# NEW CAR ASSESSMENT PROGRAM
# FORWARD COLLISION WARNING CONFIRMATION TEST
# NCAP-DRI-FCW-21-03

## 2021 Dodge Durango GT Blacktop RWD


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**29 March 2021**

**Final Report**


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


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

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Program Manager Test Engineer

Date: 29 March 2021

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|---|---|---|---|
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| 16. Abstract<br>These tests were conducted on the subject 2021 Dodge Durango GT Blacktop RWD 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 failed the stopped POV scenario but passed the slower moving and decelerating scenarios. | | | |
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Section I

# INTRODUCTION

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

Section II

# DATA SHEETS

**FORWARD COLLISION WARNING**

**DATA SHEET 1: TEST RESULTS SUMMARY**

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**2021 Dodge Durango GT Blacktop RWD**

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VIN: *1C4RDHDG8MC51xxxx*

Test Date: *3/18/2021*

Forward Collision Warning setting: *Forward Collision Warning: Only Warning*

*Forward Collision Timing: Far*

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

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

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

Overall: ***Fail***

Notes:

**FORWARD COLLISION WARNING**

**DATA SHEET 2: VEHICLE DATA**



**2021 Dodge Durango GT Blacktop RWD**

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## TEST VEHICLE INFORMATION

VIN: *1C4RDHDG8MC51xxxx*

Body Style: *SUV* Color: *DB Black*

Date Received: *3/8/2021* Odometer Reading: *36 mi*

## DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *FCA US LLC*

Date of manufacture: *11-20*

Vehicle Type: *MPV*

## DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *265/50R20 107T*

Rear: *265/50R20 107T*

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

Rear: *250 kPa (36 psi)*

## TIRES

Tire manufacturer and model: *Bridgestone Ecopia H/L 422 Plus*

Front tire specification: *265/50R20 107T*

Rear tire specification: *265/50R20 107T*

Front tire DOT prefix: *7XUM EC1*

Rear tire DOT prefix: *7XUM EC1*

**FORWARD COLLISION WARNING**

**DATA SHEET 3: TEST CONDITIONS**

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**2021 Dodge Durango GT Blacktop RWD**

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## GENERAL INFORMATION

Test date: *3/18/2021*

## AMBIENT CONDITIONS

Air temperature: *15.6 C (60 F)*

Wind speed: *0.0 m/s (0.0 mph)*

**X** Wind speed ≤ 10 m/s (22 mph).

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

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

## VEHICLE PREPARATION

**Verify the following:**

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

Fuel tank is full: **X**

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

Front: *230 kPa (33 psi)*

Rear: *250 kPa (36 psi)*

**FORWARD COLLISION WARNING**

**DATA SHEET 3: TEST CONDITIONS**

**(Page 2 of 2)**

**2021 Dodge Durango GT Blacktop RWD**

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## WEIGHT

Weight of vehicle as tested including driver and instrumentation:

| | | | |
|---|---|---|---|
| Left Front: | *589.2 kg (1299 lb)* | Right Front: | *553.8 kg (1221 lb)* |
| Left Rear: | *598.7 kg (1320 lb)* | Right Rear: | *617.3 kg (1361 lb)* |
| | | Total: | *2359.0 kg (5201 lb)* |

**FORWARD COLLISION WARNING**

**DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION**

**(Page 1 of 3)**

**2021 Dodge Durango GT Blacktop RWD**

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

*Full-Speed Forward-Collision Warning Plus. It is available on the Durango, Durango SRT, Durango Pursuit models as part of the Technology Group.*

*In the Owner's Manual, it is referred to as Forward Collision Warning (FCW) and/or Forward Collision Warning (FCW) with Mitigation.*

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

*A camera is located in the top-center of the windshield. A radar is located behind the front vehicle fascia along the centerline of the vehicle.*

Forward Collision Warning Setting used in test: *Forward Collision Warning: Only Warning*

*Forward Collision Timing: Far*

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

- **X** Warning light
- **X** Buzzer or auditory alarm
- ____ Vibration
- ____ Other ____

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

*In the event of a Forward Collision Warning event, a loud auditory warning will be provided to the driver before the initiation of automated braking. A series of three high-pitched loud beeps will be provided together with a message in the cluster indicating that the driver should brake. The text that will be displayed is: "Brake!" See Appendix A, Figure A13.*

**FORWARD COLLISION WARNING**

**DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION**

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**2021 Dodge Durango GT Blacktop RWD**

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Is the vehicle equipped with a switch whose purpose is to render FCW inoperable? **X** Yes ____ No

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

*A center mounted touchscreen is used to interact with the system menus. The hierarchy is:*

*Vehicle*

*Safety & Driving Assistance*

*Automatic Emergency Braking*

*Forward Collision Warning*

*Select from "Off", "Only Warning", or "Warning + Active Braking"*

*See Appendix A, Figure A12.*

*System settings are stored across ignition cycles.*

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

If yes, please provide a full description.

*A center mounted touchscreen is used to interact with the system menus. The hierarchy is:*

*Vehicle*

*Safety & Driving Assistance*

*Automatic Emergency Braking*

*Forward Collision Sensitivity*

*Select from "Near", "Medium", or "Far"*

*See Appendix A, Figure A12.*

*System settings are stored across ignition cycles.*

**FORWARD COLLISION WARNING**

**DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION**

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**2021 Dodge Durango GT Blacktop RWD**

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

If yes, please provide a full description.

*Avoid driving into the sun for long intervals of time when the sun is at a low elevation angle above the horizon. Also make sure that a significant amount of snow does not accumulate on the fascia in the area that covers the radar (vehicle centerline).*

Notes:

*Radar blindness. If the vehicle is moving and the radar sees no targets for a period of approximately 2 minutes, CIB will become unavailable. An audible indication will be provided to the driver and the cluster will display the message "Wipe Front Radar Sensor in Front of Vehicle." This condition can be remedied by restarting the vehicle and letting the radar see stationary objects or moving vehicles.*

*Camera blindness. Camera blindness can generally be avoided by not attempting to drive for long intervals toward the sun when it is at a low elevation angle in the horizon. In the event that the camera becomes blinded, a message stating "ACC/FCW Limited Functionality" will be displayed. In the event that the camera detects a situation of limited visibility because of the dirty windshield, a message stating "ACC/FCW Limited Functionality Clean Front Windshield" will be displayed.*

Section III

# TEST PROCEDURES

## A. Test Procedure Overview

Three test procedures were used, as follows:

Test 1. Subject Vehicle (SV) Encounters Stopped Principal Other Vehicle (POV)

Test 2. Subject Vehicle Encounters Decelerating Principal Other Vehicle

Test 3. Subject Vehicle Encounters Slower Principal Other Vehicle

With the exception of trials associated with Test 1, all trials were performed with SV and POV automatic transmissions in ‘‘Drive’’ or with manual transmissions in the highest gear capable of sustaining the desired test speed. Manual transmission clutches remained engaged during all maneuvers. Except for Test 2, the brake lights of the POV were not illuminated.

In order to pass the test, if the FCW system provides a warning timing adjustment for the driver, at least one setting must meet the criterion of the test procedure. Therefore, if the vehicle was equipped with a warning timing adjustment, only the most “conservative” (earliest warning) setting was tested.

An overview of each of the test procedures follows.

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

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

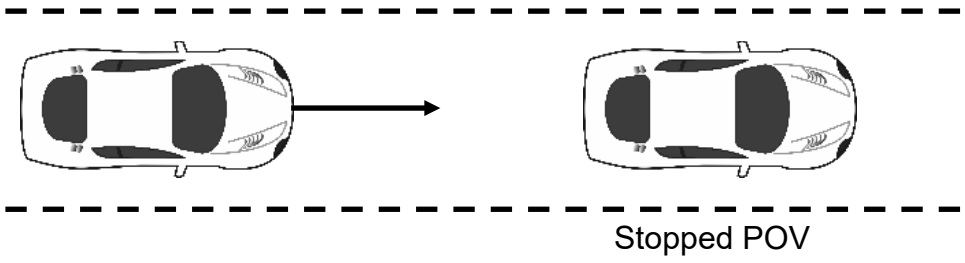



Figure 1. Depiction of Test 1

a. Alert Criteria

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

b. Procedure

The POV was parked in the center of a travel lane, with its longitudinal axis oriented parallel to the roadway edge and facing the same direction as the SV so that the SV approaches the rear of the POV.

The SV was driven at a nominal speed of 45 mph (72.4 km/h) in the center of the lane of travel, toward the parked POV. The test began when the SV was 492 ft (150 m) from the POV and ended when either of the following occurred:

- The required FCW alert occurred.
- The TTC to the POV fell to less than 90% of the minimum allowable range (i.e., TTC = 1.9 sec) for the onset of the required FCW alert.

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

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

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

Nominally, the Test 1 series was comprised of seven individual trials. The FCW system must satisfy the TTC alert criteria for at least five of the seven test trials.

2. TEST 2 – SUBJECT VEHICLE ENCOUNTERS DECELERATING PRINCIPAL OTHER VEHICLE

The SV in this test initially followed the POV at a constant time gap and then the POV suddenly decelerated, as depicted in Figure 2. The test evaluates the ability of the FCW to recognize a decelerating lead vehicle and to issue an alert to SV driver in a timely manner.

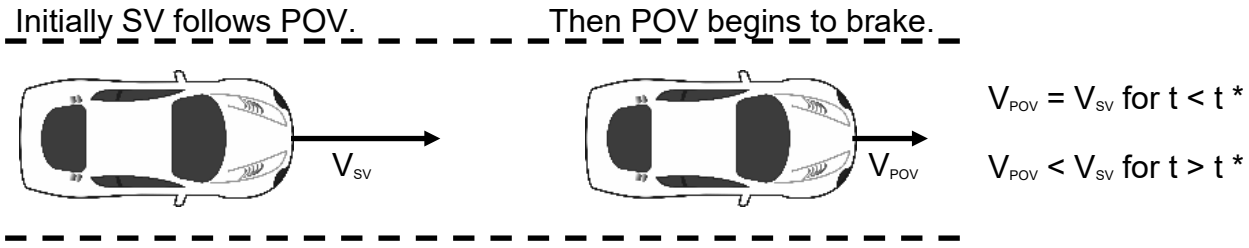



Figure 2. Depiction of Test 2

a. Alert Criteria

In order to pass the test, the FCW alert must be issued when TTC is at least 2.4 seconds. The TTC for this test, a prediction of the time it would take for the SV to collide with the POV, was calculated by considering three factors at the time of the FCW alert: (1) the speed of the SV, (2) the speed of the POV, and (3) the deceleration of the POV[1].

b. Procedure

Test 2 began with the SV and the POV traveling on a straight, flat road at a constant speed of 45.0 mph (72.4 km/h), in the center of the lane of travel. The headway from the SV to the POV was nominally maintained at 98.4 ft (30 m) until the POV braking was initiated.

The test began approximately 7 seconds before the driver of the POV started a braking maneuver in which the POV brakes were rapidly applied and modulated such that a constant deceleration of 0.3 g was achieved within 1.5 seconds after braking is initiated. The test ended when either of the following conditions was satisfied:

- The required FCW alert occurred.
- The TTC to the POV fell to less than 90% of the minimum allowable range (i.e., TTC = 2.2 sec) for the onset of the required FCW alert.

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

[1]To simplify calculation of the TTC for Test 2, the deceleration of the POV is assumed to remain constant from the time of the FCW alert until the POV comes to a stop (i.e., a “constant” rate of slowing is assumed).

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

- The initial POV vehicle speed could not deviate from the nominal speed by more than 1.0 mph (1.6 km/h) for a period of 3 seconds prior to the initiation of POV braking.
- The speed of the SV could not deviate from the nominal speed by more than 1.0 mph (1.6 km/h) for a period of 3 seconds prior to (1) the required FCW alert or (2) before the range fell to less than 90% of the minimum allowable range for onset of the required FCW alert.
- The lateral distance between the centerline of the SV, relative to the centerline of the POV, in road coordinates, could not exceed 2.0 ft (0.6 m).
- The yaw rates of the SV and POV could not exceed ±1 deg/sec during the test.
- The POV deceleration level was nominally required to be 0.3 g within 1.5 seconds after initiation of POV braking. The acceptable error magnitude of the POV deceleration was ±0.03 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).

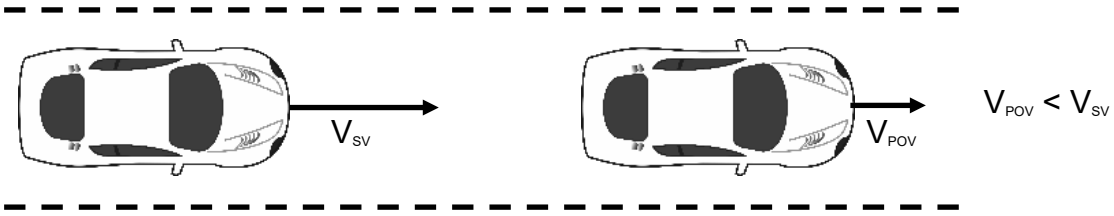



Figure 3. Depiction of Test 3

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<br>0-690 kPa | < 1% error between 20 and 100 psi | Omega DPG8001 | 17042707002 | By: DRI<br>Date: 8/18/2020<br>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<br>Date: 4/20/2020<br>Due: 4/20/2021 |
| Differential Global Positioning System | Position, Velocity | Latitude: ±90 deg<br>Longitude: ±180 deg<br>Altitude: 0-18 km<br>Velocity: 0-1000 knots | Horizontal Position: ±1 cm<br>Vertical Position: ±2 cm<br>Velocity: 0.05 km/h | Trimble GPS Receiver, 5700 (base station and in-vehicle) | 00440100989 | N/A |
| Multi-Axis Inertial Sensing System | Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles | Accels ± 10g, Angular Rate ±100 deg/s, Angle >45 deg, Velocity >200 km/h | Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h | | | By: Oxford Technical Solutions |
| | | | | SV: Oxford Inertial + | 2258 | Date: 5/3/2019<br>Due: 5/3/2021 |
| | | | | POV: | 2182 | Date: 9/16/2019<br>Due: 9/16/2021 |
| Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW) | Distance and Velocity to lane markings (LDW) and POV (FCW) | Lateral Lane Dist: ±30 m<br>Lateral Lane Velocity: ±20 m/sec<br>Longitudinal Range to POV: ±200 m<br>Longitudinal Range Rate: ±50 m/sec | Lateral Distance to Lane Marking: ±2 cm<br>Lateral Velocity to Lane Marking: ±0.02m/sec<br>Longitudinal Range: ±3 cm<br>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<br>0-2.4 m | ±.0020 in.<br>±.051 mm<br>(Single point articulation accuracy) | Faro Arm, Fusion | UO8-05-08-06636 | By: DRI<br>Date: 1/6/2021<br>Due: 1/6/2022 |

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

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

**Table 2. Auditory and Tactile Warning Filter Parameters**

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

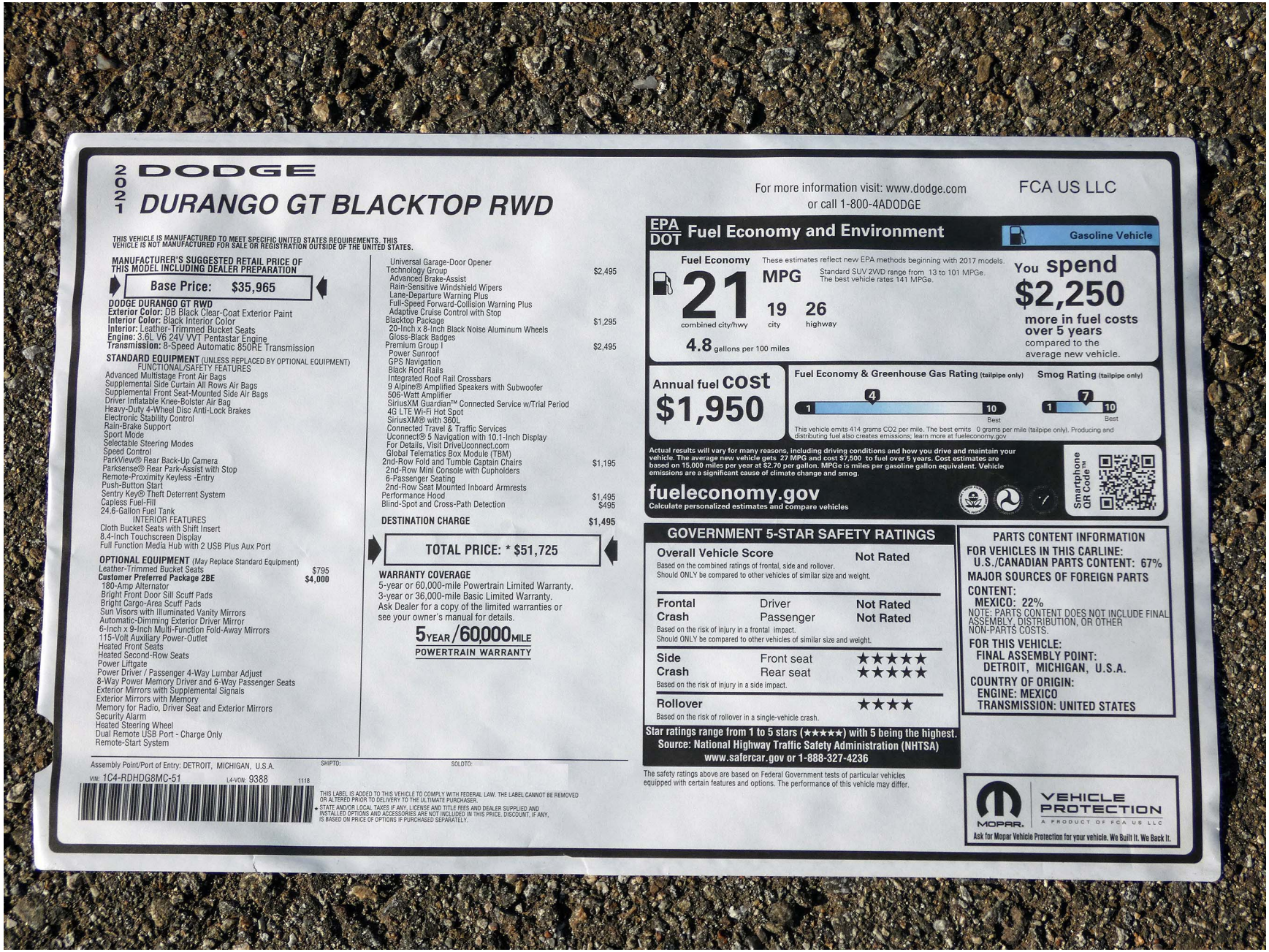
# APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2.  Rear View of Subject Vehicle



2021 DODGE
DURANGO GT BLACKTOP RWD

THIS VEHICLE IS MANUFACTURED TO MEET SPECIFIC UNITED STATES REQUIREMENTS. THIS VEHICLE IS NOT MANUFACTURED FOR SALE OR REGISTRATION OUTSIDE OF THE UNITED STATES.

MANUFACTURER'S SUGGESTED RETAIL PRICE OF THIS MODEL INCLUDING DEALER PREPARATION

Base Price: $35,965

DODGE DURANGO GT RWD
Exterior Color: DB Black Clear-Coat Exterior Paint
Interior Color: Black Interior Color
Interior: Leather-Trimmed Bucket Seats
Engine: 3.6L V6 24V VVT Pentastar Engine
Transmission: 8-Speed Automatic 850RE Transmission

STANDARD EQUIPMENT (UNLESS REPLACED BY OPTIONAL EQUIPMENT)
FUNCTIONAL/SAFETY FEATURES
Advanced Multistage Front Air Bags
Supplemental Side Curtain All Rows Air Bags
Supplemental Front Seat-Mounted Side Air Bags
Driver Inflatable Knee-Bolster Air Bag
Heavy-Duty 4-Wheel Disc Anti-Lock Brakes
Electronic Stability Control
Rain-Brake Support
Sport Mode
Selectable Steering Modes
Speed Control
ParkView® Rear Back-Up Camera
Parksense® Rear Park-Assist with Stop
Remote-Proximity Keyless -Entry
Push-Button Start
Sentry Key® Theft Deterrent System
Capless Fuel-Fill
24.6-Gallon Fuel Tank
INTERIOR FEATURES
Cloth Bucket Seats with Shift Insert
8.4-Inch Touchscreen Display
Full Function Media Hub with 2 USB Plus Aux Port

OPTIONAL EQUIPMENT (May Replace Standard Equipment)
Leather-Trimmed Bucket Seats $795
Customer Preferred Package 2BE $4,000
180-Amp Alternator
Bright Front Door Sill Scuff Pads
Bright Cargo-Area Scuff Pads
Sun Visors with Illuminated Vanity Mirrors
Automatic-Dimming Exterior Driver Mirror
6-Inch x 9-Inch Multi-Function Fold-Away Mirrors
115-Volt Auxiliary Power-Outlet
Heated Front Seats
Heated Second-Row Seats
Power Liftgate
Power Driver / Passenger 4-Way Lumbar Adjust
8-Way Power Memory Driver and 6-Way Passenger Seats
Exterior Mirrors with Supplemental Signals
Exterior Mirrors with Memory
Memory for Radio, Driver Seat and Exterior Mirrors
Security Alarm
Heated Steering Wheel
Dual Remote USB Port - Charge Only
Remote-Start System
Universal Garage-Door Opener
Technology Group $2,495
Advanced Brake-Assist
Rain-Sensitive Windshield Wipers
Lane-Departure Warning Plus
Full-Speed Forward-Collision Warning Plus
Adaptive Cruise Control with Stop
Blacktop Package $1,295
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Gloss-Black Badges
Premium Group I $2,495
Power Sunroof
GPS Navigation
Black Roof Rails
Integrated Roof Rail Crossbars
9 Alpine® Amplified Speakers with Subwoofer
506-Watt Amplifier
SiriusXM Guardian™ Connected Service w/Trial Period
4G LTE Wi-Fi Hot Spot
SiriusXM® with 360L
Connected Travel & Traffic Services
Uconnect® 5 Navigation with 10.1-Inch Display
For Details, Visit DriveUconnect.com
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2nd-Row Fold and Tumble Captain Chairs $1,195
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6-Passenger Seating
2nd-Row Seat Mounted Inboard Armrests
Performance Hood $1,495
Blind-Spot and Cross-Path Detection $495

DESTINATION CHARGE $1,495

TOTAL PRICE: * $51,725

WARRANTY COVERAGE
5-year or 60,000-mile Powertrain Limited Warranty.
3-year or 36,000-mile Basic Limited Warranty.
Ask Dealer for a copy of the limited warranties or see your owner's manual for details.

5 YEAR / 60,000 MILE
POWERTRAIN WARRANTY

Assembly Point/Port of Entry: DETROIT, MICHIGAN, U.S.A.
SHIPTO: SOLDTO:
VIN: 1C4-RDHDG8MC-51 L4-VON: 9388 1118

THIS LABEL IS ADDED TO THIS VEHICLE TO COMPLY WITH FEDERAL LAW. THE LABEL CANNOT BE REMOVED OR ALTERED PRIOR TO DELIVERY TO THE ULTIMATE PURCHASER.
* STATE AND/OR LOCAL TAXES IF ANY, LICENSE AND TITLE FEES AND DEALER SUPPLIED AND INSTALLED OPTIONS AND ACCESSORIES ARE NOT INCLUDED IN THIS PRICE. DISCOUNT, IF ANY, IS BASED ON PRICE OF OPTIONS IF PURCHASED SEPARATELY.

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FCA US LLC

EPA DOT Fuel Economy and Environment — Gasoline Vehicle

Fuel Economy
21 MPG
combined city/hwy
19 city
26 highway
4.8 gallons per 100 miles

These estimates reflect new EPA methods beginning with 2017 models.
Standard SUV 2WD range from 13 to 101 MPGe.
The best vehicle rates 141 MPGe.

You spend $2,250 more in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost $1,950

Fuel Economy & Greenhouse Gas Rating (tailpipe only): 4 (1 – 10, Best)
Smog Rating (tailpipe only): 7 (1 – 10, Best)

This vehicle emits 414 grams CO2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also creates emissions; learn more at fueleconomy.gov

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and cost $7,500 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $2.70 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov
Calculate personalized estimates and compare vehicles

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GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score: Not Rated
Based on the combined ratings of frontal, side and rollover.
Should ONLY be compared to other vehicles of similar size and weight.

Frontal Crash — Driver: Not Rated; Passenger: Not Rated
Based on the risk of injury in a frontal impact.
Should ONLY be compared to other vehicles of similar size and weight.

Side Crash — Front seat: ★★★★★; Rear seat: ★★★★★
Based on the risk of injury in a side impact.

Rollover: ★★★★
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

The safety ratings above are based on Federal Government tests of particular vehicles equipped with certain features and options. The performance of this vehicle may differ.

PARTS CONTENT INFORMATION
FOR VEHICLES IN THIS CARLINE:
U.S./CANADIAN PARTS CONTENT: 67%
MAJOR SOURCES OF FOREIGN PARTS CONTENT:
MEXICO: 22%
NOTE: PARTS CONTENT DOES NOT INCLUDE FINAL ASSEMBLY, DISTRIBUTION, OR OTHER NON-PARTS COSTS.
FOR THIS VEHICLE:
FINAL ASSEMBLY POINT:
DETROIT, MICHIGAN, U.S.A.
COUNTRY OF ORIGIN:
ENGINE: MEXICO
TRANSMISSION: UNITED STATES

MOPAR. VEHICLE PROTECTION
A PRODUCT OF FCA US LLC
Ask for Mopar Vehicle Protection for your vehicle. We Built It. We Back It.

Figure A3. Window Sticker (Monroney Label)


Figure A4. Vehicle Certification Label

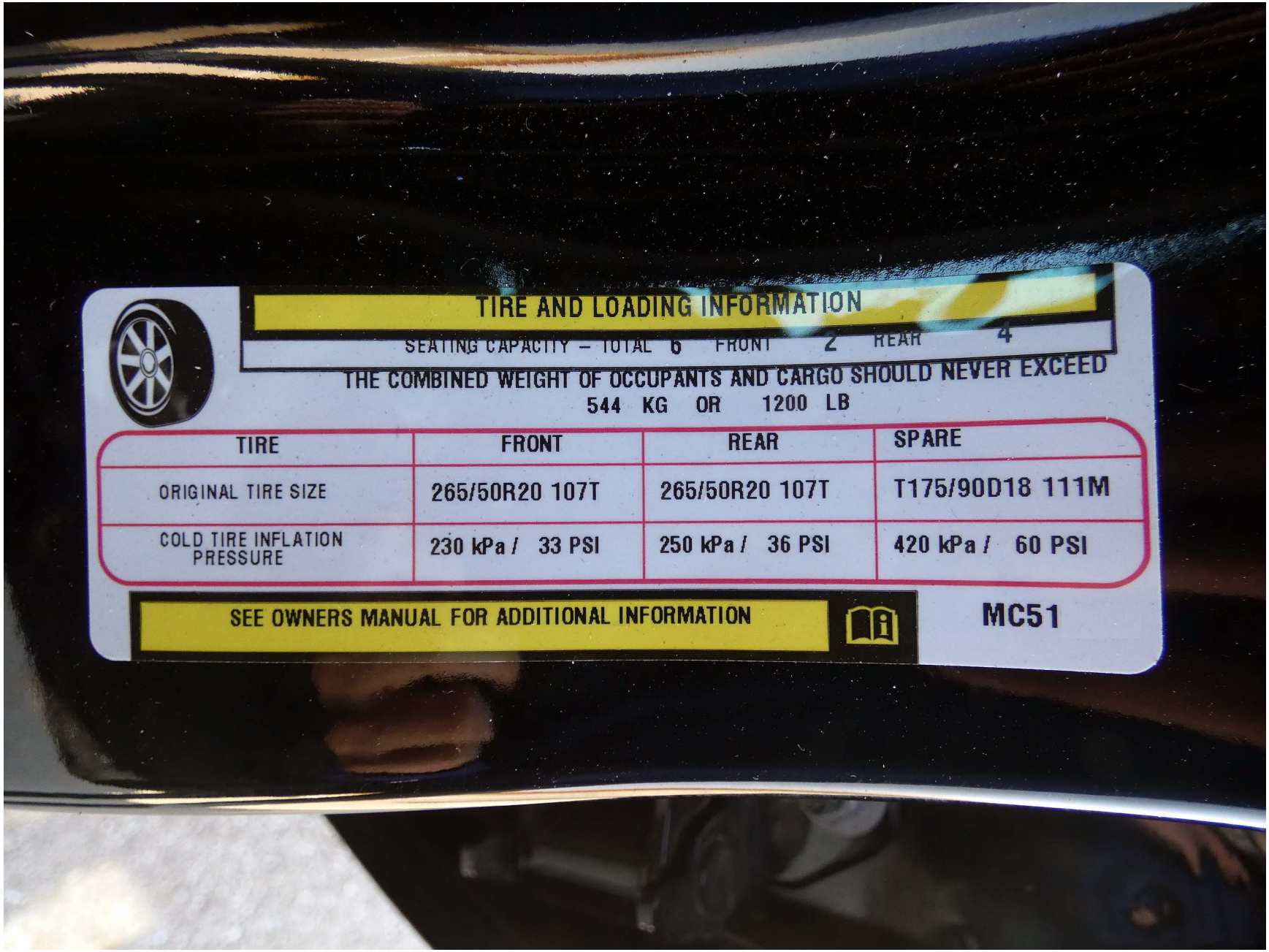


Figure A5. Tire Placard


Figure A6. Front View of Principal Other Vehicle


Figure A7. Rear View of Principal Other Vehicle


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

Figure A9. Sensors for Detecting Auditory and Visual Alerts


Figure A10. Computer Installed in Subject Vehicle


Figure A11. Brake Actuation System Installed in Principal Other Vehicle

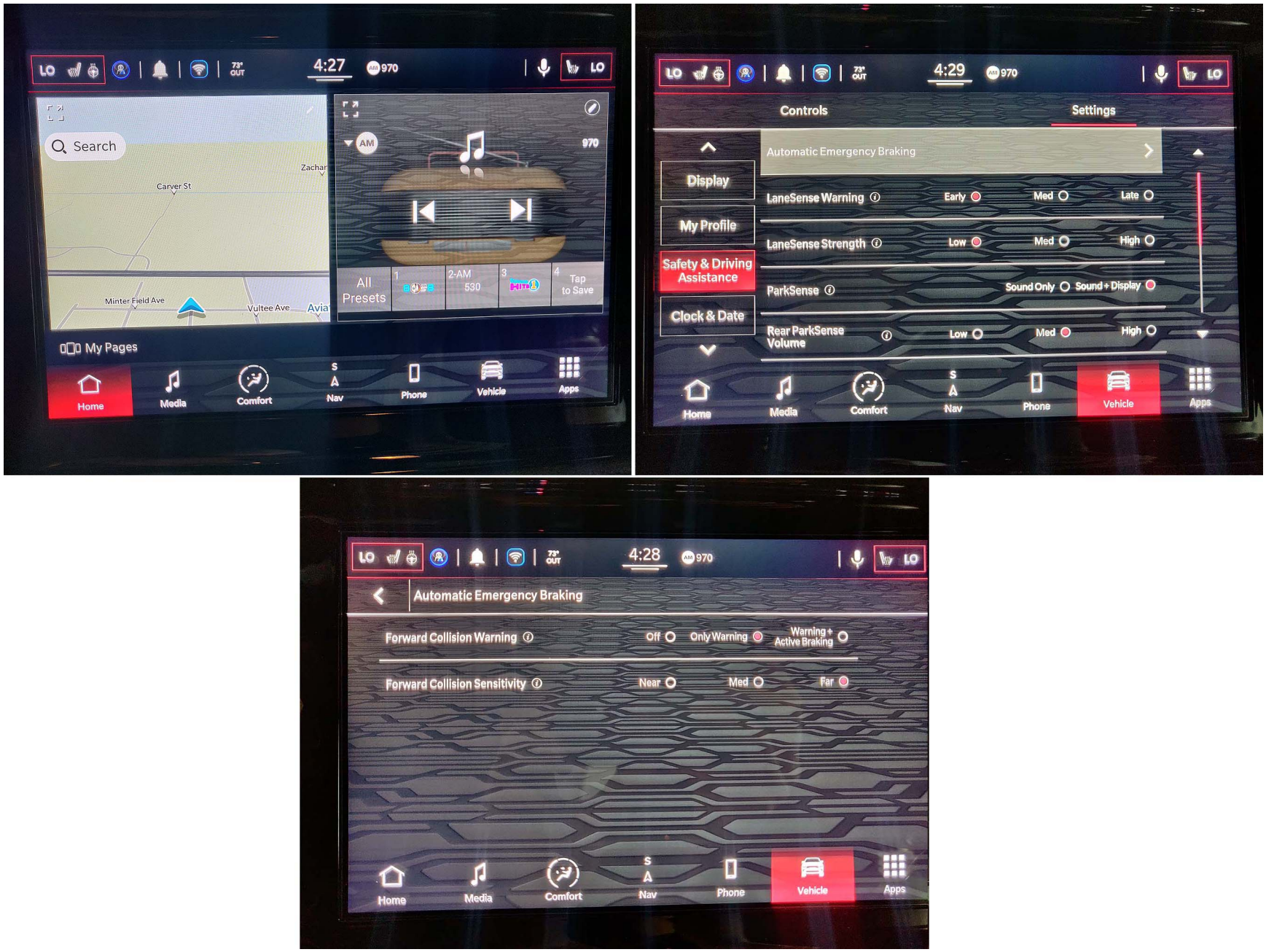


Figure A12. System Setup Menus


Figure A13. FCW Visual Alert

# APPENDIX B

Excerpts from Owner’s Manual

| Yellow Warning Lights | |
|---|---|
|  | Service Forward Collision Warning (FCW) Light — If Equipped<br>➪ page 103 |
|  | Service Adaptive Cruise Control Warning Light — If Equipped<br>➪ page 104 |
|   | Service AWD Warning Light — If Equipped<br>➪ page 104 |
|  | Service Stop/Start System Warning Light — If Equipped<br>➪ page 104 |
|  | LaneSense Warning Light — If Equipped<br>➪ page 104 |
|  | Service LaneSense Warning Light — If Equipped<br>➪ page 104 |
|  | Cruise Control Fault Warning Light — If Equipped<br>➪ page 104 |

| Yellow Indicator Lights | |
|---|---|
|   | Forward Collision Warning (FCW) OFF Indicator Light — If Equipped<br>➪ page 104 |
|   | All Wheel Drive (AWD) Low Indicator Light — If Equipped<br>➪ page 104 |
|   | NEUTRAL Indicator Light — If Equipped<br>➪ page 104 |

| Green Indicator Lights | |
|---|---|
|  | Adaptive Cruise Control (ACC) Set With Target Light — If Equipped<br>➪ page 104 |
|  | Adaptive Cruise Control (ACC) Set Without Target Light — If Equipped<br>➪ page 104 |
|  | Cruise Control Set Indicator Light — If Equipped<br>➪ page 105 |

and can lead to tire failure. Underinflation also reduces fuel efficiency and tire tread life, and may affect the vehicle's handling and stopping ability.

Please note that the TPMS is not a substitute for proper tire maintenance, and it is the driver's responsibility to maintain correct tire pressure, even if underinflation has not reached the level to trigger illumination of the TPMS low tire pressure telltale.

Your vehicle has also been equipped with a TPMS malfunction indicator to indicate when the system is not operating properly. The TPMS malfunction indicator is combined with the low tire pressure telltale. When the system detects a malfunction, the telltale will flash for approximately one minute and then remain continuously illuminated. This sequence will continue upon subsequent vehicle start-ups as long as the malfunction exists. When the malfunction indicator is illuminated, the system may not be able to detect or signal low tire pressure as intended. TPMS malfunctions may occur for a variety of reasons, including the installation of replacement or alternate tires or wheels on the vehicle that prevent the TPMS from functioning properly. Always check the TPMS malfunction telltale after replacing one or more tires or wheels on your vehicle to ensure that the replacement or alternate tires and wheels allow the TPMS to continue to function properly.

**CAUTION!**

The TPMS has been optimized for the original equipment tires and wheels. TPMS pressures and warning have been established for the tire size equipped on your vehicle. Undesirable system operation or sensor damage may result when using replacement equipment that is not of the same size, type, and/or style. Aftermarket wheels can cause sensor damage. Using aftermarket tire sealants may cause the Tire Pressure Monitoring System (TPMS) sensor to become inoperable. After using an aftermarket tire sealant it is recommended that you take your vehicle to an authorized dealer to have your sensor function checked.

### Low Fuel Warning Light

When the fuel level reaches approximately 2 gal (7.5 L), this light will turn on and a chime will sound. The light will remain on until fuel is added.

### Anti-Lock Brake System (ABS) Warning Light


This warning light monitors the ABS. The light will turn on when the ignition is placed in the ON/RUN or ACC/ON/RUN position and may stay on for as long as four seconds.

If the ABS light remains on or turns on while driving, then the Anti-Lock portion of the brake system is not functioning and service is required as soon as possible. However, the conventional brake system will continue to operate normally, assuming the Brake Warning Light is not also on.

If the ABS light does not turn on when the ignition is placed in the ON/RUN or ACC/ON/RUN position, have the brake system inspected by an authorized dealer.

### Service Forward Collision Warning (FCW) Light — If Equipped

This warning light will illuminate to indicate a fault in the Forward Collision Warning System. Contact an authorized dealer for service ⮩ page 218.

### Service Adaptive Cruise Control Warning Light — If Equipped

This light will turn on when the Adaptive Cruise Control (ACC) is not operating and needs service ⇨ page 131.

### Service AWD Warning Light — If Equipped


This telltale will turn on to indicate the All Wheel Drive (AWD) system is not functioning properly and that service is required. Contact an authorized dealer.

### Service Stop/Start System Warning Light — If Equipped

This warning light will illuminate when the Stop/Start system is not functioning properly and service is required. Contact an authorized dealer for service.

### LaneSense Warning Light — If Equipped

The LaneSense Warning Light will be solid yellow when the vehicle is approaching a lane marker. The warning light will flash when the vehicle is crossing the lane marker ⇨ page 148.

### Service LaneSense Warning Light — If Equipped

This warning light will illuminate when the LaneSense system is not operating and requires service. Please see an authorized dealer.

### Cruise Control Fault Warning Light — If Equipped

This warning light will illuminate to indicate the Cruise Control System is not functioning properly and service is required. Contact an authorized dealer.

## YELLOW INDICATOR LIGHTS

### Forward Collision Warning (FCW) OFF Indicator Light — If Equipped


This indicator light illuminates to indicate that Forward Collision Warning is off ⇨ page 218.

### All Wheel Drive (AWD) Low Indicator Light — If Equipped


This light alerts the driver that the vehicle is in the AWD LOW mode. The front and rear driveshafts are mechanically locked together forcing the front and rear wheels to rotate at the same speed. AWD LOW is designed for loose, slippery road surfaces only ⇨ page 121.

### NEUTRAL Indicator Light — If Equipped


This light alerts the driver that the 4WD power transfer case is in the NEUTRAL mode and the front and rear driveshafts are disengaged from the powertrain.

## GREEN INDICATOR LIGHTS

### Adaptive Cruise Control (ACC) Set With Target Light — If Equipped

This will display when the ACC is set and a target vehicle is detected ⇨ page 131.

### Adaptive Cruise Control (ACC) Set Without Target Light — If Equipped

This will display when the ACC is set and a target vehicle is not detected ⇨ page 131.

## ADAPTIVE CRUISE CONTROL (ACC) — IF EQUIPPED

Adaptive Cruise Control (ACC) increases the driving convenience provided by Cruise Control while traveling on highways and major roadways. However, it is not a safety system and not designed to prevent collisions. The Cruise Control function performs differently ⇨ page 129.

ACC will allow you to keep Cruise Control engaged in light to moderate traffic conditions without the constant need to reset your Cruise Control. ACC utilizes a radar sensor and a forward facing camera designed to detect a vehicle directly ahead of you.

**NOTE:**

- If the ACC sensor detects a vehicle ahead, ACC will apply limited braking or acceleration (not to exceed the original set speed) automatically to maintain a preset following distance, while matching the speed of the vehicle ahead.
- Any chassis / suspension or tire size modifications to the vehicle will affect the performance of the Adaptive Cruise Control and Forward Collision Warning system.
- Fixed Speed Cruise Control alone (an ACC distance not set) will not detect vehicles directly ahead of you. Always be aware of the mode selected ⇨ page 357.

**WARNING!**

- Adaptive Cruise Control (ACC) is a convenience system. It is not a substitute for active driver involvement. It is always the driver's responsibility to be attentive of road, traffic, and weather conditions, vehicle speed, distance to the vehicle ahead; and, most importantly, brake operation to ensure safe operation of the vehicle under all road conditions. Your complete attention is always required while driving to maintain safe control of your vehicle. Failure to follow these warnings can result in a collision and death or serious personal injury.

*(Continued)*

**WARNING!** *(Continued)*

- The ACC system:
  - Does not react to pedestrians, oncoming vehicles, and stationary objects (e.g., a stopped vehicle in a traffic jam or a disabled vehicle).
  - Cannot take street, traffic, and weather conditions into account, and may be limited upon adverse sight distance conditions.
  - Does not always fully recognize complex driving conditions, which can result in wrong or missing distance warnings.
  - Will bring the vehicle to a complete stop while following a target vehicle and hold the vehicle for two seconds in the stop position. If the target vehicle does not start moving within two seconds the ACC system will display a message that the system will release the brakes and that the brakes must be applied manually. An audible chime will sound when the brakes are released.

*(Continued)*

**NOTE:**
The brake lights will illuminate whenever the ACC system applies the brakes.

A Proximity Warning will alert the driver if ACC predicts that its maximum braking level is not sufficient to maintain the set distance. If this occurs, a visual alert "BRAKE" will flash in the instrument cluster display and a chime will sound while ACC continues to apply its maximum braking capacity.

**NOTE:**
The "BRAKE!" screen in the instrument cluster display is a warning for the driver to take action and does not necessarily mean that the Forward Collision Warning system is applying the brakes autonomously.

### Overtake Aid

When driving with Adaptive Cruise Control (ACC) engaged and following a vehicle, the system will provide an additional acceleration up to the ACC set speed to assist in passing the vehicle. This additional acceleration is triggered when the driver utilizes the left turn signal and will only be active when passing on the left hand side.

### ACC Operation At Stop

If the ACC system brings your vehicle to a standstill while following a vehicle ahead, your vehicle will resume motion, without any driver interaction, if the vehicle ahead starts moving within two seconds of your vehicle coming to a standstill.

If the vehicle in front does not start moving within two seconds of your vehicle coming to a standstill, the driver will either have to push the RES (resume) button, or apply the accelerator pedal to reengage the ACC to the existing set speed.

While ACC with Stop is holding your vehicle at a standstill, if the driver seat belt is unbuckled or the driver door is opened, the ACC with Stop system will cancel and the brakes will release. A cancel message will display on the instrument cluster display and produce a warning chime. The driver must now manually operate the vehicle's accelerator and brakes.

**WARNING!**

When the ACC system is resumed, the driver must ensure that there are no pedestrians, vehicles or objects in the path of the vehicle. Failure to follow these warnings can result in a collision and death or serious personal injury.

### Display Warnings And Maintenance

4

#### "Wipe Front Radar Sensor In Front Of Vehicle" Warning

The "ACC/FCW Unavailable Wipe Front Radar Sensor" warning will display and a chime will sound when conditions temporarily limit system performance.

This most often occurs at times of poor visibility, such as in snow or heavy rain. The ACC system may also become temporarily blinded due to obstructions, such as mud, dirt or ice. In these cases, the instrument cluster display will display the above message and the system will deactivate.

### Safety & Driving Assistance

After pressing the Safety & Driving Assistance button on the touchscreen, the following settings will be available:

| Setting Name | Description |
|---|---|
| Automatic Emergency Braking — If Equipped | This setting will take you to the selectable options for "Forward Collision Warning (FCW)" and "Forward Collision Warning Sensitivity". |
| Forward Collision Warning — If Equipped | This setting will turn the Forward Collision system on or off. The "Off" setting will deactivate the FCW system. The "Warning Only" setting will provide only an audible chime when a collision is detected. The "Warning + Active Braking" setting will provide an audible chime and apply some brake pressure when a collision is detected. |
| Forward Collision Warning Sensitivity — If Equipped | This setting will change the distance at which the Forward Collision Warning alert sounds. The "Medium" setting will have the FCW system signal when an object is in view, and the possibility of a collision is detected. The "Near" setting will have the FCW system signal when the object is closer to the vehicle. The "Far" setting will have the FCW system signal when an object is at a far distance from the vehicle. |
| LaneSense Warning — If Equipped | This setting will change the distance at which the steering wheel will provide lane departure feedback. The available settings are "Early", "Medium", and "Late". |
| LaneSense Strength — If Equipped | This setting will change the strength of the steering wheel feedback during a lane departure. The available settings are "Low", "Medium", and "High". |
| ParkSense — If Equipped | This setting will change the type of ParkSense alert when a close object is detected and provide both an audible chime and a visual display. |
| Front ParkSense Volume | This setting adjusts the volume of the Front ParkSense system. The available settings are "Low", "Medium", and "High". |
| Rear ParkSense Volume | This setting adjusts the volume of the Rear ParkSense system. The available settings are "Low", "Medium", and "High". |

NOTE:
Whenever an audible alert is requested by the BSM system, the radio is also muted.

When the system is in RCP, the system shall respond with both visual and audible alerts when a detected object is present. Whenever an audible alert is requested, the radio is also muted. Turn/hazard signal status is ignored; the RCP state always requests the chime.

**Blind Spot Alert Off**

When the BSM system is turned off there will be no visual or audible alerts from either the BSM or RCP systems.

NOTE:
The BSM system will store the current operating mode when the vehicle is shut off. Each time the vehicle is started the previously stored mode will be recalled and used.

## FORWARD COLLISION WARNING (FCW) WITH MITIGATION

FCW with Mitigation provides the driver with audible warnings, visual warnings (within the instrument cluster display), and may apply a brake jerk to warn the driver when it detects a potential frontal collision. The warnings and limited braking are intended to provide the driver with enough time to react, avoid or mitigate the potential collision.

NOTE:
FCW monitors the information from the forward looking sensors as well as the Electronic Brake Controller (EBC) to calculate the probability of a forward collision. When the system determines that a forward collision is probable, the driver will be provided with audible and visual warnings and may provide a brake jerk warning. If the driver does not take action based upon these progressive warnings, then the system will provide a limited level of active braking to help slow the vehicle and mitigate the potential forward collision. If the driver reacts to the warnings by braking and the system determines that the driver intends to avoid the collision by braking but has not applied sufficient brake force, the system will compensate and provide additional brake force as required.

If an FCW with Mitigation event begins at a speed below 38 mph (62 km/h), the system may provide the maximum or partial braking to mitigate the potential forward collision. If the Forward Collision Warning with Mitigation event stops the vehicle completely, the system will hold the vehicle at a standstill for two seconds and then release the brakes.


**FCW Message**

When the system determines a collision with the vehicle in front of you is no longer probable, the warning message will be deactivated.

NOTE:

- The minimum speed for FCW activation is 1 mph (2 km/h).
- The FCW alerts may be triggered on objects other than vehicles such as guard rails or sign posts based on the course prediction. This is expected and is a part of normal FCW activation and functionality.

- It is unsafe to test the FCW system. To prevent such misuse of the system, after four Active Braking events within an ignition cycle, the Active Braking portion of FCW will be deactivated until the next ignition cycle.
- The FCW system is intended for on-road use only. If the vehicle is taken off-road, the FCW system should be deactivated to prevent unnecessary warnings to the surroundings. If the vehicle enters 4WD Low range, the FCW system will be automatically deactivated ⇨ page 357.

**WARNING!**

Forward Collision Warning (FCW) is not intended to avoid a collision on its own, nor can FCW detect every type of potential collision. The driver has the responsibility to avoid a collision by controlling the vehicle via braking and steering. Failure to follow this warning could lead to serious injury or death.

### FCW Braking Status And Sensitivity

The FCW Sensitivity and Active Braking status are programmable through the Uconnect system ⇨ page 175.

The default sensitivity of FCW is the "Medium" setting and the system status is "Warning & Braking". This allows the system to warn the driver of a possible collision with the vehicle in front using audible/visual warnings and it applies autonomous braking.

Changing the FCW status to the "Far" setting allows the system to warn the driver of a possible collision with the vehicle in front using audible/visual warnings when the latter is at a farther distance than the "Medium" setting. This provides the most reaction time to avoid a possible collision.

Changing the FCW status to the "Near" setting allows the system to warn the driver of a possible collision with the vehicle in front when the distance between the vehicle in the front is much closer. This setting provides less reaction time than the "Far" and "Medium" settings, which allows for a more dynamic driving experience.

**NOTE:**

- Changing the FCW status to "Only Warning" prevents the system from providing limited active braking, or additional brake support if the driver is not braking adequately in the event of a potential frontal collision, but maintains the audible and visual warnings.
- Changing the FCW status to "Off" prevents the system from providing autonomous braking, or additional brake support if the driver is not braking adequately in the event of a potential frontal collision.
- The system will retain the last setting selected by the driver after ignition shut down.
- FCW may not react to irrelevant objects such as overhead objects, ground reflections, objects not in the path of the vehicle, stationary objects that are far away, oncoming traffic, or leading vehicles with the same or higher rate of speed.
- FCW will be disabled like ACC, with the unavailable screens.

### FCW Limited Warning

If the instrument cluster displays “ACC/FCW Limited Functionality” or “ACC/FCW Limited Functionality Clean Front Windshield” momentarily, there may be a condition that limits FCW functionality. Although the vehicle is still drivable under normal conditions, the active braking may not be fully available. Once the condition that limited the system performance is no longer present, the system will return to its full performance state. If the problem persists, see an authorized dealer.

### Service FCW Warning

If the system turns off, and the instrument cluster displays:

- ACC/FCW Unavailable Service Required
- Cruise/FCW Unavailable Service Required

This indicates there is an internal system fault. Although the vehicle is still drivable under normal conditions, have the system checked by an authorized dealer.

## TIRE PRESSURE MONITORING SYSTEM (TPMS)

The TPMS will warn the driver of a low tire pressure based on the vehicle recommended cold tire pressure.

The tire pressure will vary with temperature by about 1 psi (7 kPa) for every 12°F (6.5°C). This means that when the outside temperature decreases, the tire pressure will decrease. Tire pressure should always be set based on cold inflation tire pressure. This is defined as the tire pressure after the vehicle has not been driven for at least three hours, or driven less than 1 mile (1.6 km) after a three-hour period. The tire pressure will also increase as the vehicle is driven — this is normal and there should be no adjustment for this increased pressure.

See ➪ page 322 on how to properly inflate the vehicle’s tires.

The TPMS will warn the driver of a low tire pressure if the tire pressure falls below the low pressure warning threshold for any reason, including low temperature effects, or natural pressure loss through the tire.

The TPMS will continue to warn the driver of low tire pressure as long as the condition exists, and will not turn off until the tire pressure is at or above recommended cold tire pressure. Once the low tire pressure warning has been illuminated, the tire pressure must be increased to the recommended cold tire pressure in order for the TPMS Warning Light to be turned off.

**NOTE:**
When filling warm tires, the tire pressure may need to be increased up to an additional 4 psi (28 kPa) above the recommended cold placard pressure in order to turn the TPMS Warning Light off.

The system will automatically update and the TPMS Warning Light will extinguish once the updated tire pressures have been received. The vehicle may need to be driven for up to 20 minutes above 15 mph (24 km/h) to receive this information.

# APPENDIX C

## Run Log

Subject Vehicle: **2021 Dodge Durango GT Blacktop RWD** Test Date: **3/18/2021**

Principal Other Vehicle: **2006 Acura RL**

| Run | Test Type | Valid Run? | TTCW Sound (sec) | TTCW Light (sec) | TTCW Margin (sec) | Pass/Fail | Notes |
|---|---|---|---|---|---|---|---|
| 1 | **Stopped POV** | Y | 2.01 | 1.64 | -0.09 | Fail | |
| 2 | | Y | 1.46 | 1.28 | -0.64 | Fail | |
| 3 | | Y | 2.43 | 2.35 | 0.33 | Pass | |
| 4 | | Y | 1.91 | 1.79 | -0.19 | Fail | |
| 5 | | Y | 1.95 | 1.84 | -0.15 | Fail | |
| 6 | | Y | 1.97 | 1.87 | -0.13 | Fail | |
| 7 | | Y | 1.80 | 1.68 | -0.30 | Fail | |
| | | | | | | | |
| 16 | **Decelerating POV** | Y | 2.49 | 2.43 | 0.09 | Pass | |
| 17 | | N | | | | | POV Braking |
| 18 | | Y | 2.39 | 2.36 | -0.01 | Fail | |
| 19 | | Y | 2.46 | 2.44 | 0.06 | Pass | |
| 20 | | Y | 2.30 | 1.92 | -0.10 | Fail | |
| 21 | | Y | 2.54 | 2.15 | 0.14 | Pass | |
| 22 | | Y | 2.58 | 2.50 | 0.18 | Pass | |
| 23 | | Y | 2.48 | 2.45 | 0.08 | Pass | |
| | | | | | | | |

| Run | Test Type | Valid Run? | TTCW Sound (sec) | TTCW Light (sec) | TTCW Margin (sec) | Pass/Fail | Notes |
|---|---|---|---|---|---|---|---|
| 8 | Slower POV | Y | 2.42 | 2.06 | 0.42 | Pass | |
| 9 | | Y | 2.29 | 2.18 | 0.29 | Pass | |
| 10 | | Y | 2.30 | 1.93 | 0.30 | Pass | |
| 11 | | Y | 2.24 | 2.14 | 0.24 | Pass | |
| 12 | | N | | | | | POV Speed |
| 13 | | Y | 2.25 | 2.19 | 0.25 | Pass | |
| 14 | | Y | 2.14 | 1.77 | 0.14 | Pass | |
| 15 | | Y | 2.29 | 2.22 | 0.29 | Pass | |

# APPENDIX D

## Time History Plots

LIST OF FIGURES

**Description of Time History Plots**

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from both the Subject Vehicle (SV) and the Principal Other Vehicle (POV), as well as pass/fail envelopes and thresholds. The following is a description of data types shown in the time history plots, as well as a description of the color code indicating to which vehicle the data pertain.

Each time history plot consists of data pertinent to the test type under consideration, and therefore the data channels plotted vary according to test type. The test types (shown in the plot titles) include:

- FCW Test 1 – Stopped POV (SV at 45 mph)
- FCW Test 2 – Decelerating POV (Both vehicles at 45 mph with a 30 m gap, POV brakes at 0.3 g)
- FCW Test 3 – Slower Moving POV (SV at 45 mph, POV at 20 mph)

Time history figures include the following sub-plots:

- Warning – Displays the Forward Collision Warning Alert (which can be auditory, visual, or haptic). Depending on the type of FCW alert or instrumentation used to measure the alert, this can be any of the following:
    - Filtered, rectified, and normalized sound signal. The vertical scale is 0 to 1.
    - Filtered, rectified, and normalized acceleration (e.g., haptic alert, such as steering wheel vibration). The vertical scale is 0 to 1.
    - Light sensor signal.

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

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

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

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

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

**Envelopes and Thresholds**

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

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

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

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

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

For the Ax plot, a dashed black threshold line is given for at a value of -0.05 g. For a test run to be valid, the longitudinal acceleration of the Subject Vehicle must not fall below this threshold (i.e. the driver cannot apply any brakes). Additionally, for test type 2, the plot indicating the longitudinal acceleration of the Principal Other Vehicle includes a yellow envelope indicating the deceleration (0.3 g ± 0.03 g) allowed while braking. Exceedance of this threshold is indicated with red asterisks at the beginning and/or end of the threshold boundary.

**Color Codes**

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

Color codes can be broken into four categories:

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

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

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

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

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

**Other Notations**

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

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

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

**Notes**

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

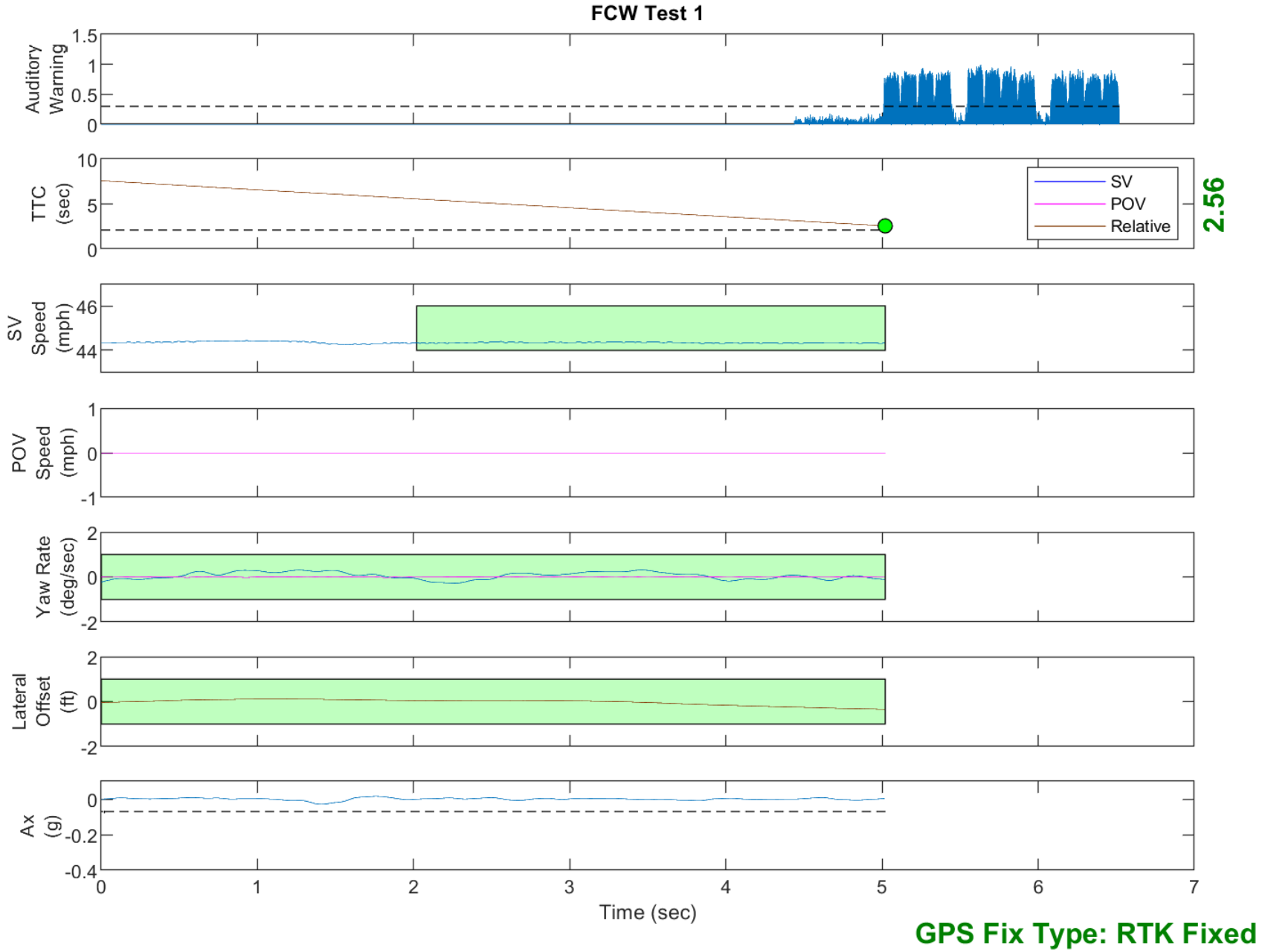


Figure D1. Example Time History for Test Type 1, Passing

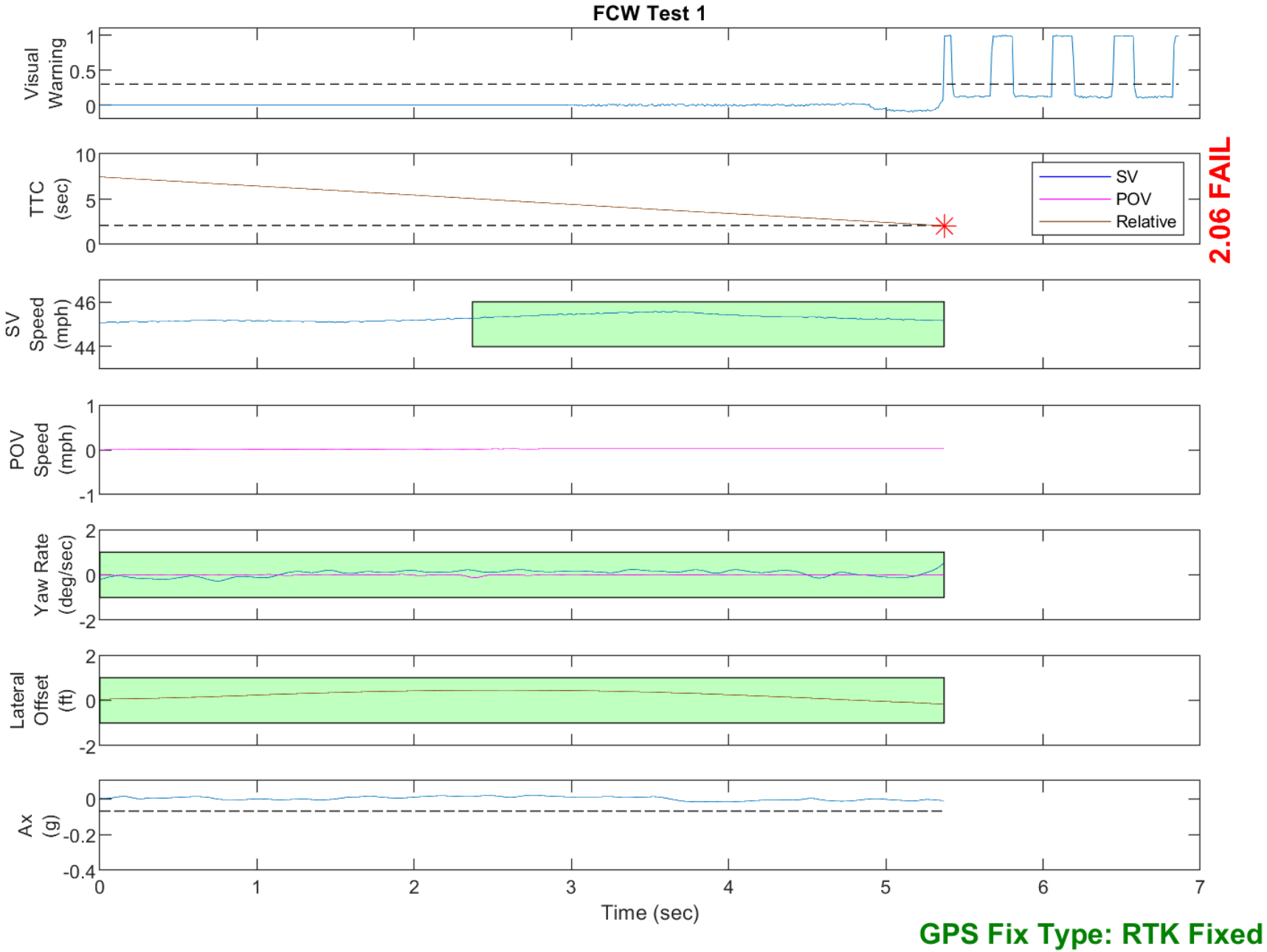


Figure D2. Example Time History for Test Type 1, Failing

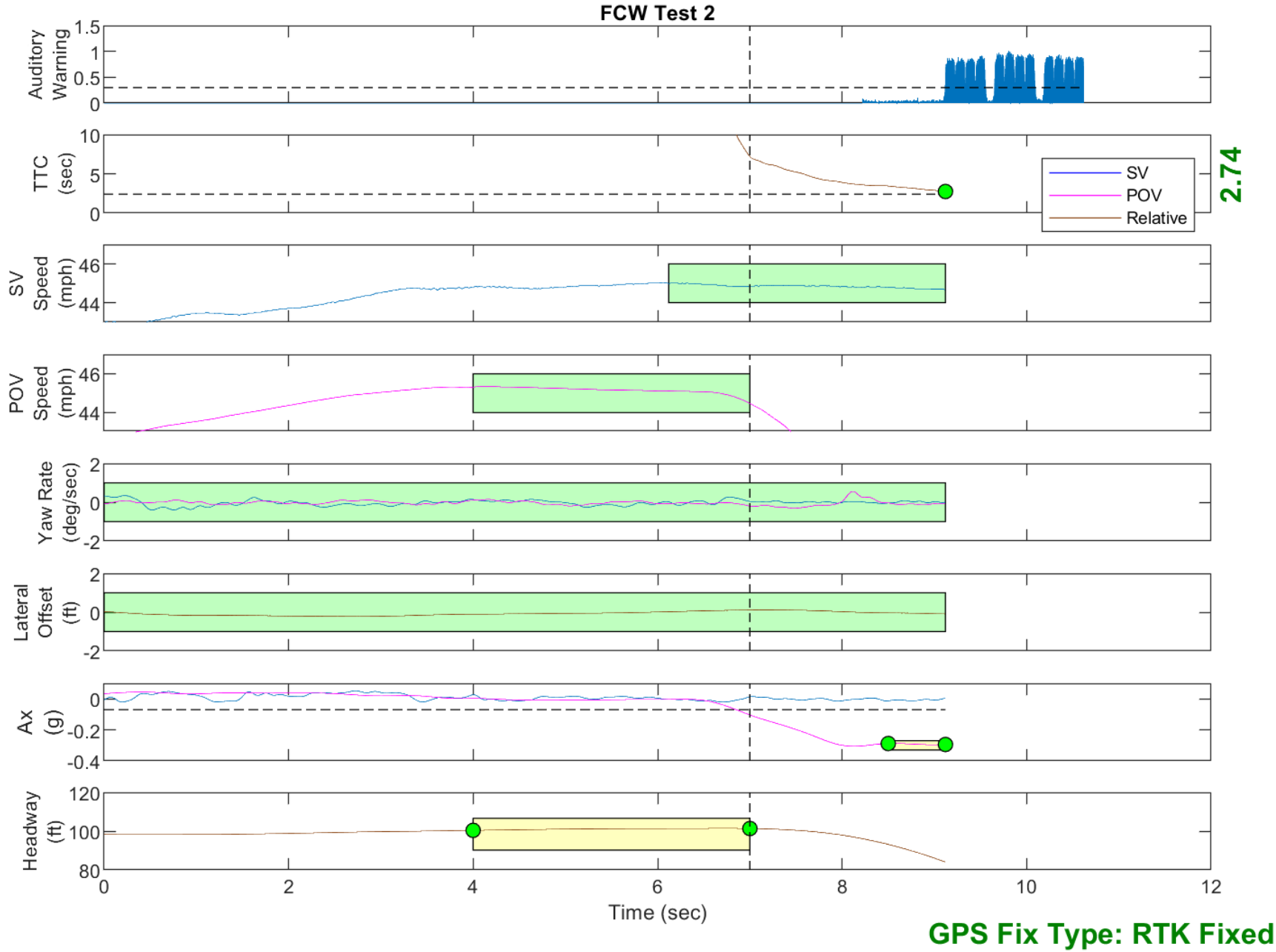


Figure D3. Example Time History for Test Type 2, Passing

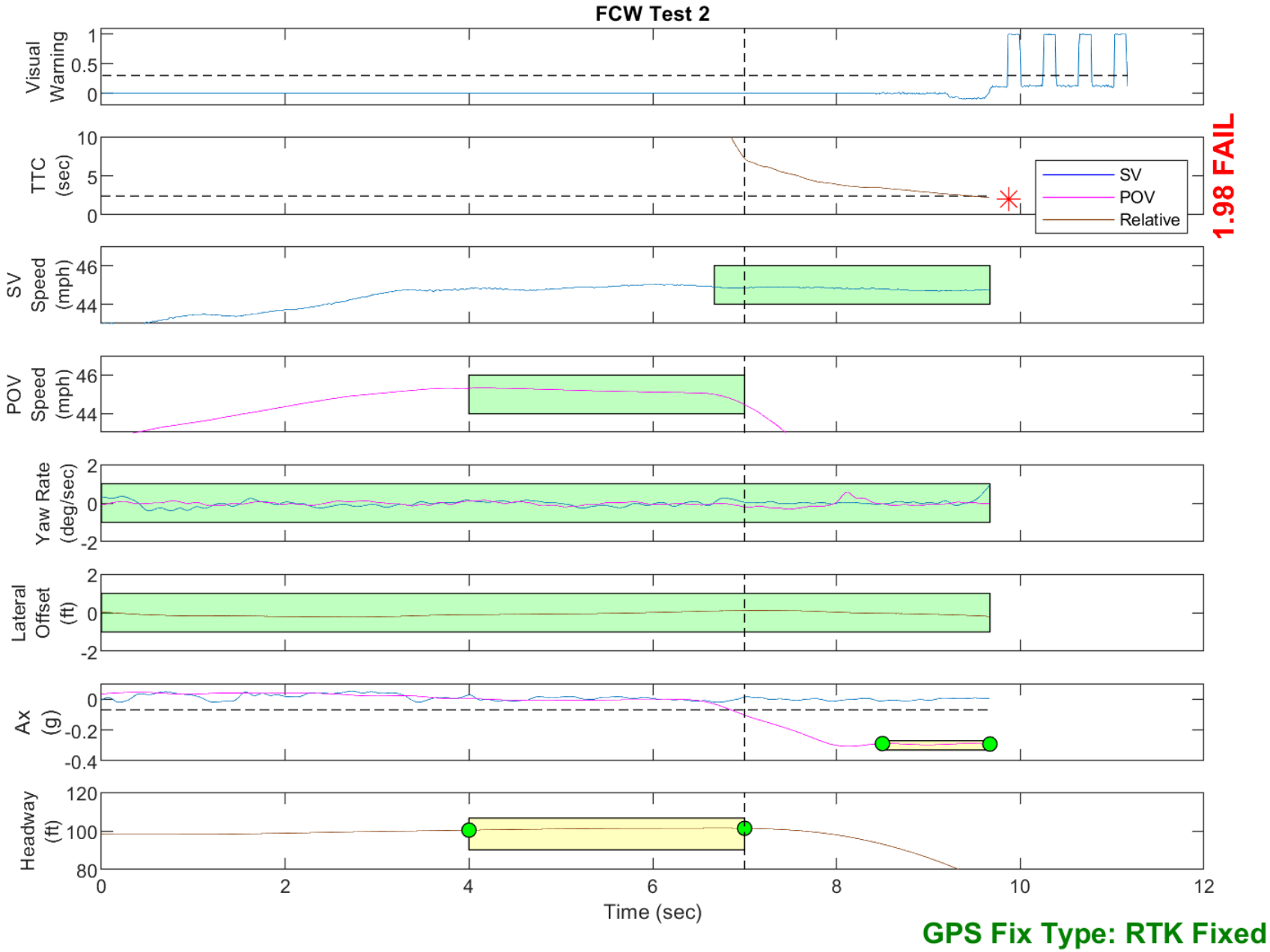


Figure D4. Example Time History for Test Type 2, Failing

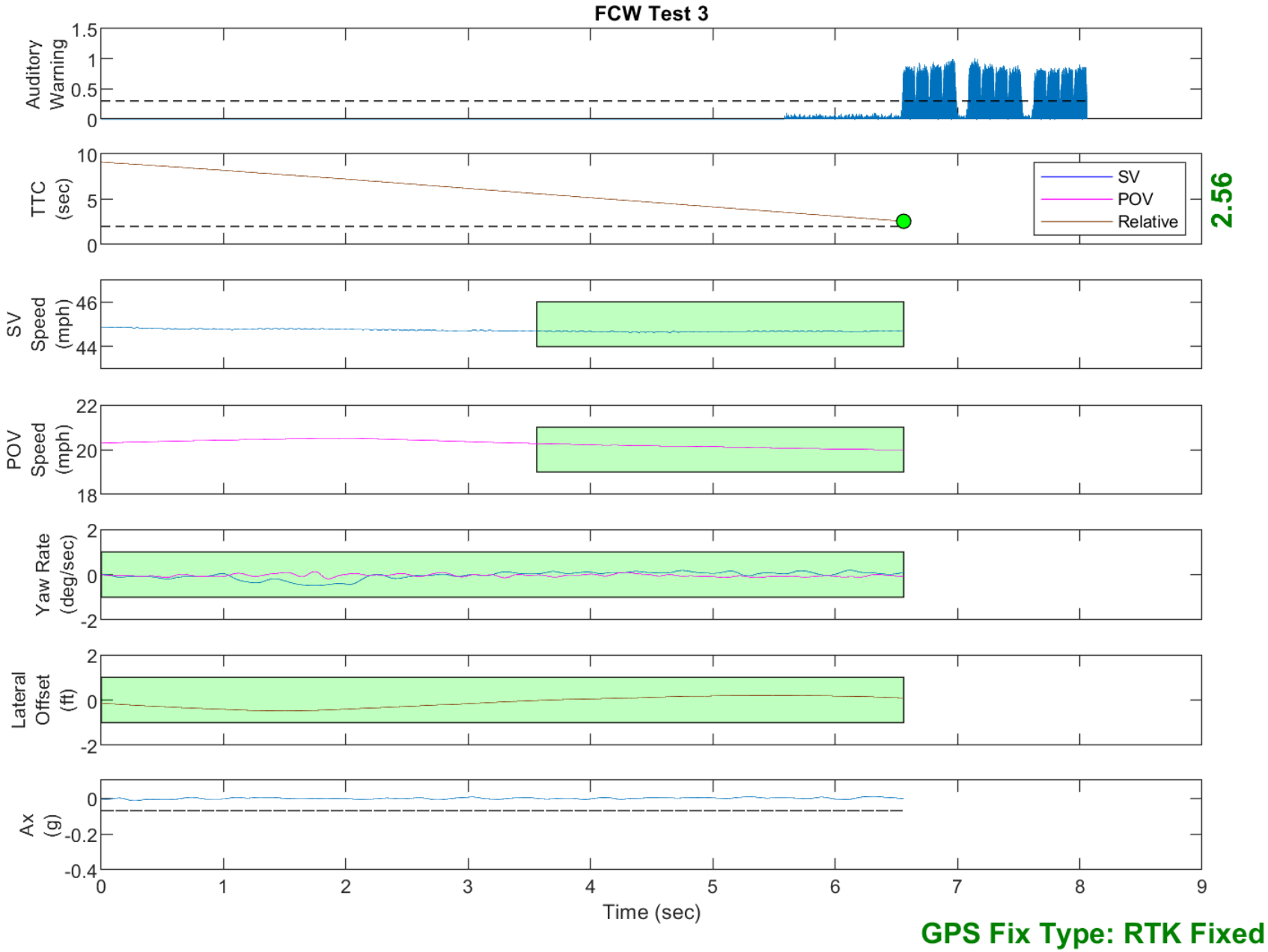


Figure D5. Example Time History for Test Type 3, Passing

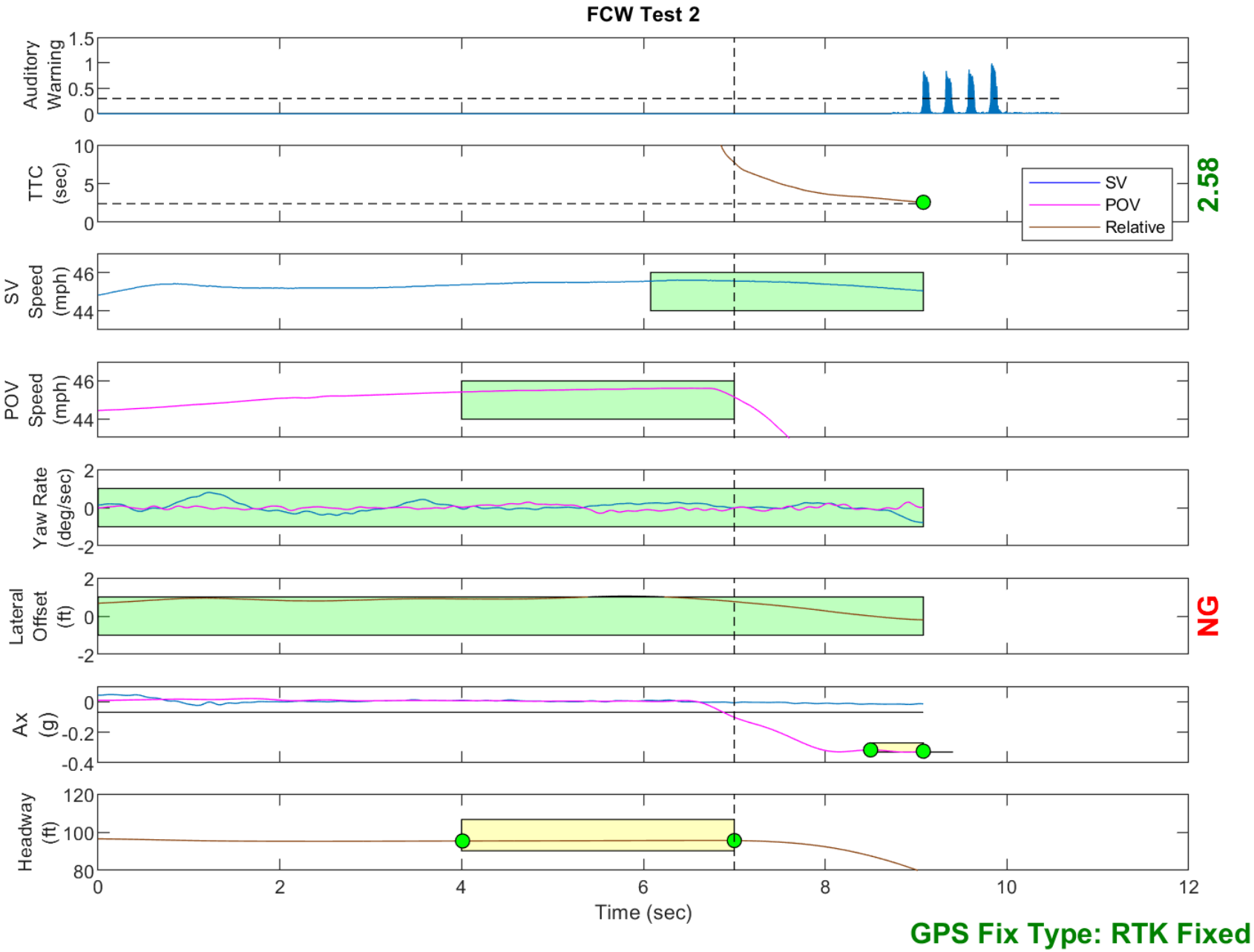


Figure D6. Example Time History Showing Invalid Lateral Offset Criteria

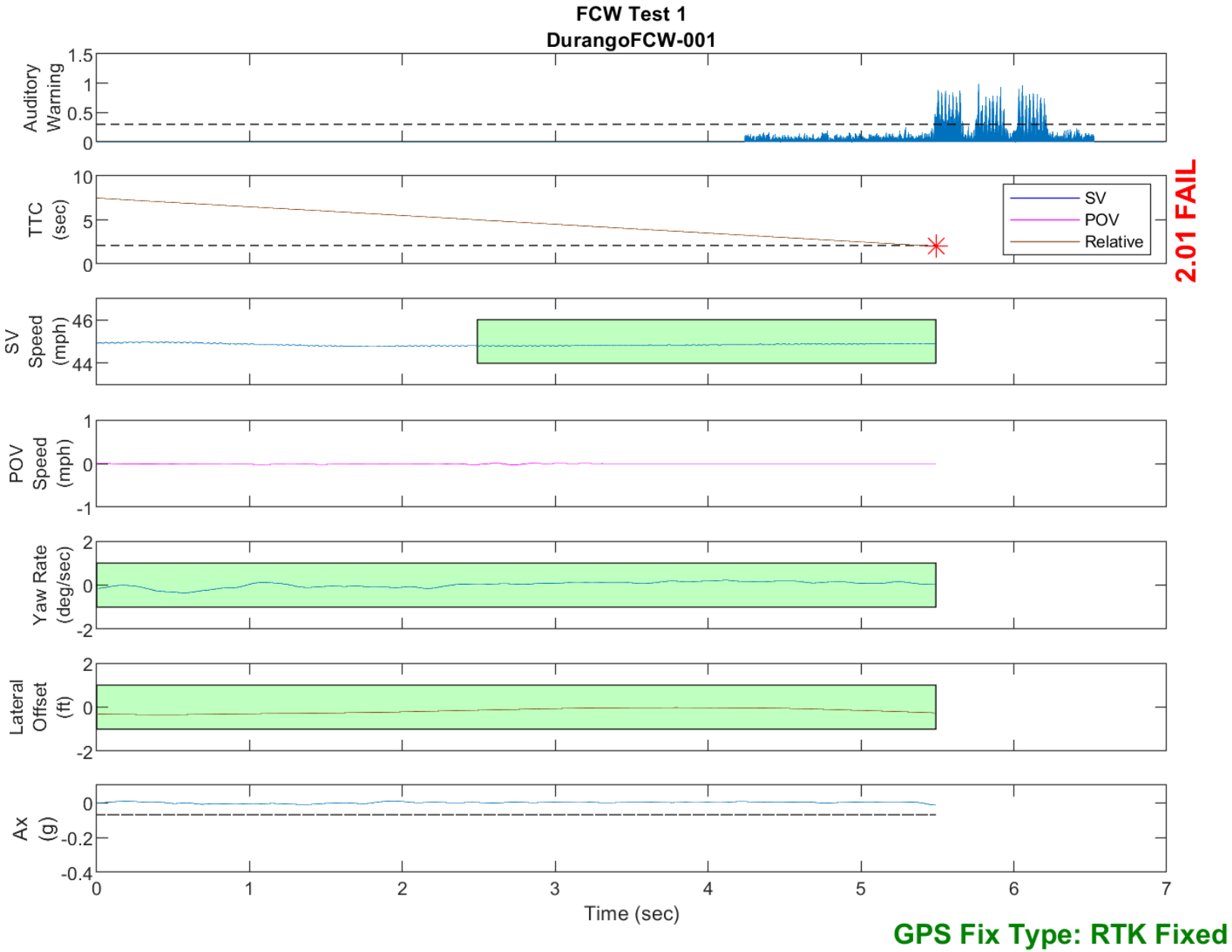


Figure D7. Time History for Run 1, FCW Test 1, Auditory Warning

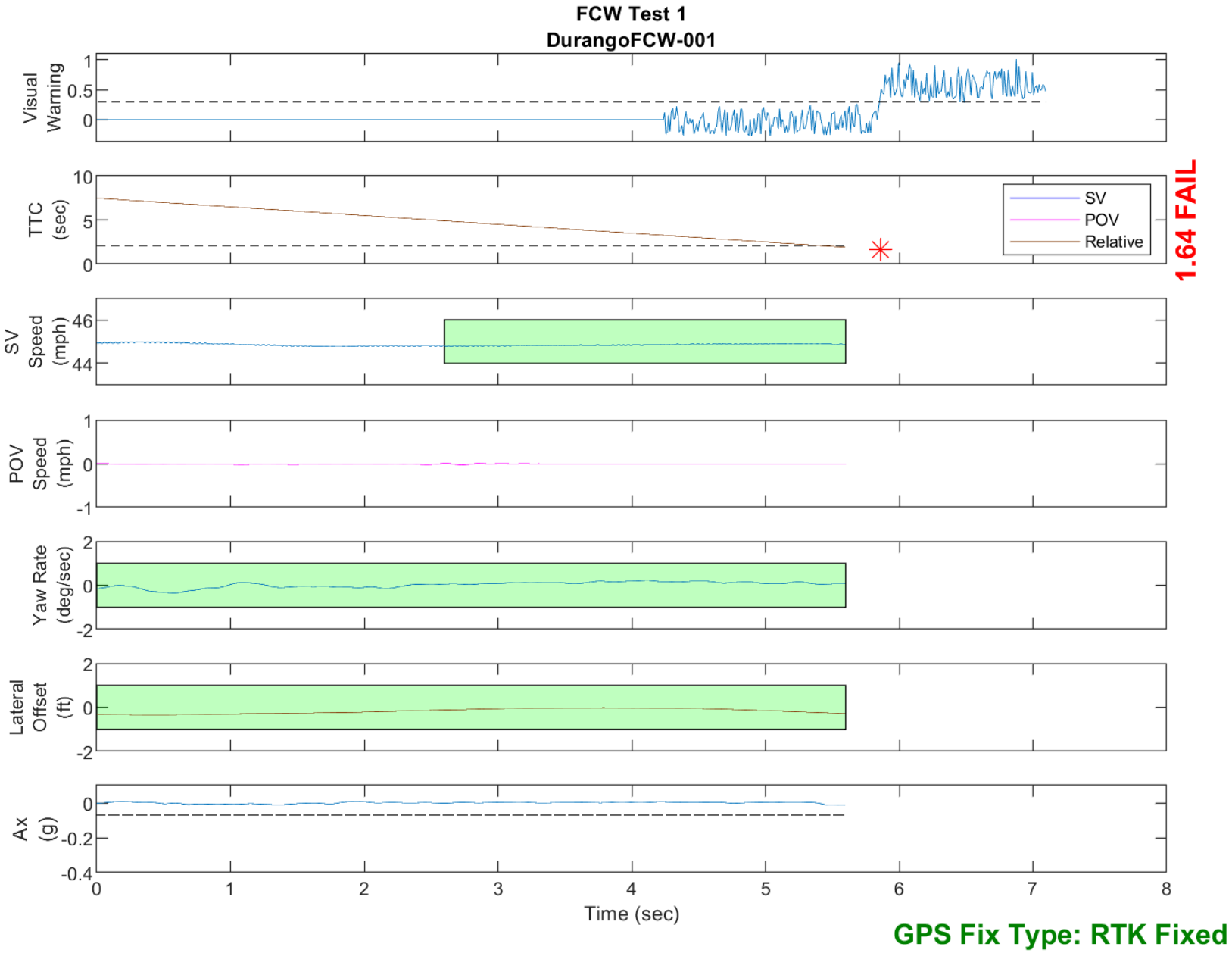


Figure D8. Time History for Run 1, FCW Test 1, Visual Warning

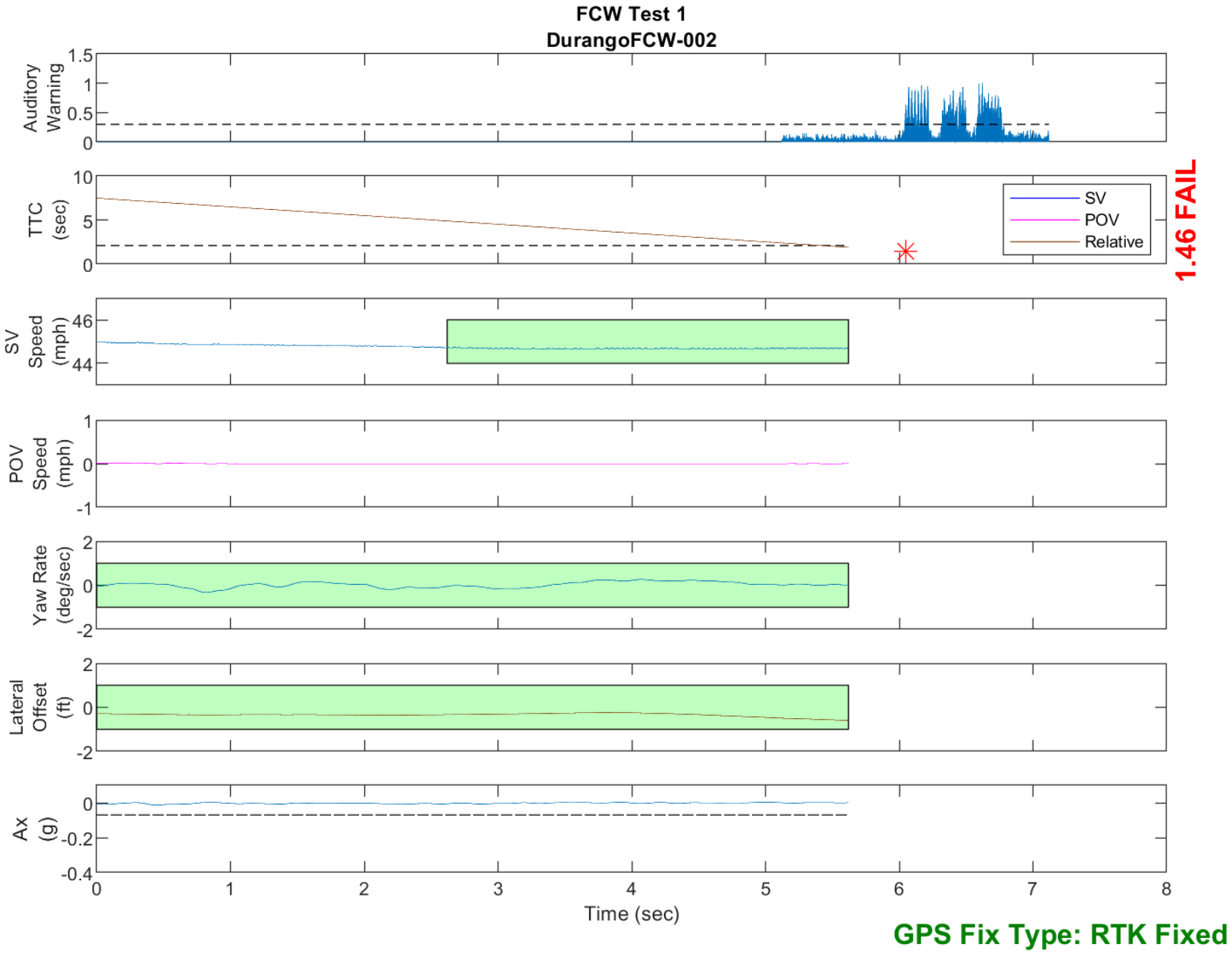


Figure D9. Time History for Run 2, FCW Test 1, Auditory Warning

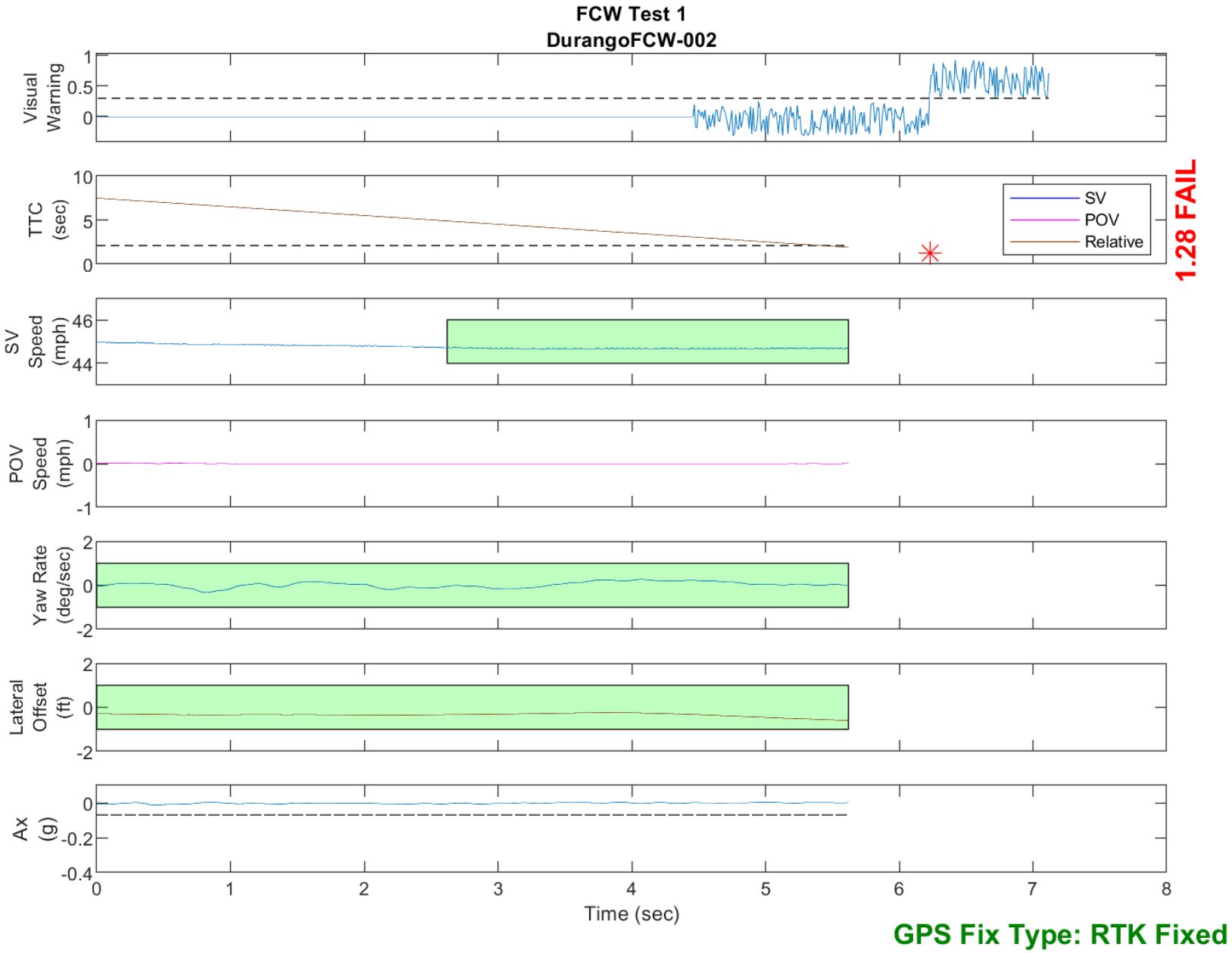


Figure D10. Time History for Run 2, FCW Test 1, Visual Warning

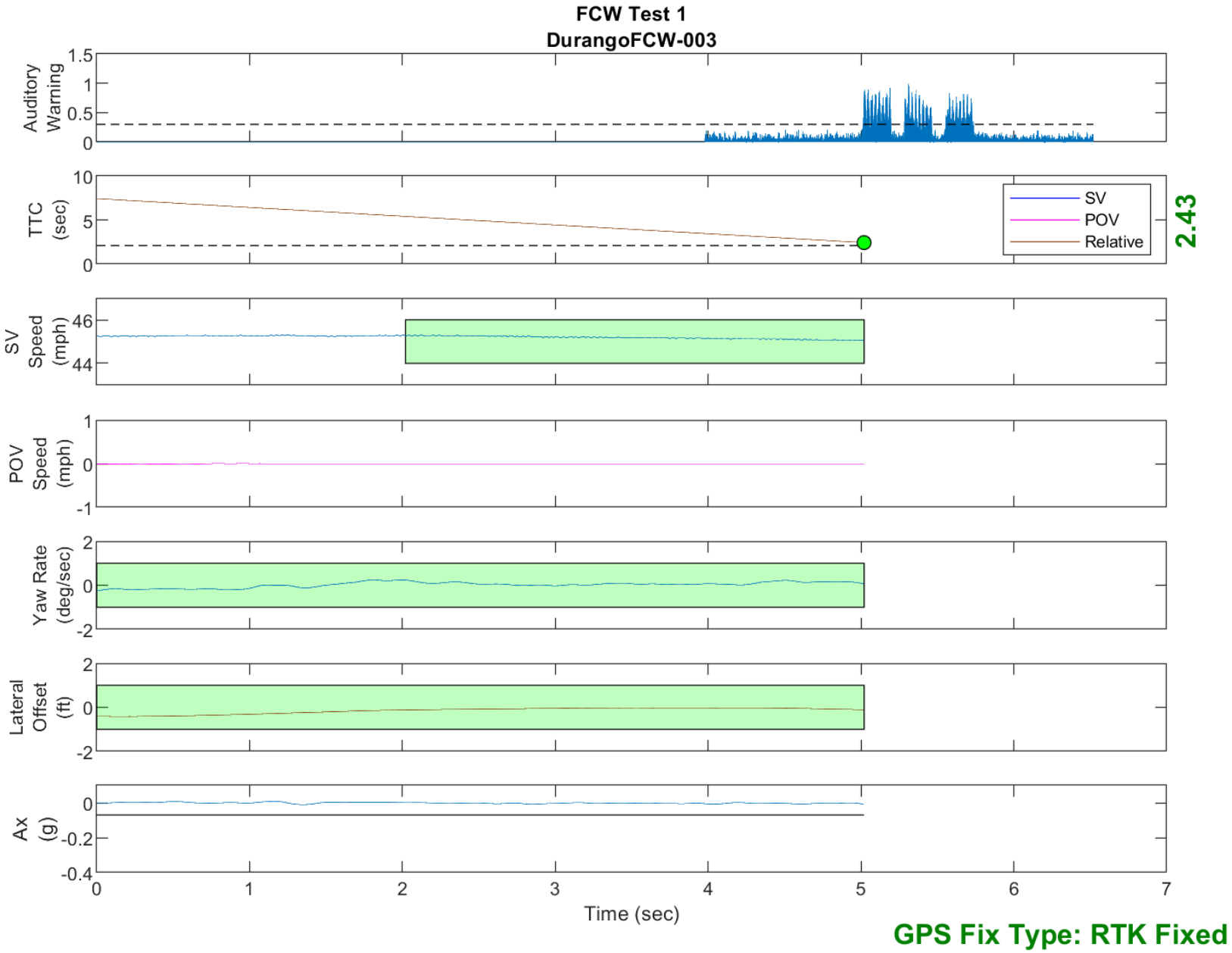


Figure D11. Time History for Run 3, FCW Test 1, Auditory Warning

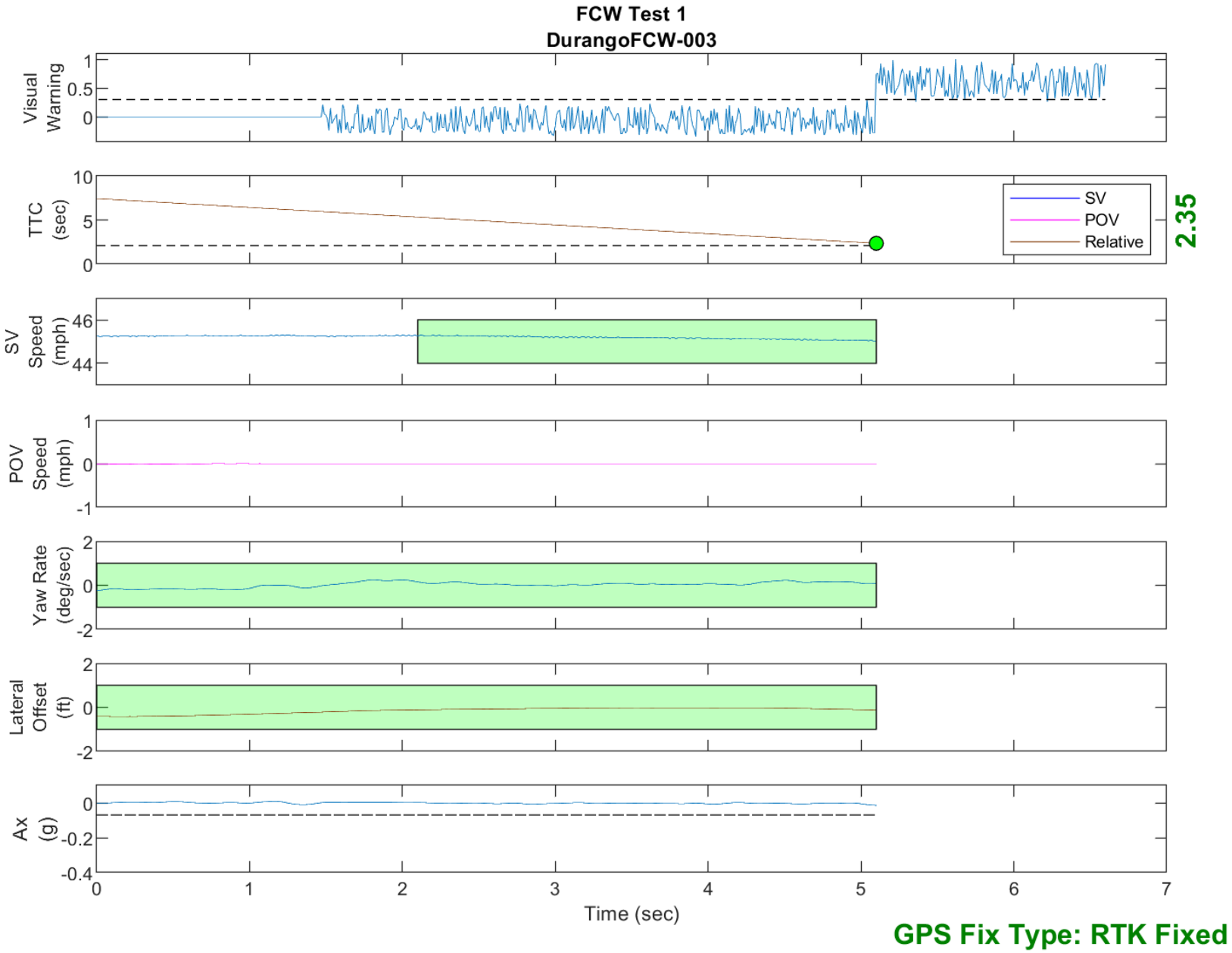


Figure D12. Time History for Run 3, FCW Test 1, Visual Warning

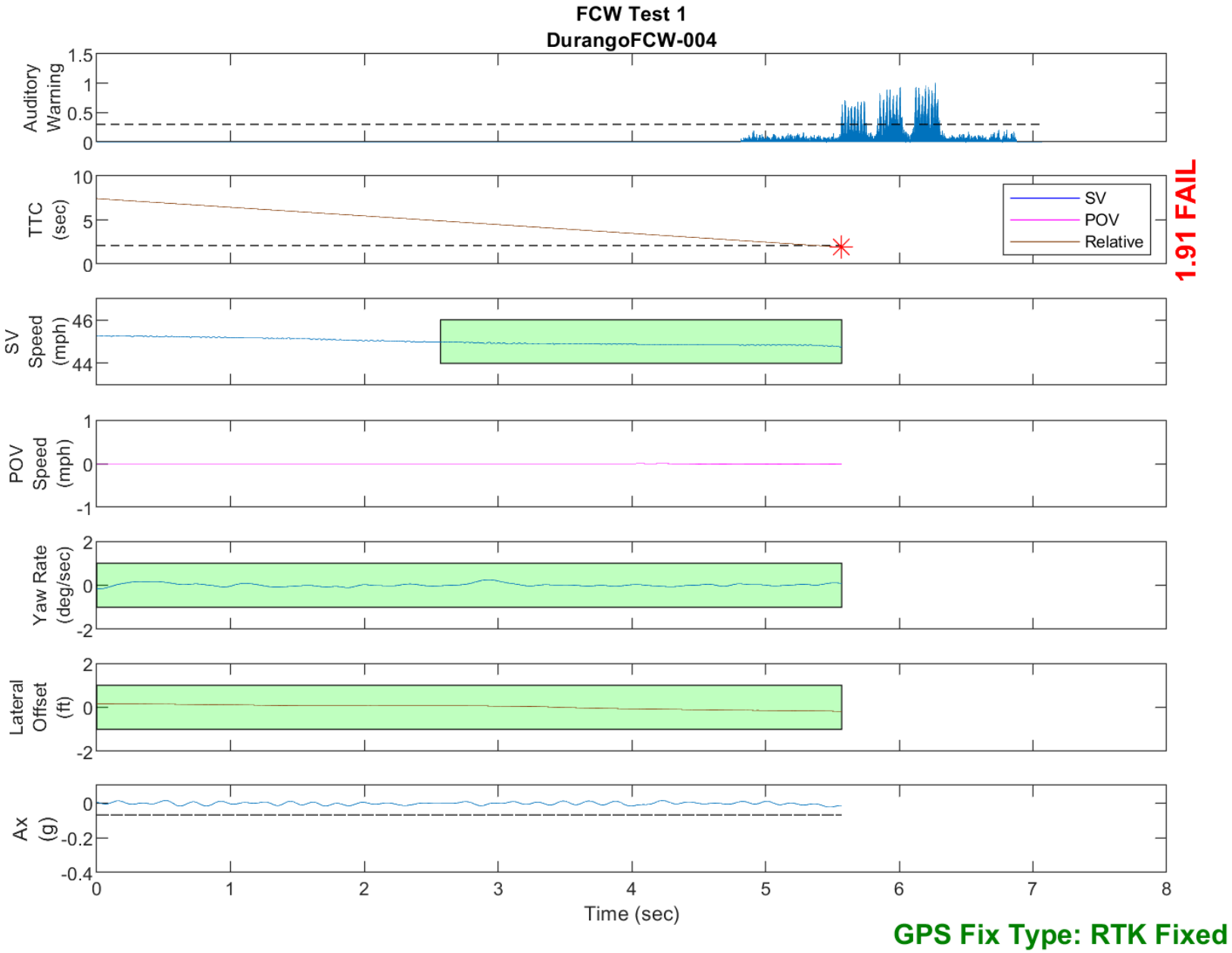


Figure D13. Time History for Run 4, FCW Test 1, Auditory Warning

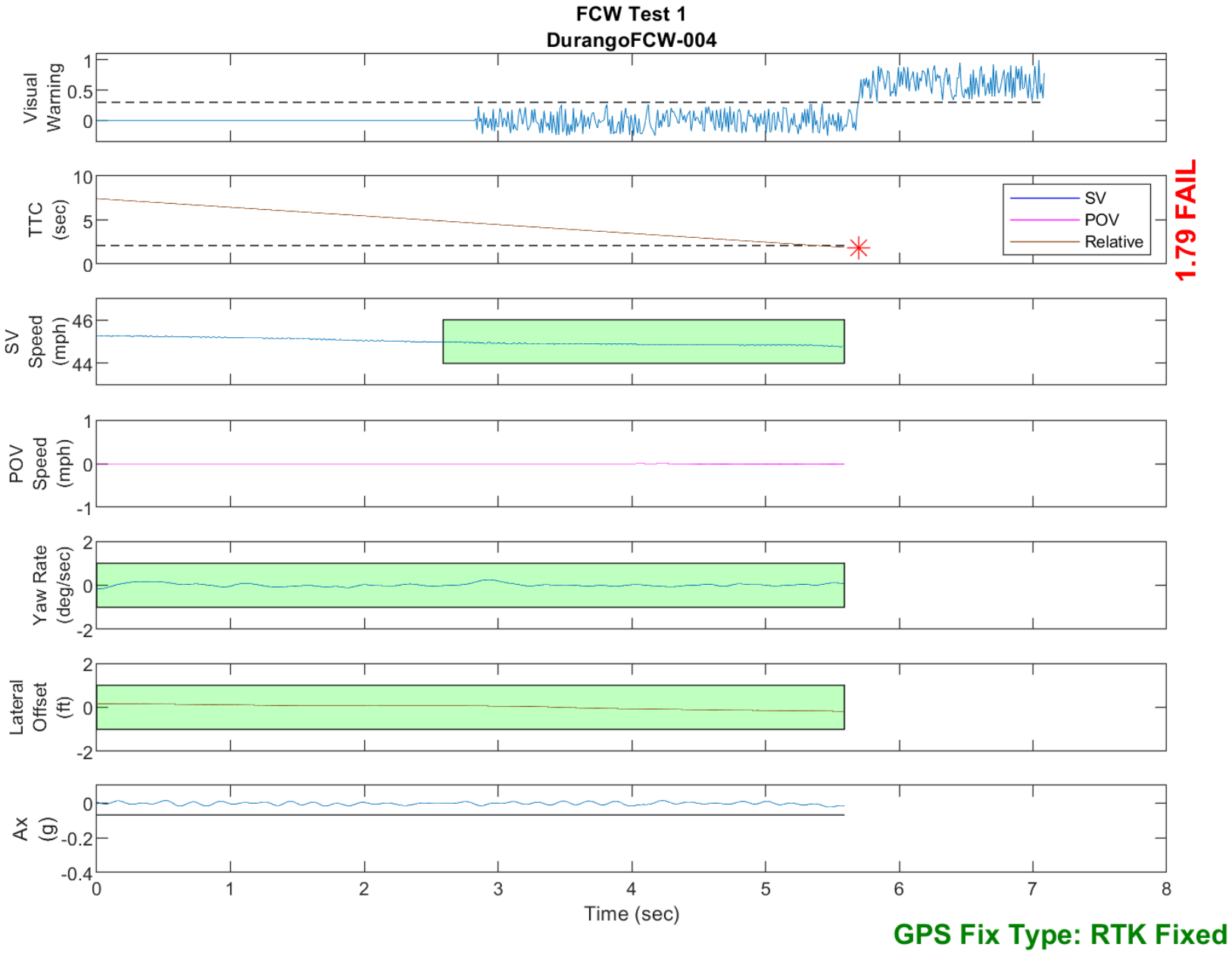


Figure D14. Time History for Run 4, FCW Test 1, Visual Warning

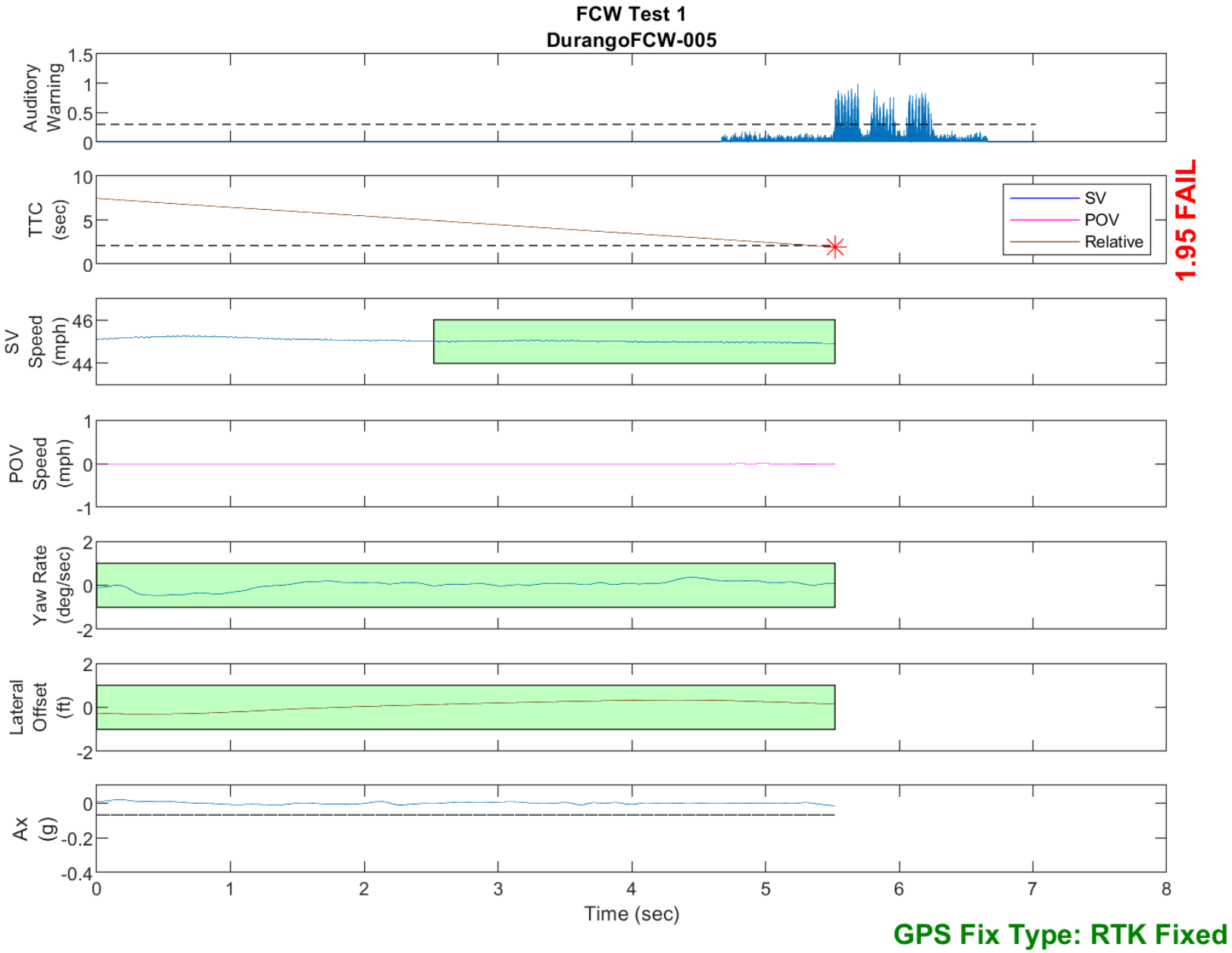


Figure D15. Time History for Run 5, FCW Test 1, Auditory Warning

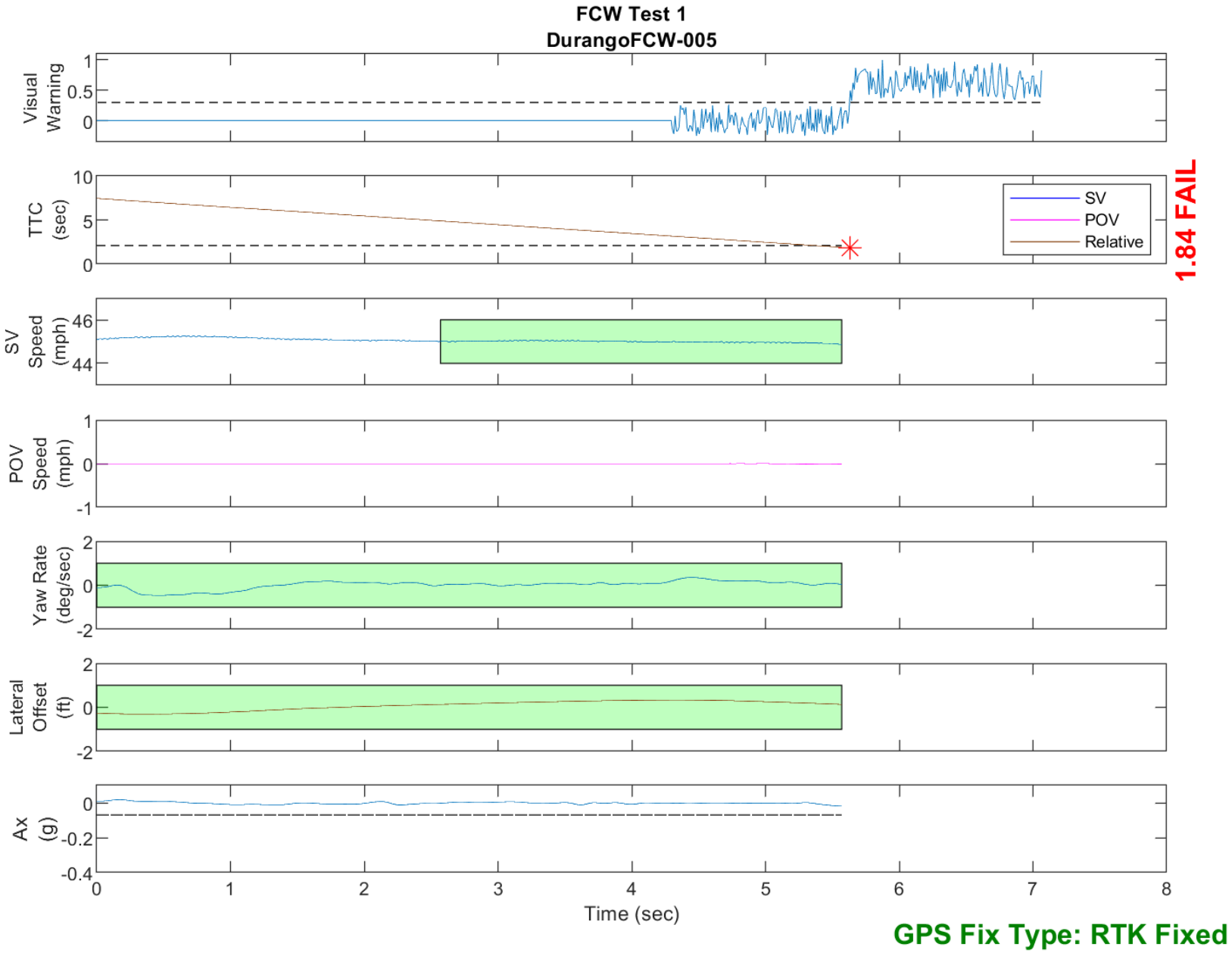


Figure D16. Time History for Run 5, FCW Test 1, Visual Warning

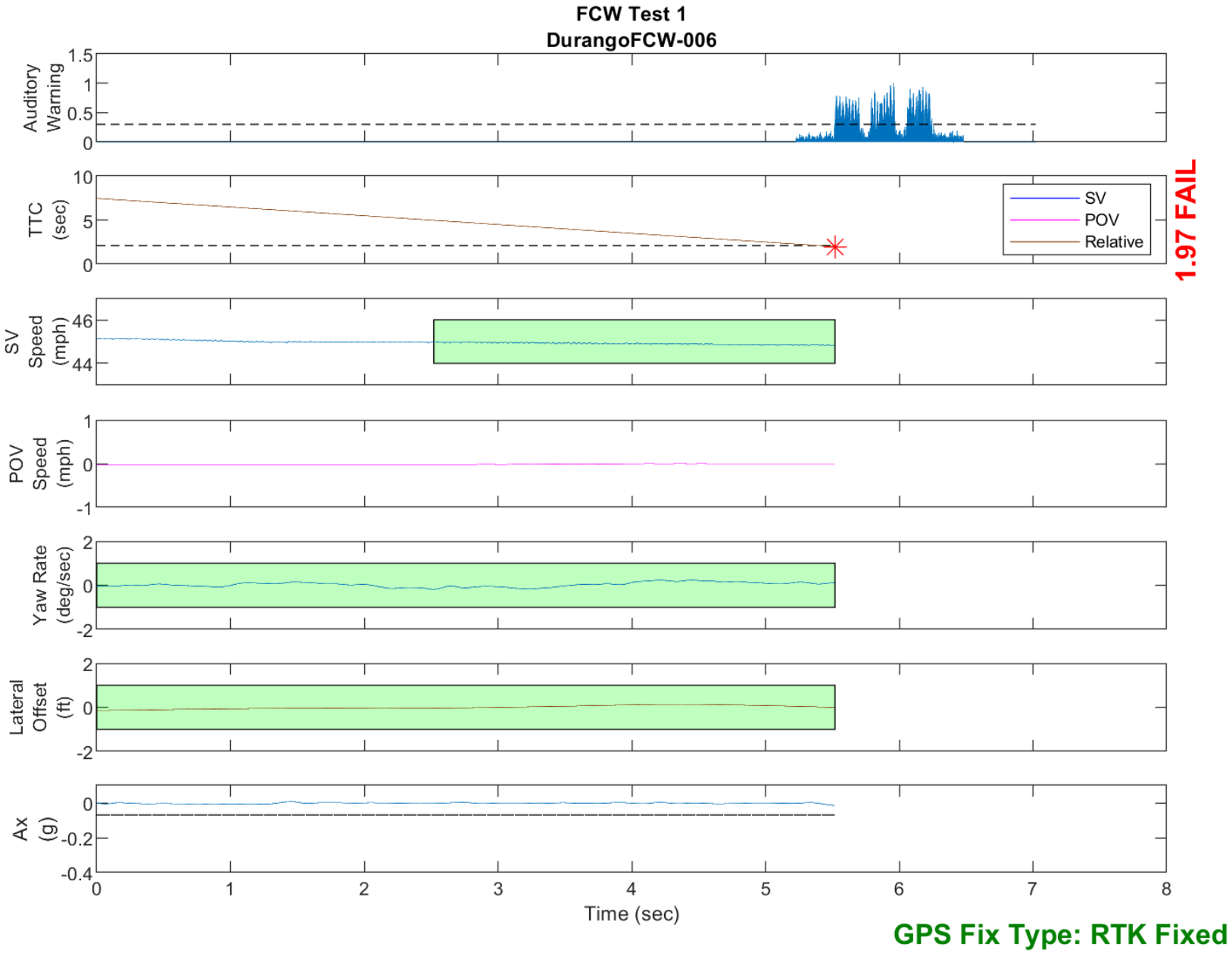


Figure D17. Time History for Run 6, FCW Test 1, Auditory Warning

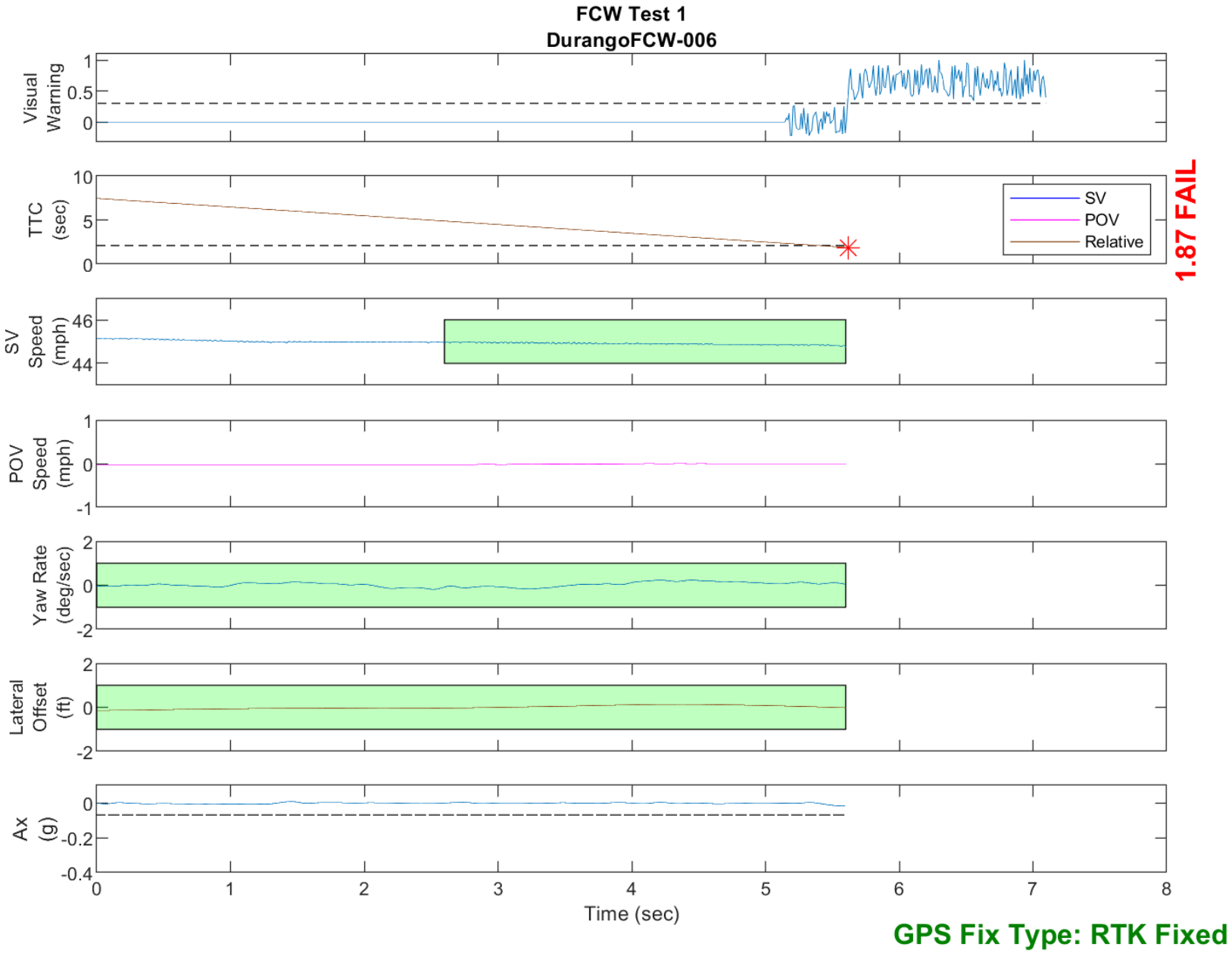


Figure D18. Time History for Run 6, FCW Test 1, Visual Warning

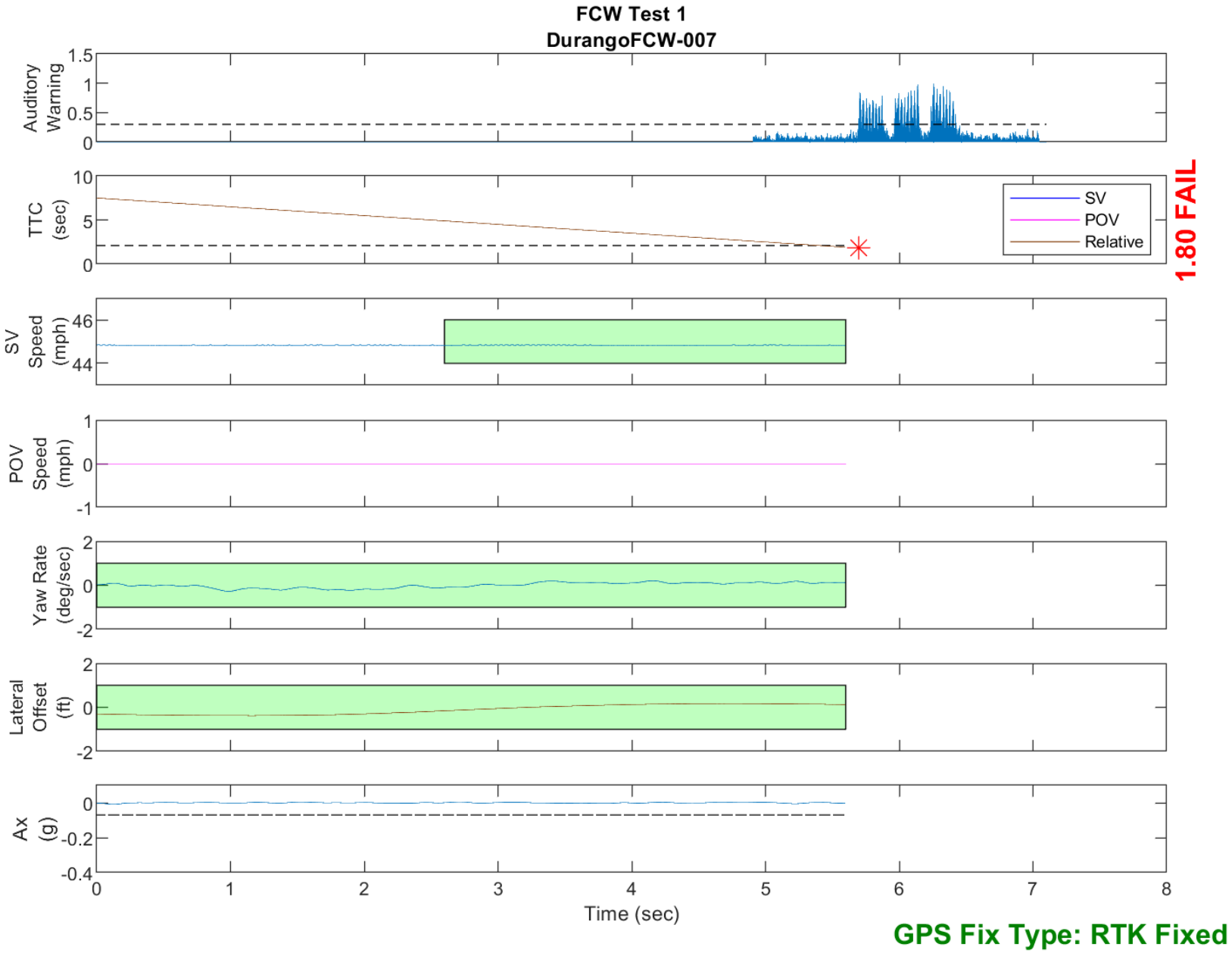


Figure D19. Time History for Run 7, FCW Test 1, Auditory Warning

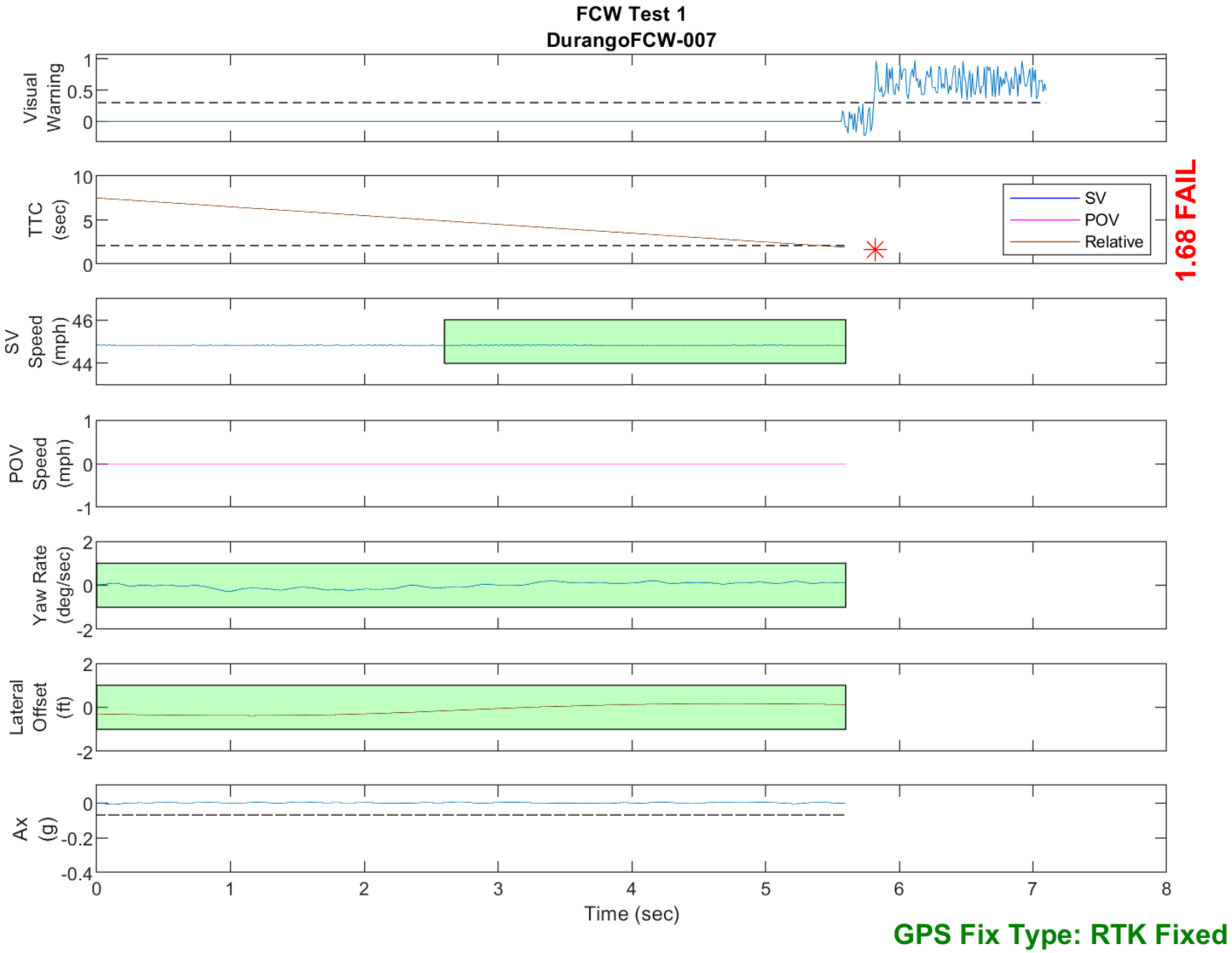


Figure D20. Time History for Run 7, FCW Test 1, Visual Warning

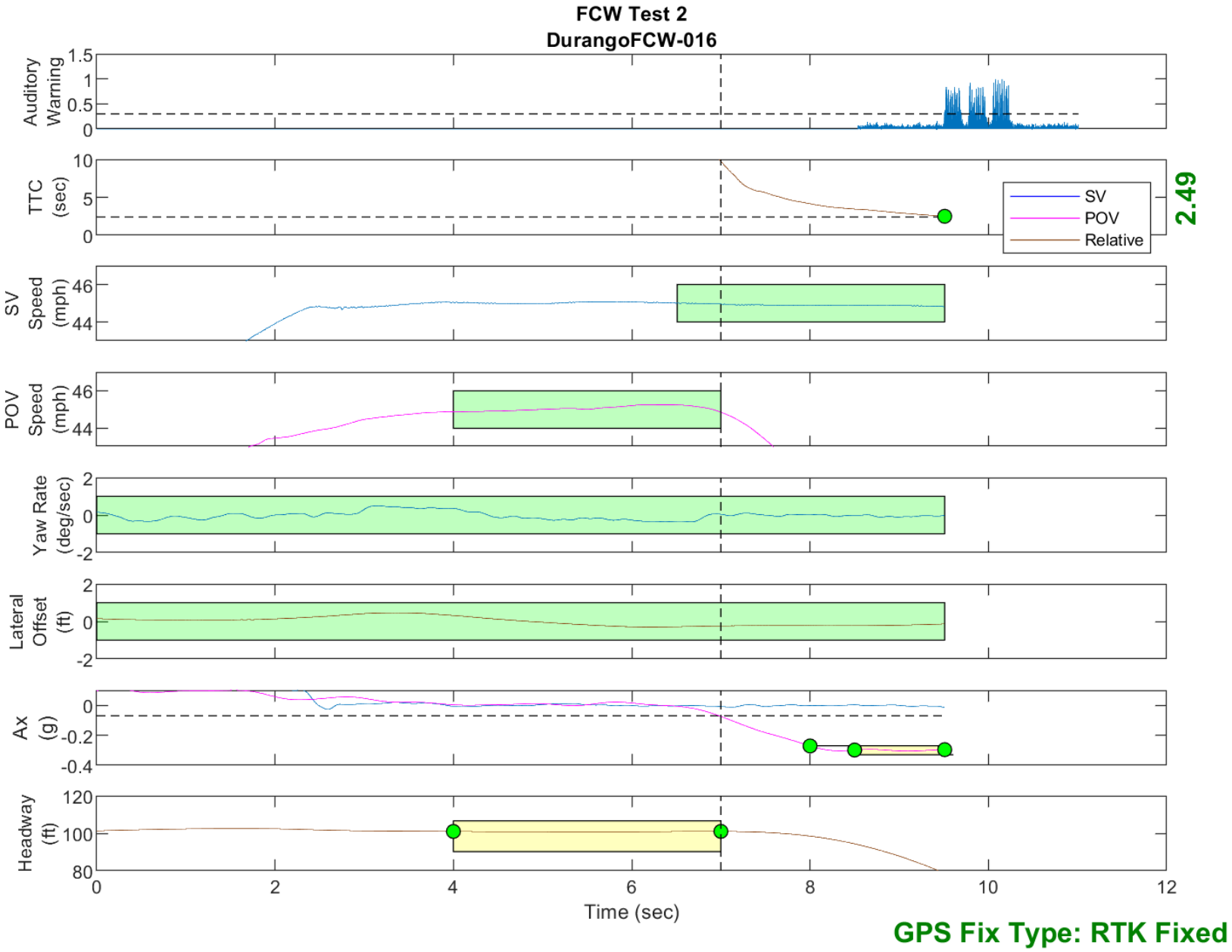


Figure D21. Time History for Run 16, FCW Test 2, Auditory Warning

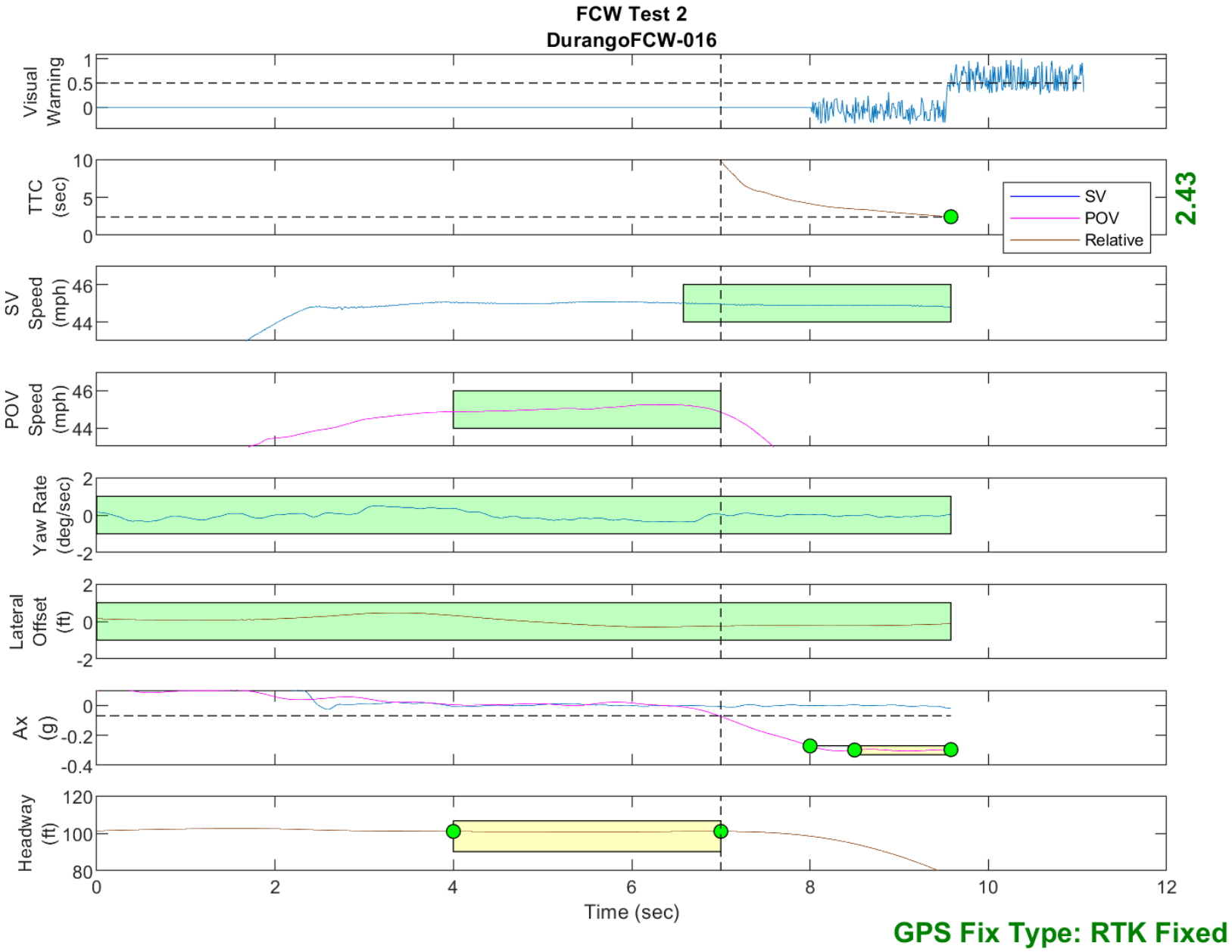


Figure D22. Time History for Run 16, FCW Test 2, Visual Warning

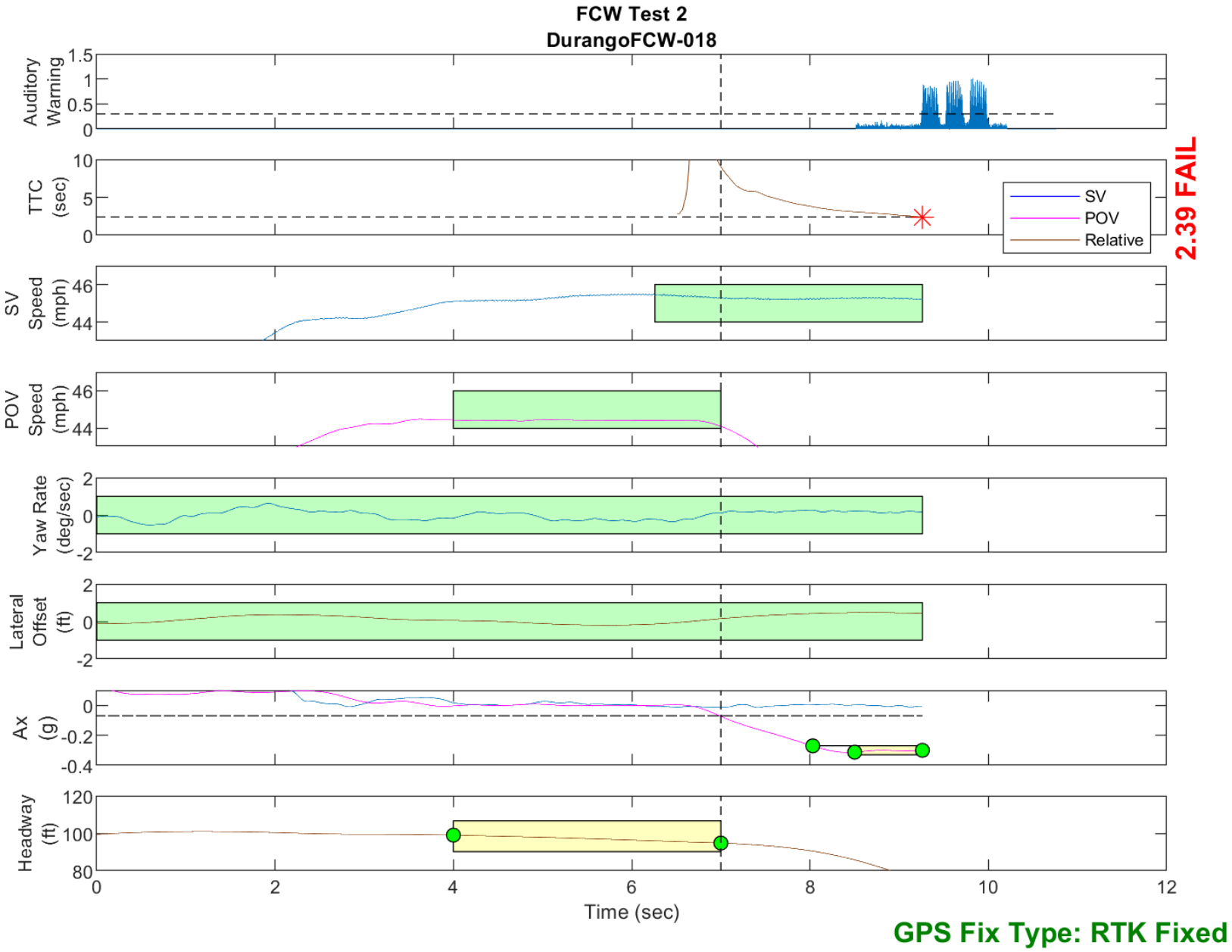


Figure D23. Time History for Run 18, FCW Test 2, Auditory Warning

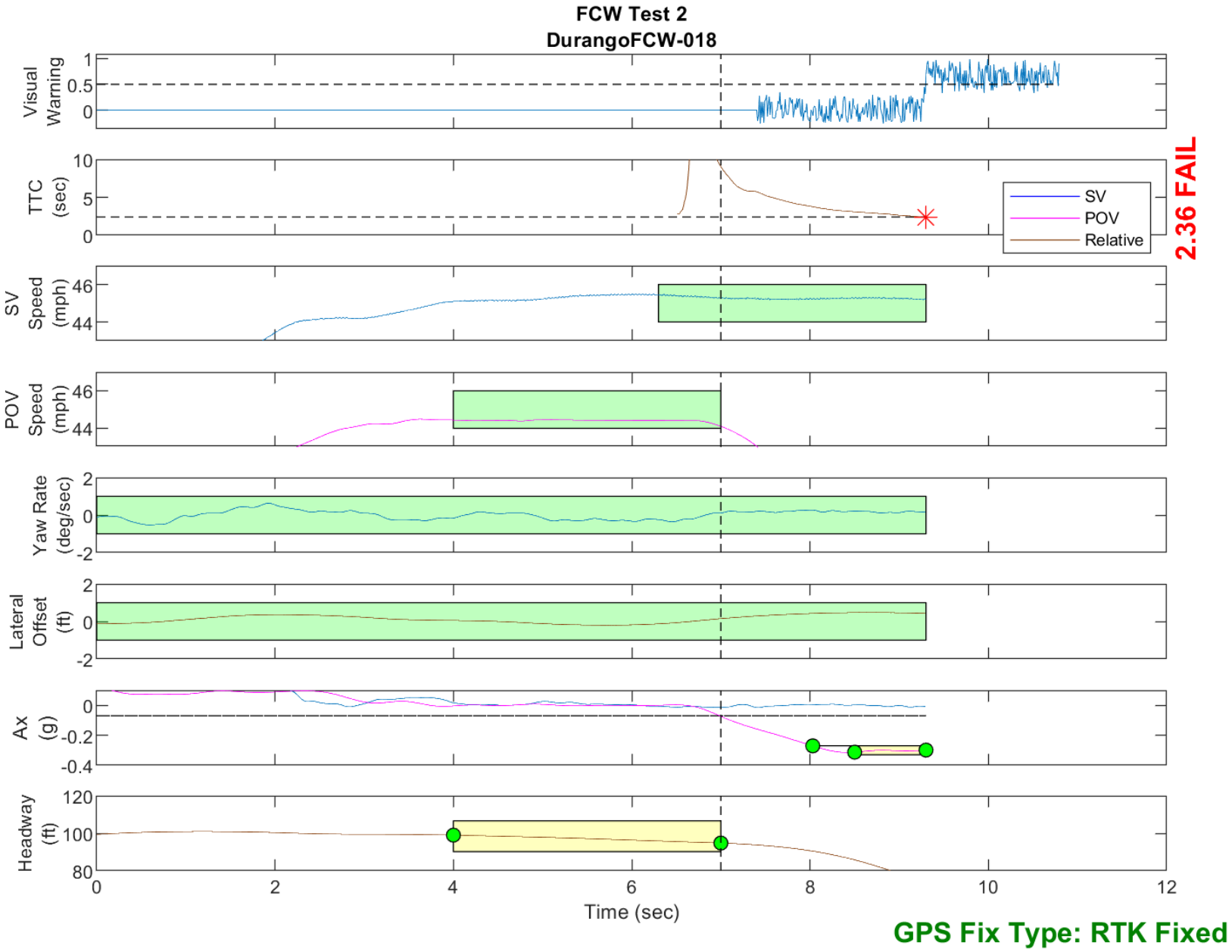


Figure D24. Time History for Run 18, FCW Test 2, Visual Warning

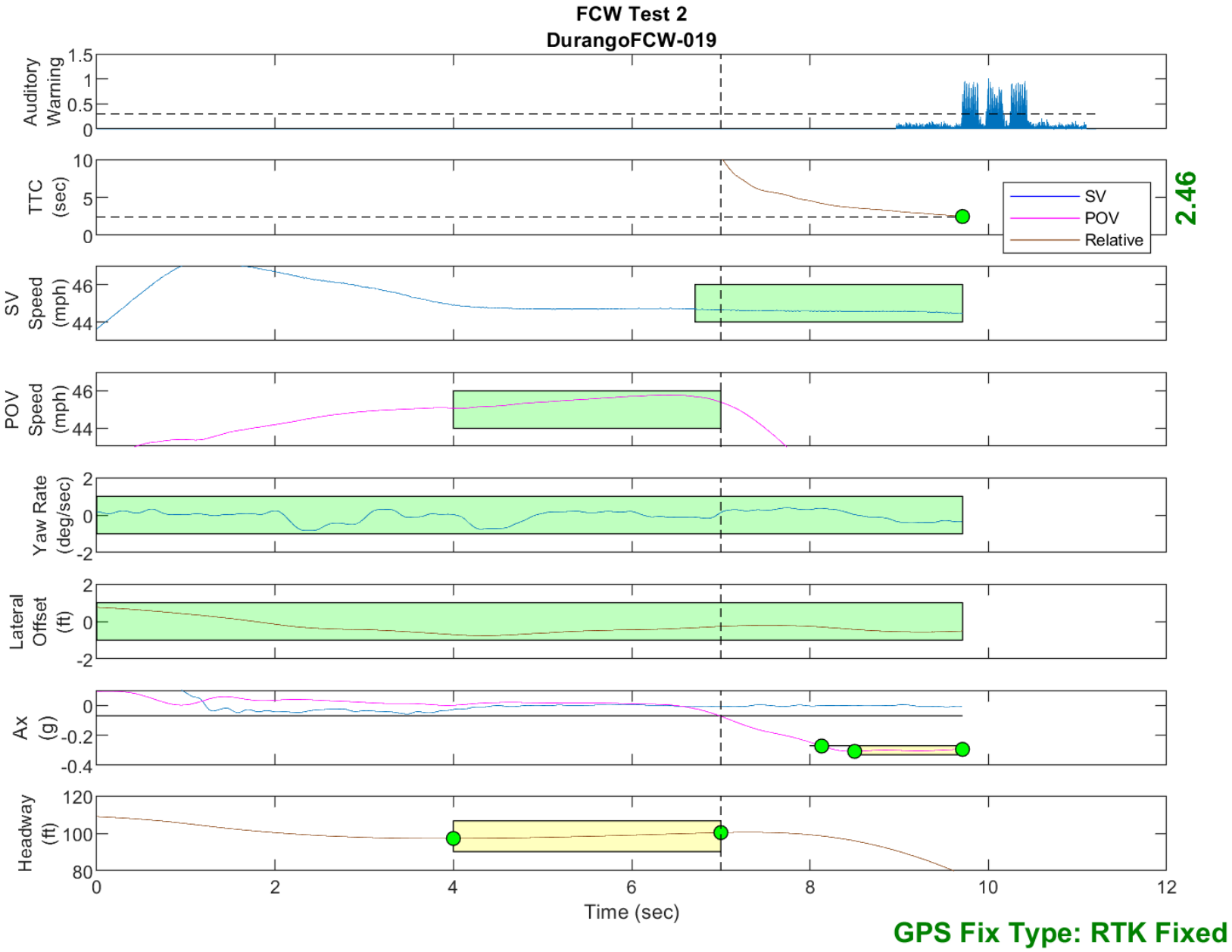


Figure D25. Time History for Run 19, FCW Test 2, Auditory Warning

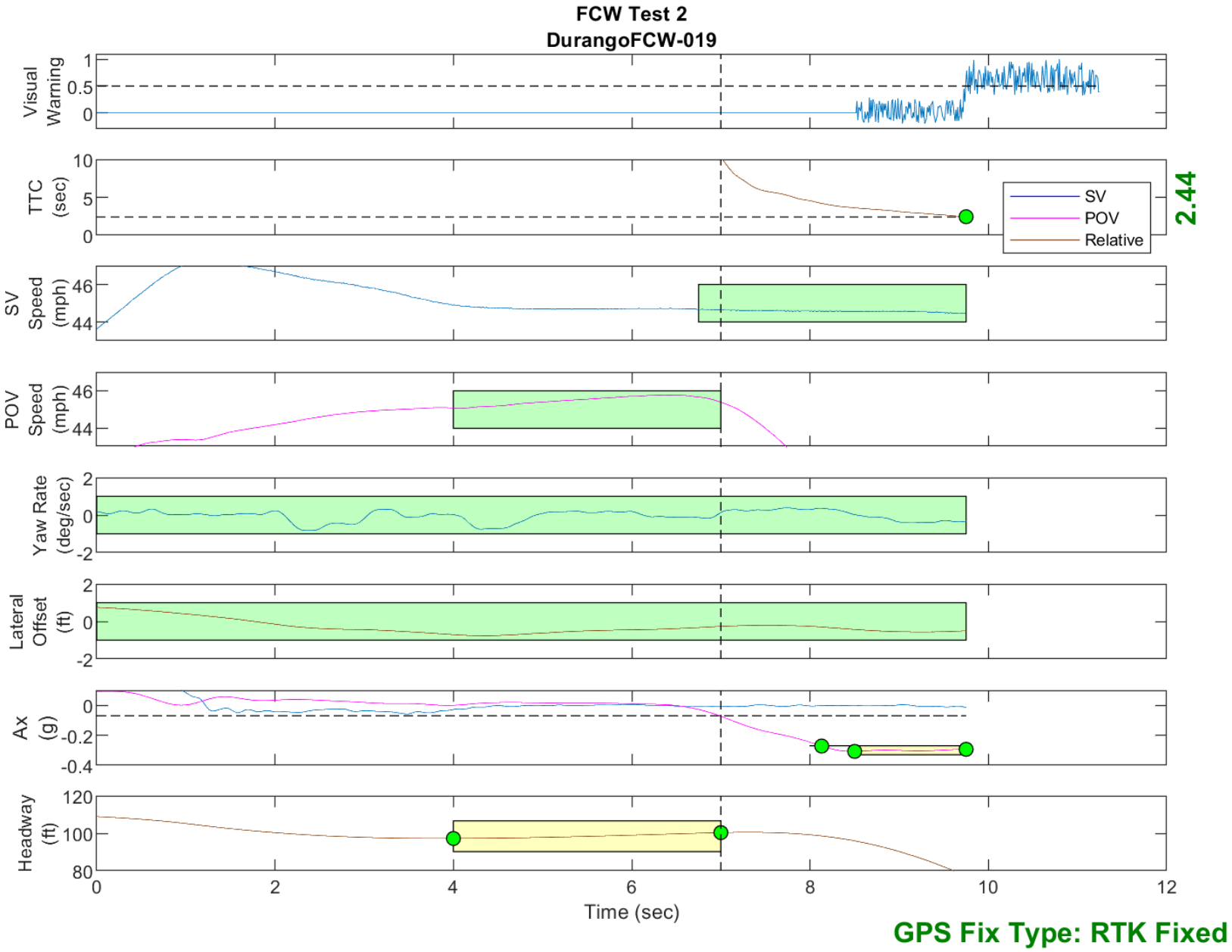


Figure D26. Time History for Run 19, FCW Test 2, Visual Warning

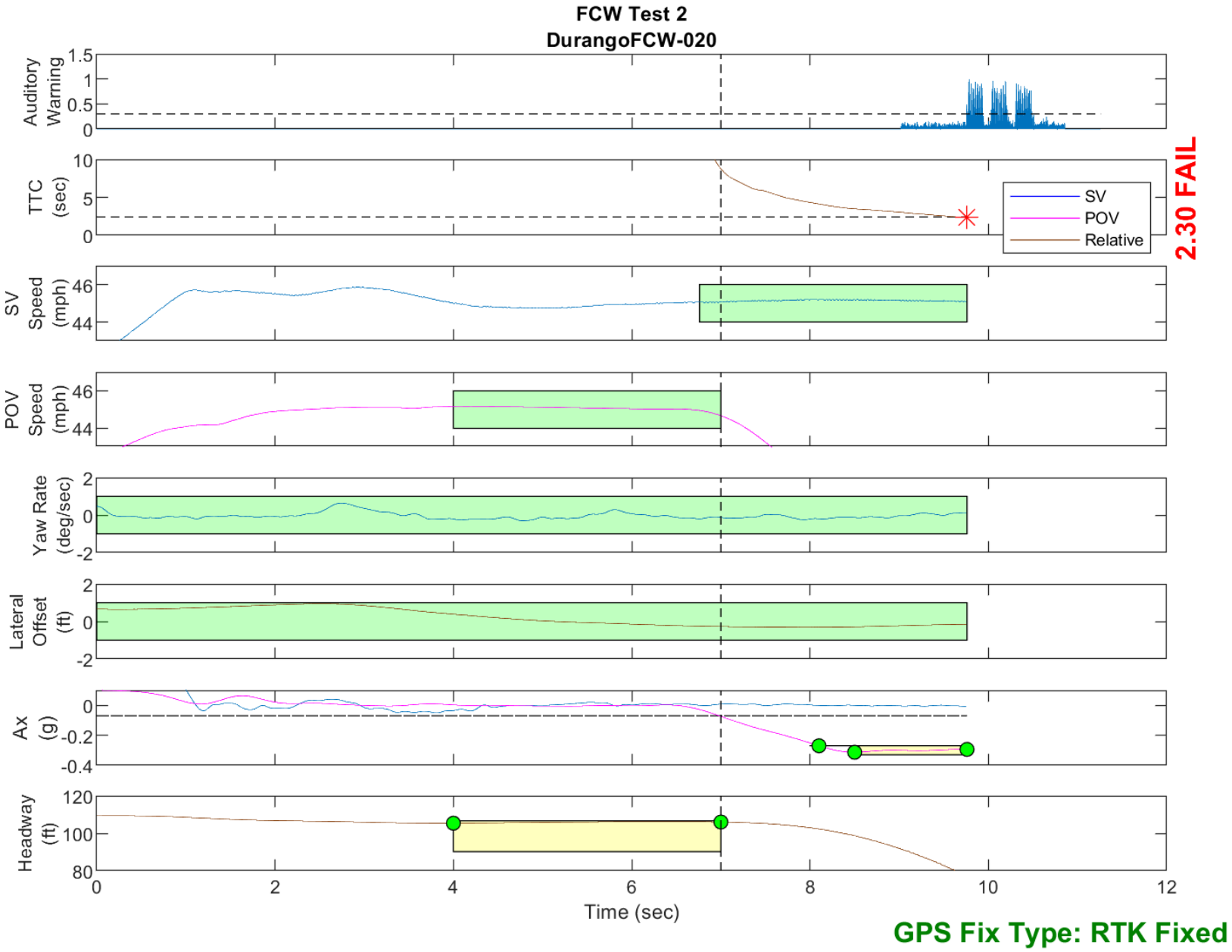


Figure D27. Time History for Run 20, FCW Test 2, Auditory Warning

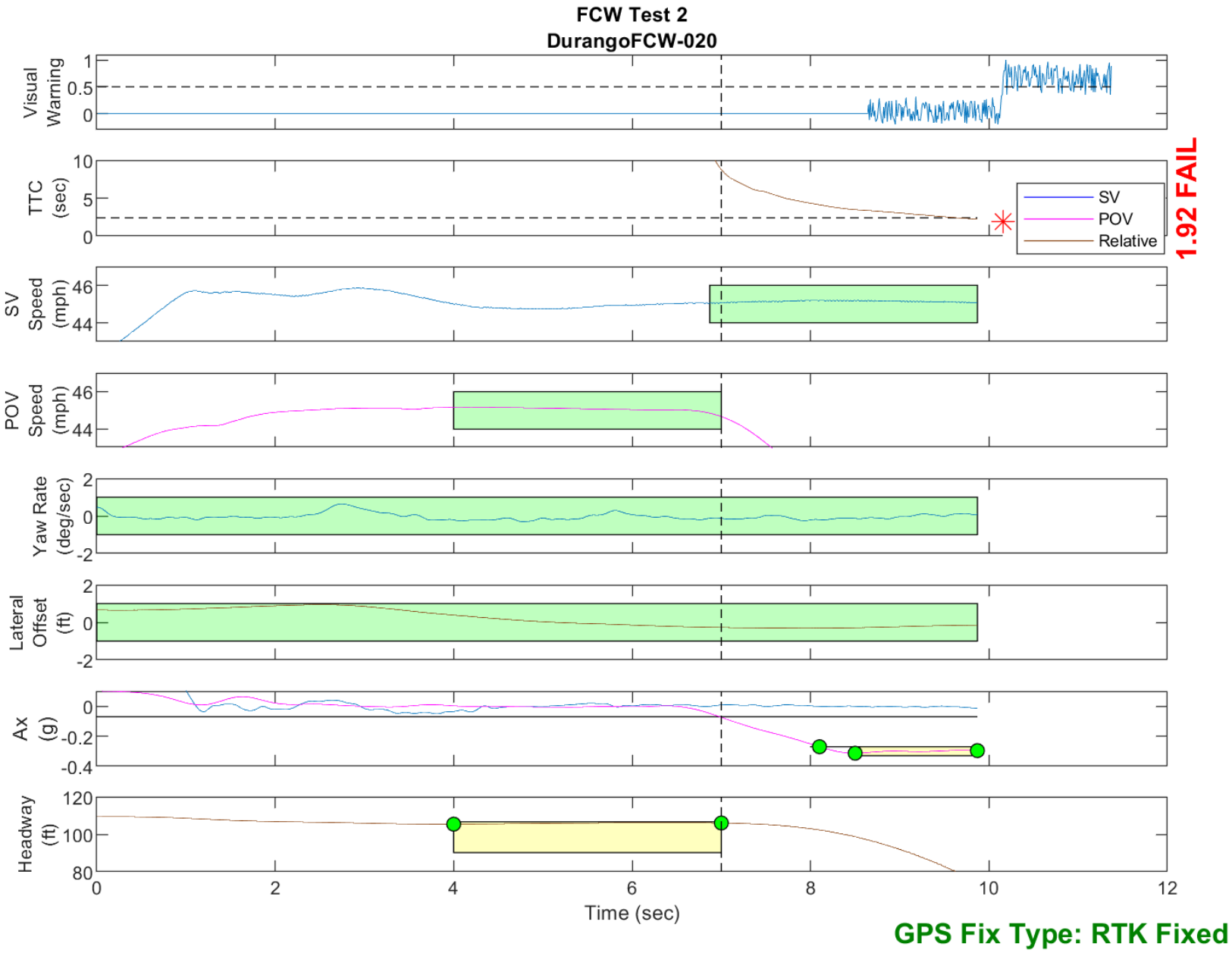


Figure D28. Time History for Run 20, FCW Test 2, Visual Warning

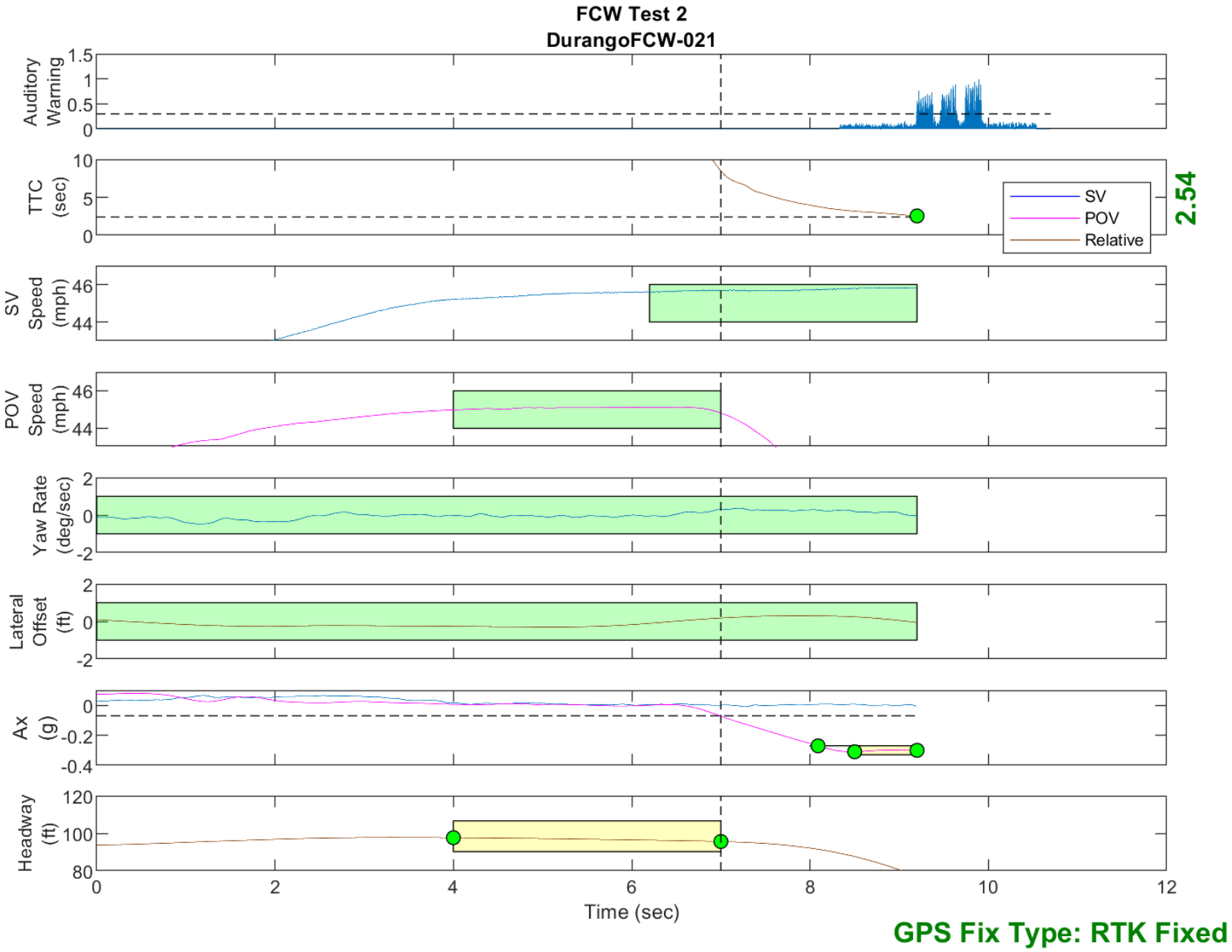


Figure D29. Time History for Run 21, FCW Test 2, Auditory Warning

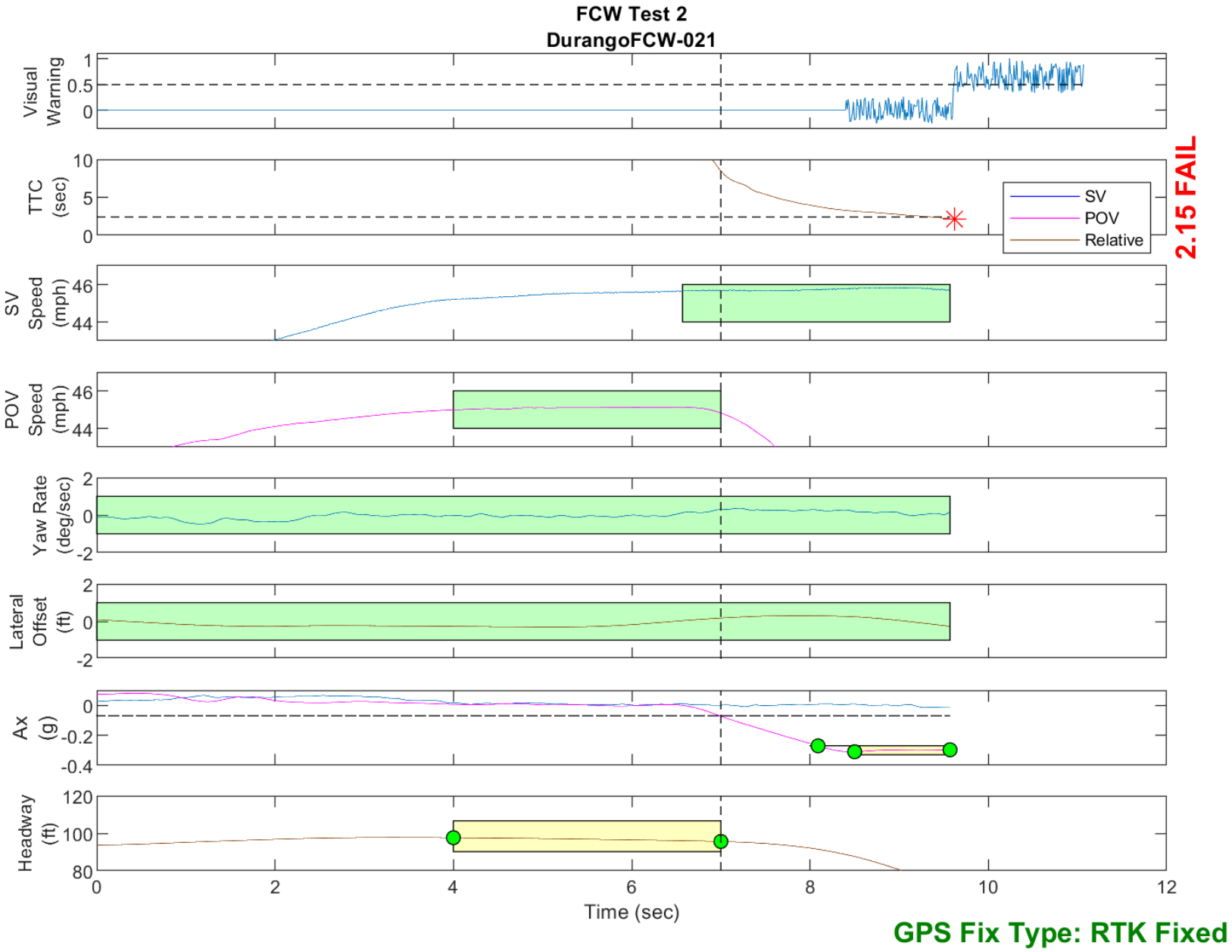


Figure D30. Time History for Run 21, FCW Test 2, Visual Warning

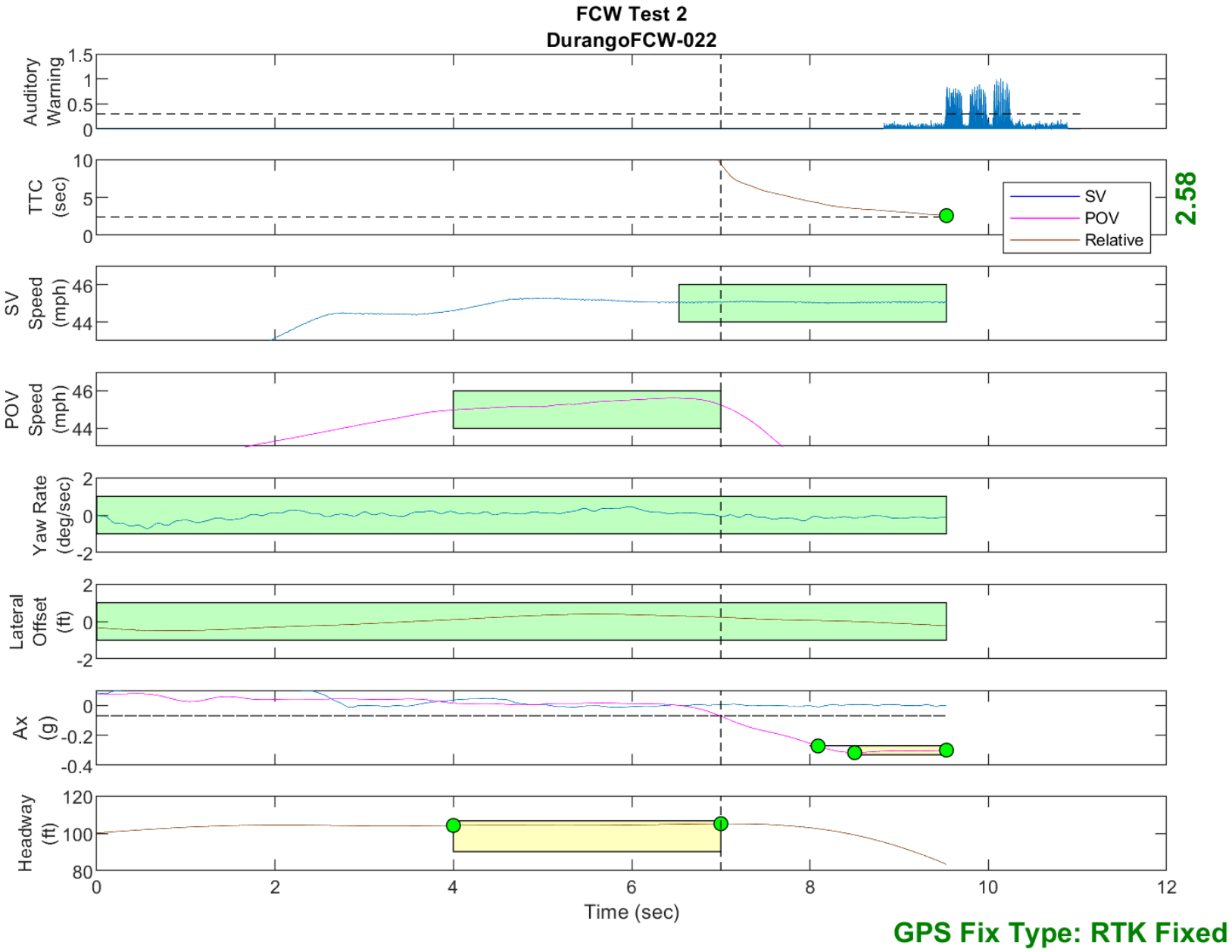


Figure D31. Time History for Run 22, FCW Test 2, Auditory Warning

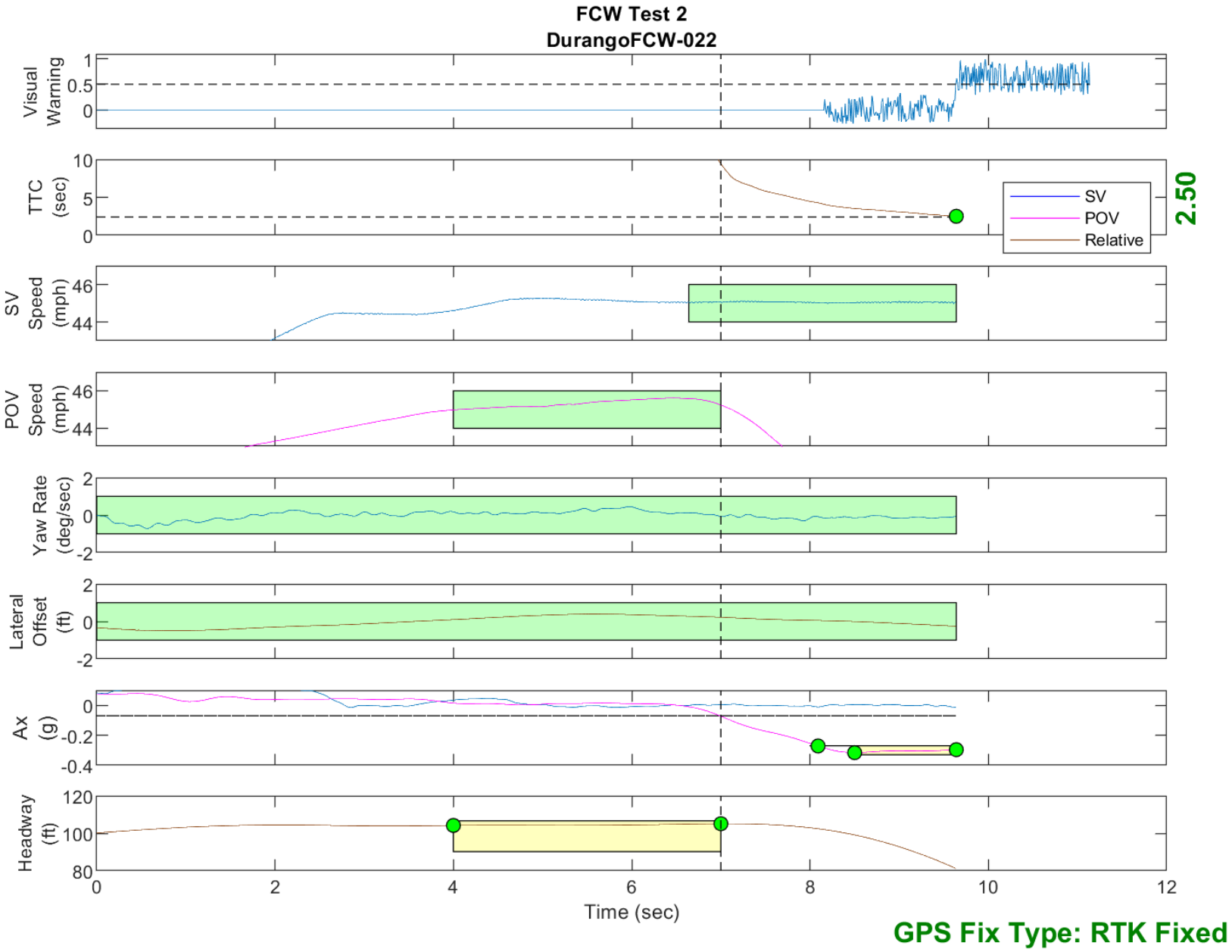


Figure D32. Time History for Run 22, FCW Test 2, Visual Warning

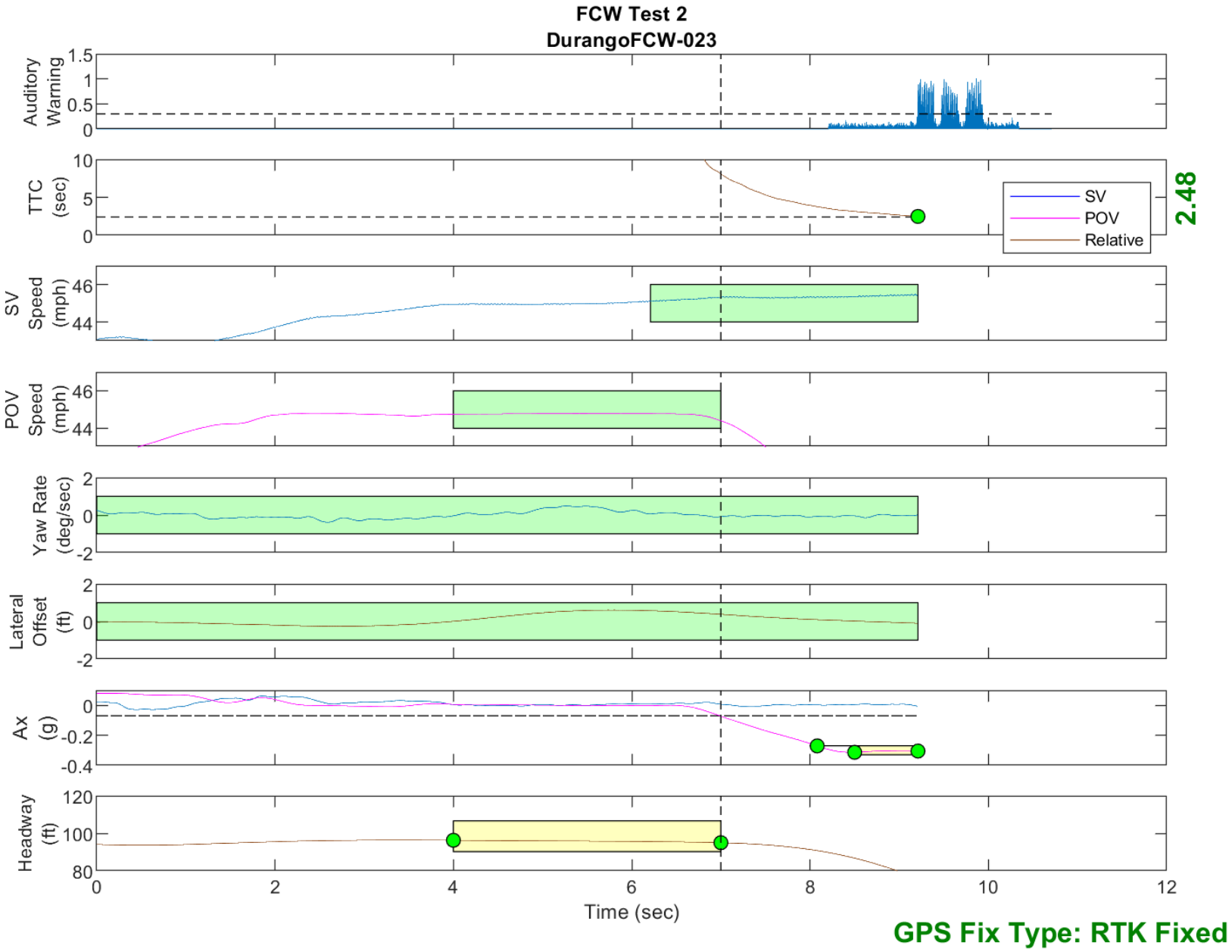


Figure D33. Time History for Run 23, FCW Test 2, Auditory Warning

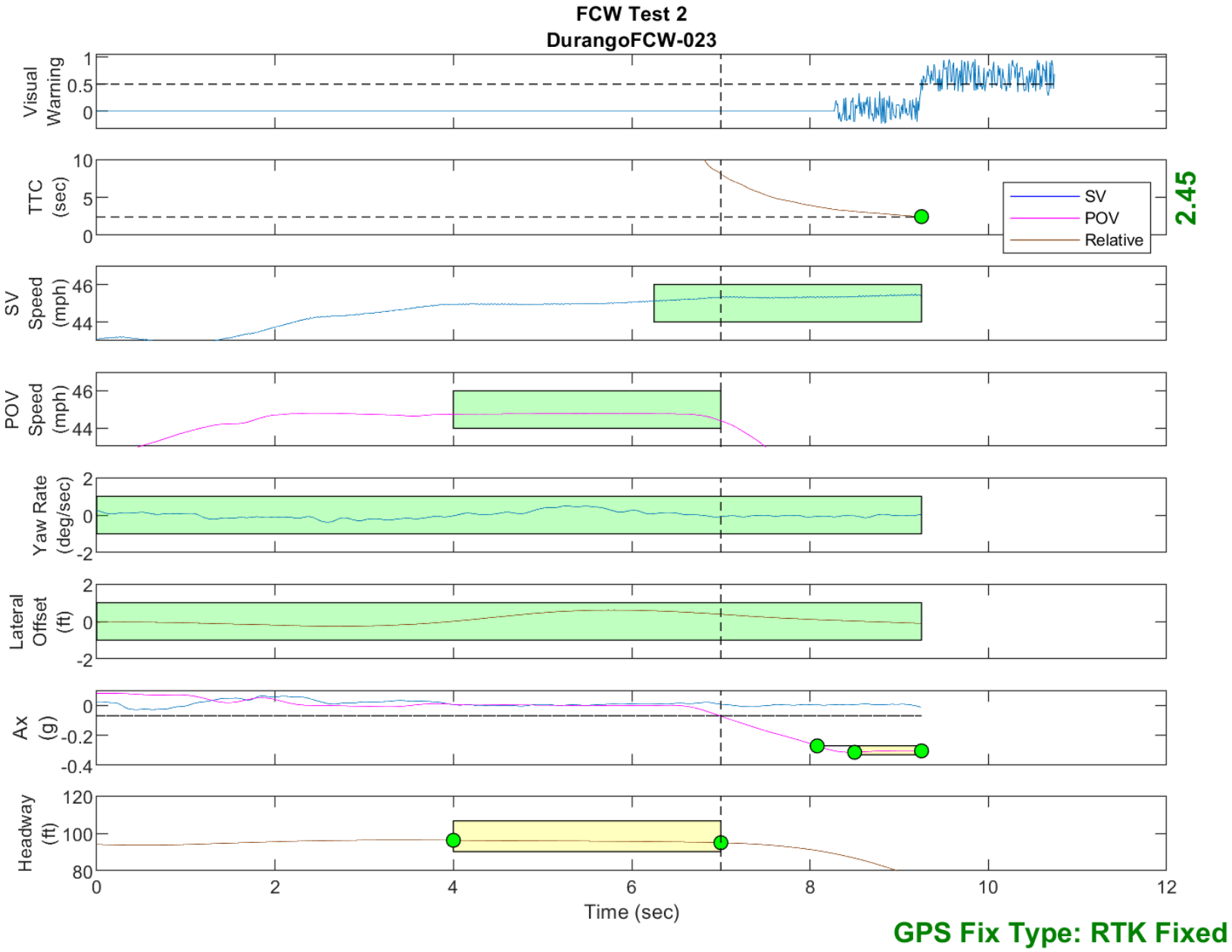


Figure D34. Time History for Run 23, FCW Test 2, Visual Warning

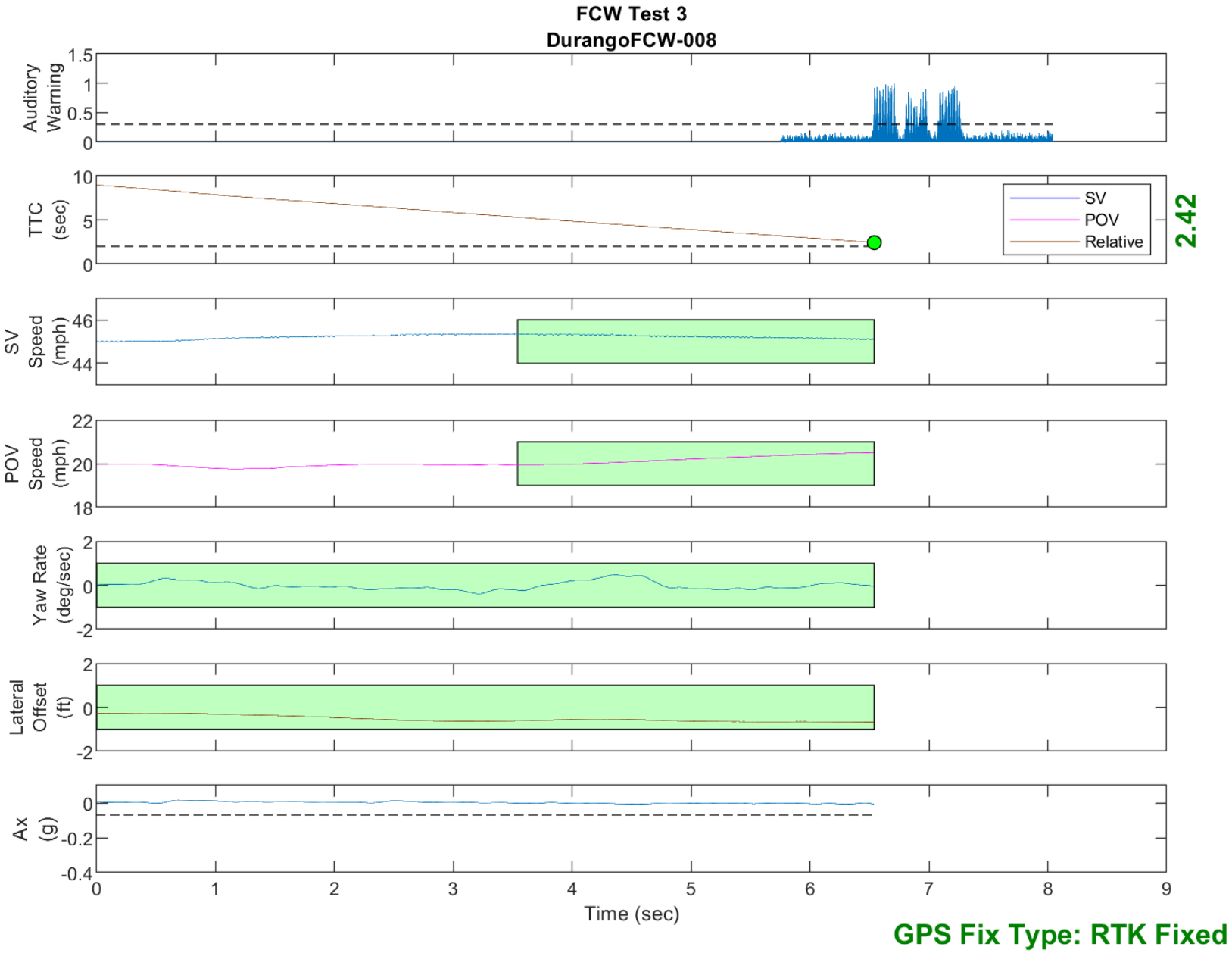


Figure D35. Time History for Run 8, FCW Test 3, Auditory Warning

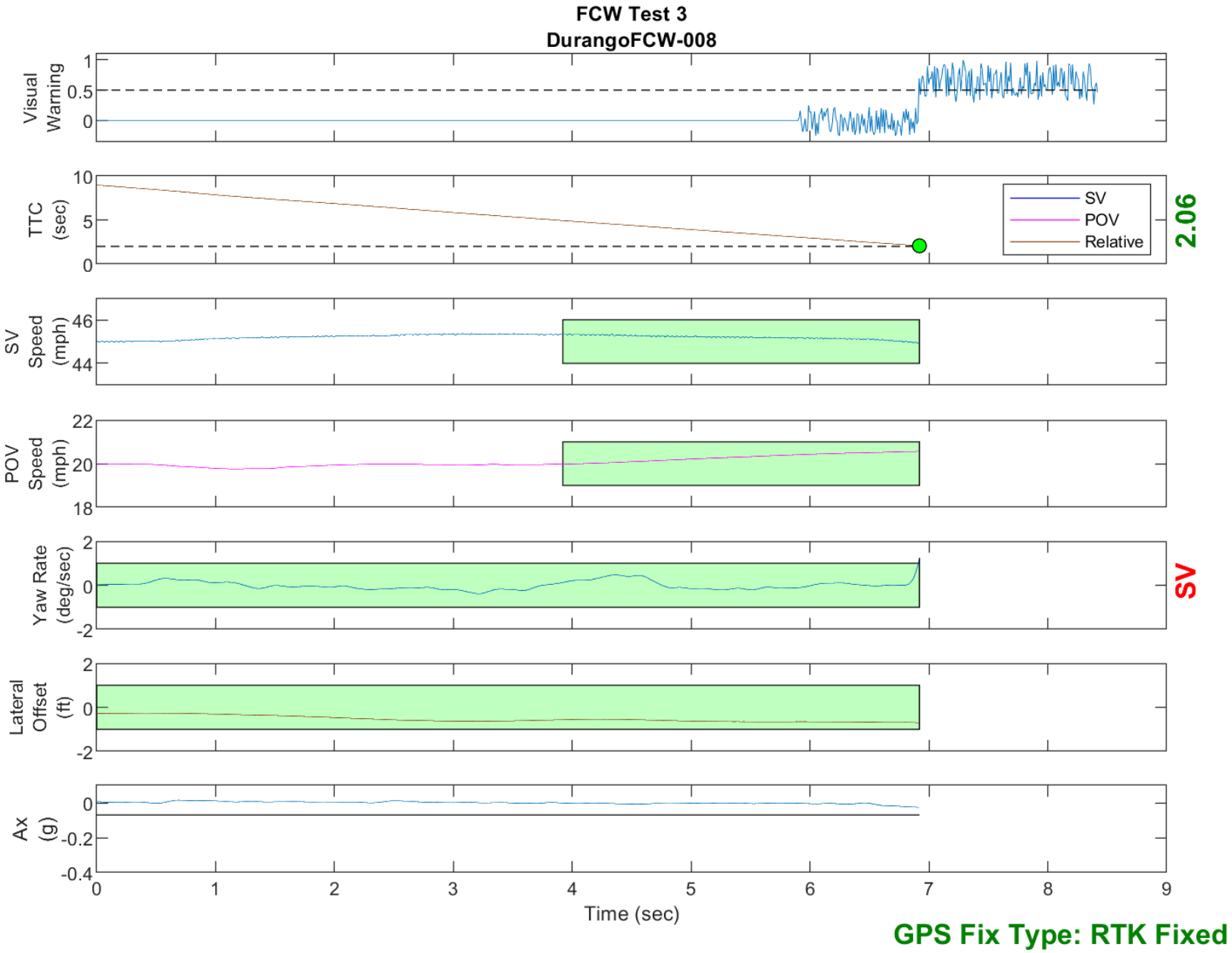


Figure D36. Time History for Run 8, FCW Test 3, Visual Warning

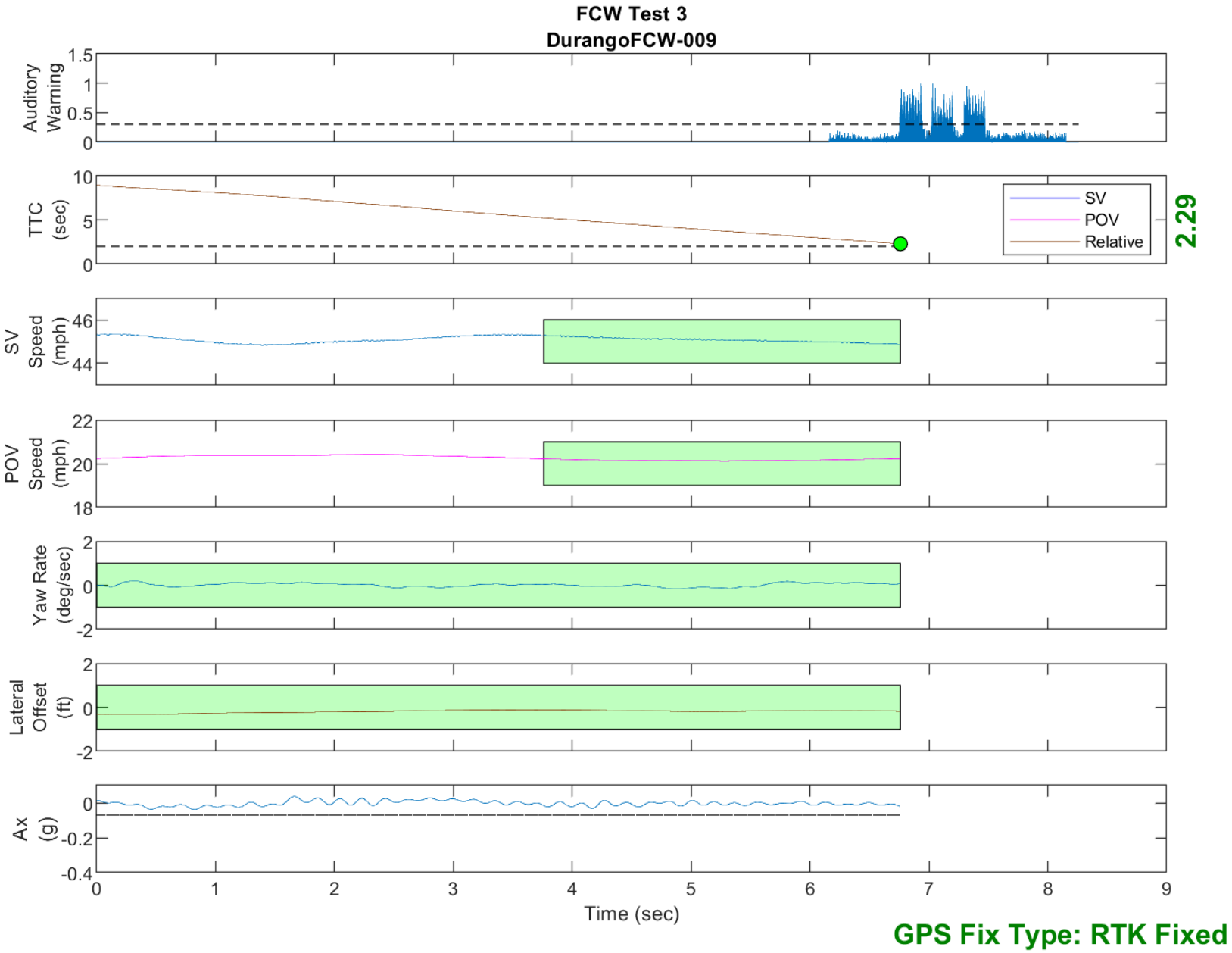


Figure D37. Time History for Run 9, FCW Test 3, Auditory Warning

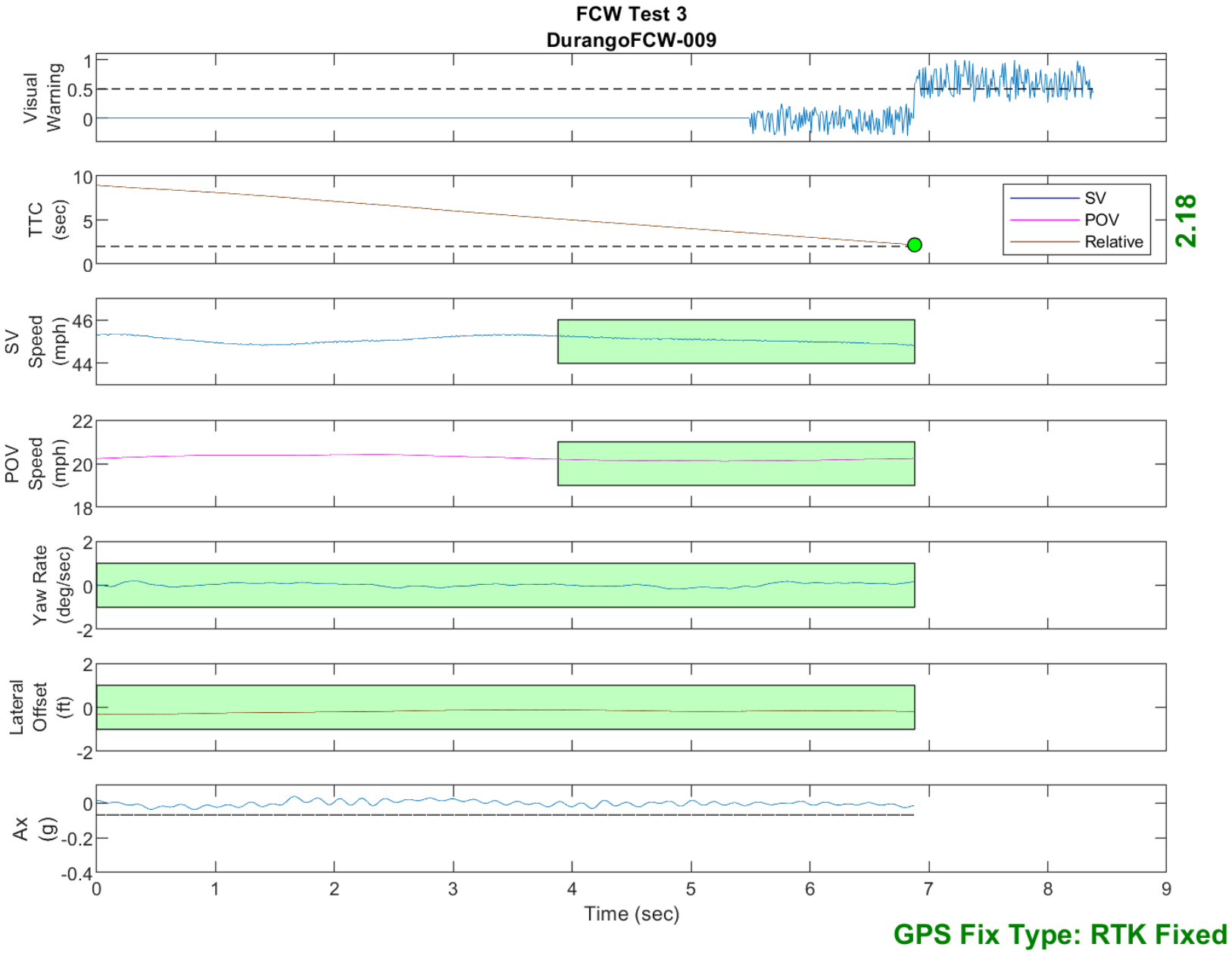


Figure D38. Time History for Run 9, FCW Test 3, Visual Warning

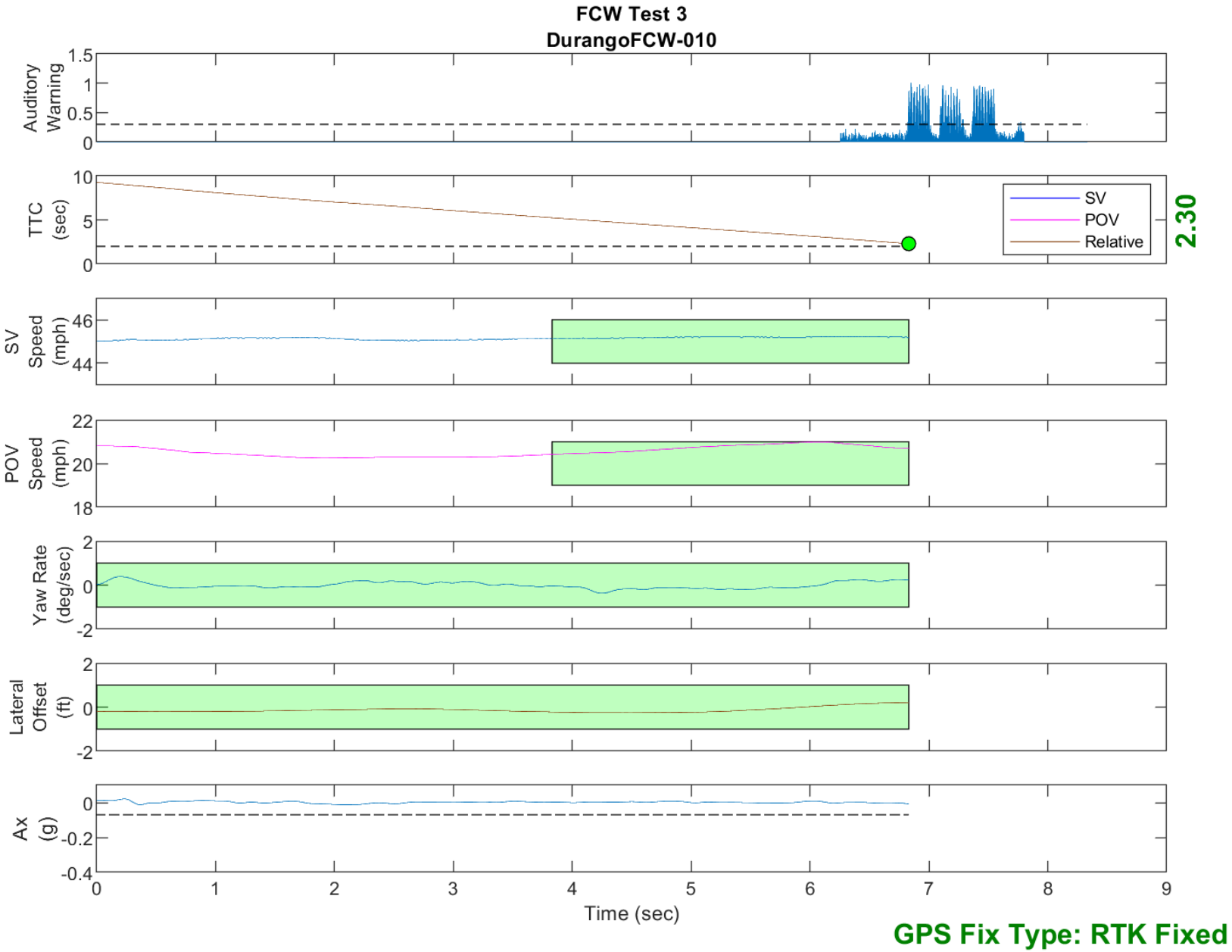


Figure D39. Time History for Run 10, FCW Test 3, Auditory Warning

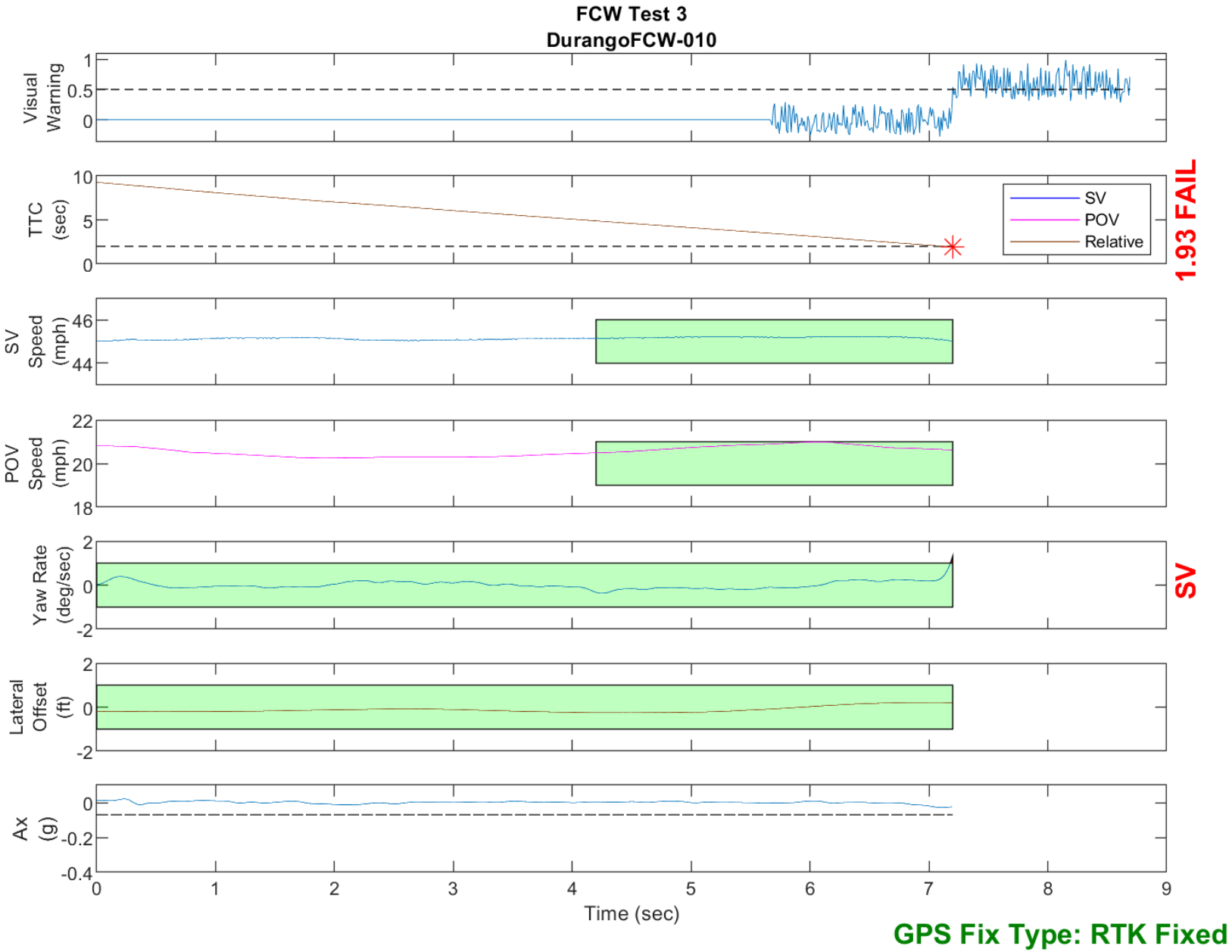


Figure D40. Time History for Run 10, FCW Test 3, Visual Warning

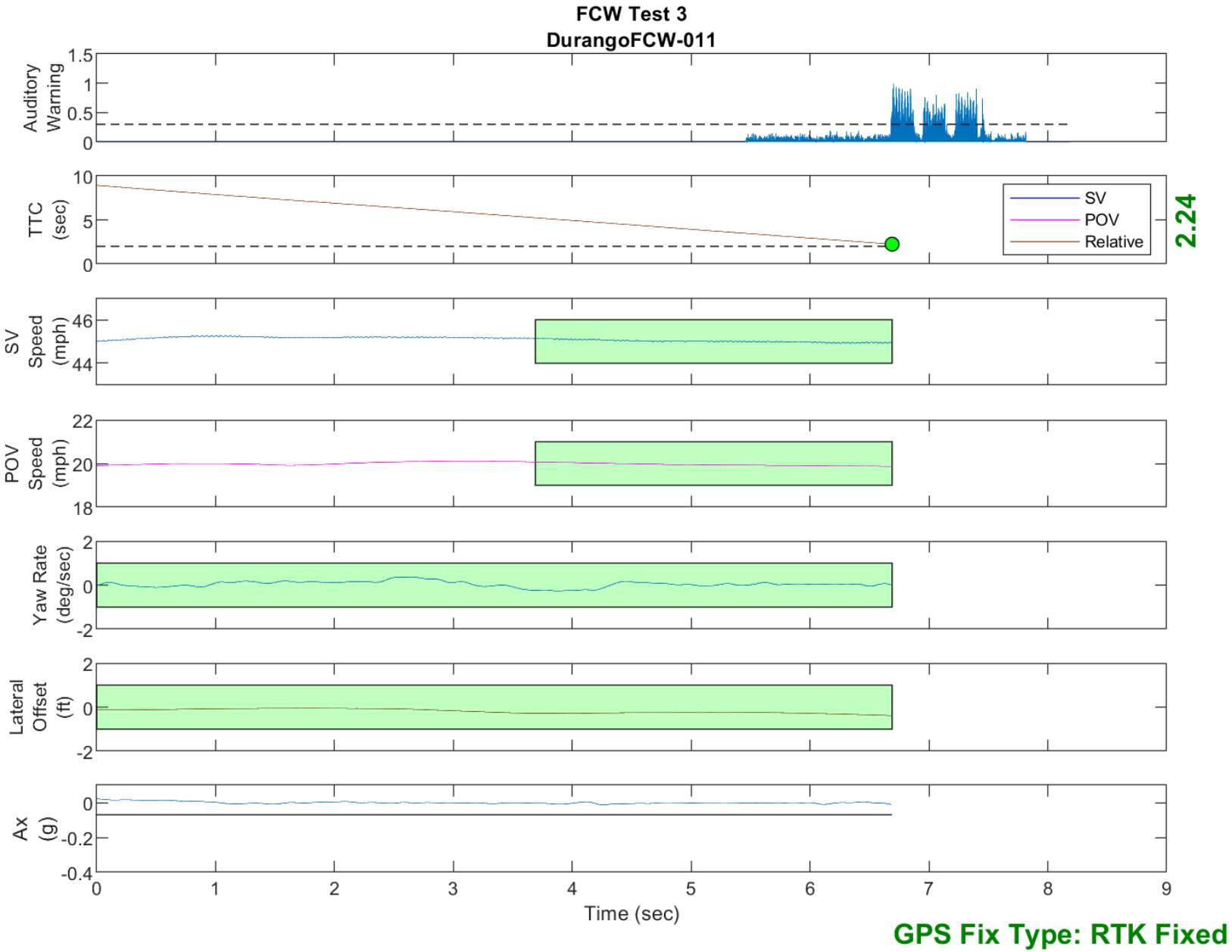


Figure D41. Time History for Run 11, FCW Test 3, Auditory Warning

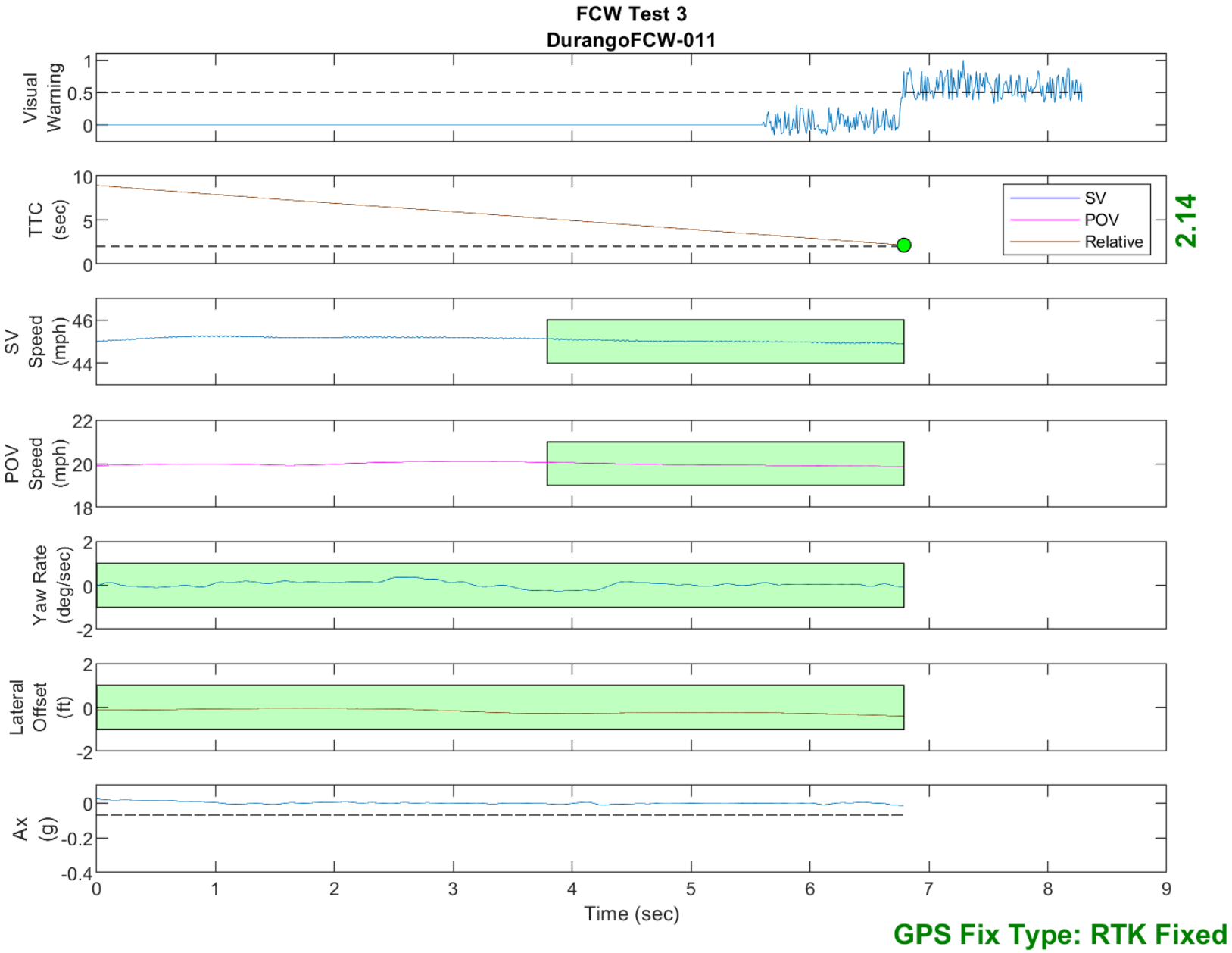


Figure D42. Time History for Run 11, FCW Test 3, Visual Warning

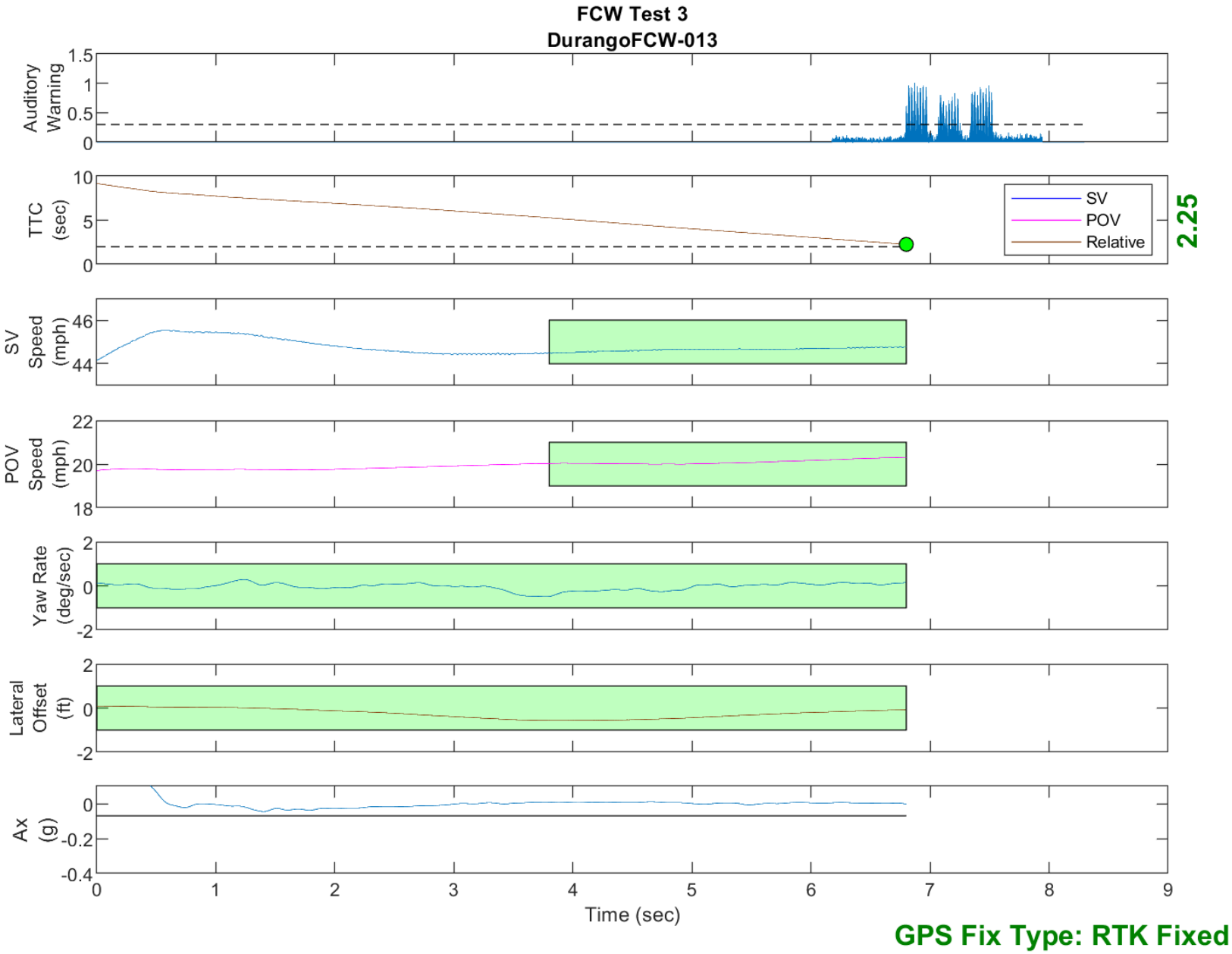


Figure D43. Time History for Run 13, FCW Test 3, Auditory Warning

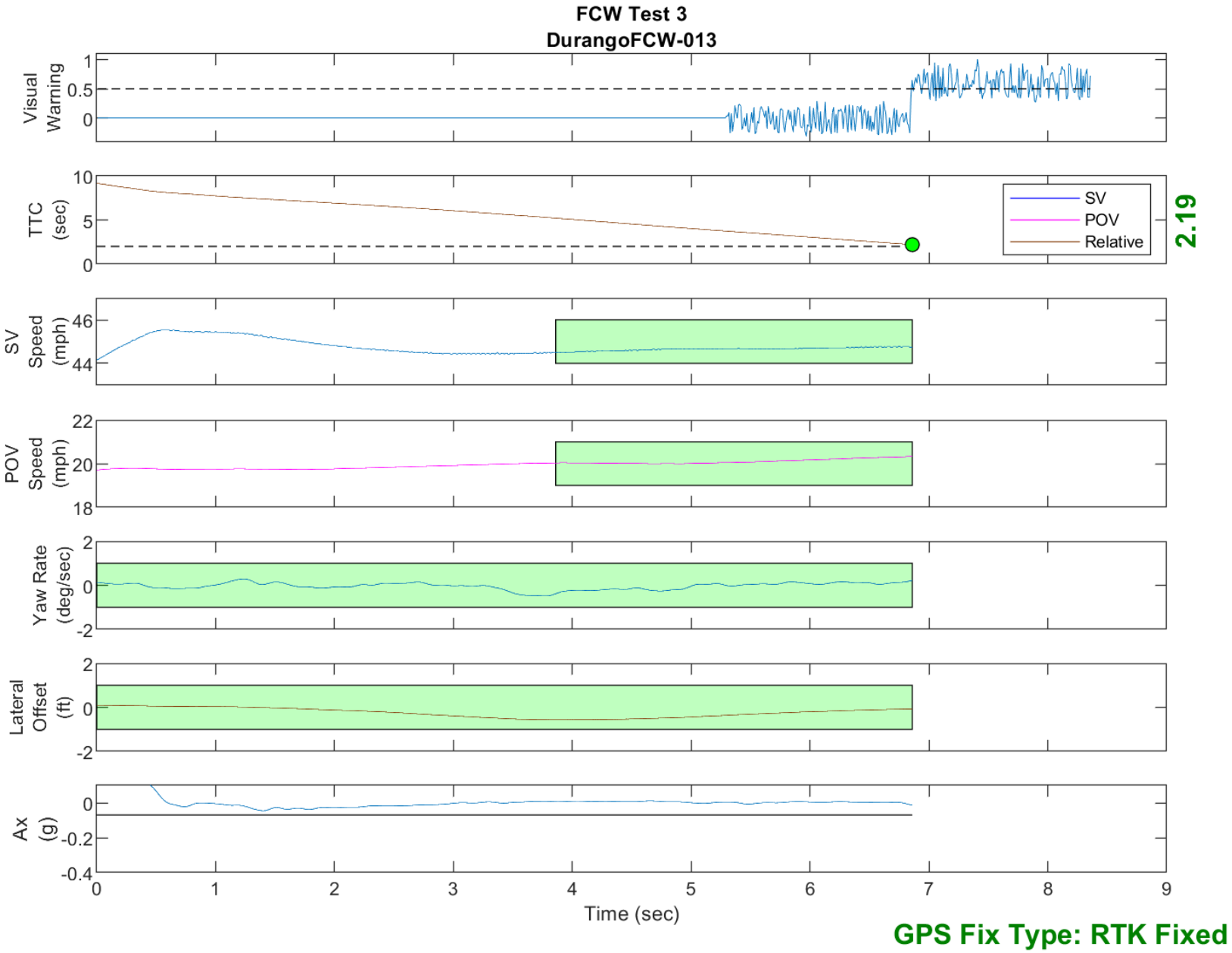


Figure D44. Time History for Run 13, FCW Test 3, Visual Warning

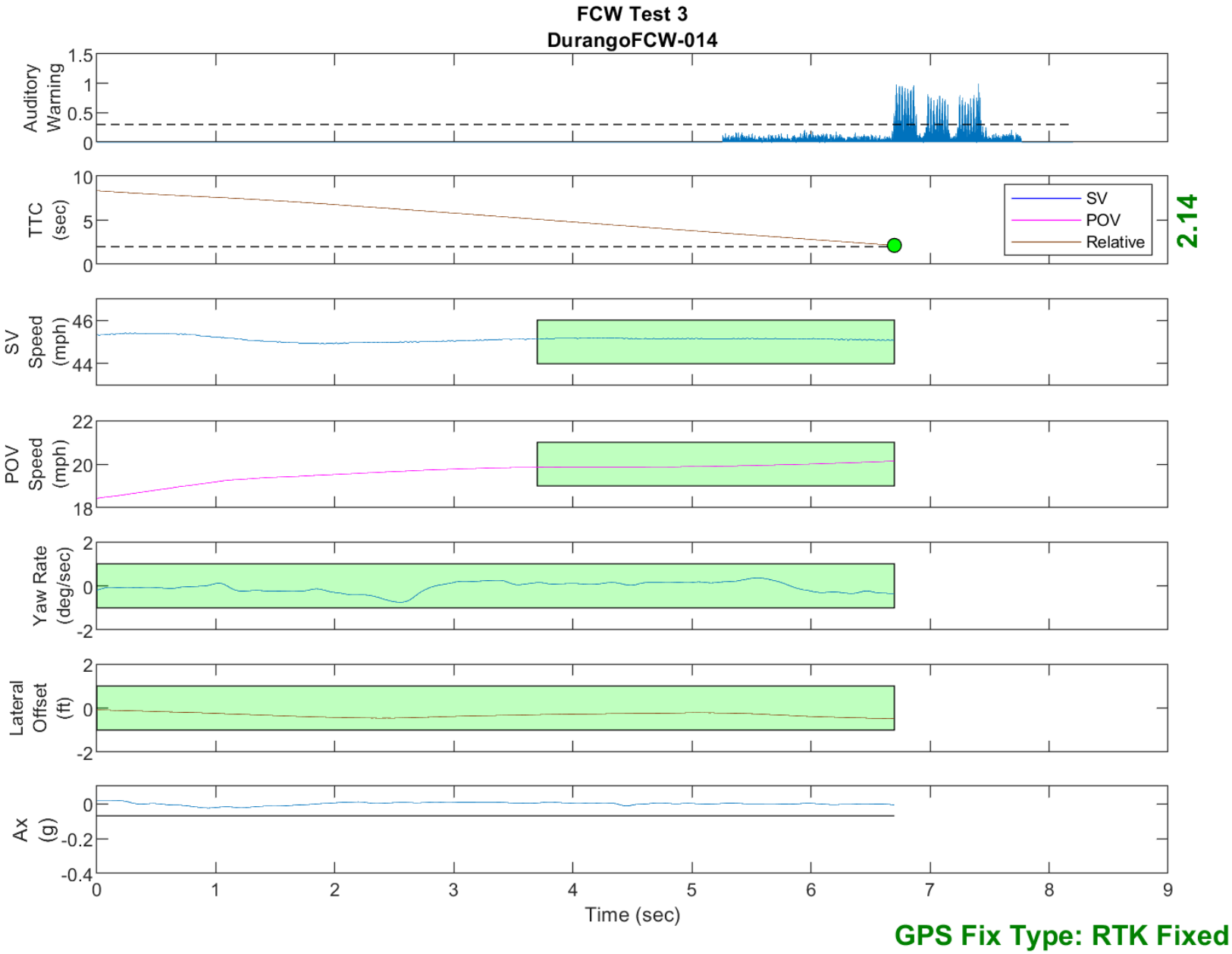


Figure D45. Time History for Run 14, FCW Test 3, Auditory Warning

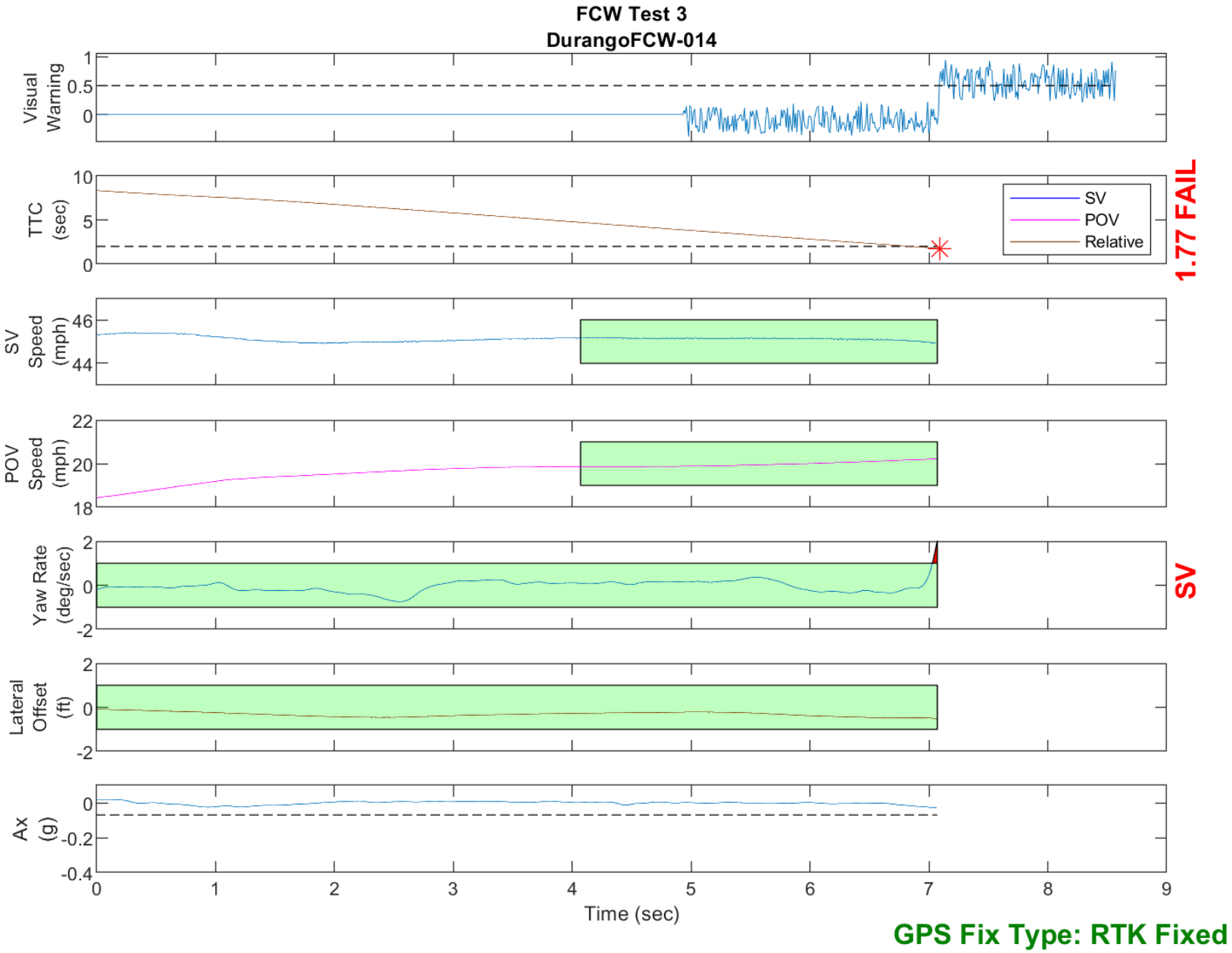


Figure D46. Time History for Run 14, FCW Test 3, Visual Warning

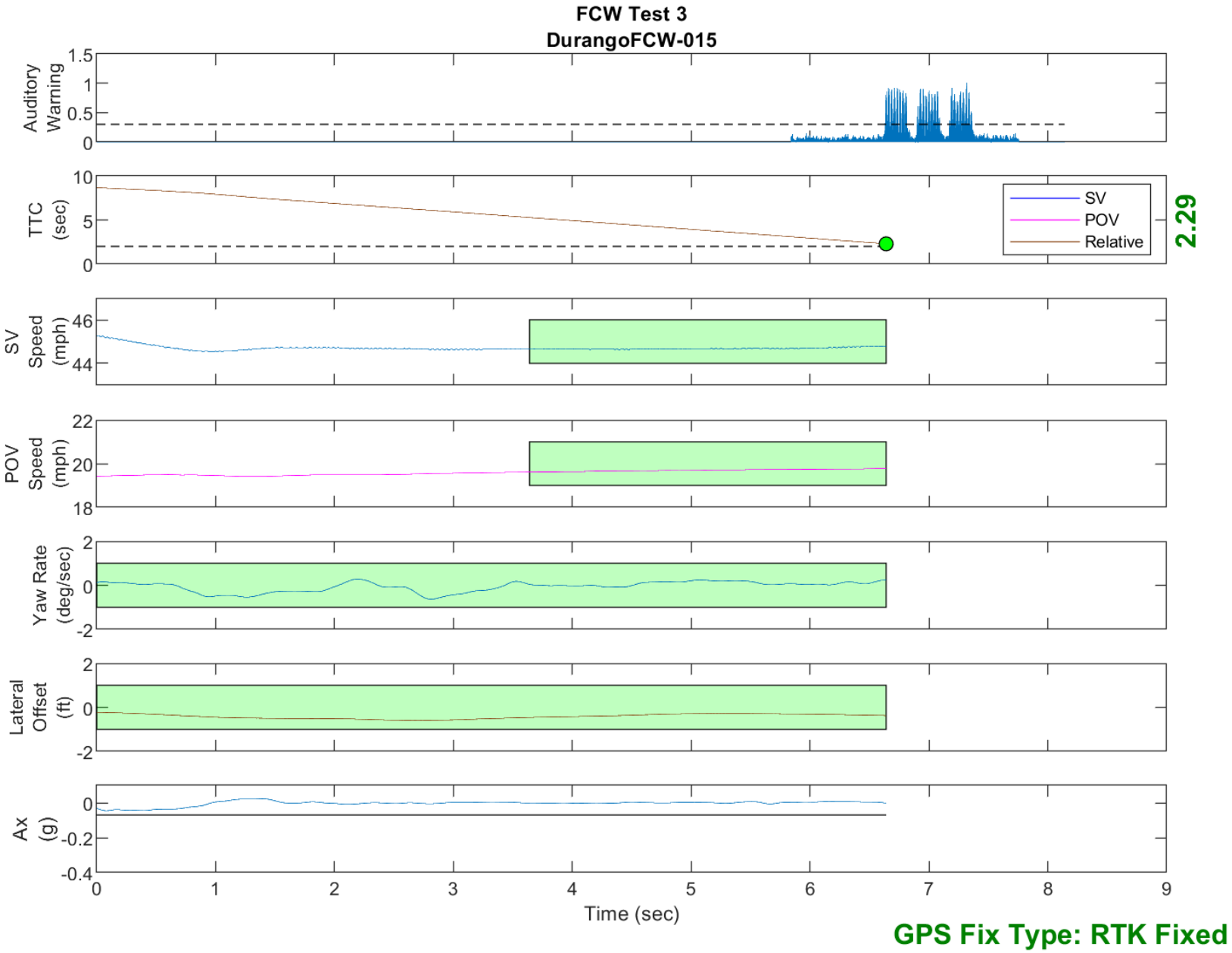


Figure D47. Time History for Run 15, FCW Test 3, Auditory Warning

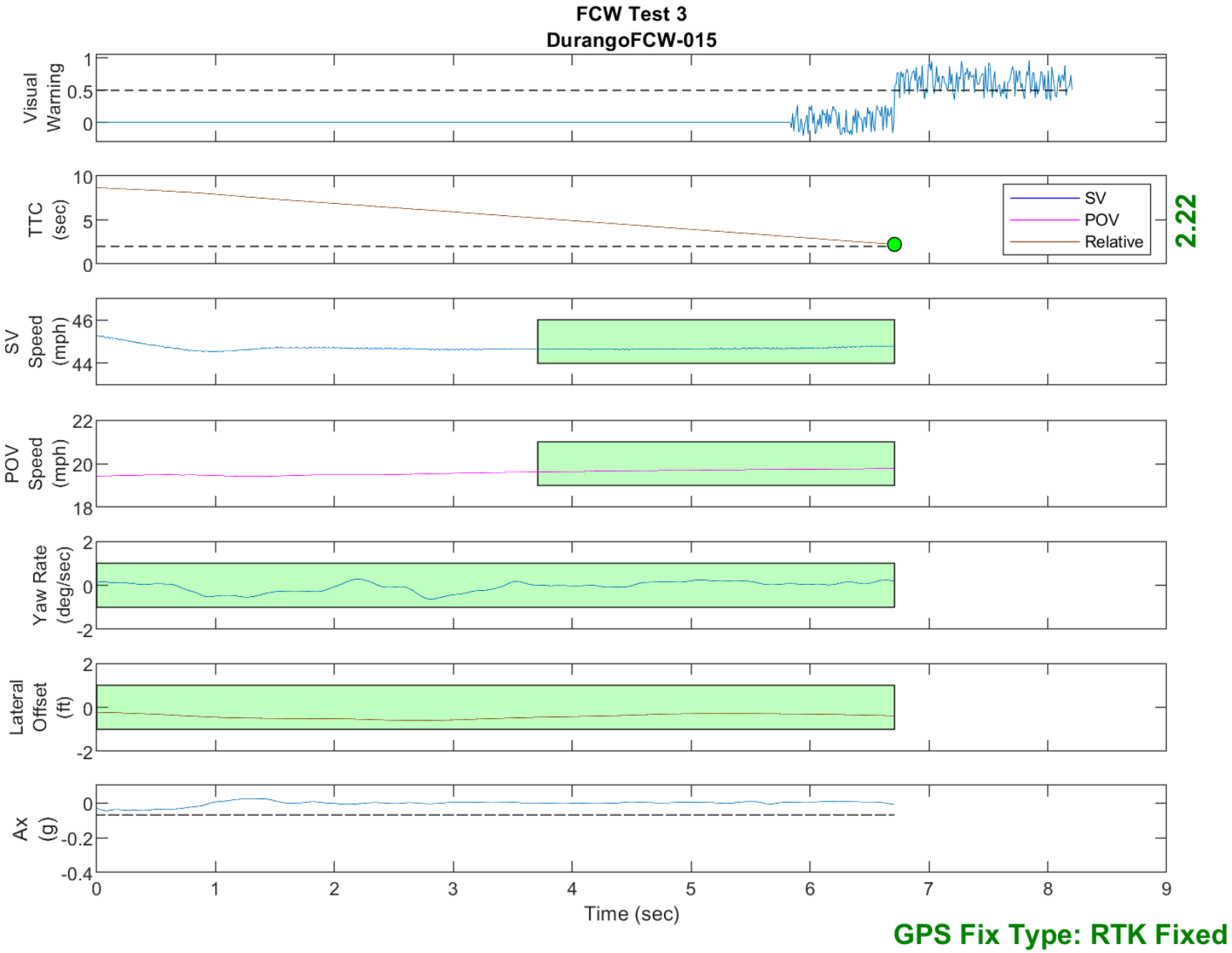


Figure D48. Time History for Run 15, FCW Test 3, Visual Warning