NEW CAR ASSESSMENT PROGRAM
FORWARD COLLISION WARNING CONFIRMATION TEST
NCAP-DRI-FCW-22-14

2022 Volkswagen Taos

DYNAMIC RESEARCH, INC.
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6 May 2022

Final Report

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

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
New Car Assessment Program
1200 New Jersey Avenue, SE
West Building, 4th Floor (NRM-110)
Washington, DC 20590

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

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16. Abstract These tests were conducted on the subject 2022 Volkswagen Taos in accordance with the specifications of the New Car Assessment Program's (NCAP's) 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 Principal 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.

The purpose of the testing reported herein was to objectively quantify the performance of a Forward Collision Warning system installed on a 2022 Volkswagen Taos. This test is part of the New Car Assessment Program to assess Forward Collision Warning Systems sponsored by the National Highway Traffic Safety Administration under Contract No. DTNH22-14-D-00333.

Section II

DATA SHEETS

FORWARD COLLISION WARNING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 1)

2022 Volkswagen Taos

VIN: *3VVSX7B23NM05xxxx*

Test start date: *5/2/2022*

Test end date: *5/2/2022*

Forward Collision Warning setting: *Early*

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

(Page 1 of 1)

2022 Volkswagen Taos

TEST VEHICLE INFORMATION

VIN: *3VVSX7B23NM05xxxx*

Body Style: *SUV* Color: *Platinum Gray Metallic*

Date Received: *4/25/2022* Odometer Reading: *54 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *VOLKSWAGEN DE MEXICO S.A. DE C.V. MEXICO*

Date of manufacture: *03/22*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *215/50R18*

Rear: *215/50R18*

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

Rear: *250 kPa (36 psi)*

TIRES

Tire manufacturer and model: *Bridgestone Turanza LS100*

Front tire specification: *215/50R18 92H*

Rear tire specification: *215/50R18 92H*

Front tire DOT prefix: *DOT 1V6 YKL10A*

Rear tire DOT prefix: *DOT 1V6 YKL10A*

FORWARD COLLISION WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2022 Volkswagen Taos

GENERAL INFORMATION

Test start date: *5/2/2022* Test end date: *5/2/2022*

AMBIENT CONDITIONS

Air temperature: *22.8 C (73 F)*

Wind speed: *1.0 m/s (2.3 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: *250 kPa (36 psi)*

FORWARD COLLISION WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2022 Volkswagen Taos

WEIGHT

Weight of vehicle as tested including driver and instrumentation:

Left Front:	*486.7 kg (1073 lb)*	Right Front:	*449.5 kg (991 lb)*
Left Rear:	*329.8 kg (727 lb)*	Right Rear:	*328.4 kg (724 lb)*
		Total:	*1594.4 kg (3515 lb)*

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

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2022 Volkswagen Taos

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

Front Assist (Forward Collision Warning & Autonomous Emergency Braking w/ Pedestrian Monitoring)

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

The FCW system uses a radar located behind the Volkswagen emblem in the front grille.

Forward Collision Warning Setting used in test: *Early*

How is the Forward Collision Warning presented to the driver? (Check all that apply)

- **X** Warning light
- **X** Buzzer or auditory 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, auditory, vibration, or combination), etc.

The FCW system alerts the driver with a visual and auditory alert. The visual alert consists of an orange vehicle between lane lines, with waves emanating to the front and sides. The auditory alert consists of a constant tone with a primary frequency of 2500 Hz.

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

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2022 Volkswagen Taos

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 FCW system can be turned on/off using the touch screen display on the center dash using the following procedure:

1. Select "Menu" to bring up the setup menu.

2. Select "Assistance Systems" -> "Front Assist" -> "Advance Warning".

3. Select between the range settings options and "Off" to turn the FCW system on/off.

Additionally, the FCW system can be turned on/off using the button located on the turn signal lever to access the “Assist Systems” menu in the instrument panel. Use the controls on the right side of the steering wheel to select "Front Assist" and select the "OK" button to turn the system on/off. When the FCW system is turned off, a warning light illuminates. The system is automatically enabled each time the engine switch is turned on.

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

If yes, please provide a full description.

The range setting can be adjusted using the touch screen display on the center dash. The procedure is as follows:

1. Select "Menu" to bring up the setup menu.

2. Select "Assistance Systems" -> "Front Assist" -> "Advance Warning".

3. Select between "Early", "Medium", and "Late".

The warning timing setting is retained when the engine switch is turned off.

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

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2022 Volkswagen Taos

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

If yes, please provide a full description.

Refer to the owner's manual page 136 shown in Appendix B pages B-4.

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)

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

This test evaluates the ability of the FCW function to detect a stopped lead vehicle, as depicted in Figure 1.

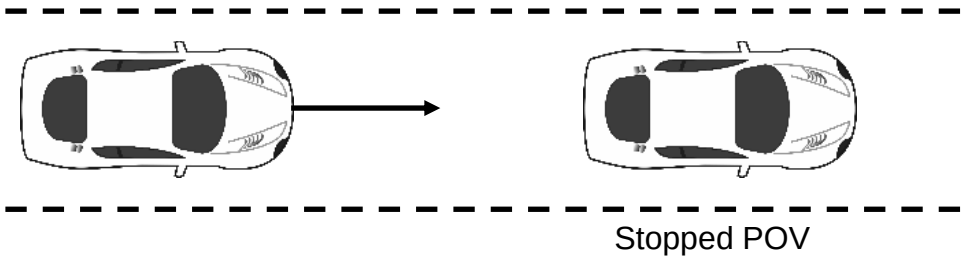

Figure 1. Depiction of Test 1

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 km/h), 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 km/h) 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 km/h) 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 or (2) 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.

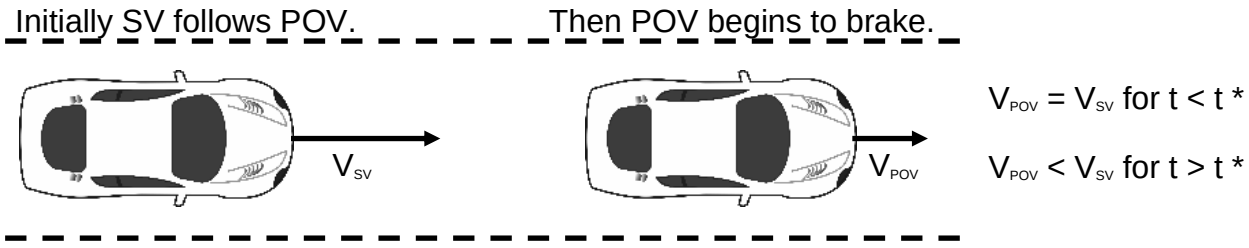

Figure 2. Depiction of Test 2

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].

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 km/h), 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.

[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).

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 km/h) 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 km/h) 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 ±0.03 g, 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) 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 km/h).

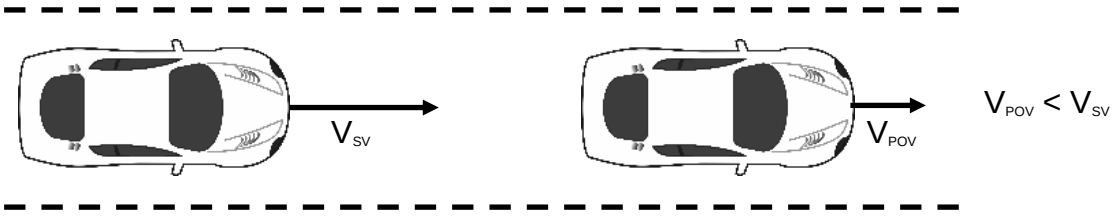

Figure 3. Depiction of Test 3

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 km/h) in the center of the lane of travel.

The SV was driven at 45.0 mph (72.4 km/h), 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., TT = 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 km/h) 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 km/h) 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:

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

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 100 psi	Omega DPG8001	17042707002	By: DRI Date: 10/5/2021 Due: 10/5/2022
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 2/11/2022 Due: 2/11/2023
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	N/A
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels ± 10g, Angular Rate ±100 deg/s, Angle >45 deg, Velocity >200 km/h	Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h			By: Oxford Technical Solutions
				SV: Oxford Inertial +	2176	Date: 6/26/2020 Due: 6/26/2022
				POV:	2258	Date: 4/28/2021 Due: 4/28/2023
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	N/A

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	N/A	N/A
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	N/A	N/A
Accelerometer	Acceleration (to measure time at haptic alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	N/A	N/A
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2022 Due: 1/6/2023

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 auditory or haptic alerts, part of the pre-test instrumentation verification process is to determine the tonal frequency of the auditory warning or the vibration frequency of the tactile warning through use of the PSD (Power Spectral Density) function in Matlab. This is accomplished in order to identify the center frequency around which a band-pass filter is applied to subsequent auditory or tactile warning data so that the beginning of such warnings can be programmatically determined. The band-pass filter used for these warning signal types is a phaseless, forward-reverse pass, elliptical (Cauer) digital filter, with filter parameters as listed in Table 2.

Table 2. Auditory and Tactile Warning Filter Parameters

Warning Type	Filter Order	Peak-to-Peak Ripple	Minimum Stop Band Attenuation	Passband Frequency Range
Auditory	5^{th}	3 dB	60 dB	Identified Center Frequency ± 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

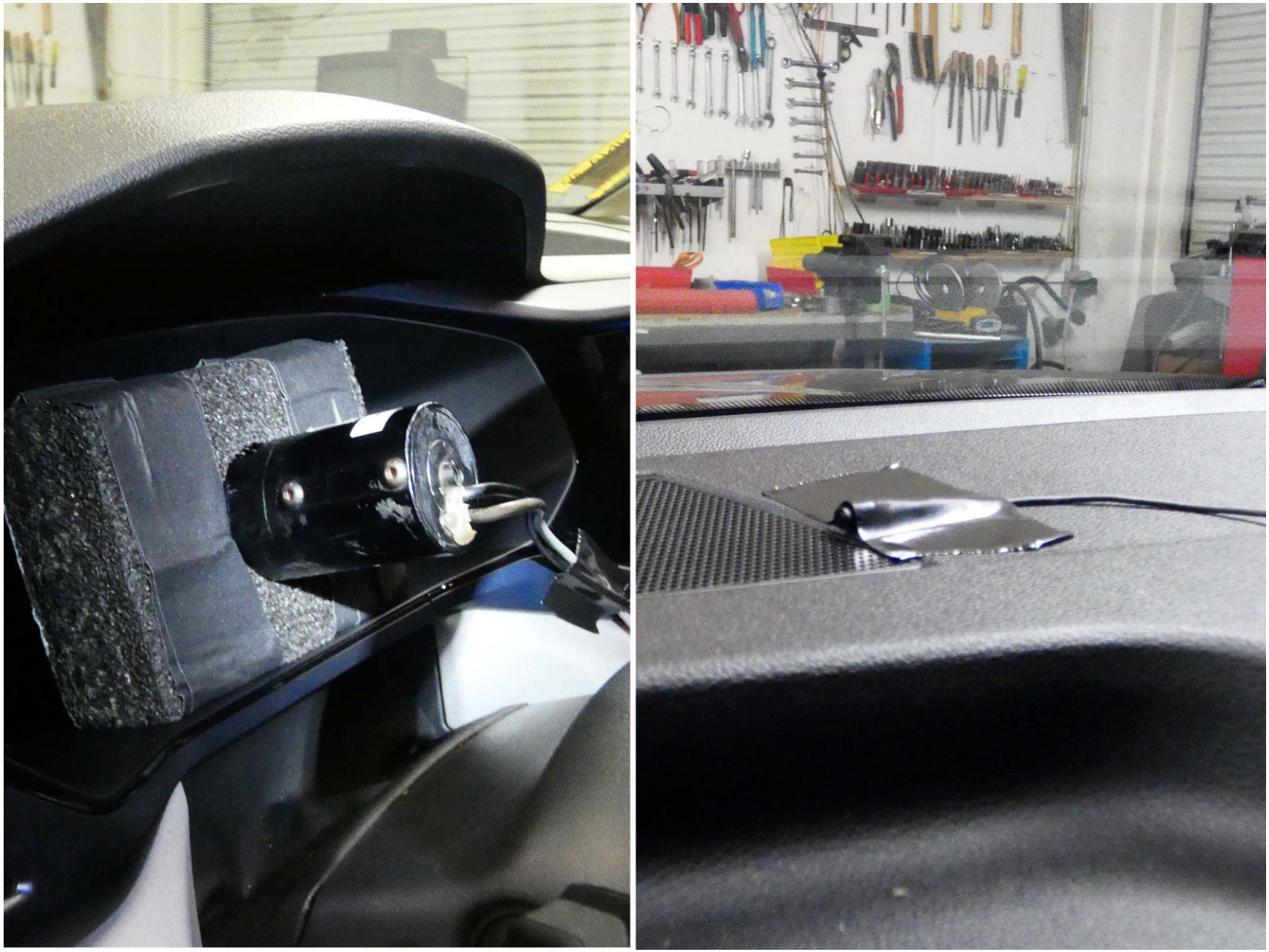

Figure A9. Sensors for Detecting Auditory and Visual Alerts

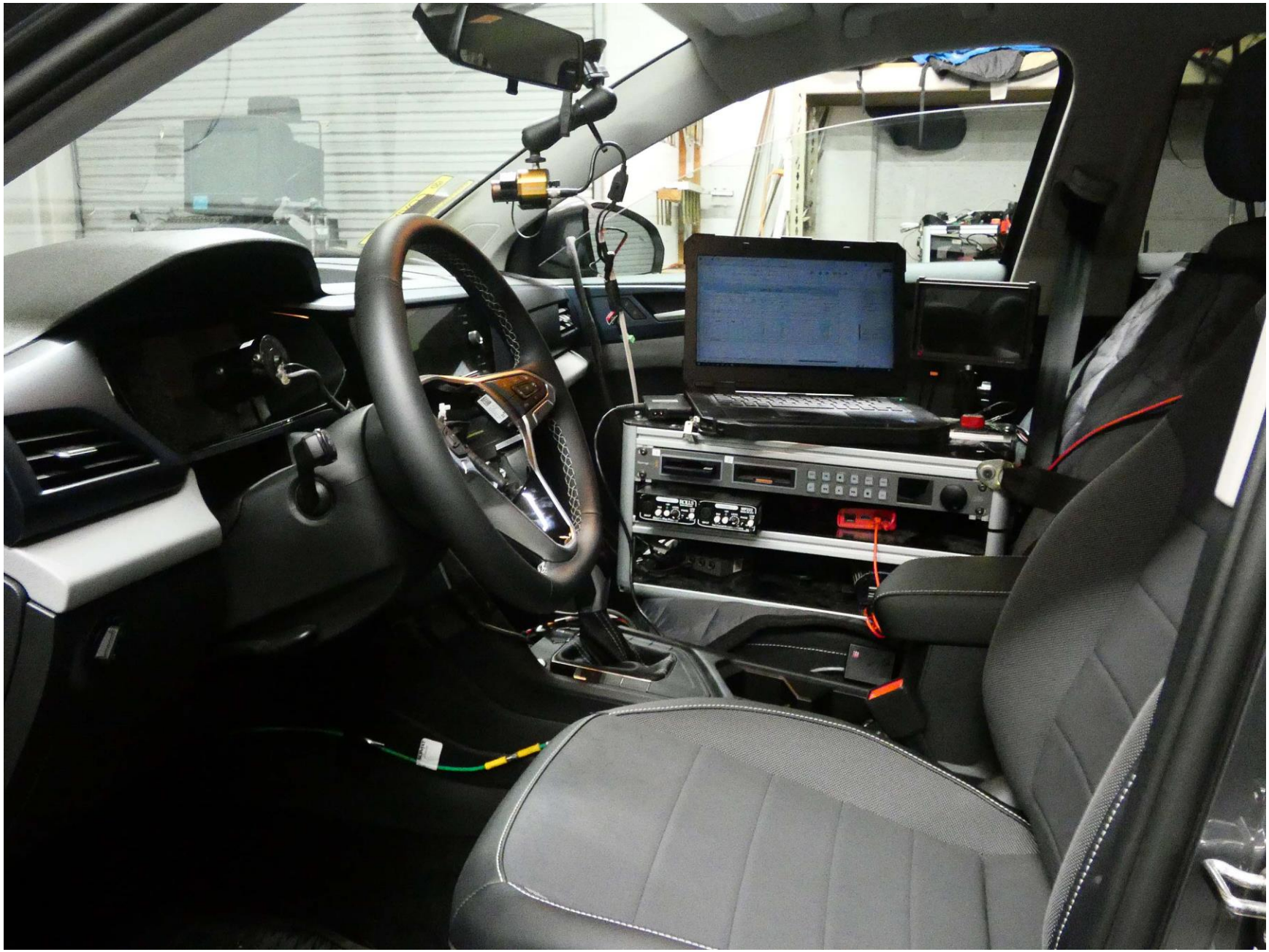

Figure A10. Computer Installed in Subject Vehicle

Figure A11. Brake Actuation System Installed in Principal Other Vehicle

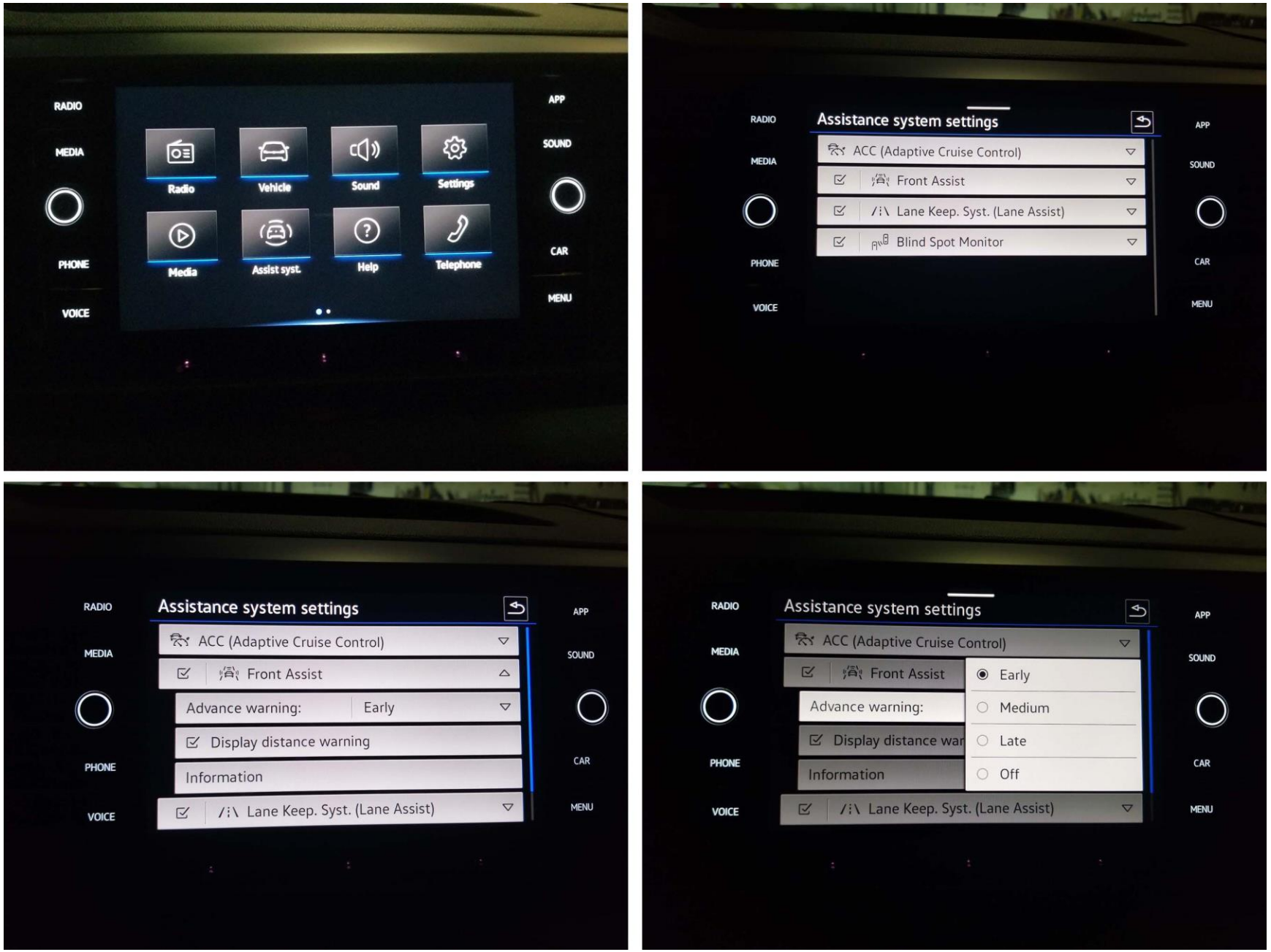

Figure A12. FCW System Warning Timing and On/Off Menu

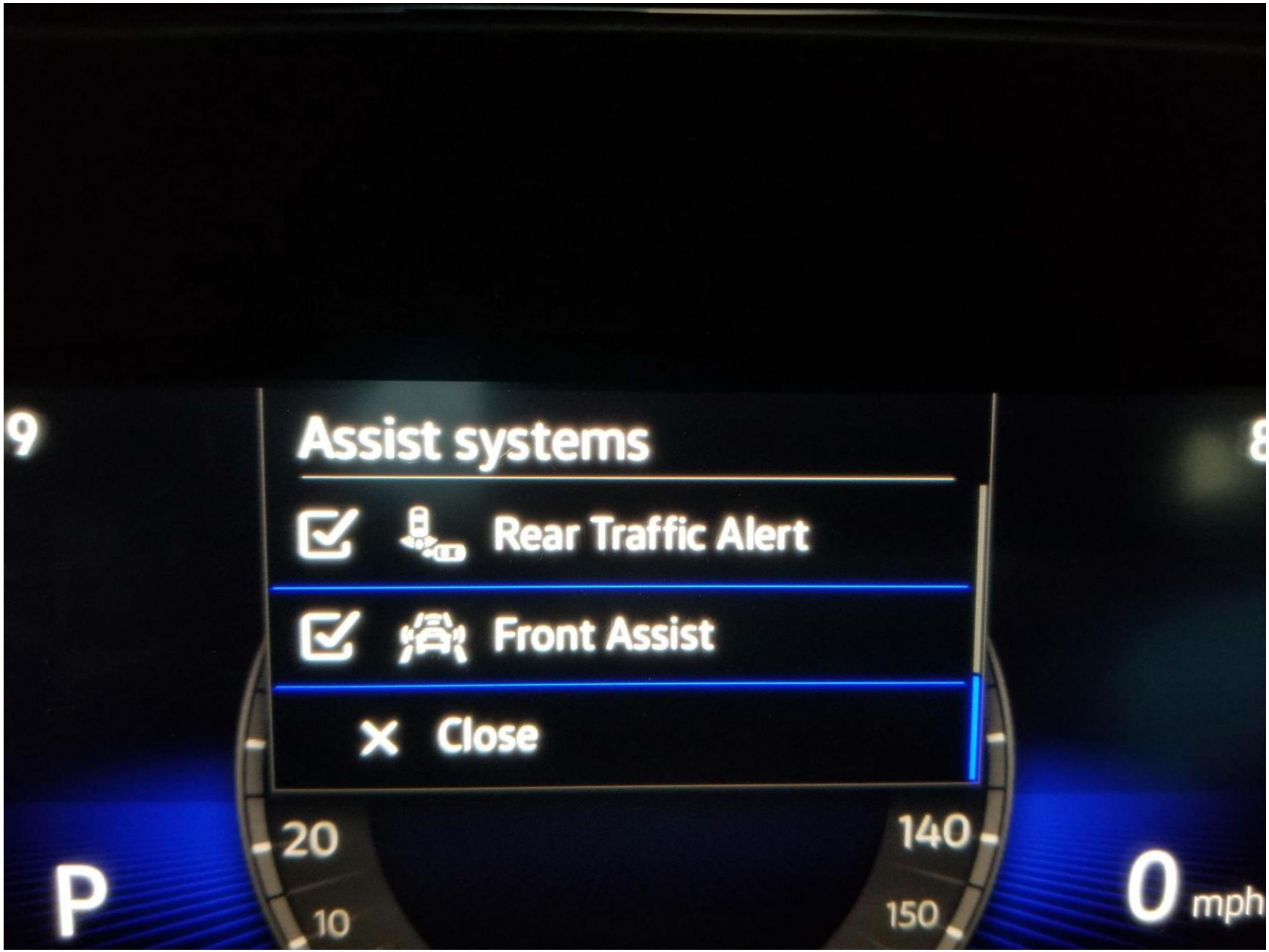

Figure A13. FCW System Instrument Panel On/Off Menu

Figure A14. Turn Signal Lever Button

Figure A15. Steering Wheel Buttons

Figure A16. Visual Alert

APPENDIX B

Excerpts from Owner’s Manual

— *Vehicles without Driving Mode Selection:* Select the desired driving mode in the Assistance systems menu in the Infotainment system.

Deactivating Adaptive Cruise Control

1. Press the button.
2. Select the speed regulation in the instrument cluster display.

Adaptive Cruise Control is deactivated. The vehicle only maintains the set speed. ◁

Troubleshooting

Please read the introductory information and heed the Warnings and Notice on page 130.

ACC is not available

The yellow indicator light turns on.

— The radar sensor is dirty. Clean the radar sensor → page 270.

— The visibility of the radar sensor is limited due to weather conditions, such as snow, or from soap residue or coatings. Clean the radar sensor → page 270.

— Radar sensor visibility is limited by attachments, decorative frames on license plate holders, or stickers. Clear the area around the radar sensor.

— The radar sensor is misaligned or damaged, for example as a result of damage to the front of the vehicle. Check if there is noticeable damage → page 275.

— Malfunction or fault. Stop the engine and restart.

— Painting work was carried out on or structural modifications were made to the front of the vehicle.

— The original Volkswagen emblem is not used.

— If the problem persists, contact an authorized Volkswagen dealer or authorized Volkswagen Service Facility.

ACC is not functioning as expected

— The radar sensor is dirty. Clean the radar sensor → page 270.

— The system limitations are not adhered to → page 131.

— The brakes are overheated, and the control has been automatically interrupted. Let the brakes cool down and check the function again.

— If the problem persists, contact an authorized Volkswagen dealer or authorized Volkswagen Service Facility.

The Adaptive Cruise Control cannot start

Make sure the following requirements are met:

— *Vehicles with an automatic transmission:* A gear is engaged for driving forward.

— The brake lights on the vehicle are functioning.

— ESC is not regulating.

— The brake pedal is not being pressed.

Unusual noises during automatic braking

— This is normal and not a cause for concern. ◁

Front Assist

Introduction

Front Assist can recognize impending forward collisions and warn the driver. In addition, the system can provide support when braking and initiate an automatic braking maneuver.

The Front Assist system can help to avoid accidents but cannot replace the driver's attention.

Front Assist works solely within the system limitations. Warning times vary depending on the Traffic Situation and the driving behavior.

Range of functions

Autonomous Emergency Braking (Front Assist) includes the following extended functions, depending on the vehicle equipment and the country:

— Pedestrian Monitoring.

The functions named are (if available) automatically active if Front Assist is switched on.

Recognizable objects

Autonomous Emergency Braking (Front Assist) can recognize the following objects, depending on the vehicle equipment and the country:

— Vehicles.

— Bikes.

— Pedestrians.

Driving with Front Assist

You can cancel automatic braking interventions by moving the steering wheel or pressing the accelerator pedal.

Automatic braking

The Front Assist can brake to a stop. The vehicle will not be held at a stop after that. Press the brake pedal.

The brake pedal feels more firm during an automatic braking maneuver.

Detecting the driving situation

Front Assist detects driving situations using radar sensors in the front of the vehicle. The range of the radar sensor is up to approximately 400 ft (120 m).

⚠ WARNING

The intelligent technology of Front Assist cannot overcome the natural laws of physics and it can only operate within the limits of the system. Do not allow the increased convenience provided by the Front Assist system to tempt you into taking risks. The Front Assist system cannot prevent accidents and severe injuries automatically. The driver is always responsible for control of the vehicle.

- Always adapt your speed and remain a safe distance to vehicles driving ahead according to the visual, weather, road, and traffic conditions.
- Please be aware that Autonomous Emergency Braking (Front Assist) cannot detect all objects in the speed range → page 136.
- When Front Assist warns you, brake the vehicle immediately or maneuver around the obstacle, depending on the driving situation.
- Autonomous Emergency Braking (Front Assist) may intervene when not desired, e.g. when the function is limited. Therefore, consider interrupting automatic Autonomous Emergency Braking (Front Assist) interventions if necessary.
- If you are unsure which functions the vehicle has included, consult an authorized Volkswagen dealer or authorized Volkswagen Service Facility before starting your journey. ◁

Warning levels and braking support

🕮 Please read the introductory information and heed the Warnings and Notice ⚠ on page 134.

Speed ranges

Autonomous Emergency Braking (Front Assist) provides maximum support within these speed ranges:

— Response to vehicles: Approx. 3 mph (approx. 5 km/h) to approx. 155 mph (approx. 250 km/h).

— Response to bikes: Approx. 3 mph (approx. 5 km/h) to approx. 155 mph (approx. 250 km/h).

— Response to pedestrians: Approx. 3 mph (approx. 5 km/h) to approx. 40 mph (approx. 65 km/h).

The support system can involve an advance warning, an immediate warning, automatic braking or braking support. A distance warning may also be displayed.

Influencing factors

Whether and in which speed range Autonomous Emergency Braking (Front Assist) reacts to the named objects is dependent on the following factors:

— Type of object.

— Movement direction of the object.

— Speed of the object.

— Speed of the vehicle.

The work area can therefore be limited if the vehicle approaches an object very quickly and thus has little time to react.

Furthermore, not all warning levels are passed through in all situations. Depending on the speed, there may not be, for example, an advance warning or immediate warning, but rather an automatic braking maneuver that occurs straight away, so as to best protect the detected object.

Distance warning

Front Assist detects if there is a safety hazard from following the vehicle ahead too closely. The indicator light turns on. Increase the distance.

Advance warning

Front Assist detects a possible collision and prepares the vehicle for possible emergency braking.

A warning tone sounds and the warning light turns on. Apply the brakes or maneuver to avoid the collision.

Immediate warning

If you do not respond to the advance warning, the brakes may be applied briefly to indicate the increasing risk of a collision. Apply the brakes or maneuver to avoid the collision.

Automatic braking

Autonomous Emergency Braking (Front Assist) can brake the vehicle automatically in several stages of increasing braking force. Reducing the vehicle speed may help to reduce the damage resulting from a collision.

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Braking support

If the system detects that you are not braking enough before an impending collision, Front Assist can increase the braking force and thus help to reduce the risk of a collision. The braking support is only active as long as you are firmly pressing the brake pedal. ◁

Front Assist limitations

📖 Please read the introductory information and heed the Warnings and Notice ⚠ on page 134.

Autonomous Emergency Braking is not available or availability is limited directly after starting the vehicle or after restarting the system. During this time, the indicator light in the instrument cluster display comes on.

Front Assist has physical and system limitations. Therefore, always pay attention and be ready to intervene as necessary.

Delayed reaction

If the radar sensor is exposed to environmental conditions that limit its function, the system may have a delayed response to this. Therefore, the display that indicates that functions are restricted may be delayed when you first start driving or while driving → page 134.

Unrecognizable objects

Autonomous Emergency Braking (Front Assist) may not react or may react with a delay to the following objects:

- If vehicles are driving close to your vehicle but outside of the sensor range, for example vehicles that are staggered around your vehicle or motorcycles
- If vehicles change to your lane close in front of your vehicle
- If vehicles have objects or accessories projecting out of the vehicle
- If there are oncoming vehicles or vehicles crossing the street
- Stationary or oncoming pedestrians; generally no reaction to people without Pedestrian Monitoring.
- Stationary cyclists, oncoming cyclists or cyclists crossing the street.
- Pedestrians and cyclists who are not detected as such, for example because they are fully or partially hidden.

Functional limitations

Front Assist may not react, may react with a delay, or may react in a way that is not desired in the following situations:

- When driving around tight curves
- When driving in heavy rain, snow, or spray
- When driving in parking garages or tunnels.
- When driving on roads with embedded metal objects, such as railroad tracks
- When driving in reverse
- If ESC is active
- If the **Offroad** driving mode is switched on (depending on the vehicle equipment).
- If the radar sensor is dirty or obstructed
- If multiple brake lights on the vehicle are malfunctioning.
- If the vehicle is accelerating very quickly or the accelerator pedal is pressed all the way down
- In complex driving situations, such as around traffic islands
- In unclear traffic situations, for example if vehicles driving ahead are braking quickly or are turning
- If Front Assist is malfunctioning

Switching off Front Assist

Depending on the system, Front Assist may not be suitable in the following situations and must be switched off if they occur → ⚠:

- If the vehicle is not being driven on public roads, for example during off-road driving or on a racetrack.
- If the vehicle is being towed or transported
- If add-ons such as auxiliary headlights cover the radar sensor.
- If the radar sensor is malfunctioning
- If there is a strong impact against the radar sensor, for example after a rear-end collision
- If there are multiple unwanted activations

⚠ WARNING

If you do not switch off Front Assist in the these situations, accidents and serious injuries could occur. ◁

Using Front Assist

Please read the introductory information and heed the Warnings and Notice ⚠ on page 134.

When you switch on the ignition, Front Assist and the advance warning (depending on the country) are automatically switched on.

However, Front Assist is not available or its availability is restricted while the indicator light is turned on.

Volkswagen recommends always leaving Front Assist, distance warning, and advance warning switched on. For exceptions to this, see → page 136.

Switching on and off

— Switch Front Assist on or off in the Assistance systems menu in the Infotainment system → page 28.

OR: switch the Front Assist on or off in the instrument cluster menu → page 26.

If you switch off Front Assist, the advance warning and distance warning will also be switched off. The yellow indicator light turns on in the instrument cluster display.

Adjusting the distance and advance warning setting

If Front Assist is switched on, you can adjust the distance and advance warning setting as follows:

— Switch the function you require on or off in the Assistance systems menu in the Infotainment system → page 28.

Depending on the equipment, you can also adjust the warning time setting for the advance warning. ◁

Troubleshooting

Please read the introductory information and heed the Warnings and Notice ⚠ on page 134.

Autonomous Emergency Braking starts

The white indicator light comes on.

— Autonomous Emergency Braking (Front Assist) is temporarily not available or has limited availability. After driving straight for a short distance, Autonomous Emergency Braking is available again and the indicator light goes out. If the vehicle does not drive, the indicator light stays on.

Front Assist is not available, and the radar sensor does not have sufficient visibility

— The radar sensor is dirty. Clean the radar sensor → page 270.

— The visibility of the radar sensor is limited due to weather conditions, such as snow, or from soap residue or coatings. Clean the radar sensor → page 270.

— Radar sensor visibility is limited by attachments, decorative frames on license plate holders, or stickers. Clear the area around the radar sensor.

— The radar sensor is misaligned or damaged, for example as a result of damage to the front of the vehicle. Check if there is noticeable damage → page 275.

— Painting work was carried out on or structural modifications were made to the front of the vehicle.

— The original Volkswagen emblem is not used.

— If the problem persists, turn off the Front Assist and contact an authorized Volkswagen dealer or authorized Volkswagen Service Facility.

Front Assist is not functioning as expected or has been triggered multiple times unnecessarily

— The radar sensor is dirty. Clean the radar sensor → page 270.

— The system limitations are not adhered to → page 136.

— If the problem persists, turn off the Front Assist and contact an authorized Volkswagen dealer or authorized Volkswagen Service Facility. ◁

Lane Keeping System (Lane Assist)

Introduction

Lane Assist helps the driver to stay in a lane, within the system limitations. This function is not suitable for, and not designed for, autonomously keeping your vehicle in a lane.

Lane Assist detects the lane markers using a camera on the windshield. If the system detects that the vehicle is coming too close to a lane marker, the system warns the driver with corrective steering. The driver can override the corrective steering at any time.

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APPENDIX C

Run Log

Subject Vehicle: **2022 Volkswagen Taos** Test Date: **5/2/2022**

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	2.87	2.74	0.77	Pass	
2		Y	2.88	2.75	0.78	Pass	
3		Y	2.84	2.72	0.74	Pass	
4		Y	2.87	2.74	0.77	Pass	
5		Y	2.86	2.73	0.76	Pass	
6		Y	2.83	2.72	0.73	Pass	
7		Y	2.91	2.77	0.81	Pass	
20	**Decelerating POV, 45**	N					POV Brakes
21		N					POV Brakes
22		Y	2.60	2.49	0.20	Pass	
23		Y	2.49	2.38	0.09	Pass	
24		Y	2.55	2.42	0.15	Pass	
25		Y	2.36	2.23	-0.04	Fail	
26		Y	2.71	2.57	0.31	Pass	
27		N					POV Brakes
28		Y	2.10	1.99	-0.30	Fail	
29		Y	2.52	2.41	0.12	Pass	

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
8	**Slower POV, 45 vs 20**	Y	2.54	2.42	0.54	Pass	
9		N					Lateral Offset
10		N					Lateral Offset
11		N					Lateral Offset
12		Y	2.68	2.53	0.68	Pass	
13		Y	2.66	2.52	0.66	Pass	
14		Y	2.56	2.43	0.56	Pass	
15		Y	2.65	2.52	0.65	Pass	
16		N					Bad GPS
17		Y	2.70	2.58	0.70	Pass	
18		N					Lateral Offset
19		Y	2.56	2.42	0.56	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.

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 – Decelerating 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 auditory, 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)

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

Other Notations

- ENV – For Ax plots only, indicates that the envelope for the POV braking was exceeded.
- NG – Indicates that the value for that variable was outside of bounds and therefore “No Good”.
- No Wng – No warning was detected.
- POV – Indicates that the value for the Principal Other Vehicle was out of bounds.
- SV – Indicates that the value for the Subject Vehicle was out of bounds.
- SR – Shows the speed reduction value.
- Thr – Indicates that the requirements for the throttle were not met.

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

Examples of 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.

Notes

When vehicles provide more than one type of alert, and when it is possible to measure the timing of these alerts, plots will be shown of each alert for each run. Because alert timing nearly always differs between alert types, a plot may indicate a valid run for one of the alerts and invalid for another. Test run validity is based on the validity window of the earliest alert, but validity determination for each individual alert is based on the timing of that alert alone. As an example, a vehicle has both visual and auditory alerts. For a particular run, the auditory alert occurs first followed by the visual alert. The validity period for the run ends when the auditory alert occurs, at which time the driver steers and/or brakes to avoid the POV. Since the visual alert occurs after the auditory alert, the run is essentially already over by the time the visual alert occurs. Depending on the relative timing gap between alerts, it may be expected that the validity criteria (yaw rate, speed, etc.) based on the timing of the visual alert could indicate an invalid run.

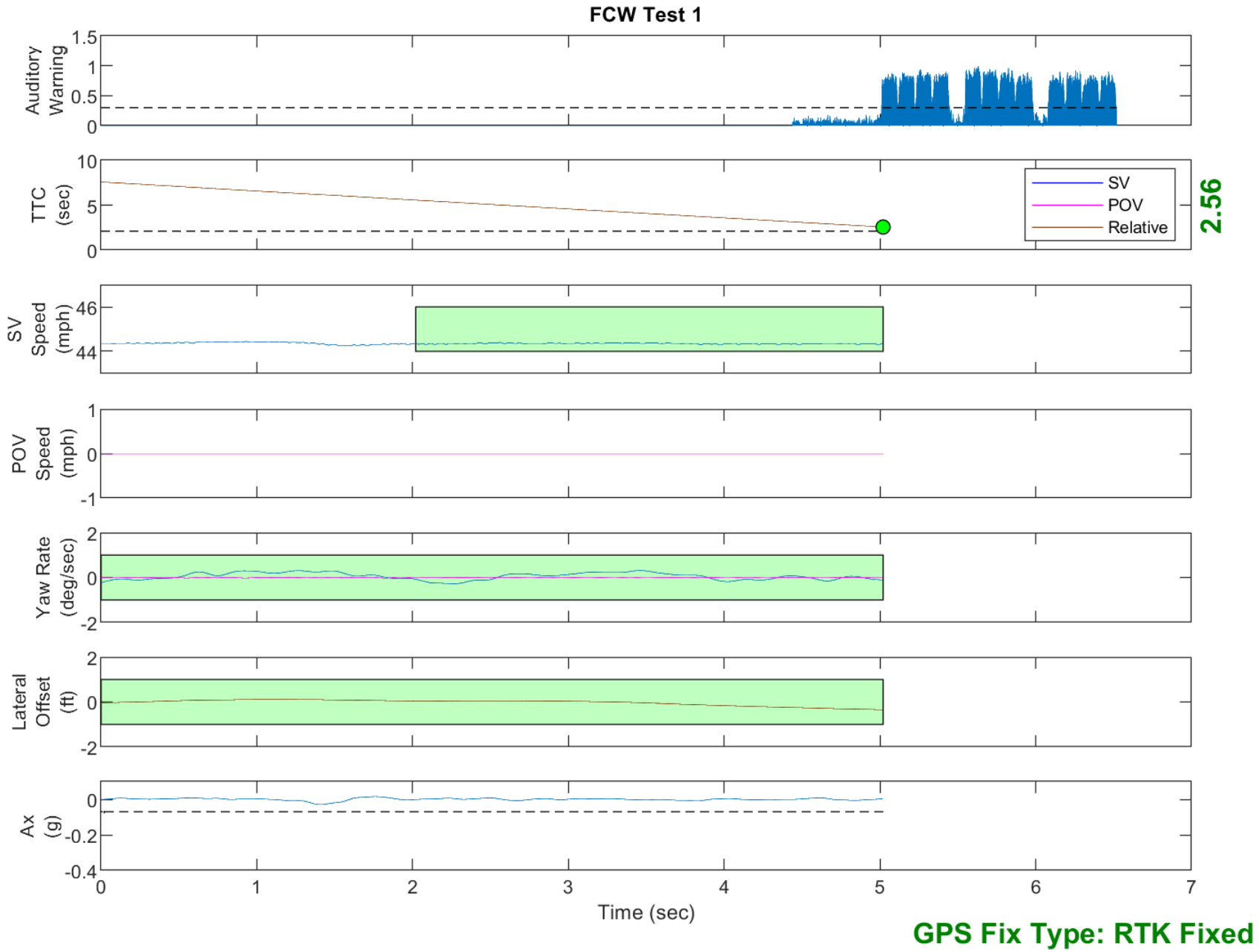

Figure D1. Example Time History for Test Type 1, Passing

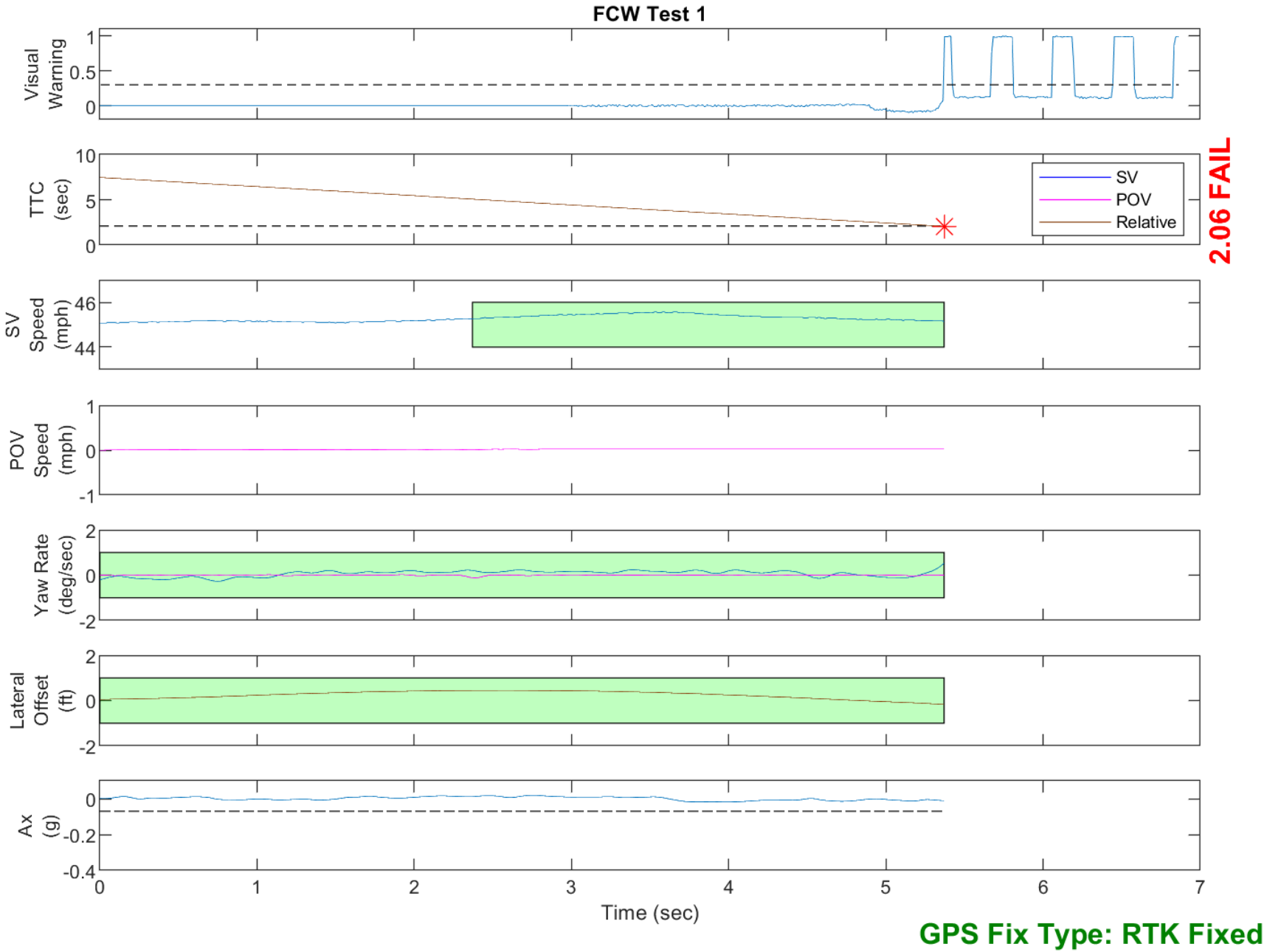

Figure D2. Example Time History for Test Type 1, Failing

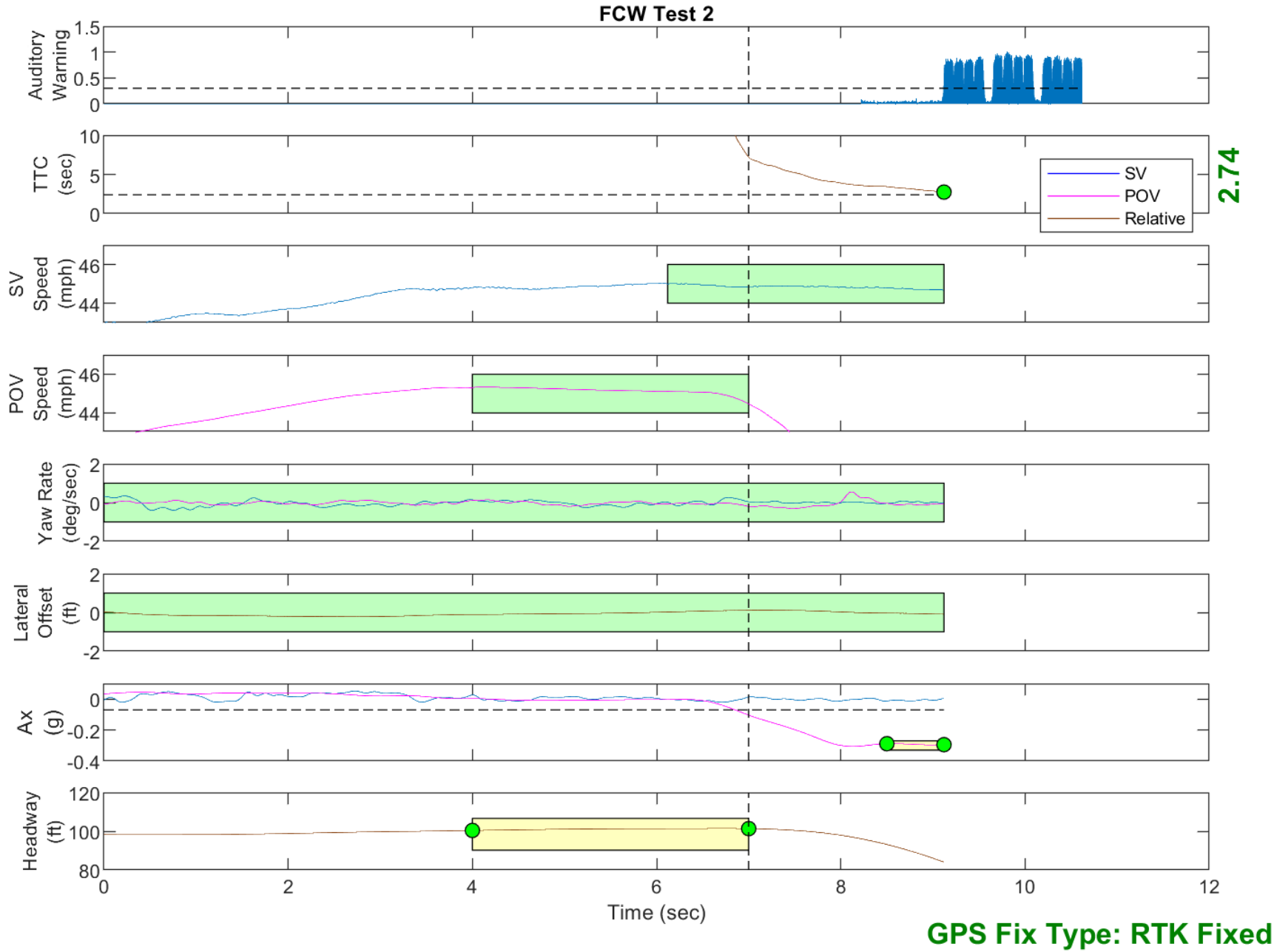

Figure D3. Example Time History for Test Type 2, Passing

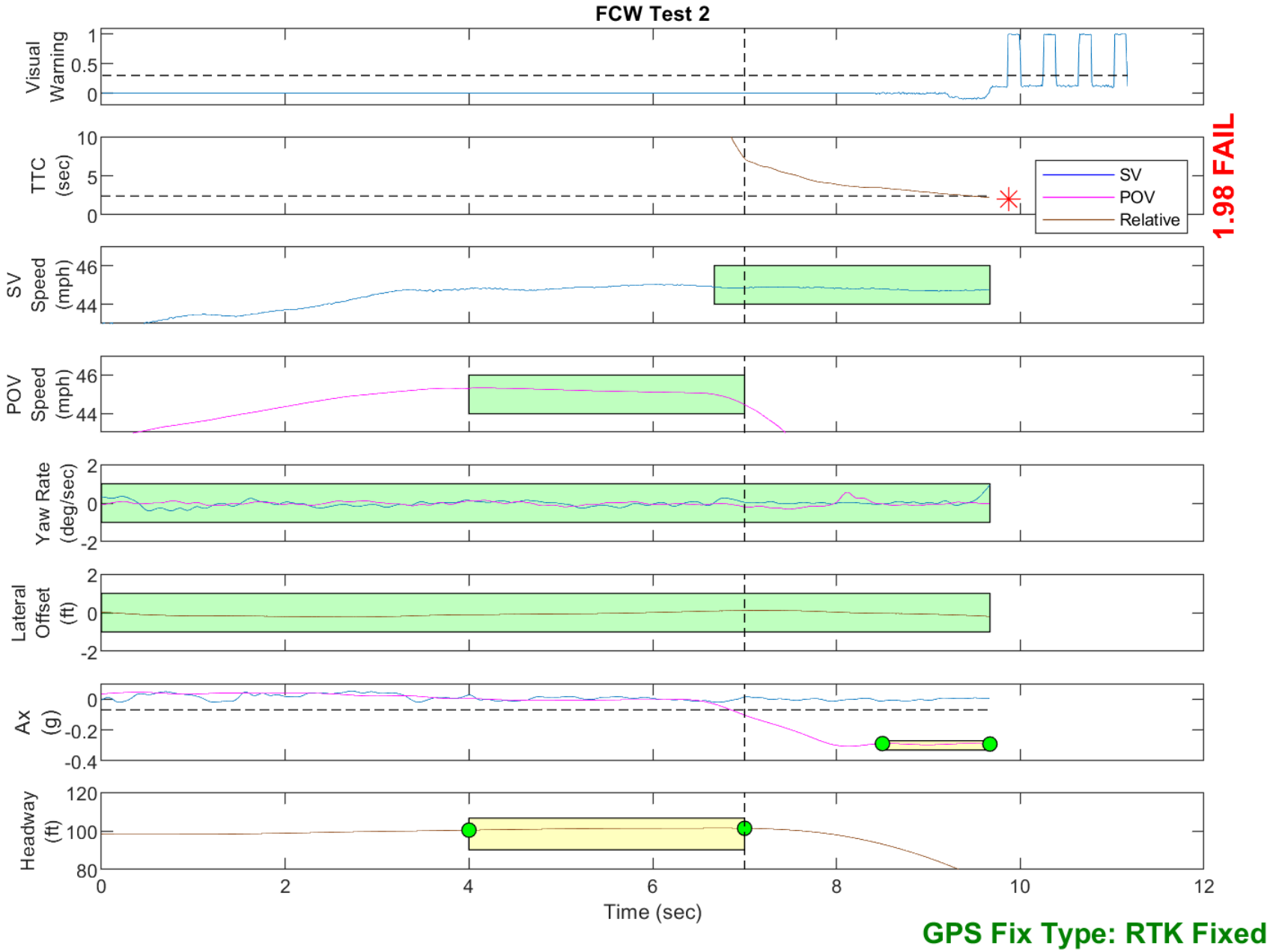

Figure D4. Example Time History for Test Type 2, Failing

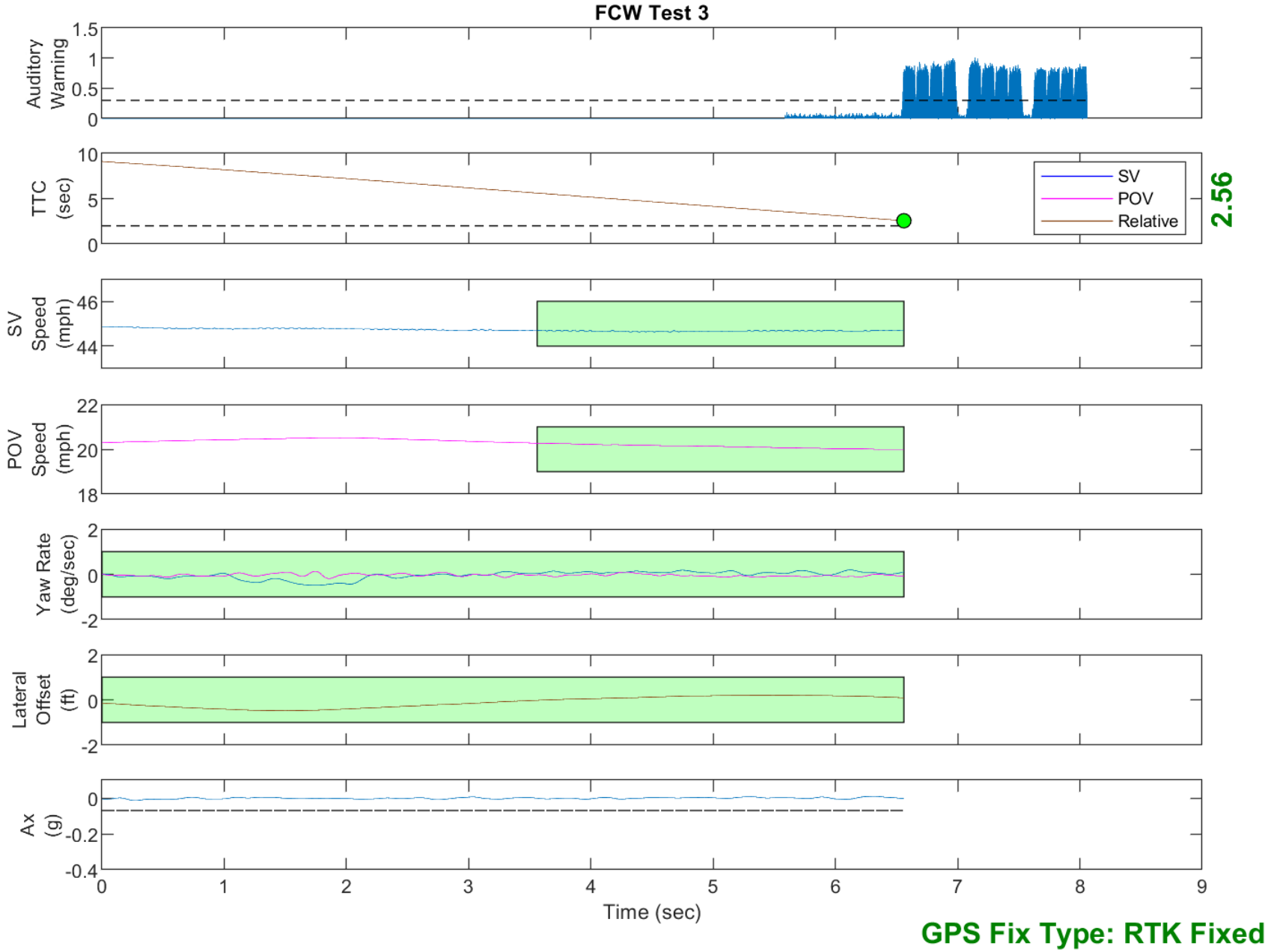

Figure D5. Example Time History for Test Type 3, Passing

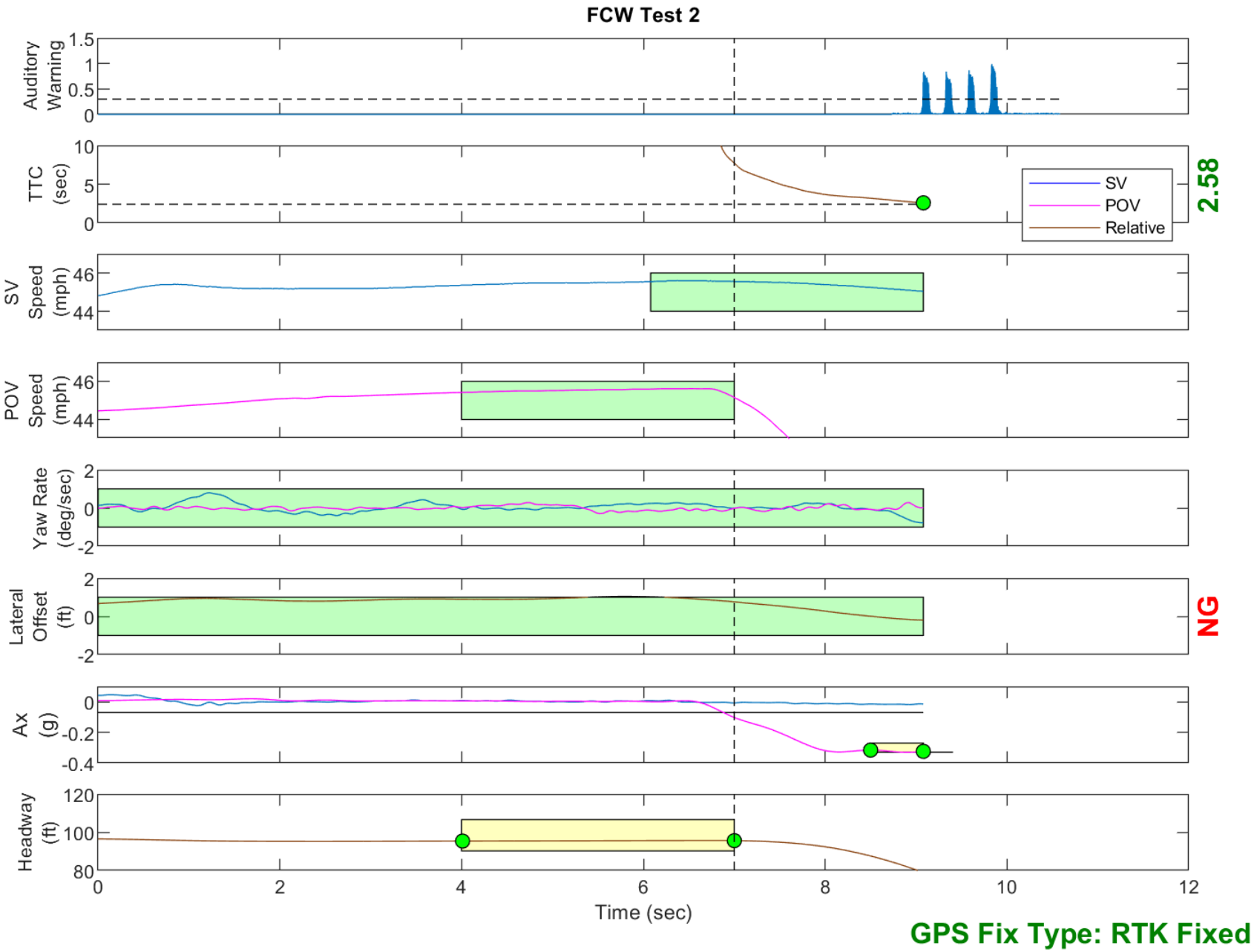

Figure D6. Example Time History Showing Invalid Lateral Offset Criteria

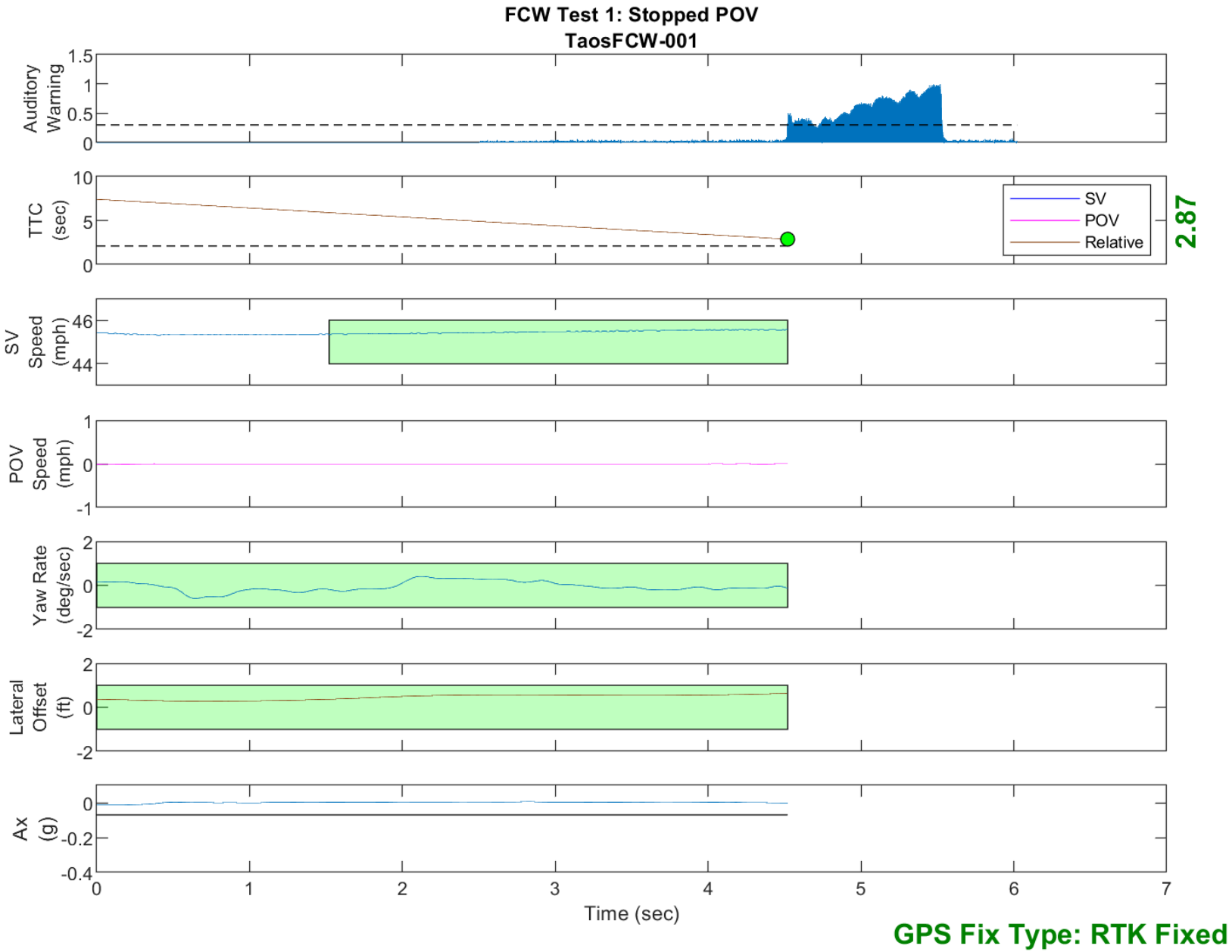

Figure D7. Time History for Run 1, Test 1 - Stopped POV, Auditory Warning

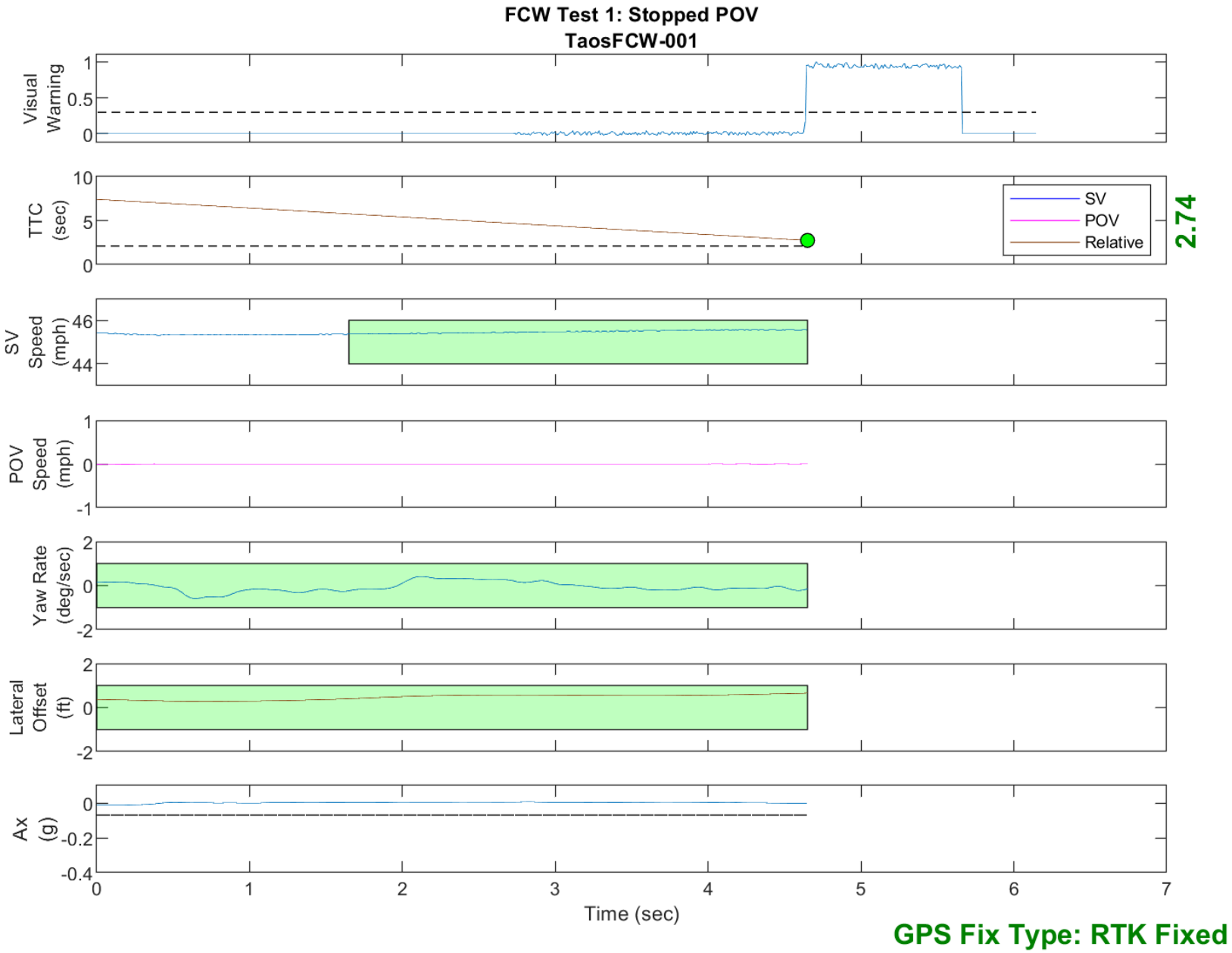

Figure D8. Time History for Run 1, Test 1 - Stopped POV, Visual Warning

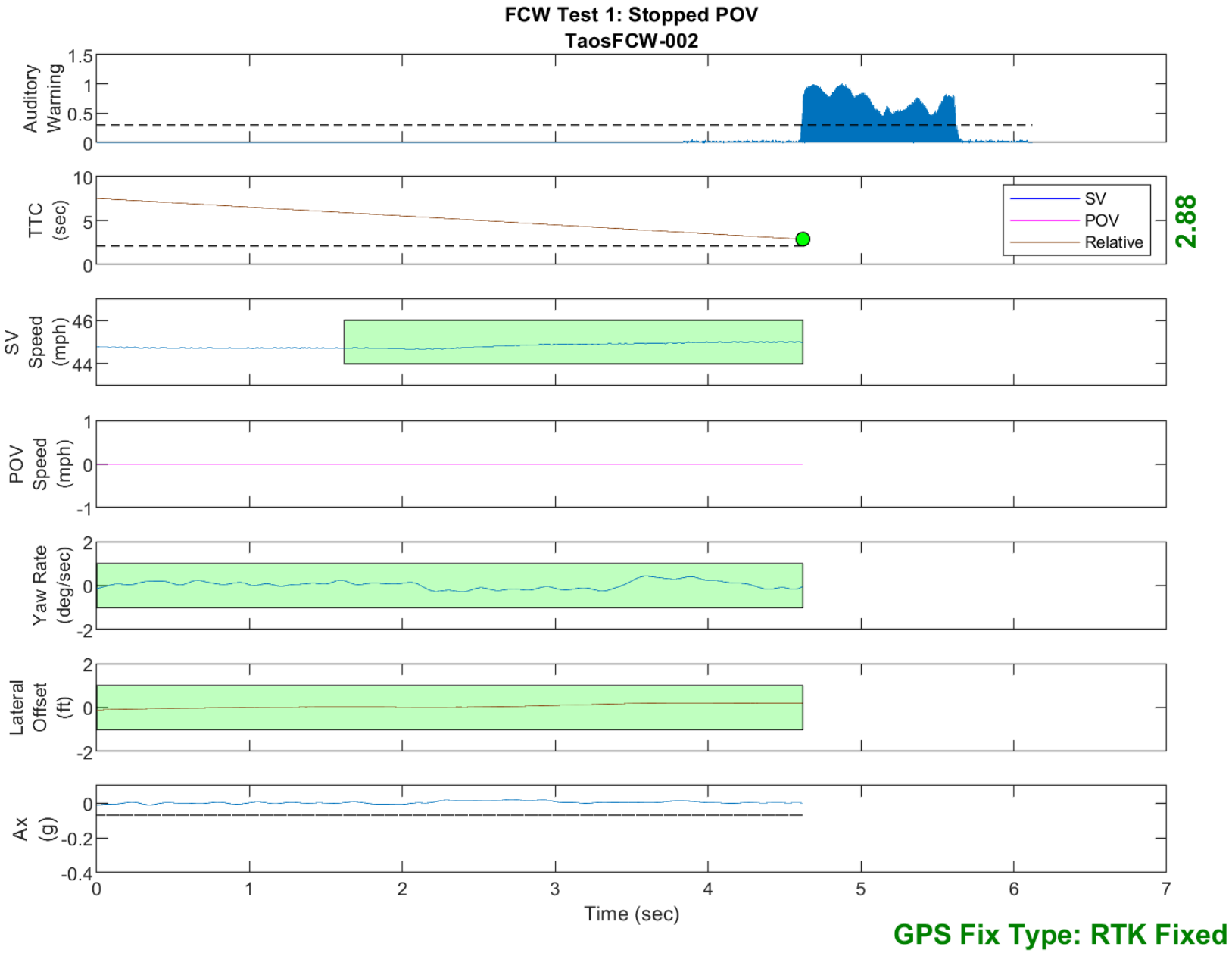

Figure D9. Time History for Run 2, Test 1 - Stopped POV, Auditory Warning

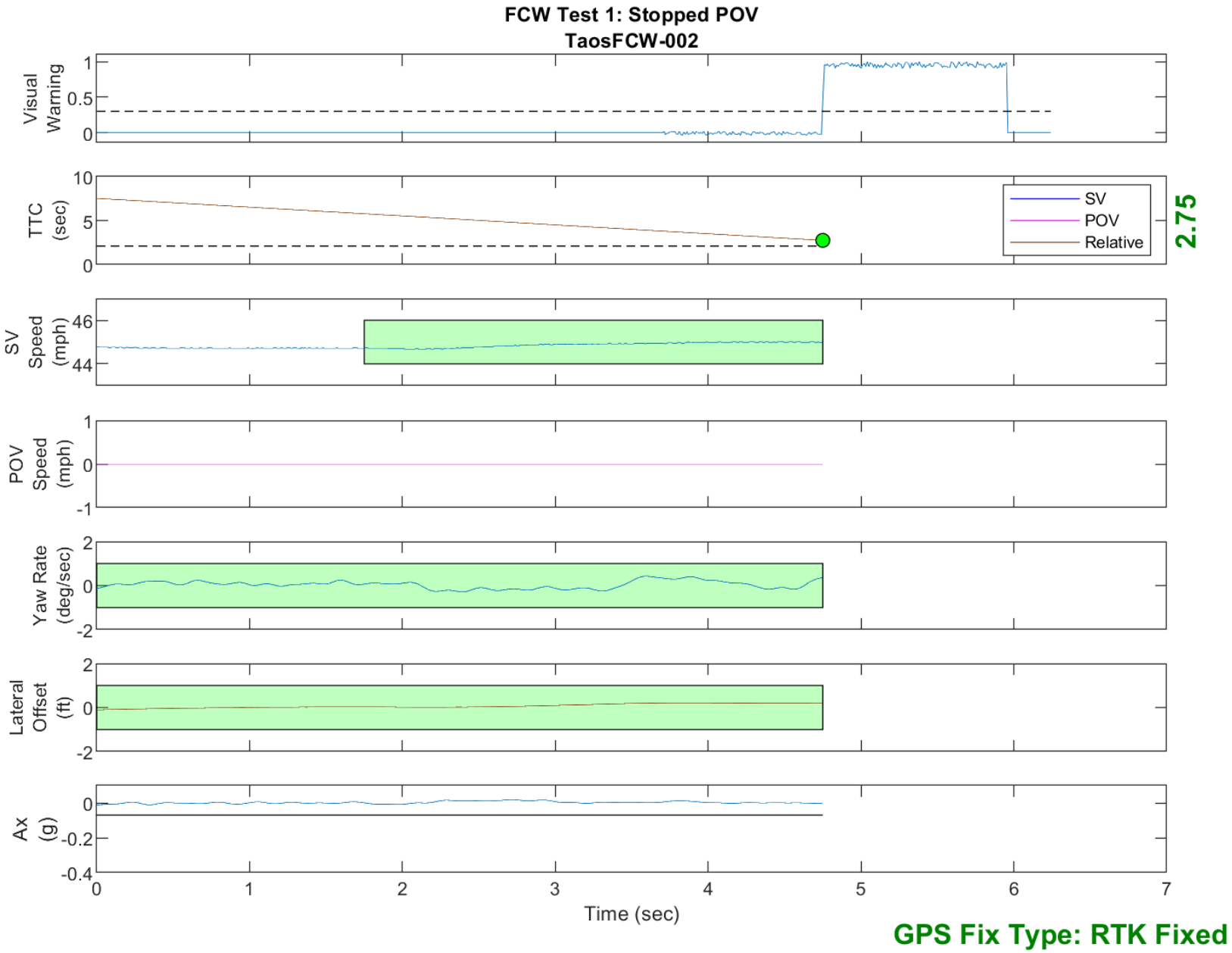

Figure D10. Time History for Run 2, Test 1 - Stopped POV, Visual Warning

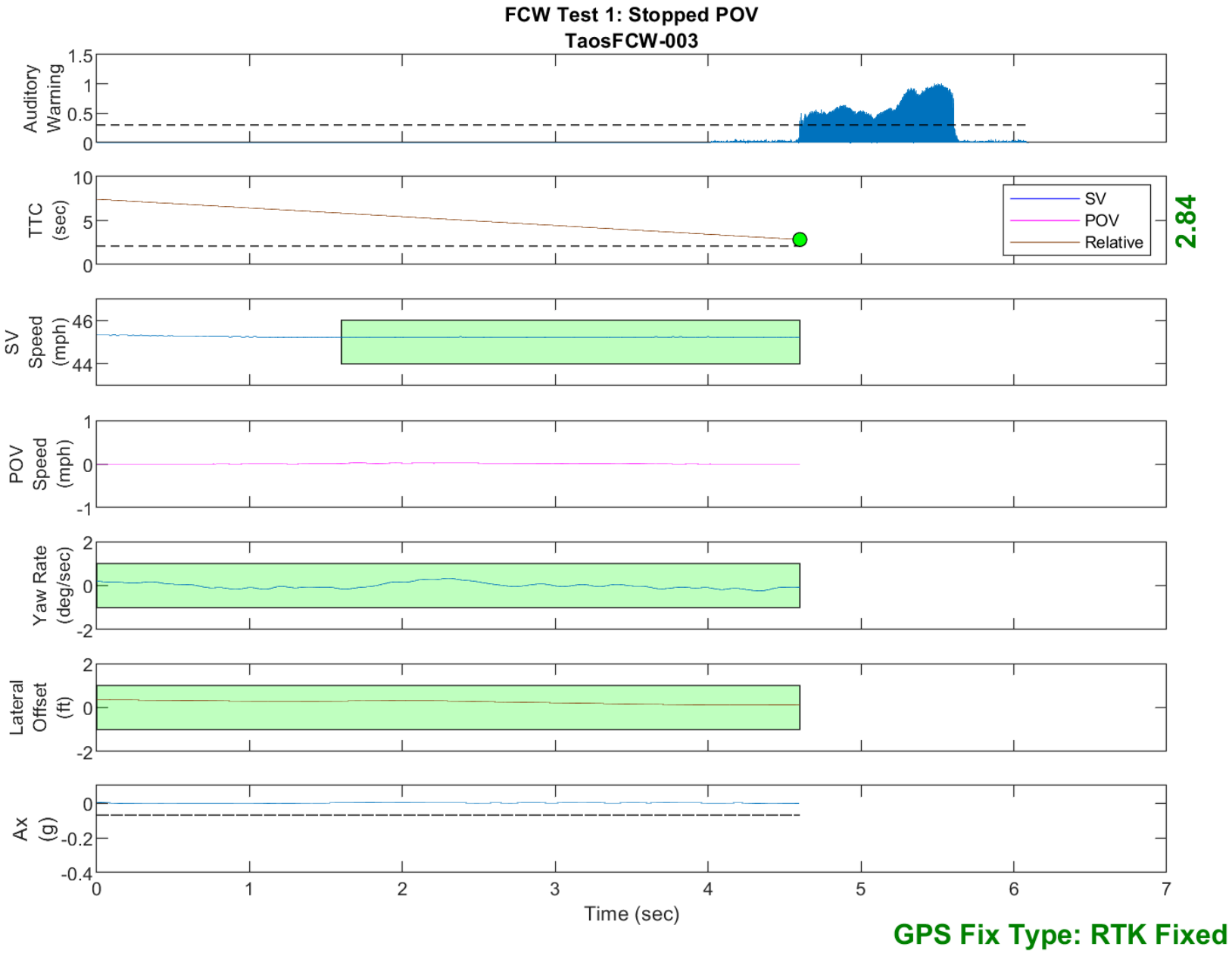

Figure D11. Time History for Run 3, Test 1 - Stopped POV, Auditory Warning

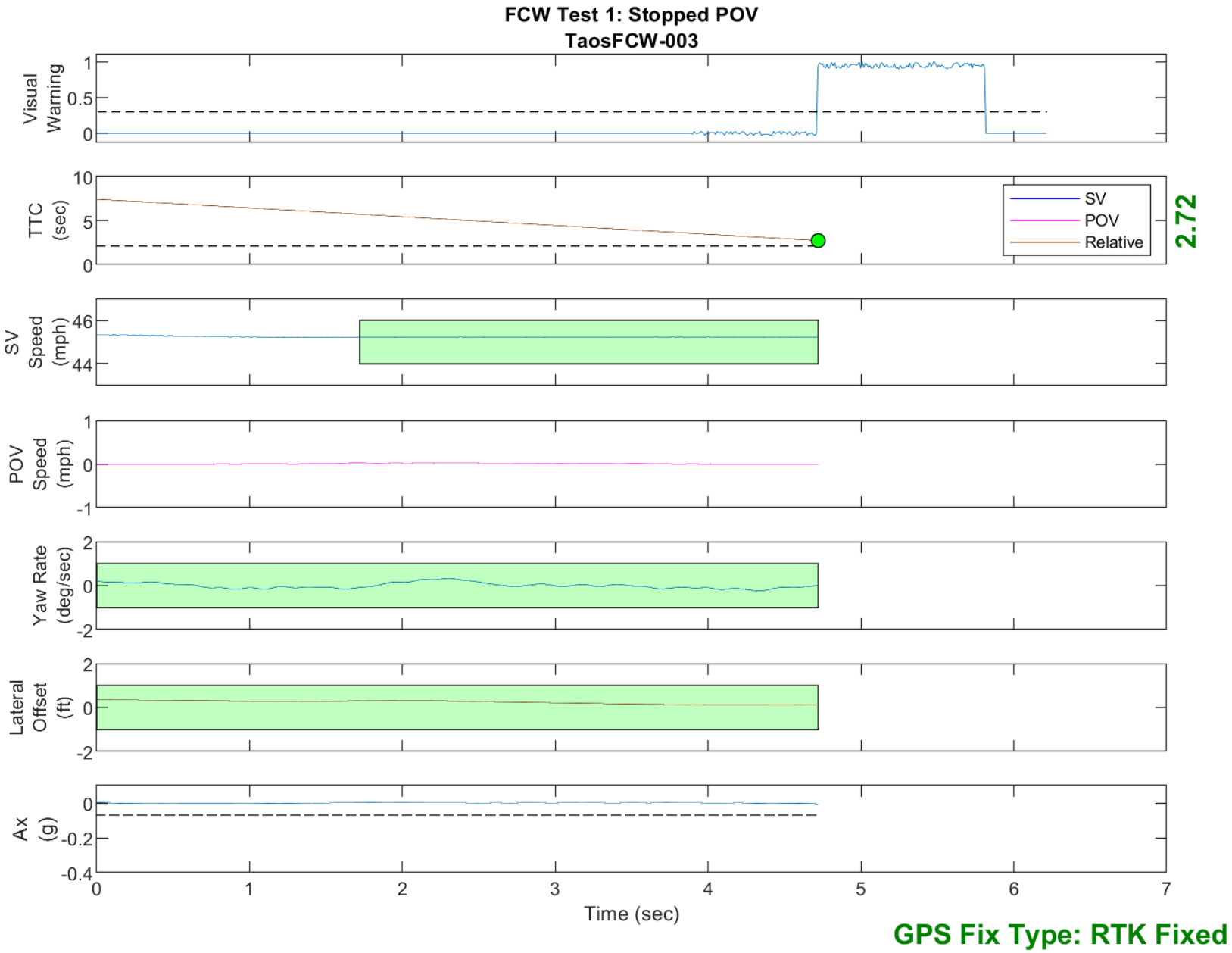

Figure D12. Time History for Run 3, Test 1 - Stopped POV, Visual Warning

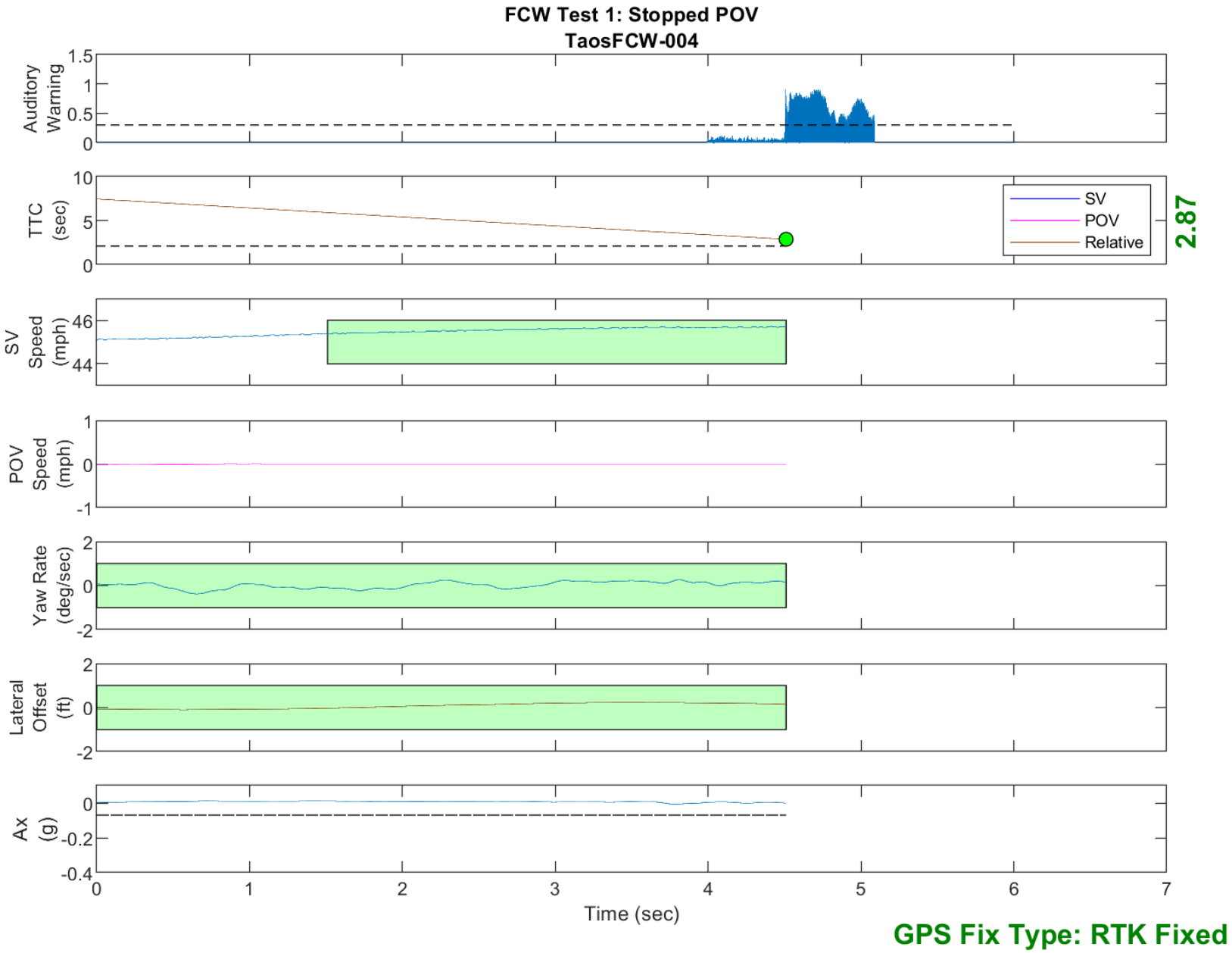

Figure D13. Time History for Run 4, Test 1 - Stopped POV, Auditory Warning

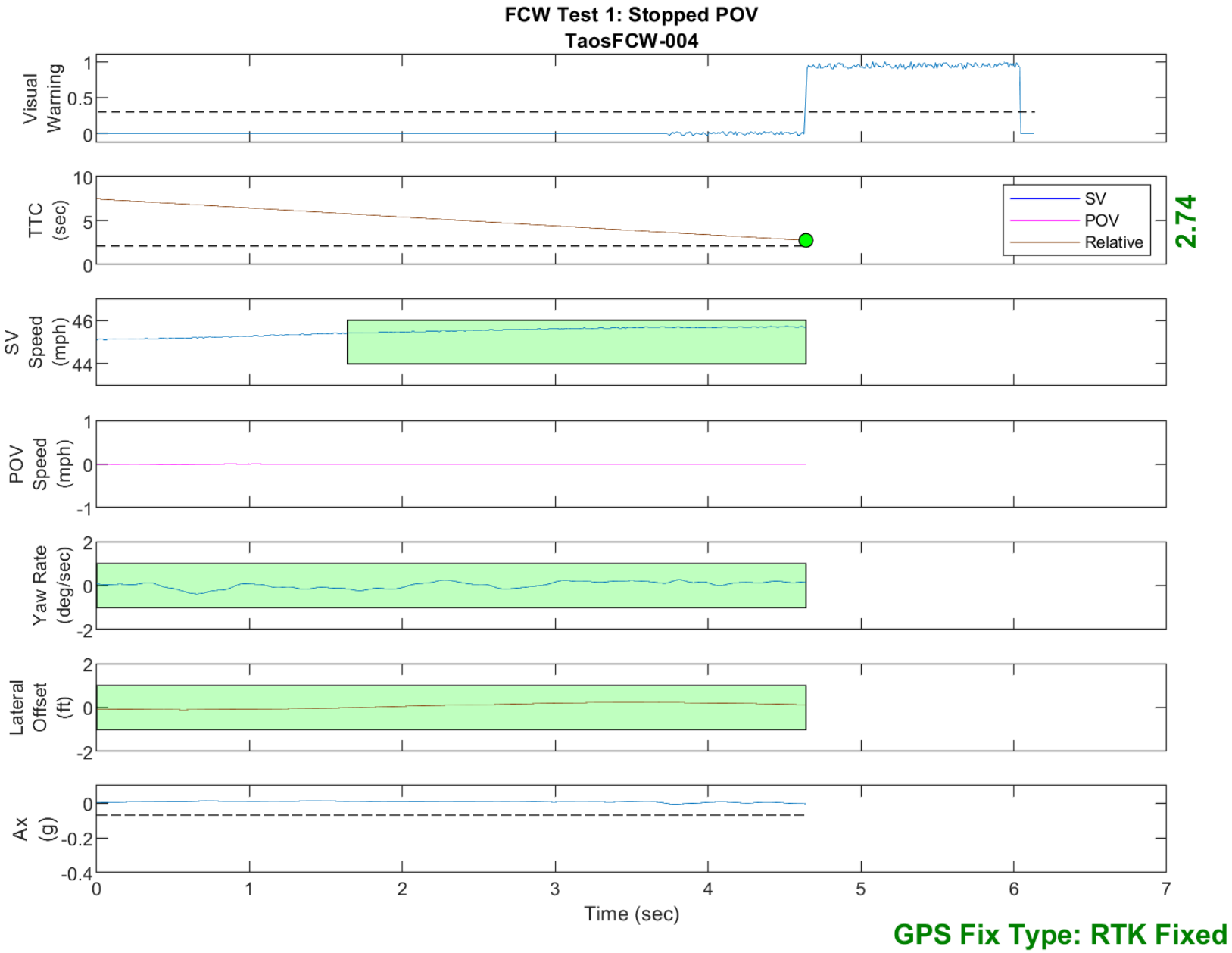

Figure D14. Time History for Run 4, Test 1 - Stopped POV, Visual Warning

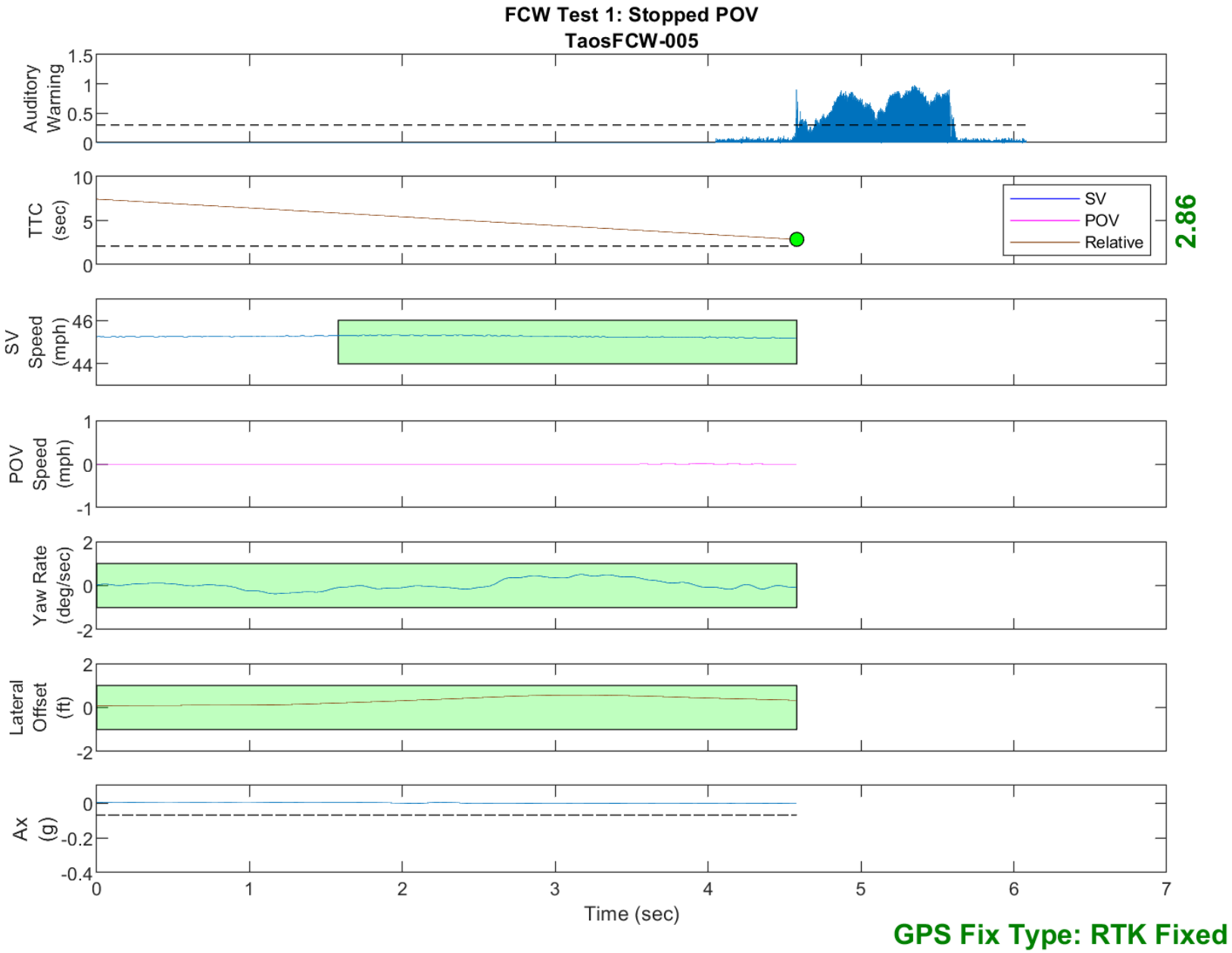

Figure D15. Time History for Run 5, Test 1 - Stopped POV, Auditory Warning

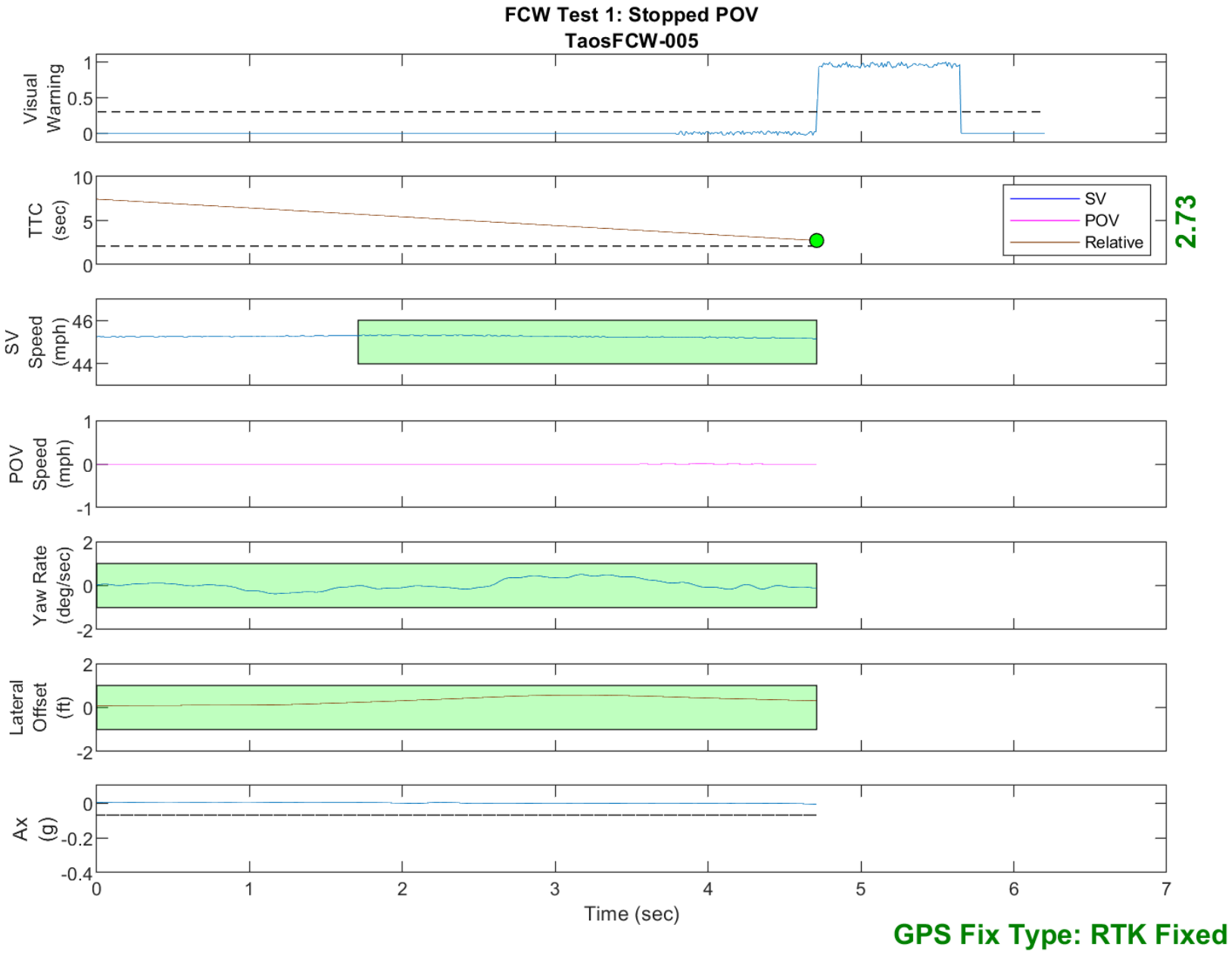

Figure D16. Time History for Run 5, Test 1 - Stopped POV, Visual Warning

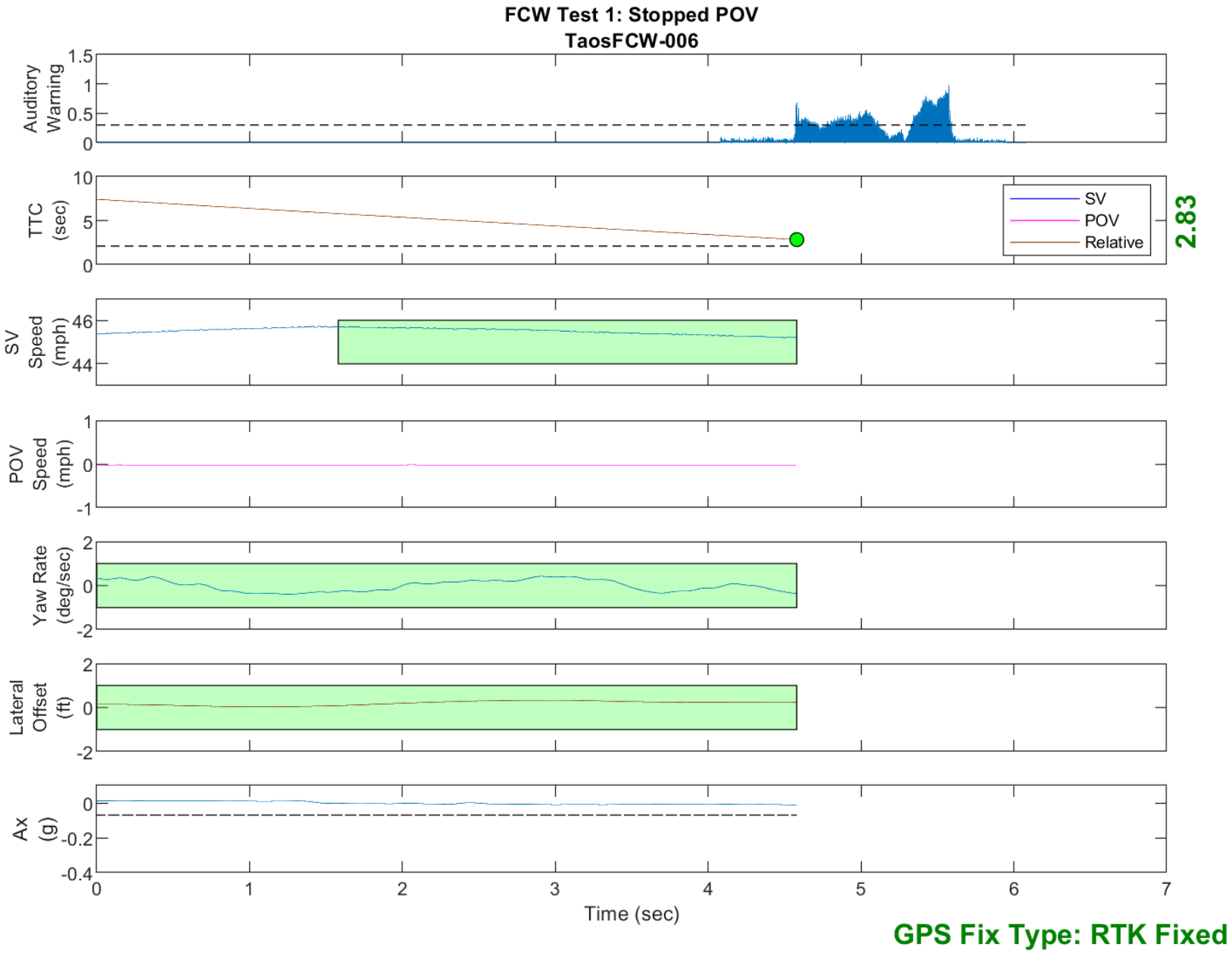

Figure D17. Time History for Run 6, Test 1 - Stopped POV, Auditory Warning

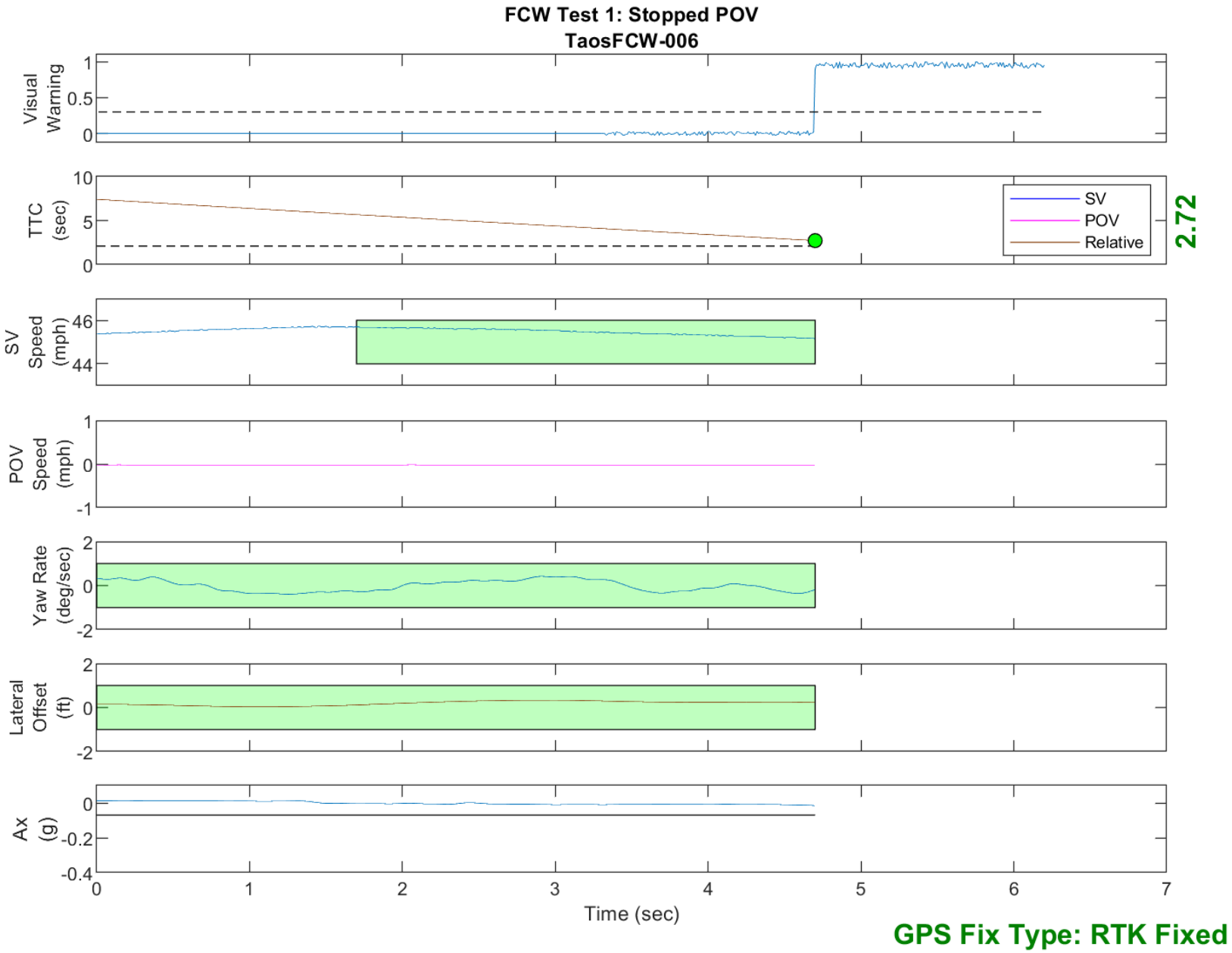

Figure D18. Time History for Run 6, Test 1 - Stopped POV, Visual Warning

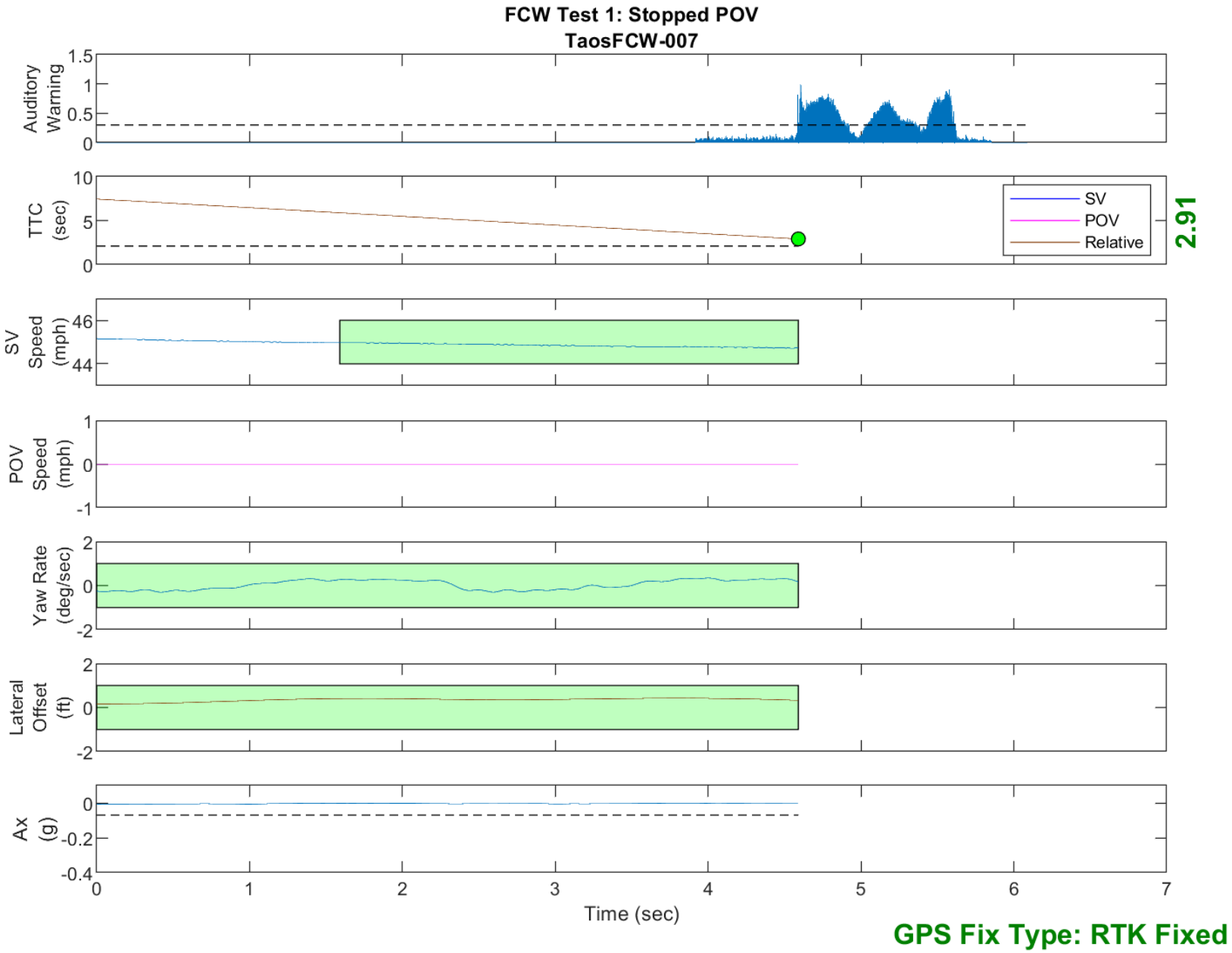

Figure D19. Time History for Run 7, Test 1 - Stopped POV, Auditory Warning

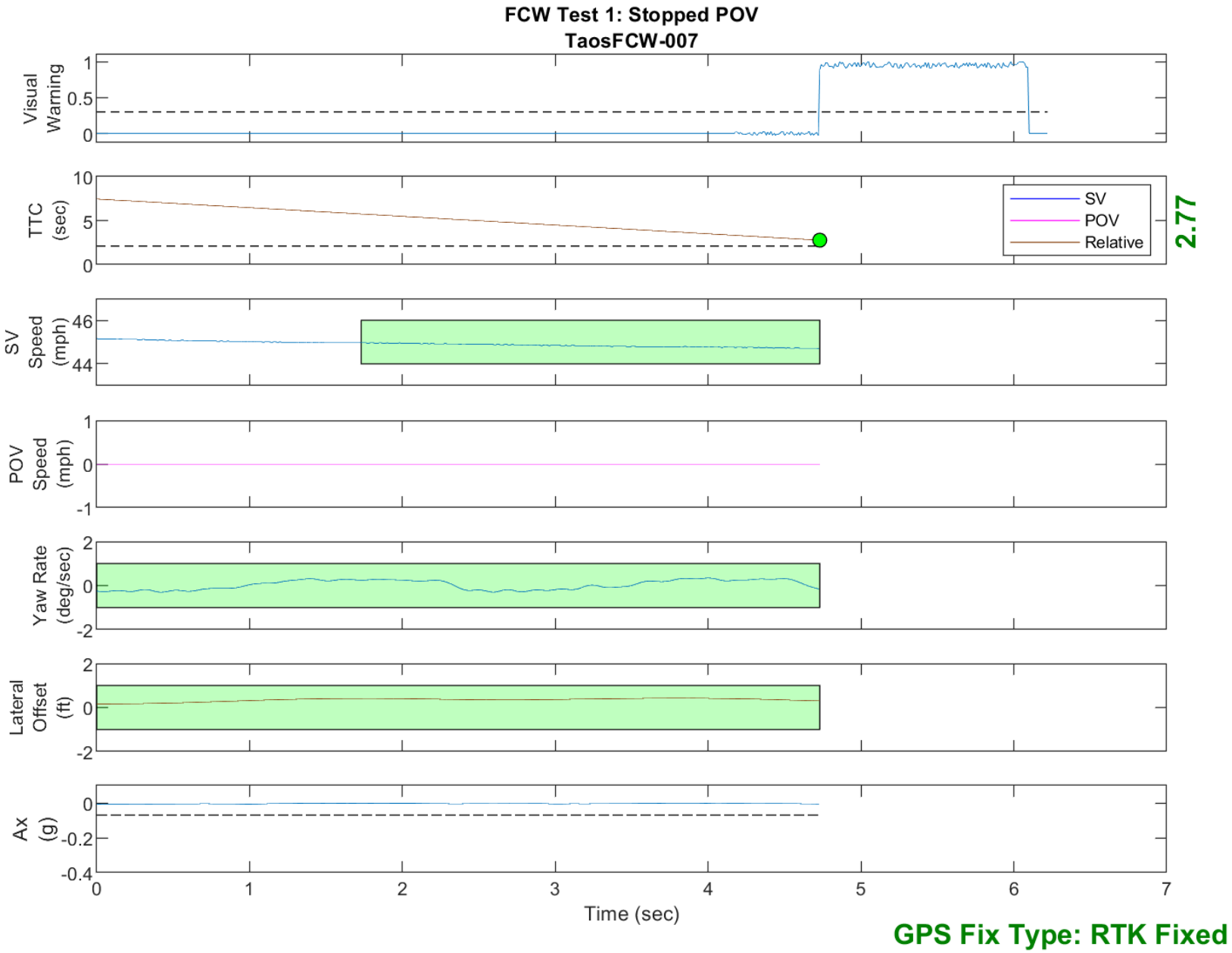

Figure D20. Time History for Run 7, Test 1 - Stopped POV, Visual Warning

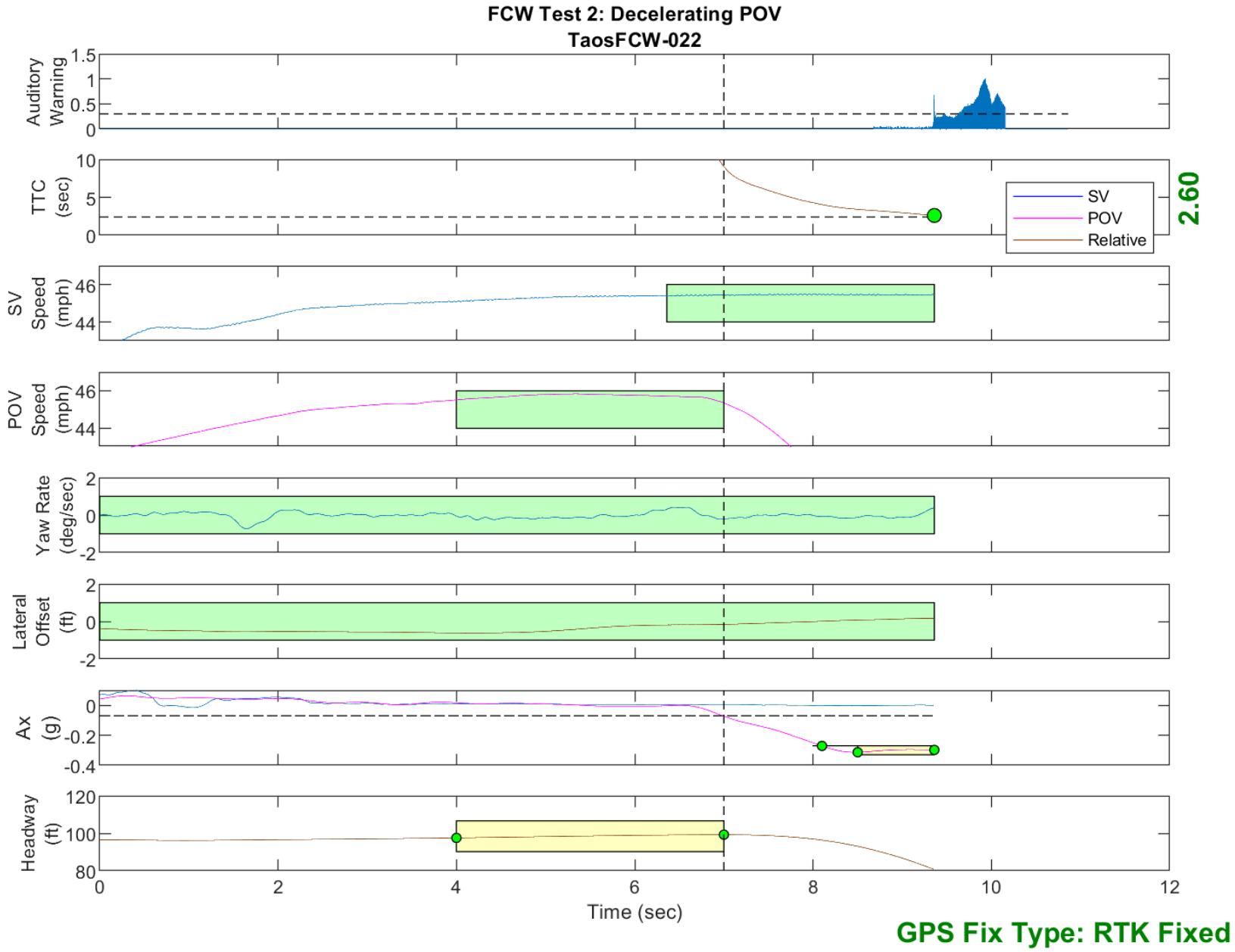

Figure D21. Time History for Run 22, Test 2 - Decelerating POV, Auditory Warning

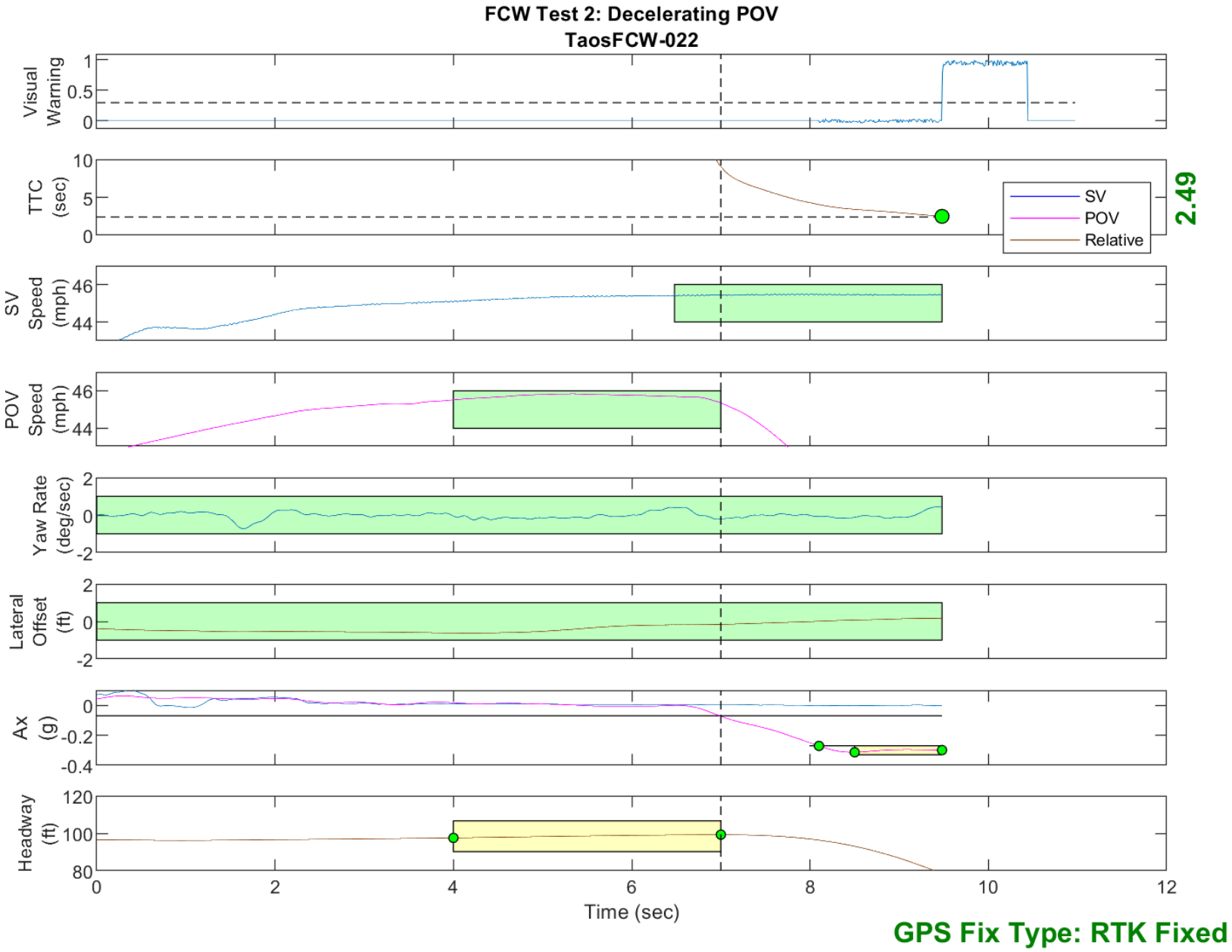

Figure D22. Time History for Run 22, Test 2 - Decelerating POV, Visual Warning

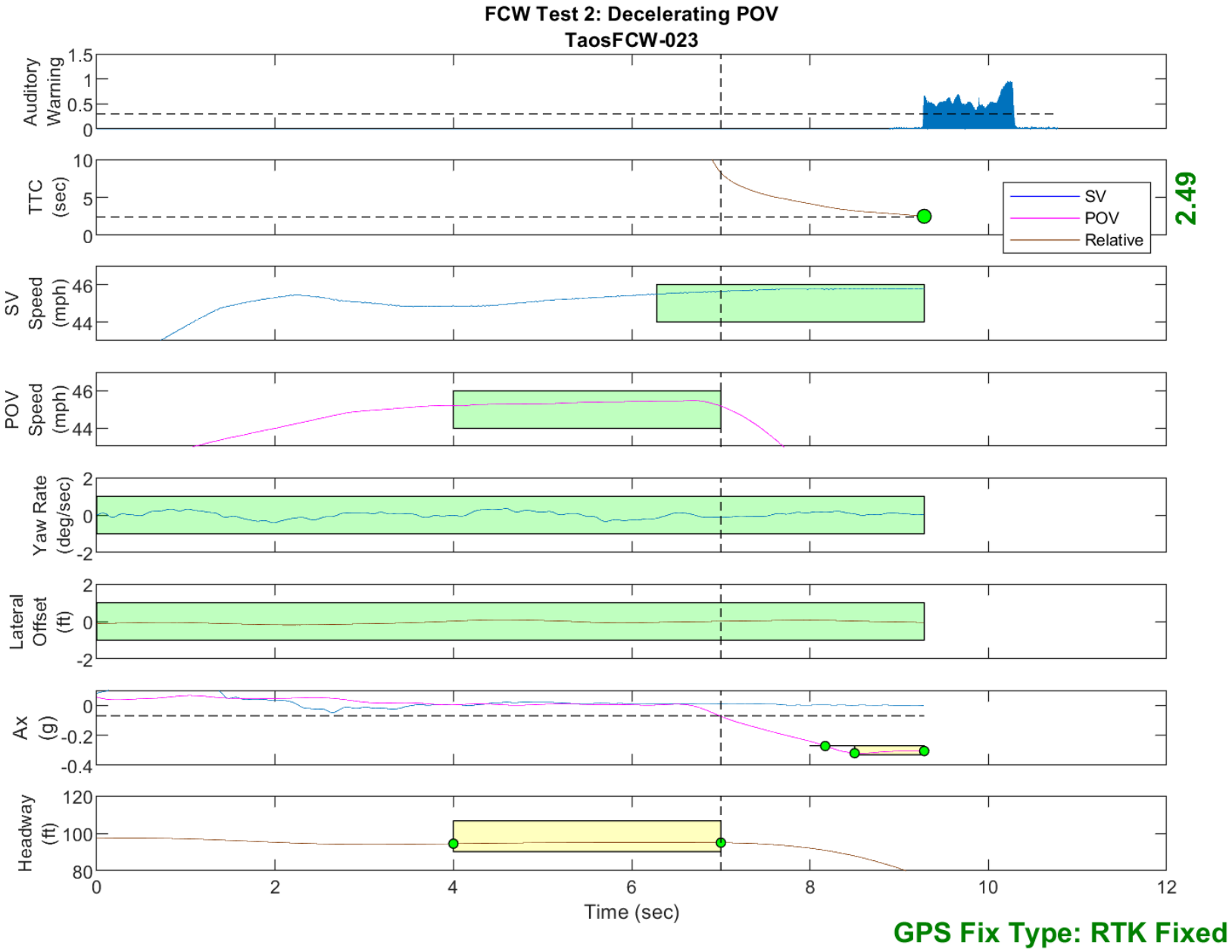

Figure D23. Time History for Run 23, Test 2 - Decelerating POV, Auditory Warning

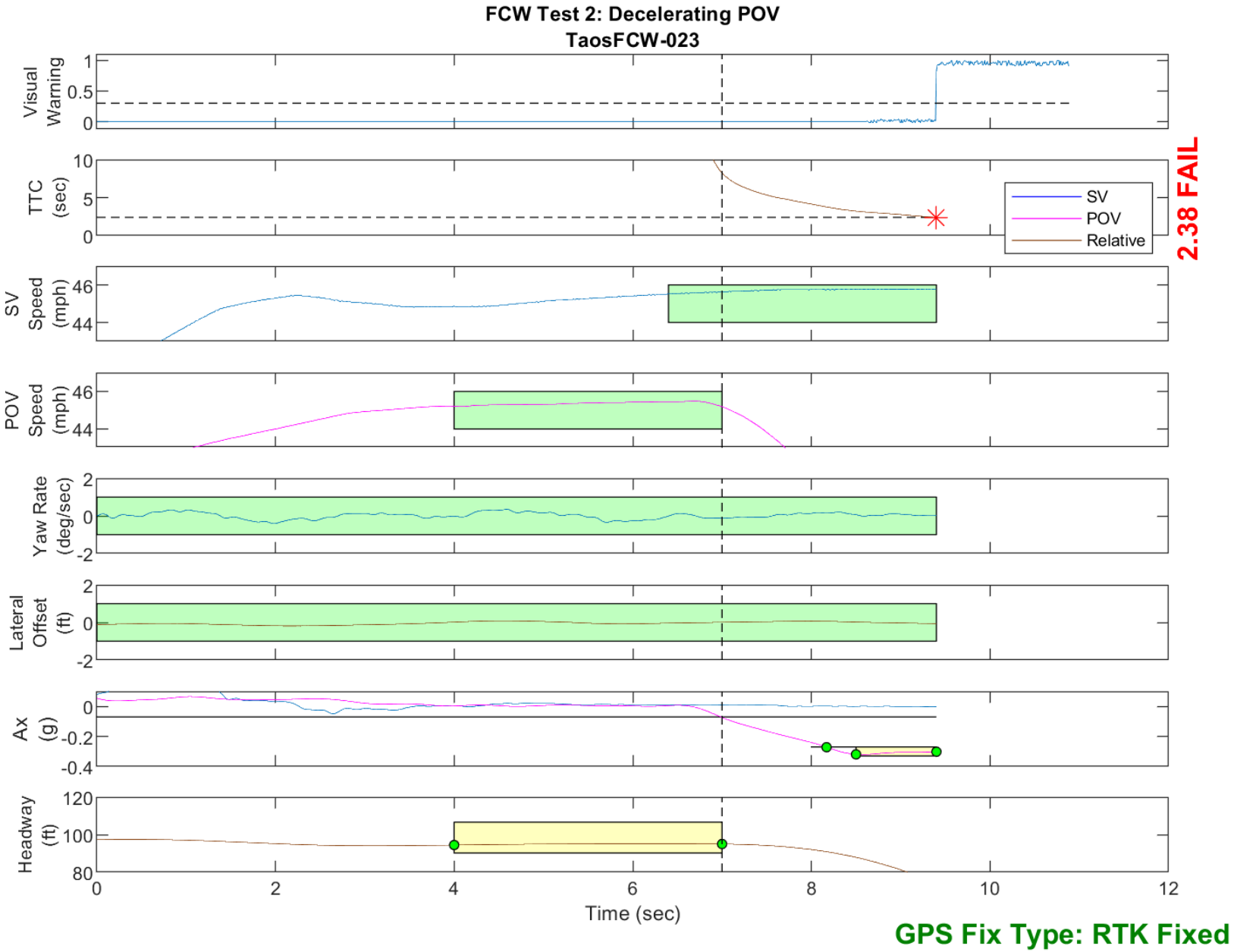

Figure D24. Time History for Run 23, Test 2 - Decelerating POV, Visual Warning

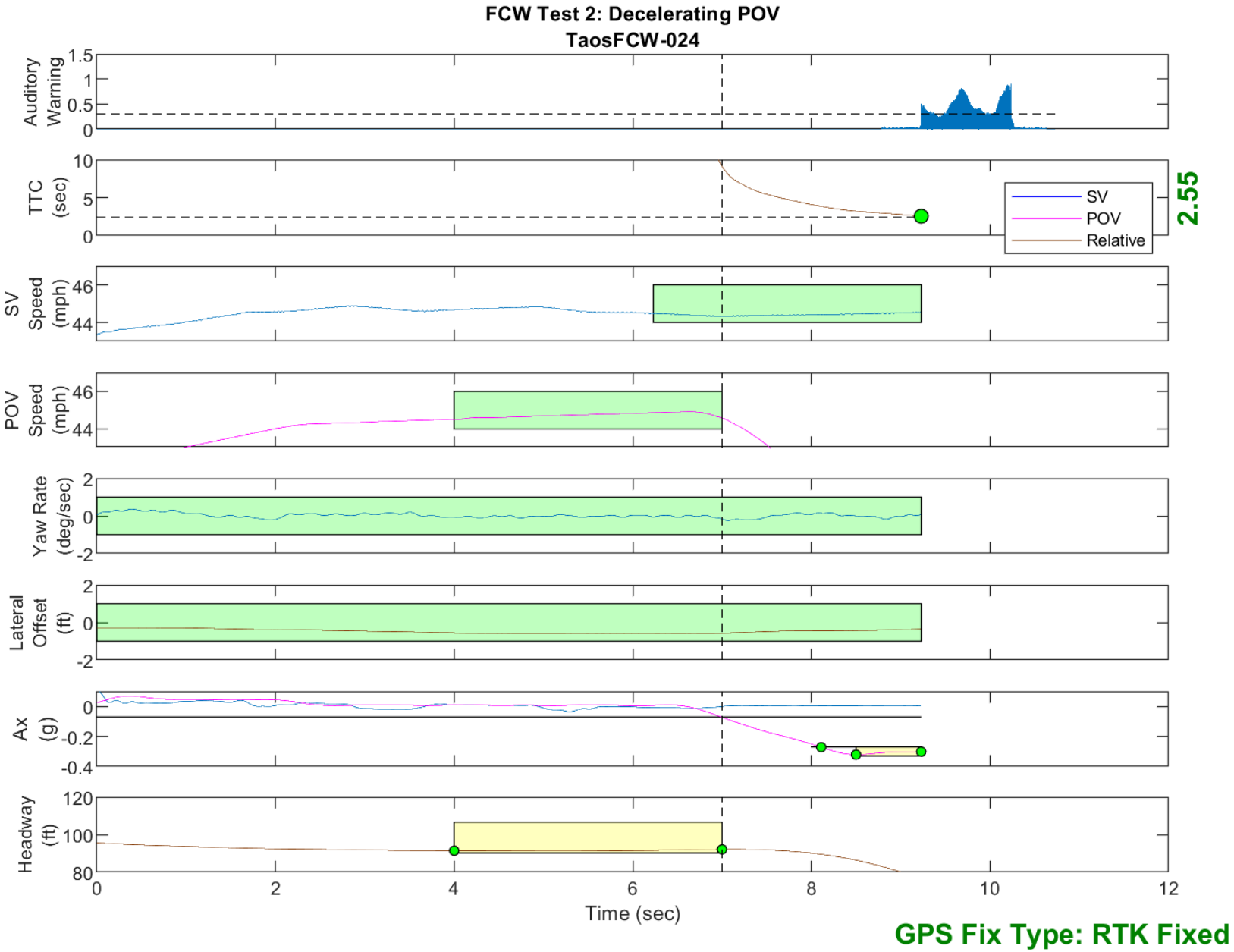

Figure D25. Time History for Run 24, Test 2 - Decelerating POV, Auditory Warning

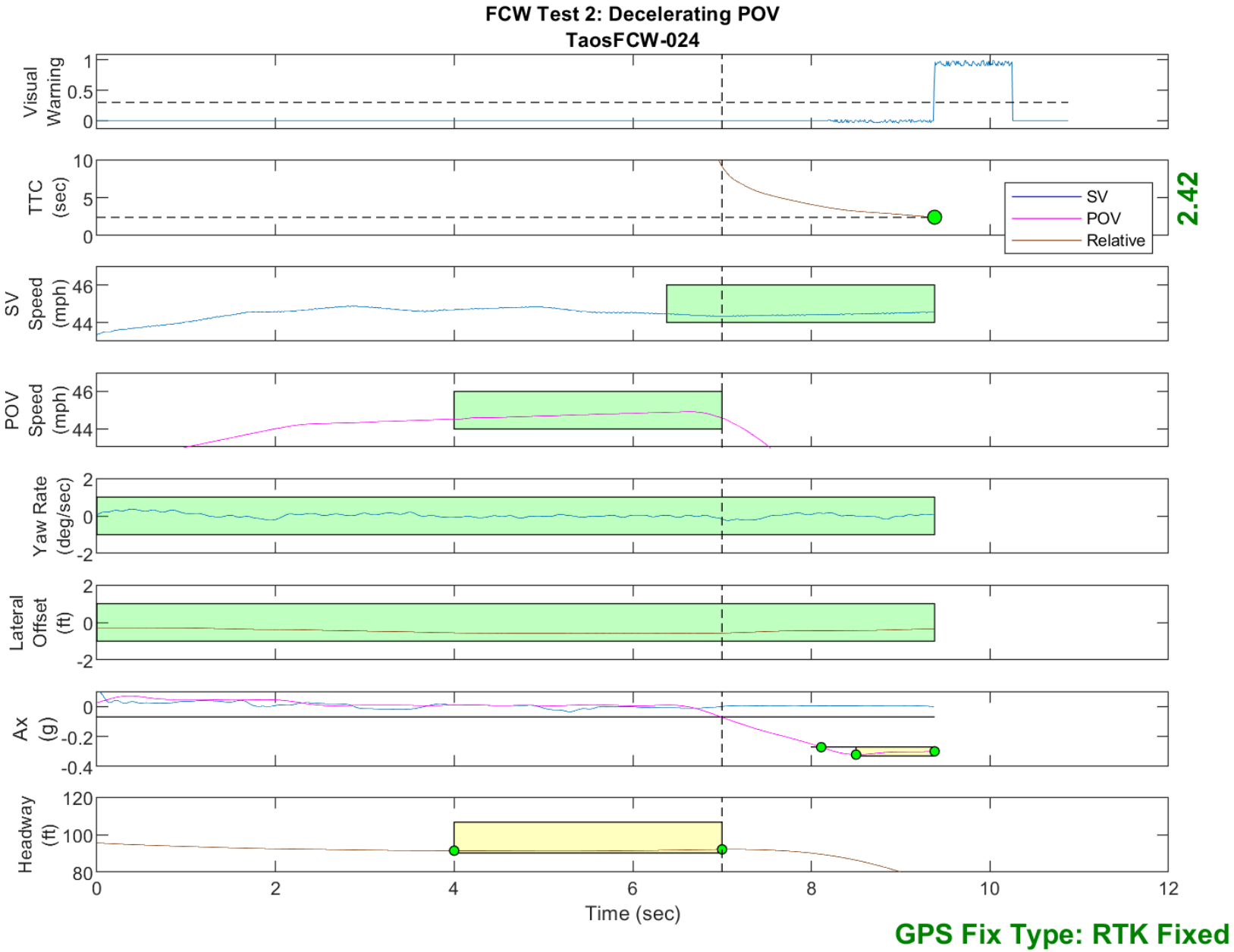

Figure D26. Time History for Run 24, Test 2 - Decelerating POV, Visual Warning

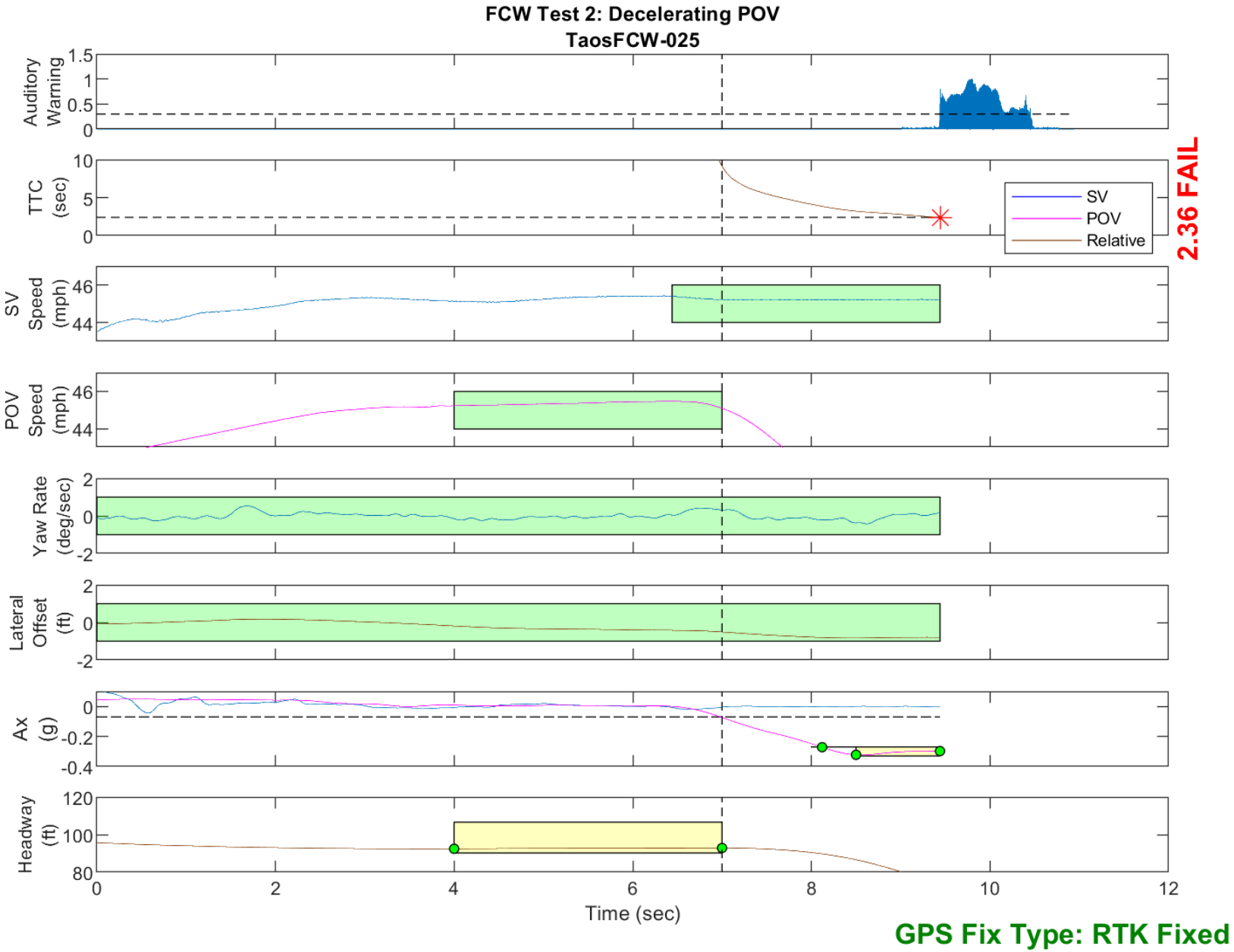

Figure D27. Time History for Run 25, Test 2 - Decelerating POV, Auditory Warning

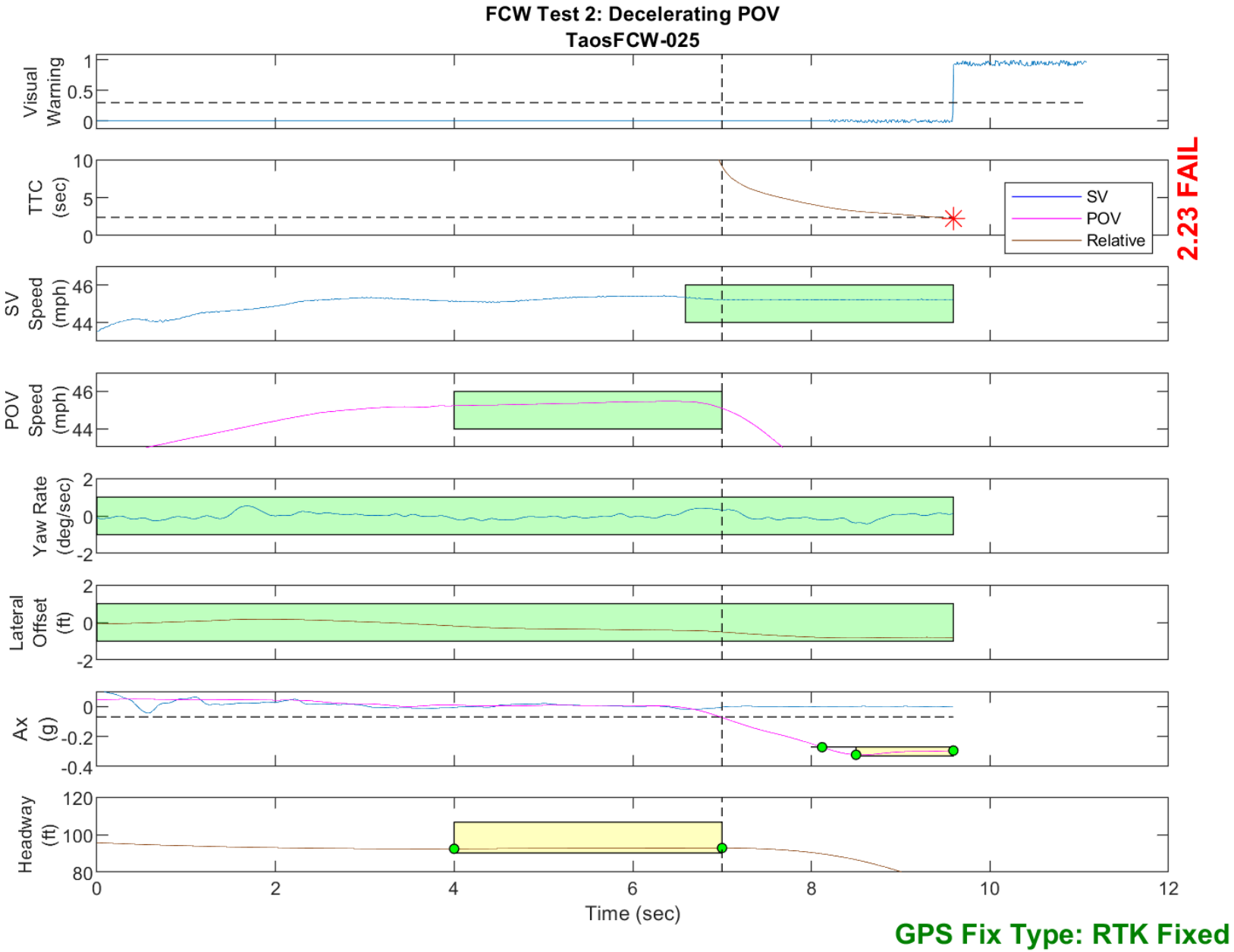

Figure D28. Time History for Run 25, Test 2 - Decelerating POV, Visual Warning

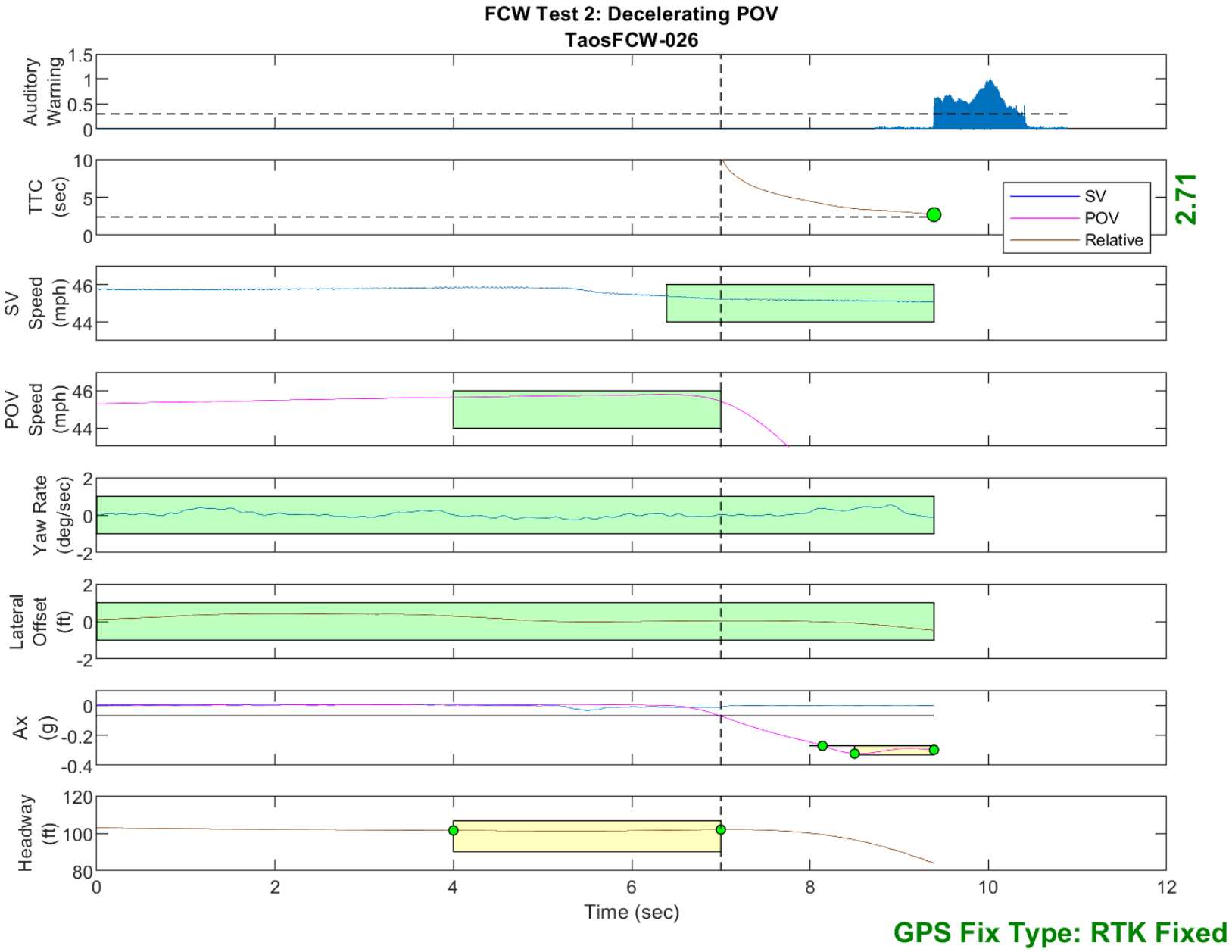

Figure D29. Time History for Run 26, Test 2 - Decelerating POV, Auditory Warning

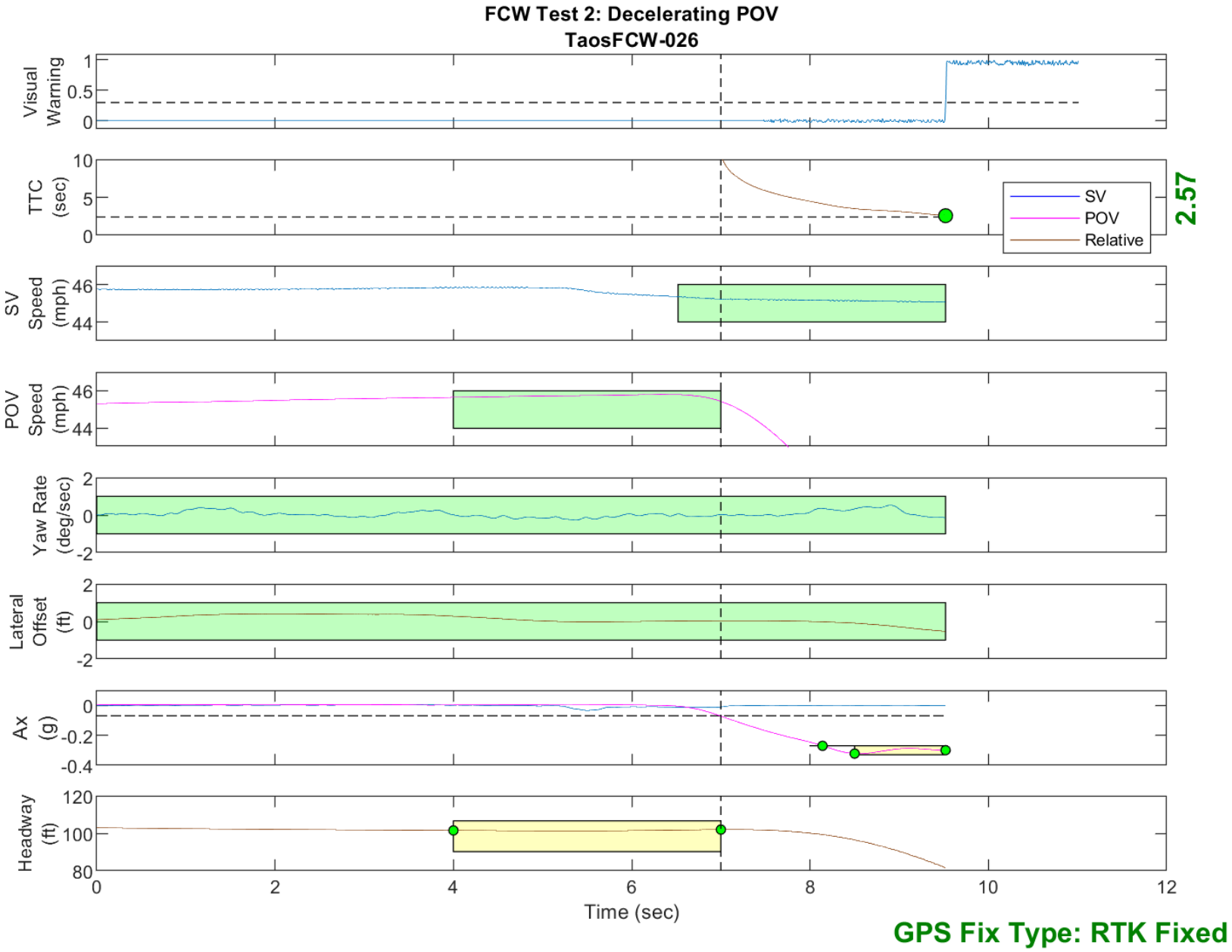

Figure D30. Time History for Run 26, Test 2 - Decelerating POV, Visual Warning

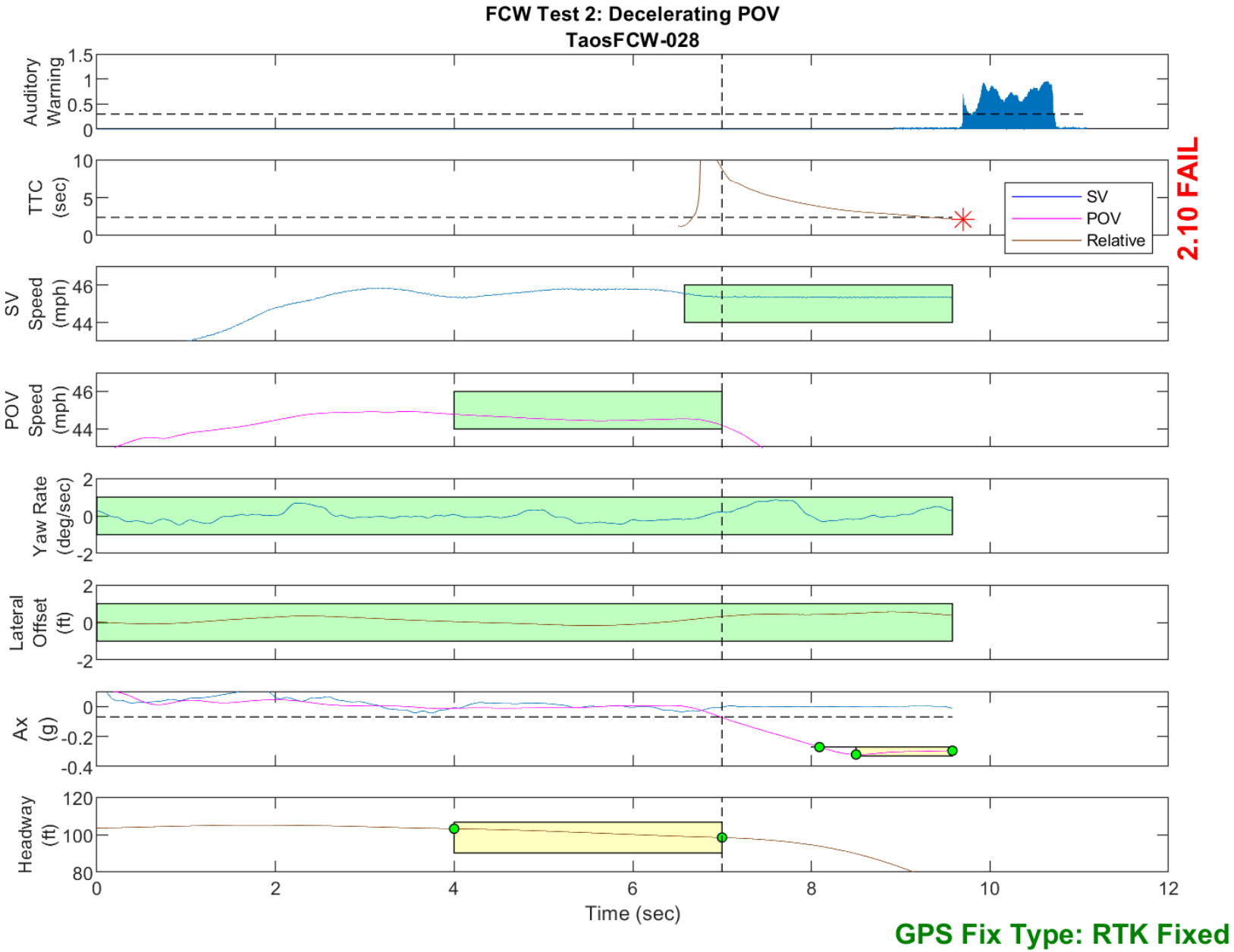

Figure D31. Time History for Run 28, Test 2 - Decelerating POV, Auditory Warning

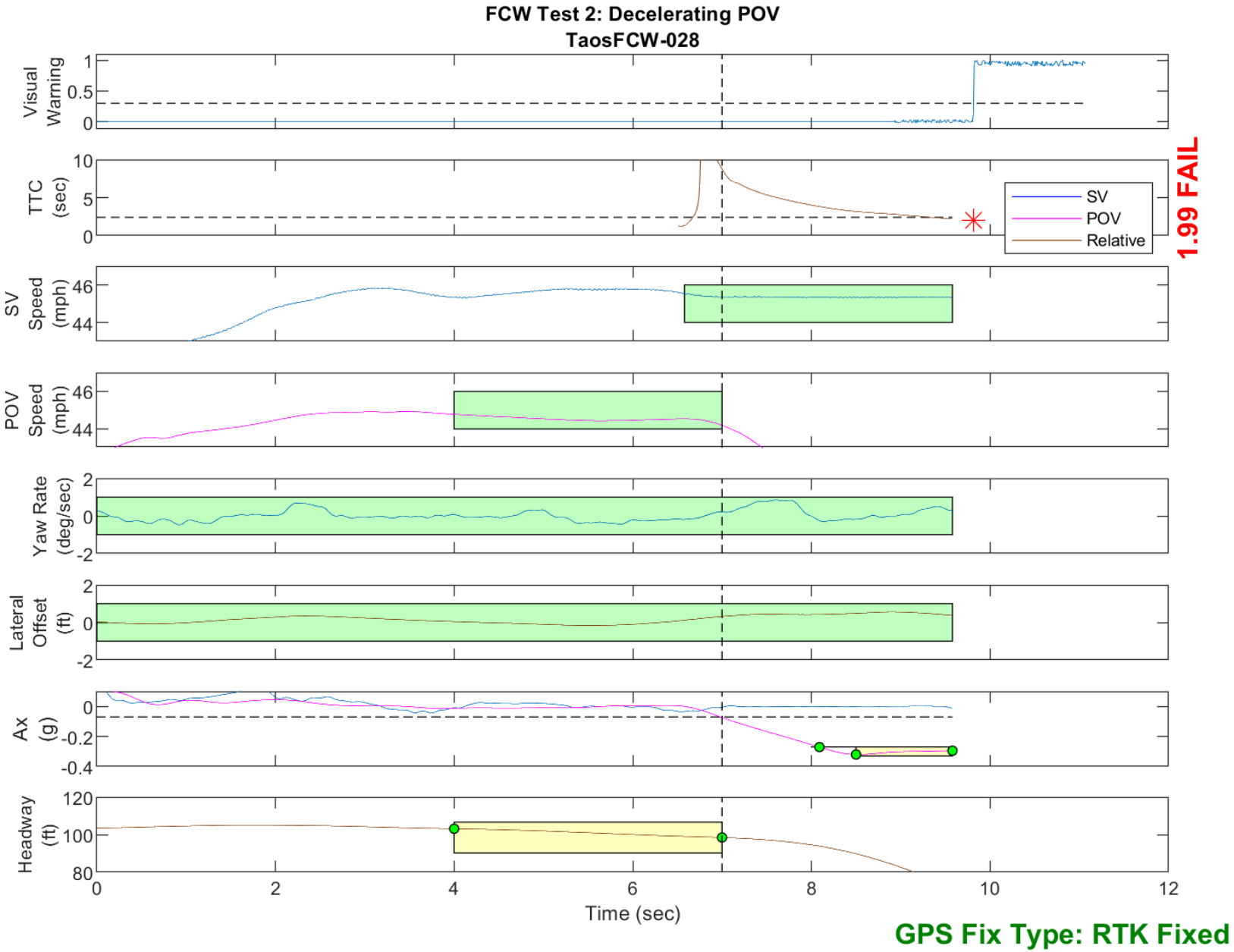

Figure D32. Time History for Run 28, Test 2 - Decelerating POV, Visual Warning

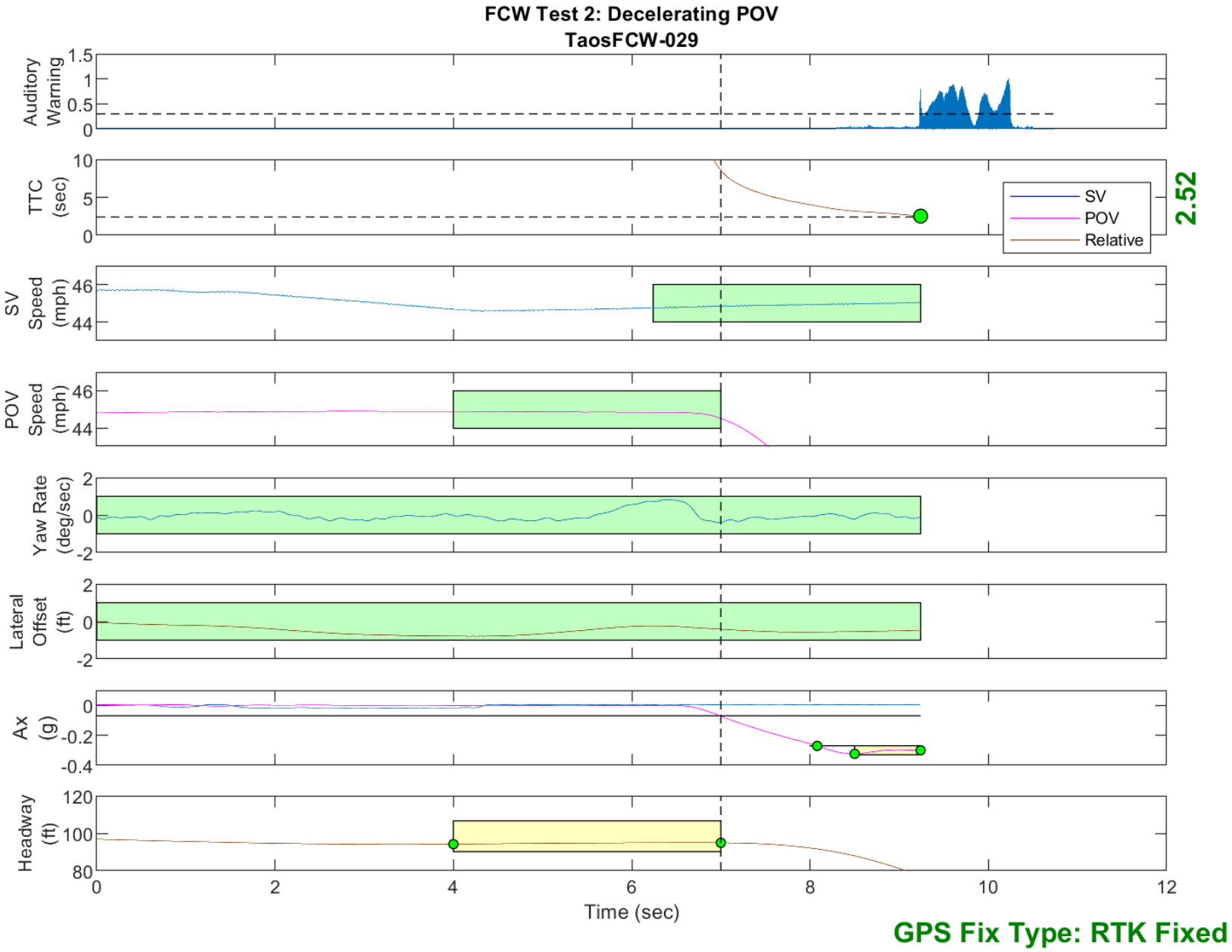

Figure D33. Time History for Run 29, Test 2 - Decelerating POV, Auditory Warning

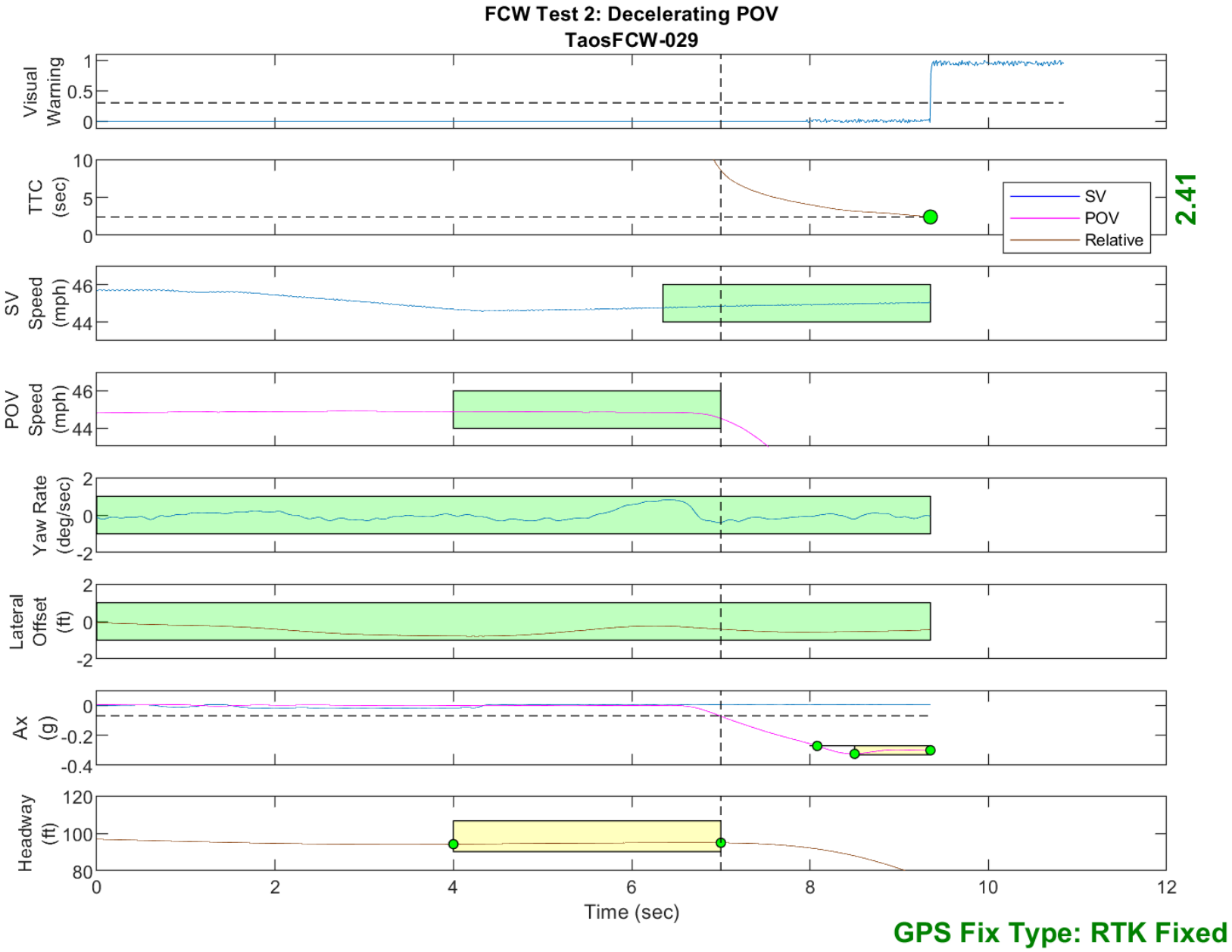

Figure D34. Time History for Run 29, Test 2 - Decelerating POV, Visual Warning

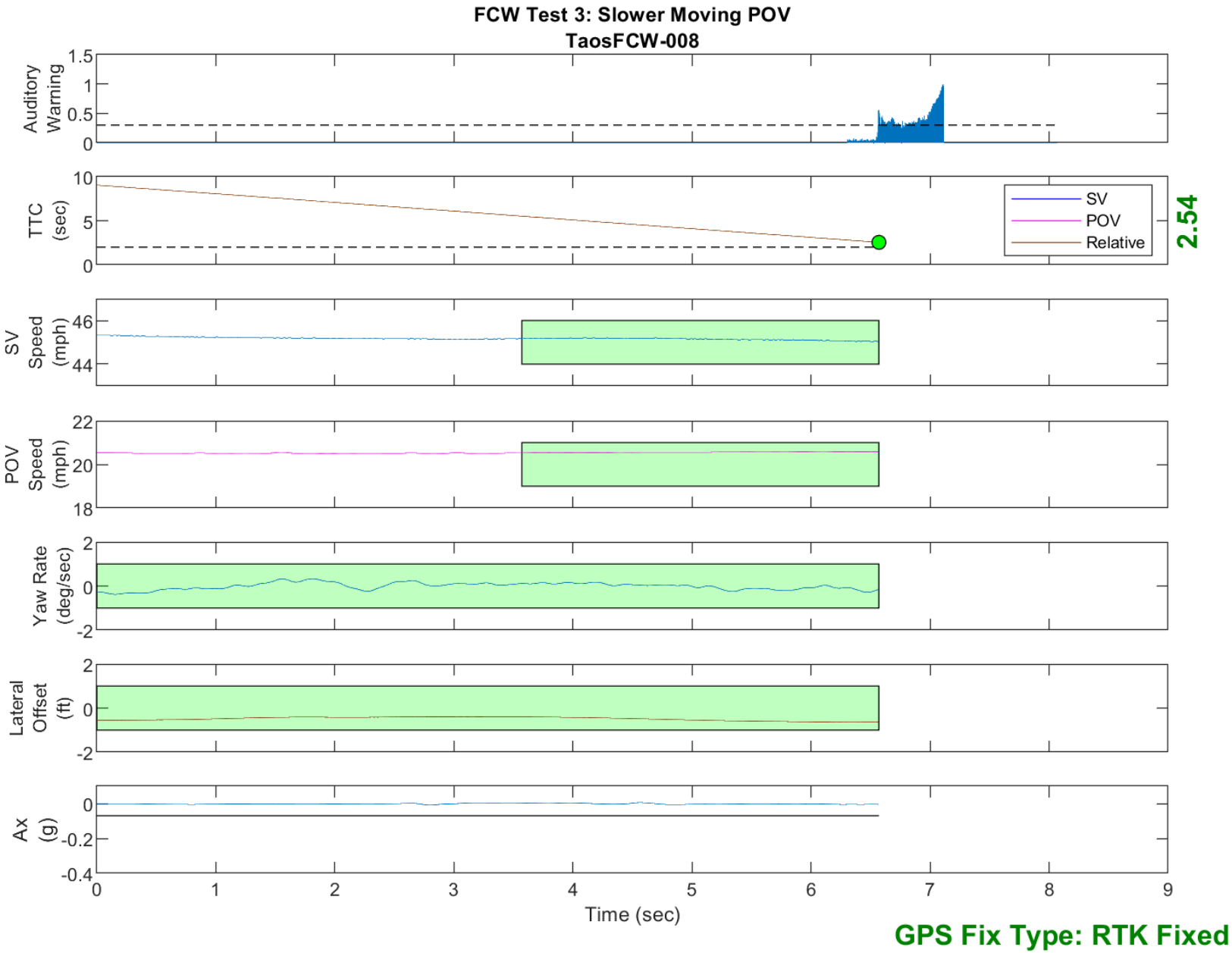

Figure D35. Time History for Run 8, Test 3 - Slower Moving POV, Auditory Warning

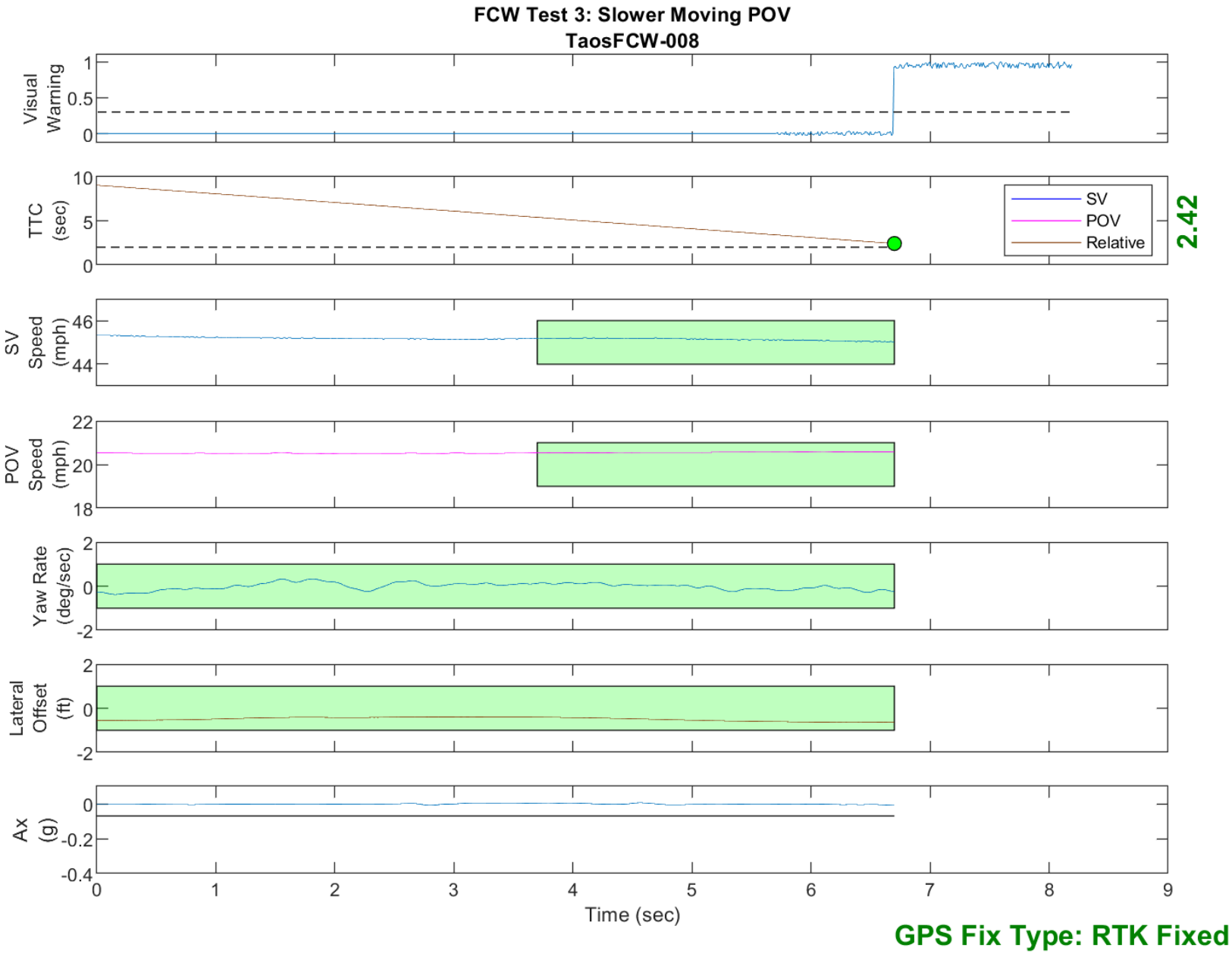

Figure D36. Time History for Run 8, Test 3 - Slower Moving POV, Visual Warning

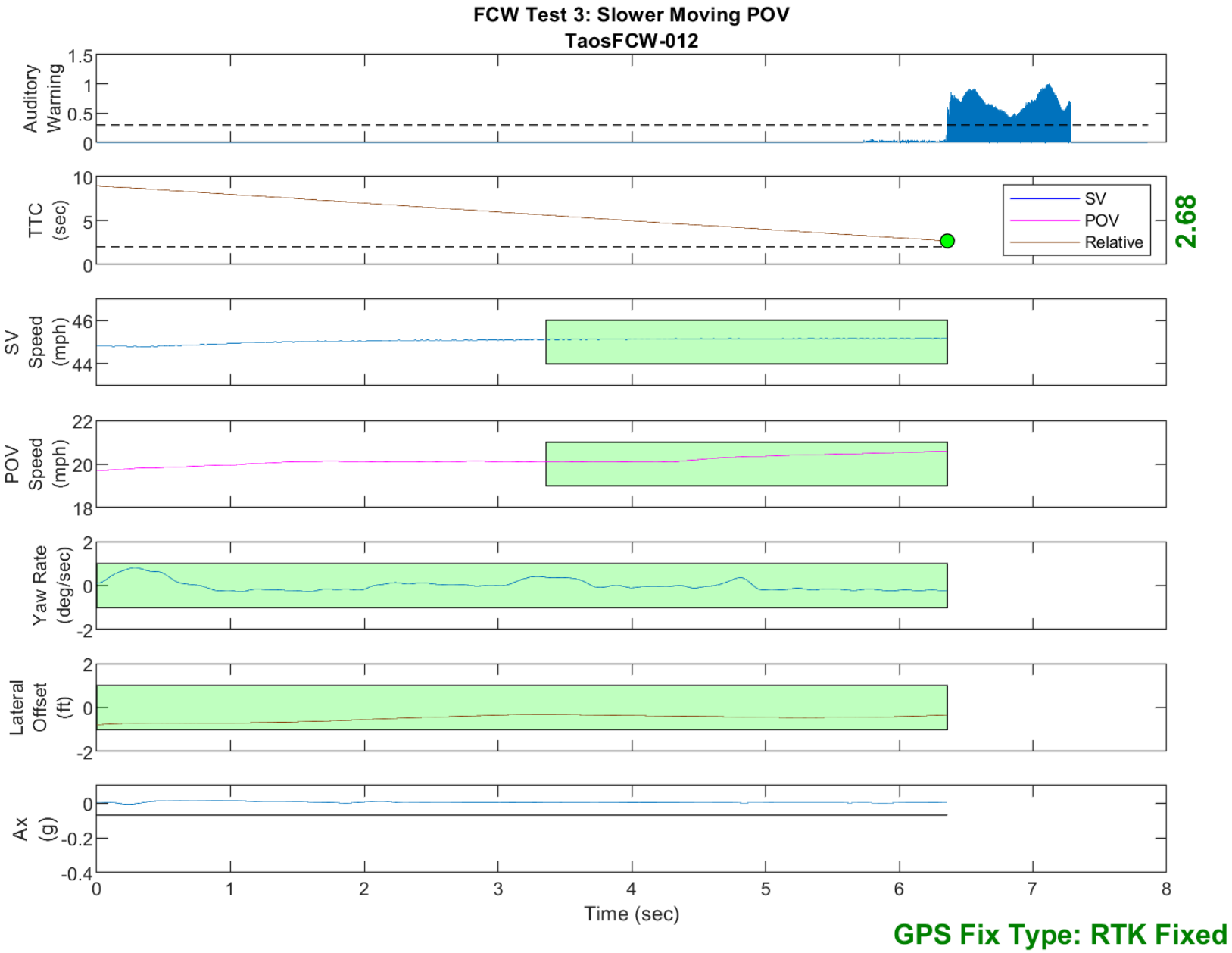

Figure D37. Time History for Run 12, Test 3 - Slower Moving POV, Auditory Warning

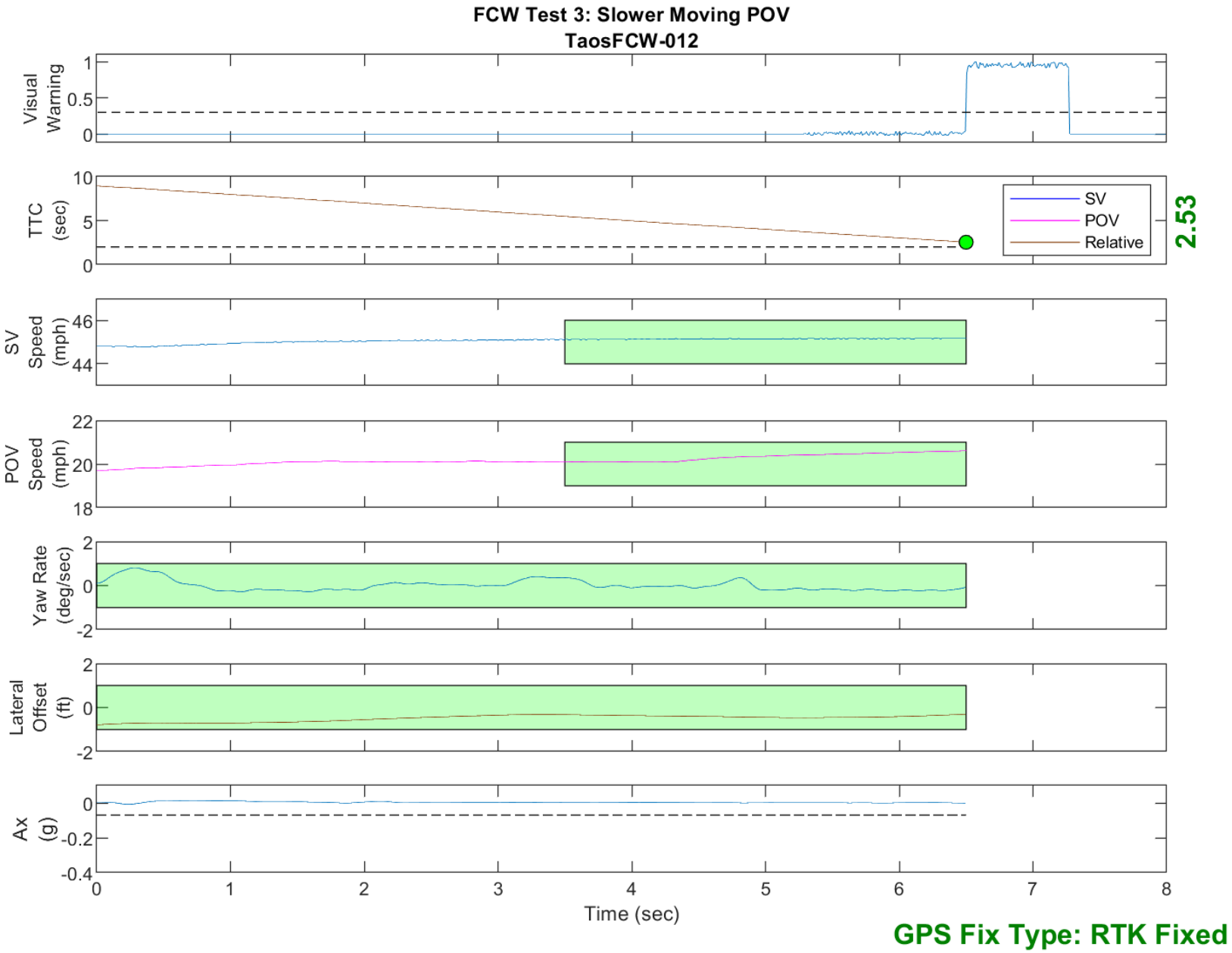

Figure D38. Time History for Run 12, Test 3 - Slower Moving POV, Visual Warning

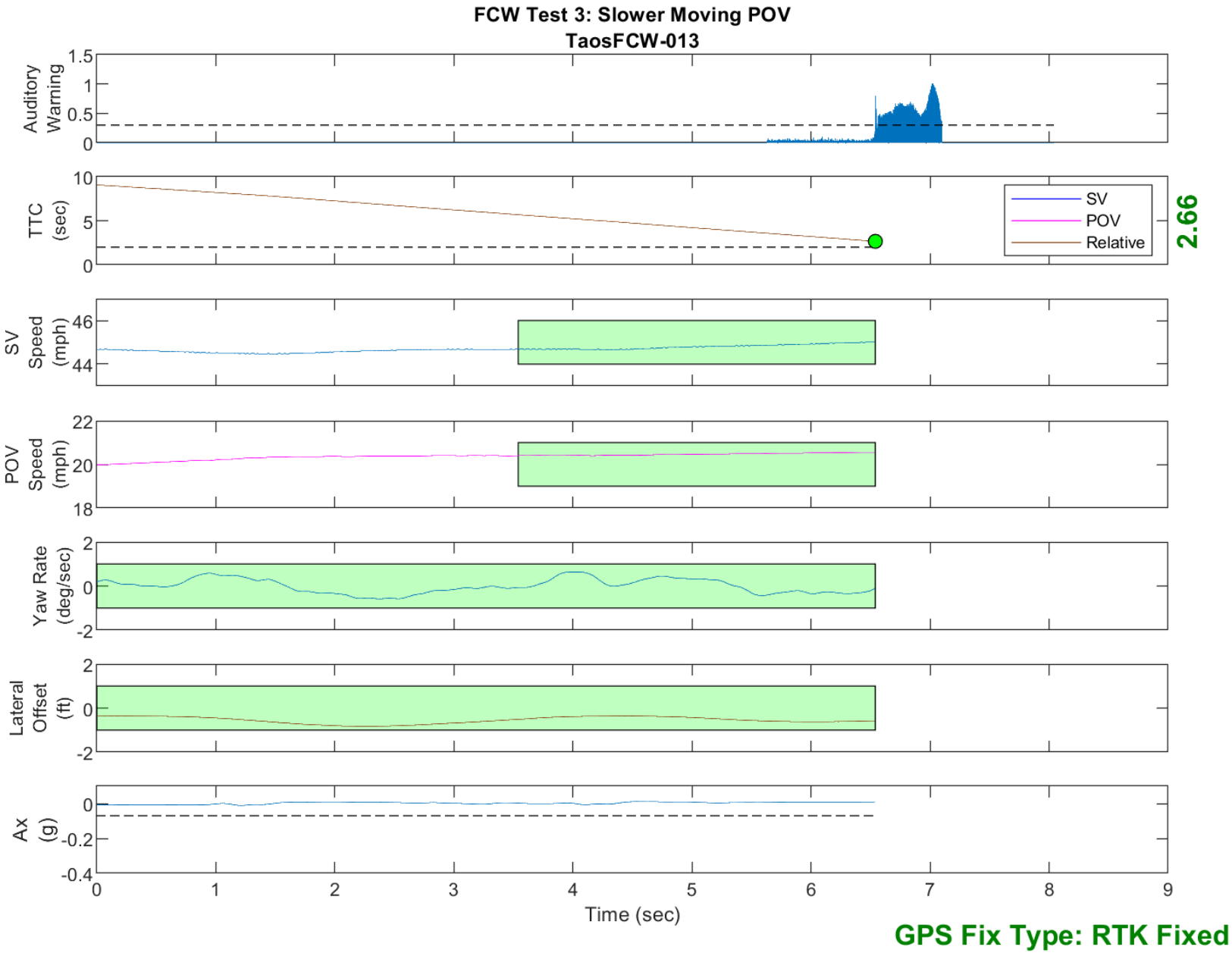

Figure D39. Time History for Run 13, Test 3 - Slower Moving POV, Auditory Warning

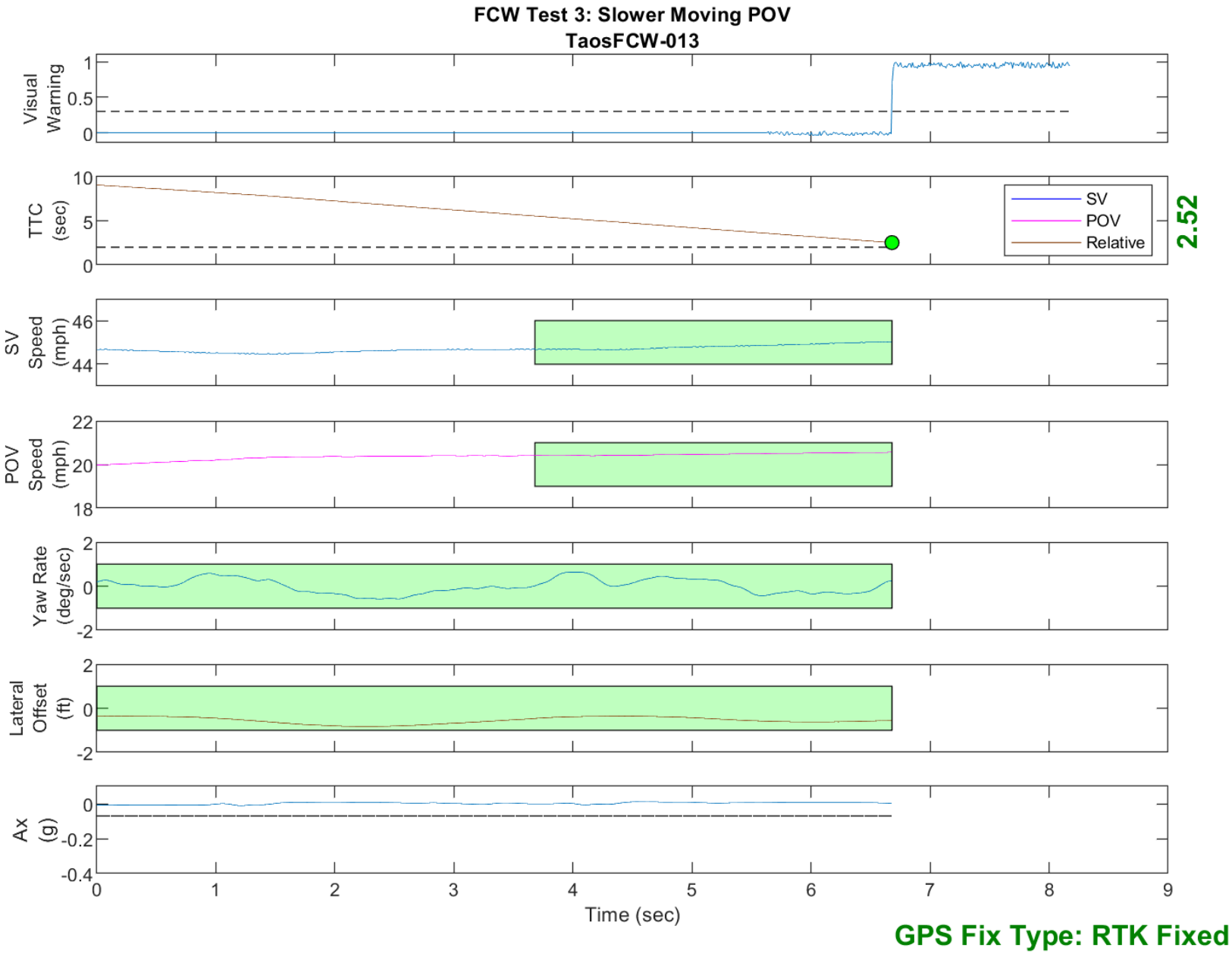

Figure D40. Time History for Run 13, Test 3 - Slower Moving POV, Visual Warning

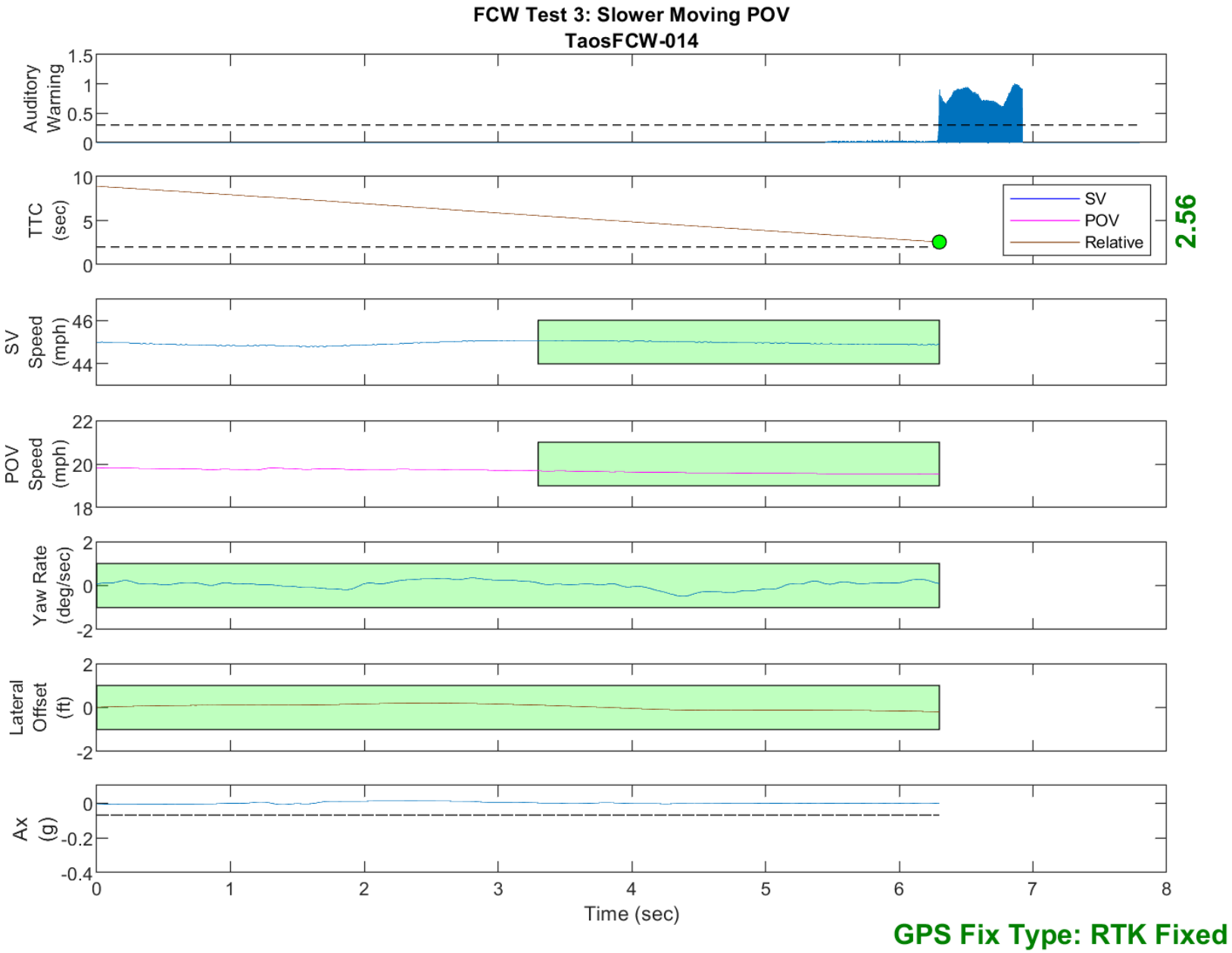

Figure D41. Time History for Run 14, Test 3 - Slower Moving POV, Auditory Warning

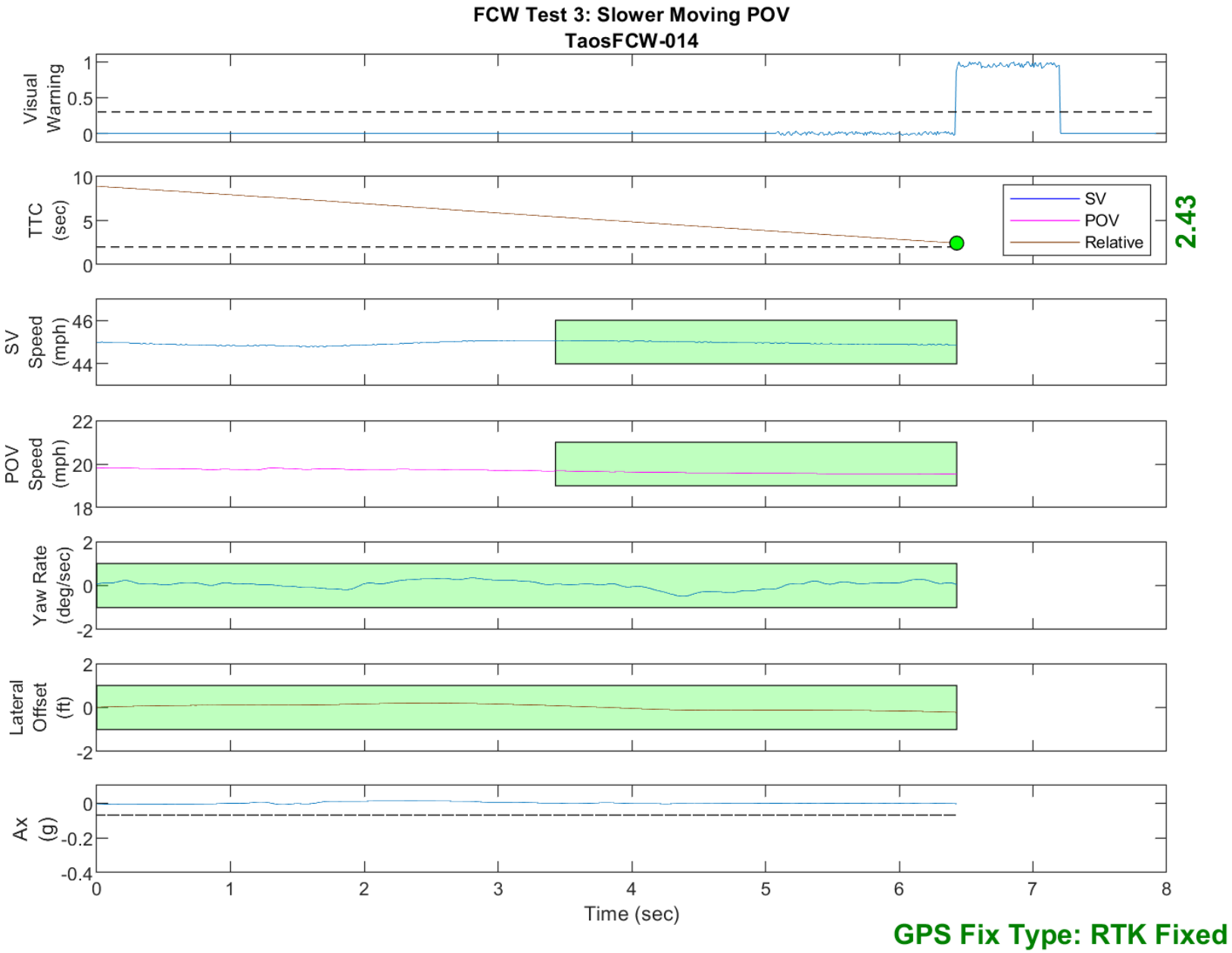

Figure D42. Time History for Run 14, Test 3 - Slower Moving POV, Visual Warning

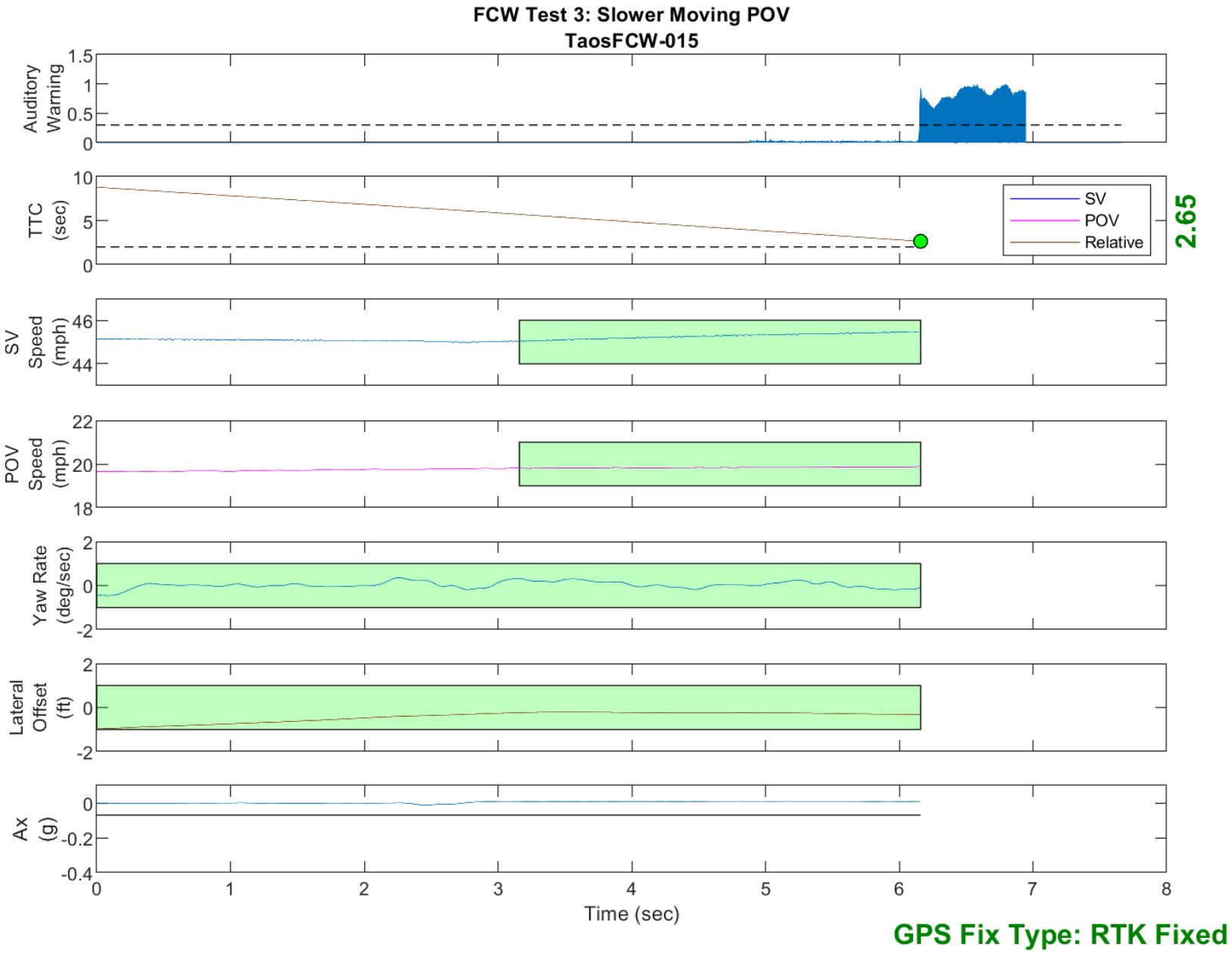

Figure D43. Time History for Run 15, Test 3 - Slower Moving POV, Auditory Warning

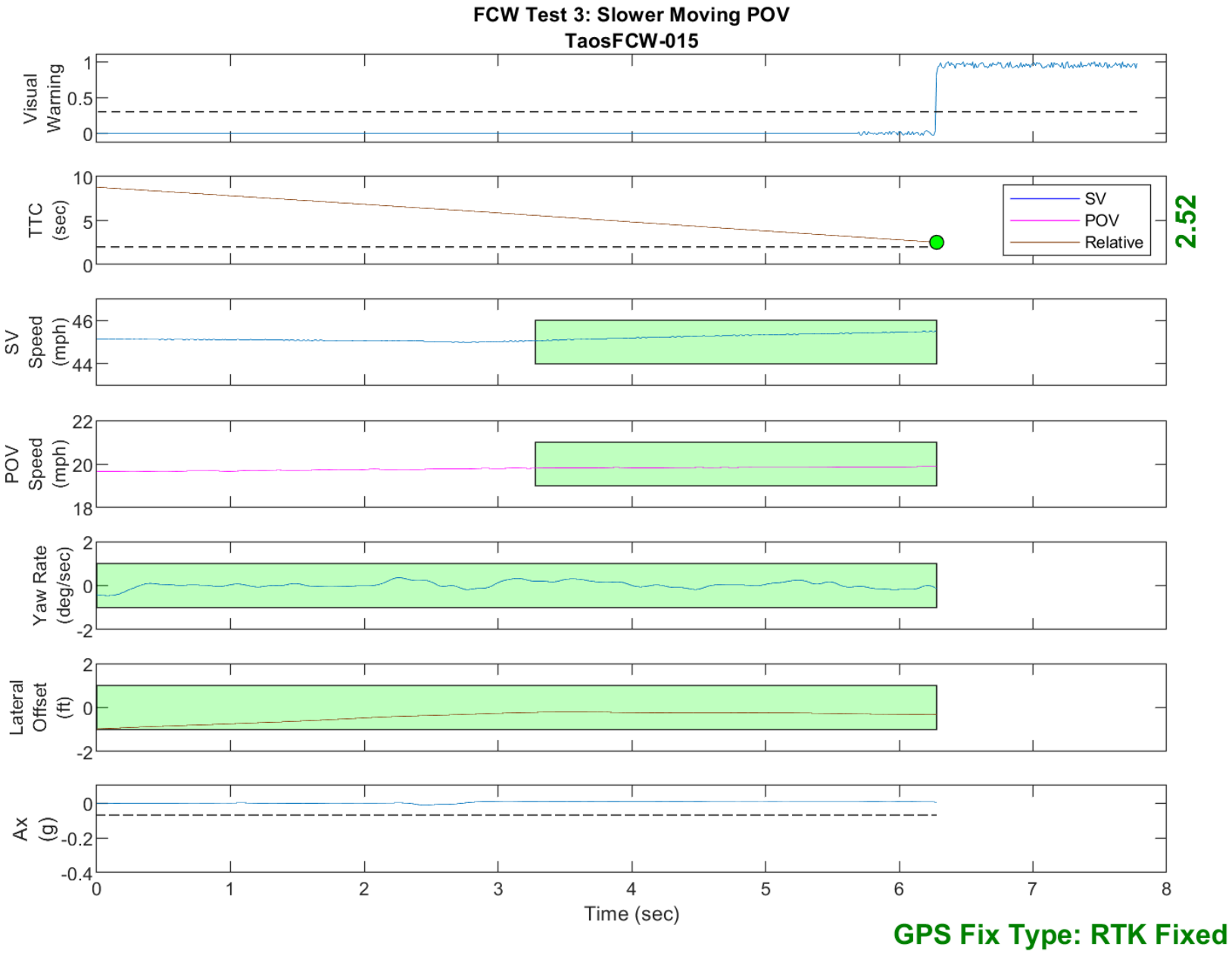

Figure D44. Time History for Run 15, Test 3 - Slower Moving POV, Visual Warning

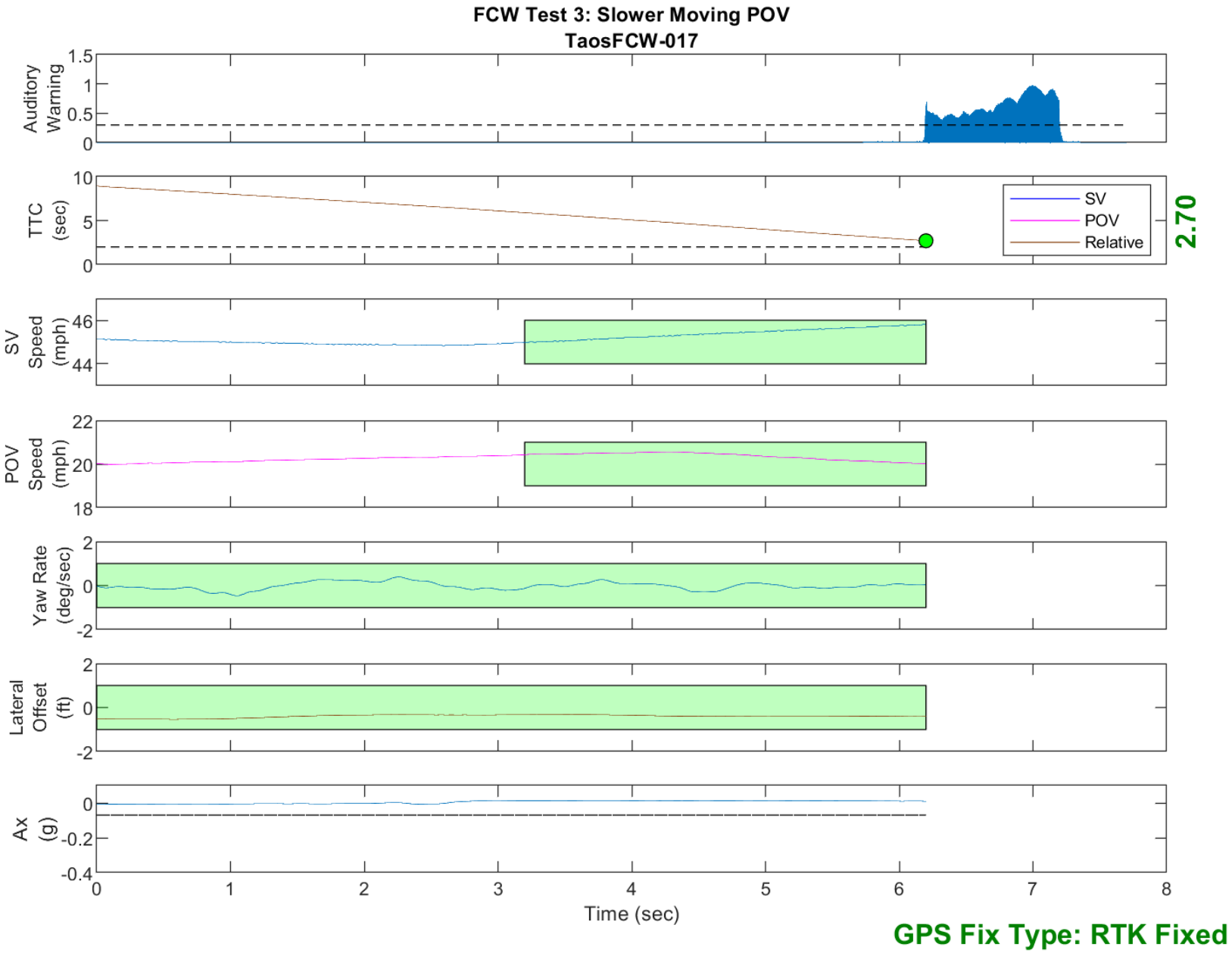

Figure D45. Time History for Run 17, Test 3 - Slower Moving POV, Auditory Warning

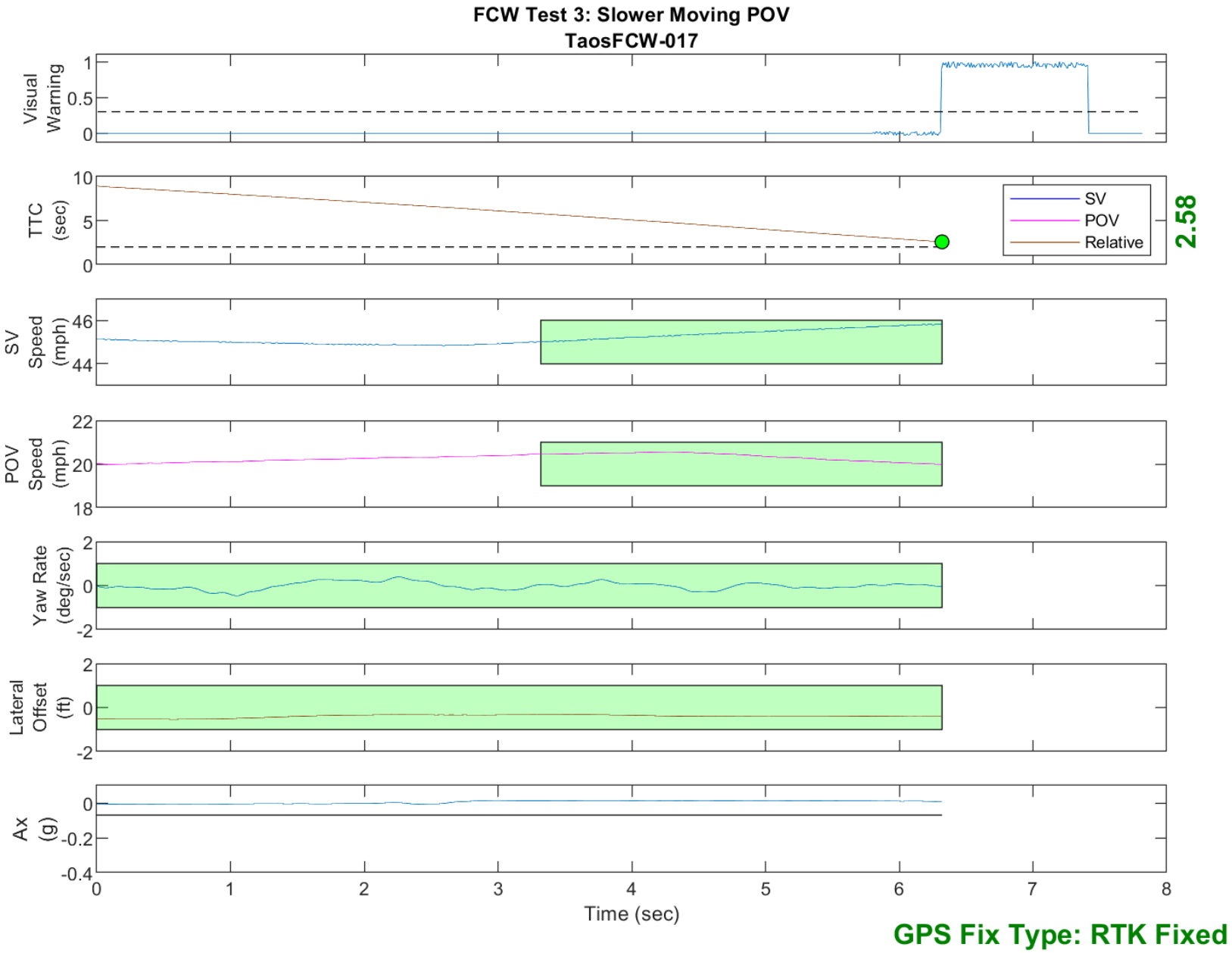

Figure D46. Time History for Run 17, Test 3 - Slower Moving POV, Visual Warning

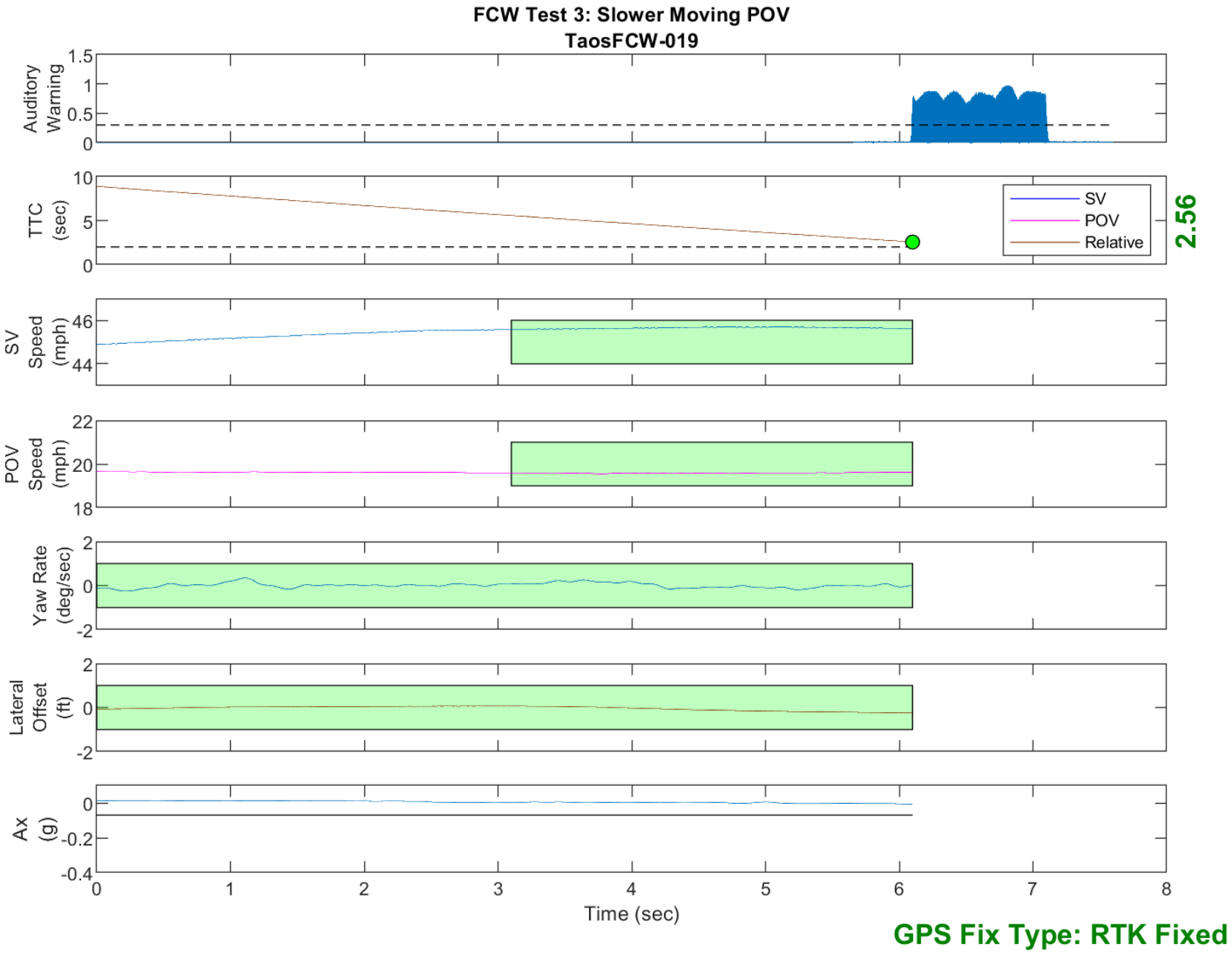

Figure D47. Time History for Run 19, Test 3 - Slower Moving POV, Auditory Warning

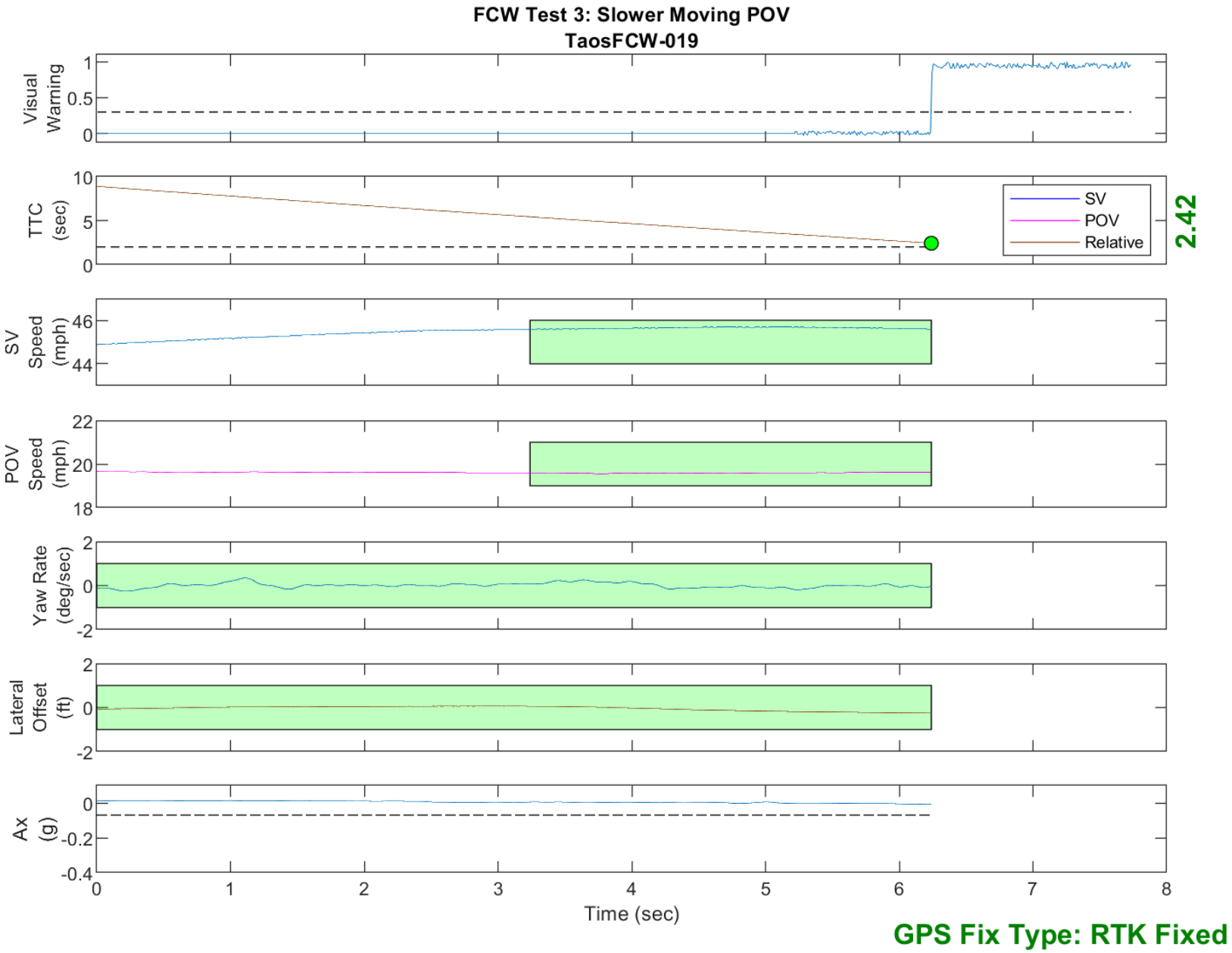

Figure D48. Time History for Run 19, Test 3 - Slower Moving POV, Visual Warning