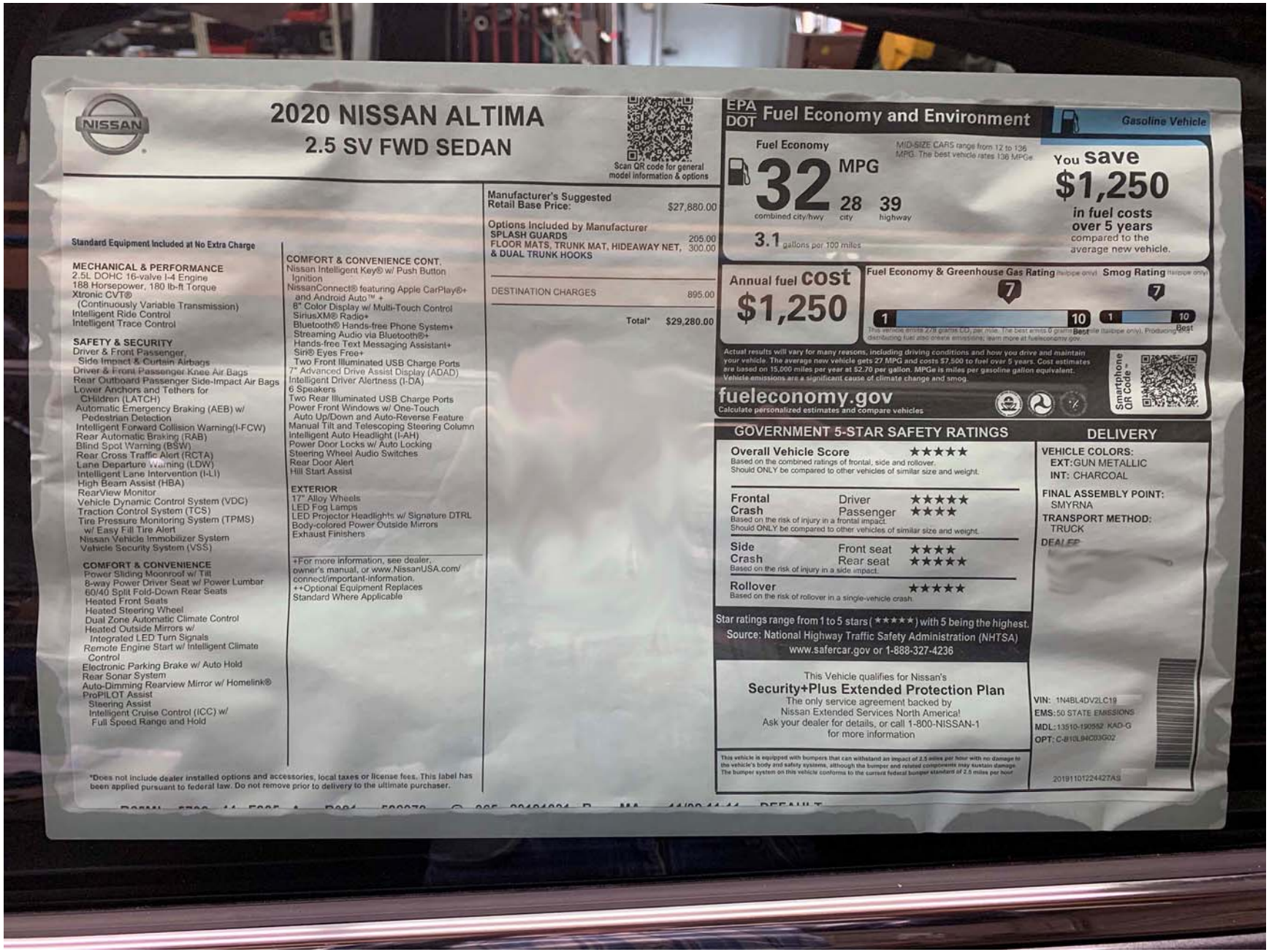


Figure A3. Window Sticker (Monroney Label)

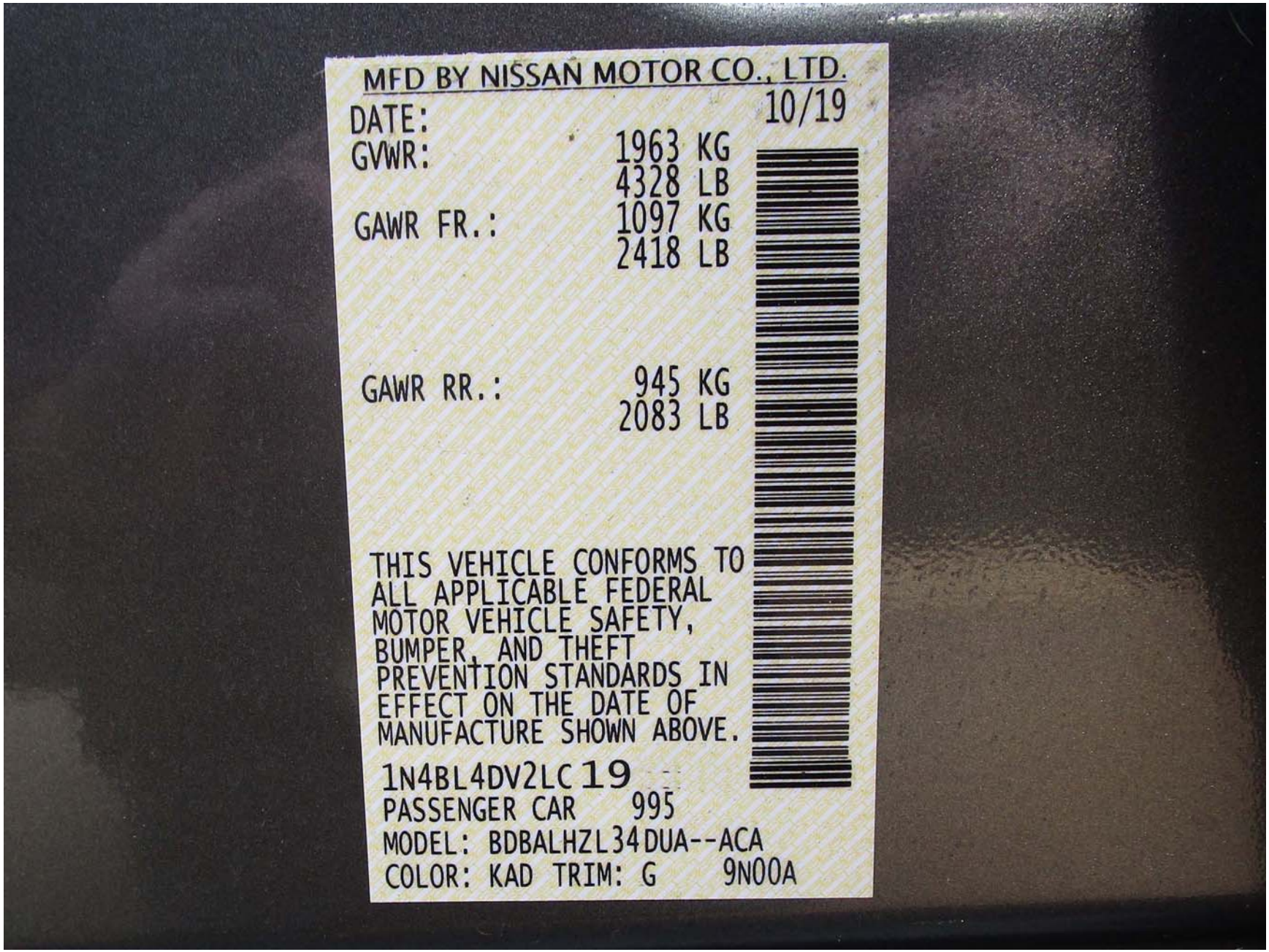


Figure A4. Vehicle Certification Label

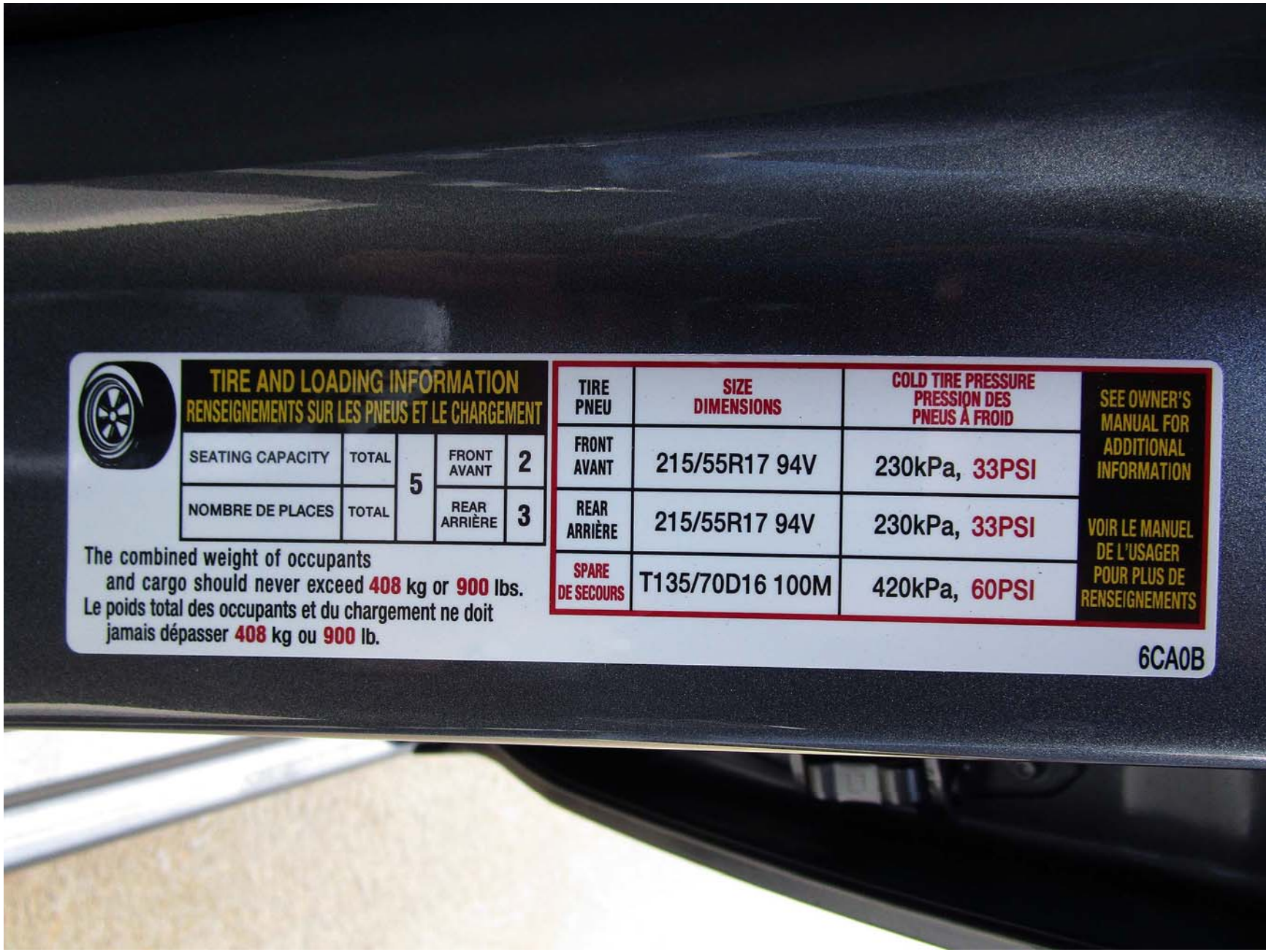


Figure A5. Tire Placard

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

Figure A7. Load Frame/Slider of SSV

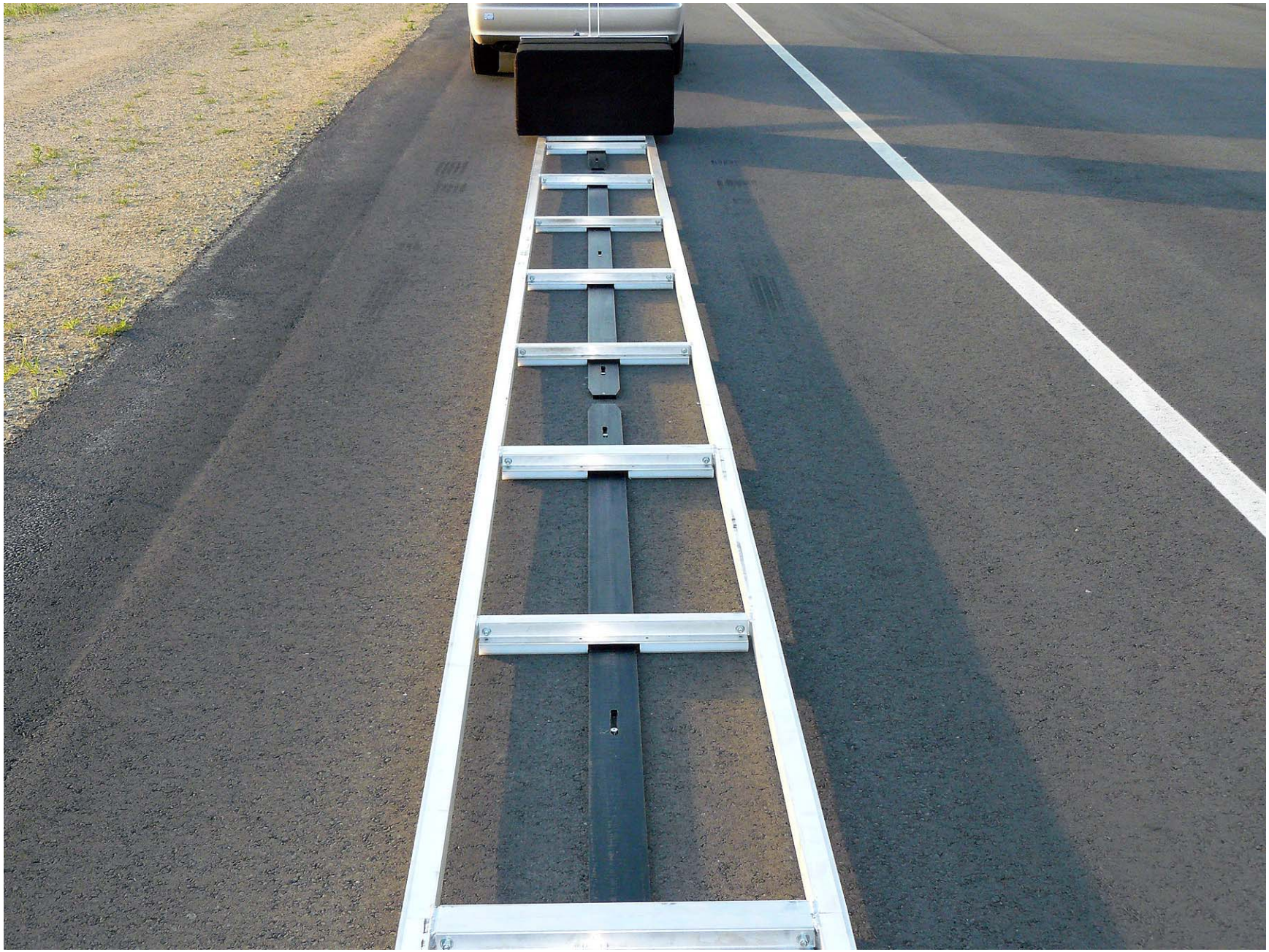


Figure A8. Two-Rail Track and Road-Based Lateral Restraint Track

Figure A9. Steel Trench Plate

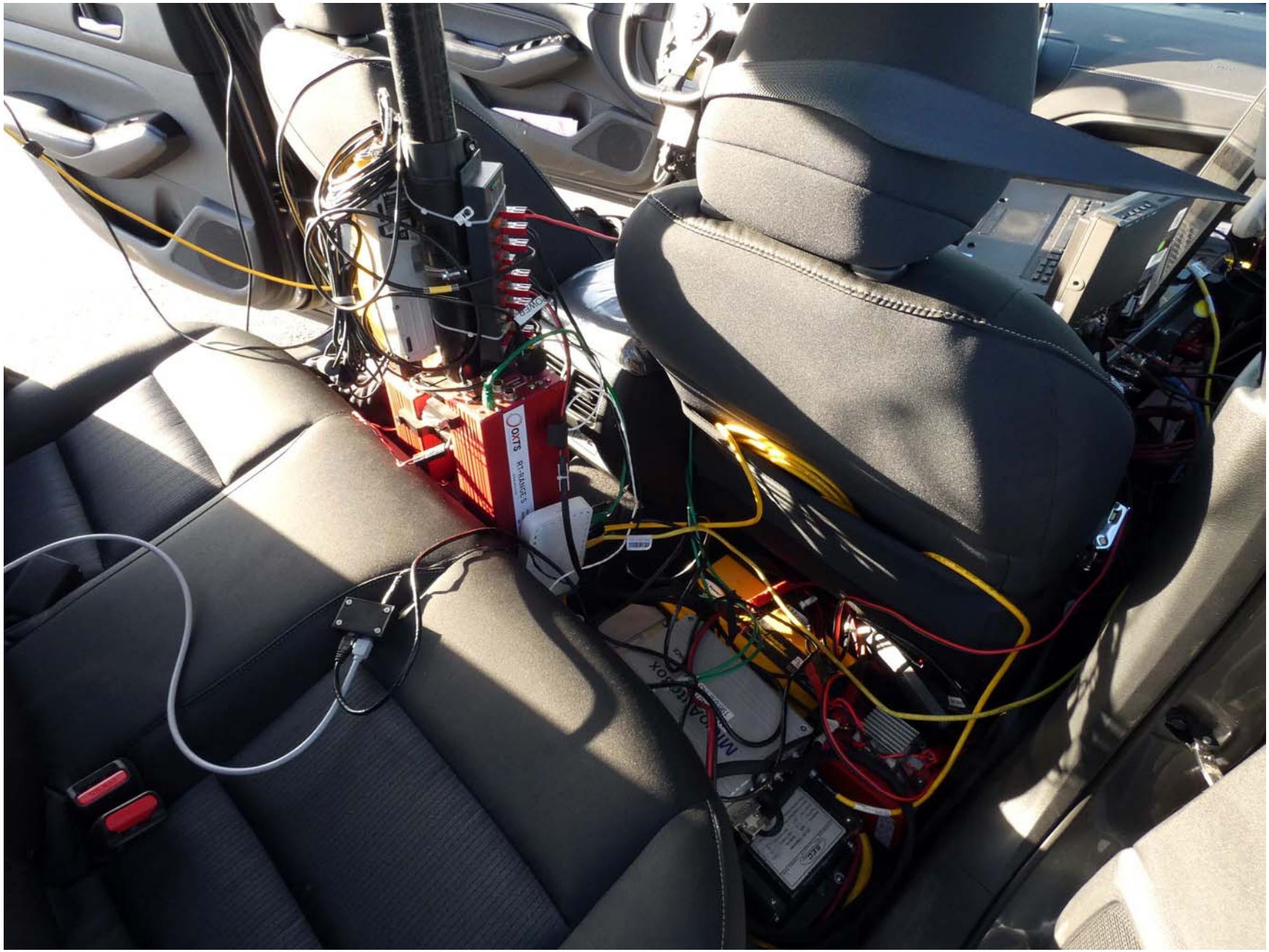


Figure A10. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A11. Sensor for Detecting Visual Alerts

Figure A12. Sensor for Detecting Auditory Alerts

Figure A13. Computer and Brake Actuator Installed in Subject Vehicle

Figure A14. Brake Actuator Installed in POV System

Figure A15. Menu Page for AEB Settings

Figure A16. Controls for Changing Parameters

Figure A17. Staged Visual Alert

APPENDIX B

Excerpts from Owner's Manual

WARNING AND INDICATOR LIGHTS

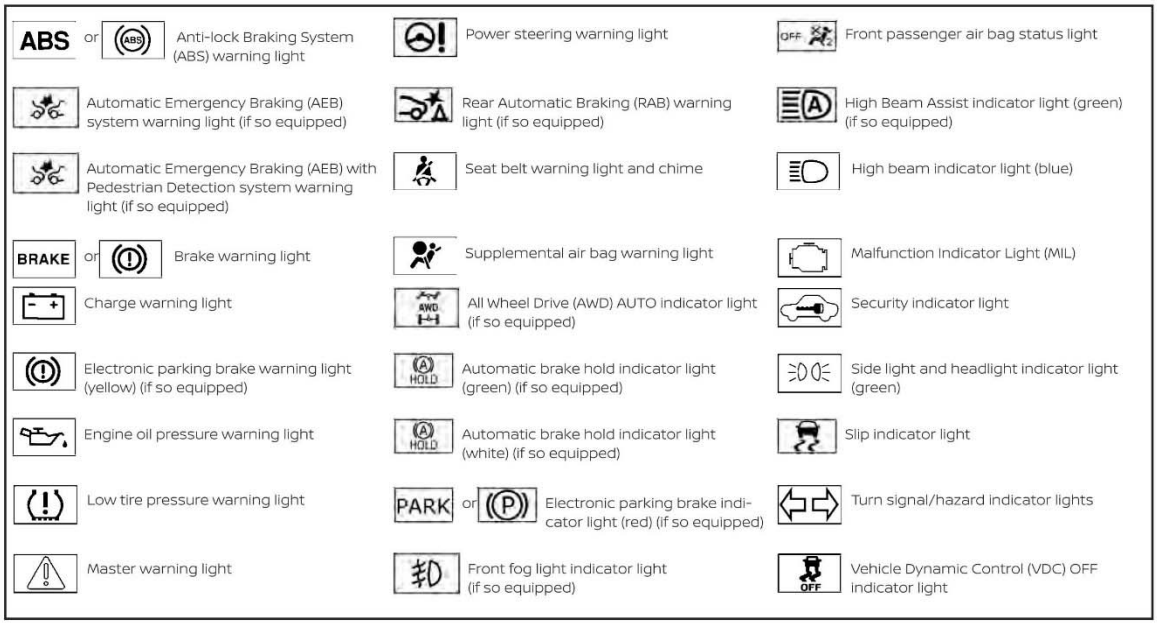
Warning light	Name	Page
ABS or 	Anti-lock Braking System (ABS) warning light	2-10
	Automatic Emergency Braking (AEB) system warning light (if so equipped)	2-10
	Automatic Emergency Braking (AEB) with Pedestrian Detection system warning light (if so equipped)	2-11
BRAKE or 	Brake warning light	2-11

Warning light	Name	Page
	Charge warning light	2-11
	Electronic parking brake warning light (yellow) (if so equipped)	2-12
	Engine oil pressure warning light	2-12
	Low tire pressure warning light	2-12
	Master warning light	2-14
	Power steering warning light	2-14
	Rear Automatic Braking (RAB) warning light (if so equipped)	2-15

Warning light	Name	Page
	Seat belt warning light and chime	2-15
	Supplemental air bag warning light	2-15

Indicator light	Name	Page
	All Wheel Drive (AWD) AUTO indicator light (if so equipped)	2-15
	Automatic brake hold indicator light (green) (if so equipped)	2-16
	Automatic brake hold indicator light (white) (if so equipped)	2-16

WARNING LIGHTS, INDICATOR LIGHTS AND AUDIBLE REMINDERS



CHECKING LIGHTS

With all doors closed, apply the parking brake, fasten the seat belts and place the ignition switch in the ON position without starting the engine. The following lights (if so equipped) will come on:

, , , , , PARK or

The following lights (if so equipped) come on briefly and then go off:

ABS or , , , , , , BRAKE or ,

If any light fails to come on or operate in a way other than described, it may indicate a burned-out bulb and/or a system malfunction. Have the system checked. It is recommended that you visit a NISSAN dealer for this service.

Some indicators and warnings are also displayed in the vehicle information display between the speedometer and tachometer. For additional information, refer to "Vehicle information display" in this section.

WARNING LIGHTS

For additional information on warnings and indicators, refer to "Vehicle information display" in this section.

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

When the ignition switch is placed in the ON position, the ABS warning light illuminates and then turns off. This indicates the ABS is operational.

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

If an ABS malfunction occurs, the anti-lock function is turned off. The brake system then operates normally but without anti-lock assistance. For additional information, refer to "Brake system" in the "Starting and driving" section of this manual.

Automatic Emergency Braking (AEB) system warning light (if so equipped)

This light comes on when the ignition switch is placed in the ON position. It turns off after the vehicle is started.

This light illuminates when the AEB system is set to OFF on the meter display.

If the light illuminates when the AEB system is on, it may indicate that the system is unavailable. For additional information, refer to "Automatic Emergency Braking (AEB)" and "Intelligent Forward Collision Warning (I-FCW)" in the "Starting and driving" section of this manual.

Automatic Emergency Braking (AEB) with Pedestrian Detection system warning light (if so equipped)

This light comes on when the ignition switch is placed in the ON position. It turns off after the engine is started.

This light illuminates when the AEB with Pedestrian Detection system is set to OFF in the vehicle information display.

If the light illuminates when the AEB with Pedestrian Detection system is on, it may indicate that the system is unavailable. For additional information, refer to "Automatic Emergency Braking (AEB) with Pedestrian Detection" and "Intelligent Forward Collision Warning (I-FCW)" in the "Starting and driving" section of this manual.

BRAKE or Brake warning light

This light functions for both the parking brake and the foot brake systems.

Parking brake indicator (if so equipped)

When the ignition switch is placed in the ON position, the light comes on when the parking brake is applied.

Low brake fluid warning light

When the ignition switch is placed in the ON position, the light warns of a low brake fluid level. If the light comes on while the engine is running with the parking brake not applied, stop the vehicle and perform the following:

1. Check the brake fluid level. Add brake fluid as necessary. For additional information, refer to "Brake fluid" in the "Do-it-yourself" section of this manual.
2. If the brake fluid level is correct, have the warning system checked. It is recommended that you visit a NISSAN dealer for this service.

⚠ WARNING

- **Your brake system may not be working properly if the warning light is on. Driving could be dangerous. If you judge it to be safe, drive carefully to the nearest service station for repairs. Otherwise, have your vehicle towed because driving it could be dangerous.**
- **Pressing the brake pedal with the engine stopped and/or a low brake fluid level may increase your stopping distance and braking will require greater pedal effort as well as pedal travel.**
- **If the brake fluid level is below the MINIMUM or MIN mark on the brake fluid reservoir, do not drive until the brake system has been checked. It is recommended that you visit a NISSAN dealer for this service.**

Charge warning light

If this light comes on while the engine is running, it may indicate the charging system is not functioning properly. Turn the engine off and check the generator belt. If the belt is loose, broken, or missing, or if the light remains on, have the system checked.

Driver Assistance

The driver assistance menu allows the user to change the settings for driving, parking, and braking aids.

Menu item		Result
Steering Assist (if so equipped)		Allows user to turn the Steering Assist of the ProPILOT Assist system on or off. For additional information, please refer to "ProPILOT Assist" in the "Starting and driving" section of this manual.
Emergency Brake		Displays available emergency braking options.
	Front	Allows user to turn the front emergency braking system on or off. For additional information, refer to "Automatic Emergency Braking (AEB)" , "Automatic Emergency Braking (AEB) with Pedestrian Detection" and "Intelligent Forward Collision Warning (I-FCW)" in the "Starting and driving" section of this manual.
	Rear (if so equipped)	Allows user to turn the rear emergency braking system on or off. For additional information, refer to "Rear Automatic Braking (RAB)" in the "Starting and driving" section of this manual.
Lane (if so equipped)		Displays available lane options.
	Lane Departure Warning	Allows user to turn the Lane Departure Warning (LDW) system on or off. For additional information, refer to "Lane Departure Warning (LDW)" in the "Starting and driving" section of this manual.
	Lane Departure Prevention (if so equipped)	Allows user to turn Intelligent Lane Intervention (I-LI) system on or off. For additional information, refer to "Intelligent Lane Intervention (I-LI)" in the "Starting and driving" section of this manual.
Blind Spot (if so equipped)		Displays available blind spot options.
	Blind Spot Warning	Allows user to turn the Blind Spot Warning (BSW) system on or off. For additional information, refer to "Blind Spot Warning (BSW)" in the "Starting and driving" section of this manual.
	Side Indicator Brightness	Allows user to change the brightness of the side indicator.
Speed Limit Sign (if so equipped)		Allows user to turn the Speed Limit Sign recognition on or off. For additional information, refer to "Traffic Sign Recognition" in the "Starting and driving" section of this manual.
Parking Aids (if so equipped)		Displays available parking aids.
	Auto Show Sonar	Allows user to auto display the sonar. For additional information, refer to "Rear Sonar System (RSS)" in the "Starting and driving" section of this manual.
	Rear	Allows user to turn the rear sonar on or off.
	Distance	Allows user to set the distance sensor range to Long/Medium/Short.

VEHICLE INFORMATION DISPLAY INDICATORS

Indicator	Name
	Automatic Emergency Braking (AEB) emergency warning indicator
	Blind Spot Warning (BSW) indicator (if so equipped)
	Cruise control indicator (if so equipped)
	Drive sport mode indicator (if so equipped)
	Intelligent Lane Intervention (I-LI) indicator (if so equipped)
	Lane Departure Warning indicator (if so equipped)

Indicator	Name
	Rear Automatic Braking (RAB) indicator (if so equipped)
	Steering Assist Alert (if so equipped)
	Steering Assist indicator (if so equipped)
	Transmission Shift position indicator
	Vehicle ahead detection indicator

Automatic Emergency Braking (AEB) emergency warning indicator

This indicator illuminates along, with an audible warning, when the system detects the possibility of a forward collision.

For additional information, refer to "Automatic Emergency Braking (AEB)" and "Automatic Emergency Braking (AEB) with Pedestrian Detection" in the "Starting and driving" section of this manual.

Blind Spot Warning (BSW) indicator (if so equipped)

This indicator shows when the BSW system is engaged.

For additional information, refer to "Blind Spot Warning (BSW)" in the "Starting and driving" section of this manual.

Cruise control indicator (if so equipped)

This indicator shows the cruise control system status.

When cruise control is activated, a green circle will illuminate to indicate it is set. The vehicle information display will also display the speed the cruise control was set at. If you accelerate past the set speed, the speed will blink until you either cancel cruise control or go back to the set speed. If cruise control is on and canceled, the speed will be displayed to show the speed the vehicle will return to if the resume button is activated.

Drive sport mode indicator (if so equipped)

A small "S" appears to the right of the Transmission Shift Position indicator in the vehicle information display when the drive sport mode is engaged.

Activate the drive sport mode by pushing the switch on the shift lever while the shift lever is in the D (Drive) position.

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

Intelligent Lane Intervention (I-LI) indicator (if so equipped)

This indicator shows when the I-LI system is engaged.

For additional information, refer to "Intelligent Lane Intervention (I-LI)" in the "Starting and driving" section of this manual.

Lane Departure Warning (LDW) indicator (if so equipped)

This indicator shows when the LDW system is engaged.

For additional information, refer to "Lane Departure Warning (LDW)" and "Intelligent Lane Intervention (I-LI)" in the "Starting and driving" section of this manual.

Rear Automatic Braking (RAB) indicator (if so equipped)

This indicator illuminates to indicate the status of the Rear Automatic Braking (RAB) system. For additional information, refer to "Rear Automatic Braking (RAB)" in the "Starting and driving" section of this manual.

Steering Assist Alert (if so equipped)

This message may appear when the Steering Assist system is engaged.

It will be displayed under the following condition:

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

Please hold on the steering wheel immediately. When the steering operation is detected, the warning turns off and the steering assist function is automatically restored.

Steering Assist indicator (if so equipped)

This indicator appears when the Steering Assist system is engaged.

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

Transmission Shift Position indicator

This indicator shows the transmission shift position.

Vehicle ahead detection indicator

This indicator shows when the Automatic Emergency Braking (AEB) system is engaged and has detected a vehicle.

For additional information, refer to "Automatic Emergency Braking (AEB)" or "Automatic Emergency Braking (AEB) with Pedestrian Detection" in the "Starting and driving" section of this manual.

Malfunction (if so equipped)

This warning appears when one or more of the following systems (if so equipped) is not functioning properly:

- Automatic Emergency Braking (AEB)
- Automatic Emergency Braking (AEB) with Pedestrian Detection
- Intelligent Forward Collision Warning (I-FCW)

If one or more of these warning appears, have the system checked. It is recommended that you visit a NISSAN dealer for this service.

For additional information, refer to "Automatic Emergency Braking (AEB)", "Automatic Emergency Braking (AEB) with Pedestrian Detection" or "Intelligent Forward Collision Warning (I-FCW) in the "Starting and driving" section of this manual.

Shipping Mode On Push Storage Fuse

This warning may appear if the extended storage switch is not pushed in. When this warning appears, push in the extended storage switch to turn off the warning. For additional information, refer to "Extended storage switch" in this section.

Not Available Parking Brake On (if so equipped)

This message may appear when the Intelligent Cruise Control (ICC) (for vehicles with ProPILOT Assist) is engaged.

Under the following condition, the ICC (for vehicles with ProPILOT Assist) system is automatically canceled:

- The electronic parking brake is applied.

The above system cannot be used when the electronic parking is activated.

For additional information, refer to "Intelligent Cruise Control (ICC) (for vehicles with ProPILOT Assist)" and "Parking brake" in the "Starting and driving" section of this manual.

Rear Door Alert is activated

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

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

⚠ WARNING

Selecting "Dismiss Message" during a stop within a trip temporarily dismisses the message for that stop without turning the system off. Alerts can be provided for other stops during the trip. Selecting "Disable Alert" turns off the Rear Door Alert system for the remainder of a trip and no audible alert will be provided.

NOTE:

This system is disabled until a driver enables it using the vehicle information display. For additional information, refer to "How to use the vehicle information display" in this section.

For additional information, refer to "Rear Door Alert" in this section.

Check Rear Seat For All Articles

When the system is enabled, this message appears when the vehicle comes to a complete stop, the vehicle is transitioned from

The above system cannot be used when the driver's seat belt is not fastened.

Not Available: Front Radar Blocked (if so equipped)

This message appears when the Intelligent Cruise Control (ICC) systems, the Automatic Emergency Braking (AEB) system, the Automatic Emergency Braking (AEB) with Pedestrian Detection system, or the Intelligent Forward Collision Warning (I-FCW) system becomes unavailable because the front radar is obstructed. For additional information, refer to "Intelligent Cruise Control (ICC) (for vehicles without ProPILOT Assist)", "Intelligent Cruise Control (ICC) (for vehicles with ProPILOT Assist)", "Automatic Emergency Braking (AEB)", "Automatic Emergency Braking (AEB) with Pedestrian Detection" or "Intelligent Forward Collision Warning (I-FCW)" in the "Starting and driving" section of this manual.

Currently not available (if so equipped)

This message may appear when the Intelligent Cruise Control (ICC) (with ProPILOT Assist) system , the ICC system or the Intelligent Lane Intervention (I-LI) system is engaged.

Under the following conditions, the ICC (with ProPILOT Assist) , the ICC system or the Intelligent Lane Intervention (I-LI) system is automatically canceled:

- When the VDC operates
- When a wheel slips
- When the VDC system is turned off

The above system cannot be used in some situations (VDC operates, wheel slip and VDC system is off.)

Not Available Poor Road Conditions (if so equipped)

This message may appear when the Intelligent Cruise Control (ICC) (with ProPILOT Assist) system , the ICC system or the Intelligent Lane Intervention (I-LI) system is engaged.

Under the following conditions, the ICC (with ProPILOT Assist) , the ICC system or the Intelligent Lane Intervention (I-LI) system is automatically canceled:

- When the VDC operates
- When a wheel slips

The above system cannot be used in some situations (VDC operates and wheel slip.)

AWD Error: See Owner's Manual (if so equipped)

This warning appears when the all-wheel drive system is not functioning properly while the engine is running.

AWD High Temp. Stop vehicle (if so equipped)

This warning may appear while trying to free a stuck vehicle due to increased oil temperature. The driving mode may change to 2-Wheel Drive (2WD). If this warning is displayed, stop the vehicle with the engine idling, as soon as it is safe to do so. Then if the warning turns off, you can continue driving.

AWD Tire Size Incorrect: See Owner's Manual (if so equipped)

This warning may appear if there is a large difference between the diameters of the front and rear wheels. Pull off the road in a safe area, with the engine idling. Check that all the tire sizes are the same, that the tire pressure is correct and that the tires are not excessively worn.

⚠ CAUTION

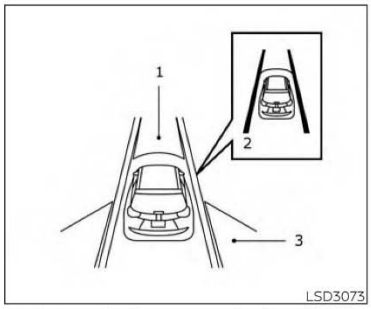
- **Except in an emergency, do not shift to the N (Neutral) position while driving. Coasting with the transmission in the N (Neutral) position may cause serious damage to the transmission.**
- **To avoid possible damage to your vehicle, when stopping the vehicle on an uphill grade, do not hold the vehicle by depressing the accelerator pedal. The foot brake should be used for this purpose.**

The CVT in your vehicle is electronically controlled to produce maximum power and smooth operation.

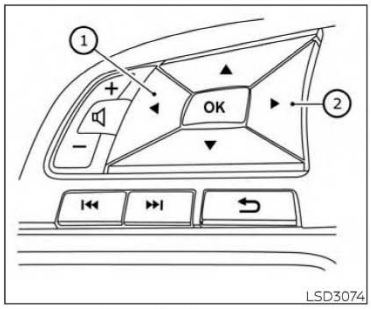
Follow these procedures for maximum vehicle performance and driving enjoyment.

NOTE:

Engine power may be automatically reduced to protect the CVT if the engine speed increases quickly when driving on slippery roads or while being tested on some dynamometers.



1. Automatic Emergency Braking (AEB)
2. Lane Departure Warning (LDW) when shaded and Intelligent Lane Intervention (I-LI) when solid
3. Blind Spot Warning (BSW)



Starting the vehicle

1. After starting the engine, fully depress the foot brake pedal before moving the shift lever out of the P (Park) position. **The Continuously Variable Transmission is designed so the foot brake pedal MUST be depressed before shifting from P (Park) to any drive position while the ignition switch is in the ON position.The shift lever cannot be moved out of P (Park) and into any of the other gear positions if the ignition switch is placed in the LOCK position.**

- **Vehicle-to-vehicle distance control mode:** The ICC system maintains a selected distance from the vehicle in front of you within the speed range of 0 to 90 mph (0 to 144 km/h) up to the set speed. The set speed can be selected by the driver between 20 to 90 mph (32 to 144 km/h). When the vehicle ahead slows to a stop, your vehicle gradually decelerates to a standstill. When the vehicle is stopped, the ICC system maintains braking force to keep your vehicle stopped.

NOTE:

When your vehicle is stopped for less than 3 seconds and the vehicle ahead begins to move, your vehicle will start moving again automatically.

- When your vehicle is at a standstill for more than 3 seconds and the vehicle ahead begins to accelerate, push the RES+ switch or lightly depress the accelerator pedal. The ICC system starts to follow the vehicle ahead.
- When no vehicle is detected ahead within the driver selected distance, the vehicle travels at the speed set by the driver. The speed must be above 20 mph (32 km/h) to use this function.

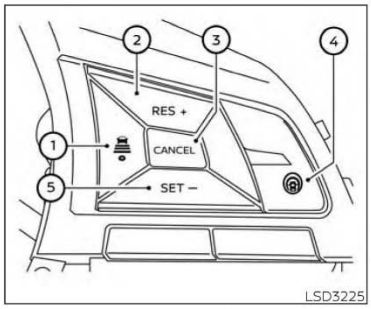
NOTE:

Even if the Automatic Emergency Braking (AEB) setting is turned off by the driver using the "Settings" menu in the vehicle information display, AEB will be automatically turned on when ICC is used.

2. **Steering Assist**

   The Steering Assist function controls the steering system to help keep your vehicle within the traveling lane.

   When there is no vehicle ahead, Steering Assist is not available at speeds under 37 mph (60 km/h).



ProPILOT Assist switches

① **DISTANCE switch:**

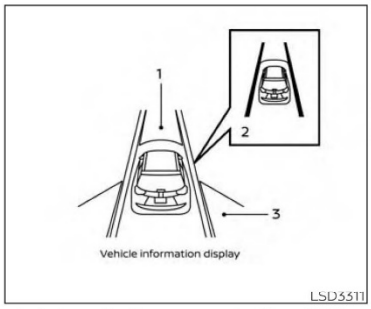
- Long
- Middle
- Short

② **RES+ switch:**

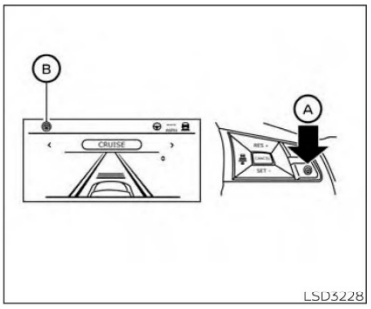
Resumes set speed or increases speed incrementally

③ **CANCEL switch:**

Deactivates the ProPILOT Assist system

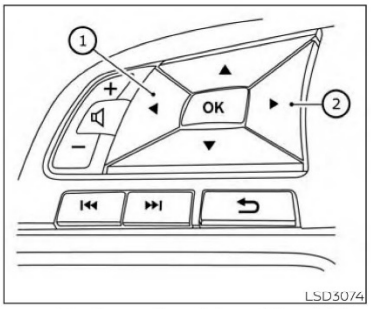


1. Automatic Emergency Braking (AEB)
2. Lane Departure Warning (LDW) when shaded and Intelligent Lane Intervention (I-LI) when solid
3. Blind Spot Warning (BSW)

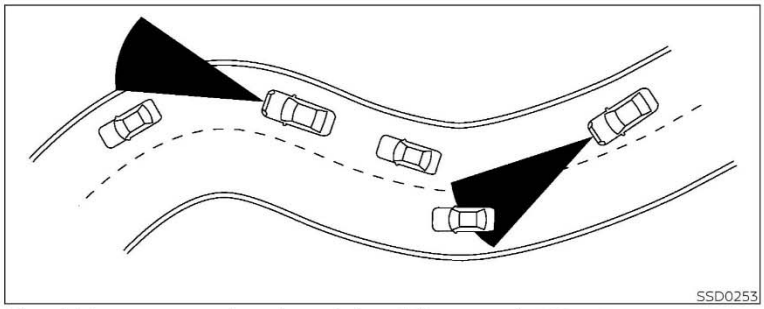


OPERATING PROPILOT ASSIST

1. Push the ProPILOT Assist switch Ⓐ. This turns on the ProPILOT Assist system.
2. A screen is displayed for a period of time that indicates the status of the driving aid functions.
   - AEB, LDW, and BSW are enabled when the specified driving aid is shaded.
   - I-LI is enabled when the driving aid is solid.



   - To change the status of the driving aids, use the ① ◄ or ② ► button to navigate the settings screen. For additional information, refer to "How to use the vehicle information display" in the "Instruments and controls" section of this manual.
3. The status of the ProPILOT Assist system is displayed in the vehicle information display Ⓑ.
4. Accelerate or decelerate your vehicle to the desired speed.


SSD0253

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

The detection of vehicles may also be affected by vehicle operation (steering maneuver or traveling position in the lane, etc.) or vehicle condition.

If this occurs, the ICC system may warn you by blinking the system indicator and sounding the chime unexpectedly. You will have to manually control the proper distance away from the vehicle traveling ahead.

Automatic cancellation

The following are conditions in which the ICC system may be temporarily unavailable. In these instances, the ICC system may not cancel and may not be able to maintain the selected following distance from the vehicle ahead.

Condition A

Under the following conditions, the ICC system is automatically canceled. A chime will sound and the system will not be able to be set:

- Any door is open.
- The driver's seat belt is not fastened.
- The vehicle ahead is not detected and your vehicle is traveling below the speed of 15 mph (24 km/h).
- Your vehicle has been stopped by the ICC system for approximately 3 minutes or longer.
- The shift lever is not in the D (Drive) position or manual shift mode.
- The electronic parking brake is applied.
- The VDC system is turned off.
- The AEB applies harder braking.
- VDC (including the traction control system) operates.
- A wheel slips.
- When distance measurement becomes impaired due to adhesion of dirt or obstruction to the sensor.

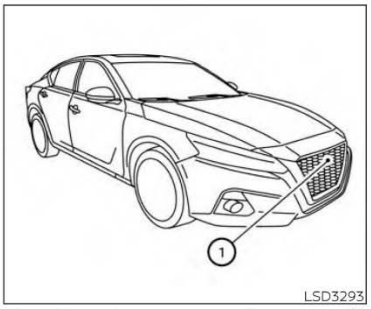
AUTOMATIC EMERGENCY BRAKING (AEB) (if so equipped)

⚠ WARNING

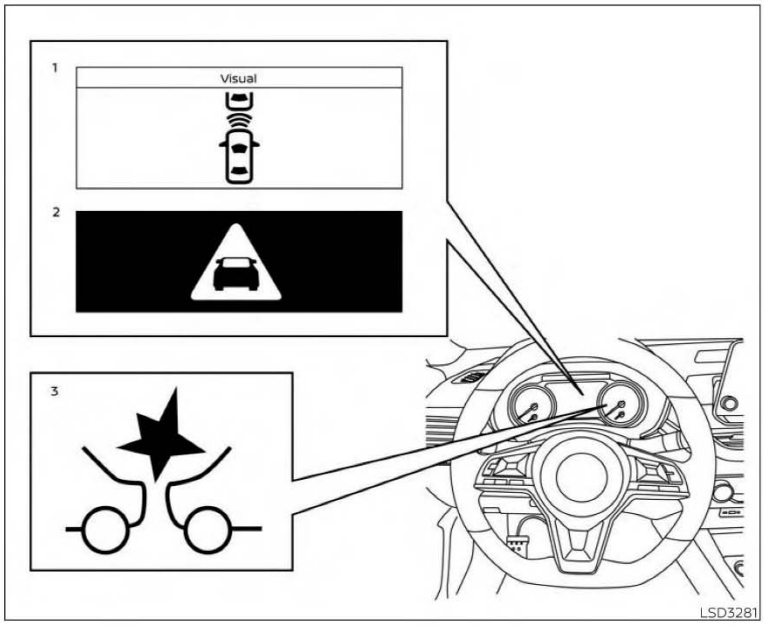
Failure to follow the warnings and instructions for proper use of the AEB system could result in serious injury or death.

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

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



The AEB system uses a radar sensor ① located on the front of the vehicle to measure the distance to the vehicle ahead in the same lane.



1. Vehicle ahead detection indicator
2. AEB emergency warning indicator
3. AEB system warning light

AEB SYSTEM OPERATION

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

If a risk of a forward collision is detected, the AEB system will provide an initial warning to the driver by both a visual and audible alert.

If the driver applies the brakes quickly and forcefully after the warning, and the AEB system detects that there is still the possibility of a forward collision, the system will automatically increase the braking force. If the driver does not take action, the AEB system issues the second visual warning and audible warning and also applies partial braking.

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

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

NOTE:

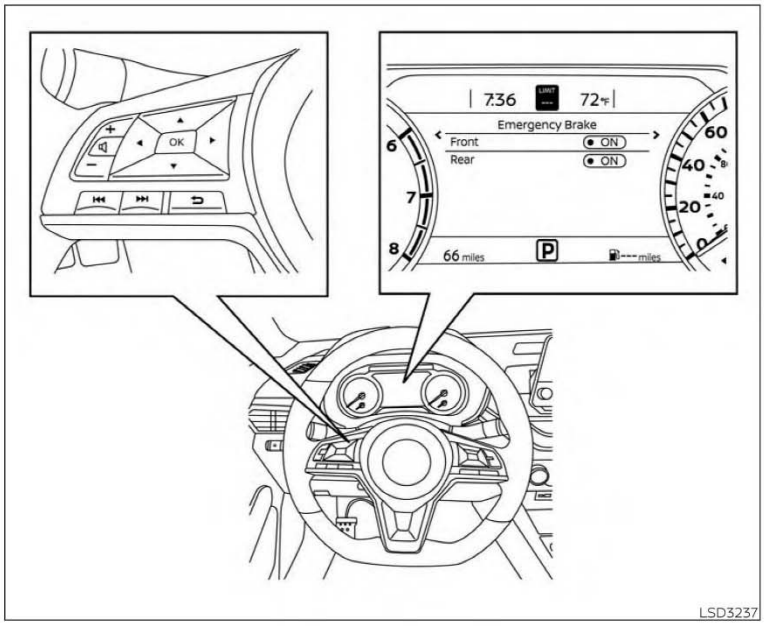
The vehicle's brake lights come on when braking is performed by the AEB system.

Depending on vehicle speed and distance to the vehicle ahead, as well as driving and roadway conditions, the system may help the driver avoid a forward collision or may help mitigate the consequences of a collision, should one be unavoidable. If the driver is handling the steering wheel, accelerating or braking, the AEB system will function later or will not function.

The automatic braking will cease under the following conditions:

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

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



TURNING THE AEB SYSTEM ON/OFF

Perform the following steps to turn the AEB system ON or OFF.

1. Press the ◀▶ button until "Settings" displays in the vehicle information display. Use the ▲▼ button to select "Driver Assistance." Then press the OK button.
2. Select "Emergency Brake" and press the OK button.
3. Select "Front" and press the OK button to turn the system on or off.

When the AEB system is turned off, the AEB system warning light illuminates.

NOTE:

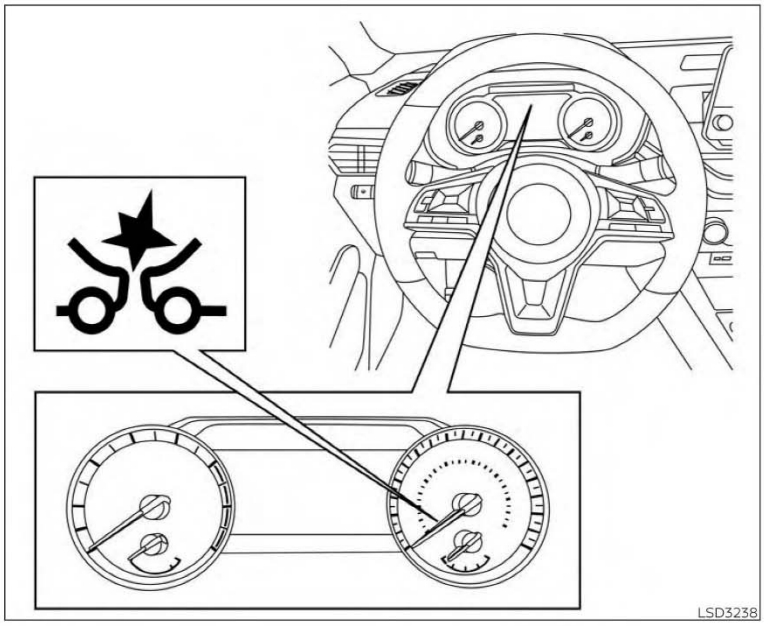
- **The AEB system will be automatically turned on when the engine is restarted.**
- **The I-FCW system is integrated into the AEB system There is not a separate selection in the vehicle information display for the I-FCW system. When the AEB is turned off, the I-FCW system is also turned off.**

AEB SYSTEM LIMITATIONS

⚠ WARNING

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

- **The AEB system cannot detect all vehicles under all conditions.**
- **The radar sensor does not detect the following objects:**
  - **Pedestrians, animals or obstacles in the roadway.**
  - **Oncoming vehicles.**
  - **Crossing vehicles.**
- **The radar sensor has some performance limitations. If a stationary vehicle is in the vehicles's path, the AEB system will not function when the vehicle is driven at speeds over approximately 50 mph (80 km/h).**
- **The radar sensor may not detect a vehicle ahead in the following conditions:**
  - **Dirt, ice, snow or other material covering the radar sensor.**
  - **Interference by other radar sources.**
  - **Snow or road spray from traveling vehicles.**
  - **If the vehicle ahead is narrow (e.g. motorcycle).**
  - **When driving on a steep downhill slope or roads with sharp curves.**
- **In some road or traffic conditions, the AEB system may unexpectedly apply partial braking. When acceleration is necessary, continue to depress the accelerator pedal to override the system.**
- **Braking distances increase on slippery surfaces.**
- **The system is designed to automatically check the sensor's functionality, within certain limitations. The system may not detect some forms of obstructions of the sensor area such as ice, snow, stickers, etc. In these cases, the system may not be able to worn the driver properly. Be sure that you check, clean and clear the sensor area regularly.**
- **Excessive noise will interfere with the warning chime sound, and the chime may not be heard.**



SYSTEM TEMPORARILY UNAVAILABLE

Condition A

When the radar sensor picks up interference from another radar source, making it impossible to detect a vehicle ahead, the AEB system is automatically turned off.

The AEB system warning light (orange) will illuminate.

Action to take:

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

Condition B

When the radar sensor of the front bumper is covered with dirt or is obstructed, the AEB system will automatically be canceled. The chime will sound and the "Not Available: Front Radar Blocked" warning message will appear in the vehicle information display.

Action to take:

If the warning message appears, stop the vehicle in a safe place, place the shift lever in the P (Park) position, and turn the engine off. When the radar signal is temporarily interrupted, clean the sensor area of the

front bumper and restart the engine. If the "Not Available: Front Radar Blocked" warning message continues to be displayed, have the system checked. It is recommended that you visit a NISSAN dealer for this service.

Condition C

When driving on roads with limited road structures or buildings (for example, long bridges, deserts, snowfields, driving next to long walls), the system may illuminate the system warning light and display the "Not Available: Front Radar Blocked" message.

Action to take:

When the above driving conditions no longer exist, turn the system back on.

NOTE:

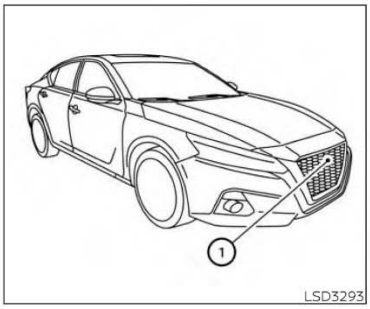
If the AEB system stops working, the I-FCW system will also stop working.

SYSTEM MALFUNCTION

If the AEB system malfunctions, it will be turned off automatically, a chime will sound, the AEB warning light (orange) will illuminate and the warning message [Malfunction] will appear in the vehicle information display.

Action to take

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



SYSTEM MAINTENANCE

The sensor ① for the AEB is located on the front of the vehicle.

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

- Always keep the sensor area of the front bumper clean.
- Do not strike or damage the areas around the sensor.
- Do not cover or attach stickers or similar objects on the front bumper near the sensor area. This could cause failure or malfunction.

- Do not attach metallic objects near the sensor area (brush guard, etc.). This could cause failure or malfunction.
- Do not alter, remove or paint the front bumper. Before customizing or restoring the front bumper, it is recommended that you visit a NISSAN dealer.

Radio frequency statement

For USA

FCC ID OAYARS4B

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

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

FCC Warning

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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

Radio frequency radiation exposure information:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

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

For Canada

Model: ARS4-B

IC: 4135A-ARS4B

FCC ID: OAYARS4B

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause interference,
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage, et
2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Radio frequency radiation exposure information:

This equipment complies with FCC and IC radiation exposure limits set forth for an uncontrolled environment.

This equipment should be installed and operated with minimum distance of 30 cm between the radiator and your body.

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

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé.

Cet équipement doit être installé et utilisé avec un minimum de 30 cm de distance entre la source de rayonnement et votre corps.

FCC Notice

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

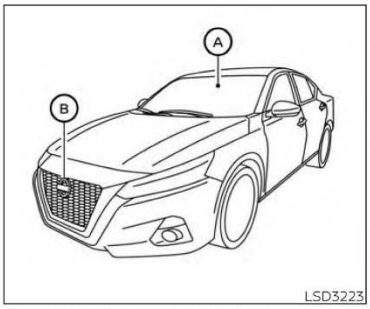
AUTOMATIC EMERGENCY BRAKING (AEB) WITH PEDESTRIAN DETECTION (if so equipped)

⚠ WARNING

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

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

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



The AEB with Pedestrian Detection system uses a radar sensor located on the front of the vehicle Ⓑ to measure the distance to the vehicle ahead in the same lane. For pedestrians, the AEB with Pedestrian Detection system uses a camera installed behind the windshield Ⓐ in addition to the radar sensor.

APPENDIX C

Run Log

Subject Vehicle: **2020 Nissan Altima** Test Date: **2/11/2020**

Principal Other Vehicle: **SSV**

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
1-11	Brake characterization and determination						See Appendix D
75	Static run						
76	**Stopped POV**	N					Throttle release
77		N					Hybrid transition rate too high
78		N					Hybrid transition rate too high
79		Y	1.11	4.78	1.11	Pass	
80		Y	2.06	15.17	1.05	Pass	
81		Y	1.98	12.05	0.98	Pass	
82		Y		0.00	0.55	Fail	No warning, 6.2 mph
83		N					NO WARNING, Radar mounting bracket suspected to be bent
84	Static run						Continuing 2/20/20, after bracket replacement and alignment
85		N					
86		Y	2.04	12.85	1.02	Pass	
87		Y	2.04	14.17	1.06	Pass	
88	Static Run						
49	Static Run						

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
50	**Slower POV, 25 vs 10**	Y	1.88	10.63	1.06	Pass	
51		Y	1.89	4.50	1.08	Pass	
52		Y	1.87	10.68	1.06	Pass	
53		Y	1.86	5.29	1.12	Pass	
54		Y	1.88	10.50	1.03	Pass	
55		Y	1.95	11.49	1.08	Pass	
56		Y	1.83	10.89	1.05	Pass	
57	Static run						
58	**Slower POV, 45 vs 20**	Y	2.62	12.26	1.07	Pass	
59		Y	2.58	13.21	1.04	Pass	
60		Y	2.60	12.62	1.07	Pass	
61		Y	2.59	12.86	1.06	Pass	
62		Y	2.58	13.65	1.11	Pass	
63		Y	2.57	12.52	1.09	Pass	
64		Y	2.49	13.07	1.08	Pass	
65	Static run						

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
66	**Decelerating POV, 35**	Y	1.83	3.00	1.15	Pass	
67		Y	1.76	2.94	1.08	Pass	
68		Y	1.69	3.60	1.12	Pass	
69		N					POV brakes
70		Y	1.85	3.07	1.13	Pass	
71		N					POV brakes
72		Y	1.60	3.63	1.09	Pass	
73		Y	1.48	3.49	1.09	Pass	
74		Y	1.65	2.00	1.10	Pass	
12	STP - Static run						
13	**Baseline, 25**	Y			0.47		
14		Y			0.48		
15		Y			0.47		
16		Y			0.50		
17		Y			0.48		
18		N					Brake force
19		N					Brake force
20		Y			0.48		
21		Y			0.47		
22	STP - Static run						

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
23	**Baseline, 45**	Y			0.45		
24		Y			0.46		
25		Y			0.49		
26		Y			0.45		
27		Y			0.48		
28		Y			0.47		
29		N			.		Brake release
30		Y			0.47		
31	STP - Static run						
32	STP - Static run						
33	**STP False Positive, 25**	Y			0.51	Pass	
34		Y			0.50	Pass	
35		Y			0.50	Pass	
36		Y			0.52	Pass	
37		Y			0.52	Pass	
38		Y			0.49	Pass	
39		Y			0.49	Pass	
40	STP - Static run						

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
41	**STP False Positive, 45**	Y			0.44	Pass	
42		Y			0.48	Pass	
43		Y			0.51	Pass	
44		Y			0.46	Pass	
45		Y			0.48	Pass	
46		Y			0.46	Pass	
47		Y			0.49	Pass	
48	STP - Static run						

APPENDIX D

Brake Characterization

Subject Vehicle: **2020 Nissan Altima** Test Date: **2/11/2020**

DBS Initial Brake Characterization				
Run Number	**Stroke at 0.4 g (in)**	**Force at 0.4 g (lb)**	**Slope**	**Intercept**
1	2.994083	17.23174	0.503248	1.089972
2	2.891356	16.76442	0.50017	1.099264
3	2.865691	17.79378	0.504501	1.101728

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	0.404	2.92		2.89	
5		25	Y	0.401	2.92		2.91	
6		45	Y	0.424	2.92		2.75	
7	**Hybrid**	35	Y	0.467	2.92	17.26	14.78	
8			Y	0.415	2.92	14.80	14.27	
9		25	Y	0.421	2.92	14.80	14.06	
10		45	Y	0.431	2.92	14.80	13.74	
11			Y	0.409	2.92	14.80	14.47	

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 frontmost point of the Subject Vehicle and the rearmost point of the Strikeable Surrogate Vehicle (SSV) towed by the Principal Other Vehicle. The minimum headway during the run is displayed to the right of the subplot.

- SV/POV Speed (mph) – Speed of the Subject Vehicle and 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.

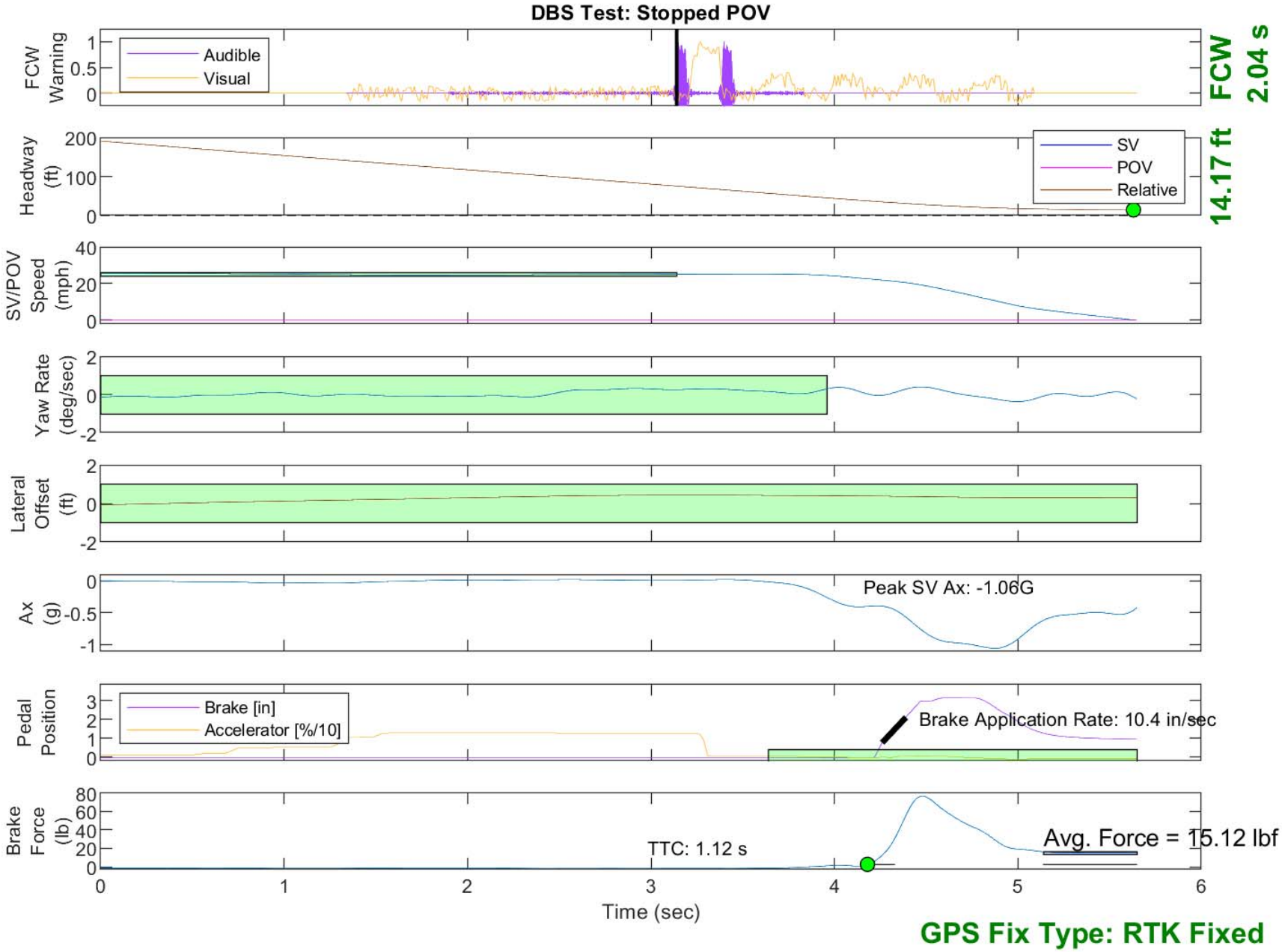


Figure E1. Example Time History for Stopped POV, Passing

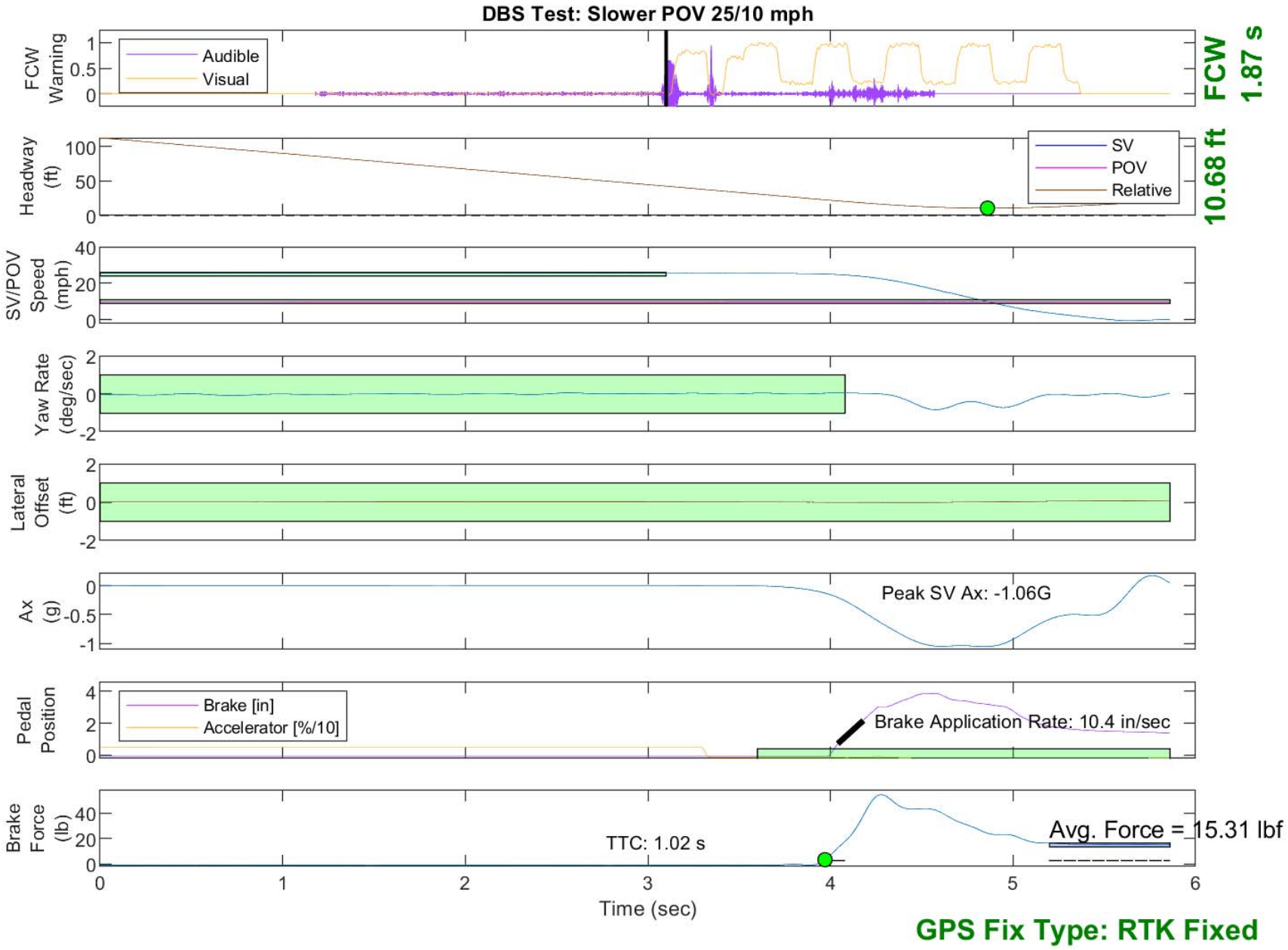


Figure E2. Example Time History for Slower POV 25 vs. 10, Passing

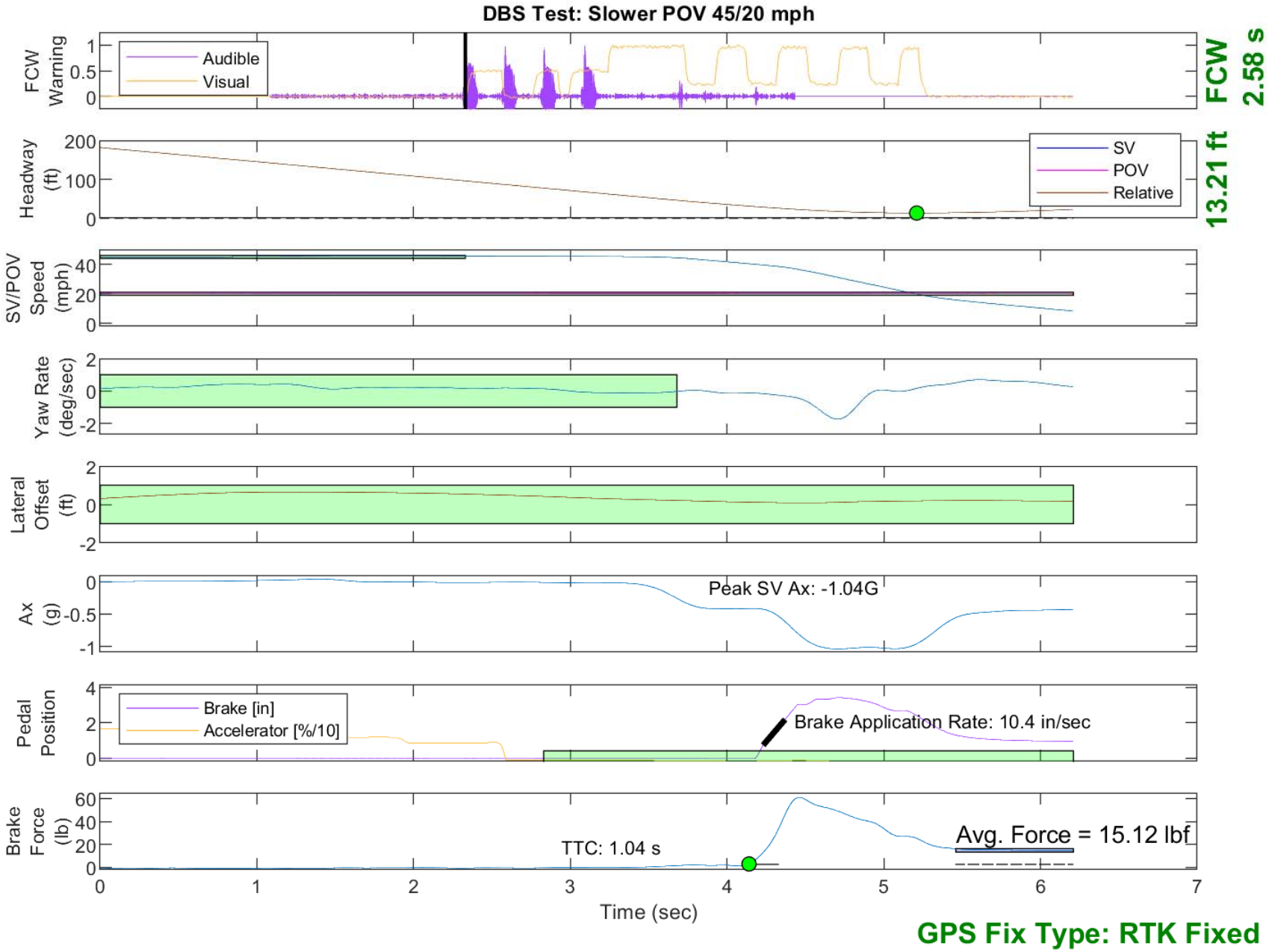


Figure E3. Example Time History for Slower POV 45 vs. 20, Passing

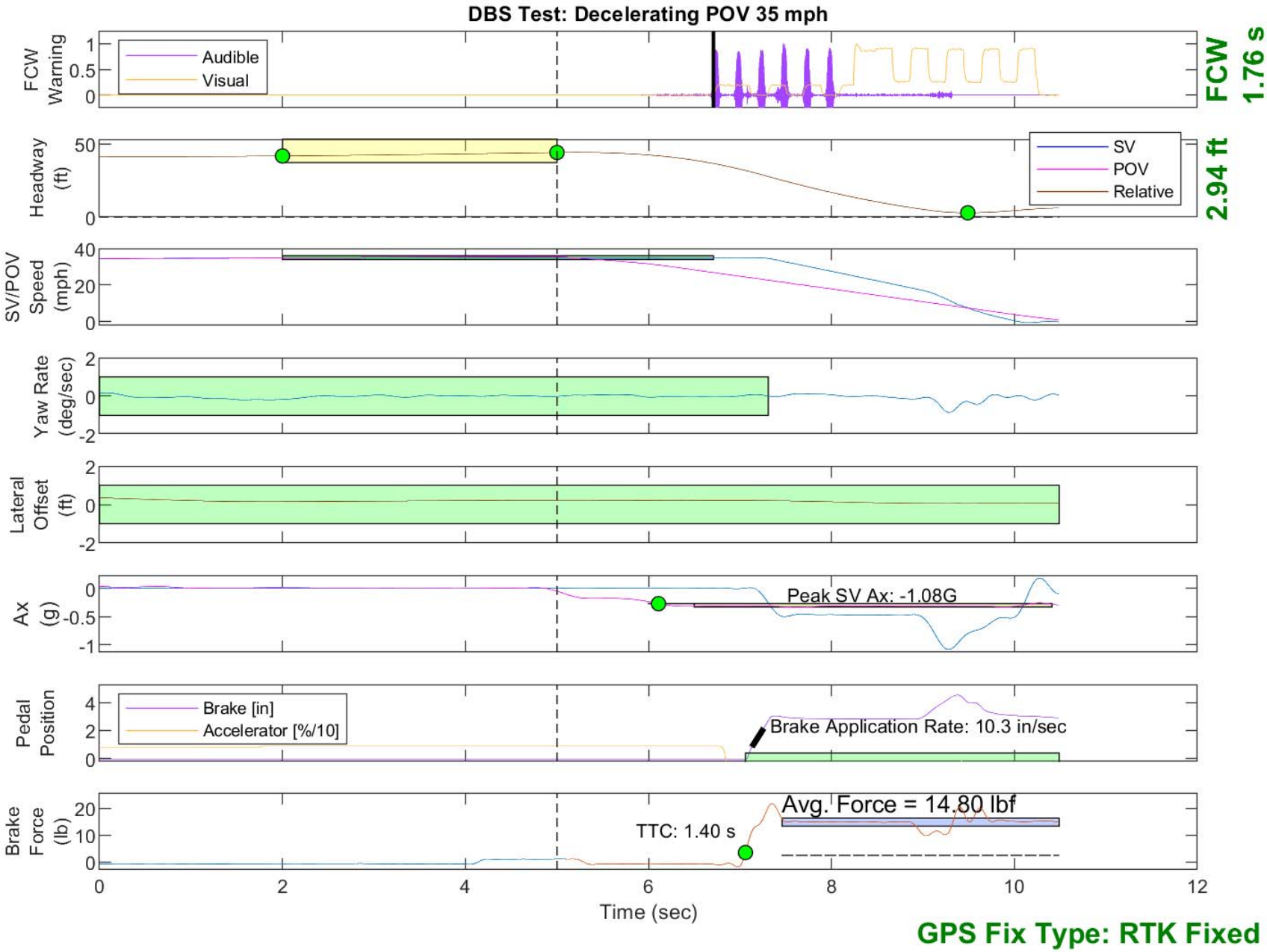


Figure E4. Example Time History for Decelerating POV 35, Passing

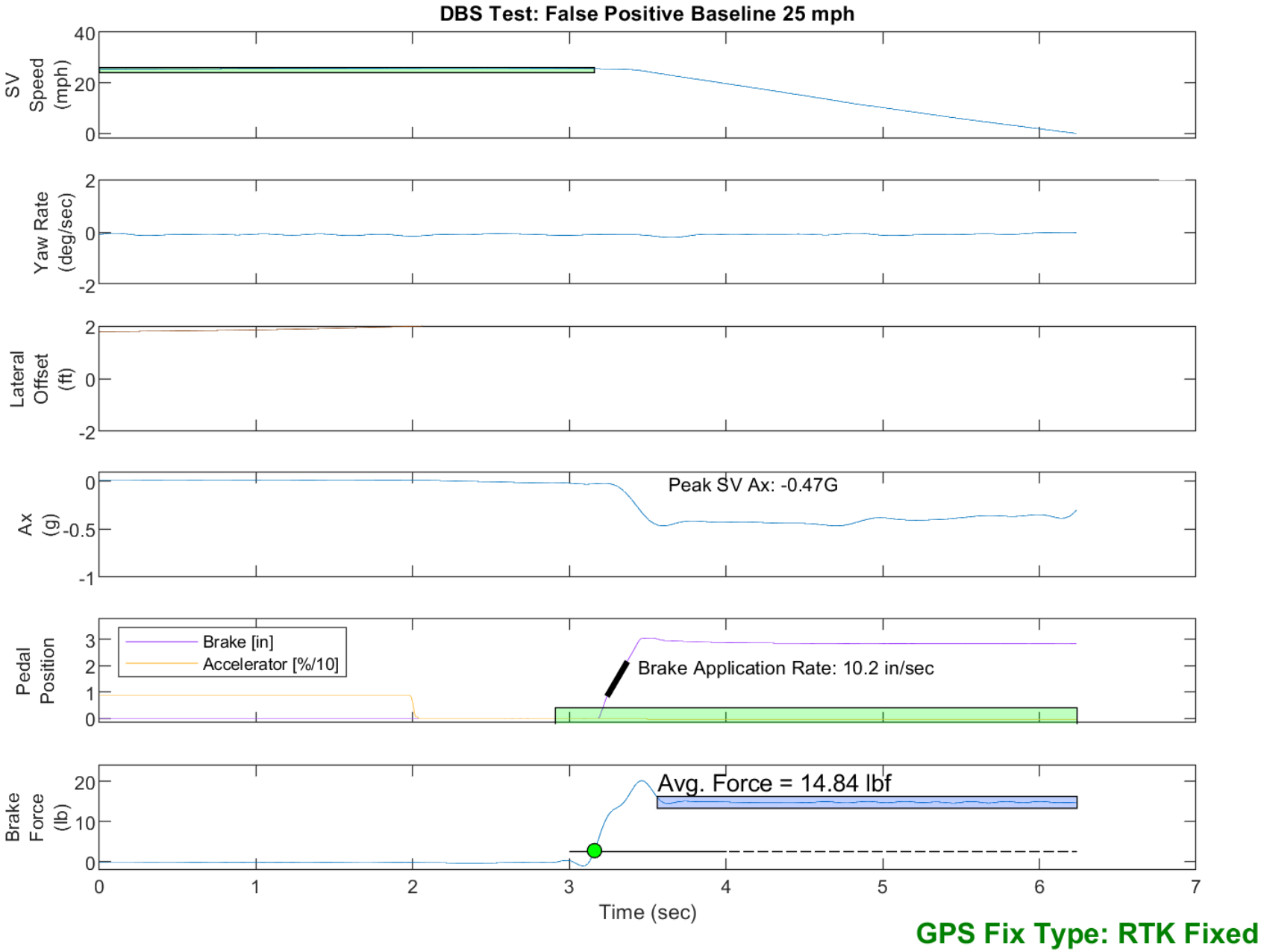


Figure E5. Example Time History for False Positive Baseline 25

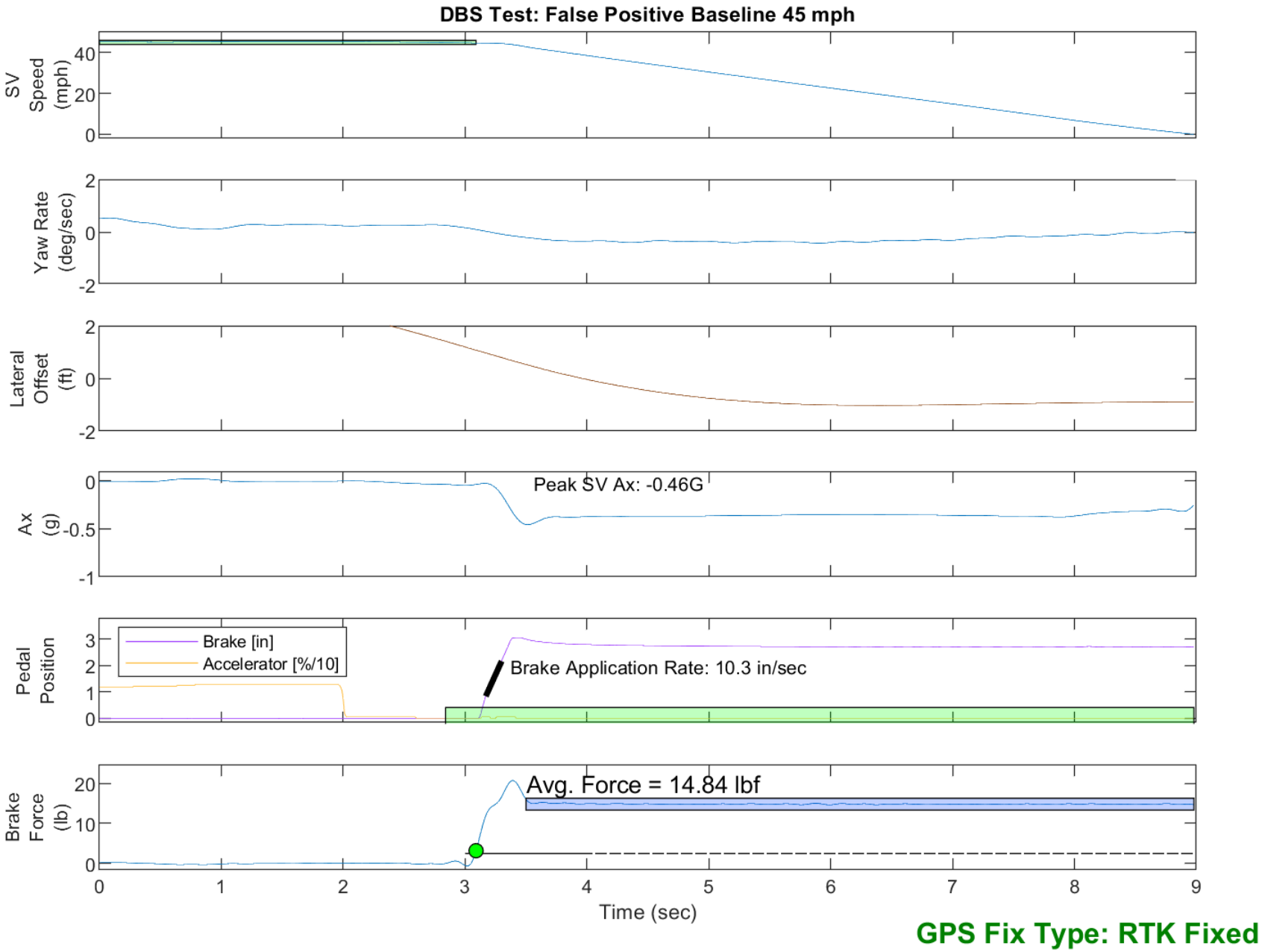


Figure E6. Example Time History for False Positive Baseline 45

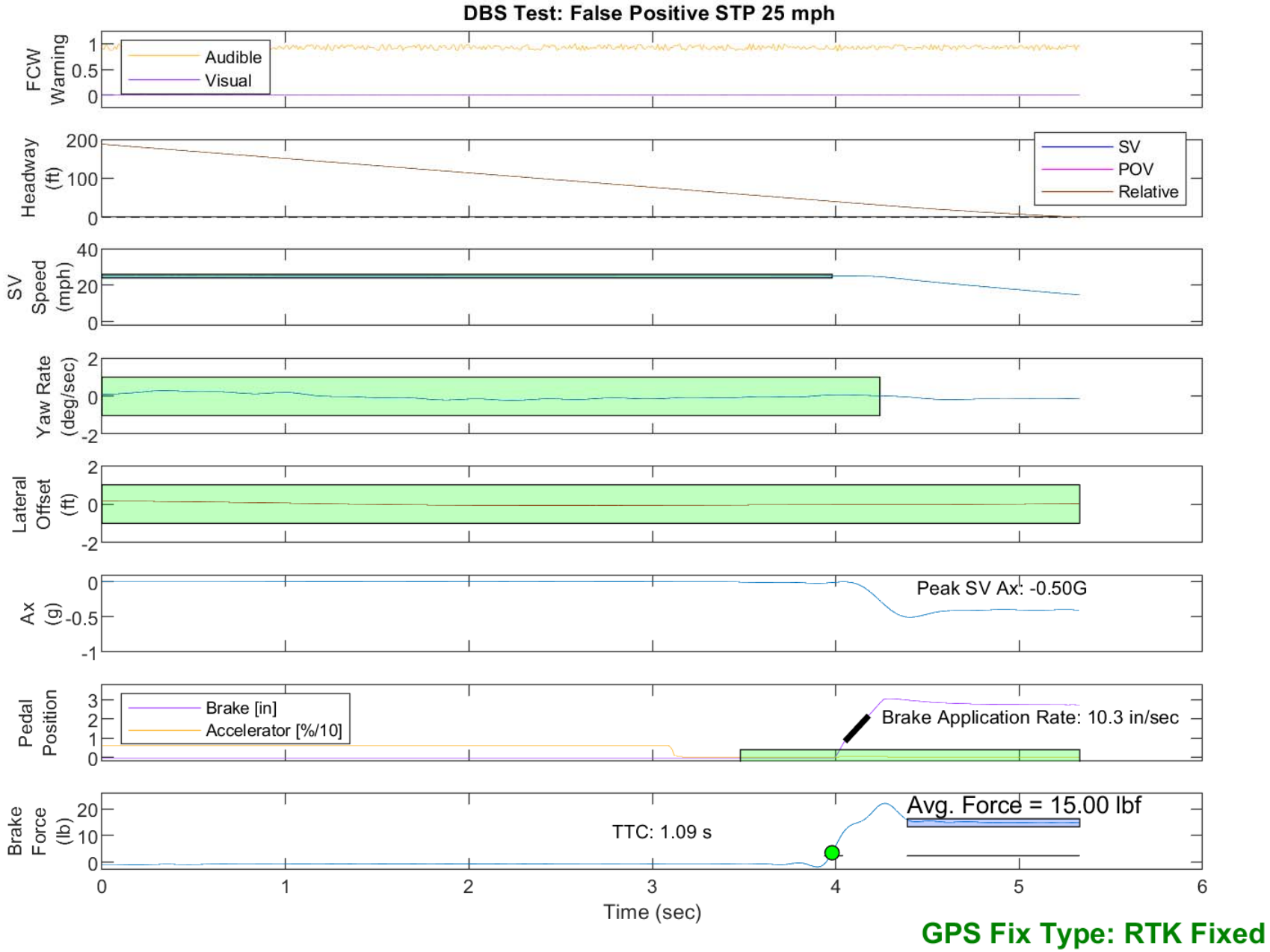


Figure E7. Example Time History for False Positive Steel Plate 25, Passing

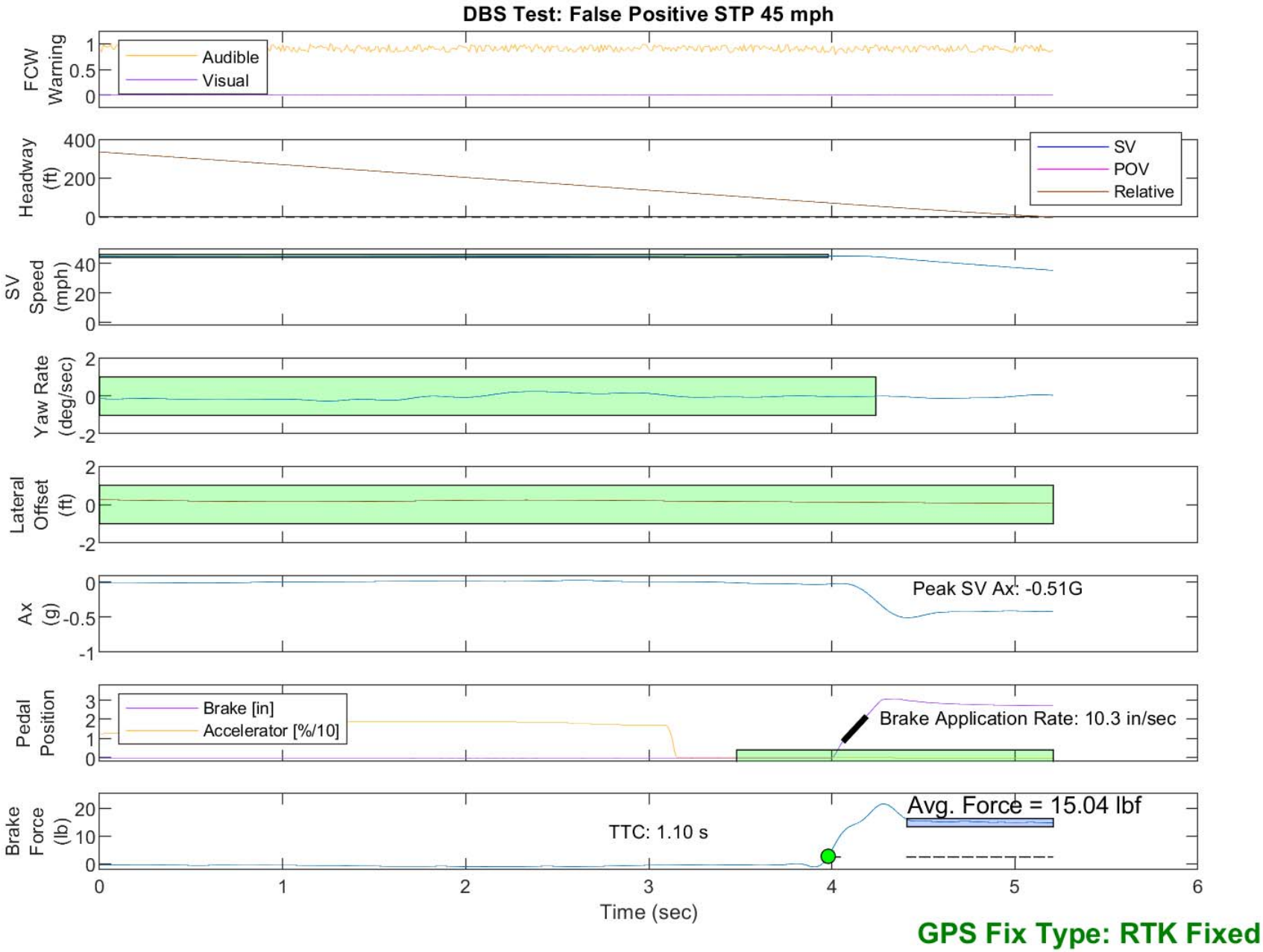


Figure E8. Example Time History for False Positive Steel Plate 45, Passing

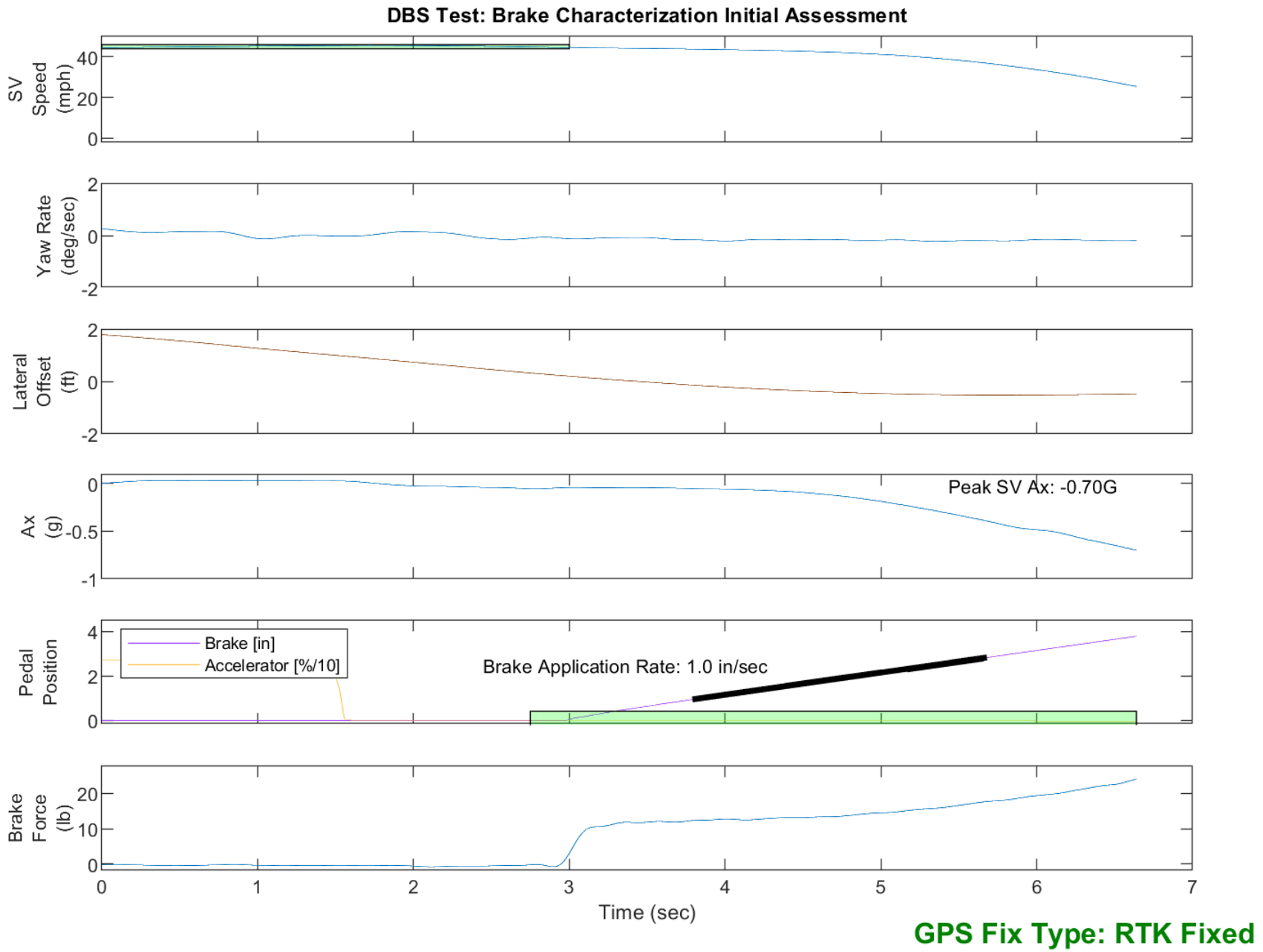


Figure E9. Example Time History for DBS Brake Characterization, Passing

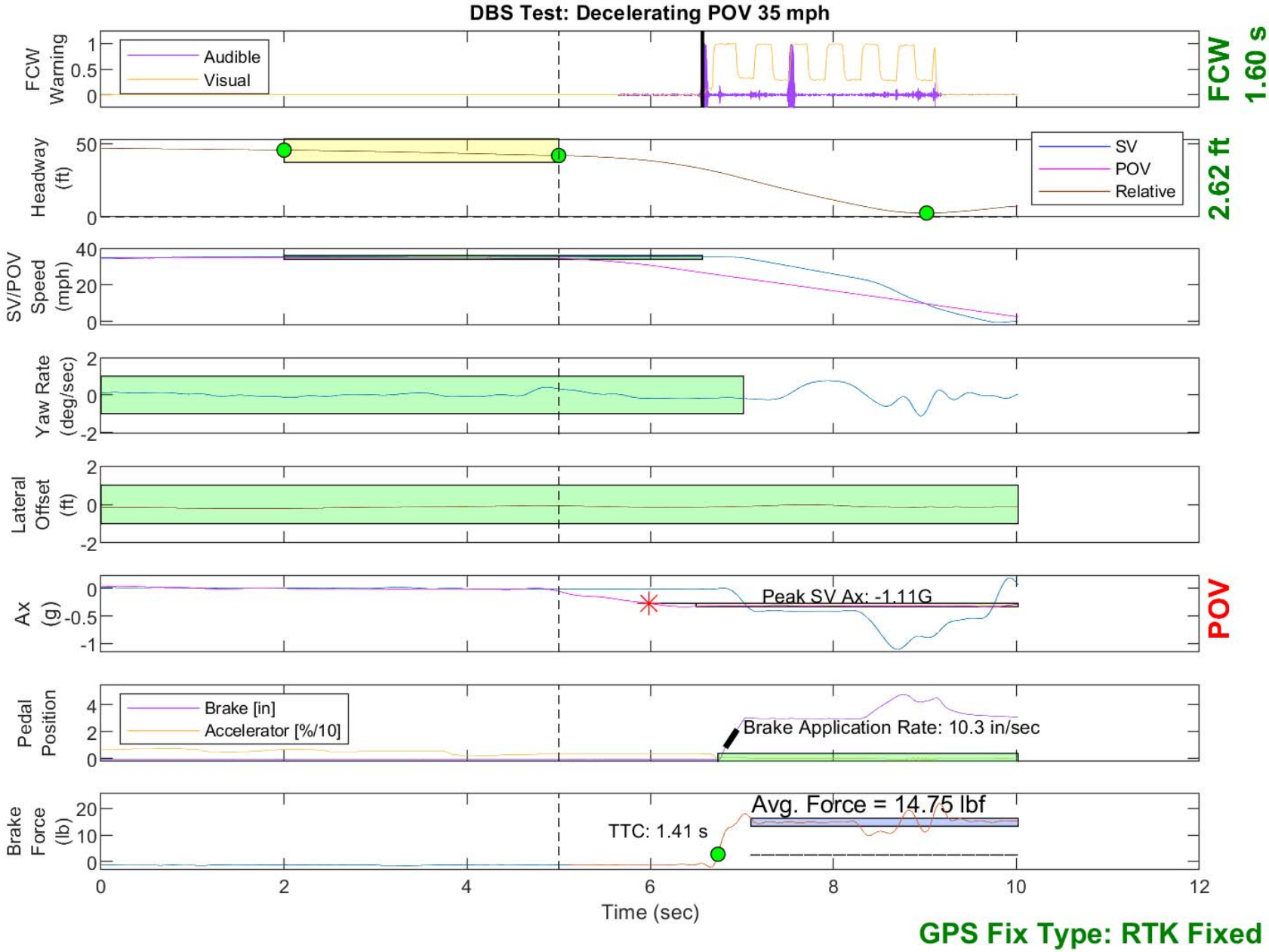


Figure E10. Example Time History Displaying Invalid POV Acceleration Criteria

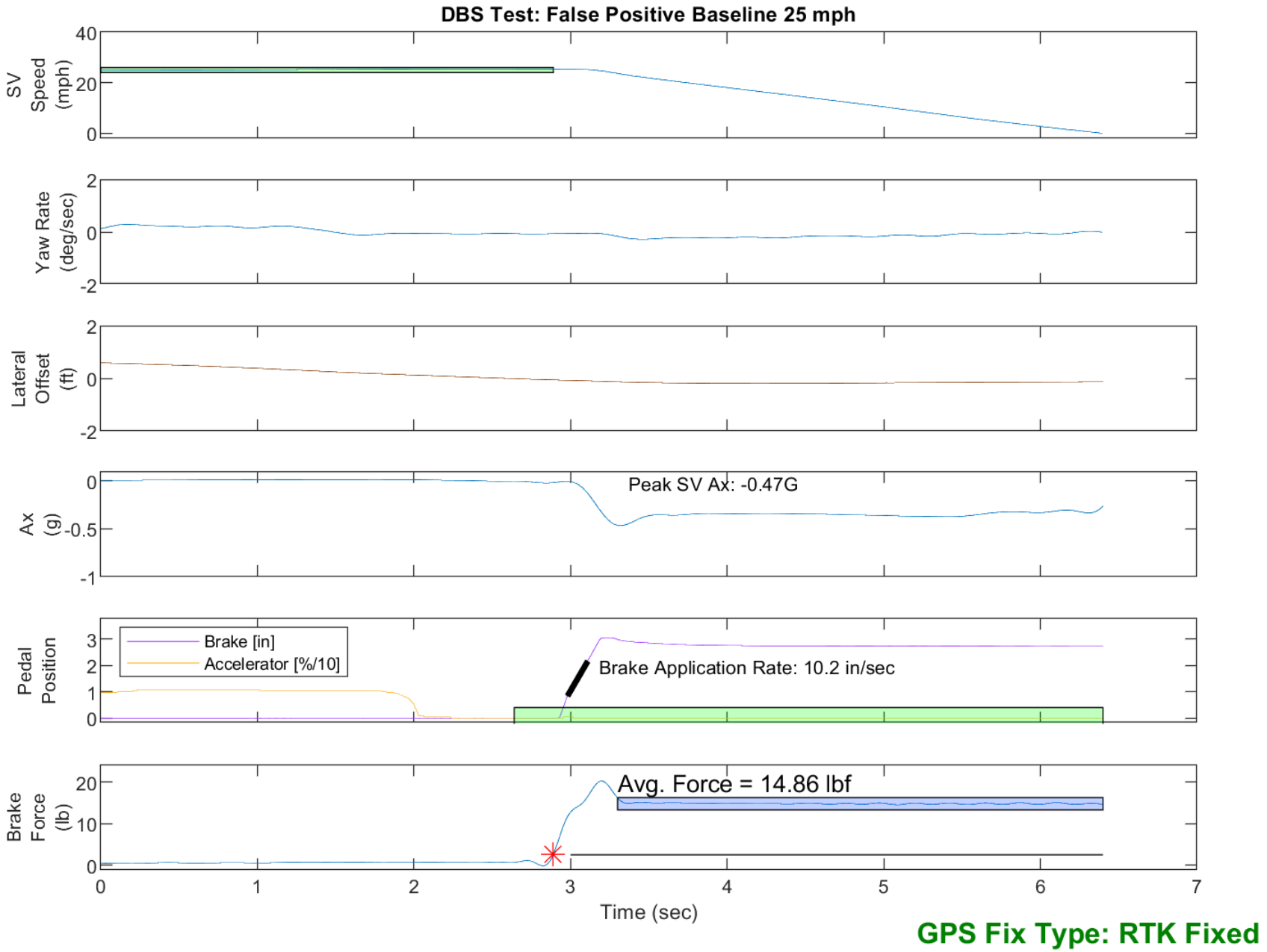


Figure E11. Example Time History Displaying Invalid Brake Force Criteria

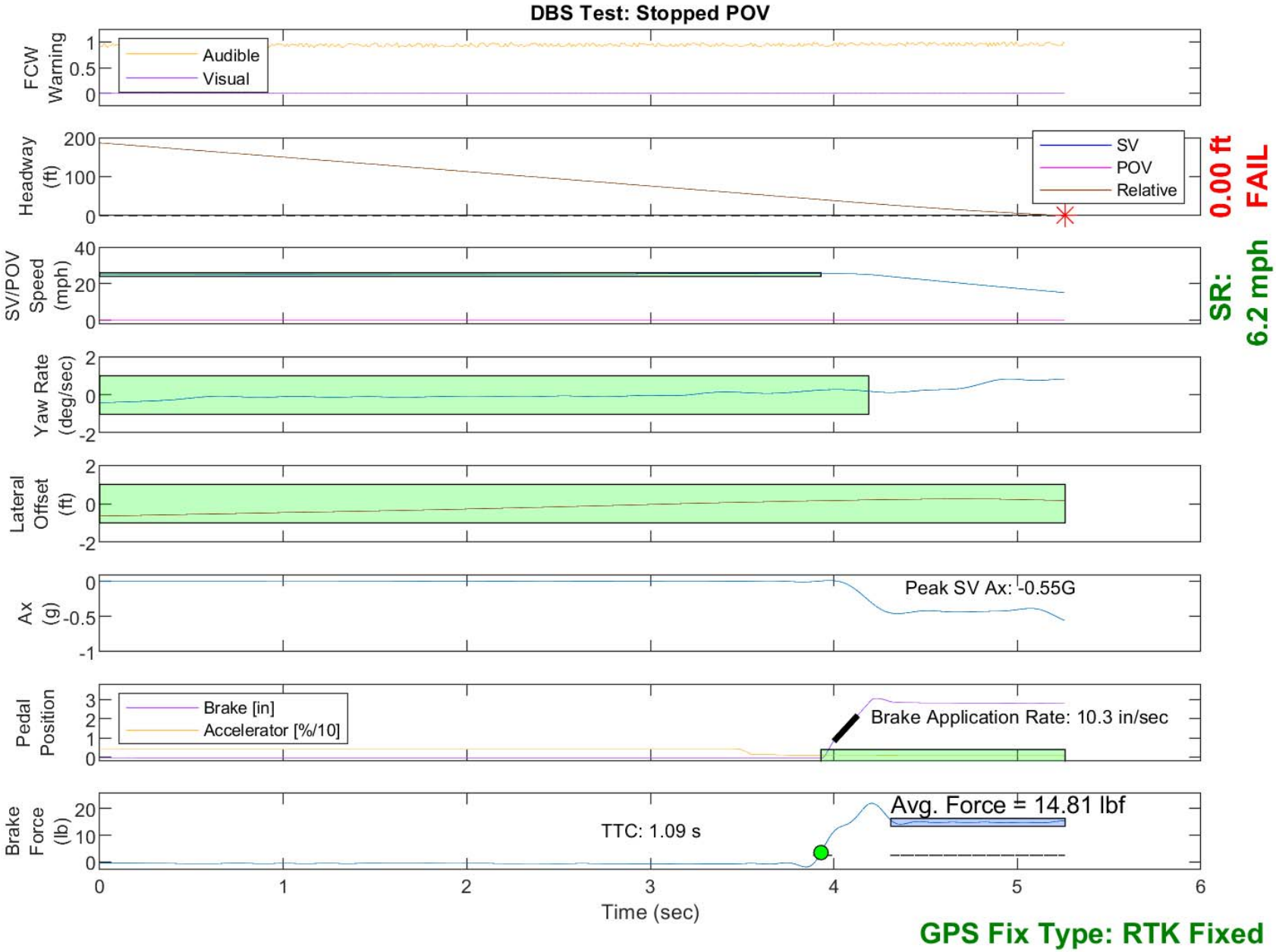


Figure E12. Example Time History for a Failed Run

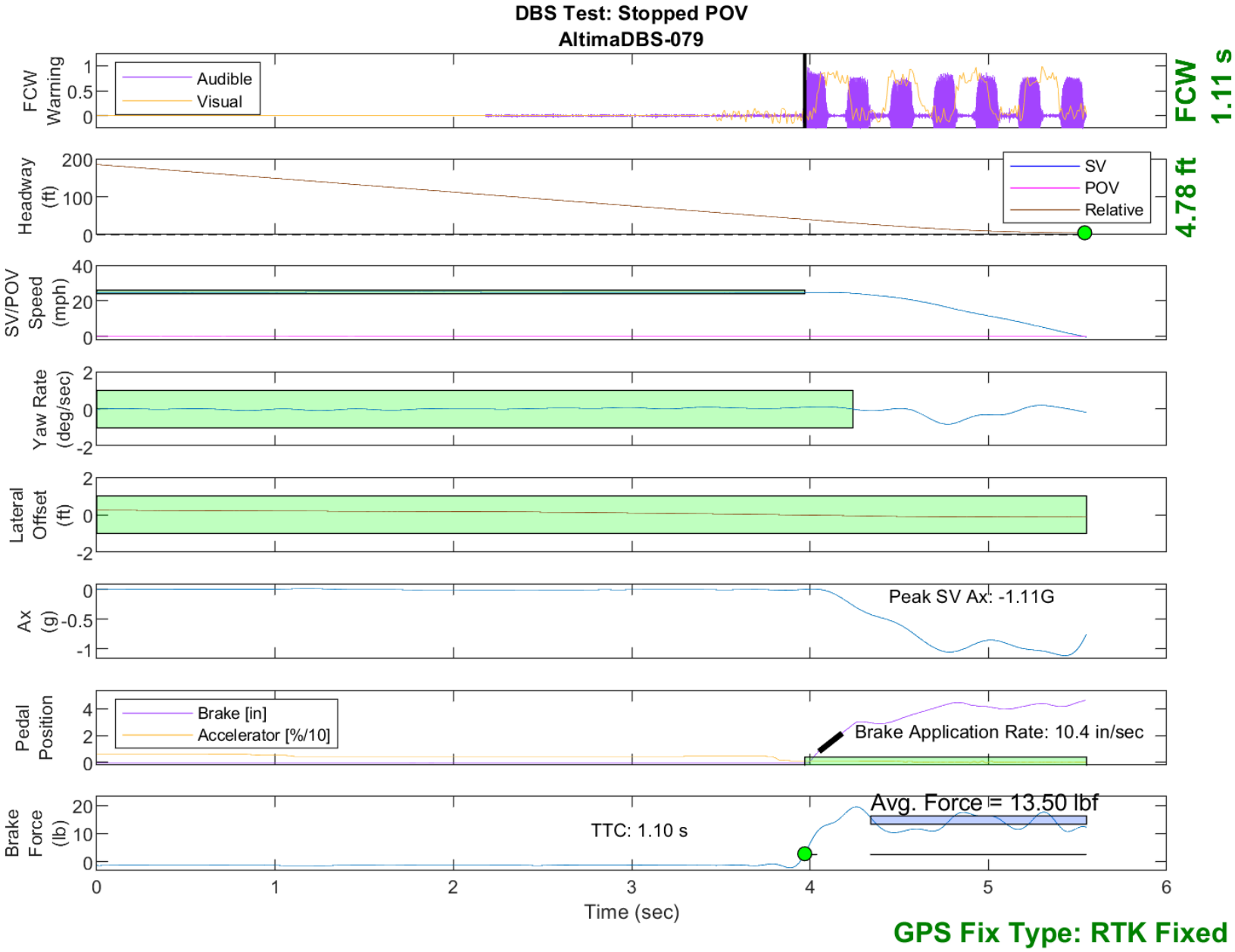


Figure E13. Time History for DBS Run 79, SV Encounters Stopped POV

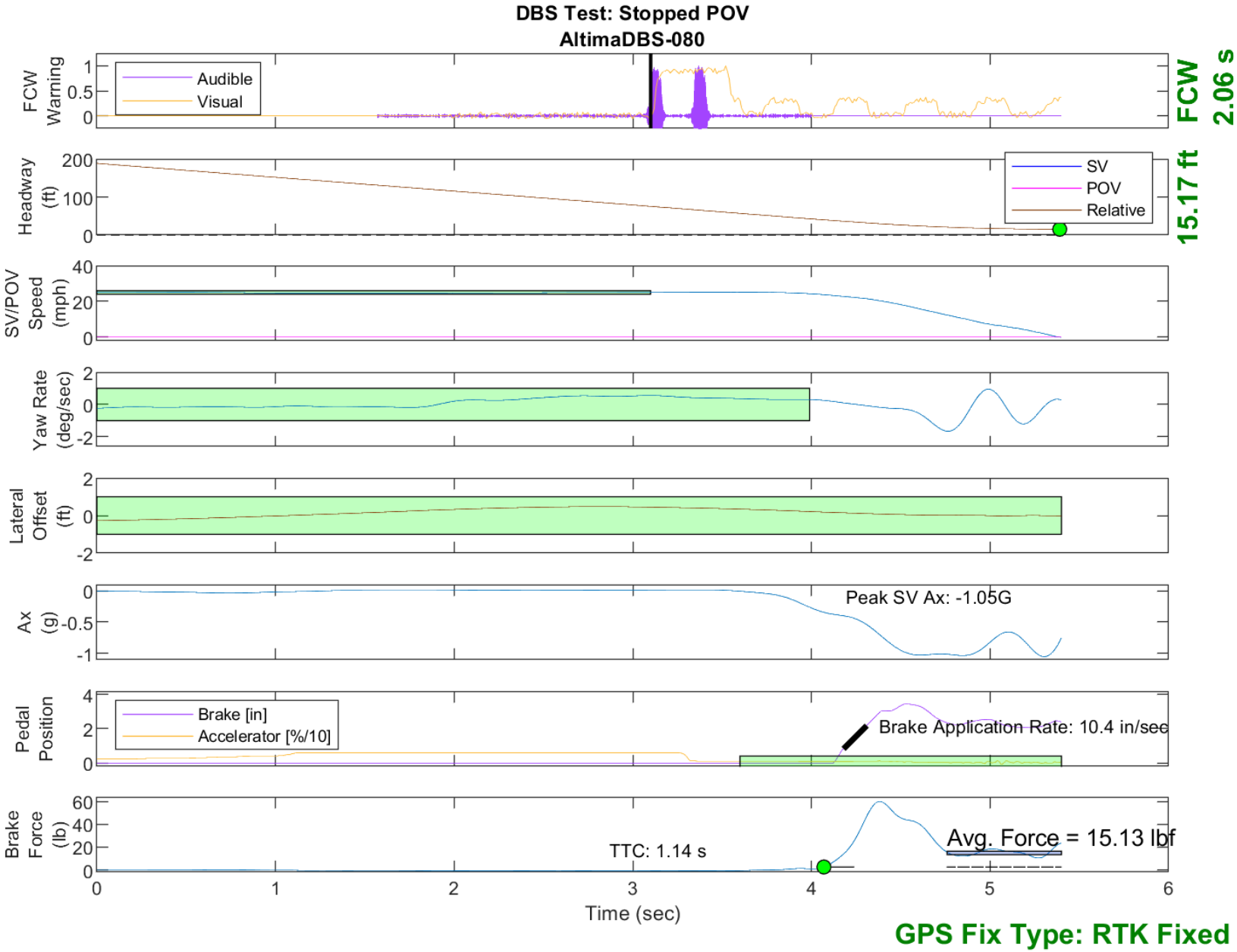


Figure E14. Time History for DBS Run 80, SV Encounters Stopped POV

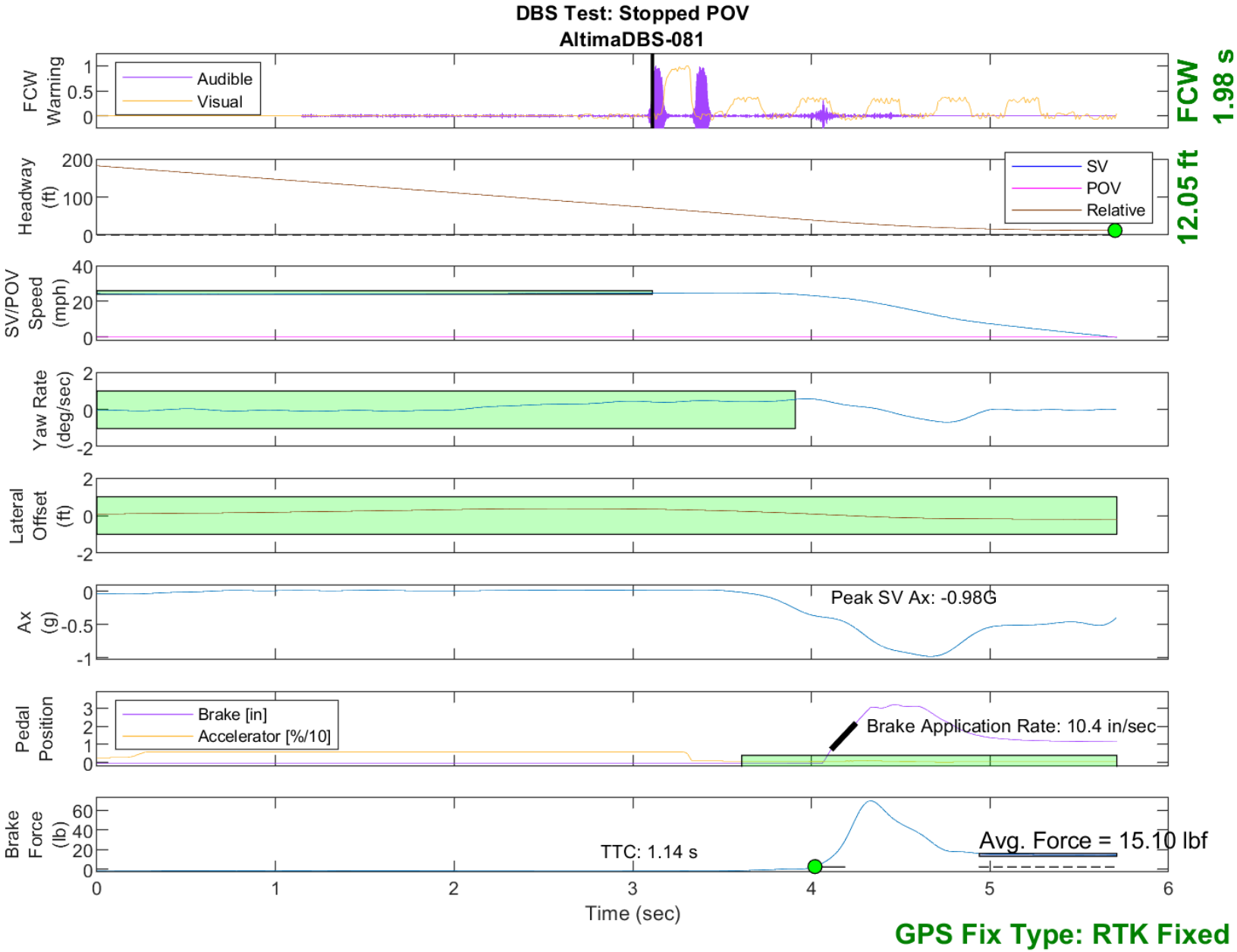


Figure E15. Time History for DBS Run 81, SV Encounters Stopped POV

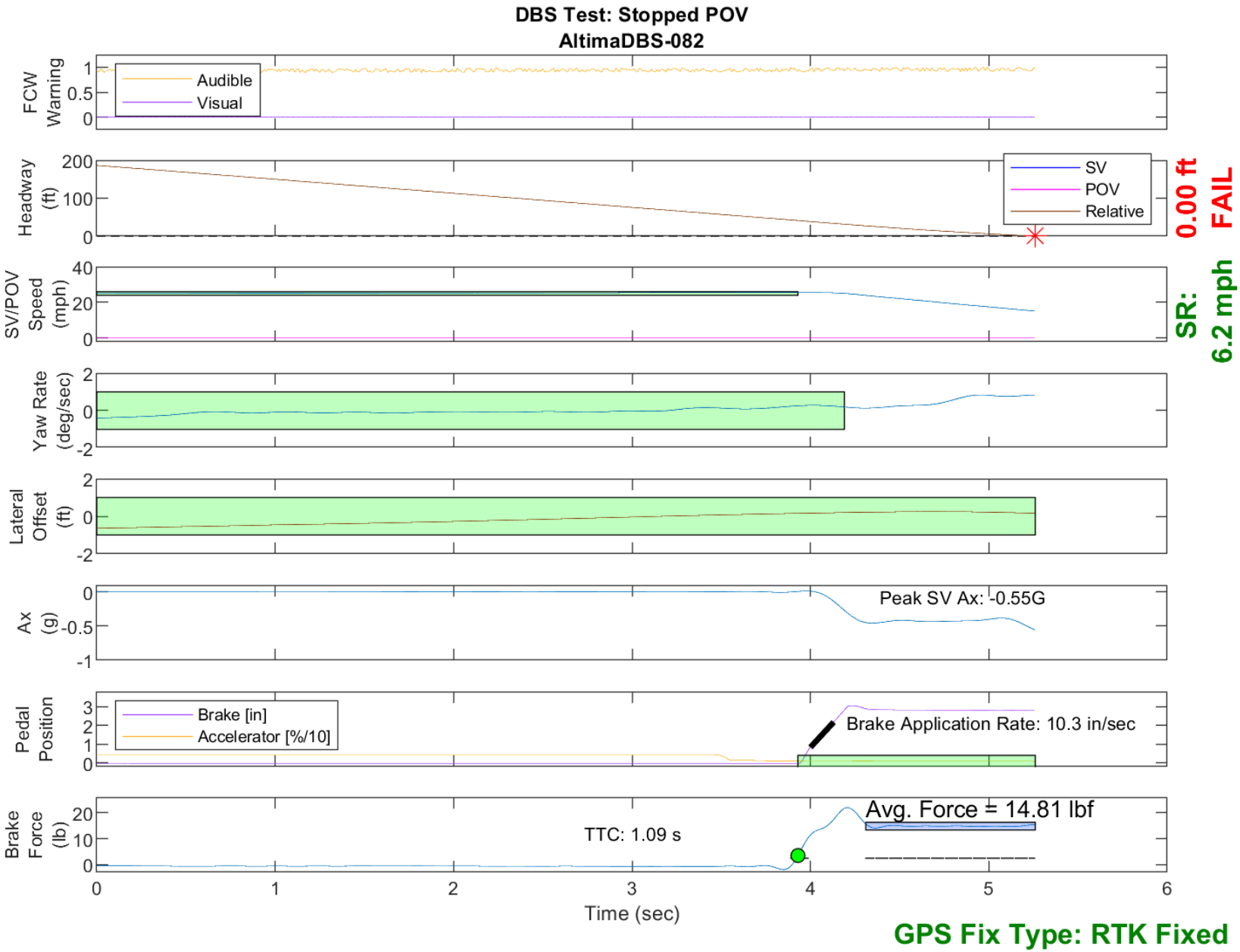


Figure E16. Time History for DBS Run 82, SV Encounters Stopped POV

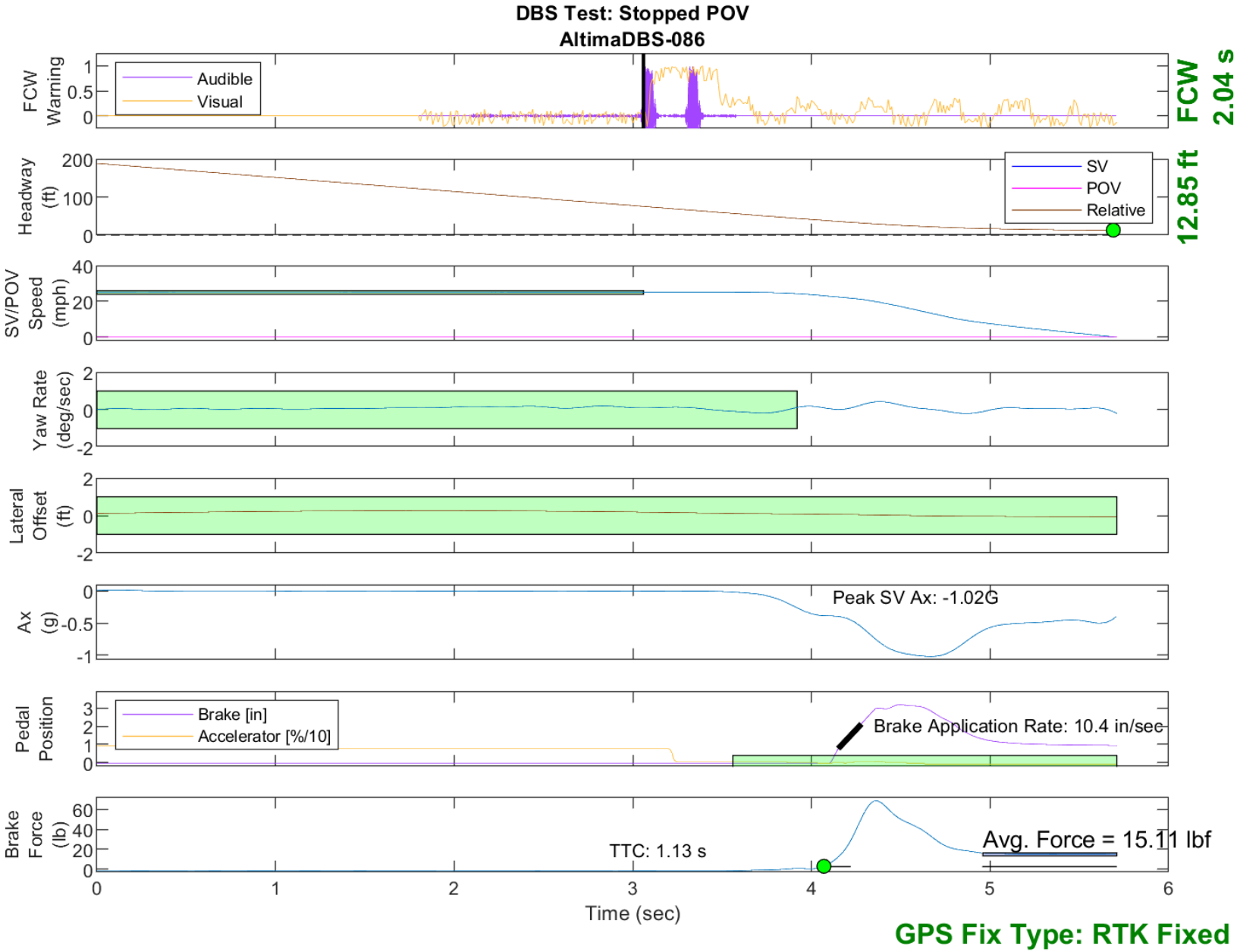


Figure E17. Time History for DBS Run 86, SV Encounters Stopped POV

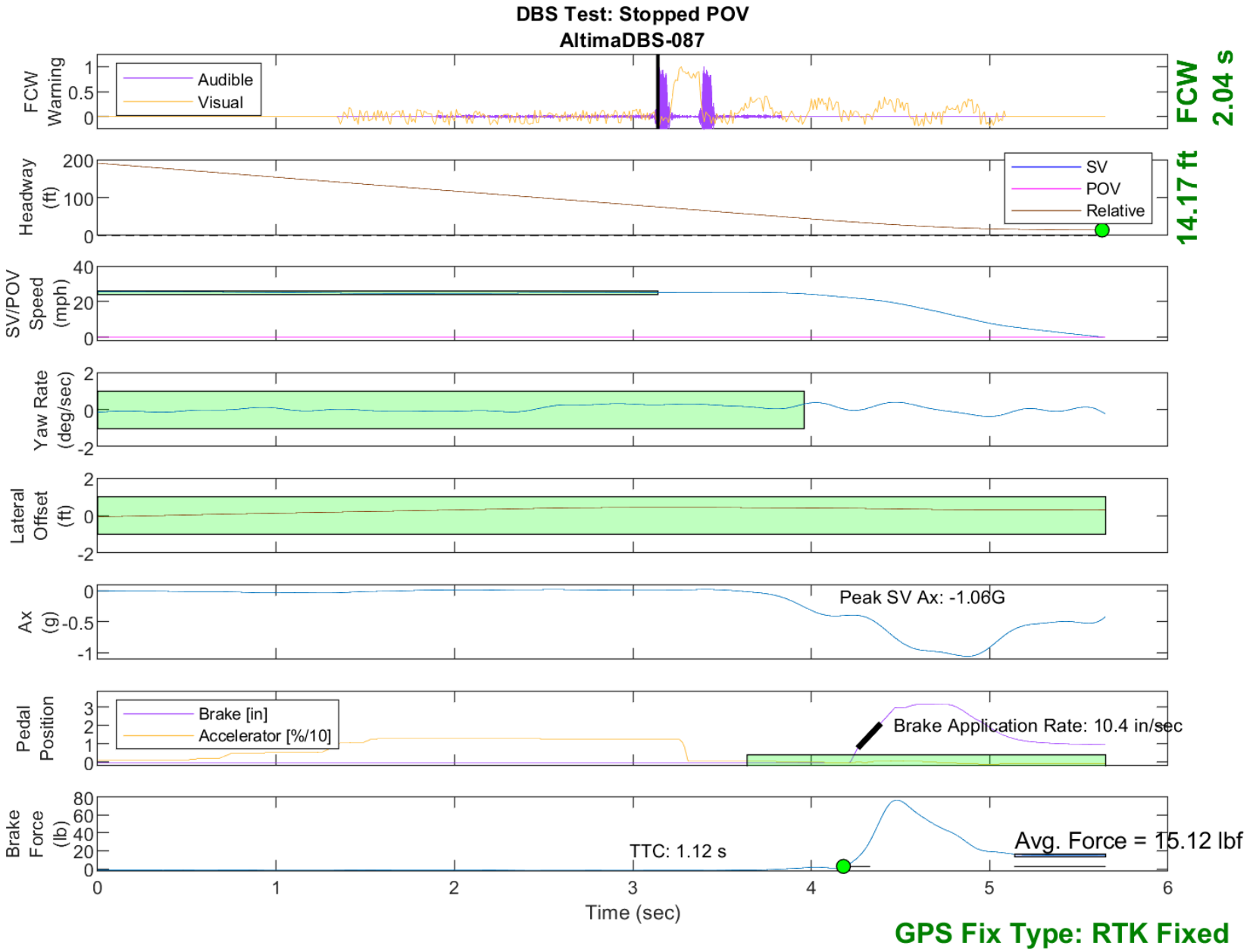


Figure E18. Time History for DBS Run 87, SV Encounters Stopped POV

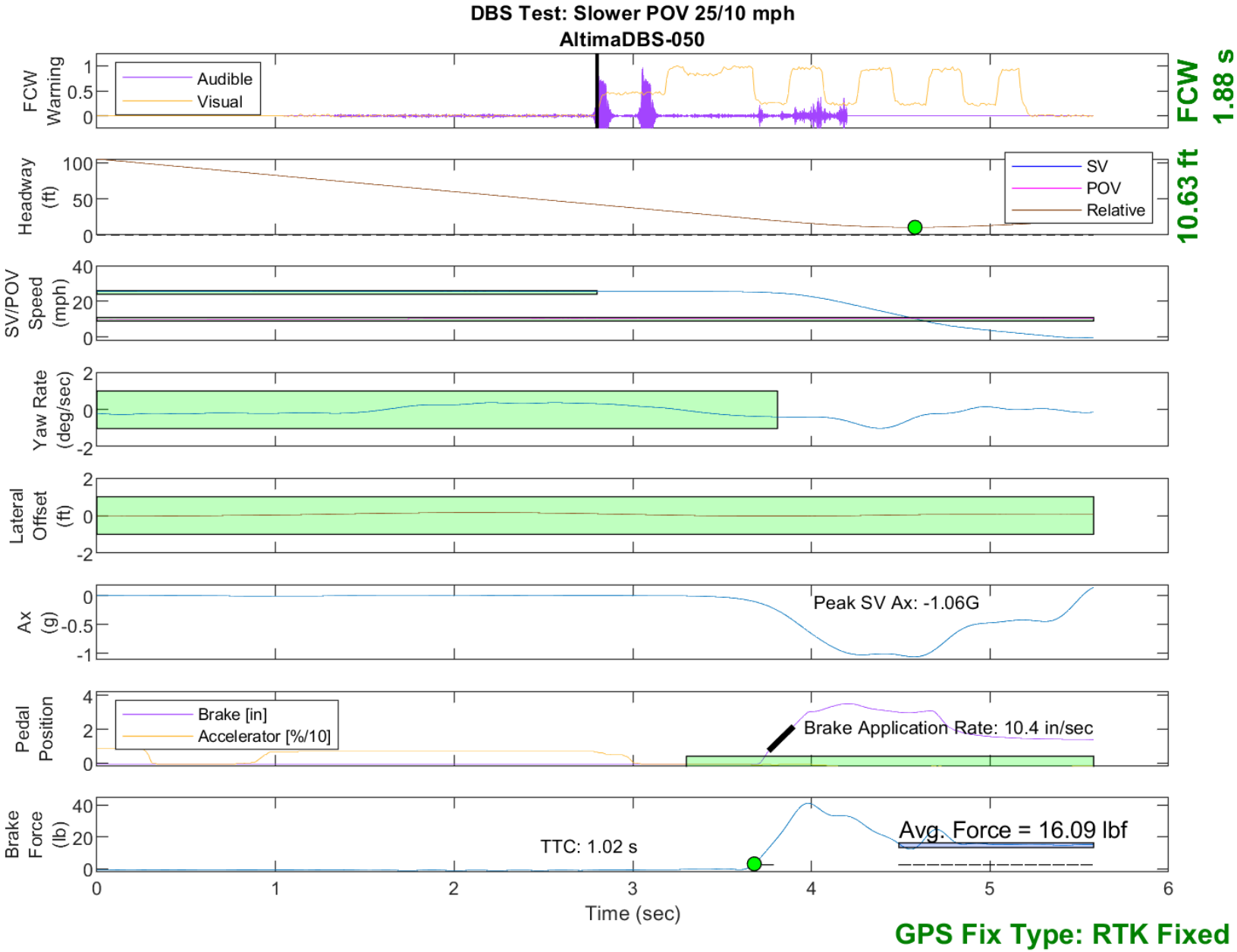


Figure E19. Time History for DBS Run 50, SV Encounters Slower POV, SV 25 mph, POV 10 mph

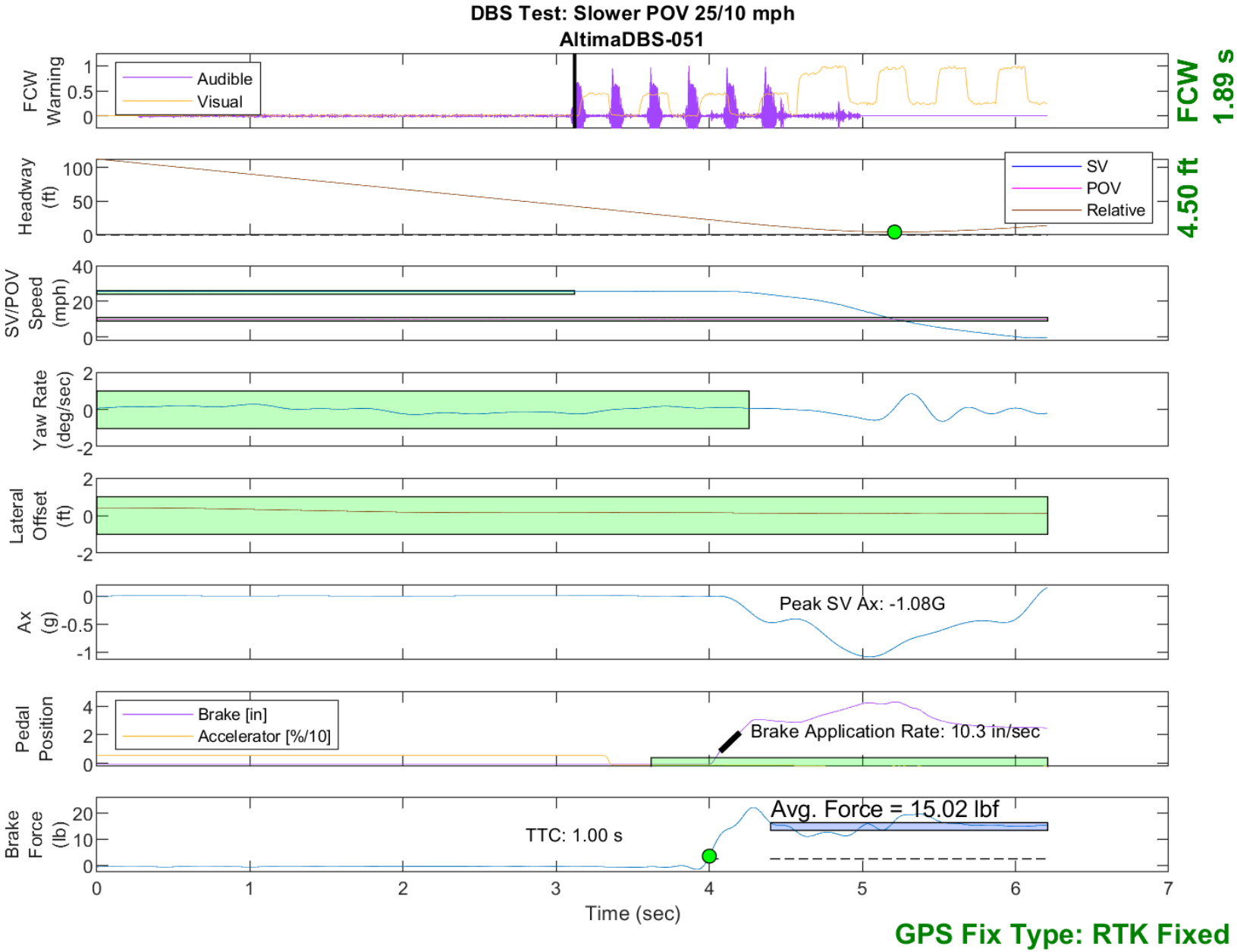


Figure E20. Time History for DBS Run 51, SV Encounters Slower POV, SV 25 mph, POV 10 mph

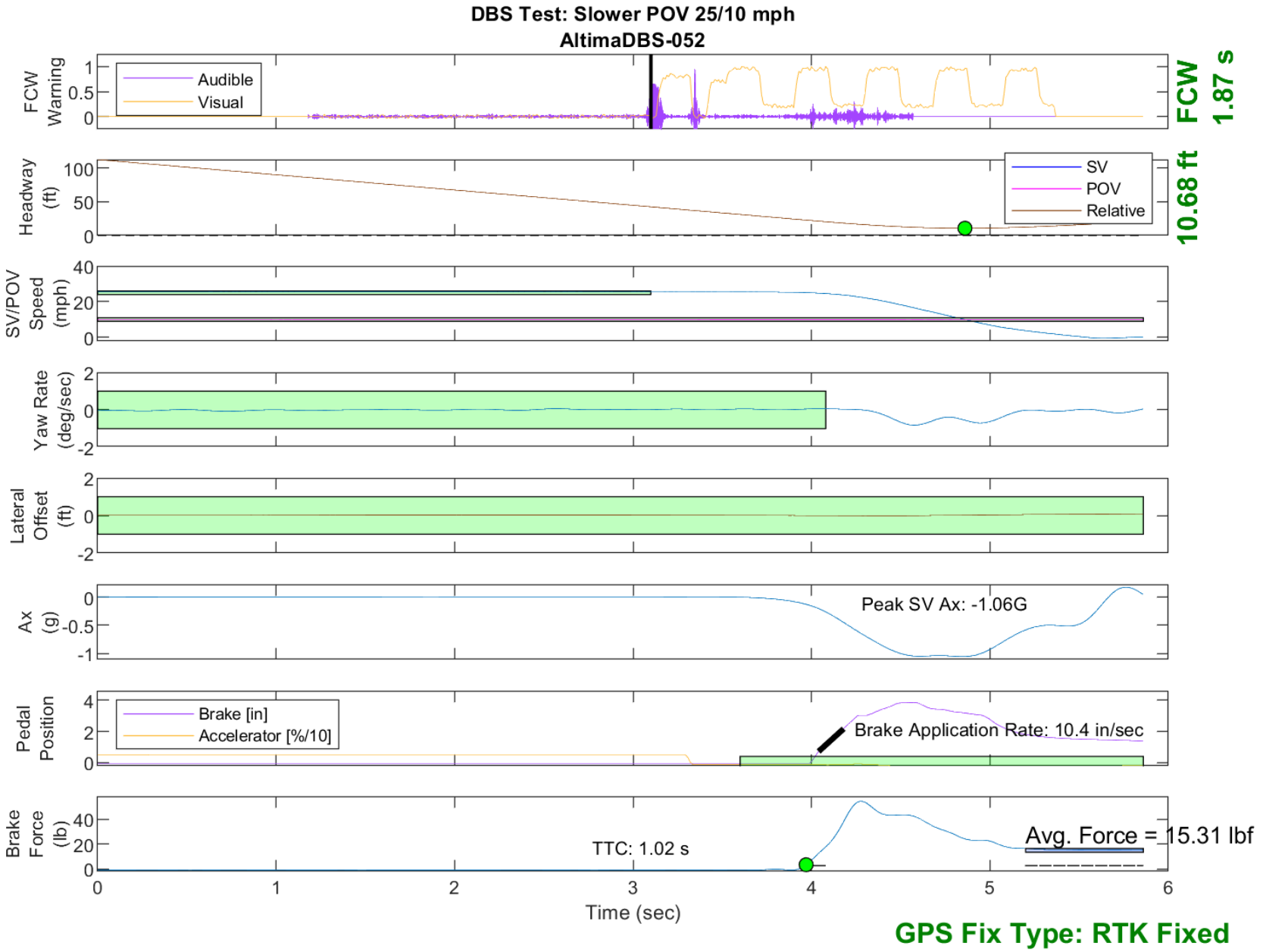


Figure E21. Time History for DBS Run 52, SV Encounters Slower POV, SV 25 mph, POV 10 mph

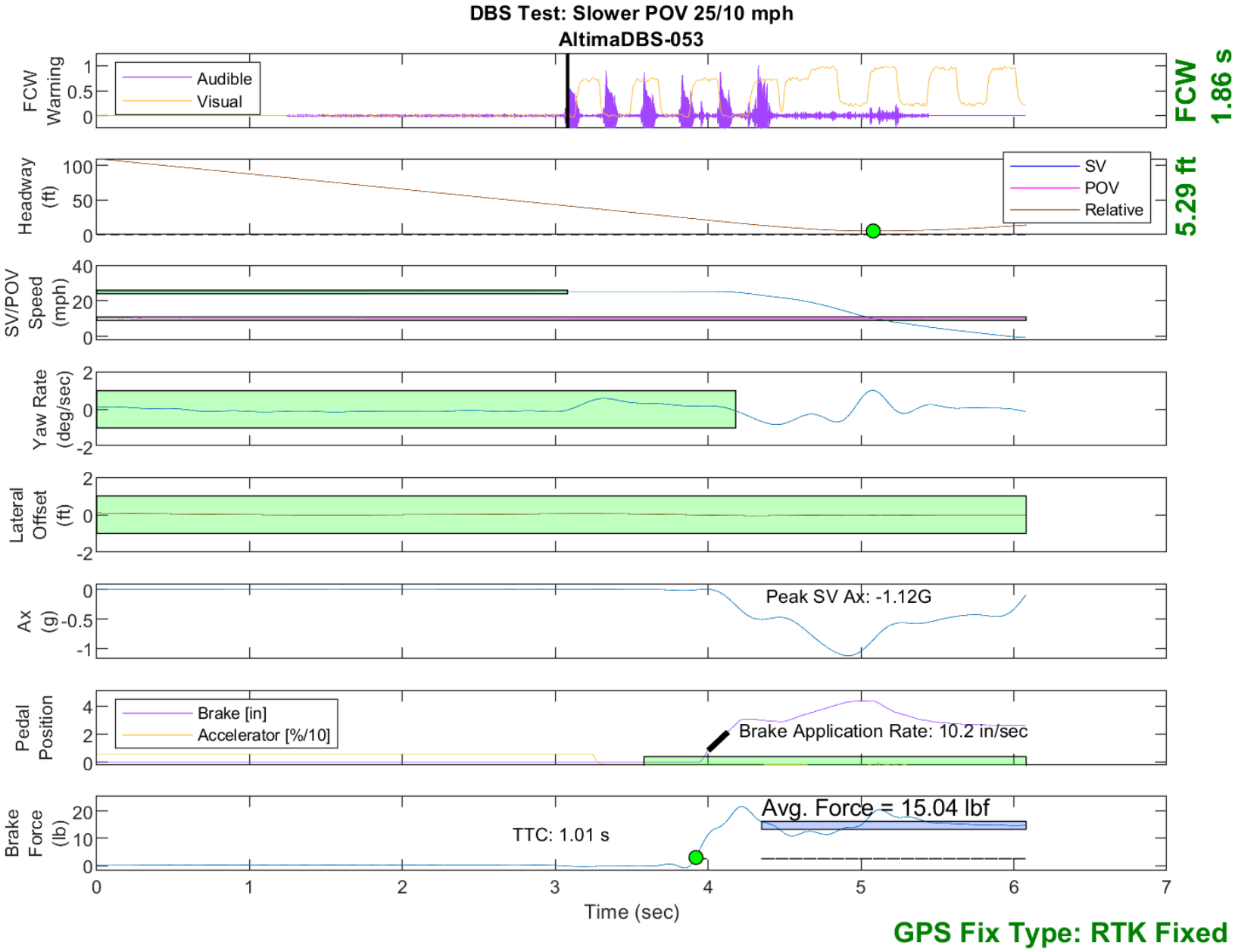


Figure E22. Time History for DBS Run 53, SV Encounters Slower POV, SV 25 mph, POV 10 mph

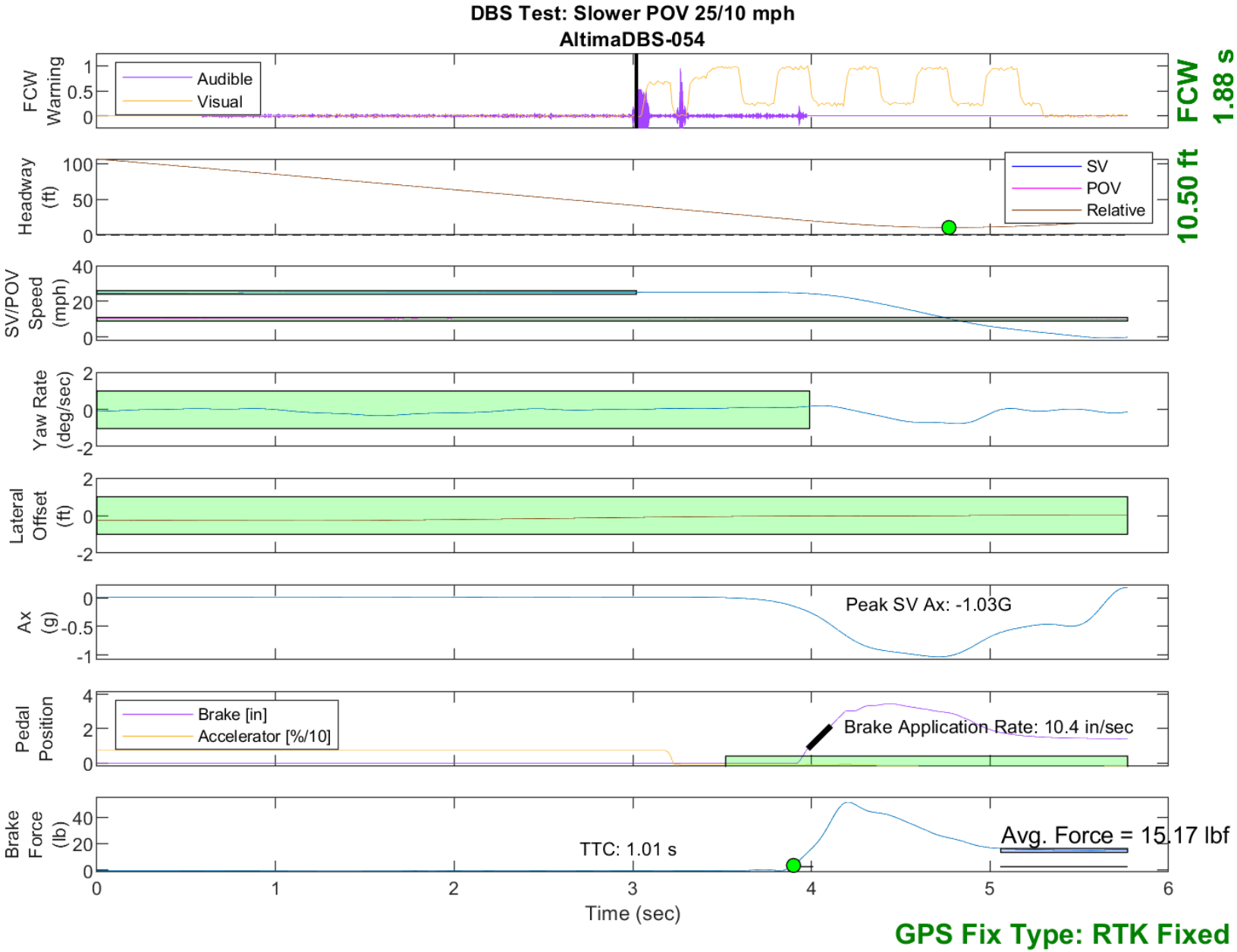


Figure E23. Time History for DBS Run 54, SV Encounters Slower POV, SV 25 mph, POV 10 mph

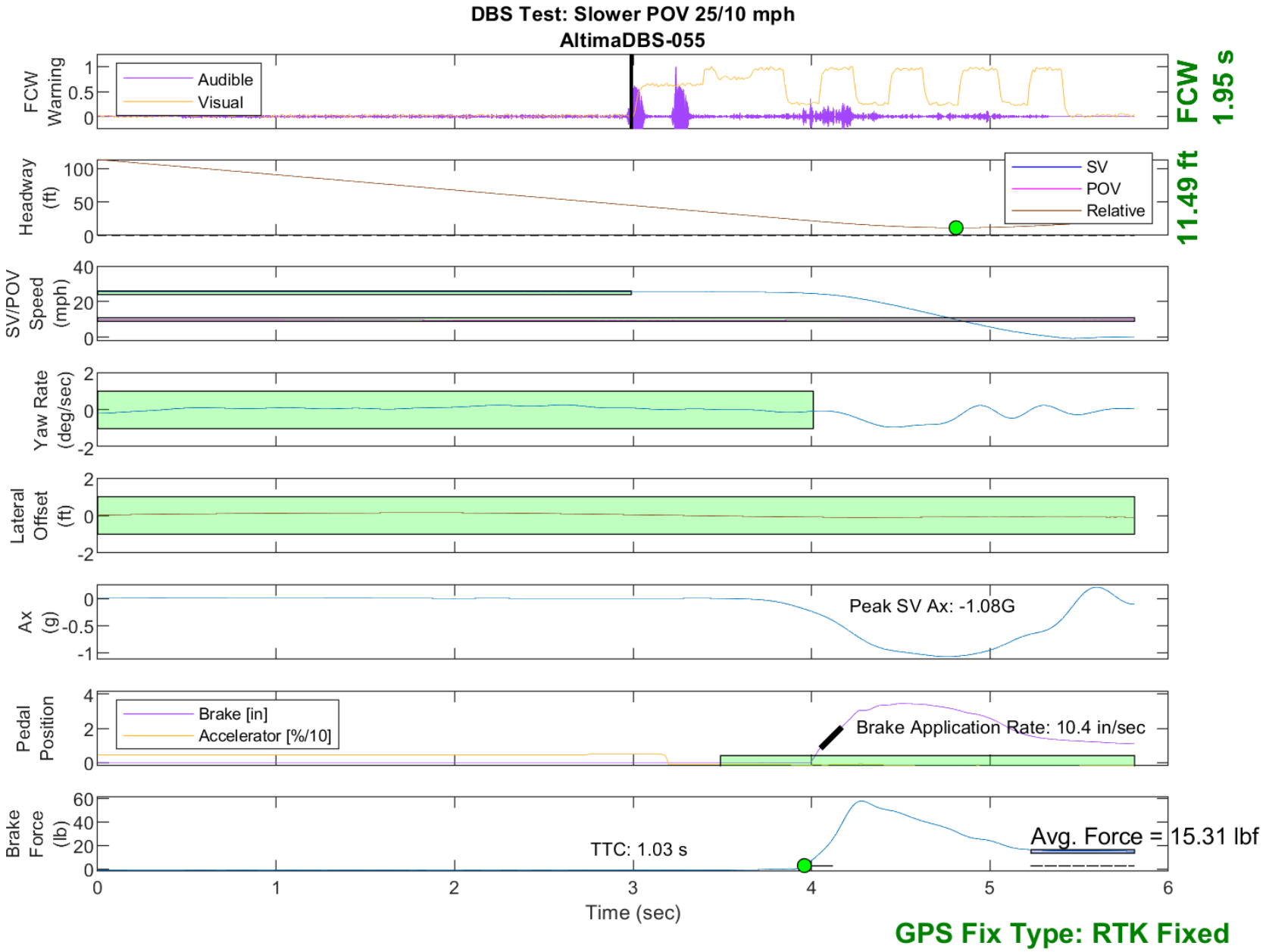


Figure E24. Time History for DBS Run 55, SV Encounters Slower POV, SV 25 mph, POV 10 mph

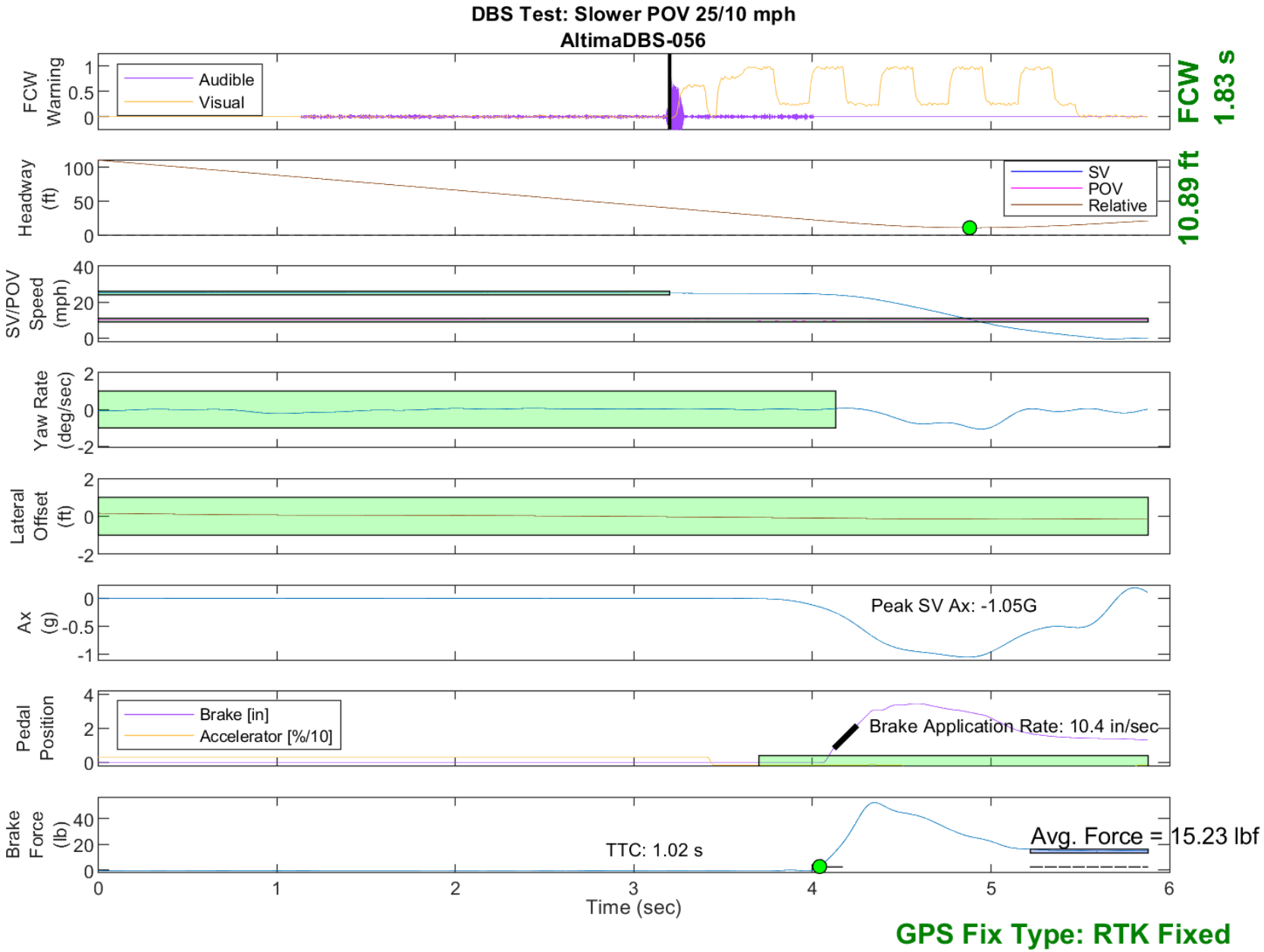


Figure E25. Time History for DBS Run 56, SV Encounters Slower POV, SV 25 mph, POV 10 mph

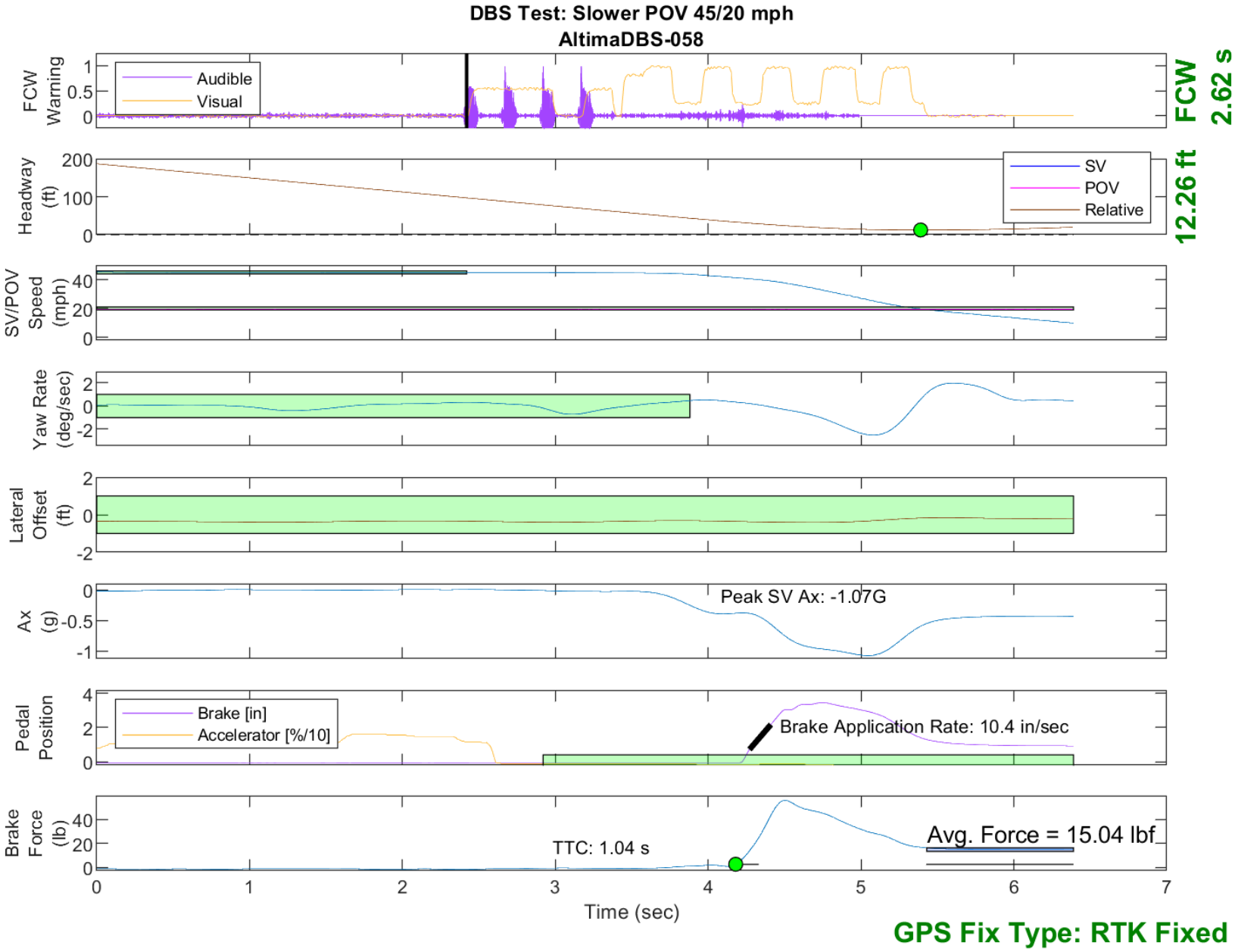


Figure E26. Time History for DBS Run 58, SV Encounters Slower POV, SV 45 mph, POV 20 mph

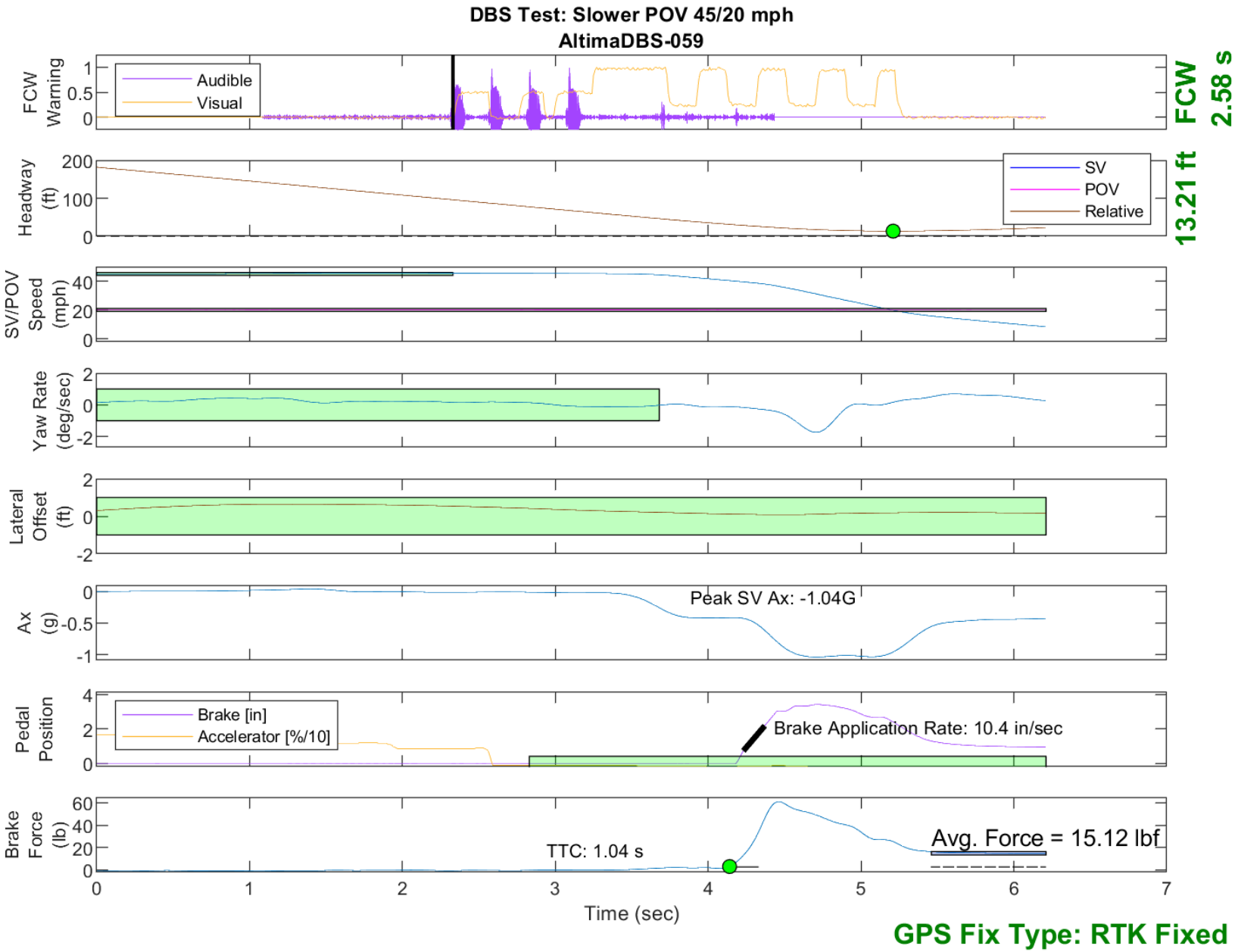


Figure E27. Time History for DBS Run 59, SV Encounters Slower POV, SV 45 mph, POV 20 mph

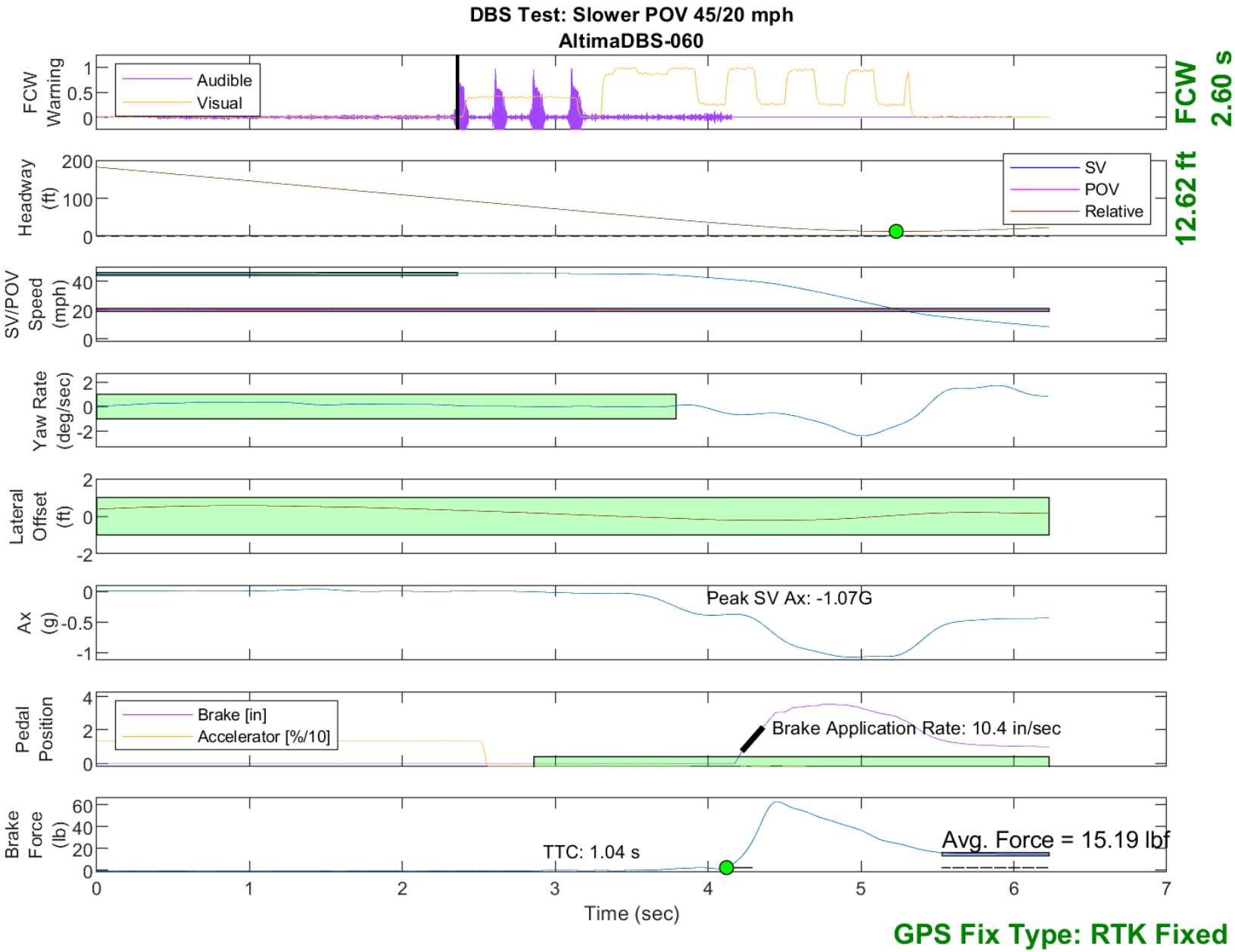


Figure E28. Time History for DBS Run 60, SV Encounters Slower POV, SV 45 mph, POV 20 mph

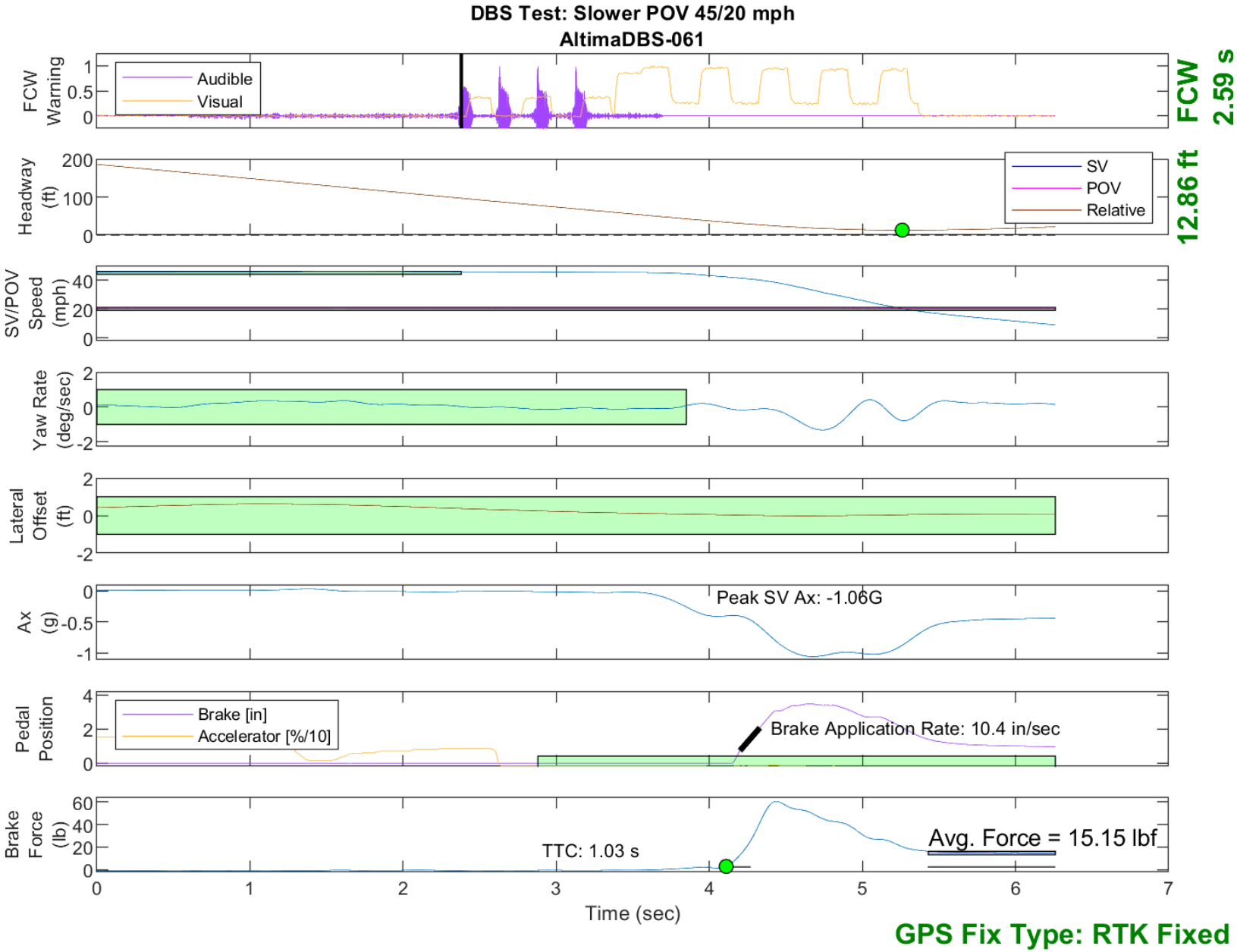


Figure E29. Time History for DBS Run 61, SV Encounters Slower POV, SV 45 mph, POV 20 mph

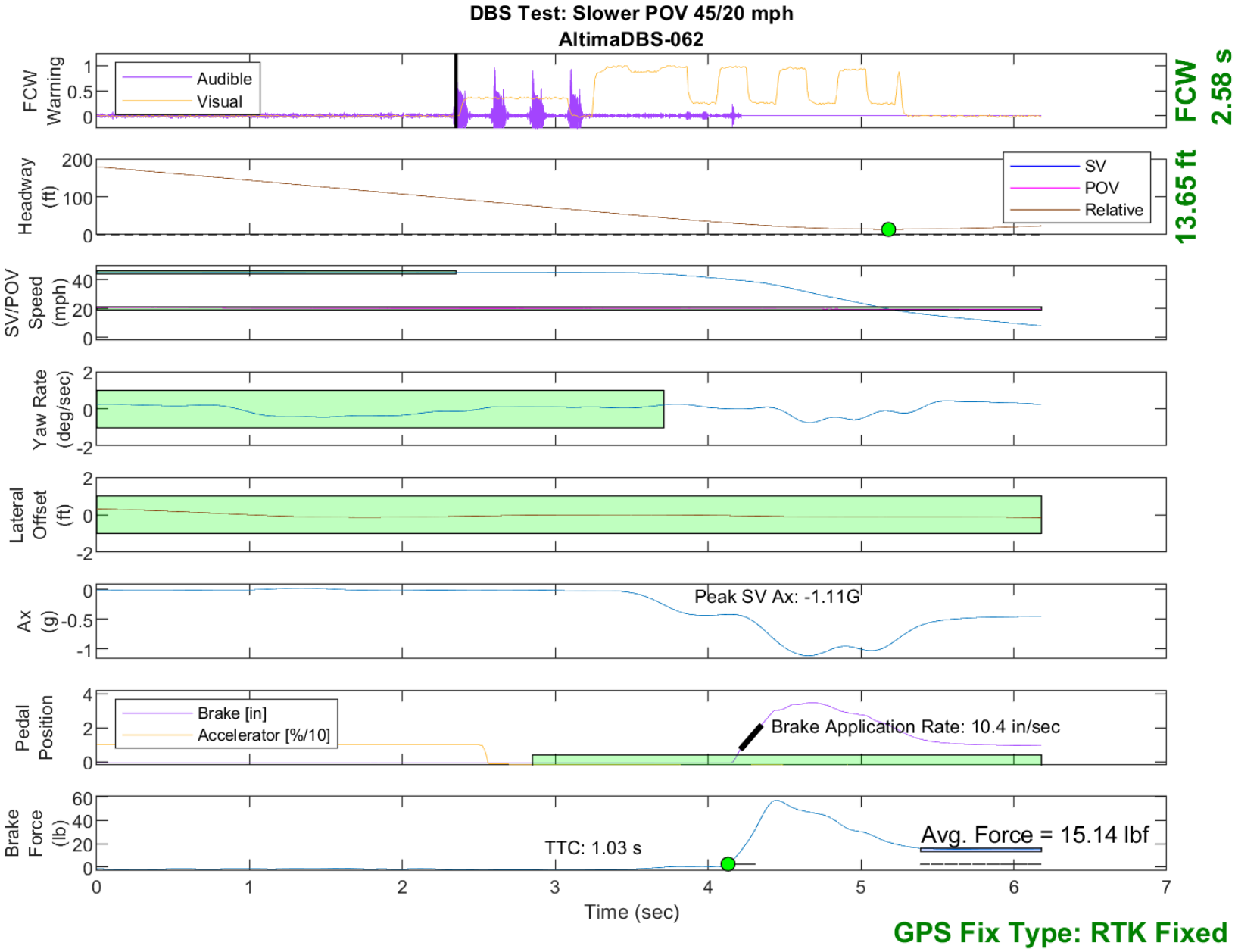


Figure E30. Time History for DBS Run 62, SV Encounters Slower POV, SV 45 mph, POV 20 mph

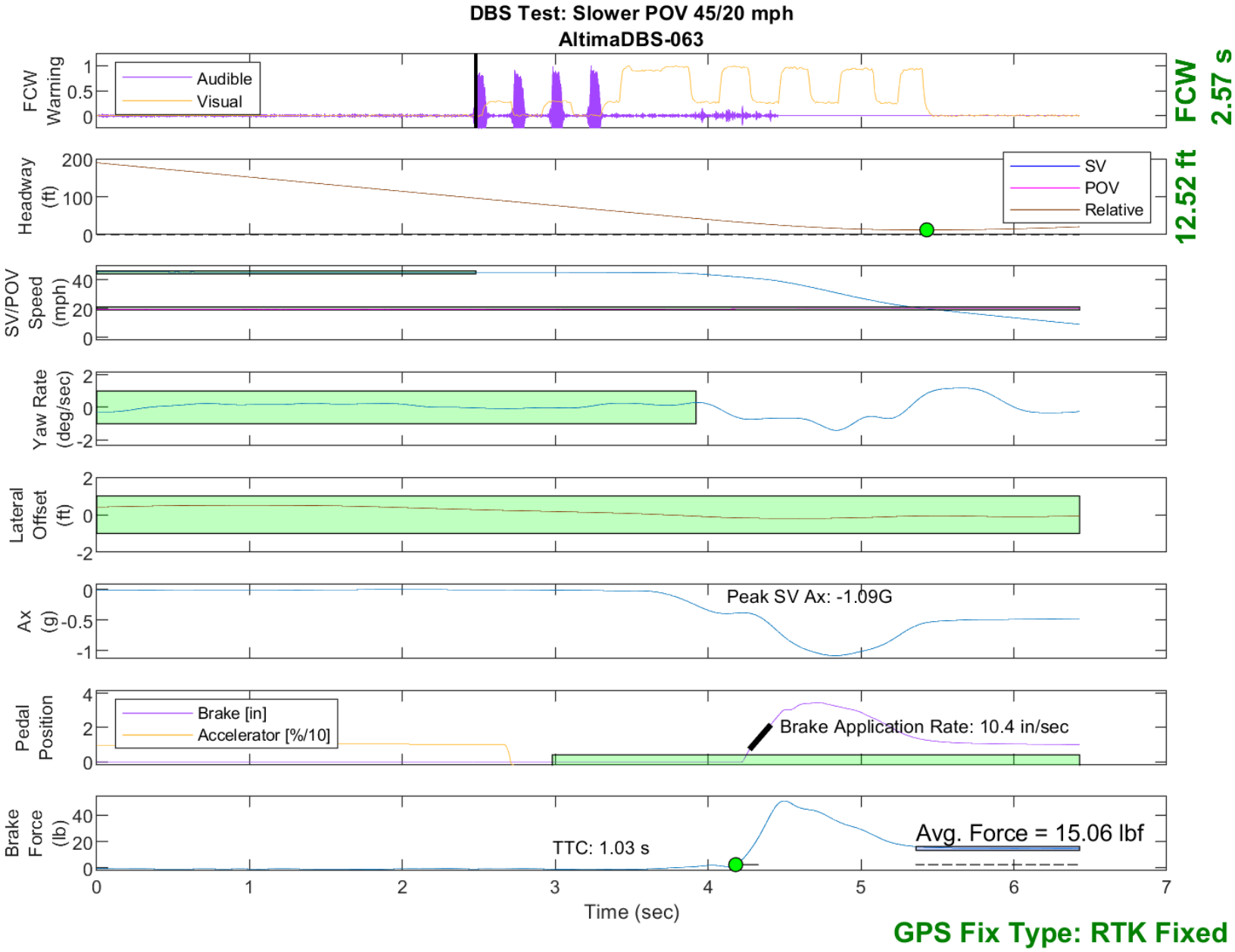


Figure E31. Time History for DBS Run 63, SV Encounters Slower POV, SV 45 mph, POV 20 mph

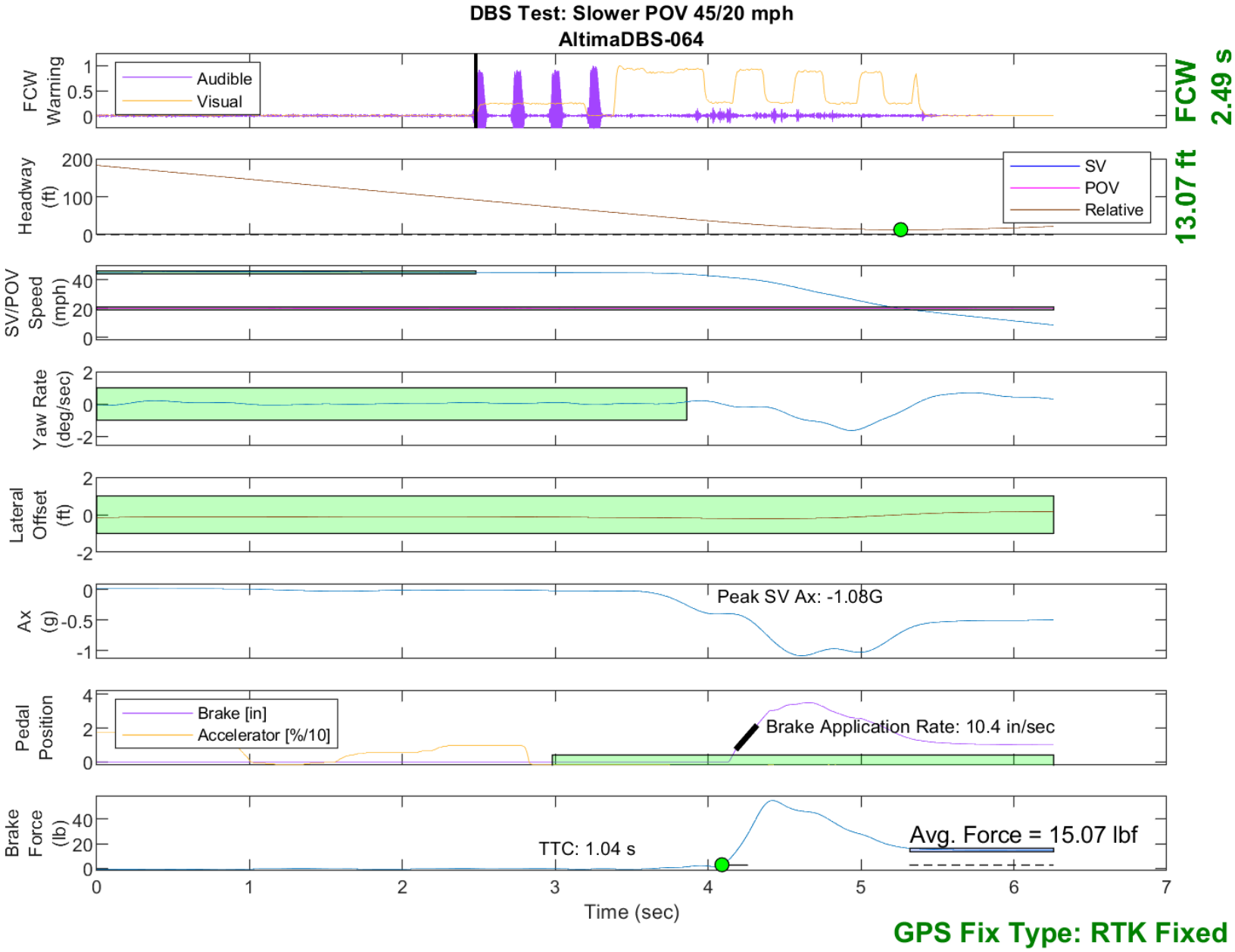


Figure E32. Time History for DBS Run 64, SV Encounters Slower POV, SV 45 mph, POV 20 mph

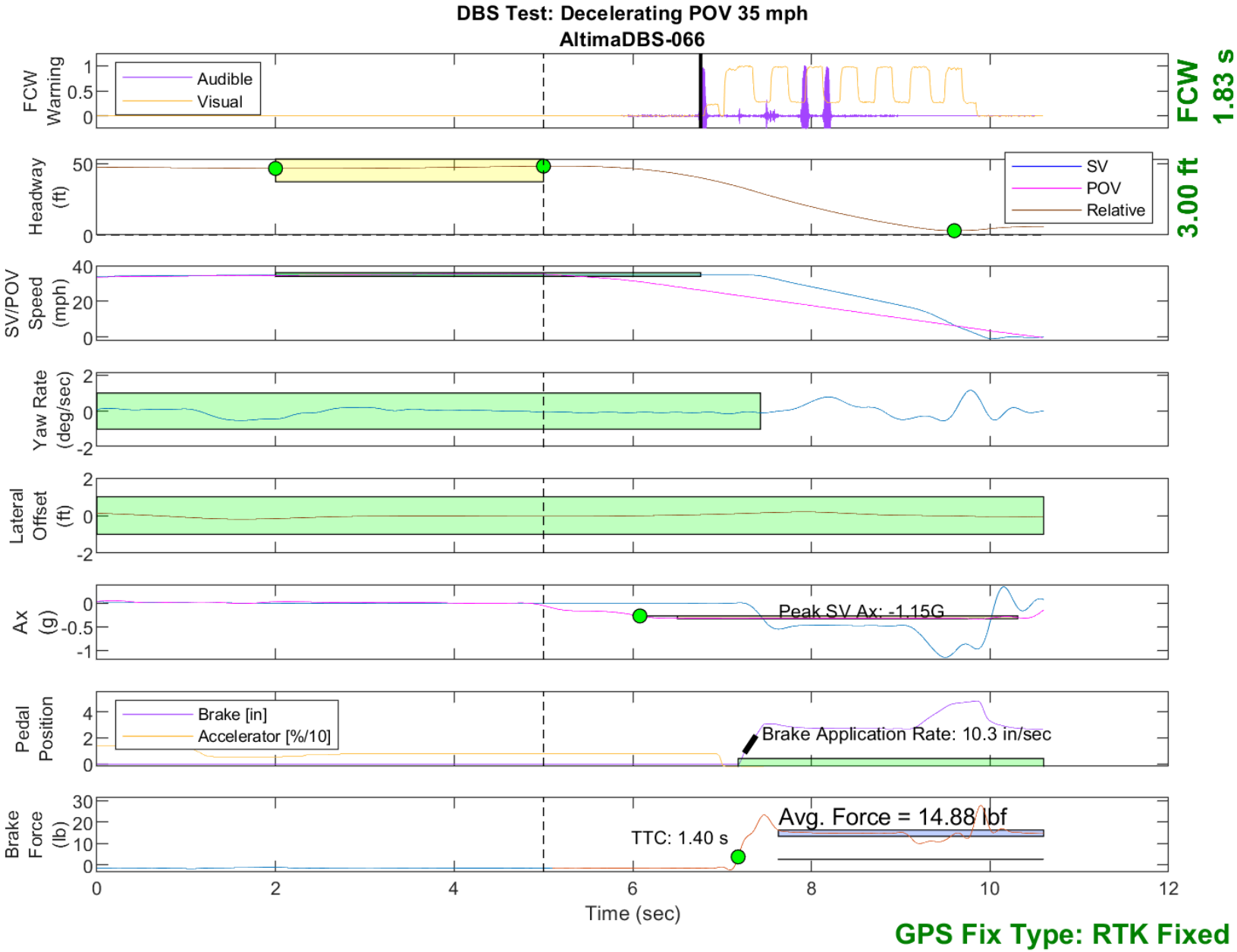


Figure E33. Time History for DBS Run 66, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

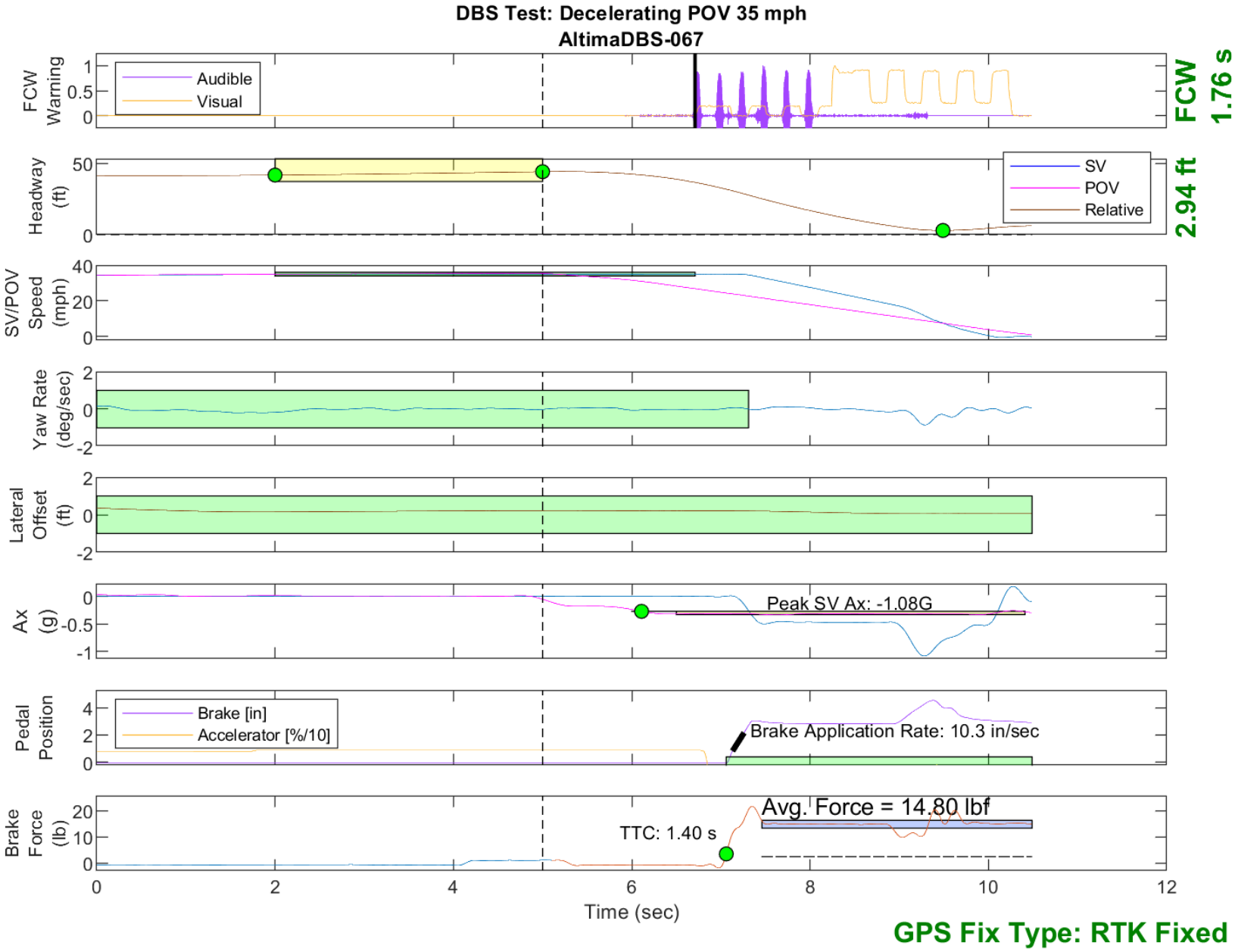


Figure E34. Time History for DBS Run 67, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

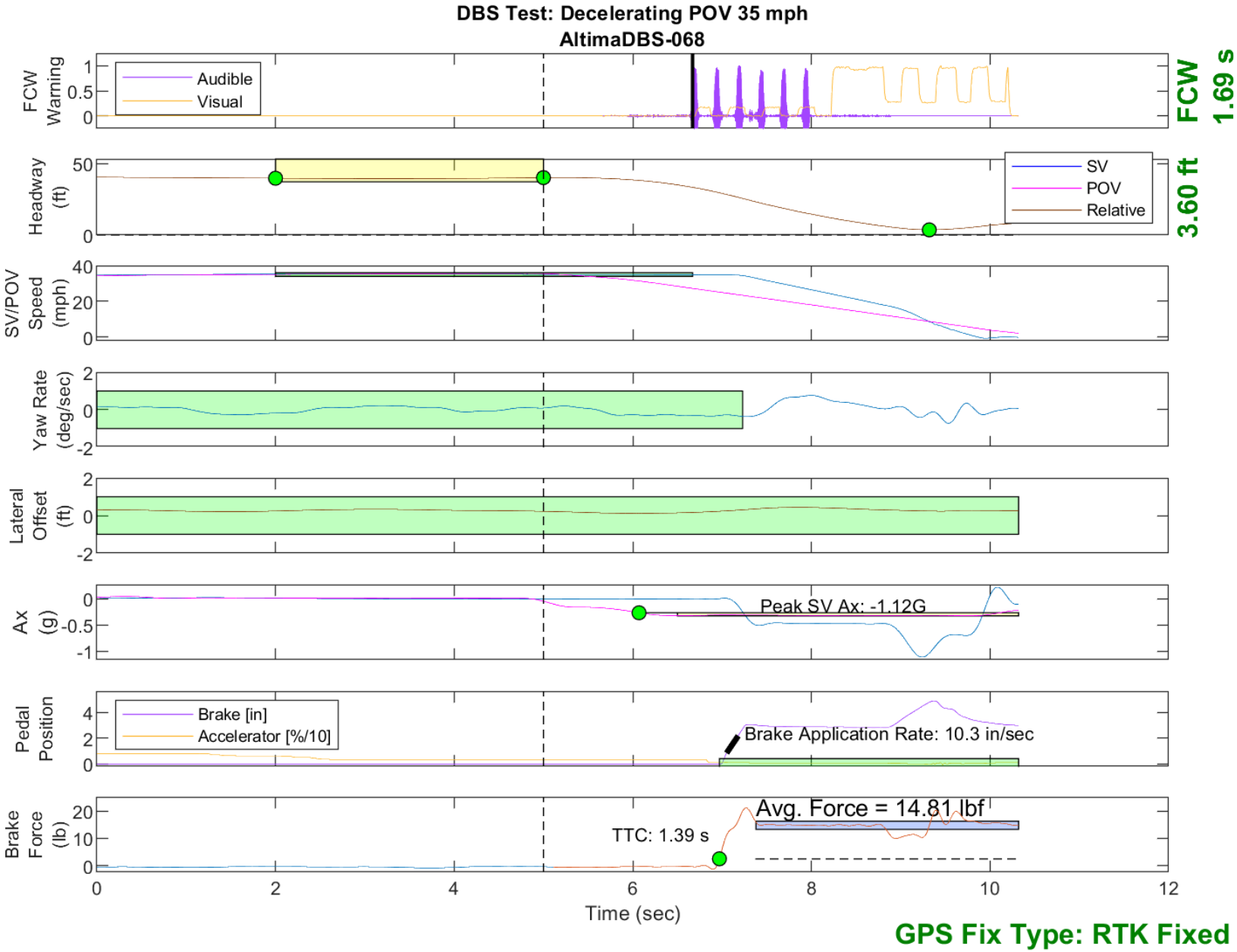


Figure E35. Time History for DBS Run 68, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

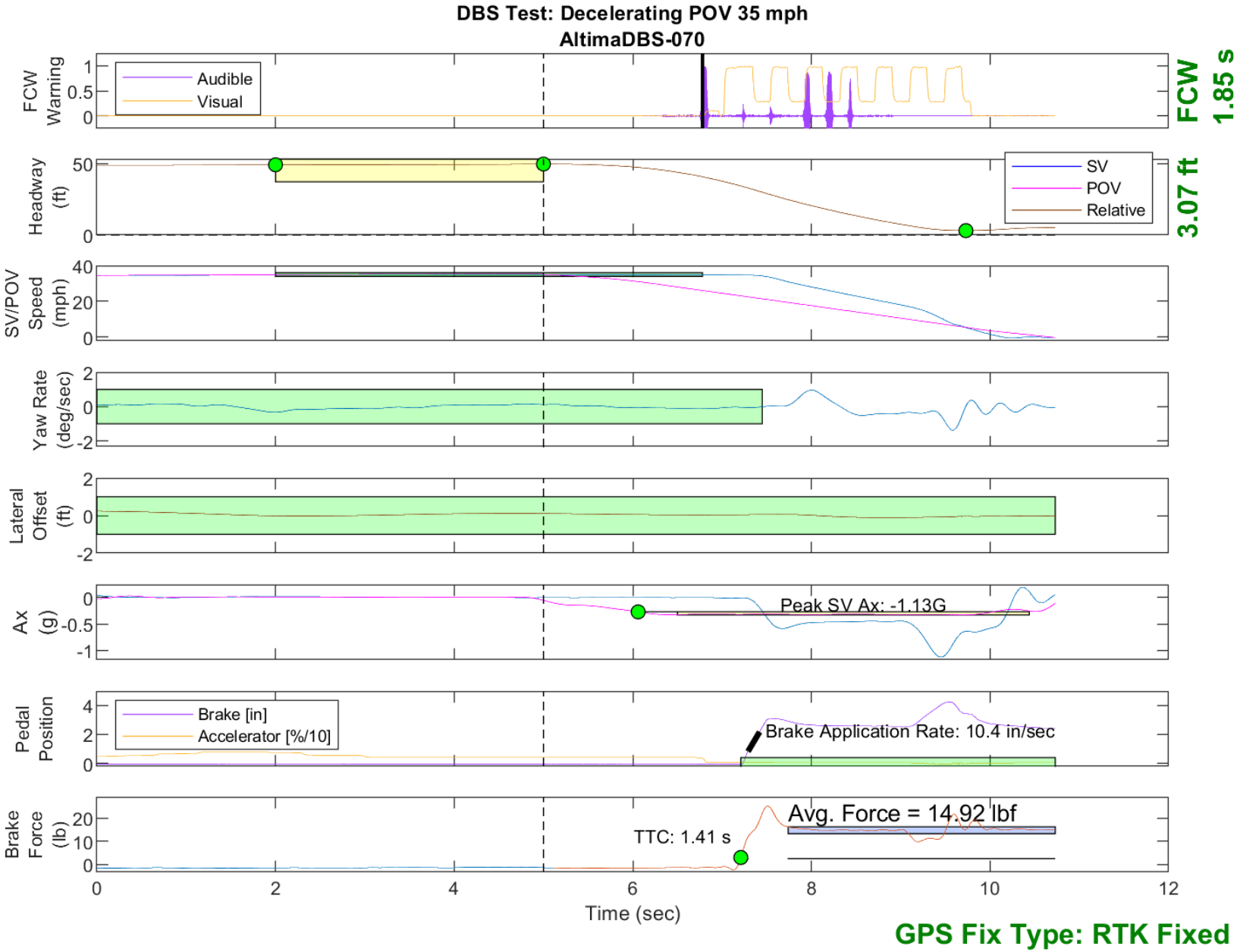


Figure E36. Time History for DBS Run 70, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

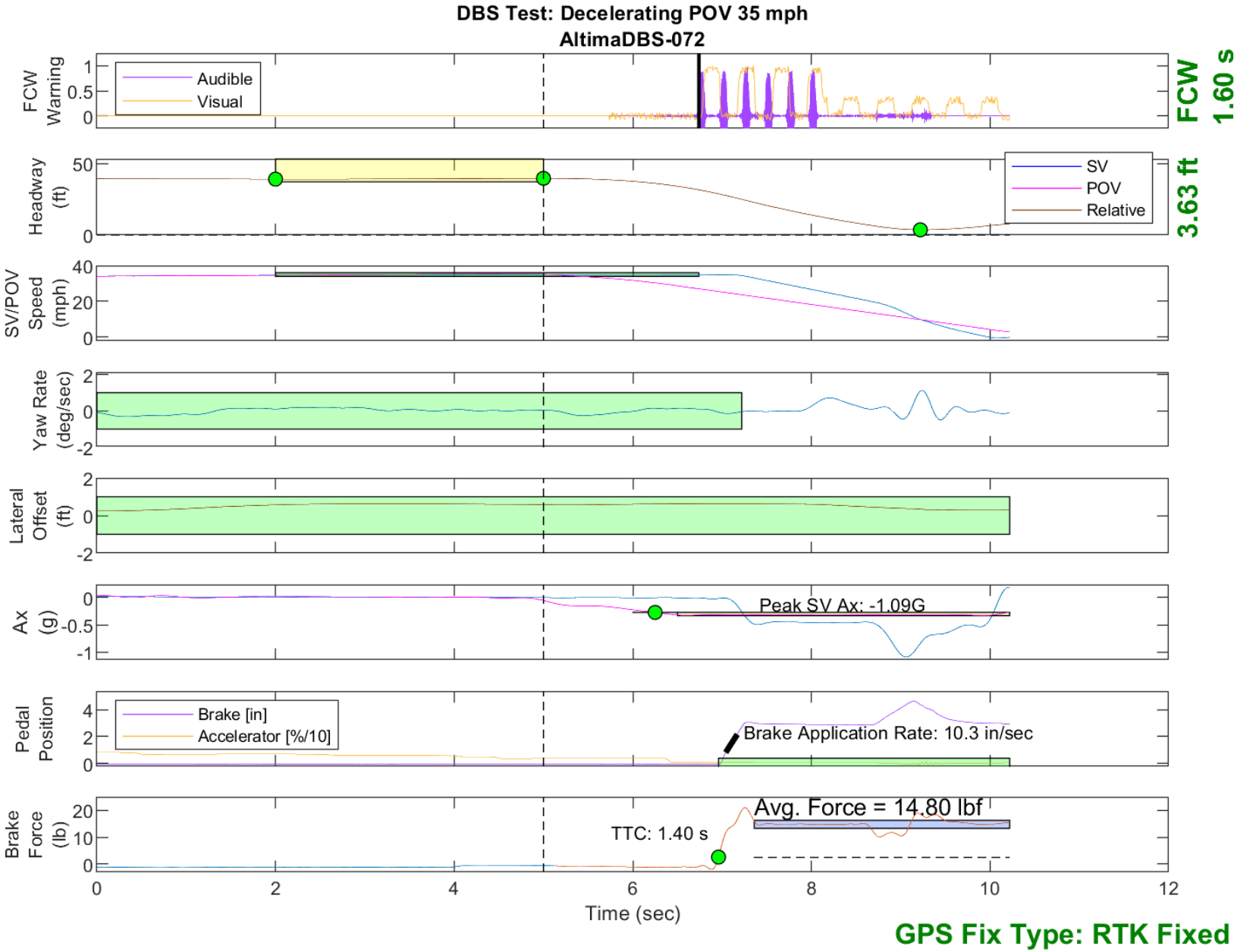


Figure E37. Time History for DBS Run 72, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

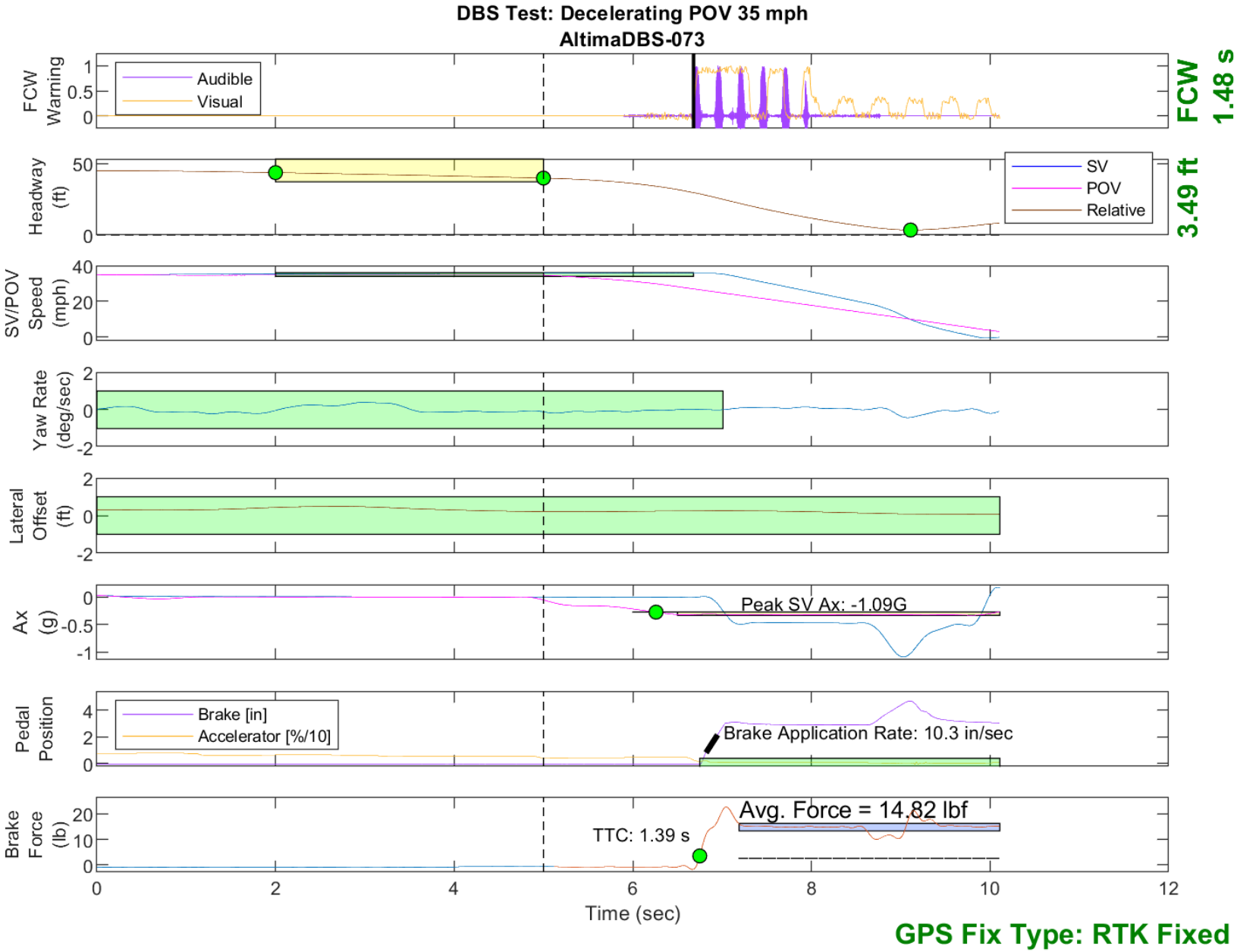


Figure E38. Time History for DBS Run 73, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

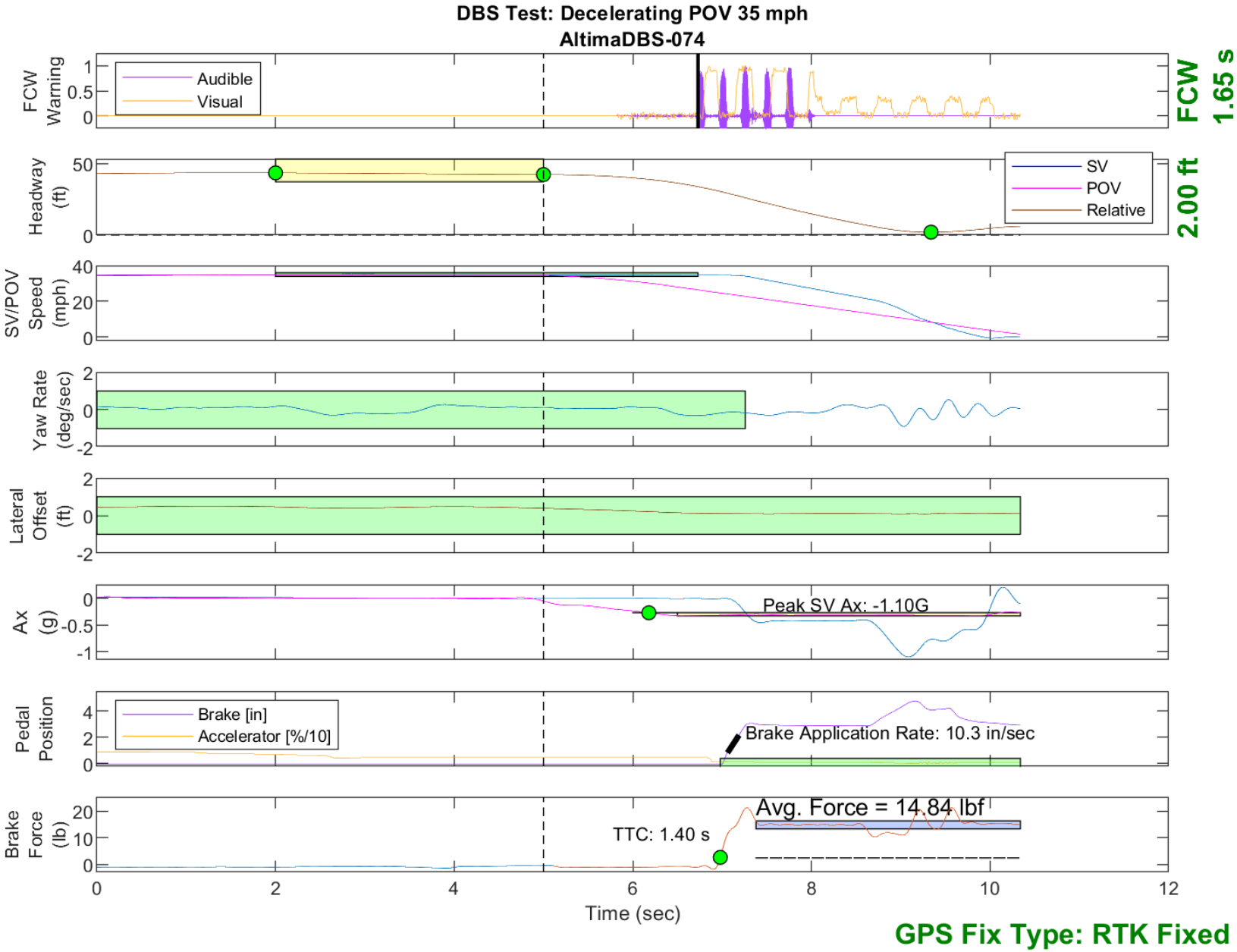


Figure E39. Time History for DBS Run 74, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

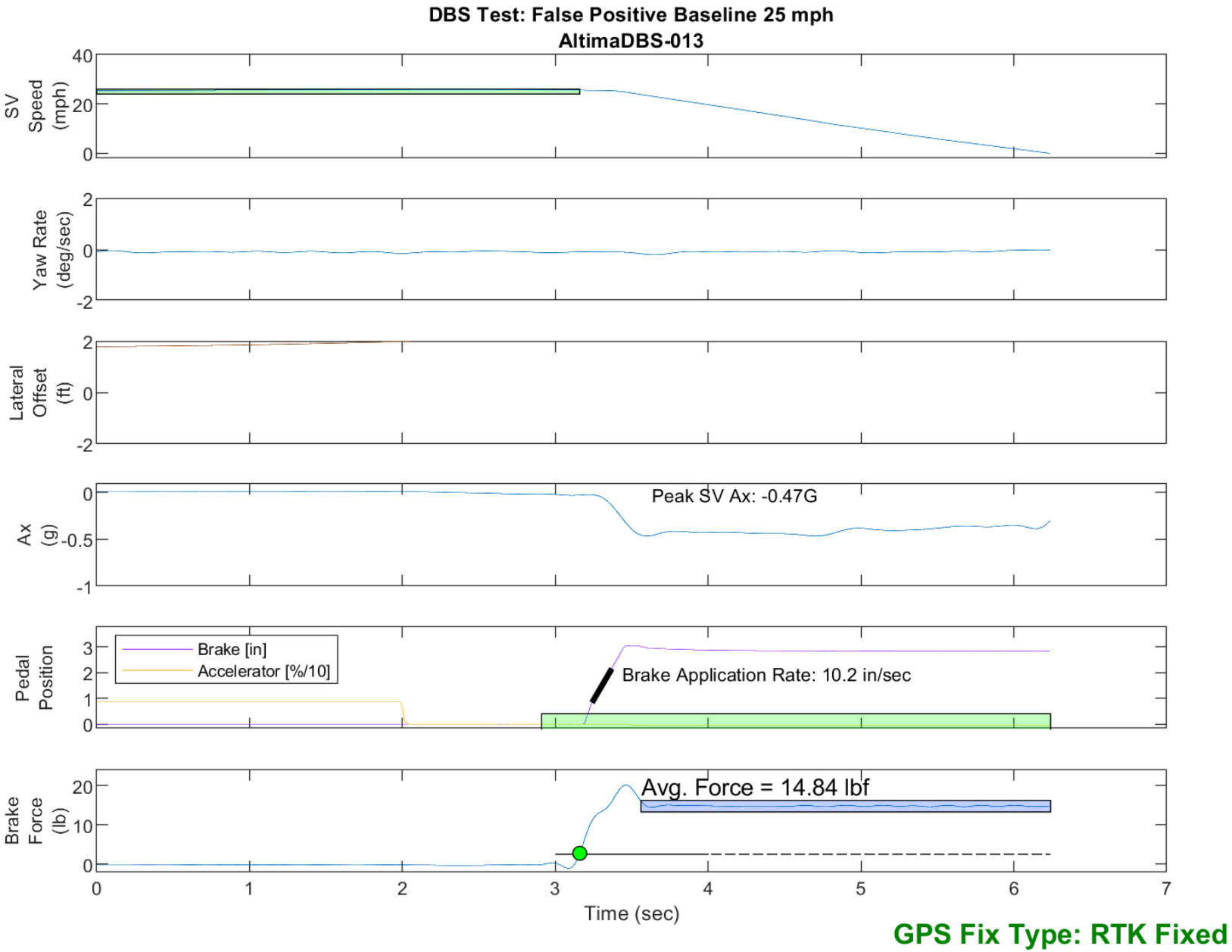


Figure E40. Time History for DBS Run 13, False Positive Baseline, SV 25 mph

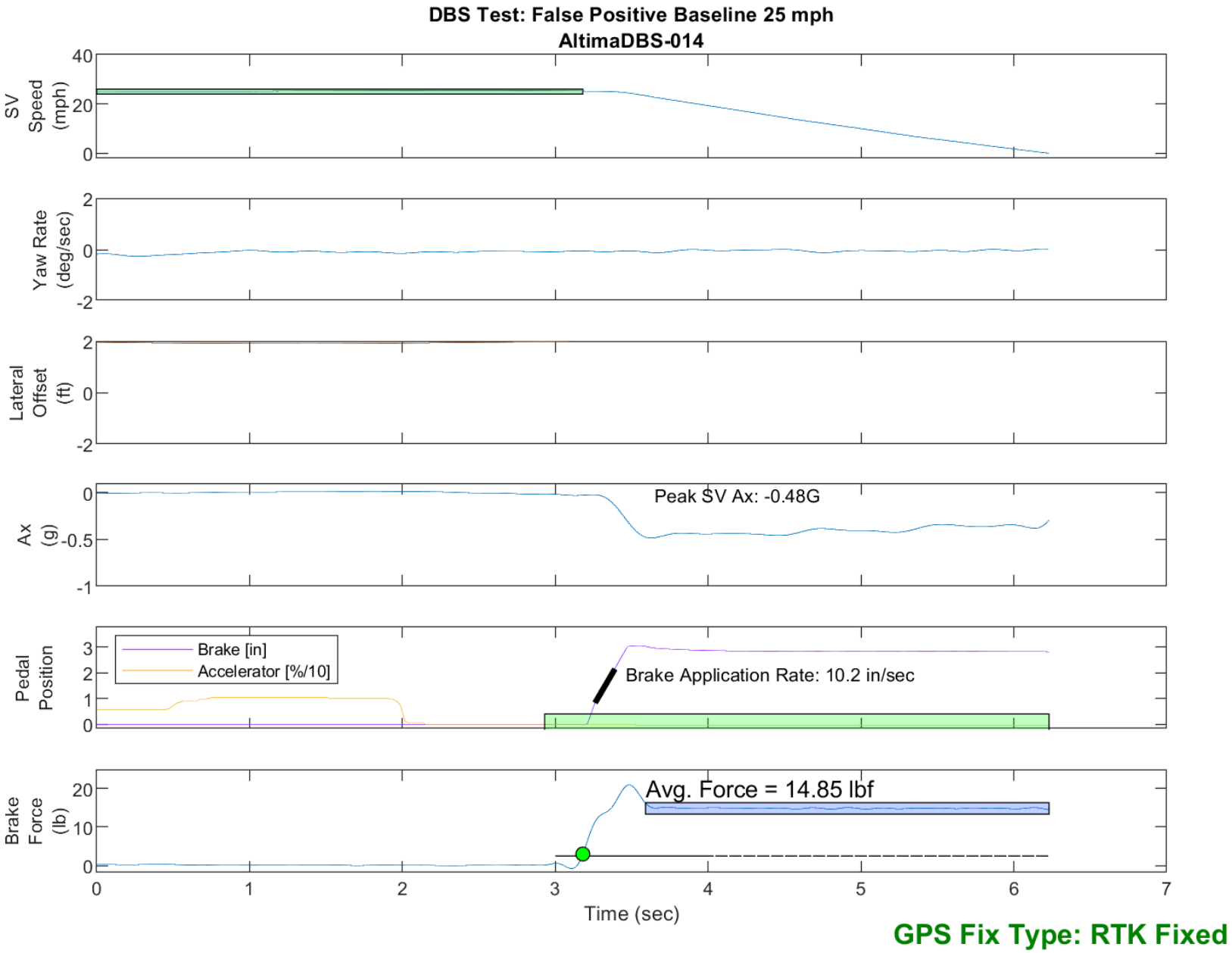


Figure E41. Time History for DBS Run 14, False Positive Baseline, SV 25 mph

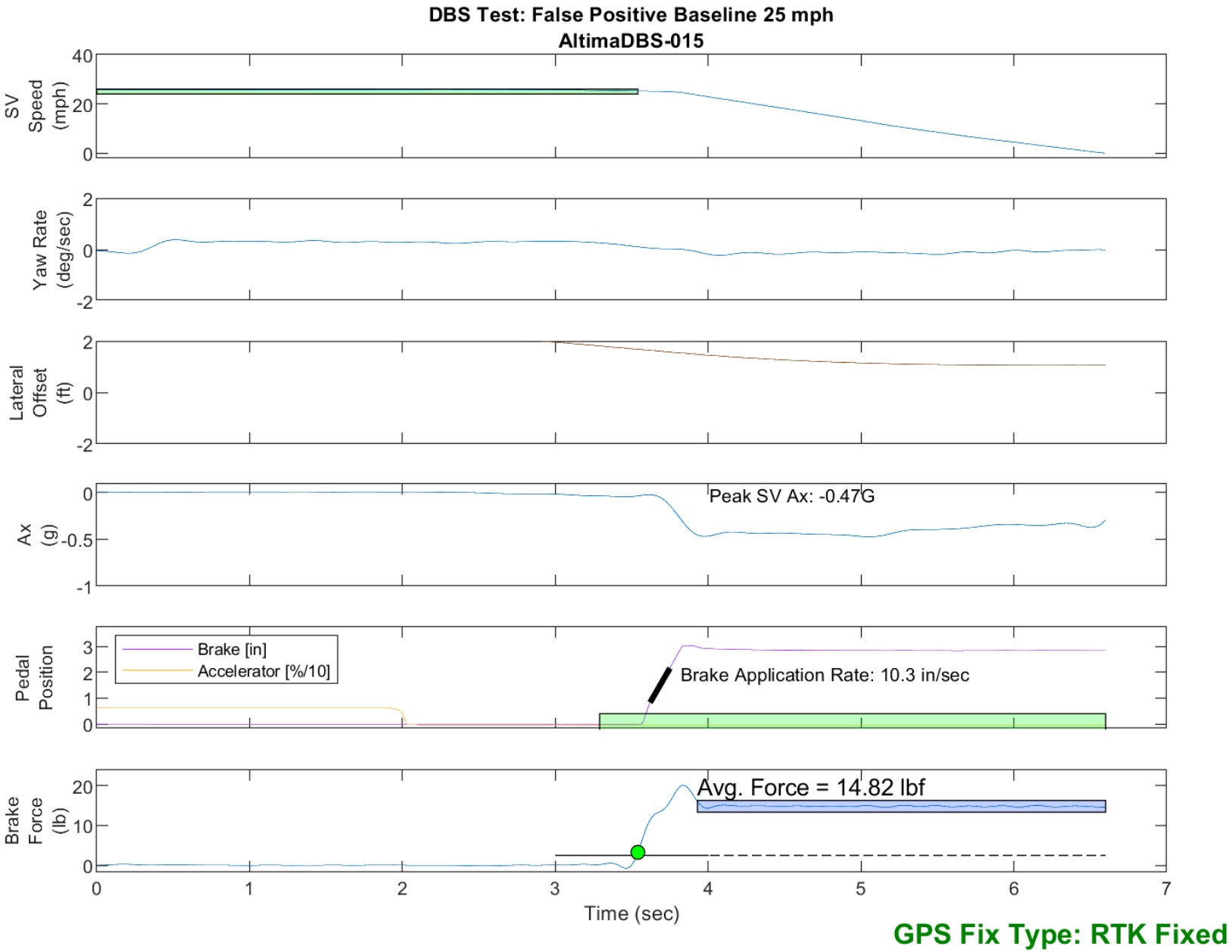


Figure E42. Time History for DBS Run 15, False Positive Baseline, SV 25 mph

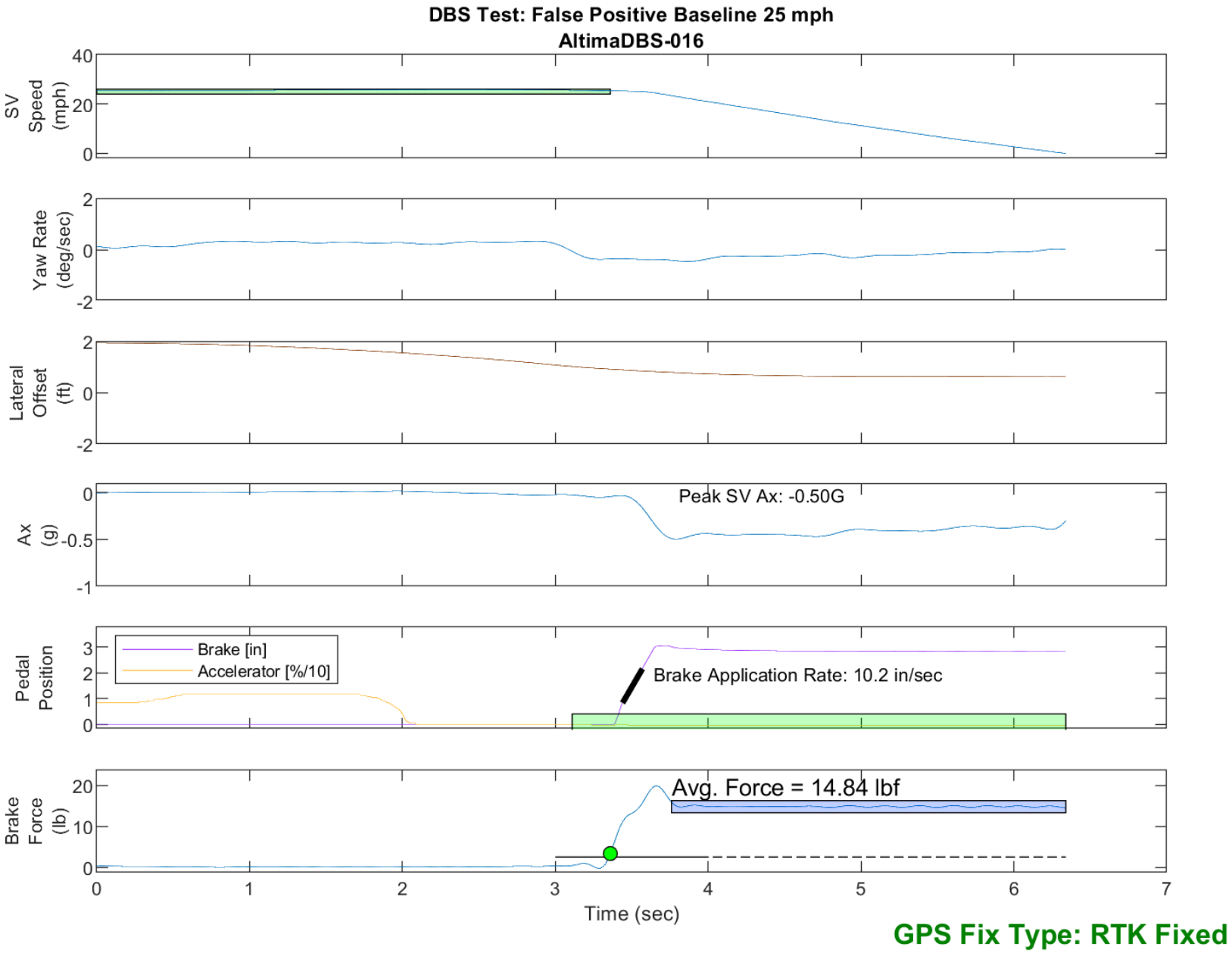


Figure E43. Time History for DBS Run 16, False Positive Baseline, SV 25 mph

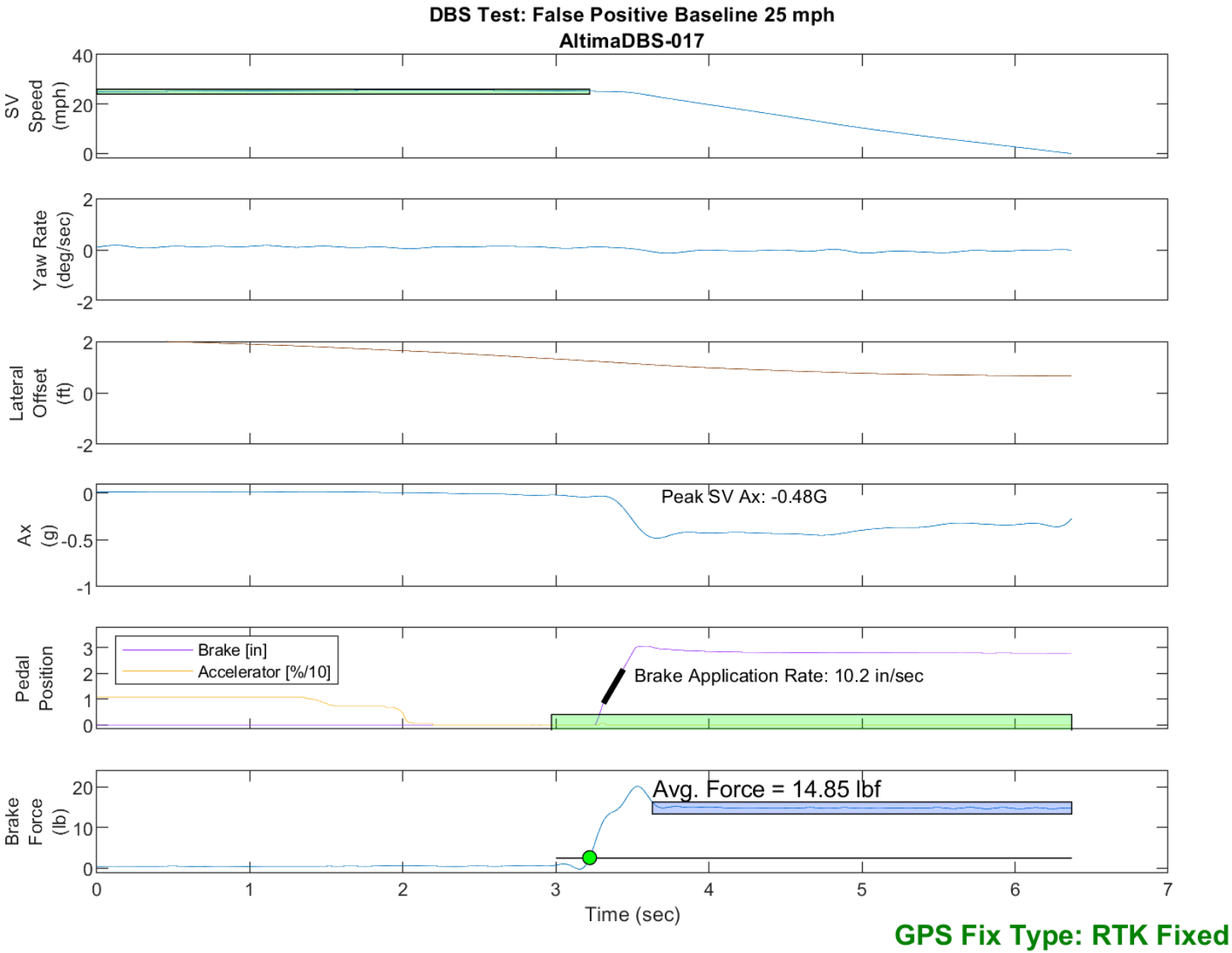


Figure E44. Time History for DBS Run 17, False Positive Baseline, SV 25 mph

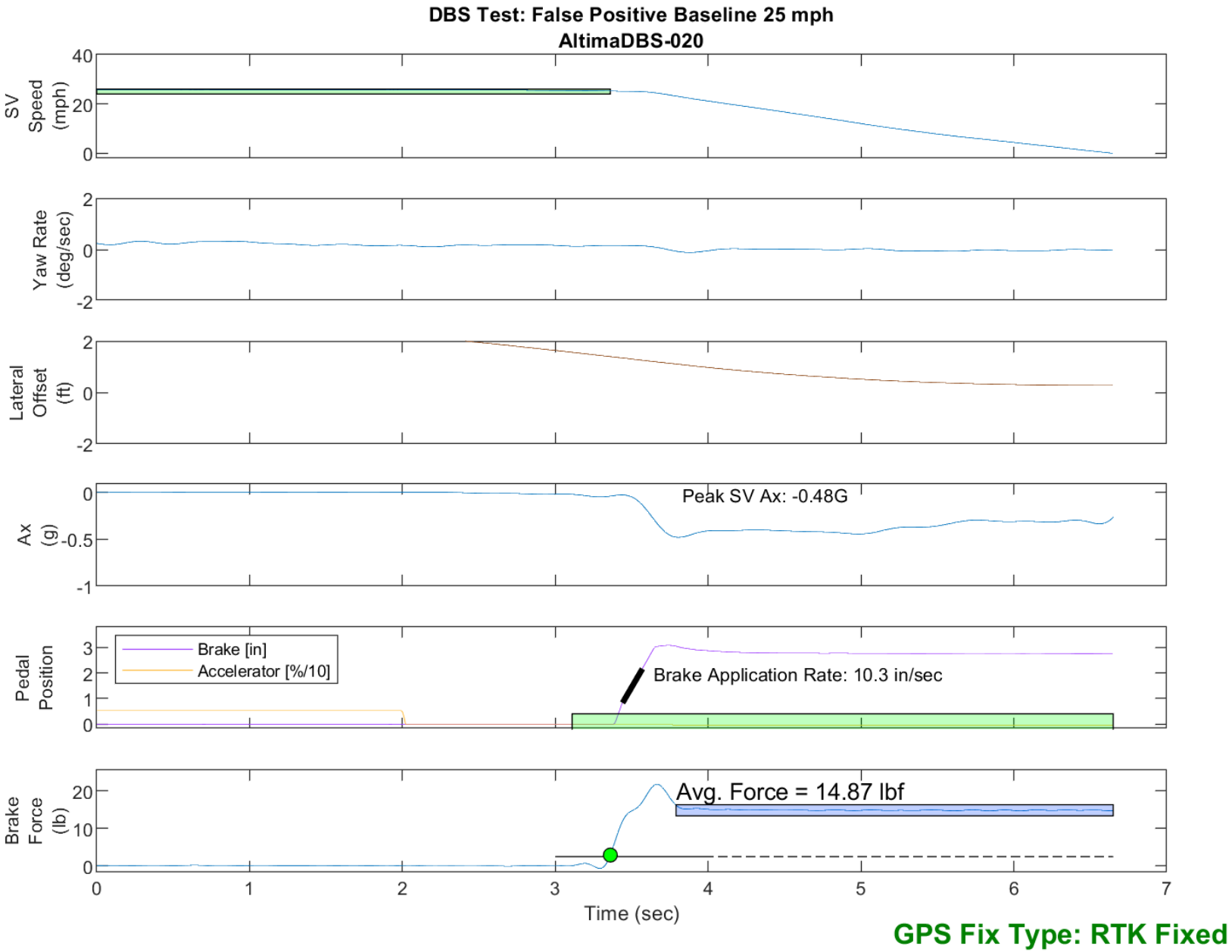


Figure E45. Time History for DBS Run 20, False Positive Baseline, SV 25 mph

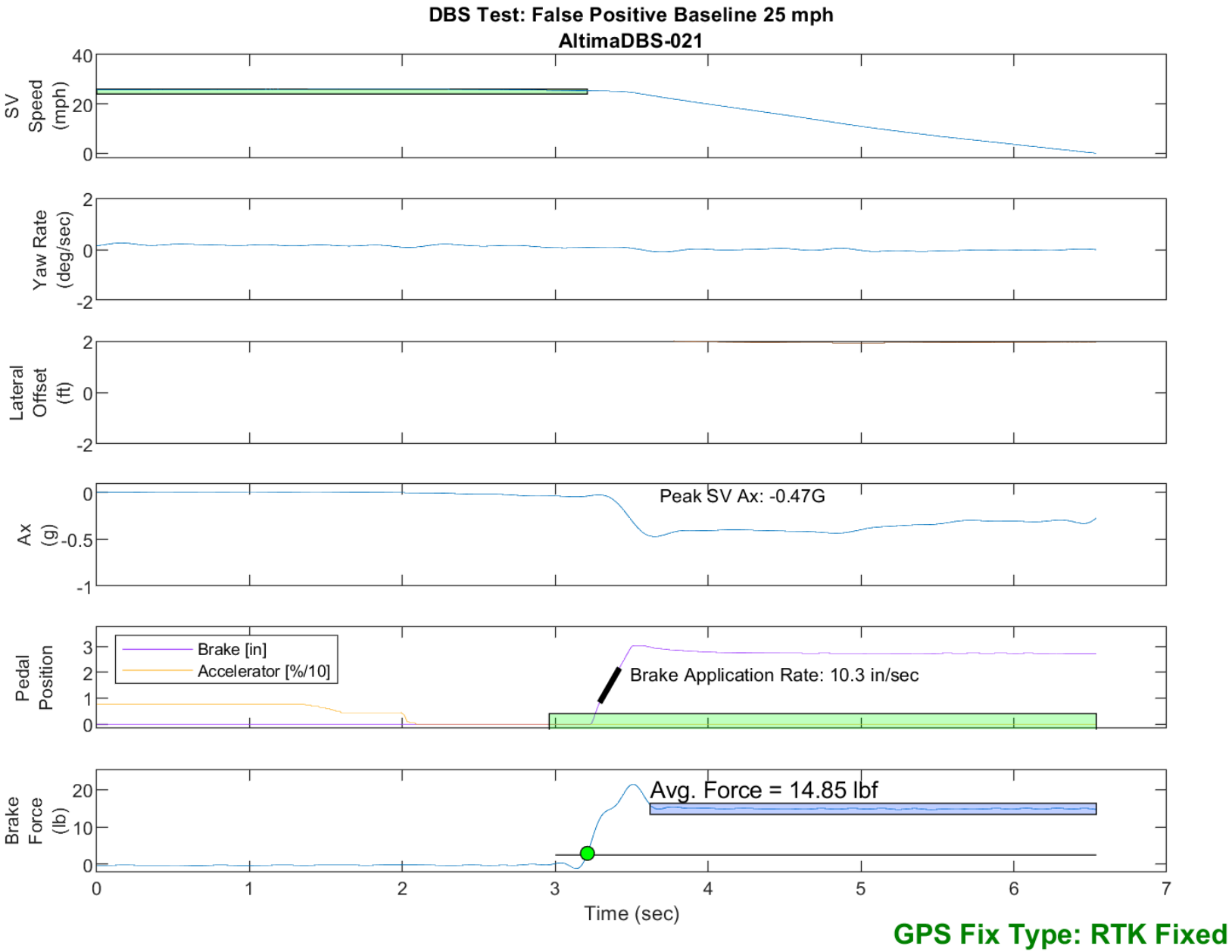


Figure E46. Time History for DBS Run 21, False Positive Baseline, SV 25 mph

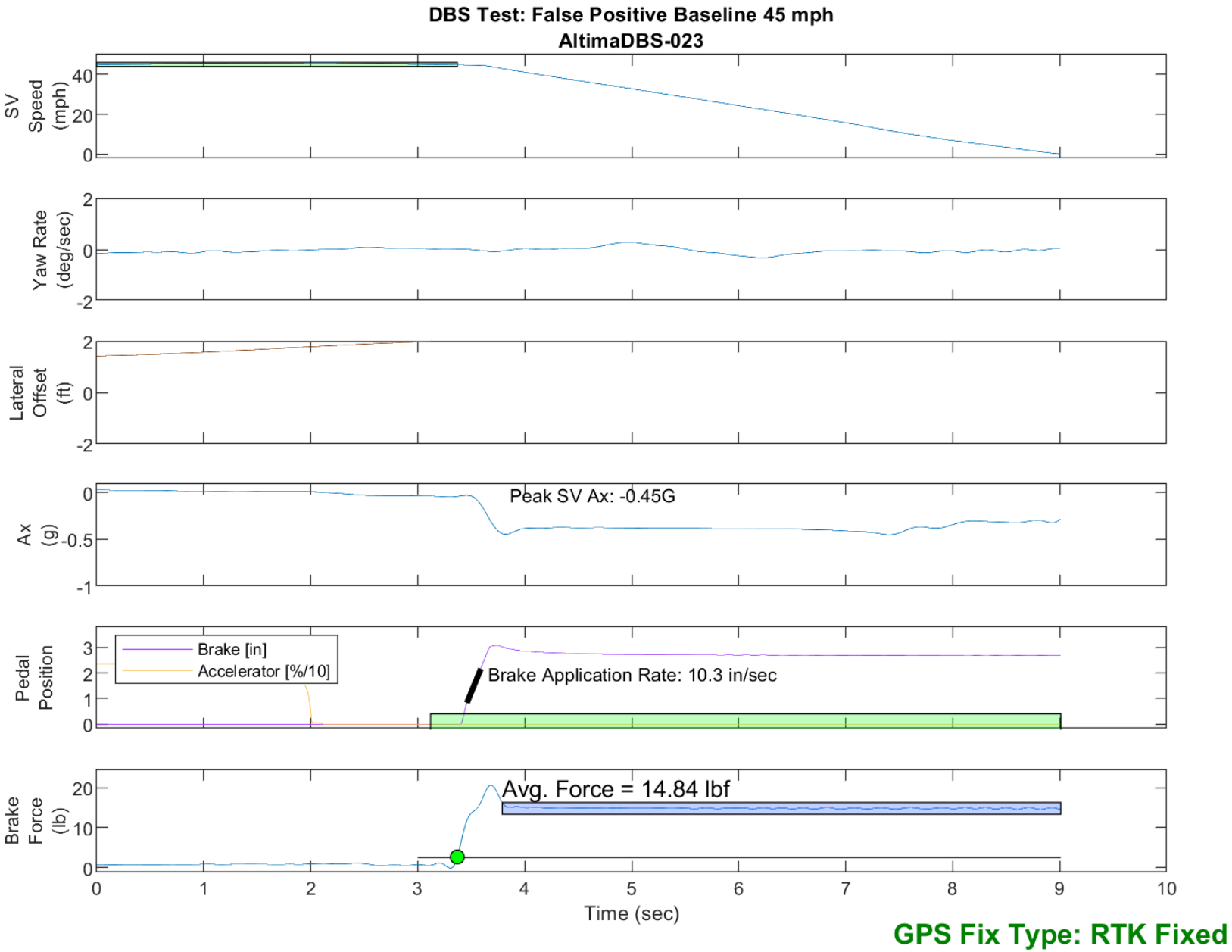


Figure E47. Time History for DBS Run 23, False Positive Baseline, SV 45 mph

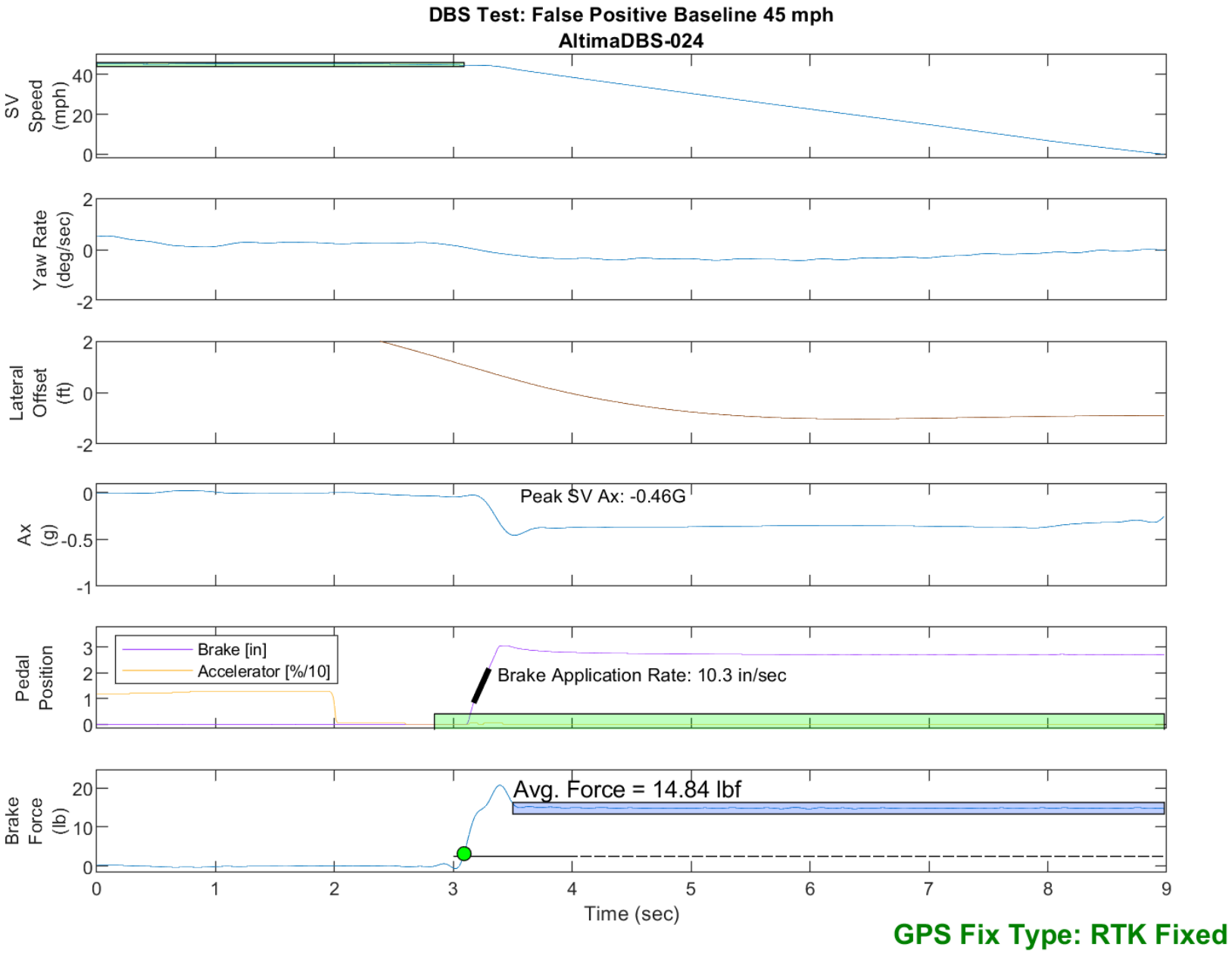


Figure E48. Time History for DBS Run 24, False Positive Baseline, SV 45 mph

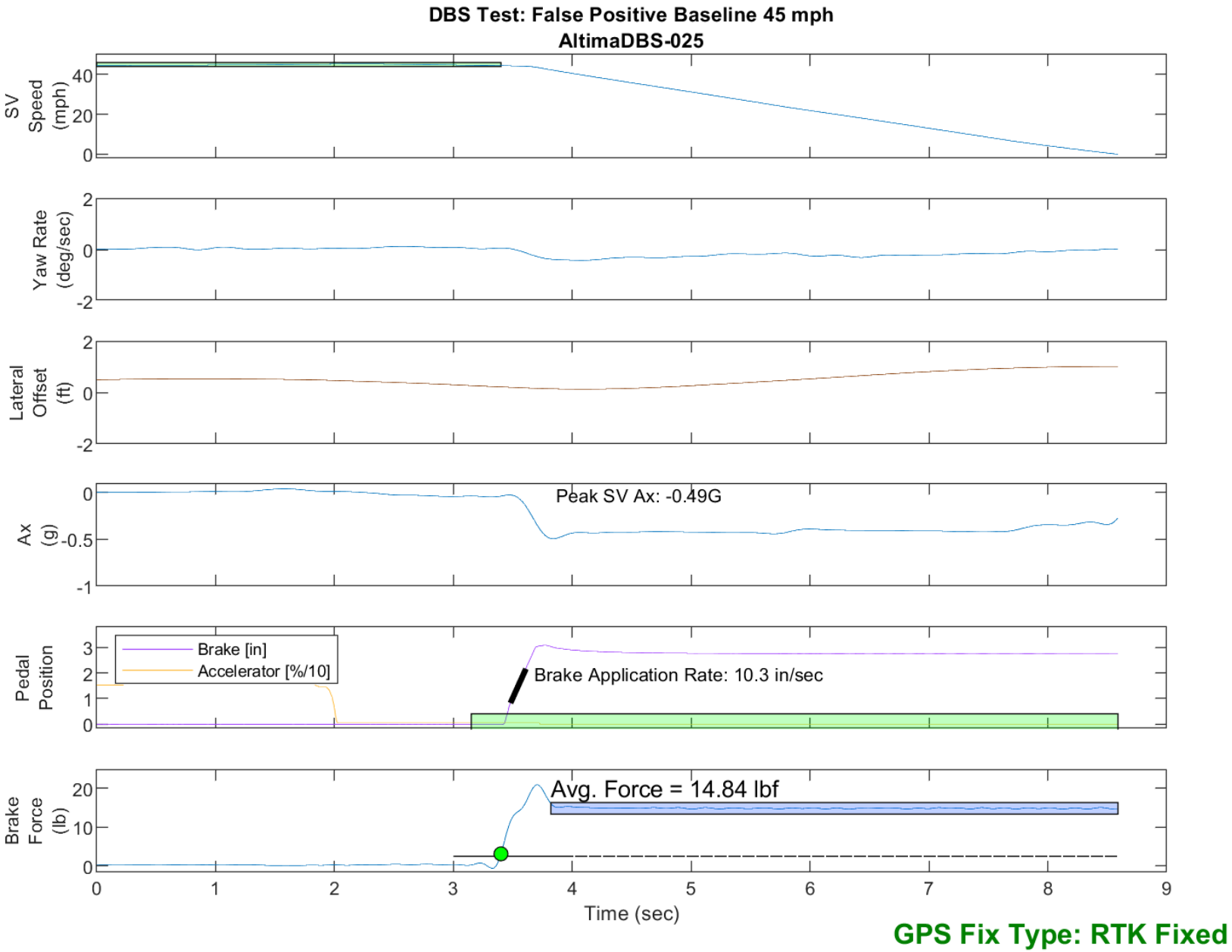


Figure E49. Time History for DBS Run 25, False Positive Baseline, SV 45 mph

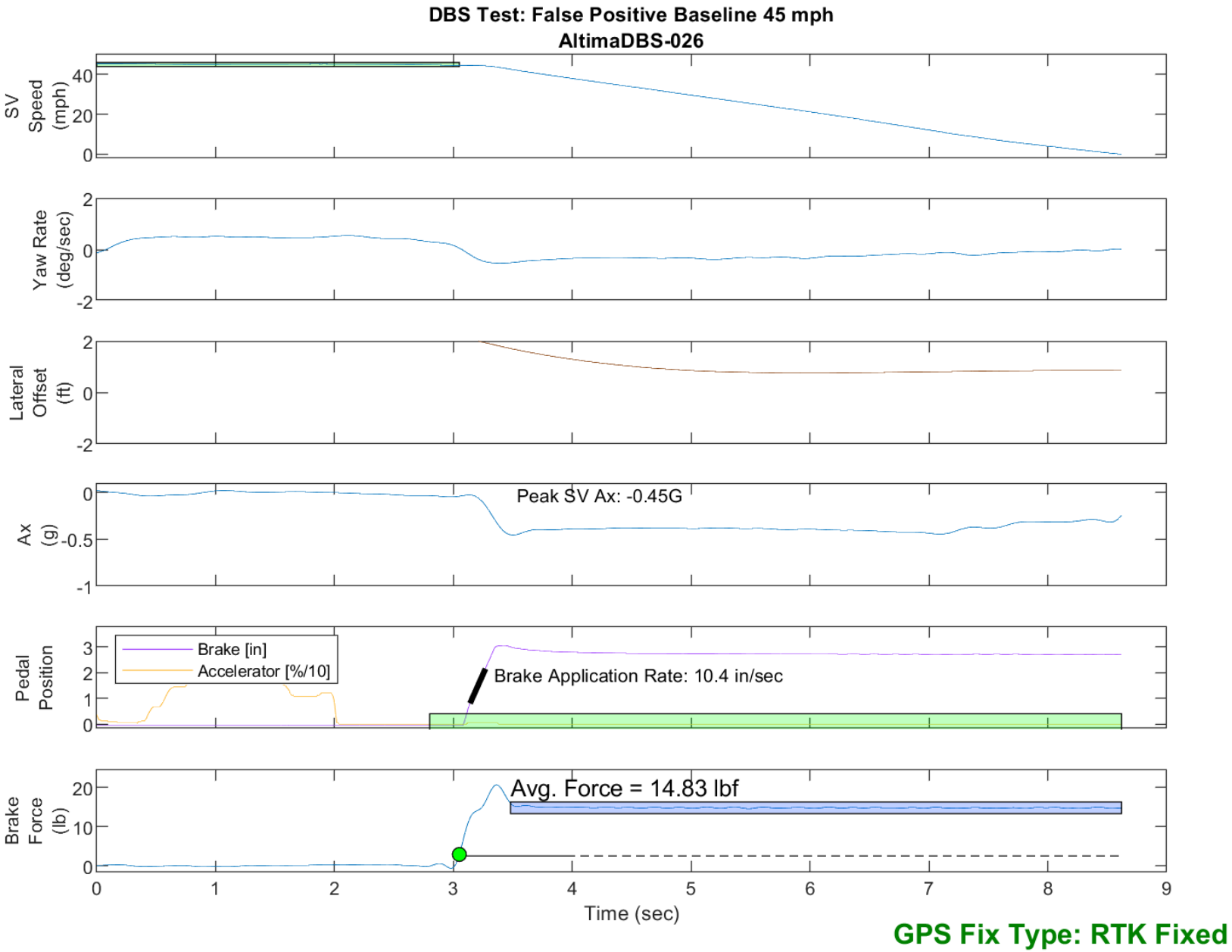


Figure E50. Time History for DBS Run 26, False Positive Baseline, SV 45 mph

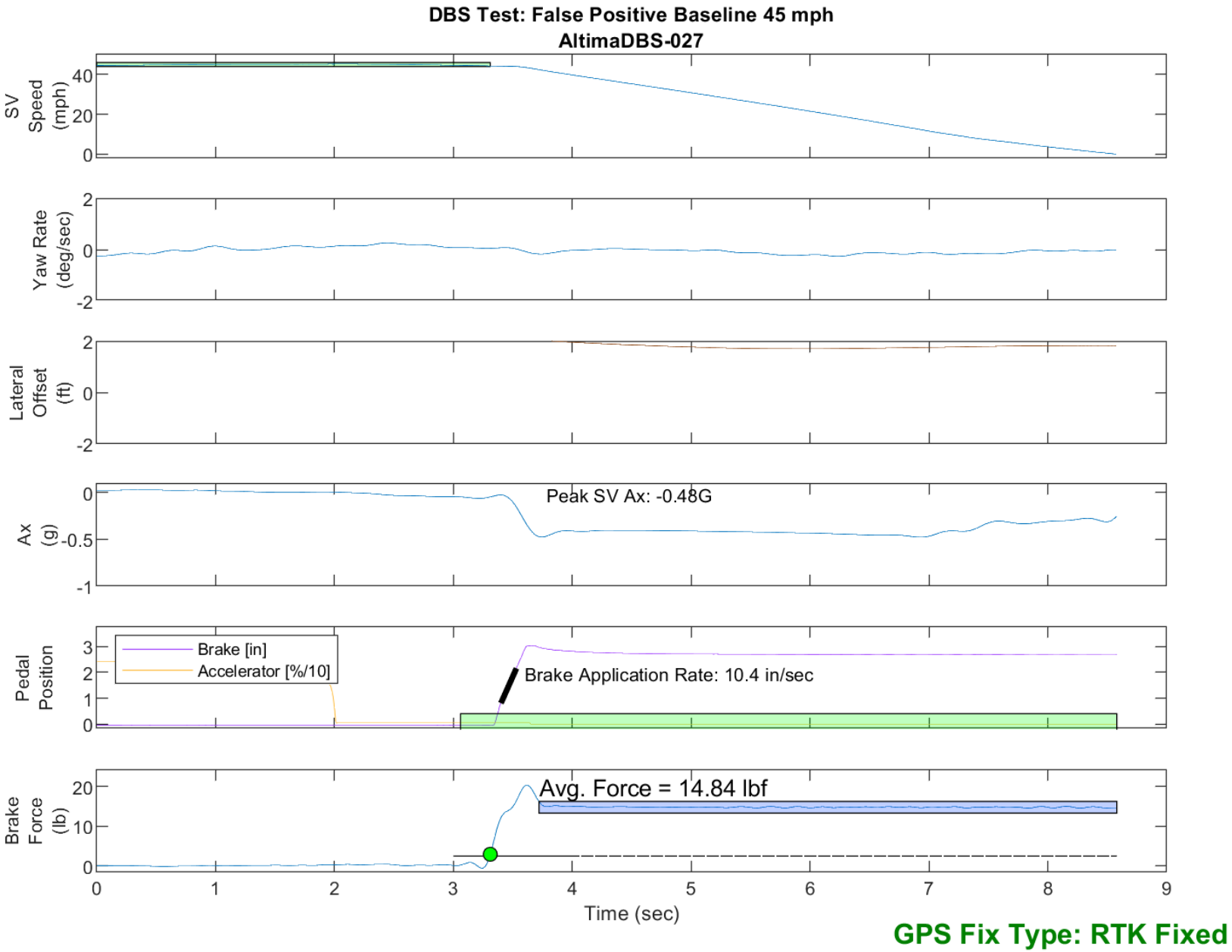


Figure E51. Time History for DBS Run 27, False Positive Baseline, SV 45 mph

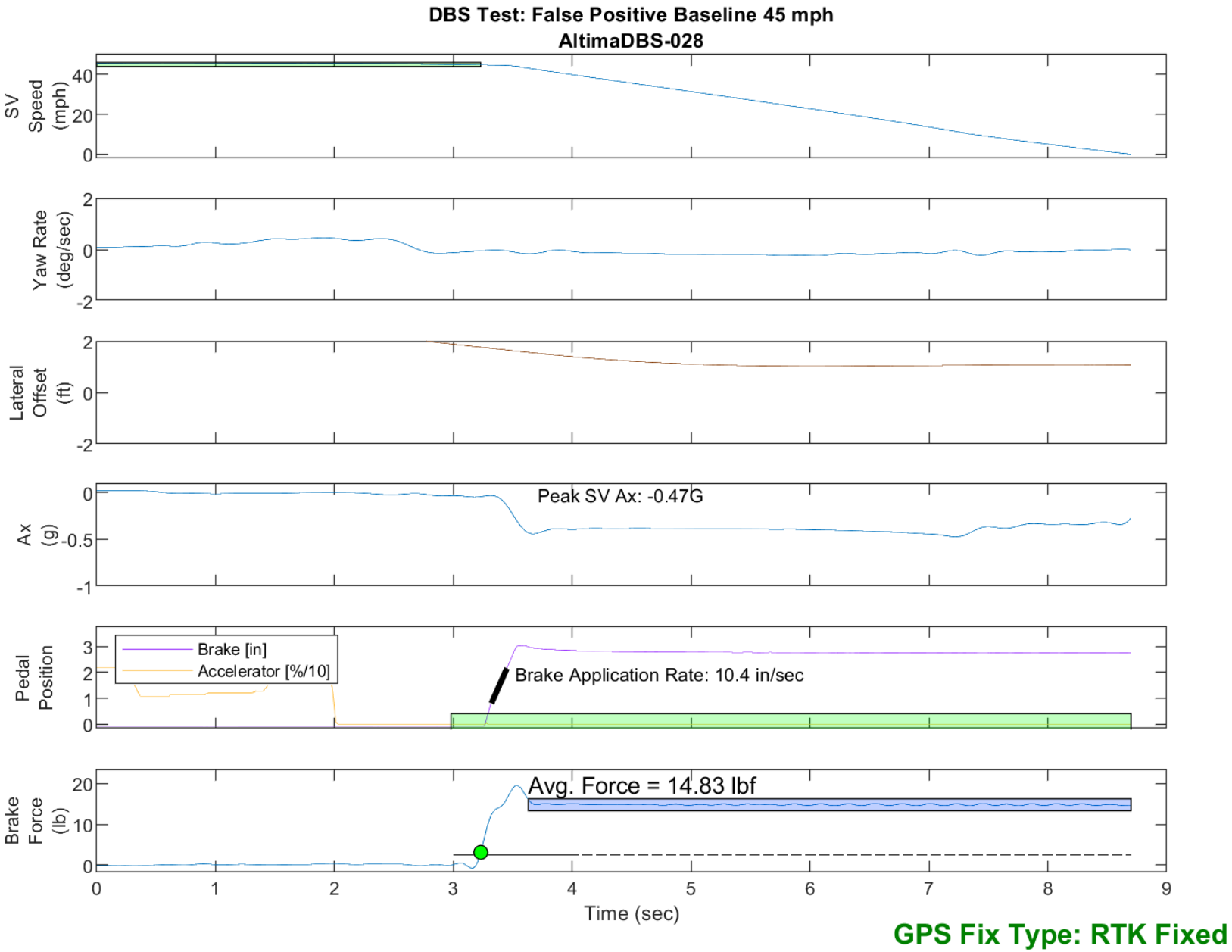


Figure E52. Time History for DBS Run 28, False Positive Baseline, SV 45 mph

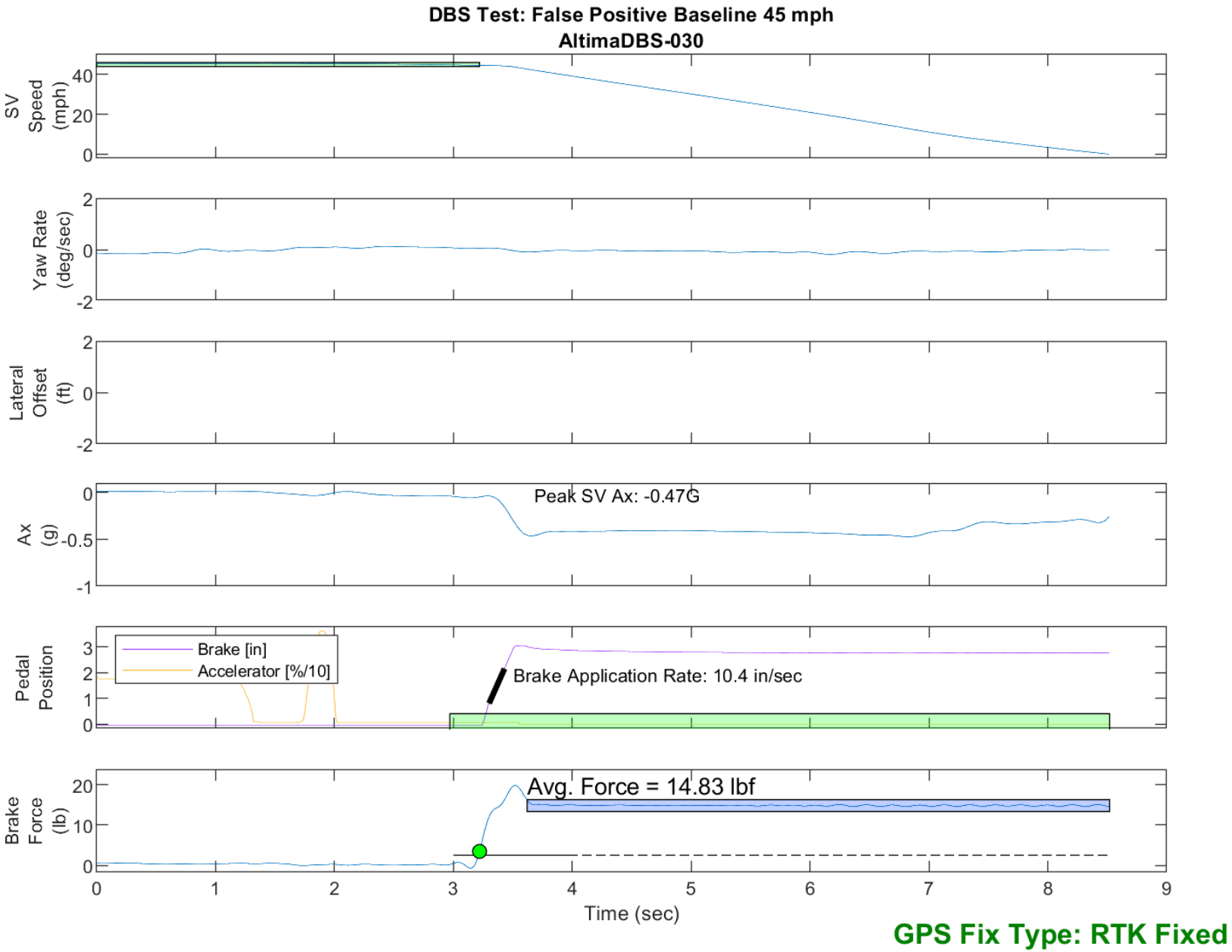


Figure E53. Time History for DBS Run 30, False Positive Baseline, SV 45 mph

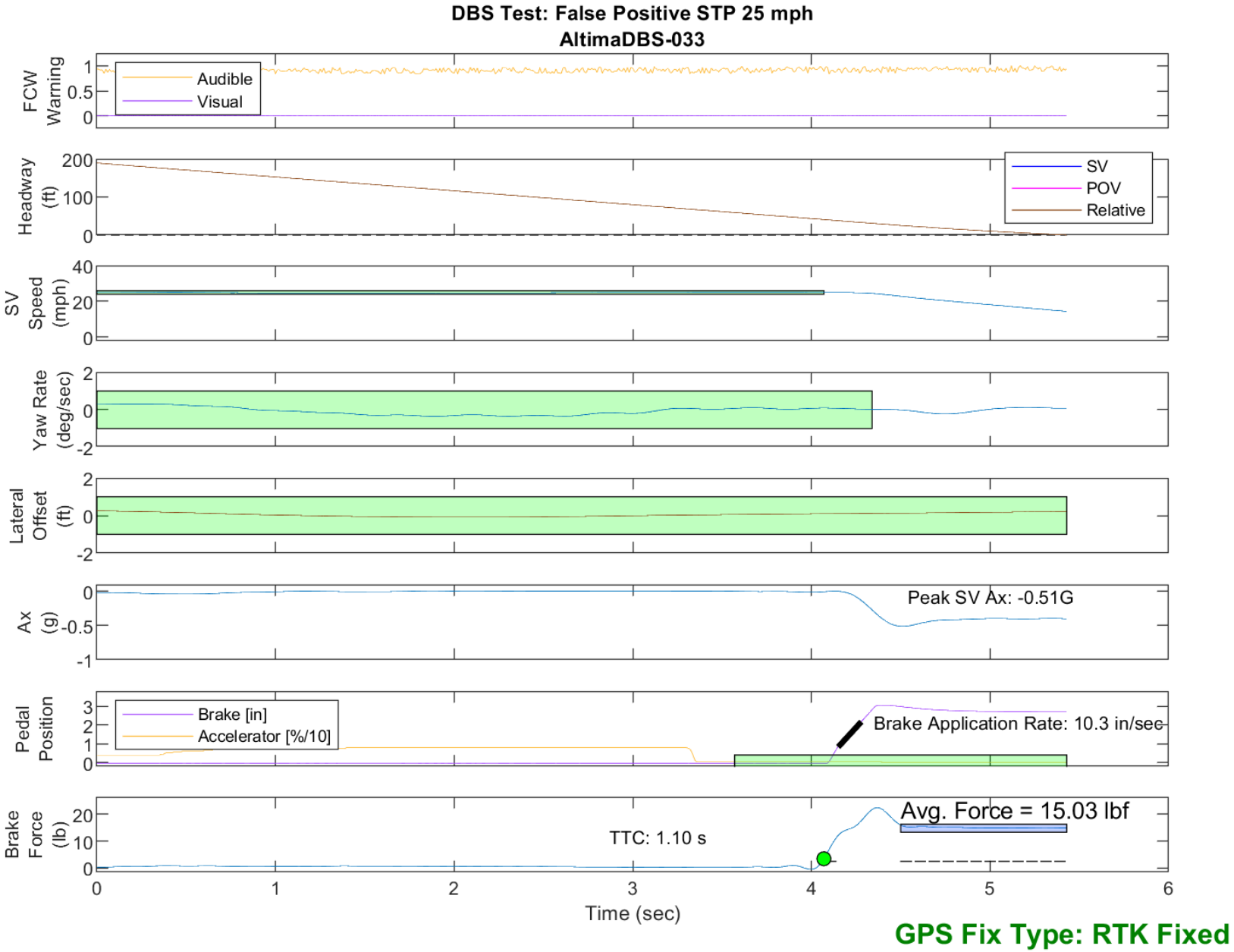


Figure E54. Time History for DBS Run 33, SV Encounters Steel Trench Plate, SV 25 mph

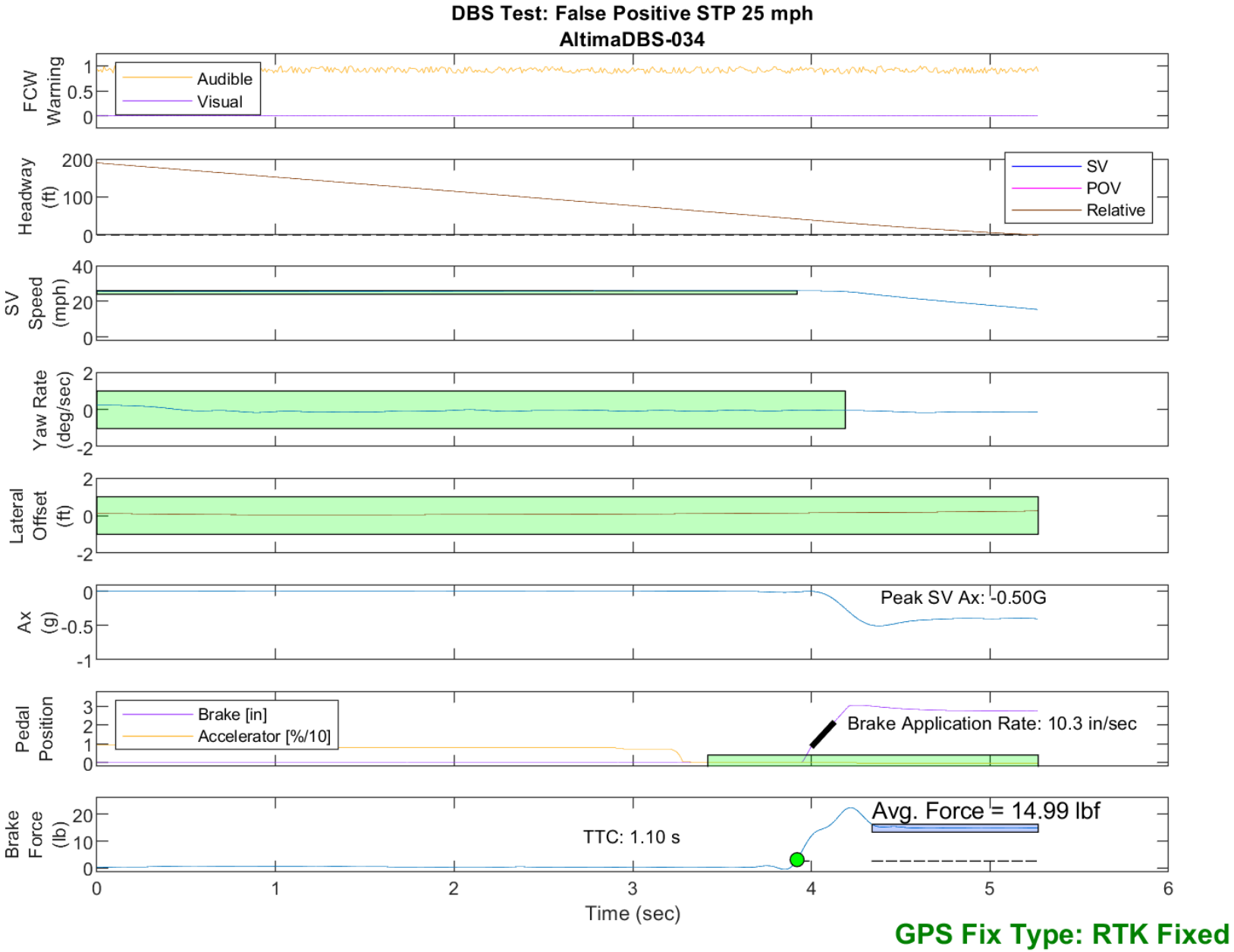


Figure E55. Time History for DBS Run 34, SV Encounters Steel Trench Plate, SV 25 mph

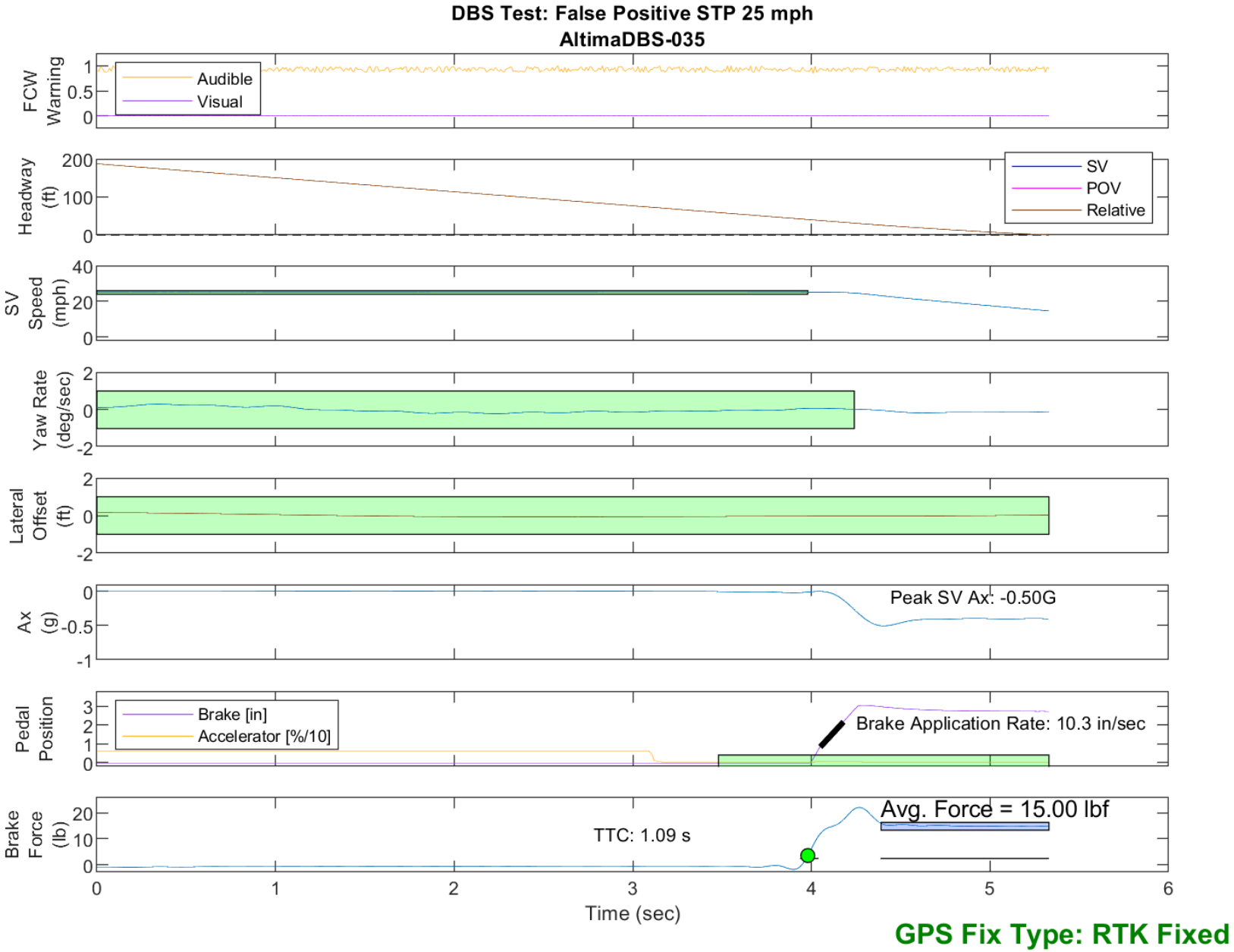


Figure E56. Time History for DBS Run 35, SV Encounters Steel Trench Plate, SV 25 mph

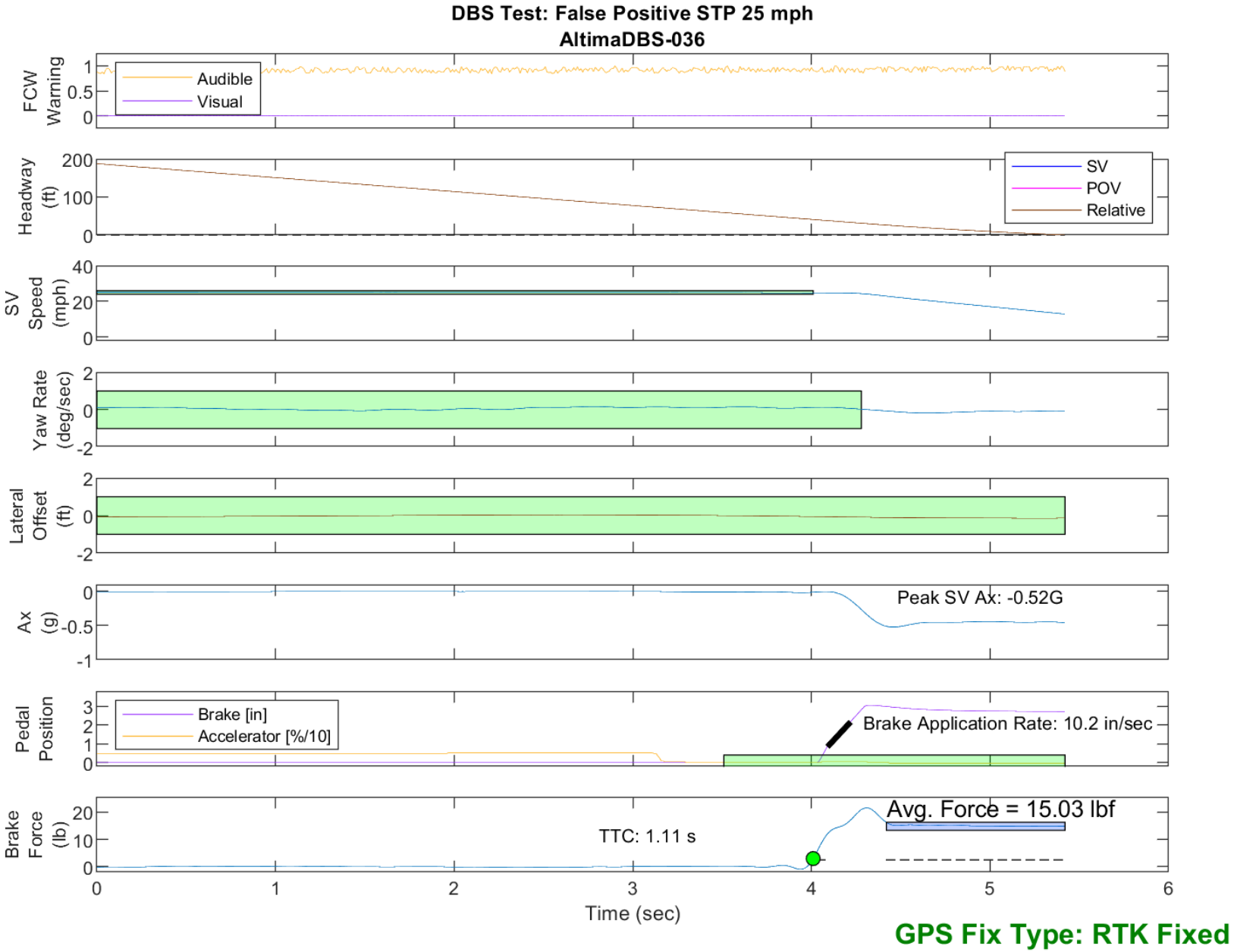


Figure E57. Time History for DBS Run 36, SV Encounters Steel Trench Plate, SV 25 mph

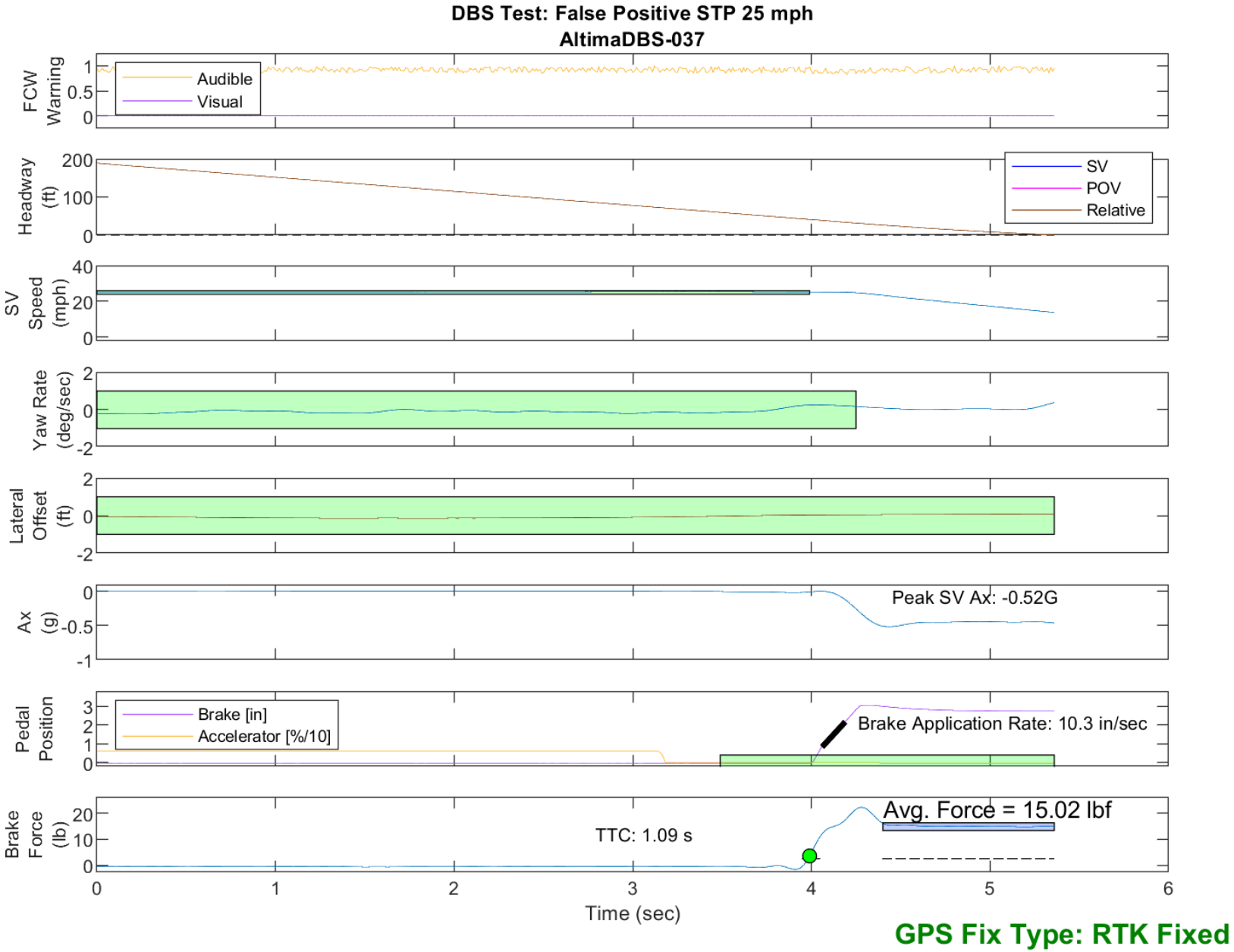


Figure E58. Time History for DBS Run 37, SV Encounters Steel Trench Plate, SV 25 mph

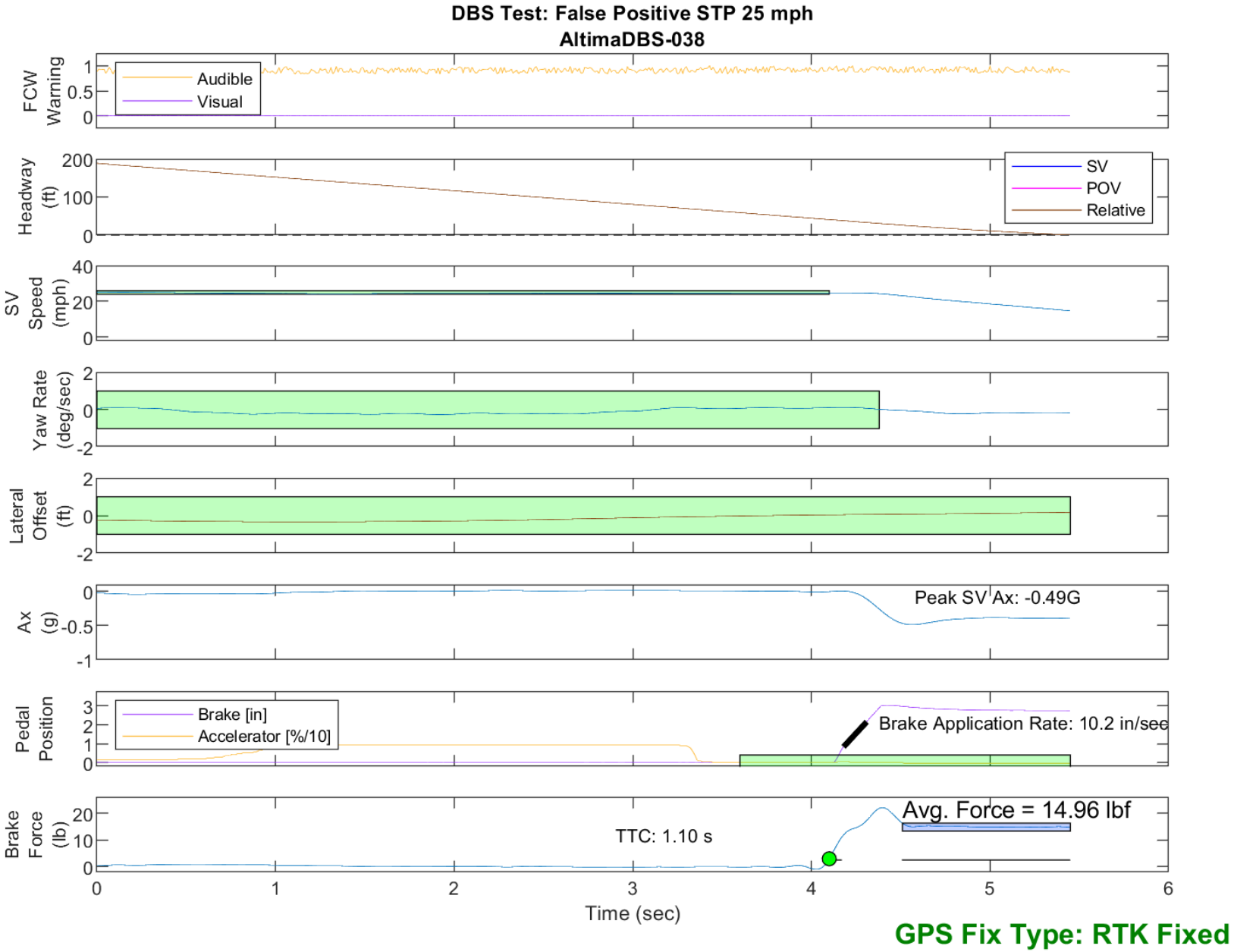


Figure E59. Time History for DBS Run 38, SV Encounters Steel Trench Plate, SV 25 mph

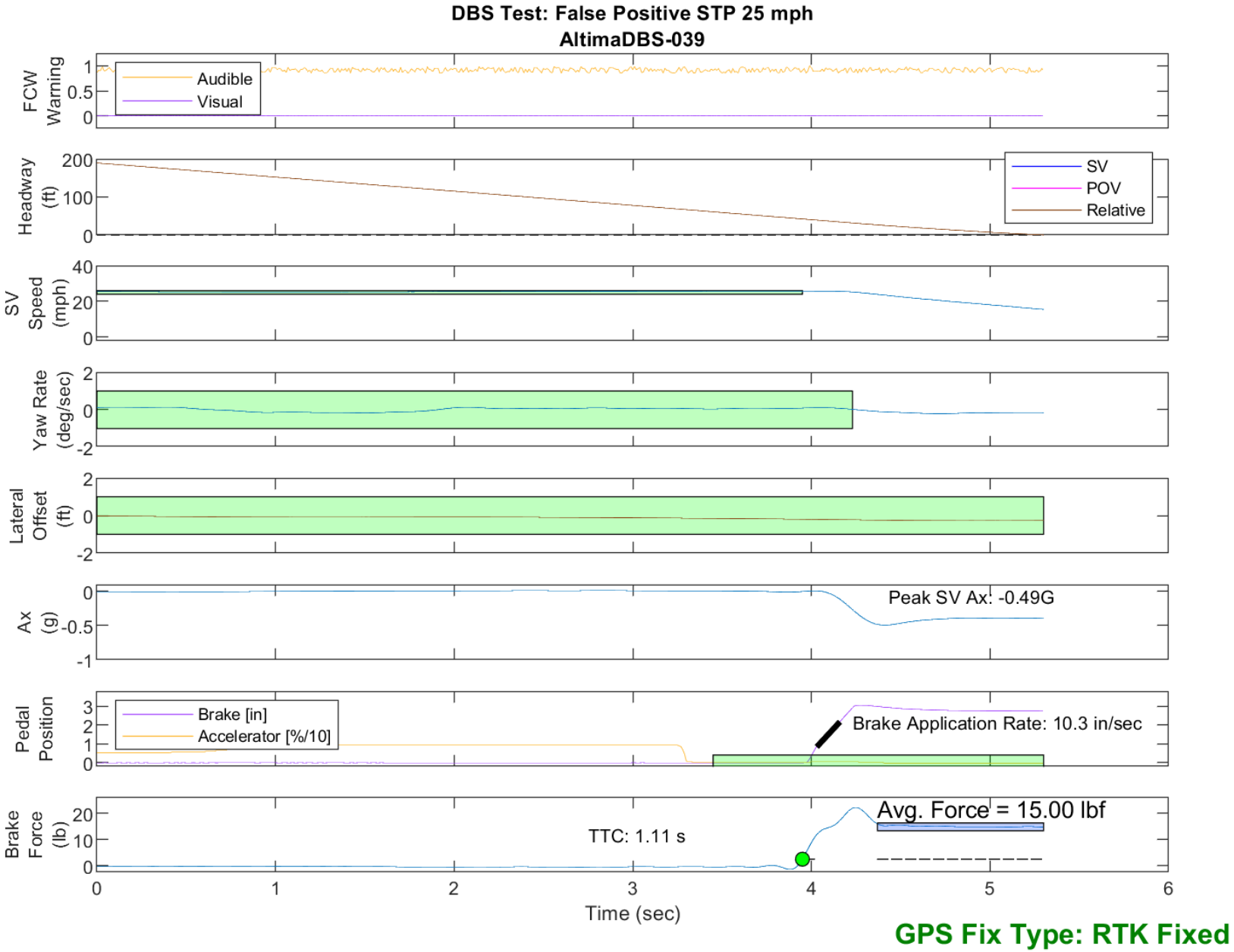


Figure E60. Time History for DBS Run 39, SV Encounters Steel Trench Plate, SV 25 mph

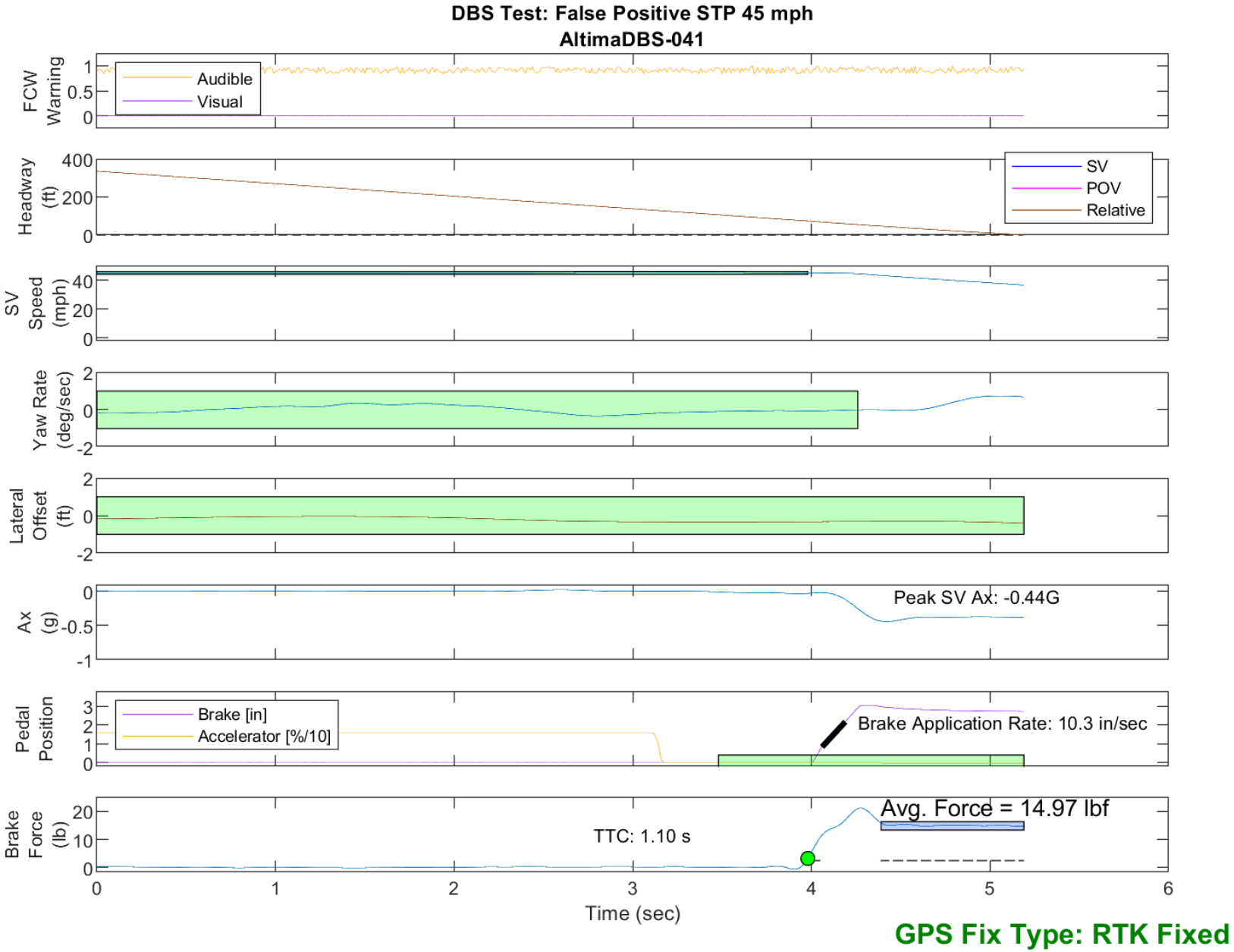


Figure E61. Time History for DBS Run 41, SV Encounters Steel Trench Plate, SV 45 mph

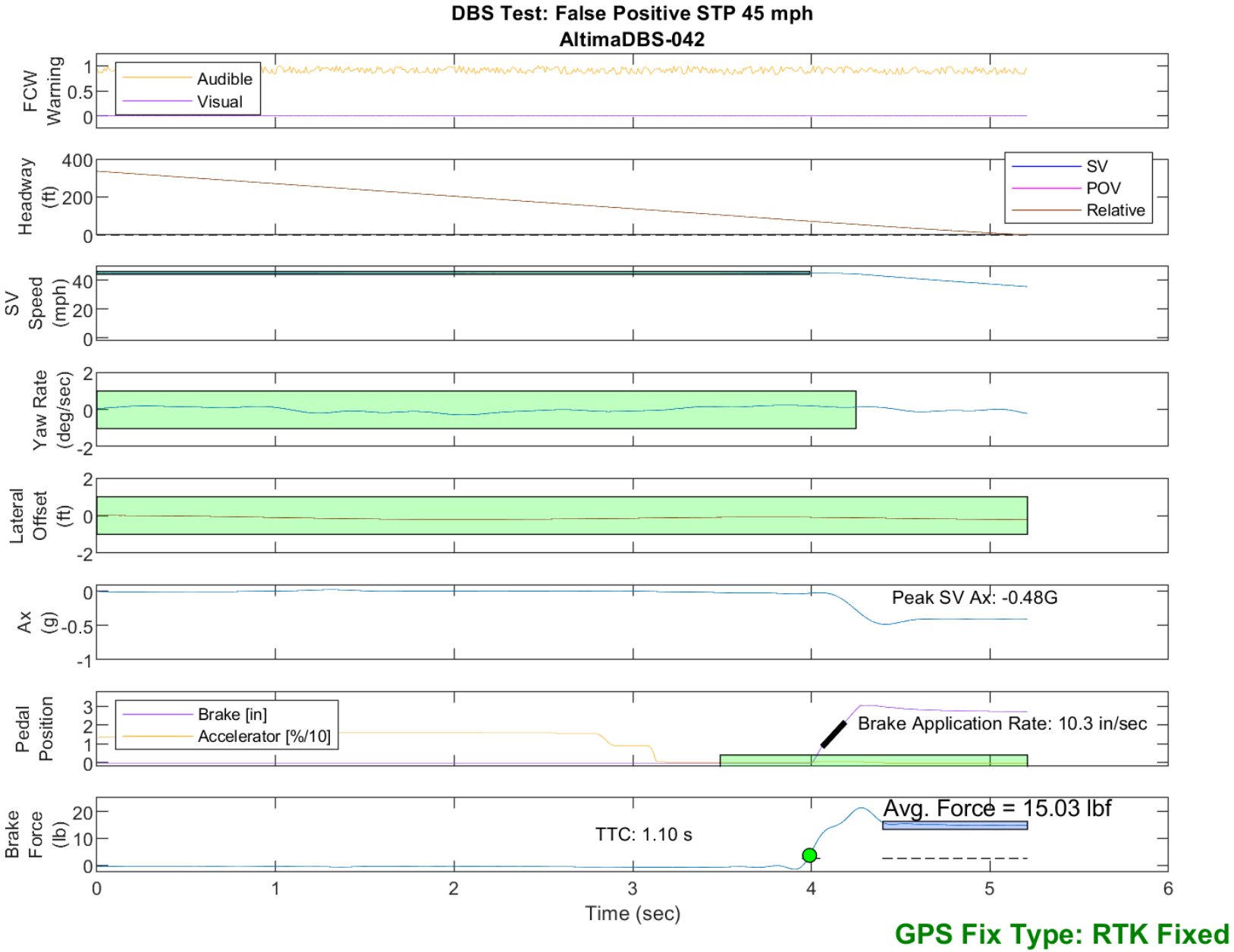


Figure E62. Time History for DBS Run 42, SV Encounters Steel Trench Plate, SV 45 mph

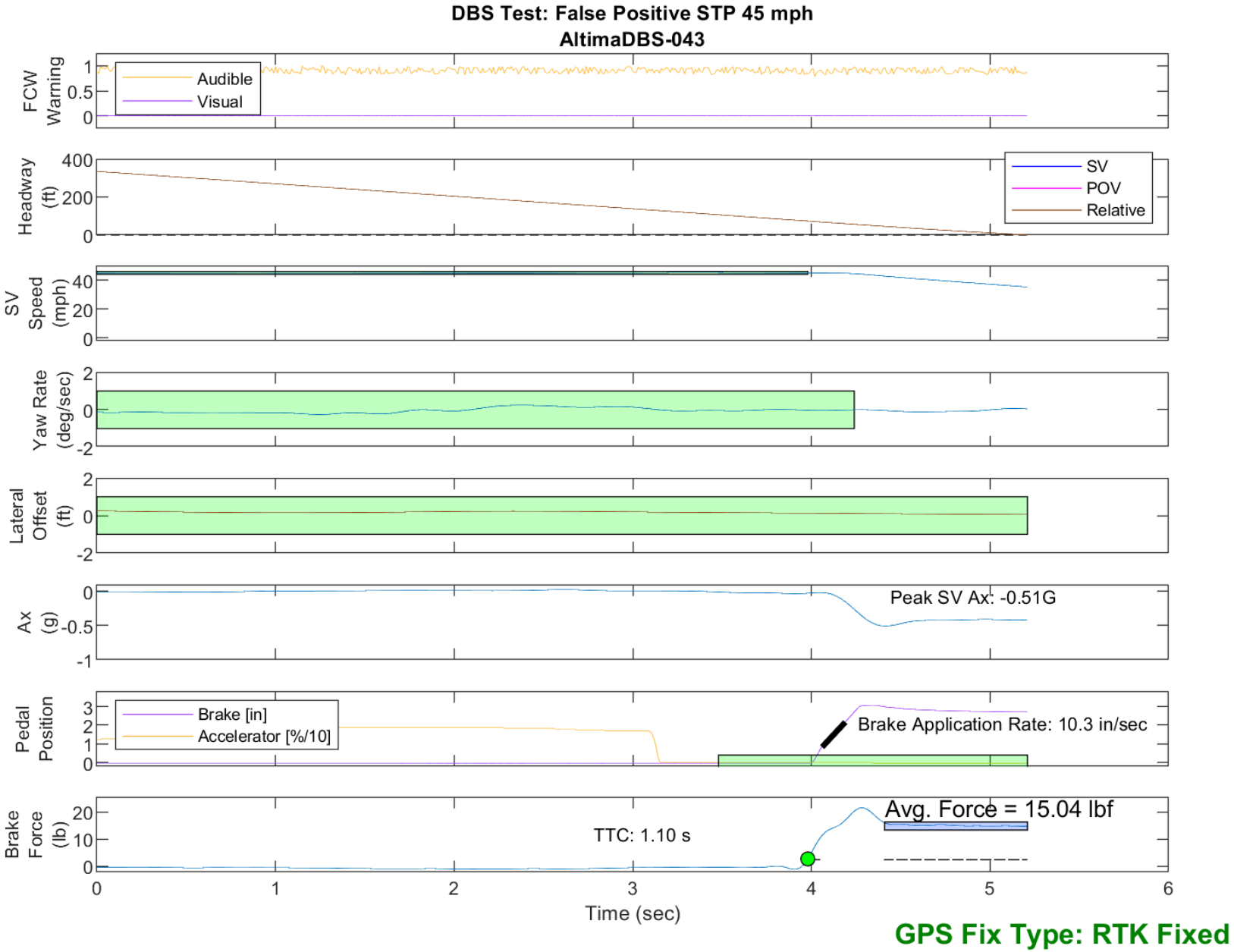


Figure E63. Time History for DBS Run 43, SV Encounters Steel Trench Plate, SV 45 mph

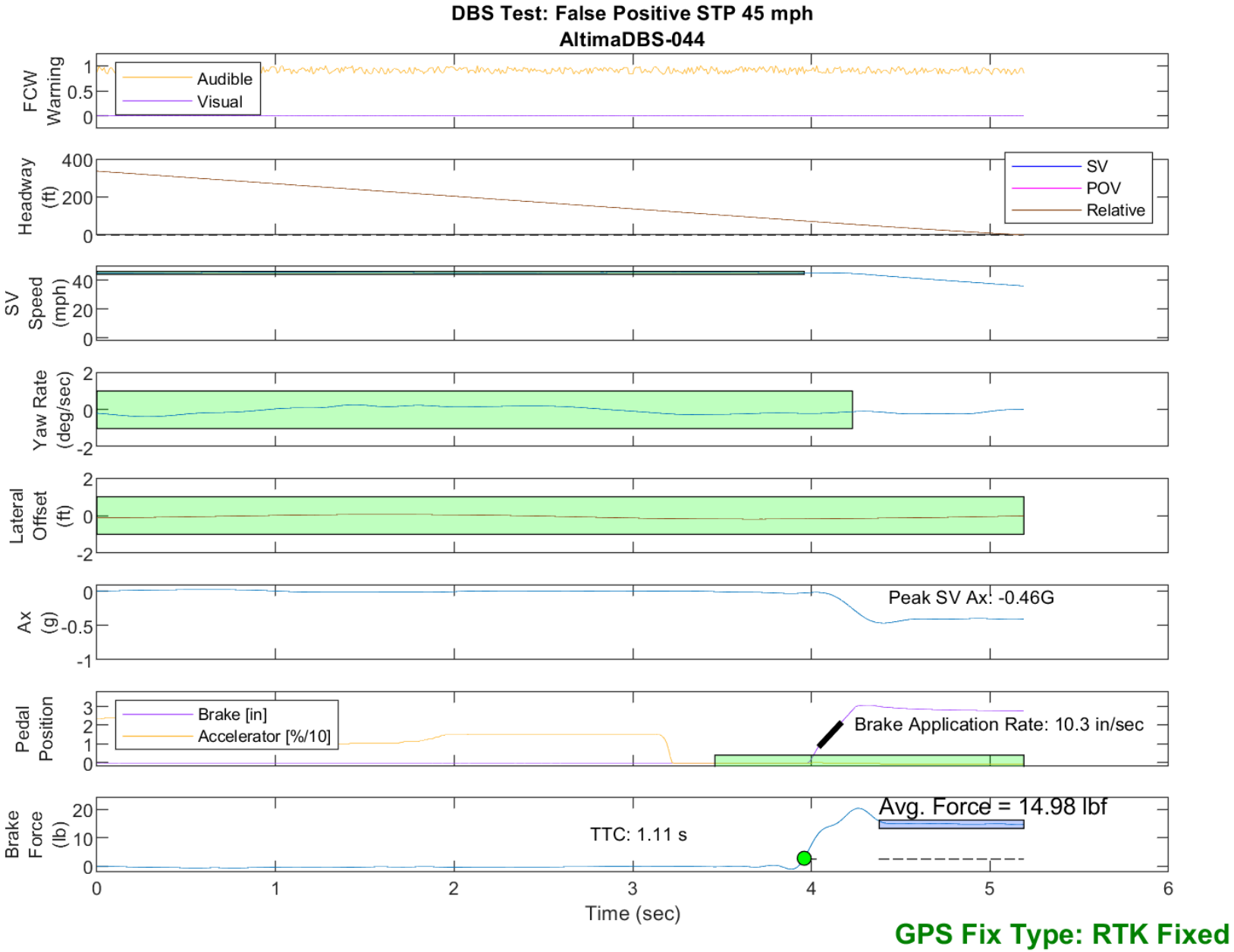


Figure E64. Time History for DBS Run 44, SV Encounters Steel Trench Plate, SV 45 mph

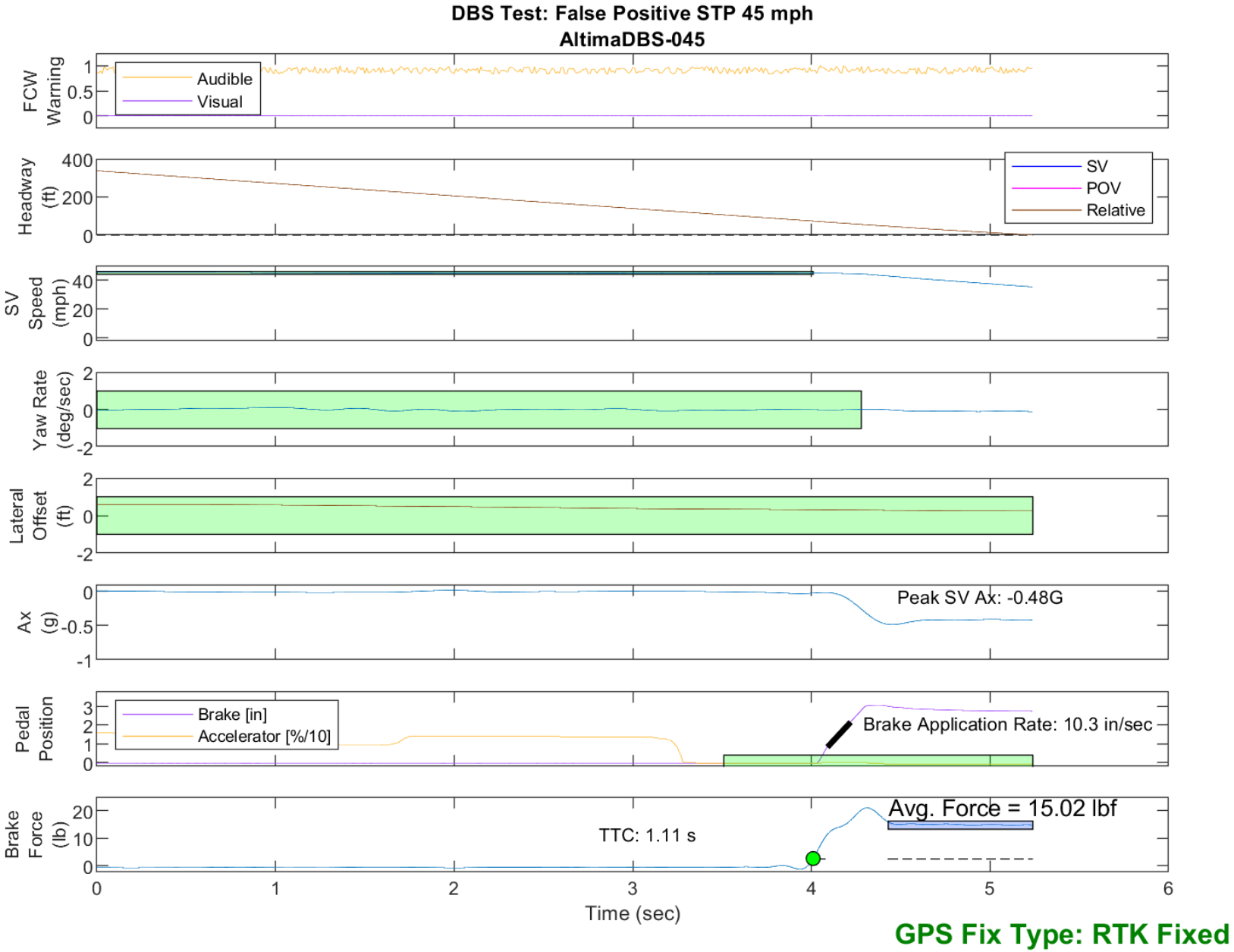


Figure E65. Time History for DBS Run 45, SV Encounters Steel Trench Plate, SV 45 mph

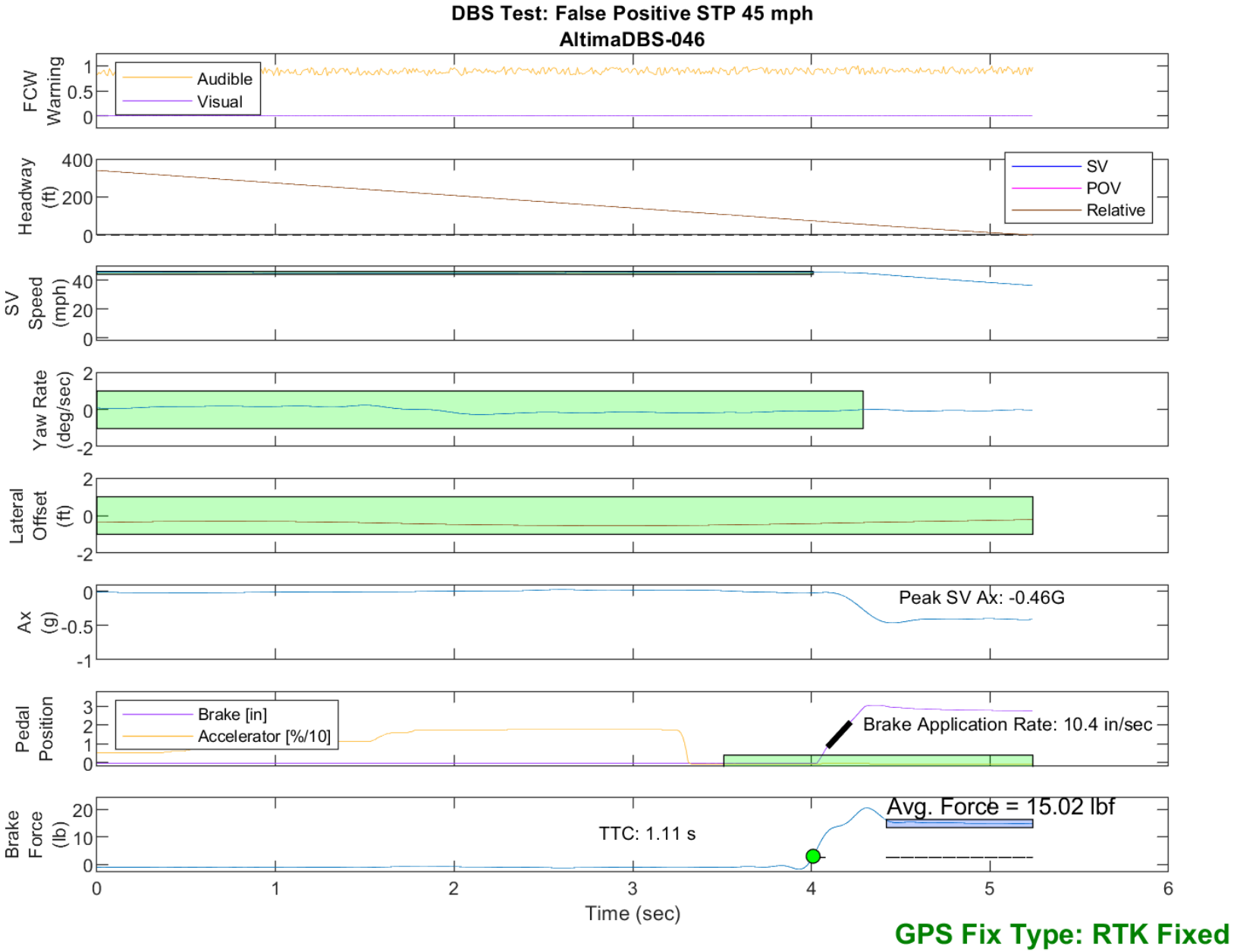


Figure E66. Time History for DBS Run 46, SV Encounters Steel Trench Plate, SV 45 mph

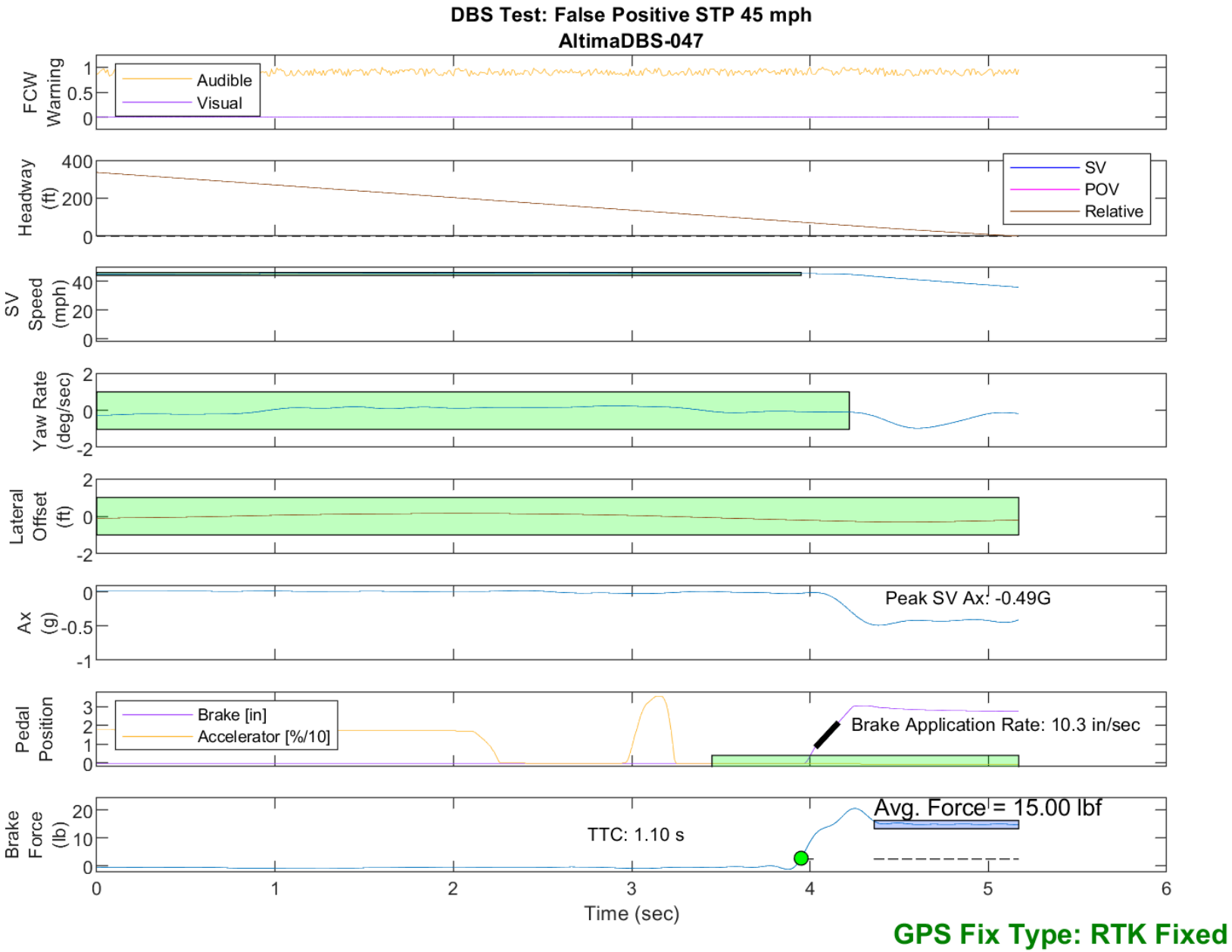


Figure E67. Time History for DBS Run 47, SV Encounters Steel Trench Plate, SV 45 mph

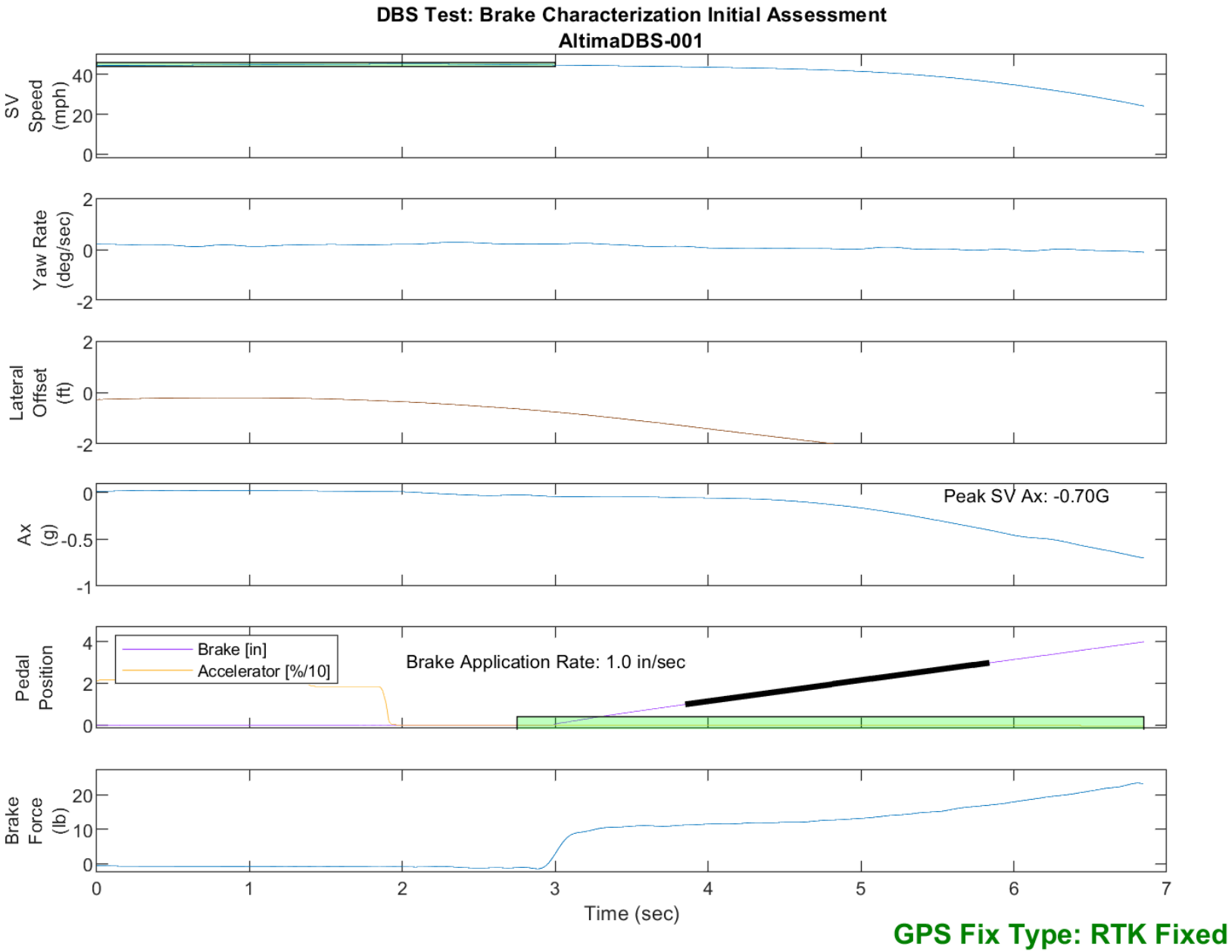


Figure E68. Time History for DBS Run 1, Brake Characterization Initial

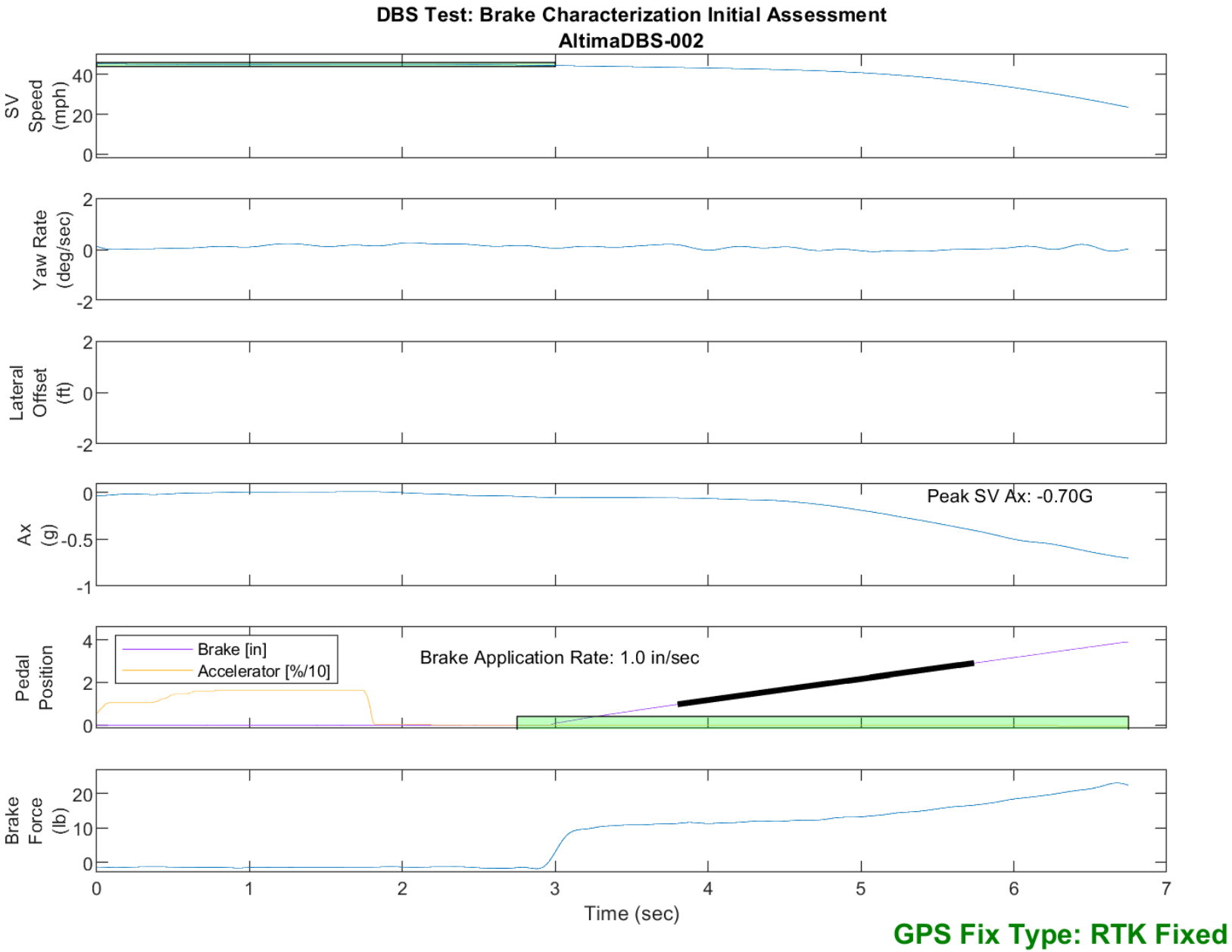


Figure E69. Time History for DBS Run 2, Brake Characterization Initial

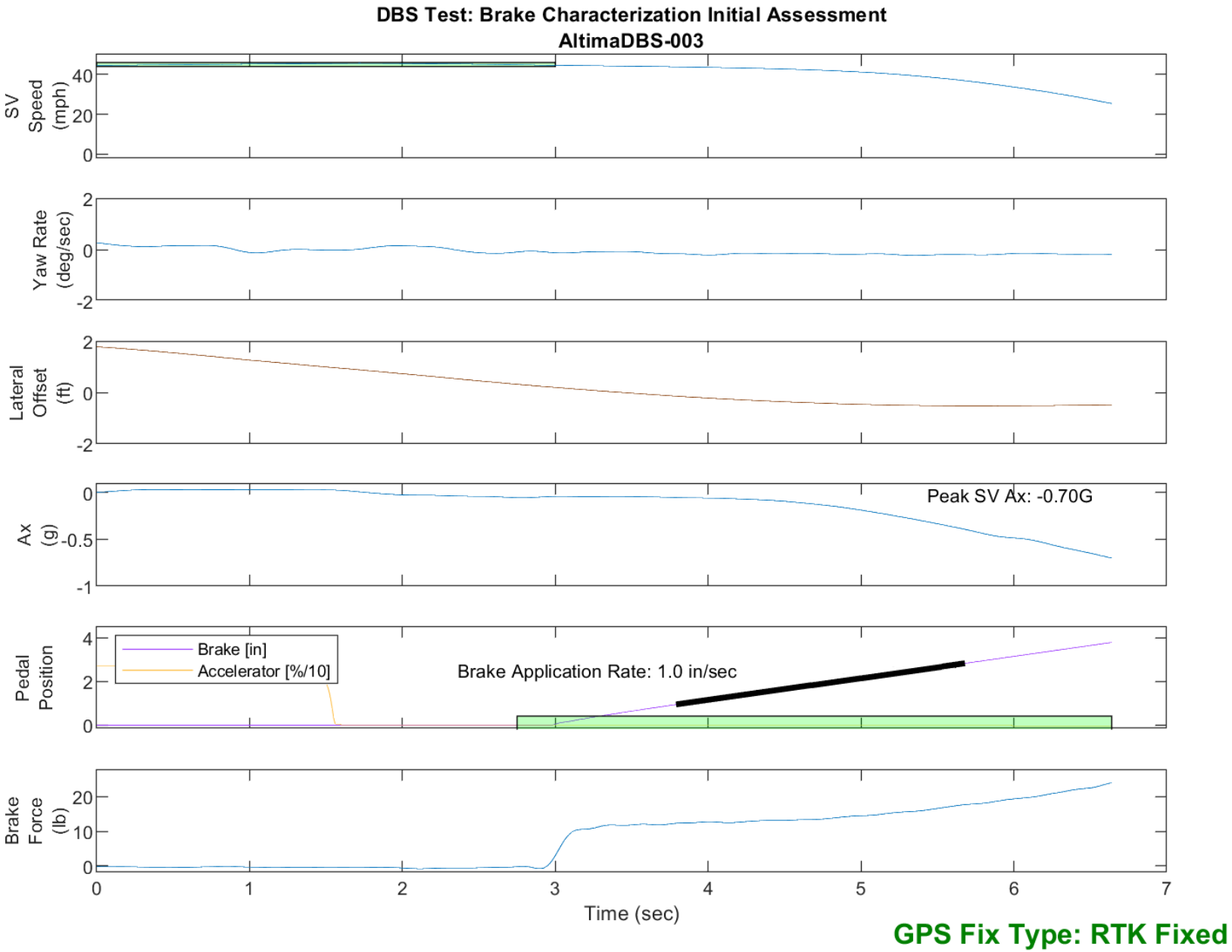


Figure E70. Time History for DBS Run 3, Brake Characterization Initial

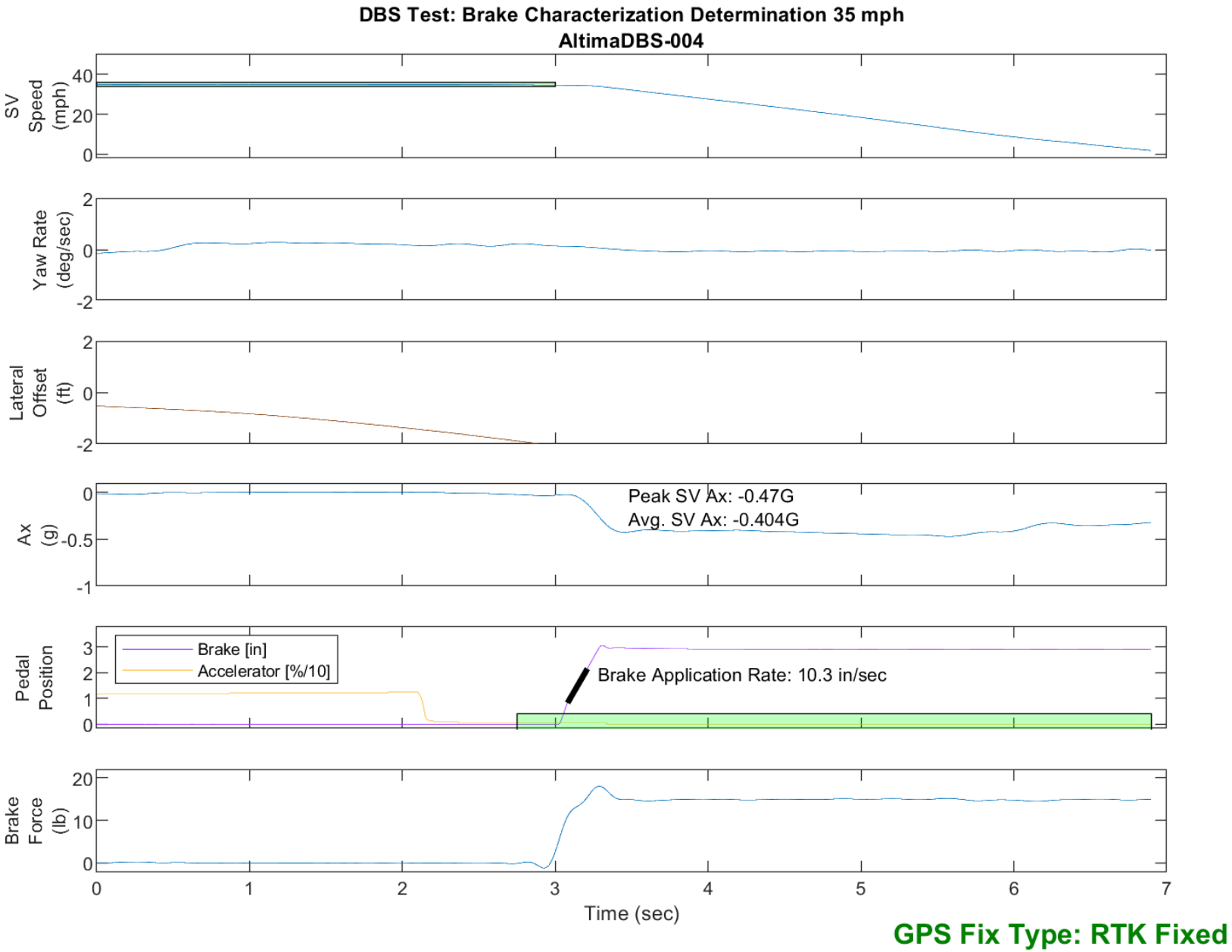


Figure E71. Time History for DBS Run 4, Brake Characterization Determination 35 mph

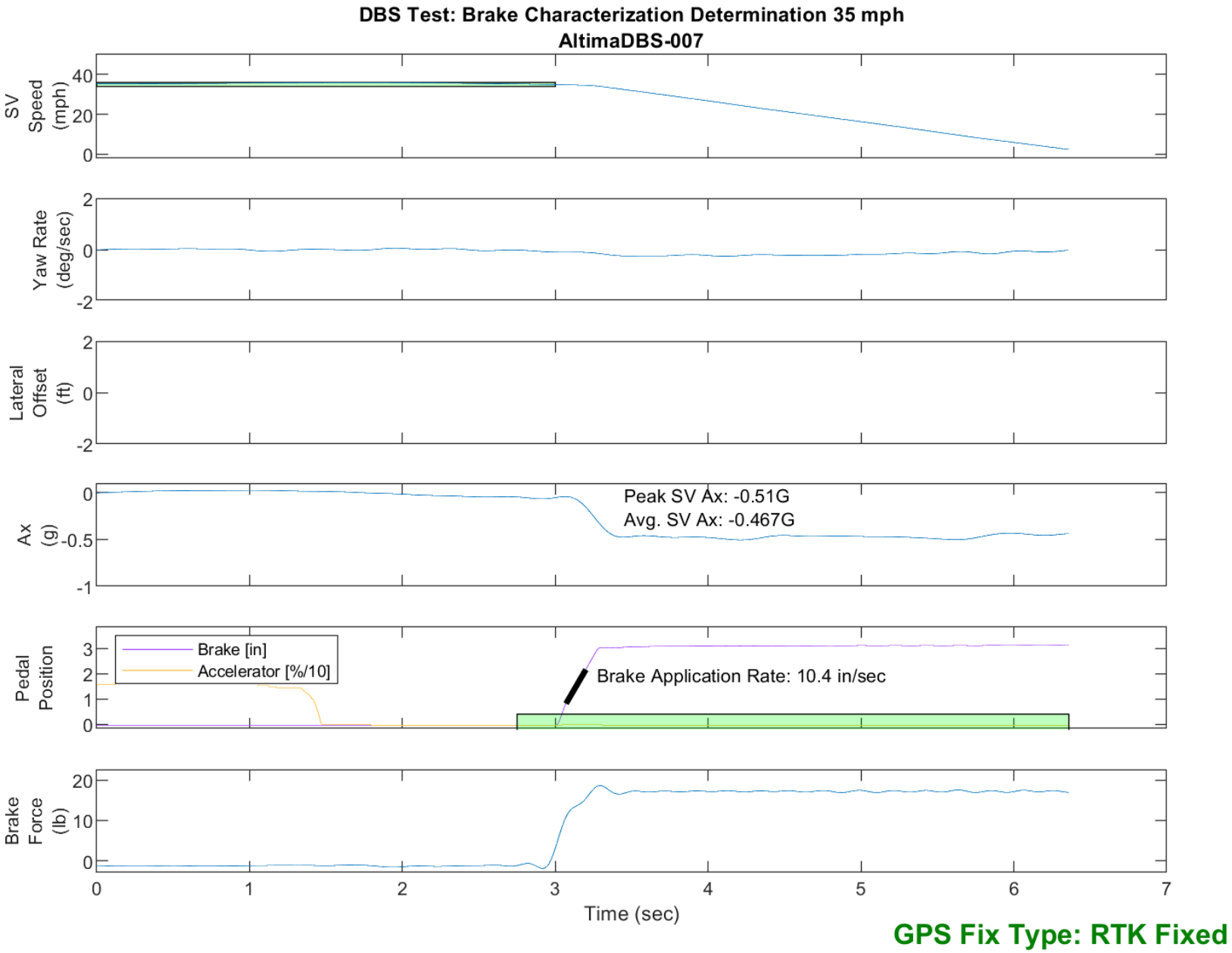


Figure E72. Time History for DBS Run 7, Brake Characterization Determination 35 mph

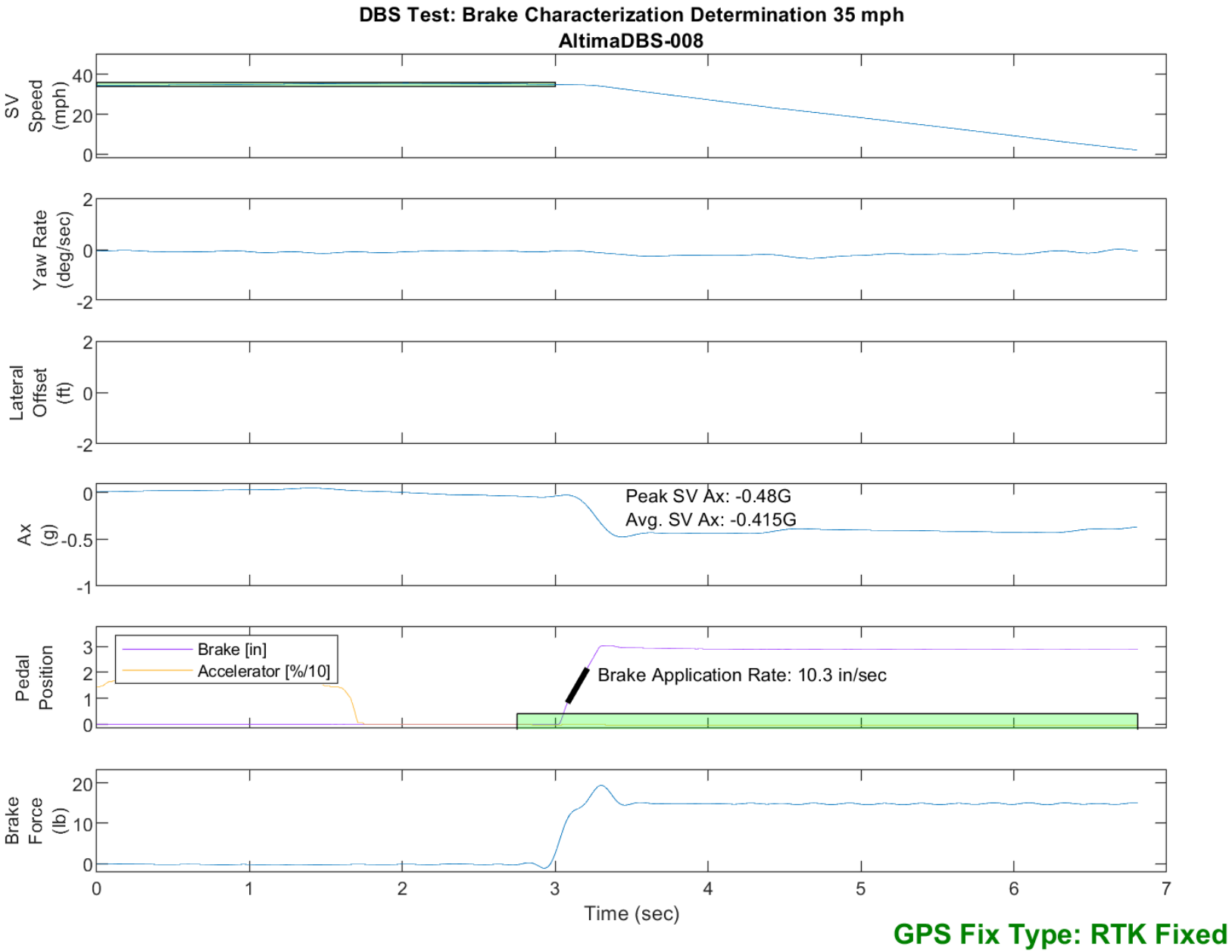


Figure E73. Time History for DBS Run 8, Brake Characterization Determination 35 mph

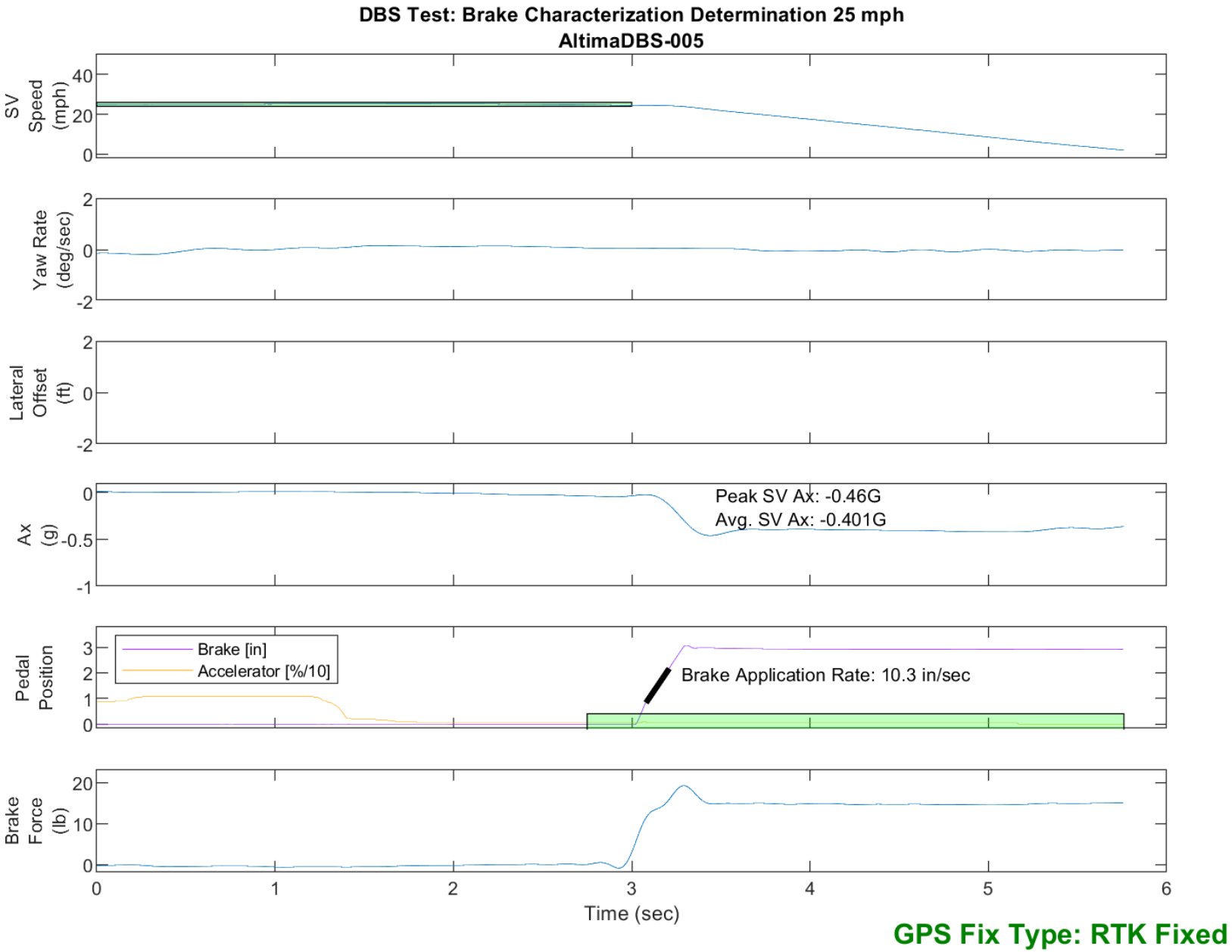


Figure E74. Time History for DBS Run 5, Brake Characterization Determination 25 mph

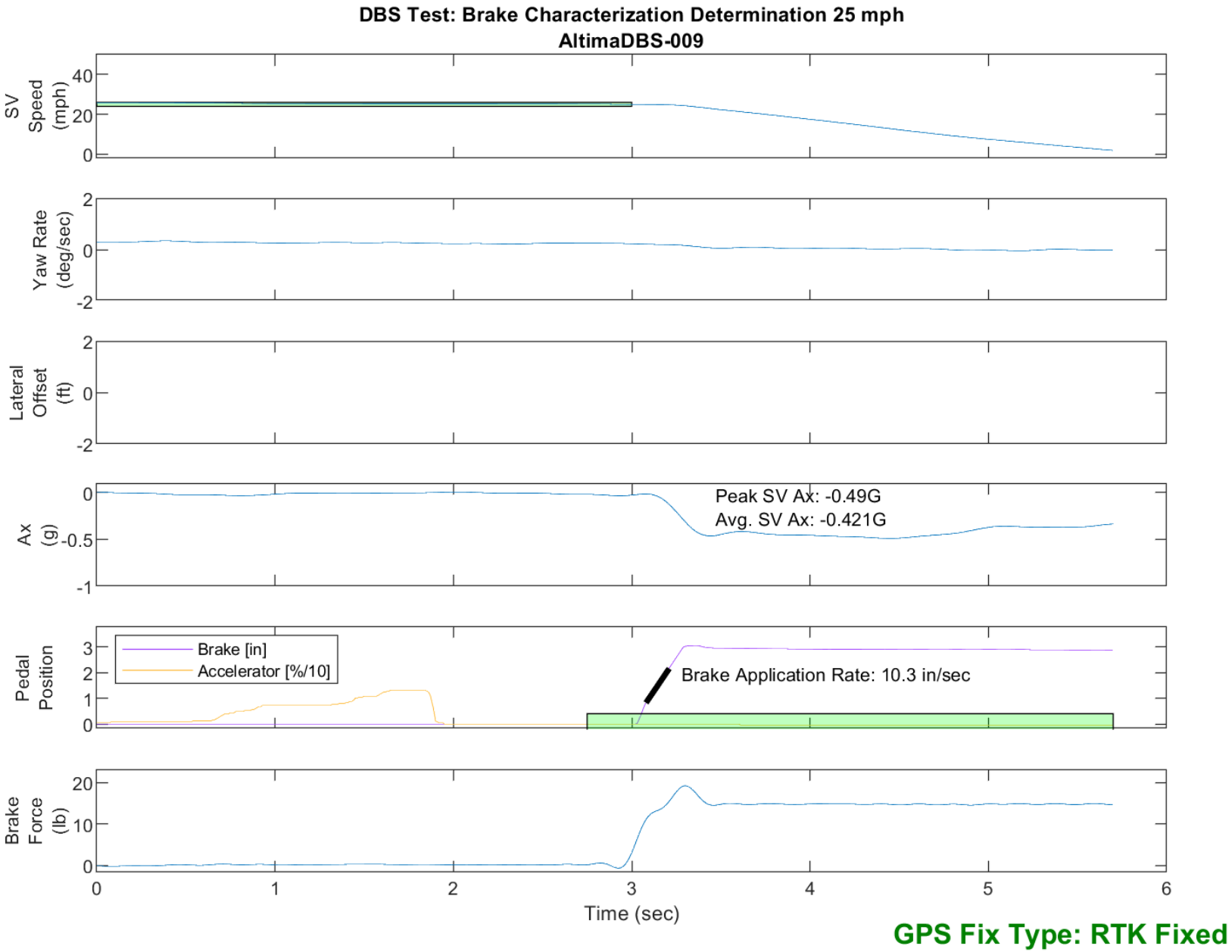


Figure E75. Time History for DBS Run 9, Brake Characterization Determination 25 mph

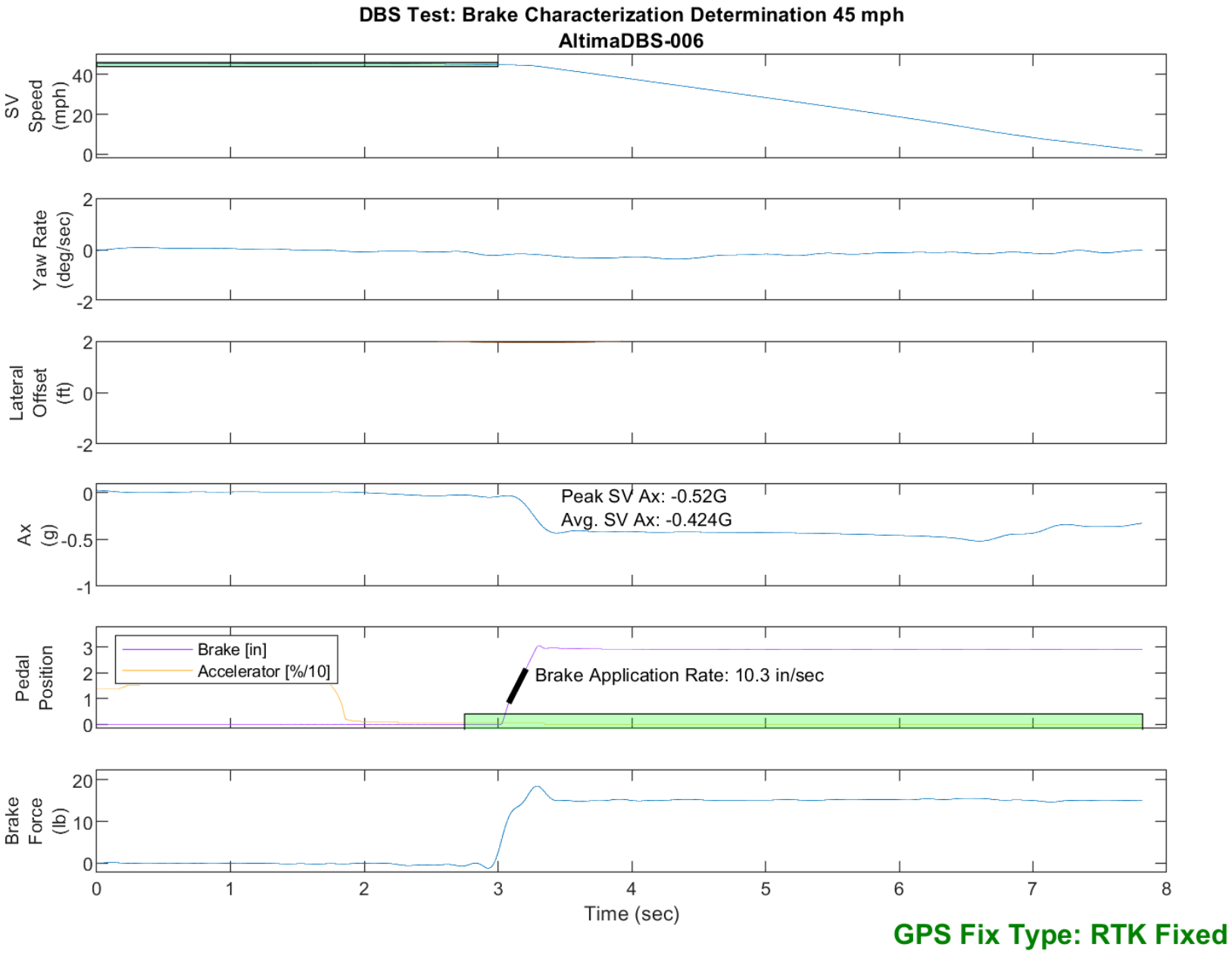


Figure E76. Time History for DBS Run 6, Brake Characterization Determination 45 mph

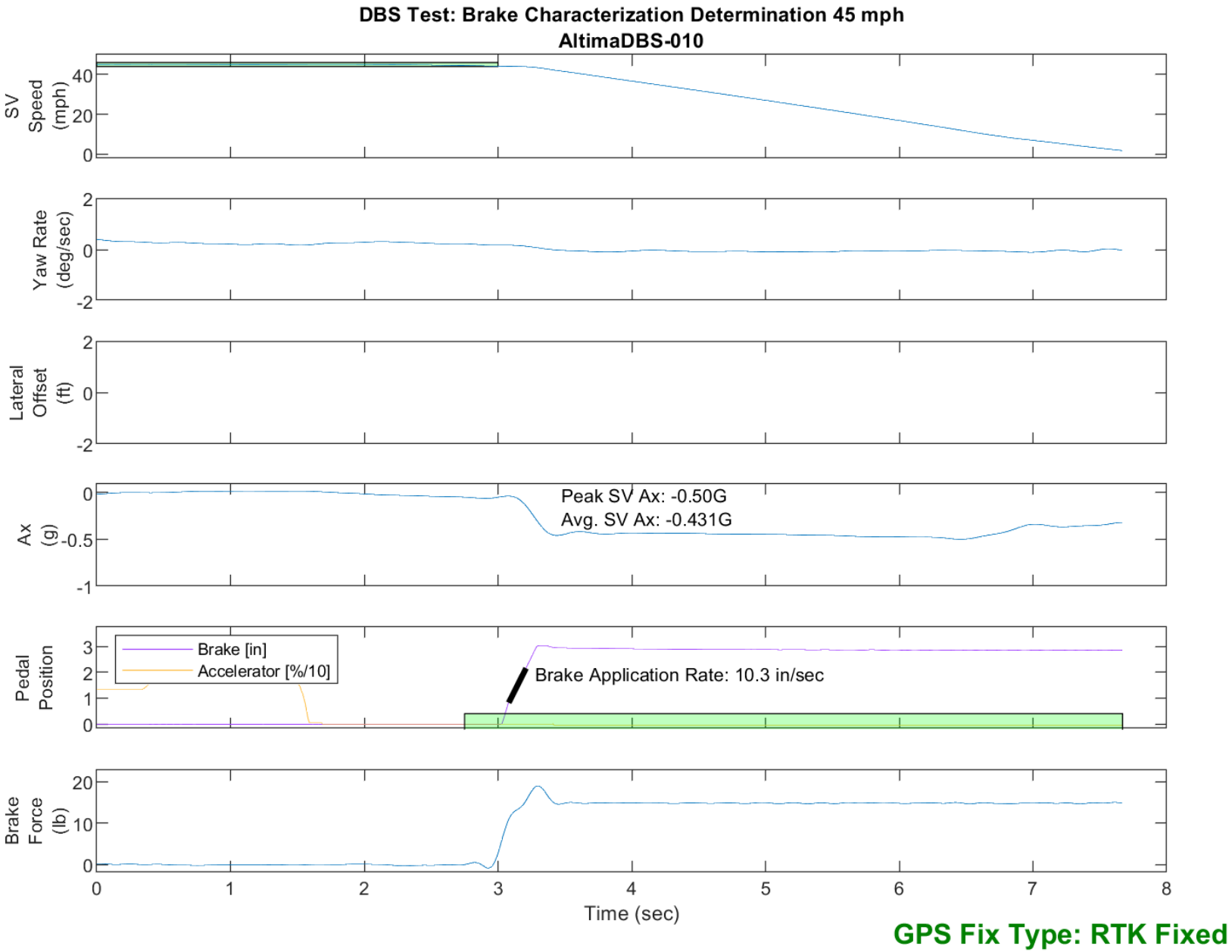


Figure E77. Time History for DBS Run 10, Brake Characterization Determination 45 mph

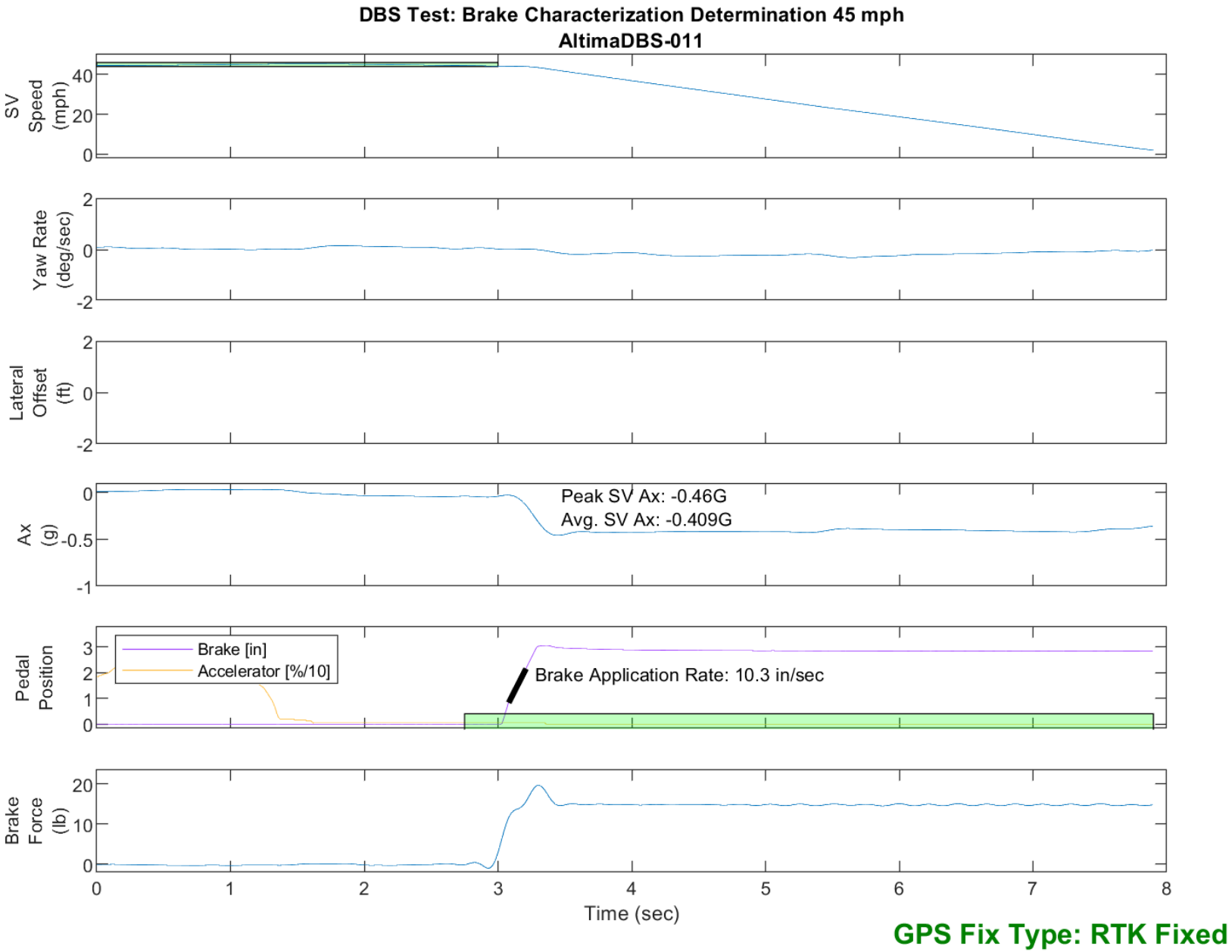


Figure E78. Time History for DBS Run 11, Brake Characterization Determination 45 mph