NEW CAR ASSESSMENT PROGRAM
DYNAMIC BRAKE SUPPORT SYSTEM CONFIRMATION TEST
NCAP-DRI-DBS-21-03

2021 Chevrolet Trailblazer FWD 4dr LT

DYNAMIC RESEARCH, INC.
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23 February 2021

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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These tests were conducted on the subject 2021 Chevrolet Trailblazer FWD 4dr LT 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.</td></tr>
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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 2021 Chevrolet Trailblazer FWD 4dr LT. This test to assess Dynamic Brake Support systems is sponsored by the National Highway Traffic Safety Administration under Contract No. DTNH22-14-D-00333 with the New Car Assessment Program (NCAP).

Section II

DATA SHEETS

DYNAMIC BRAKE SUPPORT

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 1)

2021 Chevrolet Trailblazer FWD 4dr LT

VIN: *KL79MPSL5MB06xxxx*

Test Date: *2/9/2021*

Dynamic Brake Support System setting: *Alert and Brake*

Test 1 - Subject Vehicle Encounters Stopped Principal Other Vehicle

SV 25 mph: *Pass*

Test 2 - Subject Vehicle Encounters Slower Principal Other Vehicle

SV 25 mph POV 10 mph: *Pass*

SV 45 mph POV 20 mph: *Pass*

Test 3 - Subject Vehicle Encounters Decelerating Principal Other Vehicle

SV 35 mph POV 35 mph: *Pass*

Test 4 - Subject Vehicle Encounters Steel Trench Plate

SV 25 mph: *Pass*

SV 45 mph: *Pass*

Overall: ***Pass***

Notes:

DYNAMIC BRAKE SUPPORT

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2021 Chevrolet Trailblazer FWD 4dr LT

TEST VEHICLE INFORMATION

VIN: *KL79MPSL5MB06xxxx*

Body Style: *MPV* Color: *Dark Copper Metallic*

Date Received: *2/1/2021* Odometer Reading: *281 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *GM Korea Company*

Date of manufacture: *09/20*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *225/60R17 H*

Rear: *225/60R17 H*

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

Rear: *240 kPa (35 psi)*

TIRES

Tire manufacturer and model: *Continental Procontact TX*

Front tire specification: *225/60R17 99H*

Rear tire specification: *225/60R17 99H*

Front tire DOT prefix: *16Y0F98YW*

Rear tire DOT prefix: *16Y0F98YW*

DYNAMIC BRAKE SUPPORT

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2021 Chevrolet Trailblazer FWD 4dr LT

GENERAL INFORMATION

Test date: *2/9/2021*

AMBIENT CONDITIONS

Air temperature: *12.8 C (55 F)*

Wind speed: *0.0 m/s (0.0 mph)*

X Wind speed ≤ 10 m/s (22 mph).

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

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

VEHICLE PREPARATION

Verify the following:

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

Fuel tank is full: **X**

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

Front: *240 kPa (35 psi)*

Rear: *240 kPa (35 psi)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2021 Chevrolet Trailblazer FWD 4dr LT

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*483.1 kg (1065 lb)*	Right Front:	*443.2 kg (977 lb)*
Left Rear:	*289.4 kg (638 lb)*	Right Rear:	*292.1 kg (644 lb)*
		Total:	*1507.8 kg (3324 lb)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

2021 Chevrolet Trailblazer FWD 4dr LT

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

Automatic Emergency Braking; included as standard equipment.

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

Front Camera Module – Mono Camera

System setting used for test (if applicable): *Alert and Brake*

Brake application mode used for test: *Hybrid control*

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

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

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

80 km/h (50 mph) (Per manufacturer supplied information)

Does the vehicle system require an initialization sequence/procedure?

___ Yes

X No

If yes, please provide a full description.

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

___ Yes

X No

If yes, please provide a full description.

2021 Chevrolet Trailblazer FWD 4dr LT

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.

When your vehicle approaches another detected vehicle too rapidly, the red FCA (Forward Collision Alert) display will flash on the windshield. The alert is displayed as a series of red dots. When AEB intervention is completed, an additional display appears in the instrument panel. See Appendix A, Figure 16.

The auditory alert is eight rapid high-pitched beeps that sounds from the front.

Is there a way to deactivate the system?

X Yes

___ No

If yes, please provide a full description including the switch location and method of operation, any associated instrument panel indicator, etc.

System menus are used to interact with the settings. The menu hierarchy is:

Settings

- *Vehicle*
  - *Collision/Detection Systems*
    - *Forward Collision System*
      - *Select from: Off, Alert, Alert and Brake*

See Appendix A, Figures A14 and A15.

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

2021 Chevrolet Trailblazer FWD 4dr LT

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

If yes, please provide a full description.

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

If yes, please provide a full description.

System limitations are described on page 225 of the Owner's Manual, shown in Appendix B, page B-9.

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

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

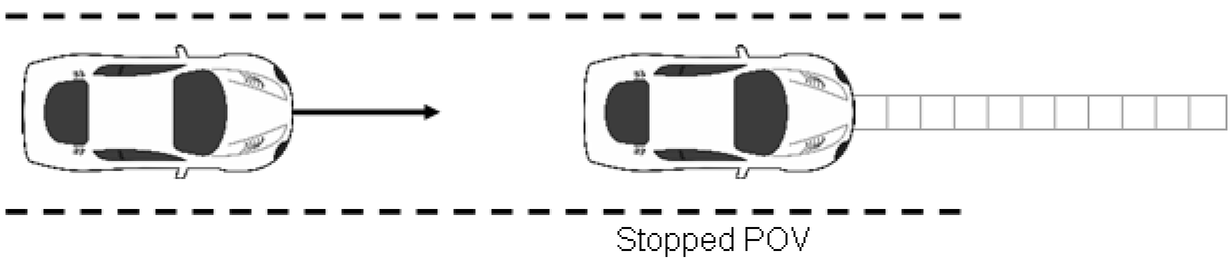

Figure 1. Depiction of Test 1

a. Procedure

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

The SV ignition was cycled prior to each test run. The SV was driven at a nominal speed of 25 mph (40.2 km/h) in the center of the lane of travel, toward the parked POV. The SV throttle pedal was released within 500 ms after t_{FCW}, i.e., within 500 ms of the FCW alert. The SV brakes were applied at TTC = 1.1 seconds (SV-to-POV distance of 40 ft (12 m)). The test concluded when either:

- The SV came into contact with the POV or

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

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

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

Table 1. Nominal Stopped POV DBS Test Choreography

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

b. Criteria

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

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

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

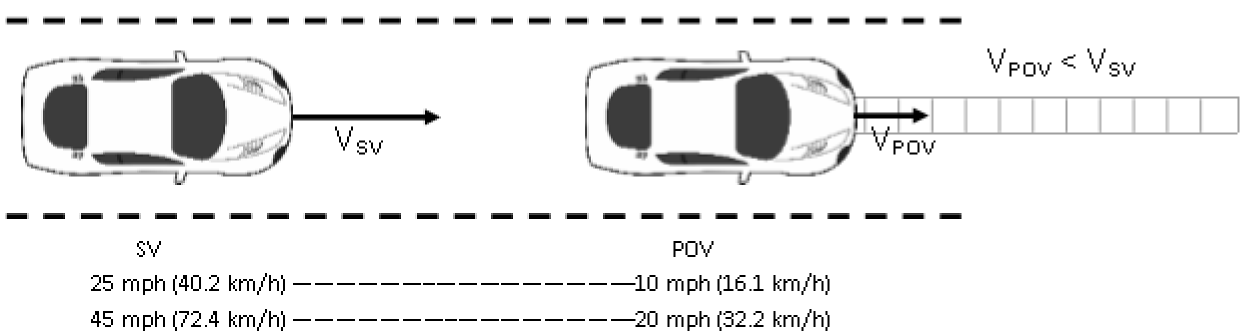

Figure 2. Depiction of Test 2

a. Procedure

The SV ignition was cycled prior to each test run. The tests were conducted two ways. In the first, the POV was driven at a constant 10.0 mph (16.1 km/h) in the center of the lane of travel while the SV was driven at 25.0 mph (40.2 km/h), in the center lane of travel, toward the slower-moving POV. In the second, the POV was driven at a constant 20.0 mph (32.2 km/h) in the center of the lane of travel while the SV was driven at 45.0 mph (72.4 km/h), in the center lane of travel, toward the slower-moving POV. In both cases, the SV throttle pedal was released within 500 ms after t_{FCW}, i.e., within 500 ms of the FCW alert. The SV brakes were applied at TTC = 1.0 seconds, assumed to be SV-to-POV distance of 22 ft (7 m) for an SV speed of 25 mph and 37 ft (11 m) for an SV speed of 45 mph.

The test concluded when either:

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

The SV driver then braked to a stop.

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

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

Table 2. Nominal Slower-Moving POV DBS Test Choreography

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

b. Criteria

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

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

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.

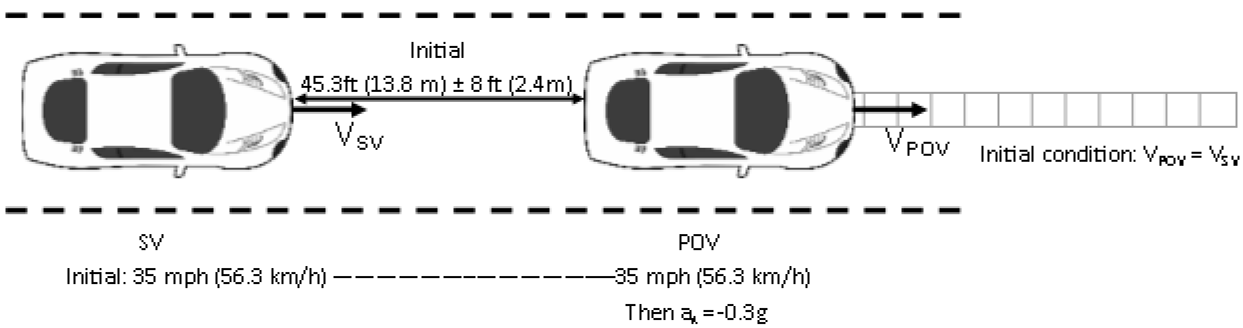

Figure 3. Depiction of Test 3

a. Procedure

The SV ignition was cycled prior to each test run. For this scenario both the POV and SV were driven at a constant 35.0 mph (56.3 km/h) in the center of the lane, with headway of 45.3 ft (13.8 m) ± 8 ft (2.4 m). Once these conditions were met, the POV tow vehicle brakes were applied to achieve 0.3 ± 0.03 g. The SV throttle pedal was released within 500 ms of $t_{FCW,}$ and the SV brakes were applied when TTC was 1.4 seconds (31.5 ft (9.6 m)).

The test concluded when either:

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

The SV driver then braked to a stop.

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

- The lateral distance between the centerline of the POV and the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The headway between the SV and POV must have been constant from the onset

of the applicable validity period to the onset of POV braking.

- The SV and POV speed could not deviate more than ±1.0 mph (1.6 km/h) during an interval defined by the onset of the validity period to the onset of POV braking.
- The average POV deceleration could not deviate by more than ±0.03 g from the nominal 0.3 g deceleration during the interval beginning at 1.5 seconds after the onset of POV braking and ending either 250 ms prior to the POV coming to a stop or the SV coming into contact with the POV.

Table 3. Nominal Decelerating POV DBS Test Choreography

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

b. Criteria

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

4. <u>TEST 4 – FALSE POSITIVE SUPPRESSION</u>

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 1.5 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	5^{th}	3 dB	60 dB	Identified Center Frequency ± 5%
Tactile	5^{th}	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 SV-to-POV 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. <u>POV AUTOMATIC BRAKING SYSTEM</u>

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 100 psi	Omega DPG8001	17042707002	By: DRI Date: 8/18/2020 Due: 8/18/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 4/20/2020 Due: 4/20/2021
Linear (string) encoder	Throttle pedal travel	10 in	0.1 in	UniMeasure LX-EP	50060726	By: DRI Date: 6/19/2020 Due: 6/19/2021
Load Cell	Force applied to brake pedal					By: DRI
		0 - 250 lb 0 -1112 N	0.1% FS	Stellar Technology PNC700	002505	Date: 5/11/2020 Due: 5/11/2021
		0-250 lb 1112 N	0.05% FS	Stellar Technology PNC700	1607338	Date: 7/2/2020 Due: 7/2/2021
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	N/A

Table 5. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels ± 10g, Angular Rate ±100 deg/s, Angle >45 deg, Velocity >200 km/h	Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h	Oxford Inertial +		By: Oxford Technical Solutions
					2258	Date: 5/3/2019 Due: 5/3/2021
					2182	Date: 9/16/2019 Due: 9/16/2021
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	N/A
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	N/A	N/A
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	N/A	N/A
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	N/A	N/A

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: 1/6/2021 Due: 1/6/2022

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

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

VIN: KL79MPSL5MB06

CHEVROLET

2021 Trailblazer FWD 4dr LT

VIN:	KL79MPSL5MB06
MODEL:	TRAILBLAZER
ENGINE:	ECOTEC 1.3L TURBO
PORT OF ENTRY:	
EXTERIOR COLOR:	DARK COPPER METALLIC
INTERIOR/SEAT COLOR:	JET BLACK
TRANSPORT:	TRUCK
ACCESSORY WEIGHT:	16 lbs./ 7 kgs.

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score ★★★★

Based on the combined rating of frontal, side and rollover.
Should ONLY be compared to other vehicles of similar size and weight.

Frontal Crash Driver ★★★★★ Passenger ★★★

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

Side Crash Front seat ★★★★★ Rear seat ★★★★★

Based on the risk of injury in a side impact.

Rollover ★★★★

Based on the risk of rollover in a single-vehicle crash.

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

STANDARD FEATURES:

ENTERTAINMENT

- Audio system, Chevrolet Infotainment 3 system 7" diagonal color touchscreen, AM/FM stereo. Additional features for compatible phones include: Bluetooth audio streaming for 2 active devices, voice command pass-through to phone, Apple CarPlay and Android Auto capable. (8" screen when (ZL3) Convenience Package and (ZL5) Driver Confidence Package are ordered.)	INCLUDED
- Audio system feature, 6-speaker system, enhanced performance	INCLUDED
- Display, 7" diagonal color touchscreen	INCLUDED
- 4G LTE Wi-Fi Hotspot capable (Terms and limitations apply. See onstar.com or dealer for details.)	INCLUDED
- Wireless Apple CarPlay/Wireless Android Auto	INCLUDED

INTERIOR

- Seats, front bucket	INCLUDED
- Seat trim, Cloth	INCLUDED
- Seats, heated driver and front passenger	INCLUDED
- Seat adjuster, driver 8-way power	INCLUDED
- Seat adjuster, driver 2-way power lumbar	INCLUDED
- Seat adjuster, front passenger 4-way manual	INCLUDED
- Seatback, front passenger flat-folding	INCLUDED
- Seat, rear 40/60 split-bench, folding (60 percent on passenger side)	INCLUDED
- Head restraints, front, 2-way adjustable	INCLUDED
- Head restraints, rear outboard, 4-way adjustable	INCLUDED

SAFETY

- Automatic Emergency Braking	INCLUDED
- Front Pedestrian Braking	INCLUDED
- Daytime Running Lamps, signature LED	INCLUDED
- Airbags, driver and front passenger frontal and knee, seat-mounted side-impact and roof rail-mounted head-curtain for all outboard seating positions and Passenger Sensing System for front passenger (Always use seat belts and child restraints. Children are safer when properly secured in a rear seat in the appropriate child restraint. See the Owner's Manual for more information.)	INCLUDED
- OnStar and Chevrolet connected services capable (Terms and limitations apply. See onstar.com or dealer for details.)	INCLUDED
- Rear Vision Camera	INCLUDED
- Lane Keep Assist with Lane Departure Warning	INCLUDED
- Following Distance Indicator	INCLUDED
- Forward Collision Alert	INCLUDED
- Seat belts, 3-point, driver and front passenger, height-adjustable includes pretensioners and front passenger load limiter	INCLUDED

EXTERIOR

- Wheels, 17" (43.2 cm) High Gloss Black machined aluminum	INCLUDED
- Tires, 225/60R17 all-season, blackwall	INCLUDED
- Wheel, spare, 16" (40.6 cm) steel	INCLUDED
- Tire, compact spare 16" (40.3 cm)	INCLUDED
- Side rails, roof-mounted (Silver-painted.)	INCLUDED

Manufacturer's Suggested Retail Price: $23,700.00

ADDED FEATURES:

PREMIUM SEATING PACKAGE includes (HVL/HVM) Leatherette interior, (N34) leather-wrapped steering wheel, (VY7) leather-wrapped shift knob and (DA5) rear center armrest	$845.00
LPO, ALL-WEATHER FLOOR MATS	$150.00
LICENSE PLATE BRACKET, FRONT	$40.00
LPO, CARGO SHADE, SOFT	$205.00
PERFORMANCE PACKAGE includes (L3T) ECOTEC 1.3L Turbo engine, (C2Y) 4255 lbs. GVWR, Sport mode and Snow mode	$395.00
CONVENIENCE PACKAGE includes (C68) automatic climate control air conditioning, (U2K) SiriusXM Radio, (UIJ) 8" diagonal color touchscreen display, (USS) one type-A and one type-C charging only USB ports, (KI6) 120-volt power outlet, (DD8) inside rearview auto-dimming mirror and (DMS) driver and front passenger illuminated vanity mirrors, covered, sliding visors	$620.00
DRIVER CONFIDENCE PACKAGE includes (UKC) Lane Change Alert with Side Blind Zone Alert, (UFG) Rear Cross Traffic Alert and (UD7) Rear Park Assist	$345.00

Total Price : **$26,300.00**

EPA DOT Fuel Economy and Environment

Gasoline Fuel

Fuel Economy

30 MPG combined city/hwy

29 city **33** highway

3.3 gallons per 100 miles

Large Cars range from 14 to 40 MPG.
The best vehicle rates 119 MPGe.

You **save** **$1,450** more in fuel costs over 5 years compared to the average new vehicle.

Annual fuel **cost** **$1,110**

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 25 MPG and costs $9,000 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $ 3.00 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov

Calculate personalized estimates and compare vehicles

Smartphone QR Code™

Manufacturer's suggested retail price includes manufacturer's recommended pre-delivery service. Gasoline license and title fees state and local taxes and dealer installed options and accessories are not included in the manufacturer's suggested retail price. This label has been affixed to this vehicle by Hyundai Motor America, pursuant to the requirements of 15 U.S.C. 1231 et seq. which prohibits its removal or alteration prior to delivery to the ultimate purchaser.

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Figure A3. Window Sticker (Monroney Label)

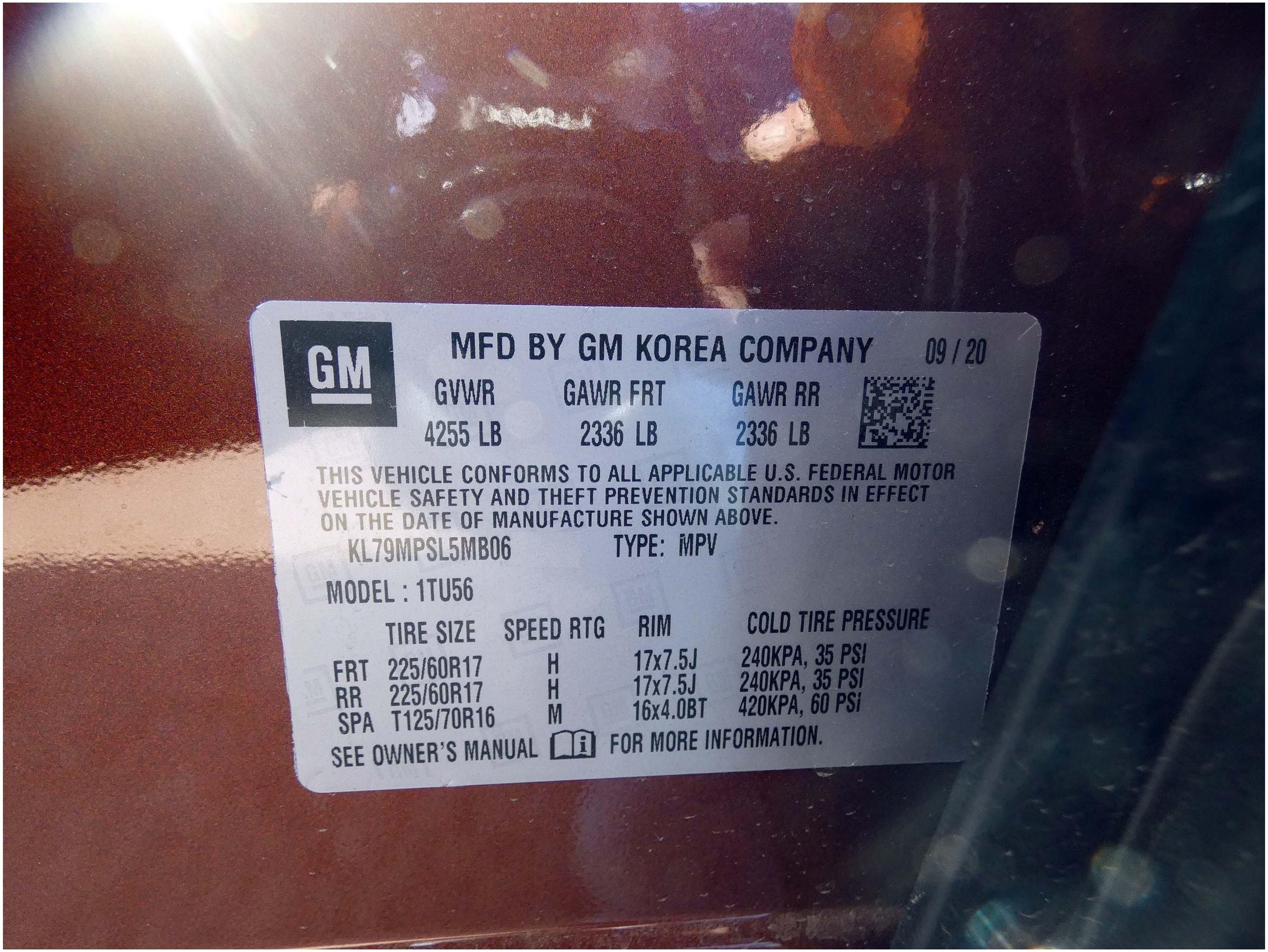


Figure A4. Vehicle Certification Label

Figure A5. Tire Placard

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

Figure A7. Load Frame/Slider of SSV

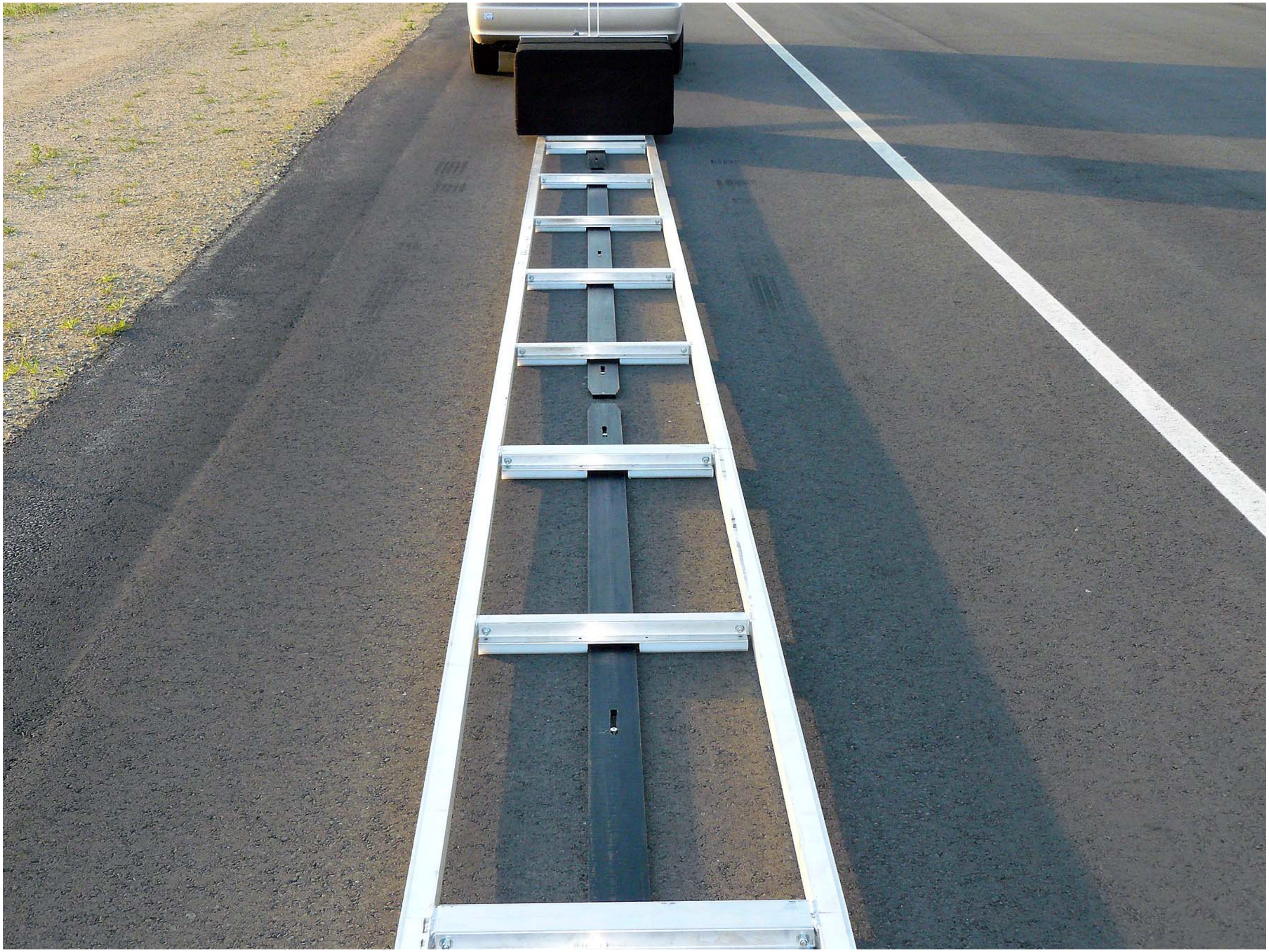


Figure A8. Two-Rail Track and Road-Based Lateral Restraint Track

Figure A9. Steel Trench Plate

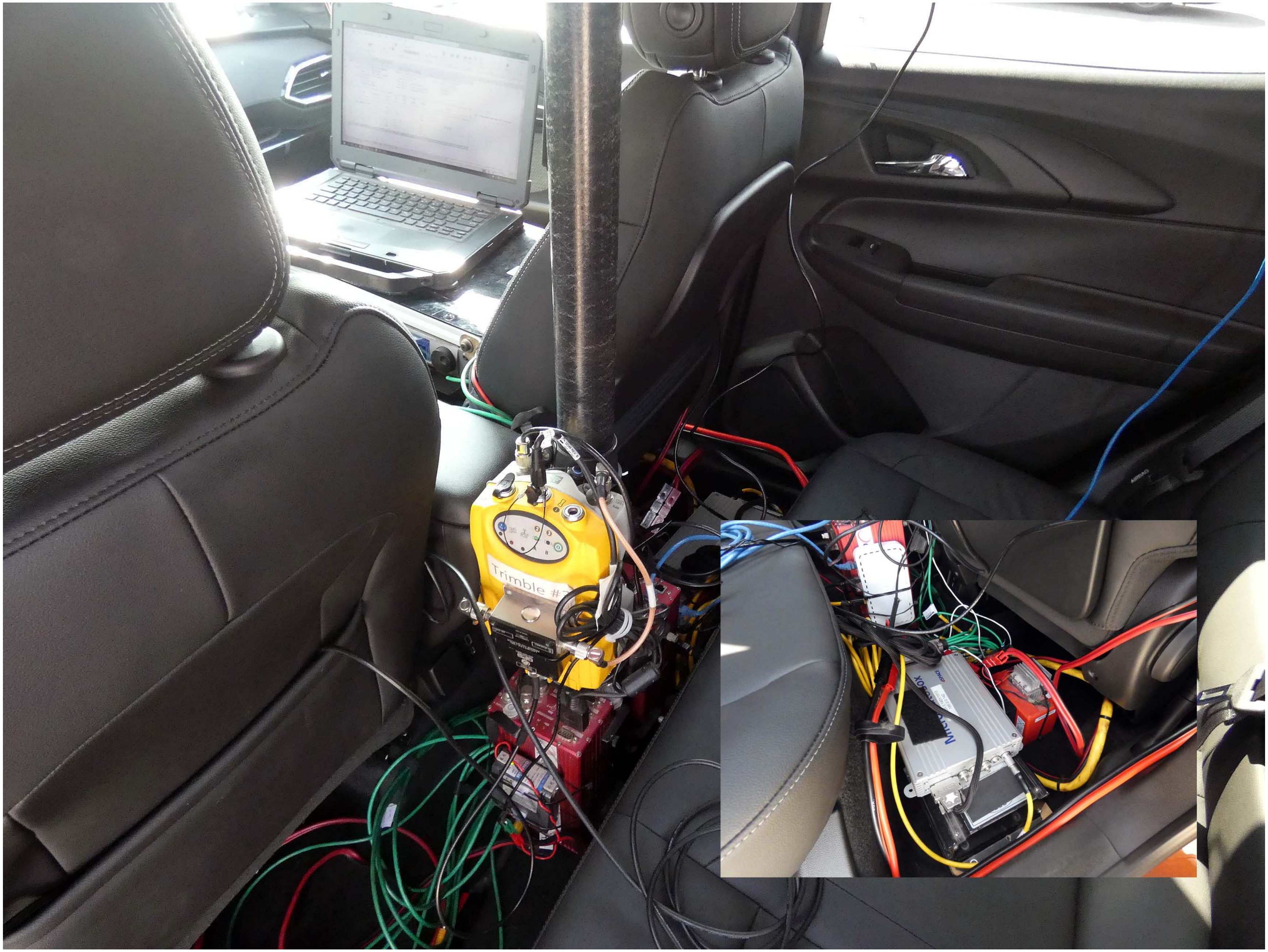


Figure A10. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A11. Sensors for Detecting Visual and Auditory Alerts

Figure A12. Computer and Brake Actuator Installed in Subject Vehicle

Figure A13. Brake Actuator Installed in POV System

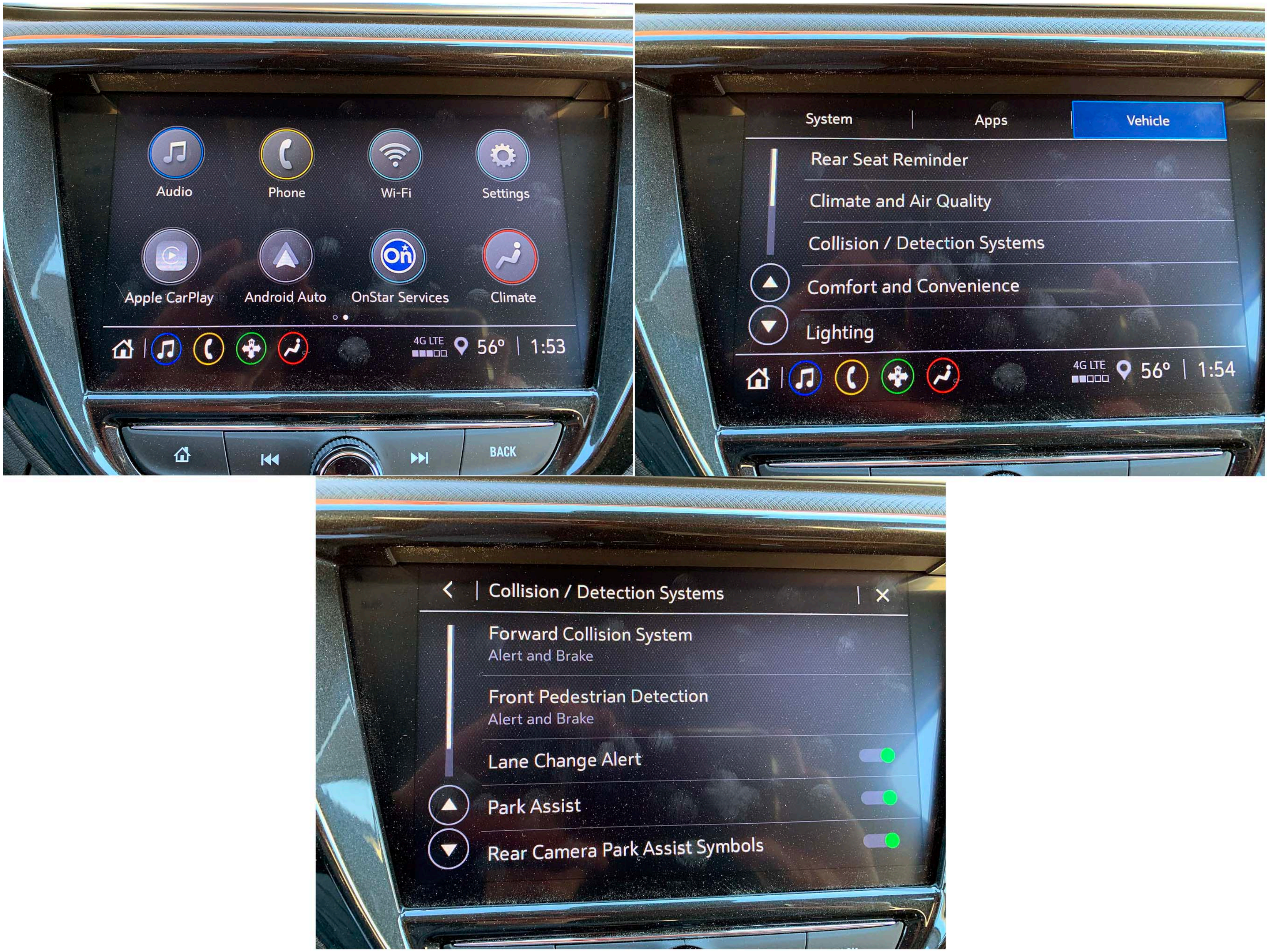
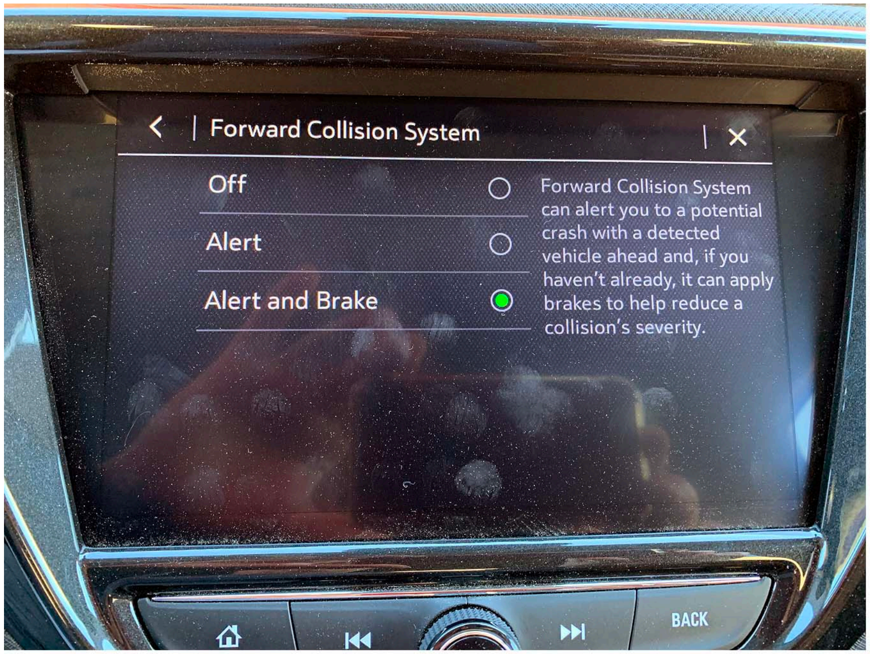


Figure A14. System Setup Menus (page 1 of 2)



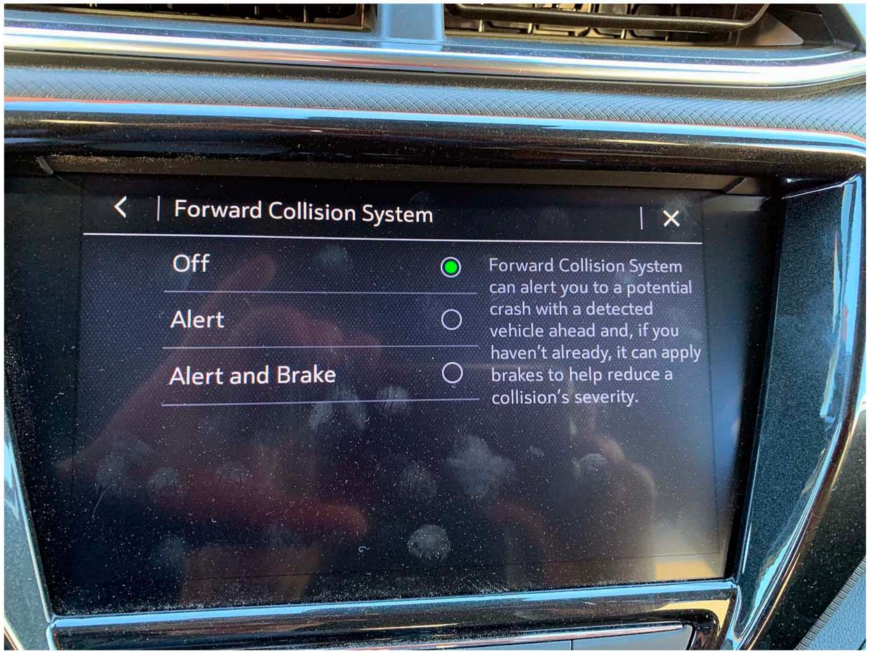


Figure A15. System Setup Menus (page 2 of 2)

Figure A16. Visual Alerts

APPENDIX B

Excerpts from Owner's Manual

Using this Manual

To quickly locate information about the vehicle, use the Index in the back of the manual. It is an alphabetical list of what is in the manual and the page number where it can be found.

About Driving the Vehicle

As with other vehicles of this type, failure to operate this vehicle correctly may result in loss of control or a crash. Be sure to read the driving guidelines in this manual in the section called "Driving and Operating" and specifically *Driver Behavior* ⇨ *181*, *Driving Environment* ⇨ *181*, and *Vehicle Design* ⇨ *181*.

Danger, Warning, and Caution

Warning messages found on vehicle labels and in this manual describe hazards and what to do to avoid or reduce them.

⚠ Danger

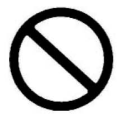
Danger indicates a hazard with a high level of risk which will result in serious injury or death.

⚠ Warning

Warning indicates a hazard that could result in injury or death.

Caution

Caution indicates a hazard that could result in property or vehicle damage.



A circle with a slash through it is a safety symbol which means "Do not," "Do not do this," or "Do not let this happen."

Symbols

The vehicle has components and labels that use symbols instead of text. Symbols are shown along with the text describing the operation or information relating to a specific component, control, message, gauge, or indicator.

: Shown when the owner's manual has additional instructions or information.

: Shown when the service manual has additional instructions or information.

⇨ **:** Shown when there is more information on another page — "see page."

Vehicle Symbol Chart

Here are some additional symbols that may be found on the vehicle and what they mean. See the features in this manual for information.

: Air Conditioning System

: Air Conditioning Refrigerant Oil

: Airbag Readiness Light

: Antilock Brake System (ABS)

: Brake System Warning Light

: Dispose of Used Components Properly

: Do Not Apply High Pressure Water

: Engine Coolant Temperature

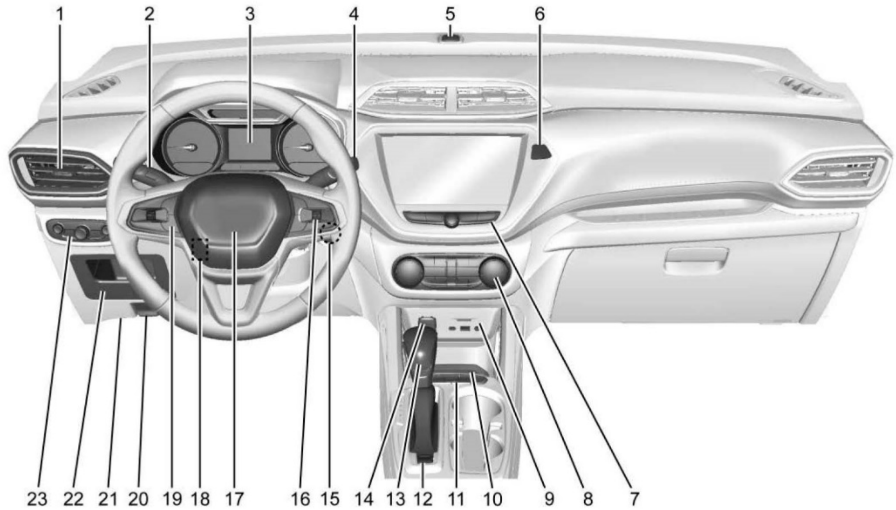
: Flame/Fire Prohibited

: Flammable

: Forward Collision Alert

: Fuse Block Cover Lock Location

Instrument Panel Overview



1. *Air Vents* ⇨ *178*.
2. Turn Signal Lever. See *Turn and Lane-Change Signals* ⇨ *117*.

   IntelliBeam System Button (If Equipped). See *Exterior Lamp Controls* ⇨ *114*.
3. *Instrument Cluster* ⇨ *89*.

   Driver Information Center (DIC) Display. See *Driver Information Center (DIC) (Base Level)* ⇨ *104* or *Driver Information Center (DIC) (Uplevel)* ⇨ *107*.
4. *Windshield Wiper/Washer* ⇨ *83*.

   Rear Window Wiper/Washer ⇨ *84*.
5. Light Sensor. See *Automatic Headlamp System* ⇨ *116*.
6. *Hazard Warning Flashers* ⇨ *117*.
7. Infotainment. See *Overview* ⇨ *122*.
8. *Climate Control Systems* ⇨ *174*.

   Automatic Climate Control System ⇨ *176*.

   Heated Front Seats ⇨ *40*. (If Equipped).
9. *USB Port* ⇨ *130*.

   Auxiliary Jack ⇨ *132*.
10. *Wireless Charging* ⇨ *86* (If Equipped).
11. Stop/Start Disable Button. See *Stop/Start System* ⇨ *195* (If Equipped).

    Lane Keep Assist (LKA) ⇨ *229* (If Equipped).

    Traction Control/Electronic Stability Control ⇨ *206*.

    Sport Mode (If Equipped). See *Driver Mode Control* ⇨ *208*

    All-Wheel Drive ⇨ *203* (If Equipped).
12. *Electric Parking Brake* ⇨ *205*.
13. Shift Lever. See *Automatic Transmission* ⇨ *201*.
14. *Power Outlets* ⇨ *85*.
15. Engine START/STOP Button. See *Ignition Positions (Key Access)* ⇨ *191* or *Ignition Positions (Keyless Access)* ⇨ *192* (If Equipped).
16. *Steering Wheel Controls* ⇨ *83*.
17. *Horn* ⇨ *83*.
18. *Steering Wheel Adjustment* ⇨ *83* (Out of View).
19. *Cruise Control* ⇨ *209*.

    Adaptive Cruise Control (Camera) ⇨ *211* (If Equipped).

    Forward Collision Alert (FCA) System ⇨ *223* (If Equipped).
20. Hood Release. See *Hood* ⇨ *245*.
21. Data Link Connector (DLC) (Out of View). See *Malfunction Indicator Lamp (Check Engine Light)* ⇨ *96*.
22. *Instrument Panel Storage* ⇨ *78*.

    Instrument Panel Fuse Block ⇨ *277*.
23. *Exterior Lamp Controls* ⇨ *114*.

Uplevel English Metric Similar

Sport Mode Light

This light comes on when Sport Mode is selected. See *Driver Mode Control* ⇨ *208*.

Lane Keep Assist (LKA) Light

After the vehicle is started, this light turns off and stays off if LKA has not been turned on or is unavailable.

If equipped, this light is white if LKA is turned on, but not ready to assist.

This light is green if LKA is turned on and is ready to assist.

LKA may assist by gently turning the steering wheel if the vehicle approaches a detected lane marking. The LKA light is amber when assisting.

This light flashes amber as a Lane Departure Warning (LDW) alert, to indicate that the lane marking has been crossed.

LKA will not assist or alert if the turn signal is active in the direction of lane departure, or if LKA detects that you are accelerating, braking or actively steering.

See *Lane Keep Assist (LKA)* ⇨ *229*.

Vehicle Ahead Indicator

If equipped, this indicator will display green when a vehicle is detected ahead and amber when you are following a vehicle ahead much too closely.

See *Forward Collision Alert (FCA) System* ⇨ *223*.

Pedestrian Ahead Indicator

If equipped, this indicator will display when a nearby pedestrian is detected directly in front of the vehicle.

See *Front Pedestrian Braking (FPB) System* ⇨ *226*.

Traction Off Light

This light comes on briefly while starting the engine. If it does not, have the vehicle serviced by your dealer. If the system is working normally, the indicator light then turns off.

Auto Rear Defog

When on, this feature turns on the rear defogger at vehicle start when the interior temperature is cold and fog is likely. See "Rear Window Defogger" under *Automatic Climate Control System* ⇨ *176*.

Touch Off or On.

Collision / Detection Systems

Touch and the following may display:

- Forward Collision System
- Front Pedestrian Detection
- Adaptive Cruise Go Notifier
- Lane Change Alert
- Rear Camera Park Assist Symbols
- Rear Cross Traffic Alert
- Rear Park Assist

Forward Collision System

This setting controls the vehicle response when detecting a vehicle ahead of you. The Off setting disables all FCA and AEB functions. With the Alert and Brake setting, both FCA and AEB are available. The Alert setting disables AEB. See *Automatic Emergency Braking (AEB)* ⇨ *224*.

Touch Off, Alert, or Alert and Brake.

Front Pedestrian Detection

This feature may help avoid or reduce the harm caused by front-end crashes with nearby pedestrians. See *Front Pedestrian Braking (FPB) System* ⇨ *226*.

Touch Off, Alert, or Alert and Brake.

Adaptive Cruise Go Notifier

This setting determines if an alert will appear when Adaptive Cruise Control brings the vehicle to a complete stop and the vehicle ahead of you starts moving again. See *Adaptive Cruise Control (Camera)* ⇨ *211*.

Touch Off or On.

Lane Change Alert

This allows the feature to be turned on or off. See *Lane Change Alert (LCA)* ⇨ *228*.

When Lane Change Alert is disabled, Side Blind Zone Alert is also disabled.

Touch Off or On.

Rear Camera Park Assist Symbols

This setting enables the Rear Camera Park Assist Symbols. See *Assistance Systems for Parking or Backing* ⇨ *221*.

Touch Off or On.

Rear Cross Traffic Alert

This setting specifies if you see alerts when the vehicle detects approaching rear cross traffic when in R (Reverse). See *Assistance Systems for Parking or Backing* ⇨ *221*.

Touch Off or On.

Rear Park Assist

This setting specifies if you have alerts when a object is detected at parking or backing when in R (Reverse). See *Assistance Systems for Parking or Backing* ⇨ *221*.

Touch Off or On.

Comfort and Convenience

Touch and the following may display:

- Chime Volume
- Handsfree Liftgate/Trunk Control
- Auto Wipe in Reverse Gear
- Extended Hill Start Assist

Chime Volume

This allows the selection of the chime volume level.

Touch + or − to adjust the volume

Also, eight rapid high-pitched beeps will sound from the front. When this Collision Alert occurs, the brake system may prepare for driver braking to occur more rapidly which can cause a brief, mild deceleration. Continue to apply the brake pedal as needed. Cruise control may be disengaged when the Collision Alert occurs.

Tailgating Alert

The vehicle ahead indicator will display amber when you are following a vehicle ahead too closely.

Selecting the Alert Timing

The Collision Alert control is on the steering wheel. Press [FCA button] to set the FCA timing to Far, Medium, or Near. The first button press shows the current setting on the DIC. Additional button presses will change this setting. The chosen setting will remain until it is changed and will affect the timing of both the Collision Alert and the Tailgating Alert features. The timing of both alerts will vary based on vehicle speed. The faster the vehicle speed, the farther away the alert will occur. Consider traffic and weather conditions when selecting the alert timing. The range of selectable alert timings may not be appropriate for all drivers and driving conditions.

If your vehicle is equipped with Adaptive Cruise Control (ACC), changing the FCA timing setting automatically changes the following gap setting (Far, Medium, or Near).

Following Distance Indicator

The following distance to a moving vehicle ahead in your path is indicated in following time in seconds on the Driver Information Center (DIC). See *Driver Information Center (DIC) (Base Level)* ⇨ *104* or *Driver Information Center (DIC) (Uplevel)* ⇨ *107*. The minimum following time is 0.5 seconds away. If there is no vehicle detected ahead, or the vehicle ahead is out of sensor range, dashes will be displayed.

Unnecessary Alerts

FCA may provide unnecessary alerts for turning vehicles, vehicles in other lanes, objects that are not vehicles, or shadows. These alerts are normal operation and the vehicle does not need service.

Cleaning the System

If the FCA system does not seem to operate properly, this may correct the issue:

- Clean the outside of the windshield in front of the rearview mirror.
- Clean the entire front of the vehicle.
- Clean the headlamps.

Automatic Emergency Braking (AEB)

If the vehicle has Forward Collision Alert (FCA), it also has AEB, which includes Intelligent Brake Assist (IBA). When the system detects a vehicle ahead in your path that is traveling in the same direction that you may be about to crash into, it can provide a boost to braking or automatically brake the vehicle. This can help avoid or lessen the severity of crashes when driving in a forward gear. Depending on the situation, the vehicle may automatically brake moderately or hard. This automatic emergency braking can only occur if a vehicle is detected. This is shown by the FCA vehicle ahead indicator being lit. See *Forward Collision Alert (FCA) System* ⇨ *223*.

The system works when driving in a forward gear between 8 km/h (5 mph) and 80 km/h (50 mph), or on vehicles with Adaptive Cruise Control (ACC), above 4 km/h (2 mph). It can detect vehicles up to approximately 60 m (197 ft).

⚠ Warning

AEB is an emergency crash preparation feature and is not designed to avoid crashes. Do not rely on AEB to brake the vehicle. AEB will not brake outside of its operating speed range and only responds to detected vehicles.

AEB may not:

- Detect a vehicle ahead on winding or hilly roads.
- Detect all vehicles, especially vehicles with a trailer, tractors, muddy vehicles, etc.

(Continued)

Warning (Continued)

- Detect a vehicle when weather limits visibility, such as in fog, rain, or snow.
- Detect a vehicle ahead if it is partially blocked by pedestrians or other objects.

Complete attention is always required while driving, and you should be ready to take action and apply the brakes and/or steer the vehicle to avoid crashes.

AEB may slow the vehicle to a complete stop to try to avoid a potential crash. If this happens, AEB may engage the Electric Parking Brake (EPB) to hold the vehicle at a stop. Release the EPB or firmly press the accelerator pedal.

⚠ Warning

AEB may automatically brake the vehicle suddenly in situations where it is unexpected and undesired. It could respond to a turning vehicle ahead, guardrails, signs, and other non-moving objects. To override AEB, firmly press the accelerator pedal, if it is safe to do so.

Intelligent Brake Assist (IBA)

IBA may activate when the brake pedal is applied quickly by providing a boost to braking based on the speed of approach and distance to a vehicle ahead.

Minor brake pedal pulsations or pedal movement during this time is normal and the brake pedal should continue to be applied as needed. IBA will automatically disengage only when the brake pedal is released.

⚠ Warning

IBA may increase vehicle braking in situations when it may not be necessary. You could block the flow of traffic. If this occurs, take your foot off the brake pedal and then apply the brakes as needed.

AEB and IBA can be disabled through vehicle personalization. See “Collision/Detection Systems” under *Vehicle Personalization* ⇨ *110*.

APPENDIX C

Run Log

Subject Vehicle: **2021 Chevrolet Trailblazer FWD 4dr LT** Test Date: **2/9/2021**

Principal Other Vehicle: **SSV**

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
1-20	Brake characterization and determination						See Appendix D
21	Static Run						Zero SV front bumper to SSV rear bumper and collect data
22	**Stopped POV**	Y	2.72	2.06	1.08	Pass	
23		Y	2.77	2.65	1.06	Pass	
24		Y	2.91	3.70	0.93	Pass	
25		Y	2.85	2.63	1.04	Pass	
26		Y	2.83	2.12	1.09	Pass	
27		Y	2.74	1.82	1.02	Pass	
28		Y	2.86	1.99	1.02	Pass	
29	Static Run						Check zero data is within ± 0.167 ft (±0.05m)
30	**Slower POV, 25 vs 10**	Y	2.72	3.10	0.59	Pass	
31		Y	2.74	3.80	0.80	Pass	
32		Y	2.92	3.64	0.70	Pass	
33		Y	2.70	3.55	0.59	Pass	
34		Y	2.76	4.03	0.86	Pass	
35		Y	2.81	3.50	0.60	Pass	
36		Y	2.81	3.20	0.65	Pass	

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
37	Static run						Check zero data is within ± 0.167 ft (±0.05m)
38	**Slower POV, 45 vs 20**	Y	3.27	4.31	0.96	Pass	
39		Y	3.27	3.35	0.87	Pass	
40		Y	3.49	3.38	0.81	Pass	
41		Y	3.21	3.45	0.82	Pass	
42		Y	3.31	2.83	1.03	Pass	
43		Y	3.18	3.23	0.98	Pass	
44		Y	3.05	3.31	0.83	Pass	
45	Static run						Check zero data is within ± 0.167 ft (±0.05m)
46	**Decelerating POV, 35**	N					Average force
47		N					Average force
48		Y	2.28	1.76	1.04	Pass	
49		Y	2.23	0.27	0.53	Pass	
50		Y	2.21	1.21	0.55	Pass	
51		Y	2.36	1.28	1.04	Pass	
52		Y	2.40	2.06	0.63	Pass	
53		Y	2.20	0.37	0.55	Pass	
54		Y	2.41	1.63	1.01	Pass	
55	Static run						Check zero data is within ± 0.167 ft (±0.05m)

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
56	STP - Static run						Zero SV front bumper to rear edge of steel plate and collect data
57	**Baseline, 25**	Y			0.43		
58		Y			0.43		
59		Y			0.41		
60		Y			0.41		
61		Y			0.42		
62		Y			0.42		
63		Y			0.43		
64	STP - Static run						Check zero data is within ± 0.167 ft (±0.05m)
65	**Baseline, 45**	Y			0.46		
66		Y			0.50		
67		Y			0.51		
68		Y			0.46		
69		Y			0.46		
70		Y			0.48		
71		Y			0.46		
72	STP - Static run						Check zero data is within ± 0.167 ft (±0.05m)
73	**STP False Positive, 25**	Y			0.44	Pass	
74		Y			0.43	Pass	
75		Y			0.43	Pass	
76		Y			0.43	Pass	

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
77	**STP False Positive, 25**	Y			0.42	Pass	
78		Y			0.41	Pass	
79		Y			0.42	Pass	
80	STP - Static run						Check zero data is within ± 0.167 ft (±0.05m)
81	**STP False Positive, 45**	N					Average decel low
82		Y			0.39	Pass	
83		Y			0.42	Pass	
84		Y			0.40	Pass	
85		Y			0.41	Pass	
86		Y			0.43	Pass	
87		Y			0.40	Pass	
88		Y			0.42	Pass	
89	STP - Static run						Check zero data is within ± 0.167 ft (±0.05m)

APPENDIX D

Brake Characterization

Subject Vehicle: **2021 Chevrolet Trailblazer FWD 4dr LT** Test Date: **2/9/2021**

DBS Initial Brake Characterization				
Run Number	**Stroke at 0.4 g (in)**	**Force at 0.4 g (lb)**	**Slope**	**Intercept**
1	2.202	12.592	0.481	-0.028
2	2.267	13.193	0.510	-0.083
3	2.242	12.680	0.474	-0.024

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	0.150	1.49		3.97	
5		35	Y	0.507	2.50		1.97	
6		35	Y	0.325	2.00		2.46	
7		35	Y	0.429	2.30		2.14	
8		35	Y	0.381	2.20		2.31	
9		25	Y	0.344	2.20		2.56	
10		25	Y	0.392	2.35		0.24	
11		45	Y	0.442	2.20		1.99	
12		45	Y	0.403	2.20		2.18	

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**
13	**Hybrid**	35	Y	0.284	2.20	8.00	11.27	
14		35	Y	0.341		10.50	12.32	
15		35	Y	0.347		12.00	13.83	
16		35	Y	0.376	2.20	12.70	13.51	
17		45	Y	0.388	2.20	12.70	13.09	
18		25	Y	0.362	2.35	12.70	14.03	
19		25	Y	0.371		13.40	14.45	
20		25	Y	0.382	2.35	14.50	15.18	

Appendix E

TIME HISTORY PLOTS

LIST OF FIGURES

Description of Time History Plots

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

Time History Plot Description

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

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

Time history figures include the following sub-plots:

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

As only the audible or haptic alert is perceptible by the driver during a test run, the earliest of either of these alerts is used to define the onset of the FCW alert. A vertical black bar on the plot indicates the TTC (sec) at the first moment of the warning issued by the FCW system. The FCW TTC is displayed to the right of the subplot in green.

- Headway (ft) – Longitudinal separation between the front-most point of the Subject Vehicle and the rearmost point of the Strikeable Surrogate Vehicle (SSV) towed by the Principal Other Vehicle. The minimum headway during the run is displayed to the right of the subplot.
- SV/POV Speed (mph) – Speed of the Subject Vehicle and the Principal Other Vehicle (if any). For DBS tests, in the case of an impact, the speed reduction experienced by the Subject Vehicle up until the moment of impact is displayed to the right of the subplot.
- Yaw Rate (deg/sec) – Yaw rate of the Subject Vehicle and Principal Other Vehicle (if any).
- Lateral Offset (ft) – Lateral offset within the lane of the Subject Vehicle to the center of the lane of travel. Note that for tests involving the Strikeable Surrogate Vehicle (SSV), the associated lateral restraint track is defined to be the center of the lane of travel. If testing is done with a different POV which does not have a lateral restraint track, lateral offset is defined to be the lateral offset between the SV and POV.
- Ax (g) – Longitudinal acceleration of the Subject Vehicle and Principal Other Vehicle (if any). The peak value of Ax for the SV is shown on the subplot.
- Pedal Position – Position of the accelerator pedal and brake pedal. The units for the brake pedal are inches and the units for the accelerator pedal are percent of full scale divided by 10.
- Brake Force (lb) – Force on the brake pedal as applied by the DBS controller. The TTC at the onset of the brake by the DBS controller is shown on the subplot. Additionally, the average force at the brake pedal while the DBS controller is active is displayed.

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 0.27 g (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 0.27 g. A green circle indicates that the test was valid (the threshold was crossed during the appropriate interval) and a red asterisk indicates that the test was invalid (the threshold was crossed 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.

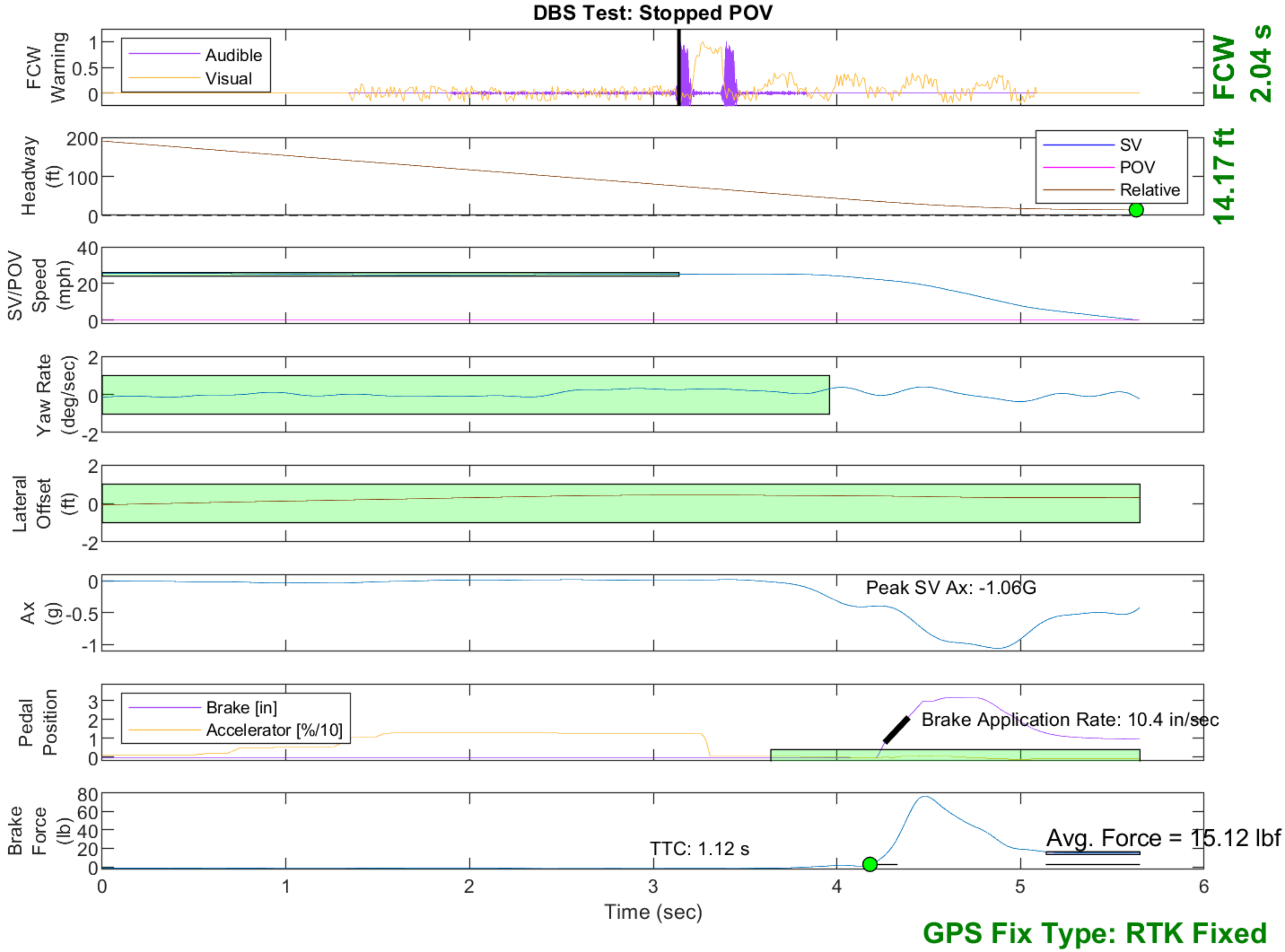


Figure E1. Example Time History for Stopped POV, Passing

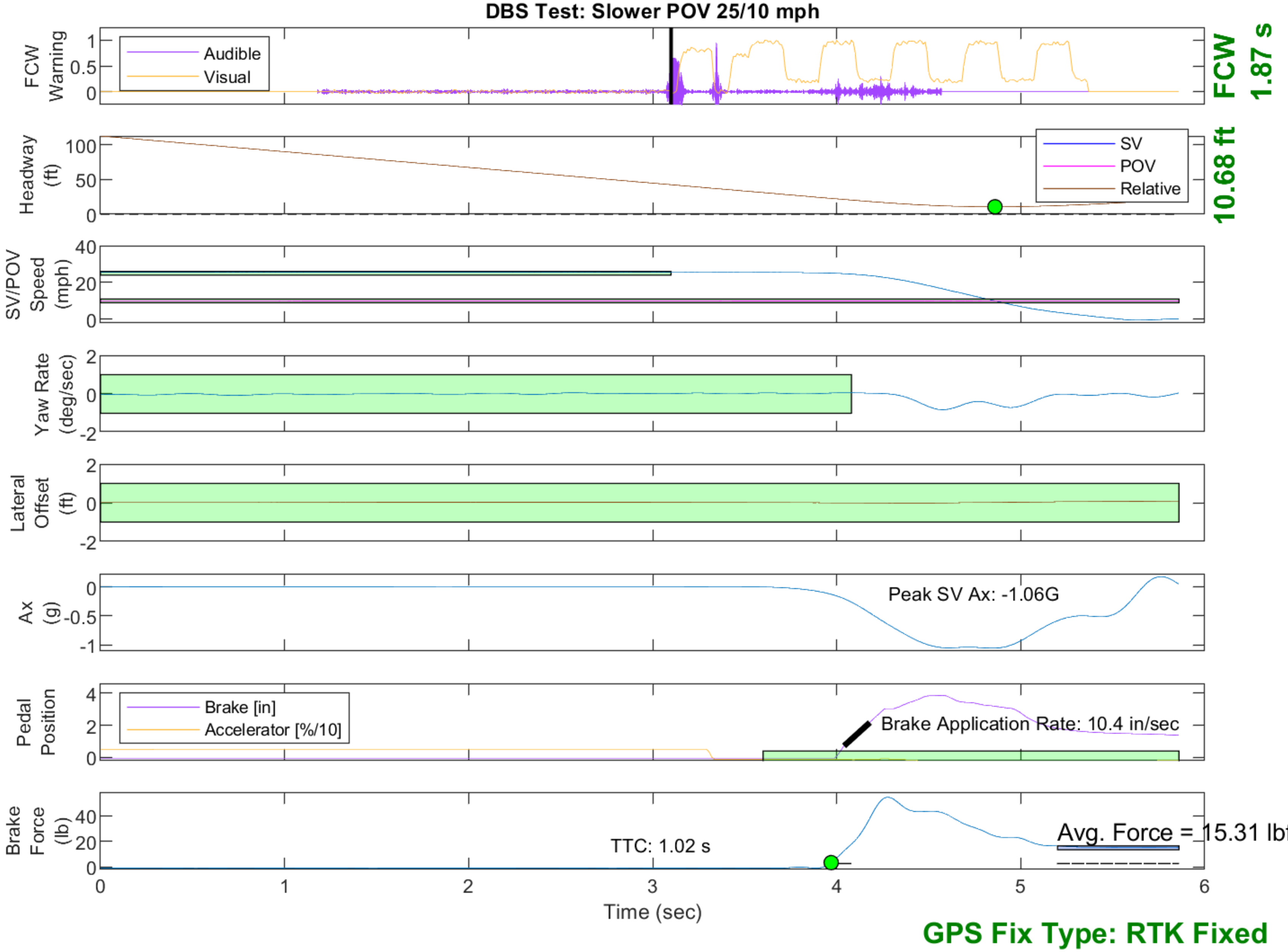


Figure E2. Example Time History for Slower POV 25 vs. 10, Passing

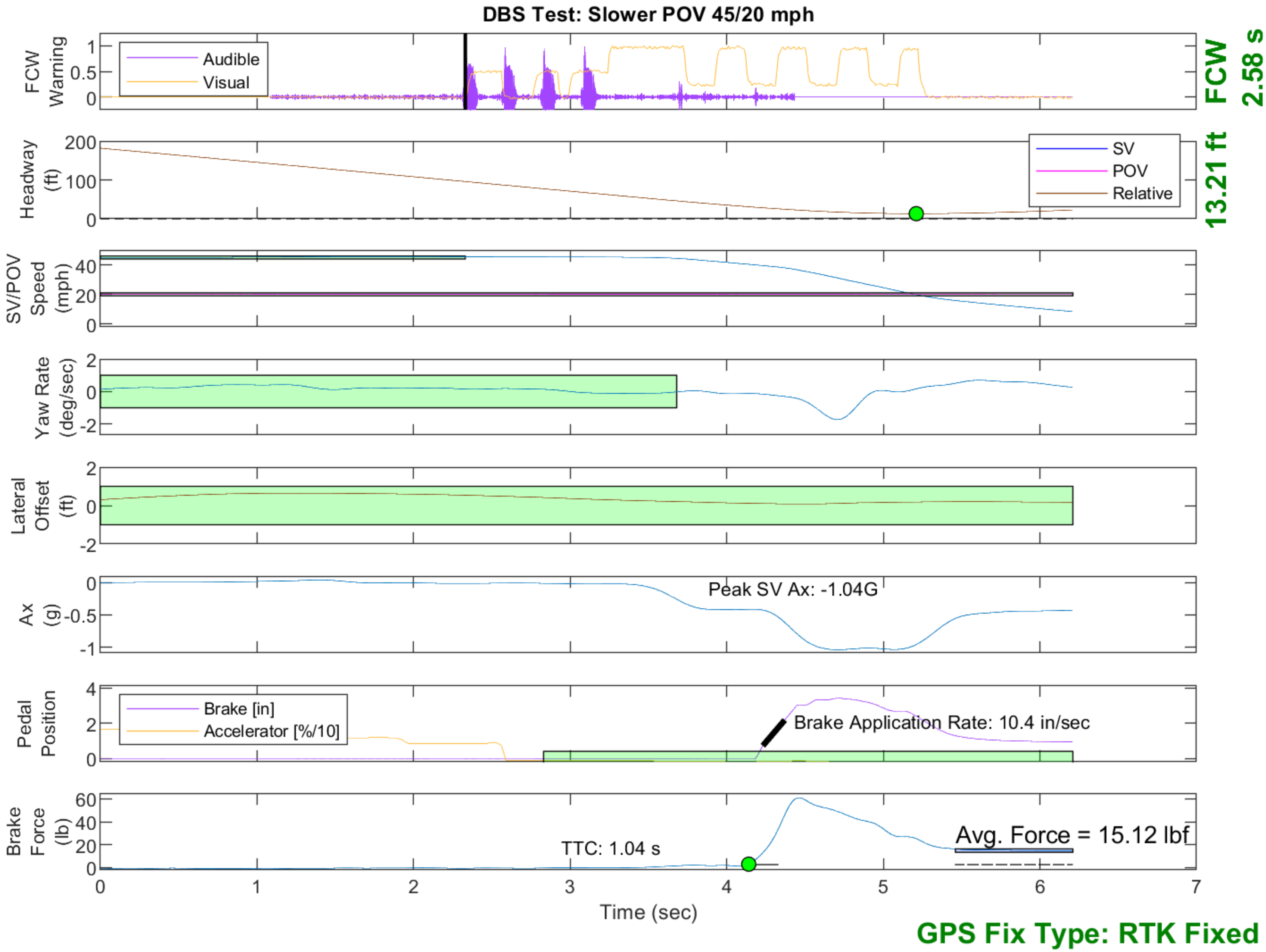


Figure E3. Example Time History for Slower POV 45 vs. 20, Passing

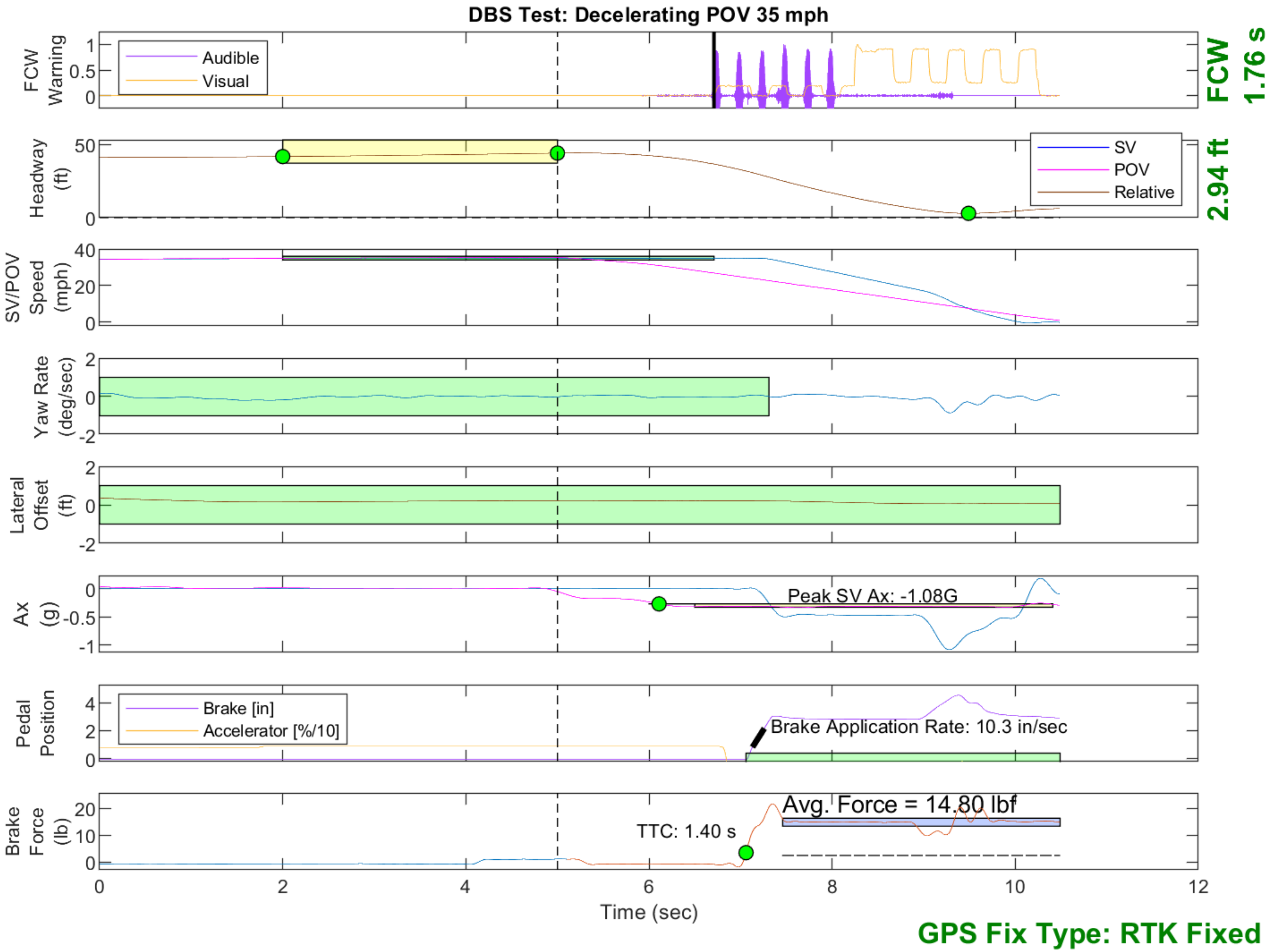


Figure E4. Example Time History for Decelerating POV 35, Passing

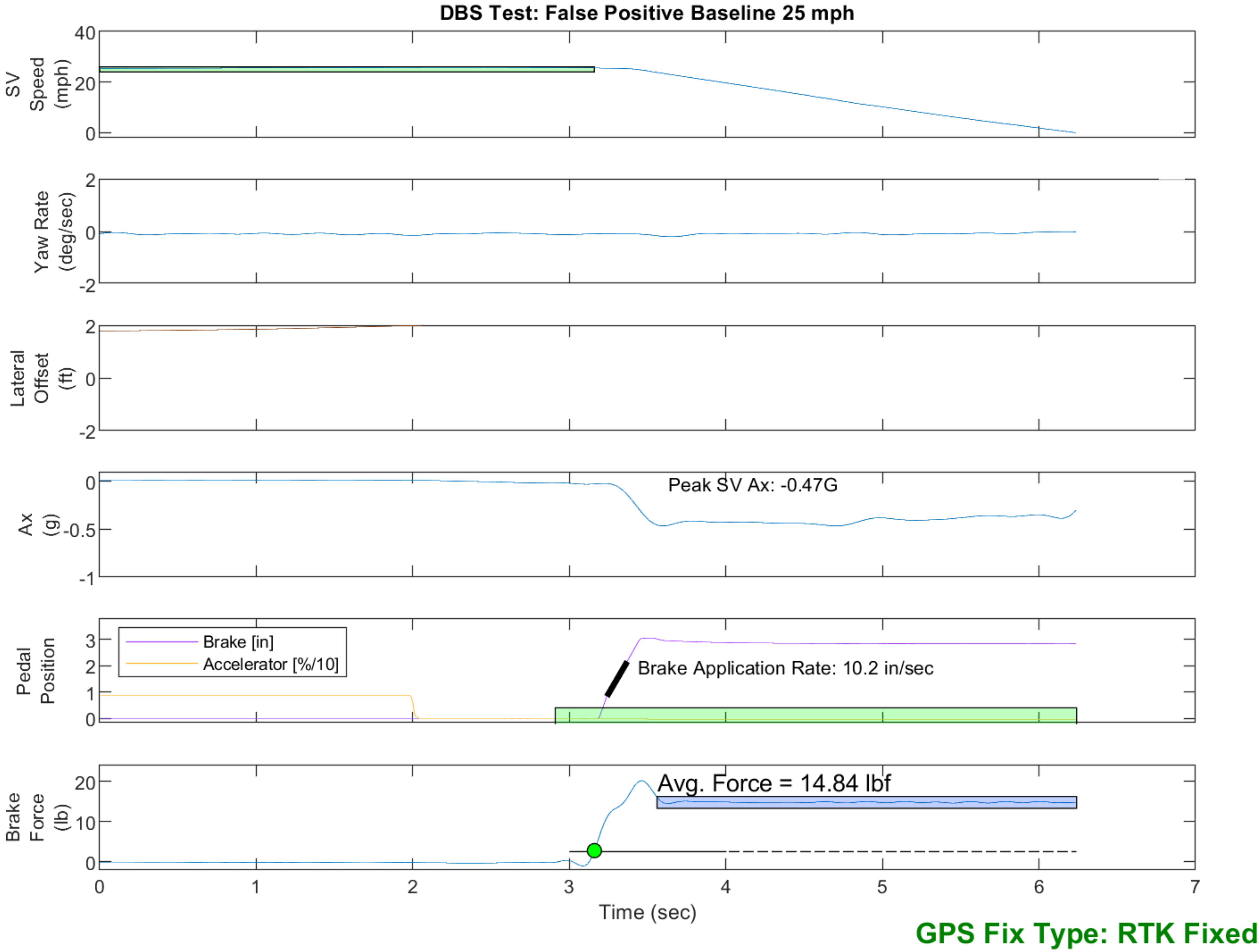


Figure E5. Example Time History for False Positive Baseline 25

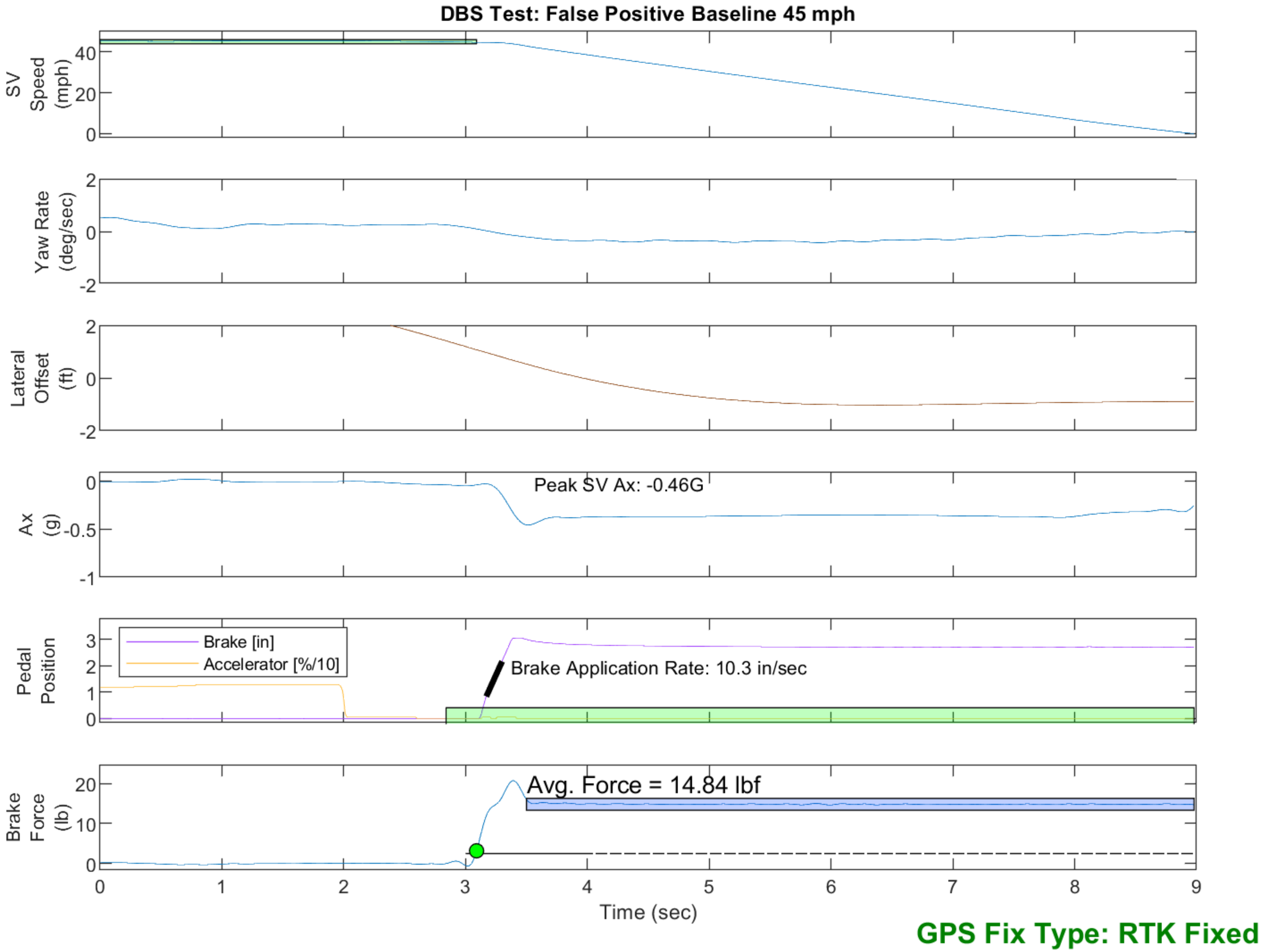


Figure E6. Example Time History for False Positive Baseline 45

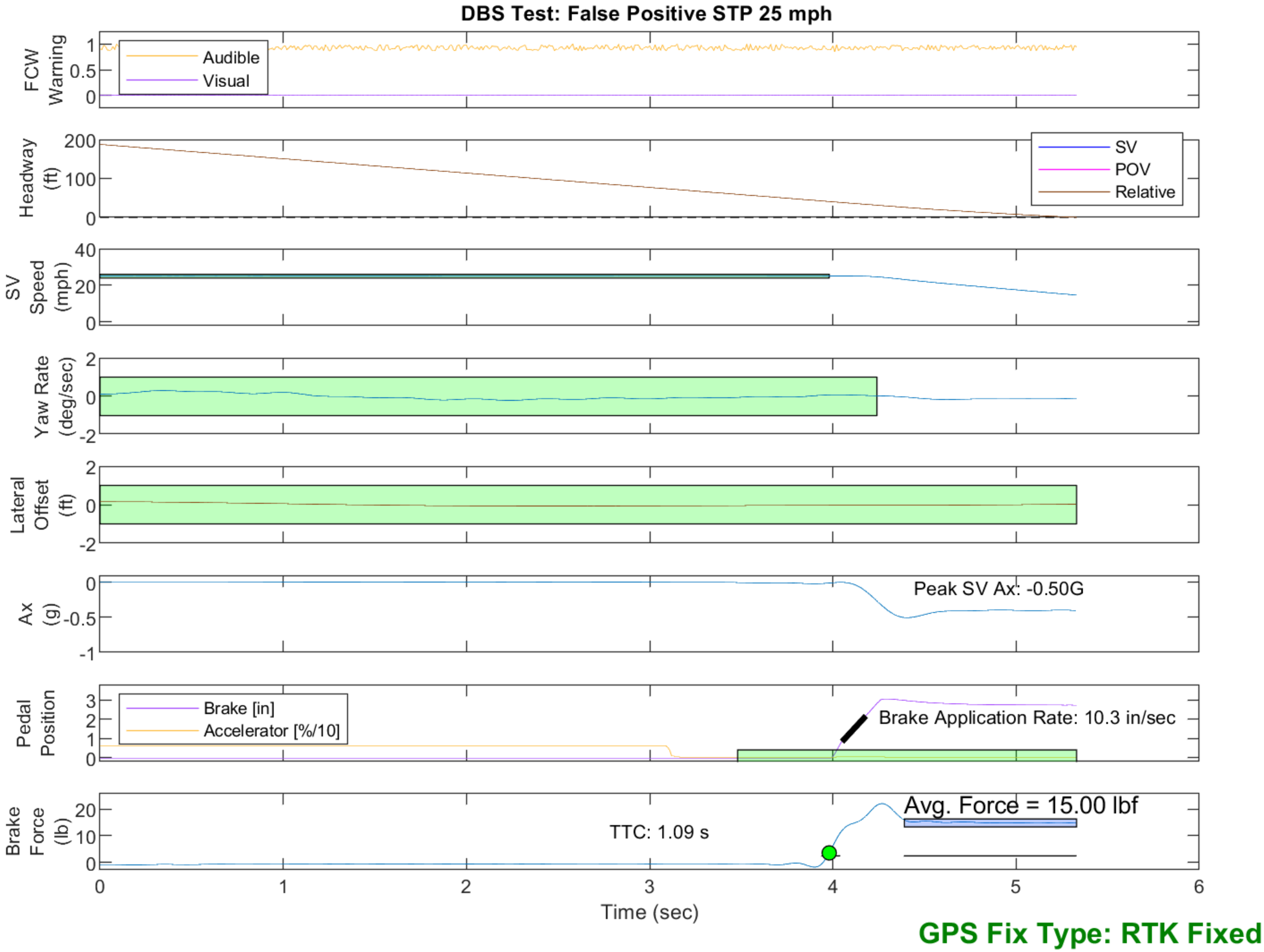


Figure E7. Example Time History for False Positive Steel Plate 25, Passing

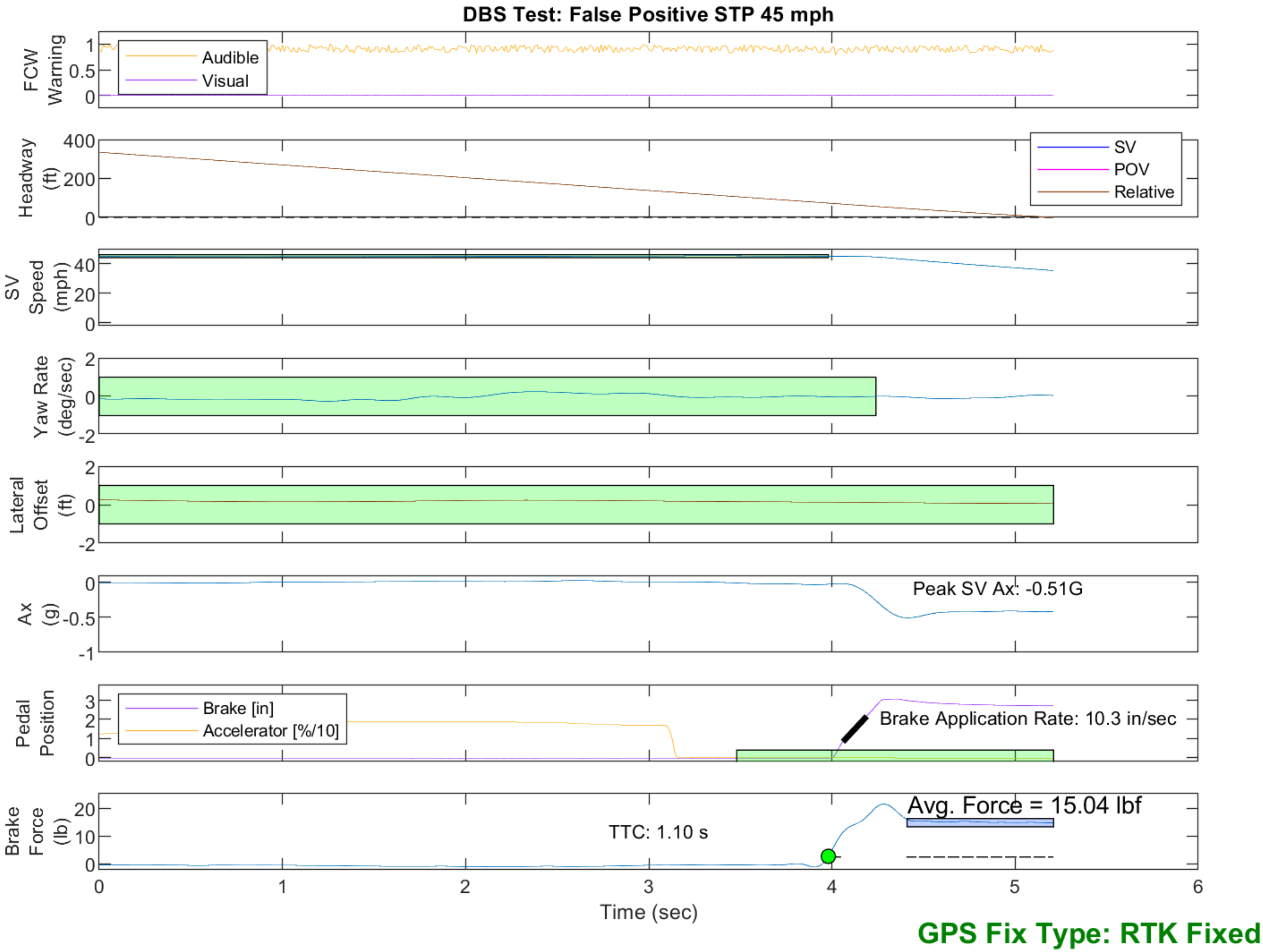


Figure E8. Example Time History for False Positive Steel Plate 45, Passing

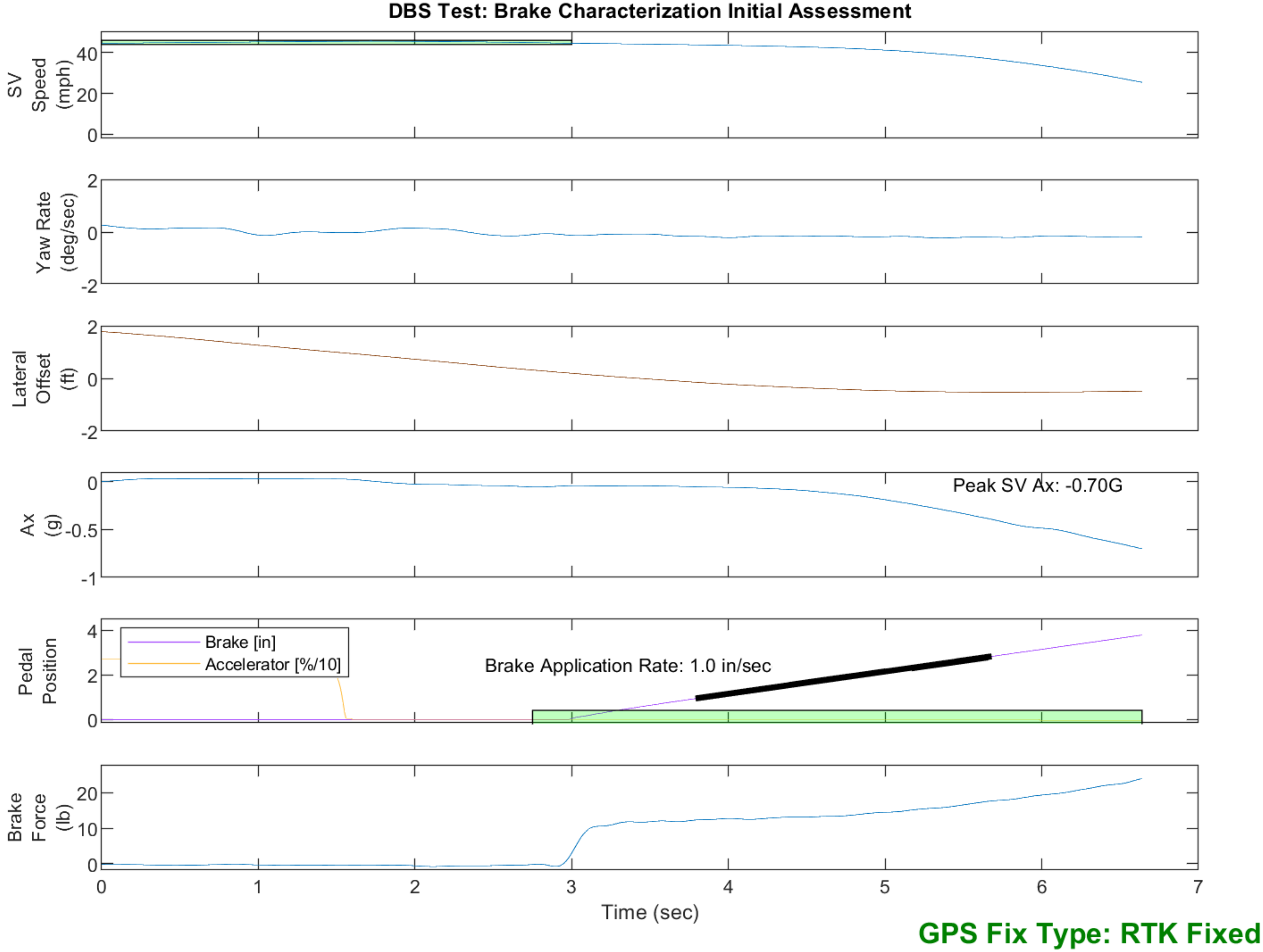


Figure E9. Example Time History for DBS Brake Characterization, Passing

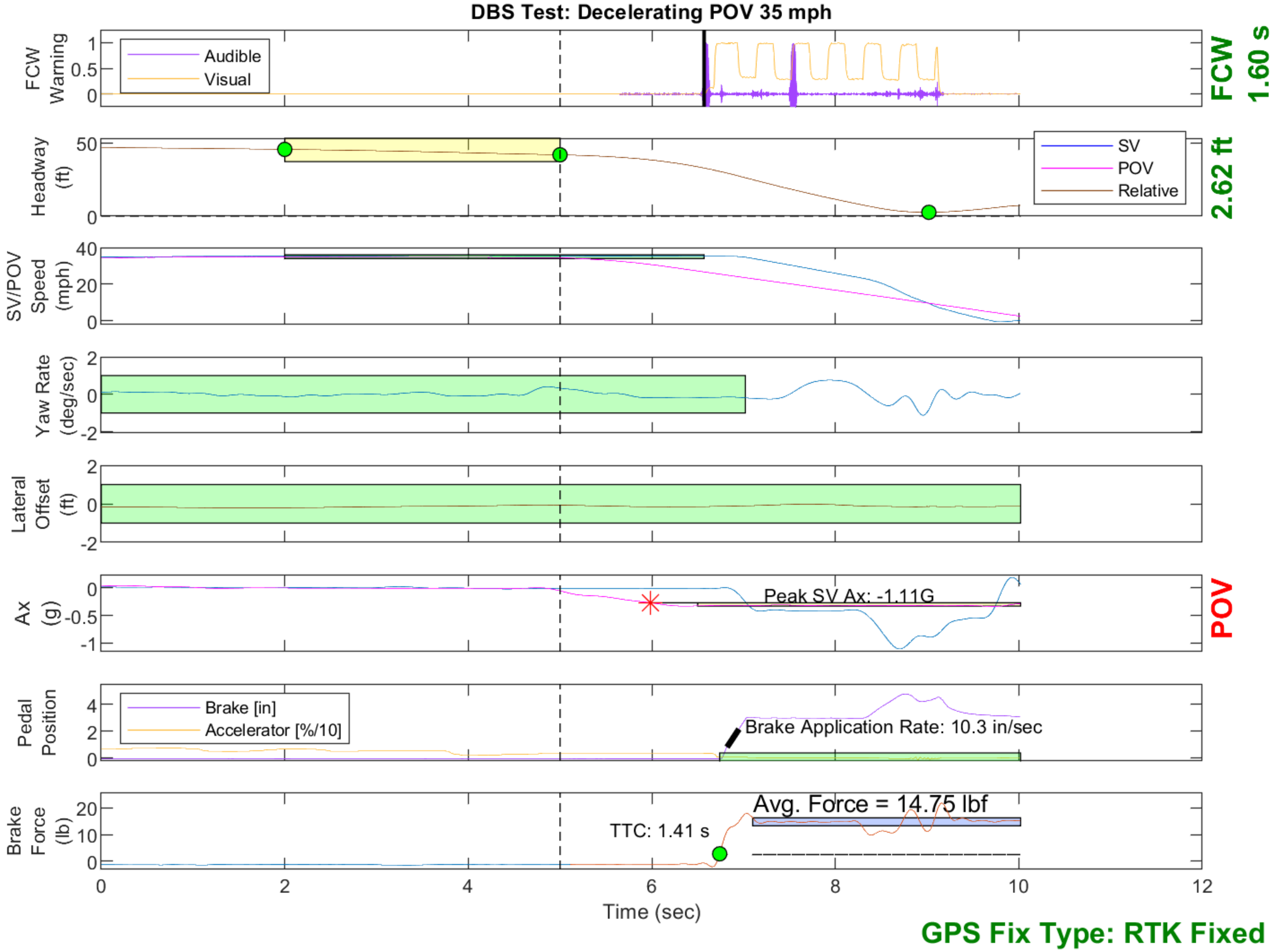


Figure E10. Example Time History Displaying Invalid POV Acceleration Criteria

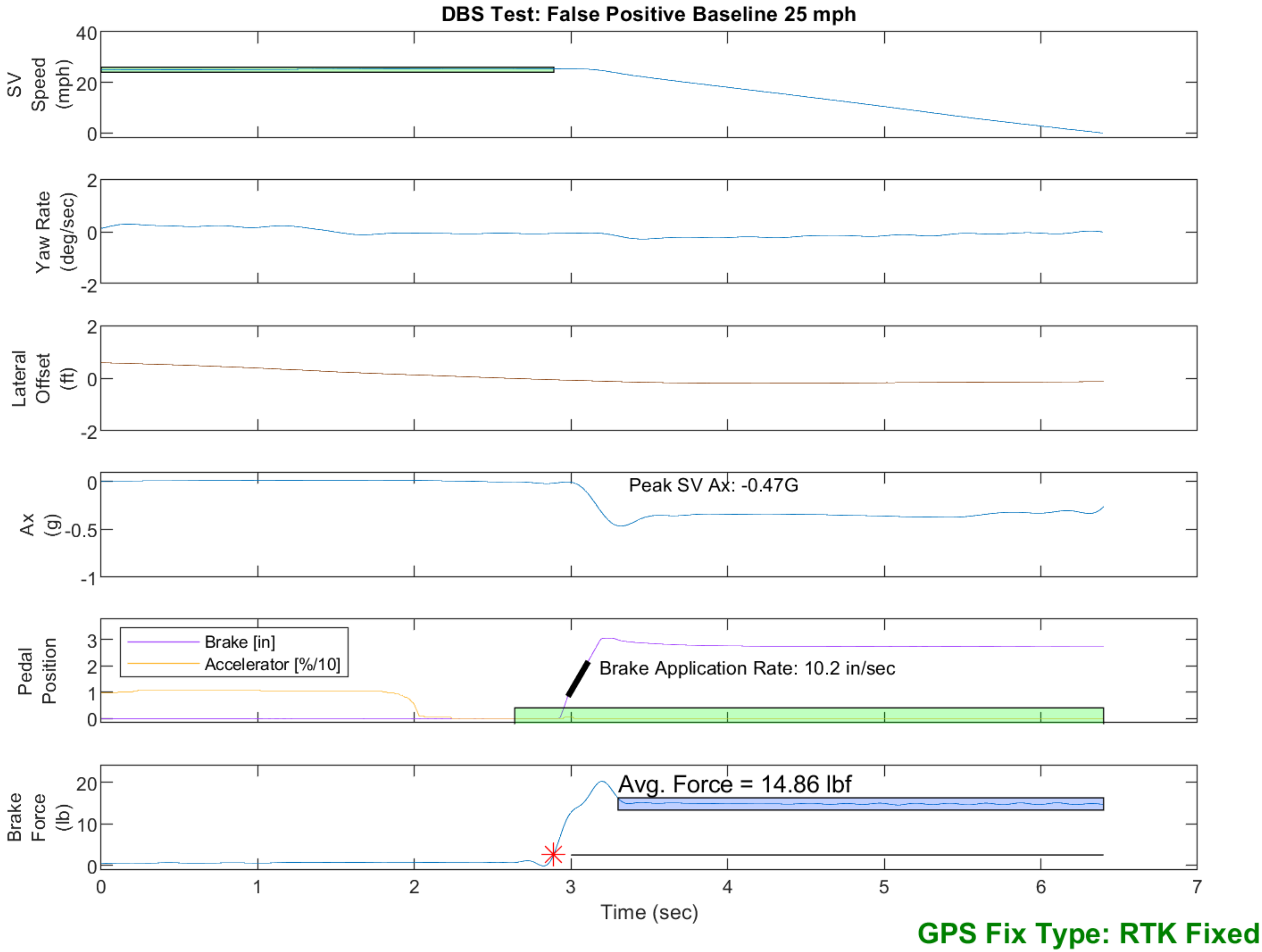


Figure E11. Example Time History Displaying Invalid Brake Force Criteria

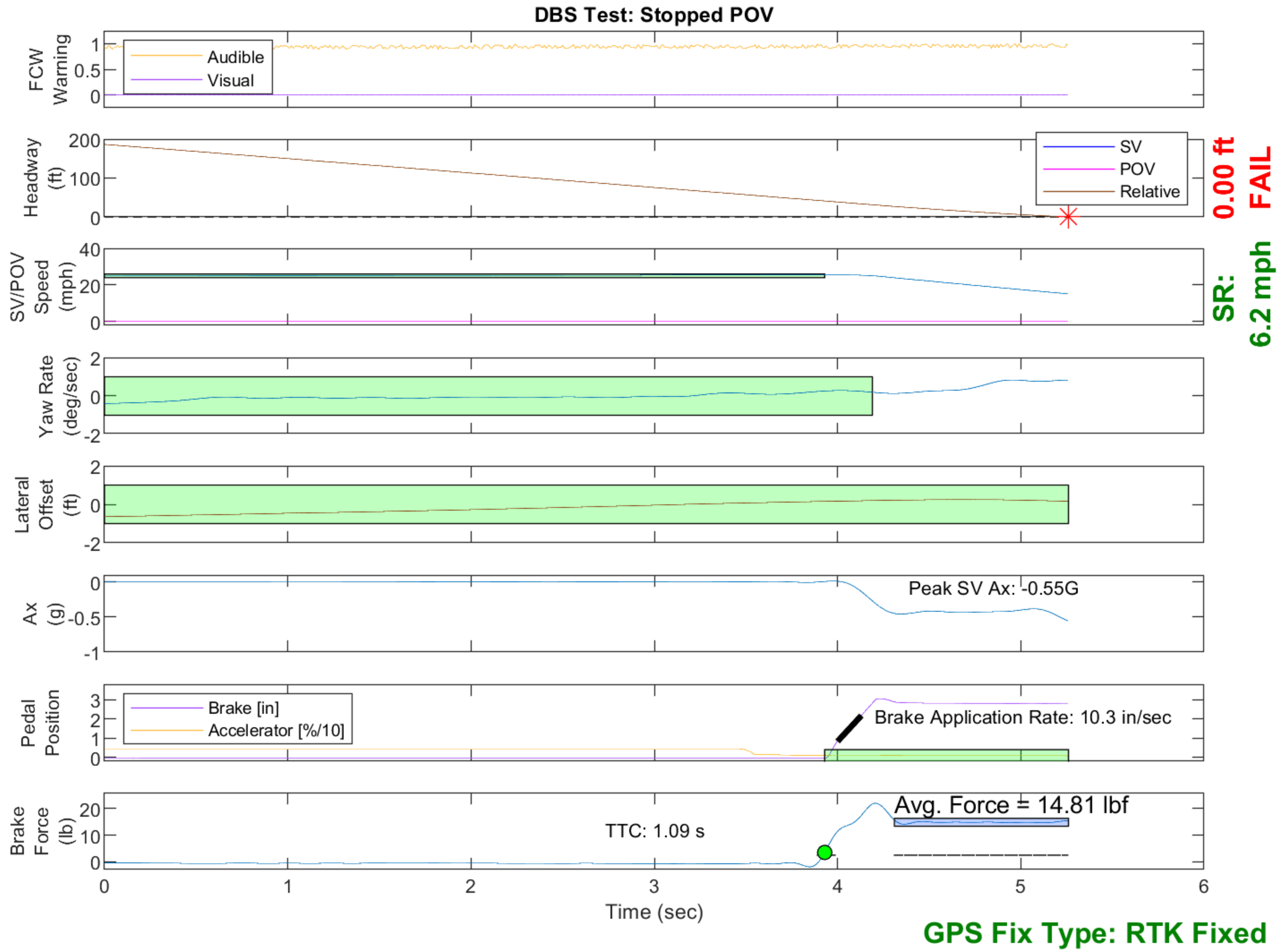


Figure E12. Example Time History for a Failed Run

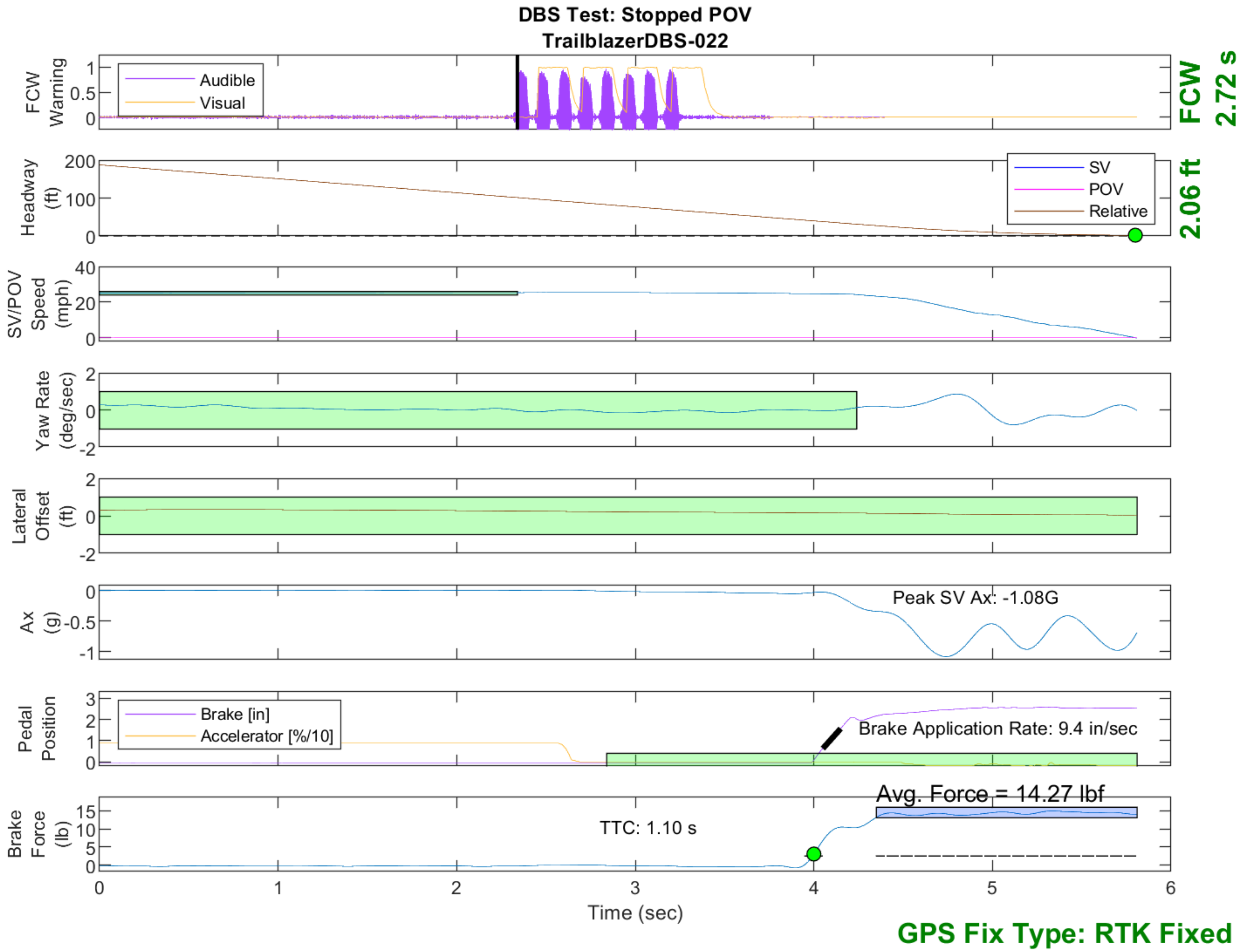


Figure E13. Time History for DBS Run 22, SV Encounters Stopped POV

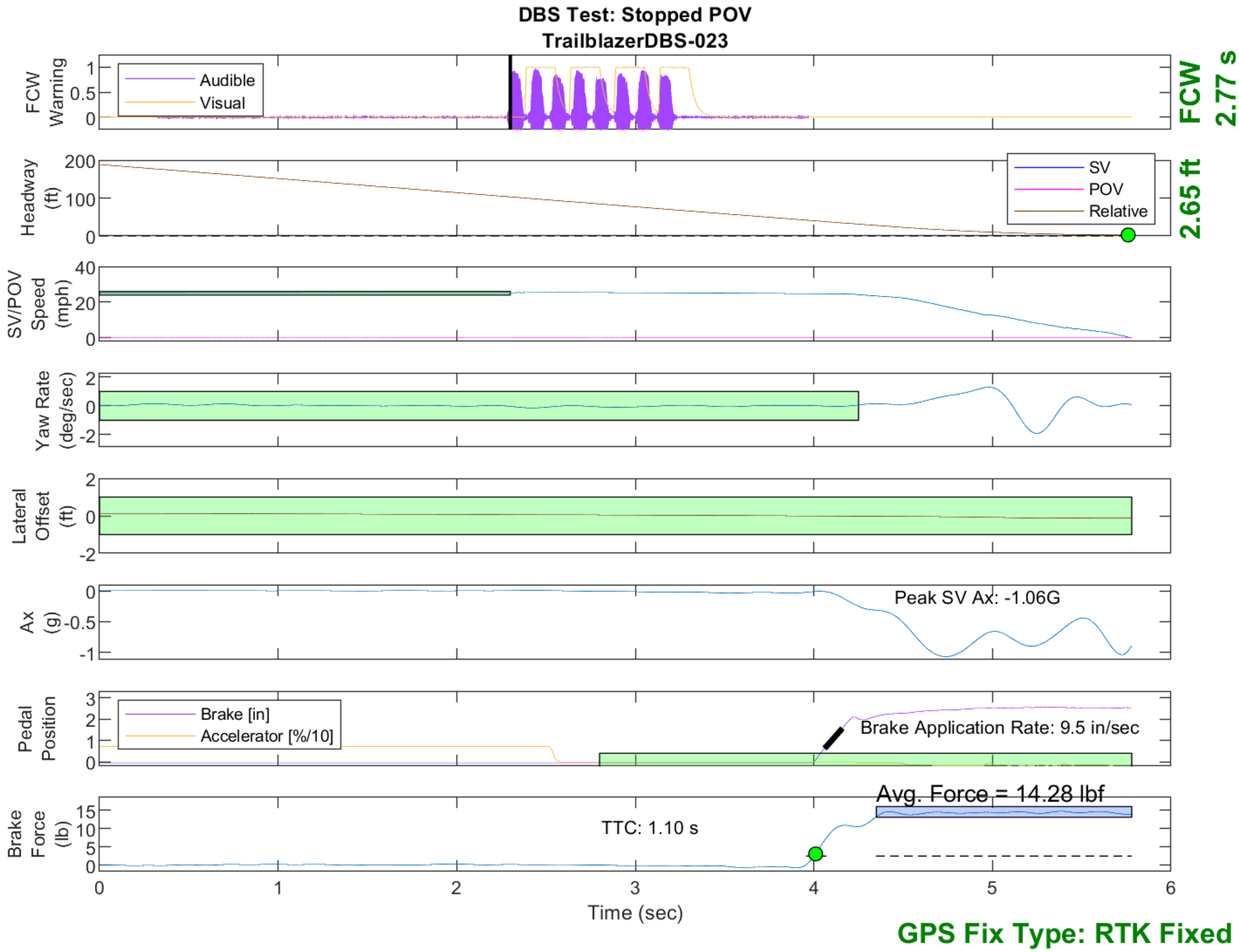


Figure E14. Time History for DBS Run 23, SV Encounters Stopped POV

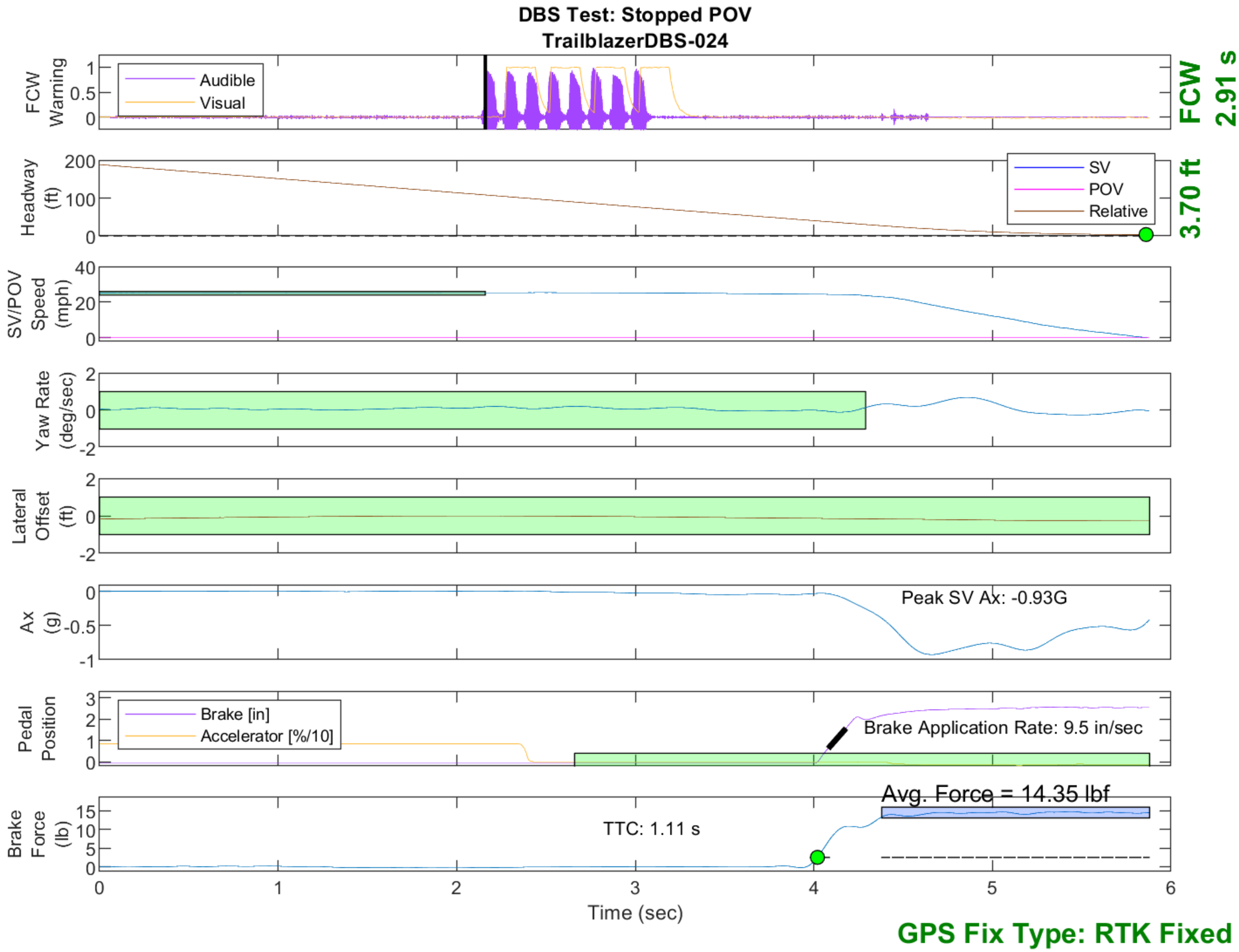


Figure E15. Time History for DBS Run 24, SV Encounters Stopped POV

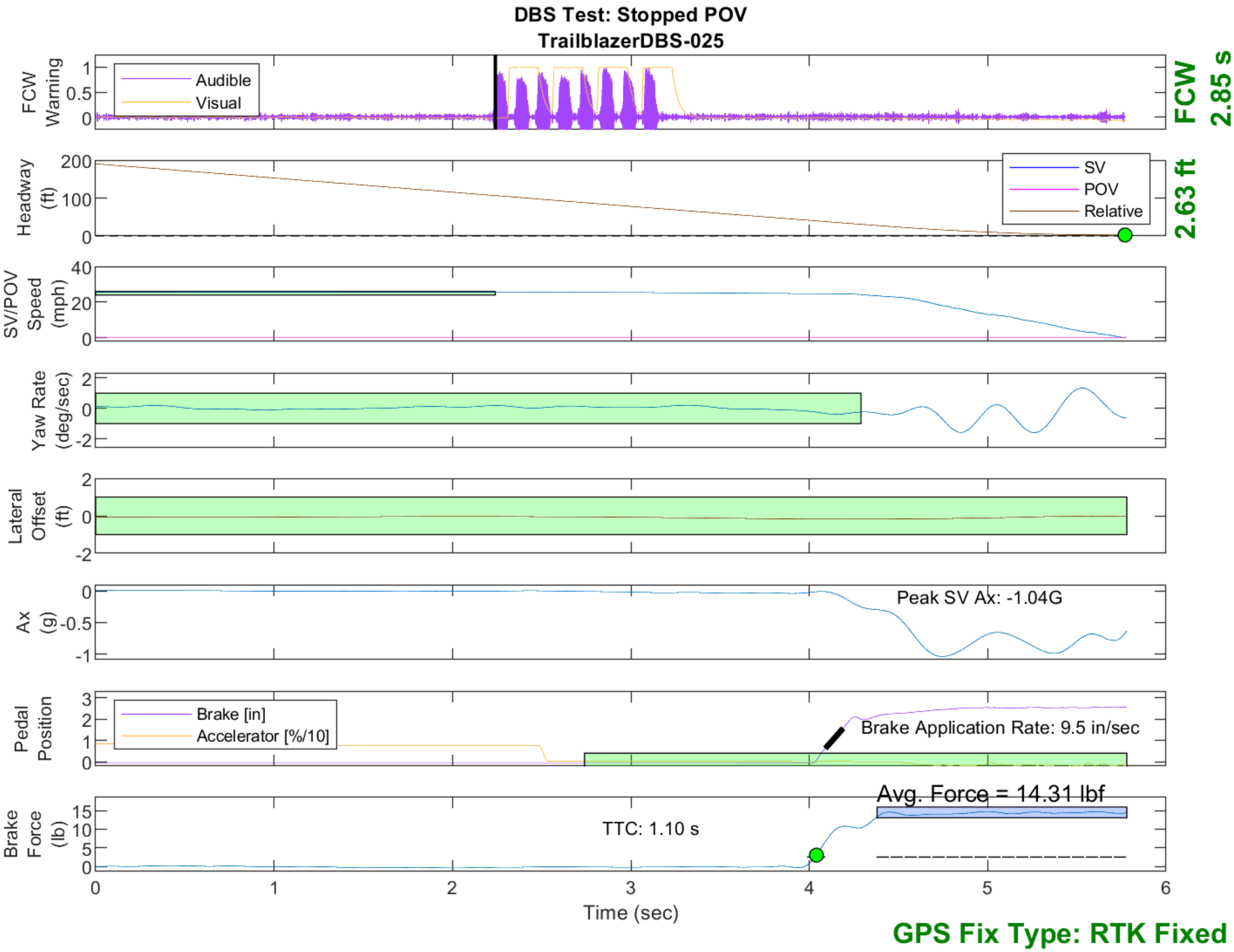


Figure E16. Time History for DBS Run 25, SV Encounters Stopped POV

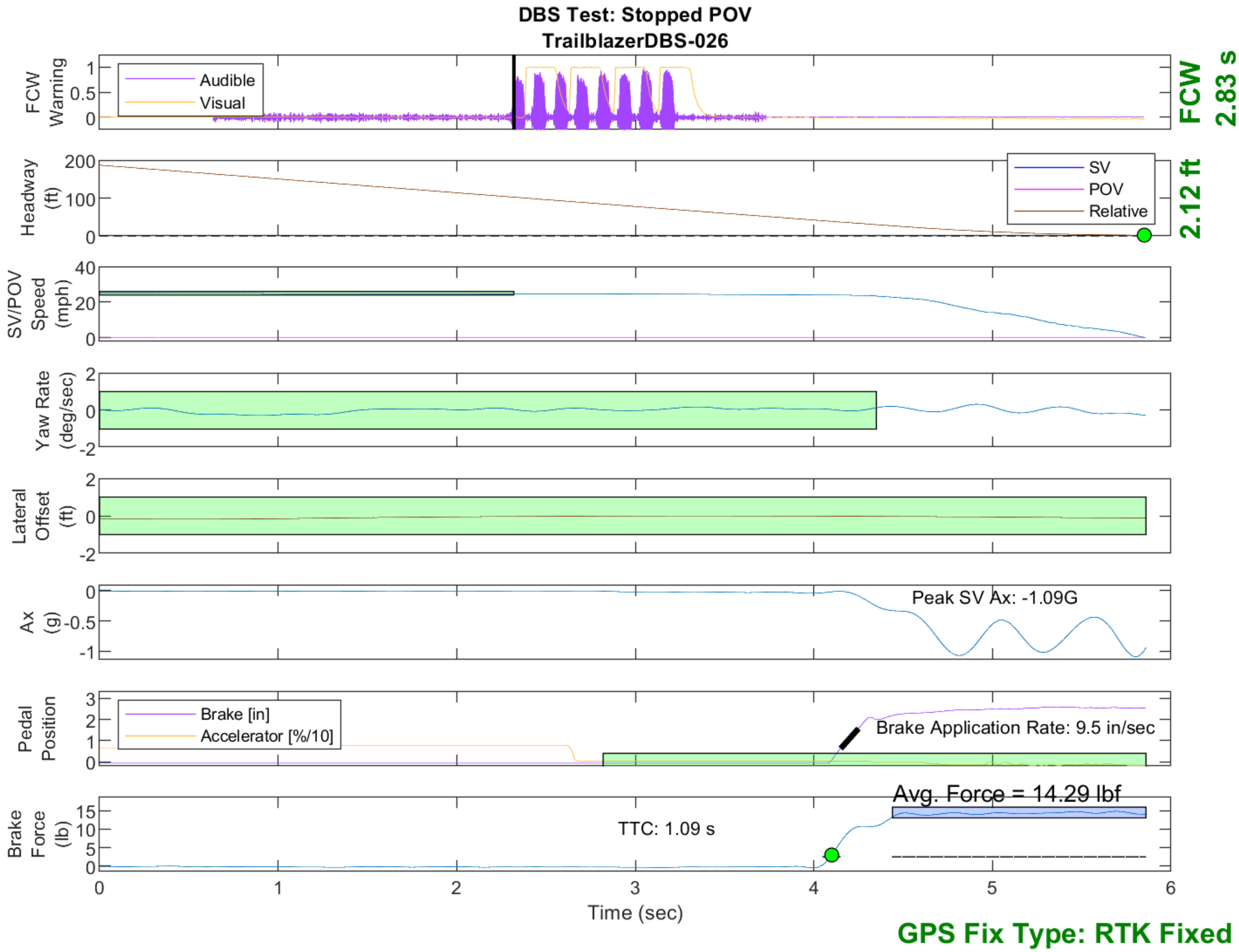


Figure E17. Time History for DBS Run 26, SV Encounters Stopped POV

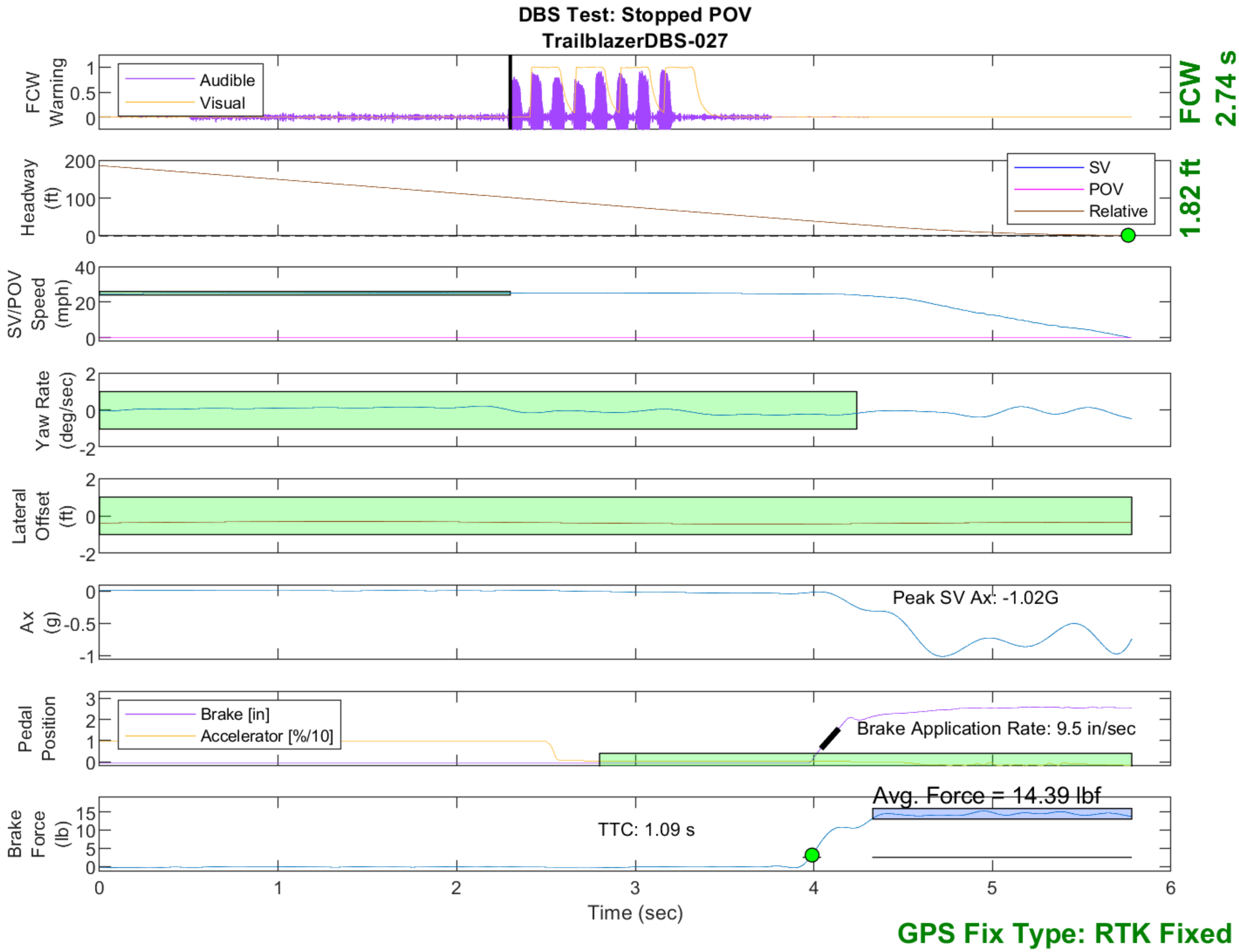


Figure E18. Time History for DBS Run 27, SV Encounters Stopped POV

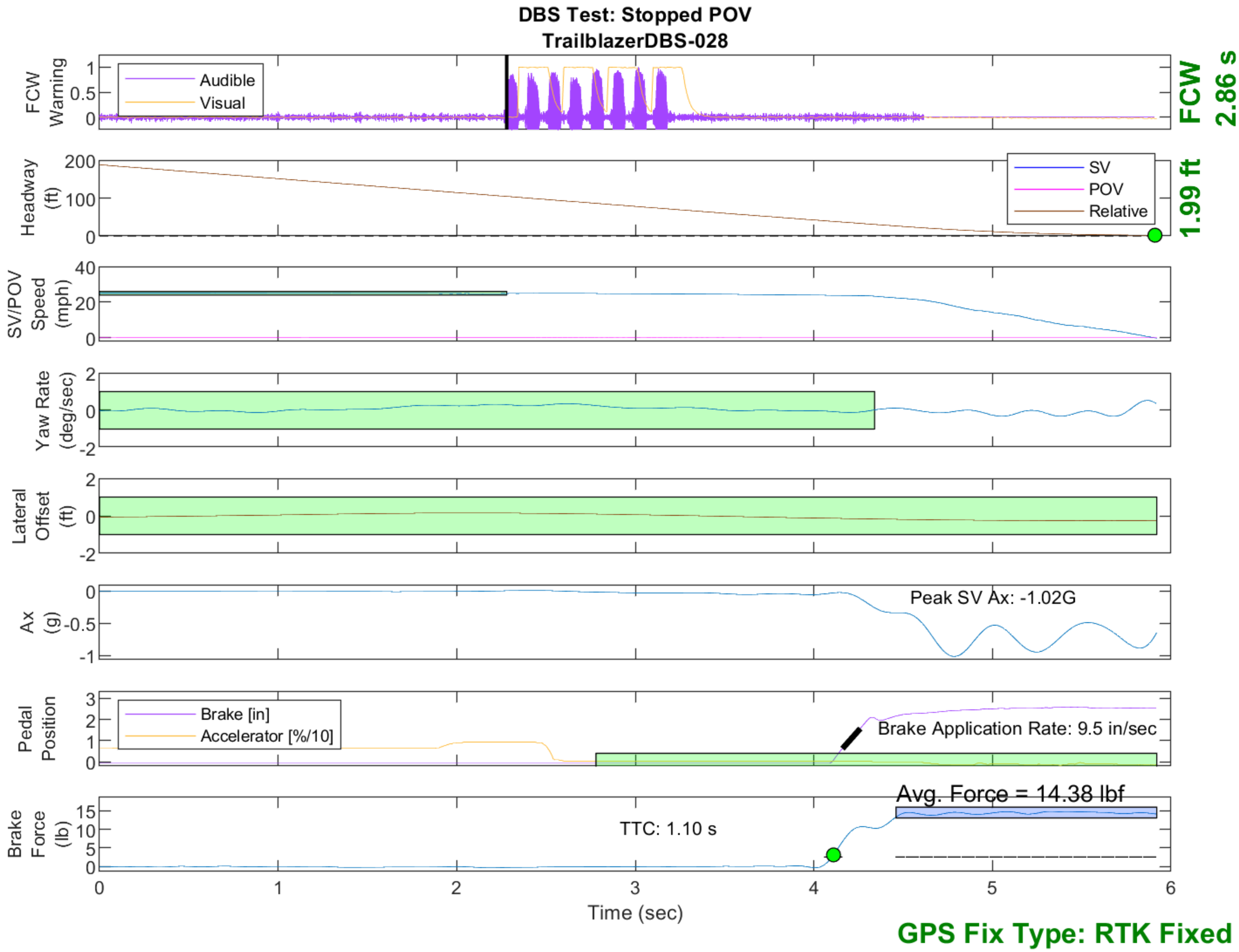


Figure E19. Time History for DBS Run 28, SV Encounters Stopped POV

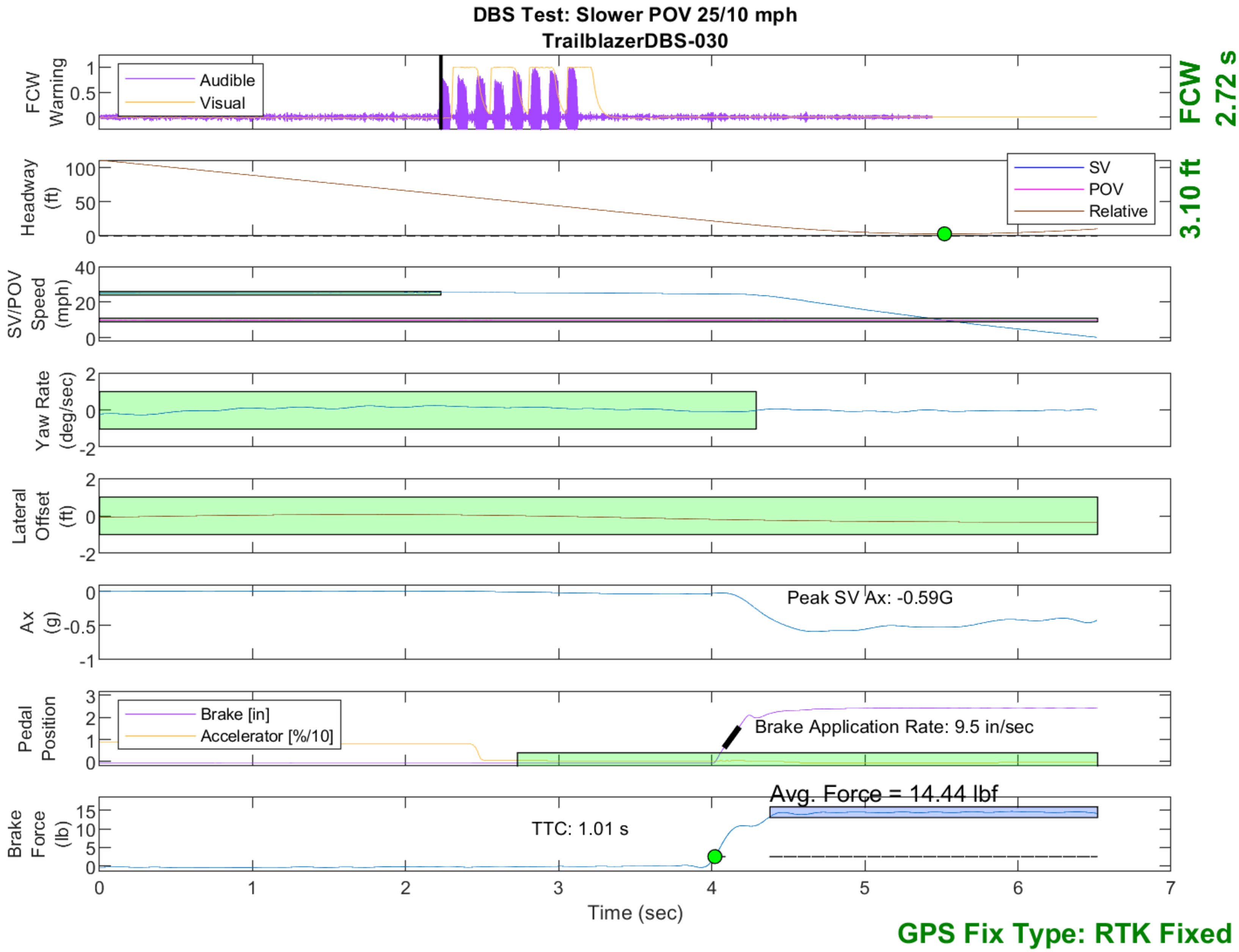


Figure E20. Time History for DBS Run 30, SV Encounters Slower POV, SV 25 mph, POV 10 mph

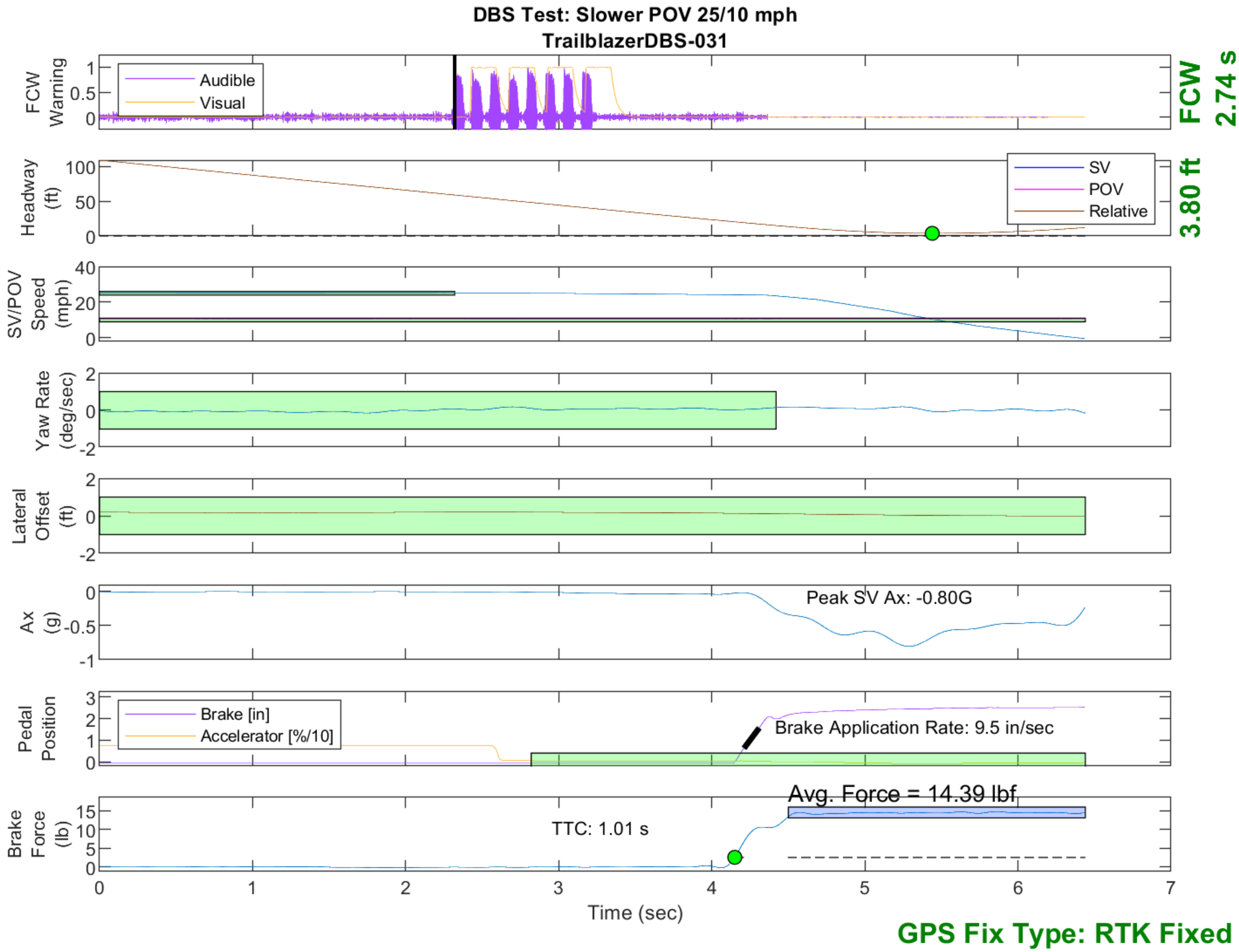


Figure E21. Time History for DBS Run 31, SV Encounters Slower POV, SV 25 mph, POV 10 mph

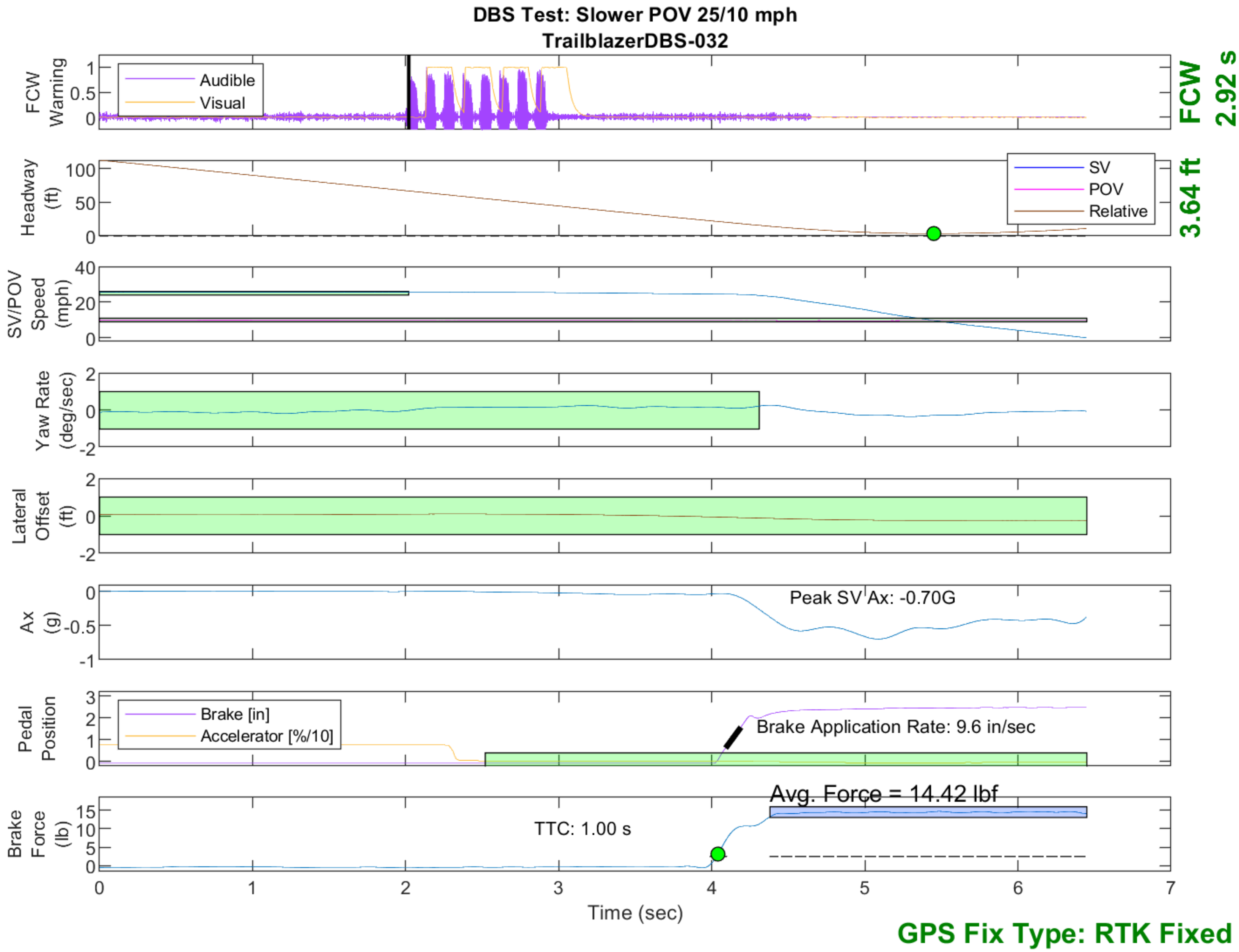


Figure E22. Time History for DBS Run 32, SV Encounters Slower POV, SV 25 mph, POV 10 mph

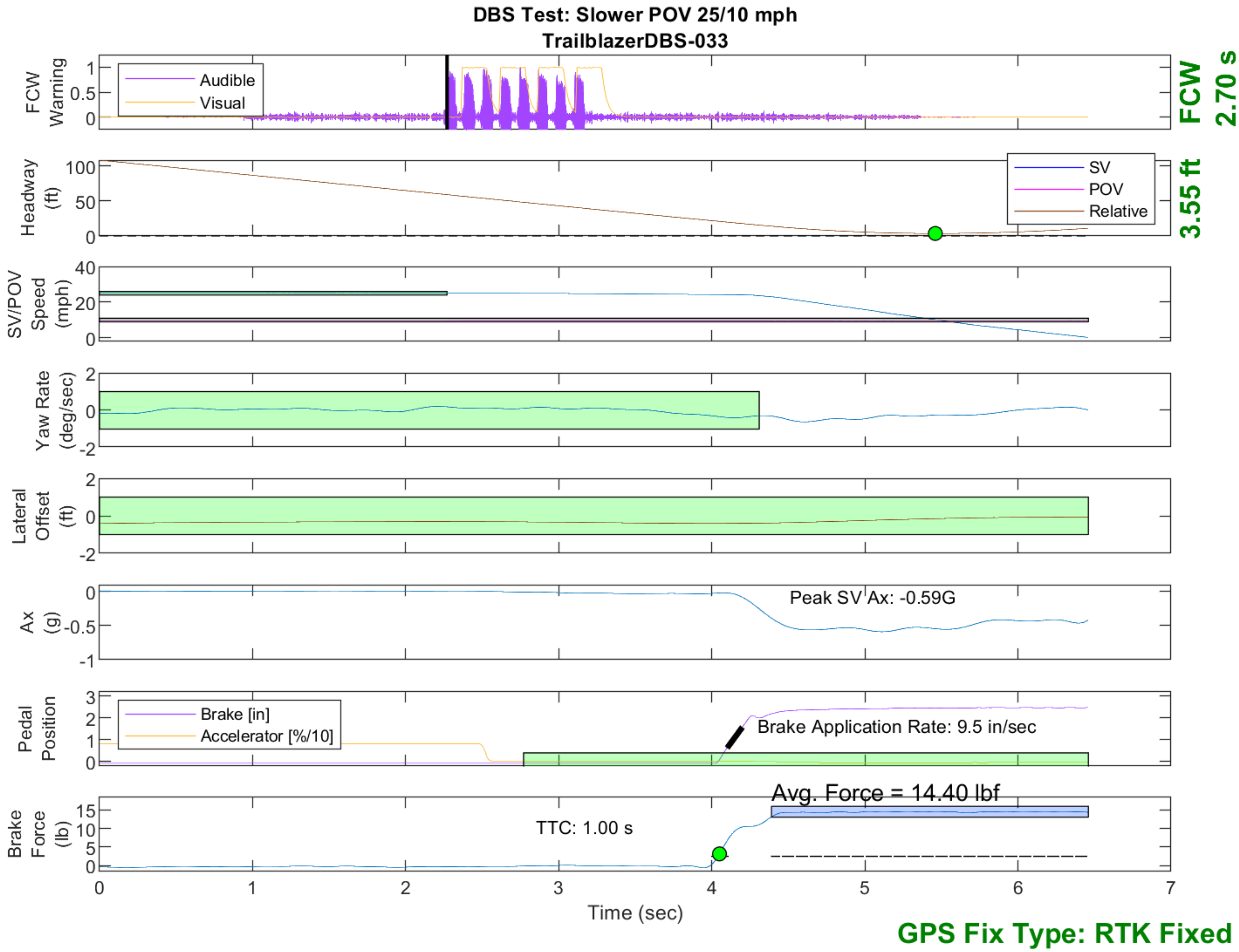


Figure E23. Time History for DBS Run 33, SV Encounters Slower POV, SV 25 mph, POV 10 mph

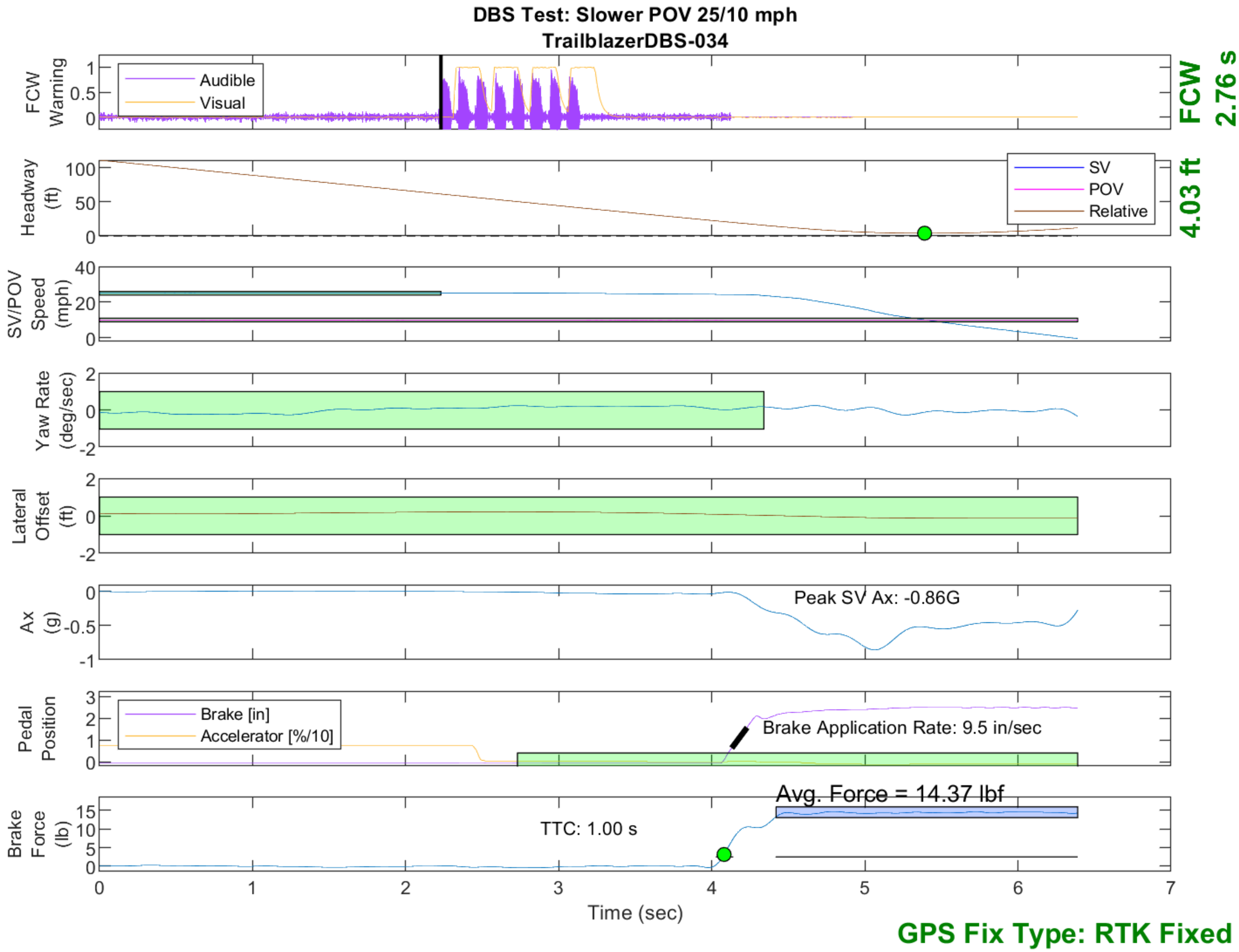


Figure E24. Time History for DBS Run 34, SV Encounters Slower POV, SV 25 mph, POV 10 mph

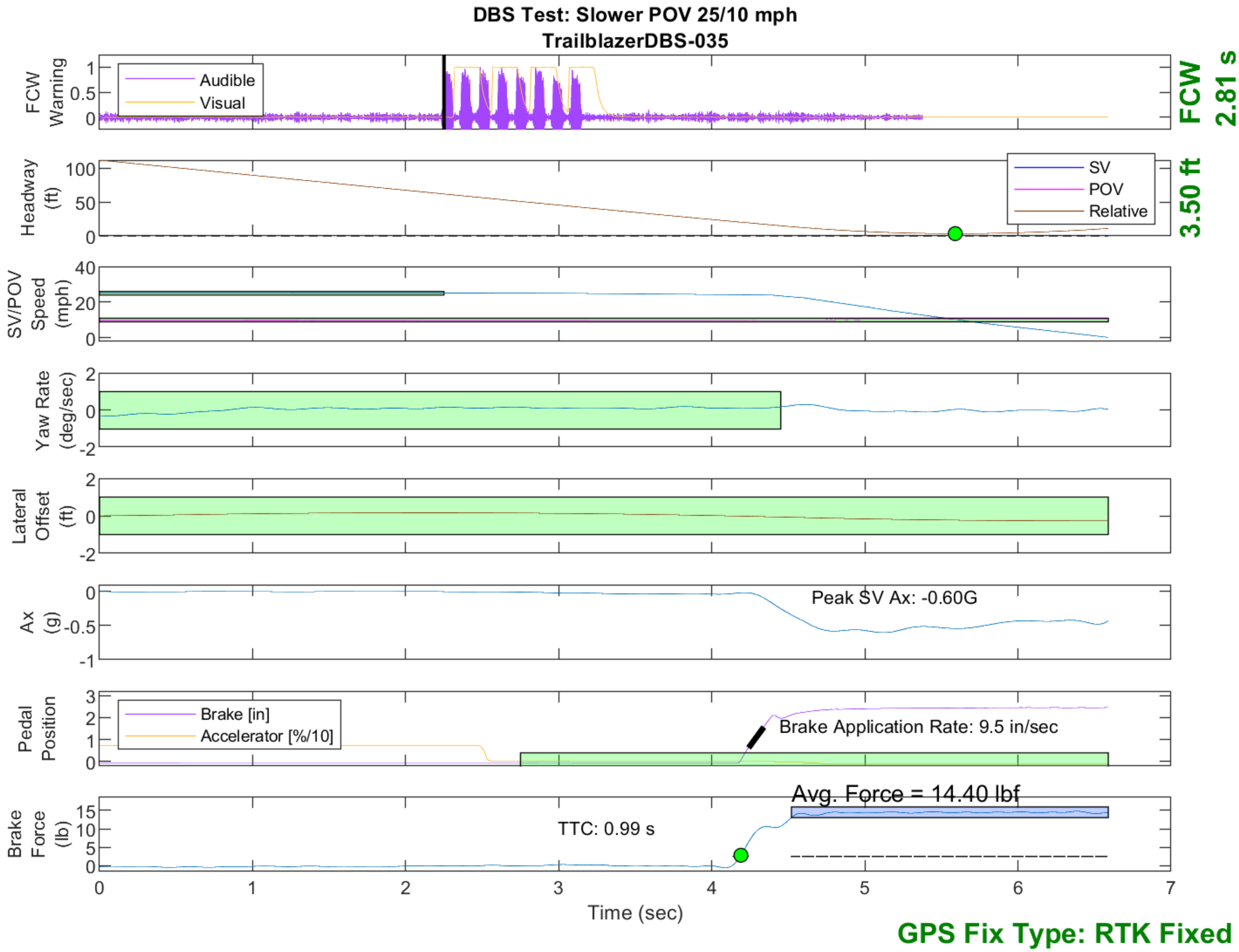


Figure E25. Time History for DBS Run 35, SV Encounters Slower POV, SV 25 mph, POV 10 mph

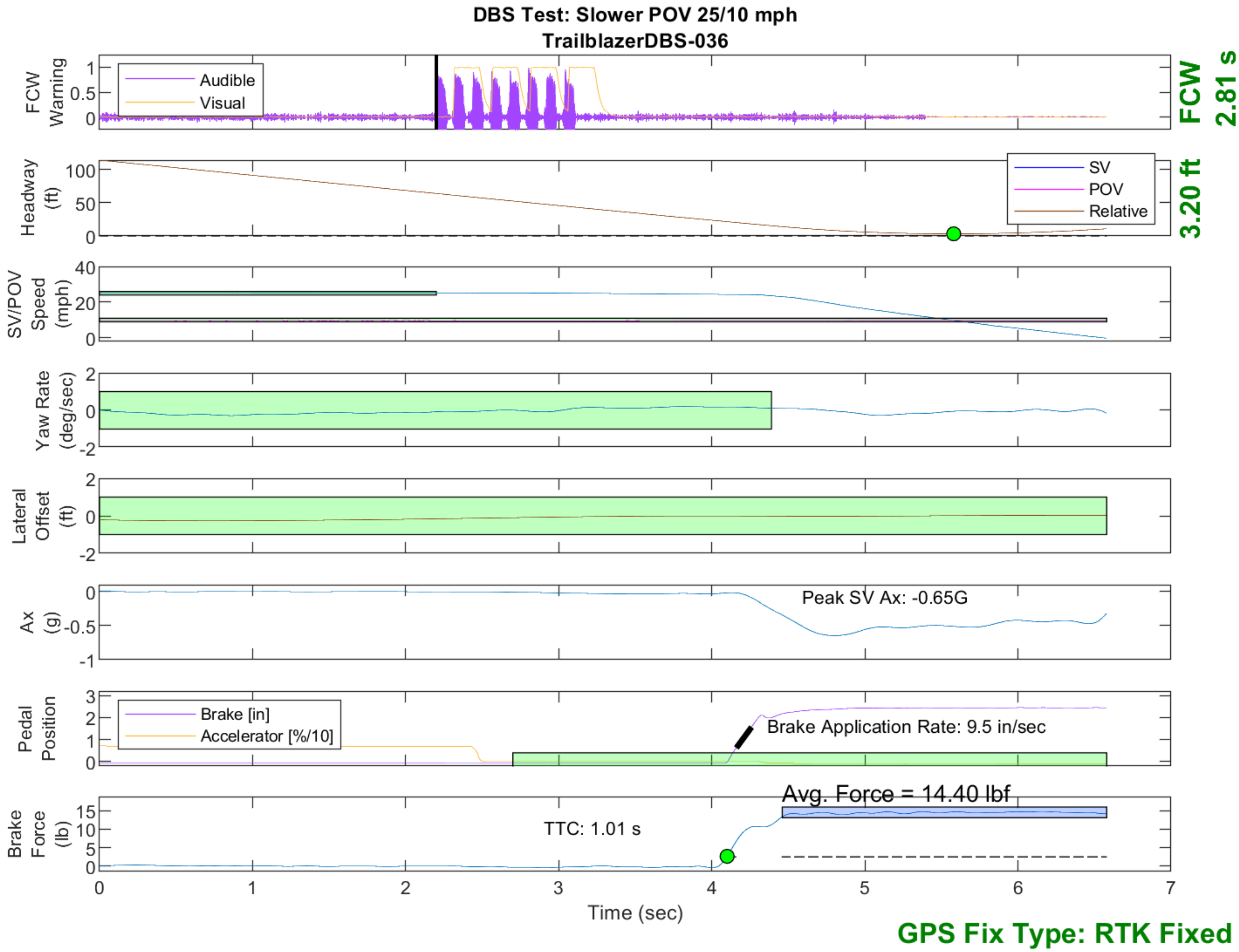


Figure E26. Time History for DBS Run 36, SV Encounters Slower POV, SV 25 mph, POV 10 mph

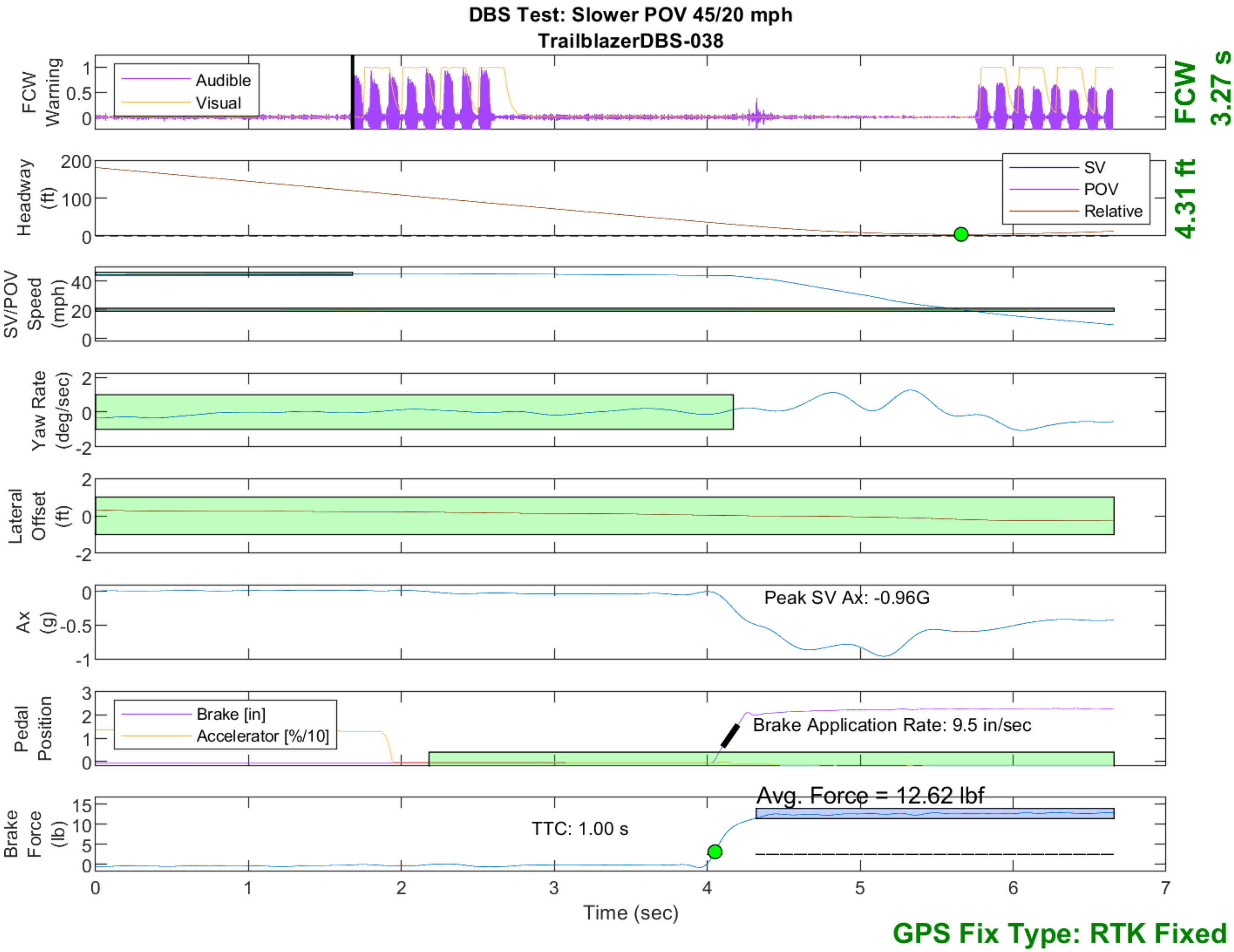


Figure E27. Time History for DBS Run 38, SV Encounters Slower POV, SV 45 mph, POV 20 mph

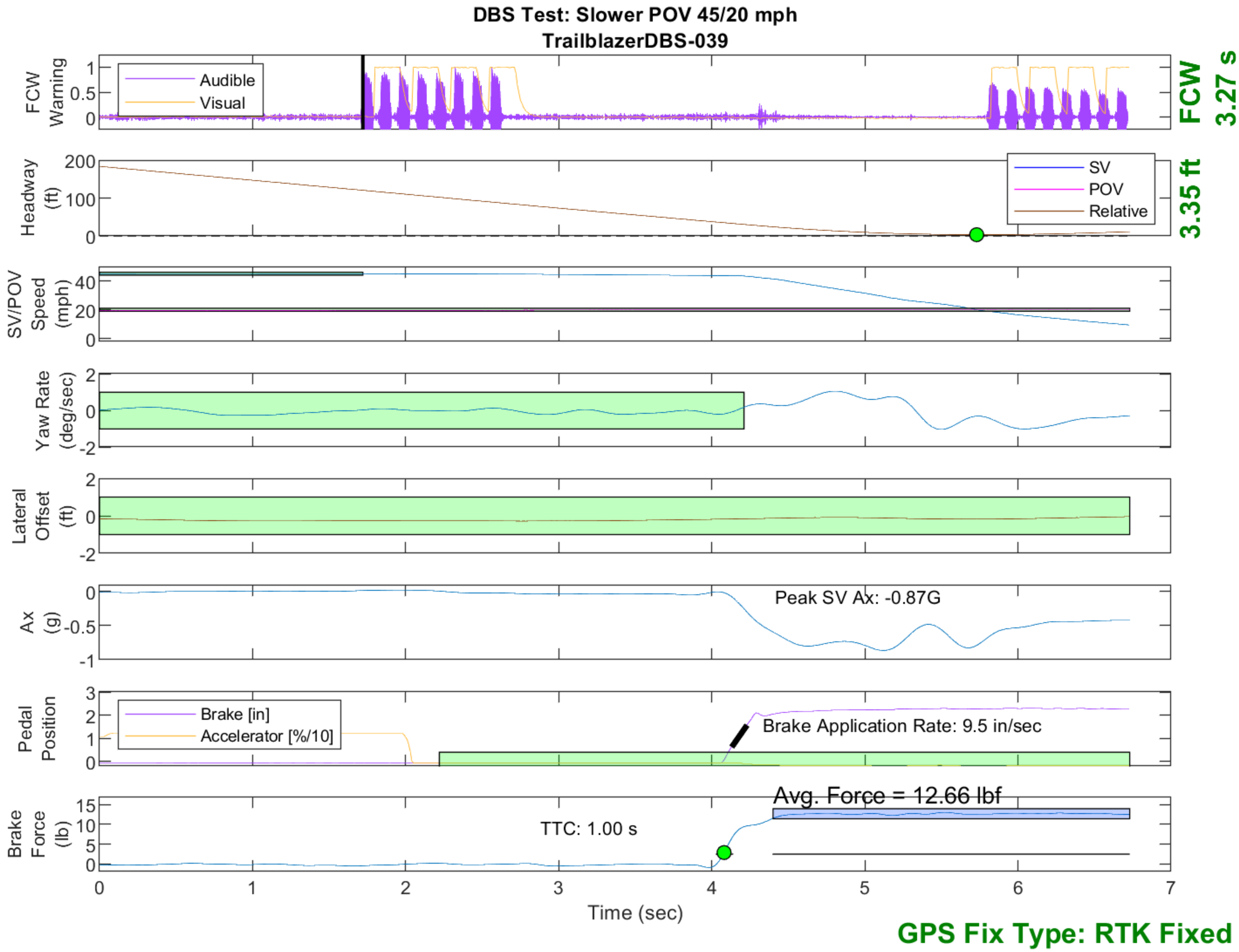


Figure E28. Time History for DBS Run 39, SV Encounters Slower POV, SV 45 mph, POV 20 mph

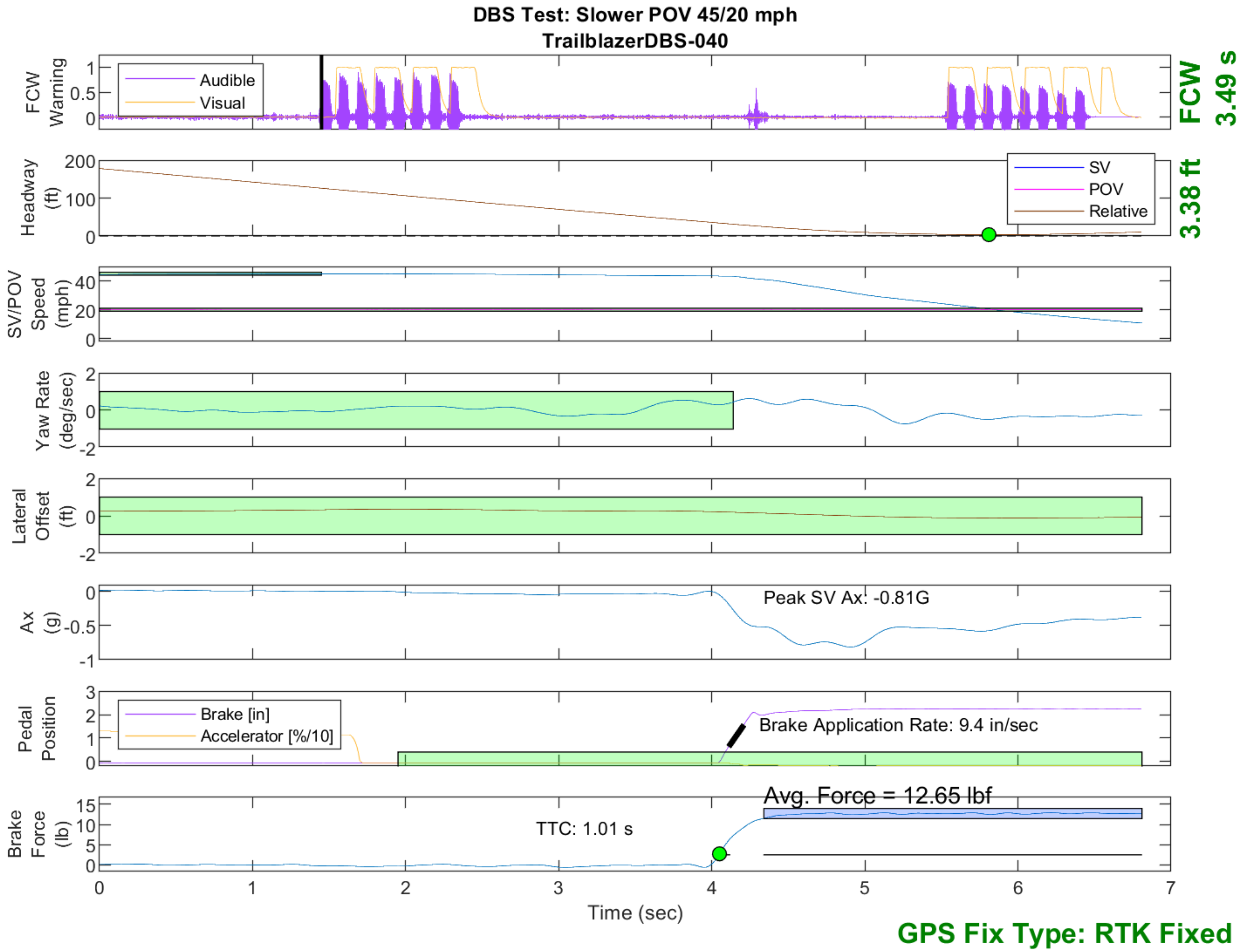


Figure E29. Time History for DBS Run 40, SV Encounters Slower POV, SV 45 mph, POV 20 mph

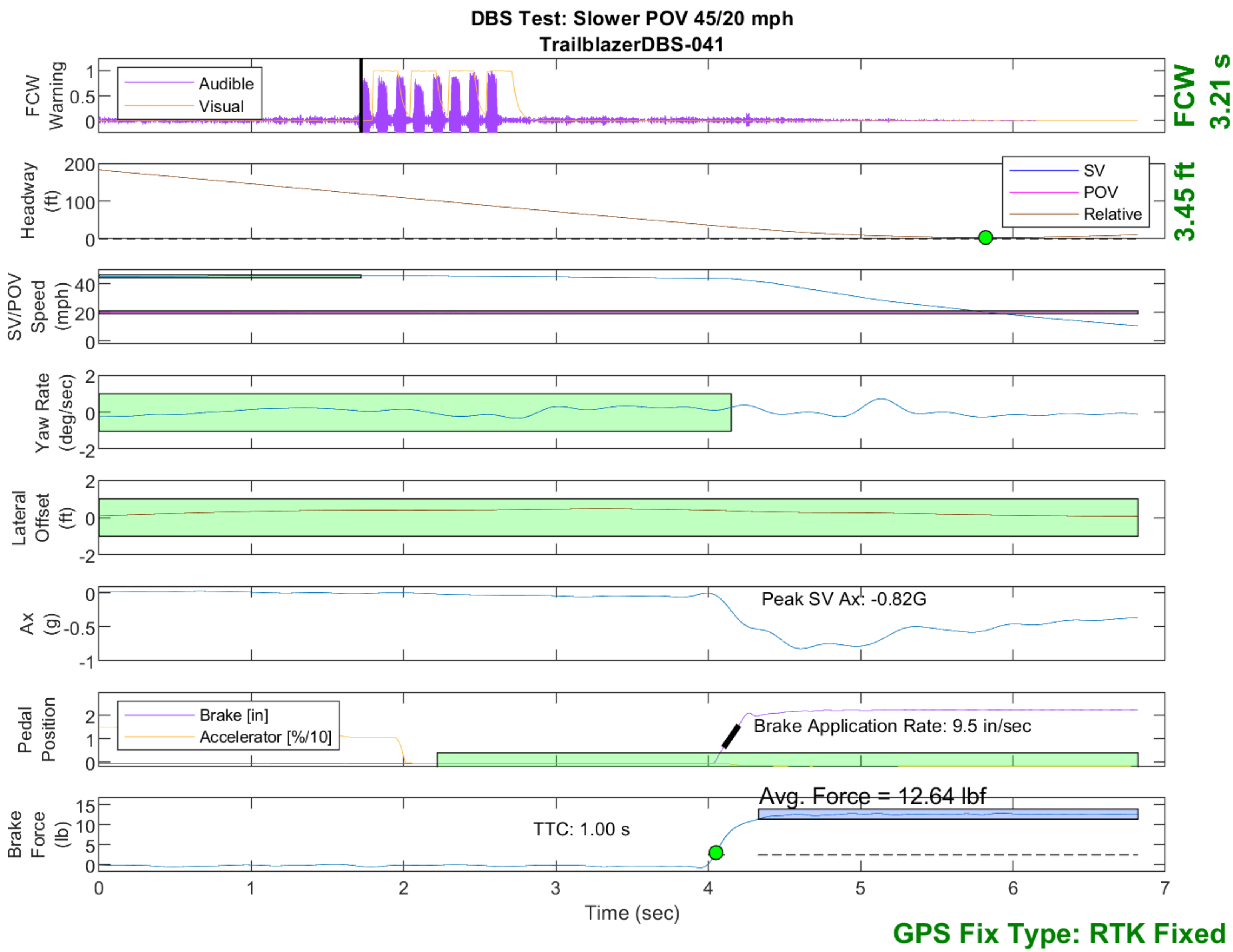


Figure E30. Time History for DBS Run 41, SV Encounters Slower POV, SV 45 mph, POV 20 mph

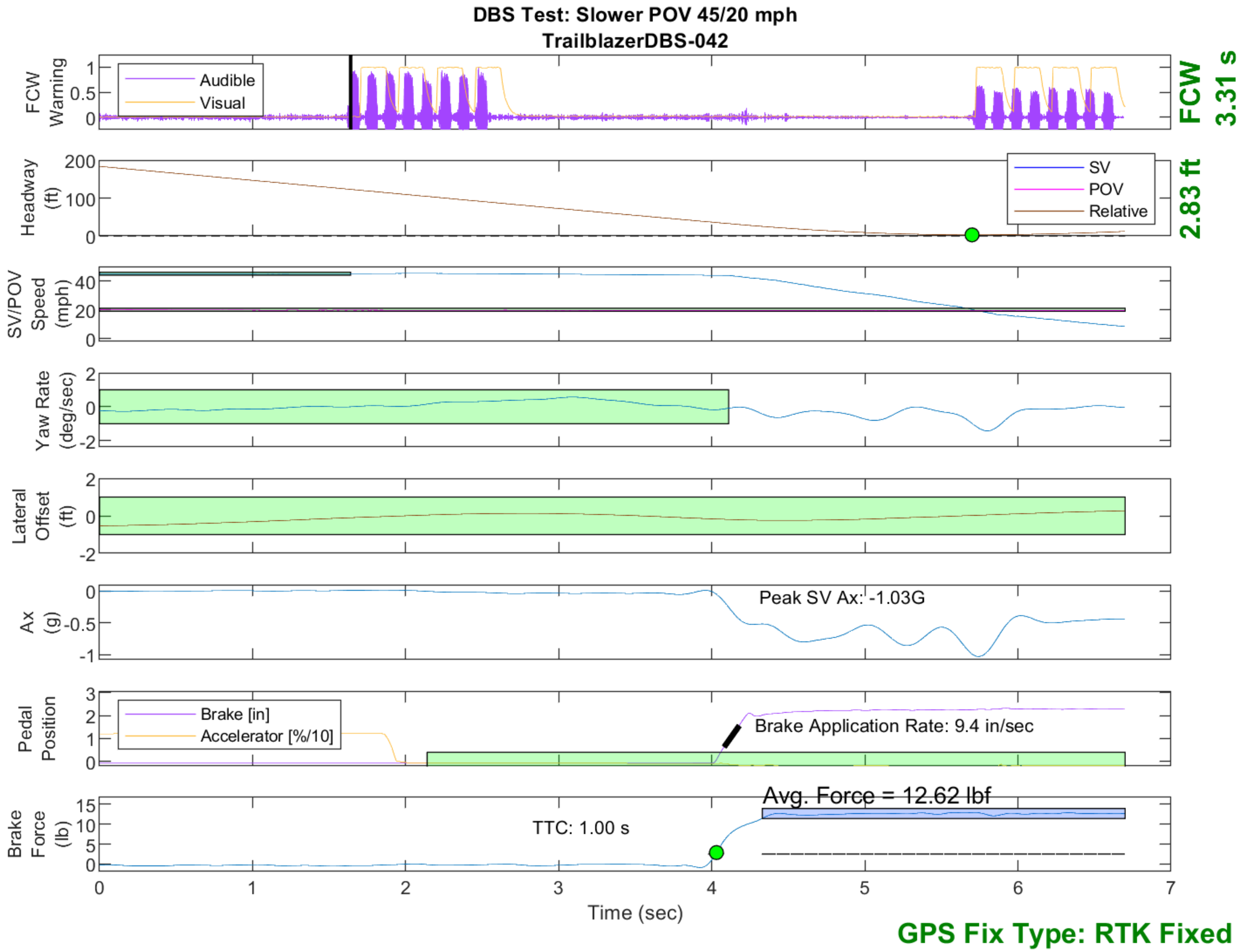


Figure E31. Time History for DBS Run 42, SV Encounters Slower POV, SV 45 mph, POV 20 mph

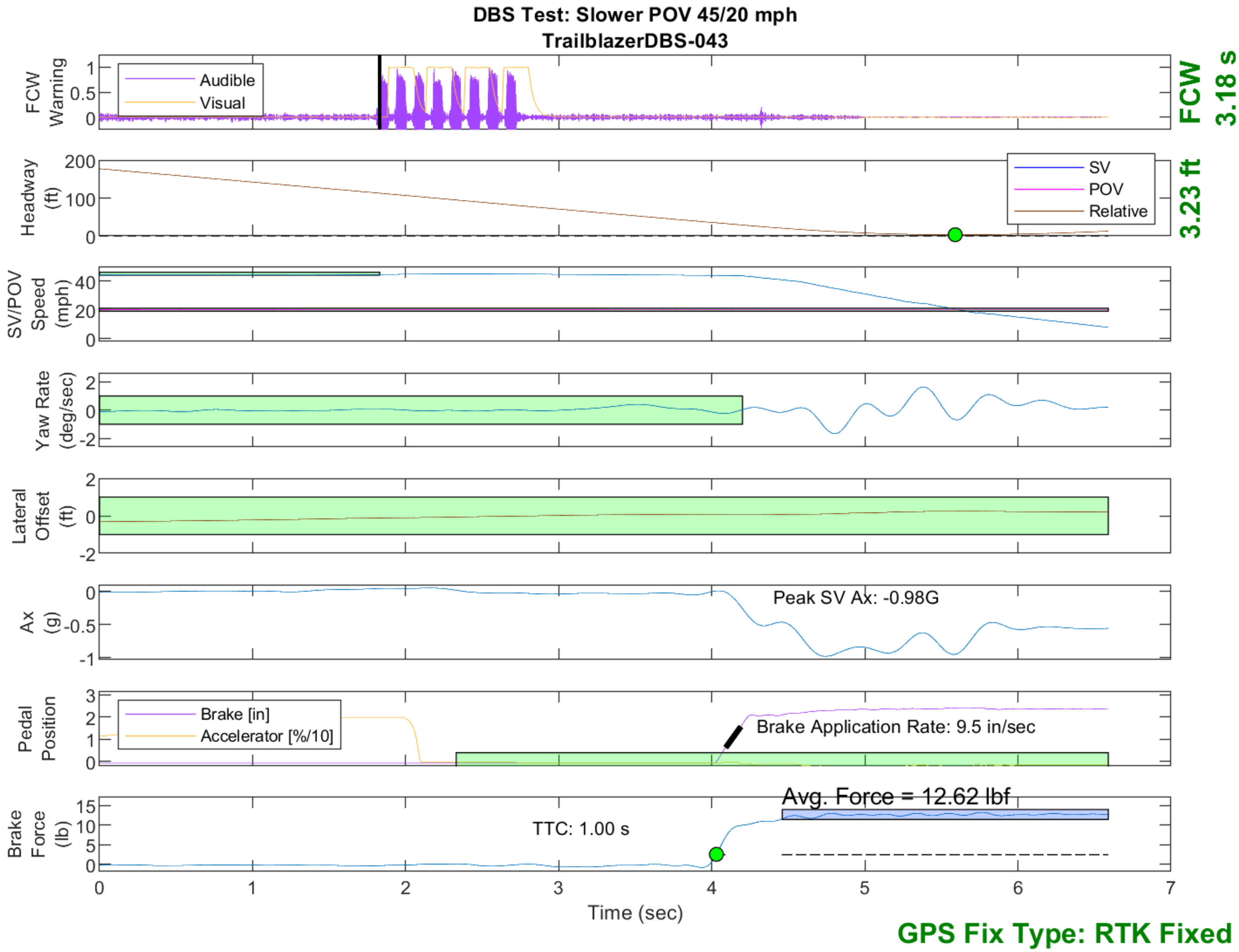


Figure E32. Time History for DBS Run 43, SV Encounters Slower POV, SV 45 mph, POV 20 mph

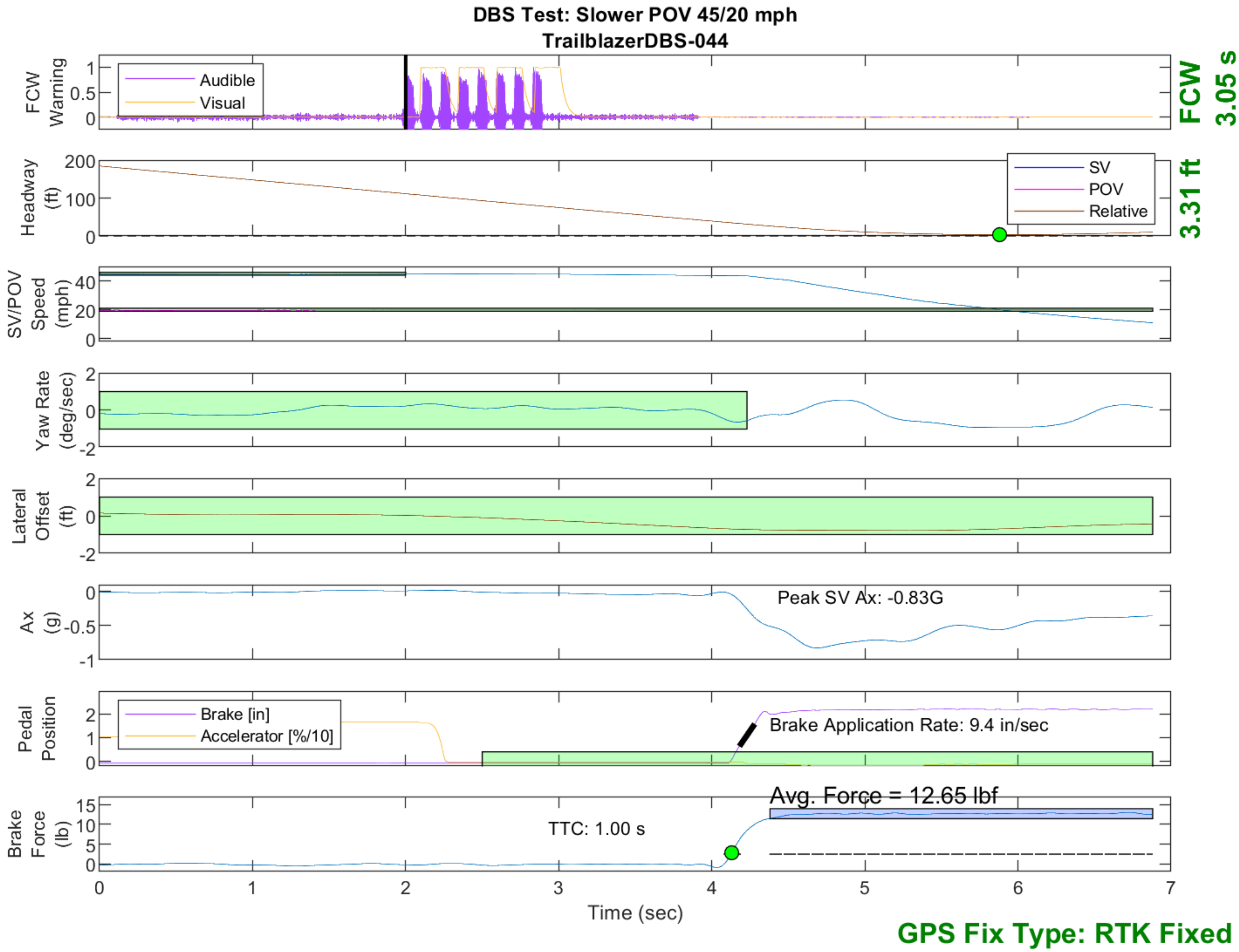


Figure E33. Time History for DBS Run 44, SV Encounters Slower POV, SV 45 mph, POV 20 mph

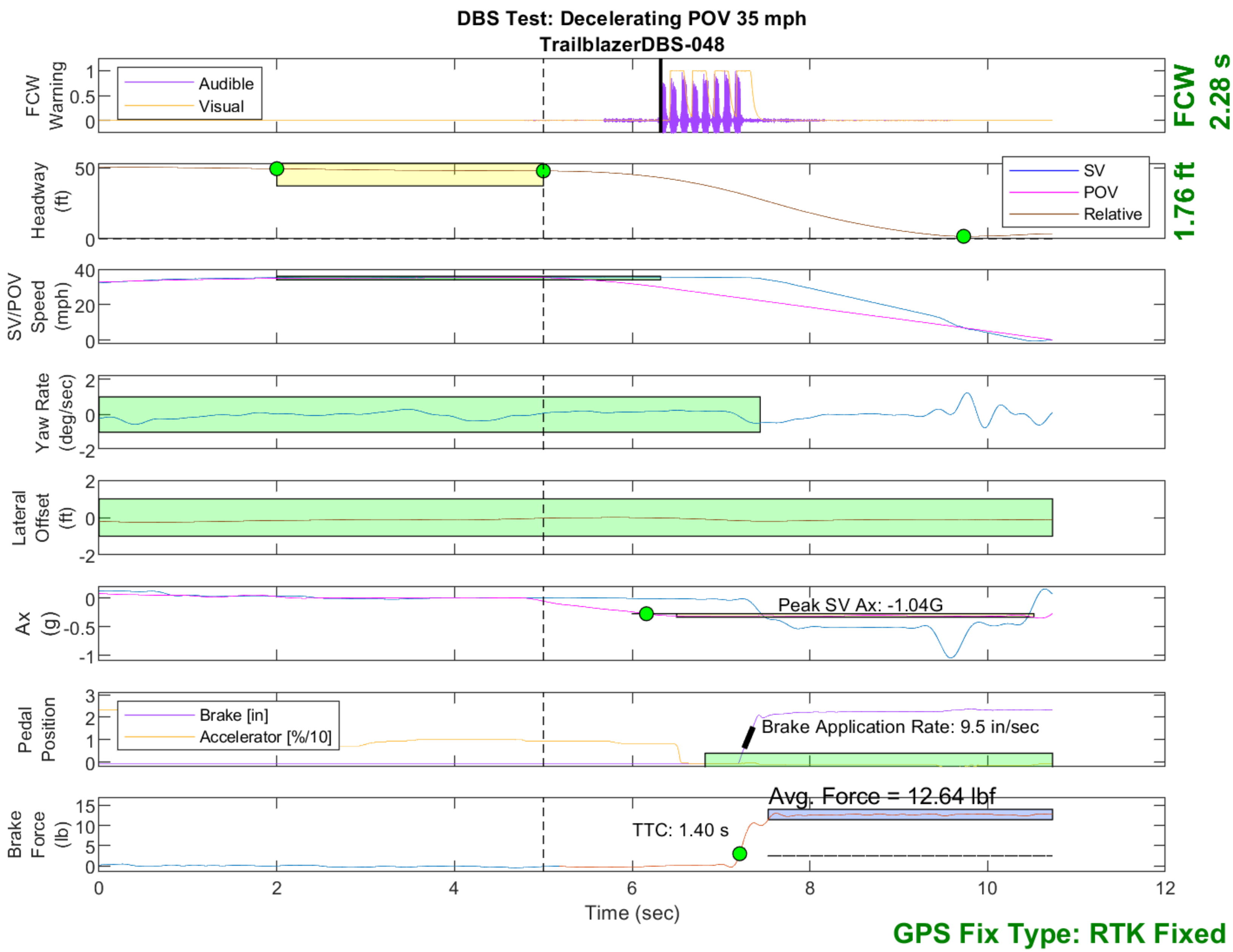


Figure E34. Time History for DBS Run 48, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

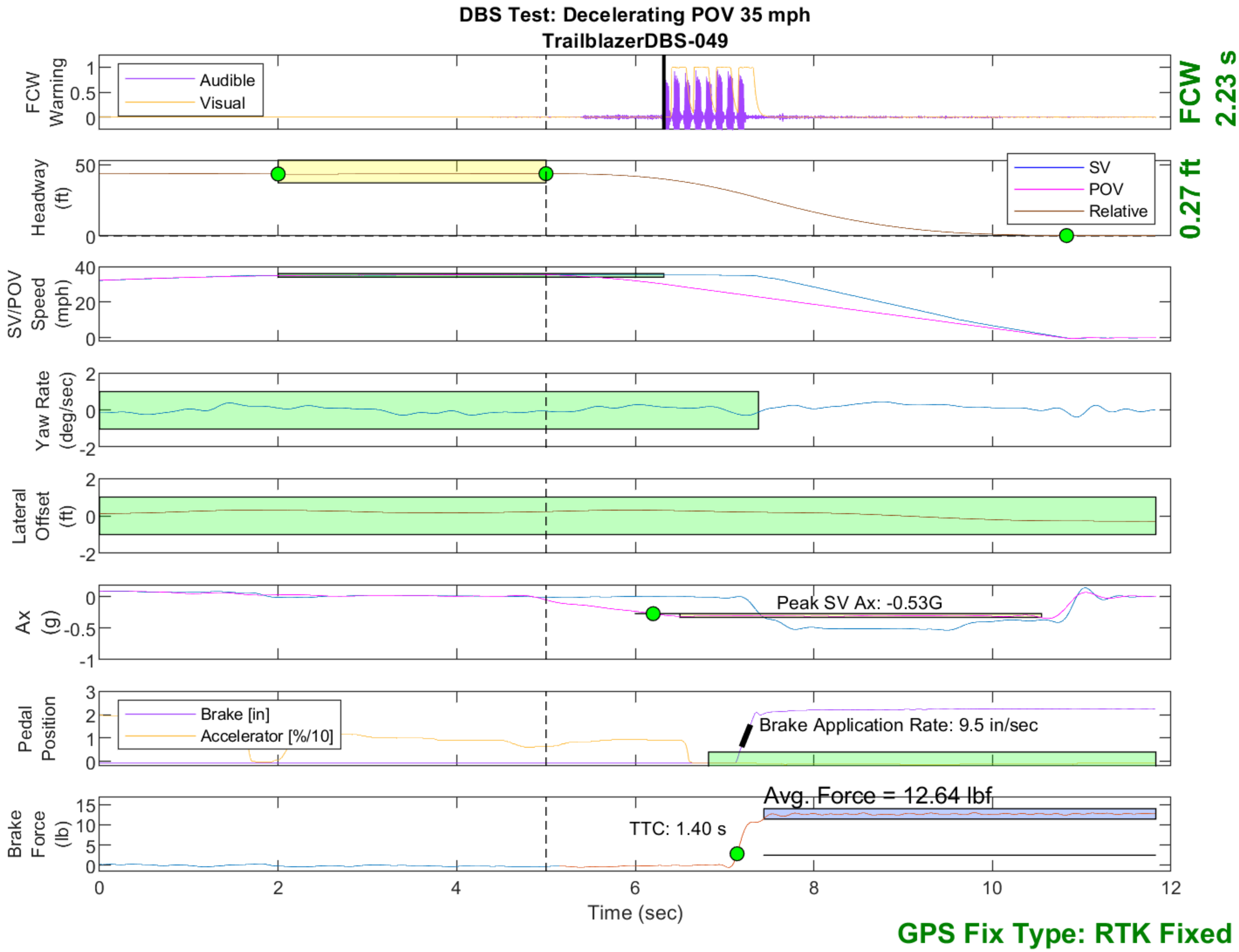


Figure E35. Time History for DBS Run 49, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

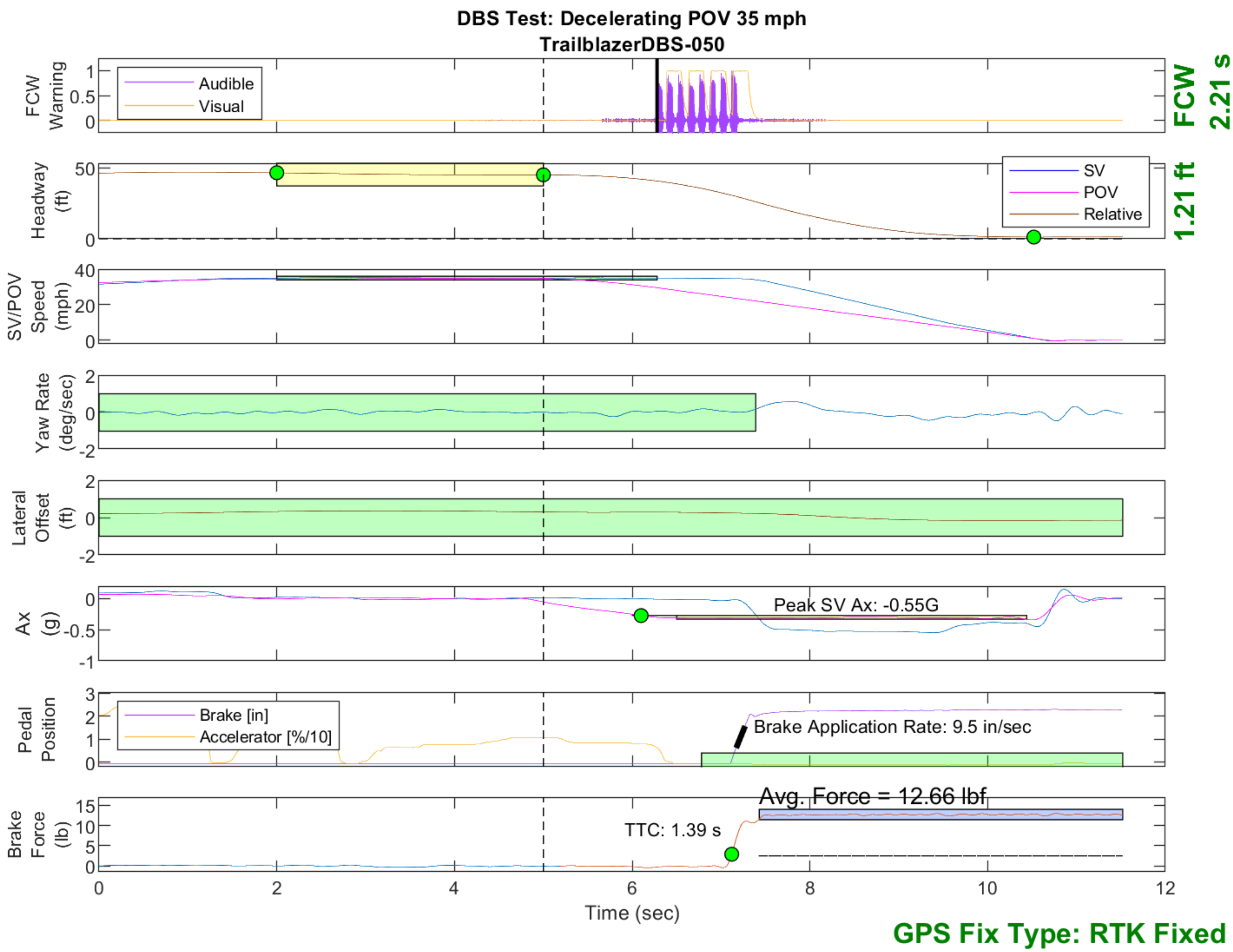


Figure E36. Time History for DBS Run 50, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

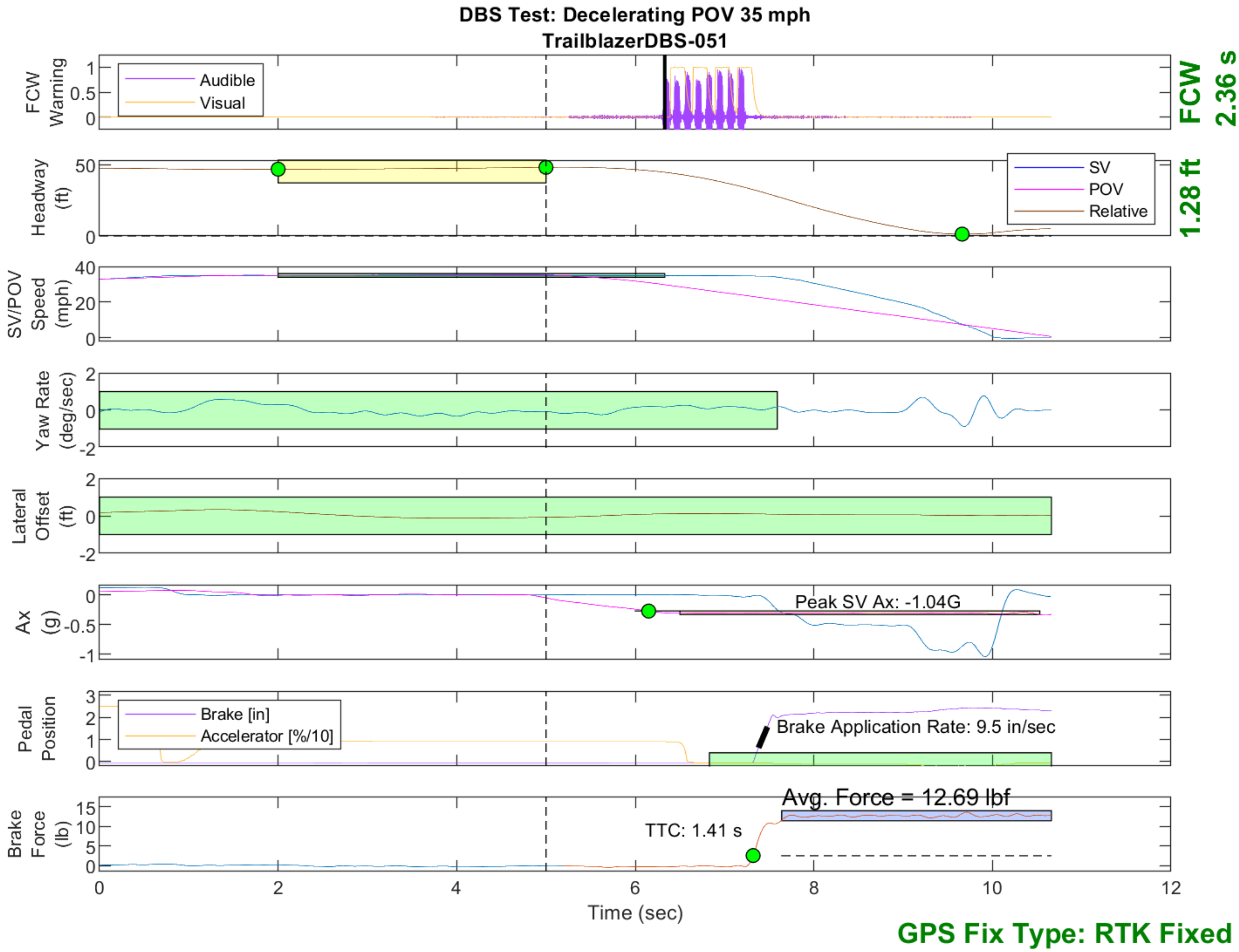


Figure E37. Time History for DBS Run 51, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

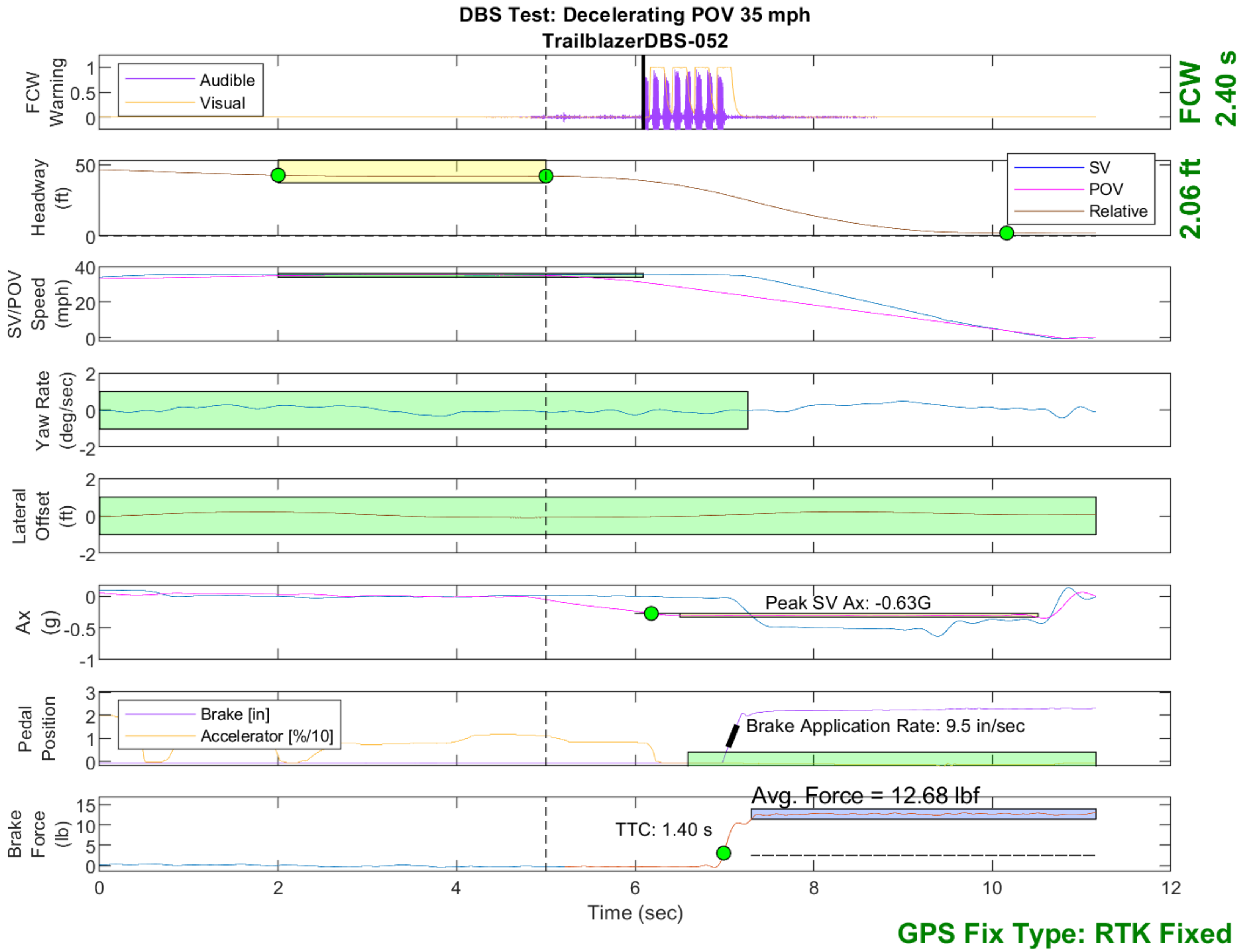


Figure E38. Time History for DBS Run 52, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

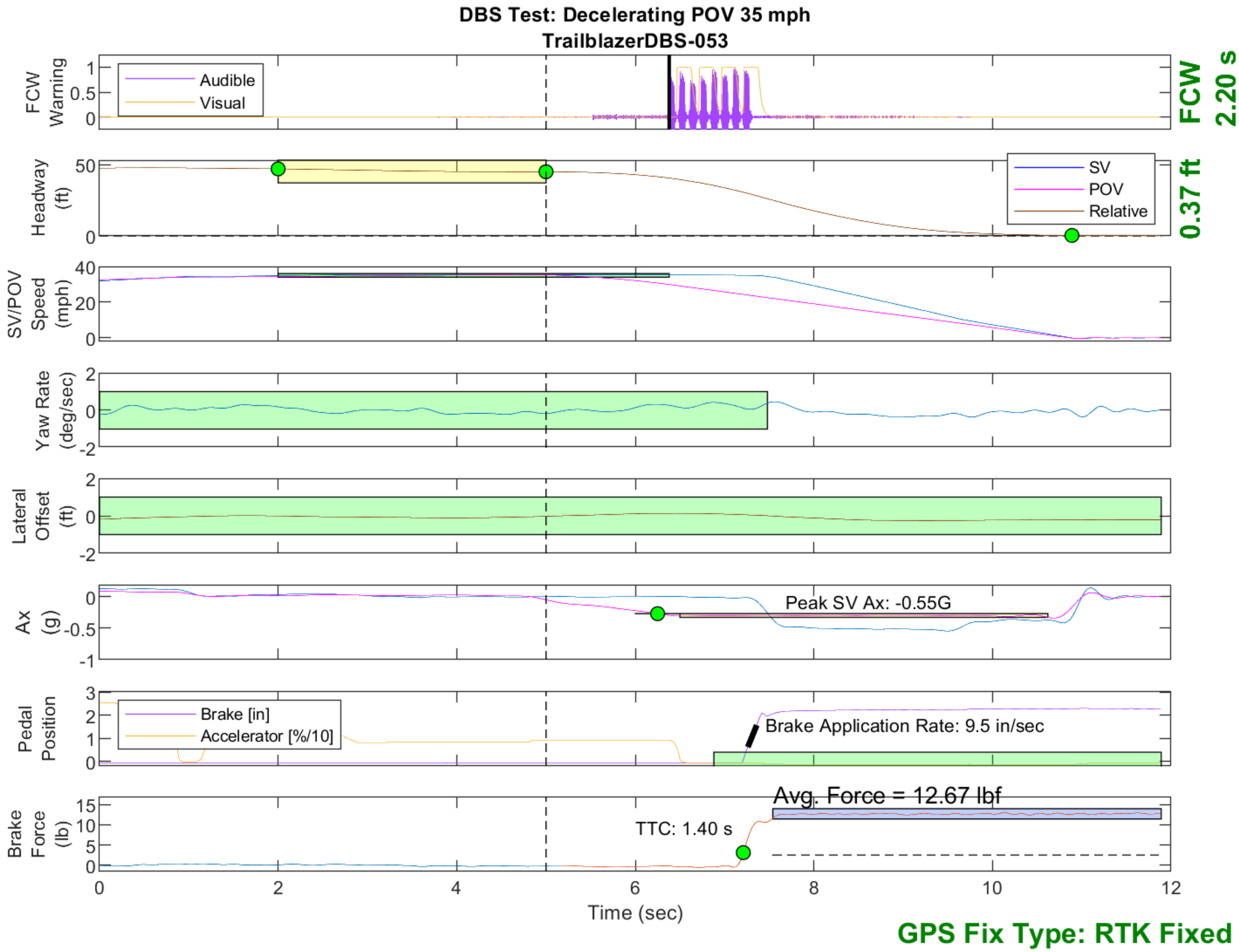


Figure E39. Time History for DBS Run 53, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

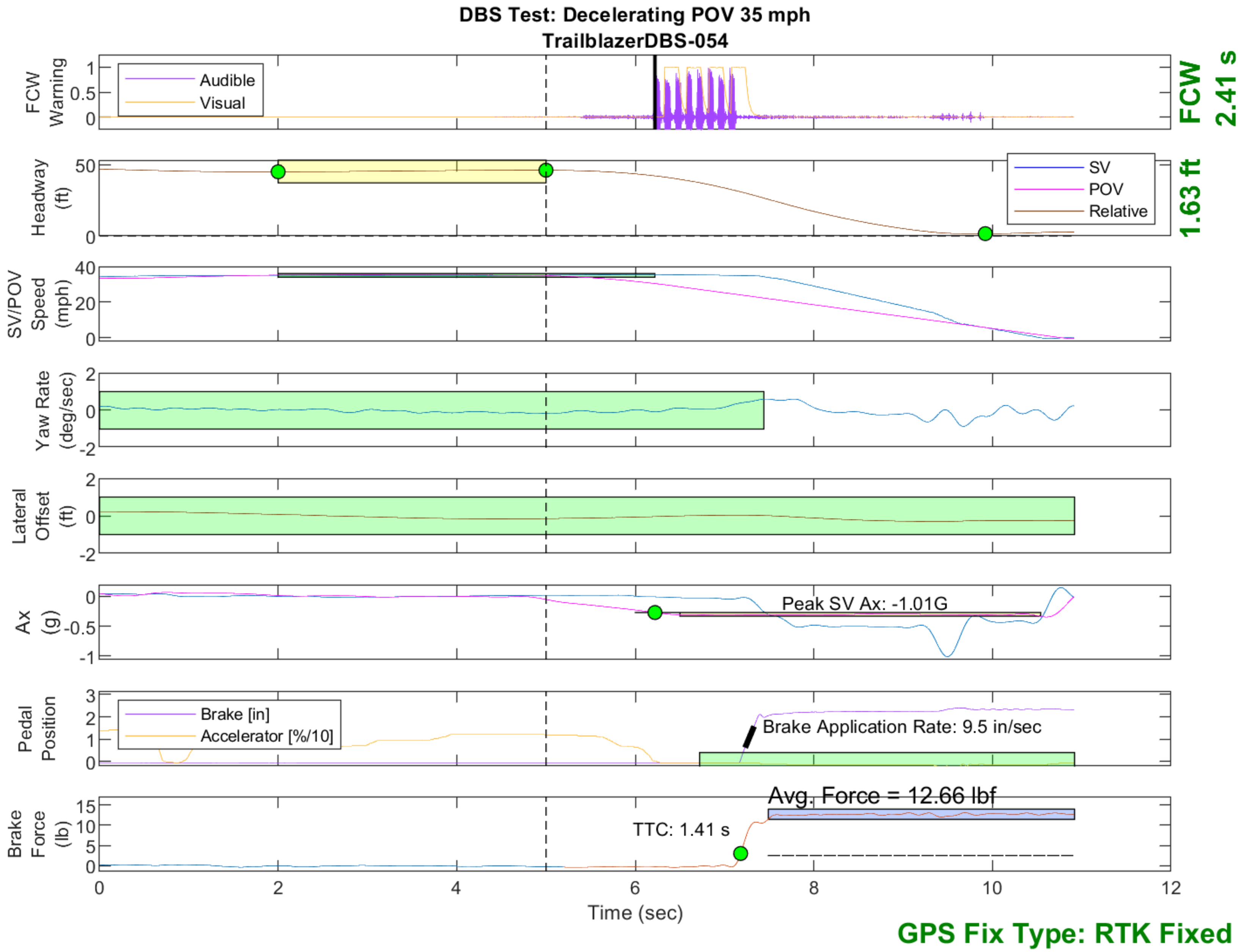


Figure E40. Time History for DBS Run 54, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

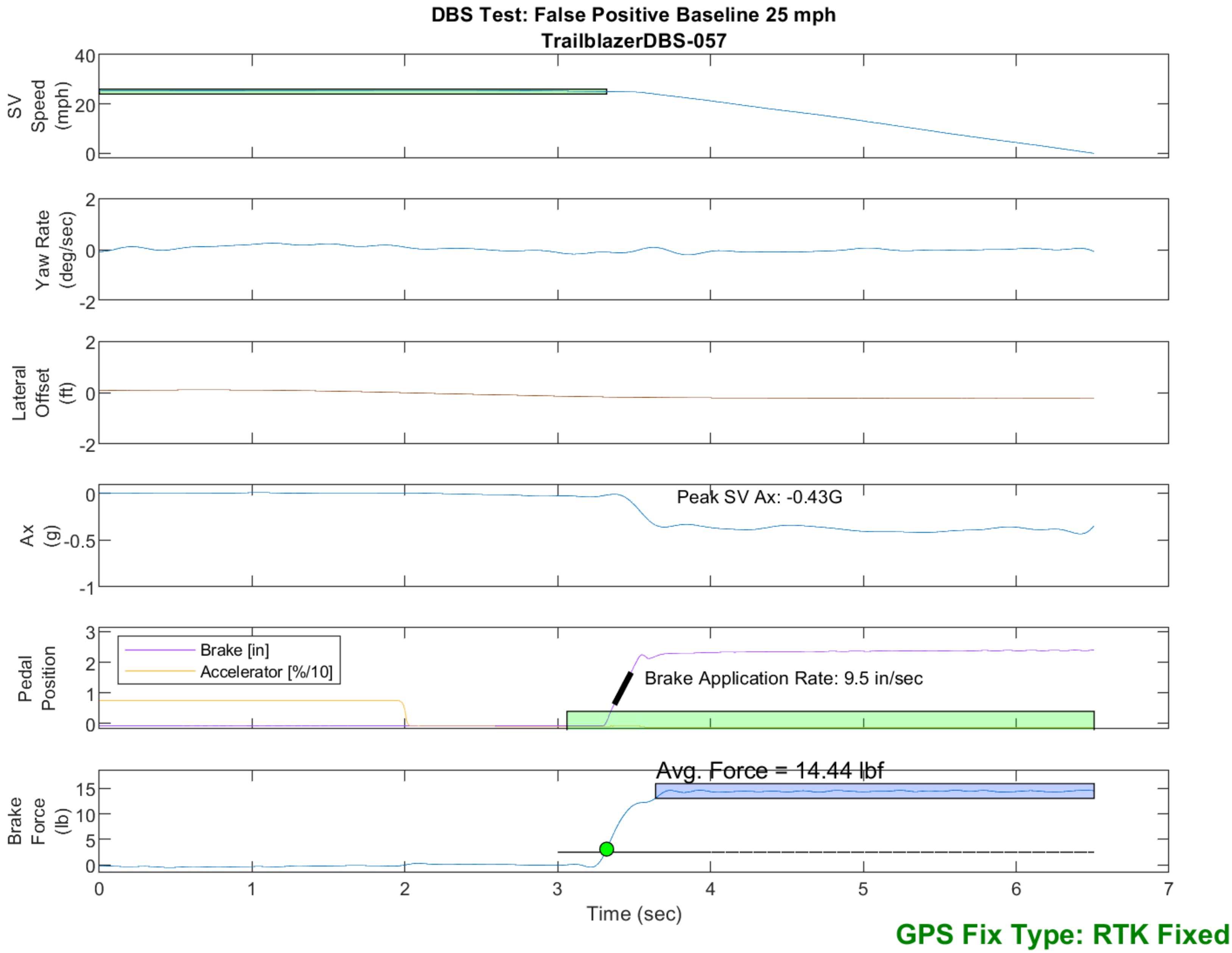


Figure E41. Time History for DBS Run 57, False Positive Baseline, SV 25 mph

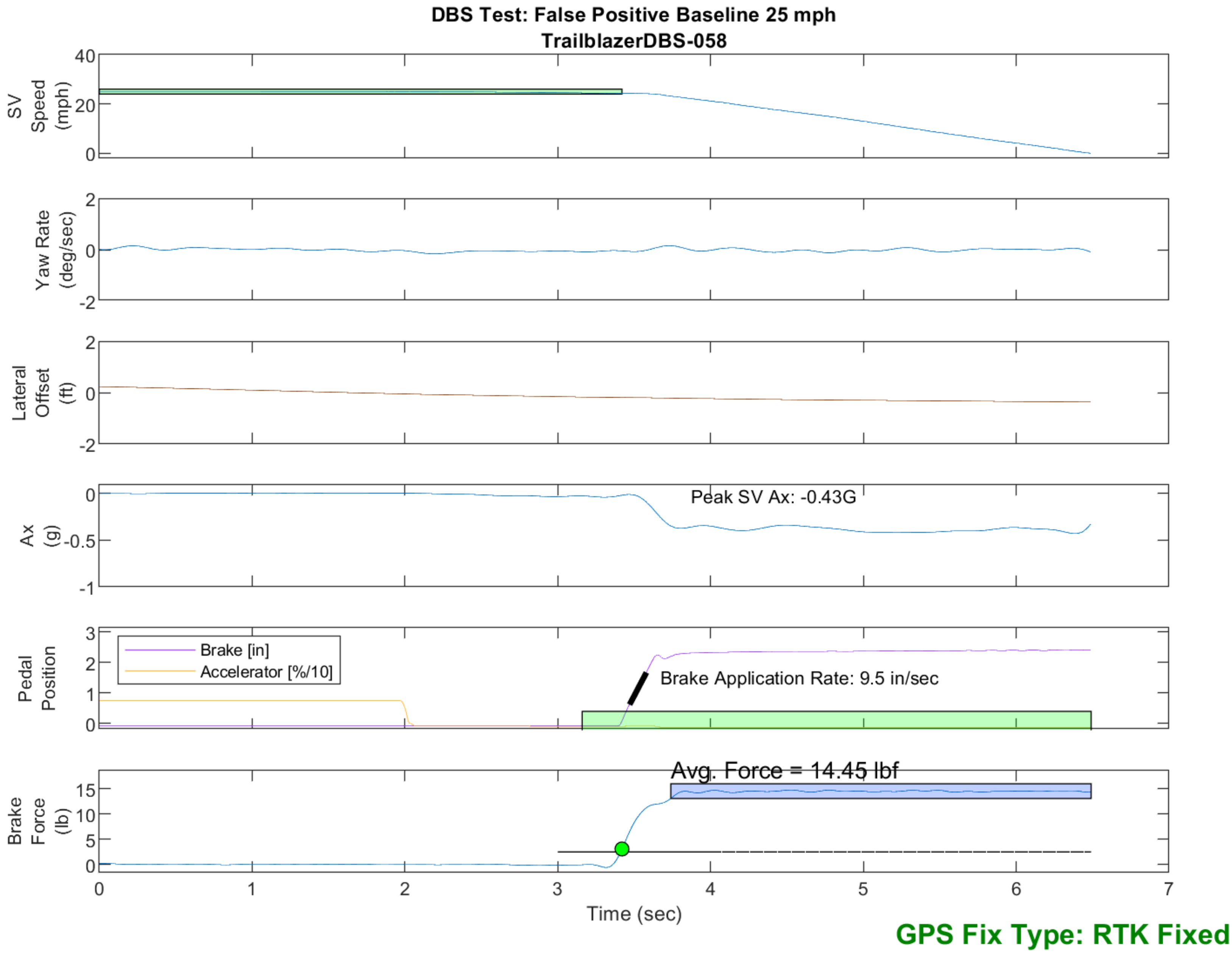


Figure E42. Time History for DBS Run 58, False Positive Baseline, SV 25 mph

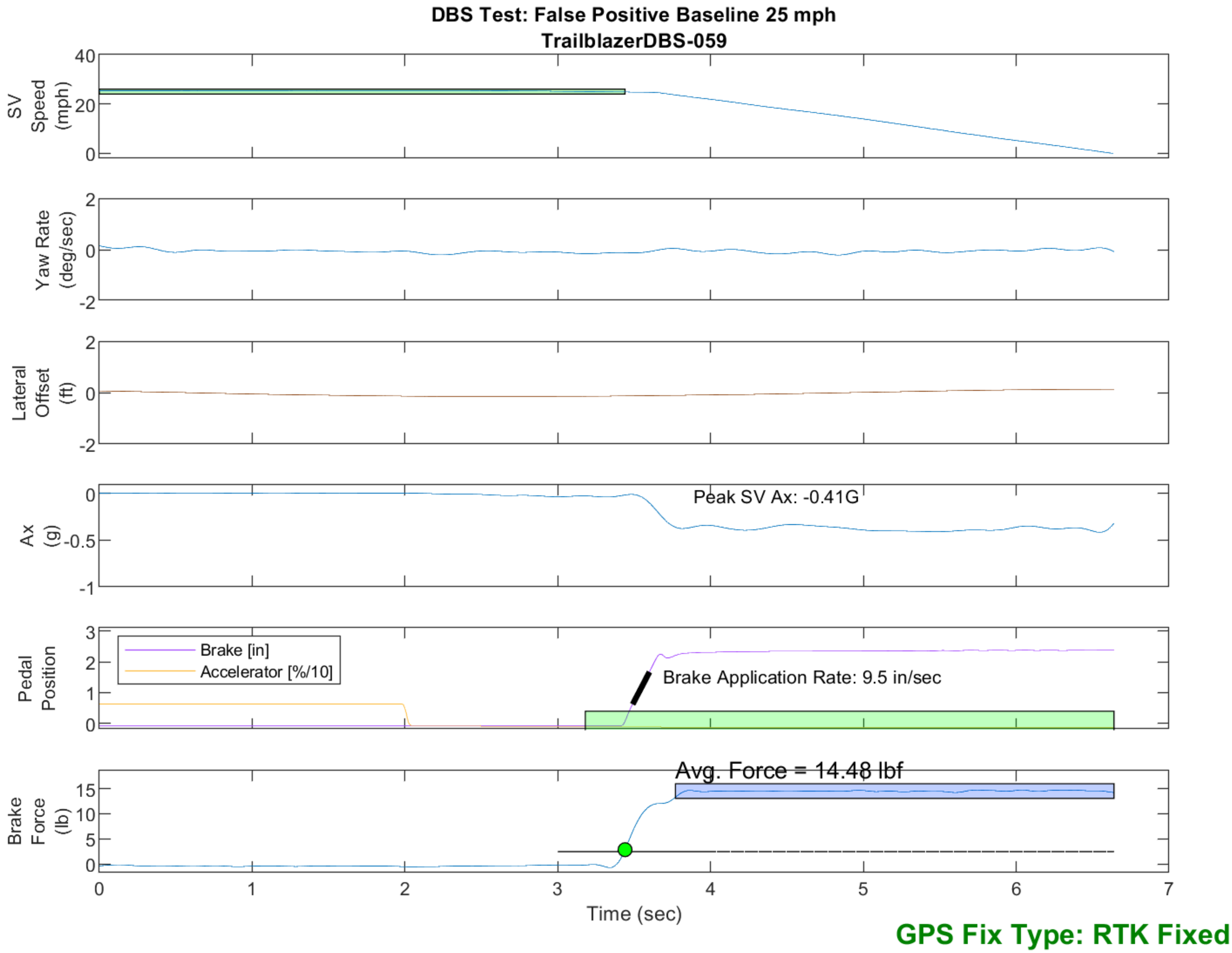


Figure E43. Time History for DBS Run 59, False Positive Baseline, SV 25 mph

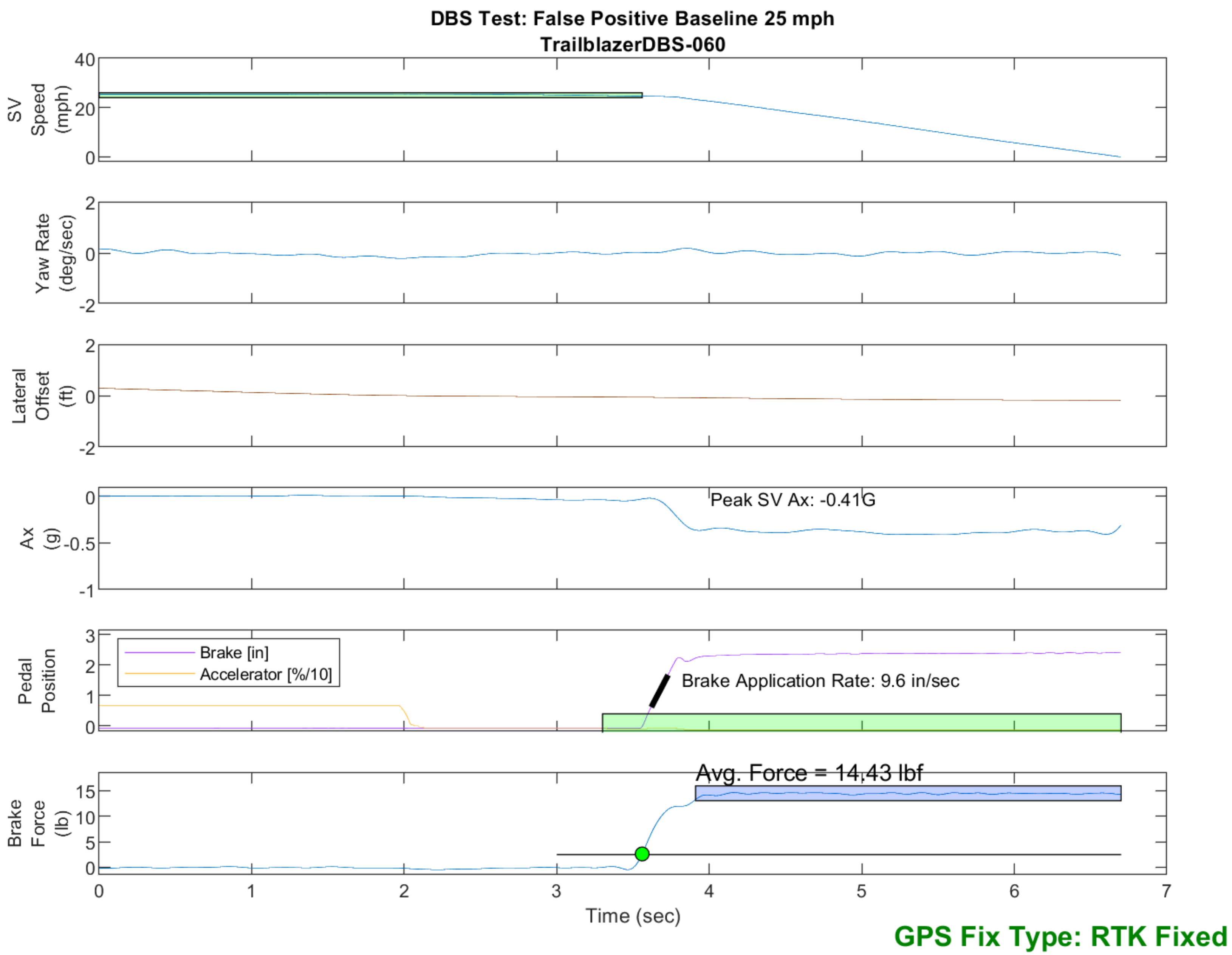


Figure E44. Time History for DBS Run 60, False Positive Baseline, SV 25 mph

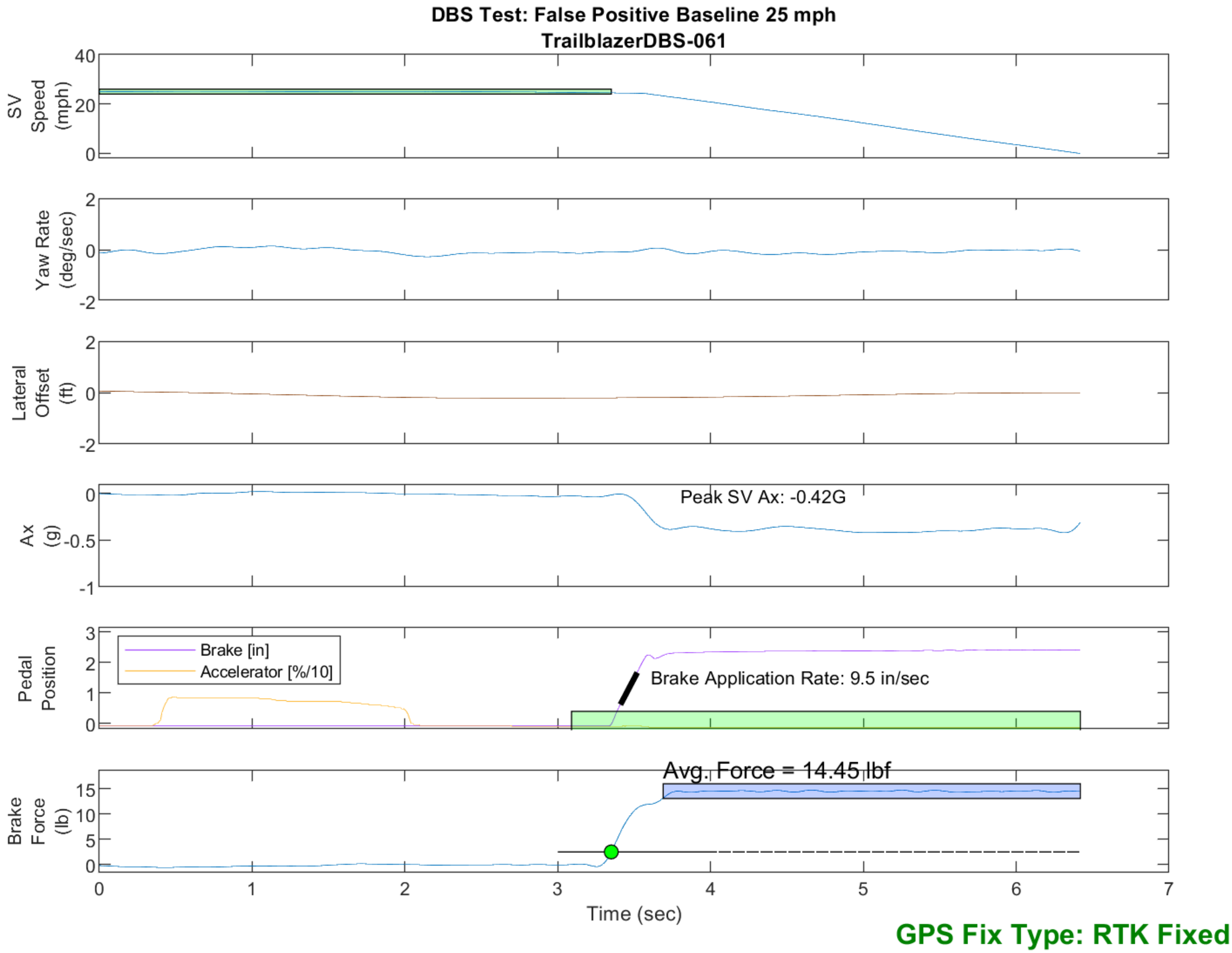


Figure E45. Time History for DBS Run 61, False Positive Baseline, SV 25 mph

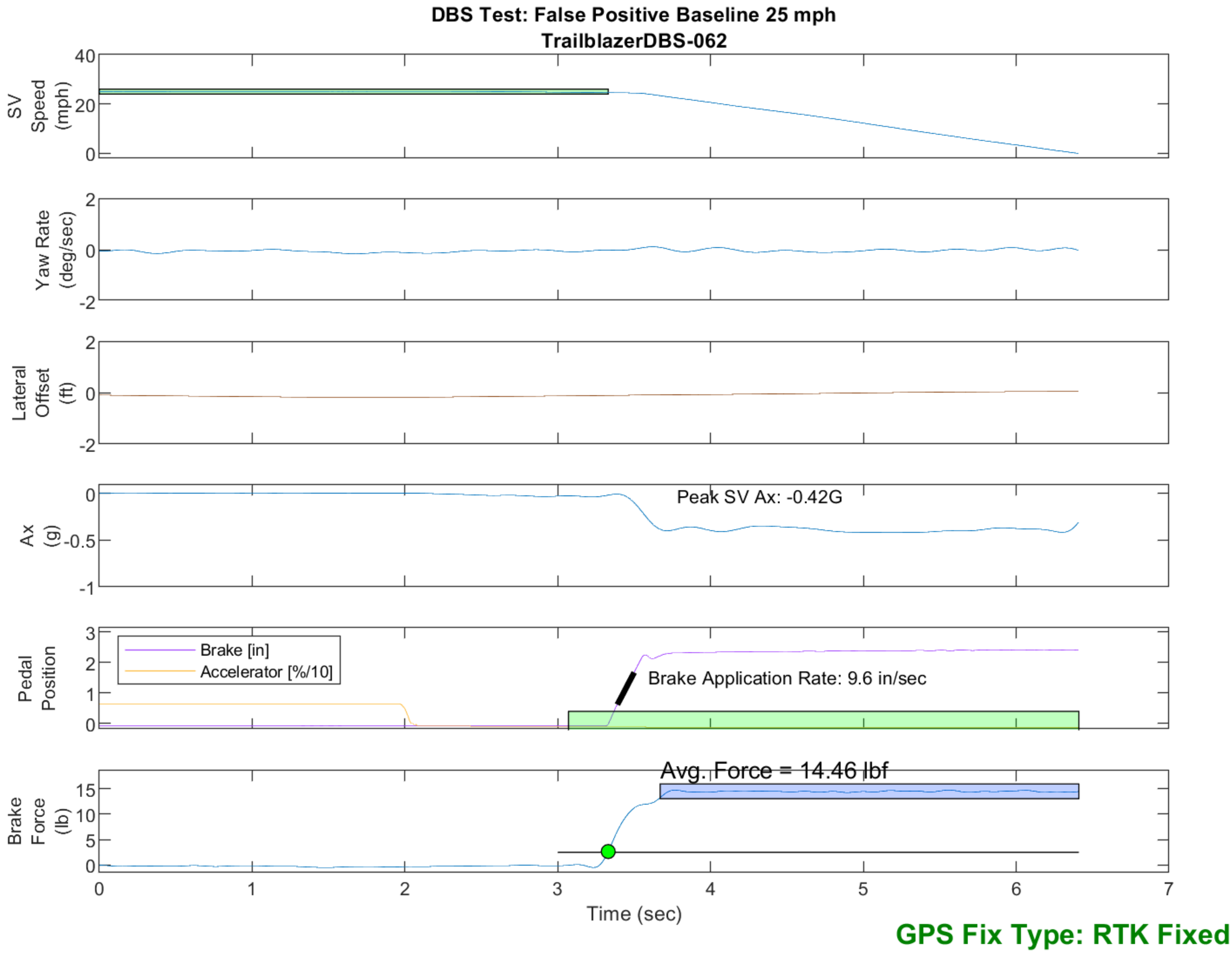


Figure E46. Time History for DBS Run 62, False Positive Baseline, SV 25 mph

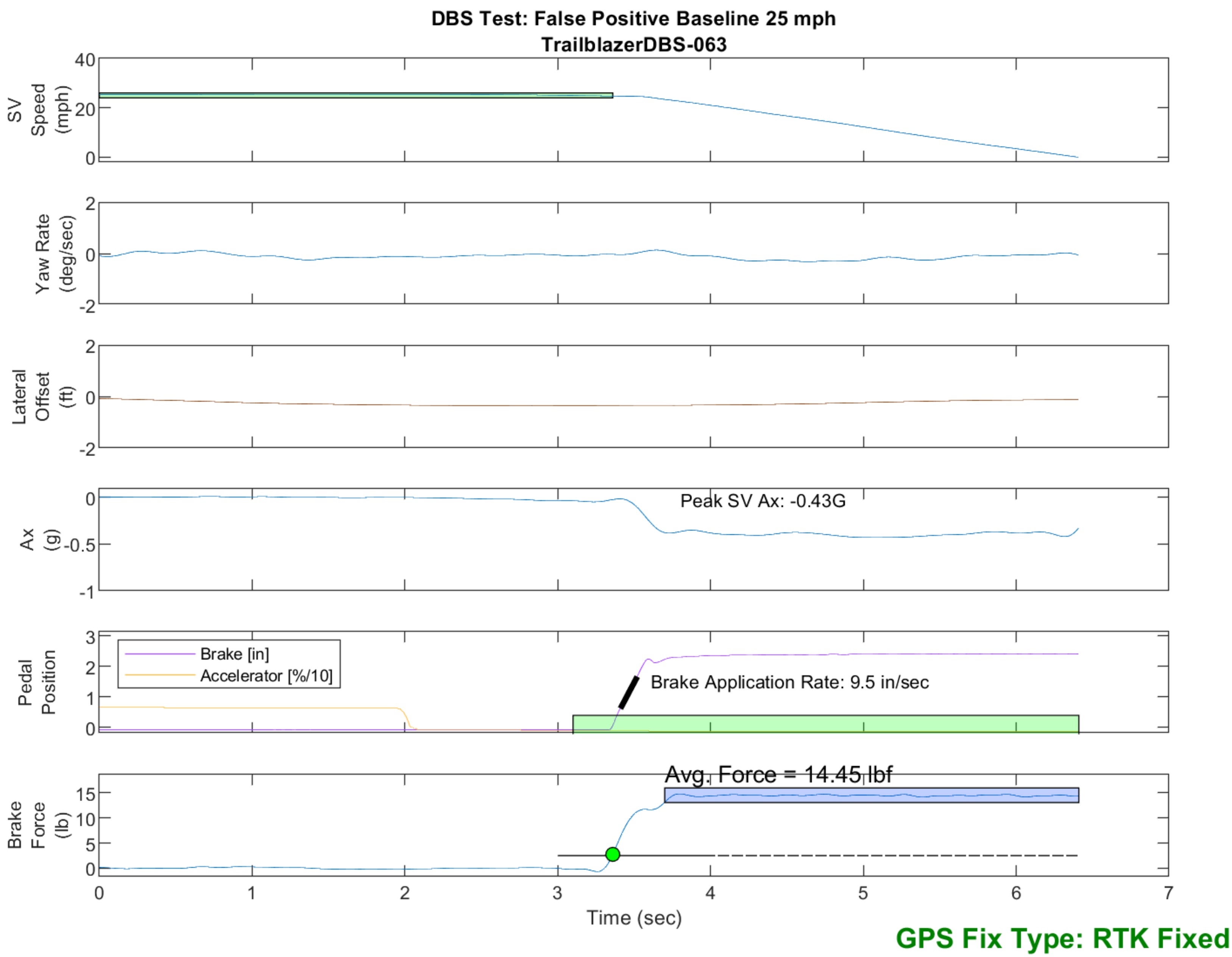


Figure E47. Time History for DBS Run 63, False Positive Baseline, SV 25 mph

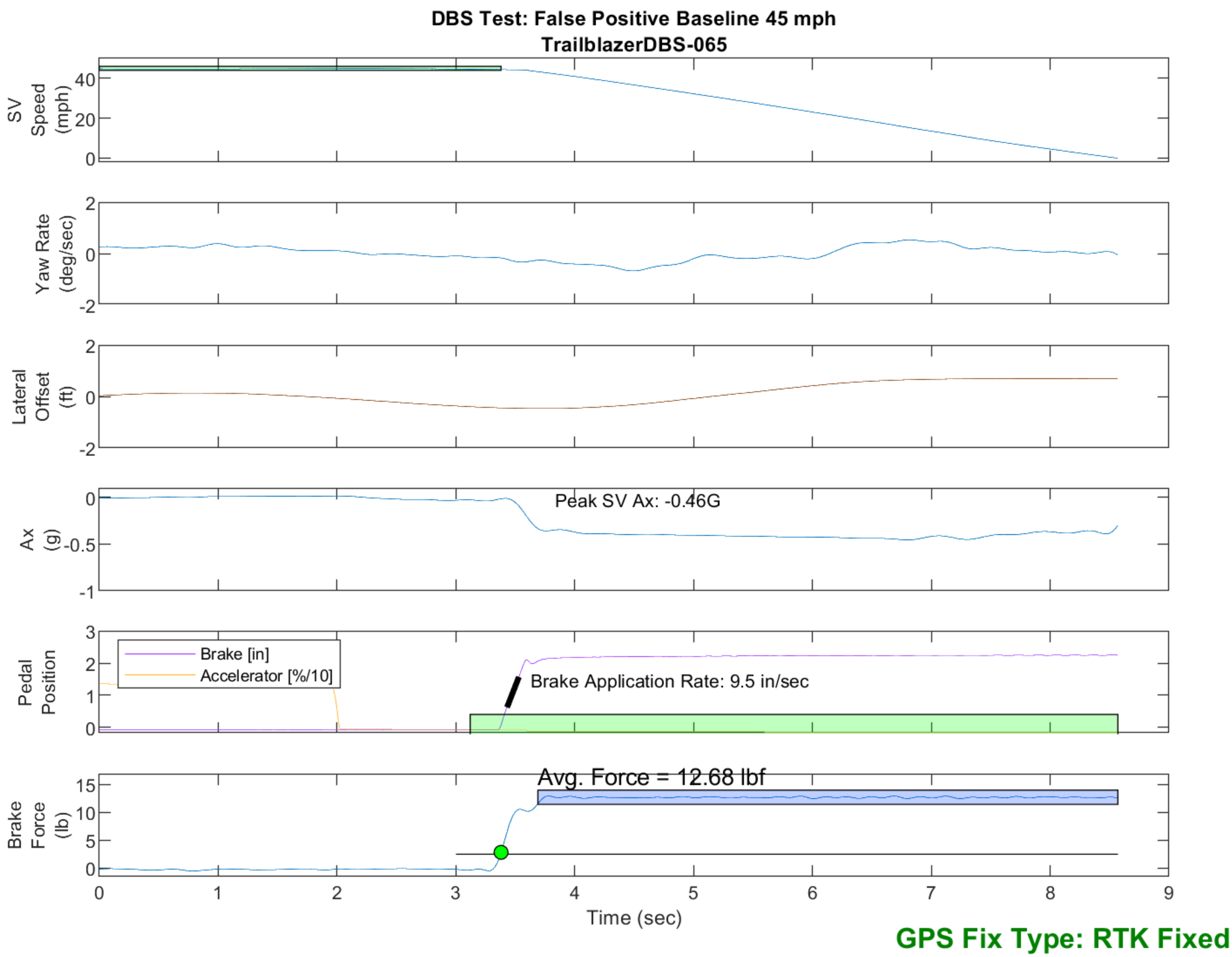


Figure E48. Time History for DBS Run 65, False Positive Baseline, SV 45 mph

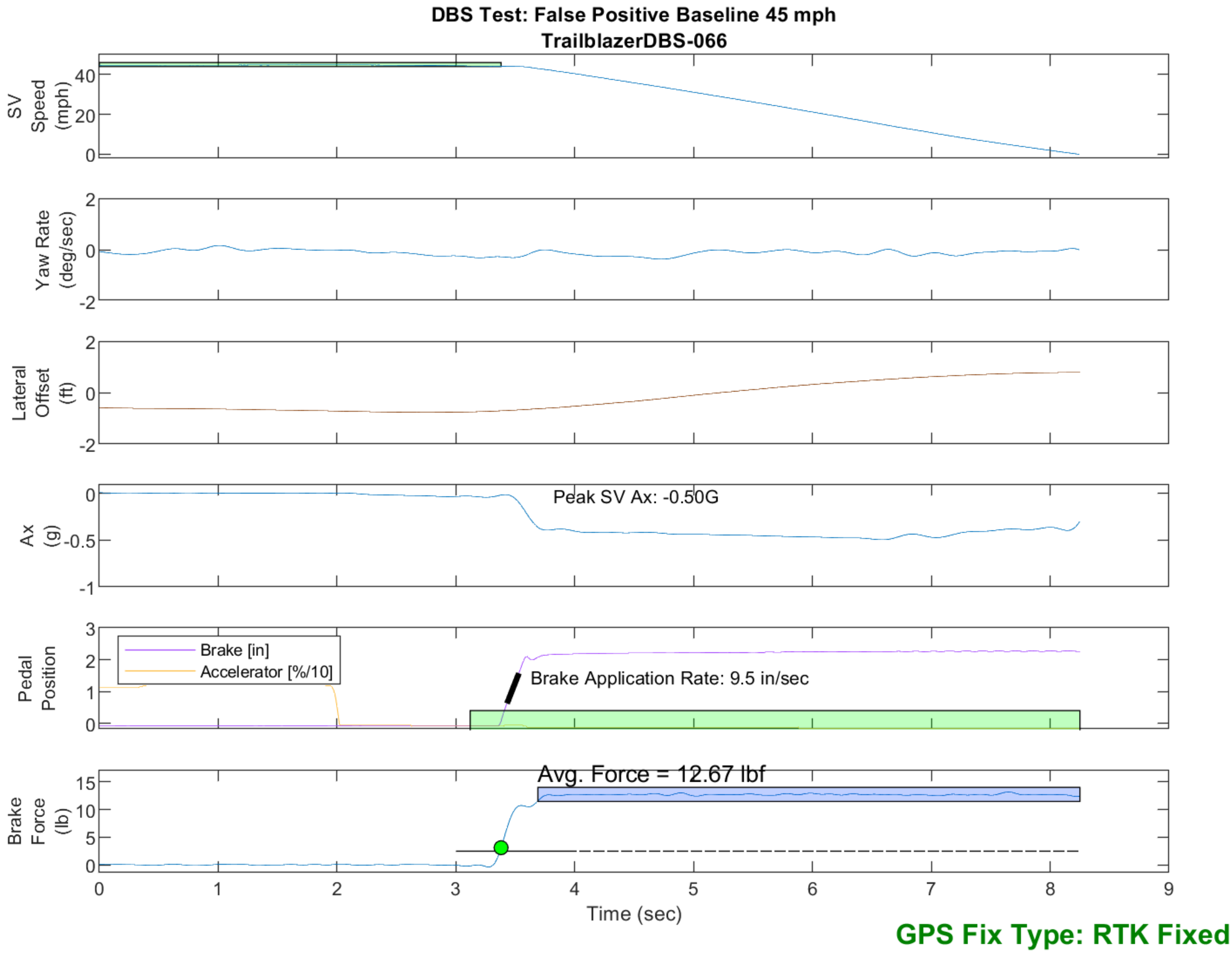


Figure E49. Time History for DBS Run 66, False Positive Baseline, SV 45 mph

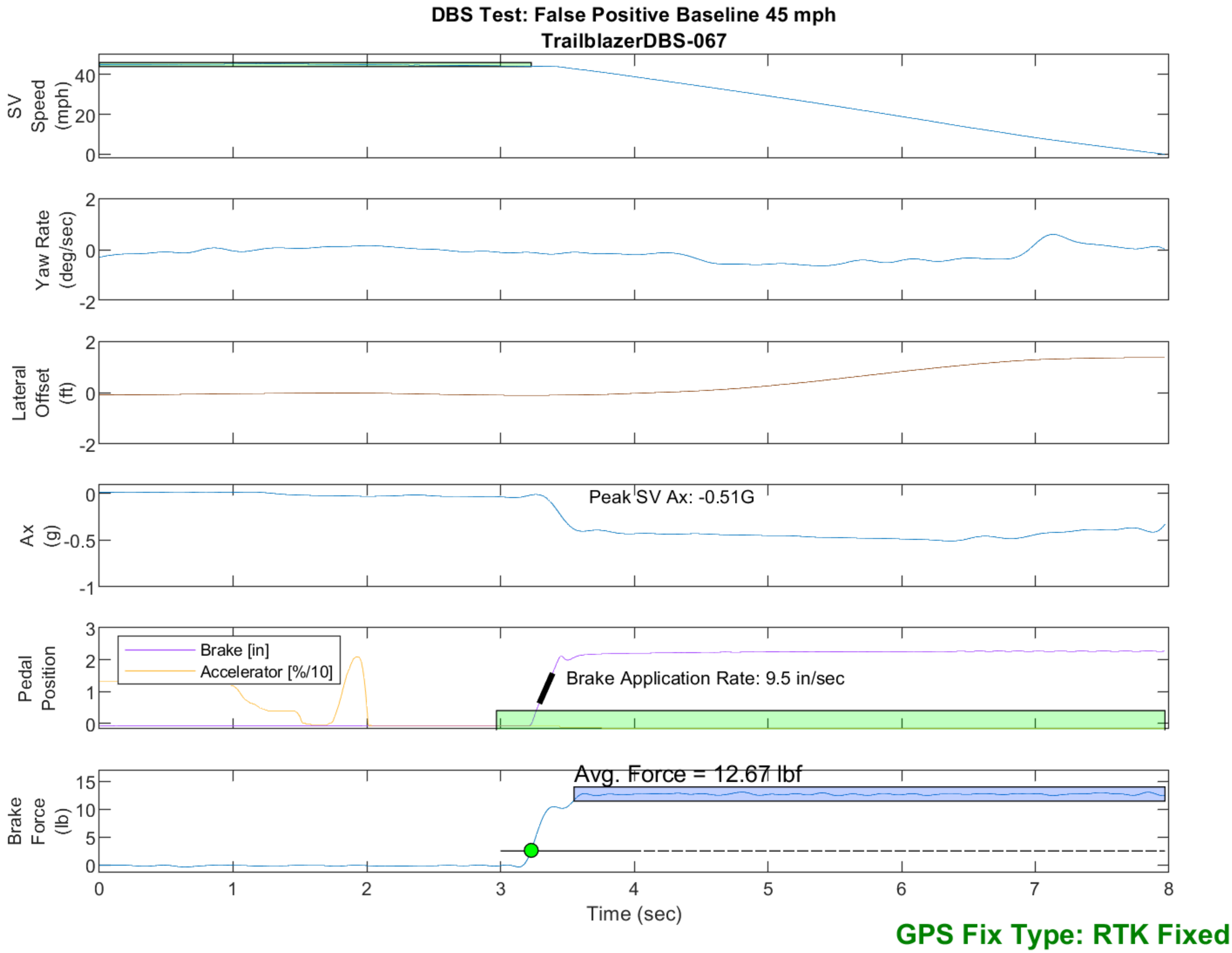


Figure E50. Time History for DBS Run 67, False Positive Baseline, SV 45 mph

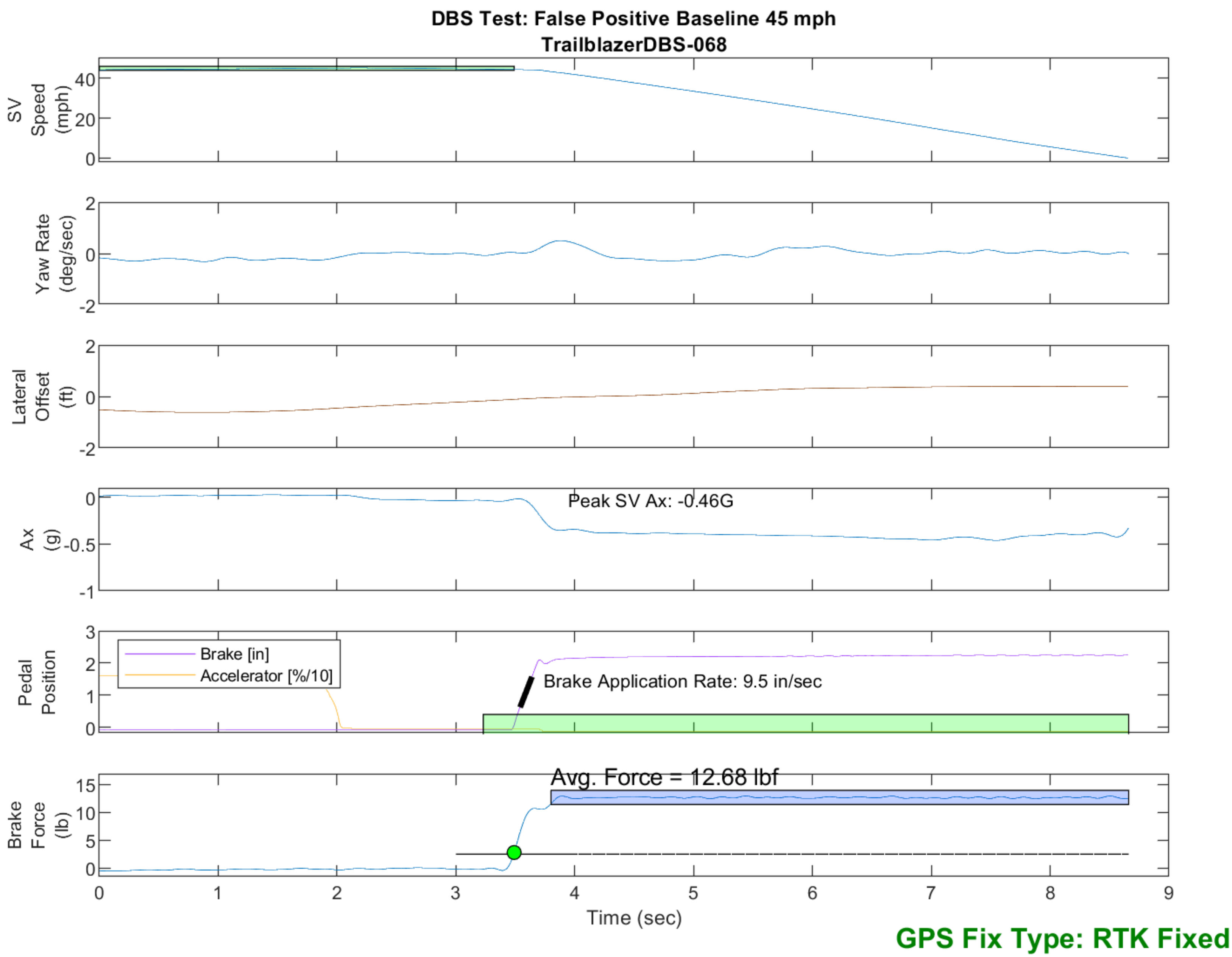


Figure E51. Time History for DBS Run 68, False Positive Baseline, SV 45 mph

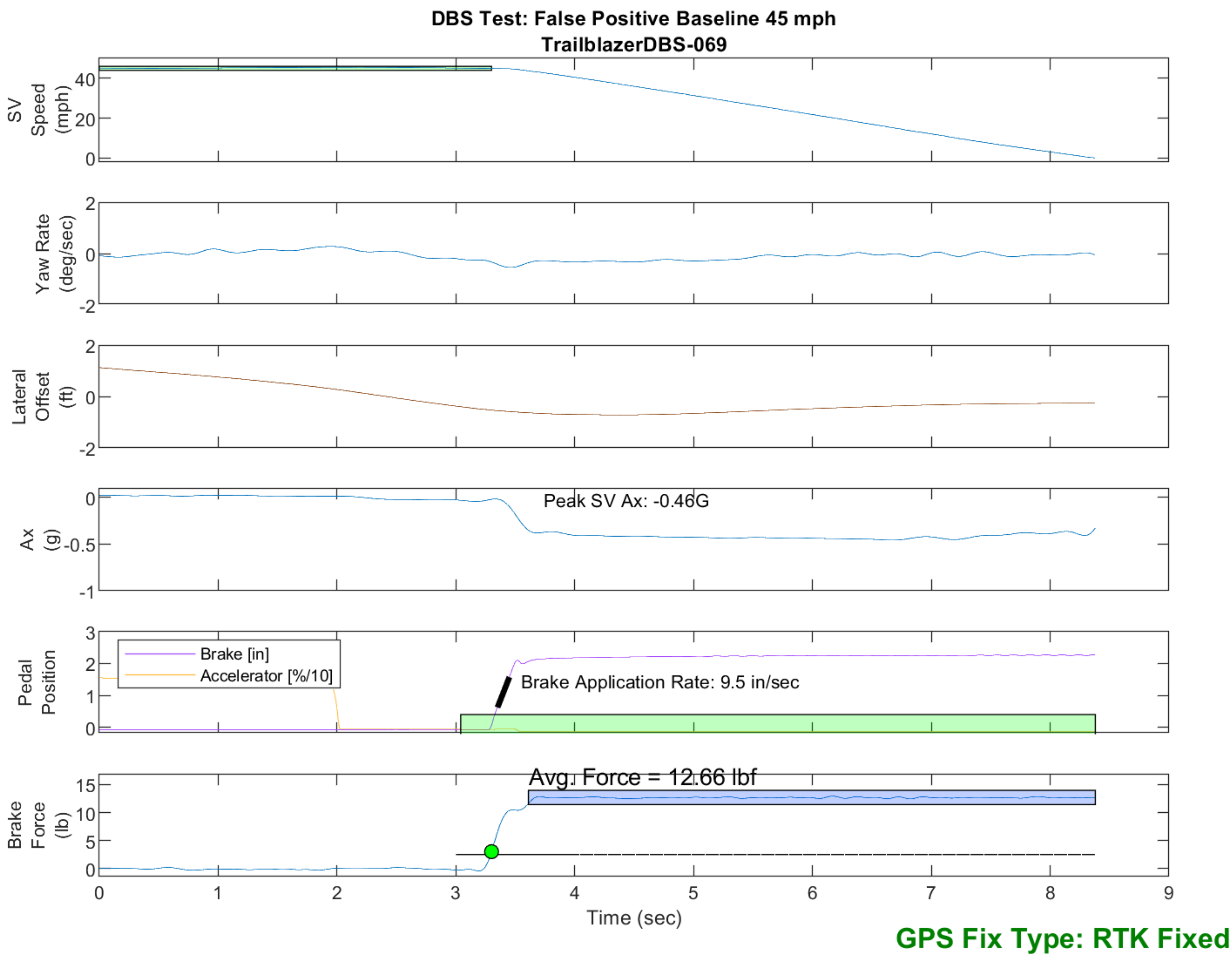


Figure E52. Time History for DBS Run 69, False Positive Baseline, SV 45 mph

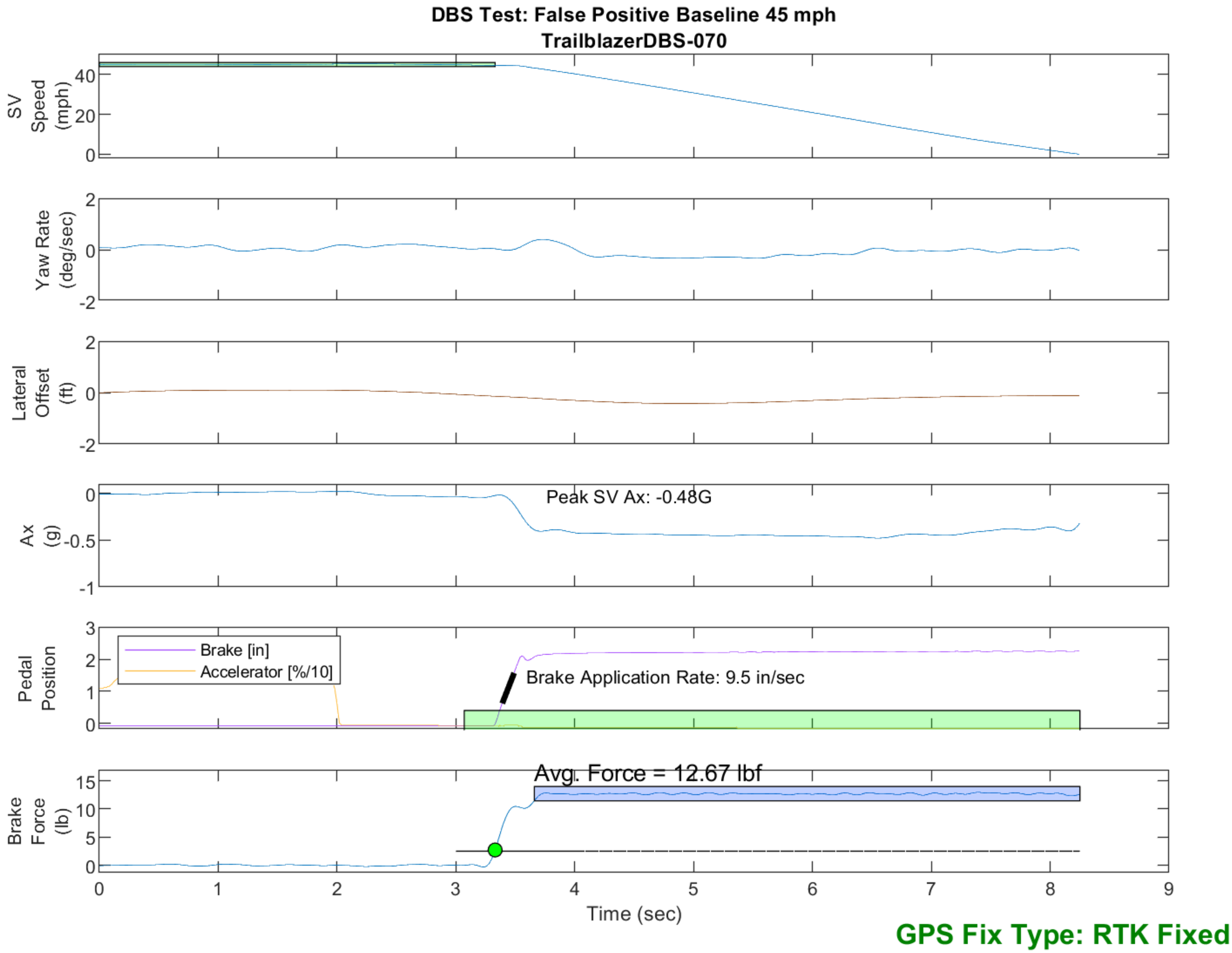


Figure E53. Time History for DBS Run 70, False Positive Baseline, SV 45 mph

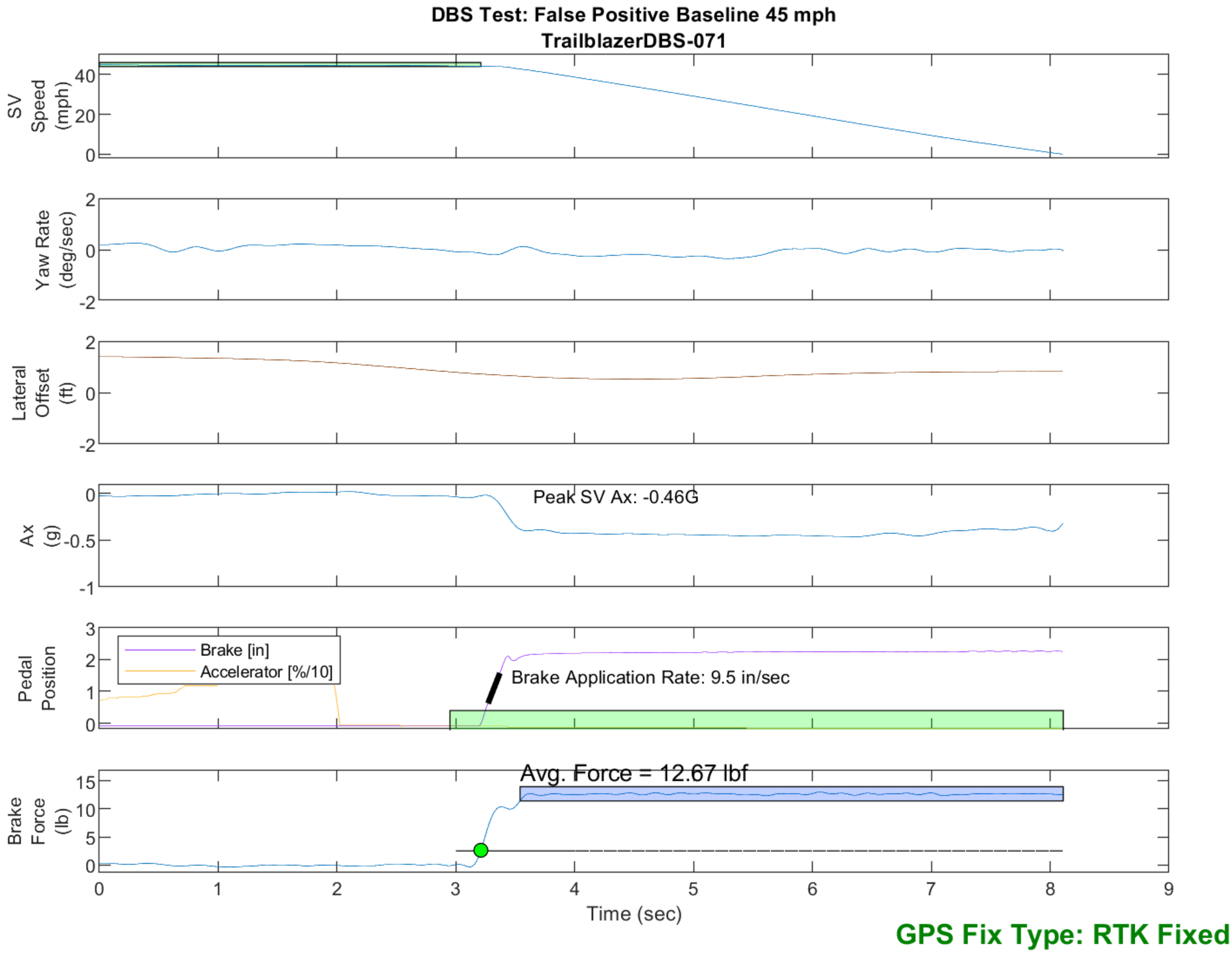


Figure E54. Time History for DBS Run 71, False Positive Baseline, SV 45 mph

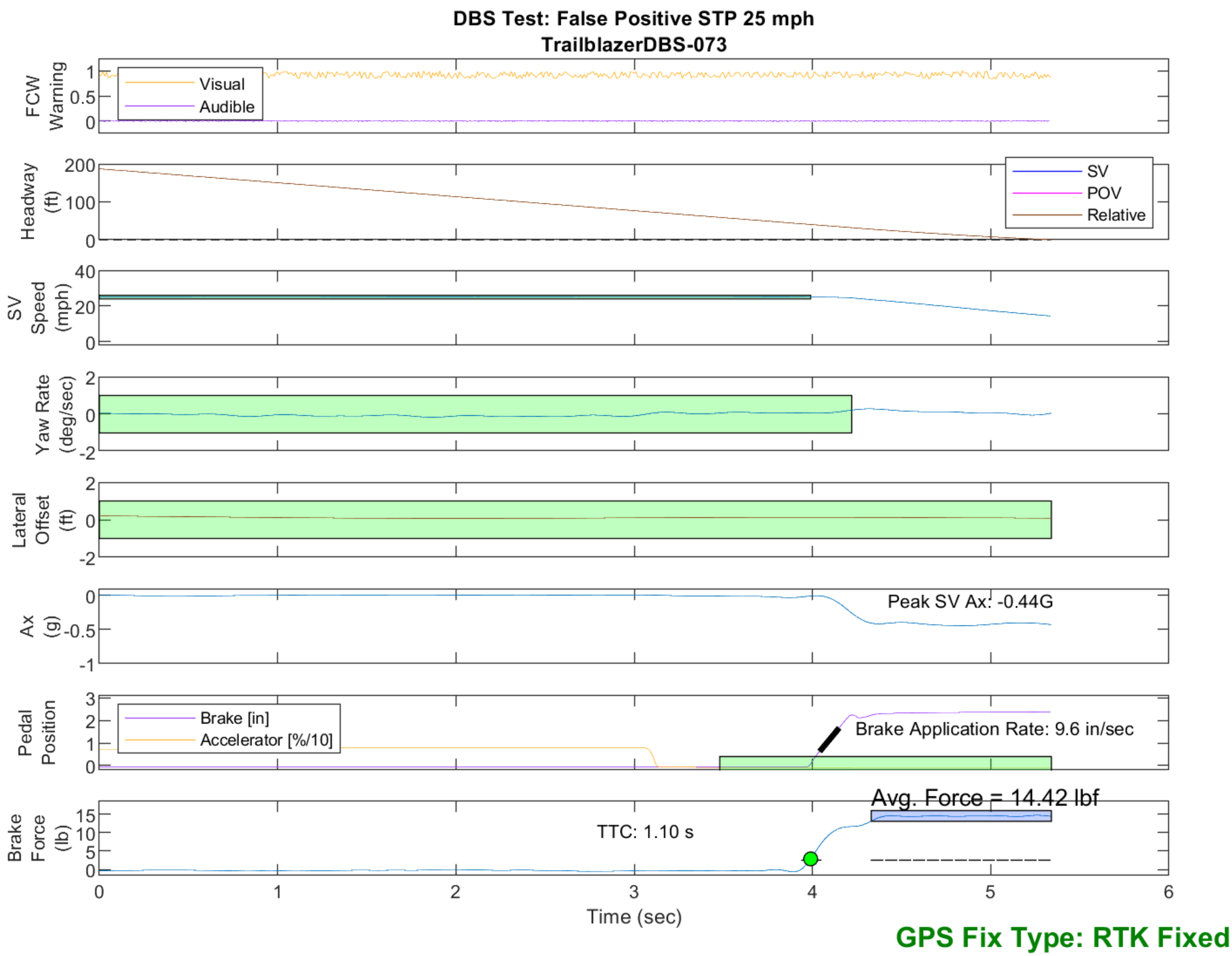


Figure E55. Time History for DBS Run 73, SV Encounters Steel Trench Plate, SV 25 mph

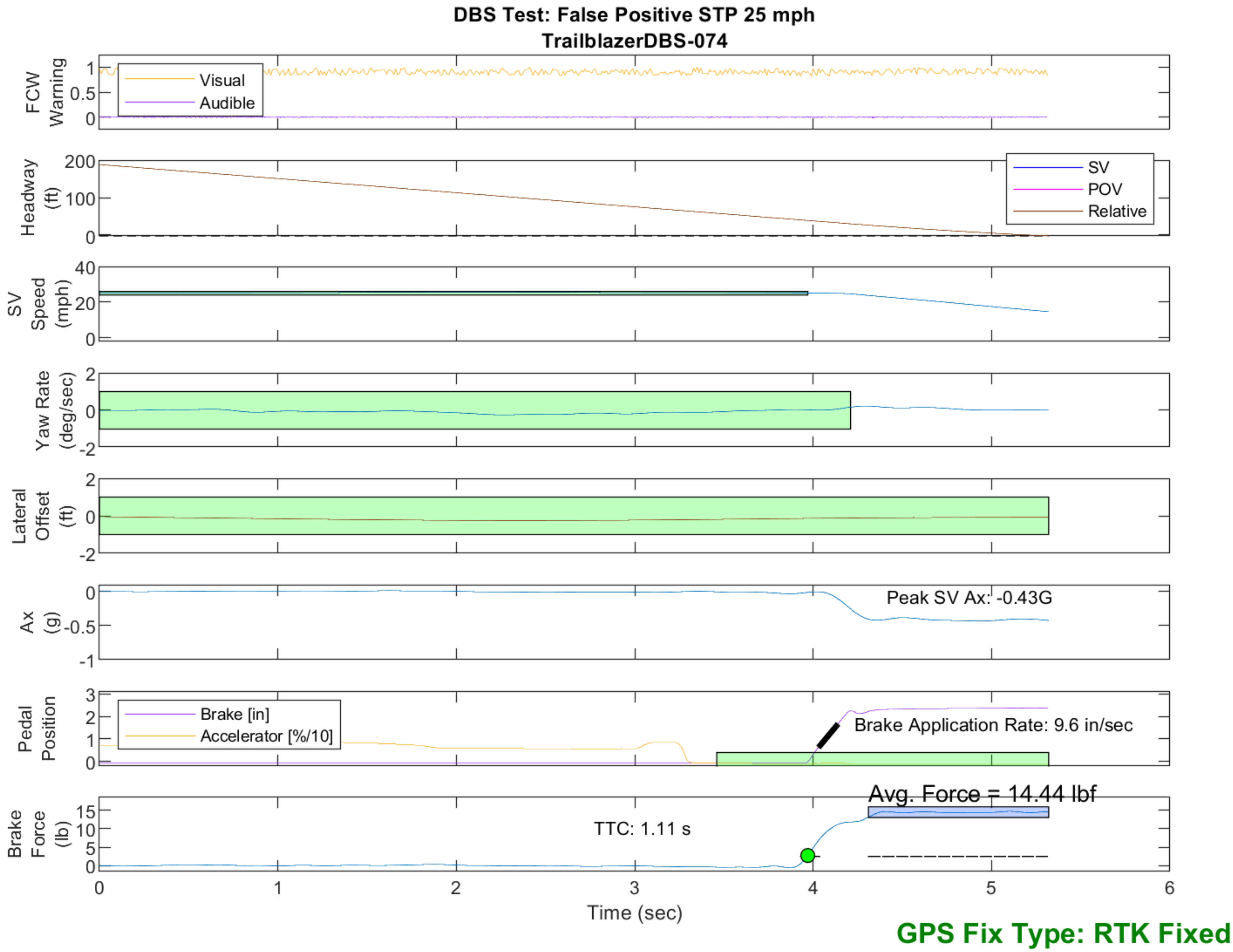


Figure E56. Time History for DBS Run 74, SV Encounters Steel Trench Plate, SV 25 mph

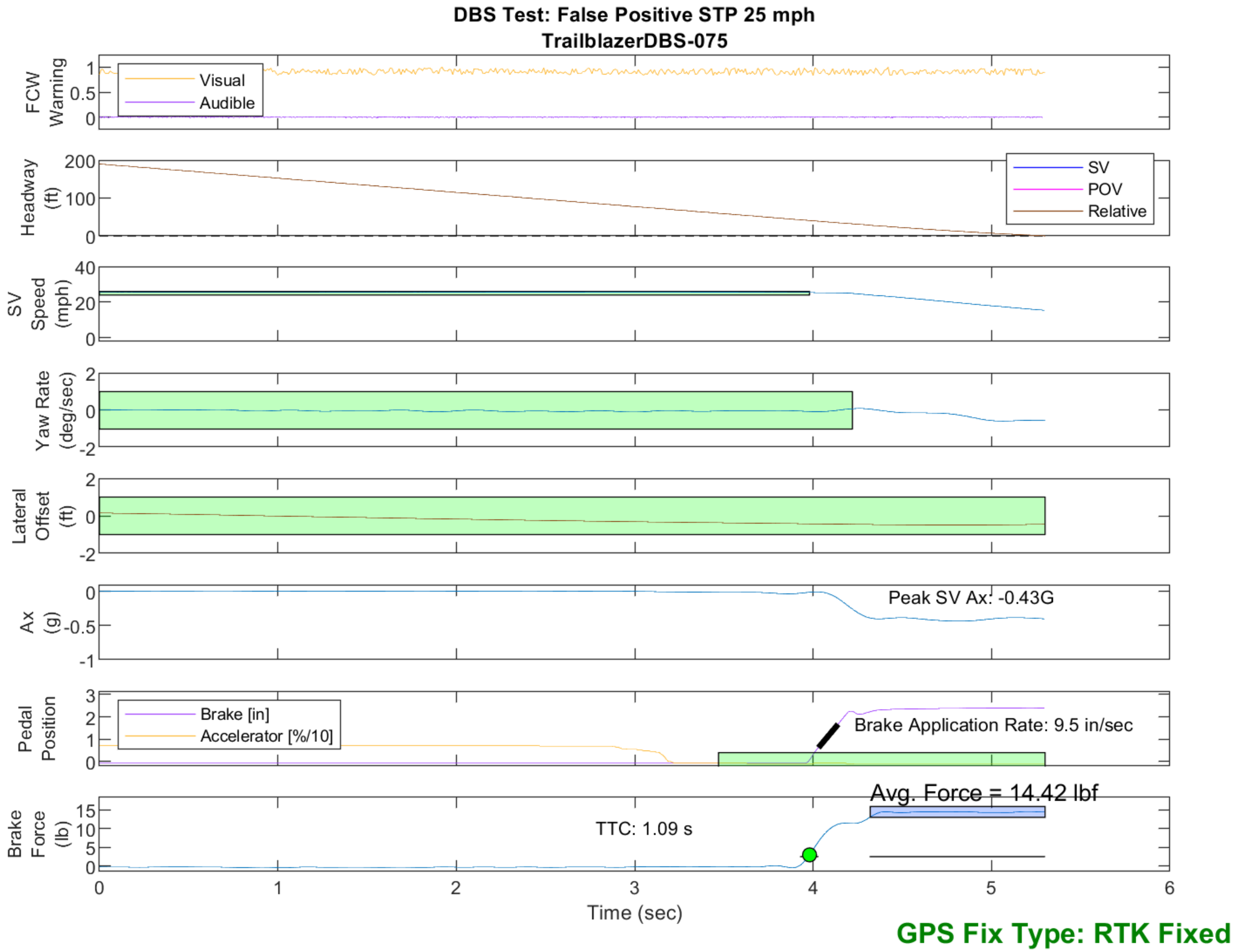


Figure E57. Time History for DBS Run 75, SV Encounters Steel Trench Plate, SV 25 mph

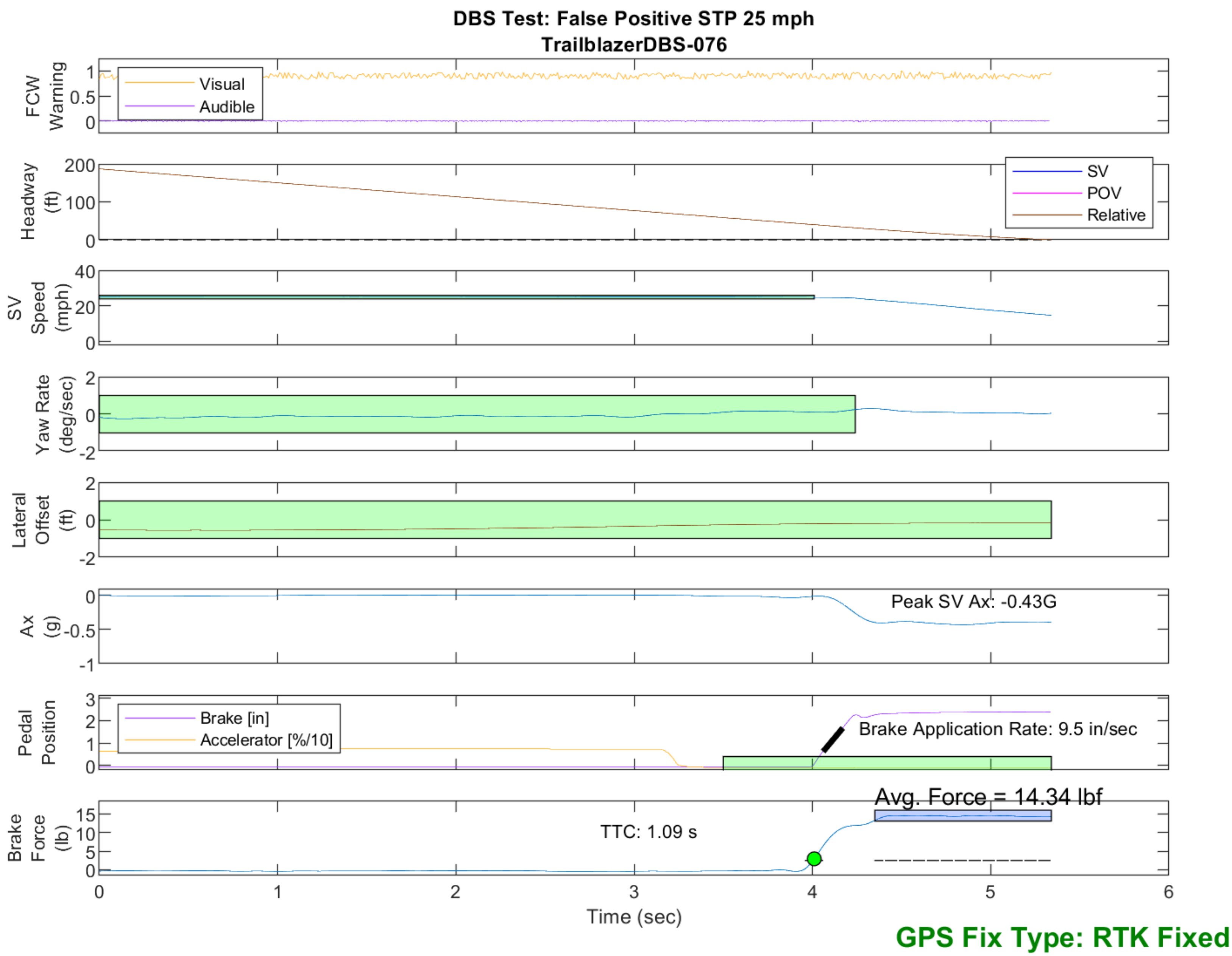


Figure E58. Time History for DBS Run 76, SV Encounters Steel Trench Plate, SV 25 mph

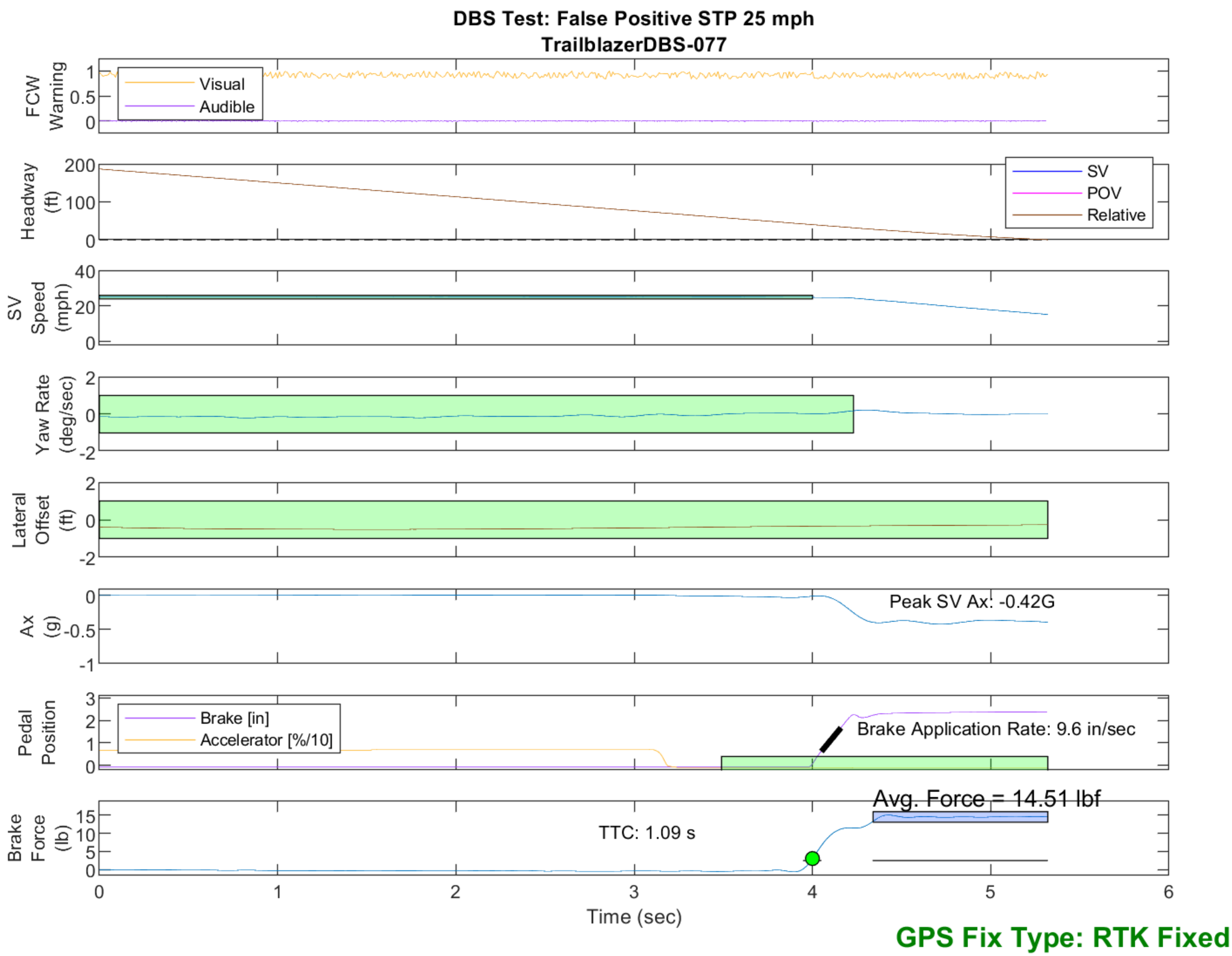


Figure E59. Time History for DBS Run 77, SV Encounters Steel Trench Plate, SV 25 mph

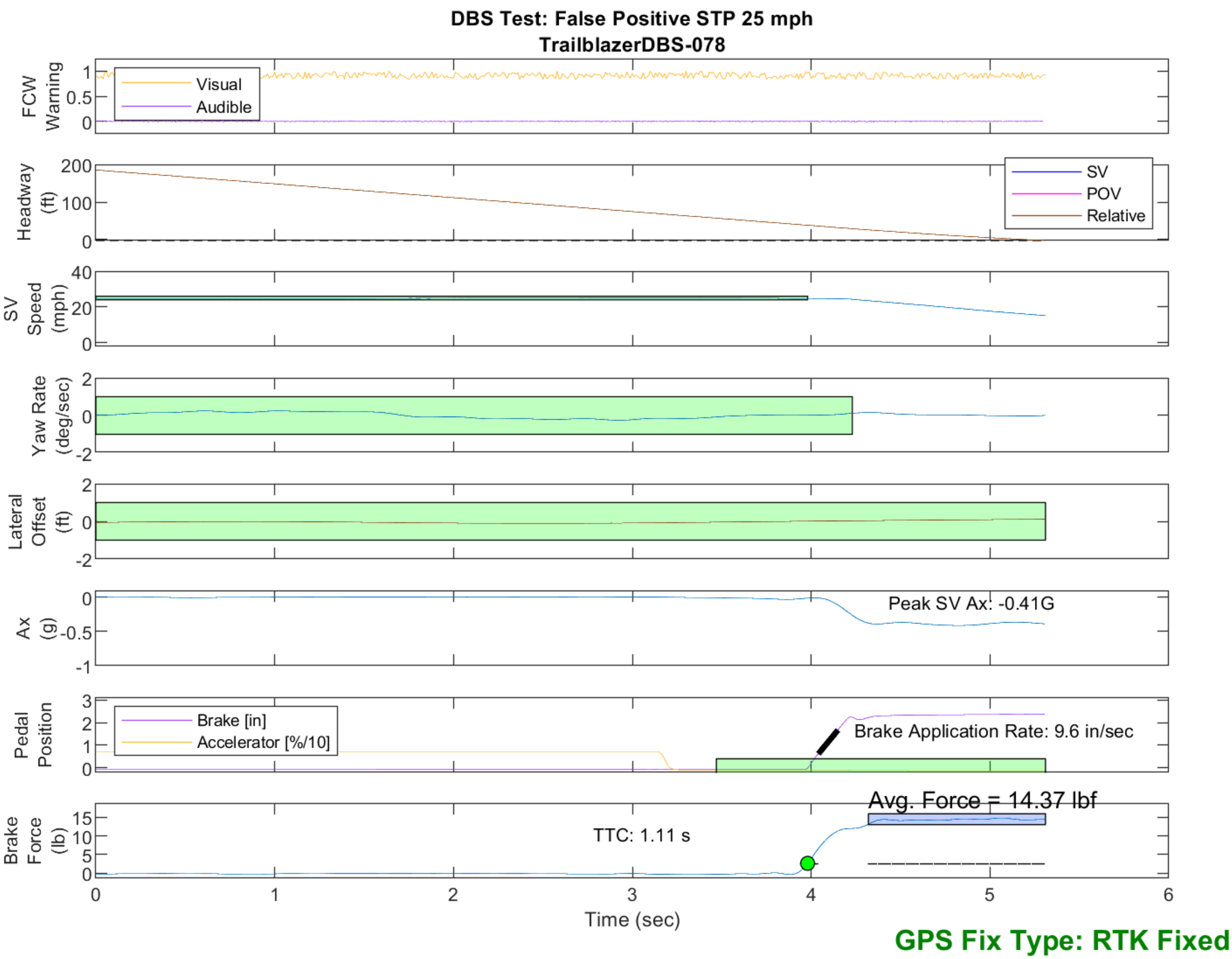


Figure E60. Time History for DBS Run 78, SV Encounters Steel Trench Plate, SV 25 mph

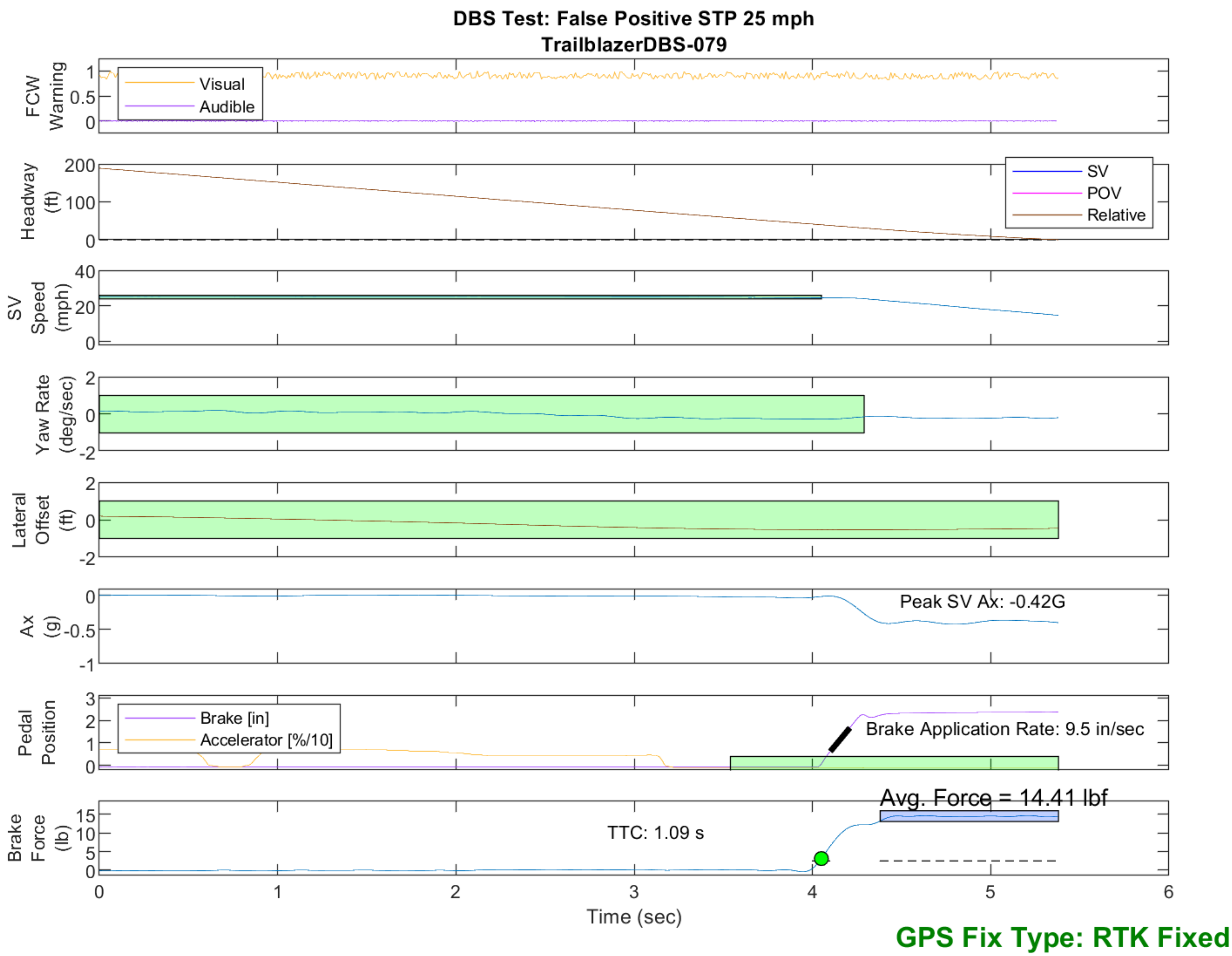


Figure E61. Time History for DBS Run 79, SV Encounters Steel Trench Plate, SV 25 mph

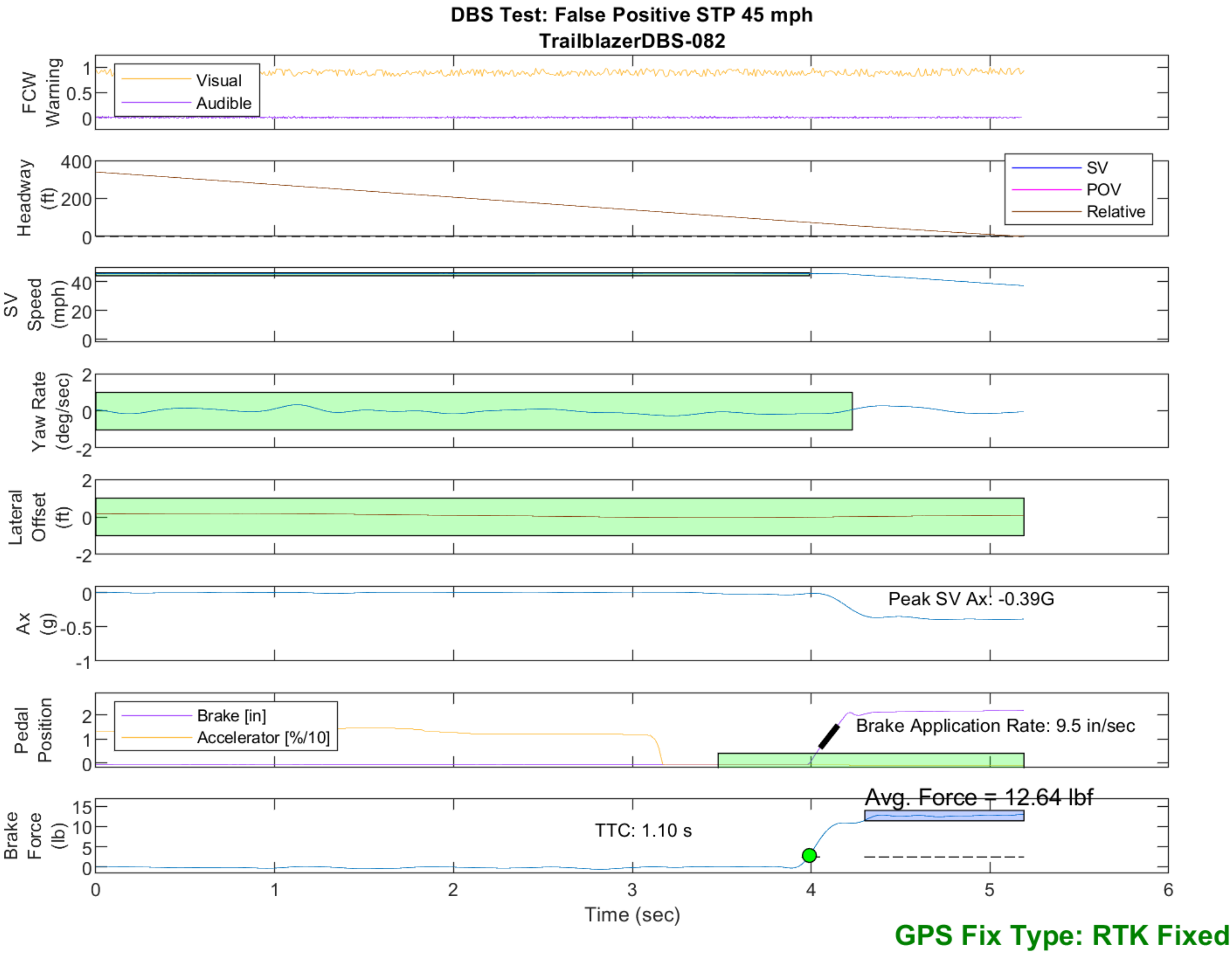


Figure E62. Time History for DBS Run 82, SV Encounters Steel Trench Plate, SV 45 mph

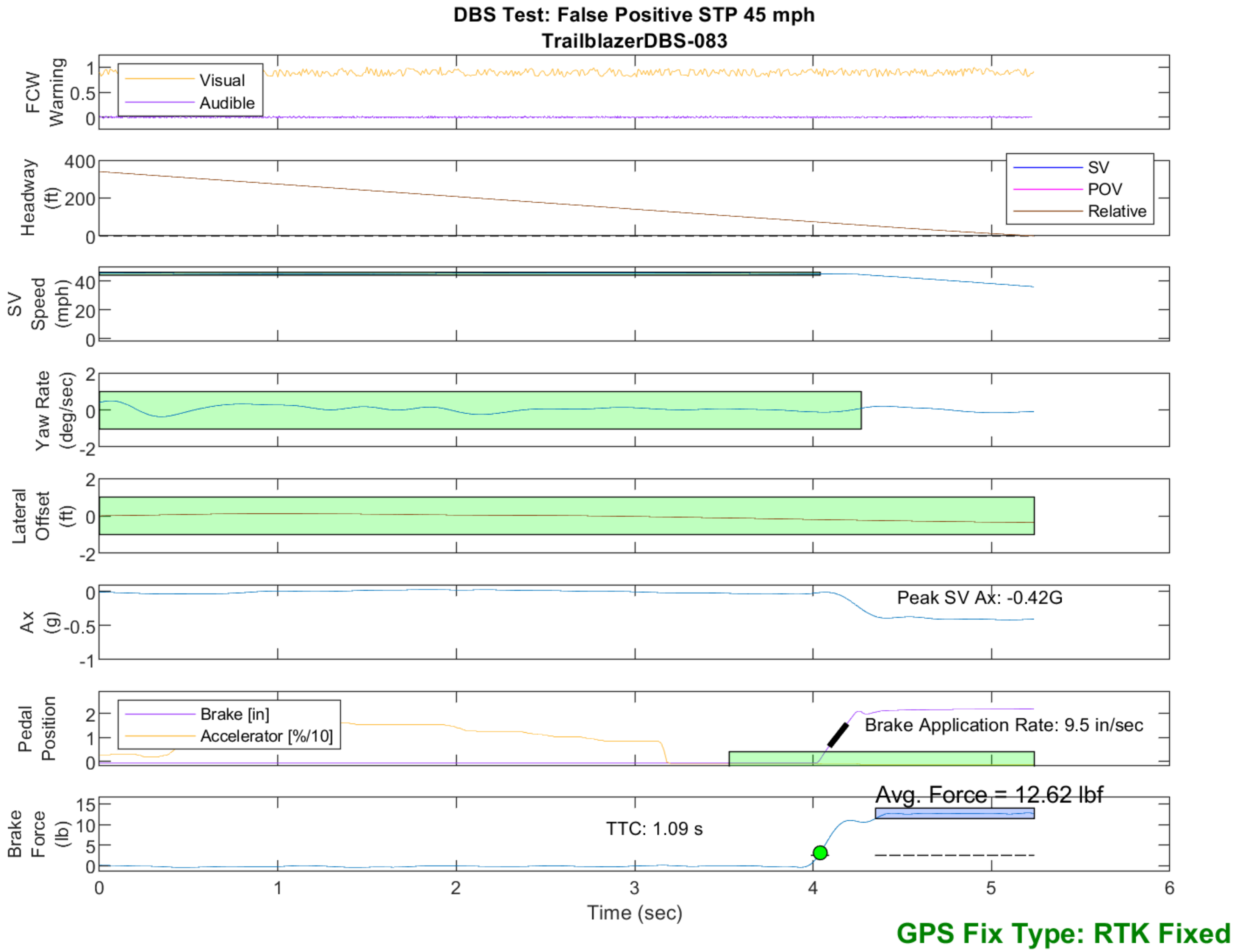


Figure E63. Time History for DBS Run 83, SV Encounters Steel Trench Plate, SV 45 mph

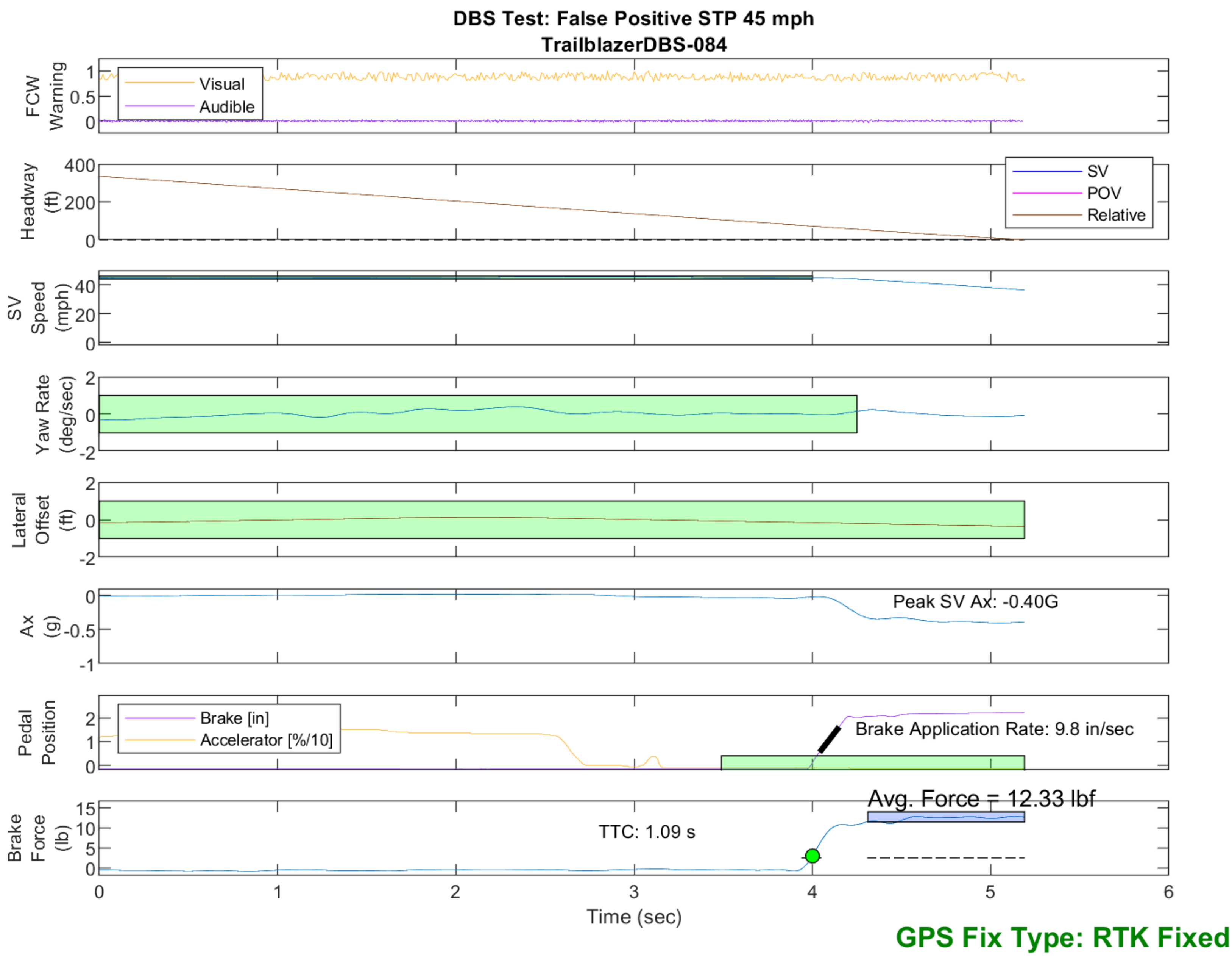


Figure E64. Time History for DBS Run 84, SV Encounters Steel Trench Plate, SV 45 mph

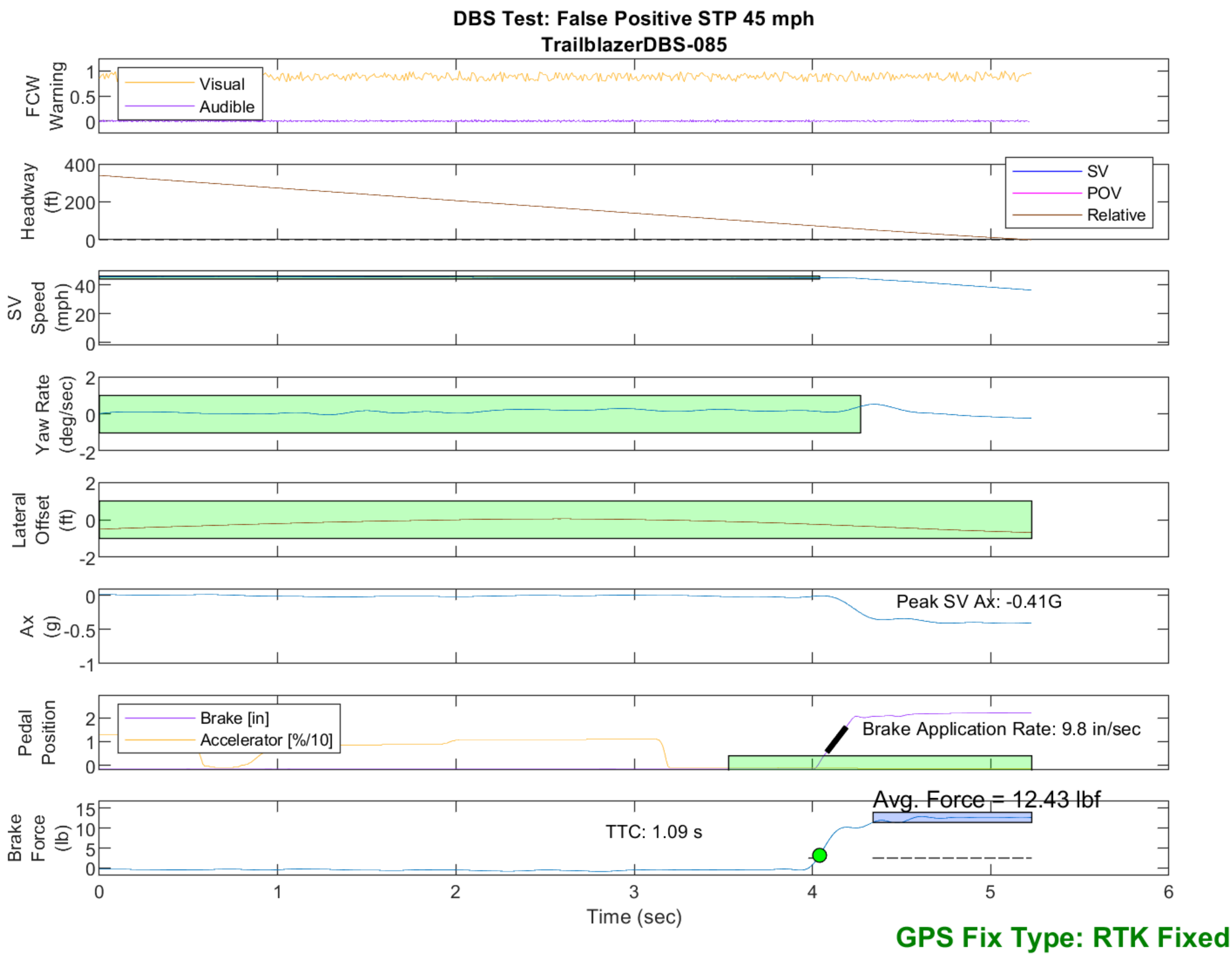


Figure E65. Time History for DBS Run 85, SV Encounters Steel Trench Plate, SV 45 mph

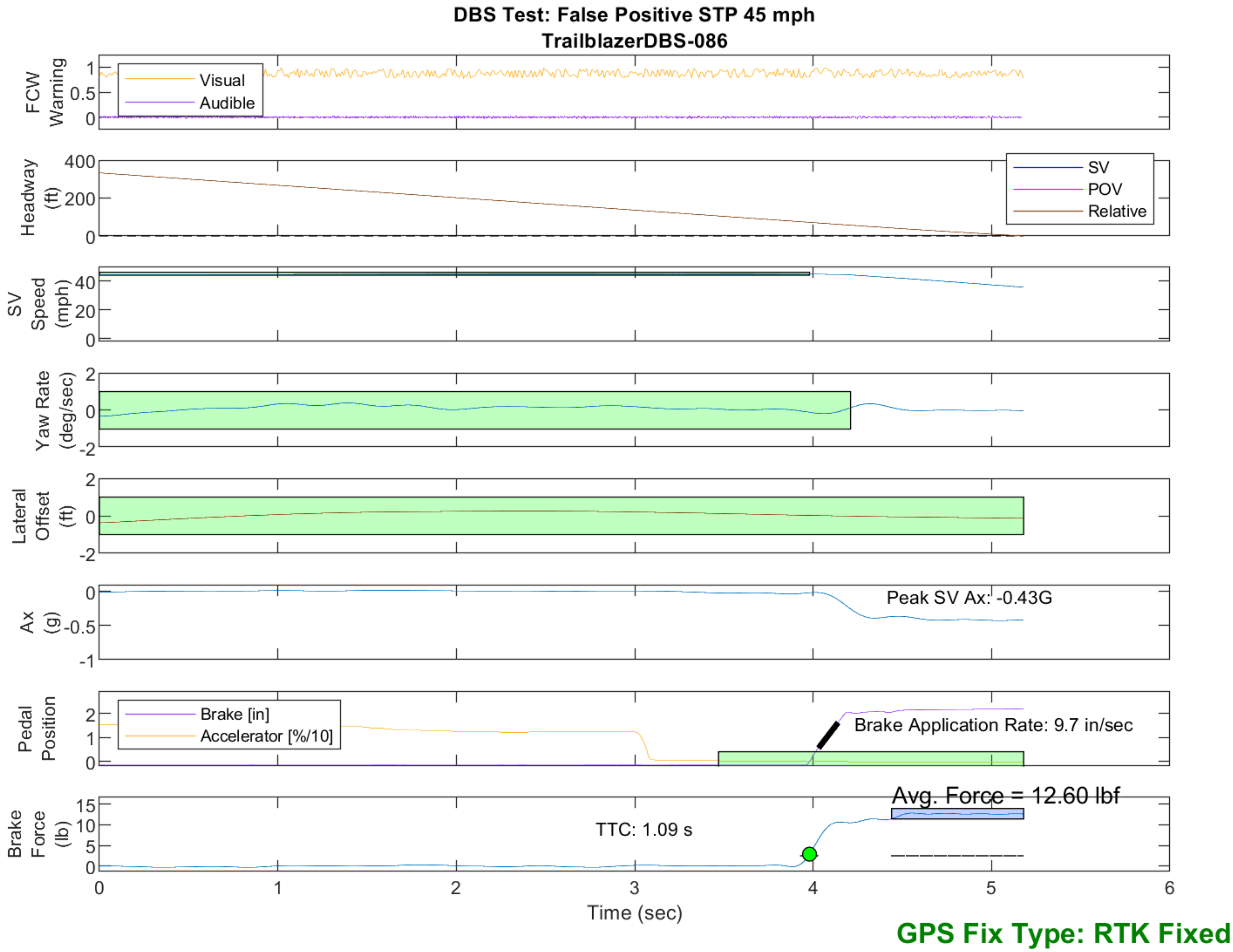


Figure E66. Time History for DBS Run 86, SV Encounters Steel Trench Plate, SV 45 mph

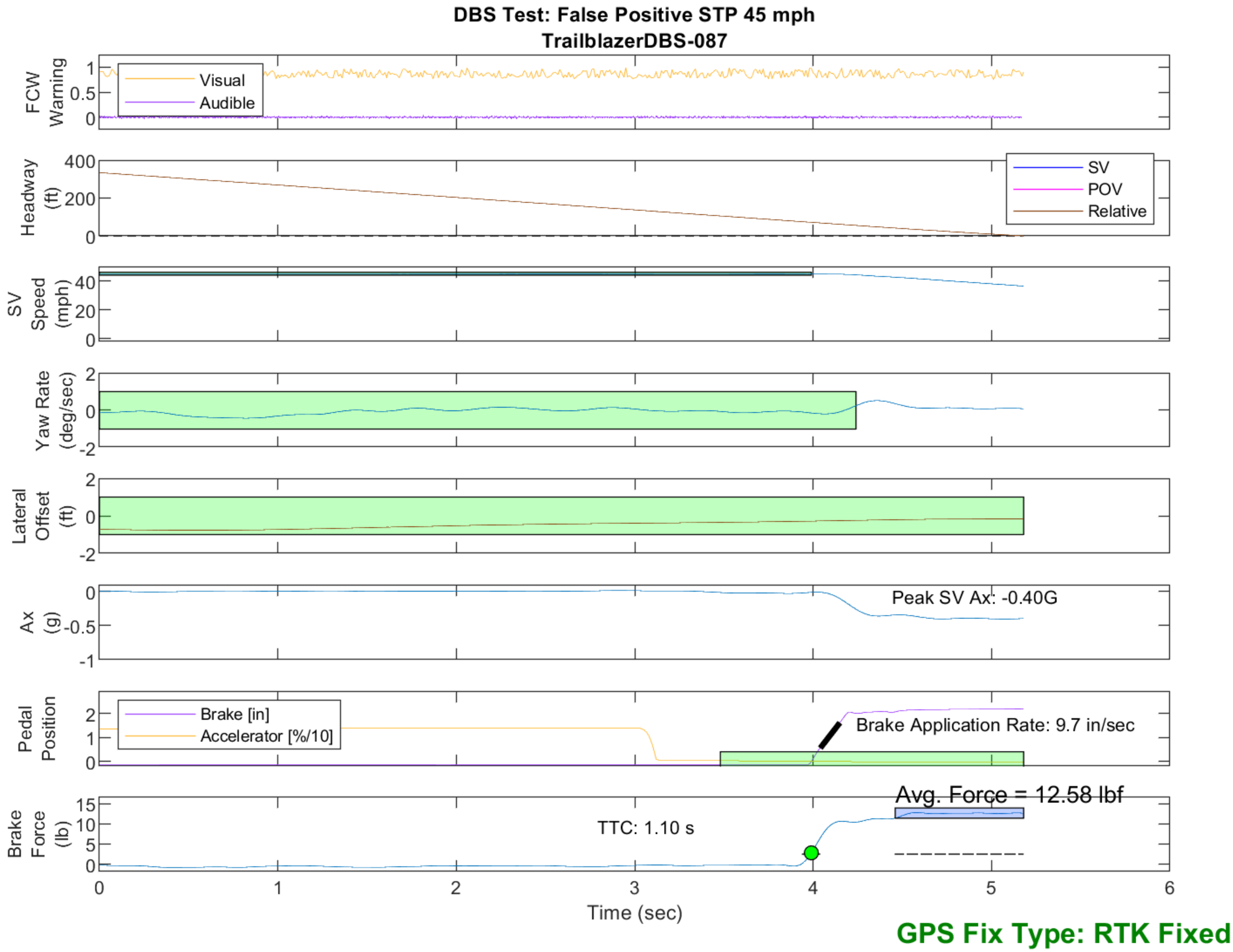


Figure E67. Time History for DBS Run 87, SV Encounters Steel Trench Plate, SV 45 mph

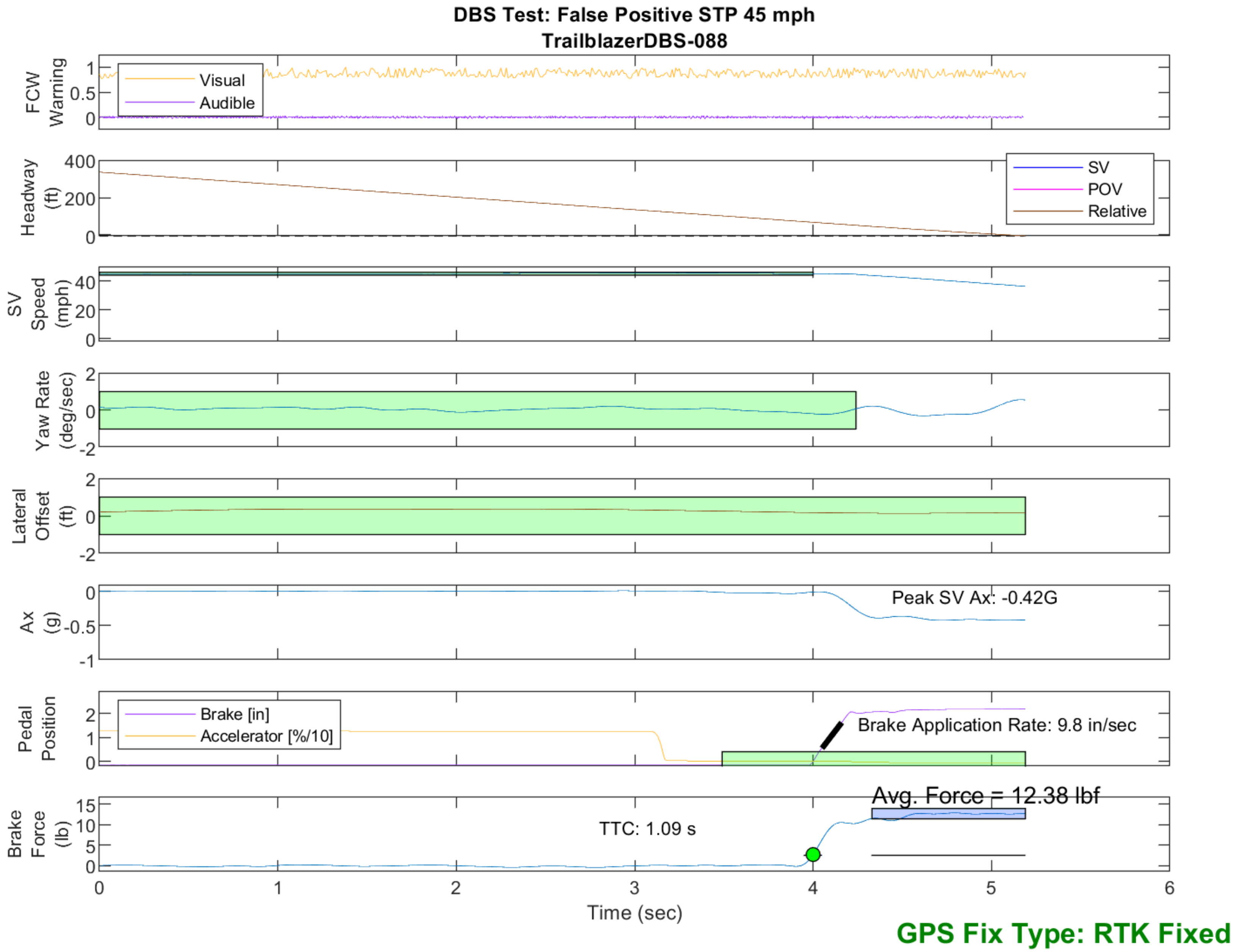


Figure E68. Time History for DBS Run 88, SV Encounters Steel Trench Plate, SV 45 mph

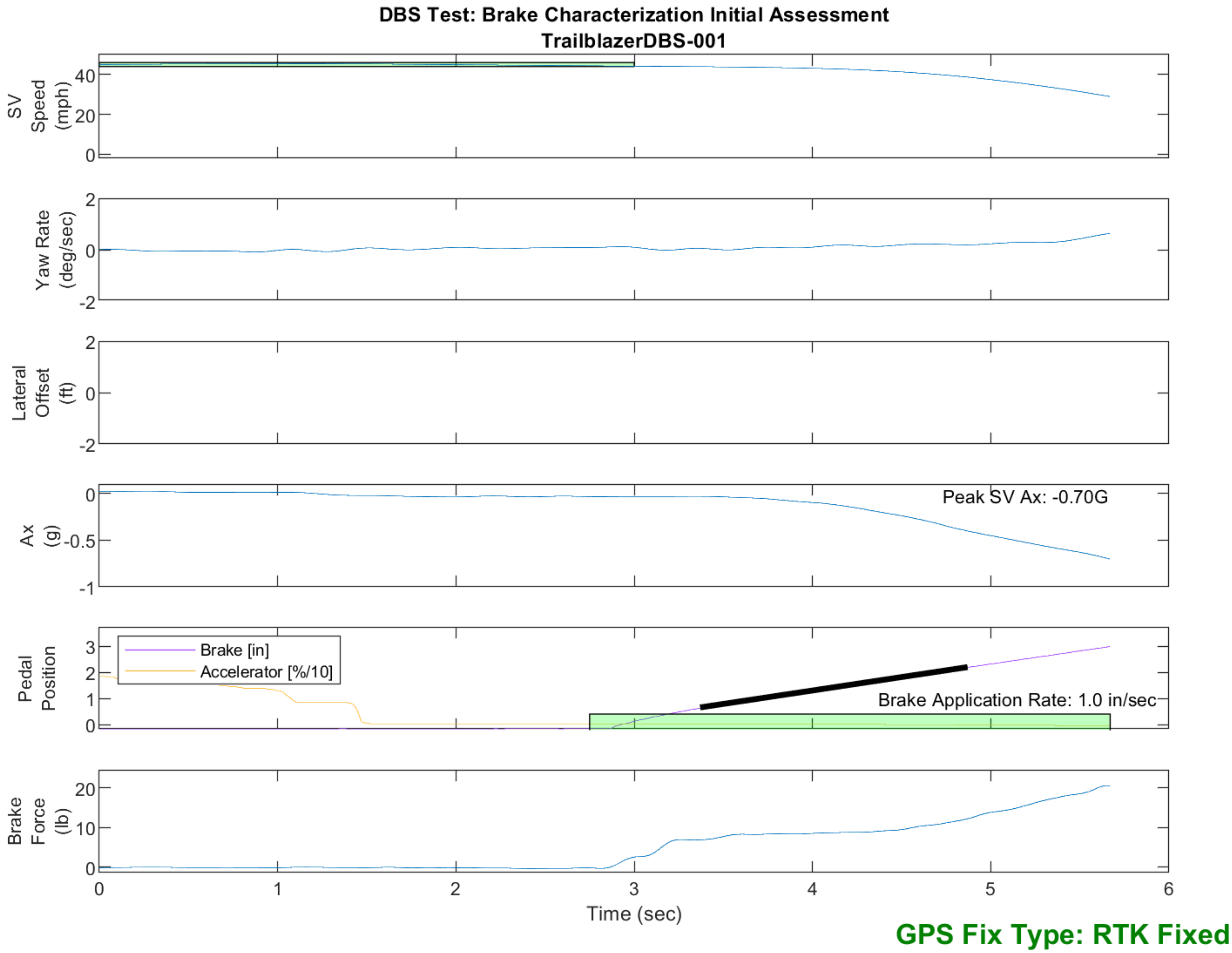


Figure E69. Time History for DBS Run 1, Brake Characterization Initial

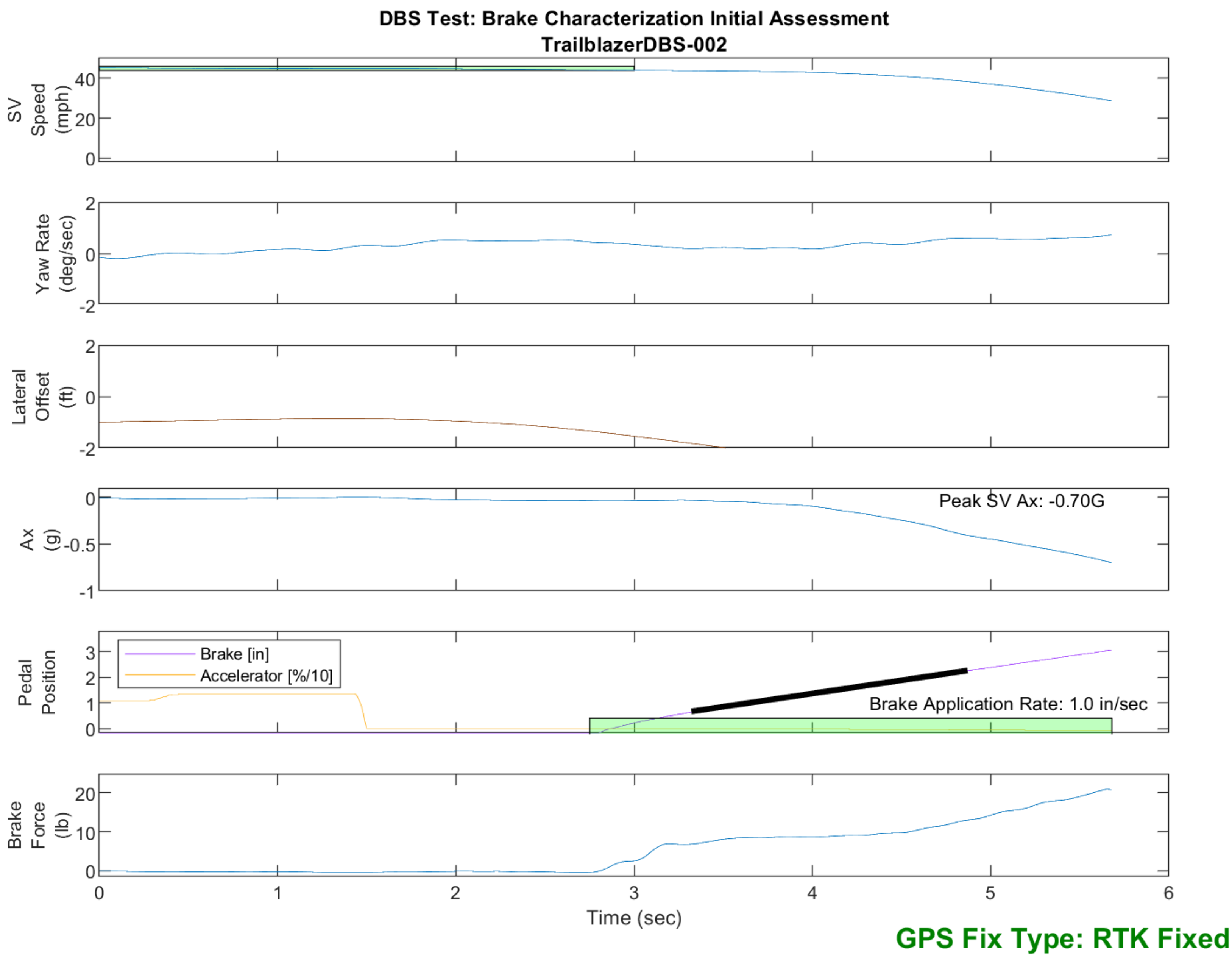


Figure E70. Time History for DBS Run 2, Brake Characterization Initial

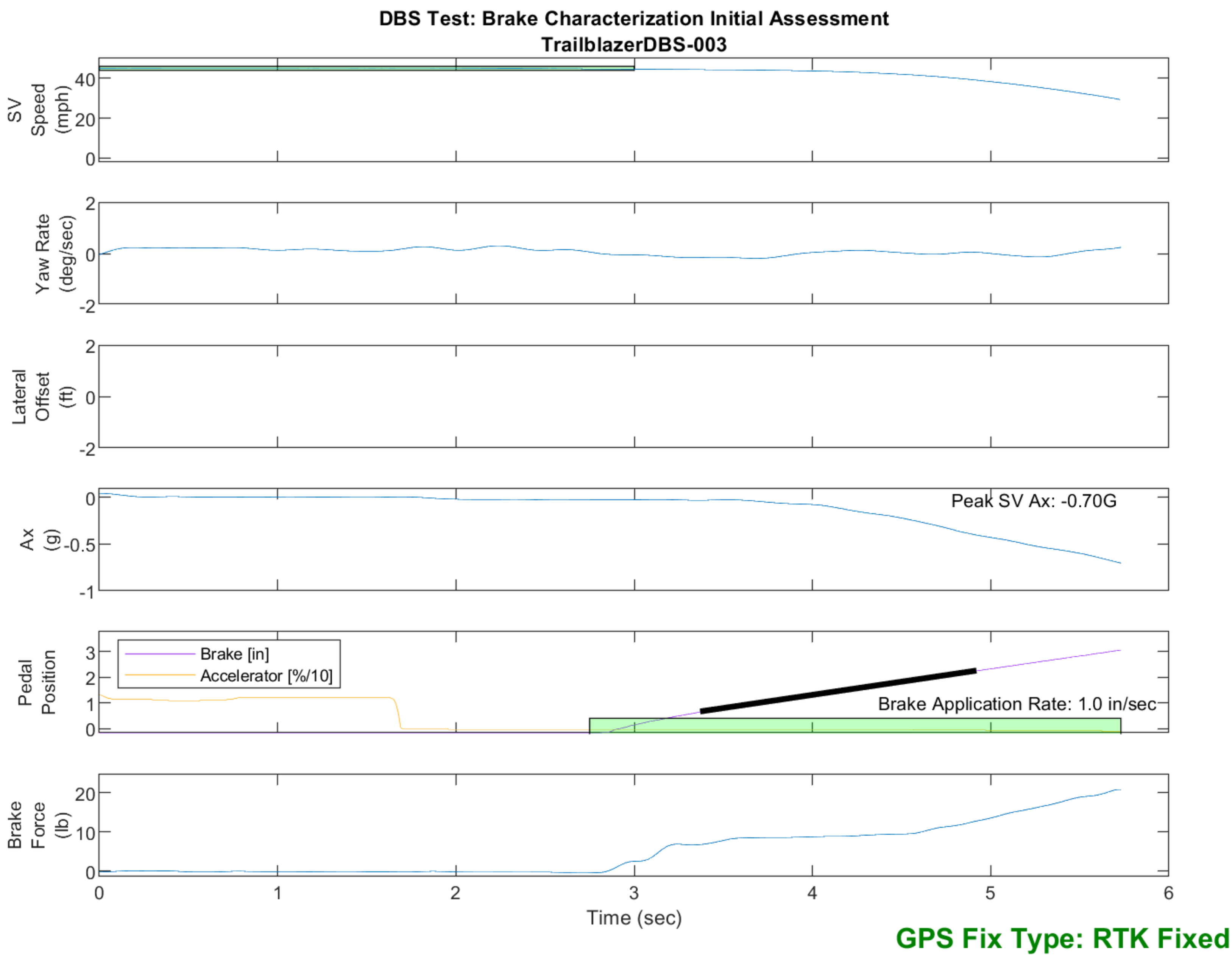


Figure E71. Time History for DBS Run 3, Brake Characterization Initial

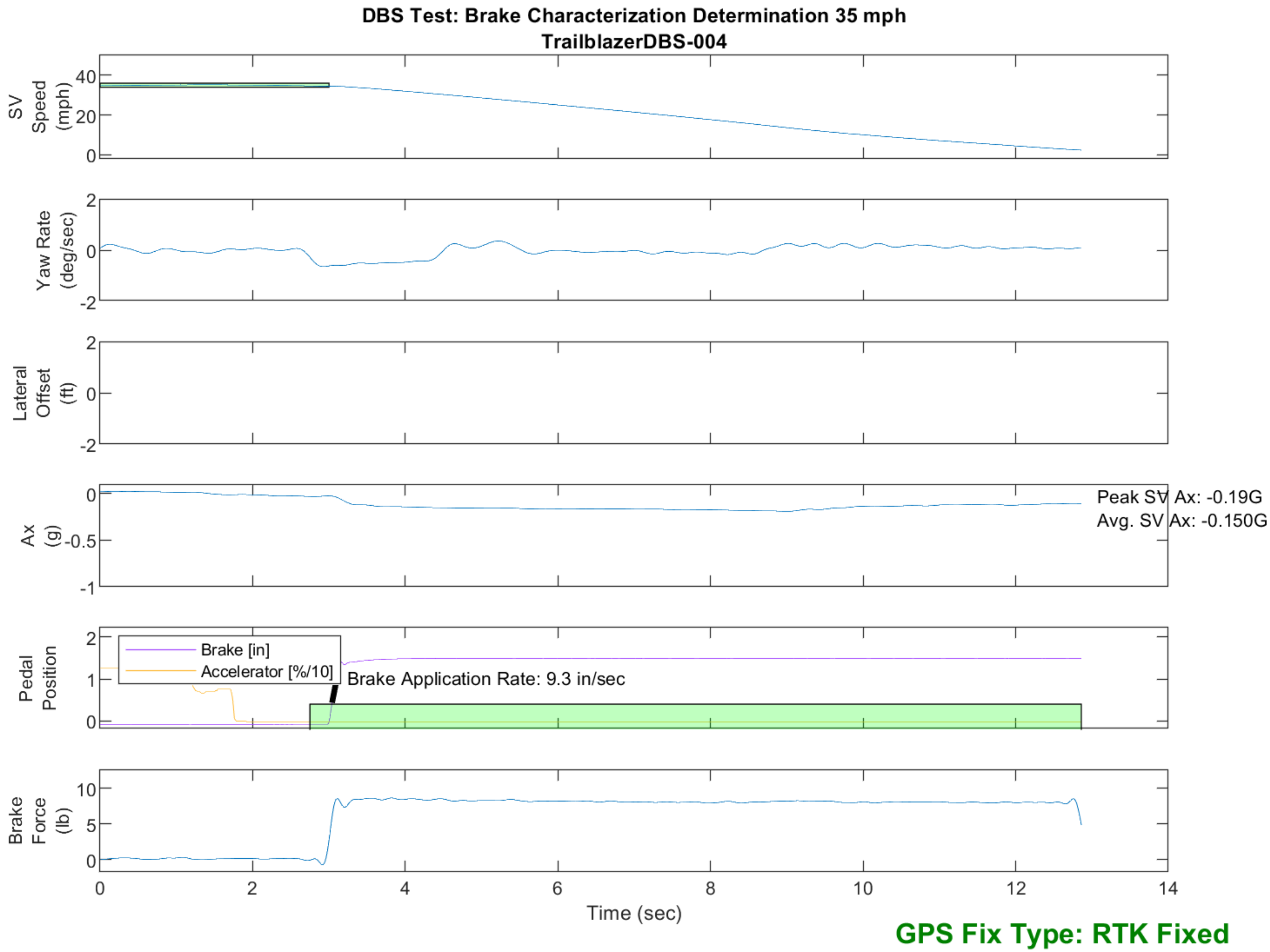


Figure E72. Time History for DBS Run 4, Brake Characterization Determination, Displacement Mode, 35 mph

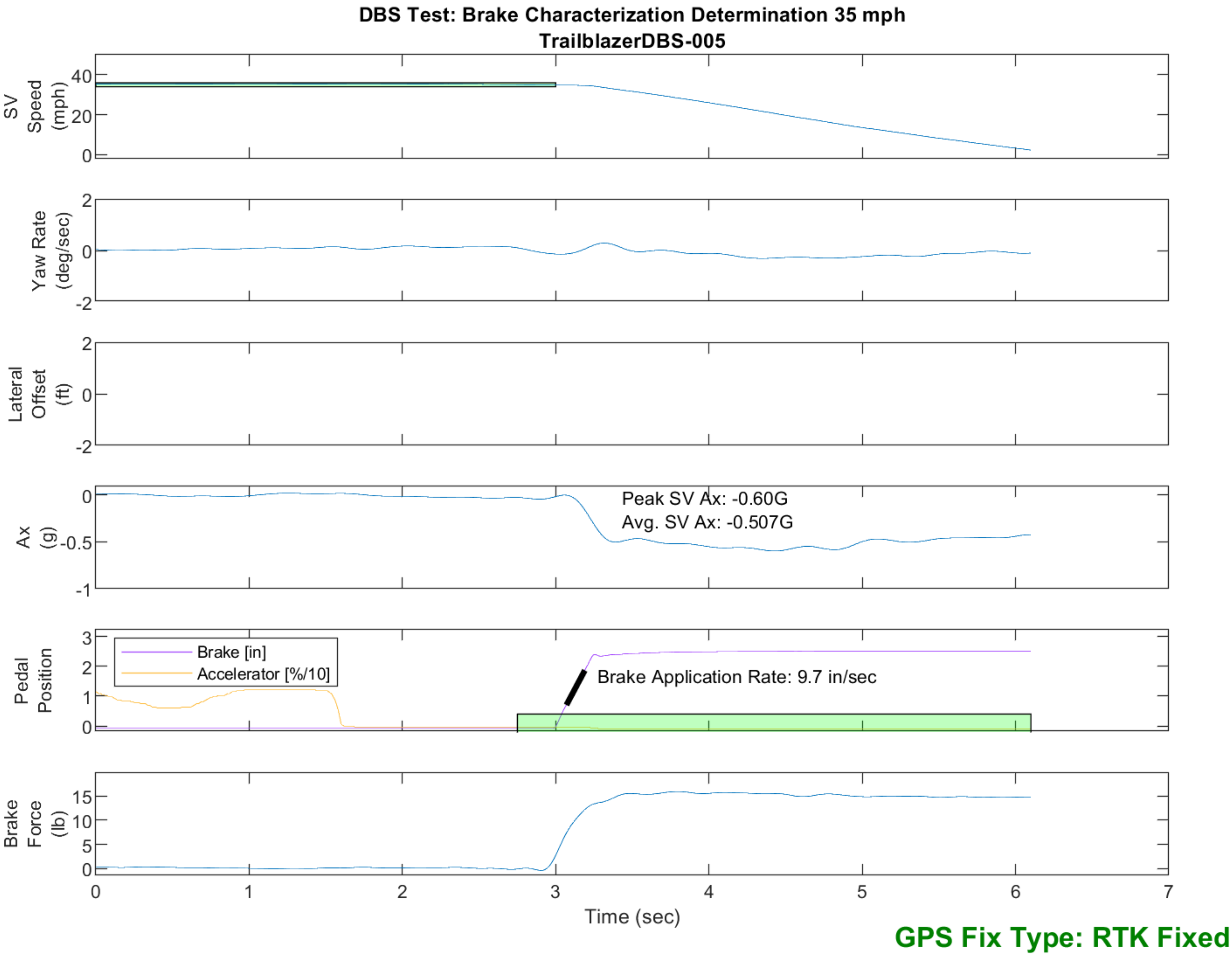


Figure E73. Time History for DBS Run 5, Brake Characterization Determination, Displacement Mode, 35 mph

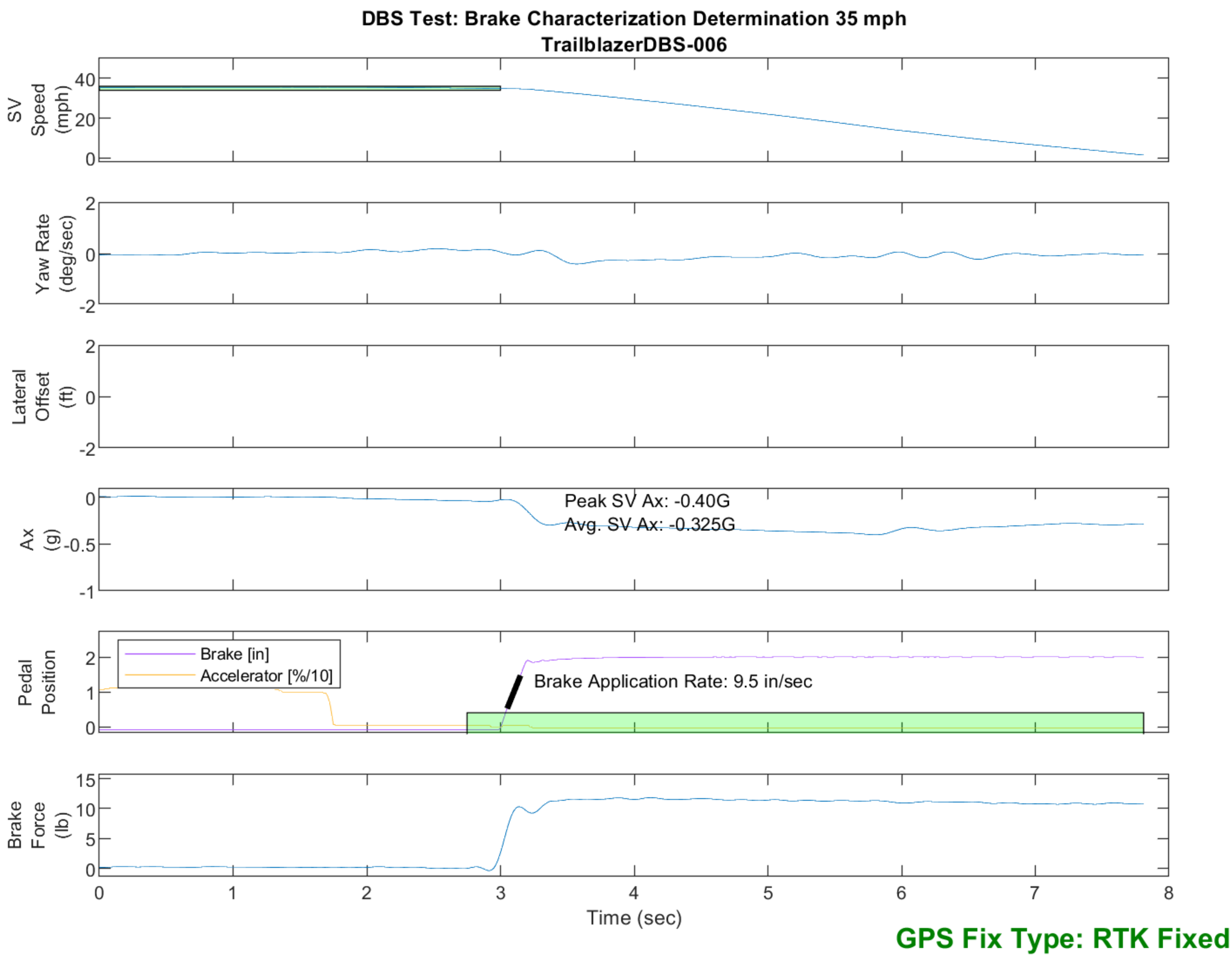


Figure E74. Time History for DBS Run 6, Brake Characterization Determination, Displacement Mode, 35 mph

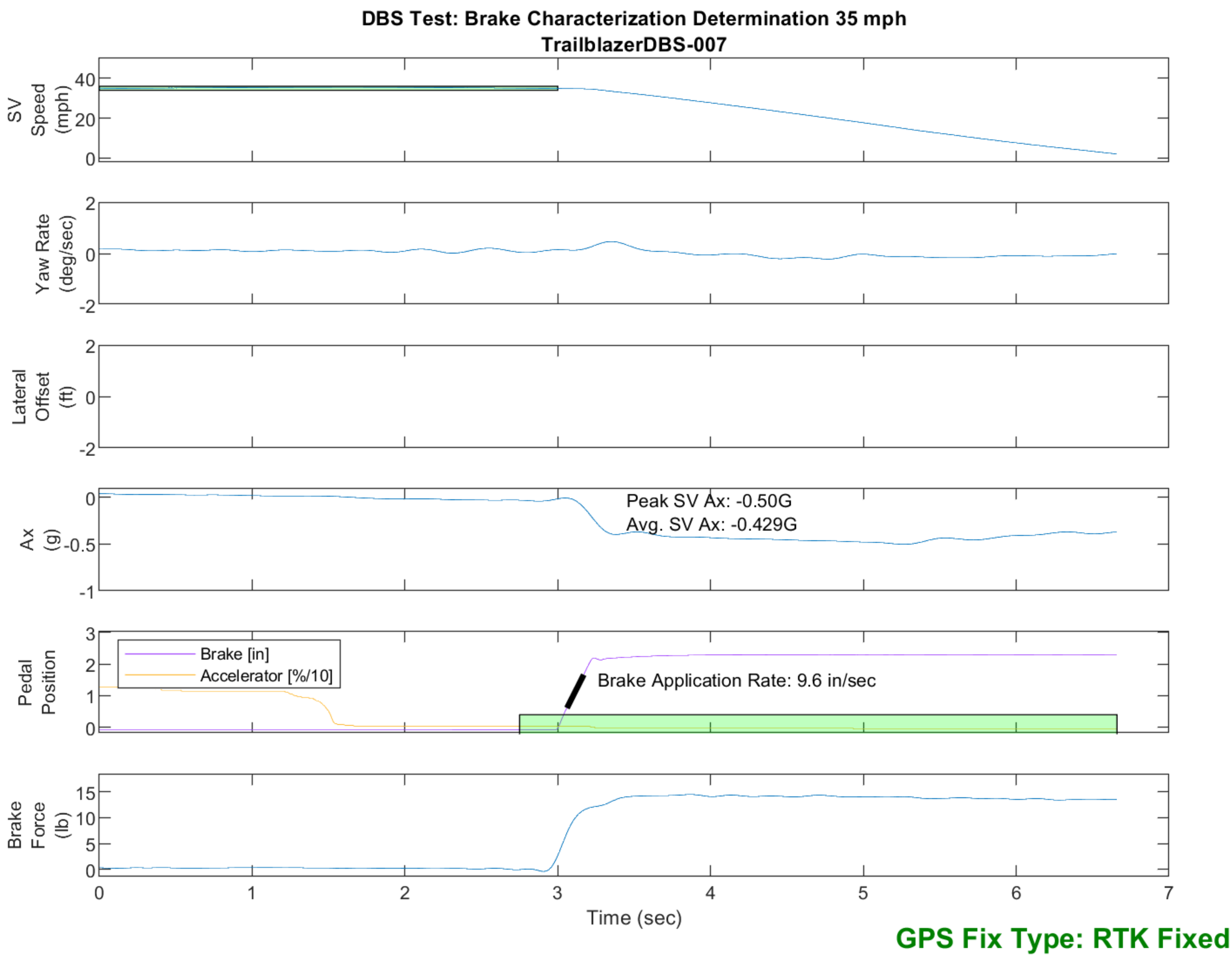


Figure E75. Time History for DBS Run 7, Brake Characterization Determination, Displacement Mode, 35 mph

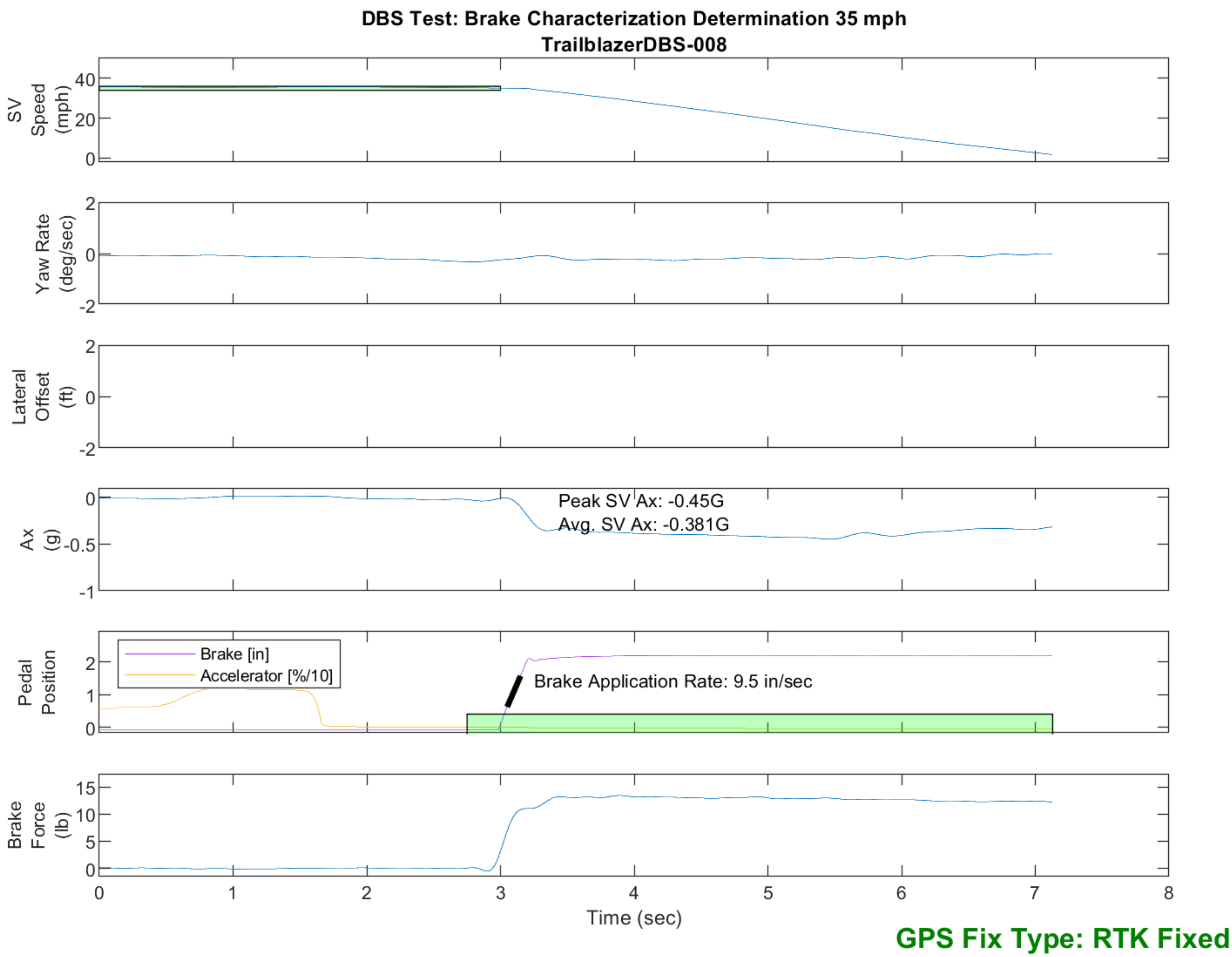


Figure E76. Time History for DBS Run 8, Brake Characterization Determination, Displacement Mode, 35 mph

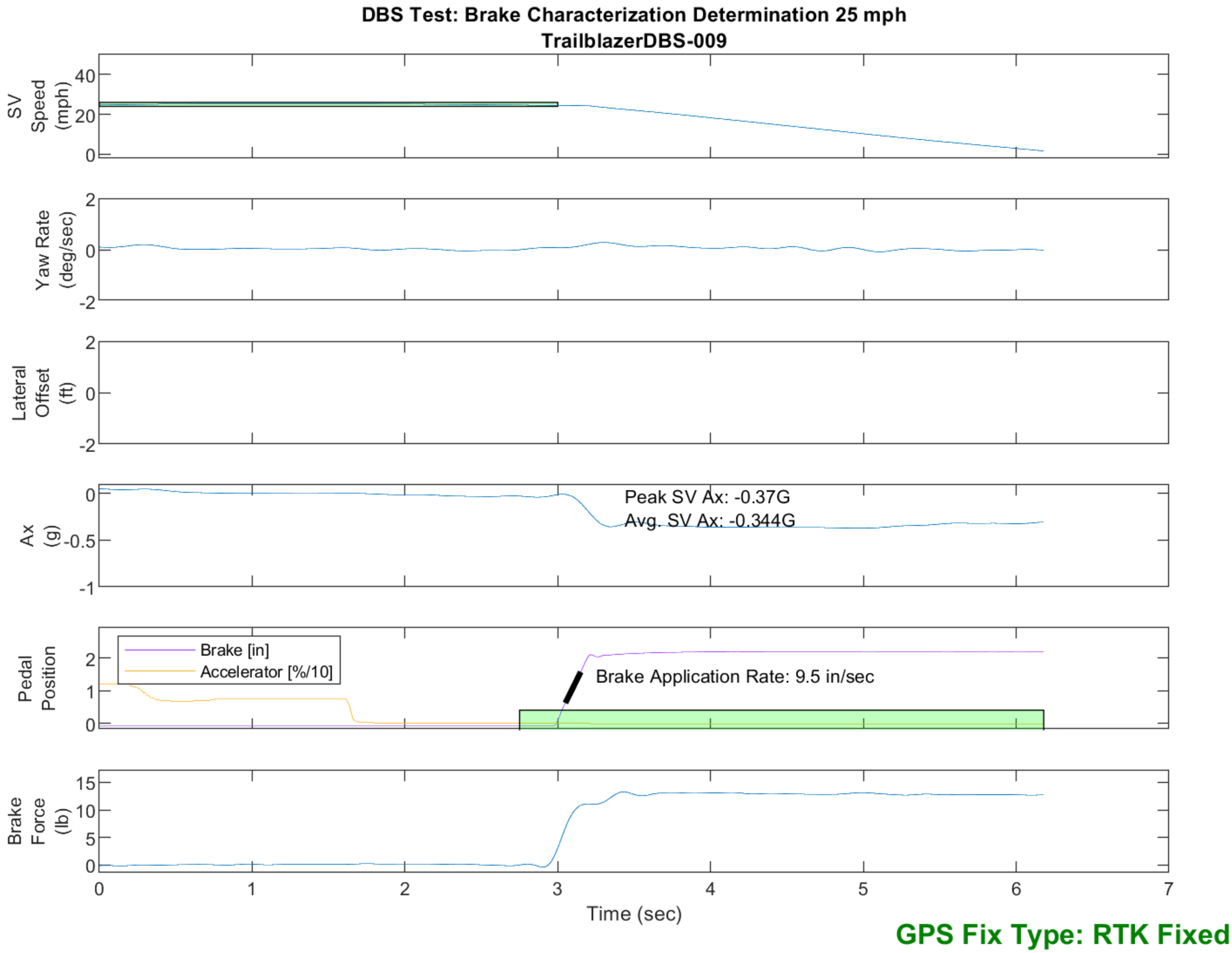


Figure E77. Time History for DBS Run 9, Brake Characterization Determination, Displacement Mode, 25 mph

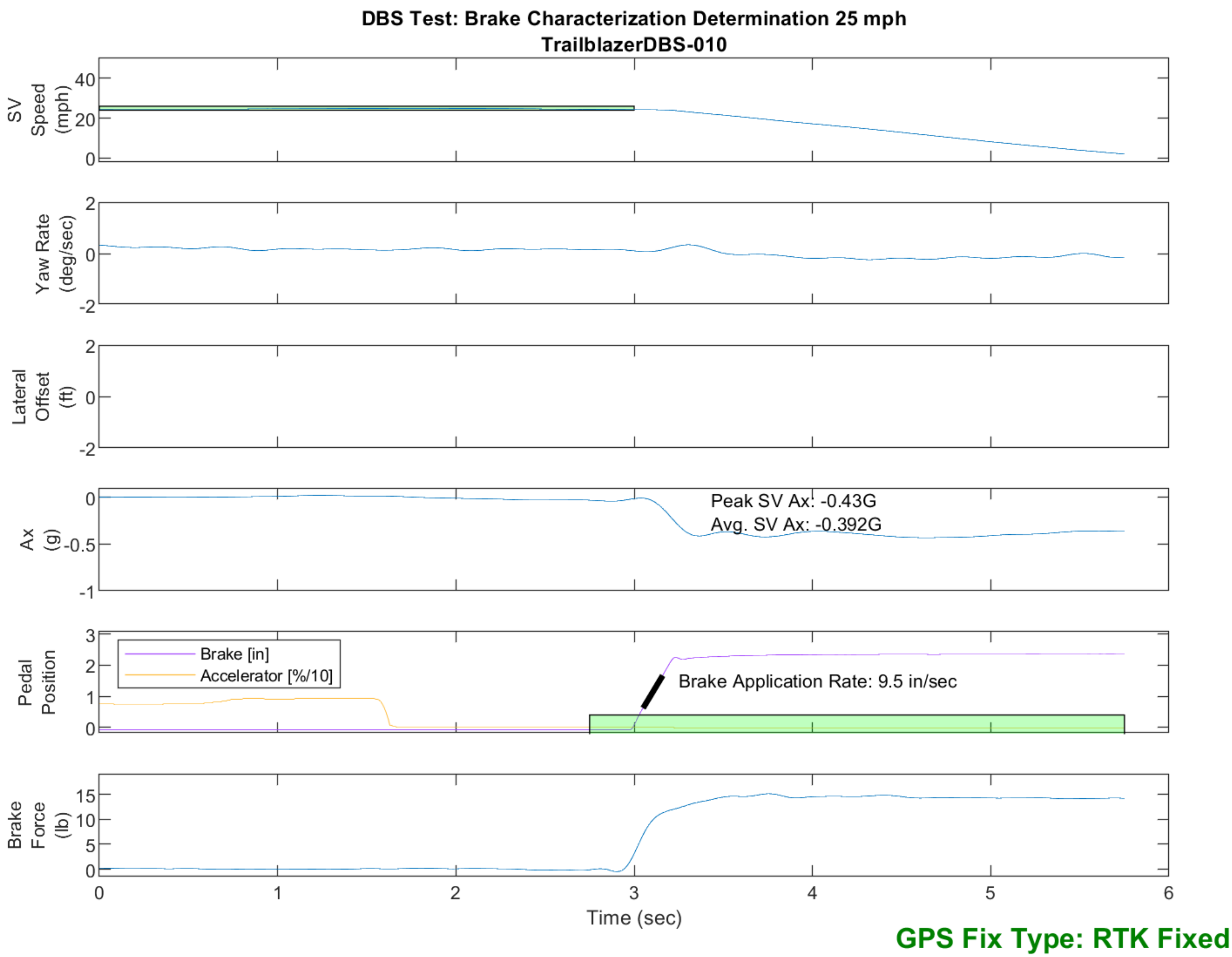


Figure E78. Time History for DBS Run 10, Brake Characterization Determination, Displacement Mode, 25 mph

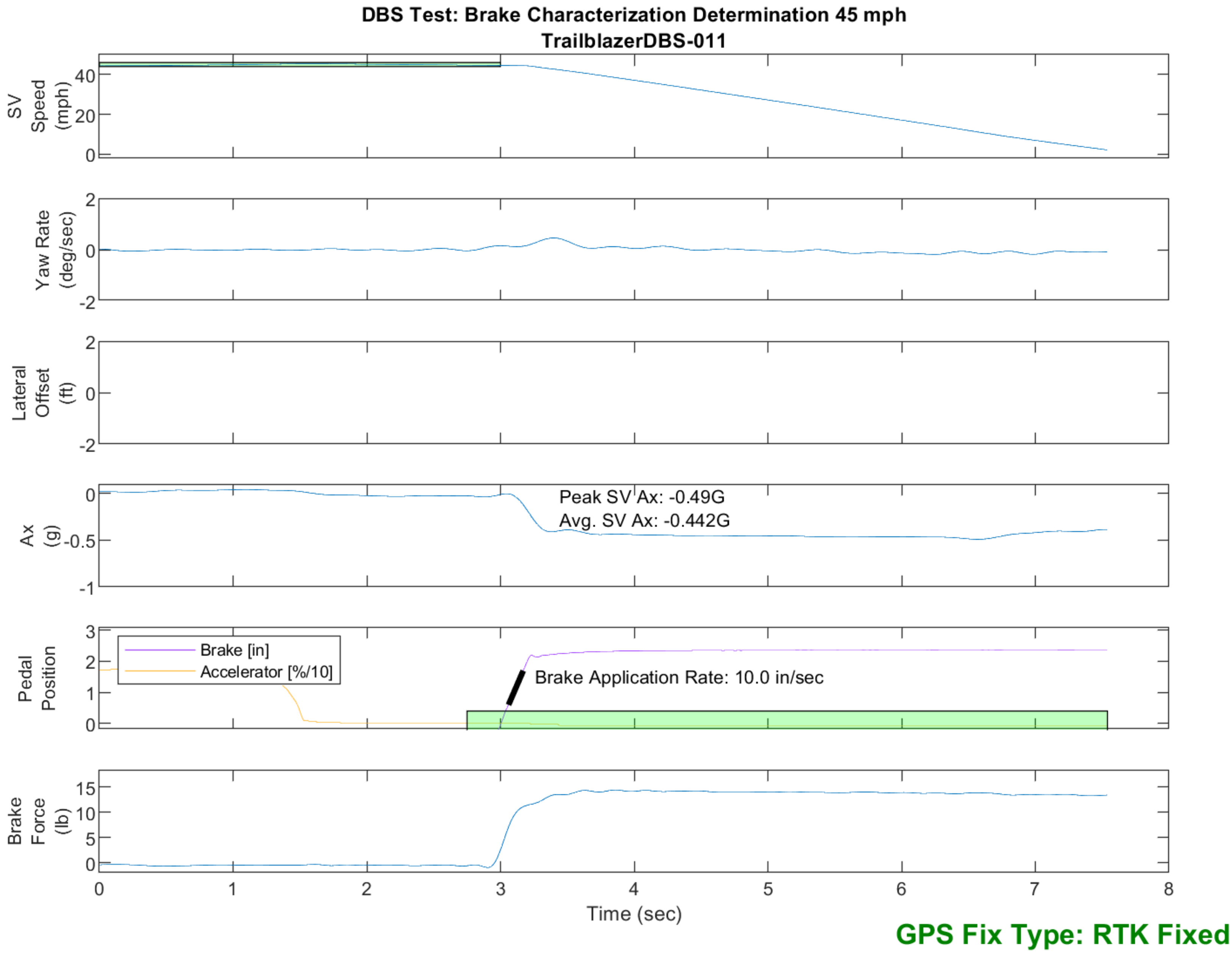


Figure E79. Time History for DBS Run 11, Brake Characterization Determination, Displacement Mode, 45 mph

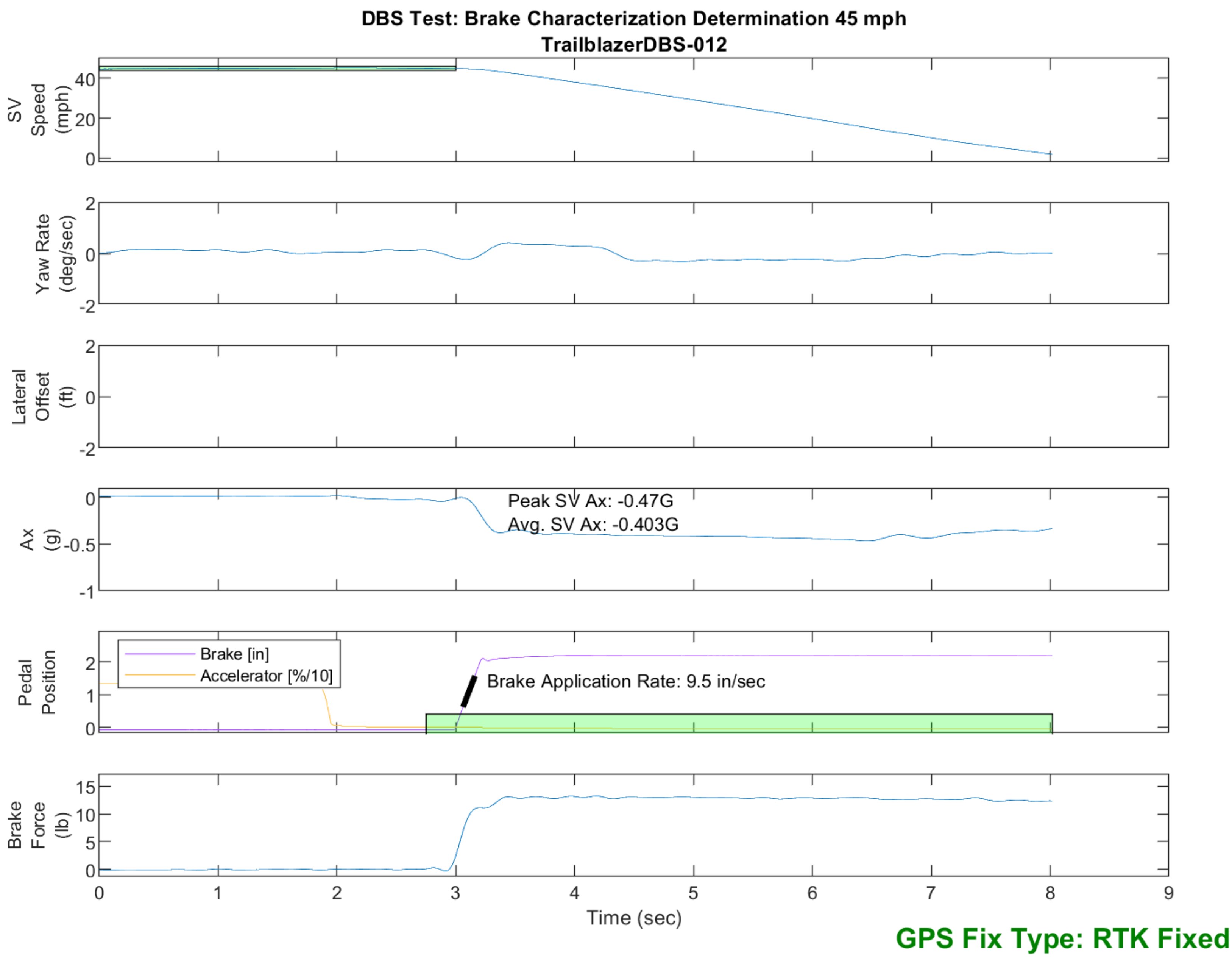


Figure E80. Time History for DBS Run 12, Brake Characterization Determination, Displacement Mode, 45 mph

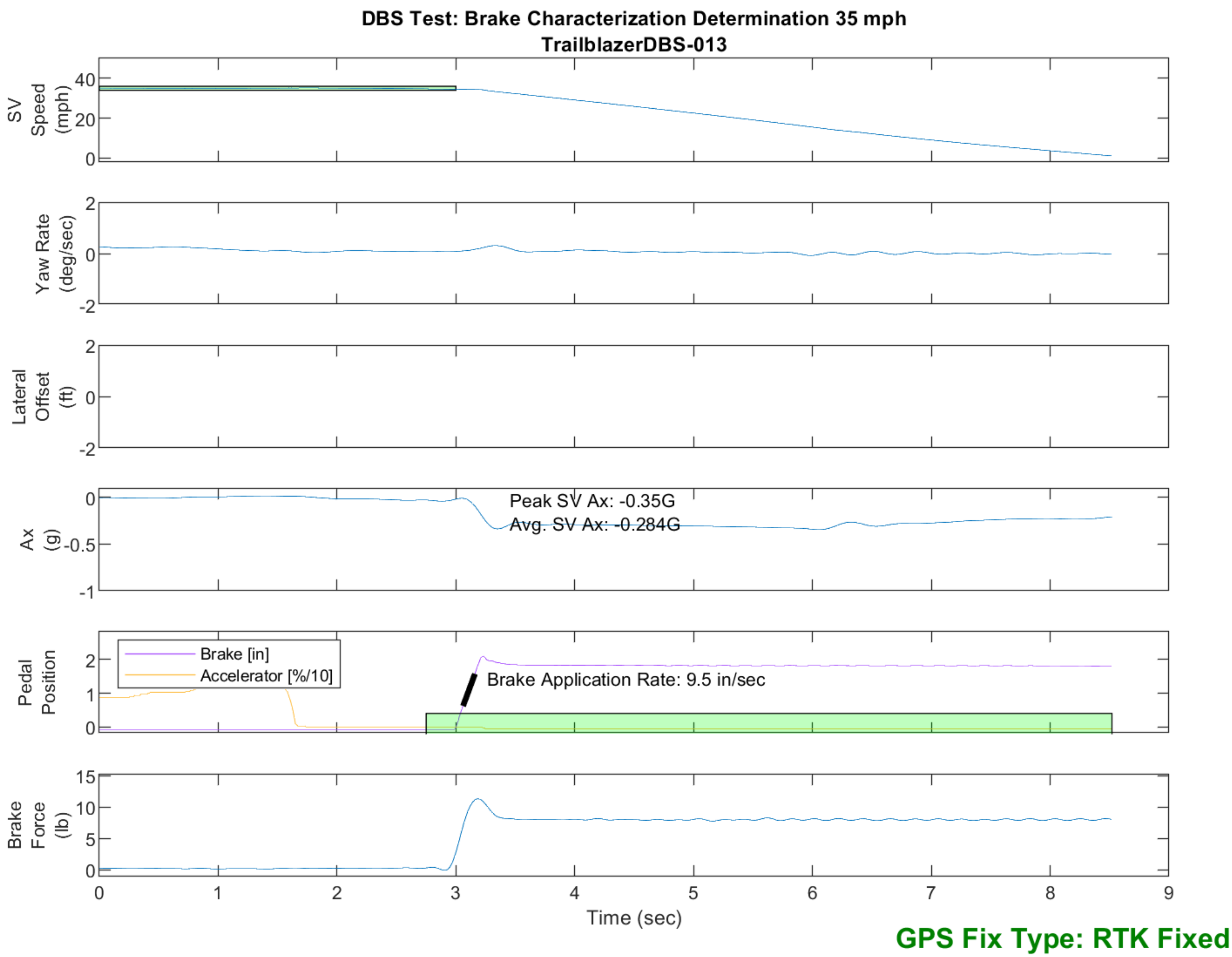


Figure E81. Time History for DBS Run 13, Brake Characterization Determination, Hybrid Mode, 35 mph

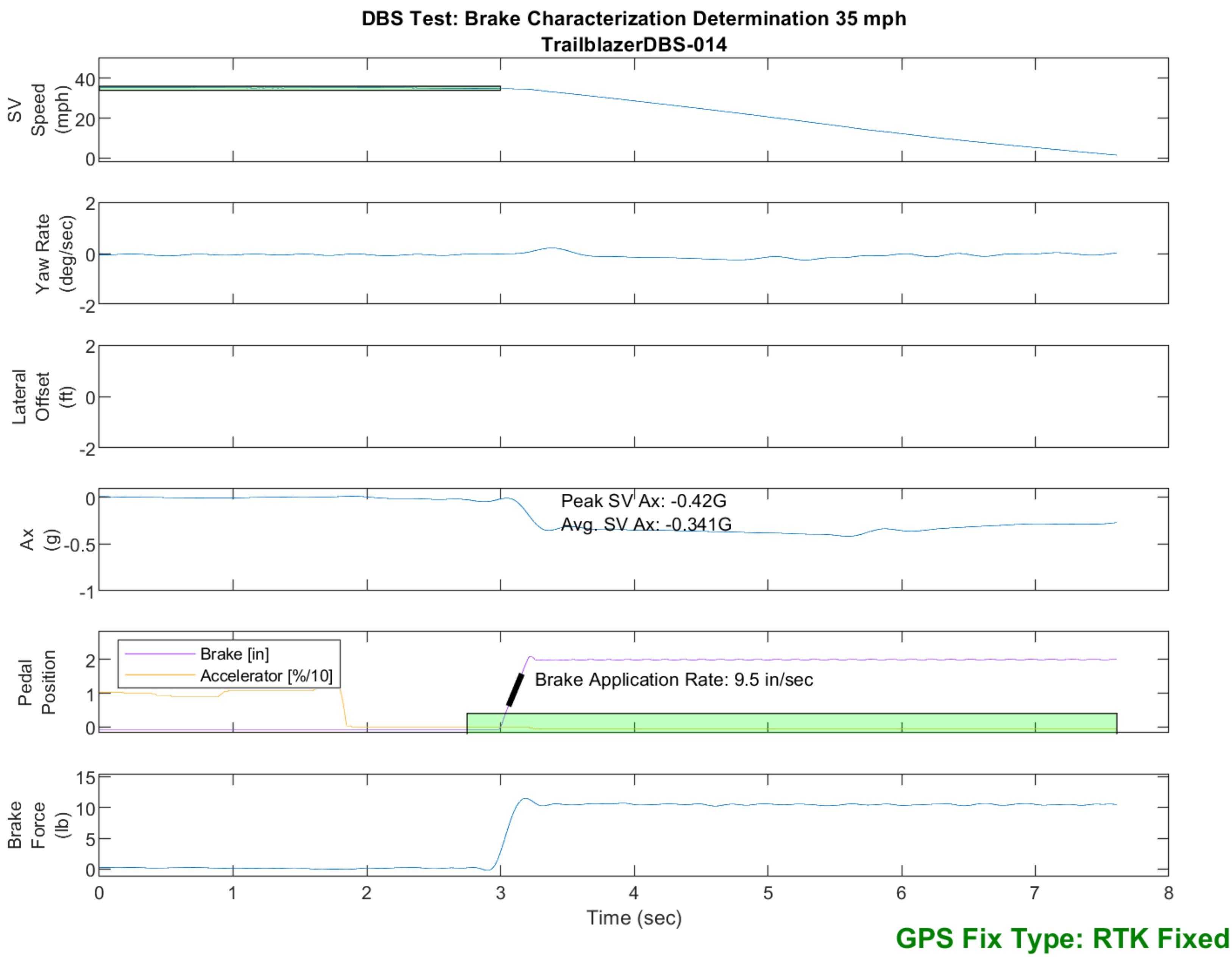


Figure E82. Time History for DBS Run 14, Brake Characterization Determination, Hybrid Mode, 35 mph

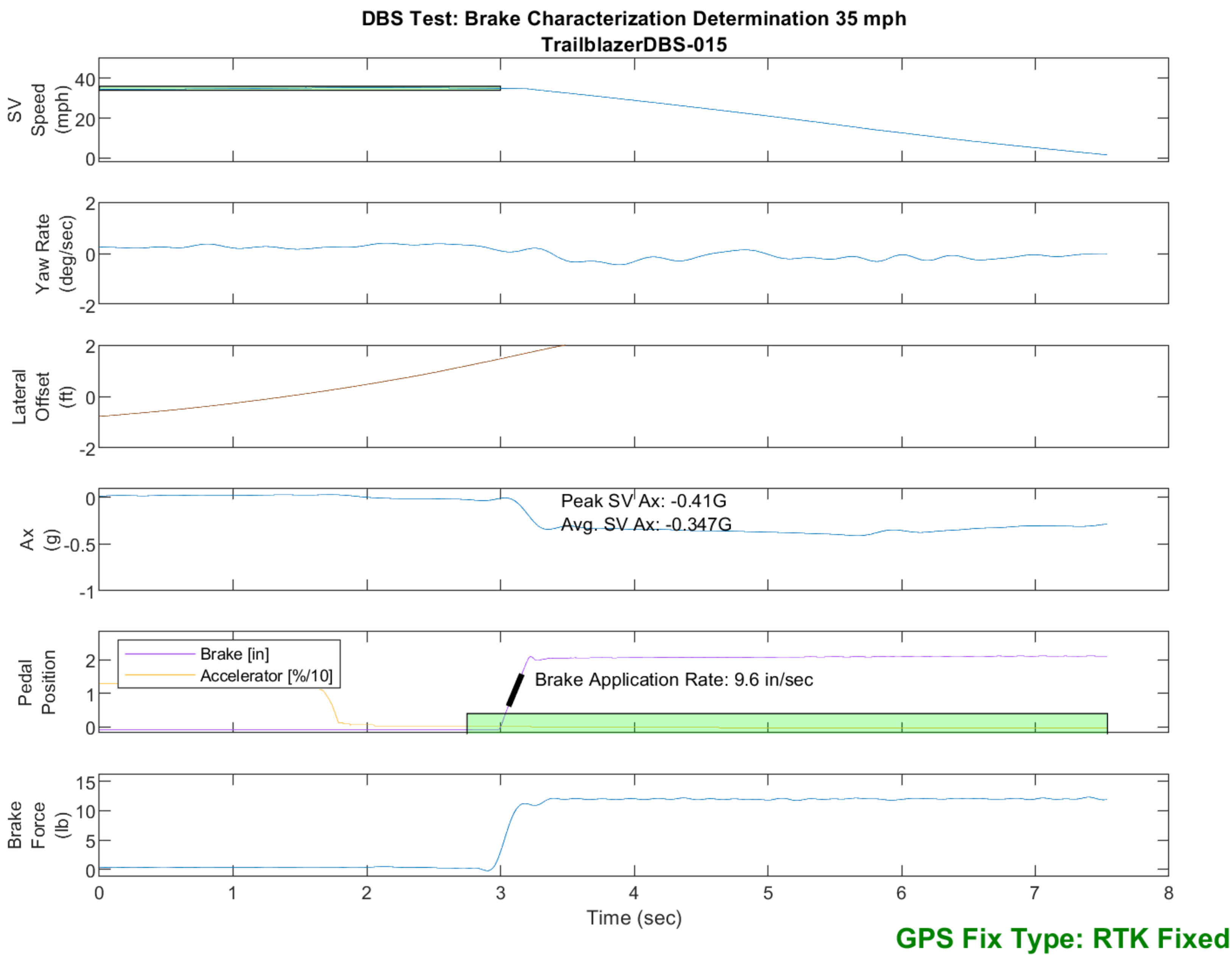


Figure E83. Time History for DBS Run 15, Brake Characterization Determination, Hybrid Mode, 35 mph

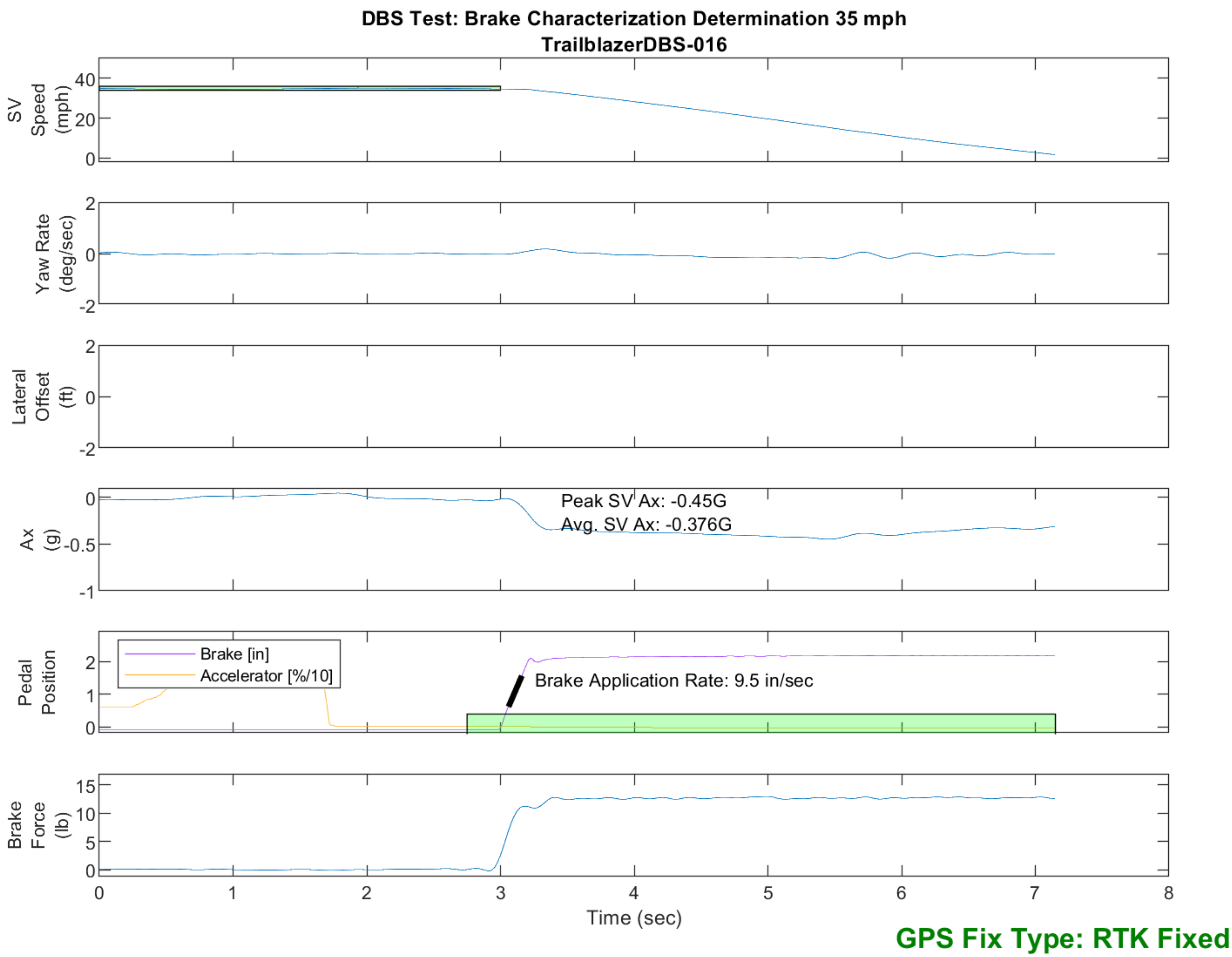


Figure E84. Time History for DBS Run 16, Brake Characterization Determination, Hybrid Mode, 35 mph

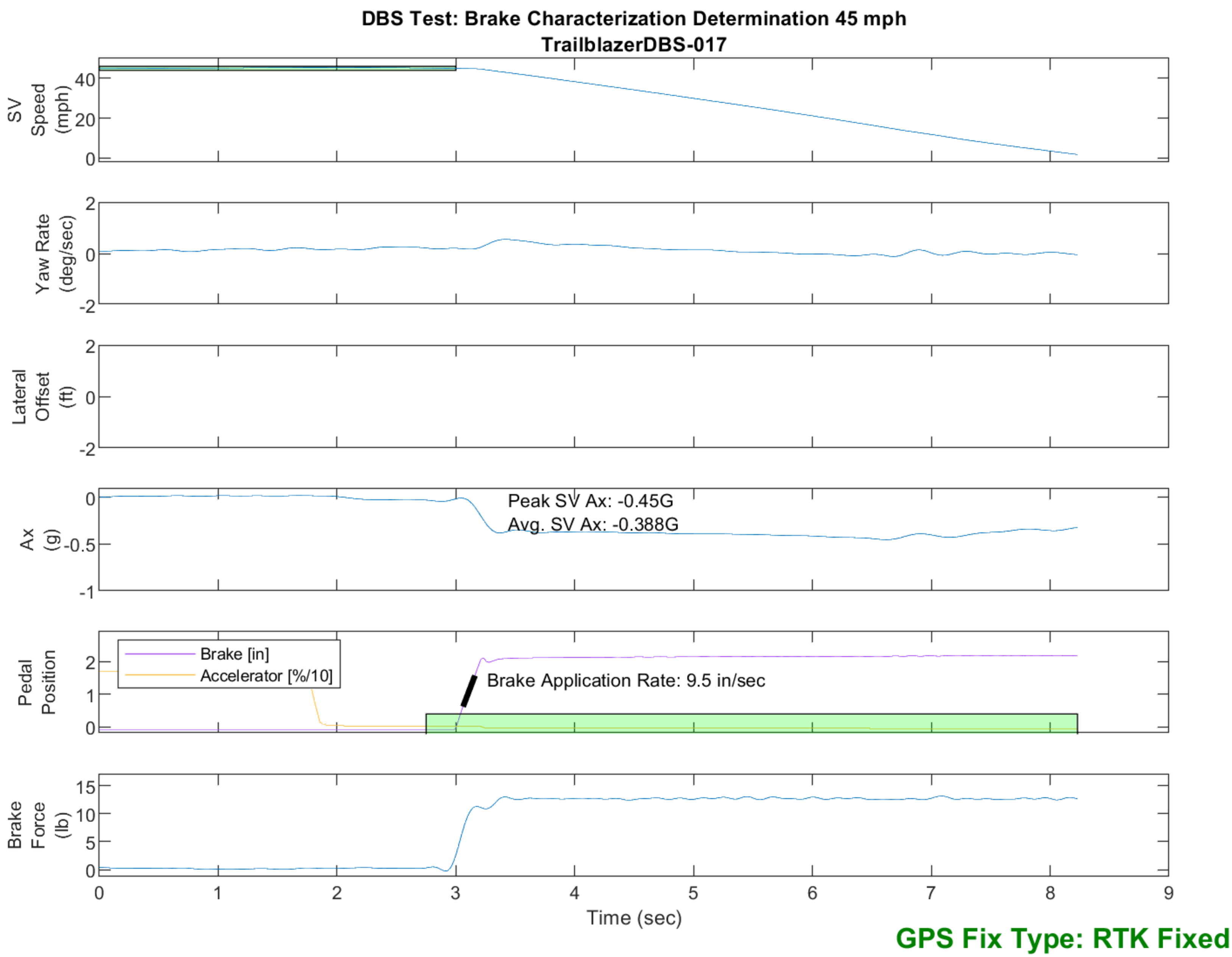


Figure E85. Time History for DBS Run 17, Brake Characterization Determination, Hybrid Mode, 45 mph

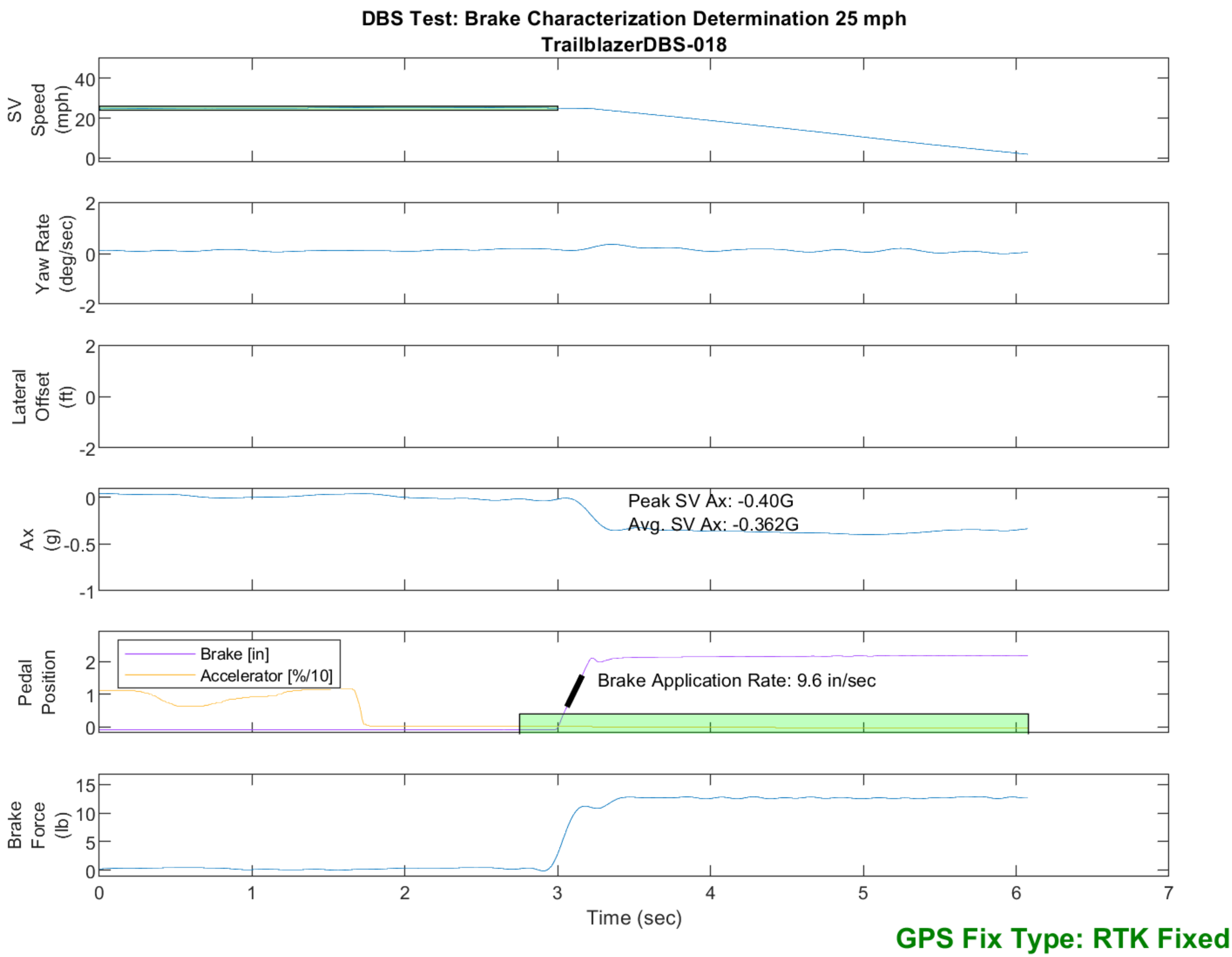


Figure E86. Time History for DBS Run 18, Brake Characterization Determination, Hybrid Mode, 25 mph

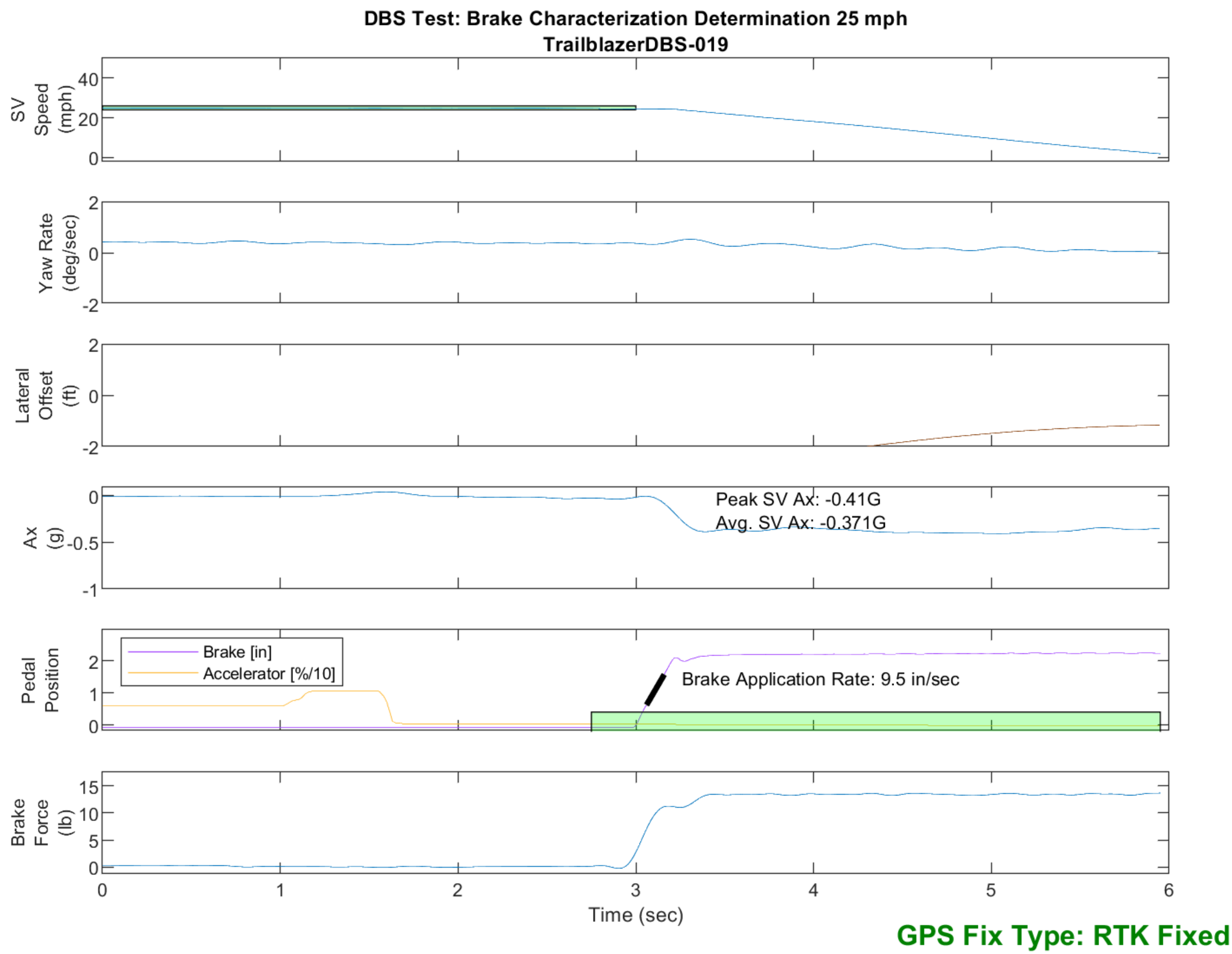


Figure E87. Time History for DBS Run 19, Brake Characterization Determination, Hybrid Mode, 25 mph

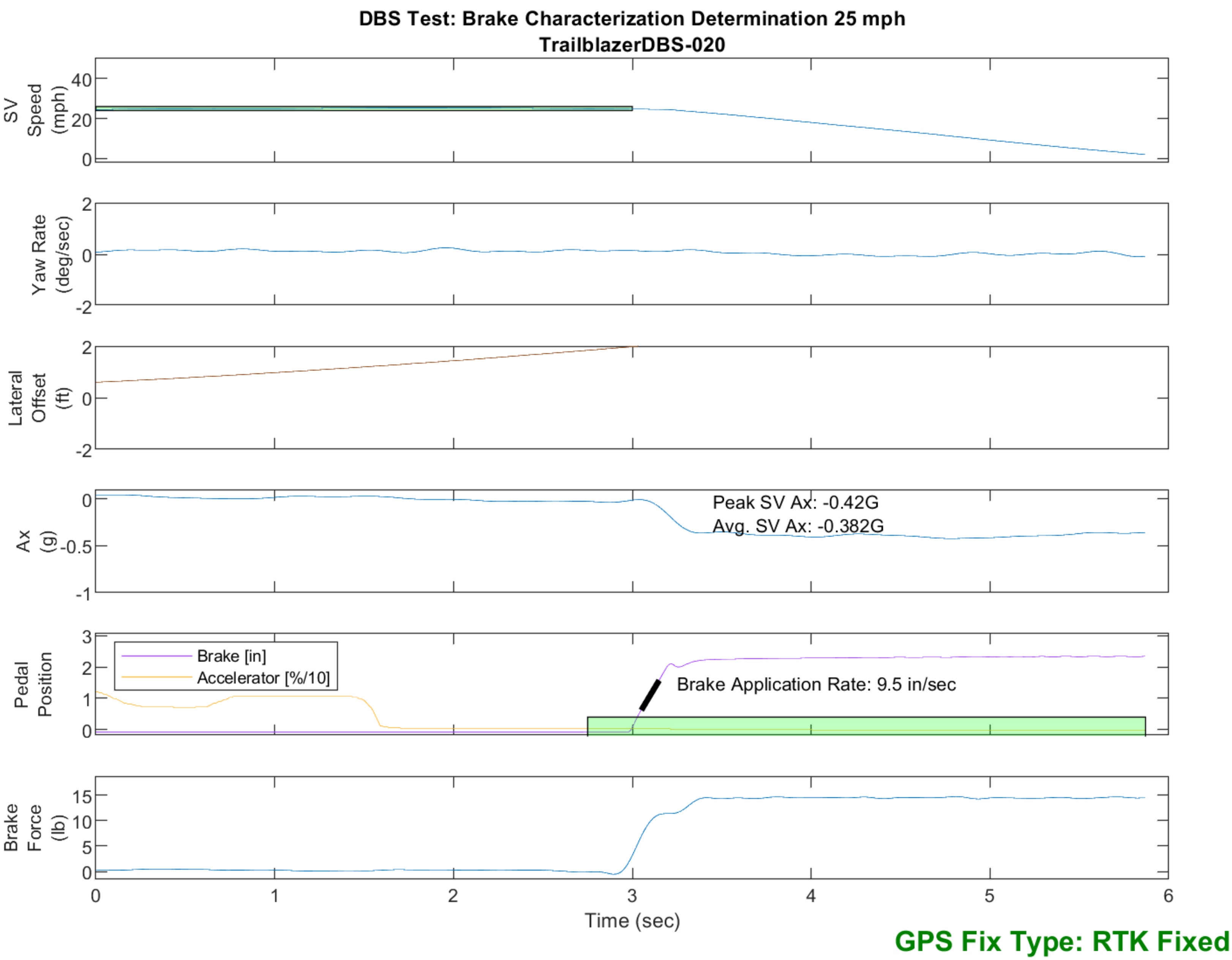


Figure E88. Time History for DBS Run 20, Brake Characterization Determination, Hybrid Mode, 25 mph