NEW CAR ASSESSMENT PROGRAM
FORWARD COLLISION WARNING CONFIRMATION TEST
NCAP-DRI-FCW-21-12

2021 Volkswagen ID.4 Pro S (Statement)

DYNAMIC RESEARCH, INC.
355 Van Ness Avenue, STE 200
Torrance, California 90501

22 July 2021

Final Report

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

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

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

Prepared By: J. Lenkeit and N. Watanabe

Program Manager Test Engineer

Date: 22 July 2021

1. Report No. NCAP-DRI-FCW-21-12	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Final Report of Forward Collision Warning Confirmation Test of a 2021 Volkswagen ID.4 Pro S (Statement).		5. Report Date 22 July 2021	
		6. Performing Organization Code DRI	
7. Author(s) J. Lenkeit, Program Manager N. Watanabe, Test Engineer		8. Performing Organization Report No. DRI-TM-20-174	
9. Performing Organization Name and Address Dynamic Research, Inc. 355 Van Ness Ave, STE 200 Torrance, CA 90501		10. Work Unit No.	
		11. Contract or Grant No. DTNH22-14-D-00333	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration New Car Assessment Program 1200 New Jersey Avenue, SE, West Building, 4th Floor (NRM-110) Washington, DC 20590		13. Type of Report and Period Covered Final Test Report July 2021	
		14. Sponsoring Agency Code NRM-110	
15. Supplementary Notes			
16. Abstract These tests were conducted on the subject 2021 Volkswagen ID.4 Pro S (Statement) in accordance with the specifications of the New Car Assessment Program's (NCAP) 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.			
17. Key Words Forward Collision Warning, FCW, New Car Assessment Program, NCAP		18. Distribution Statement Copies of this report are available from the following: NHTSA Technical Reference Division National Highway Traffic Safety Administration 1200 New Jersey Avenue, SE Washington, DC 20590	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 103	22. Price

TABLE OF CONTENTS

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.

Section II

DATA SHEETS

FORWARD COLLISION WARNING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 1)

2021 Volkswagen ID.4 Pro S (Statement)

VIN: *WVGTMPE21MP03xxxx*

Test Date: *7/8/2021*

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)

2021 Volkswagen ID.4 Pro S (Statement)

TEST VEHICLE INFORMATION

VIN: *WVGTMPE21MP03xxxx*

Body Style: *SUV* Color: *Dusk Blue Metallic*

Date Received: *5/31/2021* Odometer Reading: *17 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *VOLKSWAGEN AG*

Date of manufacture: *03/21*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *235/55 R19 105T XL*

Rear: *255/50 R19 107T XL*

Recommended cold tire pressure: Front: *290 kPa (42 psi)*

Rear: *290 kPa (42 psi)*

TIRES

Tire manufacturer and model: *Hankook Kinergy AS x ev*

Front tire specification: *235/55R19 105T*

Rear tire specification: *255/50R19 107T*

Front tire DOT prefix: *15M98 9U HO*

Rear tire DOT prefix: *15M7F 9U HO*

FORWARD COLLISION WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2021 Volkswagen ID.4 Pro S (Statement)

GENERAL INFORMATION

Test date: *7/8/2021*

AMBIENT CONDITIONS

Air temperature: *39.4 C (103 F)*

Wind speed: *4.1 m/s (9.2 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: *290 kPa (42 psi)*

Rear: *290 kPa (42 psi)*

FORWARD COLLISION WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2021 Volkswagen ID.4 Pro S (Statement)

WEIGHT

Weight of vehicle as tested including driver and instrumentation:

Left Front:	*543.4 kg (1198 lb)*	Right Front:	*527.1 kg (1162 lb)*
Left Rear:	*601.5 kg (1326 lb)*	Right Rear:	*586.9 kg (1294 lb)*
		Total:	*2258.9 kg (4980 lb)*

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 1 of 3)

2021 Volkswagen ID.4 Pro S (Statement)

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

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

Front Assist is part of the IQ.Drive feature that is standard equipment.

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

Mono camera mounted behind the windshield above the rearview mirror and radar located behind the front bumper.

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
	X	Other *Brake Jerk*

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.

Advance warning (FCW):

The system detects a possible collision and prepares the vehicle for possible emergency braking. An auditory warning sounds and the red warning lamp lights up. See Appendix A, Figure 14.

Urgent warning:

If the driver does not react to the advance warning, the system may initiate a short braking jolt in order to draw attention to the increasing collision risk.

(continued)

Automatic braking (CIB):

If the driver also does not react to the urgent warning, the vehicle can be braked automatically with braking force that increases in several stages. The reduced speed means that it is possible to minimize the consequences of an accident.

Braking intervention (DBS):

If the system detects that the driver is braking insufficiently when there is a risk of collision, the system can increase the braking force and help prevent a collision. The braking intervention takes place only for as long as the brake pedal is pressed hard.

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.

System menus are accessed by pressing the "Assist" button in the center console. An image appears in the center touchscreen showing a vehicle, two adjacent blue vehicles and blue lane lines. To disable the system:

Navigate to the Front Assist menu by either:

- *Touching the picture of a vehicle with another vehicle ahead or*
- *Touching the button in the upper right of the screen, which will bring up the Assistance system settings menu*
  - *Select Front Assist (Autonomous Emergency Braking)*
  - *Select Advance Warning*
  - *Select or deselect "Off" from the dropdown.*

Note that selecting or deselecting "Active" enables or disables the AEB portion of the system.

See Appendix A, Figures A12 and A13.

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 3 of 3)

2021 Volkswagen ID.4 Pro S (Statement)

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.

System menus are accessed by pressing the "Assist" button in the center console. An image appears in the center touchscreen showing a vehicle, two adjacent blue vehicles and blue lane lines. To disable the system:

Navigate to the Front Assist menu by either:

- *Touching the picture of a vehicle with another vehicle ahead. or*
- *Touching the button in the upper right of the screen, which will bring up the Assistance system settings menu*
  - *Select Front Assist*
  - *Select Advance Warning*
  - *Select "Early", "Medium", or "Late" to set the alert timing.*

This affects the FCW warning timing only.

See Appendix A, Figures A12 and A13.

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.

System limitations are described on page 162 of the Owner's Manual, shown in Appendix B, page B-6.

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.

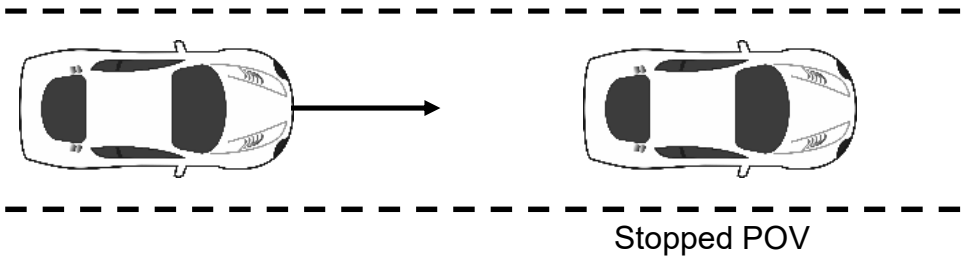

Figure 1. Depiction of Test 1

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.

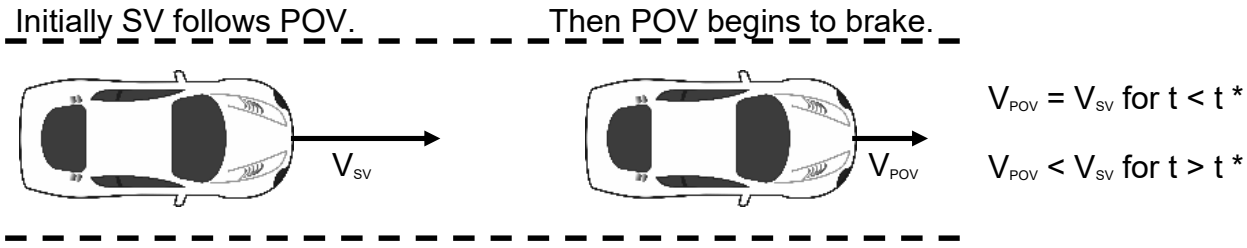

Figure 2. Depiction of Test 2

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).

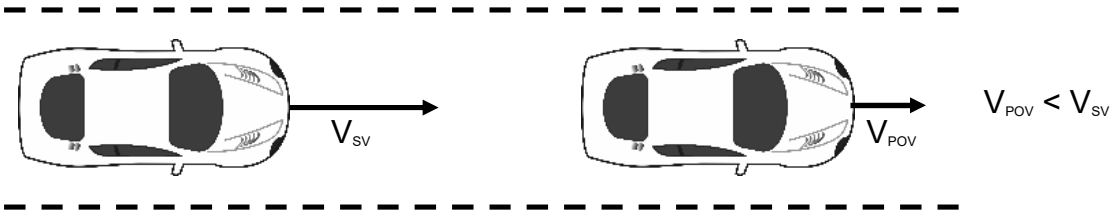

Figure 3. Depiction of Test 3

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:

- 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 100 psi	Omega DPG8001	17042707002	By: DRI Date: 8/18/2020 Due: 8/18/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 2/10/2021 Due: 2/10/2022
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	N/A
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: 1/6/2021 Due: 1/6/2022

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

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

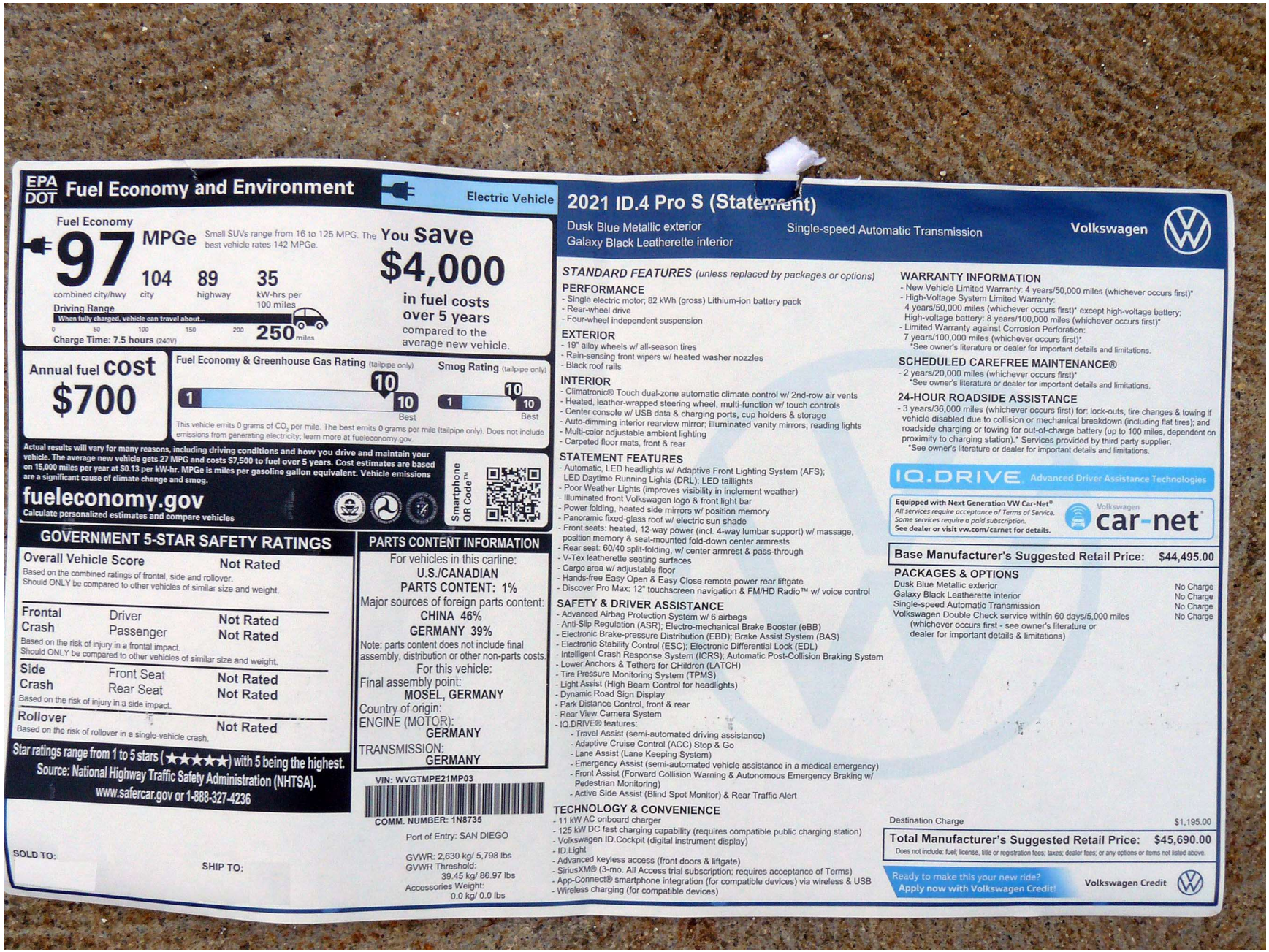

Figure A3. Window Sticker (Monroney Label)

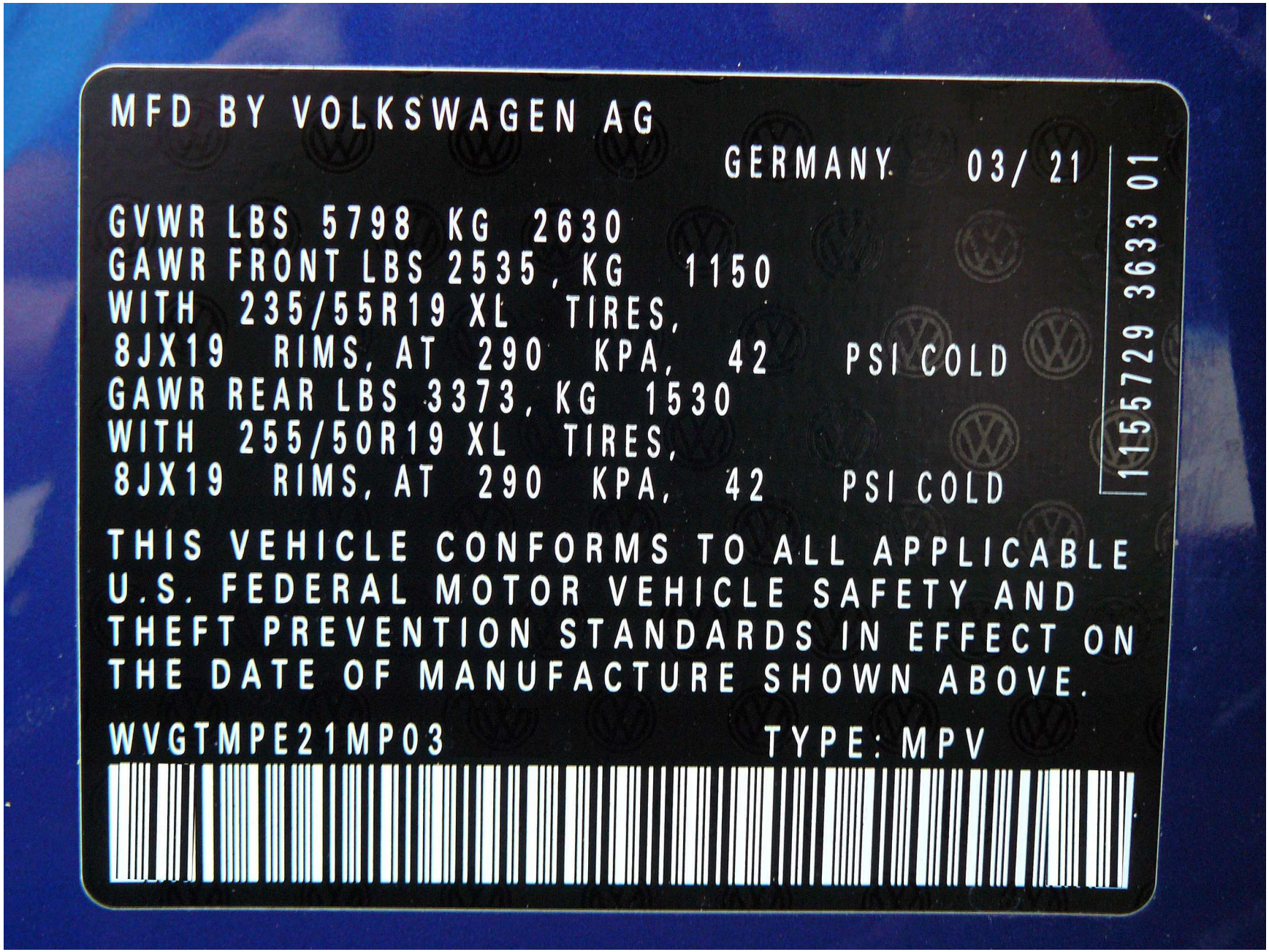

Figure A4. Vehicle Certification Label

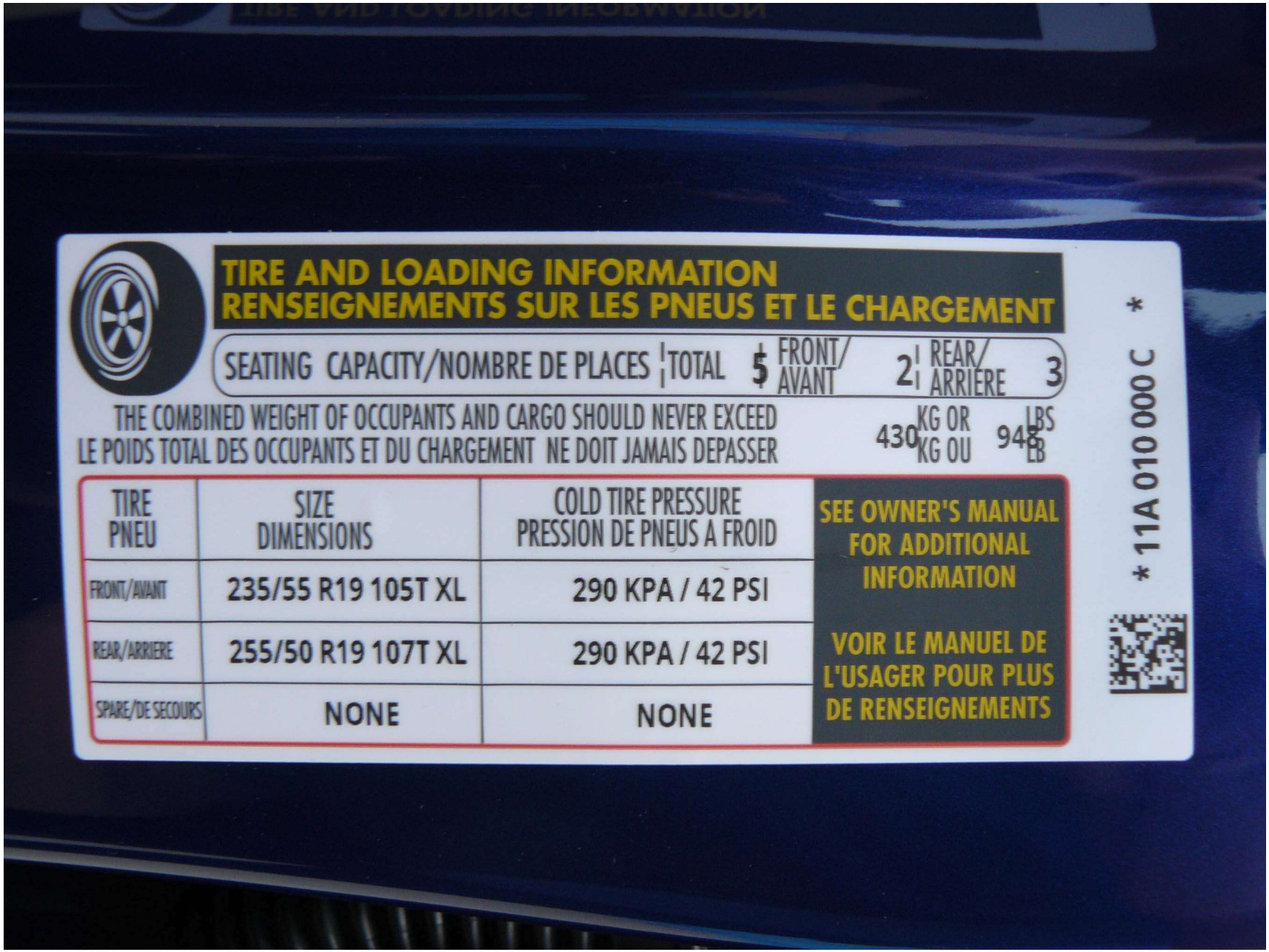

Figure A5. Tire Placard

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. Button for Accessing Assist Menus

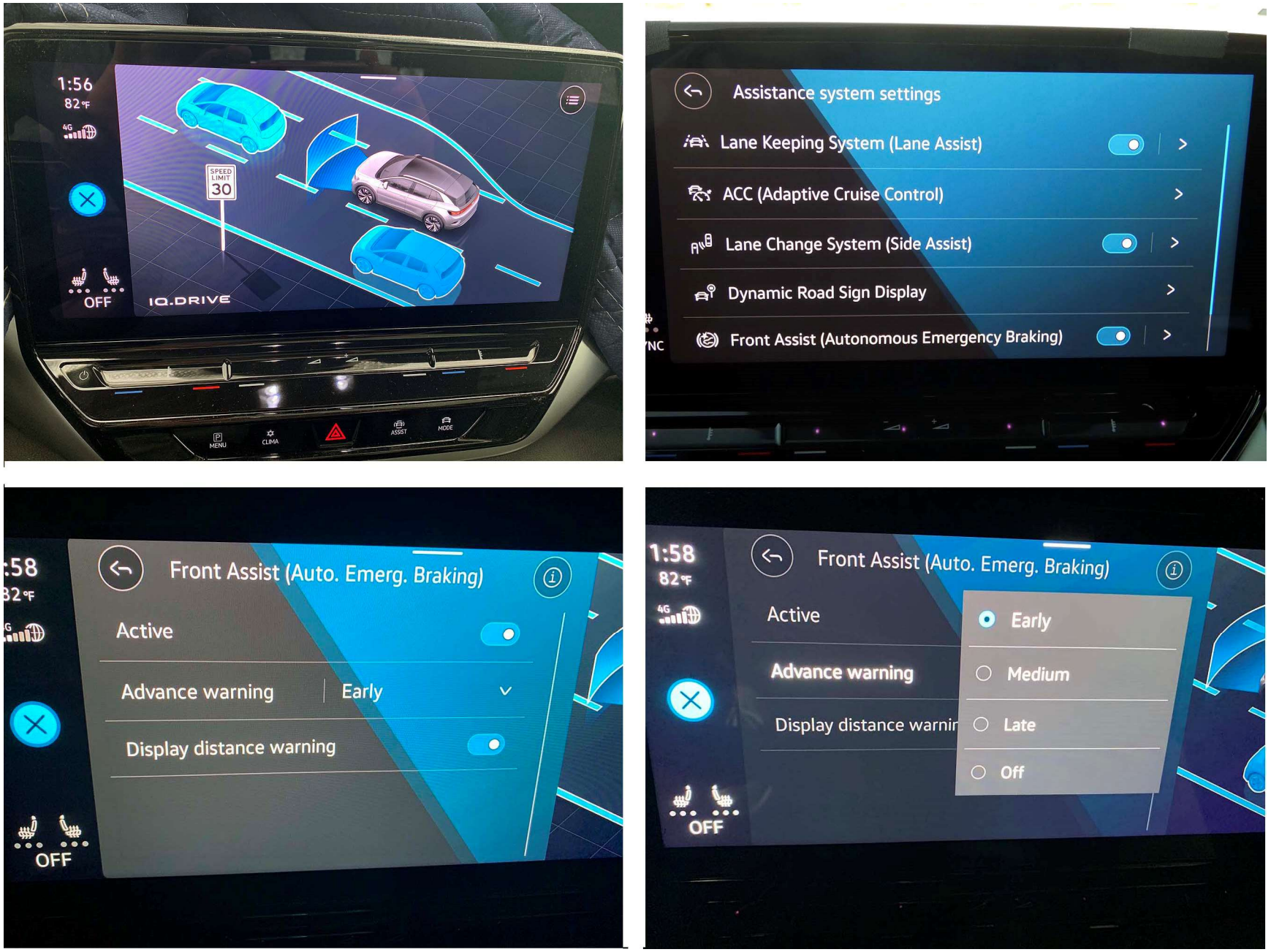

Figure A13. System Setup Menus

Figure A14. FCW Visual Alert

APPENDIX B

Excerpts from Owner’s Manual

Symbol	Meaning
	 Do not drive on! Low tyre pressure → page 327
	 Do not drive on! Fault in the Tyre Pressure Monitoring System → page 327
	Fault in electric drive system → page 139, → page 142
	Reduced power → page 137
	Electronic engine sound fault → page 140
	Front Assist not available → page 165
	Front Assist switched off → page 164
	Speed limiter not available → page 148
	Fault in the Cruise Control System → page 147
	Adaptive Cruise Control (ACC) is not available → page 156
	Emergency Assist not available → page 172
	Lane keeping system (Lane Assist) not available → page 167
	Lane keeping system (Lane Assist) is regulating → page 167
	Emergency Assist intervention → page 171
	Fault in the lane change system (Side Assist) → page 174
	Rear Traffic Alert braking intervention → page 189
	Rear Traffic Alert fault → page 189

Symbol	Meaning
	12-volt vehicle battery → page 323
	Low charge level of the high-voltage battery → page 285
	High-voltage battery empty → page 285
	Adaptive chassis control fault → page 144
	Ball head of the towing bracket is not locked → page 273
	The vehicle is held stationary → page 179
	Turn signals → page 110
	Trailer turn signal → page 111
	Cruise control system switched on, control active. → page 145
	Speed limiter active → page 147
	Lane Assist active → page 167
	Travel Assist active → page 169
	The ACC is regulating, no vehicle detected in front → page 154
	The ACC is regulating, vehicle in front detected → page 154
	Speed regulation due to the road layout → page 158
	Speed regulation due to a roundabout → page 158
	Speed regulation due to a junction → page 158
	Speed regulation due to cancellation of the speed limit → page 158
	Speed regulation due to the end of a traffic jam → page 158

11A0127210AB

If you adjust the announced speed excessively, predictive cruise control will be terminated.

If a speed limit is detected, the predictive cruise control function will adjust the stored speed even if ACC is deactivated. However, speed regulation will not take place.

If the current speed significantly exceeds a speed limit detected by the Dynamic Road Sign Display function, a warning will appear on the instrument cluster display.

When you join a motorway without a speed limit, the recommended speed will automatically be stored as the desired speed. If a higher speed has previously been stored on a motorway without a speed limit, this will be adopted instead of the recommended speed. ◁

Troubleshooting

🕮 Please refer to ⚠ at the start of the chapter on page 156.

A message is displayed that predictive cruise control is currently not available or is not available in your country.

— If this message is displayed for an extended period and predictive cruise control is available in your country, go to a qualified workshop.

Depending on the malfunction, additional information may be displayed in the vehicle status → page 30. ◁

11A012720AB

Area monitoring system (Front Assist)

🕮 Introduction to the topic

The Autonomous Emergency Braking (Front Assist) can detect imminent frontal collisions and issue corresponding warnings. The system can also provide assistance for braking and taking avoiding action and can also automatically brake the vehicle.

Front Assist can help to avoid accidents, but is not a substitute for the full concentration of the driver. Front Assist functions only within the system limits. The warning times vary depending on the traffic situation and driver behaviour.

Driving with Front Assist

You can cancel the automatic braking and steering interventions of Front Assist pressing the accelerator or steering.

Automatic braking

Front Assist can decelerate the vehicle to a standstill. The vehicle will then not be held permanently. Depress the brake pedal!

The brake pedal will feel harder during an automatic braking operation.

Detection of the traffic situation

Front Assist detects driving situations by means of a camera located in the upper area of the windscreen and a radar sensor in the front of the vehicle.

Functions included in the system

Front Assist includes the following functions depending on vehicle equipment and country:

— Pedestrian Monitoring.

— Cyclist Monitoring.

— Swerve support.

— Oncoming vehicle braking when turning.

The listed functions are automatically active when Front Assist is switched on.

⚠ WARNING

The intelligent technology used in Front Assist cannot overcome the physical limits specified, and functions only within the limits of the system. Never let the extra convenience afforded by Front Assist tempt you into taking risks when driving. The driver is always responsible for braking and steering in time.

- If Front Assist issues a warning, brake your vehicle immediately depending on the traffic situation or avoid the obstacle.
- Adapt your speed and distance from the vehicles ahead to suit visibility, weather, road and traffic conditions.
- Be prepared to take over control of the vehicle yourself at all times and to override automatic braking and steering interventions. Front Assist cannot prevent accidents and serious injuries on its own.
- Front Assist can issue unnecessary warnings and carry out unwanted braking or steering interventions in certain complex driving situations, e.g. at traffic islands.
- Front Assist can issue unnecessary warnings and carry out unwanted braking or steering interventions when its function is impaired, e.g. if the radar sensor is dirty or its position has been changed.
- Front Assist does not react to pedestrians without Pedestrian Monitoring or cyclists without Cyclist Monitoring. In addition, the system does not react to animals or to vehicles that are crossing or approaching in the same lane.
- If you are unsure about what systems your vehicle has, please enquire at a qualified workshop before starting your journey.
- Be prepared to take over control of the vehicle yourself at all times. ◁

Warning levels and braking intervention

🕮 Please refer to ⚠ at the start of the chapter on page 159.

Front Assist can detect the following objects within the system limits and depending on the vehicle equipment:

— Pedestrians, cyclists and vehicles also moving relative to your vehicle.

— Crossing pedestrians and cyclists.

— Stationary vehicles.

Front Assist can provide assistance and intervene if the vehicle is approaching a detected object in such a way that a collision with the object will occur if the vehicle speed is maintained and there is no driver intervention. The assistance may include an advance warning, an urgent warning and automatic braking.

Under ideal conditions, this can prevent a collision or help to reduce the consequences of the collision.
Front Assist operates in the following speed ranges:

	Advance warning	Urgent warning	Automatic braking	Braking intervention
Vehicle stationary	30 to 85 km/h (20 to 53 mph)	30 to 85 km/h (20 to 53 mph)	5 to 85 km/h (3 to 53 mph)	5 to 85 km/h (3 to 53 mph)

	Advance warning	Urgent warning	Automatic braking	Braking intervention
Vehicle also moving	30 to 250 km/h (20 to 155 mph)	30 to 250 km/h (20 to 155 mph)	5 to 250 km/h (3 to 155 mph)	5 to 250 km/h (3 to 155 mph)
Pedestrian also moving	30 to 85 km/h (20 to 53 mph)	30 to 85 km/h (20 to 53 mph)	5 to 85 km/h (3 to 53 mph)	5 to 85 km/h (3 to 53 mph)
Crossing pedestrian	30 to 85 km/h (20 to 53 mph)	-	5 to 65 km/h (3 to 40 mph)	5 to 65 km/h (3 to 40 mph)
Cyclist also moving	30 to 250 km/h (20 to 155 mph)	30 to 250 km/h (20 to 155 mph)	5 to 250 km/h (3 to 155 mph)	5 to 250 km/h (3 to 155 mph)
Crossing cyclist	30 to 85 km/h (20 to 53 mph)	-	5 to 65 km/h (3 to 40 mph)	5 to 65 km/h (3 to 40 mph)

The values apply only under ideal conditions and are approximate values which depend on the market and vehicle equipment. Please contact a qualified workshop if you have any queries about the equipment installed in your vehicle.

Advance warning

The system detects a possible collision and prepares the vehicle for possible emergency braking.

An acoustic warning sounds and the red warning lamp lights up. Brake or take avoiding action.

Urgent warning

If the driver does not react to the advance warning, the system may initiate a short braking jolt in order to draw attention to the increasing collision risk. Brake or take avoiding action.

Automatic braking

If the driver also does not react to the urgent warning, the vehicle can be braked automatically with braking force that increases in several stages. The reduced speed means that it is possible to minimise the consequences of an accident.

Braking intervention

If the system detects that the driver is braking insufficiently when there is a risk of collision, the system can increase the braking force and help prevent a collision. The braking intervention takes place only for as long as the brake pedal is pressed hard.

Distance warning

The system detects when safety is endangered by driving too close to the vehicle in front. The indicator lamp lights up. Increase the distance.

Speed range: around 65 km/h (around 40 mph) to around 250 km/h (around 155 mph). ◁

11A012720AB

Limits of Front Assist

Please refer to ⚠ at the start of the chapter on page 159.

Front Assist is not available or its functions are restricted immediately after the vehicle is started. The indicator lamp lights up in the instrument cluster display during this time.

Front Assist has physical and system-related limitations. You should therefore always be prepared to take full control of the vehicle if necessary.

Delayed response

If the camera or radar sensor is exposed to environmental conditions that impair functioning, the system may detect this only after a certain delay. For this reason, any restrictions to functions may be displayed only after a delay at the start of the journey and when driving → page 159.

Objects that cannot be detected

Front Assist may not react or may react with a delay or provide with an unwanted response in the following situations:

- Vehicles that are driving outside the sensor range in close proximity to your vehicle, e.g. vehicles that are driving offset to your vehicle or motorbikes.
- Vehicles that change into your lane directly in front of your vehicle.
- Vehicles with bodies or attachments that project beyond the vehicle.
- Oncoming vehicles or vehicles crossing your path.
- Oncoming pedestrians.
- Oncoming cyclists.
- When pedestrians and cyclists are not detected, for example because they are partially or fully hidden.
- Objects or narrow objects such as walls, rails, fences, posts, trees or garage doors.

Function limitations

Front Assist may not react or may react with a delay or provide with an unwanted response in the following situations:

- In tight bends.
- Driving in heavy rain, snow, fog or heavy spray.
- Driving in multi-storey car parks and tunnels.
- Driving on roads with embedded metal objects, e.g. railway tracks.
- Reversing.
- If ESC is regulating or faulty.
- If the radar sensor or camera window is dirty, covered or damaged.
- If several brake lights on the vehicle are faulty.
- If there is a fault in several brake lights on a trailer or bicycle carrier with an electrical connection to the vehicle.
- If the vehicle accelerates hard or the accelerator is fully depressed.
- In complex driving situations, e.g. at traffic islands.
- In unclear traffic situations, e.g. vehicles ahead are braking heavily or turning off.
- When the sun is low in the sky, in darkness or with glare from oncoming vehicles.
- When driving into and out of tunnels.
- If there is a fault in Front Assist.

Switching off Front Assist

Front Assist is not suitable for use in the following situations due to the limitations of the system and must be switched off → ⚠:

- If the vehicle is utilised in a capacity beyond usage on public roads, e.g. off-road or on a race track.
- If the vehicle is being towed or is loaded onto another vehicle.
- If add-on parts cover the radar sensor or camera.
- If the camera or the radar sensor is faulty.

– After external force on the radar sensor, e.g. after a rear-end collision.
– If the windscreen is damaged in the area of the camera window.
– In the event of multiple unwanted interventions.

⚠ WARNING

Failure to switch off Front Assist in the situations mentioned can result in accidents and serious injuries. ◁

Pedestrian Monitoring

🕮 Please refer to ⚠ at the start of the chapter on page 159.

Pedestrian Monitoring and Cyclist Monitoring can help to avoid accidents with pedestrians and cyclists or to mitigate the consequences of an accident.

The system may give a warning when there is a risk of collision, prepare the vehicle for emergency braking, help to brake the vehicle or perform an automatic brake intervention. In the event of an advance warning, the red warning lamp 🚶 lights up in the instrument cluster display.

When Front Assist is switched on and active, Pedestrian Monitoring is also active as an element of Front Assist.

⚠ WARNING

The intelligent technology of Pedestrian Monitoring cannot overcome the laws of physics, and functions only within the limits of the system. Never let the extra convenience afforded by Pedestrian Monitoring tempt you into taking any risks when driving. The driver is always responsible for braking in time.

- If Pedestrian Monitoring issues a warning, brake your vehicle immediately depending on the traffic situation or avoid the object.
- Pedestrian Monitoring cannot prevent accidents and serious injuries by itself.
- Pedestrian Monitoring can issue unnecessary warnings and carry out unwanted braking interventions in complex driving situations, e.g. in a sharply turning main road with an intersection.
- Pedestrian Monitoring can issue unnecessary warnings and carry out unwanted braking interventions when its function is impaired, e.g. if the radar sensor is covered or if the camera window is dirty.
- Be prepared to take over control of the vehicle yourself at all times. ◁

Swerve support

🕮 Please refer to ⚠ at the start of the chapter on page 159.

The swerve support function can help to steer the vehicle around an obstacle in critical driving situations.

If you steer to avoid an obstacle after an urgent warning, swerve support can help you. Swerve support brakes individual wheels and supports you with a corrective steering intervention as long as you steer.

Speed range

Swerve support is available in a speed range from around 30 km/h (20 mph) up to around 150 km/h (90 mph).

Limits

Swerve support does not react to crossing objects and animals. Always also observe the fundamental limits of Front Assist → page 162. ◁

11A012720AB

Oncoming vehicle braking when turning

Please refer to ⚠ at the start of the chapter on page 159.

The oncoming vehicle braking when turning function can prevent the vehicle from colliding with an oncoming vehicle during a turn.

If there is a risk of the vehicle colliding with an oncoming vehicle in the adjacent lane when turning, the oncoming vehicle braking when turning function can brake your vehicle. The vehicle can then remain in its own lane as a result.

Speed range

The oncoming vehicle braking when turning function is available up to around 15 km/h (around 9 mph).

Limits

The oncoming vehicle braking when turning function is available only if you indicate, have turned the steering wheel and have therefore started the turning manoeuvre. After changing from right-hand traffic to left-hand traffic or vice versa, the oncoming vehicle braking when turning function is available only after a certain time (30 minutes or more).

The oncoming vehicle braking when turning function does not react to persons, animals, crossing vehicles or objects that are not detected as a vehicle. Always also observe the fundamental limits of Front Assist → page 162. ◁

Operating Front Assist

Please refer to ⚠ at the start of the chapter on page 159.

Front Assist and all the included functions (country-dependent) are automatically switched on when you switch on the ignition.

However, Front Assist is not available or only partially available as long as the indicator lamp is on.

Volkswagen recommends that Front Assist and all the included functions (country-dependent) are switched on at all times. Exceptions → page 162.

Switching on and off

— Switch Front Assist on and off in the Assist systems menu of the Infotainment system → page 31.

If you switch off Front Assist, all the included functions (country-dependent) are also switched off. The yellow indicator lamp lights up in the instrument cluster display.

Making settings for the included functions (country-dependent)

You can make further settings when Front Assist is switched on:

— Switch the desired function on and off in the Assist systems menu of the Infotainment system → page 31.

You can also set the warning time for the advance warning. ◁

Troubleshooting

Please refer to ⚠ at the start of the chapter on page 159.

Front Assist is starting up.

The indicator lamp lights up.

— Front Assist is temporarily unavailable or limited. Front Assist is available after driving straight ahead for a short time, and the indicator light goes out. When the vehicle is not in motion, the indicator lamp lights up continuously.

Front Assist not available or functions restricted.

The indicator lamp lights up yellow and a text message is also displayed.

— The radar sensor or camera window is dirty. Clean the radar sensor and windscreen → page 355.

— The view of the radar sensor or camera is impaired due to the weather conditions, e.g. snow, or due to detergent deposits or coatings. Clean the radar sensor and windscreen → page 355.

— The view of the radar sensor is impaired by add-on parts, the trim frames of number plate holders or stickers. Keep the area around the radar sensor free.

— The view of the camera is impaired by add-on parts or stickers. Keep the area around the camera window free.

— The radar sensor or camera has been displaced or damaged, e.g. due to damage to the front of the vehicle or the windscreen. Check whether damage is visible → page 362.

— Paint work or structural modifications were carried out on the front of the vehicle.

— If the problem persists, switch off Front Assist and go to a qualified workshop.

Front Assist does not function as expected or is triggered unnecessarily several times.

— The radar sensor or camera window is dirty. Clean the radar sensor and windscreen → page 355.

— The system limits have been exceeded → page 162.

— Low sun or darkness.

— If the problem persists, switch off Front Assist and go to a qualified workshop.

Touch panels react differently than expected.

Moisture, dirt and grease can impede the functioning of the touch panels.

— Make sure the touch panels are always clean and dry. ◁

Lane keeping system (Lane Assist)

Introduction to the topic

Within the system limits, the lane keeping system (Lane Assist) helps the driver to stay in lane. The function is not designed to keep the vehicle in lane automatically, nor is it suited to this purpose.

Using a camera in the windscreen, the lane keeping system detects road lane markings on the road. If your vehicle moves too close to a recognised road lane marking, the system will warn the driver with a corrective steering intervention. The corrective steering intervention can be overridden by the driver at any time.

System limits

Use the lane keeping system only on motorways and well-developed country roads.

11A012720AB

APPENDIX C

Run Log

Subject Vehicle: **2021 Volkswagen ID.4 Pro S (Statement)** Test Date: **7/8/2021**

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	2.90	2.88	0.80	Pass	
2		Y	2.93	2.92	0.83	Pass	
3		Y	2.94	2.92	0.84	Pass	
4		Y	2.89	2.87	0.79	Pass	
5		Y	2.96	2.94	0.86	Pass	
6		Y	2.95	2.92	0.85	Pass	
7		Y	2.94	2.88	0.84	Pass	
Note: The nature and content of the visual display and warning for the moving POV scenarios made reliable detection of the onset of the visual warning impossible using the existing sensor. The results shown in the Appendix D visual plots are not shown here.							
15	**Decelerating POV**	N					POV brakes
16		Y	2.61	-	0.21	Pass	
17		N		-			POV speed
18		Y	2.65	-	0.25	Pass	
19		N					POV brakes
20		Y	2.57	-	0.17	Pass	
21		Y	2.62	-	0.22	Pass	
22		Y	2.69	-	0.29	Pass	
23		Y	2.67	-	0.27	Pass	

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
24	**Decelerating POV**	Y	2.64	-	0.24	Pass	
8	**Slower POV**	Y	2.58	-	0.58	Pass	
9		Y	2.64	-	0.64	Pass	
10		Y	2.56	-	0.56	Pass	
11		Y	2.63	-	0.63	Pass	
12		Y	2.62	-	0.62	Pass	
13		Y	2.53	-	0.53	Pass	
14		Y	2.60	-	0.60	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.

The visual warning plots for all but the stopped POV runs are unreliable and are presented only for completeness. The nature of the visual display and warning for the moving POV scenarios made reliable detection of the onset of the visual warning impossible using the existing sensor.

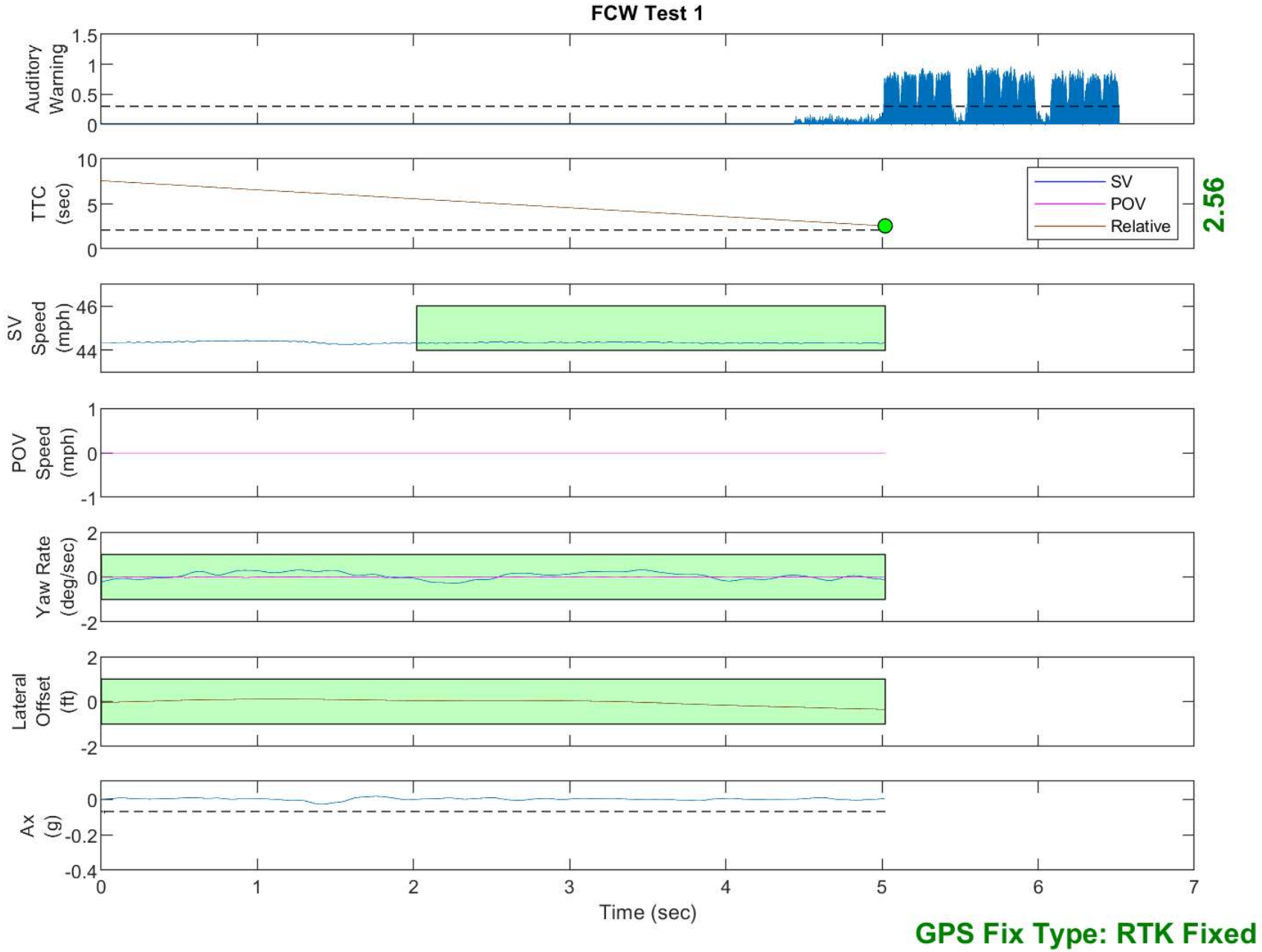

Figure D1. Example Time History for Test Type 1, Passing

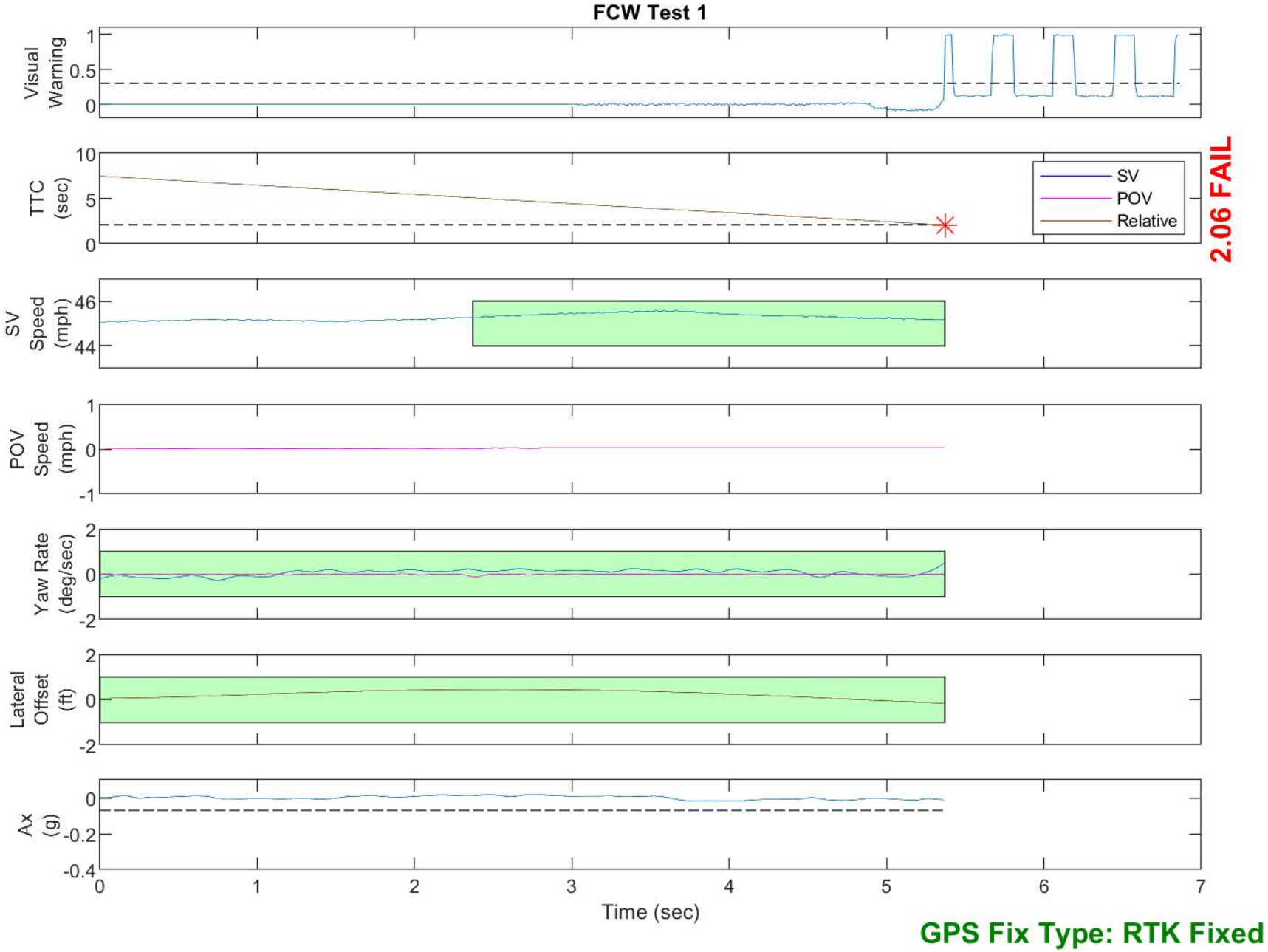

Figure D2. Example Time History for Test Type 1, Failing

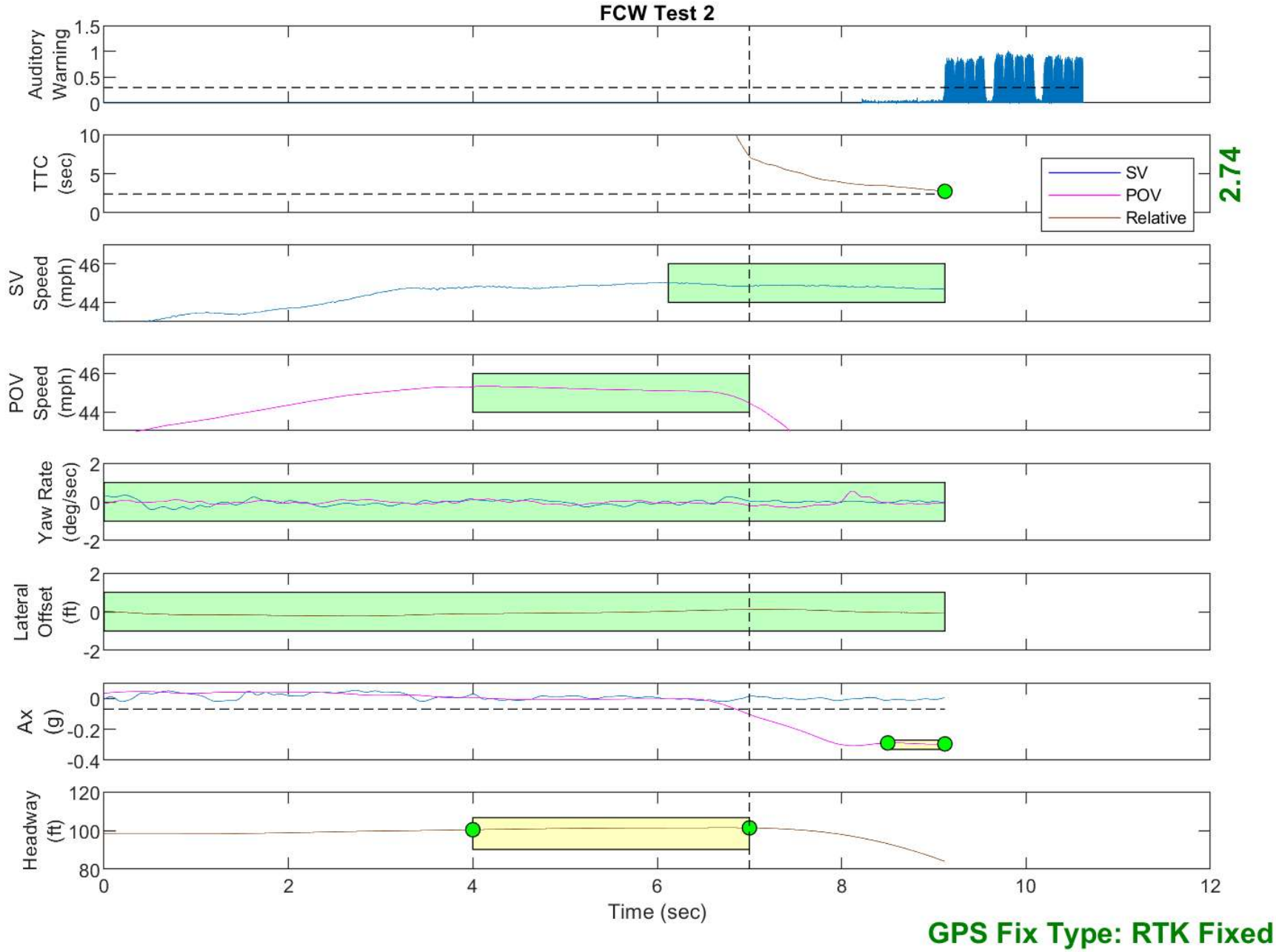

Figure D3. Example Time History for Test Type 2, Passing

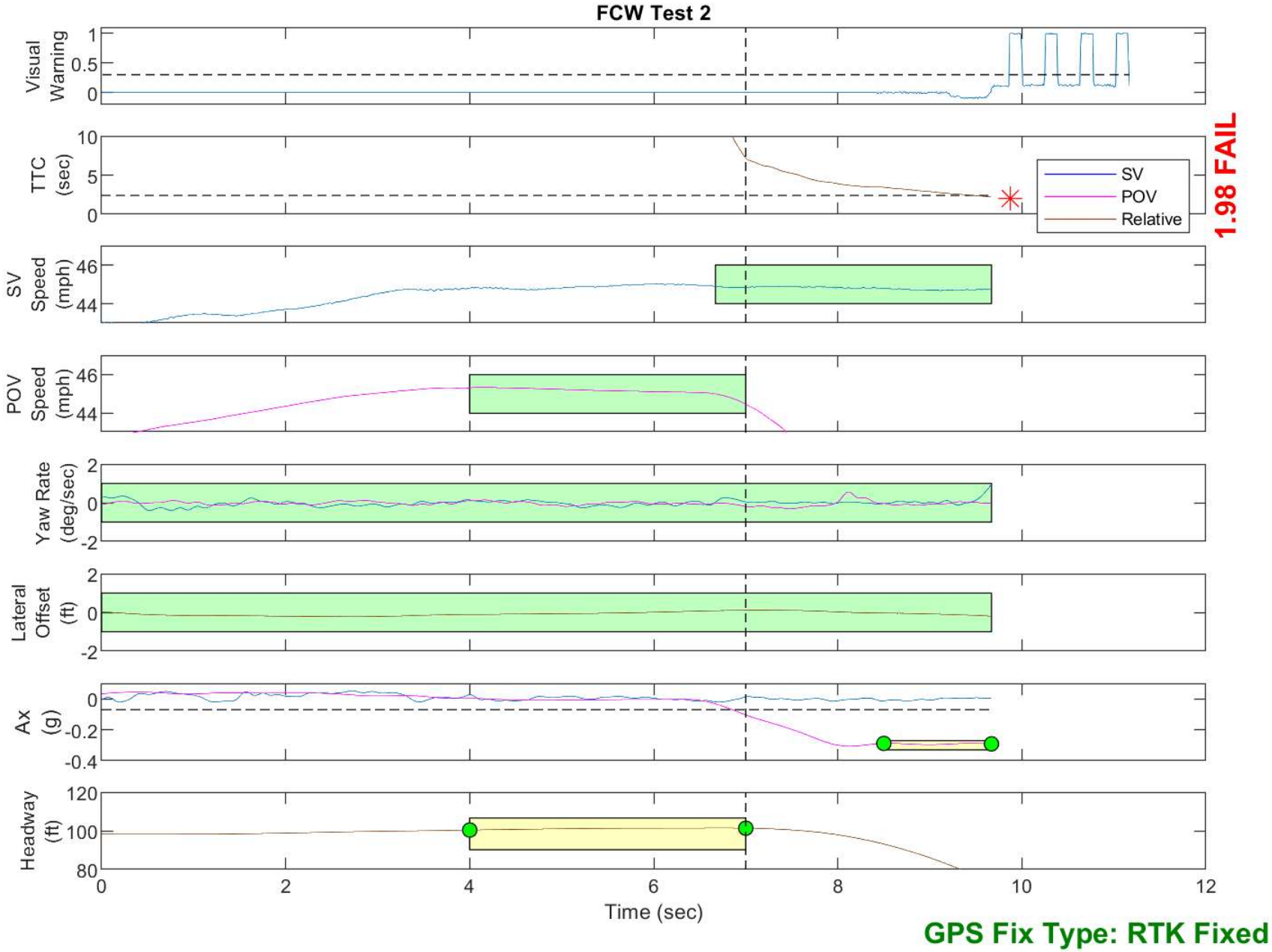

Figure D4. Example Time History for Test Type 2, Failing

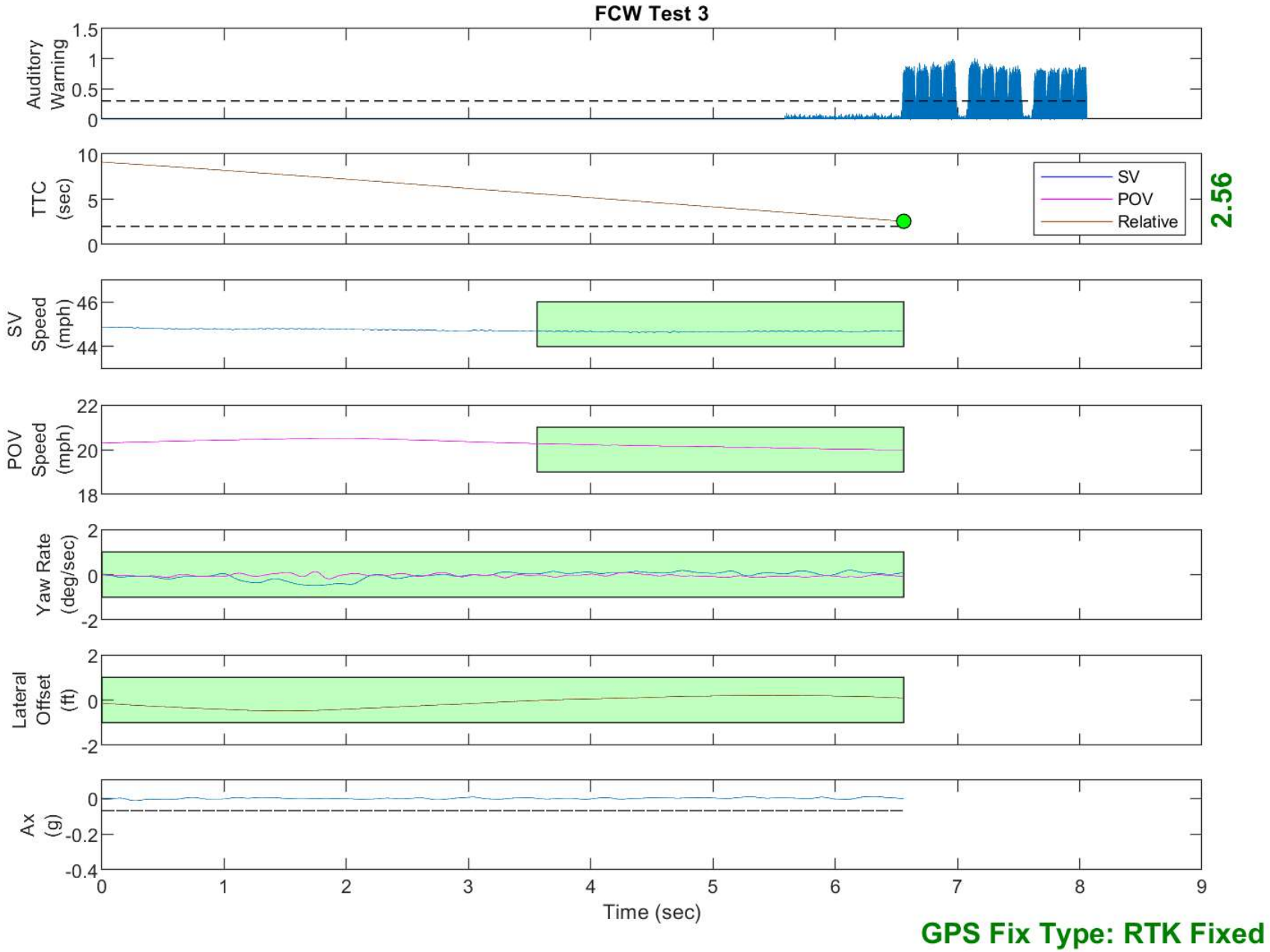

Figure D5. Example Time History for Test Type 3, Passing

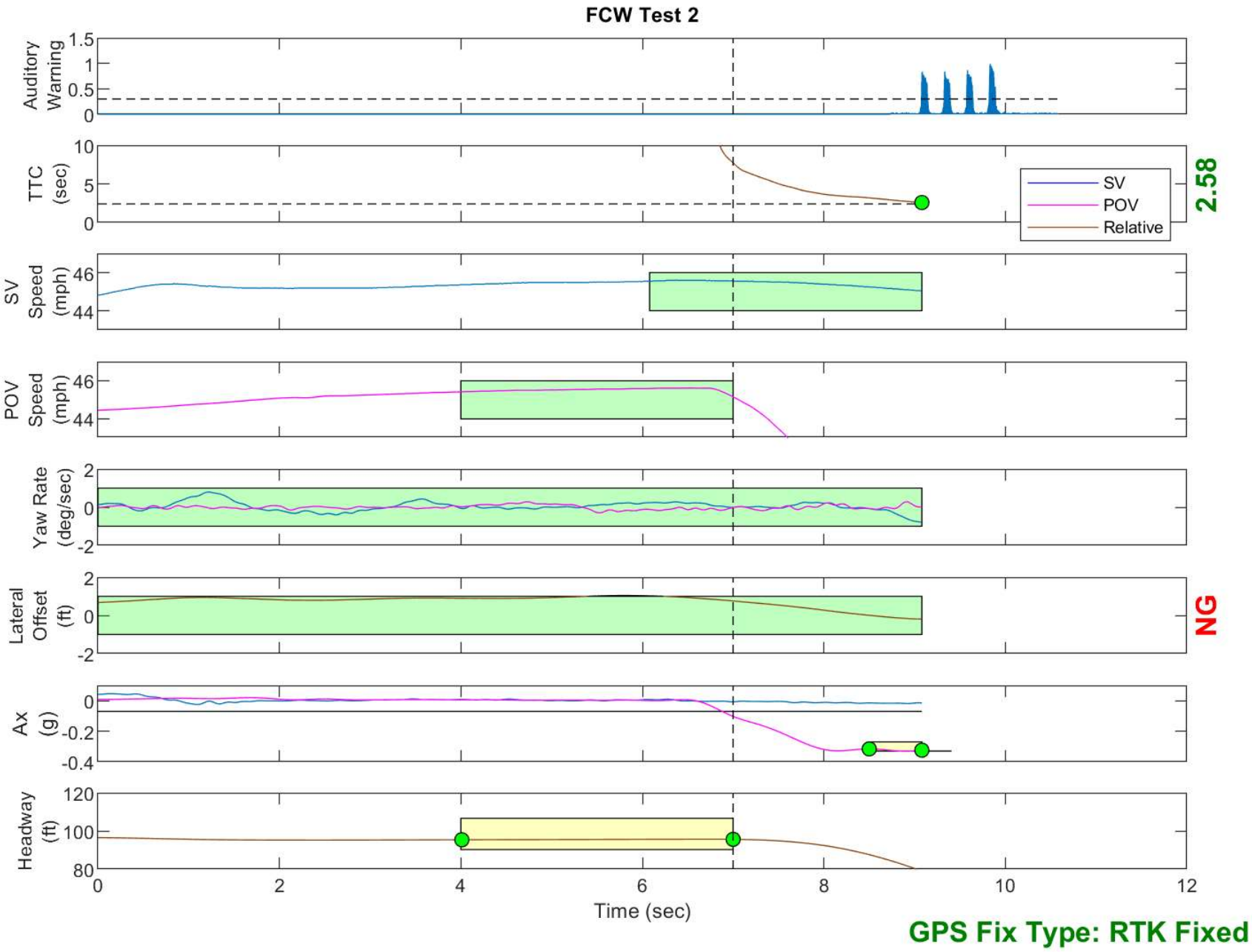

Figure D6. Example Time History Showing Invalid Lateral Offset Criteria

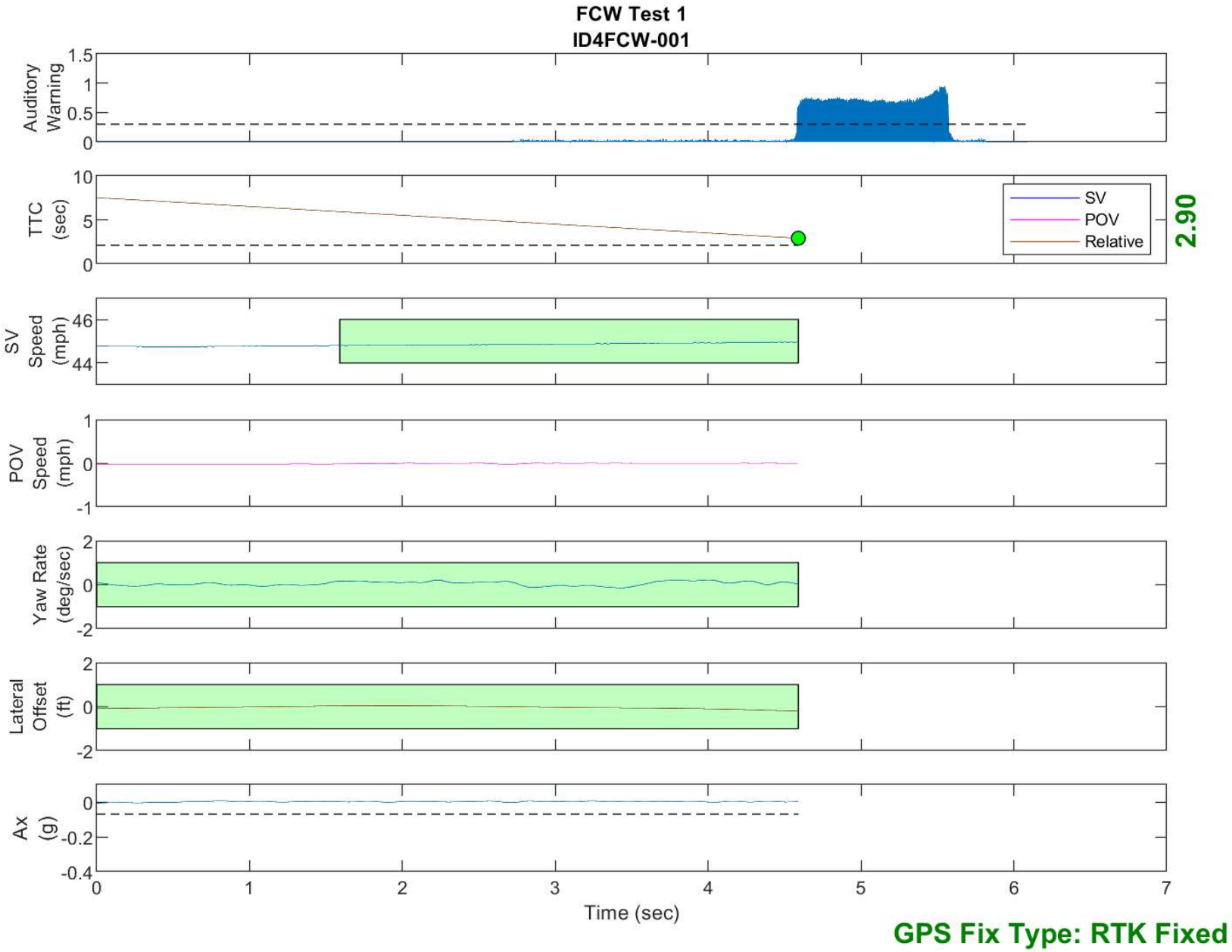

Figure D7. Time History for Run 1, FCW Test 1, Auditory Warning

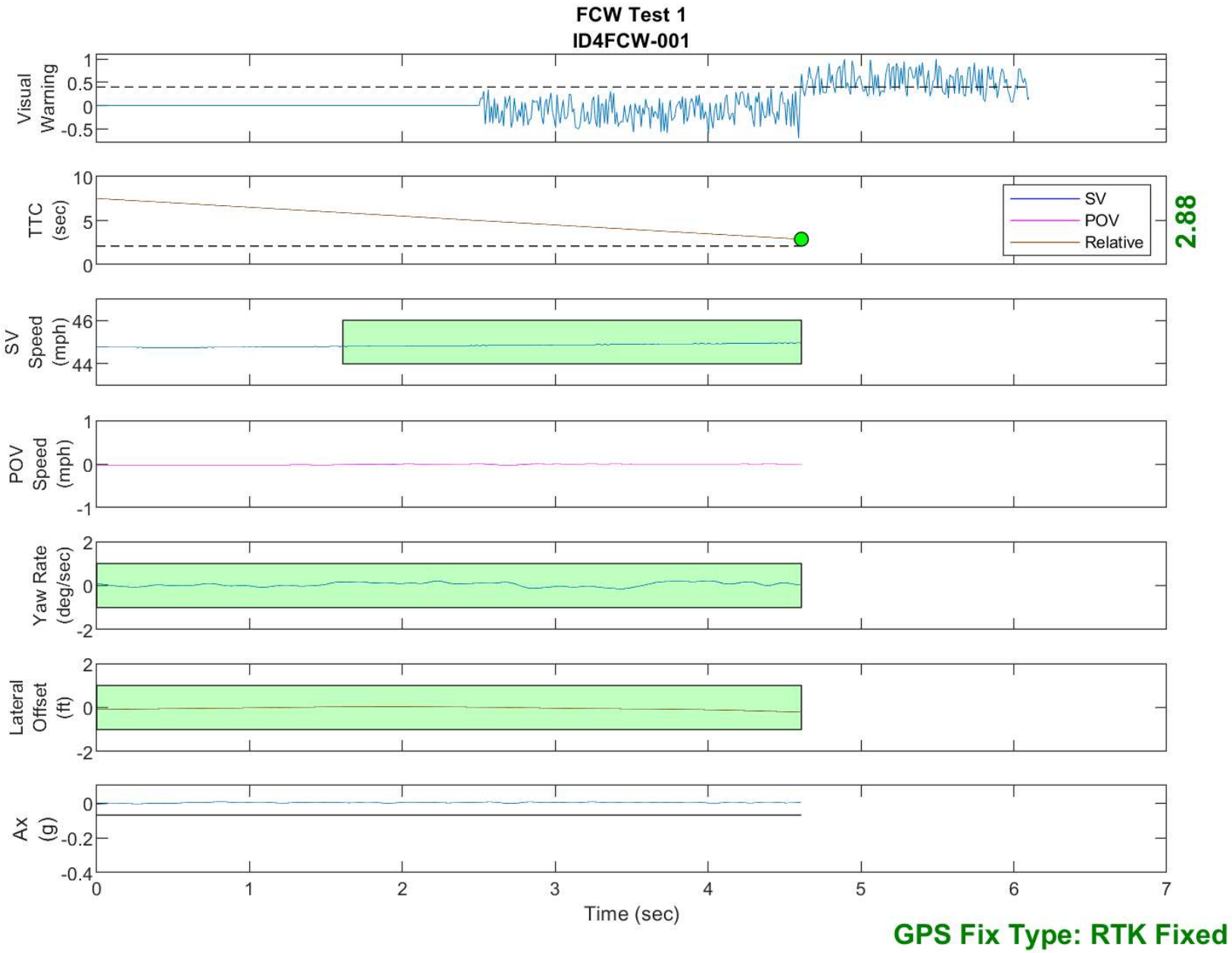

Figure D8. Time History for Run 1, FCW Test 1, Visual Warning

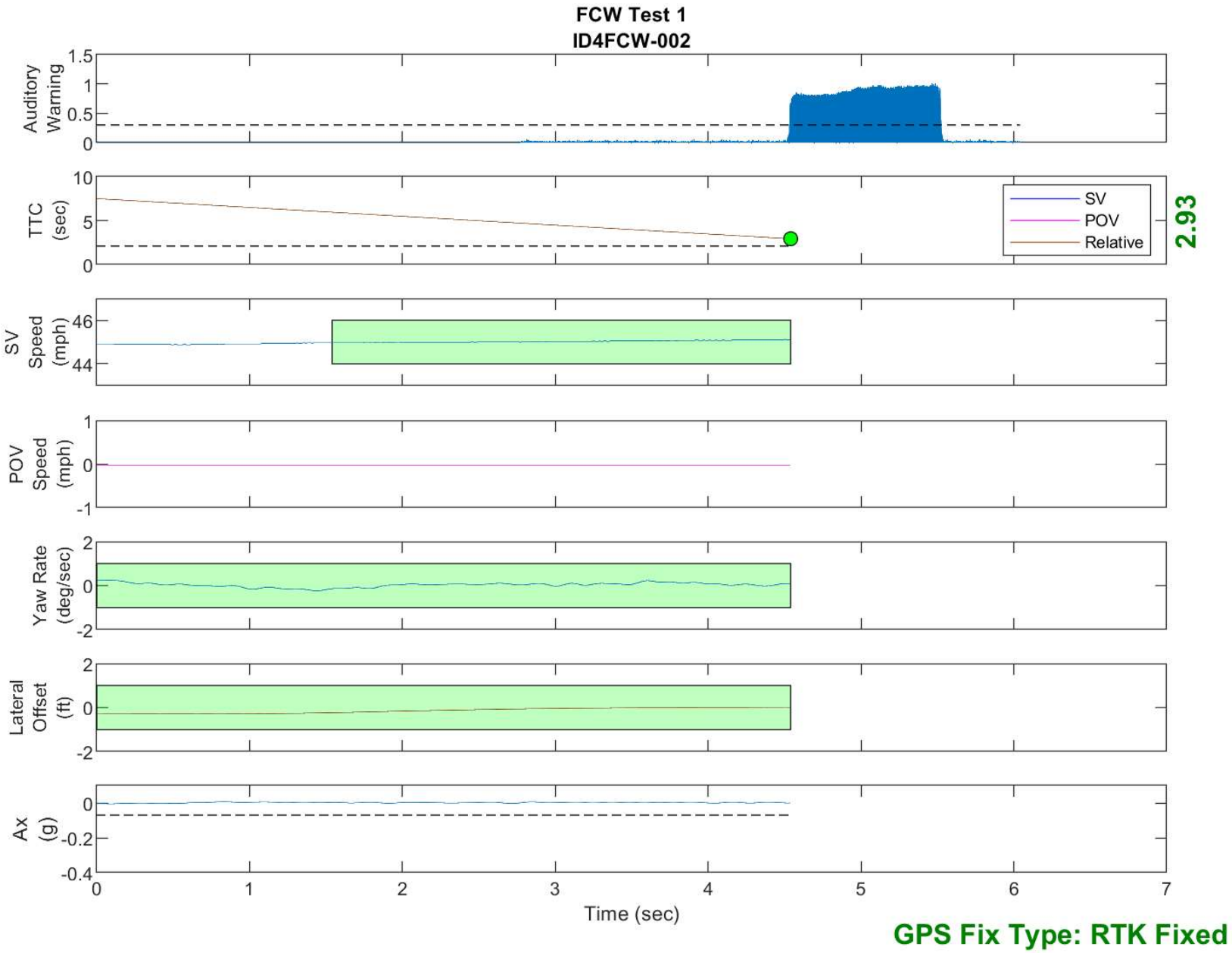

Figure D9. Time History for Run 2, FCW Test 1, Auditory Warning

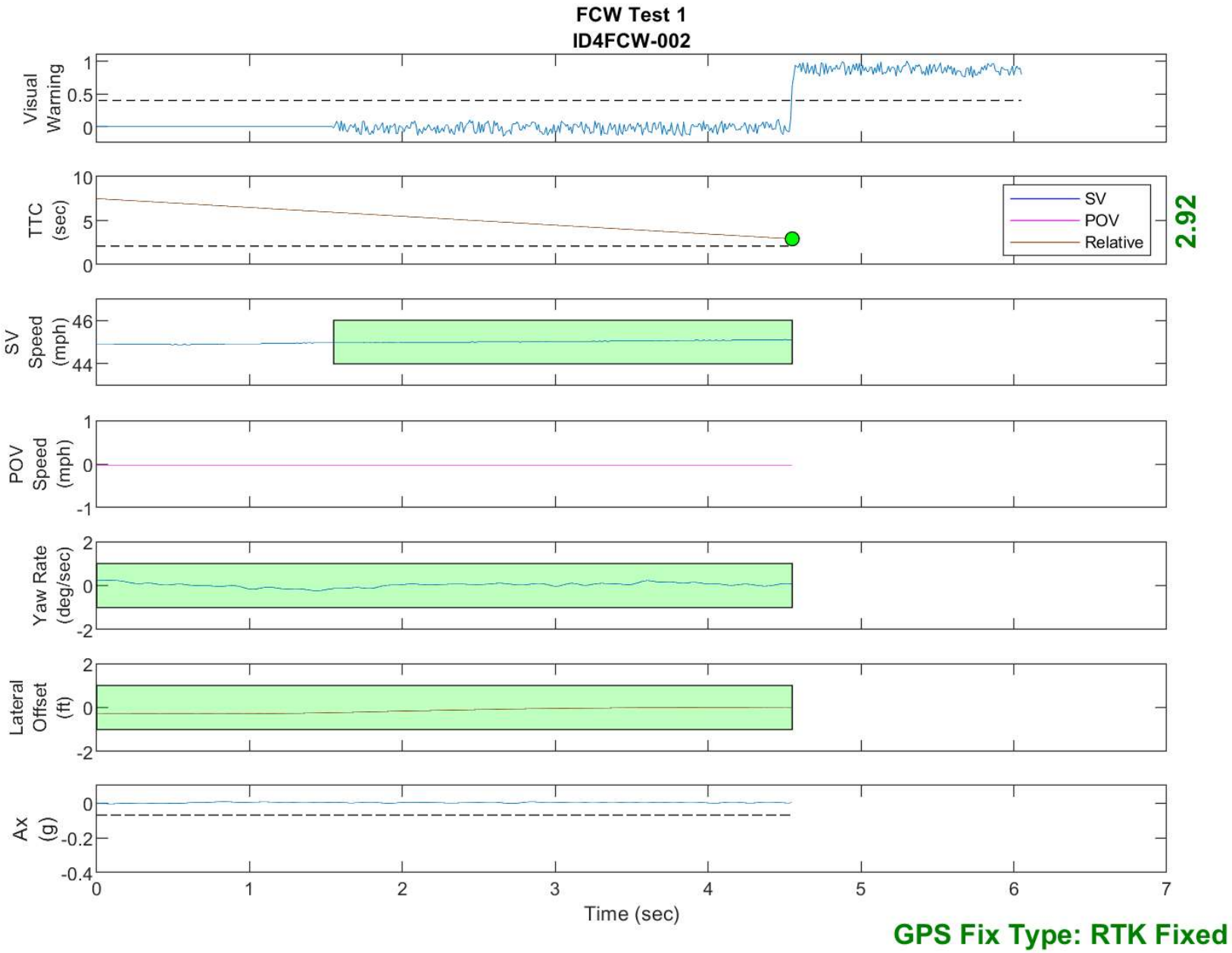

Figure D10. Time History for Run 2, FCW Test 1, Visual Warning

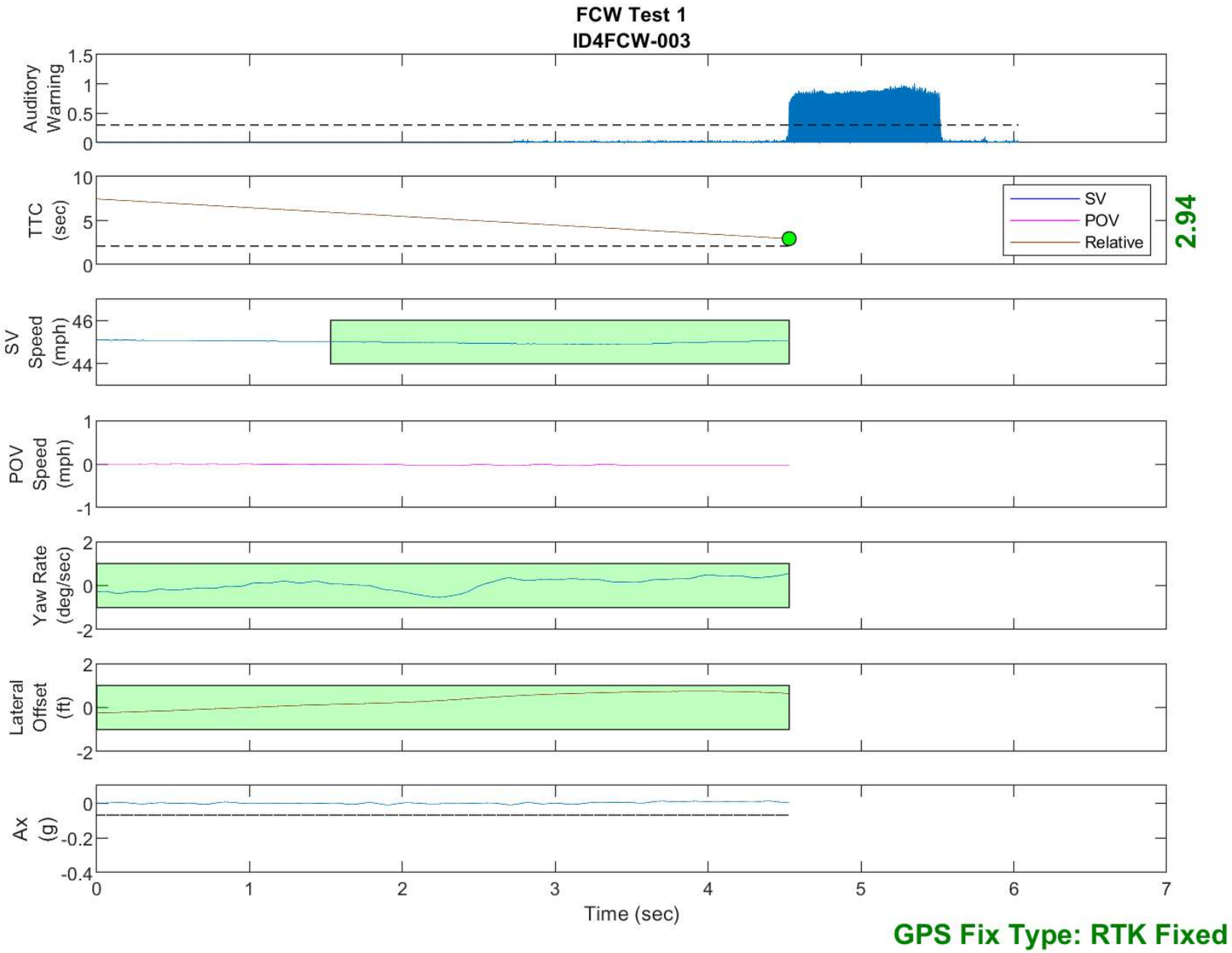

Figure D11. Time History for Run 3, FCW Test 1, Auditory Warning

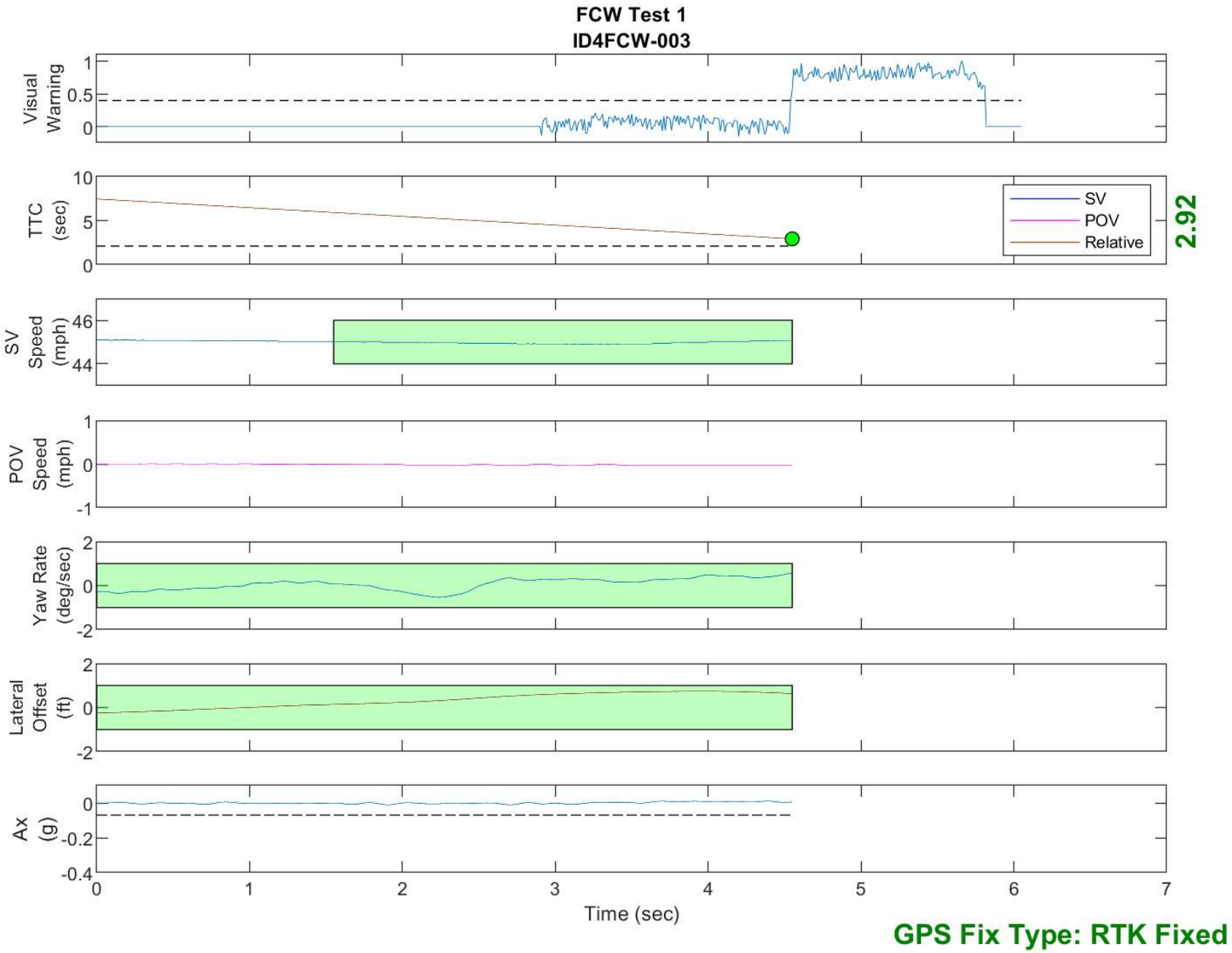

Figure D12. Time History for Run 3, FCW Test 1, Visual Warning

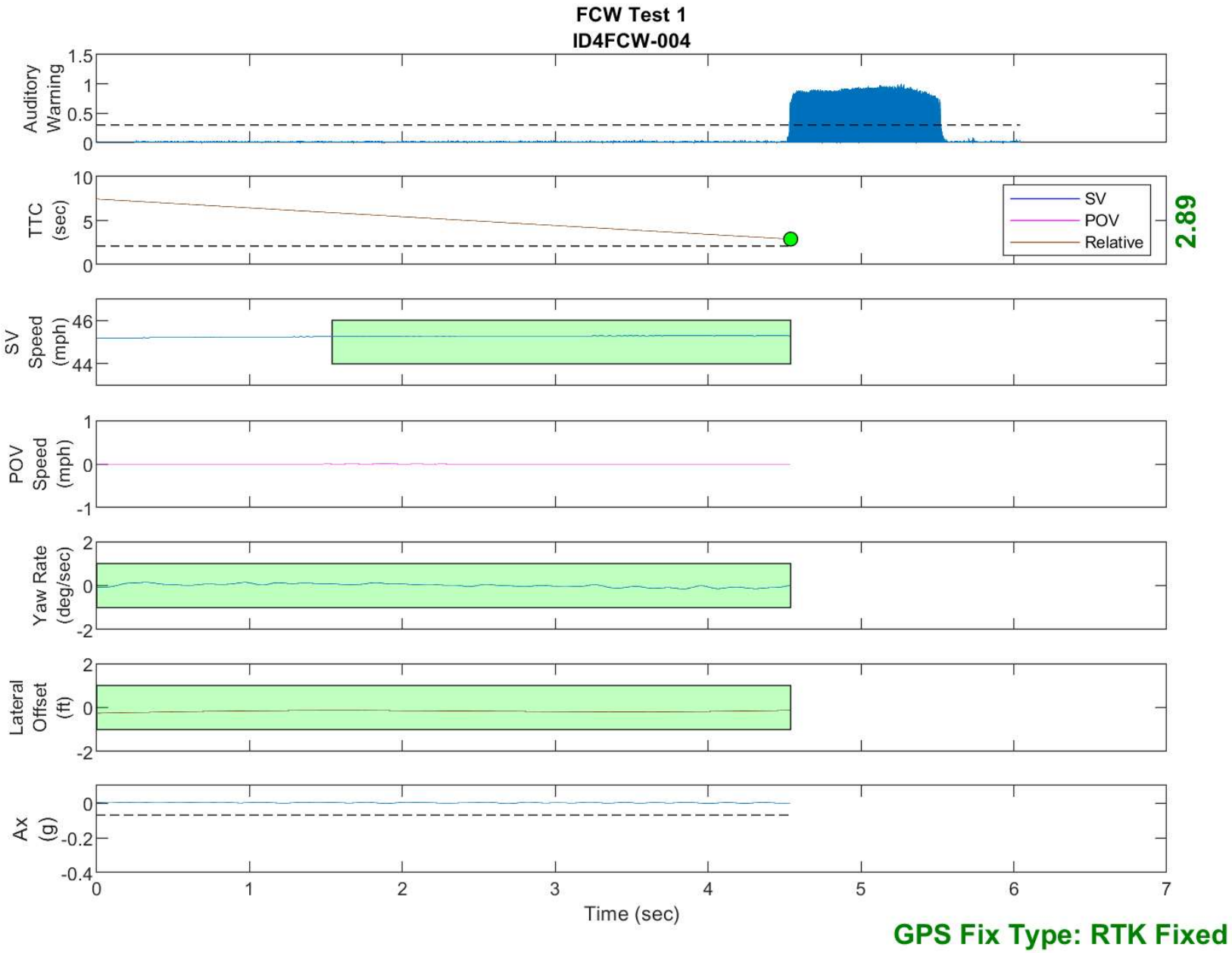

Figure D13. Time History for Run 4, FCW Test 1, Auditory Warning

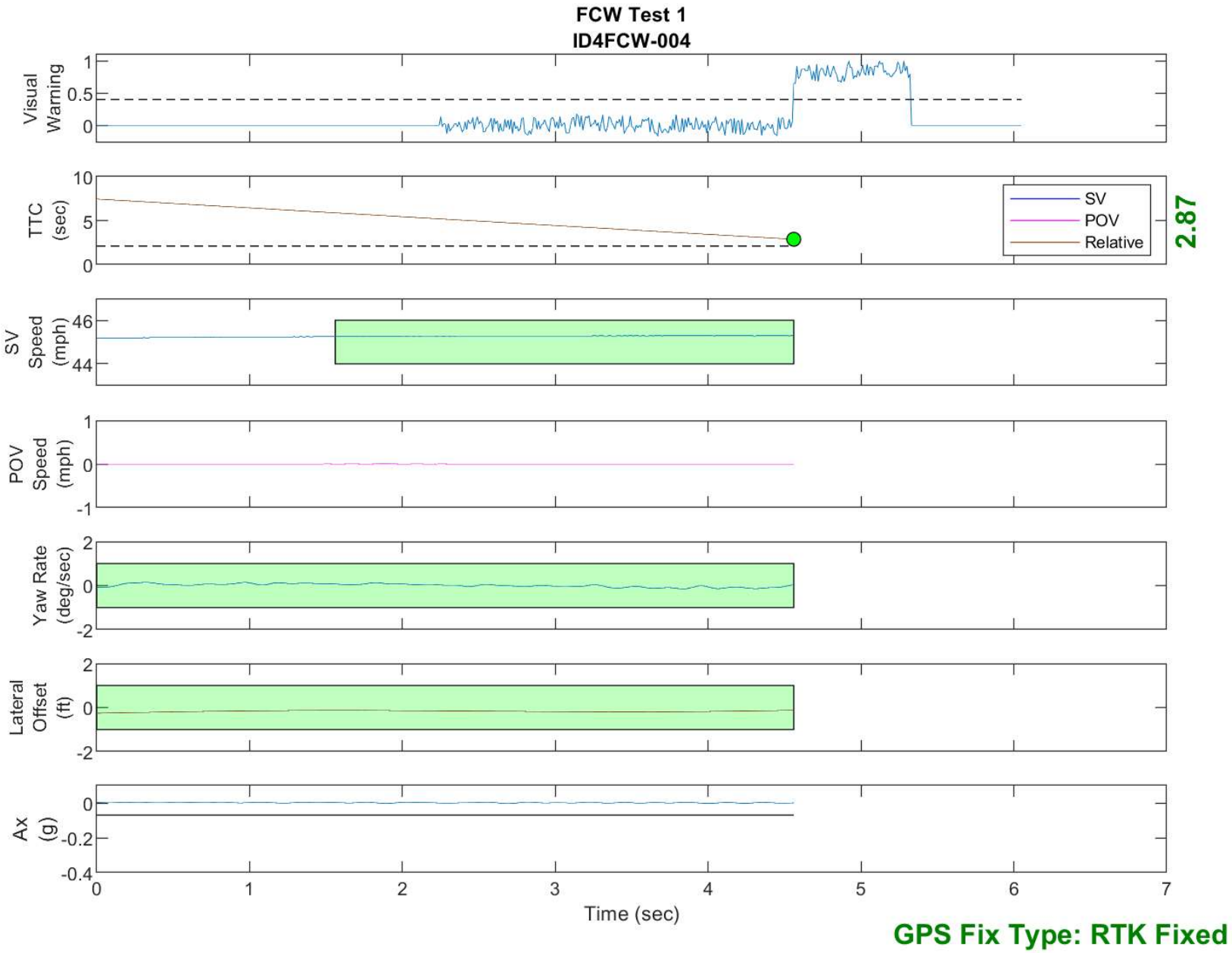

Figure D14. Time History for Run 4, FCW Test 1, Visual Warning

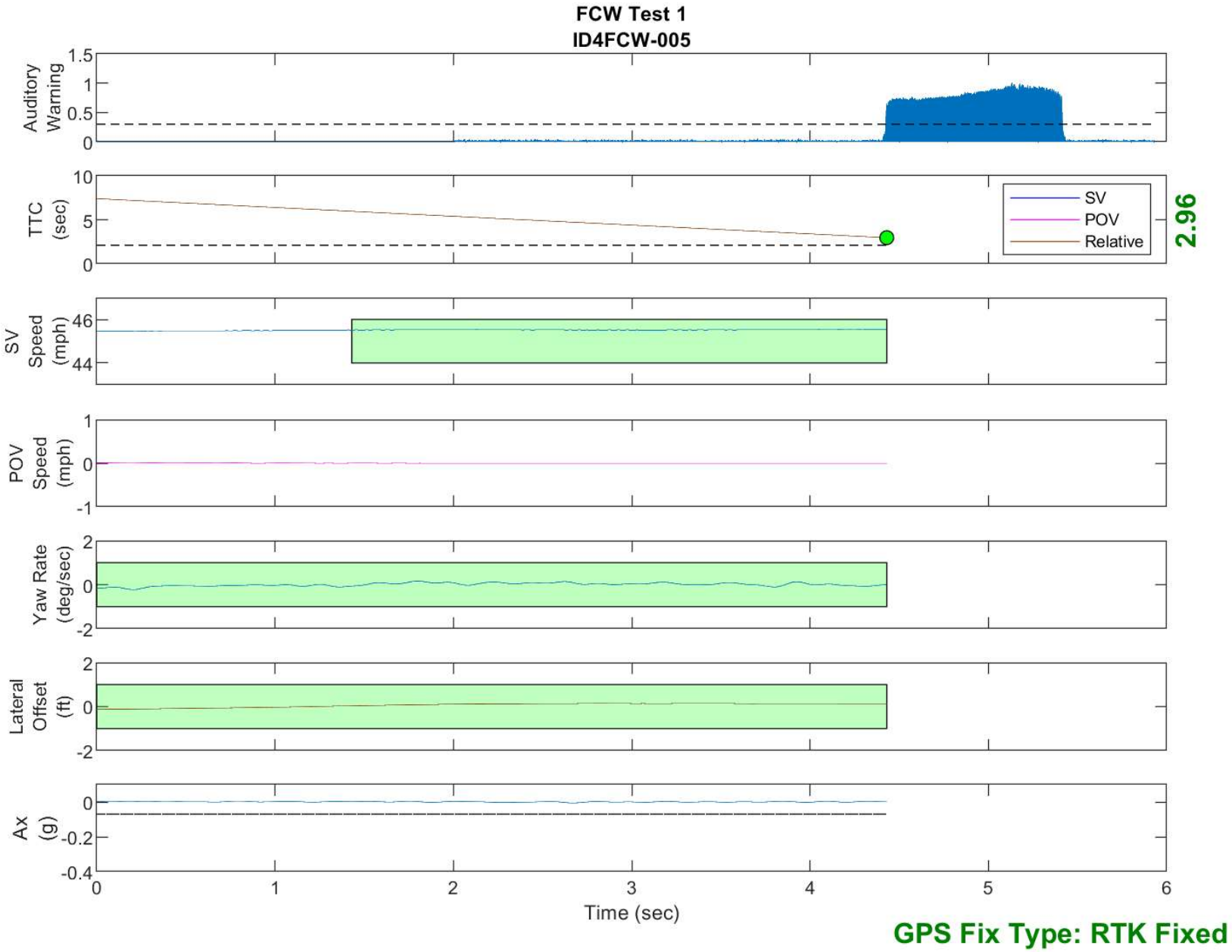

Figure D15. Time History for Run 5, FCW Test 1, Auditory Warning

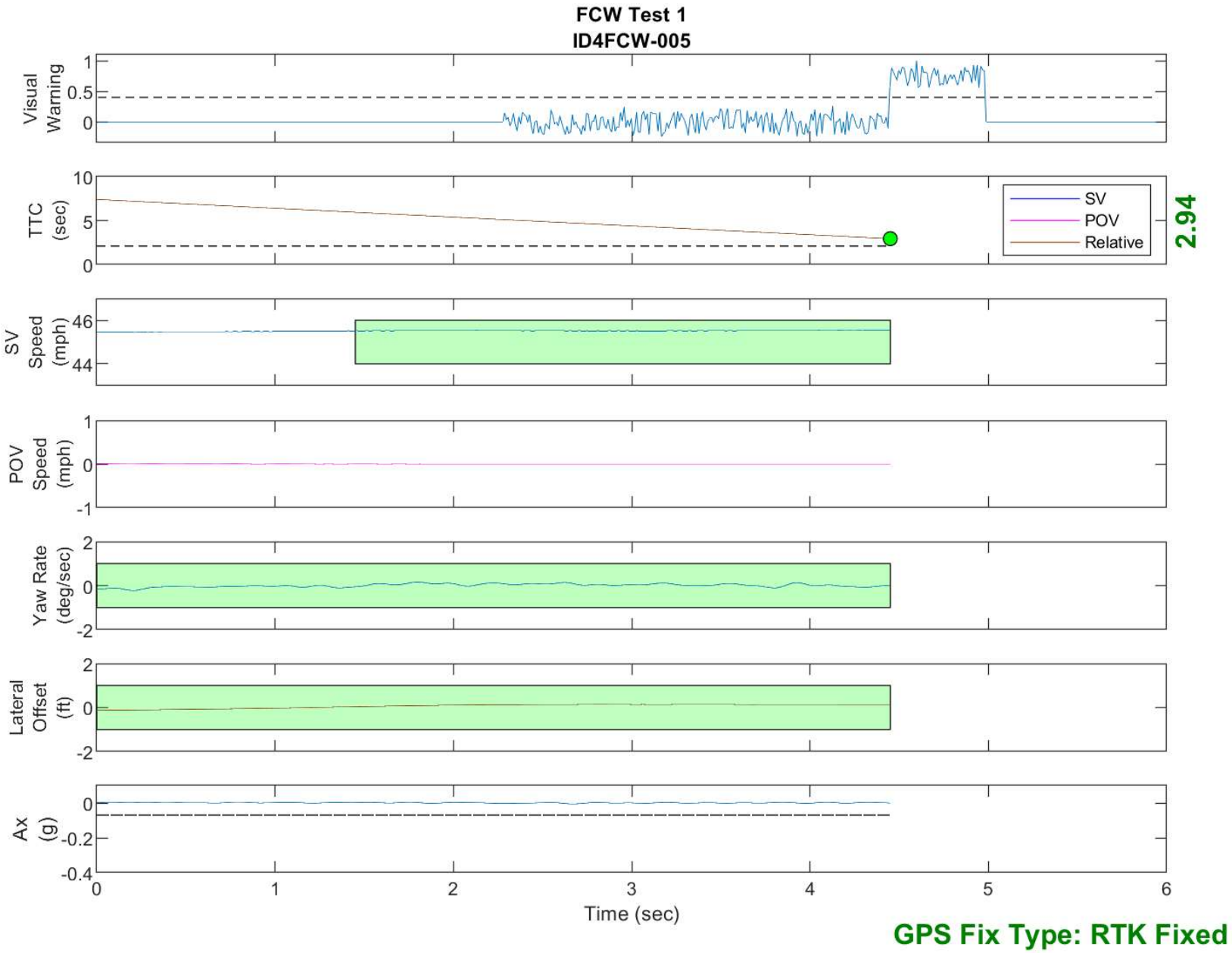

Figure D16. Time History for Run 5, FCW Test 1, Visual Warning

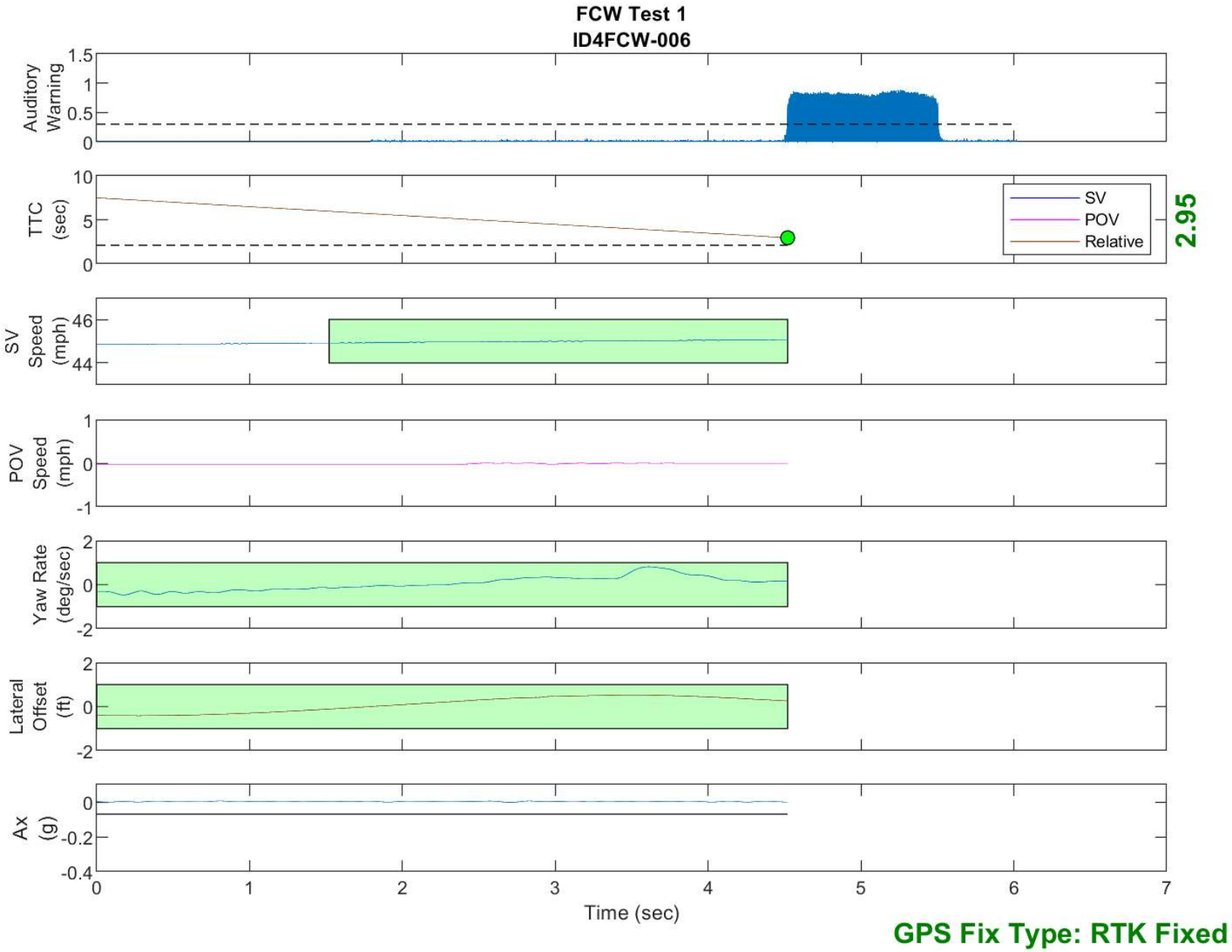

Figure D17. Time History for Run 6, FCW Test 1, Auditory Warning

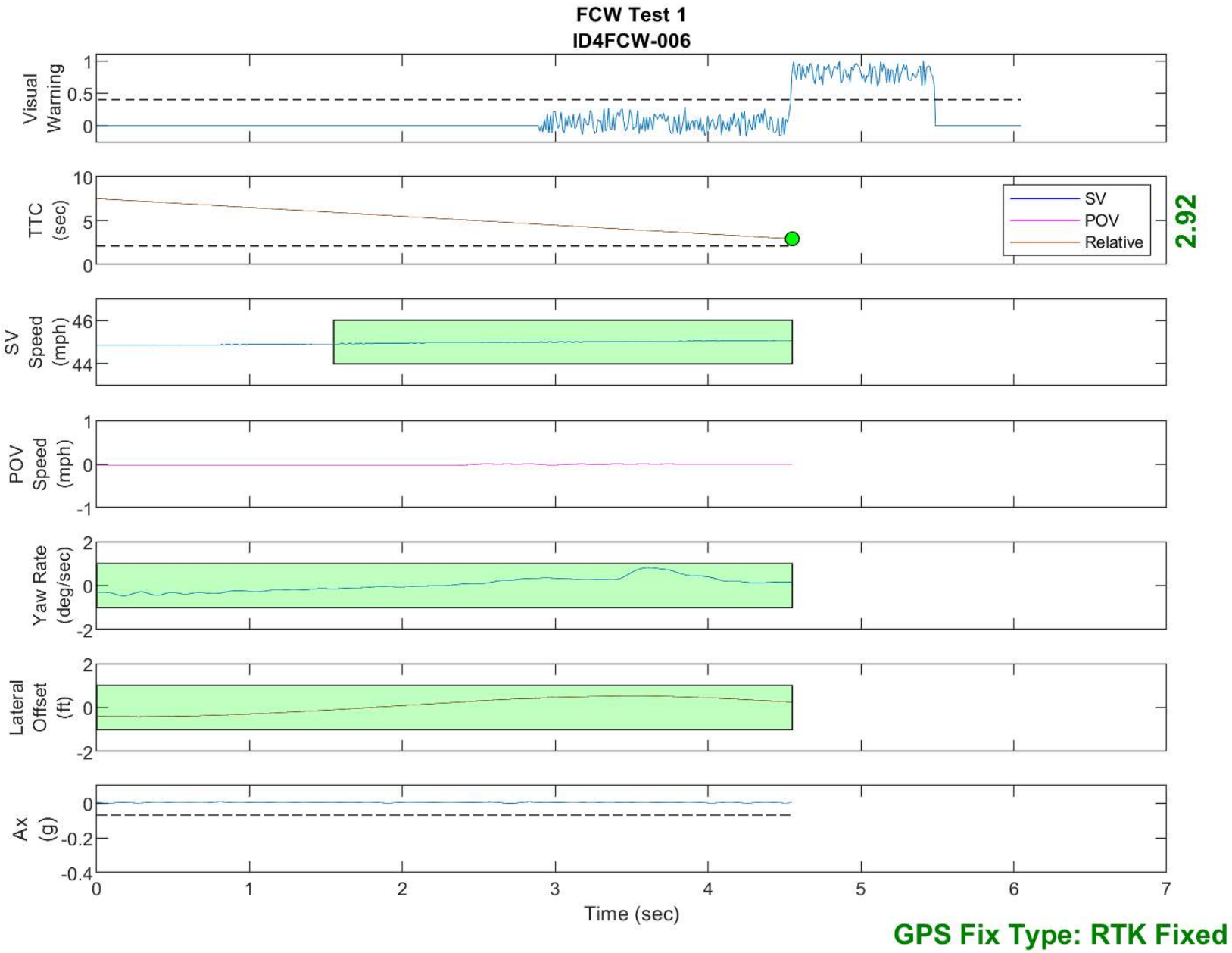

Figure D18. Time History for Run 6, FCW Test 1, Visual Warning

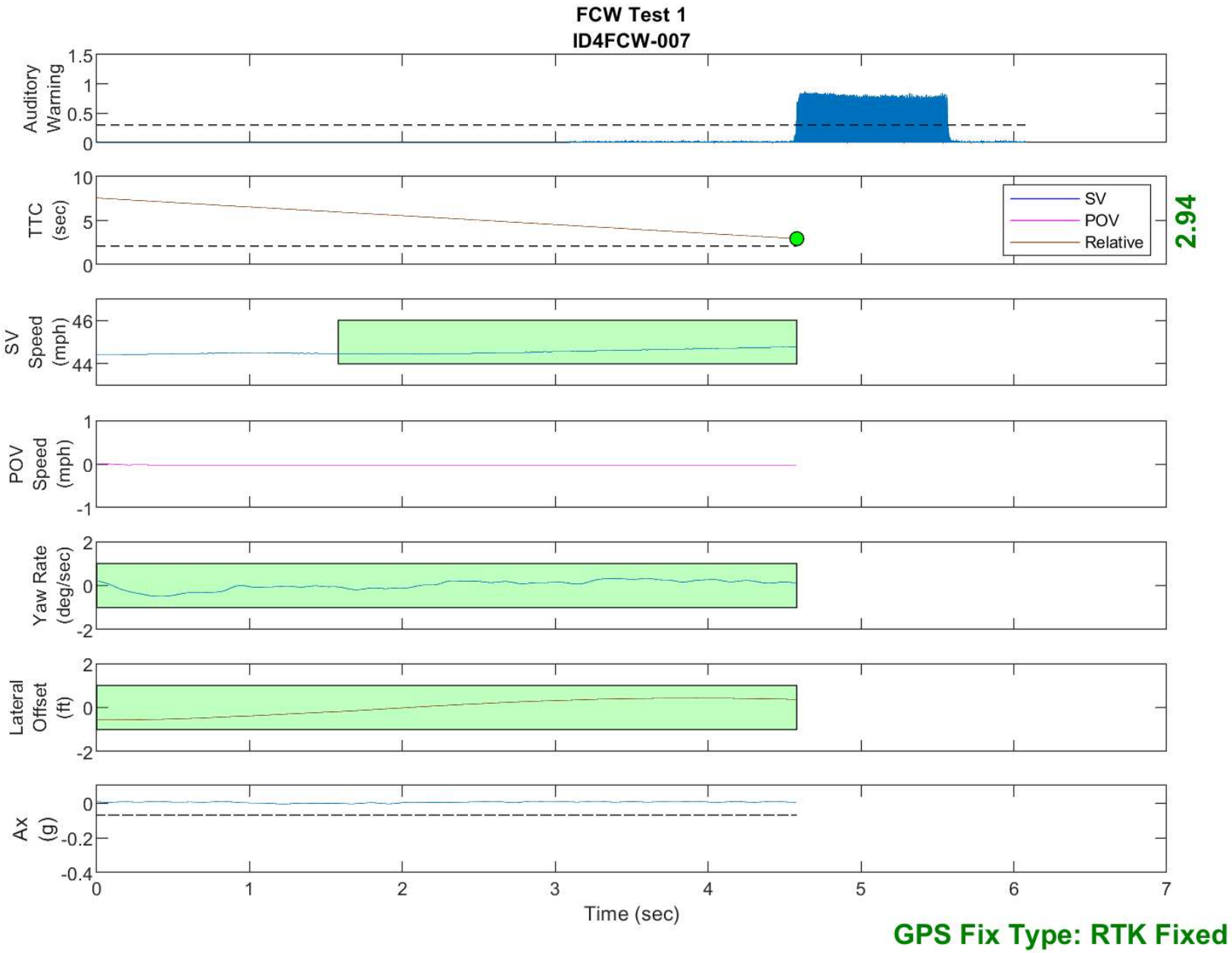

Figure D19. Time History for Run 7, FCW Test 1, Auditory Warning

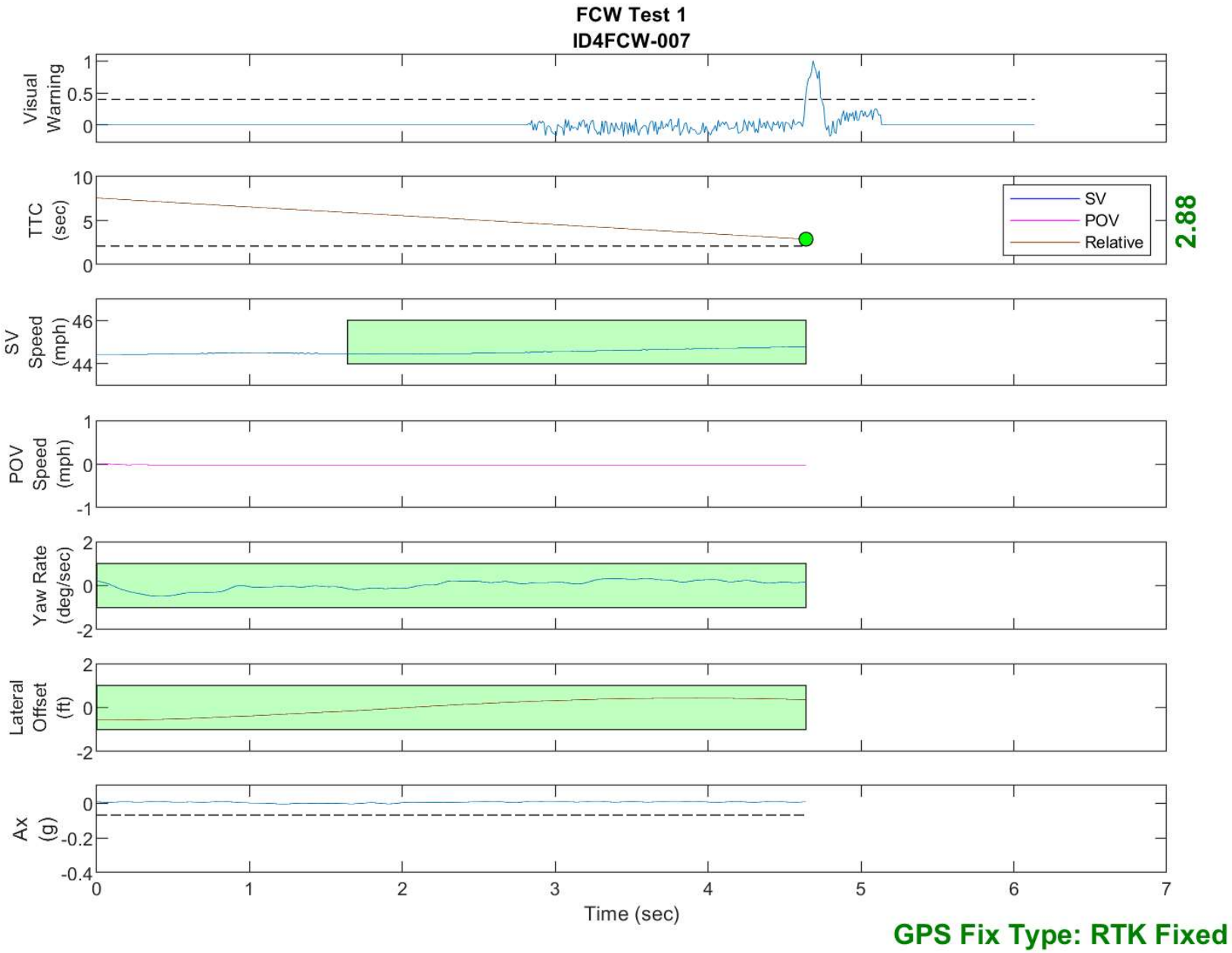

Figure D20. Time History for Run 7, FCW Test 1, Visual Warning

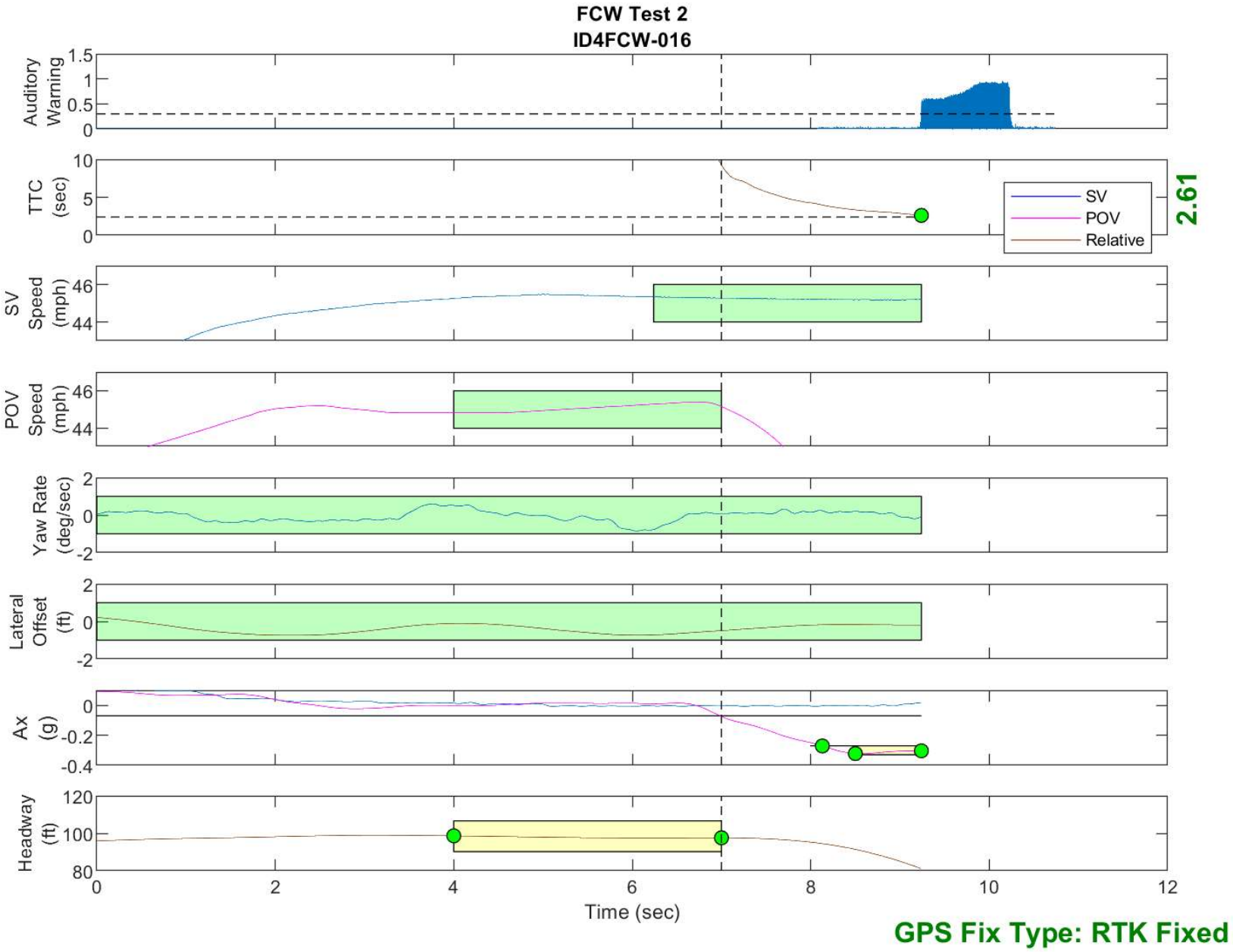

Figure D21. Time History for Run 16, FCW Test 2, Auditory Warning

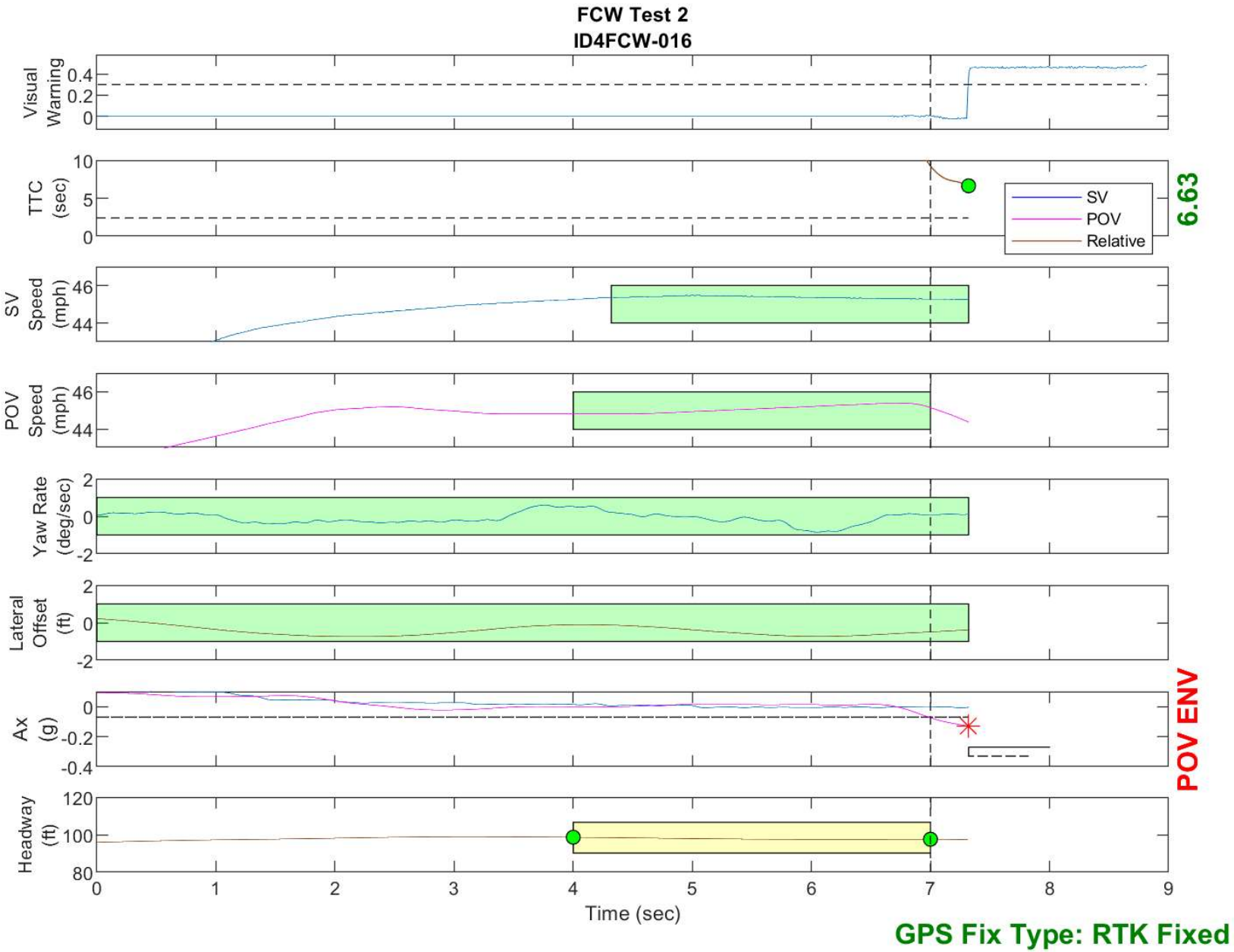

Figure D22. Time History for Run 16, FCW Test 2, Visual Warning

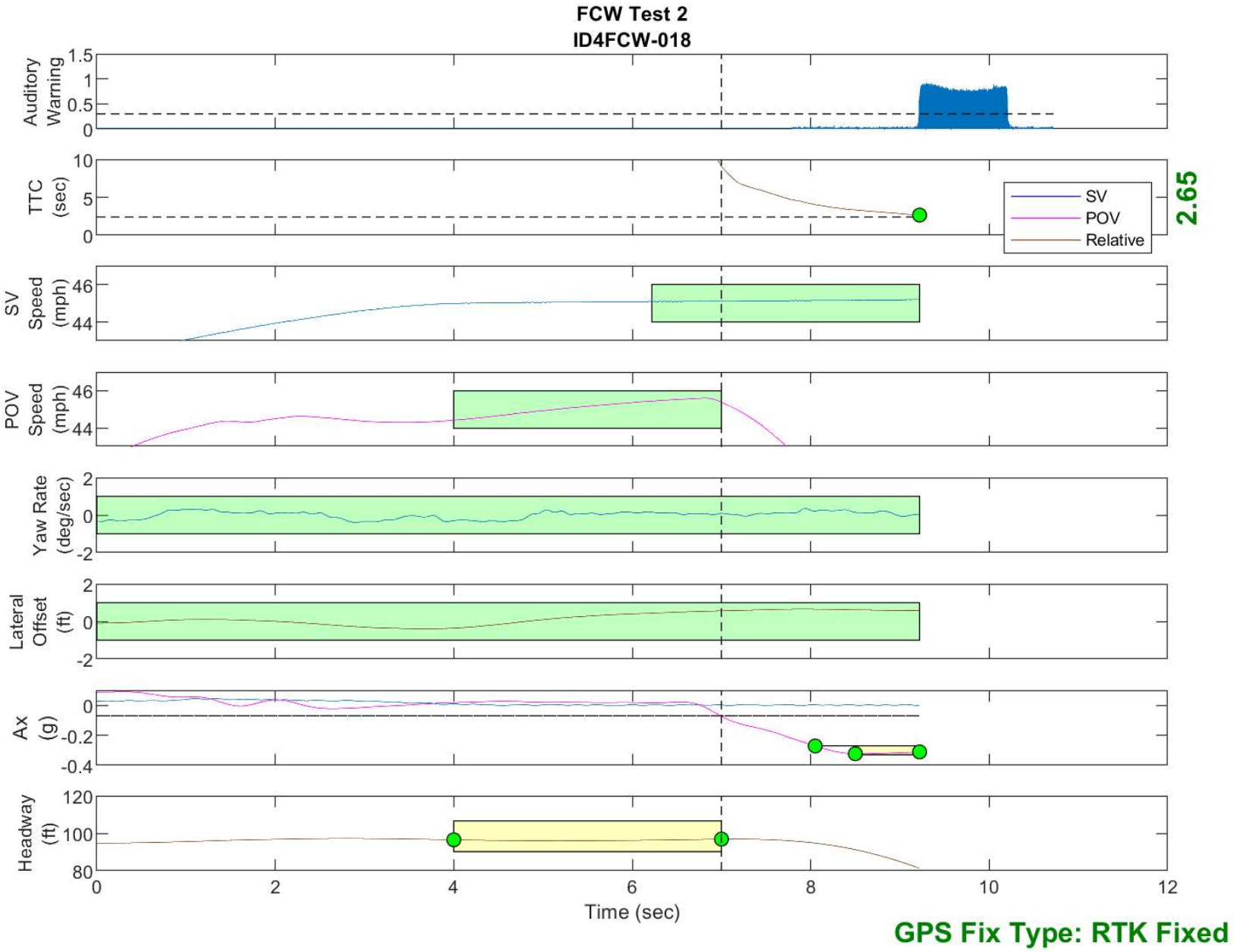

Figure D23. Time History for Run 18, FCW Test 2, Auditory Warning

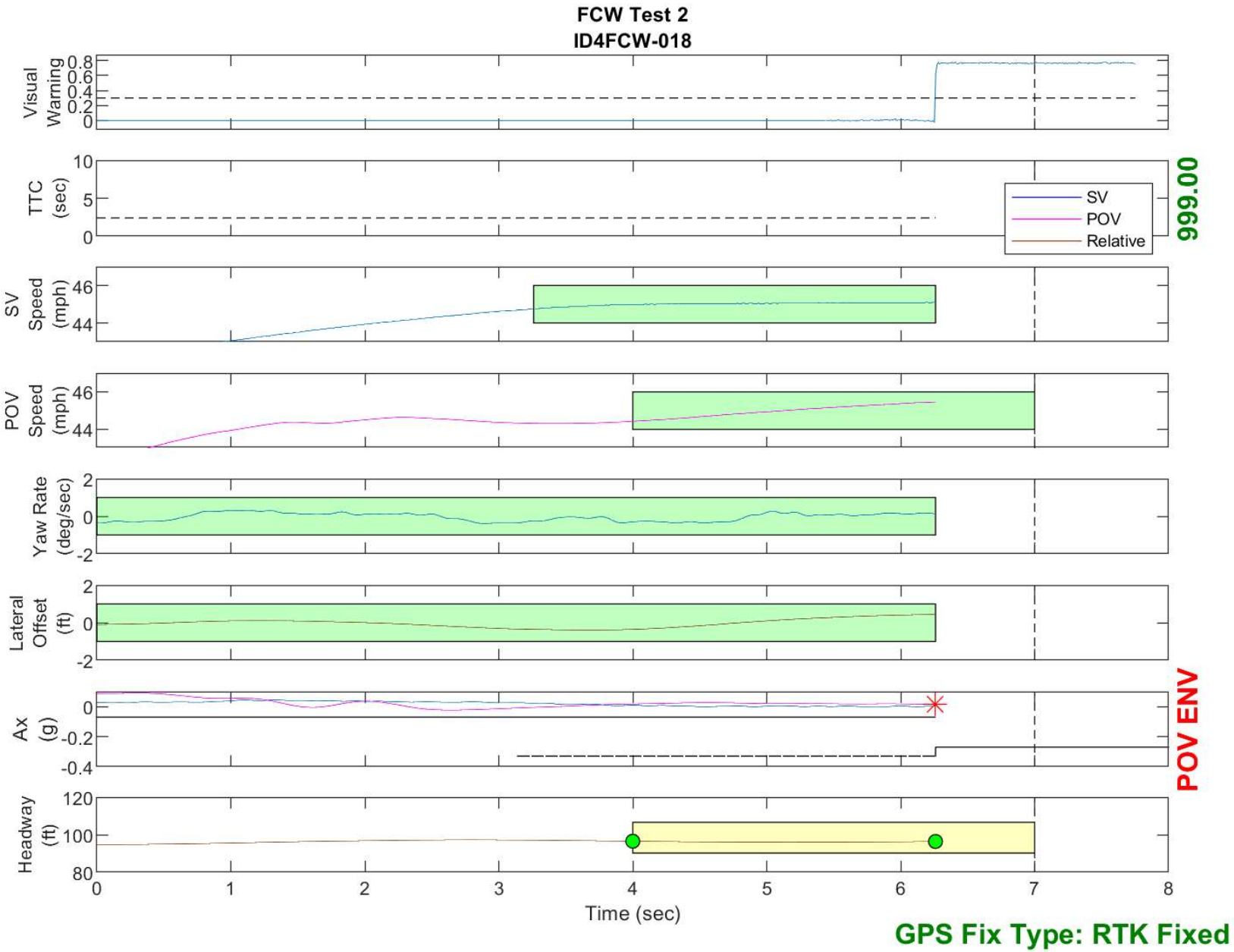

Figure D24. Time History for Run 18, FCW Test 2, Visual Warning

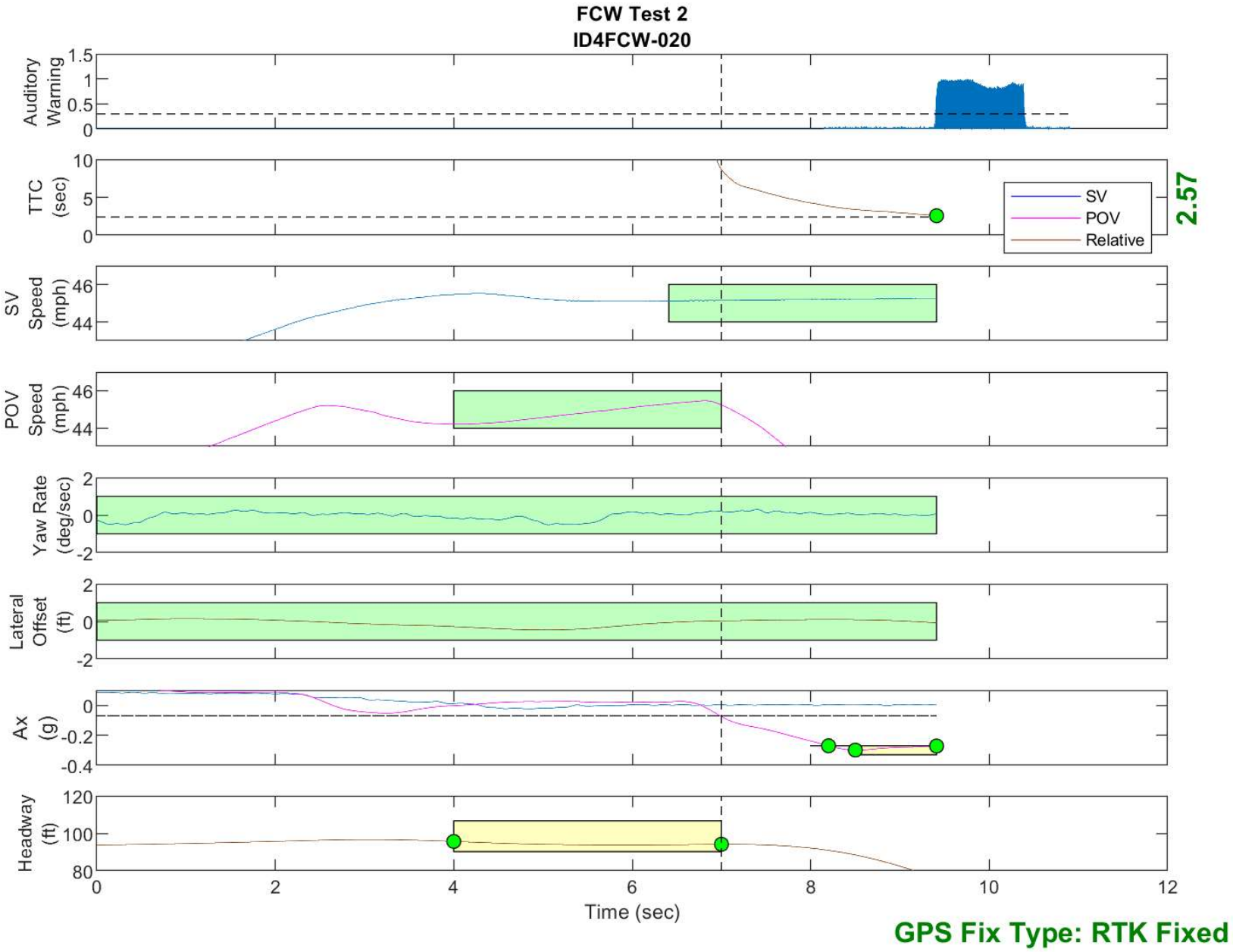

Figure D25. Time History for Run 20, FCW Test 2, Auditory Warning

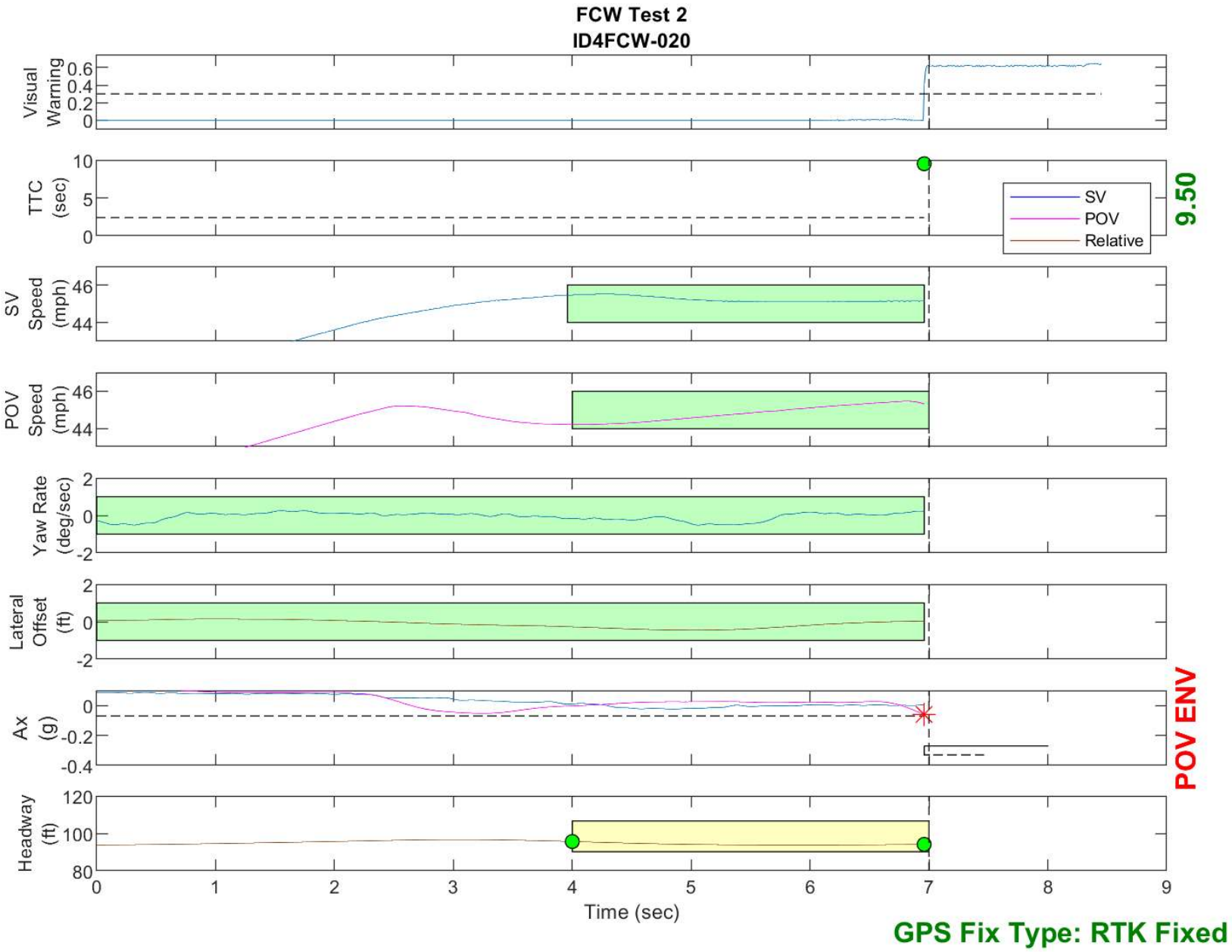

Figure D26. Time History for Run 20, FCW Test 2, Visual Warning

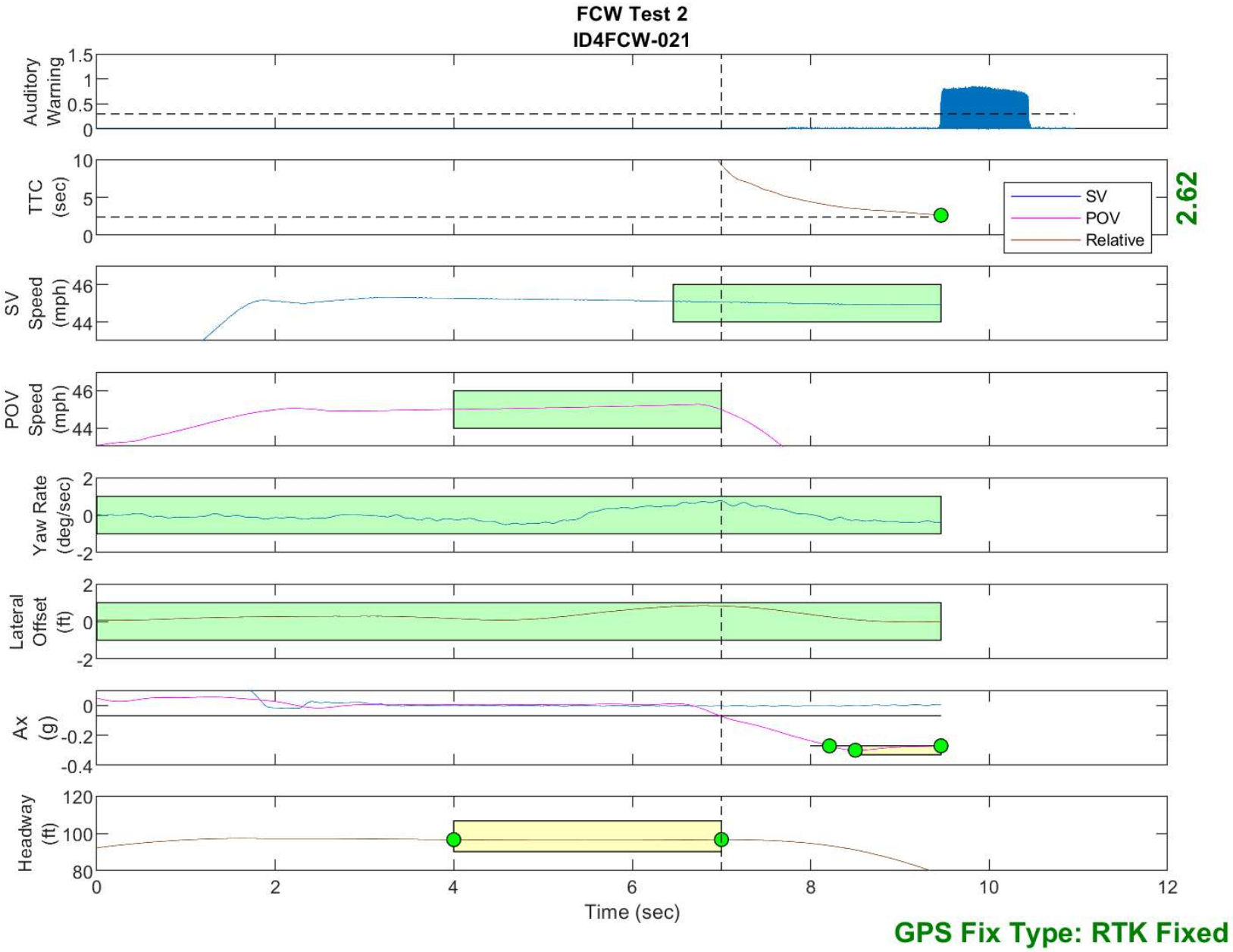

Figure D27. Time History for Run 21, FCW Test 2, Auditory Warning

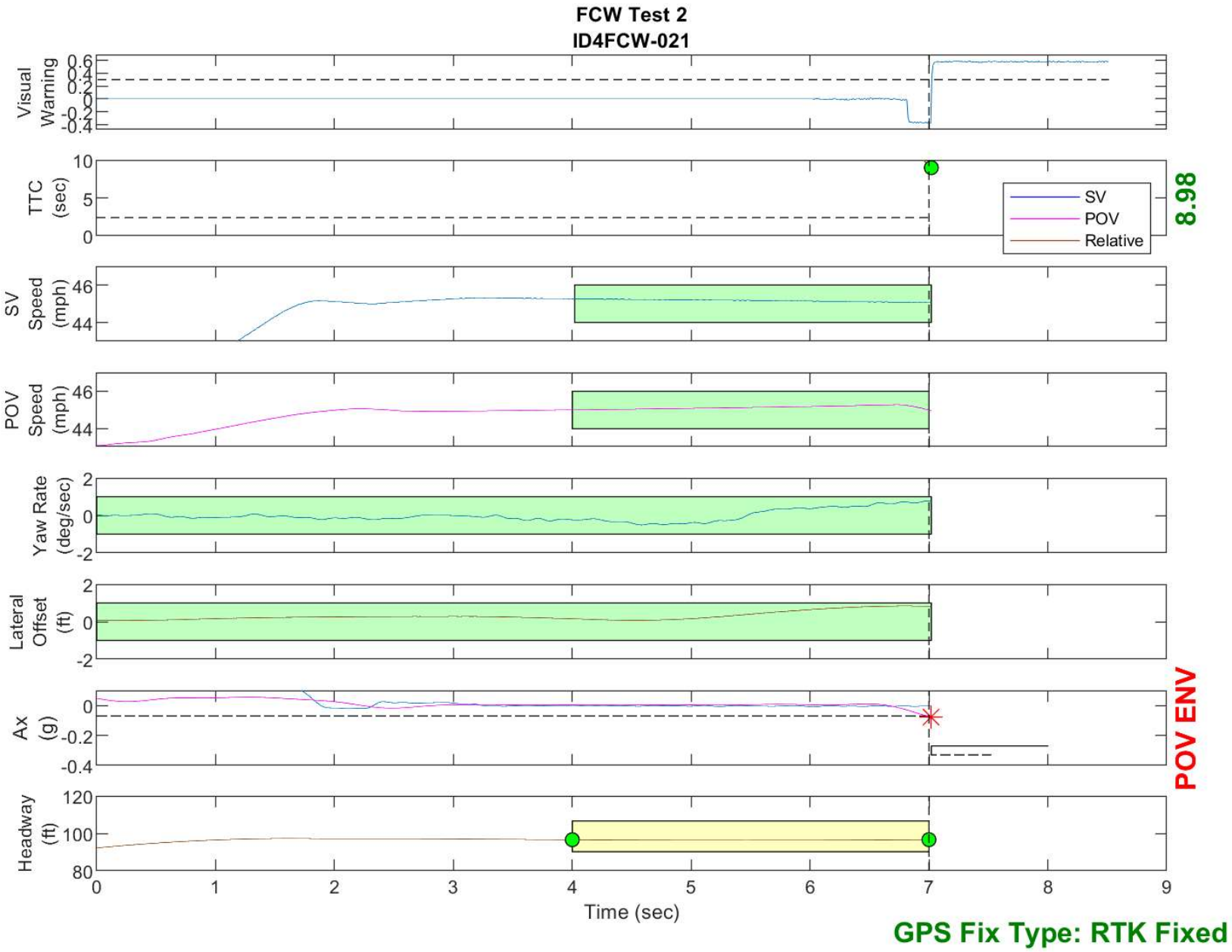

Figure D28. Time History for Run 21, FCW Test 2, Visual Warning

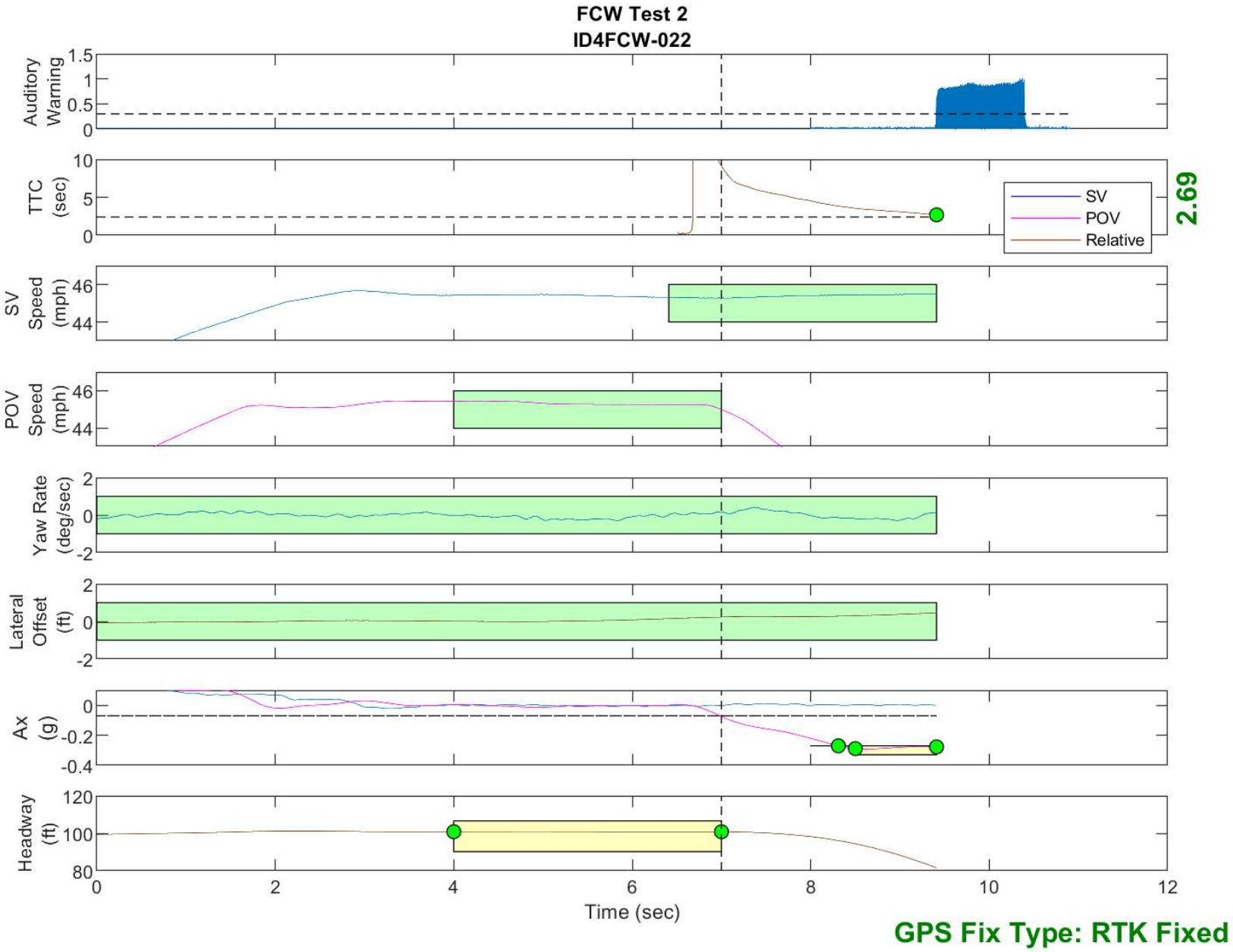

Figure D29. Time History for Run 22, FCW Test 2, Auditory Warning

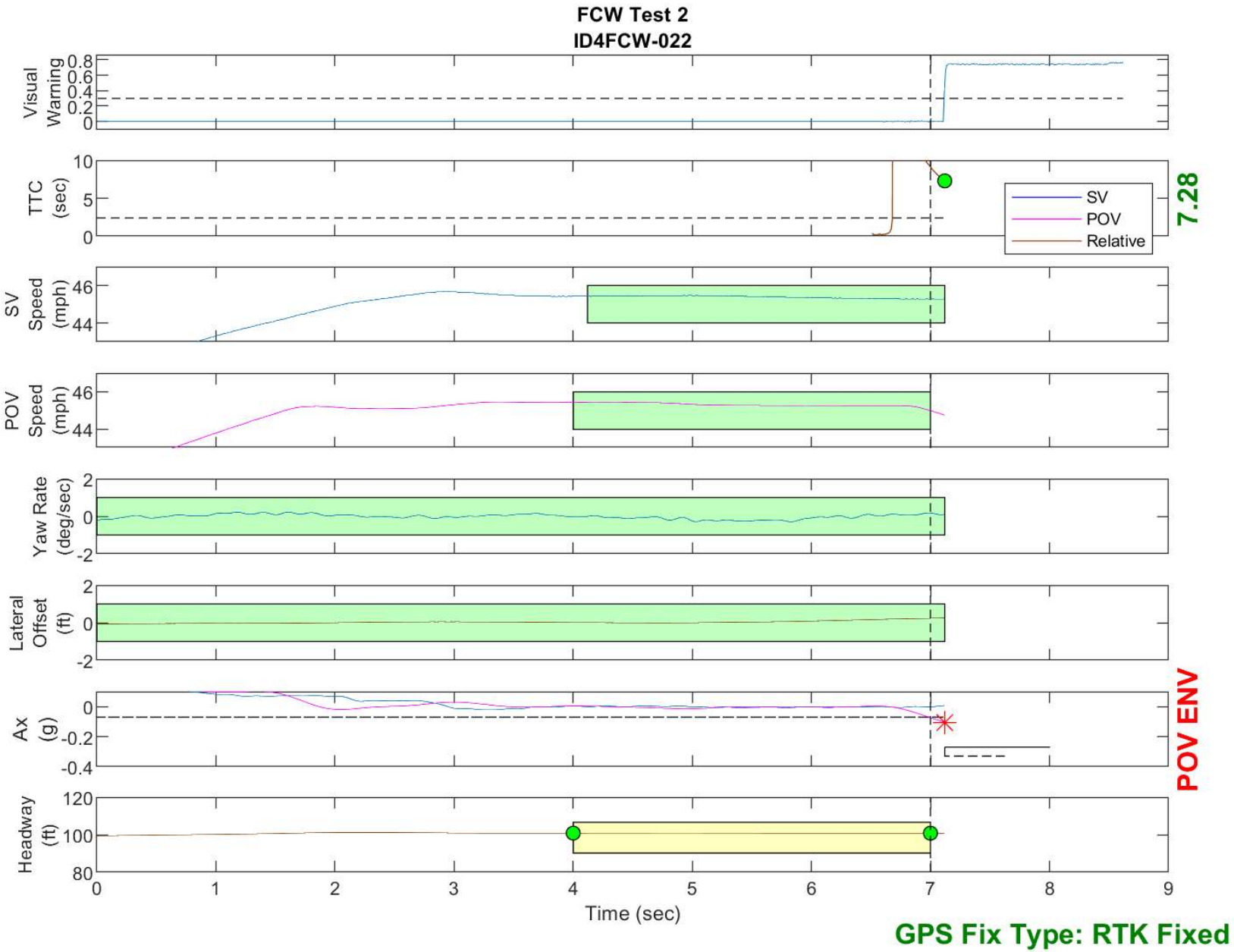

Figure D30. Time History for Run 22, FCW Test 2, Visual Warning

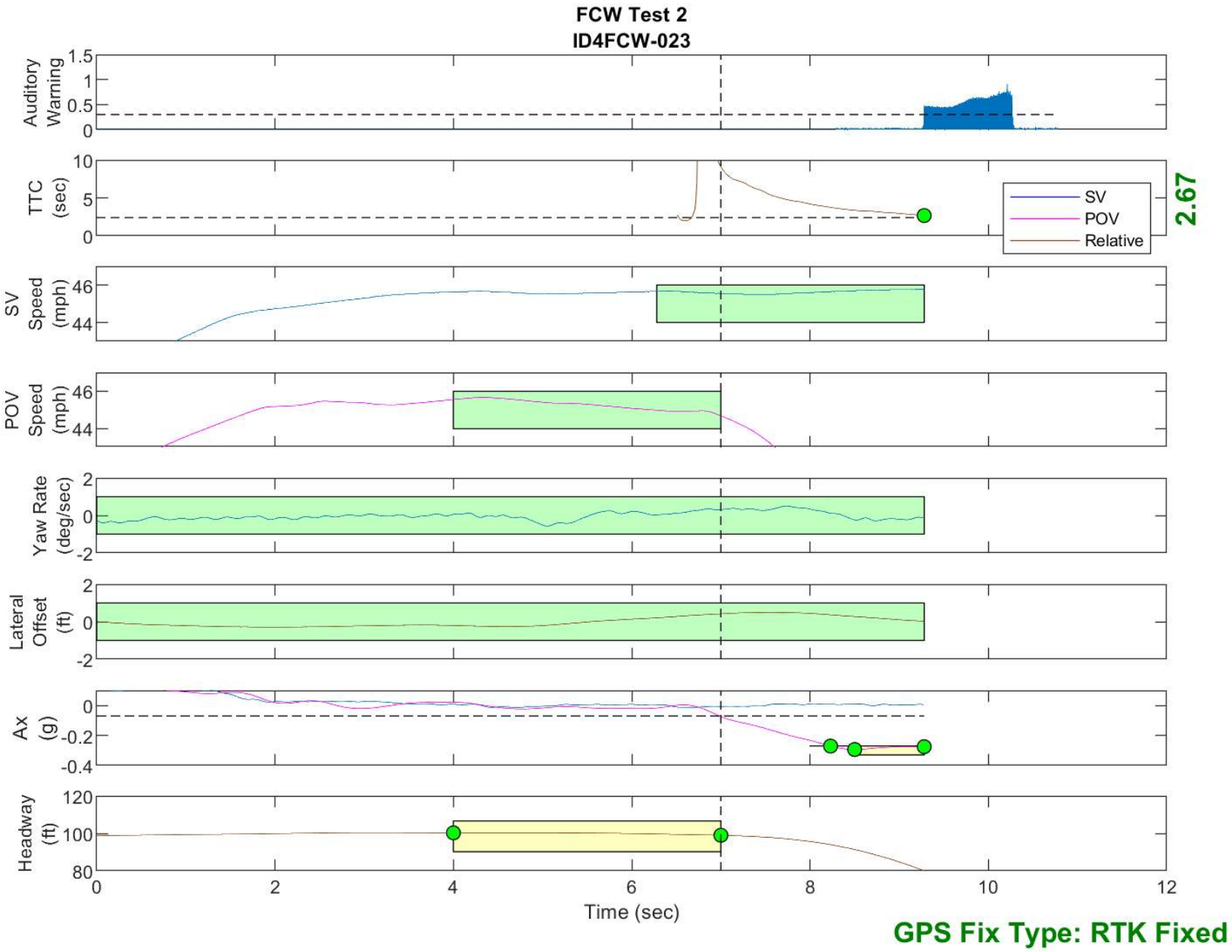

Figure D31. Time History for Run 23, FCW Test 2, Auditory Warning

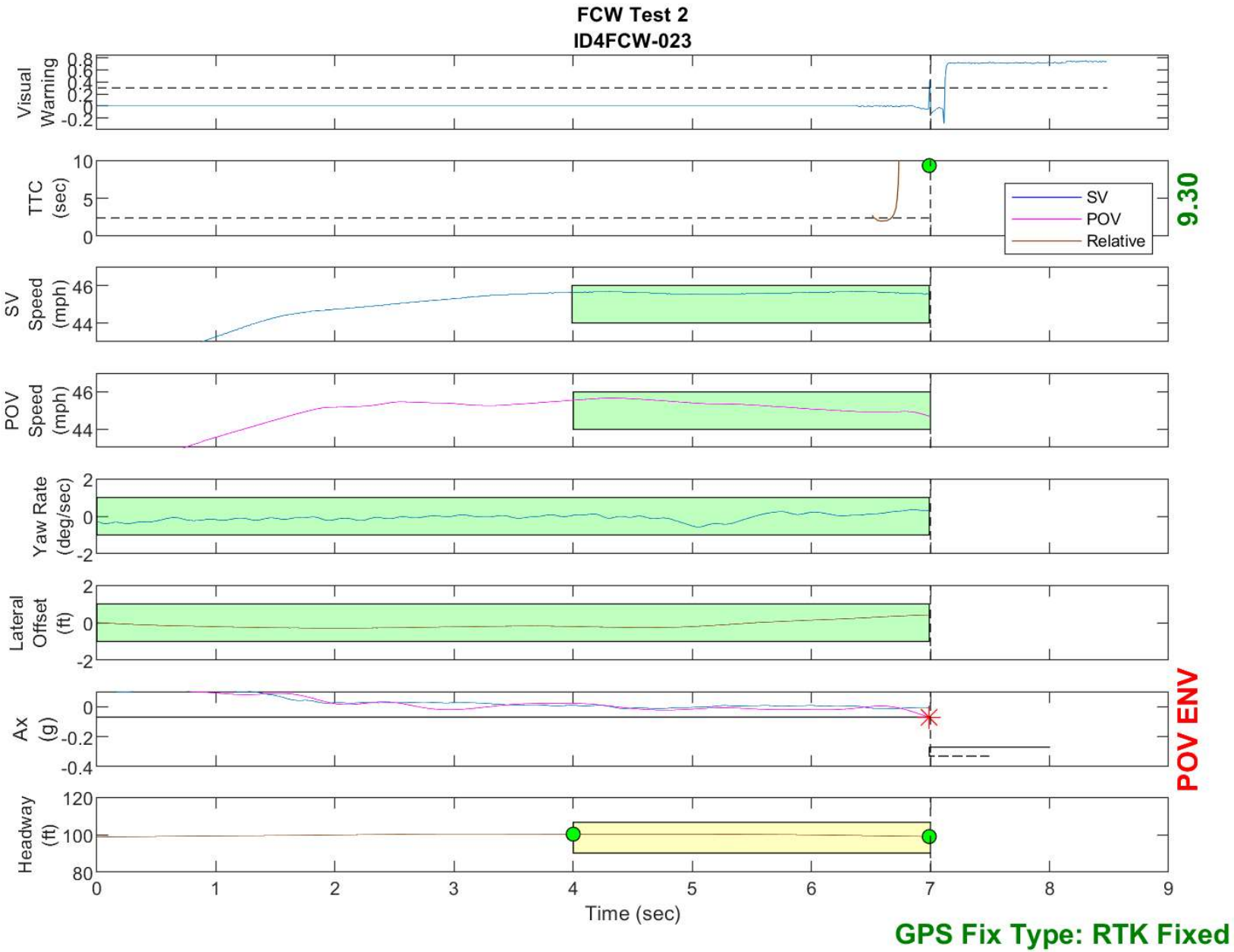

Figure D32. Time History for Run 23, FCW Test 2, Visual Warning

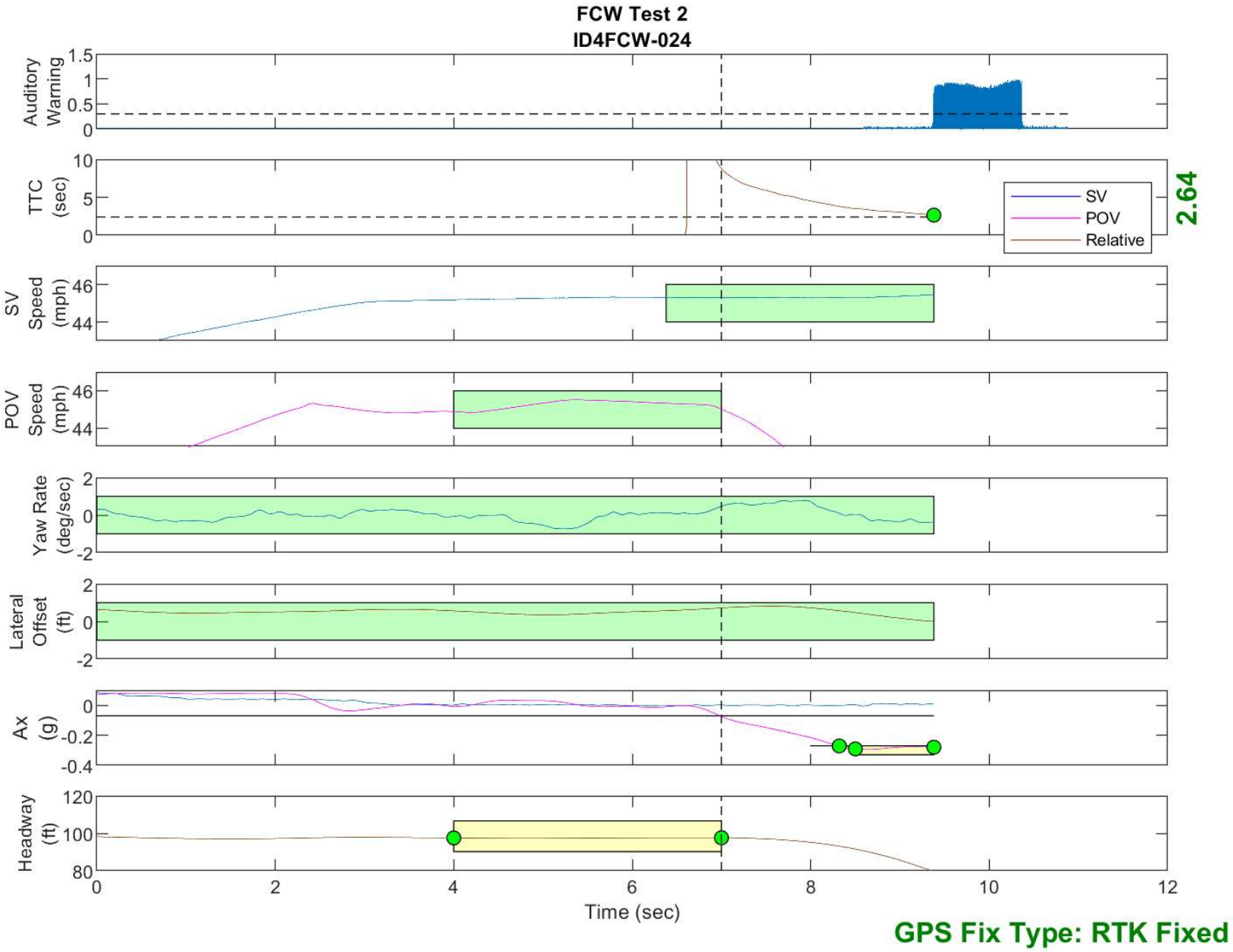

Figure D33. Time History for Run 24, FCW Test 2, Auditory Warning

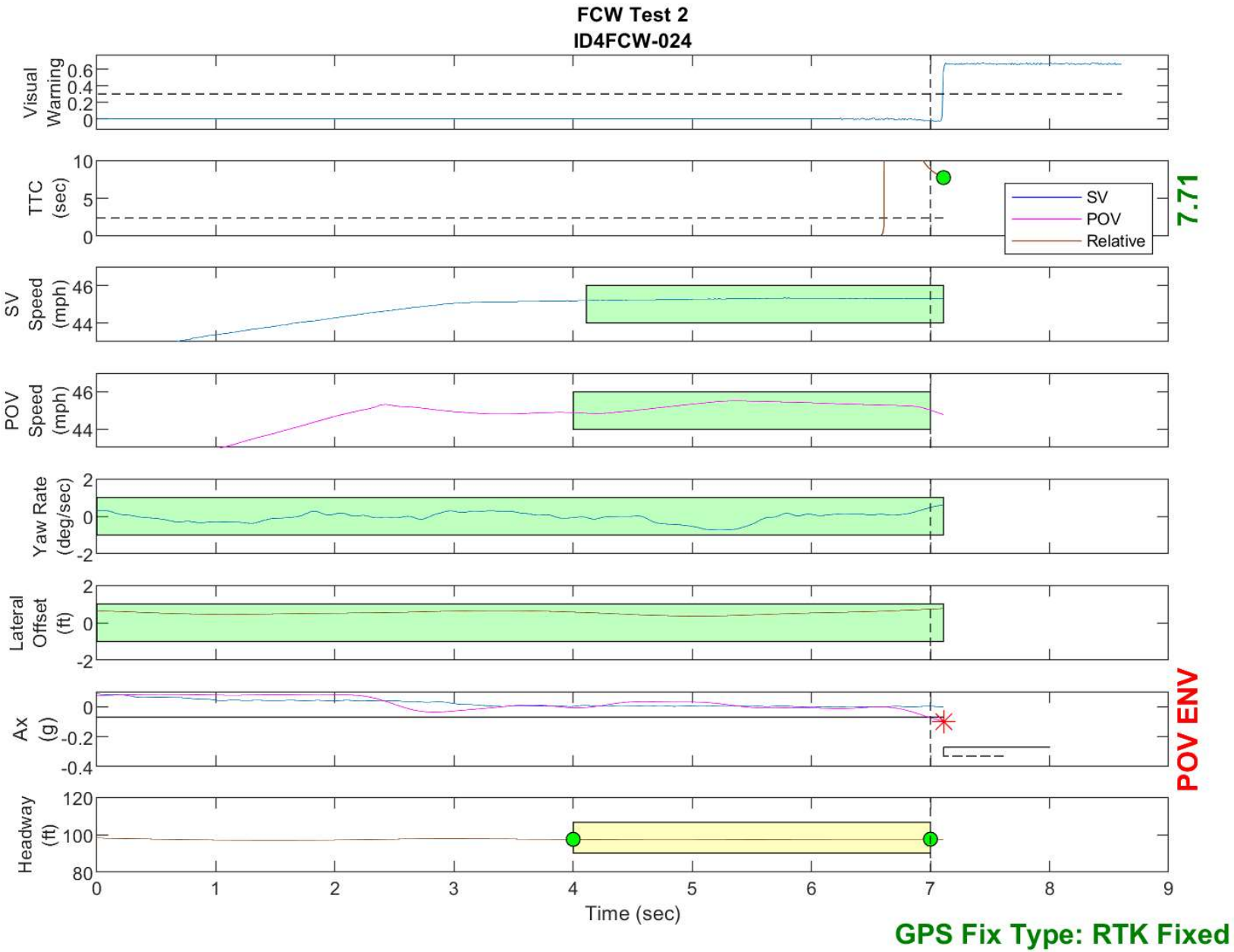

Figure D34. Time History for Run 24, FCW Test 2, Visual Warning

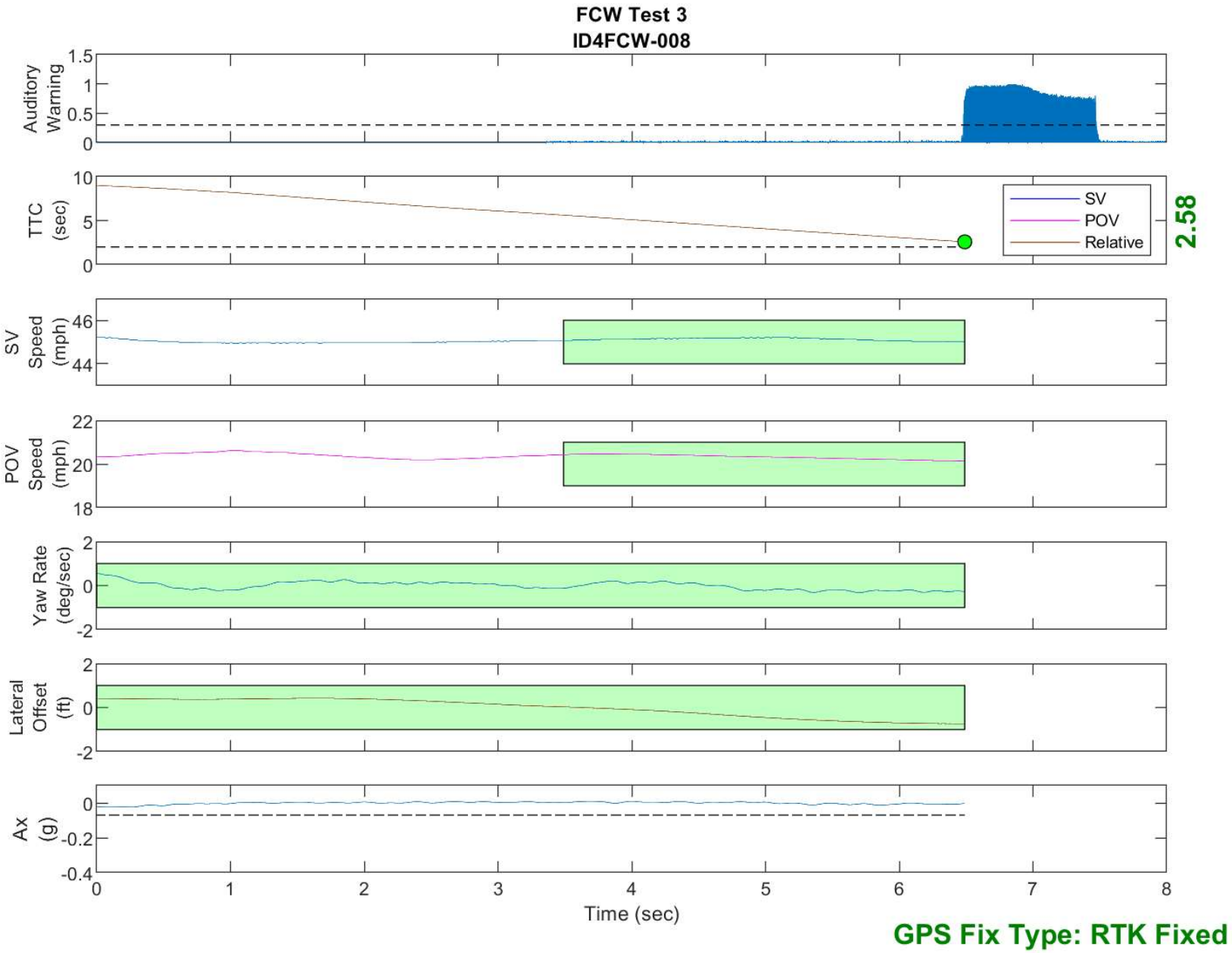

Figure D35. Time History for Run 8, FCW Test 3, Auditory Warning

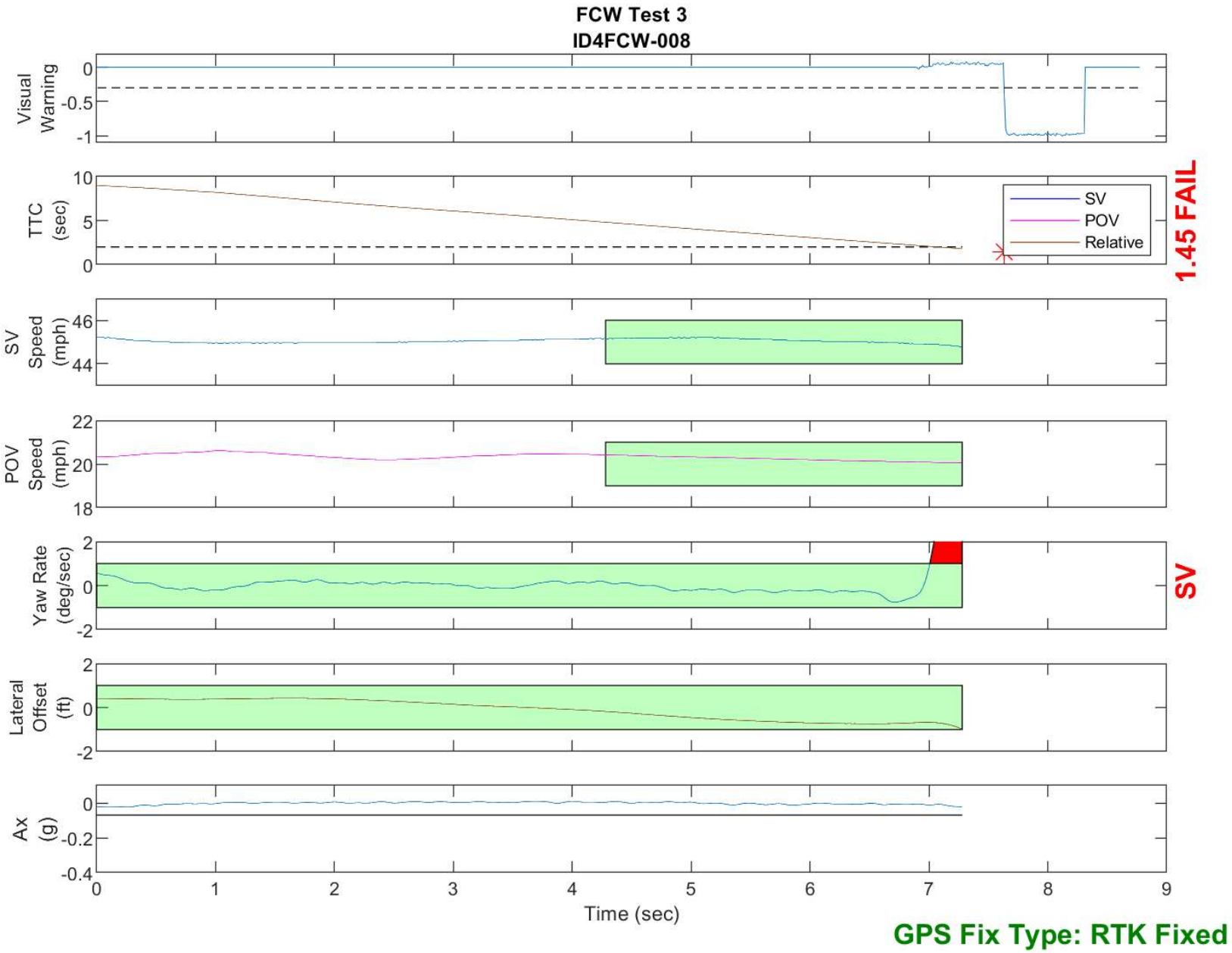

Figure D36. Time History for Run 8, FCW Test 3, Visual Warning

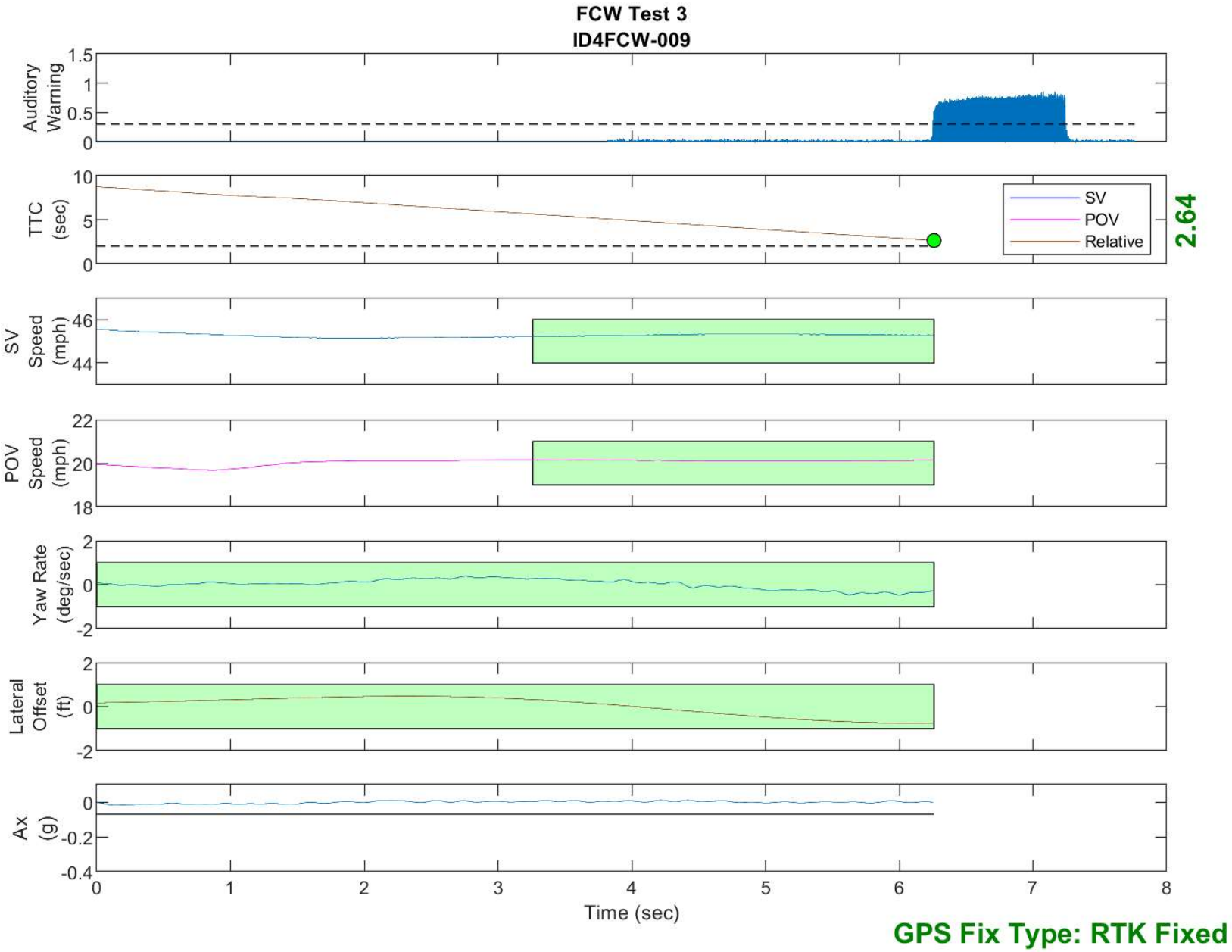

Figure D37. Time History for Run 9, FCW Test 3, Auditory Warning

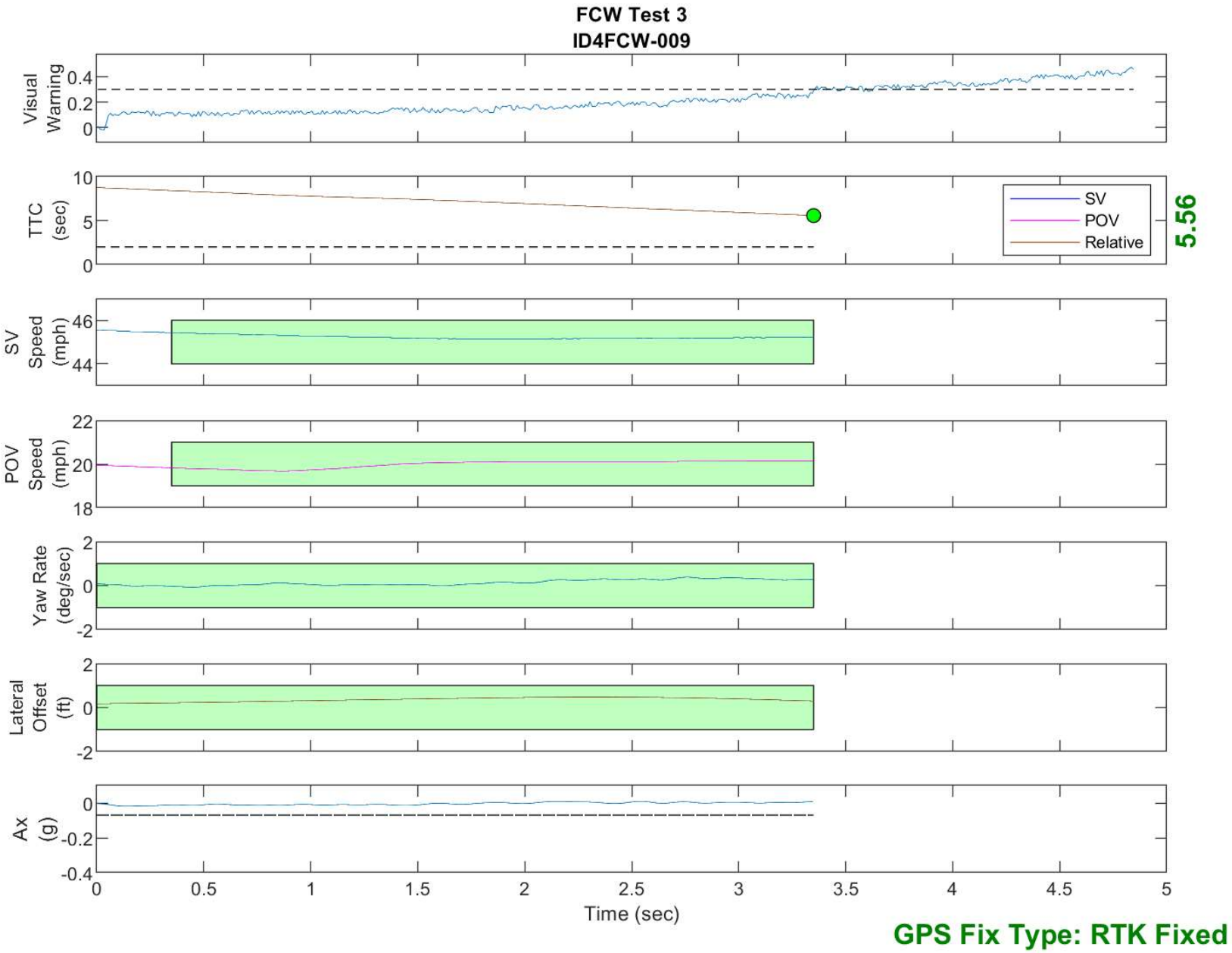

Figure D38. Time History for Run 9, FCW Test 3, Visual Warning

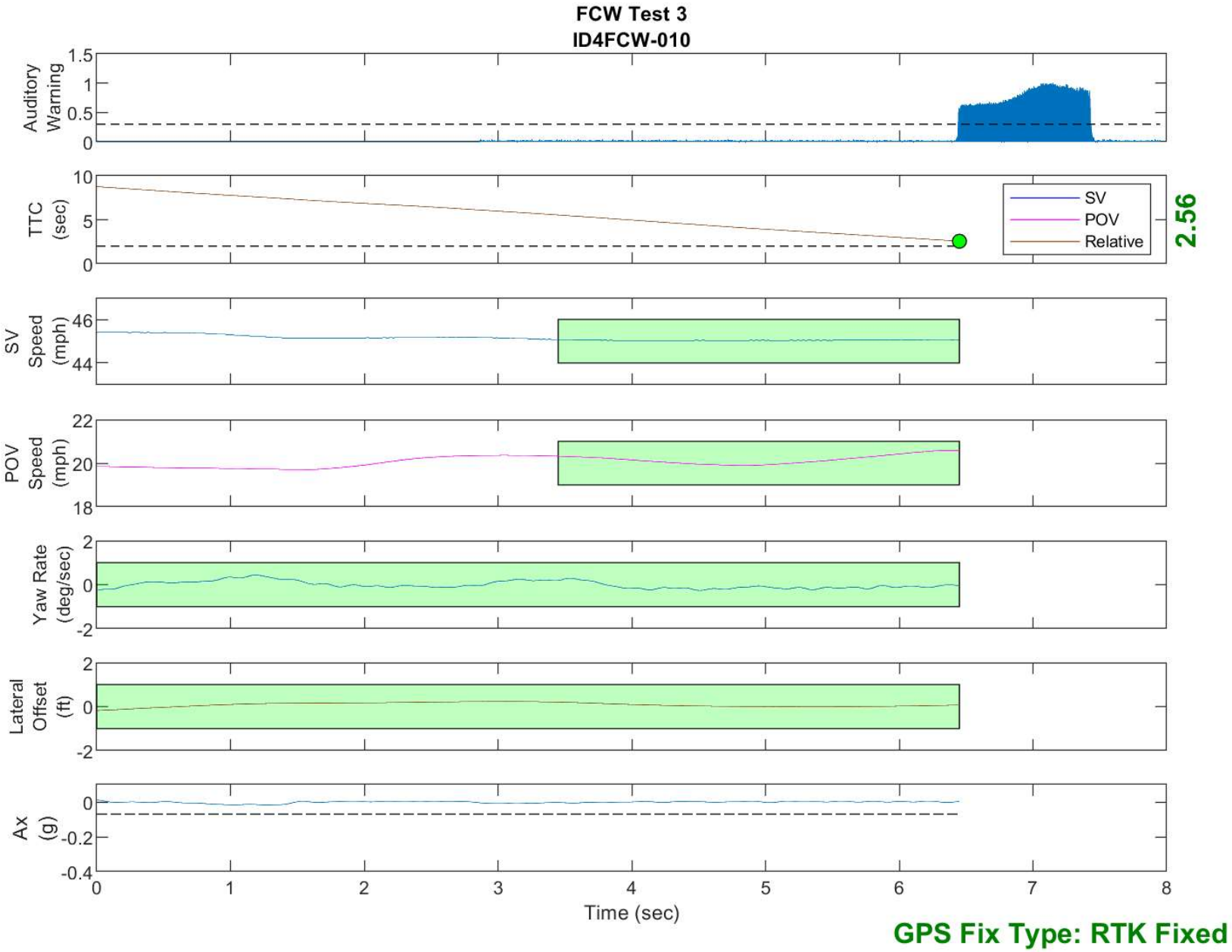

Figure D39. Time History for Run 10, FCW Test 3, Auditory Warning

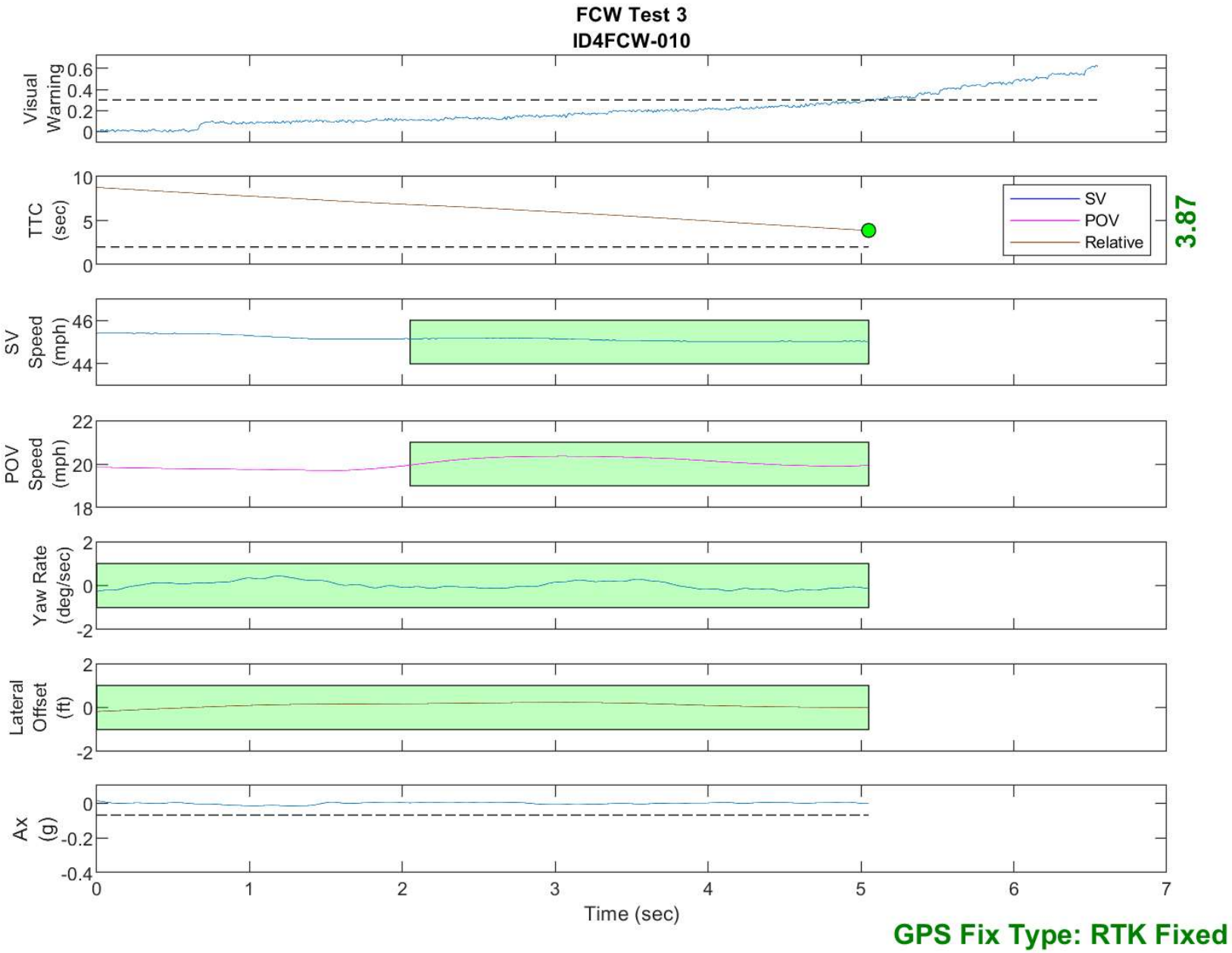

Figure D40. Time History for Run 10, FCW Test 3, Visual Warning

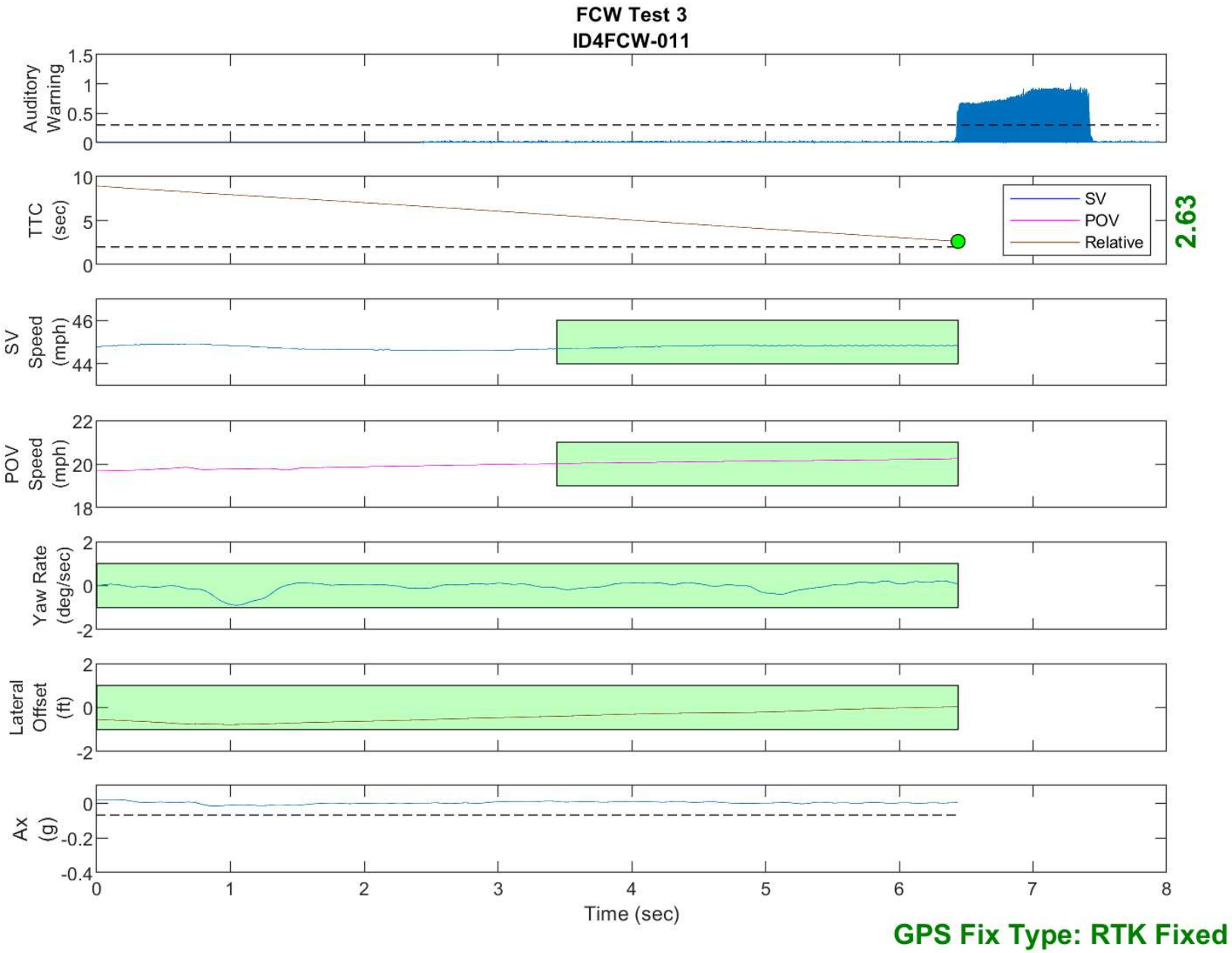

Figure D41. Time History for Run 11, FCW Test 3, Auditory Warning

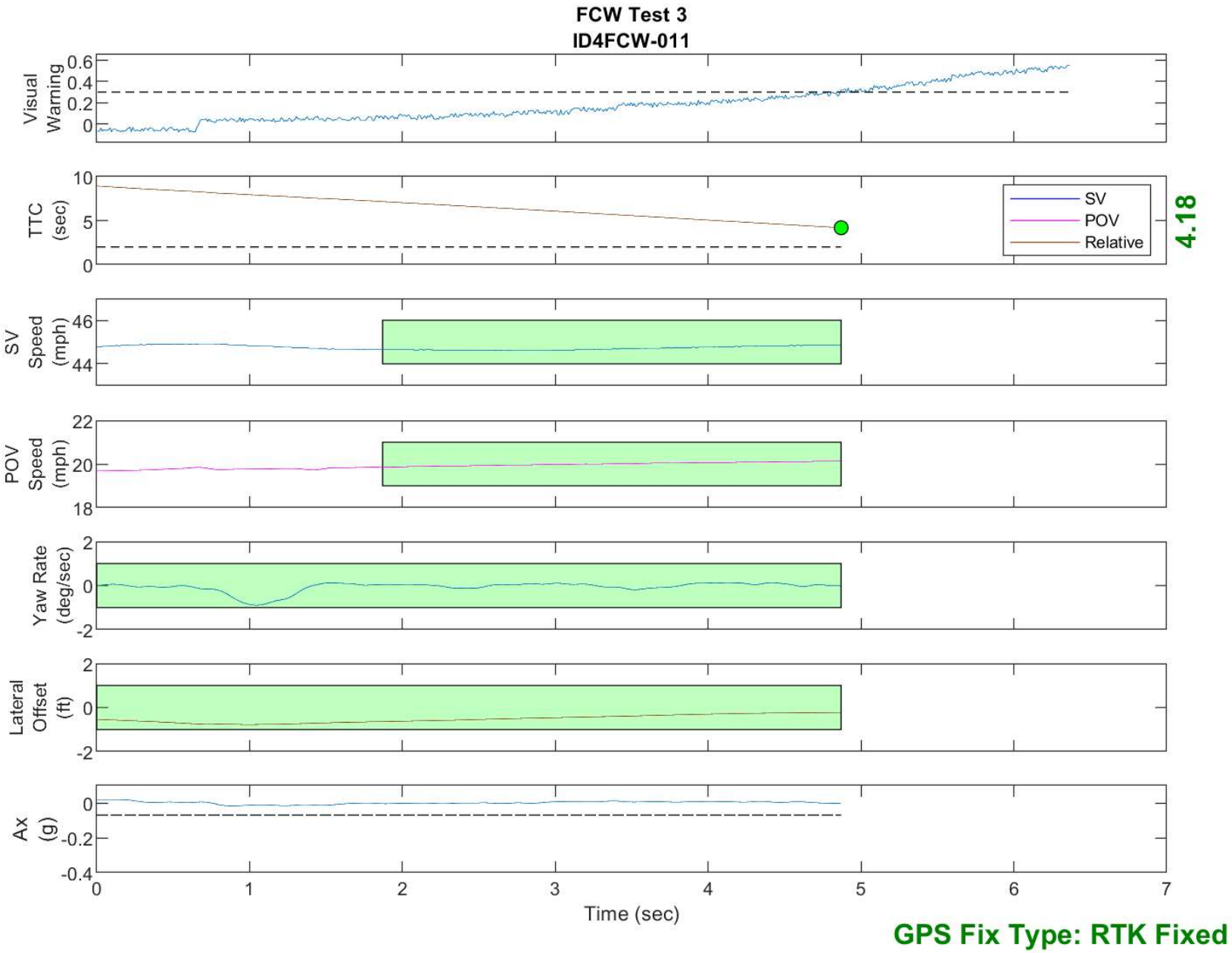

Figure D42. Time History for Run 11, FCW Test 3, Visual Warning

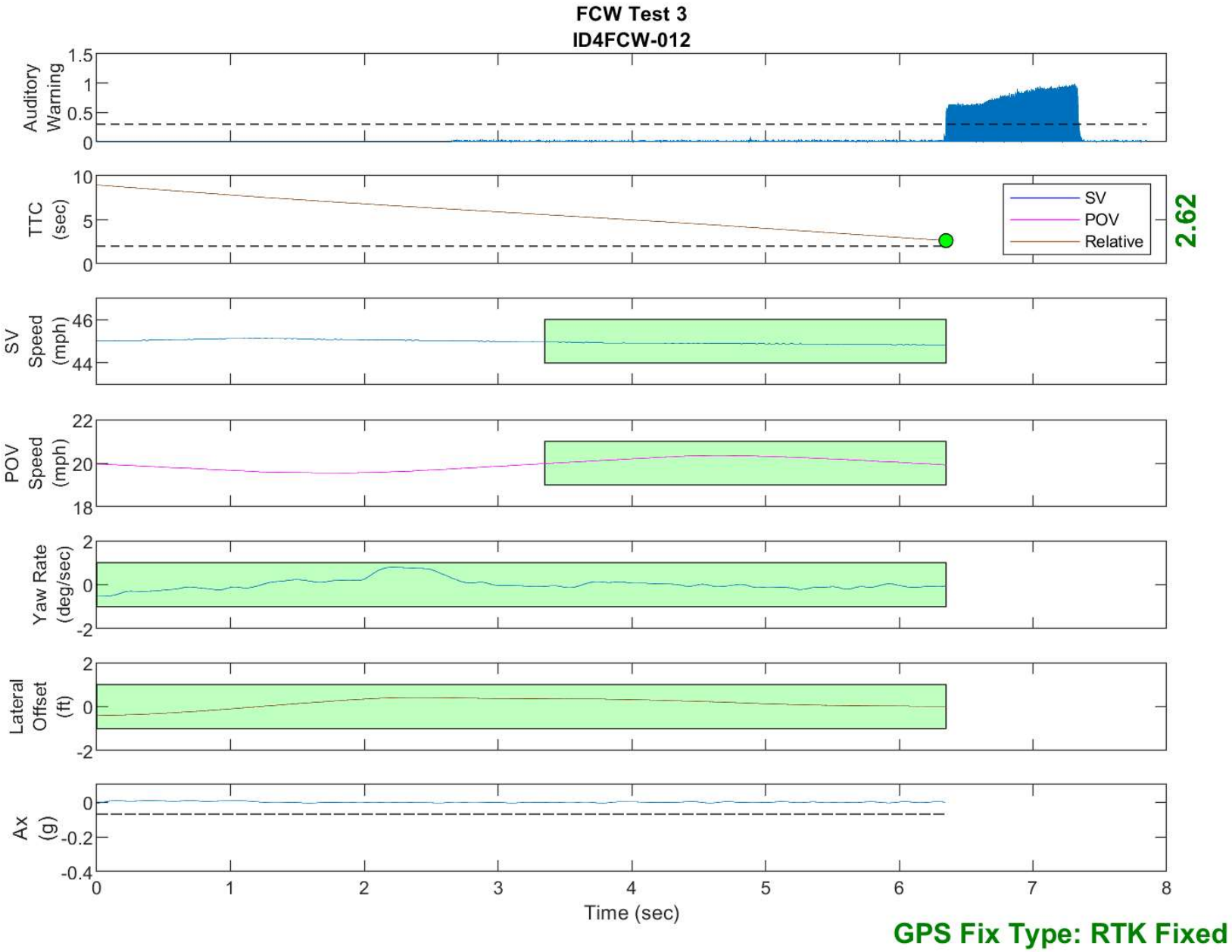

Figure D43. Time History for Run 12, FCW Test 3, Auditory Warning

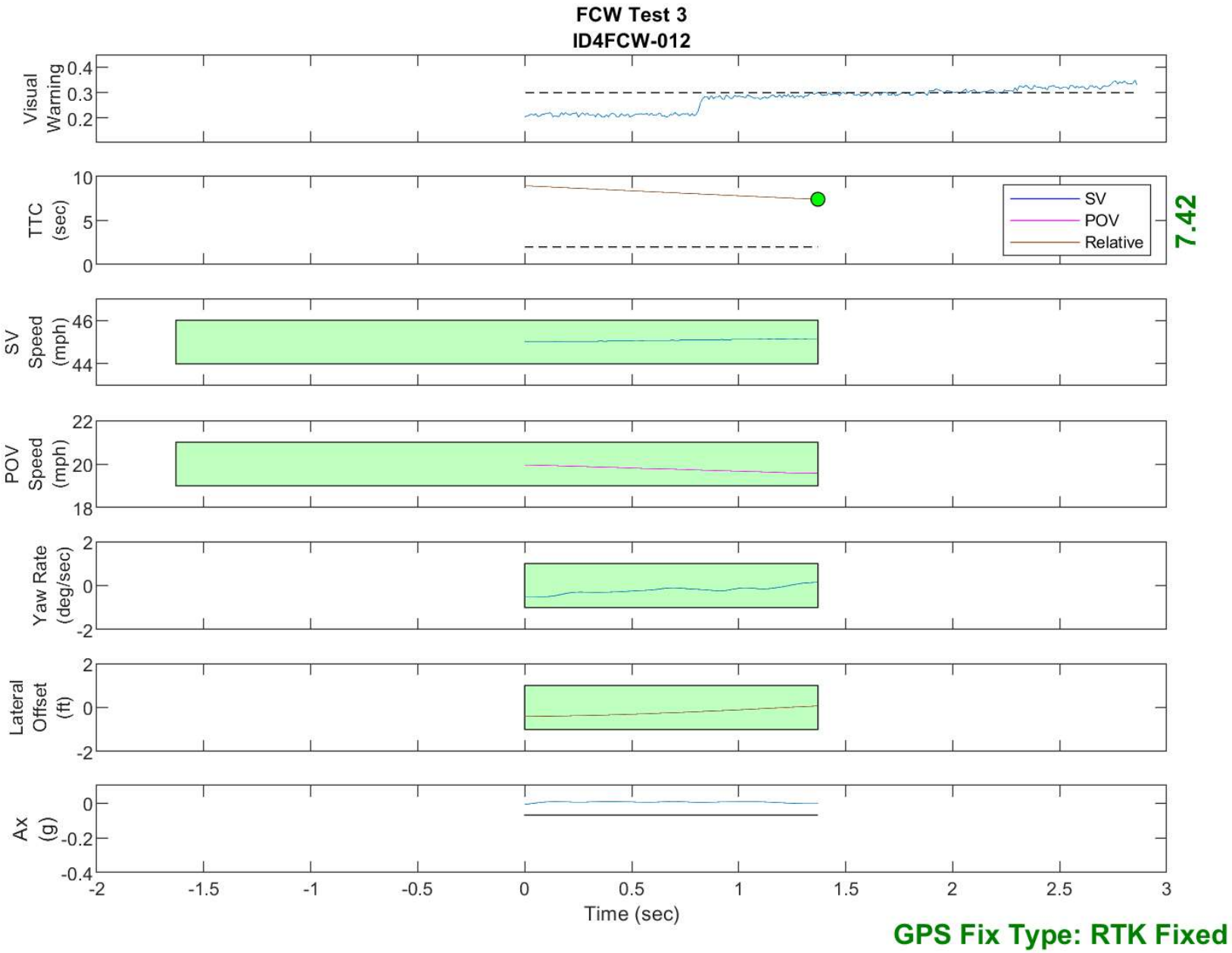

Figure D44. Time History for Run 12, FCW Test 3, Visual Warning

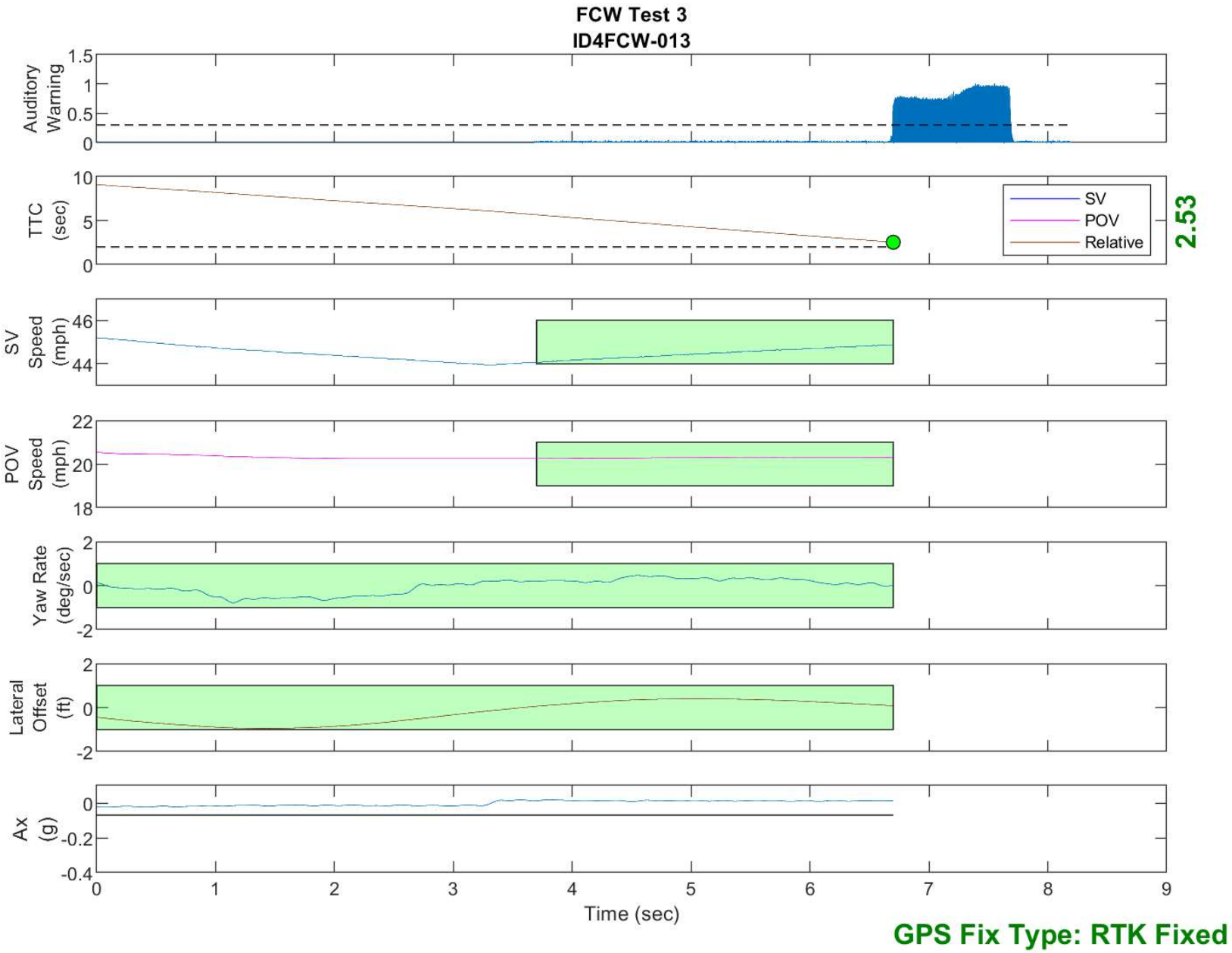

Figure D45. Time History for Run 13, FCW Test 3, Auditory Warning

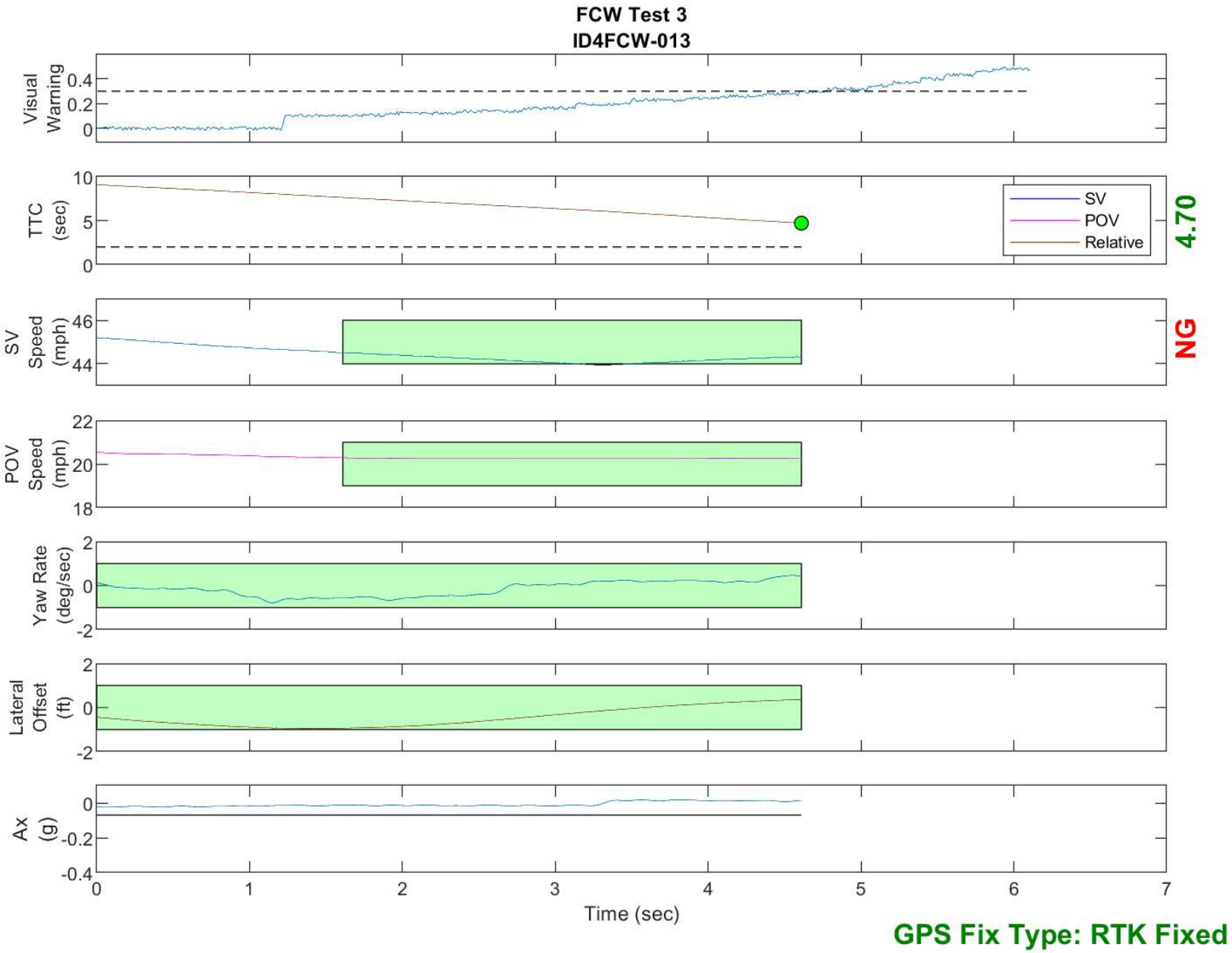

Figure D46. Time History for Run 13, FCW Test 3, Visual Warning

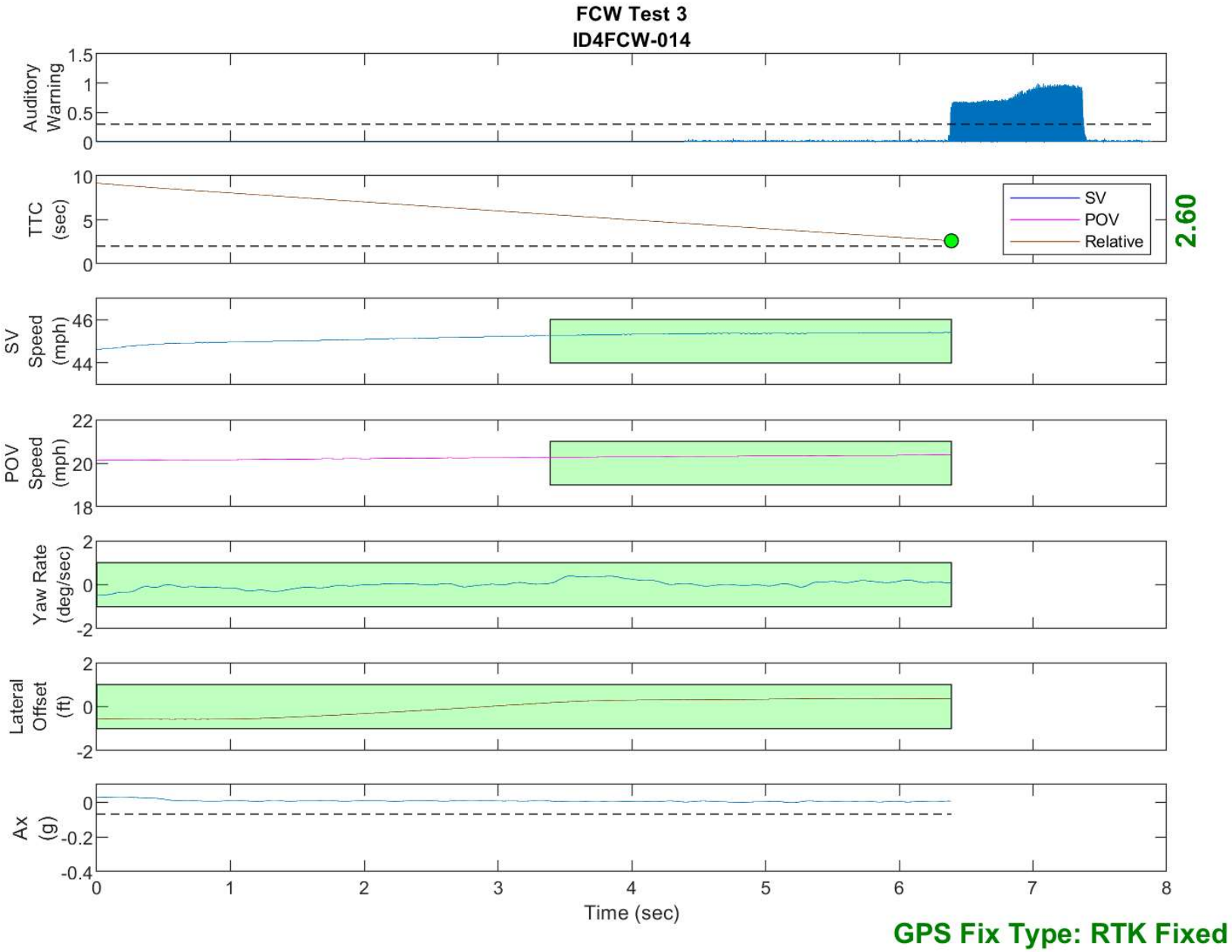

Figure D47. Time History for Run 14, FCW Test 3, Auditory Warning

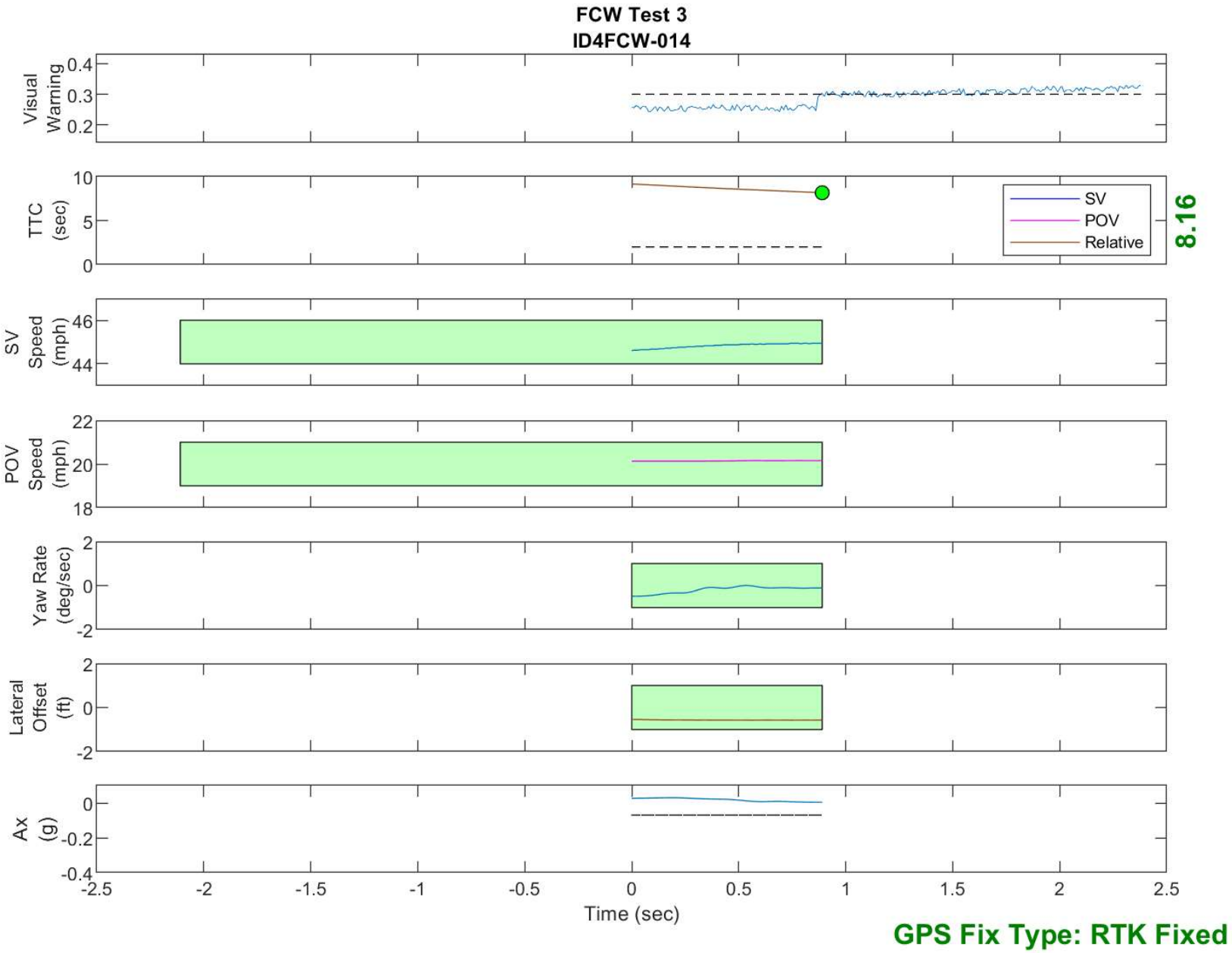

Figure D48. Time History for Run 14, FCW Test 3, Visual Warning