

**NEW CAR ASSESSMENT PROGRAM
FORWARD COLLISION WARNING CONFIRMATION TEST
NCAP-DRI-FCW-21-07**

2021 Kia K5

DYNAMIC RESEARCH, INC.

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11 March 2021

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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16. Abstract These tests were conducted on the subject 2021 Kia K5 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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TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
I. INTRODUCTION	1
II. DATA SHEETS.....	2
Data Sheet 1: Test Results Summary.....	3
Data Sheet 2: Vehicle Data	4
Data Sheet 3: Test Conditions.....	5
Data Sheet 4: Forward Collision Warning System Operation	7
III. TEST PROCEDURES	10
A. Test Procedure Overview	10
B. Principal Other Vehicle	15
C. Automatic Braking System.....	15
D. Instrumentation	15
APPENDIX A Photographs	A-1
APPENDIX B Excerpts from Owner's Manual.....	B-1
APPENDIX C Run Log.....	C-1
APPENDIX D Time Histories.....	D-1

Section I

INTRODUCTION

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

Section II

DATA SHEETS

FORWARD COLLISION WARNING
DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 1)

2021 Kia K5

VIN: 5XXG34J2XMG00xxxx

Test Date: 2/15/2021

Forward Collision Warning setting: Warning Only, timing set to Normal

Test 1 – Subject Vehicle Encounters
Stopped Principal Other Vehicle: **Pass**

Test 2 – Subject Vehicle Encounters
Decelerating Principal Other Vehicle: **Pass**

Test 3 – Subject Vehicle Encounters
Slower Principal Other Vehicle: **Pass**

Overall: **Pass**

Notes:

FORWARD COLLISION WARNING

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2021 Kia K5

TEST VEHICLE INFORMATION

VIN: 5XXG34J2XMG00xxxx

Body Style: Sedan

Color: Ebony Black

Date Received: 2/8/2021

Odometer Reading: 38 mi

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: Kia Motors Manufacturing Georgia, Inc.

Date of manufacture: JUL/14/20

Vehicle Type: Passenger Car

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: 235/45R18

Rear: 235/45R18

Recommended cold tire pressure: Front: 240 kPa (35 psi)

Rear: 240 kPa (35 psi)

TIRES

Tire manufacturer and model: Pirelli P-Zero All Season

Front tire specification: 235/45R18 94V

Rear tire specification: 235/45R18 94V

Front tire DOT prefix: 1UN WB459E

Rear tire DOT prefix: 1UN WB459E

FORWARD COLLISION WARNING
DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2021 Kia K5

GENERAL INFORMATION

Test date: 2/15/2021

AMBIENT CONDITIONS

Air temperature: 13.9 C (57 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: 240 kPa (35 psi)

Rear: 240 kPa (35 psi)

FORWARD COLLISION WARNING
DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2021 Kia K5

WEIGHT

Weight of vehicle as tested including driver and instrumentation:

Left Front: 494.9 kg (1091 lb)

Right Front: 465.4 kg (1026 lb)

Left Rear: 334.8 kg (738 lb)

Right Rear: 332.9 kg (734 lb)

Total: 1628.0 kg (3589 lb)

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 1 of 3)

2021 Kia K5

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

FCA (Forward Collision-Avoidance Assist). This is standard equipment.

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

Sensor fusion (Front camera, front radar). The front camera is located in the top center of the windshield and the front radar is located in the center of the front bumper.

Forward Collision Warning Setting used in test: Warning Only, timing set to Normal

How is the Forward Collision Warning presented to the driver? ☒ Warning light
(Check all that apply) ☒ Buzzer or audible alarm
☐ Vibration
☐ Other _____

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

The visual alert is presented in the instrument panel. It shows a picture of the rear end of a leading vehicle, the words "Collision Warning", or "Emergency Braking" and a picture of an exclamation point within a triangle. See Appendix A, Figure A14.

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 3 of 3)

2021 Kia K5

Are there other driving modes or conditions that render FCW inoperable or reduce its effectiveness?	<u> X </u>	Yes
	<u> </u>	No

If yes, please provide a full description.

System limitations are described in the Owner's Manual on pages 5-84 through 5-90 shown in Appendix B, pages B-13 through B-19.

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.

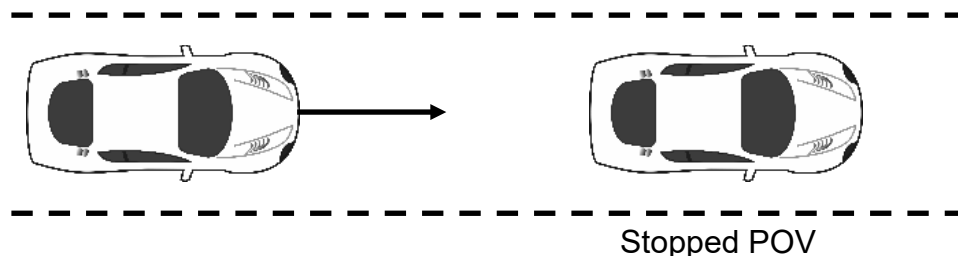


Figure 1. Depiction of Test 1

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.

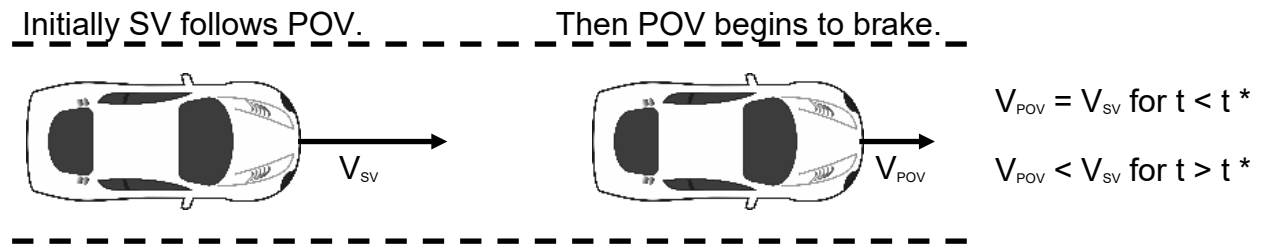


Figure 2. Depiction of Test 2

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 ± 0.03 g, measured at the time the FCW alert first occurred. An initial overshoot beyond the deceleration target was acceptable, however the first local deceleration peak observed during an individual trial could not exceed 0.375 g for more than 50 ms. Additionally, the deceleration could not exceed 0.33 g over a period defined from 500 ms after the first local deceleration peak occurs, to the time when the FCW alert first occurred.
- The tolerance for the headway from the SV to the POV was ± 8.2 ft (± 2.5 m), measured at two instants in time: (1) three seconds prior to the time the POV brake application was initiated and (2) at the time the POV brake application was initiated.
- SV driver could not apply any force to the brake pedal before (1) the required FCW alert occurred or (2) the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.

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

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

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

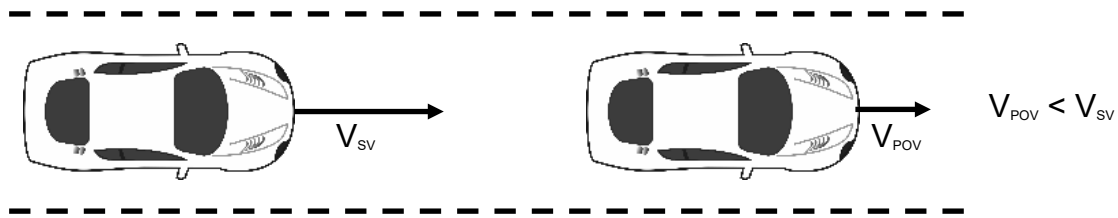


Figure 3. Depiction of Test 3

a. Alert Criteria

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

b. Procedure

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

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

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

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

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

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

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

FCW alert occurred or (2) before the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.

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

B. Principal Other Vehicle

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

C. Automatic Braking System

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

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

D. Instrumentation

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

Table 1. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and 100 psi	Omega DPG8001	17042707002	By: DRI Date: 8/18/2020 Due: 8/18/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 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	N/A
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels $\pm 10g$, 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 +	2182	Date: 9/16/2019 Due: 9/16/2021
				POV:	2258	Date: 5/3/2019 Due: 5/3/2021
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: ± 0.02 m/sec Longitudinal Range: ± 3 cm Longitudinal Range Rate: ± 0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	N/A

Table 1. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at auditory alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	N/A	N/A
Light Sensor	Light intensity (to measure time at visual alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	N/A	N/A
Accelerometer	Acceleration (to measure time at haptic alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	N/A	N/A
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2021 Due: 1/6/2022
Type	Description			Mfr, Model		Serial Number
Data Acquisition System	Data acquisition is achieved using a dSPACE MicroAutoBox II. Data from the Oxford IMU, including Longitudinal, Lateral, and Vertical Acceleration, Roll, Yaw, and Pitch Rate, Forward and Lateral Velocity, Roll and Pitch Angle are sent over Ethernet to the MicroAutoBox. The Oxford IMUs are calibrated per the manufacturer’s recommended schedule (listed above).			dSPACE Micro-Autobox II 1401/1513		
				Base Board		549068
				I/O Board		588523

For systems that implement 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

LIST OF FIGURES

	Page
Figure A1. Front View of Subject Vehicle.....	A-3
Figure A2. Rear View of Subject Vehicle	A-4
Figure A3. Window Sticker (Monroney Label).....	A-5
Figure A4. Vehicle Certification Label	A-6
Figure A5. Tire Placard	A-7
Figure A6. Front View of Principal Other Vehicle	A-8
Figure A7. Rear View of Principal Other Vehicle.....	A-9
Figure A8. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle.....	A-10
Figure A9. Sensors for Detecting Auditory and Visual Alerts	A-11
Figure A10. Computer Installed in Subject Vehicle	A-12
Figure A11. Brake Actuation System Installed in Principal Other Vehicle	A-13
Figure A12. System Setup Menus	A-14
Figure A13. Button for Accessing System Menus	A-15
Figure A14. FCW Visual Alert	A-16



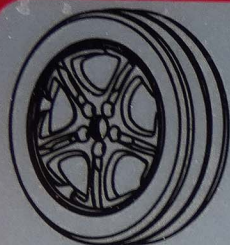
Figure A1. Front View of Subject Vehicle



Figure A2. Rear View of Subject Vehicle



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	235/45R18	240kPa , 35psi
REAR ARRIÈRE	235/45R18	240kPa , 35psi
SPARE DE SECOURS	T125/80D16	420kPa, 60psi

SEE OWNER'S
MANUAL FOR
ADDITIONAL
INFORMATION
VOIR LE MANUEL
DE L'USAGER
POUR PLUS DE
RENSEIGNEMENTS

3500

MO

Figure A5. Tire Placard



Figure A6. Front View of Principal Other Vehicle



Figure A7. Rear View of Principal Other Vehicle



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



Figure A9. Sensors for Detecting Auditory and Visual Alerts



Figure A10. Computer Installed in Subject Vehicle



Figure A11. Brake Actuation System Installed in Principal Other Vehicle



Figure A12. System Setup Menus

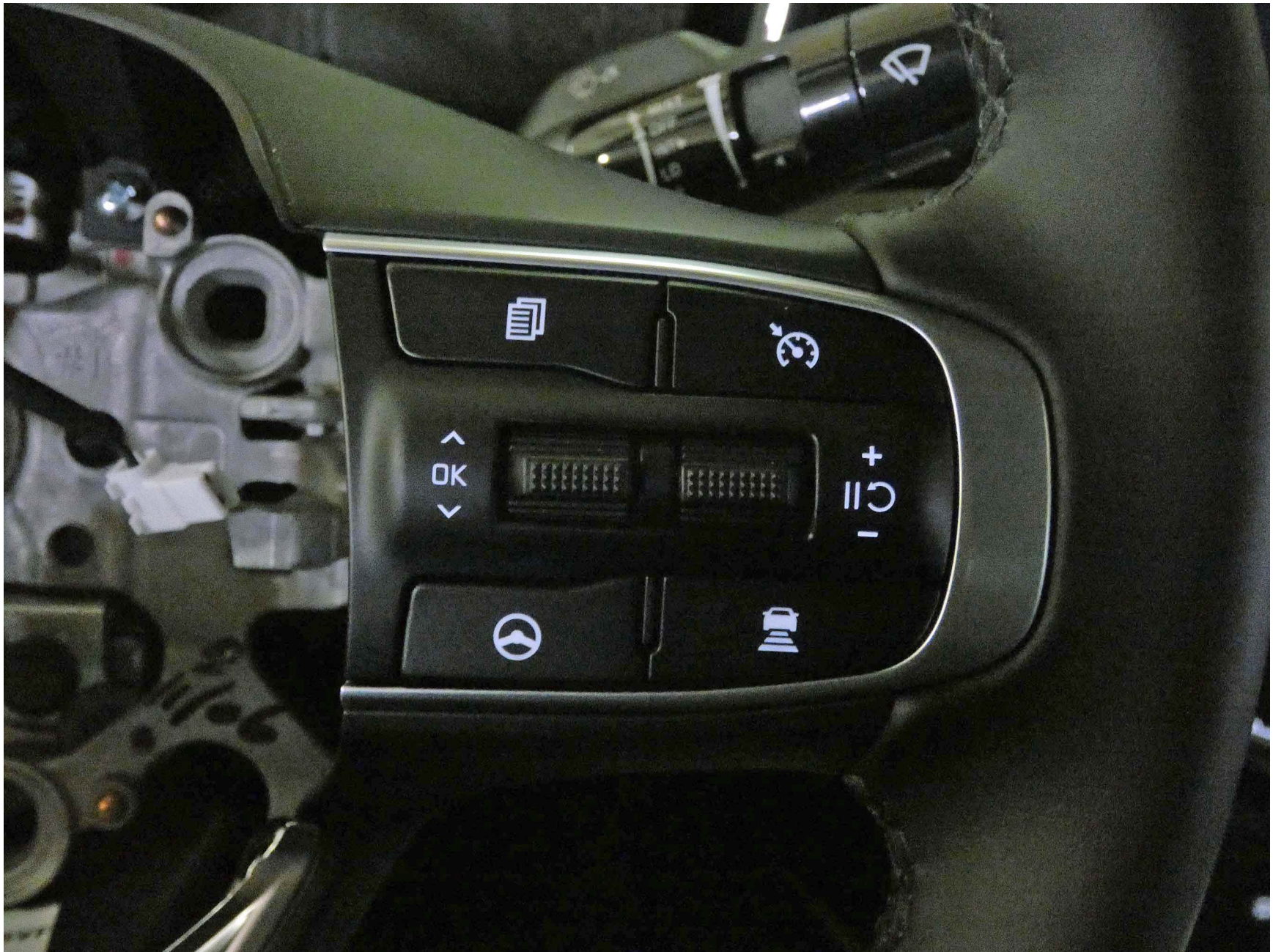


Figure A13. Button for Accessing System Menus

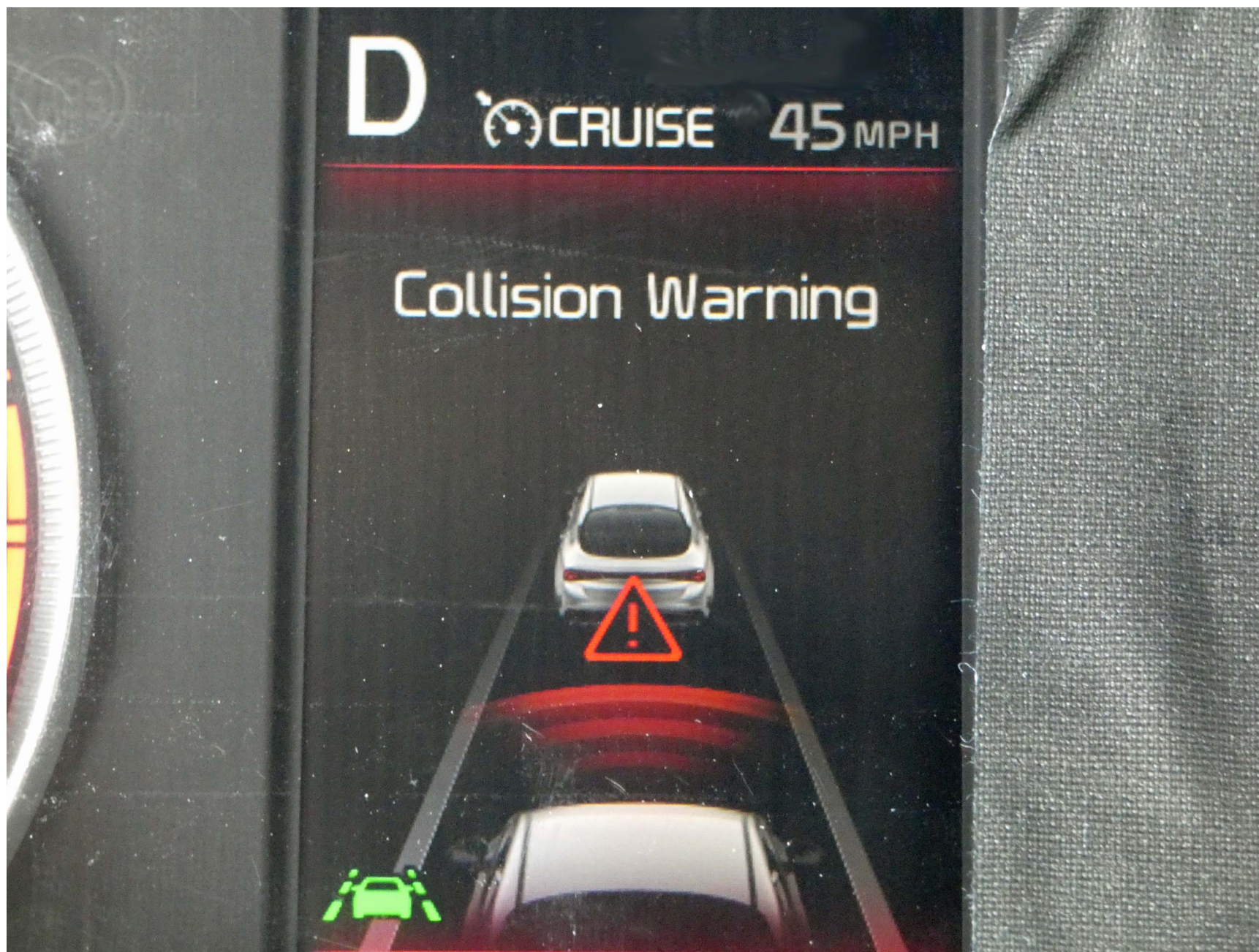


Figure A14. FCW Visual Alert

APPENDIX B



Excerpts from Owner's Manual

LCD display

The LCD display modes can be changed by using the control buttons.







LCD Display Control



1. 「」 : MODE button for changing modes
2. 「」 : MOVE switch for changing items
3. 「OK」 : SELECT/RESET button for setting or resetting the selected item

LCD display modes

The LCD display provides 5 modes. You can switch modes by pressing the Mode button.

	Mode				
	 Trip Computer	 Turn By Turn (TBT)*	 Driving Assist	 User Settings	 Master warning
 Up/Down	Fuel Economy	Route Guidance	SCC*	Head-up display*	The Master Warning mode displays warning messages related to the vehicle when one or more systems is not operating normally.
	Accumulated Info	Destination Info	LKA*	Driver Assistance	
	Drive Info		LFA*	Door	
	Speedometer		DAW*	Lights	
	Transmission Temperature		TPMS*	Sound	
				Convenience	
				Service Interval	
				Other features	
				Language	
				Reset	

The information provided may differ depending on which functions are applicable to your vehicle.

* : if equipped

* NOTICE

Keep the engine running when configuring the display settings to prevent the battery from discharging.

1. Head-Up Display (if equipped)

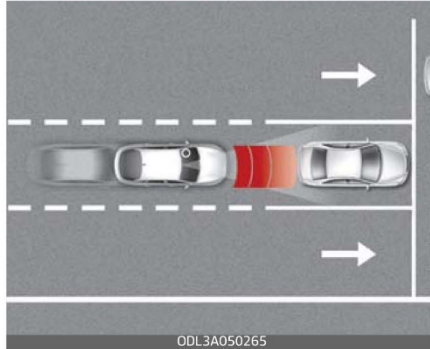
Items	Explanation
Enable Head-up display	If this item is checked, Head-Up Display will be activated.
Display Height	Adjust the height (1~20) of the HUD image on the HUD screen.
Rotation	Adjust the degree (-5~+5) of the HUD rotation.
Brightness	Adjust the intensity (1~20) of the HUD brightness.

2. Driver Assistance (if equipped)

Items	Explanation
Warning Timing	<ul style="list-style-type: none"> • Normal/Late To select the Warning time
Warning Volume	<ul style="list-style-type: none"> • High/Medium/Low To select the Warning volume
Driver Attention Warning	<ul style="list-style-type: none"> • Inattentive Driving Warning To select the function. * For more details, refer to the "Driver Attention Warning (DAW) (if equipped)" on page 5-114.
Forward Safety	To adjust Forward Collision-Avoidance Assist system. <ul style="list-style-type: none"> • Active Assist/Warning Only/Off To select the functions.
Lane Safety	To adjust Lane Keeping Assist system. <ul style="list-style-type: none"> • Lane Keeping Assist/Lane Departure Warning/Off To select the functions.
Blind-Spot Safety	<ul style="list-style-type: none"> • Blind-Spot View To activate or deactivate Blind-Spot View. <ul style="list-style-type: none"> • Safe Exit Assist To activate or deactivate Safe Exit Assist. For more details, refer to "Safe Exit Assist (SEA) (if equipped)" on page 5-109. <ul style="list-style-type: none"> • Active assist • Warning only • Off For more details, refer to "Blind-Spot Collision-Avoidance Assist (BCA) (if equipped)" on page 5-97.

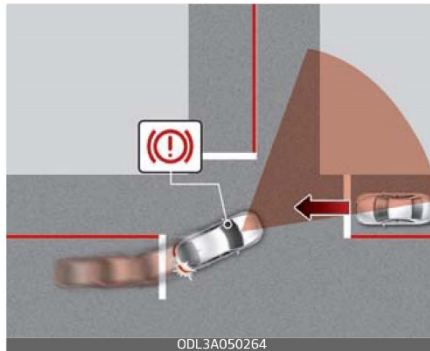
Forward Collision–Avoidance Assist (FCA) – sensor fusion (if equipped)

Basic function



Forward Collision–Avoidance Assist is designed to help detect and monitor the vehicle ahead or help detect a pedestrian or cyclist in the roadway and warn the driver that a collision is imminent with a warning message and an audible warning, and if necessary, apply emergency braking.

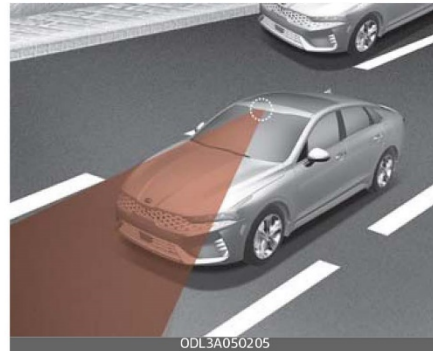
Junction Turning function



Junction Turning function will help avoid a collision with an oncoming vehicle in an adjacent lane when turning left at a crossroad with the turn signal on by applying emergency braking.

Detecting sensor

Front view camera



Front radar



Refer to the picture above for the detailed location of the detecting sensors.

⚠ CAUTION

Take the following precautions to maintain optimal performance of the detecting sensor:

- Never disassemble the detecting sensor or sensor assembly, or apply any impact on it.
- Never install any accessories or stickers on the front windshield, or tint the front windshield.
- If the detecting sensors have been replaced or repaired, have your vehicle inspected by an authorized Kia dealer/service partner.
- Pay extreme caution to keep the front view camera dry.
- Never place any reflective objects (i.e. white paper, mirror) over the dashboard. Any light reflection may prevent the system from functioning properly.
- Do not apply license plate frame or objects, such as a bumper sticker, film or a bumper guard, near the front radar cover.
- Always keep the front radar and cover clean and free of dirt and debris. Use only a soft cloth to wash the vehicle. Do not spray pressurized water directly on the sensor or sensor cover.
- If unnecessary force has been applied to the radar or around the radar, Forward Collision–Avoidance Assist may not properly operate even though a warning


message does not appear on the cluster. We recommend that the vehicle be inspected by an authorized Kia dealer/service partner.


- Use only genuine parts to repair or replace a damaged front radar cover. Do not apply paint to the front radar cover.

System Settings***Setting functions for the system******Forward Safety***

With the ENGINE START/STOP button in the ON position, select or deselect 'Driver Assistance → Forward Safety' from the Settings menu to set whether or not to use each function.

- If 'Active Assist' is selected, the system will warn the driver with a warning message and an audible warning depending on the collision risk levels. Braking assist will be applied depending on the collision risk.
- If 'Warning Only' is selected, the system will warn the driver with a warning message and an audible warning depending on the collision risk levels. Braking will not be assisted.

- If 'Off' is selected, the system will off. The 「」 warning light will illuminate on the cluster.

The driver can monitor Forward Collision-Avoidance Assist ON/OFF status from the Settings menu. If the 「」 warning light remains ON

when the system is ON, we recommend that the system be inspected by an authorized Kia dealer/service partner.


WARNING

When the engine is restarted, Forward Collision-Avoidance Assist will always turn on. However, if 'Off' is selected after the engine is restarted, the driver should always be aware of the surroundings and drive safely.

CAUTION

- If 'Warning Only' is selected, braking is not assisted.
- The settings for Forward Safety include 'Basic function' and 'Junction Turning'.

* NOTICE

Forward Collision-Avoidance Assist will turn off when ESC is turned off by pressing and holding the ESC OFF button. The 「」 warning light will illuminate on the cluster.

Warning Timing

With the ENGINE START/STOP button in the ON position, select 'Driver Assistance → Warning Timing' from the Settings menu to change the initial warning activation time for Forward Collision-Avoidance Assist.

When the vehicle is first delivered, Warning Timing is set to 'Normal'.

If you change the Warning Timing, the warning time of other Driver Assistance systems may change.

Warning Volume

With the ENGINE START/STOP button in the ON position, select 'Driver Assistance → Warning Volume' from the Settings menu to change the Warning Volume to 'High', 'Medium' or 'Low' for Forward Collision-Avoidance Assist.

If you change the warning volume, the Warning Volume of other Driver Assistance systems may change.

⚠ CAUTION

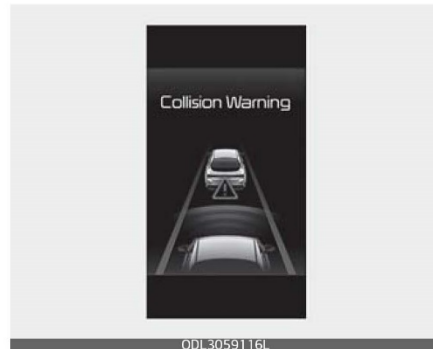
- The setting of the Warning Timing and Warning Volume applies to all functions of Forward Collision-Avoidance Assist.
- Even though 'Normal' is selected for Warning Timing, if the front vehicle suddenly stops, the initial warning activation time may seem late.
- Select 'Late' for Warning Timing when traffic is light and when driving speed is slow.

*** NOTICE**

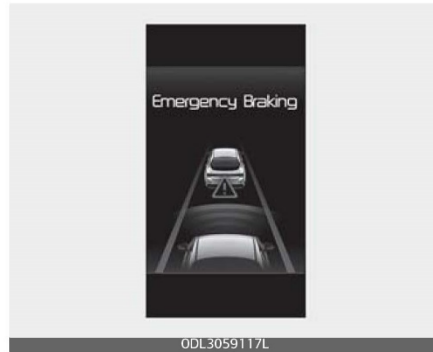
If the engine is restarted, Warning Timing and Warning Volume will maintain the last setting.

System Operation***Basic function******System warning and control***

The basic function for Forward Collision-Avoidance Assist is to warn and control the vehicle depending on the collision level: 'Collision Warning', 'Emergency Braking' and 'Stopping vehicle and ending brake control'.

Collision Warning

- To warn the driver of a collision, the 'Collision Warning' warning message will appear on the cluster, and an audible warning will sound.
- If a vehicle is detected in front, the system will operate when your vehicle speed is between approximately 6~112 mph (10~180 km/h).
- If a pedestrian or cyclist is detected in front, the system will operate when your vehicle speed is between approximately 6~53 mph (10~85 km/h).
- If 'Active Assist' is selected, braking may be assisted.

Emergency Braking

- To warn the driver that emergency braking will be assisted, the 'Emergency Braking' warning message will appear on the cluster, and an audible warning will sound.
- If a vehicle is detected in front, the system will operate when your vehicle speed is between approximately 6~47 mph (10~75 km/h).
- If a pedestrian or cyclist is detected in front, the system will operate when your vehicle speed is between approximately 6~40 mph (10~65 km/h).
- In emergency braking situation, braking is assisted with strong braking power by the system to help prevent collision with the vehicle, pedestrian or cyclist ahead.

Stopping vehicle and ending brake control

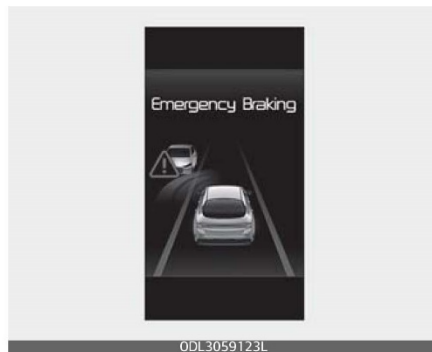
- When the vehicle is stopped due to emergency braking, the 'Drive carefully' warning message will appear on the cluster. For your safety, the driver should depress the brake pedal immediately and check the surroundings.
- Brake control will end after the vehicle is stopped by emergency braking for approximately 2 seconds.

Junction Turning function***System warning and control***

Junction Turning function will warn and control the vehicle depending on the collision level: 'Collision Warning', 'Emergency Braking' and 'Stopping vehicle and ending brake control'.

Collision Warning

- To warn the driver of a collision, the 'Collision Warning' warning message will appear on the cluster, and an audible warning will sound.
- The system will operate when your vehicle speed is between approximately 6~19 mph (10~30 km/h) and the oncoming vehicle speed is between approximately 19~44 mph (30~70 km/h).
- If 'Active Assist' is selected, braking may be assisted.

Emergency Braking

- To warn the driver that emergency braking will be assisted, the 'Emergency Braking' warning message will appear on the cluster, and an audible warning will sound.
- The system will operate when your vehicle speed is between approximately 6~19 mph (10~30 km/h) and the oncoming vehicle speed is between approximately 19~44 mph (30~70 km/h).
- In emergency braking situation, braking is assisted with strong braking power by the system to help prevent collision with the oncoming vehicle.


5

Stopping vehicle and ending brake control

- When the vehicle is stopped due to emergency braking, the 'Drive carefully' warning message will appear on the cluster. For your safety, the driver should depress the brake pedal immediately and check the surroundings.

- Brake control will end after the vehicle is stopped by emergency braking for approximately 2 seconds.

WARNING

- For your safety, change the Settings after parking the vehicle at a safe location.
- With 'Active Assist' or 'Warning Only' selected, when ESC is turned off by pressing and holding the ESC OFF button, Forward Collision-Avoidance Assist will turn off automatically. In this case, the system cannot be set from the Settings menu and the  warning light will illuminate on the cluster which is normal. If ESC is turned on by pressing the ESC OFF button, Forward Collision-Avoidance Assist will maintain the last setting.
- Forward Collision-Avoidance Assist does not operate in all situations or cannot avoid all collisions.
- The driver should hold the responsibility to control the vehicle. Do not solely depend on Forward Collision-Avoidance Assist. Rather, maintain a safe braking distance, and if necessary, depress the brake pedal to reduce driving speed or to stop the vehicle.
- Never deliberately operate Forward Collision-Avoidance Assist on people, animal, objects, etc. It may cause serious injury or death.
- Forward Collision-Avoidance Assist may not operate if the driver depresses the brake pedal to avoid collision.
- Depending on the road and driving conditions, Forward Collision-Avoidance Assist may warn the driver late or may not warn the driver.
- During Forward Collision-Avoidance Assist operation, the vehicle may stop suddenly injuring passengers and shifting loose objects. Always have the seat belt on and keep loose objects secured.
- If any other system's warning message is displayed or audible warning is generated, Forward Collision-Avoidance Assist warning message may not be displayed and audible warning may not be generated.
- You may not hear the warning sound of Forward Collision-Avoidance Assist if the surrounding is noisy.
- Forward Collision-Avoidance Assist may turn off or may not operate properly or may operate unnecessarily depending on the road conditions and the surroundings.

⚠ WARNING

- Even if there is a problem with Forward Collision-Avoidance Assist, the vehicle's basic braking performance will operate normally.
- During emergency braking, braking control by the system will automatically cancel when the driver excessively depresses the accelerator pedal or sharply steers the vehicle.



⚠ CAUTION

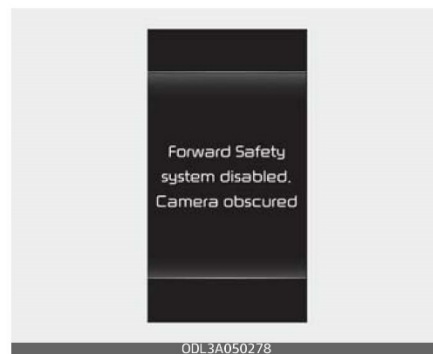
- Depending on the condition of the vehicle, pedestrian and cyclist in front and the surroundings, the speed range to operate Forward Collision-Avoidance Assist may reduce. The system may only warn the driver, or the system may not operate.
- Forward Collision-Avoidance Assist will operate under certain conditions by judging the risk level based on the condition of the oncoming vehicle, driving direction, speed and surroundings.

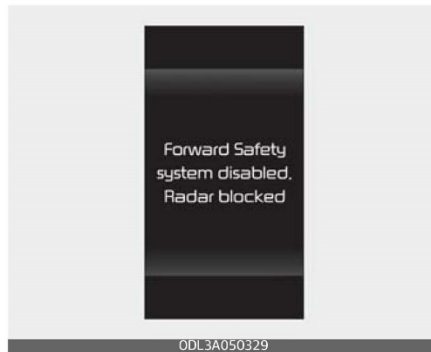
*** NOTICE**

In a situation collision is imminent, braking may be assisted by Forward Collision-Avoidance Assist when braking is insufficient by the driver.

System Malfunction and Limitations***System malfunction***

When Forward Collision-Avoidance Assist is not working properly, the 'Check Forward Safety system' warning message will appear, and the 「」 and 「」 warning lights will illuminate on the cluster. We recommend that the system be inspected by an authorized Kia dealer/service partner.

System disabled



When the front windshield where the front view camera is located, front radar cover, bumper or sensor is covered with foreign material, such as snow or rain, it can reduce the detecting performance and temporarily limit or disable Forward Collision-Avoidance Assist.

If this occurs the 'Forward Safety system disabled. Camera obscured' or the 'Forward Safety system disabled. Radar blocked' warning message, and the 「」 and 「」 warning lights will illuminate on the cluster.

The system will operate normally when snow, rain or foreign matter is removed. Always keep it clean.

If the system does not operate normally after obstruction (snow, rain, or foreign material) is removed, we recommend that the system be inspected by an authorized Kia dealer/service partner.

WARNING

- Even though the warning message or warning light does not appear on the cluster, Forward Collision-Avoidance Assist may not properly operate.
- Forward Collision-Avoidance Assist may not properly operate in an area (e.g. open terrain), where any substance are not detected after turning ON the engine.

Limitations of the system

Forward Collision-Avoidance Assist may not operate normally, or the system may operate unexpectedly under the following circumstances:

- The detecting sensor or the surroundings are contaminated or damaged
- The temperature around the front view camera is high or low
- The camera lens is contaminated due to tinted, filmed or coated windshield, damaged glass, or stuck of foreign material (sticker, bug, etc.) on the glass
- Moisture is not removed or frozen on the windshield
- Washer fluid is continuously sprayed, or the wiper is on
- Driving in heavy rain or snow, or thick fog
- The field of view of the front view camera is obstructed by sun glare

- Street light or light from an oncoming vehicle is reflected on the wet road surface, such as a puddle on the road
- An object is placed on the dashboard
- Your vehicle is being towed
- The surrounding is very bright
- The surrounding is very dark, such as in a tunnel, etc.
- The brightness changes suddenly, for example when entering or exiting a tunnel
- The brightness outside is low, and the headlamps are not on or are not bright
- Driving through steam, smoke or shadow
- Only part of the vehicle, pedestrian or cyclist is detected
- The vehicle in front is a bus, heavy truck, truck with a unusually shaped luggage, trailer, etc.
- The vehicle in front has no tail lights, tail lights are located unusually, etc.
- The brightness outside is low, and the tail lamps are not on or are not bright
- The rear of the front vehicle is small or the vehicle does not look normal, such as when the vehicle is tilted, overturned, or the side of the vehicle is visible, etc.
- The front vehicle's ground clearance is low or high
- A vehicle, pedestrian or cyclist suddenly cuts in front
- The bumper around the front radar is impacted, damaged or the front radar is out of position
- The temperature around the front radar is high or low
- Driving through a tunnel or iron bridge
- Driving in large areas where there are few vehicles or structures (i.e. desert, meadow, suburb, etc.)
- Driving near areas containing metal substances, such as a construction zone, railroad, etc.
- A material is near that reflects very well on the front radar, such as a guardrail, nearby vehicle, etc.
- The cyclist in front is on a bicycle made of material that does not reflect on the front radar
- The vehicle in front is detected late
- The vehicle in front is suddenly blocked by an obstacle
- The vehicle in front suddenly changes lane or suddenly reduces speed
- The vehicle in front is bent out of shape
- The front vehicle's speed is fast or slow
- The vehicle in front steers in the opposite direction of your vehicle to avoid a collision
- With a vehicle in front, your vehicle changes lane at low speed
- The vehicle in front is covered with snow

- You are departing or returning to the lane
- Unstable driving
- You are on a roundabout and the vehicle in front is not detected
- You are continuously driving in a circle
- The vehicle in front has an unusual shape
- The vehicle in front is driving uphill or downhill.
- The pedestrian or cyclist is not fully detected, for example, if the pedestrian is leaning over or is not fully walking upright
- The pedestrian or cyclist is wearing clothing or equipment that makes it difficult to detect as a pedestrian or cyclist

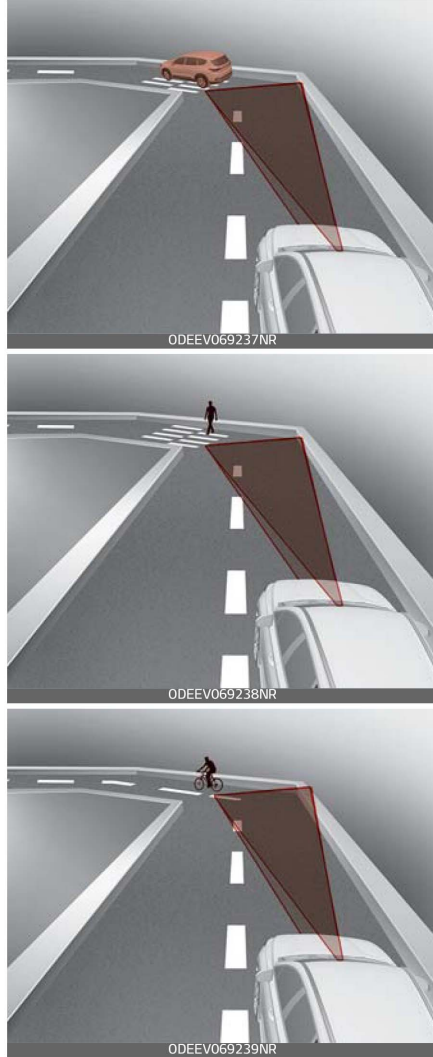
Following image shows the image the sensor recognizes as vehicle, pedestrian, and cyclist.



- The pedestrian or cyclist in front is moving intersected with the driving direction
 - There is a group of pedestrians, cyclists or a large crowd in front
 - The pedestrian or cyclist is wearing clothing that easily blends into the background, making it difficult to detect
 - The pedestrian or cyclist is difficult to distinguish from the similar shaped structure in the surroundings
 - You are driving by a pedestrian, cyclist, traffic signs, structures, etc. near the intersection
 - Driving in a parking lot
 - Driving through a tollgate, construction area, unpaved road, partial paved road, uneven road, speed bumps, etc.
 - Driving on an incline road, curved road, etc.
 - Driving through a roadside with trees or streetlights
 - The adverse road conditions cause excessive vehicle vibrations while driving
 - Your vehicle height is low or high due to heavy loads, abnormal tire pressure, etc.
 - Driving through a narrow road where trees or grass or overgrown
 - There is interference by electromagnetic waves, such as driving in an area with strong radio waves or electrical noise
- The pedestrian or cyclist in front is moving very quickly
 - The pedestrian or cyclist in front is short or is posing a low posture
 - The pedestrian or cyclist in front has impaired mobility

⚠ WARNING

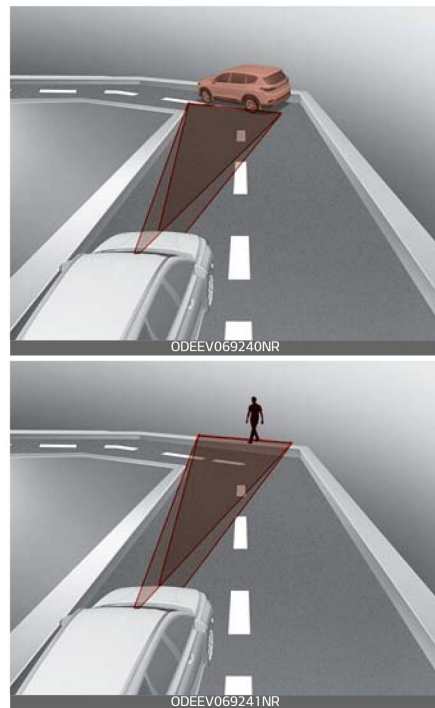
- Driving on a curve



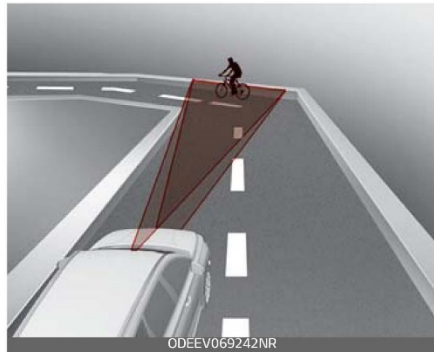
Forward Collision–Avoidance Assist may not detect other vehicles, pedestrians or cyclists in front of you on curved roads

adversely affecting the performance of the sensors. This may result in no warning, braking assist or steering assist when necessary.

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



Driving your vehicle



Forward Collision-Avoidance Assist may detect a vehicle, pedestrian or cyclist in the next lane or outside the lane when driving on a curved road. If this occurs, the system may unnecessarily warn the driver and control the brake or steering wheel. Always check the traffic conditions around the vehicle.

- Driving on a slope



Forward Collision-Avoidance Assist (FCA) – sensor fusion



Forward Collision-Avoidance Assist may not detect other vehicles, pedestrians or cyclists in front of you while driving uphill or downhill adversely affecting the performance of the sensors. This may result in unnecessary warning, braking assist or steering assist or no warning, braking assist or steering assist when necessary.

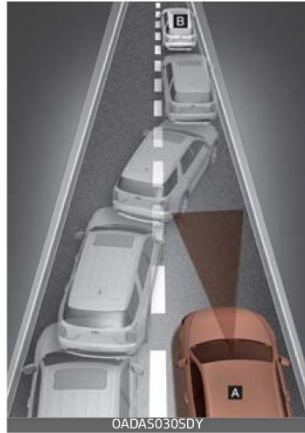
Also, vehicle speed may rapidly decrease when a vehicle, pedestrian or cyclist ahead is suddenly detected.

Always have your eyes on the road while driving uphill or down-

Driving your vehicle

hill and if necessary, steer your vehicle and depress the brake pedal to reduce your driving speed in order to maintain a safe distance.

- Changing lanes



[A]: Your vehicle
[B]: Lane changing vehicle
When a vehicle (B) moves into your lane from an adjacent lane, it cannot be detected by the sensor until it is in the sensor's detection range. Forward Collision-Avoidance Assist may not immediately detect the vehicle when the vehicle changes lanes abruptly. In this case, you must maintain a safe braking distance, and if necessary, steer your vehicle and depress the brake pedal to reduce your driving speed in order to maintain a safe distance.

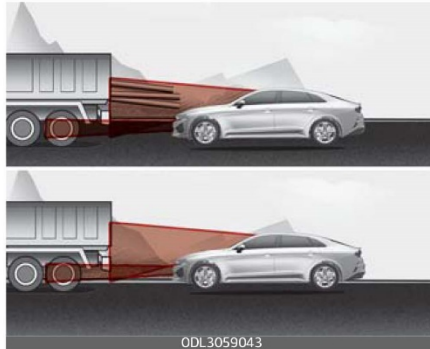
Forward Collision-Avoidance Assist (FCA) – sensor fusion



[A]: Your vehicle
[B]: Lane changing vehicle
[C]: Same lane vehicle
When a vehicle (B) in front of you merges out of the lane, Forward Collision-Avoidance Assist may not immediately detect the vehicle (C) that is now in front of you. In this case, you must maintain a safe braking distance, and if necessary, steer your vehicle and depress the brake pedal to reduce your driving speed in order to maintain a safe distance.

5

- Detecting vehicle



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. Forward Collision–Avoidance Assist 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, steer your vehicle and depress the brake pedal to reduce your driving speed in order to maintain distance.

⚠ WARNING

- When you are towing a trailer or another vehicle, we recommend that Forward Collision–Avoidance Assist is turned off due to safety reasons.
- Forward Collision–Avoidance Assist may operate if objects that are similar in shape or characteristics to vehicles, pedestrians and cyclists are detected.
- Forward Collision–Avoidance Assist does not operate on bicycles, motorcycles, or smaller wheeled objects, such as luggage bags, shopping carts, or strollers that are dragged by a pedestrian or a cyclist.
- Forward Collision–Avoidance Assist may not operate normally if interfered by strong electromagnetic waves.
- Forward Collision–Avoidance Assist may not operate for approximately 15 seconds after the vehicle is started, or the front view camera is initialized.

APPENDIX C

Run Log

Subject Vehicle: **2021 Kia K5**

Test Date: **2/15/2021**

Principal Other Vehicle: **2006 Acura RL**

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
1	Stopped POV	N					Bad light sensor reading
2		Y	2.73	2.56	0.63	Pass	
3		Y	2.71	2.57	0.61	Pass	
4		Y	2.72	2.54	0.62	Pass	
5		Y	2.69	2.56	0.59	Pass	
6		Y	2.72	2.58	0.62	Pass	
7		Y	2.72	2.50	0.62	Pass	
8		Y	2.71	2.57	0.61	Pass	
16	Decelerating POV	N					SV Speed
17		Y	2.57	2.46	0.17	Pass	
18		N					SV Speed
19		Y	2.50	2.41	0.10	Pass	
20		Y	2.54	2.42	0.14	Pass	
21		Y	2.49	2.40	0.09	Pass	
22		N					SV Ax
23		N					SV Speed
24		Y	2.55	2.44	0.15	Pass	
25		Y	2.50	2.30	0.10	Pass	

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
26	Decelerating POV	Y	2.54	2.45	0.14	Pass	
9	Slower POV	Y	2.36	2.23	0.36	Pass	
10		Y	2.32	2.20	0.32	Pass	
11		Y	2.31	2.16	0.31	Pass	
12		Y	2.35	2.23	0.35	Pass	
13		Y	2.31	2.18	0.31	Pass	
14		Y	2.35	2.15	0.35	Pass	
15		Y	2.38	2.22	0.38	Pass	

APPENDIX D

Time History Plots

LIST OF FIGURES

	Page
Figure D1. Example Time History for Test Type 1, Passing.....	D-8
Figure D2. Example Time History for Test Type 1, Failing.....	D-9
Figure D3. Example Time History for Test Type 2, Passing.....	D-10
Figure D4. Example Time History for Test Type 2, Failing.....	D-11
Figure D5. Example Time History for Test Type 3, Passing.....	D-12
Figure D6. Example Time History Showing Invalid Lateral Offset Criteria.....	D-13
Figure D7. Time History for Run 2, FCW Test 1, Audible Warning	D-14
Figure D8. Time History for Run 2, FCW Test 1, Visual Warning.....	D-15
Figure D9. Time History for Run 3, FCW Test 1, Audible Warning	D-16
Figure D10. Time History for Run 3, FCW Test 1, Visual Warning.....	D-17
Figure D11. Time History for Run 4, FCW Test 1, Audible Warning	D-18
Figure D12. Time History for Run 4, FCW Test 1, Visual Warning.....	D-19
Figure D13. Time History for Run 5, FCW Test 1, Audible Warning	D-20
Figure D14. Time History for Run 5, FCW Test 1, Visual Warning.....	D-21
Figure D15. Time History for Run 6, FCW Test 1, Audible Warning	D-22
Figure D16. Time History for Run 6, FCW Test 1, Visual Warning.....	D-23
Figure D17. Time History for Run 7, FCW Test 1, Audible Warning	D-24
Figure D18. Time History for Run 7, FCW Test 1, Visual Warning.....	D-25
Figure D19. Time History for Run 8, FCW Test 1, Audible Warning	D-26
Figure D20. Time History for Run 8, FCW Test 1, Visual Warning.....	D-27
Figure D21. Time History for Run 17, FCW Test 2, Audible Warning.....	D-28
Figure D22. Time History for Run 17, FCW Test 2, Visual Warning.....	D-29
Figure D23. Time History for Run 19, FCW Test 2, Audible Warning.....	D-30
Figure D24. Time History for Run 19, FCW Test 2, Visual Warning.....	D-31
Figure D25. Time History for Run 20, FCW Test 2, Audible Warning.....	D-32
Figure D26. Time History for Run 20, FCW Test 2, Visual Warning.....	D-33
Figure D27. Time History for Run 21, FCW Test 2, Audible Warning.....	D-34
Figure D28. Time History for Run 21, FCW Test 2, Visual Warning.....	D-35
Figure D29. Time History for Run 24, FCW Test 2, Audible Warning.....	D-36
Figure D30. Time History for Run 24, FCW Test 2, Visual Warning.....	D-37
Figure D31. Time History for Run 25, FCW Test 2, Audible Warning.....	D-38
Figure D32. Time History for Run 25, FCW Test 2, Visual Warning.....	D-39
Figure D33. Time History for Run 26, FCW Test 2, Audible Warning.....	D-40
Figure D34. Time History for Run 26, FCW Test 2, Visual Warning.....	D-41
Figure D35. Time History for Run 9, FCW Test 3, Audible Warning	D-42
Figure D36. Time History for Run 9, FCW Test 3, Visual Warning.....	D-43
Figure D37. Time History for Run 10, FCW Test 3, Audible Warning.....	D-44
Figure D38. Time History for Run 10, FCW Test 3, Visual Warning.....	D-45
Figure D39. Time History for Run 11, FCW Test 3, Audible Warning.....	D-46
Figure D40. Time History for Run 11, FCW Test 3, Visual Warning.....	D-47
Figure D41. Time History for Run 12, FCW Test 3, Audible Warning.....	D-48

Figure D42. Time History for Run 12, FCW Test 3, Visual Warning.....	D-49
Figure D43. Time History for Run 13, FCW Test 3, Audible Warning.....	D-50
Figure D44. Time History for Run 13, FCW Test 3, Visual Warning.....	D-51
Figure D45. Time History for Run 14, FCW Test 3, Audible Warning.....	D-52
Figure D46. Time History for Run 14, FCW Test 3, Visual Warning.....	D-53
Figure D47. Time History for Run 15, FCW Test 3, Audible Warning.....	D-54
Figure D48. Time History for Run 15, FCW Test 3, Visual Warning.....	D-55

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)

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
 1. Time-varying data
 2. Validation envelopes and thresholds
 3. Instantaneous samplings
 4. Text
1. Time-varying data color codes:
 - Blue = Subject Vehicle data
 - Magenta = Principal Other Vehicle data
 - Brown = Relative data between SV and POV (i.e., TTC, lateral offset and headway distance)
2. Validation envelope and threshold color codes:
 - Green envelope = time varying data must be within the envelope at all times in order to be valid
 - Yellow envelope = time varying data must be within limits at left and/or right ends
 - Black threshold (Solid) = time varying data must not exceed this threshold in order to be valid
 - Black threshold (Dashed) = for reference only – this can include warning level thresholds, TTC thresholds, and acceleration thresholds
3. Instantaneous sampling color codes:
 - Green circle = passing or valid value at a given moment in time
 - Red asterisk = failing or invalid value at a given moment in time
4. Text color codes:
 - Green = passing or valid value
 - Red = failing or invalid value

Other Notations

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

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

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

Notes

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

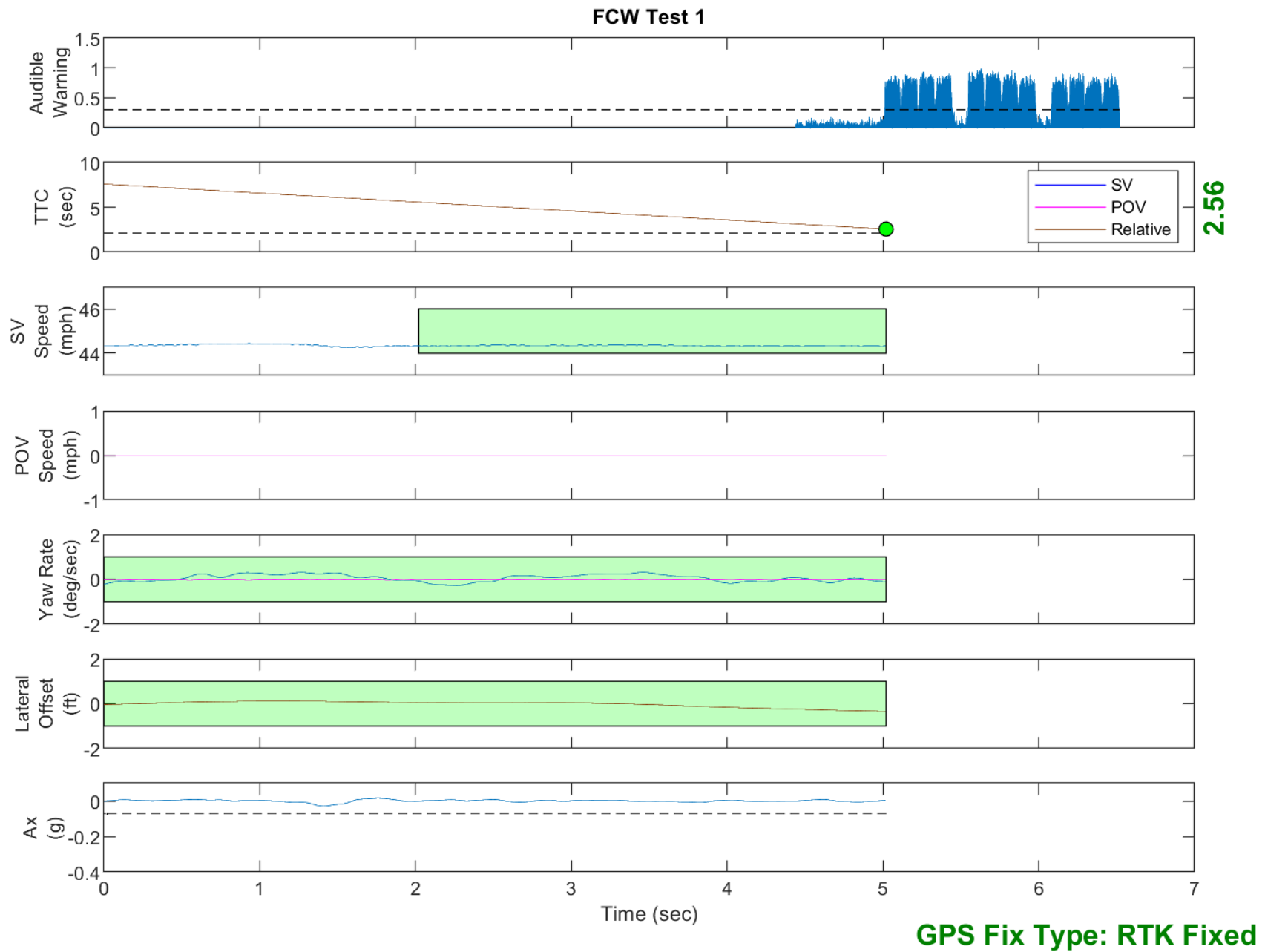


Figure D1. Example Time History for Test Type 1, Passing

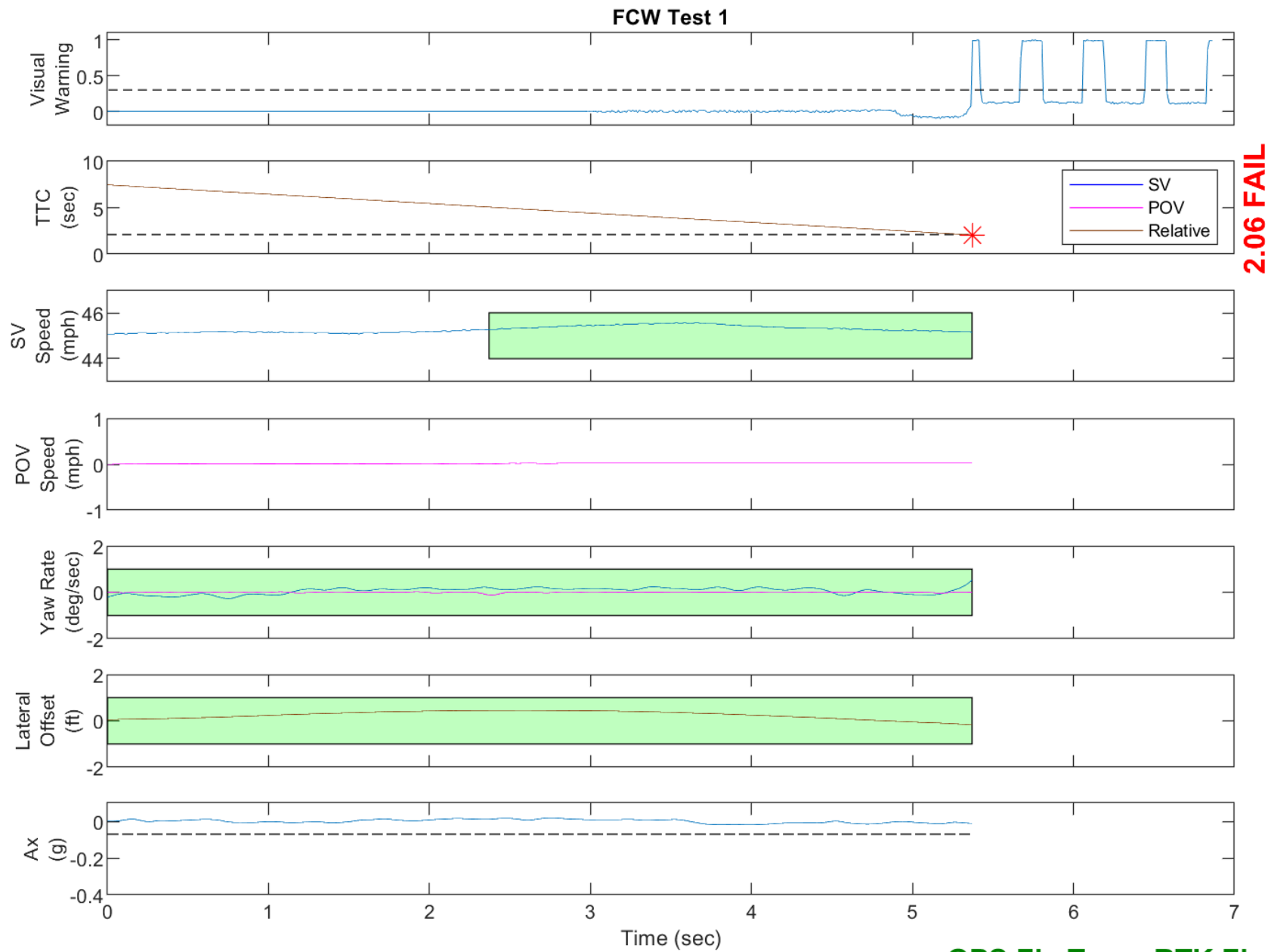
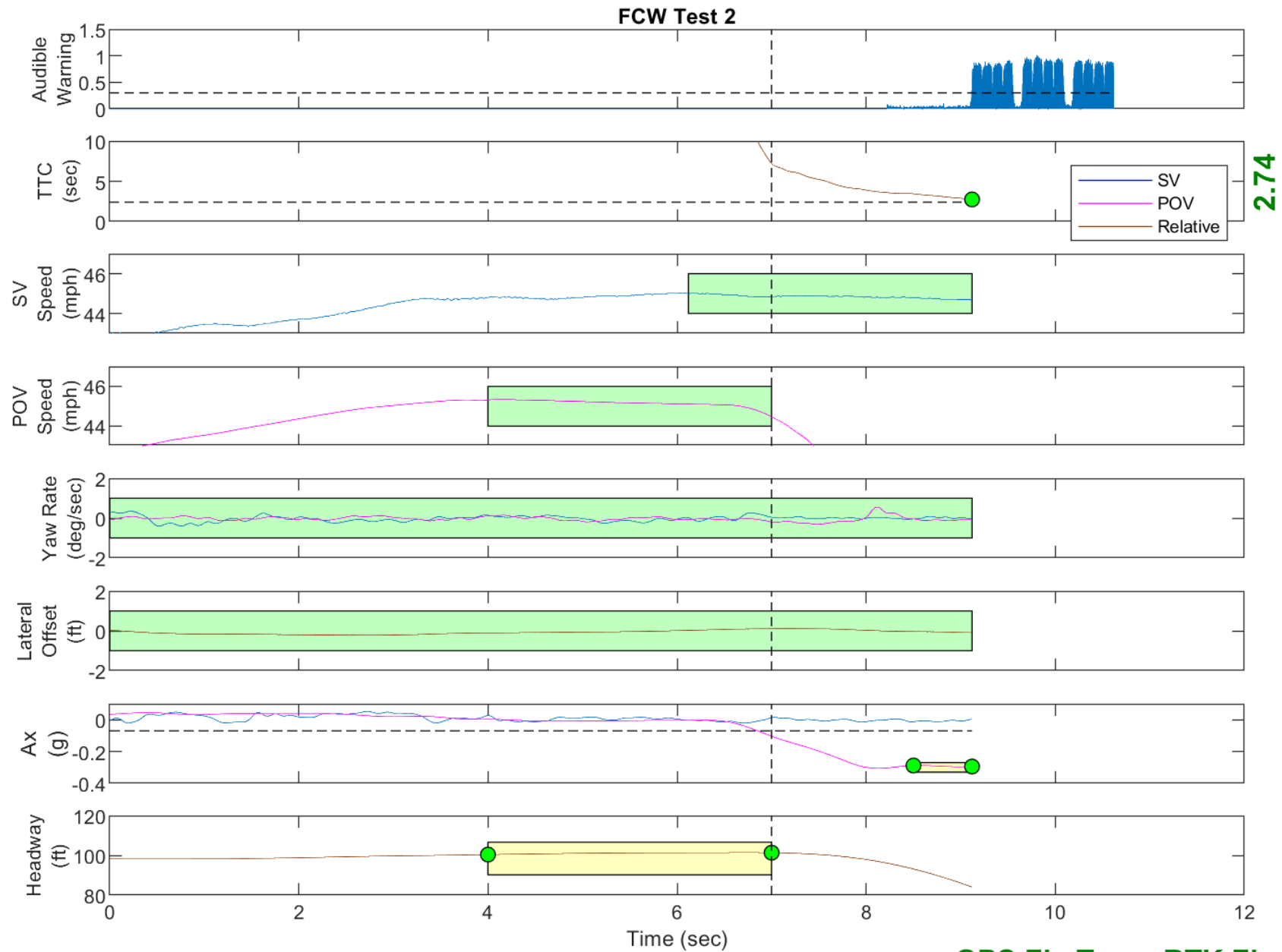
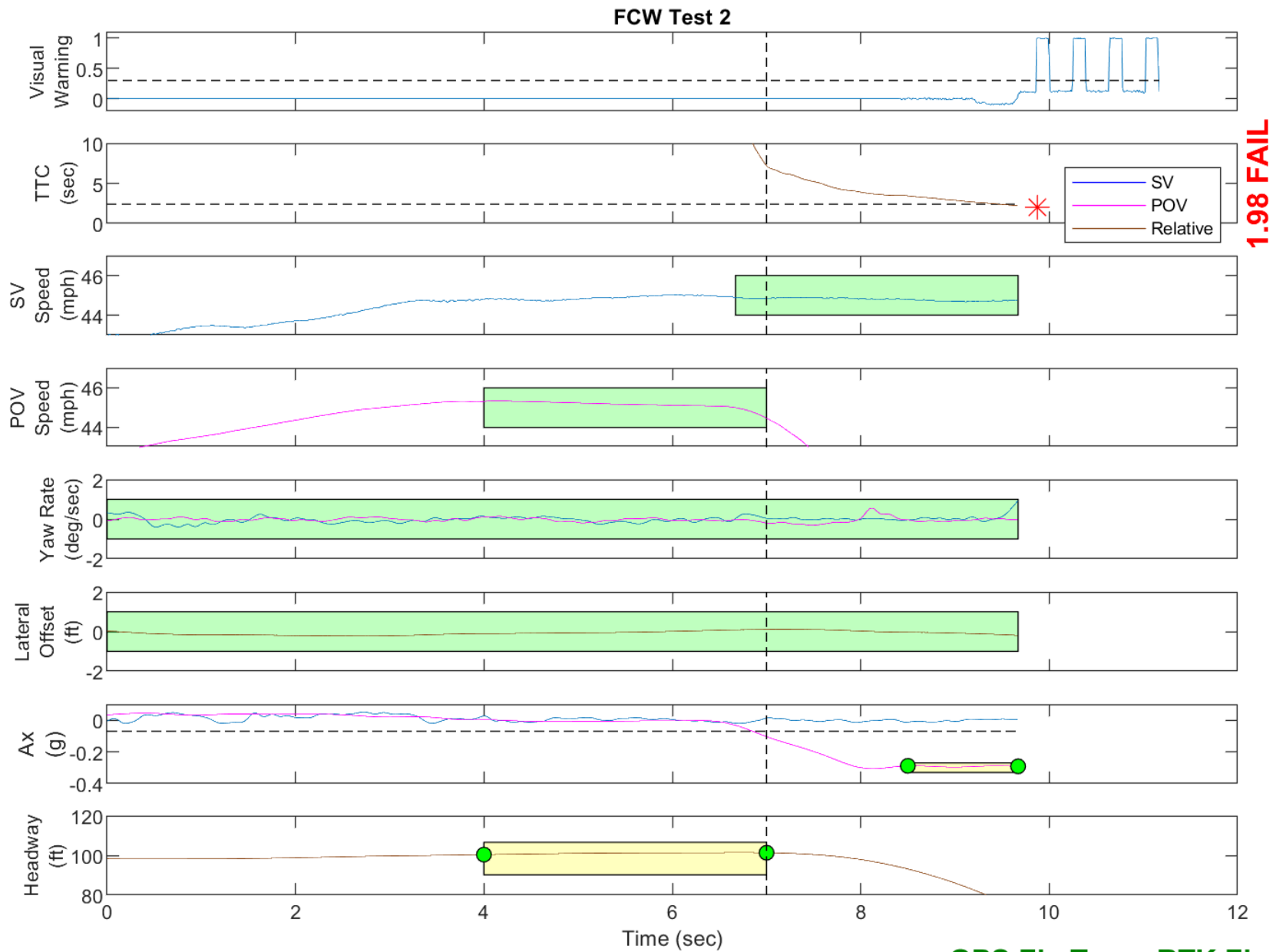


Figure D2. Example Time History for Test Type 1, Failing



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

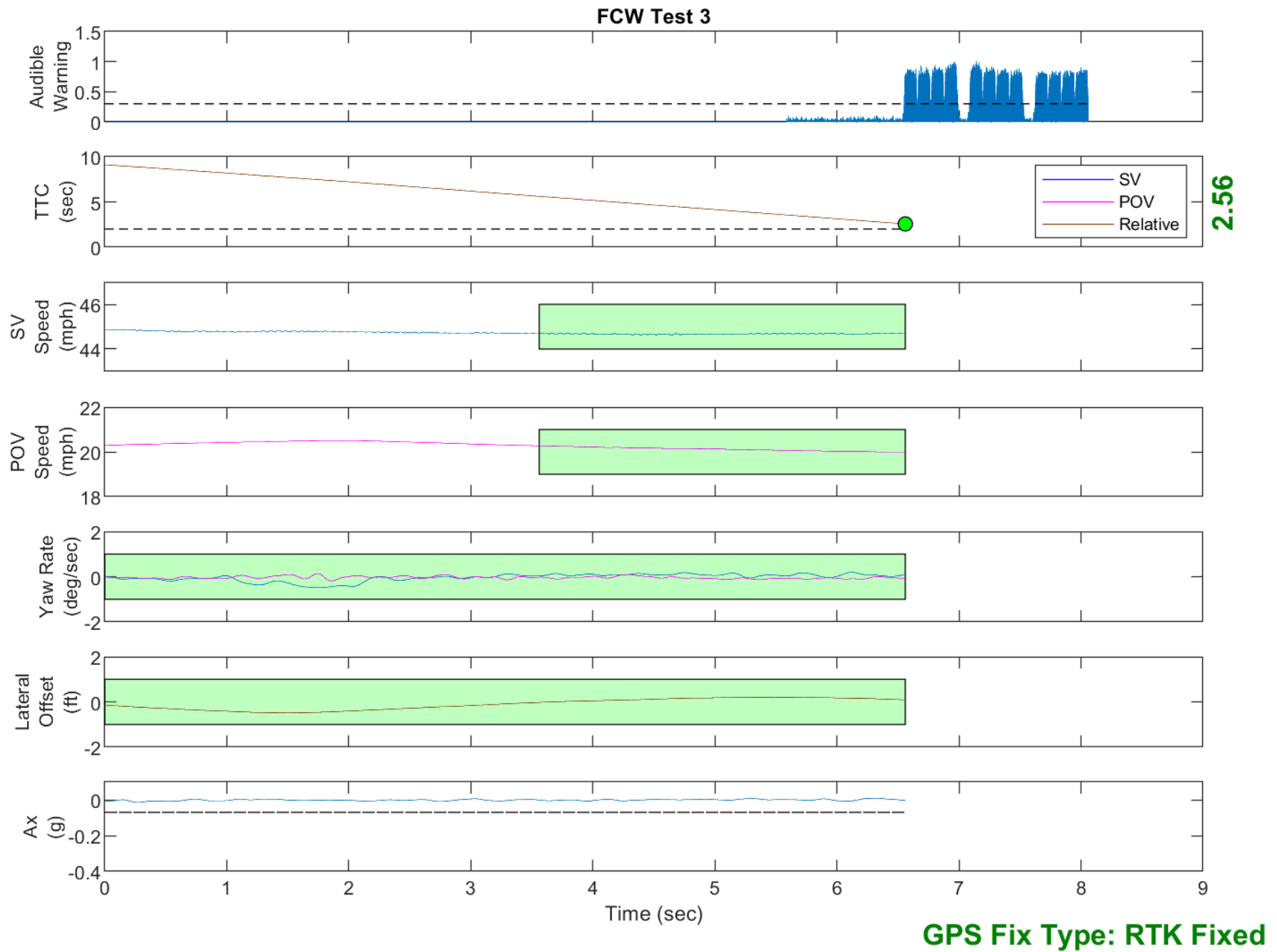


Figure D5. Example Time History for Test Type 3, Passing

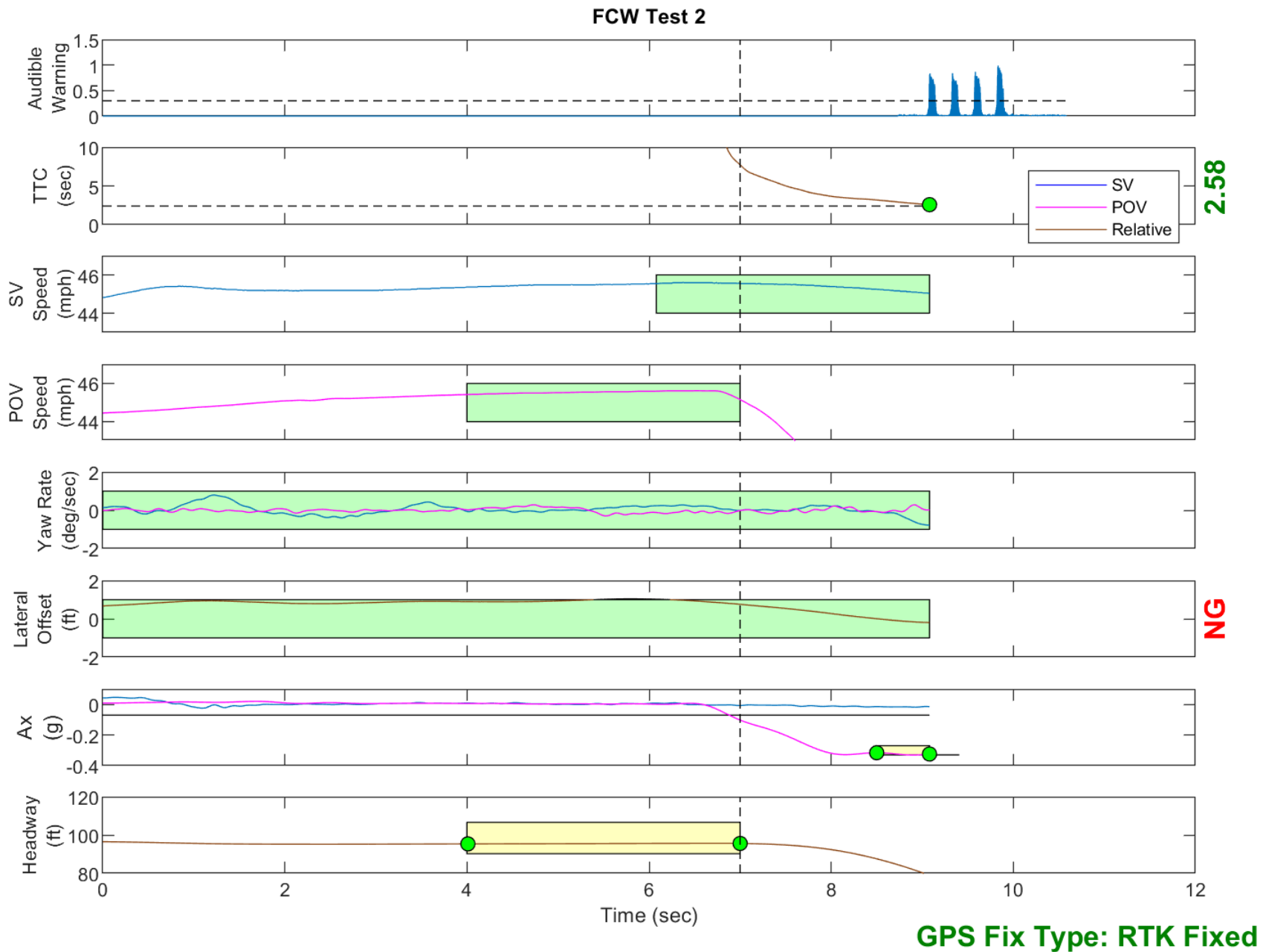


Figure D6. Example Time History Showing Invalid Lateral Offset Criteria

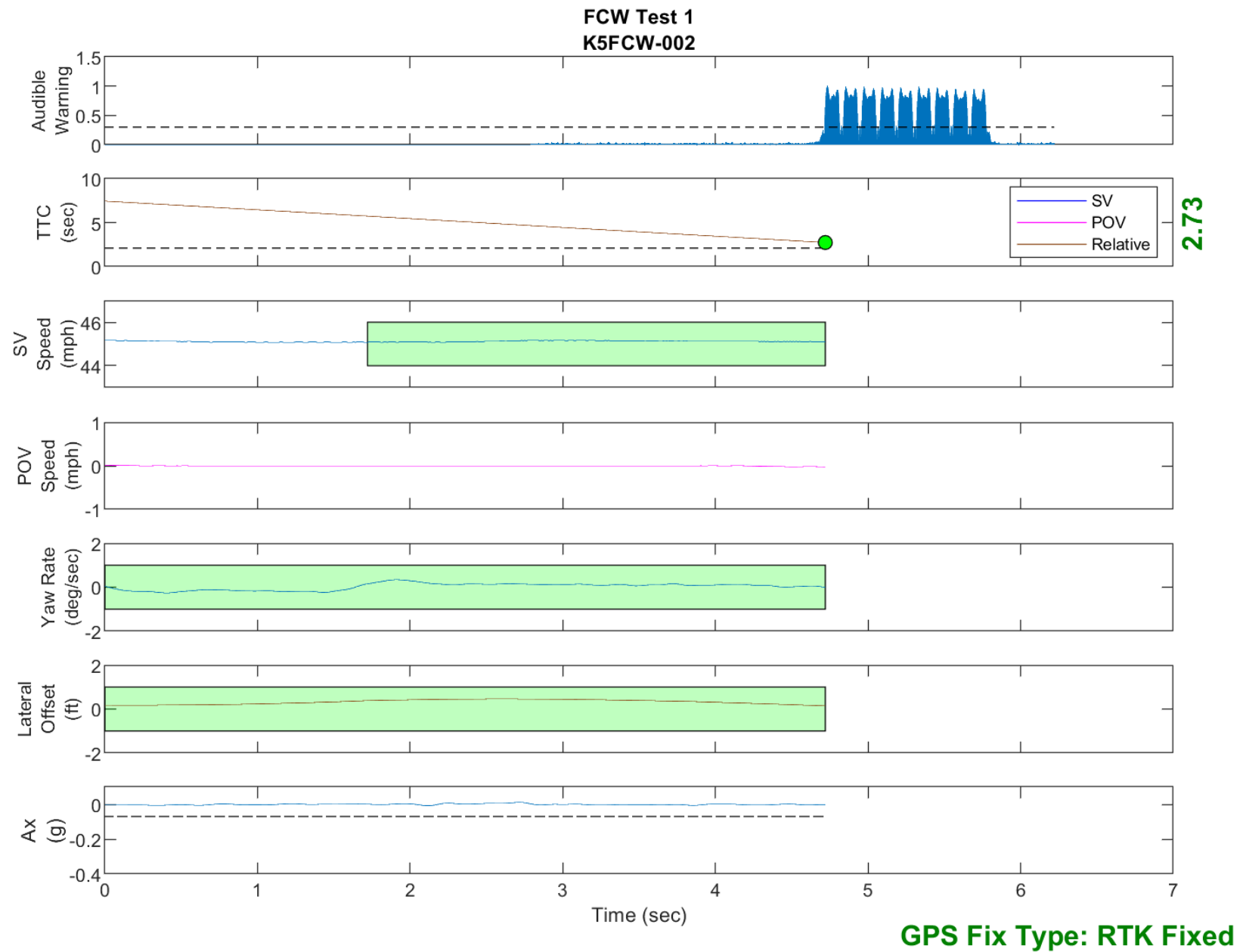


Figure D7. Time History for Run 2, FCW Test 1, Audible Warning

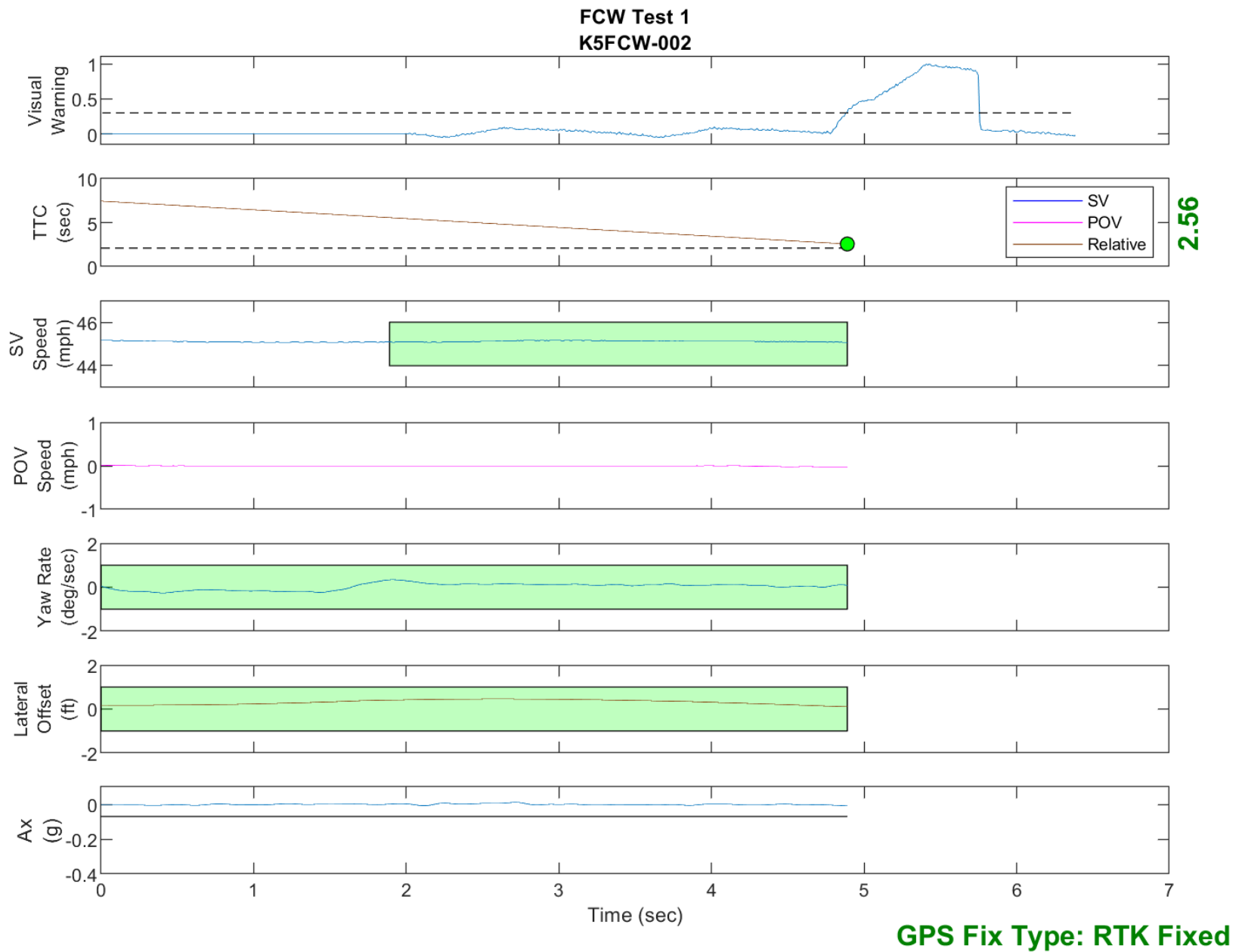


Figure D8. Time History for Run 2, FCW Test 1, Visual Warning

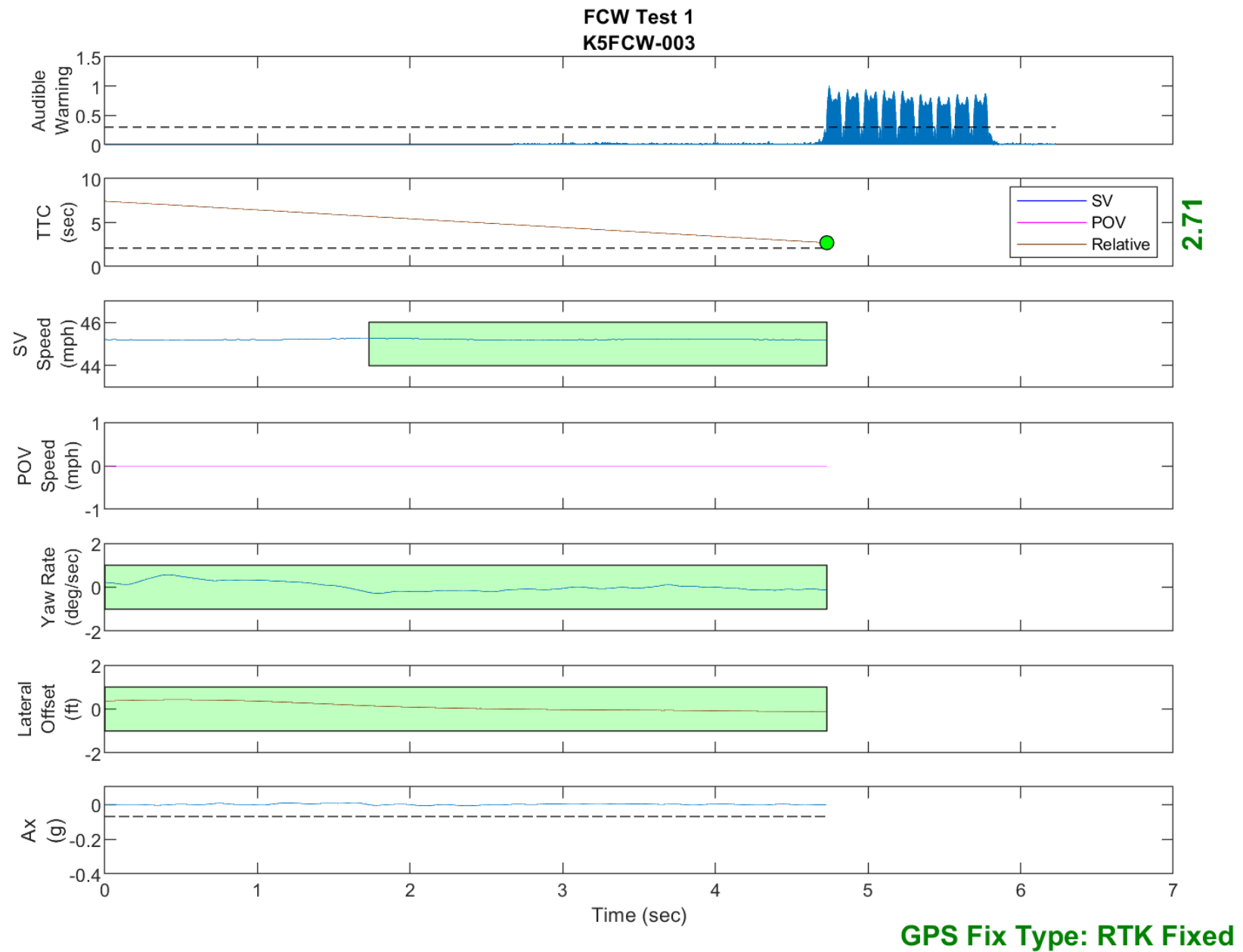


Figure D9. Time History for Run 3, FCW Test 1, Audible Warning

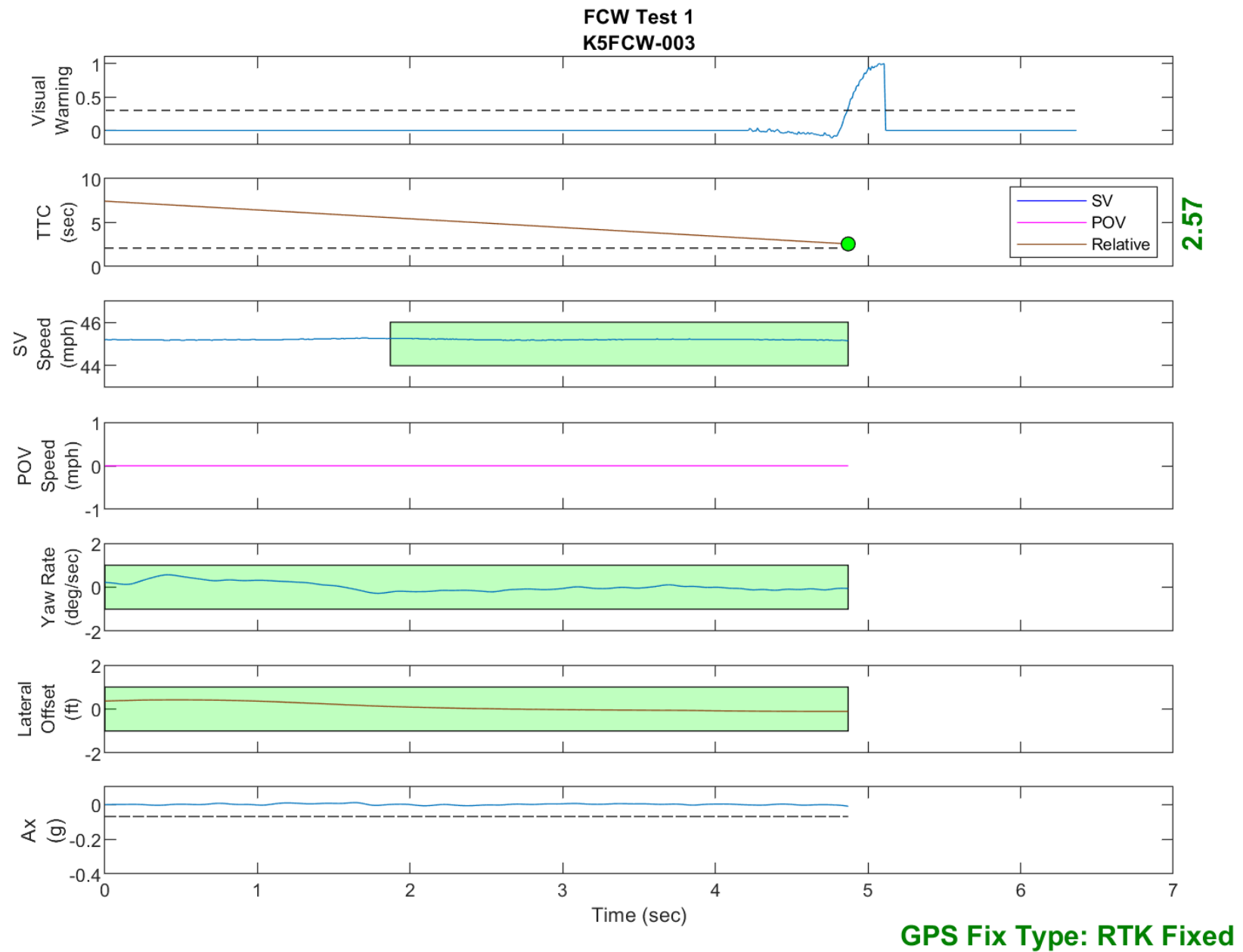


Figure D10. Time History for Run 3, FCW Test 1, Visual Warning

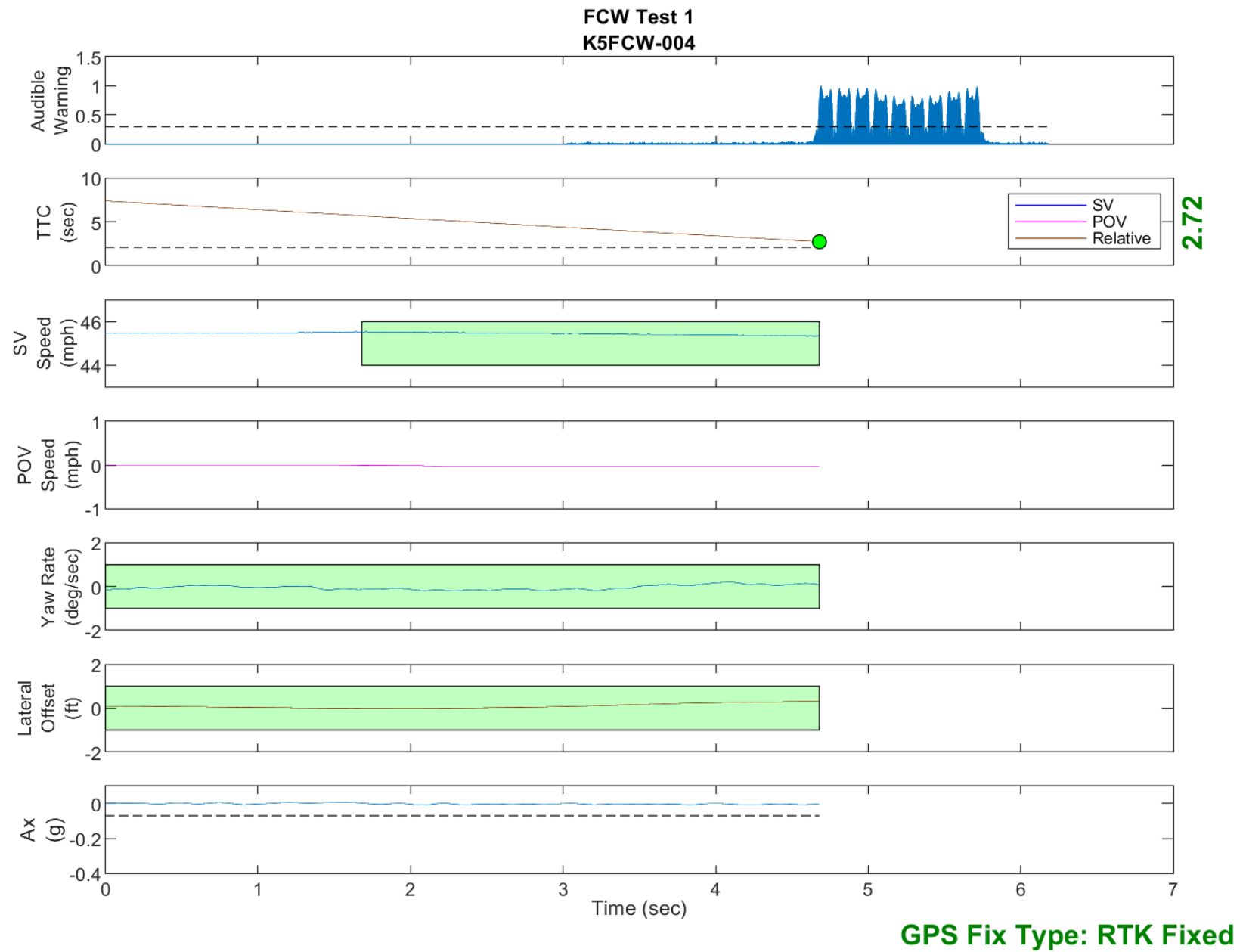


Figure D11. Time History for Run 4, FCW Test 1, Audible Warning

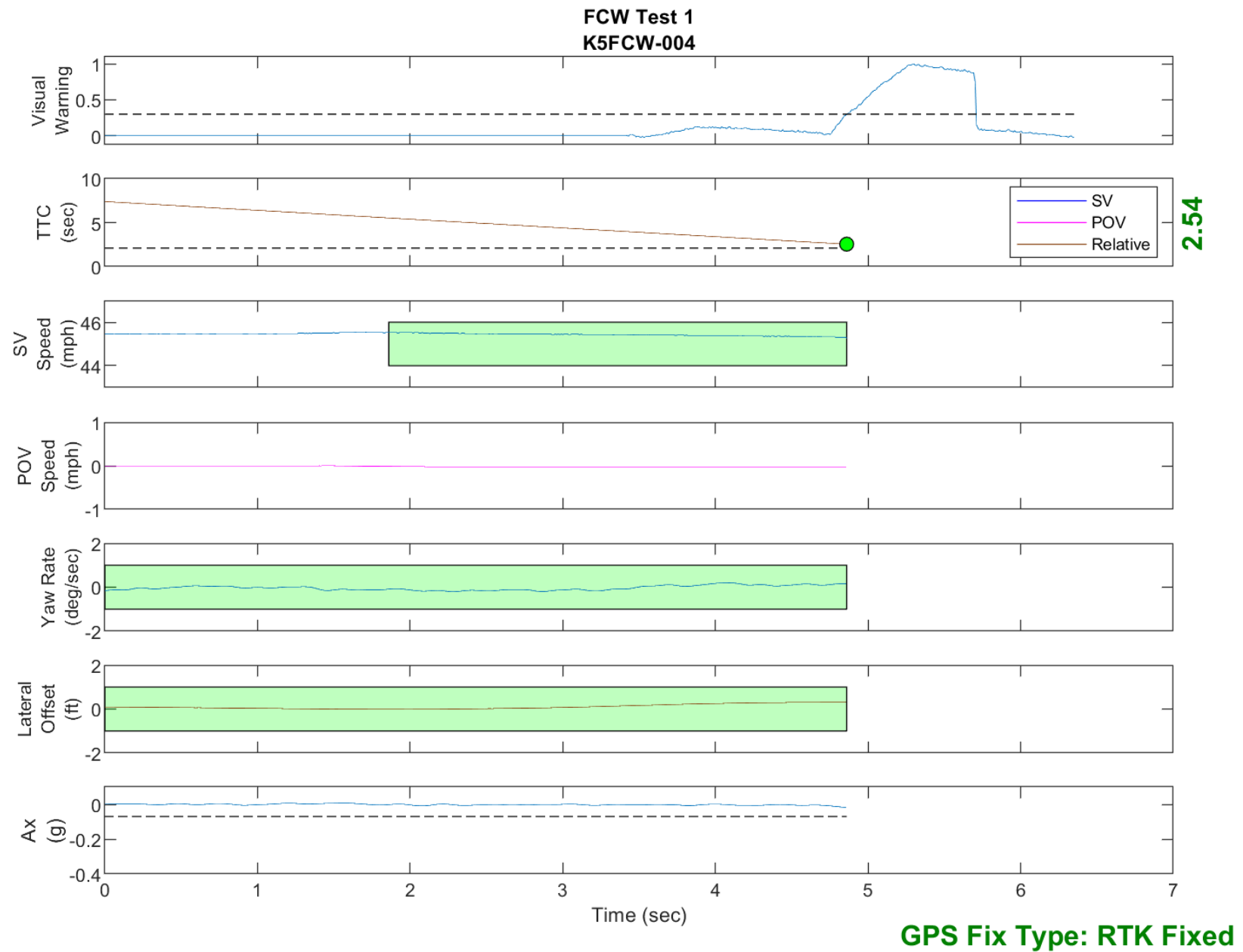


Figure D12. Time History for Run 4, FCW Test 1, Visual Warning

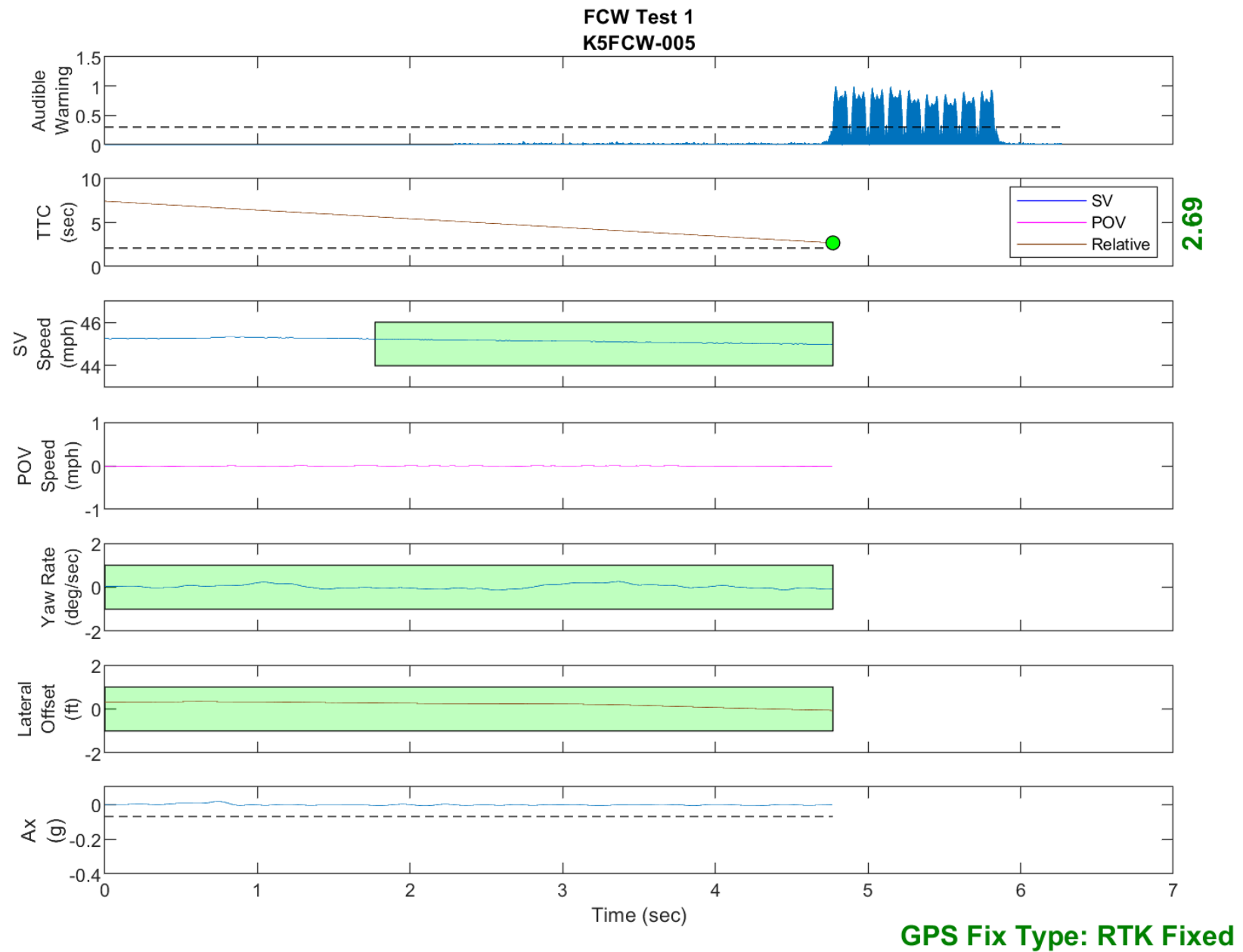


Figure D13. Time History for Run 5, FCW Test 1, Audible Warning

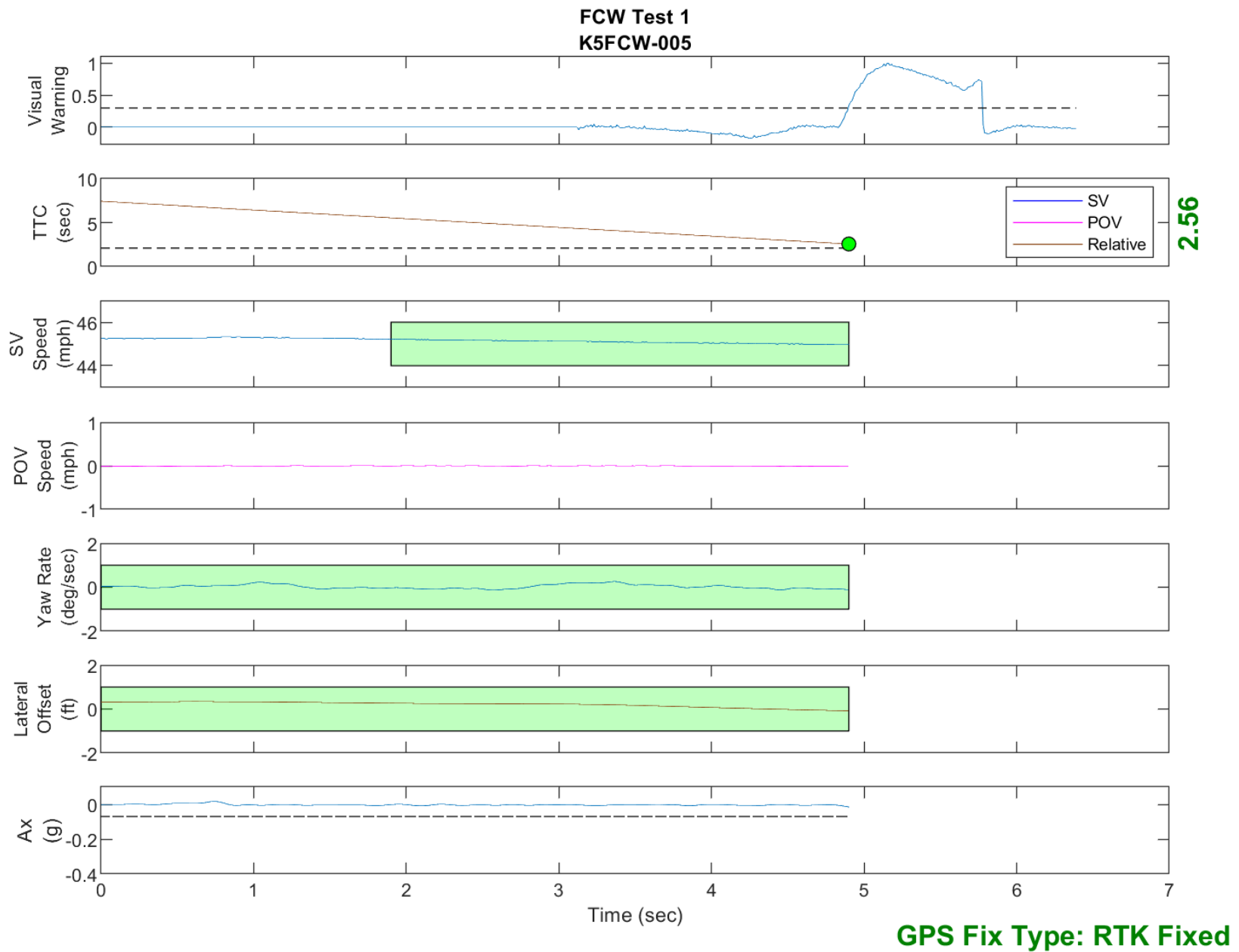


Figure D14. Time History for Run 5, FCW Test 1, Visual Warning

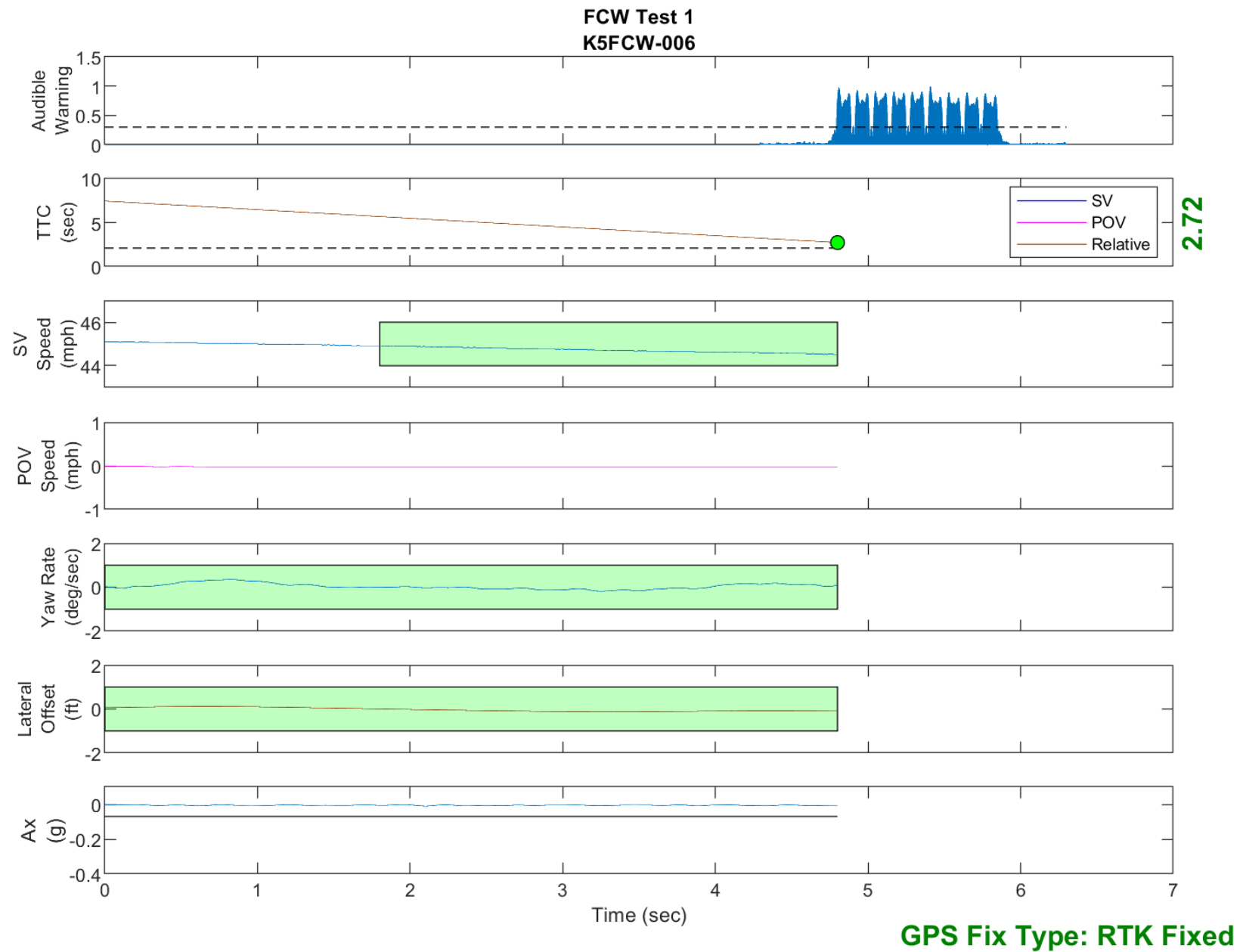


Figure D15. Time History for Run 6, FCW Test 1, Audible Warning

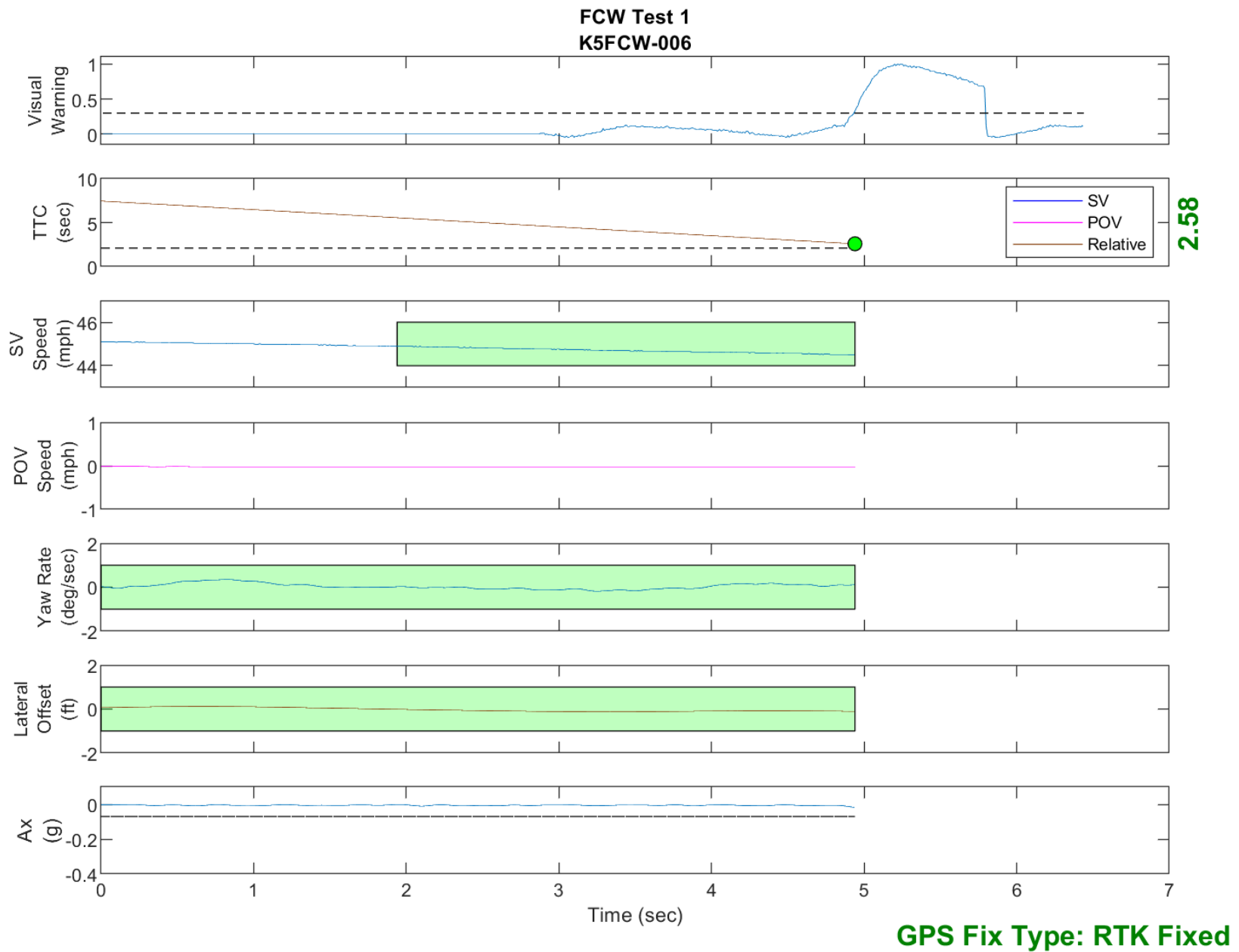


Figure D16. Time History for Run 6, FCW Test 1, Visual Warning

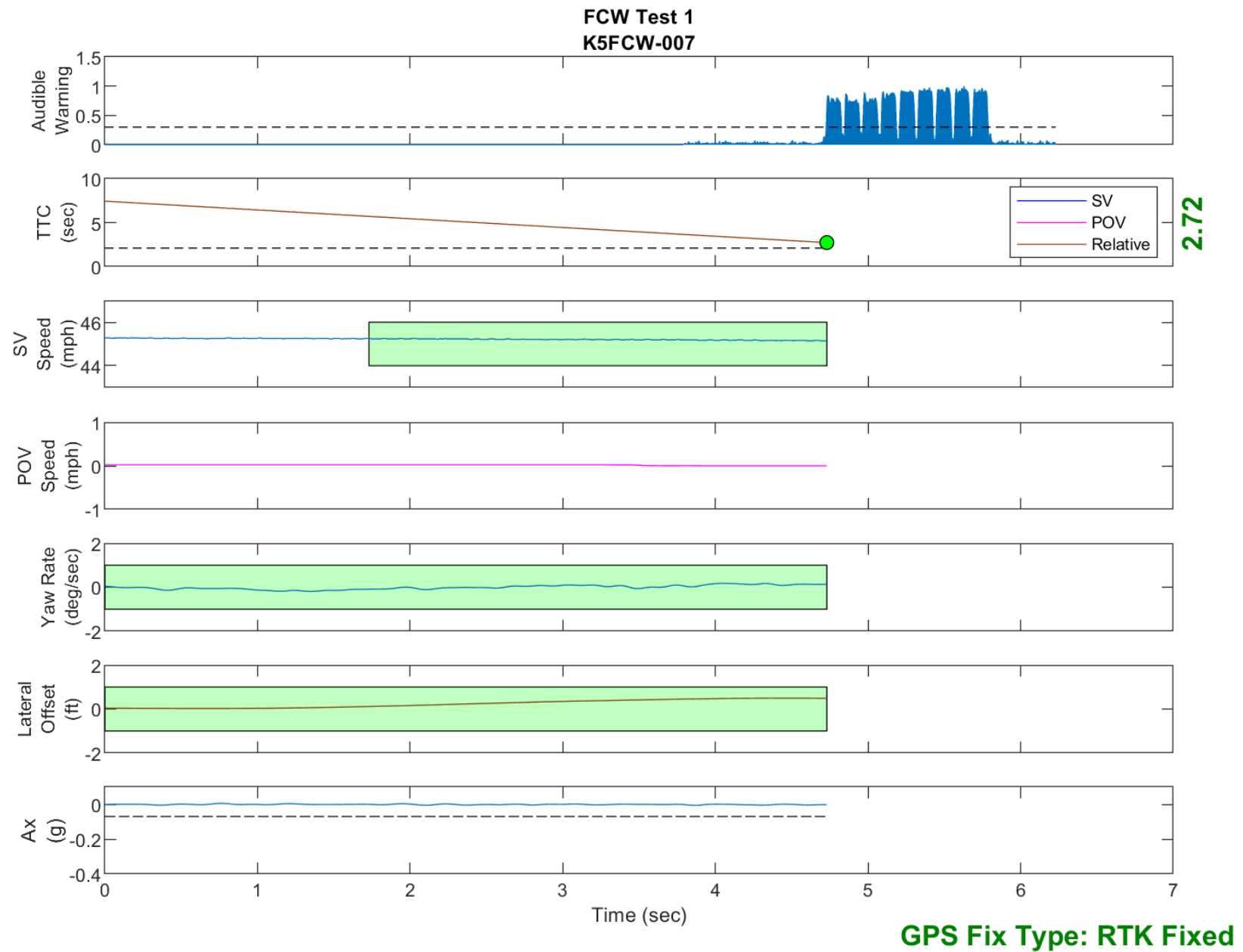


Figure D17. Time History for Run 7, FCW Test 1, Audible Warning

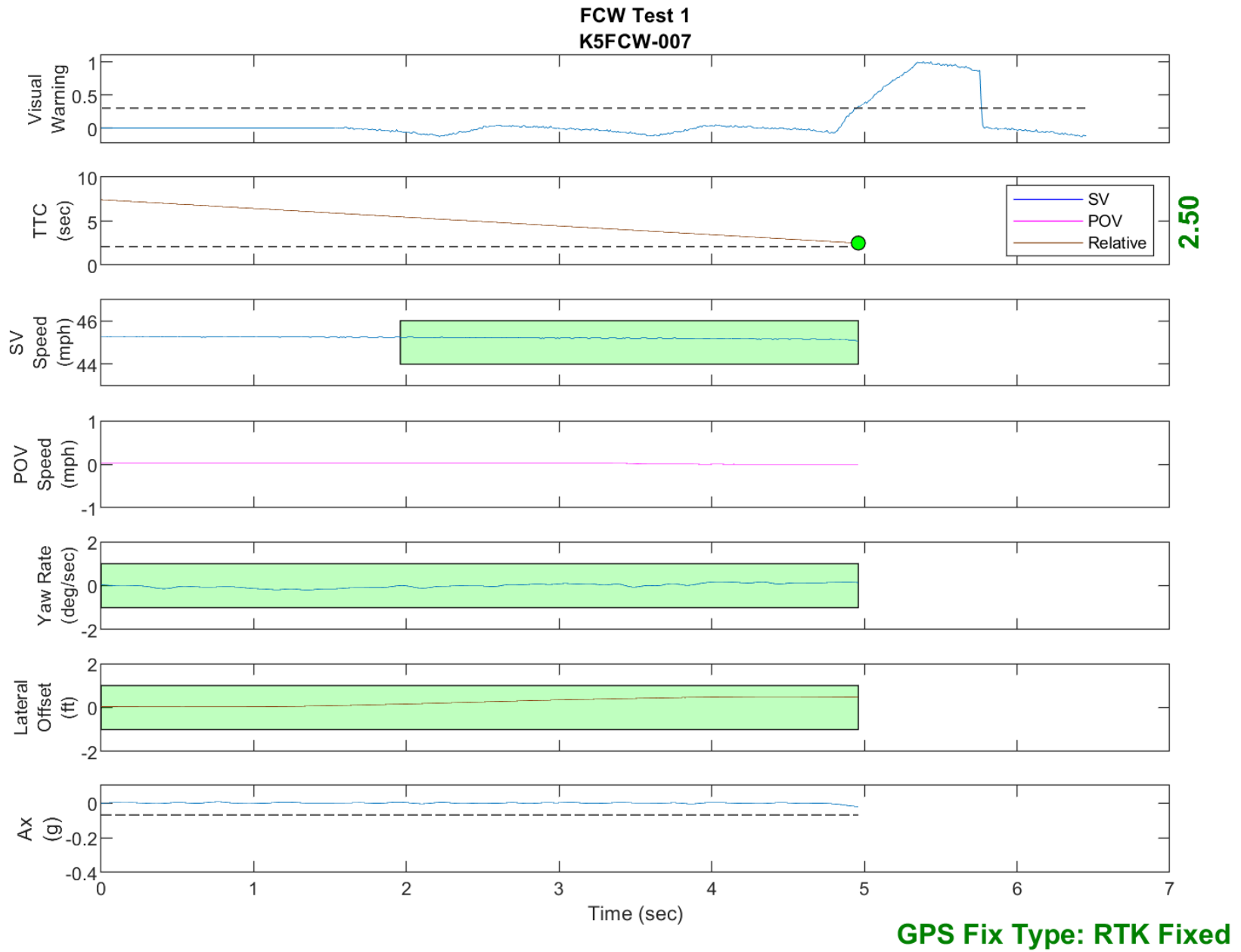


Figure D18. Time History for Run 7, FCW Test 1, Visual Warning

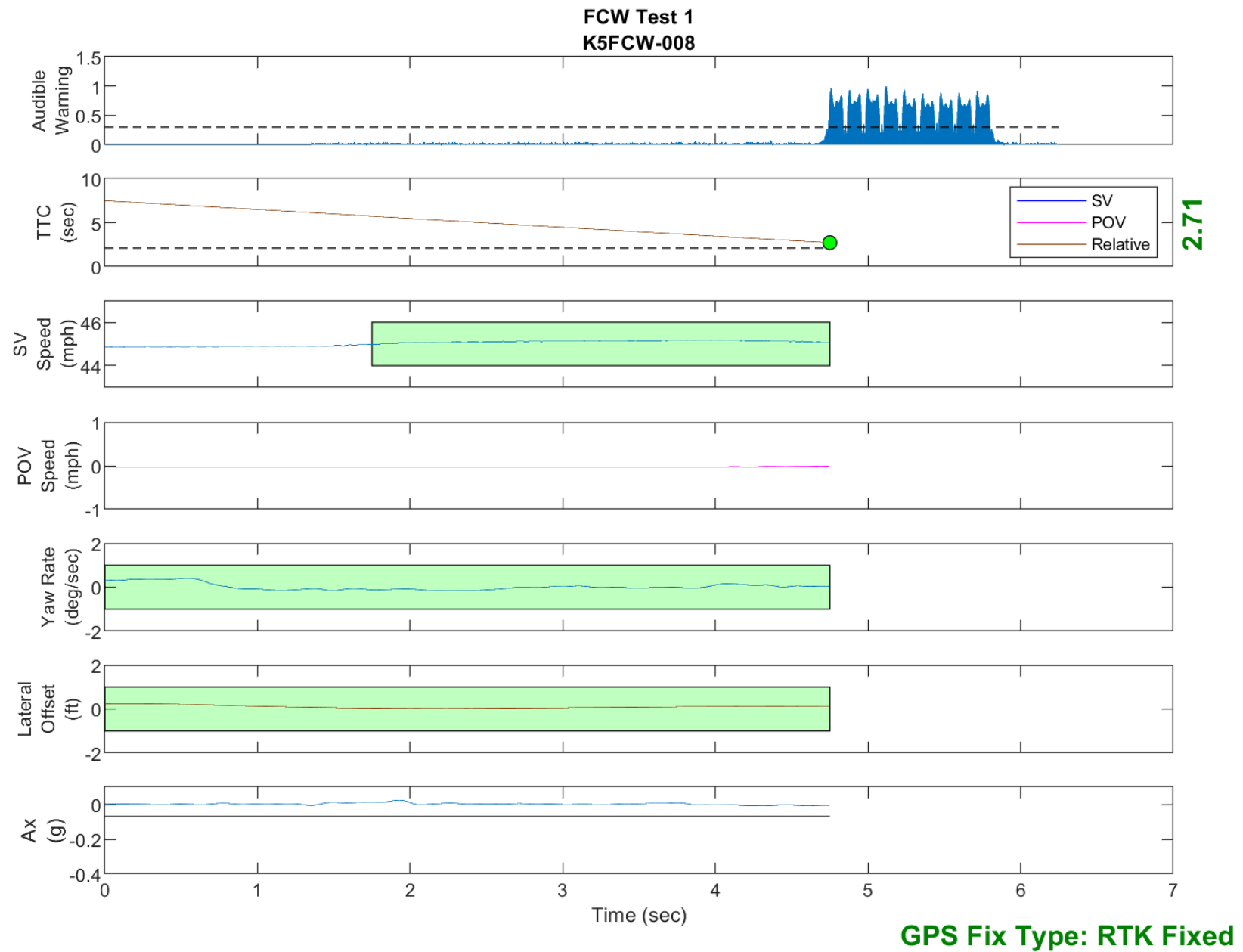


Figure D19. Time History for Run 8, FCW Test 1, Audible Warning

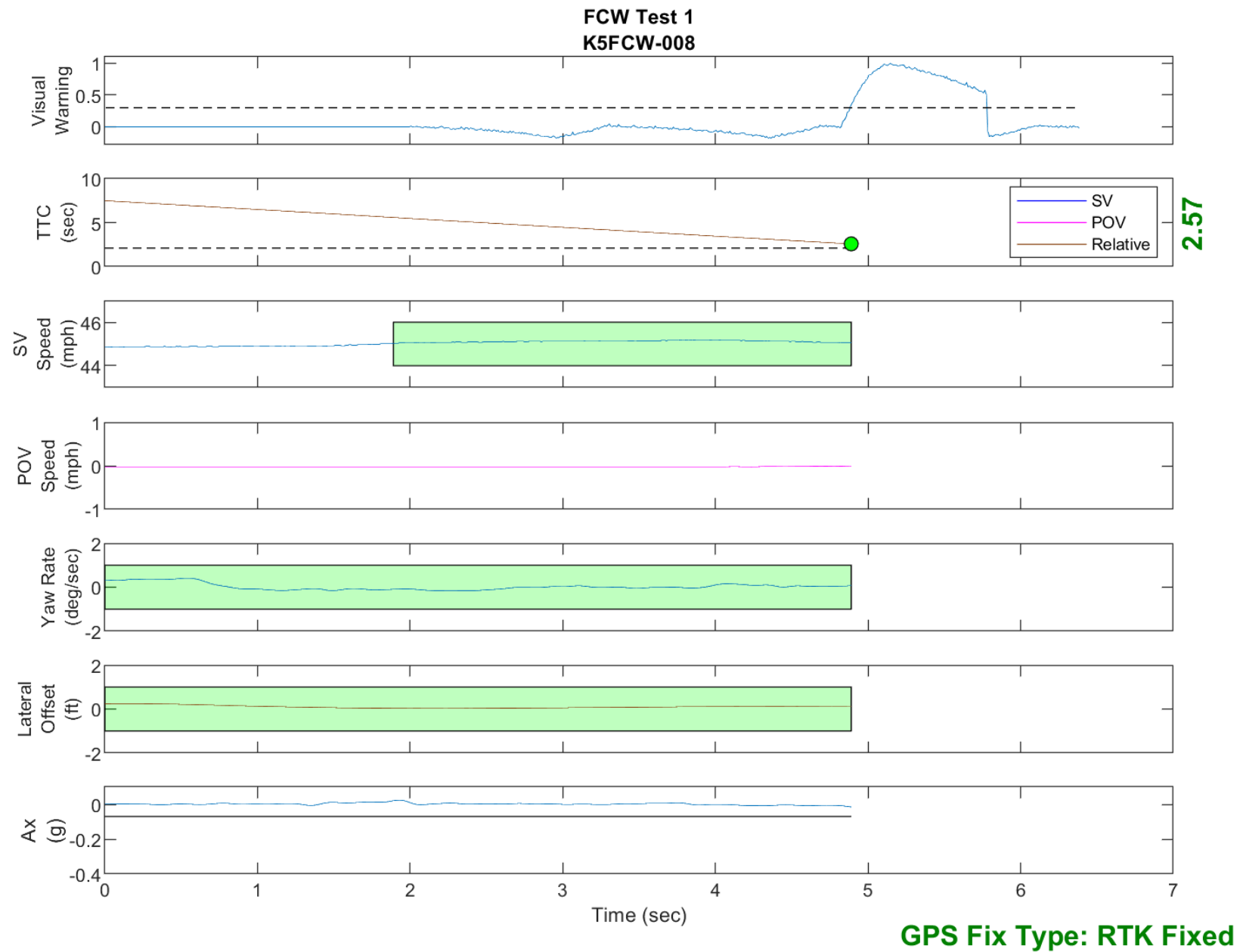


Figure D20. Time History for Run 8, FCW Test 1, Visual Warning

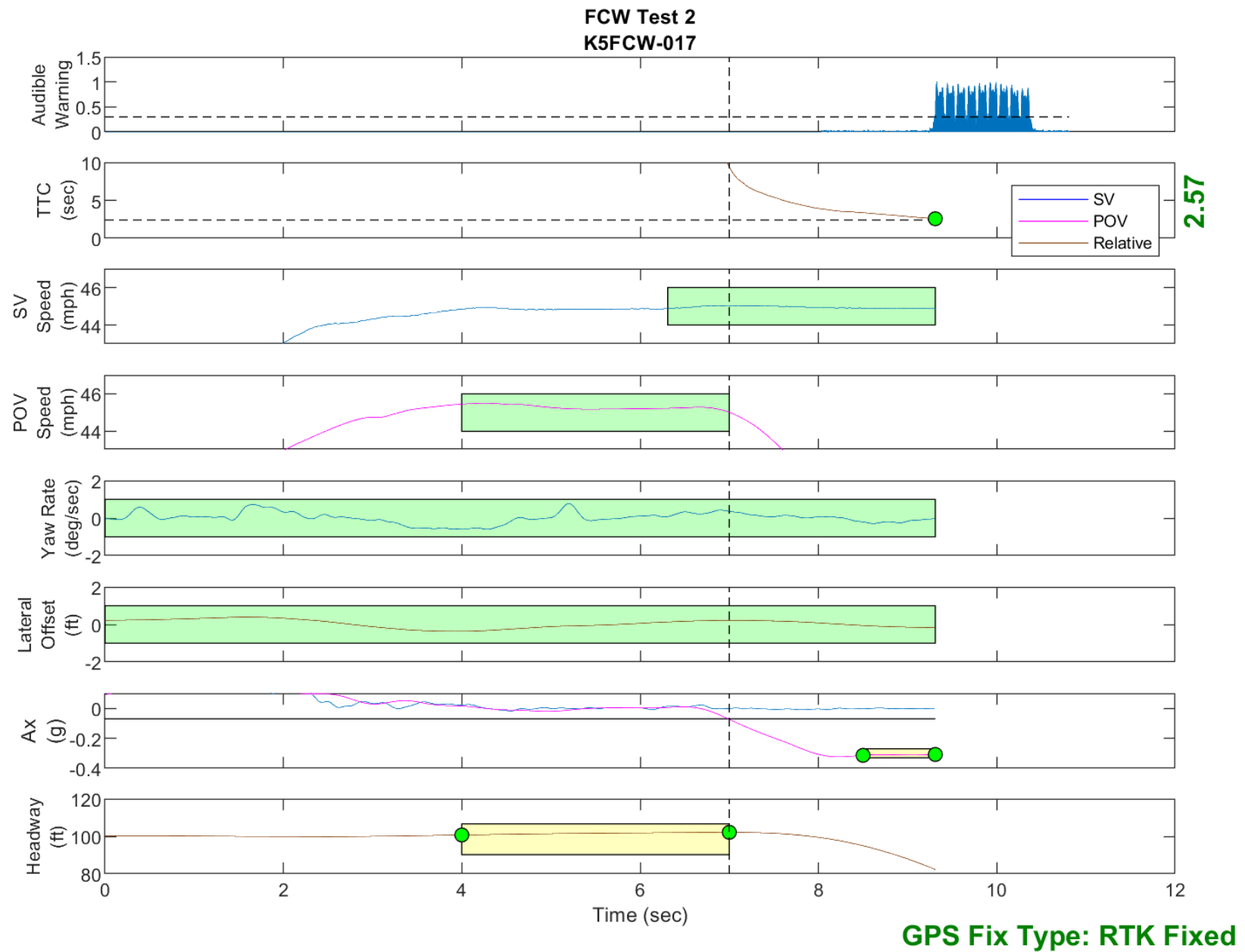


Figure D21. Time History for Run 17, FCW Test 2, Audible Warning

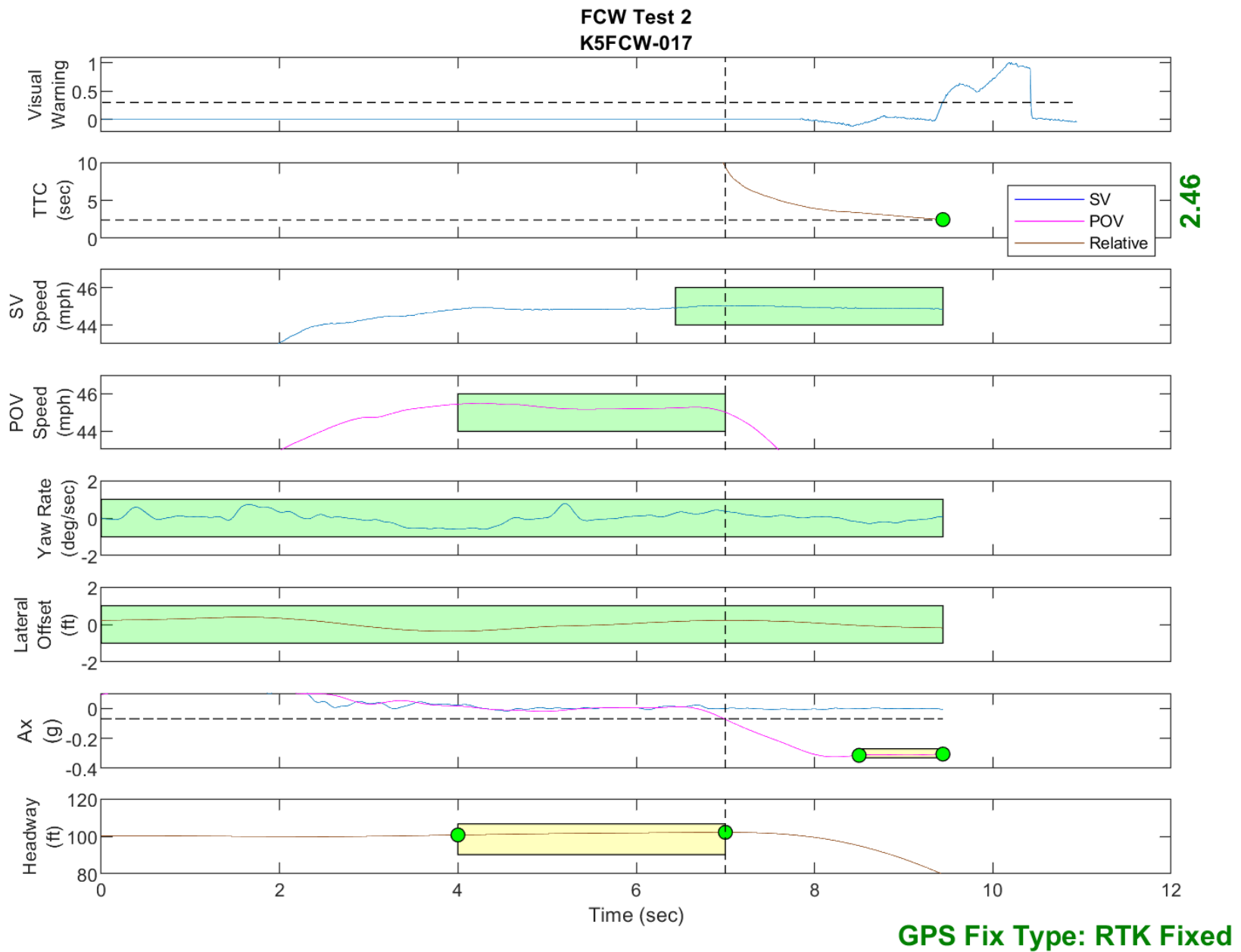


Figure D22. Time History for Run 17, FCW Test 2, Visual Warning

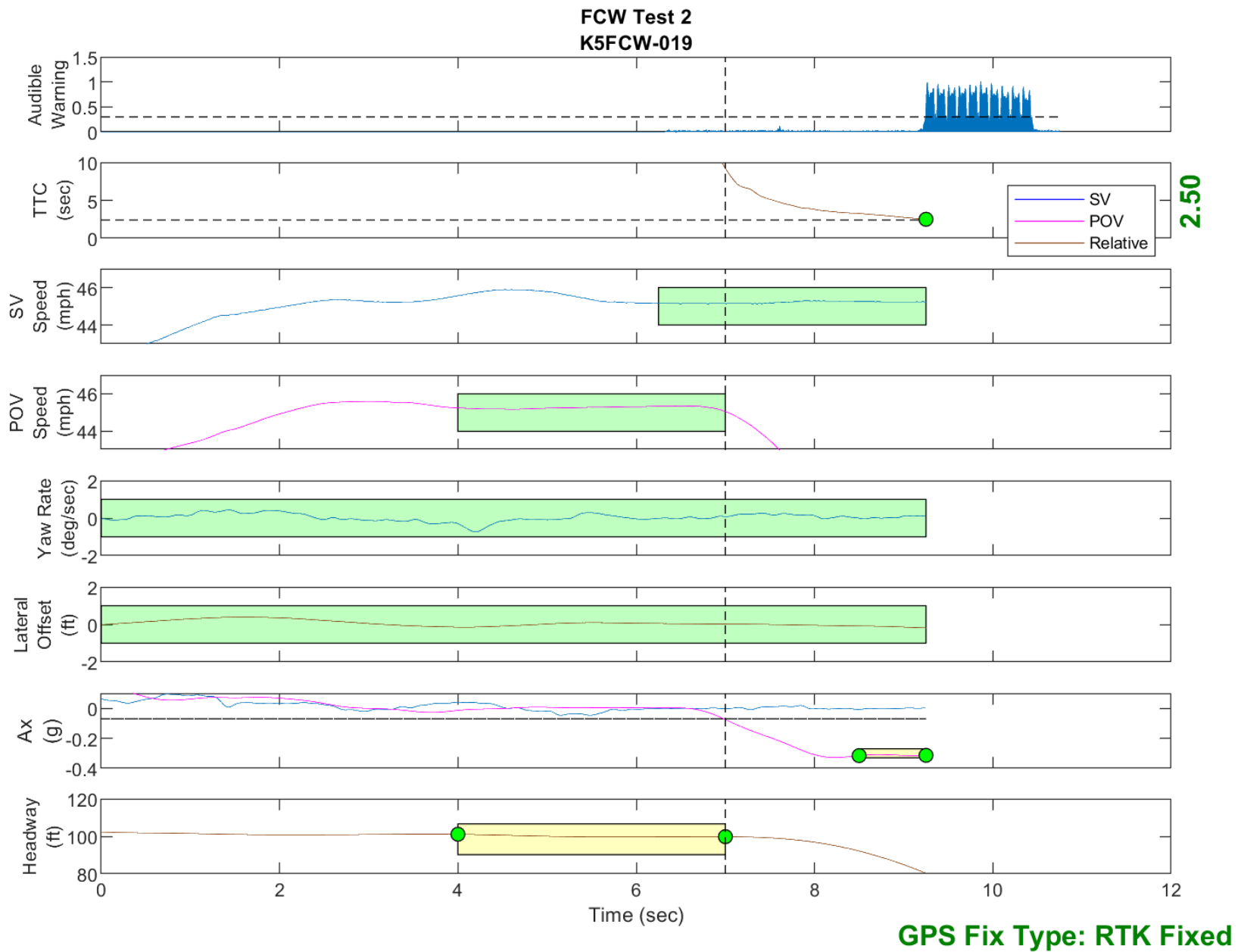


Figure D23. Time History for Run 19, FCW Test 2, Audible Warning

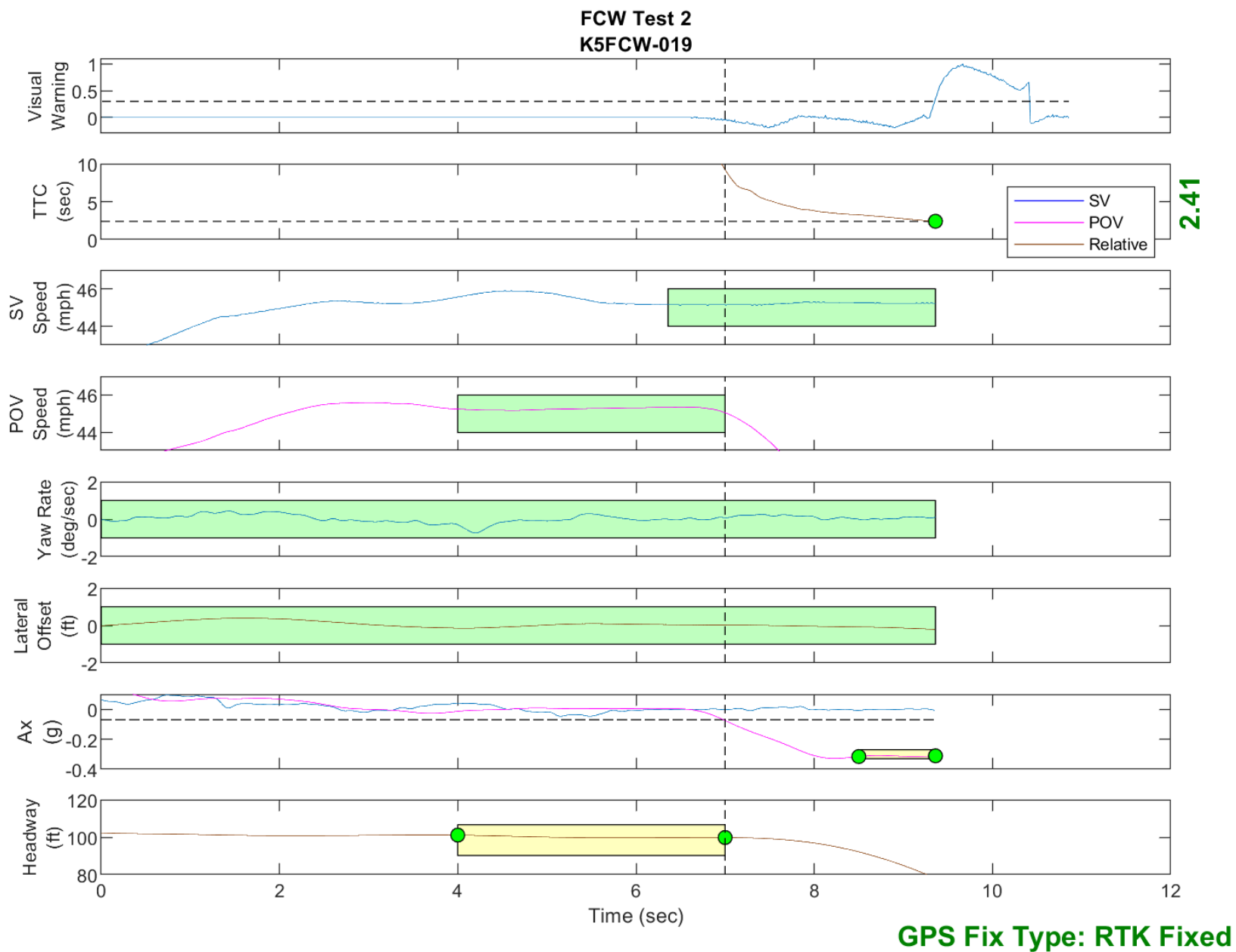


Figure D24. Time History for Run 19, FCW Test 2, Visual Warning

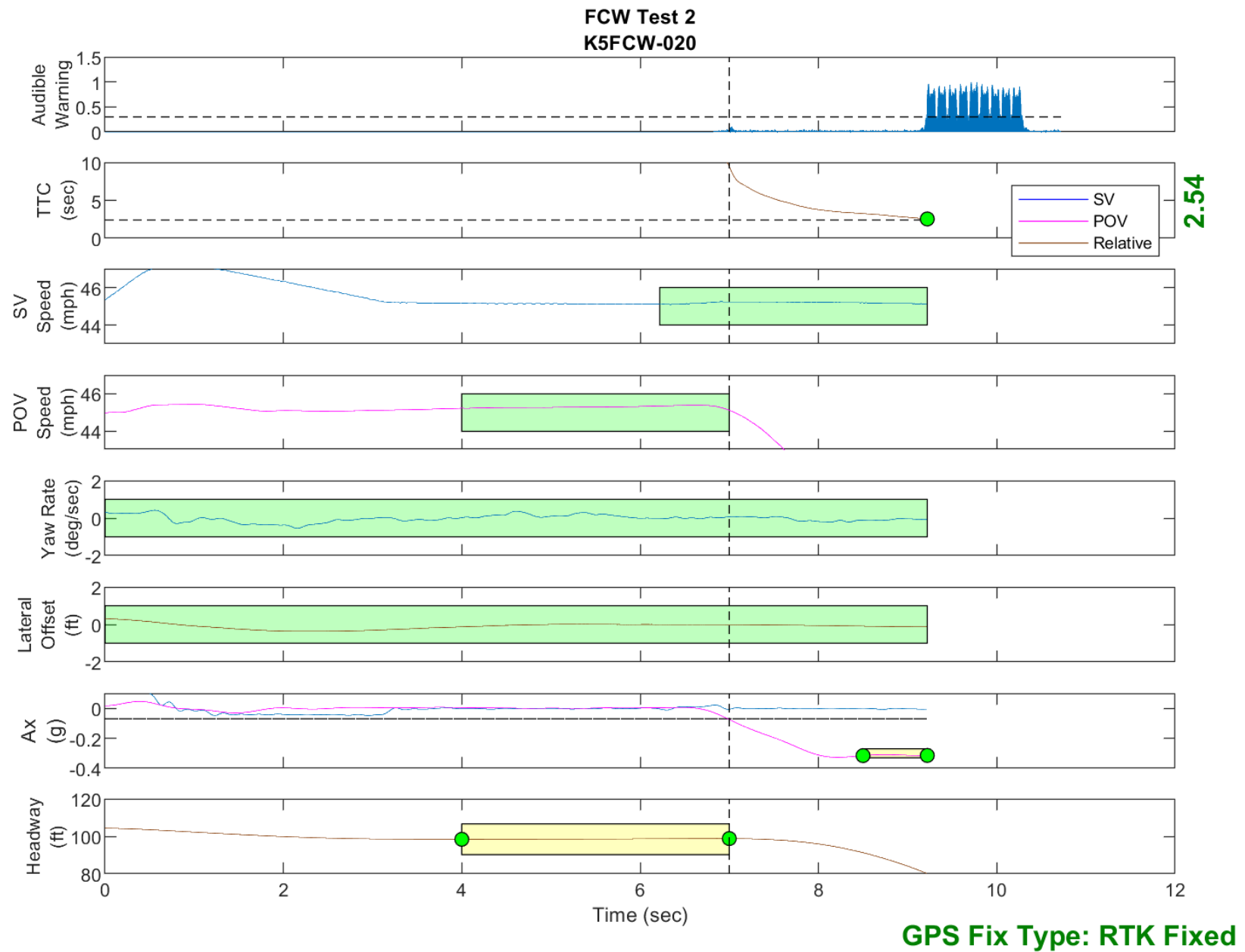


Figure D25. Time History for Run 20, FCW Test 2, Audible Warning

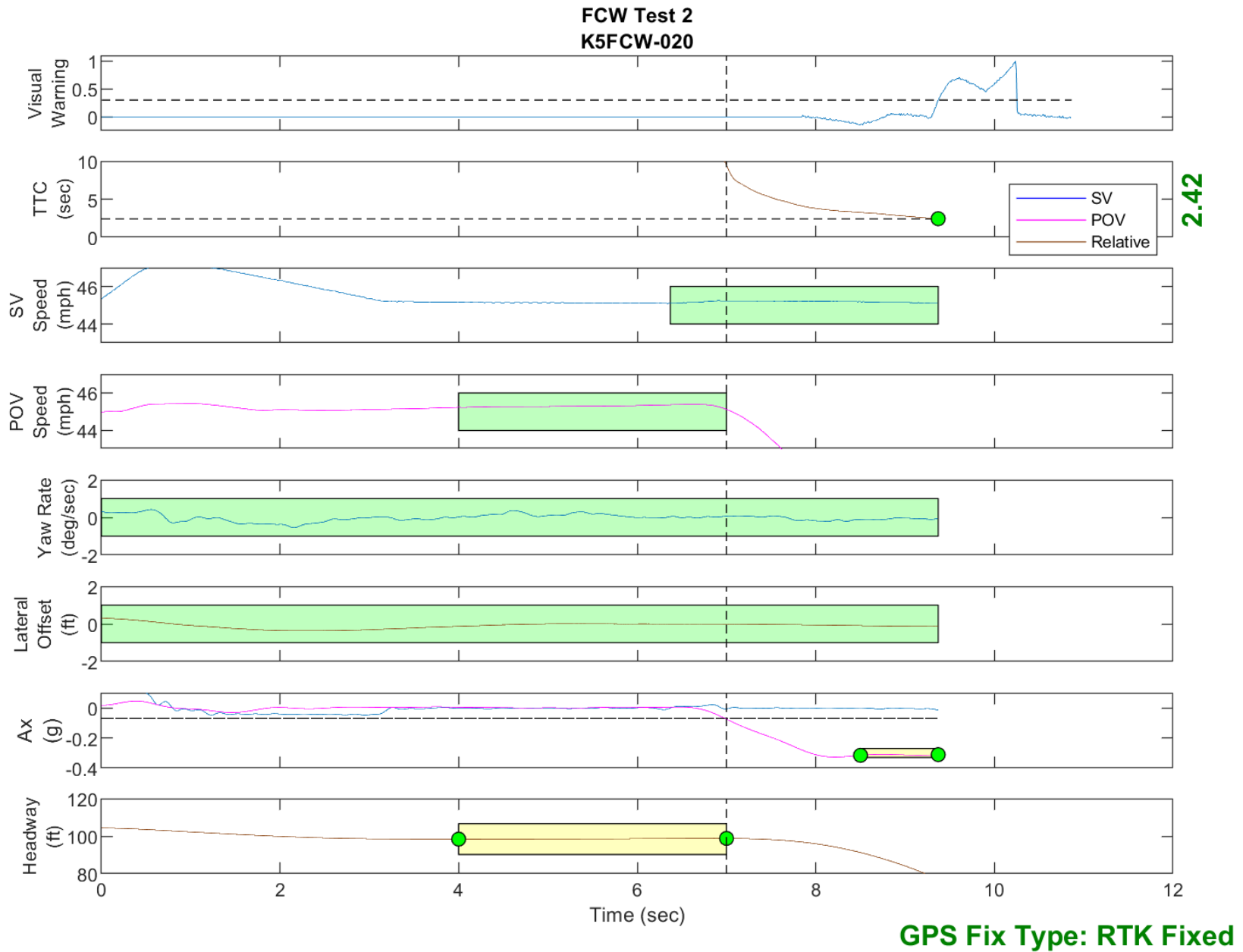


Figure D26. Time History for Run 20, FCW Test 2, Visual Warning

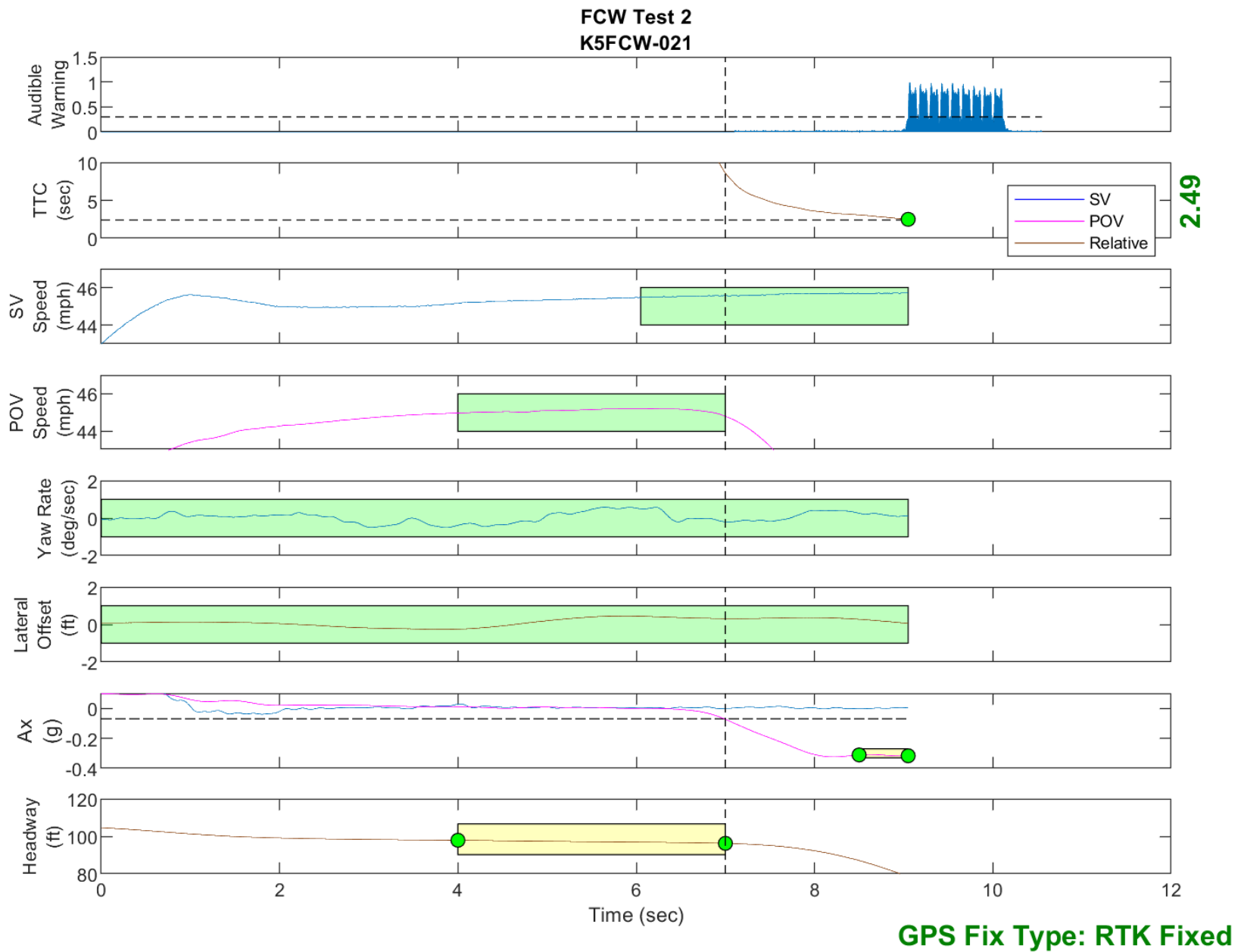


Figure D27. Time History for Run 21, FCW Test 2, Audible Warning

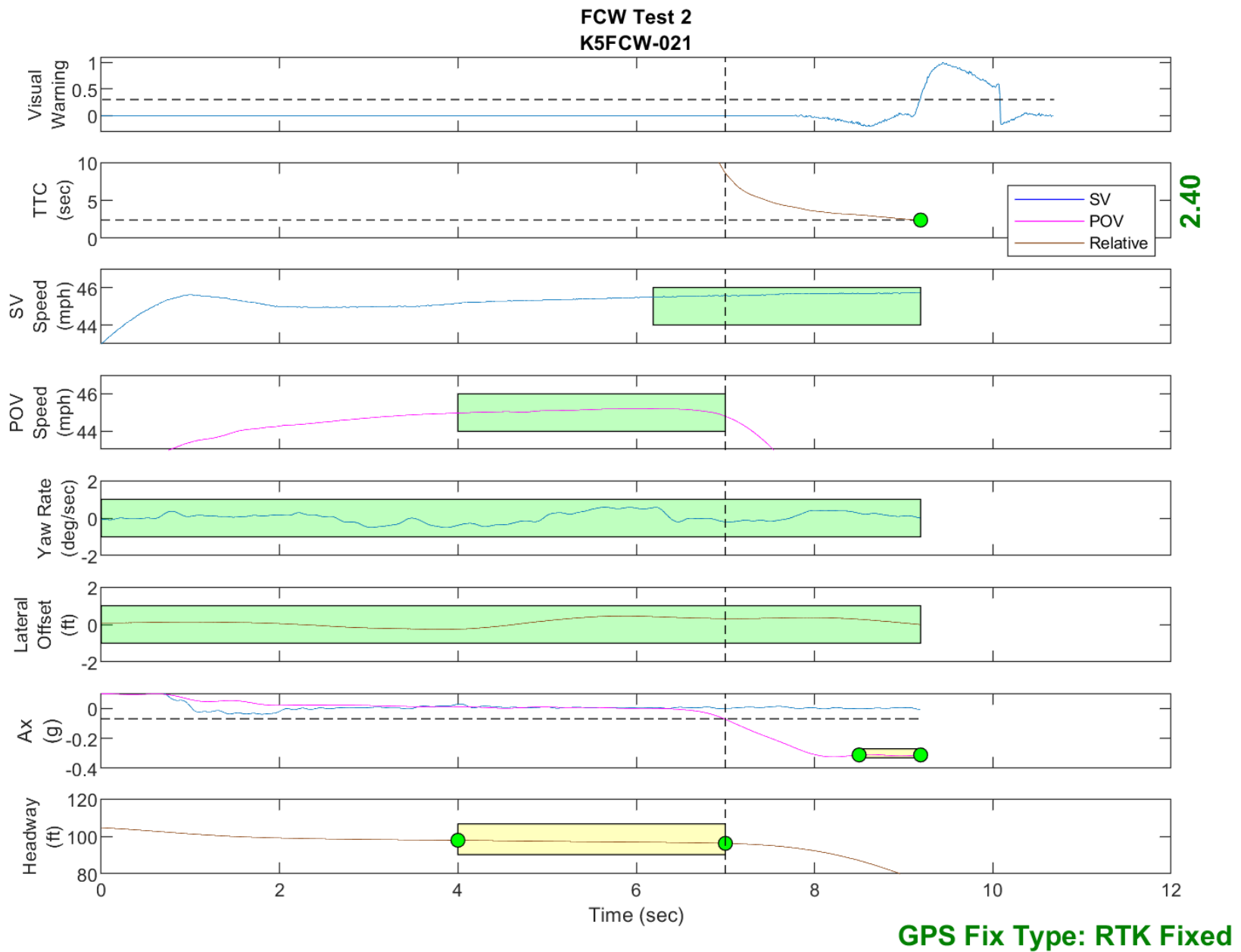


Figure D28. Time History for Run 21, FCW Test 2, Visual Warning

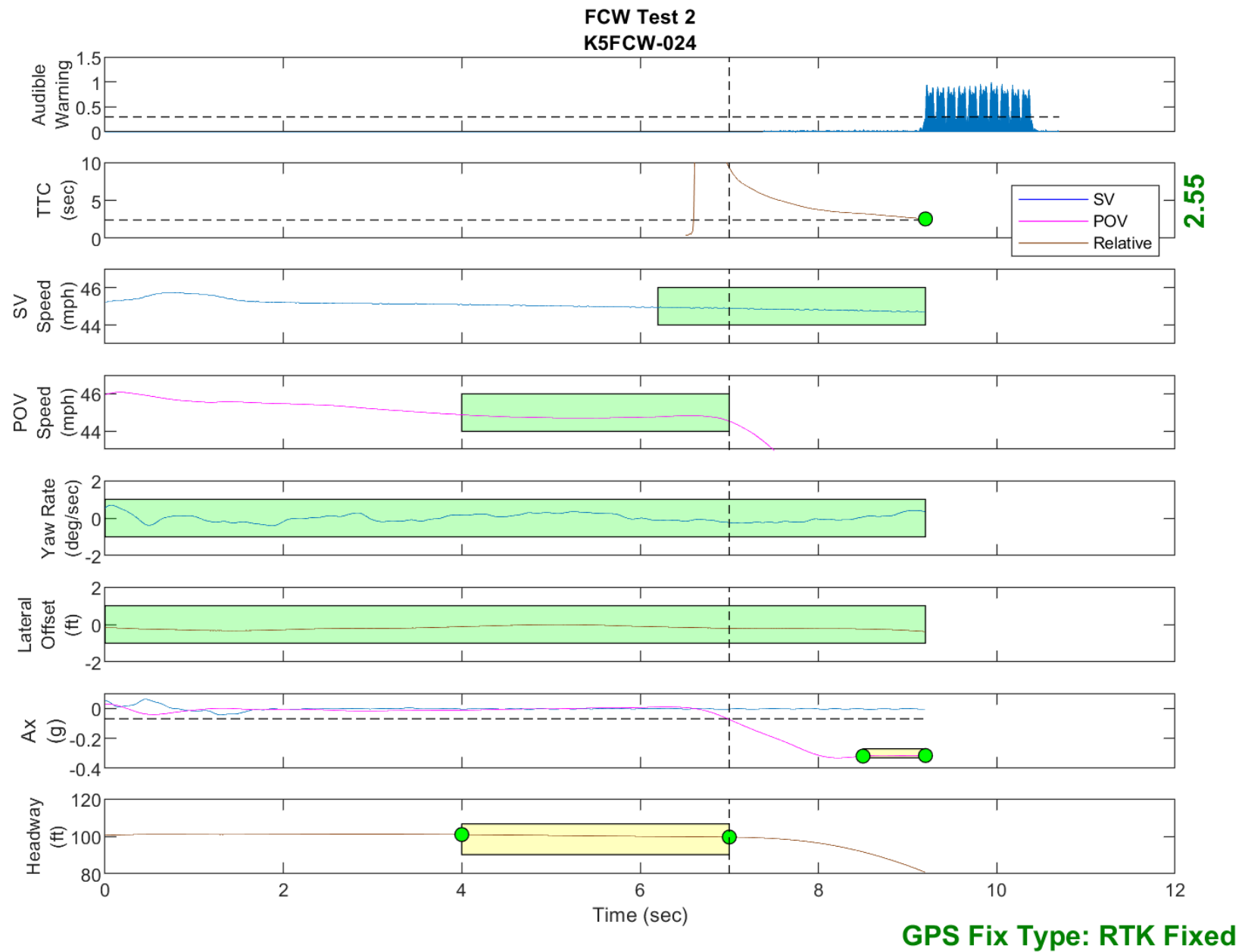


Figure D29. Time History for Run 24, FCW Test 2, Audible Warning

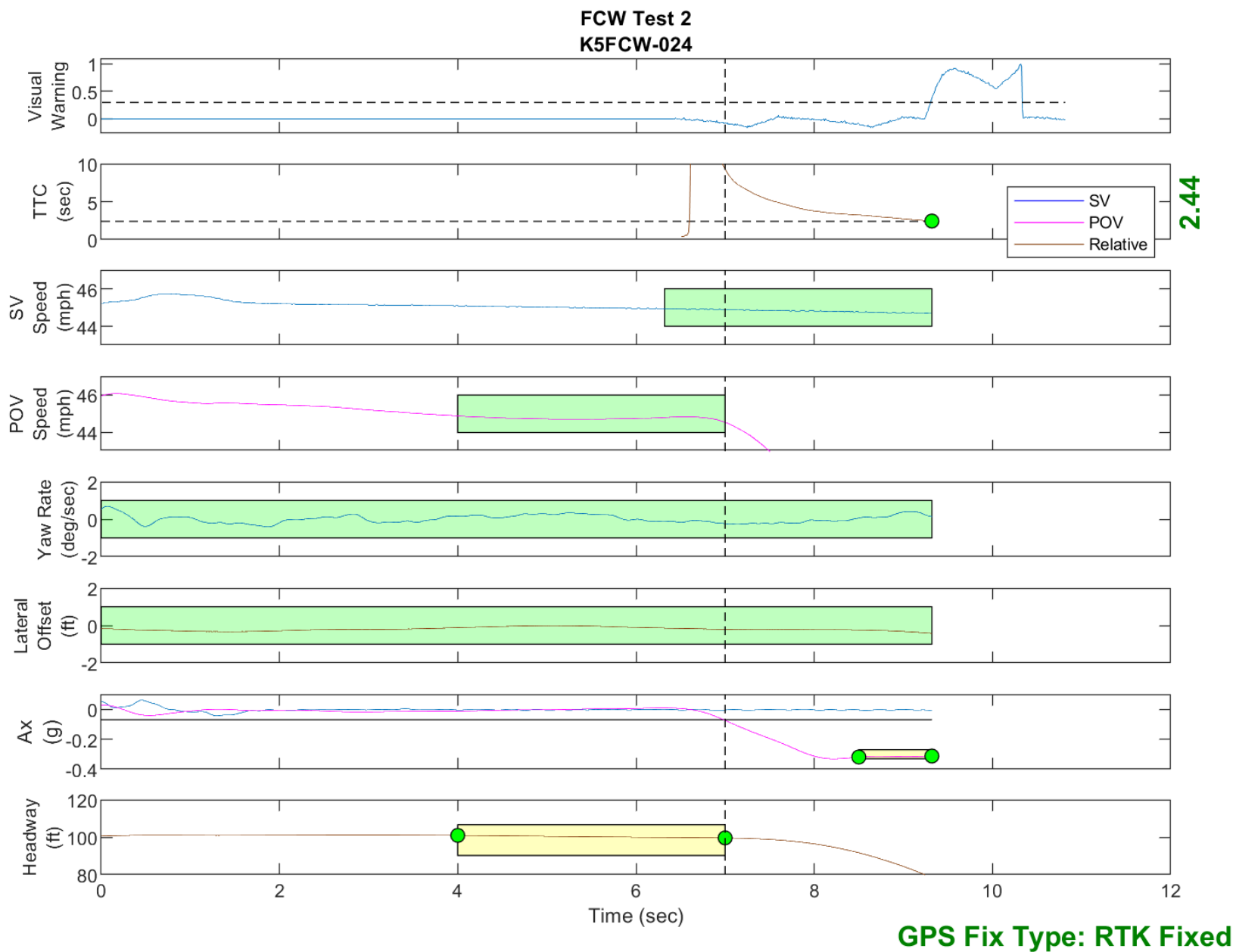


Figure D30. Time History for Run 24, FCW Test 2, Visual Warning

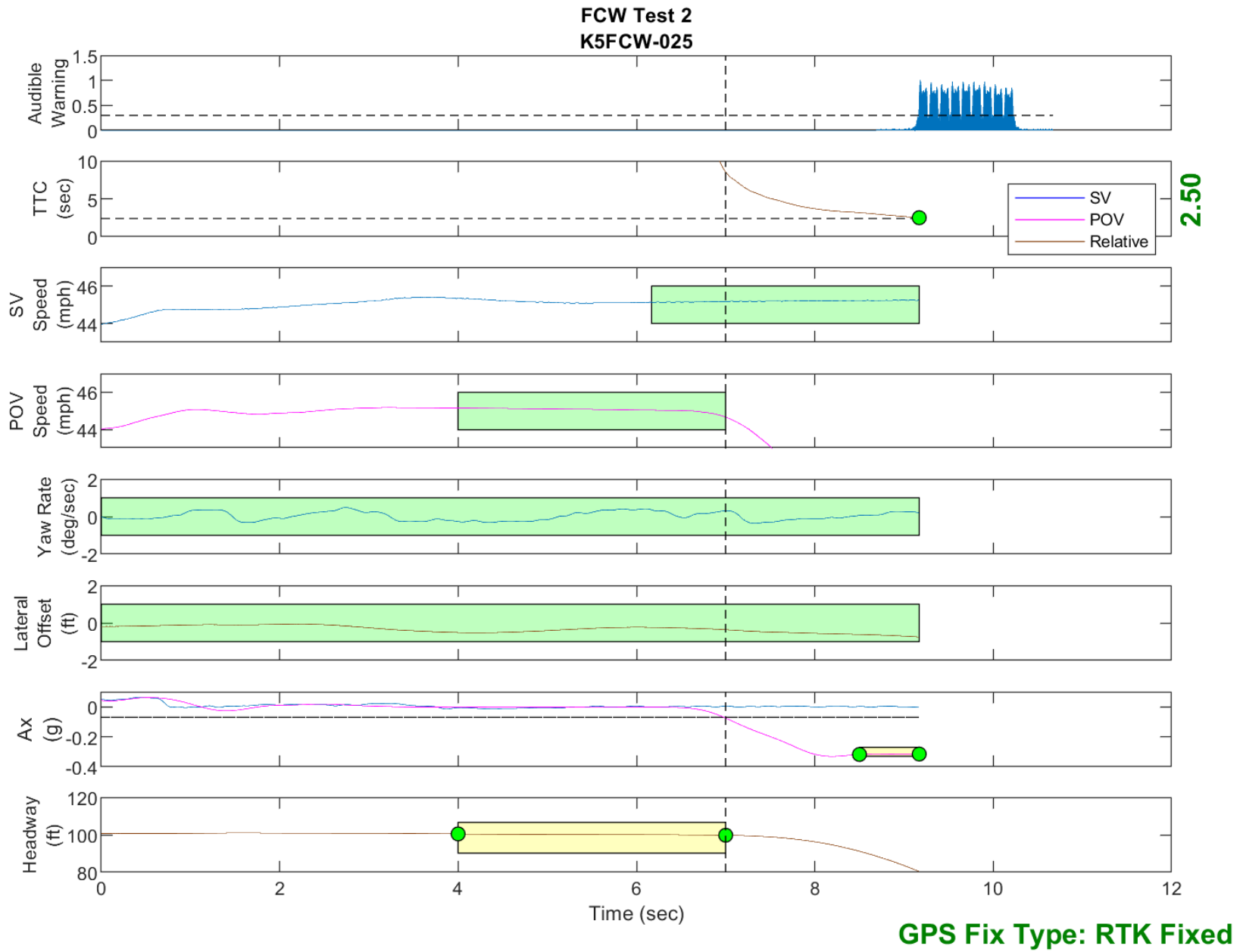
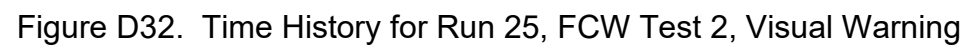


Figure D31. Time History for Run 25, FCW Test 2, Audible Warning



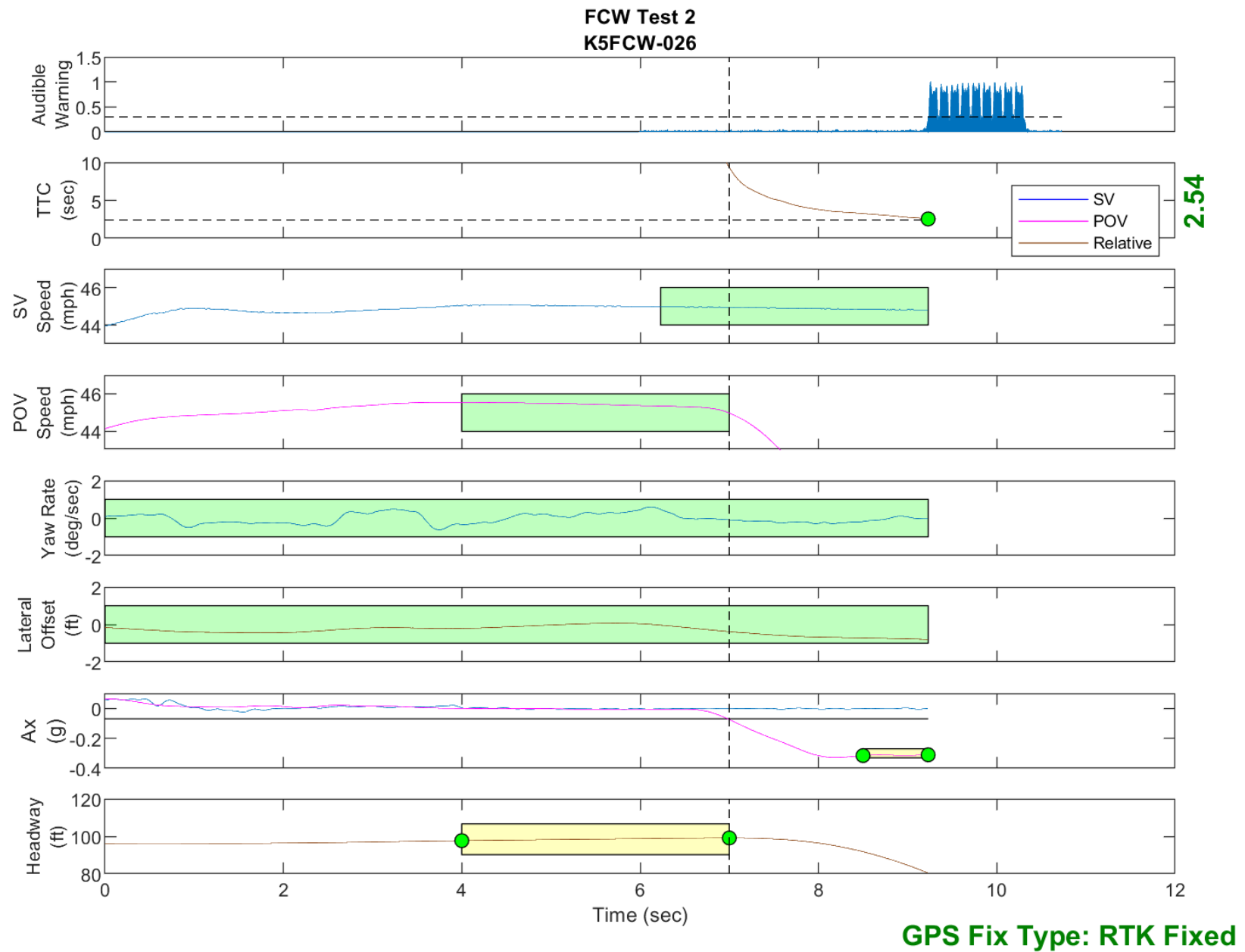


Figure D33. Time History for Run 26, FCW Test 2, Audible Warning

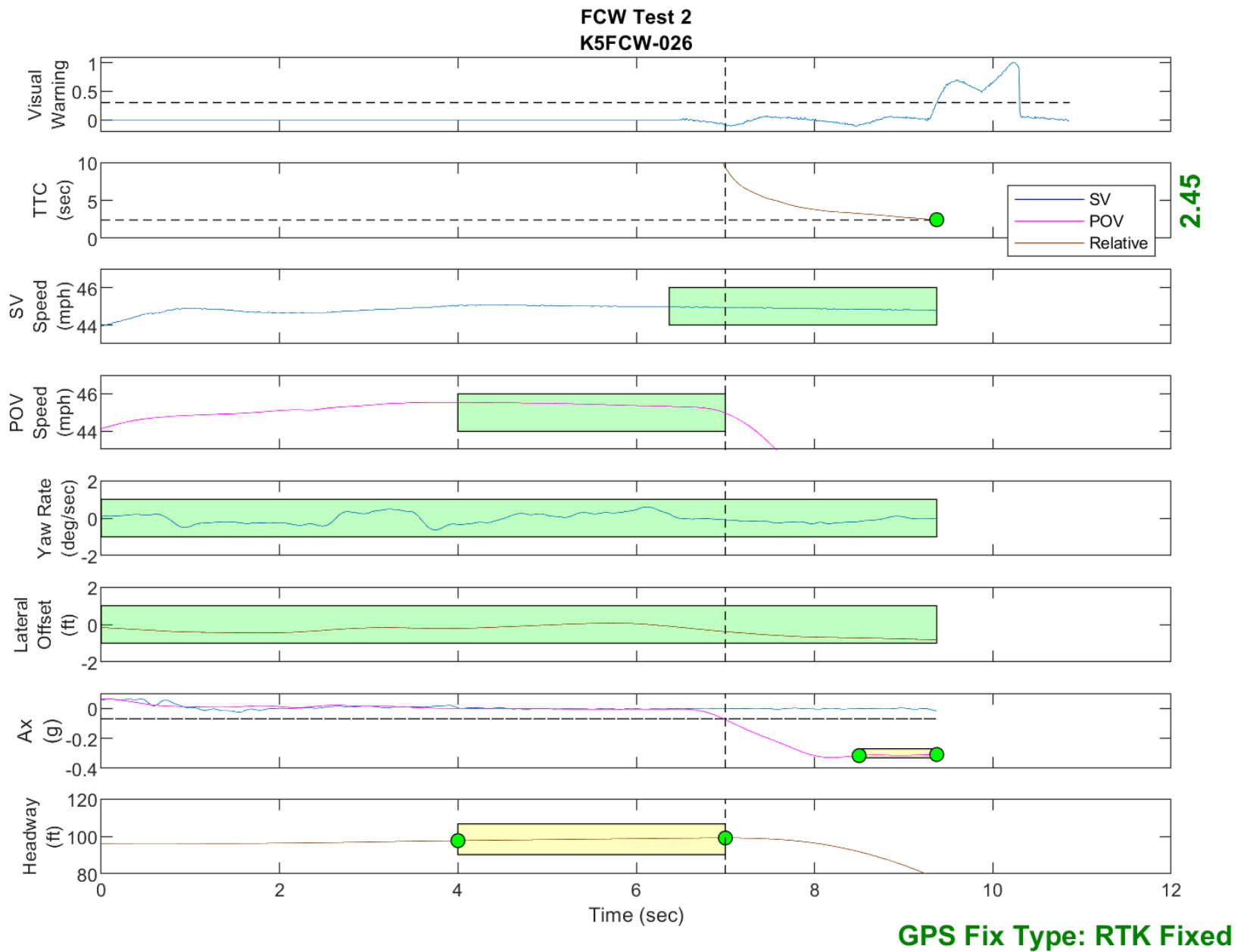


Figure D34. Time History for Run 26, FCW Test 2, Visual Warning

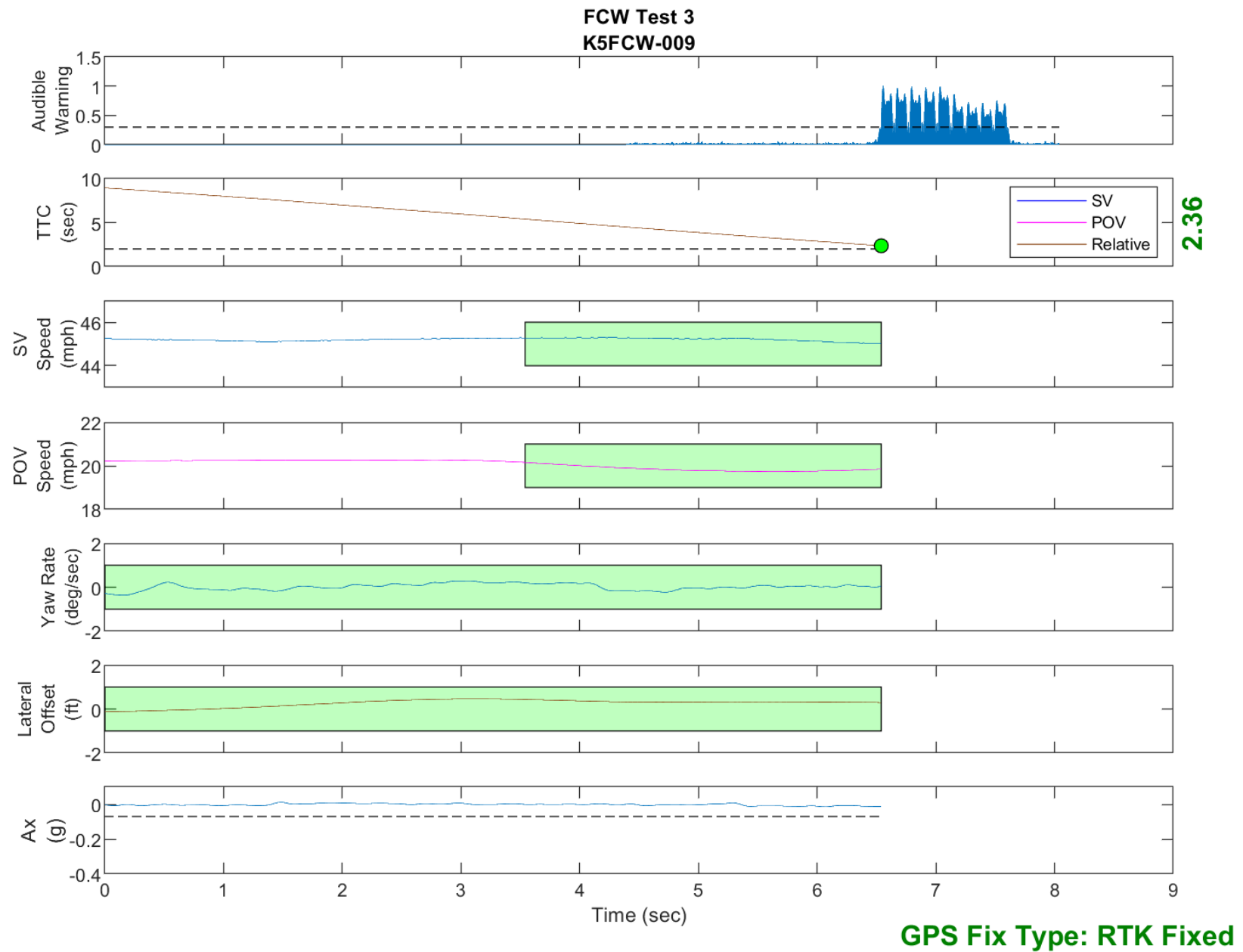


Figure D35. Time History for Run 9, FCW Test 3, Audible Warning

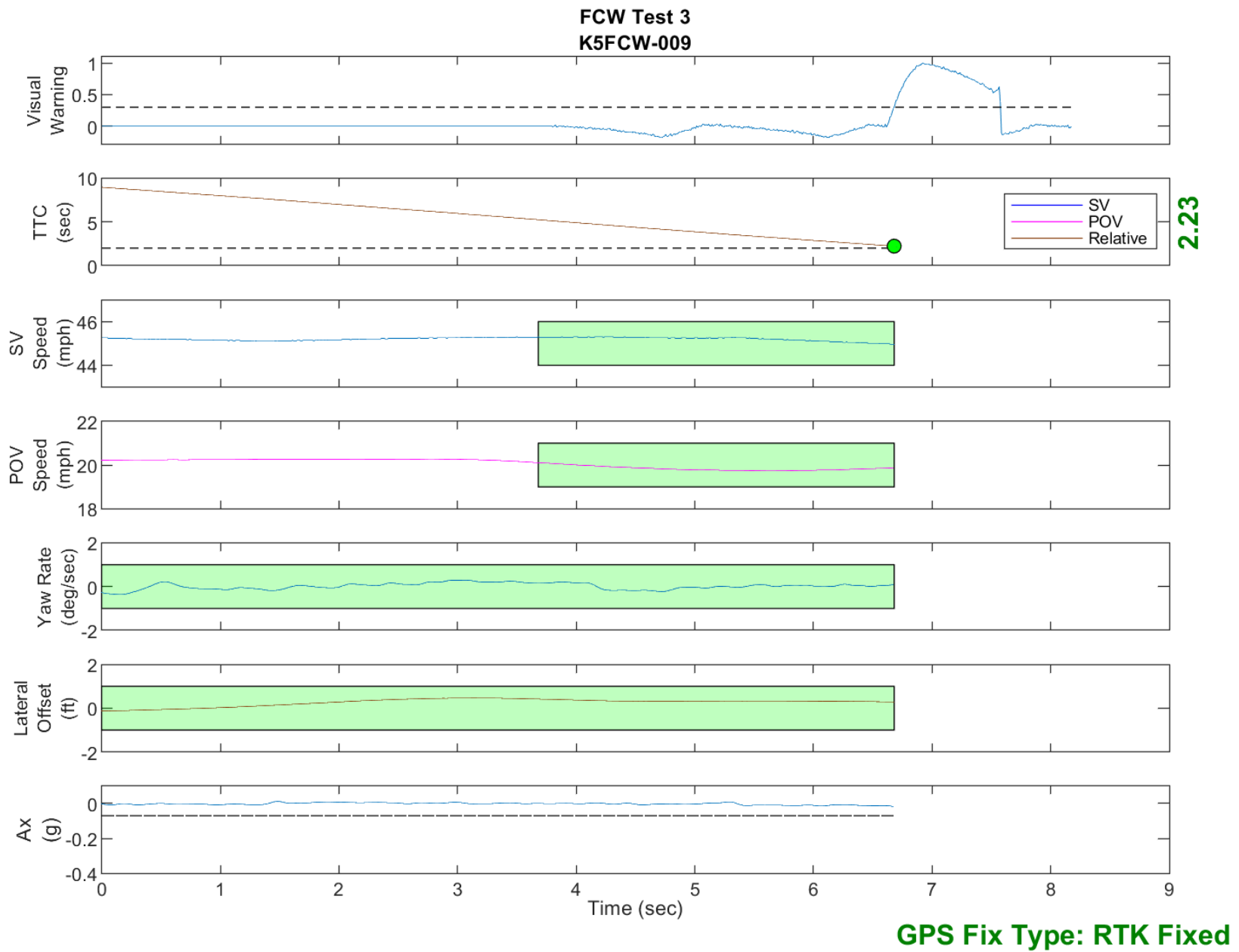


Figure D36. Time History for Run 9, FCW Test 3, Visual Warning

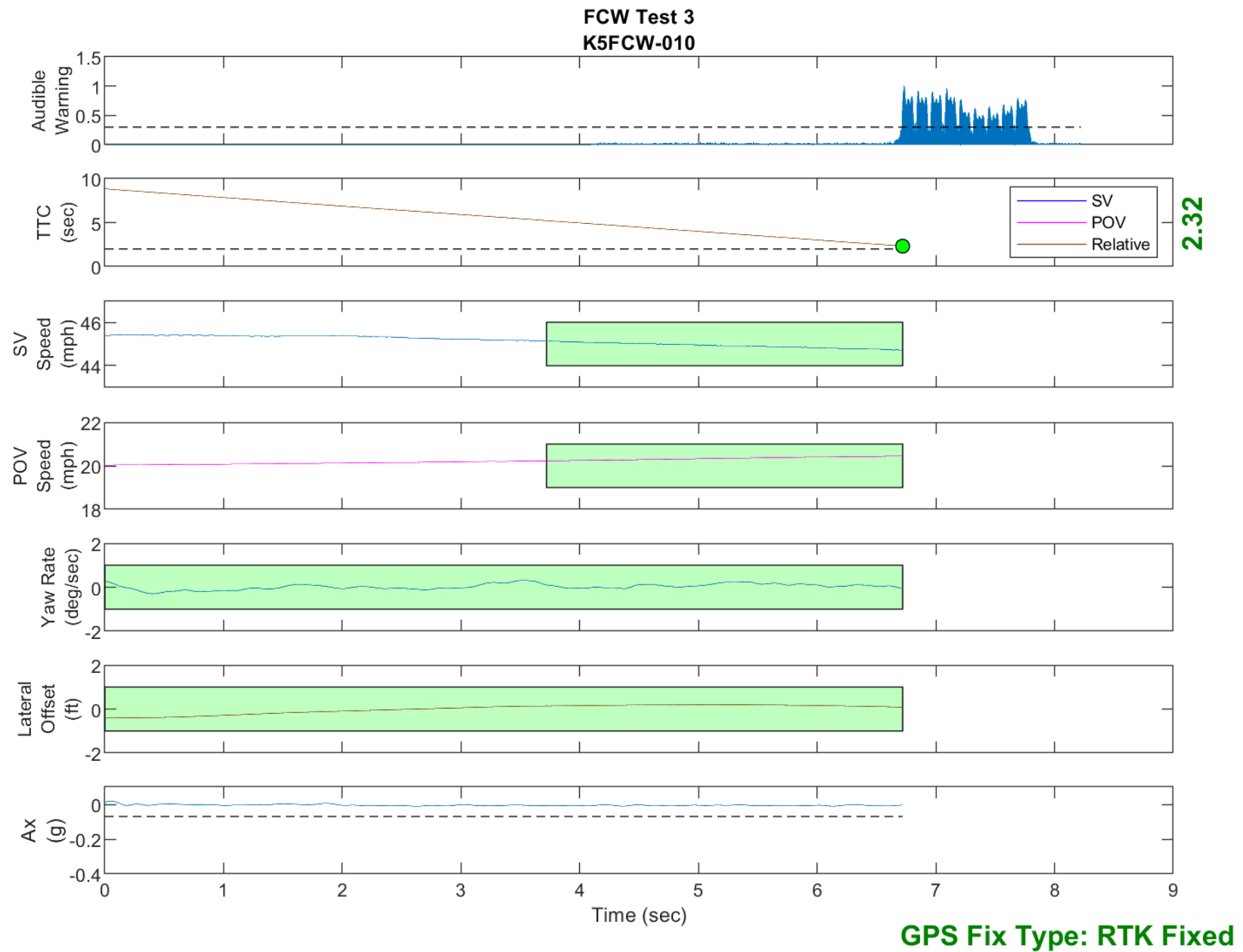


Figure D37. Time History for Run 10, FCW Test 3, Audible Warning

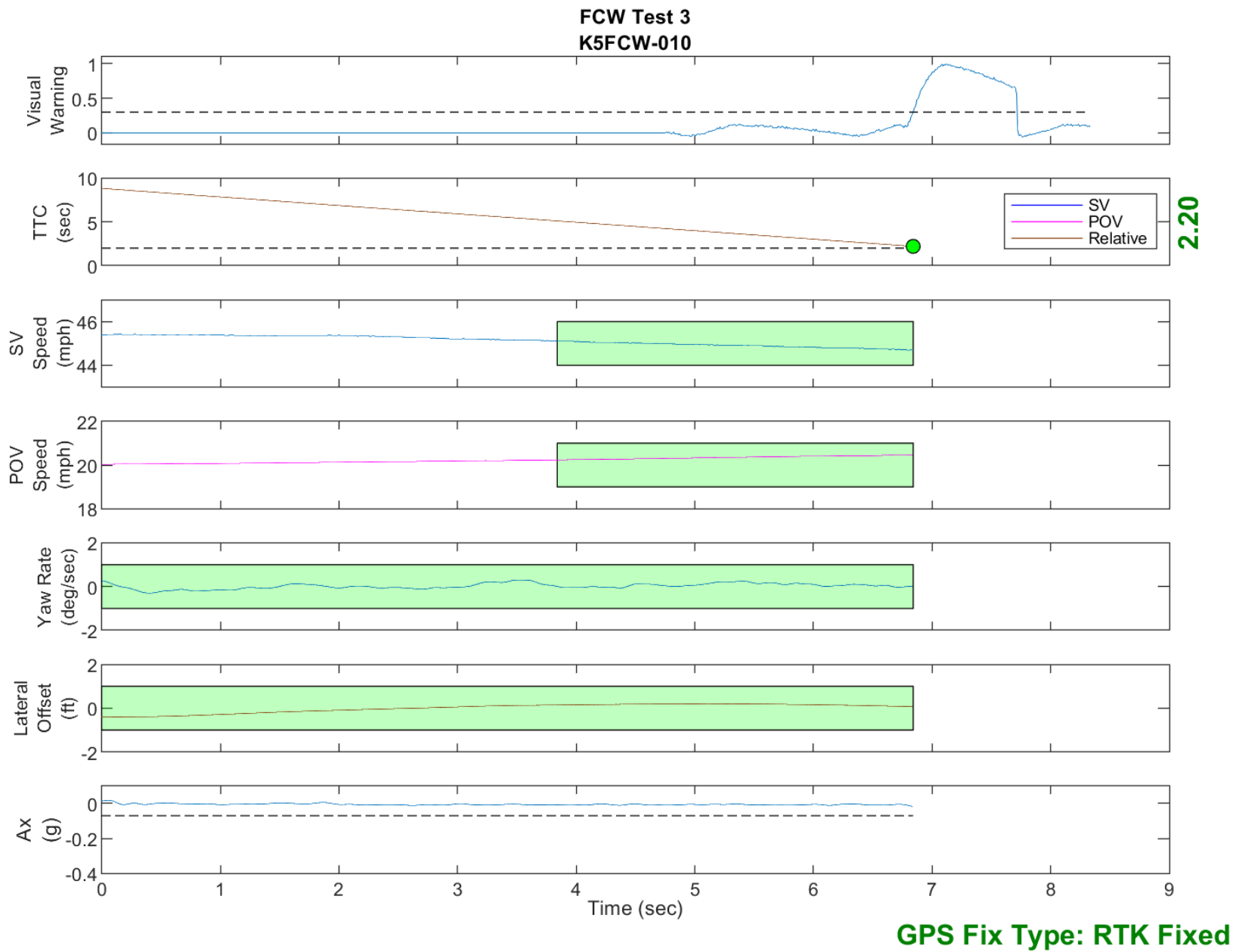


Figure D38. Time History for Run 10, FCW Test 3, Visual Warning

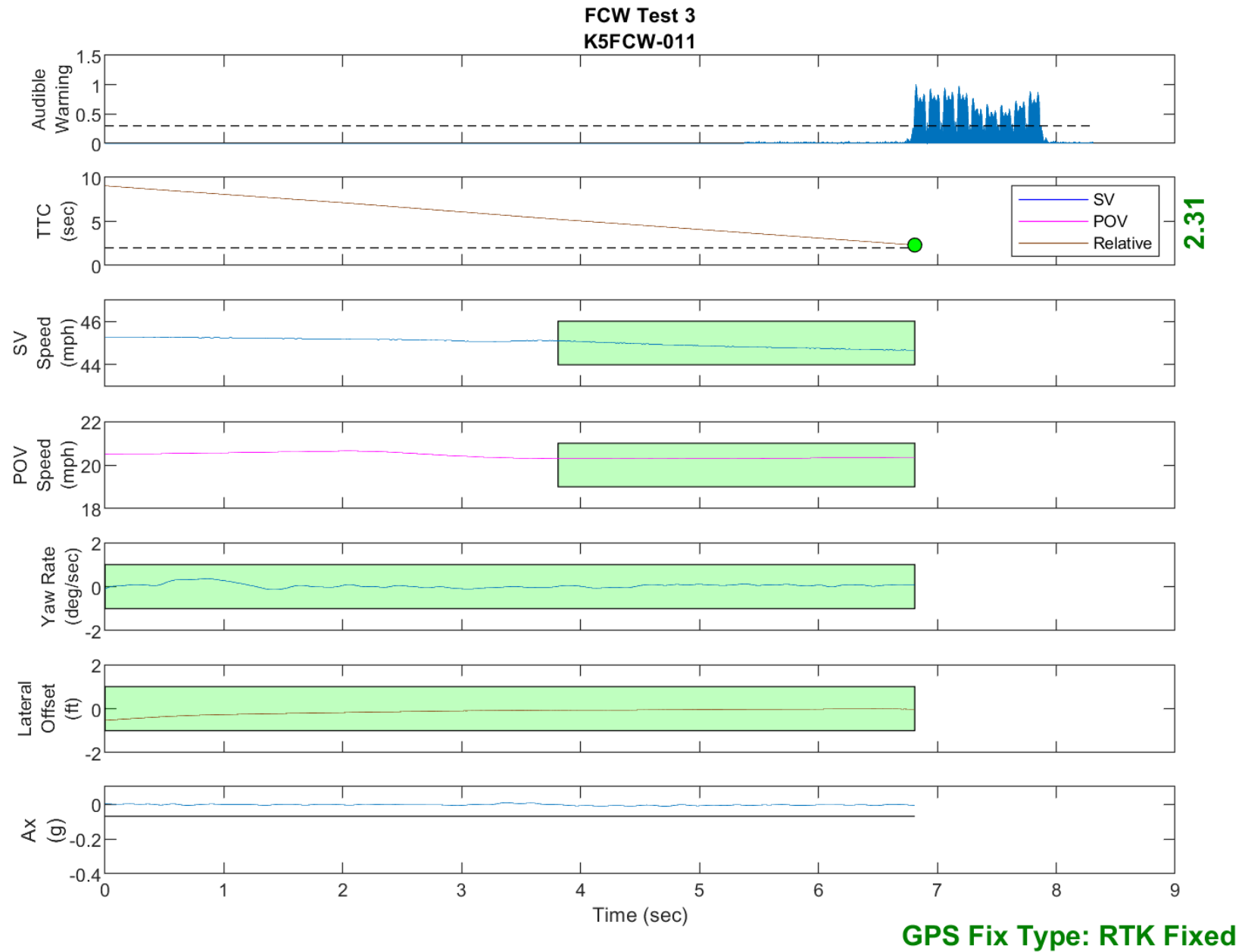


Figure D39. Time History for Run 11, FCW Test 3, Audible Warning

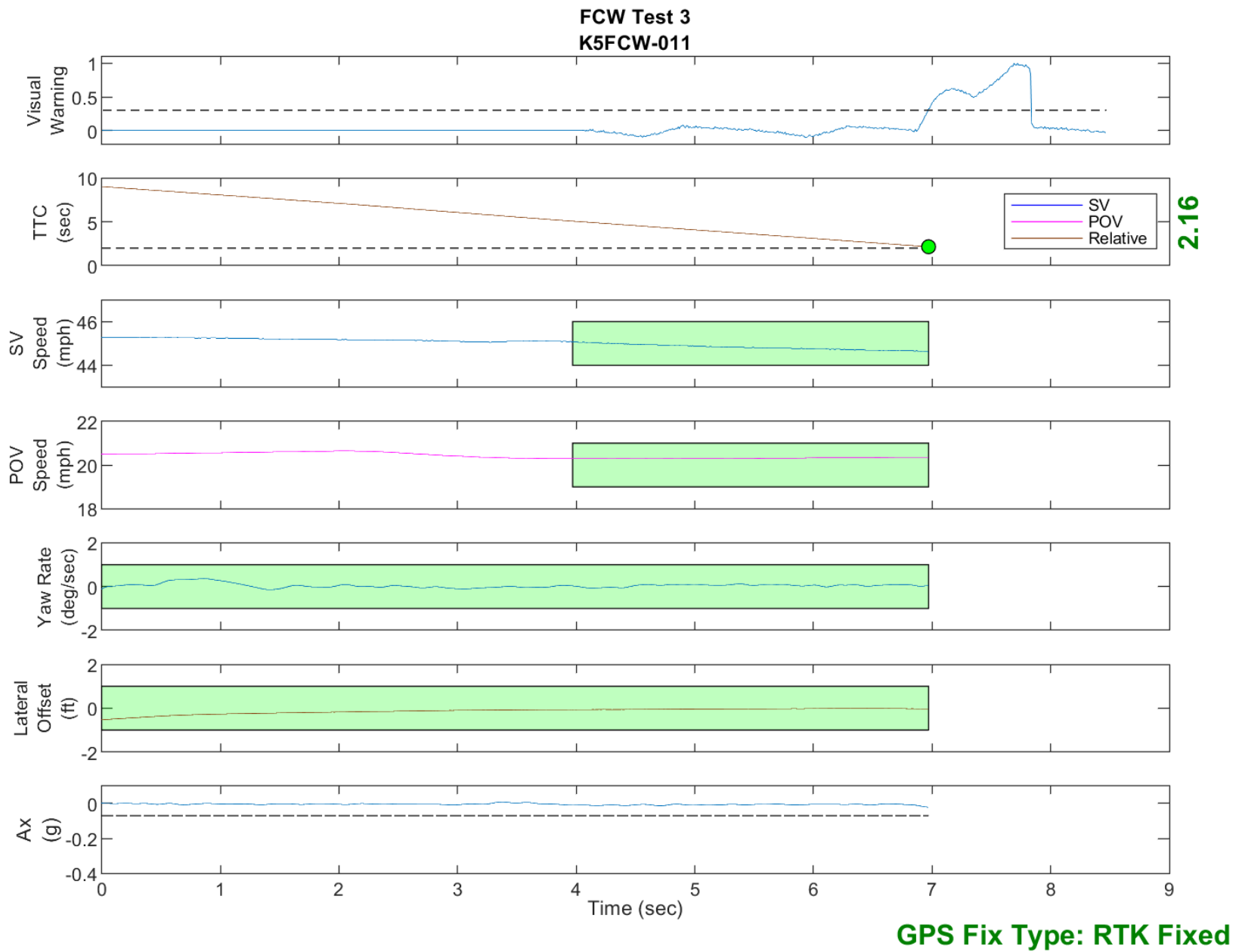


Figure D40. Time History for Run 11, FCW Test 3, Visual Warning

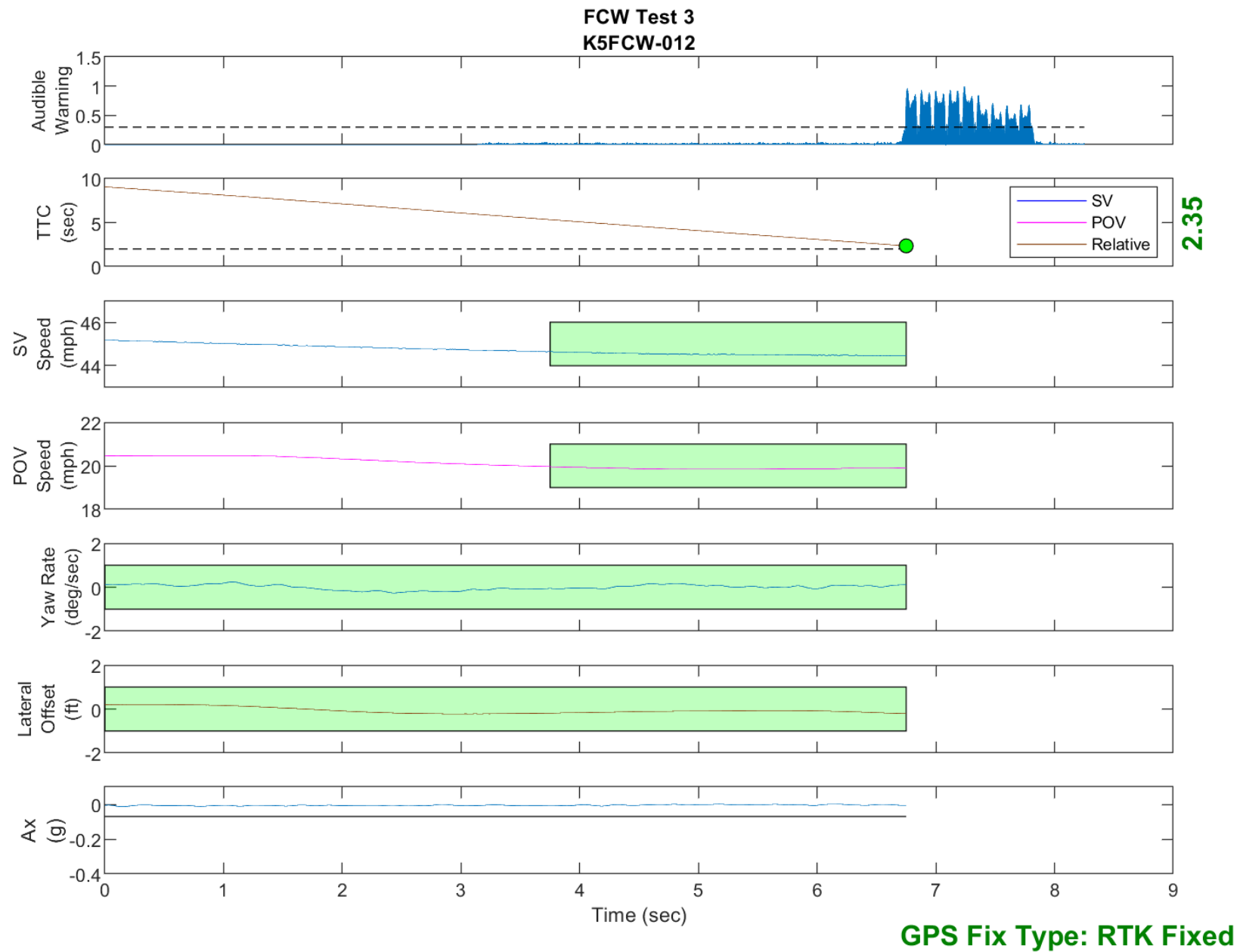


Figure D41. Time History for Run 12, FCW Test 3, Audible Warning

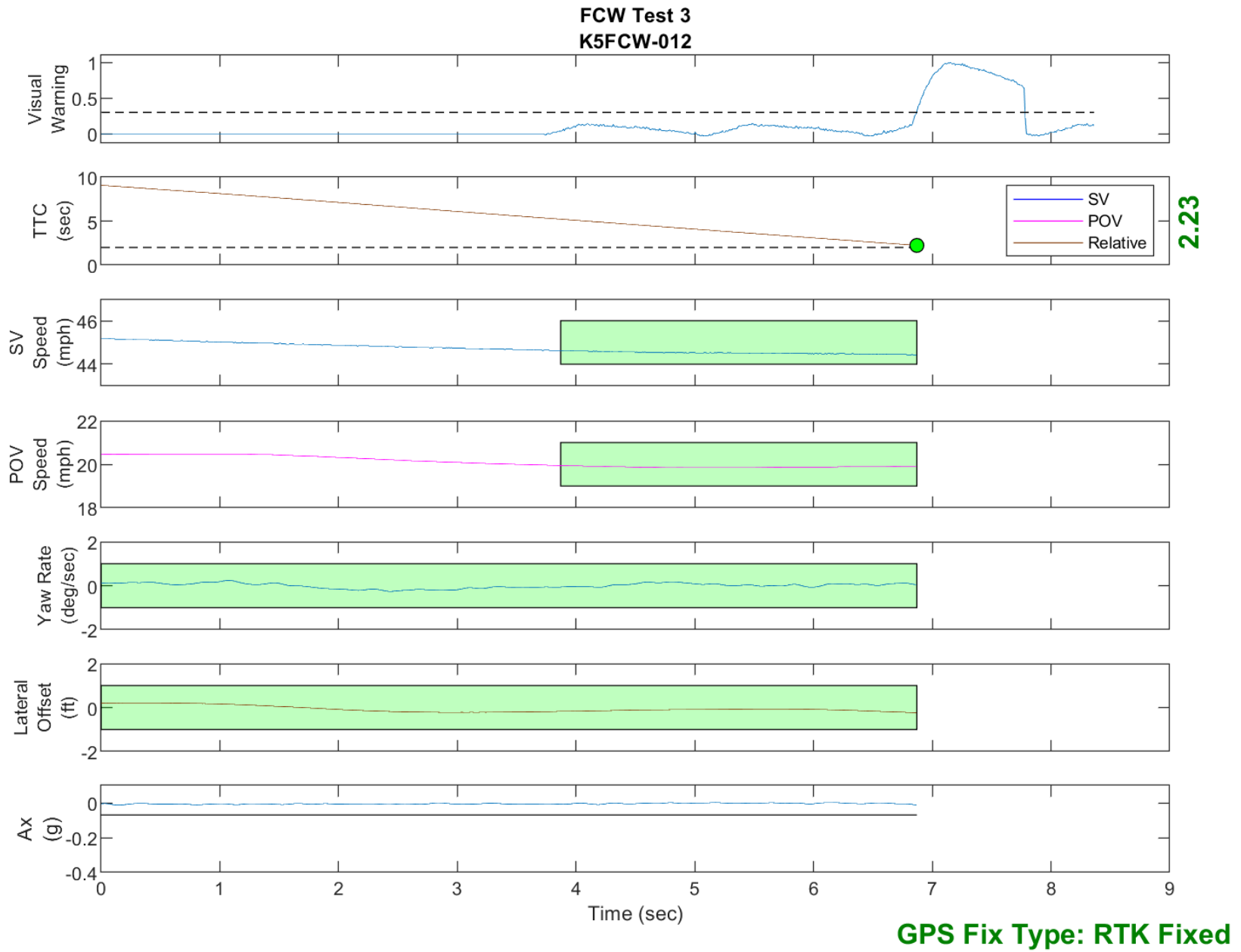


Figure D42. Time History for Run 12, FCW Test 3, Visual Warning

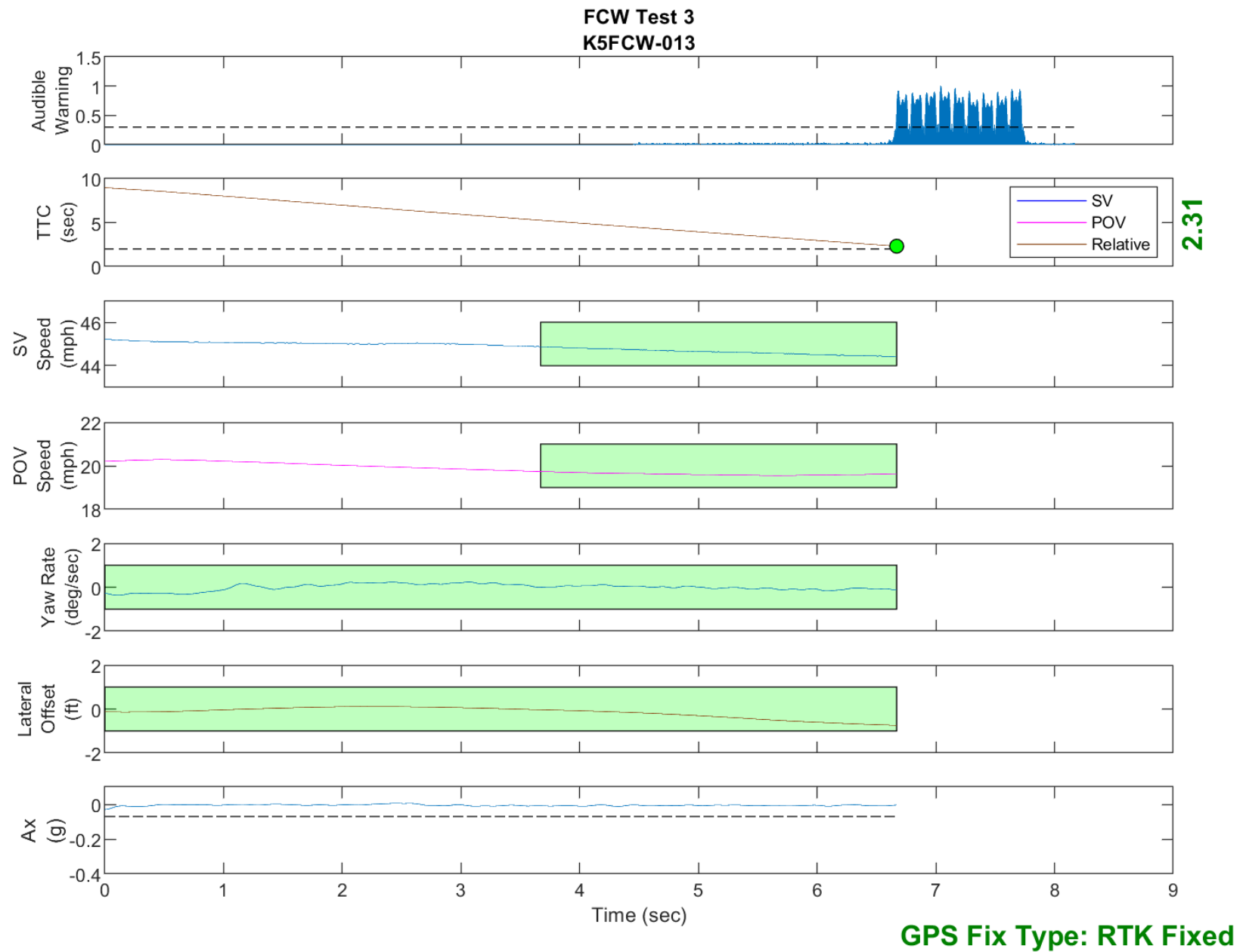


Figure D43. Time History for Run 13, FCW Test 3, Audible Warning

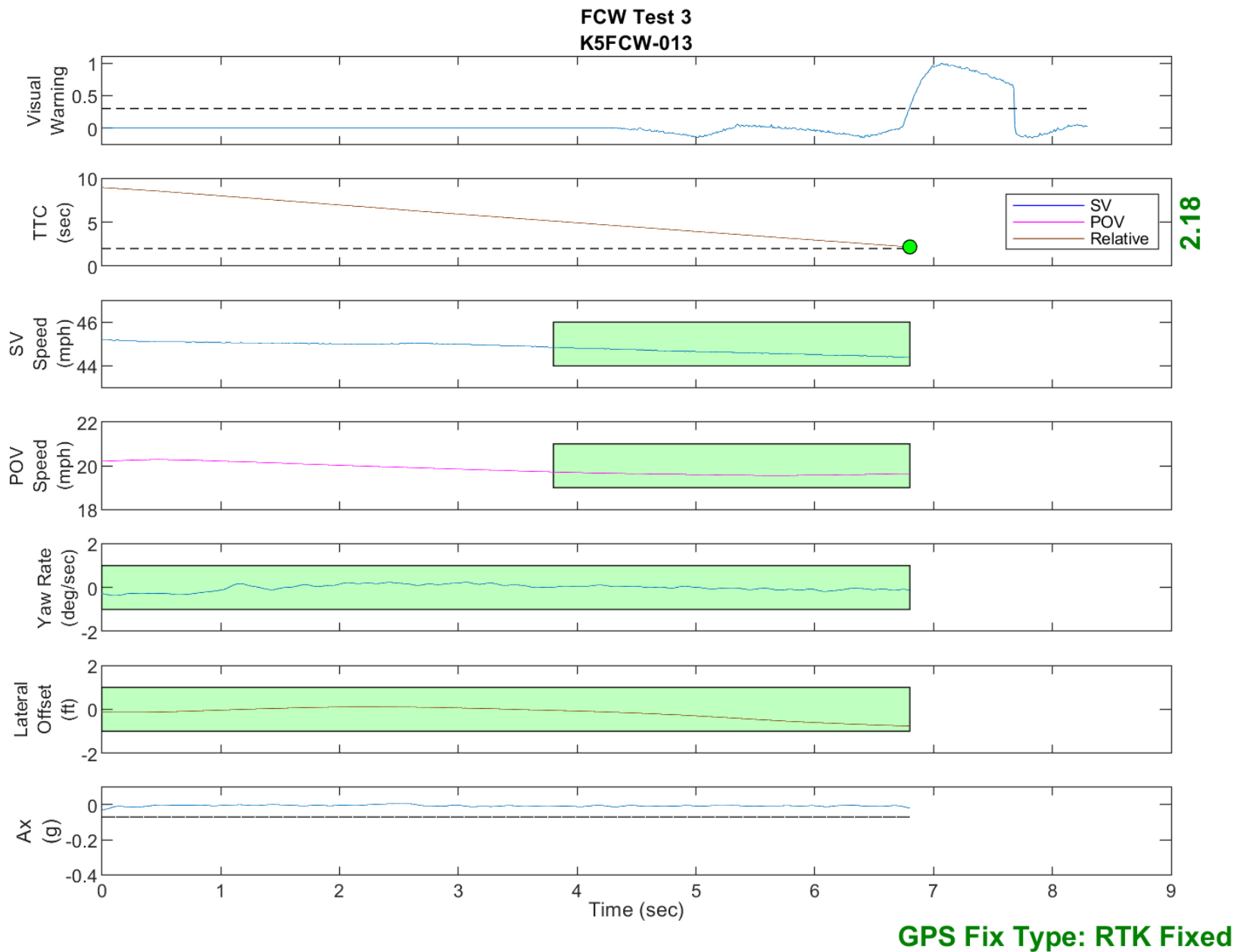


Figure D44. Time History for Run 13, FCW Test 3, Visual Warning

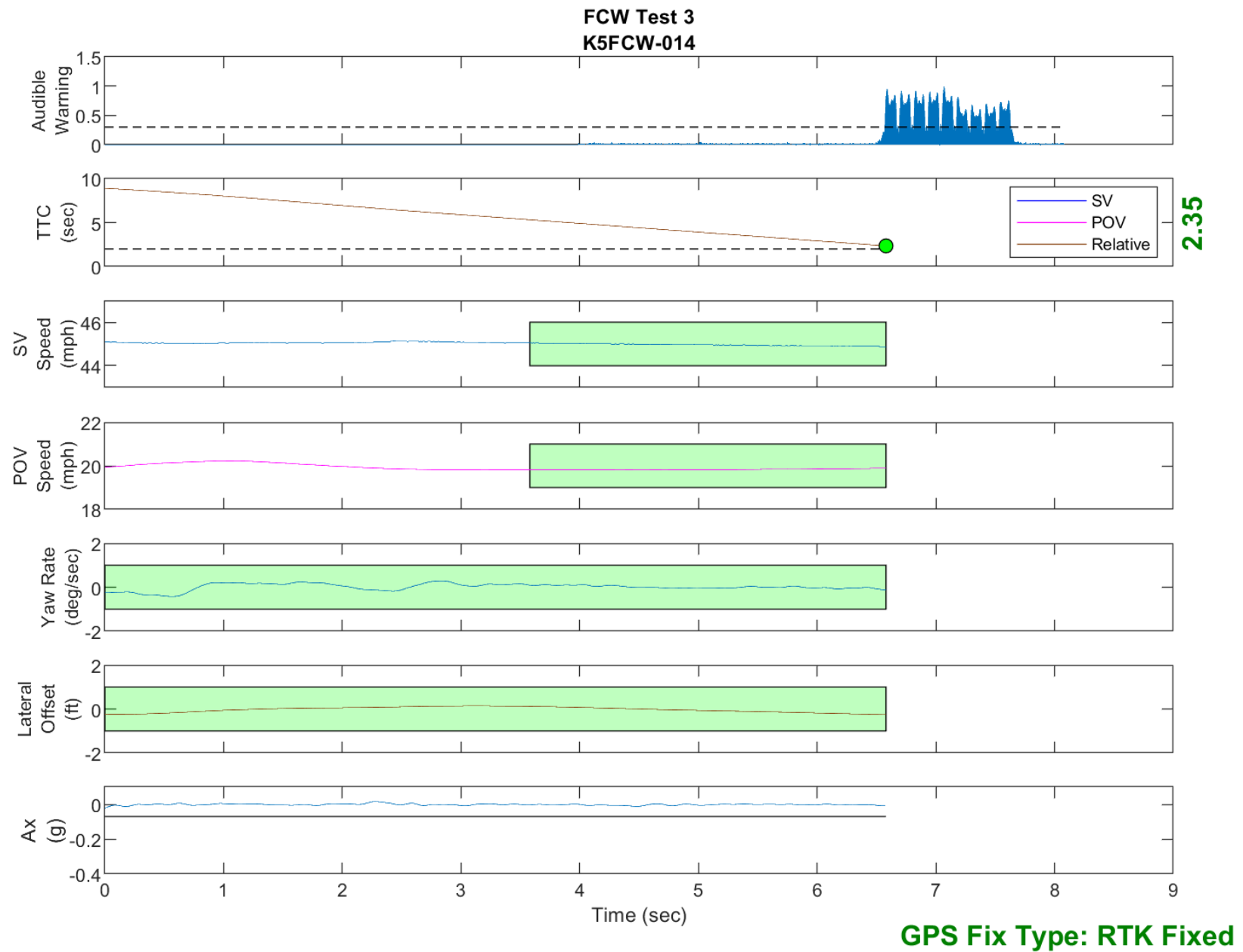


Figure D45. Time History for Run 14, FCW Test 3, Audible Warning

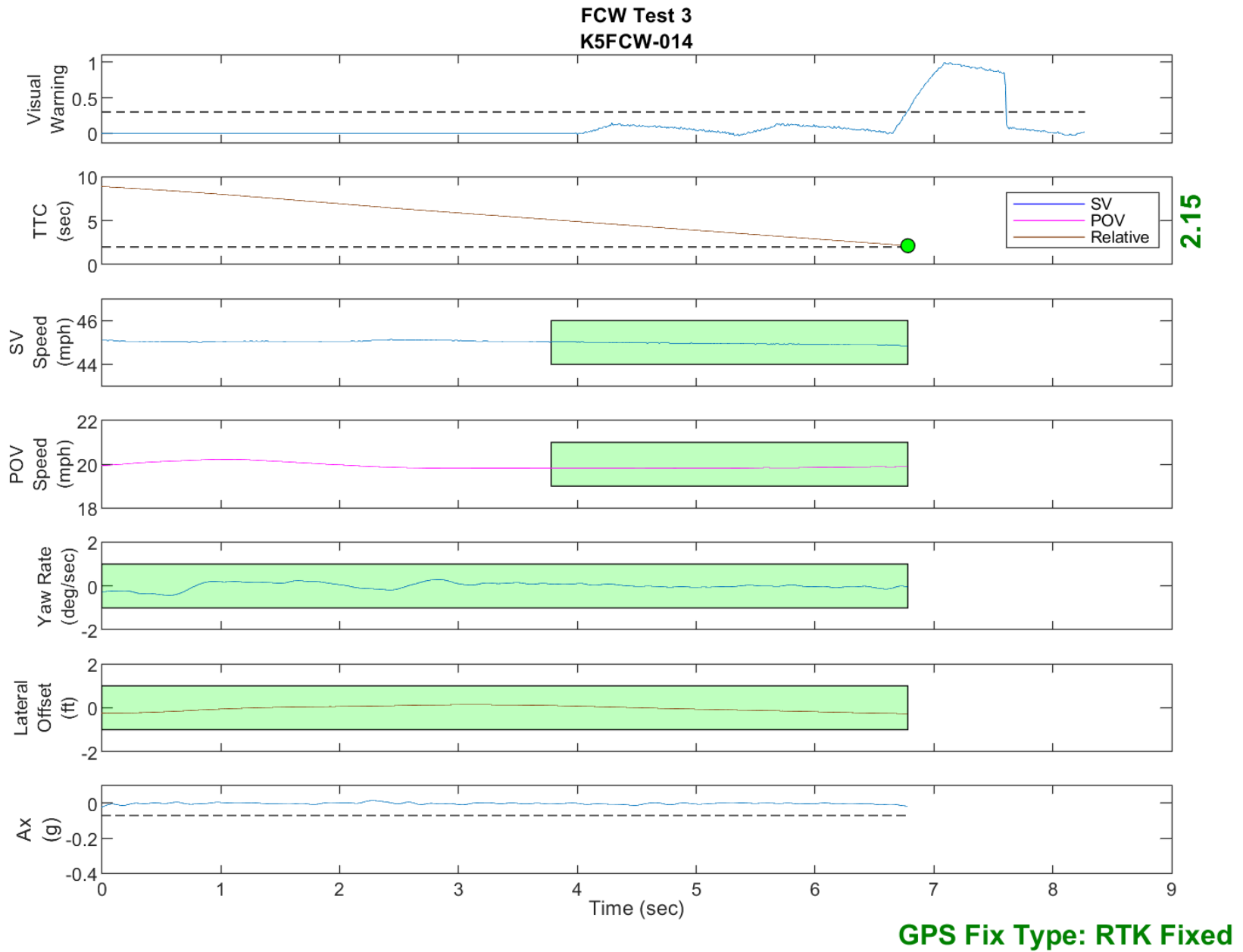


Figure D46. Time History for Run 14, FCW Test 3, Visual Warning

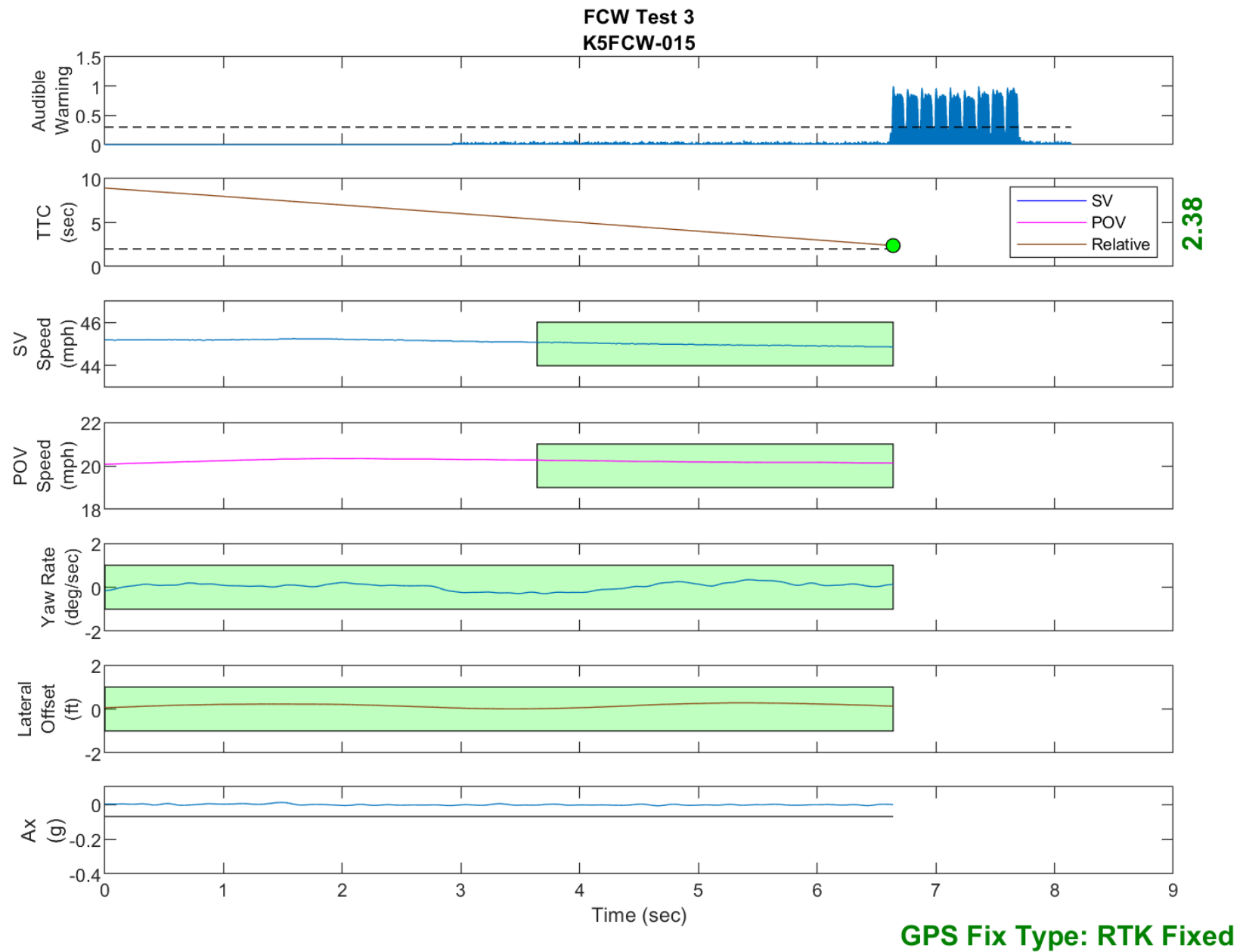


Figure D47. Time History for Run 15, FCW Test 3, Audible Warning

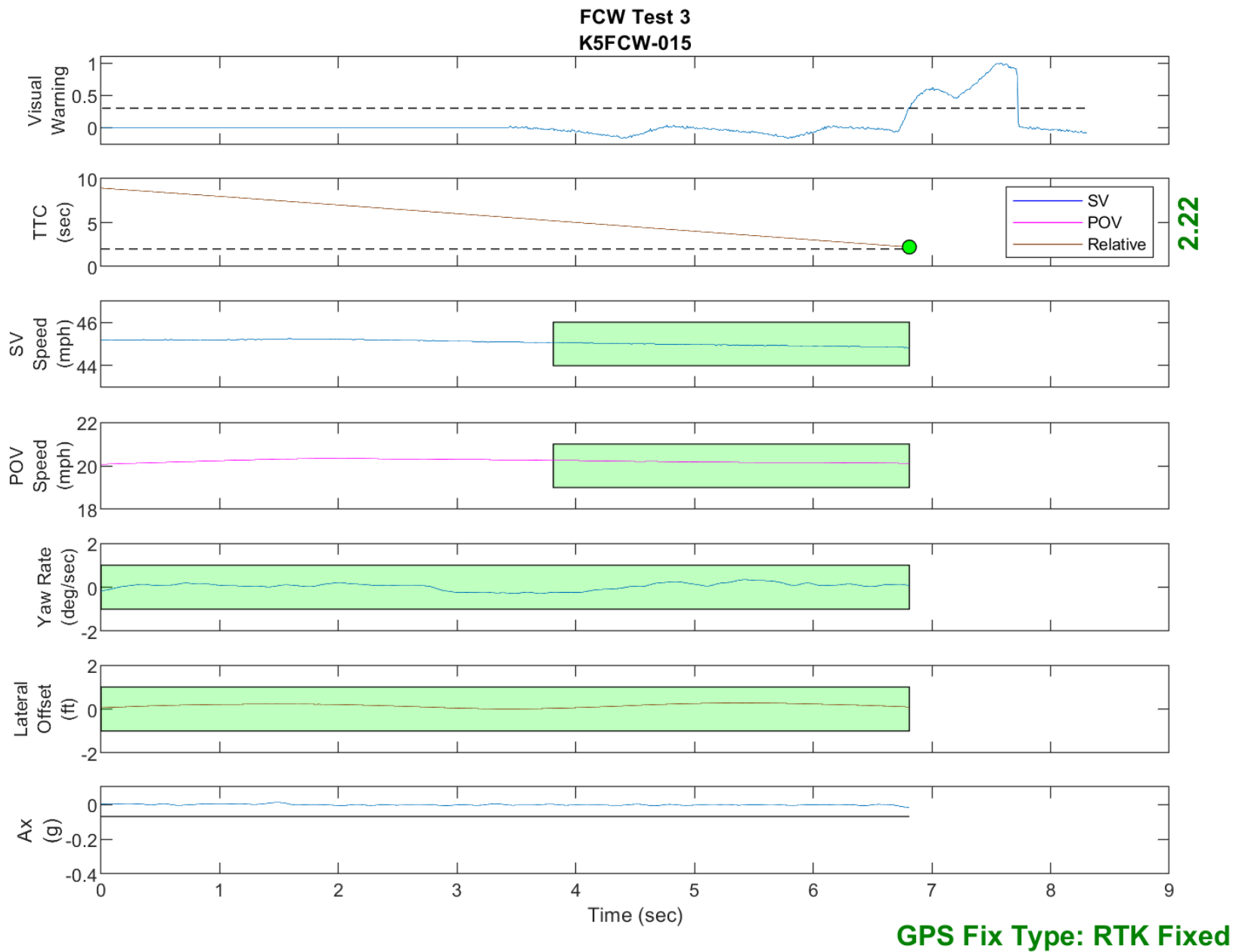


Figure D48. Time History for Run 15, FCW Test 3, Visual Warning