

**NEW CAR ASSESSMENT PROGRAM
FORWARD COLLISION WARNING CONFIRMATION TEST
NCAP-DRI-FCW-20-12**

2020 Kia Optima EX

DYNAMIC RESEARCH, INC.

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10 June 2020

Final Report

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

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National Highway Traffic Safety Administration
New Car Assessment Program
1200 New Jersey Avenue, SE
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Date: 10 June 2020

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16. Abstract These tests were conducted on the subject 2020 Kia Optima EX 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

(Page 1 of 1)

2020 Kia Optima EX

VIN: 5XXGU4L14LG41xxxx

Test Date: 3/24/2020

Forward Collision Warning setting: Early

Test 1 - Subject Vehicle Encounters Stopped Principal Other Vehicle:	<u>Pass</u>
Test 2 - Subject Vehicle Encounters Decelerating Principal Other Vehicle:	<u>Pass</u>
Test 3 - Subject Vehicle Encounters Slower Principal Other Vehicle:	<u>Pass</u>

Overall: **Pass**

Notes:

FORWARD COLLISION WARNING

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2020 Kia Optima EX

TEST VEHICLE INFORMATION

VIN: 5XXGU4L14LG41xxxx

Body Style: Sedan

Color: Ebony Black

Date Received: 3/16/2020

Odometer Reading: 23 mi

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: KIA MOTORS MANUFACTURING
GEORGIA, INC.

Date of manufacture: OCT/30/19

Vehicle Type: Passenger car

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: 215/55 R17

Rear: 215/55 R17

Recommended cold tire pressure: Front: 235 kPa (34 psi)

Rear: 235 kPa (34 psi)

TIRES

Tire manufacturer and model: Kumho Solus TA31

Front tire specification: 215/55 R17 94V

Rear tire specification: 215/55 R17 94V

Front tire DOT prefix: 00099YAY1

Rear tire DOT prefix: 00099YAY1

FORWARD COLLISION WARNING
DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2020 Kia Optima EX

GENERAL INFORMATION

Test date: 3/24/2020

AMBIENT CONDITIONS

Air temperature: 15.0 C (59 F)

Wind speed: 0.0 m/s (0.0 mph)

X Wind speed \leq 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: 235 kPa (34 psi)

Rear: 235 kPa (34 psi)

FORWARD COLLISION WARNING
DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2020 Kia Optima EX

WEIGHT

Weight of vehicle as tested including driver and instrumentation:

Left Front: 503.9 kg (1111 lb)

Right Front: 468.1 kg (1032 lb)

Left Rear: 343.4 kg (757 lb)

Right Rear: 318.9 kg (703 lb)

Total: 1634.3 kg (3603 lb)

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 1 of 3)

2020 Kia Optima EX

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

Forward Collision Avoidance Assist (FCA)

Forward Collision Warning Setting used in test: Early

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

The system uses a fusion type which includes radar and mono camera. The camera is located behind the windshield near the rearview mirror and the radar is located behind the front grill.

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

<input checked="" type="checkbox"/>	Warning light
<input checked="" type="checkbox"/>	Buzzer or audible alarm
<input checked="" type="checkbox"/>	Vibration
<input type="checkbox"/>	Other _____

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

The driver is alerted by a light in the cluster, chime, and steering wheel vibration.

The visual warning depicts the rear end view of a vehicle centered between two lane lines. When the system determines that a collision with the lead vehicle is imminent the words "Collision Warning" and a triangle with an exclamation point are displayed. In some cases, "Emergency Braking" is displayed in the later stage.

The auditory warning is a tone centered at 1515 Hz and pulsed at approximately 5 times per second.

(Note that the steering wheel vibration was not measured.)

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 2 of 3)

2020 Kia Optima EX

Is the vehicle equipped with a switch whose purpose is to render FCW inoperable? Yes

No

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

FCA is activated on every ignition. After ignition is on, the driver can turn off FCA via User Select Menu (USM). Controls on the steering wheel are used to access the system menus displayed in a center LCD. The hierarchy is:

User Settings

Driver Assistance

Forward Collision Warning (select or deselect)

See Appendix A, Figure A13.

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

No

If yes, please provide a full description.

The driver can select the initial warning activation time on the LCD display. The hierarchy is:

User Settings

Driver Assistance

Forward Collision Warning

Select: Early/Normal/Late

See Appendix A, Figure A13.

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

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2020 Kia Optima EX

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

If yes, please provide a full description.

The limitations of the system are described on pages 5-42 through 5-47 of the Owner's Manual. These pages are reproduced in Appendix B, pages B-13 through B-18.

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.

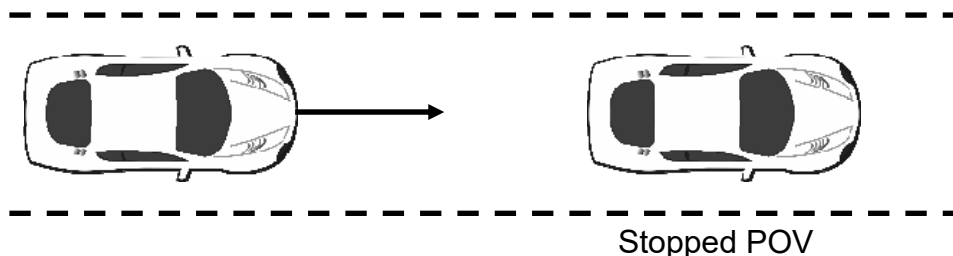


Figure 1. Depiction of Test 1

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.

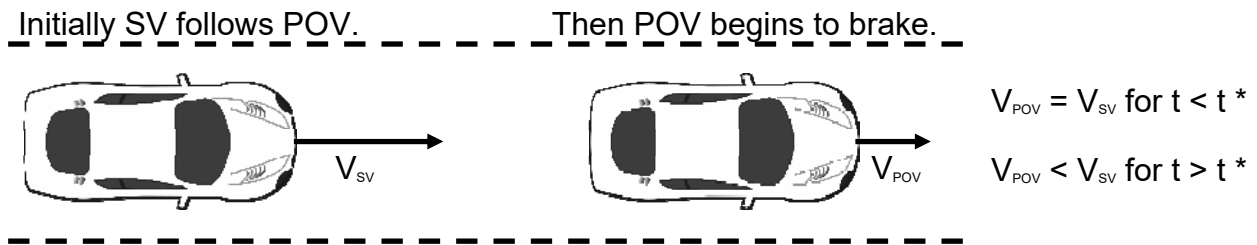


Figure 2. Depiction of Test 2

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 POV¹.

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.

¹To 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 $\pm 0.03g$, 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).

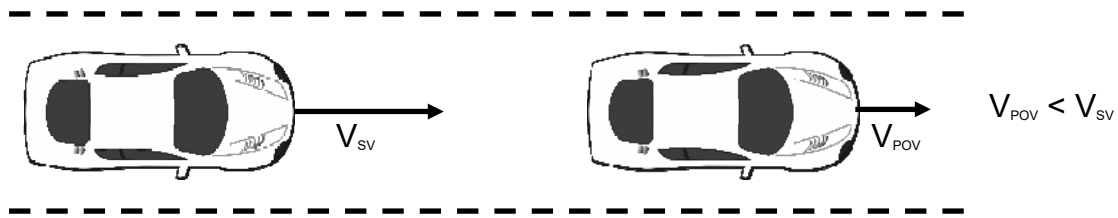


Figure 3. Depiction of Test 3

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 5338 N/	0.5% of applied load	Intercomp SWI	1110M206352	By: DRI Date: 1/6/2020 Due: 1/6/2021
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 Rat	Accels .01g, Angular Rate	Oxford Inertial +		By: Oxford Technical Solutions
					2258	Date: 5/3/2019 Due: 5/3/2021
					2176	Date: 4/11/2018 Due: 4/11/2020
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	NA

Table 1. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at auditory alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA
Light Sensor	Light intensity (to measure time at visual alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Accelerometer	Acceleration (to measure time at haptic alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2020 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 \pm 5%
Tactile	5 th	3 dB	60 dB	Identified Center Frequency \pm 20%

APPENDIX A

Photographs

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Figure A1. Front View of Subject Vehicle




Figure A2. Rear View of Subject Vehicle

2020 OPTIMA EX

MODEL/OPT. CODE: 54242 / 010
 EXTERIOR COLOR: EBONY BLACK
 INTERIOR COLOR: BLACK
 VEHICLE ID NUMBER: 5XXGU4L14LG41
 PORT OF ENTRY: WEST POINT

Sold To: _____ Ship To: _____



STANDARD FEATURES

STANDARD LX FEATURES

MECHANICAL
Drive Mode Select (DMS)

KIA DRIVEWISE DRIVER-ASSIST TECHNOLOGY
Blind-Spot Collision Warning (BCW)
Rear Cross-Traffic Collision Warning (RCCW)
Parking Distance Warning-Reverse (PDW-R)
Forward Collision-Avoidance Assist-Ped (FCA-Ped)
Lane Departure Warning (LDW)
Lane Keeping Assist-Line (LKA-L)
Driver Attention Warning (DAW)
High Beam Assist (HBA)

SAFETY
Dual Front Advanced Airbags & Driver's Knee Airbag
Dual Front Seat-Mounted Side & Full-Length Curtain Airbags
Traction Control System (TCS) & Anti-Lock Brakes (ABS)

INTERIOR, COMFORT & CONVENIENCE
8" Touchscreen w/ Android Auto & Apple CarPlay
Rear Camera with Dynamic Guidelines
Adjustable Driver's Seat w/ Lumbar Support
Adjustable Front Passenger's Seat w/ Height Adjuster
Anti-Soiling Cloth Seat Trim
Bluetooth® Wireless Technology
USB / Auxiliary Input Jack and 12 Volt Outlet
Steering Wheel Controls (Bluetooth/Audio/Cruise)
Overhead Maplights & Sunglass Holder
Remote Keyless Entry w/ Trunk Opener
Power Windows w/ Driver's One-Touch Auto-Down

EXTERIOR
Power, Heated Outside Mirrors w/ LED Turn Signal Indicators
Single Projection Headlights w/ LED DRL
16" Alloy Wheels

WARRANTY
10 Year/100,000 Mile Limited Powertrain Warranty
5 Year/60,000 Mile Limited Basic Warranty
5 Year/60,000 Mile Roadside Assistance

*Ask dealer for details

MANUFACTURER'S SUGGESTED RETAIL PRICE ▶ \$26,990.00

COMPARE EX FEATURES
Added to/in place of standard LX features
- 1.6L Gas Direct-Injection Turbo Engine
- 7-Speed Dual Clutch Transmission
- Power Adj. Driver's Seat w/ Power Lumbar
- Heated Front Seats
- Leather Trimmed Seating
- Smart Key & Push Button Start
- Smart Cruise Control w/ Stop & Go
- Electronic Parking Brake w/ Auto Hold
- Dual Zone - Full Auto Temp Control (D-FATC)
- Rear Passenger Air Vents
- Wireless Phone Charger
- UVO link (1 yr trial; see owners.kia.com for details)
- Sirius/XM w/ Free 3-Month Subscription*
- Acoustic Front Door Windows
- Auto-Dimming Rearview Mirror
- LED Tail Lamps
- Projector Fog Lamps
- 17" Alloy Wheels

ADDITIONAL INSTALLED EQUIPMENT:
(In addition to or in place of standard features)
Carpeted Floor Mats

EPA DOT Fuel Economy and Environment Gasoline Vehicle

Fuel Economy

31 MPG MIDSIZE CARS range from 12 to 136 MPG. The best vehicle rates 136 MPG.

combined city/hwy **27** city **37** highway

3.2 gallons per 100 miles

You Save \$1,000
in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost \$1,300

Fuel Economy & Greenhouse Gas Rating (tailpipe only) **7** (Scale 1-10, Best)

Smog Rating (tailpipe only) **1** (Scale 1-10, Best)

This vehicle emits 202 grams CO₂ per mile. The best emits 6 grams per mile (tailpipe only). Producing and distributing fuel also create emissions. Learn more at fueleconomy.gov.

fueleconomy.gov
Calculate personalized estimates and compare vehicles

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score ★★★★★
Based on the combined rating of frontal, side and rollover. Should ONLY be compared to other vehicles of similar size and weight.

Frontal	Driver	★★★★★
Crash	Passenger	★★★★★
Side	Front seat	★★★★★
Crash	Rear seat	★★★★★
Rollover		★★★★★

Star ratings based on the risk of injury in a frontal impact. Should ONLY be compared to other vehicles of similar size and weight.

Star ratings based on the risk of injury in a side impact.

Star ratings based on the risk of rollover in a single-vehicle crash.

Star ratings range from 1 to 5 stars (★★★★★) with 5 being the highest. Source: National Highway Traffic Safety Administration (NHTSA). www.safercar.gov or 1-888-327-4236

Manufacturer's suggested retail price includes Manufacturer's recommended pre-delivery service, license and title fees, state and local taxes and other dealer installed options and accessories not included in the manufacturer's suggested retail price.

MSRP INCLUDING OPTIONS \$27,125.00

INLAND FREIGHT AND HANDLING \$925.00

TOTAL MANUFACTURER'S SUGGESTED RETAIL PRICE ▶ \$28,050.00



DEALER:

STOCK NO.: 89997
VIN: LG41820
MODEL: 2020 KIA OPT
AVAIL. SERVICE AGT
OPTIONAL - ASK DEALER

EPA DOT Fuel Economy

Compare this vehicle

THIS AN FACTO
Rated as a top information

***DEALER'S NOT THE M SUGGESTE**

For Smog R Green

1

PROT
*PLUS govern charges, an government p charge, and

fuele
Calculate e

DEALER:

MSR: SU

Mark
Prep
Pha
Sav
Mu
Sp

FOR VEHICLES IN THIS CAR LINE U.S./CANADIAN PARTS CONTENT: 45 %

MAJOR SOURCES OF FOREIGN PARTS: KOREA: 55%

NOTE: PARTS CONTENT DOES NOT INCLUDE FINAL ASSEMBLY, DISTRIBUTION, OR OTHER NON-PARTS COSTS.

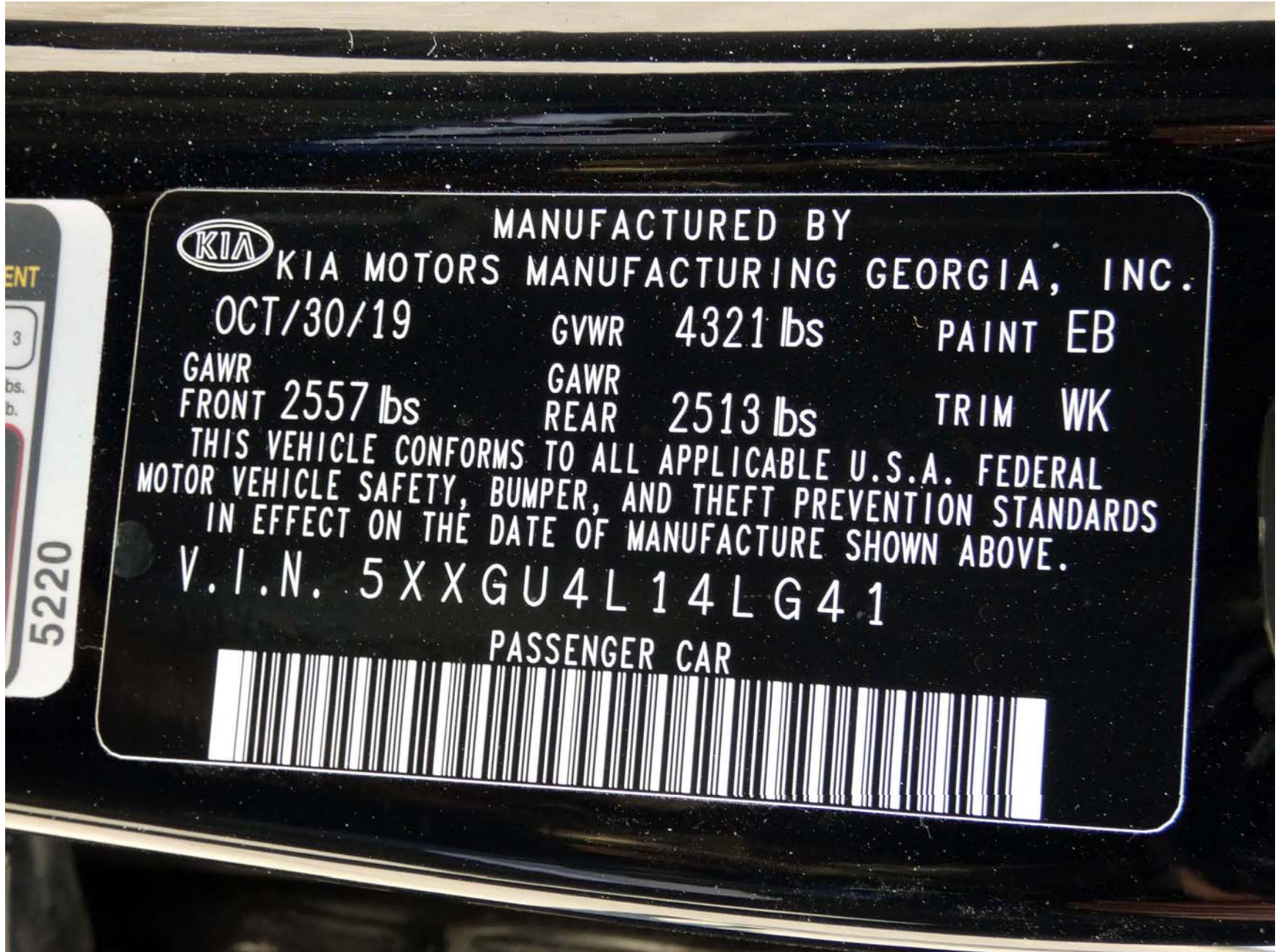
FOR THIS VEHICLE FINAL ASSEMBLY POINT: WEST POINT, GA, USA

COUNTRY OF ORIGIN ENGINE: MEXICO

TRANSMISSION: KOREA

TOTAL ADDITIONAL WEIGHT: 7.3

Figure A3. Window Sticker (Monroney Label)



MANUFACTURED BY
KIA MOTORS MANUFACTURING GEORGIA, INC.

OCT/30/19

GVWR 4321 lbs

PAINT EB

GAWR
FRONT 2557 lbs

GAWR
REAR 2513 lbs

TRIM WK

THIS VEHICLE CONFORMS TO ALL APPLICABLE U.S.A. FEDERAL
MOTOR VEHICLE SAFETY, BUMPER, AND THEFT PREVENTION STANDARDS
IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

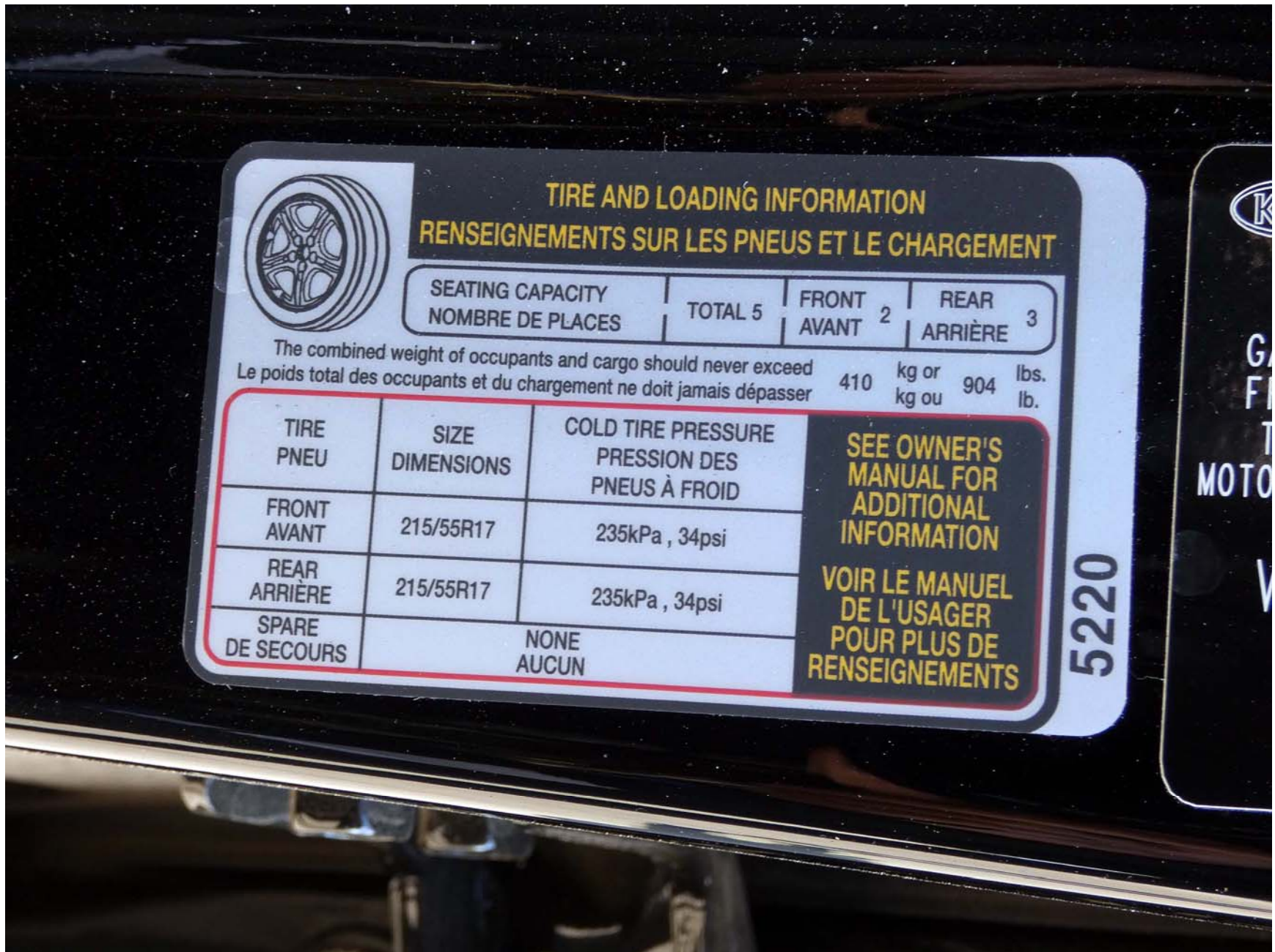
V.I.N. 5XXGU4L14LG41

PASSENGER CAR



ENT
3
bs.
b.
5220

Figure A4. Vehicle Certification Label



TIRE AND LOADING INFORMATION
RENSEIGNEMENTS SUR LES PNEUS ET LE CHARGEMENT



SEATING CAPACITY NOMBRE DE PLACES	TOTAL 5	FRONT AVANT 2	REAR ARRIÈRE 3
--------------------------------------	---------	------------------	-------------------

The combined weight of occupants and cargo should never exceed 410 kg or 904 lbs.
 Le poids total des occupants et du chargement ne doit jamais dépasser 410 kg ou 904 lb.

TIRE PNEU	SIZE DIMENSIONS	COLD TIRE PRESSURE PRESSION DES PNEUS À FROID
FRONT AVANT	215/55R17	235kPa , 34psi
REAR ARRIÈRE	215/55R17	235kPa , 34psi
SPARE DE SECOURS	NONE AUCUN	

**SEE OWNER'S
MANUAL FOR
ADDITIONAL
INFORMATION**

**VOIR LE MANUEL
DE L'USAGER
POUR PLUS DE
RENSEIGNEMENTS**

5220

Figure A5. Tire Placard



Figure A6. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle



Figure A7. Sensor for Detecting Visual Alerts



Figure A8. Sensor for Detecting Auditory Alerts



Figure A9. Computer Installed in Subject Vehicle



Figure A10. Front View of Principal Other Vehicle



Figure A11. Rear View of Principal Other Vehicle



Figure A12. Brake Actuation System Installed in Principal Other Vehicle



Figure A13. FCW System Setting Menus



Figure A14. Control for Changing System Parameters



Figure A15. FCW Visual Alert

APPENDIX B

Excerpts from Owner's Manual

Driver Assistance (if equipped)

- Driver Attention Warning :
 - Choose the alert stage (High sensitivity/Normal sensitivity/Off) of the Driver Attention Warning.
- *For more details, refer to "Driver Attention Warning (DAW)" in chapter 5.
- Lane Safety :
 - Active LKA : To activate the active LKA mode.
 - Standard LKA : To activate the standard LKA mode.
 - Lane Departure Warning : To activate the lane departure warning function.
- *For more details, refer to "Lane Keeping Assist (LKA) System" in chapter 5.
- Forward Collision-avoidance Assist (FCA) :
 - To activate or deactivate the FCA system.
- *For more details, refer to "Forward Collision-avoidance Assist (FCA)" in chapter 5.
- Forward Collision Warning :
 - Choose the initial warning alert time of the forward collision warning. (Late/Normal/Early)
- *For more details, refer to "Forward Collision-avoidance Assist (FCA)" in chapter 5.
- Blind-Spot Collision Warning Timing :
 - Choose the initial warning alert time of the blind-spot collision warning timing. (Normal/Late)
- *For more details, refer to "Blind-Spot Collision Warning" in chapter 5.
- Rear Cross-Traffic Collision Warning :
 - If this item is checked, the rear cross-traffic collision Warning function will be activated.
- *For more details, refer to "Blind-spot Collision Warning" in chapter 5.

Low Fuel

- This warning message illuminates if the fuel tank is nearly empty.
 - When the low fuel level warning light is illuminated, add fuel as soon as possible.
 - When the trip computer displays “--- km (or mile)” as range.

Check high beam assist system

- This warning message illuminates if the high beam assist system has a malfunction. In this case, have your vehicle inspected by an authorized Kia dealer.

Check headlight

- This warning message illuminates if there is a malfunction (burned-out bulb or circuit malfunction) with the headlamp. In this case, have your vehicle inspected by an authorized Kia dealer.

*** NOTICE**

- When replacing the bulb, use the same wattage bulb.
For more information, refer to “BULB WATTAGE” in chapter 8.
- If different wattage bulb is equipped with the vehicle, this warning message is not displayed.

Check Forward Collision-avoidance Assist system

- This warning message illuminates if there is a malfunction with the Forward Collision-avoidance Assist (FCA) system. In this case, have your vehicle inspected by an authorized Kia dealer.

*For more details, refer to “Forward Collision-avoidance Assist(FCA) system” in chapter 5.

⚠ WARNING - Low tire pressure

- **Significantly low tire pressure makes the vehicle unstable and can contribute to loss of vehicle control and increased braking distances.**
 - **Continued driving on low pressure tires will cause the tires to overheat and fail.**
- The TPMS cannot alert you to severe and sudden tire damage caused by external factors.
 - If you notice any vehicle instability, immediately take your foot off the accelerator pedal, apply the brakes gradually with light force, and slowly move to a safe position off the road.

Master Warning light (if equipped)



- This warning light informs the driver of the following situations
- Forward Collision-Avoidance Assist malfunction
- Blind-Spot Collision Warning radar blind
- Lamp malfunction
- High Beam Assist malfunction
- Tire Pressure Monitoring System (TPMS) malfunction
- Electronic Control Suspension (ECS) malfunction

The Master Warning Light illuminates if one or more of the above warning situations occur.

If the warning situation is solved, the master warning light will be turned off.

Forward Collision-avoidance Assist Warning light (FCA)



This indicator light illuminates:

- When there is a malfunction with the FCA.

In this case, have the vehicle inspected by an authorized Kia dealer.

FORWARD COLLISION-AVOIDANCE ASSIST (FCA) SYSTEM - CAMERA TYPE

The Forward Collision-Avoidance Assist (FCA) system is designed to help detect and monitor the vehicle or pedestrians ahead in the roadway through camera recognition to warn the driver that a collision is imminent, and if necessary, apply emergency braking.

⚠ WARNING

Take the following precautions when using the Forward Collision-Avoidance Assist (FCA) system:

- This system is only a supplemental system and it is not intended to, nor does it replace the need for extreme care and attention of the driver. The sensing range and objects detectable by the sensors are limited. Pay attention to the road conditions at all times.
- Never drive too fast in accordance with the road conditions or while cornering.
- Always drive cautiously to prevent unexpected and sudden situations from occurring. FCA does not stop the vehicle completely and is not a collision avoidance system.

System setting and activation

System setting

- The driver can activate the FCA by placing the ignition switch to the ON position and by selecting: 'User Settings → Driver Assistance → Forward Collision-Avoidance Assist' The FCA system deactivates, when the driver cancels the system setting.



The warning light illuminates on the LCD display, when you cancel the FCA system. The driver can monitor the FCA ON/OFF status on the LCD display. Also, the warning light illuminates when the ESC (Electronic Stability Control) is turned off. When the warning light remains ON with the FCA activated, have the system checked by an authorized Kia dealer.

- The driver can select the initial warning activation time on the LCD display. Go to the 'User Settings → Driver Assistance → Forward Collision Warning → Early/Normal/Late'.

The options for the initial Forward Collision Warning includes the following:

- **EARLY** - When this condition is selected, the initial Forward Collision Warning is activated earlier than normal. This setting maximizes the amount of distance between the vehicle or pedestrians ahead before the initial warning occurs. If the 'EARLY' condition feels too sensitive, change it into 'NORMAL'.
- **NORMAL** - When this condition is selected, the initial Forward Collision Warning is activated normally. This setting allows for a smaller amount of distance between the vehicle or pedestrians ahead before the initial warning occurs compared to the EARLY mode.
- **LATE** - When this condition is selected, the initial Forward Collision Warning is activated later than normal. This setting reduces the amount of distance between the vehicle or pedestrians ahead before the initial warning occurs. Select this condition only when traffic is light, and you are driving slowly.

Prerequisite for activation

The FCA gets ready to be activated, when the FCA is selected on the LCD display, and when the following prerequisites are satisfied.

- The ESC (Electronic Stability Control) is activated.
- Vehicle speed is over 8 km/h (5 mph). (The FCA is only activated within a certain speed range.)
- The system detects a vehicle or pedestrian in front, which may collide with your vehicle. (The FCA may not be activated or may sound a warning alarm in accordance with the driving situation or vehicle condition.)

*The FCA may not operate properly according to the frontal situation, the direction and speed of pedestrian.

⚠ WARNING

- **Completely stop the vehicle on a safe location before operating the switch on the steering wheel to activate/deactivate the FCA system.**
- **The FCA automatically activates upon placing the Engine Start/Stop button to the ON position. The driver can deactivate the FCA by canceling the system setting on the LCD display. To avoid driver distractions, do not attempt to set or cancel the FCA while driving the vehicle.**
- **The FCA automatically deactivates upon canceling the ESC (Electronic Stability Control). When the ESC is canceled, the FCA cannot be activated on the LCD display. The FCA warning light will illuminate, but it does not indicate a malfunction of the system.**

FCA warning message and system control

The FCA system produces warning messages, warning alarms, and emergency braking based on the level of risk of a frontal collision, such as when a vehicle ahead suddenly brakes.

The driver can select the initial warning activation time in the User Settings in the LCD display. The options for the initial Forward Collision Warning include Early, Normal or Late initial warning time.

Collision Warning (1st warning)



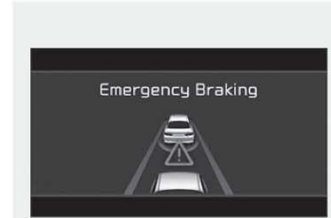
OJF058389L

This warning message appears on the LCD display with a warning chime. Additionally, some vehicle system intervention occurs by the engine management system to help decelerate the vehicle.

- Your vehicle speed may decelerate moderately.
- The FCA system limitedly controls the brakes to preemptively mitigate impact in a collision.

- It will operate if the vehicle speed is greater than 8 km/h (5 mph) and less than or equal to 60 km/h (38 mph) on a forward vehicle. (Depending on the condition of the vehicle ahead and the environment surrounding it, the possible maximum operating speed may be reduced.)

Emergency braking (2nd warning)



OJF058390L

This warning message appears on the LCD display with a warning chime. Additionally, some vehicle system intervention occurs by the engine management system to help decelerate the vehicle.

- The FCA system limitedly controls the brakes to preemptively mitigate impact in a collision. The brake control is maximized just before a collision.

- It will operate if the vehicle speed is greater than 8 km/h (5 mph) and less than or equal to 60 km/h (38 mph) on a forward vehicle. (Depending on the condition of the vehicle ahead and the environment surrounding it, the possible maximum operating speed may be reduced.)

Brake operation

- In an urgent situation, the FCA system applies the brakes.
- The FCA provides additional braking power for optimum braking performance, when the driver depresses the brake pedal.
- The braking control is automatically deactivated, when the driver sharply depresses the accelerator pedal, or when the driver abruptly operates the steering wheel.
- The FCA brake control is automatically canceled, when risk factors disappear.

CAUTION

The driver should always pay great caution to vehicle operation, even though there is no warning message or warning alarm. The warning of the FCA system may not sound while other system warning sounds.

WARNING

The FCA cannot avoid all collisions. The braking control cannot completely stop the vehicle. The driver is responsible to safely drive and control the vehicle.

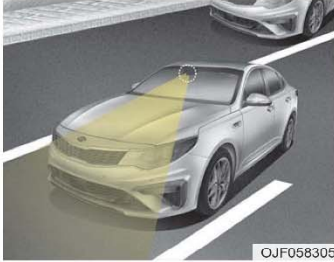
WARNING

The FCA system logic assesses the risk of a collision by monitoring several variables, such as the distance from the vehicle ahead, the speed of the vehicle ahead, and the driver's vehicle speed. Certain conditions, such as inclement weather and road conditions, may affect the operation of the FCA system.

WARNING

Never deliberately drive dangerously to activate the system.

**FCA sensor
(Front View Camera)**



In order for the FCA system to operate properly, always make sure the sensor are clean and free of dirt, snow, and debris.

Dirt, snow, or foreign substances on the sensor or its external parts may adversely affect the sensing performance of the sensor.

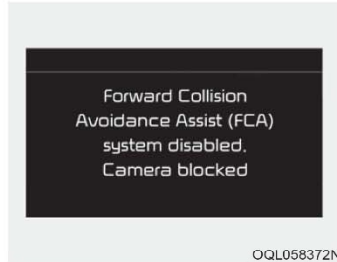
*** NOTICE**

- Never install any accessories or stickers on the front windshield, or tint the front windshield.
- Never place any reflective objects (i.e. white paper, mirror) over the dashboard. Any light reflection may cause a malfunction of the system.
- Make sure the frontal camera does not get wet.
- Never disassemble the camera assembly, or apply any impact on the camera assembly.
- Playing the vehicle audio system at high volume may prevent occupants from hearing the FCA warnings.
- Be careful not to apply unnecessary force on the sensor. If the sensor is forcibly moved out of proper alignment, the system may not operate correctly. In this case, a warning message may not be displayed. Have the vehicle inspected by an authorized Kia dealer.

*** NOTICE**

Have the vehicle inspected by an authorized Kia dealer when the windshield glass is replaced.

Warning message and warning light



When the sensor is blocked with dirt, snow, or debris, the FCA system operation may stop temporarily.

If this occurs, a warning message will appear on the LCD display.

The system will operate normally when such dirt, snow or debris is removed.

However, the FCA system may not properly operate in an area (e.g. open terrain), where any substances are not detected after turning ON the engine.

Although a warning message will not appear on the LCD display, the FCA may not properly operate.

System malfunction



- When the FCA is not working properly, the FCA warning light (⚠) will illuminate and the warning message will appear for a few seconds. After the message disappears, the master warning light (⚠) will illuminate. In this case, have the vehicle inspected by an authorized Kia dealer.
- The FCA warning message may appear along with the illumination of the ESC warning light.

⚠ WARNING

- The FCA is only a supplemental system for the driver's convenience. It is the driver's responsibility to control the vehicle operation. Do not solely depend on the FCA system. Rather, maintain a safe braking distance, and, if necessary, depress the brake pedal to reduce the driving speed or stop the vehicle.

- In certain instances and under certain driving conditions, the FCA system may activate unintentionally.

Also, due to sensing limitations, in certain situations, the front view camera recognition system may not detect the vehicle or pedestrians ahead. The FCA system may not activate and the warning message may not be displayed.

(Continued)

(Continued)

- The FCA system may not activate if the driver applies the brake pedal to avoid the risk of a collision.
- The brake control may be insufficient, possibly causing a collision, if a vehicle in front abruptly stops. Always pay extreme caution.
- The FCA system may not activate depending on road conditions, inclement weather, driving conditions or traffic conditions. Therefore, the driver should always pay attention to the road and be prepared to apply the brakes at all times.

(Continued)

(Continued)

- Even if there is any problem with the brake control function of the FCA system, the vehicle's basic braking performance will operate normally. However, brake control function for avoiding collision will not activate.
- If the vehicle in front stops suddenly, you may have less control of the brake system. Therefore, always keep a safe distance between your vehicle and the vehicle in front of you.
- Occupants may get injured, if the vehicle abruptly stops by the activated FCA system. Pay extreme caution.
- The FCA system operates only to detect vehicles in front of the vehicle.
- The FCA system may not activate to all types of vehicles.

⚠ WARNING

- The FCA system does not operate when the vehicle is in reverse.
- The FCA system is not designed to detect other objects on the road such as animals.
- The FCA system does not detect vehicles in the opposite lane.
- The FCA system does not detect cross traffic vehicles that are approaching.
- The FCA system cannot detect the driver approaching the side view of a parked vehicle (for example on a dead end street.)

In these cases, you must maintain a safe braking distance, and if necessary, depress the brake pedal to reduce the driving speed in order to maintain a safe distance.

Limitation of the system

The Forward Collision-Avoidance Assist (FCA) system is designed to monitor the vehicle or pedestrians ahead in the roadway through camera recognition to warn the driver that a collision is imminent, and if necessary, apply emergency braking.

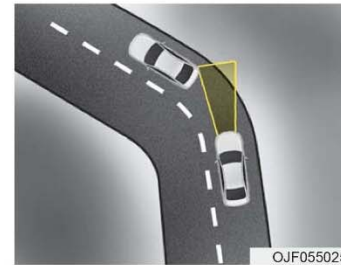
In certain situations, the camera may not be able to detect the vehicle or pedestrians ahead. In these cases, the FCA system may not operate normally. The driver must pay careful attention in the following situations where the FCA operation may be limited.

Detecting vehicles

The sensor may be limited when:

- The camera is covered object or debris
- Inclement weather such as heavy rain or snow obscures the field of view of the camera
- The camera recognition is limited
- The vehicle in front is too small to be detected (for example a motorcycle or a bicycle, etc.)
- The vehicle in front is an oversize vehicle or trailer that is too big to be detected by the camera recognition system. (for example a tractor, trailer, etc.)
- The camera's field of view is not well illuminated (either too dark or too much reflection or too much back-light that obscures the field of view)
- The vehicle in front does not have their rear lights properly turned ON or their rear lights are located unusually.
- The outside brightness changes suddenly, for example when entering or exiting a tunnel

- When light coming from a street light or an oncoming vehicle is reflected on a wet road surface such as a puddle in the road.
- The field of view in front is obstructed by sun glare or headlight of oncoming vehicle.
- The windshield glass is fogged up.
- The vehicle in front is driving erratically.
- The vehicle is on unpaved or uneven rough surfaces, or roads with sudden gradient changes.
- The vehicle is drives inside a building, such as a basement parking lot
- The camera does not recognize the entire vehicle in front.
- The camera is damaged.
- The brightness outside is too low such as when the headlamps are not on at night or the vehicle is going through a tunnel.
- Adverse road conditions cause excessive vehicle vibrations while driving
- The sensor recognition changes suddenly when passing over a speed bump
- The shadow is on the road by a median strip, trees, etc.
- The vehicle drives through a toll-gate.
- The rear part of the vehicle in front is not fully visible.
- The vehicle in front is moving vertically to the driving direction
- The vehicle in front is stopped vertically
- The vehicle in front is driving towards your vehicle or reversing
- You are on a roundabout and the vehicle in front circles



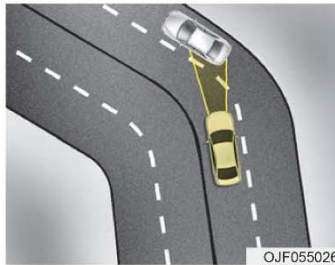
- Driving on a curve

The performance of the FCA system may be limited when driving on a curved road.

On curved roads, the other vehicle on the same lane is not recognized and the FCA system's performance may be degraded. This may produce the warning message and the warning alarm prematurely, or it may not produce the warning message or the warning alarm at all.

Also, in certain instances the camera recognition system may not detect the vehicle traveling on a curved road.

When driving on a curve, exercise caution, maintain a safe braking distance, and if necessary, depress the brake pedal to reduce your driving speed in order to maintain a safe distance.

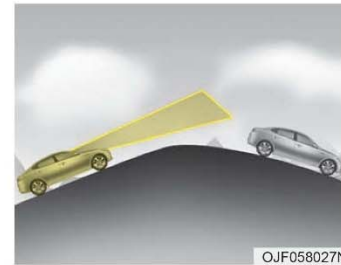


The FCA system may recognize a vehicle in the next lane when driving on a curved road.

In this case, the system may alarm the driver and apply the brake. Always pay attention to road and driving conditions while driving. If necessary, depress the brake pedal to reduce your driving speed in order to maintain a safe distance.

Also, when necessary depress the accelerator pedal to prevent the system from unnecessarily decelerating your vehicle.

Always check the traffic conditions around the vehicle.

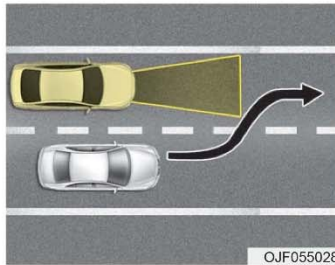


- Driving on a slope

The performance of the FCA system may be limited while driving upward or downward on a slope and may not recognize the vehicle in front in the same lane. It may prematurely produce the warning message and the warning alarm, or it may not produce the warning message and the warning alarm at all.

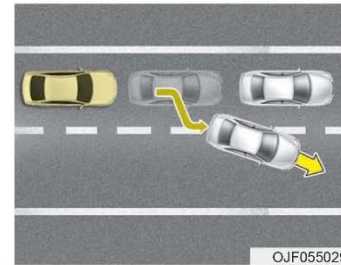
When the FCA suddenly recognizes the vehicle in front while passing over a slope, you may experience sharp deceleration.

Always keep your eyes forward while driving upward or downward on a slope, and, if necessary, depress the brake pedal to reduce your driving speed in order to maintain distance.

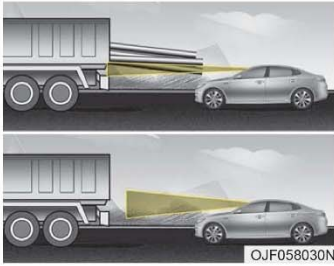


- Changing lanes

When a vehicle changes lanes in front of you, the FCA system may not immediately detect the vehicle, especially if the vehicle changes lanes abruptly. In this case, you must maintain a safe braking distance, and if necessary, depress the brake pedal to reduce your driving speed in order to maintain a safe distance.



When driving in stop-and-go traffic, and a stopped vehicle in front of you merges out of the lane, the FCA system may not immediately detect the new vehicle that is now in front of you. In this case, you must maintain a safe braking distance, and if necessary, depress the brake pedal to reduce your driving speed in order to maintain a safe distance.



- Detecting the vehicle in front of you
If the vehicle in front of you has cargo that extends rearward from the cab, or when the vehicle in front of you has higher ground clearance, additional special attention is required. The FCA system may not be able to detect the cargo extending from the vehicle. In these instances, you must maintain a safe braking distance from the rearmost object, and if necessary, depress the brake pedal to reduce your driving speed in order to maintain distance.

Detecting pedestrians

The sensor may be limited when:

- The pedestrian is not fully detected by the camera recognition system, for example, if the pedestrian is leaning over or is not fully walking upright
- The pedestrian is moving very quickly or appears abruptly in the camera detection area
- The pedestrian is wearing clothing that easily blends into the background, making it difficult to be detected by the camera recognition system
- The outside lighting is too bright (e.g. when driving in bright sunlight or in sun glare) or too dark (e.g. when driving on a dark rural road at night)
- It is difficult to detect and distinguish the pedestrian from other objects in the surroundings, for example, when there is a group of pedestrians, or a large crowd.
- There is an item similar to a person's body structure
- The pedestrian is small
- The pedestrian has impaired mobility
- The sensor recognition is limited
- The camera is covered with a foreign object or debris
- Inclement weather such as heavy rain or snow obscures the field of view of the radar sensor or camera
- When light coming from a street light or an oncoming vehicle is reflected on a wet road surface such as a puddle in the road
- The field of view in front is obstructed by sun glare
- The windshield glass is fogged up.
- The adverse road conditions cause excessive vehicle vibrations while driving
- When the pedestrian suddenly appears in front of the vehicle
- When the construction area, rail or other metal object is near the pedestrian.

⚠ WARNING

- Do not use the Forward Collision -Avoidance Assist (FCA) system when towing a vehicle. Application of the FCA system while towing may adversely affect the safety of your vehicle or the towing vehicle.
- Use extreme caution when the vehicle in front of you has cargo that extends rearward from the cab, or when the vehicle in front of you has higher ground clearance.
- The FCA system is designed to detect and monitor the vehicle ahead in the roadway through camera recognition. It is not designed to detect bicycles, motorcycles, or smaller wheeled objects such as luggage bags, shopping carts, or strollers.

(Continued)

(Continued)

- Never try to test the operation of the FCA system. Doing so may cause severe injury or death.
- When front bumper or windshield glass is replaced or repaired, have the vehicle inspected by an authorized Kia dealer.

*** NOTICE**

In some instances, the FCA system may be cancelled when subjected to electromagnetic interference.

This device complies with Industry Canada licence-exempt RSS standard(s).

Operation is subject to the following conditions:

- (1) This device may not cause interference, and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.
- (3) Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the device.

- Playing the vehicle audio system at high volume may offset the Driver Attention Warning system warning sounds.

 **CAUTION**

The Driver Attention Warning system may not properly operate with limited alerting in the following situations:

- *The lane detection performance is limited. (For more information, refer to “Lane Keeping Assist (LKA) system” in this chapter.)*
- *The vehicle is violently driven or is abruptly turned for obstacle avoidance (e.g. construction area, other vehicles, fallen objects, bumpy road).*
- *Forward drivability of the vehicle is severely undermined (possibly due to wide variation in tire pressures, uneven tire wear-out, toe-in/toe-out alignment).*

(Continued)

(Continued)

- *The vehicle drives on a curvy road.*
- *The vehicle drives on a bumpy road.*
- *The vehicle drives through a windy area.*
- *The vehicle is controlled by the following driver assistance systems:*
 - *Lane Keeping Assist (LKA) system*
 - *forward collision-avoidance assist (FCA) System.*

*** NOTICE**

The Driver Attention Warning system does not detect actual driver fatigue or drowsiness. The system monitors driving and provides a warning if it detects inattentive driving practices.

APPENDIX C

Run Log

Subject Vehicle: **2020 Kia Optima EX**

Test Date: **3/24/2020**

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	Y	2.46	2.31	0.36	Pass	
2		Y	2.46	2.29	0.36	Pass	
3		Y	2.51	2.35	0.41	Pass	
4		Y	2.48	2.31	0.38	Pass	
5		Y	2.48	2.31	0.38	Pass	
6		Y	2.49	2.33	0.39	Pass	
7		Y	2.49	2.32	0.39	Pass	
15	Decelerating POV, 45	N					SV yaw
16		Y	2.74	2.56	0.34	Pass	
17		Y	2.60	2.43	0.20	Pass	
18		Y	2.74	2.59	0.34	Pass	
19		Y	2.76	2.59	0.36	Pass	
20		Y	2.70	2.54	0.30	Pass	
21		Y	2.66	2.49	0.26	Pass	
22		N					headway
23		Y	2.77	2.58	0.37	Pass	

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
8	Slower POV, 45 vs 20	Y	2.64	2.48	0.64	Pass	
9		Y	2.67	2.50	0.67	Pass	
10		Y	2.63	2.47	0.63	Pass	
11		Y	2.67	2.51	0.67	Pass	
12		Y	2.65	2.49	0.65	Pass	
13		Y	2.69	2.50	0.69	Pass	
14		Y	2.67	2.50	0.67	Pass	

APPENDIX D

Time History Plots

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Description of Time History Plots

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from both the Subject Vehicle (SV) and the Principal Other Vehicle (POV), as well as pass/fail envelopes and thresholds. 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 ($0.3 \text{ g} \pm 0.03 \text{ g}$) 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.

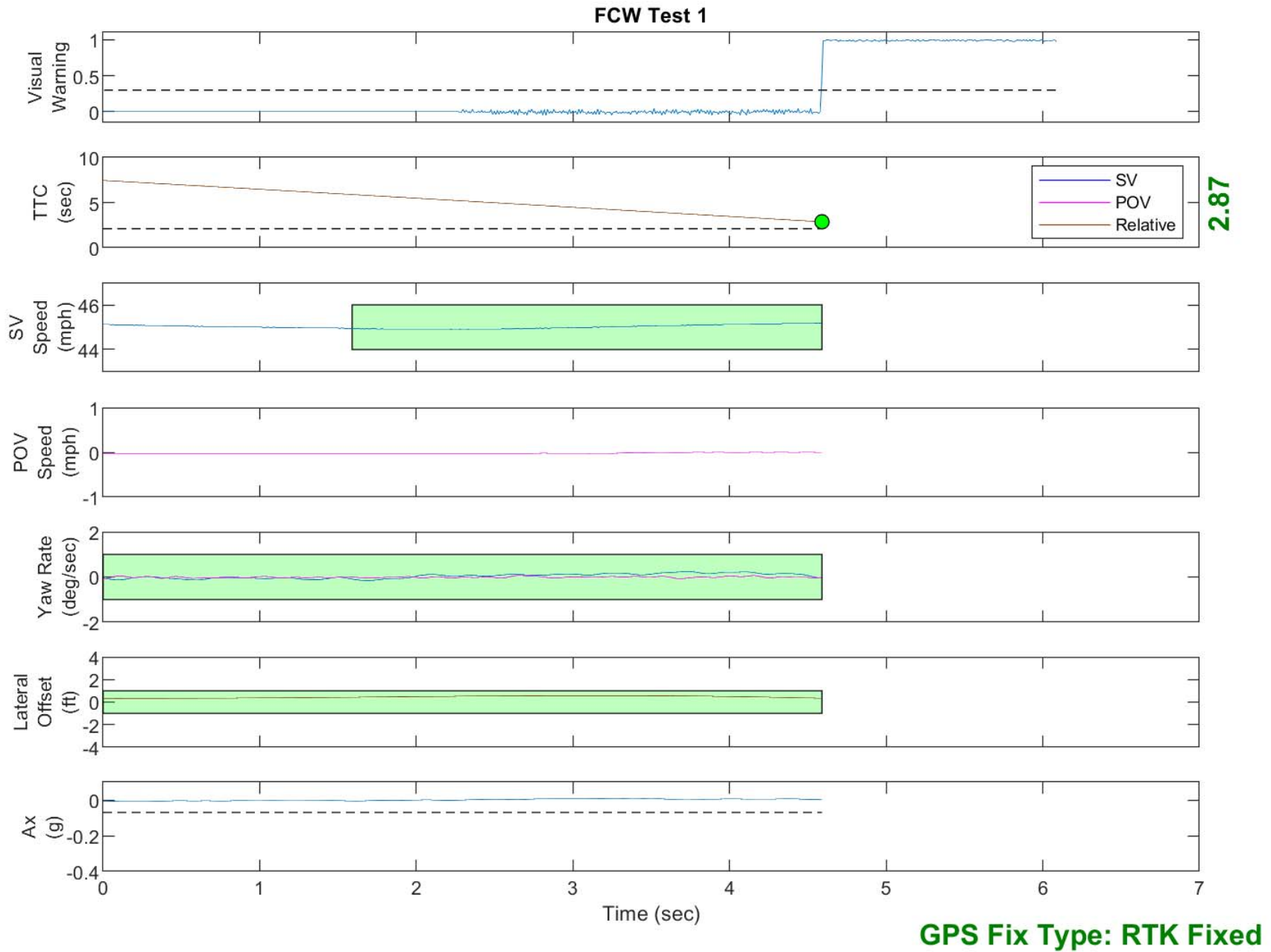


Figure D1. Example Time History for Test Type 1, Passing

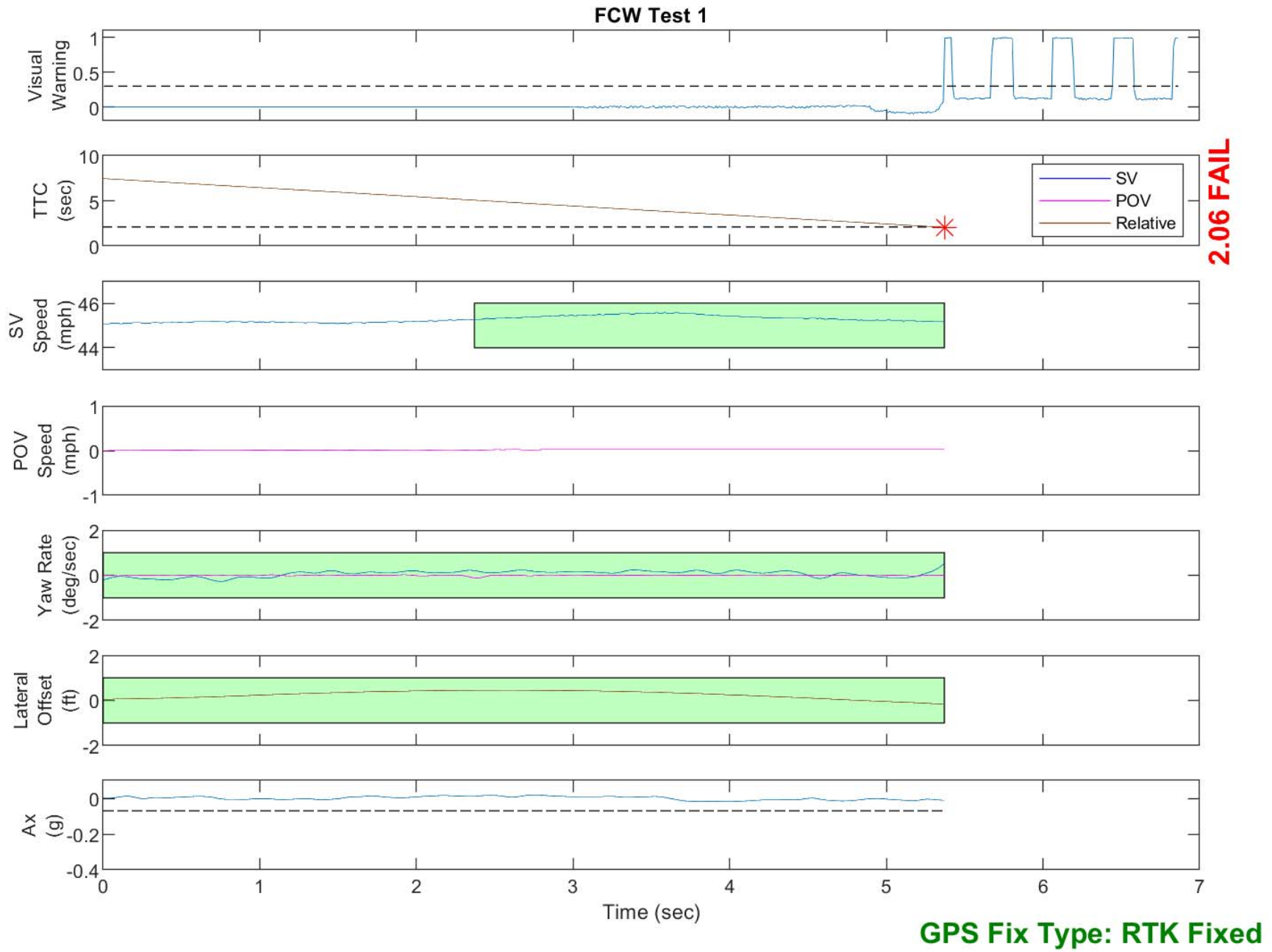
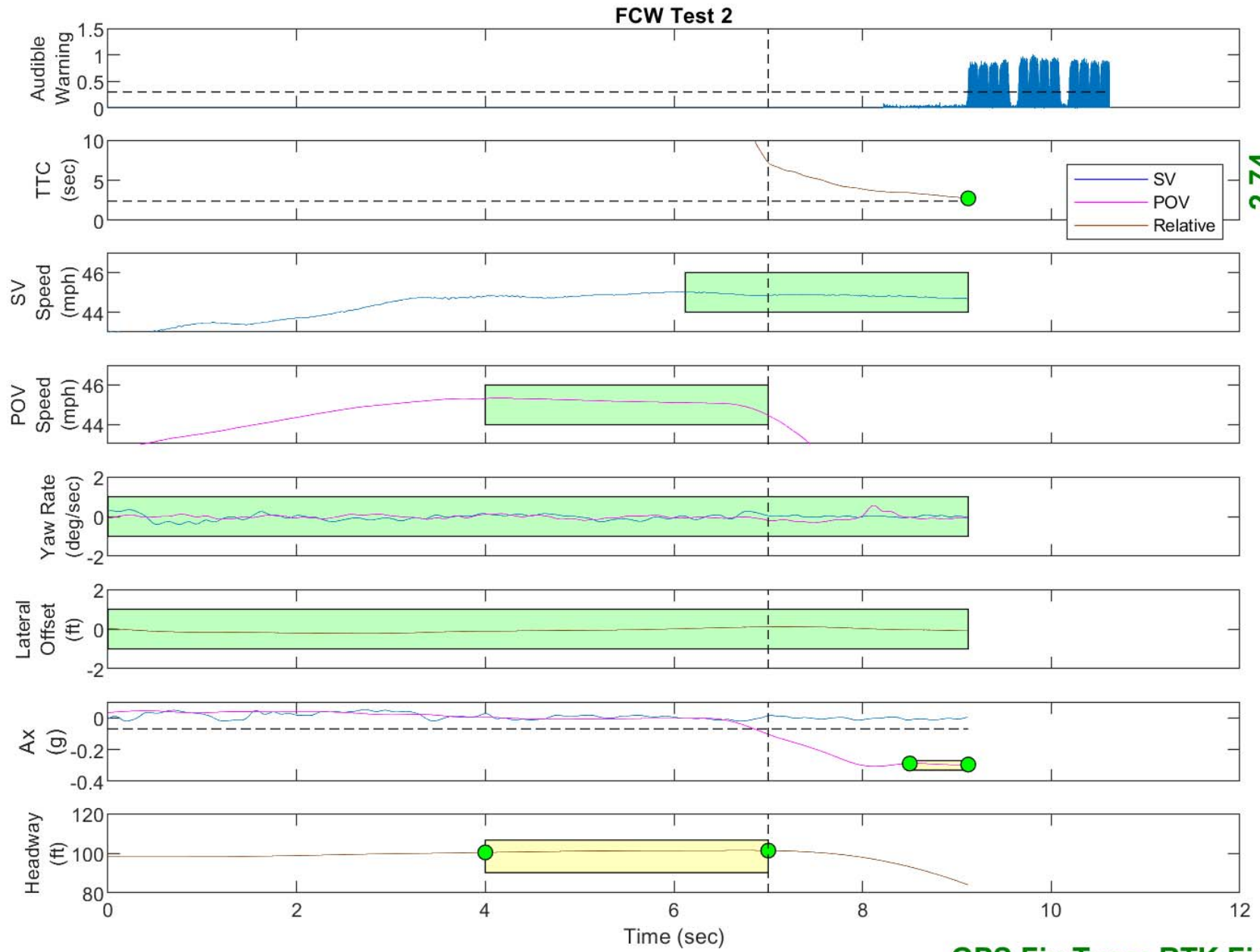
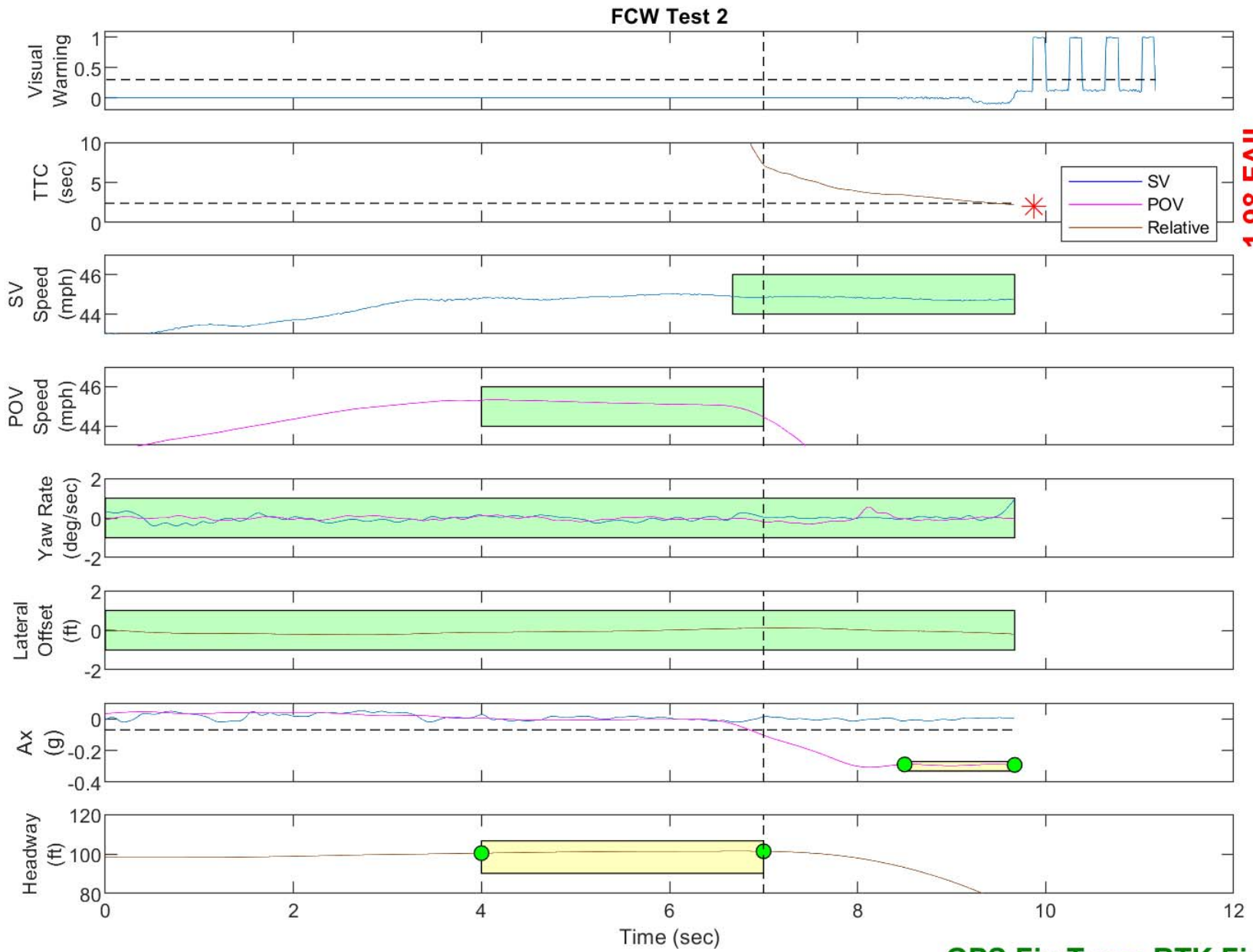


Figure D2. Example Time History for Test Type 1, Failing



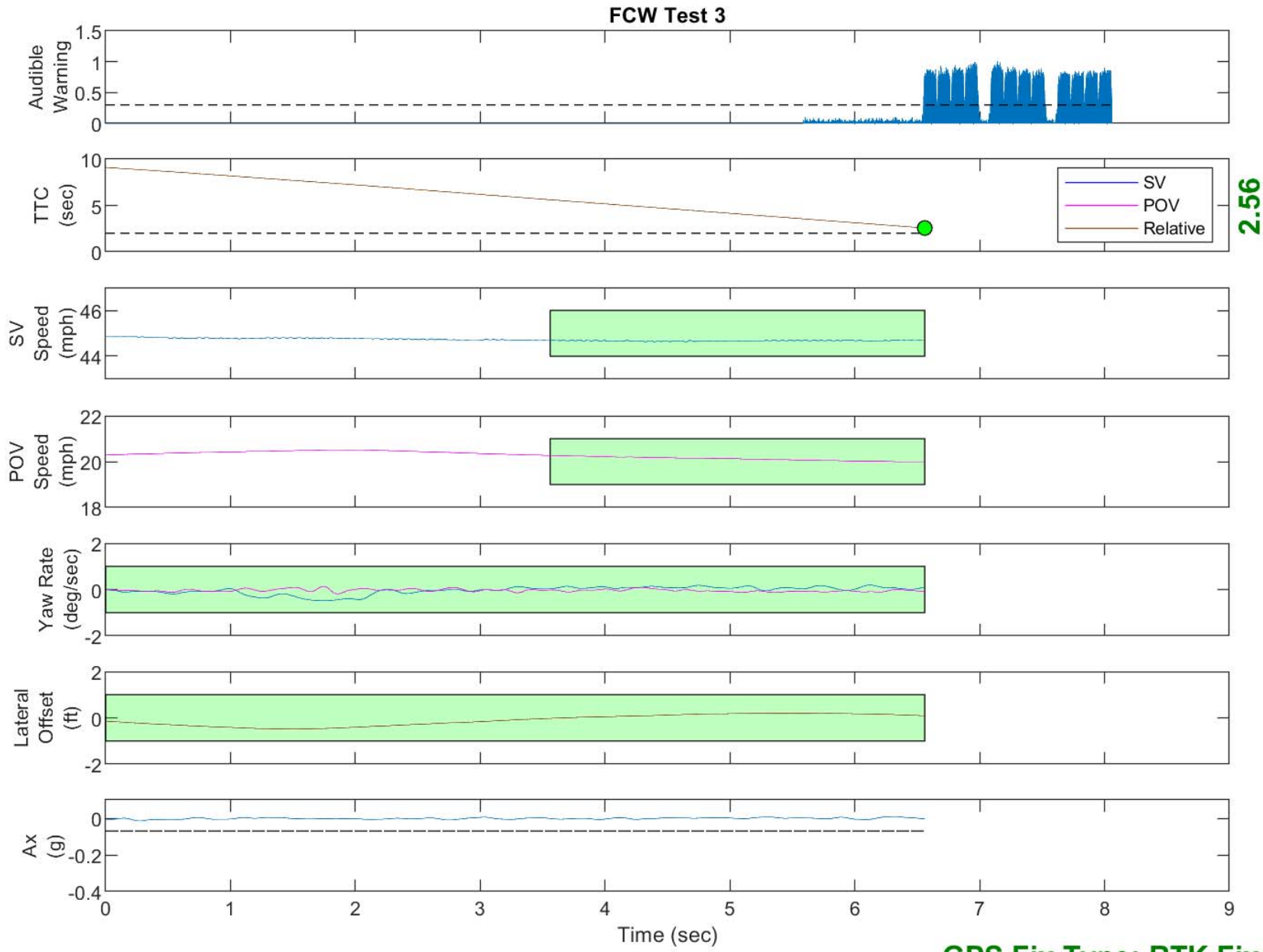
GPS Fix Type: RTK Fixed

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



GPS Fix Type: RTK Fixed

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



GPS Fix Type: RTK Fixed

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

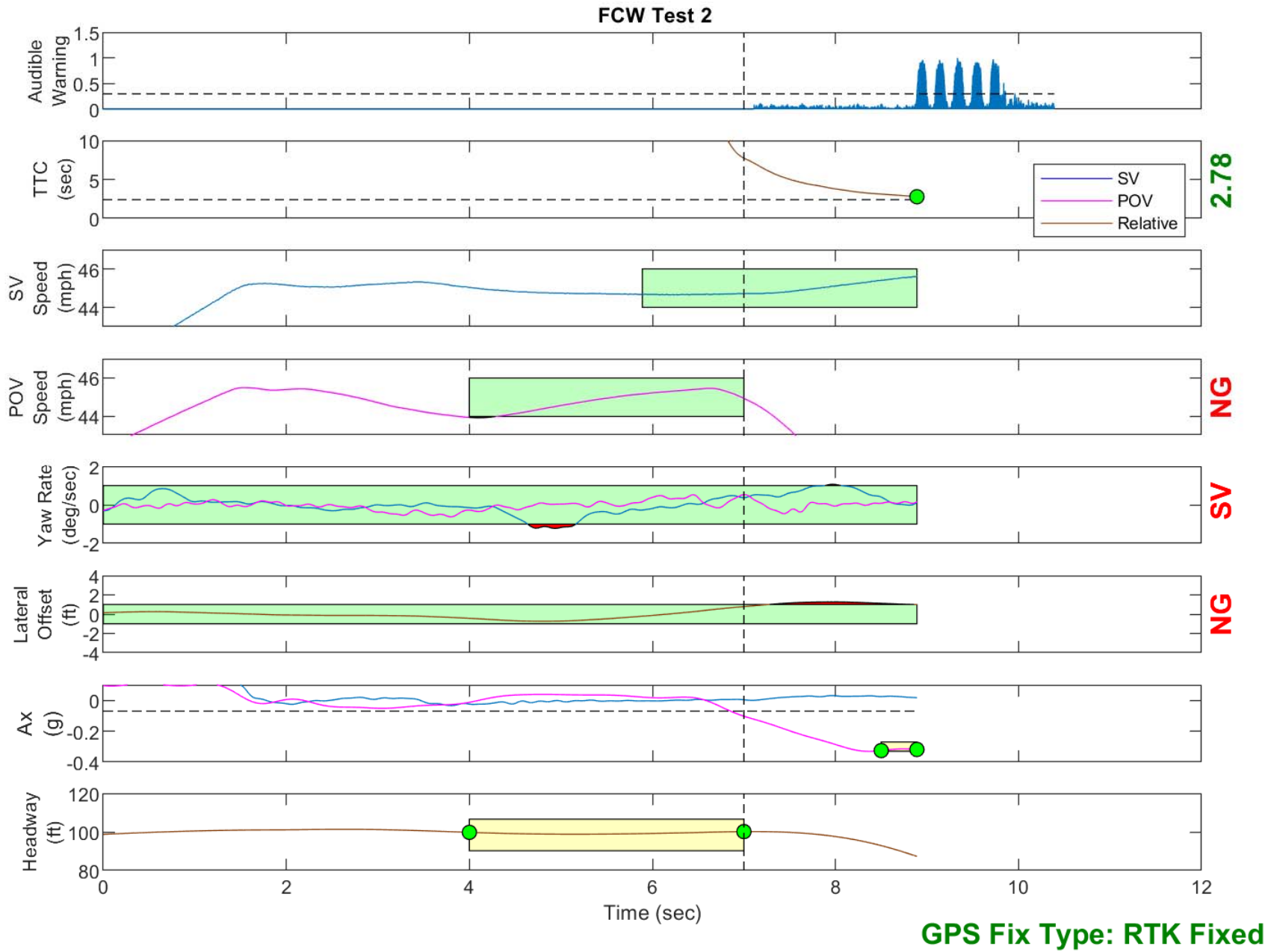


Figure D6. Example Time History Displaying Various Invalid Criteria

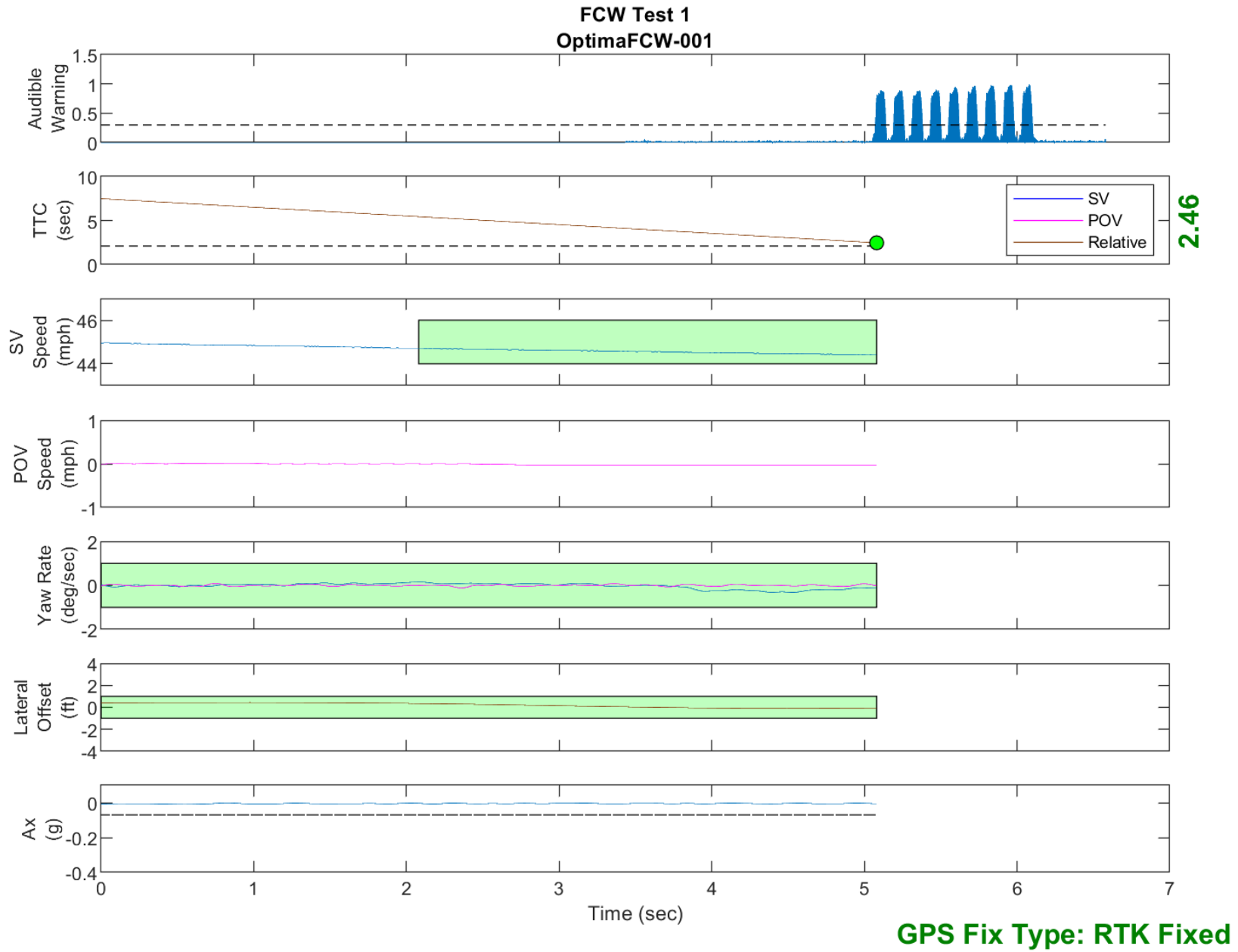


Figure D7. Time History for Run 1, FCW Test 1, Audible Warning

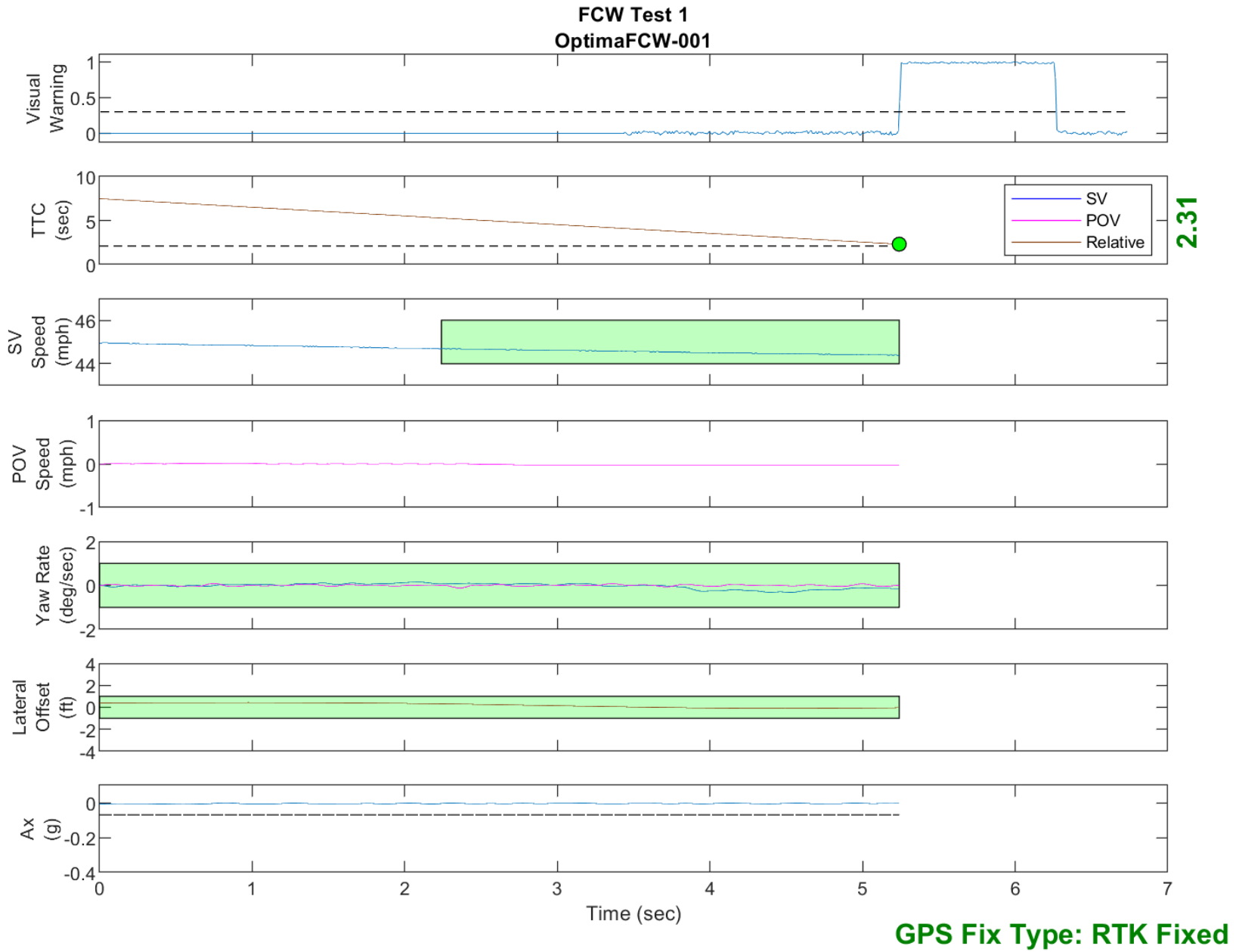


Figure D8. Time History for Run 1, FCW Test 1, Visual Warning

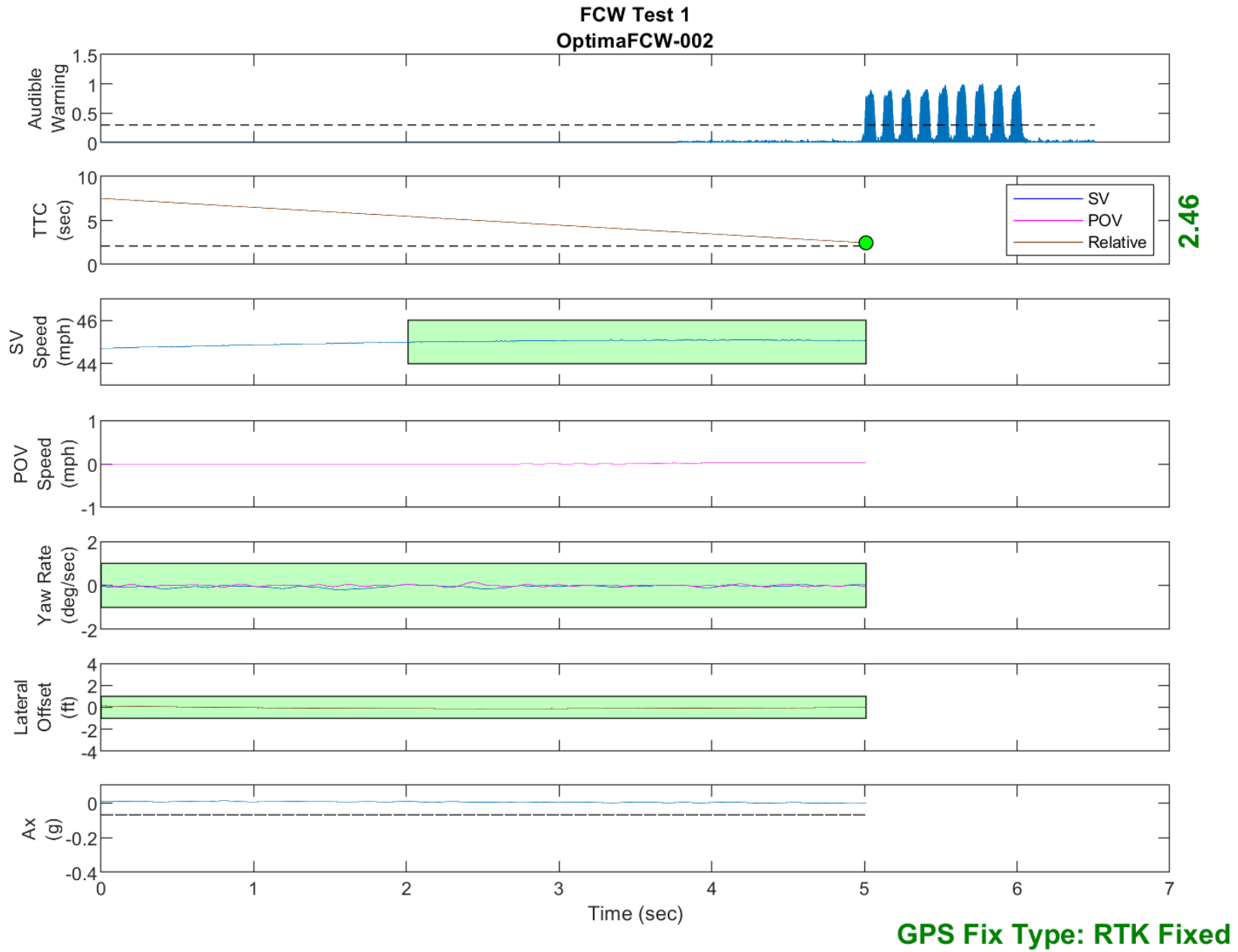


Figure D9. Time History for Run 2, FCW Test 1, Audible Warning

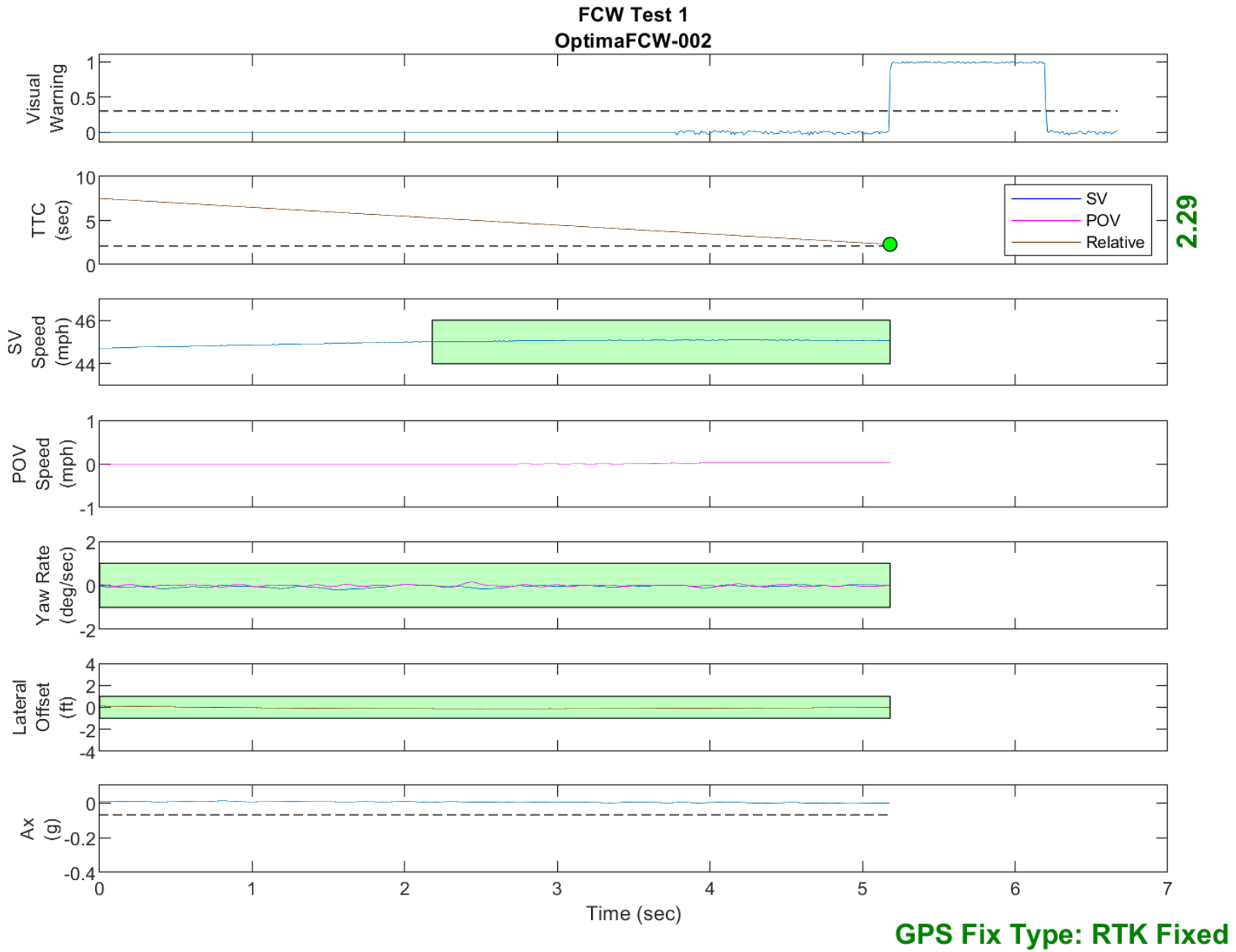


Figure D10. Time History for Run 2, FCW Test 1, Visual Warning

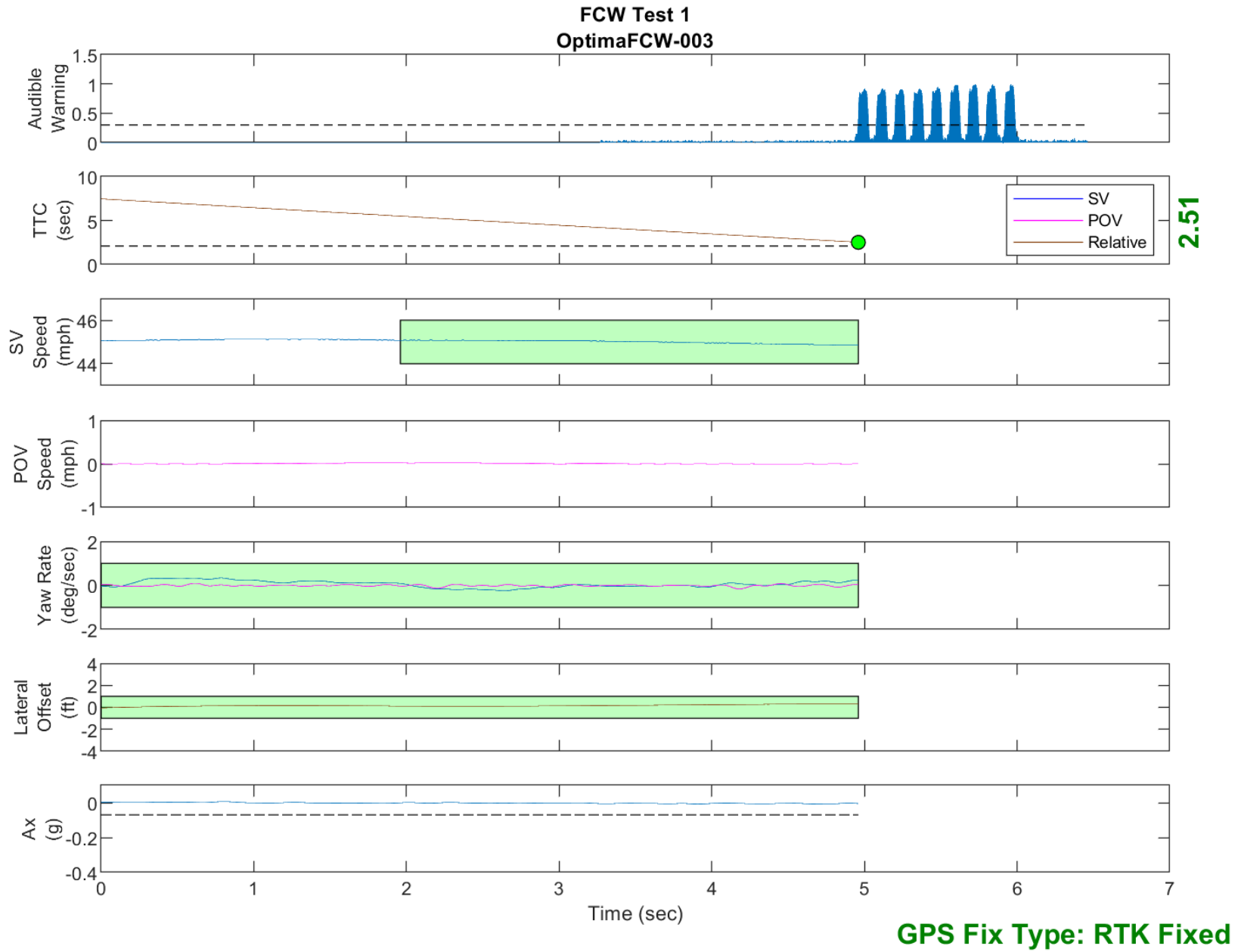


Figure D11. Time History for Run 3, FCW Test 1, Audible Warning

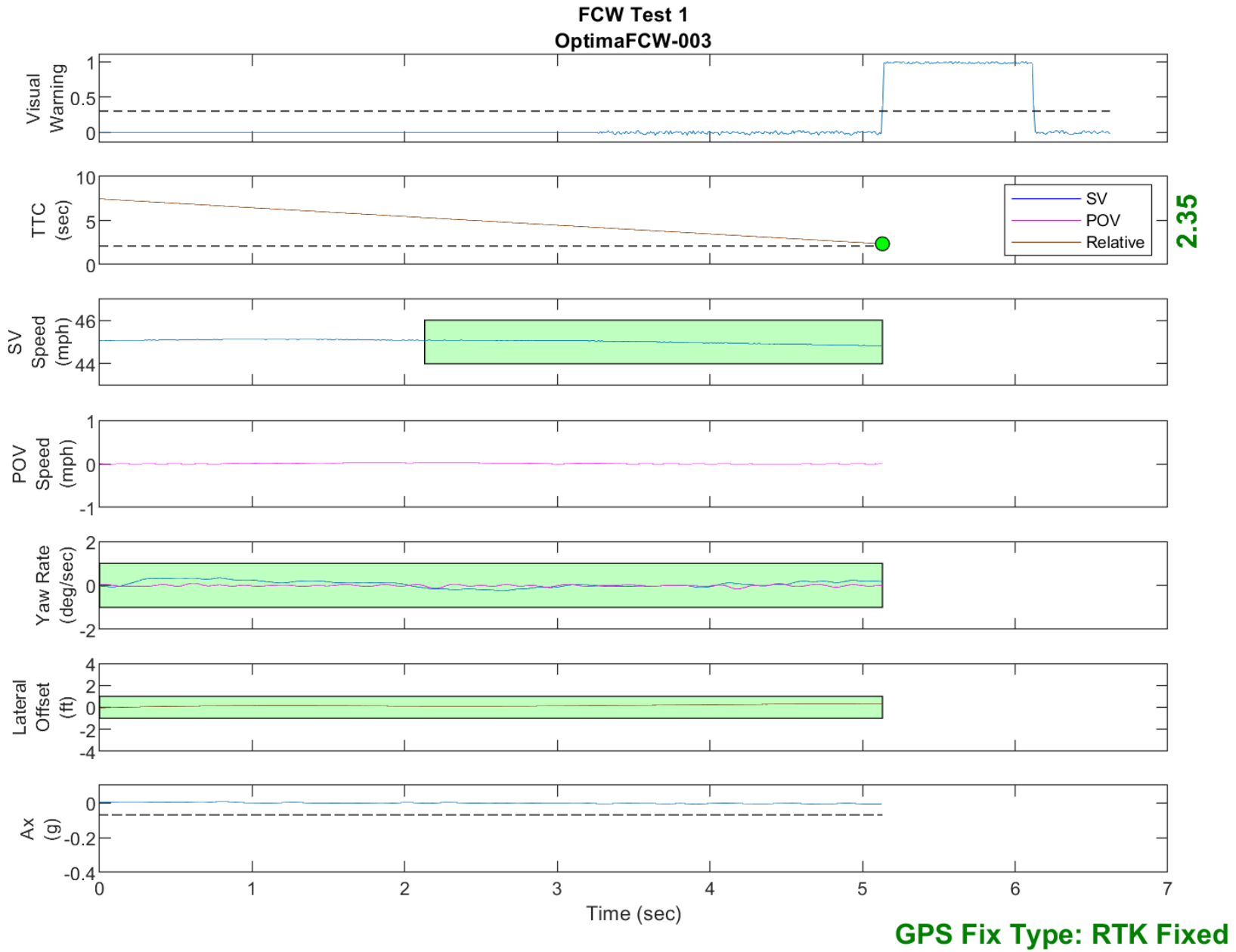


Figure D12. Time History for Run 3, FCW Test 1, Visual Warning

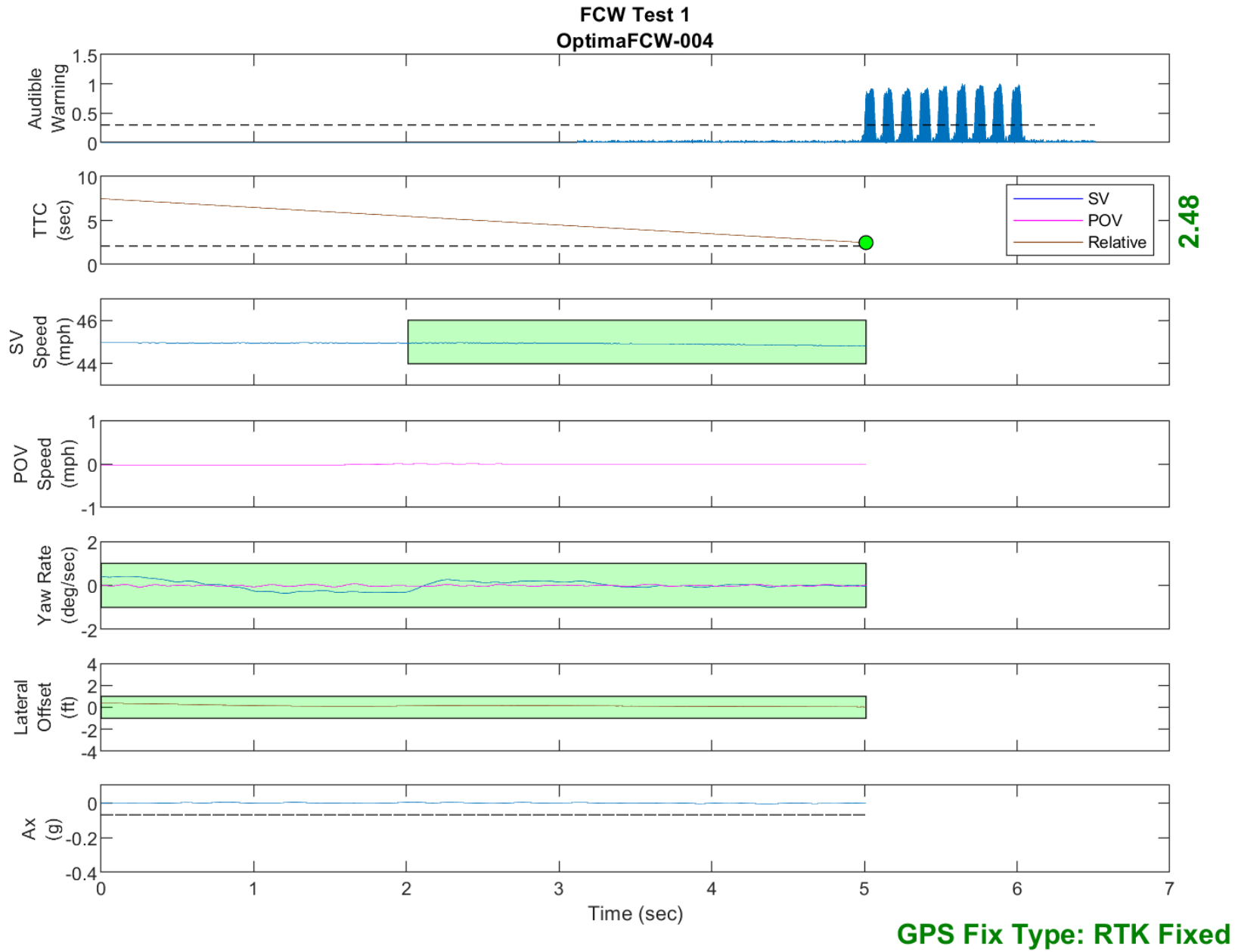


Figure D13. Time History for Run 4, FCW Test 1, Audible Warning

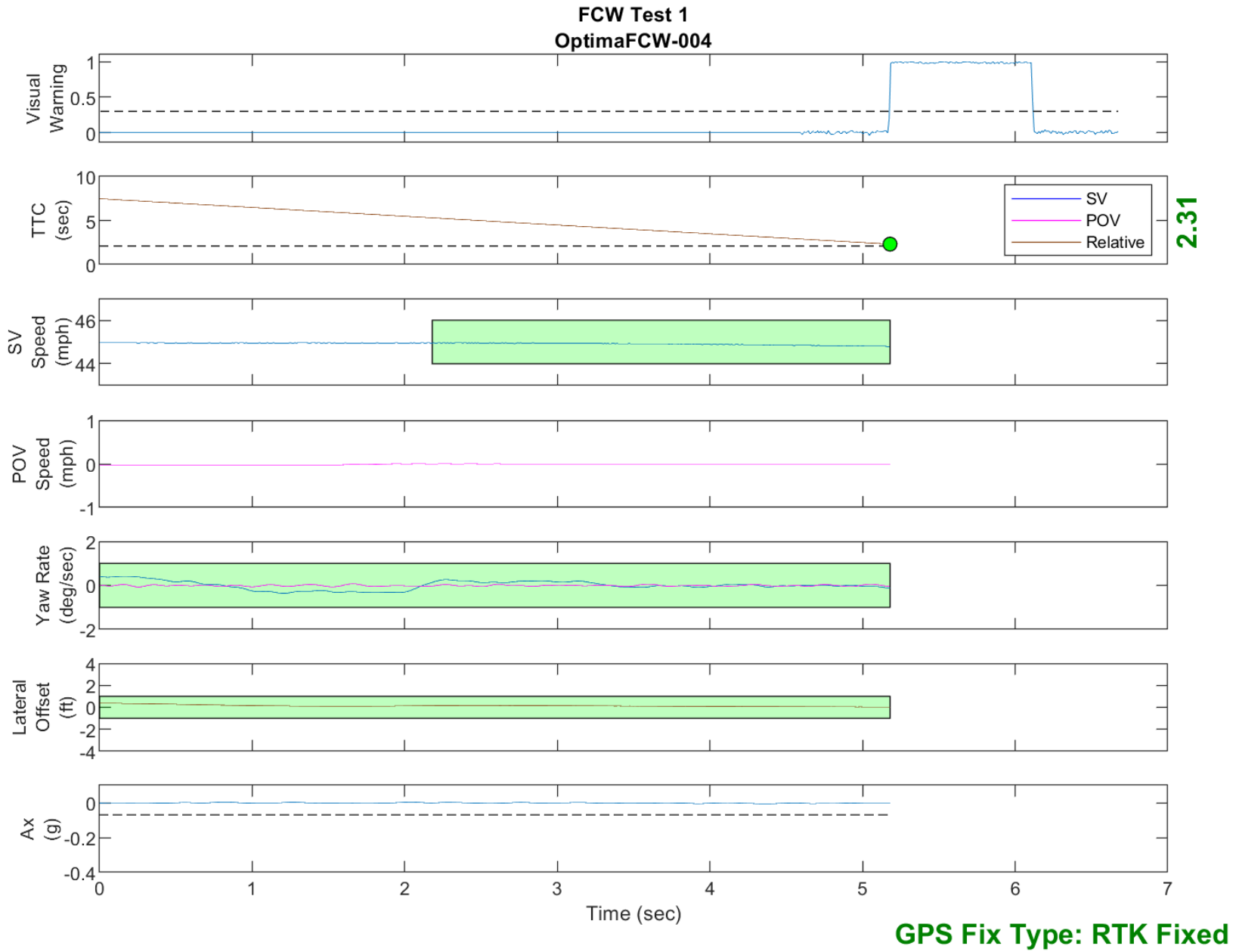


Figure D14. Time History for Run 4, FCW Test 1, Visual Warning

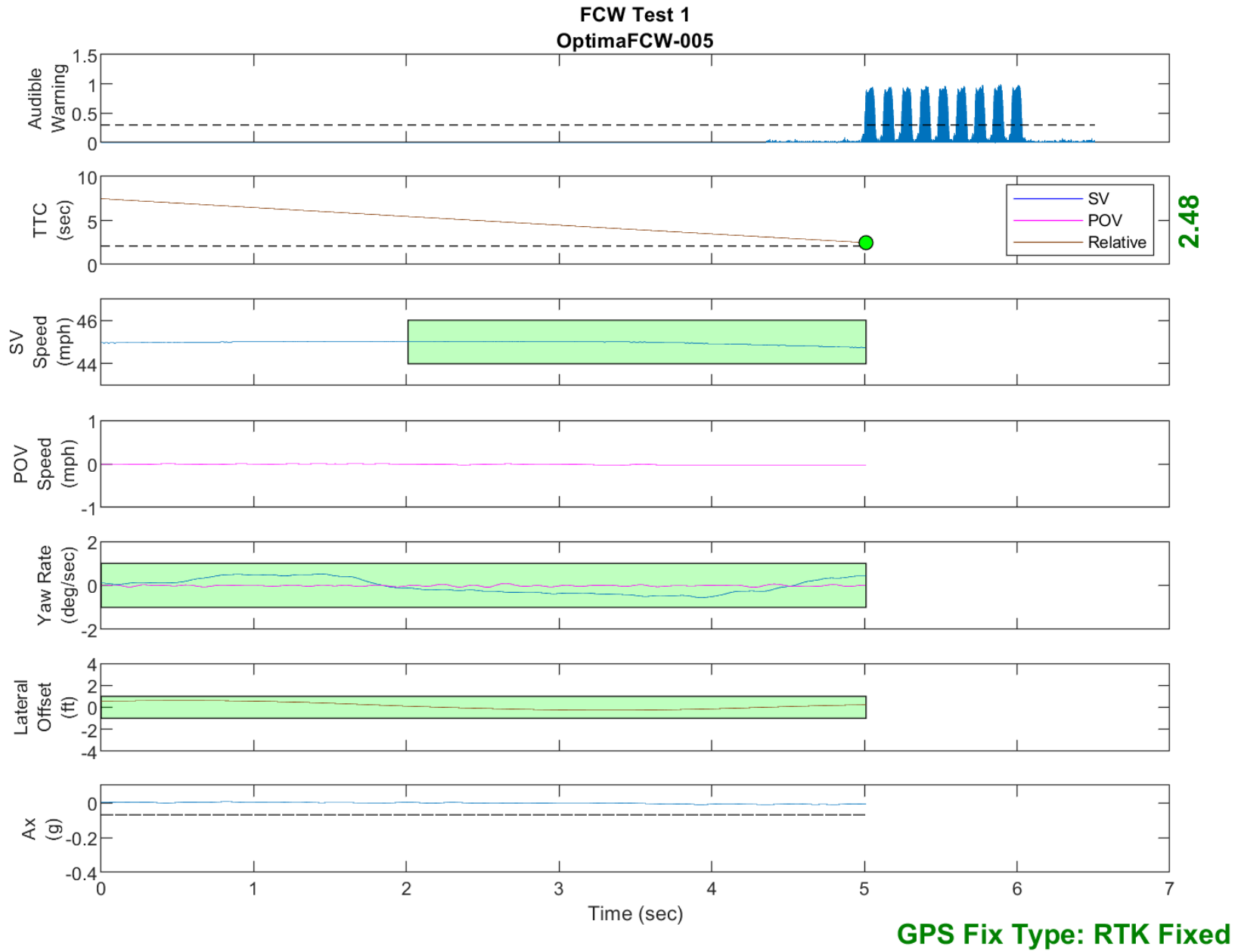


Figure D15. Time History for Run 5, FCW Test 1, Audible Warning

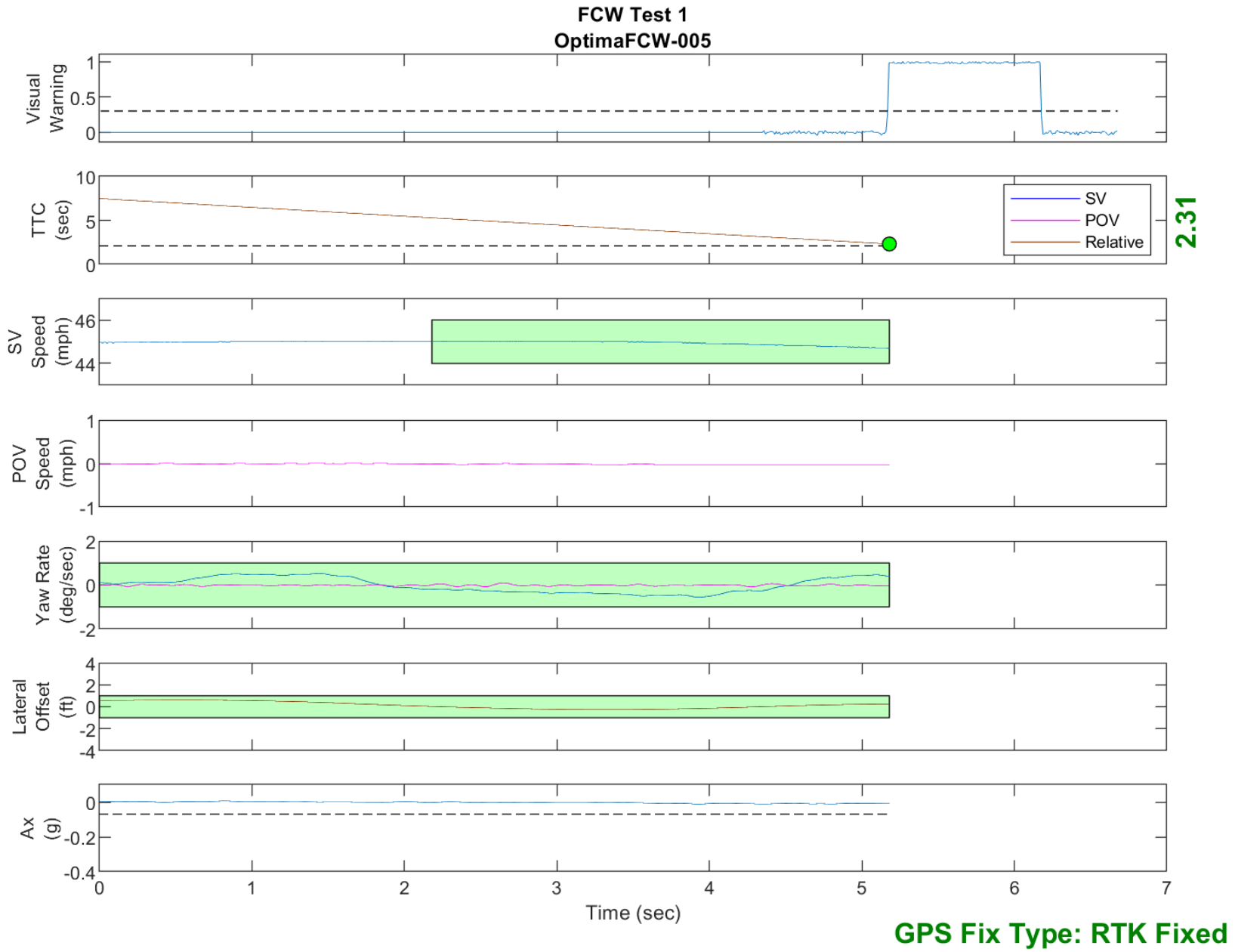


Figure D16. Time History for Run 5, FCW Test 1, Visual Warning

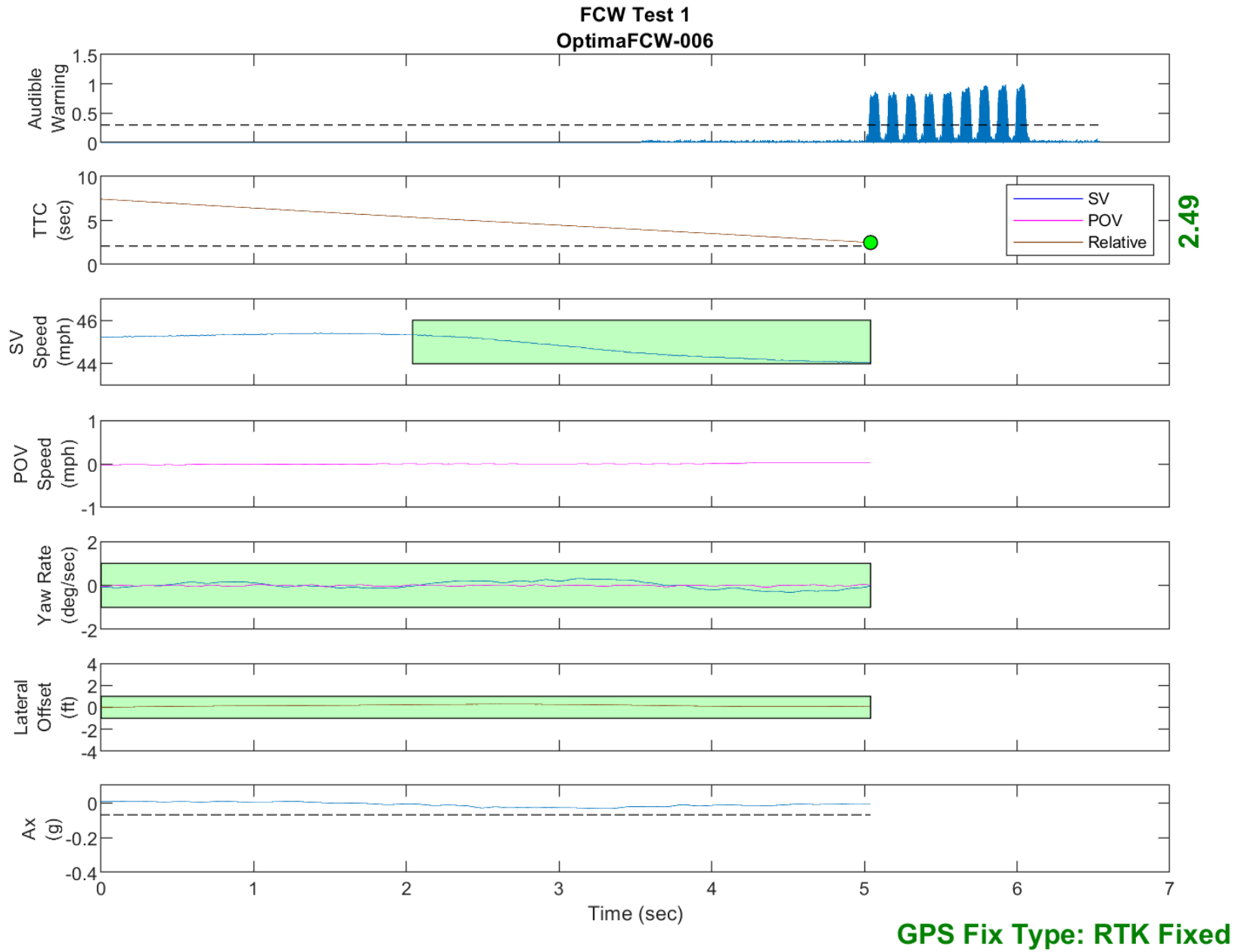


Figure D17. Time History for Run 6, FCW Test 1, Audible Warning

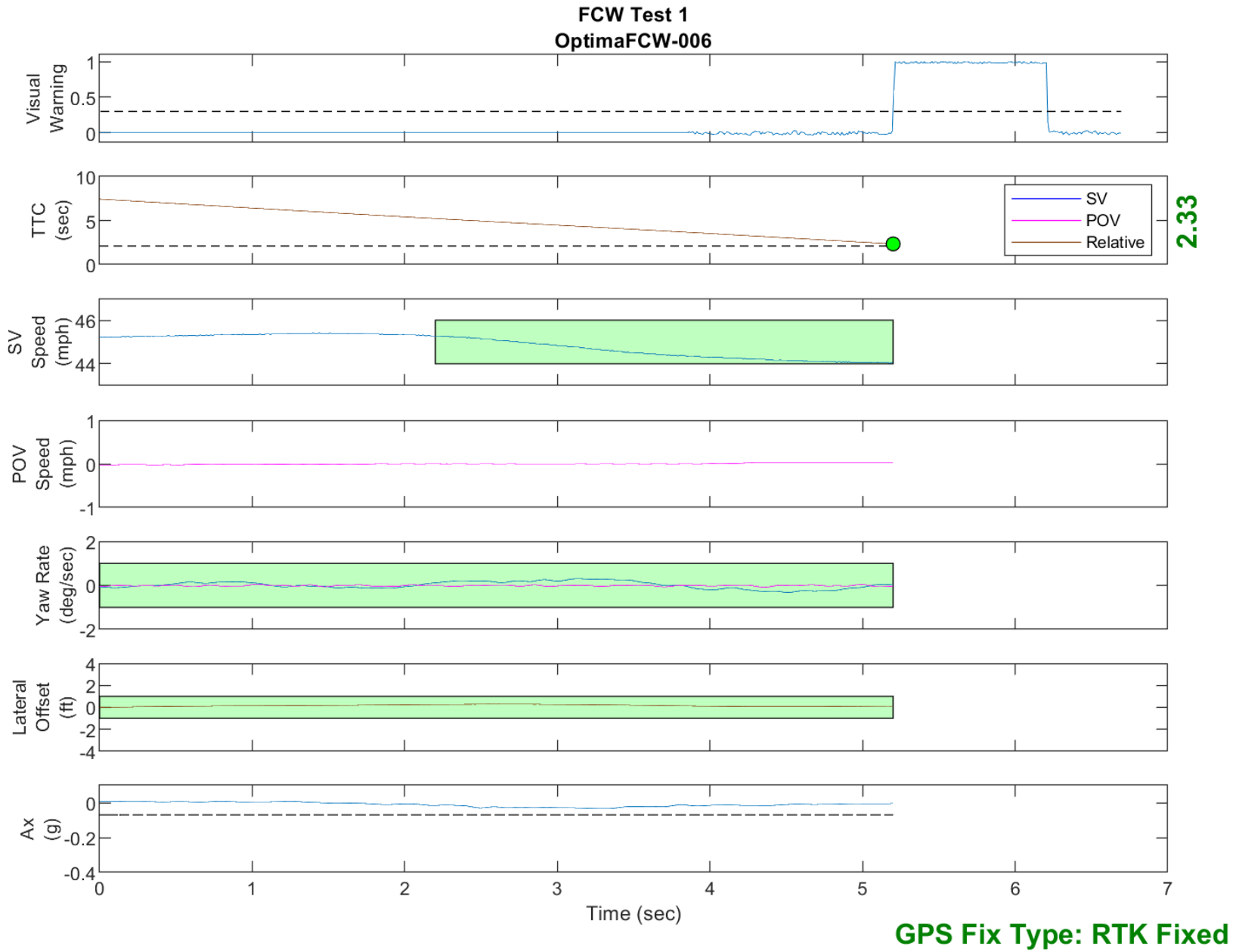


Figure D18. Time History for Run 6, FCW Test 1, Visual Warning

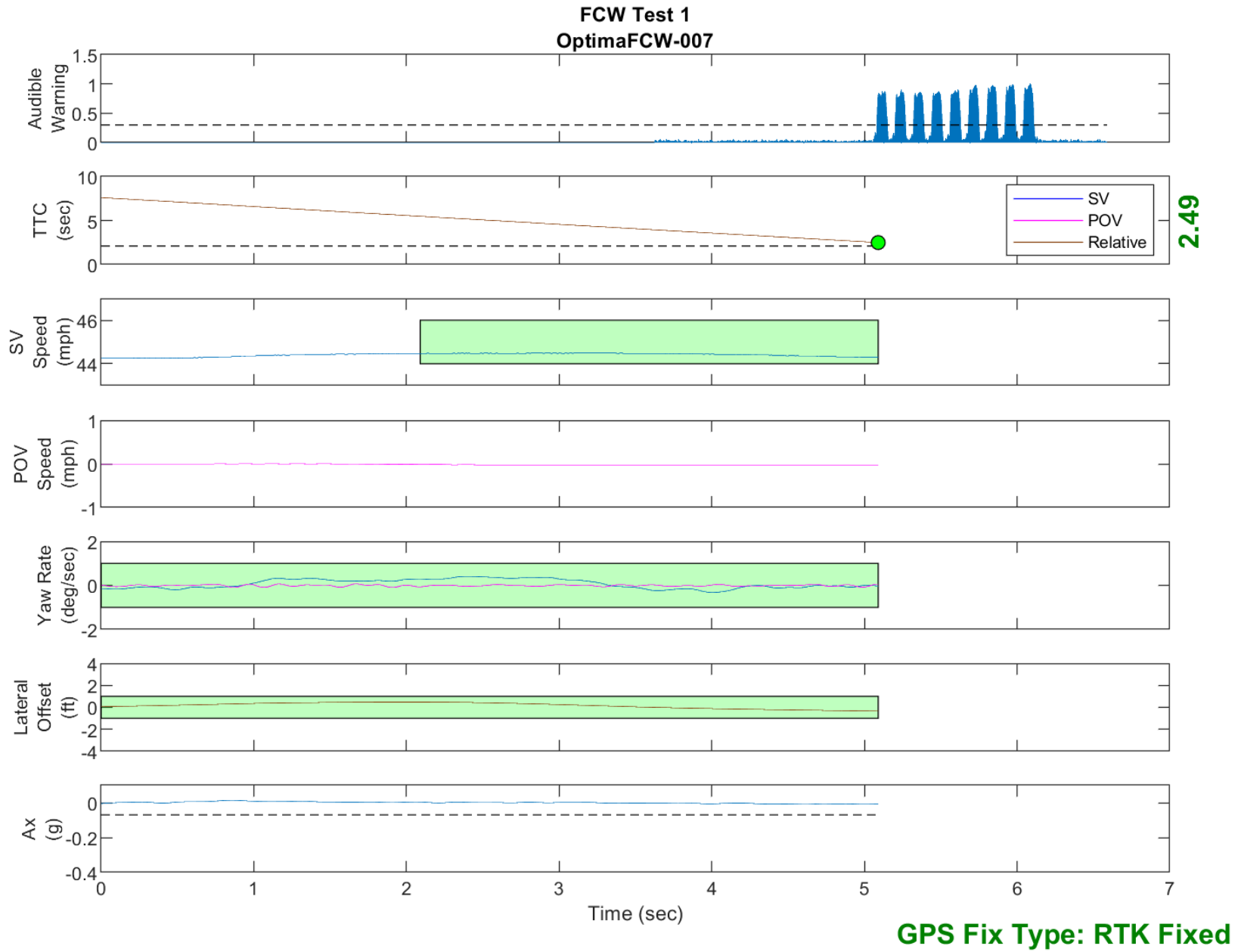


Figure D19. Time History for Run 7, FCW Test 1, Audible Warning

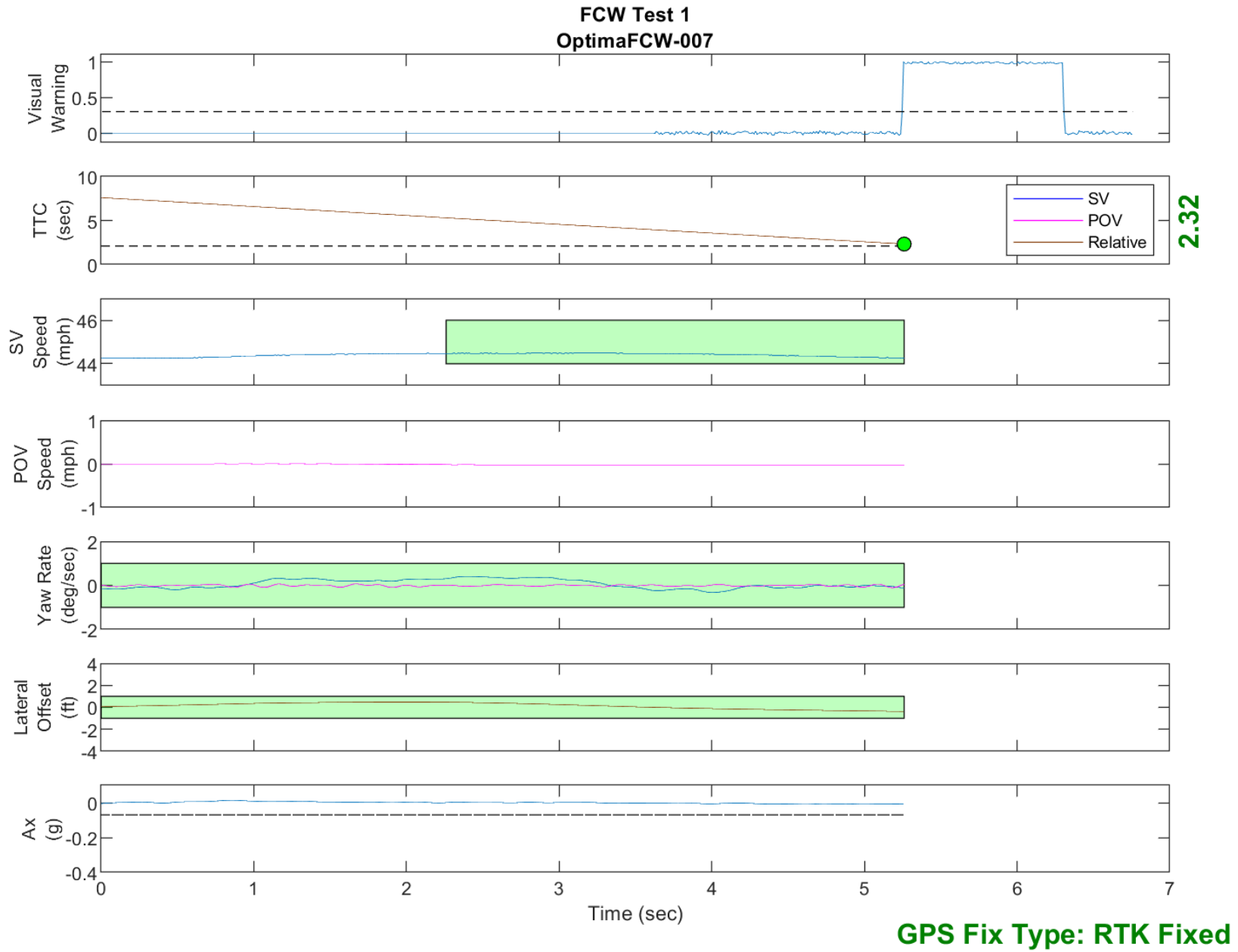


Figure D20. Time History for Run 7, FCW Test 1, Visual Warning

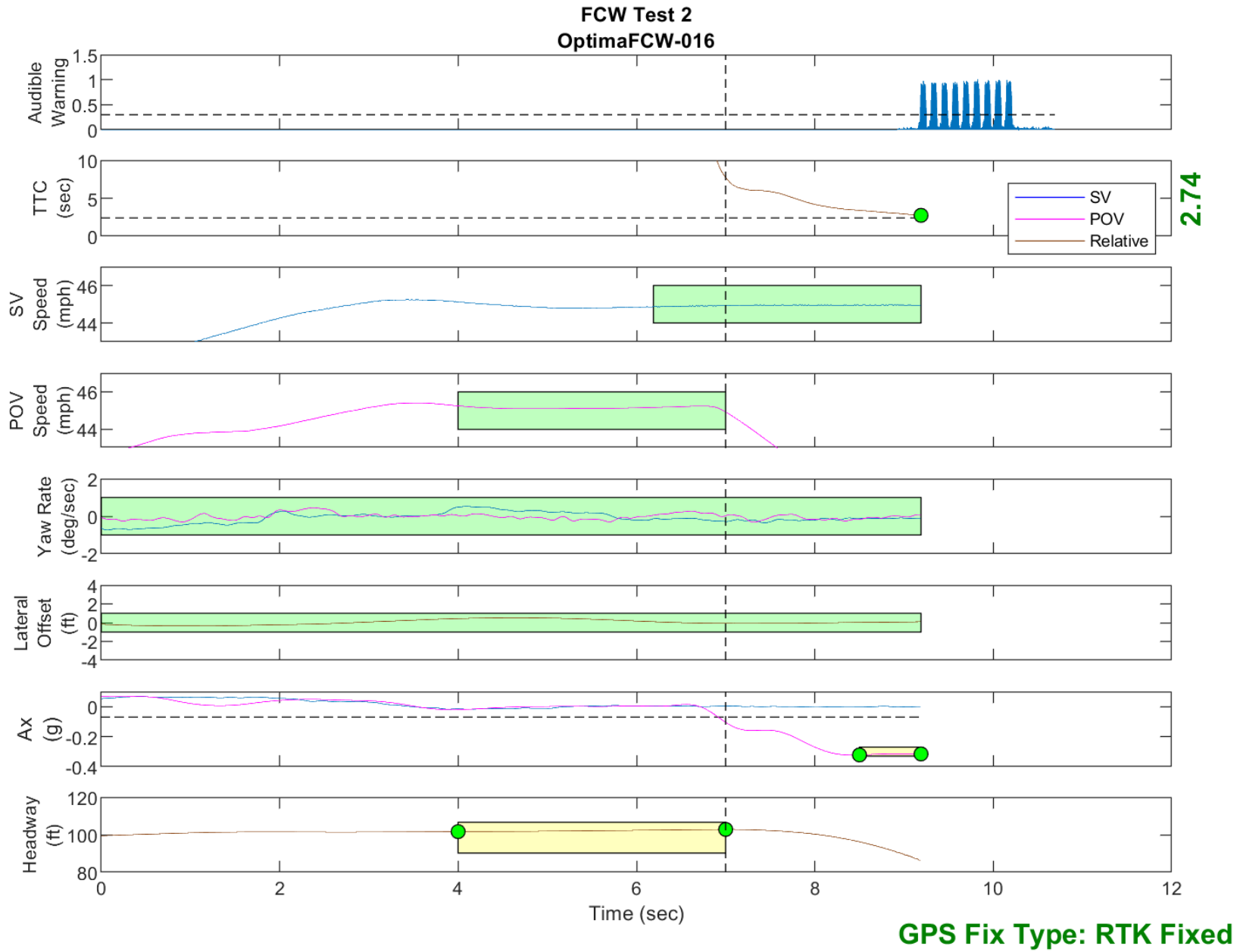


Figure D21. Time History for Run 16, FCW Test 2, Audible Warning

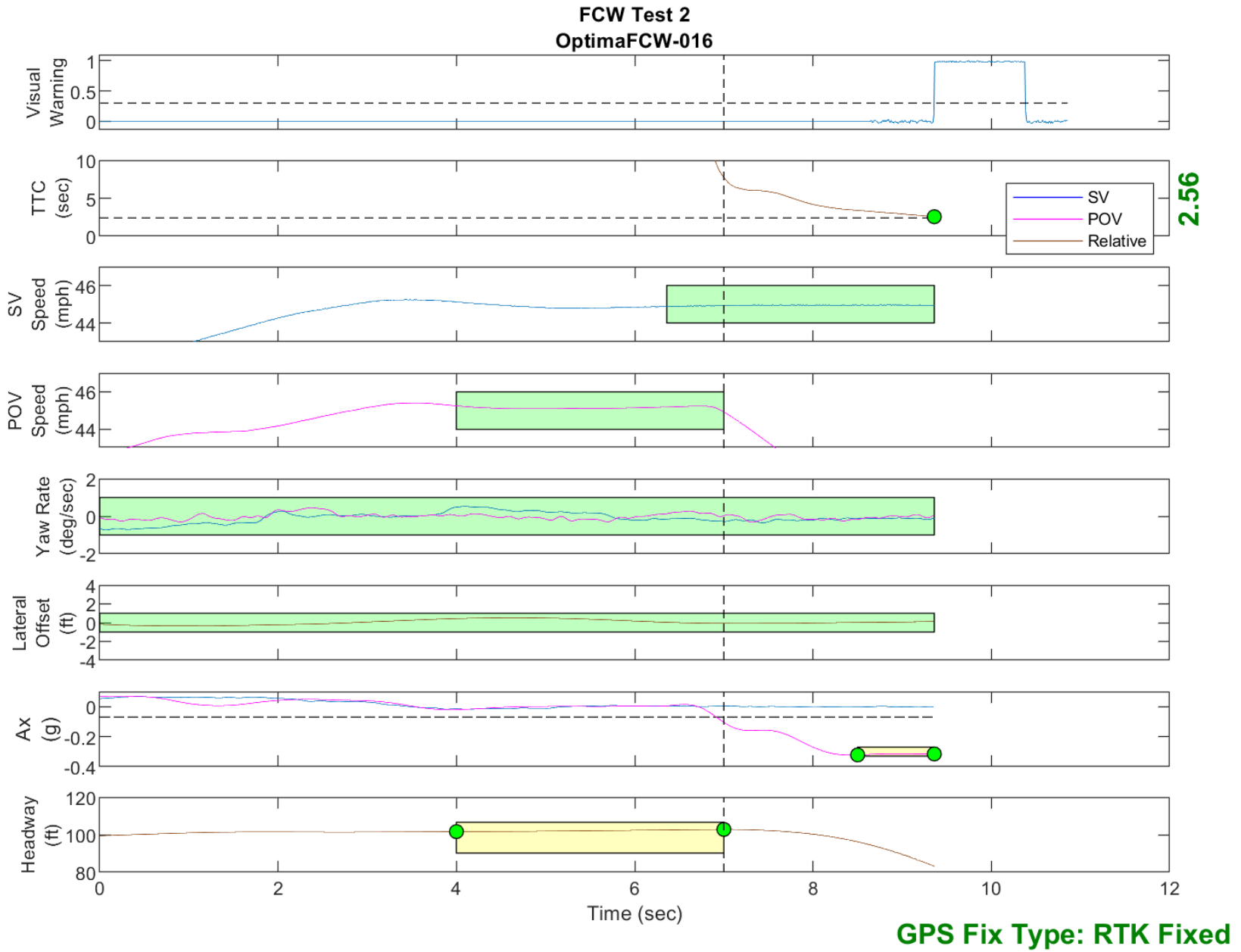


Figure D22. Time History for Run 16, FCW Test 2, Visual Warning

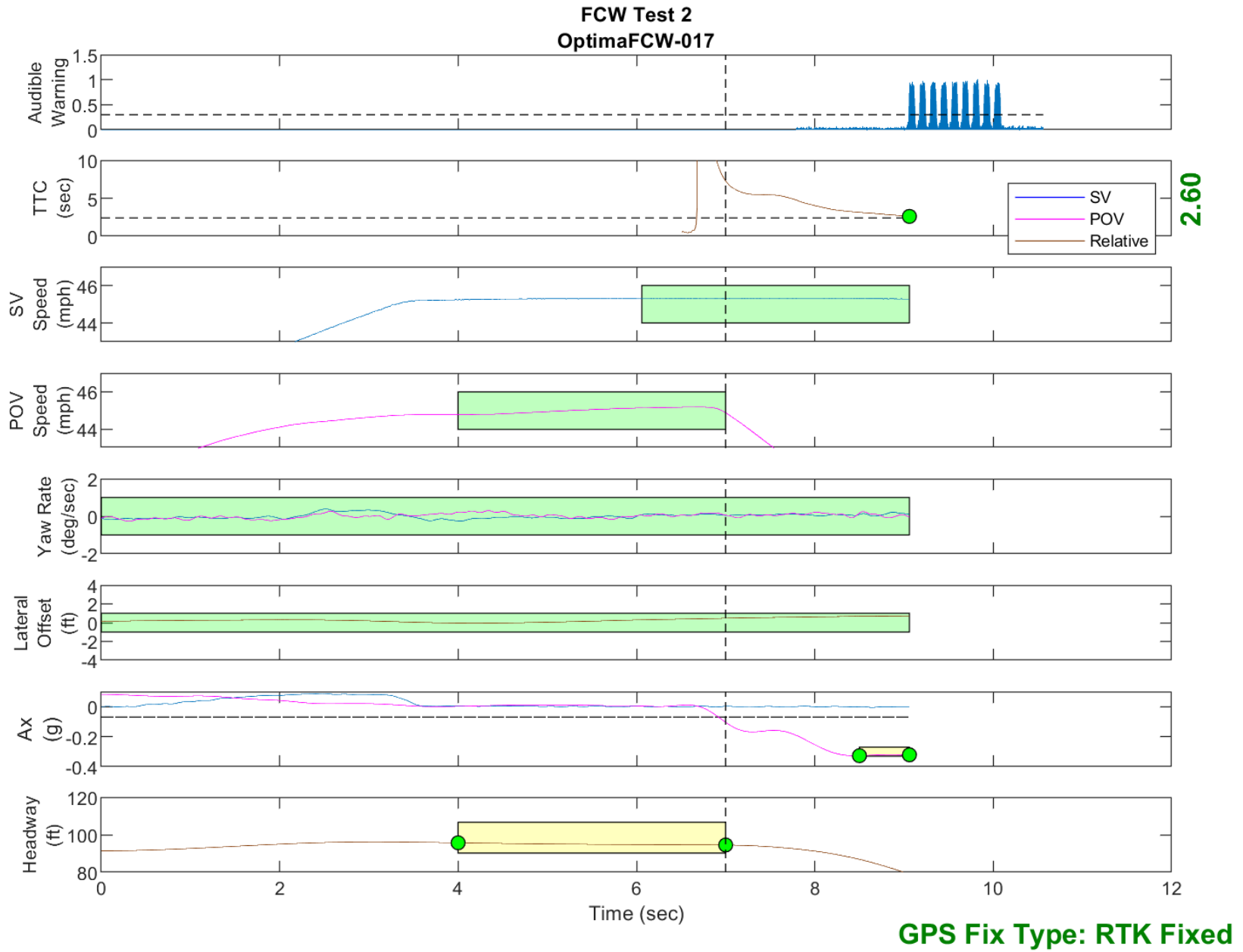


Figure D23. Time History for Run 17, FCW Test 2, Audible Warning

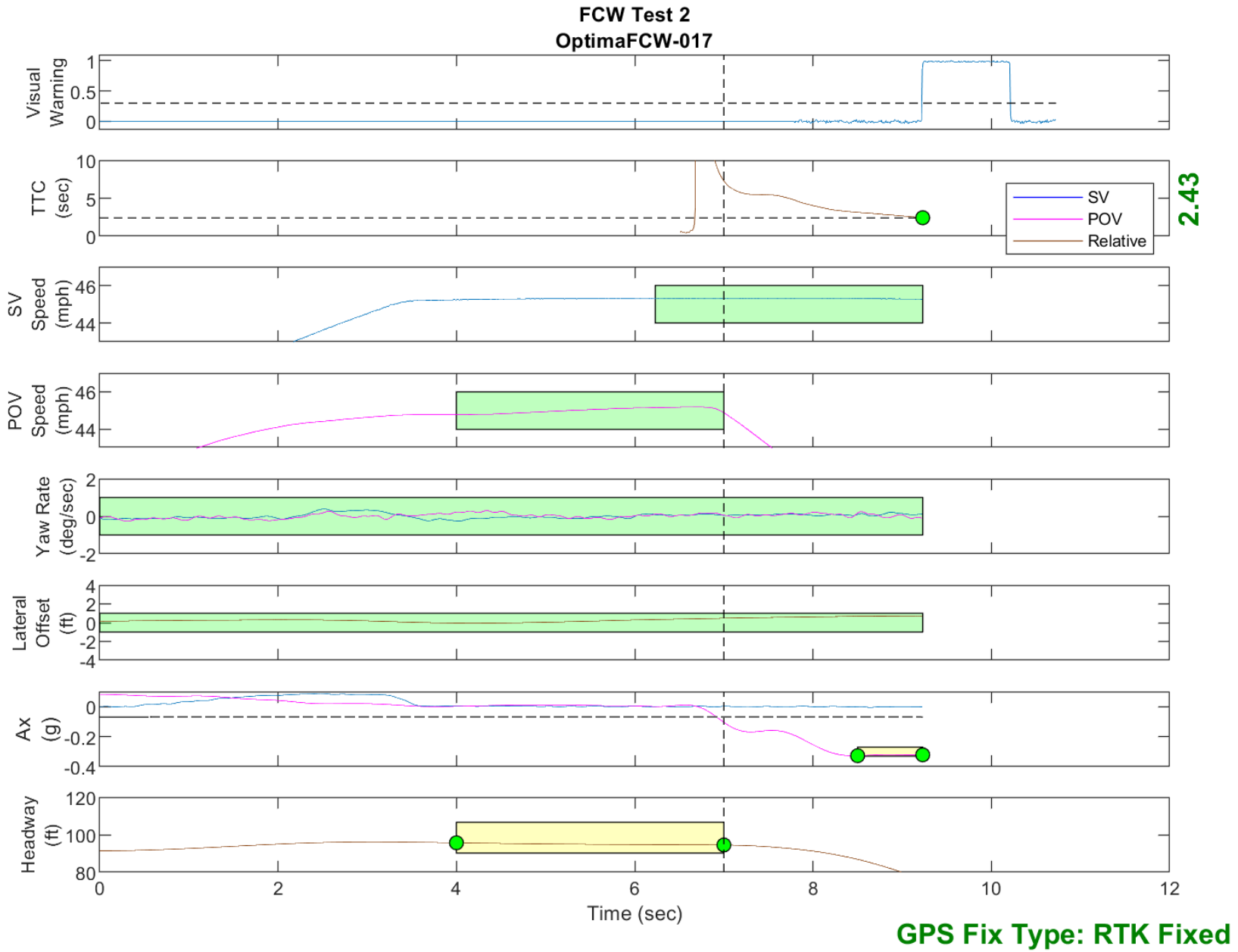


Figure D24. Time History for Run 17, FCW Test 2, Visual Warning

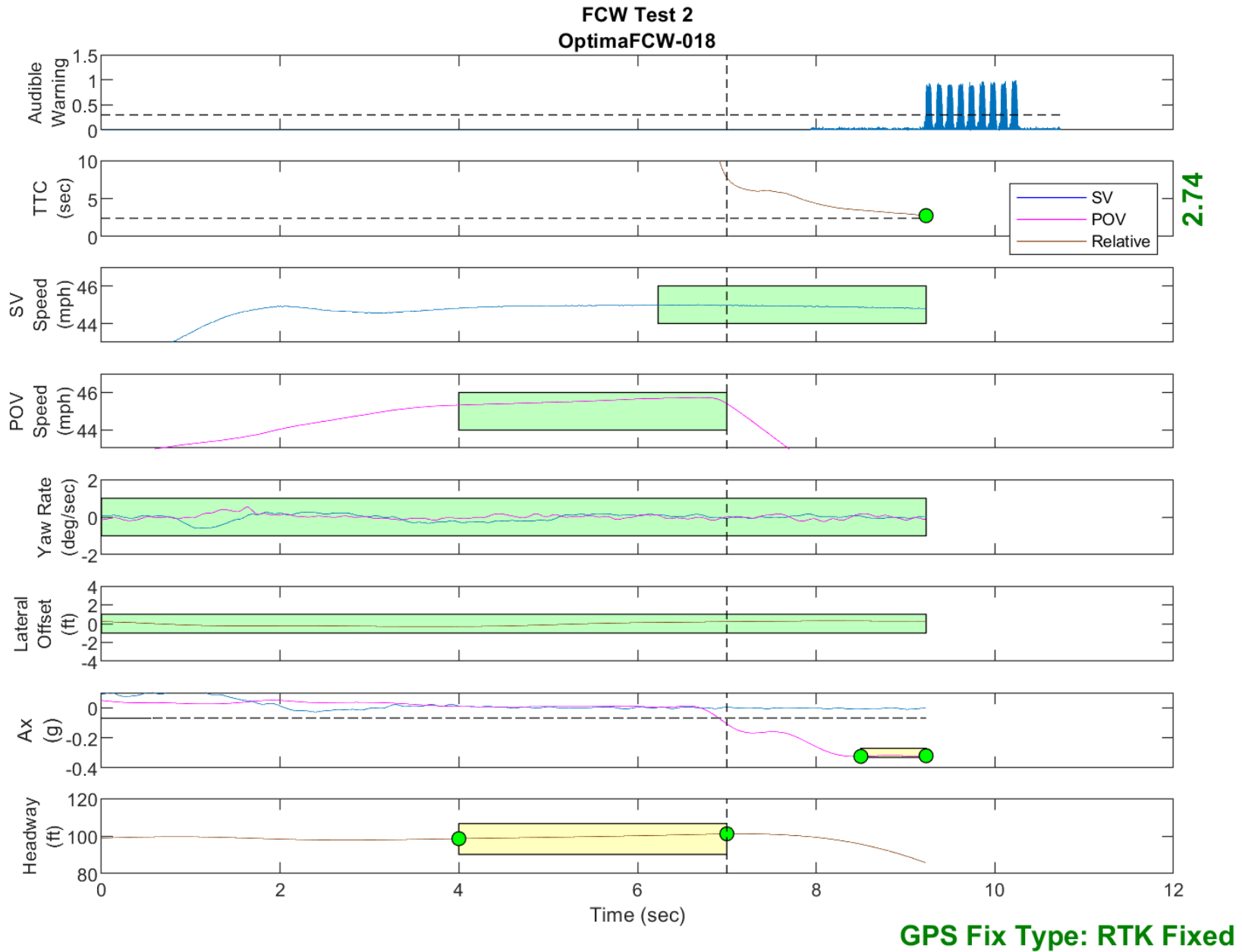


Figure D25. Time History for Run 18, FCW Test 2, Audible Warning

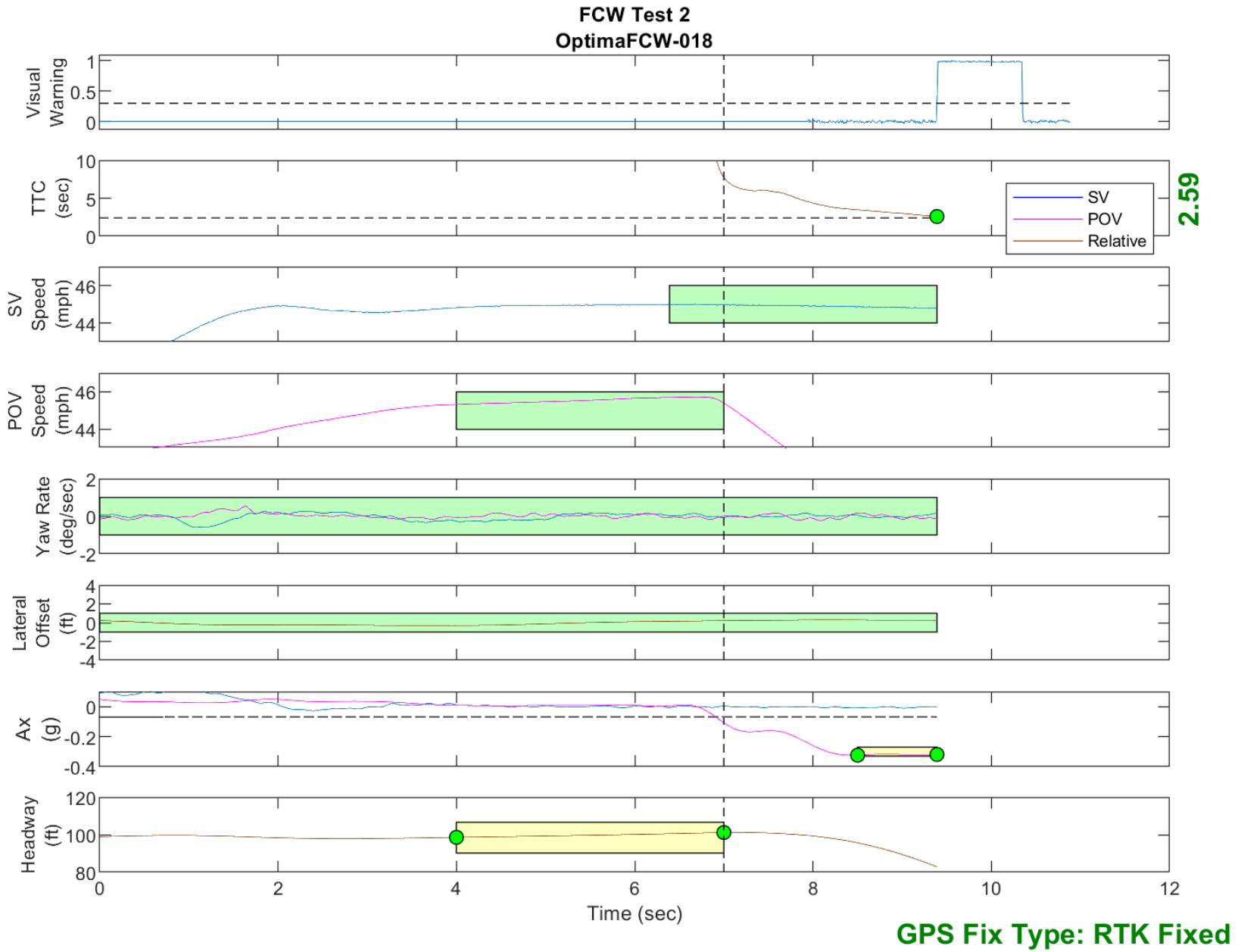


Figure D26. Time History for Run 18, FCW Test 2, Visual Warning

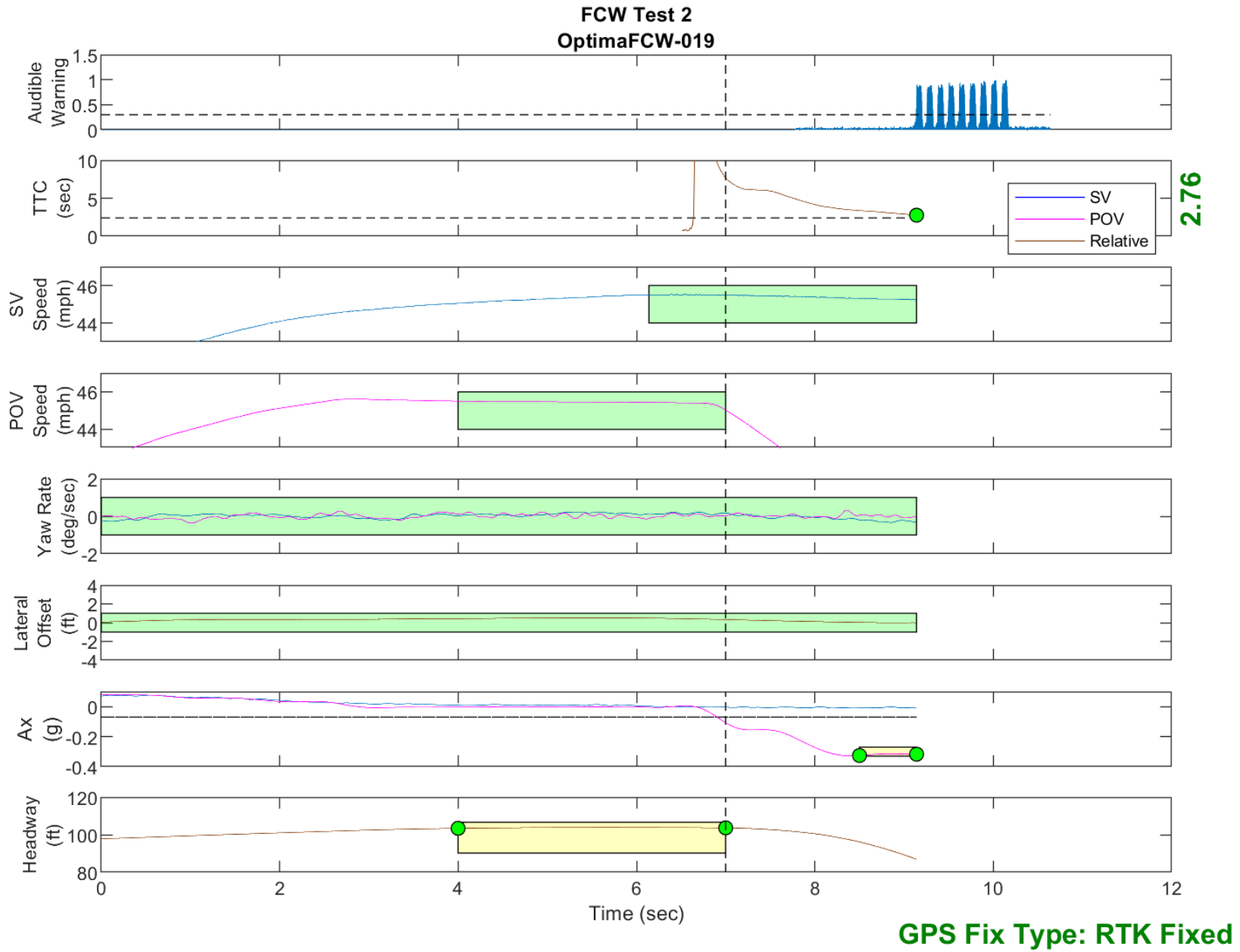


Figure D27. Time History for Run 19, FCW Test 2, Audible Warning

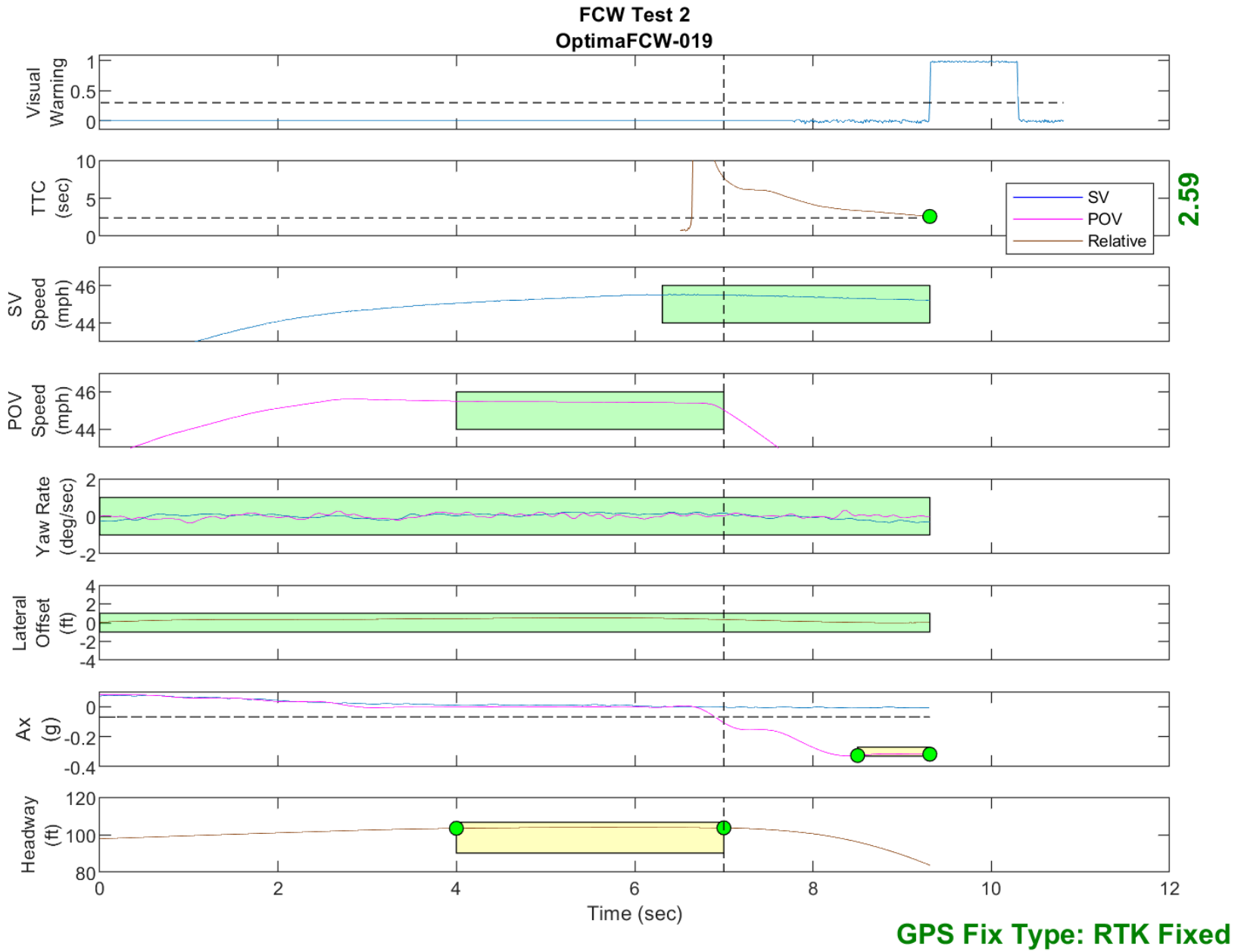


Figure D28. Time History for Run 19, FCW Test 2, Visual Warning

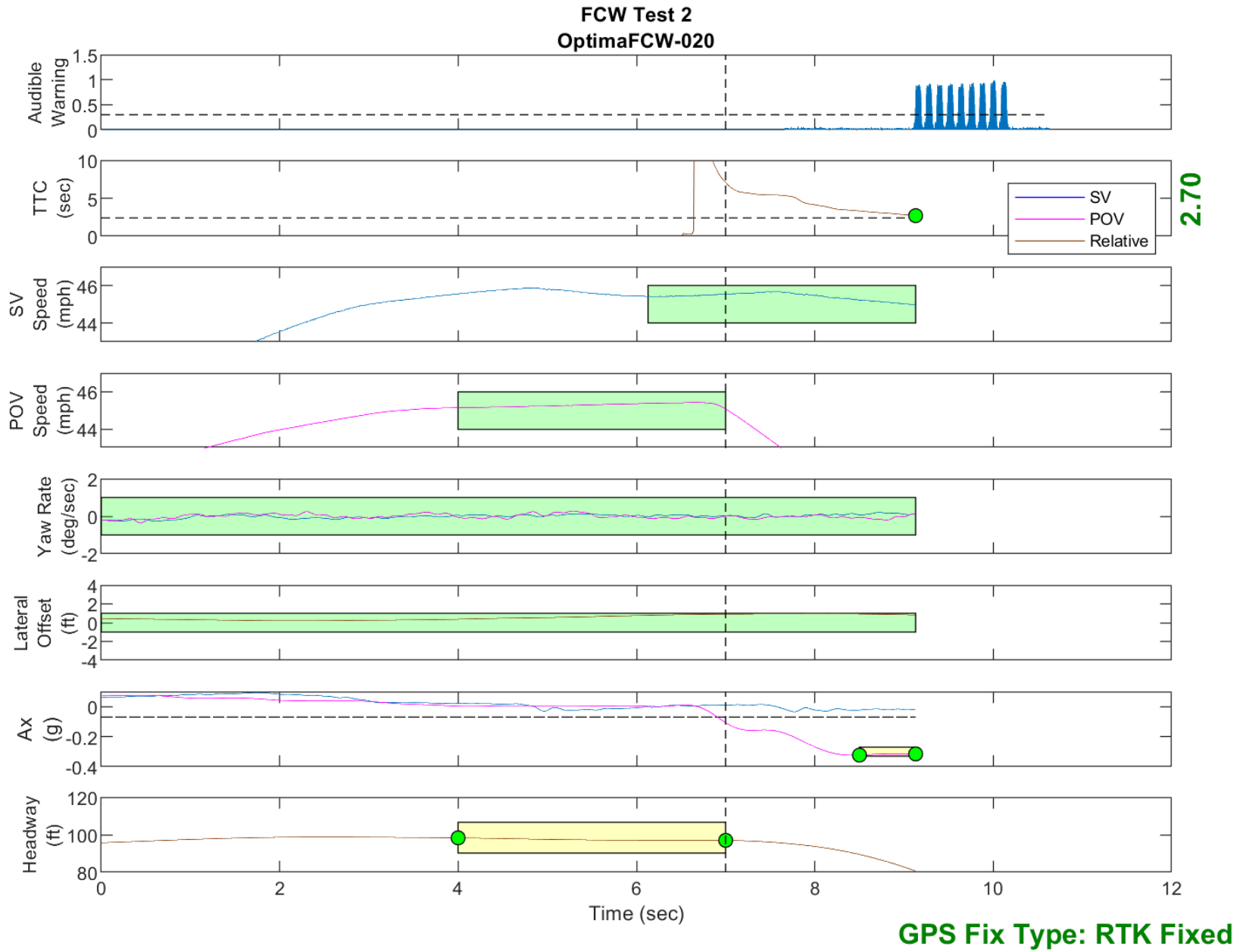


Figure D29. Time History for Run 20, FCW Test 2, Audible Warning

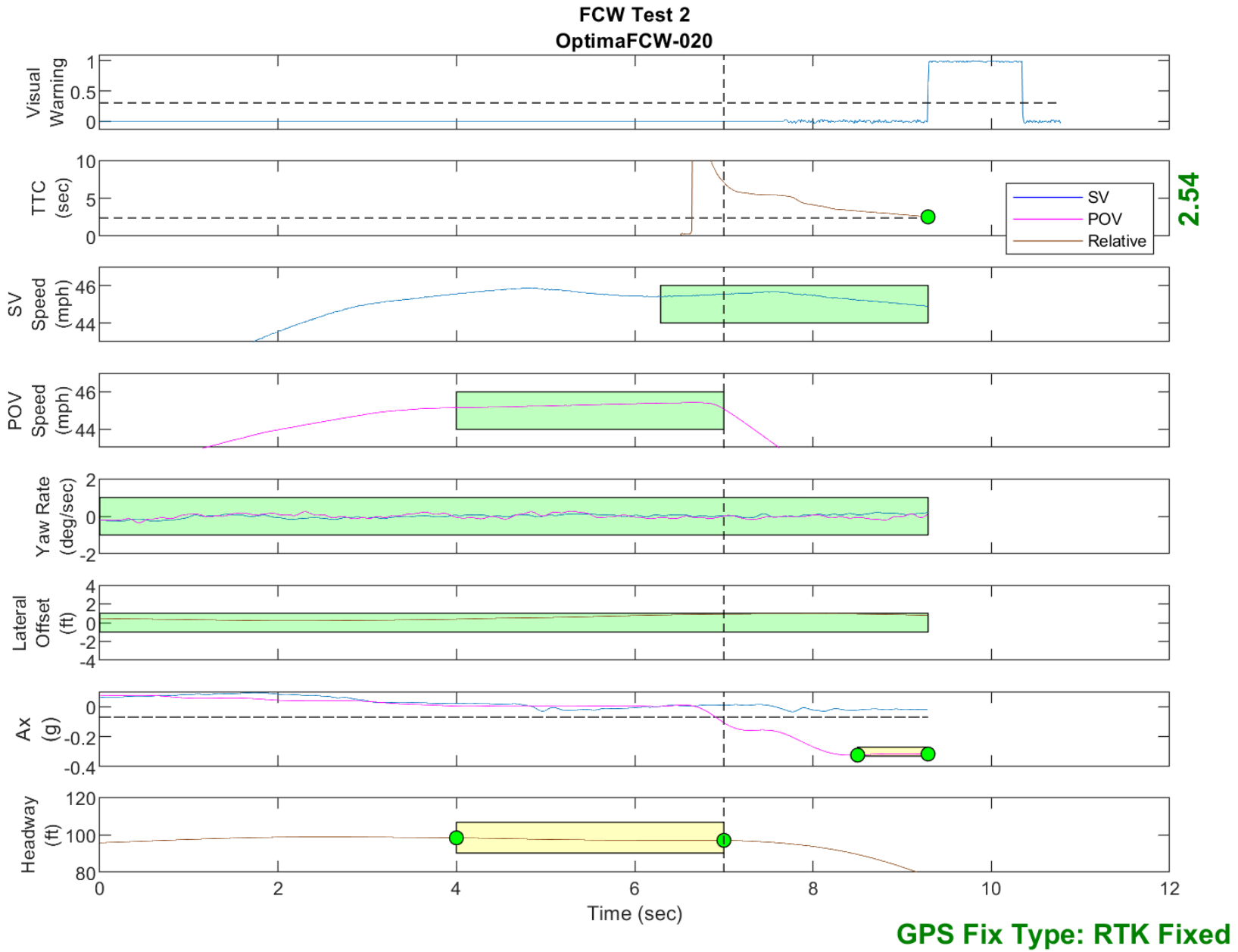


Figure D30. Time History for Run 20, FCW Test 2, Visual Warning

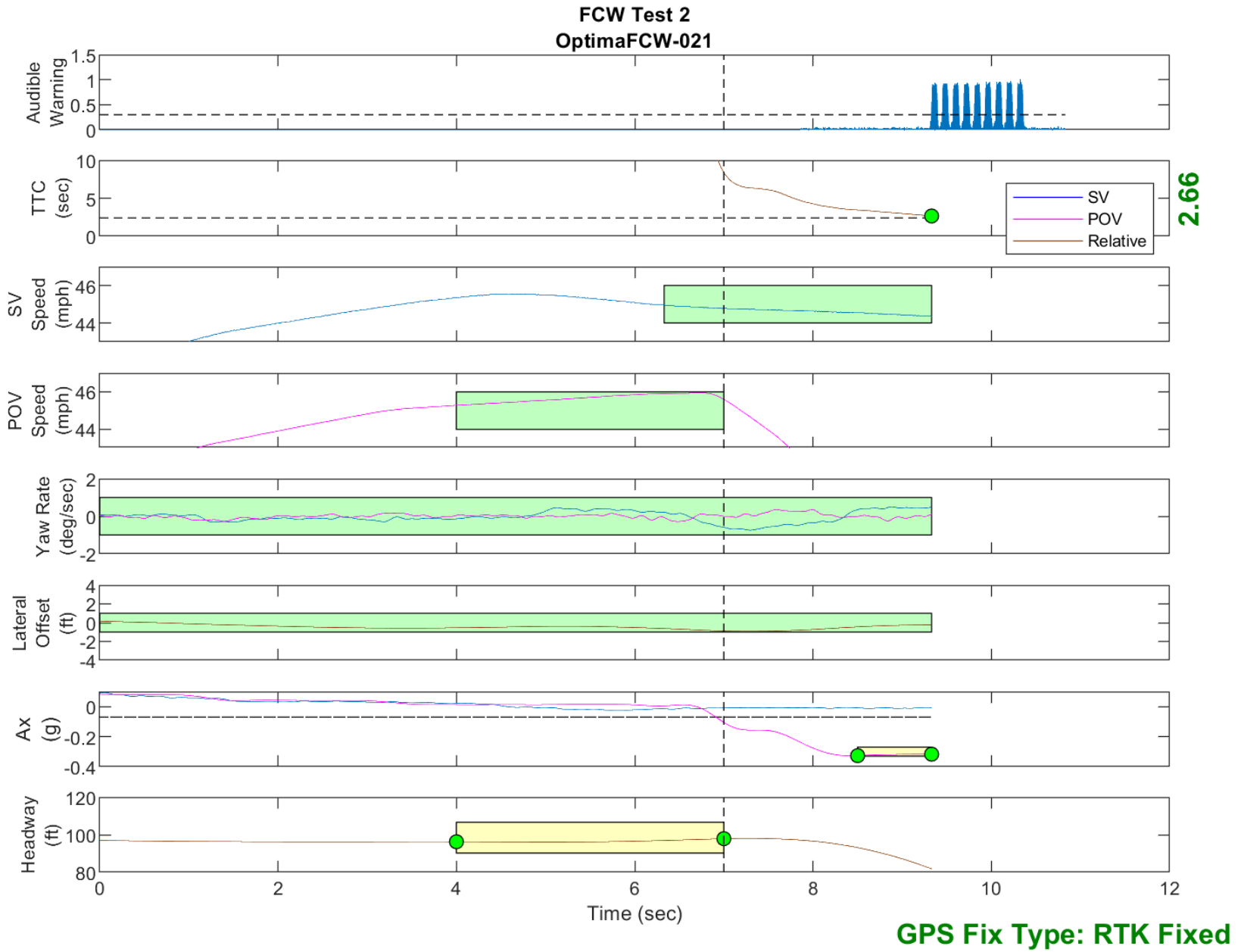


Figure D31. Time History for Run 21, FCW Test 2, Audible Warning

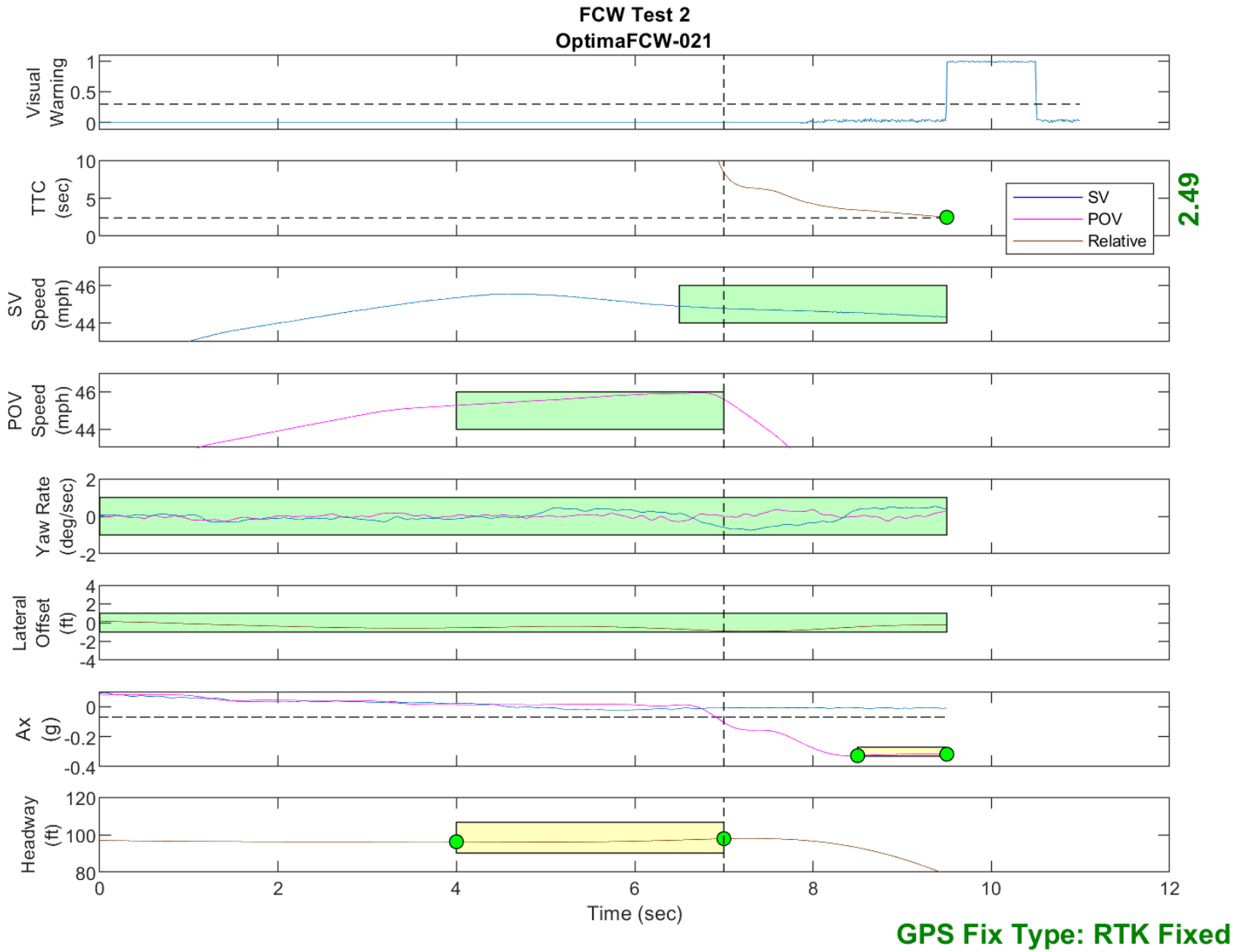


Figure D32. Time History for Run 21, FCW Test 2, Visual Warning

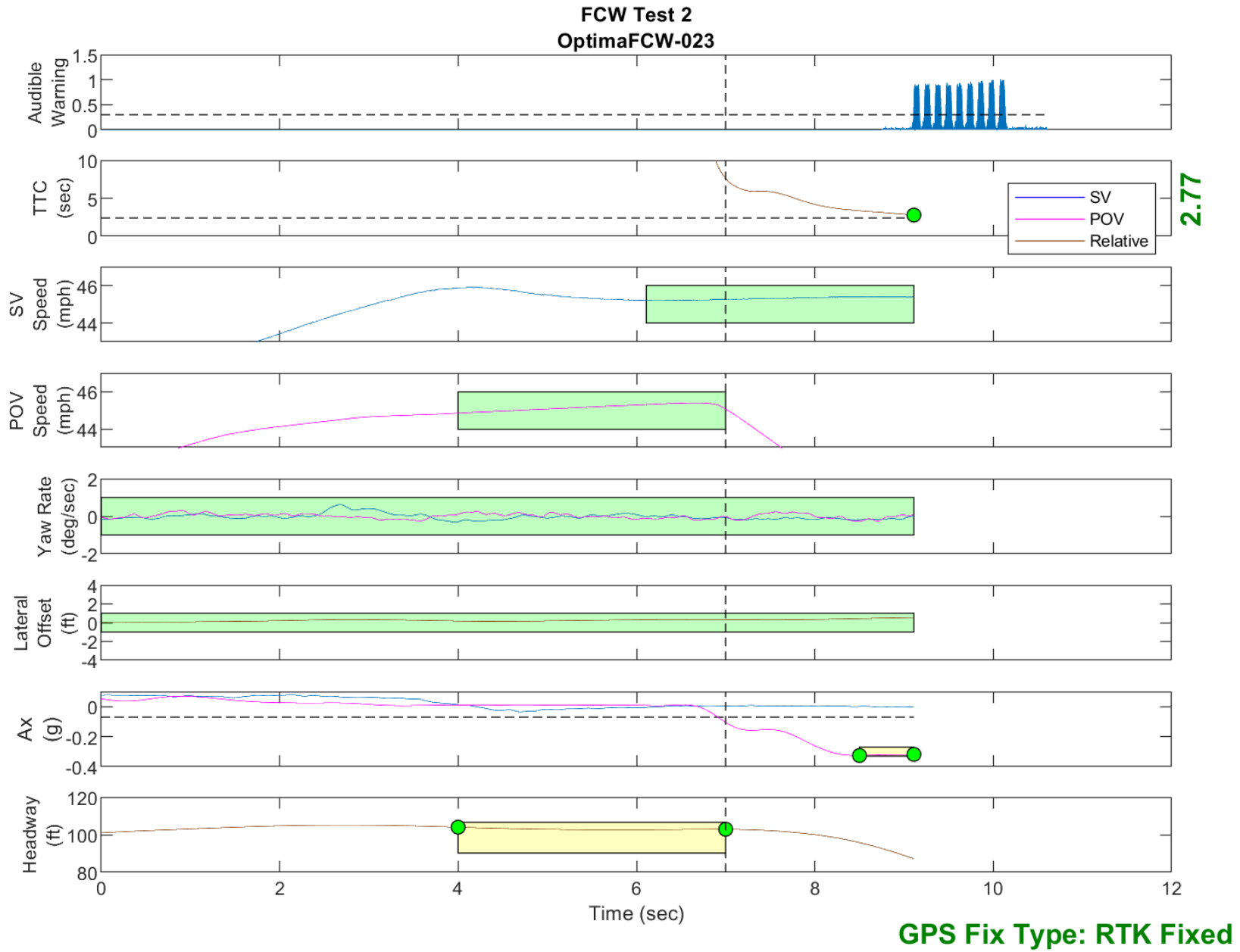


Figure D33. Time History for Run 23, FCW Test 2, Audible Warning

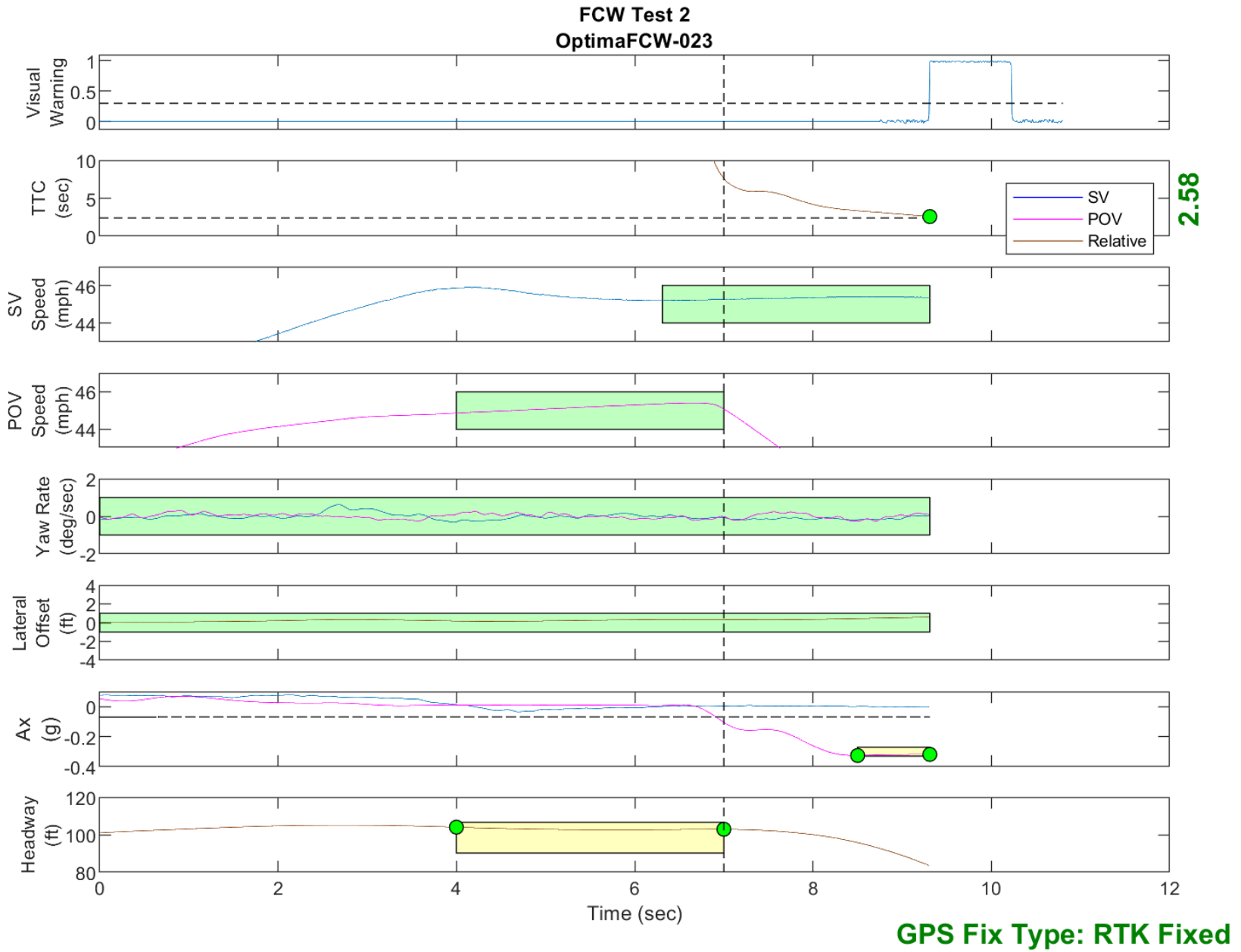


Figure D34. Time History for Run 23, FCW Test 2, Visual Warning

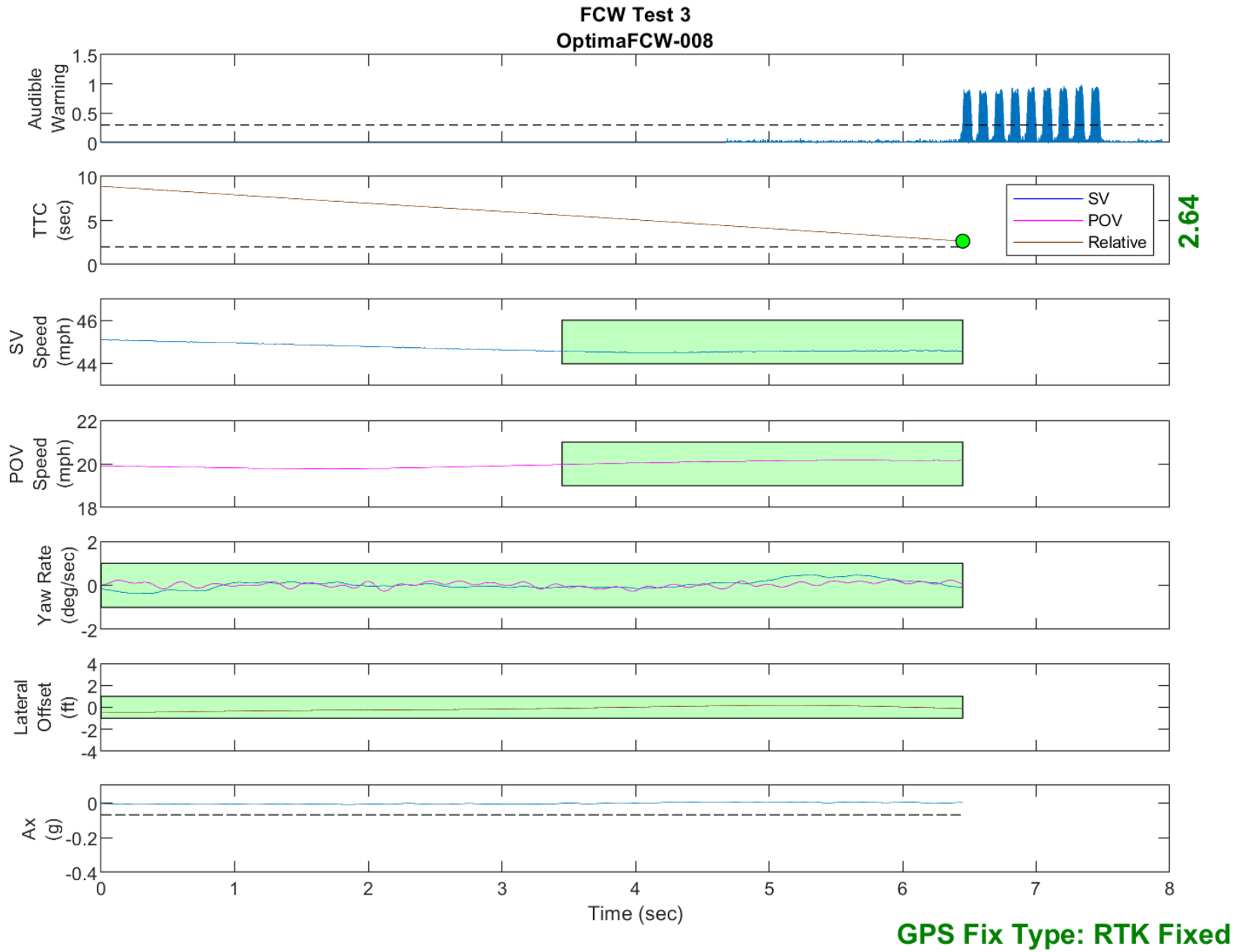


Figure D35. Time History for Run 8, FCW Test 3, Audible Warning

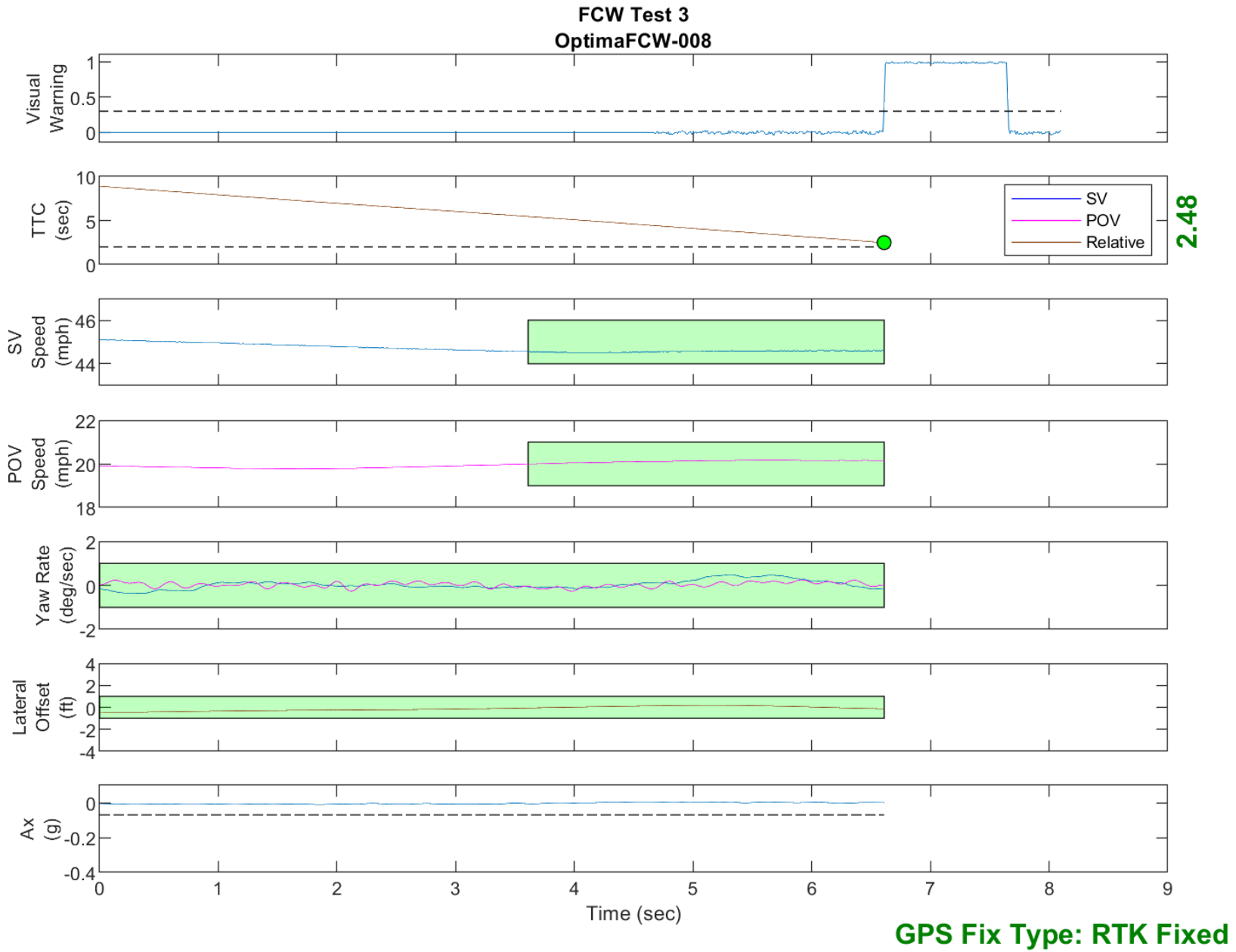


Figure D36. Time History for Run 8, FCW Test 3, Visual Warning

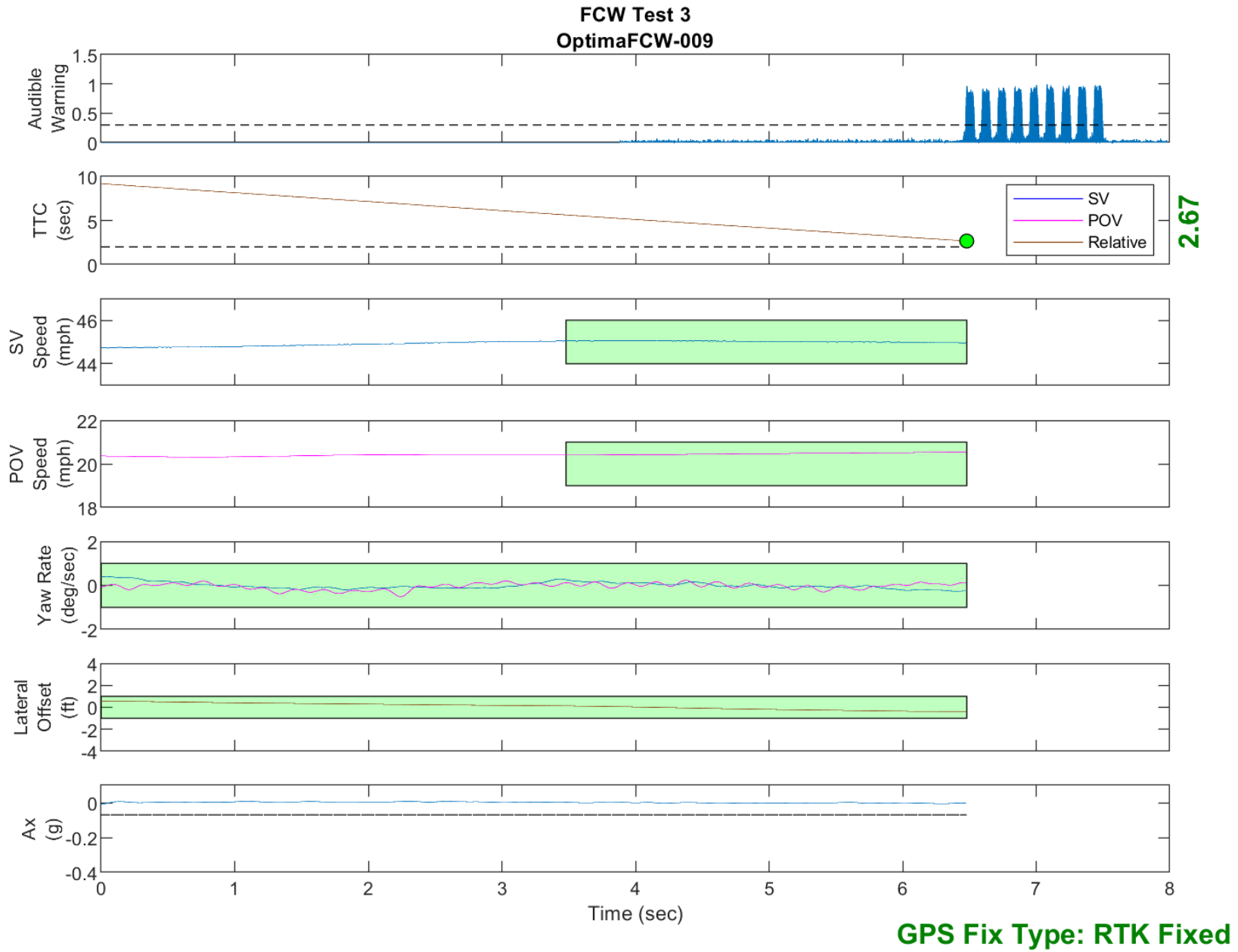


Figure D37. Time History for Run 9, FCW Test 3, Audible Warning

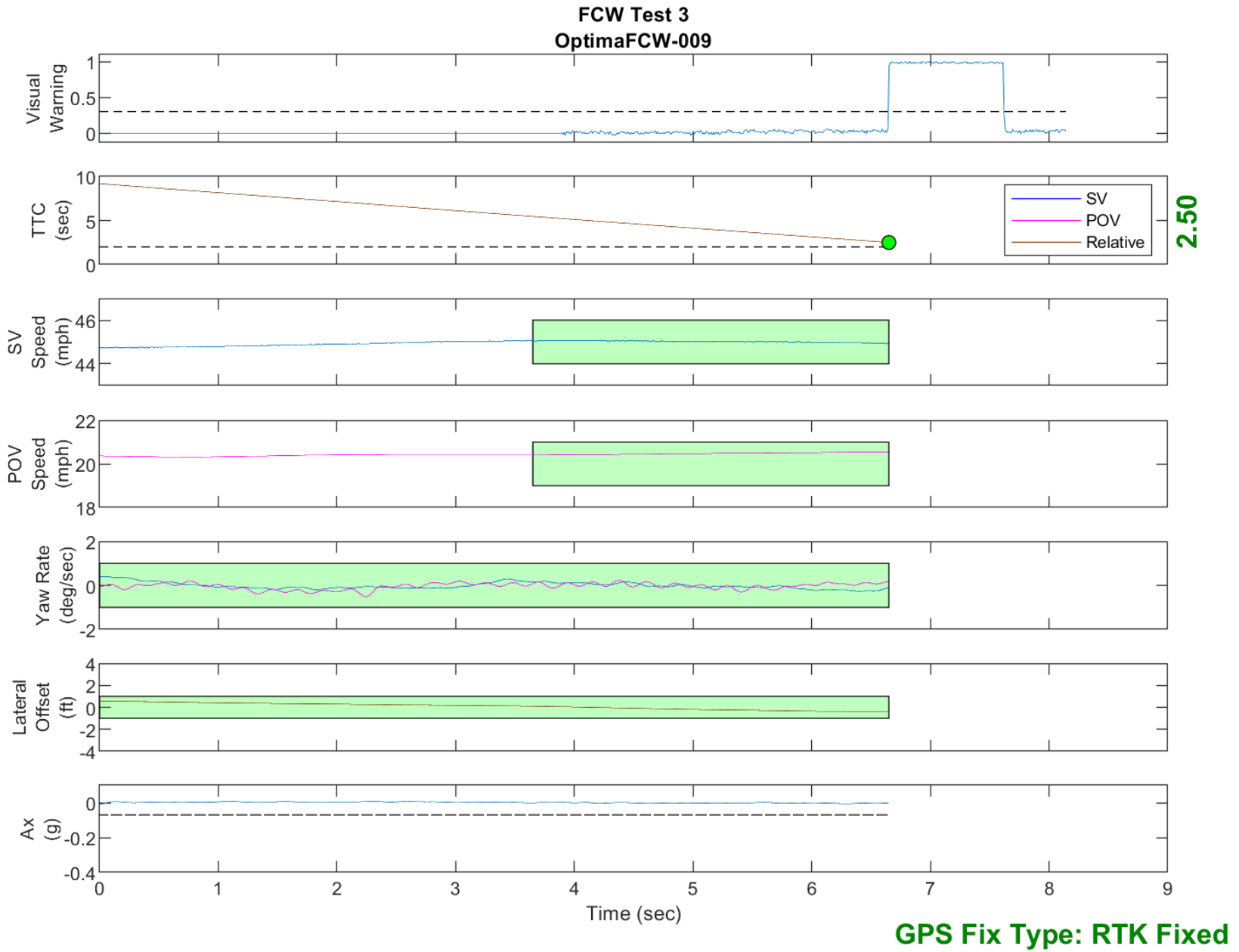


Figure D38. Time History for Run 9, FCW Test 3, Visual Warning

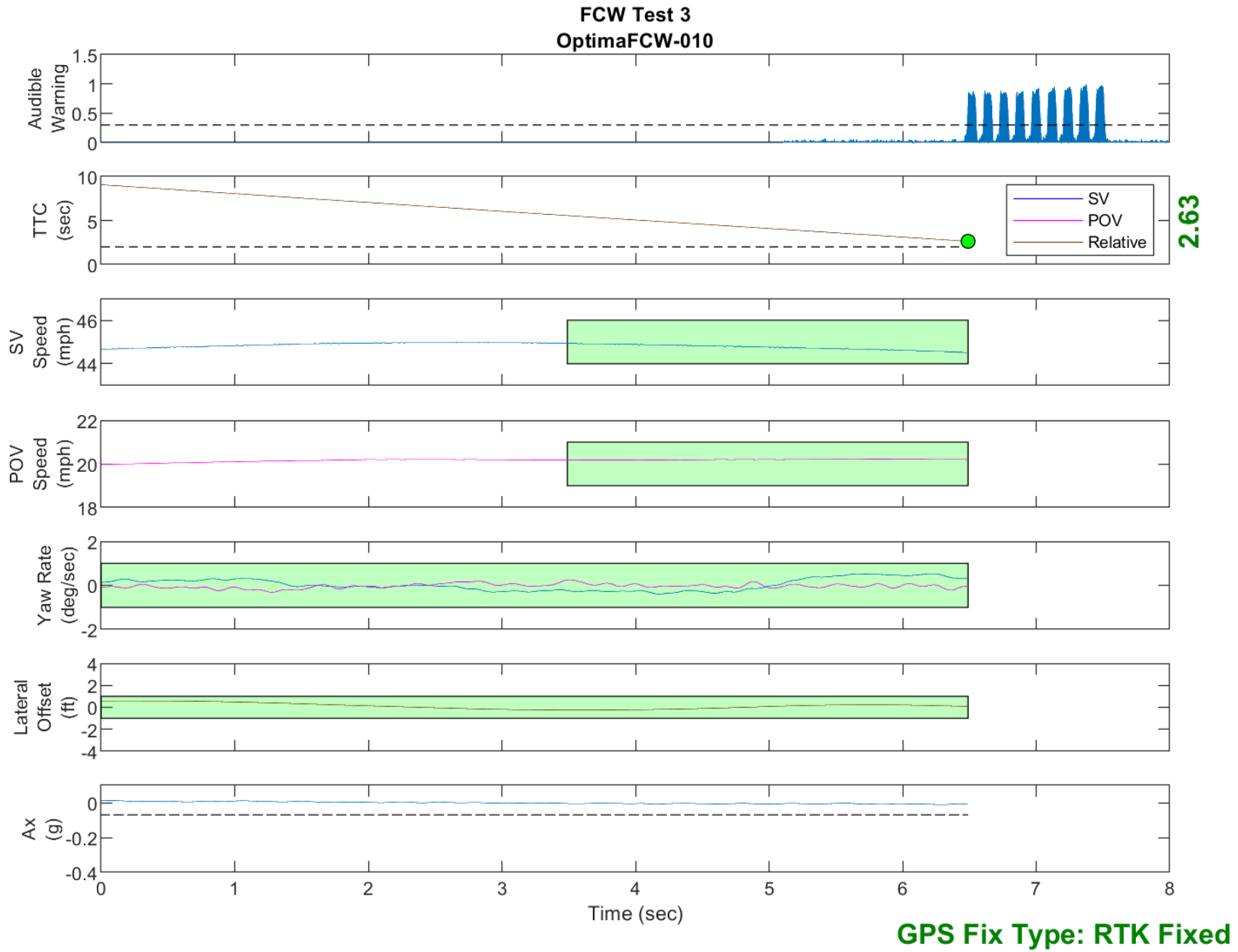


Figure D39. Time History for Run 10, FCW Test 3, Audible Warning

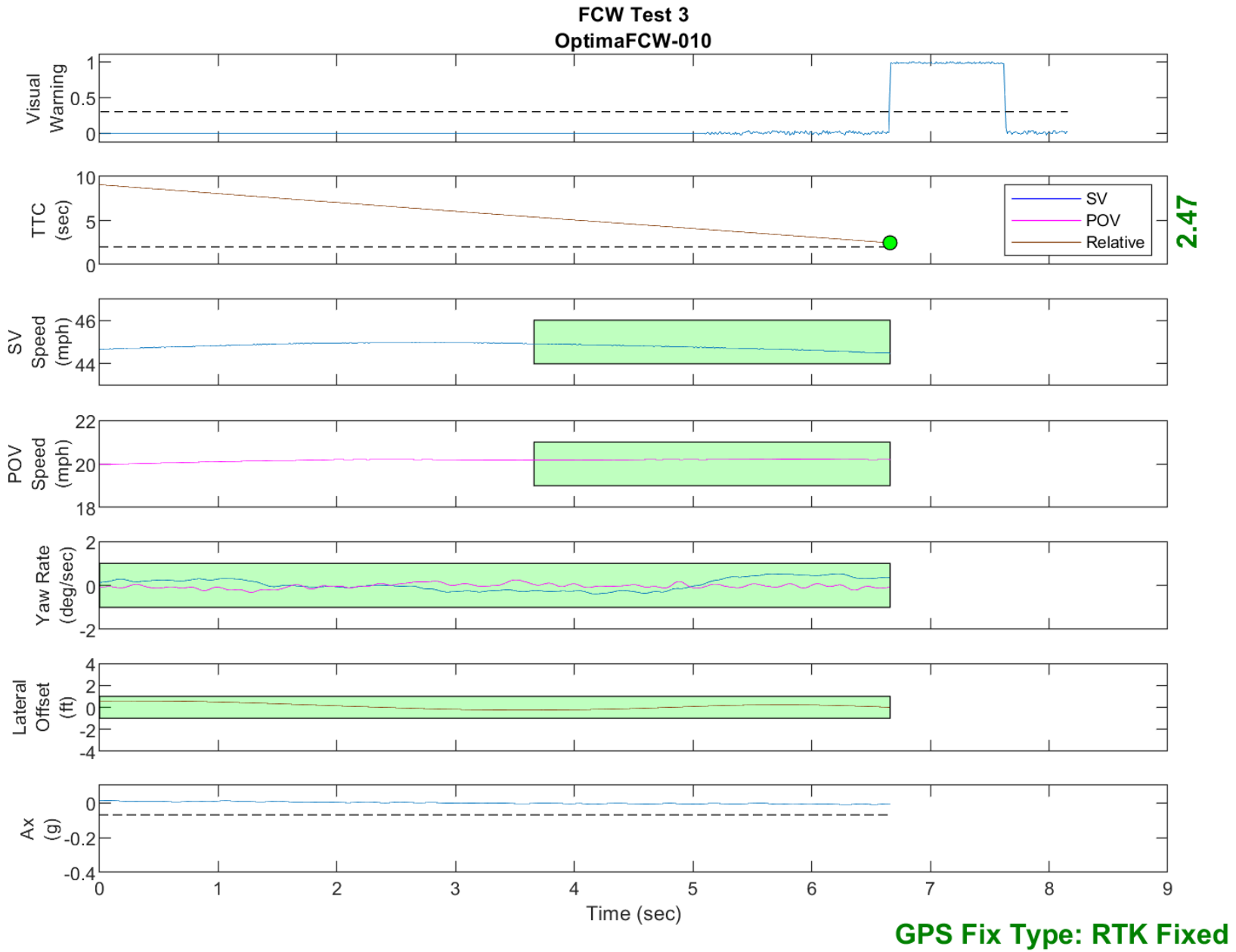


Figure D40. Time History for Run 10, FCW Test 3, Visual Warning

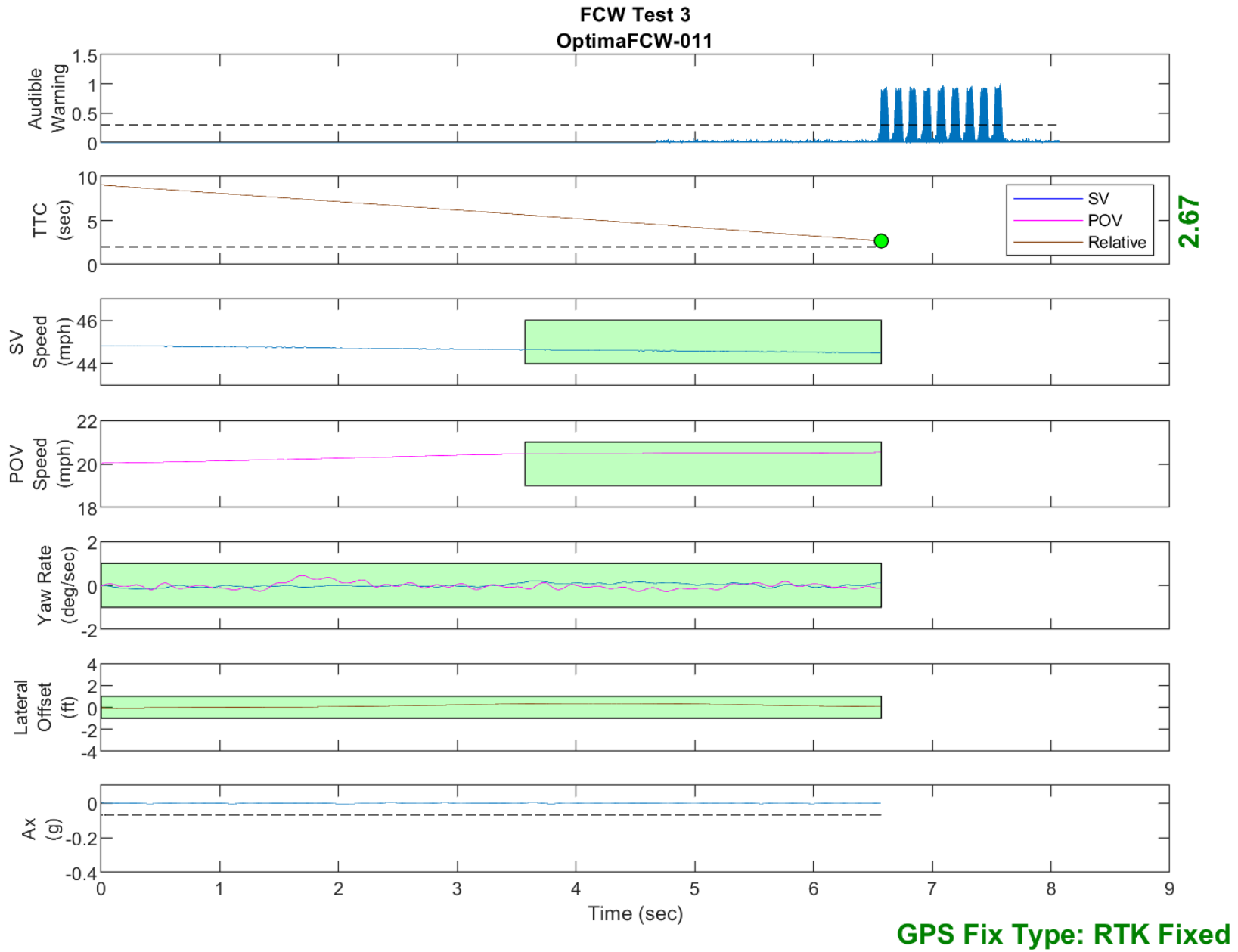


Figure D41. Time History for Run 11, FCW Test 3, Audible Warning

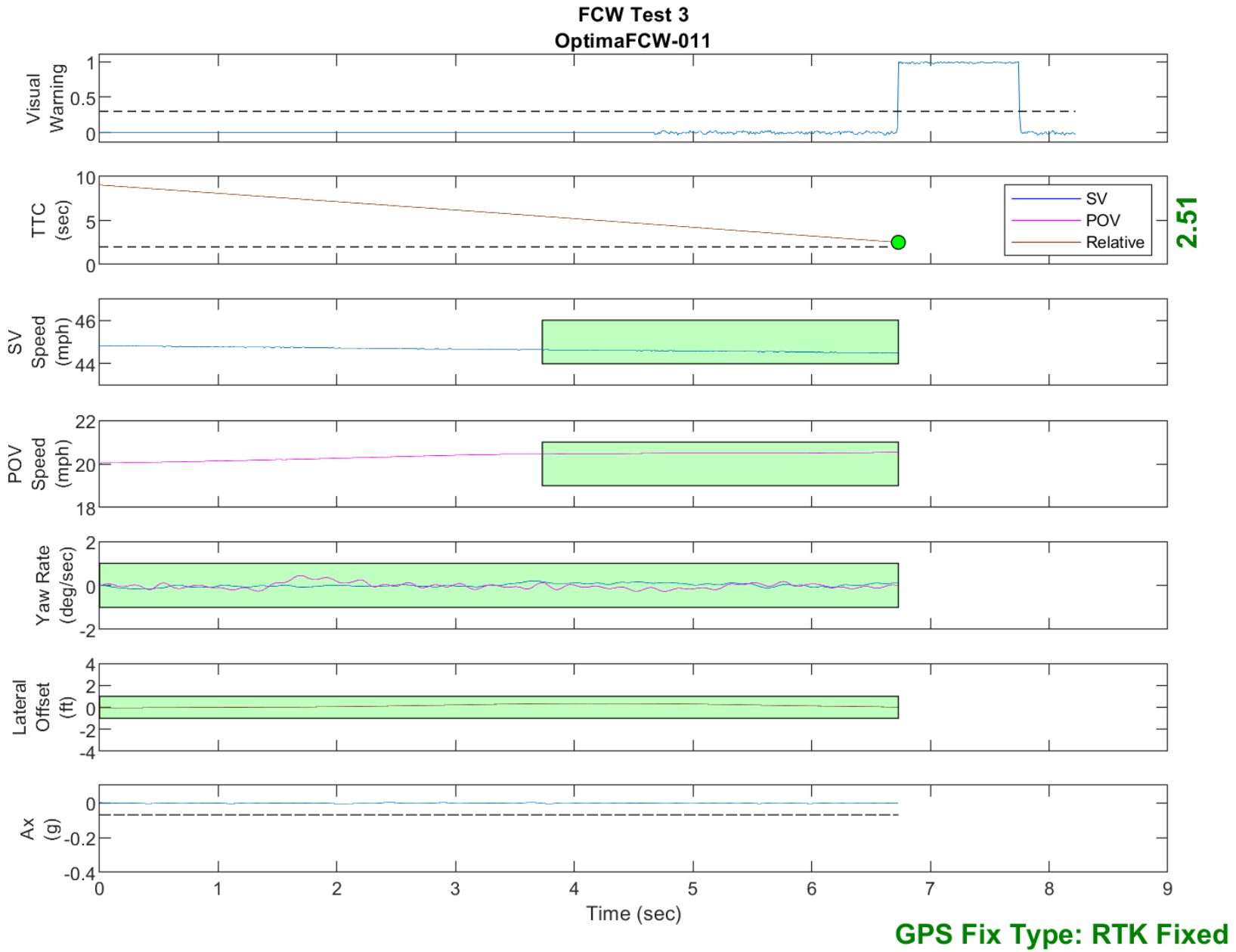


Figure D42. Time History for Run 11, FCW Test 3, Visual Warning

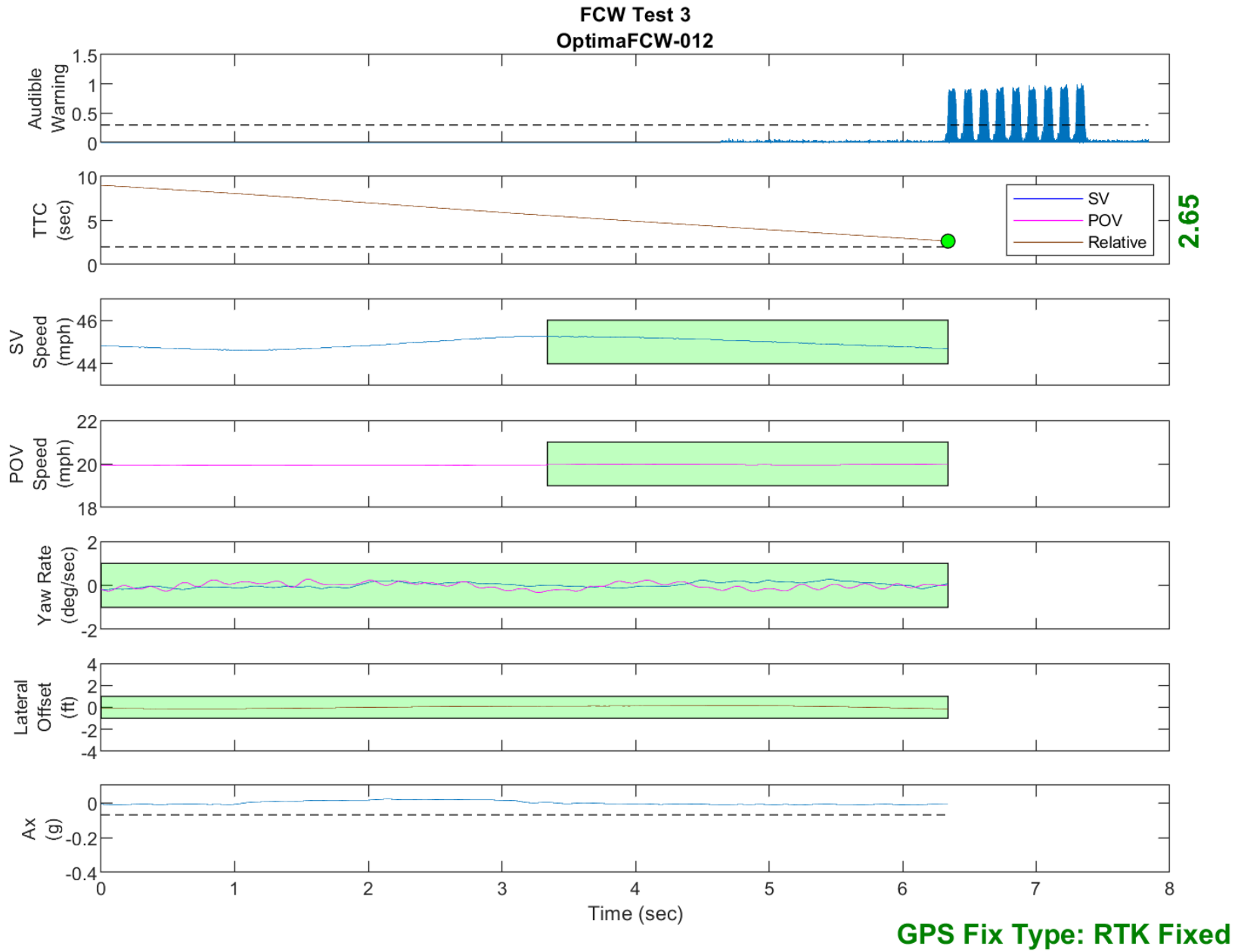


Figure D43. Time History for Run 12, FCW Test 3, Audible Warning

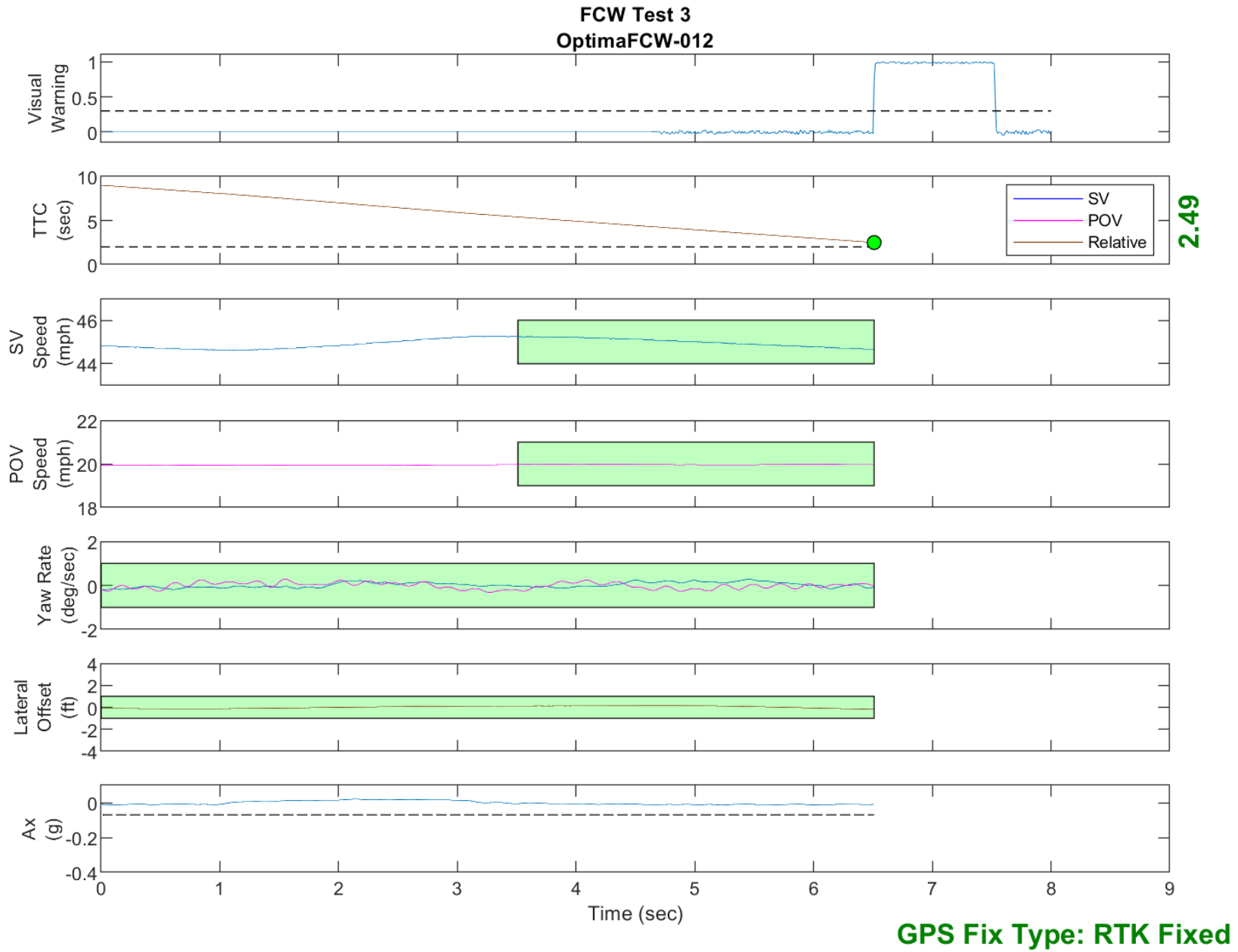


Figure D44. Time History for Run 12, FCW Test 3, Visual Warning

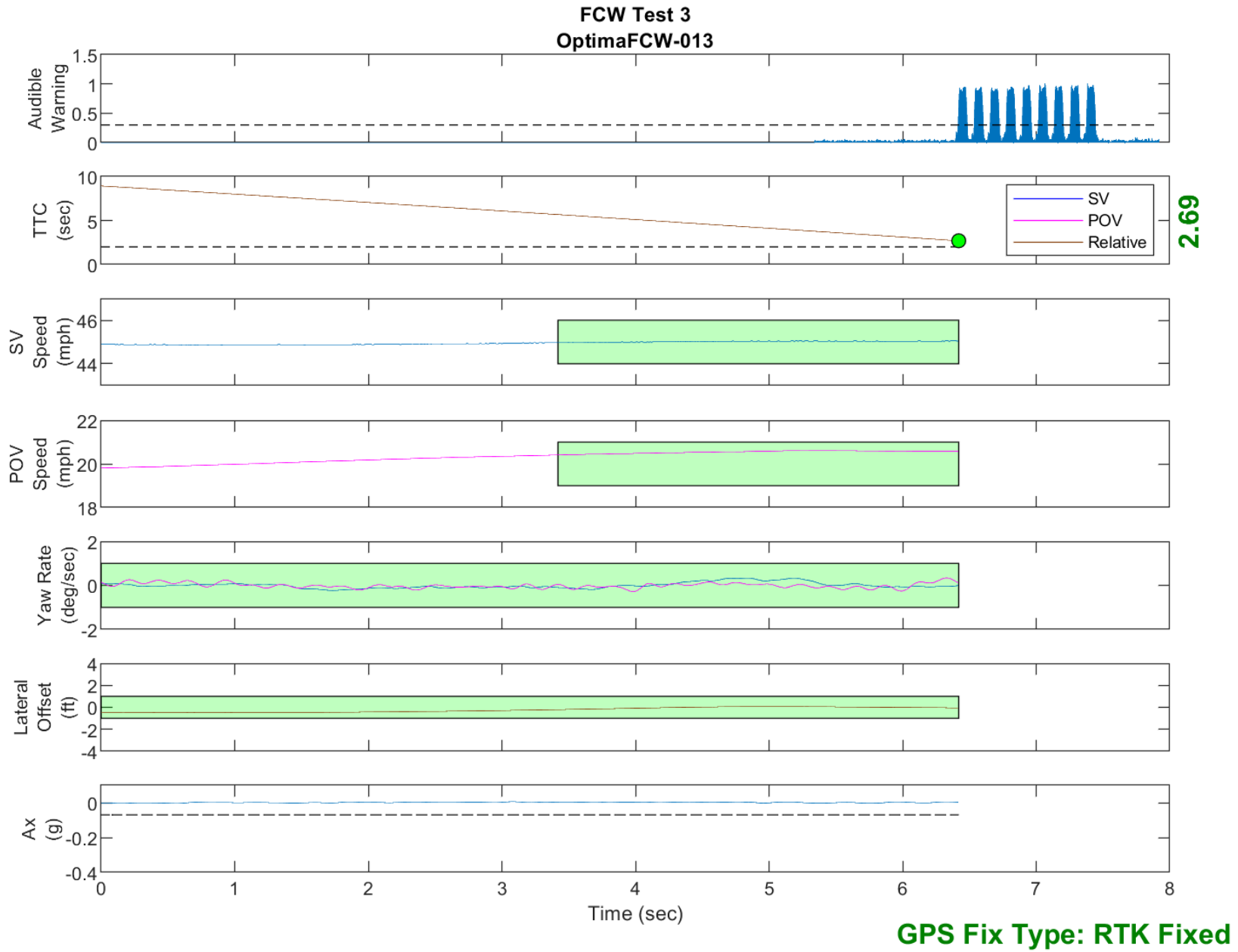


Figure D45. Time History for Run 13, FCW Test 3, Audible Warning

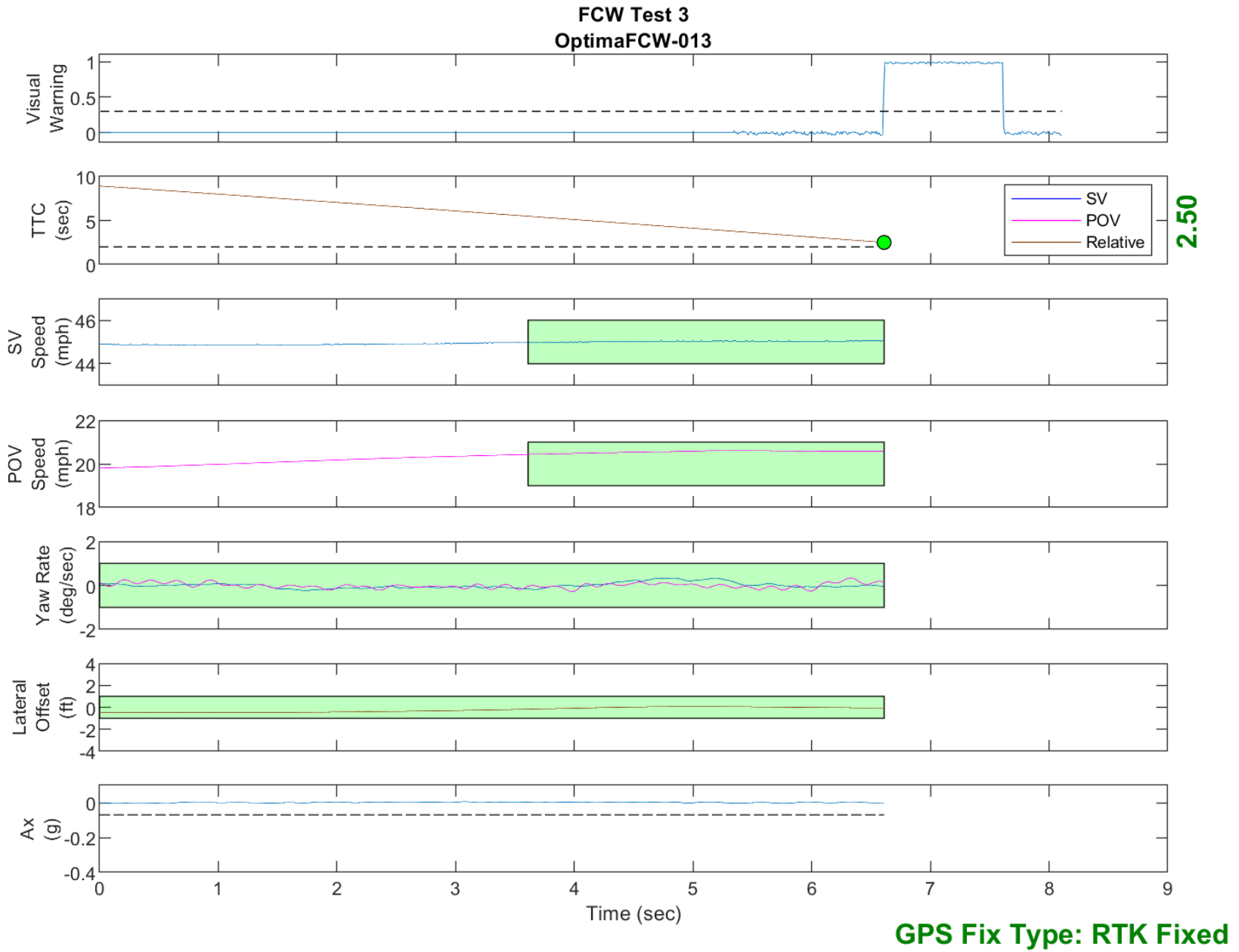


Figure D46. Time History for Run 13, FCW Test 3, Visual Warning

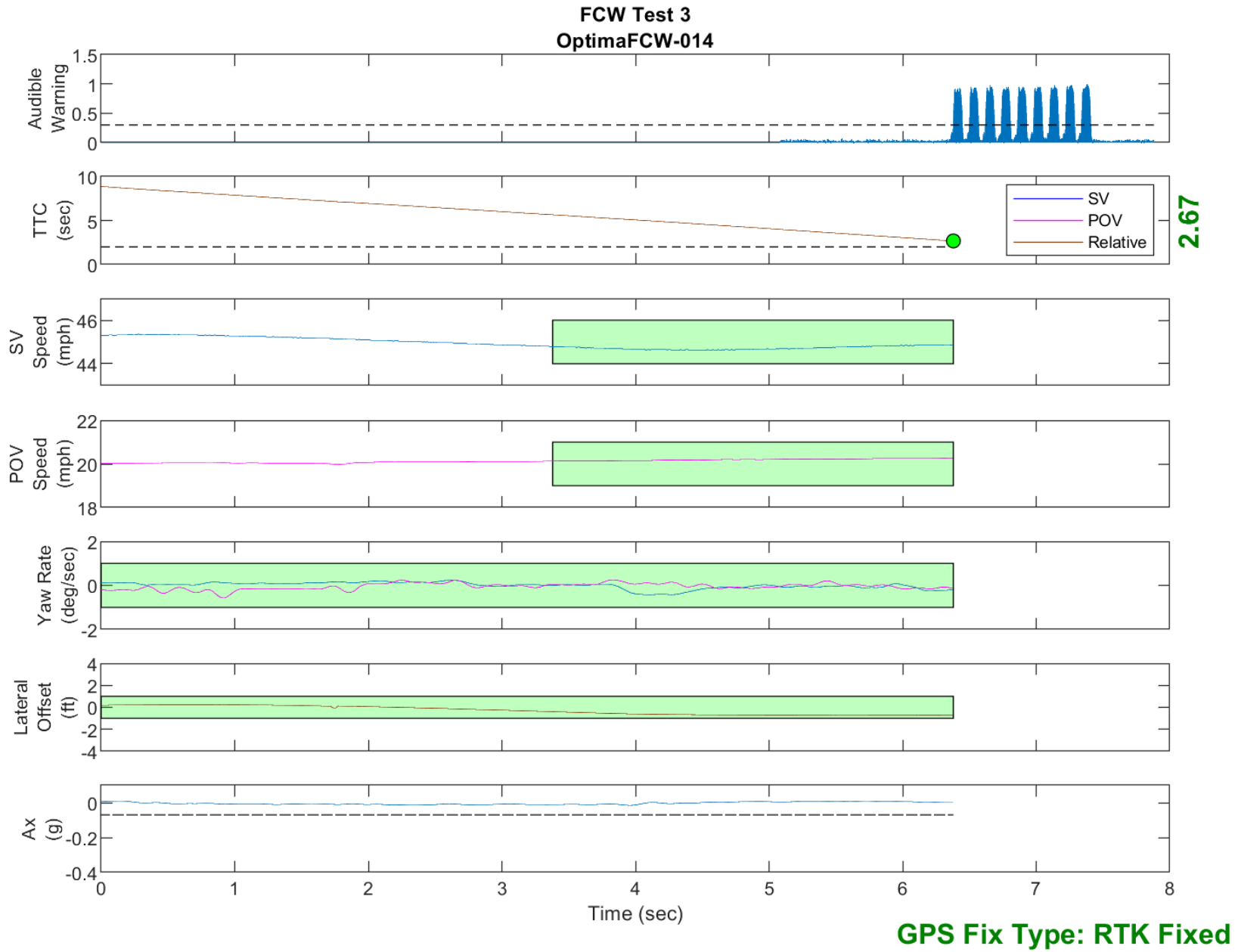


Figure D47. Time History for Run 14, FCW Test 3, Audible Warning

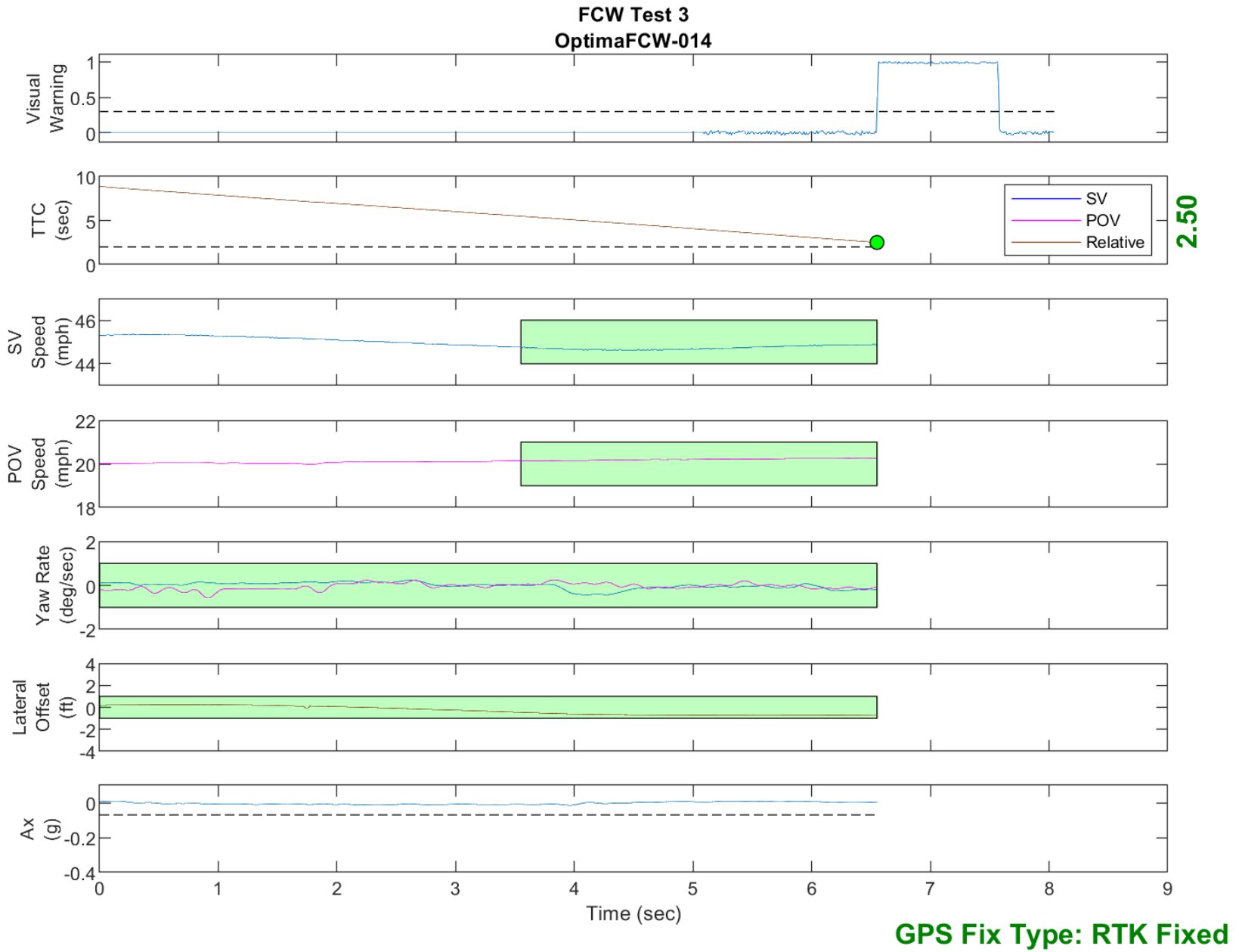


Figure D48. Time History for Run 14, FCW Test 3, Visual Warning