NEW CAR ASSESSMENT PROGRAM
FORWARD COLLISION WARNING CONFIRMATION TEST
NCAP-DRI-FCW-20-02

2020 Audi Q5 45 TFSI quattro

DYNAMIC RESEARCH, INC.
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7 August 2020

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

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16. Abstract These tests were conducted on the subject 2020 Audi Q5 45 TFSI quattro 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.			
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Section I

INTRODUCTION

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

Section II

DATA SHEETS

FORWARD COLLISION WARNING

DATA SHEET 1: TEST RESULTS SUMMARY

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2020 Audi Q5 45 TFSI quattro

VIN: *WA1BNAFY0L200xxxx*

Test Date: *6/24/2020*

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)

2020 Audi Q5 45 TFSI quattro

TEST VEHICLE INFORMATION

VIN: *WA1BNAFY0L200xxxx*

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

Date Received: *5/18/2020* Odometer Reading: *55 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Audi AG*

Date of manufacture: *08/19*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *255/45R20*

Rear: *255/45R20*

Recommended cold tire pressure: Front: *230 kPa (33 psi)*

Rear: *250 kPa (36 psi)*

TIRES

Tire manufacturer and model: *Continental Cross Contact LX Sport*

Front tire specification: *255/45R20 101H*

Rear tire specification: *255/45R20 101H*

Front tire DOT prefix: *P512WC1L*

Rear tire DOT prefix: *P512WC1L*

FORWARD COLLISION WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2020 Audi Q5 45 TFSI quattro

GENERAL INFORMATION

Test date: *6/24/2020*

AMBIENT CONDITIONS

Air temperature: *37.2 C (99 F)*

Wind speed: *4.9 m/s (11.0 mph)*

X Wind speed ≤ 10 m/s (22 mph).

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

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

VEHICLE PREPARATION

Verify the following:

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

Fuel tank is full: **X**

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

Front: *230 kPa (33 psi)*

Rear: *250 kPa (36 psi)*

FORWARD COLLISION WARNING

DATA SHEET 3: TEST CONDITIONS

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2020 Audi Q5 45 TFSI quattro

WEIGHT

Weight of vehicle as tested including driver and instrumentation:

Left Front:	*533.0 kg (1175 lb)*	Right Front:	*527.1 kg (1162 lb)*
Left Rear:	*477.2 kg (1052 lb)*	Right Rear:	*477.2 kg (1052 lb)*
		Total:	*2014.5 kg (4441 lb)*

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 1 of 3)

2020 Audi Q5 45 TFSI quattro

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

Pre Sense City

Forward Collision Warning Setting used in test: *Early*

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

Single camera located behind the windshield near the rearview mirror.

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

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

The visual warning is presented in the center of the instrument cluster. See Appendix A, Figure A15.

The auditory warning is a constant tone centered at 1800 Hz.

In addition to these, there is a brake jerk as part of the warning cascade.

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

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2020 Audi Q5 45 TFSI quattro

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.

Select in the Infotainment system: button left control button >

Vehicle

Audi drive select

Driver assistance

Audi pre sense

Turn on/off Audi pre sense - select or deselect

If the system is switched off, it switches on again automatically once the ignition is switched on again.

See Appendix A, Figures A12 and A13.

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.

Select in the Infotainment system (left control button):

Vehicle

Audi drive select

Driver assistance

Audi pre sense

Prewarning select Off, Early, Medium or Late

See Appendix A, Figures A12 and A13.

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

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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.

The system has a self-test algorithm, which will reduce the system performance or deactivate completely if the following conditions are observed:

- *Mud/dirt/snow accumulation on the sensor*
- *If the ESC is turned off or in sport mode*
- *If the system detects sensor blockage, FCW, DBS, CIB will not be available and the system will show a notification in the vehicle cluster.*

Additional system limitations are described in the Owner's Manual, pages 134 and 135, shown in Appendix B, pages B-7 and B-8.

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

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

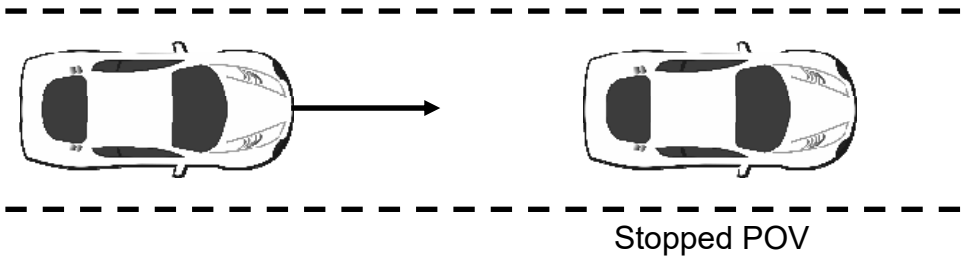

Figure 1. Depiction of Test 1

a. Alert Criteria

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

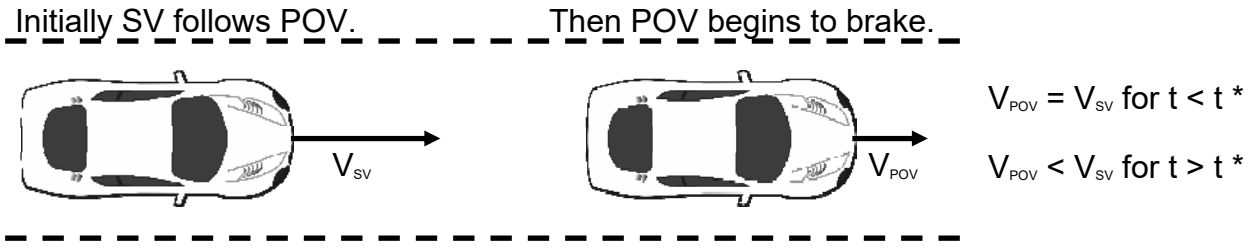

Figure 2. Depiction of Test 2

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 ±0.03g, measured at the time the FCW alert first occurred. An initial overshoot beyond the deceleration target was acceptable, however the first local deceleration peak observed during an individual trial could not exceed 0.375 g for more than 50 ms. Additionally, the deceleration could not exceed 0.33 g over a period defined from 500 ms after the first local deceleration peak occurs, to the time when the FCW alert first occurred.
- The tolerance for the headway from the SV to the POV was ±8.2 ft (±2.5 m), measured at two instants in time: (1) three seconds prior to the time the POV brake application was initiated and (2) at the time the POV brake application was initiated.
- SV driver could not apply any force to the brake pedal before (1) the required FCW alert occurred or (2) 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).

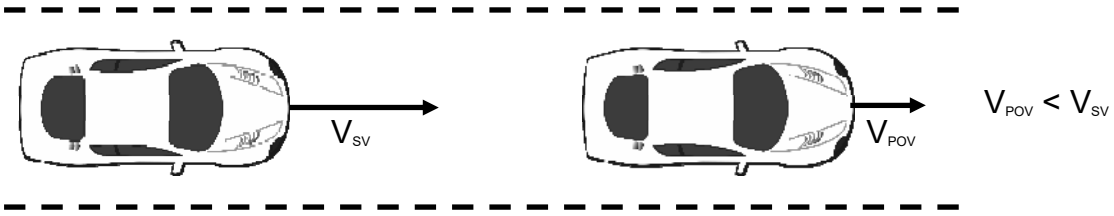

Figure 3. Depiction of Test 3

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	Omega DPG8001	17042707002	By: DRI Date: 7/3/2019 Due: 7/3/2020
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 4/20/2020 Due: 4/20/2021
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	NA
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels ± 10g, Angular 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 +	2258	Date: 5/3/2019 Due: 5/3/2021
				POV:	2182	Date: 9/16/2019 Due: 9/16/2021
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	NA

Table 1. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at auditory alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA
Light Sensor	Light intensity (to measure time at visual alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Accelerometer	Acceleration (to measure time at haptic alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2020 Due: 1/6/2021

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

For systems that implement audible or haptic alerts, part of the pre-test instrumentation verification process is to determine the tonal frequency of the audible warning or the vibration frequency of the tactile warning through use of the PSD (Power Spectral Density) function in Matlab. This is accomplished in order to identify the center frequency around which a band-pass filter is applied to subsequent audible or tactile warning data so that the beginning of such warnings can be programmatically determined. The 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. Audible and Tactile Warning Filter Parameters

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

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

Figure A3. Window Sticker (Monroney Label)

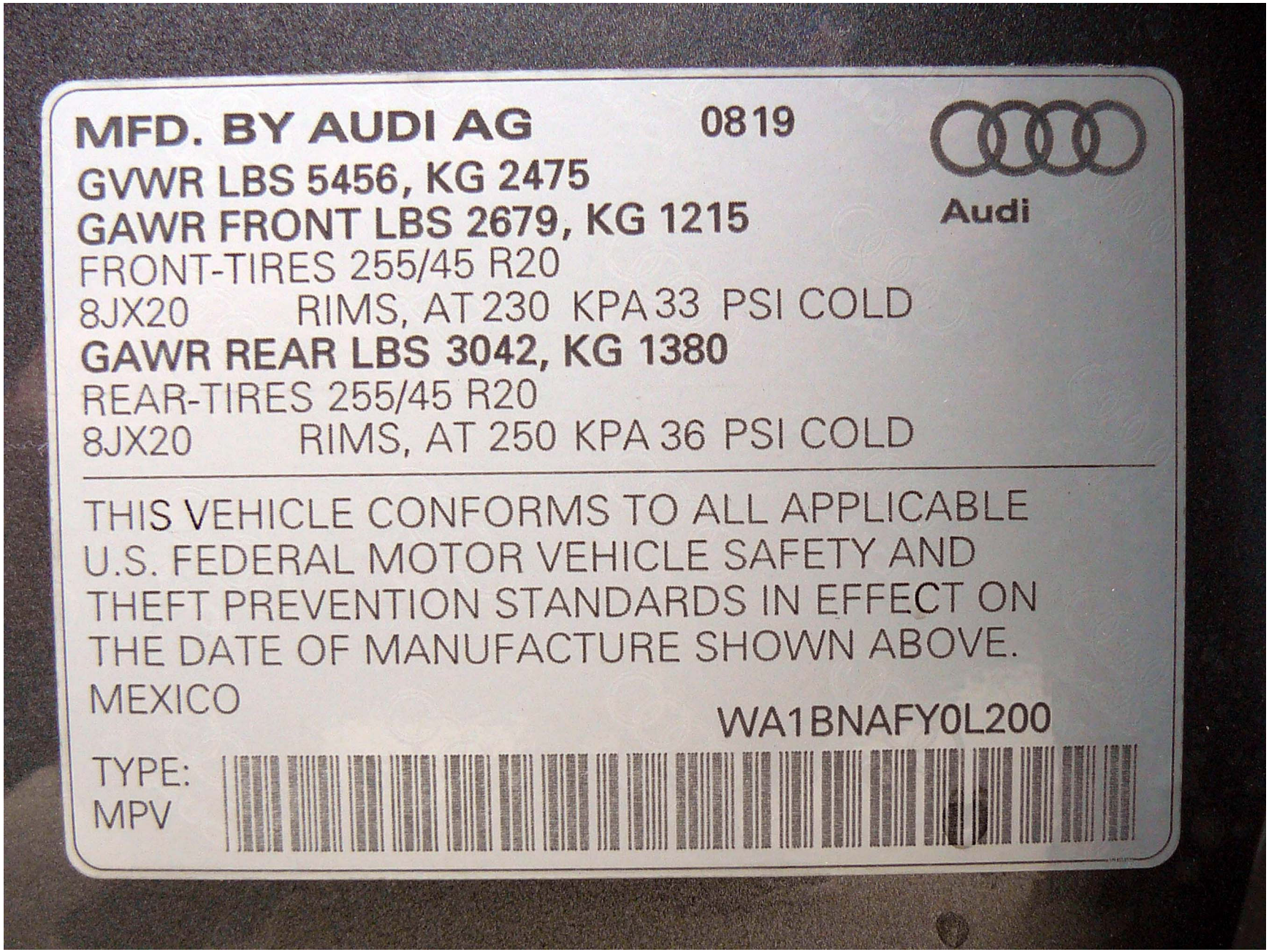

Figure A4. Vehicle Certification Label

Figure A5. Tire Placard

Figure A6. Front View of Principal Other Vehicle

Figure A7. Rear View of Principal Other Vehicle

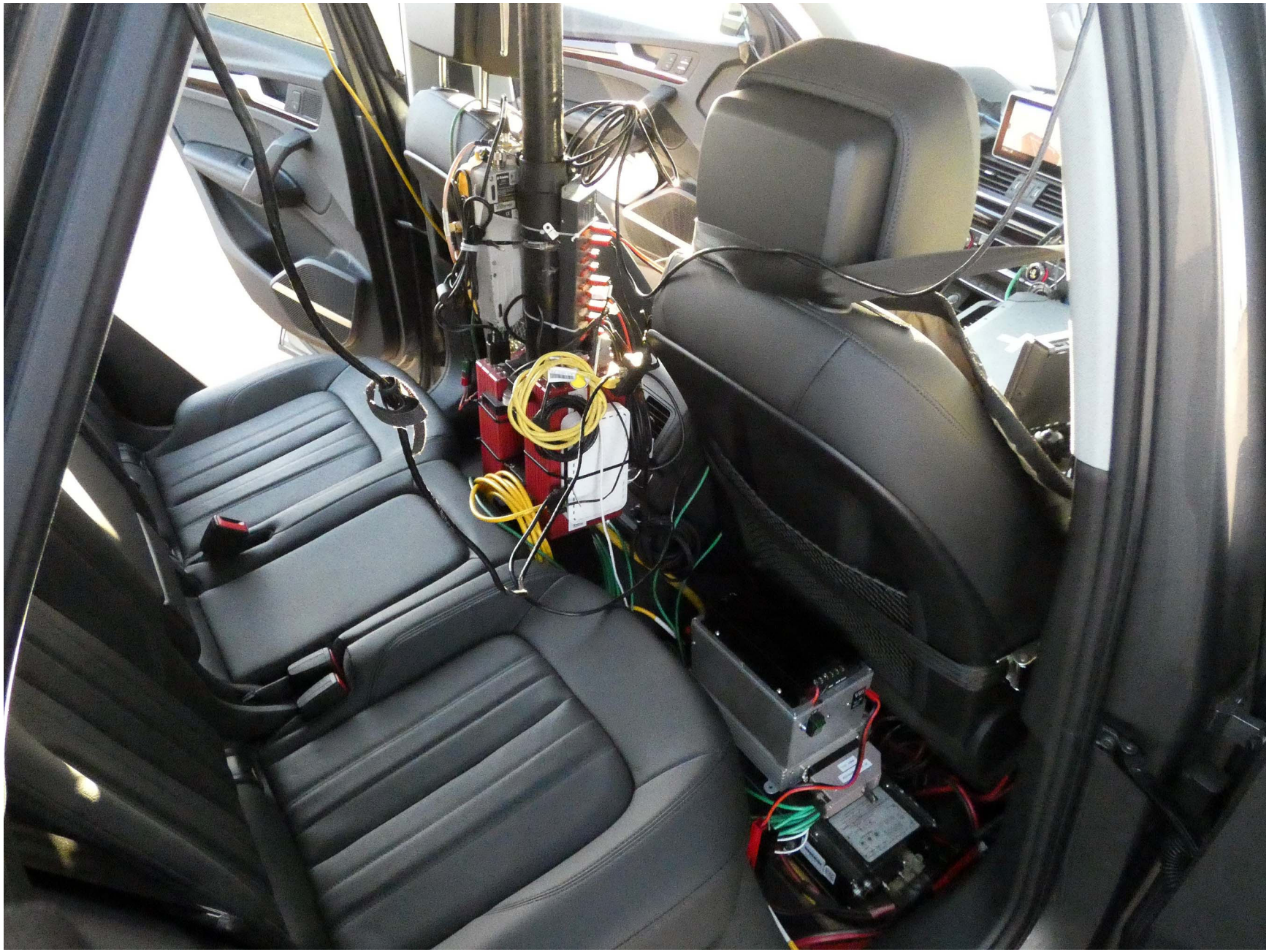

Figure A8. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A9. Sensor for Detecting Auditory Alerts

Figure A10. Sensor for Detecting Visual Alerts

Figure A11. Computer Installed in Subject Vehicle

Figure A12. Brake Actuation System Installed in Principal Other Vehicle

Figure A13. System Setup Menus (1 of 2)

Figure A14. System Setup Menus (2 of 2)

Figure A15. Control for Changing System Parameters

Figure A16. FCW Visual Alert

APPENDIX B

Excerpts from Owner’s Manual

Indicator lights overview

Description

The indicator lights in the instrument cluster blink or turn on. They indicate functions or malfunctions.

Messages may appear with some indicator lights. A warning signal will sound at the same time. The indicator lights and messages may be covered by other displays. To show them again, select the second tab for messages with the multifunction steering wheel ⇨ *page 17* or ⇨ *page 20*.

Some indicator lights in the display can display in several colors.

⚠ Central indicator light

If the ⚠ or ⚠ indicator light turns on, check the message in the instrument cluster.

Overview

Some indicator lights turn on briefly as a function check when you switch the ignition on. These systems are marked with a ✓ in the following tables. If one of these indicator lights does not turn on, there is a malfunction in that system.

Your vehicle has either a monochrome display or a multicolored display, depending on vehicle equipment. Some indicator lights appear white on a monochrome display. The ⚠ or ⚠ central indicator light turns on at the same time to indicate the priority of these indicator lights.

The following indicator lights may be available, depending on the vehicle equipment:

Red indicator lights

	Central indicator light ⇨ *page 10*, Audi pre sense ⇨ *page 131*, instrument cluster ⇨ *page 14*
	Safety belt ⇨ *page 273*
	Engine start system ⇨ *page 76*
	Transmission ⇨ *page 82*
	Drive system ⇨ *page 86*
PARK	Electromechanical parking brake ⇨ *page 89*
	Electromechanical parking brake ⇨ *page 89*
	Brake system ✓ ⇨ *page 90*, ⇨ *page 89*, ⇨ *page 335*
BRAKE	Brake system ✓ ⇨ *page 90*, ⇨ *page 89*, ⇨ *page 335*
	Steering ✓ ⇨ *page 166*
	Air suspension ⇨ *page 23*
	Electrical system ⇨ *page 336*
	Engine oil pressure ⇨ *page 330*
	Engine oil level (MIN) ⇨ *page 330*
	Cooling system ⇨ *page 333*
	Hood ⇨ *page 328*
	Adaptive cruise control ✓ ⇨ *page 123*
	Traffic jam assist ⇨ *page 128*

Yellow indicator lights

	Central indicator light ⇨ *page 10*
	Safety systems ✓ ⇨ *page 269*
	Transmission ⇨ *page 82*

	Drive system ⇨ *page 86*, ⇨ *page 333*
	Vehicle sound ⇨ *page 86*
	Engine start system ⇨ *page 76*
	Keys ⇨ *page 76*
	Electromechanical parking brake ⇨ *page 90*
	Brake system ⇨ *page 89*
	Electronic Stabilization Control (ESC) ⇨ *page 22*
	Electronic Stabilization Control (ESC) ✓ ⇨ *page 22*
ESC OFF	Electronic Stabilization Control (ESC) ⇨ *page 165*
ABS	Anti-lock braking system (ABS) ✓ ⇨ *page 22*
	Anti-lock braking system (ABS) ✓ ⇨ *page 22*
	Steering ⇨ *page 166*

	All wheel drive/sport differential ⇨ *page 23*
	Suspension control ⇨ *page 23*
	Air suspension ⇨ *page 23*
	Engine speed limitation ⇨ *page 16*
	Tank system ⇨ *page 324*
	Electrical system ⇨ *page 336*
	Engine oil level (MIN) ⇨ *page 330*

	Engine oil level (MAX) ⇨ *page 330*
	Engine oil sensor ⇨ *page 330*
	Malfunction Indicator Lamp (MIL) ✓ ⇨ *page 326*
	Engine warm-up request ⇨ *page 330*
	Washer fluid level ⇨ *page 339*
	Windshield wipers ⇨ *page 50*
AC	Charging system ⇨ *page 100*
	Parking aid ⇨ *page 163*
	Tire pressure ⇨ *page 359*
TPMS	Tire pressure ⇨ *page 359*
	Bulb failure indicator ⇨ *page 44*
	Headlight range control system ⇨ *page 44*
	Adaptive light ⇨ *page 44*
	Light/rain sensor ⇨ *page 44*, ⇨ *page 50*
	Driver's door ⇨ *page 30*
	Battery in vehicle key ⇨ *page 27*
	Audi side assist ⇨ *page 145*
	Active lane assist ⇨ *page 137*
	Audi pre sense ⇨ *page 135*
SOS	Emergency call function ⇨ *page 217* ▶

General information

Applies to: vehicles with Audi adaptive cruise control

Fig. 110 Front of the vehicle: sensors and video camera

The areas with the radar and ultrasonic sensors and the video camera ⇨ *fig. 110* must not be covered by stickers, deposits or any other objects, because this can interfere with the adaptive cruise control function. For information on cleaning, see ⇨ *page 361*. The same applies for any modifications made in the front area.

In some driving situations, the adaptive cruise control function is restricted:

– Vehicles can only be detected when they are within the sensor detection zones ⇨ *page 121, fig. 109*.
– The system has a limited ability to detect vehicles that are a short distance ahead, off to the side of your vehicle or moving into your lane.
– Objects that are difficult to detect such as motorcycles, vehicles with high ground clearance or an overhanging load are detected late or not detected at all.
– When driving through curves ⇨ *page 123*.
– When the vehicle is stationary ⇨ *page 123*.

WARNING

Always pay attention to the traffic around you when adaptive cruise control is switched on. As the driver, you are still responsible for your own speed and the distance to other vehicles. The adaptive cruise control is used to assist you. The driver must always take action to avoid a collision. The driver is always responsible for braking at the correct time.
– For safety reasons, do not use adaptive cruise control when the road surface is in poor condition and/or in bad weather conditions (such as ice, fog, gravel, heavy rain and hydroplaning). Using the system under these conditions increases the risk of an accident.
– Switch adaptive cruise control off temporarily when driving in turning lanes, on expressway exits (except if predictive control is switched on) or in construction zones. This prevents the vehicle from accelerating to the stored speed when in these situations.
– The adaptive cruise control system will not brake by itself if you put your foot on the accelerator pedal. Doing so can override the speed and distance regulation.
– When approaching stationary obstacles such as stopped traffic, adaptive cruise control will respond with limited function.
– Adaptive cruise control does not respond to people, animals, or crossing or oncoming objects.
– The function of the radar sensors can be affected by reflective objects such as guard rails, the entrance to a tunnel, heavy rain or ice.

Note

The sensors can be displaced by impacts or damage to the bumper, wheel housing and underbody. This can impair the adaptive cruise control. Have an authorized Audi dealer or authorized Audi Service Facility check their function.

Tips

For an explanation on conformity with the FCC regulations in the United States and the Industry Canada regulations, see ⇨ *page 390*.

Distance warning: currently unavailable. See owner's manual

This message appears if the system has a temporary failure. If this occurs multiple times, drive to an authorized Audi dealer or authorized Audi Service Facility immediately to have the malfunction corrected.

ACC: Please fasten seat belt

The system is not completely available if the driver's seat belt is unfastened.

Stationary object ahead

This message appears if you would like to switch the system on and there is a stationary object directly in front of your vehicle.

Door open

The system is not available when the door is open.

Audi pre sense

Introduction

Applies to: vehicles with Audi pre sense

Within the limits of the system, the pre sense functions can initiate measures in particularly dangerous situations to protect the vehicle passengers and other road users.

- Due to the interlinking of various vehicle systems, critical driving situations can be detected by **pre sense basic** and measures for preventative occupant protection are can be initiated.
- The **pre sense front** system uses the data from the adaptive cruise control* radar sensors and the camera to calculate the probability of a collision. Within the limits of the system, an impending collision with vehicles can be detected in both urban and rural speed ranges. In this case, the system warns the driver visually, acoustically and with a jerk on the brakes if necessary. If needed, it can initiate a partial or full deceleration to reduce the collision speed or to avoid the collision under certain circumstances. In conjunction with pre sense basic/rear, the front safety belts are also reversibly tensioned when needed. The pre sense front is also active when adaptive cruise control* is switched off.
- **Pre sense rear** contains pre sense basic functions. It uses the data from the side assist* radar sensors and calculates within the limits of the system the probability of a rear end collision with the vehicle behind you. Pre sense rear is also active when side assist* is switched off.
- Within the limits of the system, **pre sense city** uses the camera data and can detect an impending collision with vehicles and pedestrians. In this case, the system warns the driver visually, acoustically and with a jerk on the brakes if necessary. If needed, it can initiate a full deceleration to reduce the collision speed or to avoid the collision under certain circumstances. In conjunction with pre sense basic/rear, the front safety belts are also reversibly tensioned when needed.

WARNING

Read the general information in ⇨ ⚠ *in General information on page 122*, ⇨ ⚠ *in General information on page 141*.

Tips

- Certain pre sense functions switch off when driving in reverse.
- The pre sense functions may not be available if there is a malfunction in the ESC system or the airbag control module.
- Note that the reversible belt tensioner on the front passenger's side deactivates when the front passenger's airbag is deactivated.
- Switch the pre sense off when you are not using public streets or when loading the vehicle onto a vehicle carrier, train, ship, or other type of transportation. This can prevent an undesired intervention from the pre sense system.

Audi pre sense basic

Applies to: vehicles with Audi pre sense basic

The pre sense basic functions are activated at a speed of approximately 20 mph (30 km/h) or higher. ▶

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The following functions can be triggered under certain conditions within the limits of the system:

– Tensioning of the safety belts (for example, during heavy braking): the front safety belts have reversible belt tensioners. If a collision does not occur, the safety belts loosen slightly and are ready to trigger again.
– Closing the windows and sunroof*
– Activation of the emergency flashers[1)]

The message **Audi pre sense** ⇨ *page 132, fig. 123* will warn you about the danger.

Audi drive select*: the trigger times are adjusted depending on the mode selected.

Audi pre sense front

Applies to: vehicles with Audi pre sense front

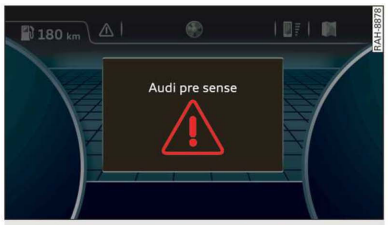

Fig. 123 Instrument cluster: approach warning

Description

Within the limits of the system, pre sense front can warn you of impending collisions and initiate the corresponding braking maneuvers or the supporting measures when avoiding a collision.

If detected in time, the system can rank the dangerous situation as critical if a vehicle driving ahead brakes suddenly, if your own vehicle is approaching a significantly slower vehicle at high speed or when there is an oncoming vehicle during a turning maneuver.

If detection is not possible, then pre sense front does not react.

Warnings

The system recognizes various dangerous situations. The **early warning** occurs if:

– A vehicle driving ahead brakes suddenly
– Your own vehicle approaches a significantly slower vehicle or stationary vehicle in the direction of travel

When this warning occurs, it may only be possible to avoid a collision by swerving or braking strongly. The message **Audi pre sense** ⇨ *fig. 123* and a warning tone will warn you about the danger.

If you do not react enough or not at all to a dangerous situation that was detected by the system, pre sense front provides assistance by applying the brakes.

If a collision is imminent, the system will first provide an **acute warning** by braking sharply. You will also warned by an indicator in the instrument cluster display ⇨ *fig. 123*. If you do not react to the acute warning, pre sense front can brake with increasing force within the limits of the system [1)]. This reduces the vehicle speed in the event of a collision. At low vehicle speeds, pre sense front can initiate a complete deceleration shortly before a collision with a vehicle driving ahead [1)]. If pre sense front determines that you are not braking strongly enough when a collision is imminent, it can increase the braking force.

The following functions trigger in conjunction with pre sense basic/rear at corresponding vehicle speeds:

– Reversible tensioning of the front safety belts
– Closing the windows and sunroof*

Audi drive select*: depending on the selected mode, the reversible belt tensioner and the closing of the windows and sunroof* are not active.

Swerve assist

Swerve assist helps you to steer the vehicle around an obstacle in a critical situation. If you avoid an obstacle after the acute warning, then the swerve assist assists you by applying slight ▶

[1)] This is not available in some countries.

underbody. Pre sense rear can be impaired by this. Have an authorized Audi dealer or authorized Audi Service Facility check their function.

Tips

– The pre sense rear functions switch off when towing a trailer.
– The pre sense rear functions may also switch off if there is a malfunction in the side assist* system.

Audi pre sense city

Applies to: vehicles with Audi pre sense city

Description

Within the limits of the system, pre sense city can warn you of impending collisions with vehicles and pedestrians and initiate the applicable braking maneuver if needed. Pre sense city is active at speeds of approximately 6 mph (10 km/h) and higher.

A pedestrian warning can occur at speeds up to 50 mph (85 km/h), and vehicle warnings can occur at speeds up to 155 mph (250 km/h). A pre sense city braking maneuver is possible at speeds up to 50 mph (85 km/h).

Warnings

The system recognizes various dangerous situations. The **early warning** occurs if:

– A vehicle driving ahead brakes suddenly
– Your own vehicle approaches a vehicle in front of you that is traveling at a significantly slower speed or that is stationary
– A pedestrian is standing in the lane or is moving into the lane

When this warning occurs, it may only be possible to avoid a collision by swerving or braking strongly. The message **Audi pre sense** ⇨ *page 132, fig. 123* and a warning tone will warn you about the danger.

The brakes may also be applied as an **acute warning** when there is an impending collision. If you do not react to the acute warning, pre sense city can brake to the point of complete deceleration within the limits of the system. This reduces the vehicle speed in the event of a collision. The message **Audi pre sense** also appears.

The following functions are triggered in conjunction with pre sense basic/rear:

– Reversible tensioning of the front safety belts
– Closing the windows and sunroof*

Audi drive select*: the function is not active depending on the mode selected.

WARNING

– Pre sense city cannot overcome the laws of physics. It is a system designed to assist and it cannot prevent a collision in every circumstance. The driver must always intervene. The driver is always responsible for braking at the correct time. Do not let the increased safety provided tempt you into taking risks. This could increase your risk of a collision.
– The system can deploy incorrectly due to system-specific limits.
– To reduce the risk of an accident, please note that the camera does not always detect every object.
– Pre sense city does not react to animals, crossing or oncoming vehicles, objects such as bars, railings or railcars, and objects that are difficult to detect ⇨ ⚠ *in General information on page 122*.
– In trailer mode, the braking behavior of the trailer can be different than usual during automatic braking.

WARNING

Pre sense city may be restricted or unavailable in the following types of situations:
– In heavy fog, rain, spray, or snow
– When there are visual obstructions, such as glare, reflections or variations in light
– When it is dark
– If the camera window or the windshield is dirty, iced over, damaged or covered
– When driving on snow, ice or loose ground
– In curves
– If the ESC was restricted or switched off
– When towing a trailer ▶

– When the driver's seat belt is unfastened
– For several seconds after the ignition is switched on

Note

Impacts or damage to the camera mount on the windshield can displace the sensor. Pre sense city can be impaired by this. Have an authorized Audi dealer or authorized Audi Service Facility check their function.

Tips

– You can cancel the system braking intervention if you accelerate considerably or swerve away.
– Keep in mind that pre sense city can brake unexpectedly. Always secure any cargo or objects that you are transporting to reduce the risk of damage or injury.
– Specific pre sense city functions switch off when the ESC is limited or switched off ⇨ *page 165* or the hill descent assist is switched on ⇨ *page 92*.
– When there is a malfunction in the camera, the pre sense city functions also switch off.

Settings in the Infotainment system

Applies to: vehicles with Audi pre sense

▸ Select in the Infotainment system: MENU button > **Vehicle** > left control button > **Driver assistance** > **Audi pre sense**.

Turn on/off Audi pre sense - The pre sense functions can be turned on and off.

If the system is switched off, it switches on again automatically once the ignition is switched on again.

Prewarning - The early warning can be switched **off** or the pre sense city/front warning point can be set (**Early**/**Medium**/**Late**).

Set the warning time for the early warning to **Early** at first. If this causes undesired early warnings to appear, then set the warning time to **Medium**. The **Late** warning time should only be set in special circumstances.

Tips

Your settings are automatically stored and assigned to the vehicle key being used.

Messages

Applies to: vehicles with Audi pre sense

Audi pre sense: malfunction! Please contact Service

This message appears when the pre sense function is affected. For example, this could be caused by a faulty sensor. Drive immediately to an authorized Audi dealer or authorized Audi Service Facility to have the malfunction repaired.

Audi pre sense: currently limited. Sensor view limited due to surroundings. See owner's manual

This message appears if the radar sensor and camera view is obstructed, for example by leaves, snow, heavy spray or dirt. If necessary, clean the sensors and the area around the camera ⇨ *page 122, fig. 110* or ⇨ *page 141, fig. 131*.

Audi pre sense: currently limited. Trailer towing mode

For vehicles with a trailer hitch installed at the factory, the pre sense rear functions switch off when the electrical connector at the socket is plugged in. There is no guarantee the functions will switch off when using a retrofitted trailer hitch.

Audi pre sense: currently limited

This message appears if the ESC is restricted or switched off, for example.

Audi pre sense: currently limited. See owner's manual

This message appears when there is a temporary failure in a subsystem, such as the ESC. If this message appears repeatedly, drive to an authorized Audi dealer or authorized Audi Service Facility to have the malfunction corrected.

Audi pre sense: emergency braking system off ▶

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This message appears if the pre sense functions are switched off through the Infotainment system or if the system is not ready.

Audi active lane assist

Description

Applies to: vehicles with Audi active lane assist

Active lane assist (lane departure warning) detects lane marker lines within the limits of the system using a camera in the windshield. If you are approaching a detected lane marker line and it appears likely that you will leave the lane, the system will warn you with corrective steering. You can override this steering at any time. If you pass over a line, the steering wheel will vibrate lightly. In order for this warning vibration to occur, it must first be switched on in the Infotainment system. Active lane assist is ready for operation when the lane marker line is detected on at least one side of the vehicle.

The system is designed for driving on expressways and highways and therefore only activates at speeds above approximately 40 mph (65 km/h).

Applies to: vehicles with side assist: If you activate a turn signal when active lane assist is ready and it classifies a lane change as critical because of vehicles traveling alongside you or approaching you, there will be noticeable corrective steering shortly before you leave the lane. This will attempt to keep your vehicle in the lane.

Applies to: vehicles without side assist: When the system is ready, it will not warn you if you activate a turn signal before crossing the lane marker line. In this case, it assumes that you are changing lanes intentionally.

Applies to: vehicles with adaptive cruise control: There is no corrective steering or warnings if the system recognizes a distinct passing maneuver. If the conditions are met, traffic jam assist switches on at speeds under approximately 40 mph (65 km/h) ⇨ *page 128*.

WARNING

- The system warns the driver that the vehicle is leaving the lane using corrective steering. The driver is always responsible for keeping the vehicle within the lane.
- The system can help you keep the vehicle in the lane, but it does not drive by itself. Always keep your hands on the steering wheel.
- Corrective steering may not occur in certain situations, such as during heavy braking.
- There may be cases where the camera does not recognize all lane marker lines. Corrective steering can only take place on the side of the vehicle where lane marker lines are detected.
- Other road structures or objects could possibly be identified unintentionally as lane marker lines. As a result, corrective steering may be unexpected or may not occur.
- The camera view can be restricted, for example by vehicles driving ahead or by rain, snow, heavy spray or light shining into the camera. This can result in active lane assist not detecting the lane marker lines or detecting them incorrectly.
- In certain situations where visibility is low, the vehicle may switch from an “early” to “late” steering correction.
- Under certain conditions such as ruts in the road, an inclined roadway or crosswinds, the corrective steering alone may not be enough to keep the vehicle in the middle of the lane.
- For safety reasons, active lane assist must not be used when there are poor road and/or weather conditions such as slippery roads, fog, gravel, heavy rain, snow and the potential for hydroplaning. Using active lane assist under these conditions may increase the risk of a crash.

APPENDIX C

Run Log

Subject Vehicle: **2020 Audi Q5 45 TFSI quattro** Test Date: **6/24/2020**

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**	N					Bad light data
2		N					Bad light data
3		Y	2.52	2.52	0.42	Pass	
4		Y	2.64	2.67	0.57	Pass	
5		Y	2.56	2.58	0.48	Pass	
6		Y	2.68	2.64	0.58	Pass	
7		Y	2.73	2.73	0.63	Pass	
8		Y	2.66	2.64	0.56	Pass	
9		Y	2.60	2.59	0.50	Pass	
17	**Decelerating POV, 45**	N					Lateral Offset Error
18		N					Lateral Offset
19		Y	2.66	2.65	0.26	Pass	
20		Y	2.71	2.70	0.31	Pass	
21		Y	2.68	2.69	0.29	Pass	
22		N					SV Yaw
23		Y	2.84	2.83	0.44	Pass	
24		N					SV Yaw
25		Y	2.78	2.77	0.38	Pass	

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
26		Y	2.61	2.61	0.21	Pass	
27		Y	2.55	2.52	0.15	Pass	
10	**Slower POV, 45 vs 20**	Y	2.82	2.80	0.82	Pass	
11		Y	2.83	2.81	0.83	Pass	
12		Y	2.84	2.85	0.85	Pass	
13		Y	2.86	2.84	0.86	Pass	
14		Y	2.78	2.77	0.78	Pass	
15		Y	2.68	2.67	0.68	Pass	
16		Y	2.95	2.94	0.95	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 audible, visual, or haptic). Depending on the type of FCW alert or instrumentation used to measure the alert, this can be any of the following:
    - Filtered, rectified, and normalized sound signal. The vertical scale is 0 to 1.
    - Filtered, rectified, and normalized acceleration (e.g., haptic alert, such as steering wheel vibration). The vertical scale is 0 to 1.
    - Light sensor signal.

- TTC (sec) – Indicates the Time to Collision as calculated up to the point of FCW alert issuance. The value of TTCW (Time to Collision at Warning) is given numerically on the right side of the figure. A passing value is indicated in green, while a failing value is indicated in red.

- SV Speed (mph) – Speed of the Subject Vehicle

- POV Speed (mph) – Speed of the Principal Other Vehicle

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

- Lateral Offset (ft) – Lateral offset within the lane from the Subject Vehicle to the Principal Other Vehicle
- Ax (g) – Longitudinal acceleration of both the Subject Vehicle and Principal Other Vehicle
- Headway (ft) – Longitudinal separation between front of Subject Vehicle to rear of Principal Other Vehicle (Exclusive to test type 2)

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

Envelopes and Thresholds

Each of the time history plot figures can contain either green or yellow envelopes and/or black threshold lines. These envelopes and thresholds are used to programmatically and visually determine the validity of a given test run. Envelope and threshold exceedances are indicated with either red shading or red asterisks, and red text is placed to the right side of the plot indicating the type of exceedance.

Green envelopes indicate that the time-varying data should not exceed the envelope boundaries at any time within the envelope. Exceedances of a green envelope are indicated by red shading in the area between the measured time-varying data and the envelope boundaries.

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

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

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

For the Ax plot, a dashed black threshold line is given for at a value of -0.05 g. For a test run to be valid, the longitudinal acceleration of the Subject Vehicle must not fall below this threshold (i.e. the driver cannot apply any brakes). Additionally, for test type 2, the plot indicating the longitudinal acceleration of the Principal Other Vehicle includes a

yellow envelope indicating the deceleration (0.3 g ± 0.03 g) allowed while braking. Exceedance of this threshold is indicated with red asterisks at the beginning and/or end of the threshold boundary.

Color Codes

Color codes have been adopted to easily identify which data correspond to which vehicle, as well as to indicate the types of envelopes and thresholds used in the plots.

Color codes can be broken into four categories:

1. Time-varying data
2. Validation envelopes and thresholds
3. Instantaneous samplings
4. Text

1. Time-varying data color codes:
   - Blue = Subject Vehicle data
   - Magenta = Principal Other Vehicle data
   - Brown = Relative data between SV and POV (i.e., TTC, lateral offset and headway distance)

2. Validation envelope and threshold color codes:
   - Green envelope = time varying data must be within the envelope at all times in order to be valid
   - Yellow envelope = time varying data must be within limits at left and/or right ends
   - Black threshold (Solid) = time varying data must not exceed this threshold in order to be valid
   - Black threshold (Dashed) = for reference only – this can include warning level thresholds, TTC thresholds, and acceleration thresholds

3. Instantaneous sampling color codes:
   - Green circle = passing or valid value at a given moment in time
   - Red asterisk = failing or invalid value at a given moment in time

4. Text color codes:
   - Green = passing or valid value
   - Red = failing or invalid value

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.

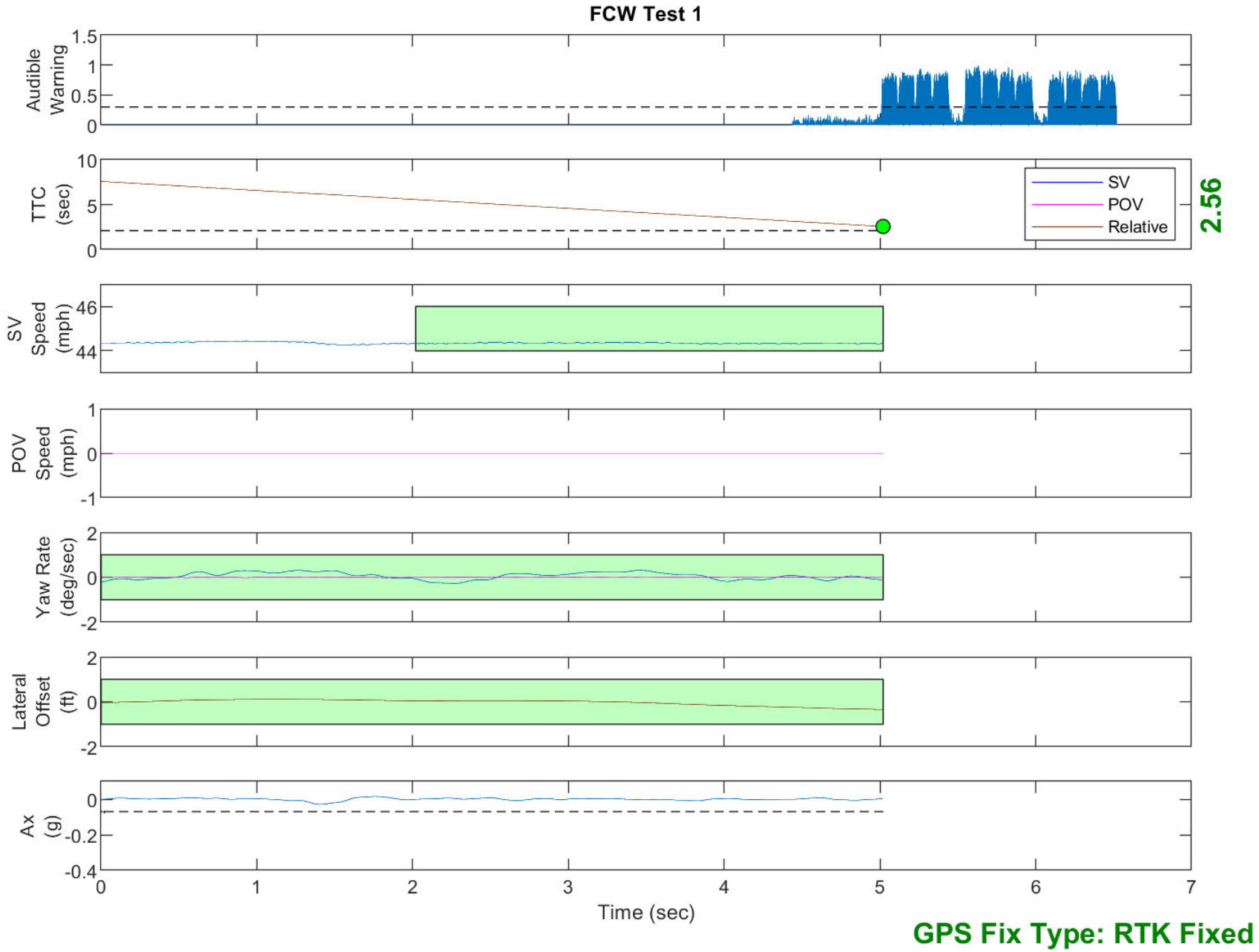

Figure D1. Example Time History for Test Type 1, Passing

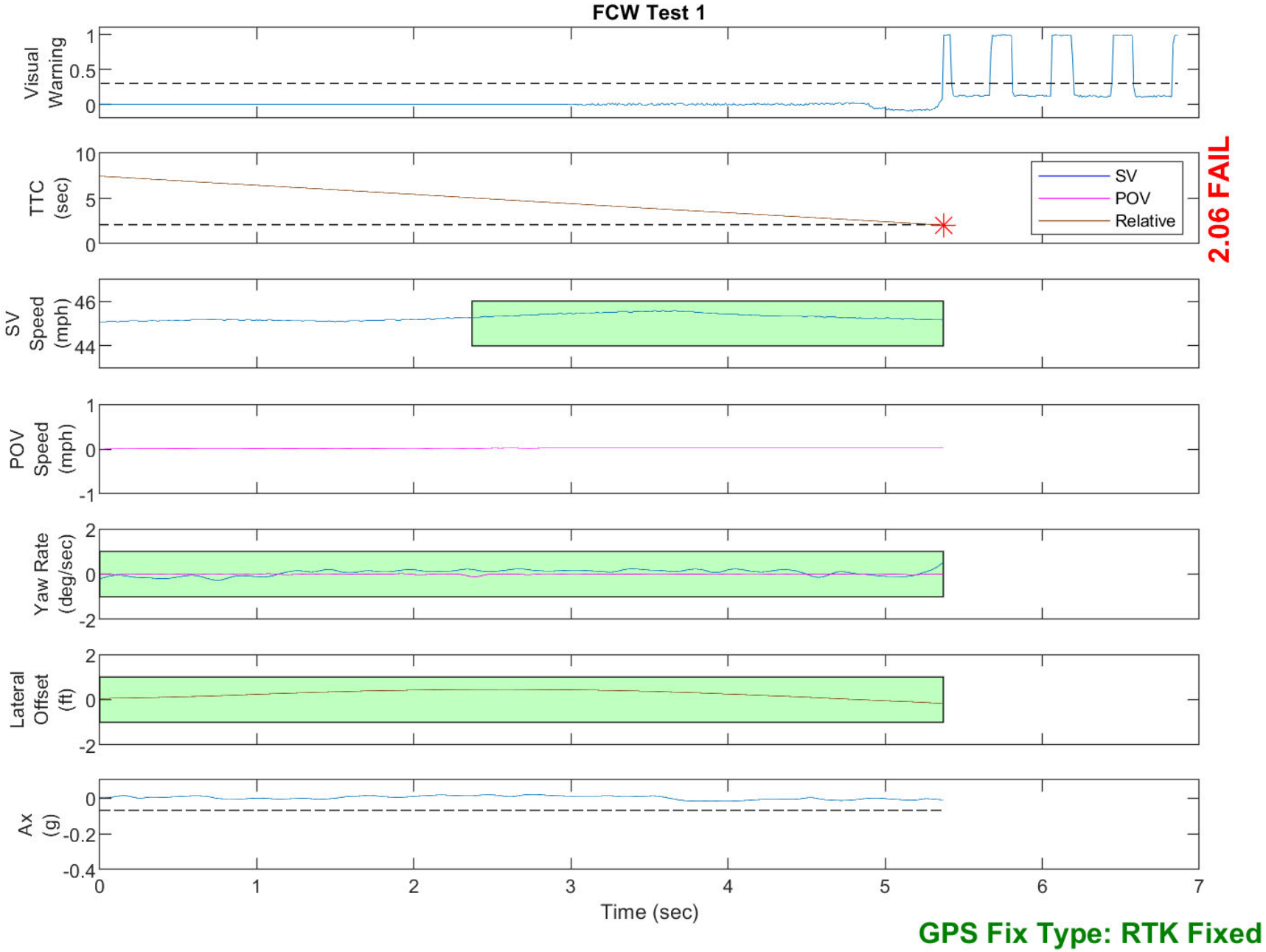

Figure D2. Example Time History for Test Type 1, Failing

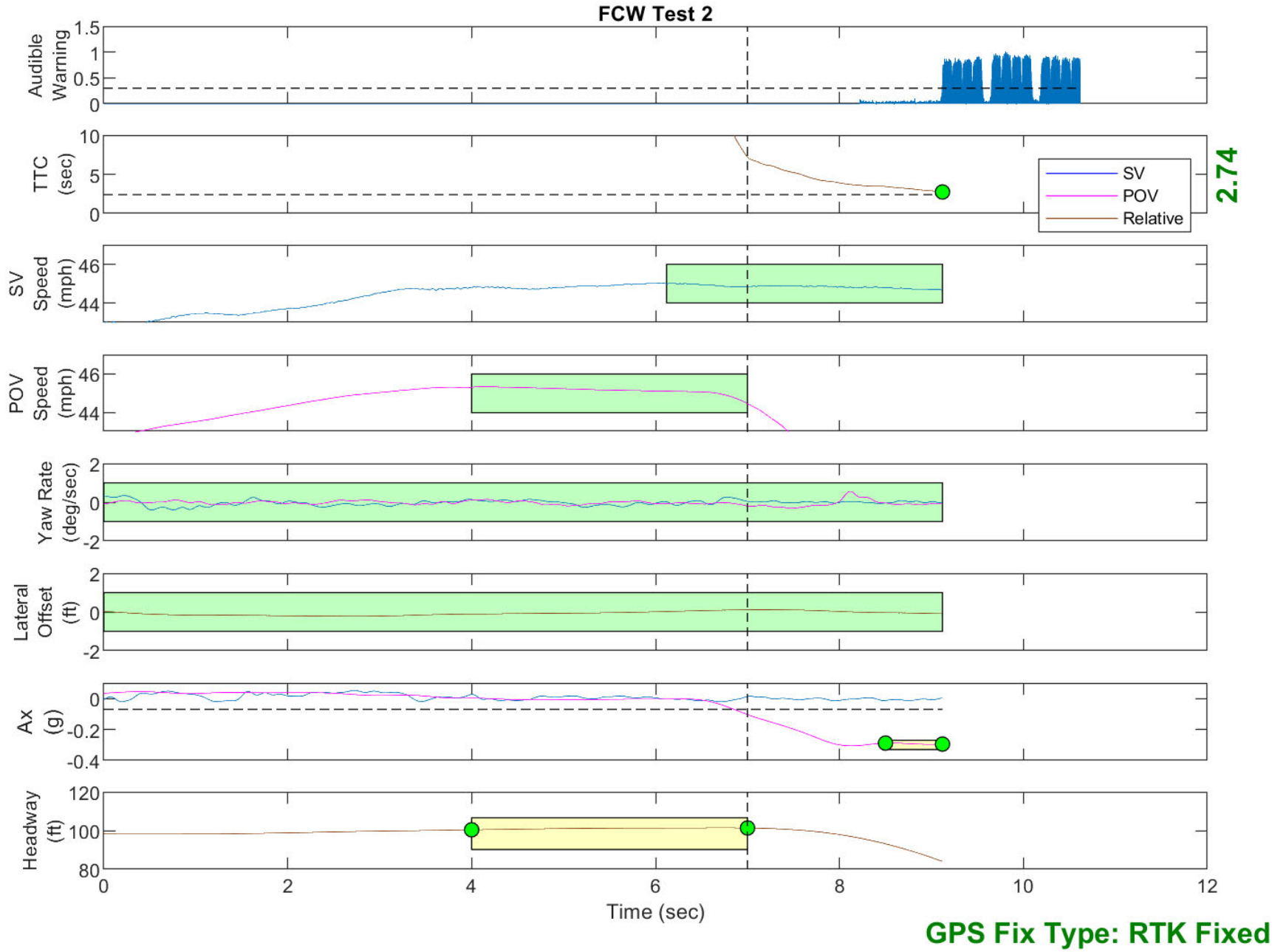

Figure D3. Example Time History for Test Type 2, Passing

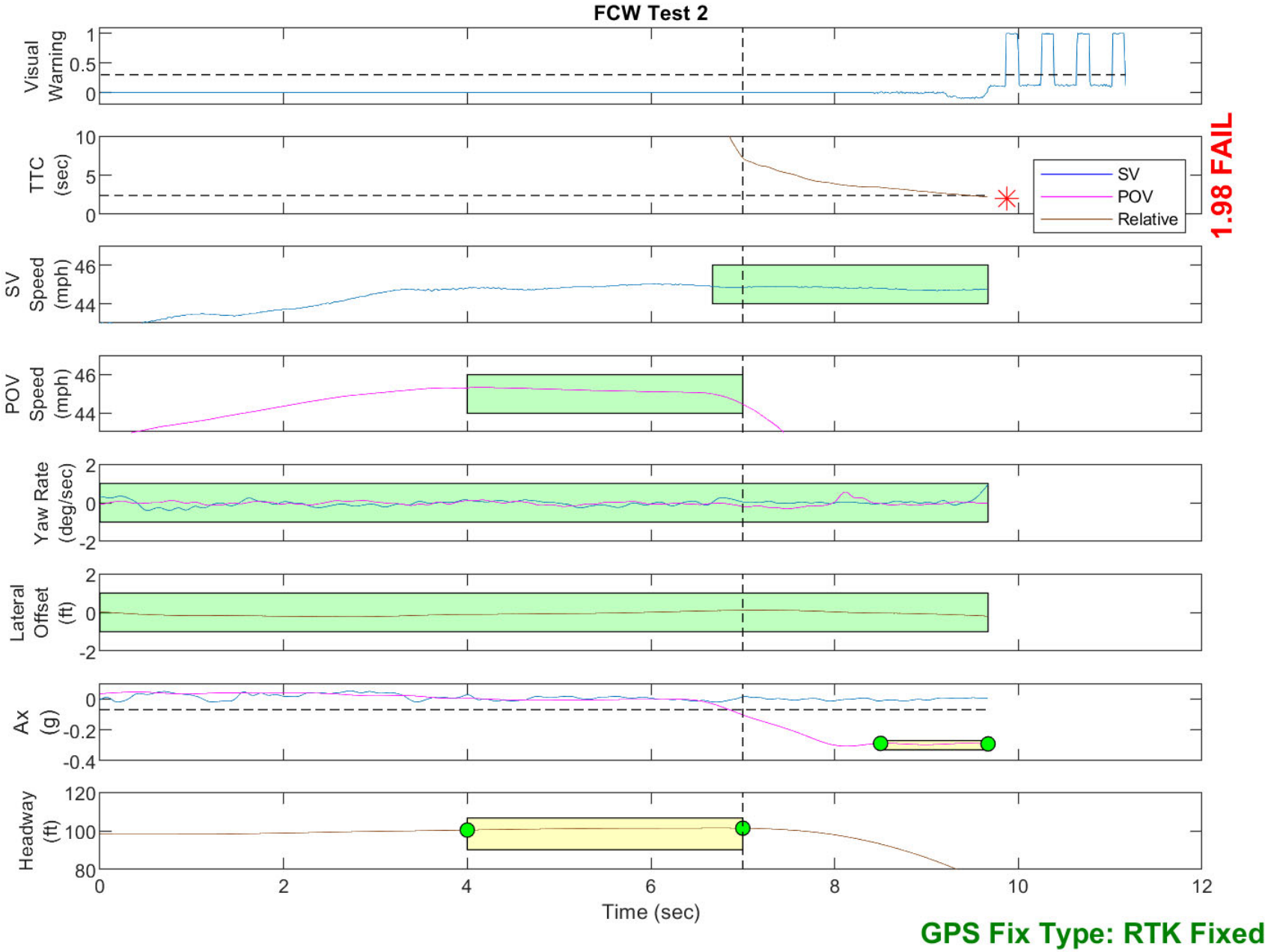

Figure D4. Example Time History for Test Type 2, Failing

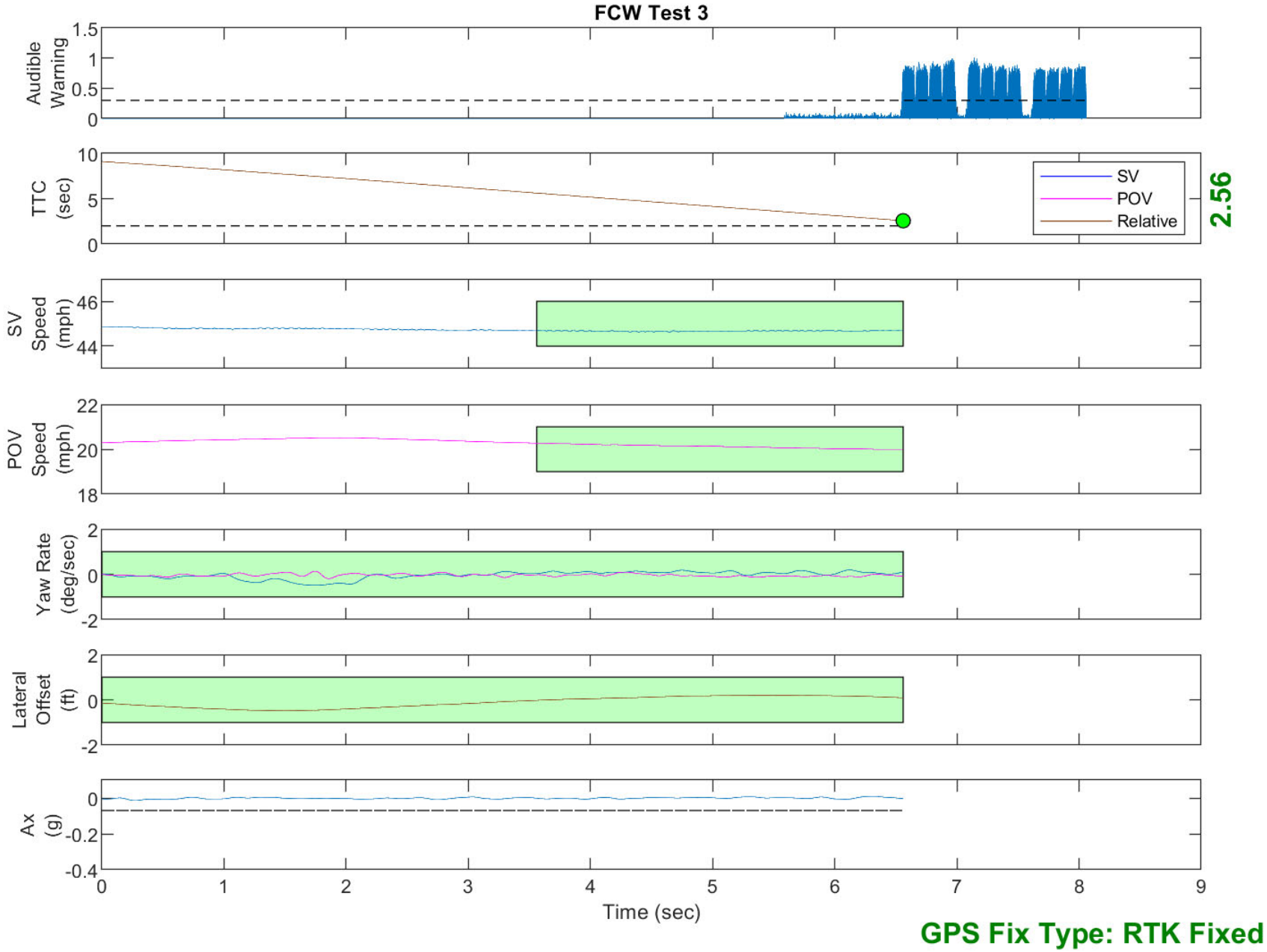

Figure D5. Example Time History for Test Type 3, Passing

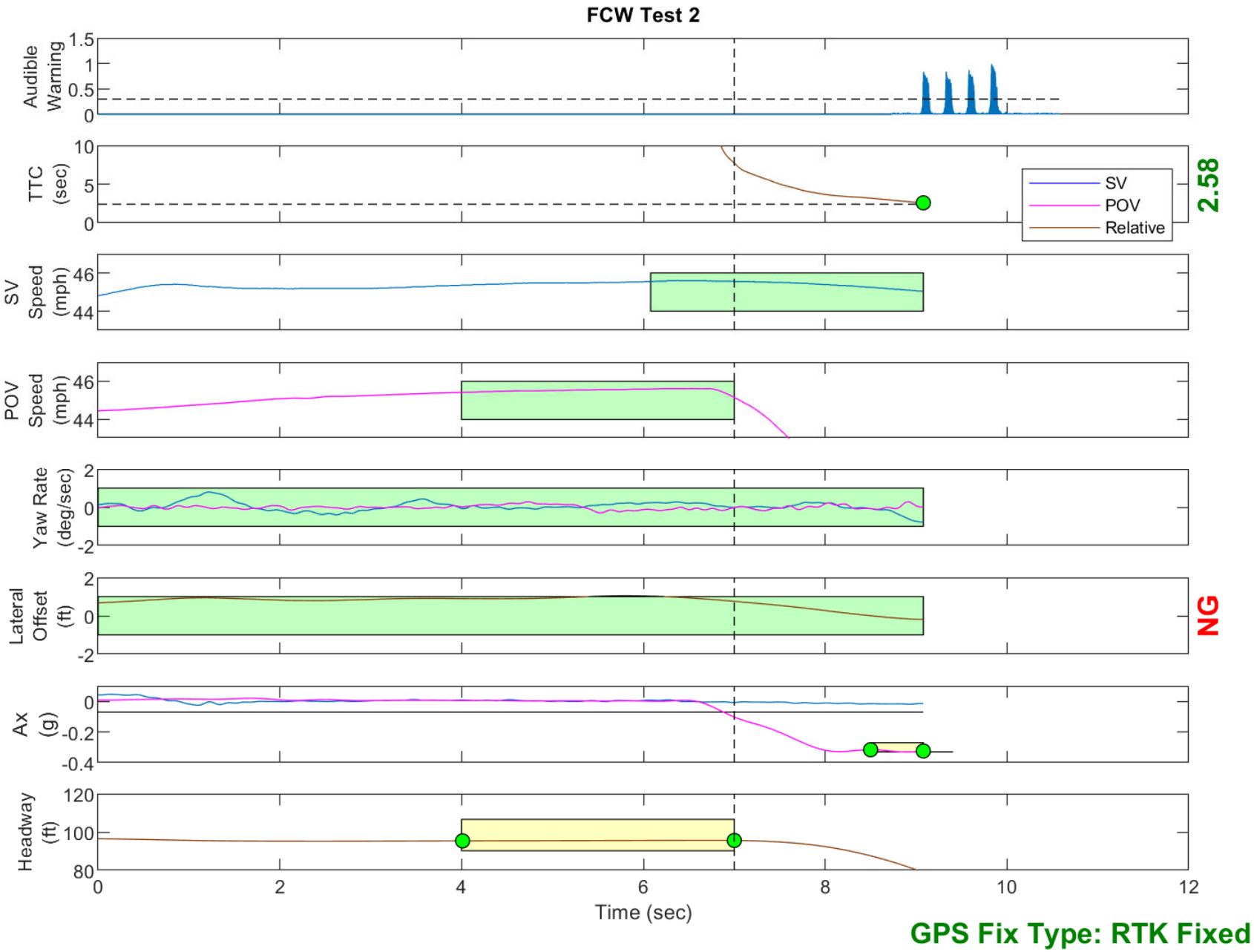

Figure D6. Example Time History Showing Invalid Lateral Offset Criteria

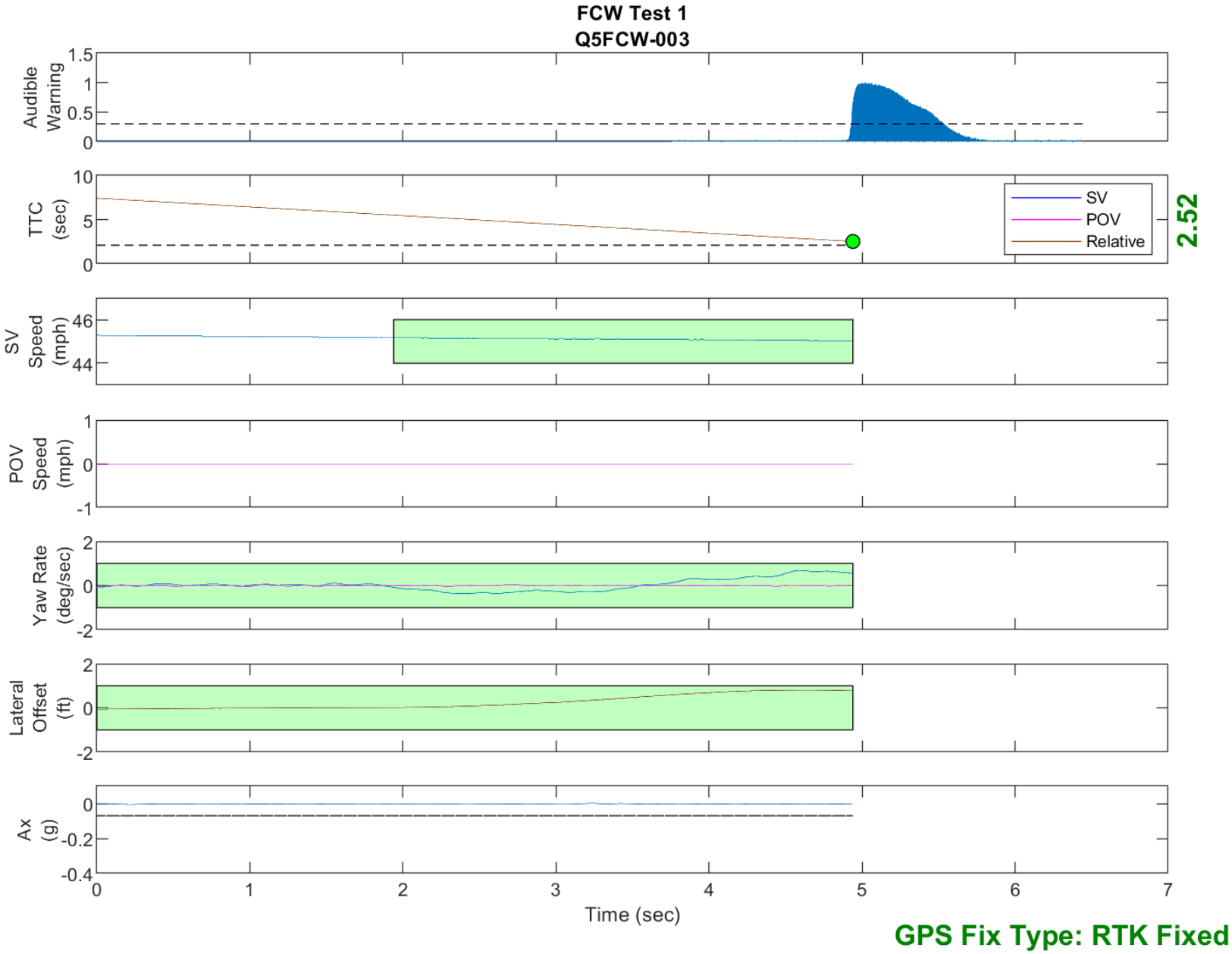

Figure D7. Time History for Run 3, FCW Test 1, Audible Warning

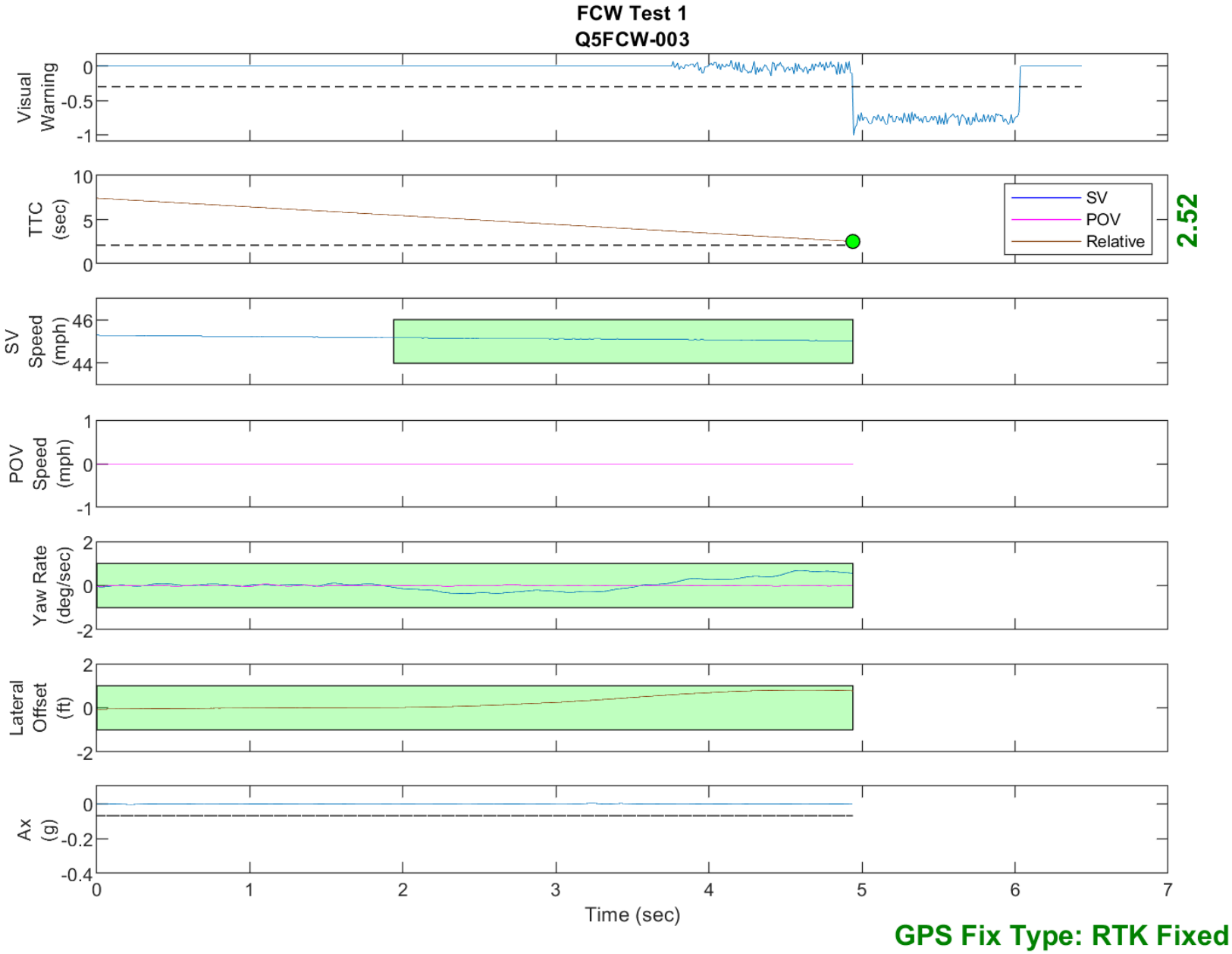

Figure D8. Time History for Run 3, FCW Test 1, Visual Warning

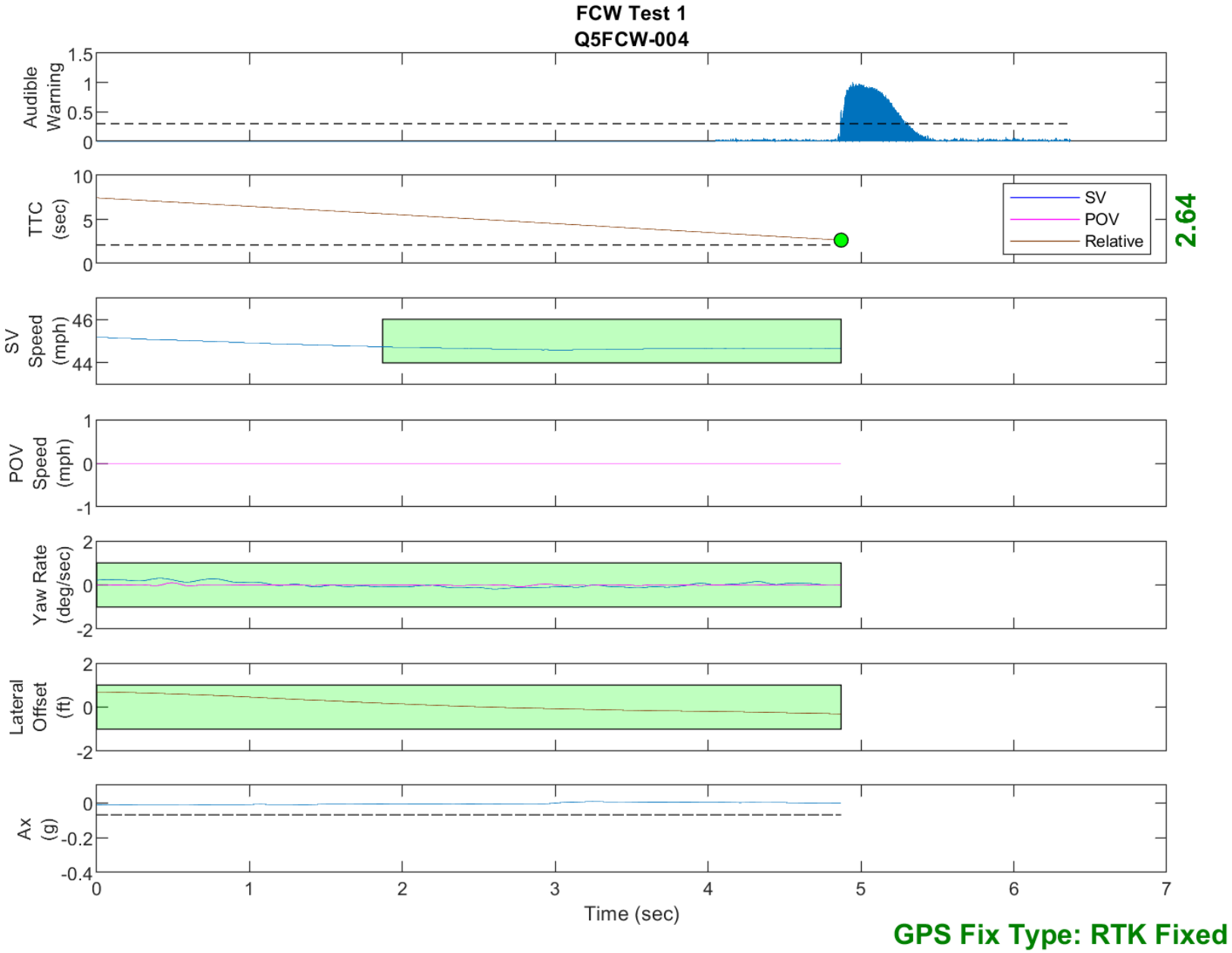

Figure D9. Time History for Run 4, FCW Test 1, Audible Warning

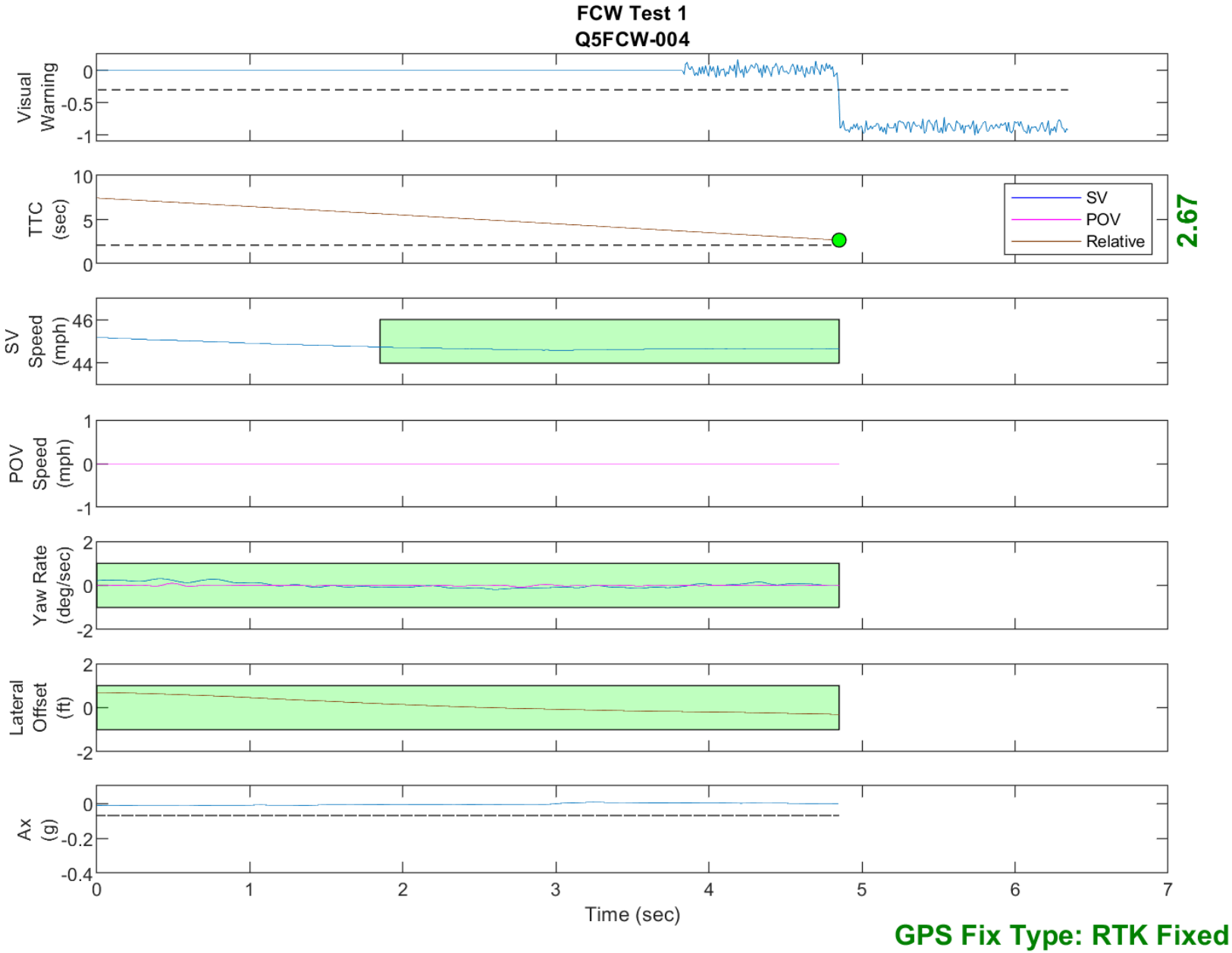

Figure D10. Time History for Run 4, FCW Test 1, Visual Warning

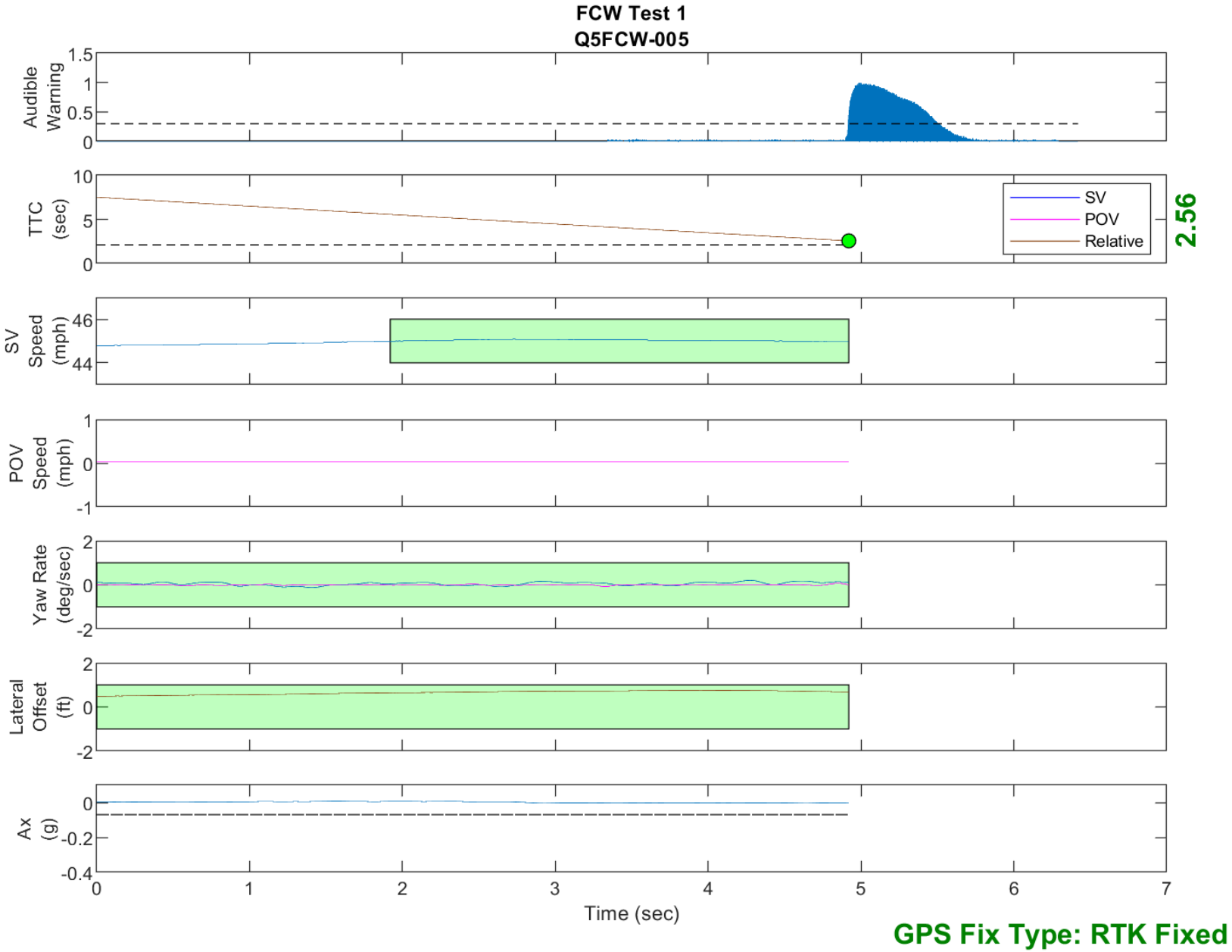

Figure D11. Time History for Run 5, FCW Test 1, Audible Warning

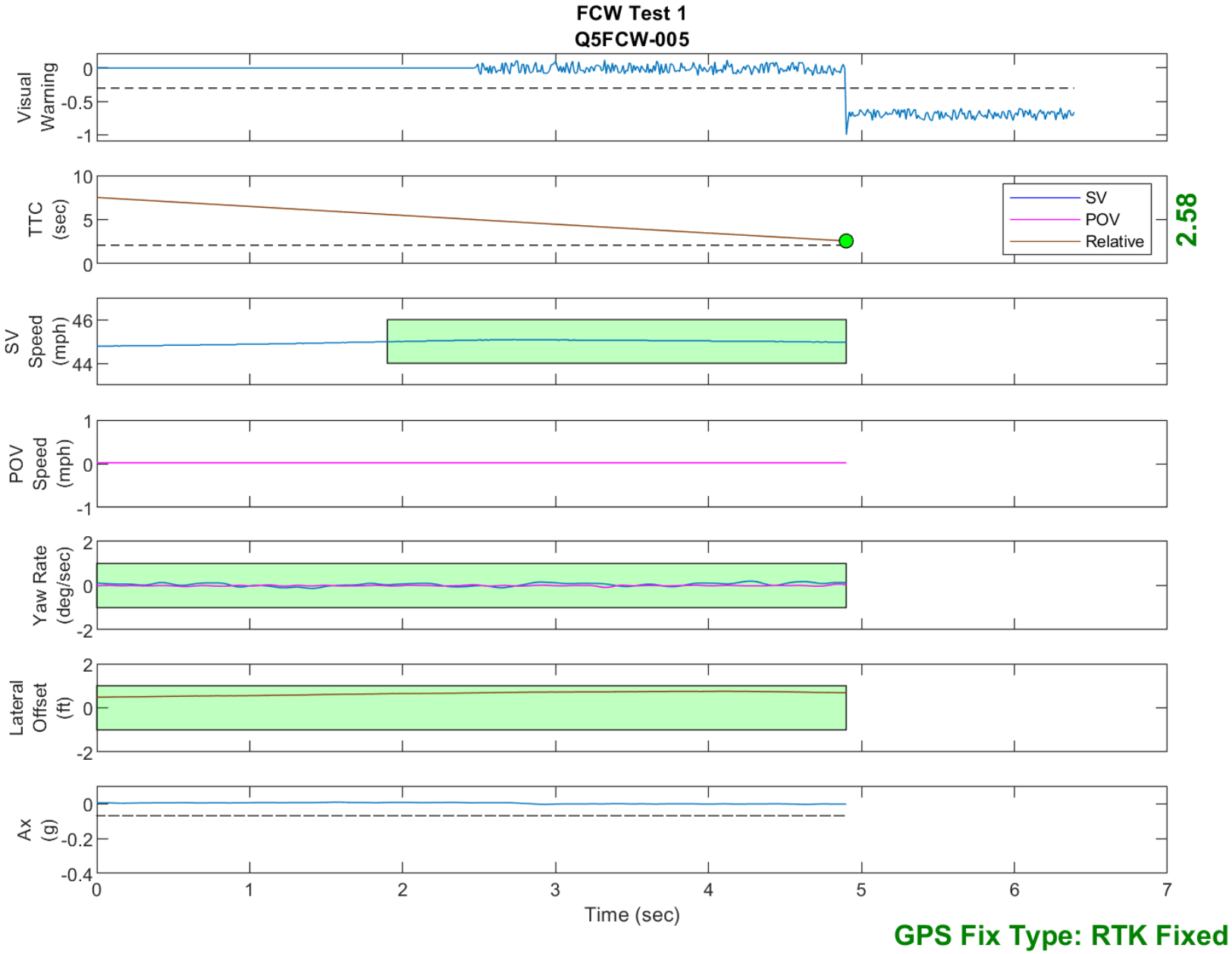

Figure D12. Time History for Run 5, FCW Test 1, Visual Warning

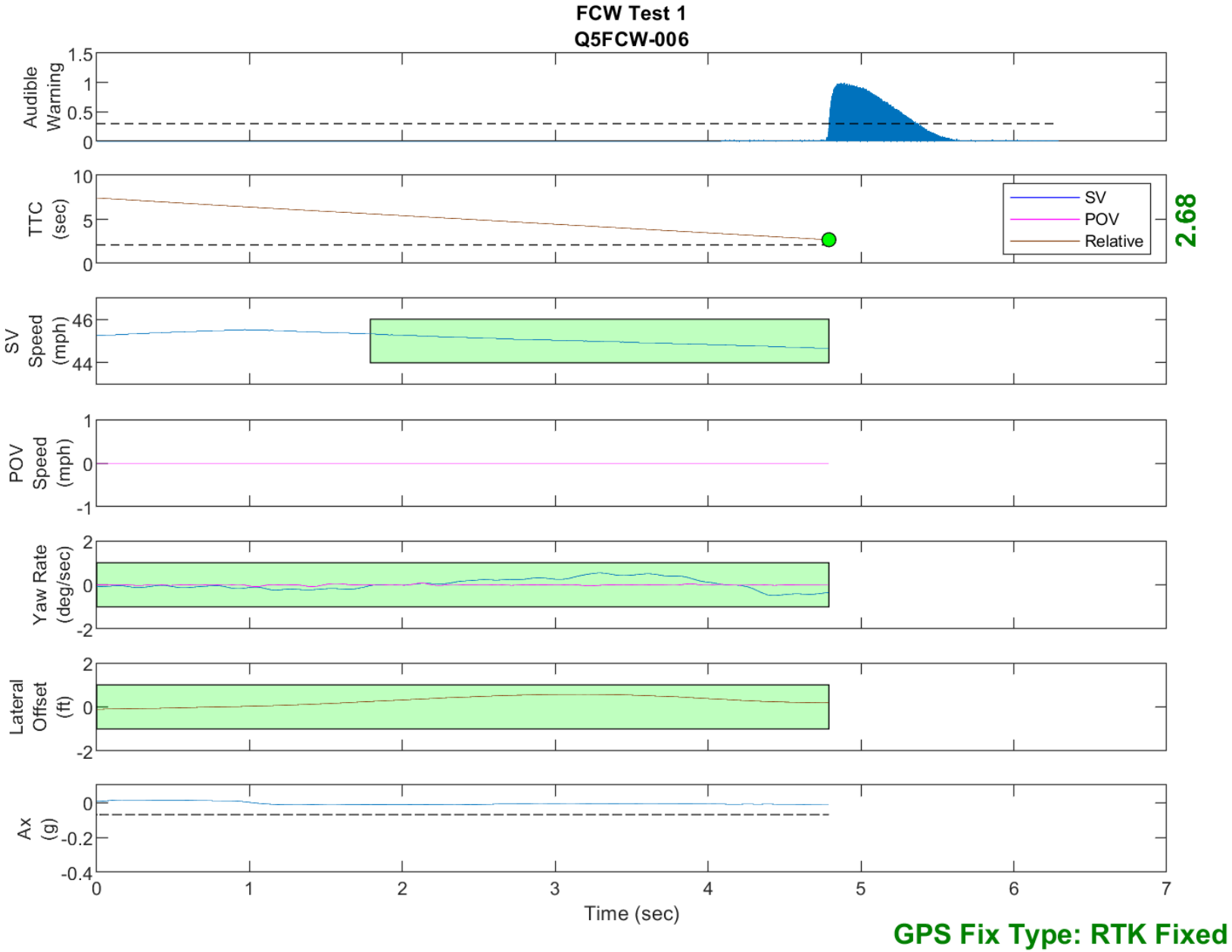

Figure D13. Time History for Run 6, FCW Test 1, Audible Warning

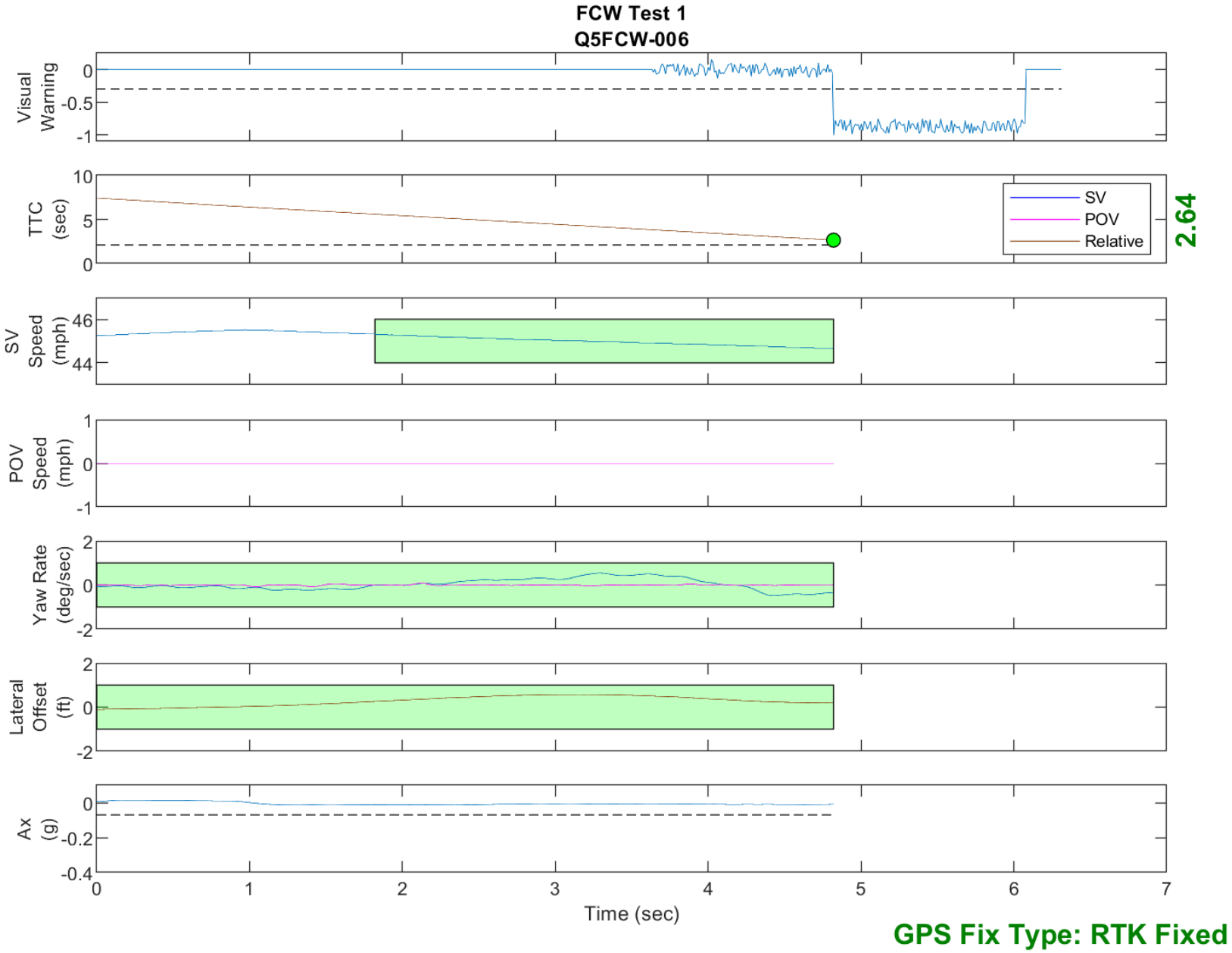

Figure D14. Time History for Run 6, FCW Test 1, Visual Warning

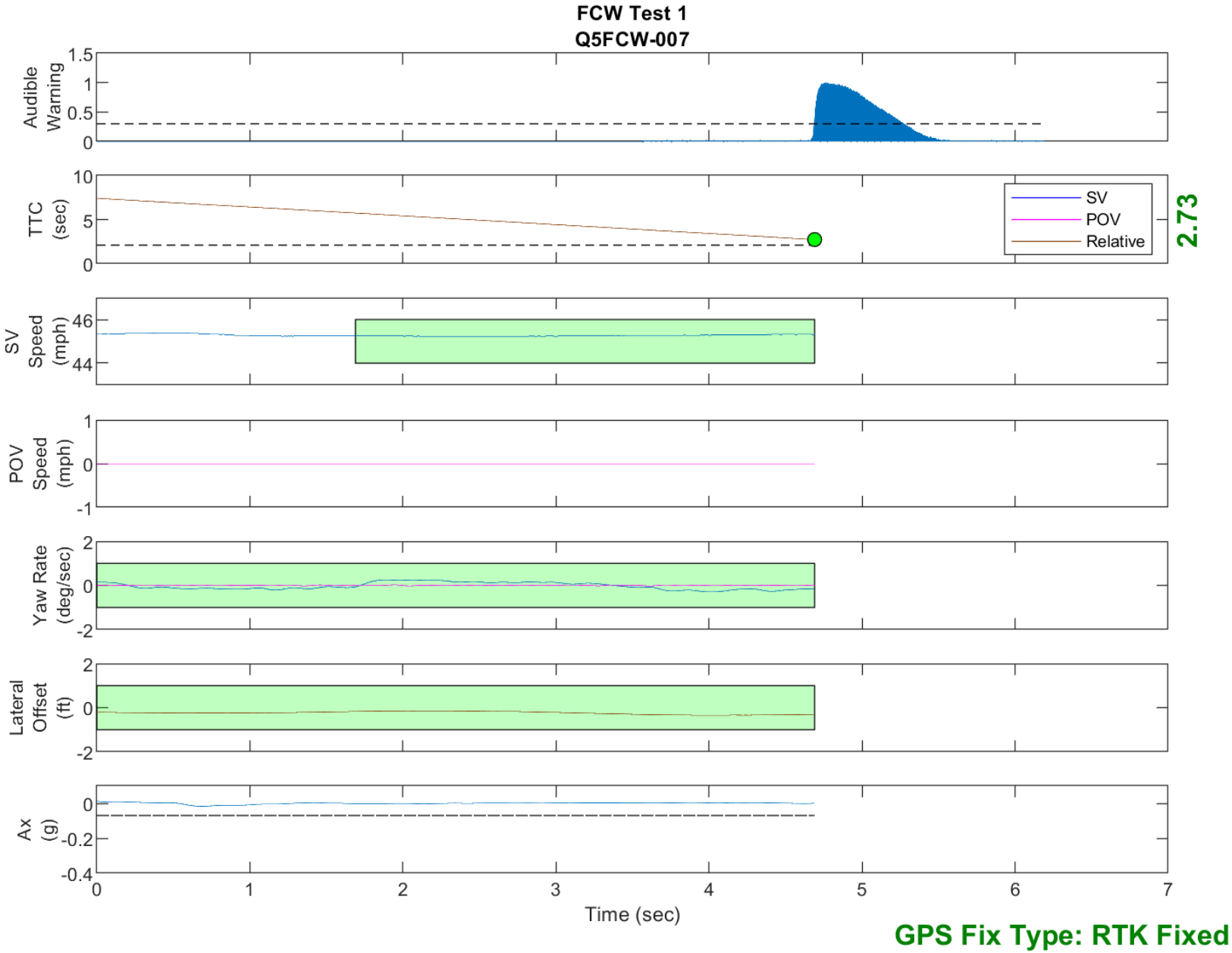

Figure D15. Time History for Run 7, FCW Test 1, Audible Warning

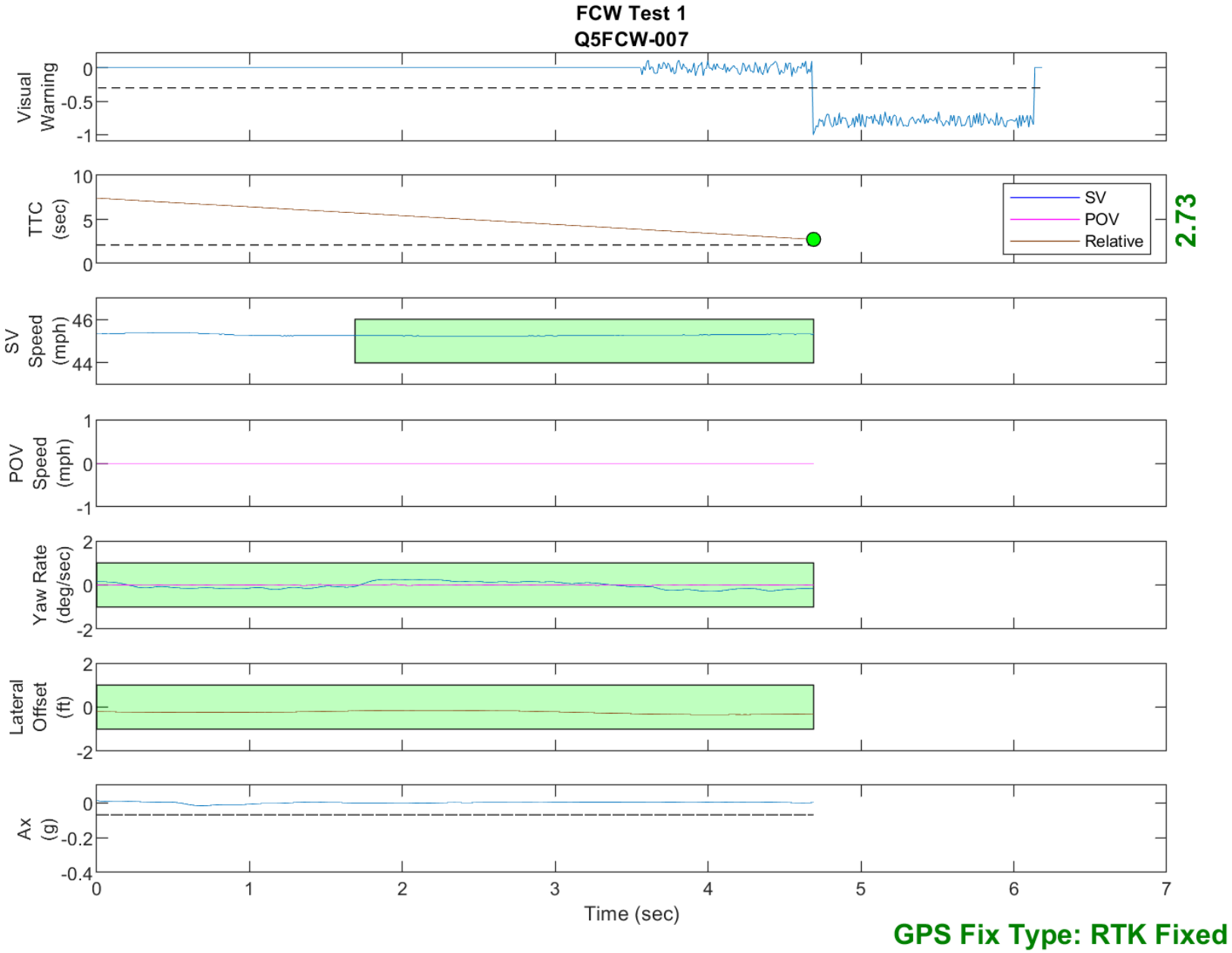

Figure D16. Time History for Run 7, FCW Test 1, Visual Warning

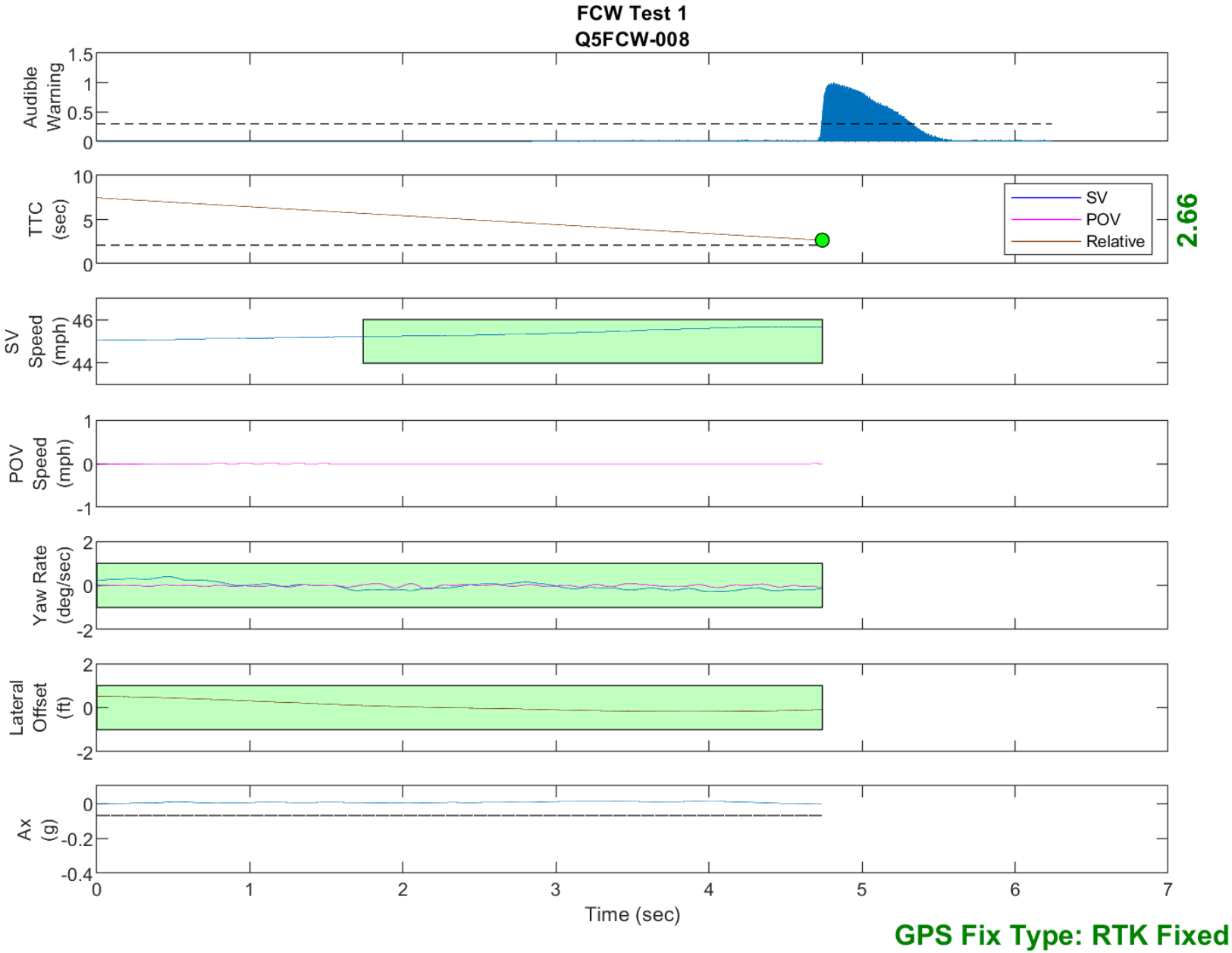

Figure D17. Time History for Run 8, FCW Test 1, Audible Warning

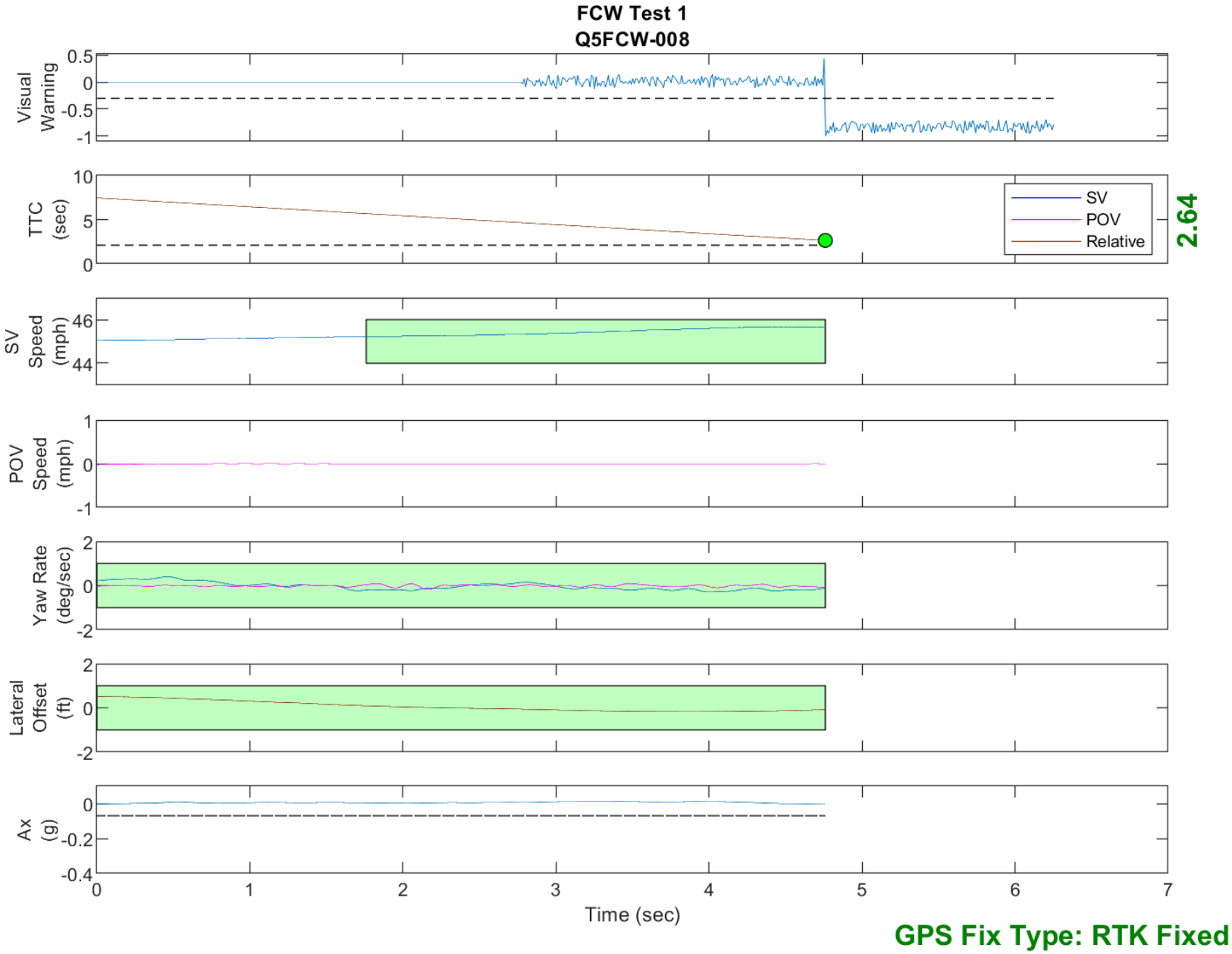

Figure D18. Time History for Run 8, FCW Test 1, Visual Warning

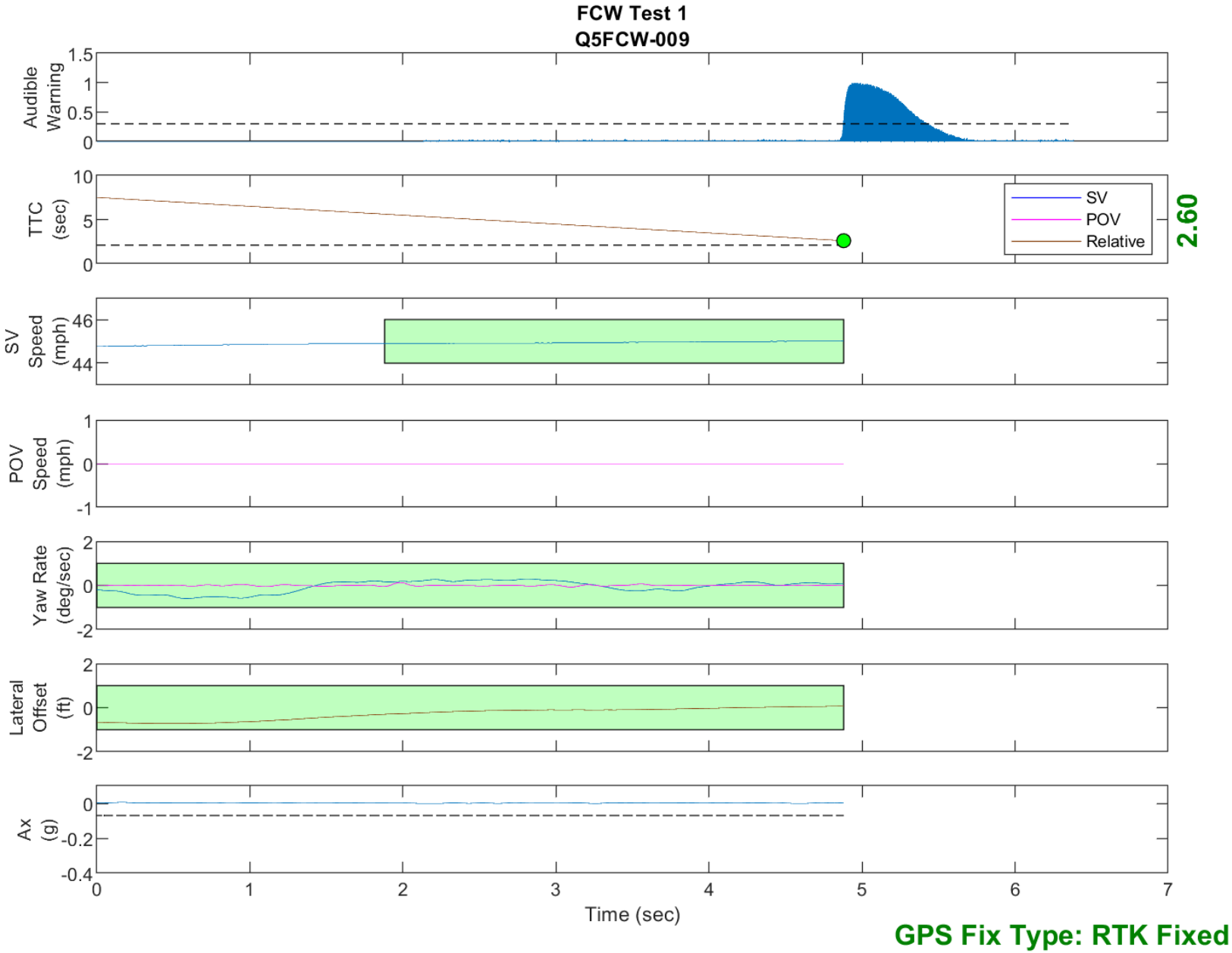

Figure D19. Time History for Run 9, FCW Test 1, Audible Warning

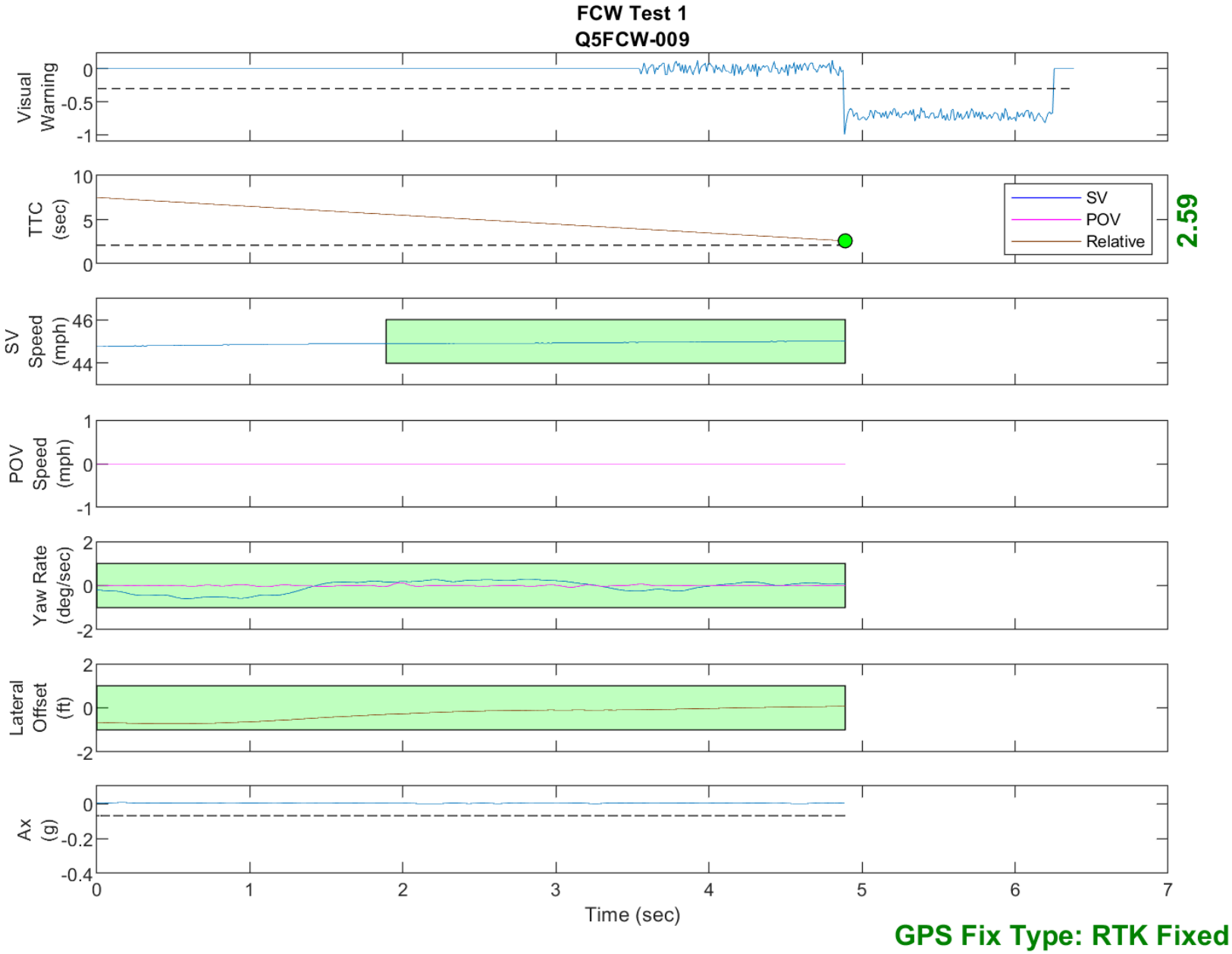

Figure D20. Time History for Run 9, FCW Test 1, Visual Warning

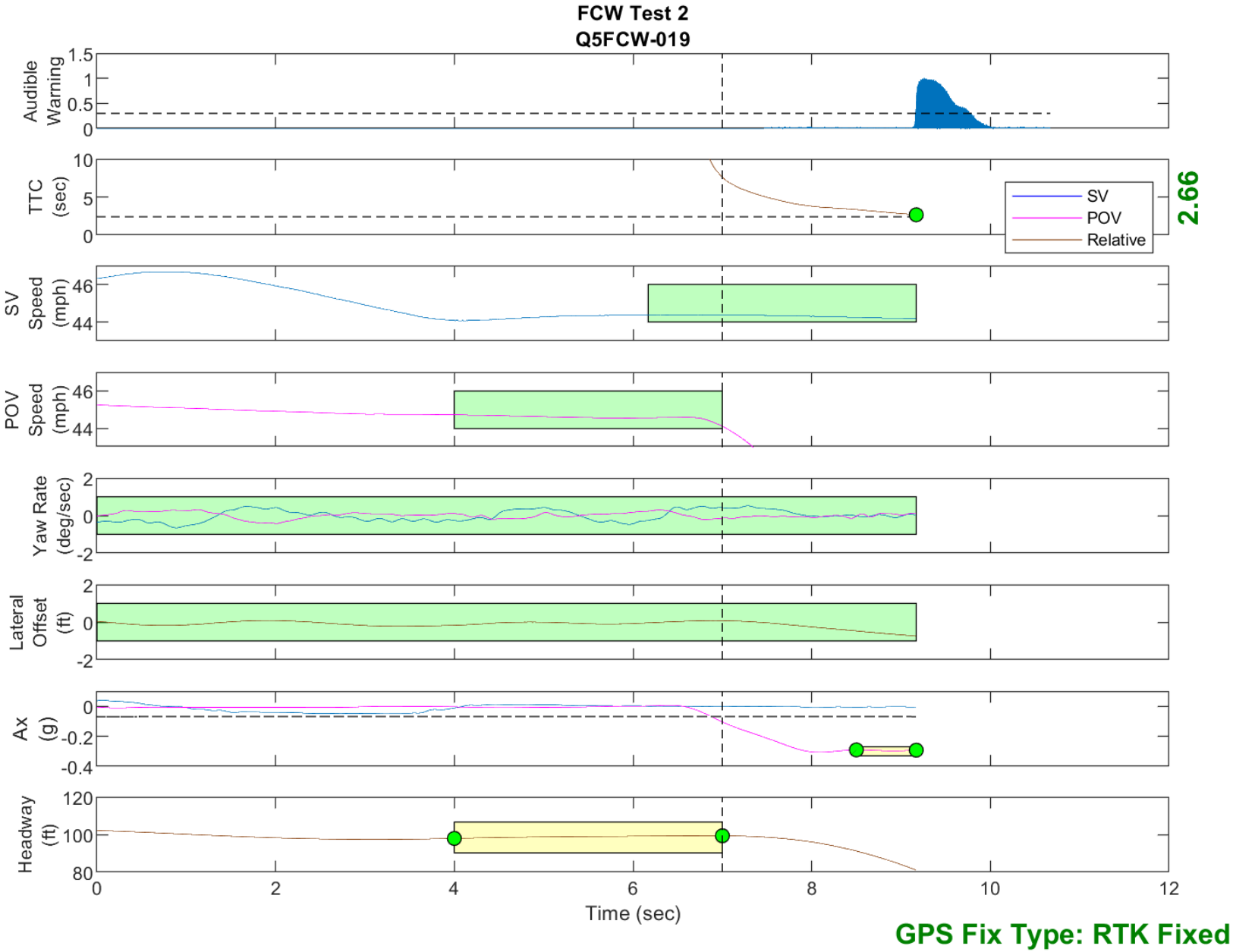

Figure D21. Time History for Run 19, FCW Test 2, Audible Warning

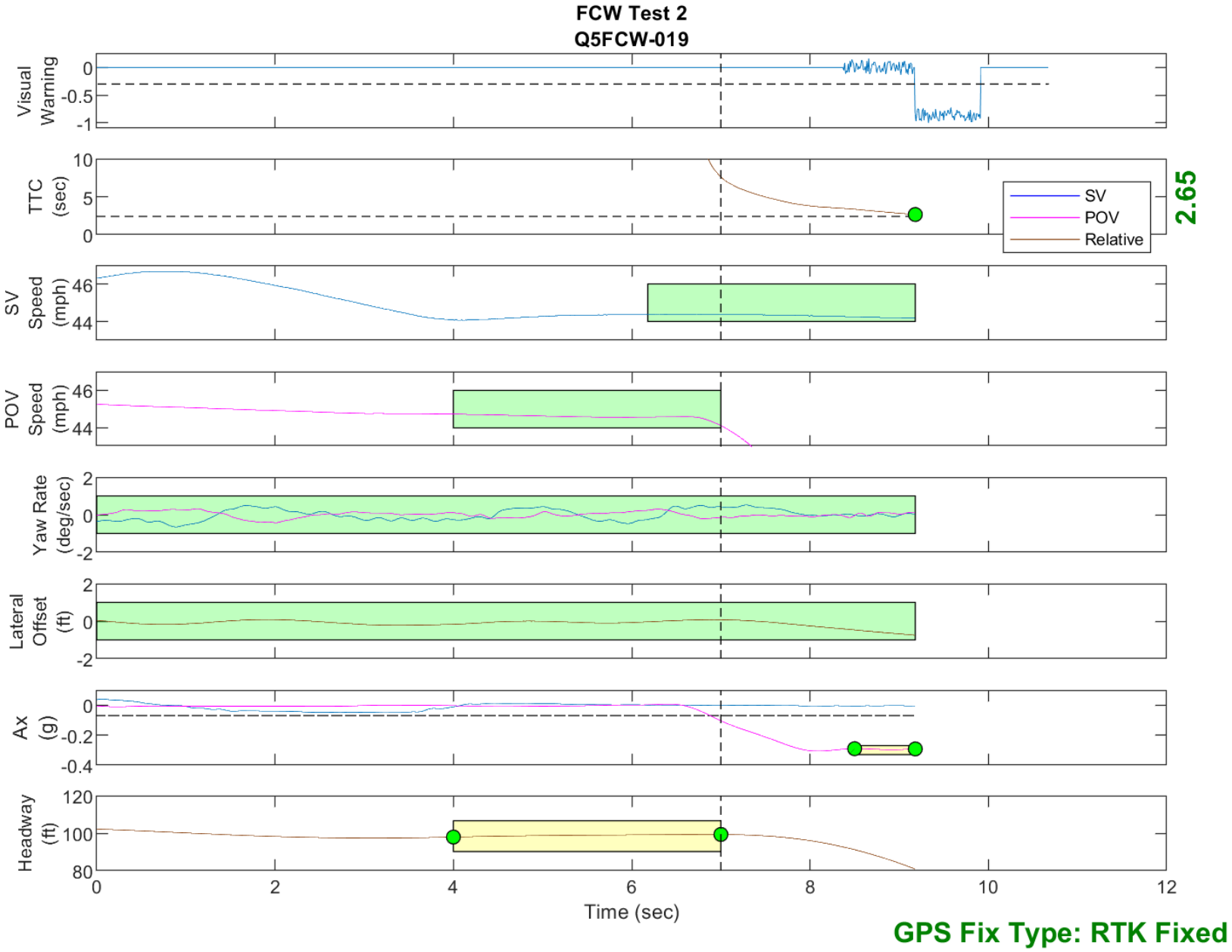

Figure D22. Time History for Run 19, FCW Test 2, Visual Warning

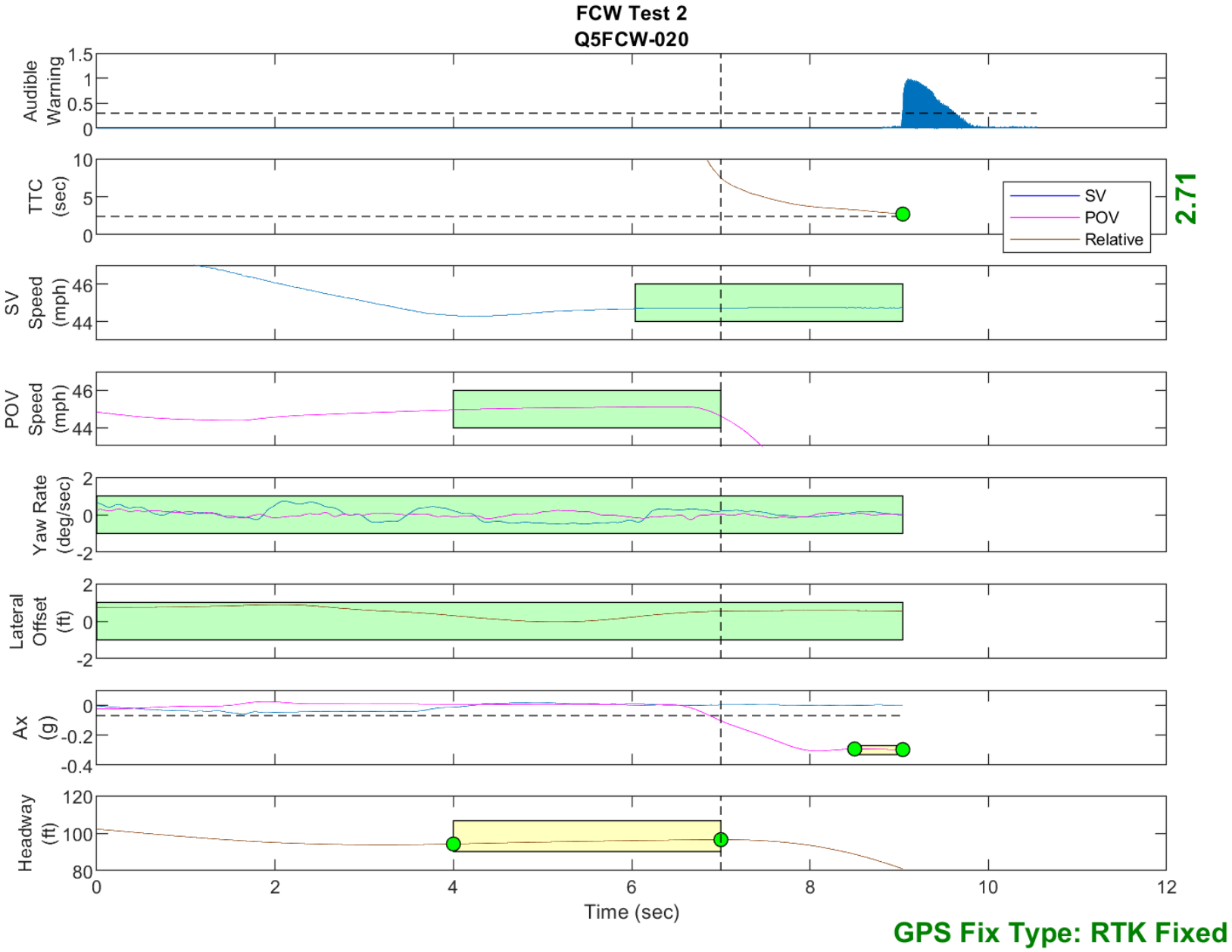

Figure D23. Time History for Run 20, FCW Test 2, Audible Warning

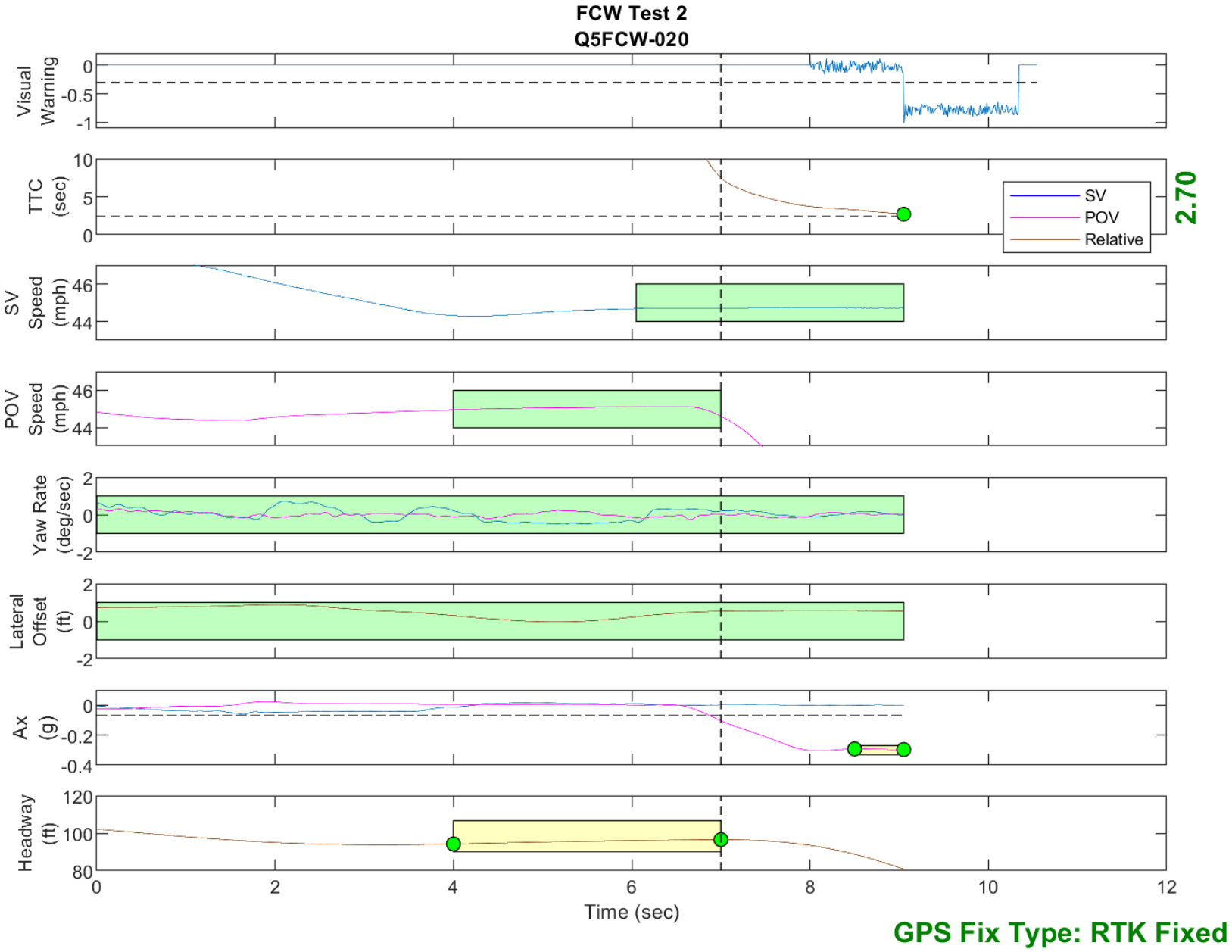

Figure D24. Time History for Run 20, FCW Test 2, Visual Warning

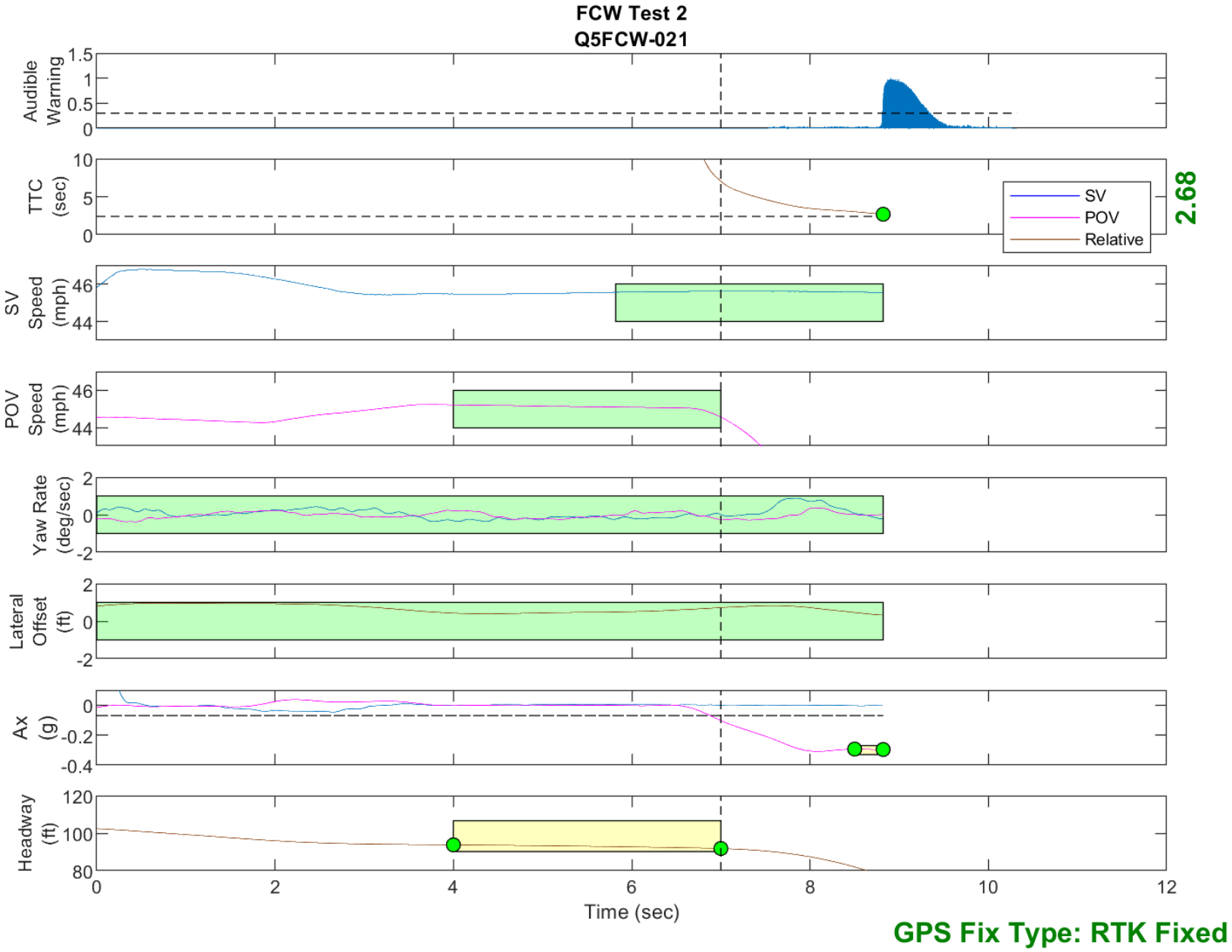

Figure D25. Time History for Run 21, FCW Test 2, Audible Warning

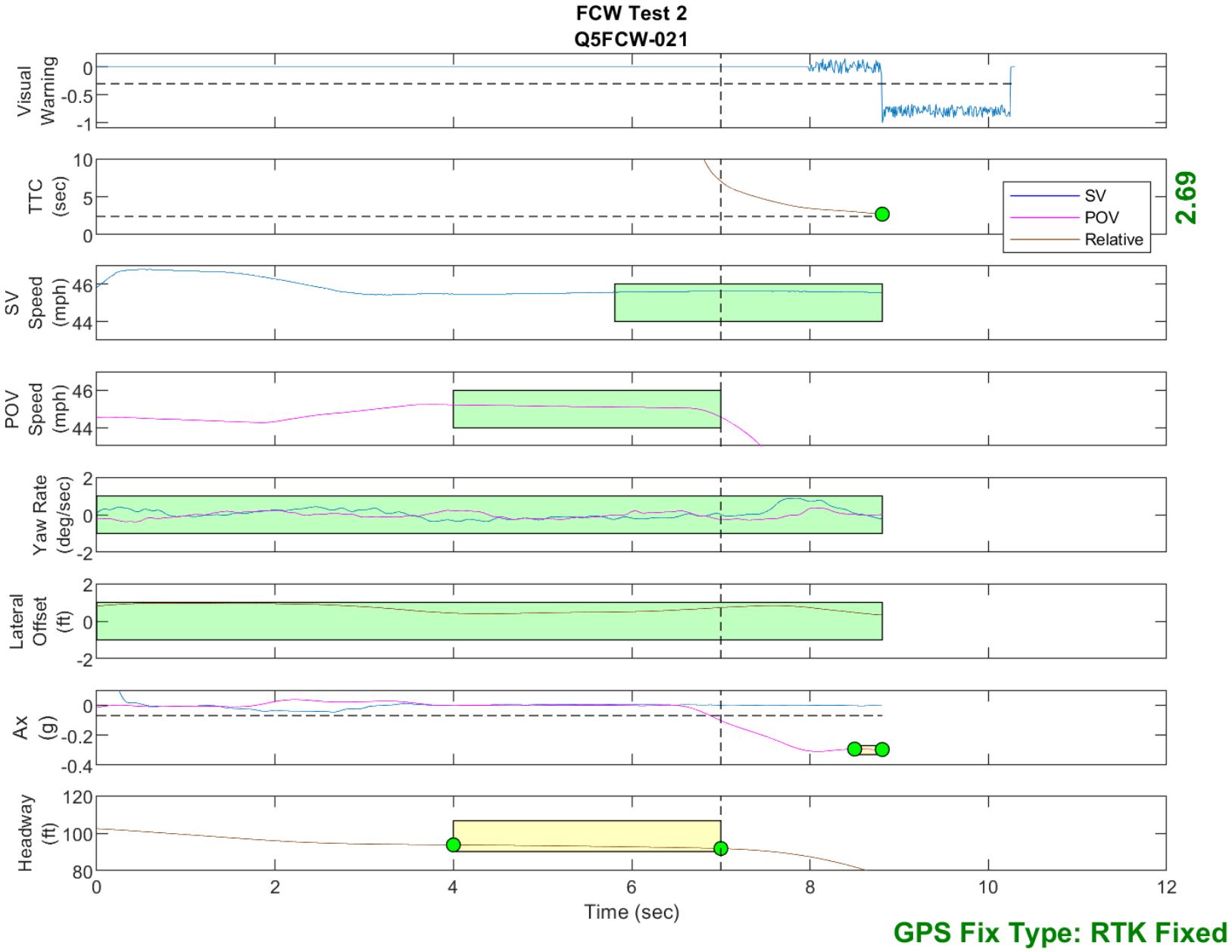

Figure D26. Time History for Run 21, FCW Test 2, Visual Warning

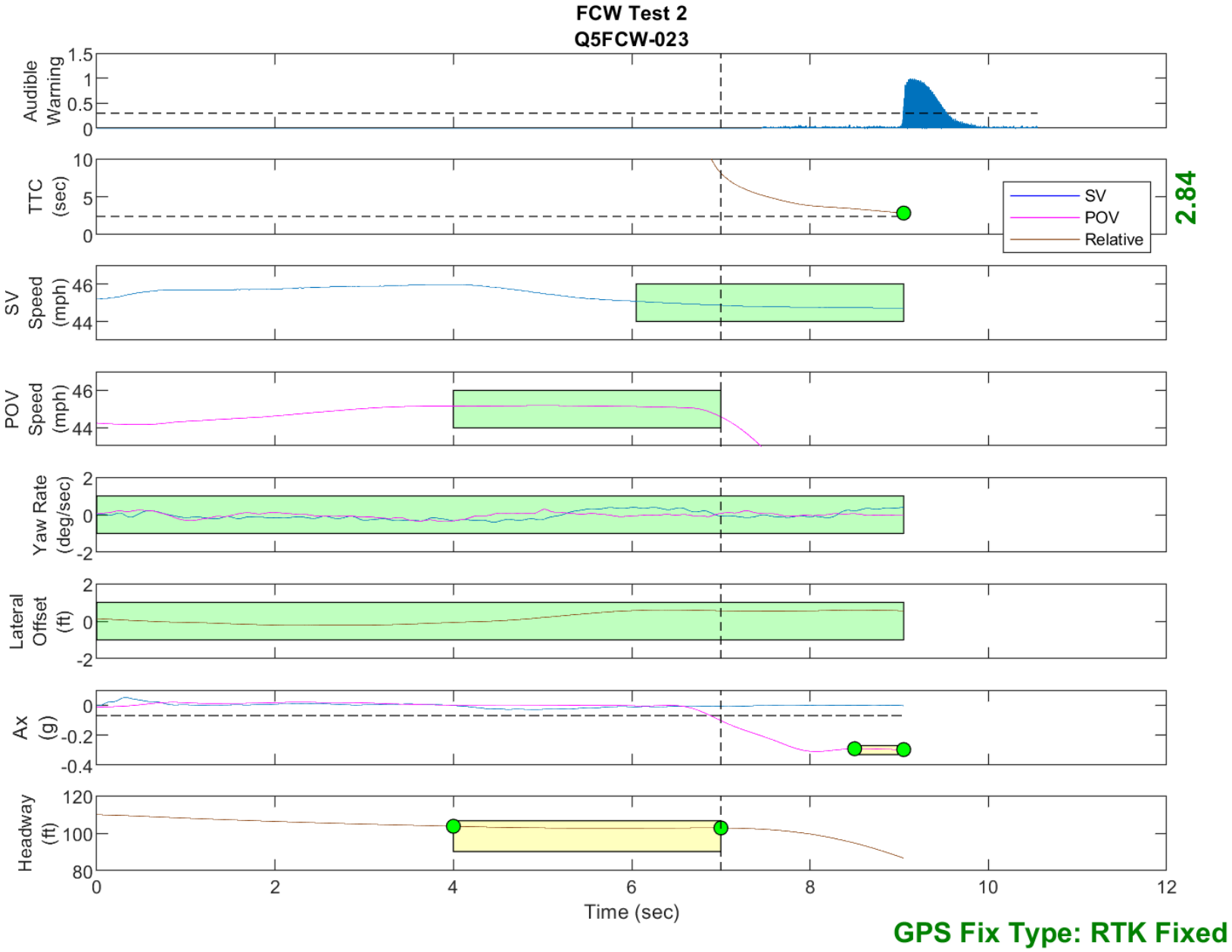

Figure D27. Time History for Run 23, FCW Test 2, Audible Warning

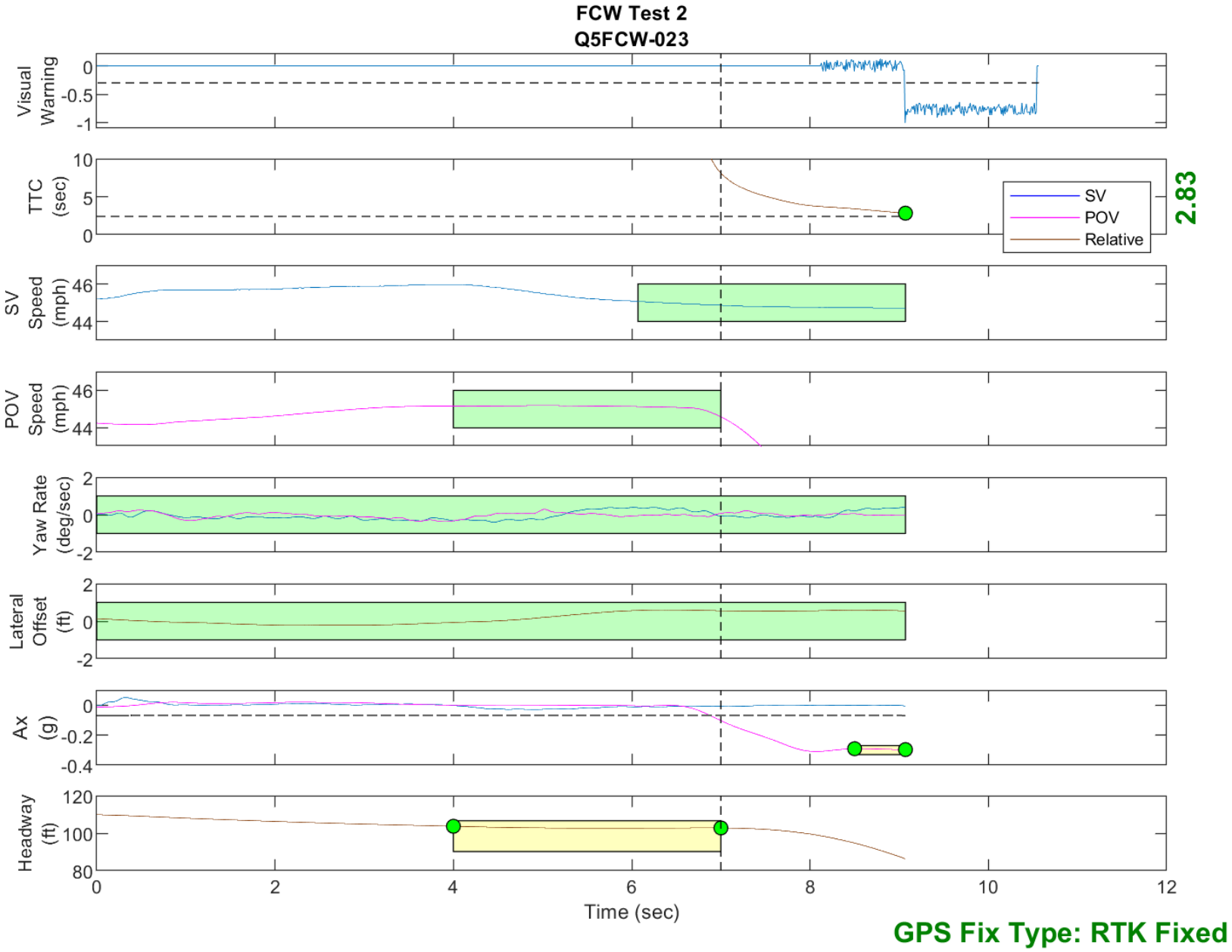

Figure D28. Time History for Run 23, FCW Test 2, Visual Warning

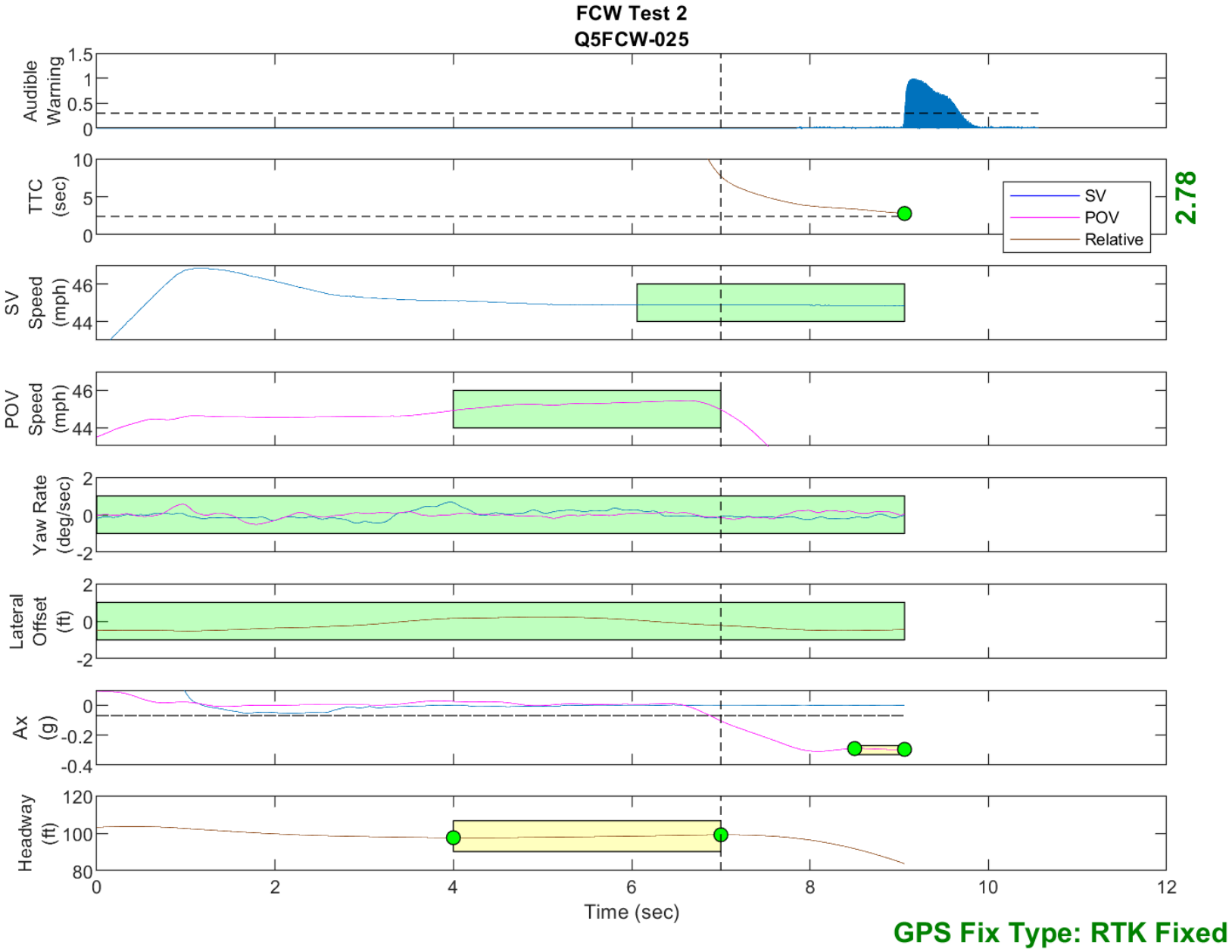

Figure D29. Time History for Run 25, FCW Test 2, Audible Warning

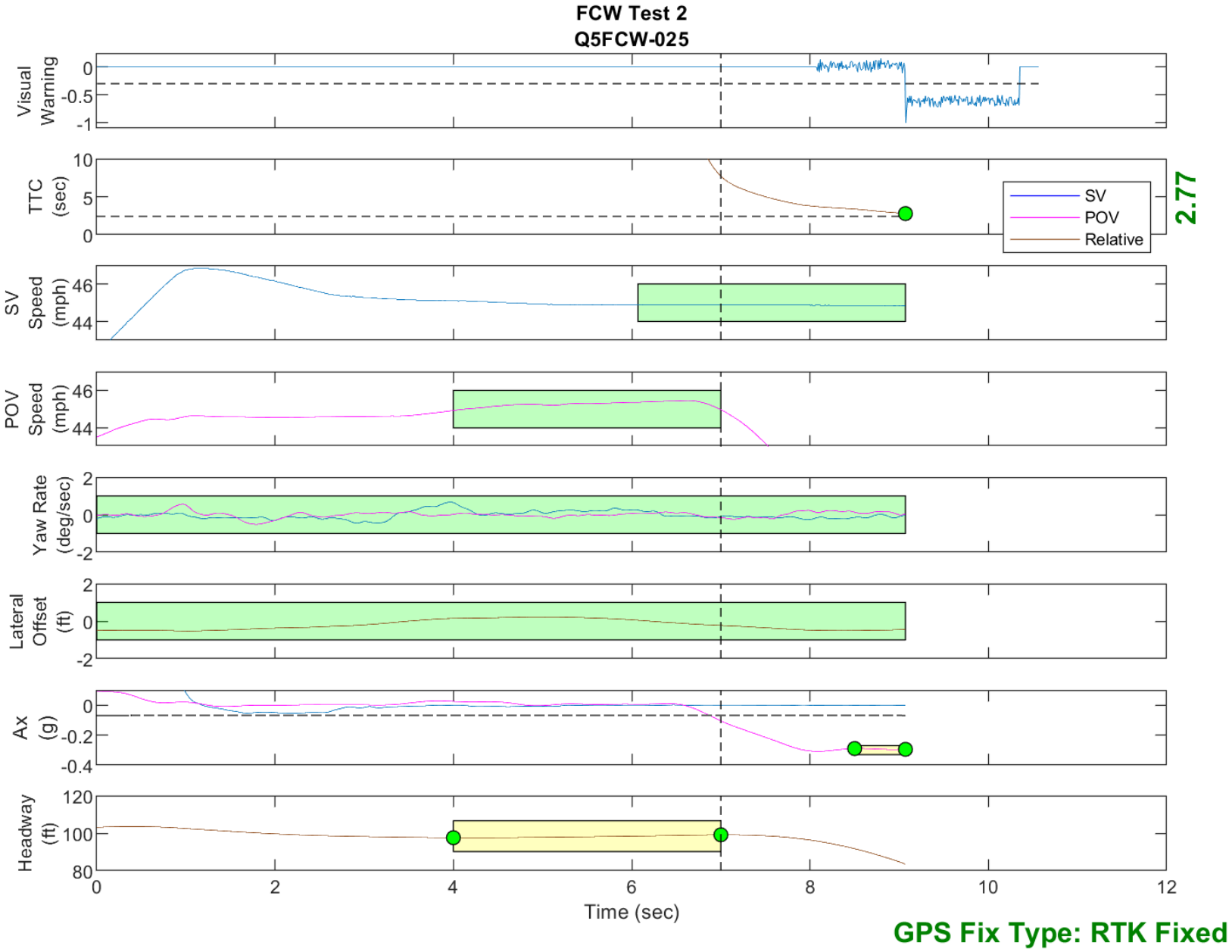

Figure D30. Time History for Run 25, FCW Test 2, Visual Warning

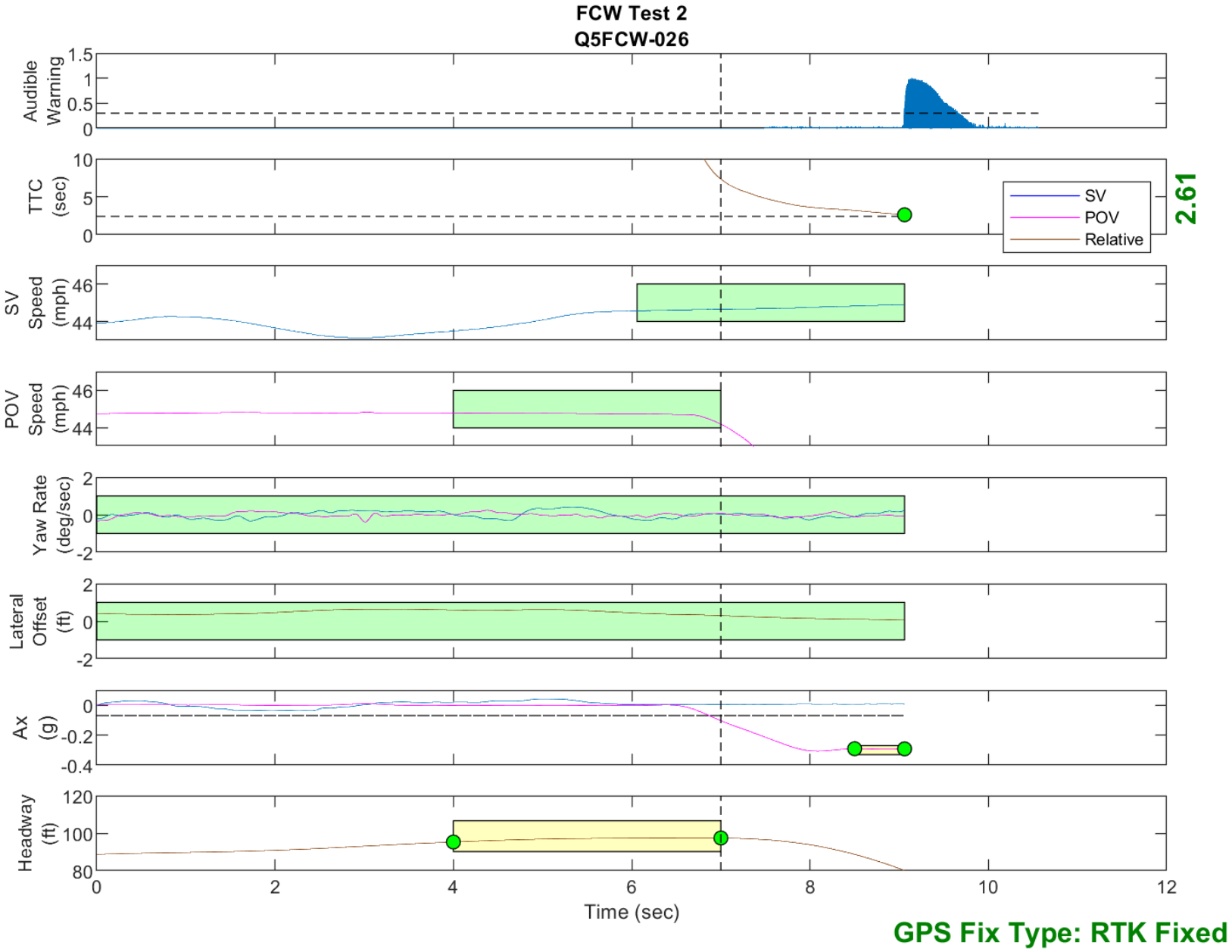

Figure D31. Time History for Run 26, FCW Test 2, Audible Warning

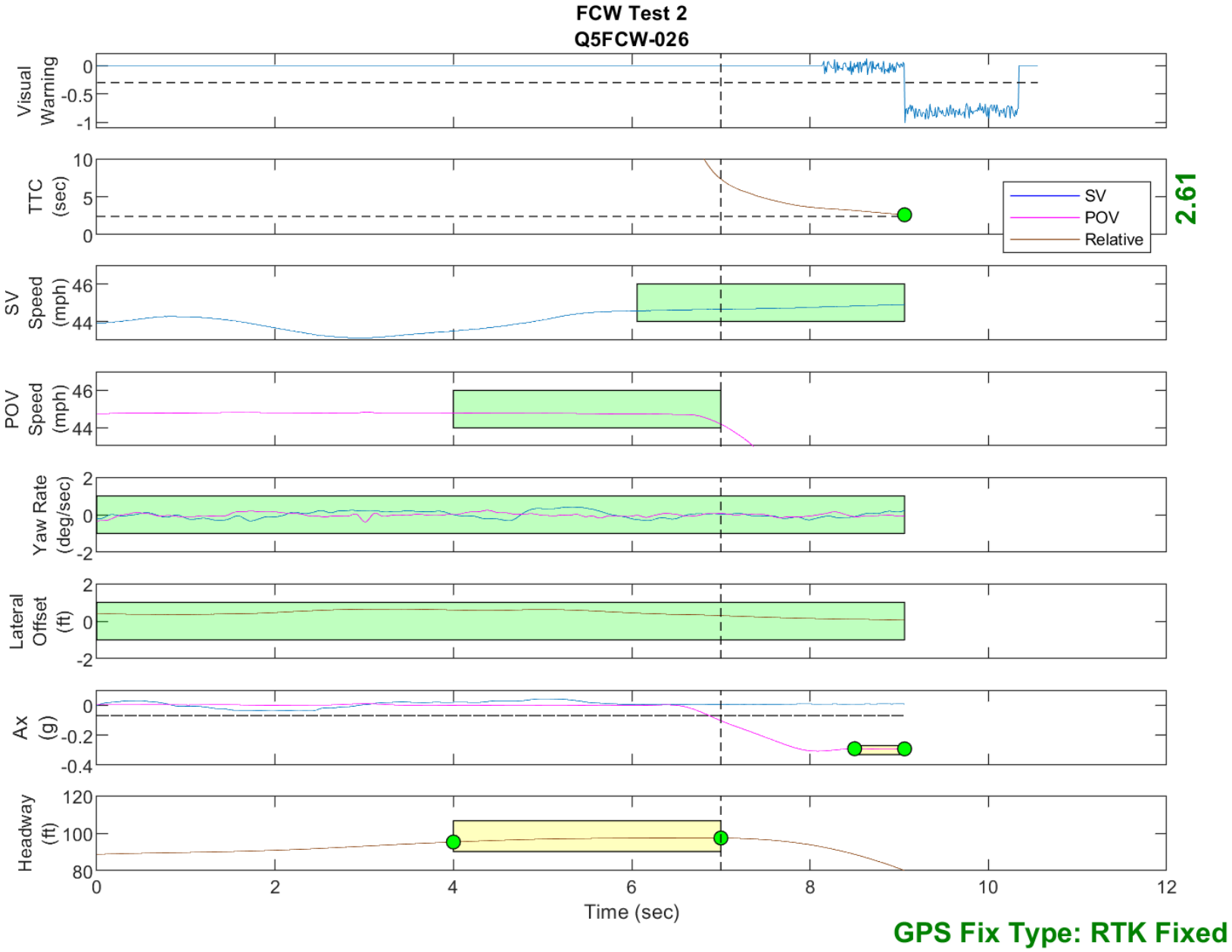

Figure D32. Time History for Run 26, FCW Test 2, Visual Warning

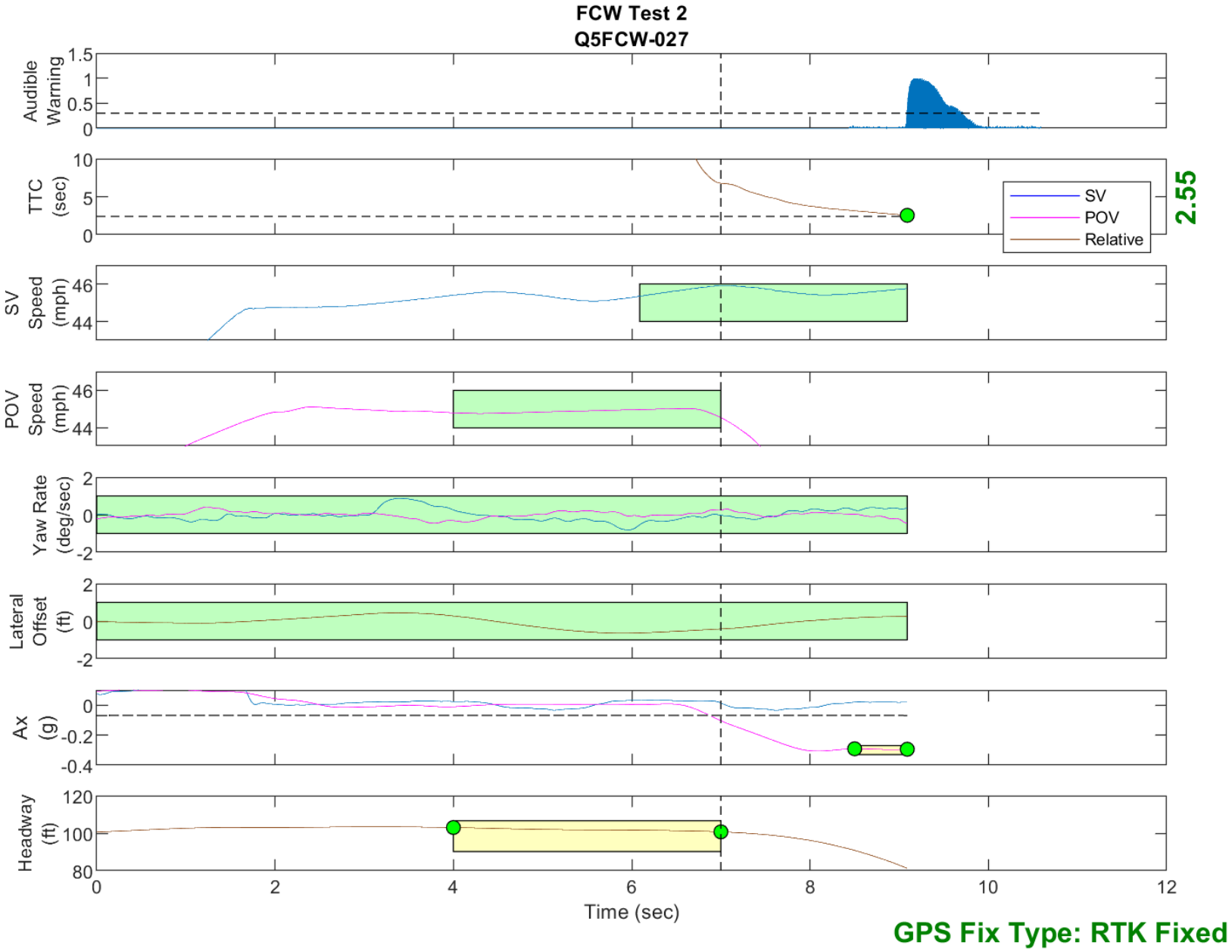

Figure D33. Time History for Run 27, FCW Test 2, Audible Warning

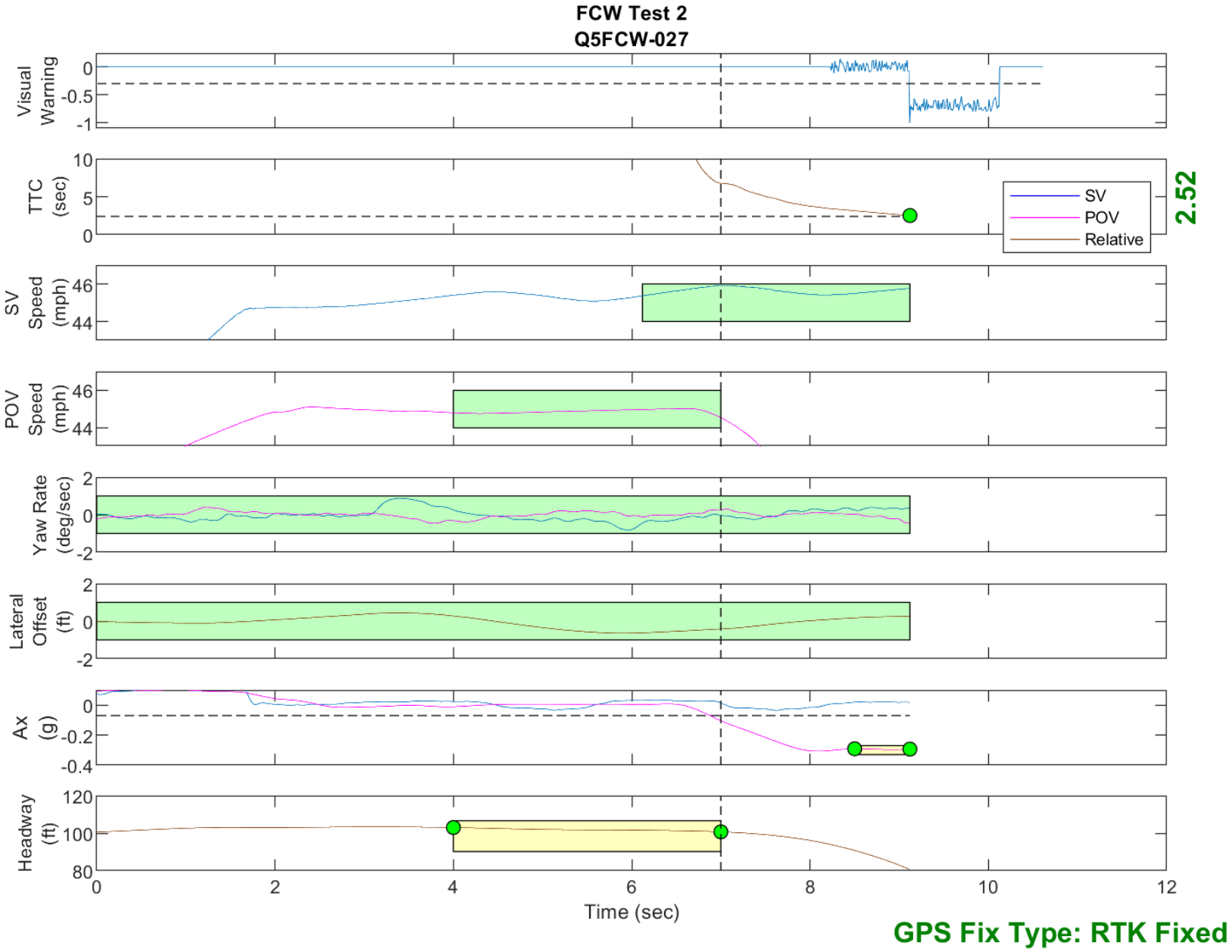

Figure D34. Time History for Run 27, FCW Test 2, Visual Warning

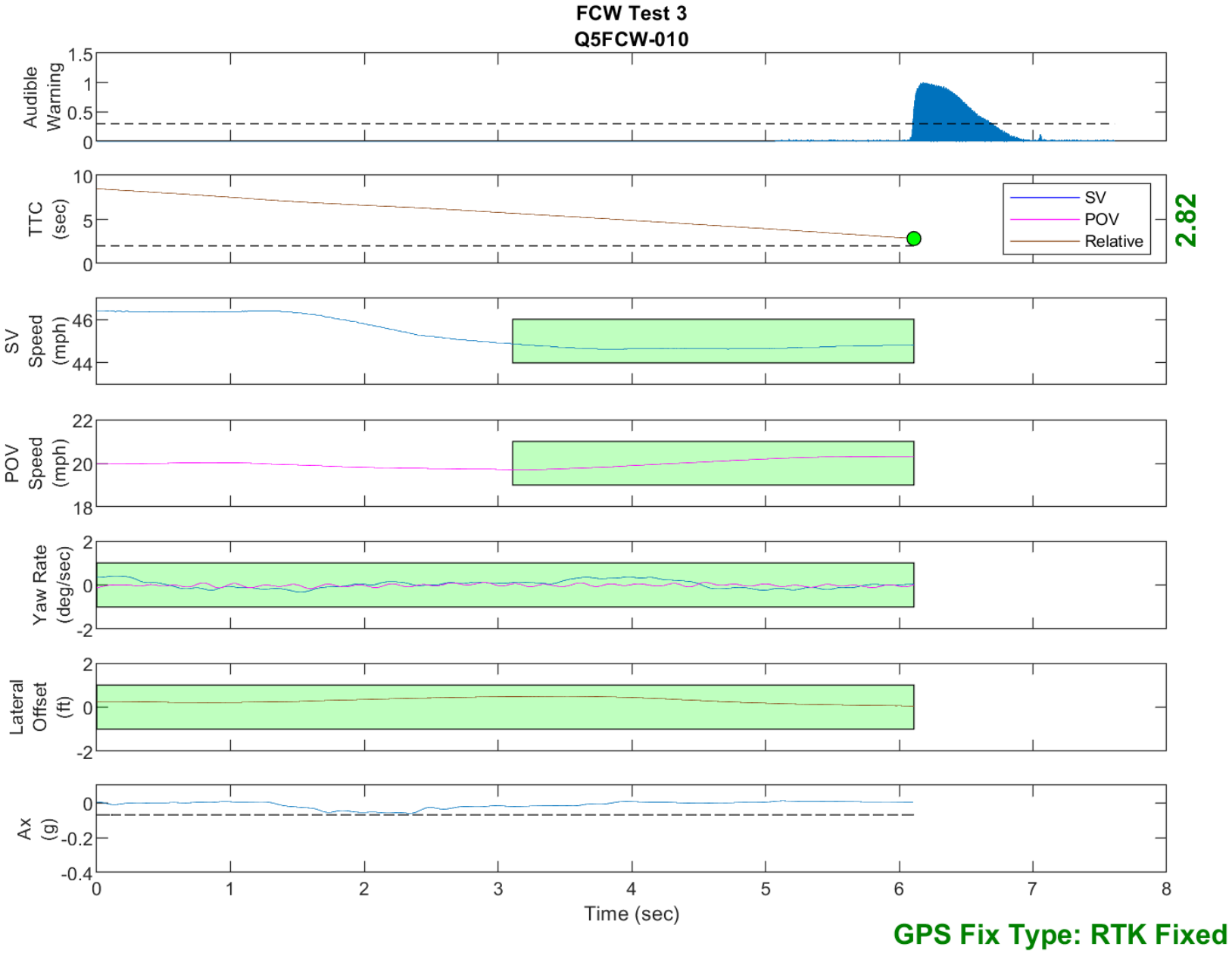

Figure D35. Time History for Run 10, FCW Test 3, Audible Warning

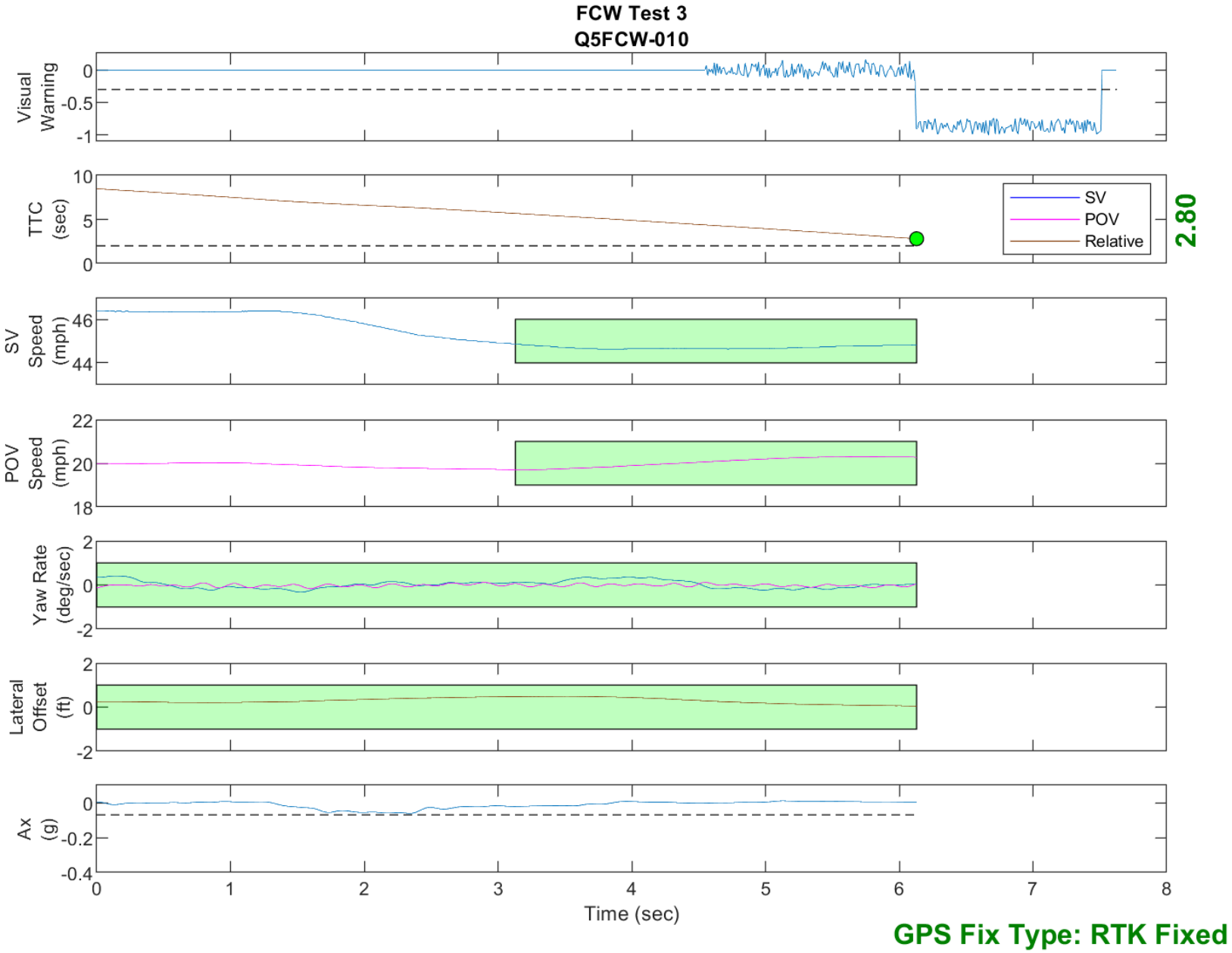

Figure D36. Time History for Run 10, FCW Test 3, Visual Warning

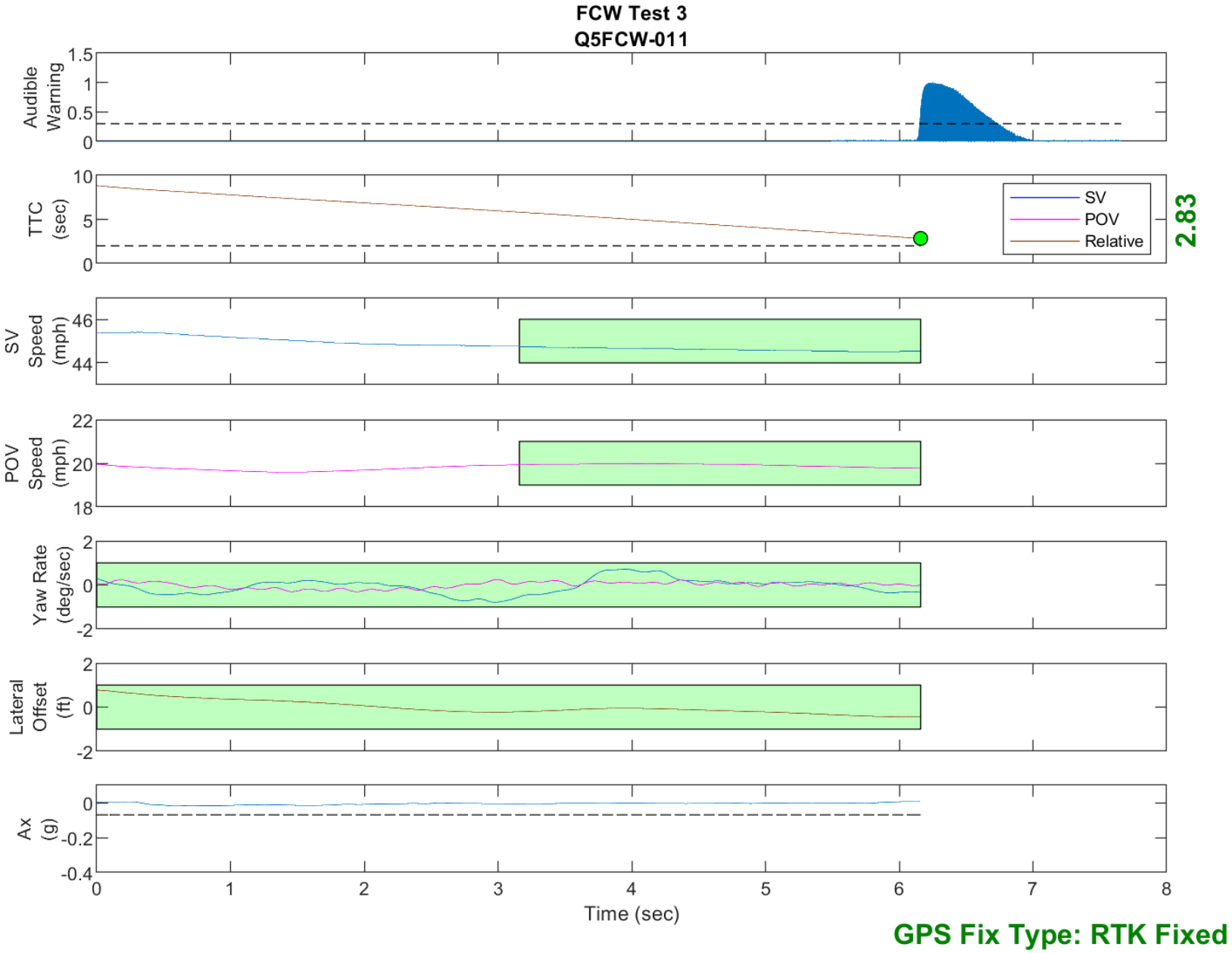

Figure D37. Time History for Run 11, FCW Test 3, Audible Warning

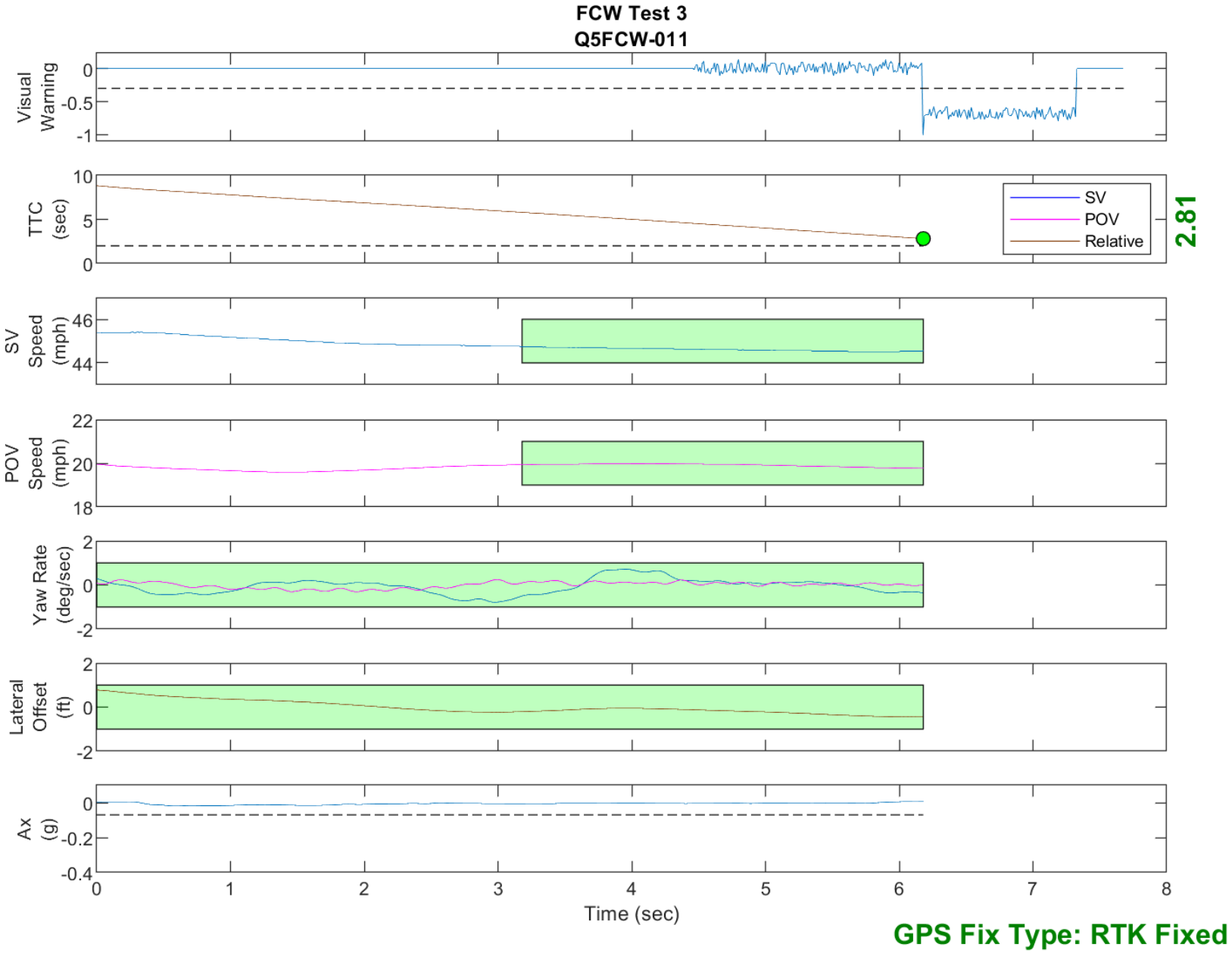

Figure D38. Time History for Run 11, FCW Test 3, Visual Warning

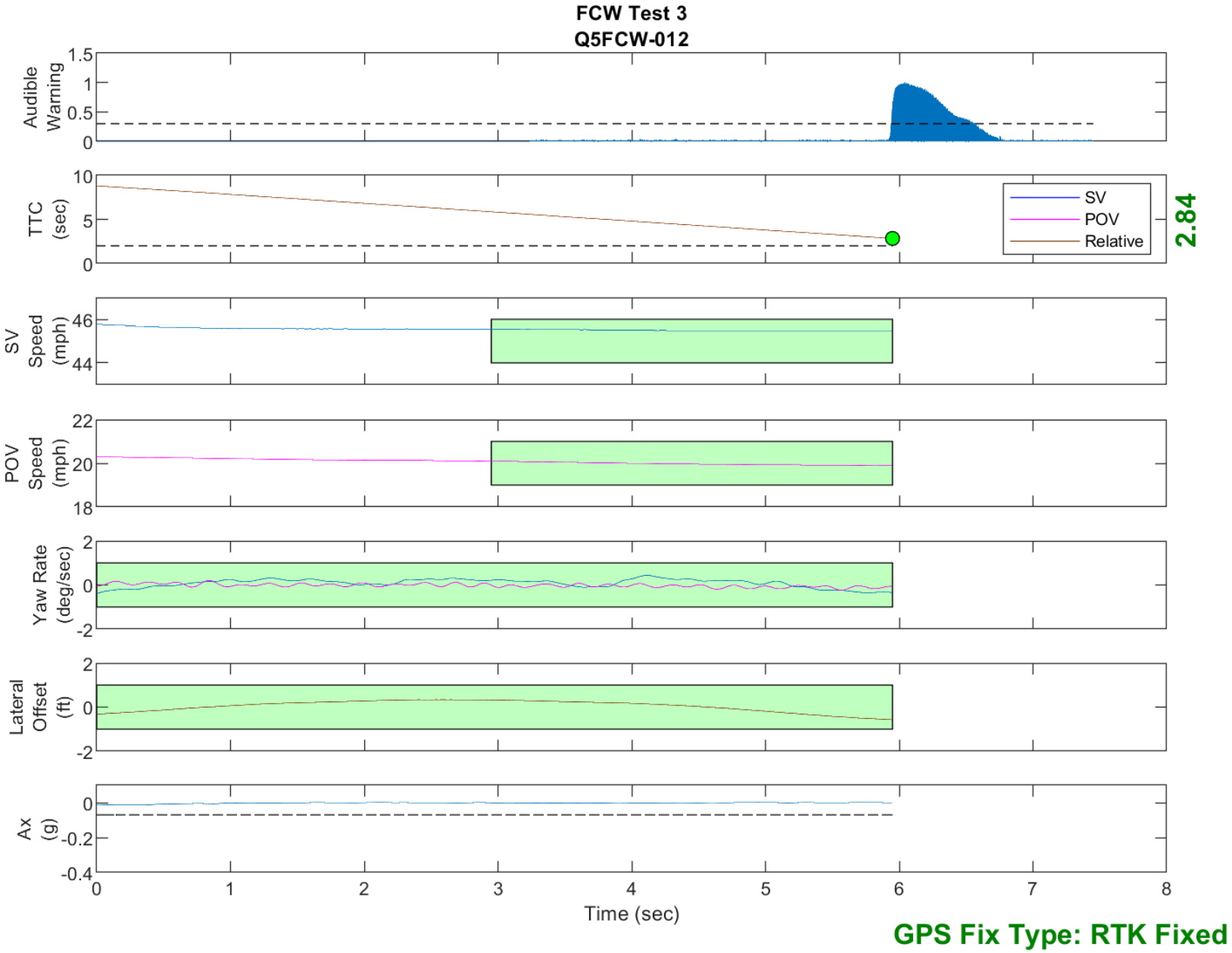

Figure D39. Time History for Run 12, FCW Test 3, Audible Warning

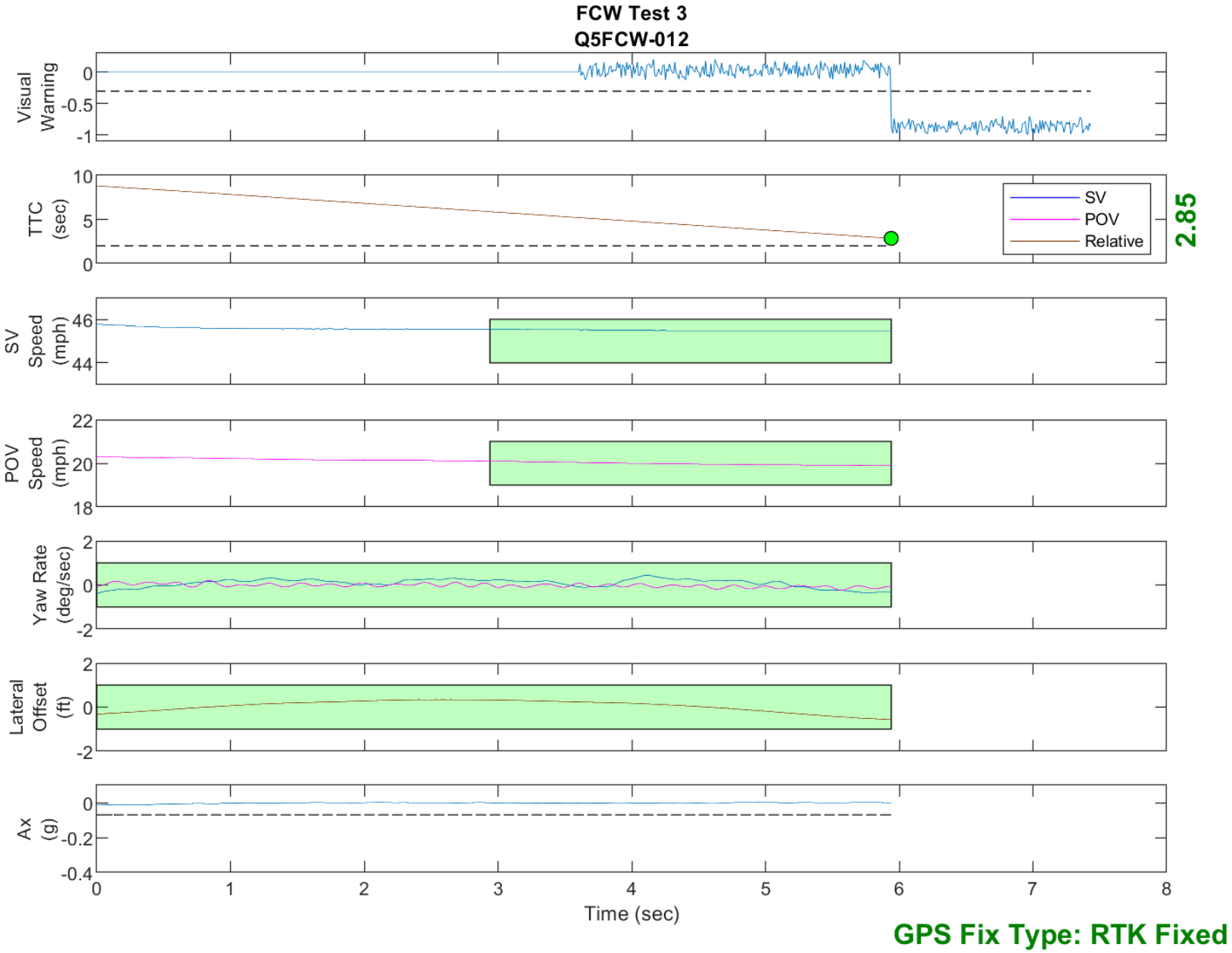

Figure D40. Time History for Run 12, FCW Test 3, Visual Warning

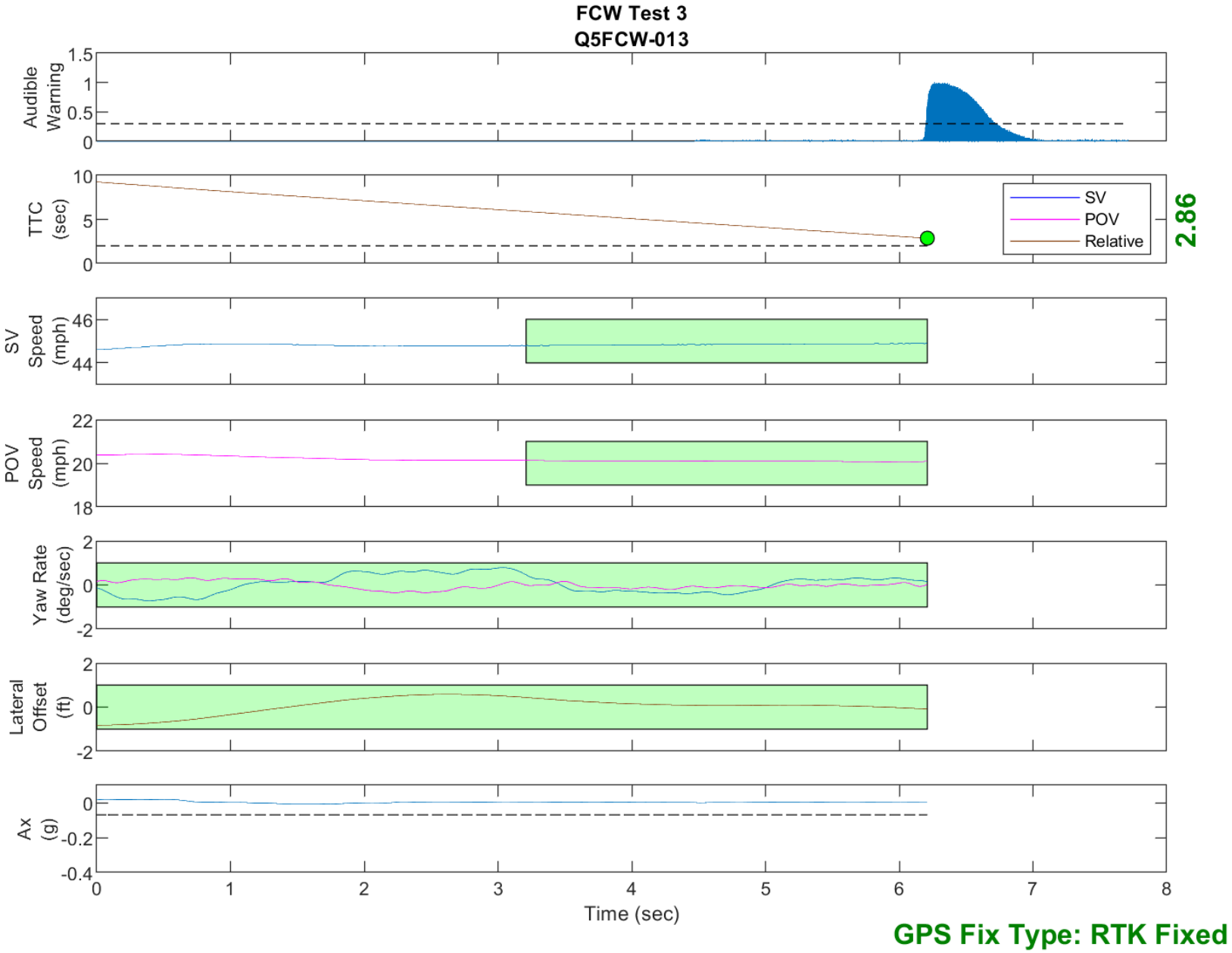

Figure D41. Time History for Run 13, FCW Test 3, Audible Warning

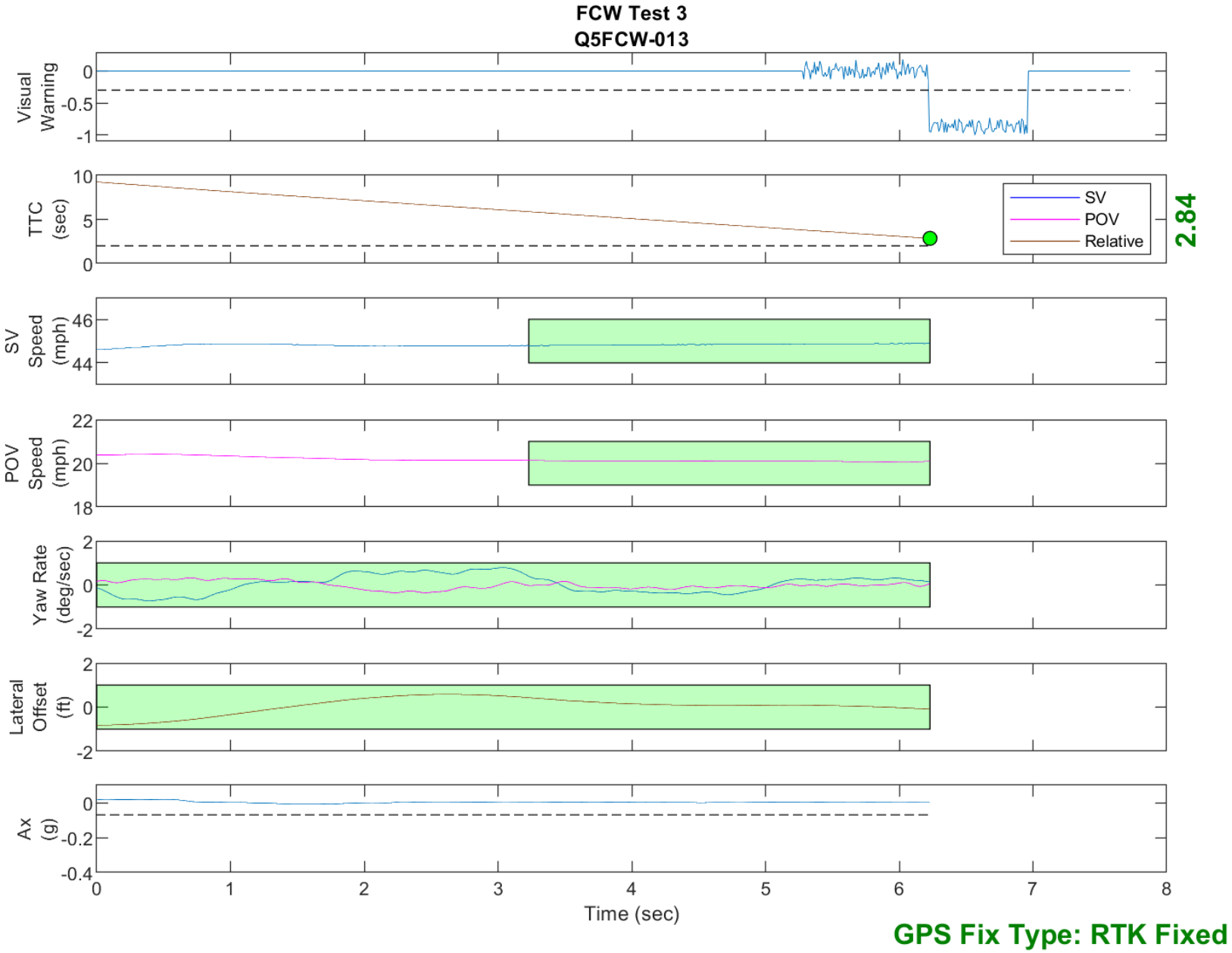

Figure D42. Time History for Run 13, FCW Test 3, Visual Warning

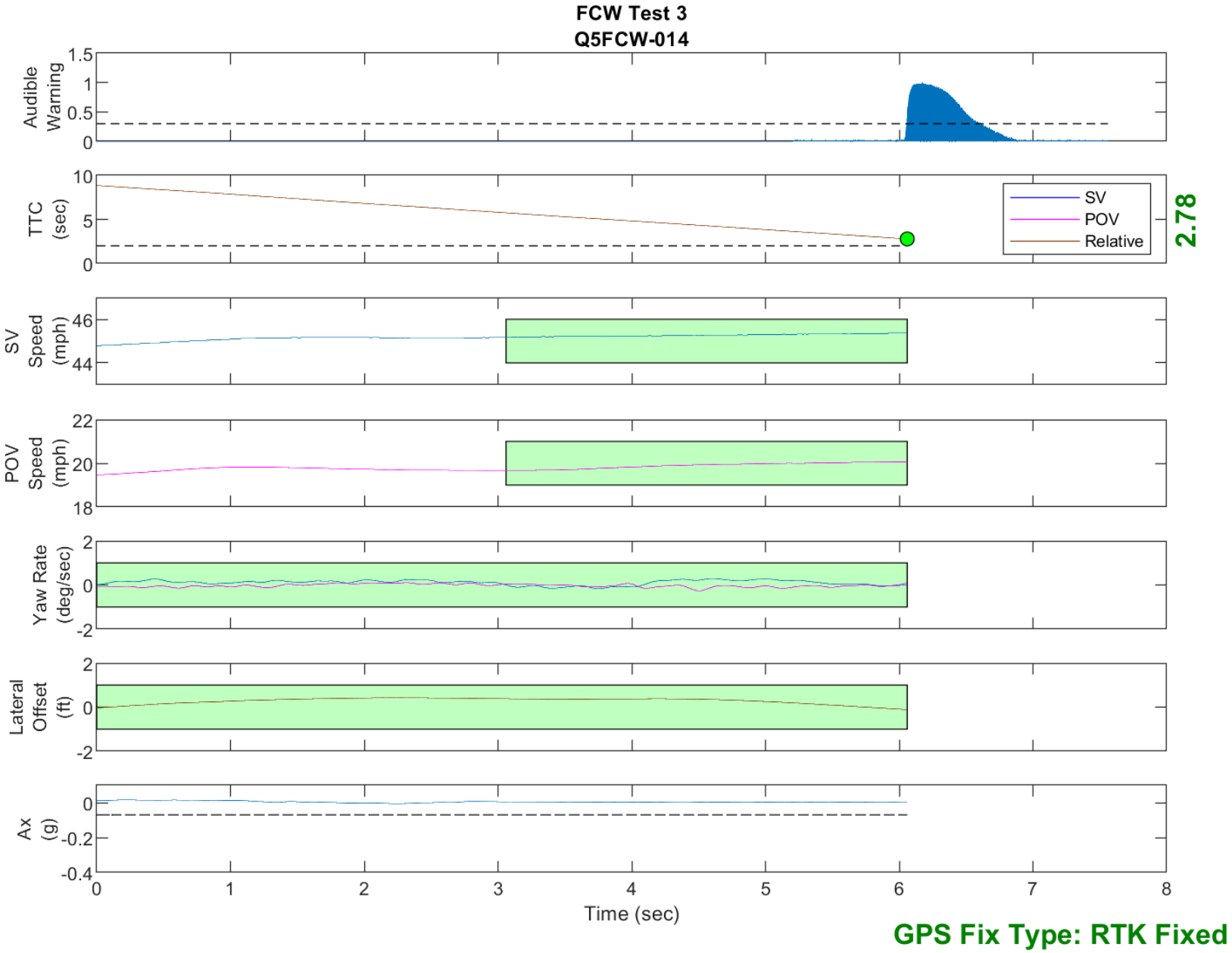

Figure D43. Time History for Run 14, FCW Test 3, Audible Warning

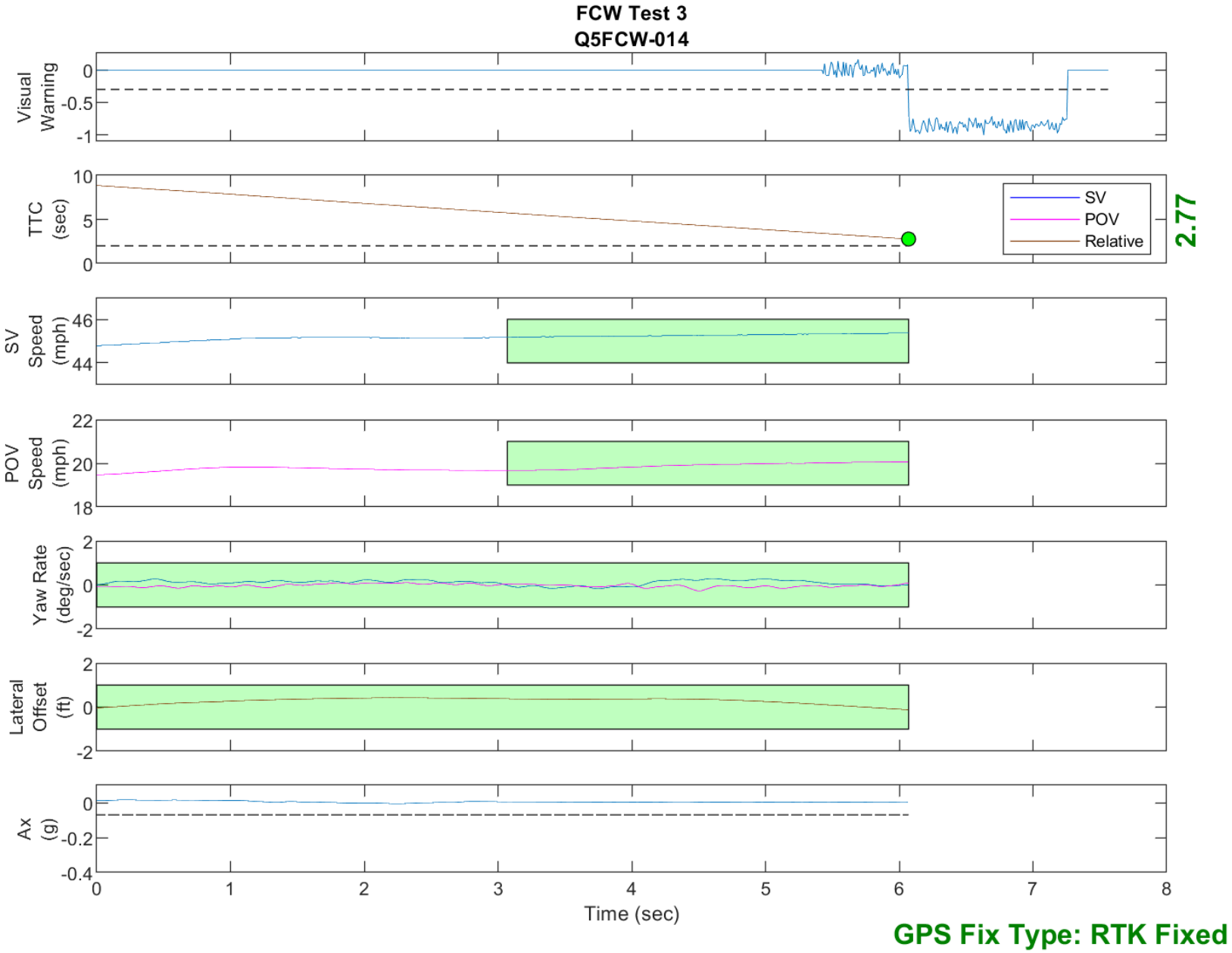

Figure D44. Time History for Run 14, FCW Test 3, Visual Warning

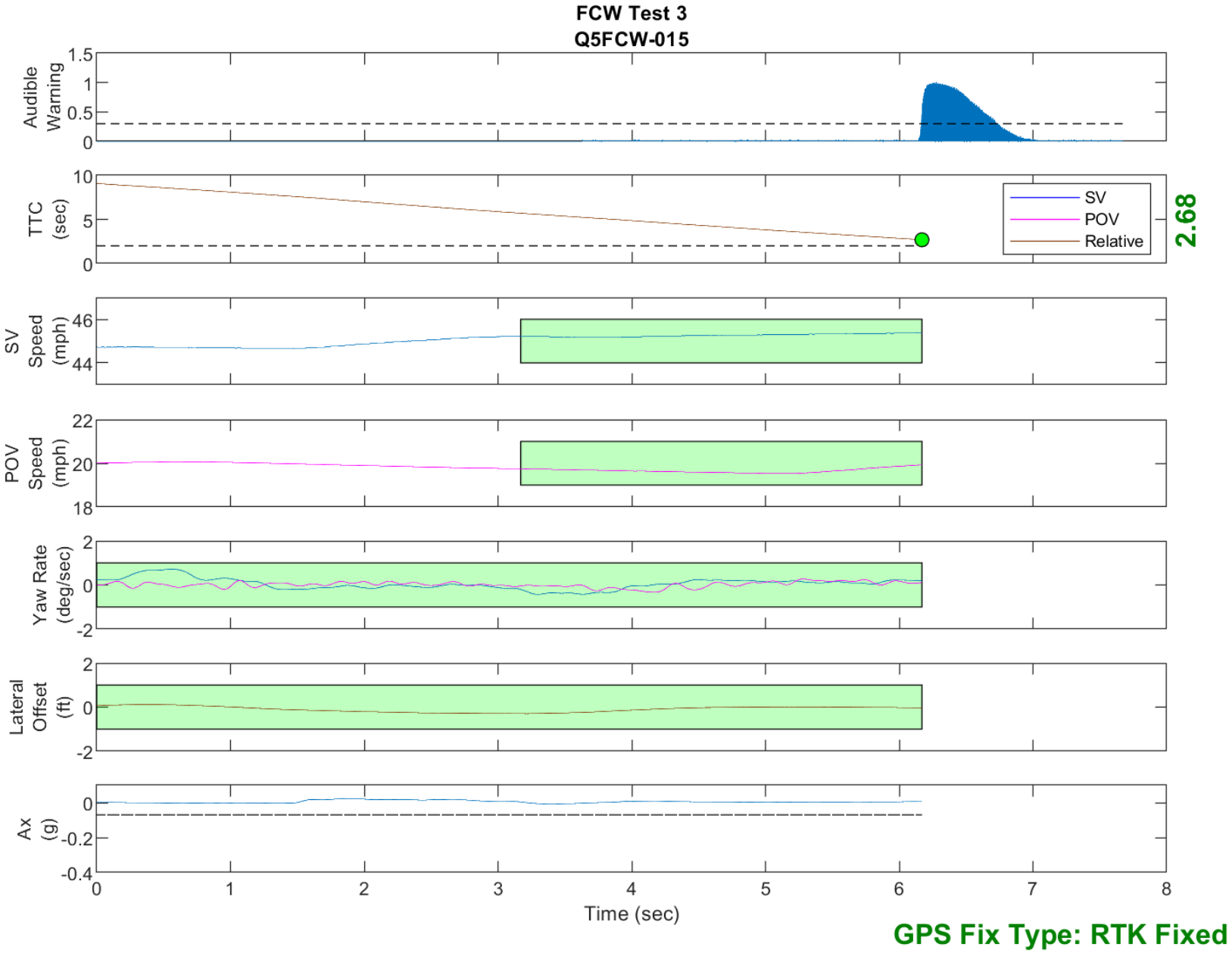

Figure D45. Time History for Run 15, FCW Test 3, Audible Warning

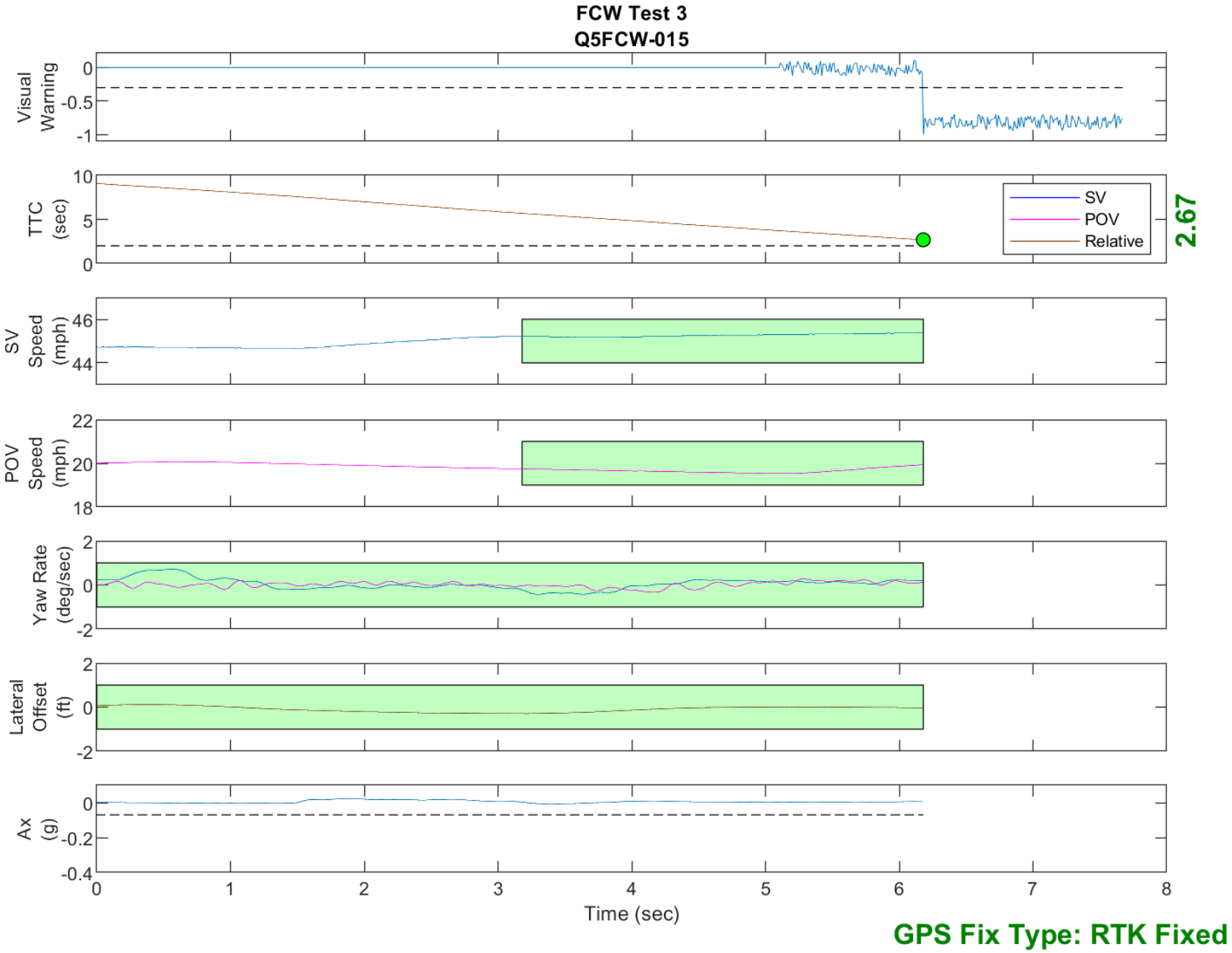

Figure D46. Time History for Run 15, FCW Test 3, Visual Warning

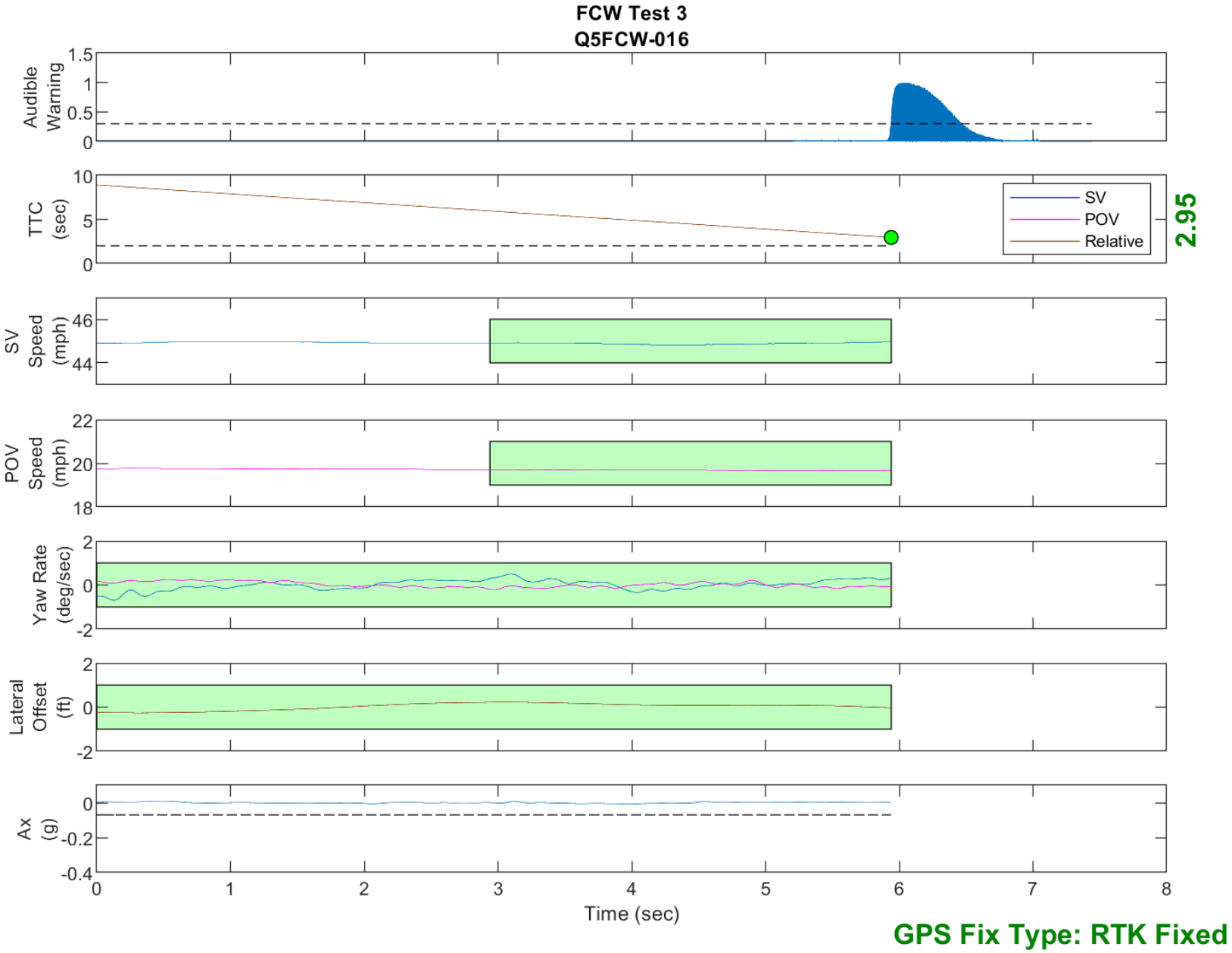

Figure D47. Time History for Run 16, FCW Test 3, Audible Warning

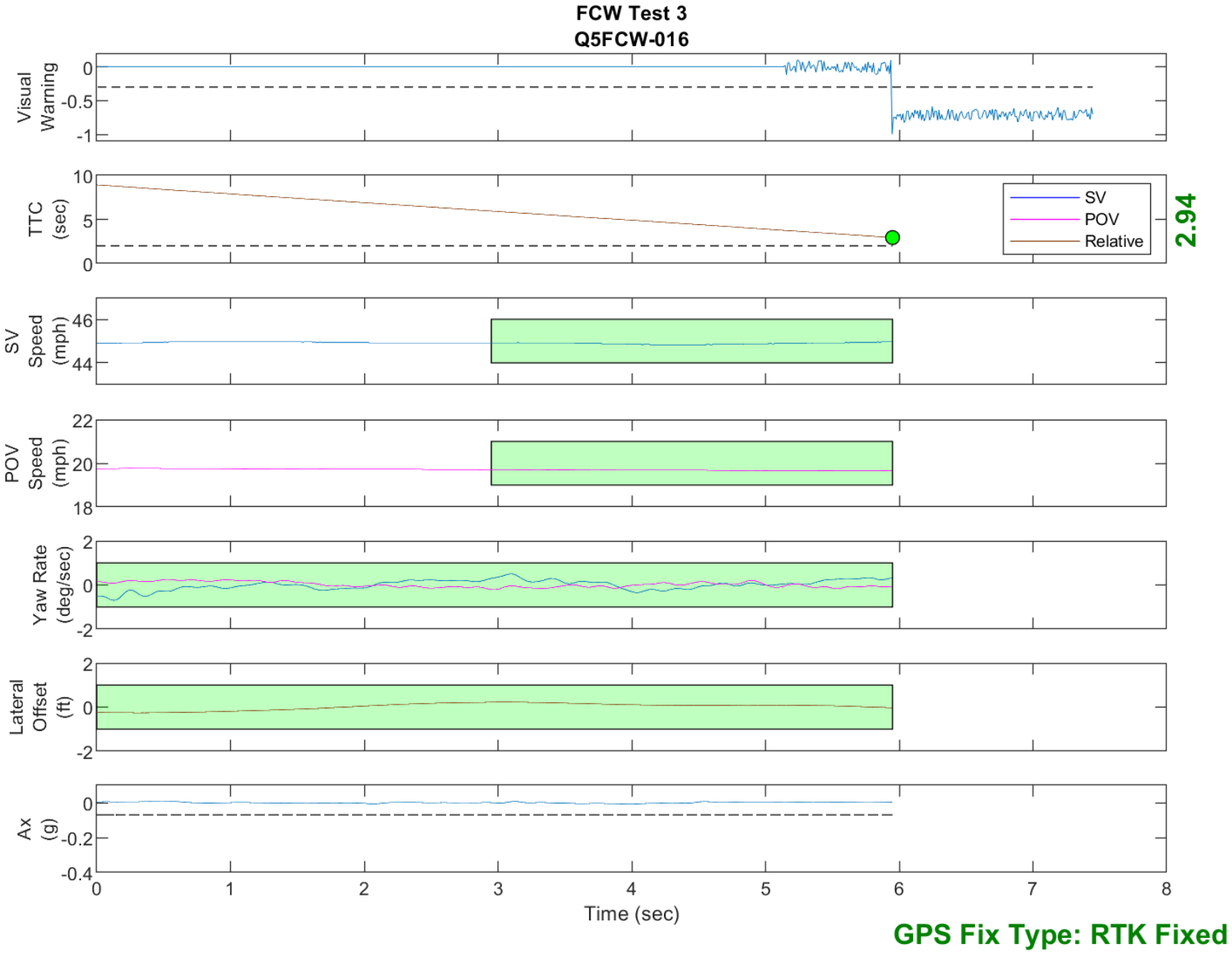

Figure D48. Time History for Run 16, FCW Test 3, Visual Warning