OCAS-DRI-FCW-19-07
NEW CAR ASSESSMENT PROGRAM
FORWARD COLLISION WARNING CONFIRMATION TEST

2019 Subaru Crosstrek Hybrid

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12 November 2019

Final Report

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

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Office of Crash Avoidance Standards
1200 New Jersey Avenue, SE
West Building, 4th Floor (NRM-200)
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16. Abstract These tests were conducted on the subject 2019 Subaru Crosstrek Hybrid in accordance with the specifications of the Office of Crash Avoidance Standards most current Test Procedure in docket NHTSA-2006-26555-0134 to confirm the performance of a forward collision warning system. The vehicle passed the requirements of the test for all three FCW test scenarios.			
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Section I
INTRODUCTION

This test evaluates the ability of a Forward Collision Warning (FCW) system to detect and alert drivers to potential hazards in the path of the vehicle as specified in the New Car Assessment Program's "Forward Collision Warning Confirmation" test procedure, dated February 2013. Three driving scenarios are utilized to assess this technology. In the first test, a subject vehicle (SV) approaches a stopped principle other vehicle (POV) in the same lane of travel. The second test begins with the SV initially following the POV at the same constant speed. After a short while, the POV stops suddenly. The third test consists of the SV, traveling at a constant speed, approaching a slower moving POV, which is also being driven at a constant speed.

Section II
DATA SHEETS

FORWARD COLLISION WARNING

DATA SHEET 1: TEST SUMMARY

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2019 Subaru Crosstrek Hybrid

VIN: *JF2GTDEC5KH3xxxx*

Test Date: *6/3/2019*

Forward Collision Warning setting: *Normal*

Test 1 -	Subject Vehicle Encounters Stopped Principal Other Vehicle:	***Pass***
Test 2 -	Subject Vehicle Encounters Decelerating Principal Other Vehicle:	***Pass***
Test 3 -	Subject Vehicle Encounters Slower Principal Other Vehicle:	***Pass***
	Overall:	***Pass***

Notes:

FORWARD COLLISION WARNING

DATA SHEET 2: VEHICLE DATA

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2019 Subaru Crosstrek Hybrid

TEST VEHICLE INFORMATION

VIN: *JF2GTDEC5KH3xxxx*

Body Style: *SUV* Color: *Crystal Black Silica*

Date Received: *5/20/2019* Odometer Reading: *156 mi*

Engine: *2 L Opposed 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: *02/19*

DATA FROM TIRE PLACARD:

Tires size as stated on Tire Placard: Front: *225/55R18*

Rear: *225/55R18*

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

Rear: *240 kPa (35 psi)*

FORWARD COLLISION WARNING

DATA SHEET 2: VEHICLE DATA

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2019 Subaru Crosstrek Hybrid

TIRES

Tire manufacturer and model: *Falken Ziex ZE001 A/S*

Front tire size: *225/55R18*

Rear tire size: *225/55R18*

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.

FORWARD COLLISION WARNING

DATA SHEET 3: TEST CONDITIONS

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2019 Subaru Crosstrek Hybrid

GENERAL INFORMATION

Test date: *6/3/2019*

AMBIENT CONDITIONS

Air temperature: *32.8 C (91 F)*

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

X Wind speed ≤ 10 m/s (22 mph).

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

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

VEHICLE PREPARATION

Verify the following:

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

Fuel tank is full: **X**

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

Front: *250 kPa (36 psi)*

Rear: *240 kPa (35 psi)*

FORWARD COLLISION WARNING

DATA SHEET 3: TEST CONDITIONS

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2019 Subaru Crosstrek Hybrid

WEIGHT

Weight of vehicle as tested including driver and instrumentation:

Left Front:	*519.4 kg (1145 lb)*	Right Front	*467.2 kg (1030 lb)*
Left Rear	*425.0 kg (937 lb)*	Right Rear	*420.0 kg (926 lb)*
		Total:	*1831.6 kg (4038 lb)*

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

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2019 Subaru Crosstrek Hybrid

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.

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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 the vehicle equipped with a switch whose purpose is to render FCW inoperable? **X** Yes ____ No

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

The switch to render FCW operable is located on the center roof panel of the vehicle. To turn the system off, press and hold the Pre-Collision Braking System OFF switch for approximately 2 seconds or longer. After a short beep sound emits, the function is turned off and the OFF indicator light on the instrument panel illuminates.

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

If yes, please provide a full description.

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

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.)*

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- *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 hybrid system*
- *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*

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- *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.*
- *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*

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- *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*

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.*

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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:*
  - *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.*

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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

Three test procedures were used, as follows:

Test 1. Subject Vehicle (SV) Encounters Stopped Principal Other Vehicle (POV) on a Straight Road
Test 2. Subject Vehicle Encounters Decelerating Principal Other Vehicle
Test 3. Subject Vehicle Encounters Slower Principal Other Vehicle

With the exception of trials associated with Test 1, all trials were performed with SV and POV 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. Except for Test 2, the brake lights of the POV were not illuminated.

In order to pass the test, if the FCW system provides a warning timing adjustment for the driver, at least one setting must meet the criterion of the test procedure. Therefore, if the vehicle was equipped with a warning timing adjustment, only the most “conservative” (earliest warning) setting was tested.

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 FCW function to detect a stopped lead vehicle, as depicted in Figure 1.

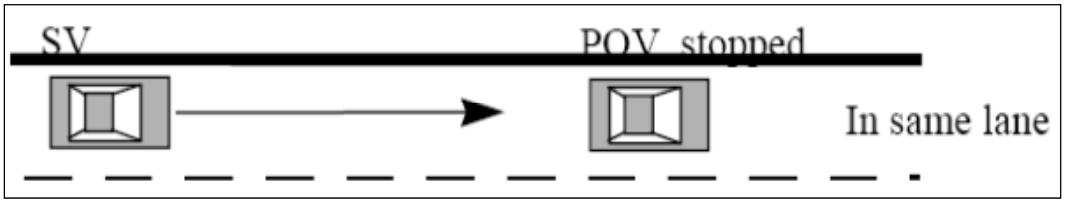


Figure 1. Depiction of Test 1

a. Alert Criteria

In order to pass the test, the FCW alert must be issued when the time-to-collision (TTC) is at least 2.1 seconds. The TTC for this test was calculated by considering the speeds of the SV and the POV at the time of the FCW alert (i.e., when the SV and POV speeds are nominally equal to 45 and 0 mph (72.4 and 0 kph), respectively).

b. 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 was driven at a nominal speed of 45 mph (72.4 kph) in the center of the lane of travel, toward the parked POV. The test began when the SV was 492 ft (150 m) from the POV and ended when either of the following occurred:

- The required FCW alert occurred.
- The TTC to the POV fell to less than 90% of the minimum allowable range (i.e., TTC = 1.9 sec) for the onset of the required FCW alert.

The SV driver then steered and/or braked to keep the SV from striking the POV.

For an individual test trial to be valid, the following was required throughout the test:

- The SV vehicle speed could not deviate from the nominal speed by more than 1.0 mph (1.6 kph) for a period of three seconds prior to (1) the required FCW alert or (2) before the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.
- The SV driver could not apply any force to the brake pedal before (1) the required FCW alert occurred, (2) or before the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.
- The lateral distance between the centerline of the SV, relative to the centerline of the POV, in road coordinates, could not exceed 2.0 ft (0.6 m).
- The yaw rate of the SV could not exceed ±1 deg/sec during the test.

Nominally, the Test 1 series was comprised of seven individual trials. The FCW system must satisfy the TTC alert criteria for at least five of the seven test trials.

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

The SV in this test initially followed the POV at a constant time gap, and then the POV suddenly decelerated, as depicted in Figure 2. The test evaluates the ability of the FCW to recognize a decelerating lead vehicle and to issue an alert to SV driver in a timely manner.

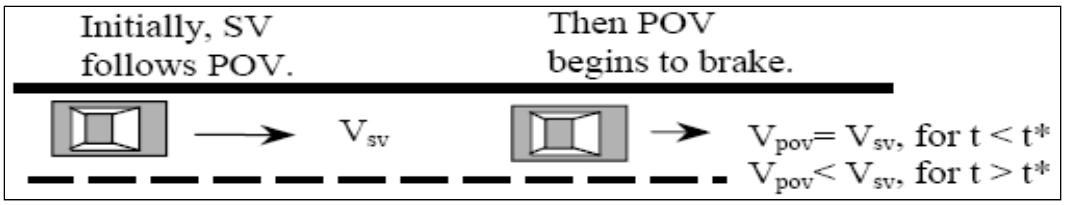


Figure 2. Depiction of Test 2

a. Alert Criteria

In order to pass the test, the FCW alert must be issued when TTC is at least 2.4 seconds. The TTC for this test, a prediction of the time it would take for the SV to collide with the POV, was calculated by considering three factors at the time of the FCW alert: (1) the speed of the SV, (2) the speed of the POV, and (3) the deceleration of the POV[1].

[1]To simplify calculation of the TTC for Test 2, the deceleration of the POV is assumed to remain constant from the time of the FCW alert until the POV comes to a stop (i.e., a "constant" rate of slowing is assumed).

b. Procedure

Test 2 began with the SV and the POV traveling on a straight, flat road at a constant speed of 45.0 mph (72.4 kph), in the center of the lane of travel. The headway from the SV to the POV was nominally maintained at 98.4 ft (30 m) until the POV braking was initiated.

The test began approximately 7 seconds before the driver of the POV started a braking maneuver in which the POV brakes were rapidly applied and modulated such that a constant deceleration of 0.3 g was achieved within 1.5 seconds after braking is initiated. The test ended when either of the following conditions was satisfied:

- The required FCW alert occurred.
- The TTC to the POV fell to less than 90% of the minimum allowable range (i.e., TTC = 2.2 sec) for the onset of the required FCW alert.

The SV driver then steered and/or braked to keep the SV from striking the POV.

For an individual test trial to be valid, the following was required throughout the test:

- The initial POV vehicle speed could not deviate from the nominal speed by more than 1.0 mph (1.6 kph) for a period of 3 seconds prior to the initiation of POV braking.
- The speed of the SV could not deviate from the nominal speed by more than 1.0 mph (1.6 kph) for a period of 3 seconds prior to (1) the required FCW alert or (2) before the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.
- The lateral distance between the centerline of the SV, relative to the centerline of the POV, in road coordinates, could not exceed 2.0 ft (0.6 m).
- The yaw rates of the SV and POV could not exceed ±1 deg/sec during the test.
- The POV deceleration level was nominally required to be 0.3 g within 1.5 seconds after initiation of POV braking. The acceptable error magnitude of the POV deceleration was ±0.03g, measured at the time the FCW alert first occurred. An initial overshoot beyond the deceleration target was acceptable, however the first local

deceleration peak observed during an individual trial could not exceed 0.375 g for more than 50 ms. Additionally, the deceleration could not exceed 0.33 g over a period defined from 500 ms after the first local deceleration peak occurs, to the time when the FCW alert first occurred.

- The tolerance for the headway from the SV to the POV was ±8.2 ft (±2.5 m), measured at two instants in time: (1) three seconds prior to the time the POV brake application was initiated, and (2) at the time the POV brake application was initiated.

- SV driver could not apply any force to the brake pedal before (1) the required FCW alert occurred, or (2) before the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.

Nominally, the Test 2 series was comprised of seven individual trials. The FCW system must satisfy the TTC alert criteria for at least five of the seven test trials.

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

This test examines the ability of the FCW system to recognize a slower lead vehicle being driven with a constant speed and to issue a timely alert. As depicted in Figure 3, the scenario was conducted with a closing speed equal to 25.0 mph (40.2 kph).

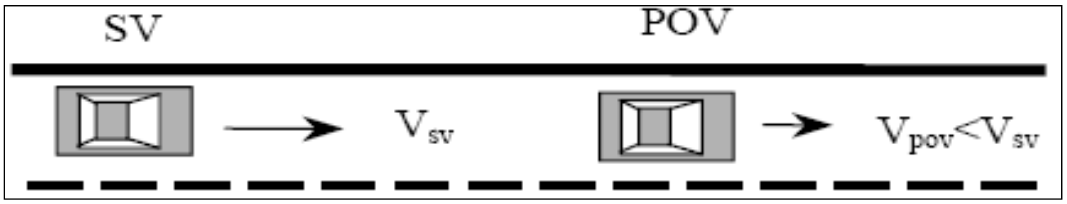


Figure 3. Depiction of Test 3

a. Alert Criteria

In order to pass the test, the FCW alert must be issued when TTC is at least 2.0 seconds. The TTC for this test, a prediction of the time it would take for the SV to collide with the POV, was calculated by considering the speeds of the SV and POV at the time of the FCW alert.

b. Procedure

Throughout the test, the POV was driven at a constant 20.0 mph (32.2 kph) in the center of the lane of travel.

The SV was driven at 45.0 mph (72.4 kph), in the center lane of travel, toward the slow-moving POV.

The test began when the headway from the SV to the POV was 329 ft (100 m) and ended when either of the following occurred:

- The required FCW alert occurred.
- The TTC to the POV fell to less than 90% of the minimum allowable range (i.e., TTC = 1.8 sec) for the onset of the required FCW alert.

The SV driver then steered and/or braked to keep the SV from striking the POV.

For an individual test trial to be valid, the following was required throughout the test:

- The SV vehicle speed could not deviate from the nominal speed by more than 1.0 mph (1.6 kph) for a period of 3 seconds prior to (1) the required FCW alert or (2) before the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.
- Speed of the POV could not deviate from the nominal speed by more than 1.0 mph (1.6 kph) during the test.
- The lateral distance between the centerline of the SV, relative to the centerline of the POV, in road coordinates, could not exceed 2.0 ft (0.6 m).
- The yaw rates of the SV and POV could not exceed ±1 deg/sec during the test.
- SV driver could not apply any force to the brake pedal before (1) the required FCW alert occurred, or (2) before the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.

Nominally, the Test 3 series was comprised of seven individual trials. The FCW system must satisfy the TTC alert criteria for at least five of the seven test trials.

B. Principal Other Vehicle

The vehicle used as the Principal Other Vehicle (POV) was a 2006 Acura RL. This satisfied the test requirement that the POV be a mid-size sedan. The vehicle had a rear license plate in order to provide a suitable representative radar profile. Vehicle loading consisted of the driver plus equipment and instrumentation.

C. Automatic Braking System

The POV was equipped with an automatic braking system, which was used in Test 2. The braking system consisted of the following components:

- High pressure nitrogen bottle, strapped to the front passenger seat, with regulator and pressure gauges
- Pneumatic piston-type actuator, with solenoid valve
- “Pickle” switch to activate brakes

D. Instrumentation

Table 1 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

TABLE 1. 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
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	NA
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

TABLE 1. TEST INSTRUMENTATION AND EQUIPMENT (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at auditory 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 visual alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Accelerometer	Acceleration (to measure time at haptic alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA
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

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 2.

Table 2. Audible and Tactile Warning Filter Parameters

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

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

Figure A3. Window Sticker (Monroney Label)

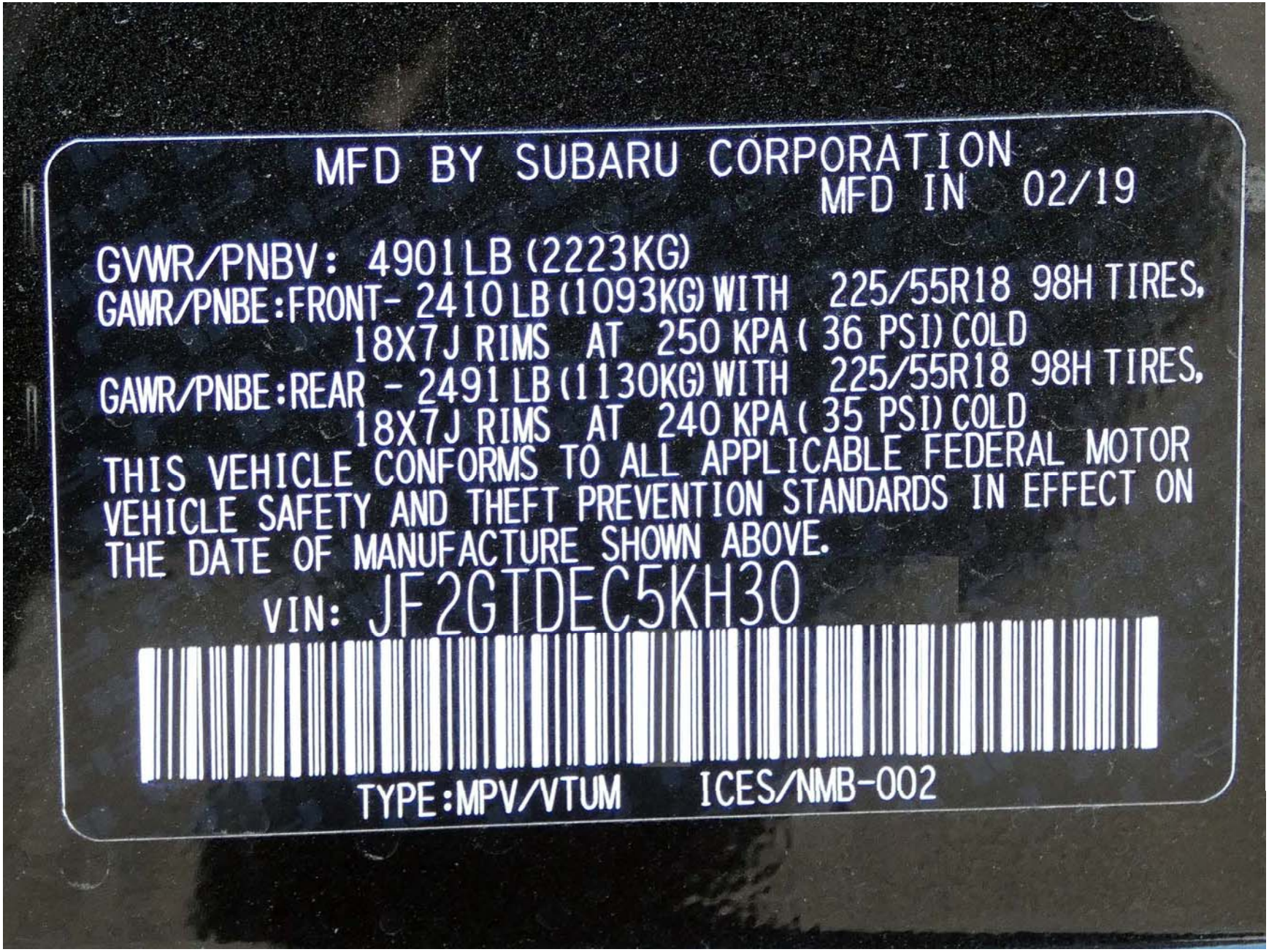


Figure A4. Vehicle Certification Label

Figure A5. Tire Placard

Figure A6. Front View of Principal Other Vehicle

Figure A7. Rear View of Principal Other Vehicle

Figure A8. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A9. Sensor for Detecting Auditory Alerts

Figure A10. Sensor for Detecting Visual Alerts

Figure A11. Computer Installed in Subject Vehicle

Figure A12. Brake Actuation System Installed in Principal Other Vehicle

Figure A13. FCW Visual Alert

Figure A14. FCW On/Off Switch

Figure A15. FCW Off Indicator

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 26.

■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 41.

■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 67.

■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 77.

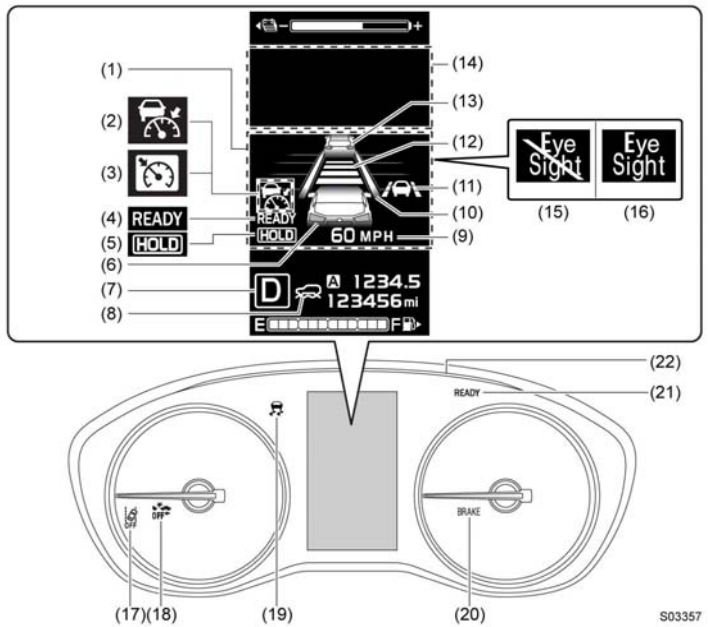
■Lane Departure Warning

This function warns the driver when the vehicle is about to drift off the road.
⇒ Refer to page 83.

■Lane Sway Warning

This function warns the driver when it detects vehicle drifting caused by driver fatigue, failure to concentrate on the road, inattention, strong crosswinds or other factors.
⇒ Refer to page 87.

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 indicator
(8) X-MODE indicator
(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) Brake system warning light
(21) Hybrid READY indicator
(22) Driver Assist indicator

■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 107.

■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 hybrid system starting. It turns off when approximately 7 seconds have elapsed since the hybrid system started.
- When it is illuminated, none of the EyeSight functions can be used except for Conventional Cruise Control.
  ⇒ Refer to page 108.

■X-MODE indicator

(X-MODE indicator) illuminates when the X-MODE is ON.
⇒ Refer to the vehicle Owner's Manual for details.

■Lane Departure Warning OFF indicator light

- This indicator 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 hybrid system 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 86.

■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 hybrid system starts.

⇒ Refer to page 40.

■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 72.

■ (Lane Keep Assist) switch

Switches Lane Keep Assist on/off.
⇒ Refer to page 72.

■ ▲ switch/ ▼ switch

These switches are used in the following situations.
- When switching the screen displayed on the combination meter display.
- When changing the Warning Volume settings, etc.

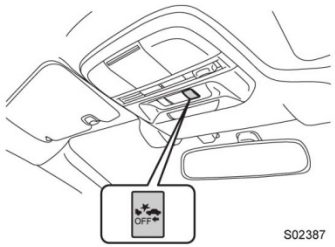
⇒ Refer to page 110.

■ (Info)/SET switch

This switch is used in the following situations.
- When displaying the message that appeared in the warning screen area again.
  ⇒ Refer to page 112.
- When changing the Warning Volume settings, etc.
  ⇒ Refer to page 110.

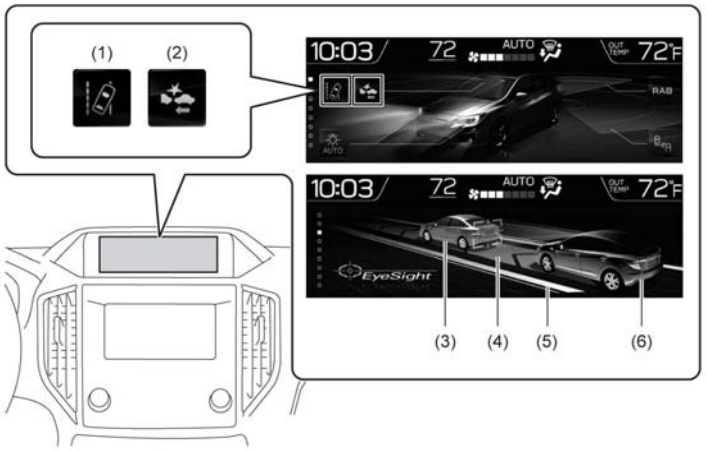
■ (Pre-Collision Braking System OFF) switch

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 39.



S02387

■Multi-function display



S03410

(1) Lane Departure/Sway Warning indicator
(2) Pre-Collision Braking System indicator
(3) Lead vehicle indicator
(4) Lane indicator
(5) Road line indicator
(6) Your own vehicle indicator

●Lane Departure/Sway Warning indicator

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

●Pre-Collision Braking System indicator

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

●Lead vehicle indicator

When the Adaptive Cruise Control is ON, and a vehicle is in front of you, the lead vehicle indicator is displayed. The lead vehicle indicator displays an image of the distance between your vehicle and the vehicle in front of you.

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, N or B 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.

- 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 hybrid system.
- 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)

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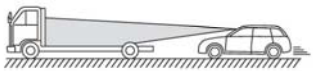
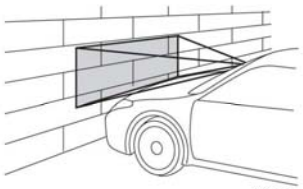
- Recognition conditions of the stereo camera
  In particular, the function may be unable to stop the vehicle or may not activate in the following cases.
  - Bad weather (for example heavy rain, a blizzard or thick fog)
  - When visibility is poor due to sand, smoke or water vapor blowing in the wind, 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

    - 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.

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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.*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

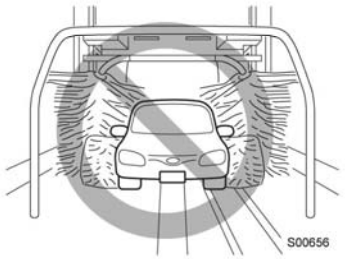
*1: The wheels and tires have functions that are critically important. Be sure to use the correct ones. For details, refer to the Owner's Manual for your vehicle.

*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.

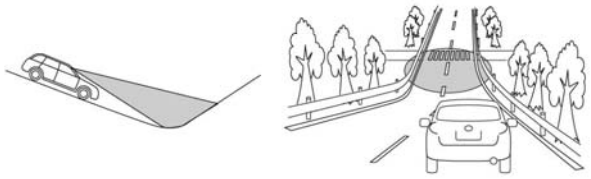
*3: For details about the combination meter, refer to the Owner's Manual for your vehicle.

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 hybrid system 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

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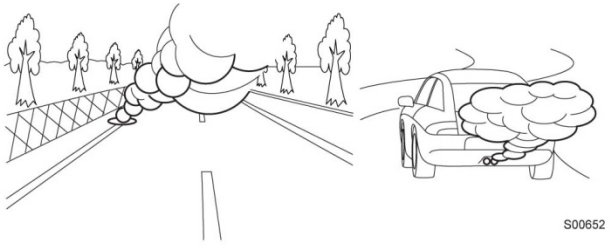
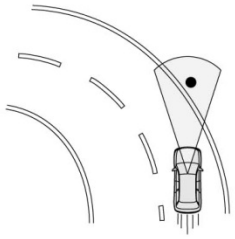
- When passing through clouds of steam or smoke, etc.
- When driving in adverse weather, such as heavy snow or snowstorms
- When the exhaust gas emitted by the vehicle in front is clearly visible in cold weather, etc.

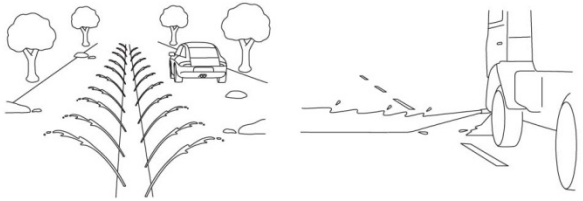


S00652

- 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



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.

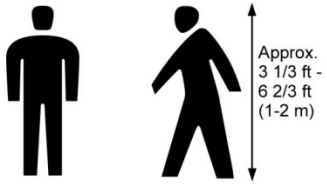
- If the driver operates the brake pedal during automatic braking, the pedal may feel stiff; however, this is normal. By depressing the brake pedal further you can apply more braking force.

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.

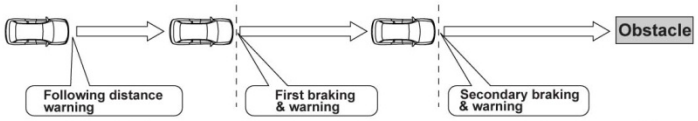
Following Distance Warning:
When the system determines that there is a risk of collision, a buzzer sounds repeated short beeps and the indicators on the combination meter display illuminate to warn the driver.
The Following Distance Warning operates when Adaptive Cruise Control is not set.
When the driver 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 hybrid system 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 hybrid system 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.

S02552



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

S03171

NOTE

- To release the brake control after the vehicle has come to a stop through Pre-Collision Braking System, perform the following.
  - Depress the brake pedal.
  - Depress the accelerator pedal (except when the select lever is in the [N] position).
  - Shift the select lever into the [P] position.
- After stopping with secondary braking, in the following cases, brake control will be released and the electronic parking brake will be applied.
  (For details about how to release the electronic parking brake, refer to the Owner's Manual for your vehicle.)
  - 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 EyeSight is temporarily stopped.
  - The driver's seatbelt is unfastened.
- 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

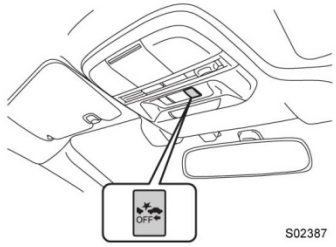
If the driver depresses the brake pedal while following distance warning is activated, the Pre-Collision Braking Assist will not work. The vehicle decelerates with the normal braking force operated by the driver.

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 brake 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.



S02387

NOTE

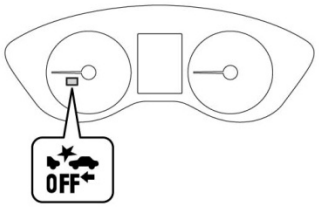
- When the Pre-Collision Braking System is turned off, the Pre-Collision Throttle Management Control function is also turned off.
- Even when the Pre-Collision Braking System is turned off, if the ignition switch is turned off and the hybrid system is then restarted, the Pre-Collision Braking System 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 hybrid system 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 107.
- When the EyeSight system has stopped temporarily.
  ⇒ Refer to page 108.



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.

CAUTION

- When shifting the select lever to the [N] or [B] position, Adaptive Cruise Control will be automatically canceled. Do not shift the lever to the [N] position unless in an emergency. Otherwise the engine brake may not operate, which could cause an accident.
- When a vehicle stops, if an automatic cancellation is performed by the system before starting the stay-stopped function (⇒ refer to page 58), the electronic parking brake will not operate.

NOTE

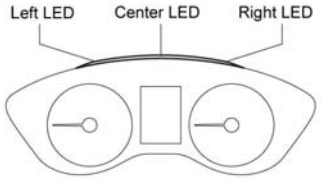
- If the EyeSight operation has temporarily stopped, the Pre-Collision Braking System OFF indicator light and Lane Departure Warning OFF indicator light illuminate, and the EyeSight temporary stop indicator is displayed on the combination meter display.
  ⇒ Refer to page 108.
- If EyeSight is malfunctioning, 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 hybrid system and restart it. If the indicators remain illuminated after restarting the hybrid system, 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 107.
- 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.

Driver Assist indicator

The operating status of the EyeSight system is indicated at the top of the combination meter.
This allows the driver to remain aware of warnings and displayed information without taking their eyes off the surrounding driving environment.
The LED indicators can be set to ON/OFF. Refer to “Customizing functions” for setting details.
⇒ Refer to page 110.

Driver Assist indicator operation

To inform the driver of the operation condition of EyeSight while driving, the LED indicators illuminate or flash at the top of the combination meter.



S03365

Display	Condition
Red indicators flash simultaneously (3 indicators)	The Following Distance Warning, Pre-Collision Braking System (first braking or secondary braking), Obstacle Detected 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 flash (alternately)	Lane Sway Warning is operating.
Yellow indicators flash 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.

List of buzzer sounds

Buzzer sound	Status	Reference page
Single continuous beep	Pre-Collision Braking System: Secondary Braking is active.	⇒ Refer to page 35.
1 short beep and 1 long beep	Adaptive Cruise Control or Conventional Cruise Control is canceled automatically.	⇒ Refer to pages 62 and 102.
	The stay-stopped function is canceled and the electronic parking brake is automatically applied.	⇒ Refer to page 60.
	Lane Keep Assist is canceled automatically.	⇒ Refer to page 75.
Repeated short beeps	Pre-Collision Braking System: First Braking is active.	⇒ Refer to page 35.
	Pre-Collision Braking System: The following distance warning is active.	
	The “Obstacle Detected” warning from Adaptive Cruise Control is active.	⇒ Refer to page 65.
	Pre-Collision Throttle Management is active.	⇒ Refer to page 77.
3 short beeps	The Lane Departure Warning is active.	⇒ Refer to page 83.
	The Lane Sway Warning is active.	⇒ Refer to page 87.
5 intermittent beeps, 1 short beep and 1 long beep	The stay-stopped function of Adaptive Cruise Control continued for 2 minutes and the electronic parking brake was automatically applied.	⇒ Refer to page 60.
3 short beeps and 1 long beep	Pre-Collision Braking System: Just before the automatic brake is slowly released by the system after the vehicle is stopped by the pre-collision braking.	⇒ Refer to page 26.
	Adaptive Cruise Control System: Just before the automatic brake is released by the system after the vehicle is stopped by the Adaptive Cruise Control System. Adaptive Cruise Control System will stop the vehicle according to the lead vehicle stops.	⇒ Refer to page 41.

List of buzzer sounds

Buzzer sound	Status	Reference page
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 96 and 98.
	EyeSight is malfunctioning.	⇒ Refer to pages 107 and 108.
	EyeSight operation is temporarily stopped.	
	Pre-Collision Braking System and Pre-Collision Throttle Management are turned on/off.	⇒ Refer to pages 39 and 82.
	The Lane Departure Warning and the Lane Sway Warning are turned on/off.	⇒ Refer to pages 85 and 89.
Two-tone beep	Lead Vehicle Start Alert is active*.	⇒ Refer to page 90.

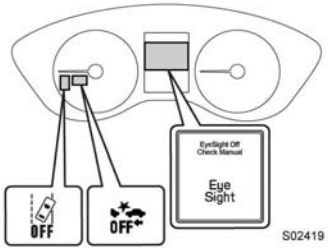
*: The buzzer that indicates when a lead vehicle is detected or when it is no longer detected (Lead Vehicle Acquisition Sound), as well as the Lead Vehicle Start Alert can be turned on or off.
⇒ Refer to page 110.

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.

NOTE

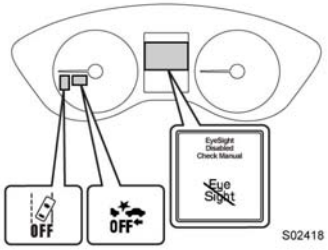
- If the EyeSight warning indicator illuminates or flashes, stop the vehicle in a safe location, turn off the hybrid system, and then restart it.
- If the indicator continues illuminating or flashing even after the hybrid system has been restarted, the EyeSight system has a malfunction. In this case, all EyeSight functions will be stopped. Normal driving will still be possible. However, contact a SUBARU dealer for an inspection.
- If the EyeSight warning indicator illuminates or flashes, the RAB system will not operate.

■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.

■Message screen list (precautions and notices)

Item	Displayed screen	ℹ mark	Reference page
Pre-Collision Braking System		None	⇒ Refer to page 35.
The “Obstacle Detected” warning	Obstacle Detected S02999	None	⇒ Refer to page 65.
Pre-Collision Throttle Management		None	⇒ Refer to page 77.
Apply Brake	Apply Brake To Hold Position S03000	None	⇒ Refer to page 35.
Lane Departure Warning	Lane Departure S03002	None	⇒ Refer to page 83.
Lane Sway Warning	Stay Alert S03003	None	⇒ Refer to page 87.
Lead Vehicle Start Alert	Vehicle Ahead Has Moved S03004	None	⇒ Refer to page 90.
Steering operation is not detected by Lane Keep Assist	Keep Hands On Steering Wheel S03001	None	⇒ Refer to page 75.
Adaptive Cruise Control/Conventional Cruise Control automatic cancellation (when the grade of the road is very steep)	Steep Slope S02425	None	⇒ Refer to pages 62 and 102.

APPENDIX C

Run Log

Subject Vehicle: **2019 Subaru Crosstrek Hybrid** Test Date: **6/3/2019**

Principal Other Vehicle: **2006 Acura RL**

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
1	**Stopped POV**	Y	2.77	2.44	0.67	Pass	No visual alert
2		Y	2.81	2.69	0.71	Pass	
3		Y	2.94	2.82	0.84	Pass	
4		Y	3.02	2.83	0.92	Pass	
5		Y	2.87	2.68	0.77	Pass	
6		Y	2.92	2.78	0.82	Pass	
7		Y	2.98	2.61	0.88	Pass	
8	**Slower POV, 45 vs 20**	Y	3.16	2.98	1.16	Pass	
9		Y	3.41	3.28	1.41	Pass	
10		Y	3.52	3.35	1.52	Pass	
11		Y	2.99	2.88	0.99	Pass	
12		Y	3.14	2.99	1.14	Pass	
13		Y	3.07	2.88	1.07	Pass	
14		Y	3.18	3.05	1.18	Pass	

Subject Vehicle: **2019 Subaru Crosstrek Hybrid** Test Date: **6/3/2019**

Principal Other Vehicle: **2006 Acura RL**

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
15	**Braking POV, 45**	Y	3.03	2.92	0.63	Pass	
16		N					Yaw Rate
17		N					POV Yaw Rate, SV Speed
18		Y	2.78	2.67	0.38	Pass	
19		Y	2.81	2.71	0.41	Pass	
20		Y	2.82	2.68	0.42	Pass	
21		Y	2.84	2.64	0.44	Pass	
22		N					SV Speed
23		Y	2.69	2.50	0.29	Pass	
24		Y	2.80	2.57	0.40	Pass	

APPENDIX D

Time History Plots

LIST OF FIGURES

Description of Time History Plots

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from both the Subject Vehicle (SV) and the Principal Other Vehicle (POV), as well as pass/fail envelopes and thresholds. 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 pertinent 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:

- FCW Test 1 – Stopped POV (SV at 45 mph)
- FCW Test 2 – Braking POV (Both vehicles at 45 mph with a 30 m gap, POV brakes at 0.3 g)
- FCW Test 3 – Slower Moving POV (SV at 45 mph, POV at 20 mph)

Time history figures include the following sub-plots:

- 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 of the following:
    - Filtered, rectified, and normalized sound signal. The vertical scale is 0 to 1.
    - Filtered, rectified, and normalized acceleration (e.g., haptic alert, such as steering wheel vibration). The vertical scale is 0 to 1.
    - Light sensor signal
- TTC (sec) – Indicates the Time to Collision as calculated up to the point of FCW alert issuance. The value of TTCW (Time to Collision at Warning) is given numerically on the right side of the figure. A passing value is indicated in green, while a failing value is indicated in red.
- SV Speed (mph) – Speed of the Subject Vehicle

- POV Speed (mph) – Speed of the Principal Other Vehicle
- Yaw Rate (deg/sec) – Yaw rate of both the Subject Vehicle and Principal Other Vehicle
- Lateral Offset (ft) – Lateral offset within the lane from the Subject Vehicle to the Principal Other Vehicle
- Ax (g) – Longitudinal acceleration of both the Subject Vehicle and Principal Other Vehicle
- Headway (ft) – Longitudinal separation between front of Subject Vehicle to rear of Principal Other Vehicle (Exclusive to test type 2)

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

Each of the time history plot figures can contain either green or yellow envelopes and/or black 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.

Green envelopes indicate that the time-varying data should 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.

Yellow envelopes indicate that the time-varying data should not exceed the envelope only at the left and/or right ends. Exceedances at the left or right extent of a yellow envelope are indicated by red asterisks.

For the warning plot, a dashed black threshold line indicates the threshold used to determine the onset of the FCW alert. The alert is considered on the first time the alert signal crosses this threshold line.

For the TTC plot, a dashed black threshold line indicates the minimum allowable TTC for the given test scenario. If the FCW alert occurs before this minimum allowable TTC, a green dot appears. However, if there is no alert or the alert occurs after the minimum allowable TTC, a red asterisk is shown on the plot.

For the Ax plot, a dashed black threshold line is given for at a value of -0.05 g. For a test run to be valid, the longitudinal acceleration of the Subject Vehicle must not fall below this threshold (i.e. the driver cannot apply any brakes). Additionally, for test type 2, the plot indicating the longitudinal acceleration of the Principal Other Vehicle includes a yellow envelope indicating the deceleration (0.3 g ± 0.03 g) allowed while braking. Exceedance of this threshold is indicated with red asterisks at the beginning and/or end of the threshold boundary.

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. Instantaneous samplings
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 not exceed this threshold in order to be valid
   - Black threshold (Dashed) = for reference only – this can include warning level thresholds, TTC thresholds, and acceleration thresholds

3. Instantaneous sampling 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 time history plots for each test type (including passing, failing and invalid runs) are shown in Figure D1 through Figure D6. Actual time history data plots for the vehicle under consideration are provided subsequently.

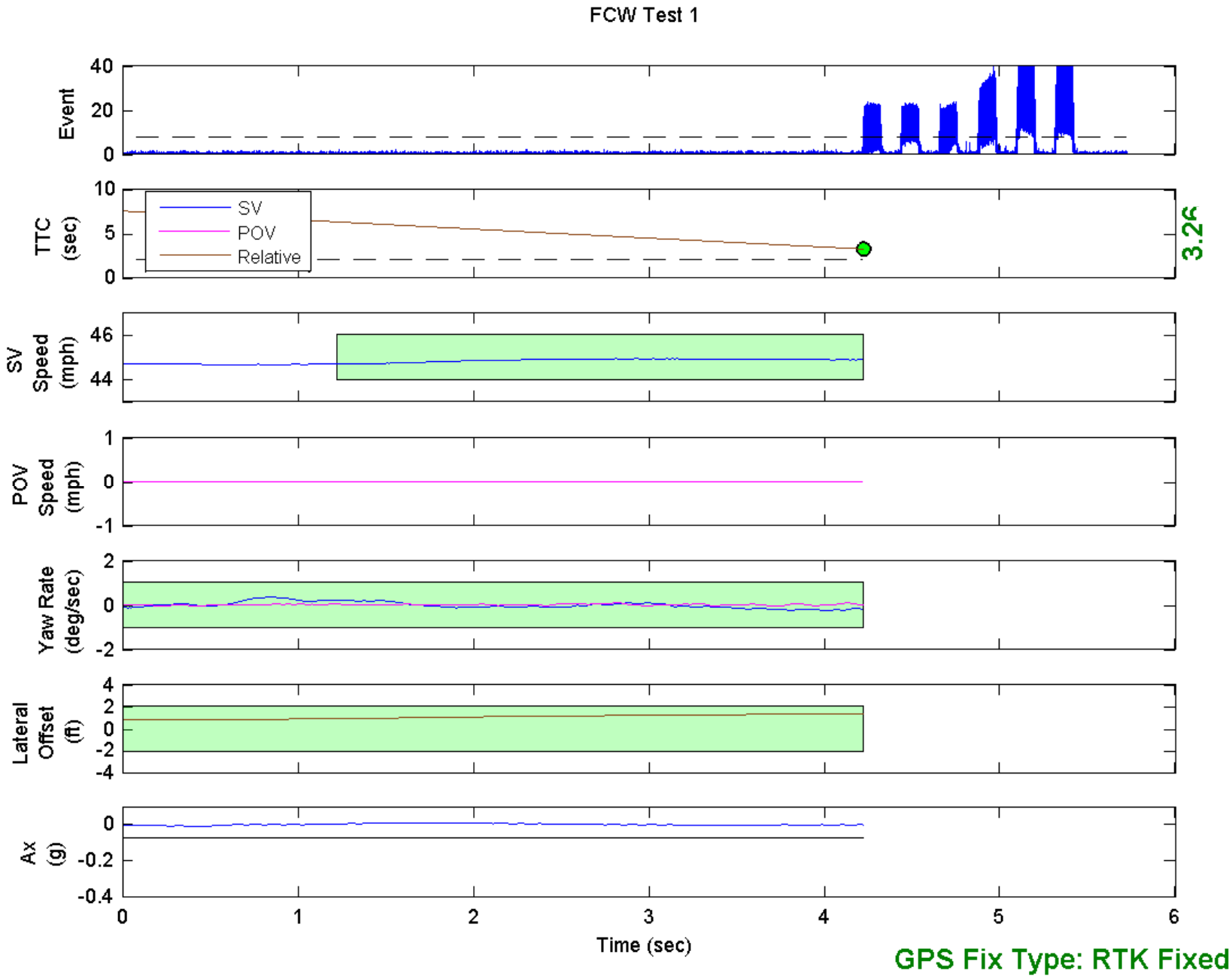


Figure D1. Example Time History for Test Type 1, Passing

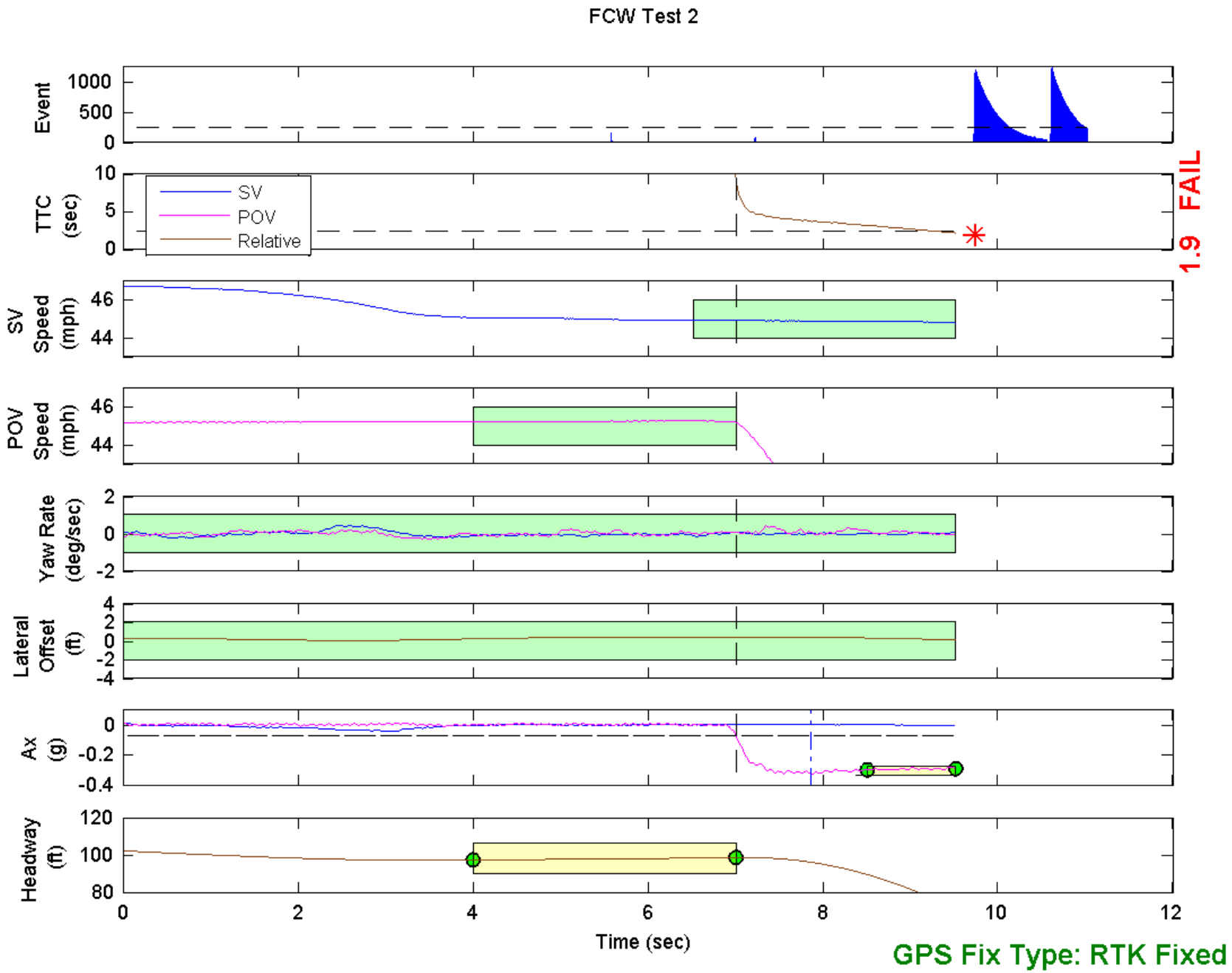


Figure D2. Example Time History for Test Type 2, Failing

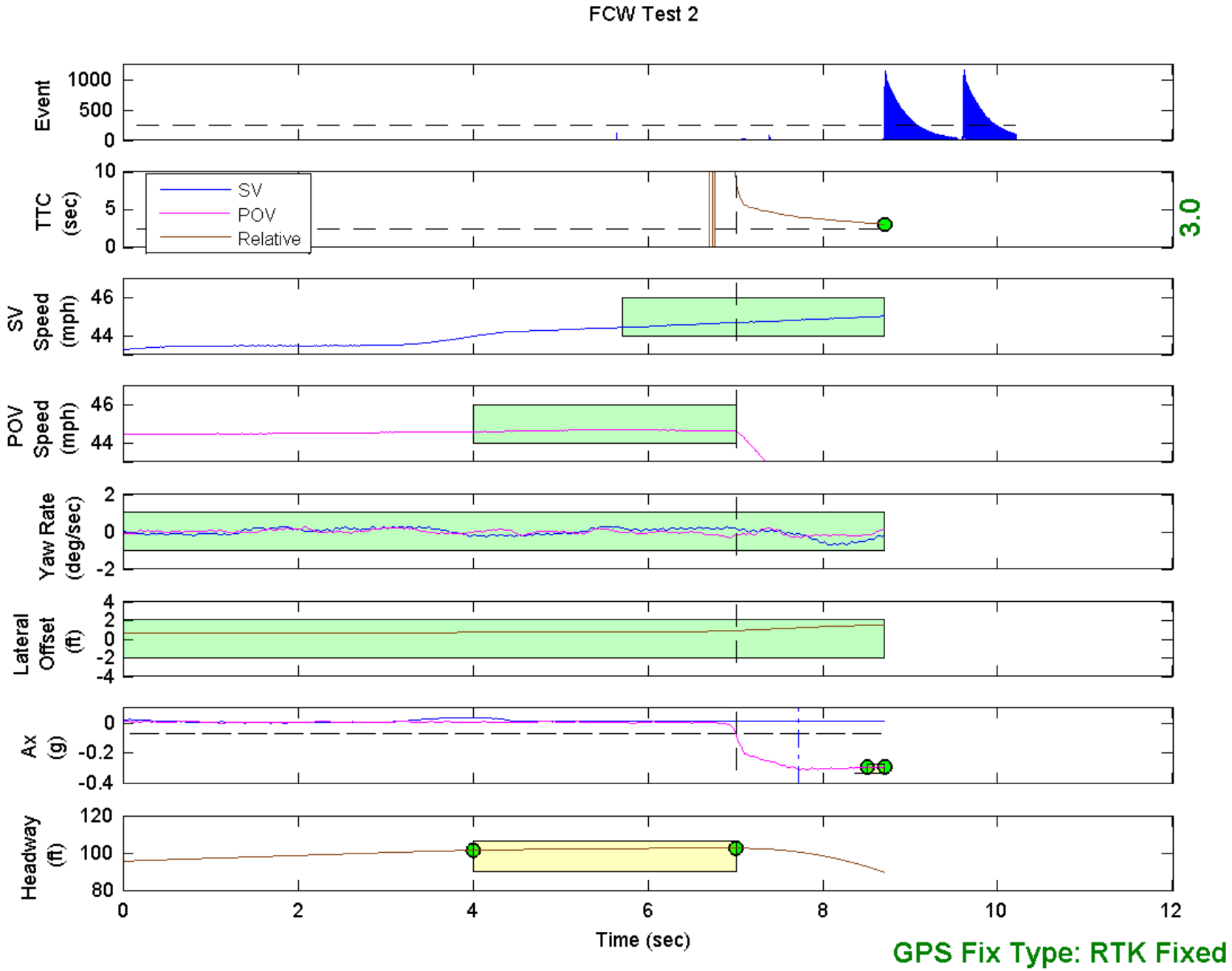


Figure D3. Example Time History for Test Type 2, Passing

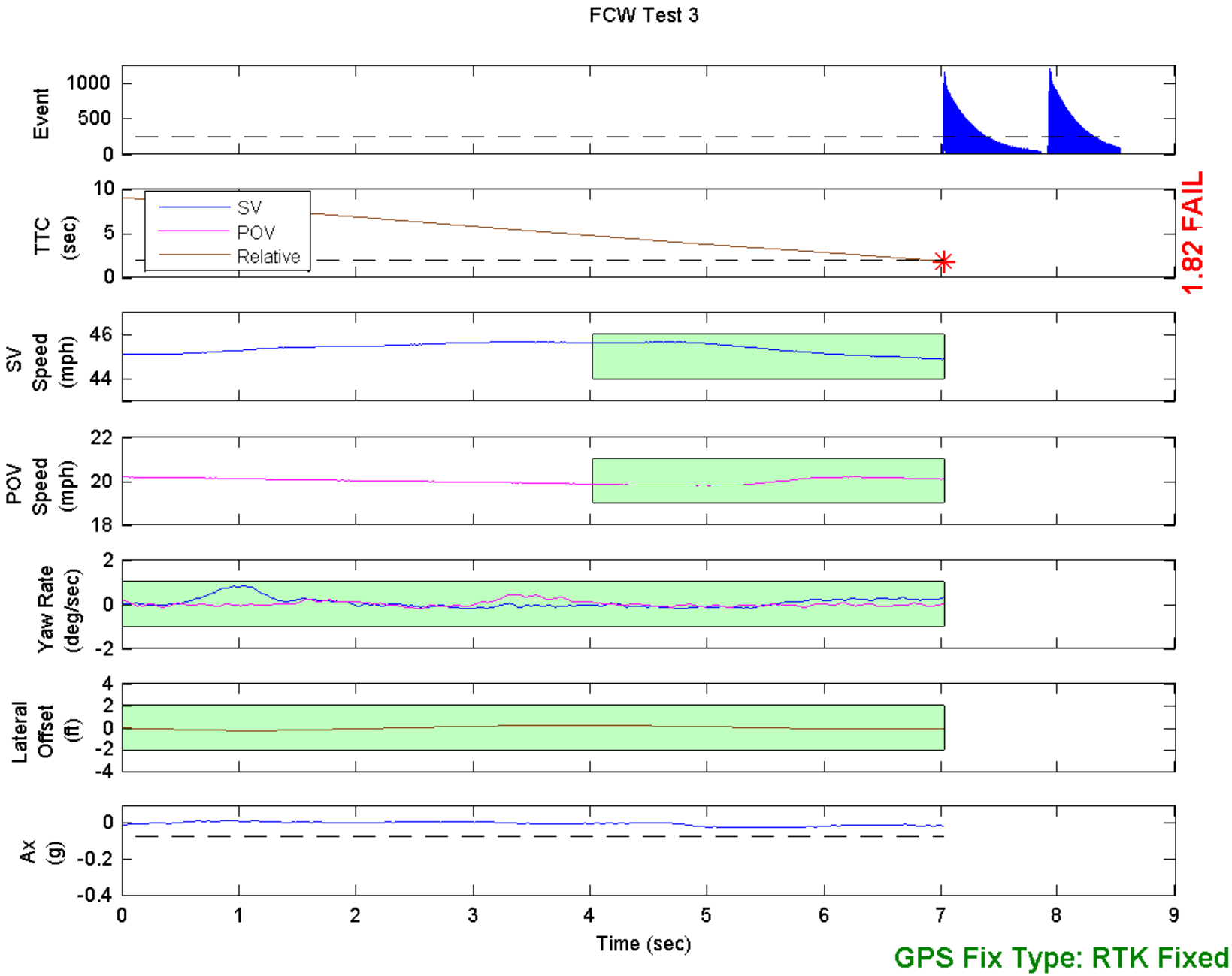


Figure D4. Example Time History for Test Type 3, Failing

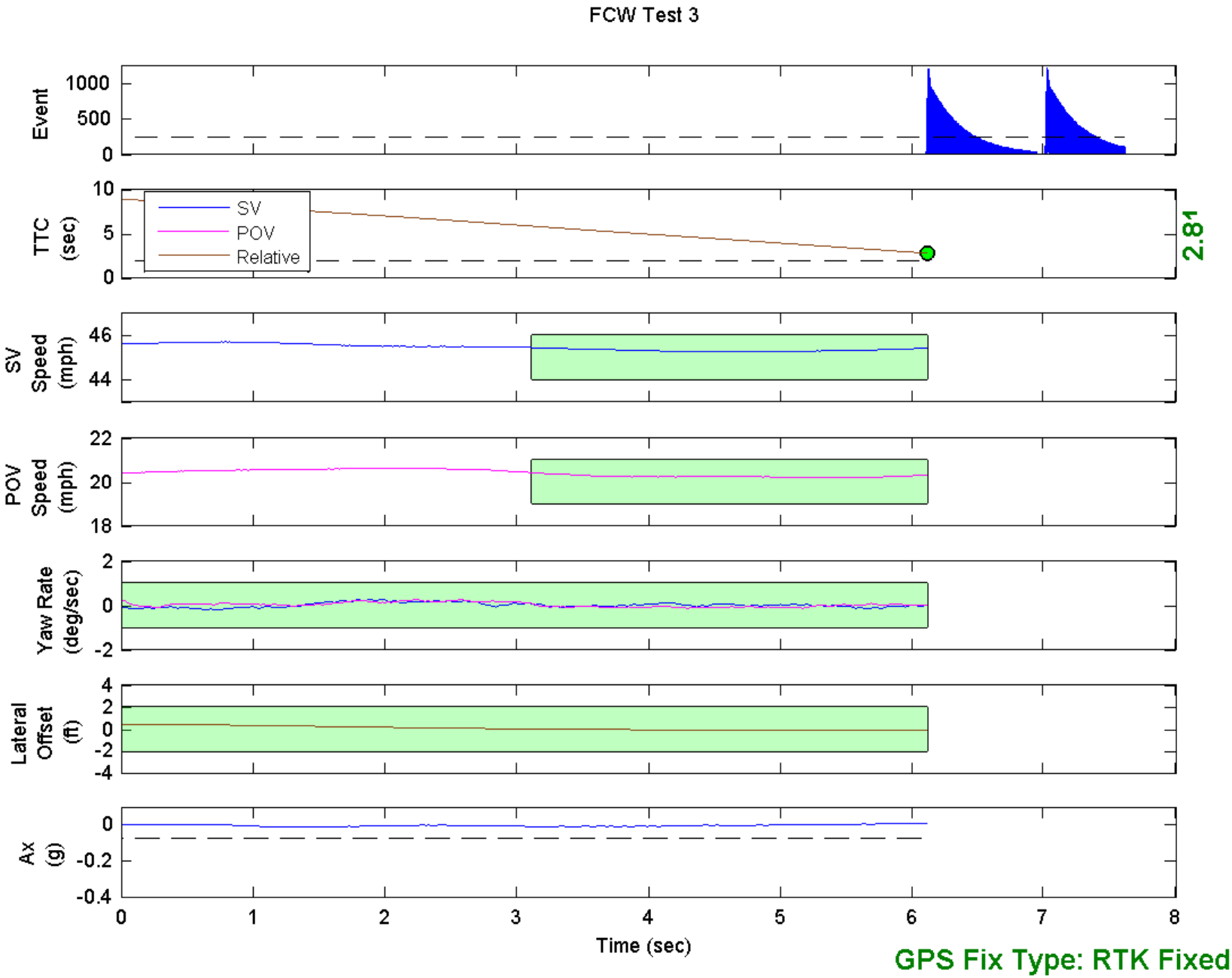


Figure D5. Example Time History for Test Type 3, Passing

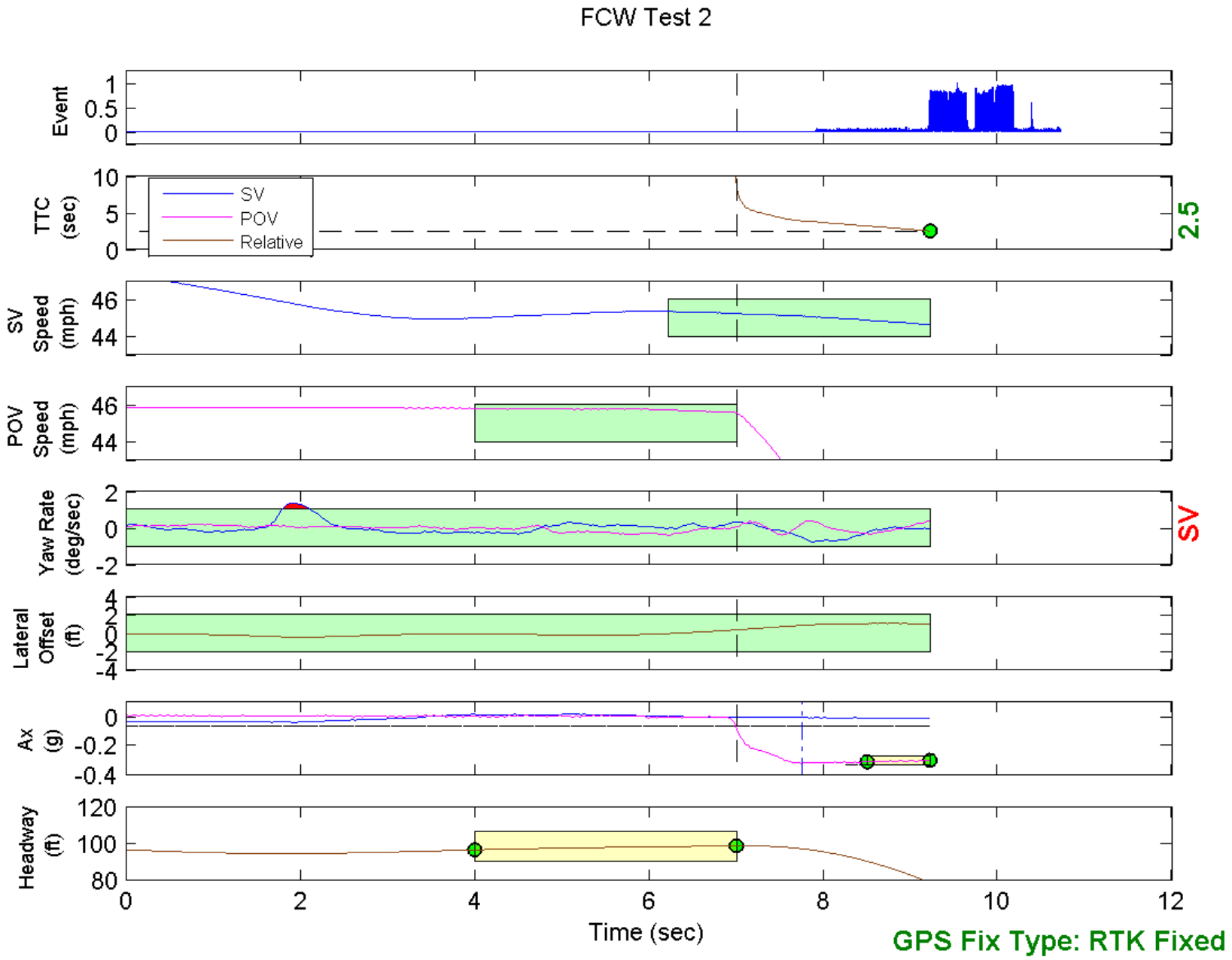


Figure D6. Example Time History for Test Type 2, Invalid Run Due to Subject Vehicle Yaw Rate

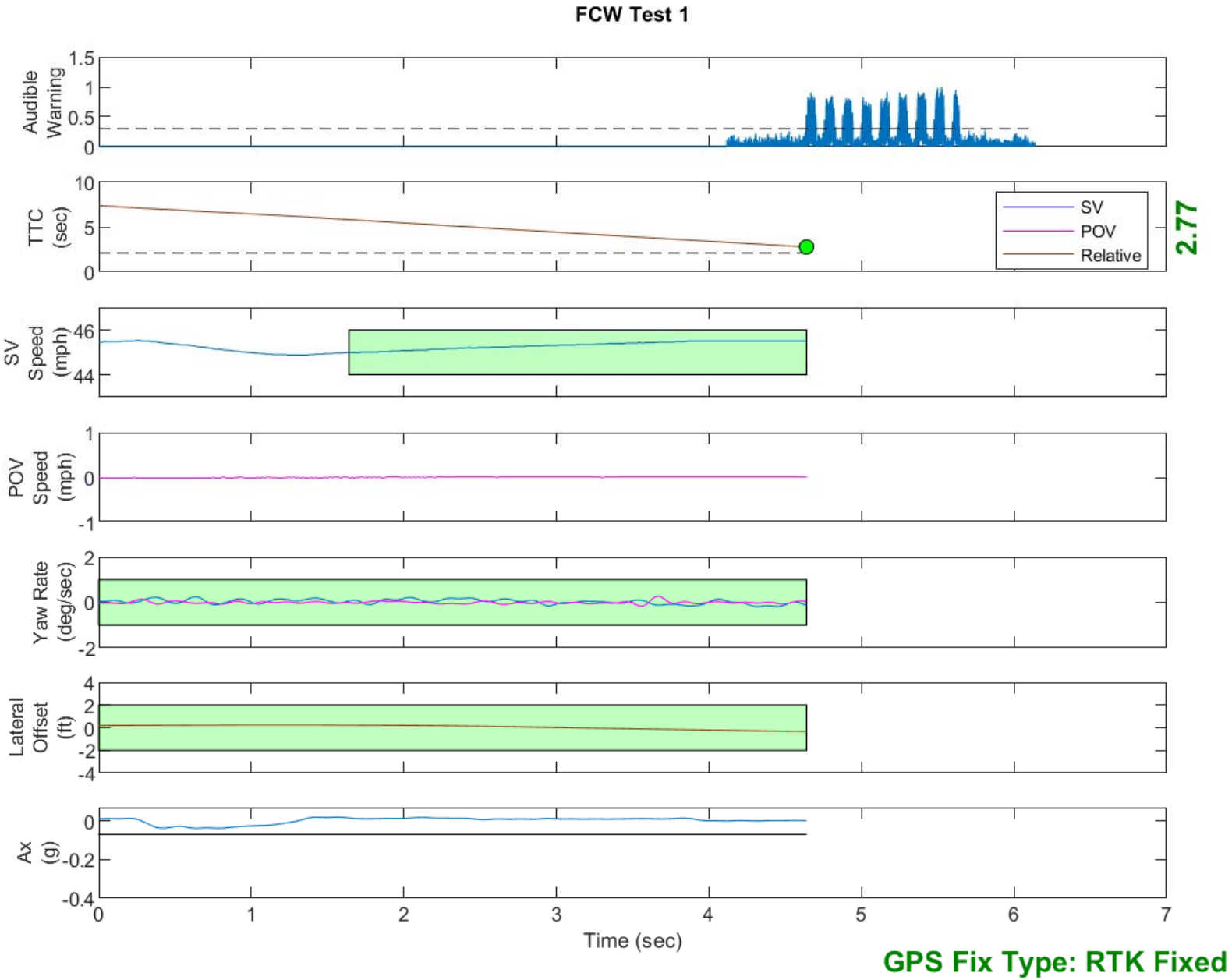


Figure D7. Time History for Run 1, FCW Test 1, Audible Warning

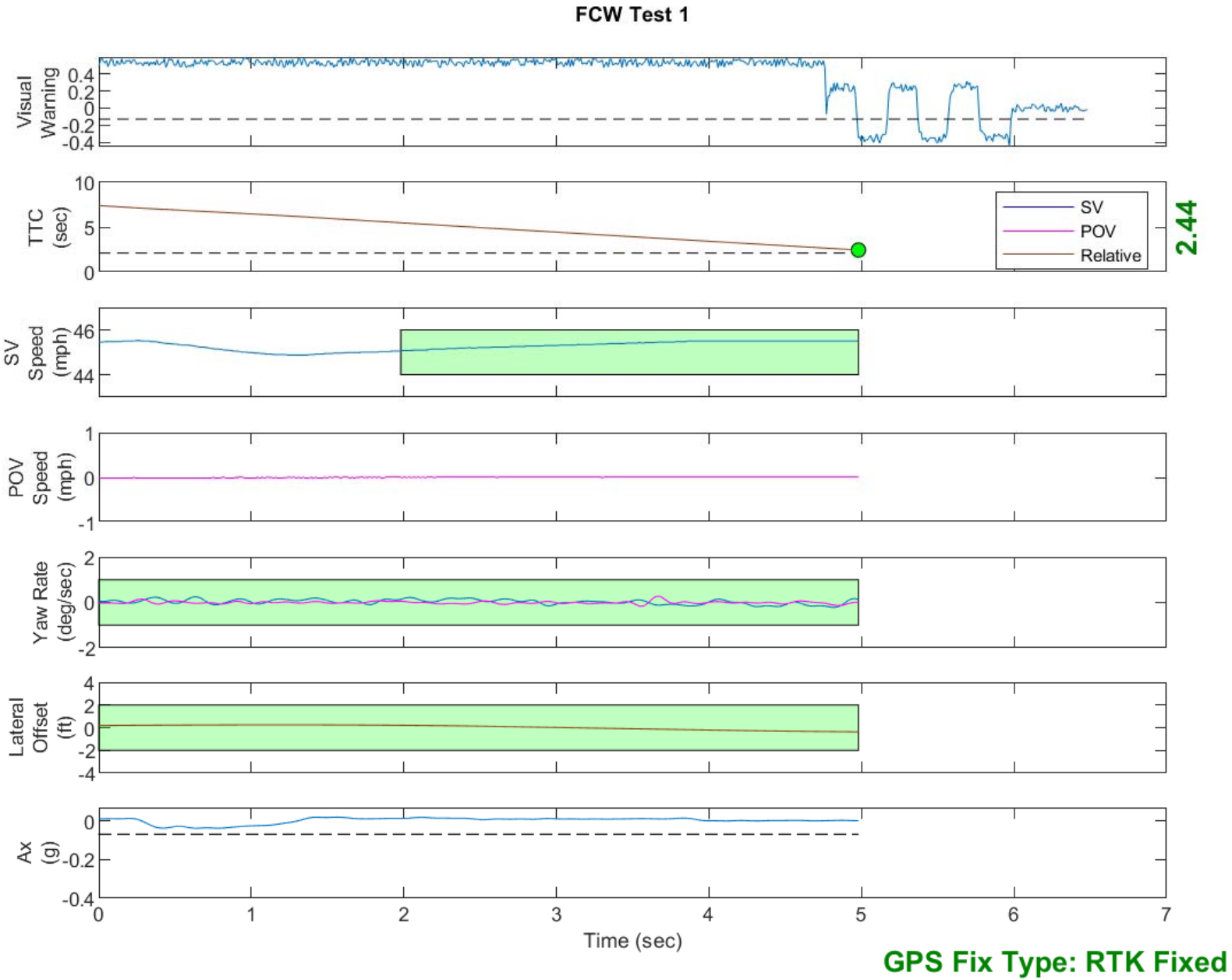


Figure D8. Time History for Run 1, FCW Test 1, Visual Warning

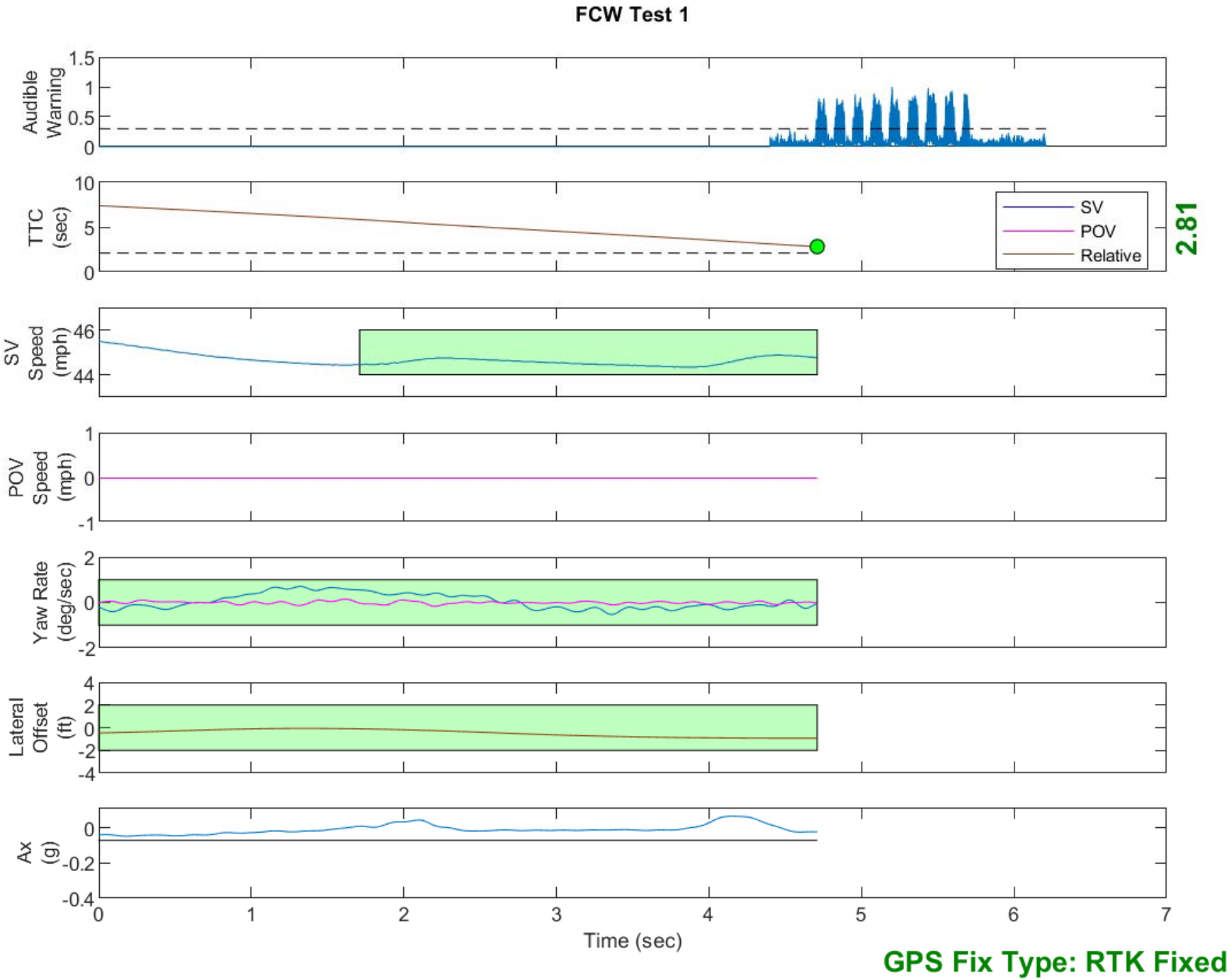


Figure D9. Time History for Run 2, FCW Test 1, Audible Warning

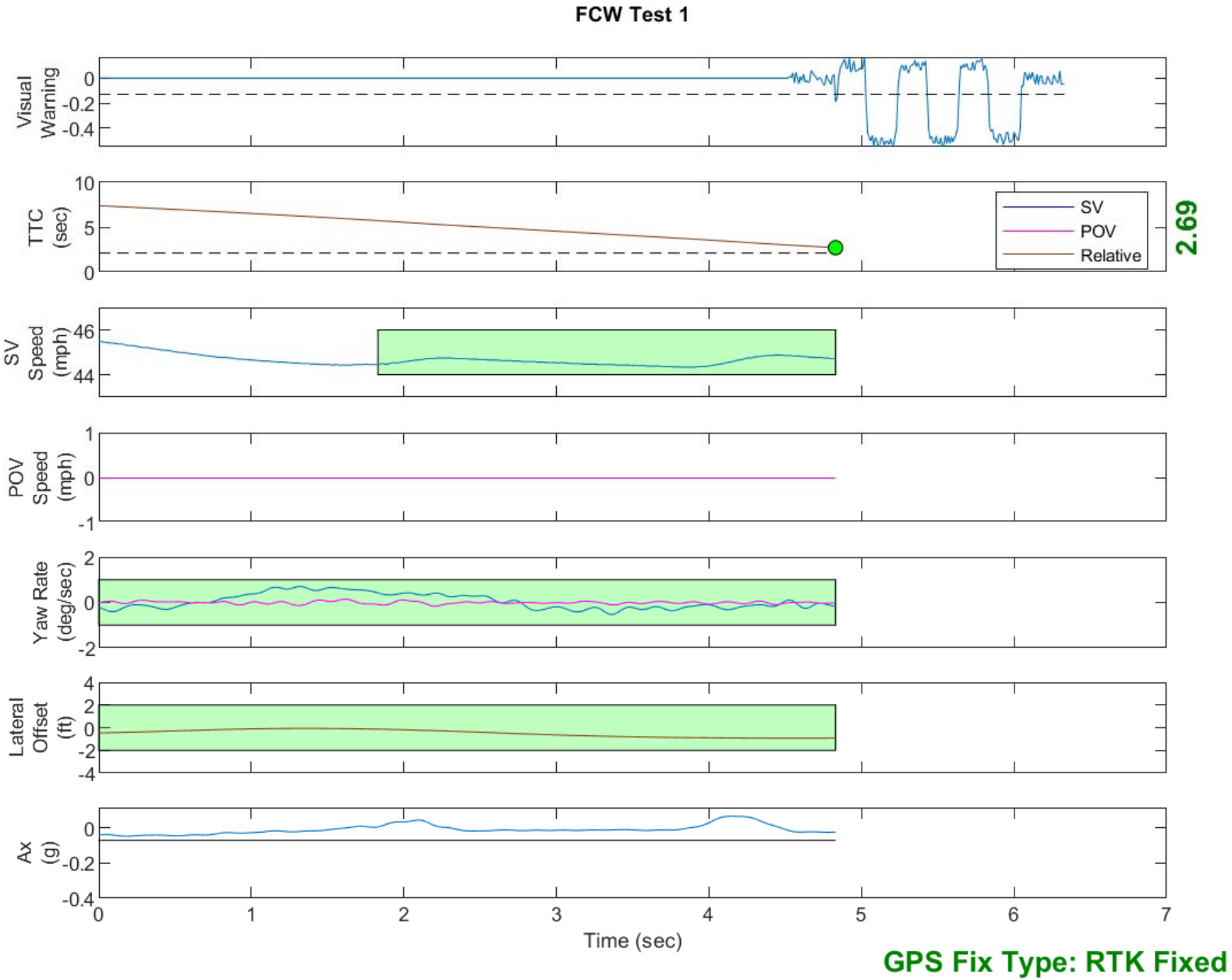


Figure D10. Time History for Run 2, FCW Test 1, Visual Warning

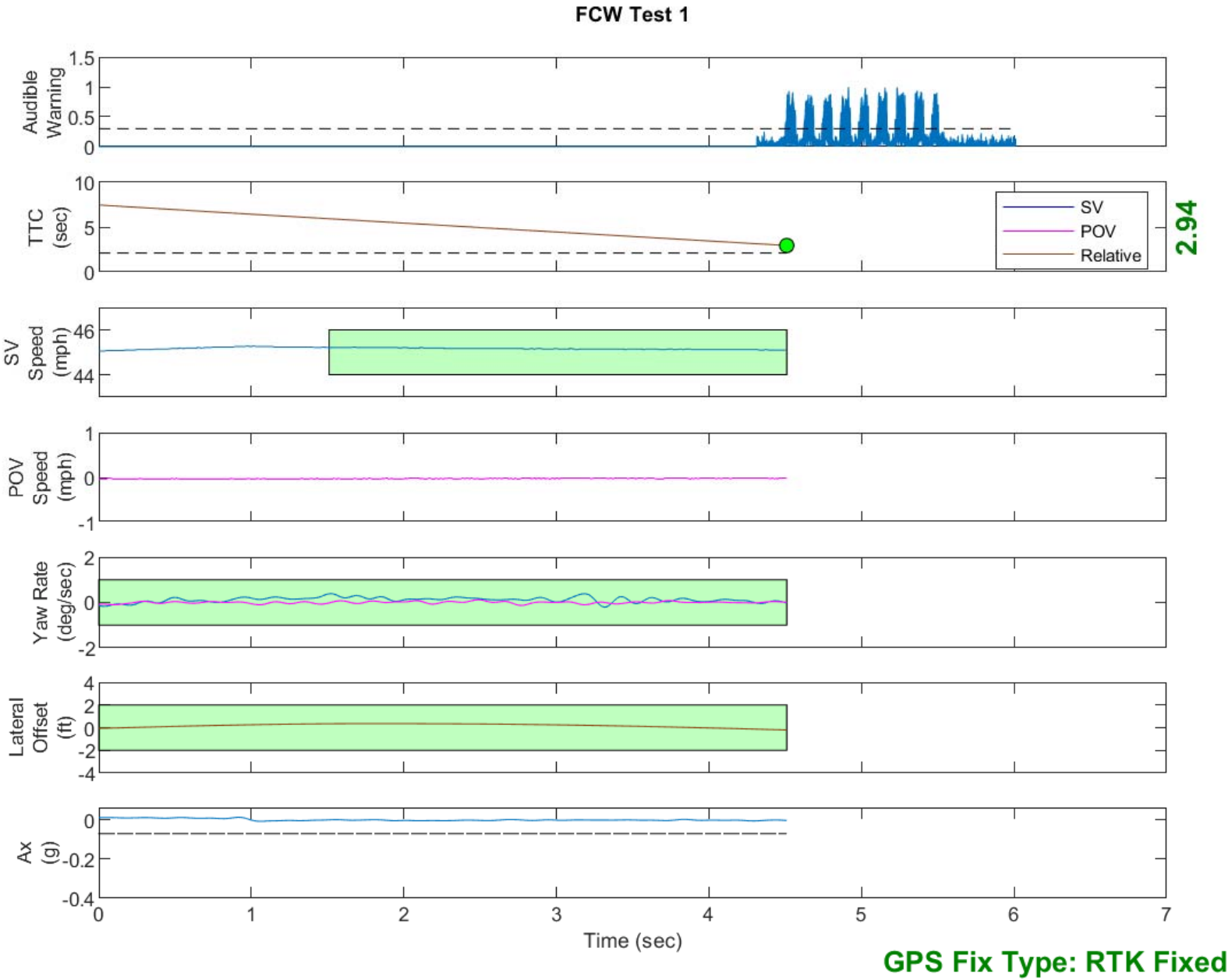


Figure D11. Time History for Run 3, FCW Test 1, Audible Warning

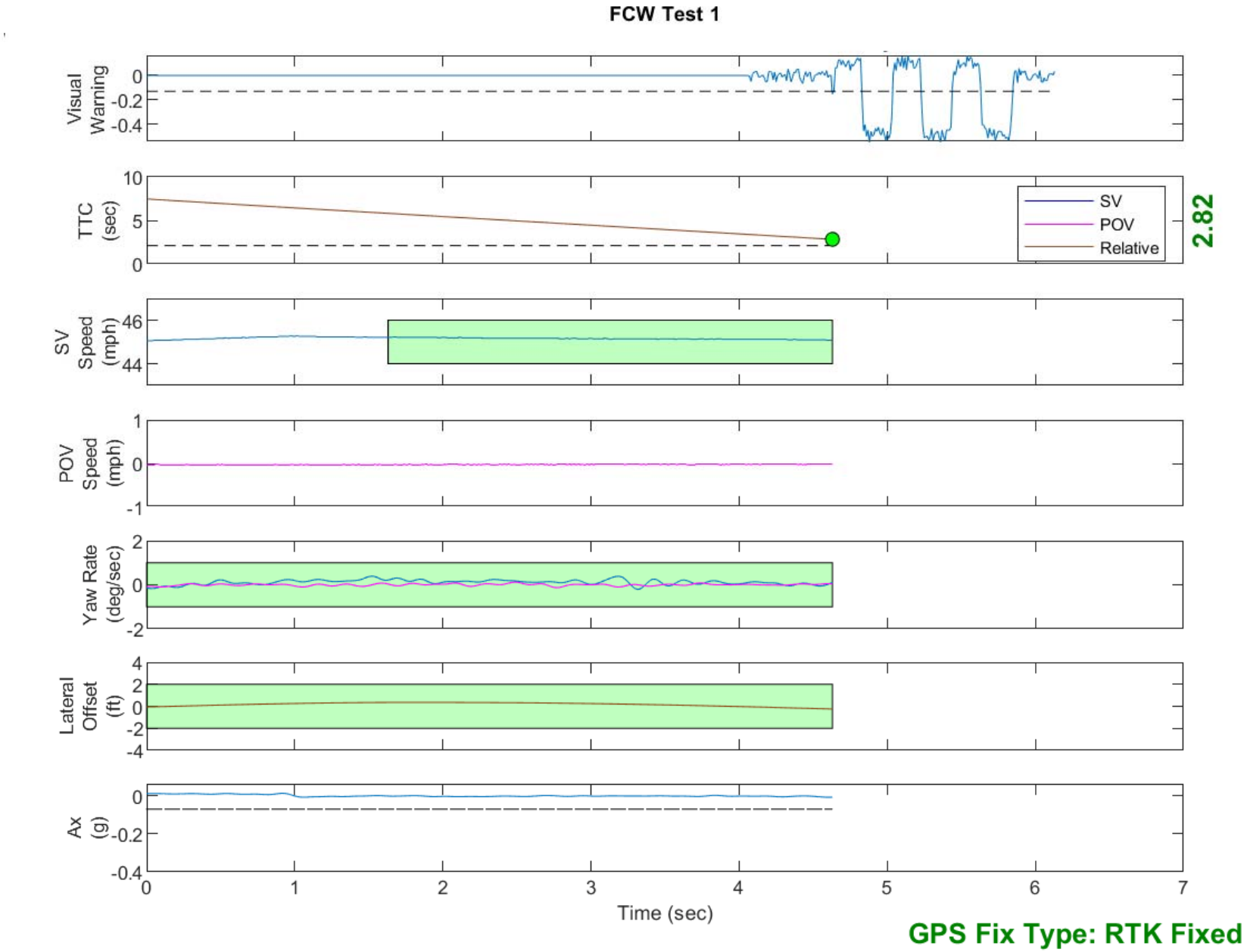


Figure D12. Time History for Run 3, FCW Test 1, Visual Warning

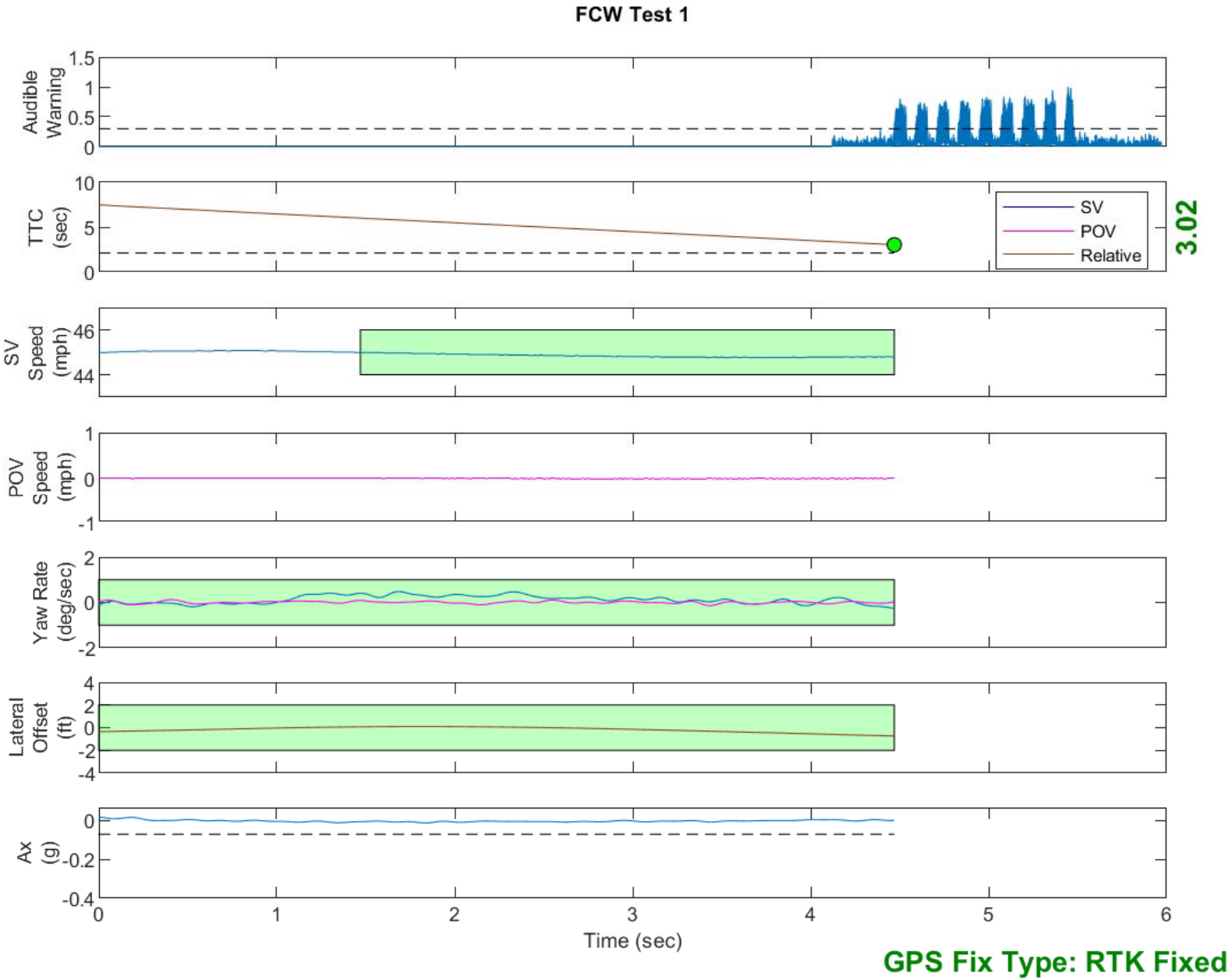


Figure D13. Time History for Run 4, FCW Test 1, Audible Warning

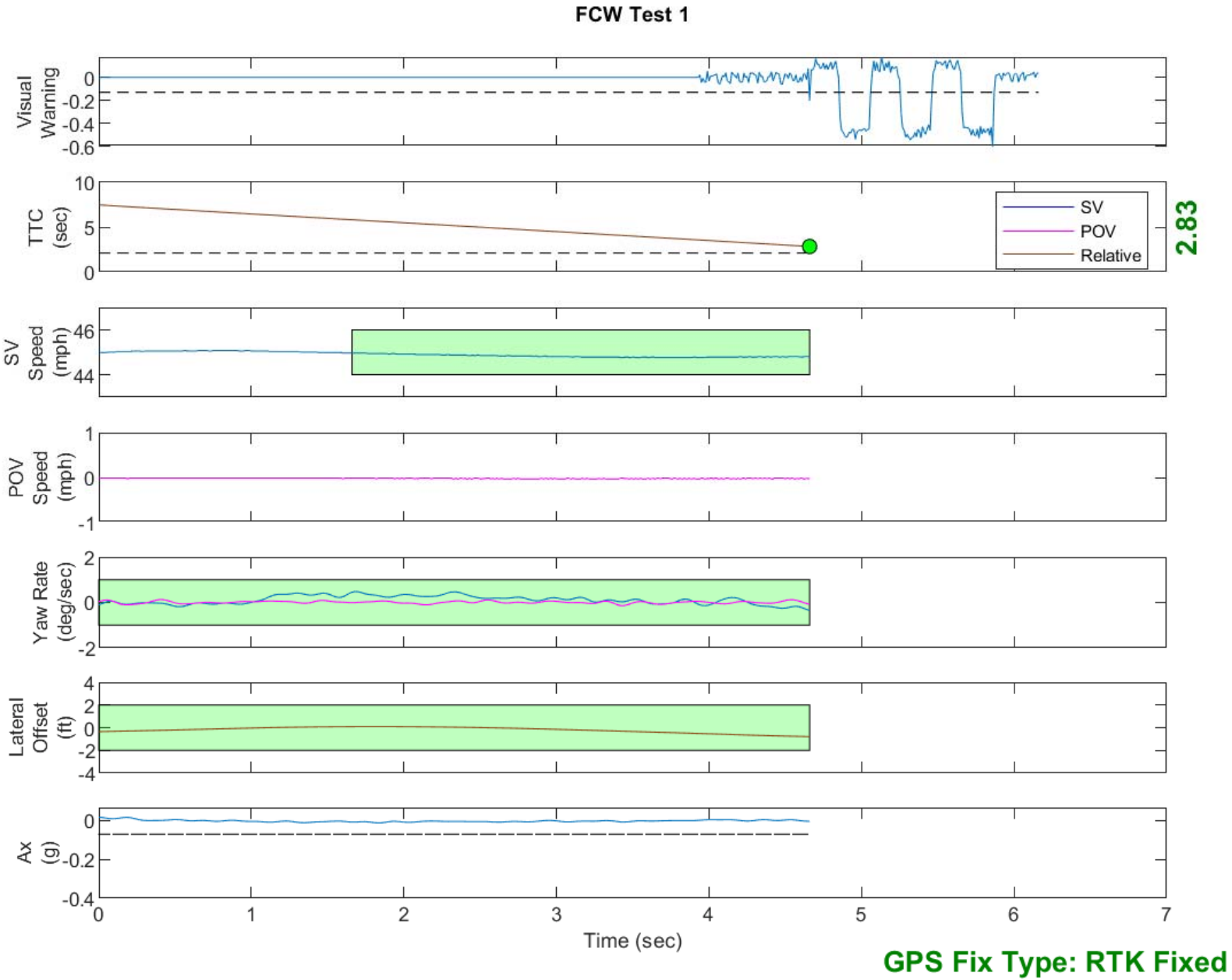


Figure D14. Time History for Run 4, FCW Test 1, Visual Warning

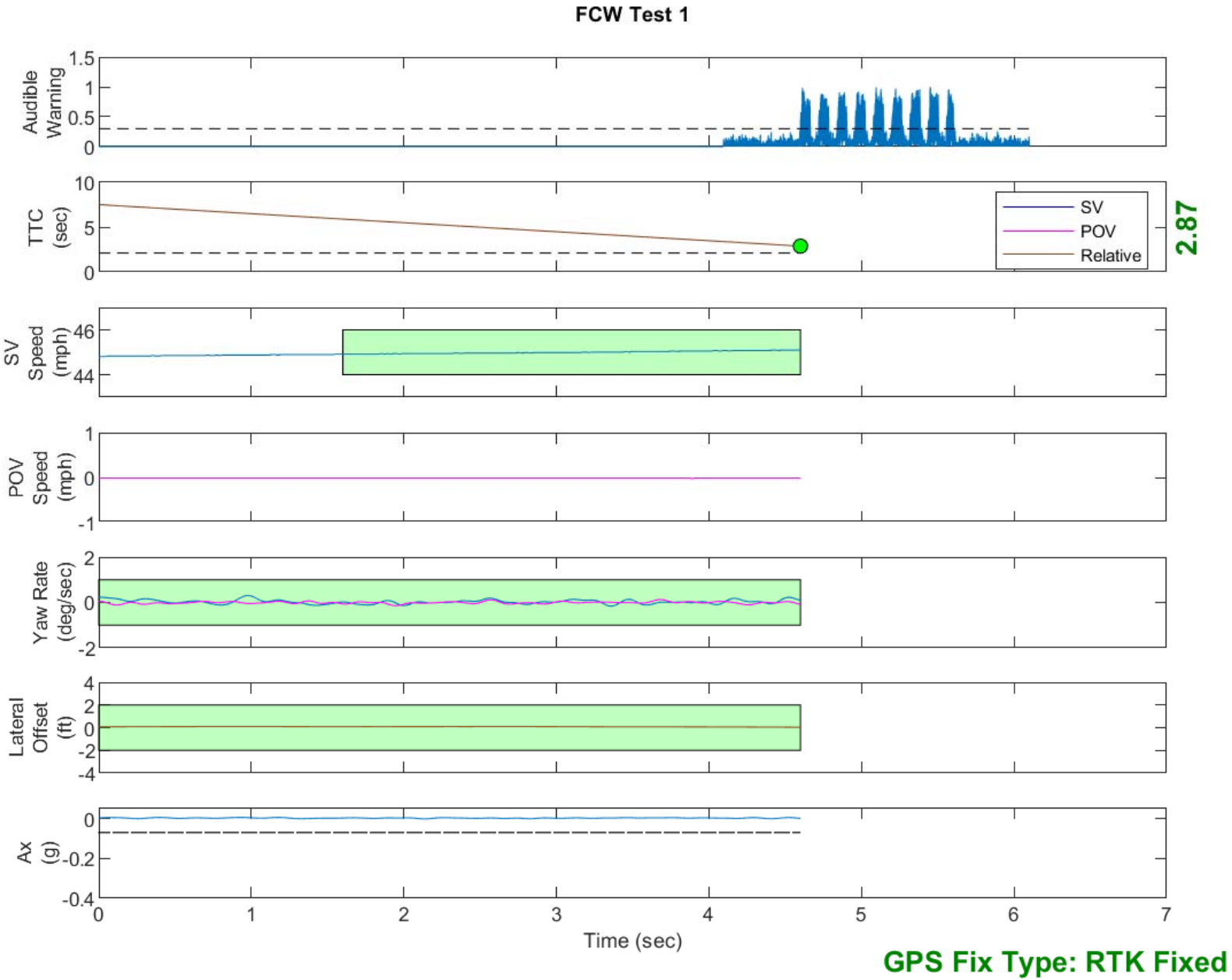


Figure D15. Time History for Run 5, FCW Test 1, Audible Warning

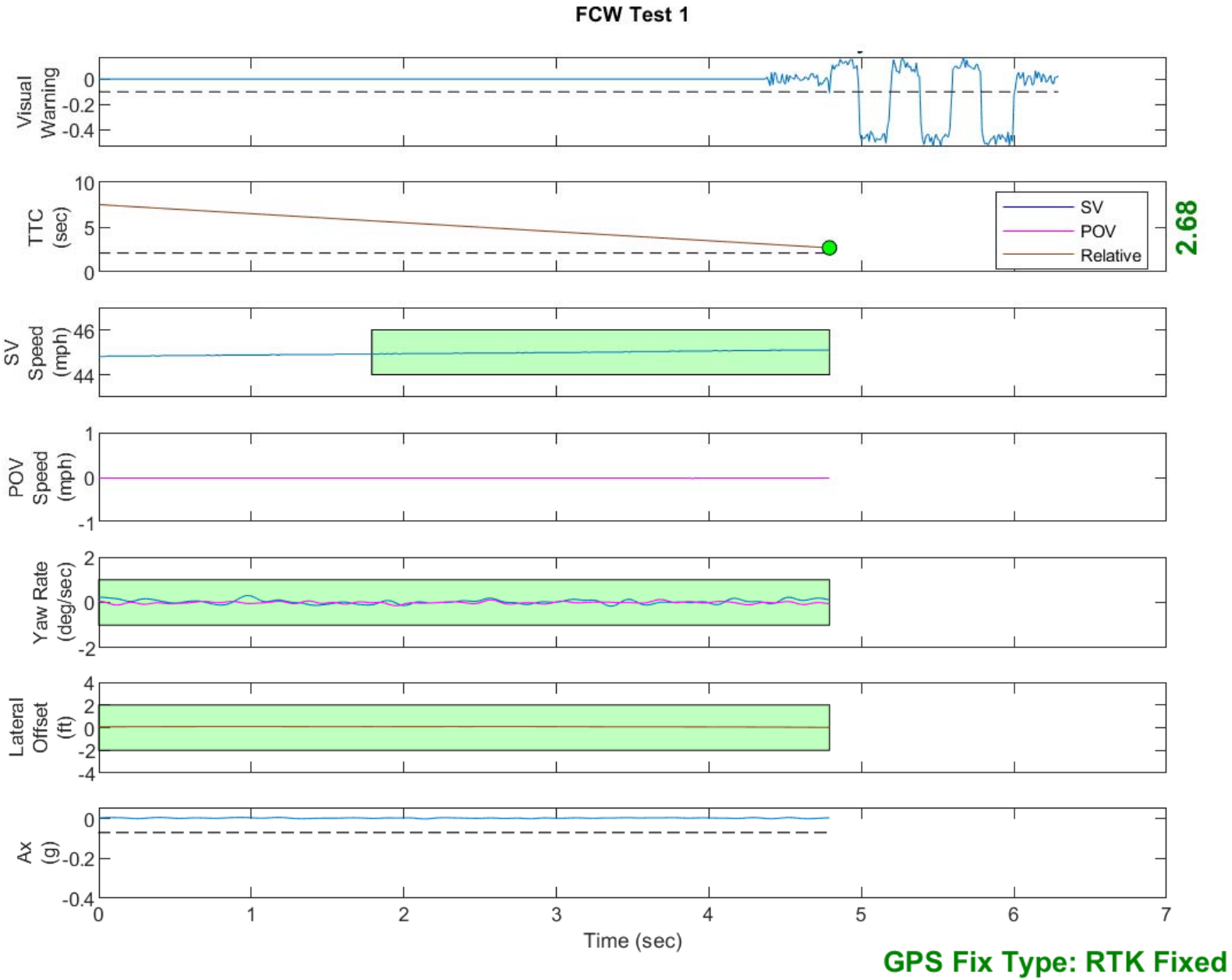


Figure D16. Time History for Run 5, FCW Test 1, Visual Warning

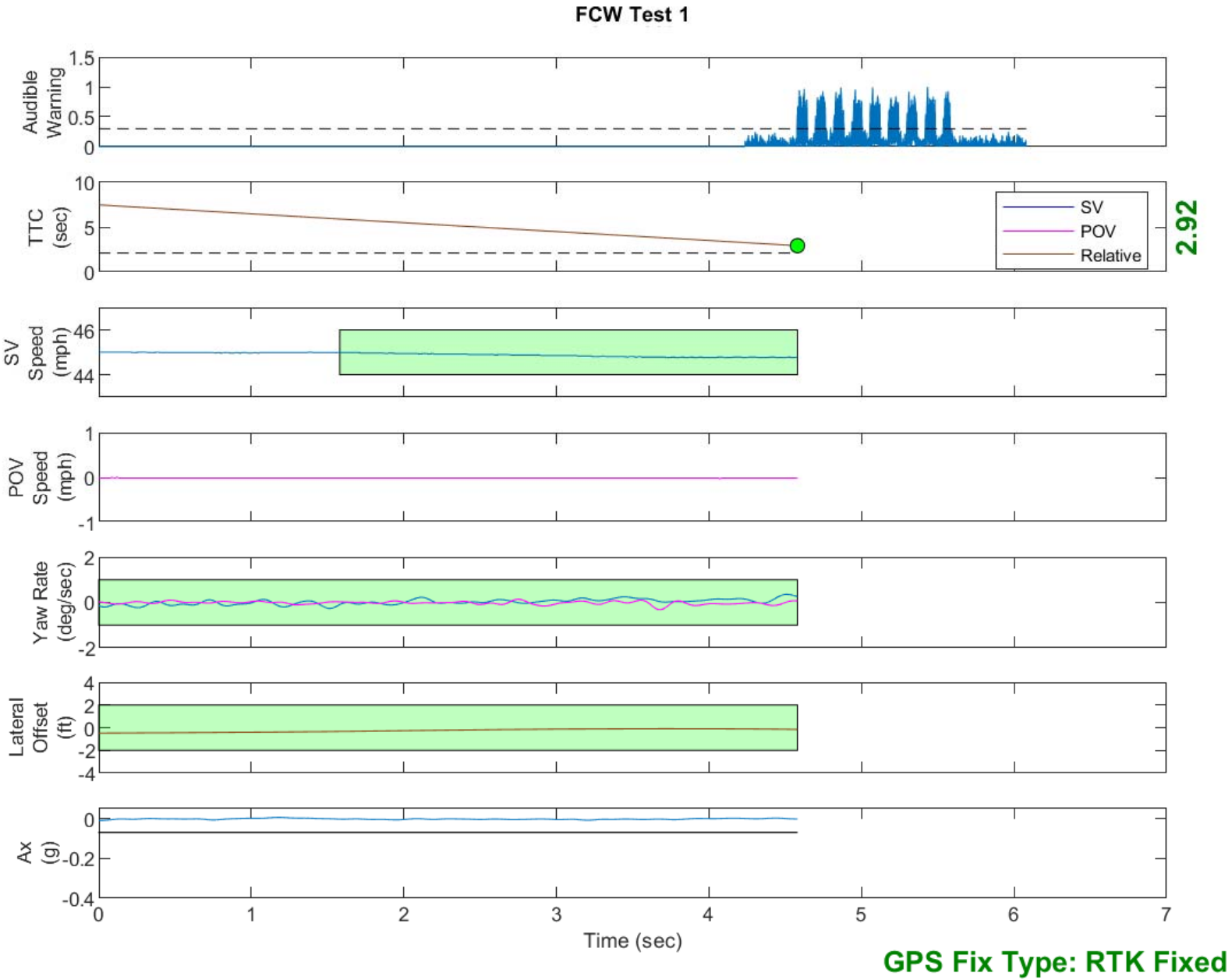


Figure D17. Time History for Run 6, FCW Test 1, Audible Warning

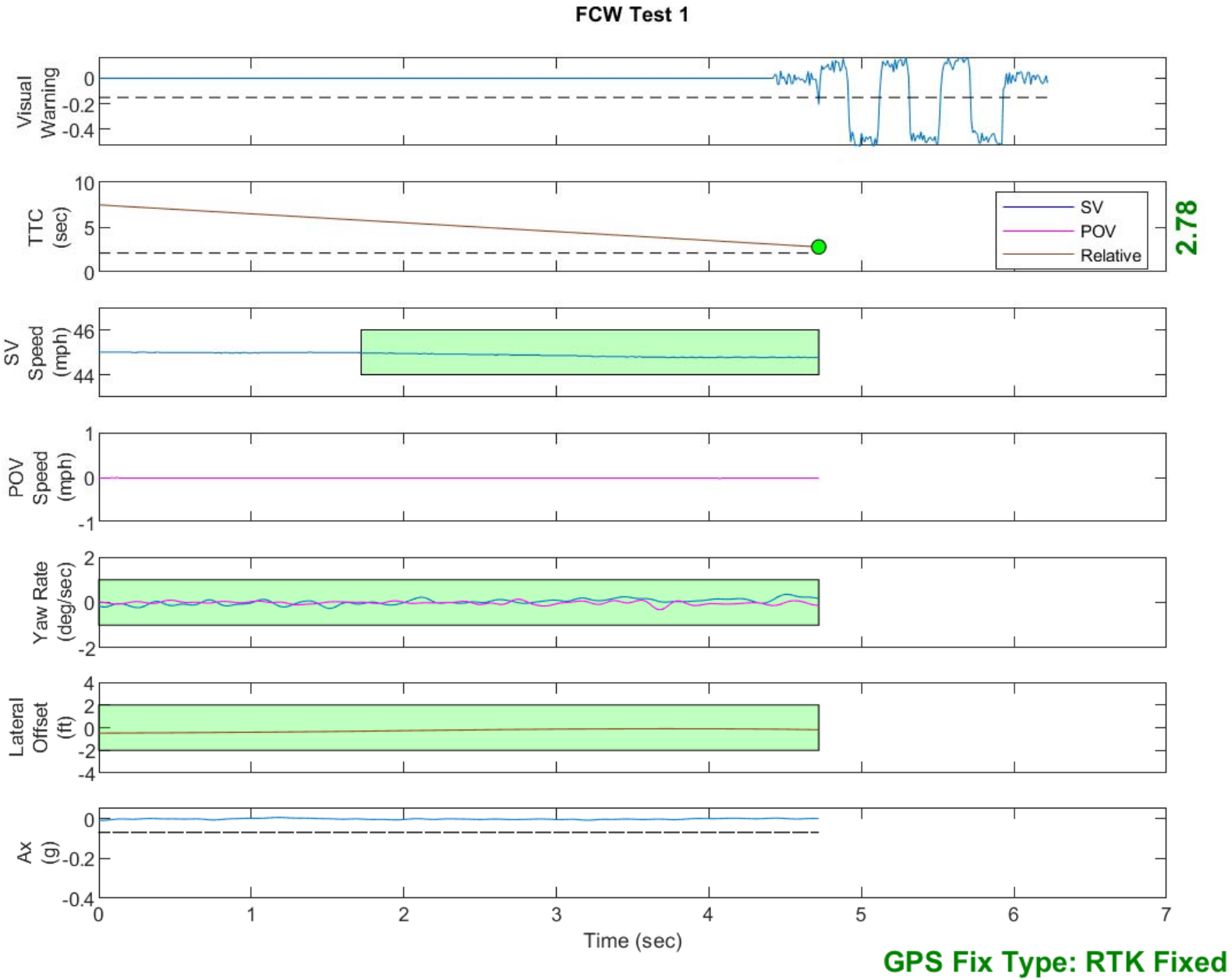


Figure D18. Time History for Run 6, FCW Test 1, Visual Warning

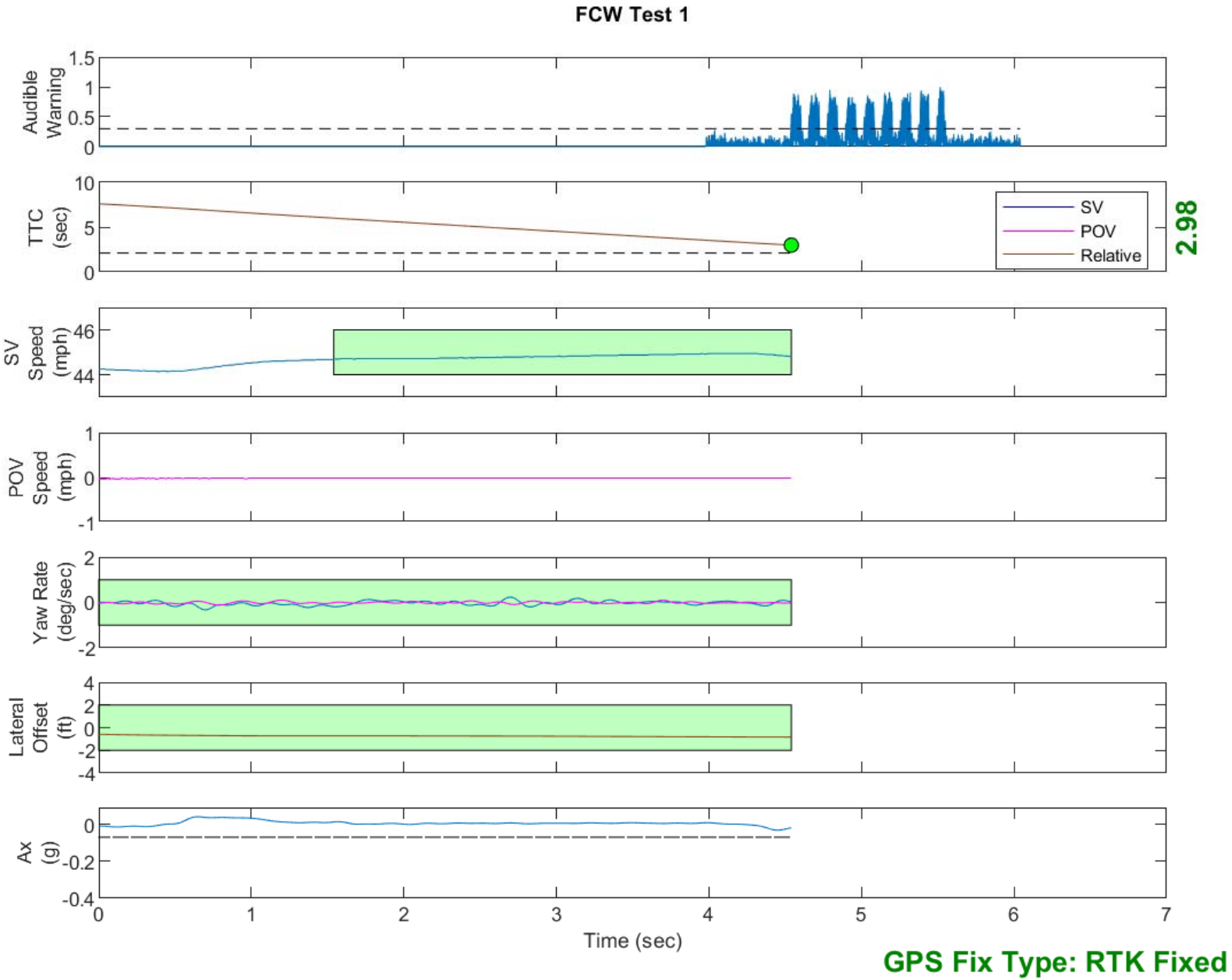


Figure D19. Time History for Run 7, FCW Test 1, Audible Warning

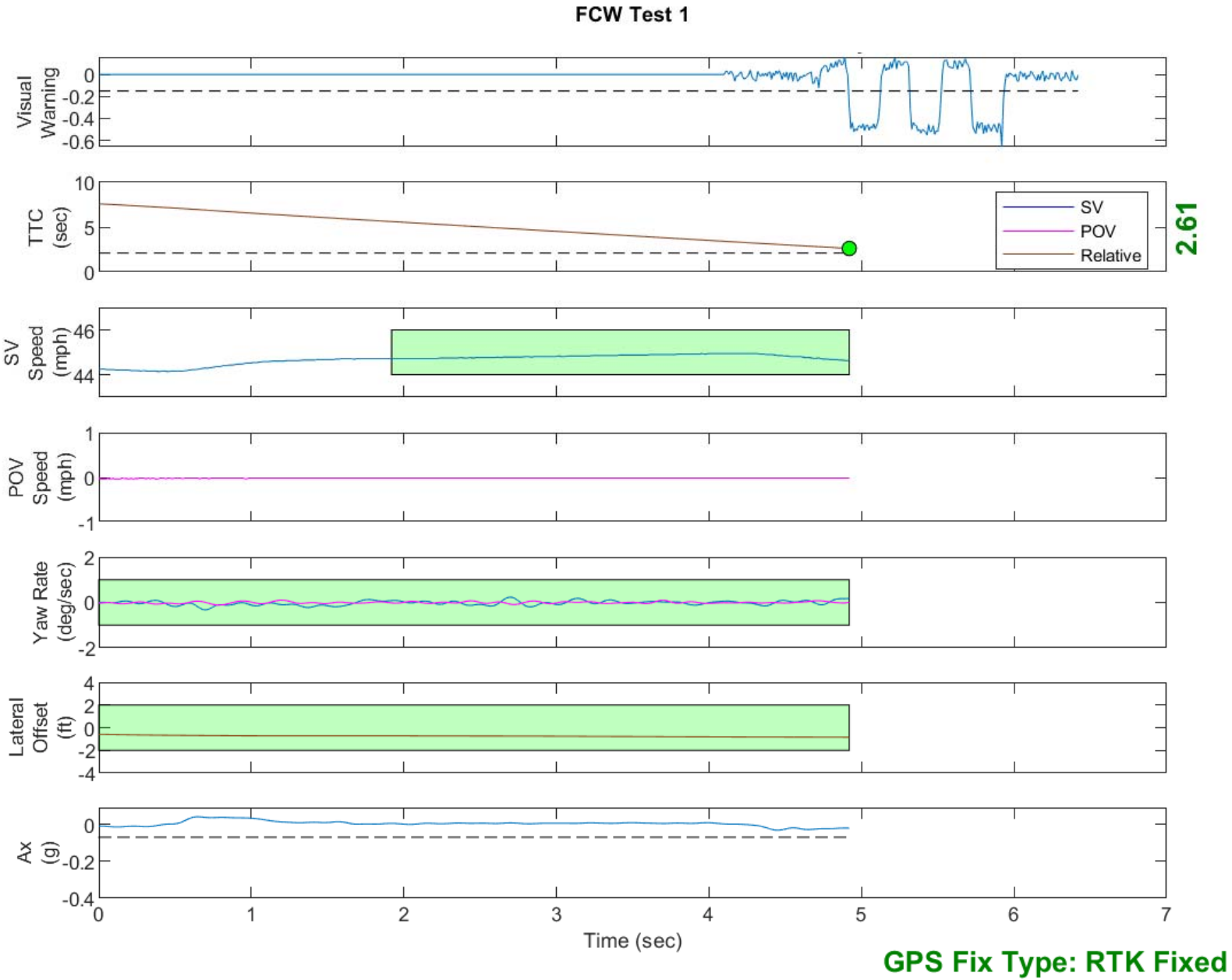


Figure D20. Time History for Run 7, FCW Test 1, Visual Warning

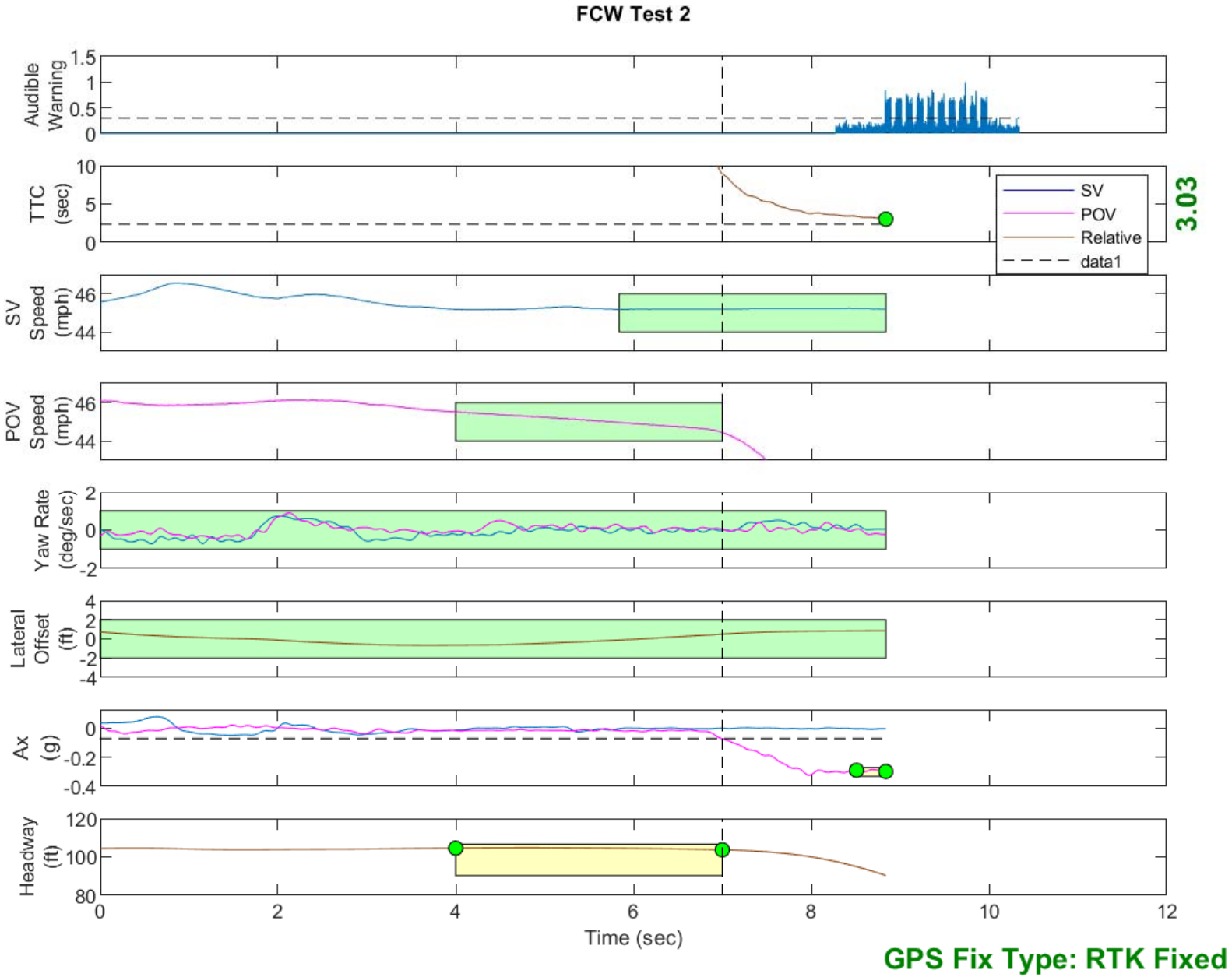


Figure D21. Time History for Run 15, FCW Test 2, Audible Warning

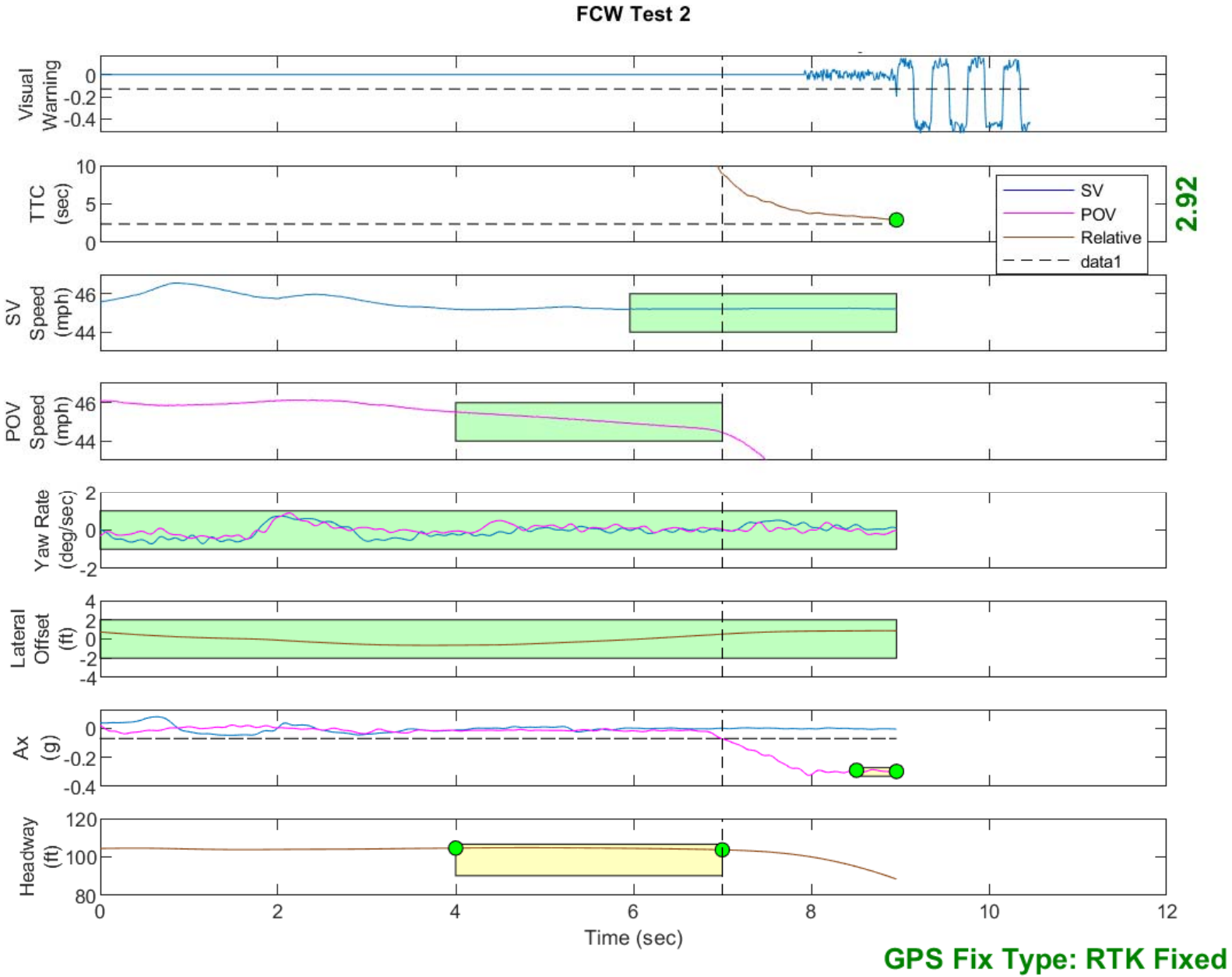


Figure D22. Time History for Run 15, FCW Test 2, Visual Warning

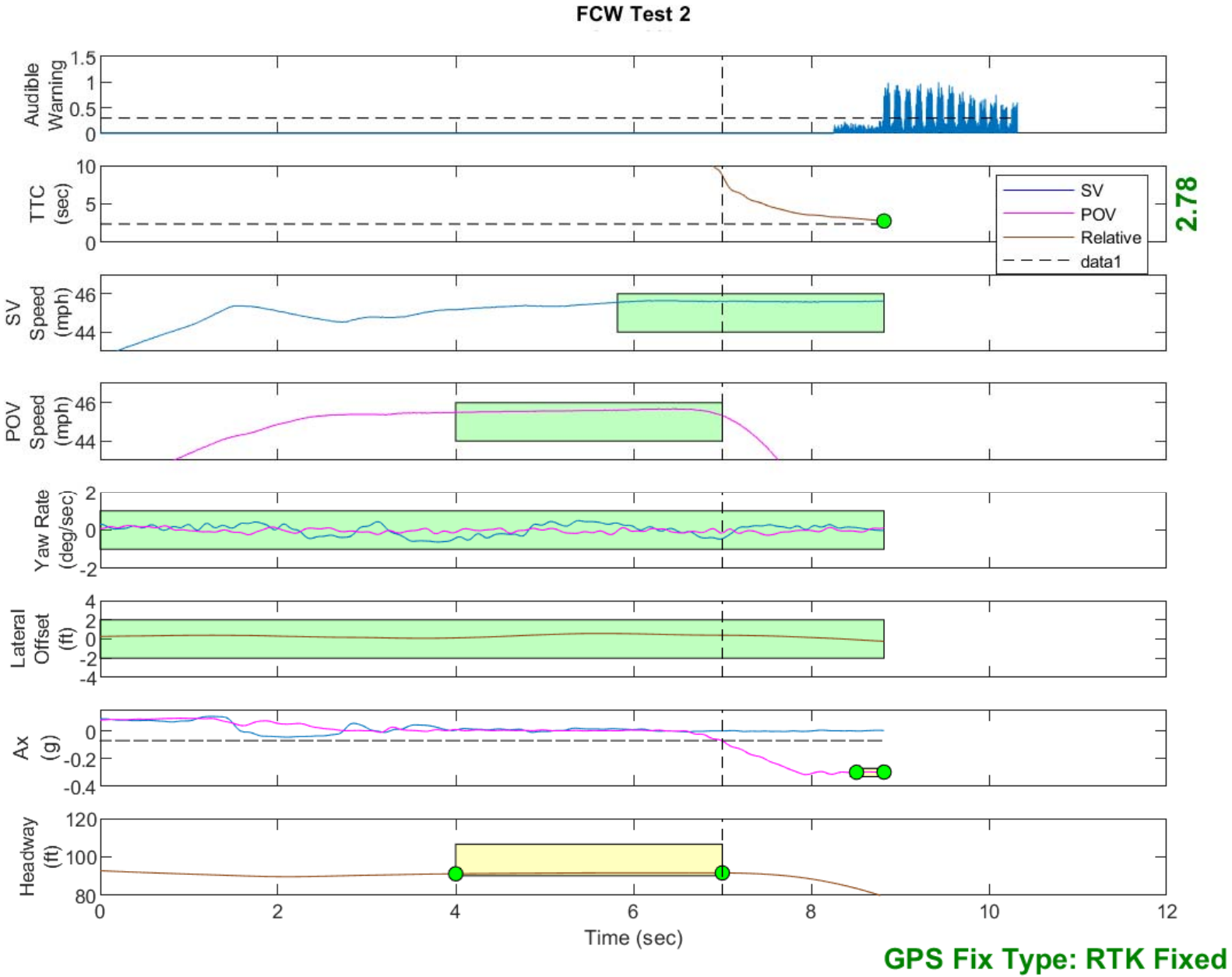


Figure D23. Time History for Run 18, FCW Test 2, Audible Warning

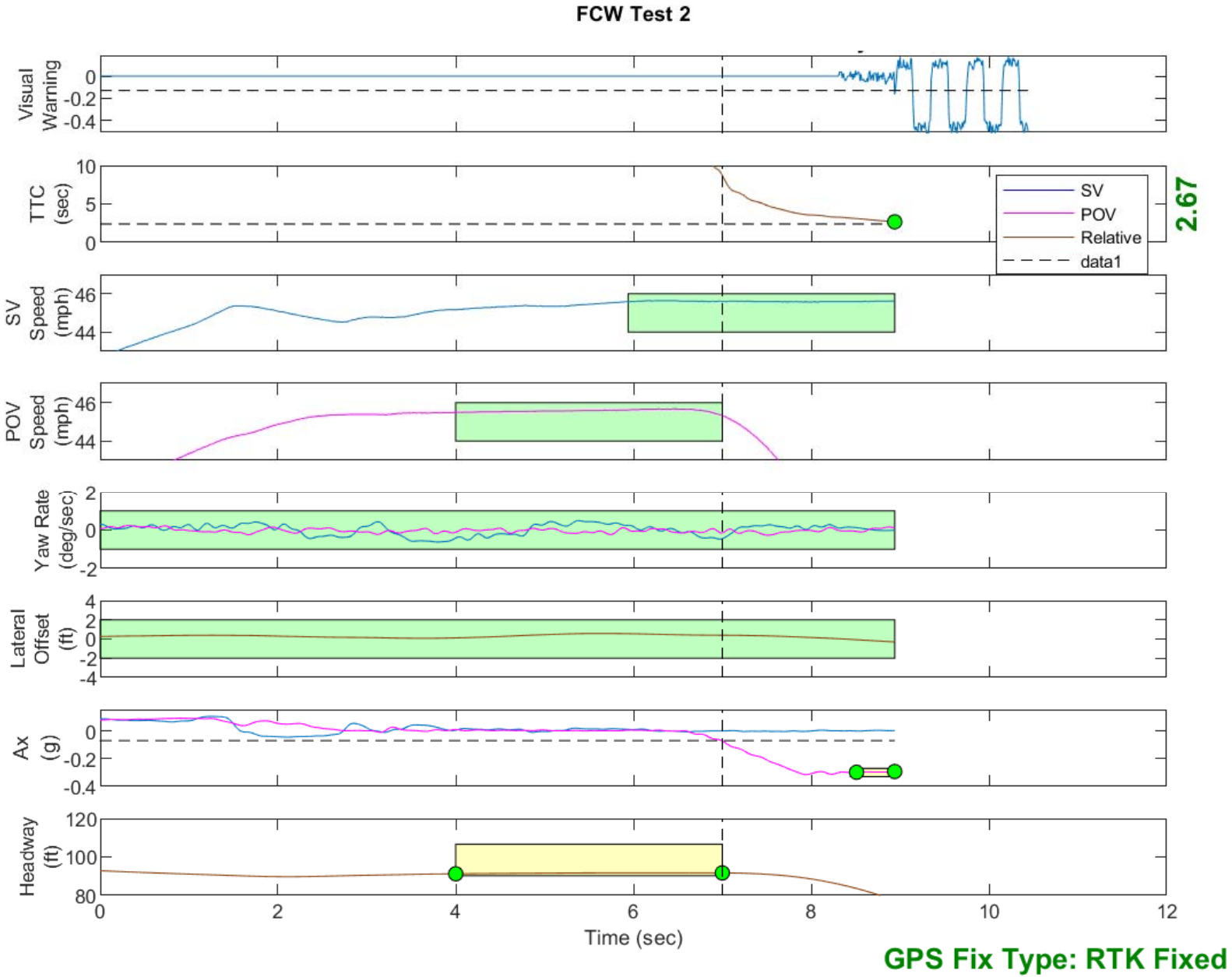


Figure D24. Time History for Run 18, FCW Test 2, Visual Warning

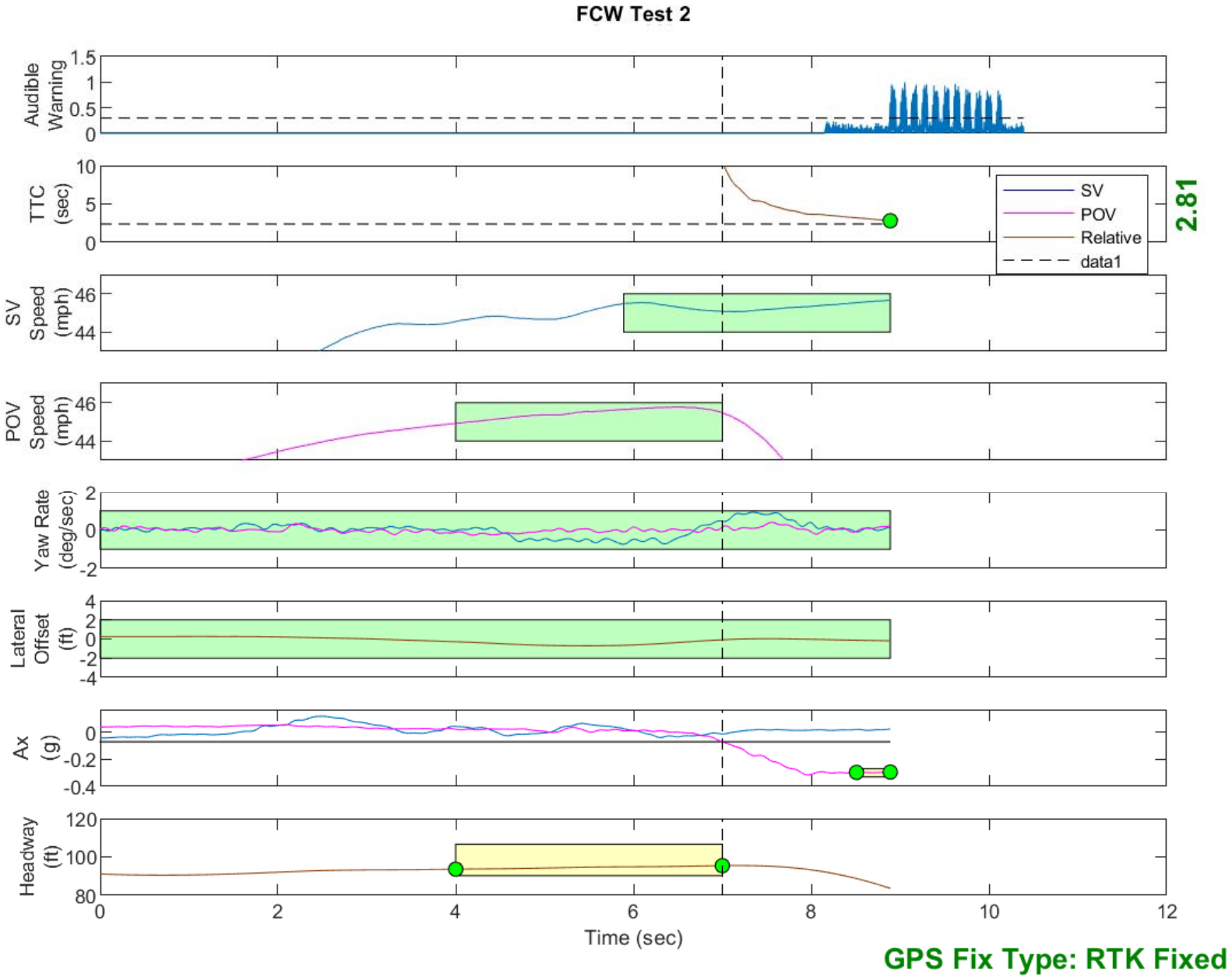


Figure D25. Time History for Run 19, FCW Test 2, Audible Warning

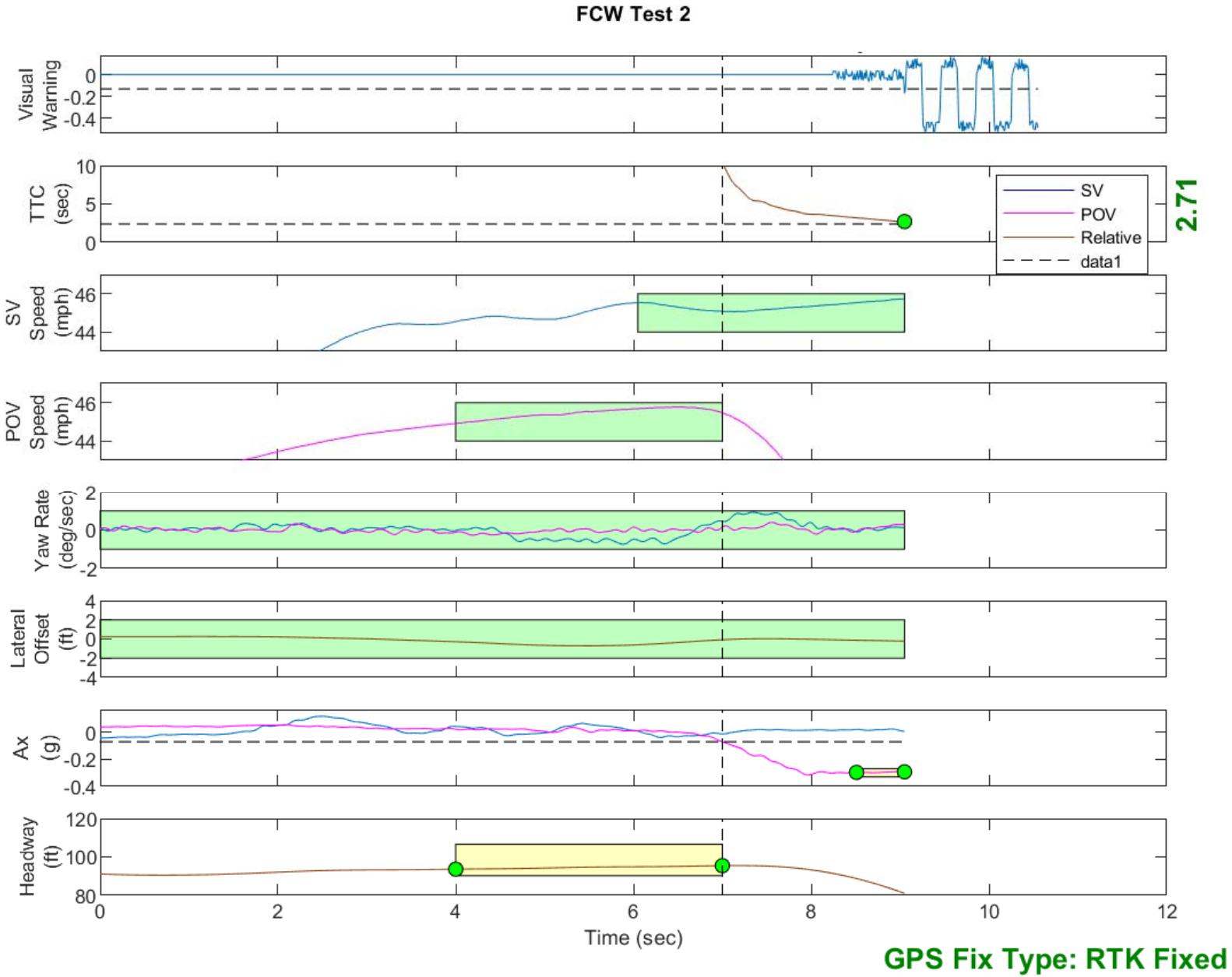


Figure D26. Time History for Run 19, FCW Test 2, Visual Warning

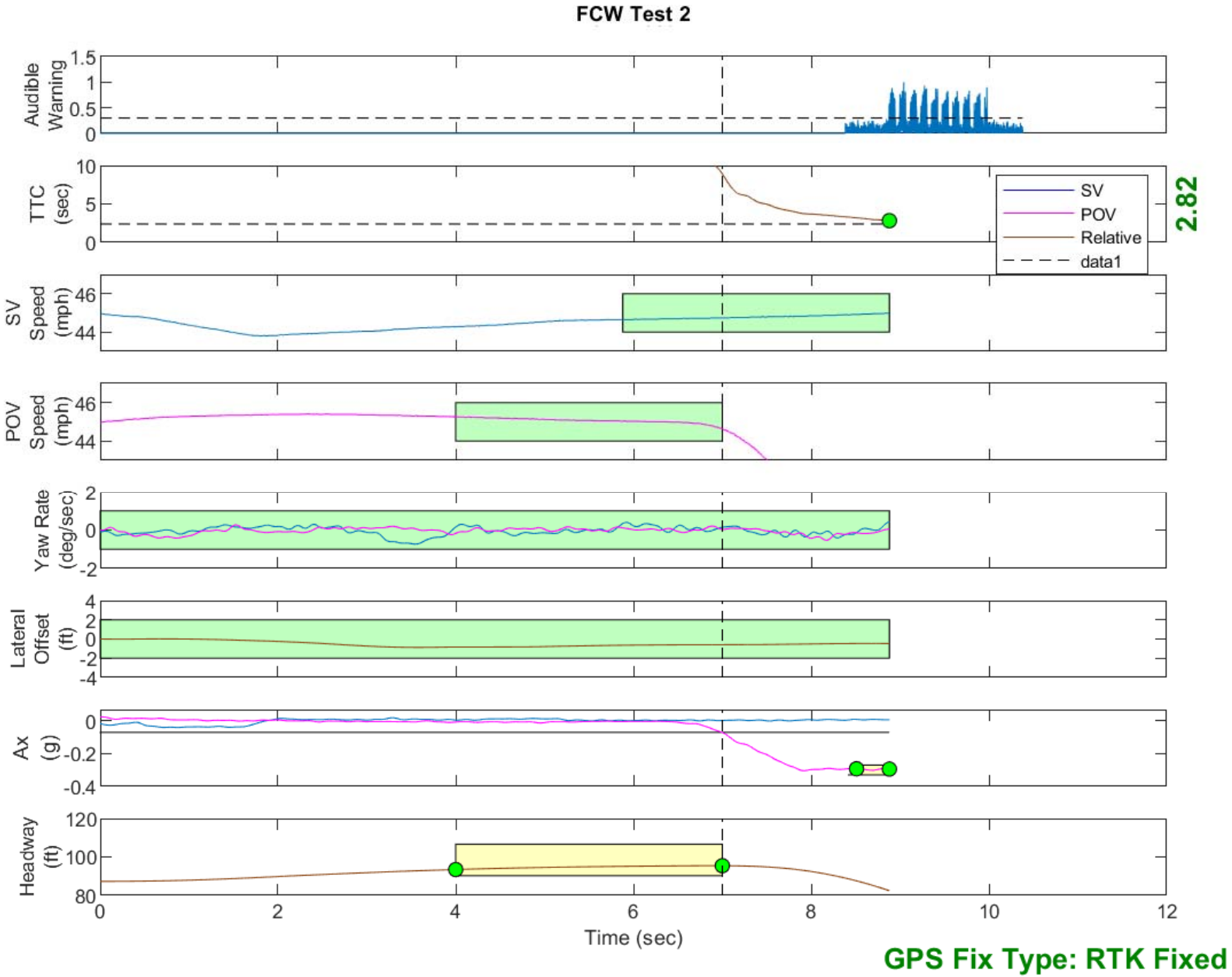


Figure D27. Time History for Run 20, FCW Test 2, Audible Warning

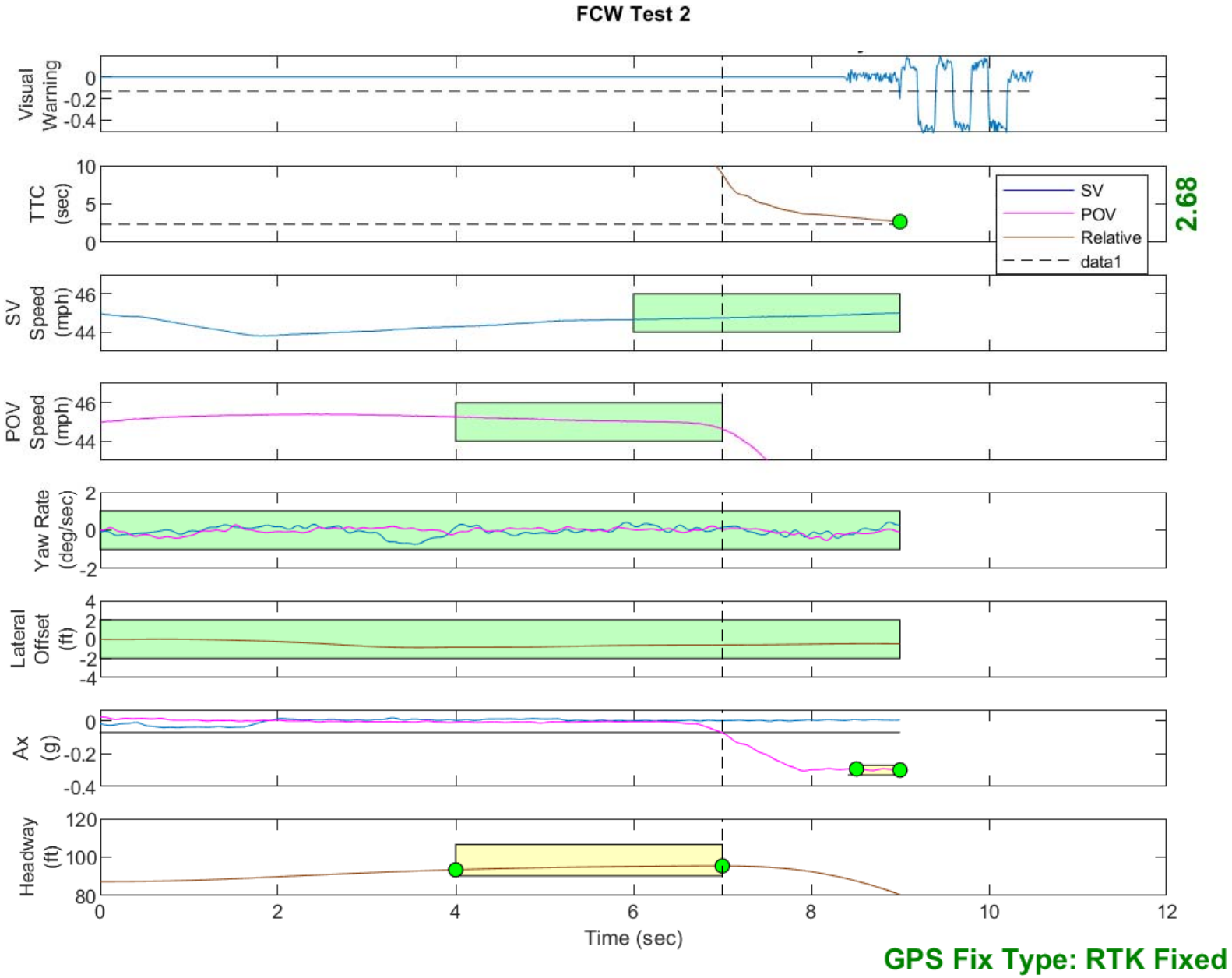


Figure D28. Time History for Run 20, FCW Test 2, Visual Warning

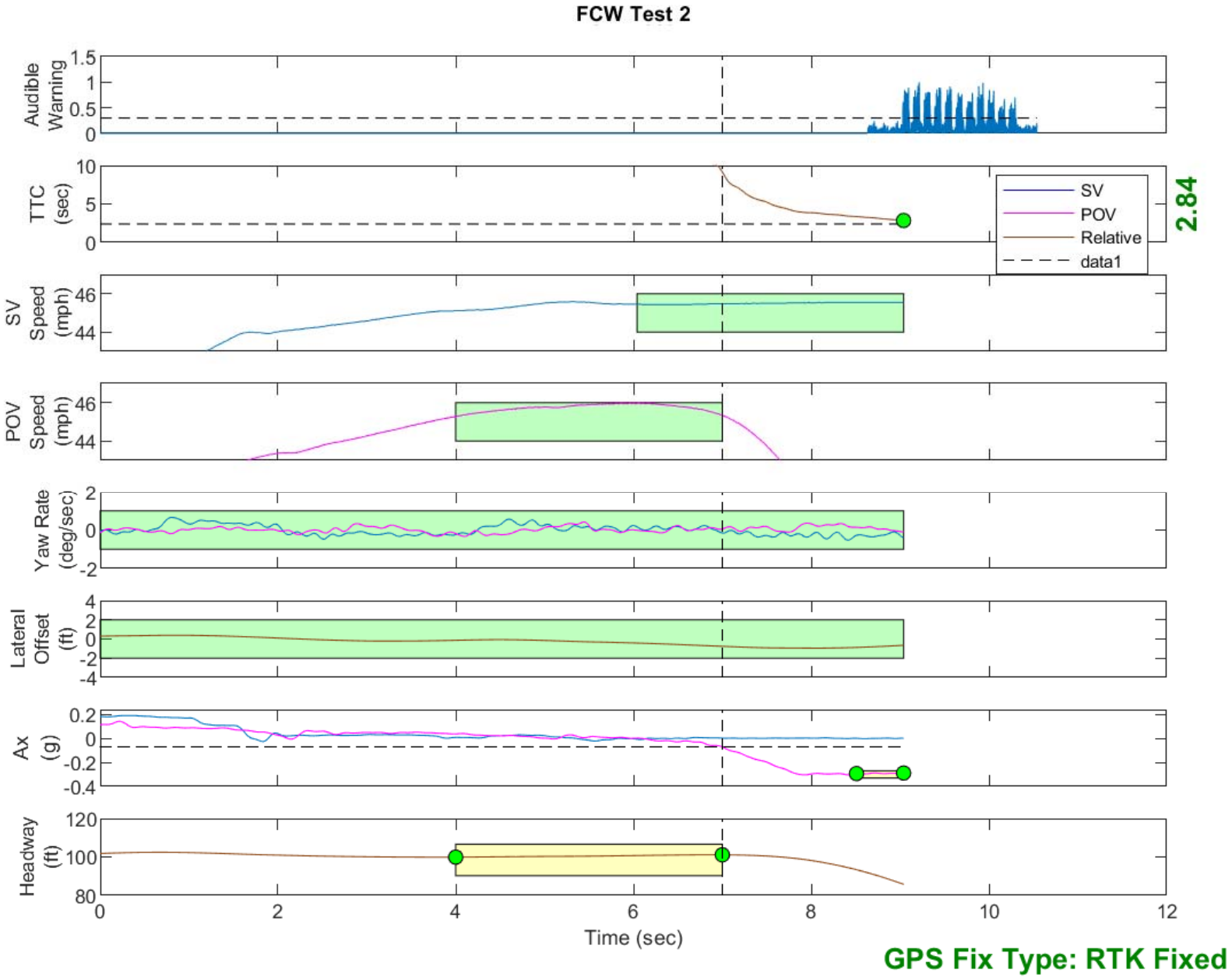


Figure D29. Time History for Run 21, FCW Test 2, Audible Warning

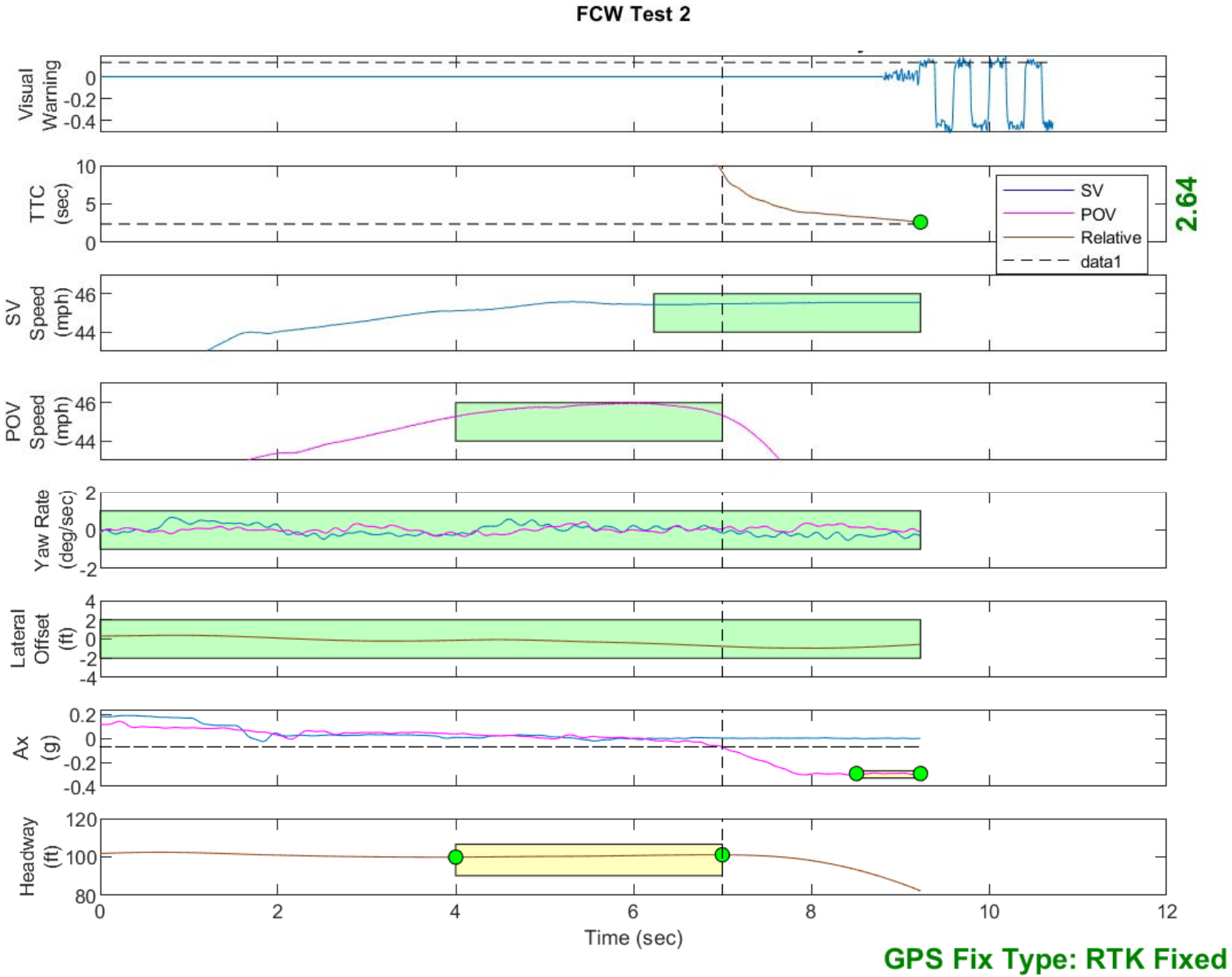


Figure D30. Time History for Run 21, FCW Test 2, Visual Warning

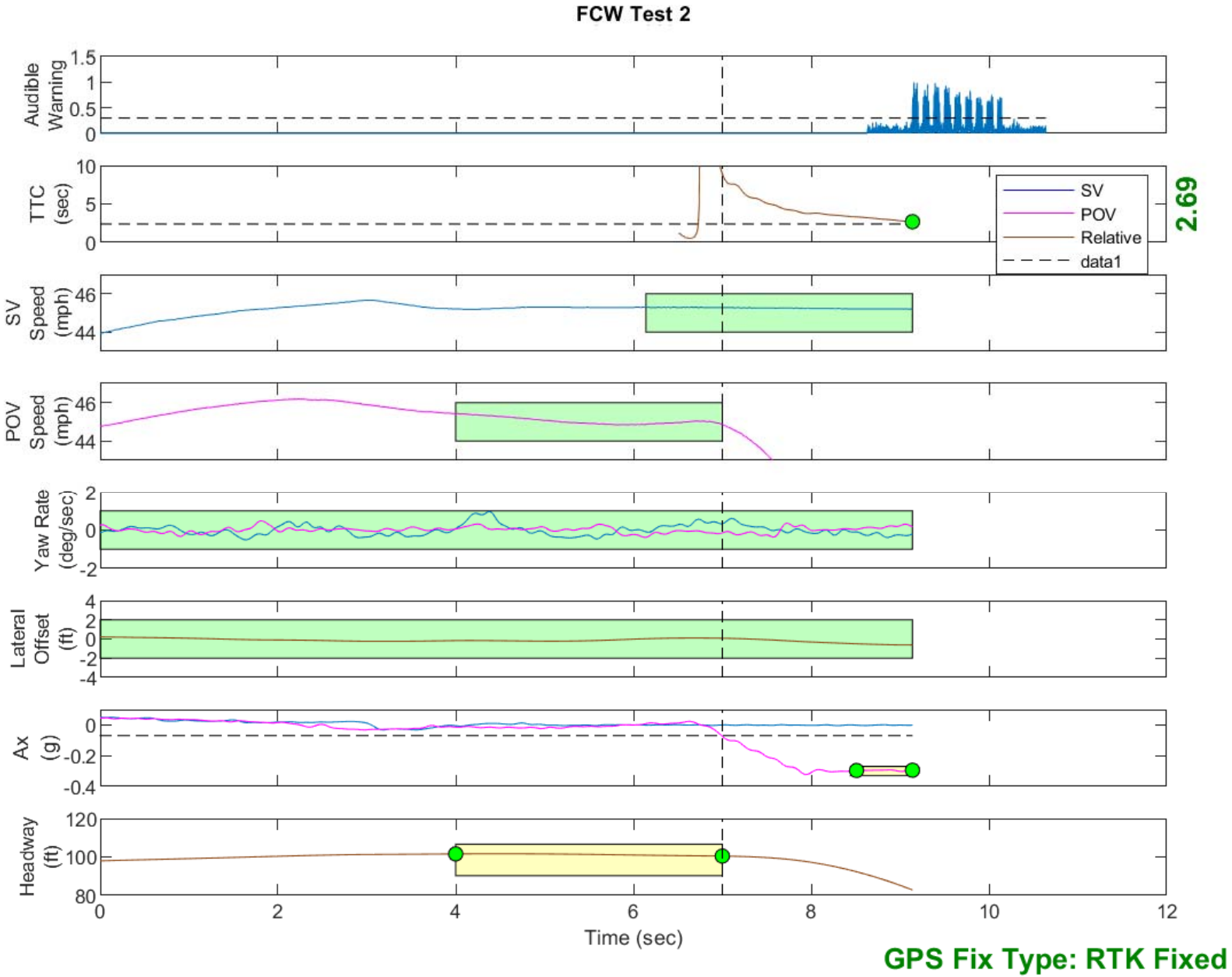


Figure D31. Time History for Run 23, FCW Test 2, Audible Warning

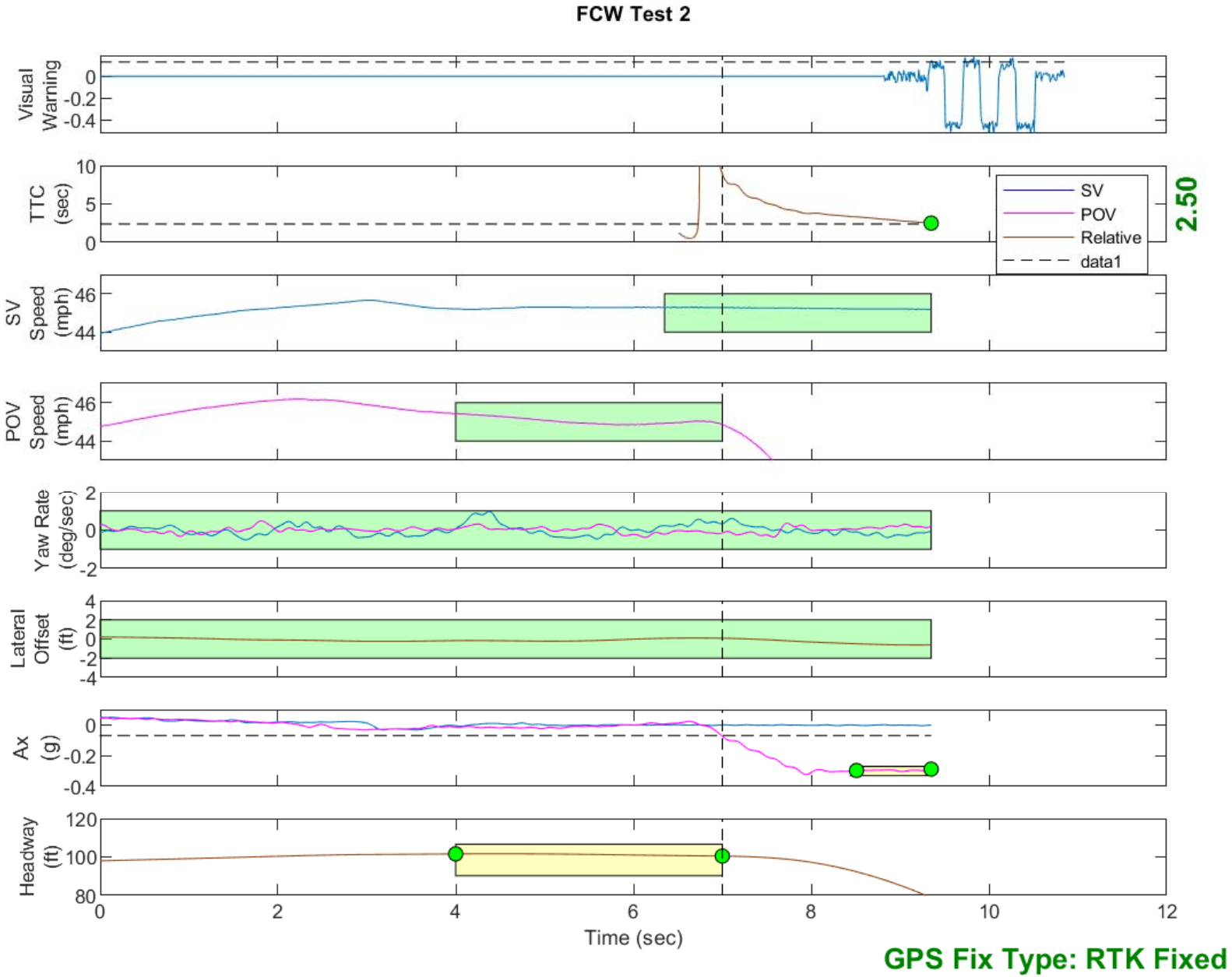


Figure D32. Time History for Run 23, FCW Test 2, Visual Warning

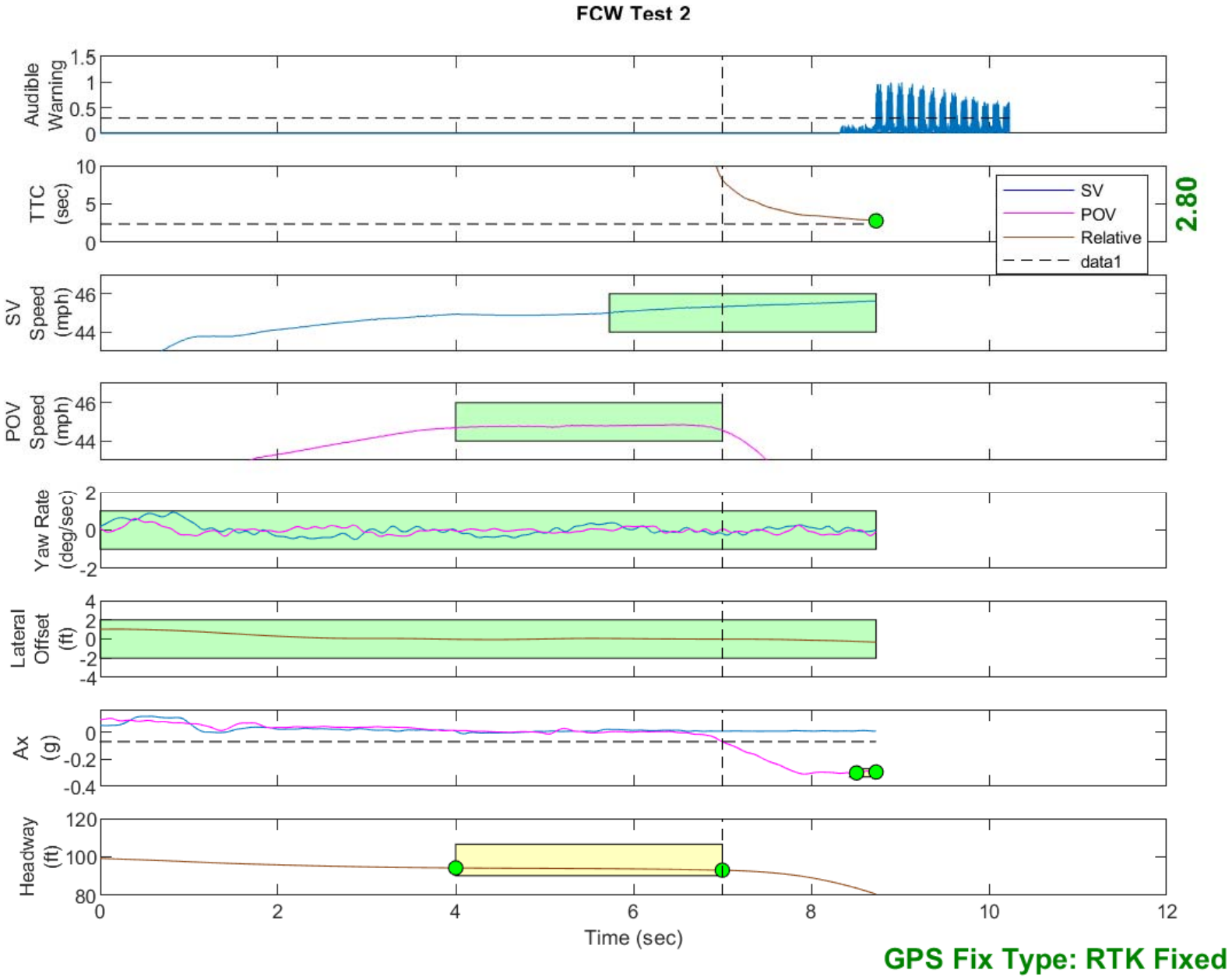


Figure D33. Time History for Run 24, FCW Test 2, Audible Warning

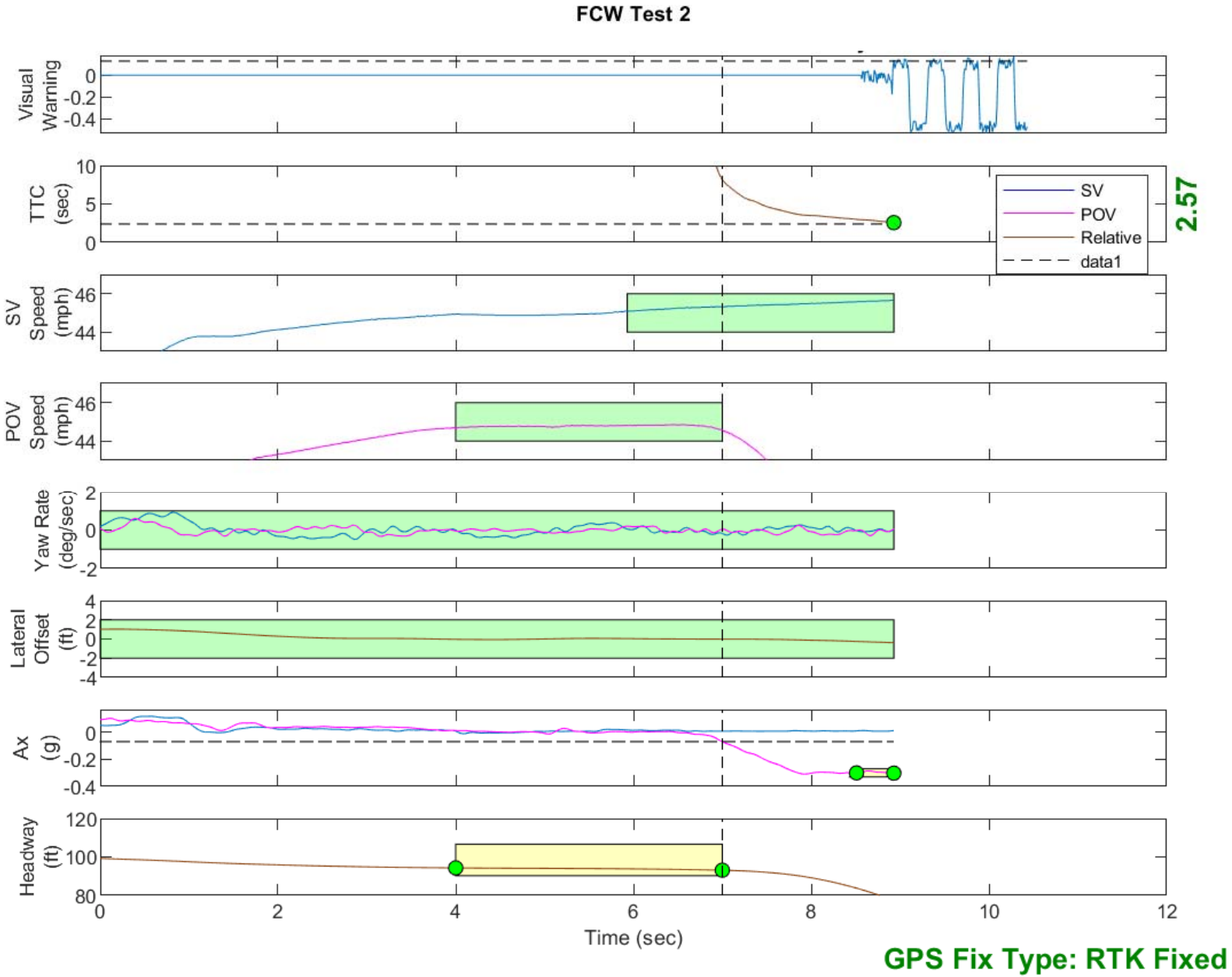


Figure D34. Time History for Run 24, FCW Test 2, Visual Warning

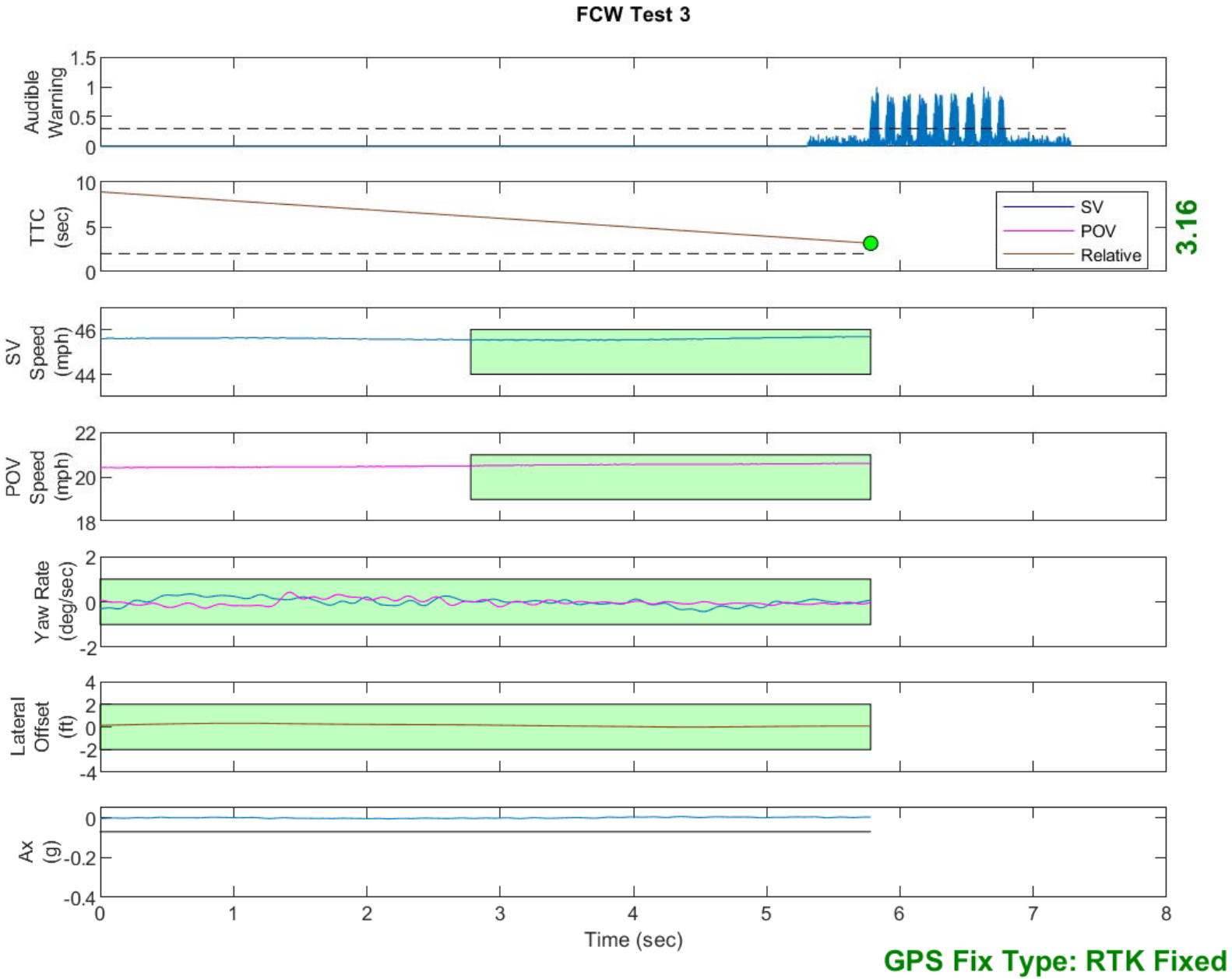


Figure D35. Time History for Run 8, FCW Test 3, Audible Warning

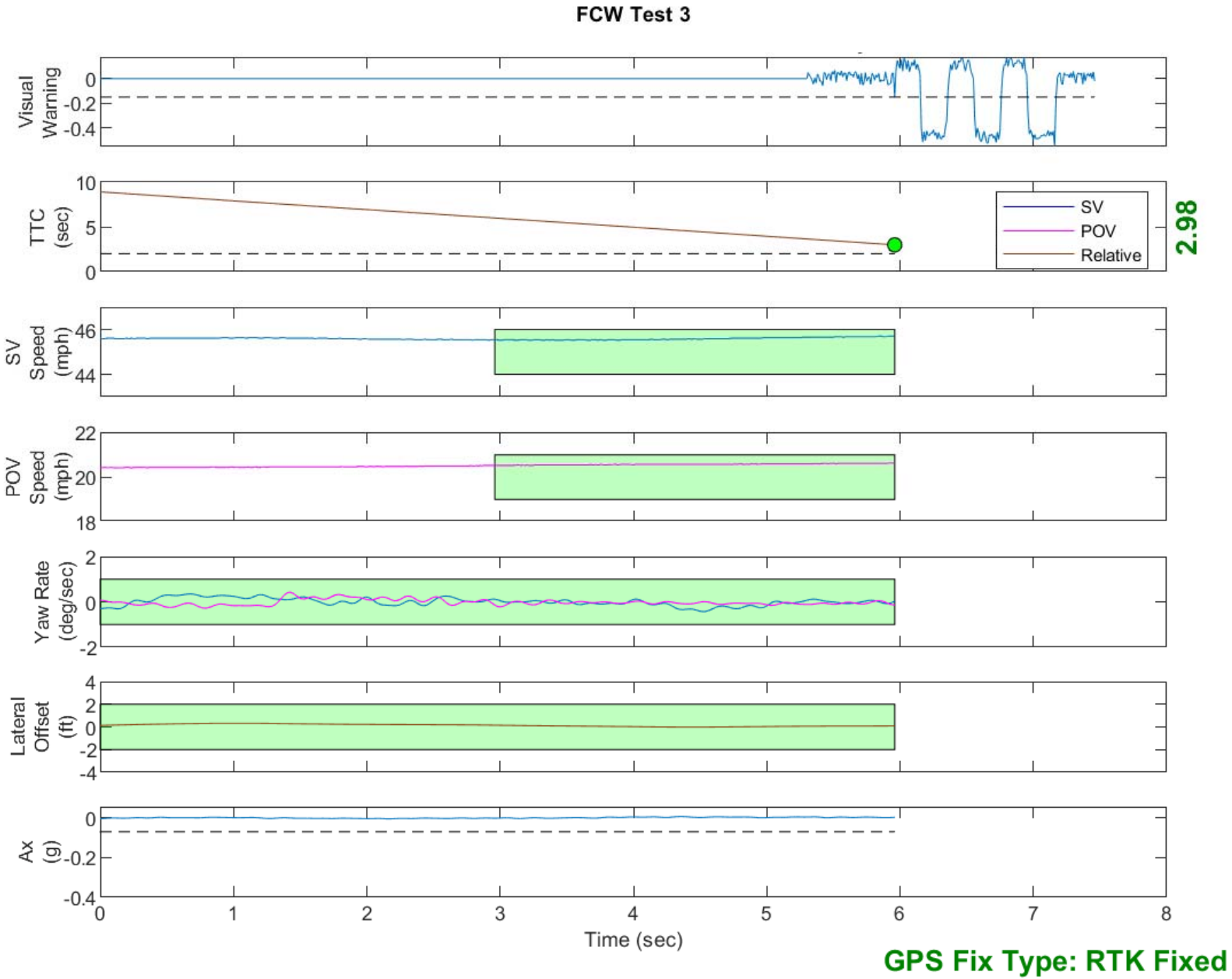


Figure D36. Time History for Run 8, FCW Test 3, Visual Warning

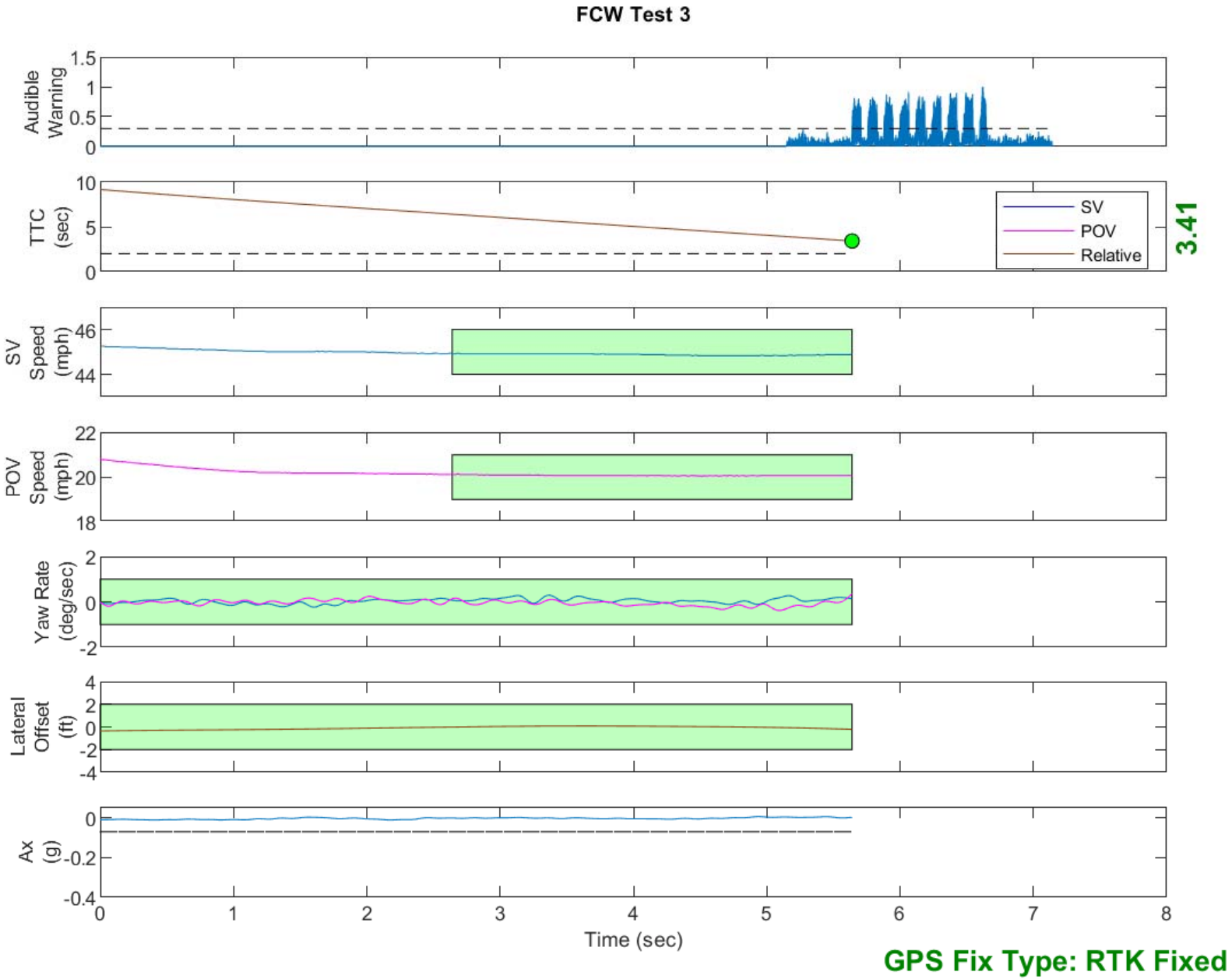


Figure D37. Time History for Run 9, FCW Test 3, Audible Warning

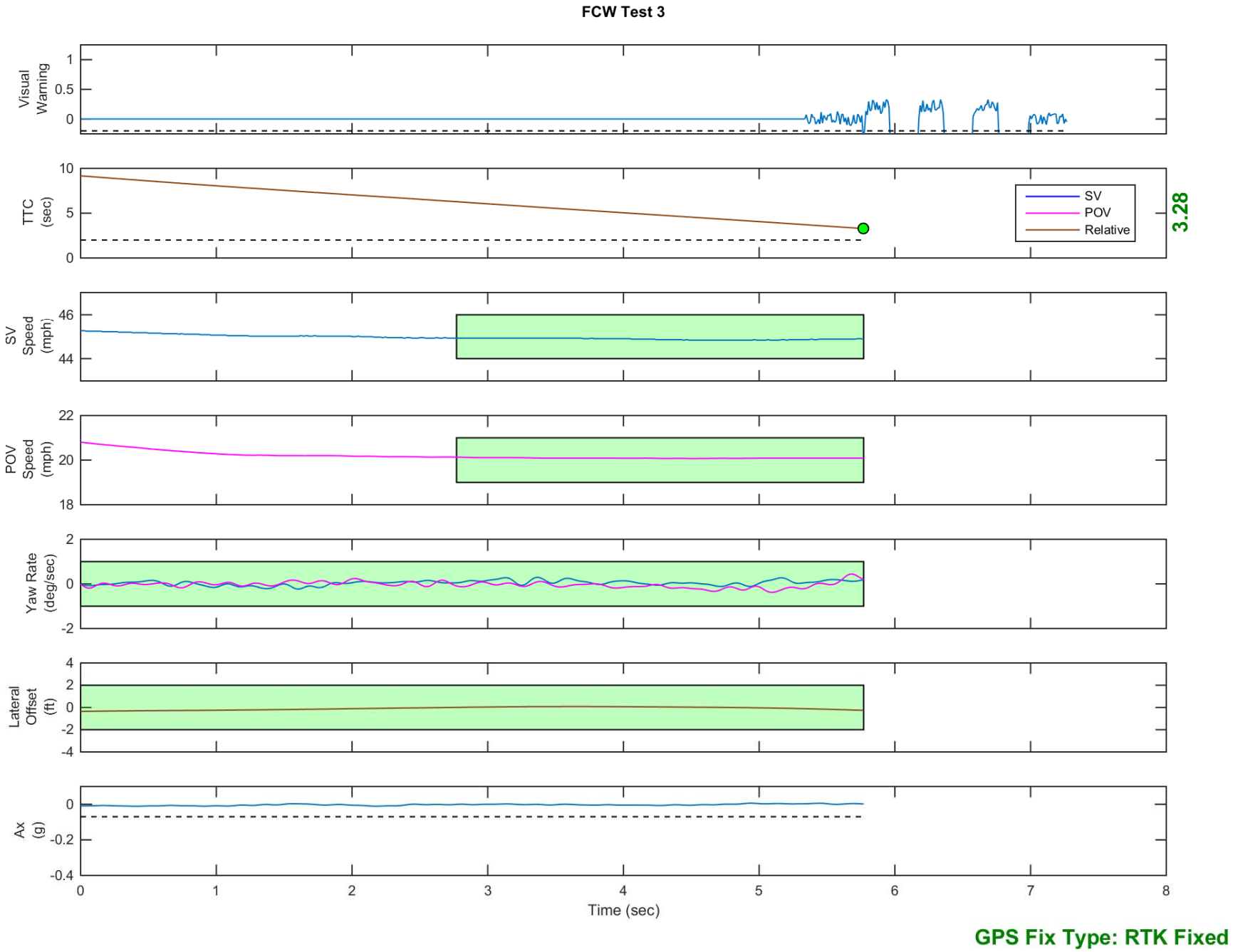


Figure D38. Time History for Run 9, FCW Test 3, Visual Warning

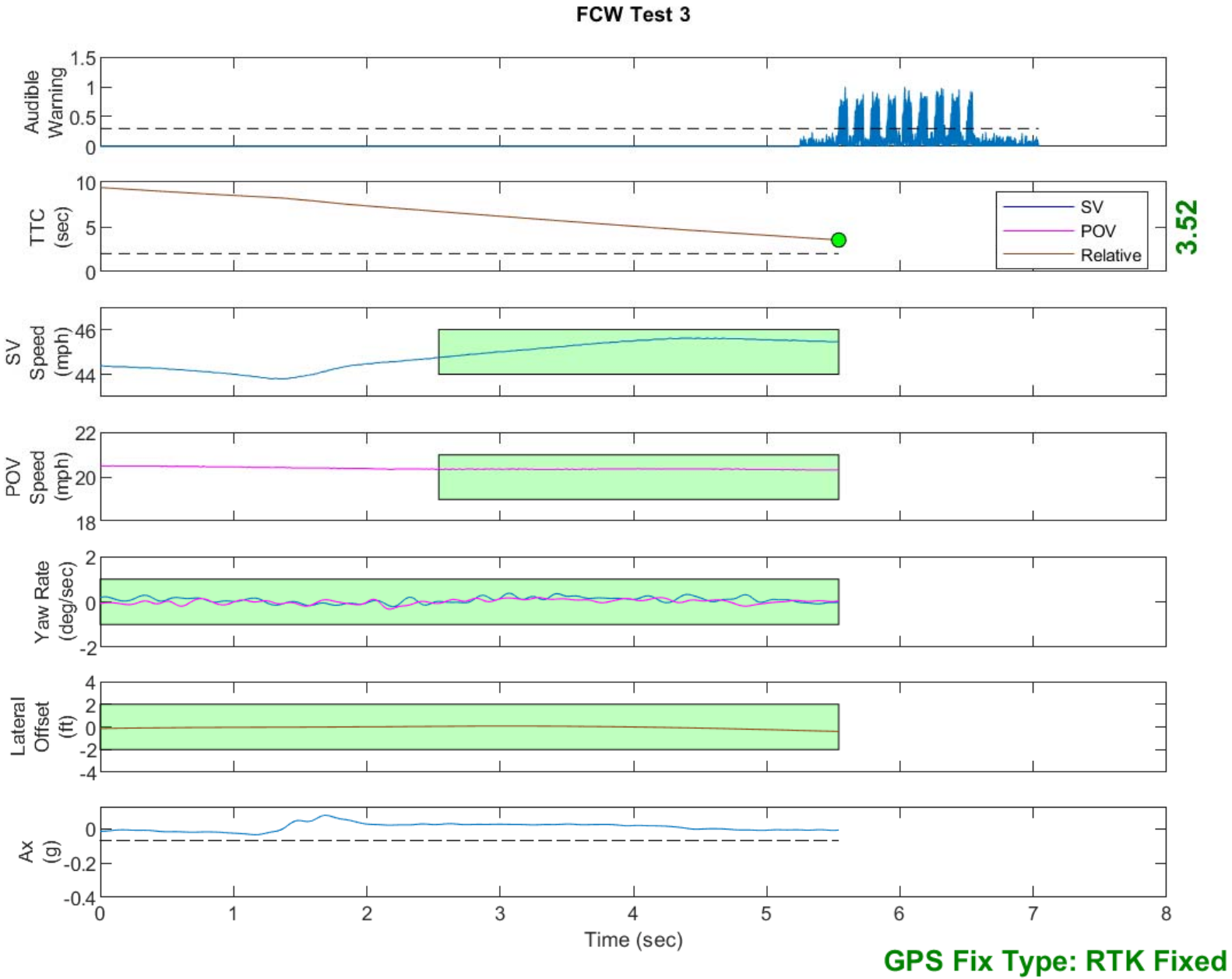


Figure D39. Time History for Run 10, FCW Test 3, Audible Warning

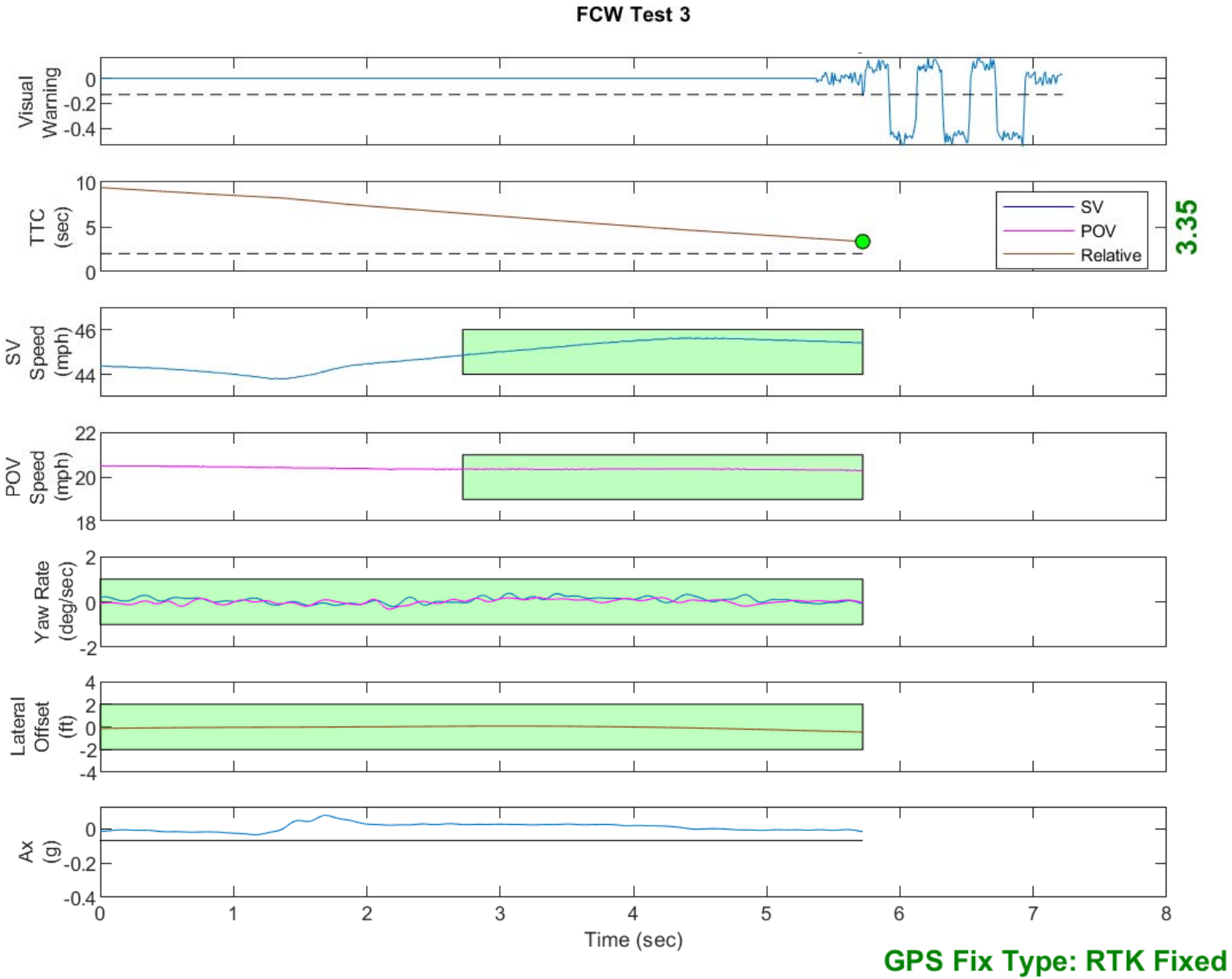


Figure D40. Time History for Run 10, FCW Test 3, Visual Warning

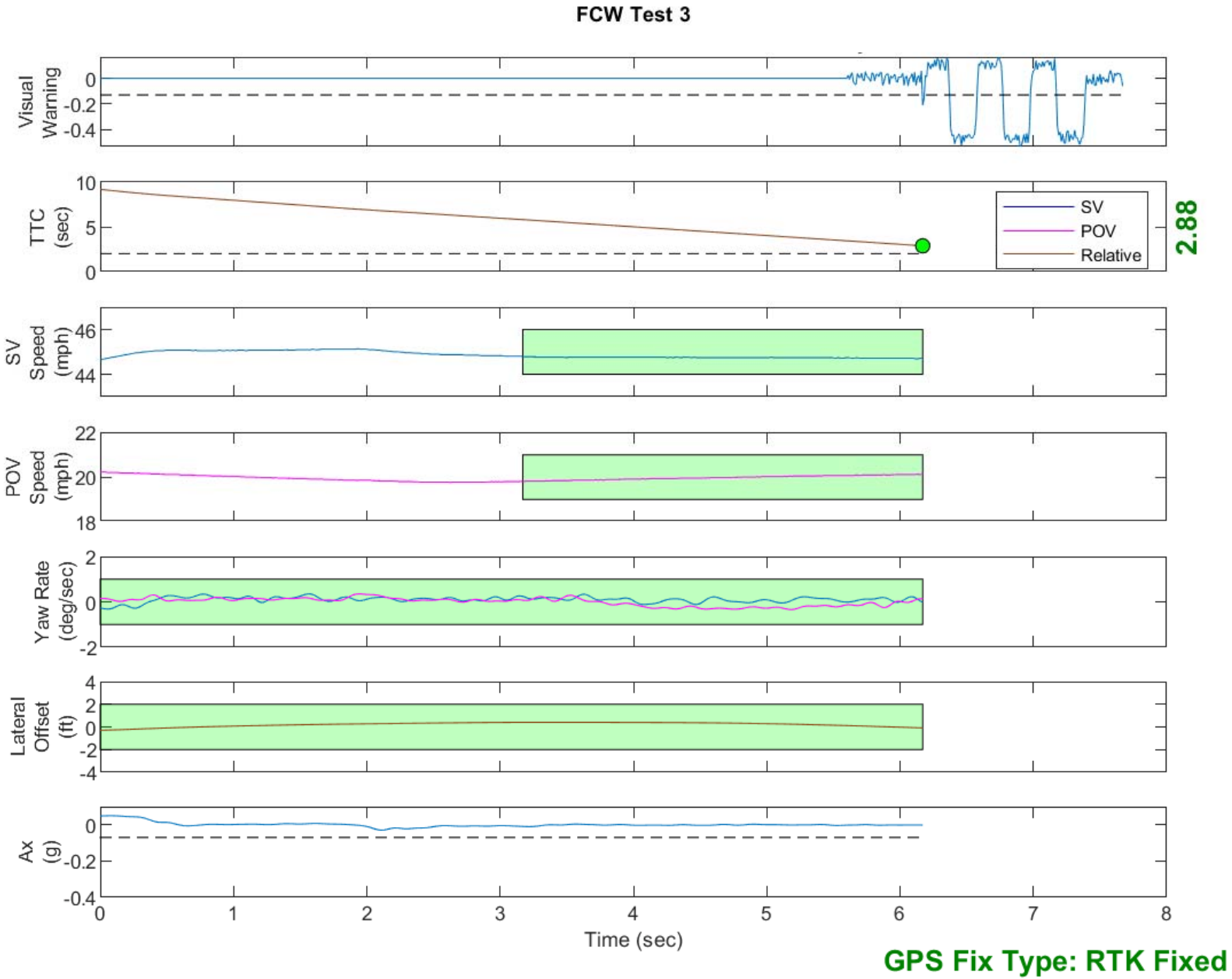


Figure D41. Time History for Run 11, FCW Test 3, Visual Warning

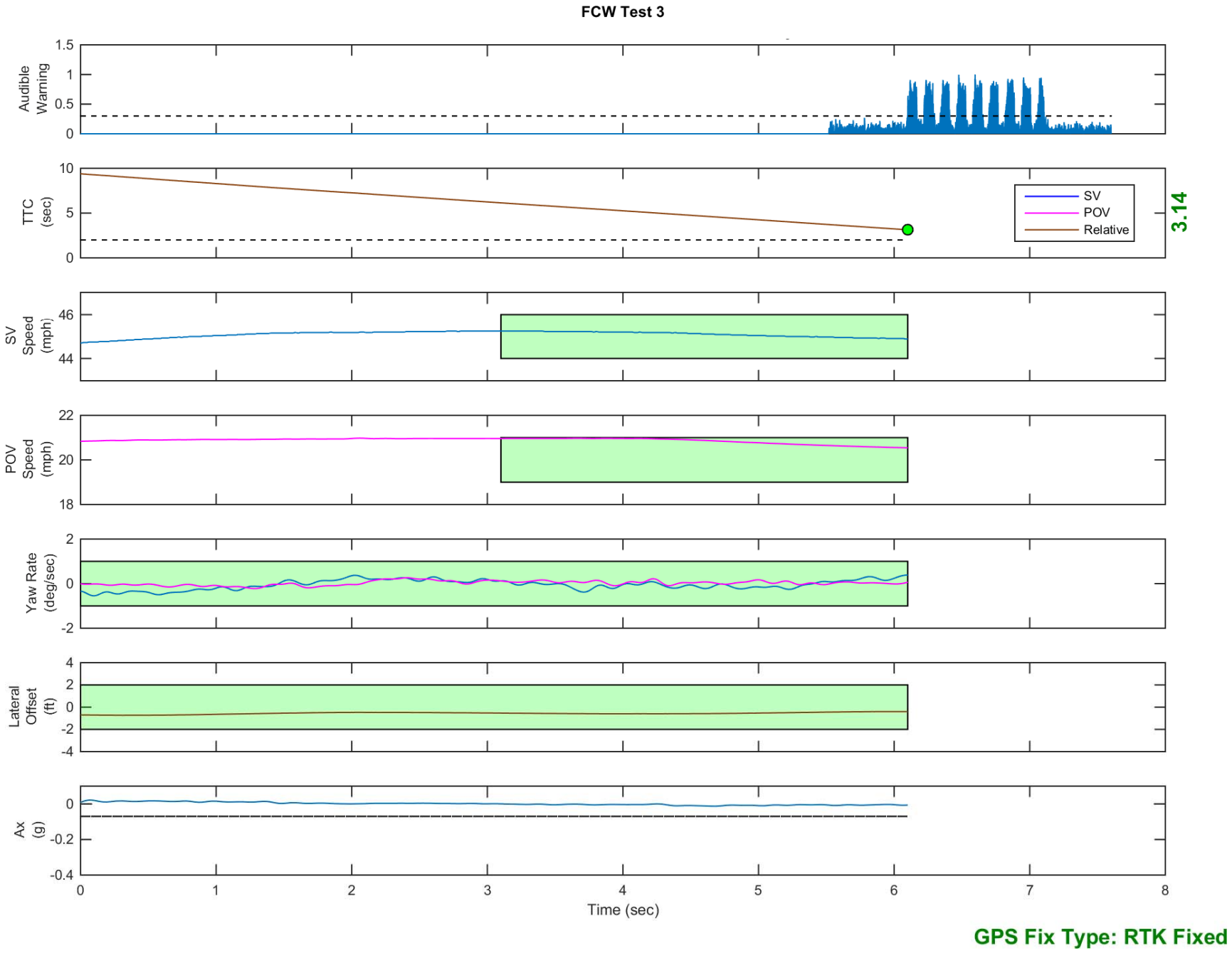


Figure D42. Time History for Run 12, FCW Test 3, Audible Warning

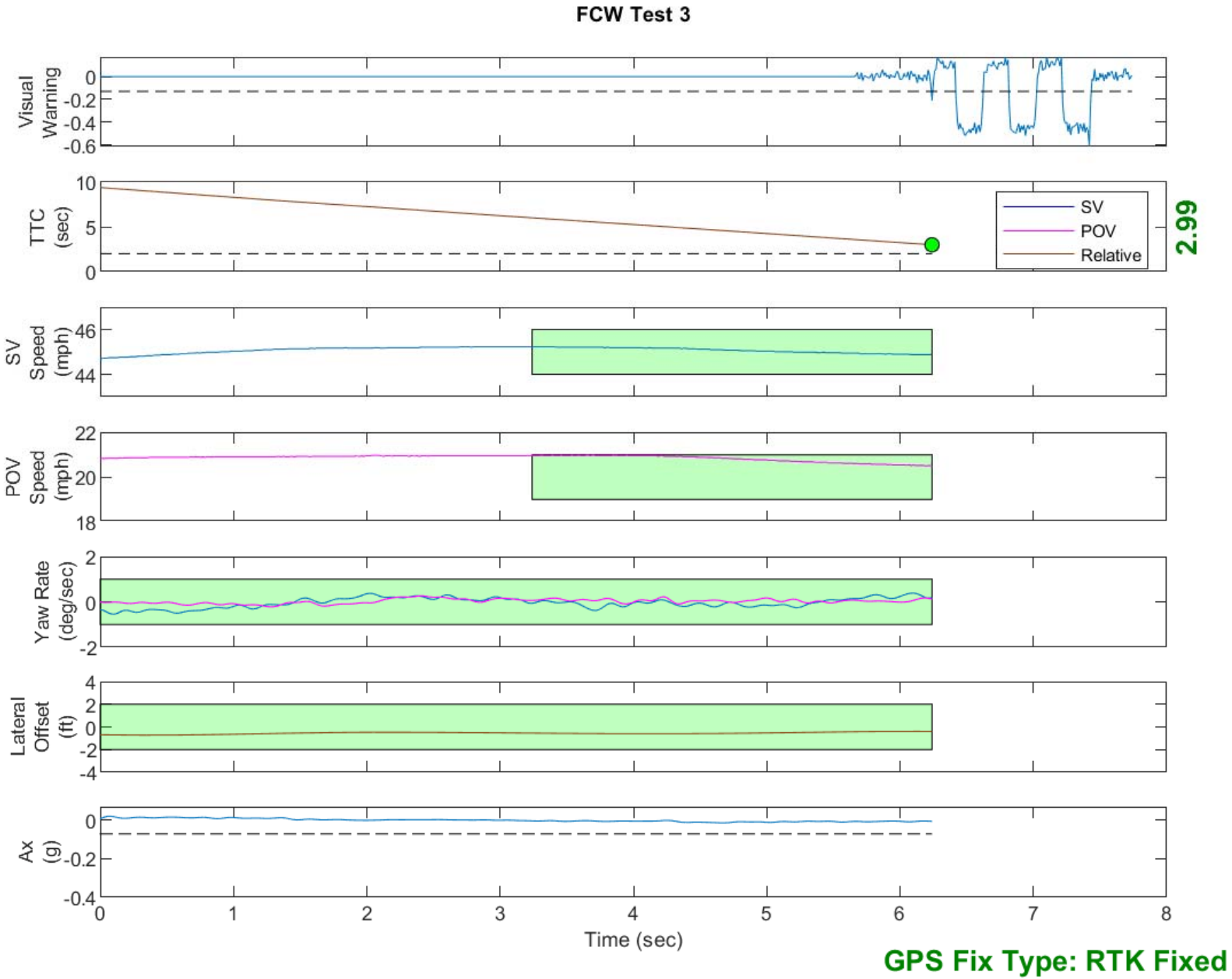


Figure D43. Time History for Run 12, FCW Test 3, Visual Warning

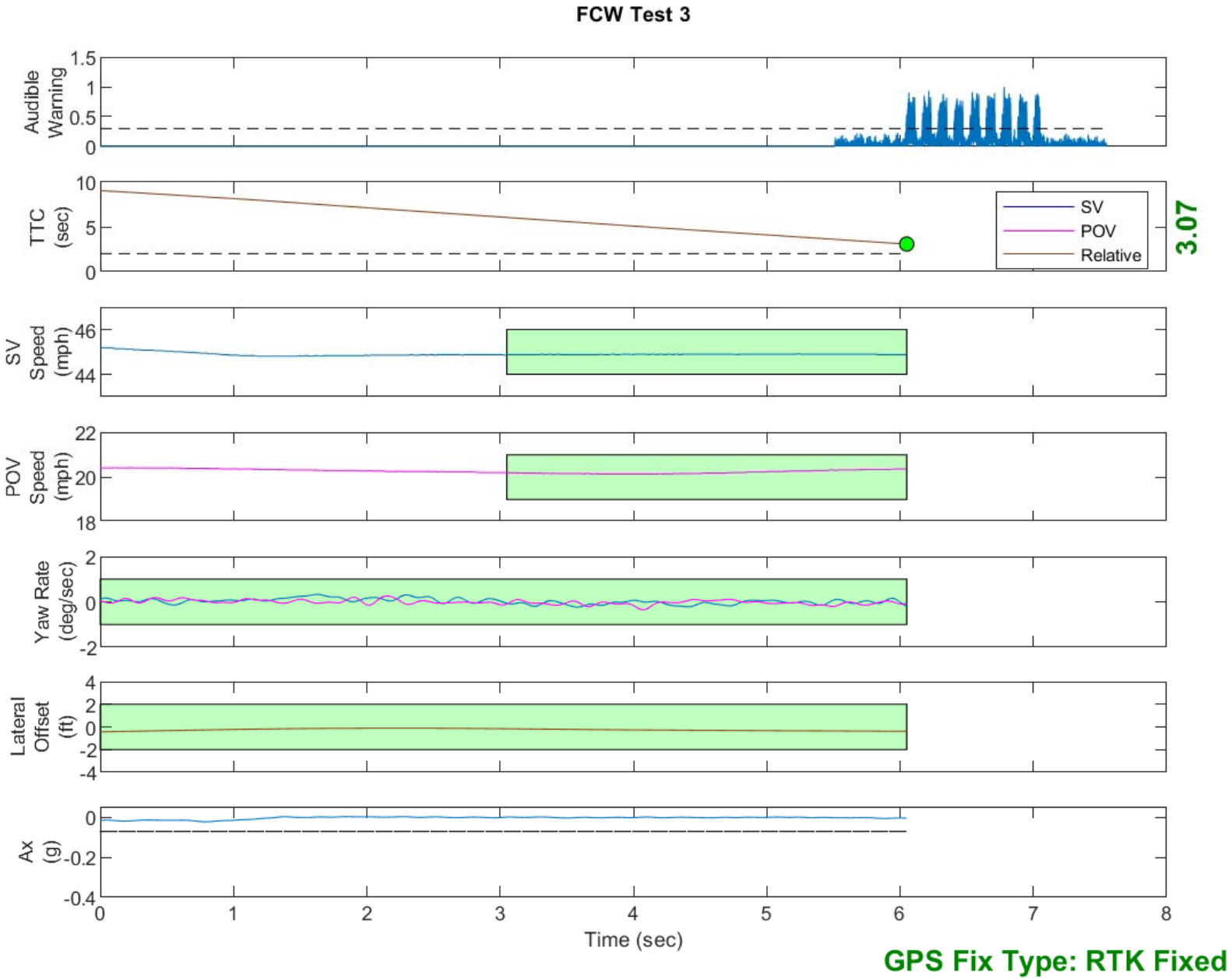


Figure D44. Time History for Run 13, FCW Test 3, Audible Warning

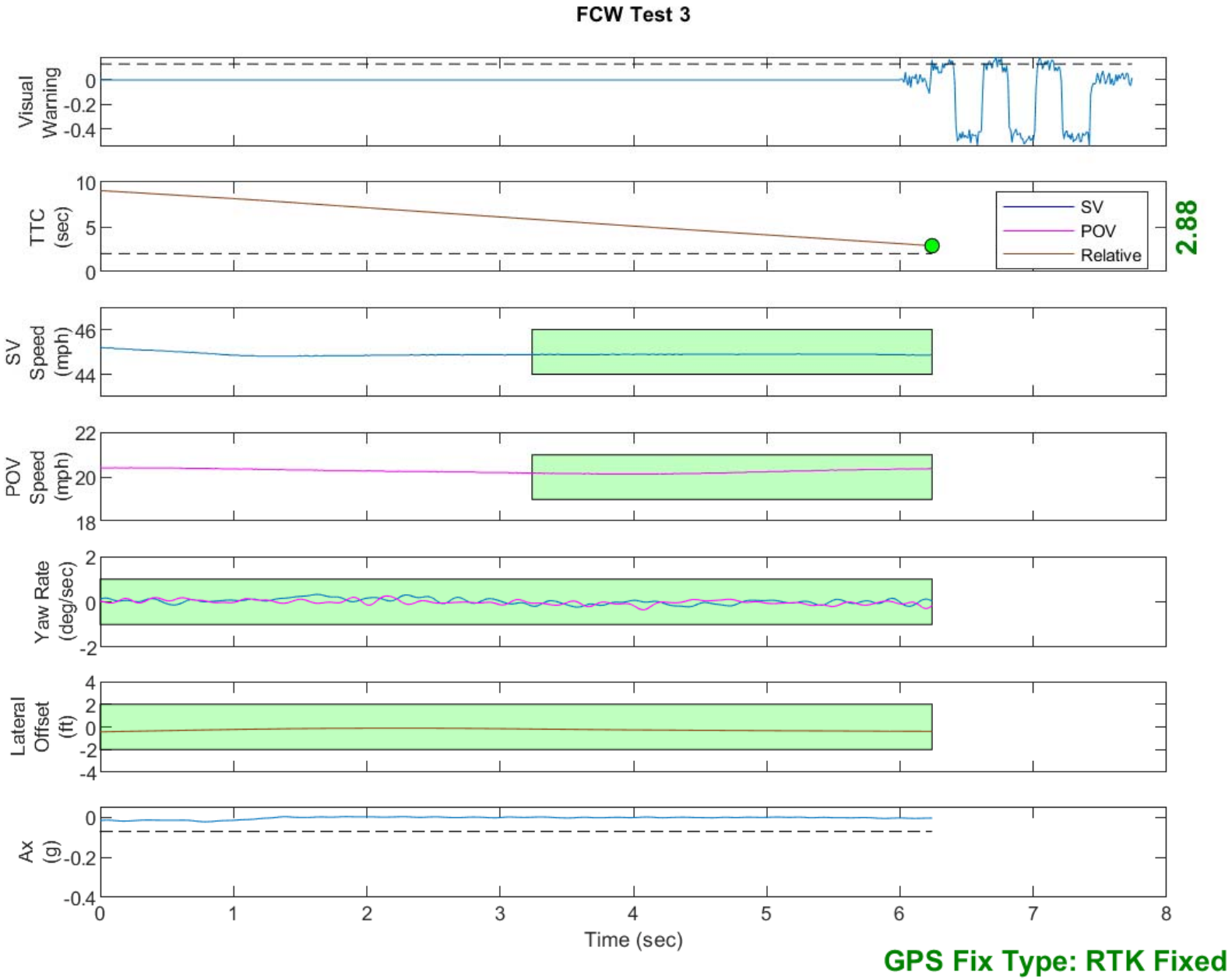


Figure D45. Time History for Run 13, FCW Test 3, Visual Warning

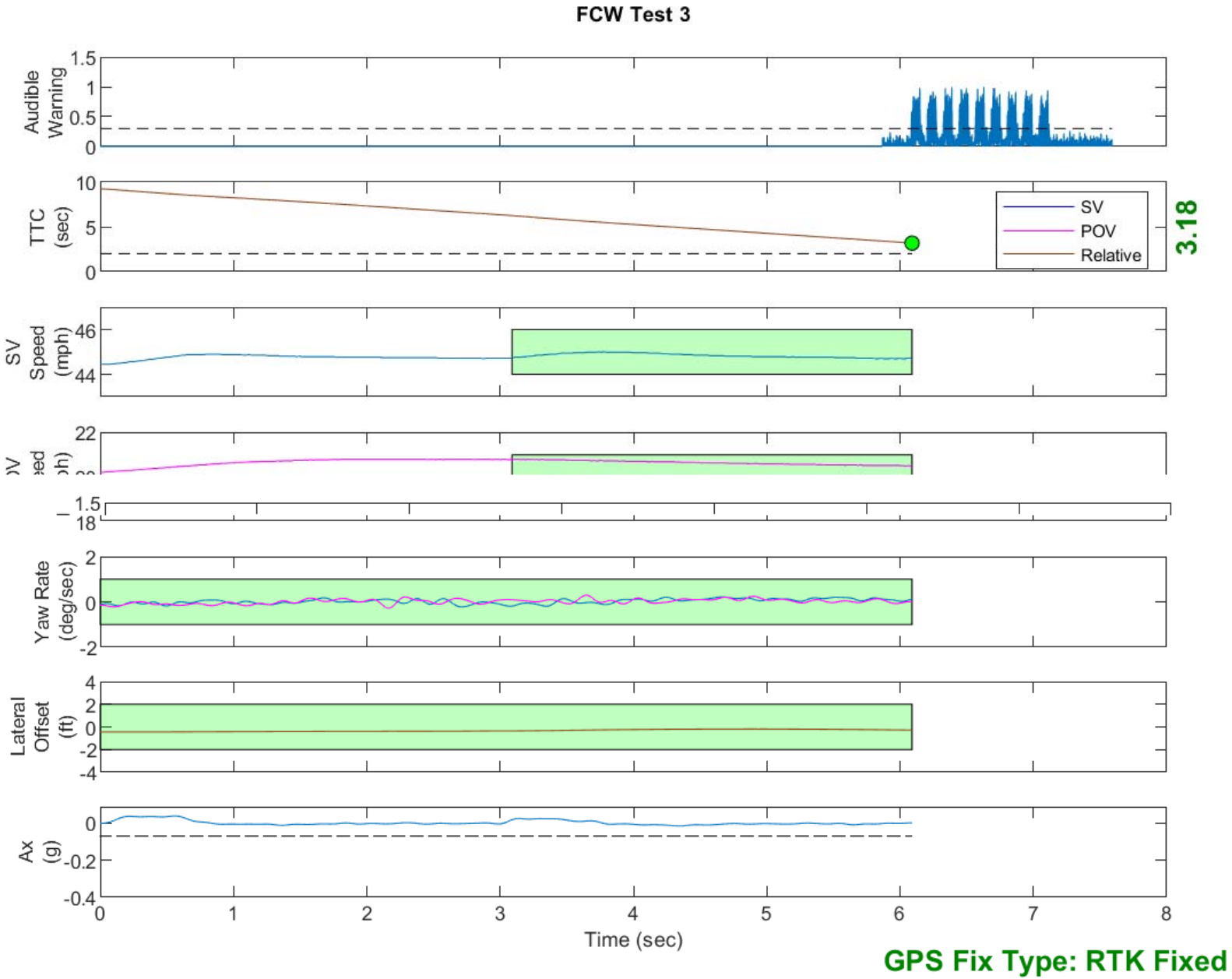


Figure D46. Time History for Run 14, FCW Test 3, Audible Warning

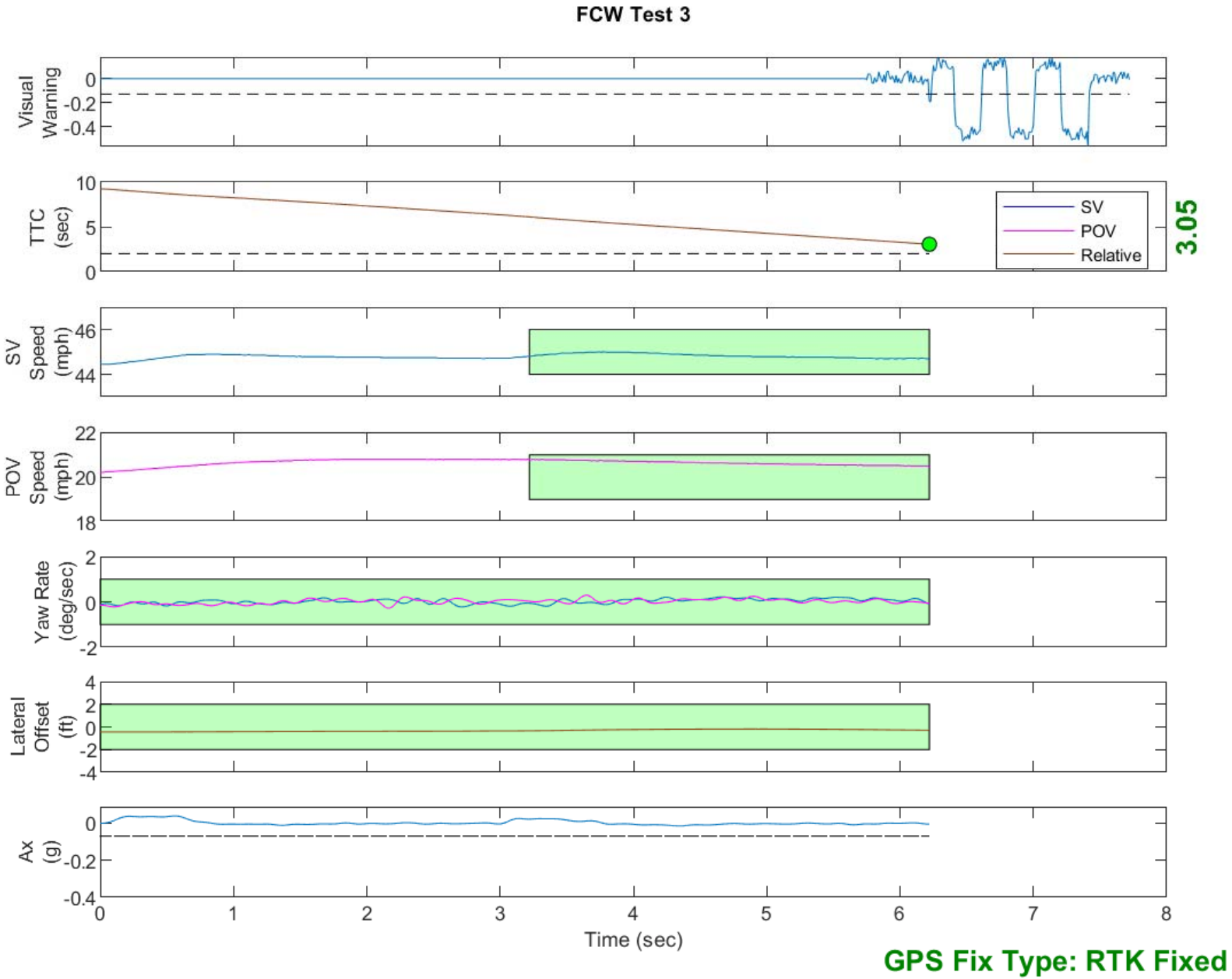


Figure D47. Time History for Run 14, FCW Test 3, Visual Warning