

OCAS-DRI-FCW-13-002

NCAP FORWARD COLLISION WARNING CONFIRMATION TEST

2013 Audi A4

DYNAMIC RESEARCH, INC.

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10 January 2013

Final Report

Prepared Under Contract No.: DTNH22-08-D-00095

**U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Office of Crash Avoidance Standards
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16. Abstract These tests were conducted on the subject 2013 Audi A4 in accordance with the specifications of the Office of Crash Avoidance Standards most current Test Procedure in docket NHTSA-2006-26555 to confirm the performance of a forward collision warning system. The vehicle passed the requirements of the test for all three FCW test scenarios.			
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Section I INTRODUCTION

This test evaluates the ability of a forward collision warning (FCW) system to detect and alert drivers to potential hazards in the path of the vehicle as specified in the New Car Assessment Program "Forward Collision Warning Confirmation", March 2010. Three driving scenarios are utilized to assess this technology. In the first test, a subject vehicle (SV) approaches a stopped principle other vehicle (POV) in the same lane of travel. The second test begins with the SV initially following the POV at the same constant speed. After a short while, the POV stops suddenly. The third test consists of the SV, traveling at a constant speed, approaching a slower moving POV, which is also being driven at a constant speed.

Section II
DATA SHEETS

FORWARD COLLISION WARNING

DATA SHEET 1: TEST SUMMARY

2013 Audi A4

VIN: WAUKFAFL2DNOxxxx

Test Date: 12/20/2012

Forward Collision Warning setting: Early

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

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

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

Overall: **Pass**

Notes:

FORWARD COLLISION WARNING

DATA SHEET 2: VEHICLE DATA

(Page 1 of 2)

2013 Audi A4

TEST VEHICLE INFORMATION

VIN: WAUKFAFL2DNOxxxx

Body Style: Sedan

Color: White

Date Received: 12/10/2012

Odometer Reading: 118 mi

Engine: 2 L Inline 4

Transmission: Automatic

Final Drive: AWD

Is the vehicle equipped with:

ABS X Yes No

Adaptive Cruise Control X Yes No

Collision Mitigating Brake System Yes X No

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: Audi AG

Date of manufacture: 0712

DATA FROM TIRE PLACARD:

Tires size as stated on Tire Placard: Front: 245/40 R18

Rear: 245/40 R18

Recommended cold tire pressure: Front: 250 kPa (36 psi)

Rear: 260 kPa (38 psi)

FORWARD COLLISION WARNING

DATA SHEET 2: VEHICLE DATA

(Page 2 of 2)

2013 Audi A4

TIRES

Tire manufacturer and model: Pirelli P6

Front tire size: P245/40 R18

Rear tire size: P245/40 R18

VEHICLE ACCEPTANCE

Verify the following before accepting the vehicle

- X All options listed on the "window sticker" are present on the test vehicle
- X Tires and wheel rims are the same as listed.
- X There are no dents or other interior or exterior flaws.
- X The vehicle has been properly prepared and is in running condition.
- X Verify that spare tire, jack, lug wrench, and tool kit (if applicable) is located in the vehicle cargo area.

FORWARD COLLISION WARNING
DATA SHEET 3: TEST CONDITIONS (Page 1 of 2)
2013 Audi A4

GENERAL INFORMATION

Test date: 12/20/2012

AMBIENT CONDITIONS

Air temperature: 10.0 C (50 F)

Wind speed: 1.5 m/s (3.5 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 X
recommended cold tire pressure:

Front: 250 kPa (36 psi)

Rear: 260 kPa (38 psi)

FORWARD COLLISION WARNING
DATA SHEET 3: TEST CONDITIONS (Page 2 of 2)
2013 Audi A4

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front: 521.6 kg (1150 lb)

Right Front 481.7 kg (1062 lb)

Left Rear 426.8 kg (941 lb)

Right Rear 416.9 kg (919 lb)

Total: 1847.0 kg (4072 lb)

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 1 of 3)

2013 Audi A4

How is the Forward Collision Warning X Warning light
presented to the driver?
(Check all that apply) X 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 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 audible alert consists of a single beep whose primary frequency is approximately 1200 Hz.

The visual alert consists of two parts. The first part is a red telltale that flashes three times and appears before the second part of the visual alert. The telltale is located on the top center of the instrument panel. It consists of an image that appears to be the rear view of two cars with radar waves in between. The second part of the visual alert is located in the center of the instrument panel in the common display area. The image consists of the word "Distance!" and an image of the top view of the front half of a car approaching the rear of another car. The first car is depicted in white and the second car is depicted in red. This image does not flash.

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 2 of 3)

2013 Audi A4

Is the vehicle equipped with a switch whose purpose is to render FCW inoperable? ☒ Yes
☐ No

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

The FCW system can be disabled using the menu system located in the MMI. The MMI display is located in the center of the dashboard and is operated using the controls on the center console. The menu settings are "Menu-->Car-->Car Systems-->Driver Assist-->Audi Braking Guard-->System-->On/Off".

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

If yes please provide a full description

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 3 of 3)

2013 Audi A4

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

If yes please provide a full description.

The system has a self test algorithm, blindness test, which will reduce the system performance if the following conditions are observed:

- Abnormal Object Detection Rate: Object detection rate where no objects or considerably fewer objects are detected compared to normal driving conditions. This can occur while remaining stationary for long periods of time without detecting obstacles (e.g., while evaluating or saving test data with NO objects in sensor view)
- Mud/snow accumulation on the sensor

Braking guard works within limits and will not respond outside the system limits, for example:

- When approaching a stopped vehicle or stationary obstacle
- The radar sensor for the braking guard works only within defined detection and range limits that may prevent the proper detection of other vehicles
- The radar sensor's function and range can be reduced by rain, snow, and heavy spray. Moving vehicles up ahead may not be promptly detected or may not be detected at all.
- Reflective surfaces including crash barriers, or tunnel entrances, may impair the function of the radar sensor.
- Sensors that are out of alignment

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) on a Straight Road
- 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.

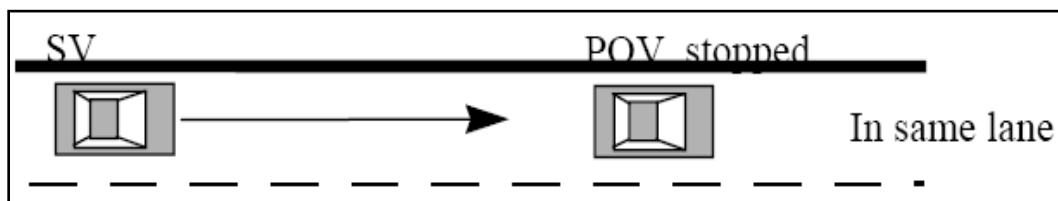


Figure 1. Depiction of Test 1

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. (Note: TTC values were computed in accordance with Ref 1). The TTC for this test was calculated by considering the speeds of the subject vehicle (SV) and the lead vehicle (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 kph), 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 the SV approaches the rear of the POV.

The SV was driven at a nominal speed of 45 mph (72.4 kph) 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 percent 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 kph) for a period of three seconds prior to (1) the required FCW alert or (2) before the range fell to less than 90 percent 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 the required FCW alert occurred, or before the range fell to less than 90 percent 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.

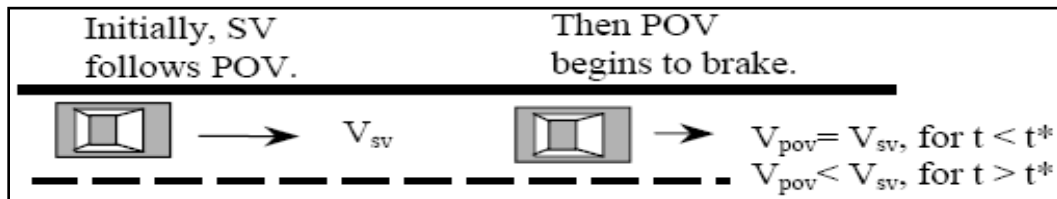


Figure 2. Depiction of Test 2

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

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).

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 kph), 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.

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 kph) 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 kph) for a period of 3 seconds prior to (1) the required FCW alert or (2) before the range fell to less than 90 percent of the minimum allowable range for onset of the required FCW alert.
- The lateral distance between the centerline of the SV, relative to the centerline of the POV, in road coordinates, could not exceed 2.0 ft (0.6 m).
- The yaw rates of the SV and POV could not exceed ± 1 deg/sec during the test.
- The POV deceleration level was nominally required to be 0.3 g within 1.5 seconds after initiation of POV braking. The acceptable error magnitude of the POV deceleration was $\pm 0.03g$, measured at the time the FCW alert first occurred. An

initial overshoot beyond the deceleration target was acceptable, however the first local deceleration peak observed during an individual trial could not exceed 0.375 g for more than 50 ms. Additionally, the deceleration could not exceed 0.33 g over a period defined from (1) 500 ms after the first local deceleration peak occurs, to (2) 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 the required FCW alert occurred, or before the range fell to less than 90 percent 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 issue a timely alert. As depicted in Figure 3, the scenario was conducted with a closing speed equal to 25.0 mph (40.2 kph).



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 kph) in the center of the lane of travel.

The SV was driven at 45.0 mph (72.4 kph), 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., $TTC = 1.8$ 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 kph) for a period of 3 seconds prior to (1) the required FCW alert or (2) before the range fell to less than 90 percent 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 kph) 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 the required FCW alert occurred, or before the range fell to less than 90 percent 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 2000 Honda Accord. This satisfied the test requirement of Ref 1 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.

As part of the pre-test instrumentation verification process, the tonal frequency of the audible warning was determined through use of the PSD (Power Spectral Density) function in Matlab. This was accomplished in order to identify the center frequency around which a band-pass filter was applied to subsequent audible warning data such that the beginning of the audible warning could be programmatically determined. The band-pass filter used for the audible warning signal was a phase-less, forward-reverse pass, 5th order elliptical (Cauer) digital filter, with 3 dB peak-to-peak ripple, minimum stop-band attenuation of 60 dB, and a pass-band of center frequency $\pm 5\%$ of the identified center frequency.

TABLE 1. TEST INSTRUMENTATION AND EQUIPMENT

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	0.5 psi 3.45 kPa	Ashcroft, D1005PS
Platform Scales	Vehicle Total, Wheel, and Axle Load	8000 lb 35.6 kN	± 1.0% of applied load	Intercomp, SWII
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)
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Latitude: ± 90 deg Longitude: ± 180 deg Altitude: 0-18 km Velocity: 0-1000 knots Accel: ± 100 m/s ² Angular Rate: ± 100 deg/s Angular Disp: ± 180 deg	Position: ± 2 cm Velocity: 0.05 km/h Accel: ≤ 0.01% of full range Angular Rate: ≤ 0.01% of full range Roll/Pitch Angle: ± 0.03 deg Heading Angle: ± 0.1 deg	Oxford Technical Solutions (OXTS), Inertial +
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ± 30 m Lateral Lane Velocity: ± 20 m/sec Longitudinal Range to POV: ± 200 m Longitudinal Range Rate: ± 50 m/sec	Lateral Distance to Lane Marking: ± 2 cm Lateral Velocity to Lane Marking: ± 0.02m/sec Longitudinal Range: ± 3 cm Longitudinal Range Rate: ± 0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range

TABLE 1. TEST INSTRUMENTATION AND EQUIPMENT (CONTD)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model
Data Acquisition System [Includes amplification, anti-aliasing, and analog to digital conversion.]	Record Time; Position; Velocity; Distance to lane markings; Headway distance; Closing Velocity; Lateral, Longitudinal, and Vertical Accels; Roll, Yaw, and Pitch Rates; Roll, Yaw and Pitch Angles.	Sufficient to meet or exceed individual sensors	Sound digitized at 10 kHz, all other channels digitized at 100 Hz. Accuracy is sufficient to meet or exceed individual sensors	SoMat, eDaq ECPU processor
				SoMat, High level Board EHLS
Microphone	Sound (to measure time at alert)	Max SPL: 139 dB/SPL Frequency Response: 40 Hz – 20 kHz	≤ 3 dB over Freq. Resp. Range	Sennheiser, e614
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor
Accelerometer	Acceleration (to measure time at alert)	± 5g	≤ 3% of full range	Silicon Designs, 2210-005
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

APPENDIX A

Photographs

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Figure A1. Front View of Subject Vehicle



Figure A2. Rear View of Subject Vehicle

2013 Audi A4 2.0T quattro tiptronic



STANDARD EQUIPMENT (unless replaced by options)

TECHNICAL

- 2.0L turbocharged I4 engine (211hp / 258lb-ft of torque) with FSI® direct injection
- Eight-speed tiptronic® transmission with sport and manual shift modes
- quattro® permanent all-wheel-drive with 40:60 torque split
- 17" 10-spoke-Star-design wheels, 245/45 all-season tires
- ABS (Anti-lock brake system) with brake assist
- ESC (Electronic Stability Control)
- Electromechanical speed-sensitive power steering
- Dynamic five-link front suspension
- Dynamic trapezoidal-link rear axle, fully independent
- Space saver spare tire

COMFORT/CONVENIENCE

- Power glass sunroof with sunshade
- Halogen headlights with front and rear fog lights
- Rain and light sensor
- Heated, power exterior mirrors
- Leather seating surfaces
- Twelve-way power driver seat and eight-way power passenger seat
- Fixed rear seatback
- Automatic climate control
- Audi concert radio with Audi premium sound
- AM/FM/SAT/1CD audio with SD card reader and aux-in
- SIRIUS® Satellite Radio (with 3-month complimentary subscription)
- Aluminum Trigon inlays

SAFETY/SECURITY

- Driver single adaptive airbag and front passenger advanced two-stage air bag supplemental restraint system.
- Driver and front passenger seat mounted side airbag supplemental restraints
- Sideguard® curtain airbags
- Anti-theft vehicle alarm system and ignition immobilizer
- Front 3-point safety belts with automatic pretensioners and load limiters, rear 3-point safety belts with automatic pretensioners
- Lower Anchors and Tethers for CHildren (LATCH) in rear

WARRANTY/MAINTENANCE

- 4-Year/50,000 mile (whichever occurs first) new vehicle limited warranty*
- 12-Year limited warranty against corrosion perforation*
- 12-Month/5,000 mile (whichever occurs first) NO CHARGE first scheduled maintenance
- 4-Year Roadside Assistance coverage provided by a third party supplier

*Please refer to the 2013 Audi Warranty Manual for complete coverage information

MANUFACTURER'S SUGGESTED RETAIL PRICE

2013 Audi A4 2.0T quattro tiptronic

Ibis White

Velvet Beige / Black interior

A4 Prestige model

- Audi adaptive light
- Audi side assist
- Audi advanced key
- Bang & Olufsen® Sound System
- Audi MMI Navigation plus package
- 18" ten-spoke-design wheels, all-season tires
- Auto-dimming interior mirror w/ compass
- Auto-dimming, heated exterior mirrors
- Audi music interface w/ iPod® cable
- Preparation for mobile phone (Bluetooth®)
- Driver information system w/ trip computer
- Heated front seats w/ driver memory
- Split-folding rear seatback
- HomeLink® garage door opener
- Audi xenon plus lighting w/ LED DRL & taillights
- Three-zone climate control

Driver Assist package

Audi adaptive cruise control

Audi drive select controls

Audi dynamic steering

Wheel lock kit

Destination Charge

Total Price:

Fuel, license, title fees, taxes and dealer-installed accessories are not included.

This vehicle is equipped with bumpers that can withstand an impact of 2.5 miles per hour with no damage to the vehicle's body and safety systems, although the bumper and related components may sustain damage. The bumper system on this vehicle conforms to the current Federal bumper standard of 2.5 miles per hour.

\$34,600.00
Included
Included
\$9,750.00

\$3,250.00

\$100.00

\$895.00

\$48,595.00

MODEL: 8K252A

VIN: WAUKFAFL2DN01

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 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.		Not Rated

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

EPA DOT Fuel Economy and Environment

Gasoline Vehicle

Fuel Economy

24 MPG
combined city/hwy
4.2 gallons per 100 miles

Compact Cars range from 14 to 60 MPG. The best vehicle rates 112 MPG.

You save
\$600

in fuel costs
over 5 years
compared to the
average new vehicle.

Annual fuel cost
\$2,200

Fuel Economy & Greenhouse Gas Rating (tailpipe only)

1 6 10 18 Best

This vehicle emits 374 grams of CO₂ per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create 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 23 MPG and costs \$11,600 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at \$3.55 per gallon. MPG 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



PARTS CONTENT INFORMATION

FOR VEHICLES IN THIS CARLINE:
U.S./CANADIAN PARTS CONTENT: 1%
MAJOR SOURCES OF FOREIGN PARTS CONTENT: GERMANY: 75%

FOR THIS VEHICLE:
FINAL ASSEMBLY POINT: NECKARSULM, GERMANY
COUNTRY OF ORIGIN: HUNGARY
ENGINE: HUNGARY
TRANSMISSION: GERMANY

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

Figure A3. Window Sticker (Monroney Label)

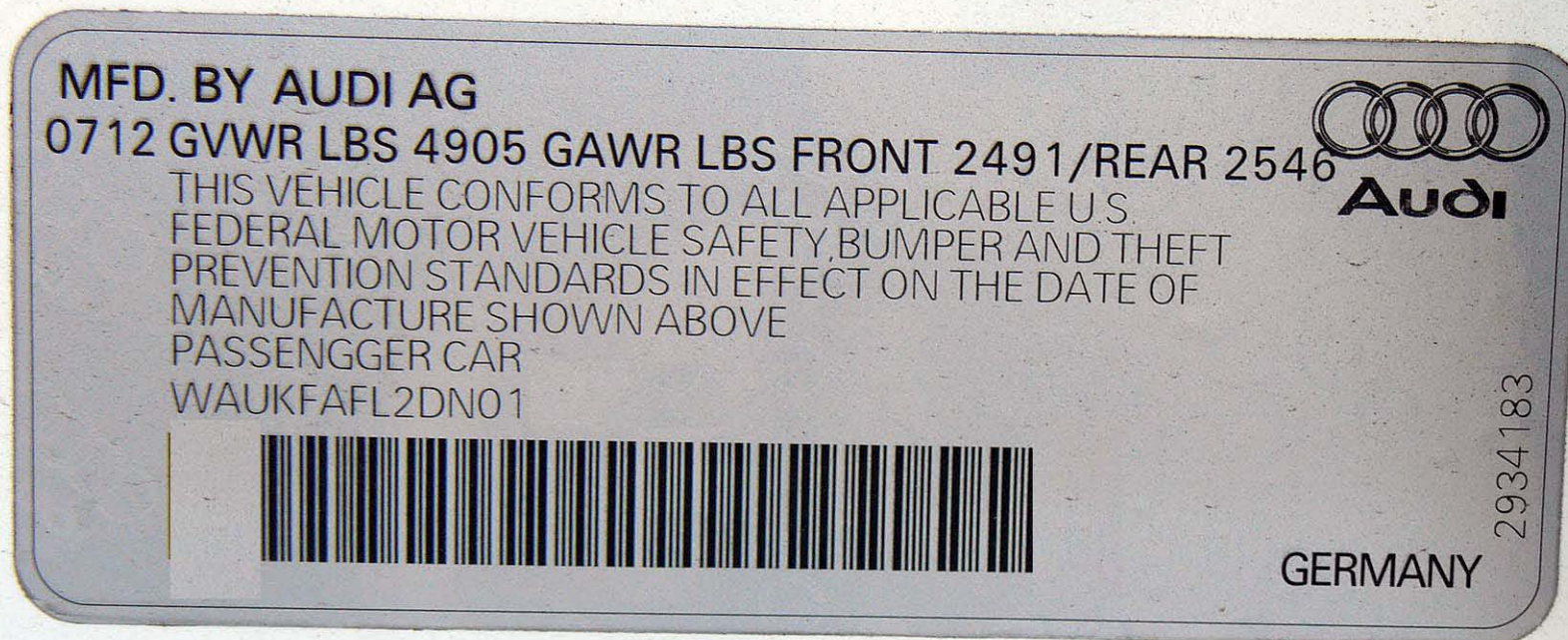


Figure A4. Vehicle Certification Label



Figure A5. Front View of Principal Other Vehicle



Figure A6. Rear View of Principal Other Vehicle



Figure A7. DGPS and Inertial Measurement Unit Installed in Subject Vehicle

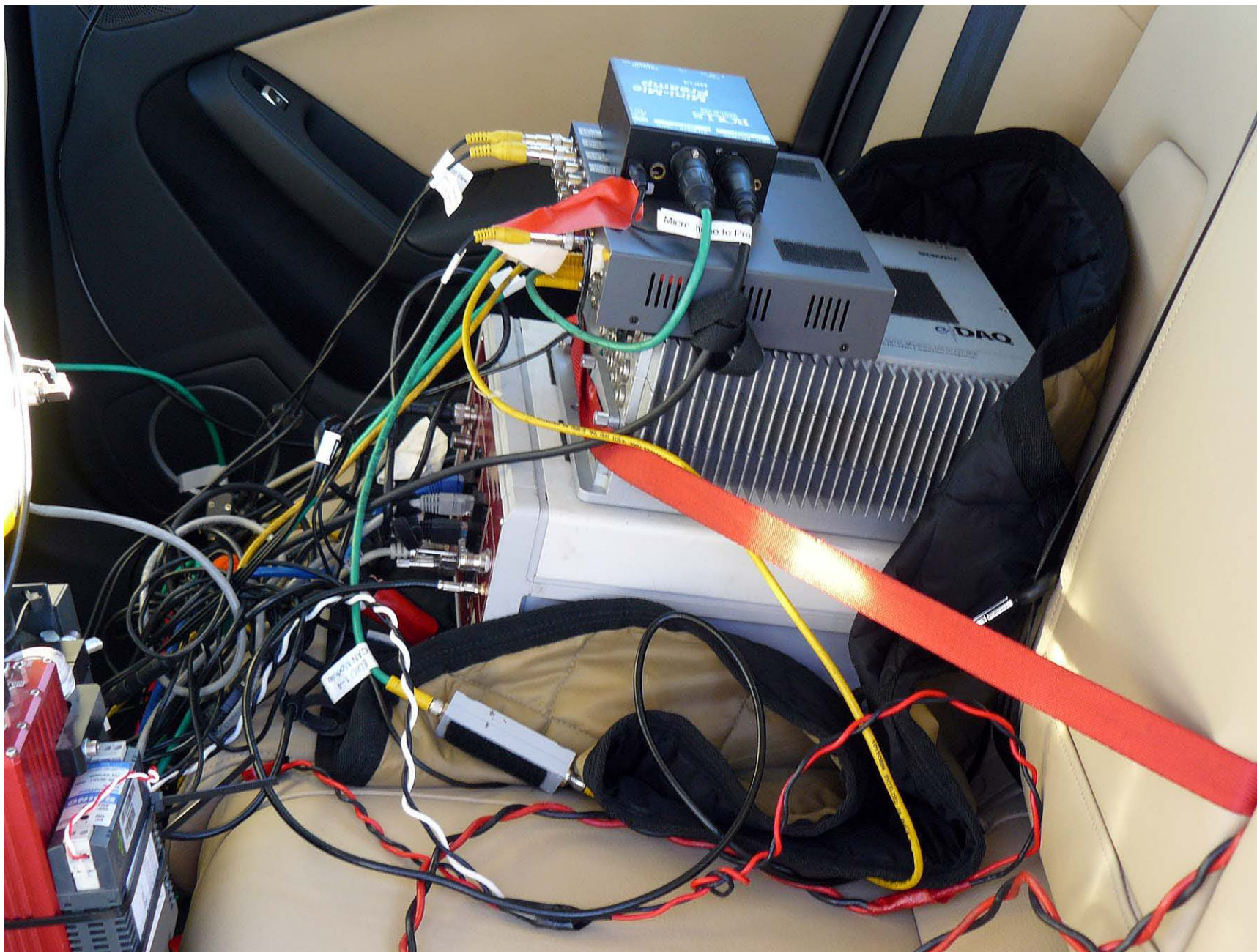


Figure A8. Data Acquisition System Installed in Subject Vehicle



Figure A9. Computer Installed in Subject Vehicle



Figure A10. Brake Actuation System Installed in Principal Other Vehicle



Figure A11. Sensors for Detecting Acoustic and Visual Alerts



Figure A12. Visual Warning Display



Figure A13. Control and Menus for Adjusting FCW Settings

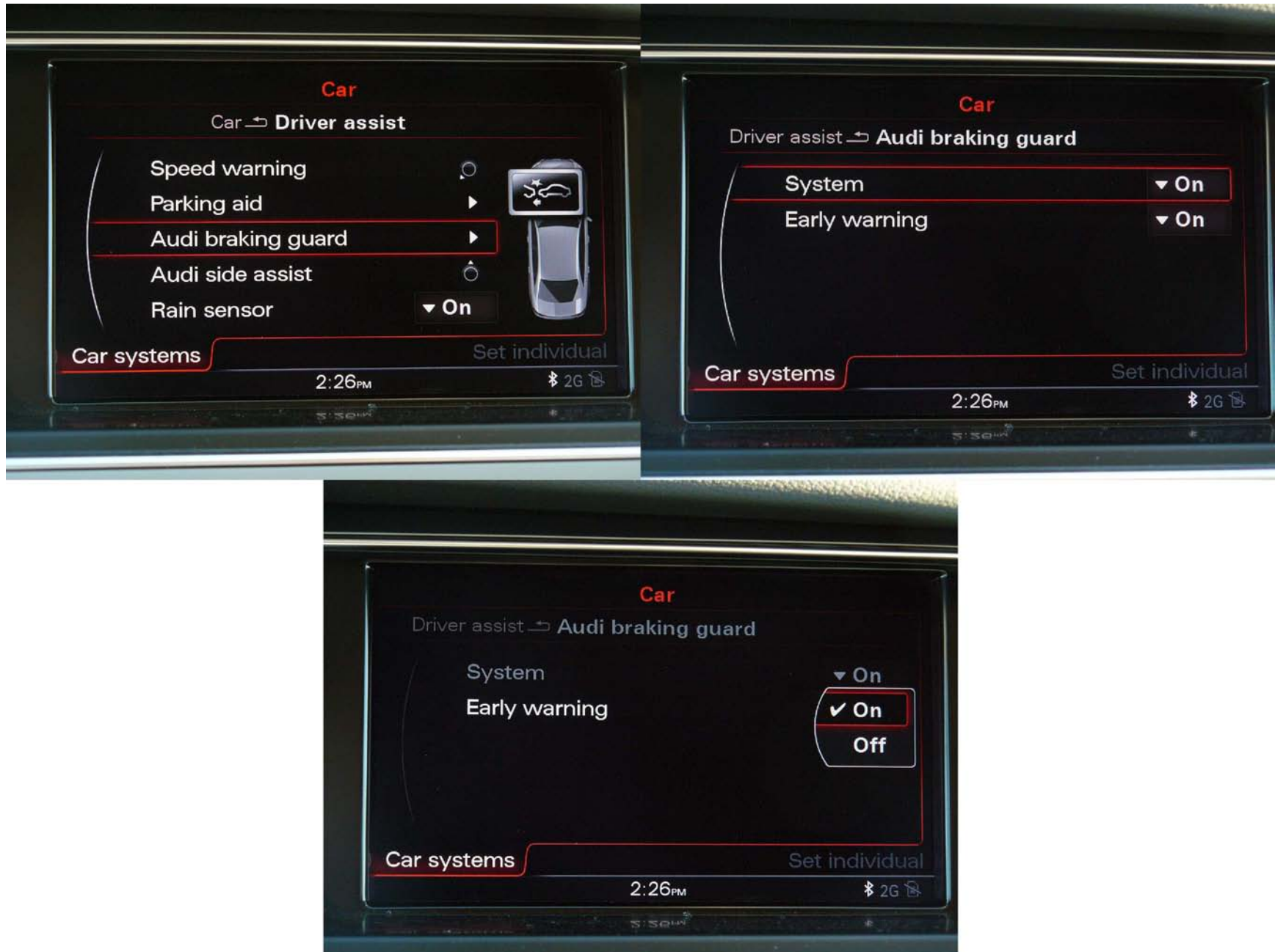


Figure A14. Menus for Adjusting FCW Settings

APPENDIX B

Excerpts from Owner's Manual

Audi adaptive cruise control and braking guard

Introduction

Applies to vehicles: with Audi adaptive cruise control

The adaptive cruise control system assists the driver by regulating vehicle speed and helping to maintain a set distance to the vehicle ahead, within the limits of the system. If the system detects a moving vehicle up ahead, adaptive cruise control can brake and then accelerate your vehicle. This helps to make driving more comfortable on long highway stretches.

The braking guard system can warn you about an impending collision and initiate braking maneuvers ⇒ *page 103*.

Adaptive cruise control and braking guard have technical limitations that you must know, so please read this section carefully, understand how the system works and use them properly at all times.

General information

General information

Applies to vehicles: with Audi adaptive cruise control



Fig. 96 Front of the vehicle: Position of radar sensor

The area that contains the radar sensor ⇒ *fig. 96* must never be covered by stickers or other objects or obstructed with dirt, insects, snow or ice that will interfere with the adaptive cruise control system and Audi braking guard. For information on cleaning, refer to ⇒ *page 201*. The same applies for any modifications made in the front area.

The function of the adaptive cruise control system and braking guard is limited under some conditions:

- Objects can only be detected when they are within sensor range ⇒ *page 99, fig. 99*.
- The system has a limited ability to detect objects that are a short distance ahead, off to the side of your vehicle or moving into your lane.
- Some kinds of vehicles are hard to detect; for example motorcycles, vehicles with high ground clearance or overhanging loads may be detected when it is too late or they may not be detected at all.
- When driving through curves ⇒ *page 98*.
- Stationary objects ⇒ *page 98*.

⚠ WARNING

Always pay attention to traffic when adaptive cruise control is switched on and braking guard is active. As the driver, you are still responsible for starting and for maintaining speed and distance to other objects. Braking guard is used to assist you. The driver must always take action to avoid a collision. The driver is always responsible for braking at the correct time.

- Improper use of adaptive cruise control can cause collisions, other accidents and serious personal injury.
- Never let the comfort and convenience that adaptive cruise control and Audi braking guard offer distract you from the need to be alert to traffic conditions and the need to remain in full control of your vehicle at all times,
- Always remember that the adaptive cruise control and Audi braking guard have limits – they will not slow the vehicle down or maintain the set distance when you drive towards an obstacle or something on or near the road that is not moving, such as vehicles stopped in a traffic jam, a stalled or disabled vehicle. If registered by the radar sensor, vehicles or obstacles that are not moving can trigger a collision warning and if

confirmed by the video camera, an acute collision warning.

- For safety reasons, do not use adaptive cruise control when driving on roads with many curves, when the road surface is in poor condition and/or in bad weather (such as ice, fog, gravel, heavy rain and hydroplaning). Using the system under these conditions could result in a collision.
- Switch adaptive cruise control off temporarily when driving in turning lanes, on expressway exits or in construction zones. This prevents the vehicle from accelerating to the set speed when in these situations.
- The adaptive cruise control system will not brake by itself if you put your foot on the accelerator pedal. Doing so can override the speed and distance regulation.
- When approaching stationary objects such as stopped traffic, adaptive cruise control will not respond and braking guard will have limited function.
- The adaptive cruise control system and braking guard do not react to people, animals, objects crossing the road or oncoming objects.
- The function of the radar sensor can be affected by reflective objects such as guard rails, the entrance to a tunnel, heavy rain or ice.
- Never follow a vehicle so closely that you cannot stop your vehicle safely. The adaptive cruise control cannot slow or brake the vehicle safely when you follow another vehicle too closely. Always remember that the automatic braking function cannot bring the vehicle to a sudden or emergency stop under these conditions.
- To prevent unintended operation, always switch ACC off when it is not being used.

Note

The sensor can be displaced by impacts or damage to the bumper, wheel housing and underbody. That could affect the adaptive

cruise control system and braking guard. Have your authorized Audi dealer or authorized Audi Service Facility check their function.

In curves

Applies to vehicles: with Audi adaptive cruise control

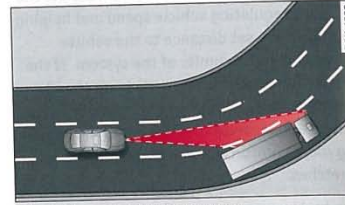


Fig. 97 Example: driving into a curve

When driving into a curve ⇨ *fig. 97* and out of a curve, the adaptive cruise control may react to a vehicle in the next lane and apply the brakes. You can override or prevent the braking by pressing the accelerator pedal briefly.

Stationary objects

Applies to vehicles: with Audi adaptive cruise control

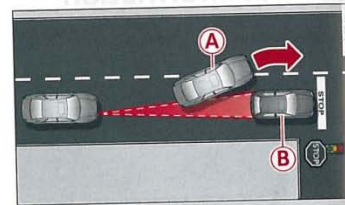


Fig. 98 Example: object changing lanes and stationary object

The adaptive cruise control system only reacts to objects that are moving or that the system has already detected as moving. For example, if a vehicle (A), which has already been detected by the adaptive cruise control, turns or changes lanes and another stationary vehicle (B) is located in front of that vehicle, the system will not react to the stationary vehicle.

95 mph (150 km/h) when the driver takes his foot off of the gas pedal.

Parking brake!

The driver message appears when the parking brake is activated. Adaptive cruise control is turned off. A chime sounds as a reminder.

Vehicles with manual transmission

Applies to vehicles: with Audi adaptive cruise control

The adaptive cruise control is available from the 2nd gear through the 6th gear in the customary RPM.

When the adaptive cruise control is turned on, you must press the clutch to shift gears (as usual). When shifting normally or when pressing the clutch, the adaptive cruise control remains turned on.

After you have engaged the gear, you do **not** need to press the gas pedal. The adaptive cruise control accelerates automatically if necessary.

If you press down on the clutch for too long or shift/couple improperly, the adaptive cruise control may turn off automatically.

i Tips

You cannot turn on the adaptive cruise control during a shifting operation.

Audi adaptive cruise control**Description**

Applies to vehicles: with Audi adaptive cruise control

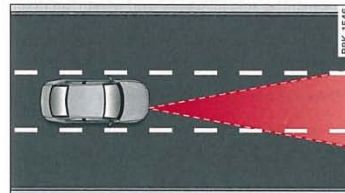


Fig. 99 Detection range

What can adaptive cruise control do?

The adaptive cruise control works in conjunction with a radar sensor installed in the front of the vehicle ⇒ *page 97, fig. 96*, which is subject to designated system limits ⇒ *page 99*. Stationary objects are disregarded.

On open roads with no traffic, adaptive cruise control works like a regular cruise control sys-

tem. The stored speed is maintained. When approaching a moving vehicle detected up ahead, the adaptive cruise control system automatically slows down to match that vehicle's speed and then maintains the distance that the driver previously stored. As soon as the system does not detect a vehicle up ahead, adaptive cruise control accelerates back up to the stored speed.

Which functions can be controlled?

When you switch adaptive cruise control on, you can set the current speed as the "control speed" ⇒ *page 100, Switching on and off*.

When driving, you can stop cruise control ⇒ *page 101* or change the speed ⇒ *page 101* at any time.

You can also set the distance to the object ahead and set the adaptive cruise control driving program ⇒ *page 102*.

Switching on and off

Applies to vehicles: with Audi adaptive cruise control

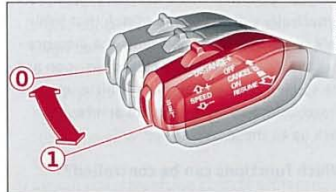


Fig. 100 Selector lever: switching on/off



Fig. 101 Instrument cluster: adaptive cruise control

You can set any speed between 20 mph and 95 mph (30 and 150 km/h).

Indicator lamps and messages in the instrument cluster display inform you about the current system status and settings.

Switching adaptive cruise control on

- Pull the lever toward you into position ① ⇒ fig. 100. **ACC standby** appears in the instrument cluster display.

Setting the speed and activating regulation

- To set the current speed, press the **SET** button ⇒ page 11, fig. 4. The set speed is

shown in the tachometer **A** and is also shown briefly in the display **D** ⇒ fig. 101.

Switching adaptive cruise control off

- Push the lever away from you into position ② until it clicks into place. The message **ACC off** appears.

Indicator lights

A - Adaptive cruise control is switched on. No vehicles are detected up ahead. The stored speed is maintained.

B - A moving vehicle is detected up ahead. The adaptive cruise control system regulates the speed and distance to the moving vehicle ahead and accelerates/brakes automatically.

C - When automatic braking is not able to keep enough distance to a previously detected moving vehicle up ahead, you must take control and brake ⇒ page 103, Request for driver intervention.

Display

If adaptive cruise control is not shown in the display, you can call it up with the **RESET** button ⇒ page 24.

Based on the symbols in the display, you can determine if the system is maintaining a distance to the vehicle ahead and what that distance is.

No vehicle - No vehicle ahead was detected.

White vehicle - A vehicle ahead was detected.

Red vehicle - Prompt for the driver to take action ⇒ page 103.

Both **arrows** on the **scale** **C** indicate the distance to the vehicle ahead. No arrow appears when the vehicle is on an open road and there is no object ahead. If an object is detected ahead, the arrow moves on the scale.

The green zone on the scale shows the stored distance. For information on changing the stored distance, refer to ⇒ page 102. If the distance selected is too close or may soon become too close, the arrows move into the red zone on the scale.

⚠ WARNING

Improper use of the adaptive cruise control can cause collisions, other accidents and serious personal injuries.

- Pressing the **[SET]** button when driving at speeds below 20 mph (30 km/h), will automatically accelerate the vehicle to 20 mph (30 km/h), which is the minimum speed that can be set.

i Tips

- If you switch the ignition or the adaptive cruise control off, the set speed is erased from the system memory.
- The electronic stabilization control (ESC) and the anti-slip-regulation (ASR) are automatically turned on when the adaptive cruise control is turned on. Both systems cannot be turned off if the adaptive cruise control is turned on. Allroad: You cannot switch the ESC to the offroad mode when adaptive cruise control is switched on.

Changing the speed

Applies to vehicles: with Audi adaptive cruise control



Fig. 102 Selector lever; changing the speed

- To increase or reduce the speed in increments, **tap** the lever up or down.
- To increase or reduce the speed quickly, **hold** the lever up or down until the red LED **A** reaches the desired speed ⇒ page 100, fig. 101.

Following any changes, the new stored speed will be displayed briefly in the display **D** ⇒ page 100, fig. 101.

Interrupting cruise control

Applies to vehicles: with Audi adaptive cruise control

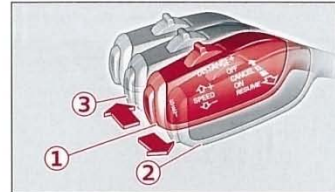


Fig. 103 Selector lever

Requirement: adaptive cruise control must be switched on ⇒ fig. 103 **1**.

Overriding cruise control

- To accelerate manually, press the accelerator pedal. The message **ACC override** appears.
- To resume adaptive cruise control, remove your foot from the gas pedal. The system returns again to the speed that was saved before.
- You can save a new speed at any time by pressing the **[SET]** button ⇒ page 11, fig. 4.

Canceling cruise control while driving

- Move the lever into position **3**. The message **ACC standby** appears. Or
- press the brake pedal.
- To resume the stored speed, move the lever into position **2**.

⚠ WARNING

Never resume the stored speed if the speed is too high for prevailing road, traffic or weather conditions.

Setting the distance

Applies to vehicles: with Audi adaptive cruise control

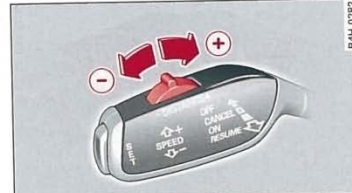


Fig. 104 Selector lever: setting the distance

- ▶ Tap the switch to display the current set distance ⇒ *fig. 104*.
- ▶ To increase or reduce the distance by increments, tap the switch again to the left or right. The distance between the two vehicles will change in the instrument cluster display.

When approaching a moving vehicle up ahead, the adaptive cruise control system brakes to match that object's speed and then maintains the stored distance. If the vehicle ahead accelerates, adaptive cruise control will also accelerate up to the stored speed.

The higher the speed, the greater the distance in yards (meters) ⇒ *Δ*. The **Distance 3** setting is recommended.

The distances provided are specified values. Depending on the driving situation and the how the vehicle ahead is driving, the actual distance may be more or less than these target distances.

The various symbols for the time increments appear briefly in the information line *Ⓢ* ⇒ *page 100, fig. 101* when you change the settings.

⌋⌋⌋⌋ **Distance 1:** This setting corresponds to a distance of 92 feet/28 meters when traveling at 62 mph (100 km/h), or a time interval of 1 second.

⌋⌋⌋ **Distance 2:** This setting corresponds to a distance of 118 feet/36 meters when traveling at 62 mph (100 km/h), or a time interval of 1.3 seconds.

⌋⌋ **Distance 3:** This setting corresponds to a distance of 164 feet/50 meters when traveling at 62 mph (100 km/h), or a time interval of 1.8 seconds.

⌋ **Distance 4:** This setting corresponds to a distance of 210 feet/64 meters when traveling at 62 mph (100 km/h), or a time interval of 2.3 seconds.

WARNING

Following other vehicles too closely increases the risk of collisions and serious personal injury.

- Setting short distances to the traffic ahead reduces the time and distance available to bring your vehicle to a safe stop and makes it even more necessary to pay close attention to traffic.
- Always obey applicable traffic laws, use good judgment, and select a safe following distance for the traffic, road and weather conditions.

Tips

- **Distance 3** is set automatically each time you switch the ignition on.
- Your standard settings are automatically stored and assigned to the remote control key being used.

Setting the driving program

Applies to vehicles: with Audi adaptive cruise control

Depending on the selected driving program and distance, driving behavior when accelerating will vary from dynamic to comfortable.

Setting the driving program for vehicles without Audi drive select*

- ▶ In the radio/MMI*, select: *CAR* function button > **Adaptive cruise control** > **Driving prog.** > **comfort, standard** or **dynamic**. Or
- ▶ Select: *CAR* function button > **Car systems*** control button > **Driver assist** > **Adaptive cruise control** > **Driving program*** > **Comfort, Standard** or **Dynamic**.

Setting the driving mode for vehicles with Audi drive select*

Refer to ⇨ page 112.

Tips

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

Request for driver intervention

Applies to vehicles: with Audi adaptive cruise control



Fig. 105 Instrument cluster: request for driver intervention

In certain situations, the system will prompt you to take action. This could happen, for example, if braking by the adaptive cruise control system is not enough to maintain enough distance to the vehicle ahead.

The instrument cluster will warn you about the danger ⇨ fig. 105:

- A red vehicle is pictured in the display.
- The text **DISTANCE!** appears in the status bar.
- The red indicator light  blinks.
- In addition, a warning tone sounds.

Audi braking guard

Description

Applies to vehicles: with Audi adaptive cruise control



Fig. 106 Instrument cluster: approach warning

Audi braking guard uses a radar sensor. It also functions within the limits of the system when adaptive cruise control is switched off.

What can Audi braking guard do?

When detected in time, the system can assess situations when a vehicle ahead brakes suddenly or if your own vehicle is traveling at a high speed and approaching a vehicle up ahead that is moving more slowly. Audi braking guard does not react if it cannot detect the situation.

The system advises you of various situations:

- The **distance warning** is given if you are too close to the vehicle ahead for a long time. If the vehicle ahead brakes sharply, you will not be able to avoid a collision. The indicator light  in the display comes on.
- The **approach warning** is given when a detected vehicle up ahead in your lane is moving much more slowly than you are or if it brakes sharply. When this warning is given, it may only be possible to avoid a collision by swerving or braking sharply. The indicator light  and indicator in the display will warn you about the danger ⇨ fig. 106. You will also hear an acoustic signal.

If you do not react fast enough or do not react at all to the situation, Audi braking guard will intervene by braking and the message **braking guard intervention** will appear. ▶

- If a collision is imminent, the system will first provide an **acute warning** by briefly and sharply applying the brakes.
- If you do not react to the acute warning, braking guard can brake within the limits of the system. This reduces the vehicle speed in the event of a collision.
- At speeds under 20 mph (30 km/h), the system can initiate a complete deceleration shortly before a collision.¹⁾
- If the Audi braking guard senses that you are not braking hard enough when a collision is imminent, it can increase the braking force.

Which functions can be controlled?

You can switch Audi braking guard and the distance/approach warning on or off in the radio or MMI ⇒ *page 104, Settings in the radio/MMI*.

WARNING

Lack of attention can cause collisions, other accidents and serious personal injuries. The Audi braking guard is an assist system and cannot prevent a collision by itself. The driver must always intervene. The driver is always responsible for braking at the correct time.

- Always pay close attention to traffic, even when the Audi braking guard is switched on. Be ready to intervene and be ready to take complete control whenever necessary. Always keep the safe and legal distance between your vehicle and vehicles up ahead.
- Audi braking guard works within limits and will not respond outside the system limits, for example when approaching a stopped vehicle or stationary obstacle (end of a traffic jam or vehicle that has broken down in traffic).
- Always remember that the radar sensor for the Audi braking guard works only within defined detection and range limits

that may prevent the proper detection of other vehicles.

- The radar sensor's function and range can be reduced by rain, snow and heavy spray. Moving vehicles up ahead may not be promptly detected or may not be detected at all.
- Reflective surfaces including crash barriers or tunnel entrances may impair the function of the radar sensor.

Tips

- You can cancel the braking that is initiated by the system by braking yourself, by accelerating noticeably or by swerving.
- Audi braking guard error messages ⇒ *page 105*.
- Keep in mind that braking guard can brake unexpectedly. Always secure any cargo or objects that you are transporting to reduce the risk of damage or injury.

Settings in the radio/MMI

Applies to vehicles: with Audi adaptive cruise control

- Select: **[CAR]** function button > **Car systems** control button > **Driver assist** > **Audi braking guard**. Or
- Select: **[CAR]** function button > **Audi braking guard**.

System - Switch Audi braking guard **On** and **Off**. When you switch the ignition on, the message **Audi braking guard off** appears if the system is switched off.

Early warning - The distance and approach warnings in the display can be switched **On/Off**.

Tips

- Your settings are automatically stored and assigned to the remote control key being used at the times the settings are made.

¹⁾ This is not available in some countries.

- If you switch the ASR/ESC off or the off-road mode on (allroad), Audi braking guard switches off automatically
⇒ *page 186*.
- Switch Audi braking guard off when you are loading the vehicle onto a vehicle carrier, train, ship or other type of transportation. This can prevent undesired warnings from the braking guard system.

Messages

Applies to vehicles: with Audi adaptive cruise control

Braking guard: Off

This driver message appears if the system is turned off via the radio/MMI*. Otherwise, if the system is turned off, the information appears every time shortly after the start of the trip.

Braking guard: Activated

This driver message appears if sharp brake pressure was applied due to an acute warning.

• • •

Three white dots appear if a setting cannot be selected with the operating lever. For example, this happens if you want to raise/lower the speed even though there was no previously saved speed.

ACC: Deactivation

The driver message appears in vehicles with manual transmission. If the clutch pedal was pressed down for too long, the adaptive cruise control turns off. A chime sounds as a reminder.

ACC: Sensor blocked

This message appears if the sensor view is obstructed, for example by leaves, snow, heavy spray or dirt. Clean the sensor ⇒ *page 97, fig. 96*.

ACC: not available

The driver message appears if there is a malfunction. The adaptive cruise control turns off. A chime sounds as a reminder. Have the sys-

tem checked by an authorized Audi dealer or authorized Audi Service Facility.

ACC: unavailable

The driver message appears if, for example, the brake temperature is too high. The adaptive cruise control is temporarily unavailable. A chime sounds as a reminder.

Engine speed!

This driver message appears in vehicles with manual transmission if the driver had not upshifted or downshifted in time while using adaptive cruise control braking or accelerating, causing the vehicle to exceed or not reach the permitted limit speed. The adaptive cruise control turns off. A chime sounds as a reminder.

Shift lever position!

Vehicles with an automatic transmission: the driver message appears if the selector lever is shifted to the N position. The adaptive cruise control is not available while in this position.

Vehicles with manual transmission: the driver message appears for vehicles with manual transmission if there is no forward gear engaged, meaning if the reverse gear or the 1st gear is engaged or if the selector lever is in the neutral position. The adaptive cruise control is not available while in this position.

Stabilization control (ESC)

This message appears if the electronic stabilization control (ESC) is taking action to stabilize the vehicle. The adaptive cruise control turns off. A chime sounds as a reminder.

Speed too low

This message appears if the current speed is too low to **set** or to **maintain** the desired speed.

The speed being saved must be at least 20 mph (30 km/h). The cruise control is turned off for speeds lower than 12 mph (20 km/h). The adaptive cruise control remains turned on for speeds above 95 mph (150 km/h) (override). It will stabilize again at ►

APPENDIX C

Run Log

Subject Vehicle:

Date:

Principal Other Vehicle:

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW CAN Sound (sec)	TTCW CAN Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
1	FCW1 (Stopped)	Y	2.35	2.34	2.41	2.41	0.25	Pass	
2		Y	2.39	2.38	2.43	2.43	0.29	Pass	
3		Y	2.36	2.36	2.41	2.41	0.26	Pass	
4		Y	2.36	2.35	2.42	2.42	0.26	Pass	
5		Y	2.40	2.40	2.46	2.46	0.30	Pass	
6		Y	2.38	2.37	2.44	2.44	0.28	Pass	
7		Y	2.33	2.32	2.40	2.40	0.23	Pass	
8	FCW3 (Slower)	Y	2.36	2.36	2.42	2.42	0.36	Pass	
9		Y	2.07	2.07	2.12	2.12	0.07	Pass	
10		N							SV speed low
11		Y	2.19	2.19	2.25	2.25	0.19	Pass	
12		Y	2.14	2.13	2.19	2.19	0.14	Pass	
13		Y	2.26	2.26	2.32	2.32	0.26	Pass	
14		N							POV speed high
15		Y	2.25	2.25	2.31	2.31	0.25	Pass	
16		Y	2.31	2.31	2.35	2.35	0.31	Pass	

Subject Vehicle:

Date:

Principal Other Vehicle:

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW CAN Sound (sec)	TTCW CAN Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
17	FCW2 (Braking)	Y	2.59	2.59	2.65	2.65	0.19	Pass	
18		Y	2.72	2.72	2.75	2.75	0.32	Pass	
19		Y	2.75	2.74	2.80	2.80	0.35	Pass	
20		Y	2.68	2.68	2.75	2.75	0.28	Pass	
21		Y	2.78	2.78	2.83	2.83	0.38	Pass	
22		Y	2.67	2.67	2.71	2.71	0.27	Pass	
23		Y	2.68	2.68	2.77	2.77	0.28	Pass	

APPENDIX D

Time History Plots

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Description of Time History Plots

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from both the Subject Vehicle and the Principal Other Vehicle, 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.

Time History Plot Description

Each time history plot consists of data pertinent to the test type under consideration. The data shown in time history plots for test type 2 differs slightly from the data shown in test types 1 and 3, owing to the headway distance criterion which is used exclusively for test type 2.

Time history figures include the following sub-plots:

- Event – indicates timing of warning issued by FCW system. Depending on the type of FCW alert or instrumentation used to measure the alert, this can be any of the following,:
 - o Filtered and rectified sound signal
 - o Filtered and rectified acceleration (e.g., steering wheel vibration)
 - o Light sensor signal
 - o Discrete on/off value
- 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 test type 2, the plot indicating the longitudinal acceleration of the Principal Other Vehicle includes a solid black threshold line indicating the maximum deceleration (-0.33 g) allowed while braking. Exceedance of this threshold is indicated with red shading in the area between the measured time-varying data and 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

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

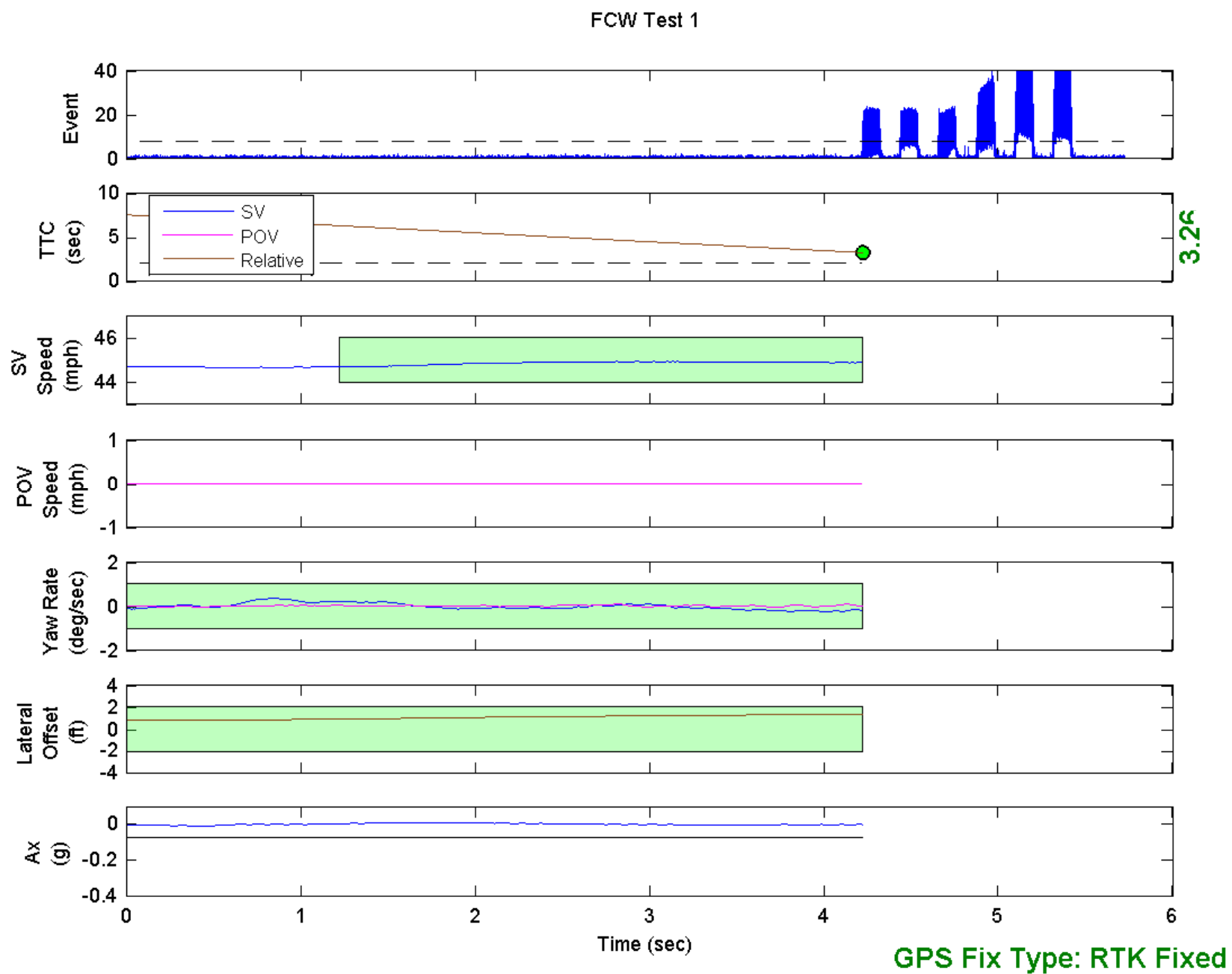


Figure D1. Example Time History for Test Type 1, Passing

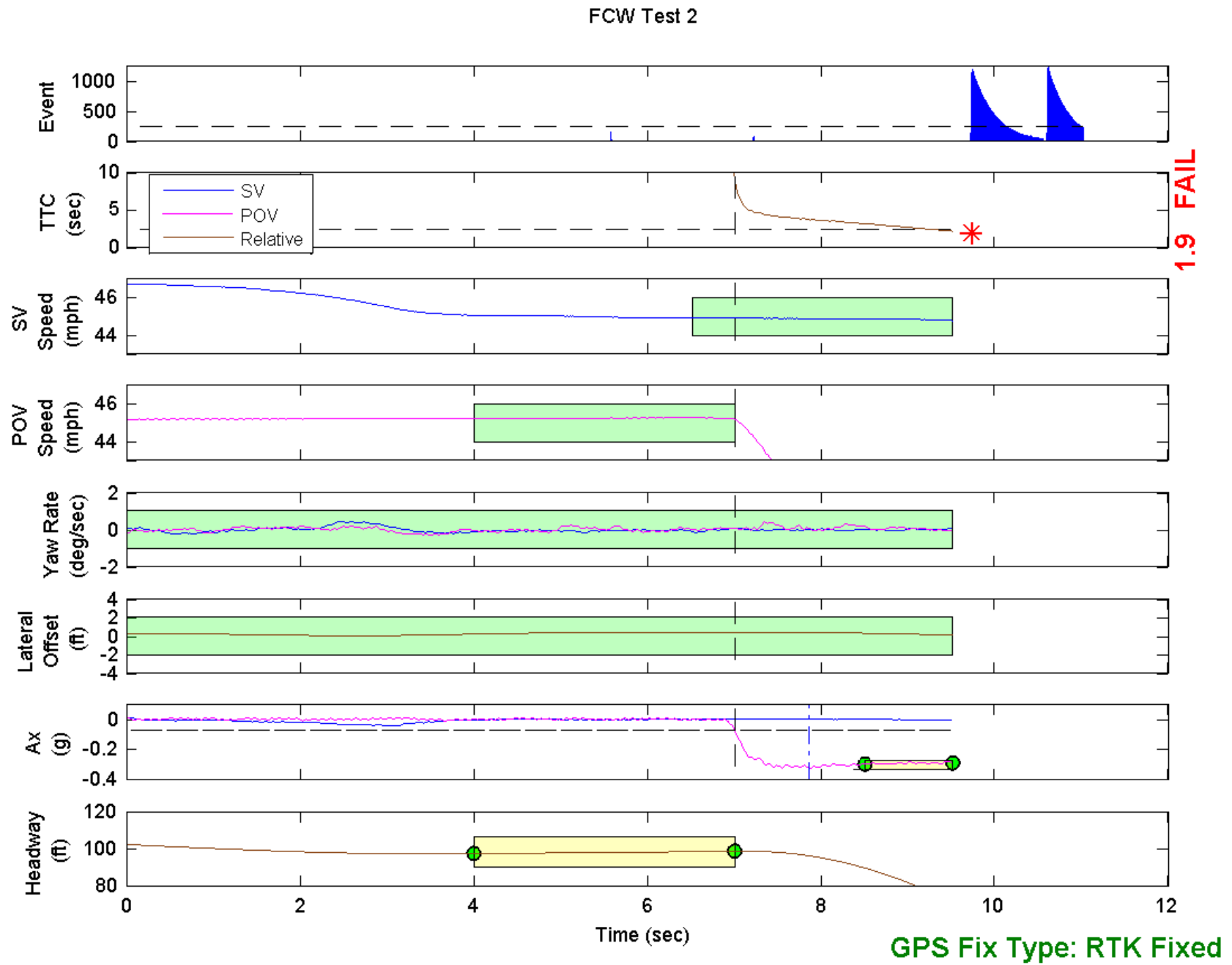


Figure D2. Example Time History for Test Type 2, Failing

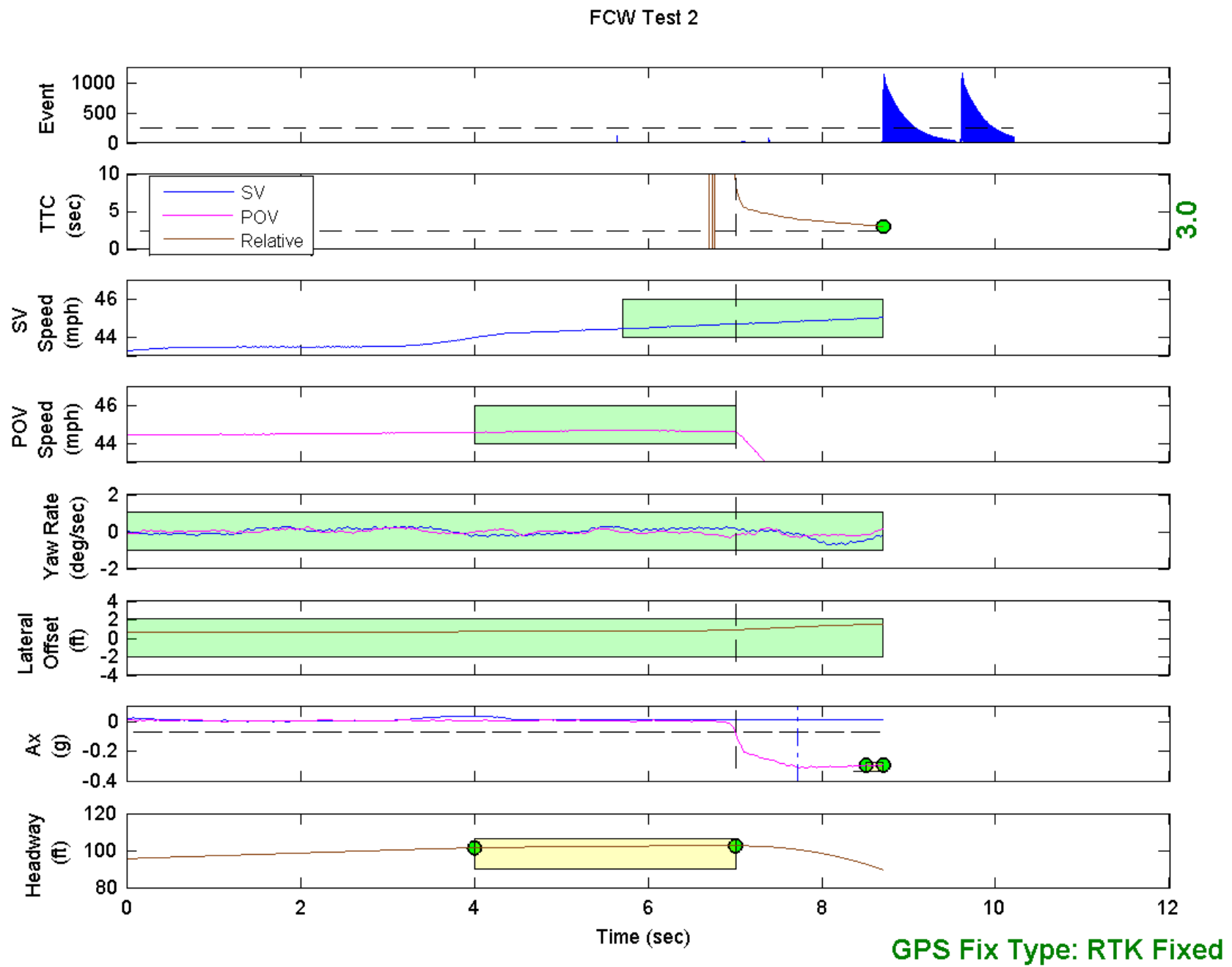


Figure D3. Example Time History for Test Type 2, Passing

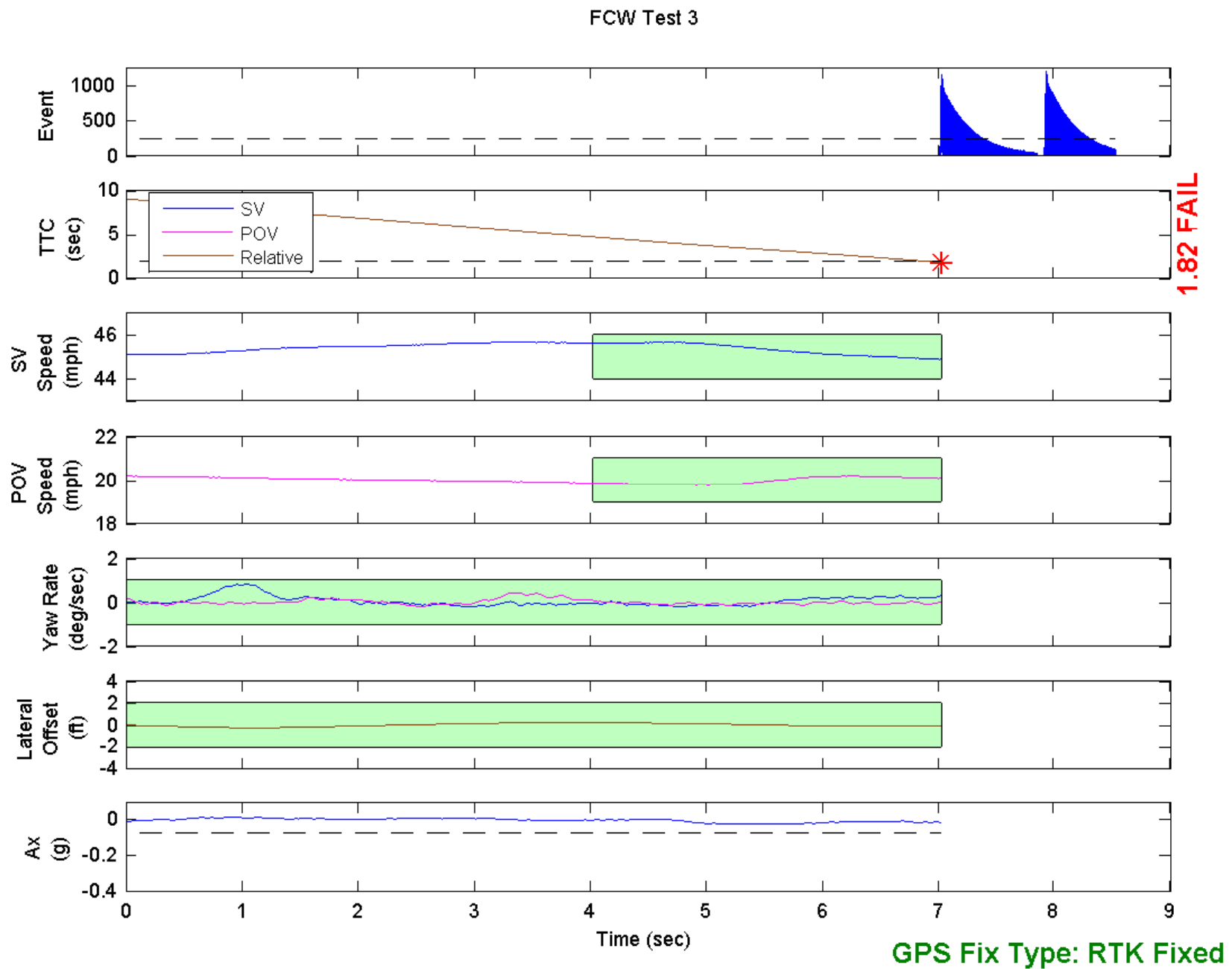


Figure D4. Example Time History for Test Type 3, Failing

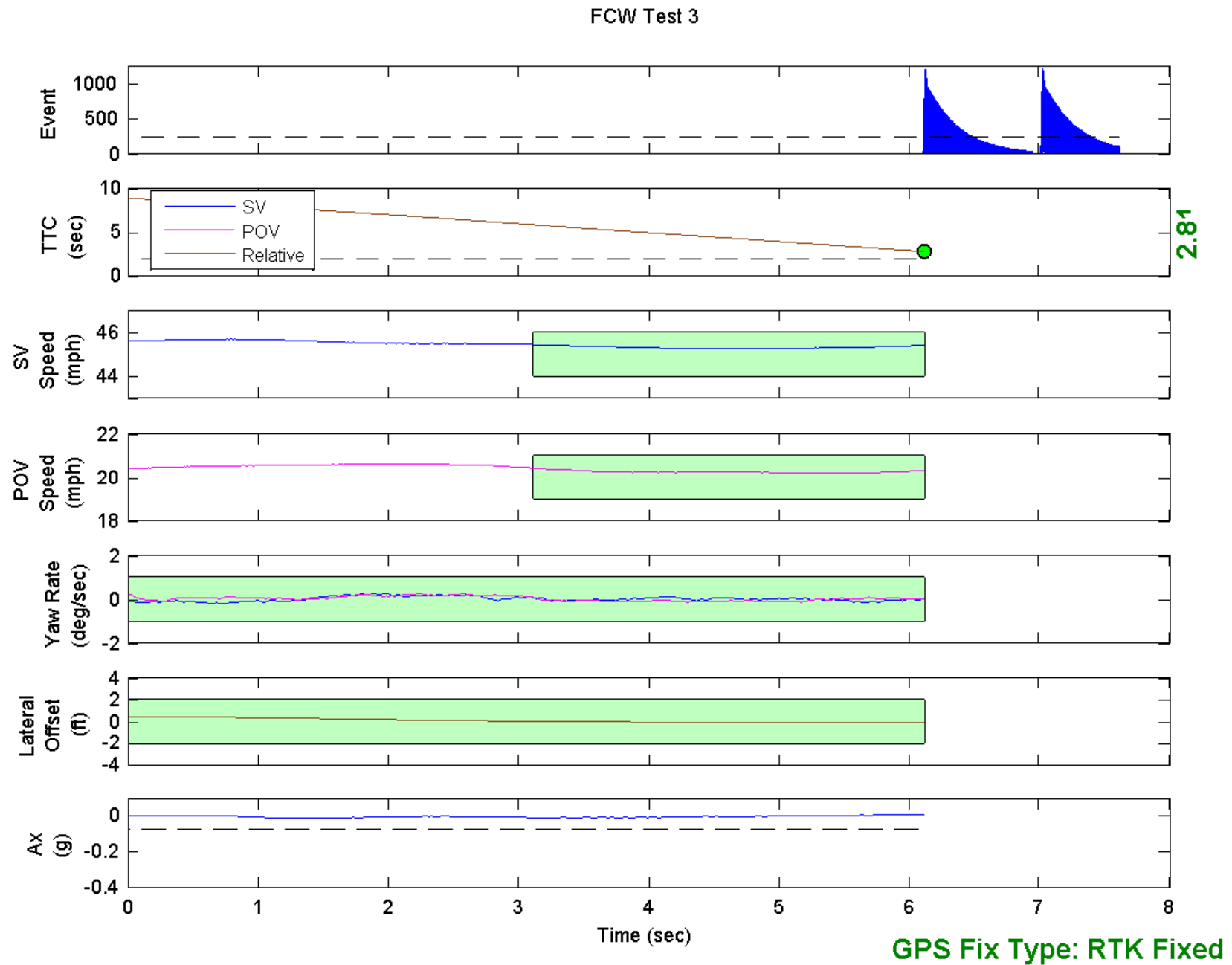


Figure D5. Example Time History for Test Type 3, Passing

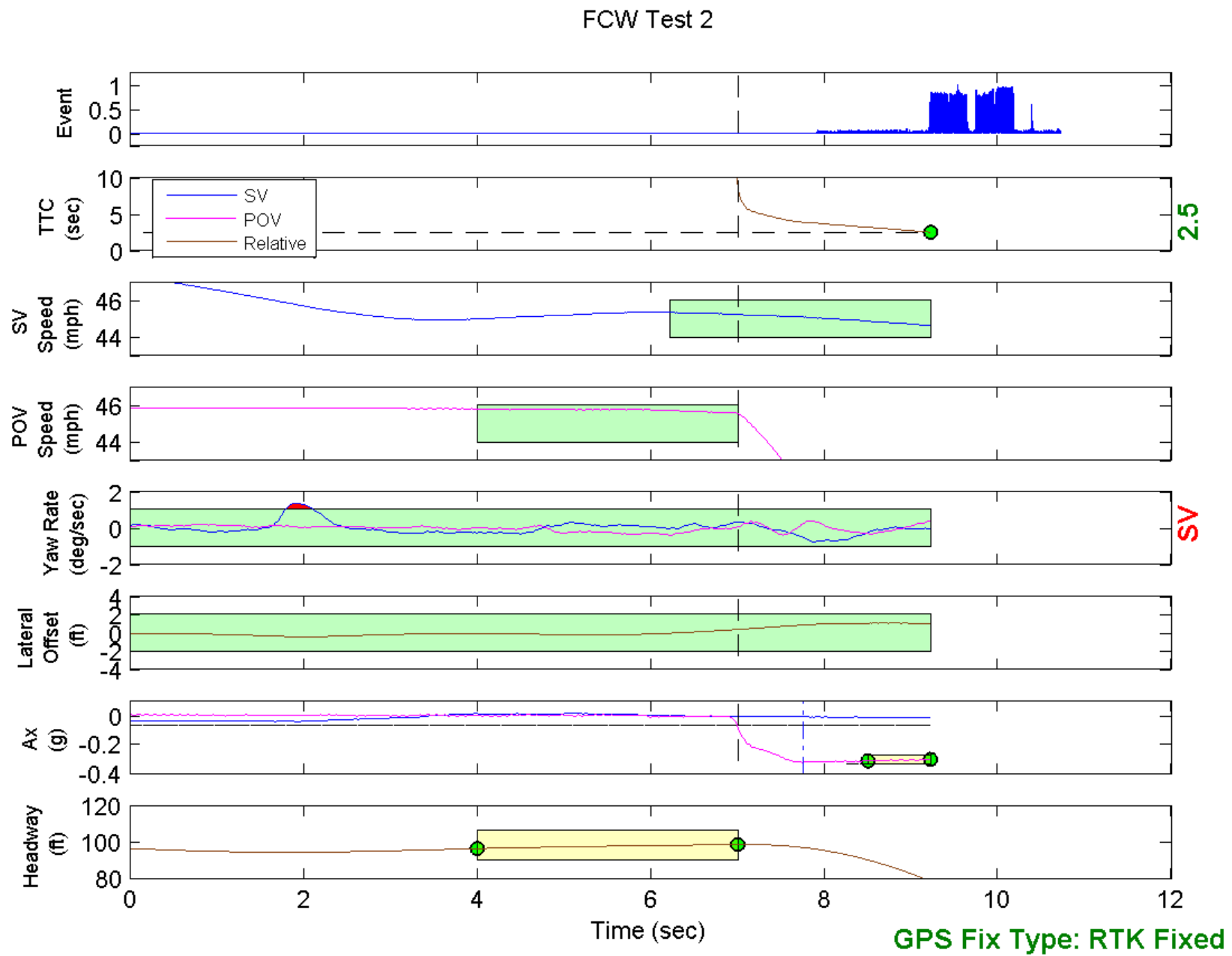


Figure D6. Example Time History for Test Type 2, Invalid Run Due to Subject Vehicle Yaw Rate

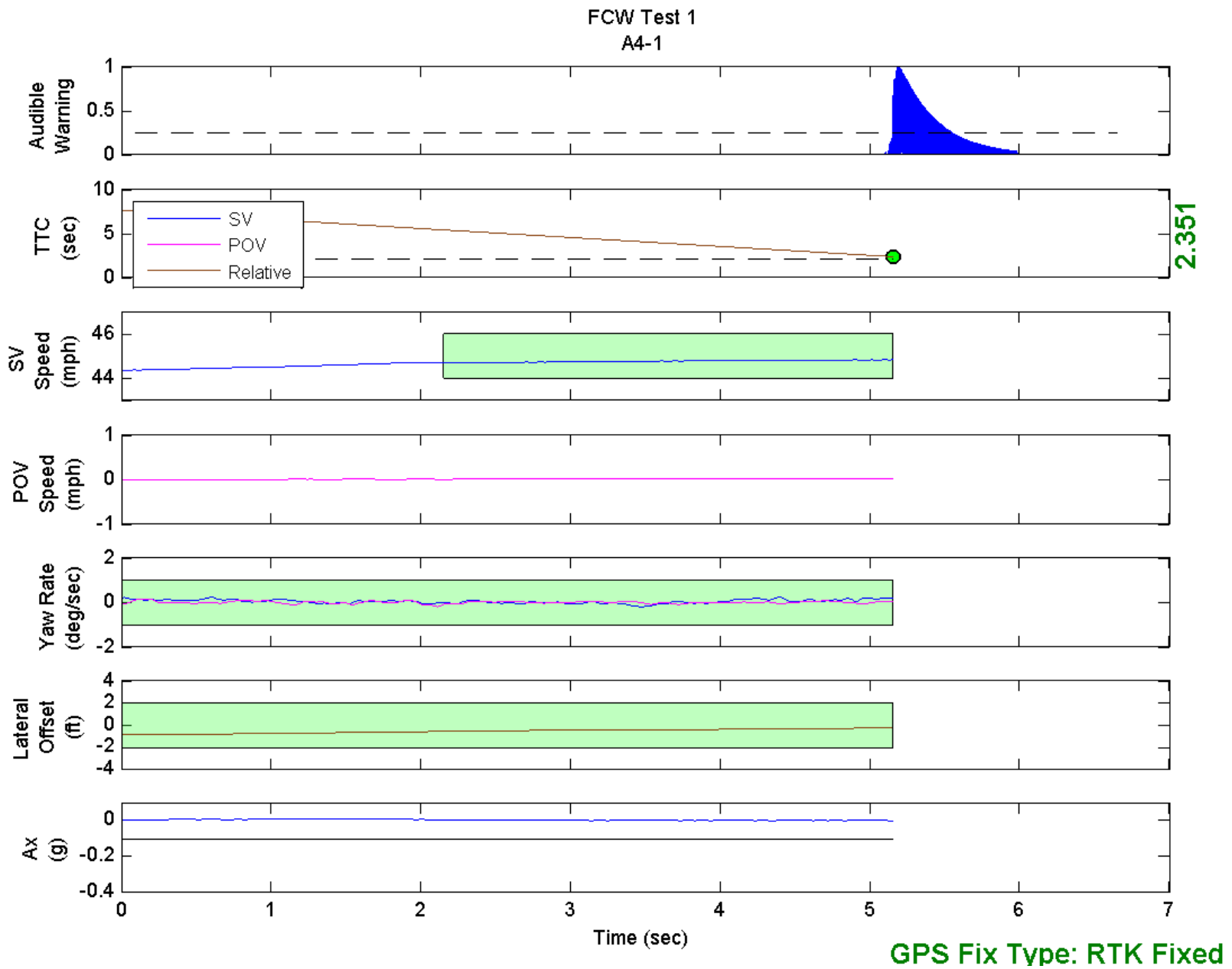


Figure D7. Time History for Run 1, FCW Test 1, Audible Warning

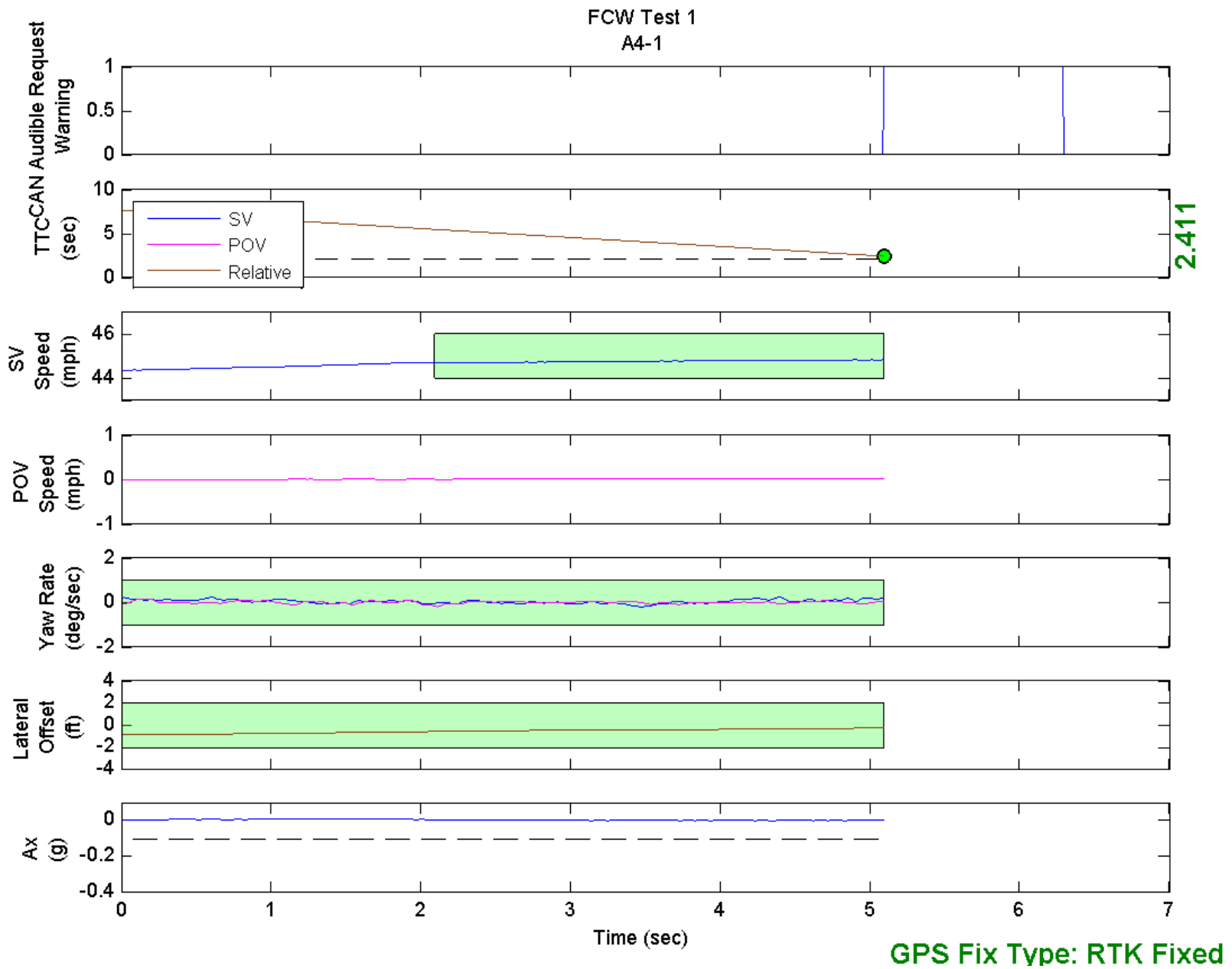


Figure D8. Time History for Run 1, FCW Test 1, CAN Audible Warning Request

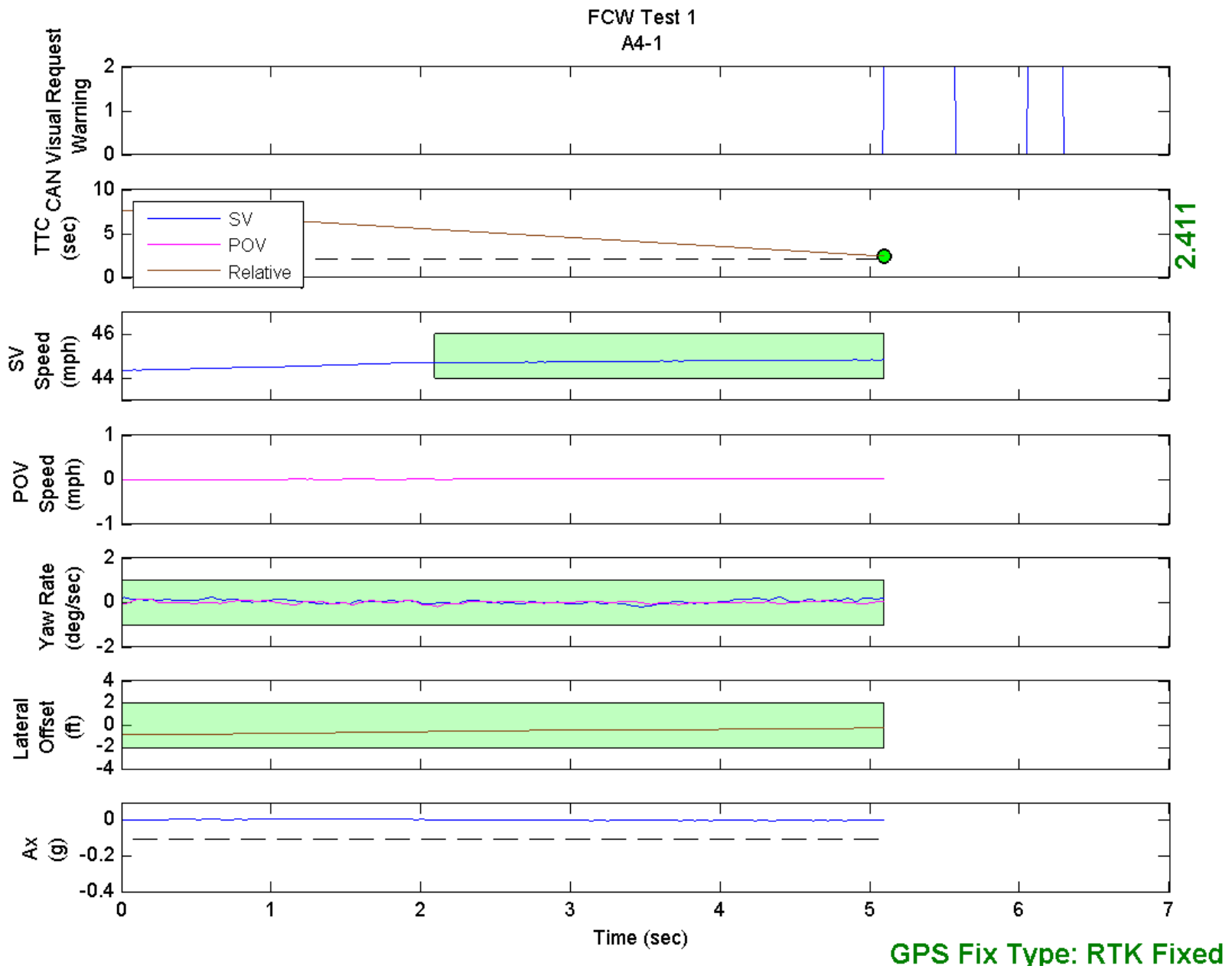


Figure D9. Time History for Run 1, FCW Test 1, CAN Visual Warning Request

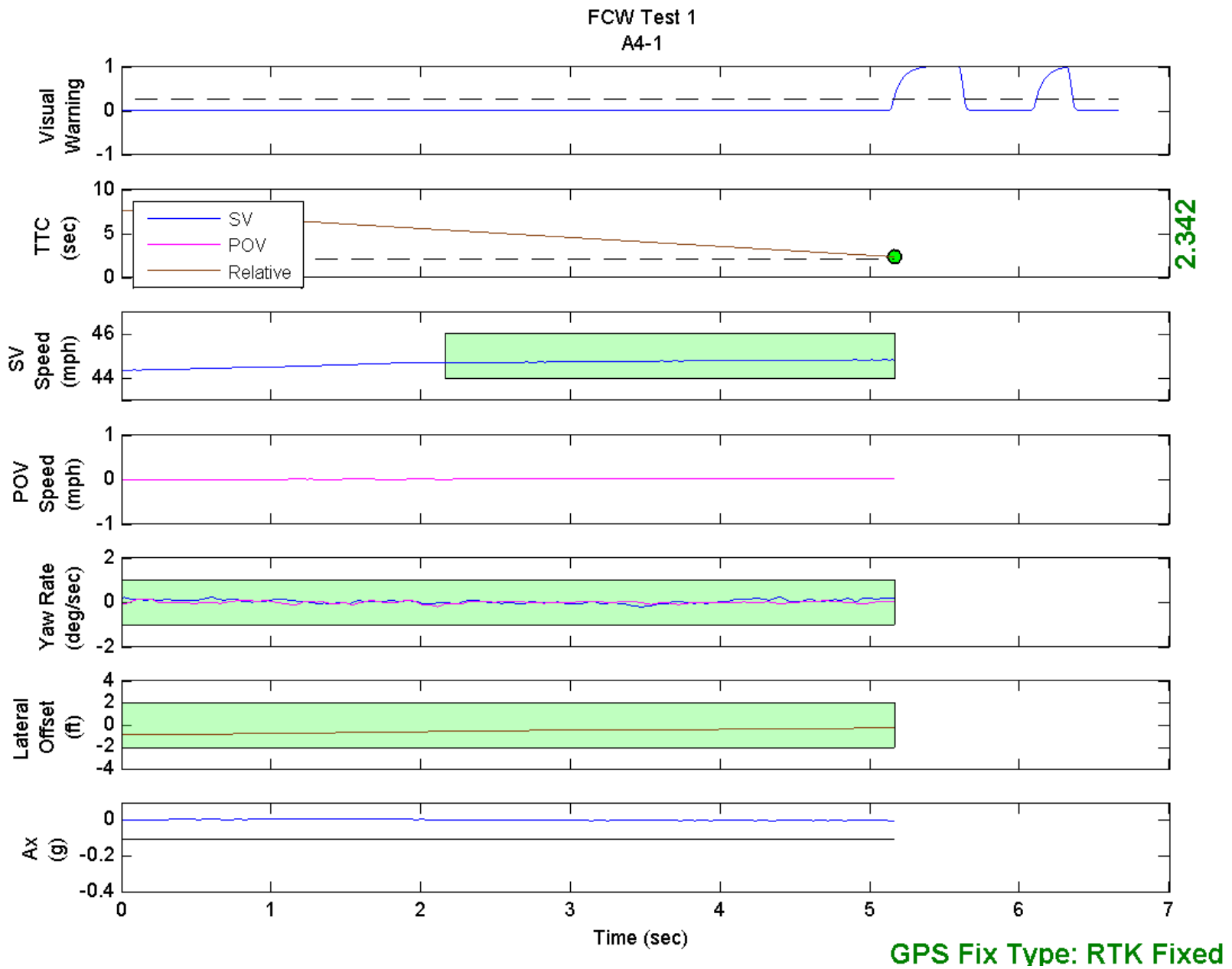


Figure D10. Time History for Run 1, FCW Test 1, Visual Warning

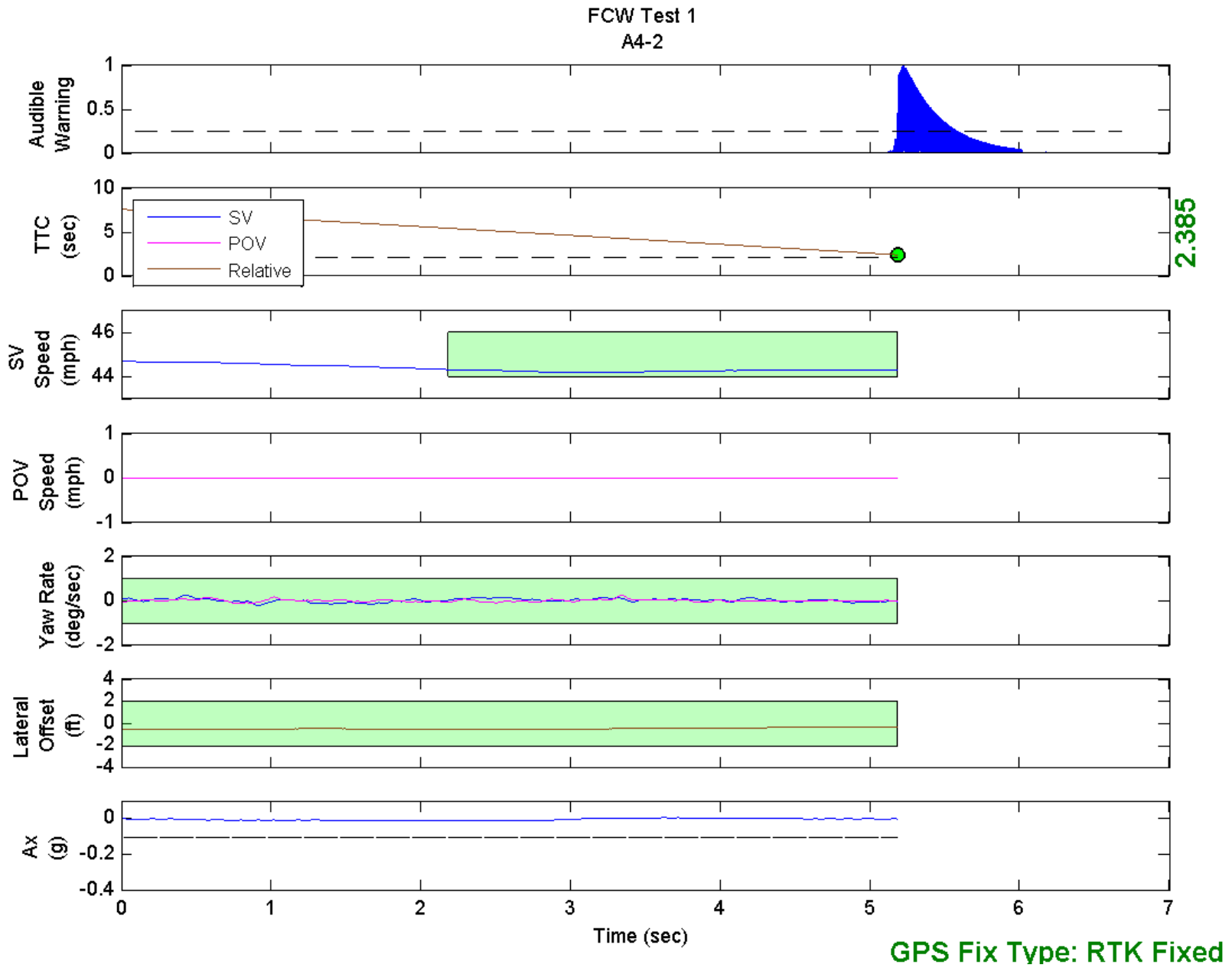


Figure D11. Time History for Run 2, FCW Test 1, Audible Warning

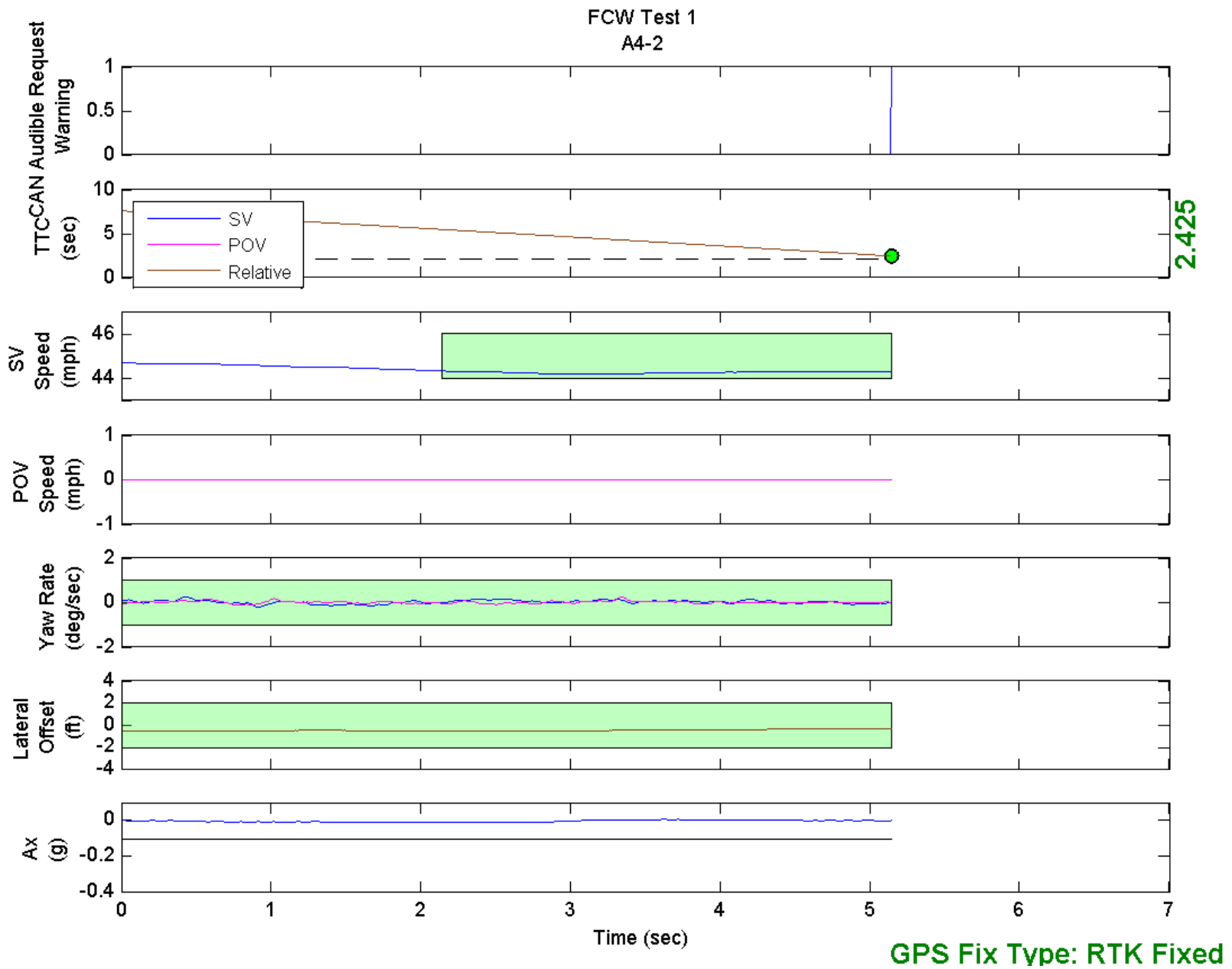


Figure D12. Time History for Run 2, FCW Test 1, CAN Audible Warning Request

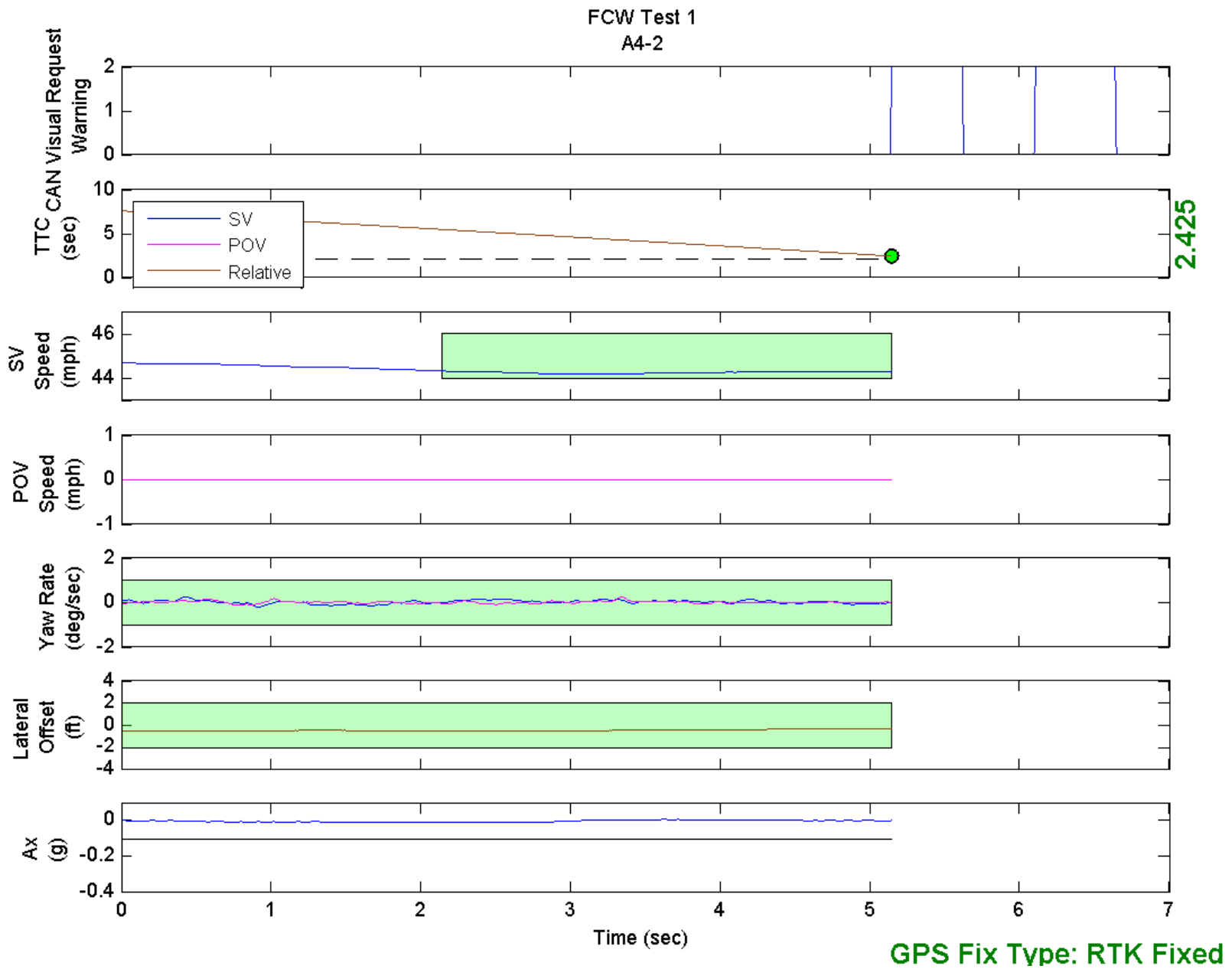


Figure D13. Time History for Run 2, FCW Test 1, CAN Visual Warning Request

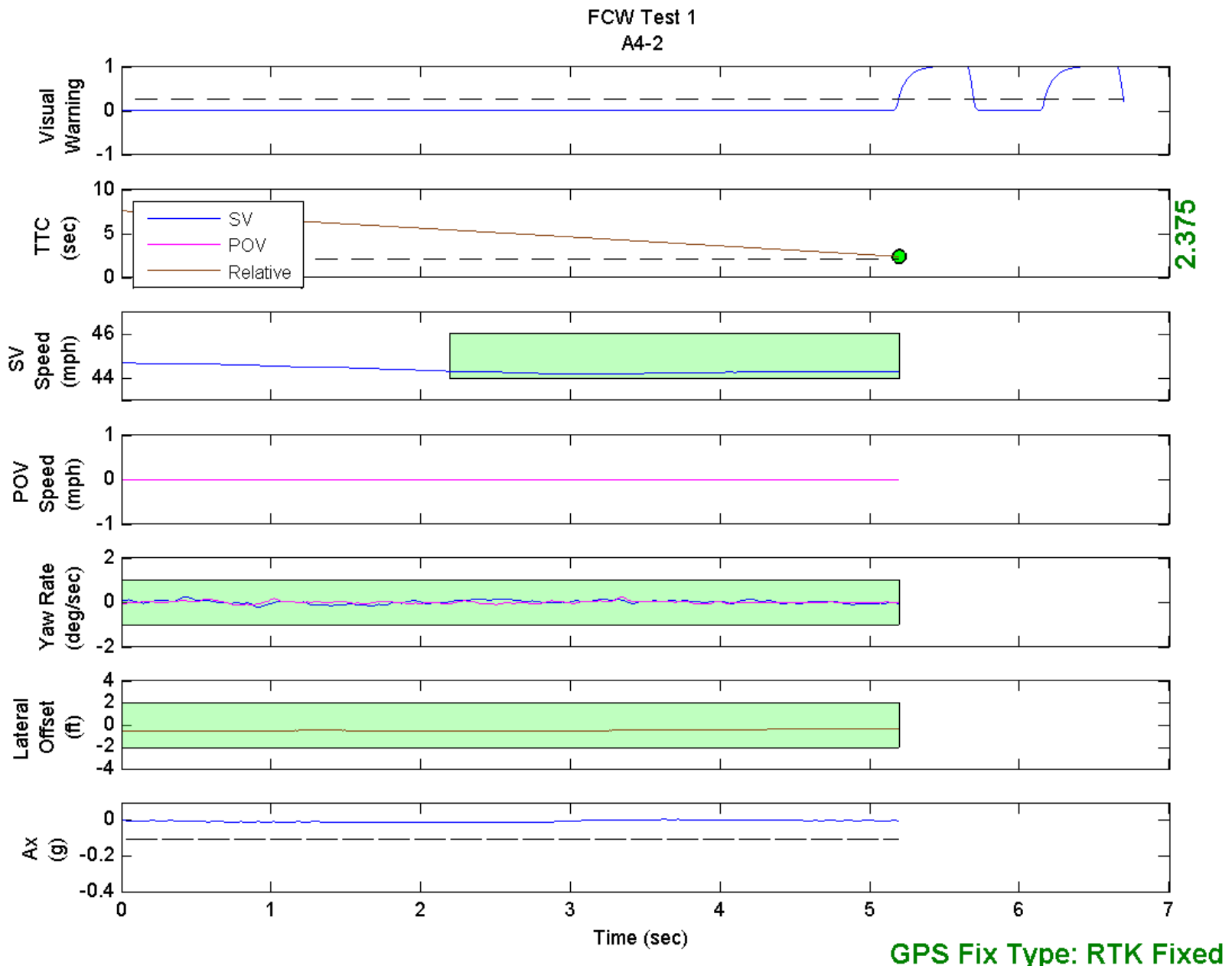


Figure D14. Time History for Run 2, FCW Test 1, Visual Warning

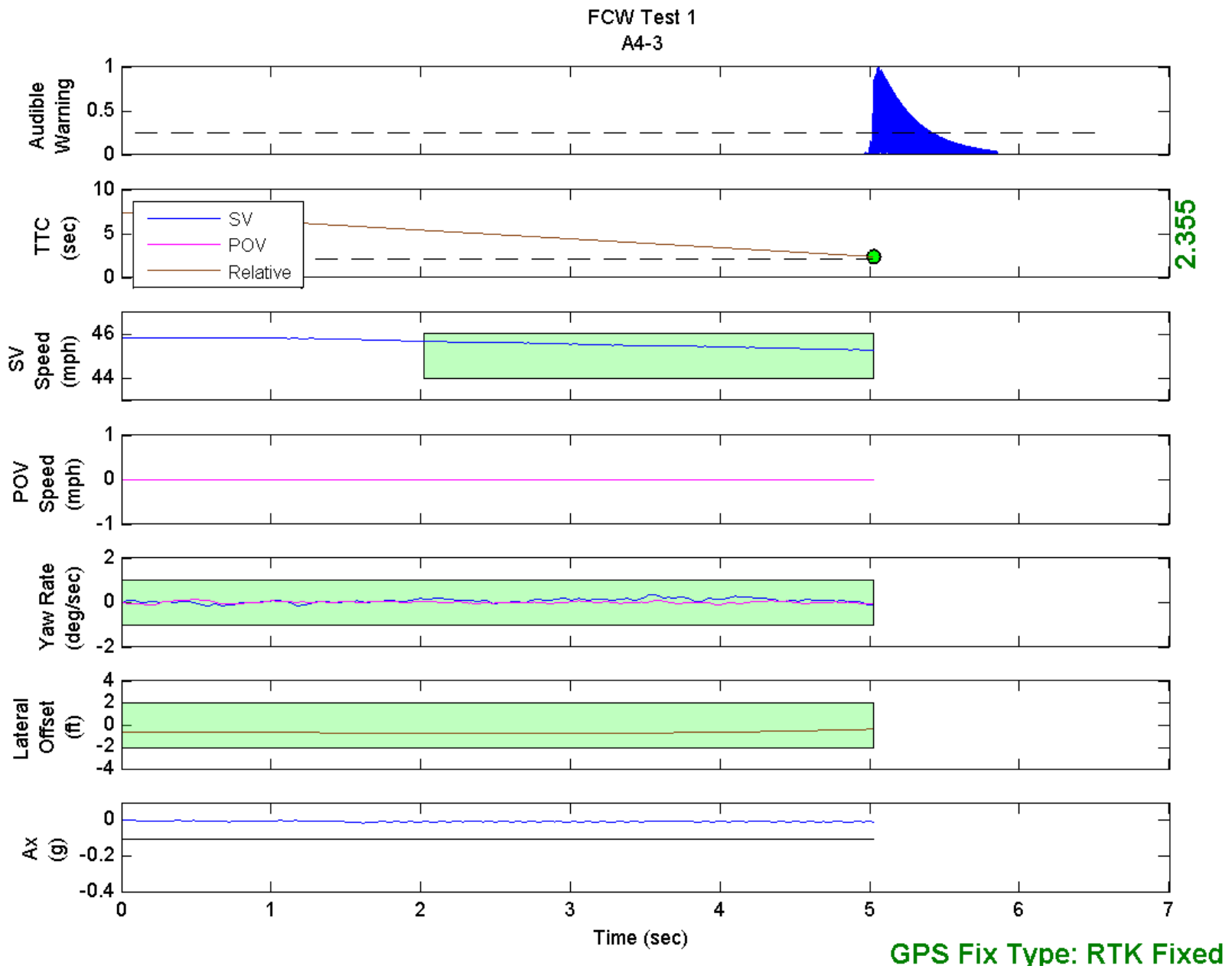


Figure D15. Time History for Run 3, FCW Test 1, Audible Warning

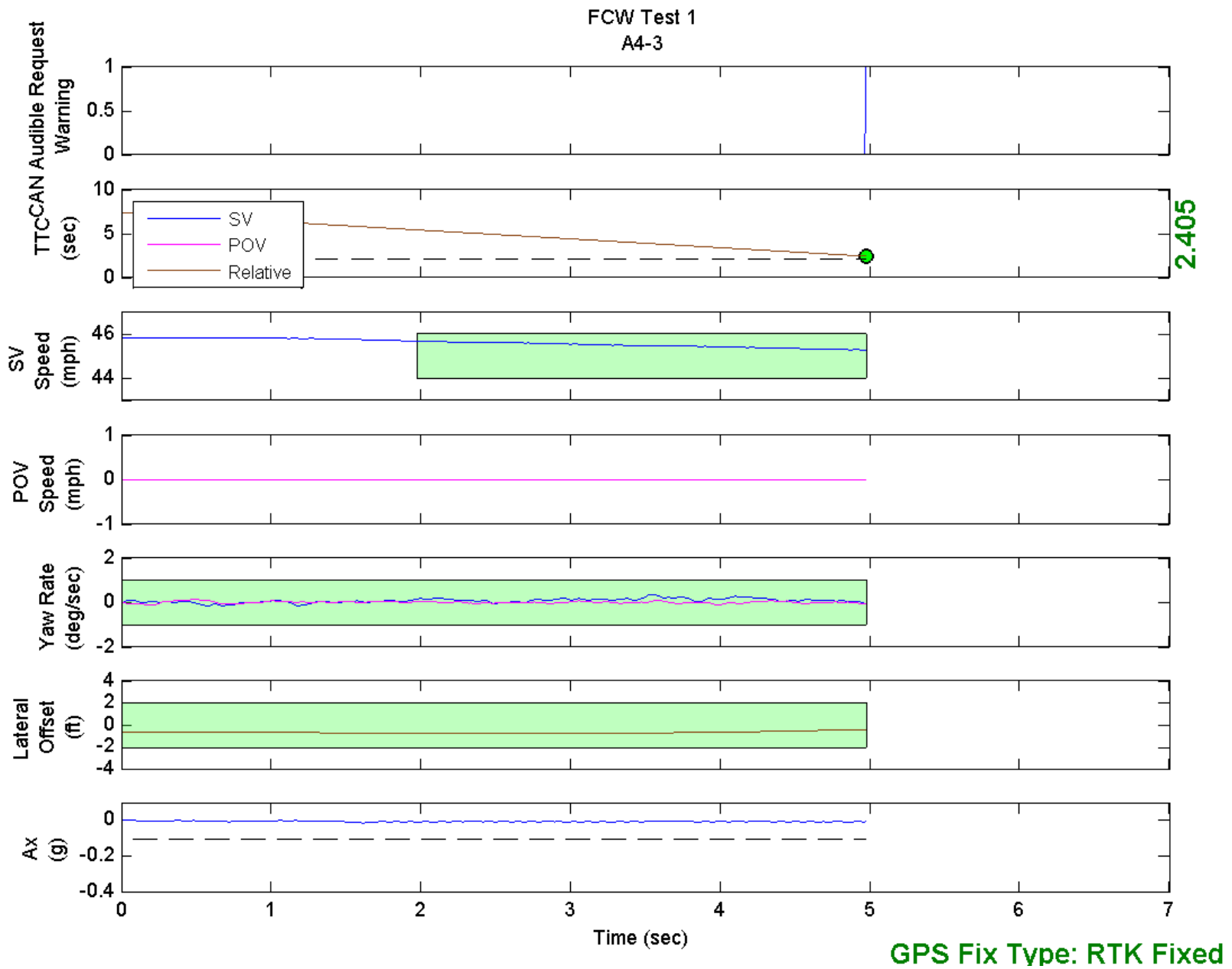


Figure D16. Time History for Run 3, FCW Test 1, CAN Audible Warning Request

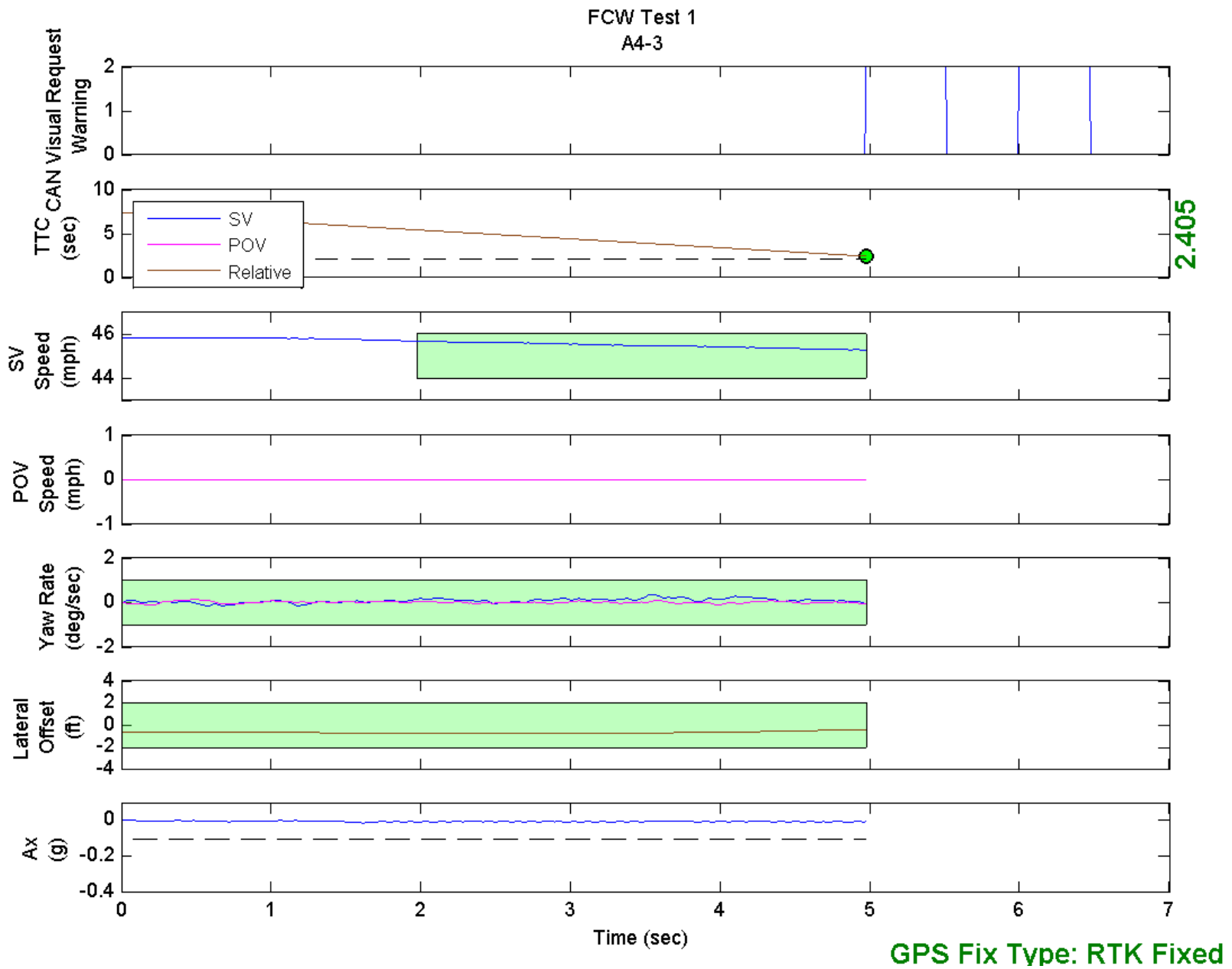


Figure D17. Time History for Run 3, FCW Test 1, CAN Visual Warning Request

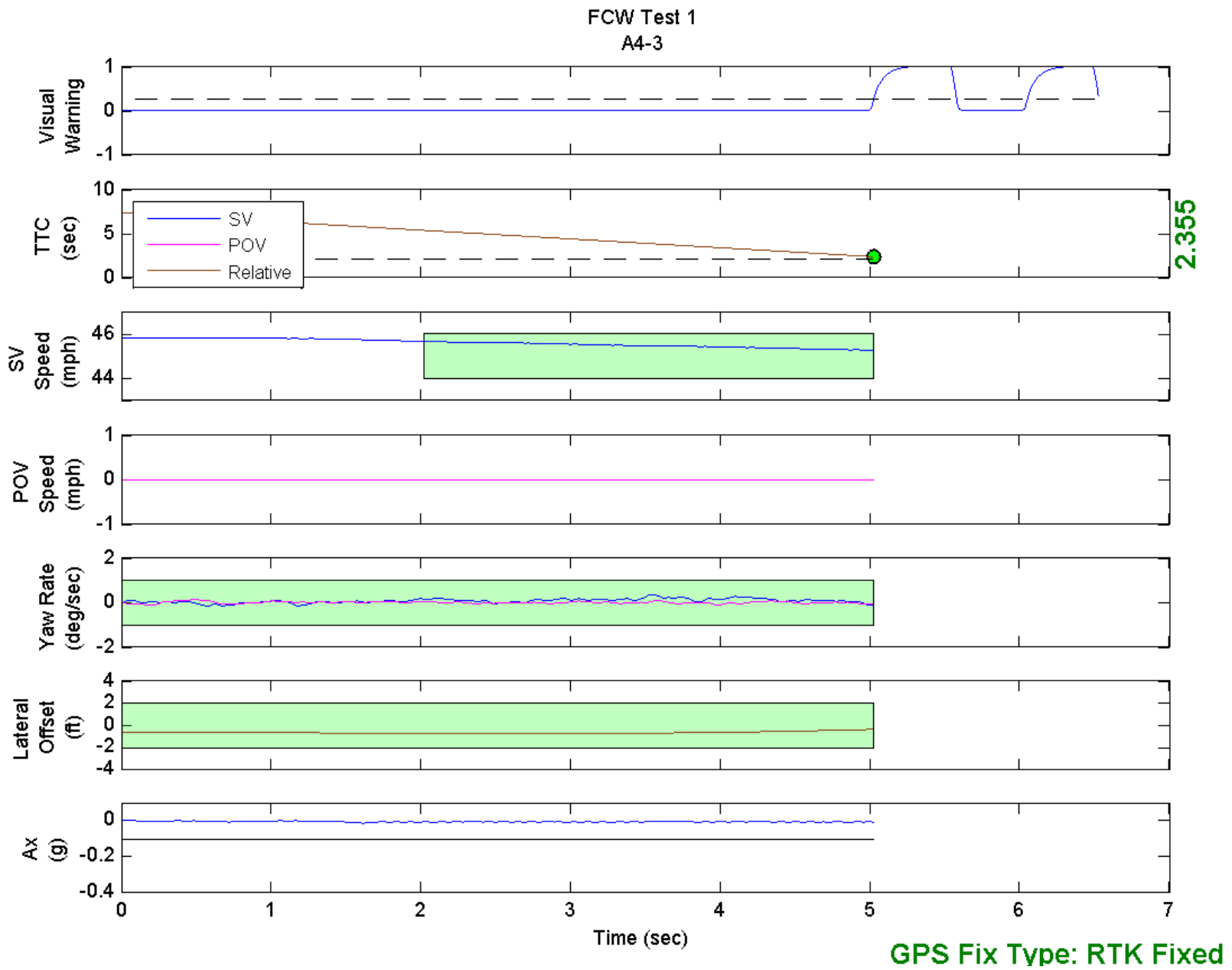


Figure D18. Time History for Run 3, FCW Test 1, Visual Warning

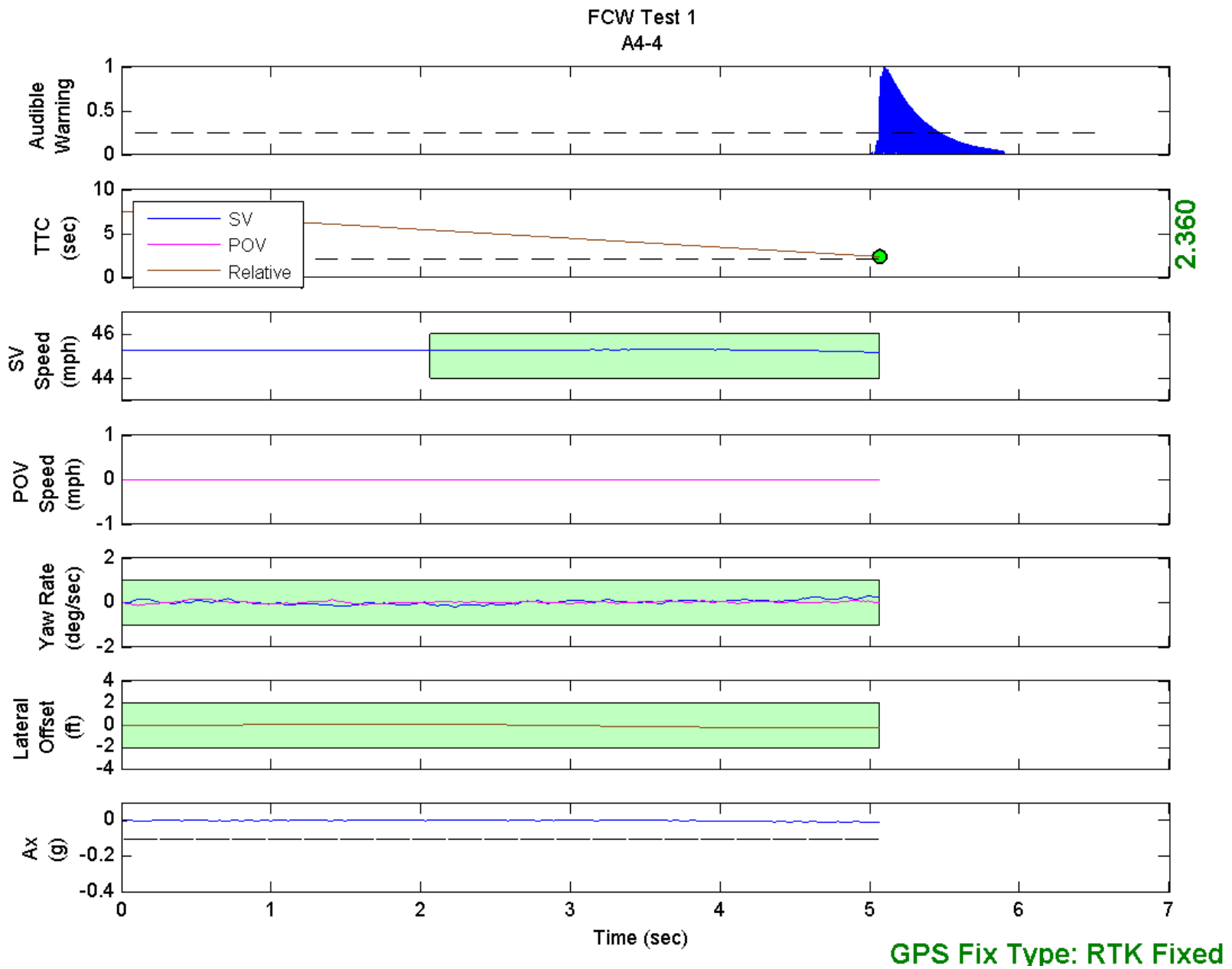


Figure D19. Time History for Run 4, FCW Test 1, Audible Warning

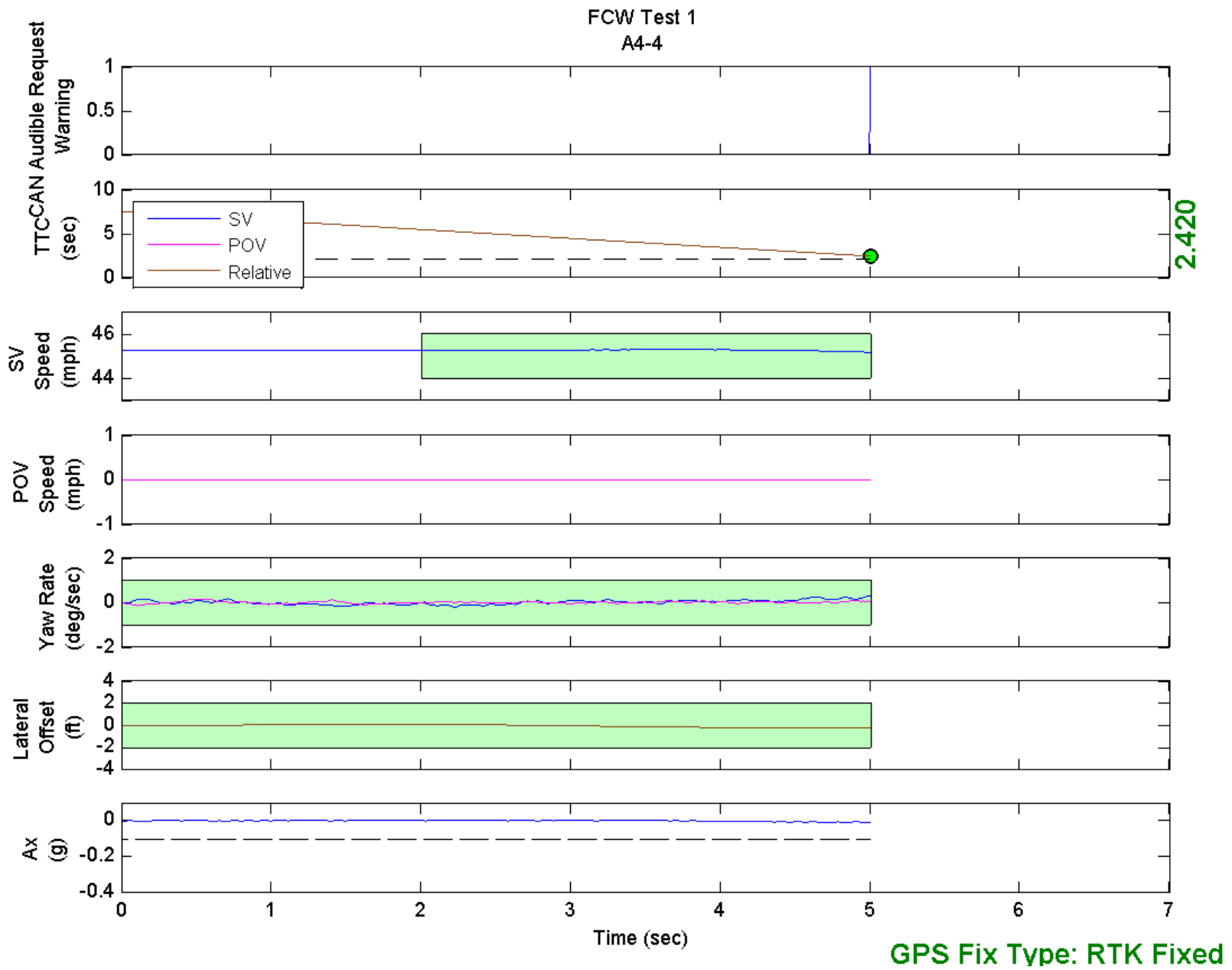


Figure D20. Time History for Run 4, FCW Test 1, CAN Audible Warning Request

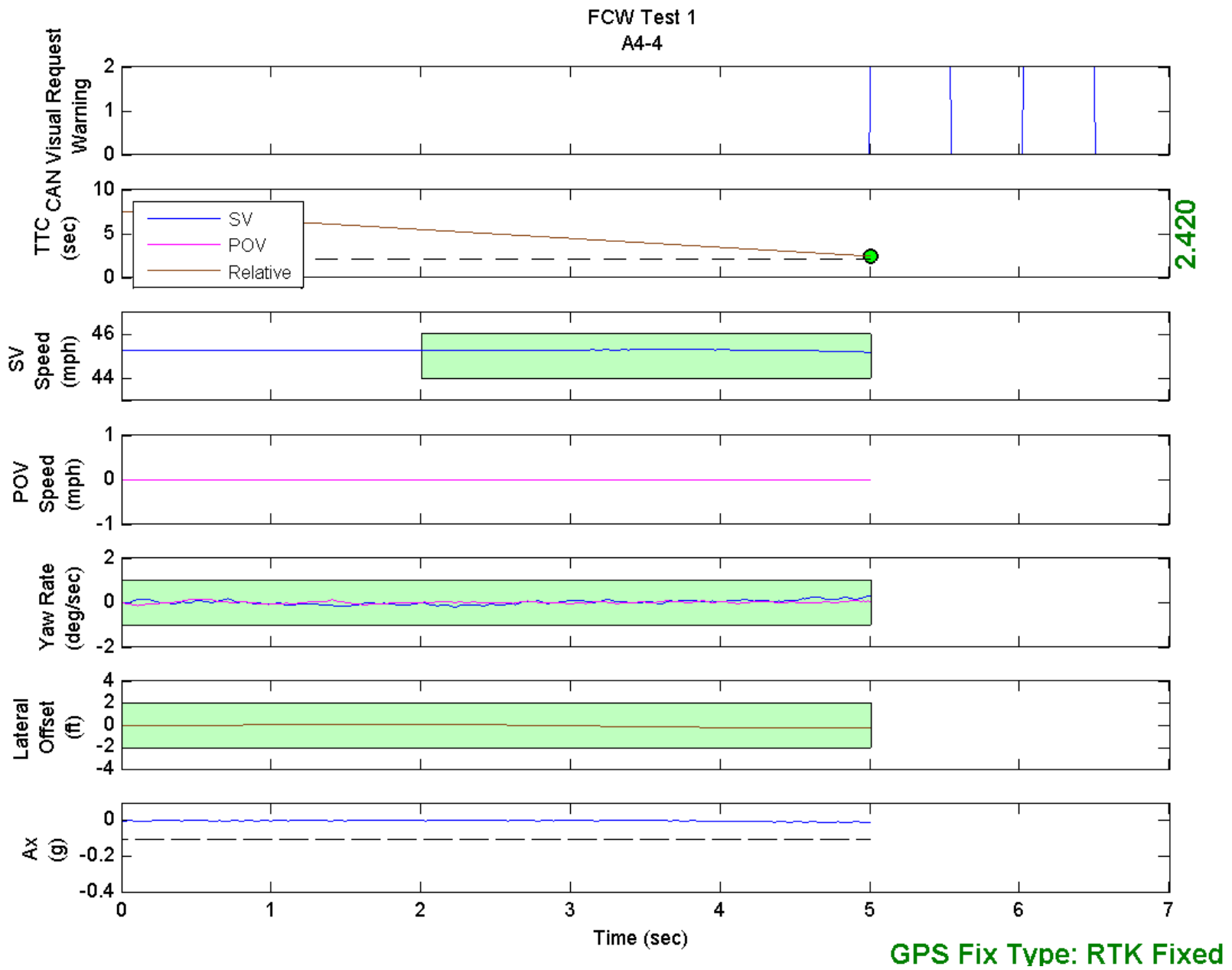


Figure D21. Time History for Run 4, FCW Test 1, CAN Visual Warning Request

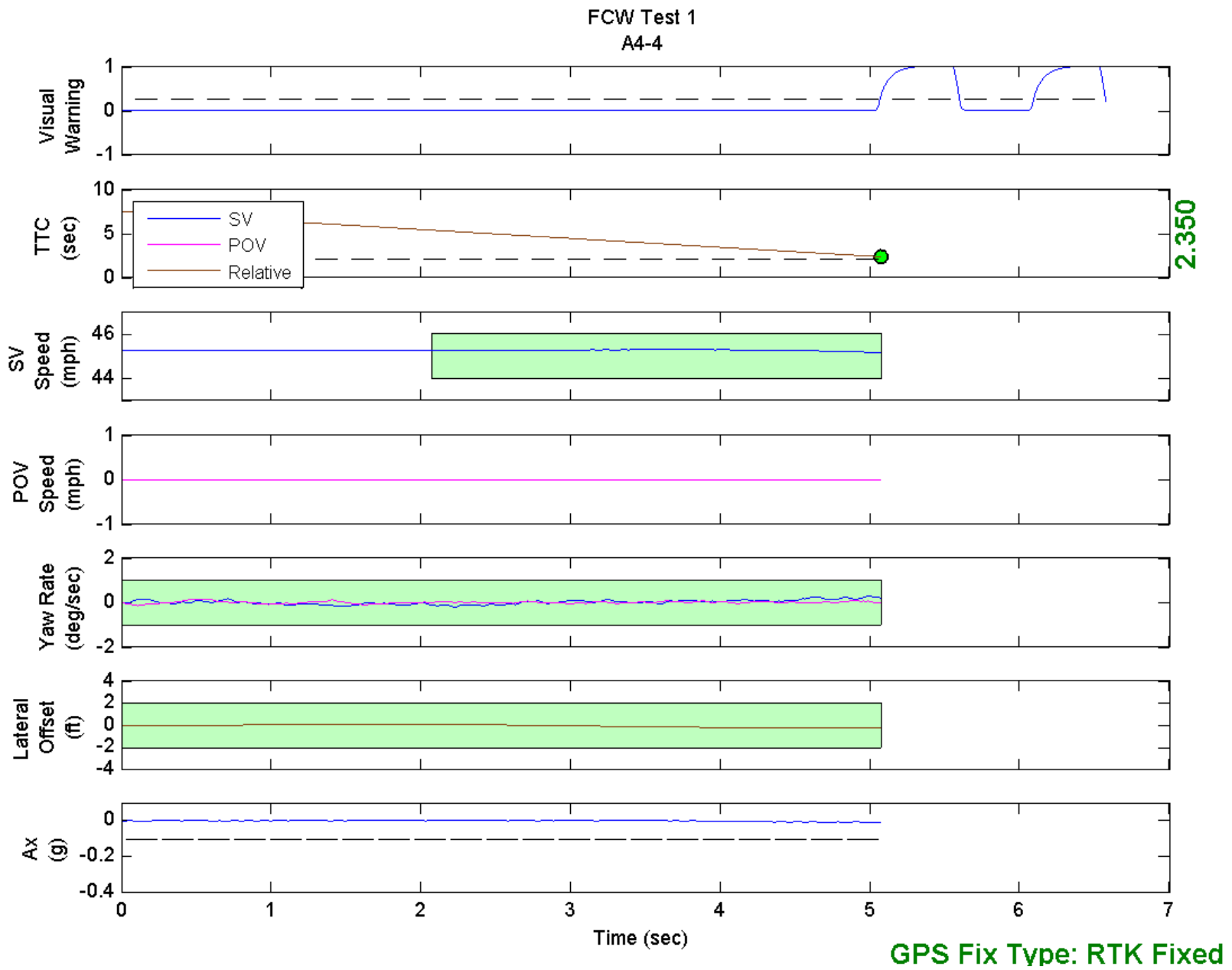


Figure D22. Time History for Run 4, FCW Test 1, Visual Warning

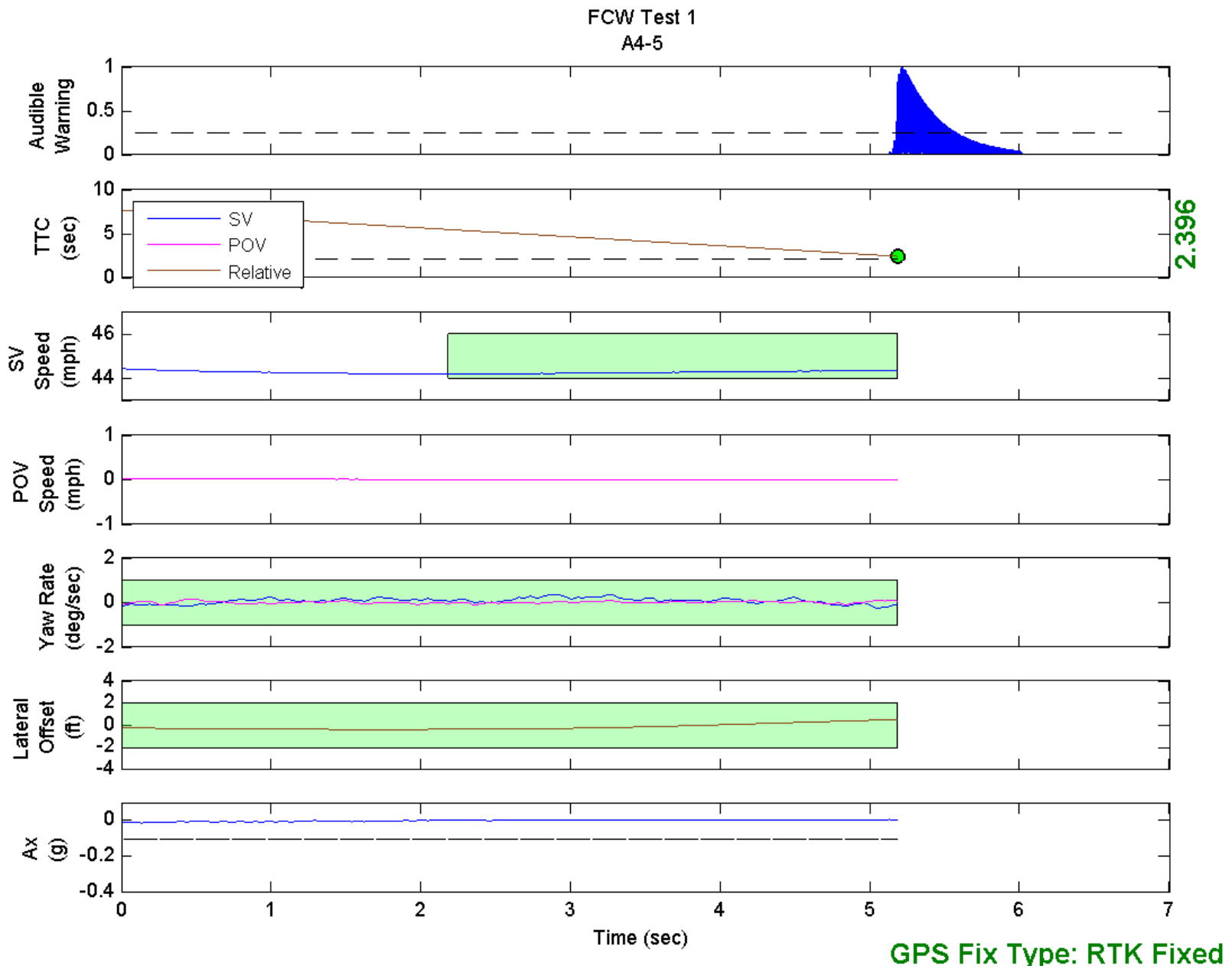


Figure D23. Time History for Run 5, FCW Test 1, Audible Warning

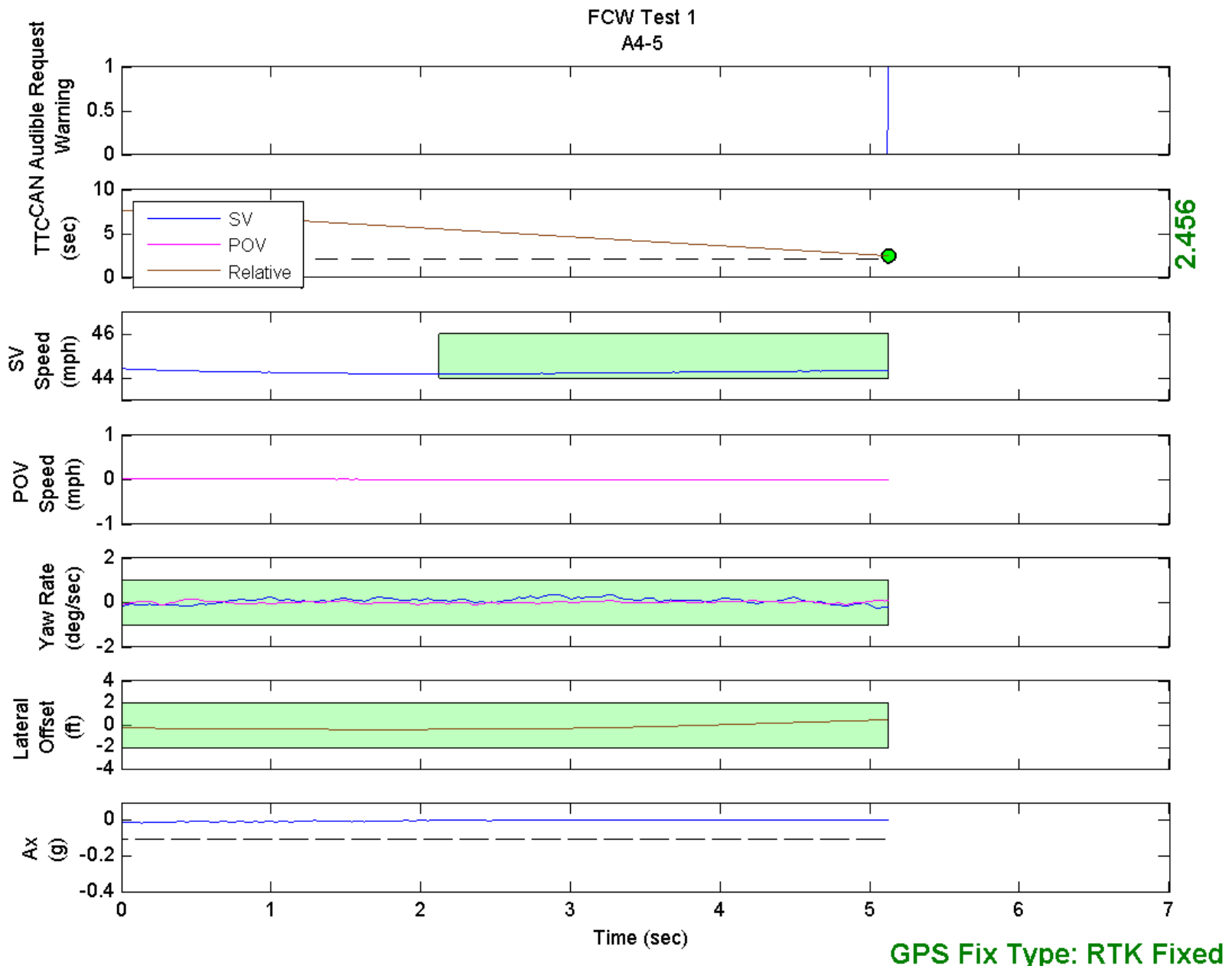


Figure D24. Time History for Run 5, FCW Test 1, CAN Audible Warning Request

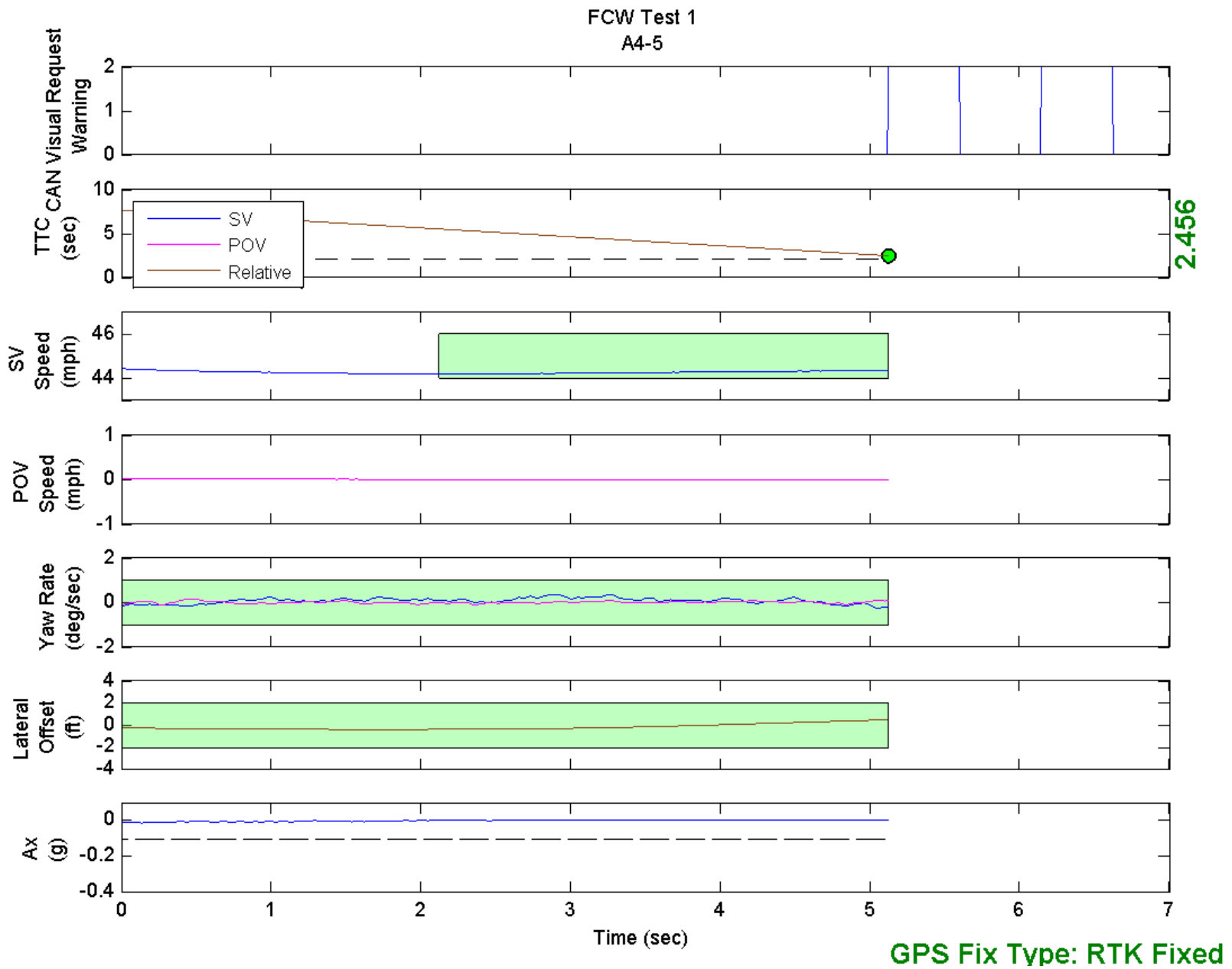


Figure D25. Time History for Run 5, FCW Test 1, CAN Visual Warning Request

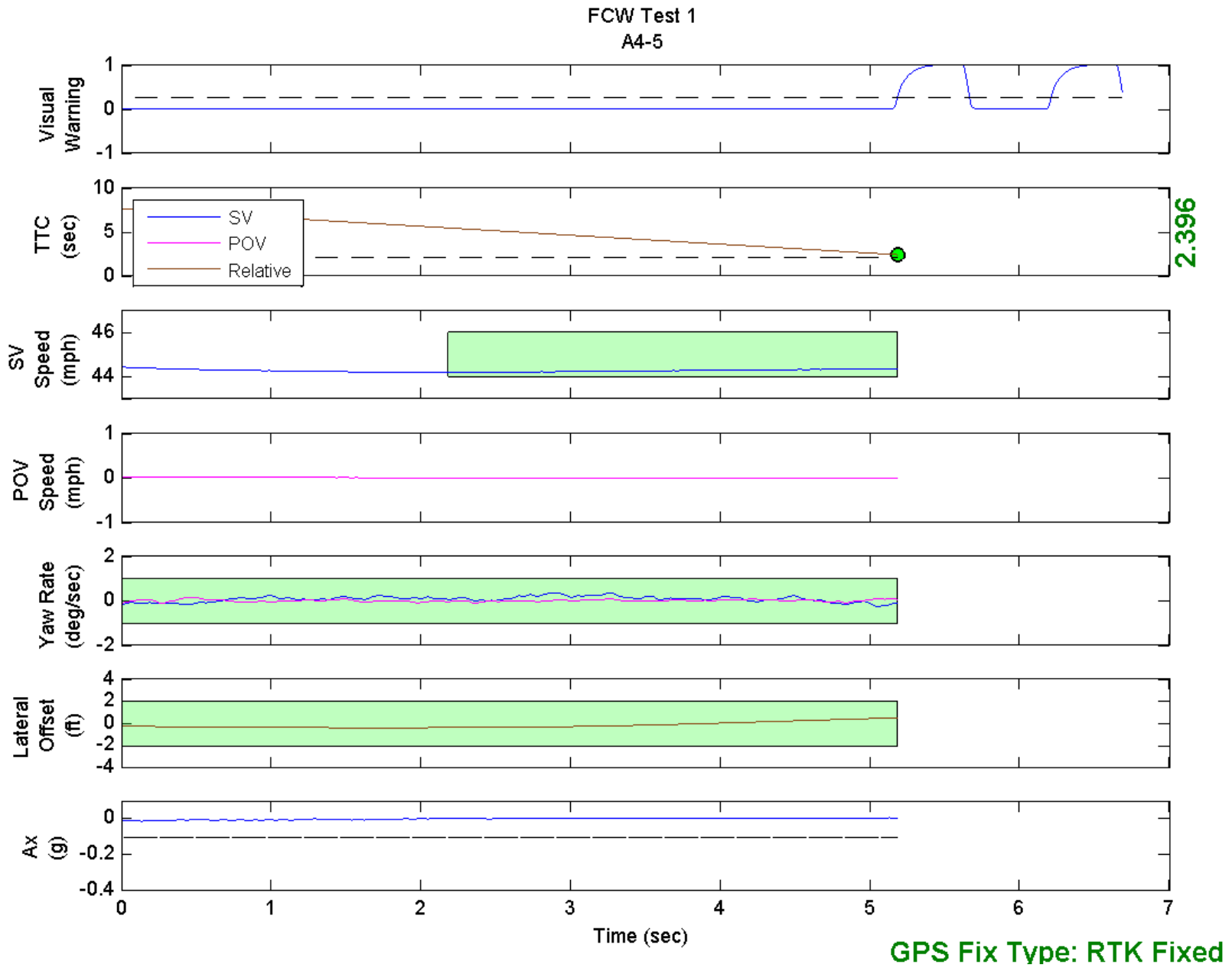


Figure D26. Time History for Run 5, FCW Test 1, Visual Warning

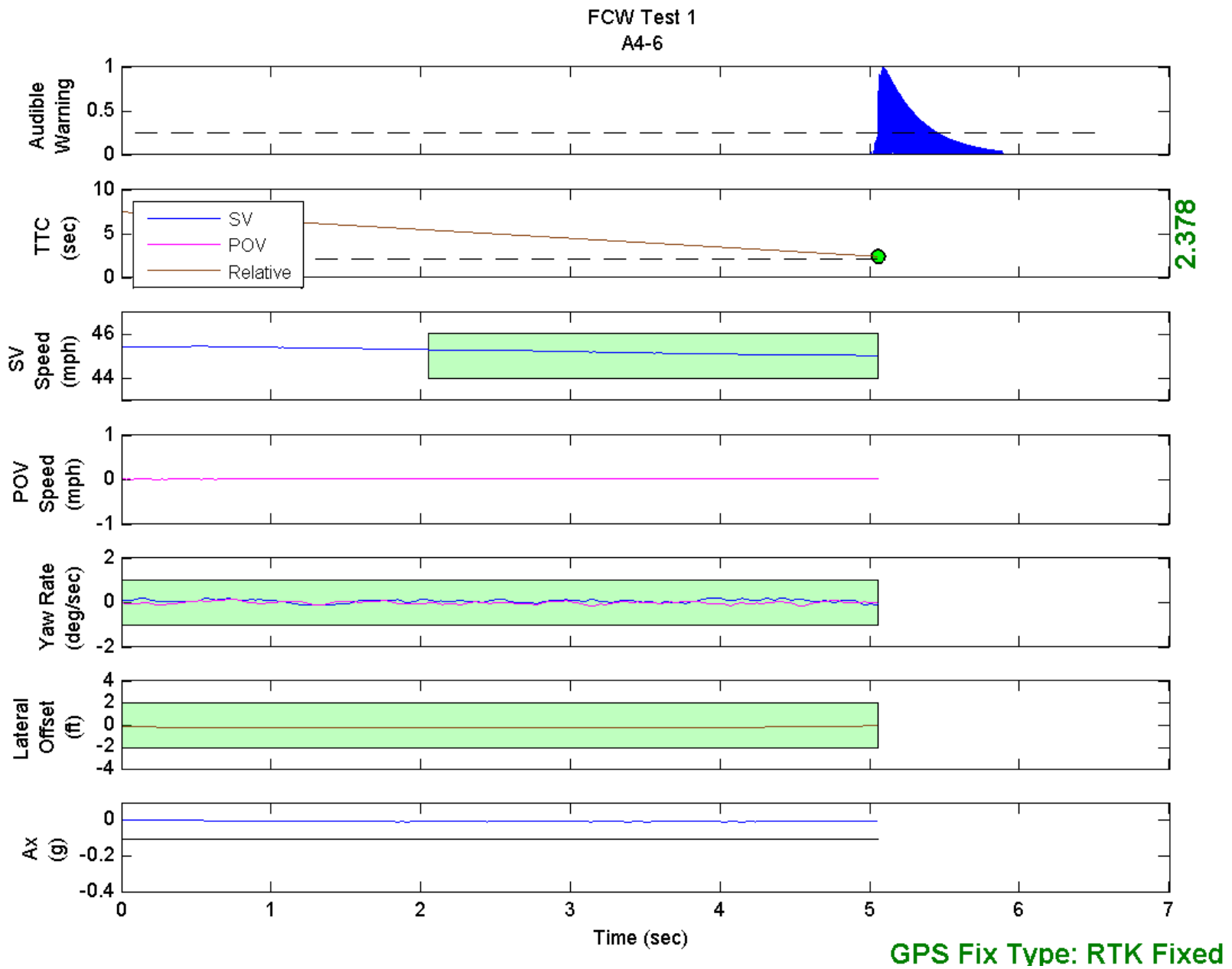


Figure D27. Time History for Run 6, FCW Test 1, Audible Warning

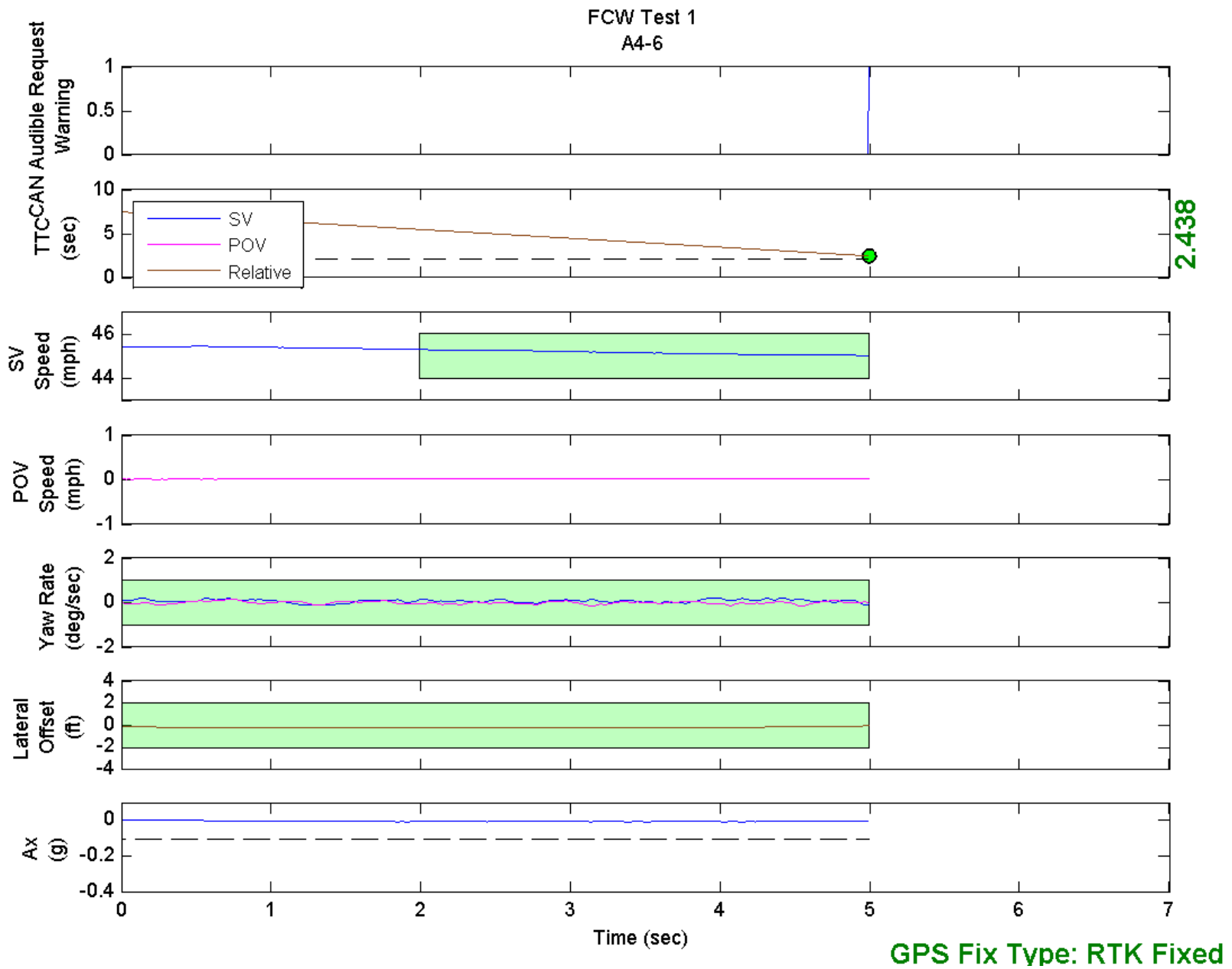


Figure D28. Time History for Run 6, FCW Test 1, CAN Audible Warning Request

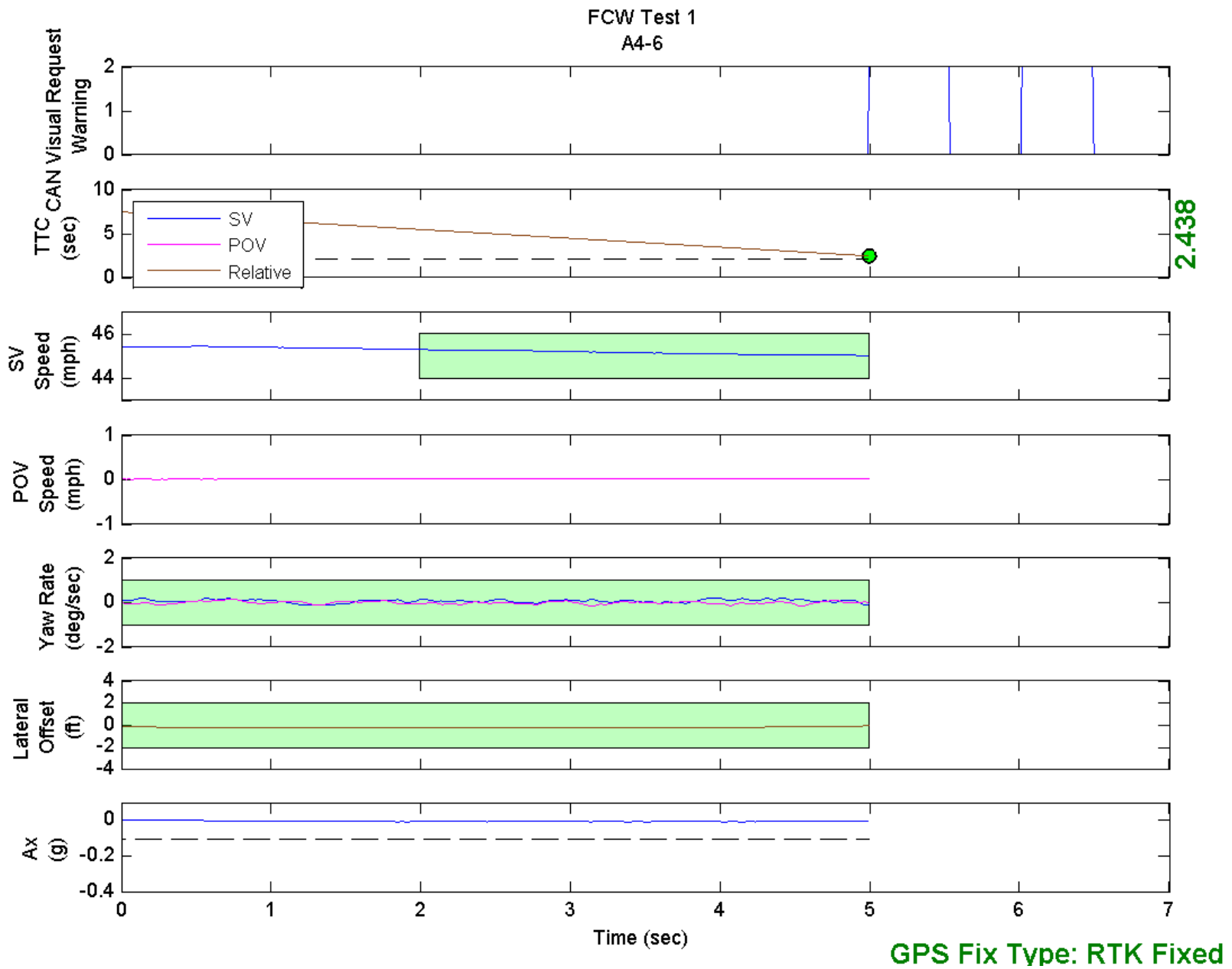


Figure D29. Time History for Run 6, FCW Test 1, CAN Visual Warning Request

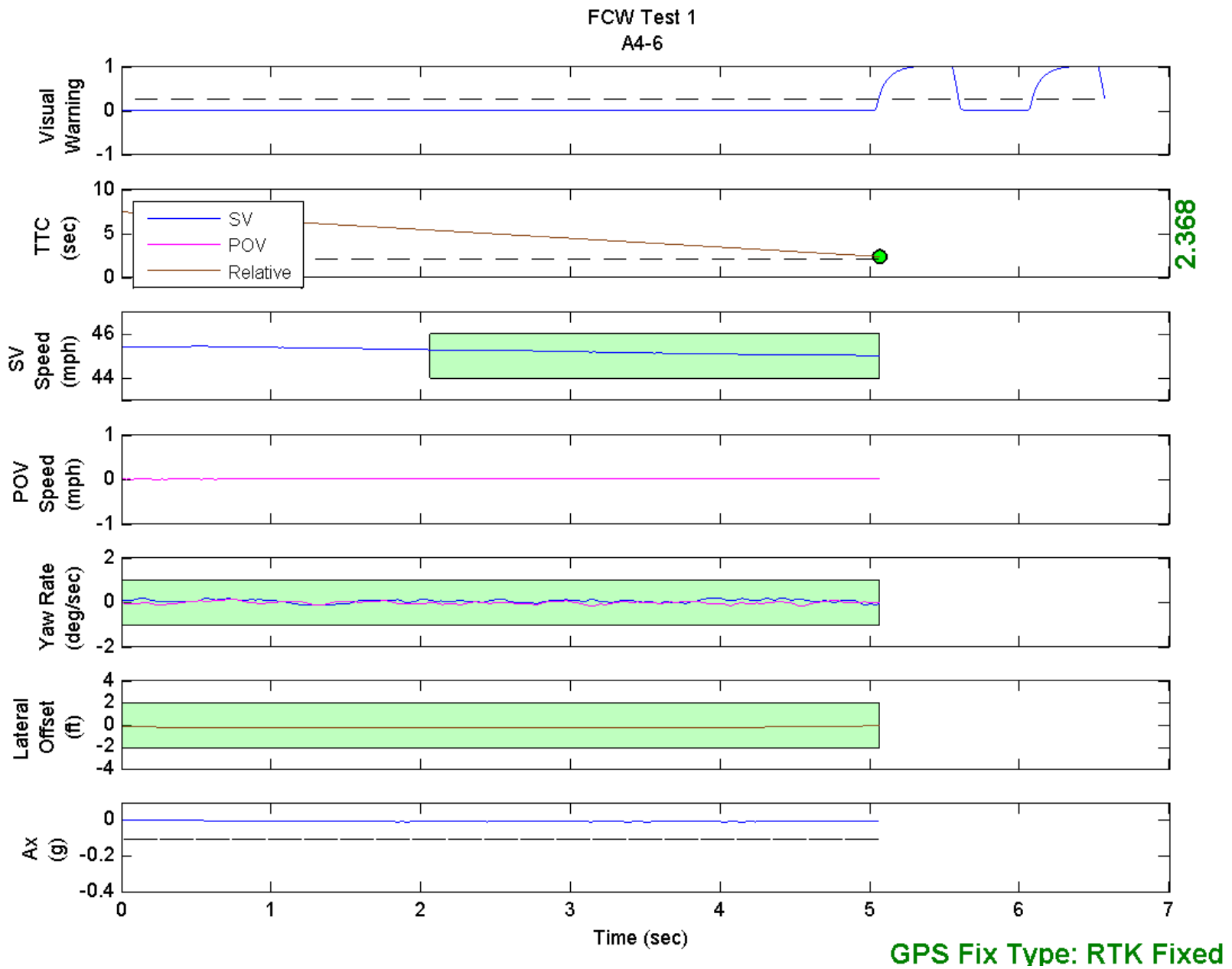


Figure D30. Time History for Run 6, FCW Test 1, Visual Warning

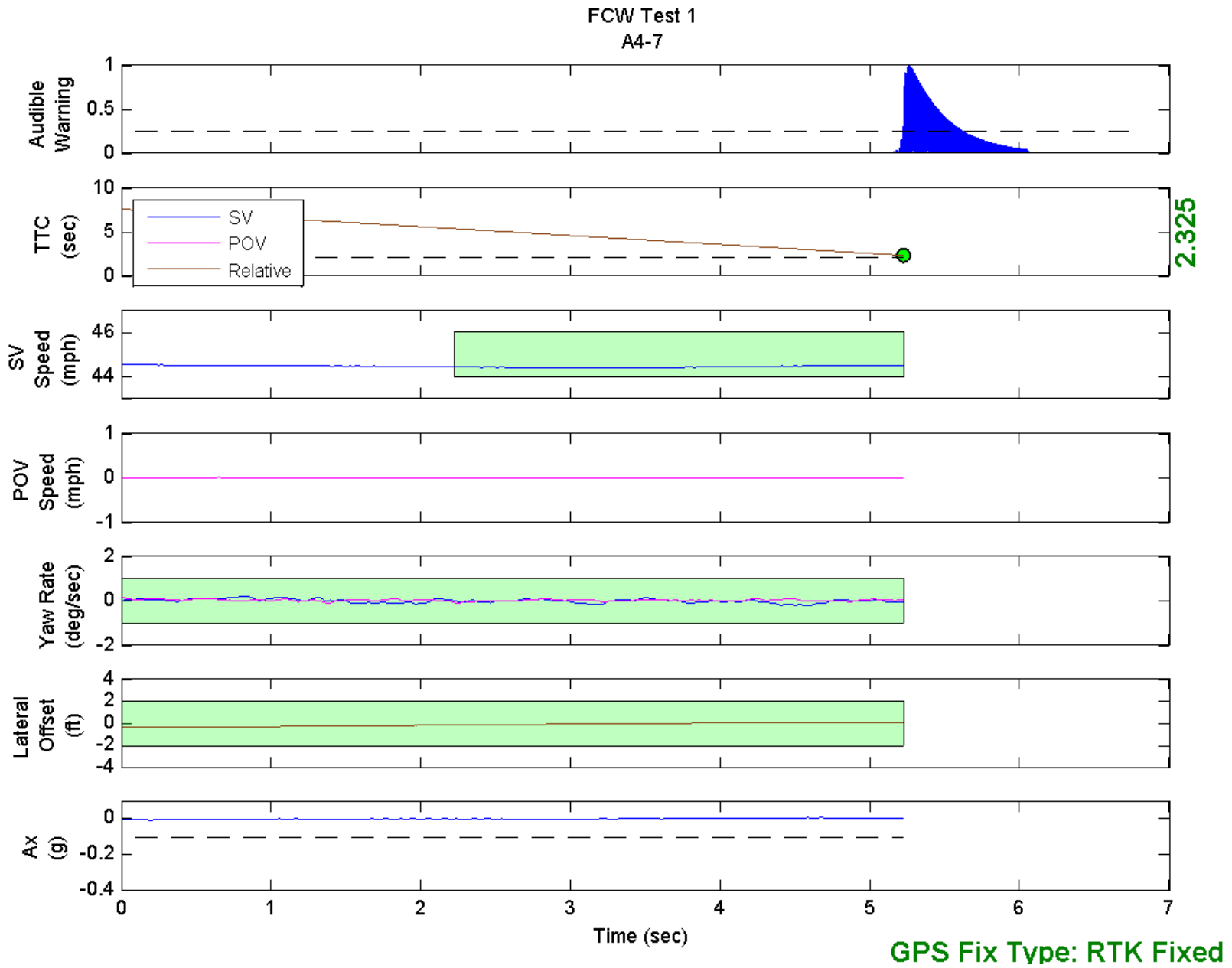


Figure D31. Time History for Run 7, FCW Test 1, Audible Warning

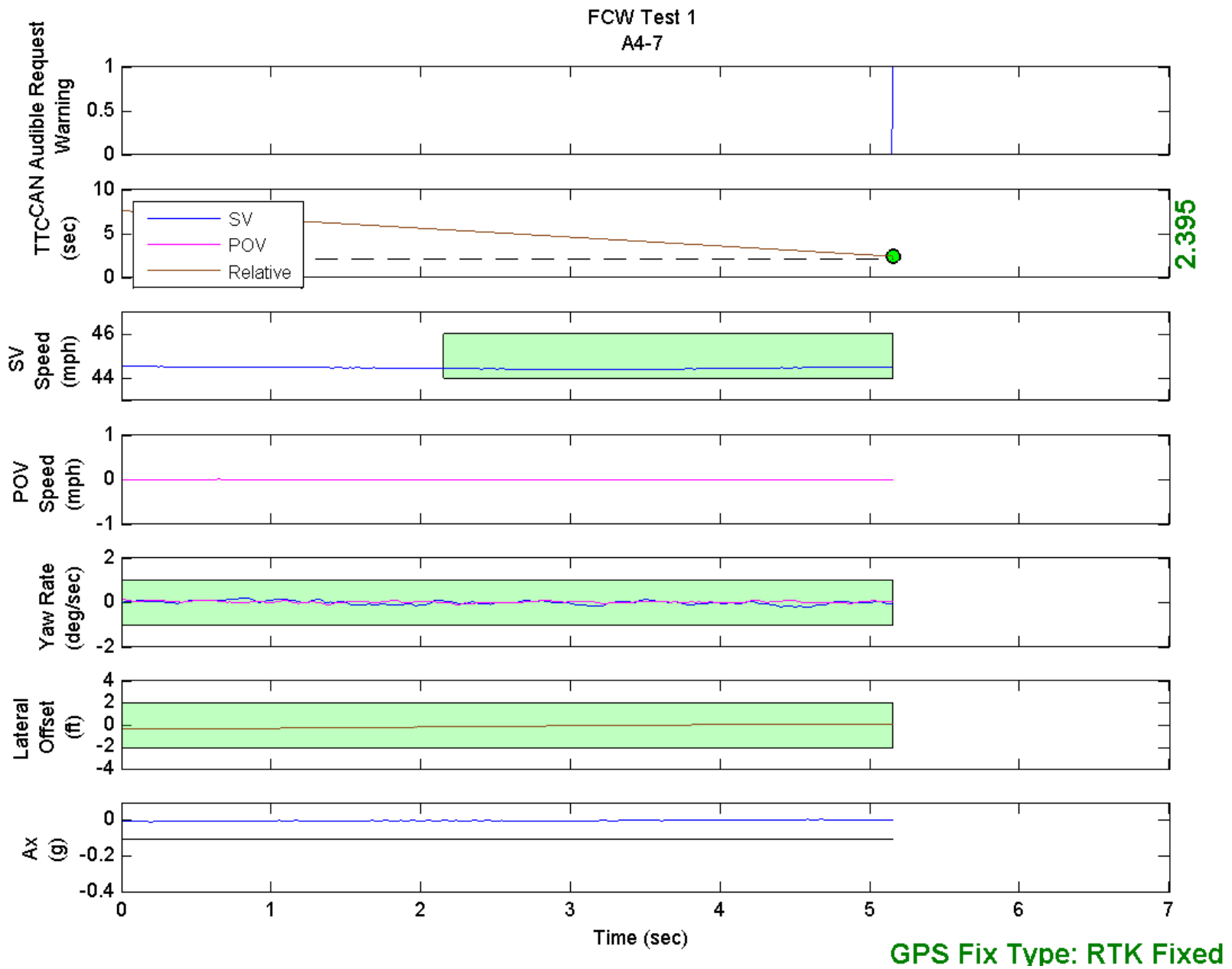


Figure D32. Time History for Run 7, FCW Test 1, CAN Audible Warning Request

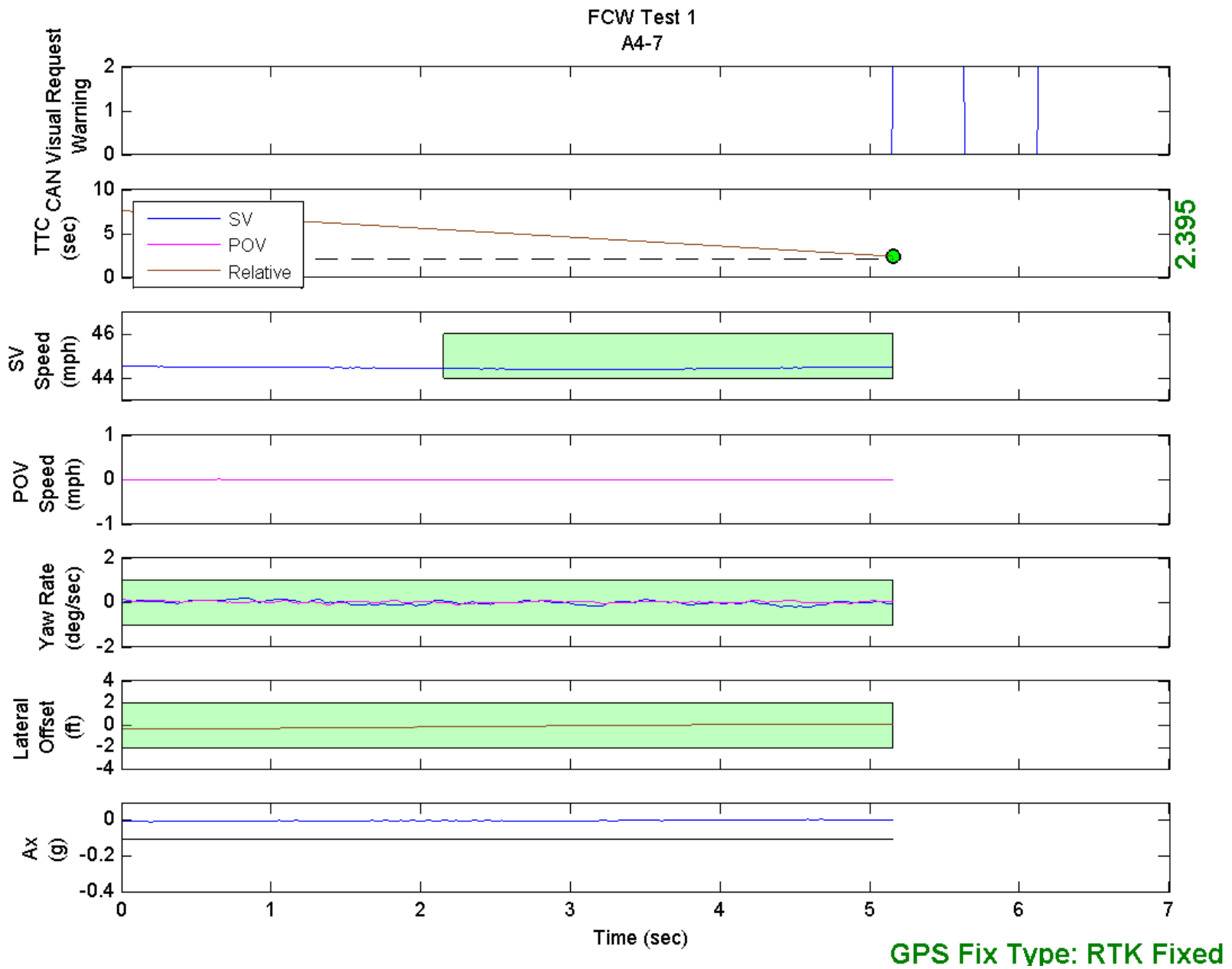


Figure D33. Time History for Run 7, FCW Test 1, CAN Visual Warning Request

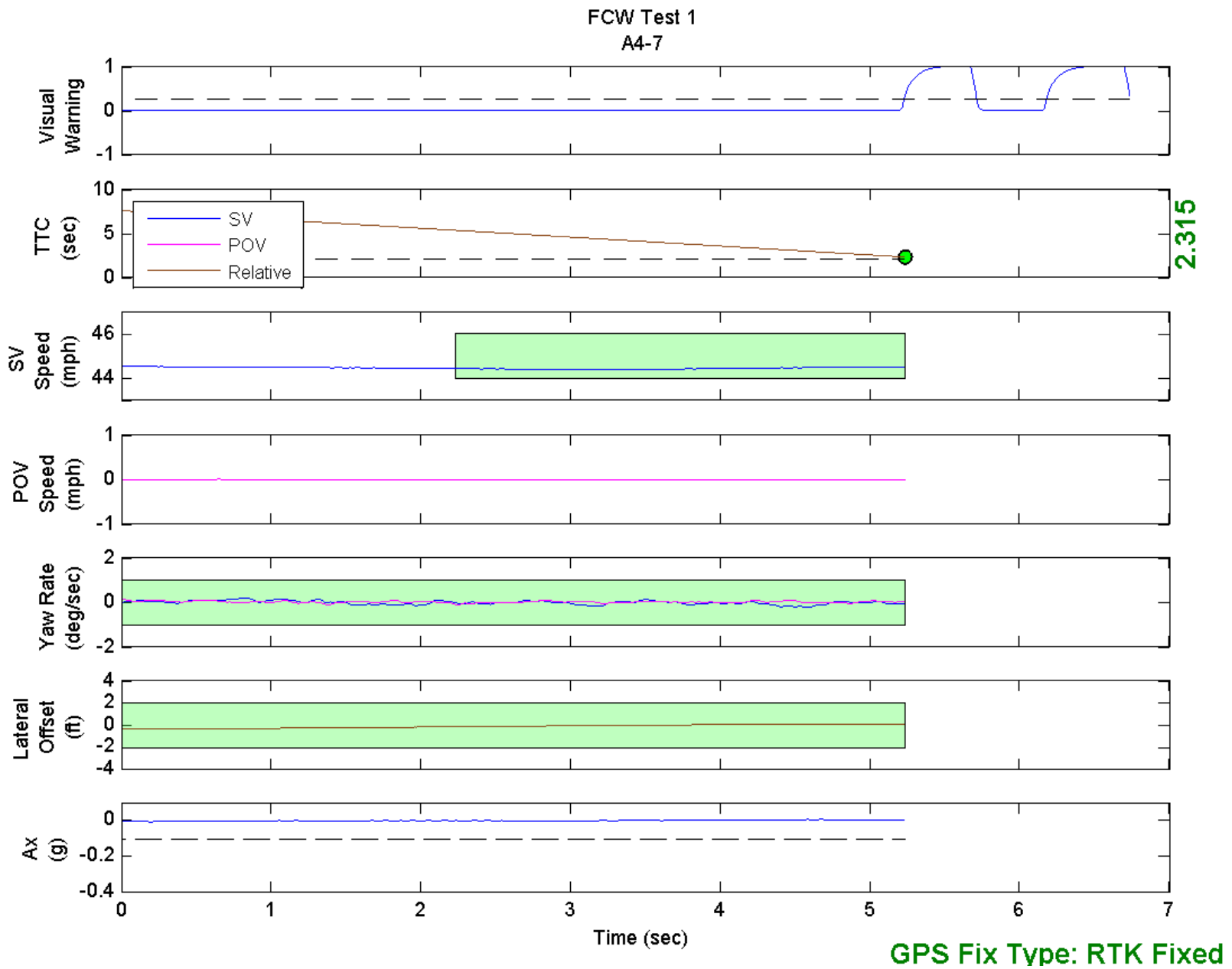


Figure D34. Time History for Run 7, FCW Test 1, Visual Warning

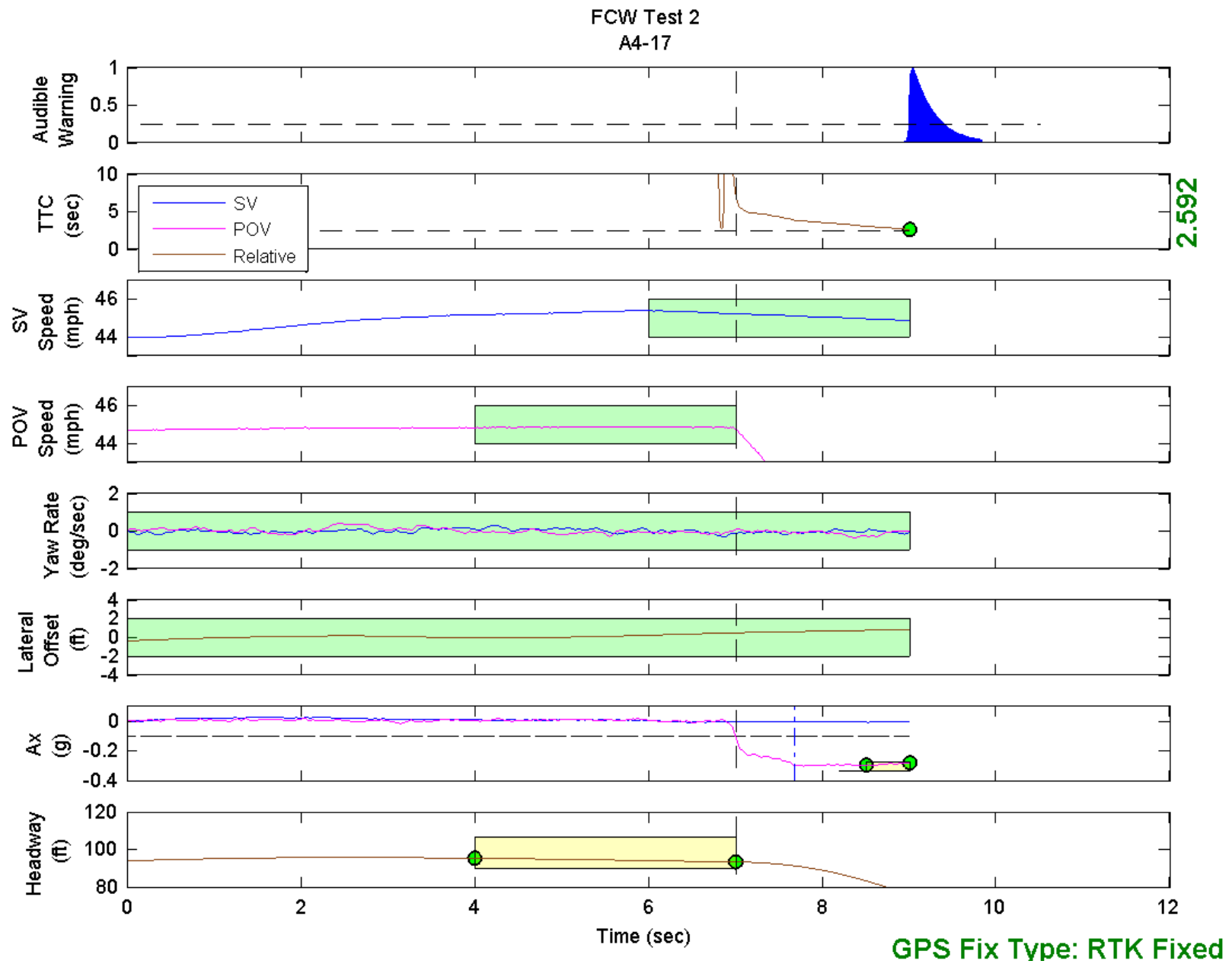


Figure D35. Time History for Run 17, FCW Test 2, Audible Warning

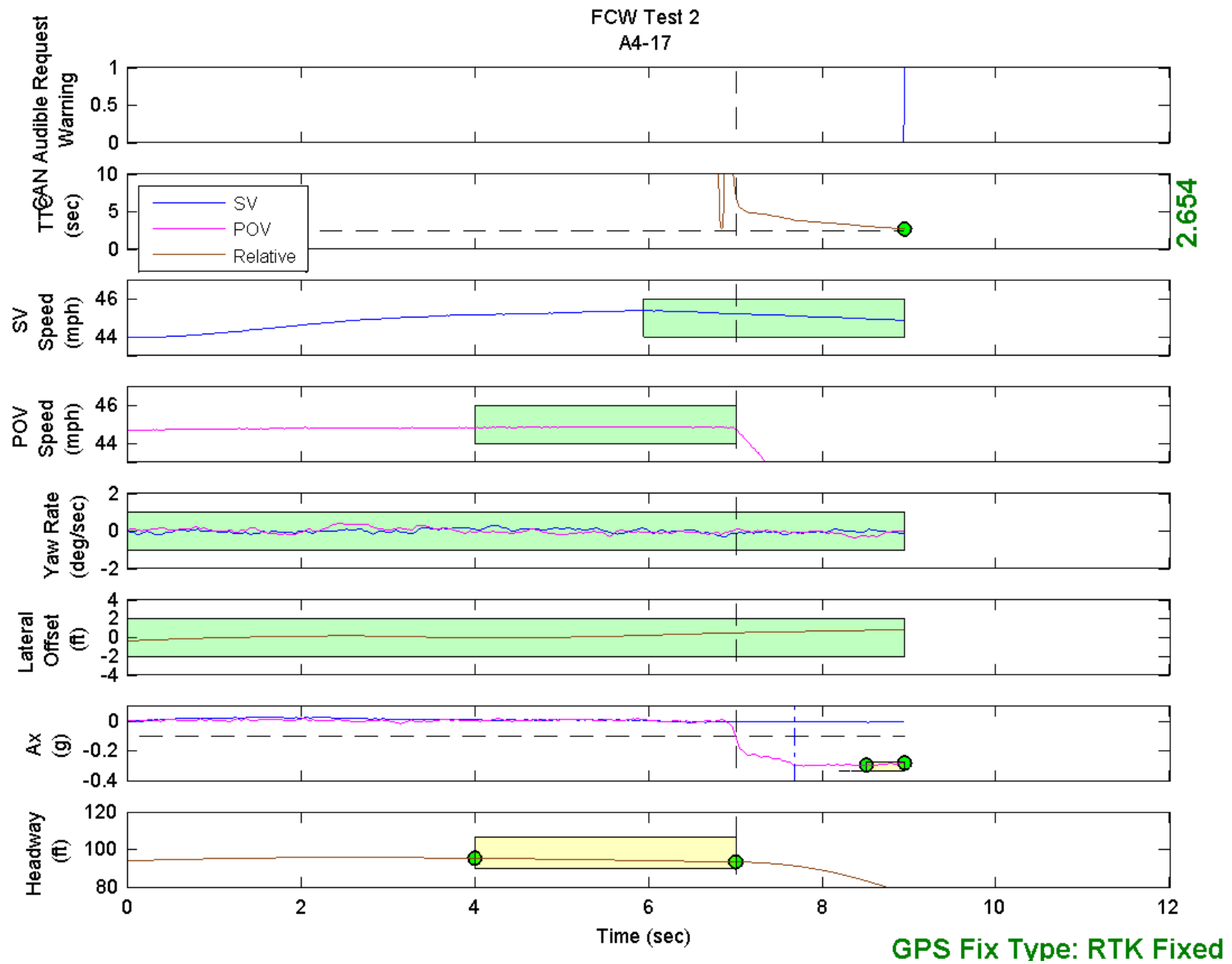


Figure D36. Time History for Run 17, FCW Test 2, CAN Audible Warning Request

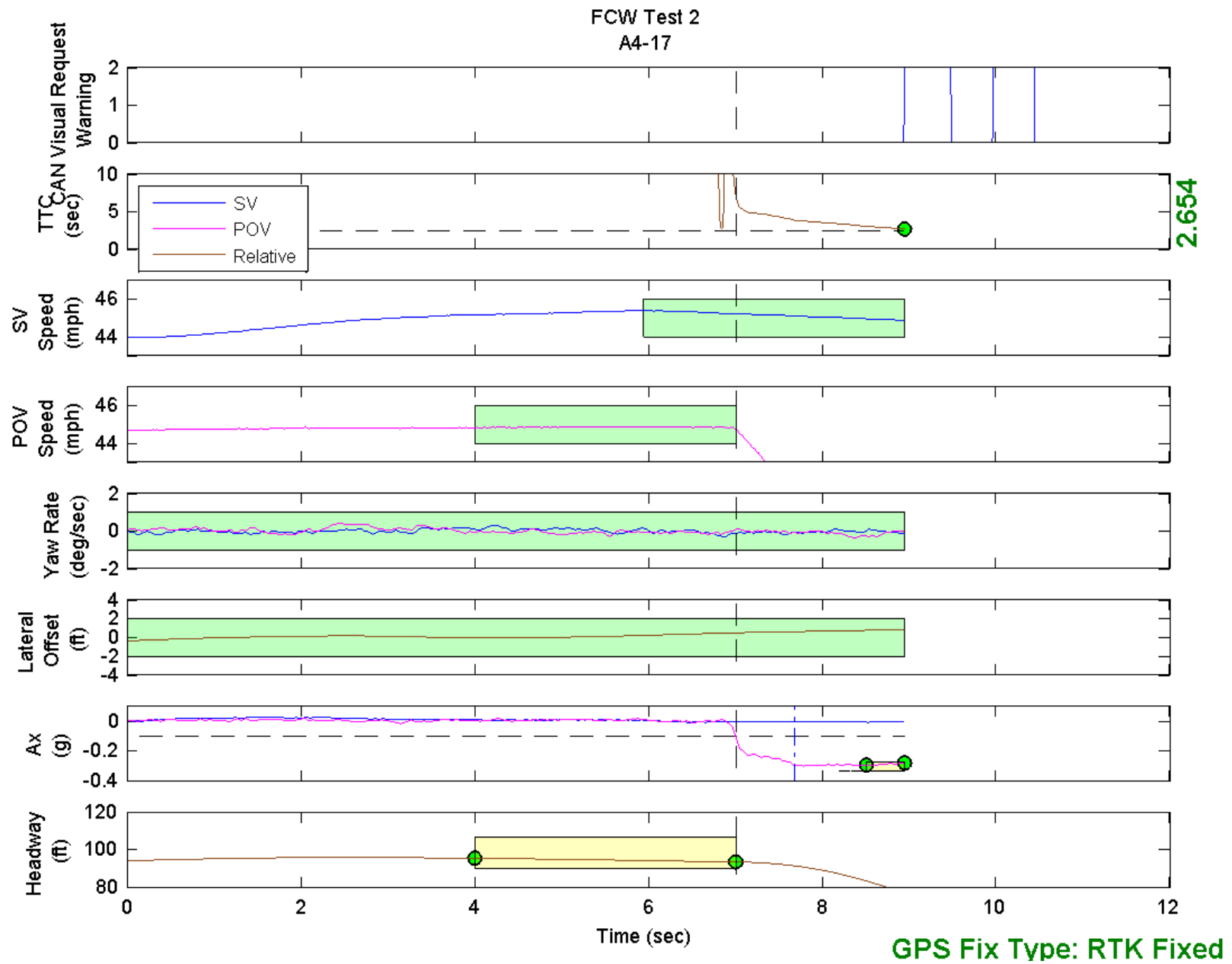


Figure D37. Time History for Run 17, FCW Test 2, CAN Visual Warning Request

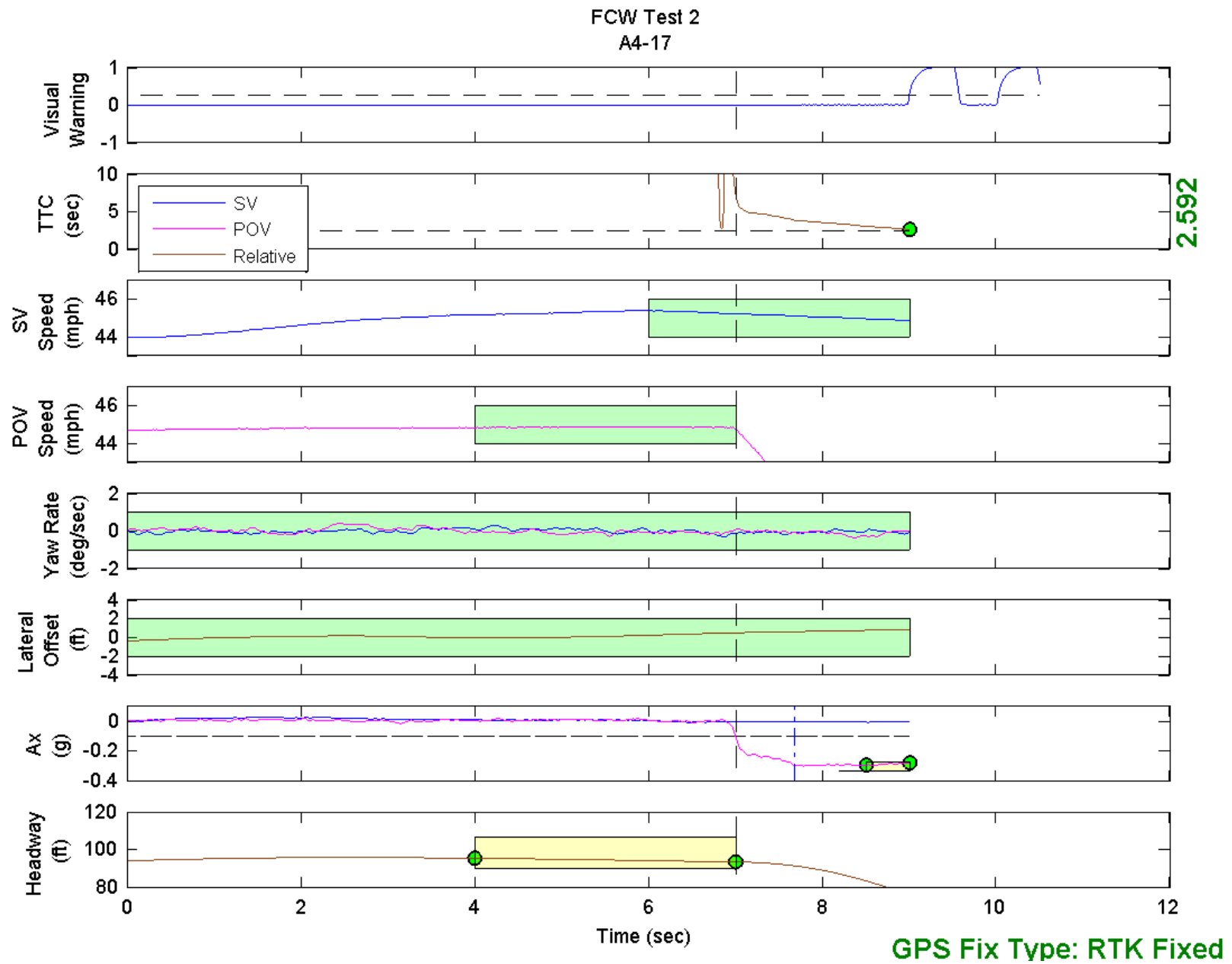
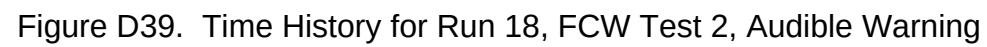


Figure D38. Time History for Run 17, FCW Test 2, Visual Warning



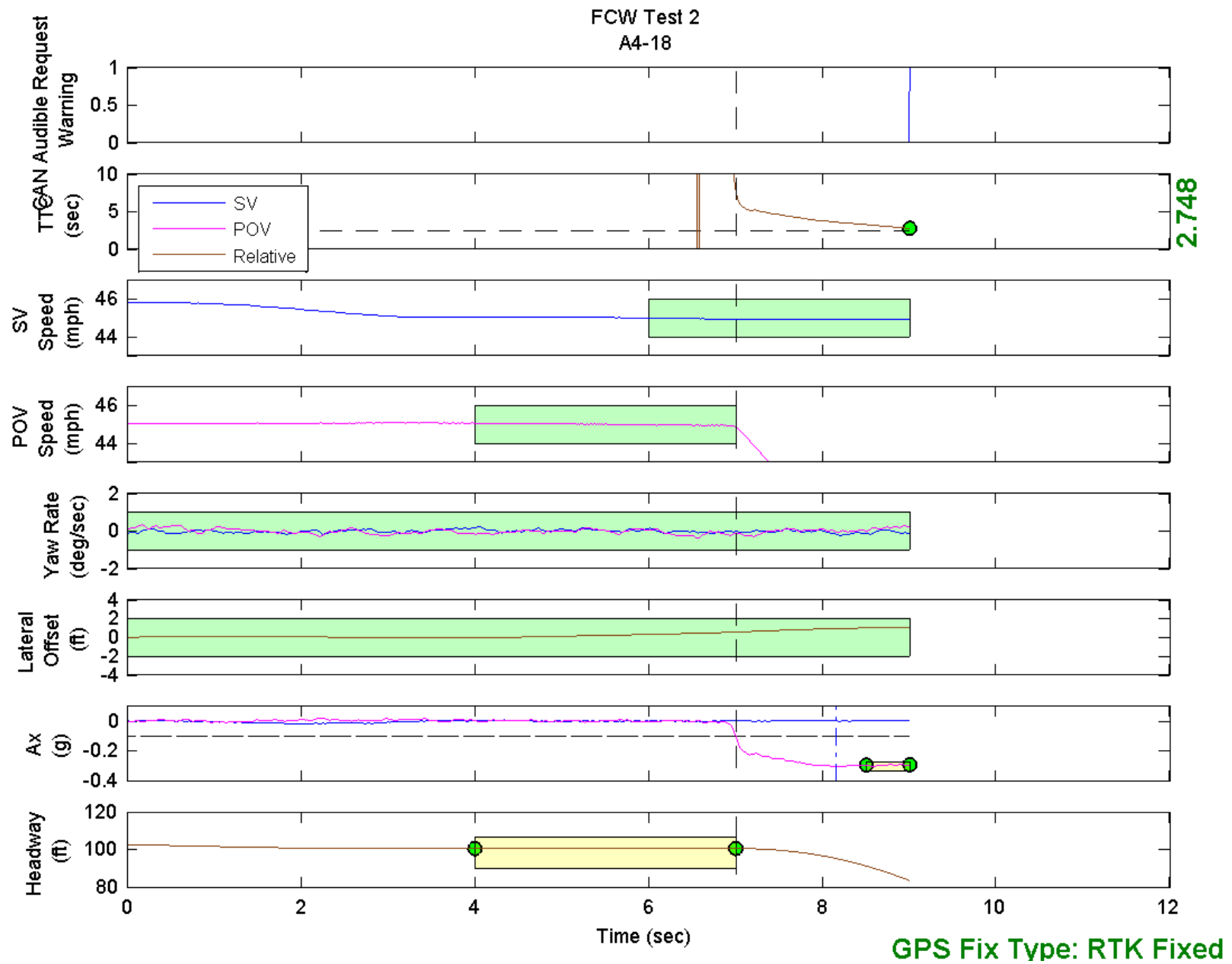


Figure D40. Time History for Run 18, FCW Test 2, CAN Audible Warning Request

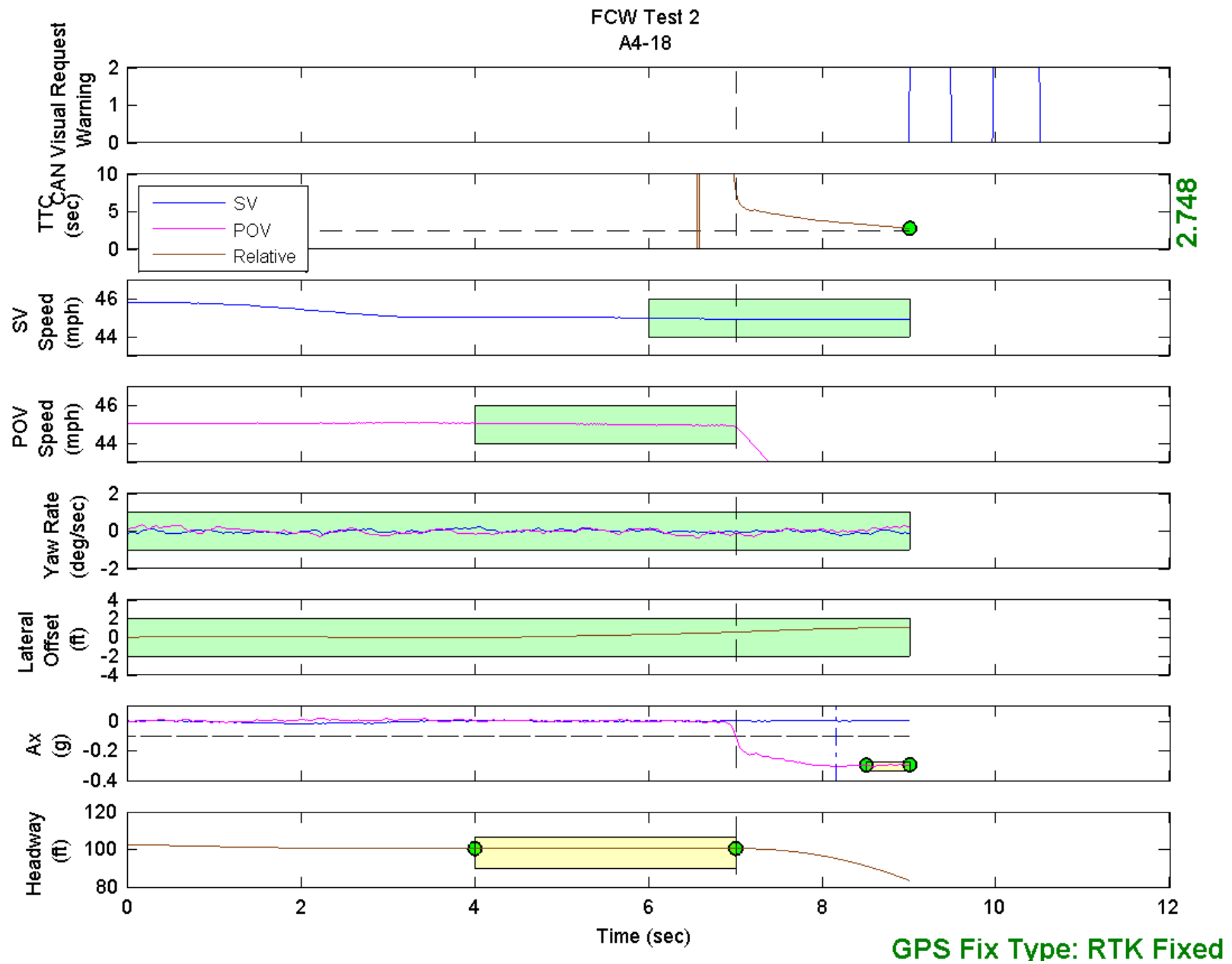


Figure D41. Time History for Run 18, FCW Test 2, CAN Visual Warning Request

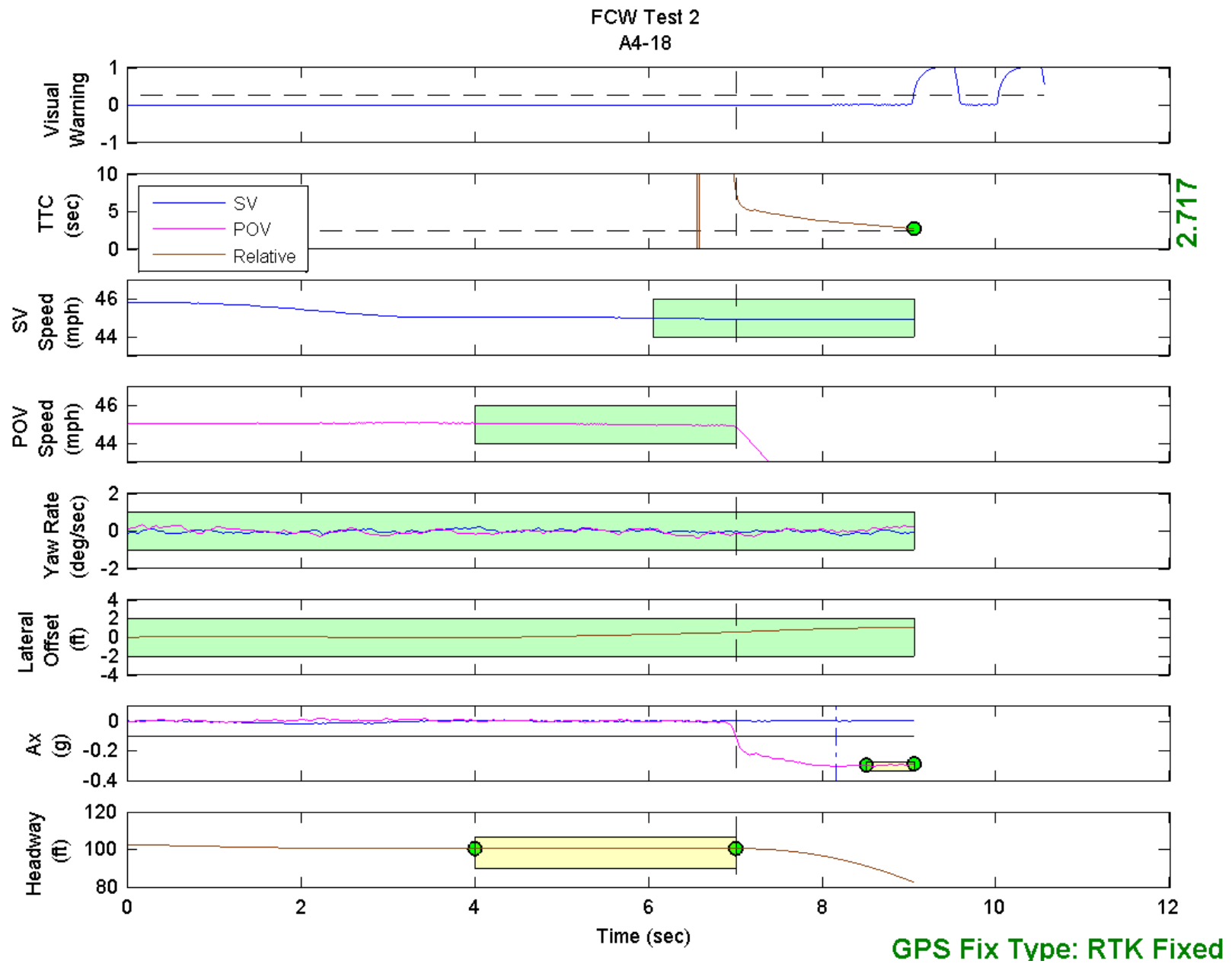


Figure D42. Time History for Run 18, FCW Test 2, Visual Warning

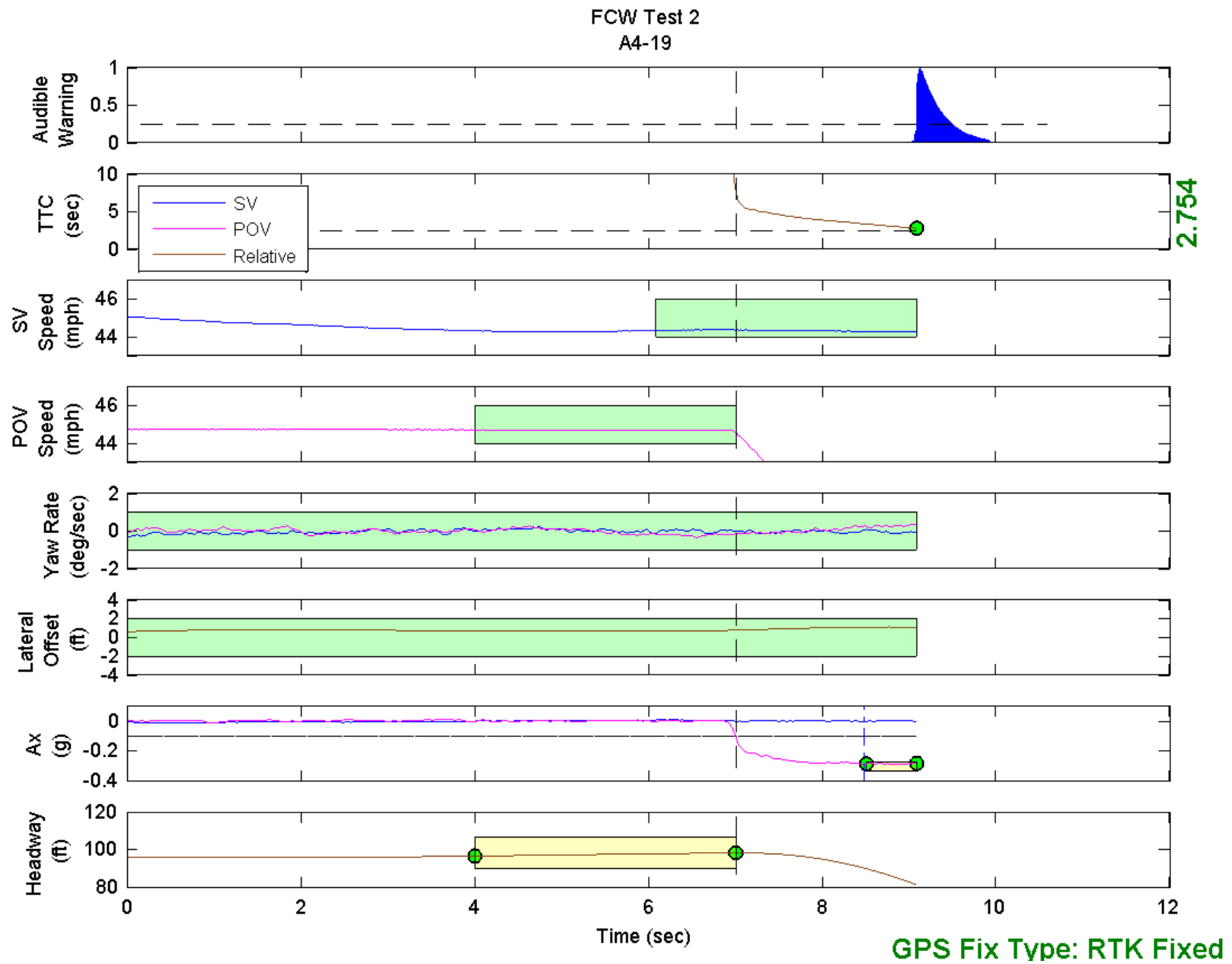


Figure D43. Time History for Run 19, FCW Test 2, Audible Warning

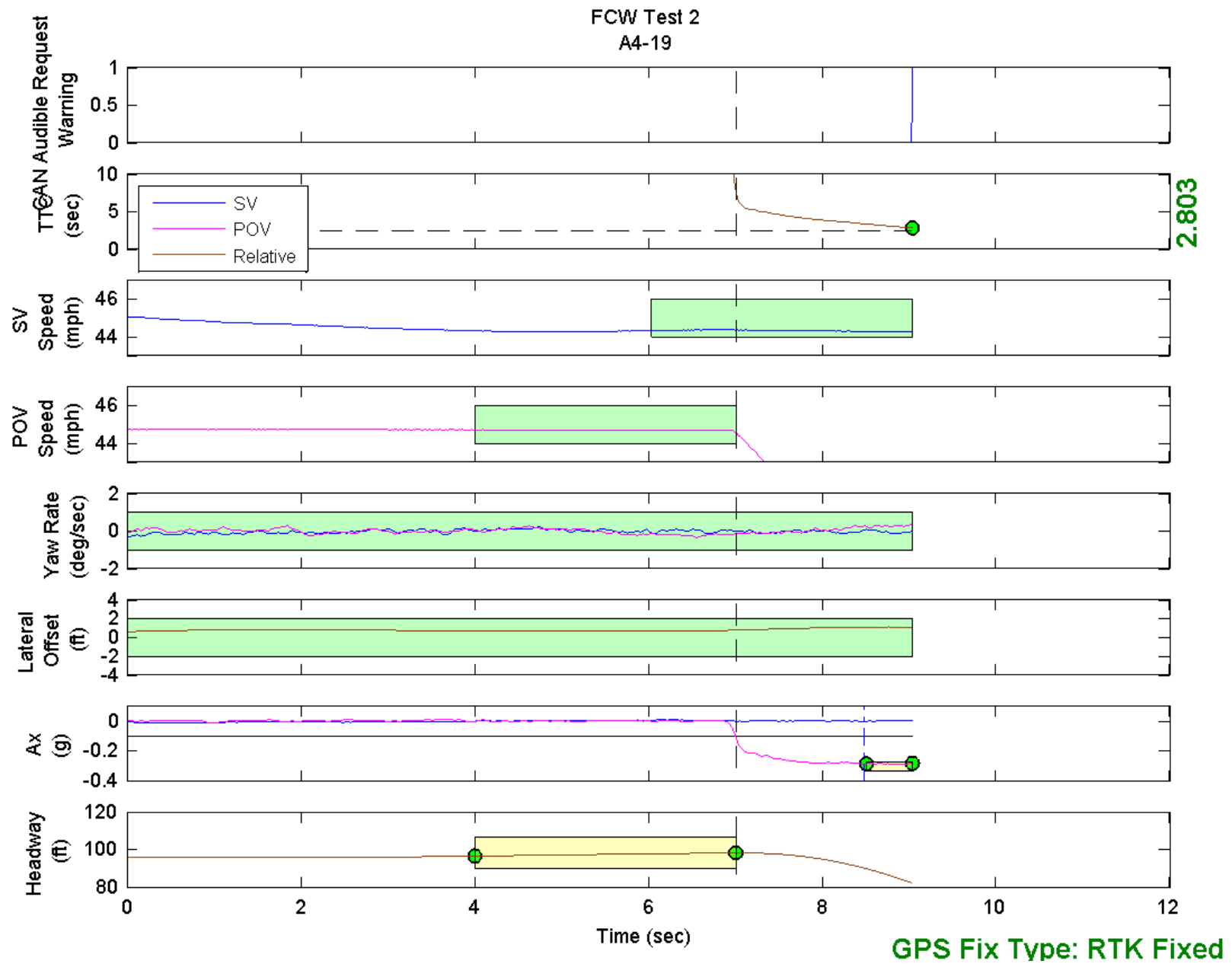


Figure D44. Time History for Run 19, FCW Test 2, CAN Audible Warning Request

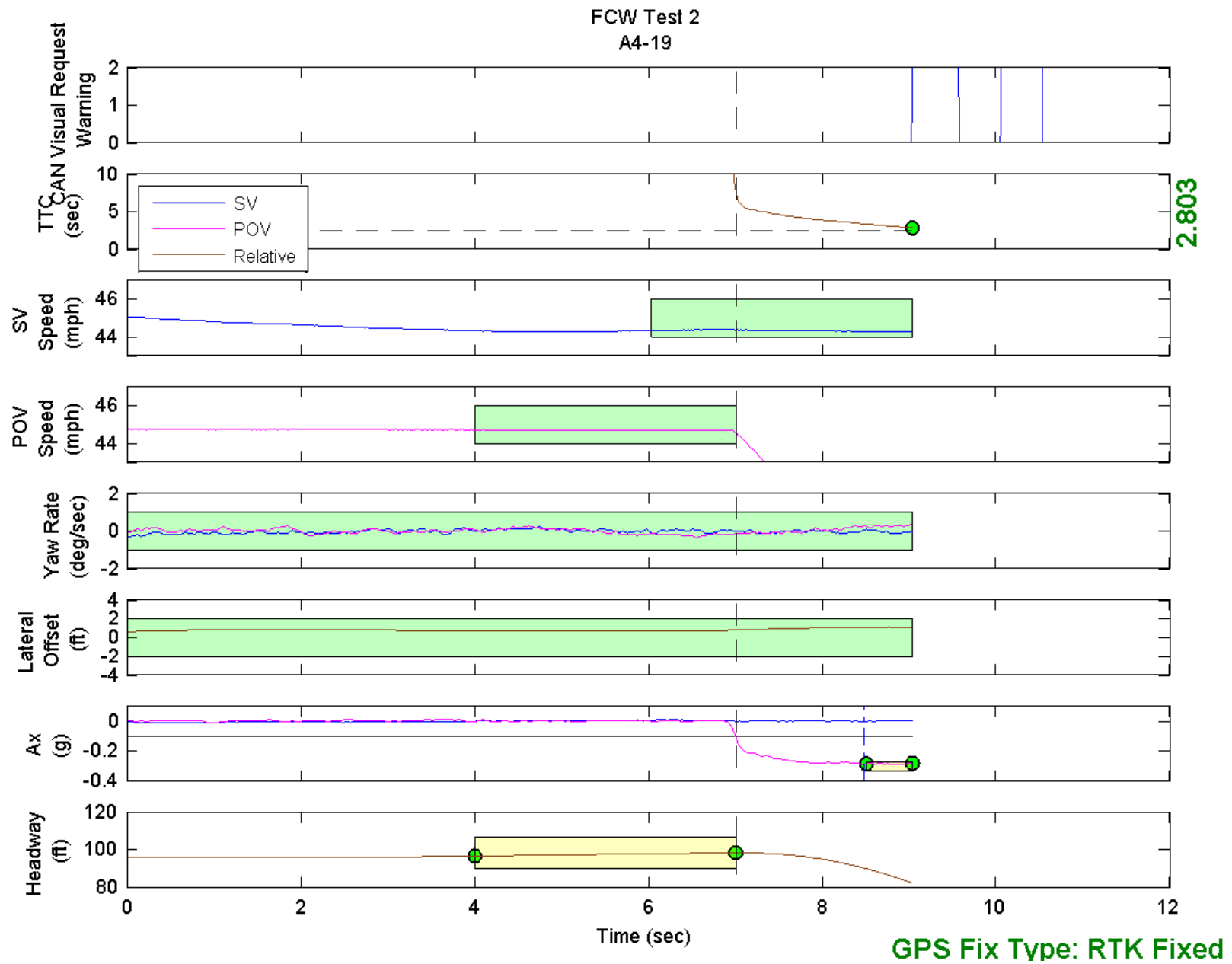


Figure D45. Time History for Run 19, FCW Test 2, CAN Visual Warning Request

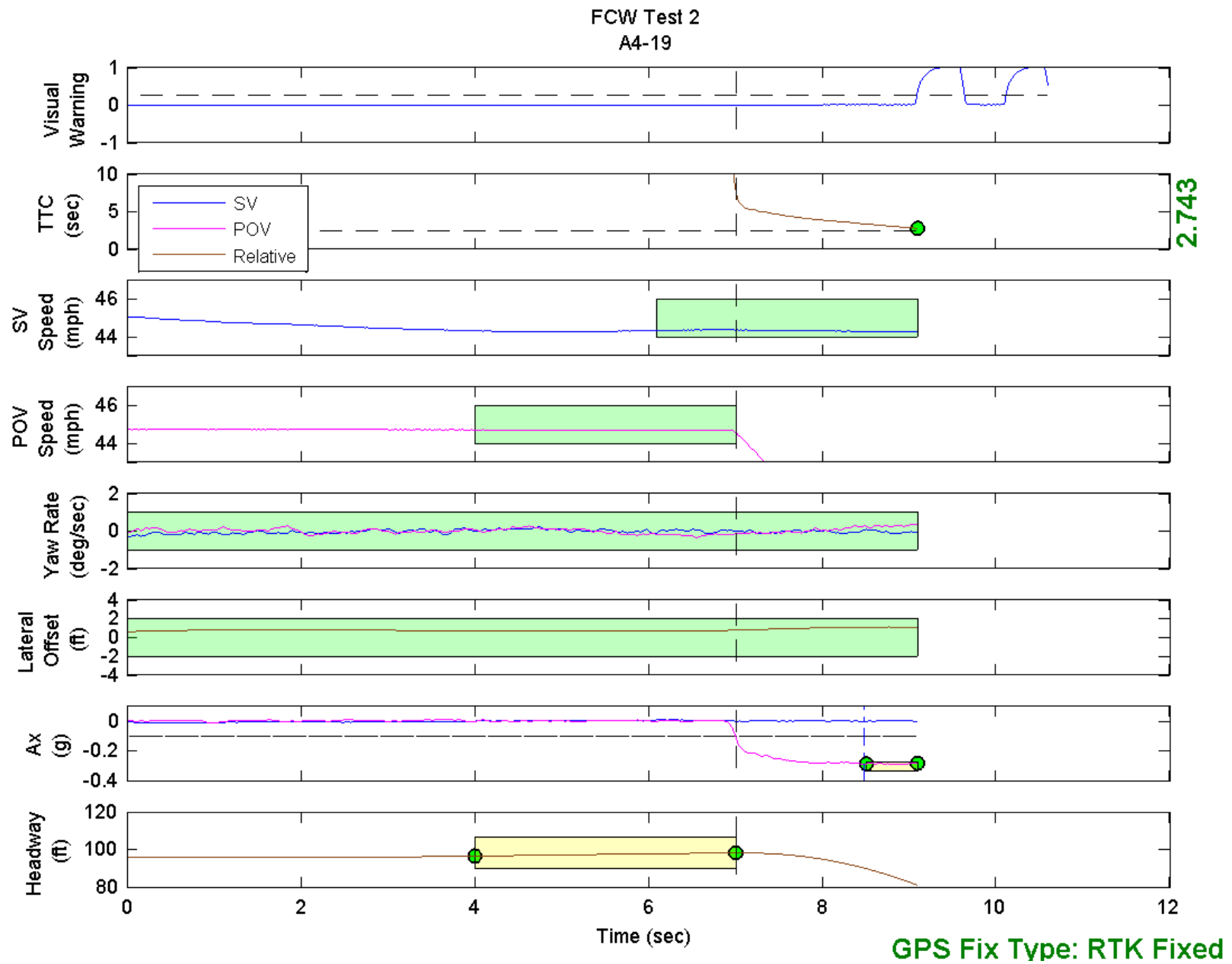


Figure D46. Time History for Run 19, FCW Test 2, Visual Warning

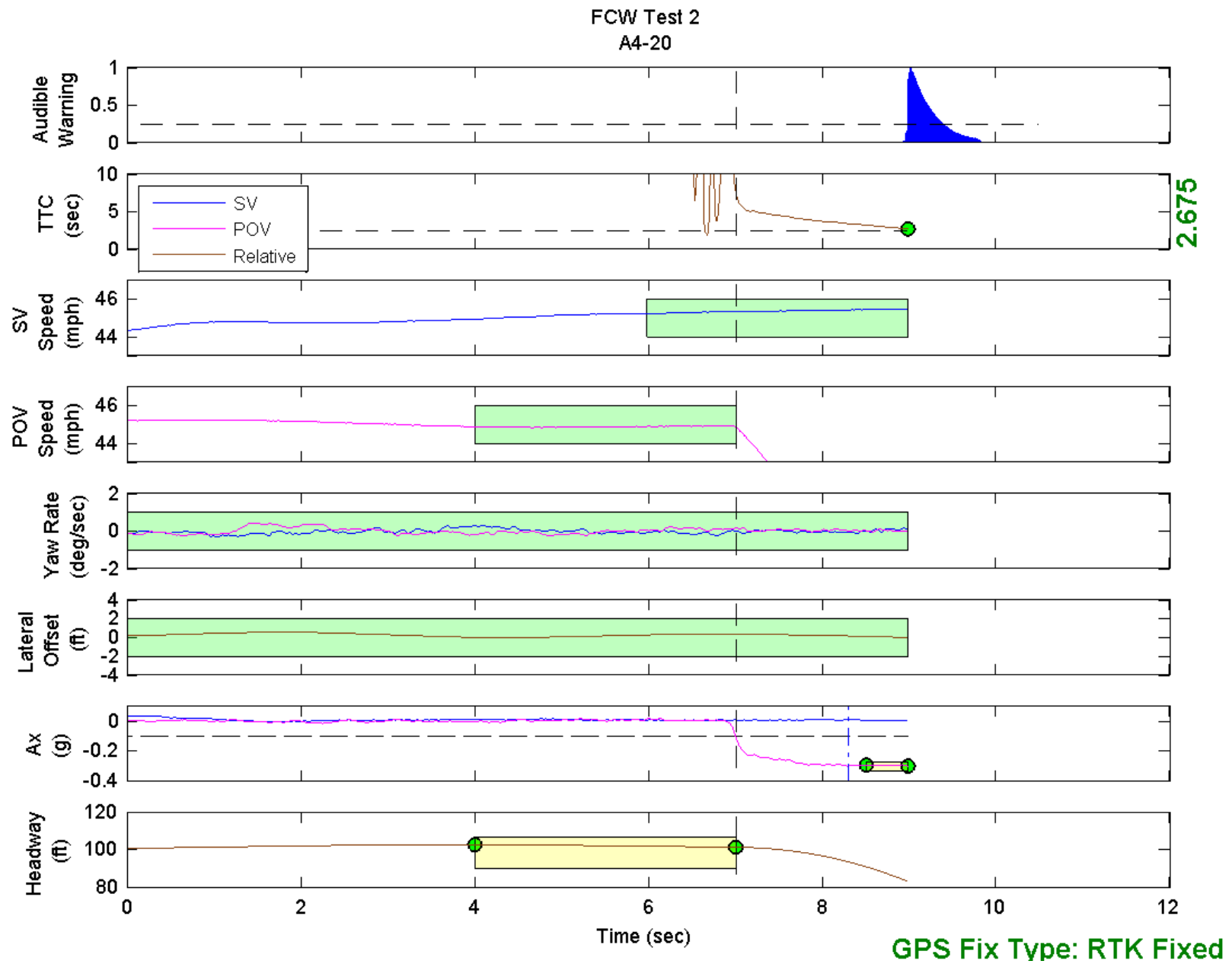


Figure D47. Time History for Run 20, FCW Test 2, Audible Warning

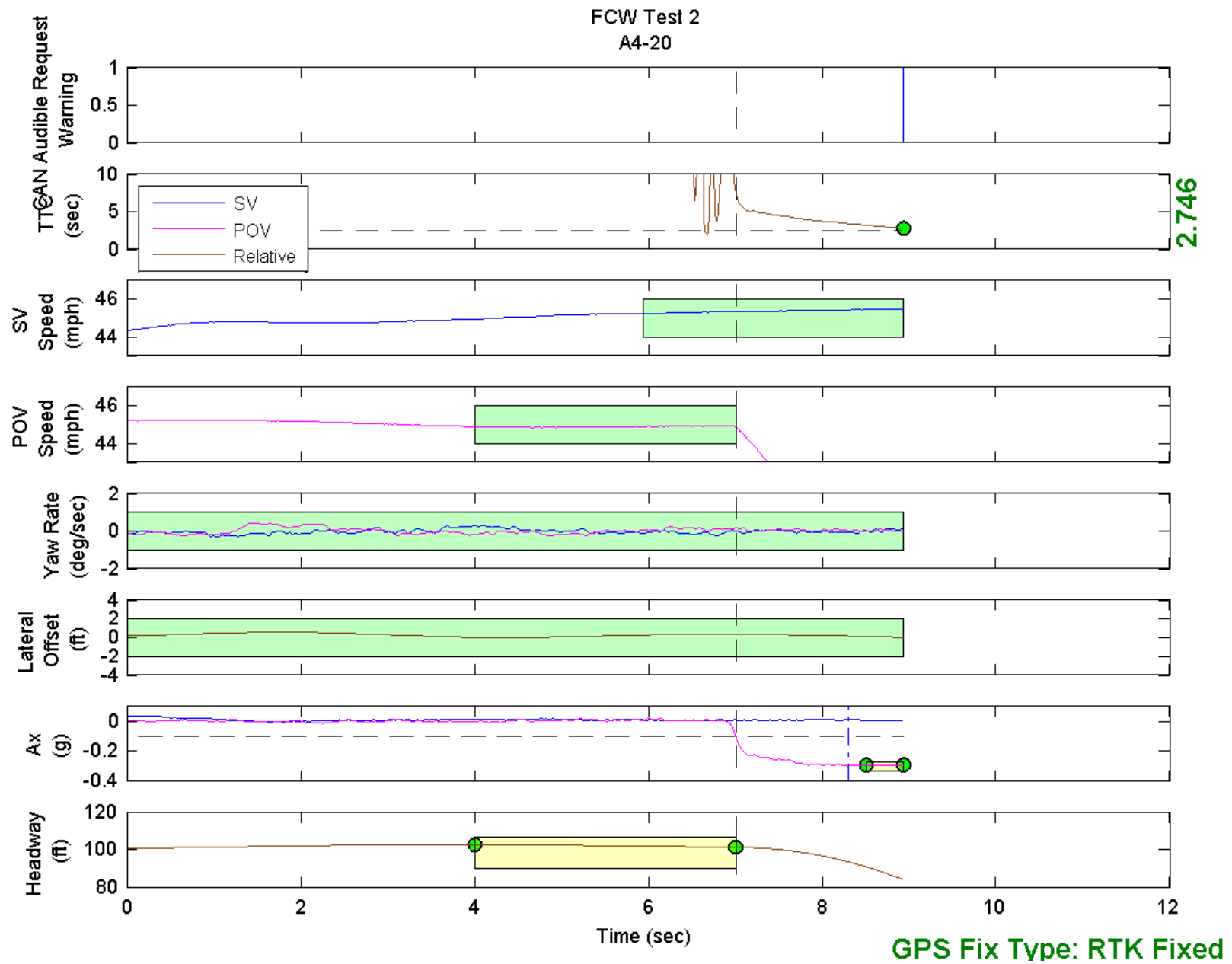


Figure D48. Time History for Run 20, FCW Test 2, CAN Audible Warning Request

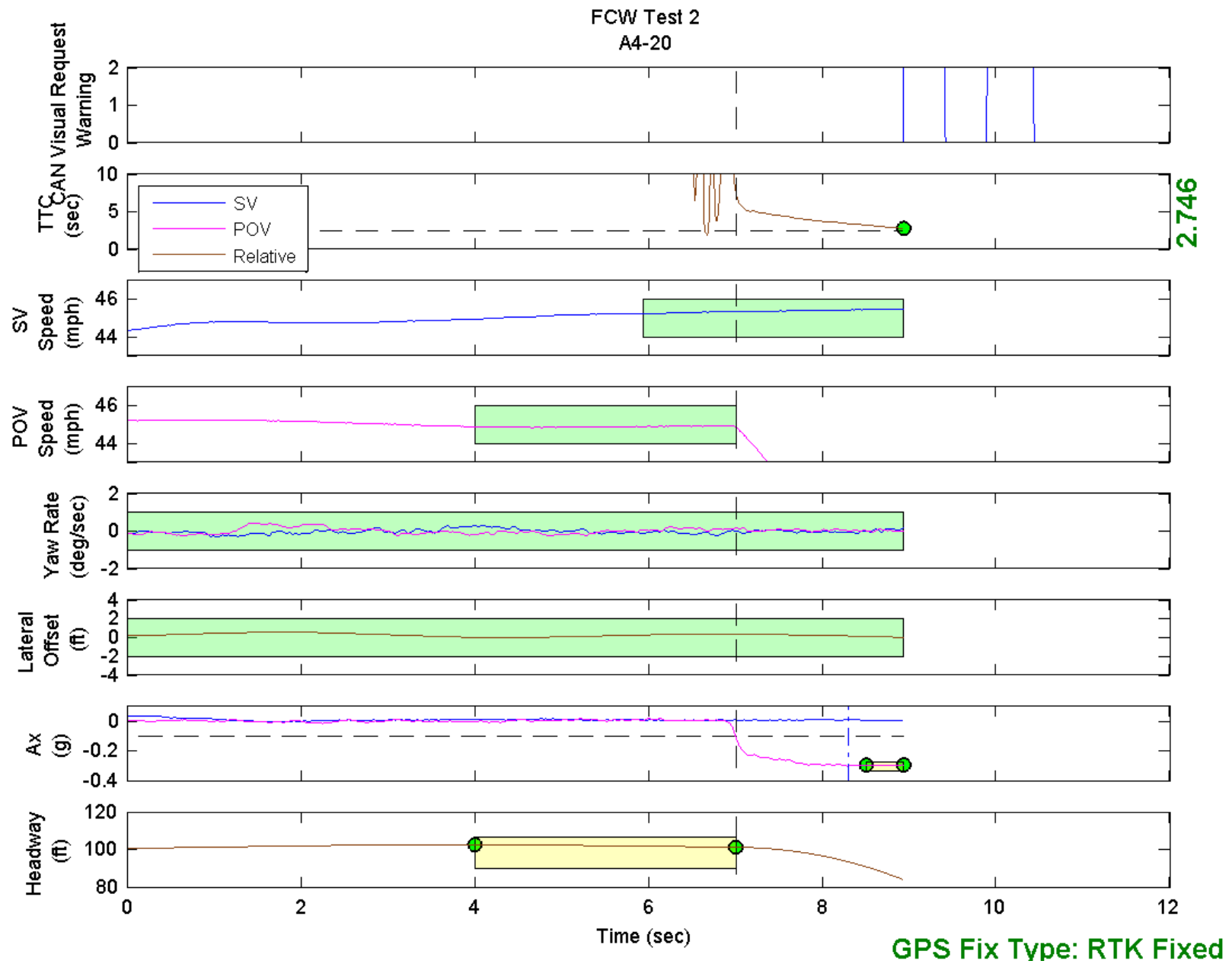


Figure D49. Time History for Run 20, FCW Test 2, CAN Visual Warning Request

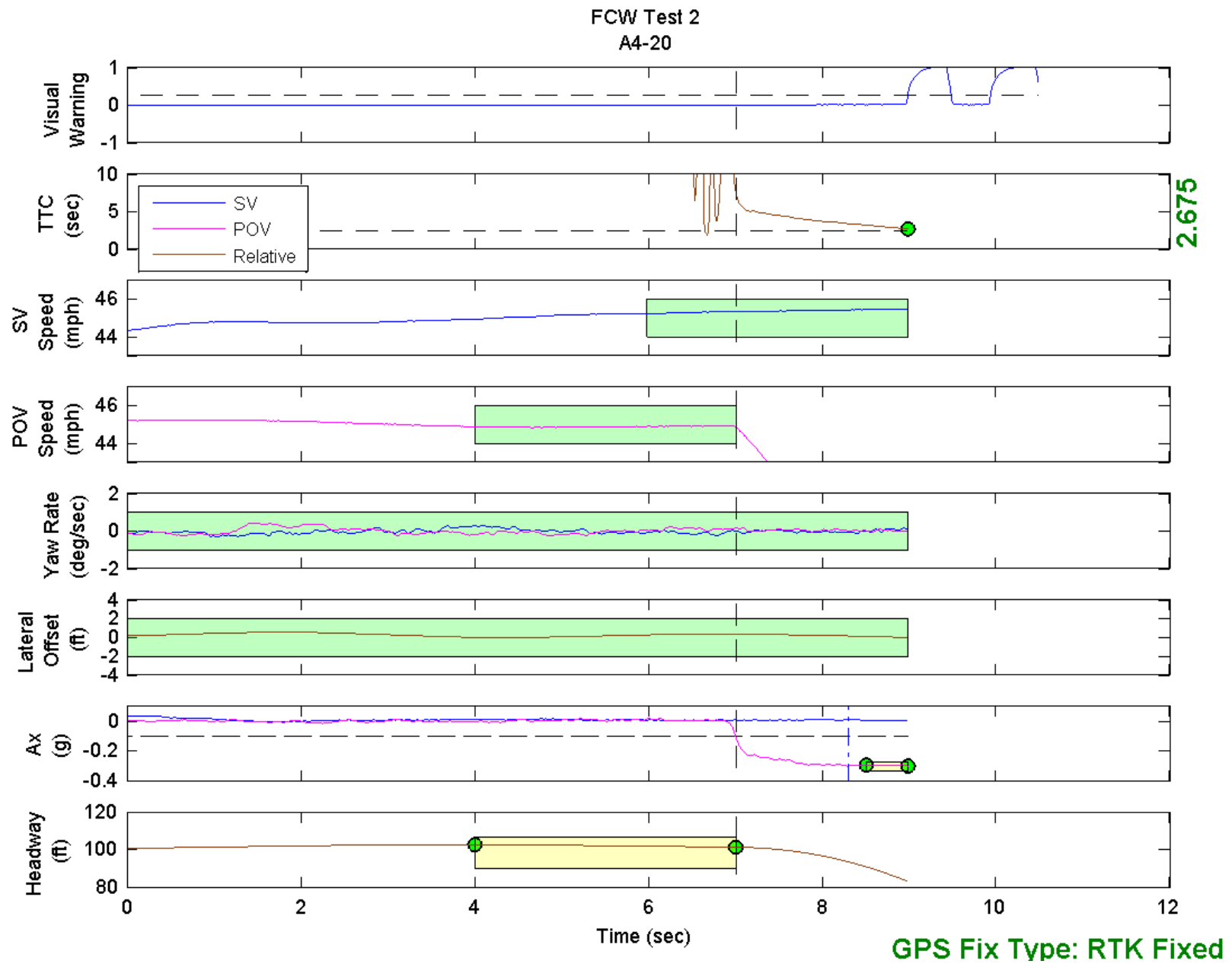


Figure D50. Time History for Run 20, FCW Test 2, Visual Warning

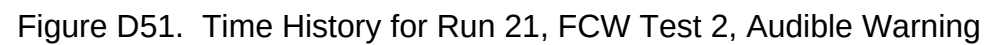


Figure D52. Time History for Run 21, FCW Test 2, CAN Audible Warning Request

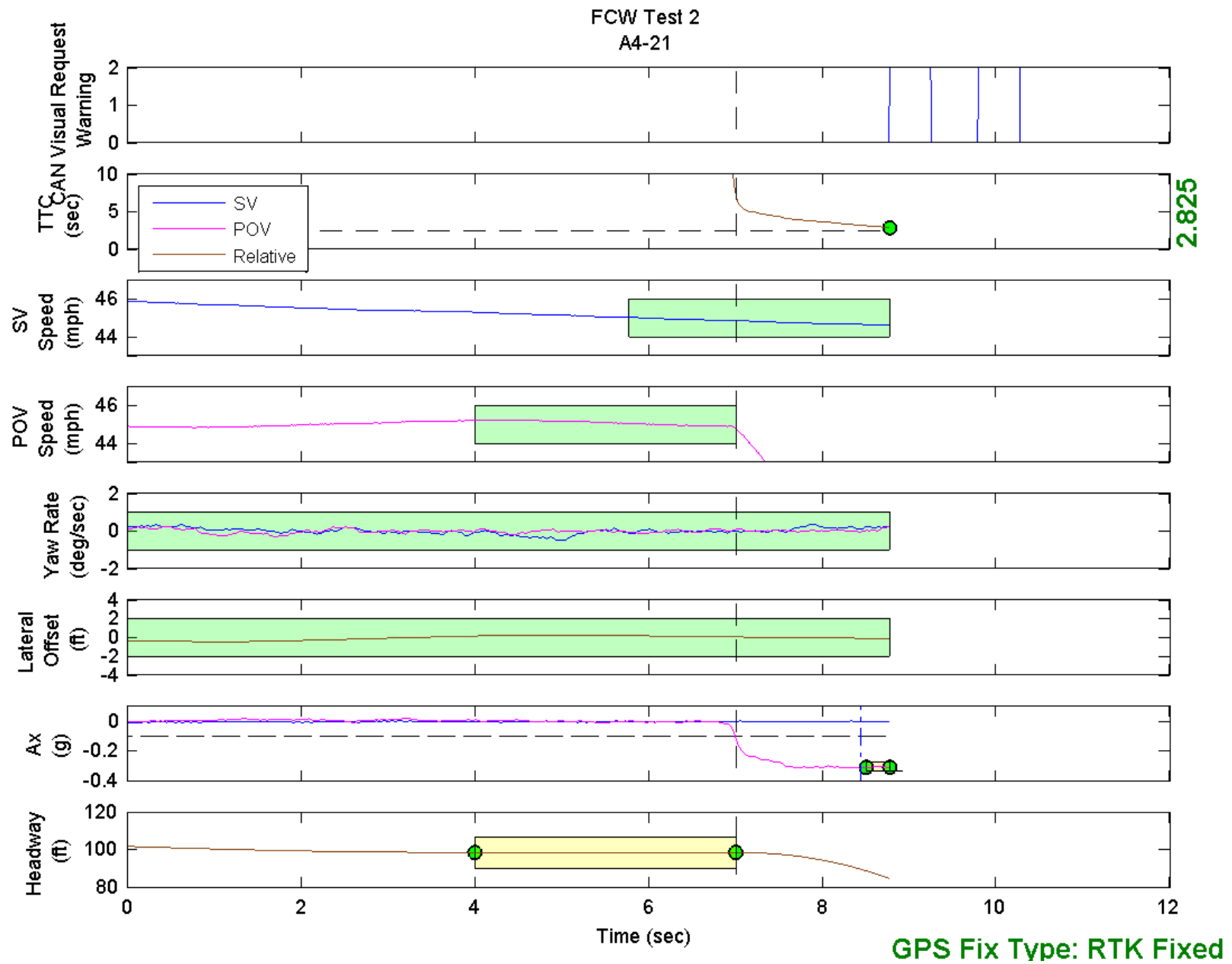


Figure D53. Time History for Run 21, FCW Test 2, CAN Visual Warning Request

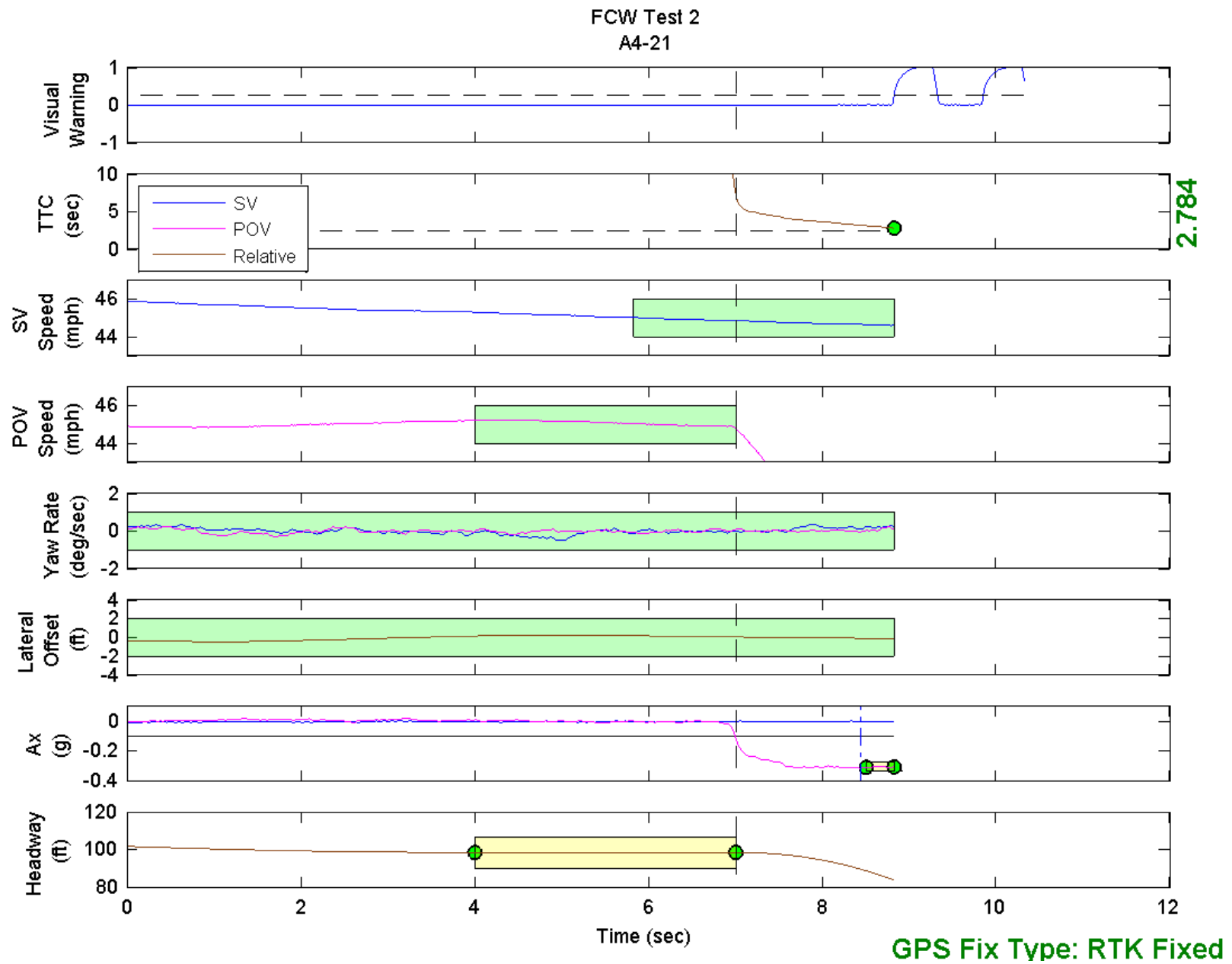
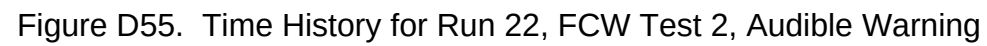


Figure D54. Time History for Run 21, FCW Test 2, Visual Warning



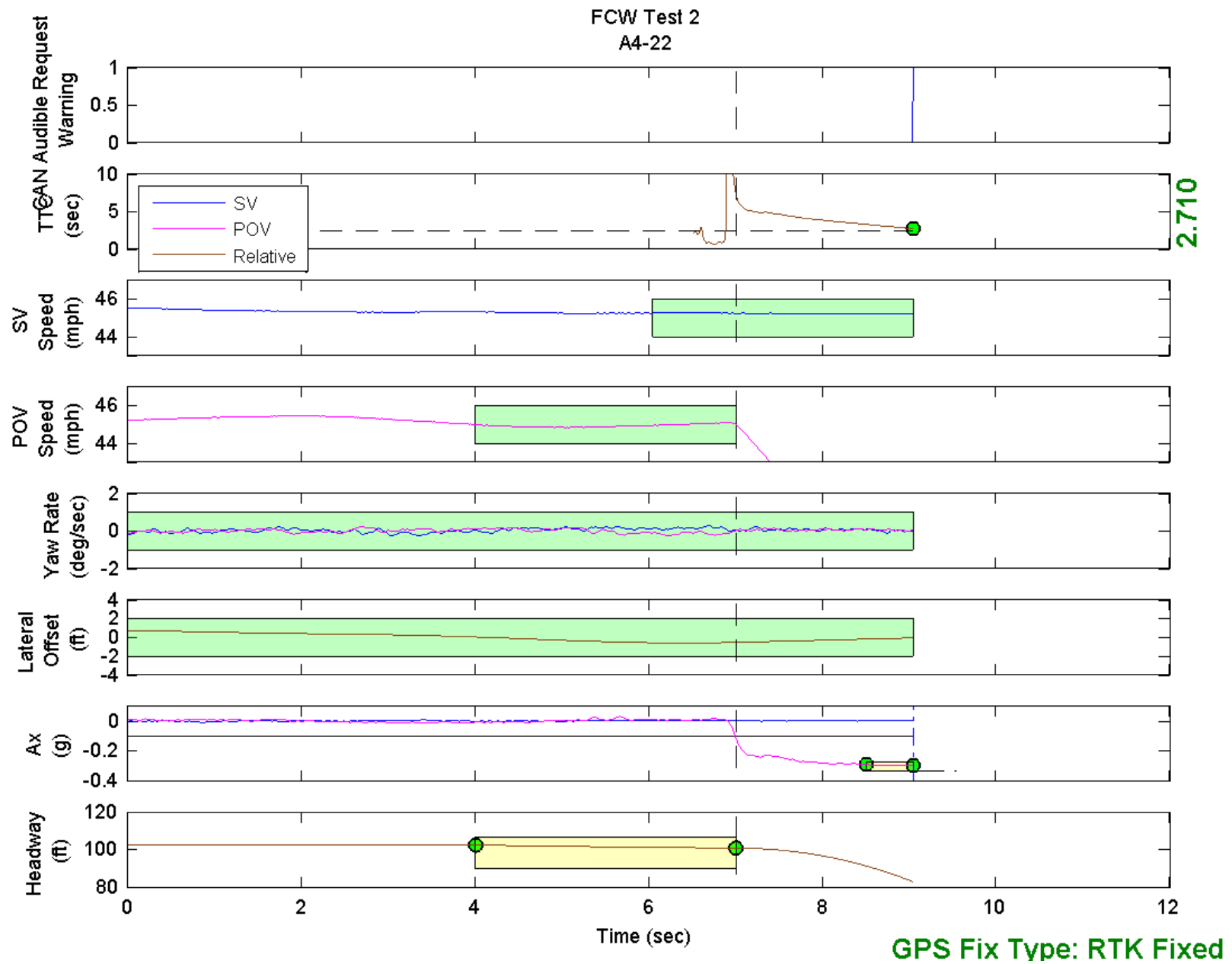


Figure D56. Time History for Run 22, FCW Test 2, CAN Audible Warning Request

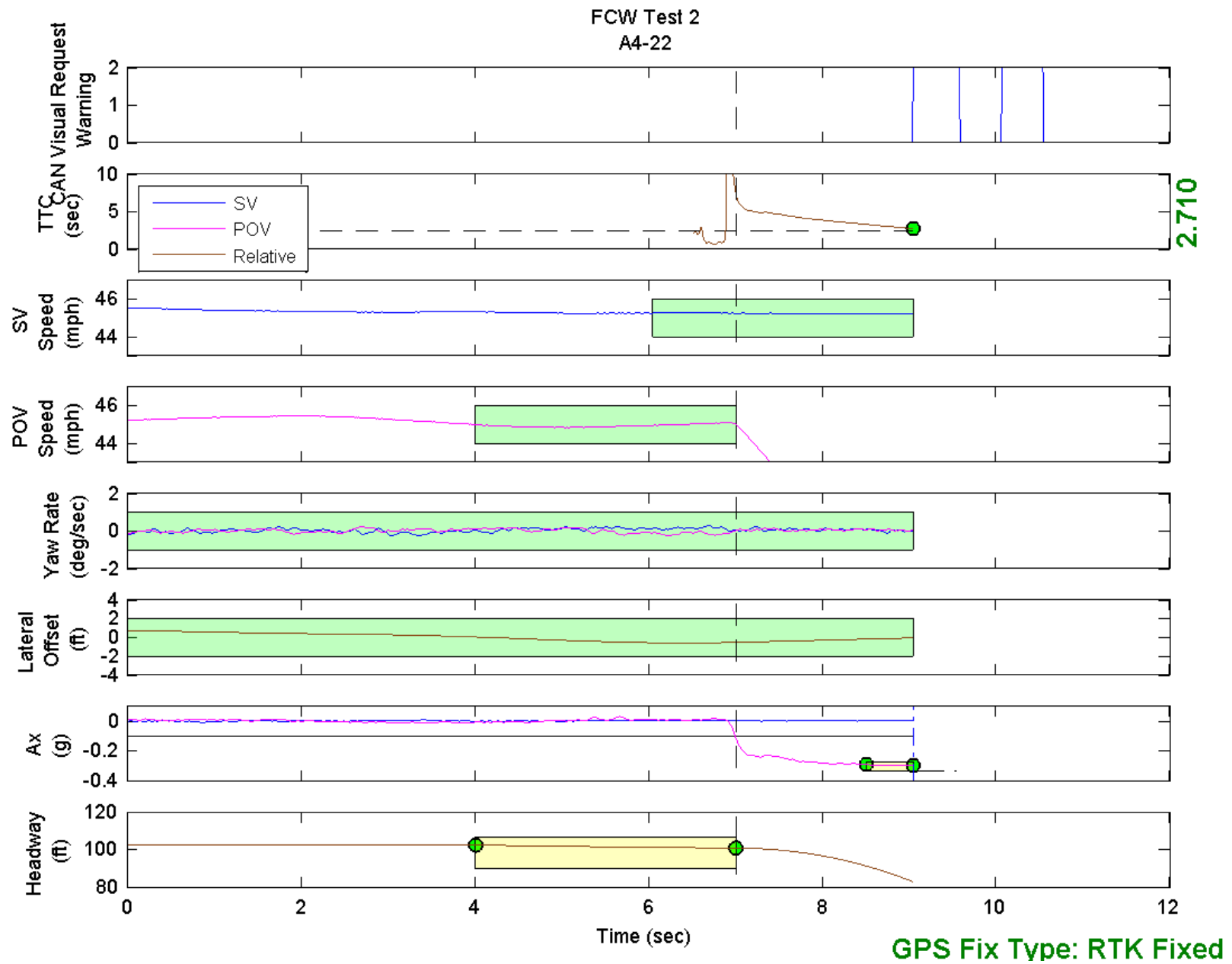
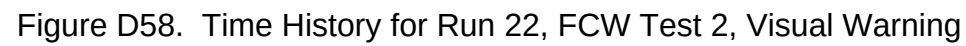
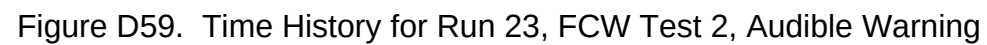


Figure D57. Time History for Run 22, FCW Test 2, CAN Visual Warning Request





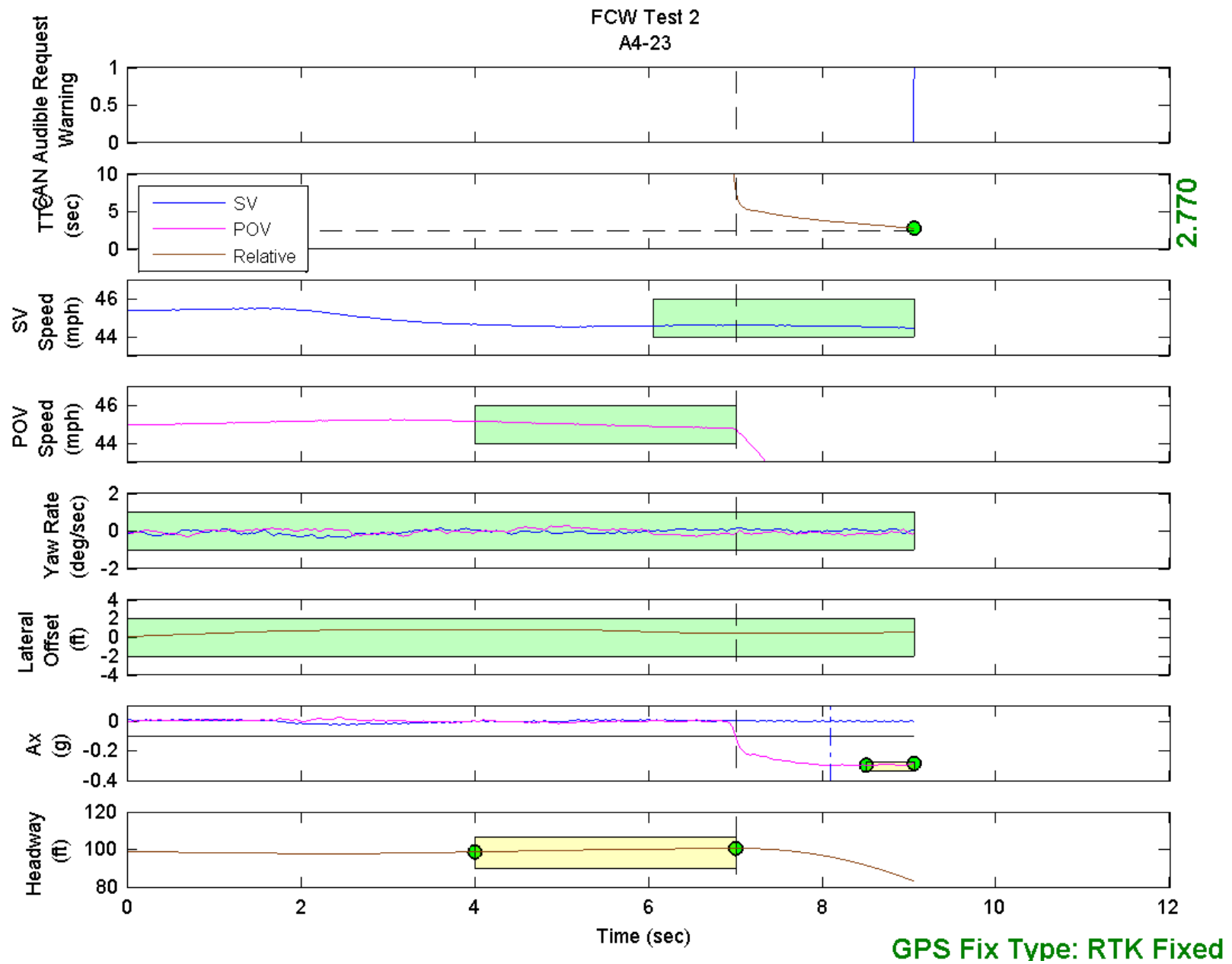


Figure D60. Time History for Run 23, FCW Test 2, CAN Audible Warning Request

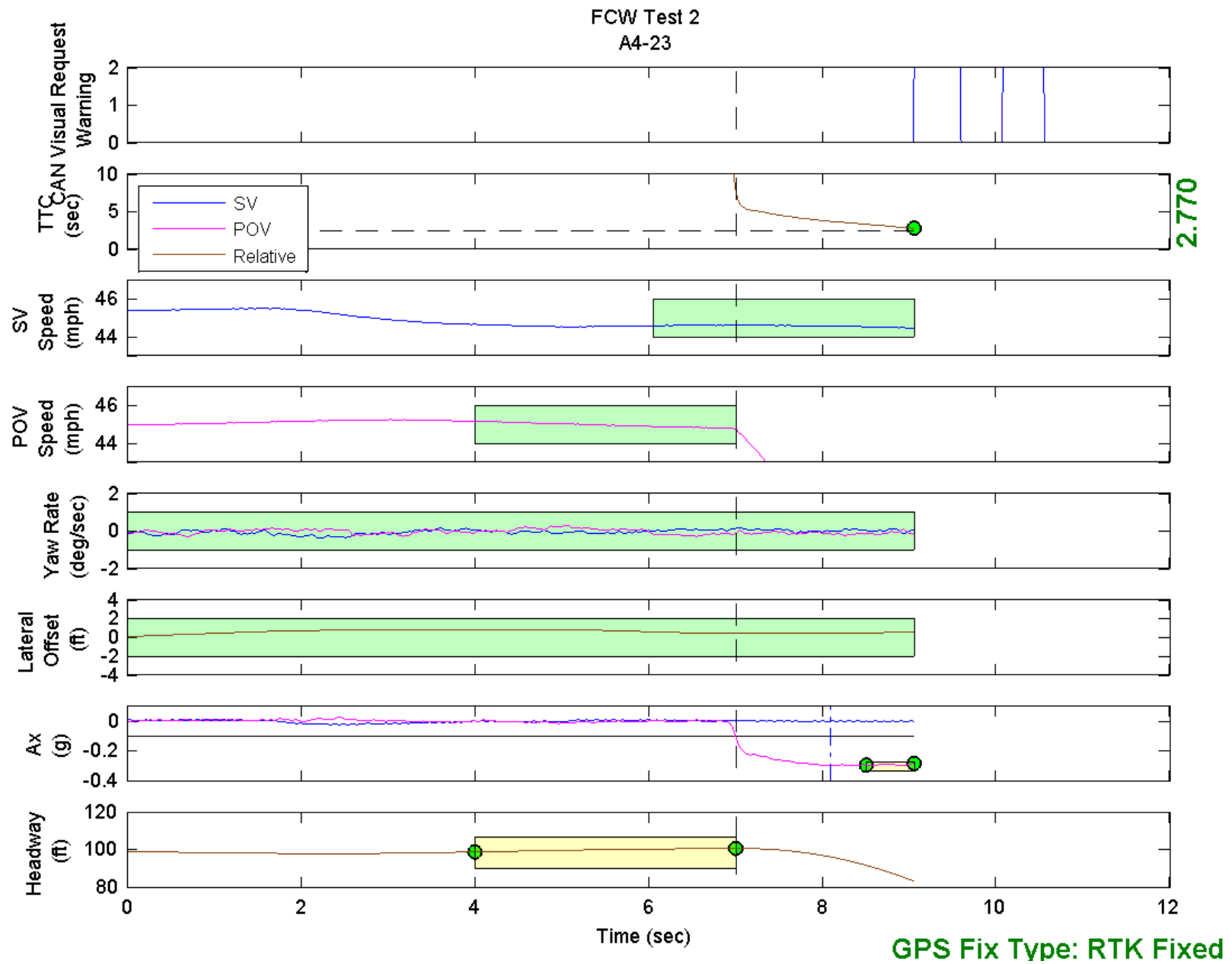


Figure D61. Time History for Run 23, FCW Test 2, CAN Visual Warning Request

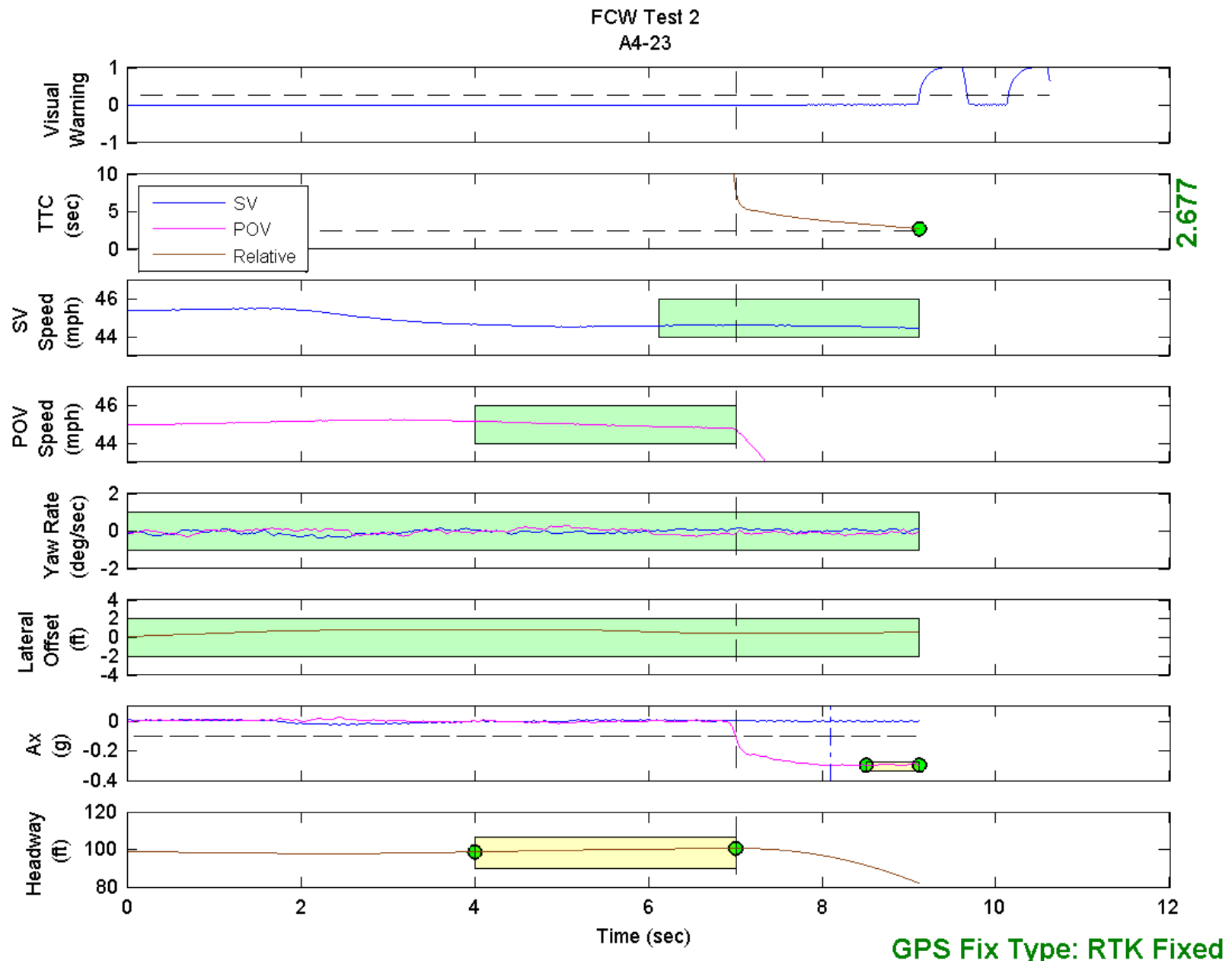


Figure D62. Time History for Run 23, FCW Test 2, Visual Warning

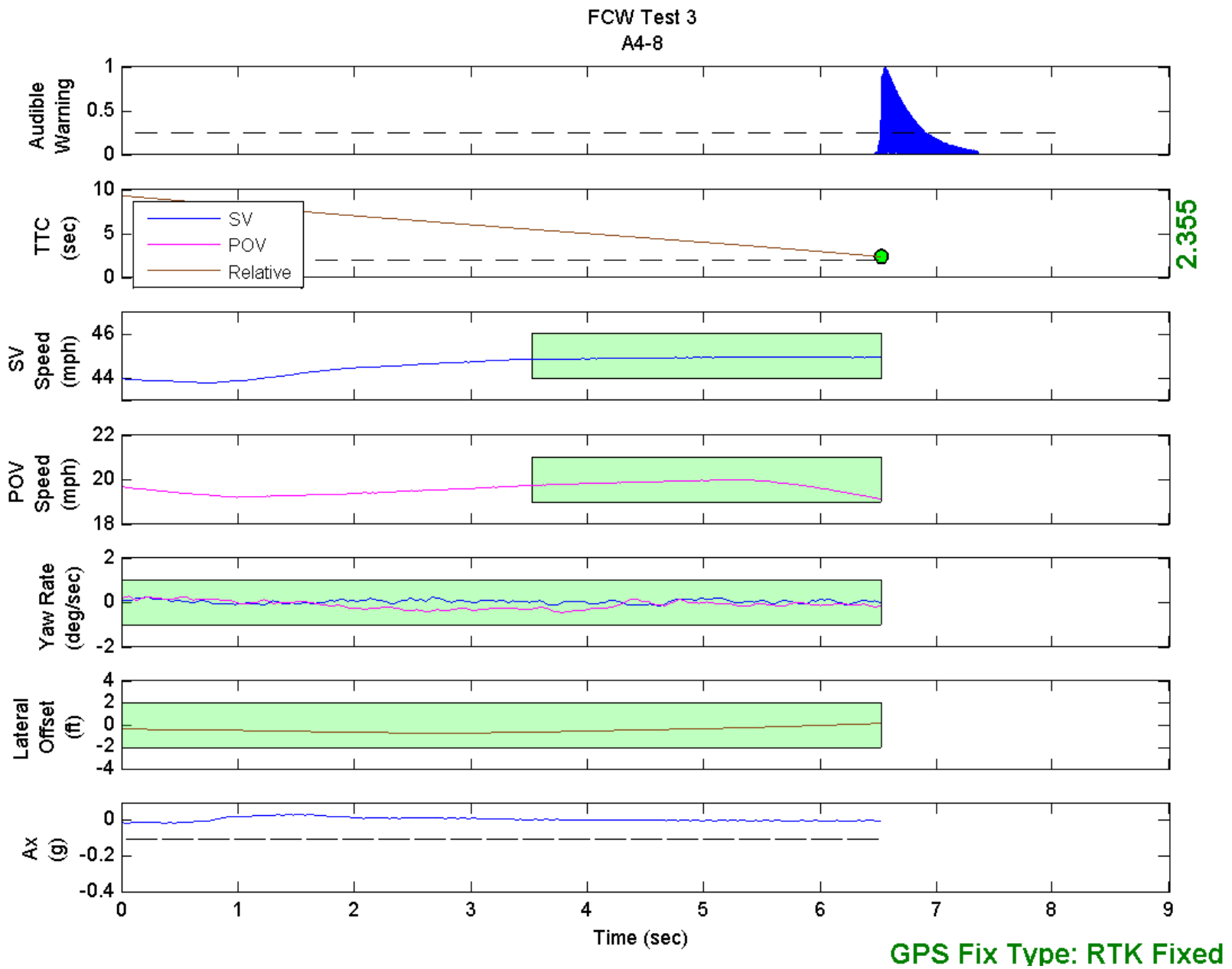


Figure D63. Time History for Run 8, FCW Test 3, Audible Warning

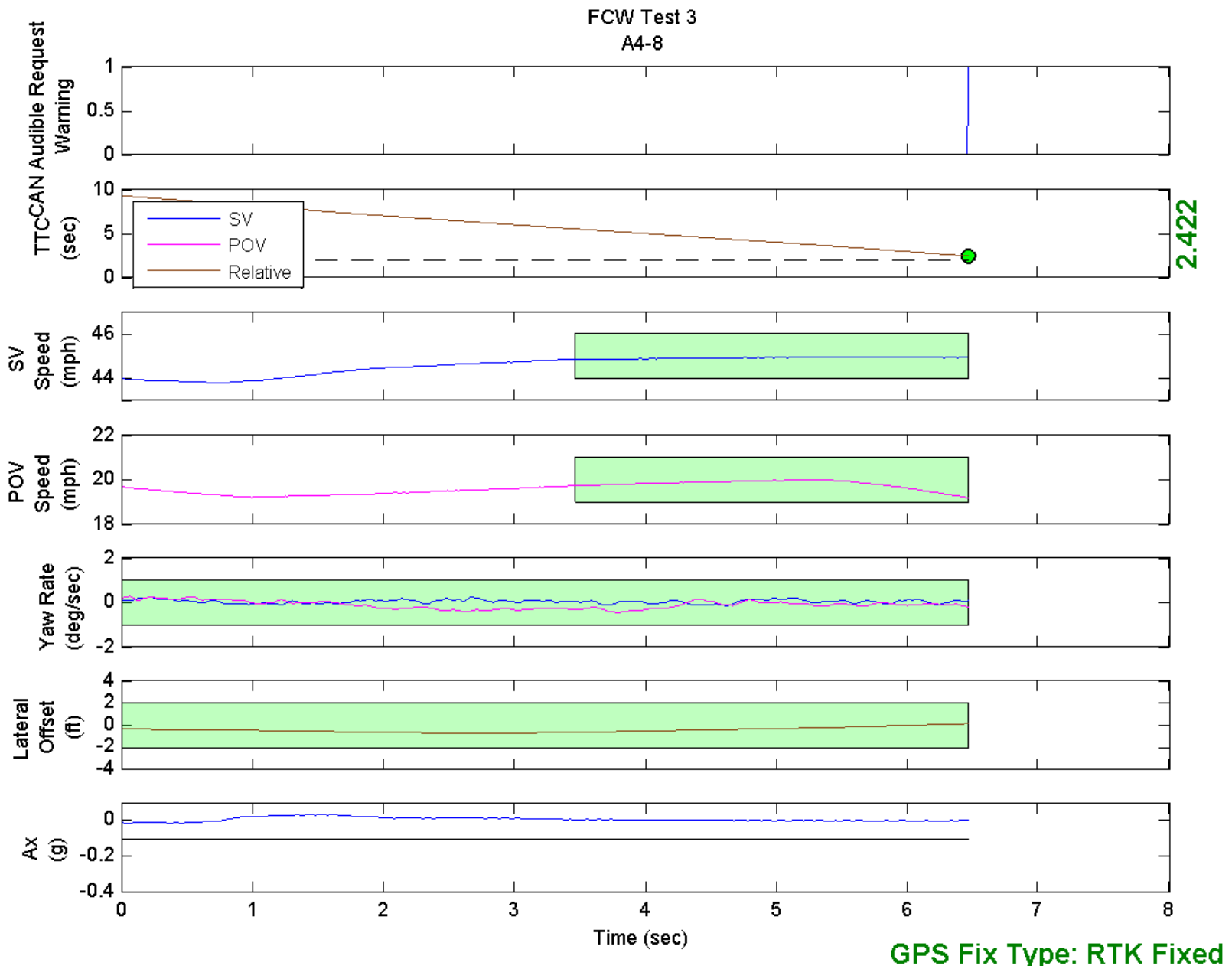


Figure D64. Time History for Run 8, FCW Test 3, CAN Audible Warning Request

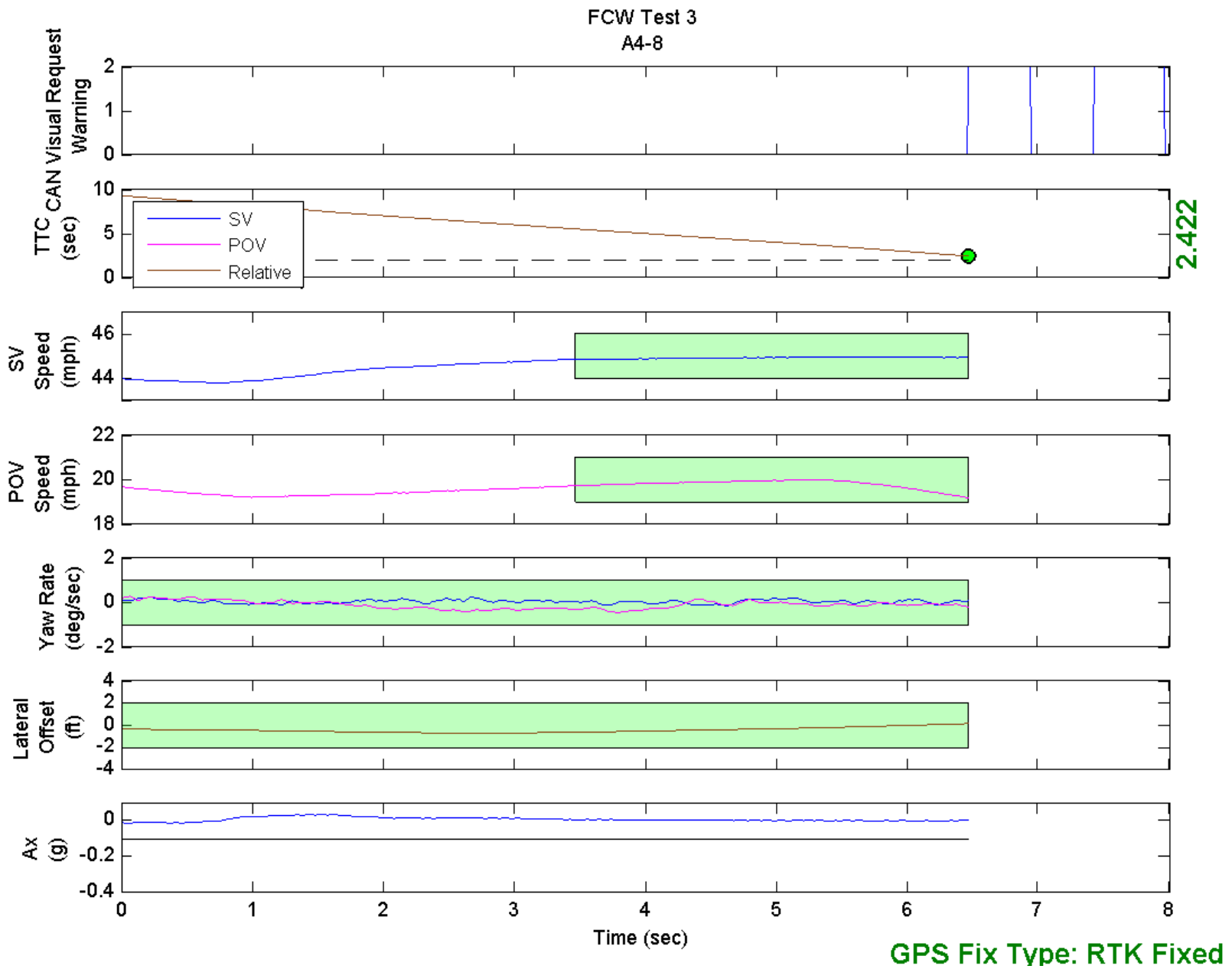


Figure D65. Time History for Run 8, FCW Test 3, CAN Visual Warning Request

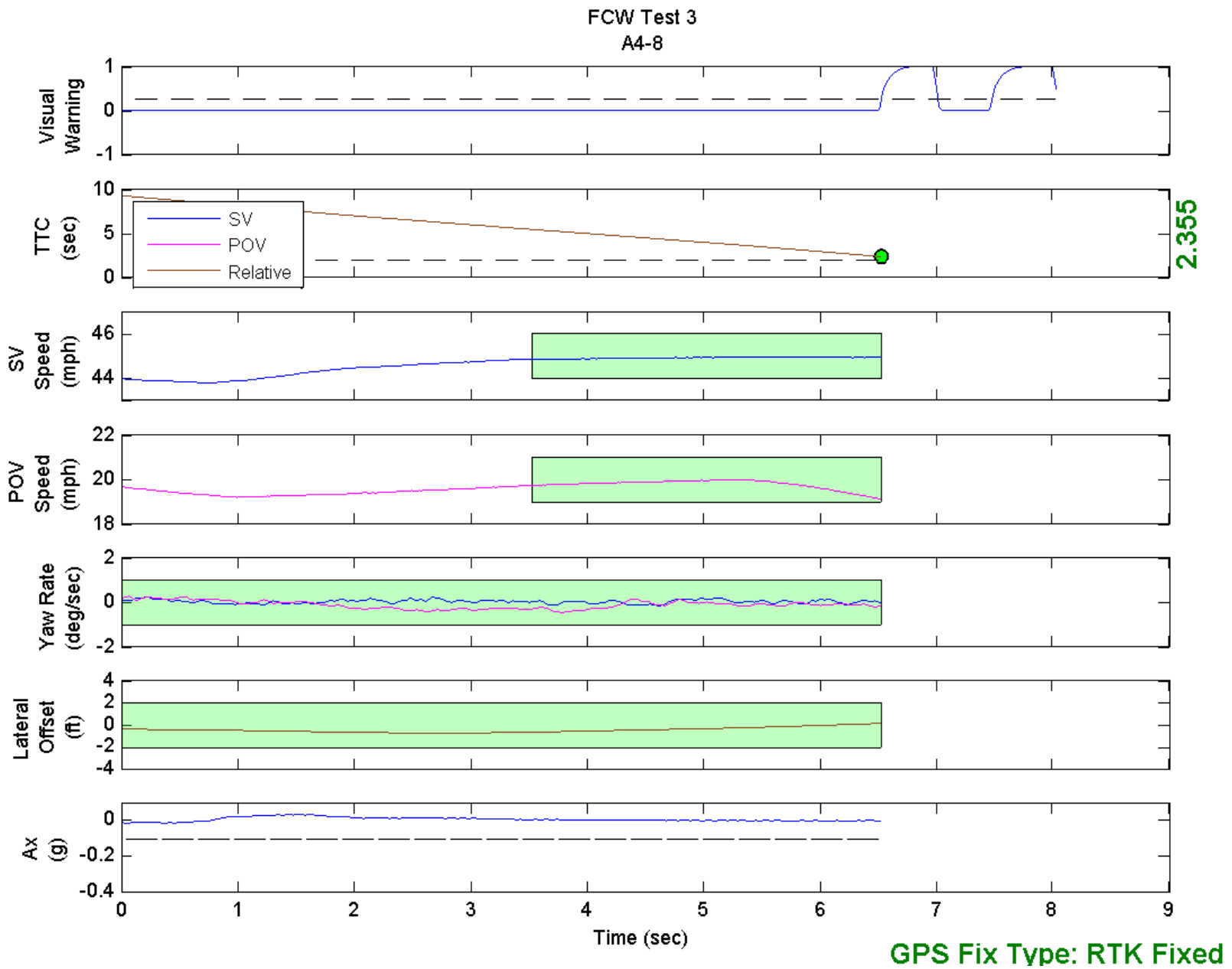


Figure D66. Time History for Run 8, FCW Test 3, Visual Warning

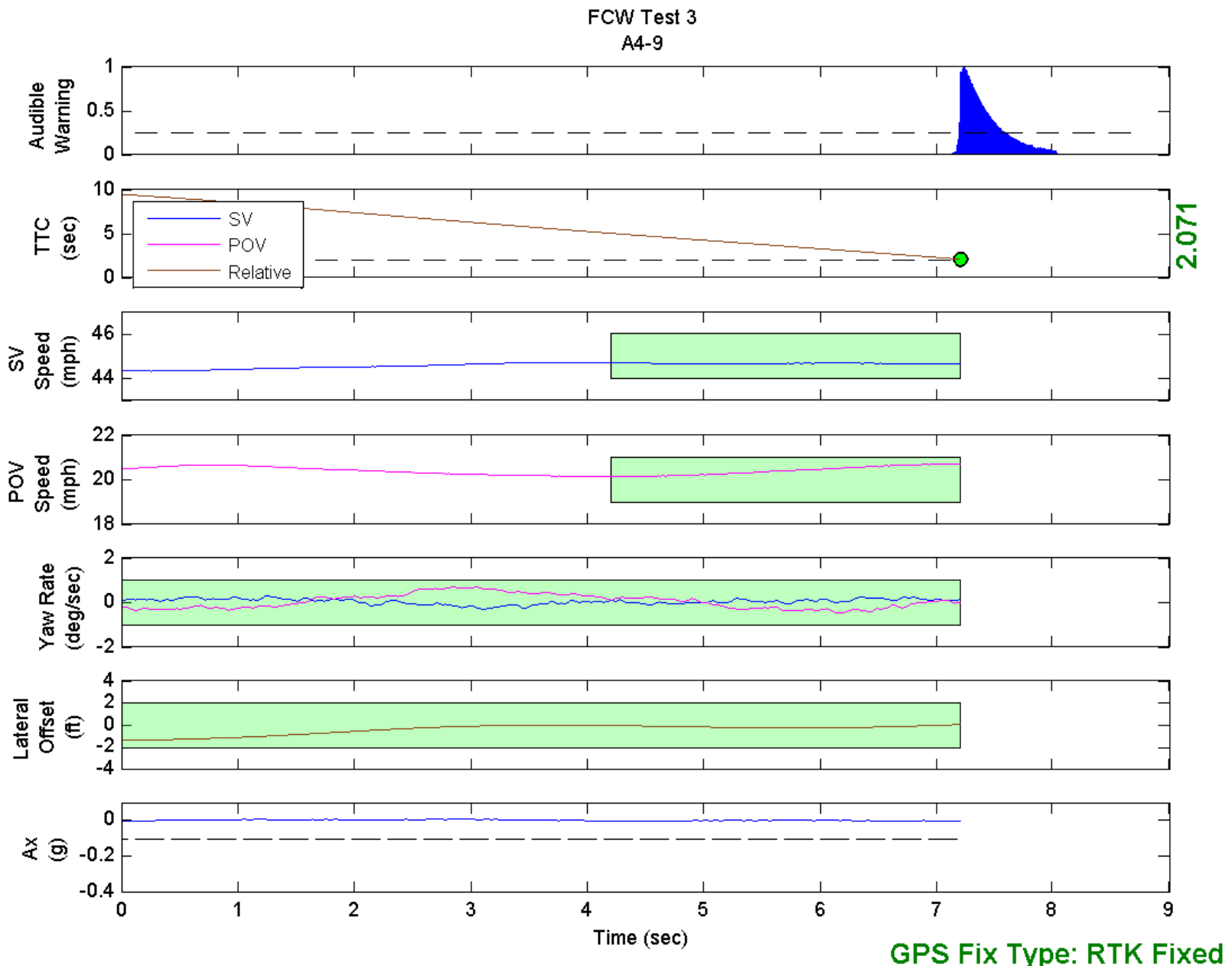


Figure D67. Time History for Run 9, FCW Test 3, Audible Warning

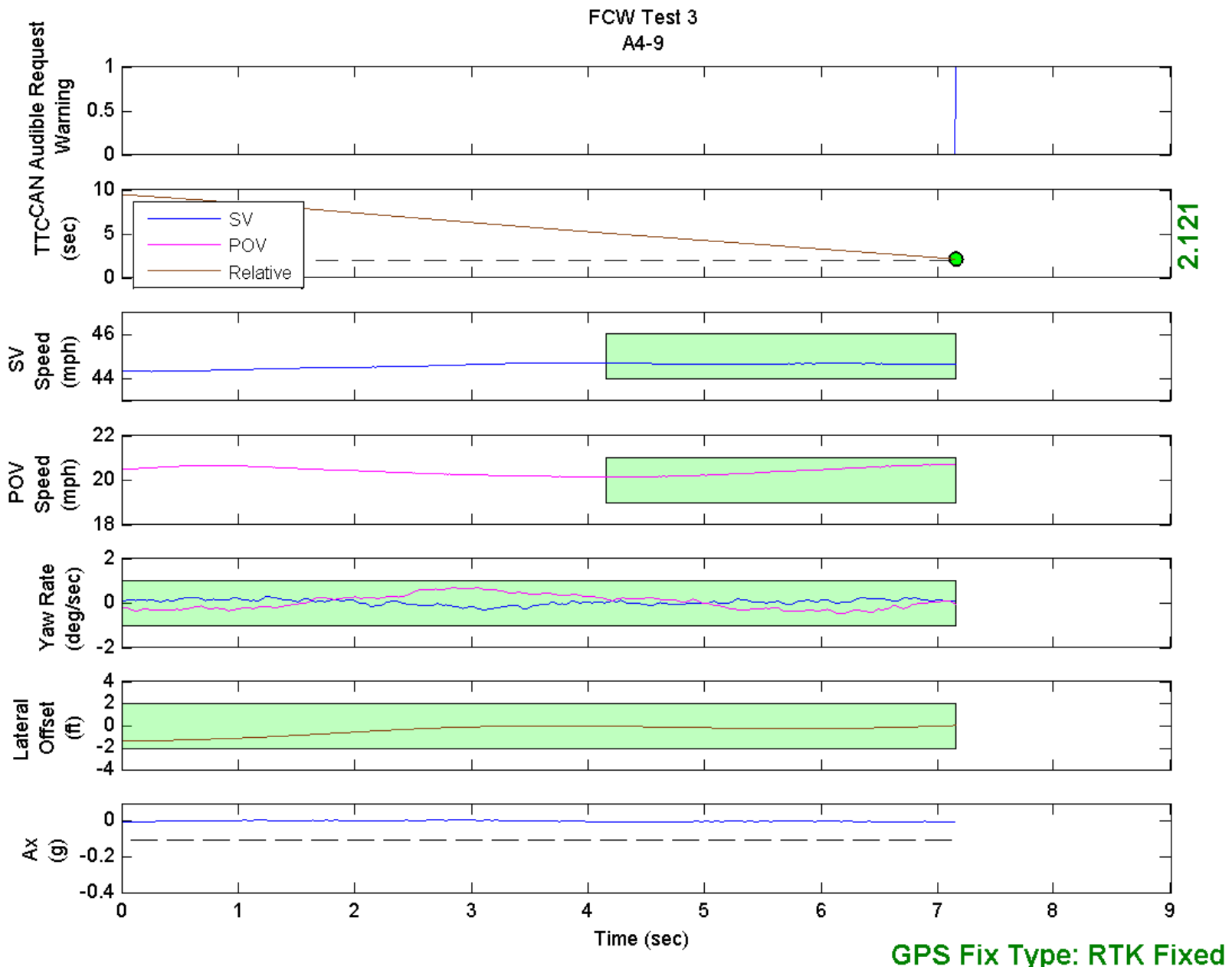


Figure D68. Time History for Run 9, FCW Test 3, CAN Audible Warning Request

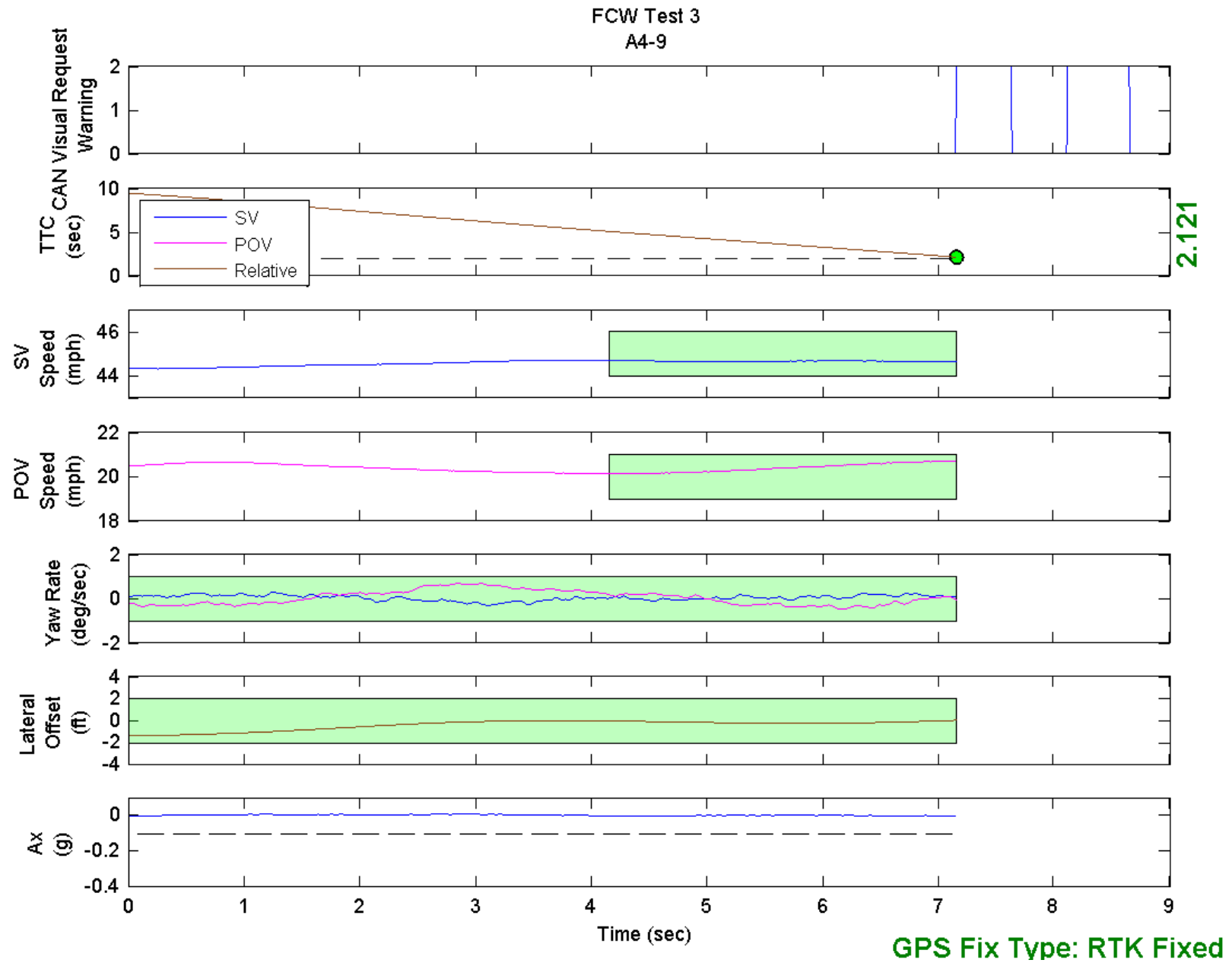


Figure D69. Time History for Run 9, FCW Test 3, CAN Visual Warning Request

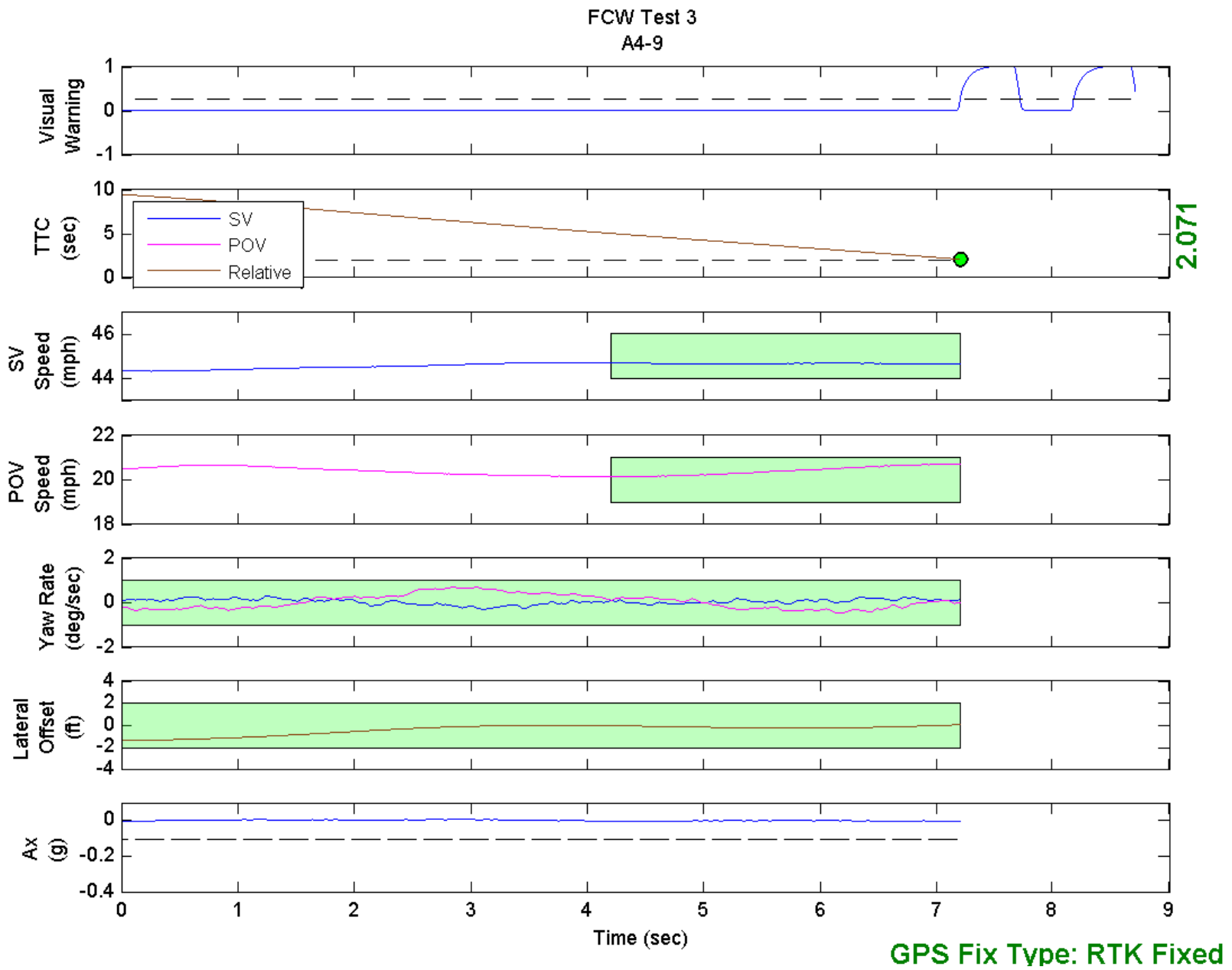


Figure D70. Time History for Run 9, FCW Test 3, Visual Warning

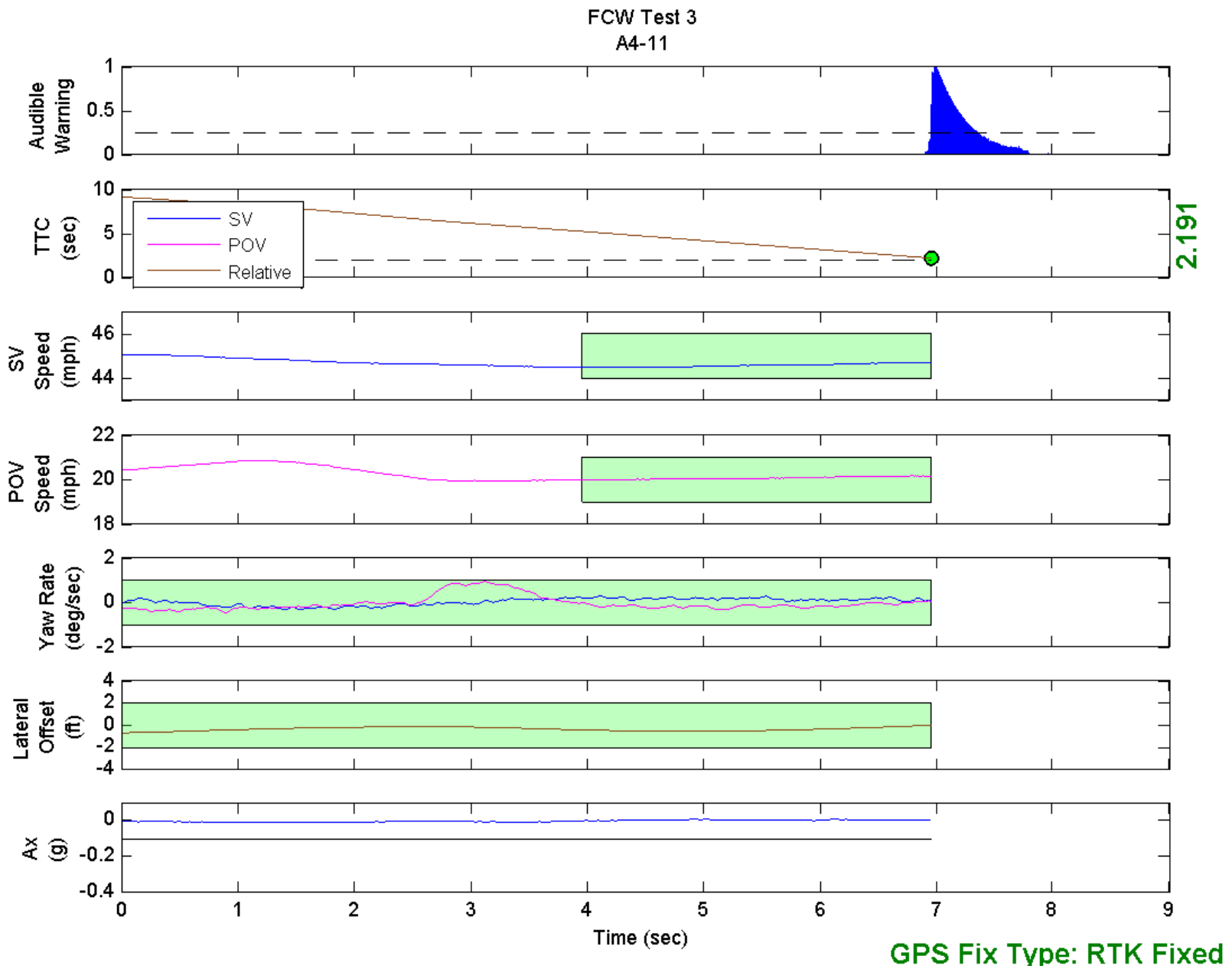


Figure D71. Time History for Run 11, FCW Test 3, Audible Warning

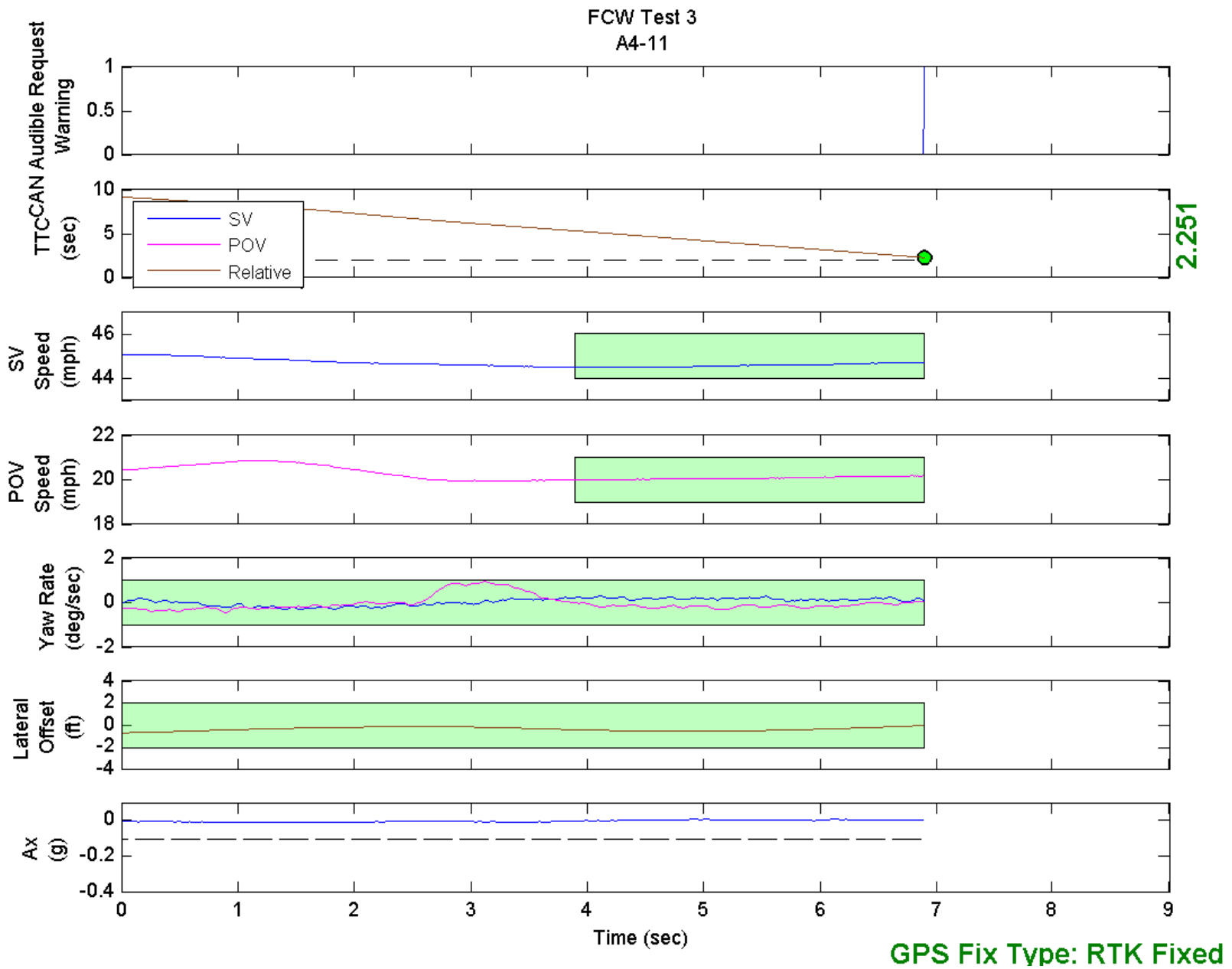


Figure D72. Time History for Run 11, FCW Test 3, CAN Audible Warning Request

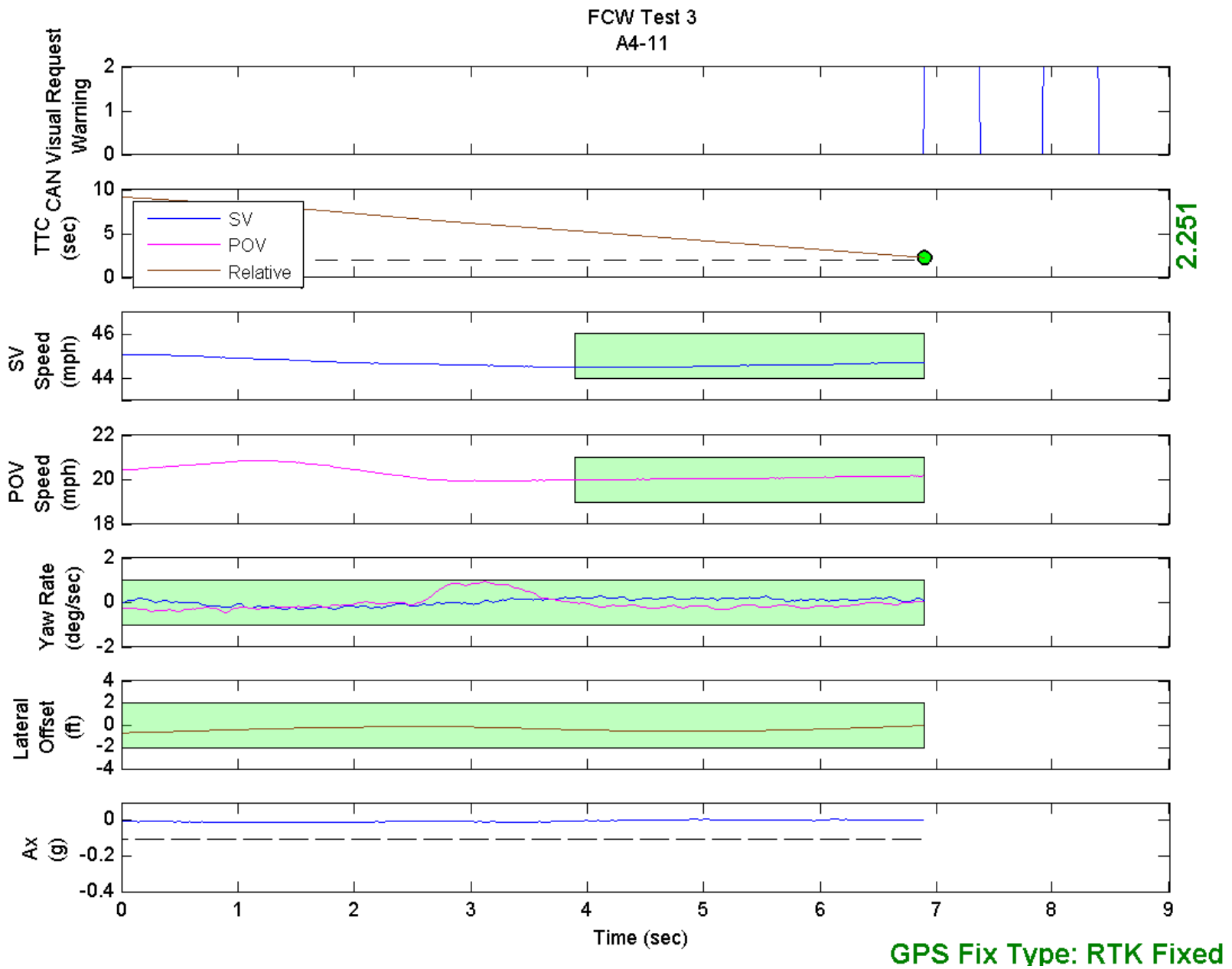


Figure D73. Time History for Run 11, FCW Test 3, CAN Visual Warning Request

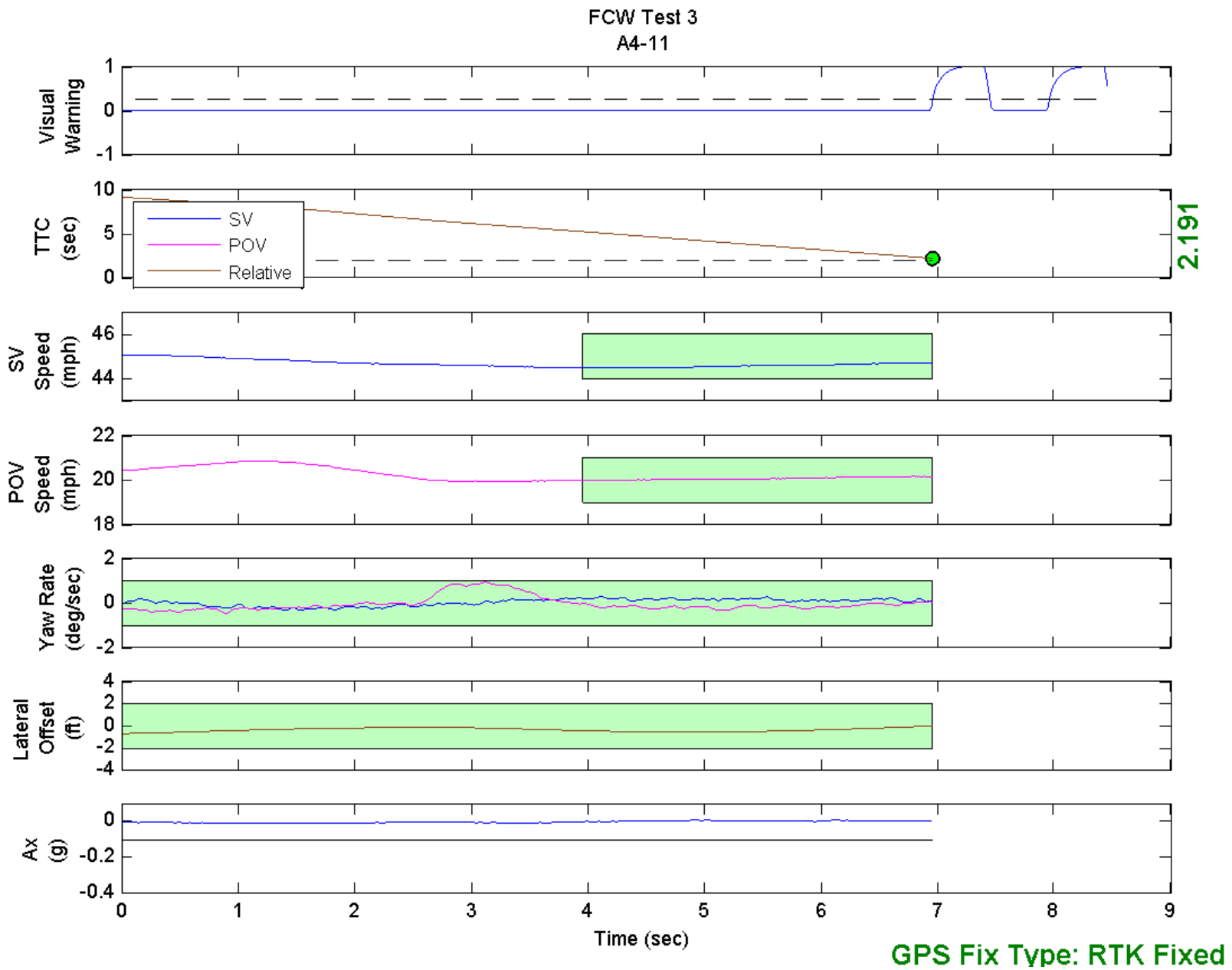


Figure D74. Time History for Run 11, FCW Test 3, Visual Warning

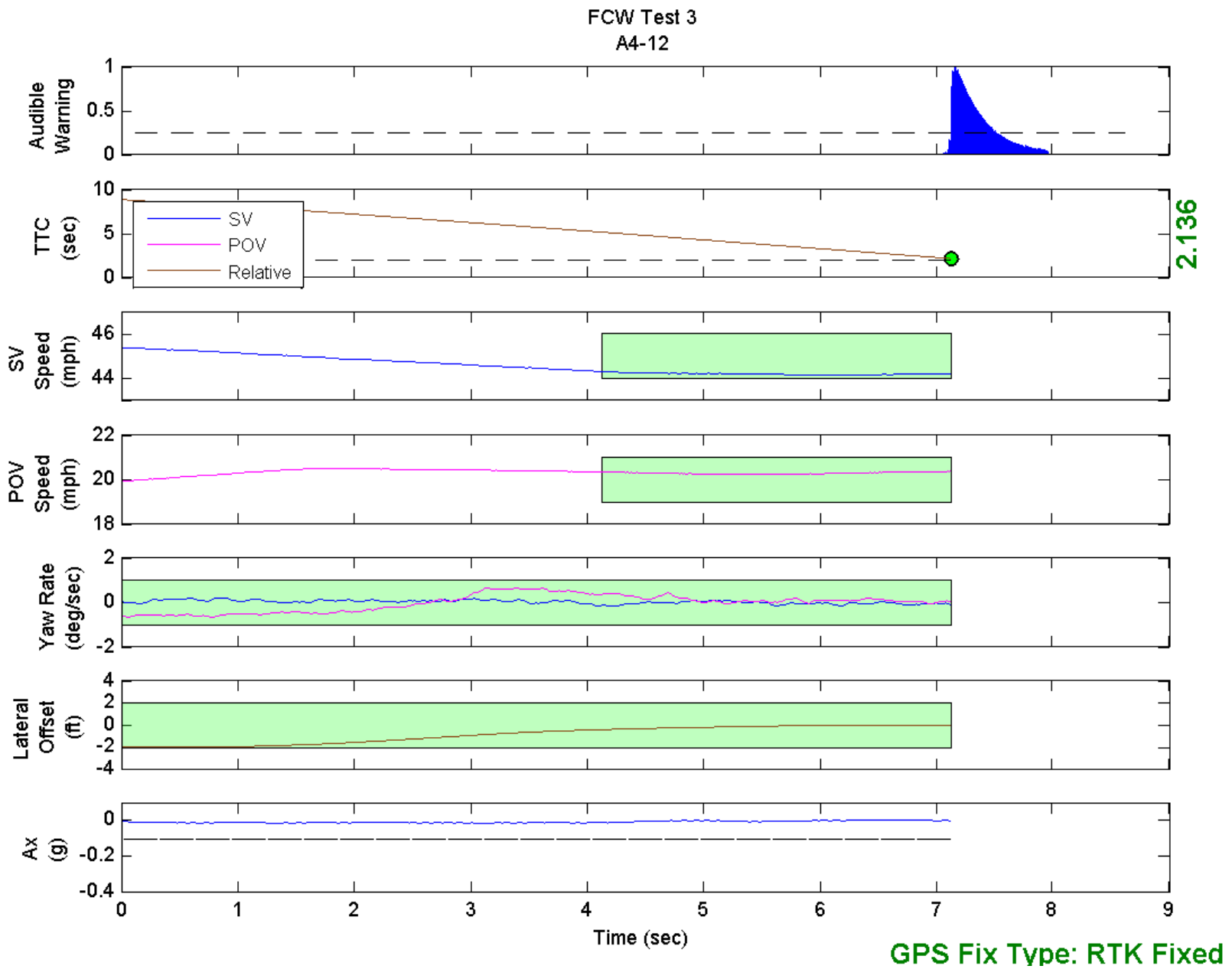


Figure D75. Time History for Run 12, FCW Test 3, Audible Warning

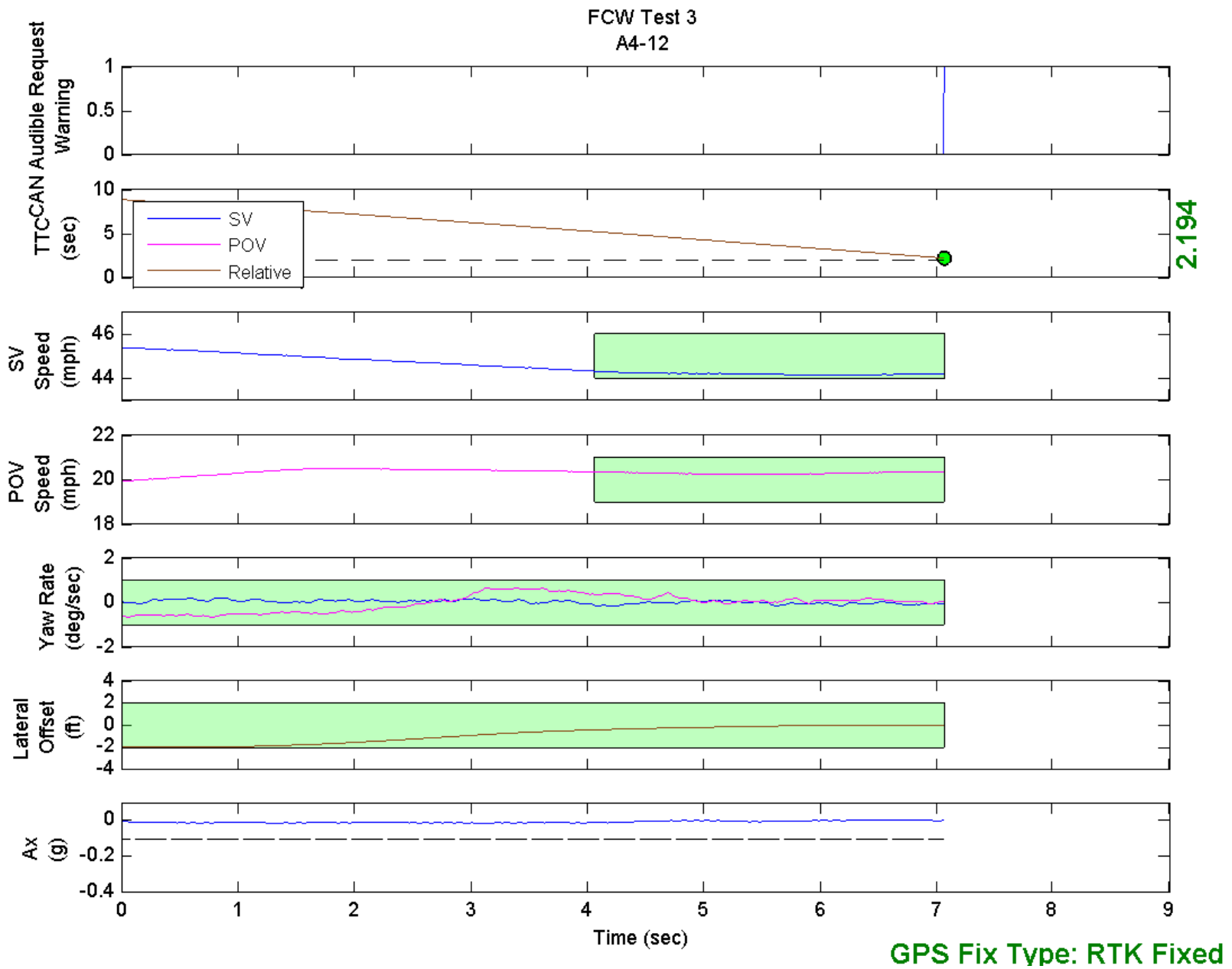


Figure D76. Time History for Run 12, FCW Test 3, CAN Audible Warning Request

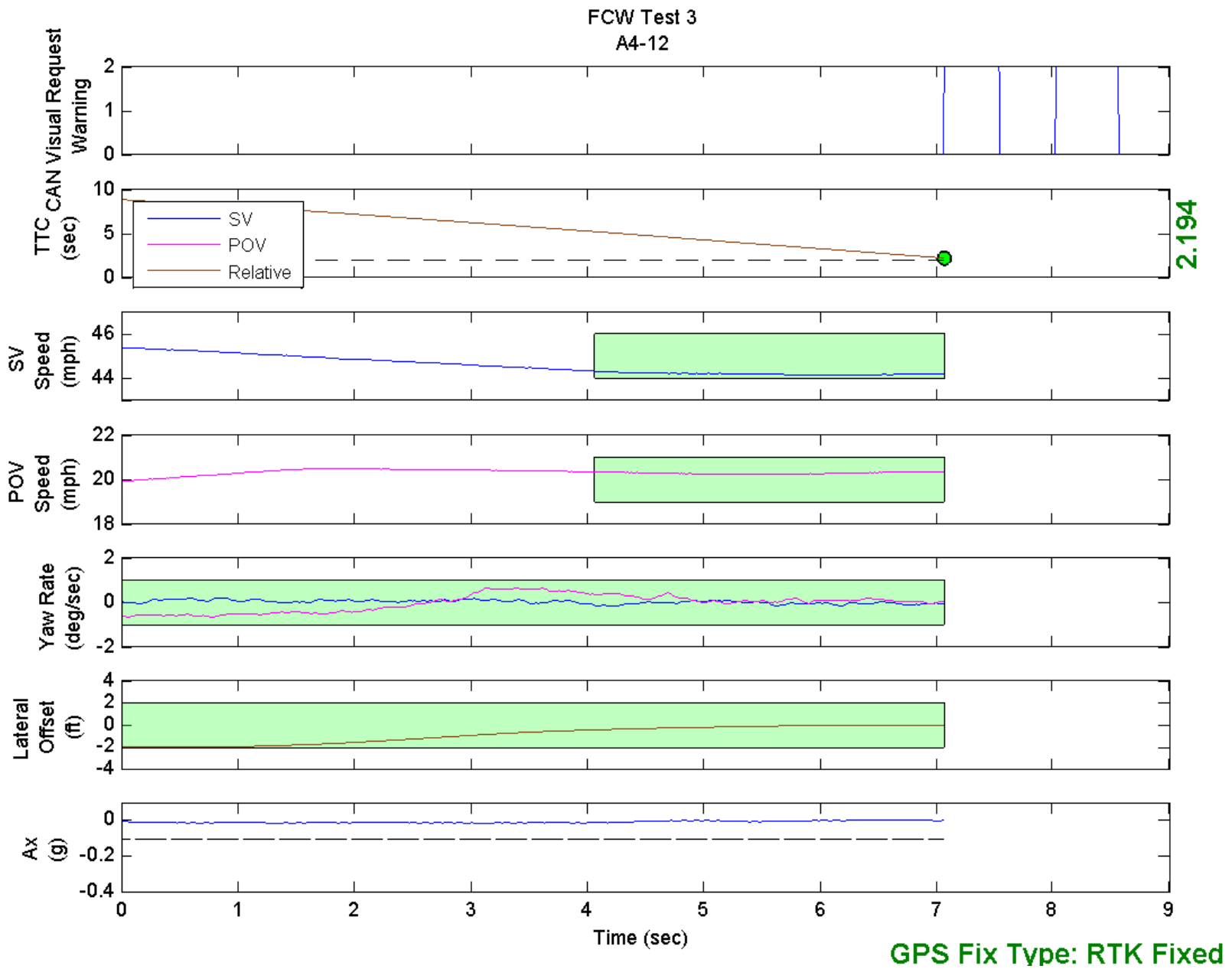


Figure D77. Time History for Run 12, FCW Test 3, CAN Visual Warning Request

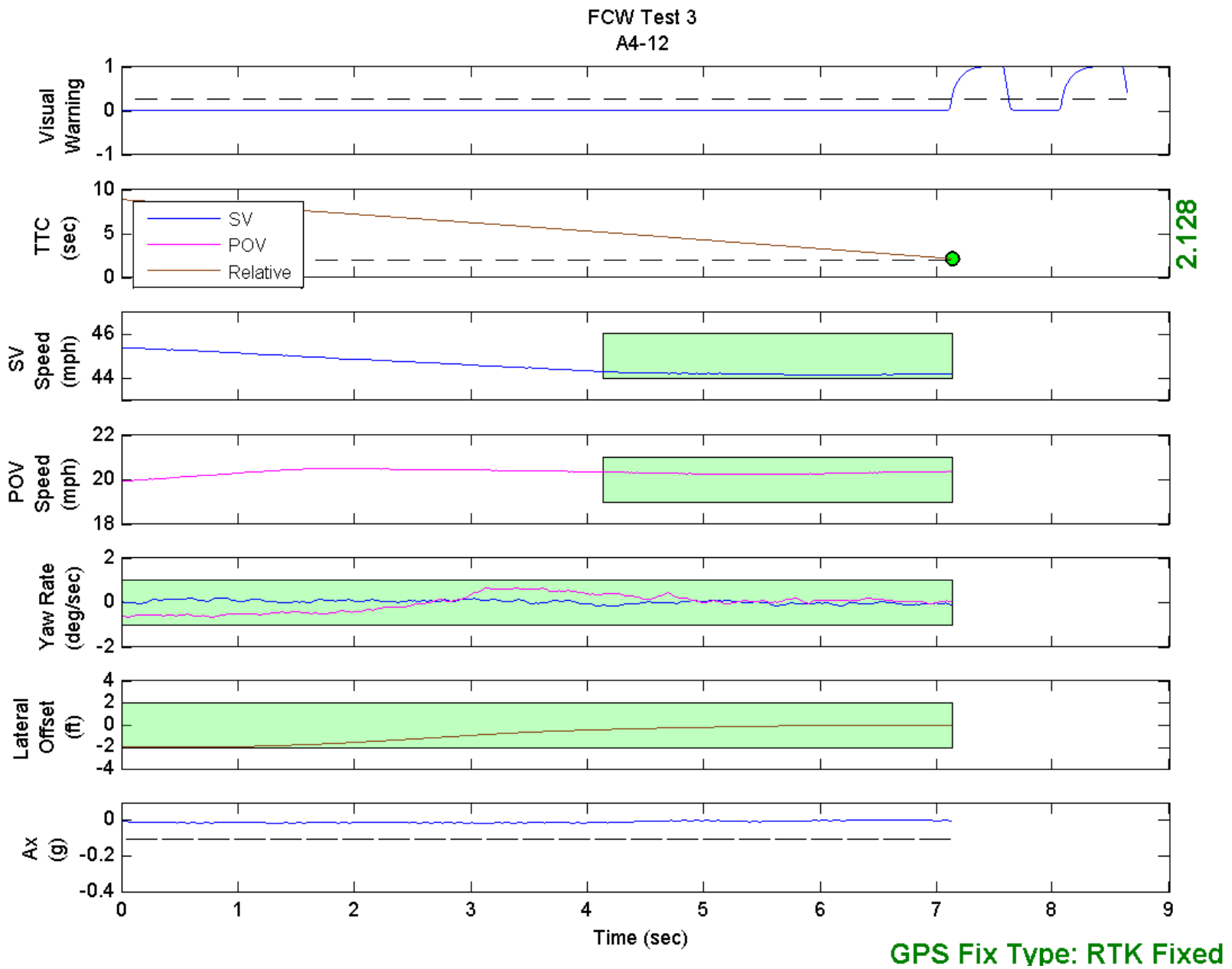


Figure D78. Time History for Run 12, FCW Test 3, Visual Warning

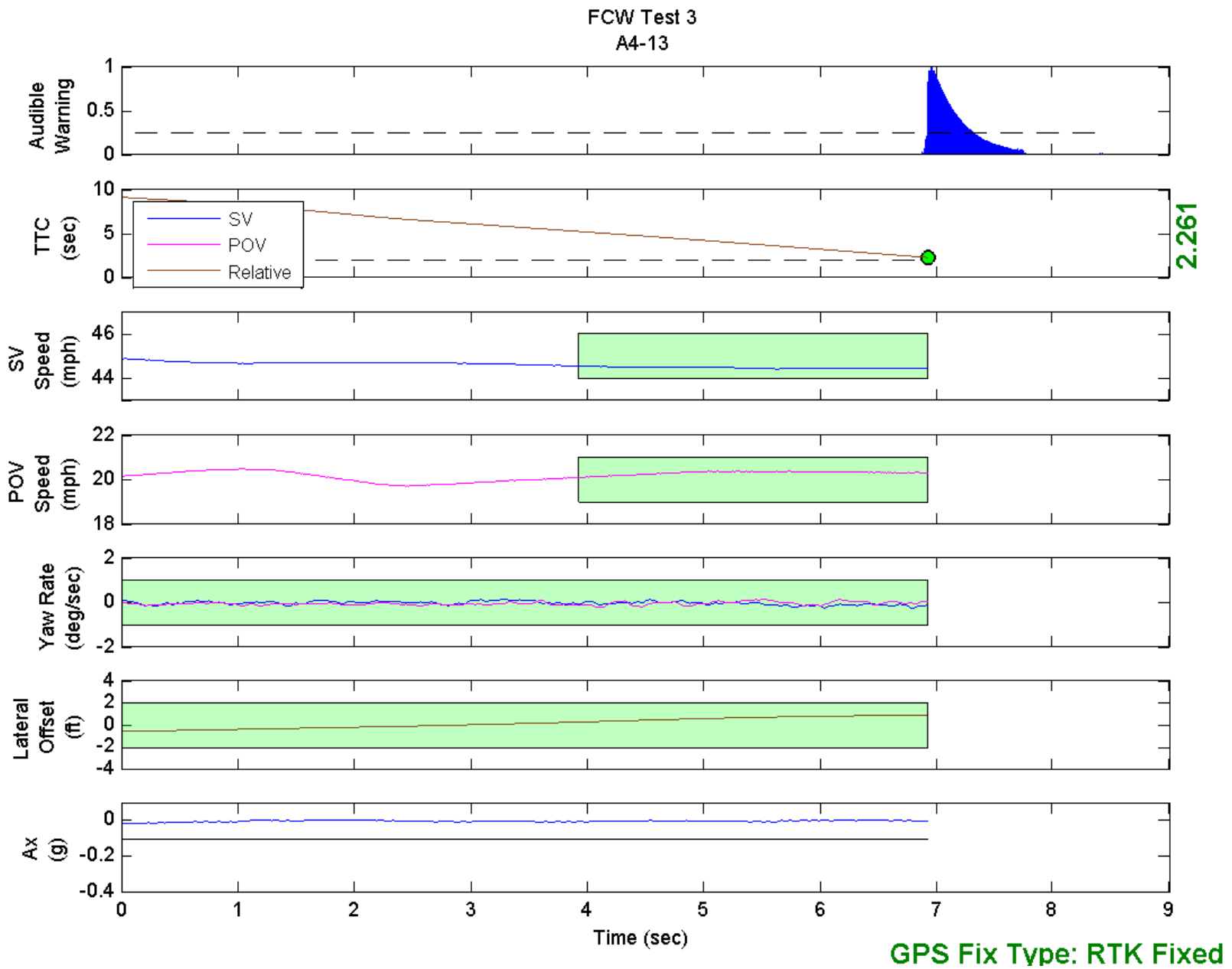


Figure D79. Time History for Run 13, FCW Test 3, Audible Warning

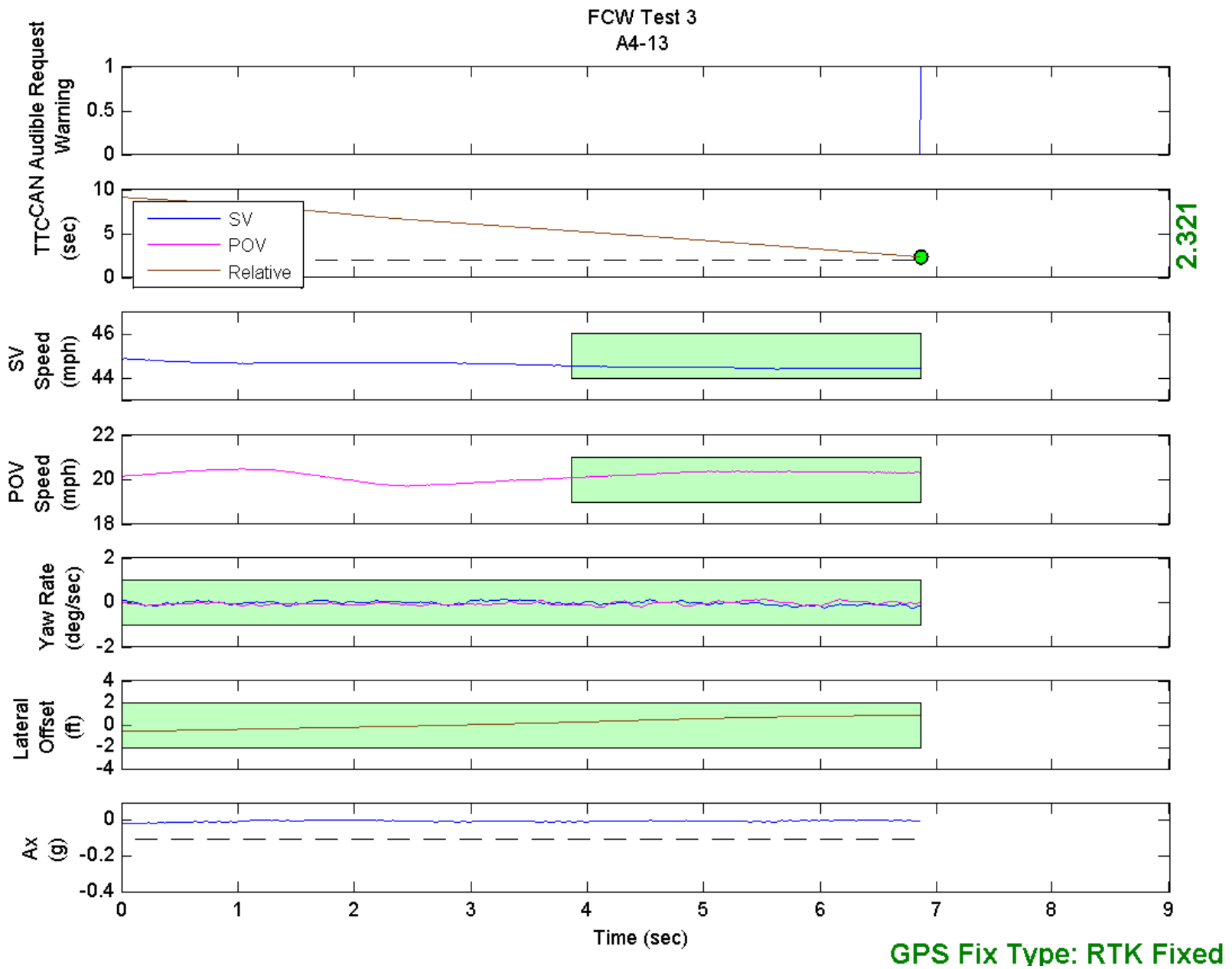


Figure D80. Time History for Run 13, FCW Test 3, CAN Audible Warning Request

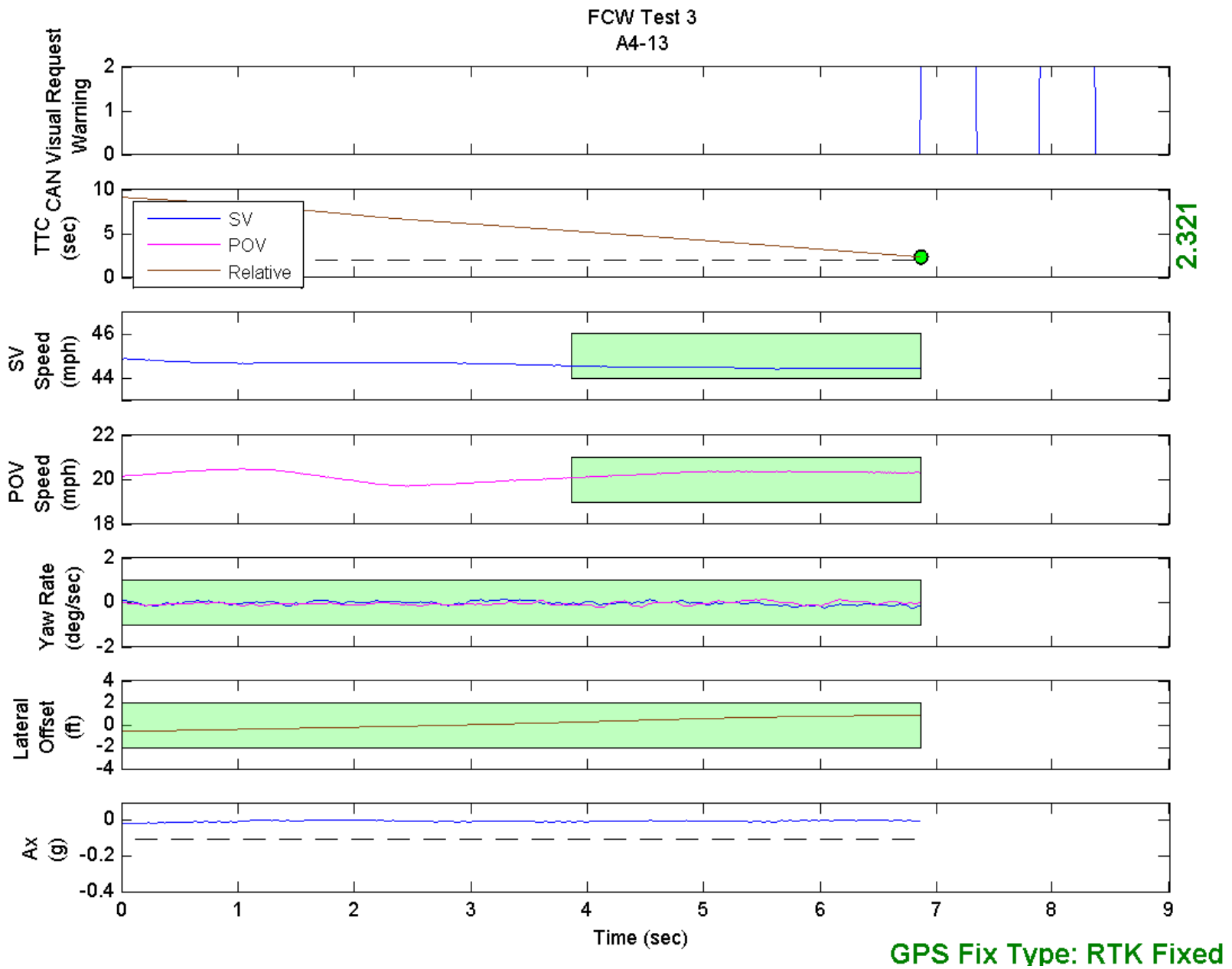


Figure D81. Time History for Run 13, FCW Test 3, CAN Visual Warning Request

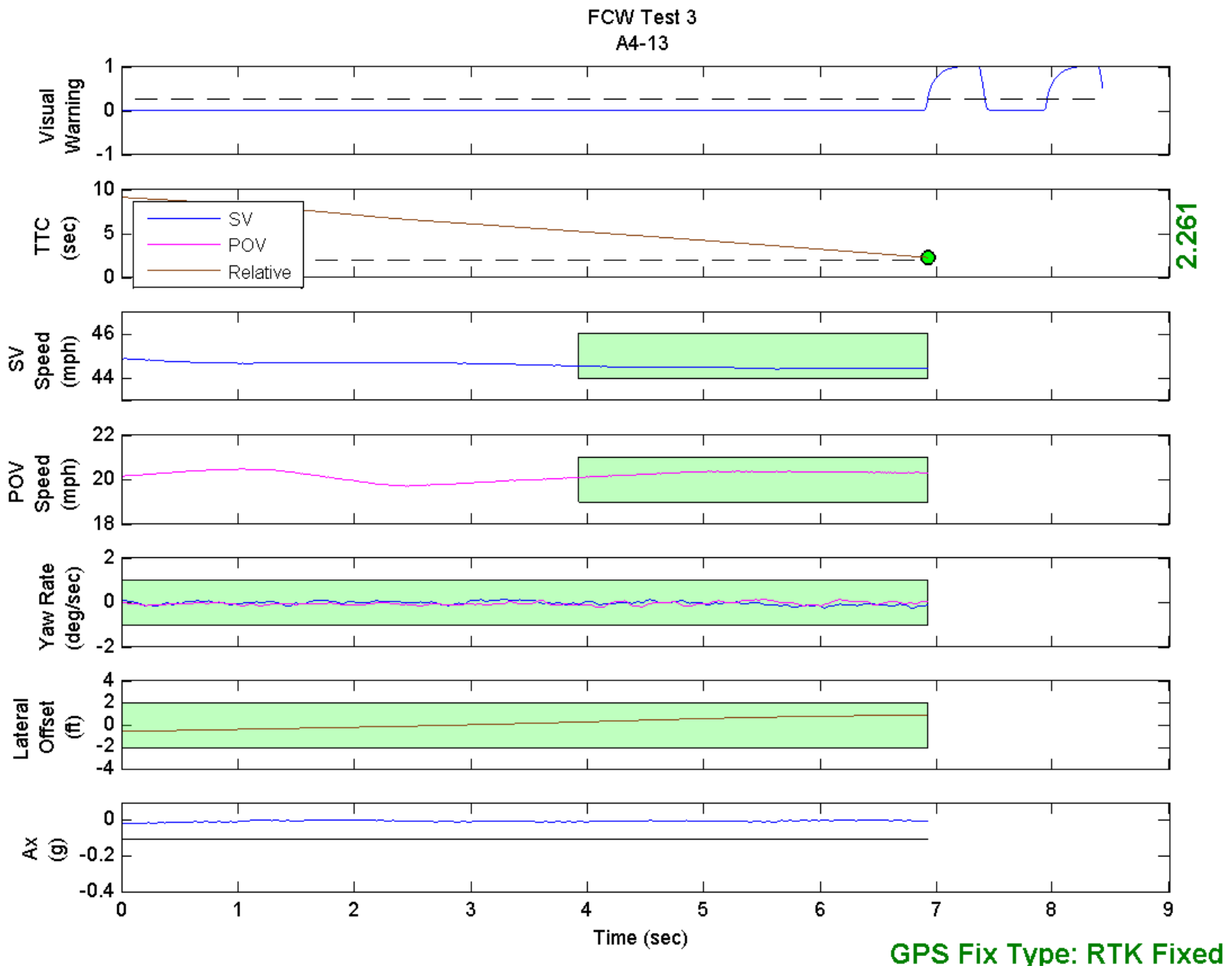


Figure D82. Time History for Run 13, FCW Test 3, Visual Warning

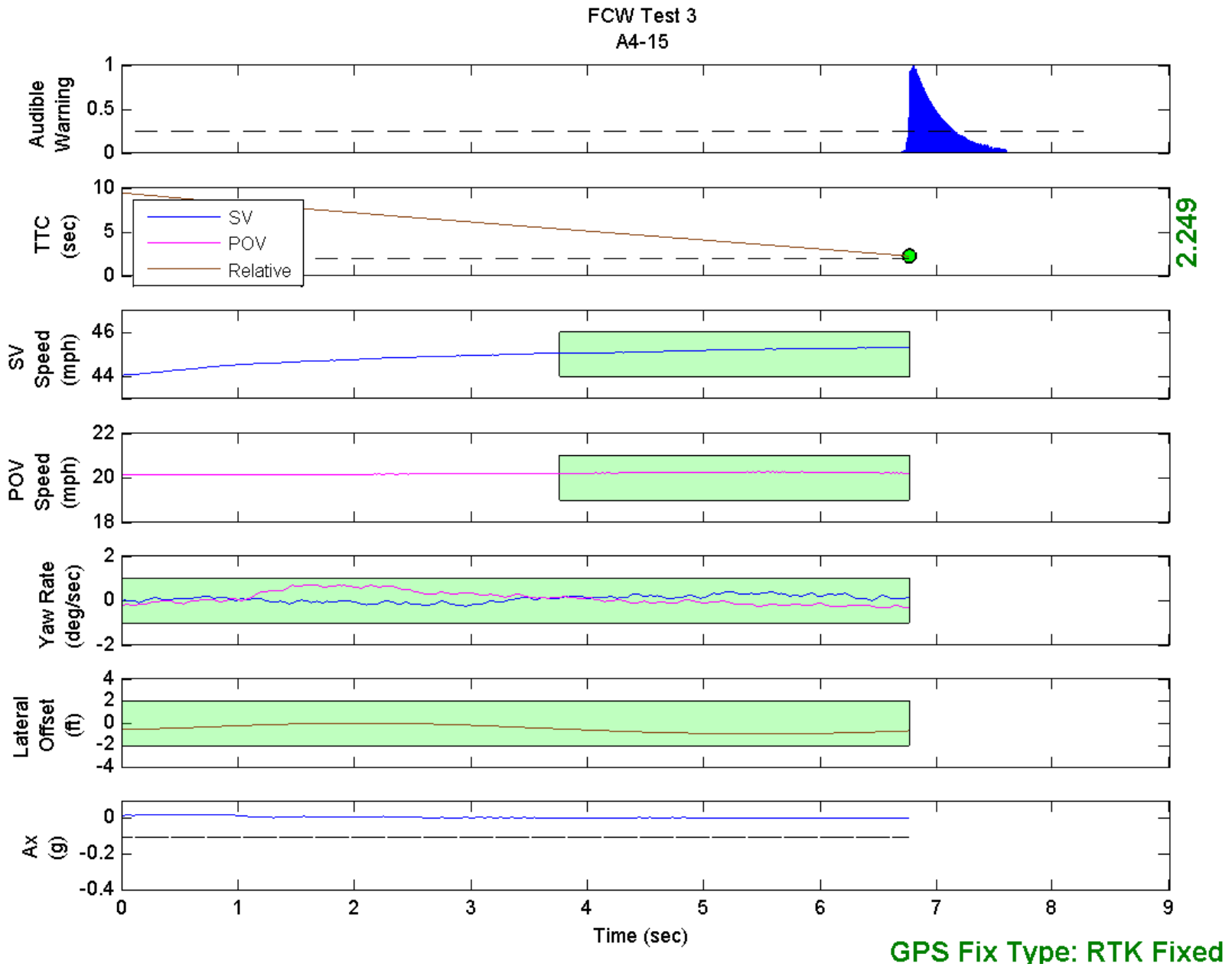


Figure D83. Time History for Run 15, FCW Test 3, Audible Warning

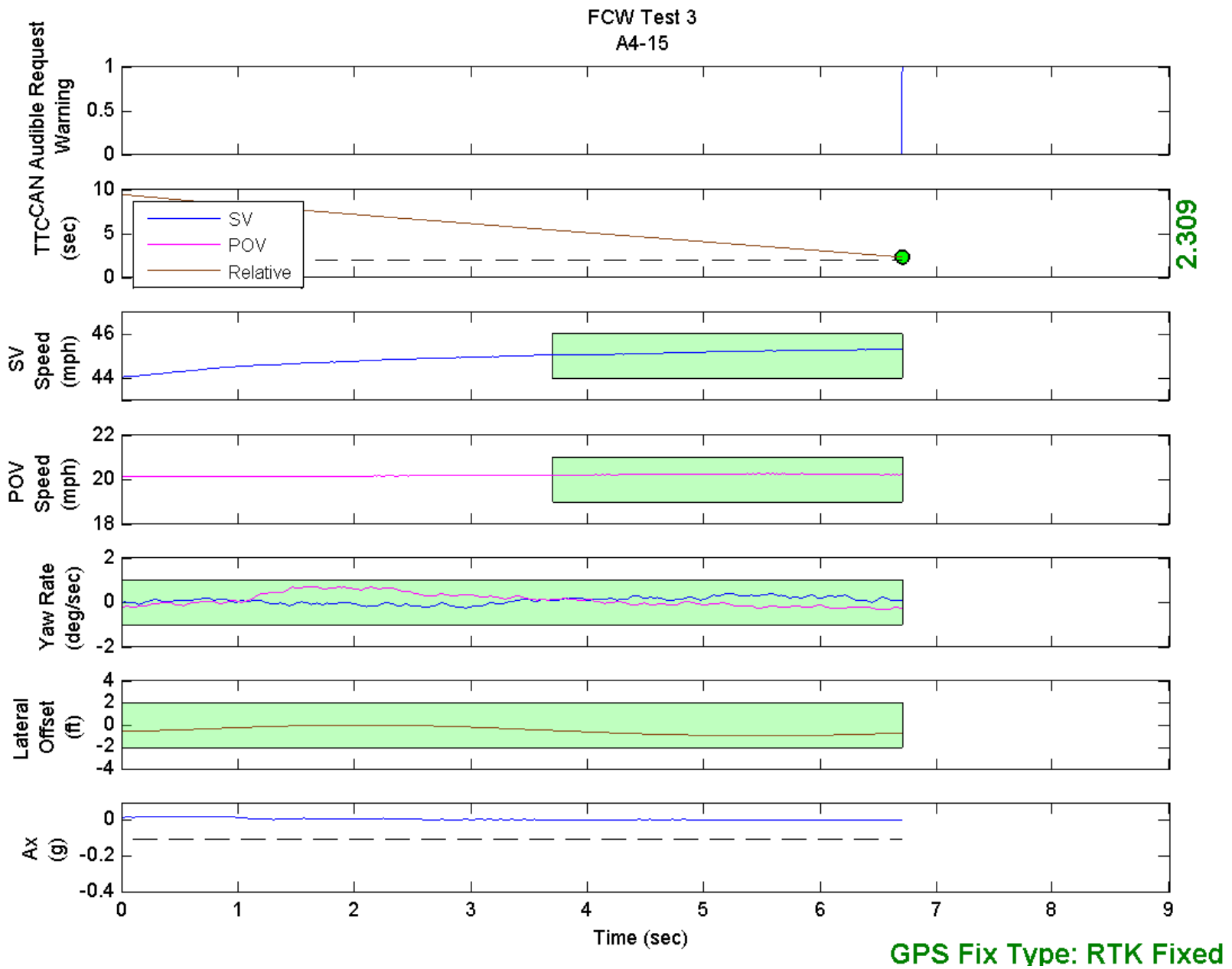


Figure D84. Time History for Run 15, FCW Test 3, CAN Audible Warning Request

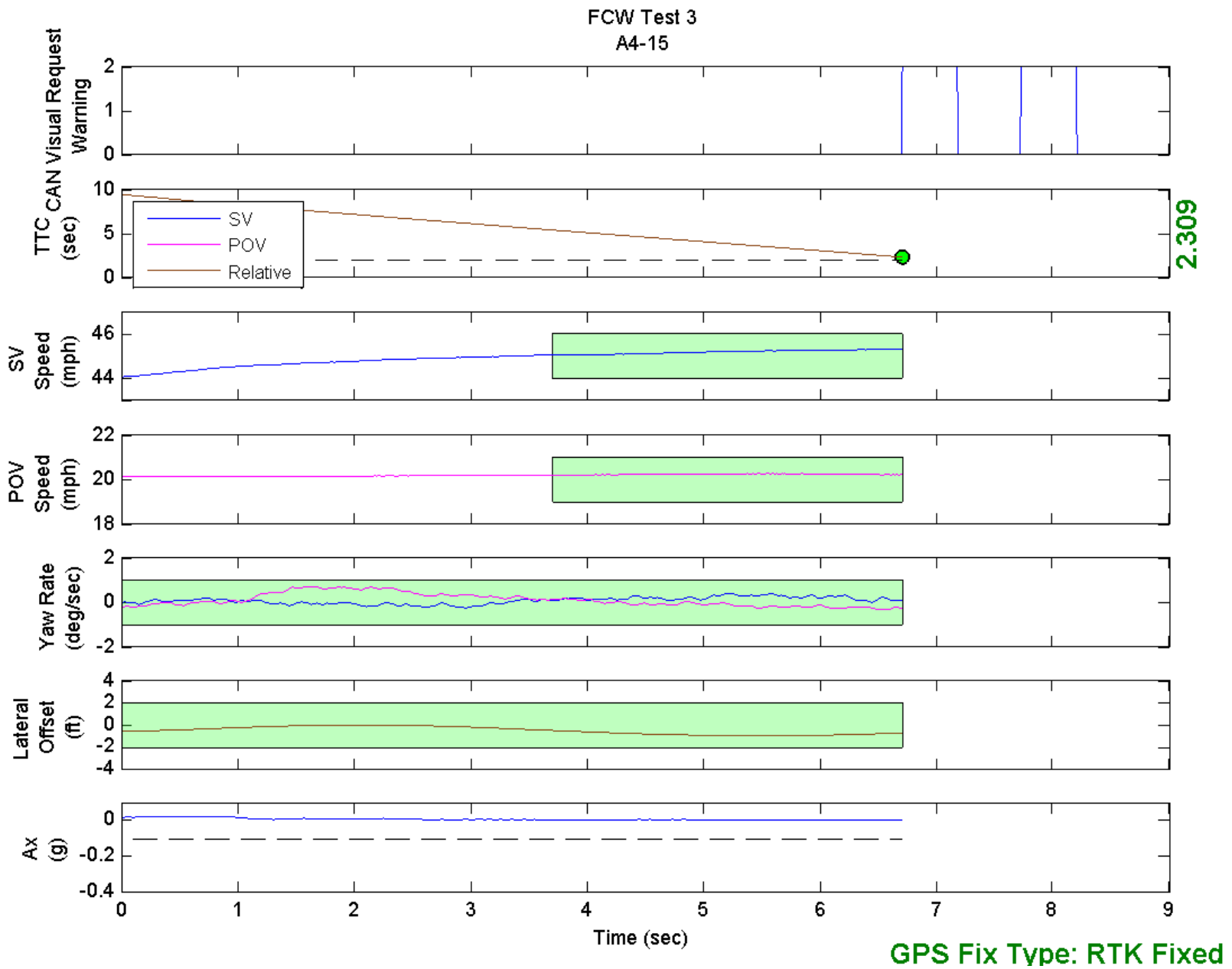


Figure D85. Time History for Run 15, FCW Test 3, CAN Visual Warning Request

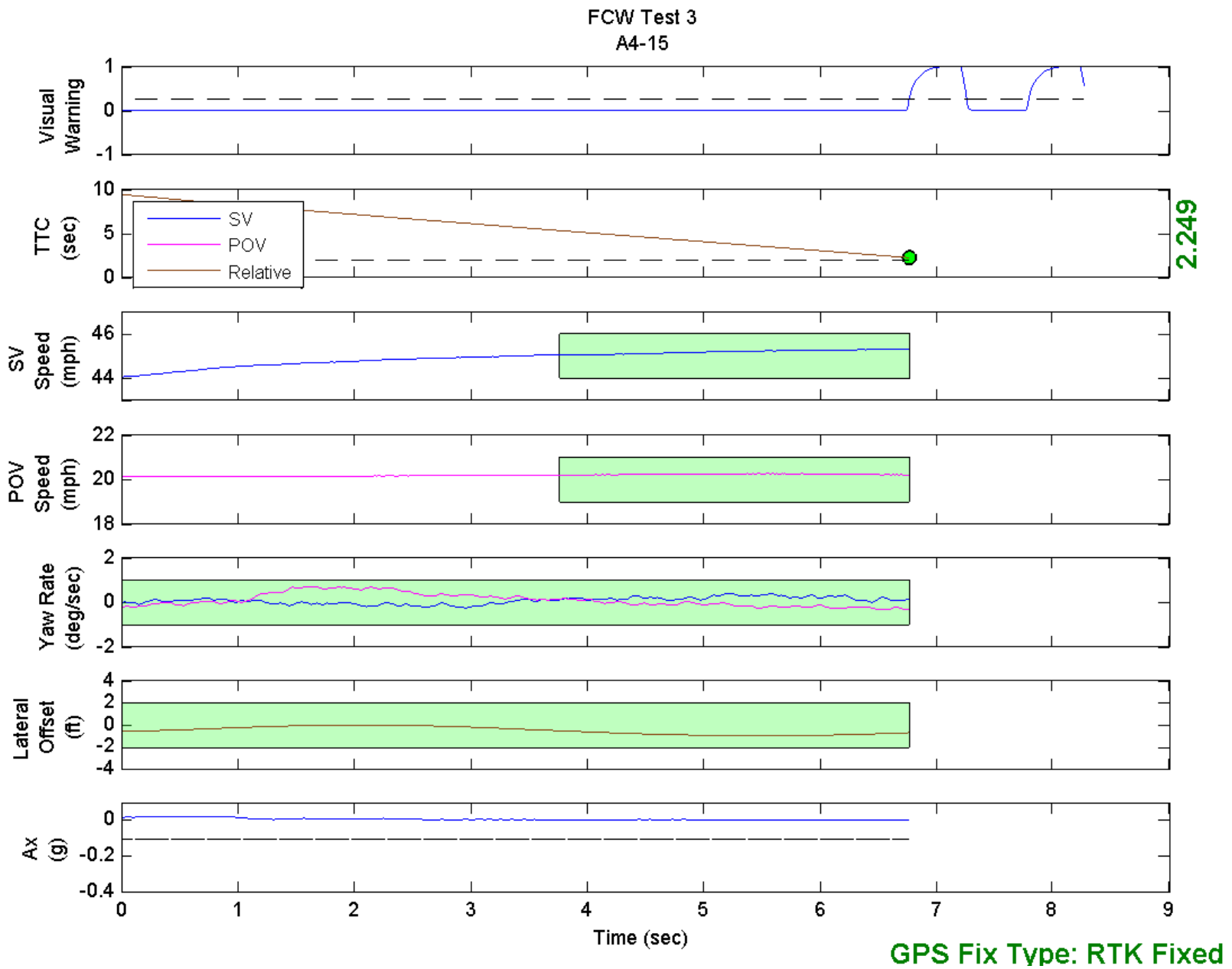


Figure D86. Time History for Run 15, FCW Test 3, Visual Warning

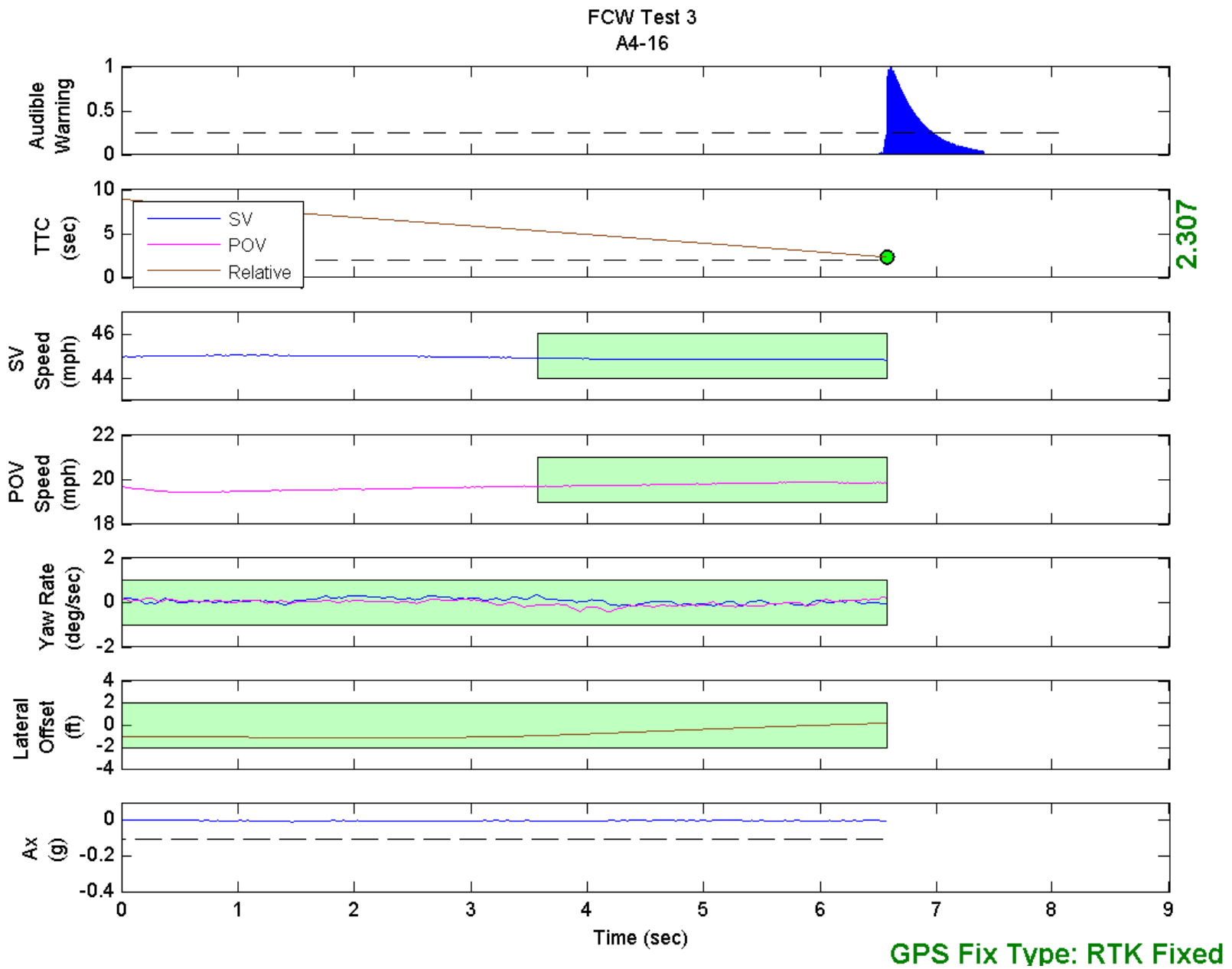


Figure D87. Time History for Run 16, FCW Test 3, Audible Warning

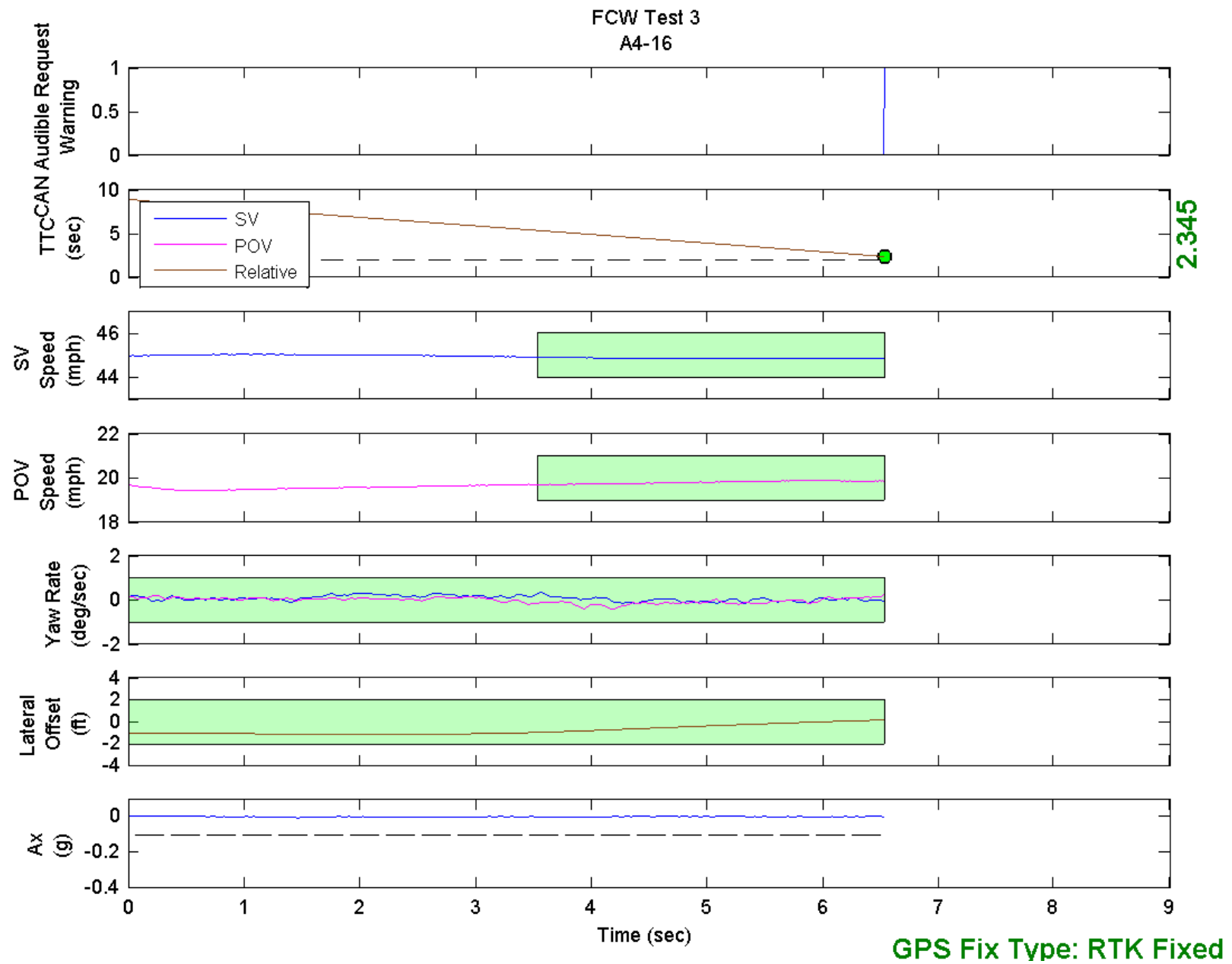


Figure D88. Time History for Run 16, FCW Test 3, CAN Audible Warning Request

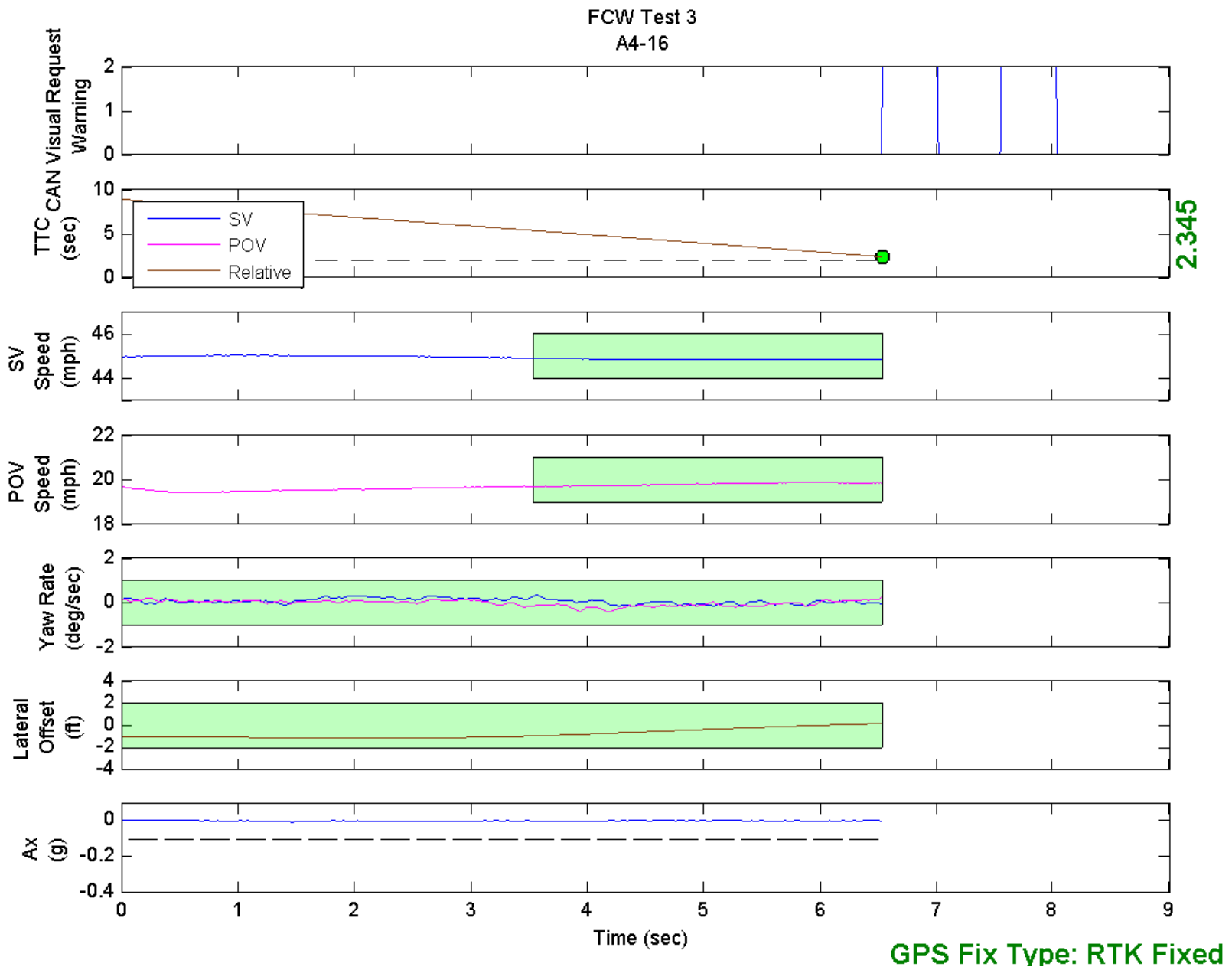


Figure D89. Time History for Run 16, FCW Test 3, CAN Visual Warning Request

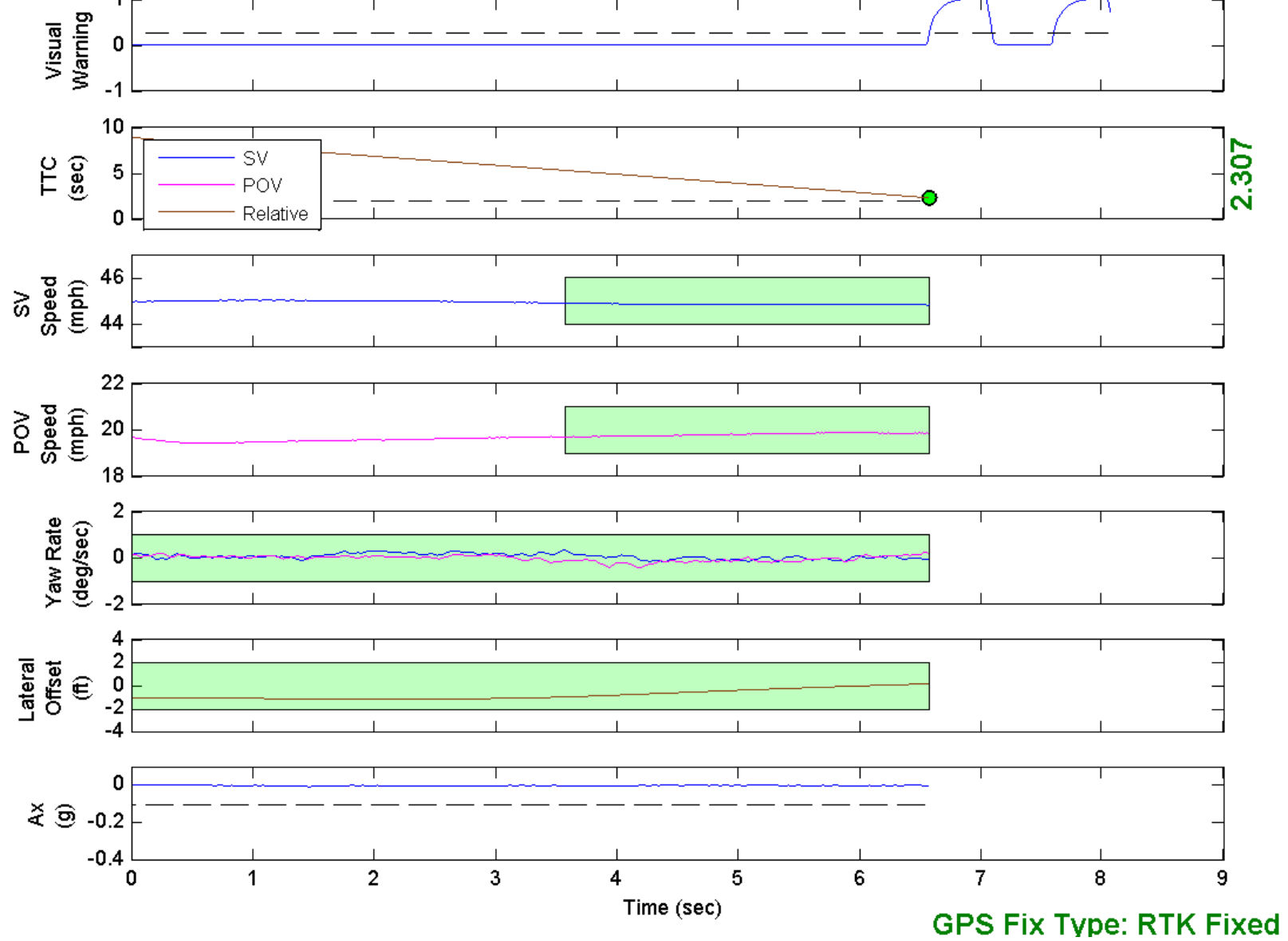


Figure D90. Time History for Run 16, FCW Test 3, Visual Warning