OCAS-DRI-DBS-19-18
NEW CAR ASSESSMENT PROGRAM
DYNAMIC BRAKE SUPPORT CONFIRMATION TEST

2019 Subaru Ascent

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25 November 2019

Final Report

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U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Office of Crash Avoidance Standards
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16. Abstract These tests were conducted on the subject 2019 Subaru Ascent in accordance with the specifications of the Office of Crash Avoidance Standards most current Test Procedure in docket NHTSA-2015-0006-0026; DYNAMIC BRAKE SUPPORT PERFORMANCE EVALUATION CONFIRMATION TEST FOR THE NEW CAR ASSESSMENT PROGRAM, October 2015. The vehicle passed the requirements of the test for all four DBS test scenarios.			
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Section I
OVERVIEW AND TEST SUMMARY

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

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

The method prescribed by the National Highway Traffic Safety Administration (NHTSA) to evaluate DBS performance on the test track involves three longitudinal, rear-end type crash configurations and a false positive test. In the rear-end scenarios, a subject vehicle (SV) approaches a stopped, slower-moving, or decelerating principal other vehicle (POV) in the same lane of travel. For these tests, the POV is a strikeable object with the characteristics of a compact passenger car. The fourth scenario is used to evaluate the propensity of a DBS system to inappropriately activate in a non-critical driving scenario that does not present a safety risk to the SV occupant(s).

The purpose of the testing reported herein was to objectively quantify the performance of a Dynamic Brake Support system installed on a 2019 Subaru Ascent. This test to assess Dynamic Brake Support systems is sponsored by the National Highway Traffic Safety Administration under Contract No. DTNH22-14-D-00333 with the New Car Assessment Program (NCAP).

Section II
DATA SHEETS

DYNAMIC BRAKE SUPPORT

DATA SHEET 1: TEST RESULTS SUMMARY

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2019 Subaru Ascent

SUMMARY RESULTS

VIN: *4S4WMABD2K34xxxx*

Test Date: *4/23/2019*

Test 1 - Subject Vehicle Encounters Stopped Principal Other Vehicle

SV 25 mph: *Pass*

Test 2 - Subject Vehicle Encounters Slower Principal Other Vehicle

SV 25 mph POV 10 mph: *Pass*

SV 45 mph POV 20 mph: *Pass*

Test 3 - Subject Vehicle Encounters Decelerating Principal Other Vehicle

SV 35 mph POV 35 mph: *Pass*

Test 4 - Subject Vehicle Encounters Steel Trench Plate

SV 25 mph: *Pass*

SV 45 mph: *Pass*

Overall: *Pass*

Notes:

DYNAMIC BRAKE SUPPORT

DATA SHEET 2: VEHICLE DATA

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2019 Subaru Ascent

TEST VEHICLE INFORMATION

VIN: *4S4WMABD2K34xxxx*

Body Style: *SUV* Color: *Tungsten Metallic*

Date Received: *4/11/2019* Odometer Reading: *101 mi*

Engine: *2.4 L Inline 4*

Transmission: *CVT*

Final Drive: *AWD*

Is the vehicle equipped with:

ABS	**X**	Yes	____	No
Adaptive Cruise Control	**X**	Yes	____	No
Collision Mitigating Brake System	**X**	Yes	____	No

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Subaru Corporation*

Date of manufacture: *10/18*

DATA FROM TIRE PLACARD:

Tires size as stated on Tire Placard: Front: *245/60R18*

Rear: *245/60R18*

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

Rear: *240 kPa (35 psi)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 2: VEHICLE DATA

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2019 Subaru Ascent

TIRES

Tire manufacturer and model: *Falken Ziex ZE001A A/S*

Front tire size: *245/60R18*

Rear tire size: *245/60R18*

VEHICLE ACCEPTANCE

Verify the following before accepting the vehicle:

X All options listed on the “window sticker” are present on the test vehicle.

X Tires and wheel rims are the same as listed.

X There are no dents or other interior or exterior flaws.

X The vehicle has been properly prepared and is in running condition.

X Verify that spare tire, jack, lug wrench, and tool kit (if applicable) is located in the vehicle cargo area.

DYNAMIC BRAKE SUPPORT

DATA SHEET 3: TEST CONDITIONS

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GENERAL INFORMATION

Test date: *4/23/2019*

AMBIENT CONDITIONS

Air temperature: *22.2 C (72 F)*

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

X Windspeed ≤ 10 m/s (22 mph)

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

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

VEHICLE PREPARATION

Verify the following:

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

Fuel tank is full: **X**

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

Front: *240 kPa (35 psi)*

Rear: *240 kPa (35 psi)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 3: TEST CONDITIONS

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WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*610.1 kg (1345 lb)*	Right Front	*563.8 kg (1243 lb)*
Left Rear	*497.1 kg (1096 lb)*	Right Rear	*488.5 kg (1077 lb)*
		Total:	*2159.5 kg (4761 lb)*

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

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Name of the DBS option, option package, etc.

Pre-Collision Braking System

System setting used for test (if applicable):

Default - System On

Brake application mode used for test:

Hybrid Control

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

1 mph (Per manufacturer supplied information)

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

100 mph (Per manufacturer supplied information)

Does the vehicle system require an initialization sequence/procedure?

Yes. Approximately 1 hour of driving on normal roadways under the following conditions:

- *Dry road surfaces*
- *Daylight hours*
- *Public road with both left and right lane markings*
- *If traffic exists, keep a comfortable distance from lead vehicles*
- *Maintain posted speed limit.*

Please do not perform the initialization in inclement weather.

If the vehicle ignition is turned off and the engine is restarted following each run, it is NOT necessary to reinitialize the system.

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

The system may switch off if AEB has operated 3 times in one driving cycle, in which case the Pre-Collision Braking System OFF indicator light illuminates and AEB is NOT operational. The system is reactivated by cycling the ignition, after which it takes approximately 7 seconds for the pre-collision braking system to become functional.

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

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

The alerts are staged depending on the urgency of the situation.

Following Distance Warning:

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

First Braking and Warning:

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

Secondary Braking and Warning:

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

(Continued next page)

<Apply Brake message>

Even after the vehicle has stopped, depress the brake pedal. Until the brake pedal is depressed, a message appears and stays in the warning screen area of the combination meter display for approximately 2 minutes. A single continuous beep sounds while the message is displayed.

Is there a way to deactivate the system? **X** Yes

_____ No

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

A button is provided in the upper console, above the windscreen. It is necessary to press and hold the Pre-Collision Braking System OFF switch for approximately 2 seconds. The system is automatically reactivated after cycling the ignition.

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

X No

If yes, please provide a full description.

DYNAMIC BRAKE SUPPORT

DATA SHEET 4: DYNAMIC BRAKE SUPPORT SYSTEM OPERATION

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

If yes, please provide a full description.

There may be cases when detection of an object is not possible depending on a variety of conditions. For example, when a vehicle is viewed from the side, oncoming vehicle, vehicles approaching in reverse, small animals or children, or walls or doors are not likely to be detected.

Conditions in which the Pre-Collision Braking system cannot detect obstacles:

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

(continued next page)

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

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- *When there is a wall, etc. in front of a stopped vehicle*
- *When there is another object near the vehicle*
- *When a vehicle, etc. has its side facing you.*
- *With vehicles that are backing up or with oncoming vehicles, etc.*
- *When the size and height of an obstacle is smaller than the limitations of the stereo camera's recognition capability*
  - *With small animals or children, etc.*
  - *With pedestrians who are sitting or lying down*
- *When the detected object is a fence or wall, etc. with a uniform pattern (a striped pattern or brick pattern, etc.)*
- *When there is a wall or door made of glass or a mirror in front*
- *When the vehicle in front suddenly swerves, accelerates, or decelerates.*
- *When a vehicle, motorcycle, bicycle or pedestrian suddenly cuts in from the side or suddenly runs in front of you.*
- *When you suddenly change lanes and your vehicle is immediately behind an obstacle*
- *When there is a vehicle, motorcycle, bicycle or pedestrian in a location close to your vehicle's bumper*
- *When the speed difference between your vehicle and an obstacle is 4 MPH (5 km/h) or less (As braking is performed once the obstacle is in close proximity to your vehicle, depending on the shape and size of the obstacle, there may be some cases when the obstacle is outside the range of the camera's field of view.)*
- *When driving on sharp curves, steep uphill grades or steep downhill grades*
- *When driving on a bumpy or unpaved road*
- *When there are changes in brightness, such as at a tunnel entrance or exit*

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The system may not operate correctly under the conditions listed below. When these conditions occur, turn off the Pre-Collision Braking System.

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

In the following situations, turn off the Pre-Collision Braking System. Otherwise the Pre-Collision Braking System may activate unexpectedly.

- *When the vehicle is being towed*
- *When loading the vehicle onto a carrier*
- *When a chassis dynamometer, free-rollers or similar equipment is used*

(Continued next page)

- *When a mechanic lifts up the vehicle, starts the engine and spins the wheels freely*
- *When passing hanging banners, flags or branches, or when thick/tall vegetation is contacting the vehicle*
- *When driving on a race track*
- *When using a drive-through car wash*

- *The Pre-Collision Braking System may activate in the following situations.*
  - *When passing through an automatic gate (opening and shutting)*
  - *When driving close to the vehicle in front*
  - *When driving in a location where the grade of the road changes rapidly*
  - *When visibility is poor due to sand, smoke or water vapor blowing in the wind, or when the front vision is obscured due to water splashes, snow, dirt or dust stir up generated by the vehicle in front or oncoming traffic*
  - *When passing through clouds of steam or smoke, etc.*
  - *When driving in adverse weather, such as heavy snow or snowstorms*
  - *When the exhaust gas emitted by the vehicle in front is clearly visible in cold weather, etc.*
  - *When there is an obstacle on a curve or intersection*
  - *When narrowly passing a vehicle or an object*
  - *When stopping very close to a wall or a vehicle in front*
  - *When passing through water spray from road sprinklers or snow clearing sprinklers on the road.*
  - *If there is cargo or installed accessories, etc. that are protruding beyond the edge of the front bumper, the vehicle's length will increase and the system may not be able to prevent a collision.*
  - *If the driver operates the brake pedal during automatic braking, the pedal may feel stiff; however, this is normal. By depressing the brake pedal further you can apply more braking force*

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In the following conditions, the possibility that system may not be able to detect a pedestrian as an object is particularly high.

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

Notes:

Section III
TEST PROCEDURES

A. TEST PROCEDURE OVERVIEW

Four test scenarios were used, as follows:

Test 1. Subject Vehicle (SV) Encounters Stopped Principal Other Vehicle (POV)
Test 2. Subject Vehicle Encounters Slower Principal Other Vehicle
Test 3. Subject Vehicle Encounters Decelerating Principal Other Vehicle
Test 4. Subject Vehicle Encounters Steel Trench Plate

An overview of each of the test procedures follows.

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

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

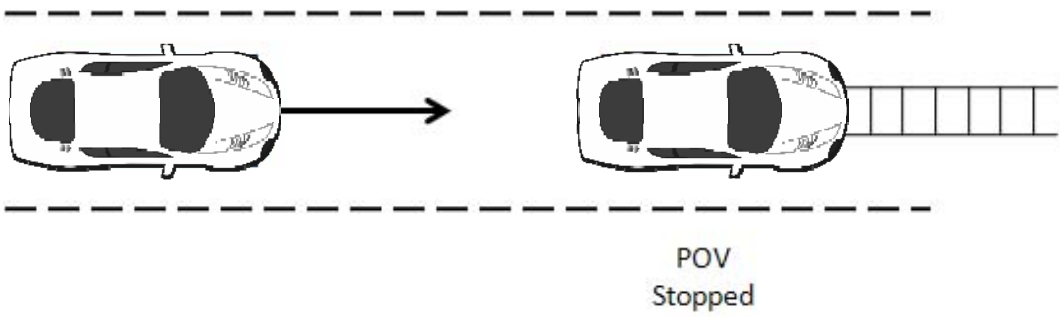

Figure 1. Depiction of Test 1

a. Procedure

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

The SV ignition was cycled prior to each test run. The SV was driven at a nominal speed of 25 mph (40.2 kph) 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 kph) 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 kph)	0	5.1 → t_{FCW}	187 ft (57 m) → t_{FCW}	Within 500 ms of FCW1 onset	Varies	1.1	40 ft (12 m)

b. Criteria

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

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

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

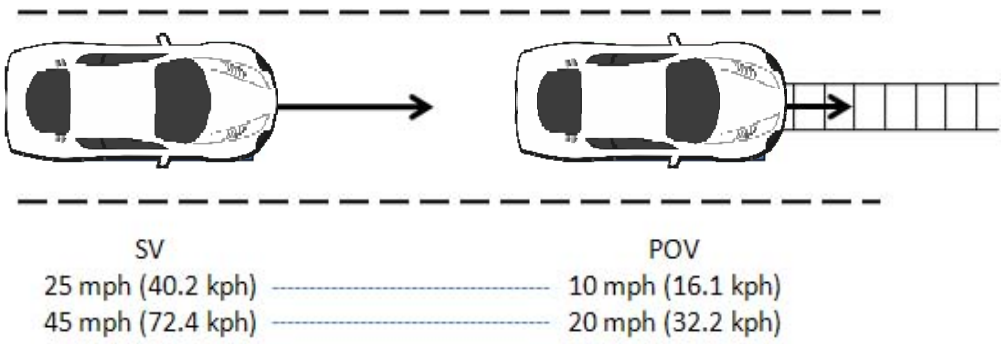

Figure 2. Depiction of Test 2

a. Procedure

The SV ignition was cycled prior to each test run. The tests were conducted two ways. In the first, the POV was driven at a constant 10.0 mph (16.1 kph) in the center of the lane of travel while the SV was driven at 25.0 mph (40.2 kph), 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 kph) in the center of the lane of travel while the SV was driven at 45.0 mph (72.4 kph), 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 kph) 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 kph) 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 kph)	10 mph (16 kph)	5.0 → t_{FCW}	110 ft (34 m) → t_{FCW}	Within 500 ms of FCW1 onset	Varies	1.0	22 ft (7 m)
45 mph (72 kph)	20 mph (32 kph)	5.0 → t_{FCW}	183 ft (56 m) → t_{FCW}	Within 500 ms of FCW1 onset	Varies	1.0	37 ft (11 m)

b. Criteria

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

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

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

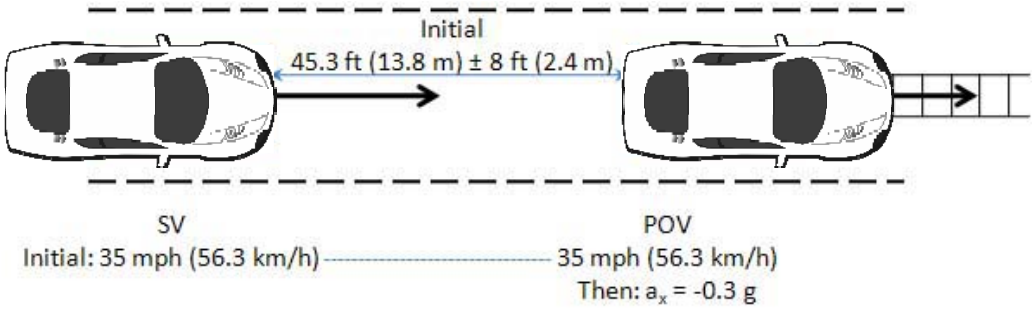

Figure 3. Depiction of Test 3 with POV Decelerating

a. Procedure

The SV ignition was cycled prior to each test run. For this scenario both the POV and SV were driven at a constant 35.0 mph (56.3 kph) in the center of the lane, with headway of 45 ft (14 m) ± 8 ft (2.4 m). Once these conditions were met, the POV tow vehicle brakes were applied to achieve 0.3 ± 0.03 g. The SV throttle pedal was released within 500 ms of $t_{FCW,}$ and the SV brakes were applied when TTC was 1.4 seconds (31.5 ft (9.6 m)).

The test concluded when either:

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

The SV driver then braked to a stop.

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

- The lateral distance between the centerline of the POV and the center of the travel lane could not deviate more than ±1 ft (0.3 m) during the validity period.
- The headway between the SV and POV must have been constant from the onset of the applicable validity period to the onset of POV braking.
- The SV and POV speed could not deviate more than ±1.0 mph (1.6 kph) 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 kph)	35 mph (56 kph)	3.0 seconds prior to POV braking → t_{FCW}	45 ft (14 m) → t_{FCW}	Within 500 ms of FCW1 onset	Varies	1.4	32 ft (10 m)

b. Criteria

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

4. TEST 4 – FALSE POSITIVE SUPPRESSION

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

a. Procedure

This test was conducted at two speeds, 25 mph (40.2 kph) and 45 mph (72.4 kph). The SV was driven directly towards, and over, the STP, which was positioned in the center of a travel lane, with its longest sides parallel to the road edge. The SV was driven at constant speed in the center of the lane toward the STP. If the SV did not present an FCW alert during the approach to the STP by TTC = 2.1 s, the SV driver initiated release of the throttle pedal at TTC = 2.1 s and the throttle pedal was fully released within 500 ms of TTC = 2.1 s. The SV brakes were applied at TTC of 1.1 seconds, assumed to be 40 ft (12.3 m) from the edge of the STP at 25 mph or 73 ft (22.1 m) at 45 mph. The test concluded when the front most part of the SV reached a vertical plane defined by the edge of the STP first encountered by the SV.

b. Criteria

In order to pass the False Positive test series, the magnitude of the SV deceleration reduction attributable to DBS intervention must have been less than or equal to 1.25 times the average of the deceleration experienced by the baseline command from the braking actuator for at least five of seven valid test trials.

B. GENERAL INFORMATION

1. t_{FCW}

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

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

Table 4. Audible and Tactile Warning Filter Parameters

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

2. General Validity Criteria

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

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

3. Validity Period

The valid test interval began:

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

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

Test 3: 3 seconds before the onset of POV braking

Test 4: 2 seconds prior to the SV throttle pedal being released

The valid test interval ended:

Test 1: When either of the following occurred:

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

Test 2: When either of the following occurred:

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

Test 3: When either of the following occurred:

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

Test 4: When the SV stopped.

4. Static Instrumentation Calibration

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

For Tests 1, 2, and 3, the SV, POV, and POV moving platform and tow vehicle were centered in the same travel lane with the same orientation (i.e., facing the same direction). For Test 4, the SV and STP were centered in the same travel lane.

For Tests 1, 2, and 3, the SV was positioned such that it just contacted a vertical plane defining the rearmost location of the POV. For Test 4, the front-most location of the SV was positioned such that it just reached a vertical plane defined by the leading edge of the STP first encountered by the SV (i.e., just before it is driven onto the STP). This is the “zero position.”

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

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

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

5. Number of Trials

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

6. Transmission

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

C. PRINCIPAL OTHER VEHICLE

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

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

- POV element, whose requirements 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.

- POV delivery system, whose requirements are to:

    - Accurately control the nominal POV speed up to 35 mph (56 kph).
    - 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.

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.

Operationally, the POV shell is attached to the slider and load frame, which includes rollers that allow the entire assembly to move longitudinally along the guide rail. The guide rail is coupled to a tow vehicle and guided by the lateral restraint track secured to the test track surface. The rail includes a provision for restraining the shell and roller assembly in the rearward direction. In operation, the shell and roller assembly engages the rail assembly through detents to prevent relative motion during run-up to test speeds and minor deceleration of the tow vehicle. The combination of rearward stops and forward motion detents allows the test conditions, such as relative POV-SV headway distance and speed etc., to be achieved and adjusted as needed in the preliminary part of a test. If during the test, the SV strikes the rear of the POV shell, the detents are overcome and the entire shell/roller assembly moves forward in a two-stage manner along the rail and away from the SV. The forward end of the rail has a soft stop to restrain forward motion of the shell/roller assembly. After impacting the SSV, the SV driver uses the steering wheel to maintain SV position in the center of the travel lane, thereby straddling the two-rail track. The SV driver must manually apply the SV brakes after impact. The SSV system is shown in Figures A6 through A8 and a detailed description can be found in the NHTSA report: NHTSA'S STRIKEABLE SURROGATE VEHICLE PRELIMINARY DESIGN + OVERVIEW, May 2013.

D. FOUNDATION BRAKE SYSTEM CHARACTERIZATION

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

This characterization was accomplished by recording longitudinal acceleration and brake pedal force and travel data for a variety of braking runs. For three initial brake characterization runs, the vehicle was driven at 45 mph, and the brakes were applied at a rate of 1 inch/sec up to the brake input level needed for at least 0.7 g. Linear regressions were performed on the data from each run to determine the linear vehicle deceleration response as a function of both applied brake pedal force and brake pedal travel. The brake input force or displacement level needed to achieve a vehicle deceleration of 0.4 g was determined from the average of the three runs. Using the 0.4 g brake input force or displacement level found from the three initial runs, subsequent runs were performed at 25 mph, 35 mph, and 45 mph, with the brakes applied at a rate of 10 inch/sec to the determined 0.4 g brake input force or displacement level. For each of the three test speeds, if the average calculated deceleration level was found to be within 0.4 ± 0.025 g, the resulting force or displacement was recorded and used. If the average calculated deceleration level exceeded this tolerance, the brake input force or displacement levels were adjusted and retested until the desired magnitude was realized. Prior to each braking event, the brake pad temperatures were required to be in the range of 149° - 212°F.

E. BRAKE CONTROL

1. Subject Vehicle programmable brake controller

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

- Constant pedal displacement. By maintaining constant actuator stroke, the position of the vehicle's brake pedal remains fixed for the duration of the input. To achieve this, the brake controller modulates application force.

- Hybrid control. Hybrid control uses position-based control to command the initial brake application rate and actuator position, then changes to force-based control to command a reduction of applied force to a predetermined force. This force is maintained until the end of the braking maneuver by allowing the brake controller to modulate actuator displacement.

2. Subject Vehicle brake parameters

- Each test run began with the brake pedal in its natural resting position, with no preload or position offset.

- The onset of the brake application was considered to occur when the brake actuator had applied 2.5 lbf (11 N) of force to the brake pedal.

- The magnitude of the brake application was that needed to produce 0.4 g deceleration, as determined in the foundation brake characterization.

- The SV brake application rate was between 9 to 11 in/s (229 to 279 mm/s), where the application rate is defined as the slope of a linear regression line applied to brake pedal position data over a range from 25% to 75% of the commanded input magnitude.

3. POV Automatic Braking System

The POV was equipped with an automatic braking system, which was used in Test Type 3. The braking system consisted of the following components:

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

- PC module programmed for control of the stroke and rate of the linear actuator.

- Switch to activate actuator.

F. INSTRUMENTATION

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

TABLE 5. TEST INSTRUMENTATION AND EQUIPMENT

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and	Omega DPG8001	17042707002	By: DRI Date: 6/21/2018 Due: 6/21/2019
Platform Scales	Vehicle Total, Wheel, and Axle Load	1200 lb/platform 5338 N/	0.5% of applied load	Intercomp SWI	1110M206352	By: DRI Date: 1/3/2019 Due: 1/3/2020
Linear (string) encoder	Throttle pedal travel	10 in 254 mm	0.1 in 2.54 mm	UniMeasure LX-EP	43020490	By: DRI Date: 5/1/2018 Due: 5/1/2019
Load Cell	Force applied to brake pedal					By: DRI
		0 - 250 lb 0 -1112 N	0.1% FS	Honeywell 41A	1464391	Date: 8/28/2018 Due: 8/28/2019
		0-250 lb 1112 N	0.05% FS	Stellar Technology PNC700	1607338	Date: 8/28/2018 Due: 8/28/2019
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 kph	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	NA

TABLE 5. TEST INSTRUMENTATION AND EQUIPMENT (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels ± 10g, Angular Rat	Accels .01g, Angular Rate	Oxford Inertial +		By: Oxford Technical Solutions
					2182	Date: 10/16/2017 Due: 10/16/2019
					2176	Date: 4/11/2018 Due: 4/11/2020
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	NA
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/2/2019 Due: 1/2/2020

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

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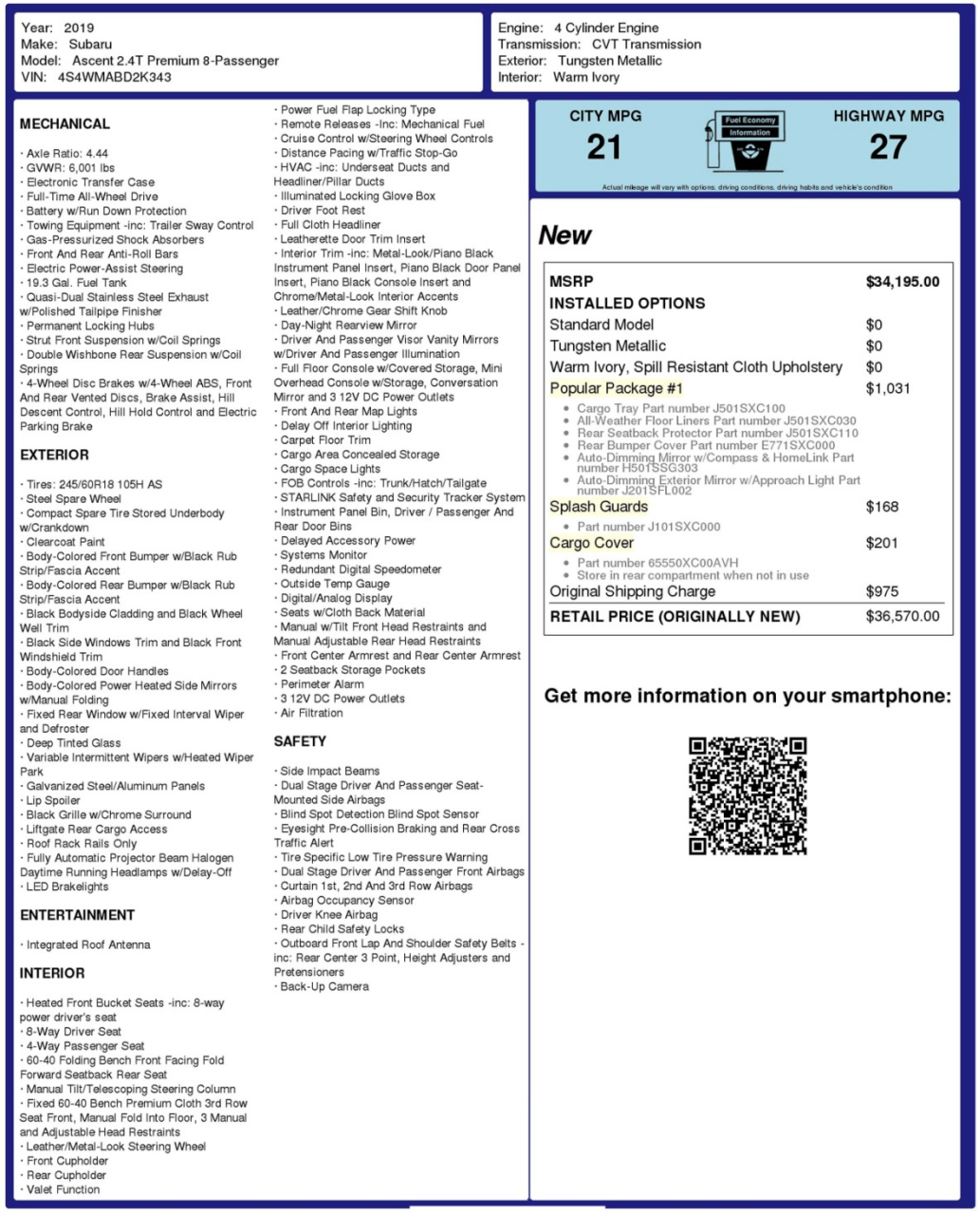
Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle



Year: 2019
Make: Subaru
Model: Ascent 2.4T Premium 8-Passenger
VIN: 4S4WMABD2K343

Engine: 4 Cylinder Engine
Transmission: CVT Transmission
Exterior: Tungsten Metallic
Interior: Warm Ivory

MECHANICAL

· Axle Ratio: 4.44
· GVWR: 6,001 lbs
· Electronic Transfer Case
· Full-Time All-Wheel Drive
· Battery w/Run Down Protection
· Towing Equipment -inc: Trailer Sway Control
· Gas-Pressurized Shock Absorbers
· Front And Rear Anti-Roll Bars
· Electric Power-Assist Steering
· 19.3 Gal. Fuel Tank
· Quasi-Dual Stainless Steel Exhaust w/Polished Tailpipe Finisher
· Permanent Locking Hubs
· Strut Front Suspension w/Coil Springs
· Double Wishbone Rear Suspension w/Coil Springs
· 4-Wheel Disc Brakes w/4-Wheel ABS, Front And Rear Vented Discs, Brake Assist, Hill Descent Control, Hill Hold Control and Electric Parking Brake

EXTERIOR

· Tires: 245/60R18 105H AS
· Steel Spare Wheel
· Compact Spare Tire Stored Underbody w/Crankdown
· Clearcoat Paint
· Body-Colored Front Bumper w/Black Rub Strip/Fascia Accent
· Body-Colored Rear Bumper w/Black Rub Strip/Fascia Accent
· Black Bodyside Cladding and Black Wheel Well Trim
· Black Side Windows Trim and Black Front Windshield Trim
· Body-Colored Door Handles
· Body-Colored Power Heated Side Mirrors w/Manual Folding
· Fixed Rear Window w/Fixed Interval Wiper and Defroster
· Deep Tinted Glass
· Variable Intermittent Wipers w/Heated Wiper Park
· Galvanized Steel/Aluminum Panels
· Lip Spoiler
· Black Grille w/Chrome Surround
· Liftgate Rear Cargo Access
· Roof Rack Rails Only
· Fully Automatic Projector Beam Halogen Daytime Running Headlamps w/Delay-Off
· LED Brakelights

ENTERTAINMENT

· Integrated Roof Antenna

INTERIOR

· Heated Front Bucket Seats -inc: 8-way power driver's seat
· 8-Way Driver Seat
· 4-Way Passenger Seat
· 60-40 Folding Bench Front Facing Fold Forward Seatback Rear Seat
· Manual Tilt/Telescoping Steering Column
· Fixed 60-40 Bench Premium Cloth 3rd Row Seat Front, Manual Fold Into Floor, 3 Manual and Adjustable Head Restraints
· Leather/Metal-Look Steering Wheel
· Front Cupholder
· Rear Cupholder
· Valet Function
· Power Fuel Flap Locking Type
· Remote Releases -Inc: Mechanical Fuel
· Cruise Control w/Steering Wheel Controls
· Distance Pacing w/Traffic Stop-Go
· HVAC -inc: Underseat Ducts and Headliner/Pillar Ducts
· Illuminated Locking Glove Box
· Driver Foot Rest
· Full Cloth Headliner
· Leatherette Door Trim Insert
· Interior Trim -inc: Metal-Look/Piano Black Instrument Panel Insert, Piano Black Door Panel Insert, Piano Black Console Insert and Chrome/Metal-Look Interior Accents
· Leather/Chrome Gear Shift Knob
· Day-Night Rearview Mirror
· Driver And Passenger Visor Vanity Mirrors w/Driver And Passenger Illumination
· Full Floor Console w/Covered Storage, Mini Overhead Console w/Storage, Conversation Mirror and 3 12V DC Power Outlets
· Front And Rear Map Lights
· Delay Off Interior Lighting
· Carpet Floor Trim
· Cargo Area Concealed Storage
· Cargo Space Lights
· FOB Controls -inc: Trunk/Hatch/Tailgate
· STARLINK Safety and Security Tracker System
· Instrument Panel Bin, Driver / Passenger And Rear Door Bins
· Delayed Accessory Power
· Systems Monitor
· Redundant Digital Speedometer
· Outside Temp Gauge
· Digital/Analog Display
· Seats w/Cloth Back Material
· Manual w/Tilt Front Head Restraints and Manual Adjustable Rear Head Restraints
· Front Center Armrest and Rear Center Armrest
· 2 Seatback Storage Pockets
· Perimeter Alarm
· 3 12V DC Power Outlets
· Air Filtration

SAFETY

· Side Impact Beams
· Dual Stage Driver And Passenger Seat-Mounted Side Airbags
· Blind Spot Detection Blind Spot Sensor
· Eyesight Pre-Collision Braking and Rear Cross Traffic Alert
· Tire Specific Low Tire Pressure Warning
· Dual Stage Driver And Passenger Front Airbags
· Curtain 1st, 2nd And 3rd Row Airbags
· Airbag Occupancy Sensor
· Driver Knee Airbag
· Rear Child Safety Locks
· Outboard Front Lap And Shoulder Safety Belts -inc: Rear Center 3 Point, Height Adjusters and Pretensioners
· Back-Up Camera

CITY MPG **21**

Fuel Economy Information

HIGHWAY MPG **27**

Actual mileage will vary with options, driving conditions, driving habits and vehicle's condition

New

MSRP	**$34,195.00**
INSTALLED OPTIONS	
Standard Model	$0
Tungsten Metallic	$0
Warm Ivory, Spill Resistant Cloth Upholstery	$0
Popular Package #1	$1,031
• Cargo Tray Part number J501SXC100 • All-Weather Floor Liners Part number J501SXC030 • Rear Seatback Protector Part number J501SXC110 • Rear Bumper Cover Part number E771SXC000 • Auto-Dimming Mirror w/Compass & HomeLink Part number H501SSG303 • Auto-Dimming Exterior Mirror w/Approach Light Part number J201SFL002	
Splash Guards	$168
• Part number J101SXC000	
Cargo Cover	$201
• Part number 65550XC00AVH • Store in rear compartment when not in use	
Original Shipping Charge	$975
RETAIL PRICE (ORIGINALLY NEW)	$36,570.00

Get more information on your smartphone:

Figure A3. Window Sticker (Monroney Label)

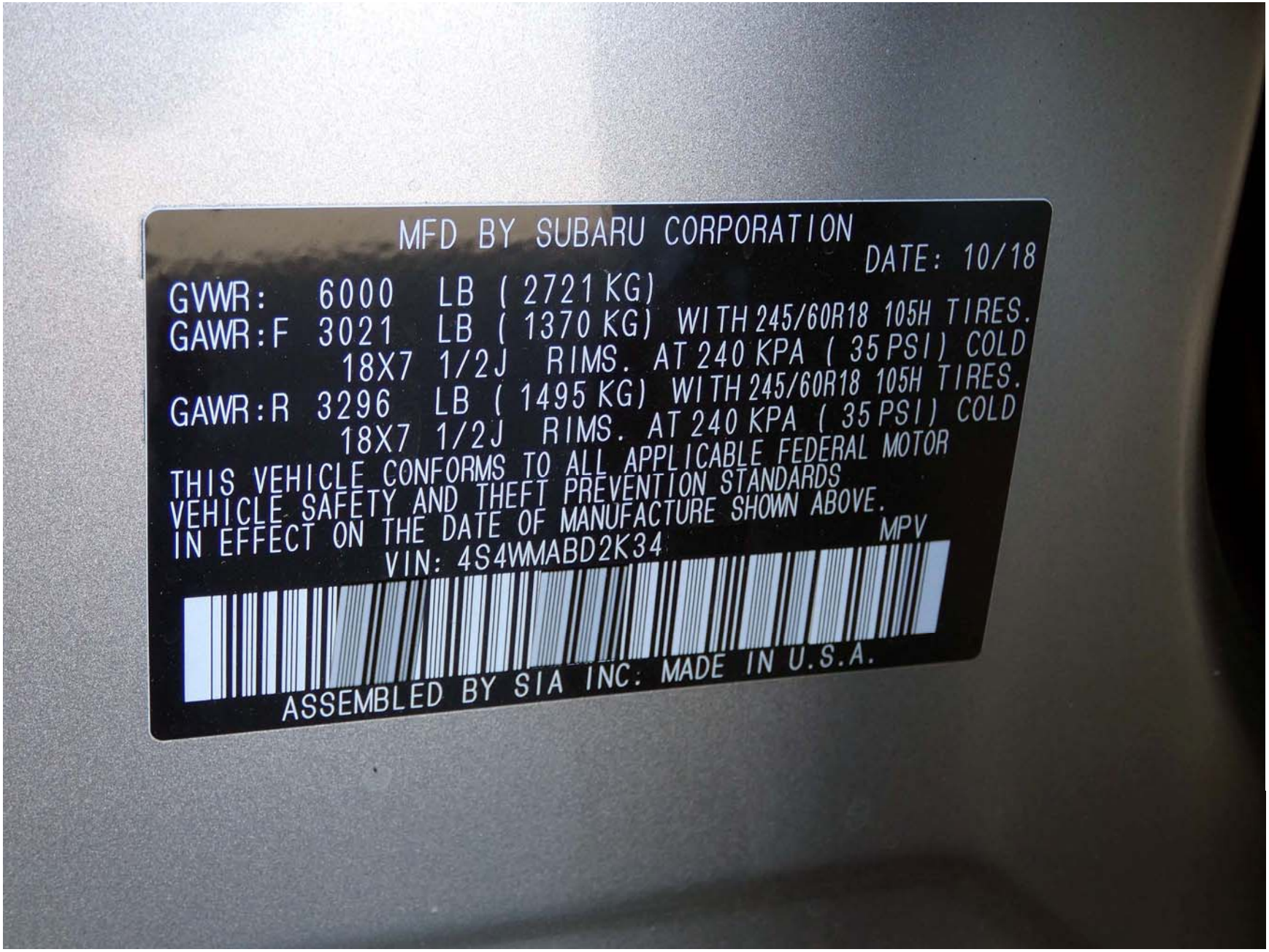


Figure A4. Vehicle Certification Label

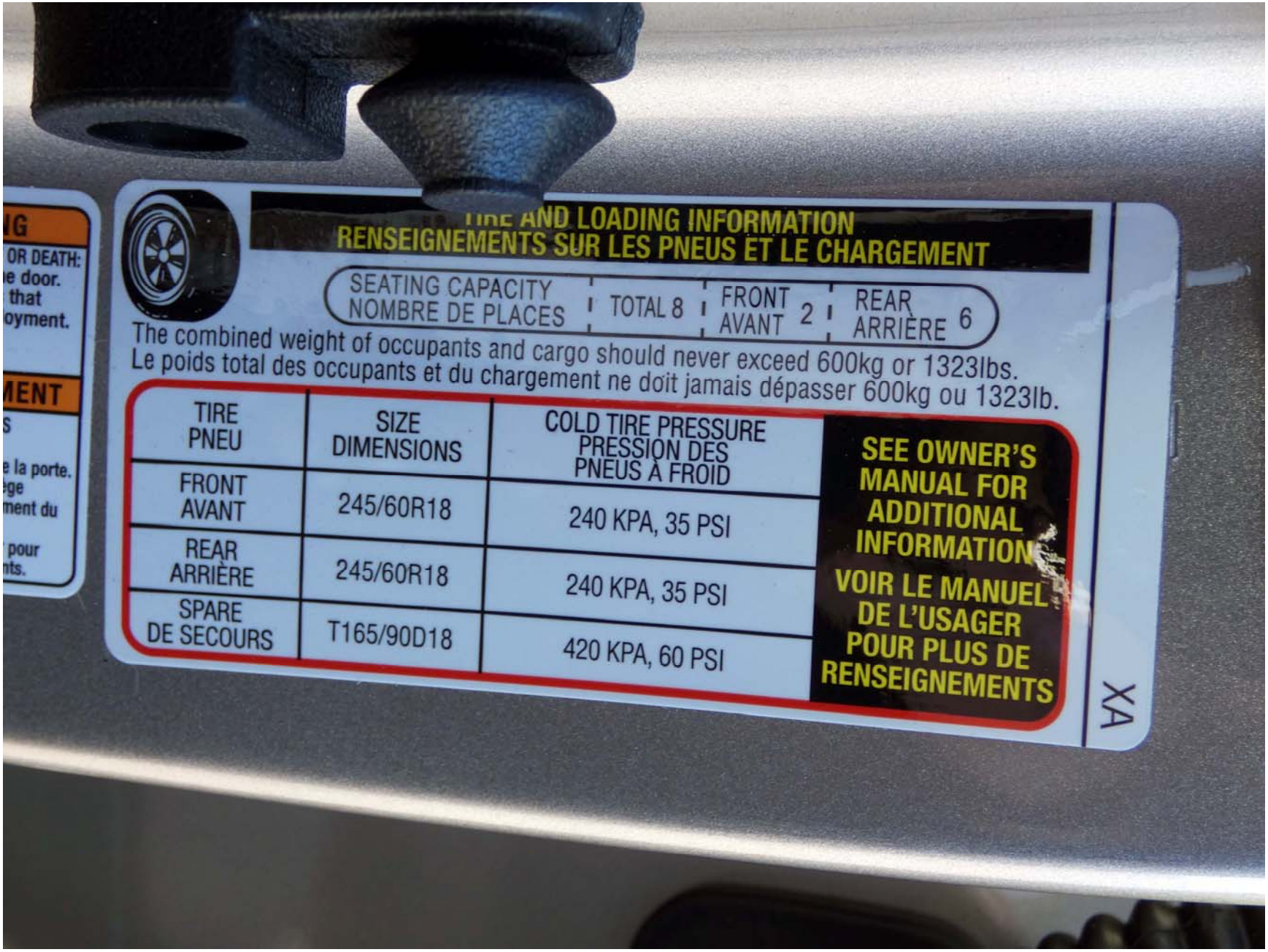


Figure A5. Tire Placard

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

Figure A7. Load Frame/Slider of SSV

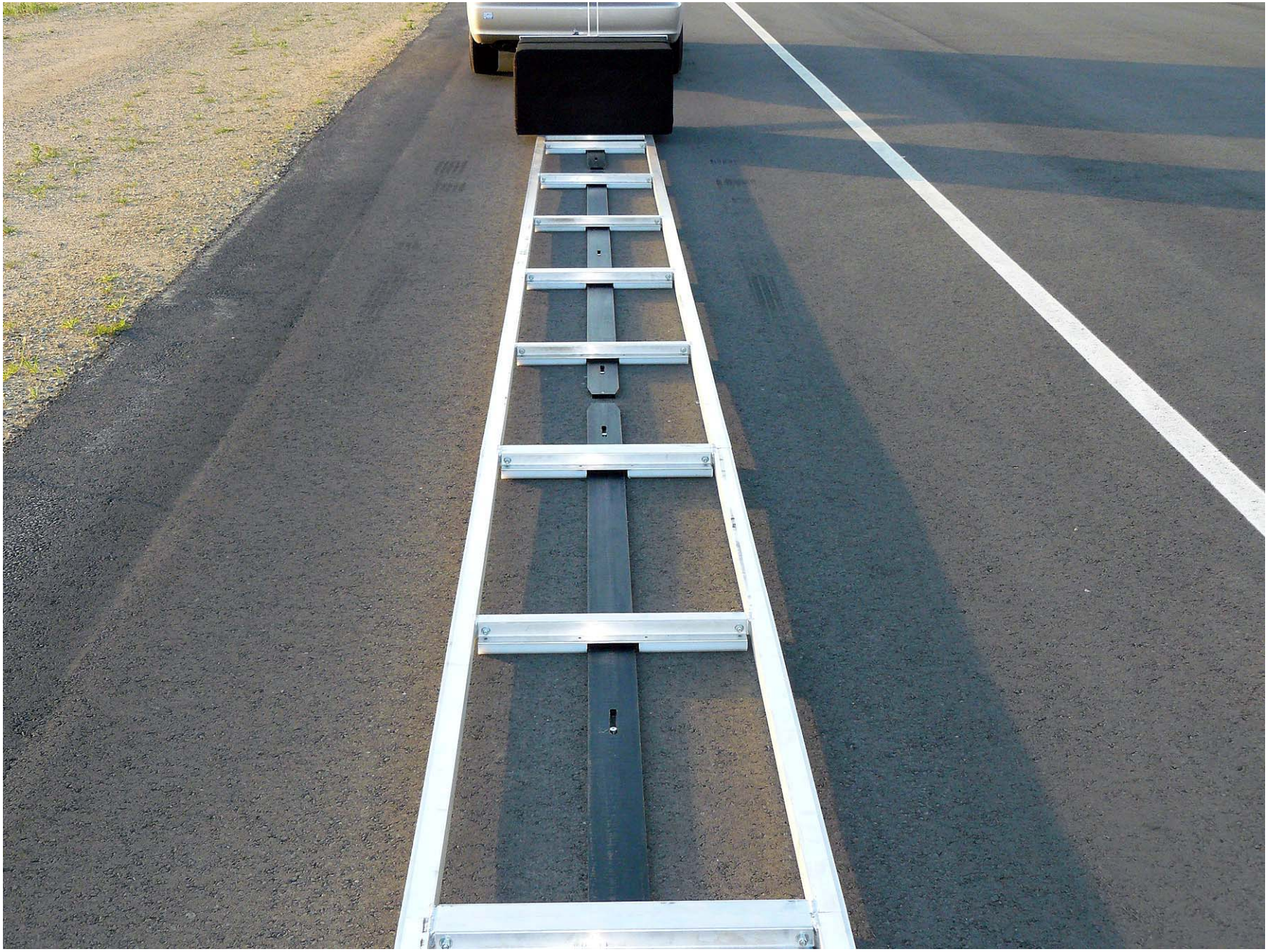


Figure A8. Two-Rail Track and Road-Based Lateral Restraint Track

Figure A9. Steel Trench Plate

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

Figure A11. Sensor for Detecting Auditory Alerts

Figure A12. Sensor for Detecting Visual Alerts

Figure A13. Computer and Brake Actuator Installed in Subject Vehicle

Figure A14. Brake Actuator Installed in POV System

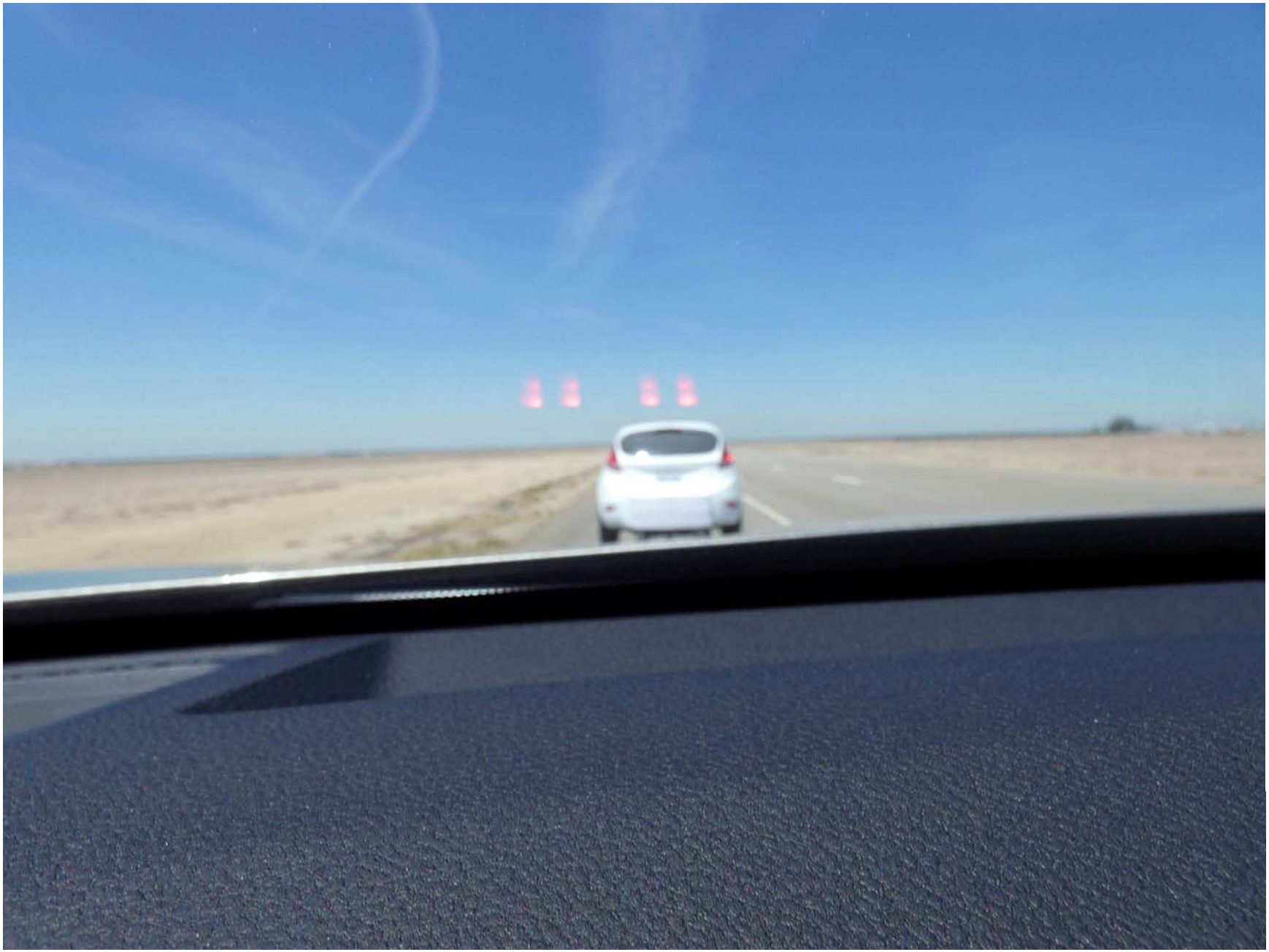


Figure A15. AEB Heads-Up Visual Alert

Figure A16. AEB Instrument Panel Visual Alert

Figure A17. AEB Off Indicator Light

Figure A18. AEB On/Off Switch

APPENDIX B

Excerpts from Owner's Manual

EyeSight Functions

EyeSight includes the following functions.

■Pre-Collision Braking System

This function uses a following distance warning feature to warn the driver to take evasive action when there is the possibility of a collision with a vehicle or obstacle in front of you. If the driver does not take evasive action, the brakes are applied automatically to help reduce vehicle collision damage or, if possible, help prevent a collision.
⇒ Refer to page 25.

■Adaptive Cruise Control

This function maintains the set vehicle speed and when there is a vehicle in front in the same traffic lane, it follows the speed of the vehicle in front up to the maximum of the set vehicle speed.
⇒ Refer to page 40.

■Lane Keep Assist

This function helps suppress lane drifting by detecting lane markings (e.g., white lines) on highways and roads, and by assisting steering operation.
⇒ Refer to page 70.

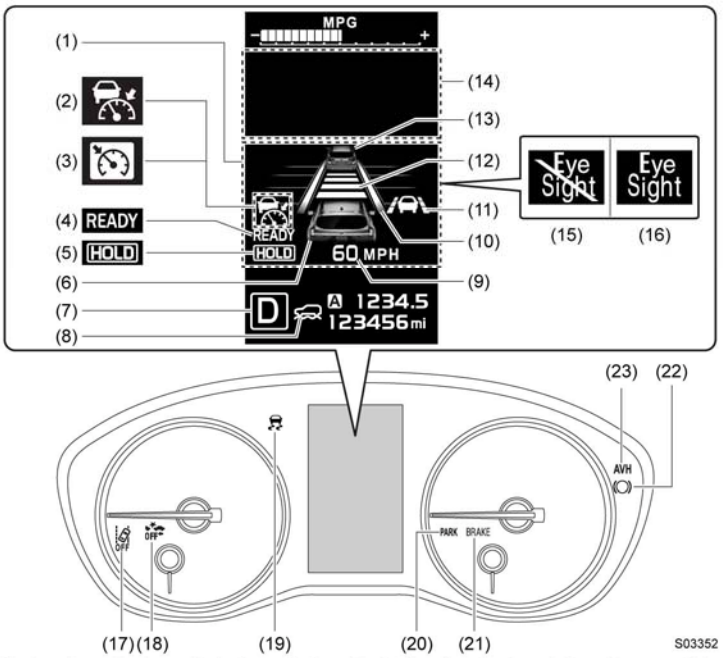
■Pre-Collision Throttle Management

This function reduces accidental forward movement caused by the select lever being placed in the wrong position or the accelerator pedal being accidentally depressed, or depressed too strongly.
⇒ Refer to page 81.

■Lane Departure Warning

This function warns the driver when the vehicle is about to drift off the road.
⇒ Refer to page 88.

Instrument panel display layout



* Display units can be changed in the Screen Settings. For details, refer to the Owner's Manual for your vehicle.

(1) EyeSight display area
(2) Adaptive Cruise Control indicator
(3) Conventional Cruise Control indicator
(4) READY indicator
(5) HOLD indicator
(6) Your vehicle indicator
(7) Select lever/gear position indicator
(8) X-MODE indicator light
(9) Set vehicle speed display
(10) Lane indicator
(11) Lane Keep Assist indicator
(12) Following distance setting indicator
(13) Lead vehicle indicator
(14) Warning screen area
(15) EyeSight temporary stop indicator (White)
(16) EyeSight warning indicator (Yellow)
(17) Lane Departure Warning OFF indicator light
(18) Pre-Collision Braking System OFF indicator light
(19) Vehicle Dynamics Control warning light
(20) Electronic parking brake indicator light
(21) Brake system warning light
(22) Auto Vehicle Hold ON indicator light
(23) Auto Vehicle Hold operation indicator light

■Select lever/gear position indicator

This indicator illuminates and shows which position the select lever or the gear is in.

■EyeSight warning indicator (yellow)

- This indicator illuminates or flashes when a malfunction occurs in the EyeSight system.
- When it is illuminated or flashing, none of the EyeSight functions can be used (including Adaptive Cruise Control and the Pre-Collision Braking System, etc.).

⇒ Refer to page 112.

■EyeSight temporary stop indicator (white)

- This indicator illuminates when the EyeSight system is temporarily stopped.
- When the ignition switch is placed in the ON position, it will illuminate if the (CRUISE) switch or (Lane Keep Assist) switch is set to ON within approximately 7 seconds of the engine starting. It turns off when approximately 7 seconds have elapsed since the engine started.
- When it is illuminated, none of the EyeSight functions can be used except for Conventional Cruise Control.

⇒ Refer to page 114.

■X-MODE indicator light

(X-MODE indicator light) illuminates when the X-MODE is ON.

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

■Lane Departure Warning OFF indicator light

- This indicator illuminates when the Lane Departure Warning and Lane Sway Warning are off.
- It also illuminates when the ignition switch is turned to the ON position. Approximately 7 seconds after the engine starts, the Lane Departure Warning OFF indicator light will turn off or remain illuminated depending on the current status (ON or OFF).

⇒ Refer to page 91.

■ Pre-Collision Braking System OFF indicator light

- Illuminates when the Pre-Collision Braking System and Pre-Collision Throttle Management are off.
- It also illuminates when the ignition switch is turned to the ON position, and then turns off approximately 7 seconds after the engine starts.

⇒ Refer to page 39.

■ Lane indicator

This indicator illuminates in gray when the (Lane Keep Assist) switch is pressed. When the Lane Keep Assist is operational or operating, this indicator illuminates in white.

⇒ Refer to page 76.

■ Brake System warning light

If the brake warning light illuminates when the electronic parking brake is released while driving, turn the Pre-Collision Braking System off. At this time, do not use the Conventional Cruise Control mode or Adaptive Cruise Control mode.

If the brake warning light does not turn off, immediately pull the vehicle over to a safe location. Contact a SUBARU dealer to have the system inspected.

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

■ Electronic parking brake indicator light

This indicator light illuminates when the electronic parking brake is applied.

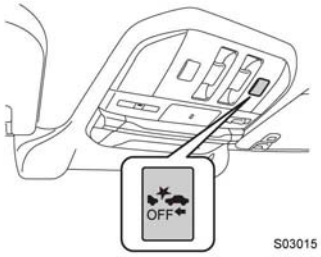
⇒ Refer to the vehicle Owner's Manual for details.

■ Your vehicle indicator

When the brake pedal is depressed or the brake control function is activated, the brake indicator light illuminates in red.

■ (Pre-Collision Braking System OFF) switch

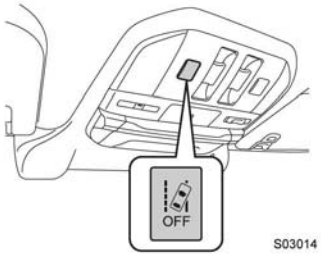
Press and hold this switch for approximately 2 seconds or longer to turn off the Pre-Collision Braking System and Pre-Collision Throttle Management.
When these functions are off, the Pre-Collision Braking System OFF indicator light on the instrument panel illuminates.
Press and hold the switch again to turn on the Pre-Collision Braking System and Pre-Collision Throttle Management. This turns off the Pre-Collision Braking System OFF indicator light.
⇒ Refer to page 38.



S03015

■ (Lane Departure Warning OFF) switch

Press and hold this switch for approximately 2 seconds or longer to turn off the Lane Departure Warning and Lane Sway Warning functions.
When these functions are off, the Lane Departure Warning OFF indicator light on the instrument panel illuminates.
Press and hold the switch again to turn on the Lane Departure Warning and Lane Sway Warning functions. This turns off the Lane Departure Warning OFF indicator light.
⇒ Refer to page 90.



S03014

Pre-Collision Braking System

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

⚠ WARNING

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

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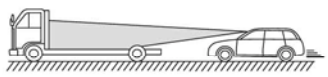
- When the difference in speed with the obstacle in front is the following figure*1 or more, it may not be possible to avoid a collision. Even if the speed difference is the following figure*1 or less, in cases such as when another vehicle cuts in front of you, or in other cases depending on visibility,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

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

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

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

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



S02133

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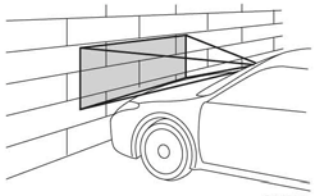
- With non-standard shaped vehicles (vehicle transporters or vehicles with a sidecar fitted, etc.)
- When the height of the vehicle is low, etc.

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


S00653

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

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

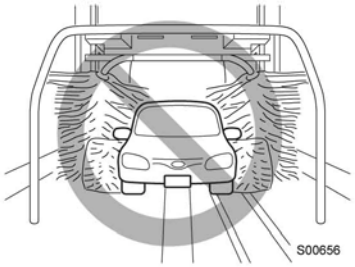
*1: The wheels and tires have functions that are critically important. Be sure to use the correct ones. For details, refer to the Owner's Manual for your vehicle.

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

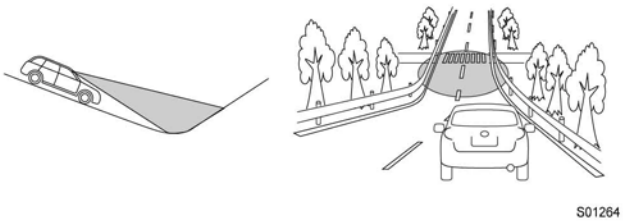
*3: For details about the combination meter, refer to the Owner's Manual for your vehicle.

CAUTION

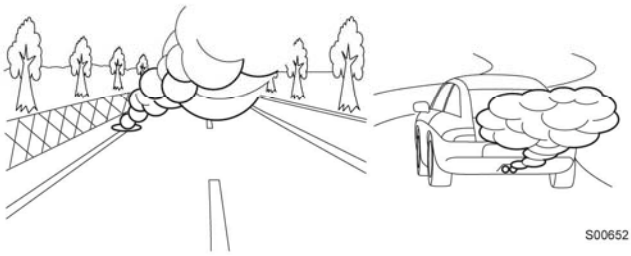
- In the following situations, turn off the Pre-Collision Braking System. Otherwise the Pre-Collision Braking System may activate unexpectedly.
  - When the vehicle is being towed
  - When loading the vehicle onto a carrier
  - When a chassis dynamometer, free-rollers or similar equipment is used
  - When a mechanic lifts up the vehicle, starts the engine and spins the wheels freely
  - When passing hanging banners, flags or branches, or when thick/tall vegetation is contacting the vehicle
  - When driving on a race track
  - When using a drive-through car wash



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

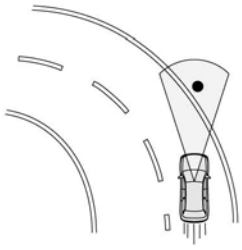


- When visibility is poor due to sand, smoke or water vapor blowing in the wind, or when the front vision is obscured due to water splashes, snow, dirt or dust stir up generated by the vehicle in front or oncoming traffic
- When passing through clouds of steam or smoke, etc.
- When driving in adverse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



S00652

- When there is an obstacle on a curve or intersection
- When narrowly passing a vehicle or an object
- When stopping very close to a wall or a vehicle in front
- When passing through water spray from road sprinklers or snow clearing sprinklers on the road.



S02669

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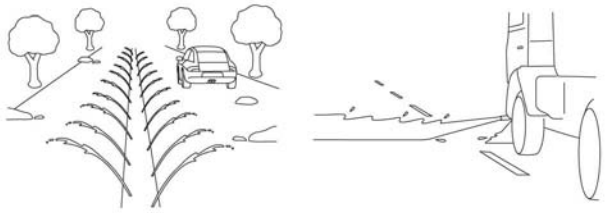


S02636

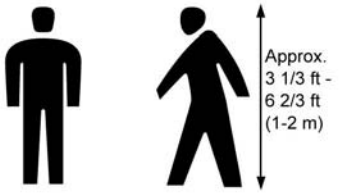
- If there is cargo or installed accessories, etc. that are protruding beyond the edge of the front bumper, the vehicle's length will increase and the system may not be able to prevent a collision.
- If the driver operates the brake pedal during automatic braking, the pedal may feel stiff; however, this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

NOTE

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

■ Detection of pedestrians

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



S02846

⚠ WARNING

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

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

Pre-Collision Braking System operation

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

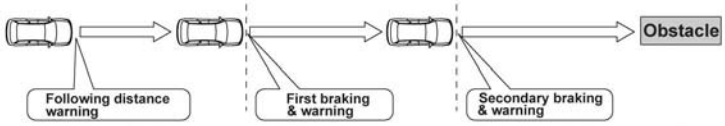
Following Distance Warning:
When the system determines that there is a risk of collision, a buzzer sounds repeated short beeps and the indicators on the combination meter display illuminate to warn the driver.
The Following Distance Warning operates when Adaptive Cruise Control is not set.
When the driver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

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

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

<Apply Brake message>
Even after the vehicle has stopped, depress the brake pedal. Until the brake pedal is depressed, a message appears and stays in the warning screen area of the combination meter display for approximately 2 minutes. A single continuous beep sounds while the message is displayed.

S02962



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

S03354

NOTE

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

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

Pre-Collision Braking Assist operation

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

CAUTION

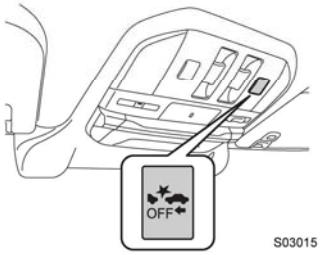
If the driver depresses the brake pedal while following distance warning is activated, the Pre-Collision Braking Assist will not work. The vehicle decelerates with the normal braking force operated by the driver.

NOTE

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

Turning off the Pre-Collision Braking System

Press and hold the Pre-Collision Braking System OFF switch for approximately 2 seconds or longer to turn off the Pre-Collision Braking System (including Pre-Collision Braking Assist). When 1 short beep sound emits, this control is turned off and the Pre-Collision Braking System OFF indicator light on the instrument panel illuminates.
To turn the control back on, press and hold the Pre-Collision Braking System OFF switch for approximately 2 seconds or longer again. When this control is turned on, the Pre-Collision Braking System OFF indicator light turns off.



S03015

NOTE

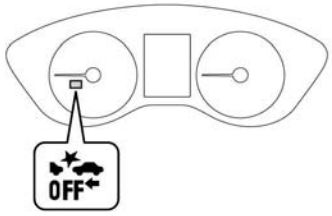
- When the Pre-Collision Braking System is turned off, the Pre-Collision Throttle Management Control function is also turned off.
- Even when the Pre-Collision Braking System is turned off, if the ignition switch is turned off and the engine is then restarted, the Pre-Collision Braking System will be turned on. The system default setting when the vehicle is restarted in “ON”.

■ Pre-Collision Braking System OFF indicator light

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

It also illuminates under the following conditions.

- When the EyeSight system has a malfunction.
  ⇒ Refer to page 112.
- When the EyeSight system has stopped temporarily.
  ⇒ Refer to page 114.



S02407

NOTE

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

NOTE

- If the EyeSight operation has temporarily stopped, the Pre-Collision Braking System OFF indicator light and Lane Departure Warning OFF indicator light illuminate, and the EyeSight temporary stop indicator is displayed on the combination meter display.
  ⇒ Refer to page 114.
- If EyeSight is malfunctioning, the EyeSight warning indicator is displayed on the combination meter display, and the Pre-Collision Braking System OFF indicator light and Lane Departure Warning OFF indicator light will also illuminate. If this occurs, stop the vehicle in a safe location and then turn off the engine and restart it. If the indicators remain illuminated after restarting the engine, Adaptive Cruise Control cannot be used. This will not interfere with ordinary driving; however the system should be inspected by a SUBARU dealer as soon as possible.
  ⇒ Refer to page 112.
- When the operation of Adaptive Cruise Control has been automatically canceled, perform the Adaptive Cruise Control setting operation again after the condition that caused the cancellation has been corrected. If the Adaptive Cruise Control function cannot be activated even after the condition has been corrected, EyeSight may be malfunctioning. This will not interfere with ordinary driving; however contact a SUBARU dealer and have the system inspected.

List of buzzer sounds

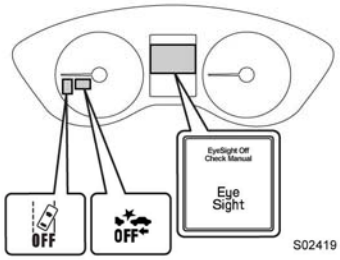
Buzzer sound	Status	Reference page
Single continuous beep	Pre-Collision Braking System: Secondary Braking is active.	⇒Refer to page 34.
1 short beep and 1 long beep	Adaptive Cruise Control or Conventional Cruise Control is canceled automatically.	⇒Refer to pages 64 and 107.
	The stay-stopped function is canceled and the electronic parking brake is automatically applied.	⇒Refer to page 64.
	Lane Keep Assist is canceled automatically.	⇒Refer to page 79.
Repeated short beeps	Pre-Collision Braking System: First Braking is active.	⇒Refer to page 34.
	Pre-Collision Braking System: The following distance warning is active.	
	The "Obstacle Detected" warning from Adaptive Cruise Control is active.	⇒Refer to page 68.
	Pre-Collision Throttle Management is active.	⇒Refer to page 81.
3 short beeps	The Lane Departure Warning is active.	⇒Refer to page 88.
	The Lane Sway Warning is active.	⇒Refer to page 92.
1 short beep	Either of the following occurred while Adaptive Cruise Control was set. - A vehicle in front is detected*. - A vehicle in front is no longer detected*.	⇒Refer to page 51.
	The cruise control mode (Adaptive Cruise Control ⟷ Conventional Cruise Control) is changed.	⇒Refer to pages 102 and 104.
	EyeSight is malfunctioning.	⇒Refer to pages 112 and 114.
	EyeSight operation is temporarily stopped.	
	Pre-Collision Braking System and Pre-Collision Throttle Management are turned on/off.	⇒Refer to pages 38 and 87.
	The Lane Departure Warning and the Lane Sway Warning are turned on/off.	⇒Refer to pages 90 and 94.

EyeSight malfunction and temporary stop

If a malfunction is detected in the EyeSight system, the indicators in the instrument panel and the combination meter display inform the driver of the malfunction. Check the displayed contents and take the appropriate action.

■Malfunction (including position/angle misalignment of stereo camera)

The buzzer sounds 1 short beep and the EyeSight warning indicator (yellow) flashes or illuminates. At the same time, the Pre-Collision Braking System OFF indicator light and the Lane Departure Warning OFF indicator light will illuminate. A message will also be displayed on the combination meter display.



S02419

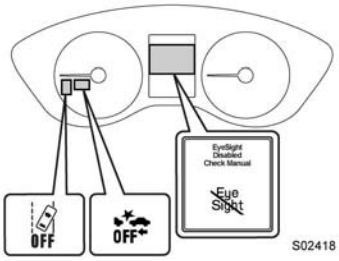
Displayed screen	Cause	Action
EyeSight Off Check Manual S03005	An EyeSight malfunction or position/angle misalignment of stereo camera has occurred.	Inspection and adjustment is necessary. Contact your SUBARU dealer.

CAUTION

If both the EyeSight warning indicator and the CHECK ENGINE warning light/malfunction indicator light illuminate at the same time while driving, have your vehicle checked/repaired by a SUBARU dealer as soon as possible. EyeSight cannot be used if there is an abnormality with the engine, etc.

■Temporary stop

The buzzer will sound one short beep, and the EyeSight temporary stop indicator (white), Pre-Collision Braking System OFF indicator light and Lane Departure Warning OFF indicator light will illuminate at the same time.
A message will also be displayed on the combination meter display.
When the cause has been resolved, temporary stop will be canceled and the EyeSight system will automatically restart.



S02418

Displayed screen	Cause	Action
EyeSight Disabled No Camera View S02996	It is difficult for the stereo camera to detect objects in front • The windshield is dirty or fogged up • Poor weather conditions • Strong light from the front	• Clean the windshield. • In poor weather conditions or if there is strong light from the front, the EyeSight system will restart once you have driven your vehicle for a period of time and the conditions affecting the system have improved. If the system does not restart, even after the conditions have improved and a period of time has elapsed, contact your SUBARU dealer for an inspection.
EyeSight Disabled Temp Range S02997	In low or high temperatures	The system will restart once the temperature is within the operational range of the EyeSight system. If the system does not restart, even when the temperature inside the vehicle is within the operational range, contact your SUBARU dealer for an inspection.

Displayed screen	Cause	Action
	• The EyeSight system is starting up. • The system has determined that the vehicle is extremely inclined. • The Pre-Collision secondary braking has operated 3 times after the engine was started. • The engine has stopped. • The electronic power steering system is in the overheating prevention status because the steering wheel has been operated while the vehicle is at a standstill or driving at an extremely slow speed. • The EyeSight system judged a different value due to the removal or installation of the steering wheel. • The wheels are out of balance. • The wheels are out of alignment.	The system will restart once the cause has been eliminated. At this time, it may take some time for the system to restart. If the system does not restart, even after the conditions have improved and a period of time has elapsed, contact your SUBARU dealer for an inspection.

NOTE

- When the EyeSight temporary stop indicator is illuminated, no EyeSight functions can be used except for Conventional Cruise Control.
- When the EyeSight temporary stop indicator is illuminated, the RAB system may not operate (models equipped with RAB).

●EyeSight Assist Monitor (only equipped models)

The ON/OFF operation assigned to each EyeSight Assist Monitor LED indicator can be set for color.

Display	Condition
Red indicators flashing simultaneously (4 indicators)	The Following Distance Warning, Pre-Collision Braking System (first braking or secondary braking), Brake More Warning or Pre-Collision Throttle Management is operating.
Yellow indicator flashes (one side)	The Lane Departure Warning (The side where the vehicle has left its lane flashes, and the side that has not left its lane illuminates.) is operating.
Yellow indicators flashing (alternately)	Lane Sway Warning is operating.
Yellow indicators illuminate simultaneously	Steering wheel operation could not be detected for a certain period of time.
Green indicator illuminates	A vehicle is detected ahead while Adaptive Cruise Control is operating.

●The Cruise Control Acceleration Characteristics of the Adaptive Cruise Control system can be set to one of four levels.

Lv. 4 (Dynamic): Mode used when powerful acceleration is required.

Lv. 3 (Standard): Mode used when performing frequent following, with a following function that focuses on the speed of the vehicle ahead.

Lv. 2 (Comfort): Mode used when performing following with smooth movement.

Lv. 1 (Eco): Mode that focuses on fuel economy over following the vehicle ahead, it is used when performing following with smooth movement.

NOTE

When “Return” is selected, the system will return to the screen 1 level above the current one.

●Canceling the custom functions

In the following cases, the custom functions will be canceled and the “Change settings” screen will be displayed.

- When you pull and hold the i (Info)/SET switch toward you
- When the engine is turned off
- When the switch is not operated for approximately 30 seconds

■Message screen list (precautions and notices)

Item	Displayed screen	ℹ mark	Reference page
Pre-Collision Braking System		None	⇒Refer to page 34.
The “Obstacle Detected” warning	 S02999	None	⇒Refer to page 68.
Pre-Collision Throttle Management		None	⇒Refer to page 81.
Apply Brake	 S03000	None	⇒Refer to page 34.
Lane Departure Warning	 S03002	None	⇒Refer to page 88.
Lane Sway Warning	 S03003	None	⇒Refer to page 92.
Lead vehicle Start alert	 S03004	None	⇒Refer to page 95.
Steering operation is not detected by Lane Keep Assist	 S03001	None	⇒Refer to page 80.
Adaptive Cruise Control/Conventional Cruise Control automatic cancellation (when the grade of the road is very steep)	 S02425	None	⇒Refer to pages 64 and 107.

APPENDIX C

Run Log

Subject Vehicle: **2019 Subaru Ascent** Test Date: 4/23/2019

Principal Other Vehicle: SSV

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
1-13	**Brake characterization and confirmation**						See Appendix D
14	Static Run						
15	**Stopped POV**	N					Brake Force Onset
16		Y	2.89	14.53	1.01	Pass	
17		Y	2.87	15.81	1.02	Pass	
18		Y	2.88	14.72	1.02	Pass	
19		Y	2.89	15.68	1.02	Pass	
20		Y	2.97	13.10	1.01	Pass	
21		Y	2.89	12.78	1.02	Pass	
22		Y	2.91	12.98	1.00	Pass	
23	Static Run						
24	**Slower POV, 25 vs 10**	Y	2.51	8.51	0.82	Pass	
25		Y	2.51	6.28	0.69	Pass	
26		Y	2.51	6.79	0.72	Pass	
27		Y	2.47	5.80	0.66	Pass	
28		Y	2.59	6.31	0.74	Pass	

Subject Vehicle: **2019 Subaru Ascent** Test Date: 4/23/2019

Principal Other Vehicle: SSV

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
29		Y	2.54	7.52	0.76	Pass	
30		Y	2.50	6.92	0.73	Pass	
31	Static run						
32	Static run						
33	**Slower POV, 45 vs 20**	Y	3.23	8.71	0.96	Pass	
34		Y	2.90	13.54	0.99	Pass	
35		N					Brake Onset
36		Y	3.51	10.49	0.96	Pass	
37		N					Brake Onset
38		Y	3.20	11.42	0.97	Pass	
39		Y	3.11	9.50	0.97	Pass	
40	Static run						
41	**Braking POV, 35**	N					POV Braking Late
42		Y	1.88	6.47	0.58	Pass	
43		N					POV Speed

Subject Vehicle: **2019 Subaru Ascent** Test Date: 4/23/2019

Principal Other Vehicle: SSV

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
44		Y	1.74	6.48	0.55	Pass	
45		N					Throttle, Early Braking
46		Y	2.03	6.83	0.96	Pass	
47		Y	2.01	4.51	0.56	Pass	
48		Y	2.02	7.14	0.95	Pass	
49		N					Brake Force Onset
50		N					Brake Force Onset
51		Y	1.97	6.68	0.98	Pass	
52		Y	1.91	6.49	0.80	Pass	
53		N					Early Brake Force
54	Static run						
55	STP - Static run						
56	**Baseline, 25**	Y			0.42		
57		Y			0.43		
58		Y			0.42		
59		Y			0.42		
60		Y			0.42		
61		Y			0.41		
62		Y			0.43		

Subject Vehicle: **2019 Subaru Ascent** Test Date: 4/23/2019

Principal Other Vehicle: SSV

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
63	STP - Static run						
64	**Baseline, 45**	Y			0.41		
65		Y			0.42		
66		Y			0.44		
67		Y			0.46		
68		Y			0.44		
69		Y			0.45		
70		Y			0.44		
71	STP - Static run						
72	**STP False Positive, 25**	N					Low Braking
73		Y			0.42	Pass	
74		N					Low Braking
75		Y			0.41	Pass	
76		Y			0.40	Pass	
77		Y			0.42	Pass	
78		Y			0.41	Pass	
79		N					Throttle Drop

Subject Vehicle: **2019 Subaru Ascent** Test Date: 4/23/2019

Principal Other Vehicle: SSV

Run	Test Type	Valid Run?	FCW TTC (s)	Minimum Distance (ft)	Peak Deceleration (g)	Pass/Fail	Notes
80		N					Low Braking
81		N					High Braking
82		Y			0.43	Pass	
83	STP - Static run						
84	**STP False Positive, 45**	Y			0.40	Pass	
85		Y			0.42	Pass	
86		N					Throttle Drop
87		N					Brake force
88		Y			0.41	Pass	
89		Y			0.43	Pass	
90		Y			0.42	Pass	
91		Y			0.42	Pass	
92		Y			0.44	Pass	
93	STP - Static run						

APPENDIX D

Brake Characterization

Subject Vehicle: **2019 Subaru Ascent** Test Date: 4/23/2019

DBS Initial Brake Characterization				
Run Number	**Stroke at 0.4 g (in)**	**Force at 0.4 g (lb)**	**Slope**	**Intercept**
1	3.896498	18.2282	0.351933	0.750289
2	4.179411	18.4718	0.356926	0.732721
3	3.987021	20.94731	0.359603	0.705803

DBS Brake Characterization Confirmation								
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	0.482	4.02		3.34	Decel High
5			Y	0.387	3.50		3.62	
6		25	Y	0.404	3.50		3.47	
7		45	Y	0.397	3.50		3.53	
8	**Hybrid**	35	N	0.431	3.50	18.00	16.71	Decel High
9			Y	0.422	3.50	17.00	16.11	
10		25	Y	0.416	3.50	17.00	16.35	
11		45	N	0.447	3.50	17.00	15.21	Decel High
12			N	0.454	3.50	16.50	14.54	Decel High
13			Y	0.413	3.50	15.50	15.01	

Appendix E

TIME HISTORY PLOTS

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

Time history figures include the following sub-plots:

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

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

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

- SV/POV Speed (mph) – Speed of the Subject Vehicle and the Principal Other Vehicle (if any). For DBS tests, in the case of an impact, the speed reduction experienced by the Subject Vehicle up until the moment of impact is displayed to the right of the subplot.

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

- Lateral Offset (ft) – Lateral offset within the lane of the Subject Vehicle to the center of the lane of travel. Note that for tests involving the Strikeable Surrogate Vehicle (SSV), the associated lateral restraint track is defined to be the center of the lane of travel. If testing is done with a different POV which does not have a lateral restraint track, lateral offset is defined to be the lateral offset between the SV and POV.

- Ax (g) – Longitudinal acceleration of the Subject Vehicle and Principal Other Vehicle (if any). The peak value of Ax for the SV is shown on the subplot.

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

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

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

Envelopes and Thresholds

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

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

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

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

For the Ax plot, if the scenario is an AEB brake to stop scenario, a vertical dashed black line is displayed for all plots indicating the moment of first POV braking. The yellow envelope in this case is relevant to the POV braking only. The left edge of the envelope is at 1.5 seconds after the first POV braking. A solid black threshold line extends horizontally 0.5 seconds to the left of the envelope. This threshold line represents the time during which the Ax of the Principal Other Vehicle must first achieve 0.27g (the upper edge of the envelope, i.e., 0.30 g ± 0.03 g). A green circle or red asterisk is displayed at the moment the POV brake level achieves 0.27g. A green circle indicates that the test was valid (the threshold was crossed during the appropriate interval) and a red asterisk indicates that the test was invalid (the threshold was crossed out of the appropriate interval).

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

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. The yellow envelope in this case is used only to visualize the target average brake force necessary for the test 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
   - 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

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

Time history data plots for the tests of the vehicle under consideration herein are provided beginning with Figure E13.

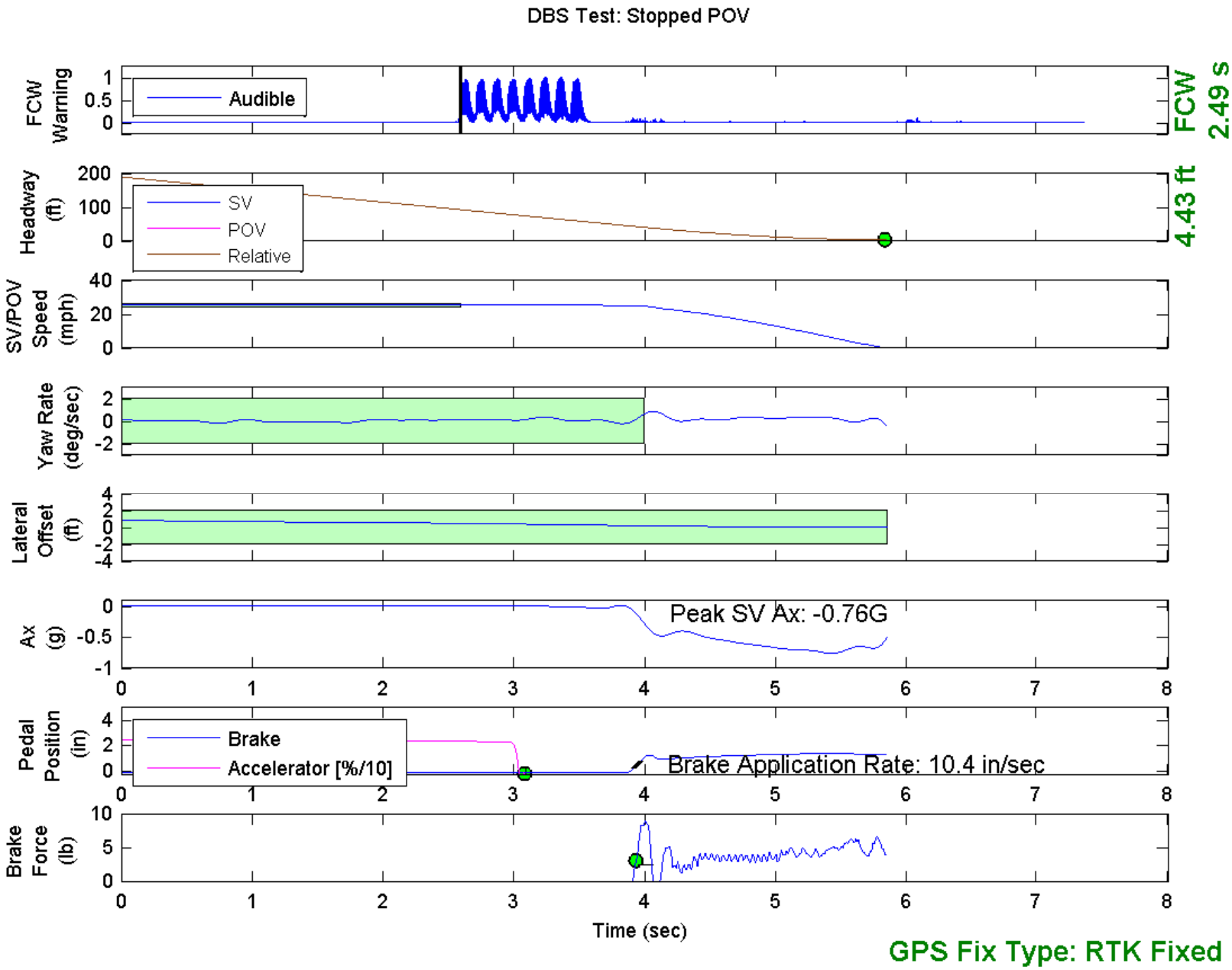

Figure E1. Example Time History for Stopped POV, Passing

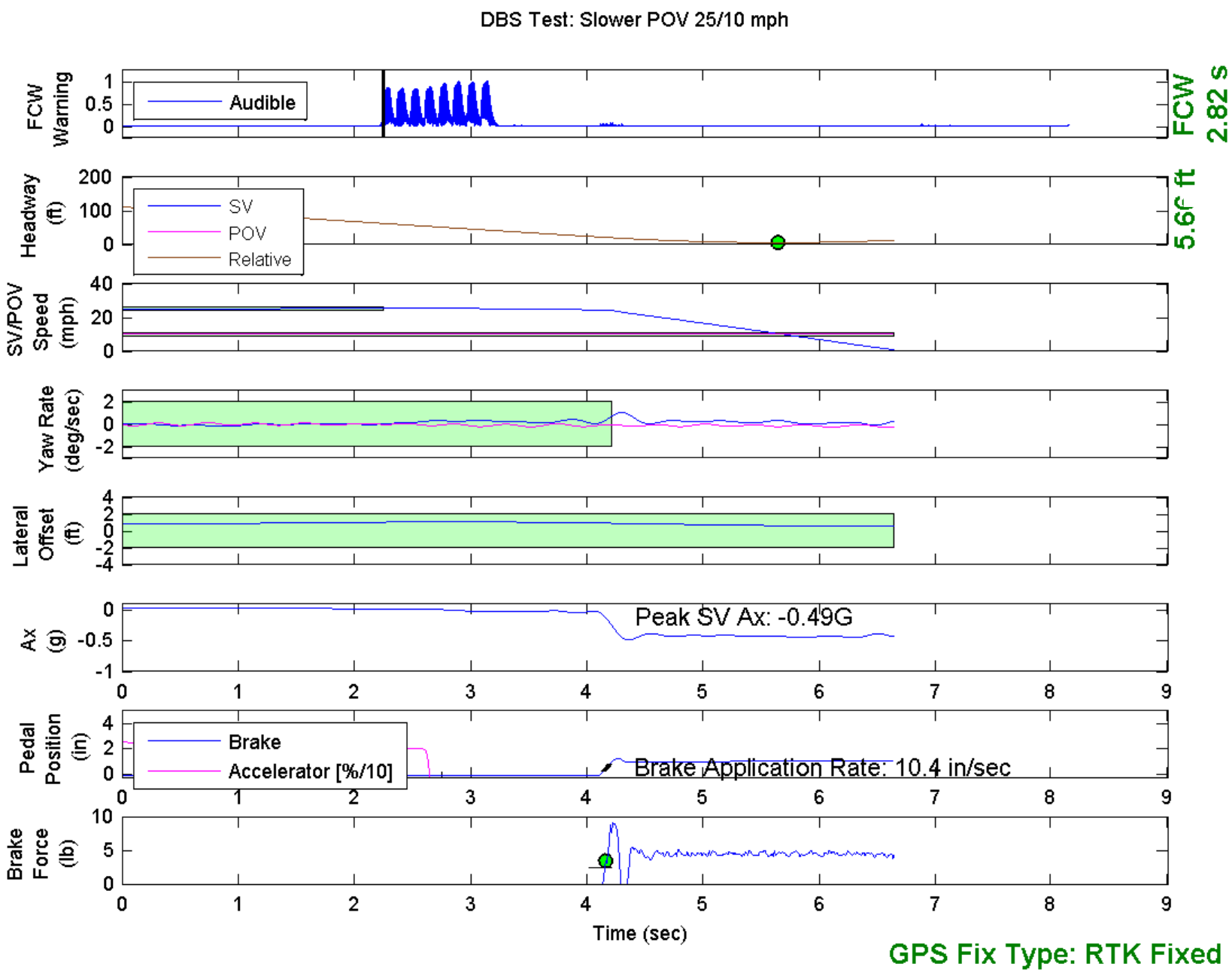

Figure E2. Example Time History for Slower POV 25 vs. 10, Passing

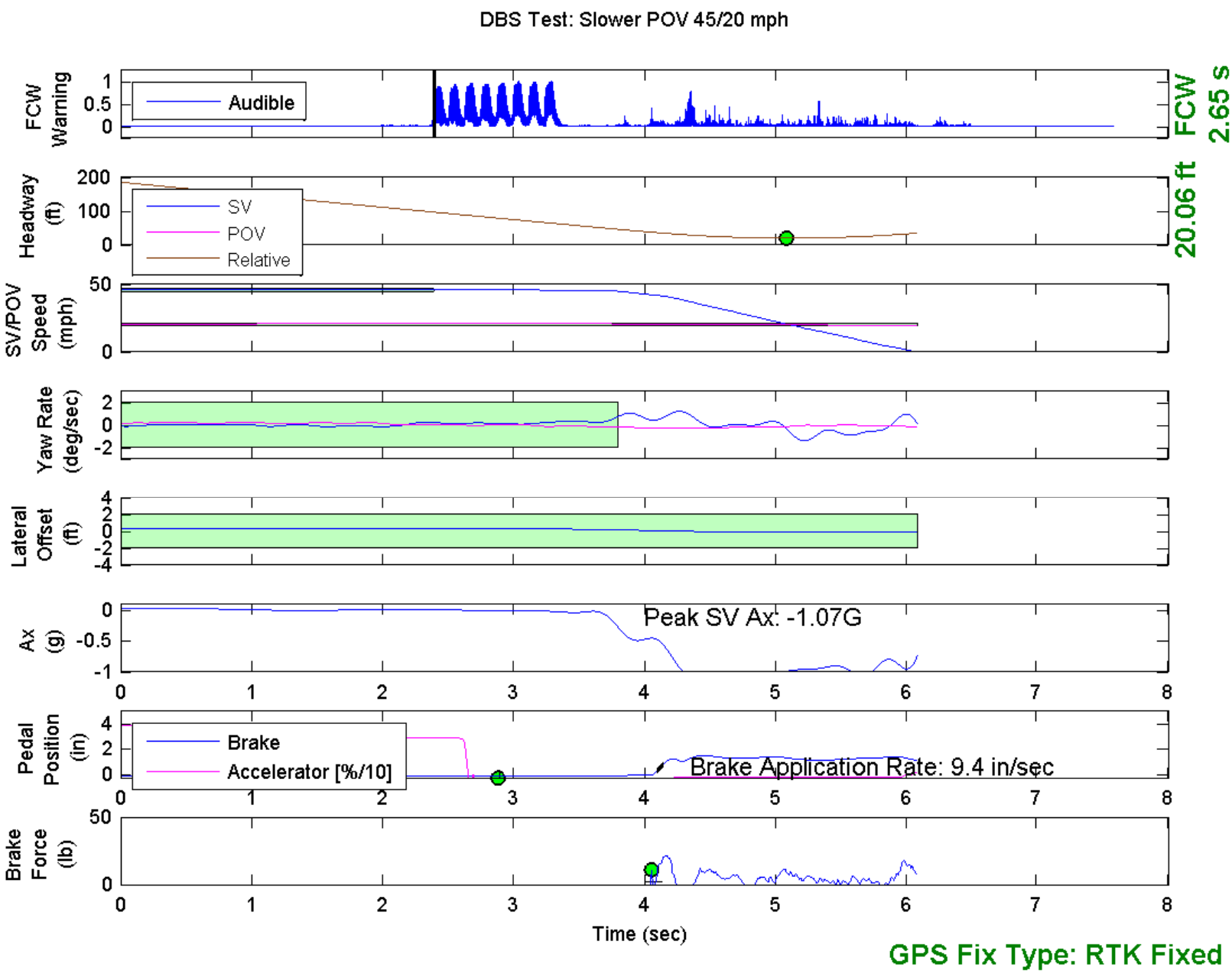

Figure E3. Example Time History for Slower POV 45 vs. 20, Passing

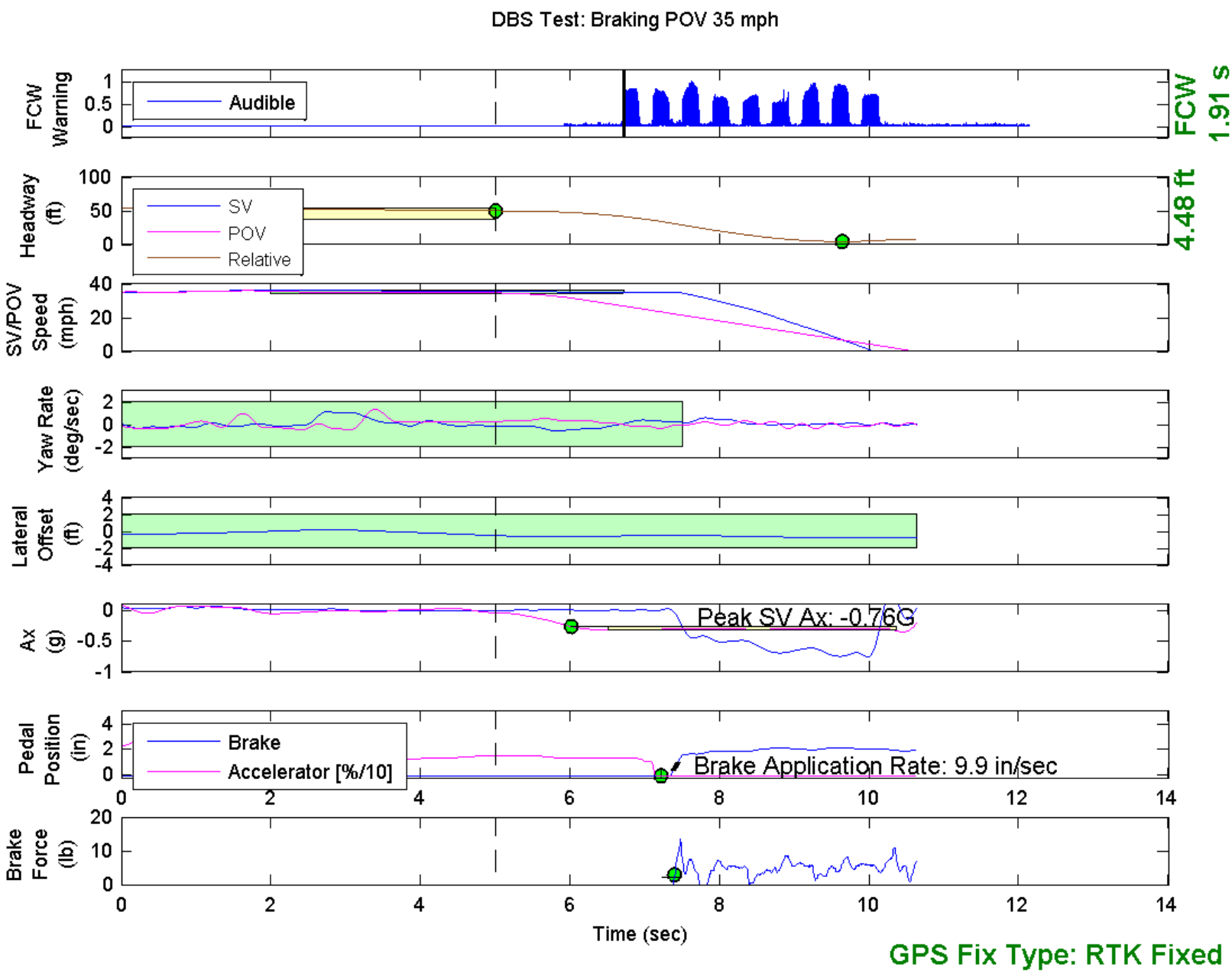

Figure E4. Example Time History for Braking POV 35, Passing

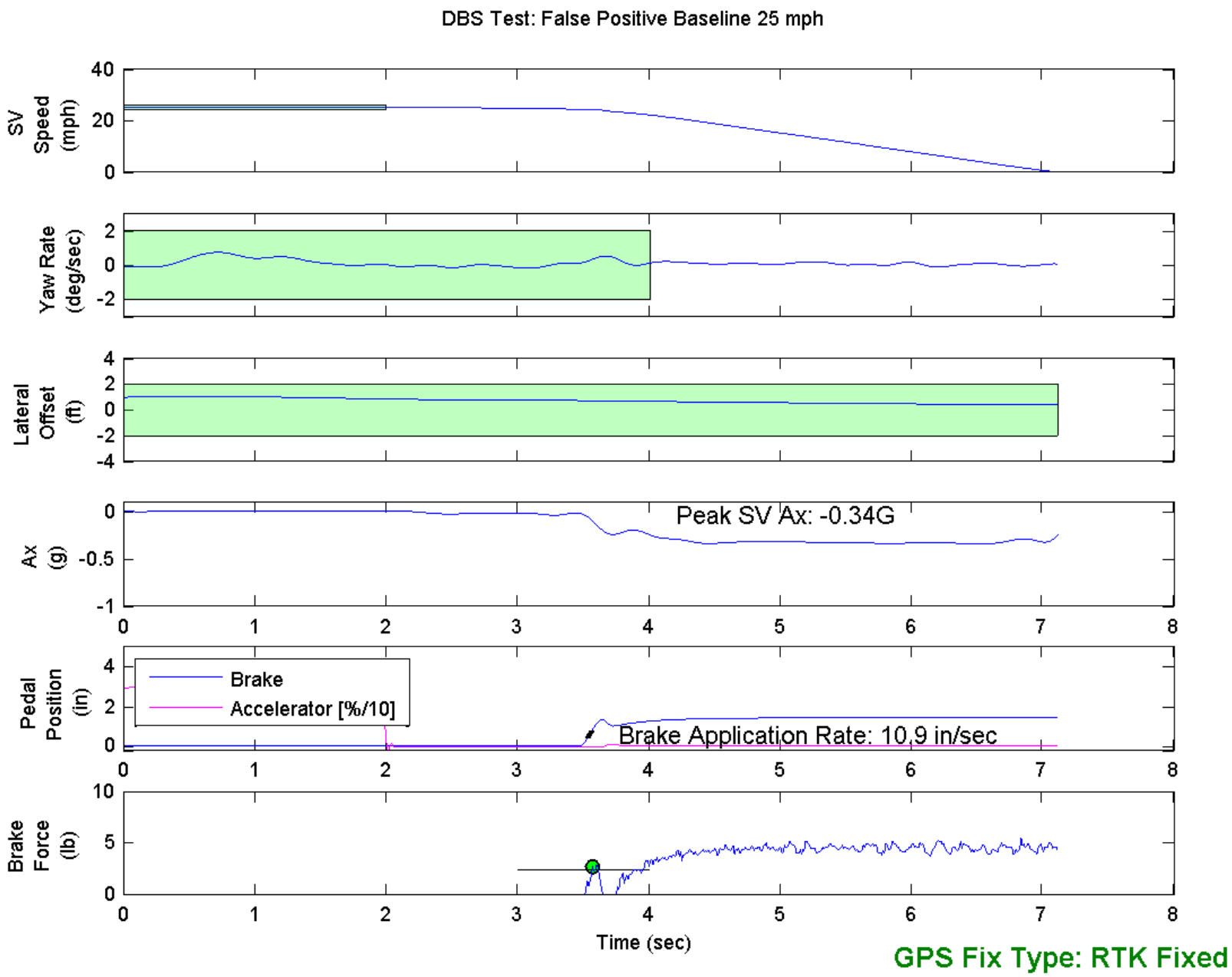

Figure E5. Example Time History for False Positive Baseline 25, Passing

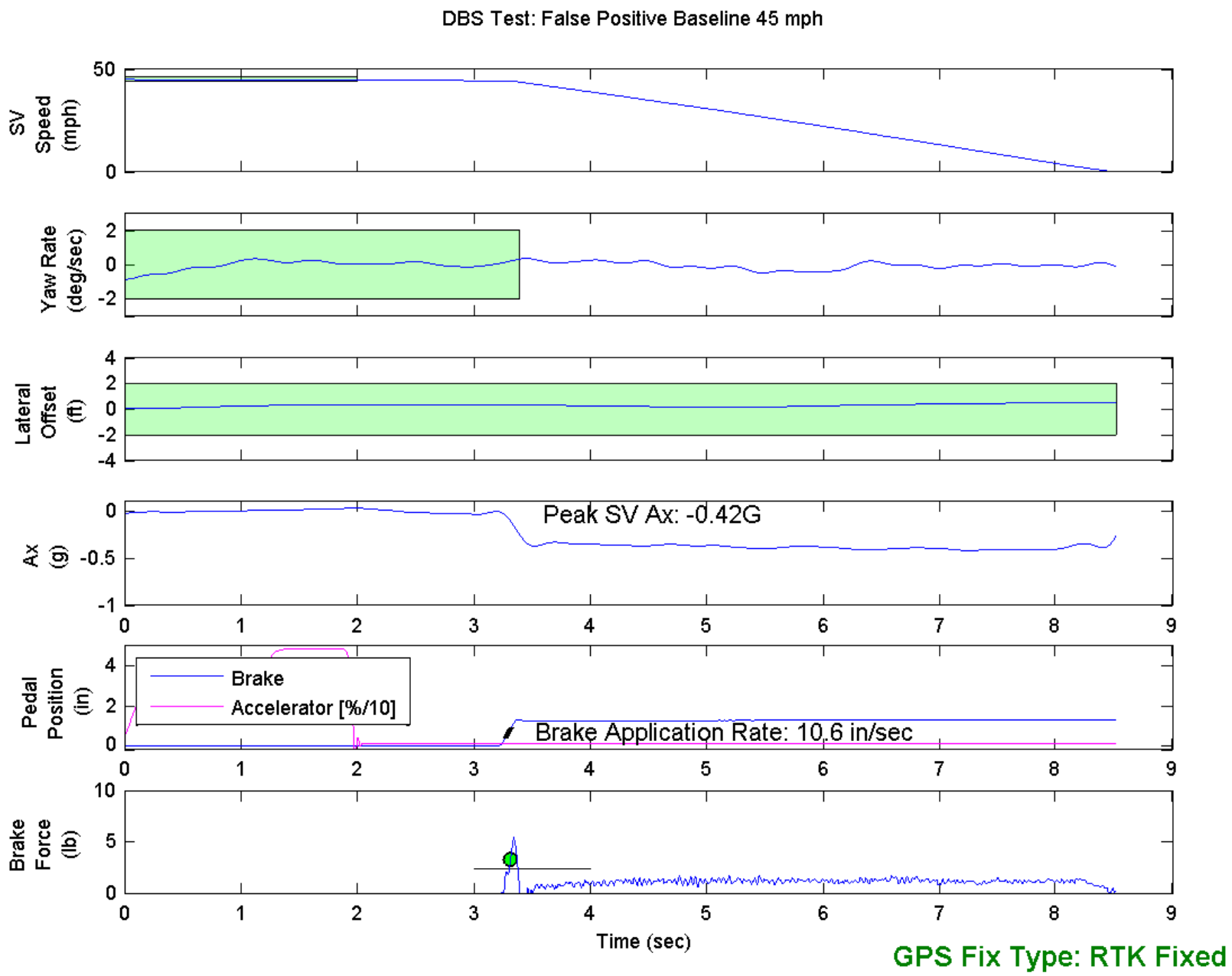

Figure E6. Example Time History for False Positive Baseline 45, Passing

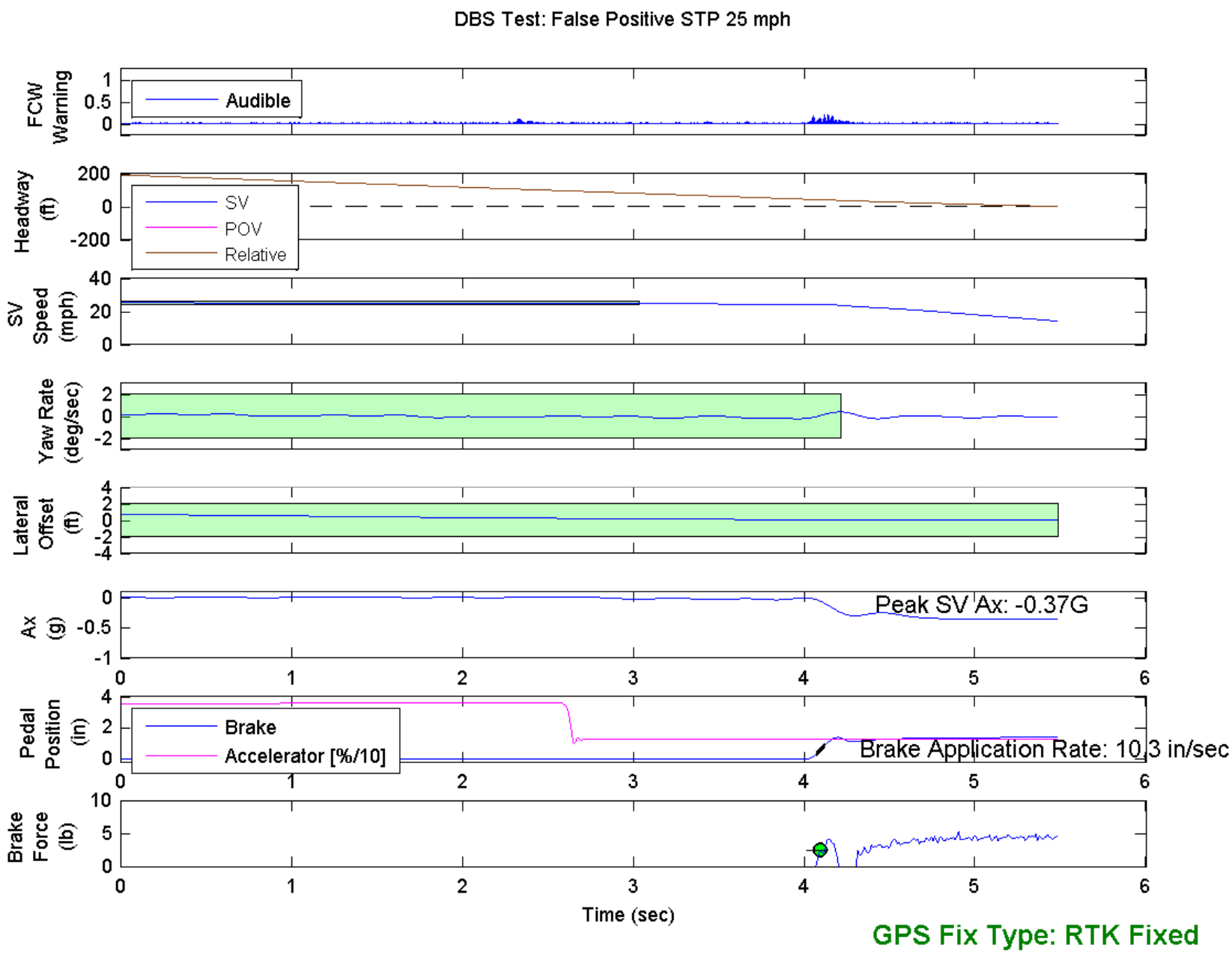

Figure E7. Example Time History for False Positive Steel Plate 25, Passing

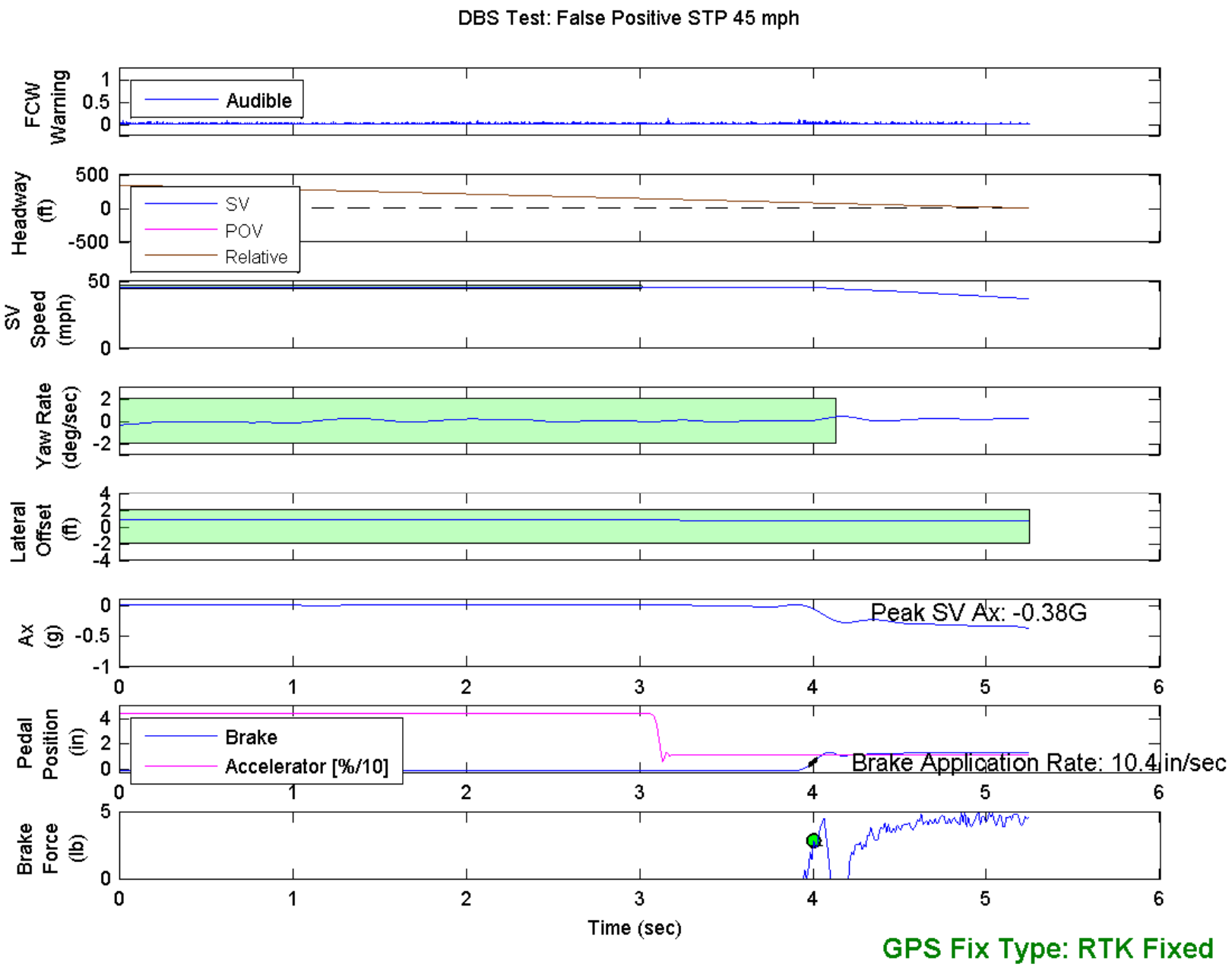

Figure E8. Example Time History for False Positive Steel Plate 45, Passing

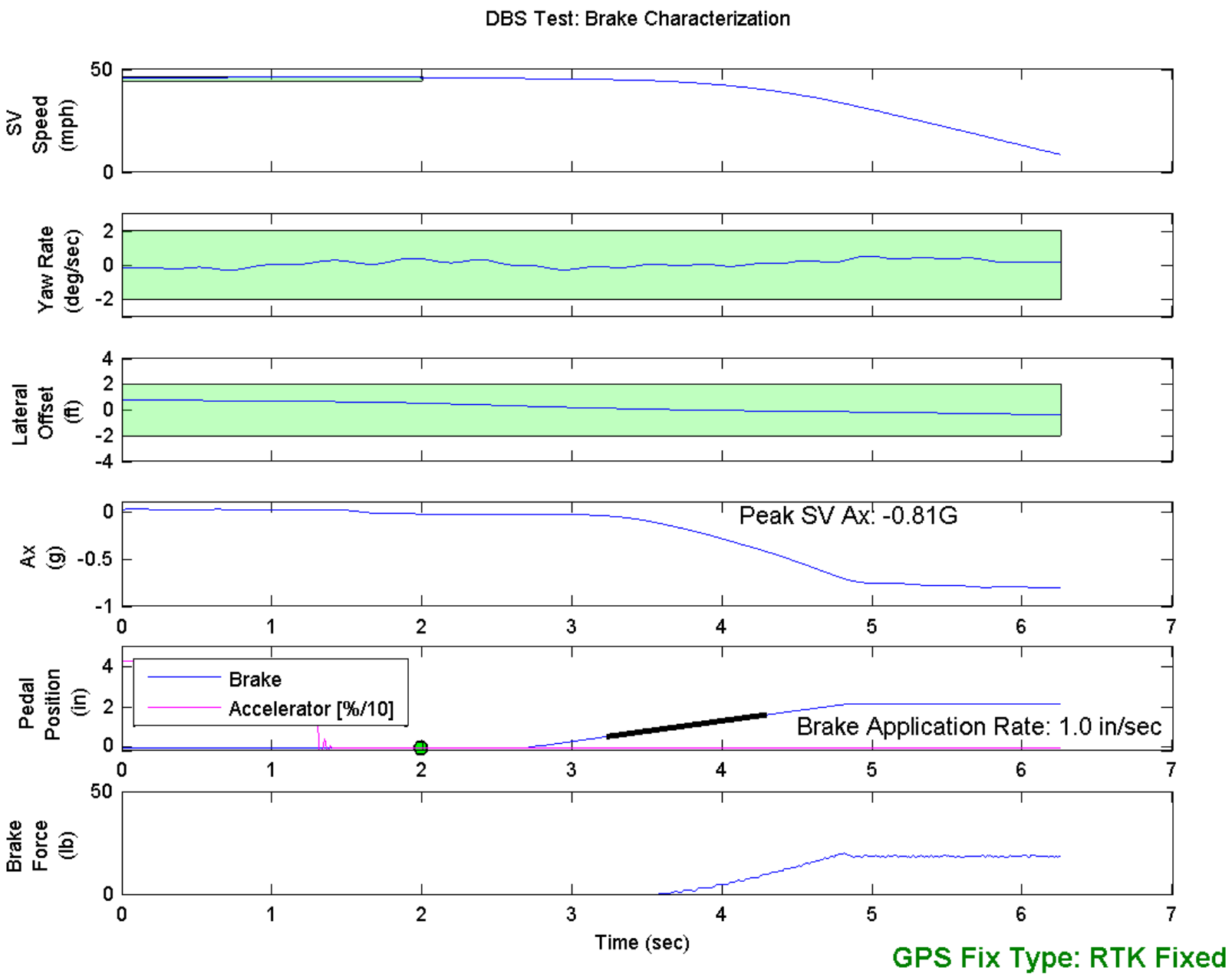

Figure E9. Example Time History for DBS Brake Characterization, Passing

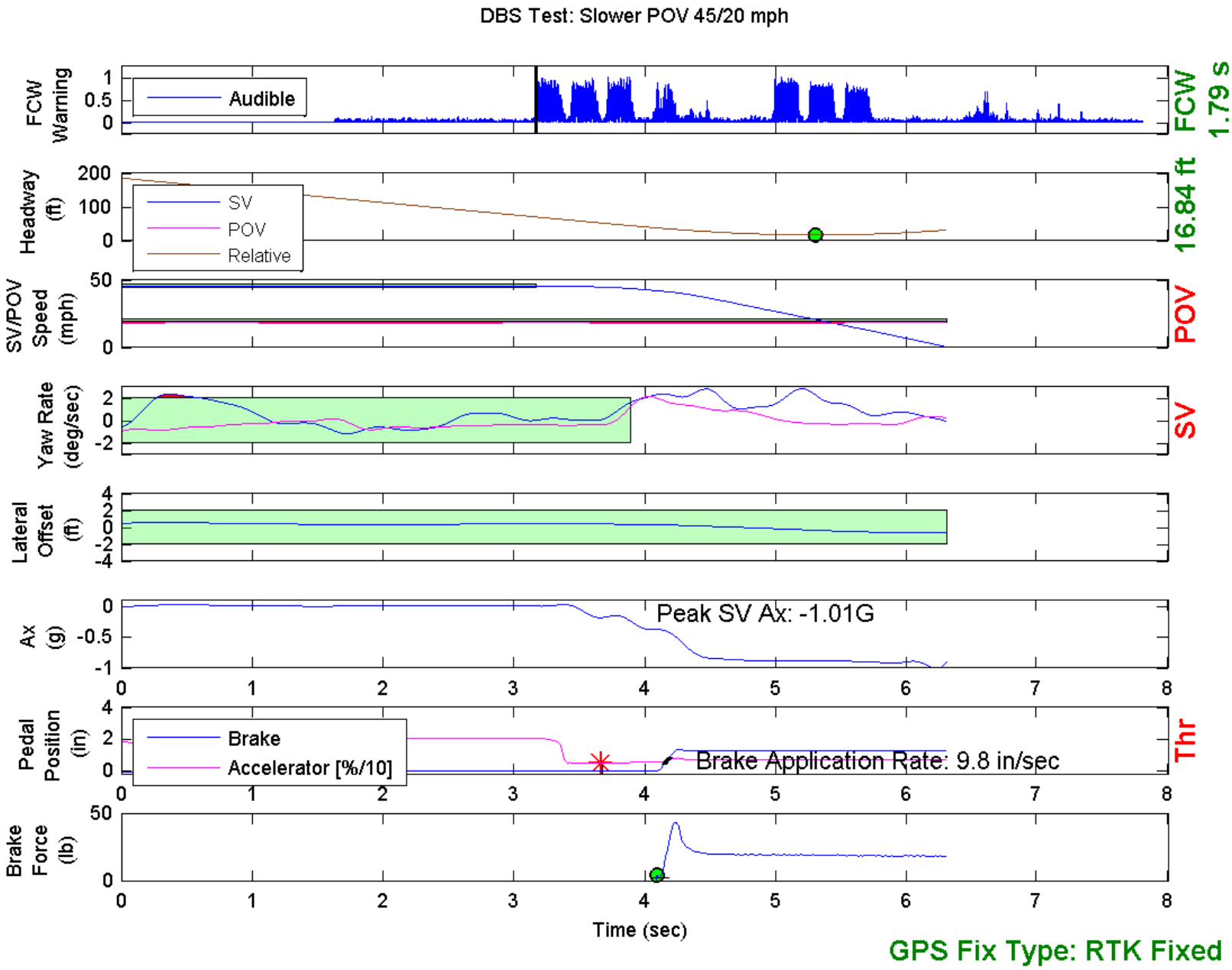

Figure E10. Example Time History Displaying Various Invalid Criteria

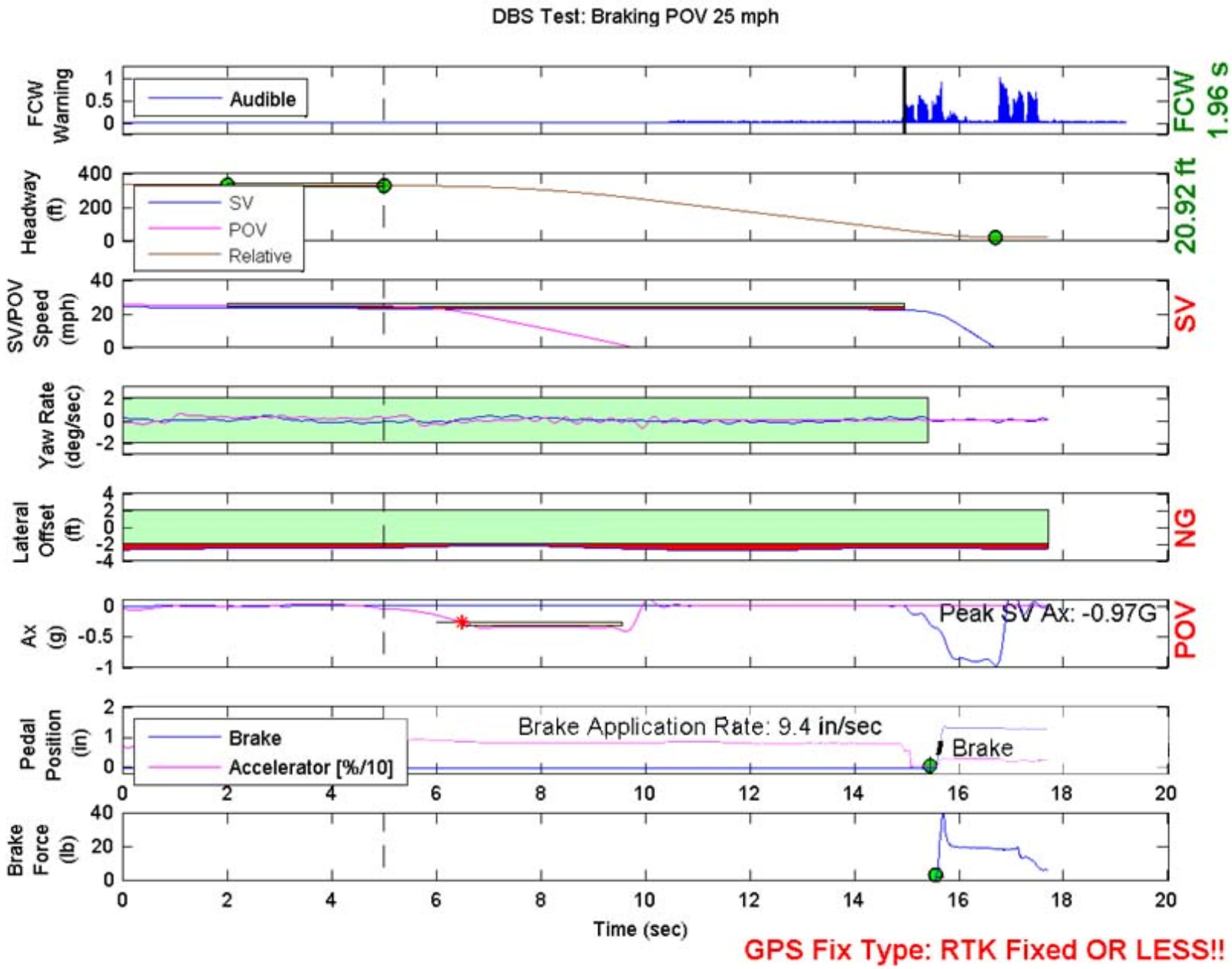

Figure E11. Example Time History Displaying Various Invalid Criteria

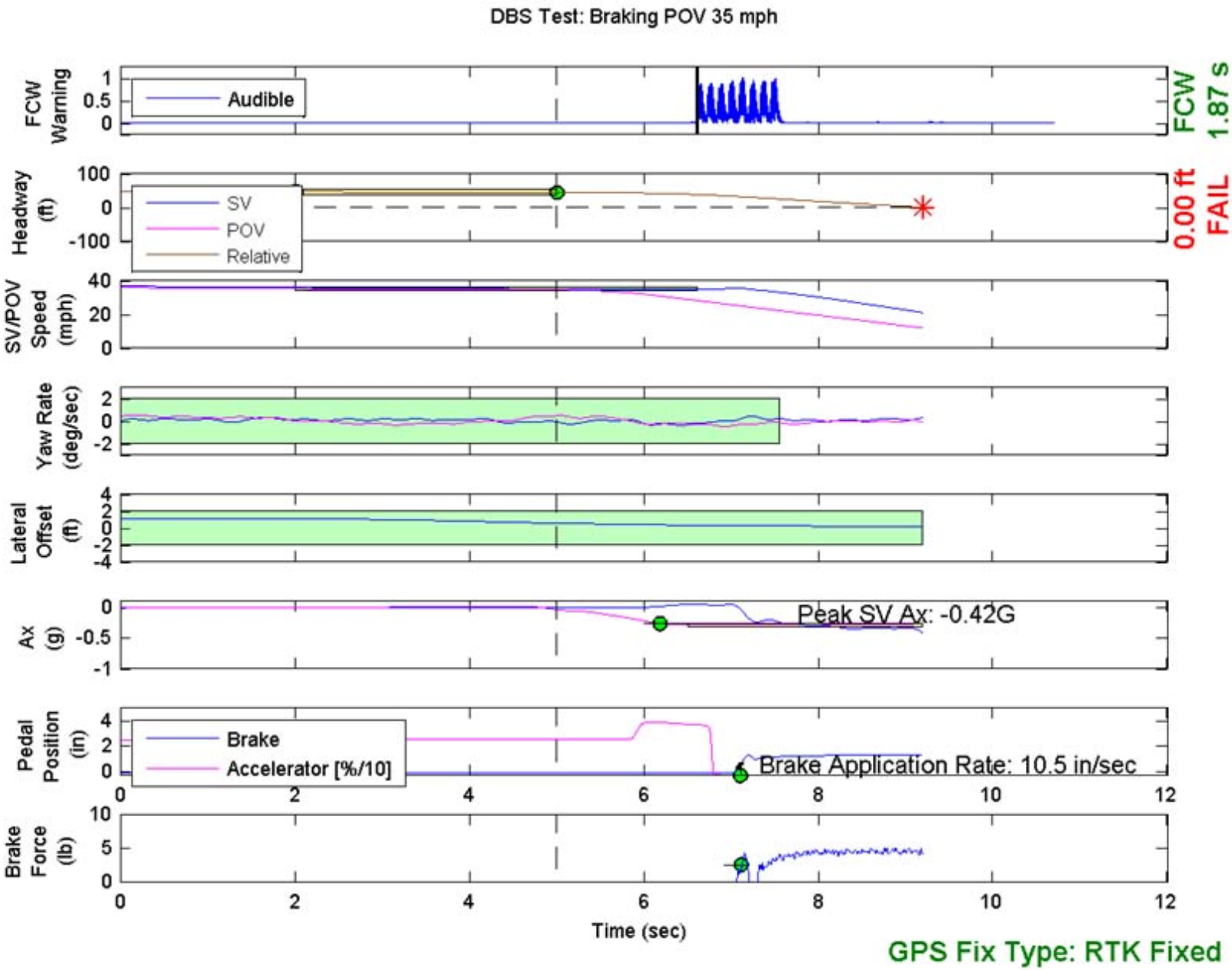

Figure E12. Example Time History for a Failed Run

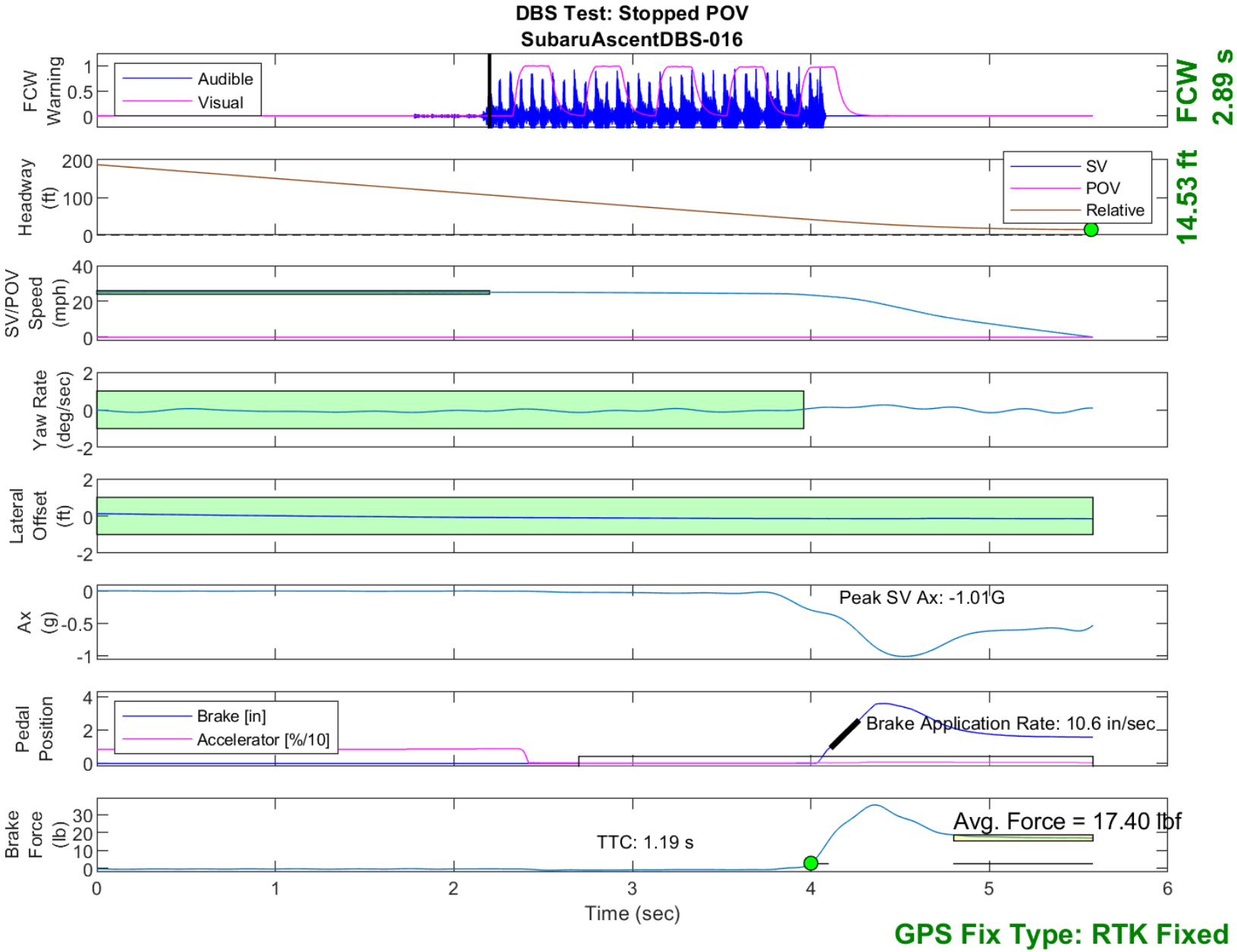

Figure E13. Time History for DBS Run 16, SV Encounters Stopped POV

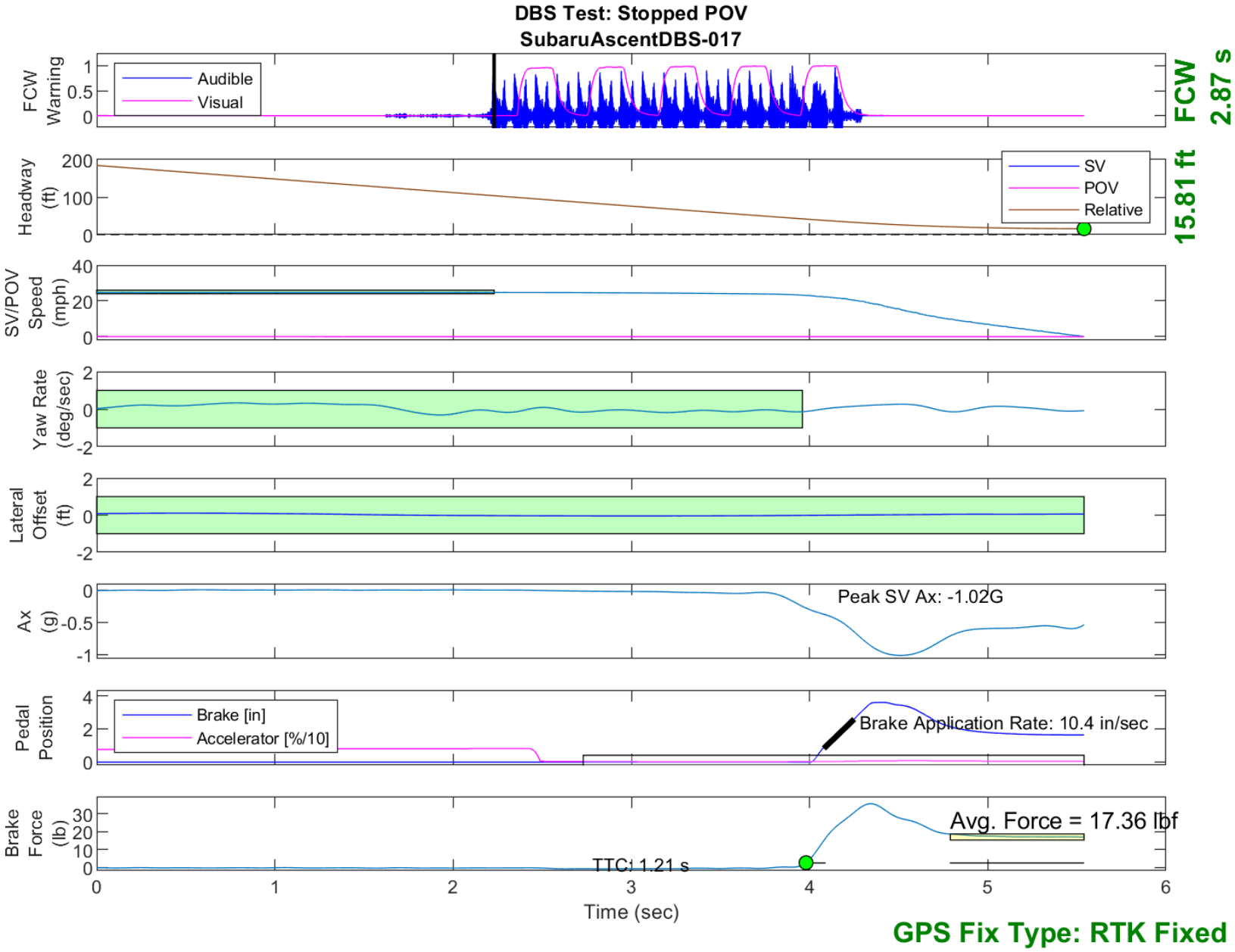

Figure E14. Time History for DBS Run 17, SV Encounters Stopped POV

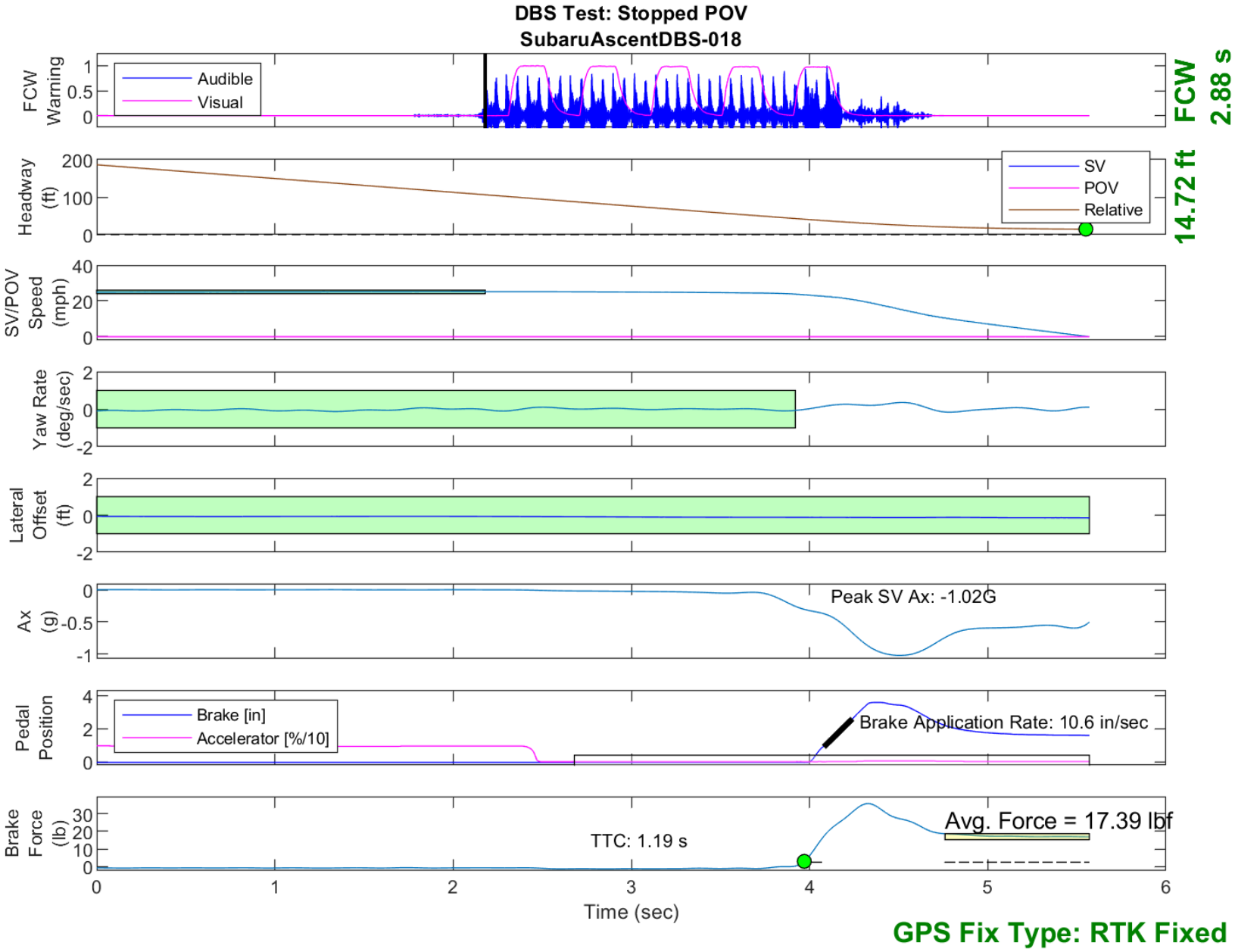

Figure E15. Time History for DBS Run 18, SV Encounters Stopped POV

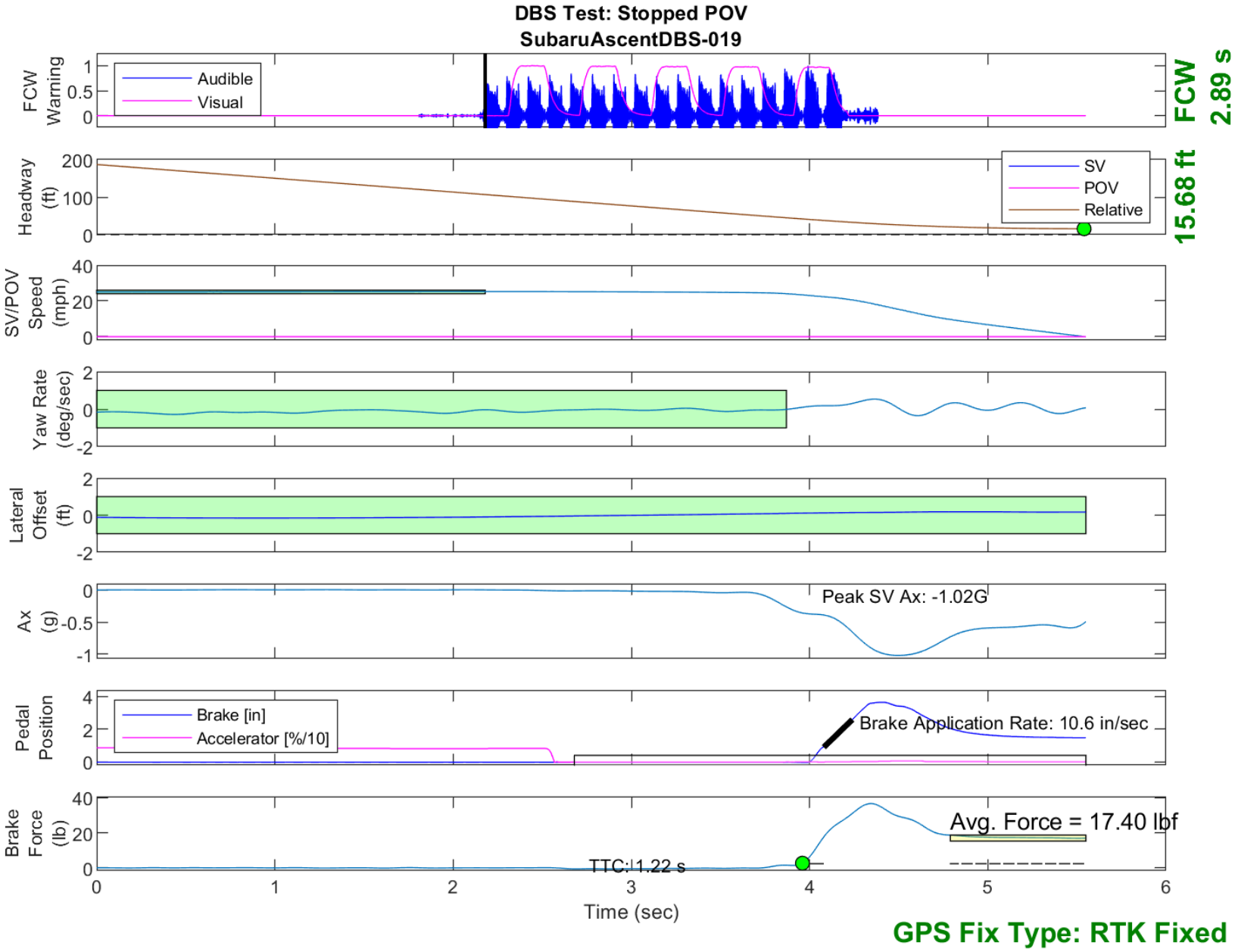

Figure E16. Time History for DBS Run 19, SV Encounters Stopped POV

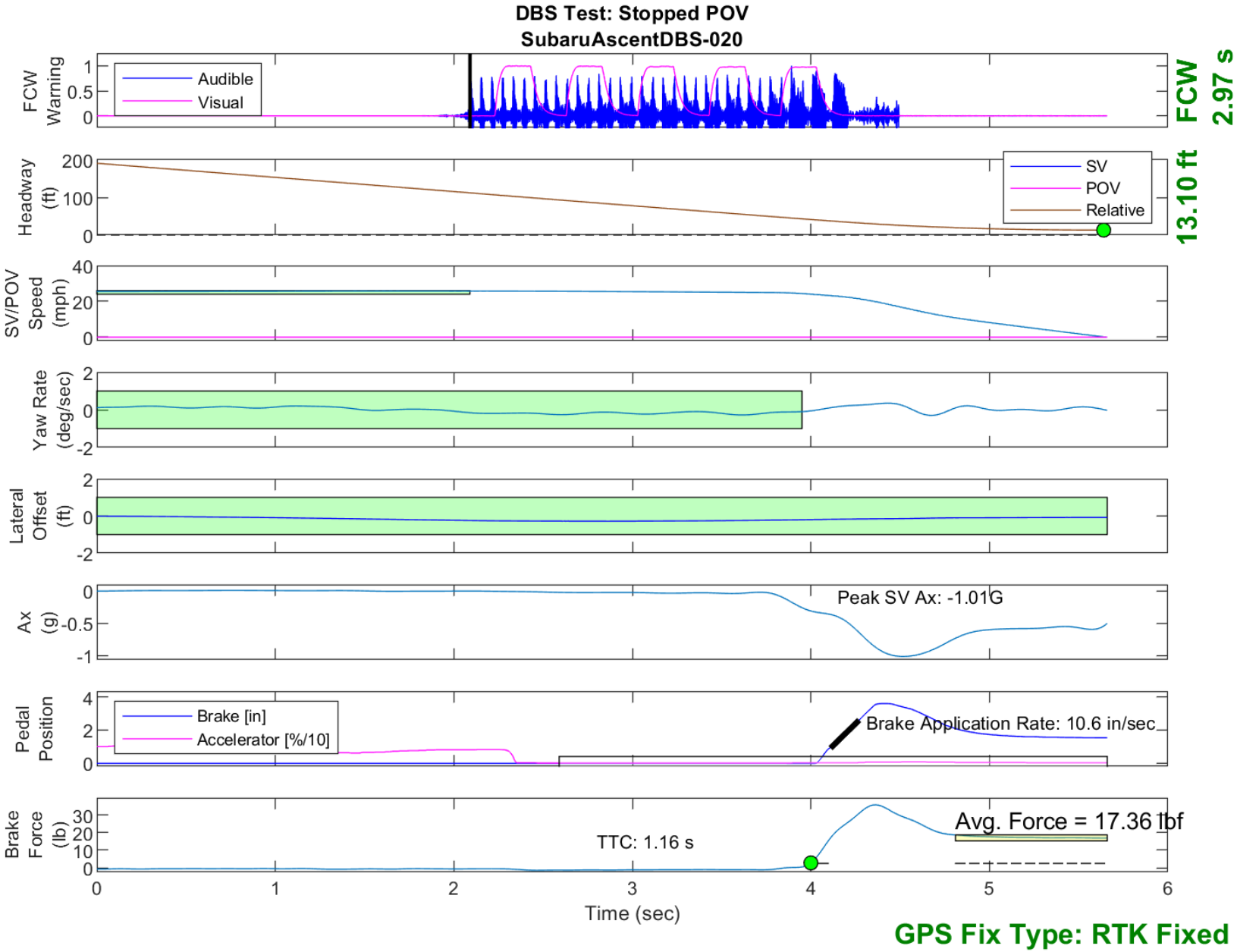

Figure E17. Time History for DBS Run 20, SV Encounters Stopped POV

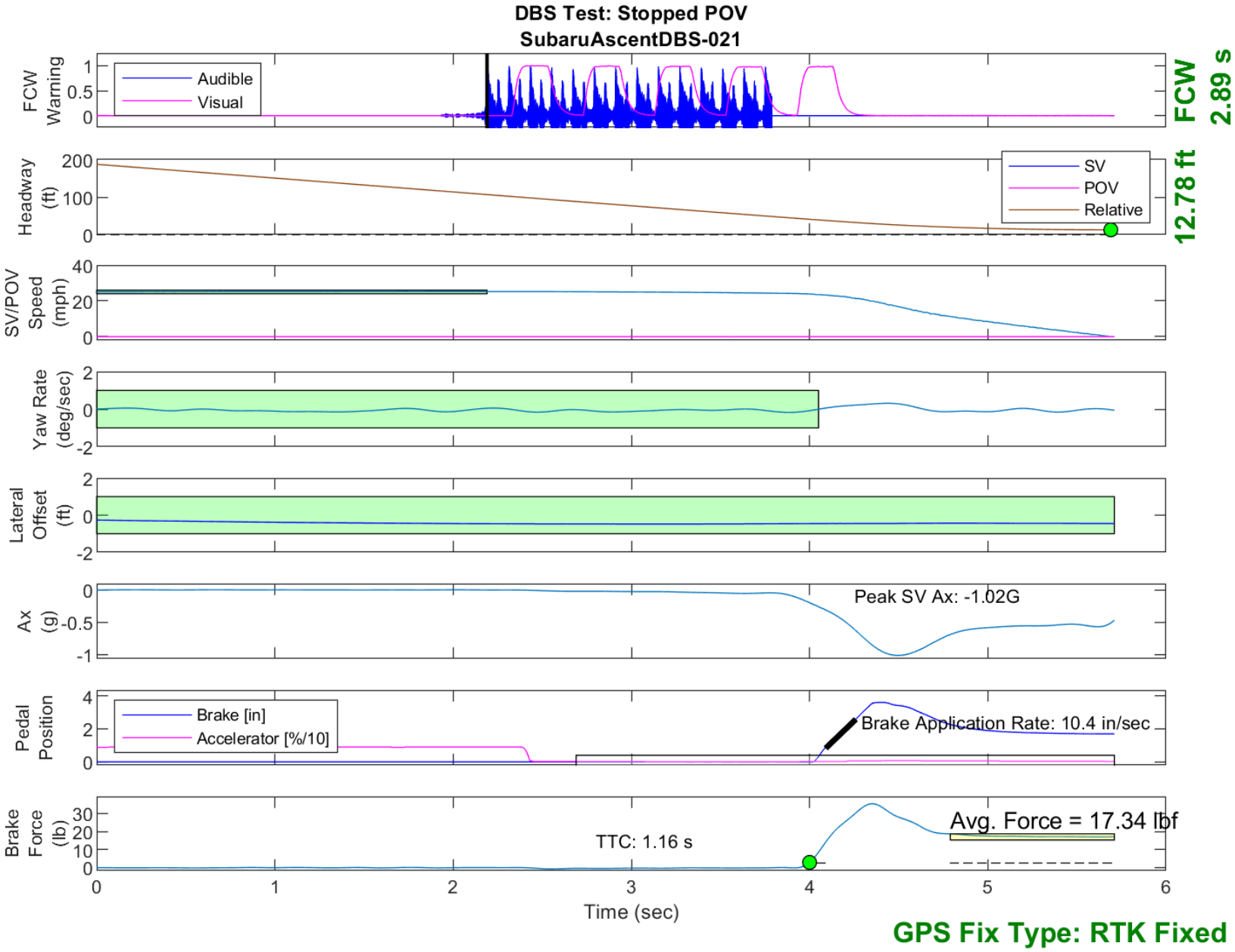

Figure E18. Time History for DBS Run 21, SV Encounters Stopped POV

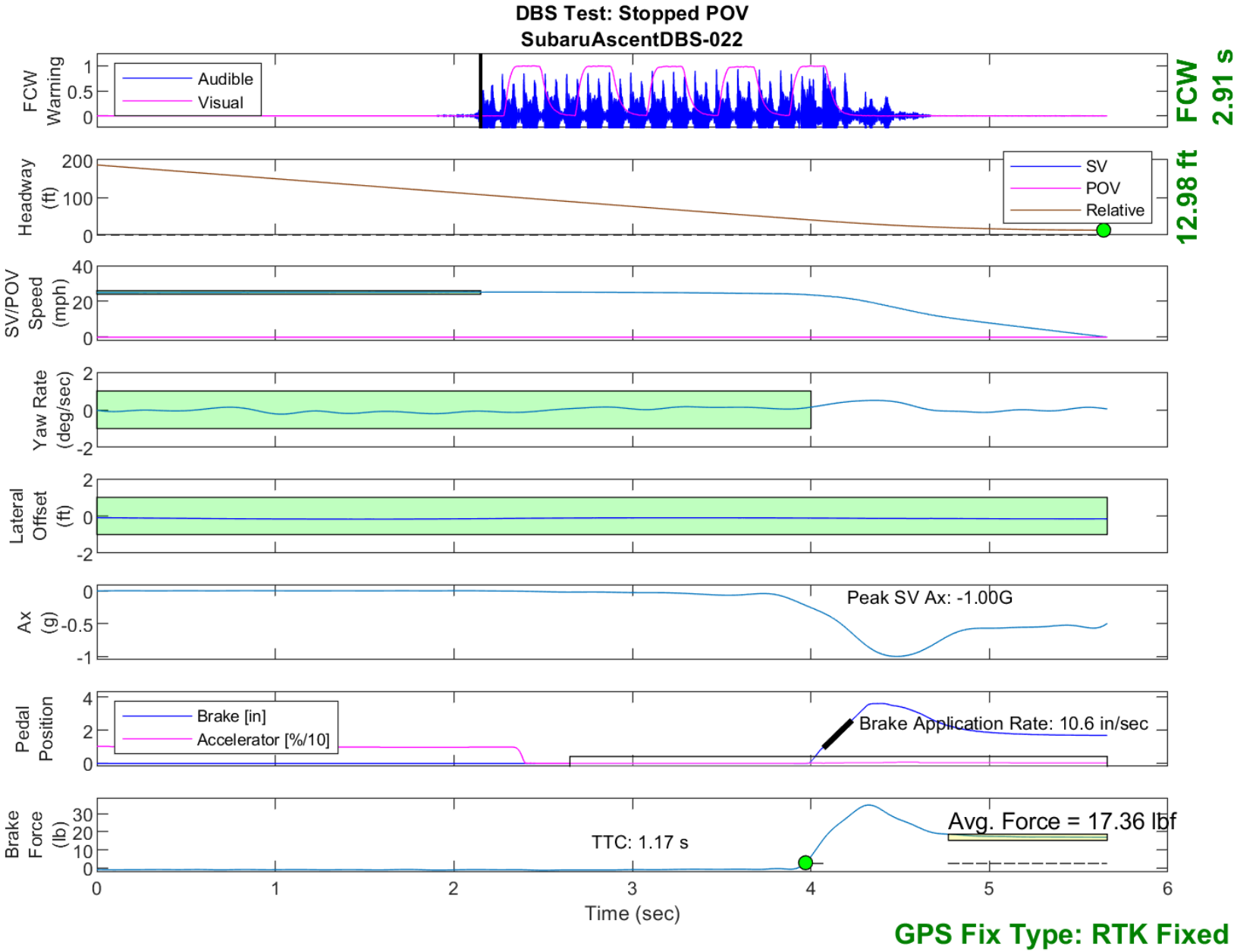

Figure E19. Time History for DBS Run 22, SV Encounters Stopped POV

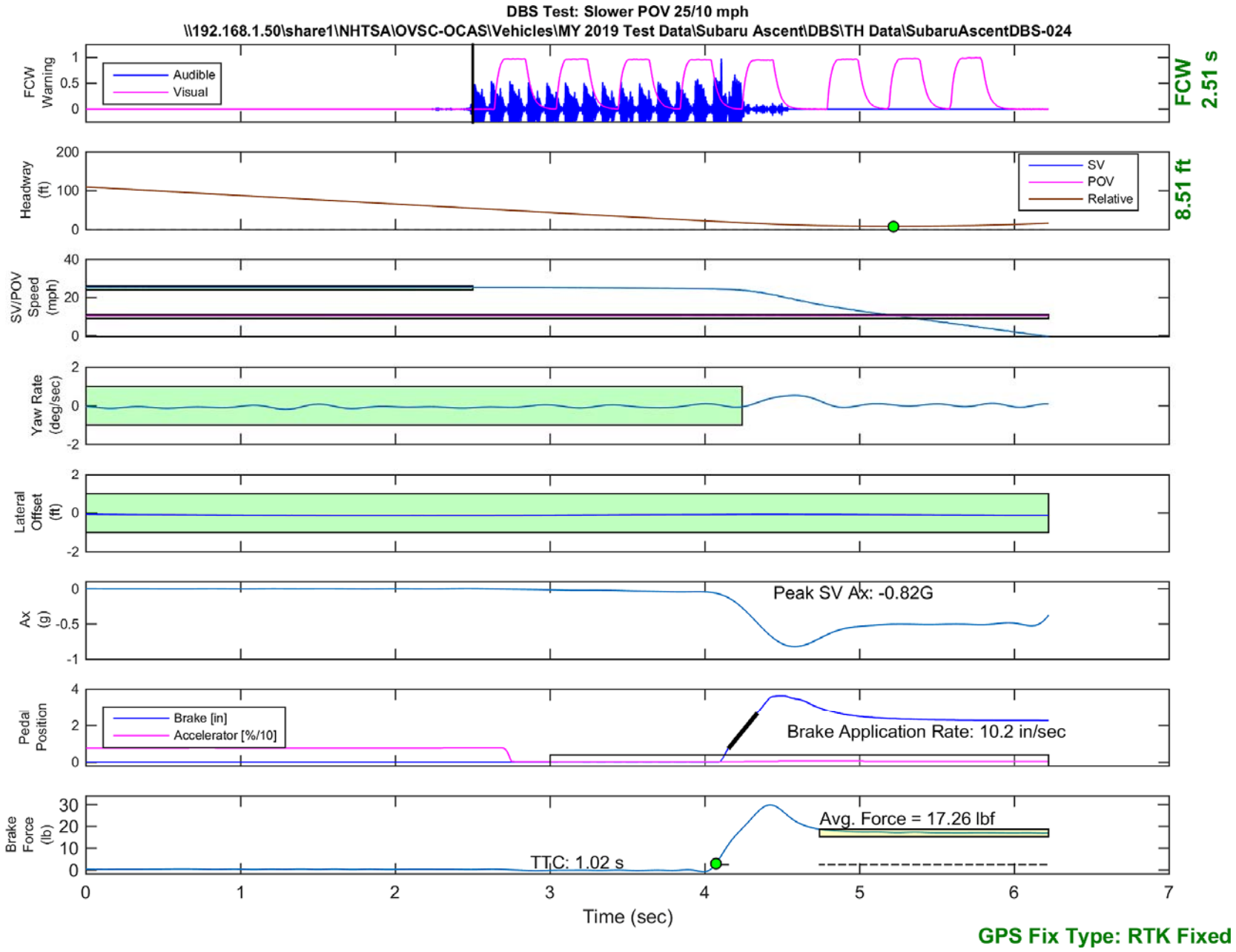

Figure E20. Time History for DBS Run 24, SV Encounters Slower POV, SV 25 mph, POV 10 mph

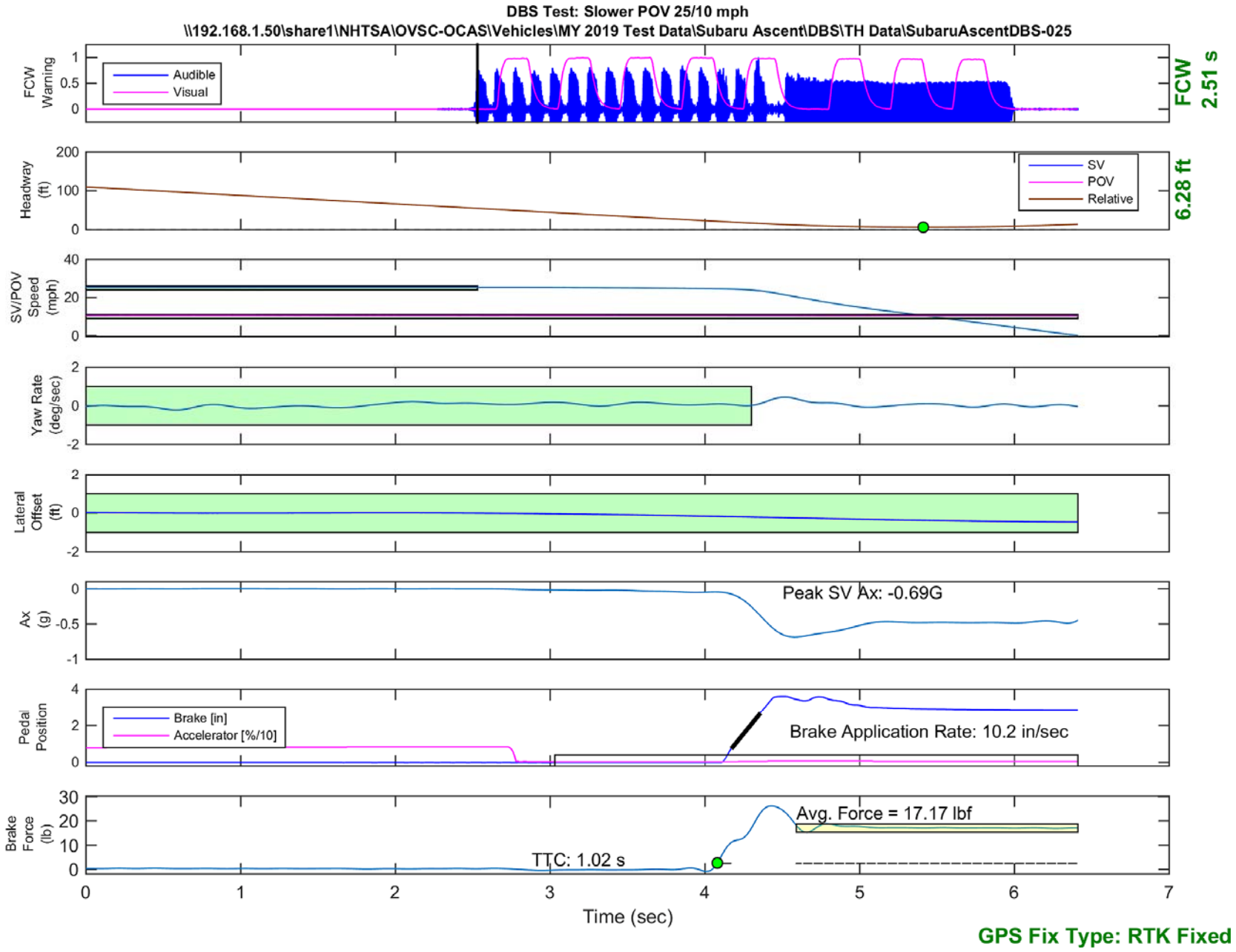

Figure E21. Time History for DBS Run 25, SV Encounters Slower POV, SV 25 mph, POV 10 mph

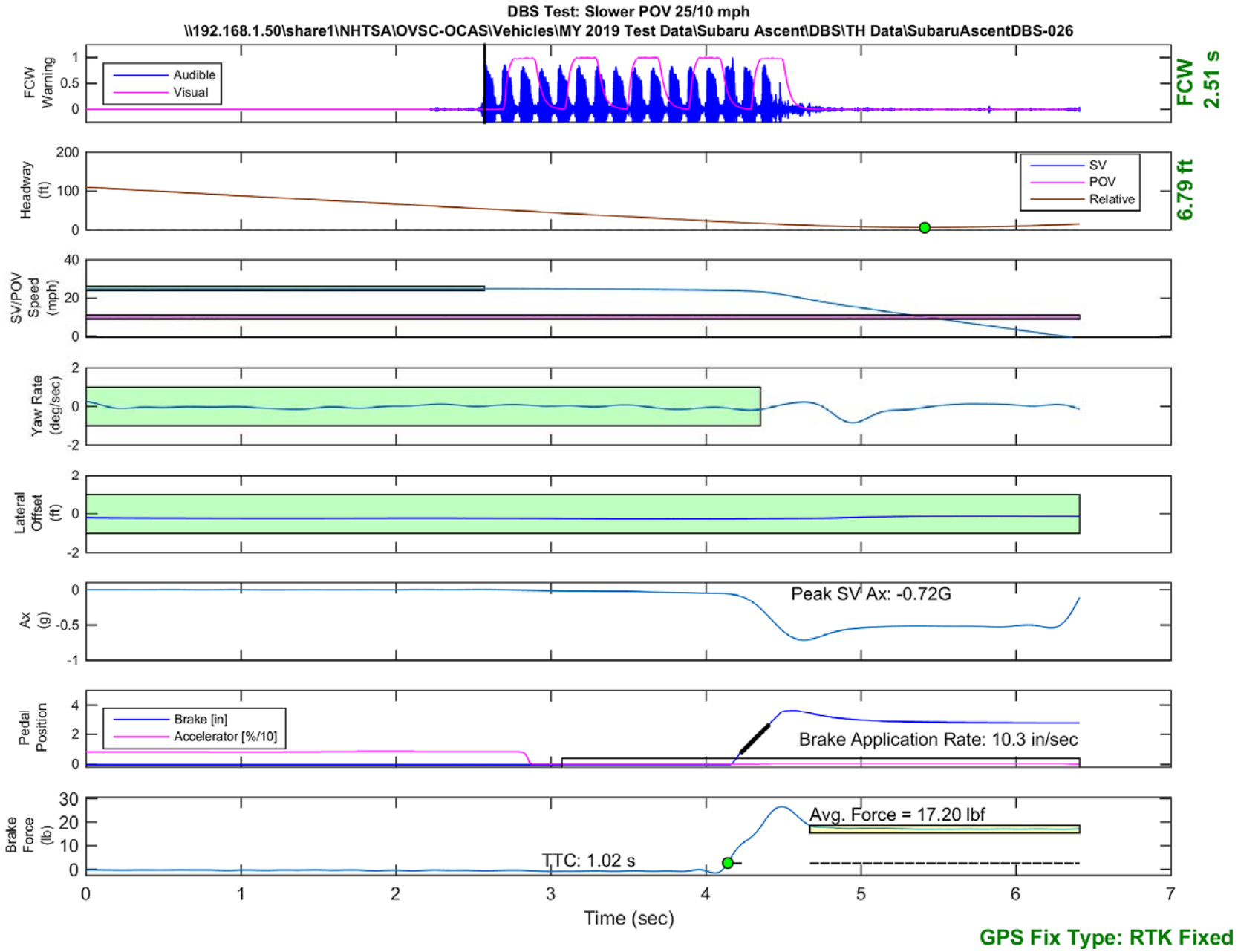

Figure E22. Time History for DBS Run 26, SV Encounters Slower POV, SV 25 mph, POV 10 mph

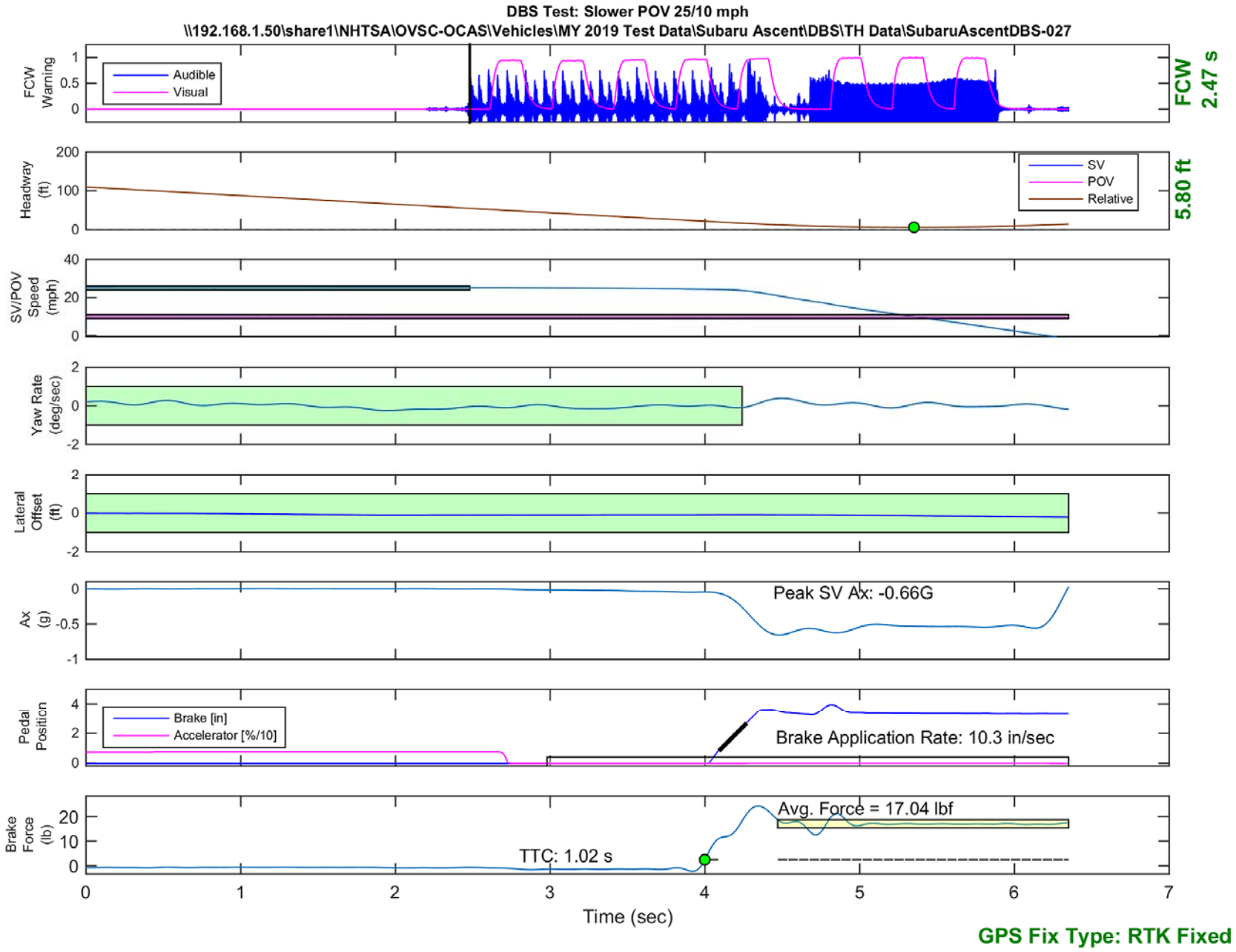

Figure E23. Time History for DBS Run 27, SV Encounters Slower POV, SV 25 mph, POV 10 mph

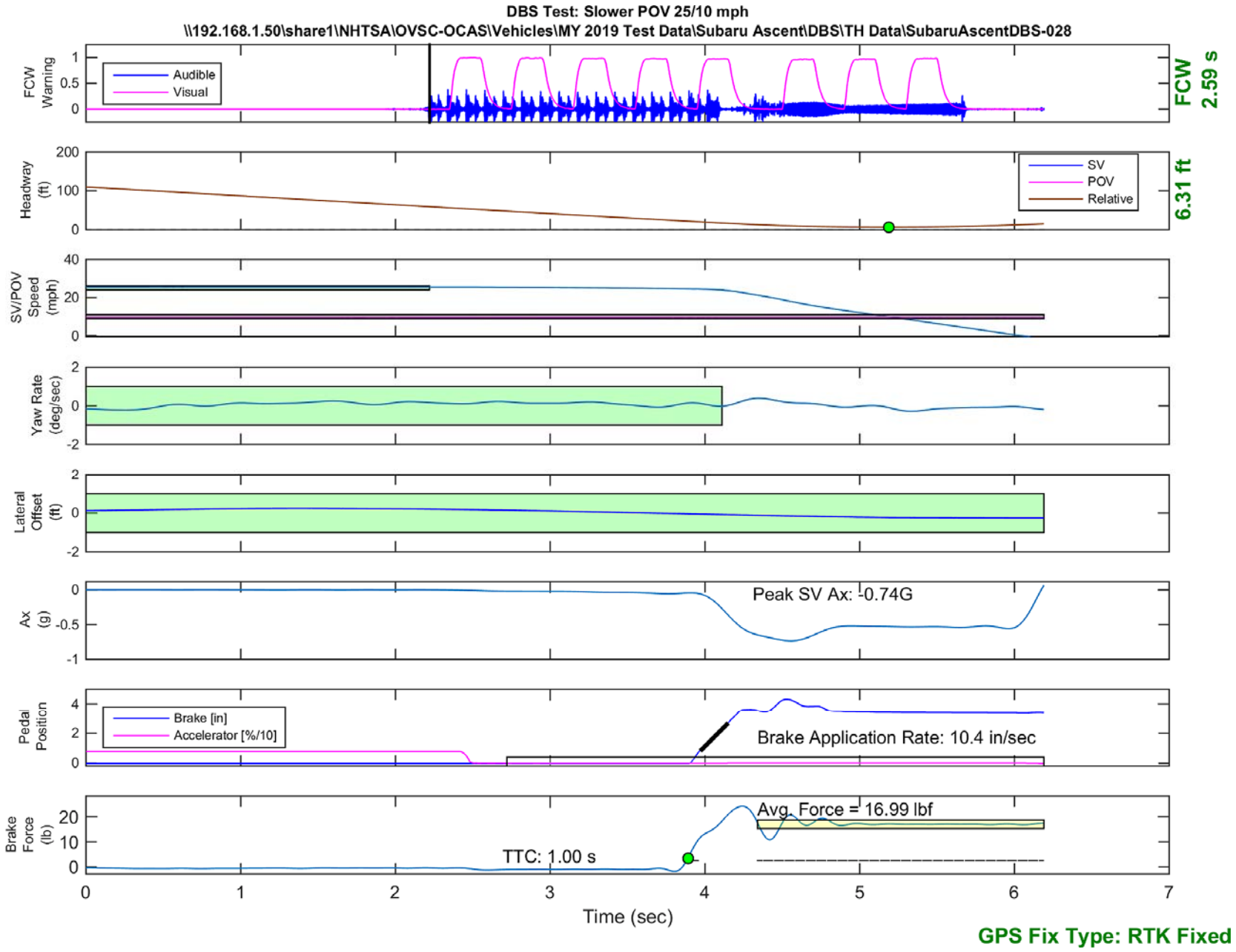

Figure E24. Time History for DBS Run 28, SV Encounters Slower POV, SV 25 mph, POV 10 mph

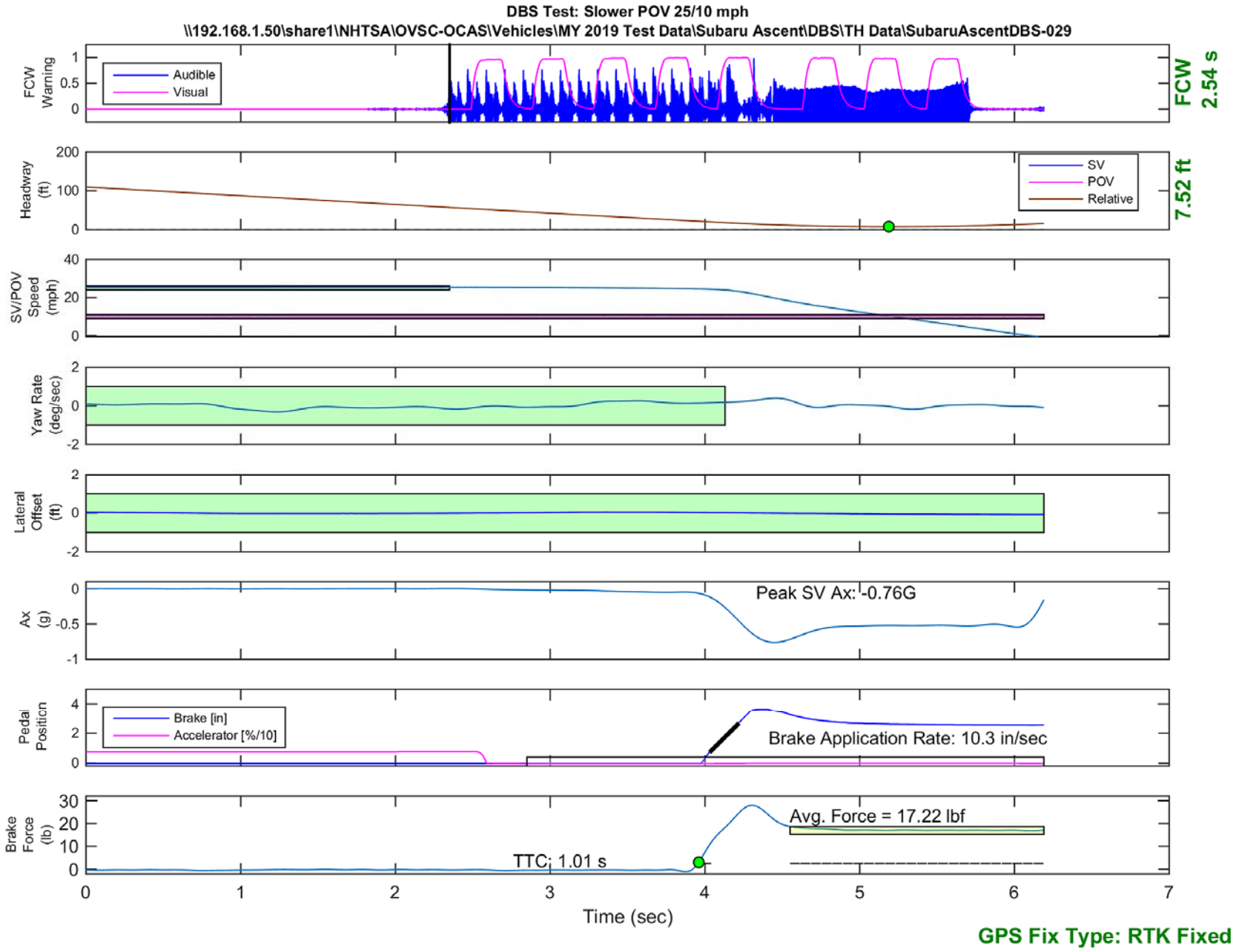

Figure E25. Time History for DBS Run 29, SV Encounters Slower POV, SV 25 mph, POV 10 mph

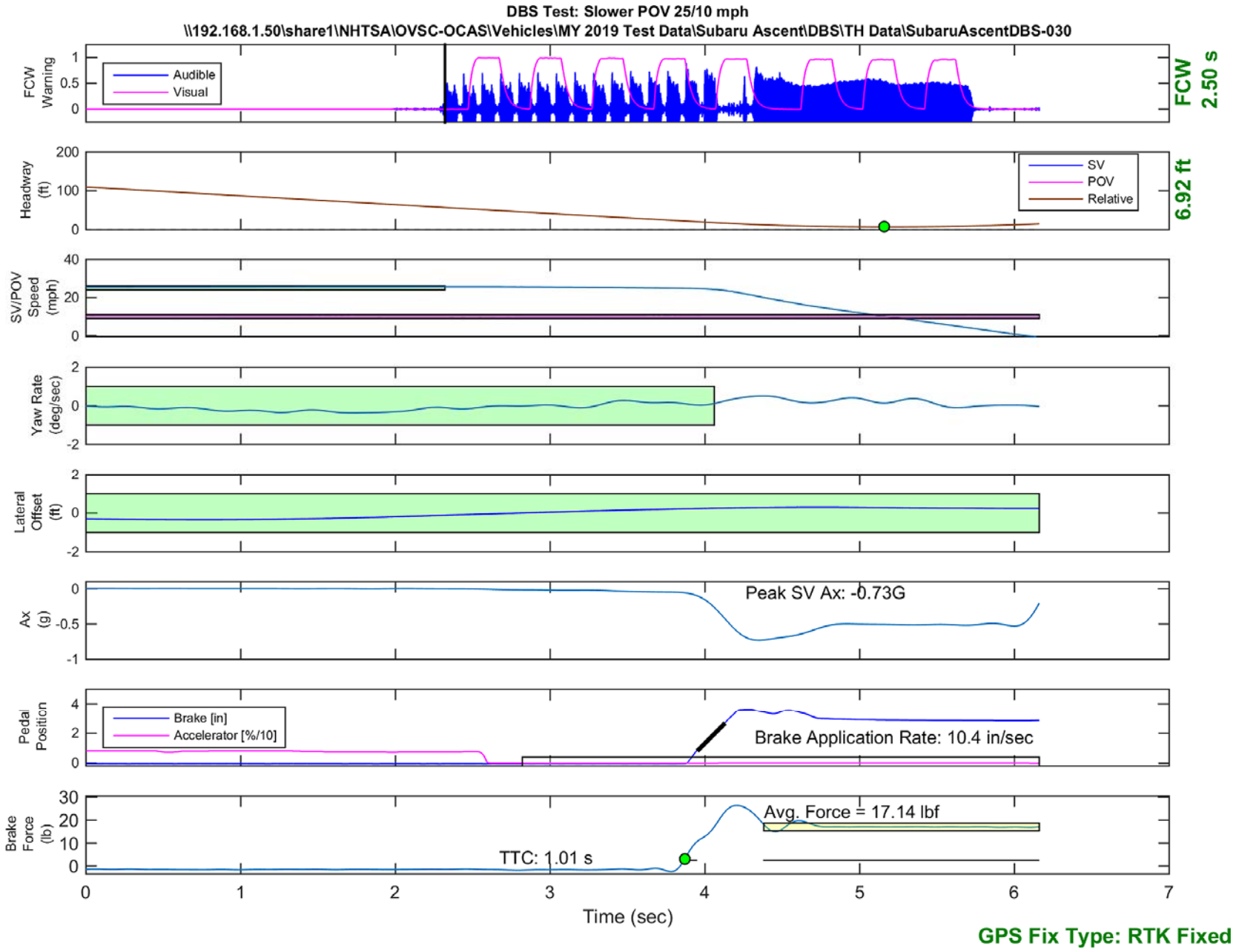

Figure E26. Time History for DBS Run 30, SV Encounters Slower POV, SV 25 mph, POV 10 mph

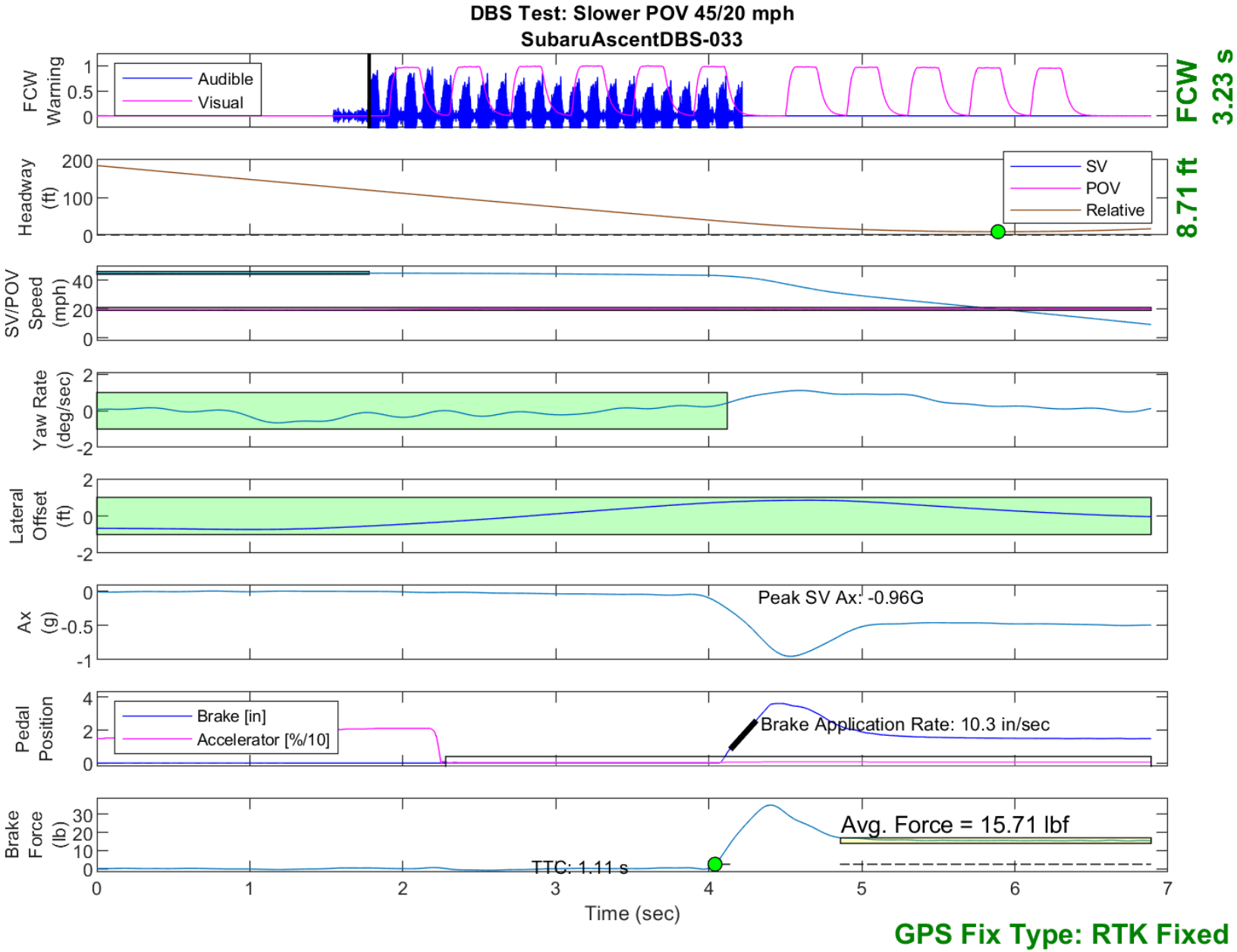

Figure E27. Time History for DBS Run 33, SV Encounters Slower POV, SV 45 mph, POV 20 mph

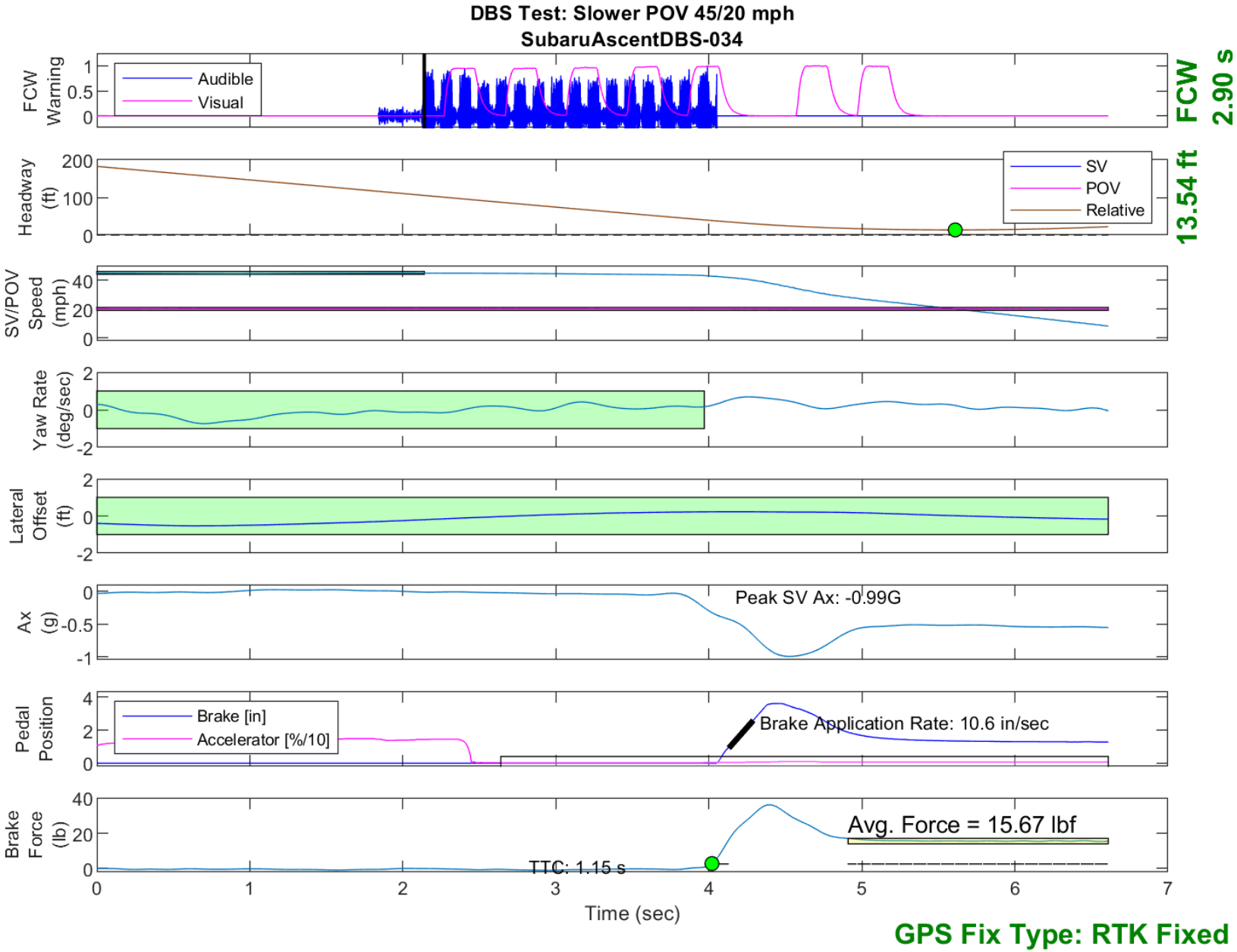

Figure E28. Time History for DBS Run 34, SV Encounters Slower POV, SV 45 mph, POV 20 mph

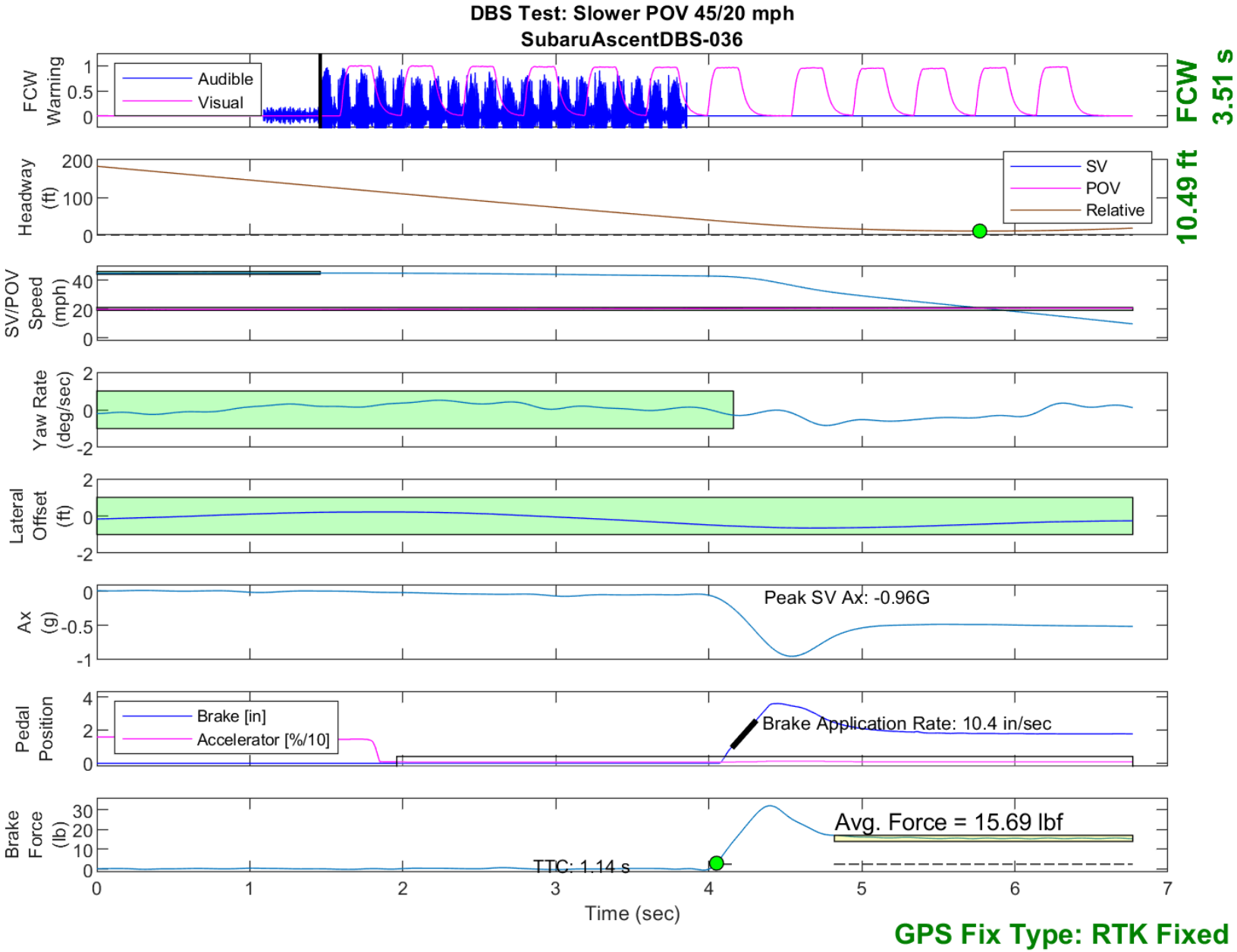

Figure E29. Time History for DBS Run 36, SV Encounters Slower POV, SV 45 mph, POV 20 mph

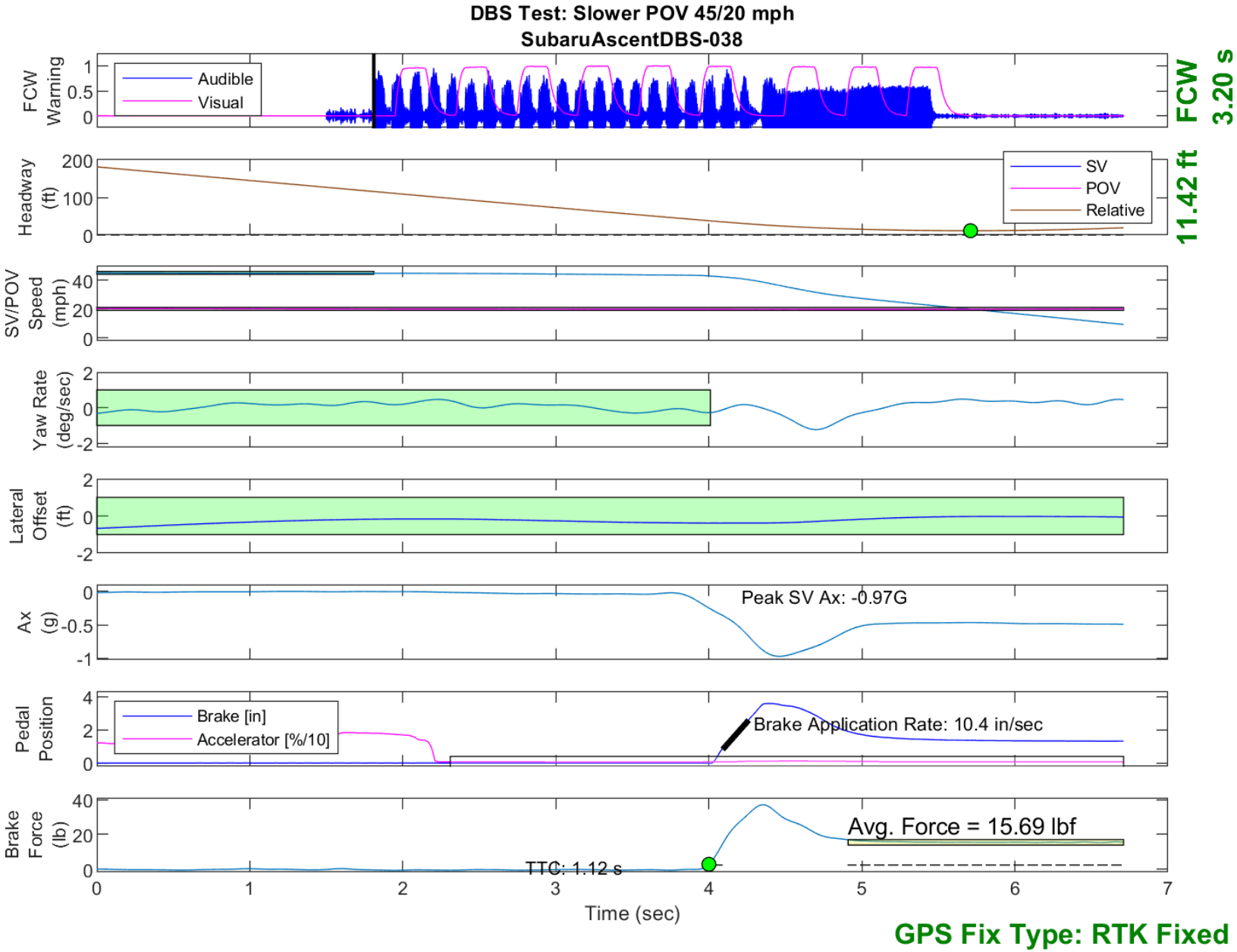

Figure E30. Time History for DBS Run 38, SV Encounters Slower POV, SV 45 mph, POV 20 mph

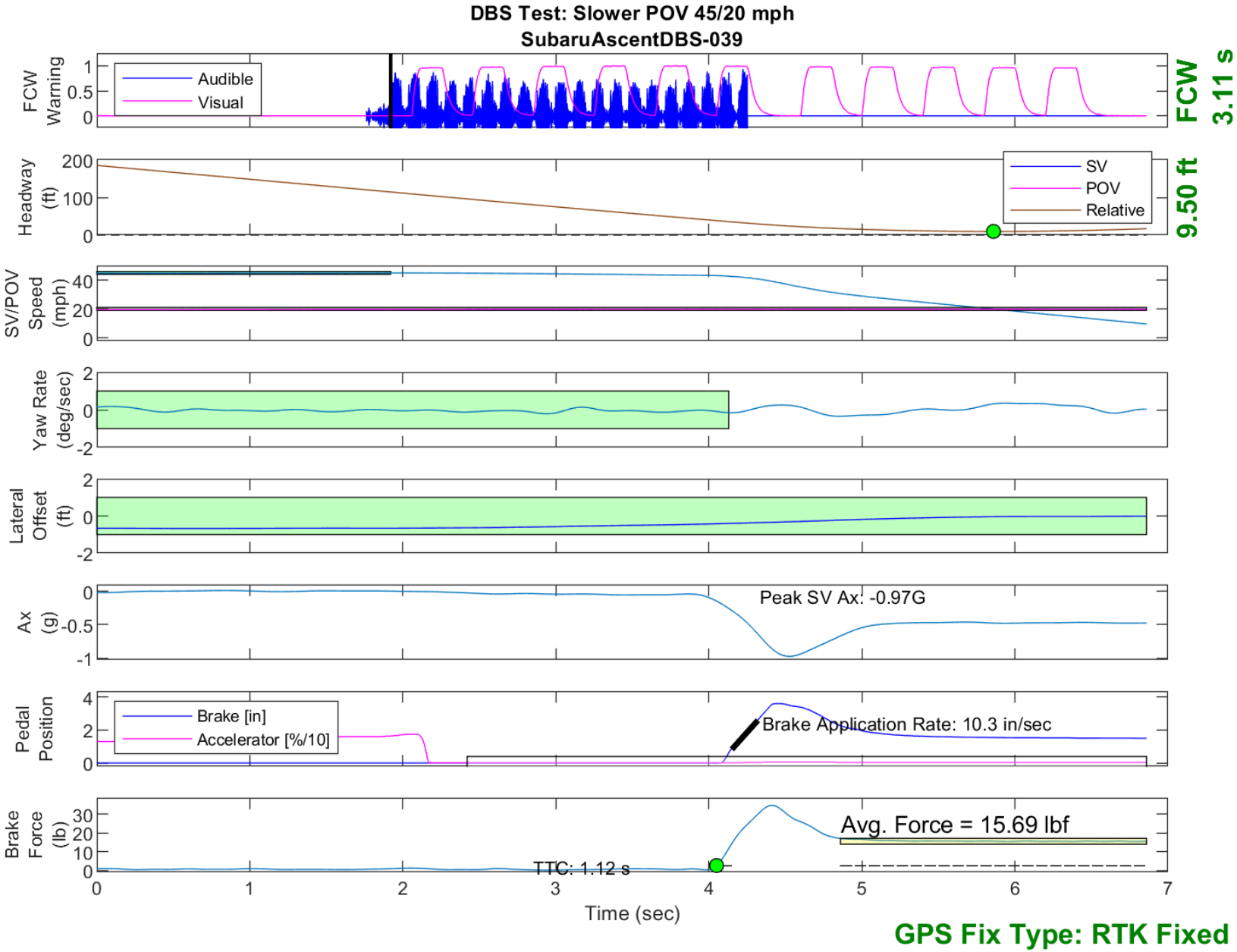

Figure E31. Time History for DBS Run 39, SV Encounters Slower POV, SV 45 mph, POV 20 mph

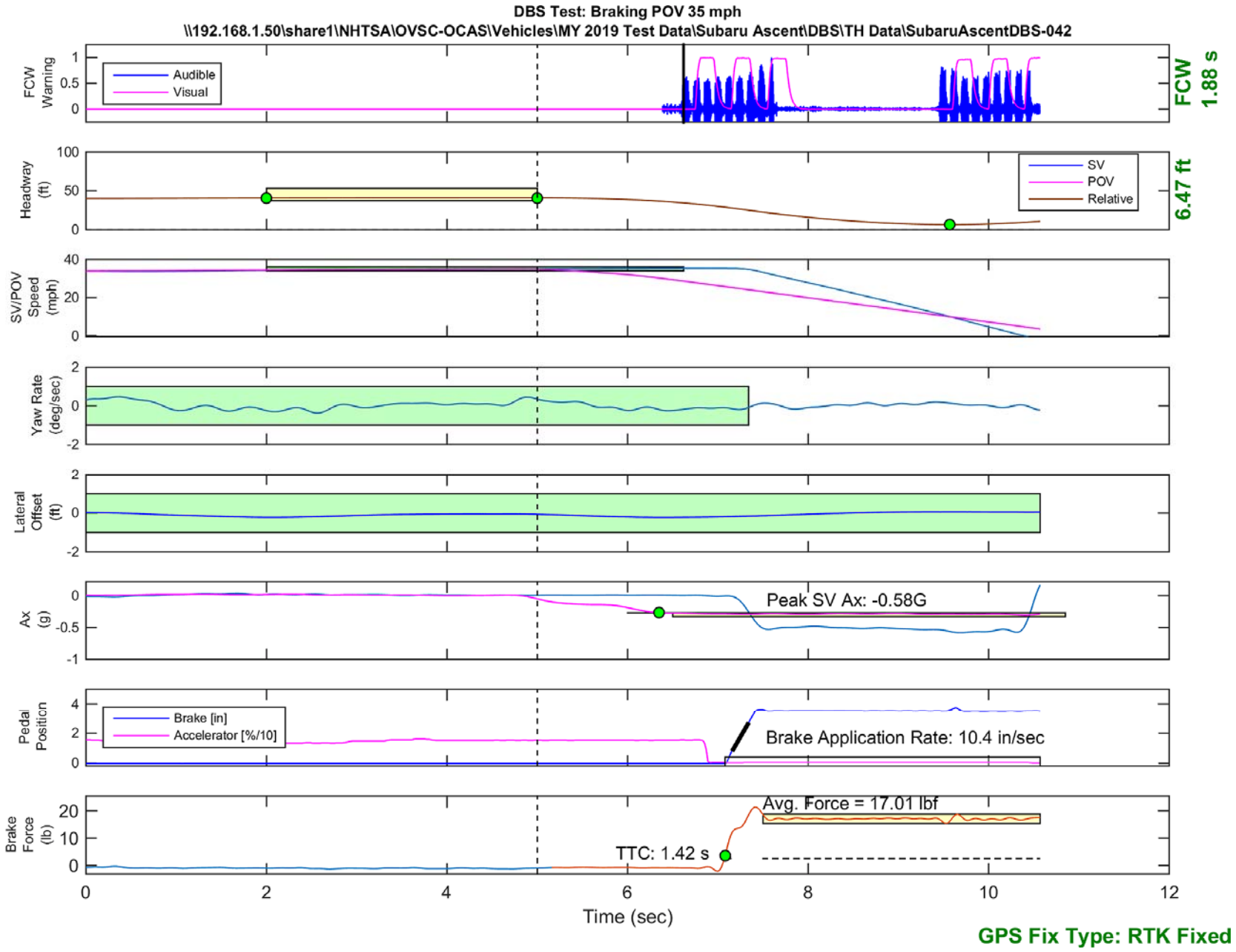

Figure E32. Time History for DBS Run 42, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

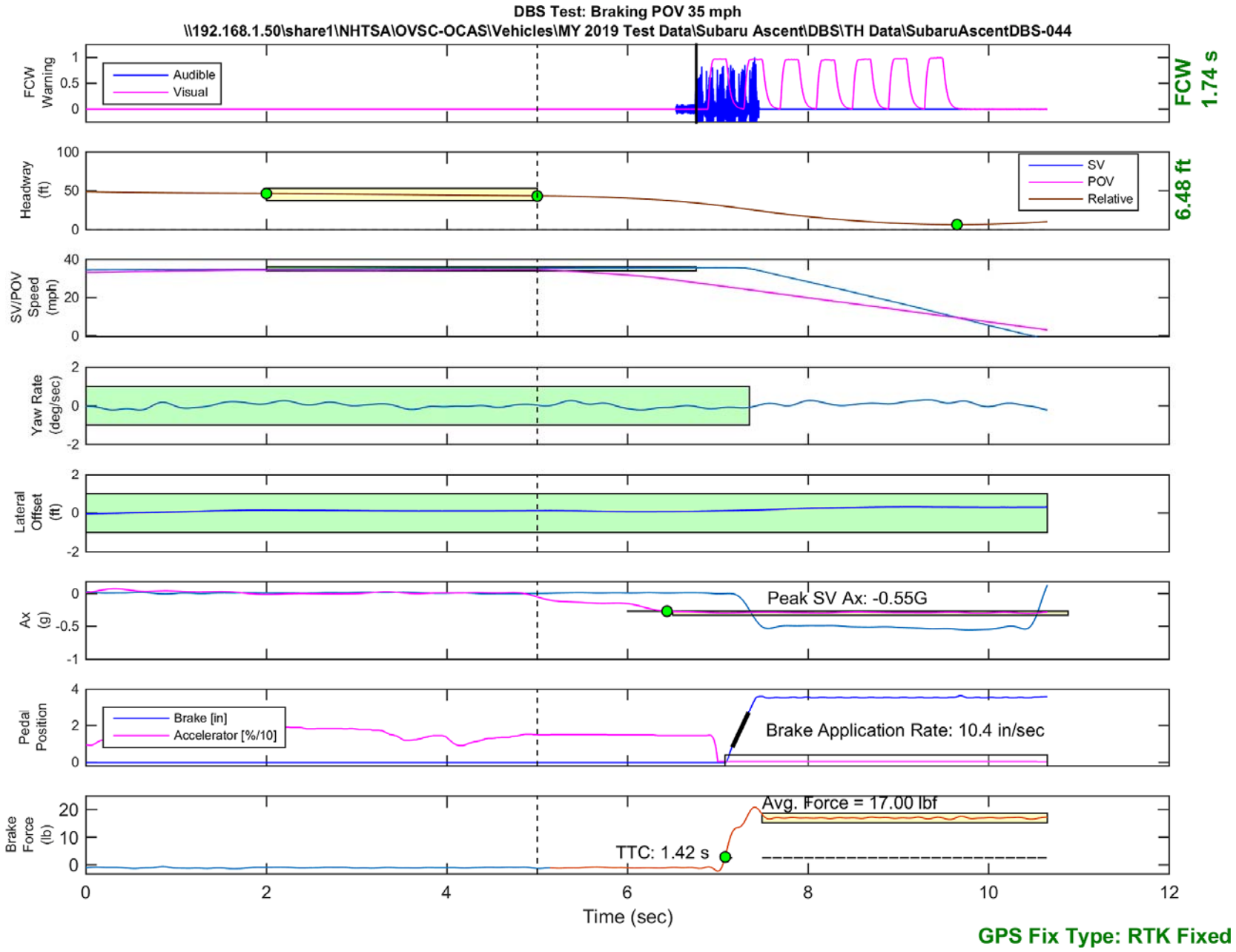

Figure E33. Time History for DBS Run 44, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

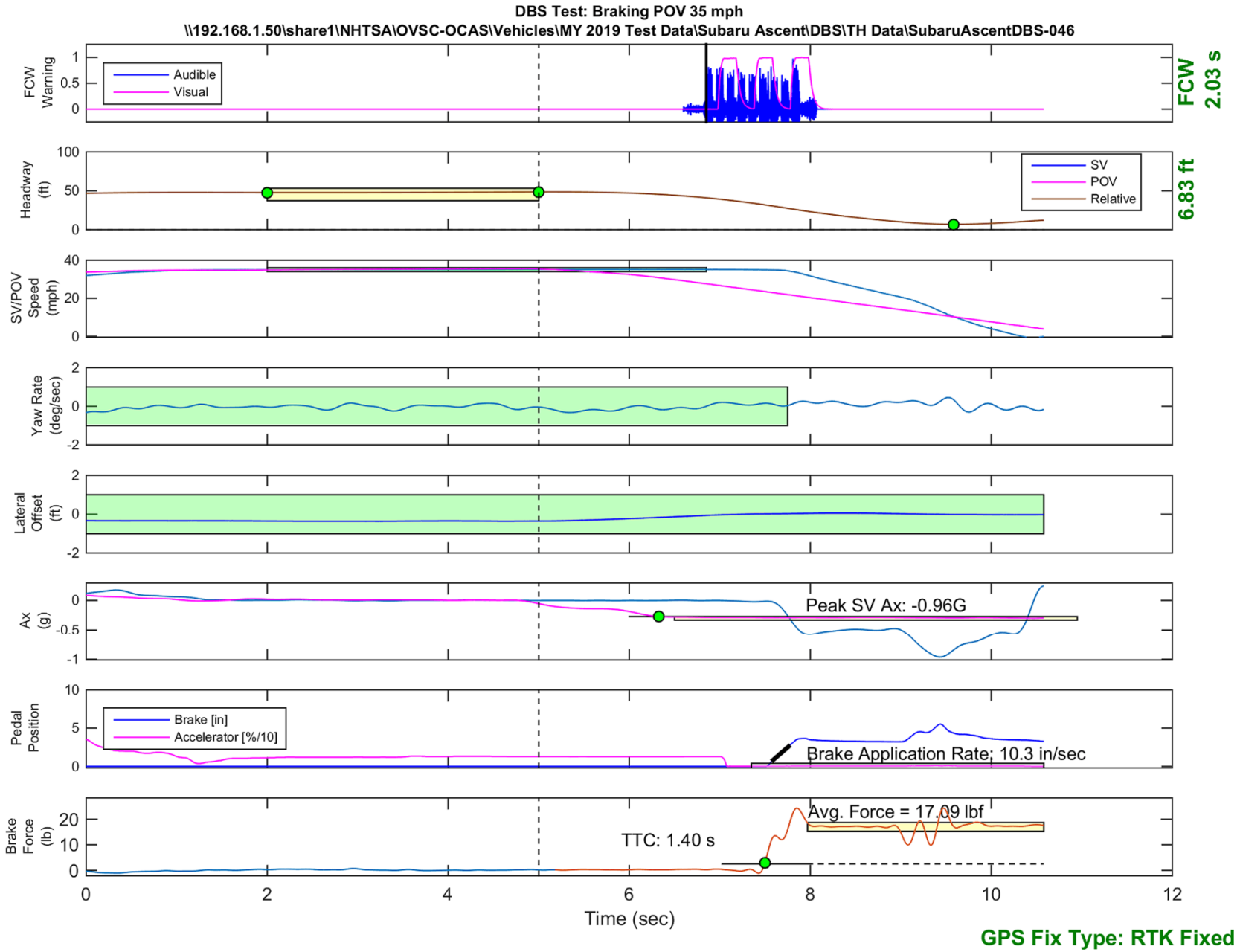

Figure E34. Time History for DBS Run 46, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

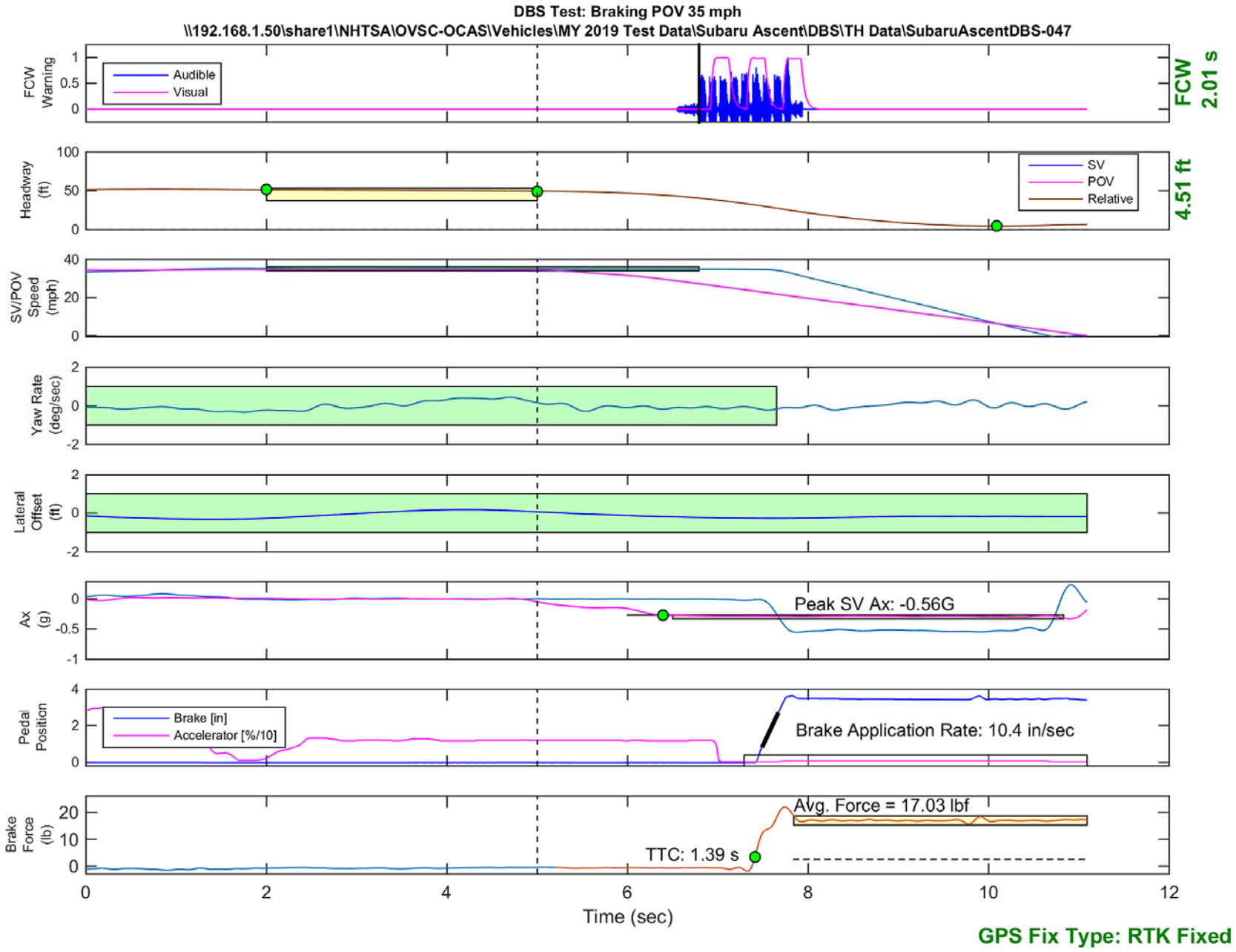

Figure E35. Time History for DBS Run 47, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

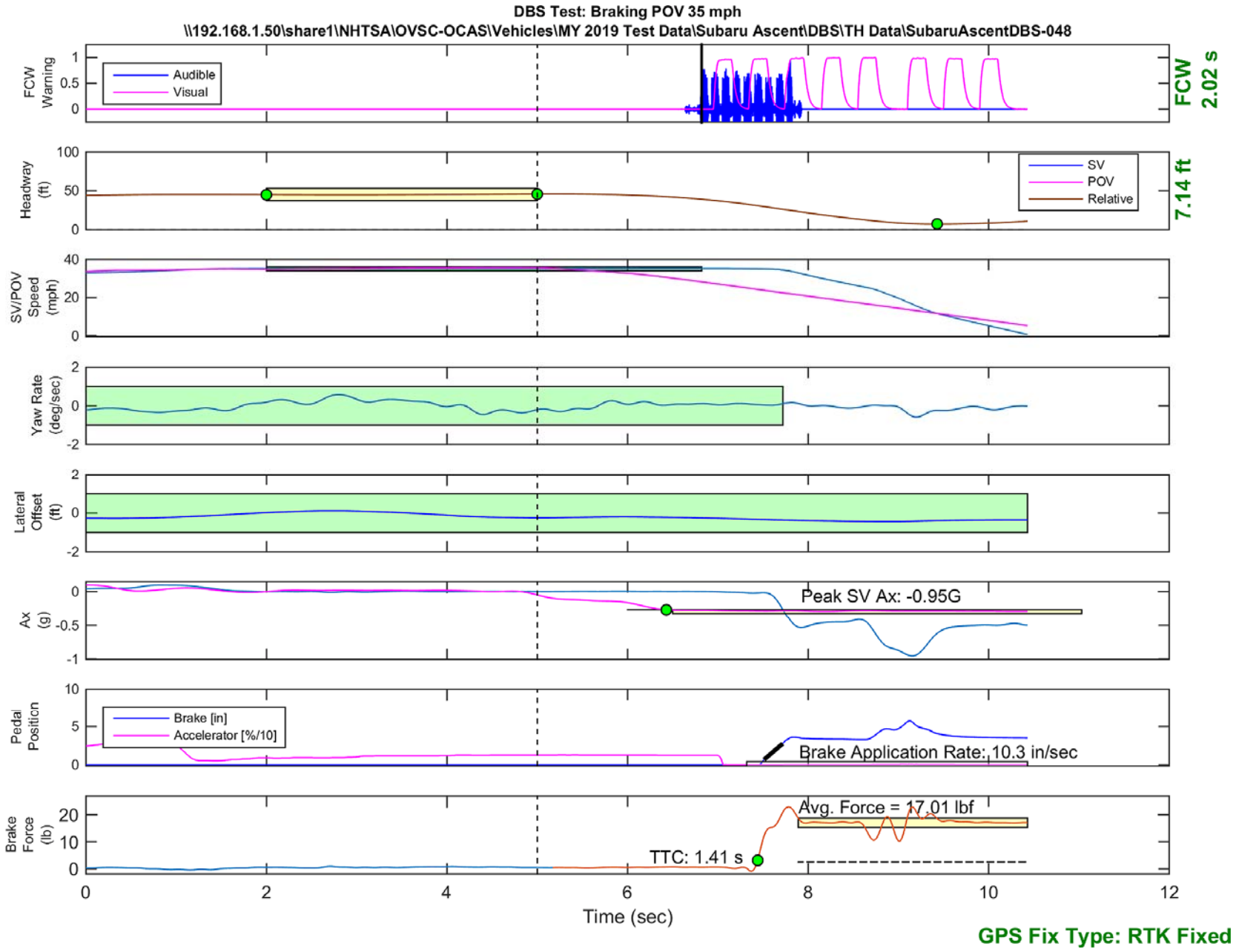

Figure E36. Time History for DBS Run 48, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

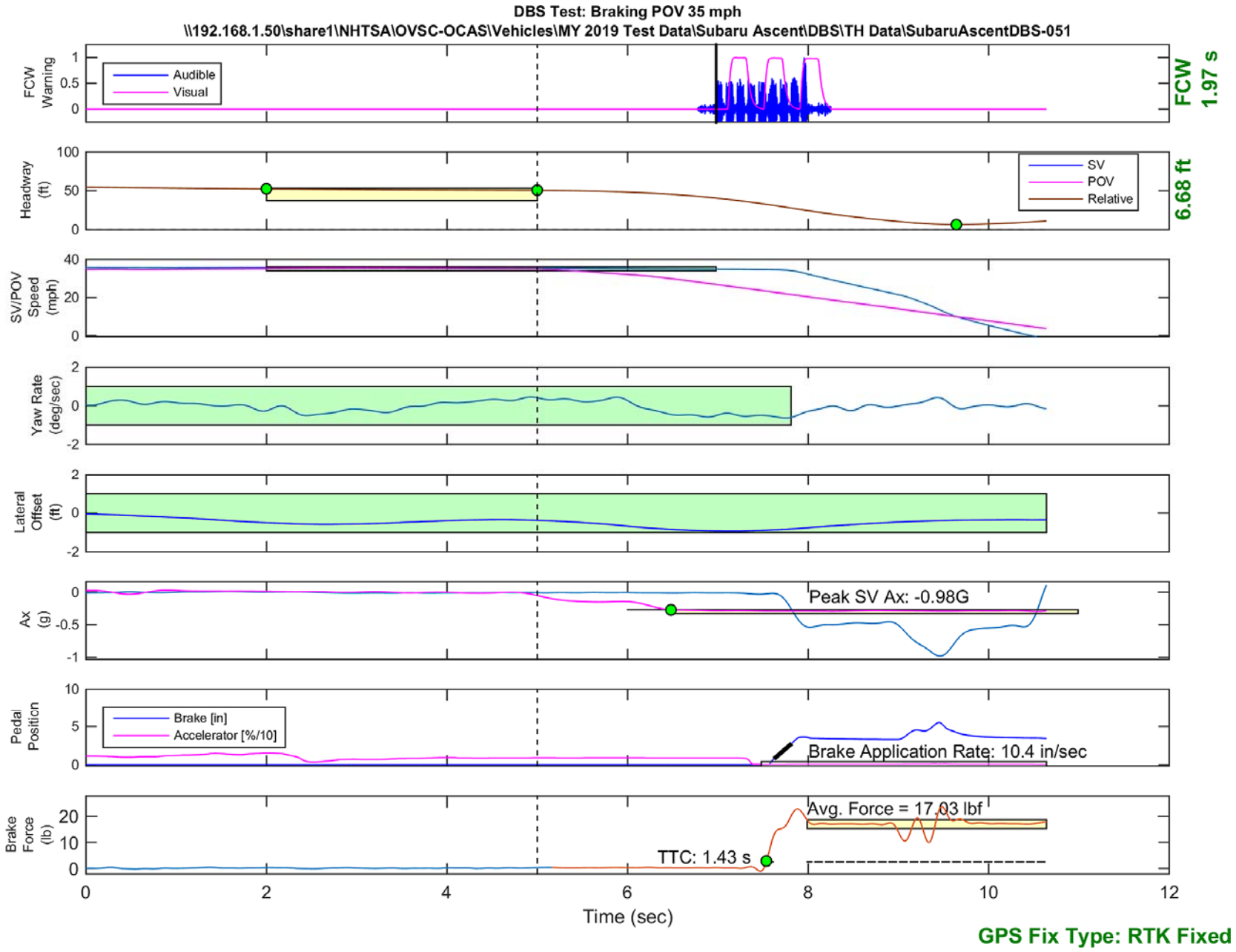

Figure E37. Time History for DBS Run 51, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

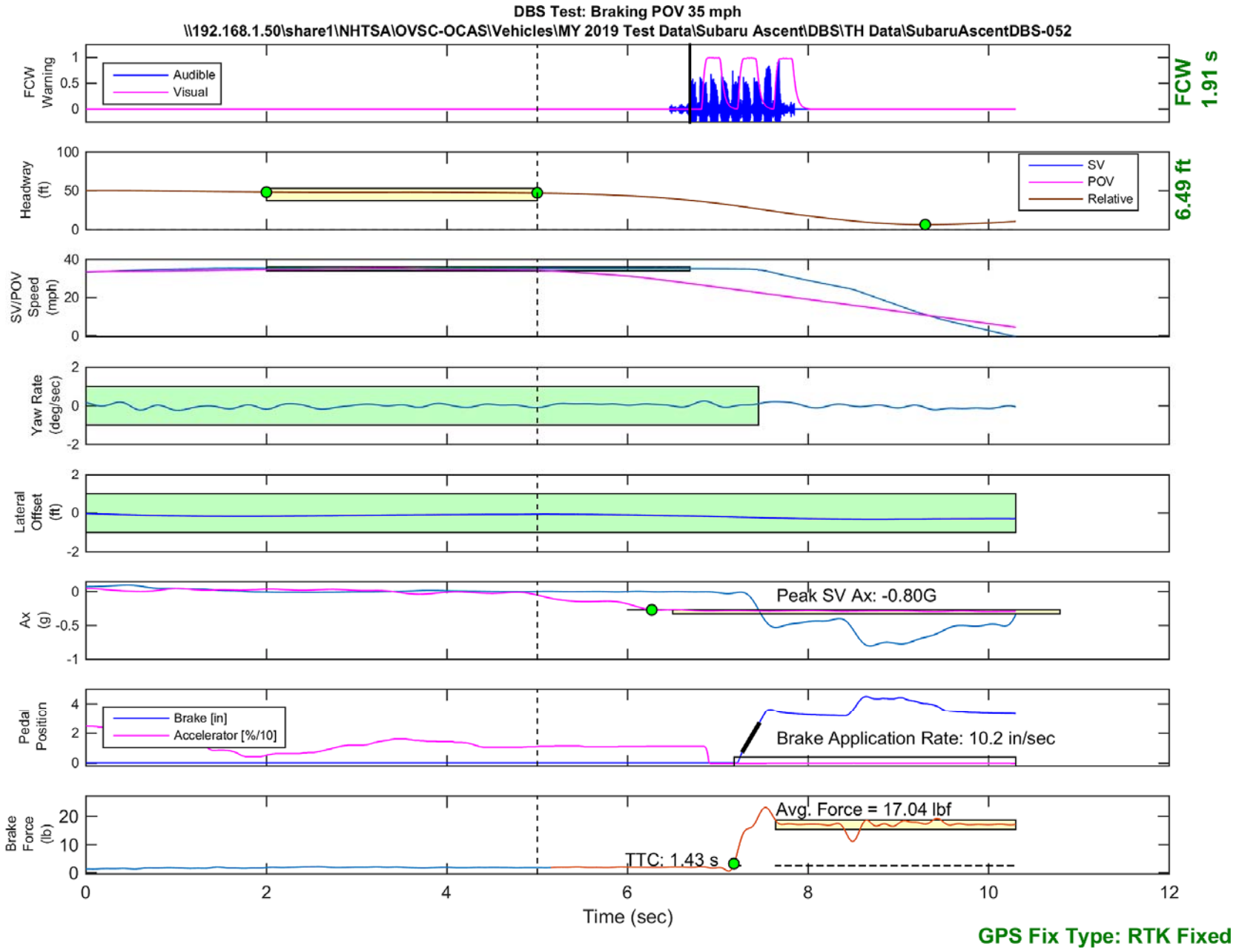

Figure E38. Time History for DBS Run 52, SV Encounters Decelerating POV, SV 35 mph, POV 35 mph

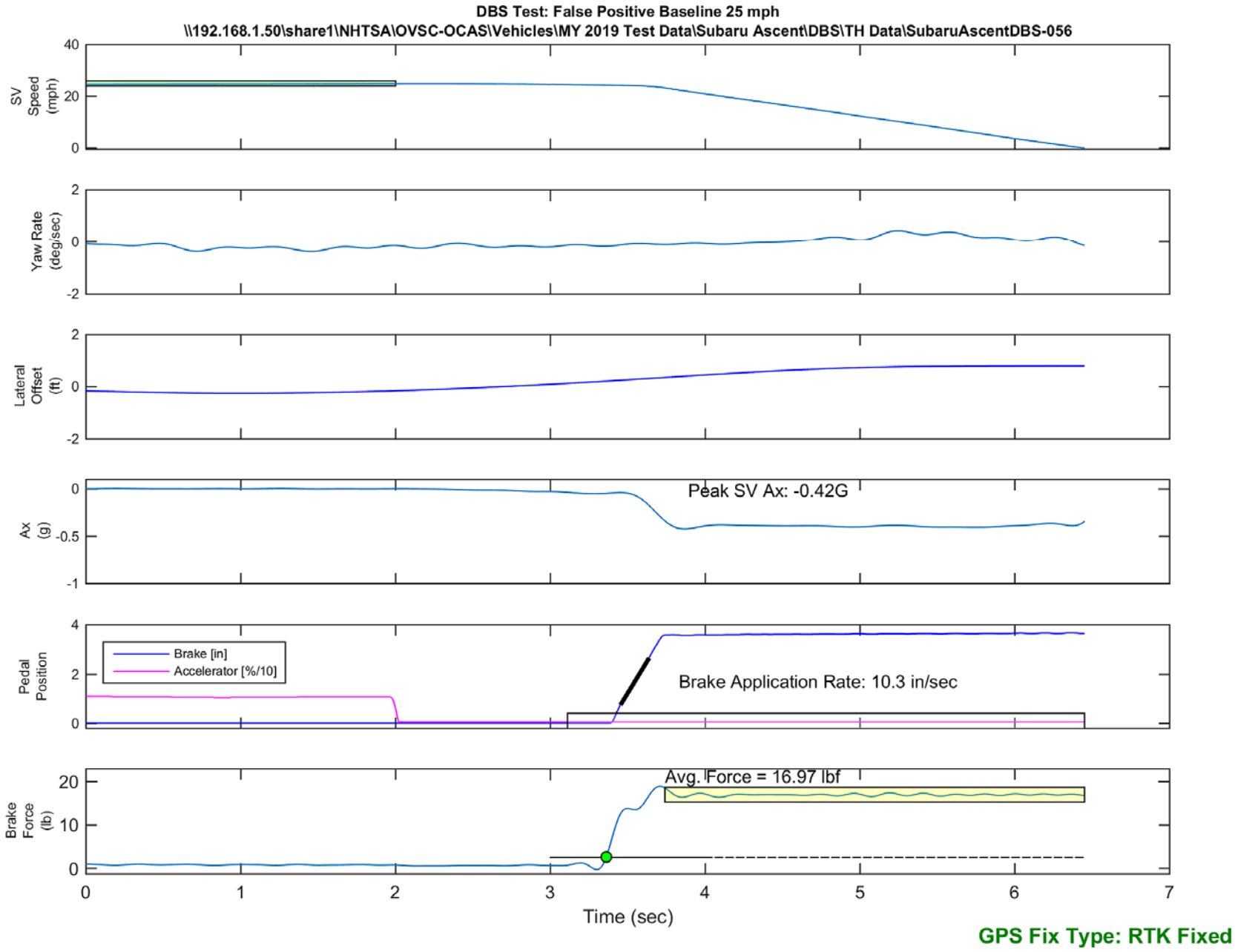

Figure E39. Time History for DBS Run 56, False Positive Baseline, SV 25 mph

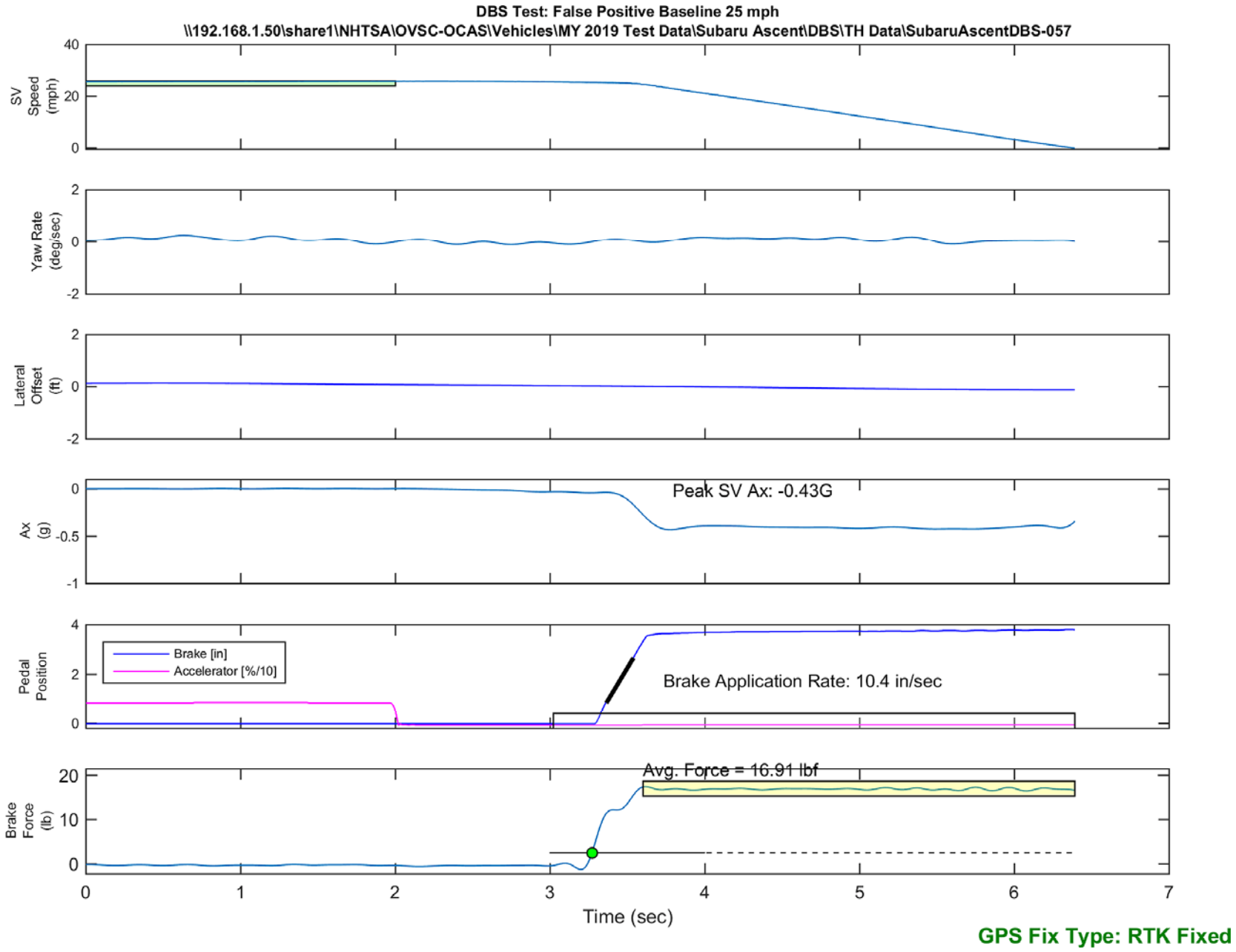

Figure E40. Time History for DBS Run 57, False Positive Baseline, SV 25 mph

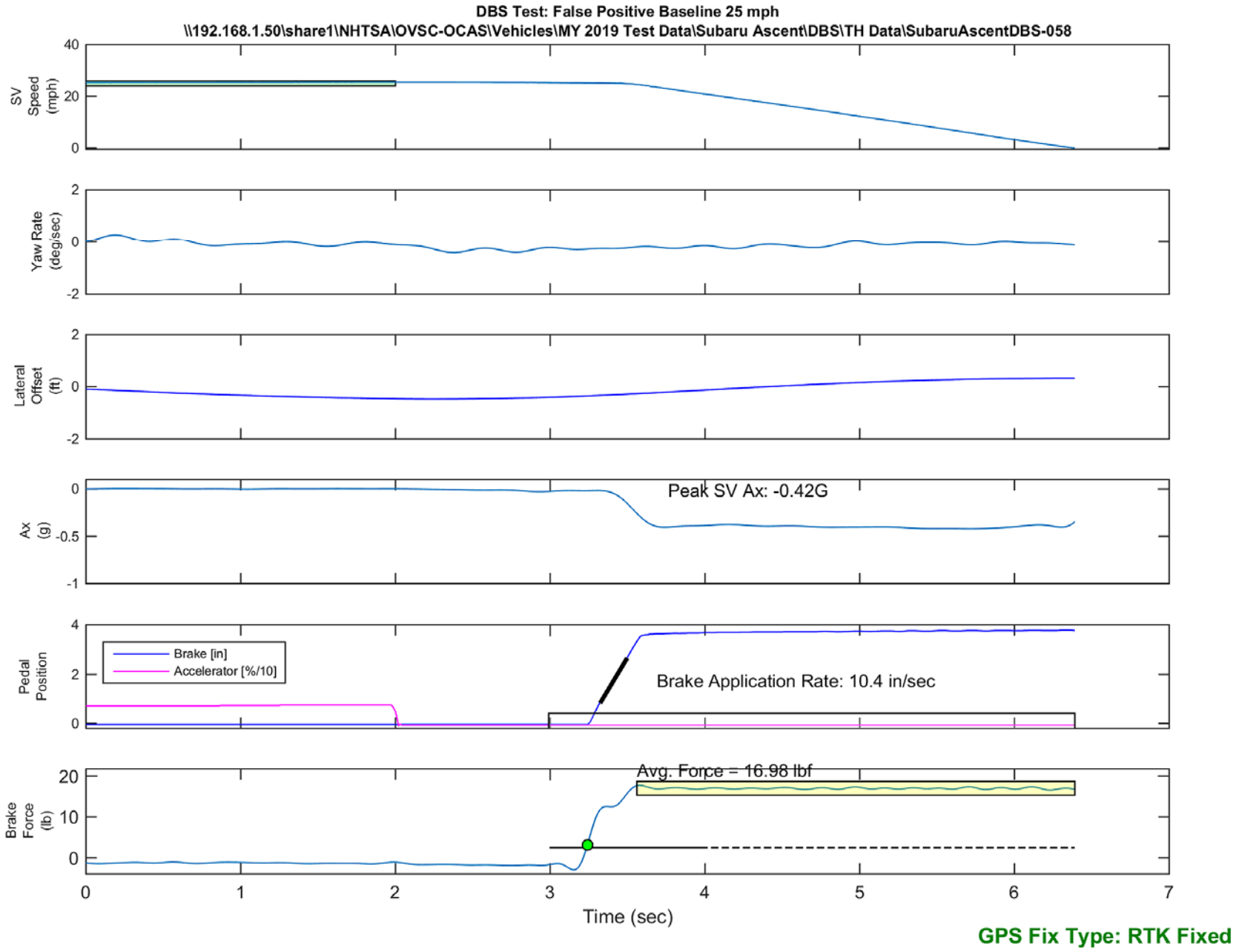

Figure E41. Time History for DBS Run 58, False Positive Baseline, SV 25 mph

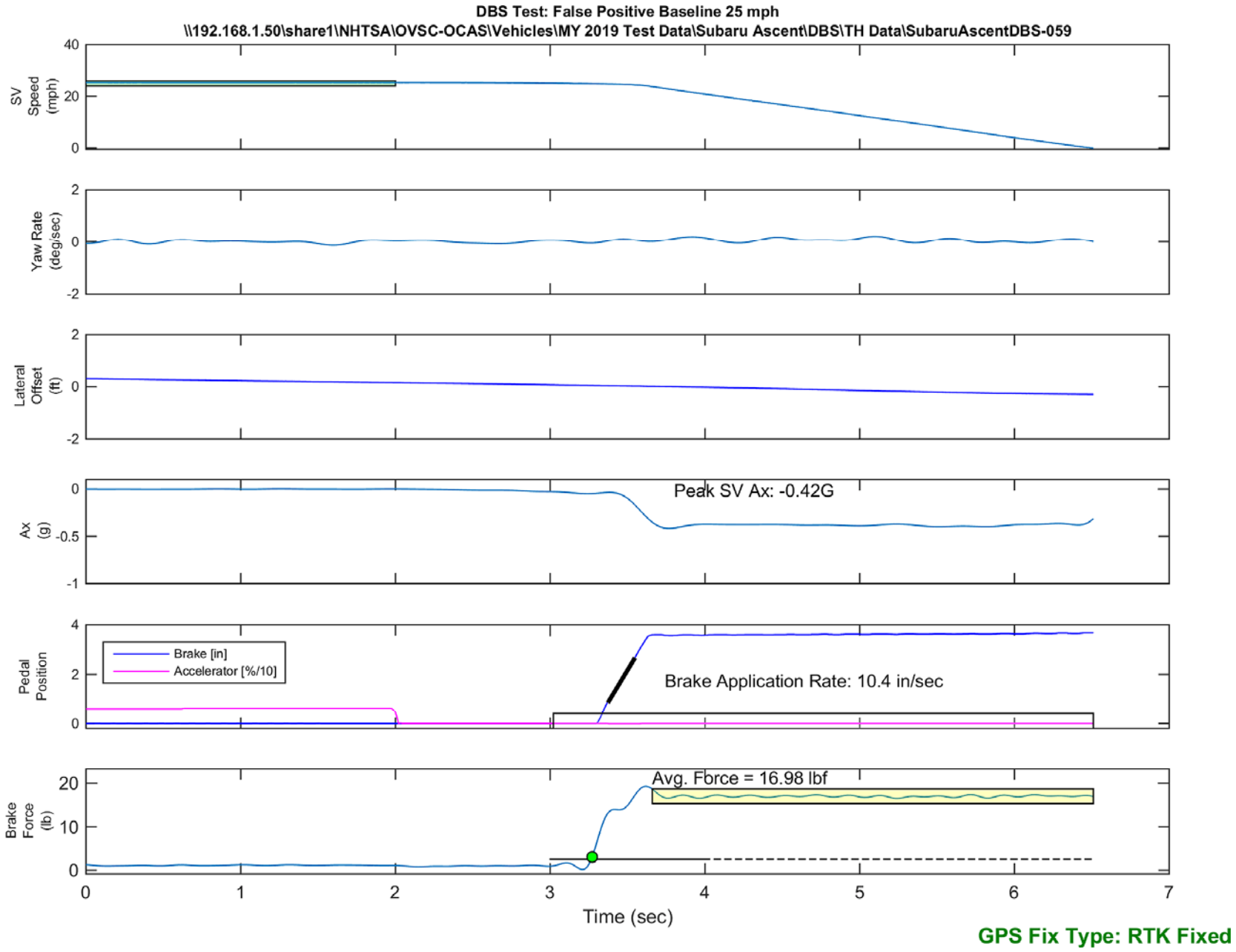

Figure E42. Time History for DBS Run 59, False Positive Baseline, SV 25 mph

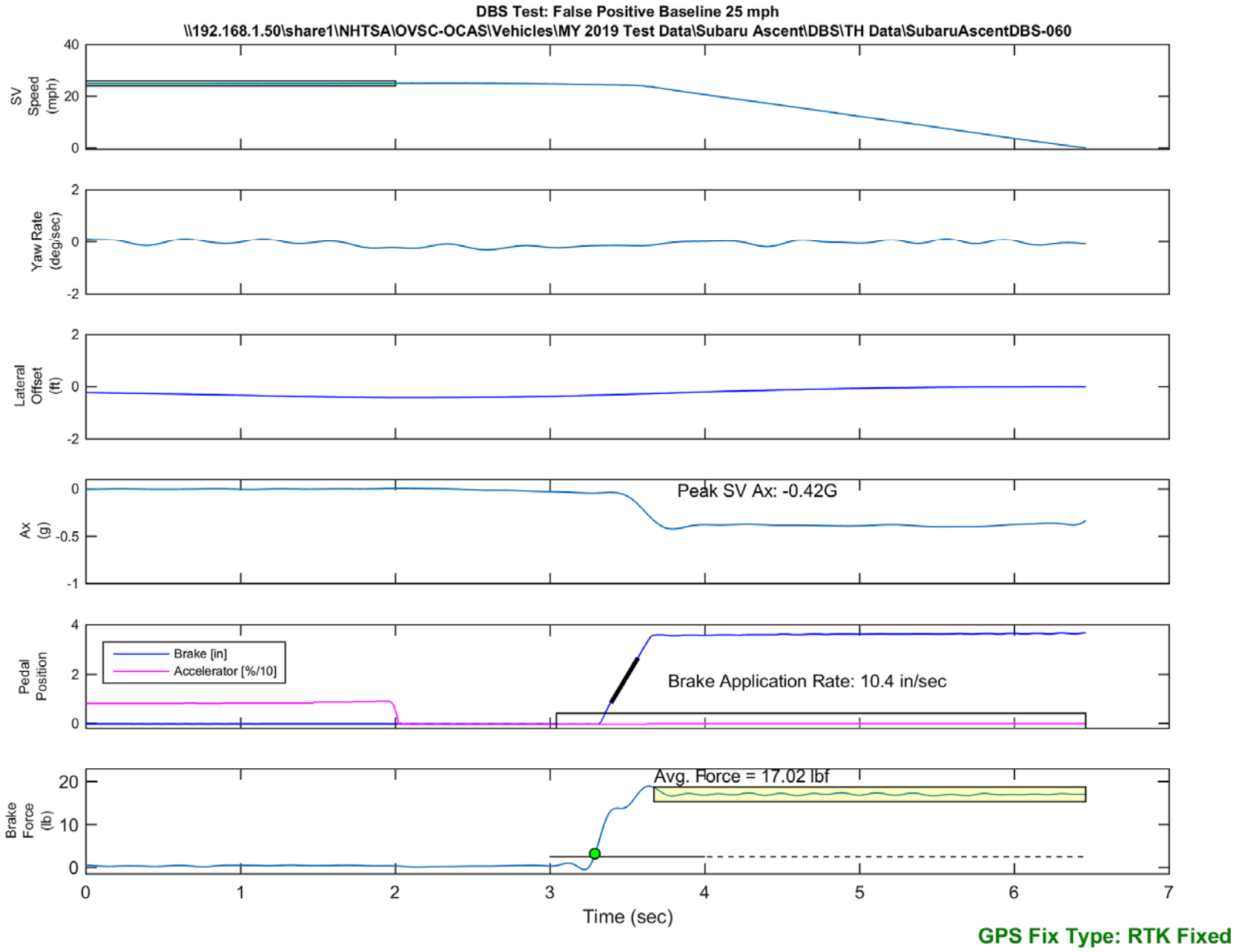

Figure E43. Time History for DBS Run 60, False Positive Baseline, SV 25 mph

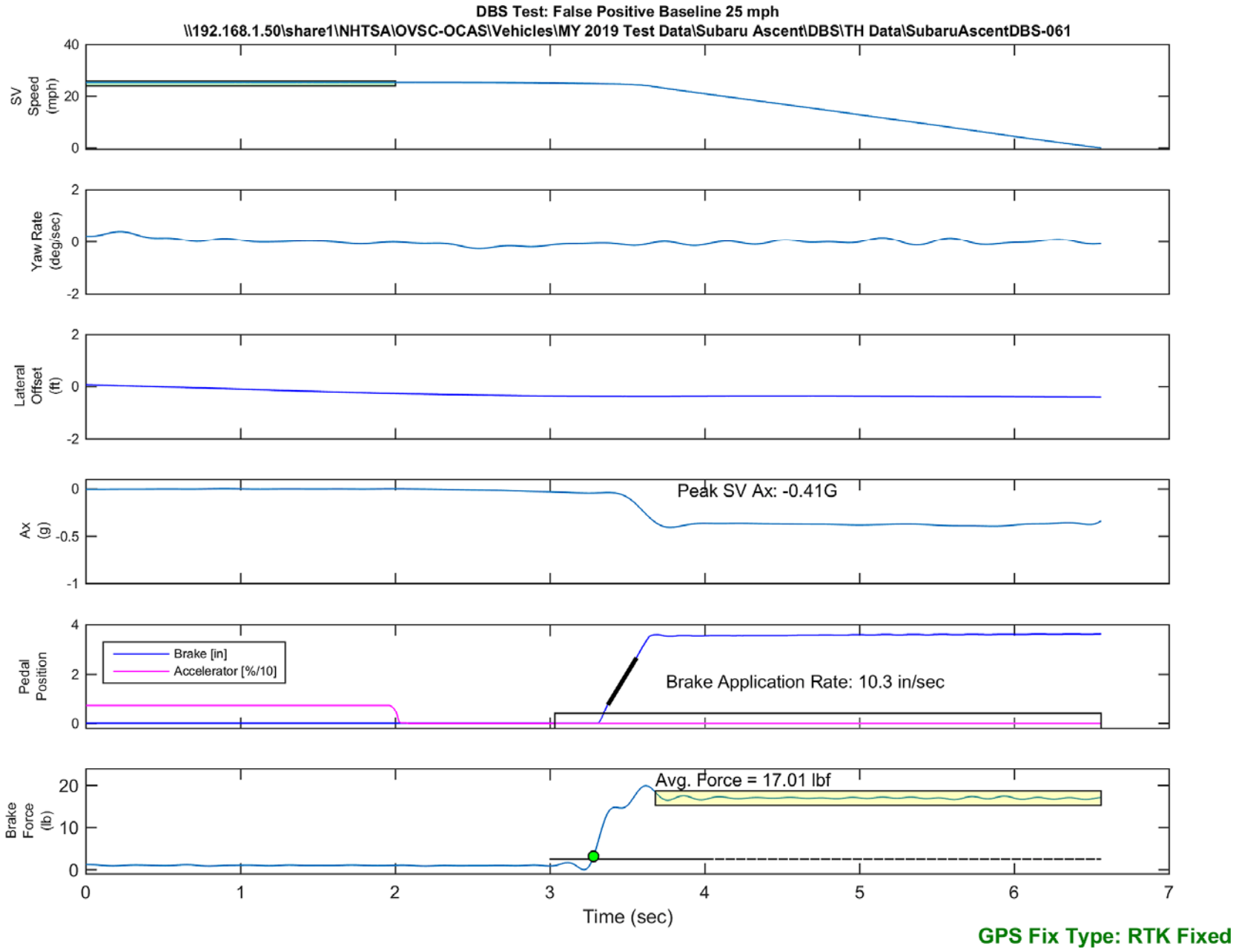

Figure E44. Time History for DBS Run 61, False Positive Baseline, SV 25 mph

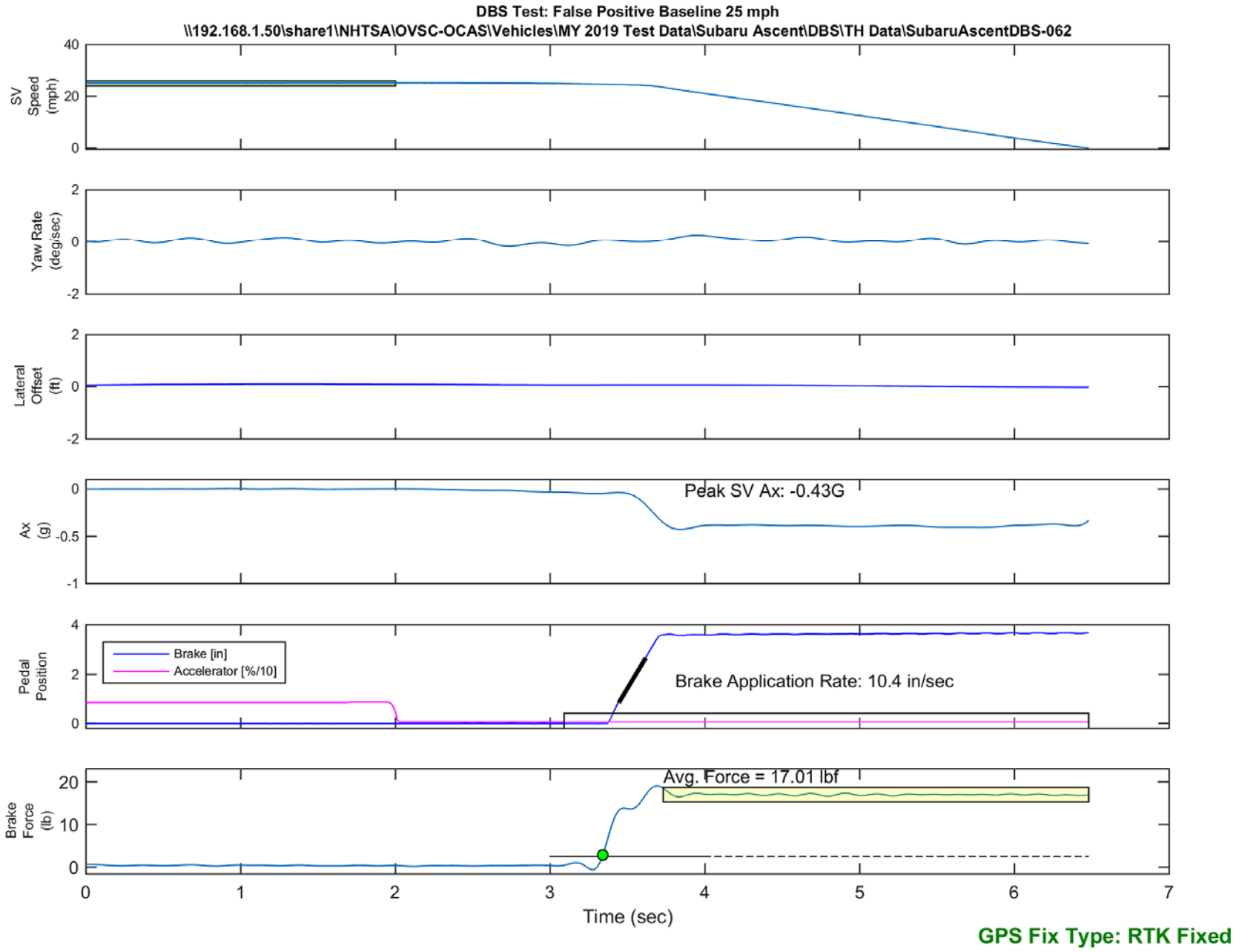

Figure E45. Time History for DBS Run 62, False Positive Baseline, SV 25 mph

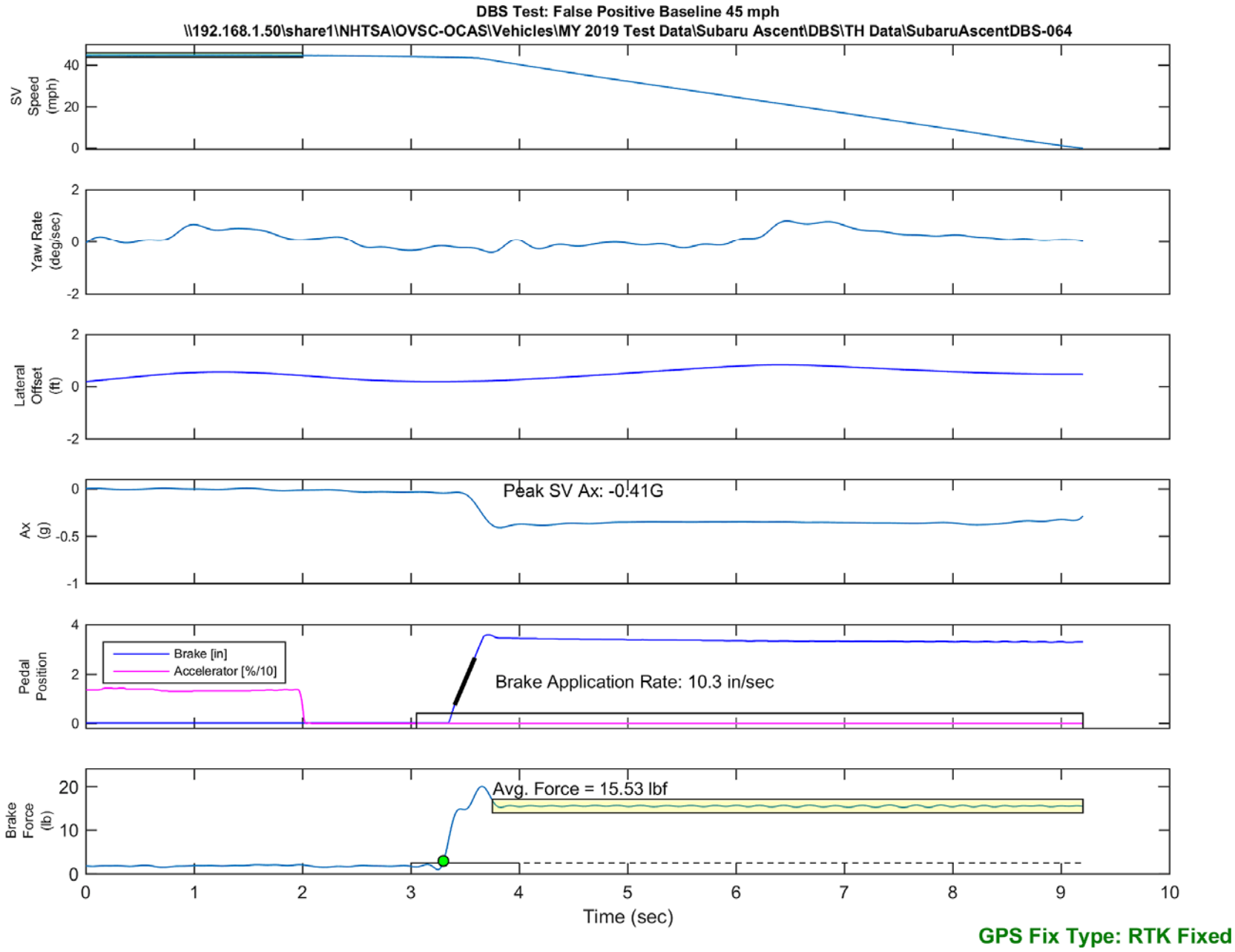

Figure E46. Time History for DBS Run 64, False Positive Baseline, SV 45 mph

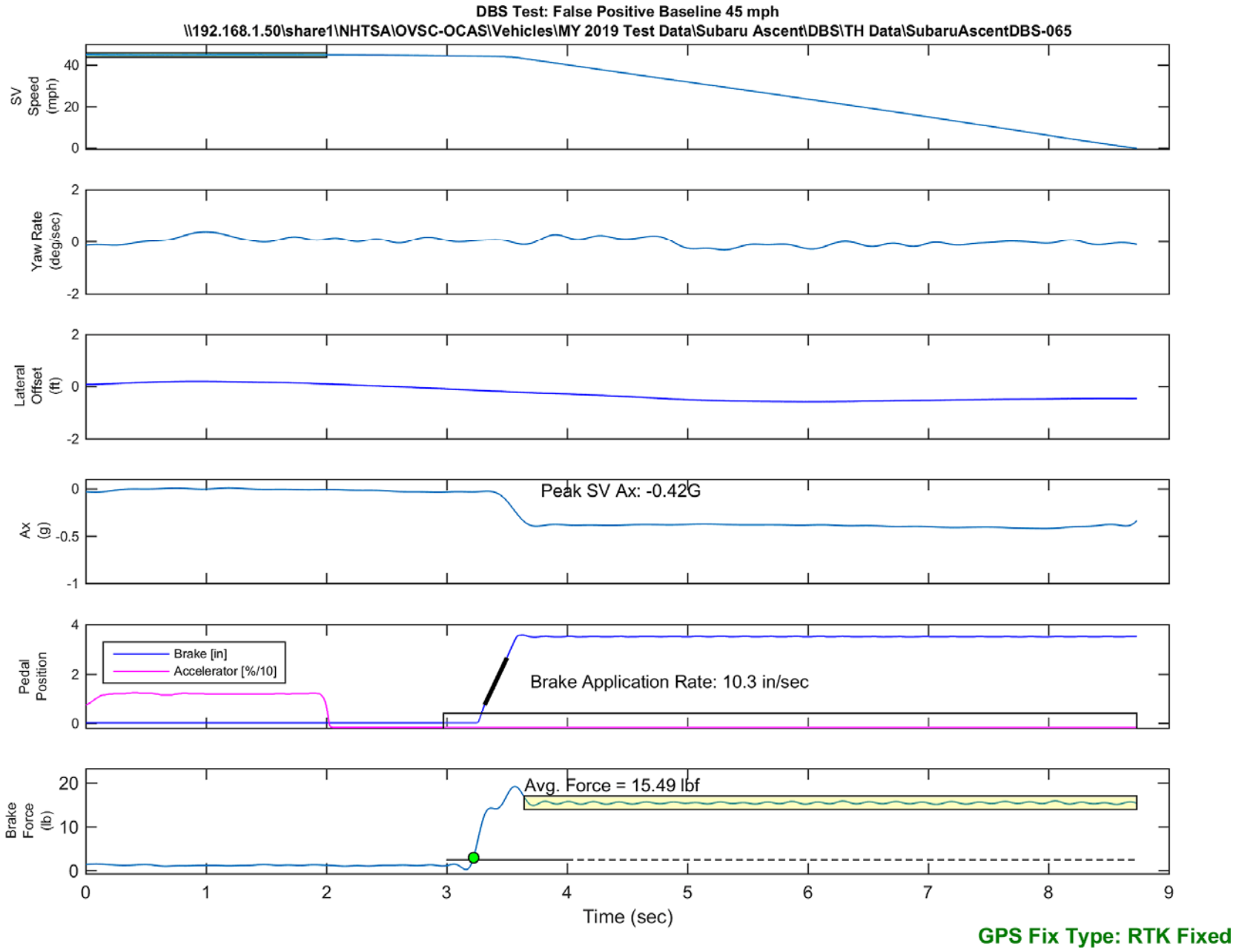

Figure E47. Time History for DBS Run 65, False Positive Baseline, SV 45 mph

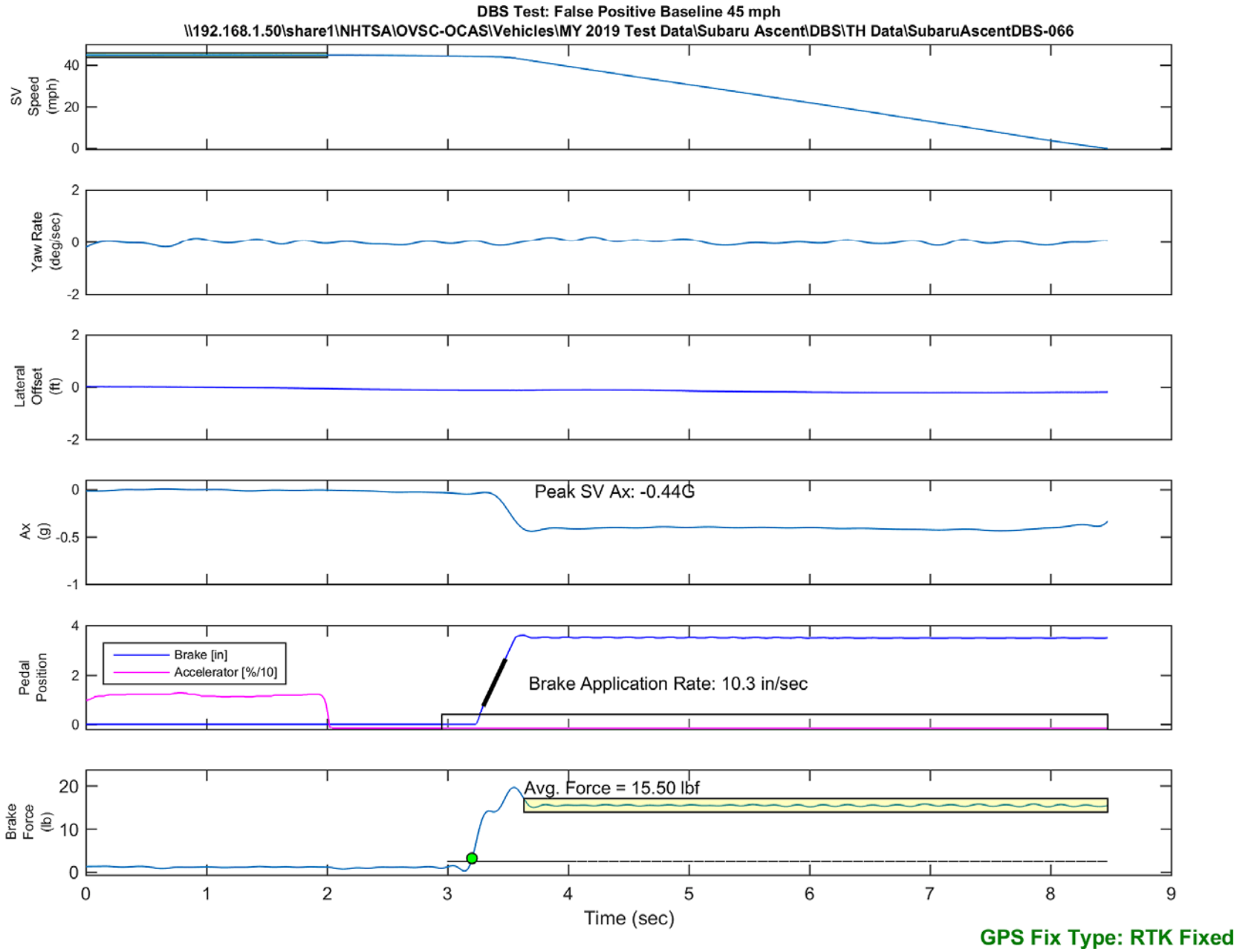

Figure E48. Time History for DBS Run 66, False Positive Baseline, SV 45 mph

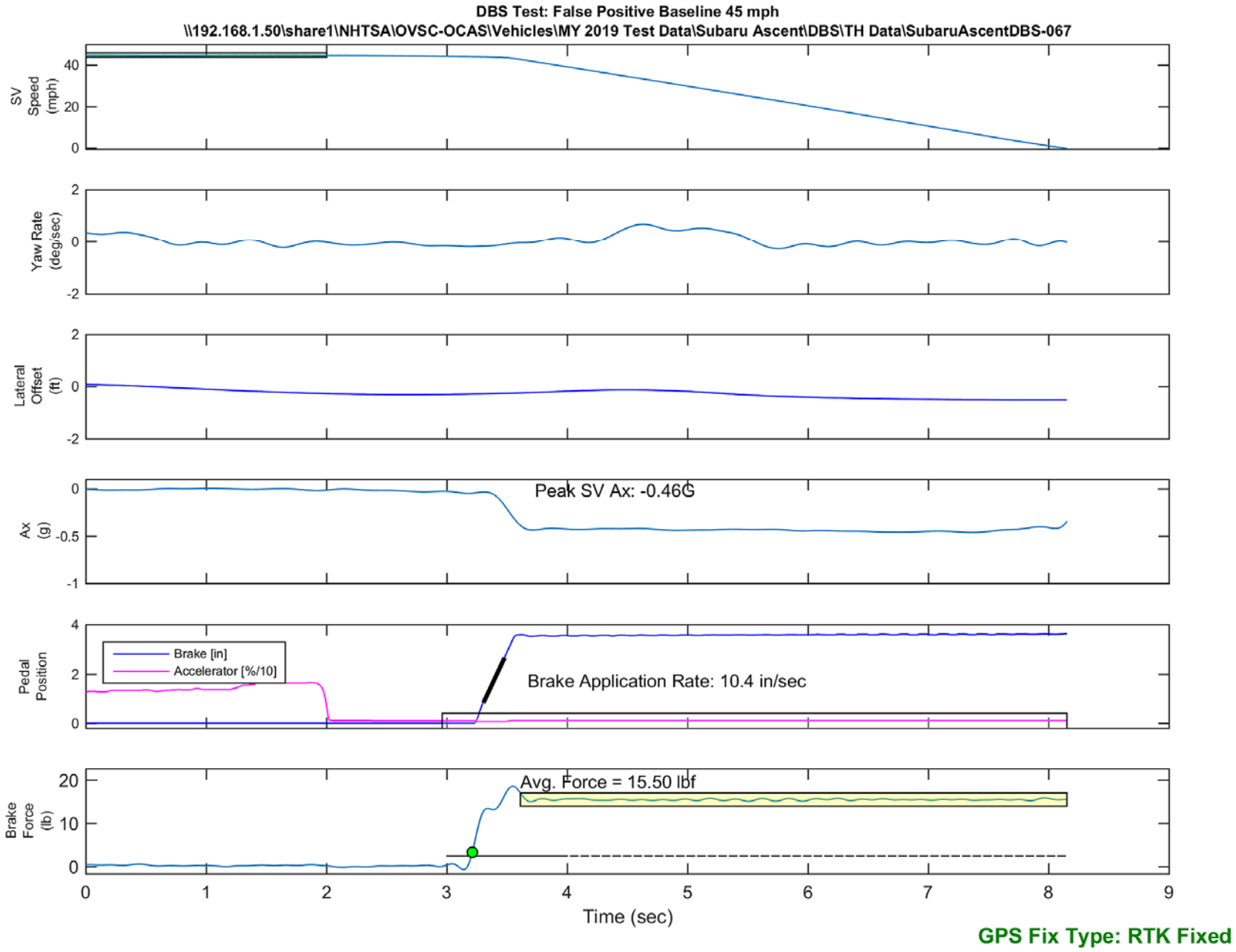

Figure E49. Time History for DBS Run 67, False Positive Baseline, SV 45 mph

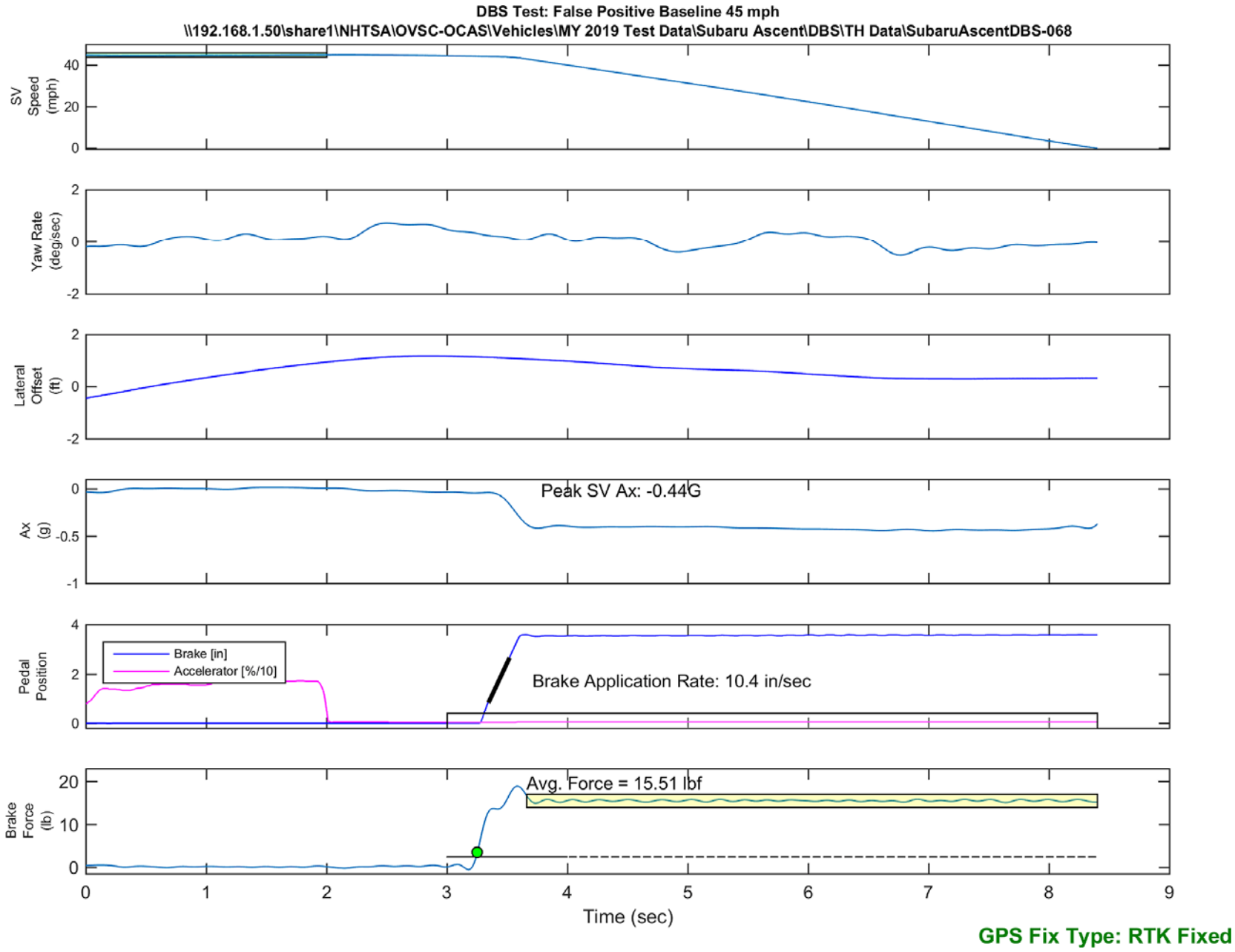

Figure E50. Time History for DBS Run 68, False Positive Baseline, SV 45 mph

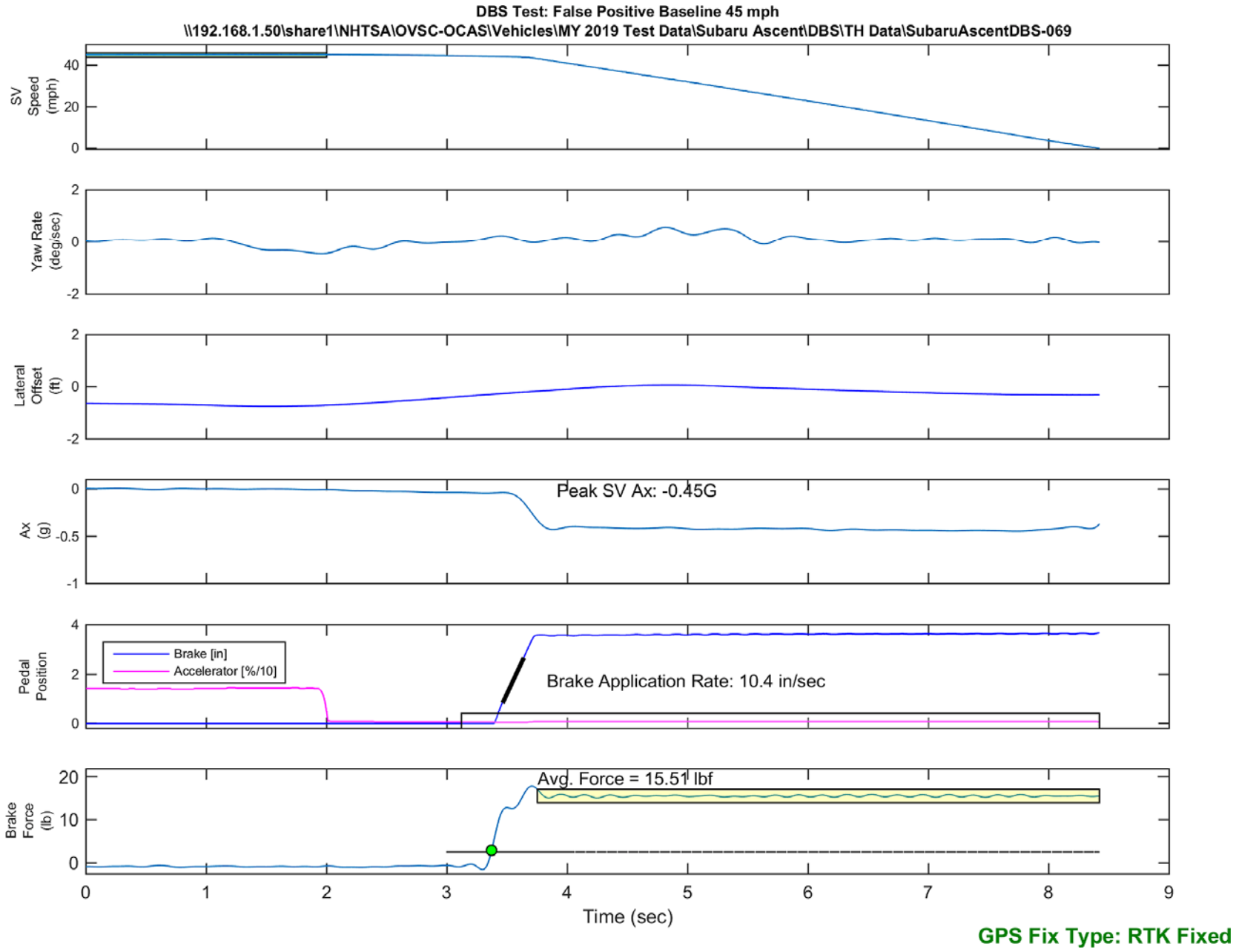

Figure E51. Time History for DBS Run 69, False Positive Baseline, SV 45 mph

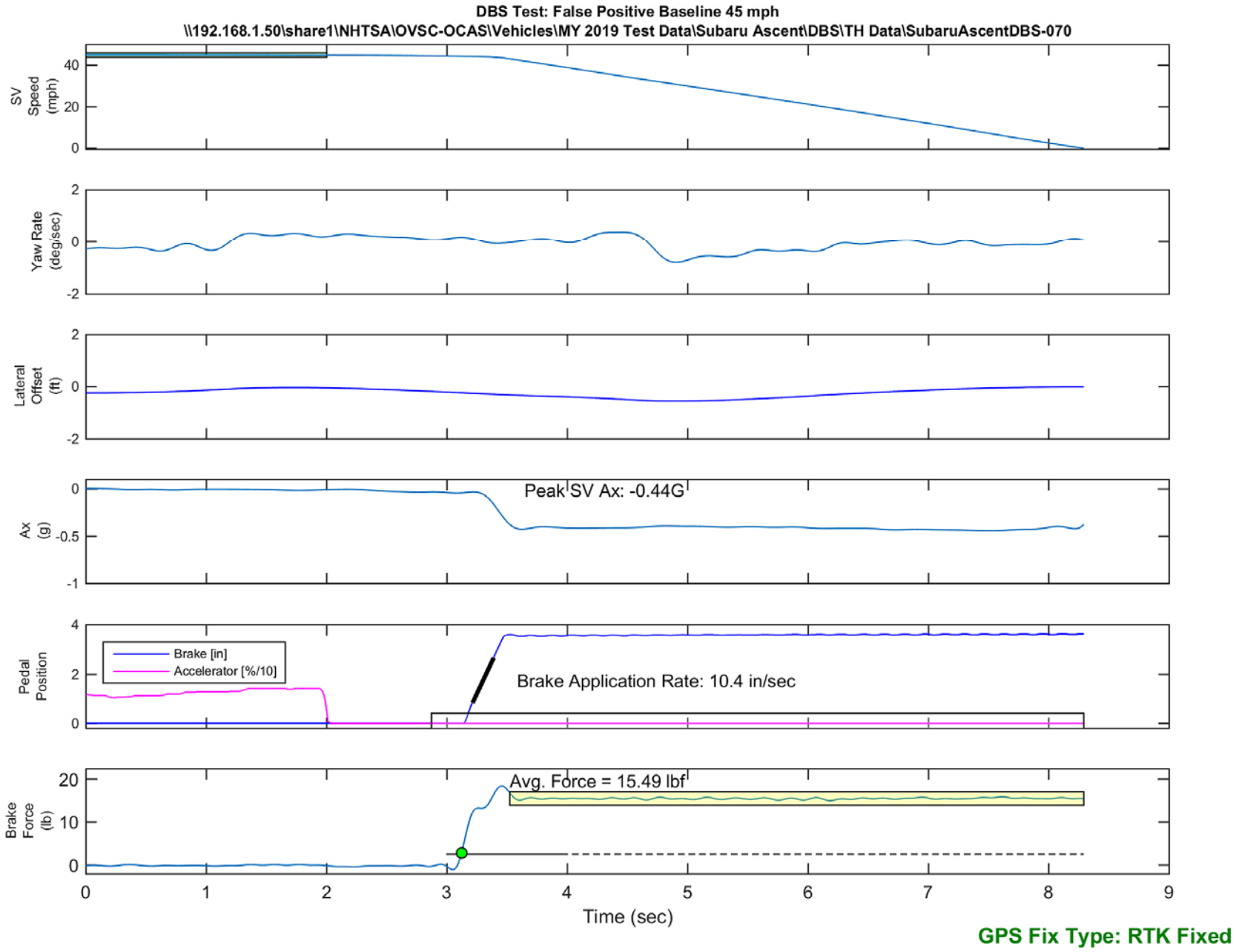

Figure E52. Time History for DBS Run 70, False Positive Baseline, SV 45 mph

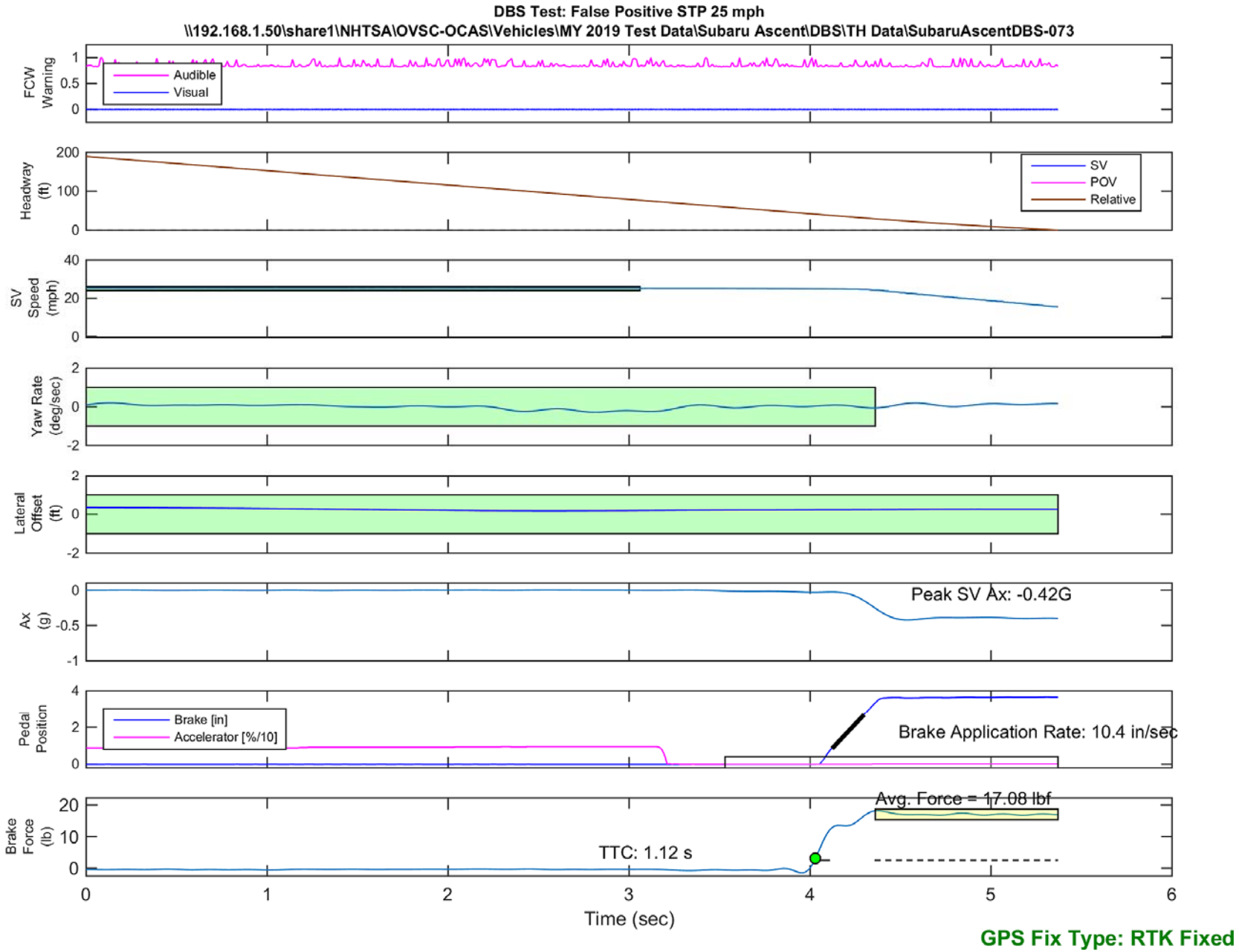

Figure E53. Time History for DBS Run 73, SV Encounters Steel Trench Plate, SV 25 mph

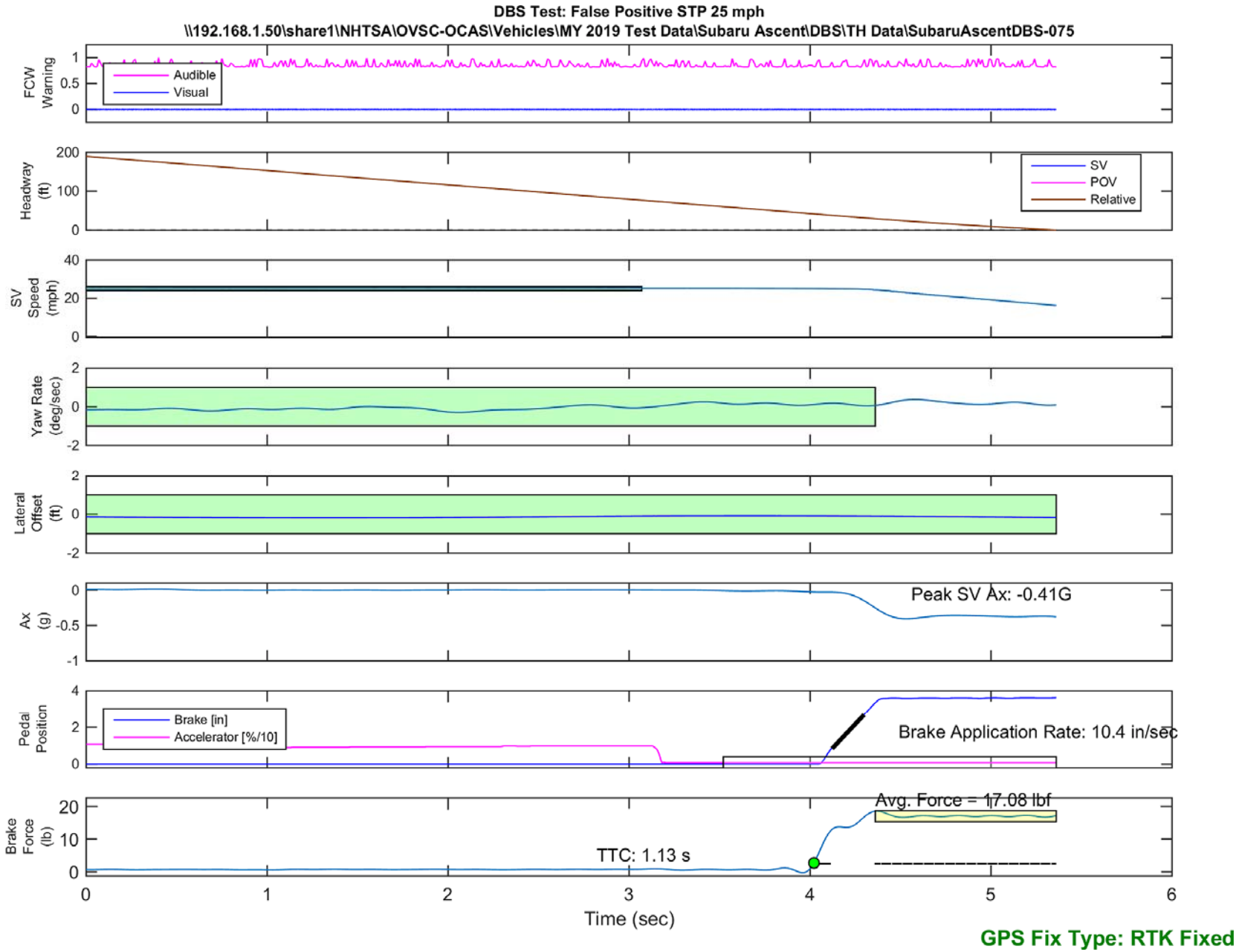

Figure E54. Time History for DBS Run 75, SV Encounters Steel Trench Plate, SV 25 mph

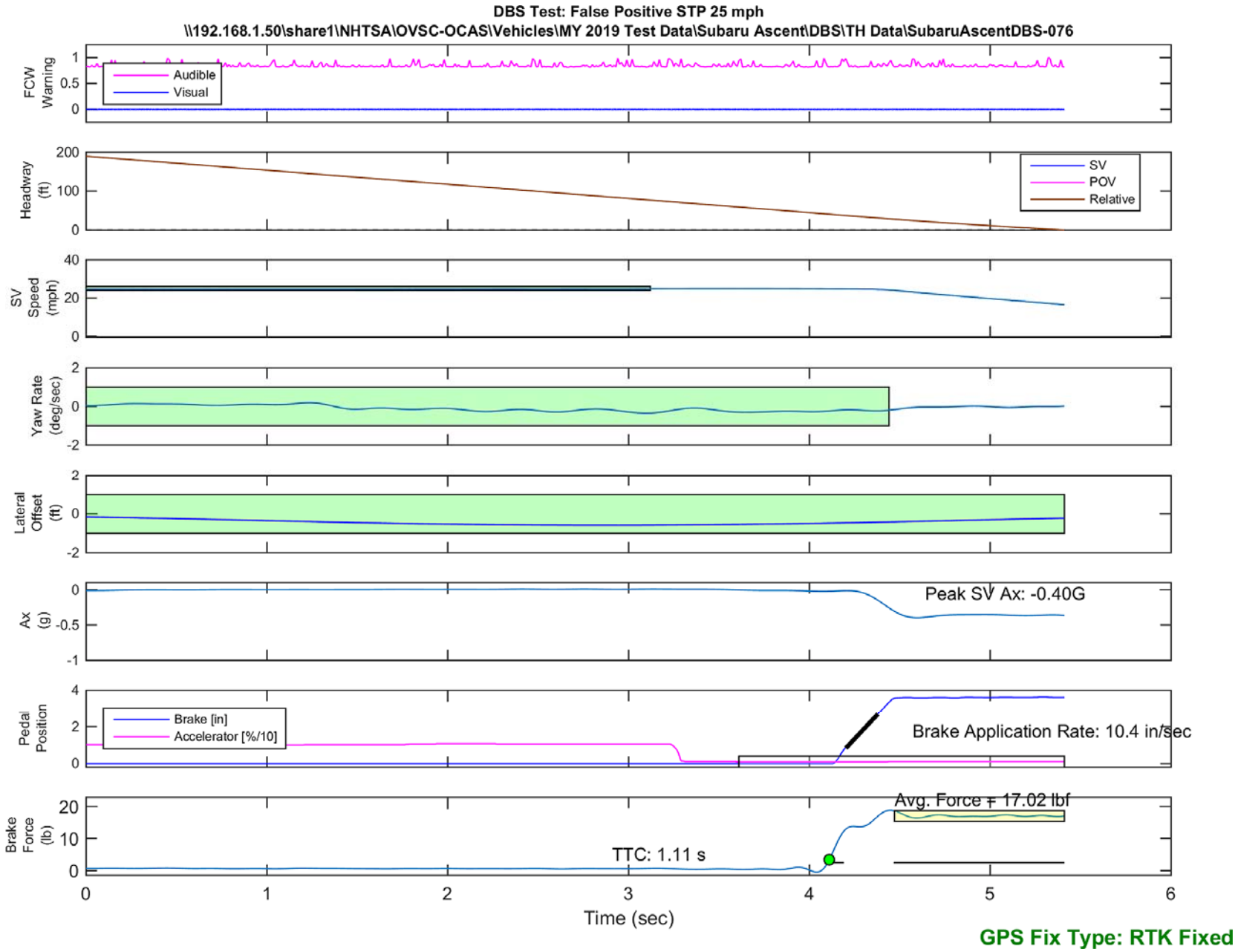

Figure E55. Time History for DBS Run 76, SV Encounters Steel Trench Plate, SV 25 mph

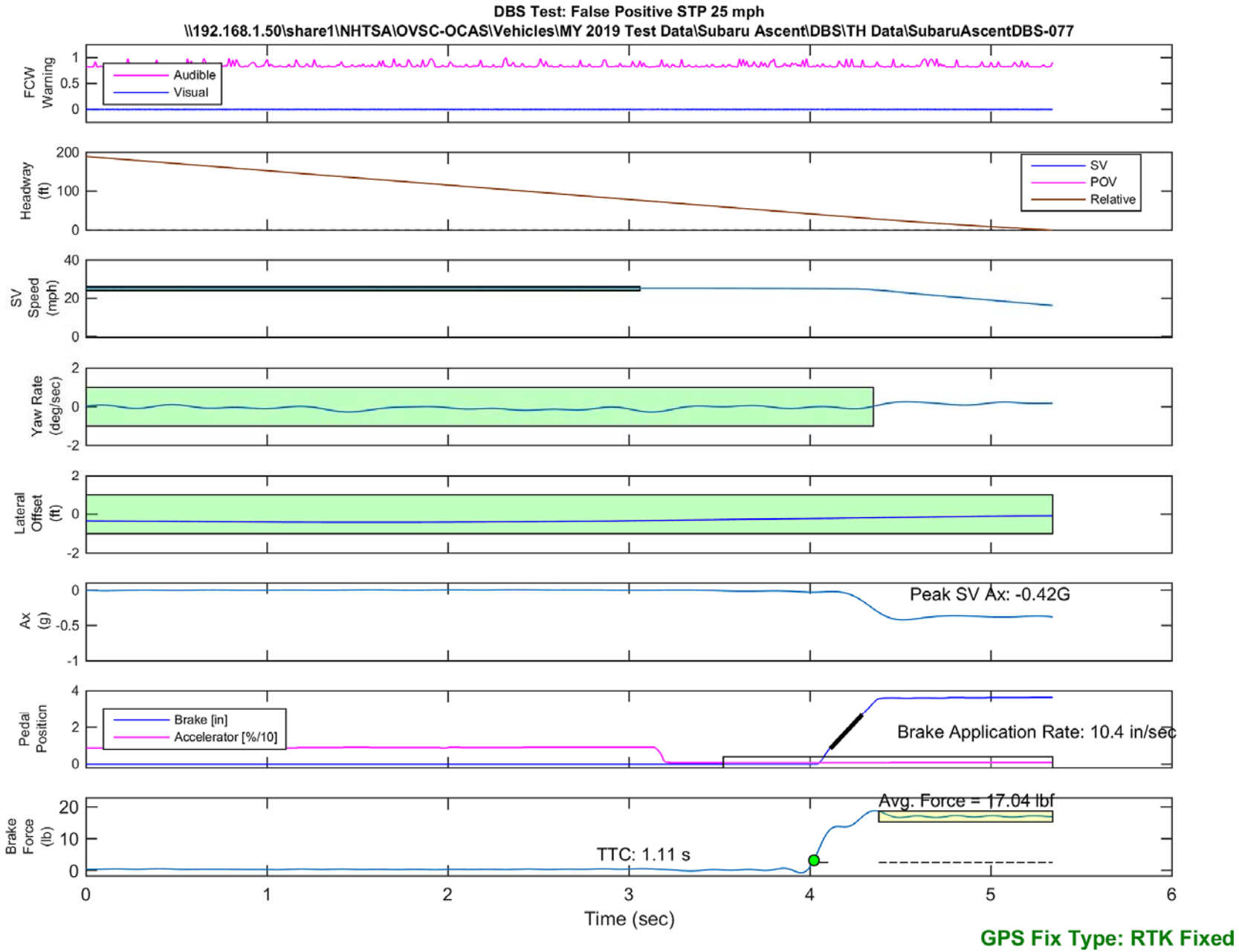

Figure E56. Time History for DBS Run 77, SV Encounters Steel Trench Plate, SV 25 mph

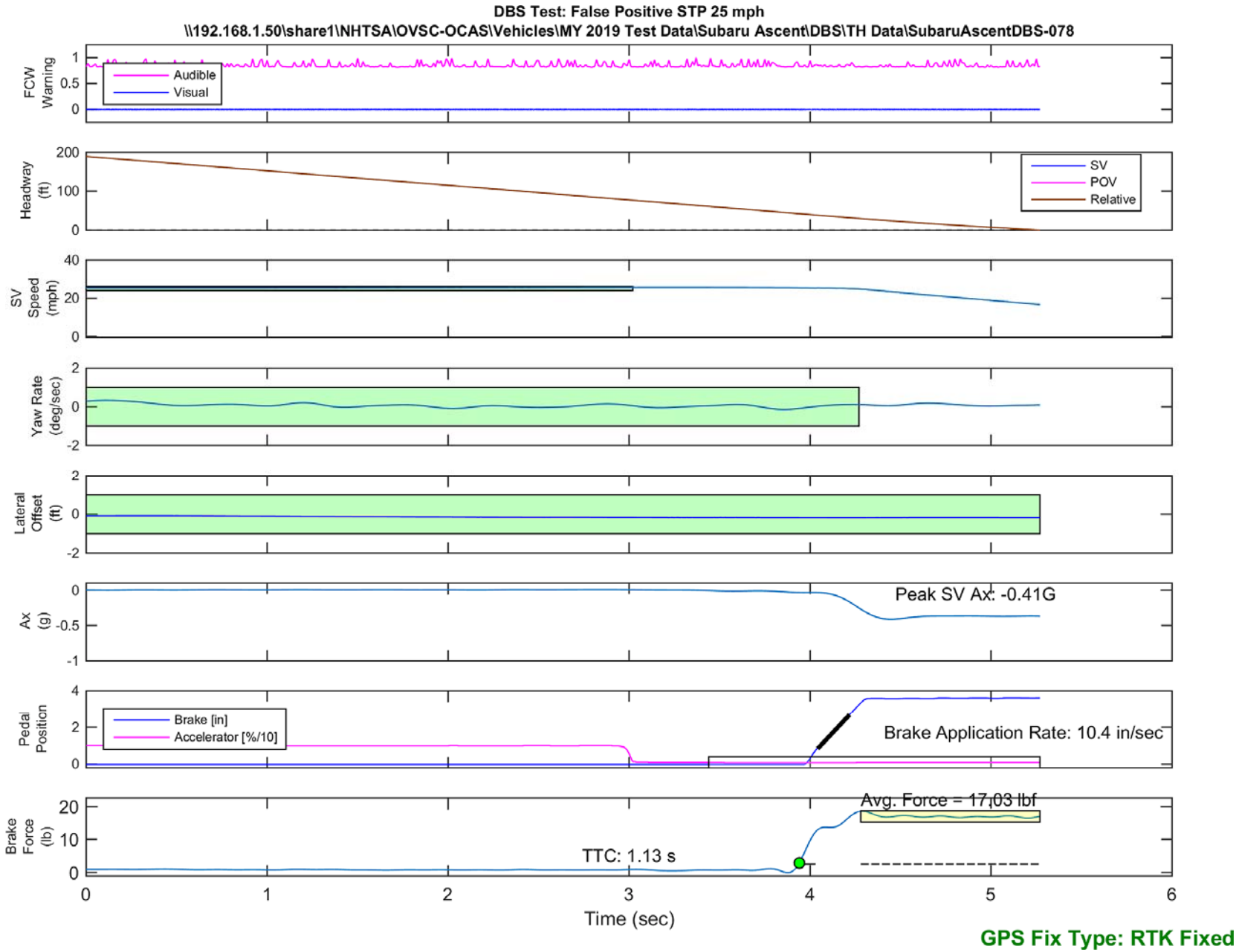

Figure E57. Time History for DBS Run 78, SV Encounters Steel Trench Plate, SV 25 mph

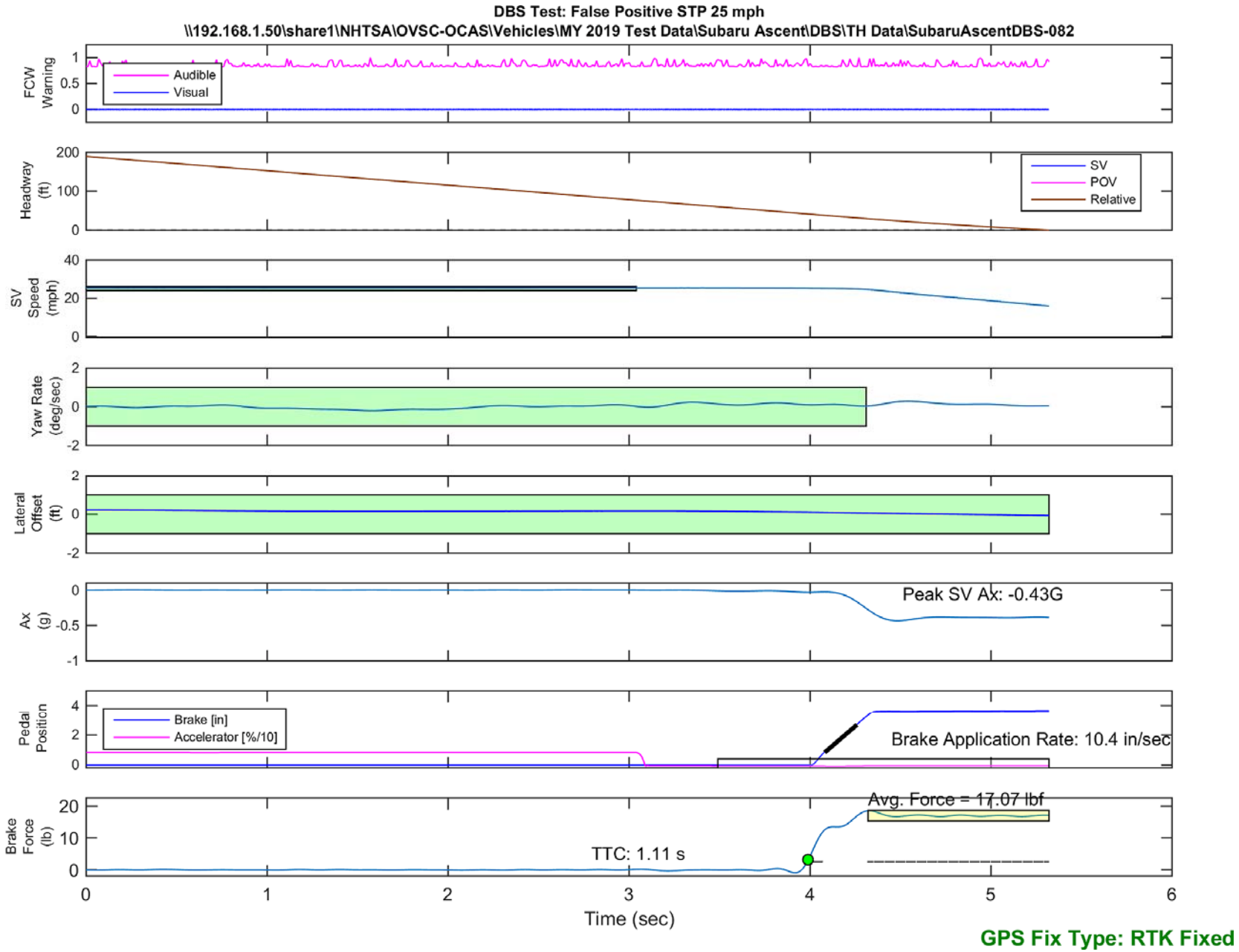

Figure E58. Time History for DBS Run 82, SV Encounters Steel Trench Plate, SV 25 mph

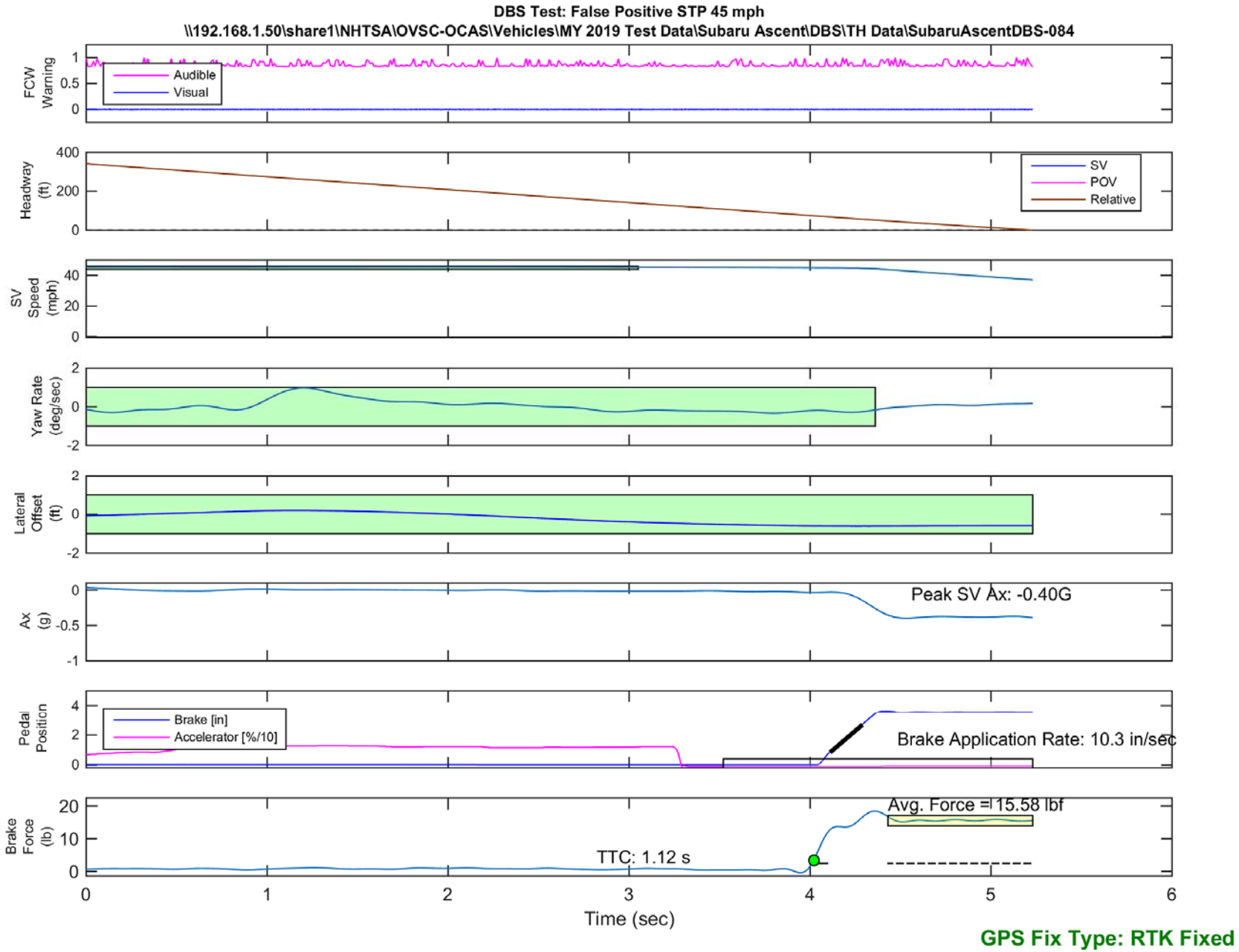

Figure E59. Time History for DBS Run 84, SV Encounters Steel Trench Plate, SV 45 mph

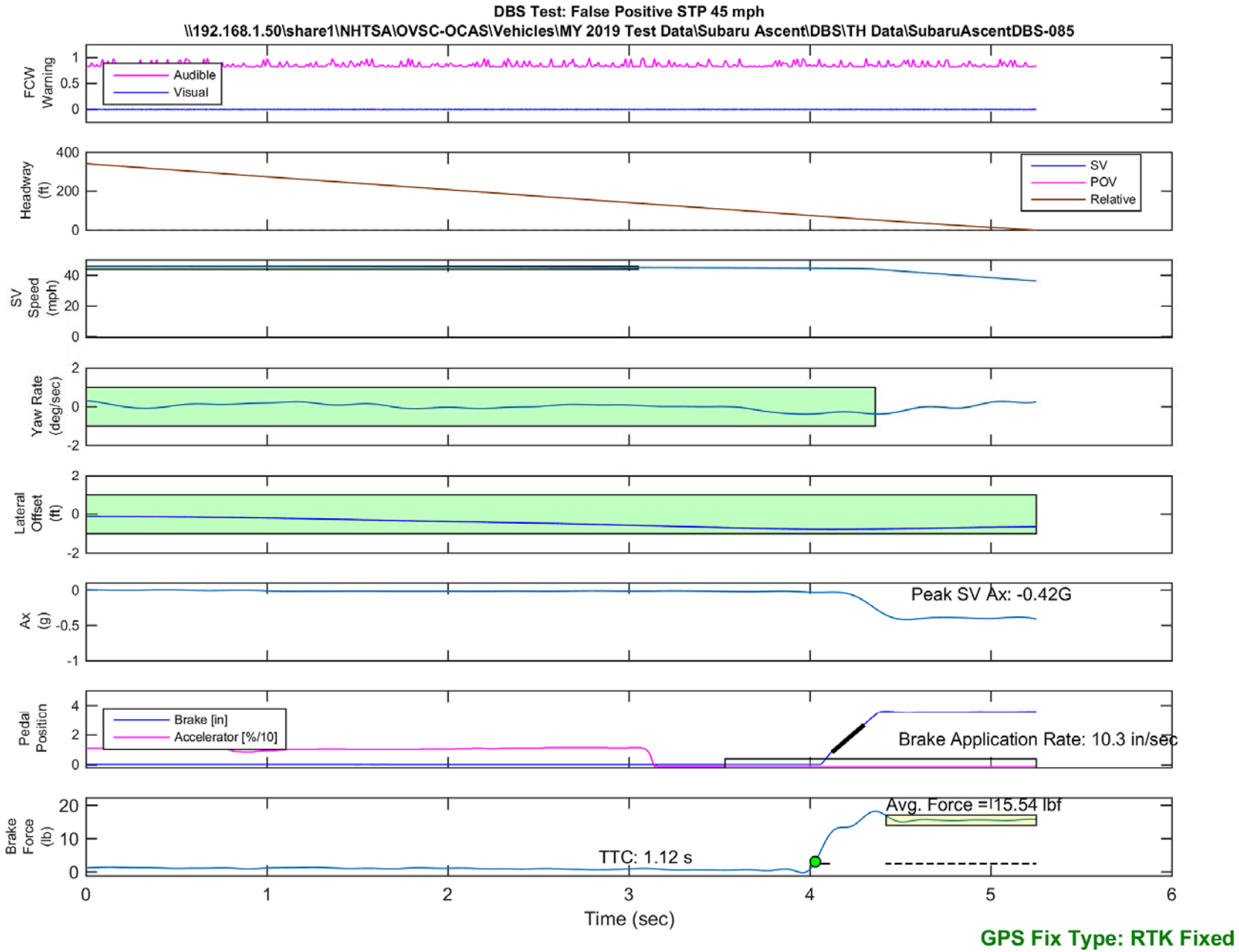

Figure E60. Time History for DBS Run 85, SV Encounters Steel Trench Plate, SV 45 mph

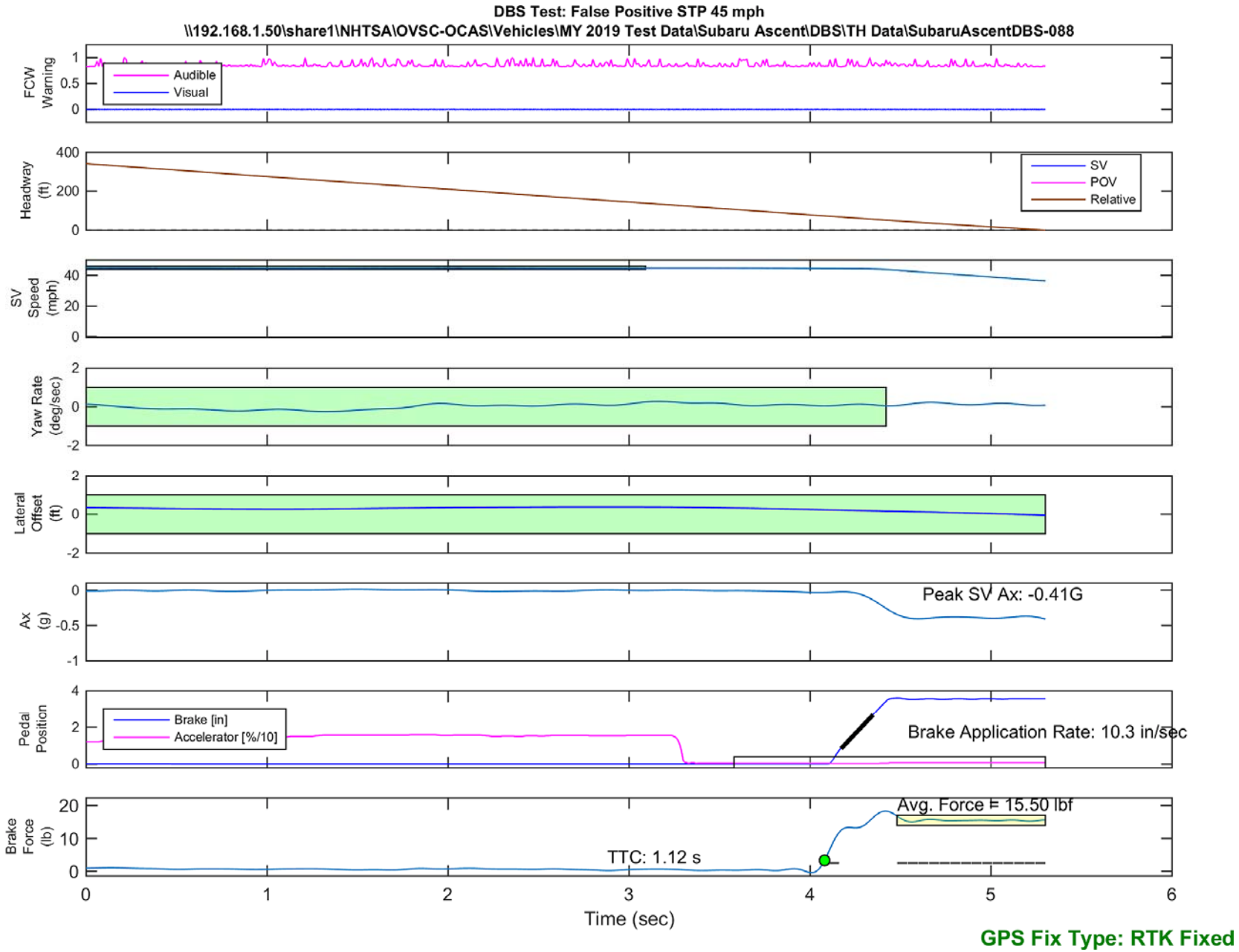

Figure E61. Time History for DBS Run 88, SV Encounters Steel Trench Plate, SV 45 mph

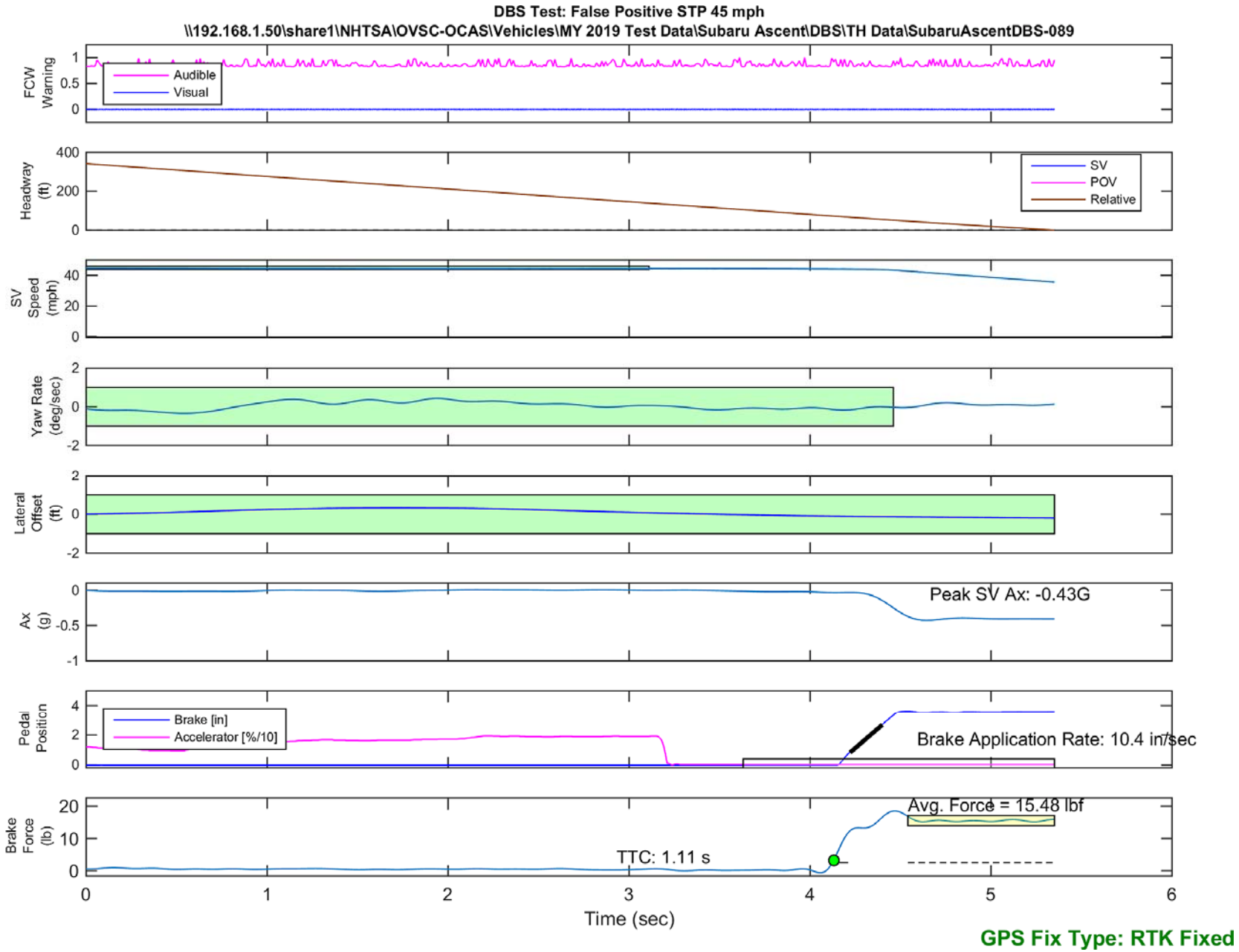

Figure E62. Time History for DBS Run 89, SV Encounters Steel Trench Plate, SV 45 mph

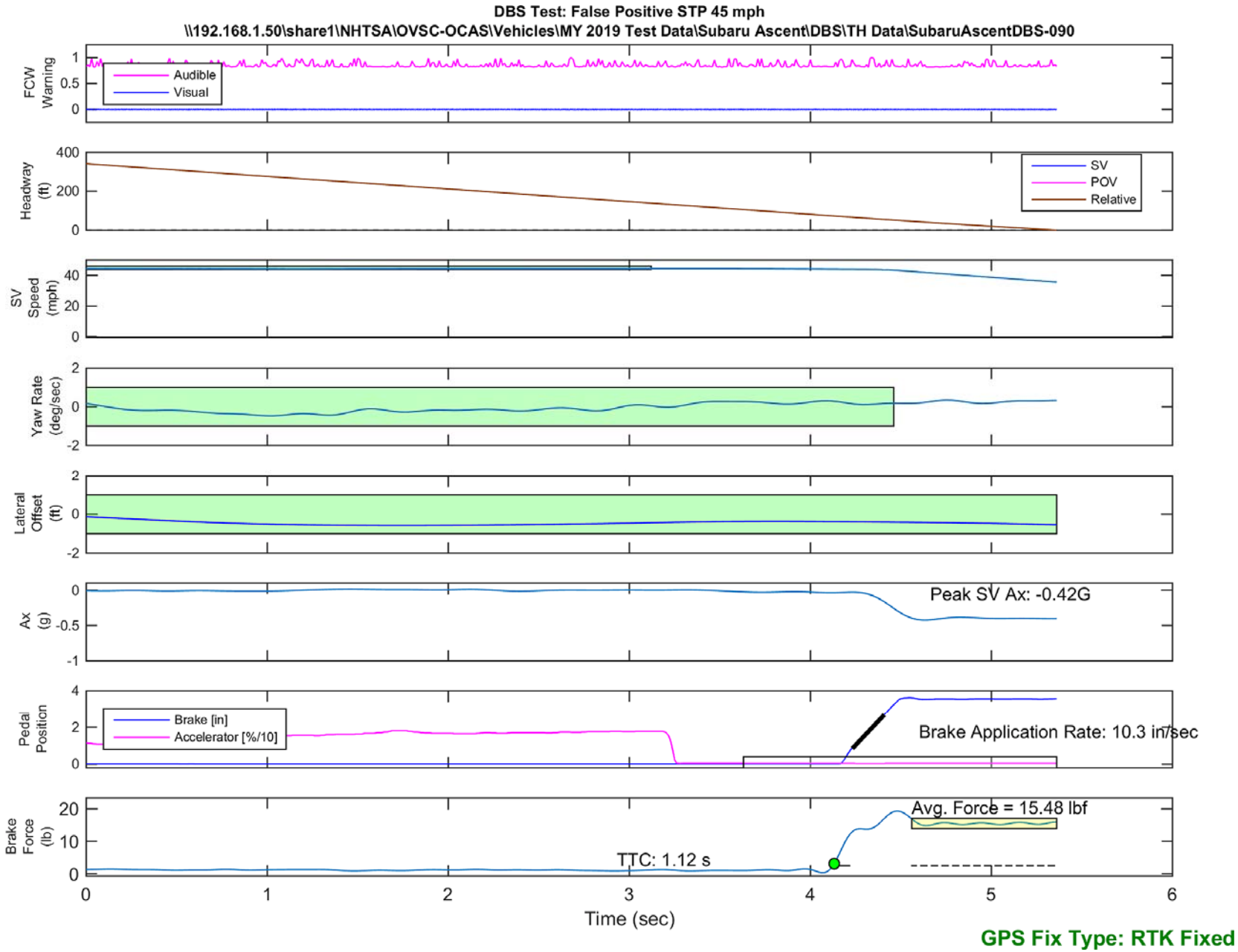

Figure E63. Time History for DBS Run 90, SV Encounters Steel Trench Plate, SV 45 mph

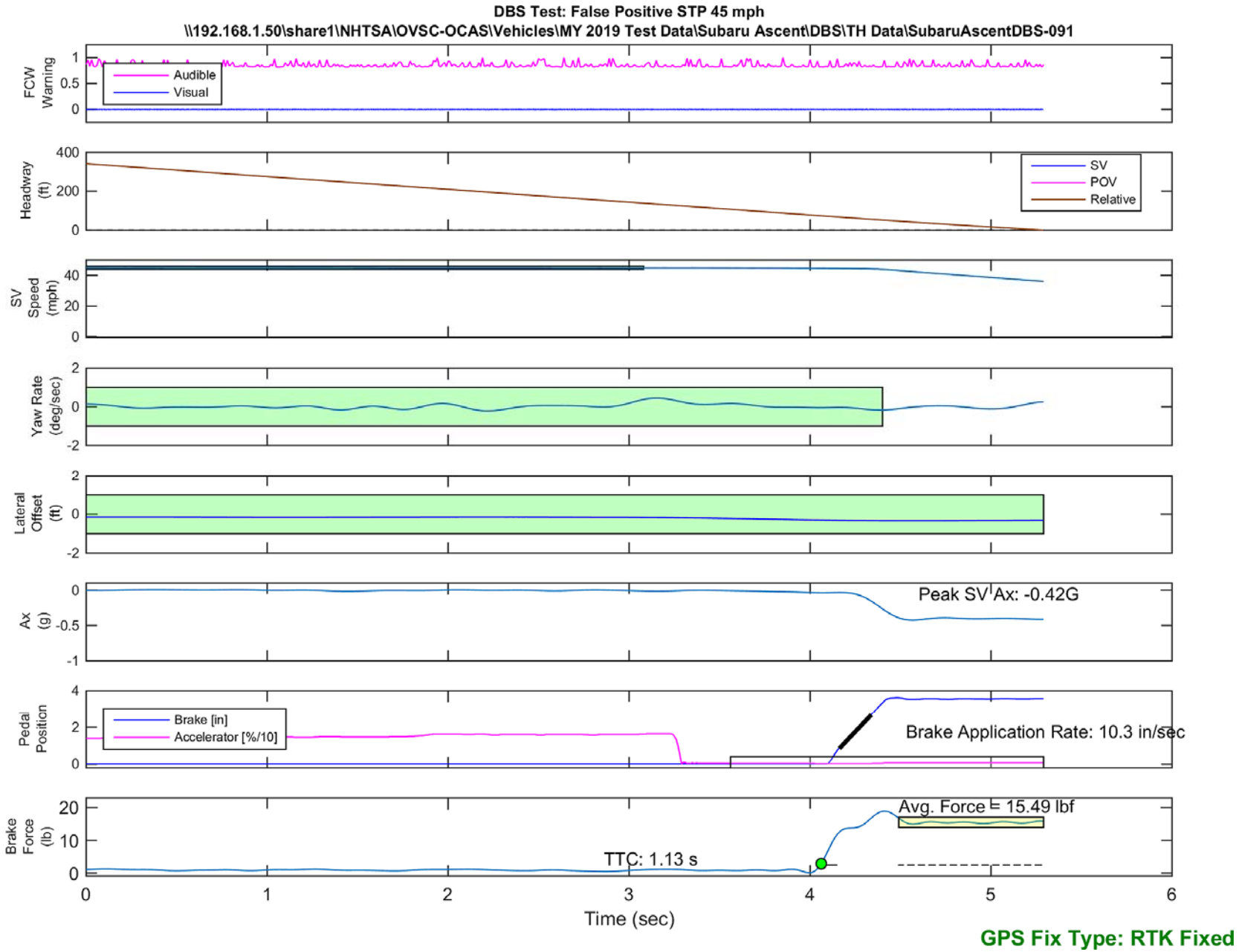

Figure E64. Time History for DBS Run 91, SV Encounters Steel Trench Plate, SV 45 mph

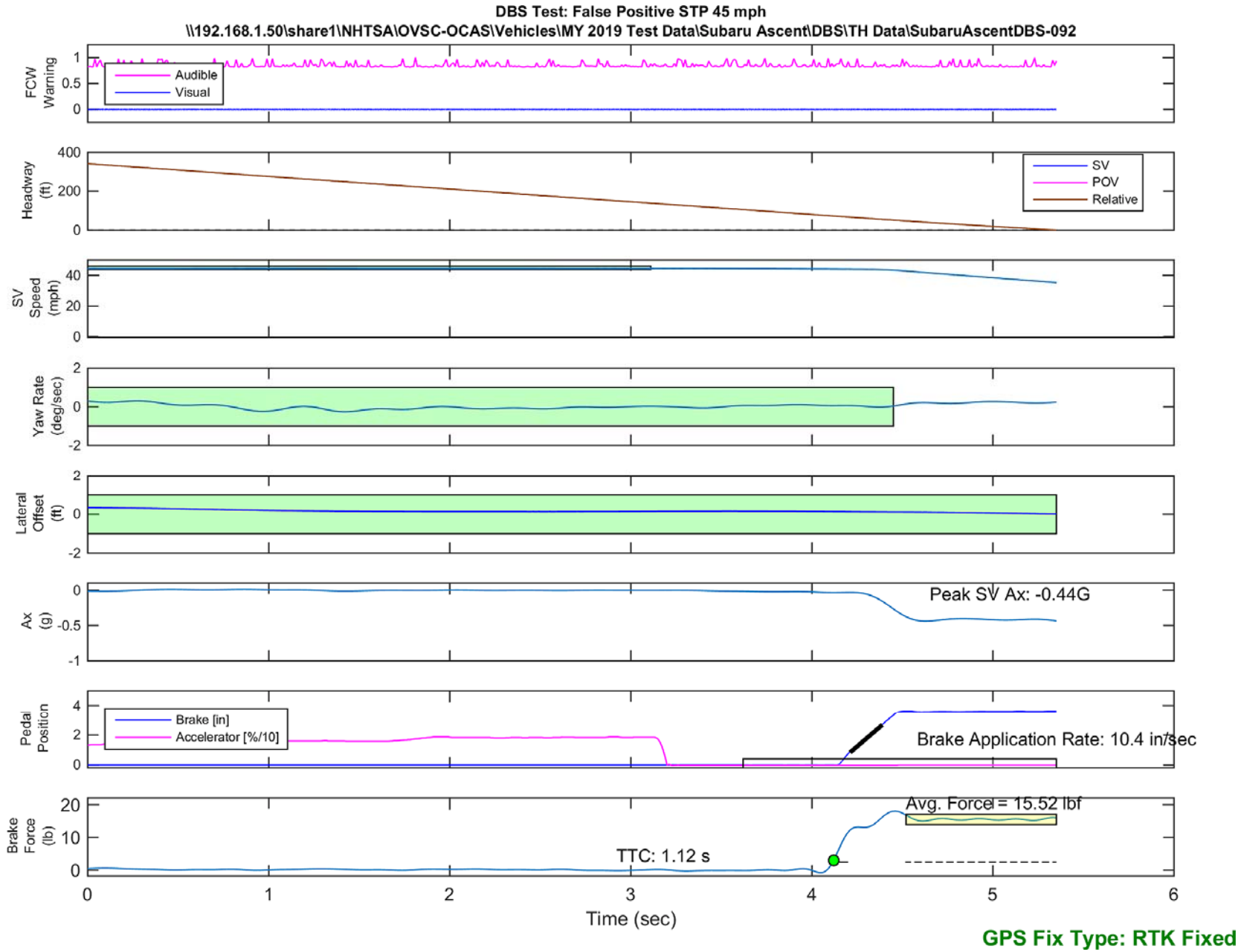

Figure E65. Time History for DBS Run 92, SV Encounters Steel Trench Plate, SV 45 mph

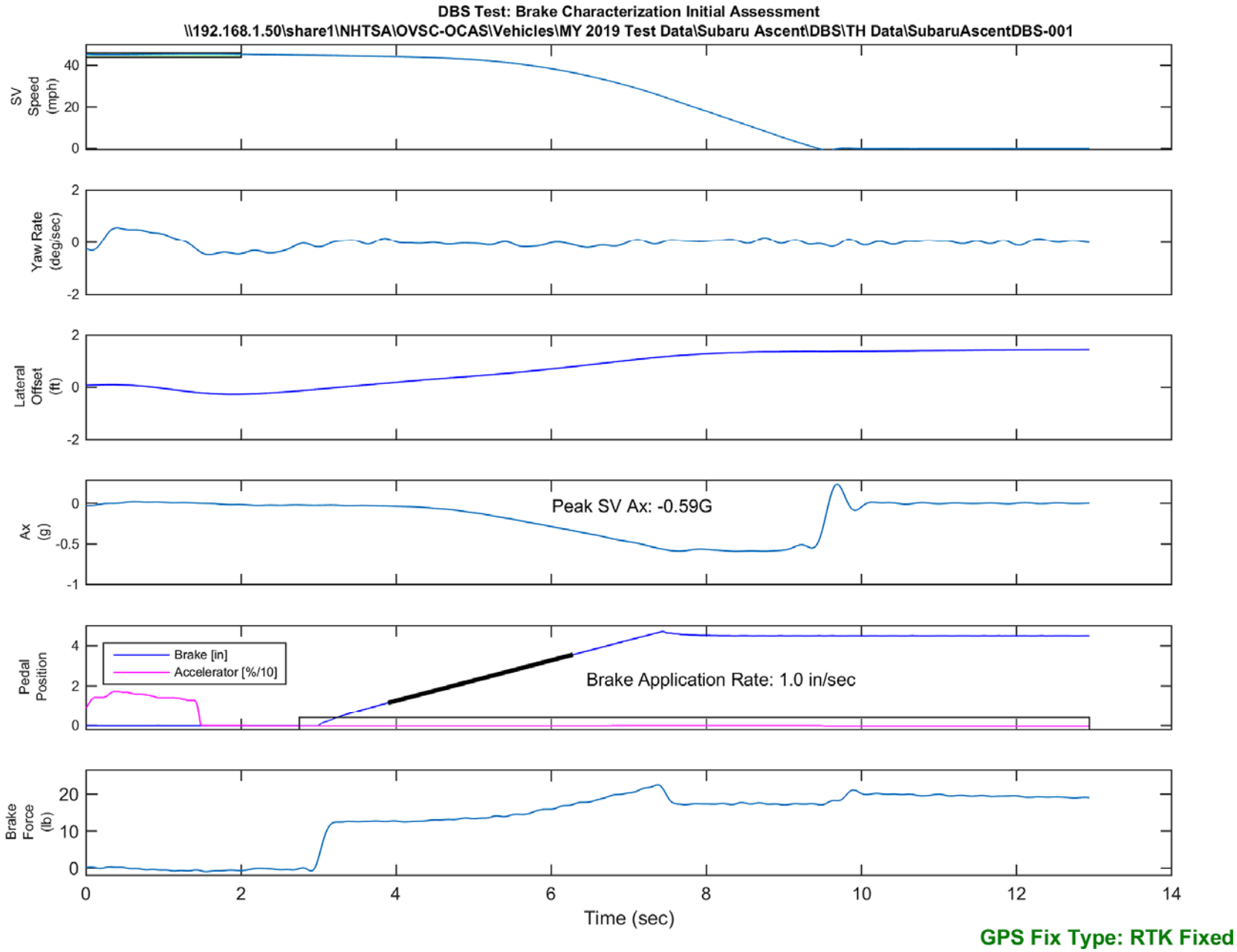

Figure E66. Time History for DBS Run 1, Brake Characterization Initial

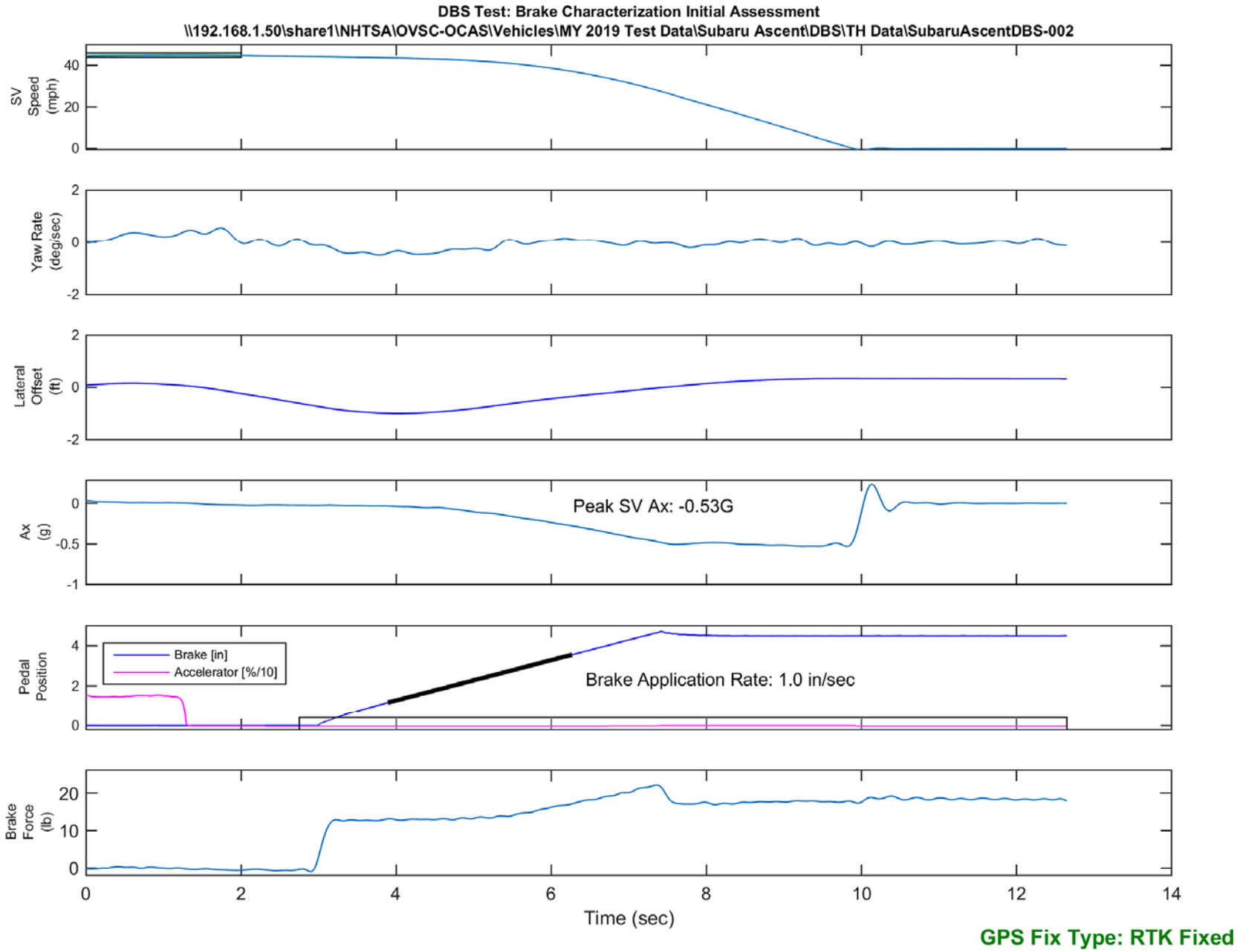

Figure E67. Time History for DBS Run 2, Brake Characterization Initial

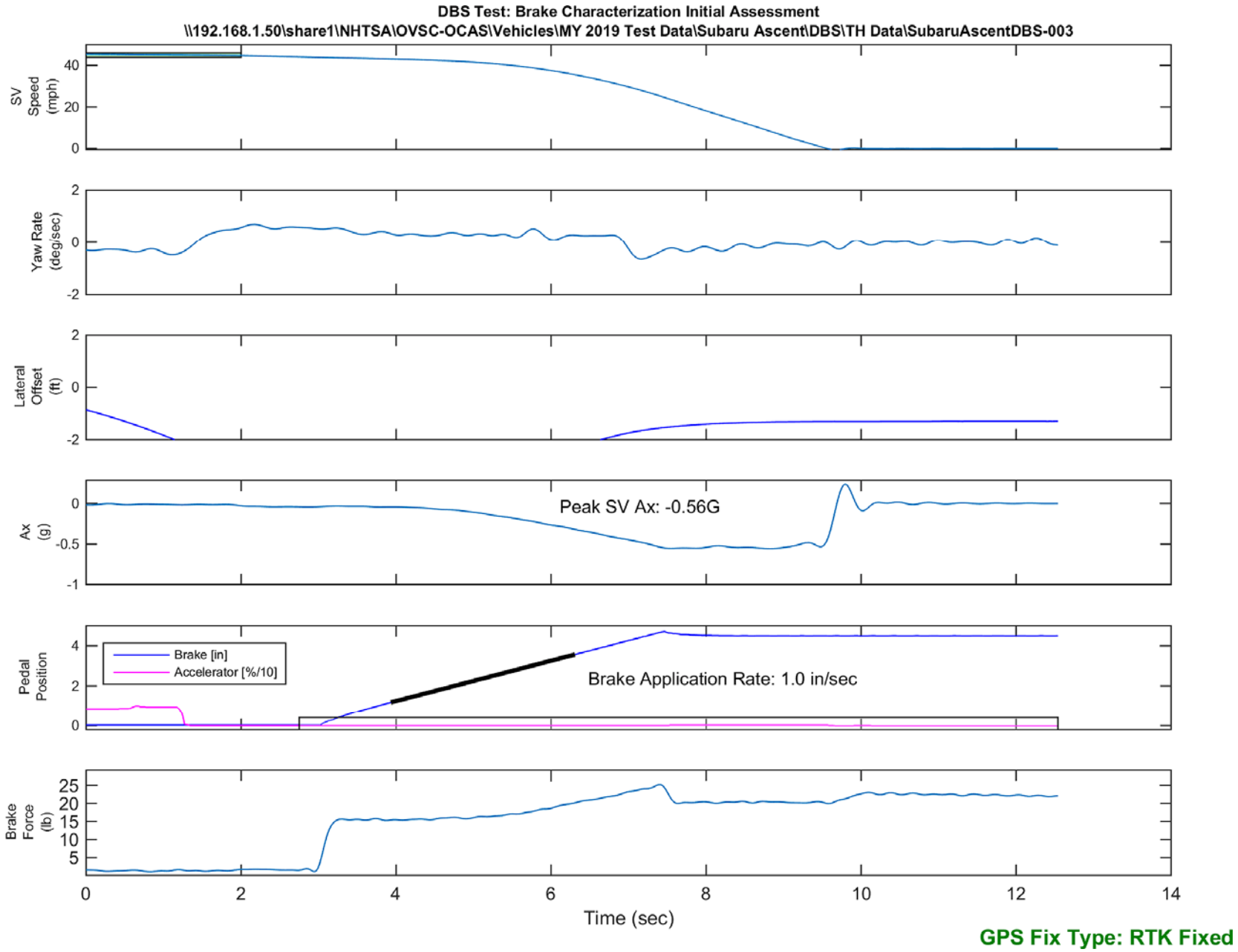

Figure E68. Time History for DBS Run 3, Brake Characterization Initial

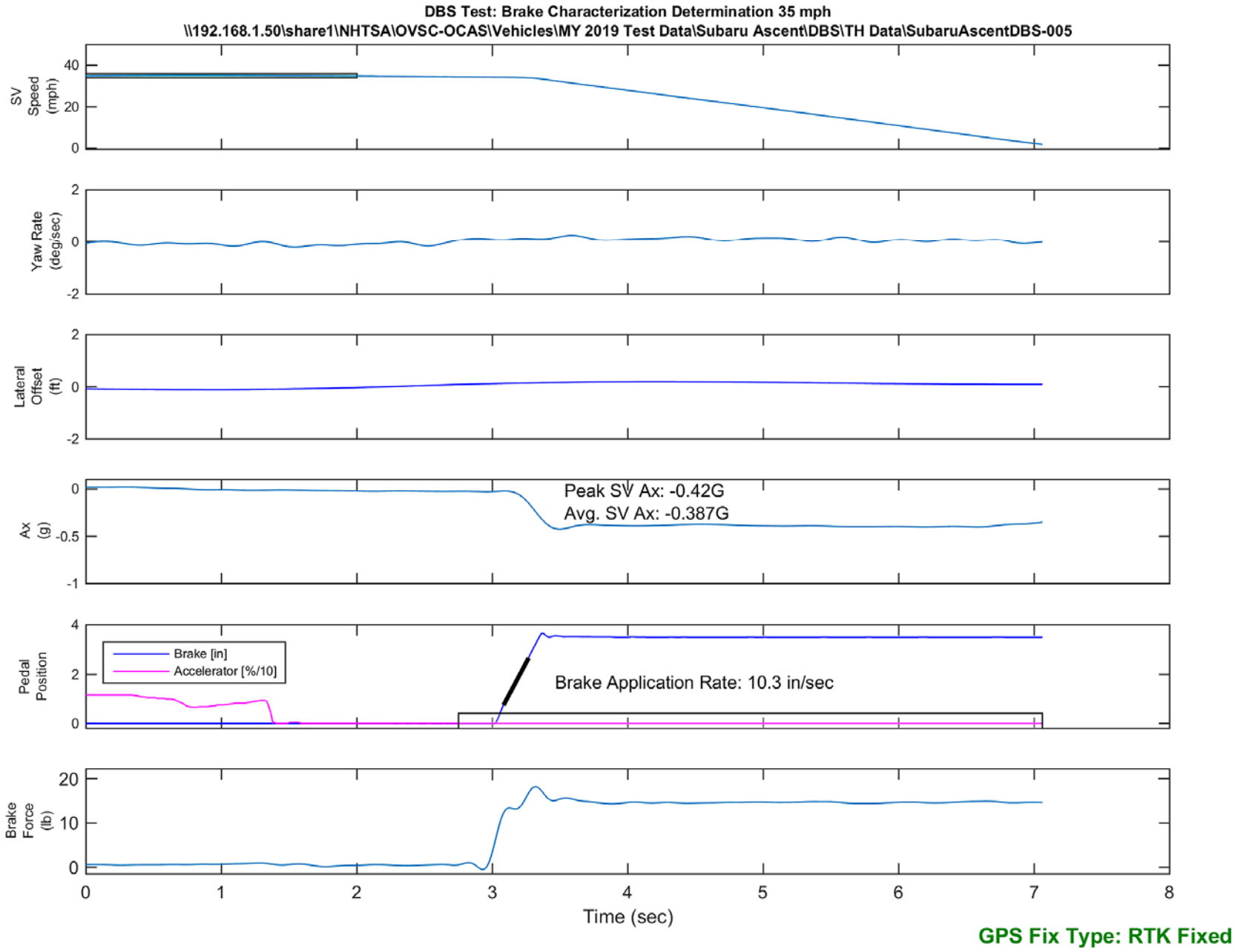

Figure E69. Time History for DBS Run 5, Brake Characterization Determination 35 mph

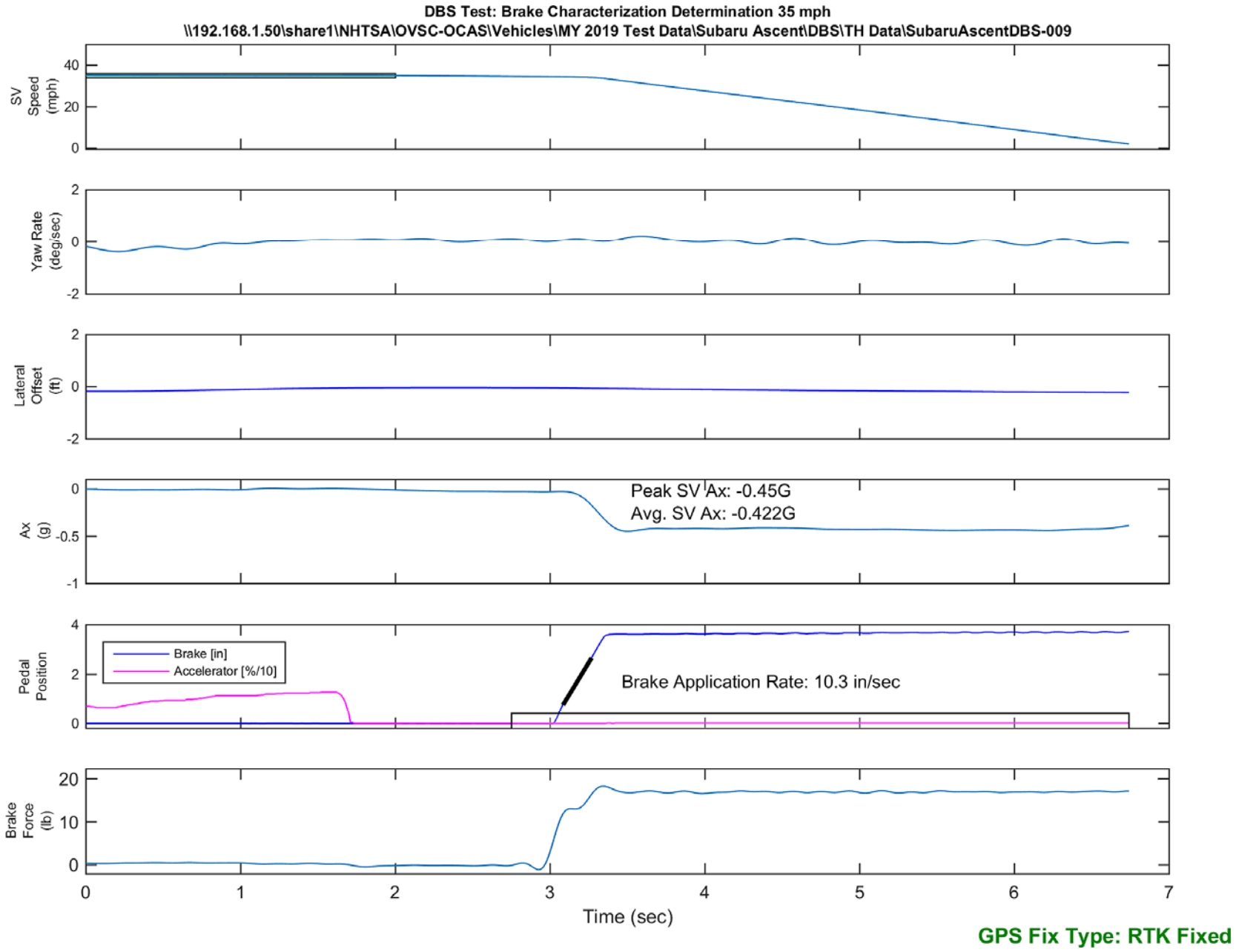

Figure E70. Time History for DBS Run 9, Brake Characterization Determination 35 mph

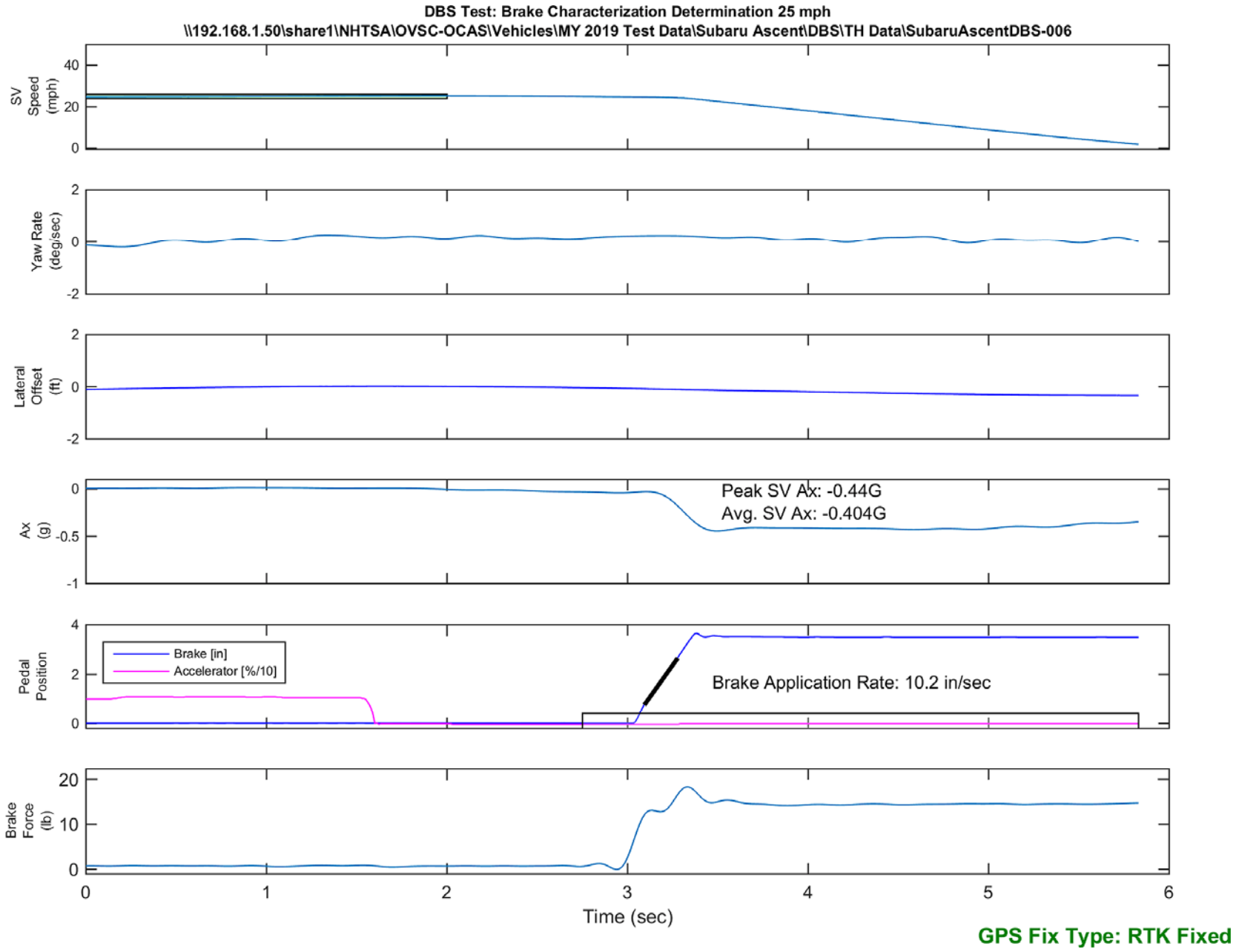

Figure E71. Time History for DBS Run 6, Brake Characterization Determination 25 mph

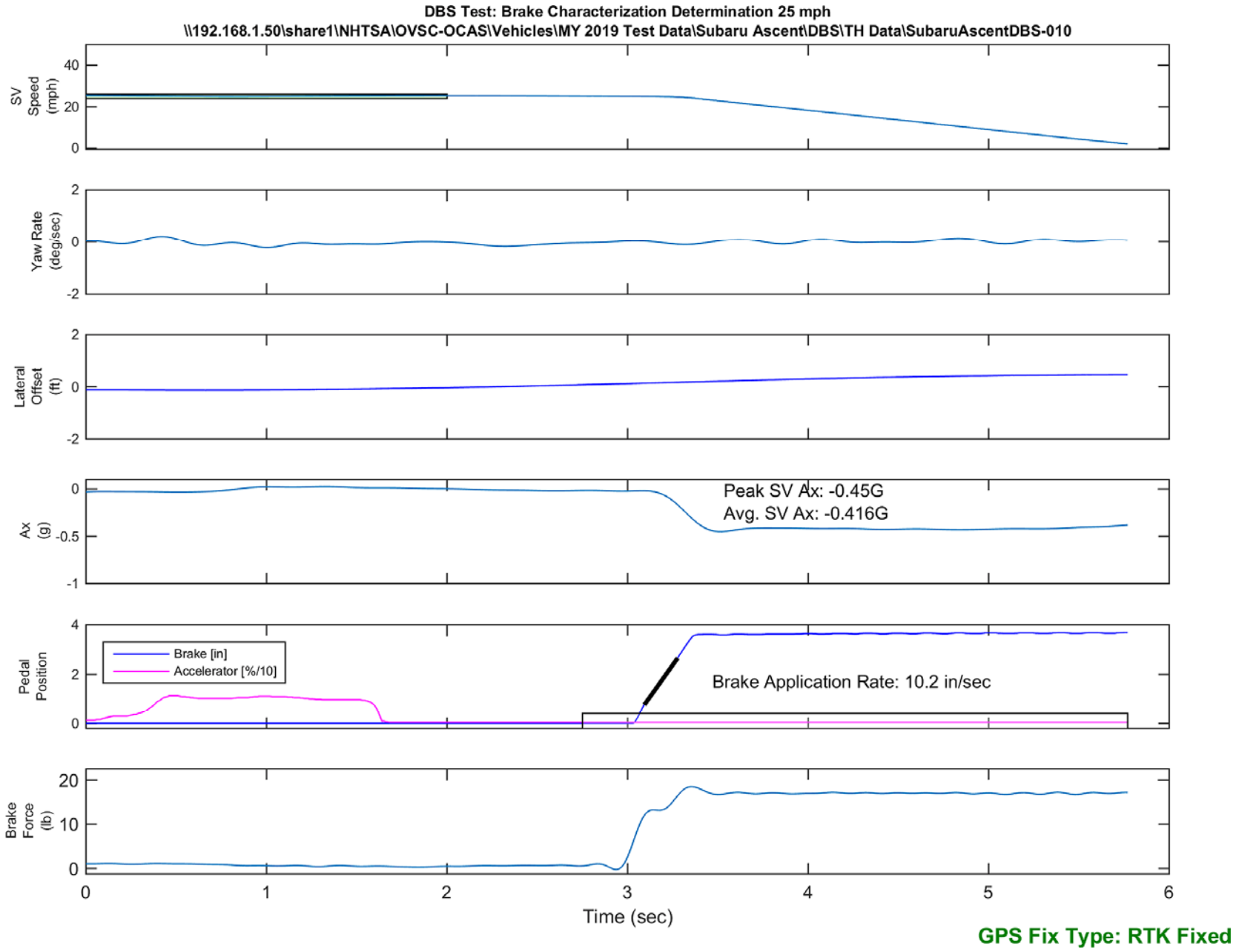

Figure E72. Time History for DBS Run 10, Brake Characterization Determination 25 mph

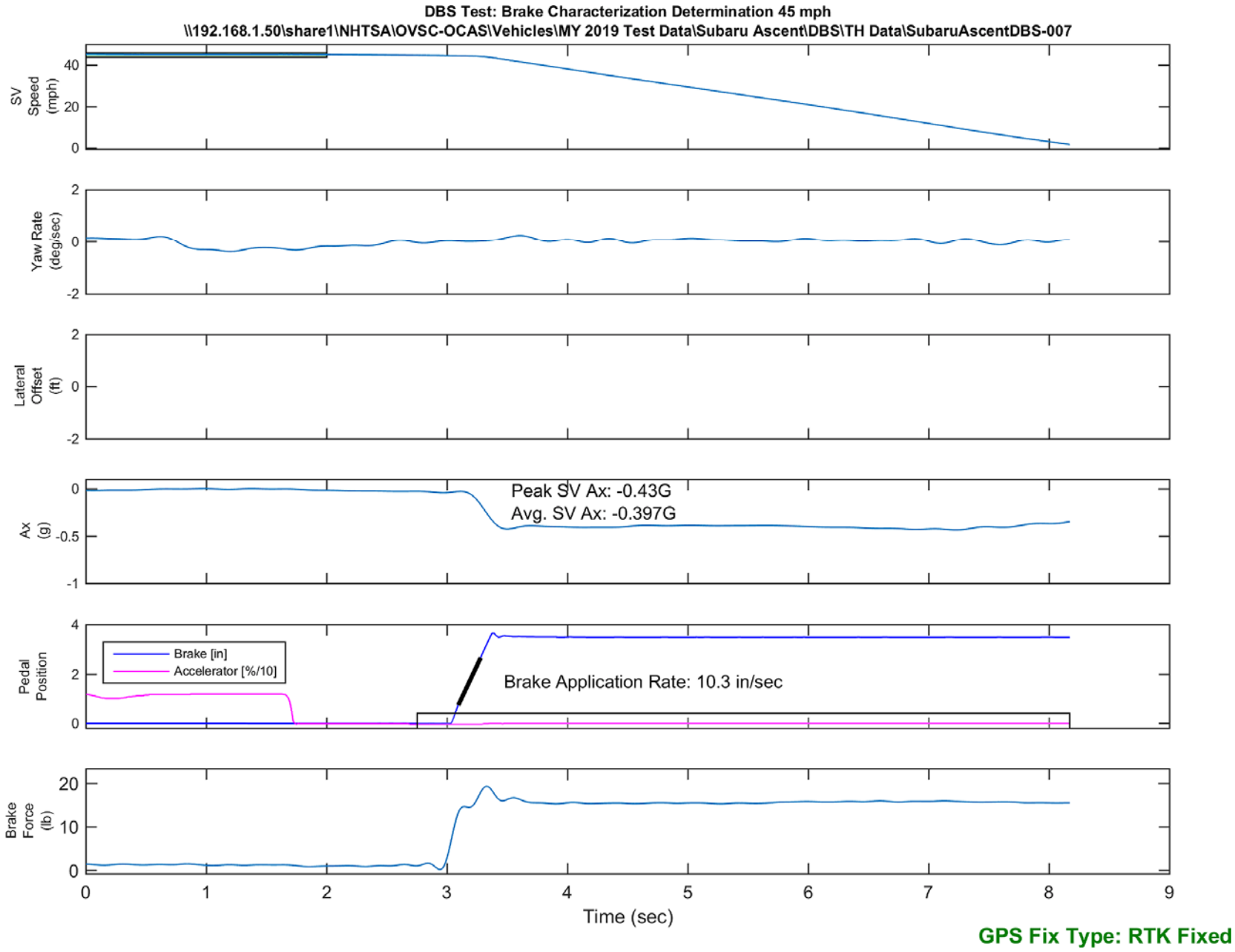

Figure E73. Time History for DBS Run 7, Brake Characterization Determination 45 mph

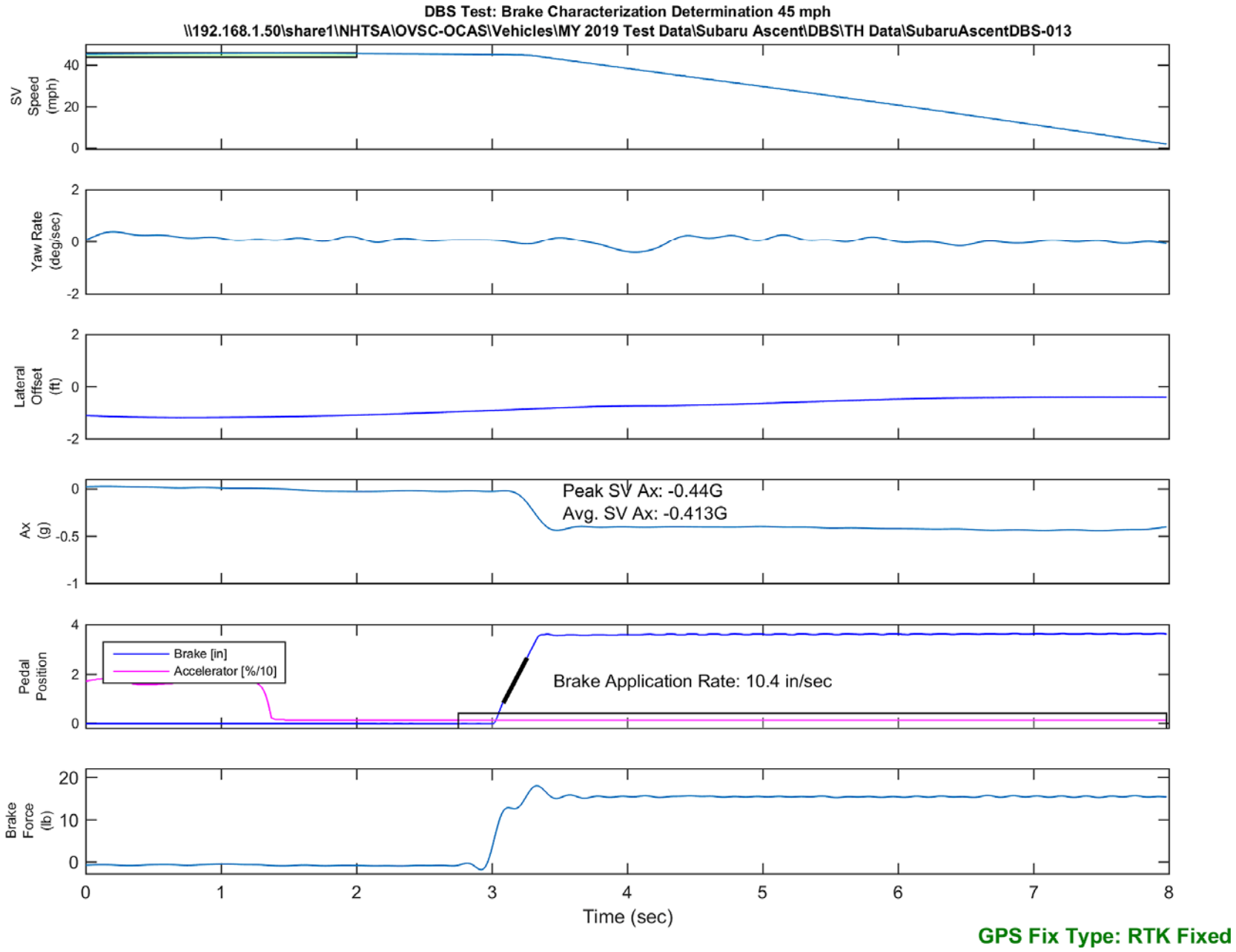

Figure E74. Time History for DBS Run 13, Brake Characterization Determination 45 mph