

**NEW CAR ASSESSMENT PROGRAM
DYNAMIC BRAKE SUPPORT SYSTEM CONFIRMATION TEST
NCAP-DRI-DBS-21-14**

2021 Ram 1500 Laramie Crew Cab 4x4

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15 April 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
West Building, 4th Floor (NRM-110)
Washington, DC 20590**

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

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Date: 15 April 2021

1. Report No. NCAP-DRI-DBS-21-14	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Final Report of Dynamic Brake Support System Confirmation Test of a 2021 Ram 1500 Laramie Crew Cab 4x4.		5. Report Date 15 April 2021	
		6. Performing Organization Code DRI	
7. Author(s) J. Lenkeit, Technical Director A. Ricci, Test Engineer		8. Performing Organization Report No. DRI-TM-20-218	
9. Performing Organization Name and Address Dynamic Research, Inc. 355 Van Ness Ave, STE 200 Torrance, CA 90501		10. Work Unit No.	
		11. Contract or Grant No. DTNH22-14-D-00333	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration New Car Assessment Program 1200 New Jersey Avenue, SE, West Building, 4th Floor (NRM-110) Washington, DC 20590		13. Type of Report and Period Covered Final Test Report March – April 2021	
		14. Sponsoring Agency Code NRM-110	
15. Supplementary Notes			
16. Abstract These tests were conducted on the subject 2021 Ram 1500 Laramie Crew Cab 4x4 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 scenarios except the 35 mph vs. 35 mph decelerating POV scenario, resulting in an overall fail for the system.			
17. Key Words Dynamic Brake Support, DBS, AEB, New Car Assessment Program, NCAP		18. Distribution Statement Copies of this report are available from the following: NHTSA Technical Reference Division National Highway Traffic Safety Administration 1200 New Jersey Avenue, SE Washington, DC 20590	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 152	22. Price

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
I. INTRODUCTION	1
II. DATA SHEETS	2
Data Sheet 1: Test Results Summary	3
Data Sheet 2: Vehicle Data	4
Data Sheet 3: Test Conditions	5
Data Sheet 4: Dynamic Brake System Operation	7
III. TEST PROCEDURES	11
A. Test Procedure Overview	11
B. General Information	16
C. Principal Other Vehicle	19
D. Foundation Brake System Characterization	20
E. Brake Control	21
F. Instrumentation	22
APPENDIX A Photographs	A-1
APPENDIX B Excerpts from Owner's Manual	B-1
APPENDIX C Run Log	C-1
APPENDIX D Brake Characterization	D-1
APPENDIX E Time Histories	E-1

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 (SV) 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 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 Ram 1500 Laramie Crew Cab 4x4. 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 Ram 1500 Laramie Crew Cab 4x4

VIN: 1C6SRFJT8MN68xxxx

Test Date: 3/15/2021

Dynamic Brake Support System setting:

Forward Collision Warning: Warn + Active Braking

Forward Collision Sensitivity: Medium

**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: Fail

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

SV 25 mph: Pass

SV 45 mph: Pass

Overall: Fail

DYNAMIC BRAKE SUPPORT
DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2021 Ram 1500 Laramie Crew Cab 4x4

TEST VEHICLE INFORMATION

VIN: 1C6SRFJT8MN68xxxx

Body Style: PU/CC

Color: Bright White

Date Received: 3/8/2021

Odometer Reading: 16 mi

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: FCA US LLC

Date of manufacture: 02/21

Vehicle Type: Truck

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: 275/65R18 116T

Rear: 275/65R18 116T

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

Rear: 250 kPa (36 psi)

TIRES

Tire manufacturer and model: Goodyear Wrangler Fortitude HT

Front tire specification: 275/65R18 116T

Rear tire specification: 275/65R18 116T

Front tire DOT prefix: 4BYJ JK1R

Rear tire DOT prefix: 4BYJ JK1R

DYNAMIC BRAKE SUPPORT
DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2021 Ram 1500 Laramie Crew Cab 4x4

GENERAL INFORMATION

Test date: 3/15/2021

AMBIENT CONDITIONS

Air temperature: 10.0 C (50 F)

Wind speed: 3.6 m/s (8.1 mph)

X Wind speed \leq 10 m/s (22 mph).

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

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

VEHICLE PREPARATION

Verify the following:

All non-consumable fluids at 100% capacity: X

Fuel tank is full: X

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

Front: 250 kPa (36 psi)

Rear: 250 kPa (36 psi)

DYNAMIC BRAKE SUPPORT
DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2021 Ram 1500 Laramie Crew Cab 4x4

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front: 776.6 kg (1712 lb)

Right Front: 725.3 kg (1599 lb)

Left Rear: 532.1 kg (1173 lb)

Right Rear: 519.4 kg (1145 lb)

Total: 2553.4 kg (5629 lb)

DYNAMIC BRAKE SUPPORT
DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

(Page 1 of 4)

2021 Ram 1500 Laramie Crew Cab 4x4

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

Full Speed Forward Collision Warning Plus; standard equipment on the subject vehicle, but optional on other trims.

Available as an optional upgrade as part of the Advanced Safety Group, Safety and Convenience Group, or Limited LVL 1 Equipment Group on other models.

The system is referred to in the Owner's Manual as "Forward Collision Warning (FCW) With Mitigation"

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

Integrated camera and radar sensors located behind the upper center of the windshield.

System setting used for test (if applicable):

Forward Collision Warning: Warn + Active Braking

Forward Collision Sensitivity: Medium

Brake application mode used for test: Hybrid control

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

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

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

200 km/h (124 mph) (Per manufacturer supplied information)

Does the vehicle system require an initialization sequence/procedure?

Yes

No

If yes, please provide a full description.

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

(Page 2 of 4)

2021 Ram 1500 Laramie Crew Cab 4x4

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

If yes, please provide a full description.

In the event of 4 AEB events with braking within the same key cycle, the cluster will display the message "FCW-NOT AVAILABLE-AUTOBRAKE DISABLED," and AEB will not be available until the ignition is cycled (vehicle is stopped and restarted).

How is the Forward Collision Warning presented to the driver? Warning light
 Buzzer or auditory alarm
(Check all that apply) Vibration
 Other _____

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

In the event of an AEB or Forward Collision Warning event, a loud auditory warning will be provided to the driver before the initiation of automated braking. A series of three high-pitched loud beeps will be provided together with a message in the cluster indicating that the driver should brake. The text which will be displayed is: "Brake!". See Appendix A, Figure A15.

The auditory alert is a 2122 Hz tone that is pulsed at approximately 5 Hz.

DYNAMIC BRAKE SUPPORT
DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

(Page 3 of 4)

2021 Ram 1500 Laramie Crew Cab 4x4

Is there a way to deactivate the system? Yes
 No

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

The center mounted touchscreen is used to access system menus. The menu hierarchy is:

Settings

Safety Driving Assistance

Forward Collision Warning: check or uncheck "Off" box

See Appendix A, Figure A14.

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

If yes, please provide a full description.

The center mounted touchscreen is used to access system menus. The menu hierarchy is:

Settings

Safety Driving Assistance

Forward Collision Sensitivity: select "Near", "Med", or "Far"

See Appendix A, Figure A14.

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

DYNAMIC BRAKE SUPPORT
DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

(Page 4 of 4)

2021 Ram 1500 Laramie Crew Cab 4x4

If yes, please provide a full description.

System limitations are described on page 325 of the Owner's Manual, shown in Appendix B, Page B-9.

Notes:

Radar blindness. If the vehicle is moving and the radar sees no targets for a period of approximately 2 minutes, AEB will become unavailable. An auditory indication will be provided to the driver and the cluster will display the message "FCW Not Available Wipe Front Radar Sensor." This condition can be remedied by restarting the vehicle and letting the radar see stationary objects or moving vehicles.

Camera blindness. Camera blindness can generally be avoided by not attempting to drive for long intervals toward the sun when it is at a low elevation angle in the horizon. In the event that the camera becomes blinded a message stating "ACC/FCW Limited Functionality Clean Front Windshield" will be displayed. In the event that the camera detects a situation of limited visibility because of the dirty windshield, a message stating "ACC/FCW Limited Functionality Clean Front Windshield" will be displayed.

Section III

TEST PROCEDURES

A. Test Procedure Overview

Four test scenarios were used, as follows:

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

Test 2. Subject Vehicle Encounters Slower Principal Other Vehicle

Test 3. Subject Vehicle Encounters Decelerating Principal Other Vehicle

Test 4. Subject Vehicle Encounters Steel Trench Plate

An overview of each of the test procedures follows.

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

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

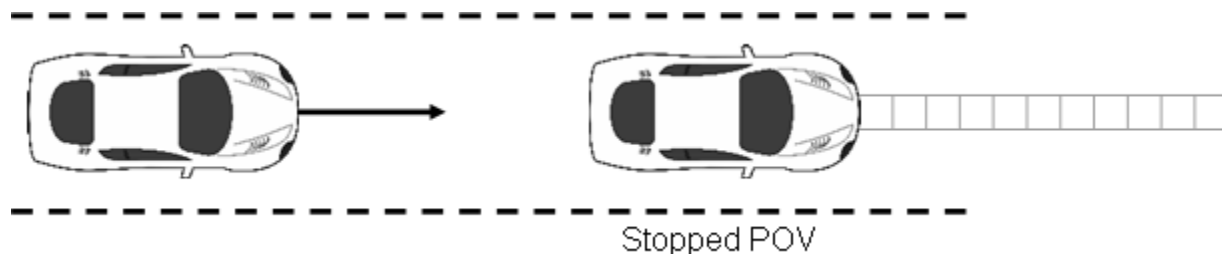


Figure 1. Depiction of Test 1

a. Procedure

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

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

- The SV came into contact with the POV or

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

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

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

Table 1. Nominal Stopped POV DBS Test Choreography

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

b. Criteria

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

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

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

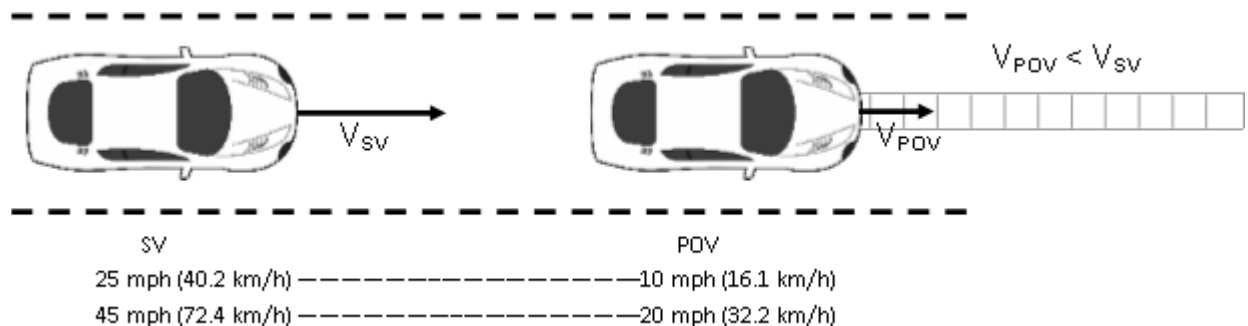


Figure 2. Depiction of Test 2

a. Procedure

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

The test concluded when either:

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

The SV driver then braked to a stop.

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

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

Table 2. Nominal Slower-Moving POV DBS Test Choreography

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

b. Criteria

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

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

This test evaluates the ability of the DBS system to detect and respond to a lead vehicle slowing with a constant deceleration in the immediate forward path of the SV as depicted in Figure 3. Should the SV foundation brake system be unable to prevent an SV-to-POV impact for a given test condition, the DBS system should automatically provide supplementary braking capable of preventing an SV-to-POV collision.

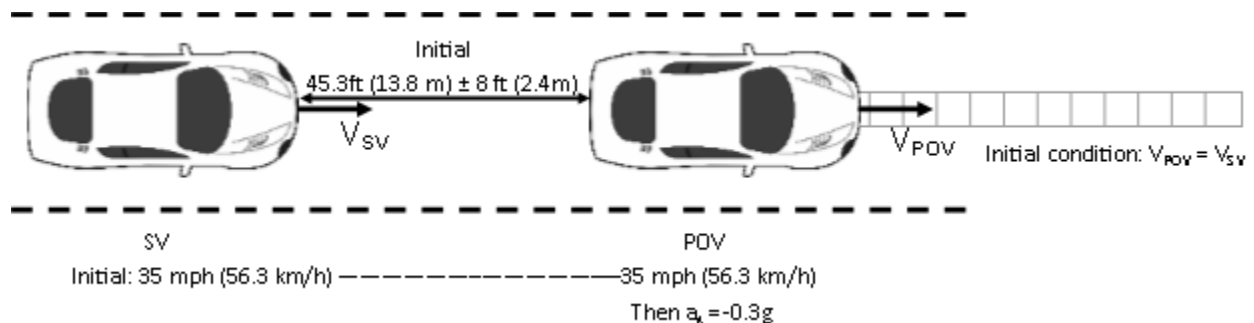


Figure 3. Depiction of Test 3

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 $0.3 \pm 0.03 g$. The SV throttle pedal was released within 500 ms of t_{FCW} , and the SV brakes were applied when TTC was 1.4 seconds (31.5 ft (9.6 m)).

The test concluded when either:

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

The SV driver then braked to a stop.

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

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

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

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

Table 3. Nominal Decelerating POV DBS Test Choreography

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

b. Criteria

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

4. TEST 4 – FALSE POSITIVE SUPPRESSION

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

a. Procedure

This test was conducted at two speeds, 25 mph (40.2 km/h) and 45 mph (72.4 km/h). The SV was driven directly towards, and over, the STP, which was positioned in the center of a travel lane, with its longest sides parallel to the road edge. The SV was driven at constant speed in the center of the lane toward the STP. If the SV did not present an FCW alert during the approach to the STP by $TTC = 2.1$ s, the SV driver initiated release of the throttle pedal at $TTC = 2.1$ s and the throttle pedal was fully released within 500 ms

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

b. Criteria

In order to pass the False Positive test series, the magnitude of the SV deceleration reduction attributable to DBS intervention must have been less than or equal to 1.5 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 auditory, and the onset of the alert is determined by post-processing the test data.

For systems that implement auditory or haptic alerts, part of the pre-test instrumentation verification process is to determine the tonal frequency of the auditory warning or the vibration frequency of the tactile warning through use of the PSD (Power Spectral Density) function in Matlab. This is accomplished in order to identify the center frequency around which a band-pass filter is applied to subsequent auditory or tactile warning data so that the beginning of such warnings can be programmatically determined. The band-pass filter used for these warning signal types is a phaseless, forward-reverse pass, elliptical (Cauer) digital filter, with filter parameters as listed in Table 4.

Table 4. Auditory and Tactile Warning Filter Parameters

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

2. GENERAL VALIDITY CRITERIA

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

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

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

3. The braking system consisted of the following components:

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

F. Instrumentation

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

Table 5. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and 100 psi	Omega DPG8001	17042707002	By: DRI Date: 8/18/2020 Due: 8/18/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 4/20/2020 Due: 4/20/2021
Linear (string) encoder	Throttle pedal travel	10 in 254 mm	0.1 in 2.54 mm	UniMeasure LX-EP	45040532	By: DRI Date: 7/2/2020 Due: 7/2/2021
Load Cell	Force applied to brake pedal					By: DRI
		0-250 lb 1112 N	0.05% FS	Stellar Technology PNC700	1607338	Date: 7/2/2020 Due: 7/2/2021
		0 - 250 lb 0 -1112 N	0.1% FS	Honeywell 41A	1464391	Date: 2/4/2021 Due: 2/4/2022
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	N/A

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;	Accels $\pm 10g$, 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
	Lateral, Longitudinal and Vertical Velocities;				2258	Date: 5/3/2019 Due: 5/3/2021
	Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles				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: ± 0.02 m/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)	$\pm 5g$	$\leq 3\%$ 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

	Page
Figure A1. Front View of Subject Vehicle.....	A-3
Figure A2. Rear View of Subject Vehicle	A-4
Figure A3. Window Sticker (Monroney Label).....	A-5
Figure A4. Vehicle Certification Label	A-6
Figure A5. Tire Placard	A-7
Figure A6. Rear View of Principal Other Vehicle (SSV).....	A-8
Figure A7. Load Frame/Slider of SSV	A-9
Figure A8. Two-Rail Track and Road-Based Lateral Restraint Track.....	A-10
Figure A9. Steel Trench Plate	A-11
Figure A10. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle.....	A-12
Figure A11. Sensors for Detecting Visual and Auditory Alerts	A-13
Figure A12. Computer and Brake Actuator Installed in Subject Vehicle.....	A-14
Figure A13. Brake Actuator Installed in POV System	A-15
Figure A14. AEB Setup Menus	A-16
Figure A15. Visual Alert	A-17



Figure A1. Front View of Subject Vehicle

A-3



Figure A2. Rear View of Subject Vehicle



2021 MODEL YEAR
RAM 1500 LARAMIE CREW CAB 4X4

For more information visit: www.ramtrucks.com
or call 1-866-RAMINFO

FCA US LLC

THIS VEHICLE IS MANUFACTURED TO MEET SPECIFIC UNITED STATES REQUIREMENTS. THIS VEHICLE IS NOT MANUFACTURED FOR SALE OR REGISTRATION OUTSIDE OF THE UNITED STATES.

MANUFACTURER'S SUGGESTED RETAIL PRICE OF THIS MODEL INCLUDING DEALER PREPARATION

Base Price: **\$47,980**

RAM 1500 LARAMIE CREW CAB 4X4
Exterior Color: Bright White Clear-Coat Exterior Paint
Interior Color: Black Interior Color
Interior: Leather-Trim 40 / 20 / 40 Bench Seat
Engine: 5.7L V8 HEMI® MDS VVT Engine
Transmission: 8-Speed Automatic 8HP75 Transmission

STANDARD EQUIPMENT (UNLESS REPLACED BY OPTIONAL EQUIPMENT)
FUNCTIONAL/SAFETY FEATURES

Advanced Multistage Front Air Bags
Supplemental Front Seat-Mounted Side Air Bags
Supplemental Side-Curtain Front and Rear Air Bags
ParkView® Rear Back-Up Camera
Full-Speed Forward-Collision Warning Plus
Advanced Brake-Assist
3.21 Rear Axle Ratio
Class IV Receiver-Hitch
7-Pin Wiring Harness
Push-Button Start
Remote-Start System
Remote-Proximity Keyless-Entry
Ready-Alert Braking
Rain-Brake Support
Dampened Tailgate
Tire-Fill Alert
Active Front Air-Dams

INTERIOR FEATURES

Uconnect® 4 with 8.4-inch Display
Apple CarPlay®
Google Android Auto™
7.0-inch TFT Color Display-Cluster
Full Function Media Hub with 2-USB Plus Aux Port
Integrated Voice Command with Bluetooth®
115-Volt Auxiliary Power-Outlet
115-Volt Auxiliary Rear Power-Outlet
12-Volt Auxiliary Power-Outlet
9 Amplified Speakers with Subwoofer
A/C with Dual-Zone Auto Temperature Control
Leather-Wrapped Steering Wheel
Heated Steering Wheel

Assembly Point/Port of Entry: STERLING HTS, MICH., U.S.A.
VIN: 1C6-SRFJT8MN-68

Tilt / Telescope Steering-Column
Power Adjustable Pedals with Memory
8-Way Power Driver and Passenger Seats
Heated Front Seats
Ventilated Front Seats
2nd-Row In-Floor Storage Bins
Rear Power-Sliding Window
SiriusXM® with 6-Month Radio Sub Call 800-643-2112
For More Info, Call 800-643-2112

EXTERIOR FEATURES

18-Inch x 8.0-Inch Aluminum Painted Wheels
275/65R18 BSW All-Season LRR Tire
18-Inch Full-Size Steel Spare Wheel
LED Reflector Headlamps
Front LED Fog Lamps
LED Tail Lamps
Premium Power Mirrors
Exterior Mirrors Courtesy Lamps

OPTIONAL EQUIPMENT (May Replace Standard Equipment)

Customer Preferred Package 25H \$1,795
5.7L V8 HEMI® MDS VVT Engine \$1,695
DESTINATION CHARGE

TOTAL PRICE: * \$51,470

WARRANTY COVERAGE

5-year or 60,000-mile Powertrain Limited Warranty.
3-year or 36,000-mile Basic Limited Warranty.
Ask Dealer for a copy of the limited warranties or see your owner's manual for details.

**5 YEAR / 60,000 MILE
POWERTRAIN WARRANTY**

EPA DOT Fuel Economy and Environment

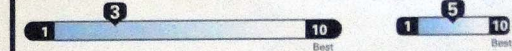
Fuel Economy These estimates reflect new EPA methods beginning with 2017 models.
17 MPG Standard pickups range from 14 to 27 MPG.
The best vehicle rates 141 MPG.
15 21
combined city/hwy city highway
5.9 gallons per 100 miles

Gasoline Vehicle

**You spend
\$5,750**
more in fuel costs
over 5 years
compared to the
average new vehicle.

**Annual fuel cost
\$2,650**

Fuel Economy & Greenhouse Gas Rating (tailpipe only) Smog Rating (tailpipe only)



This vehicle emits 823 grams CO2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also creates emissions. Learn more at fuelconomy.gov

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and cost \$7,900 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.

fuelconomy.gov
Calculate personalized estimates and compare vehicles



GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score ★★★★★
Based on the combined ratings of frontal, side and rollover.
Should ONLY be compared to other vehicles of similar size and weight.

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

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

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

Based on the risk of injury in a side impact.

Rollover ★★★★★

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

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

The safety ratings above are based on Federal Government tests of particular vehicles equipped with certain features and options. The performance of this vehicle may differ.

PARTS CONTENT INFORMATION

FOR VEHICLES IN THIS CARLINE:
U.S./CANADIAN PARTS CONTENT: 58%
MAJOR SOURCES OF FOREIGN PARTS

CONTENT:
MEXICO: 32%
NOTE: PARTS CONTENT DOES NOT INCLUDE FINAL ASSEMBLY, DISTRIBUTION, OR OTHER NON-PARTS COSTS.

FOR THIS VEHICLE:
FINAL ASSEMBLY POINT:
STERLING HTS, MICH., U.S.A.

COUNTRY OF ORIGIN:
ENGINE: MEXICO
TRANSMISSION: UNITED STATES



SHPTD: S0LTD:
THIS LABEL IS ADDED TO THIS VEHICLE TO COMPLY WITH FEDERAL LAW. THE LABEL CANNOT BE REMOVED OR ALTERED PRIOR TO DELIVERY TO THE ULTIMATE PURCHASER.
* STATE AND/OR LOCAL TAXES IF ANY, LICENSE AND TITLE FEES AND DEALER SUPPLIED AND INSTALLED OPTIONS AND ACCESSORIES ARE NOT INCLUDED IN THIS PRICE. DISCOUNT, IF ANY, IS BASED ON PRICE OF OPTIONS IF PURCHASED SEPARATELY.



Figure A3. Window Sticker (Monroney Label)



MFD BY: FCA US LLC
VIN: 1C6SRFJT8MN68
VEHICLE MADE IN: U.S.A.



DATE OF MFR (BUILT): 2-21		GVWR: 7100 LB / 3221 KG	
GAWR FRONT: 3900 LB / 1770 KG	WITH	GAWR REAR: 4100 LB / 1860 KG	WITH
18X8.0	RIMS	18X8.0	RIMS
275/65R18 116T	TIRES	275/65R18 116T	TIRES
AT 250 kPa / 36 PSI	COLD	AT 250 kPa / 36 PSI	COLD
TYPE: TRUCK	PAINT: PW7	MDH: 021513	MKT: 875

THIS VEHICLE CONFORMS TO ALL APPLICABLE U.S.A. FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

Figure A4. Vehicle Certification Label



TIRE AND LOADING INFORMATION

SEATING CAPACITY – TOTAL **6** FRONT **3** REAR **3**

THE COMBINED WEIGHT OF OCCUPANTS AND CARGO SHOULD NEVER EXCEED
787 KG OR 1737 LB

TIRE	FRONT	REAR	SPARE
ORIGINAL TIRE SIZE	275/65R18 116T	275/65R18 116T	245/70R18 110S
COLD TIRE INFLATION PRESSURE	250 kPa / 36 PSI	250 kPa / 36 PSI	310 kPa / 45 PSI

SEE OWNERS MANUAL FOR ADDITIONAL INFORMATION



MN68

Figure A5. Tire Placard



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



Figure A7. Load Frame/Slider of SSV

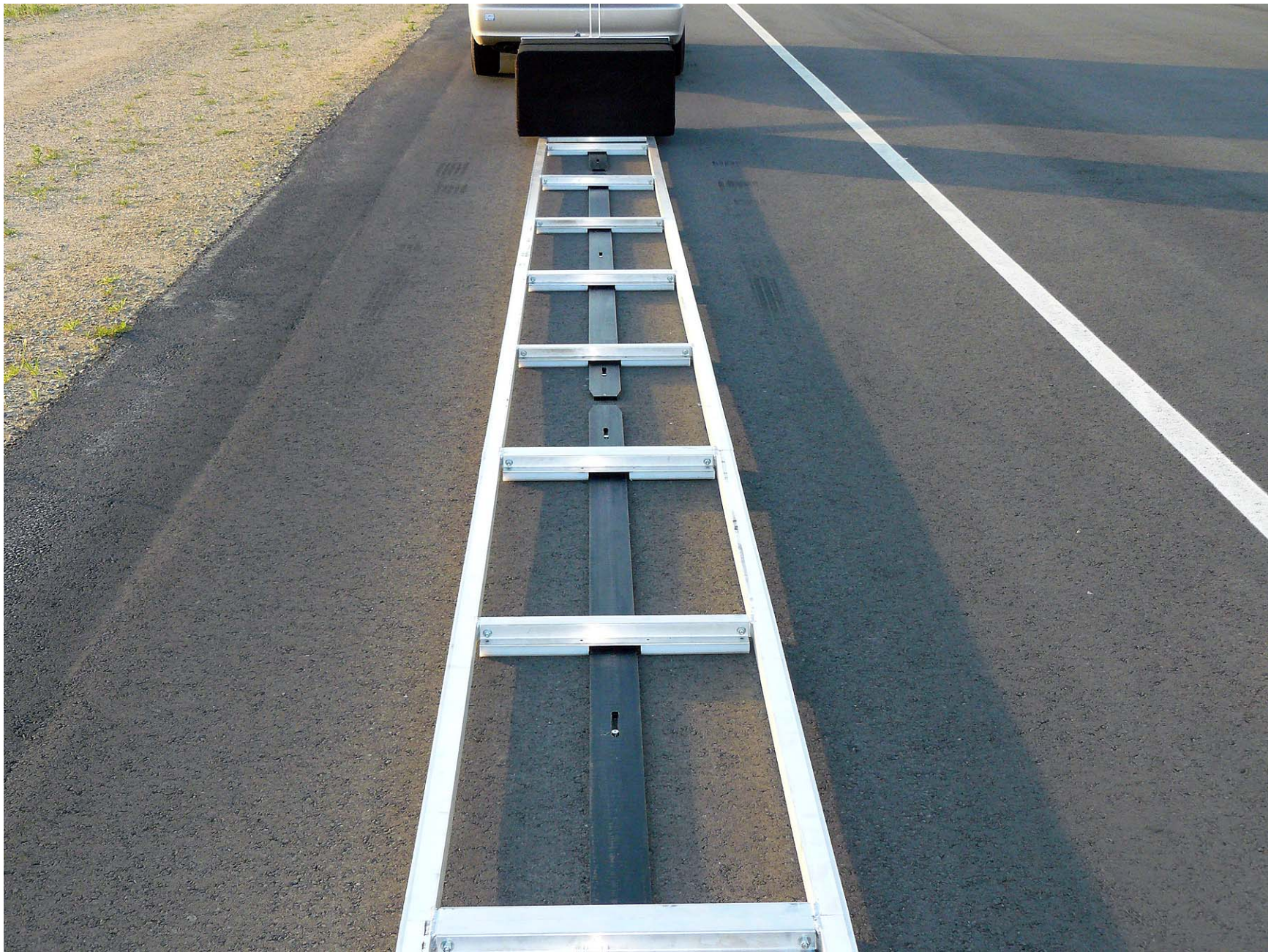


Figure A8. Two-Rail Track and Road-Based Lateral Restraint Track



Figure A9. Steel Trench Plate
A-11



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

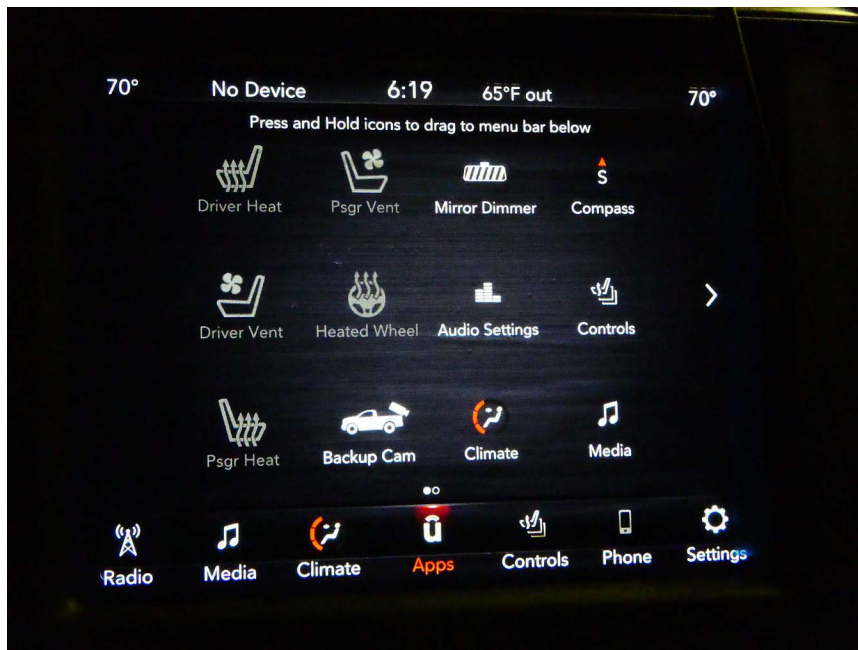




Figure A14. AEB Setup Menus
A-16
















Figure A15. Visual Alert
A-17

APPENDIX B




Excerpts from Owner's Manual





Red Warning Lights	
	Transmission Temperature Warning Light – If Equipped ⇨ page 129
	Door Open Warning Light ⇨ page 129








Yellow Warning Lights	
	Adaptive Cruise Control (ACC) Fault Warning Light – If Equipped ⇨ page 129
	Air Suspension Fault Warning Light – If Equipped ⇨ page 129
	Engine Check/Malfunction Indicator Warning Light (MIL) ⇨ page 130
	Electronic Park Brake Warning Light ⇨ page 130
	Electronic Stability Control (ESC) Active Warning Light – If Equipped ⇨ page 130

Yellow Warning Lights	
	Electronic Stability Control (ESC) OFF Warning Light – If Equipped ⇨ page 131
	Service LaneSense Warning Light – If Equipped ⇨ page 131
	Low Washer Fluid Warning Light – If Equipped ⇨ page 131
	Low Fuel Warning Light ⇨ page 131
	Tire Pressure Monitoring System (TPMS) Warning Light ⇨ page 131
	Anti-Lock Brake System (ABS) Warning Light ⇨ page 132
	Rear Axle Locker Fault Indicator Light – If Equipped ⇨ page 132
	Service Forward Collision Warning (FCW) Light – If Equipped ⇨ page 132

1

Yellow Warning Lights	
	Service Stop/Start System Warning Light ⇨ page 133
	Service 4WD Warning Light – If Equipped ⇨ page 133
	Cruise Control Fault Warning Light ⇨ page 133

Yellow Indicator Lights	
	Forward Collision Warning Off Indicator Light – If Equipped ⇨ page 133
	Air Suspension Payload Protection Indicator Light – If Equipped ⇨ page 133
	Trailer Merge Assist Indicator Light – If Equipped ⇨ page 133
	TOW/HAUL Indicator Light ⇨ page 133

Yellow Indicator Lights	
	Cargo Light On Indicator Light ⇨ page 133
	Air Suspension Off-Road 1 Indicator Light – If Equipped ⇨ page 133
	Air Suspension Off-Road 2 Indicator Light – If Equipped ⇨ page 133
	Air Suspension Normal Height Indicator Light – If Equipped ⇨ page 134
	Air Suspension Aerodynamic Height Indicator Light – If Equipped ⇨ page 134
	Entry/Exit Indicator Light – If Equipped ⇨ page 134
	Air Suspension Ride Height Raising Indicator Light – If Equipped ⇨ page 134

Your vehicle has also been equipped with a TPMS malfunction indicator to indicate when the system is not operating properly. The TPMS malfunction indicator is combined with the low tire pressure telltale. When the system detects a malfunction, the telltale will flash for approximately one minute and then remain continuously illuminated. This sequence will continue upon subsequent vehicle start-ups as long as the malfunction exists. When the malfunction indicator is illuminated, the system may not be able to detect or signal low tire pressure as intended. TPMS malfunctions may occur for a variety of reasons, including the installation of replacement or alternate tires or wheels on the vehicle that prevent the TPMS from functioning properly. Always check the TPMS malfunction telltale after replacing one or more tires or wheels on your vehicle to ensure that the replacement or alternate tires and wheels allow the TPMS to continue to function properly.

CAUTION!

The TPMS has been optimized for the original equipment tires and wheels. TPMS pressures and warning have been established for the tire size equipped on your vehicle. Undesirable system operation or sensor damage may result when using replacement equipment that is not of the same size, type, and/or style. Aftermarket wheels can cause sensor damage. Using aftermarket tire sealants may cause the Tire Pressure Monitoring System (TPMS) sensor to become inoperable. After using an aftermarket tire sealant it is recommended that you take your vehicle to an authorized dealer to have your sensor function checked.

Anti-Lock Brake System (ABS) Warning Light

This warning light monitors the ABS. The light will turn on when the ignition is placed in the ON/RUN or ACC/ON/RUN position and may stay on for as long as four seconds.

If the ABS light remains on or turns on while driving, then the Anti-Lock portion of the brake system is not functioning and service is required as soon as possible. However, the conventional brake system will continue to operate normally, assuming the Brake Warning Light is not also on.

If the ABS light does not turn on when the ignition is placed in the ON/RUN or ACC/ON/RUN position, have the brake system inspected by an authorized dealer.

Rear Axle Locker Fault Indicator Light – If Equipped

This warning light will illuminate to indicate when a rear axle locker fault has been detected.

Service Forward Collision Warning (FCW) Light – If Equipped

This warning light will illuminate to indicate a fault in the FCW System. Contact an authorized dealer for service → page 324.

Service Stop/Start System Warning Light – If Equipped

This warning light will illuminate when the Stop/Start system is not functioning properly and service is required. Contact an authorized dealer for service.

Service 4WD Warning Light – If Equipped

This warning light will illuminate to signal a fault with the 4WD system. If the light stays on or comes on during driving, it means that the 4WD system is not functioning properly and that service is required. We recommend you drive to the nearest service center and have the vehicle serviced immediately.

Cruise Control Fault Warning Light

This warning light will illuminate to indicate the Cruise Control System is not functioning properly and service is required. Contact an authorized dealer.

YELLOW INDICATOR LIGHTS**Forward Collision Warning Off Indicator Light – If Equipped**

This indicator light illuminates to indicate that Forward Collision Warning is off.

Air Suspension Payload Protection Indicator Light – If Equipped

This indicator light will illuminate to indicate that the maximum payload may have been exceeded or load leveling cannot be achieved at its current ride height. Protection Mode will automatically be selected to “protect” the air suspension system, air suspension adjustment is limited due to payload.

Trailer Merge Assist Indicator Light – If Equipped

This indicator light will illuminate to indicate when Trailer Merge Assist has been activated → page 318.

TOW/HAUL Indicator Light

This indicator light will illuminate when TOW/HAUL mode is selected.

Cargo Light – If Equipped

This indicator light will illuminate when the cargo light is activated by pushing the cargo light button on the headlight switch.

3**Air Suspension Off-Road 1 Indicator Light – If Equipped**

This light will illuminate when the air suspension system is set to the Off-Road 1 setting → page 165.

Air Suspension Off-Road 2 Indicator Light – If Equipped

This light will illuminate when the air suspension system is set to the Off-Road 2 setting → page 165.

The maximum braking applied by ACC is limited; however, the driver can always apply the brakes manually, if necessary.

NOTE:

The brake lights will illuminate whenever the ACC system applies the brakes.

A Proximity Warning will alert the driver if ACC predicts that its maximum braking level is not sufficient to maintain the set distance. If this occurs, a visual alert "BRAKE" will flash in the instrument cluster display and a chime will sound while ACC continues to apply its maximum braking capacity.

NOTE:

The "BRAKE!" Screen in the instrument cluster display is a warning for the driver to take action and does not necessarily mean that the Forward Collision Warning system is applying the brakes autonomously.

Overtake Aid

When driving with Adaptive Cruise Control (ACC) engaged, and following a vehicle, the system will provide an additional acceleration up to the ACC set speed to assist in passing the vehicle.

This additional acceleration is triggered when the driver utilizes the left turn signal and will only be active when passing on the left hand side.

ACC Operation At Stop

If the ACC system brings your vehicle to a standstill while following the vehicle in front, your vehicle will resume motion without any driver intervention if the vehicle in front starts moving within two seconds.

If the vehicle in front does not start moving within two seconds of your vehicle coming to a standstill, the driver will either have to push the RES (resume) button, or apply the accelerator pedal to reengage the ACC to the existing set speed.

NOTE:

After the ACC system holds your vehicle at a standstill for approximately three consecutive minutes, the parking brake will be activated, and the ACC system will be cancelled.

While ACC is holding your vehicle at a standstill, if the driver seat belt is unbuckled or the driver door is opened, the parking brake will be activated, and the ACC system will be cancelled.

WARNING!

When the ACC system is resumed, the driver must ensure that there are no pedestrians, vehicles or objects in the path of the vehicle. Failure to follow these warnings can result in a collision and death or serious personal injury.

Display Warnings And Maintenance

"Wipe Front Radar Sensor In Front Of Vehicle" Warning

The "ACC/FCW Unavailable Wipe Front Radar Sensor" warning will display and also a chime will indicate when conditions temporarily limit system performance.

This most often occurs at times of poor visibility, such as in snow or heavy rain. The ACC system may also become temporarily blinded due to obstructions, such as mud, dirt or ice. In these cases, the instrument cluster display will display "ACC/FCW Unavailable Wipe Front Radar Sensor" and the system will deactivate.

The "ACC/FCW Unavailable Wipe Front Radar Sensor" message can sometimes be displayed while driving in highly reflective areas (i.e. ice

4

Setting Name	Descriptions
ParkView Backup Camera Delay	This setting will add a timed delay to the rear backup camera when shifting out of reverse.
ParkView Backup Camera Active Guidelines	This setting will turn the backup camera active guidelines on or off.
ParkView Backup Camera Fixed Guidelines	This setting will turn the backup camera fixed guidelines on or off.

Safety/Driving Assistance

When the Safety/Driving Assistance button is selected on the touchscreen, the system displays the options related to the vehicle's safety settings. These options will differ depending on the features equipped on the vehicle. The settings may display in list form or within subfolders on the screen. To access a subfolder, select the desired folder; the available options related to that feature will then display on the screen.

Setting Name	Description
Forward Collision Warning Sensitivity	This setting will change the distance at which the Forward Collision Warning (FCW) alert sounds. The "Medium" setting will have the FCW system signal when an object is in view, and the possibility of a collision is detected. The "Near" setting will have the FCW system signal when the object is closer to the vehicle. The "Far" setting will have the FCW system signal when an object is at a far distance from the vehicle.
Forward Collision Warning	This setting will turn the Forward Collision Warning system on or off. The "Off" setting will deactivate the FCW system. The "Warning Only" setting will provide only an audible chime when a collision is detected. The "Warning + Active Braking" setting will provide an audible chime and apply some brake pressure when a collision is detected.
Pedestrian Emergency Braking	This setting will turn the Pedestrian Emergency Braking system on or off.

- Trailer length between 30 ft and 39.5 ft (9 m to 12 m) — Blind spot zone will be adjusted to Max distance $\frac{30}{39.5}$.

NOTE:

Trailer length is determined within +/- 3 ft (1 m) of actual length. Trailers that are the same size as the category limit, 10/20/30 ft (3/6/9 m), could be subject to being placed in the category above or below the correct one.

Trailer Merge Warning

Trailer Merge Warning is the extension of the blind spot function to cover the length of the trailer, plus a safety margin, to warn the driver when there is a vehicle in the adjacent lane. The driver is alerted by the illumination of the BSM warning light located in the outside mirror on the side the other vehicle is detected on. In addition, an audible (chime) alert will be heard and radio volume will be reduced → page 322.

NOTE:

- The Trailer Merge Alert system DOES NOT alert the driver about rapidly approaching vehicles that are outside the detection zones.
- The Blind Spot Monitoring (BSM) system may experience drop outs (blinking on and off) of

the side mirror warning indicator lamps when a motorcycle or any small object remains at the side of the vehicle for extended periods of time (more than a couple of seconds).

- Crowded areas such as parking lots, neighborhoods, etc. may lead to an increased amount of false alerts. This is normal operation.

WARNING!

The Blind Spot Monitoring system is only an aid to help detect objects in the blind spot zones. The BSM system is not designed to detect pedestrians, bicyclists, or animals. Even if your vehicle is equipped with the BSM system, always check your vehicle's mirrors, glance over your shoulder, and use your turn signal before changing lanes. Failure to do so can result in serious injury or death.

FORWARD COLLISION WARNING (FCW) WITH MITIGATION — IF EQUIPPED

FCW with Mitigation provides the driver with audible warnings, visual warnings (within the instrument cluster display), and may apply a brake jerk to warn the driver when it detects a

potential frontal collision. The warnings and limited braking are intended to provide the driver with enough time to react, avoid or mitigate the potential collision.

NOTE:

FCW monitors the information from the forward looking sensors as well as the Electronic Brake Controller (EBC), to calculate the probability of a forward collision. When the system determines that a forward collision is probable, the driver will be provided with audible and visual warnings as well as a possible brake jerk warning.

If the driver does not take action based upon these progressive warnings, then the system will provide a limited level of active braking to help slow the vehicle and mitigate the potential forward collision. If the driver reacts to the warnings by braking and the system determines that the driver intends to avoid the collision by braking but has not applied sufficient brake force, the system will compensate and provide additional brake force as required.

If a FCW with Mitigation event begins at a speed below 32 mph (52 km/h), the system may provide the maximum braking possible to mitigate the potential forward collision. If the

Forward Collision Warning with Mitigation event stops the vehicle completely, the system will hold the vehicle at standstill for two seconds and then release the brakes.

!BRAKE!

0616123823JUS

FCW Message

When the system determines a collision with the vehicle in front of you is no longer probable, the warning message will be deactivated
 ↪ page 482.

NOTE:

- The minimum speed for FCW activation is 3 mph (5 km/h).
- The FCW alerts may be triggered on objects other than vehicles such as guard rails or sign posts based on the course prediction. This is expected and is a part of normal FCW activation and functionality.

- It is unsafe to test the FCW system. To prevent such misuse of the system, after four Active Braking events within a key cycle, the Active Braking portion of FCW will be deactivated until the next key cycle.
- The FCW system is intended for on-road use only. If the vehicle is taken off-road, the FCW system should be deactivated to prevent unnecessary warnings to the surroundings.
- FCW may not react to irrelevant objects such as overhead objects, ground reflections, objects not in the path of the vehicle, stationary objects that are far away, oncoming traffic, or leading vehicles with the same or higher rate of speed.
- FCW will be disabled like ACC, with the unavailable screens.

WARNING!

Forward Collision Warning (FCW) is not intended to avoid a collision on its own, nor can FCW detect every type of potential collision. The driver has the responsibility to avoid a collision by controlling the vehicle via braking and steering. Failure to follow this warning could lead to serious injury or death.

Turning FCW On or Off

The FCW button is located in the Uconnect display in the control settings ↪ page 237.

- To turn the FCW system on, press the forward collision button once.
- To turn the FCW system off, press the forward collision button once.

NOTE:

- When the FCW is “on”, this allows the system to warn the driver of a possible collision with the vehicle in front.
- When the FCW is “off”, this prevents the system from warning the driver of a possible collision with the vehicle in front. If the FCW is set to “off”, “FCW OFF” will be displayed in the instrument cluster display.
- When FCW status is set to “Only Warning”, this prevents the system from providing limited active braking, or additional brake support if the driver is not braking adequately in the event of a potential frontal collision.

6

- When FCW status is set to “Warning and Braking”, this allows the system to warn the driver of a possible collision with the vehicle in front using audible/visual warnings and it applies autonomous braking.
- The FCW system state is defaulted to “Full On” from one ignition cycle to the next. If the system is turned off, it will reset to “Full On” when the vehicle is restarted.

FCW Braking Status And Sensitivity

The FCW Sensitivity and Active Braking status are programmable through the Uconnect system → page 237.

- Far
 - When the sensitivity of FCW is set to the “Far” setting and the system status is “Only Warning”, this allows the system to warn the driver of a possible more distant collision with the vehicle in front using audible/visual warnings.
 - More cautious drivers that do not mind frequent warnings may prefer this setting.

- Medium

- When the sensitivity of FCW is set to the “Medium” setting and the system status is “Only Warning”, this allows the system to warn the driver of a possible collision with the vehicle in front using audible/visual warnings.

- Near

- When the sensitivity of FCW is set to the “Near” setting and the system status is “Only Warning”, this allows the system to warn the driver of a possible closer collision with the vehicle in front using audible/visual warnings.
- This setting provides less reaction time than the “Far” and “Medium” settings, which allows for a more dynamic driving experience.
- More dynamic or aggressive drivers that want to avoid frequent warnings may prefer this setting.

FCW Limited Warning

If the instrument cluster displays “ACC/FCW Limited Functionality” or “ACC/FCW Limited Functionality Clean Front Windshield” momentarily, there may be a condition that limits FCW functionality. Although the vehicle is still driveable under normal conditions, the active braking may not be fully available. Once the condition that limited the system performance is no longer present, the system will return to its full performance state. If the problem persists, see an authorized dealer.

Service FCW Warning

If the system turns off, and the instrument cluster displays:

- ACC/FCW Unavailable Service Required
- Cruise/FCW Unavailable Service Required

This indicates there is an internal system fault. Although the vehicle is still drivable under normal conditions, have the system checked by an authorized dealer.

APPENDIX C

Run Log

Subject Vehicle: **2021 Ram 1500 Laramie Crew Cab 4x4**

Test Date: **3/15/2021**

Principal Other Vehicle: **SSV**

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
1-15	Brake characterization and determination						See Appendix D
50	Static Run						Zero SV front bumper to SSV rear bumper and collect data
51	Stopped POV	Y	1.84	8.59	1.02	Pass	
52		Y	1.78	7.99	1.03	Pass	
53		N					Avg brake force high, pedal moving during DBS
54		Y	1.75	8.39	1.02	Pass	
55		Y	1.75	8.59	1.00	Pass	
56		Y	1.69	8.69	0.98	Pass	
57		Y	1.73	8.47	1.00	Pass	
58		N					Avg brake force high, pedal moving during DBS
59		N					Avg brake force high, pedal moving during DBS
60		Y	1.77	7.93	1.00	Pass	
61	Static Run						
62	Slower POV, 25 vs 10	N					Avg Brake force high, pedal moving during DBS
63		N					Avg brake force high, pedal moving during DBS

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
64	Slower POV, 25 vs 10	N					Avg brake force, brake force p = 0.01
65		Y	1.56	7.95	1.00	Pass	Brake force p = 0.05
66		Y	1.58	8.22	0.97	Pass	
67		N					Avg brake force high, pedal moving during DBS
68		N					Avg brake force high, pedal moving during DBS
69		Y	1.59	8.19	0.99	Pass	Brake force i = 0.7
70		Y	1.54	8.27	0.97	Pass	
71		Y	1.60	8.40	0.99	Pass	
72		Y	1.56	8.42	0.99	Pass	
73		Y	1.64	8.46	0.99	Pass	
74	Static run						Check zero data is within ± 0.167 ft (± 0.05 m)
75	Slower POV, 45 vs 20	N					CIB system activates very early, brake actuator only fires near minimum headway
76		Y	2.43	25.04	0.99	Pass	Very early CIB onset, well before actuator. Changed timing calculation to distance. (Note: distance calculation was used for runs 76-84)
77		Y	2.38	23.15	0.99	Pass	
78		Y	2.43	22.92	1.00	Pass	
79		N					POV speed

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
80	Slower POV, 45 vs 20	Y	2.44	21.56	0.96	Pass	
81		Y	2.48	22.27	0.98	Pass	
82		N					Brake actuator never fired, CIB braking extremely early
83		Y	2.35	22.67	0.97	Pass	
84		Y	2.47	22.83	1.01	Pass	
85	Static run						Check zero data is within ± 0.167 ft (± 0.05 m)
86	Static run						Check zero data is within ± 0.167 ft (± 0.05 m)
87	Decelerating POV, 35	Y	1.69	0.00	0.64	Fail	AEB braking at very last moment
88		Y	1.62	0.00	0.72	Fail	AEB braking at very last moment
89		N					POV braking late
90		Y	1.74	0.00	0.66	Fail	AEB braking at very last moment
91		Y	1.53	1.33	0.65	Pass	
92		N					Throttle
93		N					POV braking late
94		Y	1.62	3.54	0.70	Pass	
95		Y	1.60	5.74	0.72	Pass	
96		Y	1.74	2.57	0.72	Pass	
97	Static run						Check zero data is within ± 0.167 ft (± 0.05 m)

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
16	STP - Static run						Zero SV front bumper to rear edge of steel plate and collect data
17	Baseline, 25	Y			0.55		
18		Y			0.56		
19		Y			0.55		
20		Y			0.54		
21		Y			0.53		
22		Y			0.52		
23		Y			0.53		
24	STP - Static run						Check zero data is within ± 0.167 ft (± 0.05 m)
25	Baseline, 45	Y			0.53		
26		Y			0.57		
27		N					SV speed
28		Y			0.55		
29		Y			0.57		
30		Y			0.56		
31		Y			0.57		
32		Y			0.63		
33	STP - Static run						Check zero data is within ± 0.167 ft (± 0.05 m)
34	STP False Positive, 25	Y			0.56	Pass	
35		Y			0.57	Pass	
36		Y			0.54	Pass	

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
37	STP False Positive, 25	Y			0.53	Pass	
38		Y			0.53	Pass	
39		Y			0.53	Pass	
40		Y			0.51	Pass	
41	STP - Static run						Check zero data is within ± 0.167 ft (± 0.05 m)
42	STP False Positive, 45	Y			0.49	Pass	
43		Y			0.54	Pass	
44		Y			0.46	Pass	
45		Y			0.47	Pass	
46		Y			0.50	Pass	
47		Y			0.47	Pass	
48		Y			0.52	Pass	
49	STP - Static run						Check zero data is within ± 0.167 ft (± 0.05 m)

APPENDIX D

Brake Characterization

Subject Vehicle: 2021 Ram 1500 Laramie Crew Cab 4x4

Test Date: 3/15/2021

DBS Initial Brake Characterization				
Run Number	Stroke at 0.4 g (in)	Force at 0.4 g (lb)	Slope	Intercept
1	3.021	14.563	0.561	-0.573
2	3.070	14.524	0.572	-0.597
3	3.054	14.170	0.585	-0.633

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	N					Decel high
5		35	Y	0.416	2.95		2.84	
6		25	Y	0.415	2.95		2.84	
7		45	Y	0.393	2.95		3.00	
8	Hybrid	45	N					Decel high
9		45	N					Decel high
10		45	N					Decel high
11		45	N					Decel high
12		45	N					Decel high

DBS Brake Characterization Determination								
Run	DBS Mode	Speed	Valid Run	Average Decel. (g)	0.4 g Stroke Value (in)	0.4 g Force Value (lb)	Stroke/Force Calculator (in)	Notes
13	Hybrid	45	Y	0.406		9.50	9.36	
14		35	Y	0.396		9.50	9.60	
15		25	Y	0.421		9.50	9.03	

Appendix E

TIME HISTORY PLOTS

LIST OF FIGURES

	Page
Figure E1. Example Time History for Stopped POV, Passing	E-11
Figure E2. Example Time History for Slower POV 25 vs. 10, Passing	E-12
Figure E3. Example Time History for Slower POV 45 vs. 20, Passing	E-13
Figure E4. Example Time History for Decelerating POV 35, Passing	E-14
Figure E5. Example Time History for False Positive Baseline 25	E-15
Figure E6. Example Time History for False Positive Baseline 45	E-16
Figure E7. Example Time History for False Positive Steel Plate 25, Passing	E-17
Figure E8. Example Time History for False Positive Steel Plate 45, Passing	E-18
Figure E9. Example Time History for DBS Brake Characterization, Passing	E-19
Figure E10. Example Time History Displaying Invalid POV Acceleration Criteria	E-20
Figure E11. Example Time History Displaying Invalid Brake Force Criteria	E-21
Figure E12. Example Time History for a Failed Run	E-22
Figure E13. Time History for DBS Run 51, SV Encounters Stopped POV	E-23
Figure E14. Time History for DBS Run 52, SV Encounters Stopped POV	E-24
Figure E15. Time History for DBS Run 54, SV Encounters Stopped POV	E-25
Figure E16. Time History for DBS Run 55, SV Encounters Stopped POV	E-26
Figure E17. Time History for DBS Run 56, SV Encounters Stopped POV	E-27
Figure E18. Time History for DBS Run 57, SV Encounters Stopped POV	E-28
Figure E19. Time History for DBS Run 60, SV Encounters Stopped POV	E-29
Figure E20. Time History for DBS Run 65, SV Encounters Slower POV, SV 25 mph, POV 10 mph	E-30
Figure E21. Time History for DBS Run 66, SV Encounters Slower POV, SV 25 mph, POV 10 mph	E-31
Figure E22. Time History for DBS Run 69, SV Encounters Slower POV, SV 25 mph, POV 10 mph	E-32
Figure E23. Time History for DBS Run 70, SV Encounters Slower POV, SV 25 mph, POV 10 mph	E-33
Figure E24. Time History for DBS Run 71, SV Encounters Slower POV, SV 25 mph, POV 10 mph	E-34
Figure E25. Time History for DBS Run 72, SV Encounters Slower POV, SV 25 mph, POV 10 mph	E-35
Figure E26. Time History for DBS Run 73, SV Encounters Slower POV, SV 25 mph, POV 10 mph	E-36
Figure E27. Time History for DBS Run 76, SV Encounters Slower POV, SV 45 mph, POV 20 mph	E-37
Figure E28. Time History for DBS Run 77, SV Encounters Slower POV, SV 45 mph, POV 20 mph	E-38
Figure E29. Time History for DBS Run 78, SV Encounters Slower POV, SV 45 mph, POV 20 mph	E-39
Figure E30. Time History for DBS Run 80, SV Encounters Slower POV, SV 45 mph, POV 20 mph	E-40

Figure E31. Time History for DBS Run 81, SV Encounters Slower POV, SV 45 mph, POV 20 mph	E-41
Figure E32. Time History for DBS Run 83, SV Encounters Slower POV, SV 45 mph, POV 20 mph	E-42
Figure E33. Time History for DBS Run 84, SV Encounters Slower POV, SV 45 mph, POV 20 mph	E-43
Figure E34. Time History for DBS Run 87, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph	E-44
Figure E35. Time History for DBS Run 88, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph	E-45
Figure E36. Time History for DBS Run 90, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph	E-46
Figure E37. Time History for DBS Run 91, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph	E-47
Figure E38. Time History for DBS Run 94, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph	E-48
Figure E39. Time History for DBS Run 95, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph	E-49
Figure E40. Time History for DBS Run 96, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph	E-50
Figure E41. Time History for DBS Run 17, False Positive Baseline, SV 25 mph	E-51
Figure E42. Time History for DBS Run 18, False Positive Baseline, SV 25 mph	E-52
Figure E43. Time History for DBS Run 19, False Positive Baseline, SV 25 mph	E-53
Figure E44. Time History for DBS Run 20, False Positive Baseline, SV 25 mph	E-54
Figure E45. Time History for DBS Run 21, False Positive Baseline, SV 25 mph	E-55
Figure E46. Time History for DBS Run 22, False Positive Baseline, SV 25 mph	E-56
Figure E47. Time History for DBS Run 23, False Positive Baseline, SV 25 mph	E-57
Figure E48. Time History for DBS Run 25, False Positive Baseline, SV 45 mph	E-58
Figure E49. Time History for DBS Run 26, False Positive Baseline, SV 45 mph	E-59
Figure E50. Time History for DBS Run 28, False Positive Baseline, SV 45 mph	E-60
Figure E51. Time History for DBS Run 29, False Positive Baseline, SV 45 mph	E-61
Figure E52. Time History for DBS Run 30, False Positive Baseline, SV 45 mph	E-62
Figure E53. Time History for DBS Run 31, False Positive Baseline, SV 45 mph	E-63
Figure E54. Time History for DBS Run 32, False Positive Baseline, SV 45 mph	E-64
Figure E55. Time History for DBS Run 34, SV Encounters Steel Trench Plate, SV 25 mph	E-65
Figure E56. Time History for DBS Run 35, SV Encounters Steel Trench Plate, SV 25 mph	E-66
Figure E57. Time History for DBS Run 36, SV Encounters Steel Trench Plate, SV 25 mph	E-67
Figure E58. Time History for DBS Run 37, SV Encounters Steel Trench Plate, SV 25 mph	E-68
Figure E59. Time History for DBS Run 38, SV Encounters Steel Trench Plate, SV 25 mph	E-69
Figure E60. Time History for DBS Run 39, SV Encounters Steel Trench Plate, SV 25 mph	E-70

Figure E61.	Time History for DBS Run 40, SV Encounters Steel Trench Plate, SV 25 mph	E-71
Figure E62.	Time History for DBS Run 42, SV Encounters Steel Trench Plate, SV 45 mph	E-72
Figure E63.	Time History for DBS Run 43, SV Encounters Steel Trench Plate, SV 45 mph	E-73
Figure E64.	Time History for DBS Run 44, SV Encounters Steel Trench Plate, SV 45 mph	E-74
Figure E65.	Time History for DBS Run 45, SV Encounters Steel Trench Plate, SV 45 mph	E-75
Figure E66.	Time History for DBS Run 46, SV Encounters Steel Trench Plate, SV 45 mph	E-76
Figure E67.	Time History for DBS Run 47, SV Encounters Steel Trench Plate, SV 45 mph	E-77
Figure E68.	Time History for DBS Run 48, SV Encounters Steel Trench Plate, SV 45 mph	E-78
Figure E69.	Time History for DBS Run 1, Brake Characterization Initial	E-79
Figure E70.	Time History for DBS Run 2, Brake Characterization Initial	E-80
Figure E71.	Time History for DBS Run 3, Brake Characterization Initial	E-81
Figure E72.	Time History for DBS Run 5, Brake Characterization Determination, Displacement Mode, 35 mph	E-82
Figure E73.	Time History for DBS Run 6, Brake Characterization Determination, Displacement Mode, 25 mph	E-83
Figure E74.	Time History for DBS Run 7, Brake Characterization Determination, Displacement Mode, 45 mph	E-84
Figure E75.	Time History for DBS Run 13, Brake Characterization Determination, Hybrid Mode, 45 mph	E-85
Figure E76.	Time History for DBS Run 14, Brake Characterization Determination, Hybrid Mode, 35 mph	E-86
Figure E77.	Time History for DBS Run 15, Brake Characterization Determination, Hybrid Mode, 25 mph	E-87

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

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

- 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., $0.30 \text{ g} \pm 0.03 \text{ g}$). 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 force 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 Figures 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.

Notes

For valid runs, plots are shown for all warning types. In some cases, one of the plots may indicate that a run was invalid, but if the run was valid for either warning type it is considered valid. The companion plots are shown for the sake of completeness.

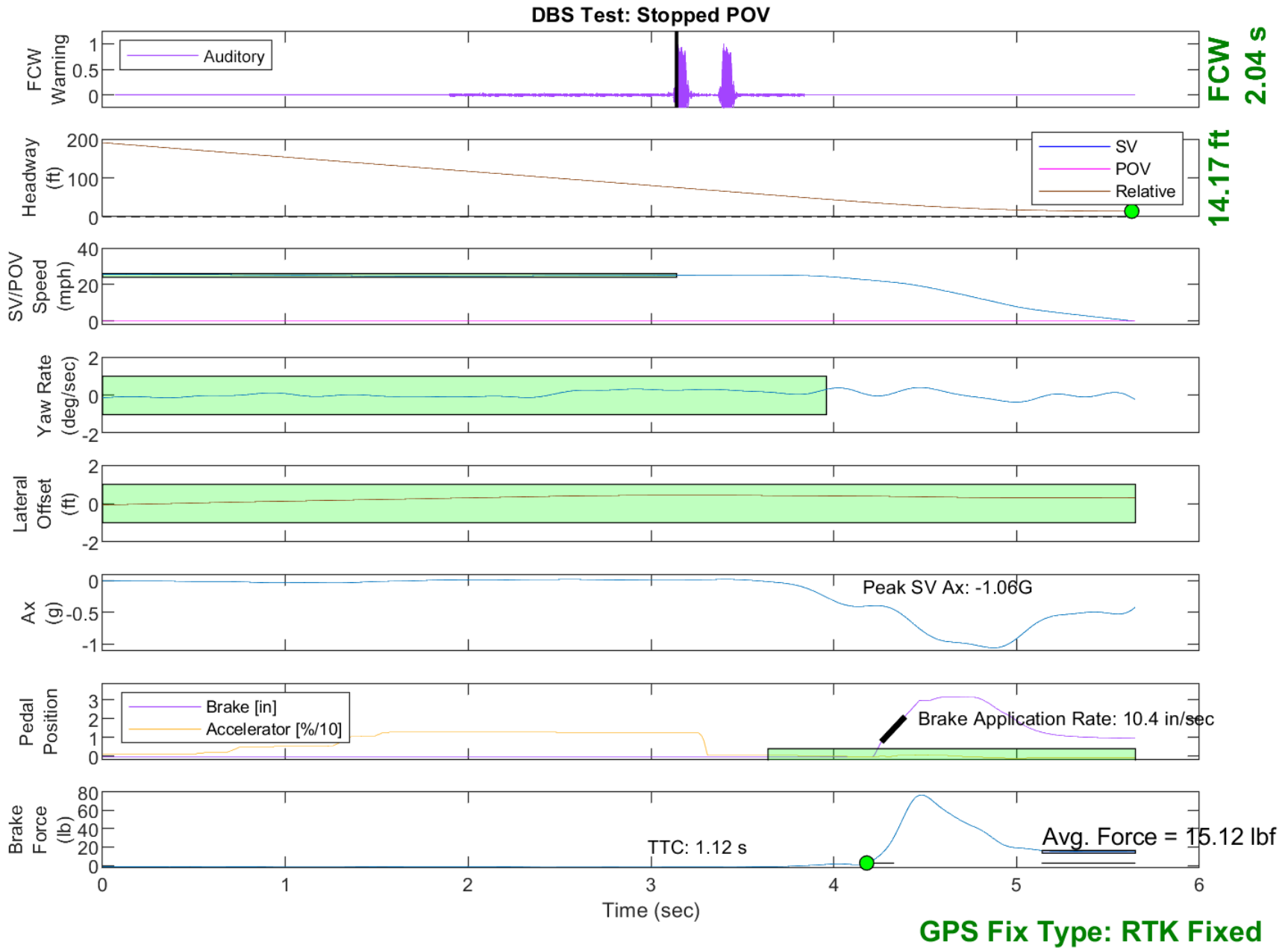


Figure E1. Example Time History for Stopped POV, Passing

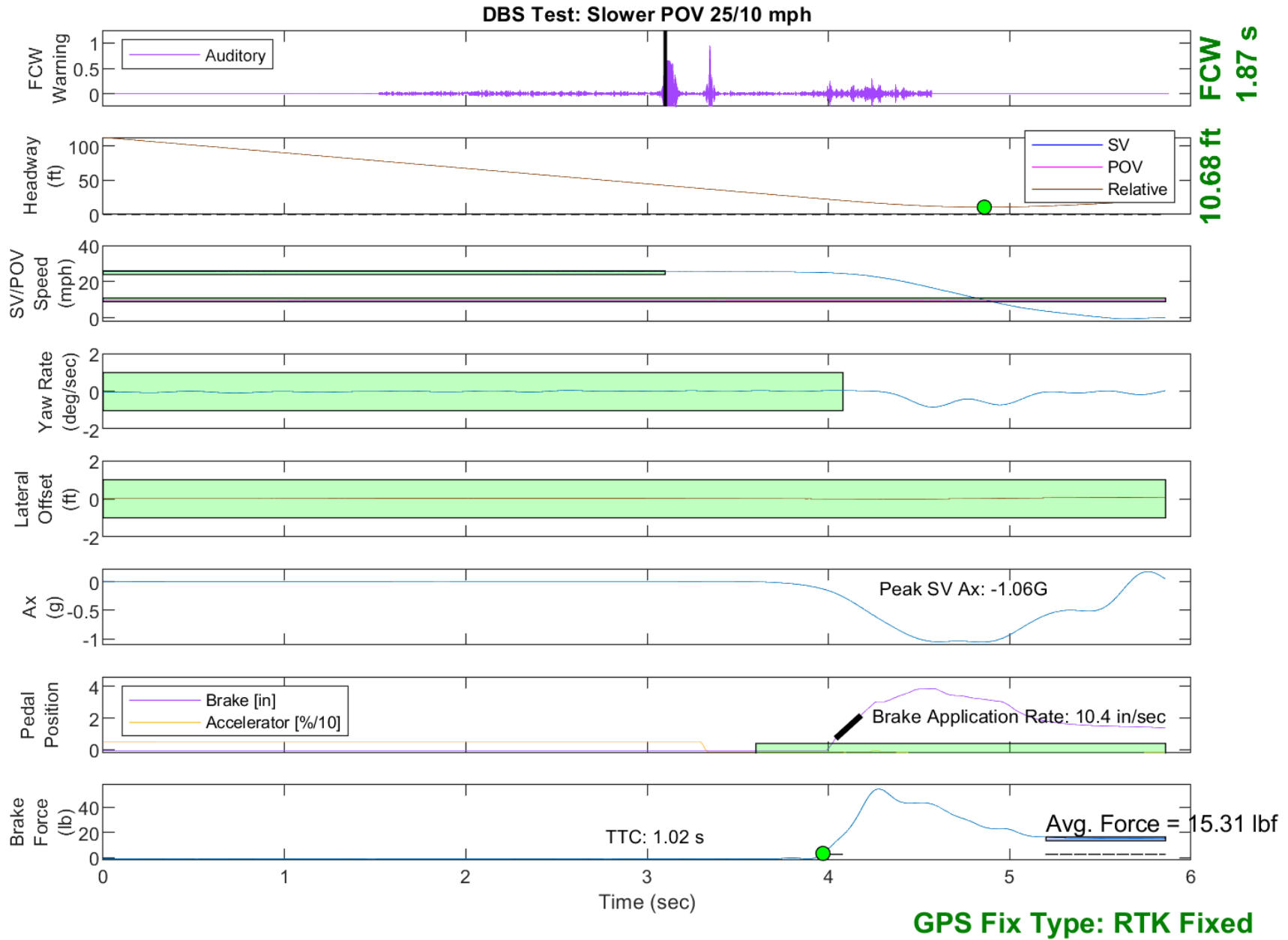


Figure E2. Example Time History for Slower POV 25 vs. 10, Passing

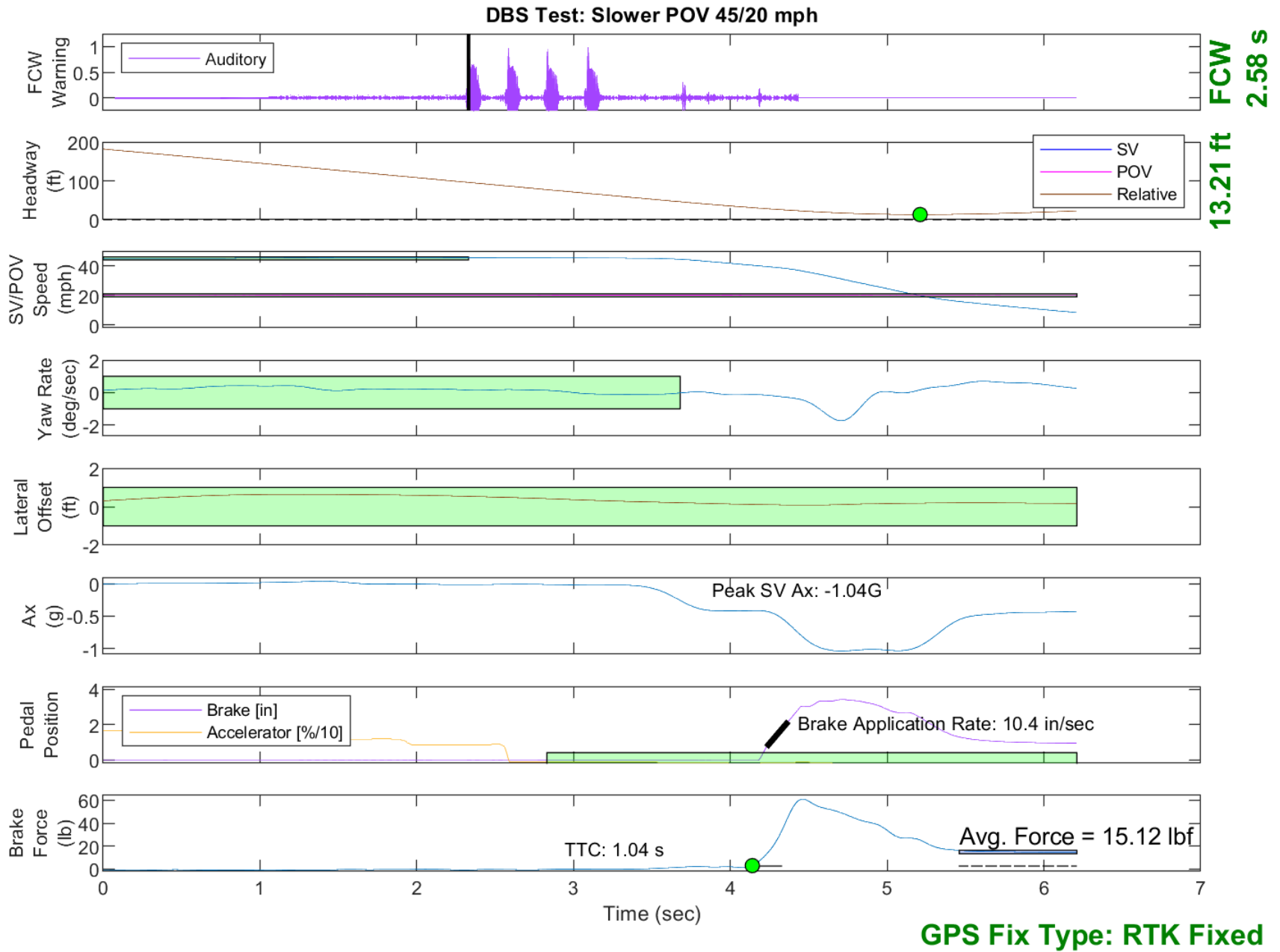


Figure E3. Example Time History for Slower POV 45 vs. 20, Passing

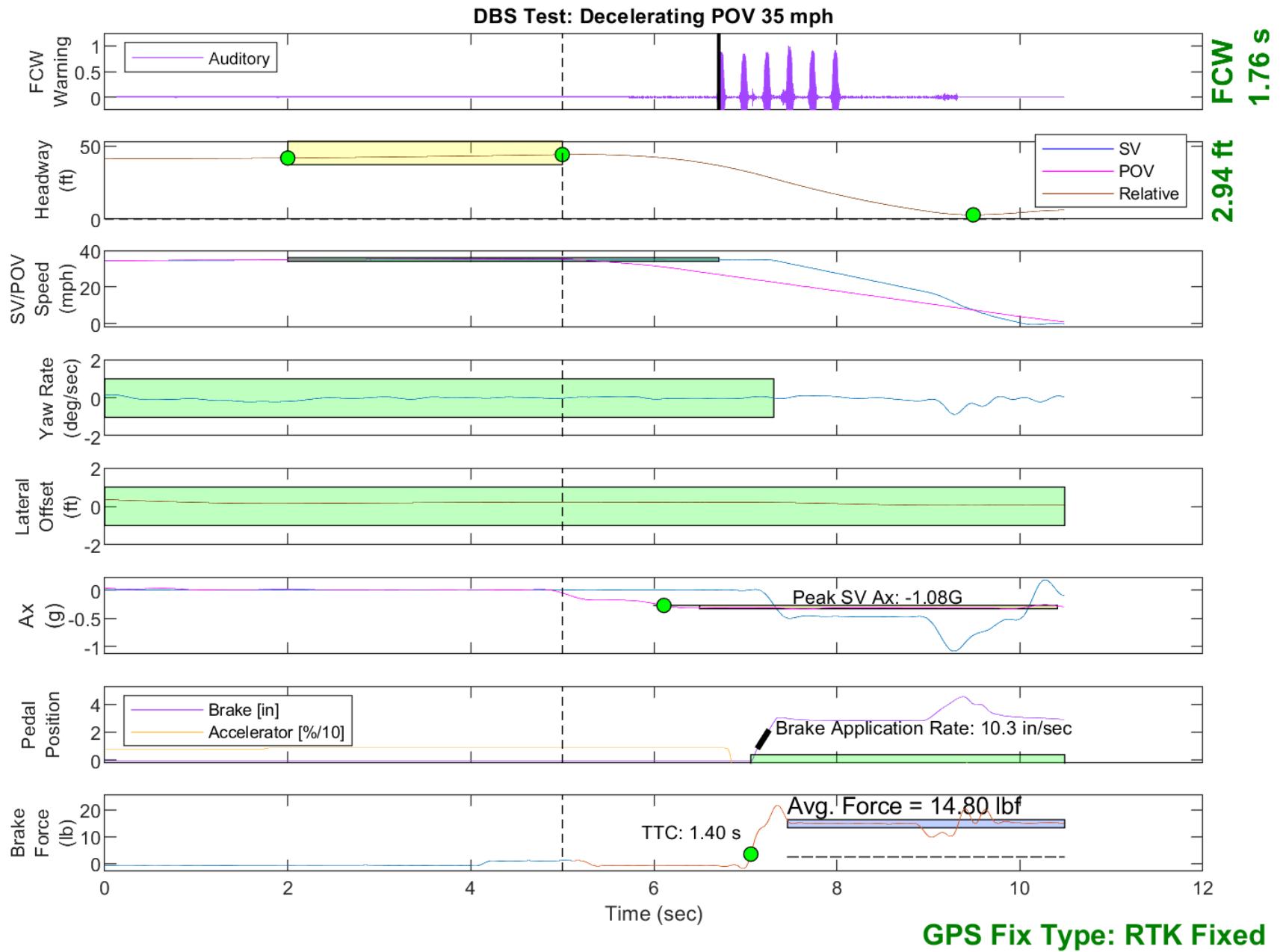
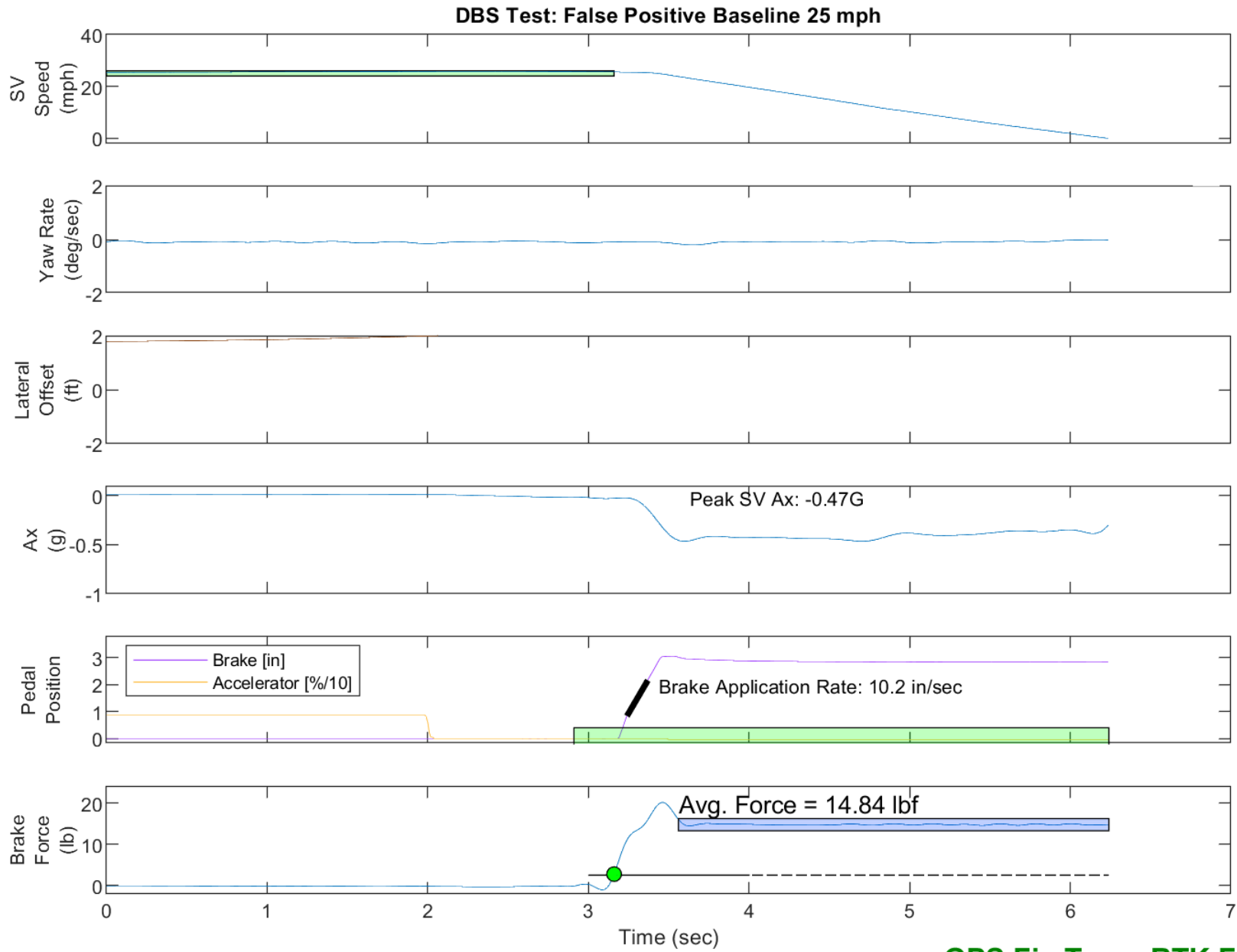
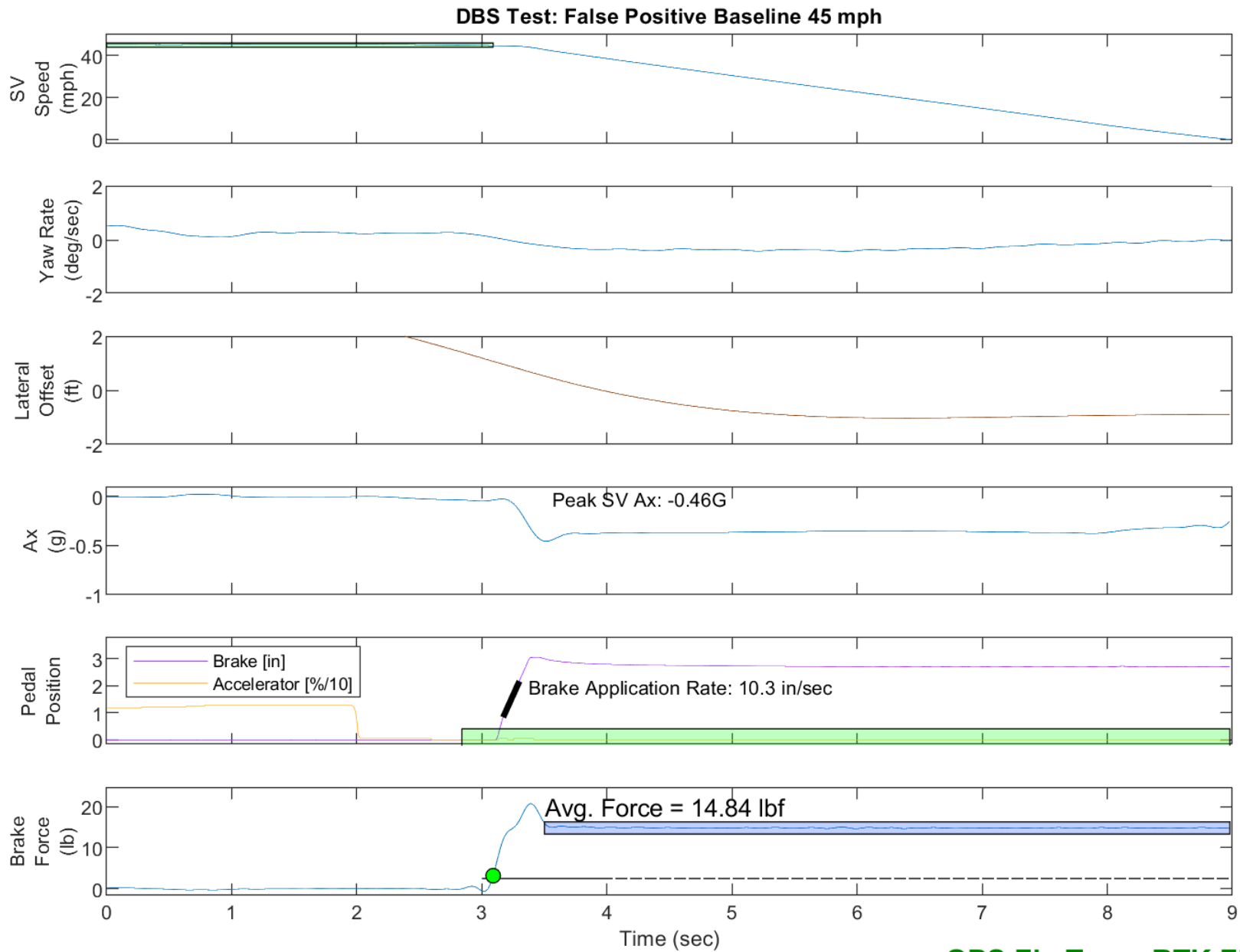


Figure E4. Example Time History for Decelerating POV 35, Passing



GPS Fix Type: RTK Fixed

Figure E5. Example Time History for False Positive Baseline 25



GPS Fix Type: RTK Fixed

Figure E6. Example Time History for False Positive Baseline 45

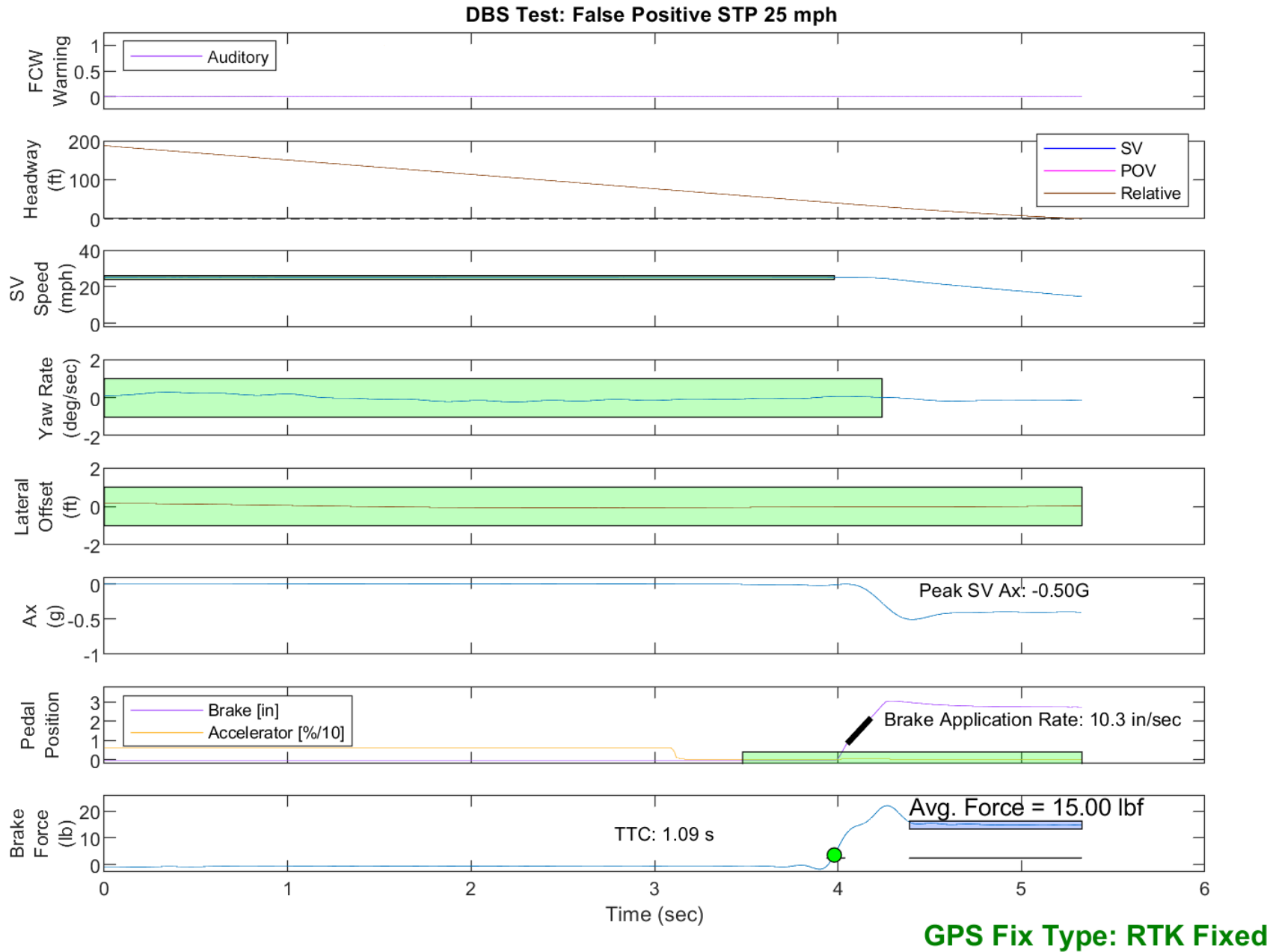


Figure E7. Example Time History for False Positive Steel Plate 25, Passing

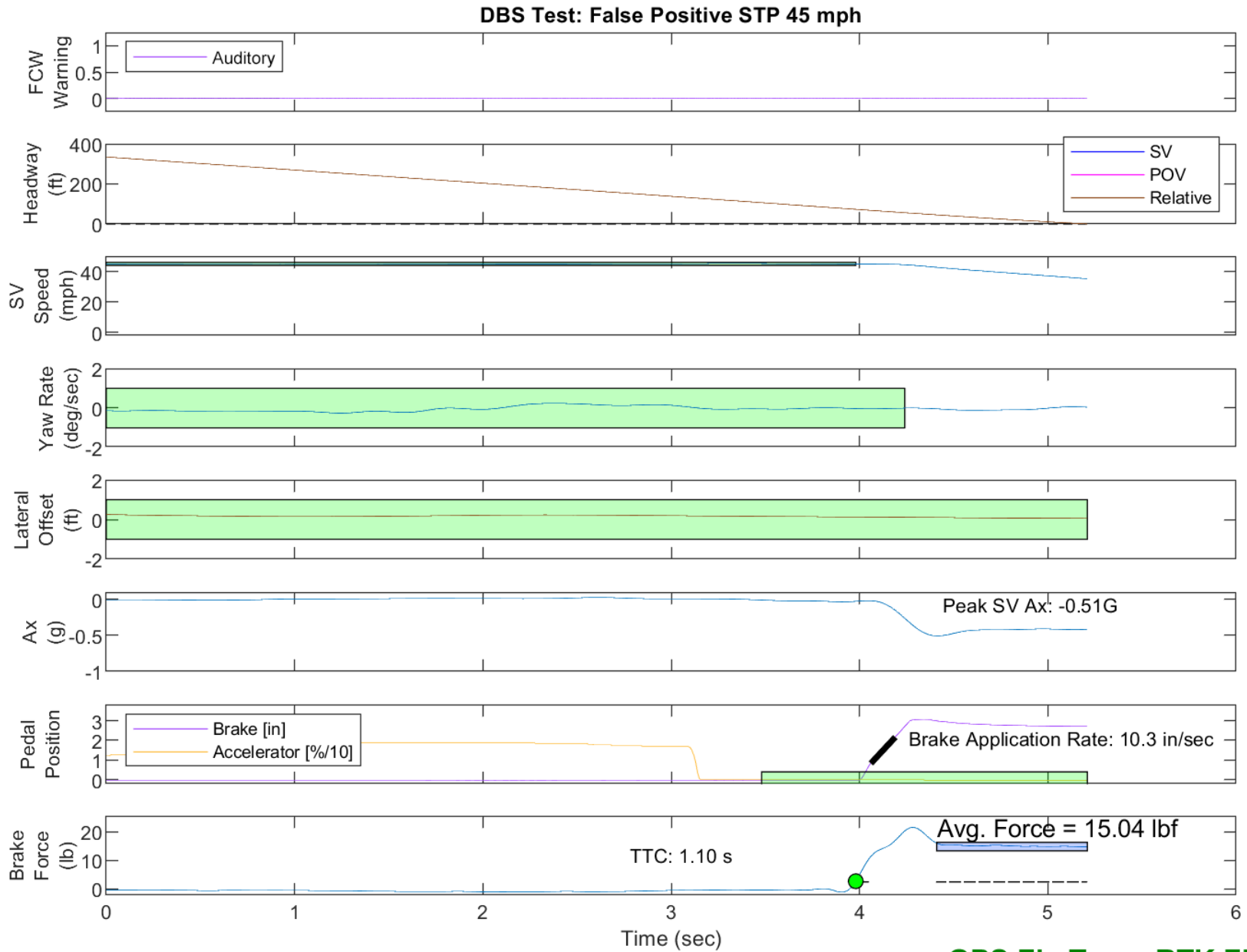


Figure E8. Example Time History for False Positive Steel Plate 45, Passing

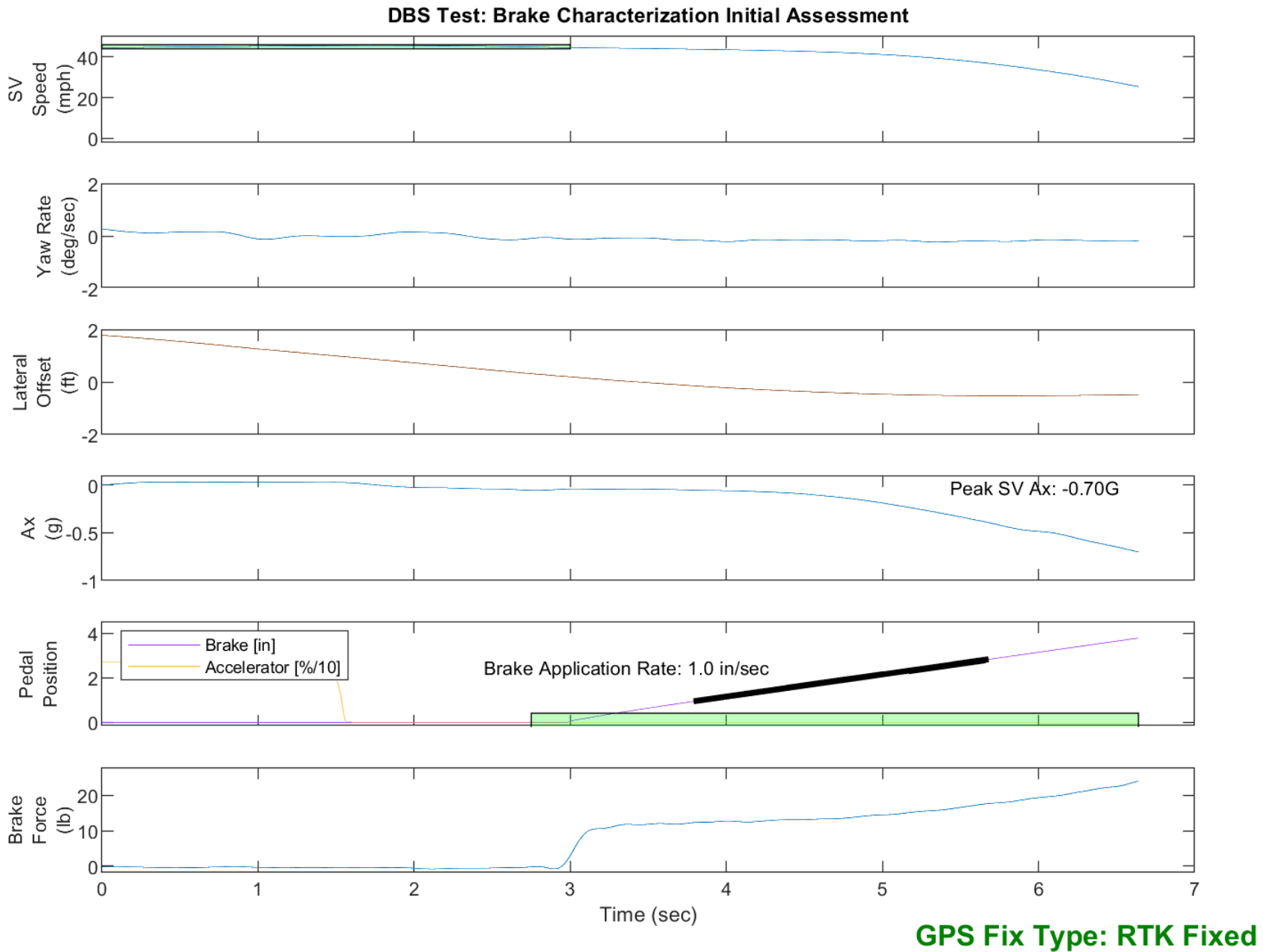


Figure E9. Example Time History for DBS Brake Characterization, Passing

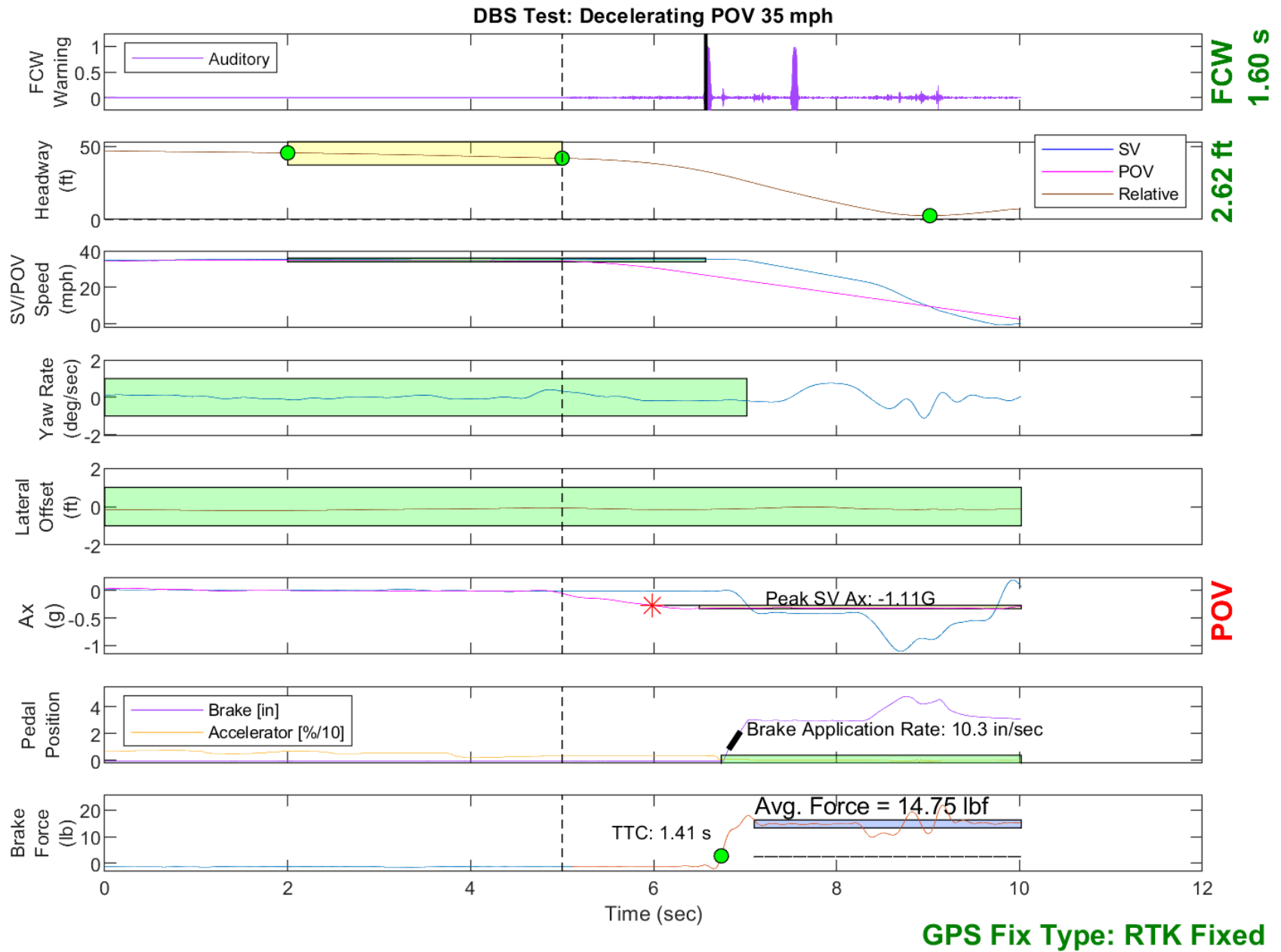
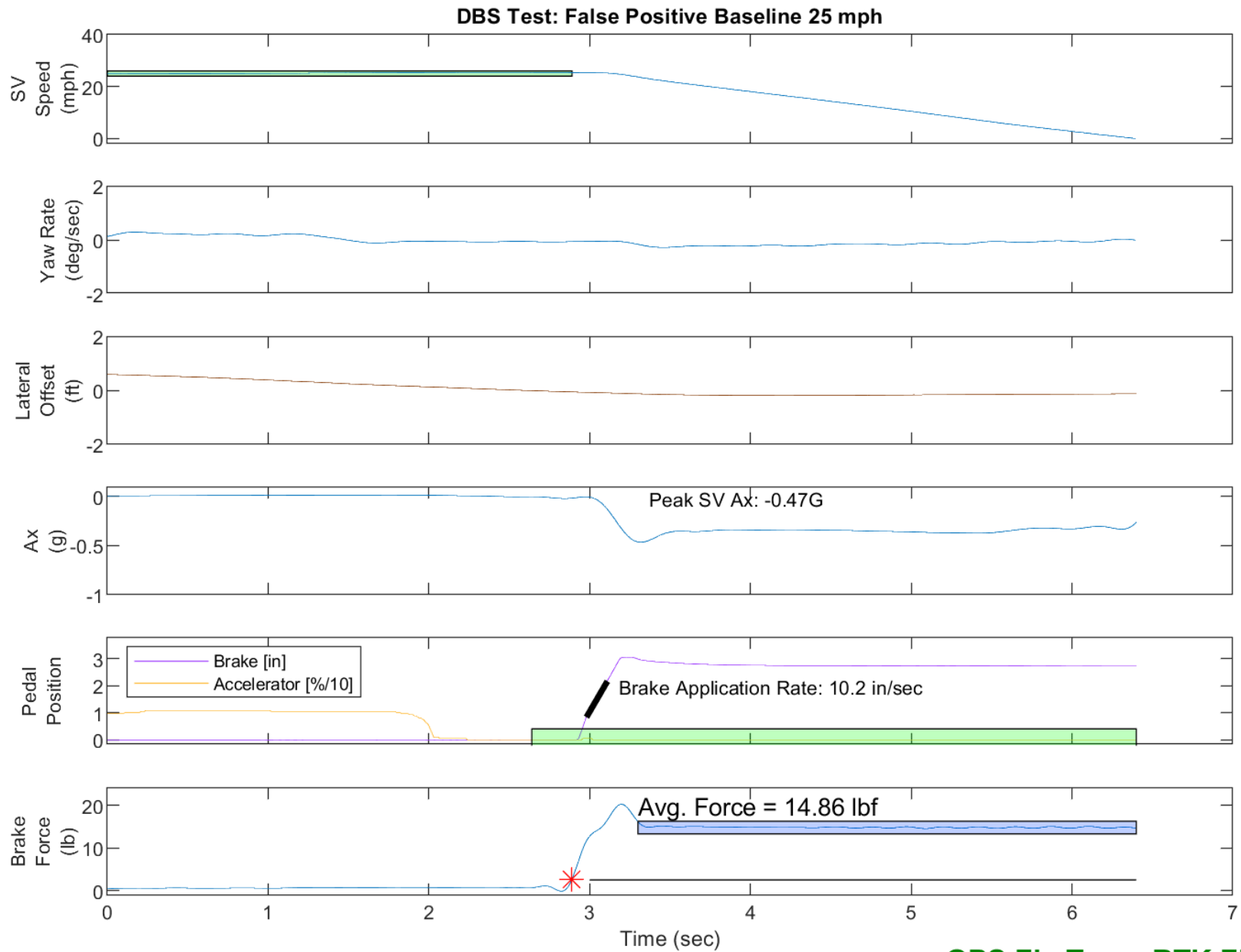


Figure E10. Example Time History Displaying Invalid POV Acceleration Criteria



GPS Fix Type: RTK Fixed

Figure E11. Example Time History Displaying Invalid Brake Force Criteria

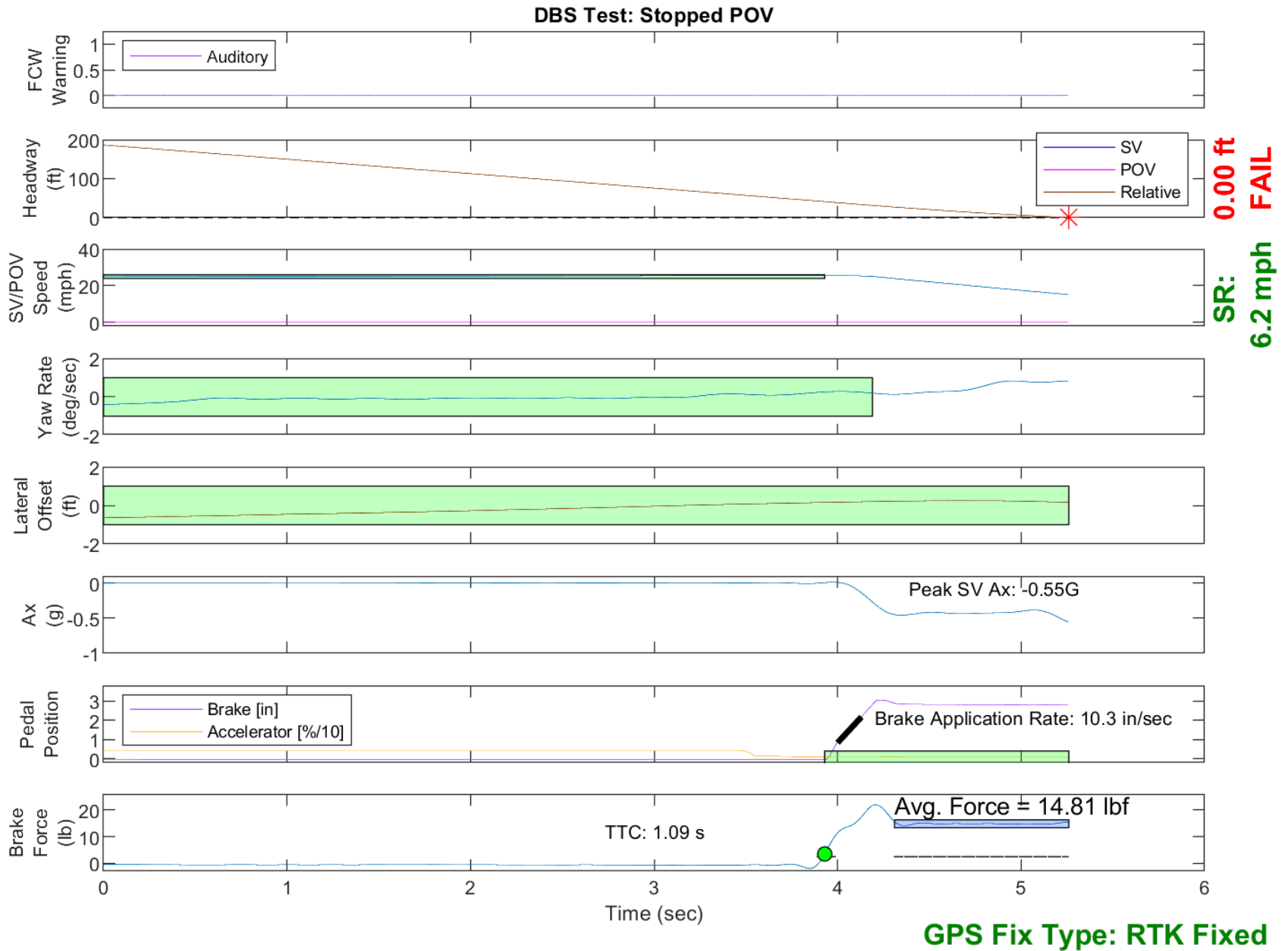


Figure E12. Example Time History for a Failed Run

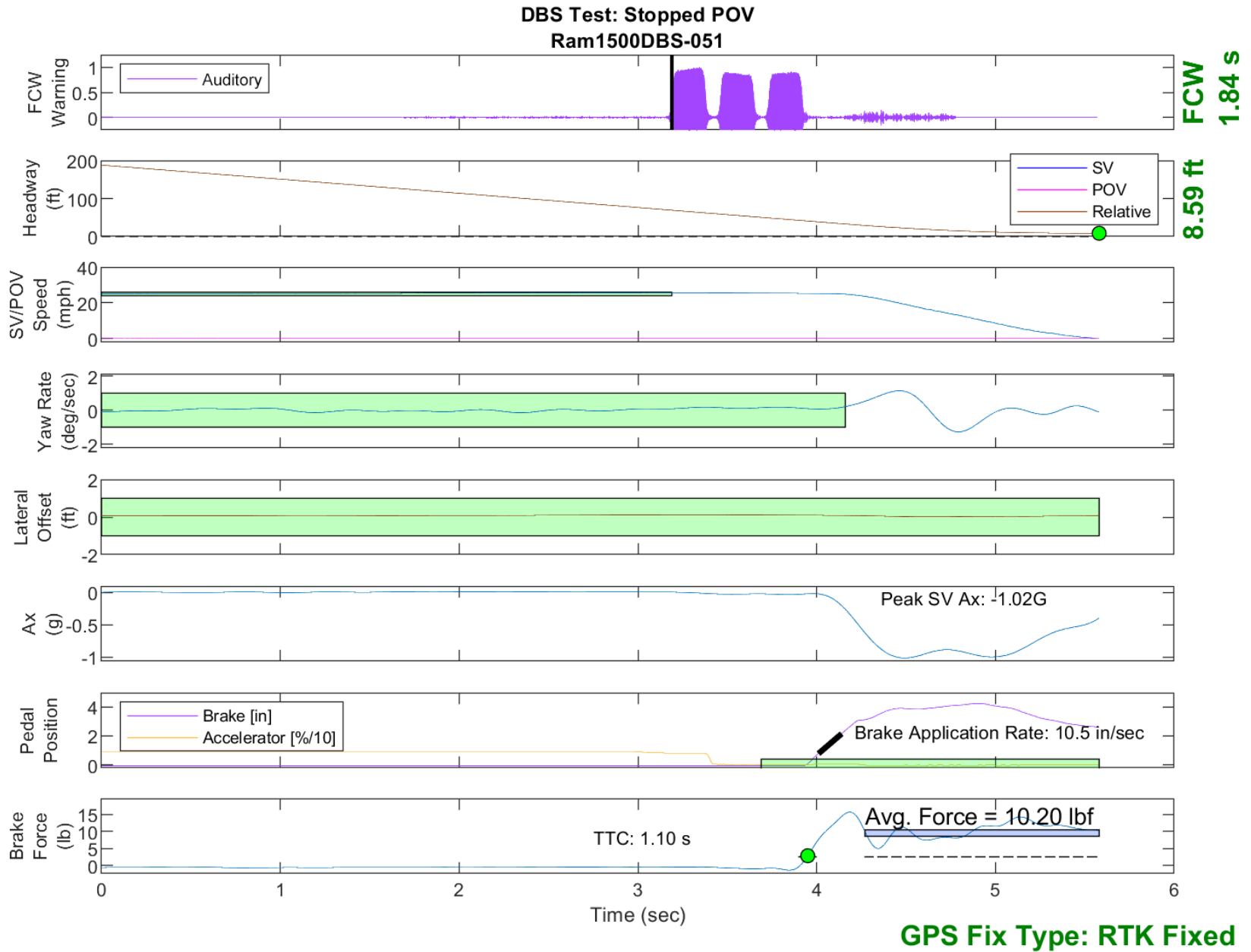


Figure E13. Time History for DBS Run 51, SV Encounters Stopped POV

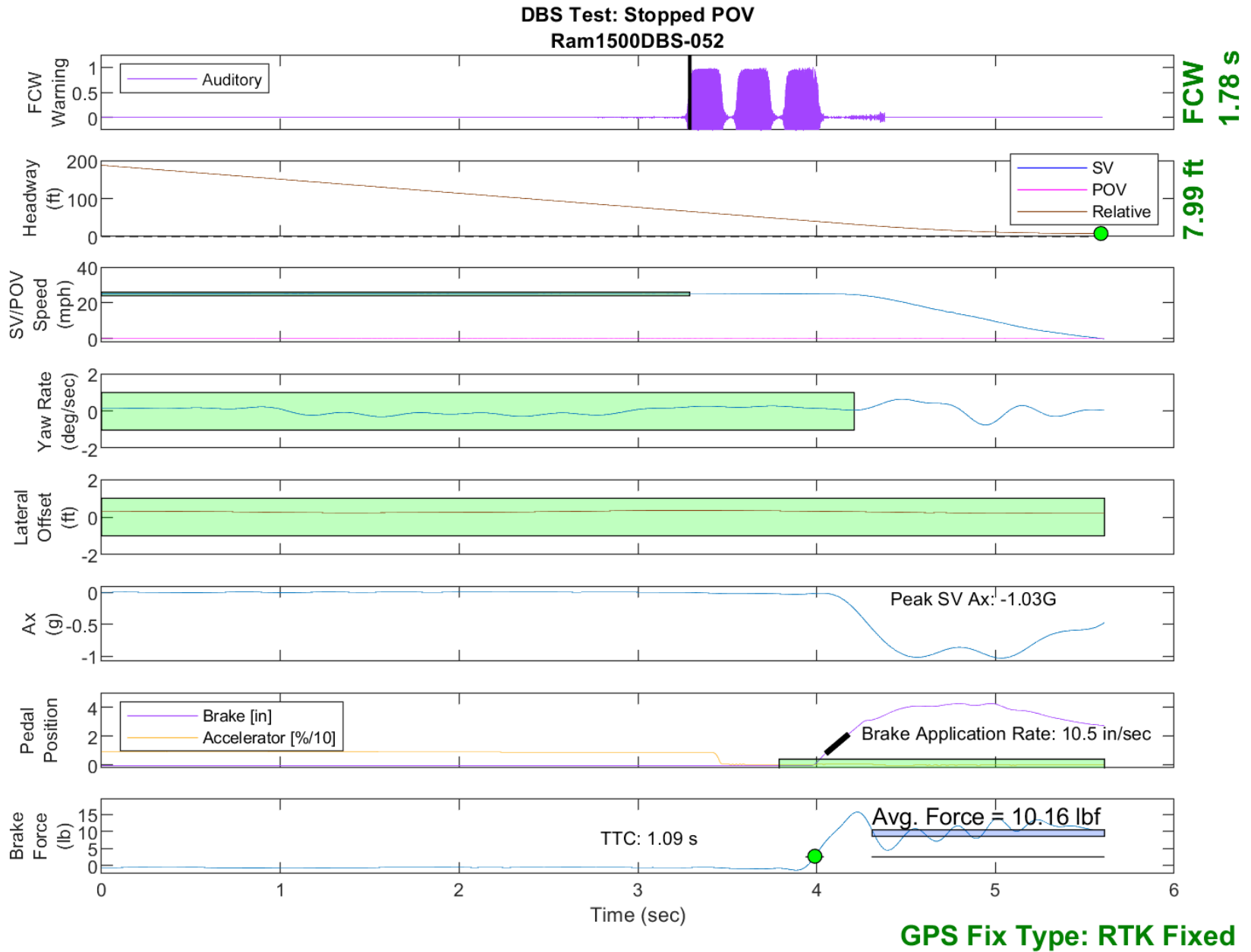


Figure E14. Time History for DBS Run 52, SV Encounters Stopped POV

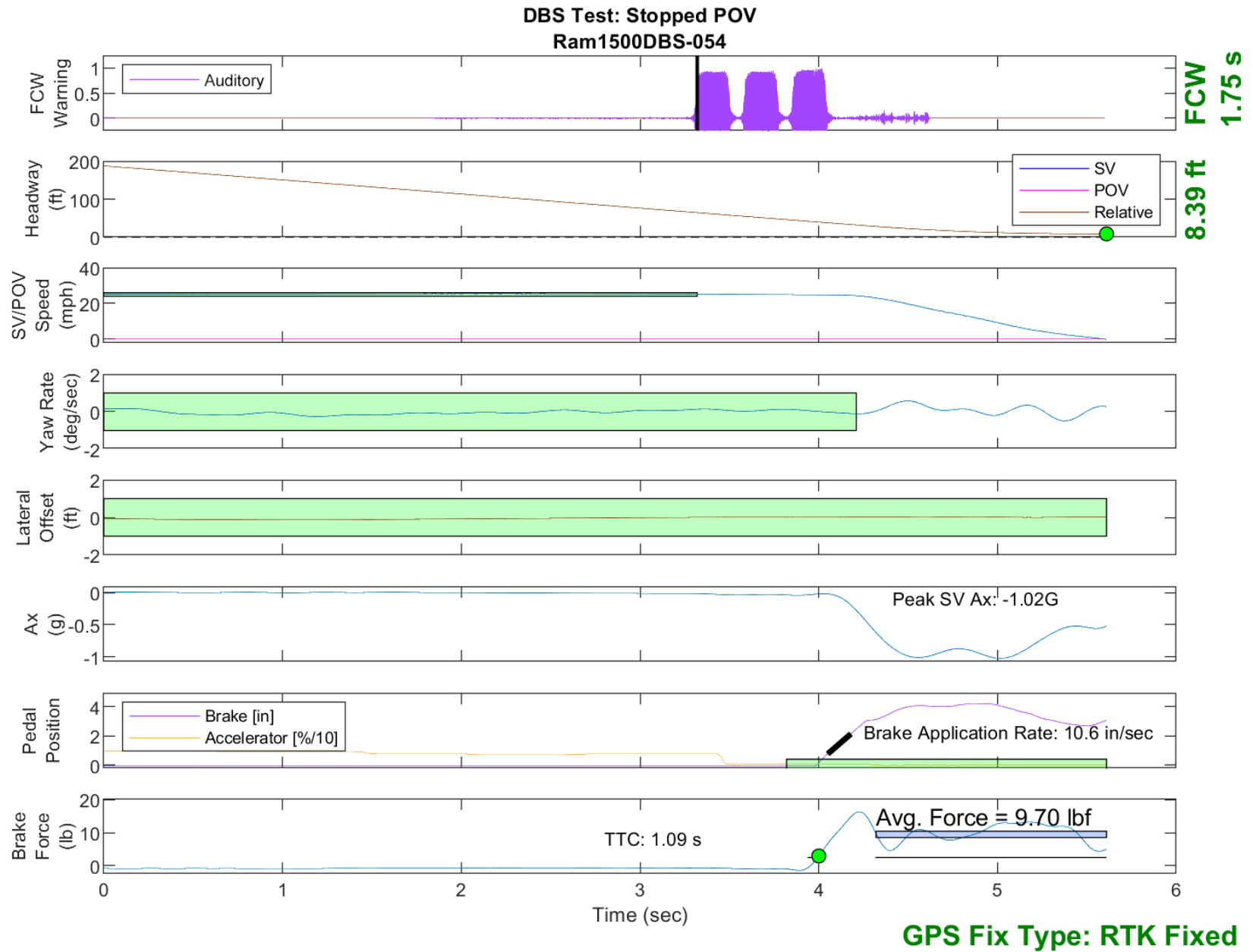


Figure E15. Time History for DBS Run 54, SV Encounters Stopped POV

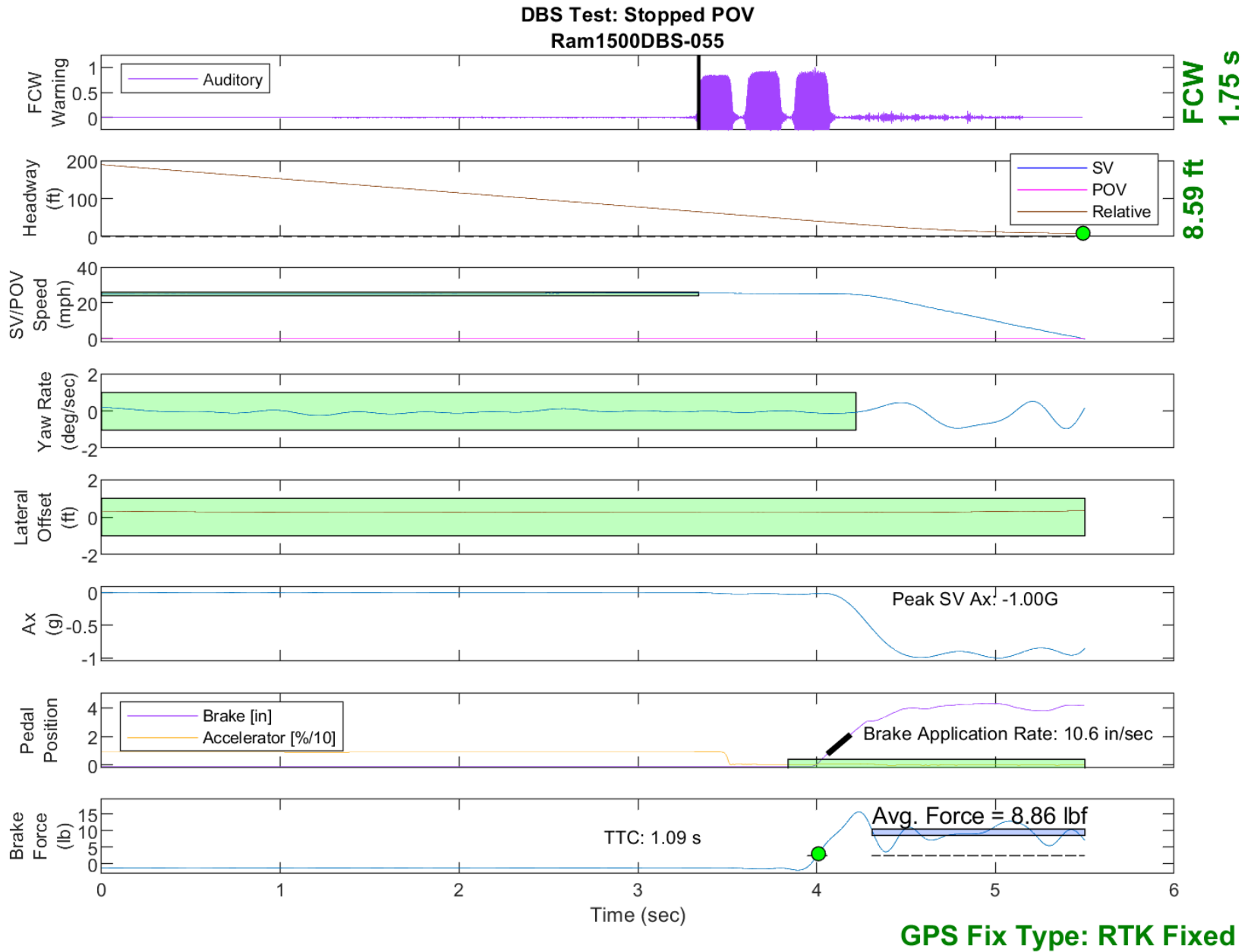


Figure E16. Time History for DBS Run 55, SV Encounters Stopped POV

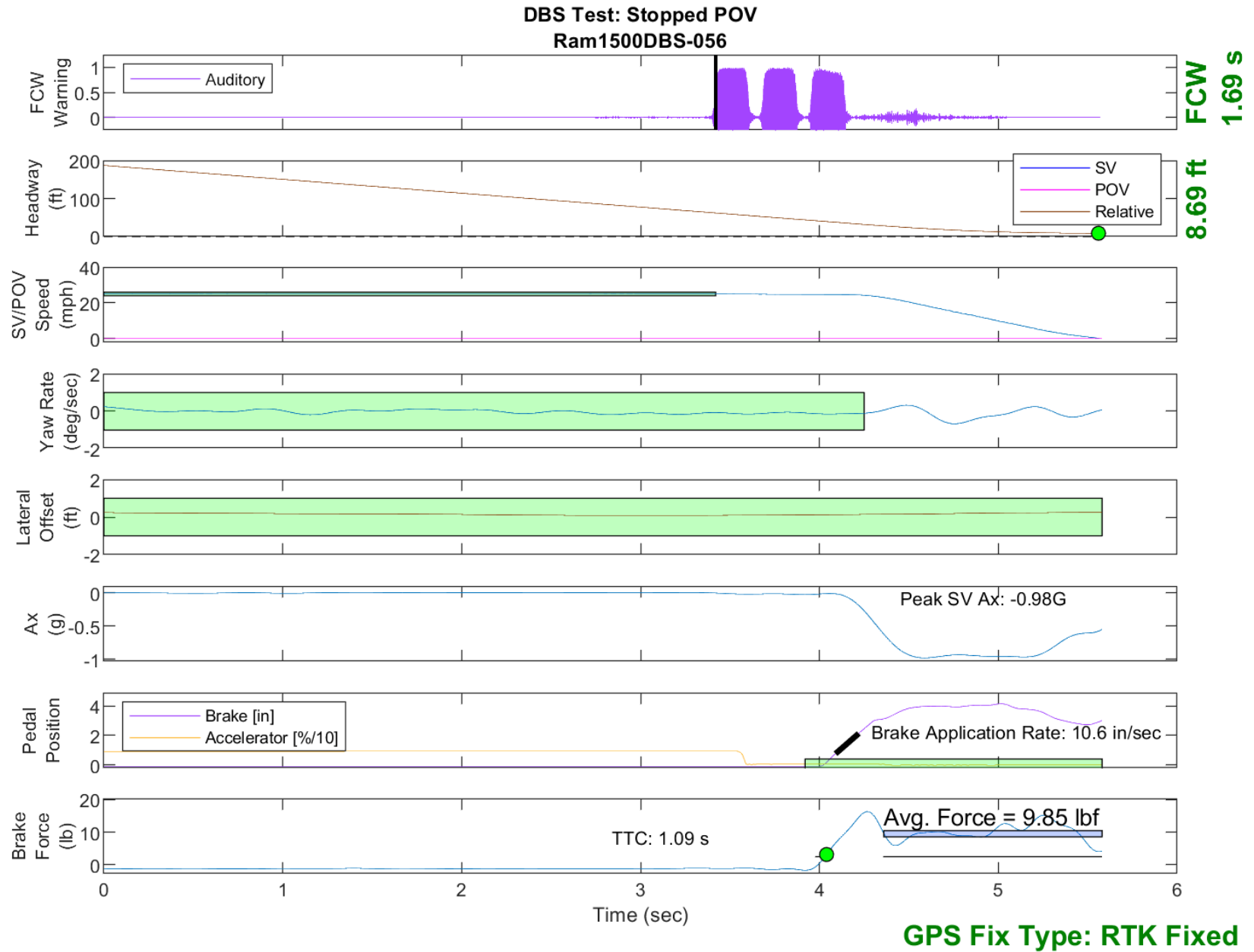


Figure E17. Time History for DBS Run 56, SV Encounters Stopped POV

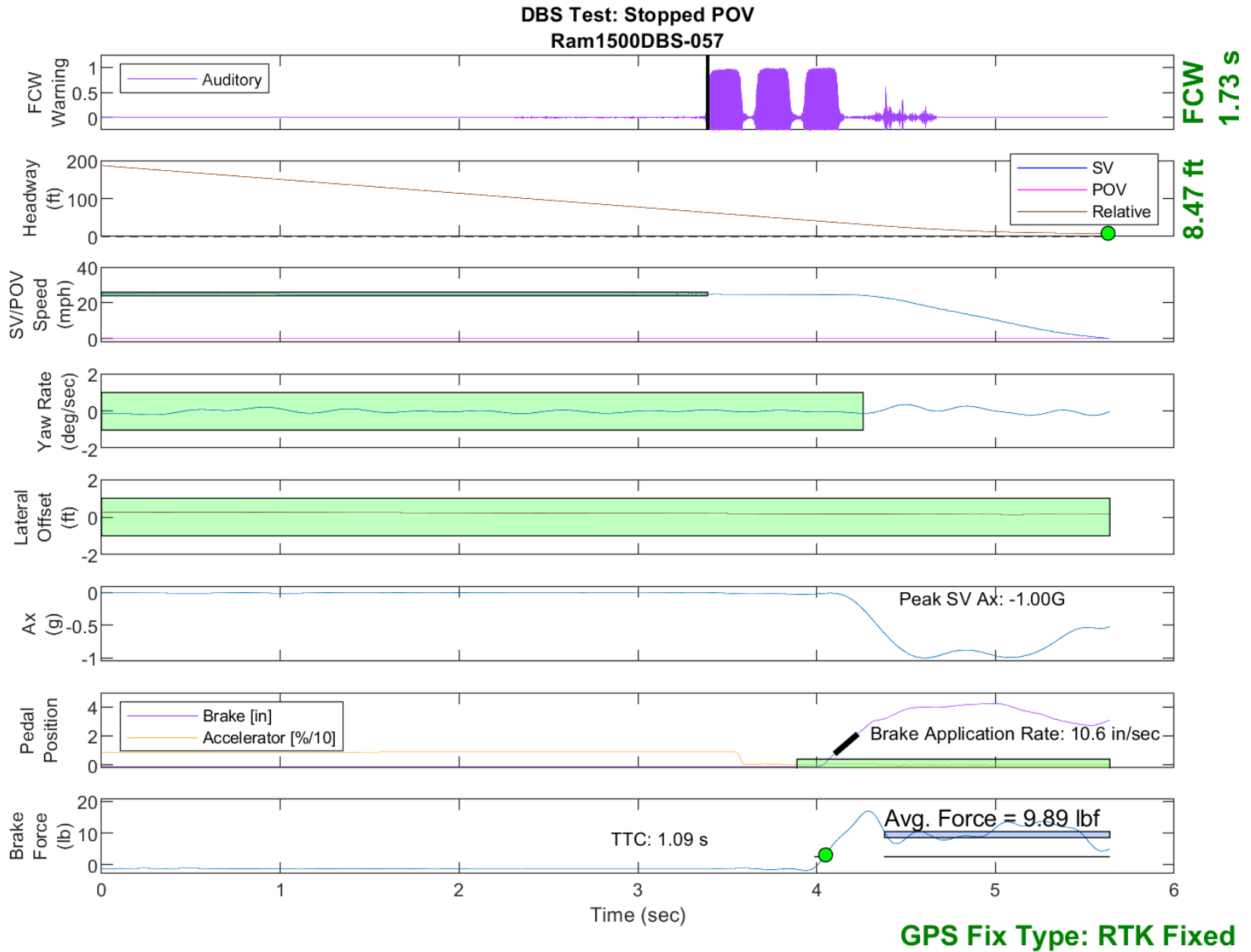


Figure E18. Time History for DBS Run 57, SV Encounters Stopped POV

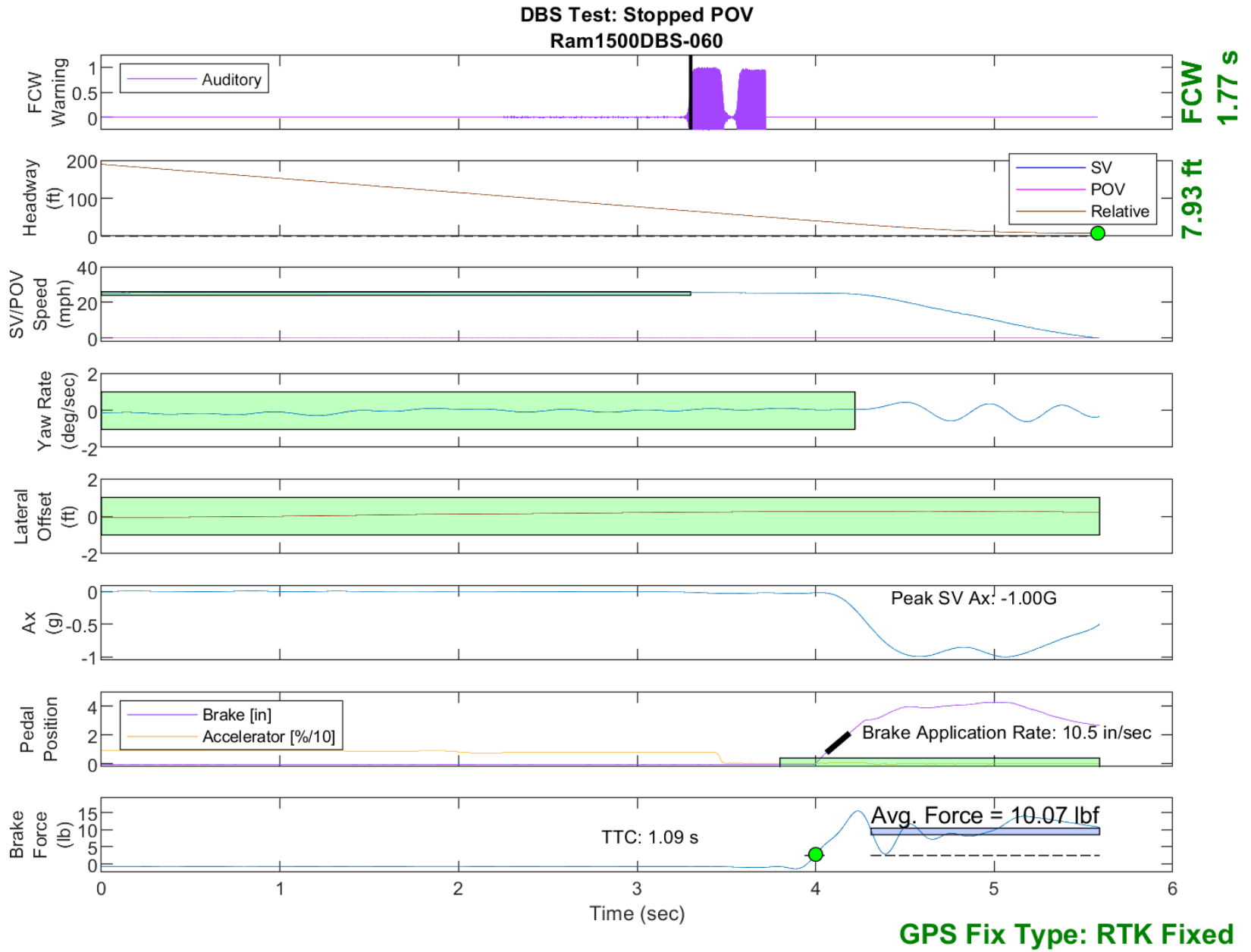


Figure E19. Time History for DBS Run 60, SV Encounters Stopped POV

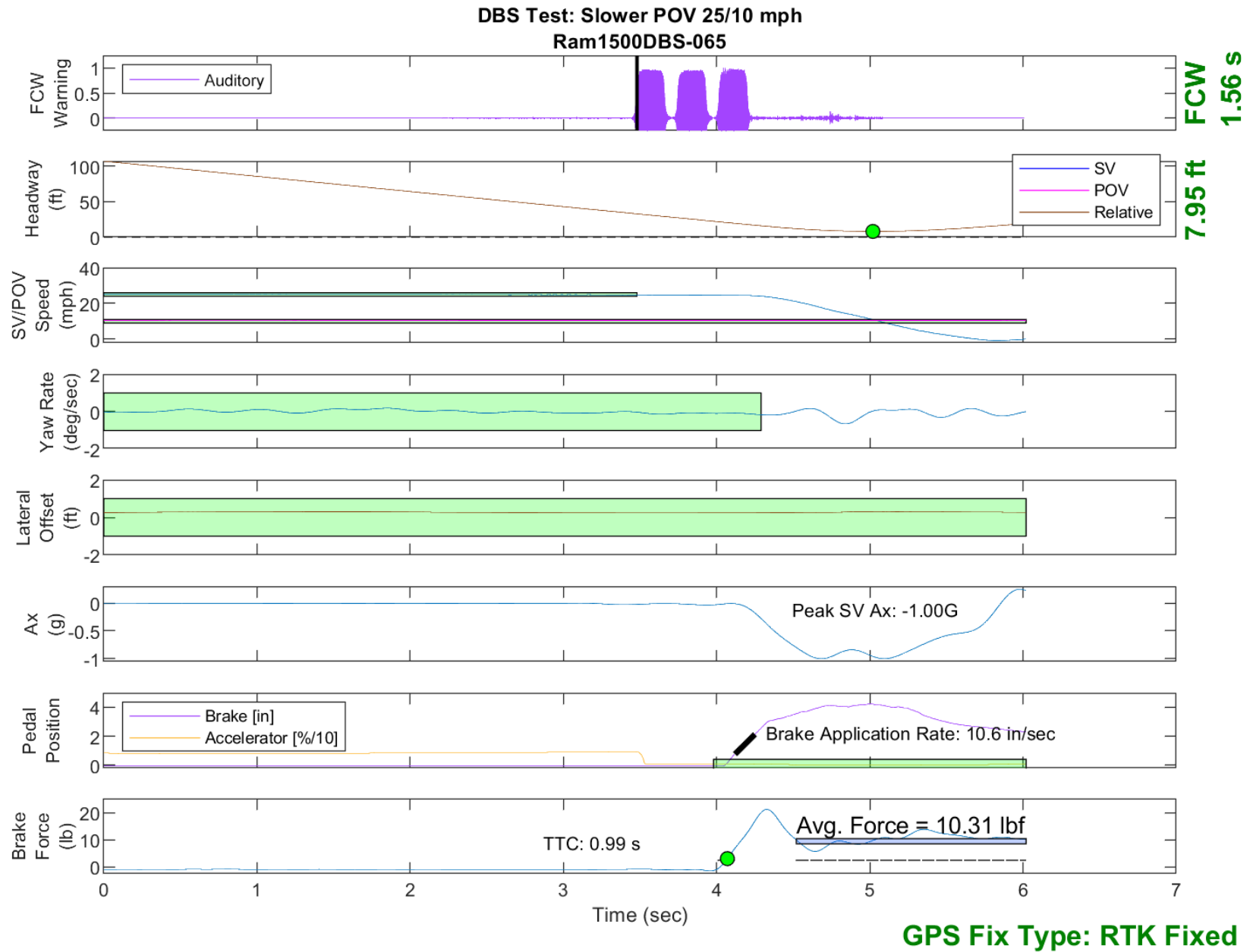


Figure E20. Time History for DBS Run 65, SV Encounters Slower POV, SV 25 mph, POV 10 mph

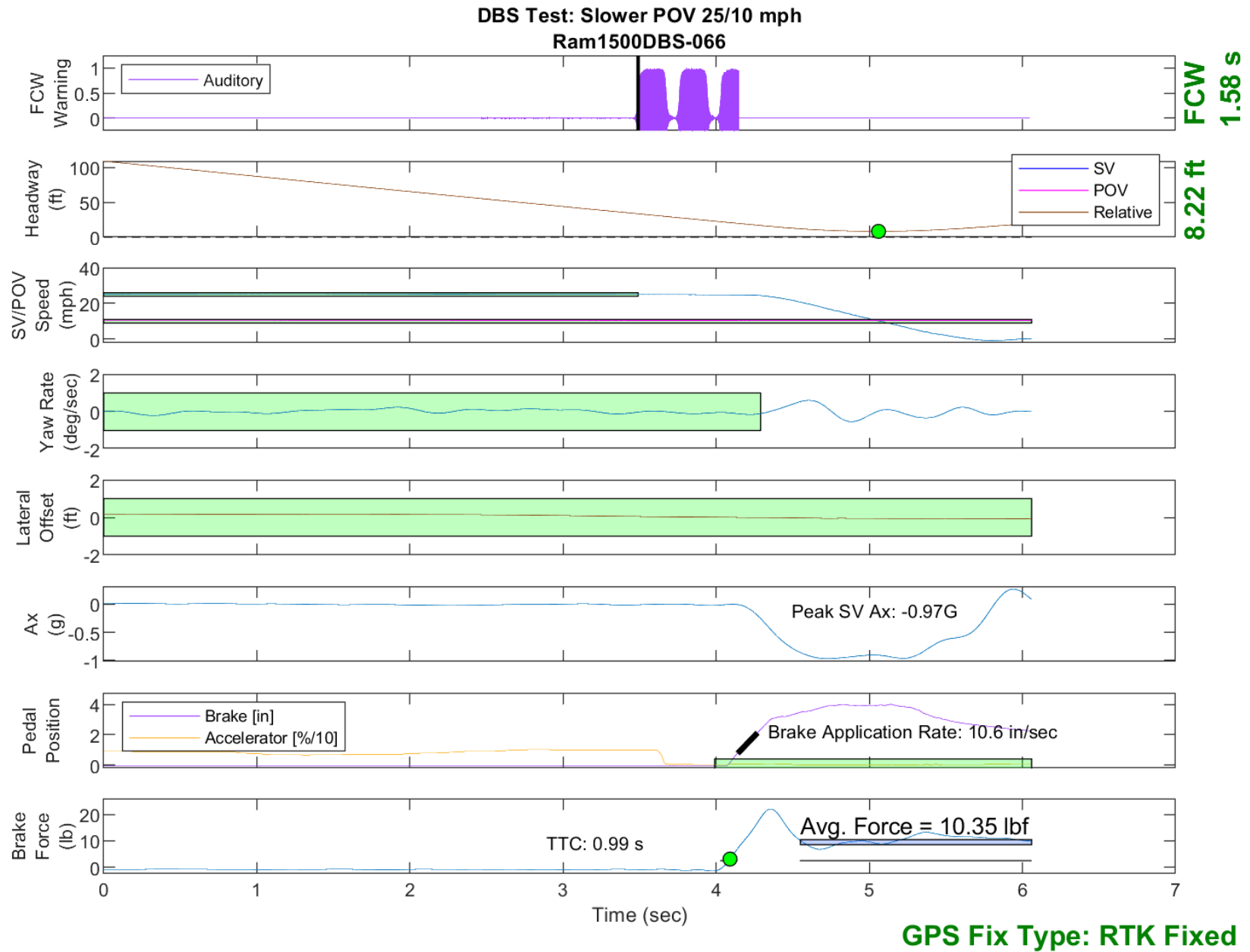


Figure E21. Time History for DBS Run 66, SV Encounters Slower POV, SV 25 mph, POV 10 mph

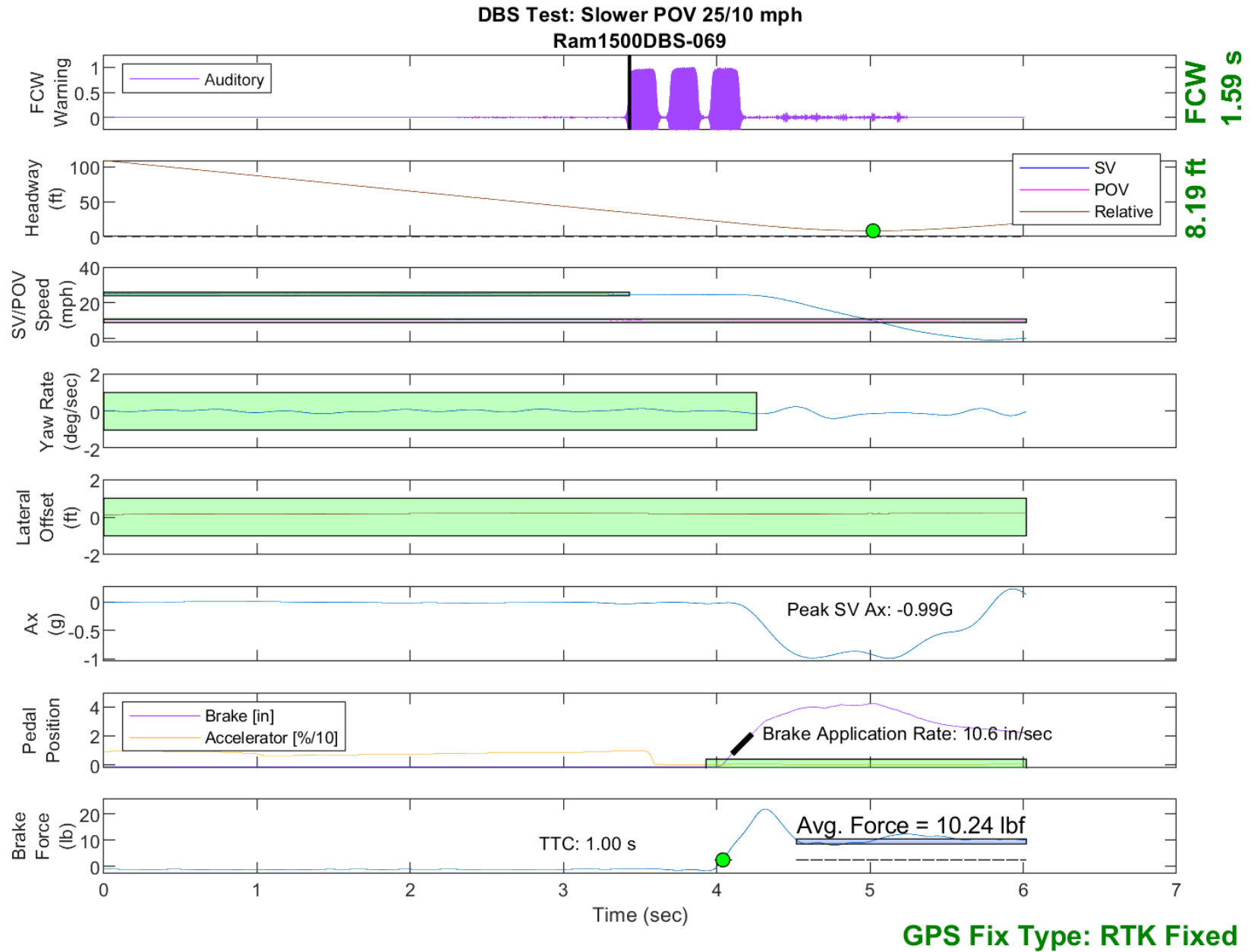


Figure E22. Time History for DBS Run 69, SV Encounters Slower POV, SV 25 mph, POV 10 mph

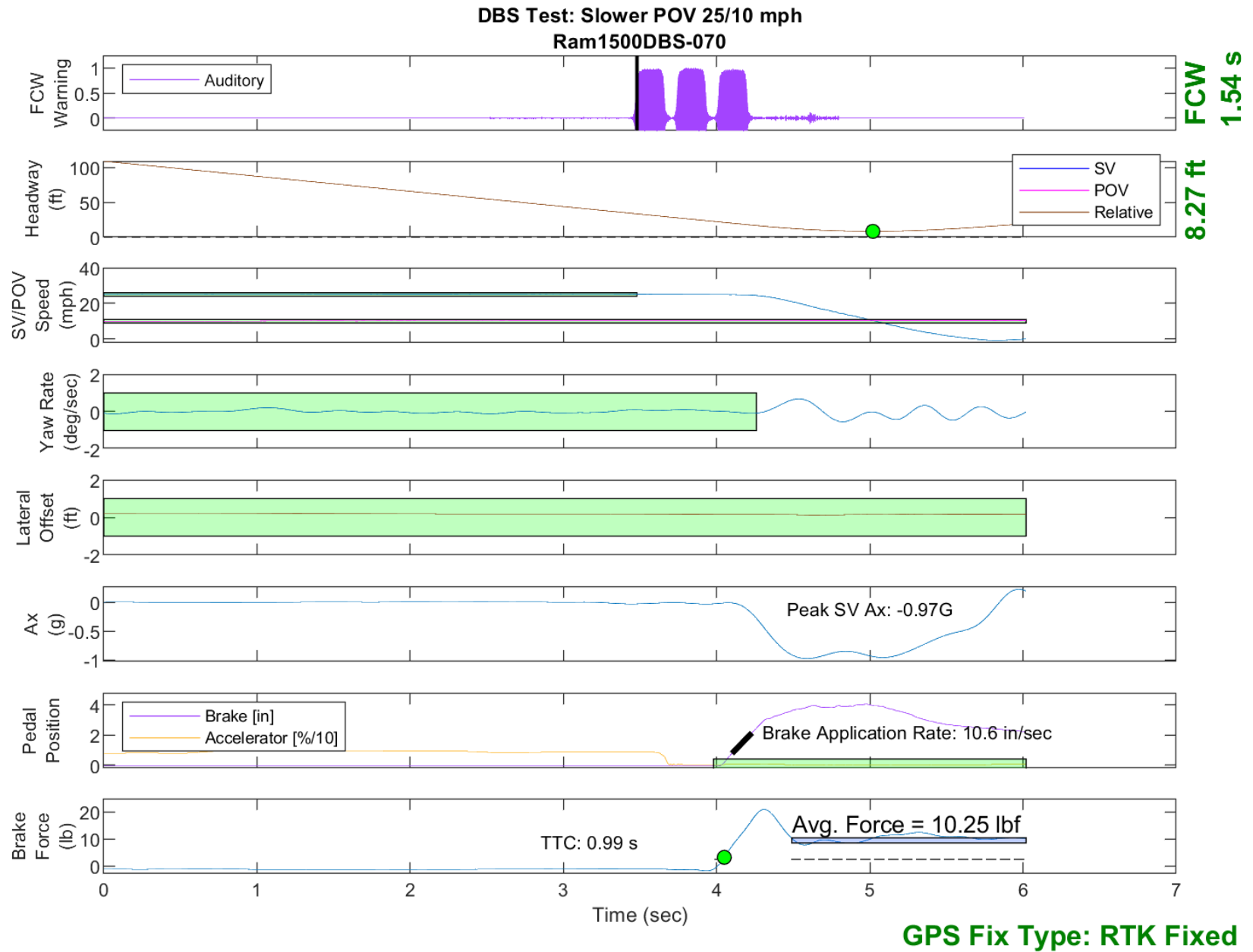


Figure E23. Time History for DBS Run 70, SV Encounters Slower POV, SV 25 mph, POV 10 mph

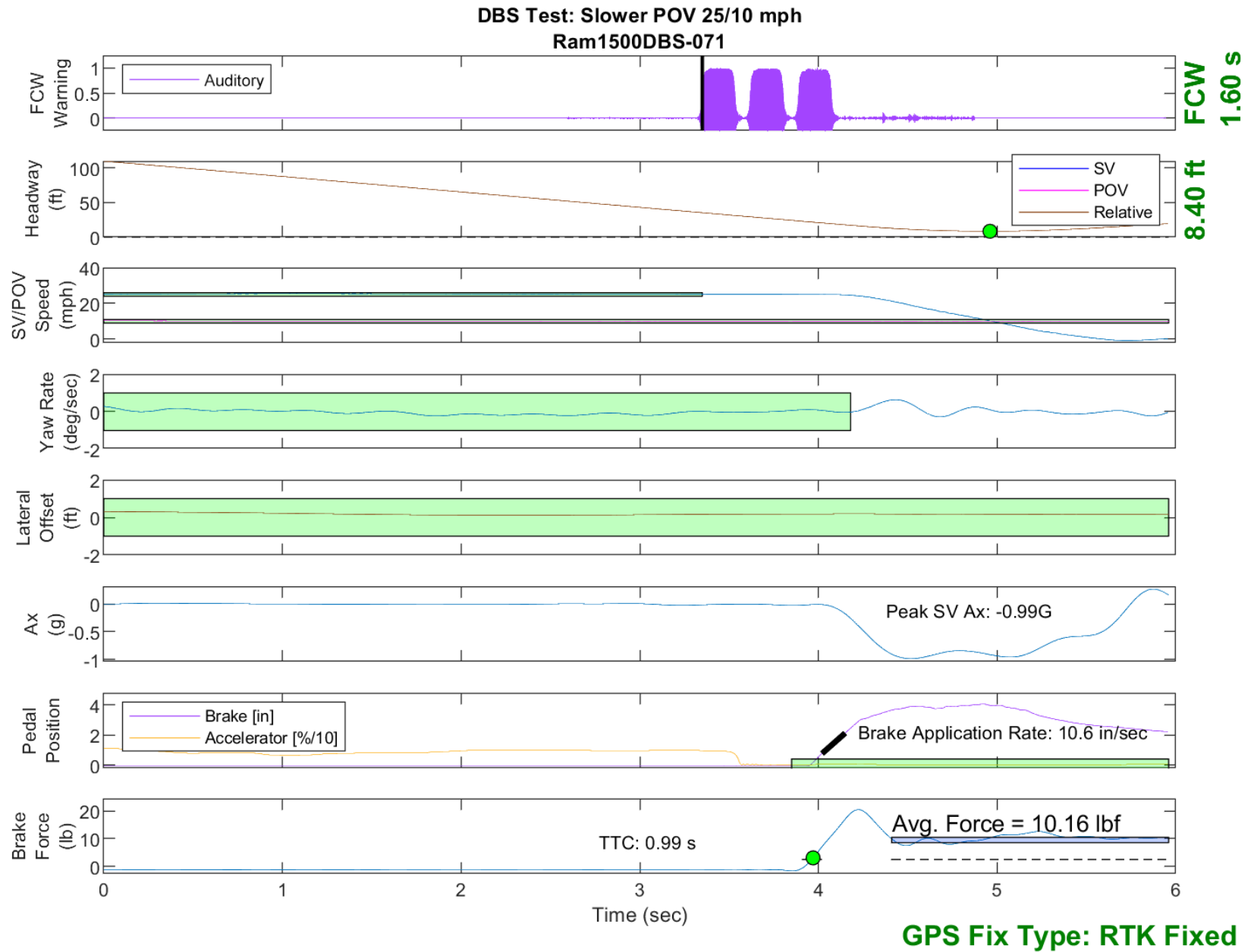


Figure E24. Time History for DBS Run 71, SV Encounters Slower POV, SV 25 mph, POV 10 mph

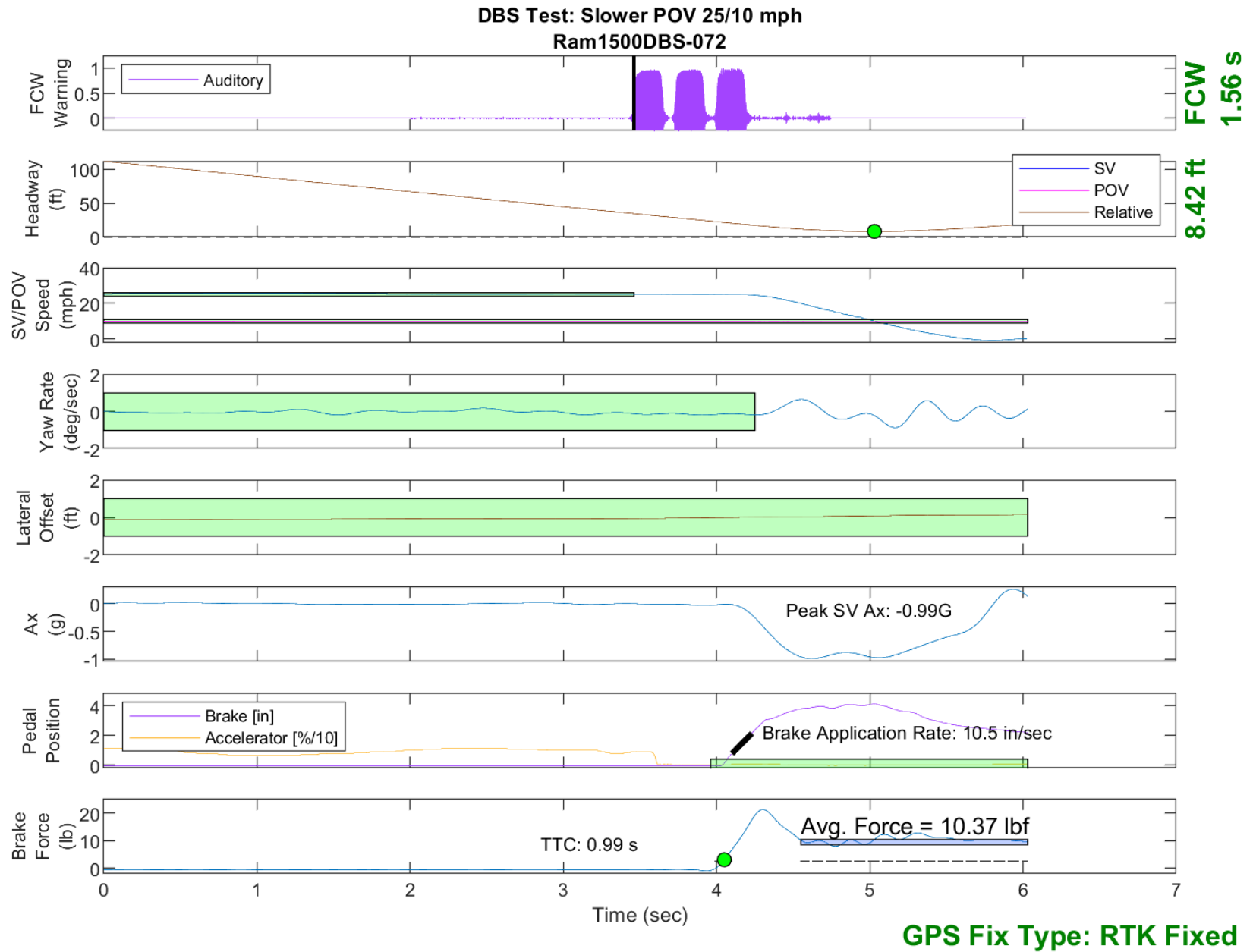


Figure E25. Time History for DBS Run 72, SV Encounters Slower POV, SV 25 mph, POV 10 mph

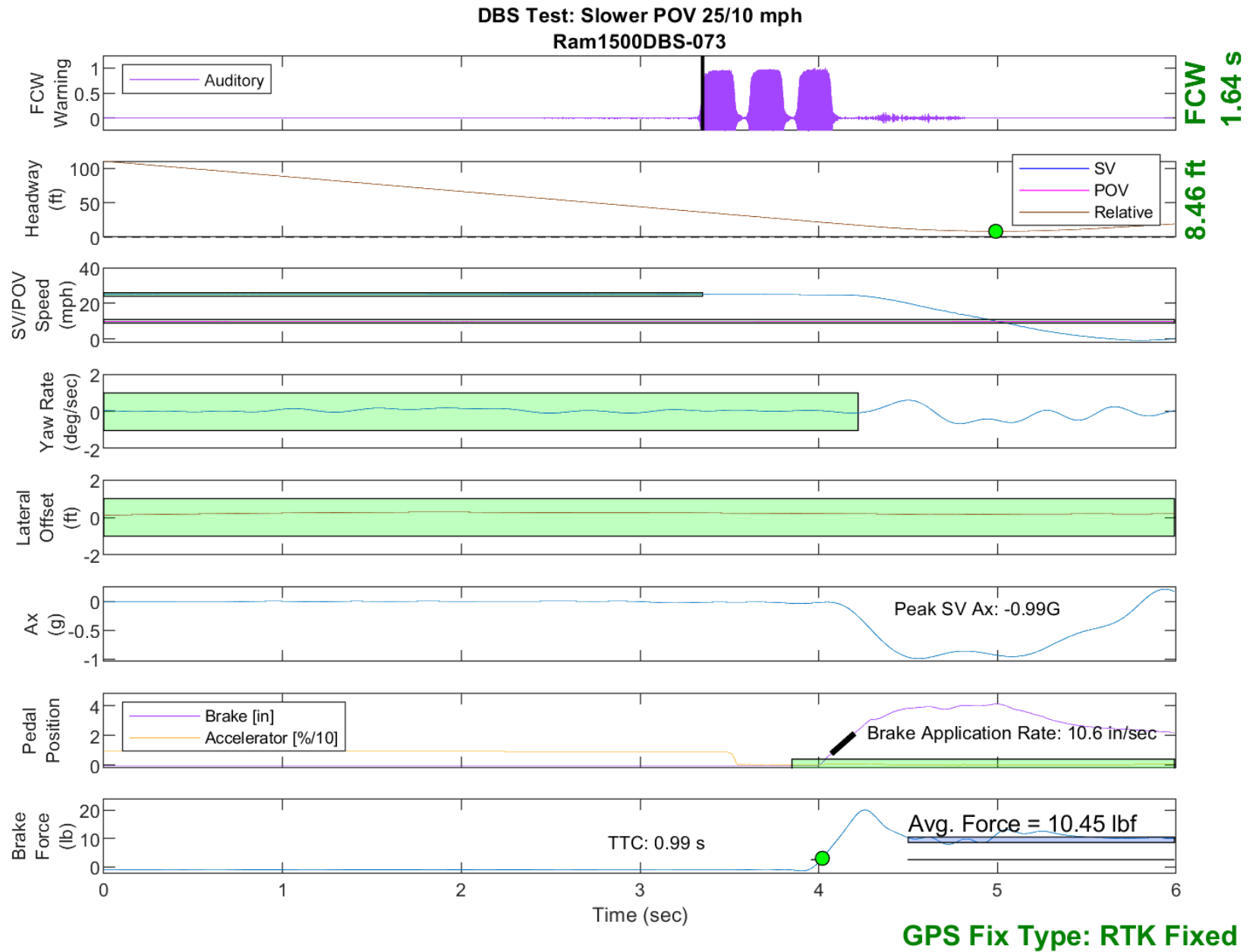


Figure E26. Time History for DBS Run 73, SV Encounters Slower POV, SV 25 mph, POV 10 mph

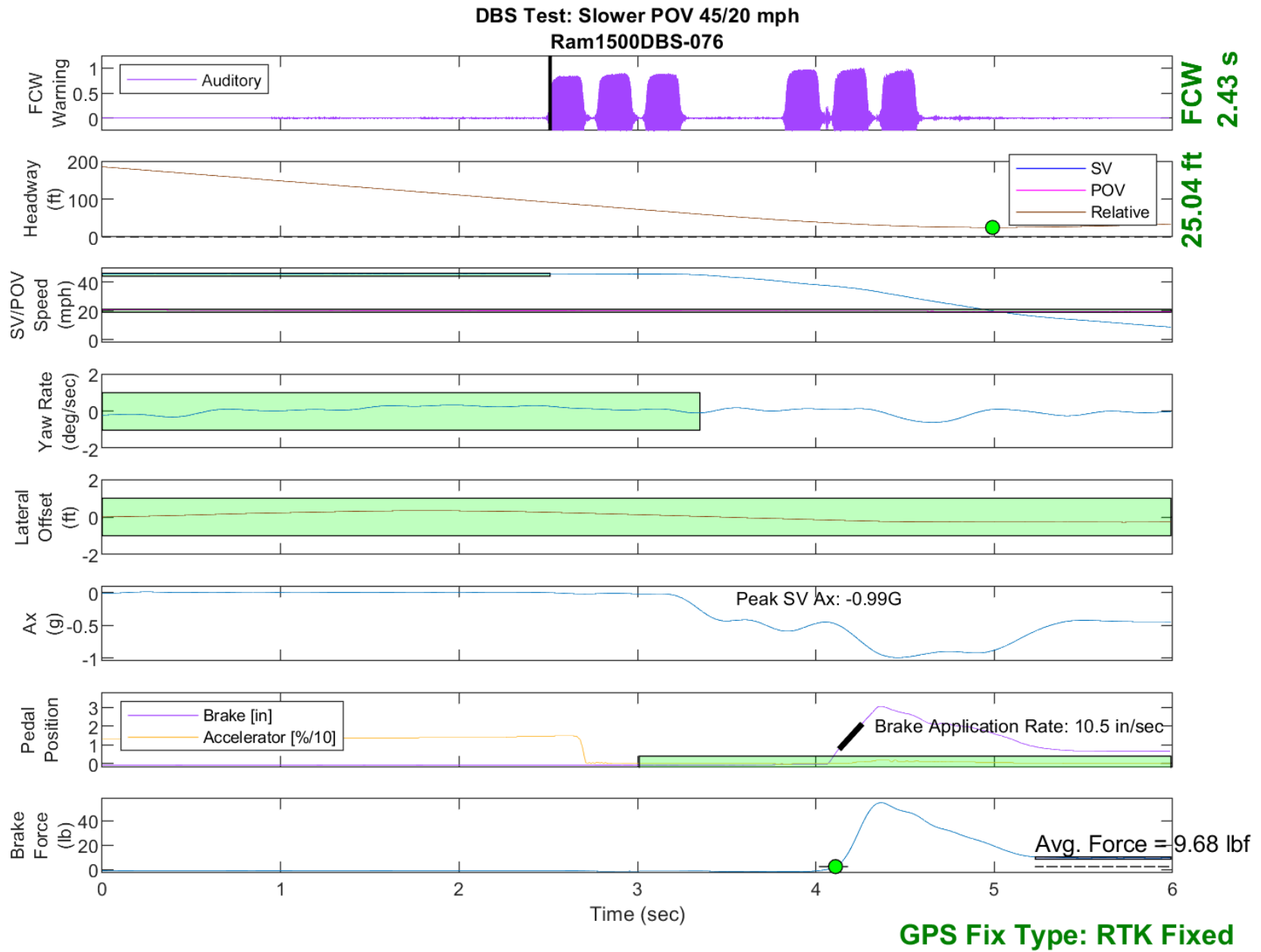


Figure E27. Time History for DBS Run 76, SV Encounters Slower POV, SV 45 mph, POV 20 mph

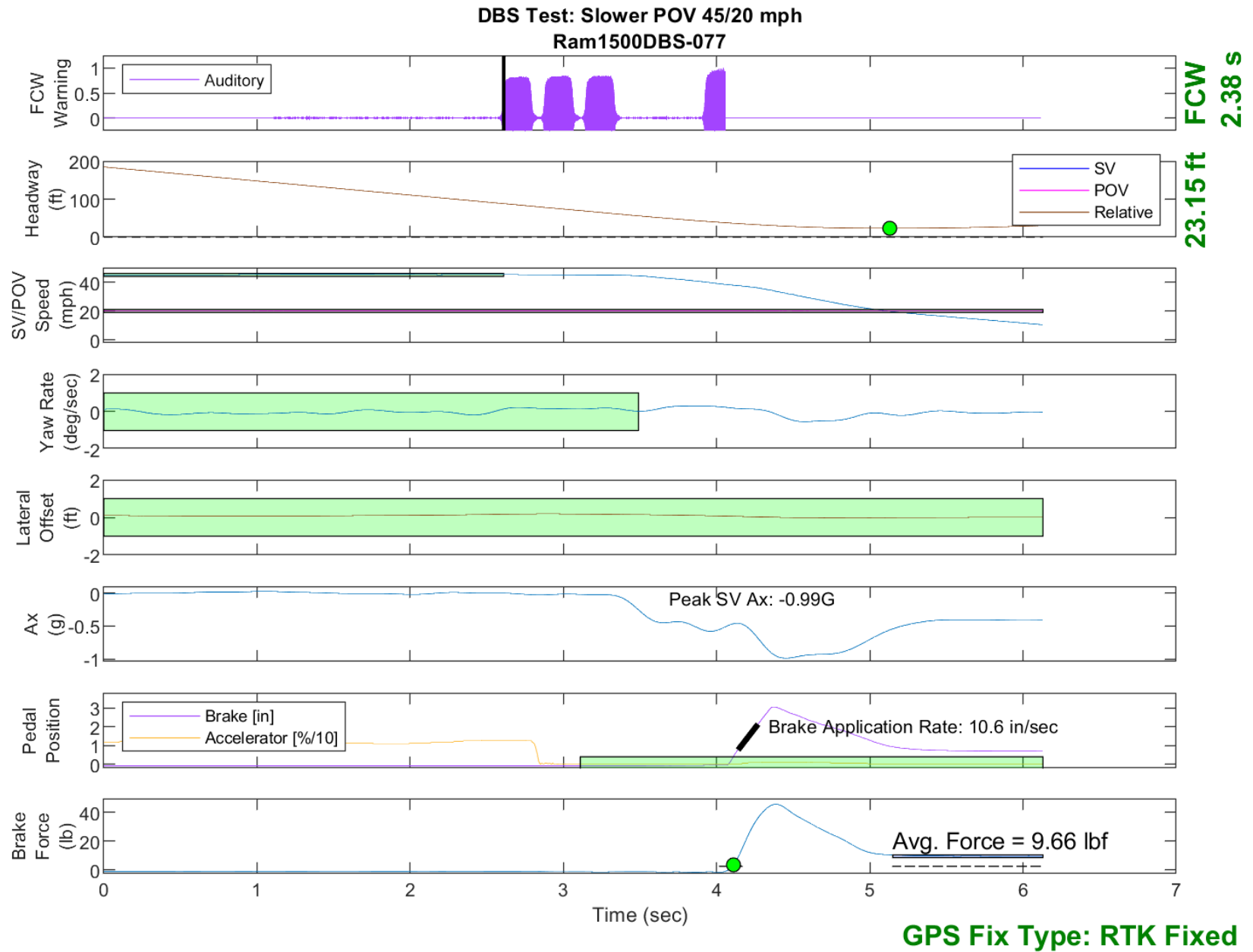


Figure E28. Time History for DBS Run 77, SV Encounters Slower POV, SV 45 mph, POV 20 mph

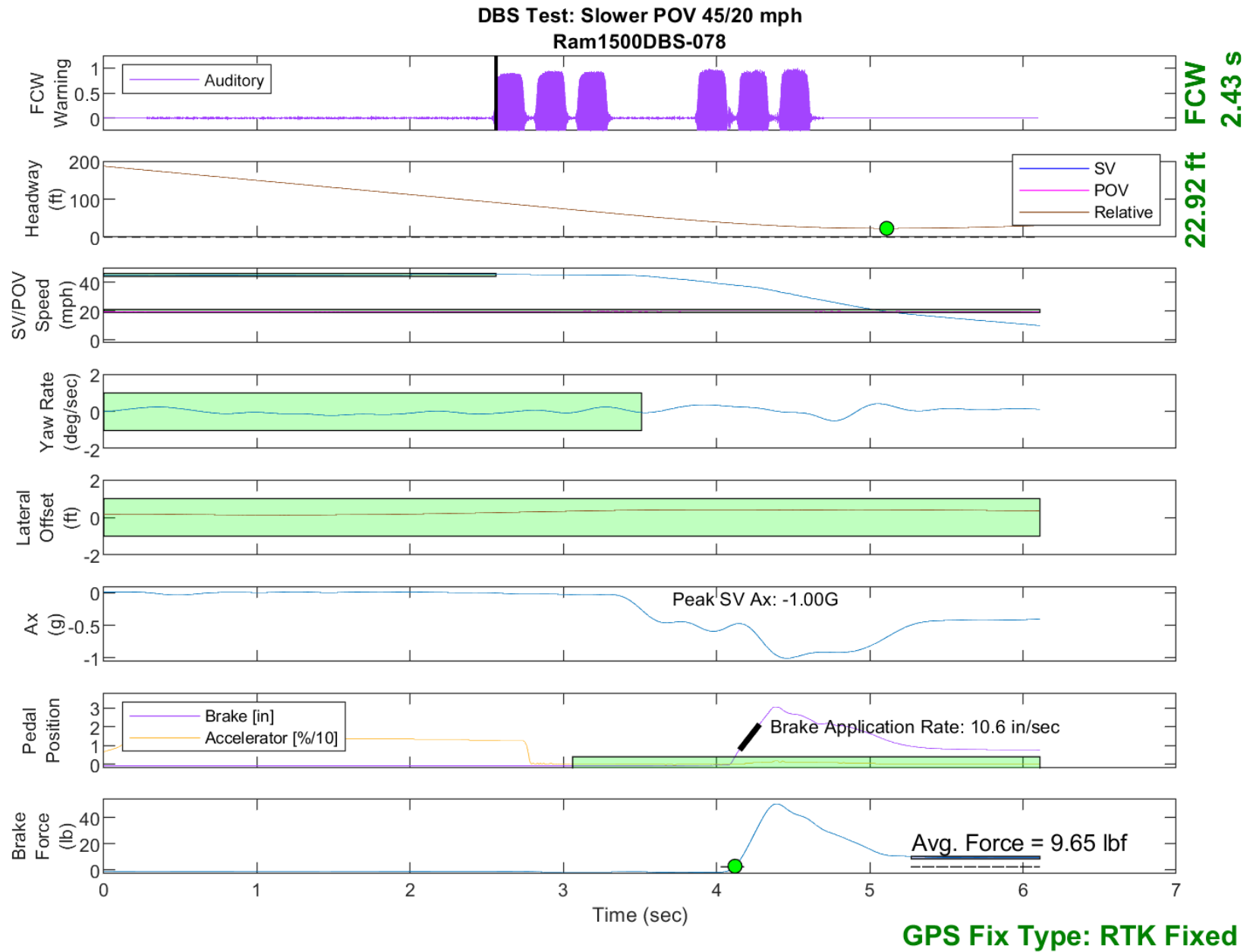


Figure E29. Time History for DBS Run 78, SV Encounters Slower POV, SV 45 mph, POV 20 mph

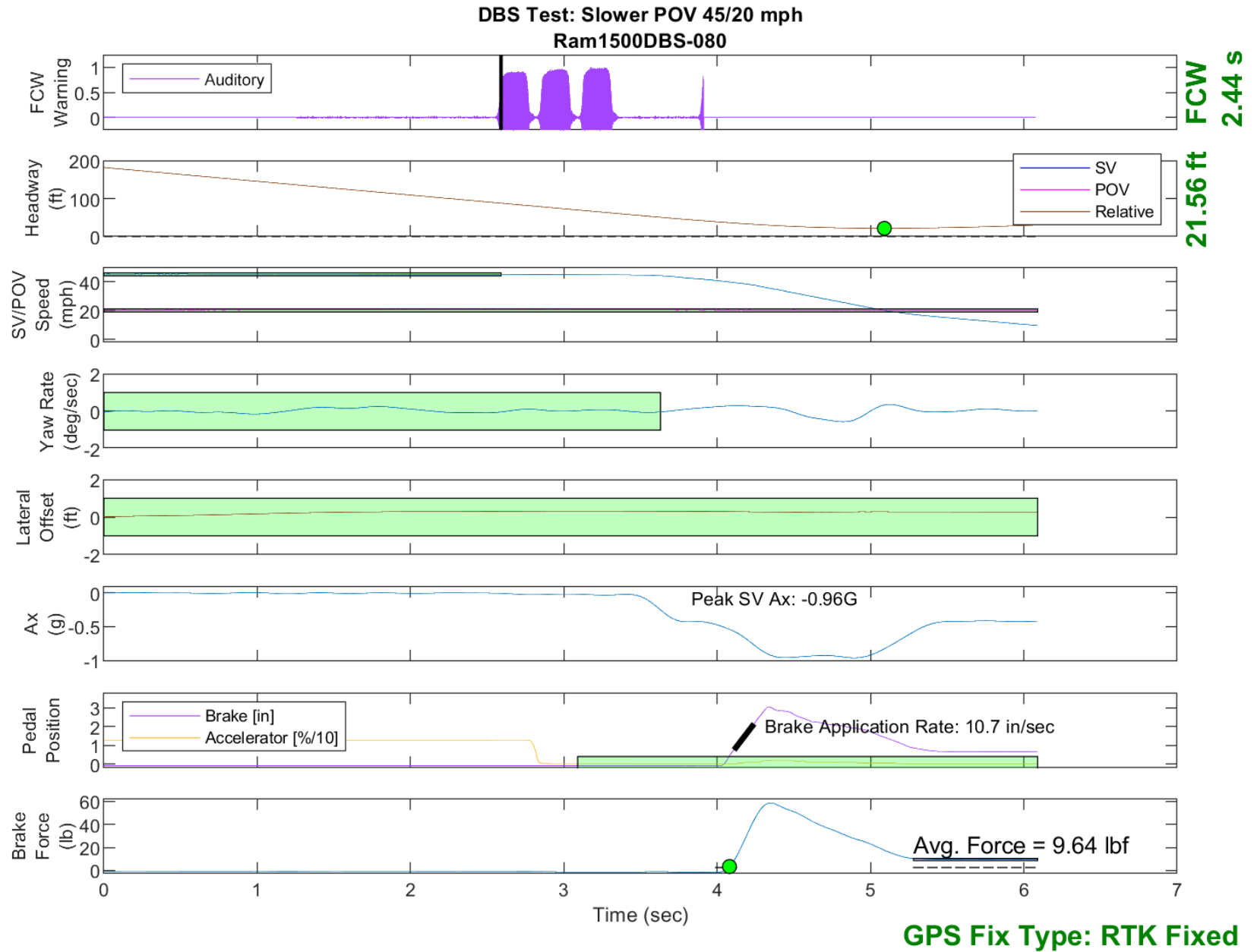


Figure E30. Time History for DBS Run 80, SV Encounters Slower POV, SV 45 mph, POV 20 mph

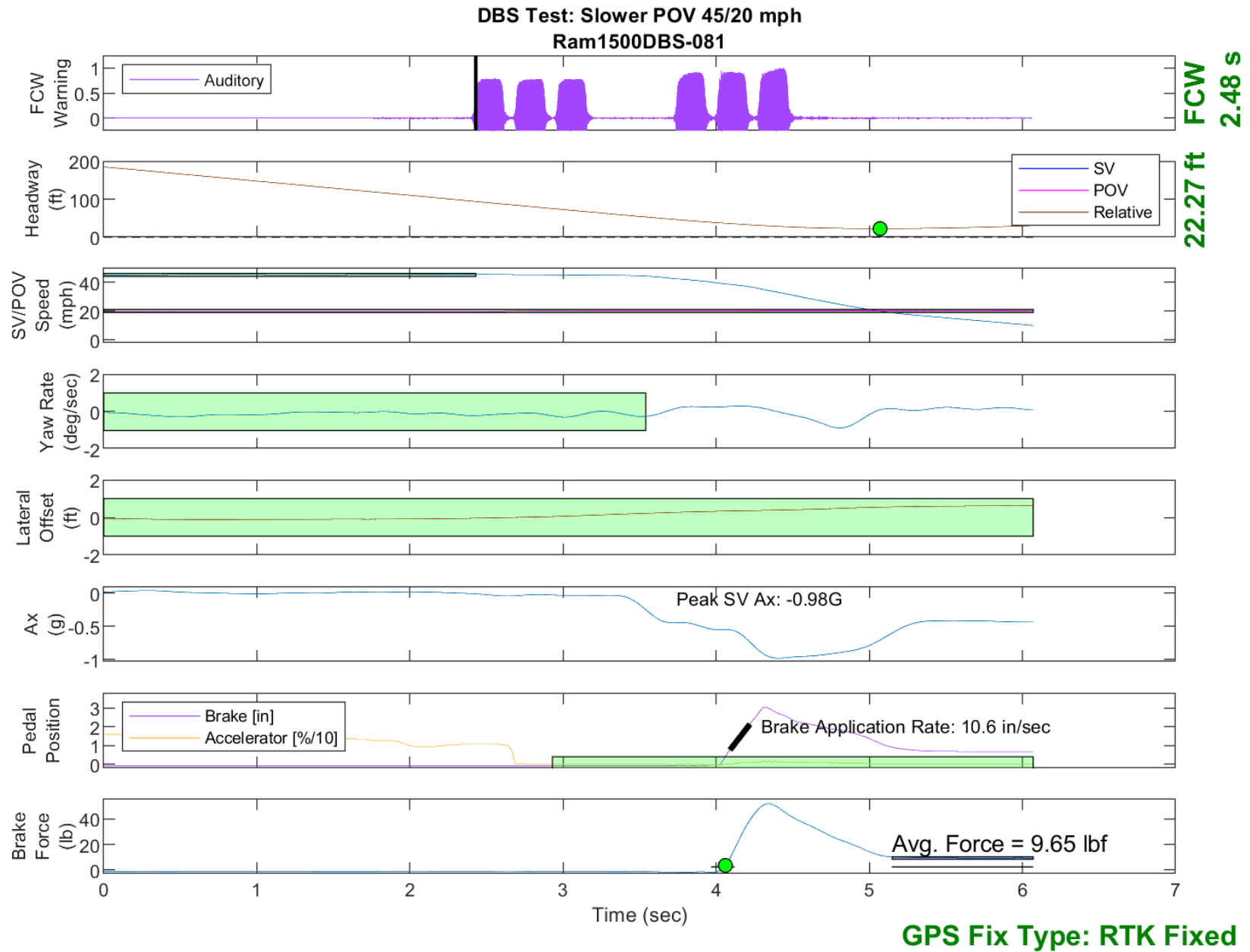


Figure E31. Time History for DBS Run 81, SV Encounters Slower POV, SV 45 mph, POV 20 mph

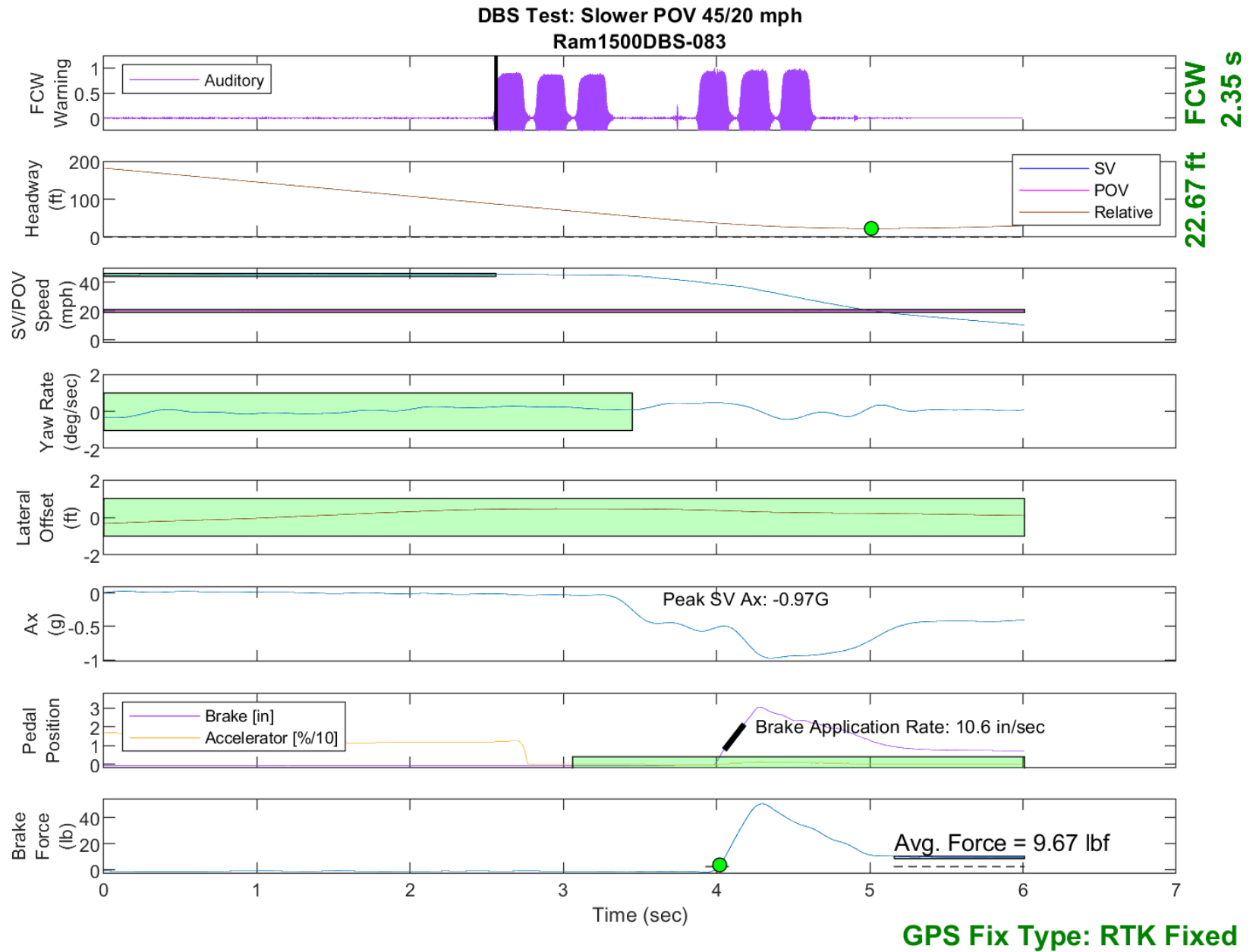


Figure E32. Time History for DBS Run 83, SV Encounters Slower POV, SV 45 mph, POV 20 mph

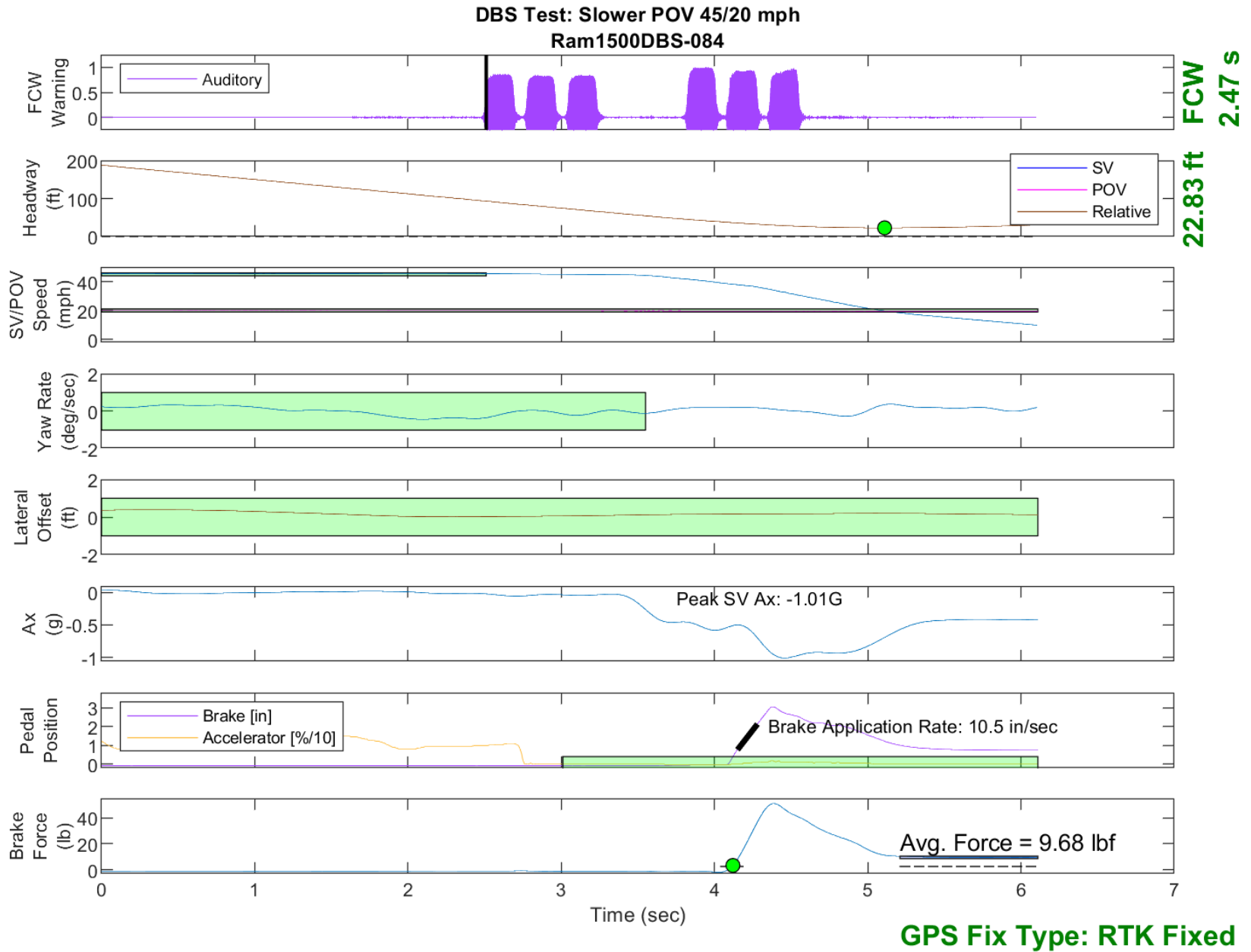


Figure E33. Time History for DBS Run 84, SV Encounters Slower POV, SV 45 mph, POV 20 mph

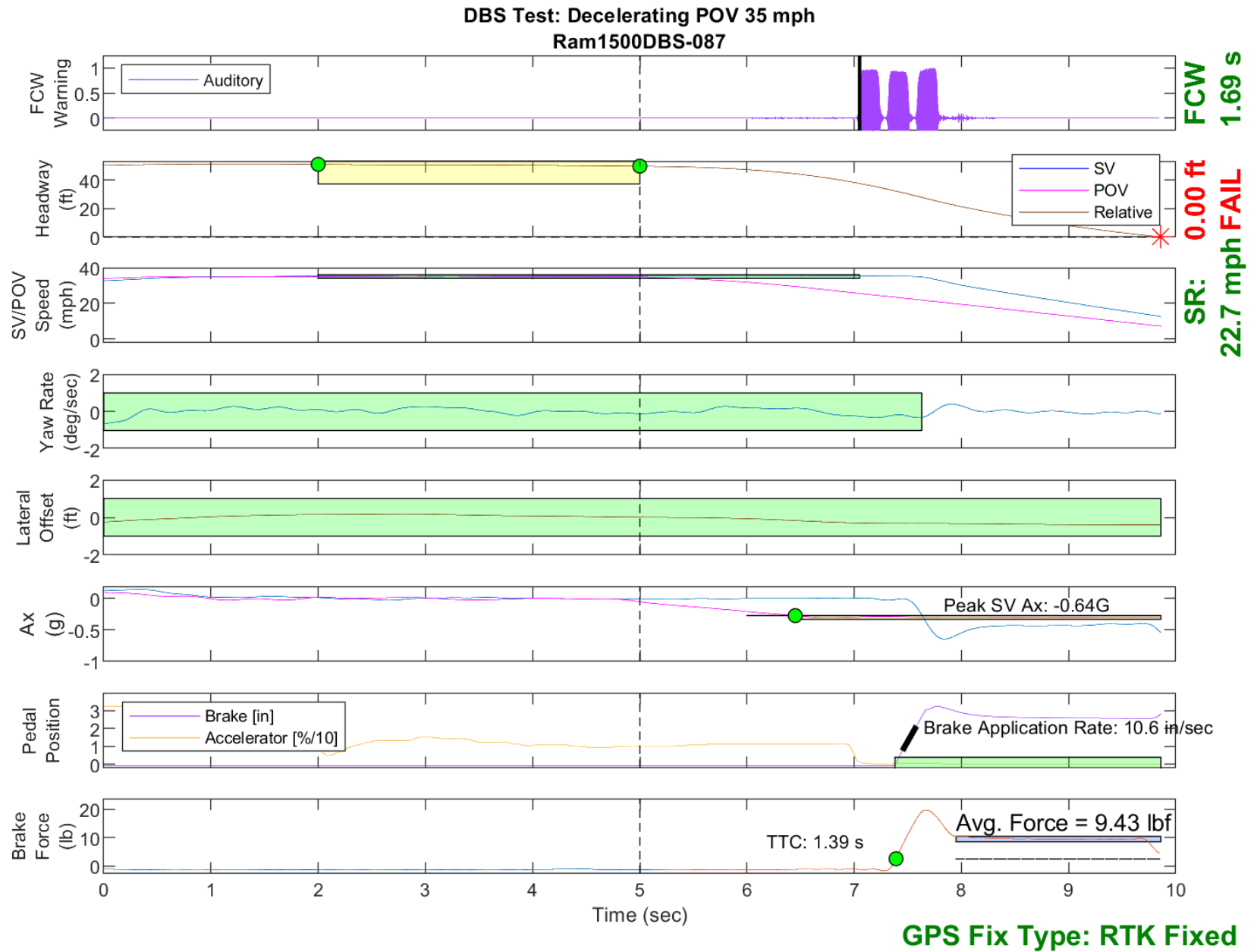


Figure E34. Time History for DBS Run 87, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

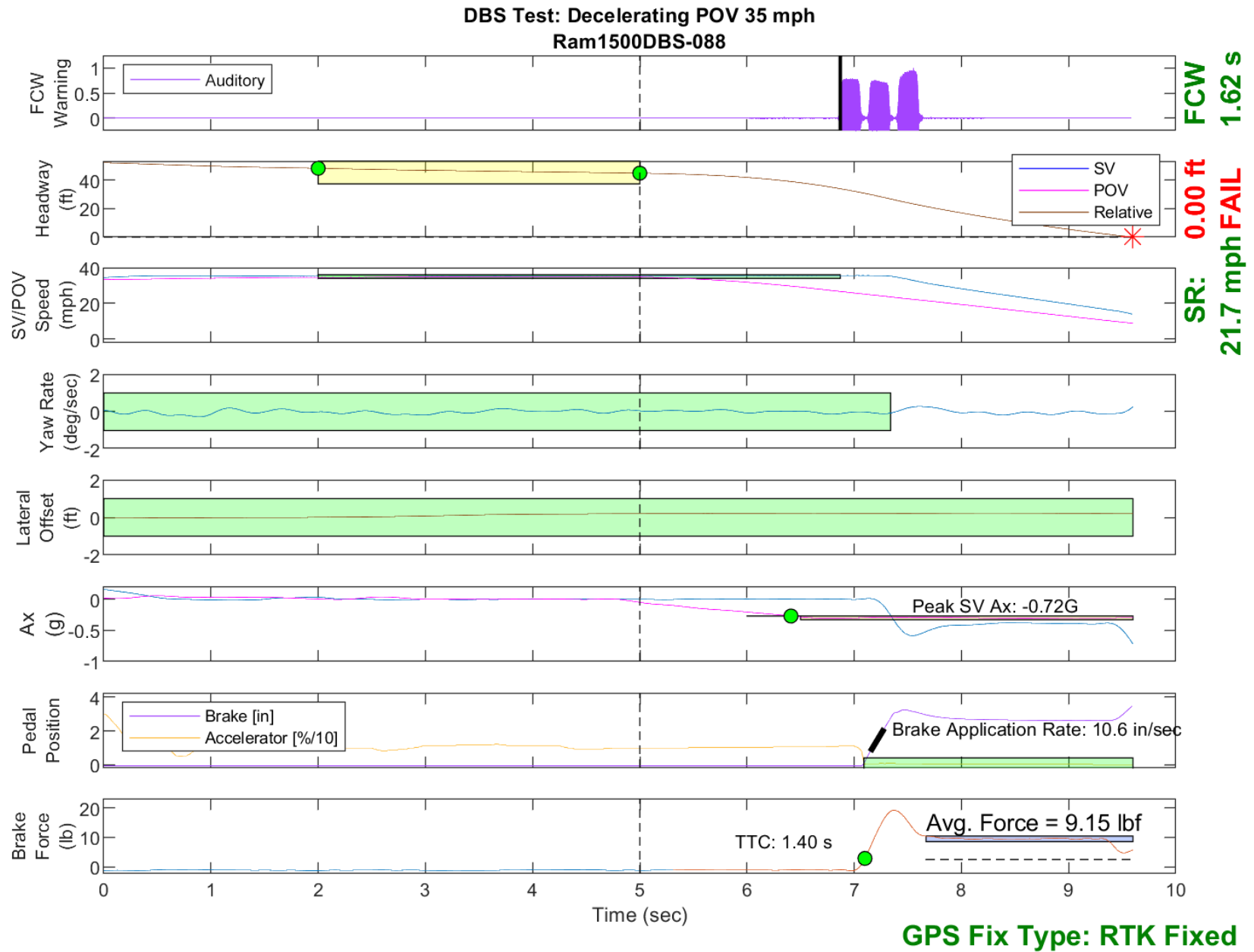


Figure E35. Time History for DBS Run 88, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

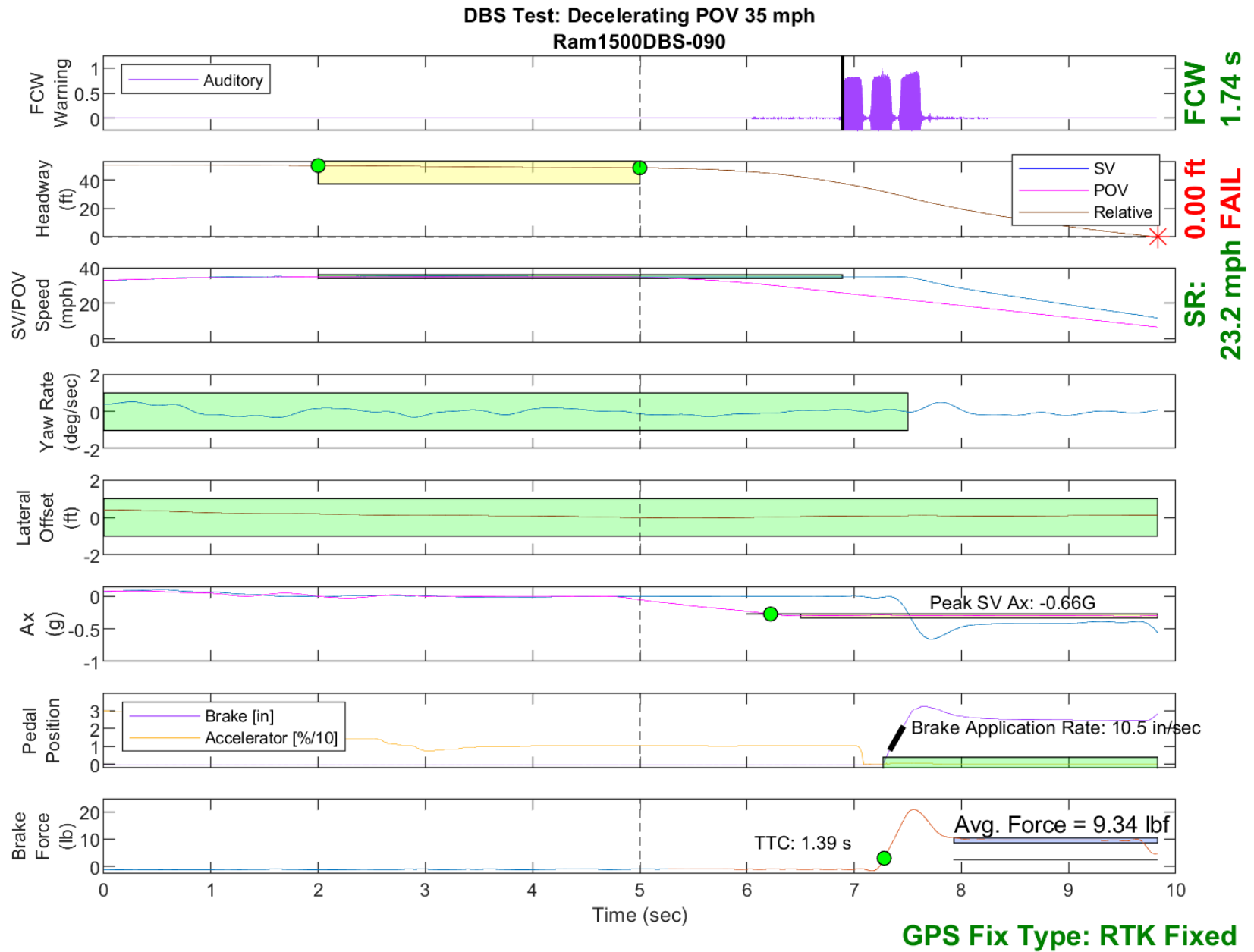


Figure E36. Time History for DBS Run 90, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

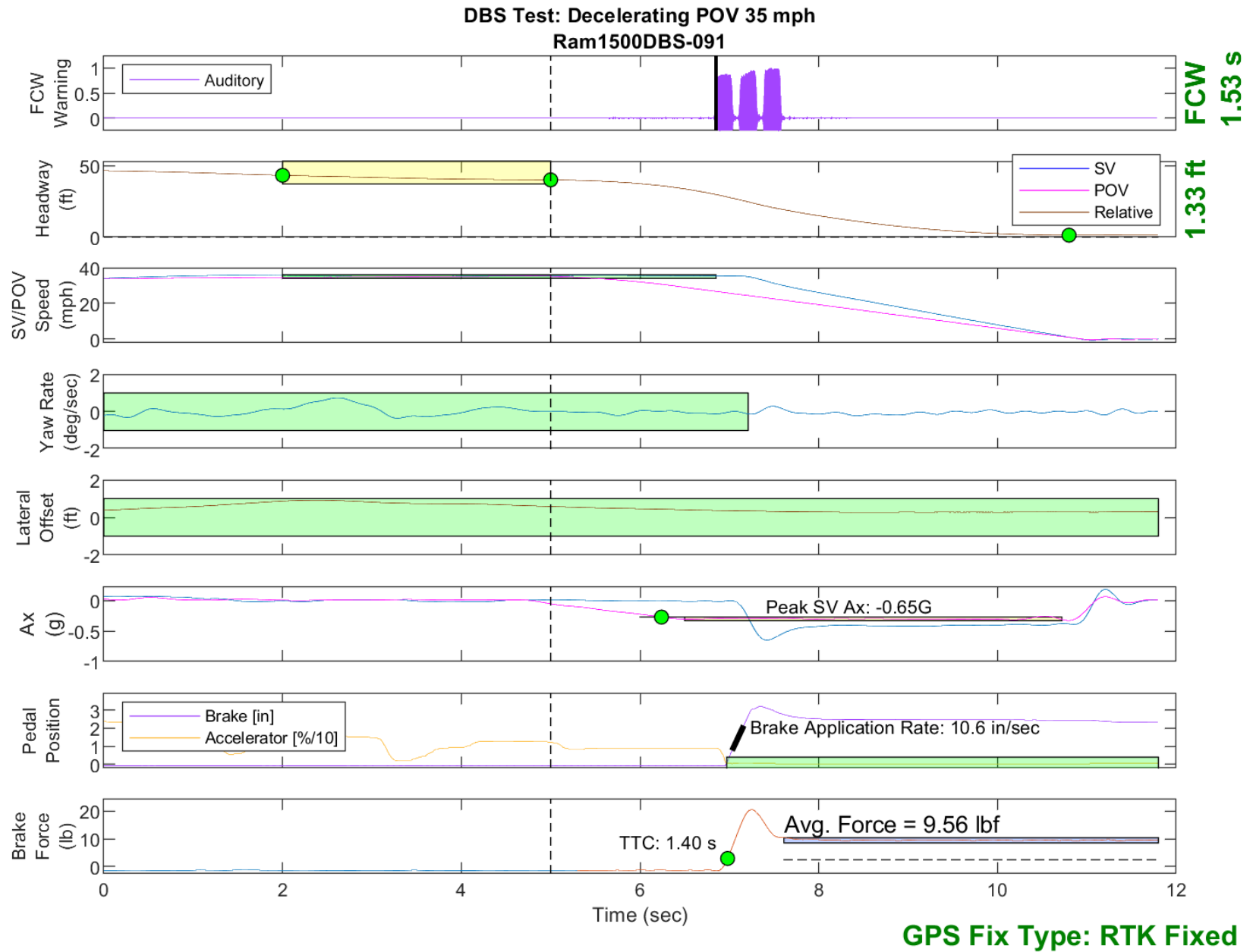


Figure E37. Time History for DBS Run 91, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

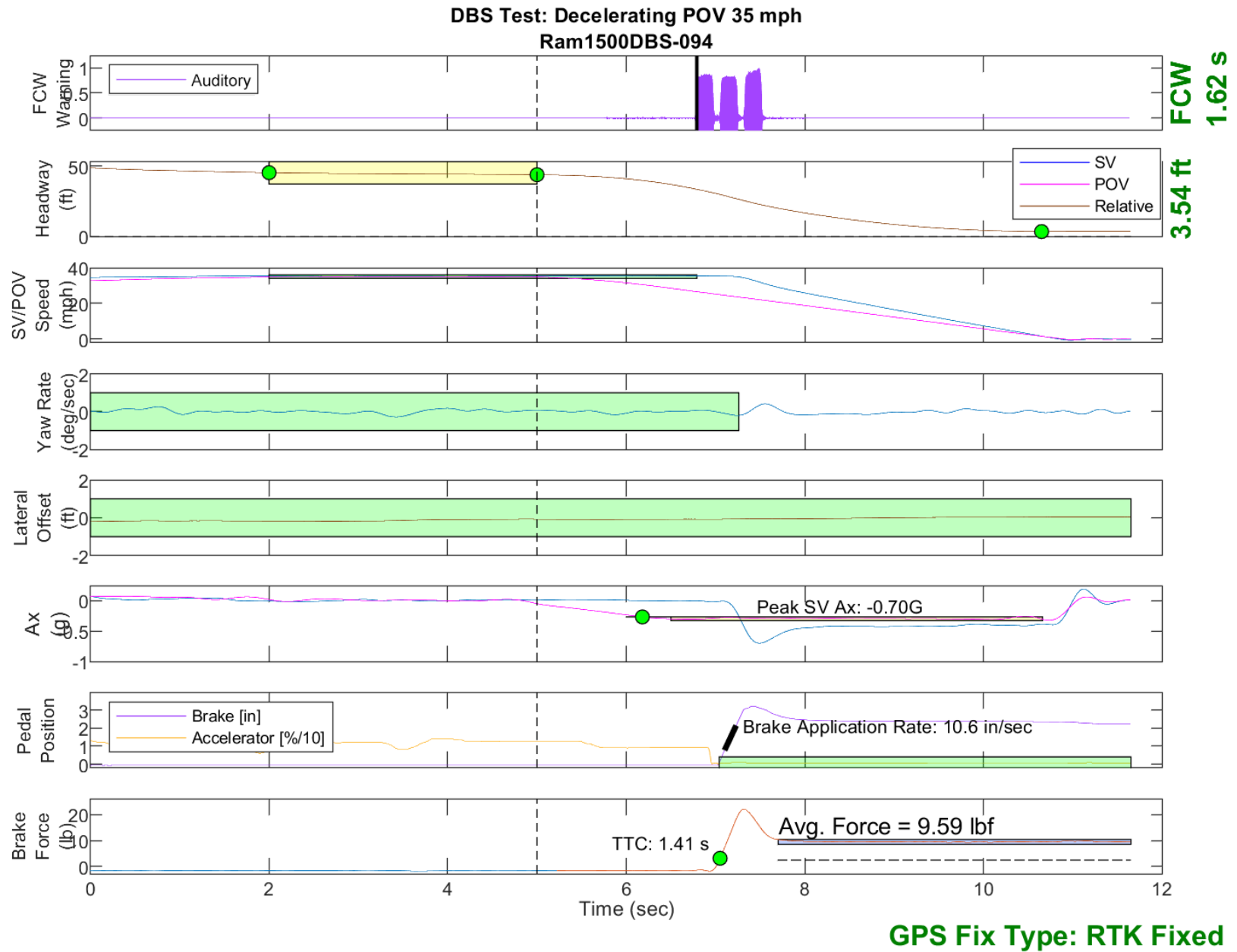


Figure E38. Time History for DBS Run 94, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

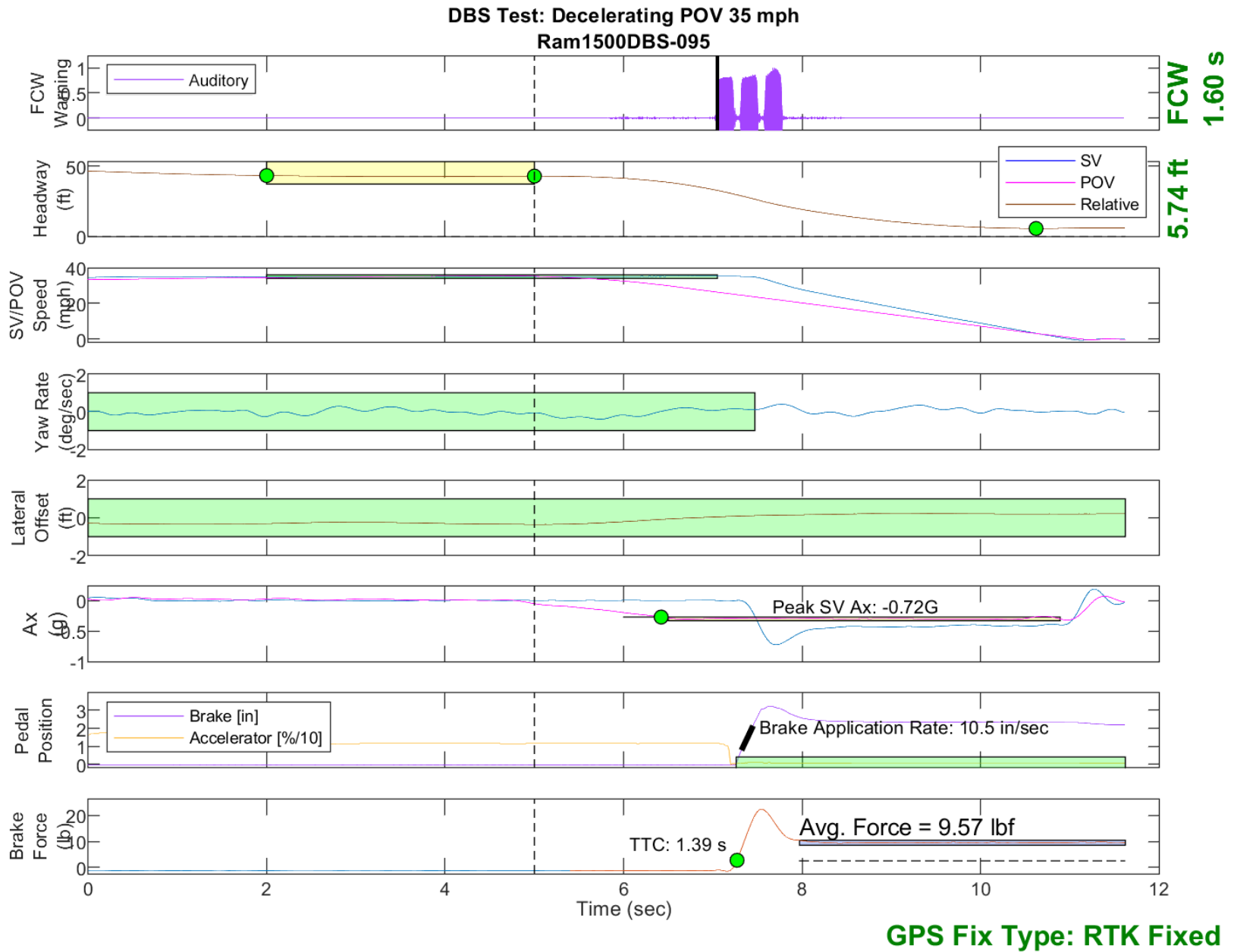


Figure E39. Time History for DBS Run 95, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

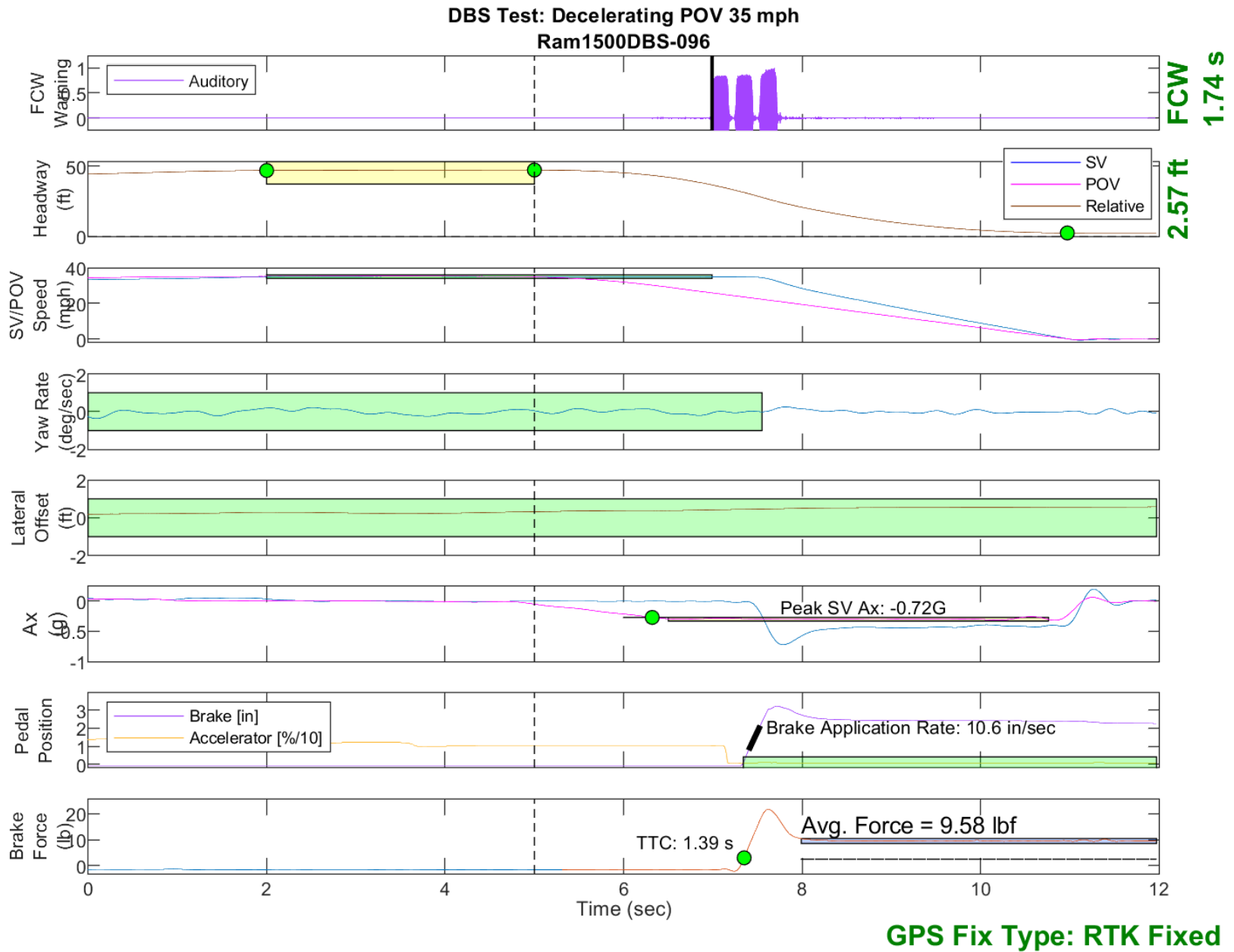


Figure E40. Time History for DBS Run 96, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

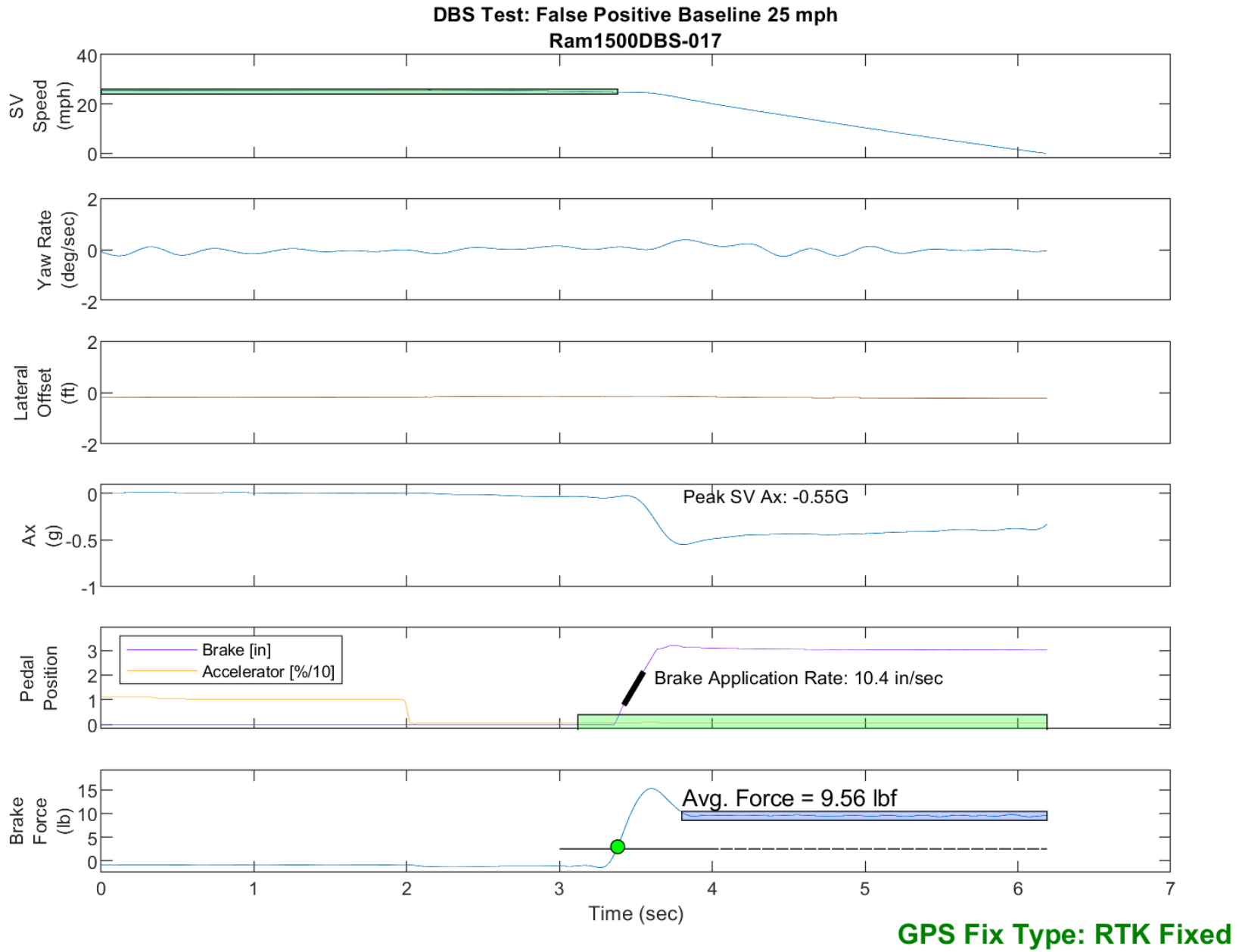


Figure E41. Time History for DBS Run 17, False Positive Baseline, SV 25 mph

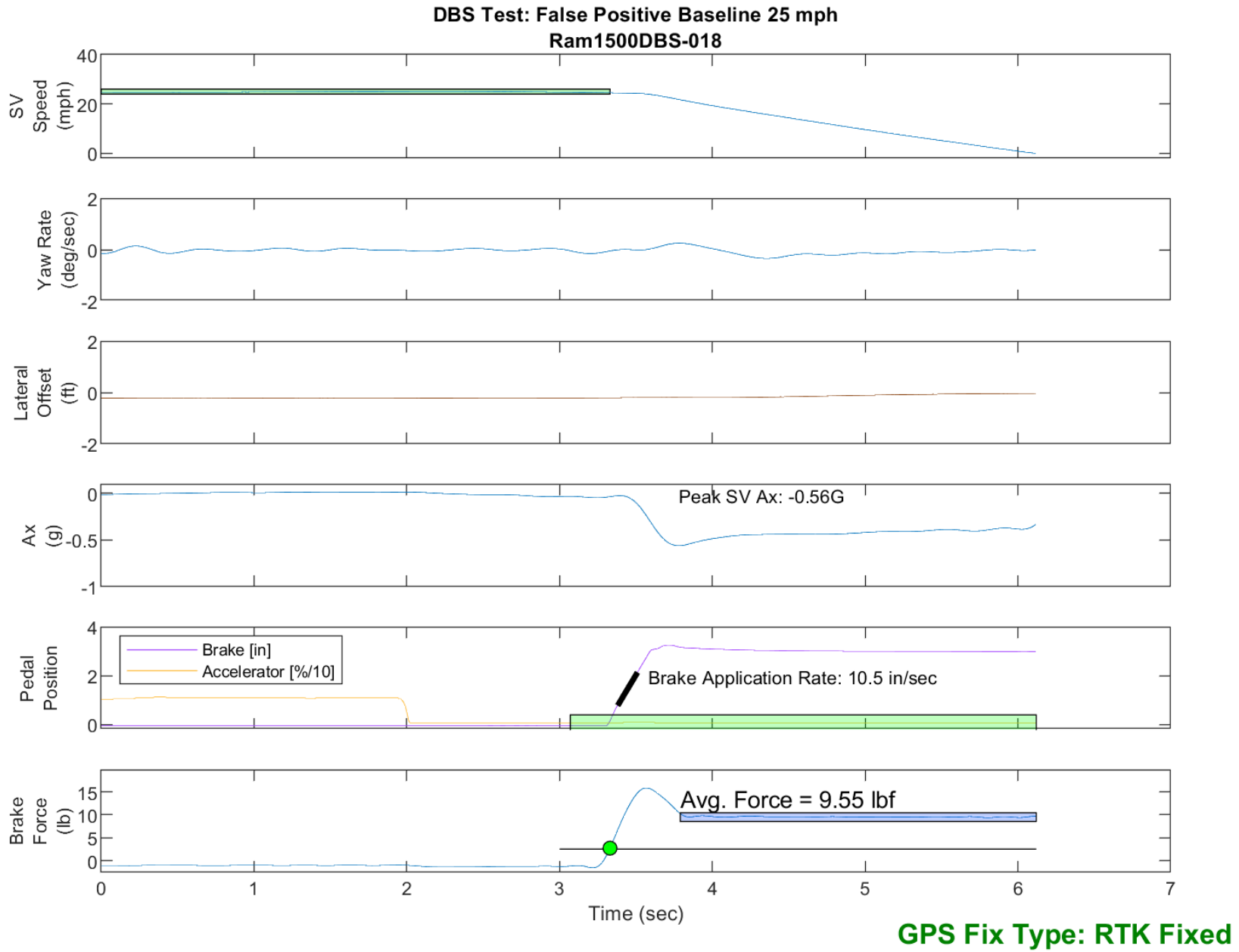


Figure E42. Time History for DBS Run 18, False Positive Baseline, SV 25 mph

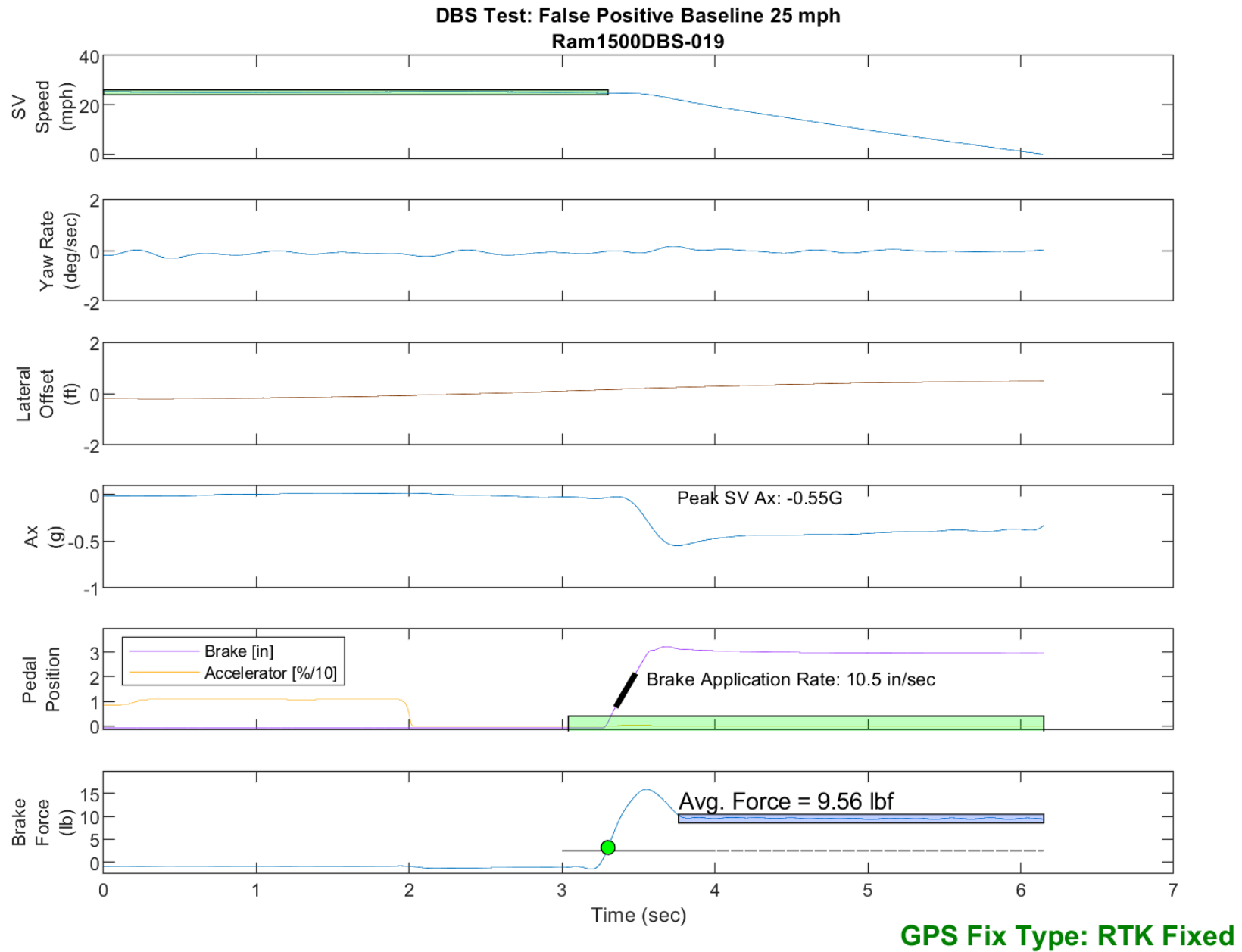


Figure E43. Time History for DBS Run 19, False Positive Baseline, SV 25 mph

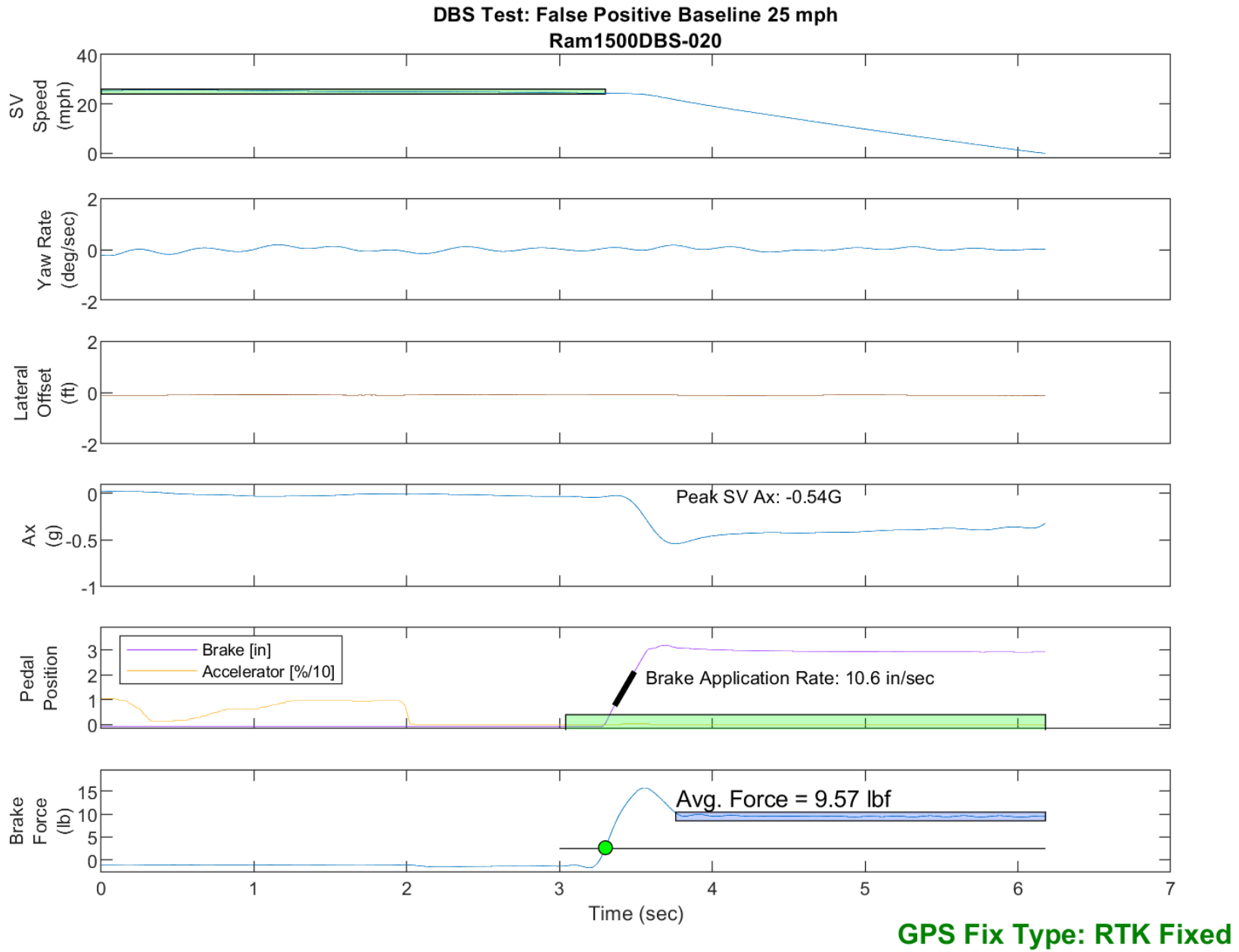


Figure E44. Time History for DBS Run 20, False Positive Baseline, SV 25 mph

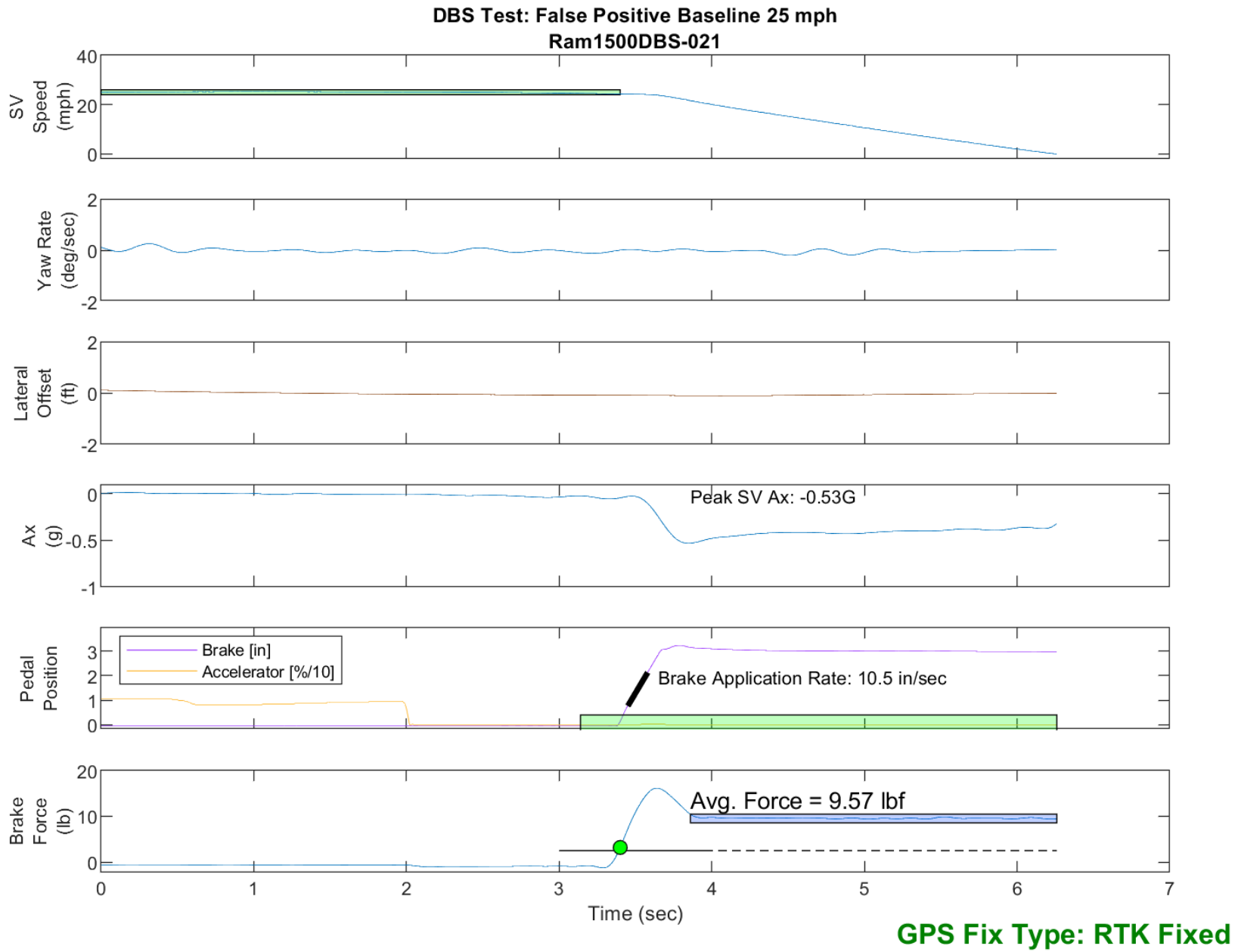


Figure E45. Time History for DBS Run 21, False Positive Baseline, SV 25 mph

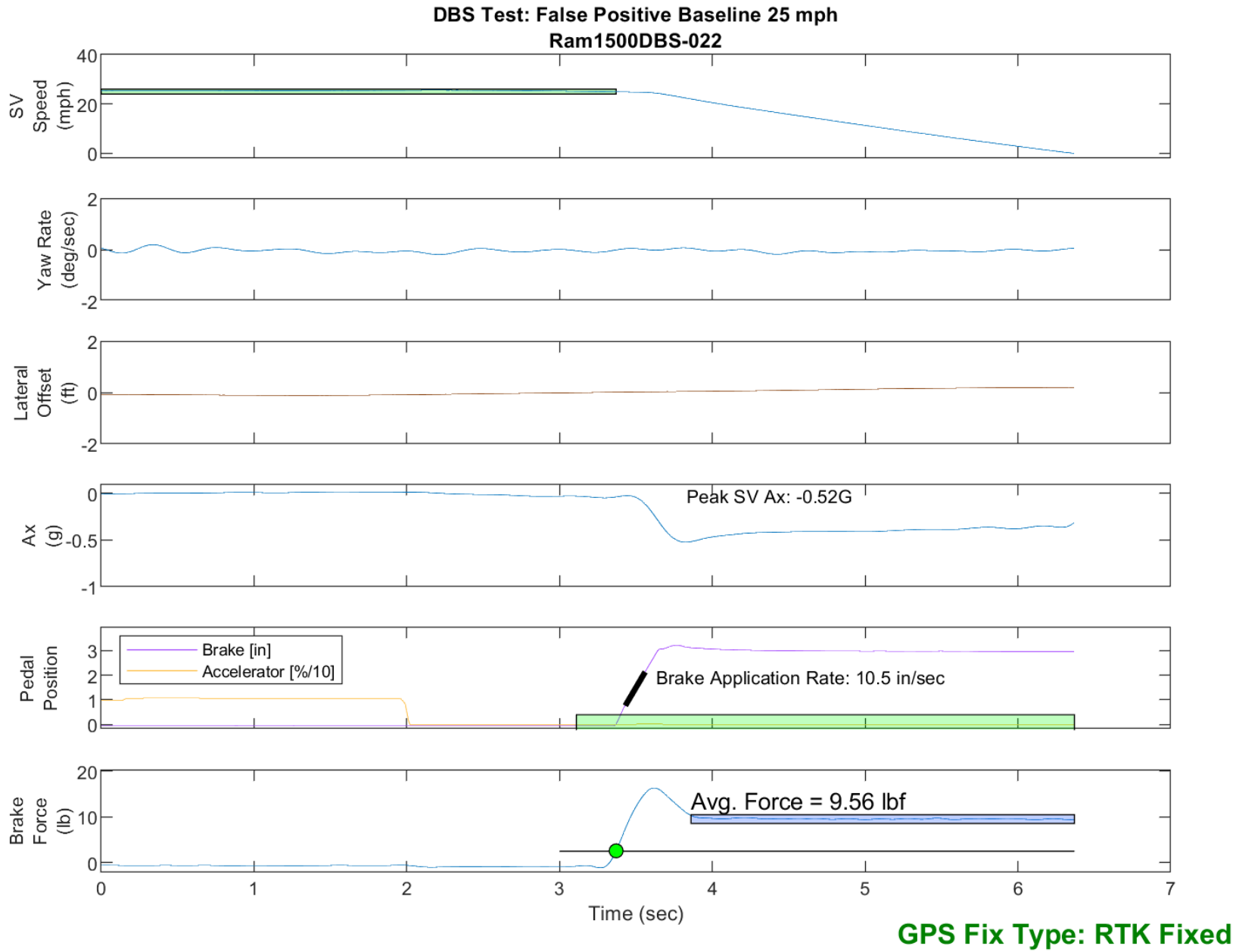


Figure E46. Time History for DBS Run 22, False Positive Baseline, SV 25 mph

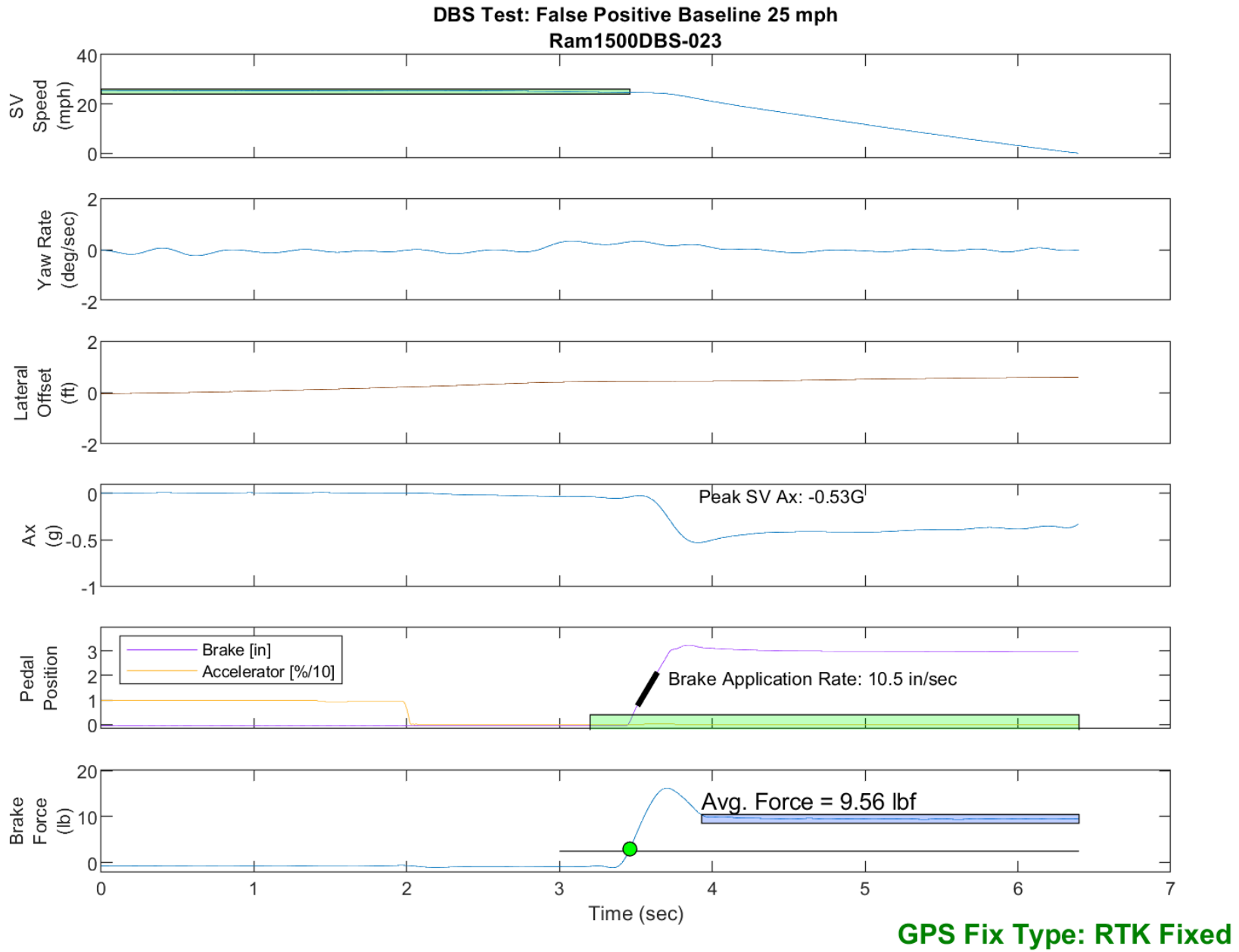


Figure E47. Time History for DBS Run 23, False Positive Baseline, SV 25 mph

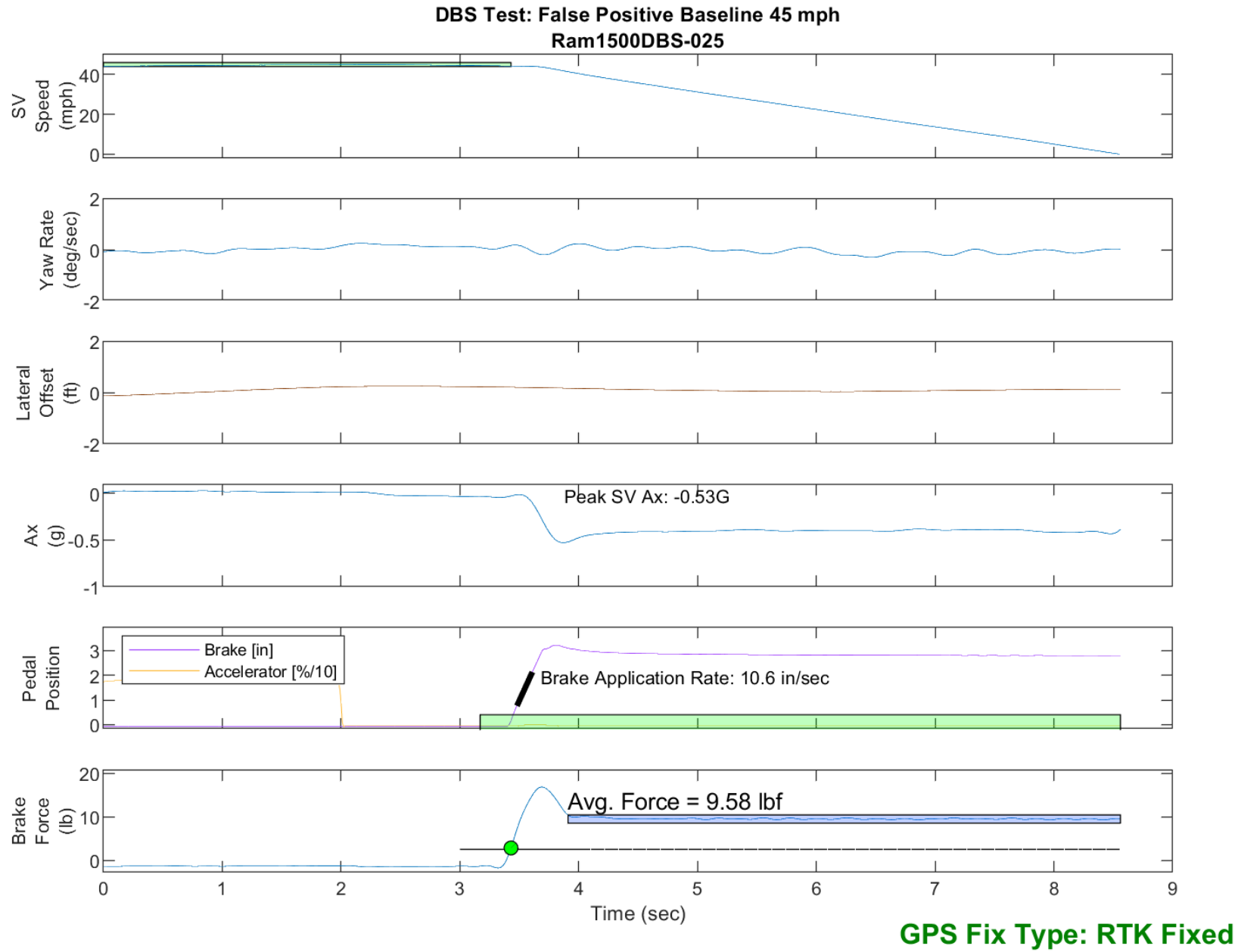


Figure E48. Time History for DBS Run 25, False Positive Baseline, SV 45 mph

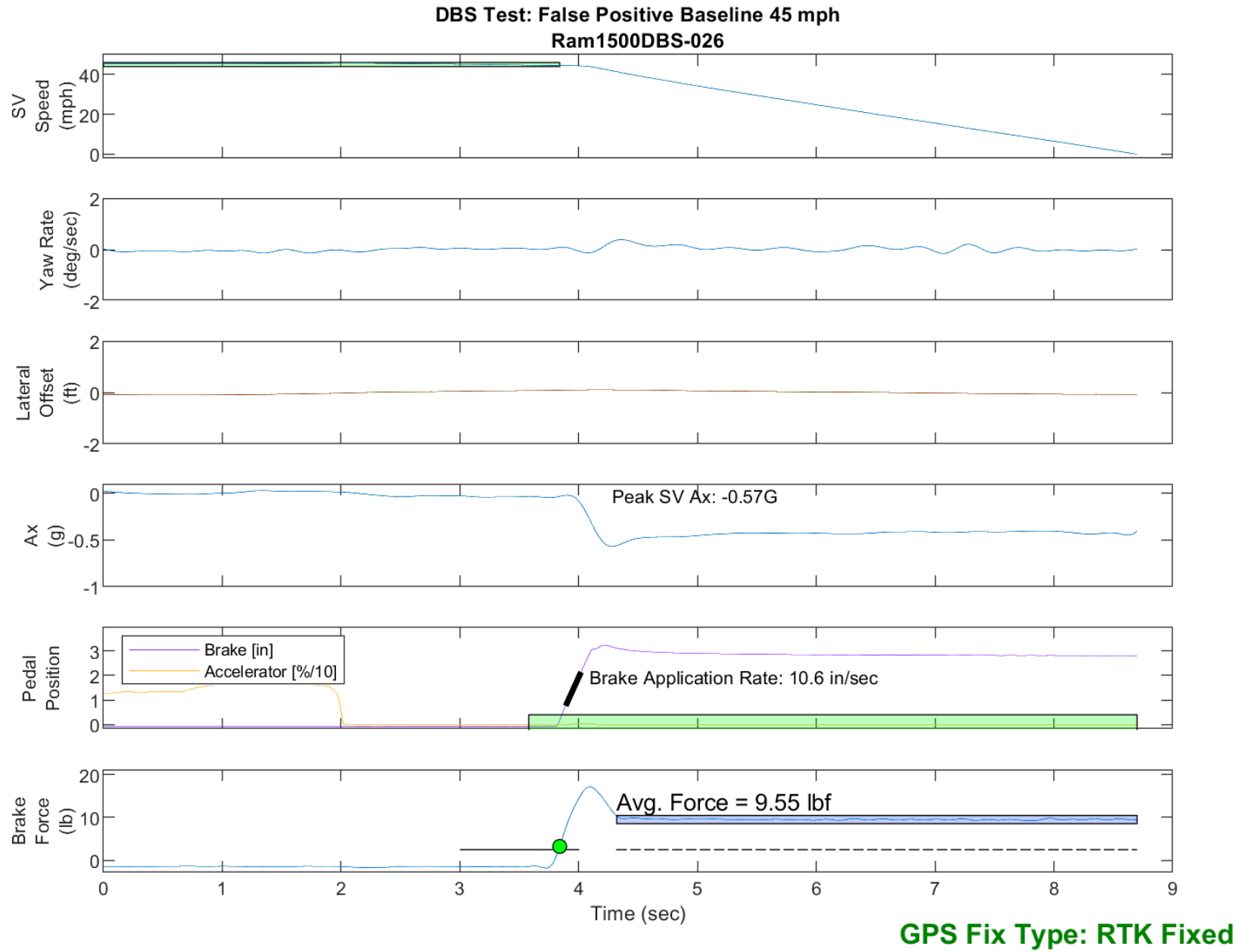


Figure E49. Time History for DBS Run 26, False Positive Baseline, SV 45 mph

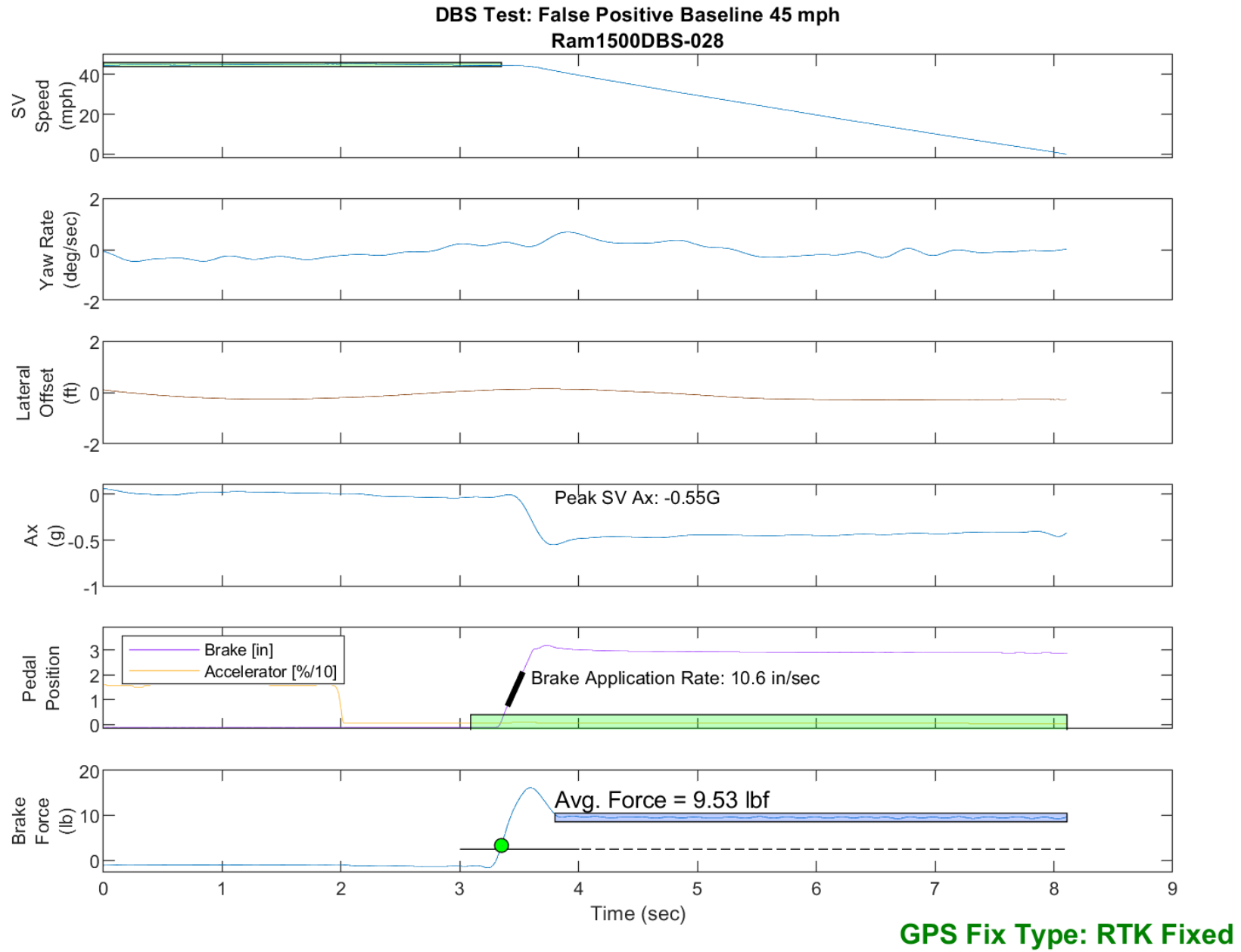


Figure E50. Time History for DBS Run 28, False Positive Baseline, SV 45 mph

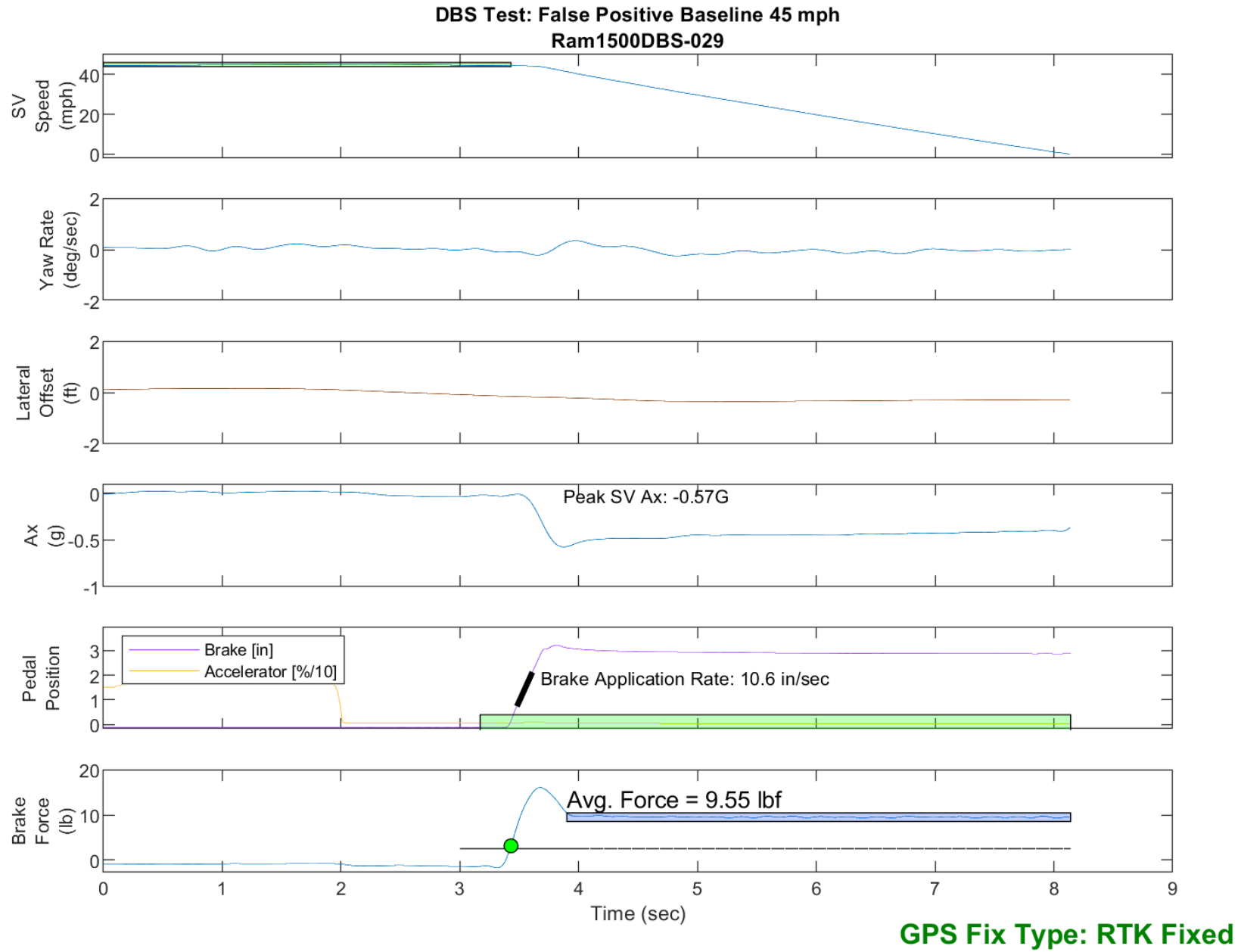


Figure E51. Time History for DBS Run 29, False Positive Baseline, SV 45 mph

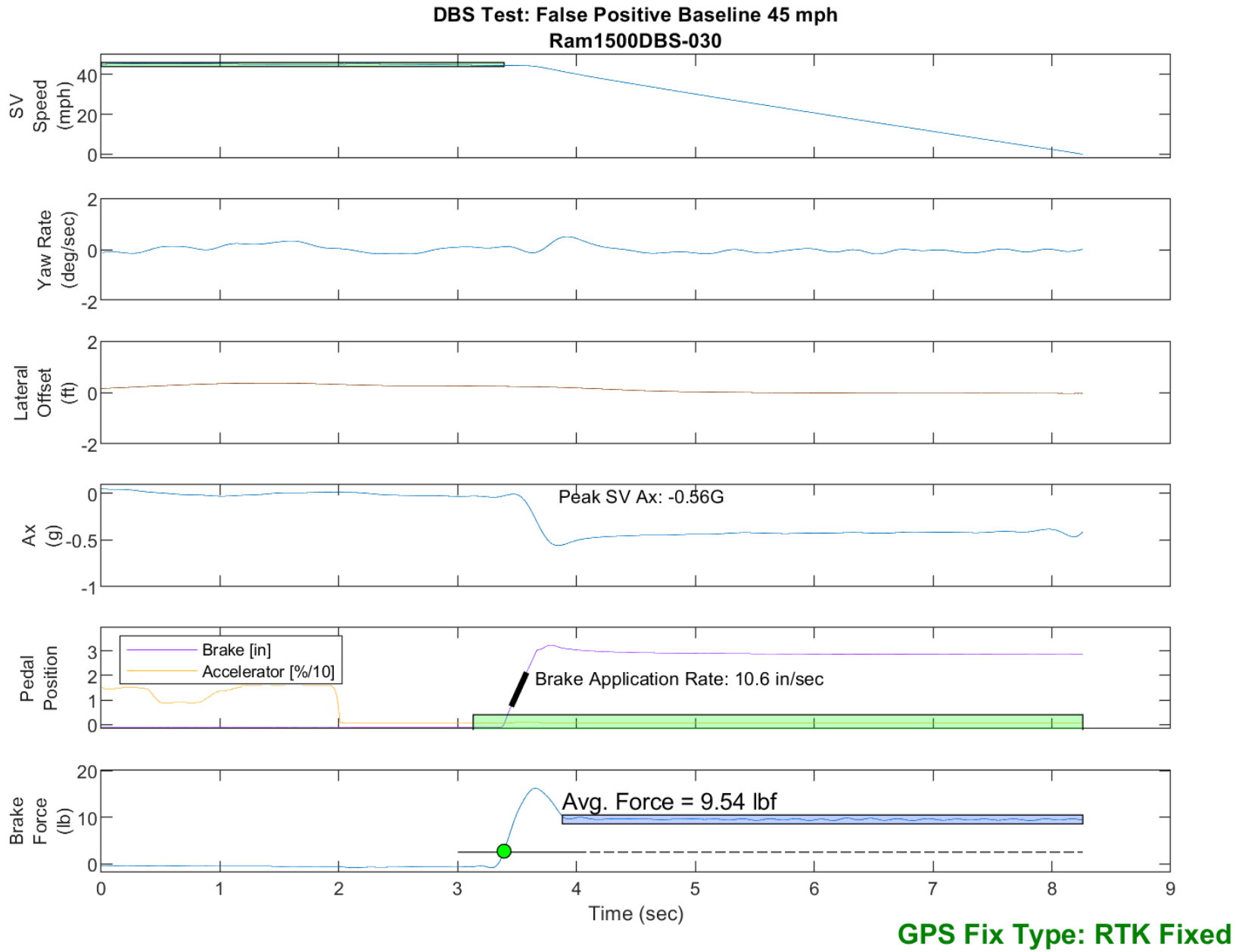


Figure E52. Time History for DBS Run 30, False Positive Baseline, SV 45 mph

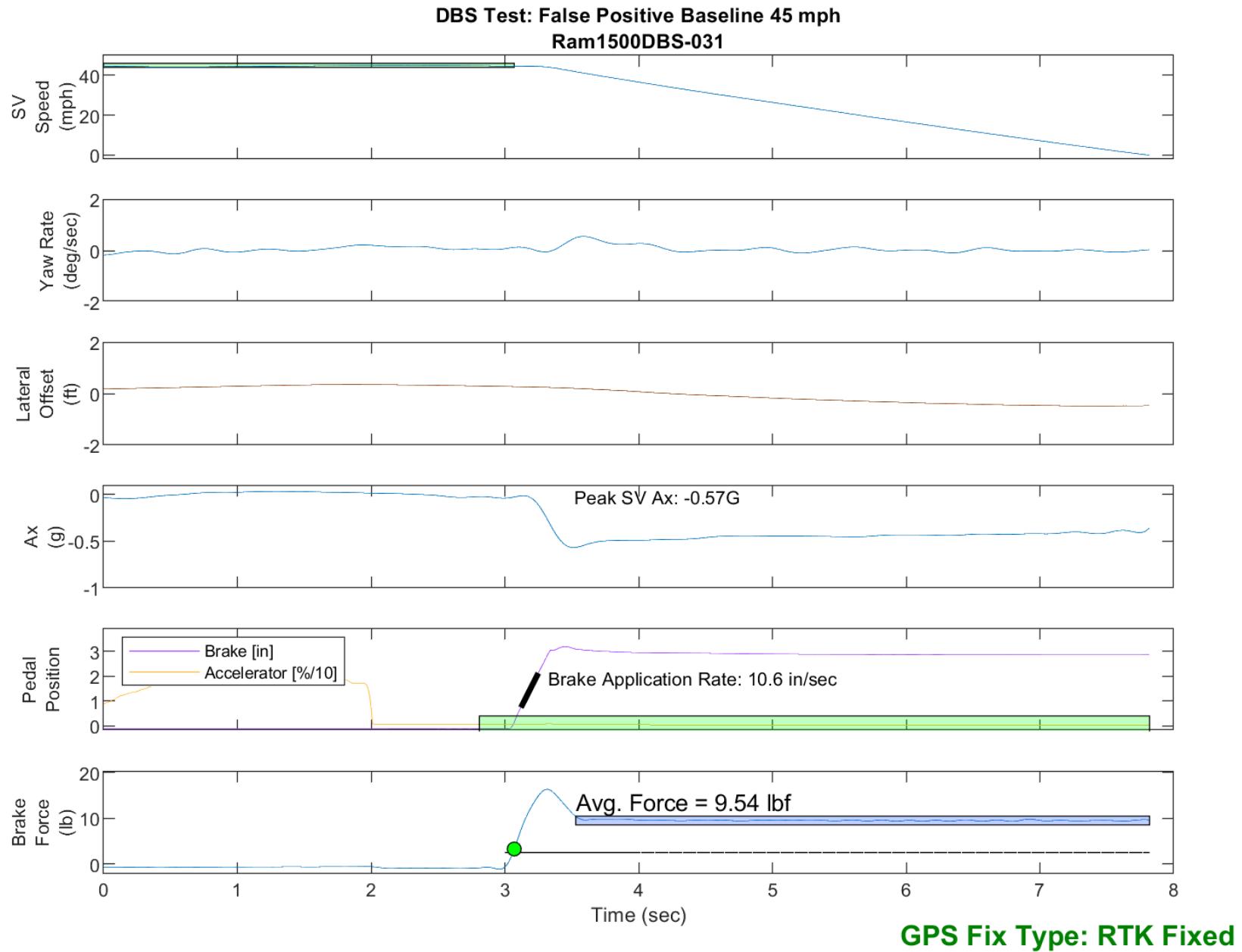


Figure E53. Time History for DBS Run 31, False Positive Baseline, SV 45 mph

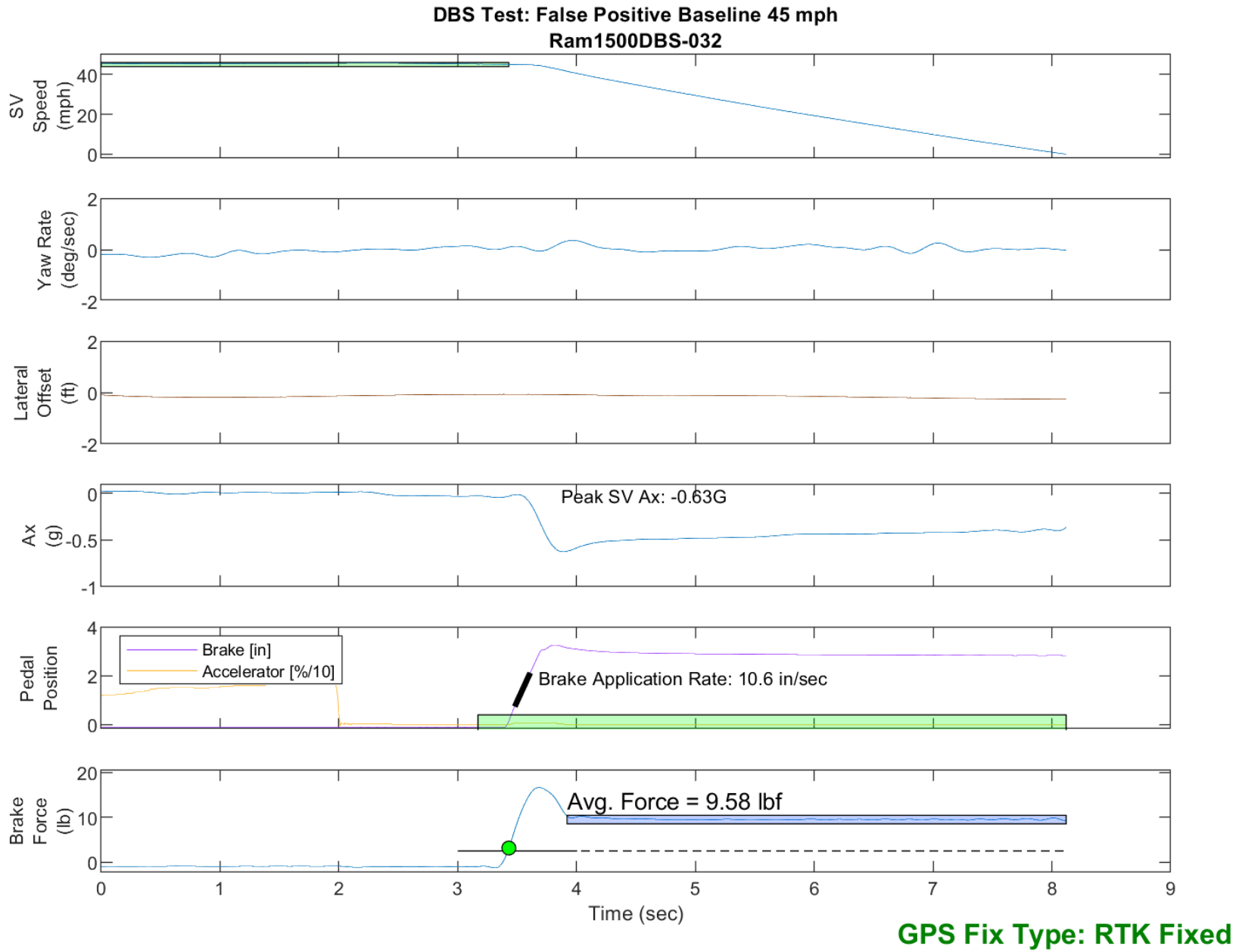


Figure E54. Time History for DBS Run 32, False Positive Baseline, SV 45 mph

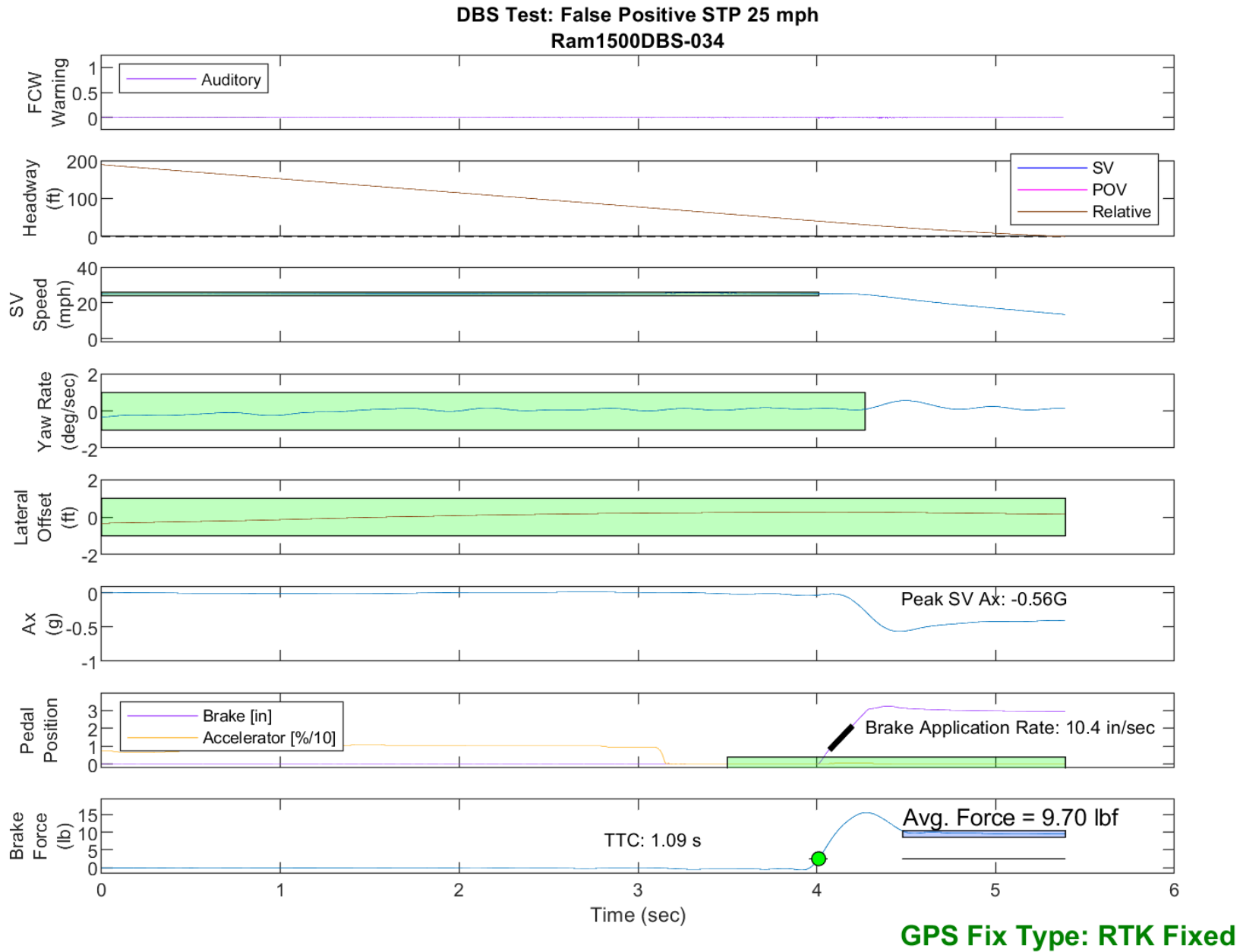


Figure E55. Time History for DBS Run 34, SV Encounters Steel Trench Plate, SV 25 mph

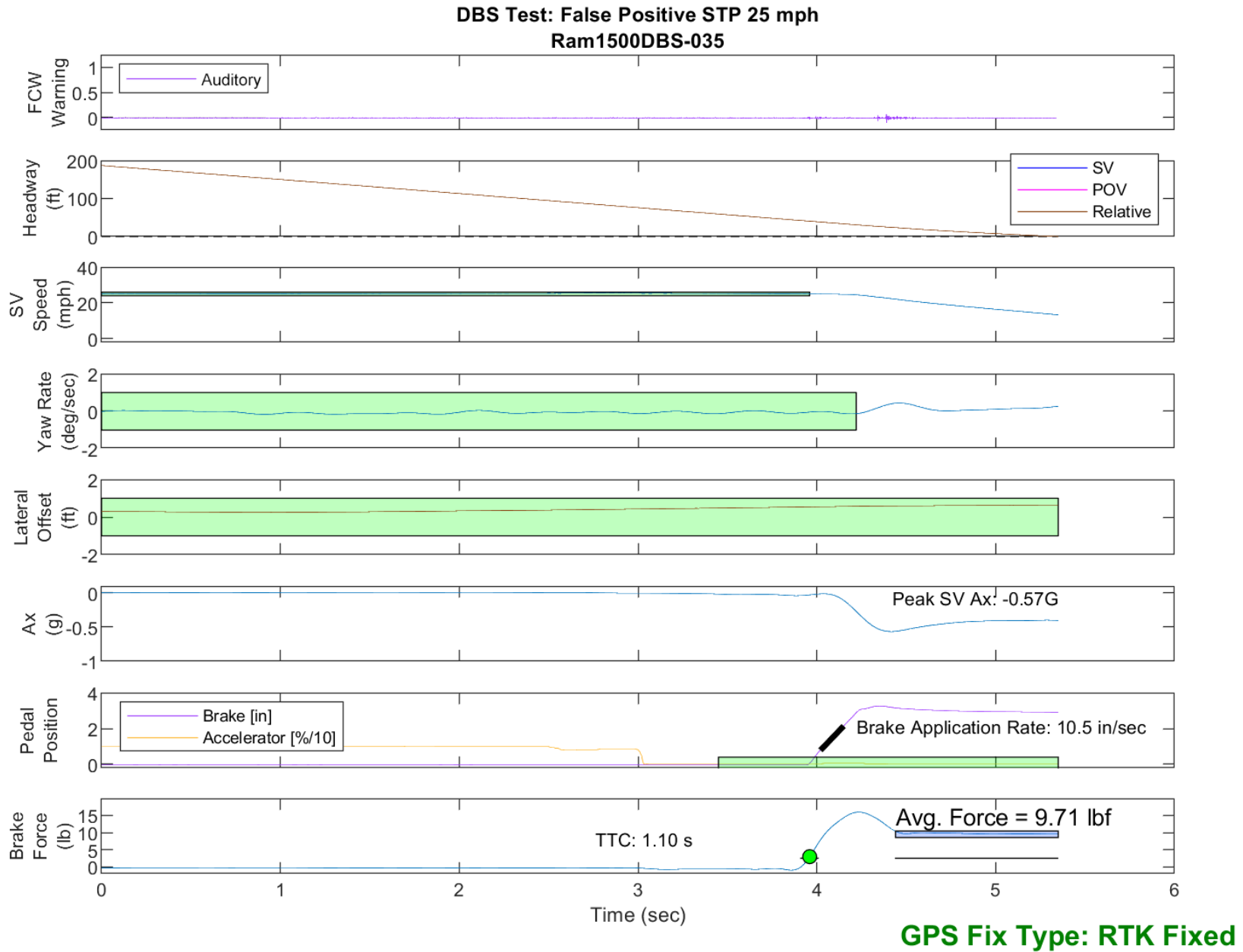


Figure E56. Time History for DBS Run 35, SV Encounters Steel Trench Plate, SV 25 mph

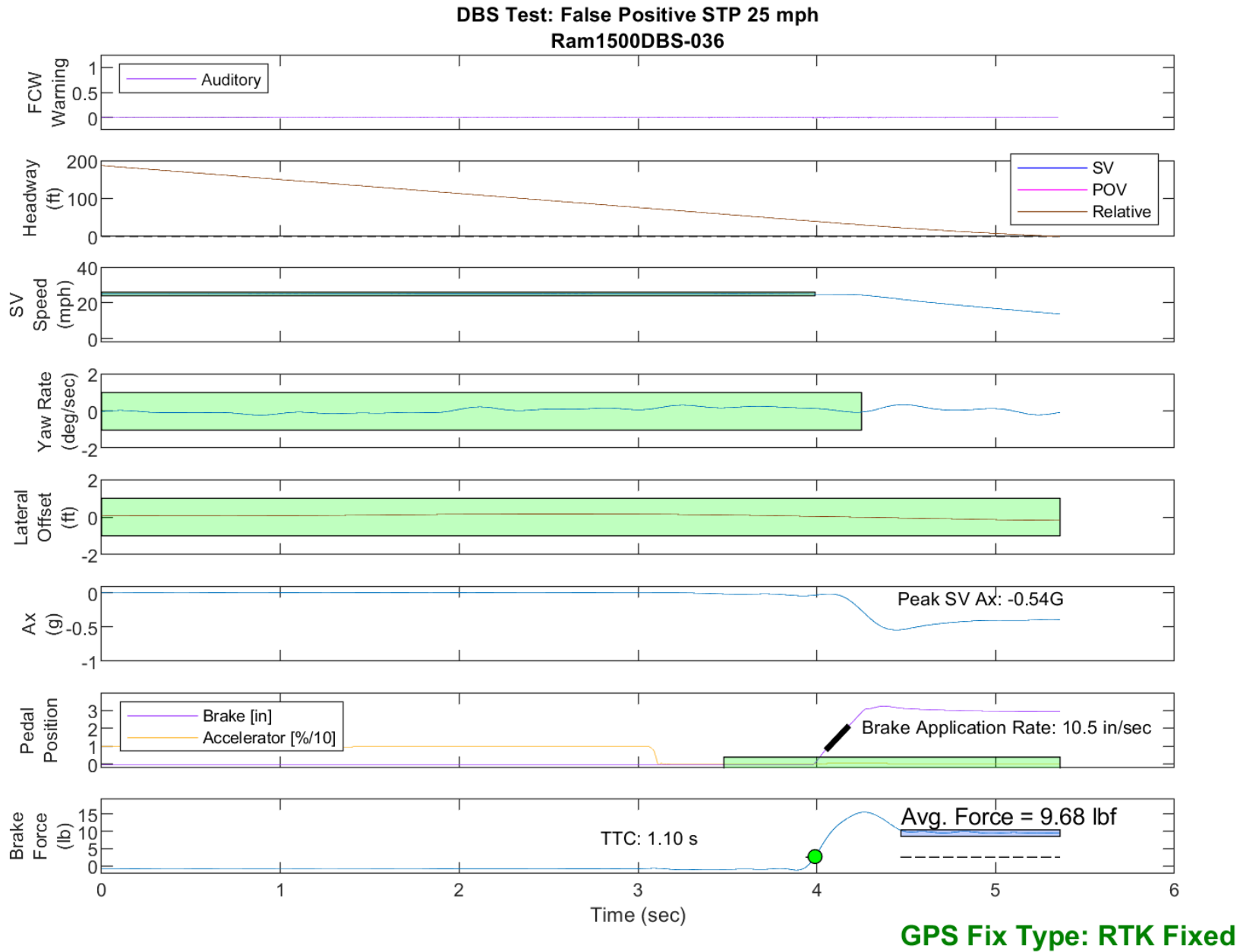


Figure E57. Time History for DBS Run 36, SV Encounters Steel Trench Plate, SV 25 mph

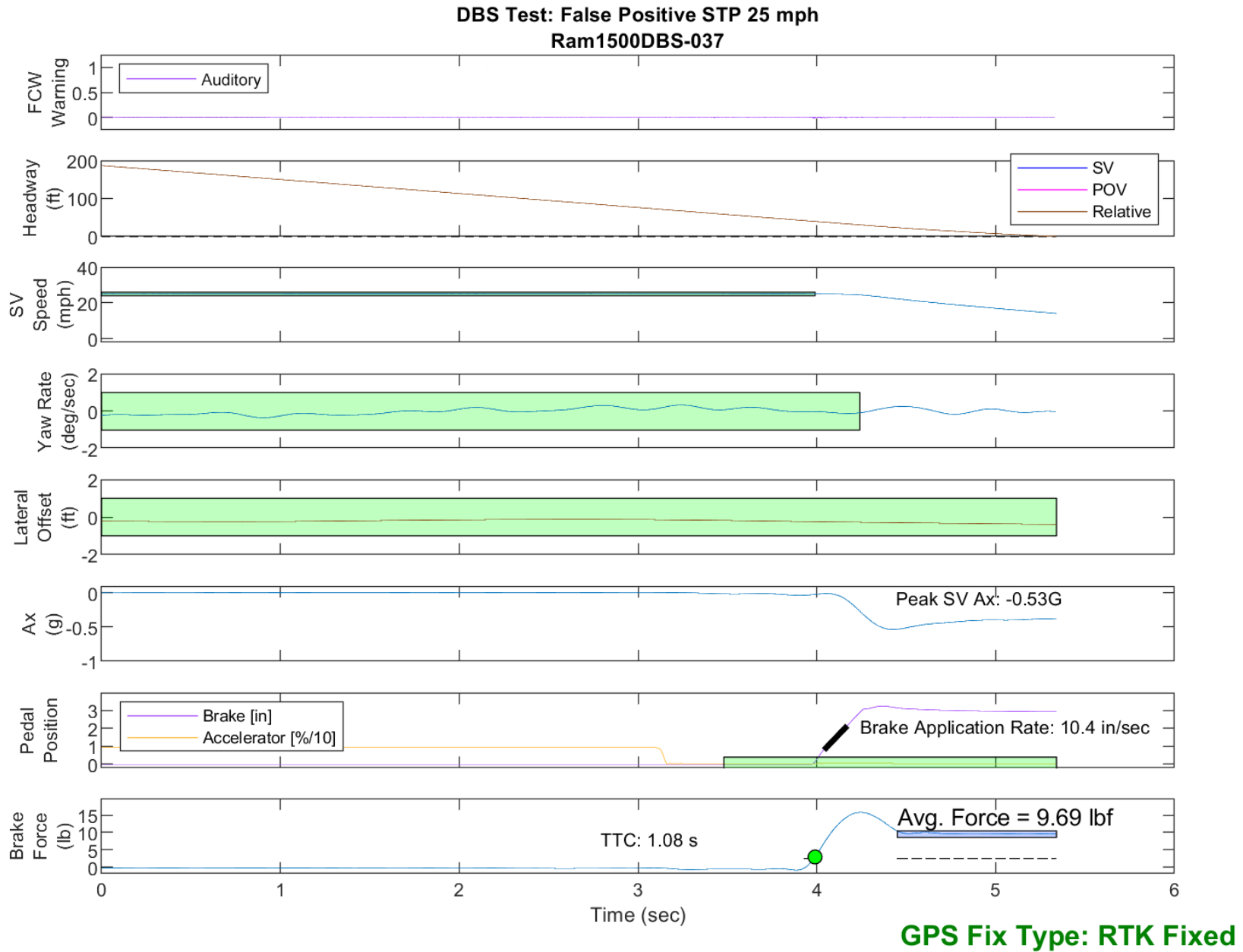


Figure E58. Time History for DBS Run 37, SV Encounters Steel Trench Plate, SV 25 mph

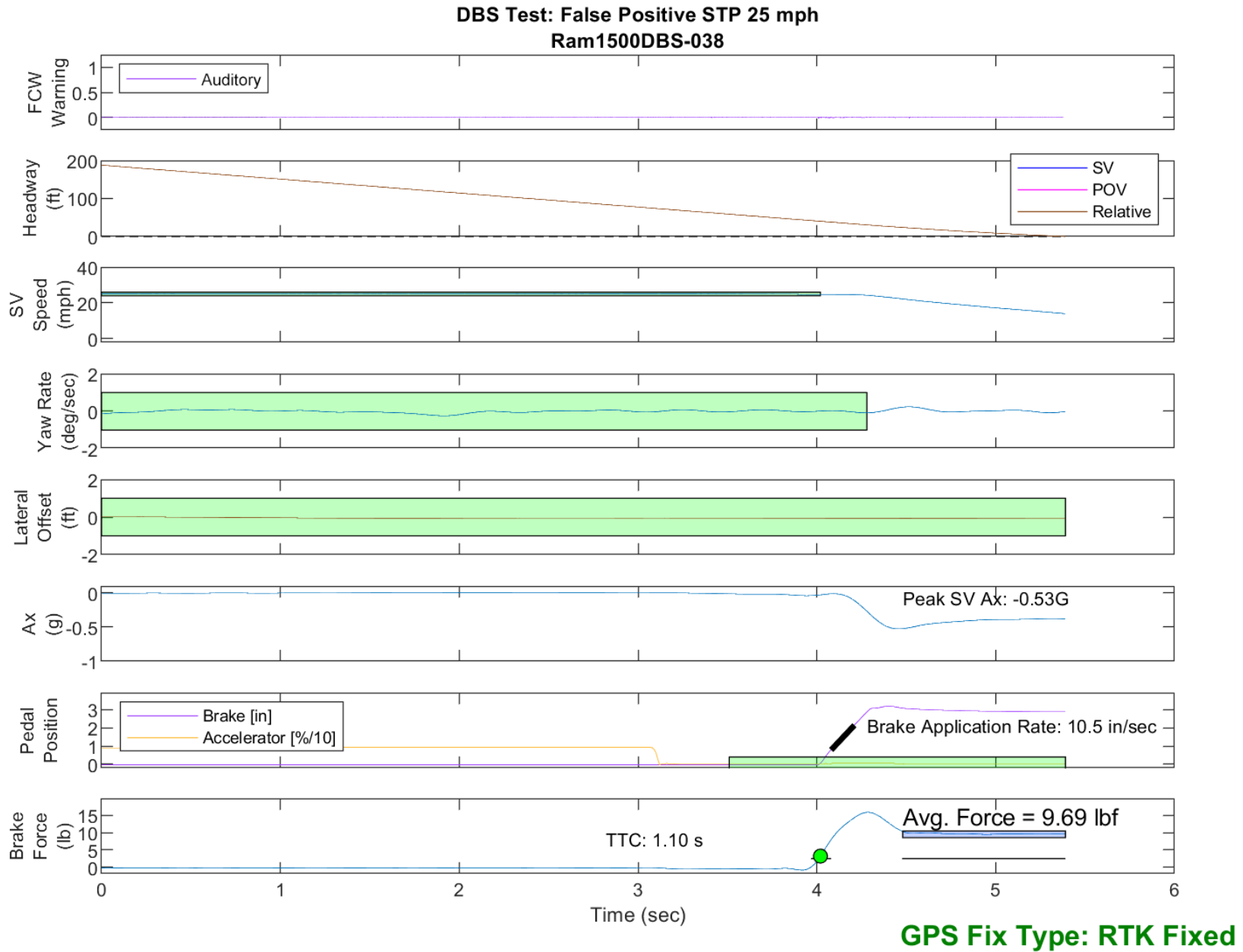


Figure E59. Time History for DBS Run 38, SV Encounters Steel Trench Plate, SV 25 mph

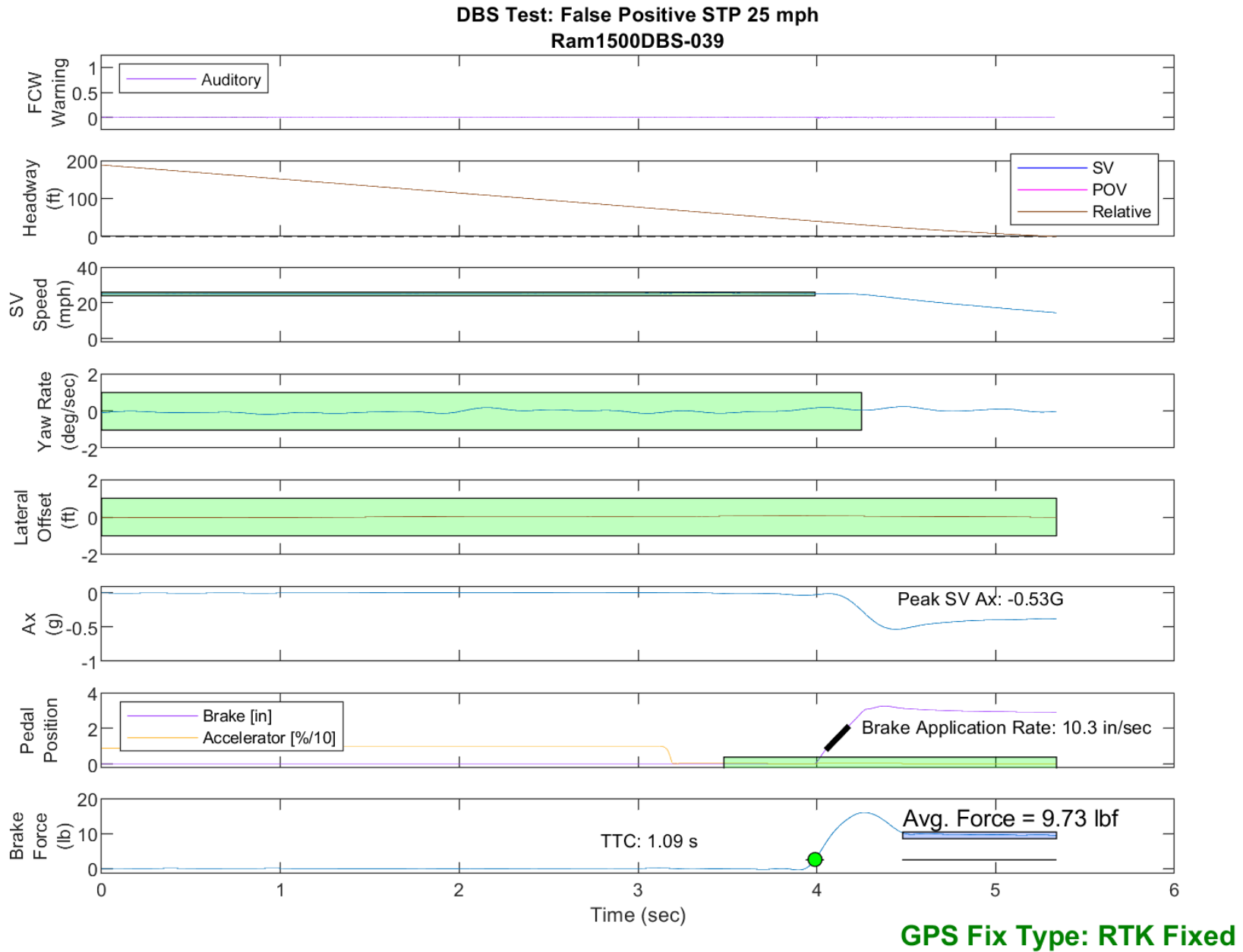


Figure E60. Time History for DBS Run 39, SV Encounters Steel Trench Plate, SV 25 mph

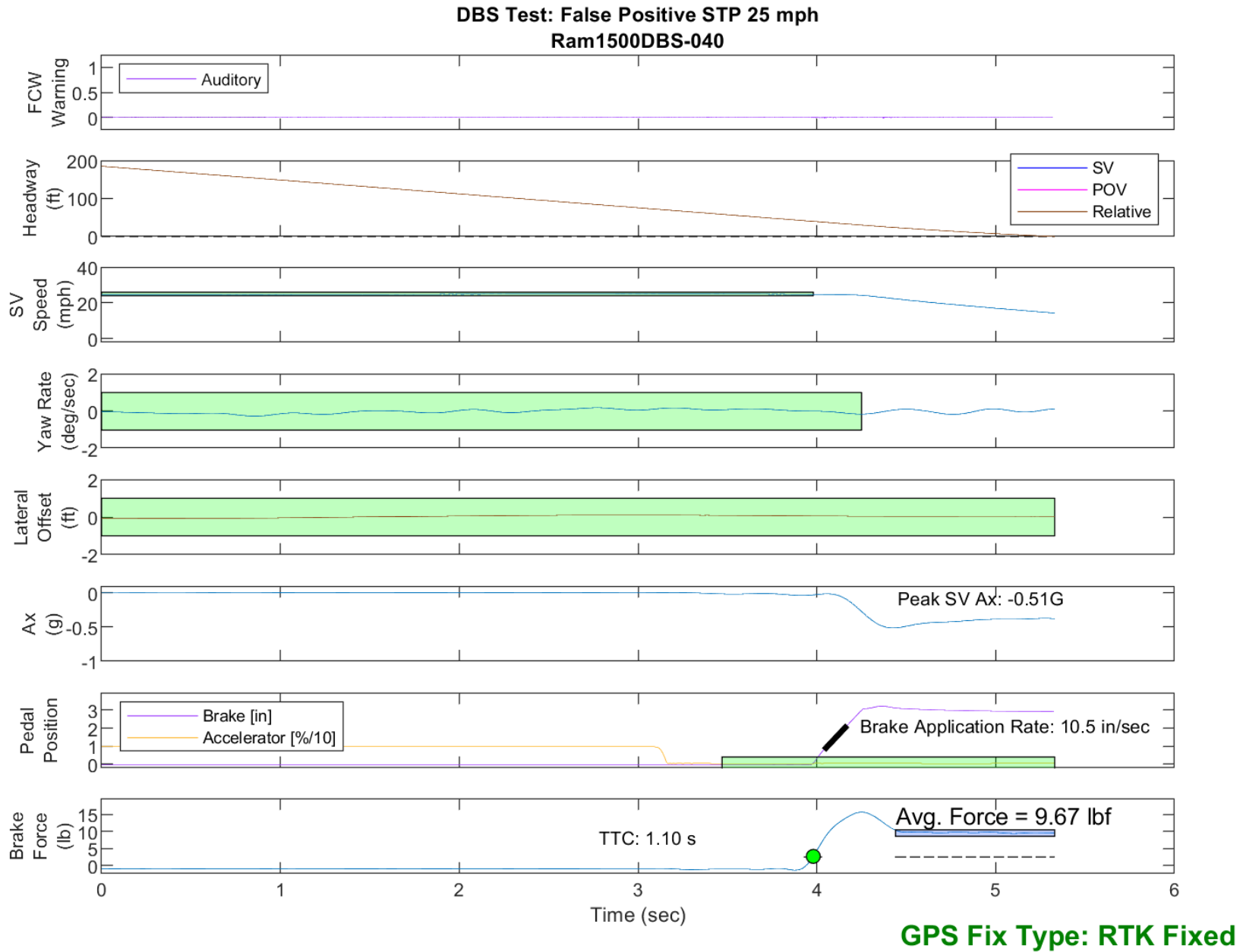
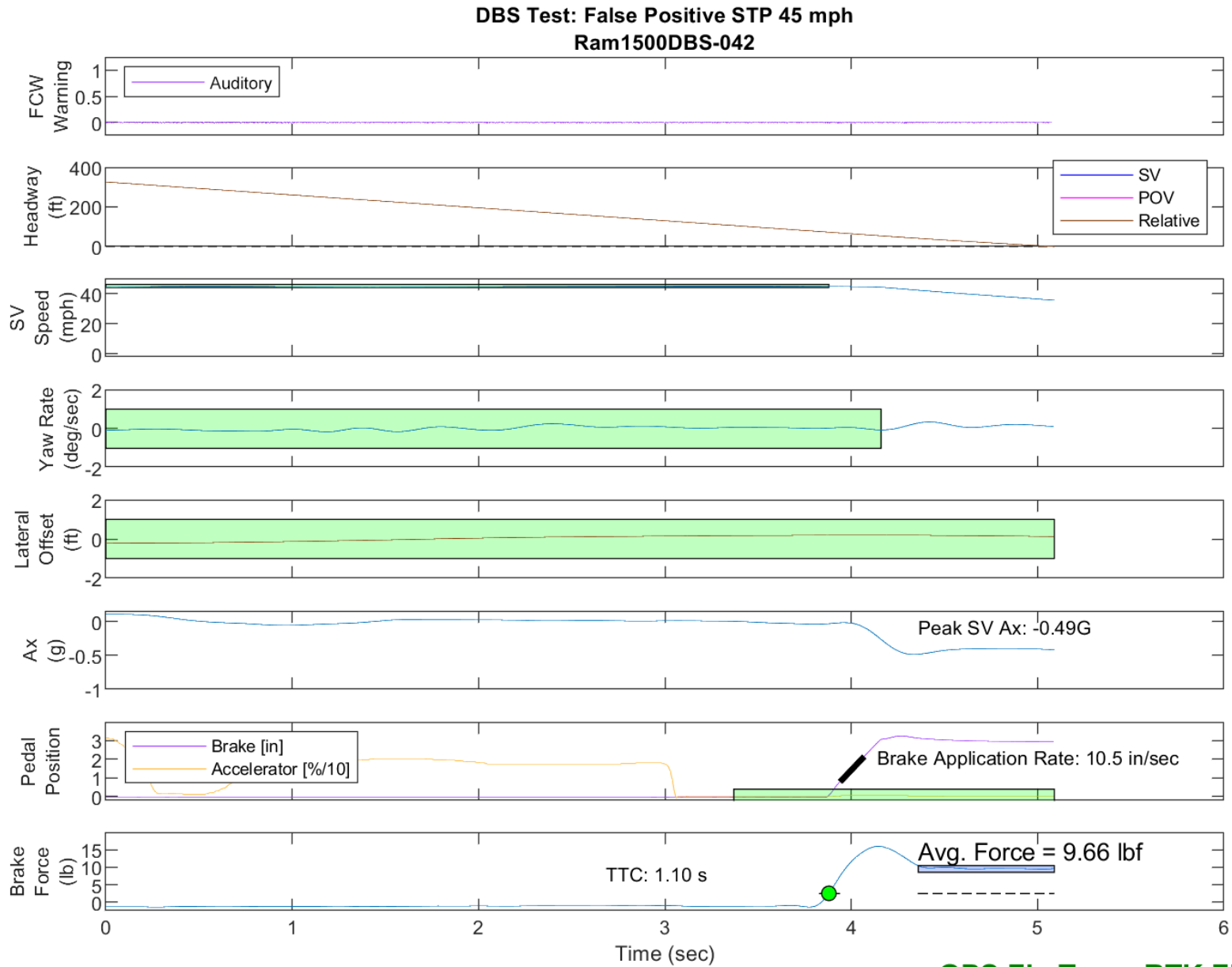


Figure E61. Time History for DBS Run 40, SV Encounters Steel Trench Plate, SV 25 mph



GPS Fix Type: RTK Fixed

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

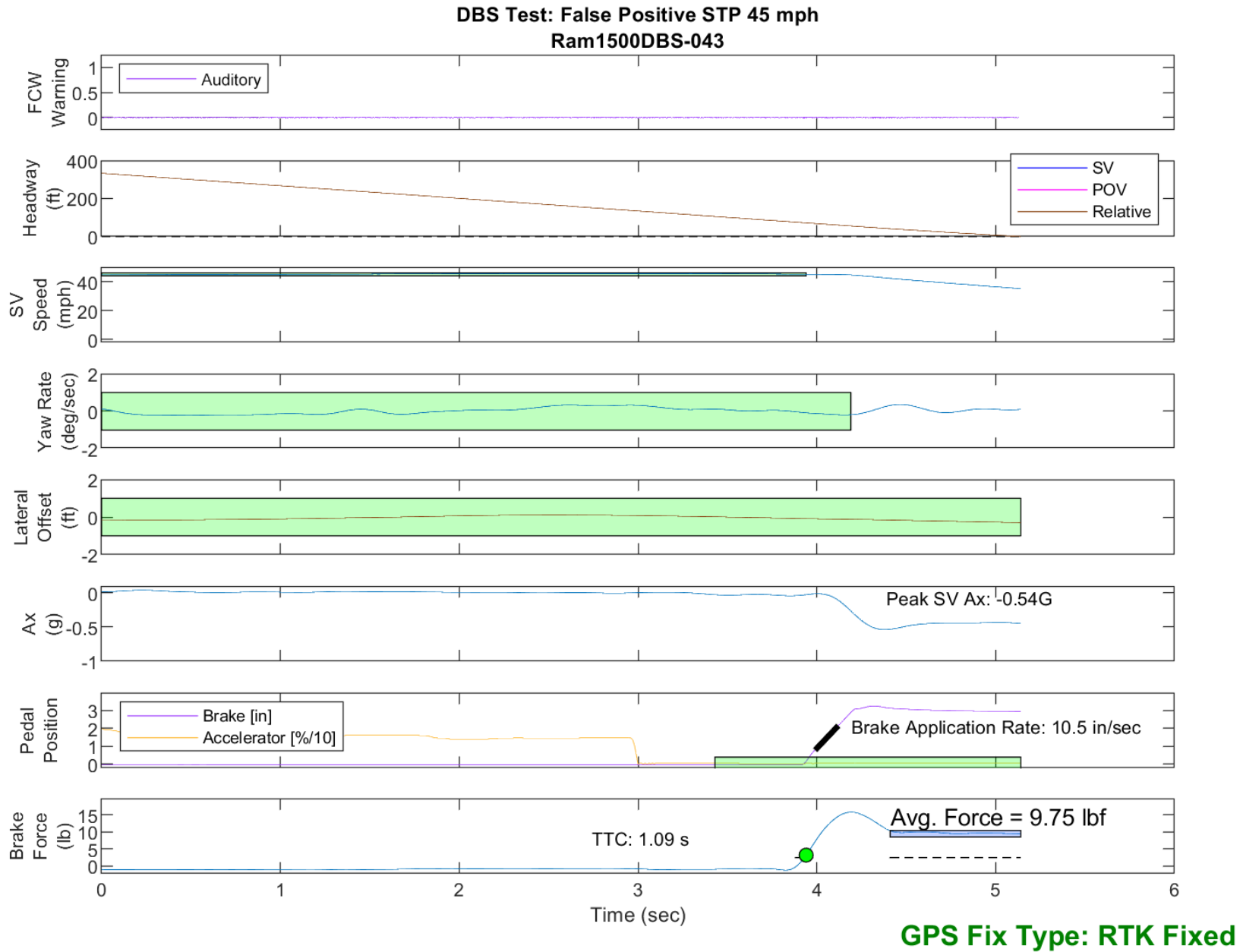


Figure E63. Time History for DBS Run 43, SV Encounters Steel Trench Plate, SV 45 mph

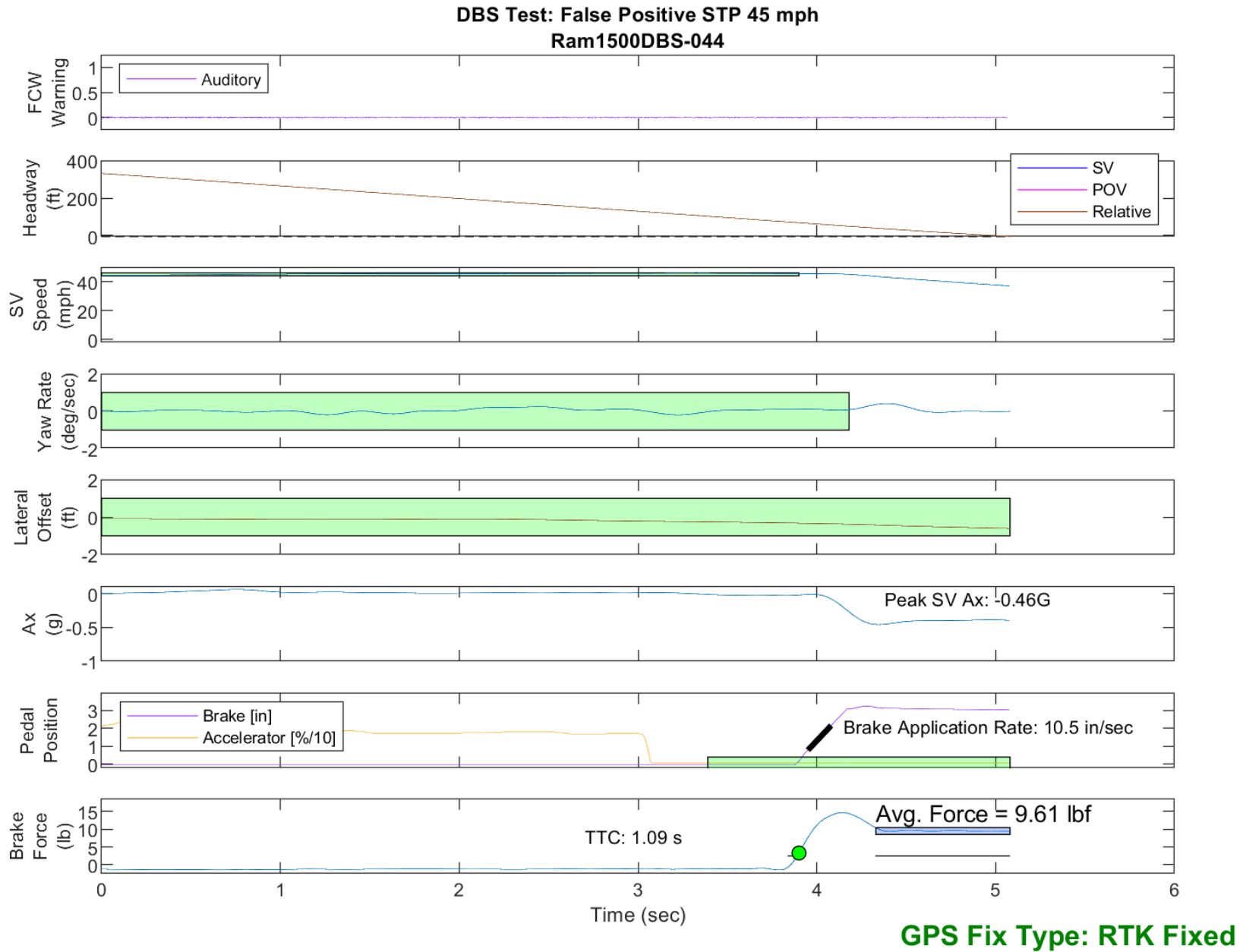


Figure E64. Time History for DBS Run 44, SV Encounters Steel Trench Plate, SV 45 mph

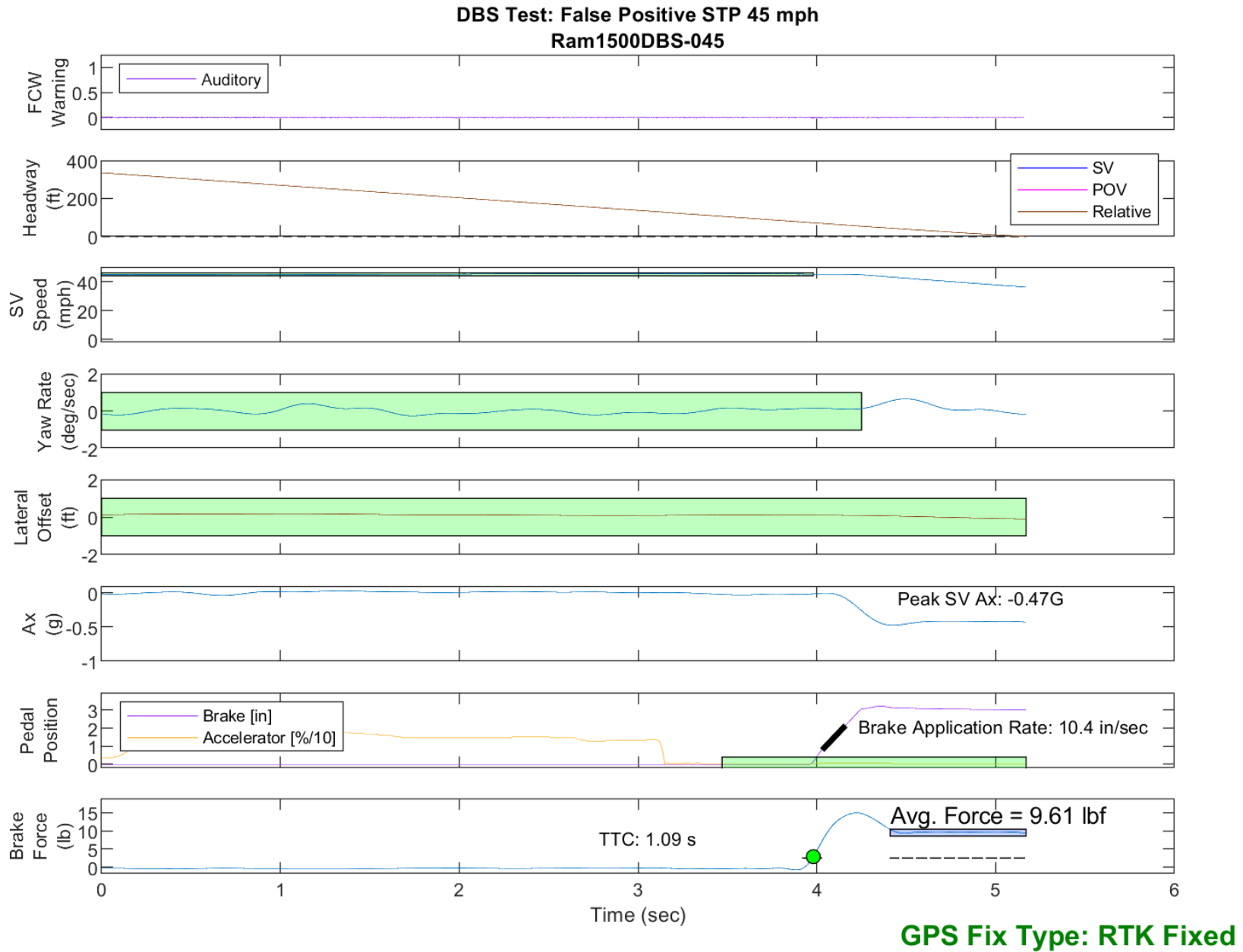


Figure E65. Time History for DBS Run 45, SV Encounters Steel Trench Plate, SV 45 mph

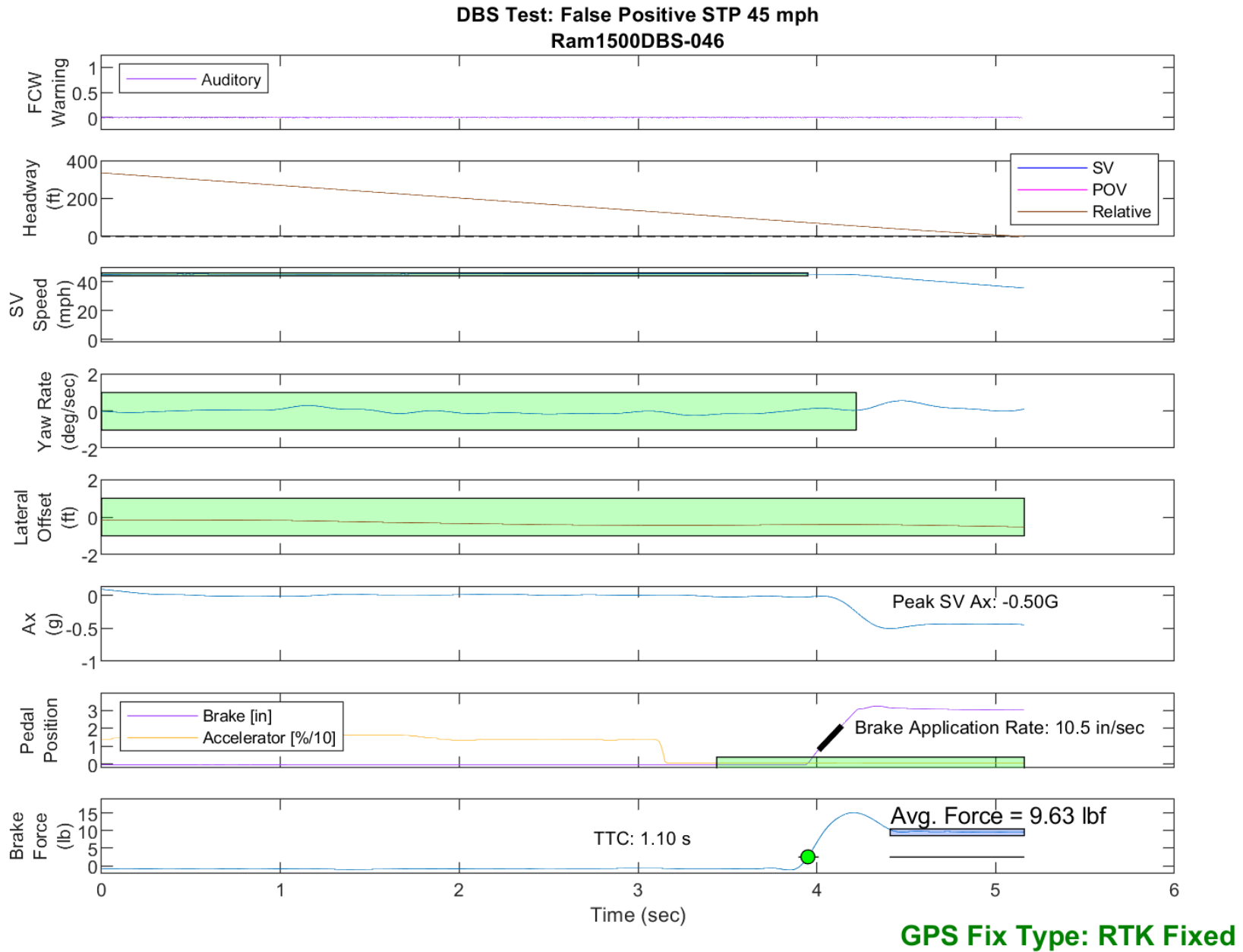


Figure E66. Time History for DBS Run 46, SV Encounters Steel Trench Plate, SV 45 mph

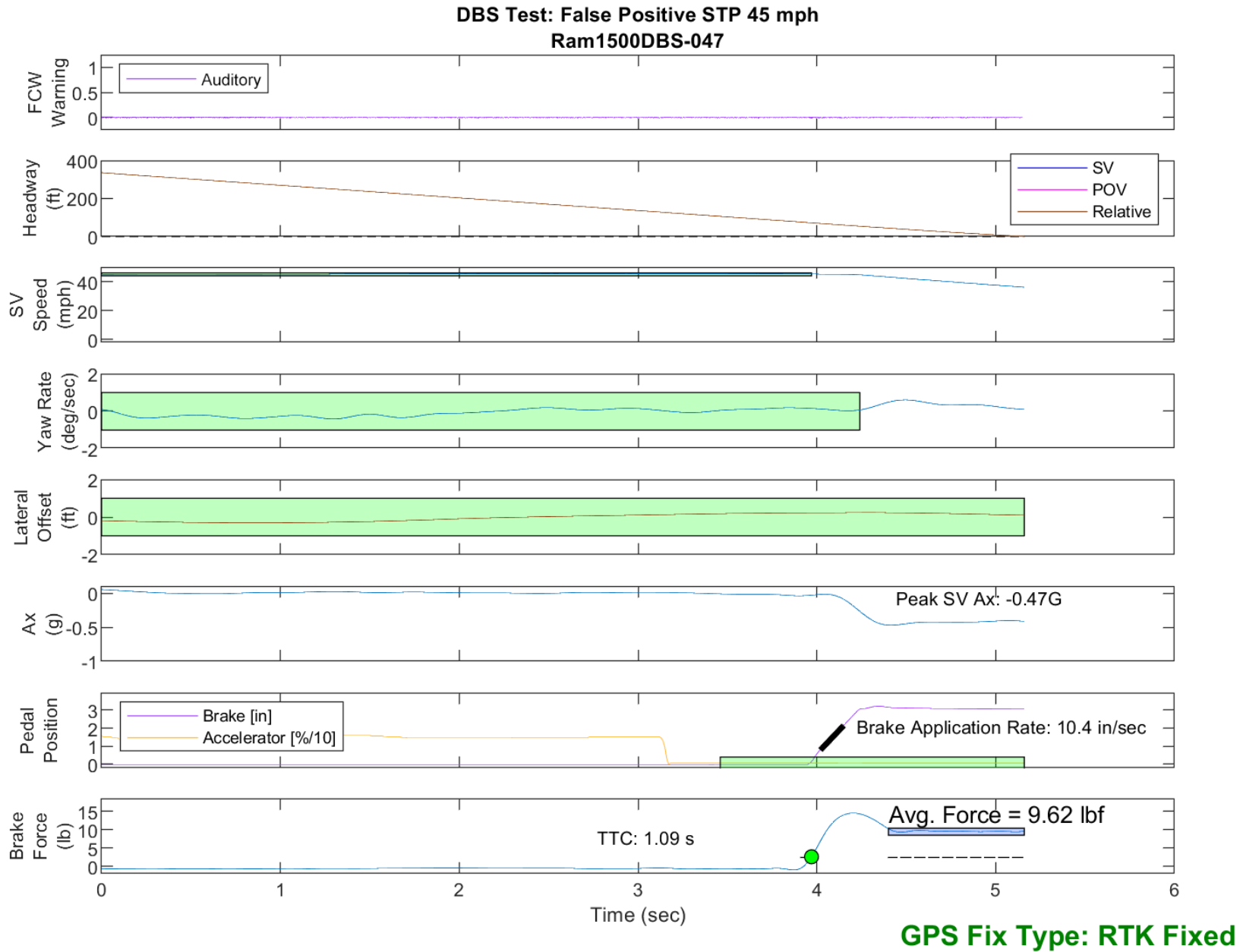


Figure E67. Time History for DBS Run 47, SV Encounters Steel Trench Plate, SV 45 mph

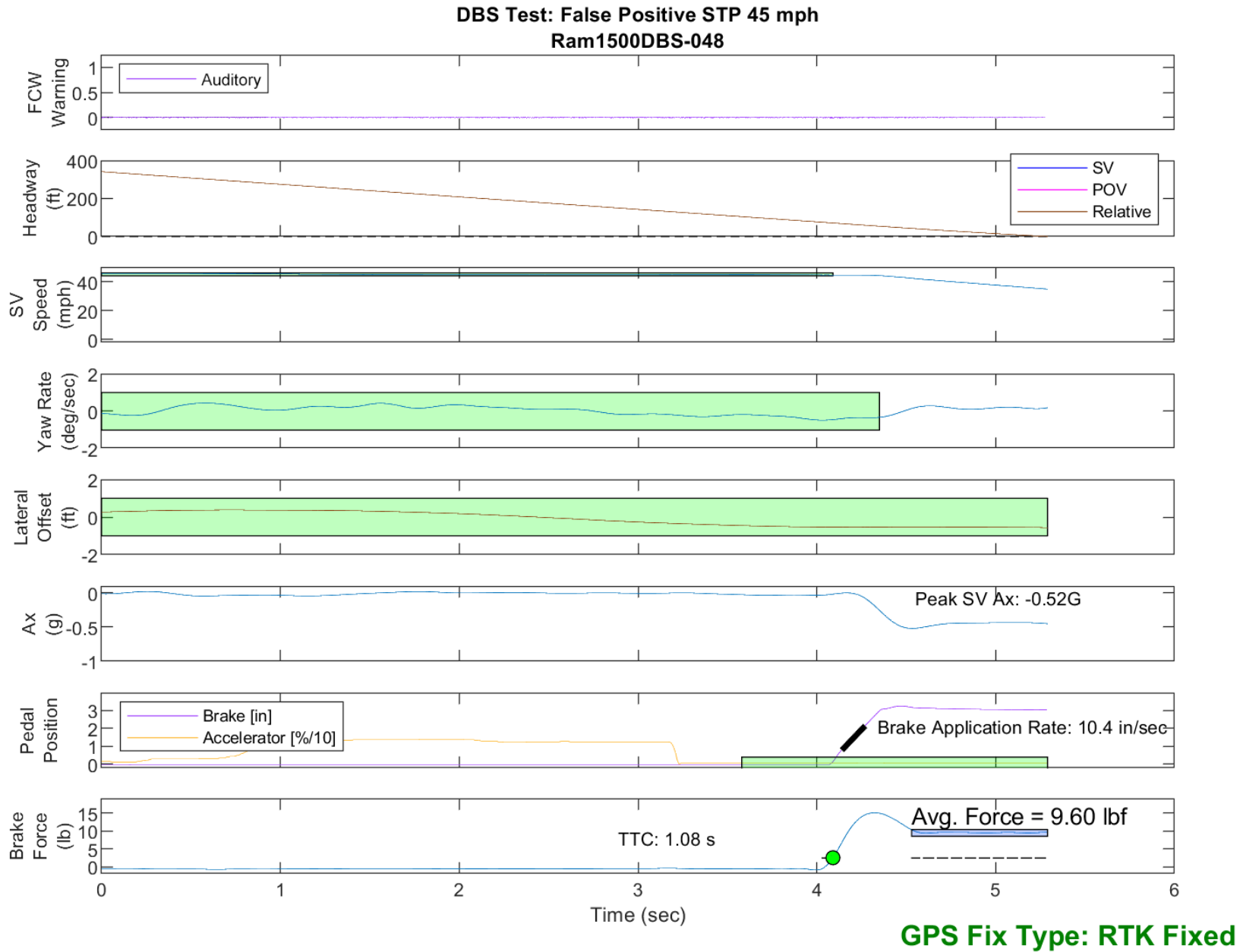


Figure E68. Time History for DBS Run 48, SV Encounters Steel Trench Plate, SV 45 mph

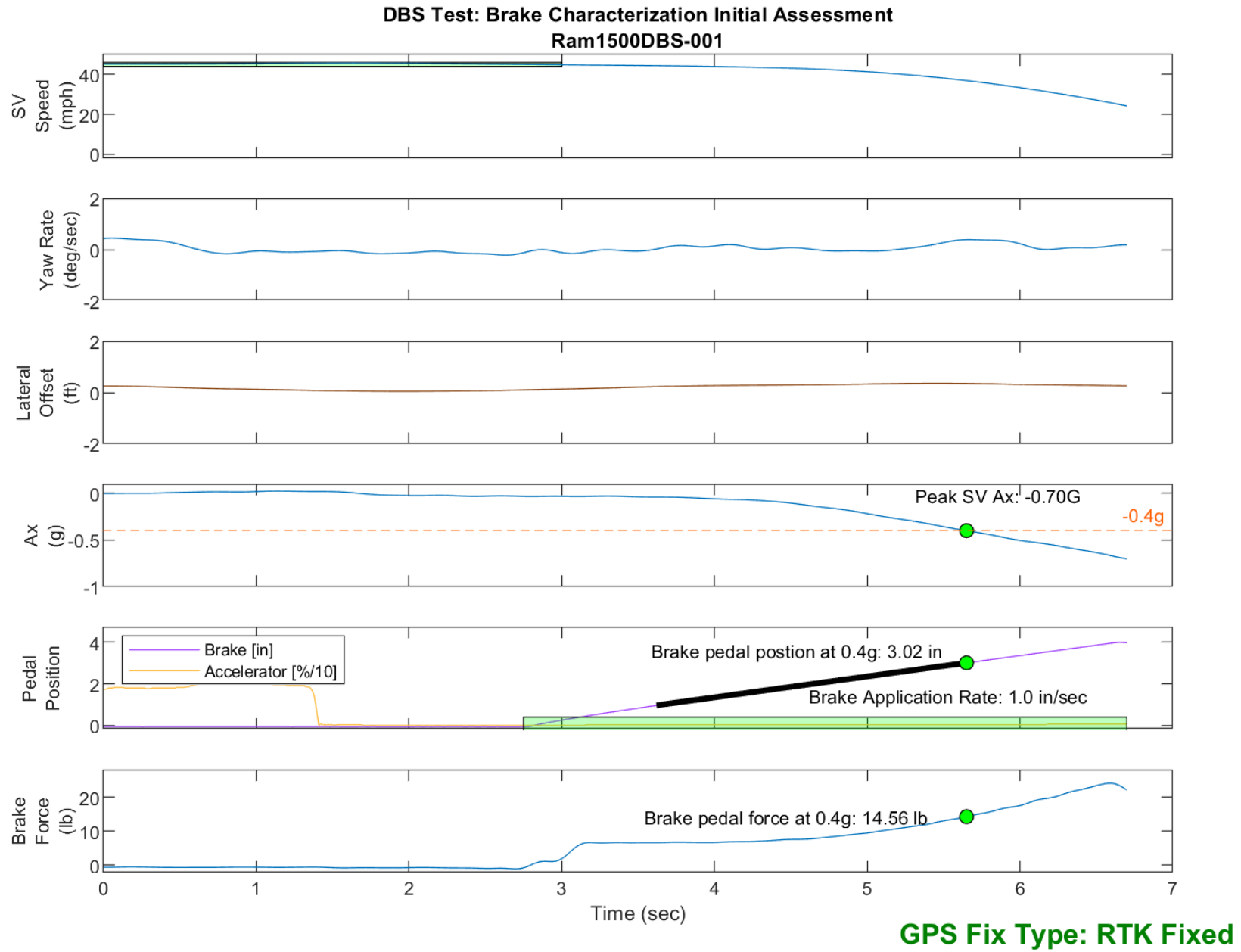


Figure E69. Time History for DBS Run 1, Brake Characterization Initial

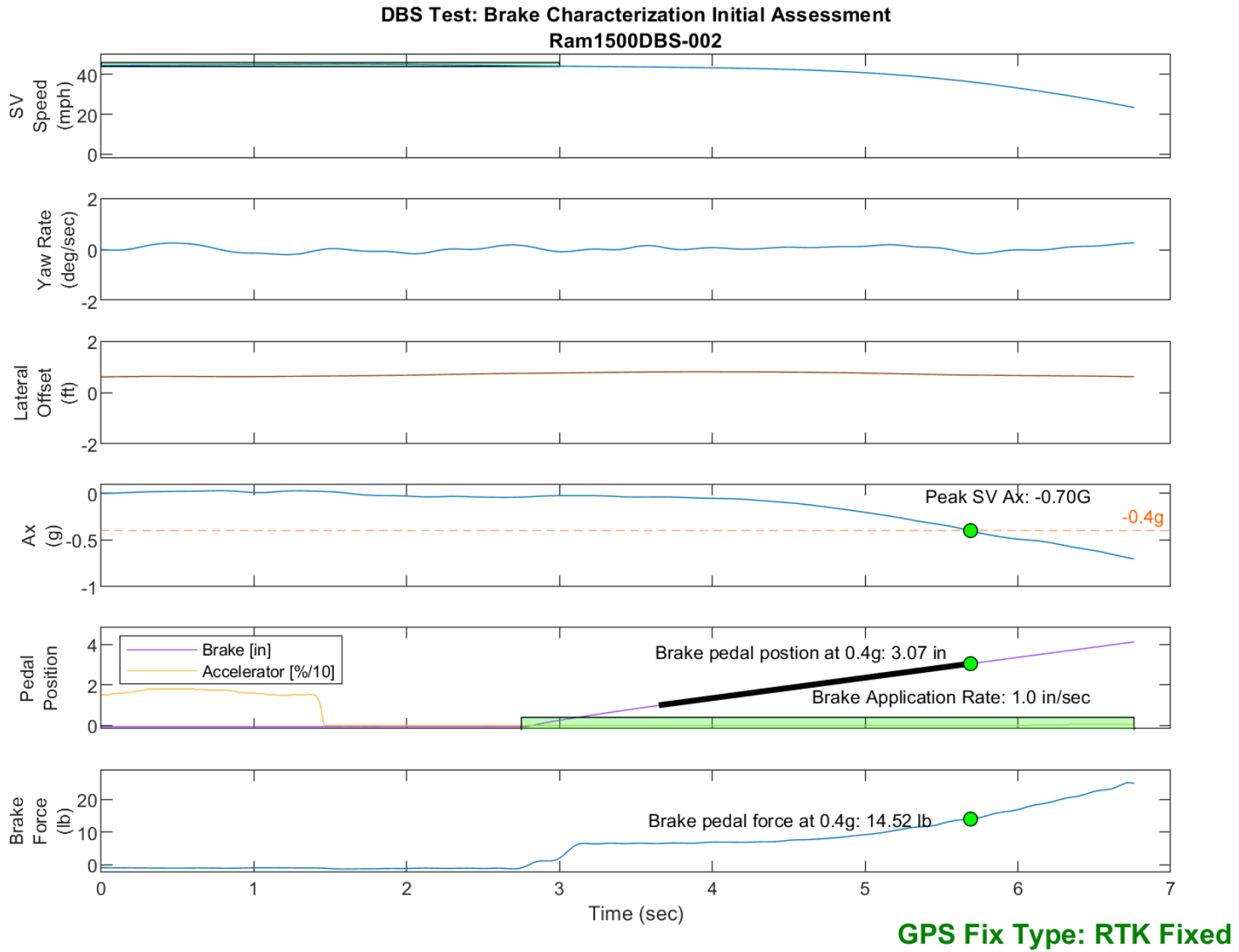
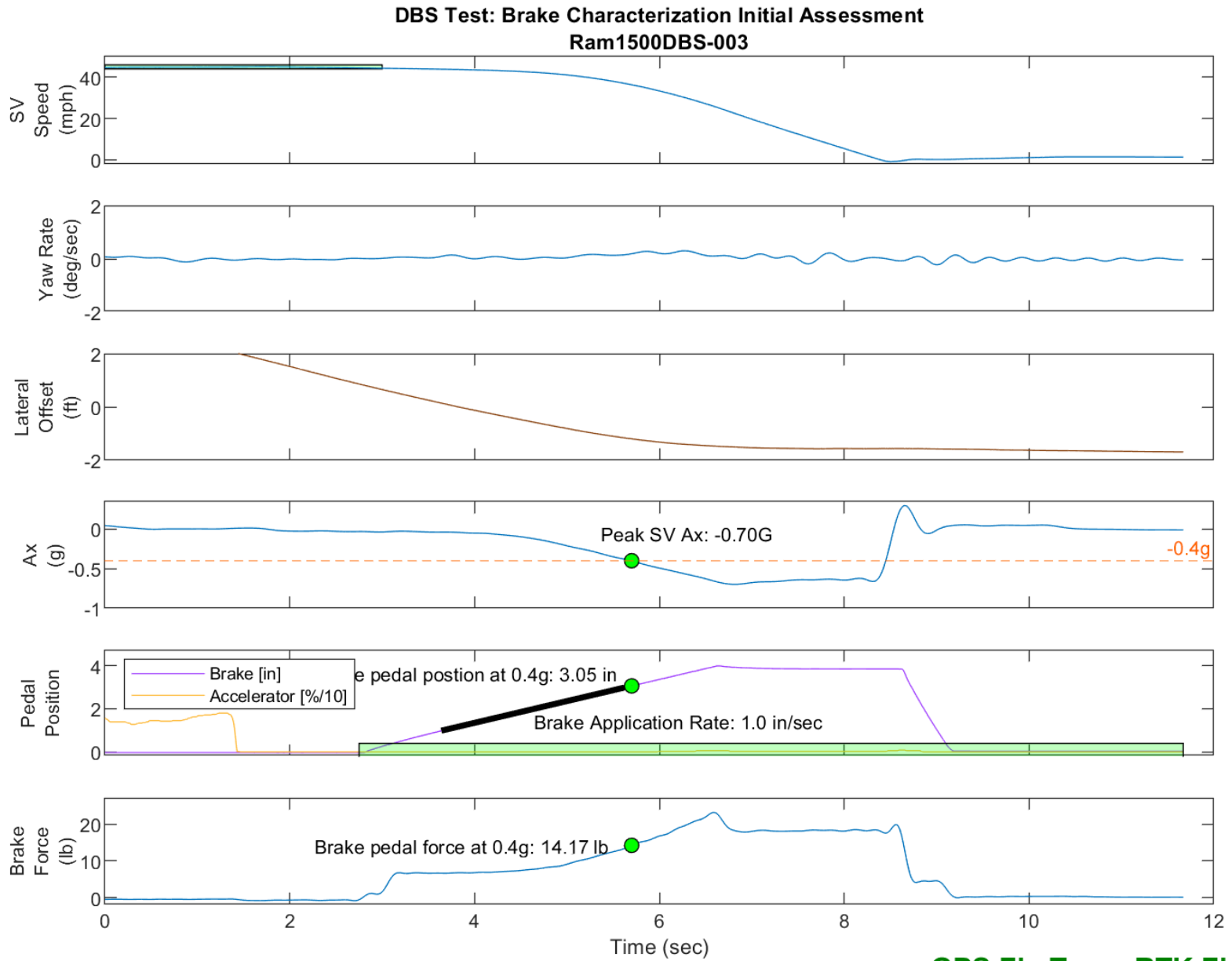


Figure E70. Time History for DBS Run 2, Brake Characterization Initial



GPS Fix Type: RTK Fixed

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

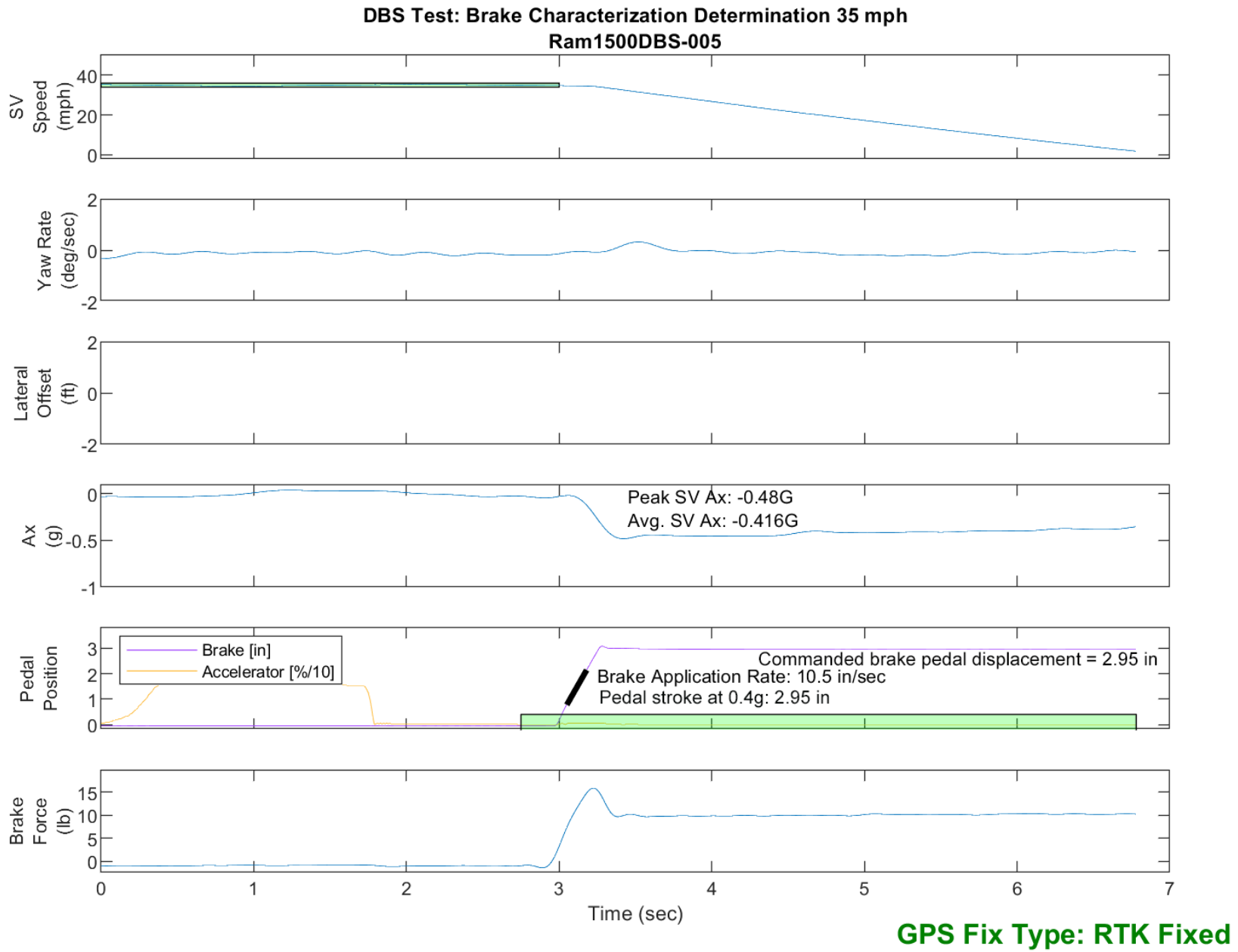
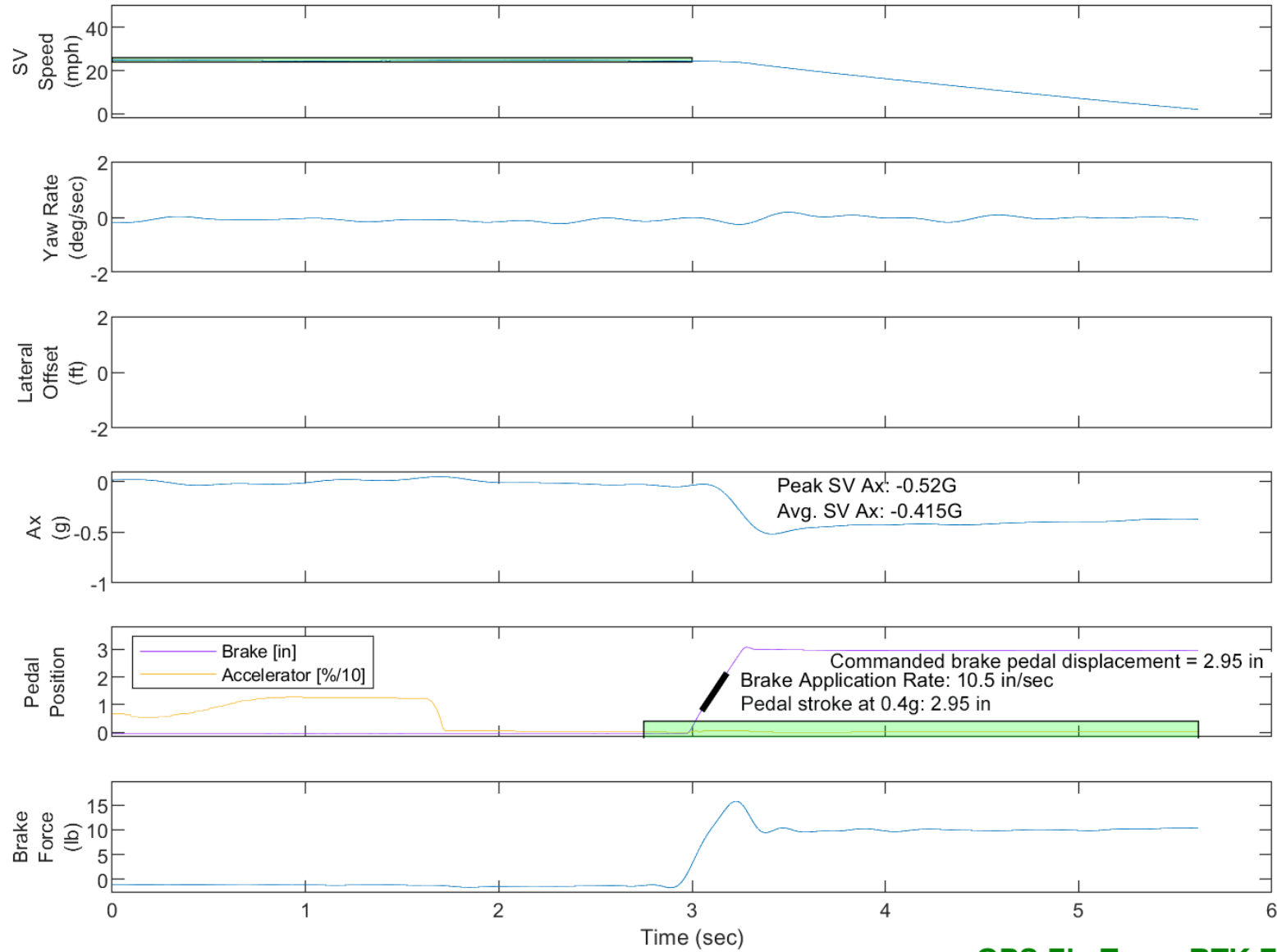


Figure E72. Time History for DBS Run 5, Brake Characterization Determination, Displacement Mode, 35 mph

DBS Test: Brake Characterization Determination 25 mph
Ram1500DBS-006



GPS Fix Type: RTK Fixed

Figure E73. Time History for DBS Run 6, Brake Characterization Determination, Displacement Mode, 25 mph

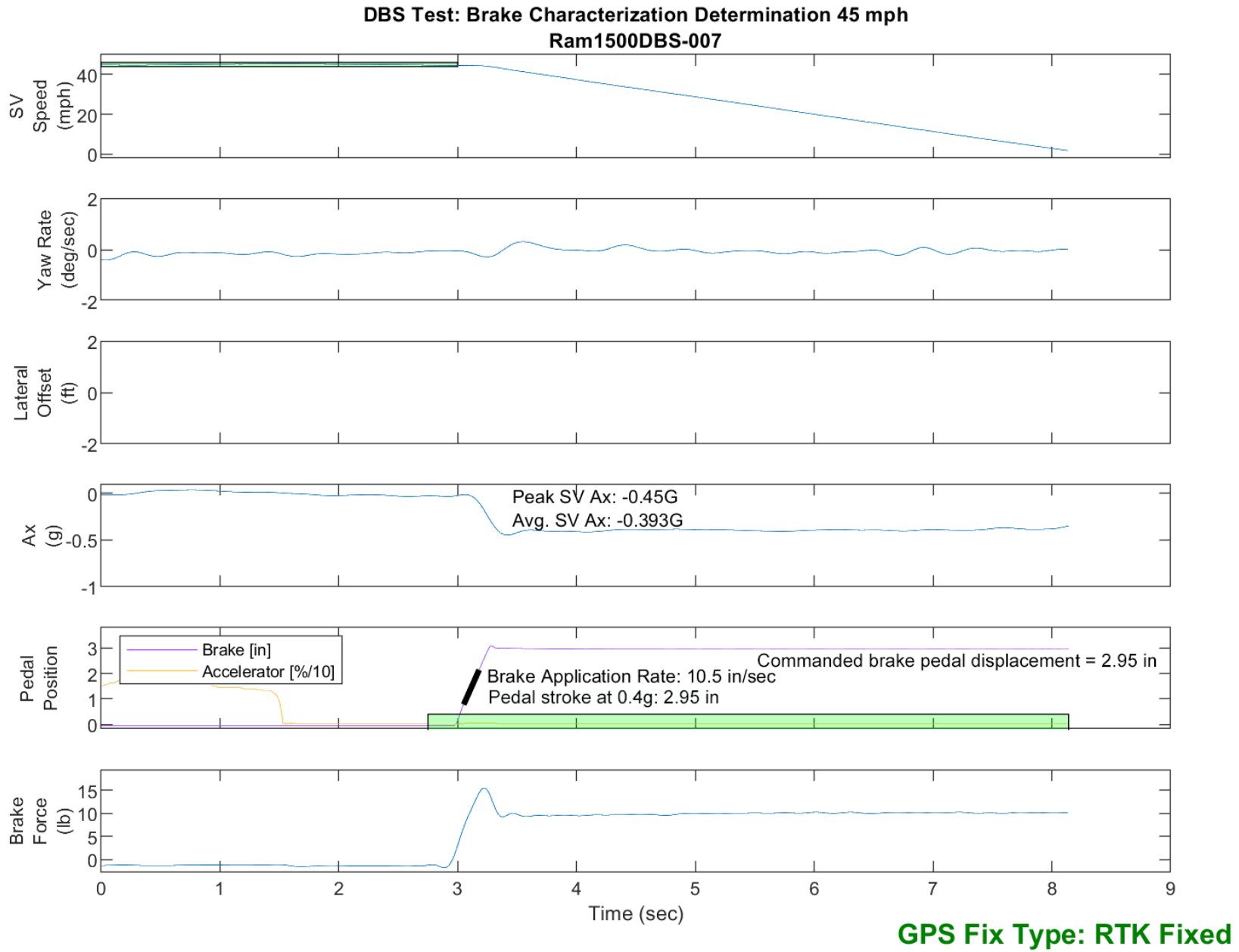


Figure E74. Time History for DBS Run 7, Brake Characterization Determination, Displacement Mode, 45 mph

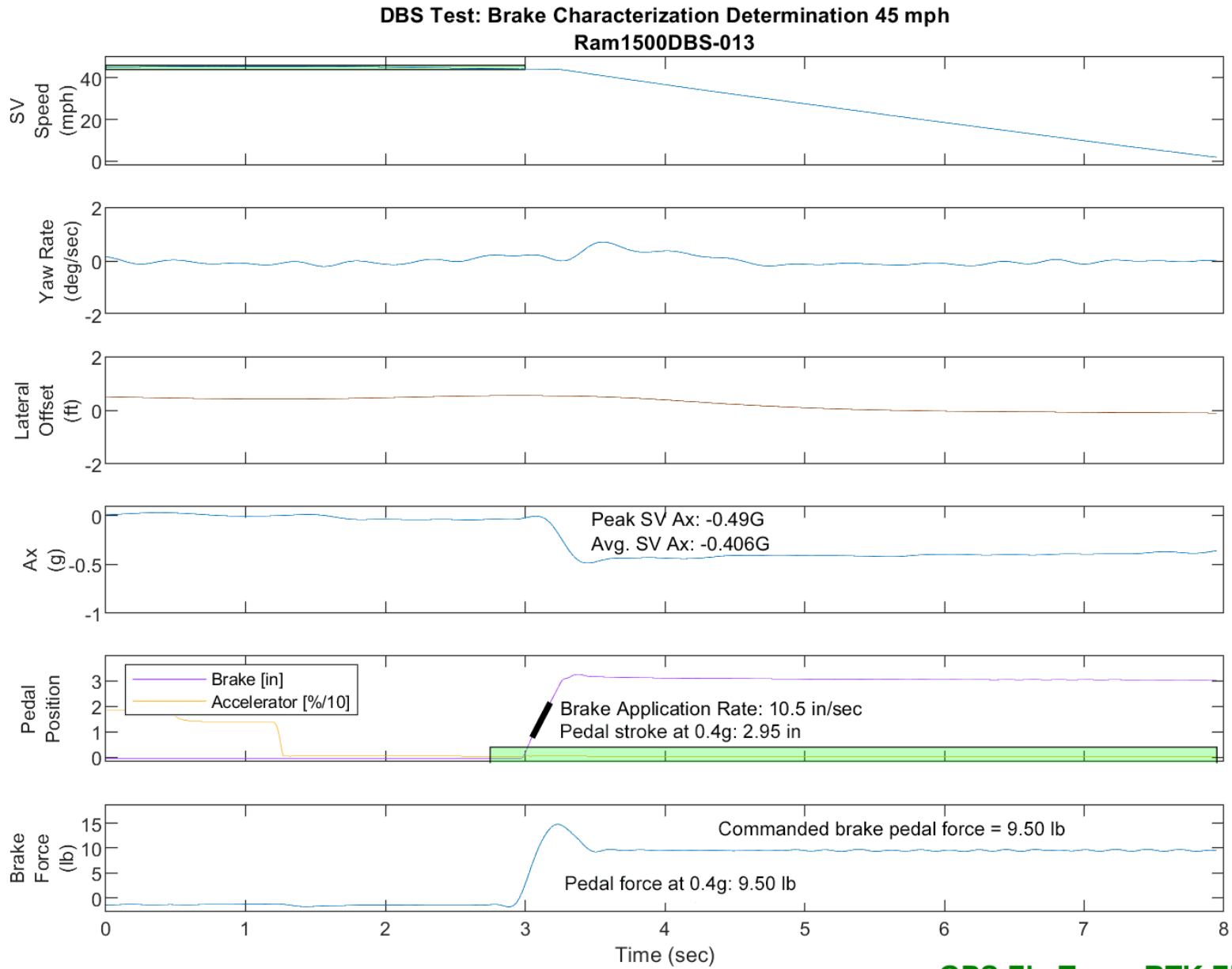


Figure E75. Time History for DBS Run 13, Brake Characterization Determination, Hybrid Mode, 45 mph

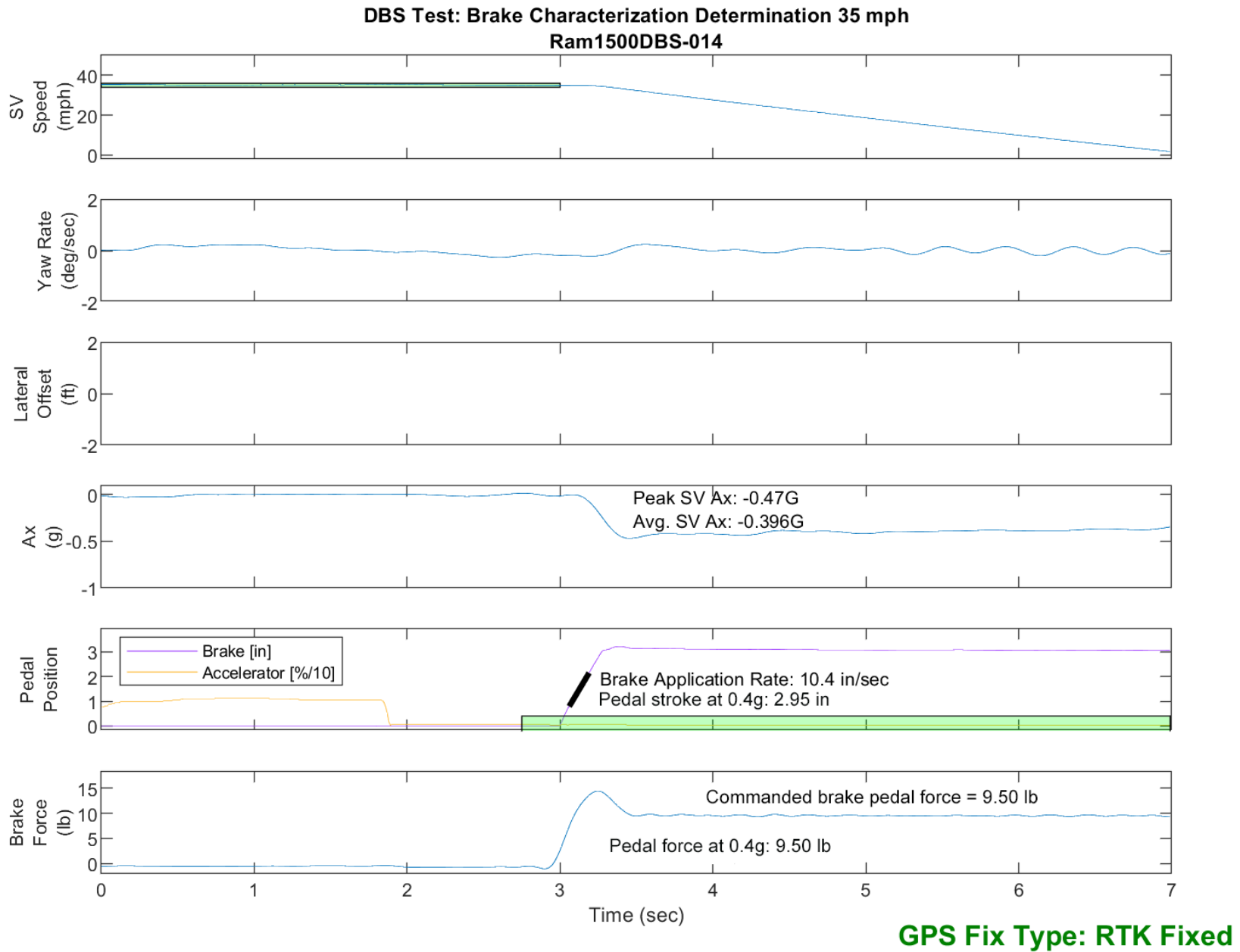


Figure E76. Time History for DBS Run 14, Brake Characterization Determination, Hybrid Mode, 35 mph

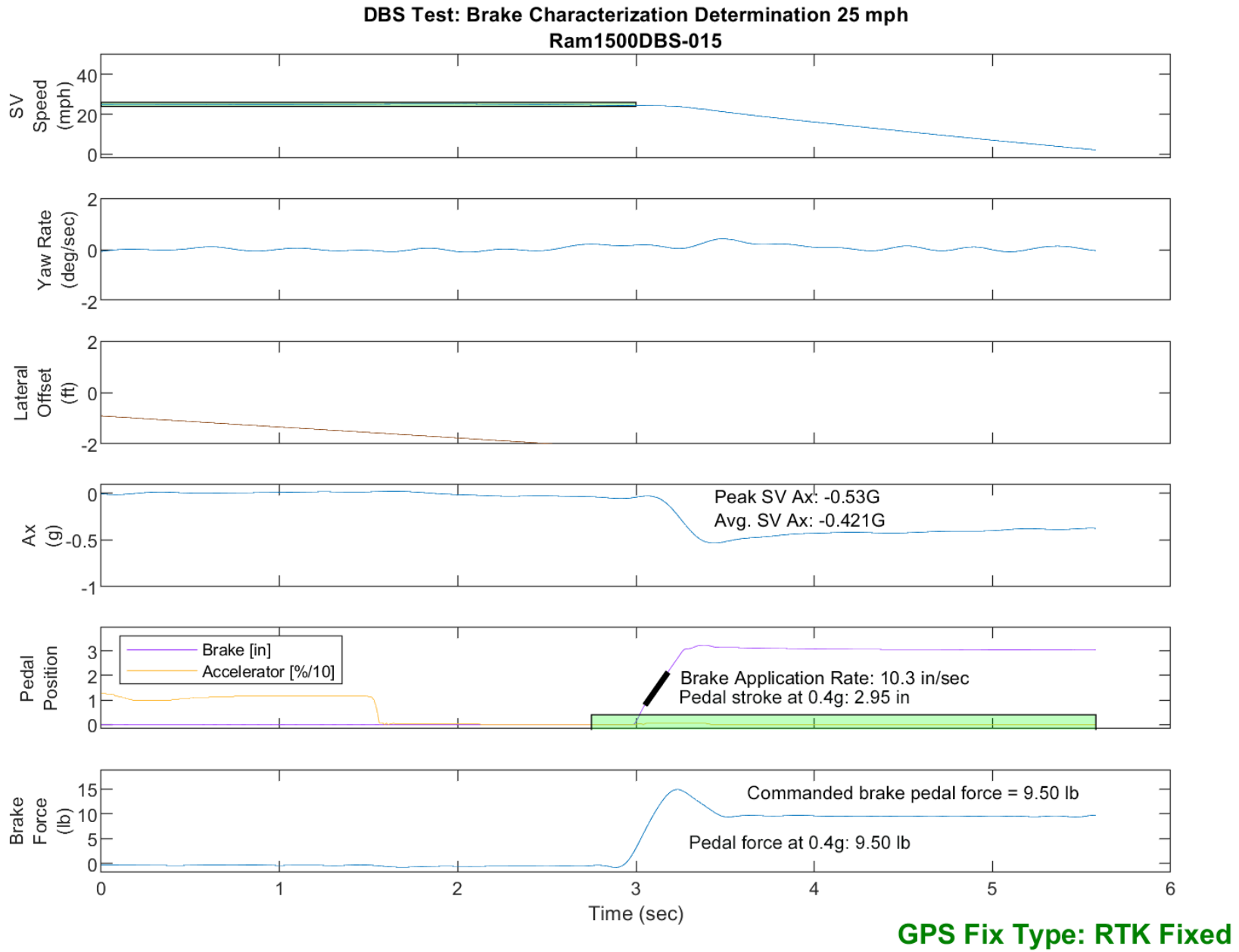


Figure E77. Time History for DBS Run 15, Brake Characterization Determination, Hybrid Mode, 25 mph