

OCAS-DRI-FCW-13-005

NCAP FORWARD COLLISION WARNING CONFIRMATION TEST

2013 Buick Encore

DYNAMIC RESEARCH, INC.

355 Van Ness Avenue, STE 200
Torrance, California 90501



4 April 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
1200 New Jersey Avenue, SE
West Building, 4th Floor (NVS-120)
Washington, DC 20590**

Prepared for the Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DTNH22-08-D-00095.

This publication is distributed by the U.S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings, and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturer's names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products of manufacturers.

Prepared By: J. Lenkeit

Approved By: B. Kebschull

Approval Date: 4 April 2013

1. Report No. OCAS-DRI-FCW-13-005	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Final Report of Forward Collision Warning Testing of a 2013 Buick Encore.		5. Report Date 4 April 2013	
		6. Performing Organization Code DRI	
7. Author(s) John F. Lenkeit, Technical Director Brian Kebschull, Principal Engineer		8. Performing Organization Report No. DRI-TM-12-104	
9. Performing Organization Name and Address Dynamic Research, Inc. 355 Van Ness Ave, STE 200 Torrance, CA 90501		10. Work Unit No.	
		11. Contract or Grant No. DTNH22-08-D-00095	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Crash Avoidance Standards 1200 New Jersey Avenue, SE, West Building, 4th Floor (NVS-120) Washington, D.C. 20590		13. Type of Report and Period Covered Final Test Report March 2013	
		14. Sponsoring Agency Code NVS-120	
15. Supplementary Notes			
16. Abstract These tests were conducted on the subject 2013 Buick Encore 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.			
17. Key Words Forward Collision Warning, FCW, New Car Assessment Program, NCAP		18. Distribution Statement Copies of this report are available from the following: NHTSA Technical Reference Division National Highway Traffic Safety Administration 1200 New Jersey Avenue, SE Washington, D.C. 20590	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 103	22. Price

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
I. INTRODUCTION	1
II. DATA SHEETS	2
A. Data Sheet 1: Test Summary	3
B. Data Sheet 2: Vehicle Data.....	4
C. Data Sheet 3: Test Conditions.....	6
D. Data Sheet 4: Forward Collision Warning System Operation.....	8
III. TEST PROCEDURES	11
A. Test Procedure Overview.....	11
B. Principal Other Vehicle.....	17
C. Automatic Braking System.....	17
D. Instrumentation.....	17
Appendix A Photographs	A1
Appendix B Excerpts from Owner's Manual	B1
Appendix C Run Logs.....	C1
Appendix D Time Histories	D1

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 Buick Encore

VIN: KL4CJDSB5DB1xxxx

Test Date: 3/13/2013

Forward Collision Warning setting: Long

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 Buick Encore

TEST VEHICLE INFORMATION

VIN: KL4CJDSB5DB1xxxx

Body Style: SUV

Color: Black

Date Received: 3/4/2013

Odometer Reading: 40 mi

Engine: 1.4 L Inline 4

Transmission: Automatic

Final Drive: FWD

Is the vehicle equipped with:

ABS X Yes No

Adaptive Cruise Control Yes X No

Collision Mitigating Brake System Yes X No

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: GM Korea Company

Date of manufacture: 01/13

DATA FROM TIRE PLACARD:

Tires size as stated on Tire Placard: Front: P215/55R18 H

Rear: P215/55R18 H

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

Rear: 240 kPa (35 psi)

FORWARD COLLISION WARNING

DATA SHEET 2: VEHICLE DATA

(Page 2 of 2)

2013 Buick Encore

TIRES

Tire manufacturer and model: Continental Conti Pro Contact

Front tire size: P215/55R18

Rear tire size: P215/55R18

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 Buick Encore

GENERAL INFORMATION

Test date: 3/13/2013

AMBIENT CONDITIONS

Air temperature: 23.9 C (75 F)

Wind speed: 1.0 m/s (2.3 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: 240 kPa (35 psi)

Rear: 240 kPa (35 psi)

FORWARD COLLISION WARNING
DATA SHEET 3: TEST CONDITIONS (Page 2 of 2)
2013 Buick Encore

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front: 492.1 kg (1085 lb)

Right Front 455.4 kg (1004 lb)

Left Rear 324.8 kg (716 lb)

Right Rear 310.3 kg (684 lb)

Total: 1582.6 kg (3489 lb)

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 1 of 3)

2013 Buick Encore

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 three repeated beeps whose primary frequency is approximately 2000 Hz.

The visual alert consists of an image of two vehicles about to have a rear end collision with a star in between and the words "Forward Collision Alert" below. The image appears in the common display area in the center of the instrument panel. (Figure A.12)

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 2 of 3)

2013 Buick Encore

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.

A switch located on the left side of the steering wheel toggles the warning system between "Long", "Medium", "Short", and "Off" modes. The switch has an image of two vehicles about to have a rear end collision with a star above it. (Figure A.14)

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

A switch located on the left side of the steering wheel toggles the warning system between "Long", "Medium", "Short", and "Off" modes. The switch has an image of two vehicles about to have a rear end collision with a star above it. (Figure A.13)

FORWARD COLLISION WARNING

DATA SHEET 4: FORWARD COLLISION WARNING SYSTEM OPERATION

(Page 3 of 3)

2013 Buick Encore

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.

FCW crash alerts are suppressed in the case of braking and certain steering maneuvers. The FCW system is inoperable below 25 mph.

FCW system may not detect a vehicle ahead if the sensor is blocked by dirt, snow, or ice, or if the windshield is damaged. It may also not detect a vehicle on winding or hilly roads, or in conditions that can limit visibility such as fog, rain, or snow, or if the headlamps or windshield are not cleaned or in proper condition.

The FCW system may provide unnecessary alerts to turning vehicles, vehicles in other lanes, objects that are not vehicles, or shadows.

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.

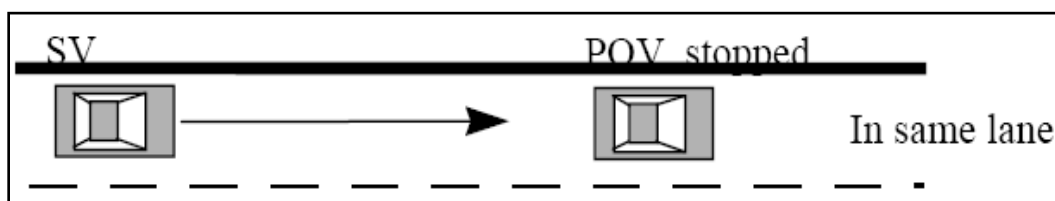


Figure 1. Depiction of Test 1

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.

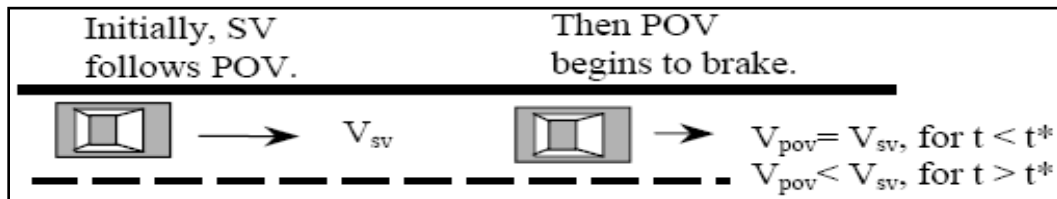


Figure 2. Depiction of Test 2

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

LIST OF FIGURES

	Page
Figure A1. Front View of Subject Vehicle	A-3
Figure A2. Rear View of Subject Vehicle	A-4
Figure A3. Window Sticker (Monroney Label)	A-5
Figure A4. Vehicle Certification Label	A-6
Figure A5. Front View of Principal Other Vehicle	A-7
Figure A6. Rear View of Principal Other Vehicle	A-8
Figure A7. DGPS and Inertial Measurement Unit Installed in Subject Vehicle	A-9
Figure A8. Data Acquisition System Installed in Subject Vehicle.....	A-10
Figure A9. Computer Installed in Subject Vehicle.....	A-11
Figure A10. Brake Actuation System Installed in Principal Other Vehicle...	A-12
Figure A11. Sensors for Detecting Acoustic and Visual Alerts	A-13
Figure A12. Visual Warning Display.....	A-14
Figure A13. FCW On/Off and Distance Switch	A-15
Figure A14. Displays for FCW Range Adjustment	A-16



Figure A1. Front View of Subject Vehicle



Figure A2. Rear View of Subject Vehicle



2013 ENCORE FWD-PREMIUM GROUP

EXTERIOR: CARBON BLACK METALLIC
INTERIOR: EBONY

ENGINE, ECOTEC TURBO 1.4L
TRANSMISSION, 6 SPD AUTOMATIC

STANDARD EQUIPMENT

ITEMS FEATURED BELOW ARE INCLUDED AT NO EXTRA CHARGE IN THE STANDARD VEHICLE PRICE SHOWN

- 4 YEAR/50,000 MILE BUMPER-TO-BUMPER WARRANTY SEE DEALER FOR DETAILS
- 6 YEAR / 70,000 MILE POWERTRAIN LIMITED WARRANTY SEE DEALER FOR DETAILS

MECHANICAL

- ENGINE, ECOTEC TURBO 1.4L VVT, DOHC 4-CYLINDER
- TRANSMISSION, 6 SPD AUTOMATIC

SAFETY & SECURITY

- REMOTE KEYLESS ENTRY W/ PANIC ALARM
- AIRBAGS, DRIVER & FRONT PASSENGER: FRONTAL, KNEE; FRONT AND REAR OUTBOARD OCCUPANTS: SIDE-IMPACT AND HEAD CURTAIN
- STABILITRAK-STABILITY CONTROL

SYSTEM W/ TRACTION CONTROL

- ANTI LOCK BRAKE SYSTEM
- 4 WHEEL DISC BRAKES
- HEADLAMP CONTROL AUTOMATIC ON & OFF
- 6 MTHS ONSTAR DIRECTIONS AND CONNECTIONS WITH AUTOMATIC CRASH RESPONSE & TURN-BY-TURN NAVIGATION (ASK DEALER ABOUT GEOGRAPHIC COVERAGE)
- FORWARD COLLISION ALERT
- LANE DEPARTURE WARNING
- TIRE PRESSURE MONITOR (EXCL SPARE TIRE)
- CONTENT THEFT ALARM, THEFT DETERRENT SYSTEM
- REAR VISION CAMERA SYSTEM

INTERIOR

- QUIET TUNING
- MEMORY PACKAGE INCLUDING DRIVER SIDE SEAT SETTINGS, OUTSIDE MIRRORS, AUDIO SYSTEM

& AIR CONDITIONING

- LEATHER APPOINTED SEATS
- DRIVER & FRONT PASSENGER HEATED SEATS
- SEAT ADJUSTER, DRIVER 6-WAY POWER W/ MANUAL RECLINE
- SEAT ADJUSTER, FRONT PASS. 6-WAY POWER W/ MANUAL RECLINE
- SEATBACK, PASSENGER FLAT-FOLD
- SEAT, REAR 60/40 SPLIT-BENCH, FOLDING
- POWER WINDOW W/ EXPRESS DRIVER UP/DOWN
- WINDOW FRONT PASSENGER & REAR POWER EXPRESS DOWN
- WINDSHIELD WIPERS, RAIN SENSING
- CLIMATE CONTROL, DUAL-ZONE AUTOMATIC
- VISORS, DRIVER/FRONT PASSENGER W/ ILLUMINATED VANITY MIRRORS
- INSIDE REARVIEW MIRROR, AUTO DIMMING

- CARGO COVER, REAR, STOWABLE
- REAR WINDOW DEFROSTER
- POWER DOOR LOCKS WITH LOCKOUT PROTECTION
- CRUISE CONTROL
- POWER OUTLET, 120 VOLT
- LEATHER WRAP STEERING WHEEL
- STEERING COLUMN, TILT AND TELESCOPIC
- XM RADIO + SERVICE SUBSCRIPTION SOLD SEPARATELY BY SIRIUSXM AFTER 3 MTHS
- DRIVER INFORMATION CENTER
- STEERING WHEEL CONTROLS
- FRONT AND REAR PARKING ASSIST ULTRASONIC
- COLOR DISPLAY RADIO W/ 7" SCREEN, INTELLILINK, USB PORT, INPUT JACK
- BLUETOOTH FOR PHONE AND MUSIC
- AUDIO SYSTEM - BOSE PREMIUM
- REMOTE VEHICLE STARTER SYSTEM
- HEATED STEERING WHEEL

Visit us at www.buick.com

EXTERIOR

- GLASS, DEEP-TINTED
- MIRRORS, OUTSIDE HEATED, POWER-ADJUSTABLE, BODY-COLOR MANUAL FOLDING
- DOOR HANDLES, CHROME
- WHEELS, 18" ALUMINUM
- TIRE, COMPACT SPARE
- FRONT FOG LAMPS
- HEADLAMPS, HALOGEN
- ROOF RACK, SIDE RAILS

OPTIONS & PRICING

MANUFACTURER'S SUGGESTED RETAIL PRICE

STANDARD VEHICLE PRICE **\$28,190.00**

OPTIONS INSTALLED BY THE MANUFACTURER (MAY REPLACE STANDARD EQUIPMENT SHOWN)

WHEELS, 18" CHROMED ALUMINUM	995.00
POWER SUNROOF	800.00
AUDIO SYSTEM WITH NAVIGATION AM/FM/SIRIUSXM STEREO W/	795.00

INTELLILINK WITH 7" DIAGONAL SCREEN, USB PORT, INPUT JACK CARBON BLACK METALLIC FRONT & REAR SPLASH GUARDS (DEALER INSTALLED) FLOOR MATS, ALL WEATHER FRONT AND REAR (DEALER INSTALLED) CARGO TRAY (DEALER INSTALLED) CUSTOMER DIALOG NETWORK

TOTAL OPTIONS \$
TOTAL VEHICLE & OPTIONS \$3
DESTINATION CHARGE

TOTAL VEHICLE PRICE* \$32

EPA DOT Fuel Economy and Environment

Gasoline Vehicle

Fuel Economy
28 MPG
combined city/hwy
25 city
33 highway
3.6 gallons per 100 miles

Small SUVs range from 16 to 30 MPG. The best vehicle rates 112 MPGe.

You save
\$2,100
in fuel costs
over 5 years
compared to the
average new vehicle.

Annual fuel cost
\$1,900

Fuel Economy & Greenhouse Gas Rating (tailpipe only)

8

This vehicle emits 295 grams CO₂ per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions; learn more at fuelconomy.gov.

Smog Rating (tailpipe only)

6

Best

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. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fuelconomy.gov

Calculate personalized estimates and compare vehicles



GOVERNMENT 5-STAR SAFETY RATINGS

This vehicle has not been rated by the government for overall vehicle score, frontal crash, side crash or rollover risk.

Source: National Highway Traffic Safety Administration (NHTSA)
www.safercar.gov or 1-888-327-4236



Equipped with the safety and connectivity of OnStar.

Push your blue button or visit onstar.com for details.

PARTS CONTENT INFORMATION

FOR VEHICLES IN THIS CARLINE:
U.S./CANADIAN PARTS CONTENT: 21%
MAJOR SOURCES OF FOREIGN PARTS CONTENT: KOREA 51%
CHINA 18%

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

FOR THIS VEHICLE:
FINAL ASSEMBLY POINT:
BUPYEONG GU, IN KOREA
COUNTRY OF ORIGIN:
ENGINE: UNITED STATES
TRANSMISSION: KOREA

ORDER NO ORSW4V SALES CODE E
SALES MODEL CODE 43V78
DEALER NO 46453
FINAL ASSEMBLY:
BUPYEONG GU, IN KOREA
VIN KL4CJDSB5DB10
DEALER TO WHOM DELIVERED



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

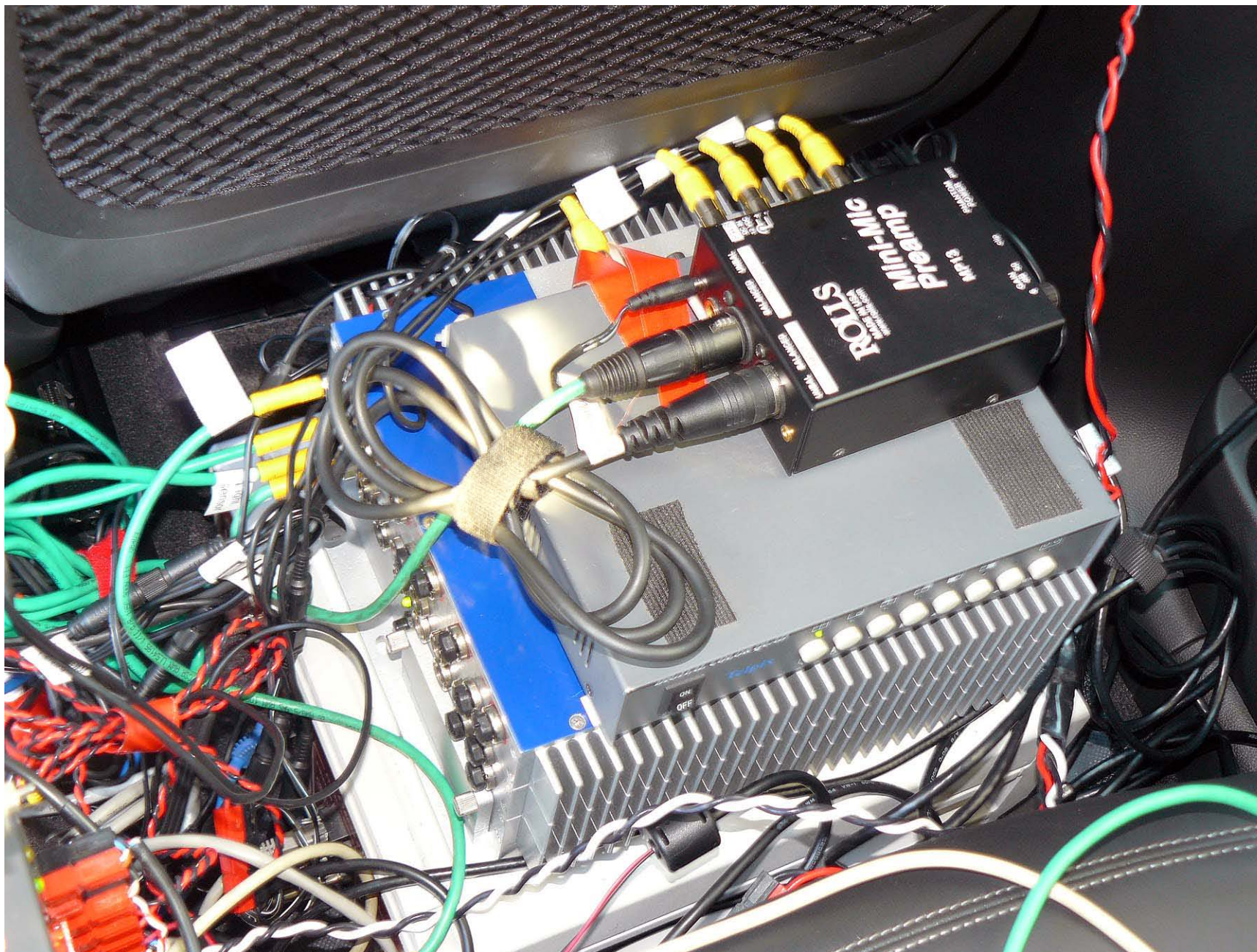


Figure A8. Data Acquisition System Installed in Subject Vehicle



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. FCW On/Off and Distance Switch

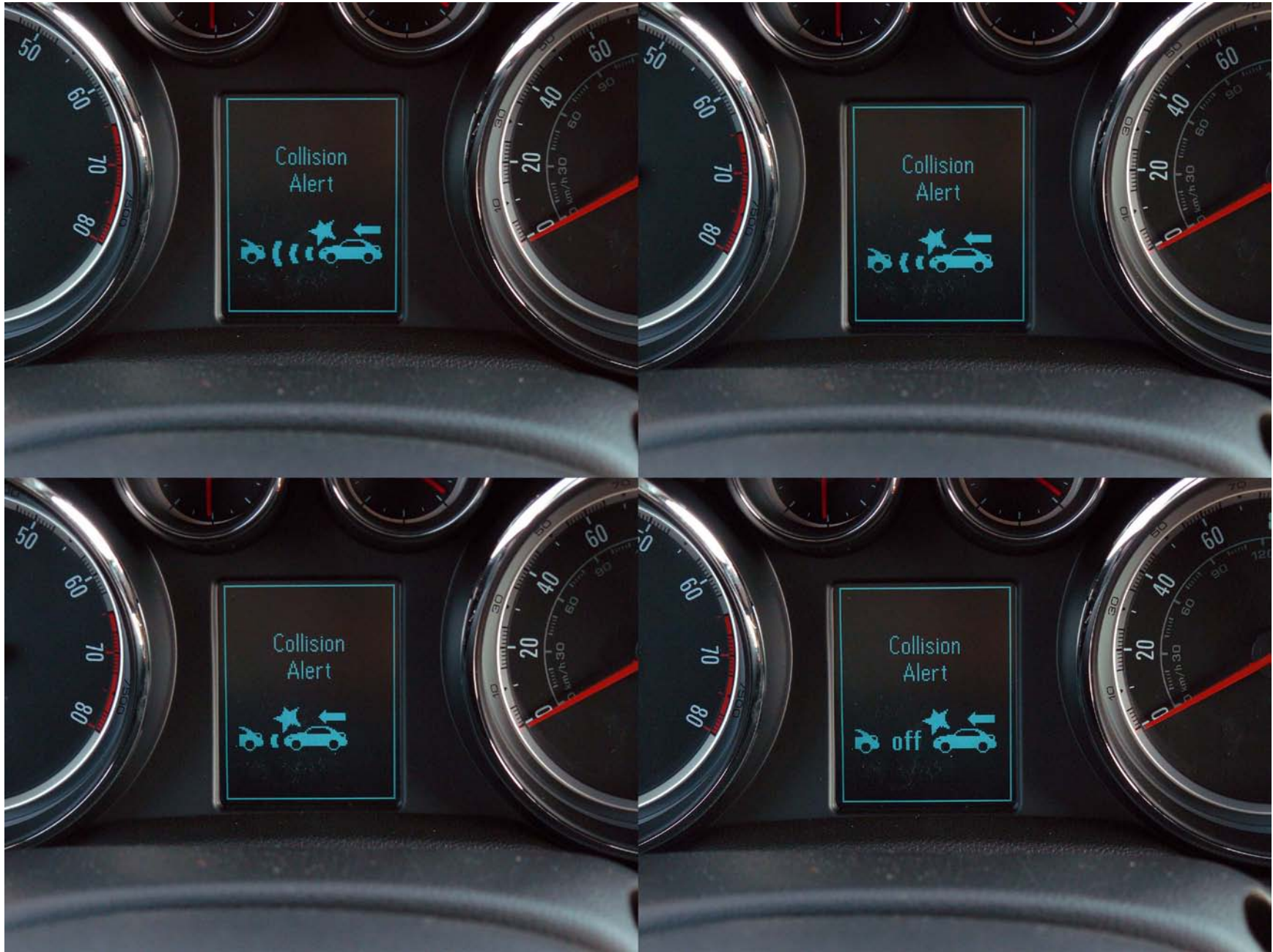


Figure A14. Displays for FCW Range Adjustment

APPENDIX B

Excerpts from Owner's Manual

5-18 Instruments and Controls

If this light stays on, or comes on while driving, the system may not be working. If this happens, see your dealer for service.

Lane Departure Warning (LDW) Light



For vehicles with the LDW system, this light briefly comes on amber while starting the vehicle. If it does not, have the vehicle serviced by your dealer. If the system is working normally, the indicator light then turns off.

This light also comes on green when the system is switched on and ready to operate.

See *Lane Departure Warning (LDW)* on page 9-40.

Vehicle Ahead Indicator



If available, this light displays green when a vehicle is detected ahead.

See *Forward Collision Alert (FCA) System* on page 9-34.

Traction Off Light



This light comes on briefly while starting the engine. If it does not, have the vehicle serviced by your dealer. If the system is working normally, the indicator light then turns off.

The traction off light comes on when the Traction Control System (TCS) has been turned off by pressing and releasing the TCS/StabiliTrak button.

This light and the StabiliTrak OFF light come on when StabiliTrak is turned off.

If the TCS is off, wheel spin is not limited. Adjust driving accordingly.

See *Traction Control System (TCS)* on page 9-28 and *StabiliTrak® System* on page 9-30.

StabiliTrak® OFF Light



This light comes on briefly while starting the engine. If it does not, have the vehicle serviced by your dealer.

5-28 Instruments and Controls

If this message is on, but there is no reduction in performance, proceed to your destination. The performance may be reduced the next time the vehicle is driven. The vehicle may be driven at a reduced speed while this message is on, but maximum acceleration and speed may be reduced. Anytime this message stays on, the vehicle should be taken to your dealer for service as soon as possible.

Fuel System Messages

FUEL LEVEL LOW

This message displays when the vehicle is low on fuel. Refuel as soon as possible.

TIGHTEN GAS CAP

This message displays when the fuel cap is not on tight. Tighten the fuel cap.

Lamp Messages

AUTOMATIC LIGHT CONTROL ON

This message is displayed when the automatic light control has been turned on. See *Automatic Headlamp System* on page 6-3.

AUTOMATIC LIGHT CONTROL OFF

This message is displayed when the automatic light control has been turned off. See *Automatic Headlamp System* on page 6-3.

XXX TURN INDICATOR FAILURE

When one of the turn signals is out, this message displays to show which bulb needs to be replaced. See *Bulb Replacement* on page 10-23 and *Replacement Bulbs* on page 10-26 for more information on turn signal bulb replacement.

TURN SIGNAL ON

This message is displayed if the turn signal has been left on. Turn off the turn signal.

Object Detection System Messages

FORWARD COLLISION ALERT OFF

If equipped with the Forward Collision Alert (FCA) system, this message may display if the FCA system cannot activate due to a temporary condition. See *Forward Collision Alert (FCA) System* on page 9-34.

FRONT CAMERA BLOCKED, CLEAN WINDSHIELD

This message displays when the Lane Departure Warning (LDW) and Forward Collision Alert (FCA) systems are disabled because the camera view is blocked and cannot operate properly. It may also activate during heavy rain or due to

road spray. To clean the system, clean the outside of the windshield area in front of the LDW/FCA camera sensor.

LANE DEPARTURE WARNING UNAVAILABLE

If equipped with the Lane Departure Warning (LDW) system, this message may display if the LDW system cannot activate due to a temporary condition. See *Lane Departure Warning (LDW)* on page 9-40.

PARK ASSIST OFF

This message displays when the park assist system has been turned off or when there is a temporary condition causing the system to be disabled. See *Ultrasonic Parking Assist* on page 9-36.

PARK ASSIST FAULT CLEAN BUMPER

This message displays if snow, mud, ice, or dirt is blocking the sensors on the bumpers. Clean the bumpers.

SERVICE LANE DEPARTURE WARNING

This message displays when the Lane Departure Warning (LDW) system is disabled and need service. See your dealer.

SERVICE PARKING ASSIST

This message displays if there is a problem with the Ultrasonic Front and Rear Parking Assist (UFRPA) system. Do not use this system to help you park. See *Ultrasonic Parking Assist* on page 9-36.

Ride Control System Messages

ALL WHEEL DRIVE OFF

If your vehicle has the All-Wheel Drive (AWD) system, this message displays when the rear drive system is overheating. This message turns off when the rear drive system cools down. If the warning message stays on for a while, you need to reset the warning message. To reset the warning message, turn the ignition off and then back on again. If the message stays on, see your dealer right away. See *All-Wheel Drive* on page 9-26 for more information.

SERVICE ALL WHEEL DRIVE SYSTEM

If your vehicle has the All-Wheel Drive (AWD) system, this message displays if a problem occurs with this system. If this message appears, stop as soon as possible and turn off the vehicle. Restart the vehicle and check for the message on the DIC display. If the message

9-34 Driving and Operating

you might have to step on the accelerator pedal to maintain the vehicle speed. When going downhill, you might have to brake or shift to a lower gear to maintain the vehicle speed. When the brakes are applied the cruise control is disengaged.

Ending Cruise Control

There are three ways to end cruise control:

- Step lightly on the brake pedal; when cruise control disengages, the indicator light will not be lit.
- Press .
- Press  to turn the cruise control system off completely. The cruise control cannot be resumed.

Erasing Speed Memory

The cruise control set speed is erased from memory by pressing  or if the vehicle is turned off.

Object Detection Systems

Forward Collision Alert (FCA) System

The Forward Collision Alert (FCA) system may help to avoid or reduce the harm caused by front-end crashes. FCA provides a visual alert and beeps when approaching a vehicle directly ahead too quickly.

The forward-looking FCA camera sensor is on the windshield ahead of the rearview mirror. FCA detects vehicles within a distance of approximately 60 m (197 ft) and operates at speeds above 40 km/h (25 mph).

WARNING

FCA is a warning system and does not apply the brakes. When approaching a slower-moving or stopped vehicle ahead too rapidly, or when following a vehicle too closely, FCA may not provide a warning with enough time to help avoid a crash. FCA does not warn of pedestrians, animals, signs, guardrails, bridges, construction barrels, or other objects. Be ready to take action and apply the brakes. For more information, see *Defensive Driving* on page 9-4.

Detecting the Vehicle Ahead



FCA warnings will not occur unless the FCA system detects a vehicle ahead. The vehicle ahead indicator will display green when a vehicle is detected in front. Vehicles may not be detected on curves, highway exit ramps, or hills; or due to poor visibility. FCA will not detect another vehicle ahead until it is completely in the driving lane.

WARNING

FCA does not provide a warning to help avoid a crash, unless it detects a vehicle. FCA may not detect a vehicle ahead if the FCA sensor is blocked by dirt, snow,
(Continued)

WARNING (Continued)

or ice, or if the windshield is damaged. It may also not detect a vehicle on winding or hilly roads, or in conditions that can limit visibility such as fog, rain, or snow, or if the headlamps or windshield are not cleaned or in proper condition. Keep the windshield, headlamps, and FCA sensors clean and in good repair.

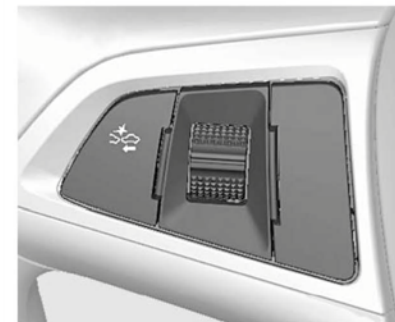
Collision Alert



When your vehicle approaches another vehicle too rapidly, the FCA display will come on and several beeps will sound from the front.

When this occurs, the brake system prepares for driver braking to occur more rapidly, if needed.

Selecting the Alert Timing



The Collision Alert control is on the steering wheel. Press to set the alert timing. The first button press shows the current control setting on the DIC. Additional button presses will change this setting and turn the system off.

Unnecessary Alerts

FCA may provide unnecessary alerts to turning vehicles, vehicles in other lanes, objects that are not vehicles, or shadows. These alerts are normal operation and the vehicle does not need service.

Other Messages

There are messages that may appear on the Driver Information Center (DIC) in the instrument cluster to provide information about FCA. See *Object Detection System Messages* on page 5-28.

Cleaning the System

If the FCA system does not seem to operate properly, clean the outside of the windshield area in front of the camera sensor before considering taking the vehicle in for service.

Ultrasonic Parking Assist

If available, the Ultrasonic Front and Rear Parking Assist (UFRPA) system, assists the driver with

parking and avoiding objects. UFRPA operates at speeds less than 8 km/h (5 mph). The sensors on the front and rear bumper detect objects up to 1.2 m (4 ft) in front of the vehicle, 2.5 m (8 ft) behind the vehicle, and at least 25 cm (10 in) off the ground and below liftgate level. This detection distance may be less during warmer or humid weather.

WARNING

The parking assist system does not detect children, pedestrians, bicyclists, animals, or objects located below the bumper or that are too close or too far from the vehicle. It is not available at speeds greater than 8 km/h (5 mph). To prevent injury, death, or vehicle damage, even with parking assist, always check the area around the vehicle and check all mirrors before moving forward or backing.

How the System Works

When the vehicle is shifted into R (Reverse) the front and rear sensors are automatically turned on. After the vehicle is shifted out of R (Reverse), the rear sensors are turned off and the front sensors stay on until the vehicle is above a speed of 8 km/h (5 mph). For the front park assist system to be active again without shifting into R (Reverse), the park assist button on the center stack must be pressed. See "Turning the System On and Off" later in this section.

UFRPA operates only at speeds less than 8 km/h (5 mph).

When the vehicle is in N (Neutral), the system may be active. If the vehicle is in a car wash, the sensors may detect objects in the car wash. See "Turning the System On and Off" later in this section to turn the system off.

APPENDIX C

Run Log

Subject Vehicle: 2013 Buick Encore

Date: 13 March 2013

Principal Other Vehicle: 2000 Honda Accord

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
1	FCW1 (Stopped)	Y	2.31	2.16	0.21	Pass	
2		Y	2.26	2.07	0.16	Pass	
3		Y	2.32	2.16	0.22	Pass	
4		Y	2.38	2.23	0.28	Pass	
5		Y	2.35	2.13	0.25	Pass	
6		Y	2.47	2.31	0.37	Pass	
7		Y	2.08	1.90	-0.02	Pass	
8	FCW3 (Slower)	N					yaw rate
9		Y	2.55	2.38	0.55	Pass	
10		Y	2.45	2.26	0.45	Pass	
11		Y	2.48	2.32	0.48	Pass	
12		Y	2.75	2.59	0.75	Pass	
13		Y	2.87	2.70	0.87	Pass	

Subject Vehicle: 2013 Buick Encore

Date: 13 March 2013

Principal Other Vehicle: 2000 Honda Accord

Run	Test Type	Valid Run?	TTCW Sound (sec)	TTCW Light (sec)	TTCW Margin (sec)	Pass/Fail	Notes
14	FCW3 (Slower)	Y	2.66	2.50	0.66	Pass	
15		Y	2.23	2.10	0.23	Pass	
16	FCW2 (Braking)	Y	2.86	2.68	0.46	Pass	
17		Y	2.85	2.66	0.45	Pass	
18		Y	2.60	2.48	0.20	Pass	
19		Y	3.38	3.23	0.98	Pass	
20		N					
21		Y	3.04	2.86	0.64	Pass	
22							skipped
23		Y	3.33	3.19	0.93	Pass	
24		Y	2.51	2.37	0.11	Pass	

APPENDIX D

Time History Plots

LIST OF FIGURES

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

Figure D37. Time History for Run 10, FCW Test 3, Audible Warning.....	D-43
Figure D38. Time History for Run 10, FCW Test 3, Visual Warning.....	D-44
Figure D39. Time History for Run 11, FCW Test 3, Audible Warning.....	D-45
Figure D40. Time History for Run 11, FCW Test 3, Visual Warning.....	D-46
Figure D41. Time History for Run 12, FCW Test 3, Audible Warning.....	D-47
Figure D42. Time History for Run 12, FCW Test 3, Visual Warning.....	D-48
Figure D43. Time History for Run 13, FCW Test 3, Audible Warning.....	D-49
Figure D44. Time History for Run 13, FCW Test 3, Visual Warning.....	D-50
Figure D45. Time History for Run 14, FCW Test 3, Audible Warning.....	D-51
Figure D46. Time History for Run 14, FCW Test 3, Visual Warning.....	D-52
Figure D47. Time History for Run 15, FCW Test 3, Audible Warning.....	D-53
Figure D48. Time History for Run 15, FCW Test 3, Visual Warning.....	D-54

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.

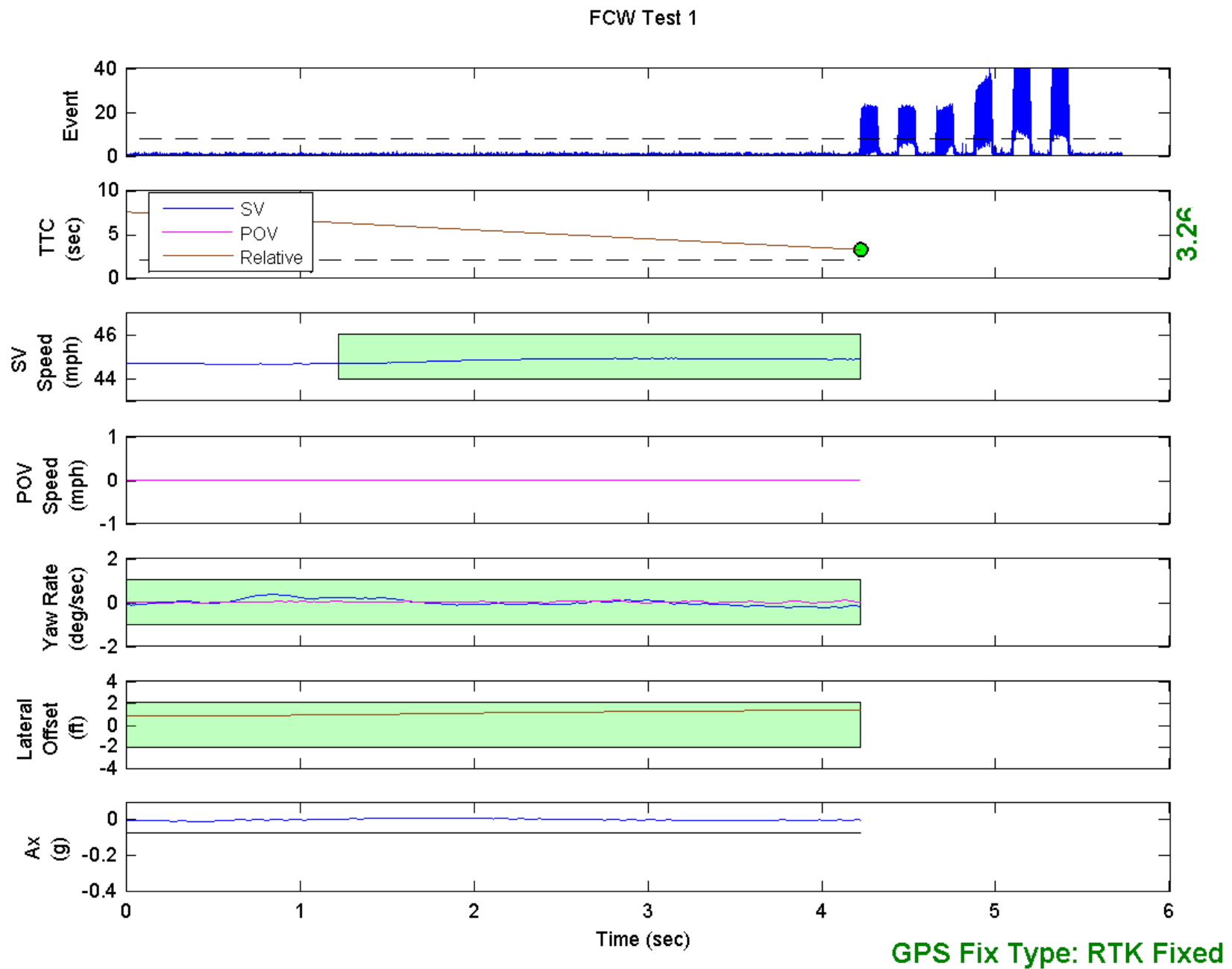


Figure D1. Example Time History for Test Type 1, Passing

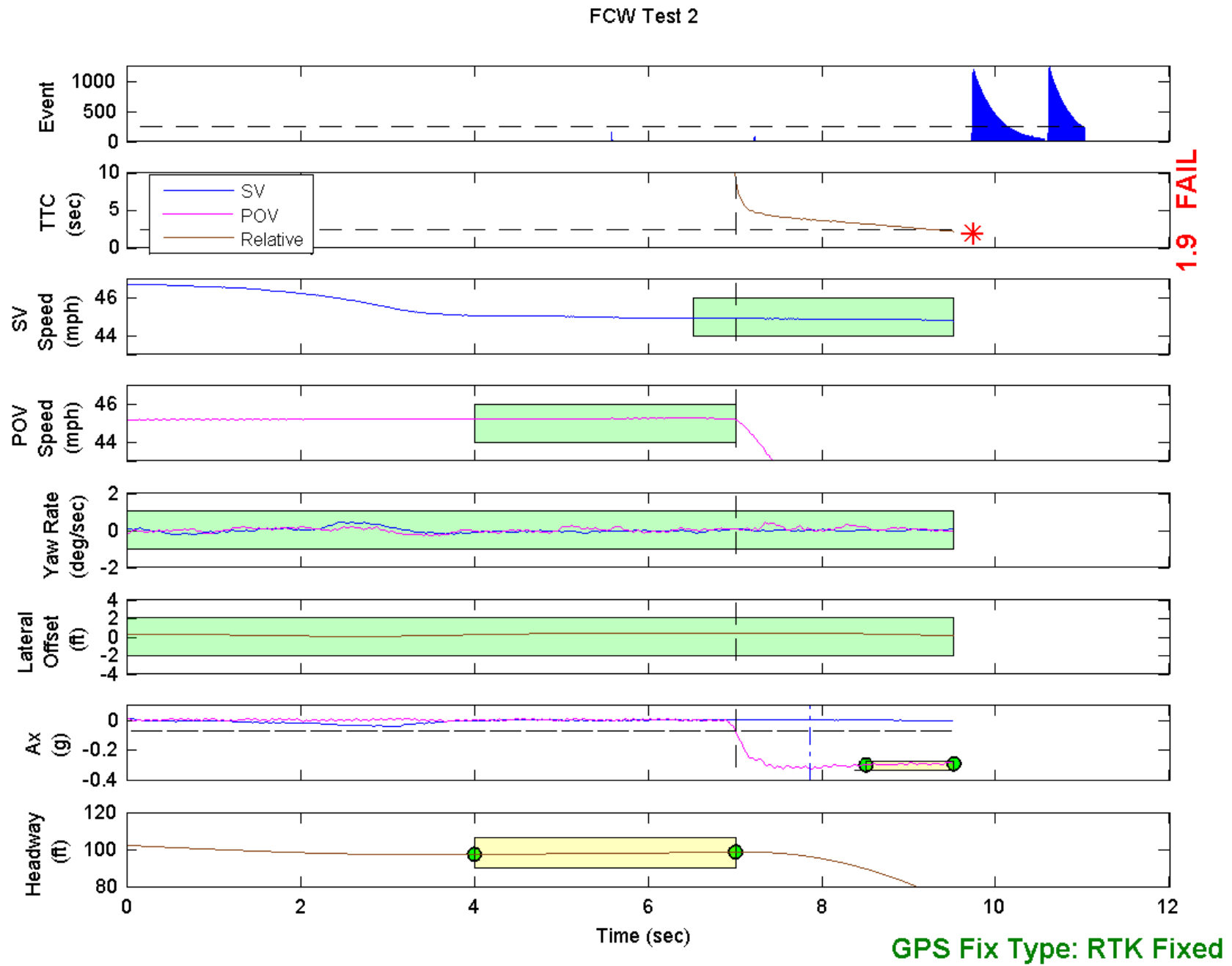


Figure D2. Example Time History for Test Type 2, Failing

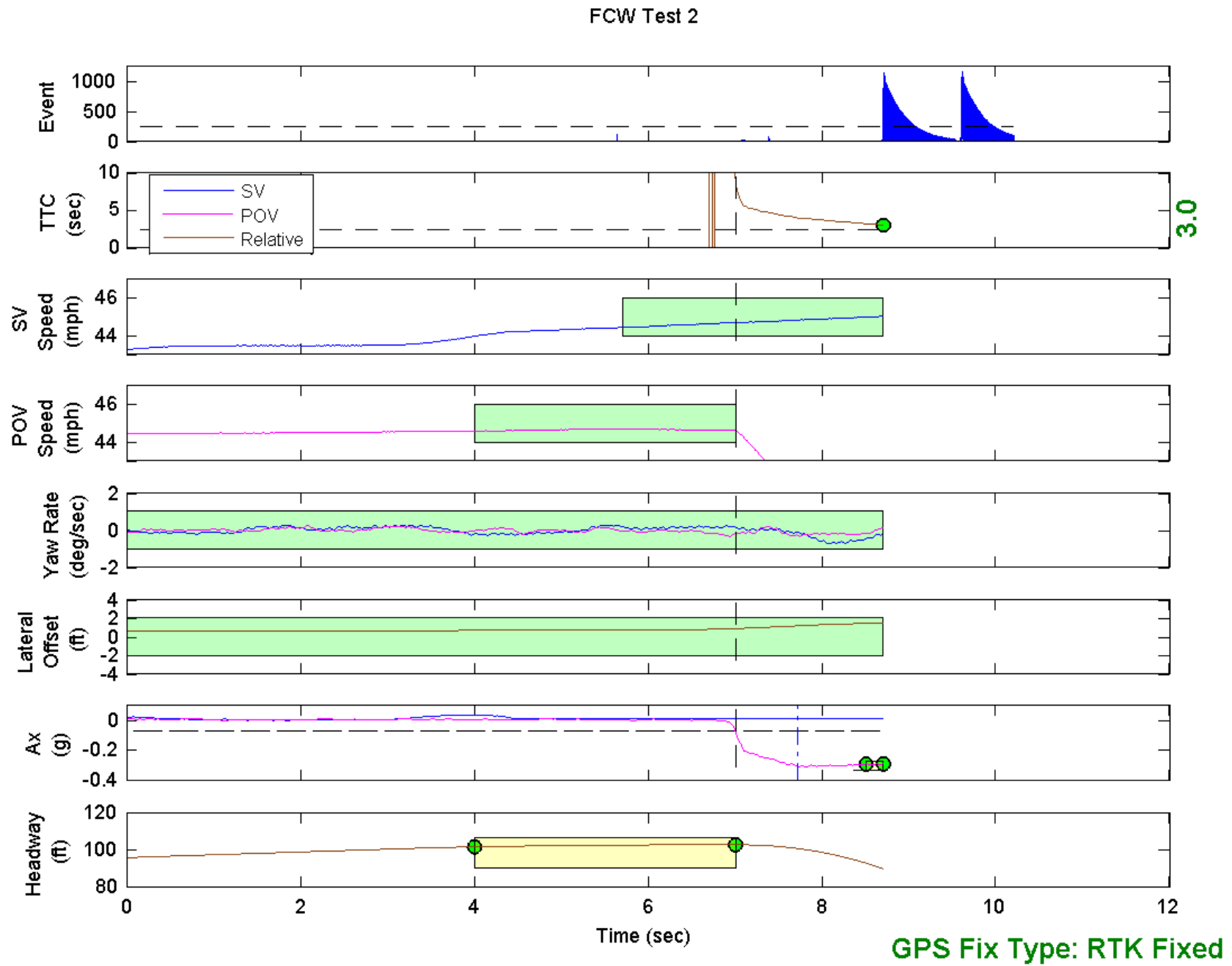


Figure D3. Example Time History for Test Type 2, Passing

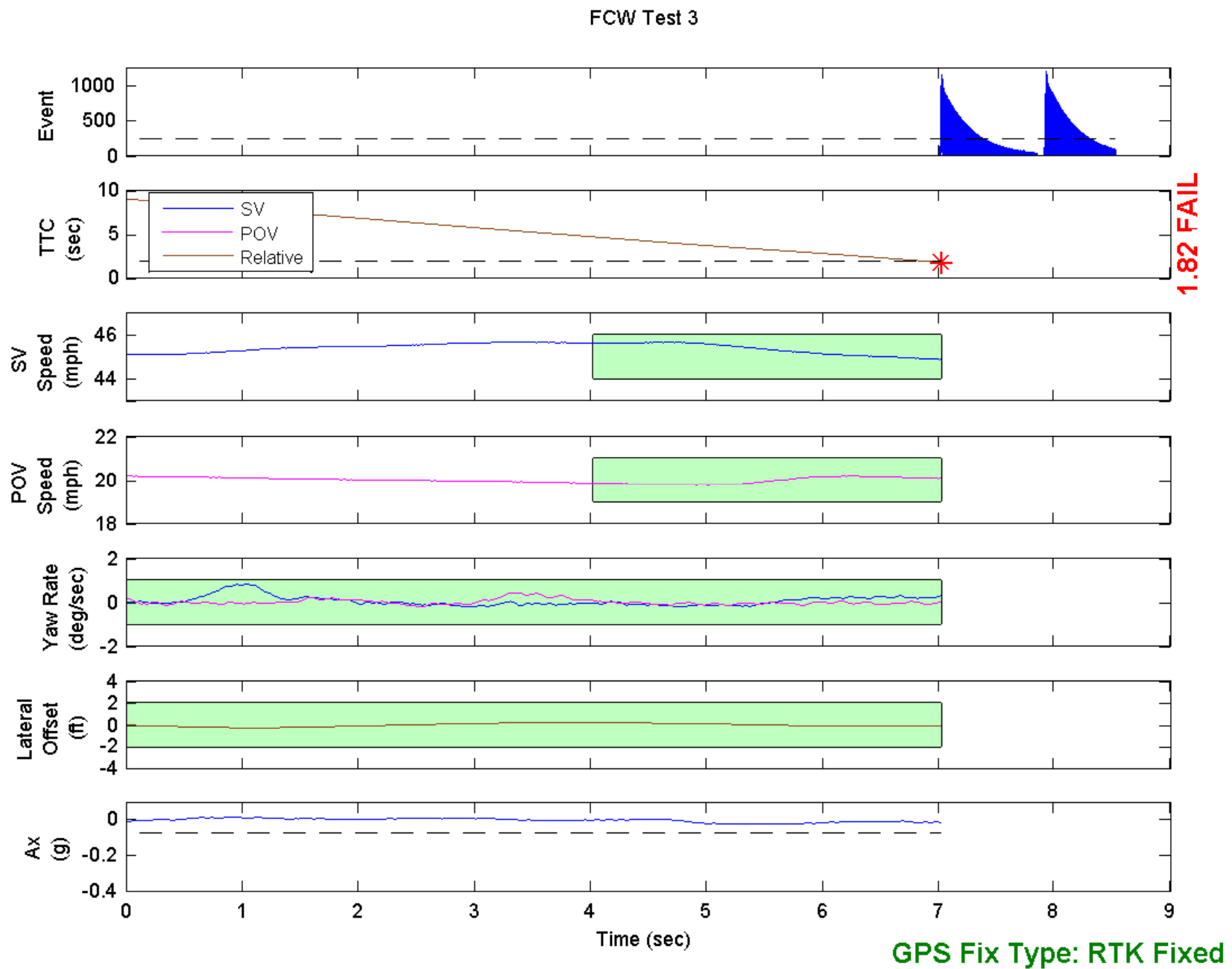


Figure D4. Example Time History for Test Type 3, Failing

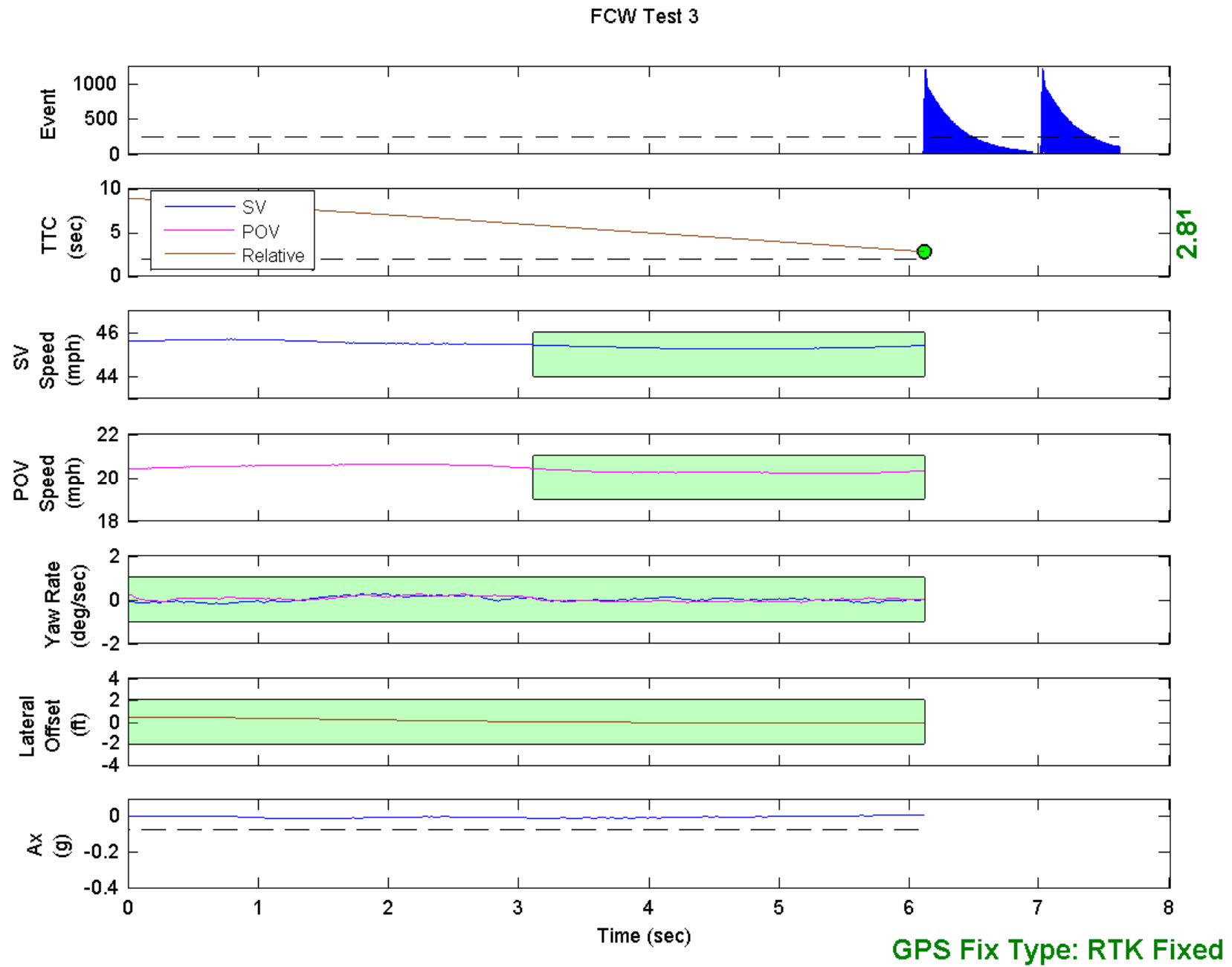


Figure D5. Example Time History for Test Type 3, Passing

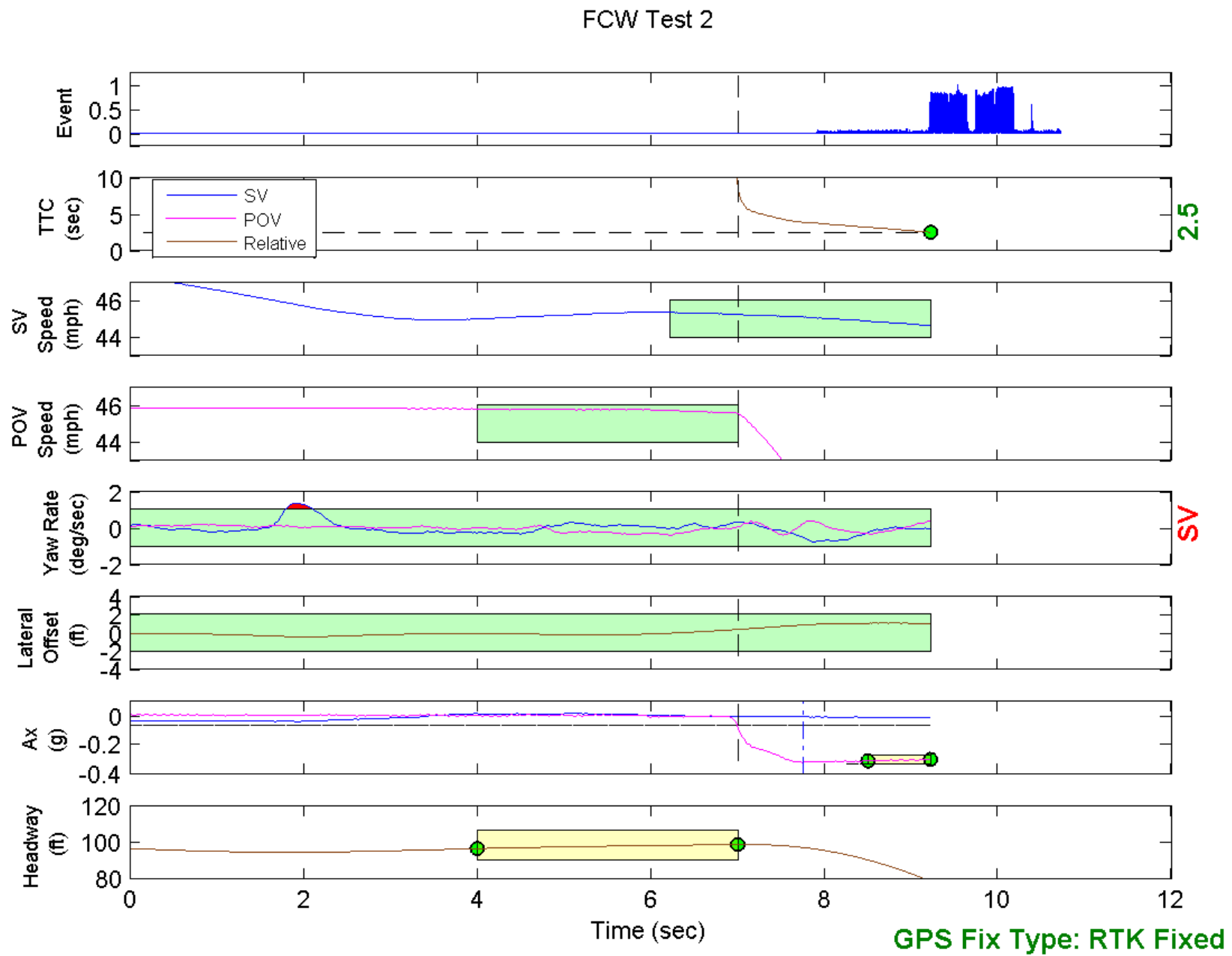


Figure D6. Example Time History for Test Type 2, Invalid Run Due to Subject Vehicle Yaw Rate

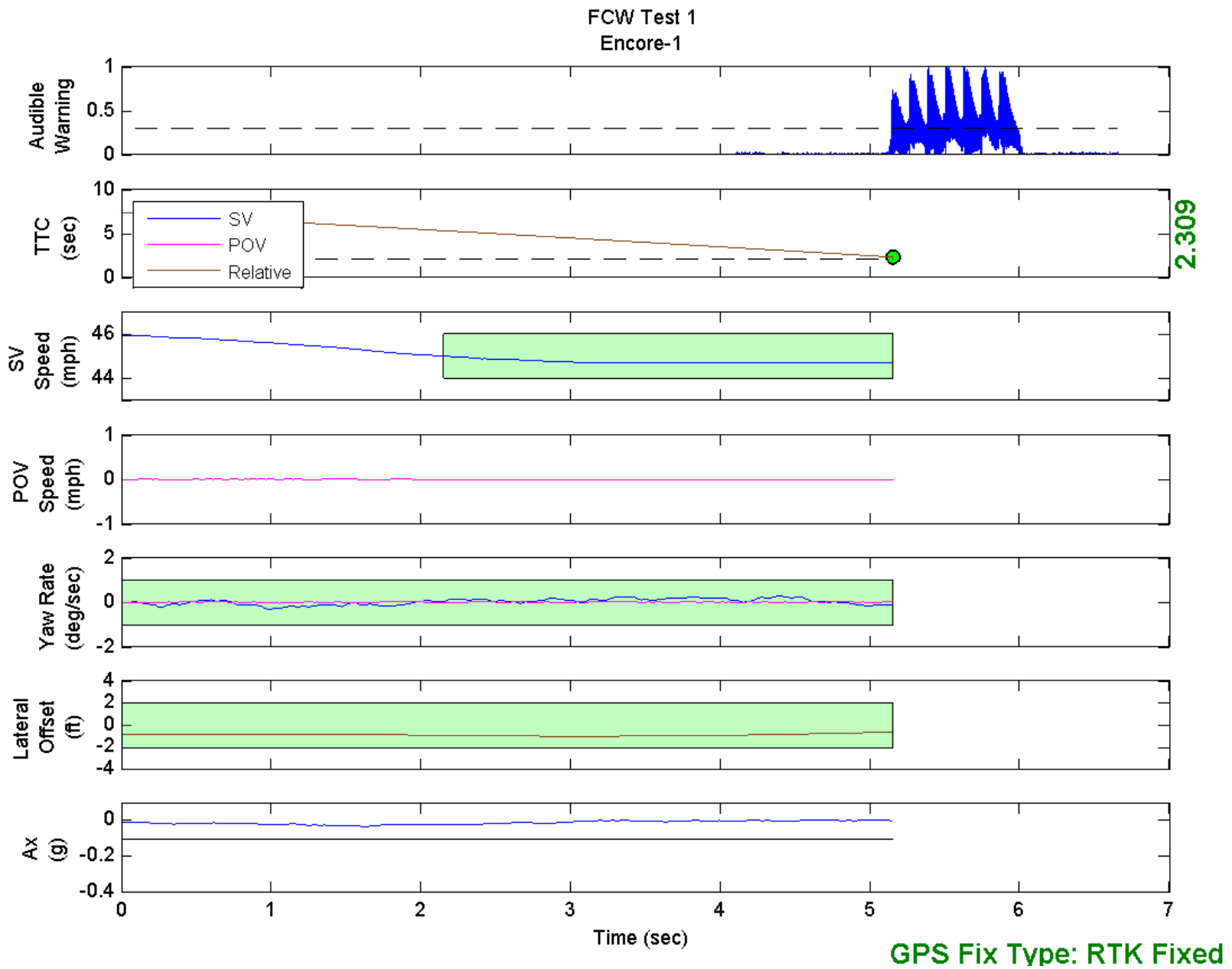


Figure D7. Time History for Run 1, FCW Test 1, Audible Warning

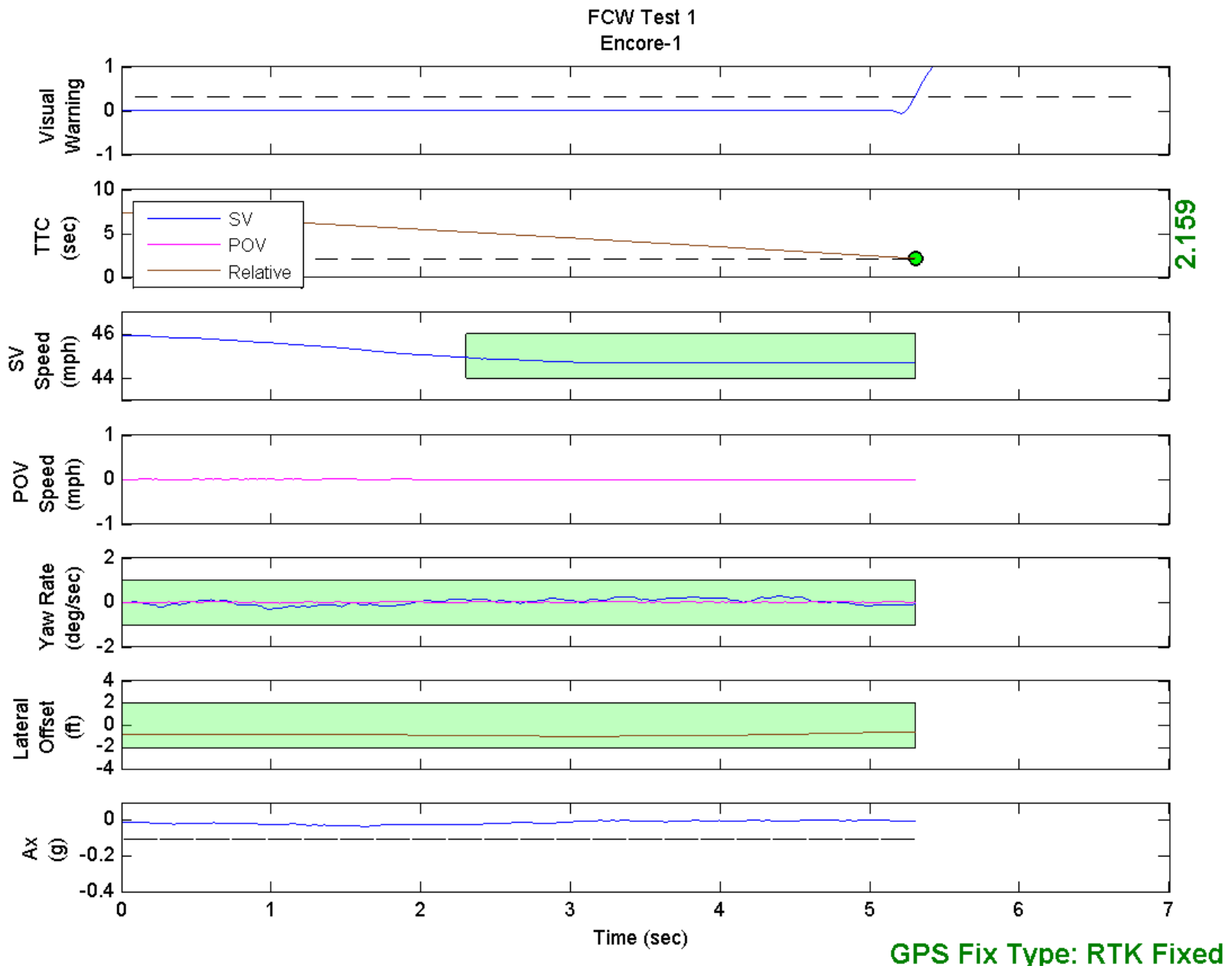


Figure D8. Time History for Run 1, FCW Test 1, Visual Warning

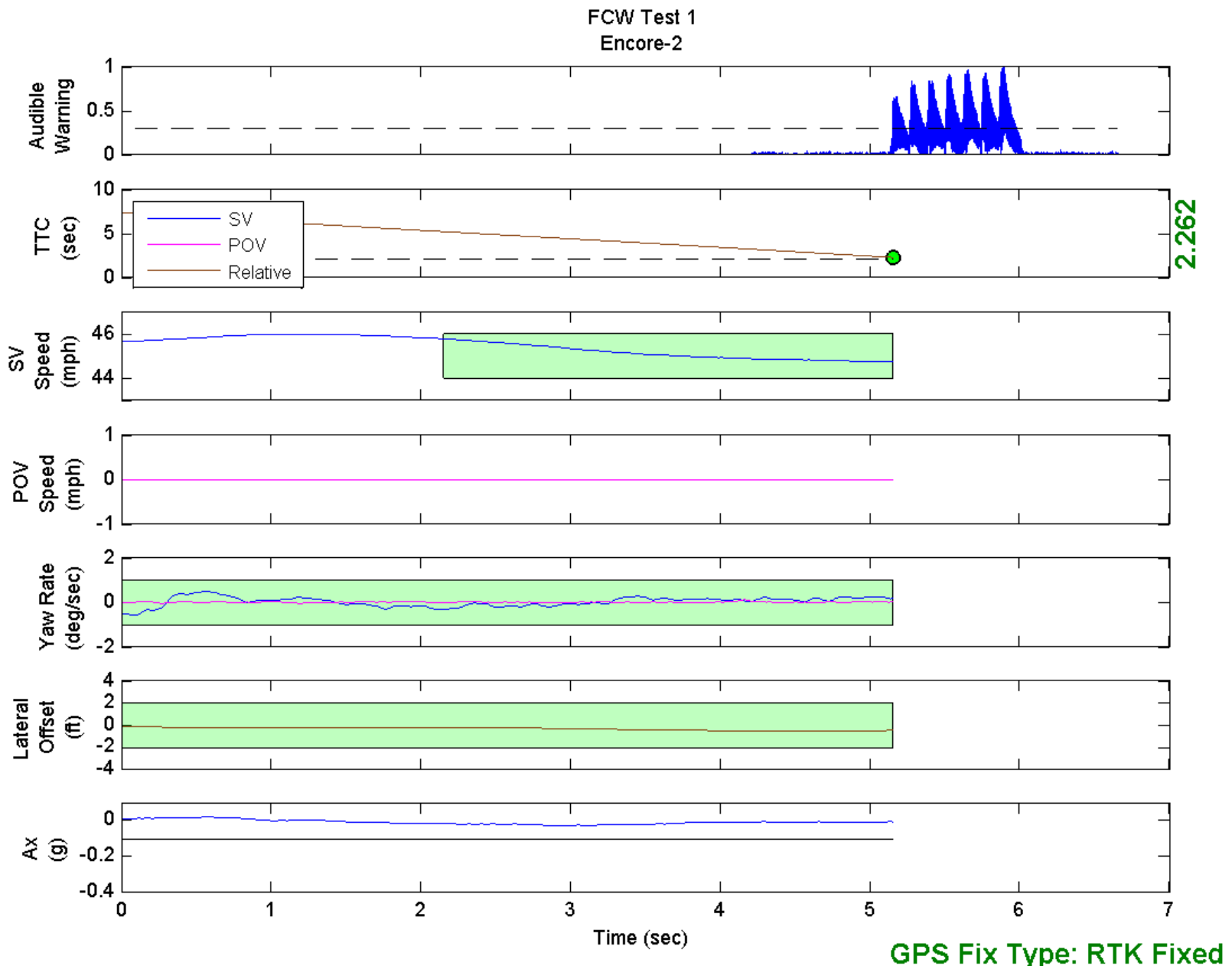


Figure D9. Time History for Run 2, FCW Test 1, Audible Warning

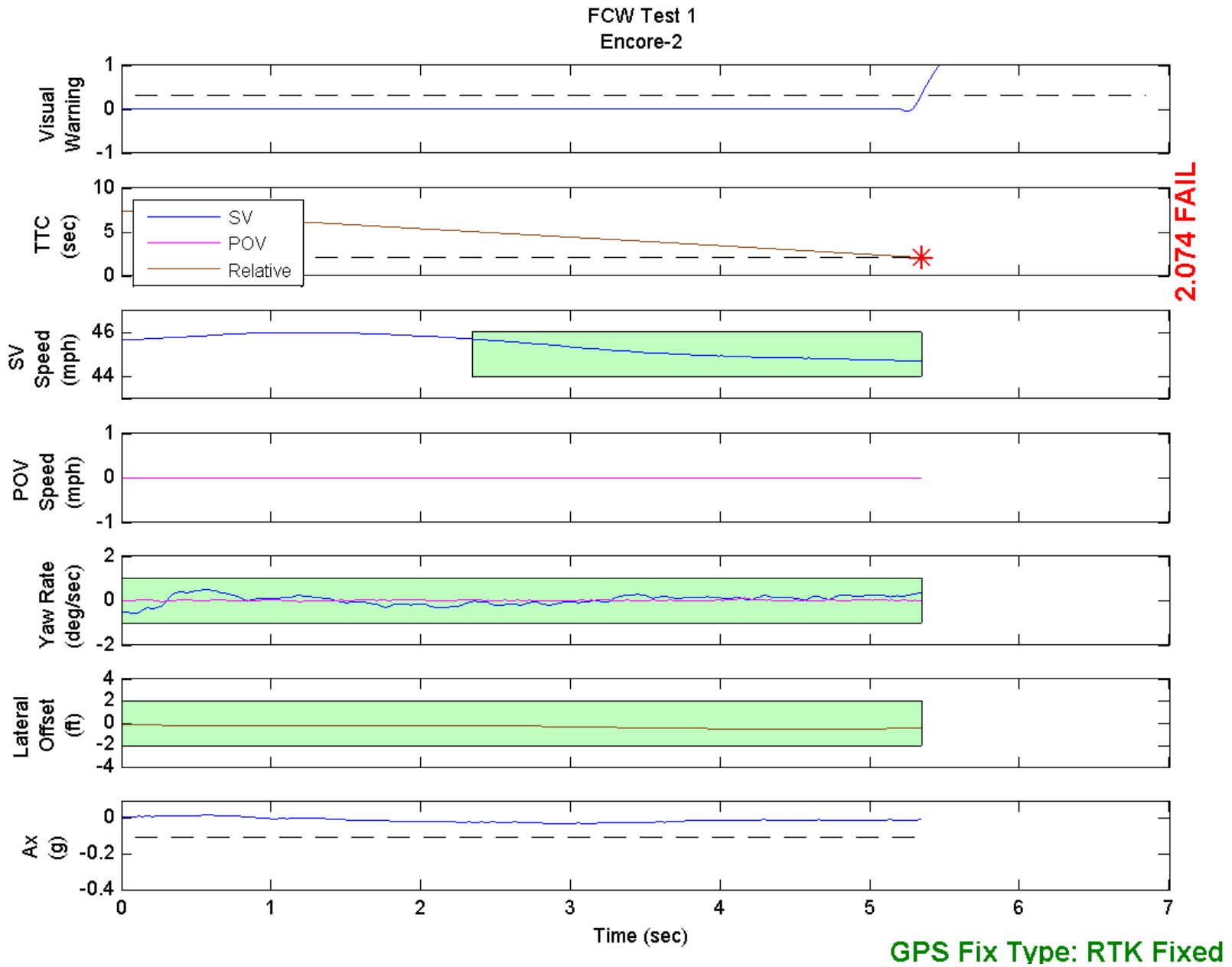


Figure D10. Time History for Run 2, FCW Test 1, Visual Warning

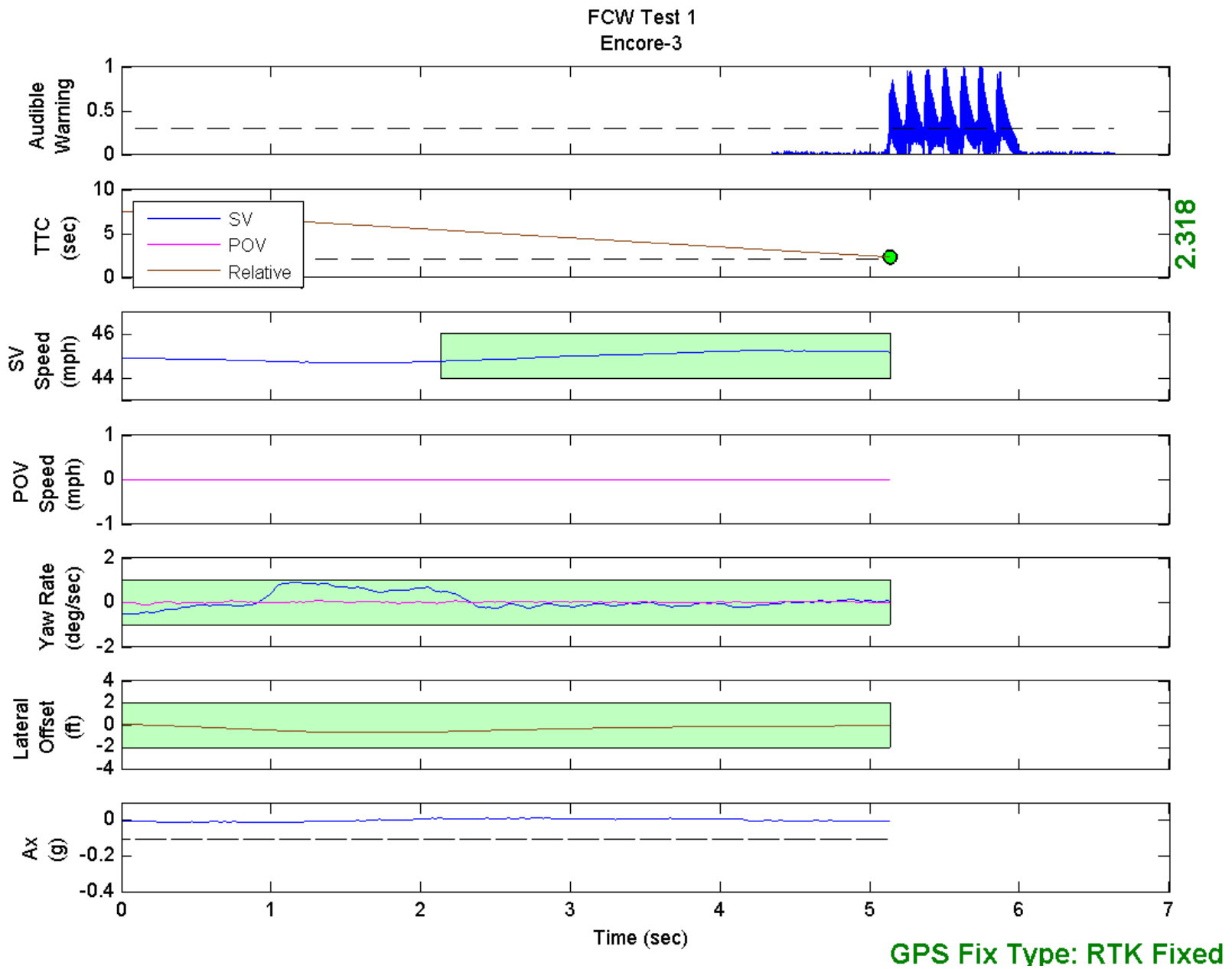


Figure D11. Time History for Run 3, FCW Test 1, Audible Warning

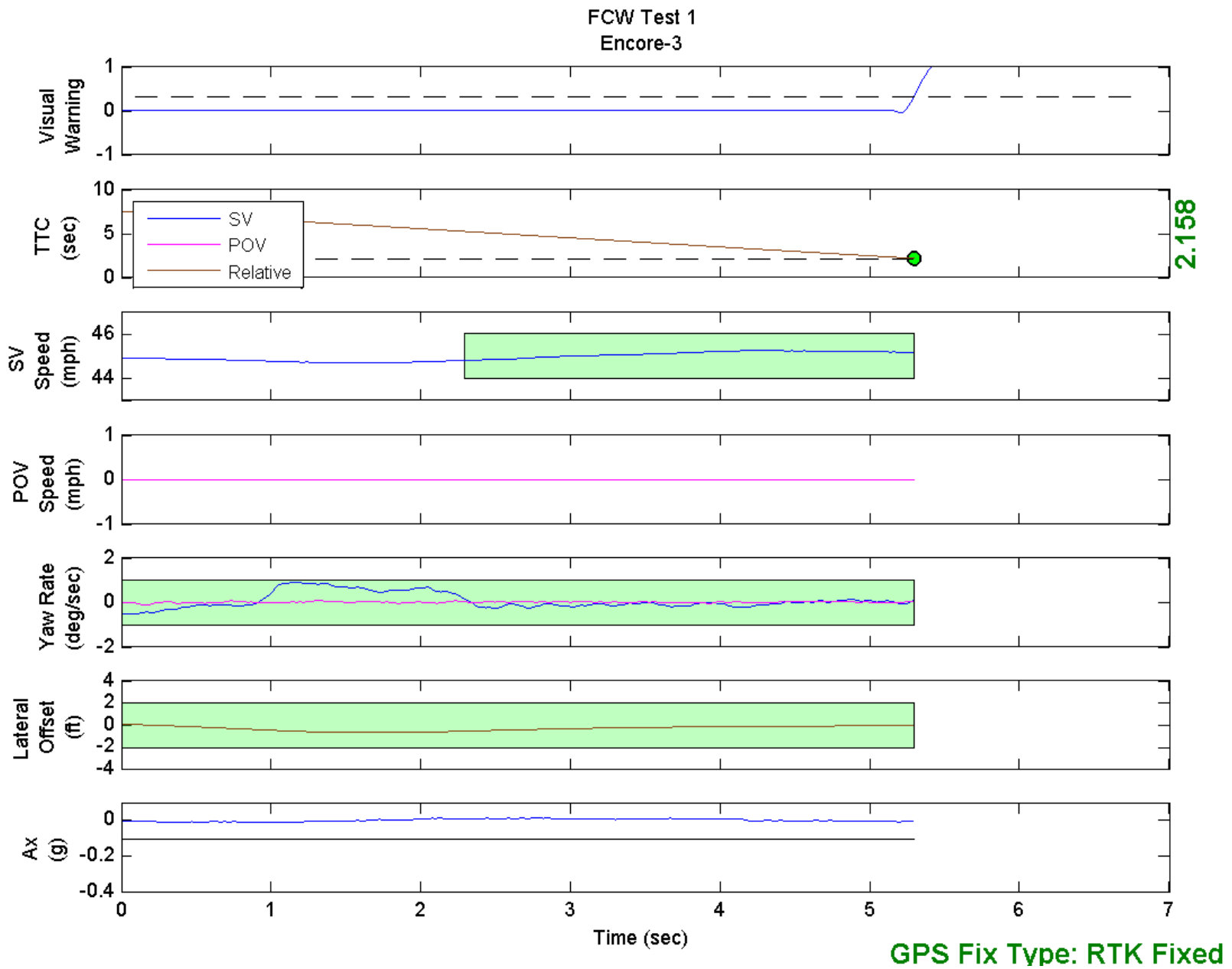


Figure D12. Time History for Run 3, FCW Test 1, Visual Warning

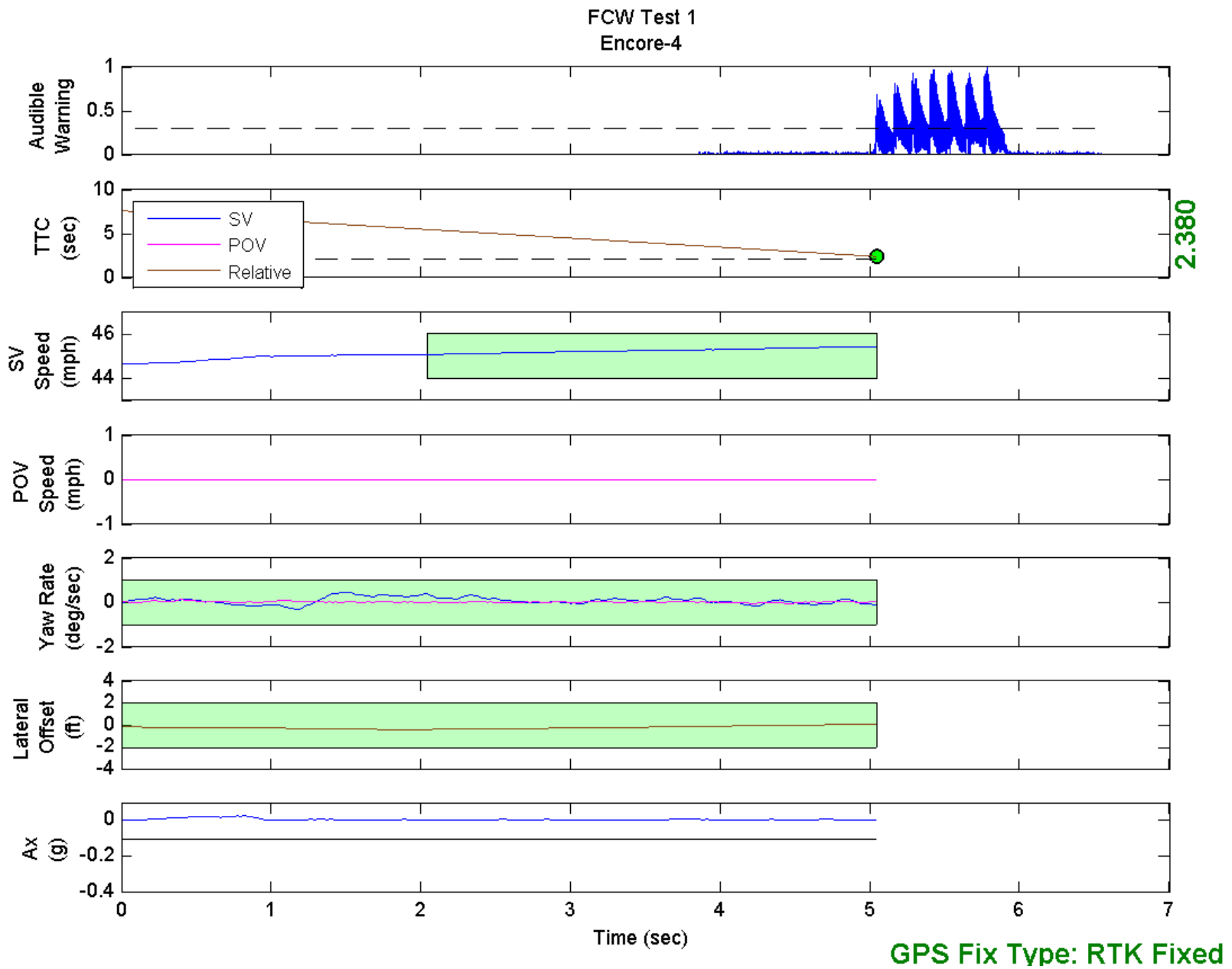


Figure D13. Time History for Run 4, FCW Test 1, Audible Warning

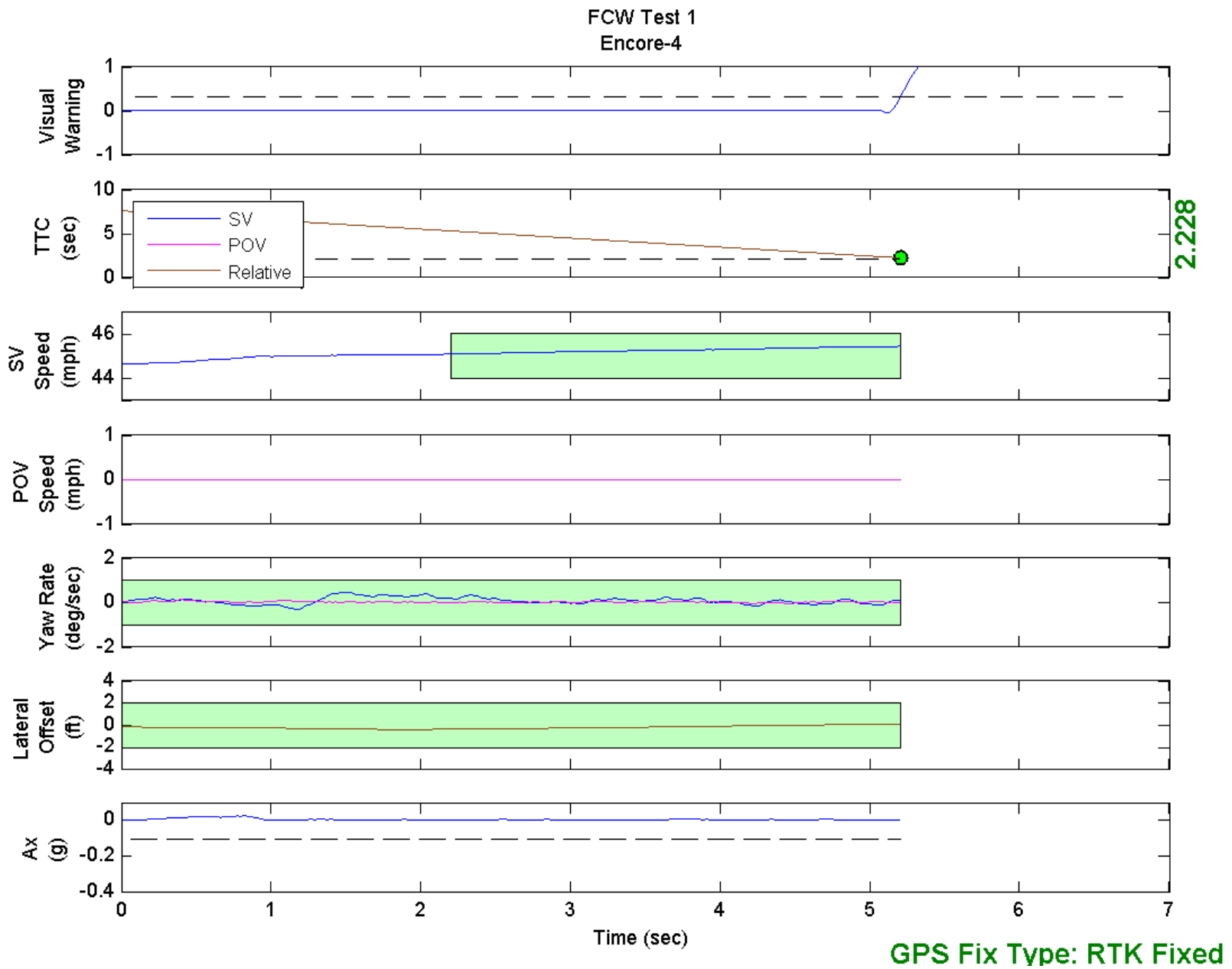


Figure D14. Time History for Run 4, FCW Test 1, Visual Warning

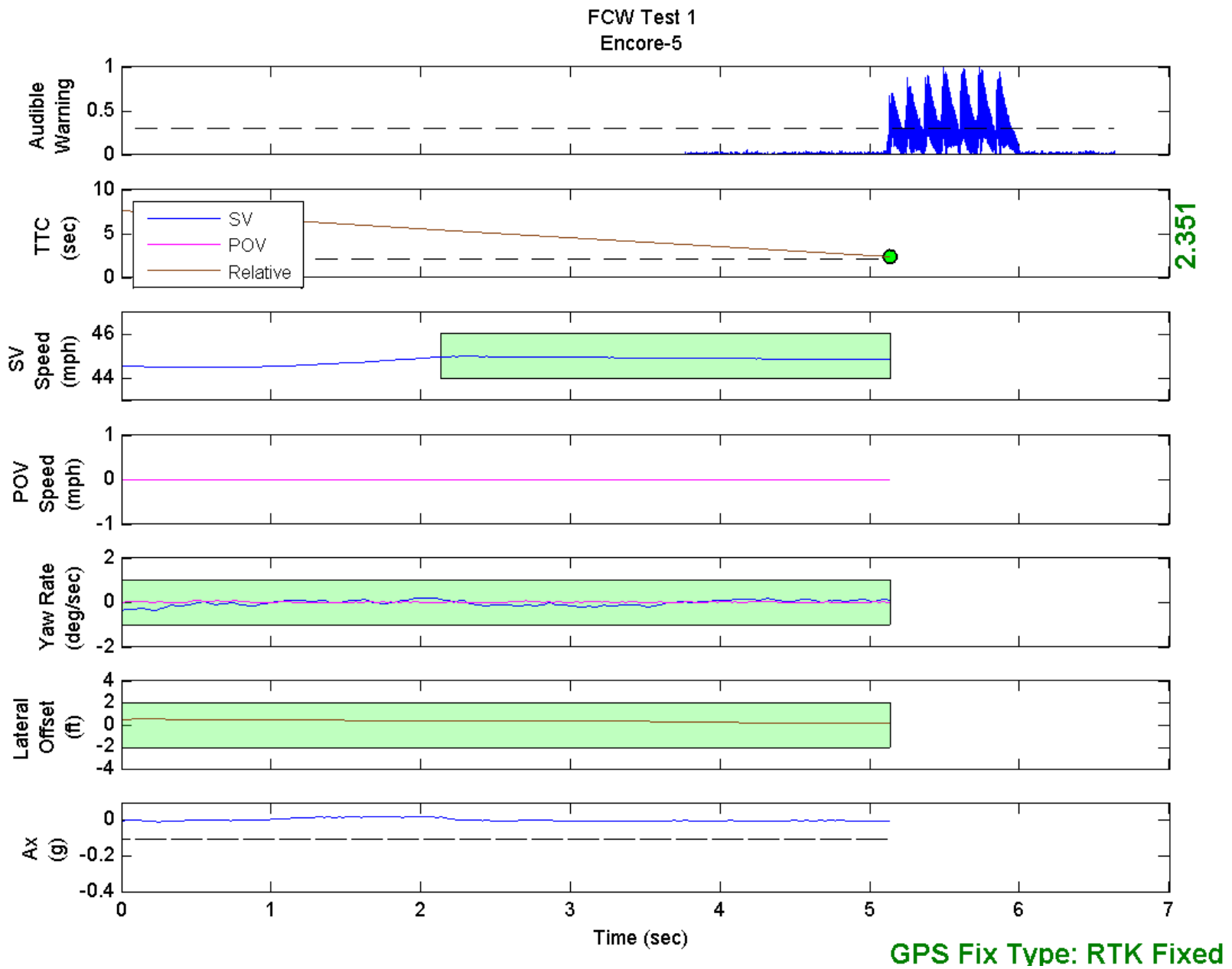


Figure D15. Time History for Run 5, FCW Test 1, Audible Warning

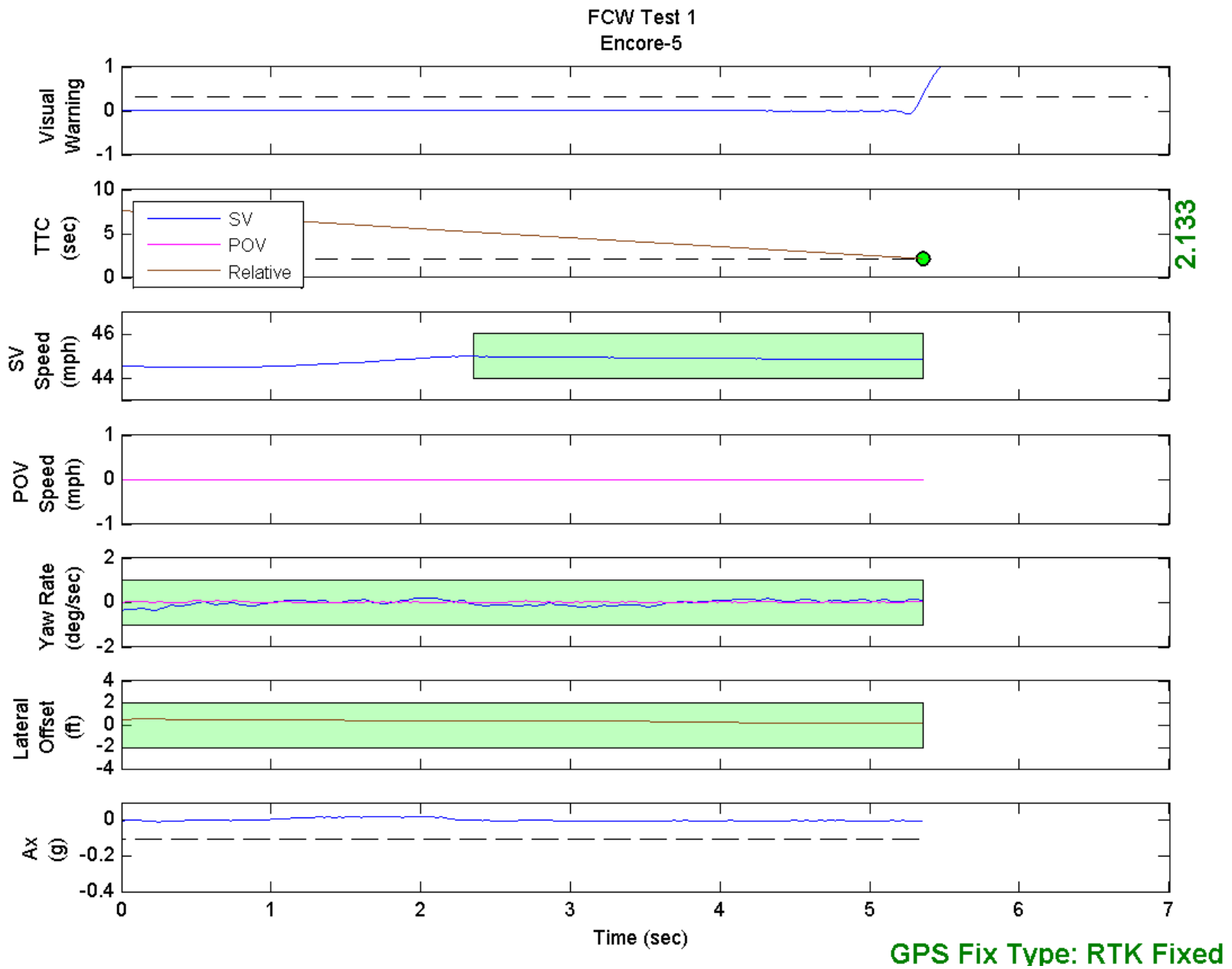


Figure D16. Time History for Run 5, FCW Test 1, Visual Warning

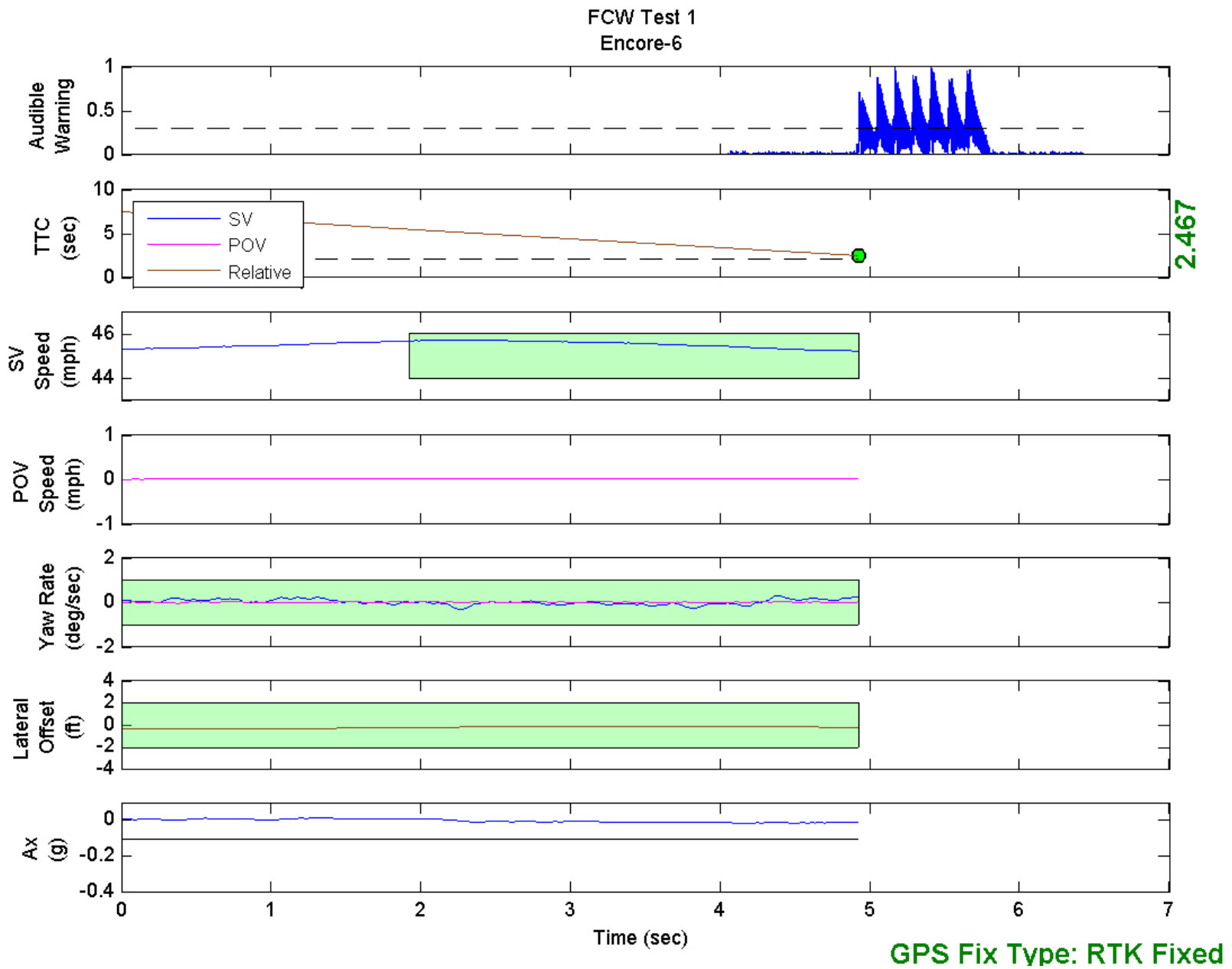


Figure D17. Time History for Run 6, FCW Test 1, Audible Warning

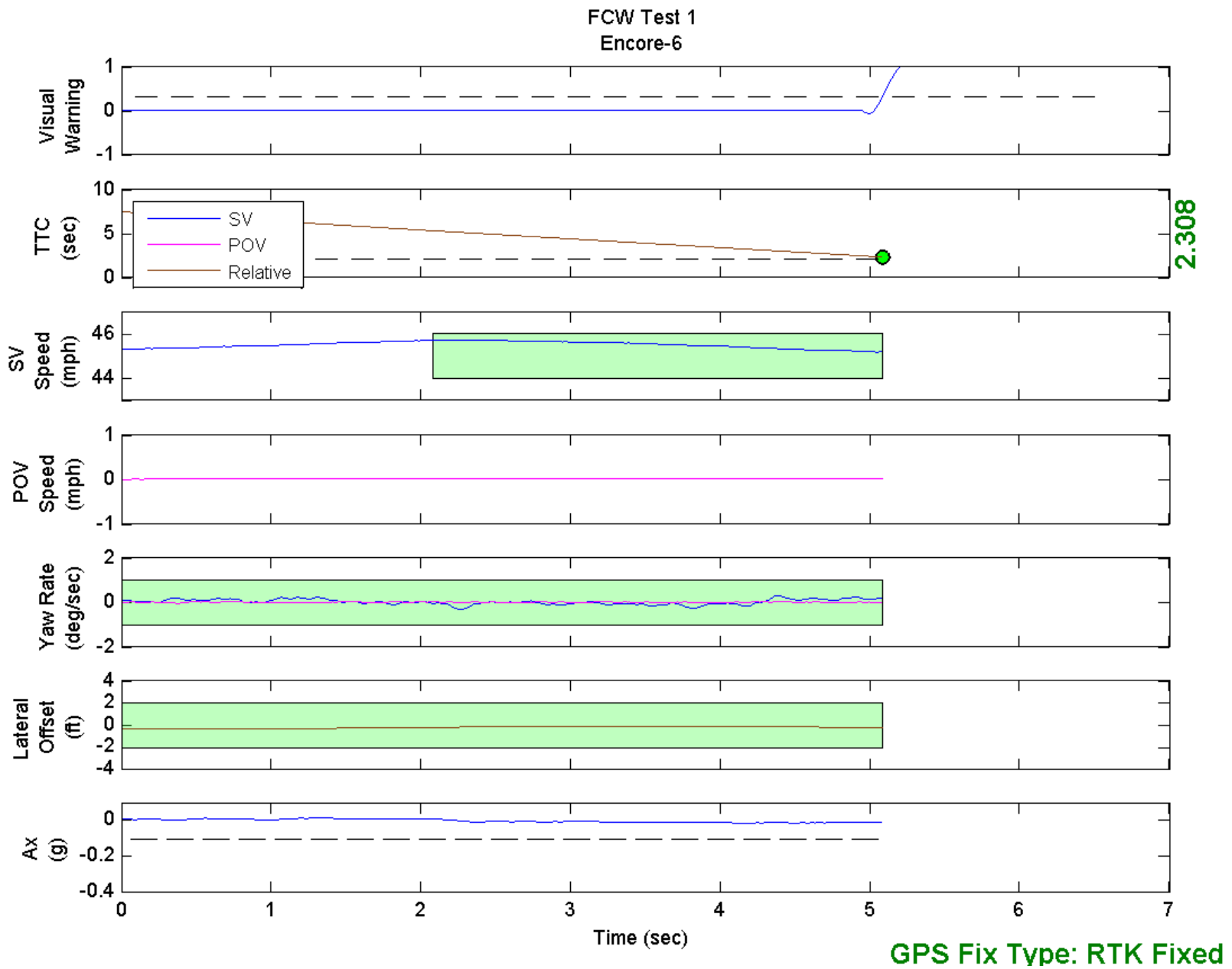


Figure D18. Time History for Run 6, FCW Test 1, Visual Warning

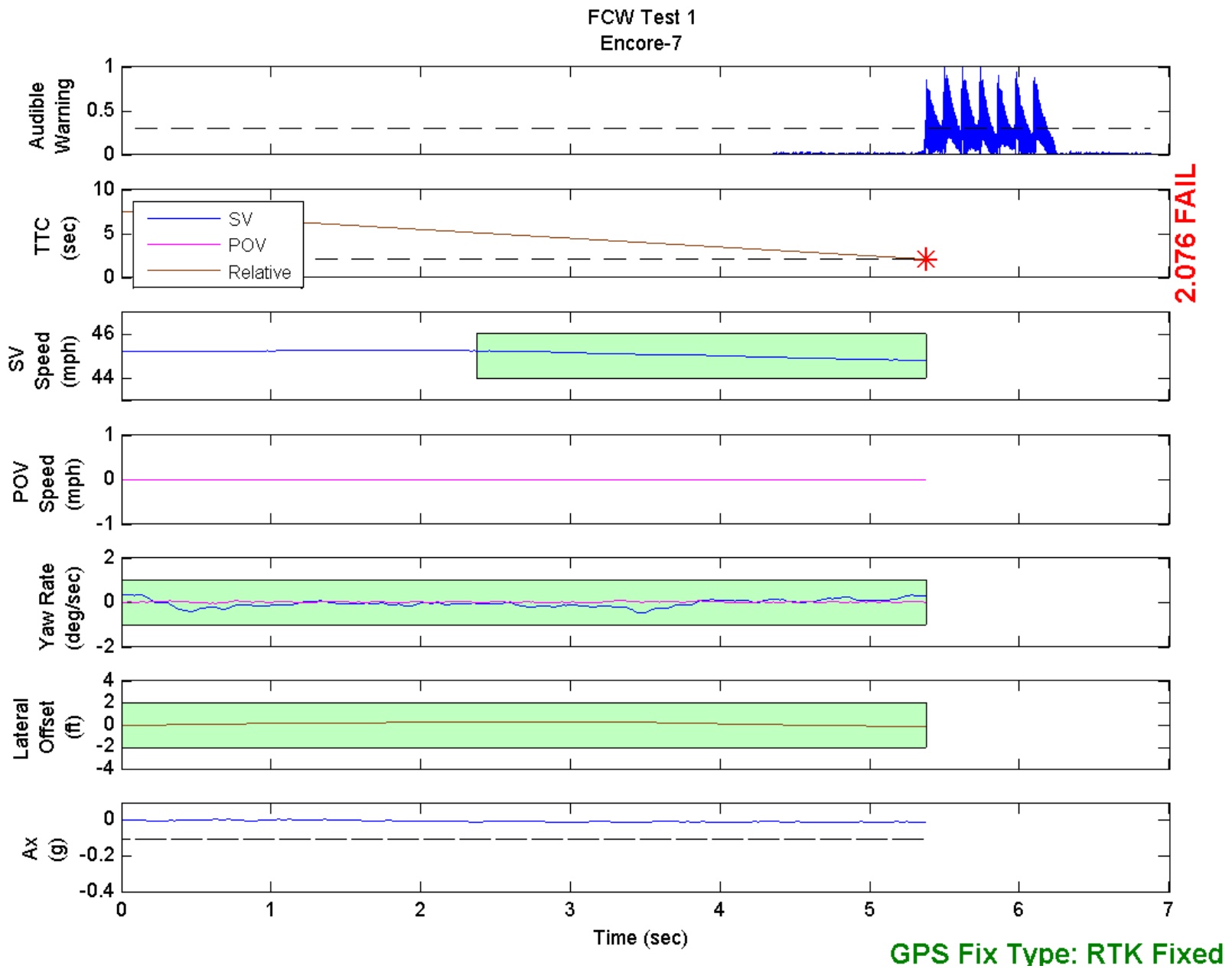


Figure D19. Time History for Run 7, FCW Test 1, Audible Warning

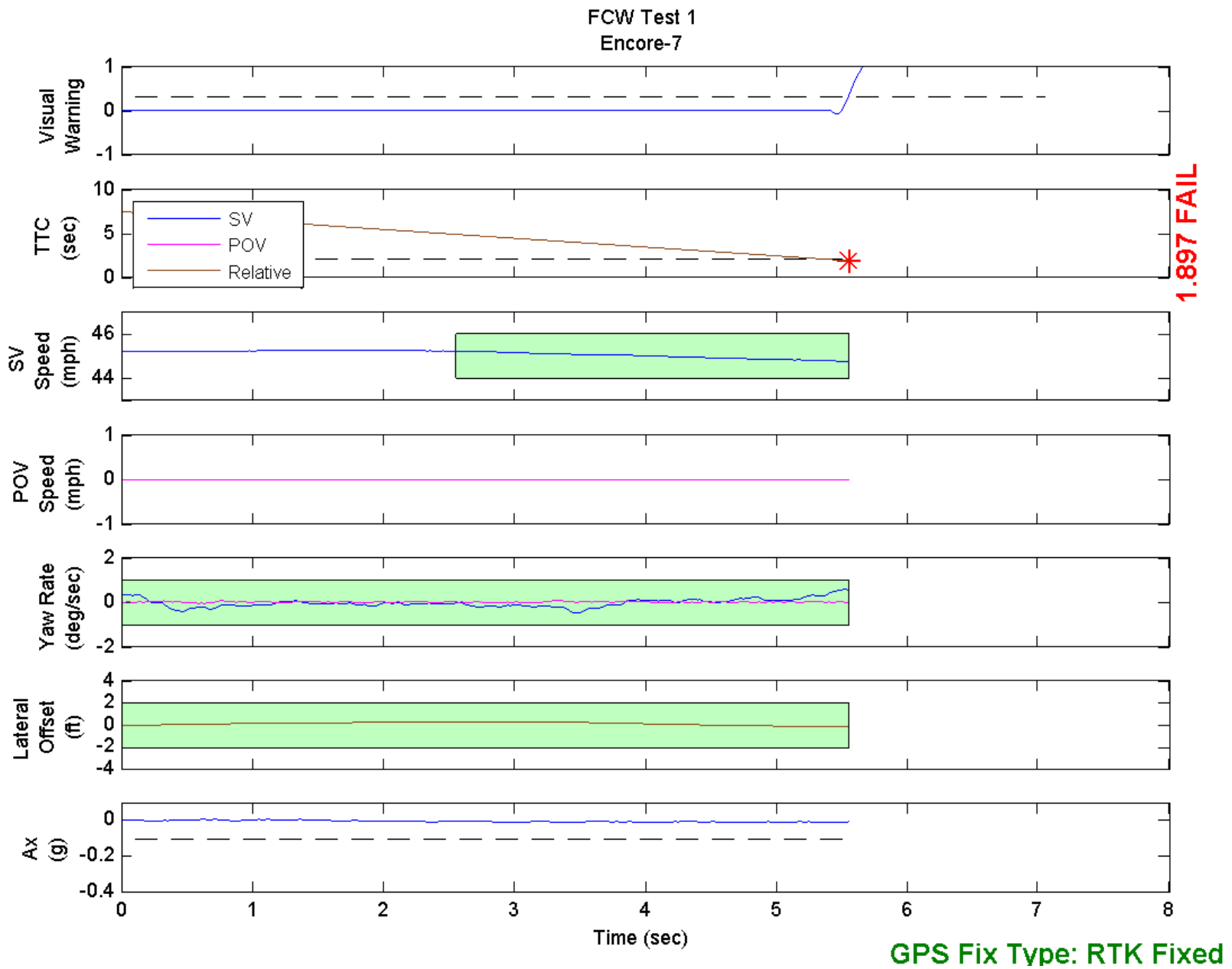


Figure D20. Time History for Run 7, FCW Test 1, Visual Warning

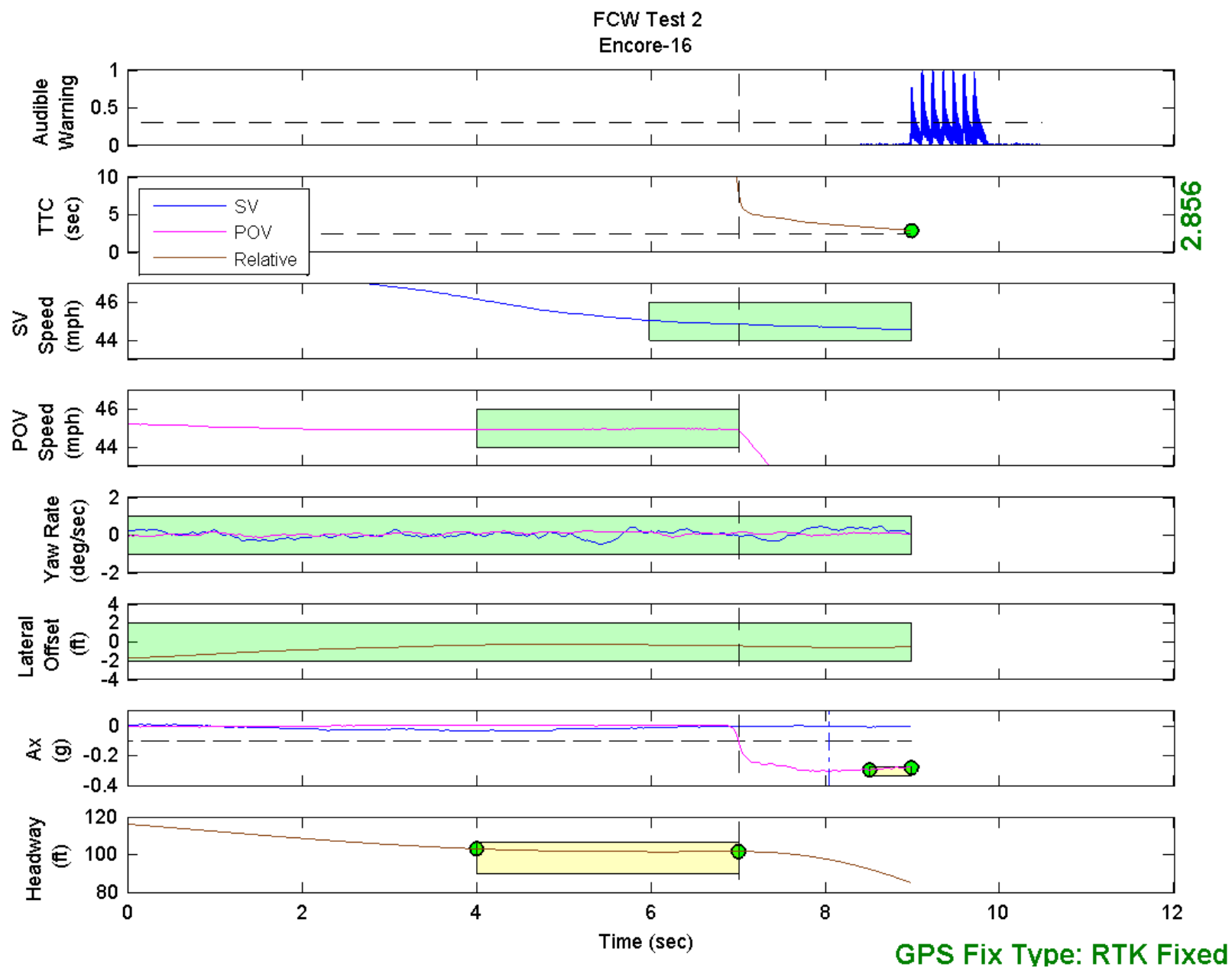


Figure D21. Time History for Run 16, FCW Test 2, Audible Warning

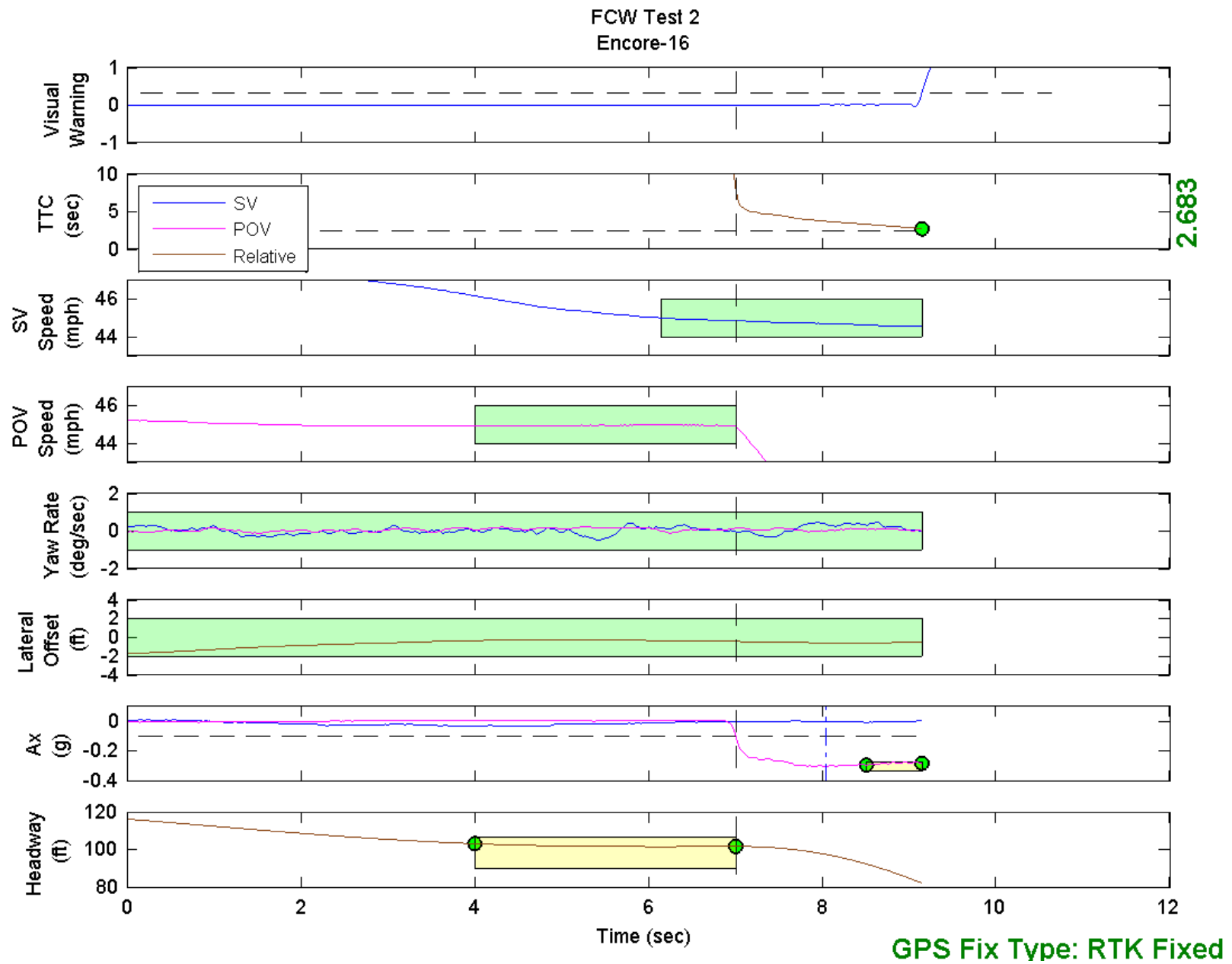


Figure D22. Time History for Run 16, FCW Test 2, Visual Warning

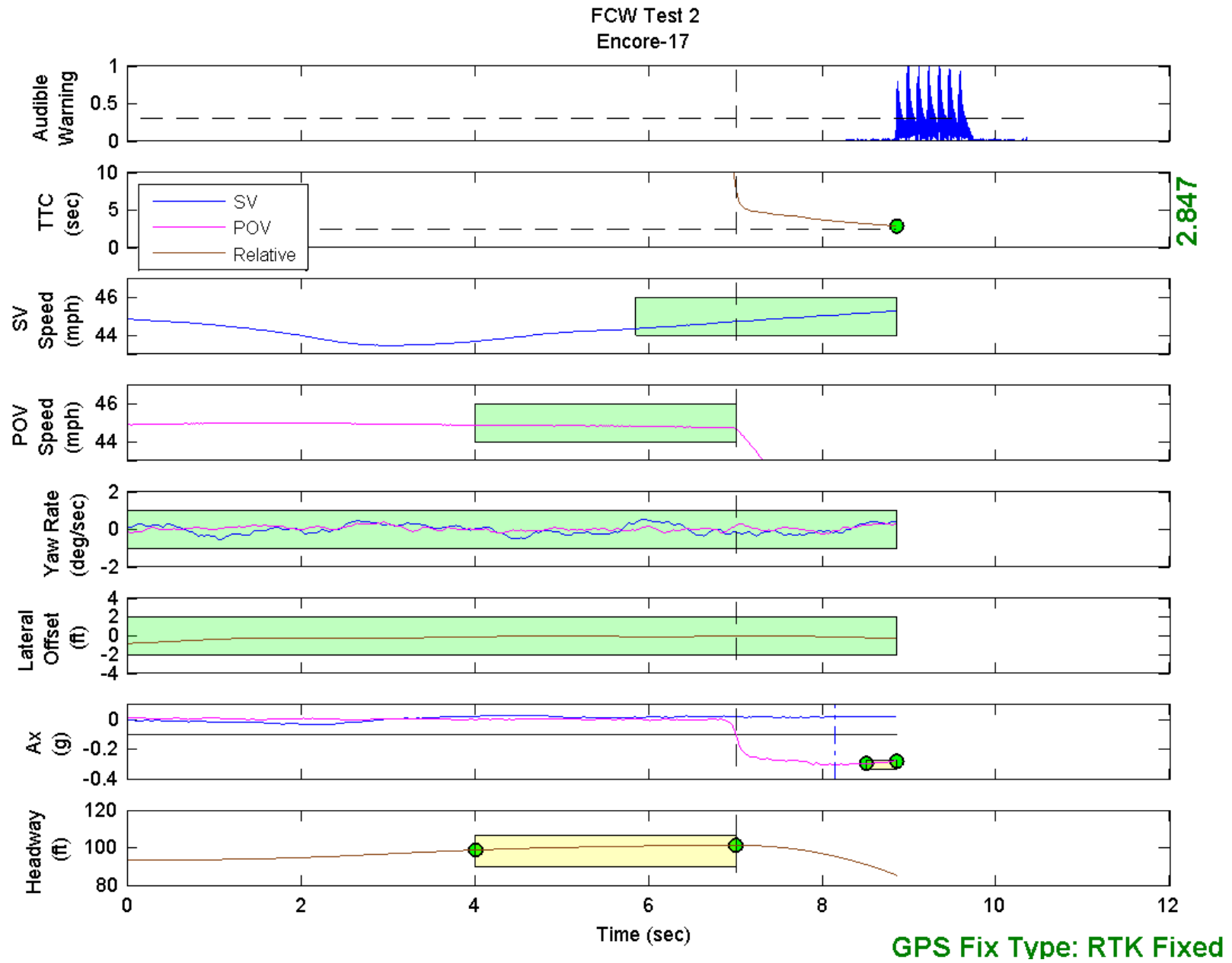


Figure D23. Time History for Run 17, FCW Test 2, Audible Warning

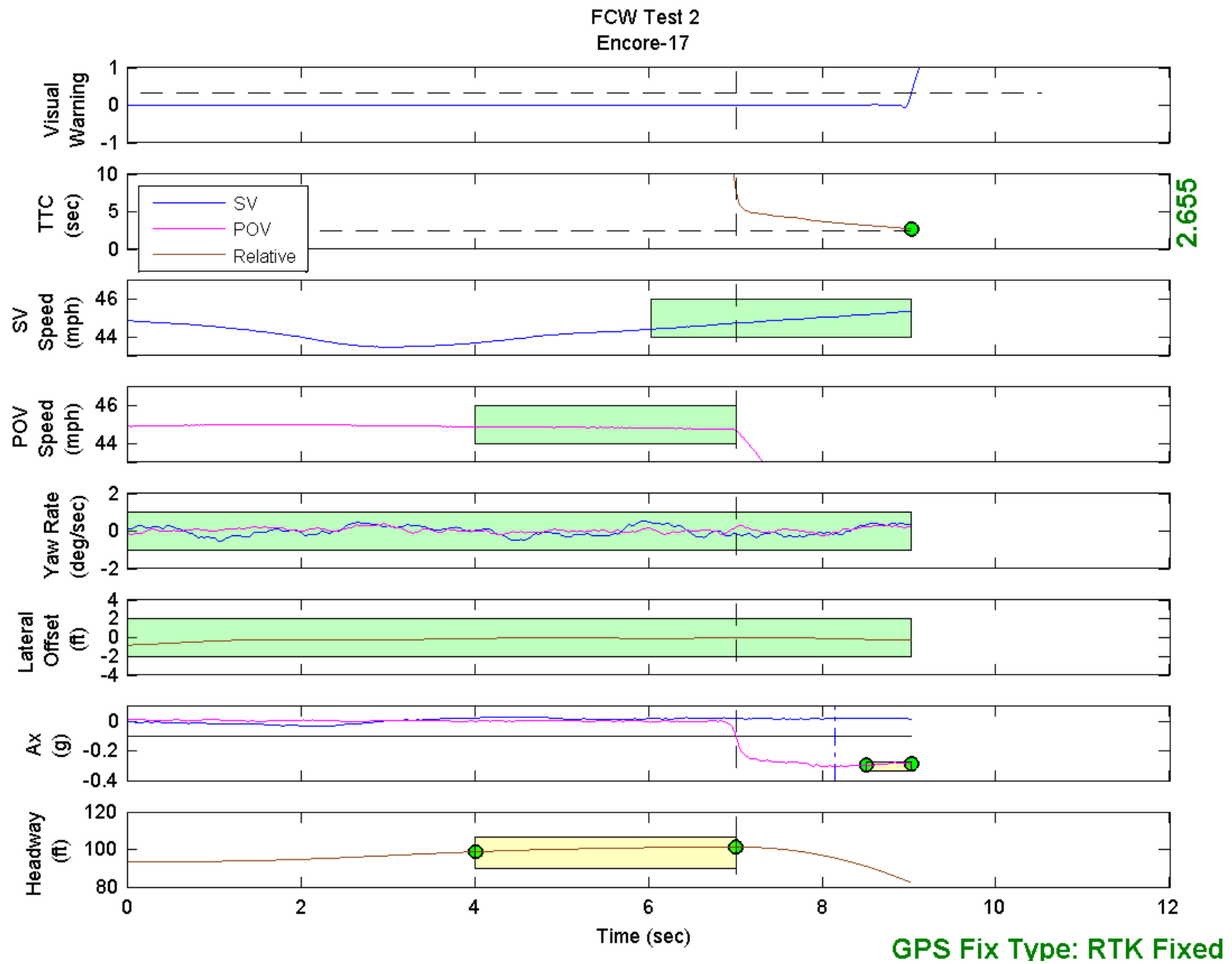


Figure D24. Time History for Run 17, FCW Test 2, Visual Warning

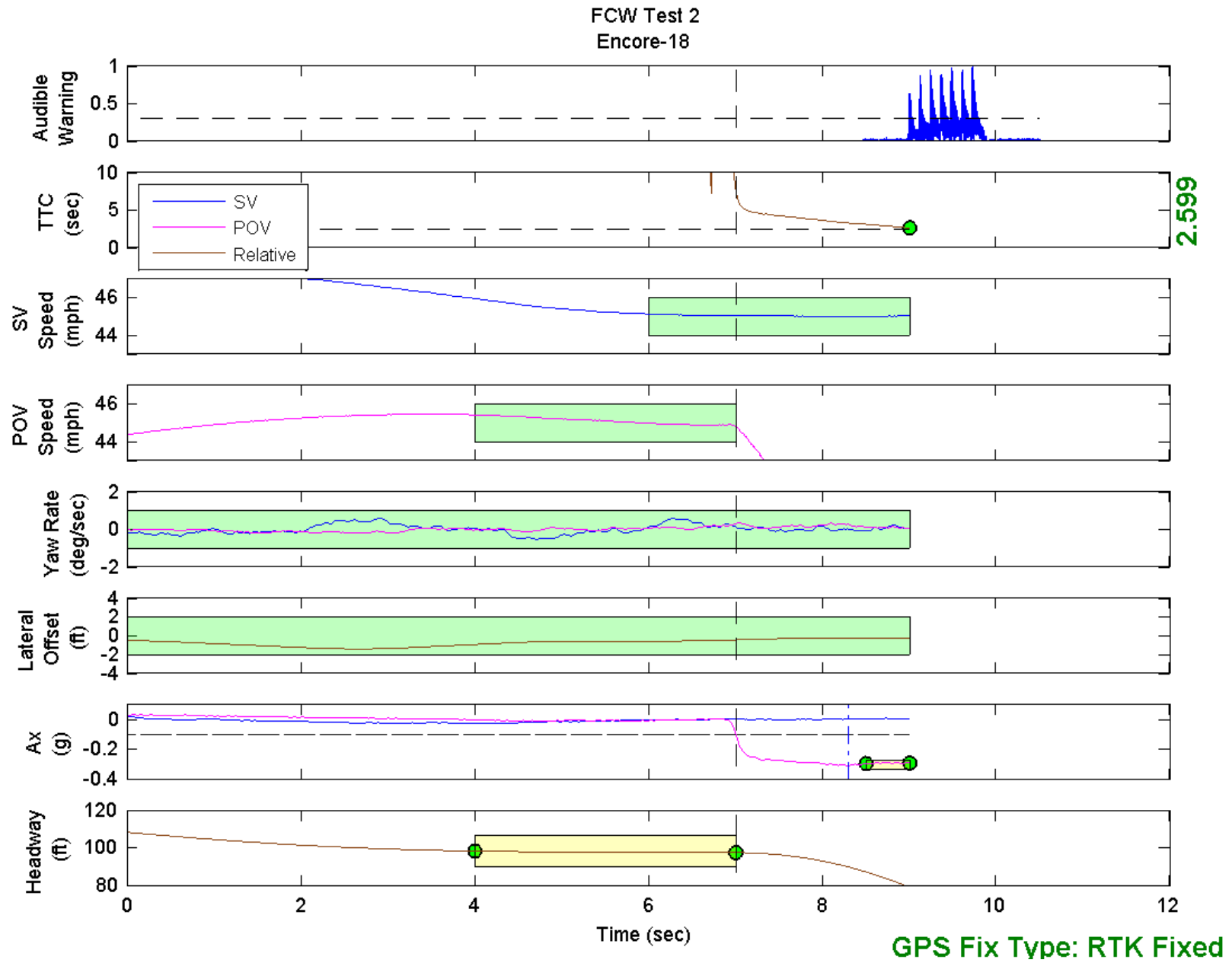


Figure D25. Time History for Run 18, FCW Test 2, Audible Warning

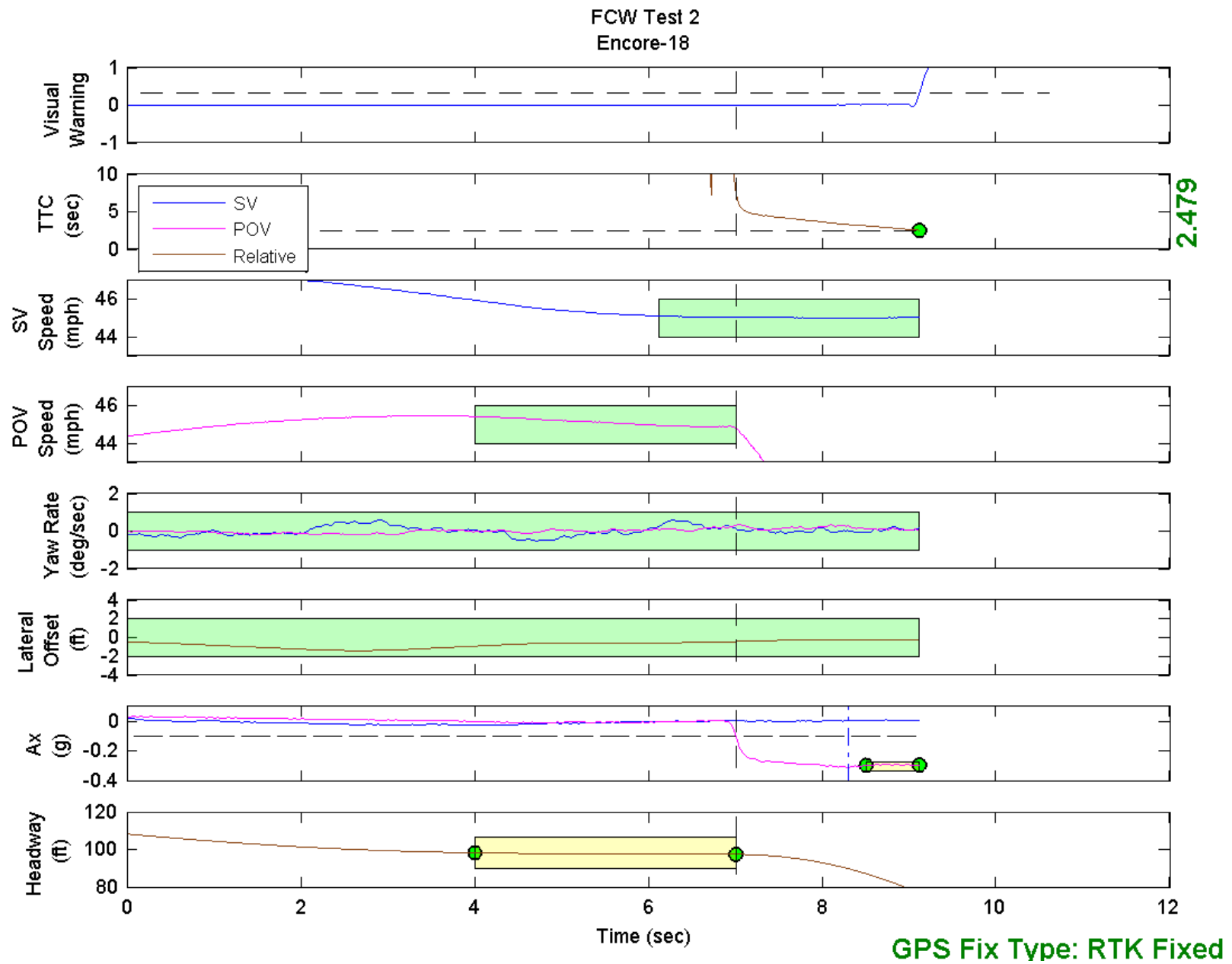


Figure D26. Time History for Run 18, FCW Test 2, Visual Warning

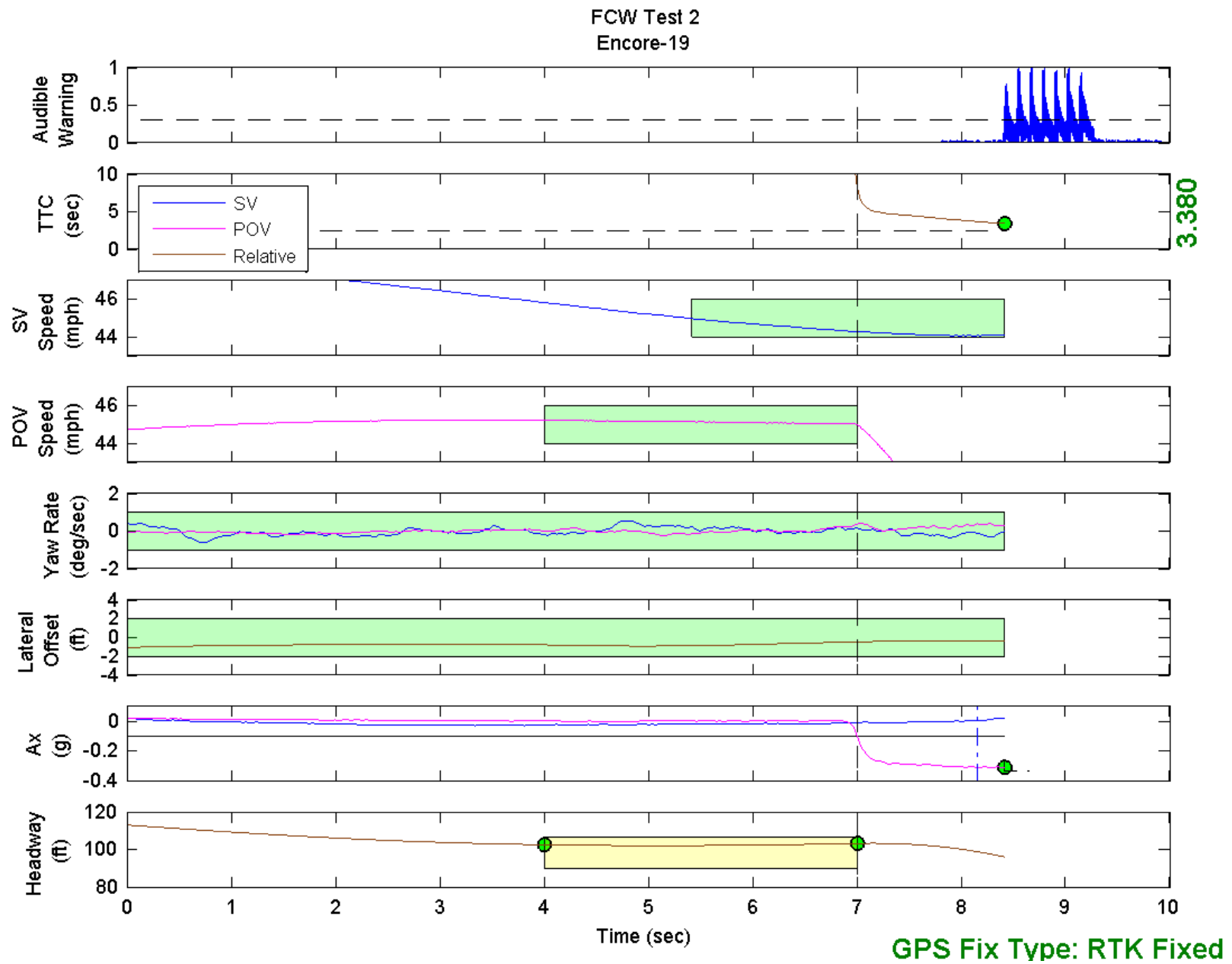


Figure D27. Time History for Run 19, FCW Test 2, Audible Warning

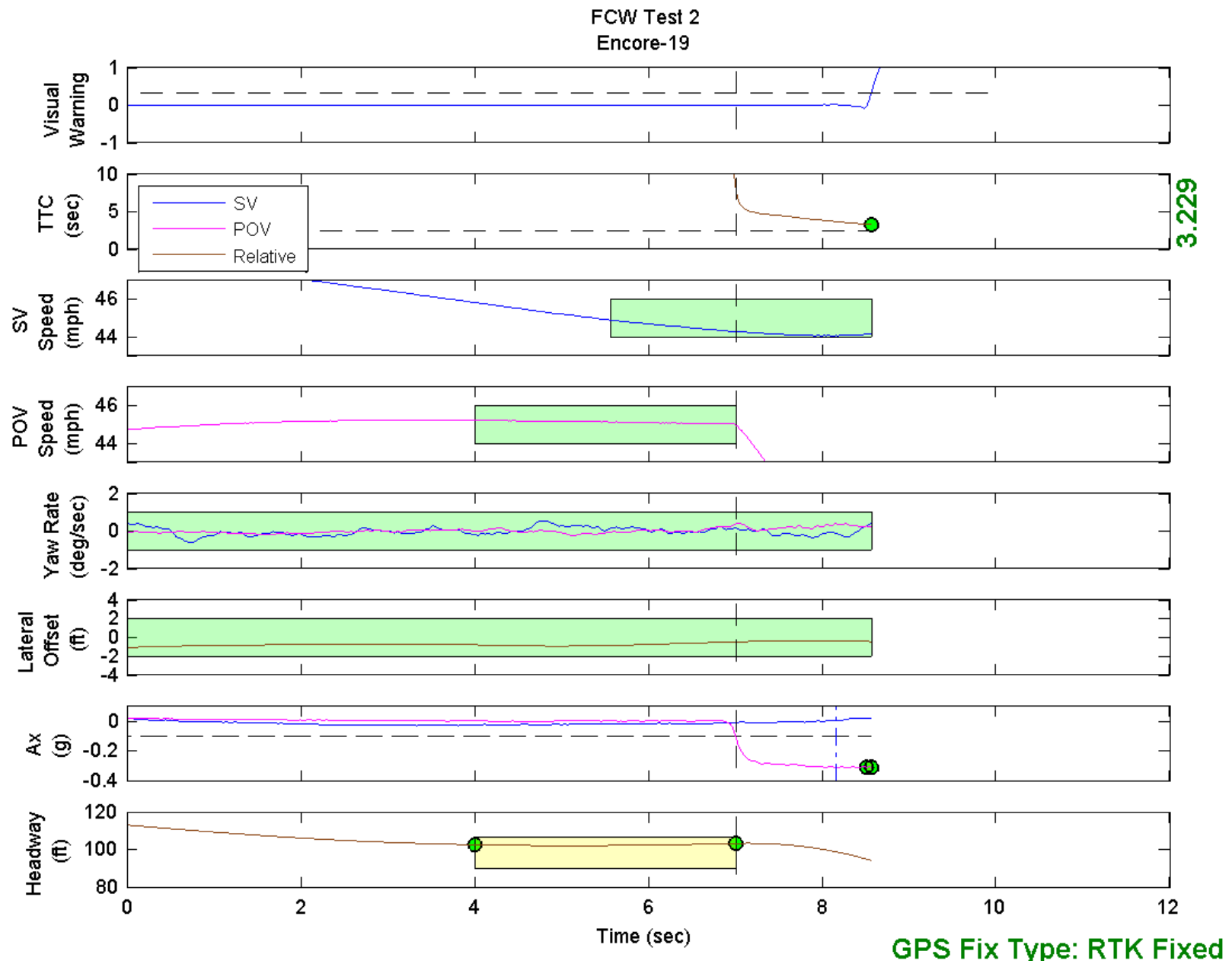


Figure D28. Time History for Run 19, FCW Test 2, Visual Warning

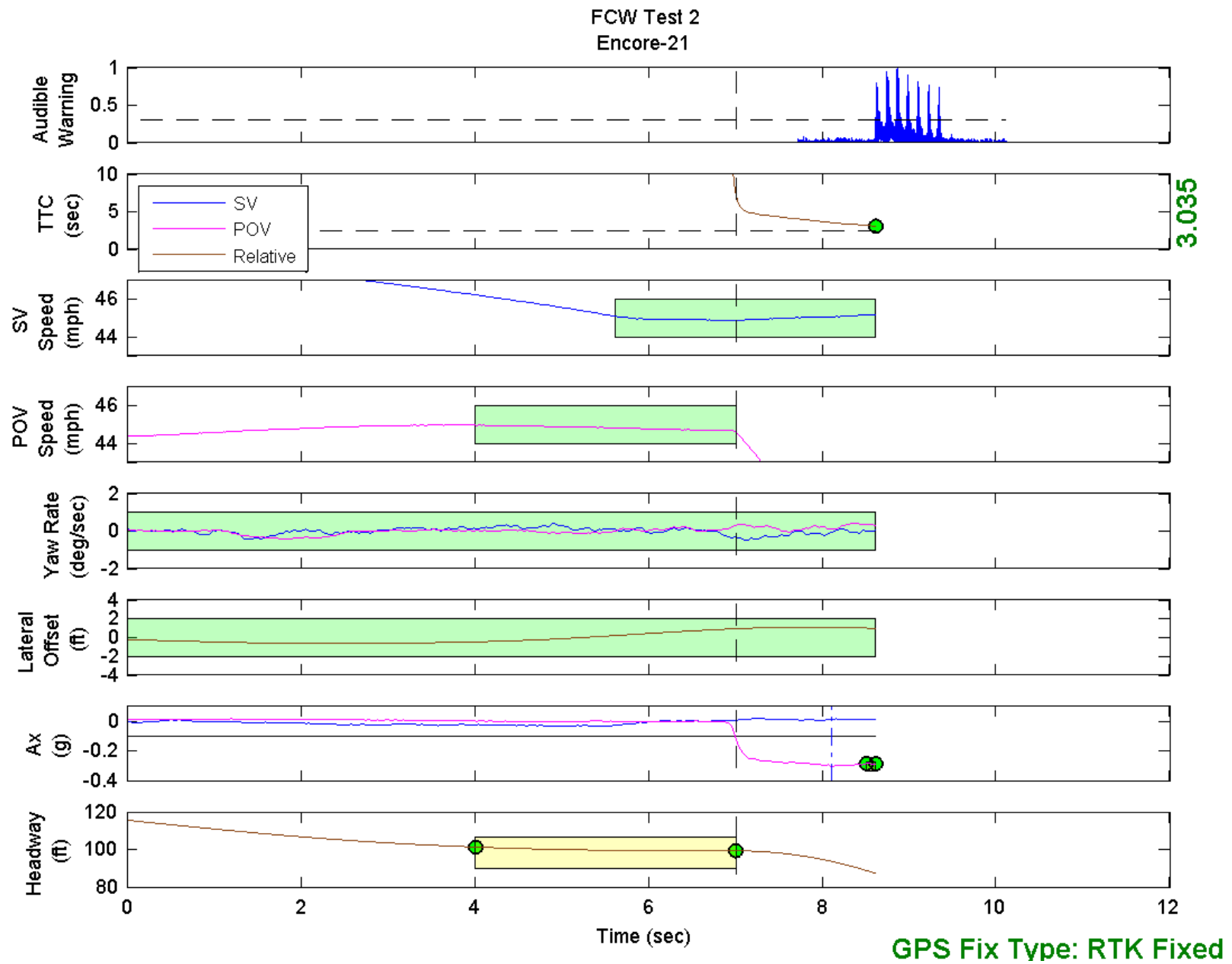


Figure D29. Time History for Run 21, FCW Test 2, Audible Warning

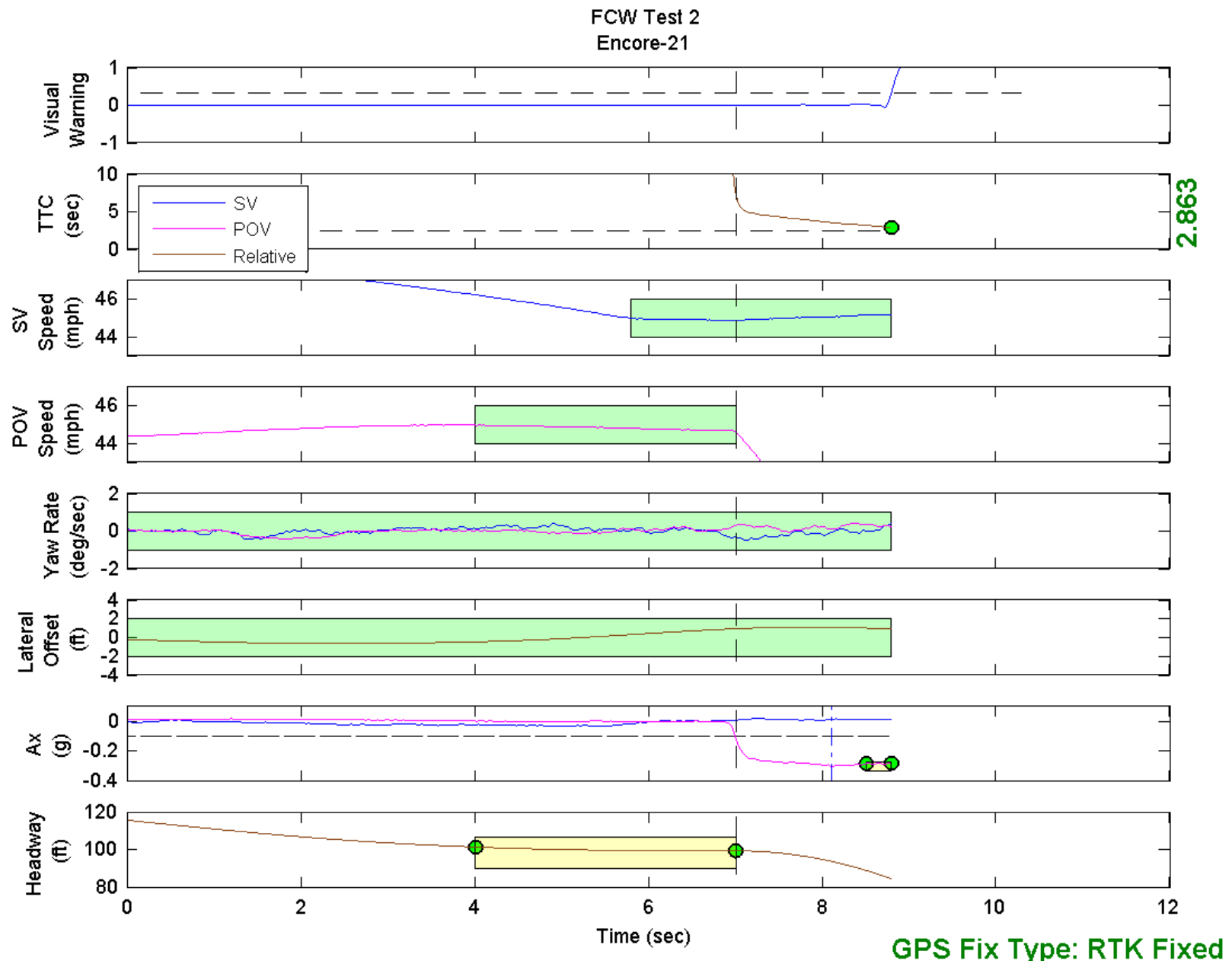


Figure D30. Time History for Run 21, FCW Test 2, Visual Warning

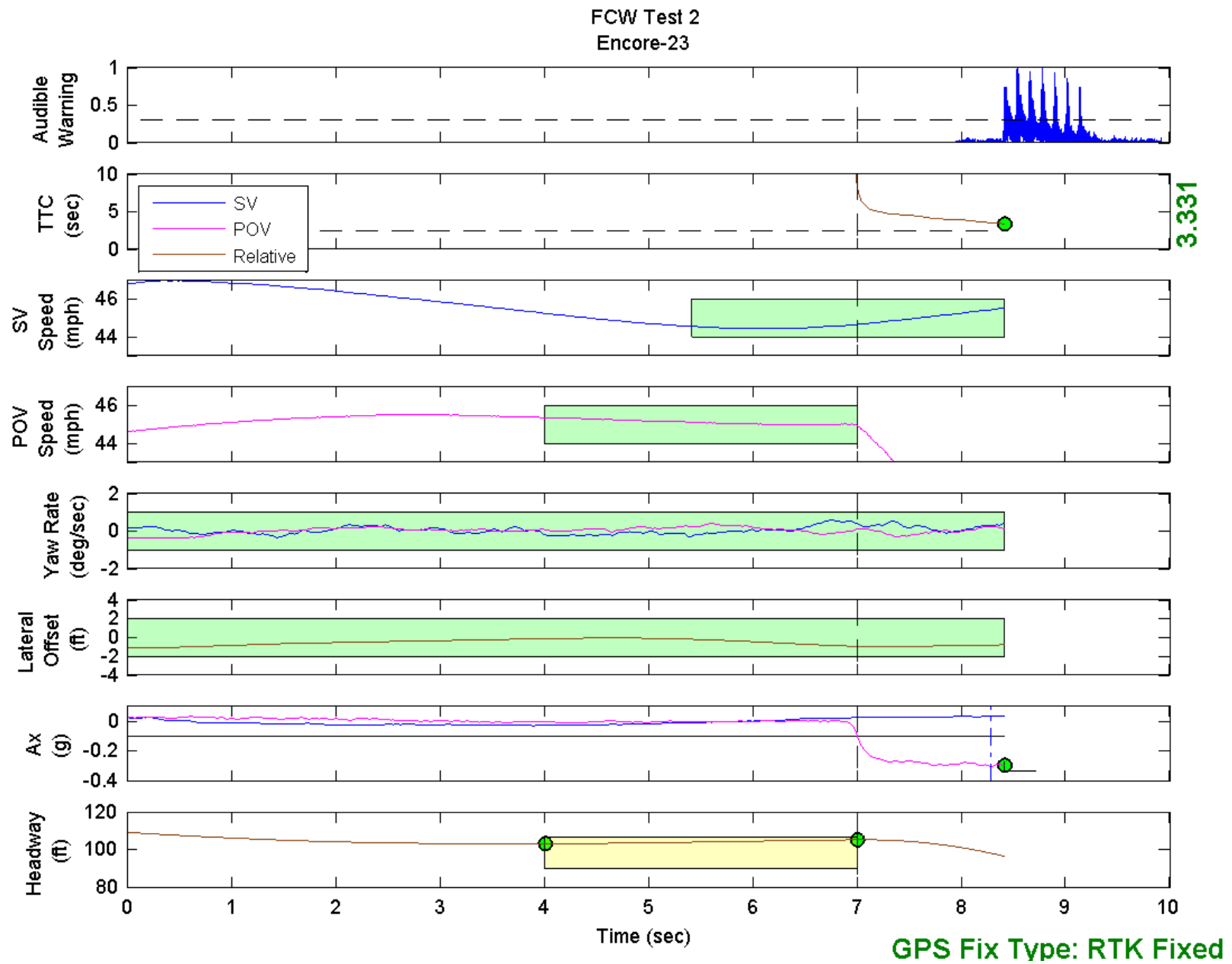


Figure D31. Time History for Run 23, FCW Test 2, Audible Warning

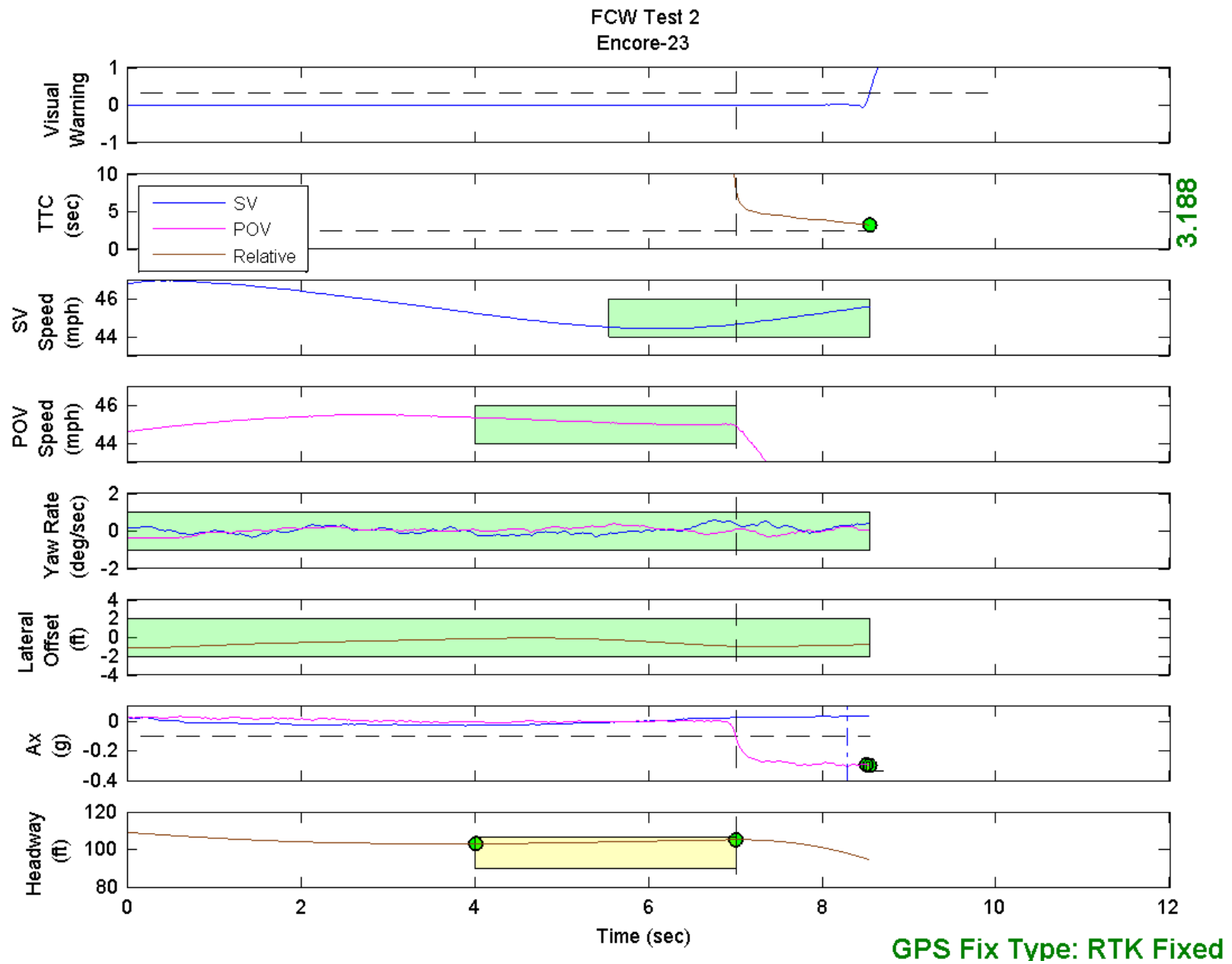


Figure D32. Time History for Run 23, FCW Test 2, Visual Warning

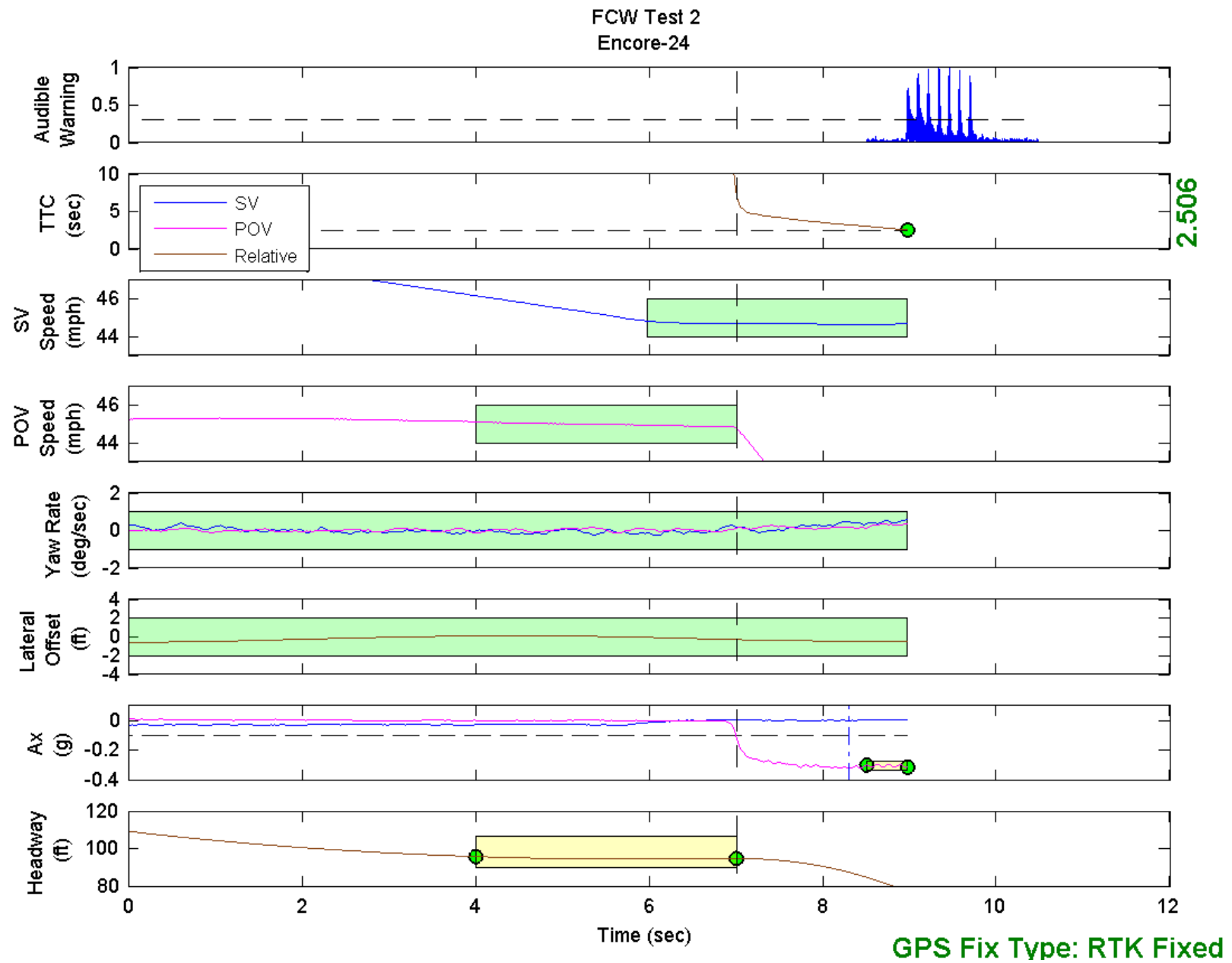
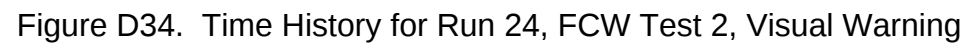


Figure D33. Time History for Run 24, FCW Test 2, Audible Warning



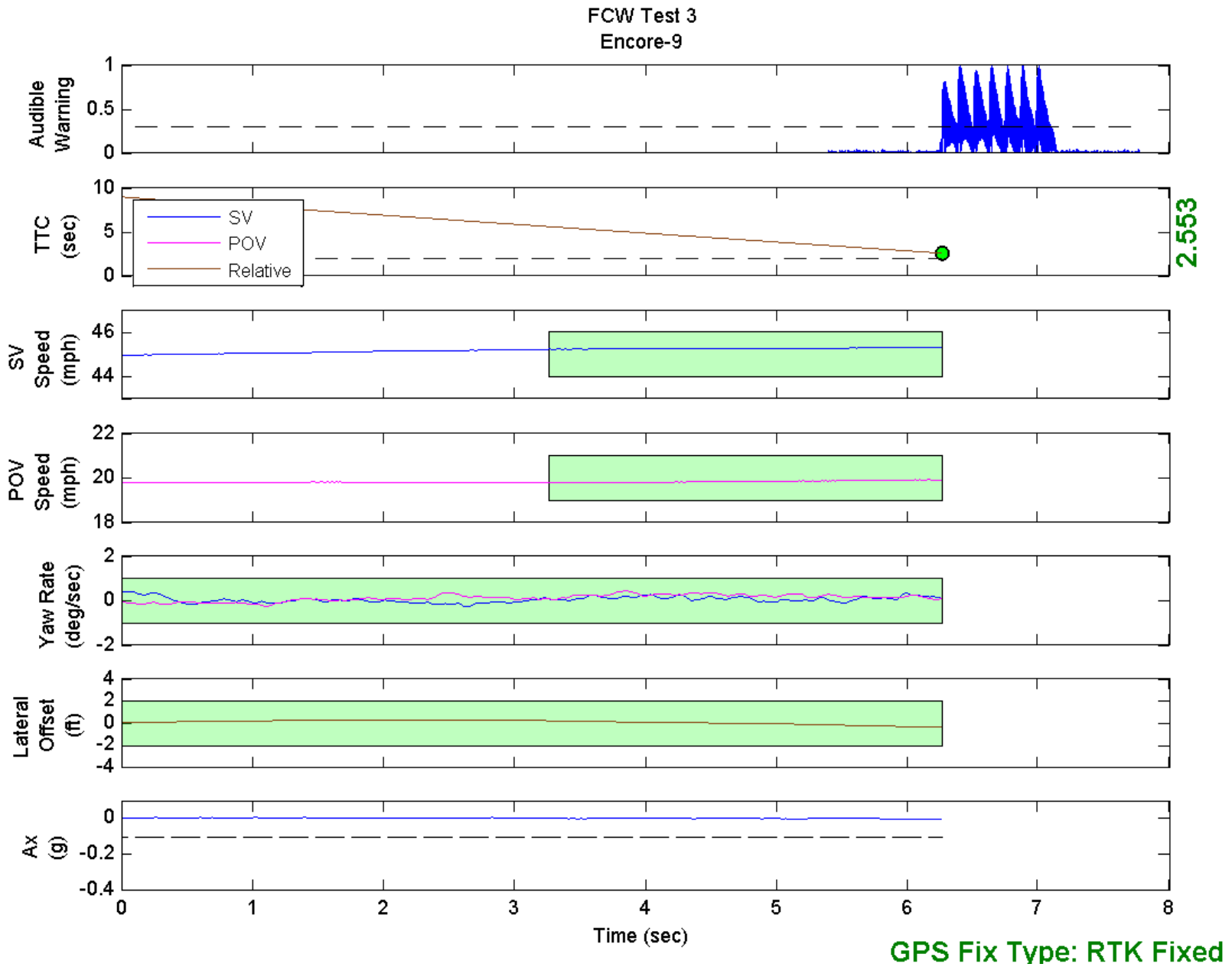


Figure D35. Time History for Run 9, FCW Test 3, Audible Warning

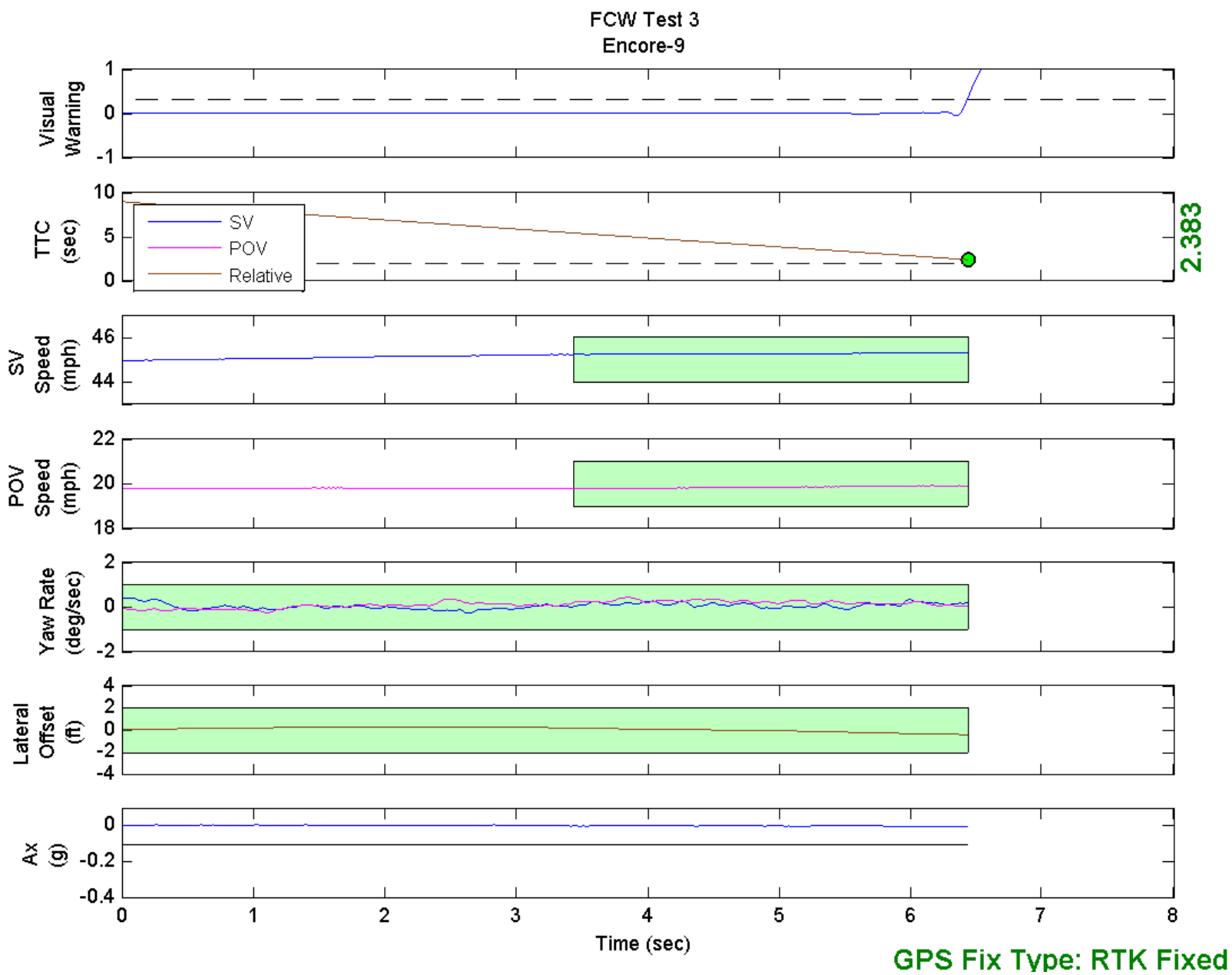


Figure D36. Time History for Run 9, FCW Test 3, Visual Warning

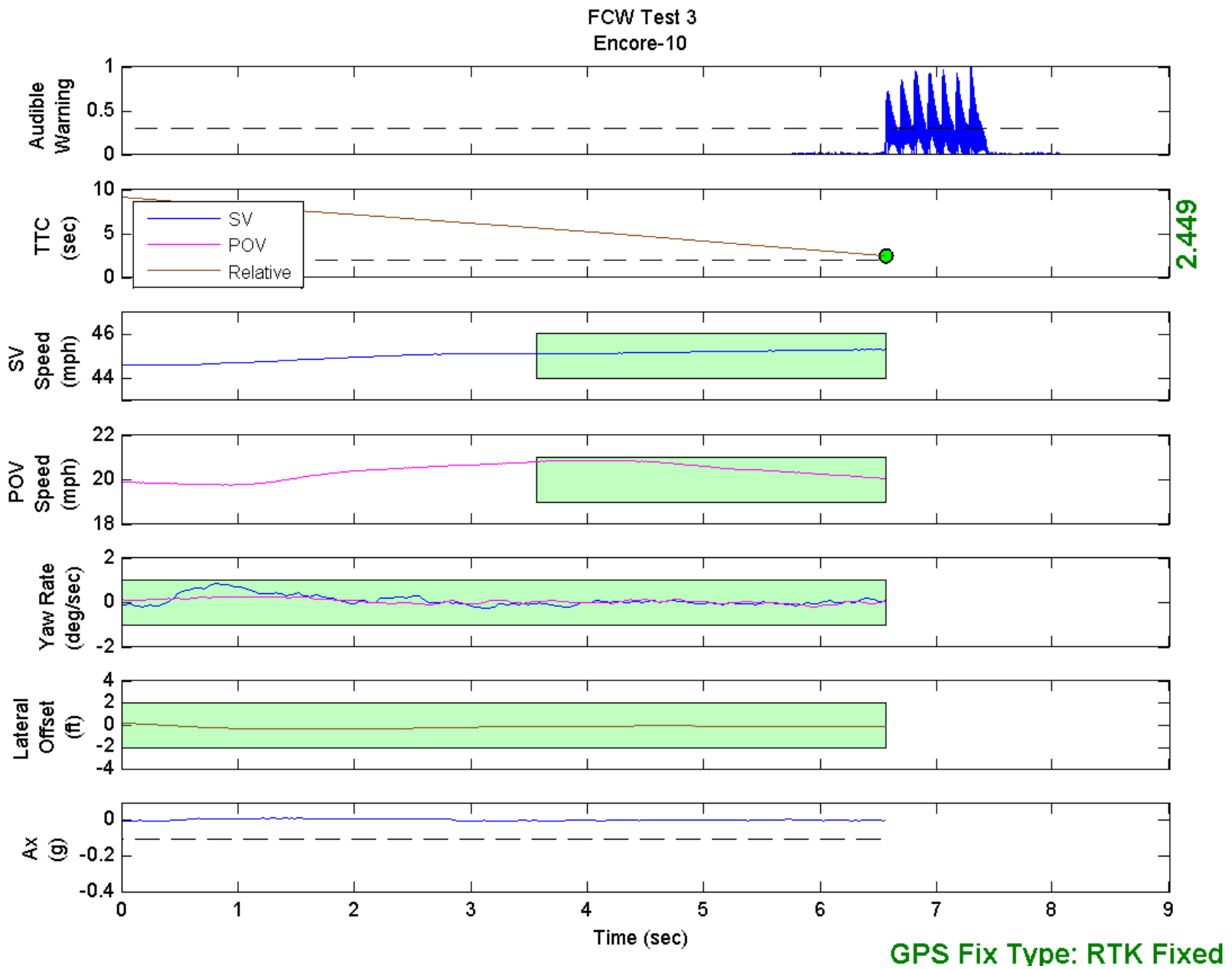


Figure D37. Time History for Run 10, FCW Test 3, Audible Warning

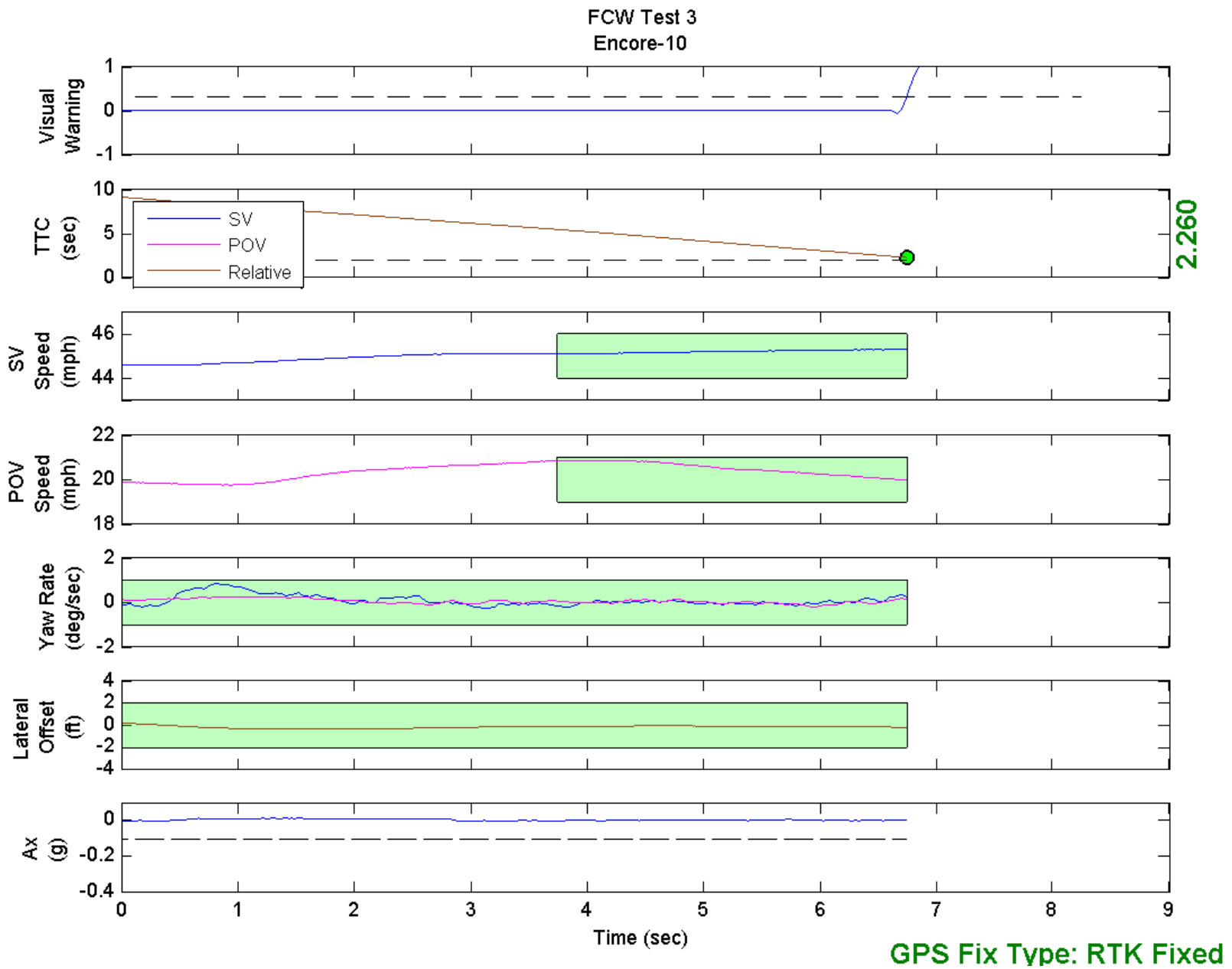


Figure D38. Time History for Run 10, FCW Test 3, Visual Warning

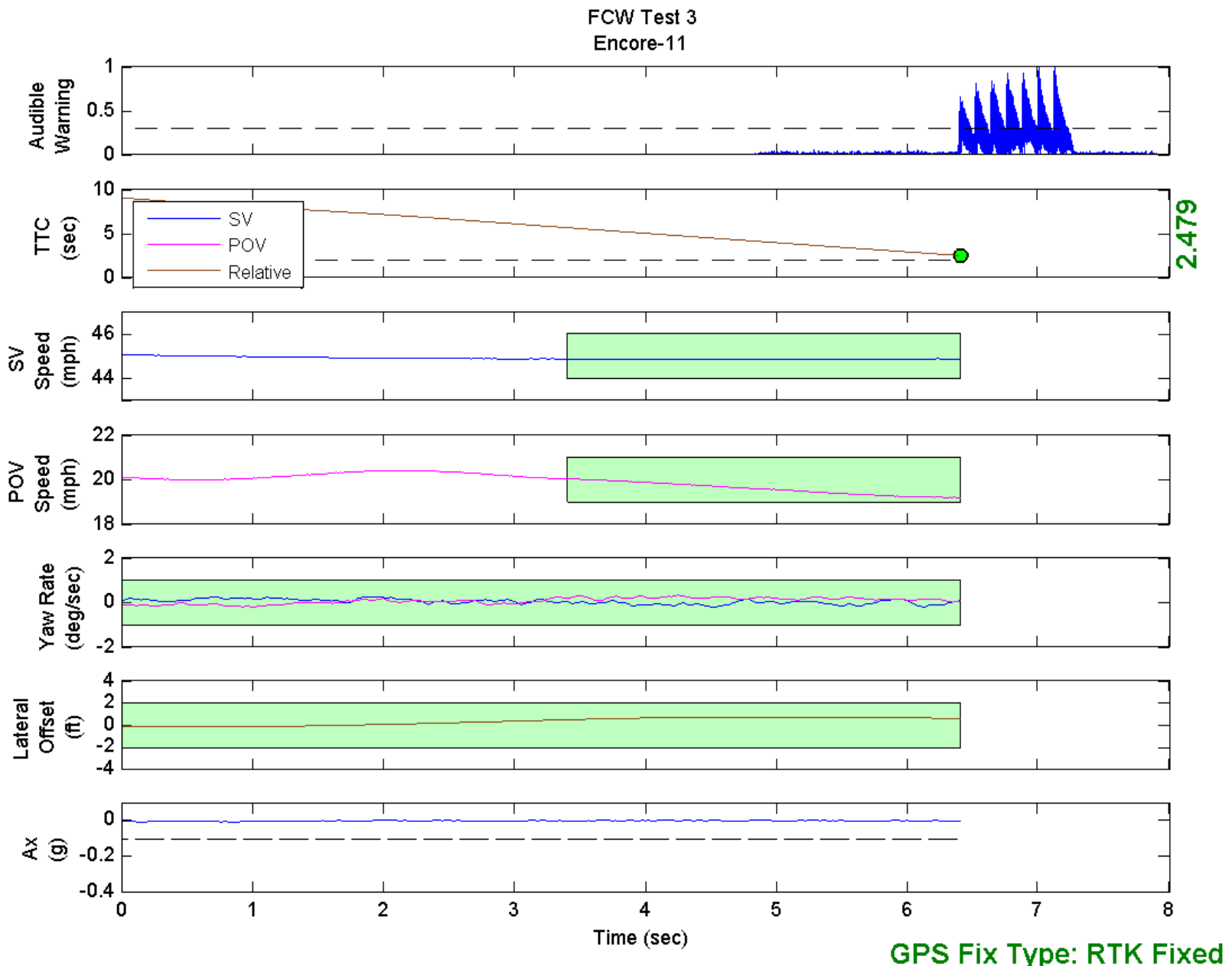


Figure D39. Time History for Run 11, FCW Test 3, Audible Warning

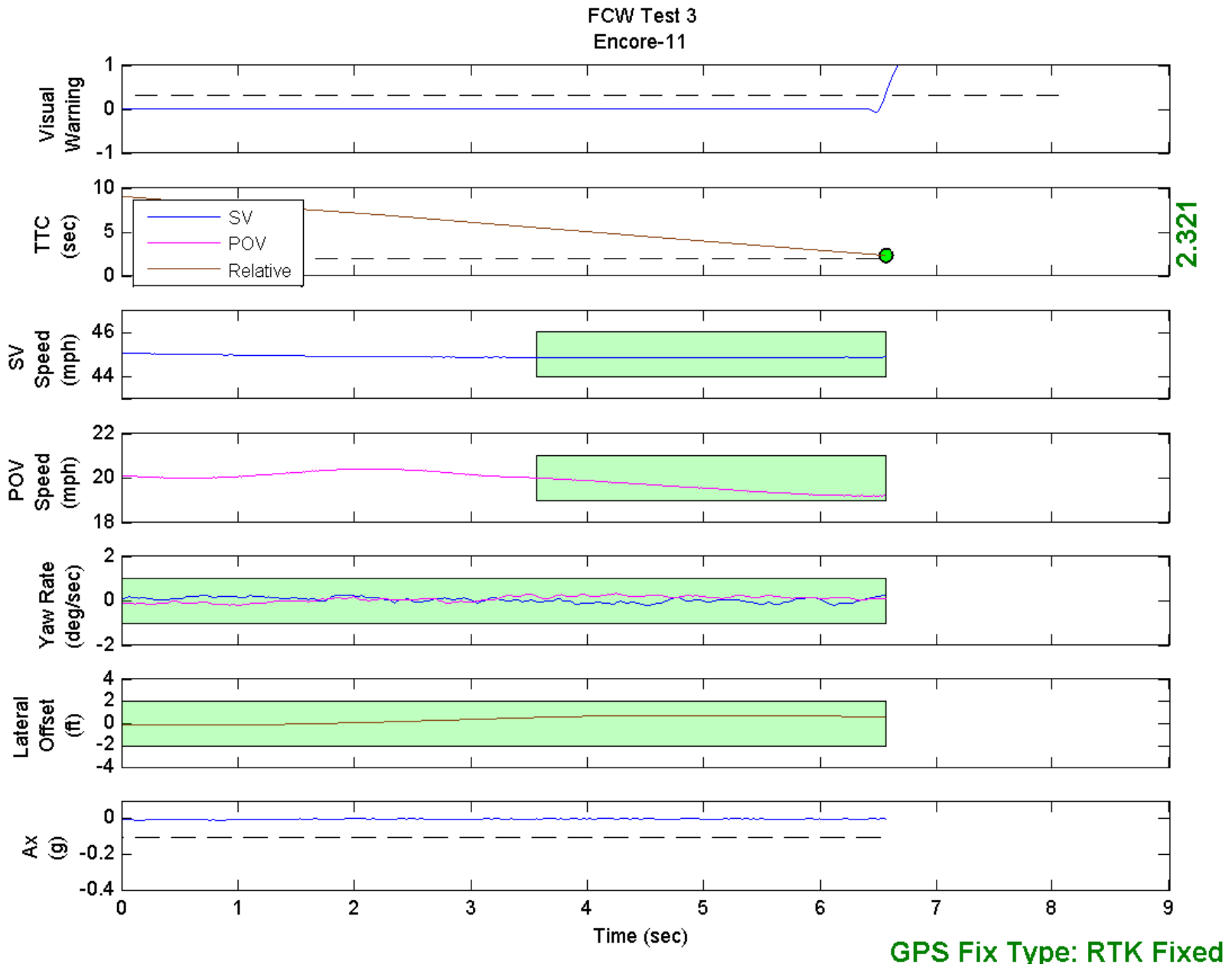


Figure D40. Time History for Run 11, FCW Test 3, Visual Warning

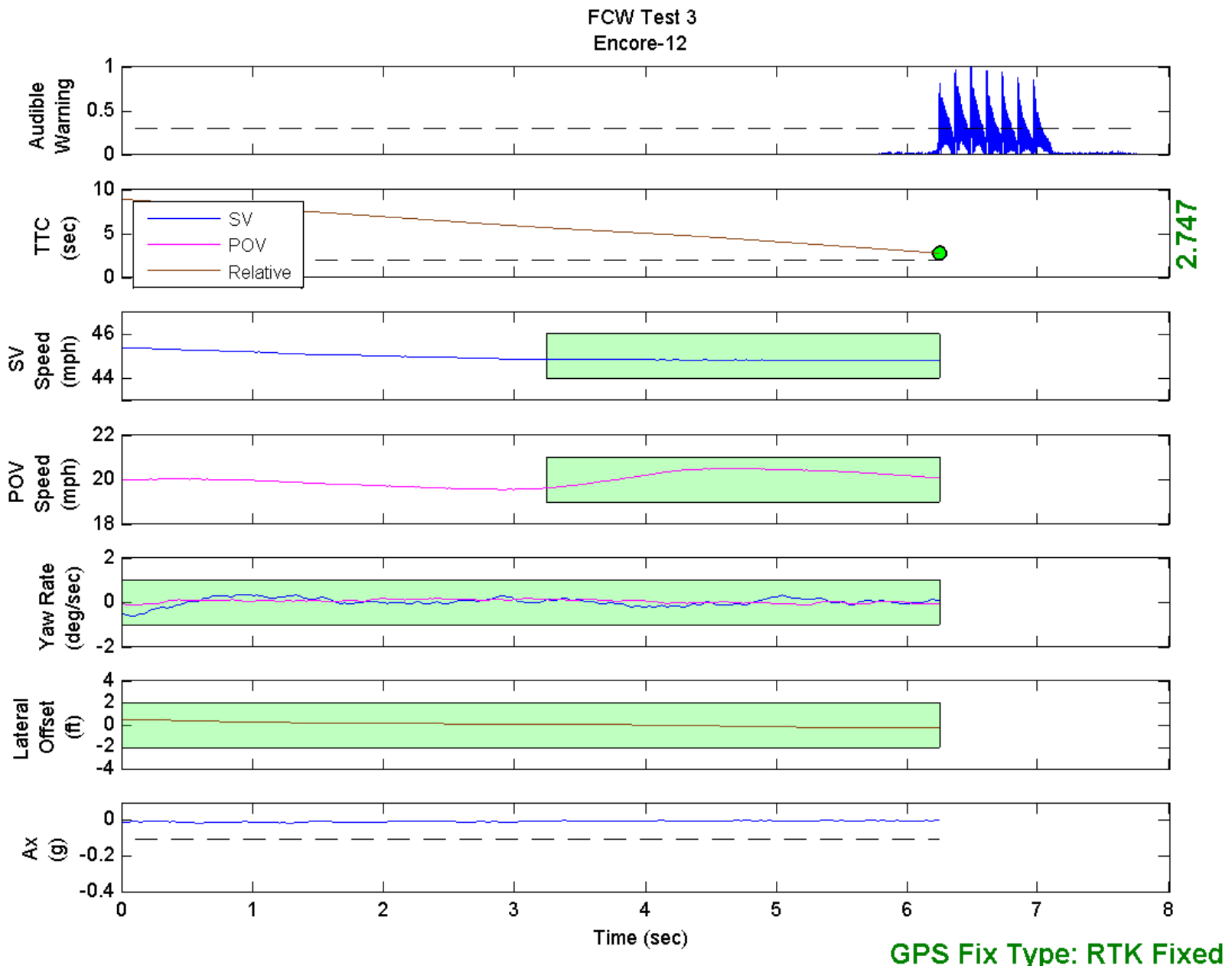


Figure D41. Time History for Run 12, FCW Test 3, Audible Warning

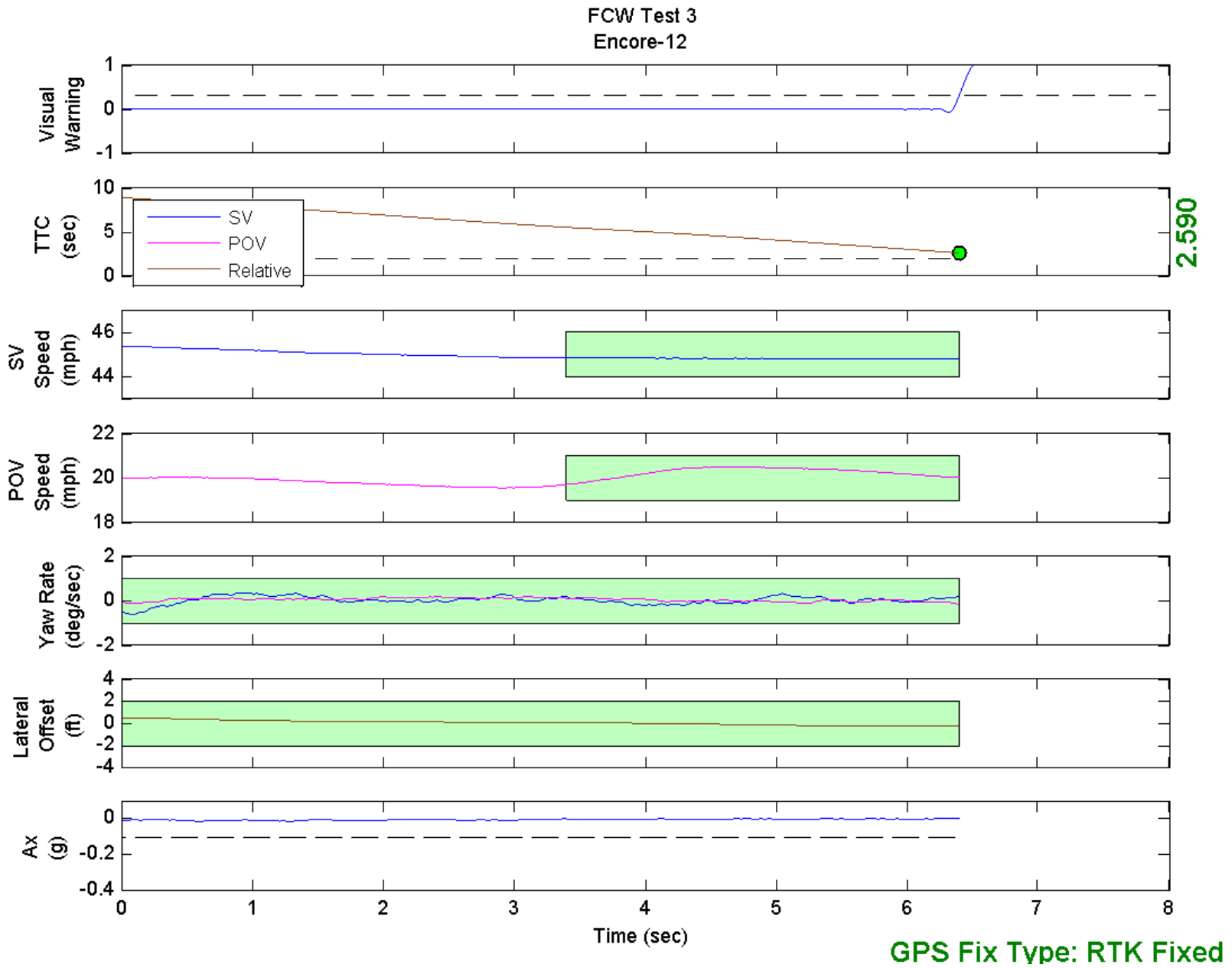


Figure D42. Time History for Run 12, FCW Test 3, Visual Warning

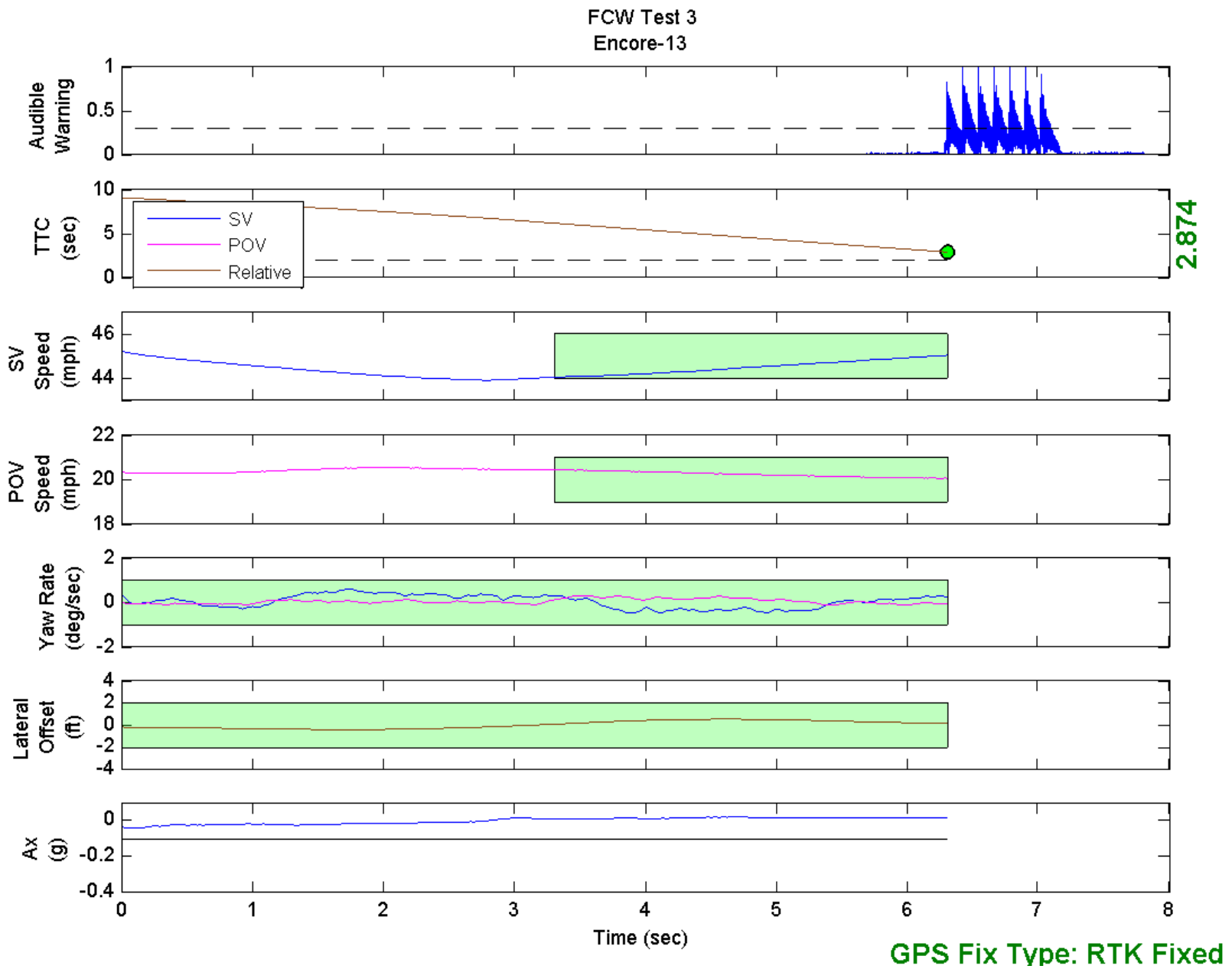


Figure D43. Time History for Run 13, FCW Test 3, Audible Warning

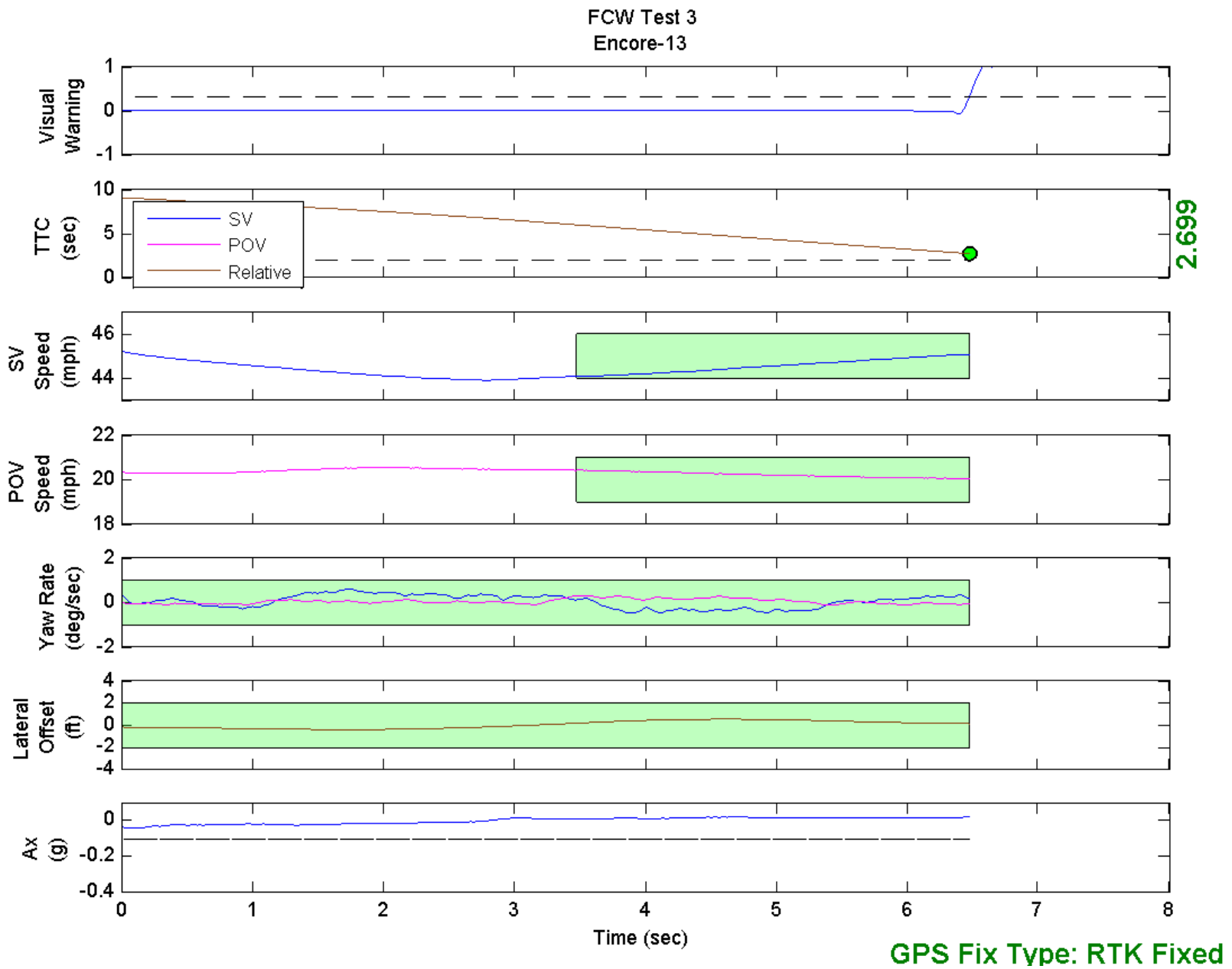


Figure D44. Time History for Run 13, FCW Test 3, Visual Warning

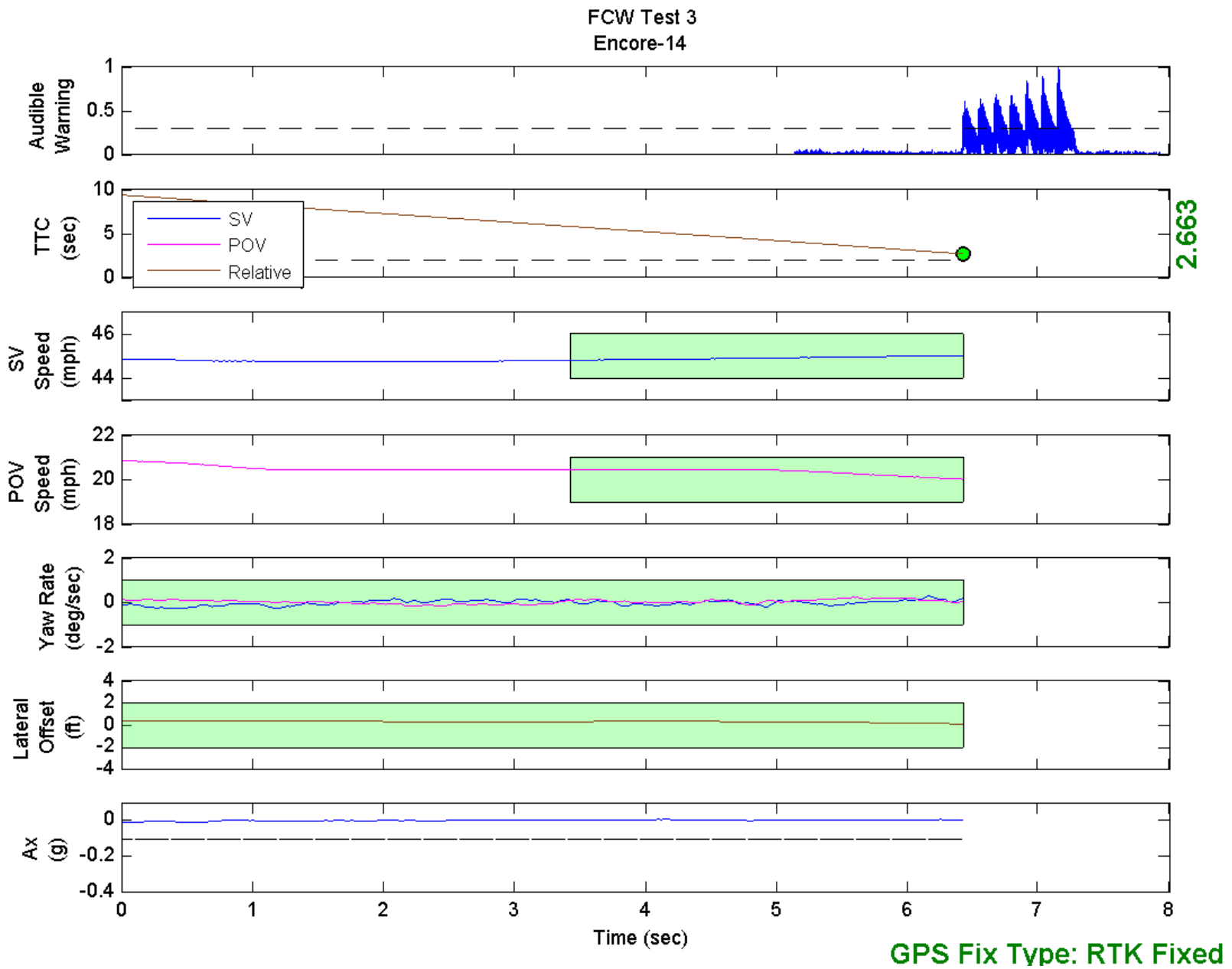


Figure D45. Time History for Run 14, FCW Test 3, Audible Warning

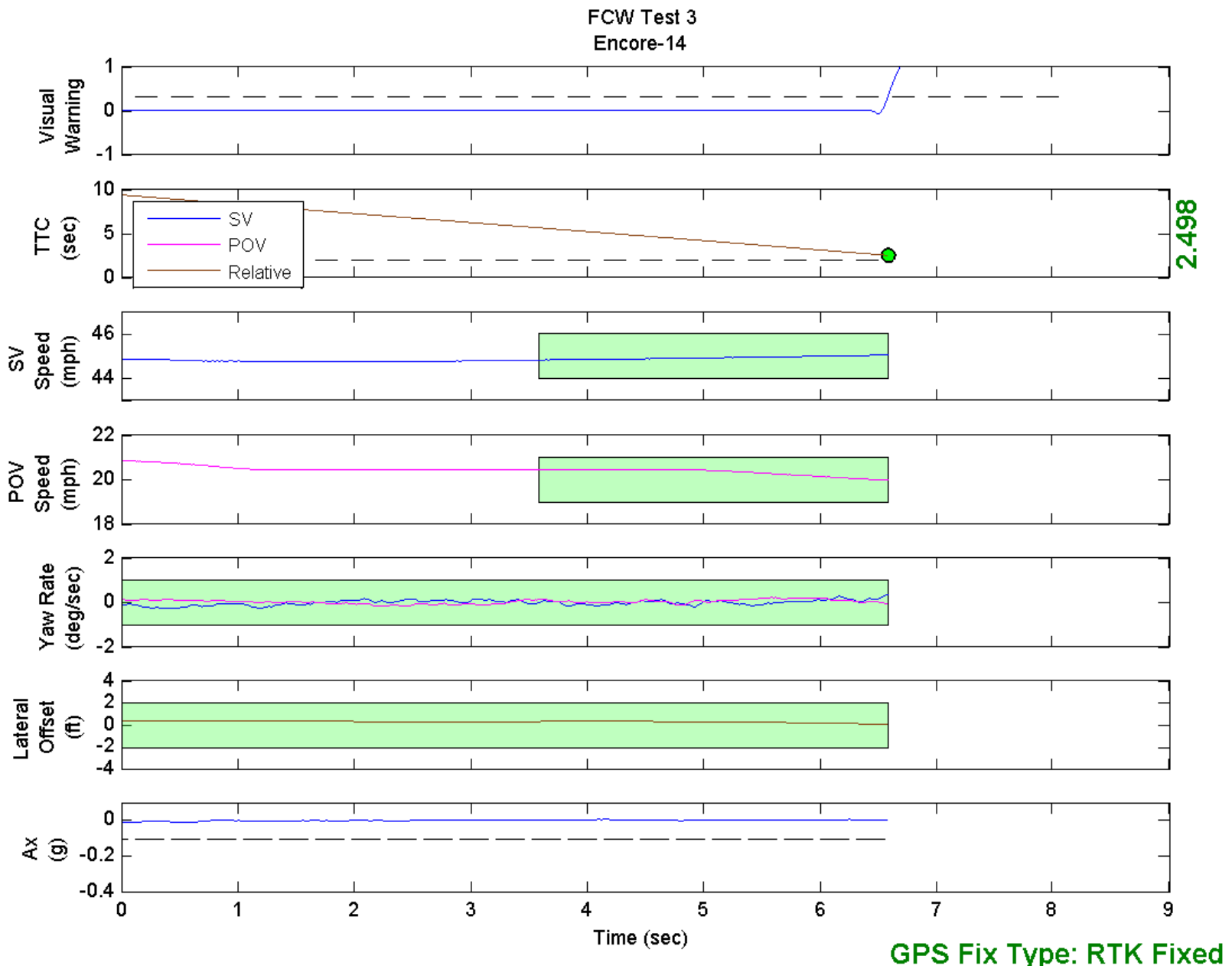


Figure D46. Time History for Run 14, FCW Test 3, Visual Warning

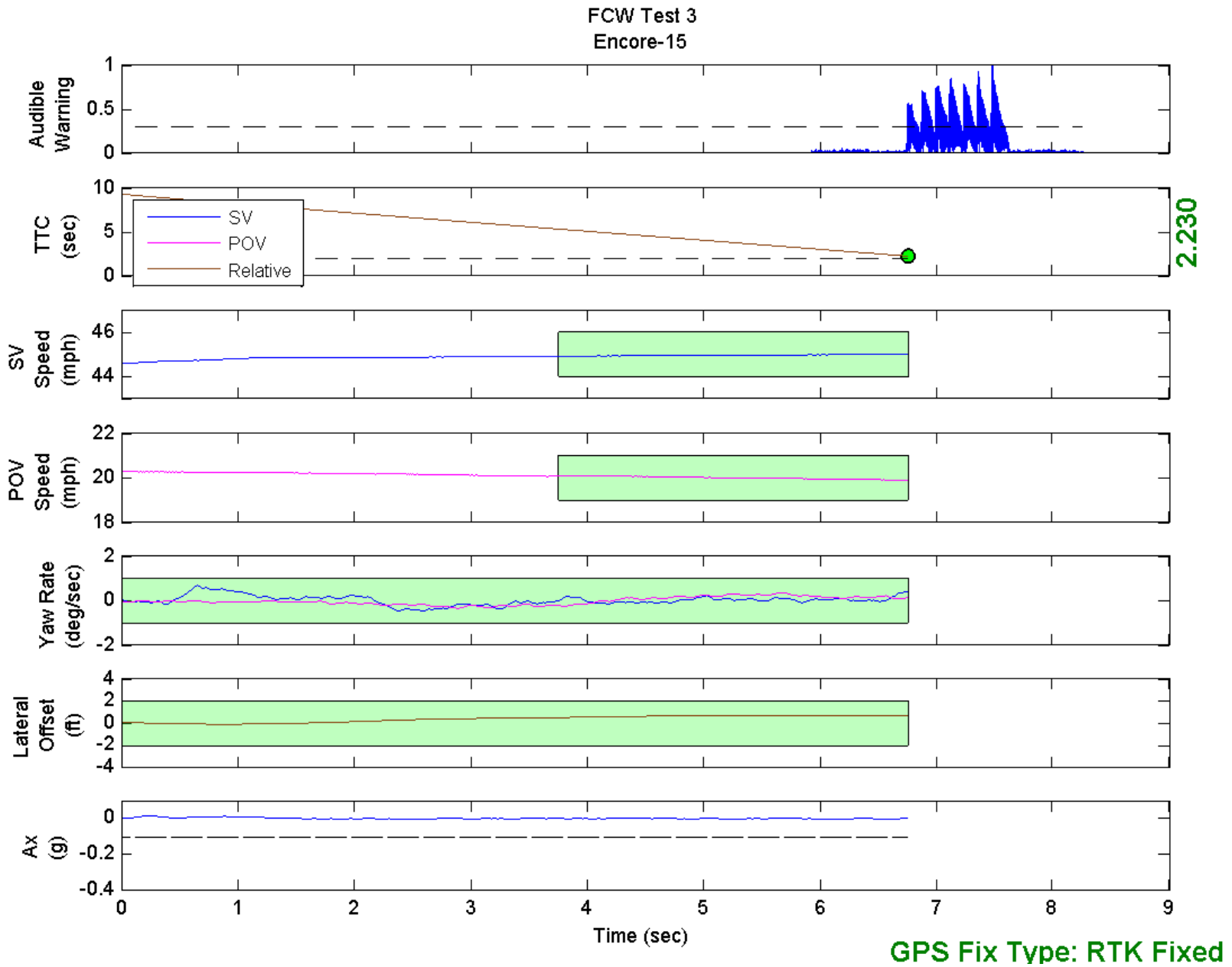


Figure D47. Time History for Run 15, FCW Test 3, Audible Warning

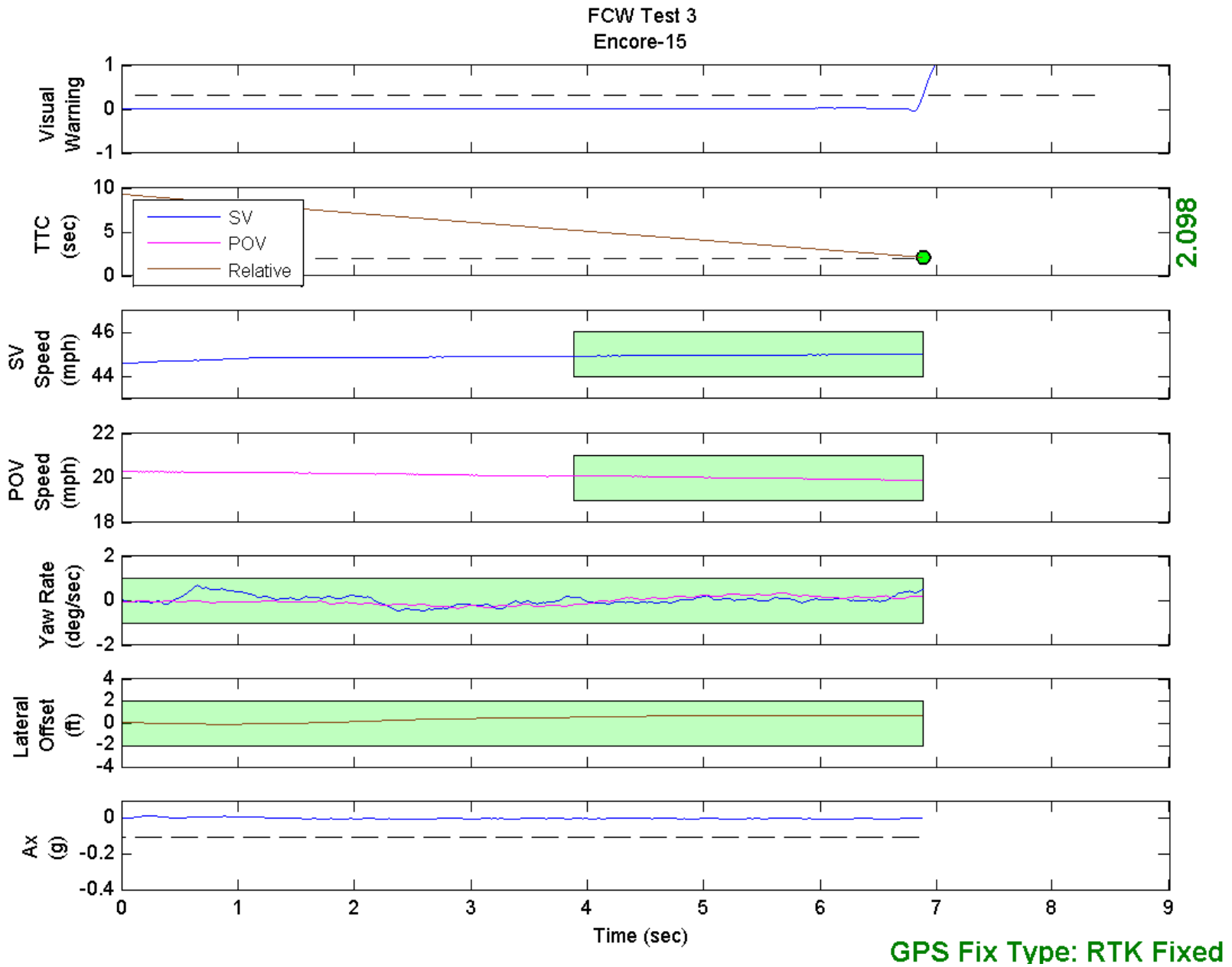


Figure D48. Time History for Run 15, FCW Test 3, Visual Warning