NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST
NCAP-DRI-LDW-22-01

2022 Chevrolet Bolt EUV Premier

DYNAMIC RESEARCH, INC.
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6 September 2022

Final Report

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

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

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16. Abstract These tests were conducted on the subject 2022 Chevrolet Bolt EUV Premier in accordance with the specifications of the New Car Assessment Program's (NCAP's) most current Test Procedure in docket NHTSA-2006-26555-0135 to confirm the performance of a Lane Departure Warning system. The vehicle passed the requirements of the test for all three lane marking types and for both directions.			
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TABLE OF CONTENTS

Section I

INTRODUCTION

The test procedure is described in detail in the National Highway Traffic Safety Administration (NHTSA) document "LANE DEPARTURE WARNING SYSTEM CONFIRMATION TEST" dated February of 2013 (Docket No. NHTSA-2006-26555-0135). Its purpose is to confirm the performance of LDW systems installed on light vehicles with gross vehicle weight ratings (GVWR) of up to 10,000 lbs. Current LDW technology relies on sensors to recognize a lane delimiting edge line. As such, the test procedures described in the document rely on painted lines, taped lines, or Botts Dots being present on the test course to emulate those found on public roadways. Although it is impossible to predict what technologies could be used by future LDW systems (e.g., magnetic markers, RADAR reflective striping, ultra violet paint, infrared, etc.), it is believed that minor modifications to these procedures, when deemed appropriate, could be used to accommodate the evaluation of alternative or more advanced LDW systems.

The purpose of the testing reported herein was to objectively quantify the performance of a Lane Departure Warning system installed on a 2022 Chevrolet Bolt EUV Premier. This test is part of the New Car Assessment Program to assess Lane Departure Warning Systems sponsored by the National Highway Traffic Safety Administration under Contract No. DTNH22-14-D-00333 with the New Car Assessment Program (NCAP).

Section II

DATA SHEETS

LANE DEPARTURE WARNING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 1)

2022 Chevrolet Bolt EUV Premier

VIN: *1G1FZ6S05N412xxxx*

Test start date: *8/30/2022*

Test end date: *8/30/2022*

Lane Departure Warning setting: *N/A*

Test 1 – Continuous White Line	Left: *Pass*	Right: *Pass*
Test 2 – Dashed Yellow Line	Left: *Pass*	Right: *Pass*
Test 3 – Botts Dots	Left: *Pass*	Right: *Pass*

Overall: *Pass*

Notes:

LANE DEPARTURE WARNING

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2022 Chevrolet Bolt EUV Premier

TEST VEHICLE INFORMATION

VIN: *1G1FZ6S05N412xxxx*

Body Style: *SUV* Color: *Cherry Red Tintcoat*

Date Received: *8/19/2022* Odometer Reading: *63 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *General Motors LLC*

Date of manufacture: *05/22*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *215/50R17 H*

Rear: *215/50R17 H*

Recommended cold tire pressure: Front: *260 kPa (38 psi)*

Rear: *260 kPa (38 psi)*

TIRES

Tire manufacturer and model: *Michelin Energy Saver A/S*

Front tire size: *215/50R17 91H*

Rear tire size: *215/50R17 91H*

Front tire DOT prefix: *1B338 03RX*

Rear tire DOT prefix: *1B338 03RX*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2022 Chevrolet Bolt EUV Premier

GENERAL INFORMATION

Test start date: *8/30/2022*

Test end date: *8/30/2022*

AMBIENT CONDITIONS

Air temperature: *35.0 C (95 F)*

Wind speed: *3.6 m/s (8.1 mph)*

X Wind speed ≤10 m/s (22 mph)

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

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

VEHICLE PREPARATION

Verify the following:

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

Fuel tank is full: **X**

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

Front: *260 kPa (38 psi)*

Rear: *260 kPa (38 psi)*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2022 Chevrolet Bolt EUV Premier

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*519.8 kg (1146 lb)*	Right Front:	*494.4 kg (1090 lb)*
Left Rear:	*415.5 kg (916 lb)*	Right Rear:	*408.7 kg (901 lb)*
		Total:	*1838.4 kg (4053 lb)*

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 1 of 3)

2022 Chevrolet Bolt EUV Premier

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

"Lane Keep Assist with Lane Departure Warning" comes standard on this vehicle as part of "Chevy Safety Assist".

Type and location of sensor(s) used:

The LDW system uses a mono camera in the top center of the windshield.

Lane Departure Warning Setting used in test:

N/A

How is the Lane Departure Warning presented to the driver? (Check all that apply)

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

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

The LDW system as part of Lane Keep Assist (LKA), alerts the driver with a visual and auditory alert. The visual alert is displayed in the instrument panel and consists of an image of a vehicle between lane lines. When LDW/LKA activates, the lane line image corresponding to the lane marking the vehicle approaches, changes color from green to amber. If the vehicle crosses over the lane marking, an auditory alert may activate which consists of three beeps with an approximate frequency of 750 Hz.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 2 of 3)

2022 Chevrolet Bolt EUV Premier

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

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

The LDW system can be turned on/off using the button located below the center dash display.

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

If yes, please provide a full description.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 3 of 3)

2022 Chevrolet Bolt EUV Premier

Are there other driving modes or conditions that render LDW inoperable or reduce its effectiveness?

X Yes

_____ No

If yes, please provide a full description.

Refer to the owner's manual page 199 shown in Appendix B page B-3 for additional information.

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

Each LDW test involved one of three lane marking types: solid white lines, dashed yellow lines, or Botts Dots. Lane departures were done both to the left and to the right, and each test condition was repeated five times, as shown in Table 1.

Table 1. LDW Test Matrix

Lane Geometry	Line Type	Departure Direction	Number of Trials
Straight	Solid	L	5
		R	5
	Dashed	L	5
		R	5
	Botts Dots	L	5
		R	5

Prior to the start of a test series involving a given lane marking type and departure direction combination, the accuracy of the distance to lane marking measurement was verified. This was accomplished by driving the vehicle to the approximate location at which the lane departure would occur and placing the tire at the lane marking edge of interest (i.e., distance to lane marking = 0). The real-time display of distance to the lane marking was then observed to verify that the measured distance was within the tolerance (5 cm). If the measured distance was found to be greater than the tolerance, the instrumentation setup was checked and corrected, if necessary. If the measured distance was found to be within the tolerance, the instrumentation setup was considered appropriate and the test series was begun.

To begin the maneuver, the vehicle was accelerated from rest to a test speed of 72.4 km/h (45 mph), while being driven in a straight line parallel to the lane marking of interest, with the centerline of the vehicle approximately 1.83 m (6.0 ft) from the lane edge (i.e., such that the vehicle would pass through the center of the start gate). The test speed was achieved at least 60 m (200 ft) before the start gate was reached. Striking any start gate cones was not permitted, and any run in which a cone was struck was considered to be invalid. Also, during the initialization and test phases, the test driver avoided using turn signals and avoided applying any sudden acceleration, sudden steering, or sudden braking, and any use of the turn signals, sudden acceleration, sudden steering, or sudden braking invalidated the test trial.

Data collection began with the vehicle at least 60 m (200 ft) from the start gate, which was configured using a pair of non-reflective, low-contrast color traffic cones. A second set of cones, placed 6 m (20 ft) longitudinally before the start gate, was used to guide the driver into the start gate. The lateral width between the cone pairs was 20 cm (8 in) greater than the width of the vehicle, and the centerline of each pair was laterally offset from the lane marking by 1.8 m (6 ft).

Once the driver passed the gate, the driver manually input sufficient steering to achieve a lane departure with a target lateral velocity of 0.5 m/s with respect to the lane line. As shown in Figure 1, two additional non-reflective cones were used to guide the driver in making this steering maneuver. Throughout the maneuver, the driver modulated the throttle or used cruise control, as appropriate, such that vehicle speed remained at constant speed. The test was considered complete when the vehicle crossed at least 1 m (3.3 ft) over the lane edge boundary.

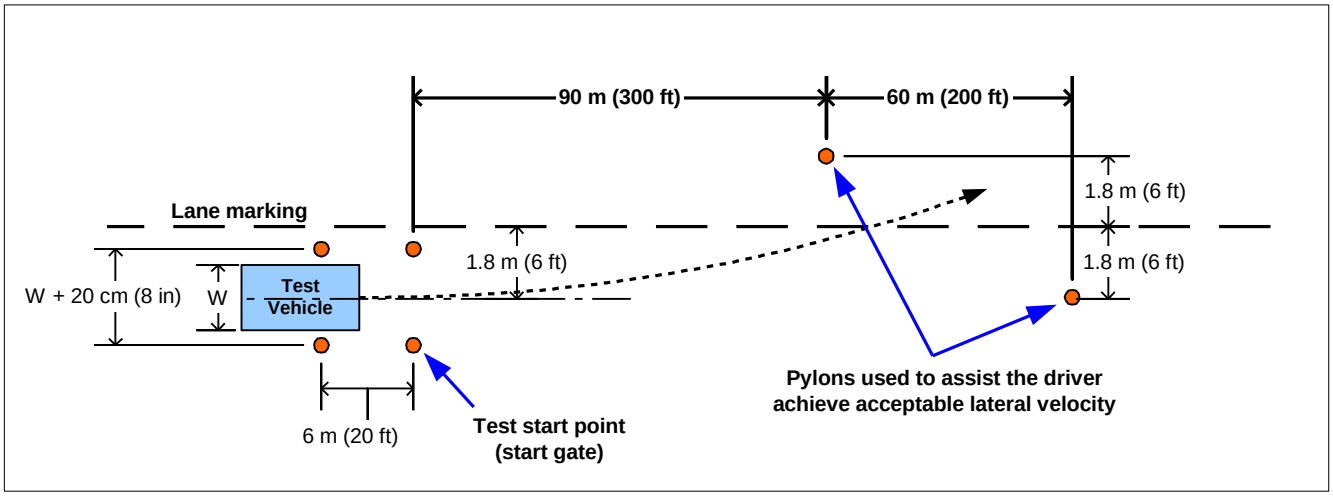

Figure 1. Position of Cones Used to Assist Driver

Data collected included vehicle speed, position, and yaw rate. In addition to cone strikes, vehicle speed and yaw rate data were used to identify invalid runs as described in Section C below. Data from trials where speed or yaw rate were outside of the performance specification were not considered valid.

B. Lane Delineation Markings

The New Car Assessment Program's Test Procedure for the confirmation of a Lane Departure Warning system contains a requirement that all lane markings meet United States Department of Transportation (USDOT) specifications as described in the Manual on Uniform Traffic Control Devices (MUTCD) and be considered in "very good condition".

1. Lane Marker Width

The width of the edge line marker was 10 to 15 cm (4 to 6 in). This is considered to be a normal width for longitudinal pavement markings under Section 3A.05 of the MUTCD.

2. Line Marking Color and Reflectivity

Lane marker color and reflectivity met all applicable standards. These standards include those from the International Commission of Illumination (CIE) for color and the American Society for Testing and Materials (ASTM) on lane marker reflectance.

3. Line Styles

The tests described in this document required the use of three lane line configurations: continuous solid white, discontinuous dashed yellow, and discontinuous with raised pavement markers.

- Continuous White Line

  A continuous white line is defined as a white line that runs for the entire length of the test course.

- Dashed Yellow Line

  As stated in the MUTCD, and as shown in Figure 2, a discontinuous dashed yellow line is defined as by a series of 3 m (10 ft) broken (dashed) yellow line segments, spaced 9.1 m (30 ft) apart.

- Raised Pavement Marker Line (Botts Dots)

  California Standard Plans indicates raised pavement markers are commonly used in lieu of painted strips for marking roads in California. Other states, mainly in the southern part of the United States, rely on them as well. These markers may be white or yellow, depending on the specific application, following the same basic colors of their analogous white and yellow painted lines. Following the California 2006 Standard Plans, three types of raised pavement markings are used to form roadway lines. It is believed that these types of roadway markings are the hardest for an LDW sensor system to process. Type A and Type AY are non-reflective circular domes that are approximately 10 cm (4 in) in diameter and approximately 1.8 cm (0.7 in) high. Type C and D are square markings that are retro reflective in two directions measuring approximately 10 x 10 x 5 cm (4 x 4 x 0.5 in), and Type G and H that are the same as C and D only retro reflective in a single direction.

For the tests described in this document, raised pavement markers were set up following California Standard Plan A20A, Detail 4, as shown in Figure 3. Note that in this figure, the squares are Type D yellow reflectors and the circles are yellow Type AY discs.

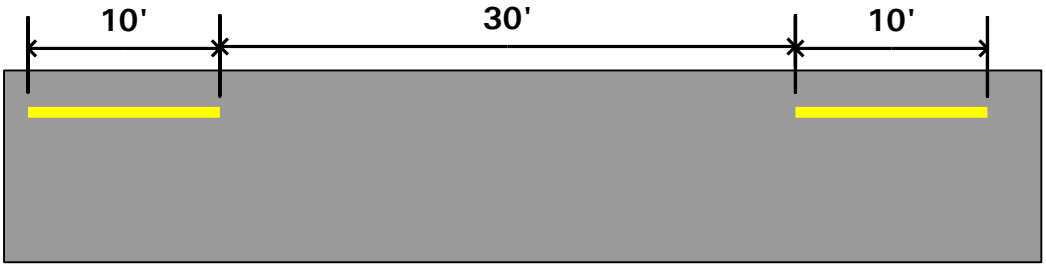

Figure 2. MUTCD Discontinuous Dashed Line Specifications

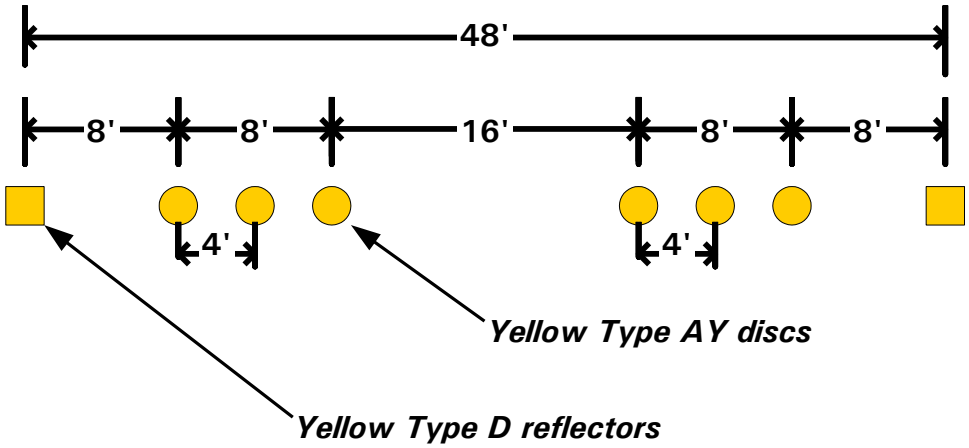

Figure 3. California Standard Plan A20A, Detail 4

C. Test Validity

1. Speed

All LDW tests were conducted at 72.4 km/h (45 mph). Test speed was monitored and a test was considered valid if the test speed remained within ± 2 km/h (± 1.2 mph) of the 72.4 km/h (45 mph) target speed. It was required that the speed must remain within this window from the start of the test until any part of the vehicle crossed a lane line by 1 m (3.3 ft) or more.

2. Lateral Velocity

All tests were conducted with a lateral velocity of 0.1 to 0.6 m/s (0.3 to 2.0 ft/s), measured with respect to the lane line at the time of the alert. To assist the test driver in being able to efficiently establish the target lateral velocity, cones were positioned in the manner shown in Figure 1.

3. Yaw Rate

It was required that the magnitude of the vehicle's yaw rate could not exceed 1.0 deg/sec at any time during lane departure maneuver, from the time the vehicle passes through the start gate to the instant the vehicle has crossed a lane line by 1 m (3.3 ft).

D. Pass/Fail Criteria

The measured test data were used to determine the pass/fail outcome for each trial. The outcome was based on whether the LDW produced an appropriate alert during the maneuver. In the context of this test procedure, a lane departure is said to occur when any part of the two-dimensional polygon used to represent the test vehicle breaches the inboard lane line edge (i.e., the edge of the line close to the vehicle before the departure occurs). In the case of tests performed in this procedure, the front corner of the polygon, defined as the intersection of the center of the front wheels (longitudinally) with the outboard edge of the front tire (laterally), crossed the line edge first. So, for example, if the vehicle departed its lane to the left, the left front corner of the polygon would first breach the lane line edge.

For an individual trial to be considered a "pass":

- Test speed, lateral velocity, and yaw rate validity conditions must be satisfied.
- The LDW alert must not occur when the lateral position of the vehicle is greater than 0.75 m (2.5 ft) from the lane line edge (i.e., prior to the lane departure).
- The LDW alert must occur before the lane departure exceeds 0.3 m (1.0 ft).

For an overall, "Pass" the LDW system must satisfy the pass criteria for 3 of 5 individual trials for each combination of departure direction and lane line type (60%), and pass 20 of the 30 trials overall (66%).

E. Instrumentation

Table 2 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

Table 2. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and 100 psi	Omega DPG8001	17042707002	By: DRI Date: 10/5/2021 Due: 10/5/2022
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 2/11/2022 Due: 2/11/2023
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	N/A
Multi-Axis Inertial Sensing System	Position: Longitudinal, Lateral, and Vertical Accels: Lateral, Longitudinal and Vertical Velocities: Roll, Pitch, Yaw Rates: Roll, Pitch, Yaw Angles	Accels ± 10g, Angular Rate ±100 deg/s, Angle >45 deg, Velocity >200 km/h	Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h	Oxford Inertial +	2182	By: Oxford Technical Solutions[1] Date: 11/19/2021 Due: 11/19/2023
Real-Time Calculation of Position and Velocity Relative to Lane Markings	Distance and velocity to lane markings	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	N/A

[1] Oxford Technical Solutions recommends calibration every two years.

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	N/A	N/A
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	N/A	N/A
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2022 Due: 1/6/2023

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

For systems that implement auditory or haptic alerts, part of the pre-test instrumentation verification process is to determine the tonal frequency of the auditory warning or the vibration frequency of the tactile warning through use of the PSD (Power Spectral Density) function in Matlab. This is accomplished in order to identify the center frequency around which a band-pass filter is applied to subsequent auditory or tactile warning data so that the beginning of such warnings can be programmatically determined. The band-pass filter used for these warning signal types is a phaseless, forward-reverse pass, elliptical (Cauer) digital filter, with filter parameters as listed in Table 3.

Table 3. Auditory and Tactile Warning Filter Parameters

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

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

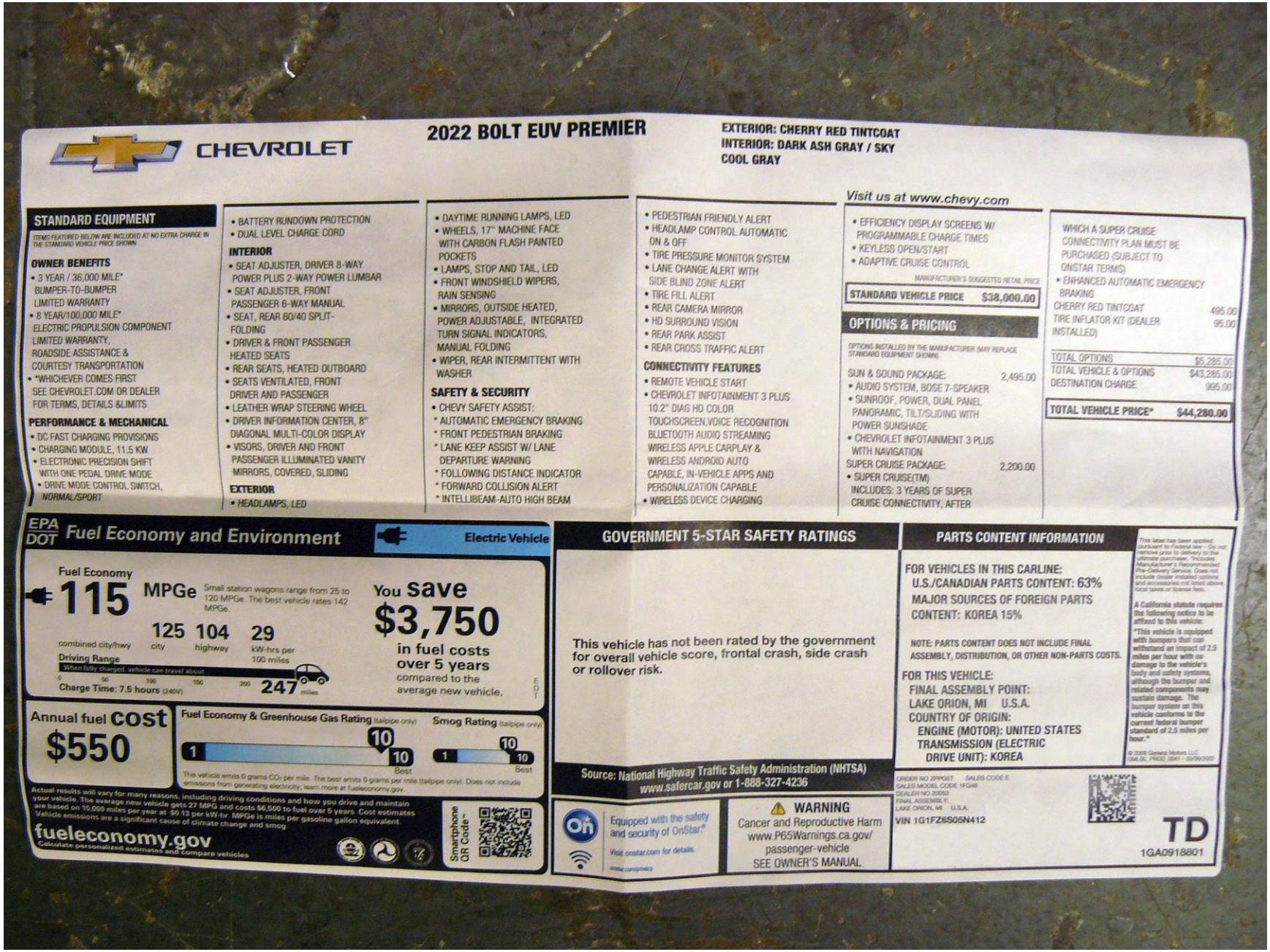

Figure A3. Window Sticker (Monroney Label)

Figure A4. Vehicle Certification Label

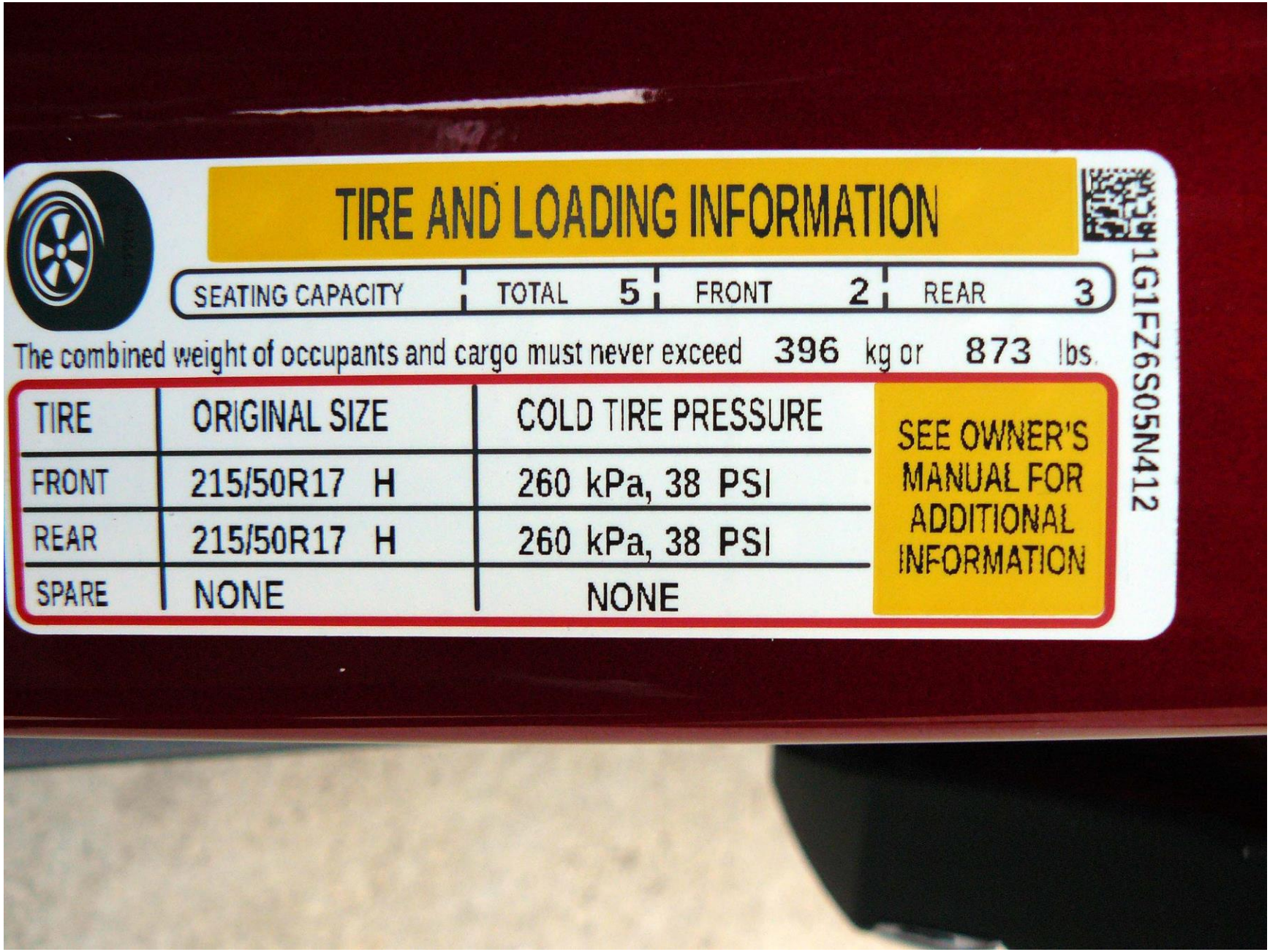

Figure A5. Tire Placard

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

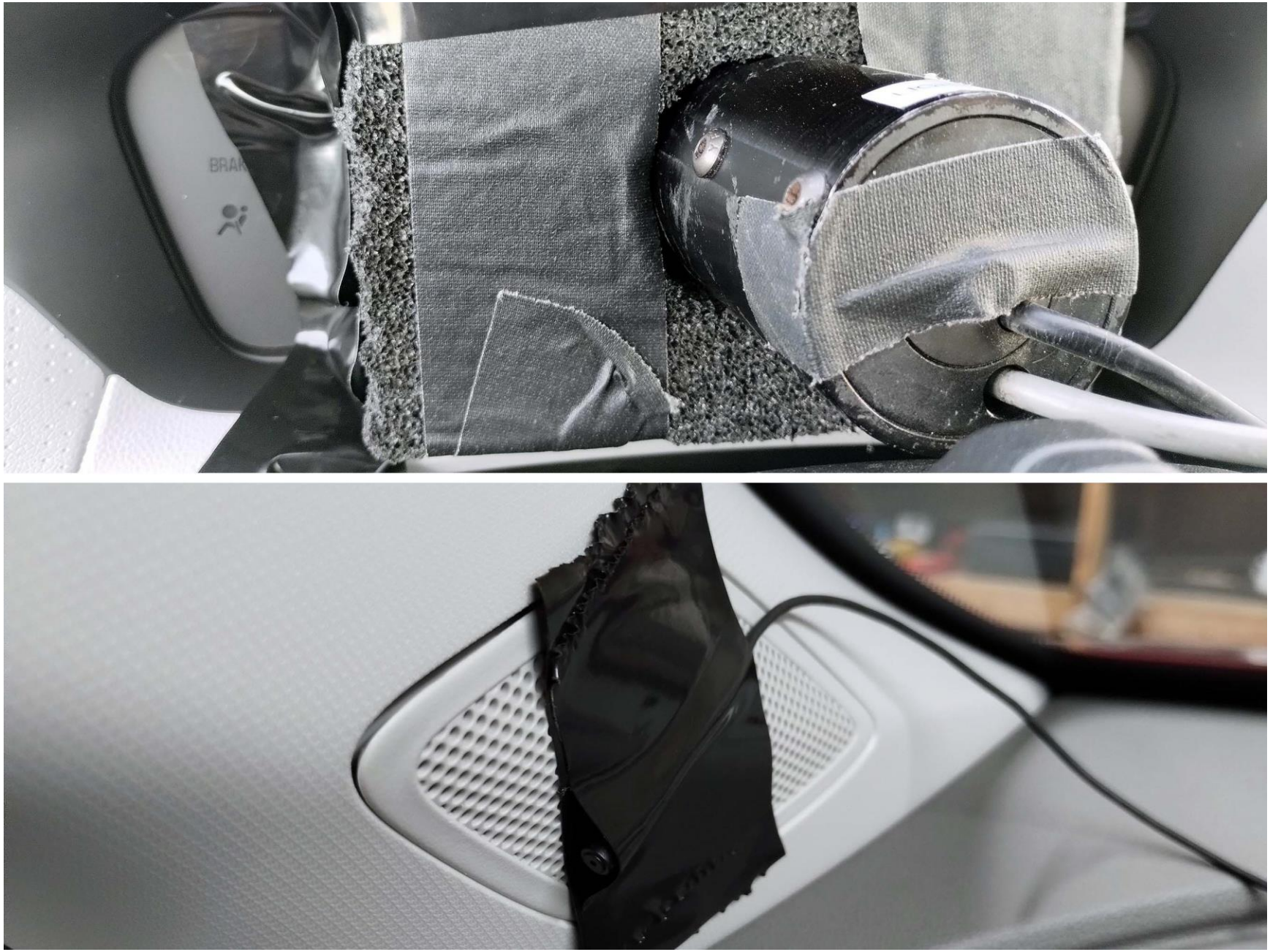

Figure A7. Sensors for Detecting Visual and Auditory Alerts

Figure A8. Computer Installed in Subject Vehicle

Figure A9. Visual Alert

Figure A10. Button for Turning LDW On/Off

APPENDIX B

Excerpts from Owner’s Manual

are also warned of vehicles rapidly approaching from up to 70 m (230 ft) behind the vehicle.

How the System Works

The LCA symbol lights up in the side mirrors when the system detects a moving vehicle in the next lane over that is in the side blind zone or rapidly approaching that zone from behind. A lit LCA symbol indicates it may be unsafe to change lanes. Before making a lane change, check the LCA display, check mirrors, glance over your shoulder, and use the turn signals.

Left Side Mirror Display

Right Side Mirror Display

When the vehicle is started, both outside mirror LCA displays will briefly come on to indicate the system is operating. When the vehicle is in a forward gear, the left or right side mirror display will light up if a moving vehicle is detected in the next lane over in that blind zone or rapidly approaching that zone. If the turn signal is activated in the same direction as a detected vehicle, this display will flash as an extra warning not to change lanes.

LCA can be disabled through vehicle personalization. See "Collision/Detection Systems" under *Vehicle Personalization* ⇨ *102*. If LCA is disabled by the driver, the LCA mirror displays will not light up.

When the System Does Not Seem to Work Properly

The LCA system requires some driving for the system to calibrate to maximum performance. This calibration may occur more quickly if the vehicle is driven on a straight highway road with traffic and roadside objects (e.g., guardrails, barriers).

LCA displays may not come on when passing a vehicle quickly or for a stopped vehicle. LCA may alert to objects attached to the vehicle, such as a bicycle, or object extending out to either side of the vehicle. Attached objects may also interfere with the detection of vehicles. This is normal system operation; the vehicle does not need service.

LCA may not always alert the driver to vehicles in the next lane over, especially in wet conditions or when driving on sharp curves. The system does not need to be serviced. The system may light up due to guardrails, signs, trees, shrubs, and other non-moving objects. This is normal system operation; the vehicle does not need service.

LCA may not operate when the LCA sensors in the left or right corners of the rear bumper are covered with mud, dirt, snow, ice, or slush, or in heavy rainstorms. For cleaning instructions, see "Washing the Vehicle" under *Exterior Care* ⇨ *266*. If the DIC still displays the system unavailable message after cleaning both sides of the vehicle toward the rear corners of the vehicle, see your dealer.

If the LCA displays do not light up when moving vehicles are in the side blind zone or rapidly approaching this zone and the system is clean, the system may need service. Take the vehicle to your dealer.

Lane Keep Assist (LKA)

If equipped, LKA may help avoid crashes due to unintentional lane departures. This system uses a camera to detect lane markings between 60 km/h (37 mph) and 180 km/h (112 mph). It may assist by gently turning the steering wheel if the vehicle approaches a detected lane marking. It may

also provide a Lane Departure Warning (LDW) alert if the vehicle crosses a detected lane marking. LKA can be overriden by turning the steering wheel. This system is not intended to keep the vehicle centered in the lane. LKA will not assist and alert if the turn signal is active in the direction of lane departure, or if it detects that you are accelerating, braking or actively steering.

⚠ Warning

The LKA system does not continuously steer the vehicle. It may not keep the vehicle in the lane or give a Lane Departure Warning (LDW) alert, even if a lane marking is detected.

The LKA and LDW systems may not:

- Provide an alert or enough steering assist to avoid a lane departure or crash.
- Detect lane markings under poor weather or visibility conditions. This can occur if the windshield or headlamps are blocked by dirt, snow, or ice; if they are not in proper condition; or if the sun shines directly into the camera.

(Continued)

Warning (Continued)

- Detect road edges.
- Detect lanes on winding or hilly roads.

If LKA only detects lane markings on one side of the road, it will only assist or provide an LDW alert when approaching the lane on the side where it has detected a lane marking. Even with LKA and LDW, you must steer the vehicle. Always keep your attention on the road and maintain proper vehicle position within the lane, or vehicle damage, injury, or death could occur. Always keep the windshield, headlamps, and camera sensors clean and in good repair. Do not use LKA in bad weather conditions or on roads with unclear lane markings, such as construction zones.

⚠ Warning

Using LKA while towing a trailer or on slippery roads could cause loss of control of the vehicle and a crash. Turn the system off.

How the System Works

LKA uses a camera sensor installed on the windshield ahead of the rearview mirror to detect lane markings. It may provide brief steering assist if it detects an unintended lane departure. It may further provide an audible alert or the driver seat may pulse indicating that a lane marking has been crossed.

To turn LKA on and off, press  on the center console. If equipped, the indicator light on the button comes on when LKA is on and turns off when LKA is disabled.

When on,  is white, if equipped, indicating that the system is not ready to assist.  is green if LKA is ready to assist. LKA may assist by gently turning the steering wheel if the vehicle approaches a detected lane marking.  is amber when assisting. It may also provide a Lane Departure Warning (LDW) alert by flashing  amber if the vehicle crosses a detected lane marking. Additionally, there may be three beeps, or the driver seat may pulse three times, on the right or left, depending on the lane departure direction.

Take Steering

The LKA system does not continuously steer the vehicle. If LKA does not detect active driver steering, an alert and chime may be provided. Steer the vehicle to dismiss. LKA may become temporarily unavailable after repeated take steering alerts.

When the System Does Not Seem to Work Properly

The system performance may be affected by:

- Close vehicles ahead.
- Sudden lighting changes, such as when driving through tunnels.
- Banked roads.
- Roads with poor lane markings, such as two-lane roads.

If the LKA system is not functioning properly when lane markings are clearly visible, cleaning the windshield may help.

A camera blocked message may display if the camera is blocked. Some driver assistance systems may have reduced performance or not work at all. An LKA or LDW unavailable message may display if the systems are temporarily unavailable. This message could be due to a blocked camera. The LKA system does not need service. Clean the outside of the windshield behind the rearview mirror.

LKA assistance and/or LDW alerts may occur due to tar marks, shadows, cracks in the road, temporary or construction lane markings, or other road imperfections. This is normal system operation; the vehicle does not need service. Turn LKA off if these conditions continue.

Charging

When to Charge

When the high voltage battery is getting low, charging messages may display.

The CHARGE VEHICLE SOON message indicates that the driving range is low and the vehicle needs to be charged soon. As the charge level drops, the PROPULSION POWER IS REDUCED message is displayed and the accelerator pedal response is reduced. In addition, the remaining range value will change to LOW indicating the vehicle should be charged immediately.

When the energy is fully depleted, the OUT OF ENERGY, CHARGE VEHICLE NOW message displays and the vehicle slows to a stop. Brake and steering assist will still operate. Once the vehicle has stopped, turn the vehicle off. See *Propulsion Power Messages* ⇨ *101*.

Plug-In Charging

This section explains the process for charging the high voltage battery. Do not allow the vehicle to remain in temperature extremes for long periods without being driven or plugged in. Plug the vehicle in when temperatures are below 0 °C (32 °F) and above 32 °C (90 °F) to maximize high voltage battery life.

Charge times will vary based on battery condition, charge level, and outside temperature. See *Programmable Charging* ⇨ *90* for charge mode selection.

If equipped, the vehicle can be charged using DC charging equipment typically found at service stations and other public locations.

The following table shows the amount of range added and time to full charge based on how the vehicle is being charged:

APPENDIX C

Run Log

Subject Vehicle: **2022 Chevrolet Bolt EUV Premier** Test start date: **8/30/2022**

Driver: **Anthony Saldana** Test end date: **8/30/2022**

Note: For Distance at Warning, positive values indicate inside the lane

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Audible Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
1	**Botts**	**Left**	Y		0.61	Pass	Audible alert occurs under specific circumstances that cannot be reliably reproduced.
2			Y		0.79	Pass	
3			Y		0.73	Pass	
4			Y		0.79	Pass	
5			Y	-1.50	0.69	Pass	Audible alert invalid due to distance to lane edge. However, visual alert was valid resulting in an overall valid run.
6			Y		0.66	Pass	
7			Y	-1.60	0.78	Pass	Audible alert invalid due to distance to lane edge and lateral lane velocity. However, visual alert was valid resulting in an overall valid run.
8	**Botts**	**Right**	Y		0.48	Pass	
9			Y		0.83	Pass	
10			Y		0.70	Pass	
11			Y		0.66	Pass	
12			Y		0.73	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Audible Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
13			Y		0.63	Pass	
14			Y		0.55	Pass	
15	**Solid**	**Right**	Y		0.70	Pass	
16			Y		1.17	Pass	
17			Y		0.59	Pass	
18			Y		0.76	Pass	
19			Y		0.50	Pass	
20			Y		0.59	Pass	
21			Y		0.77	Pass	
22	**Solid**	**Left**	Y		1.25	Pass	
23			Y		0.62	Pass	
24			Y		0.92	Pass	
25			N				Speed
26			Y		0.61	Pass	
27			Y	-0.98	0.66	Pass	
28			Y	-0.92	0.84	Pass	
29			Y	-1.01	0.90	Pass	
30	**Dashed**	**Left**	Y		0.89	Pass	
31			Y		1.06	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Audible Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
32			Y		0.90	Pass	
33			Y		0.89	Pass	
34			Y		0.61	Pass	
35			Y		0.64	Pass	
36			Y		0.91	Pass	
37	**Dashed**	**Right**	Y		0.70	Pass	
38			Y		0.62	Pass	
39			Y		0.69	Pass	
40			Y		0.61	Pass	
41			Y		0.45	Pass	
42			Y		0.78	Pass	
43			Y		0.68	Pass	

APPENDIX D

Time History Plots

LIST OF FIGURES

Description of Time History Plots

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from the Subject 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 for data envelopes.

Time History Plot Description

Time history figures include the following sub-plots:

- Warning – Indicates timing of warning issued by LDW system. Depending on the type of LDW alert or instrumentation used to measure the alert, this can be any of the following:
    - Filtered and rectified sound signal
    - Filtered and rectified acceleration (e.g., steering wheel vibration)
    - Light sensor signal
    - Discrete on/off value
- Speed (mph) – Speed of the Subject Vehicle
- Yaw Rate (deg/sec) – Yaw rate of the Subject Vehicle
- Distance to Lane Edge (ft) – Lateral distance (in lane coordinates) from the outer front tire bulge to the inside edge of the lane marking of interest for a given test (a positive value indicates the vehicle is completely within the lane while a negative value indicates that the outer front tire bulge has crossed over the inner lane marking edge). The distance to the lane edge at the moment the LDW alert is issued, is displayed to the right of subplot.
- Lateral Lane Velocity (ft/sec) – Lateral velocity (in lane coordinates) of the outer front tire bulge
- Bird’s Eye View – Indicates the position of the Subject Vehicle with respect to the lane marking of interest for a given test. Green rectangles represent the Subject Vehicle’s position at approximately 2 second intervals, while the yellow rectangle indicates the position of the Subject Vehicle at the time of LDW warning issuance.

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 right end. Exceedances at the right extent of a yellow envelope are indicated by red asterisks. Data within the boundaries at the right extent of a yellow envelope are indicated by green circles.

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

Color Codes

Color codes have been adopted to easily identify the types of data, envelopes, and thresholds used in the plots.

Color codes can be broken into three categories:

1. Validation envelopes and thresholds
2. Instantaneous samplings
3. Text

1. 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 right end
   - 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 which are used to determine the timing of the alert

2. 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

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

Other Notations

- NG – Indicates that the value for that variable was outside of bounds and therefore “No Good”.
- No Wng – No warning was detected.

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

Examples of time history plots (including passing, failing and invalid runs) are shown in Figure D1 through Figure D3. Actual time history data plots for the vehicle under consideration are provided subsequently.

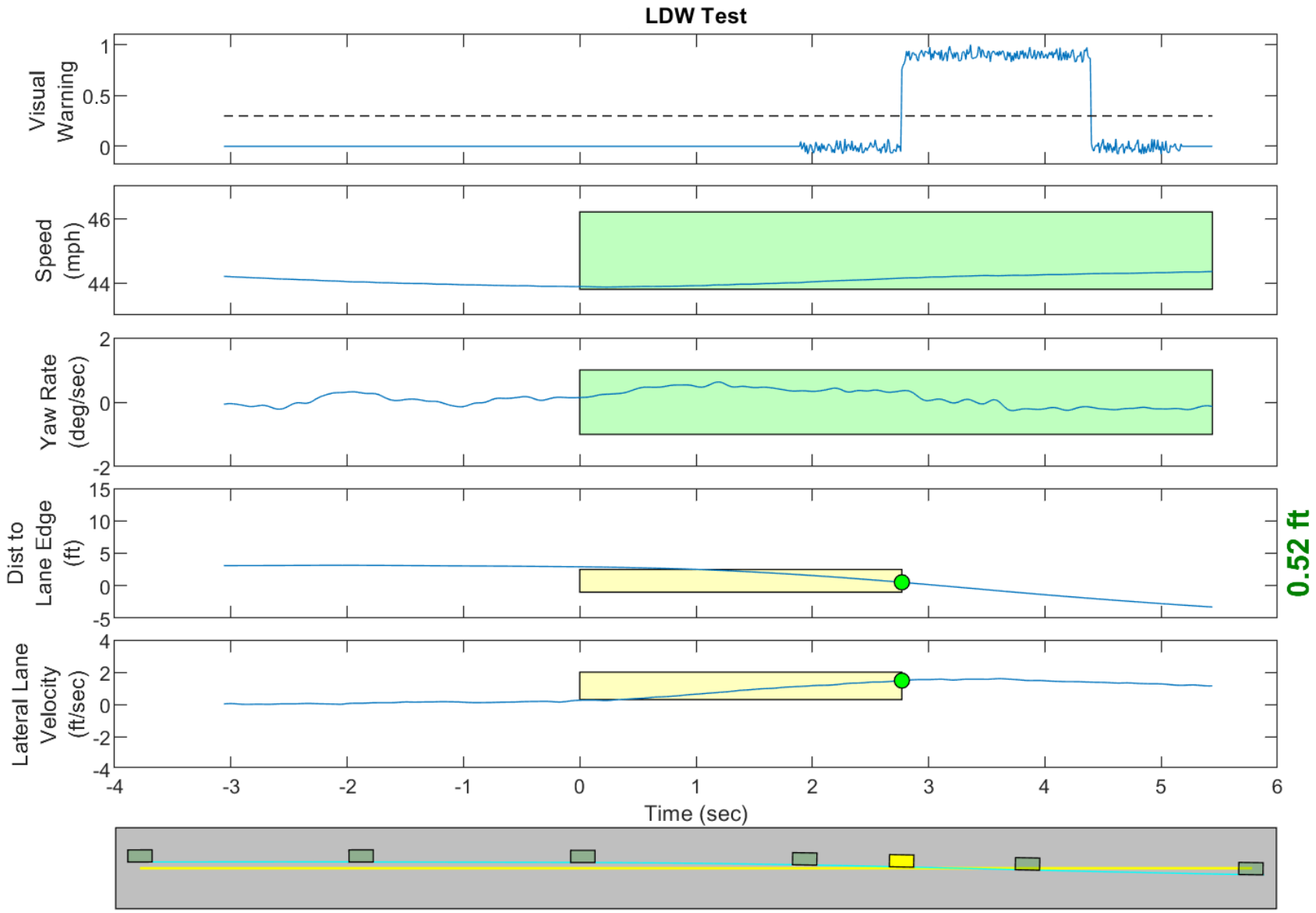

Figure D1. Example Time History for Lane Departure Warning Test, Passing

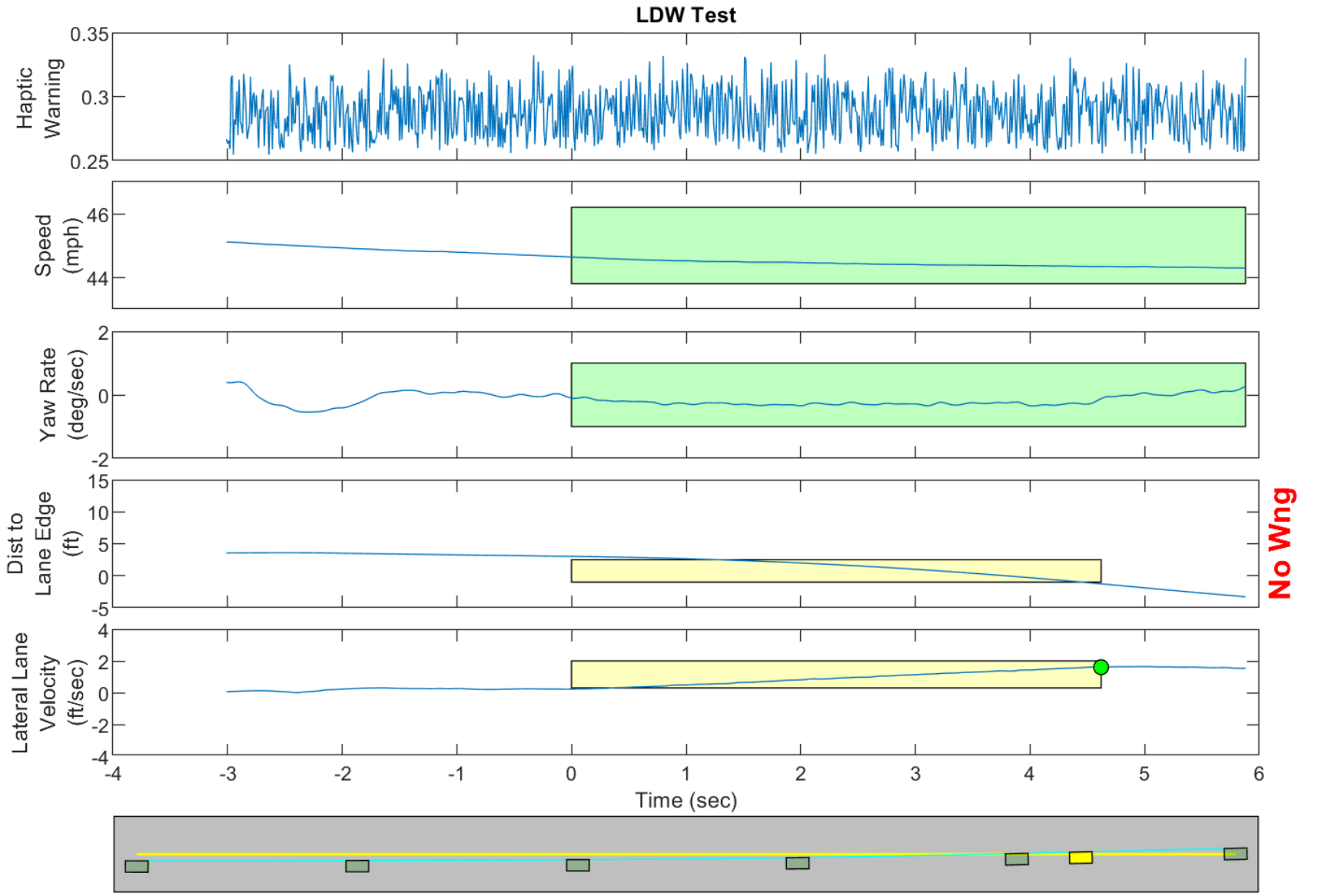

Figure D2. Example Time History for Lane Departure Warning Test, Failing, No Warning Issued

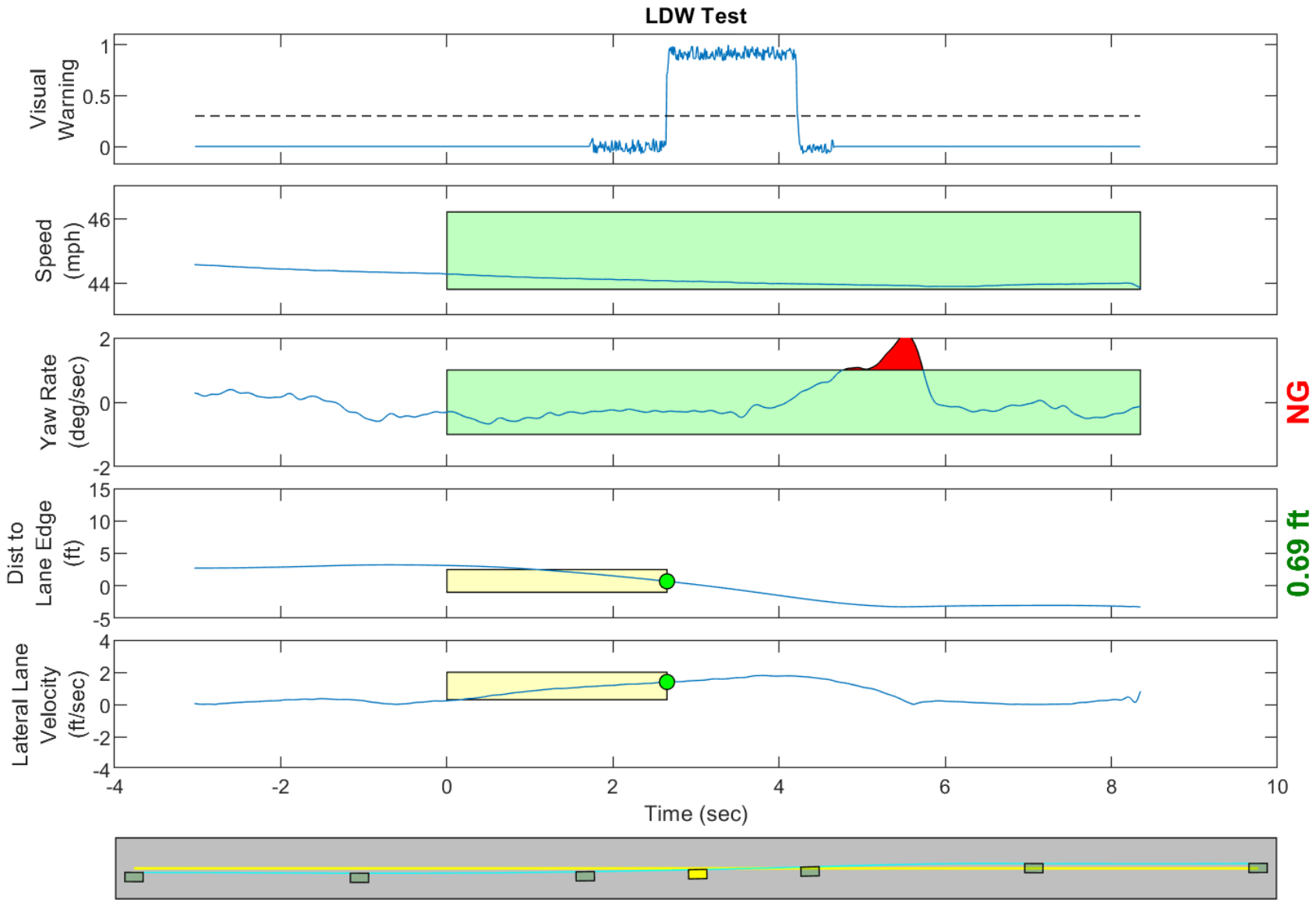

Figure D3. Example Time History for Lane Departure Warning Test, Invalid Run Due to Subject Vehicle Yaw Rate

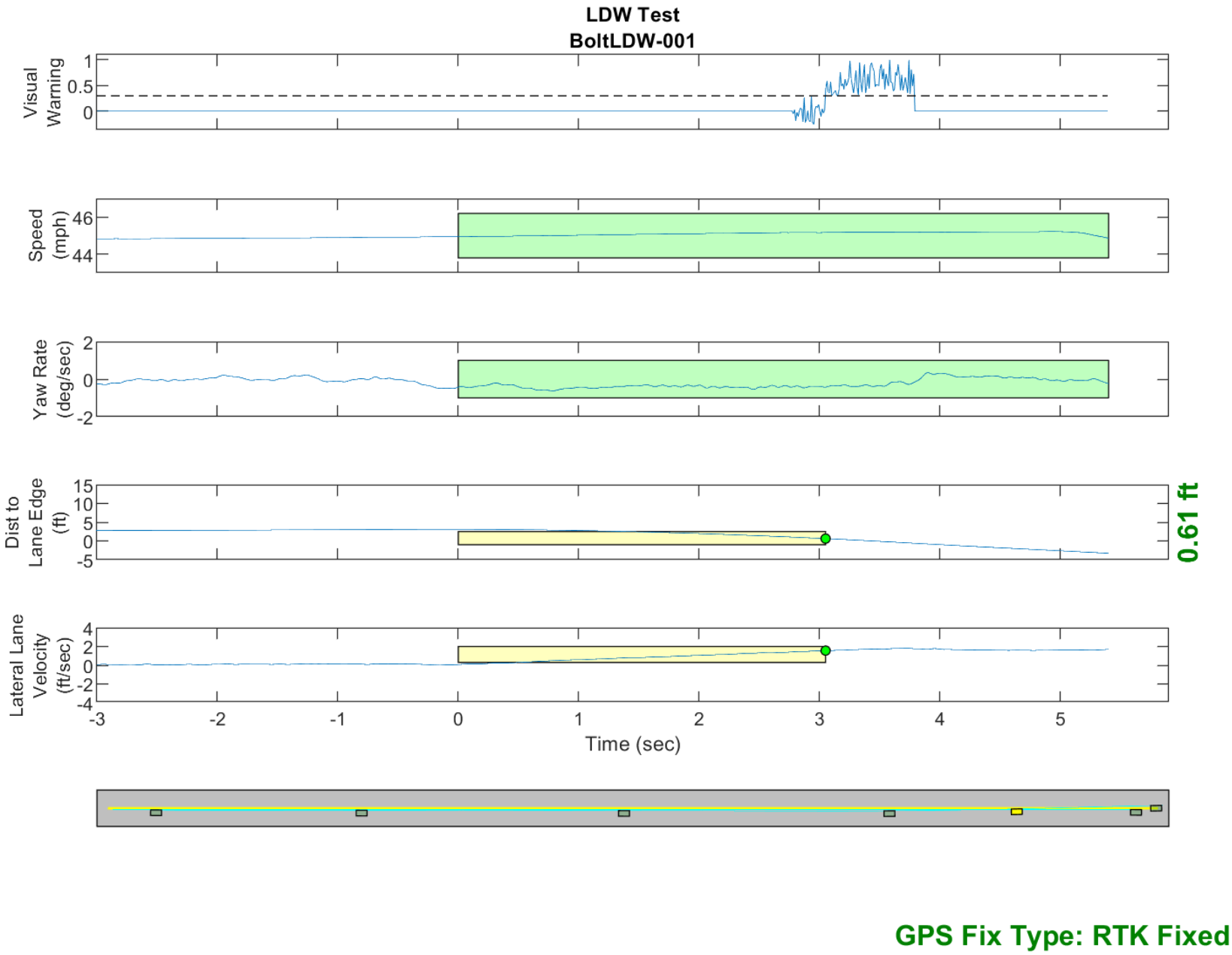

Figure D4. Time History for Run 01, Botts Dots, Left Departure, Visual Warning

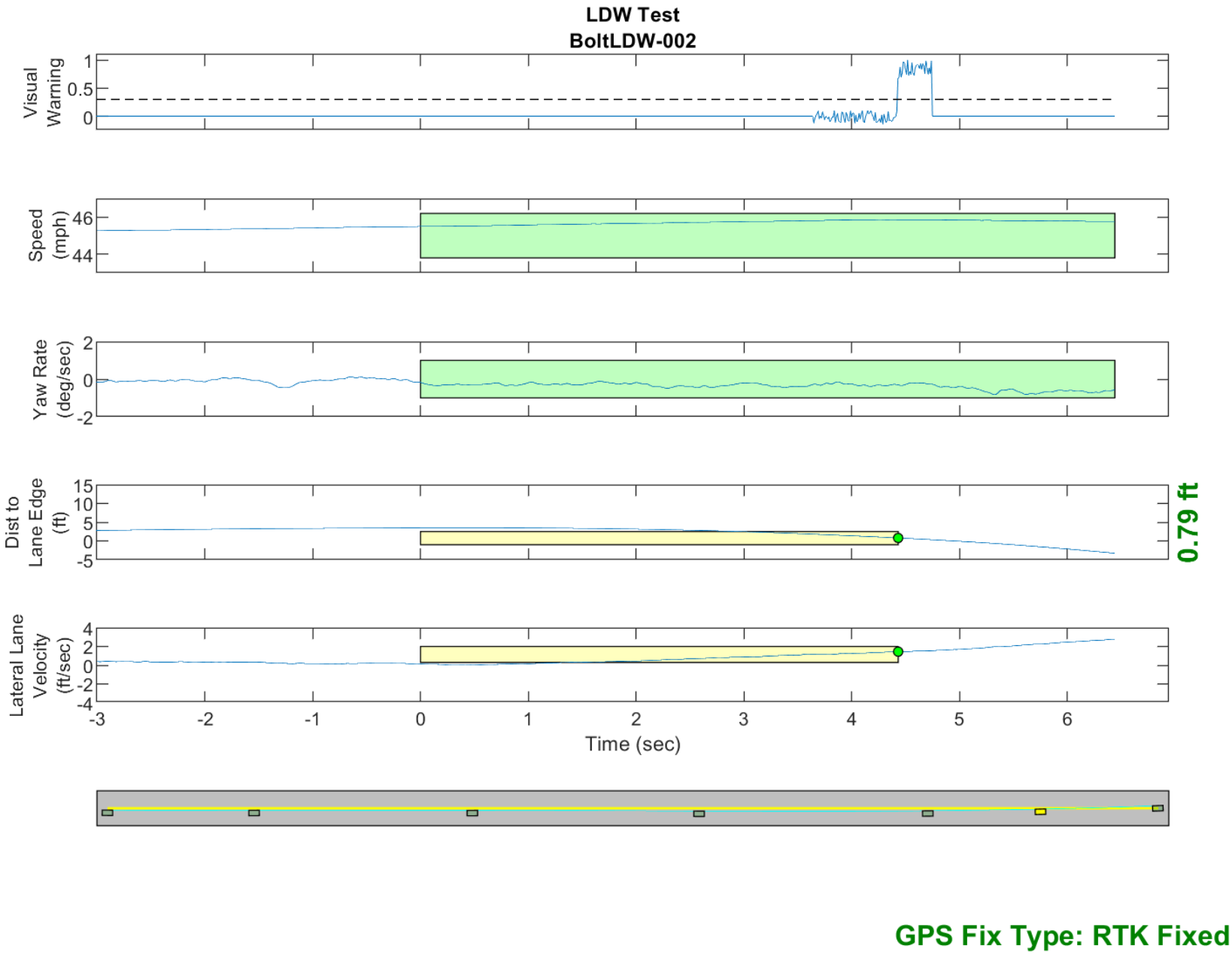

Figure D5. Time History for Run 02, Botts Dots, Left Departure, Visual Warning

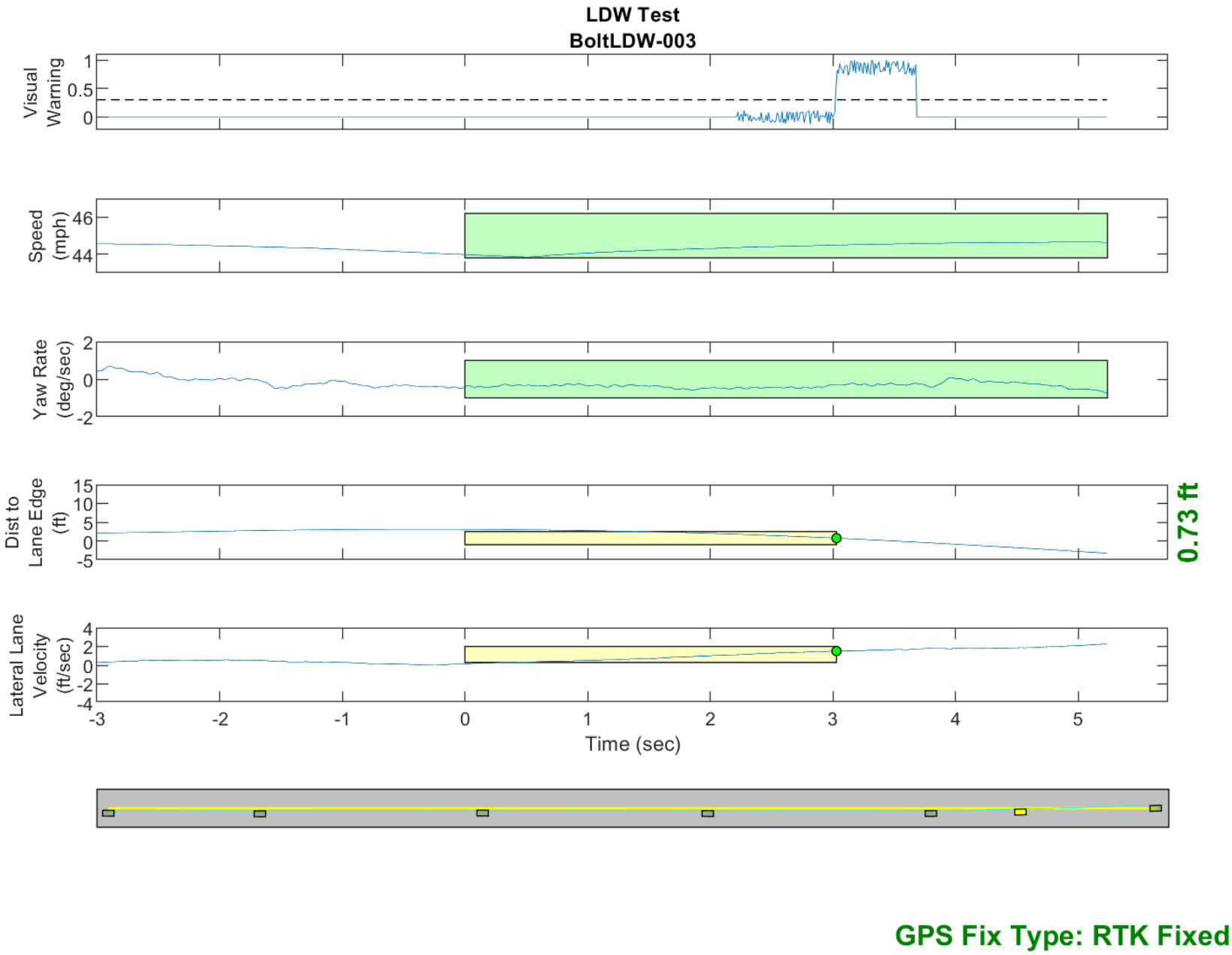

Figure D6. Time History for Run 03, Botts Dots, Left Departure, Visual Warning

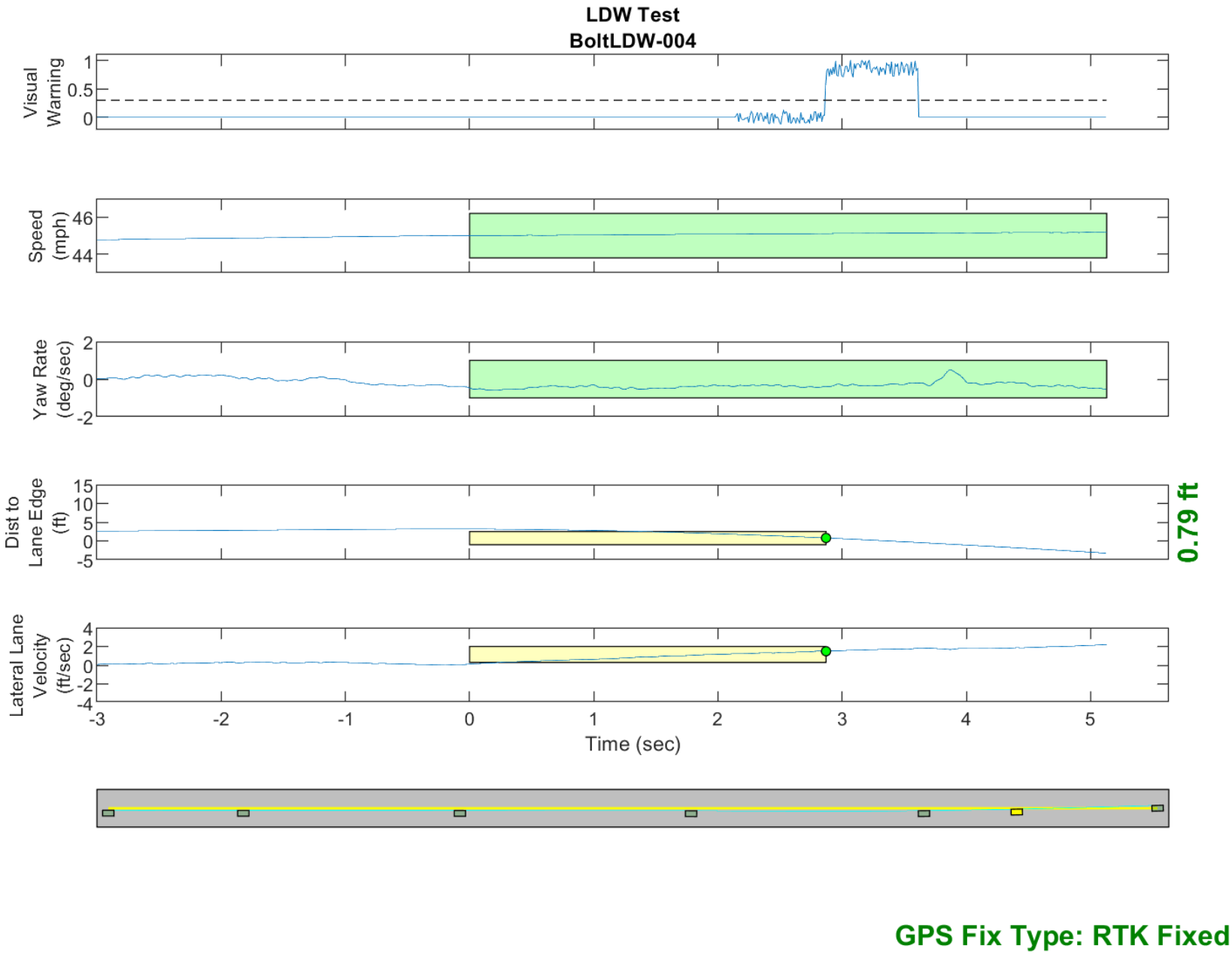

Figure D7. Time History for Run 04, Botts Dots, Left Departure, Visual Warning

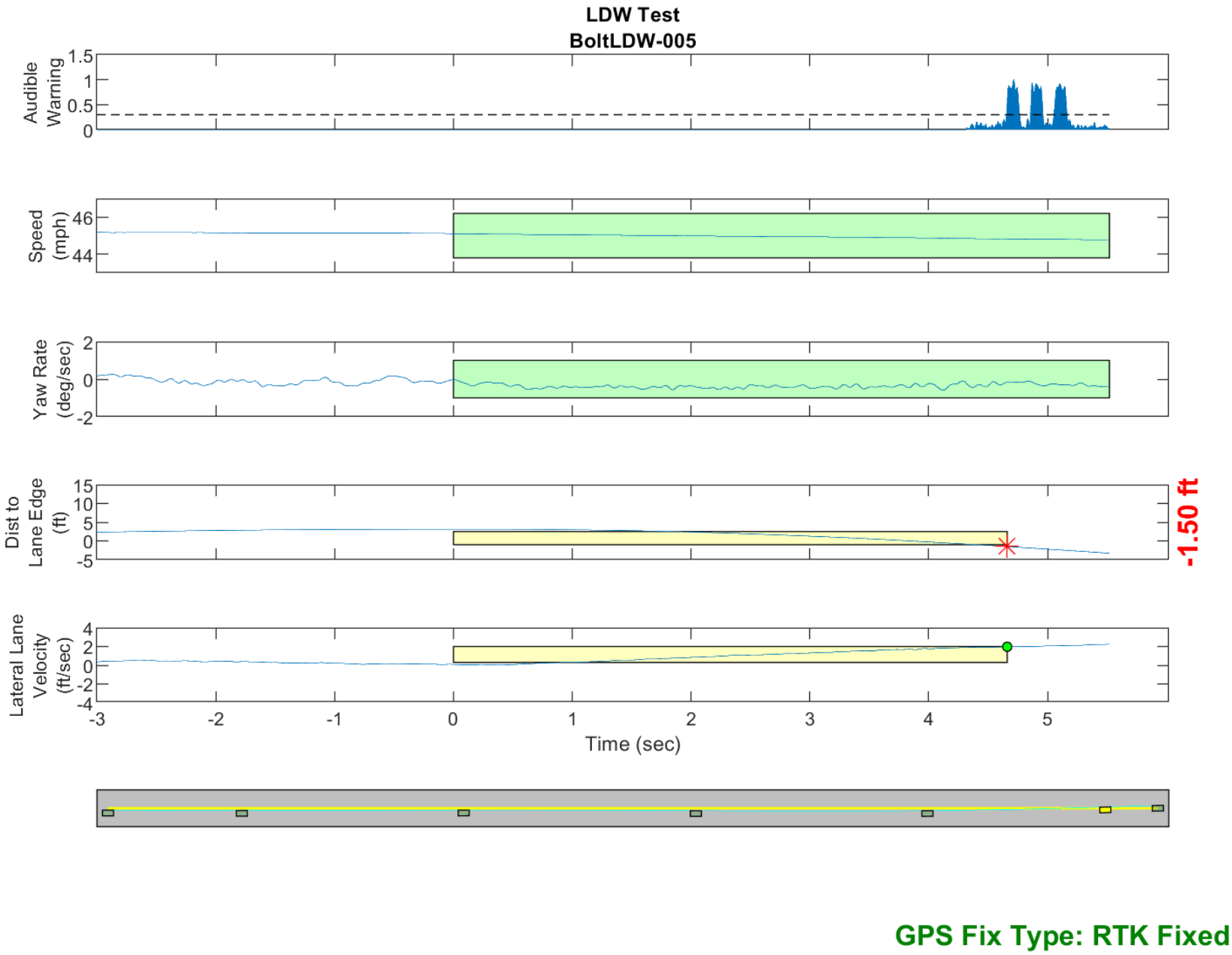

Figure D8. Time History for Run 05, Botts Dots, Left Departure, Auditory Warning

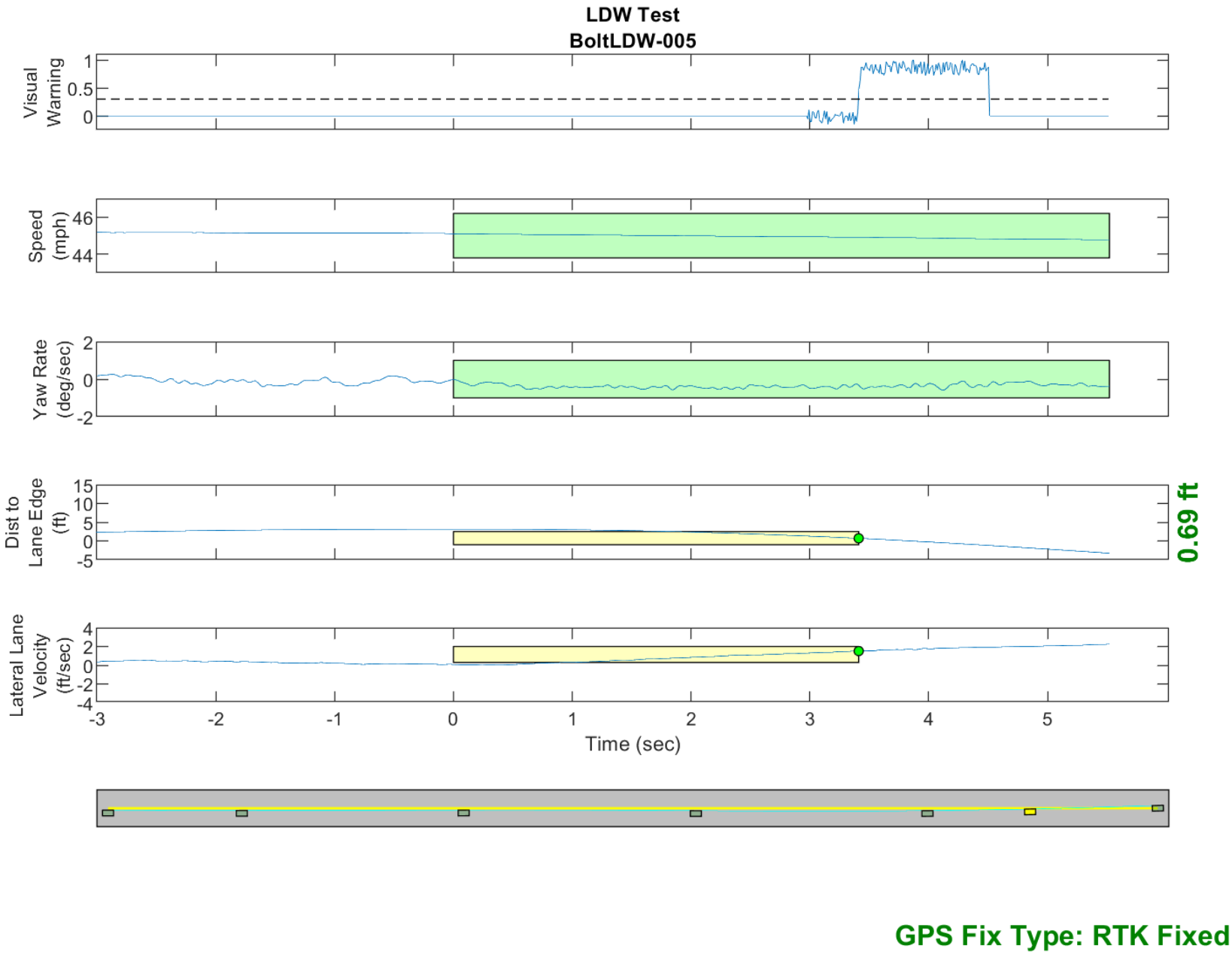

Figure D9. Time History for Run 05, Botts Dots, Left Departure, Visual Warning

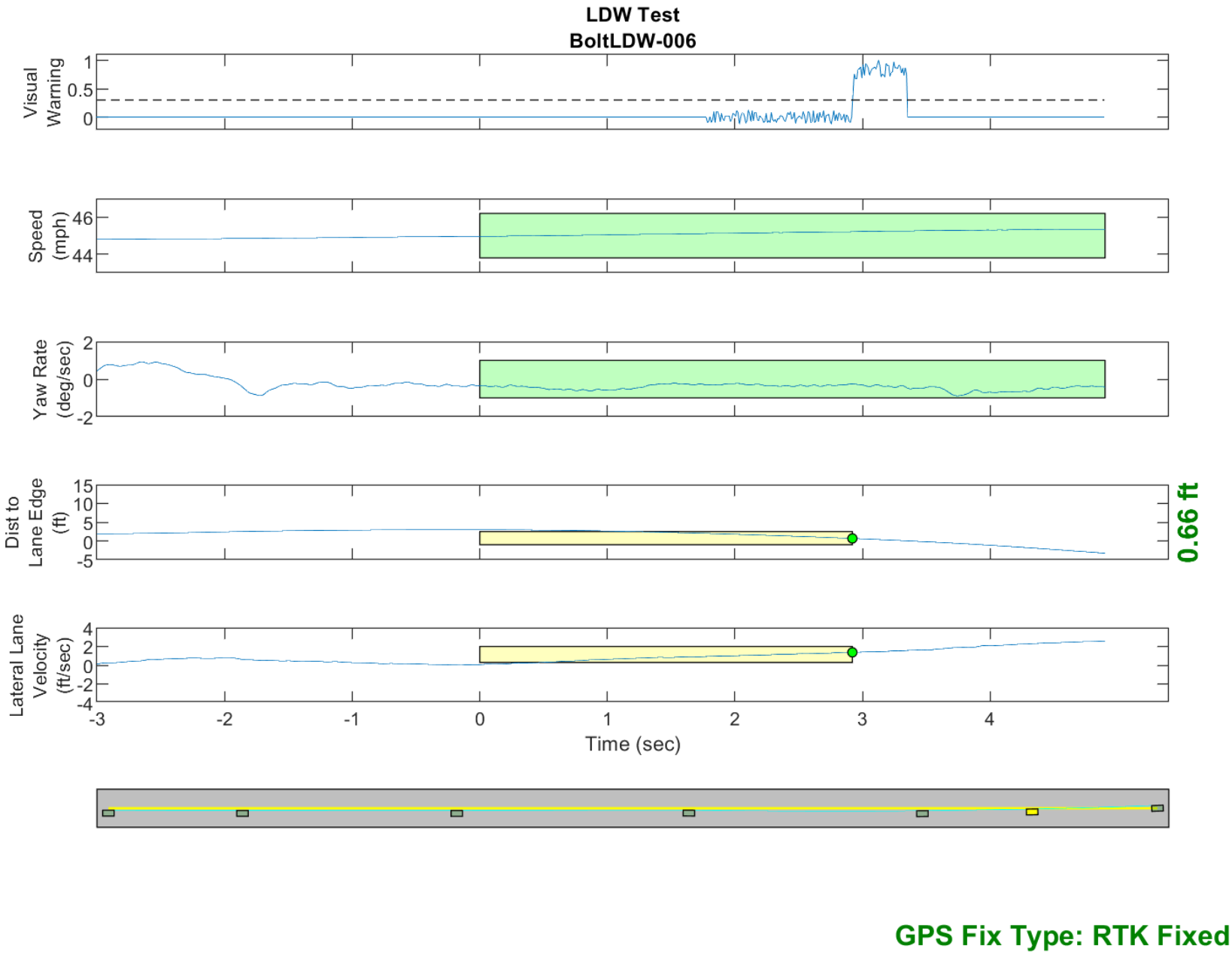

Figure D10. Time History for Run 06, Botts Dots, Left Departure, Visual Warning

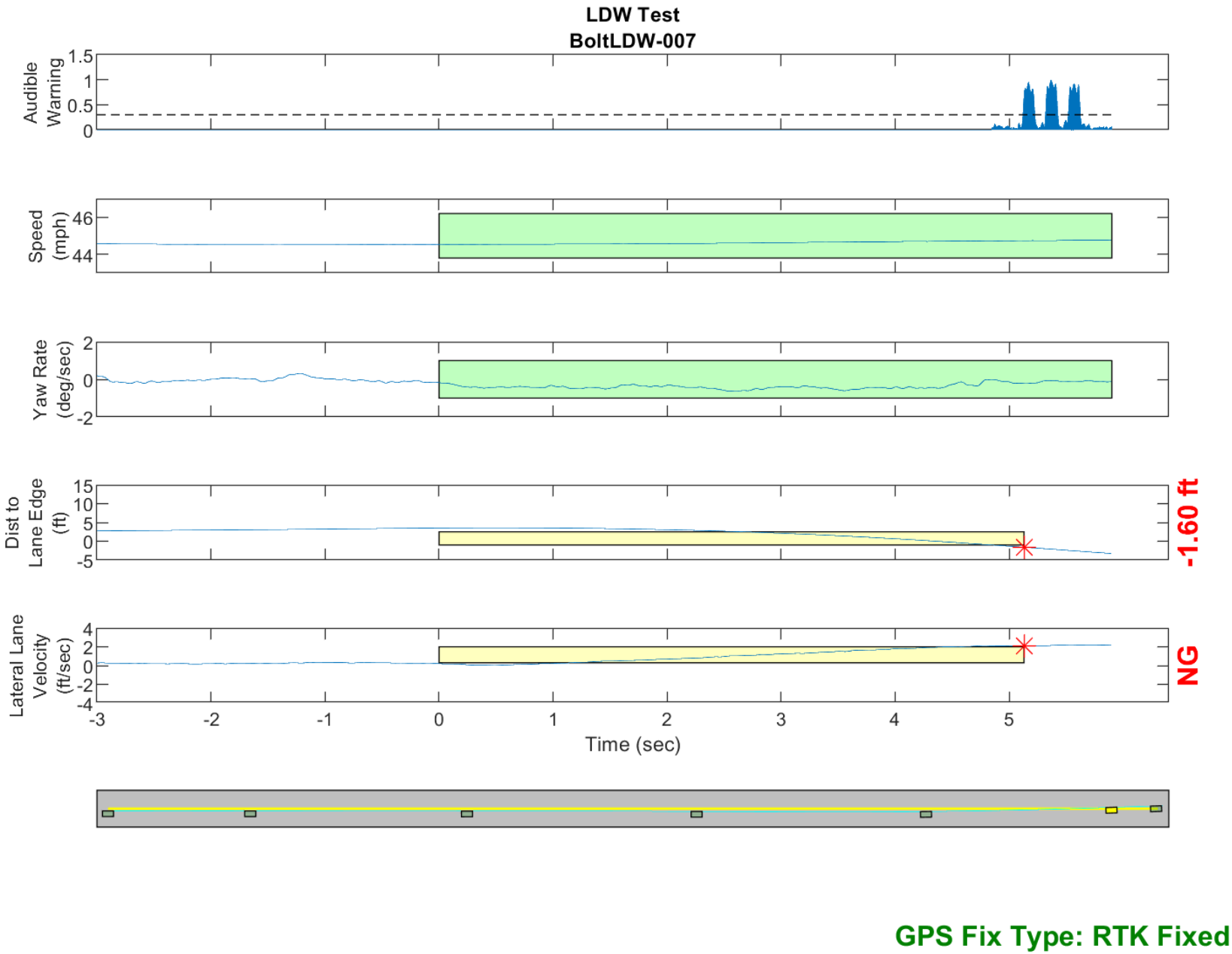

Figure D11. Time History for Run 07, Botts Dots, Left Departure, Auditory Warning

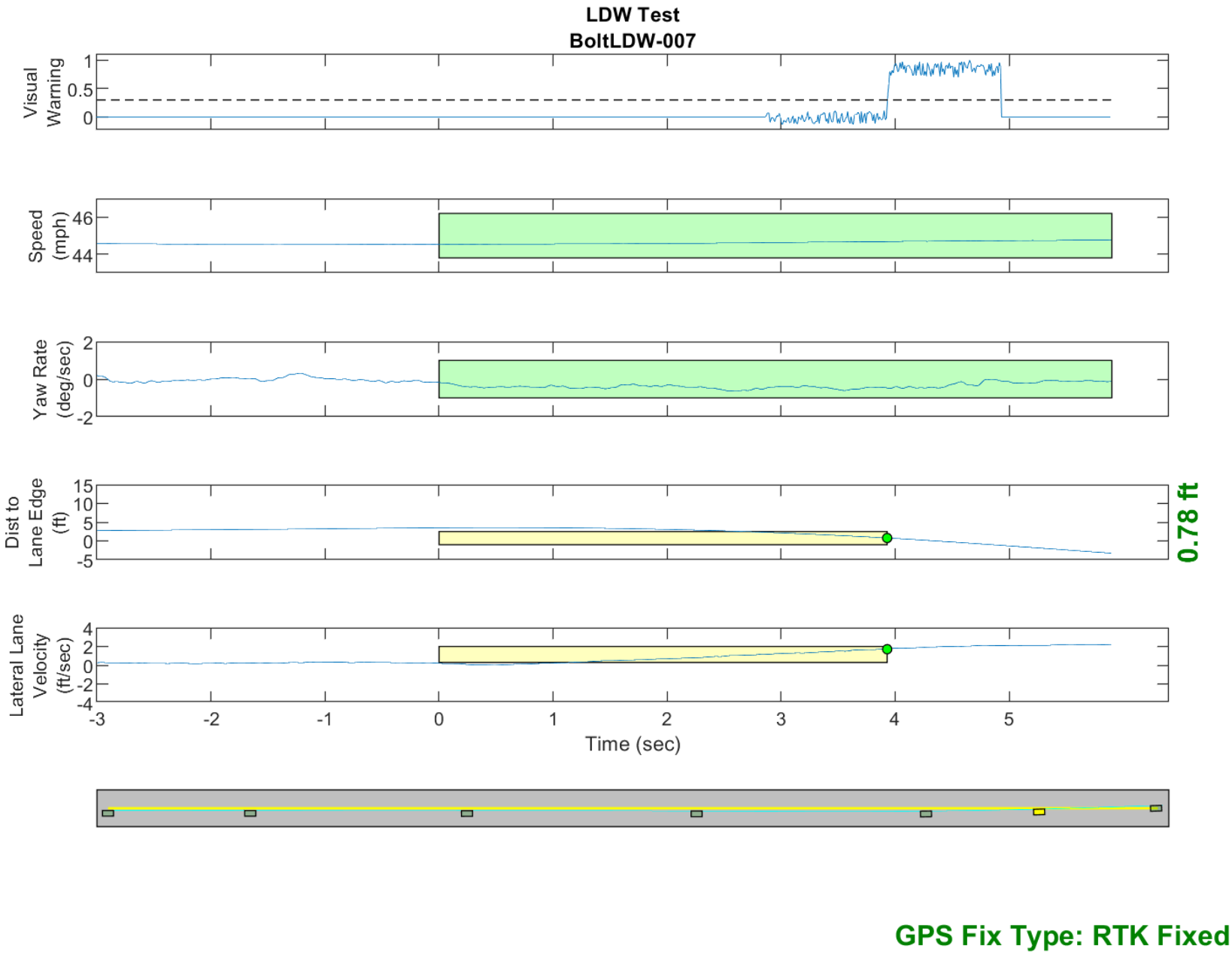

Figure D12. Time History for Run 07, Botts Dots, Left Departure, Visual Warning

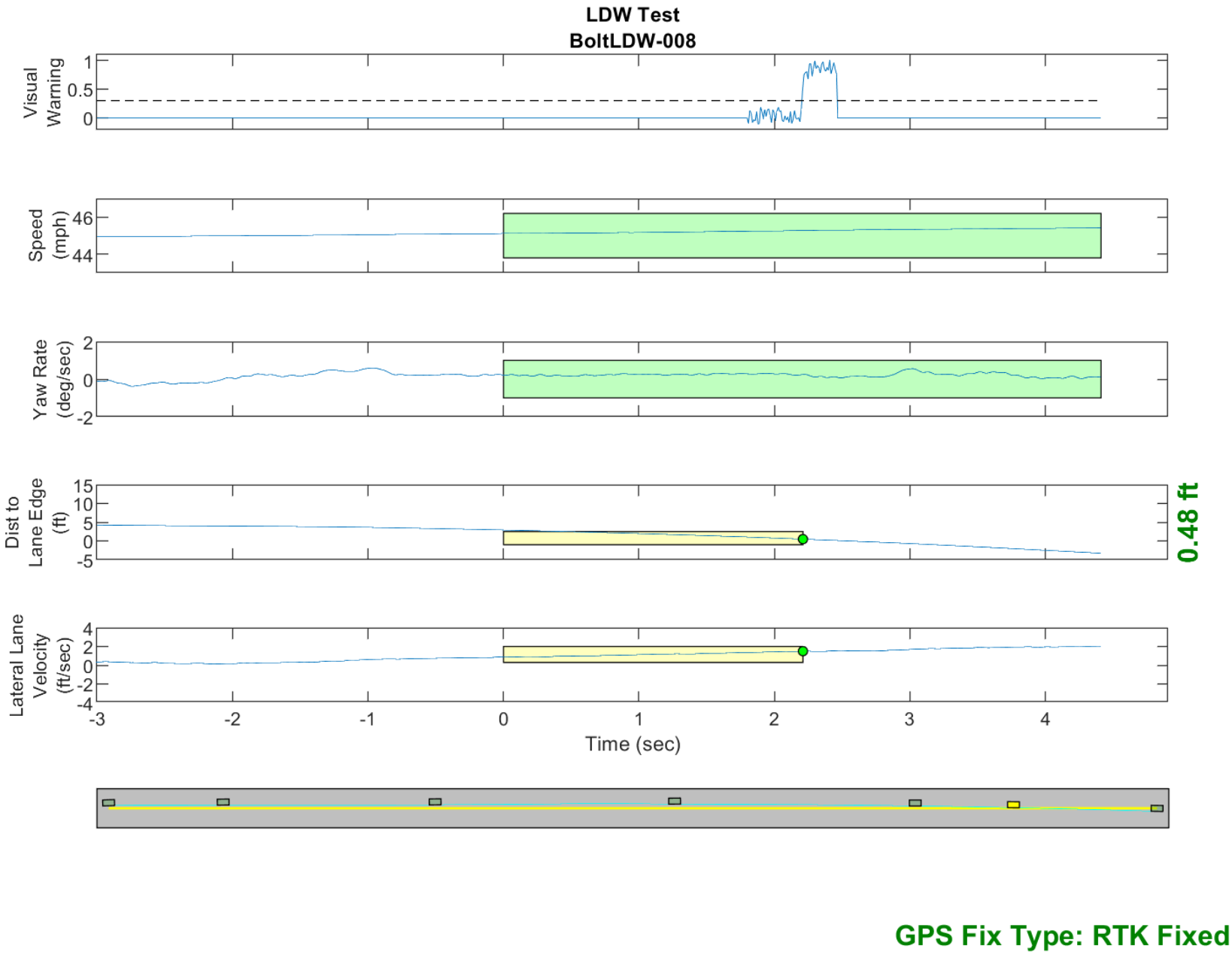

Figure D13. Time History for Run 08, Botts Dots, Right Departure, Visual Warning

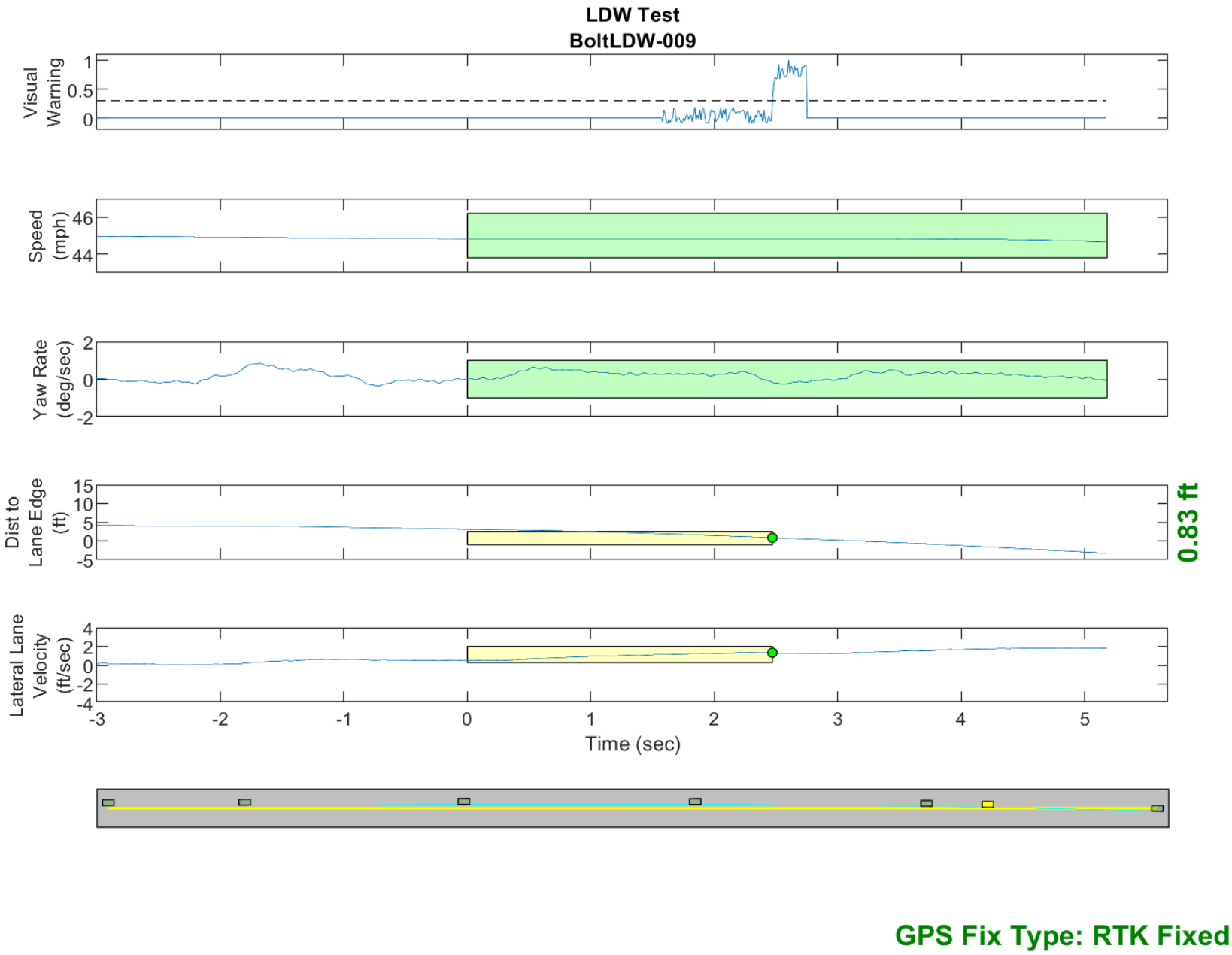

Figure D14. Time History for Run 09, Botts Dots, Right Departure, Visual Warning

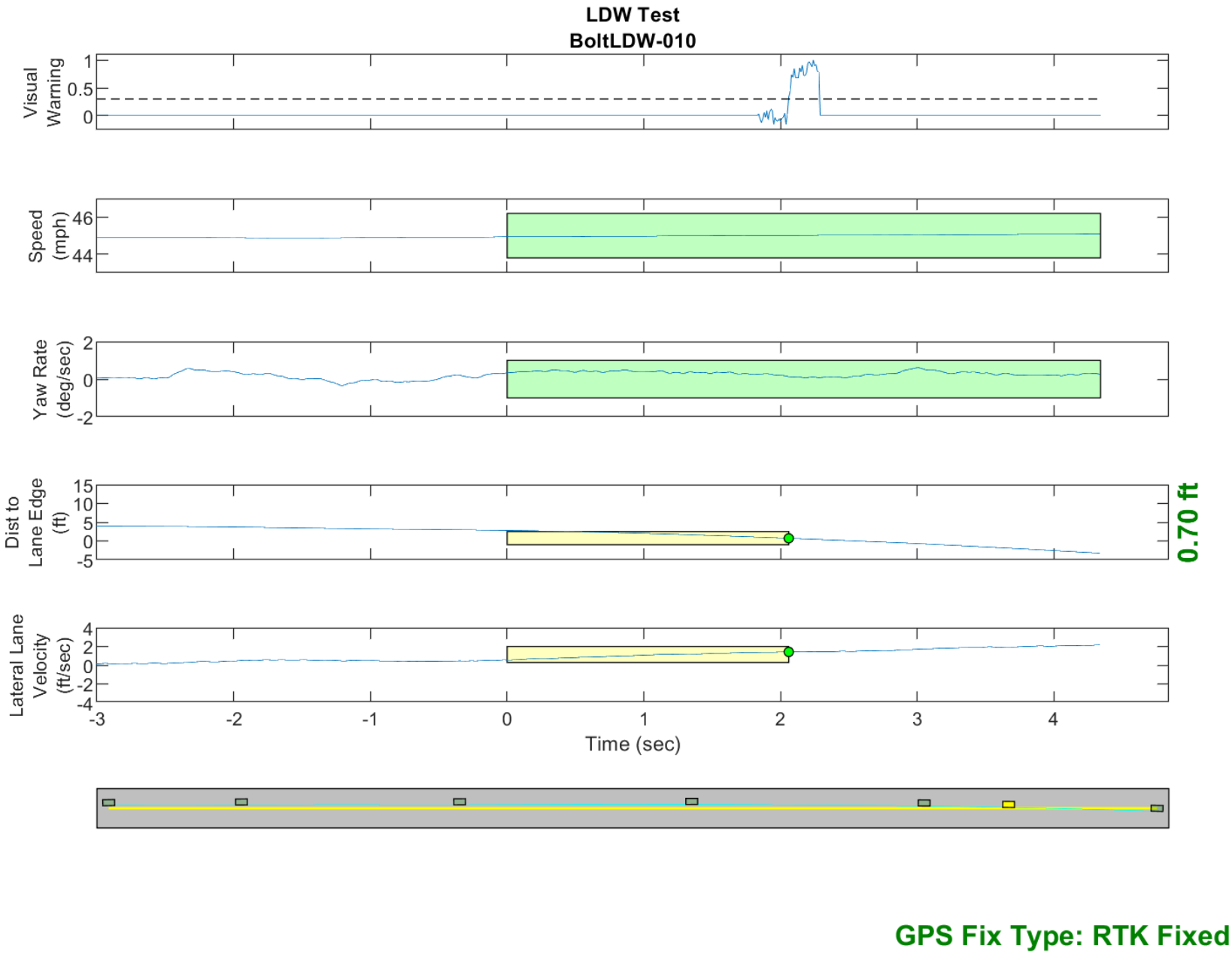

Figure D15. Time History for Run 10, Botts Dots, Right Departure, Visual Warning

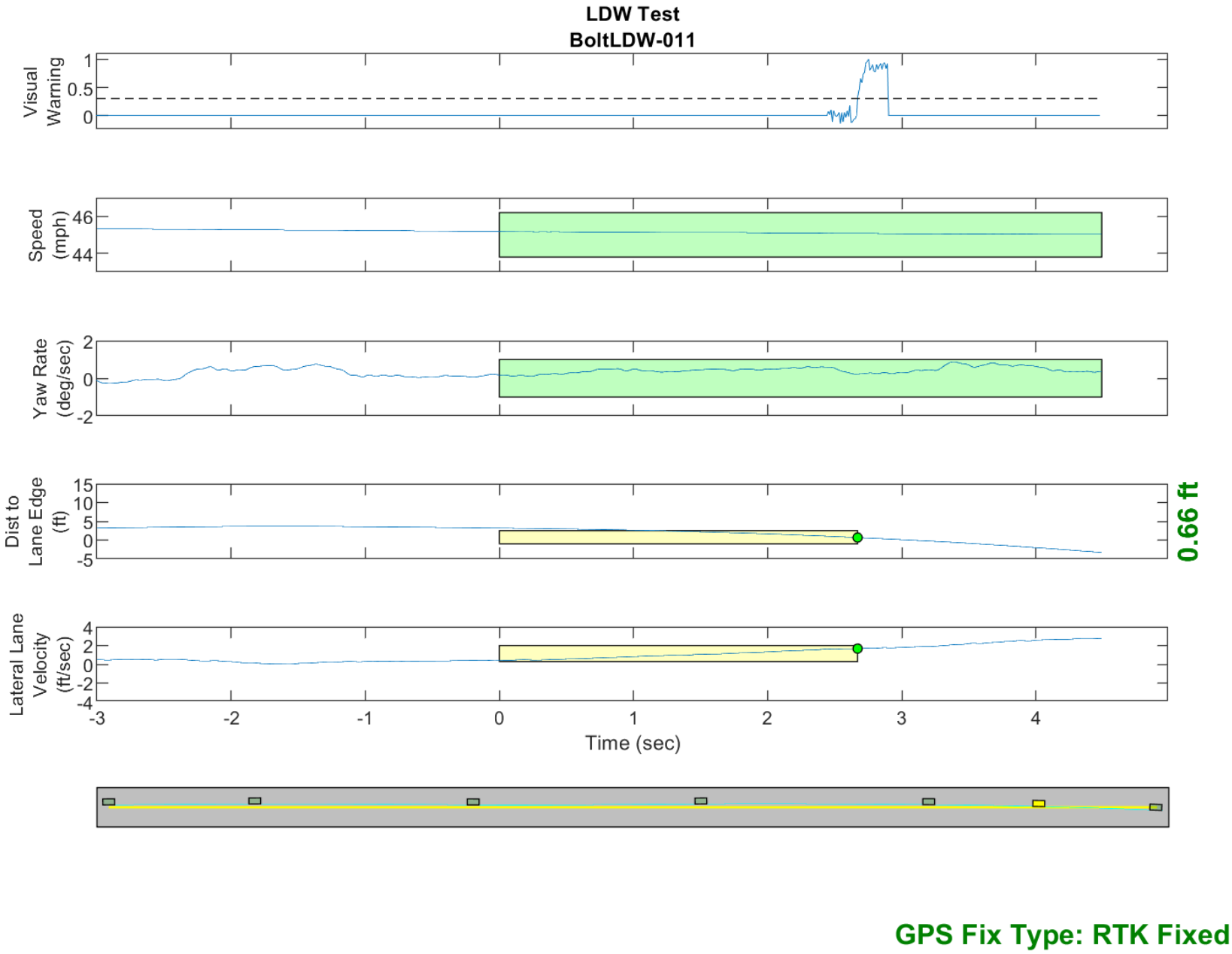

Figure D16. Time History for Run 11, Botts Dots, Right Departure, Visual Warning

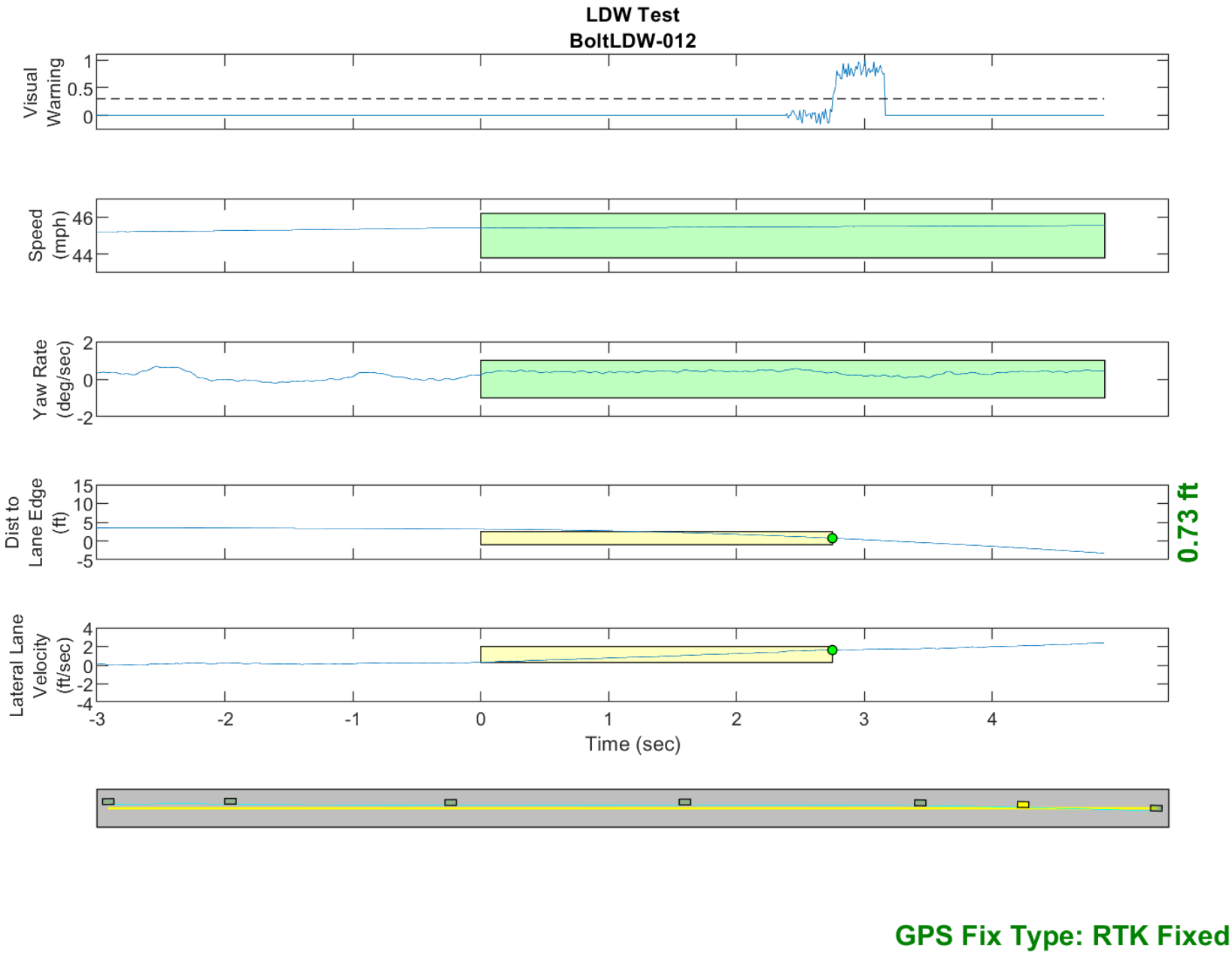

Figure D17. Time History for Run 12, Botts Dots, Right Departure, Visual Warning

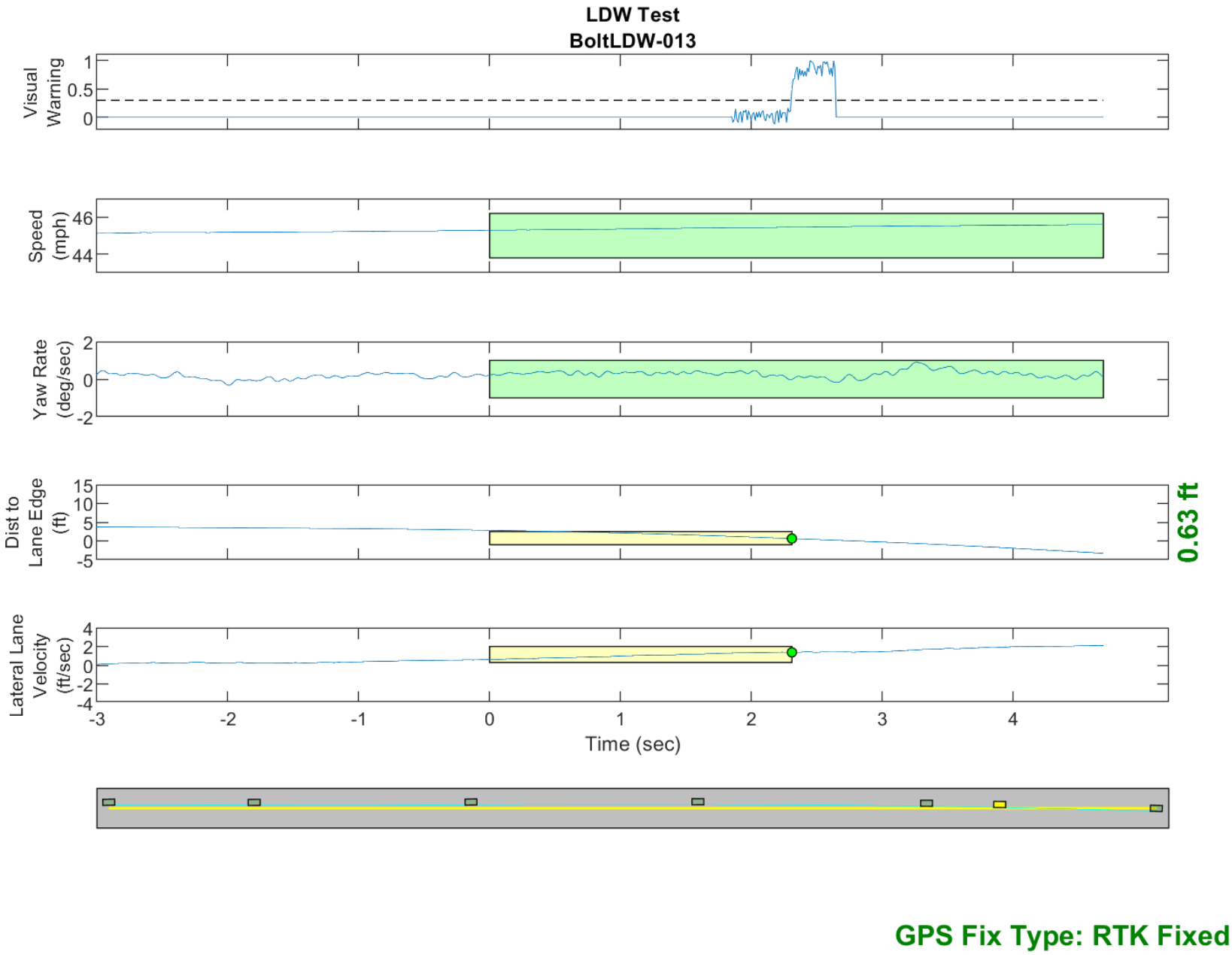

Figure D18. Time History for Run 13, Botts Dots, Right Departure, Visual Warning

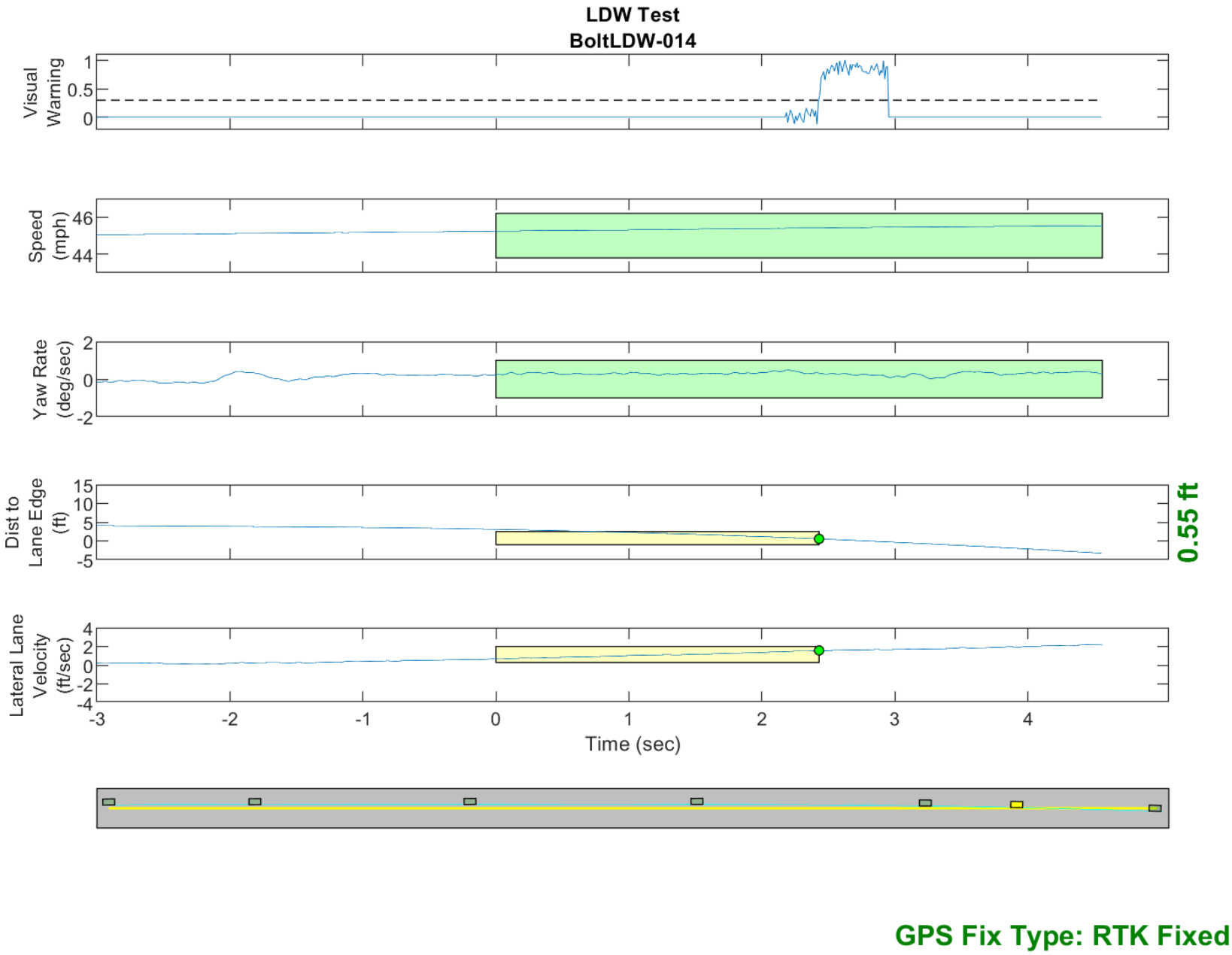

Figure D19. Time History for Run 14, Botts Dots, Right Departure, Visual Warning

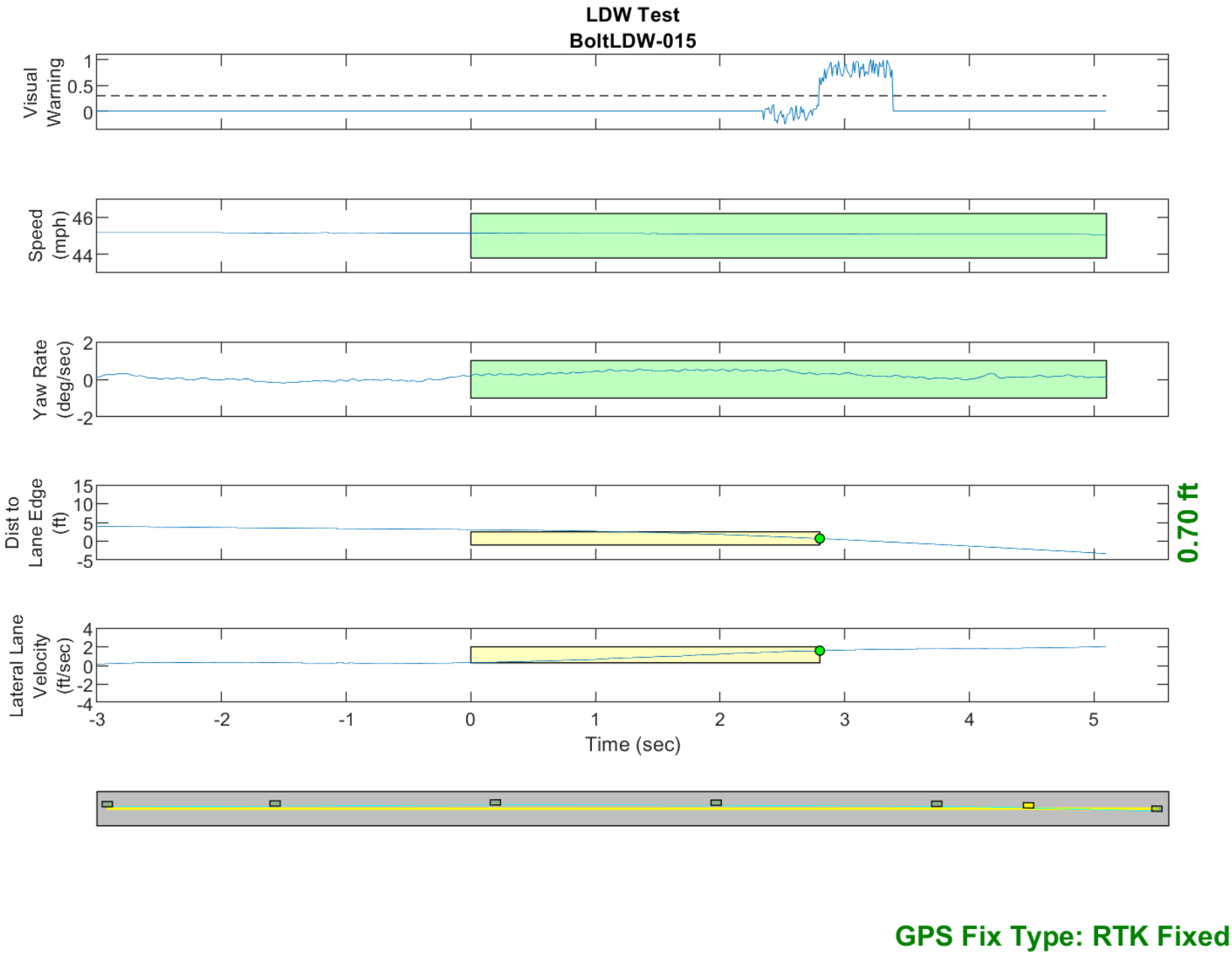

Figure D20. Time History for Run 15, Solid Line, Right Departure, Visual Warning

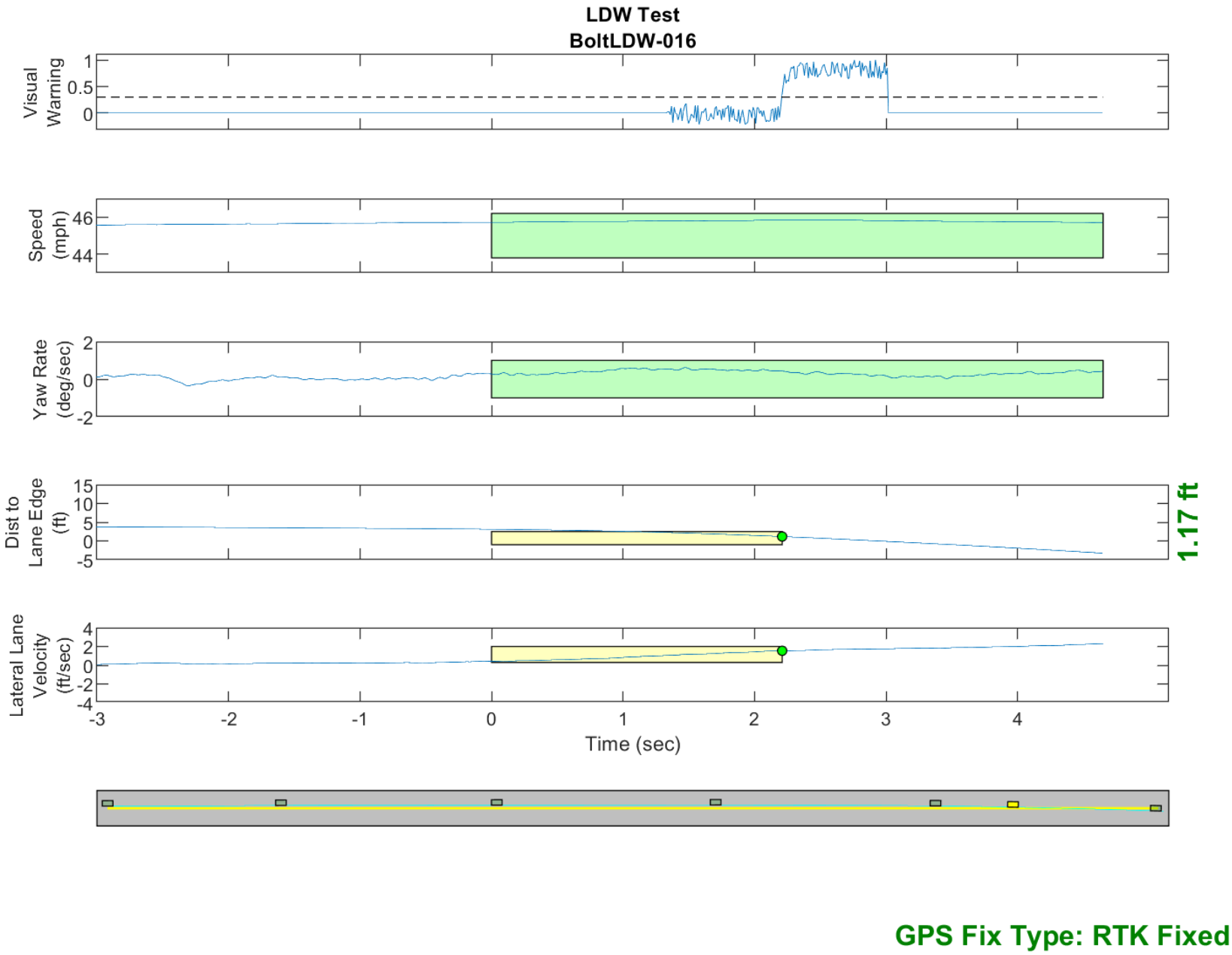

Figure D21. Time History for Run 16, Solid Line, Right Departure, Visual Warning

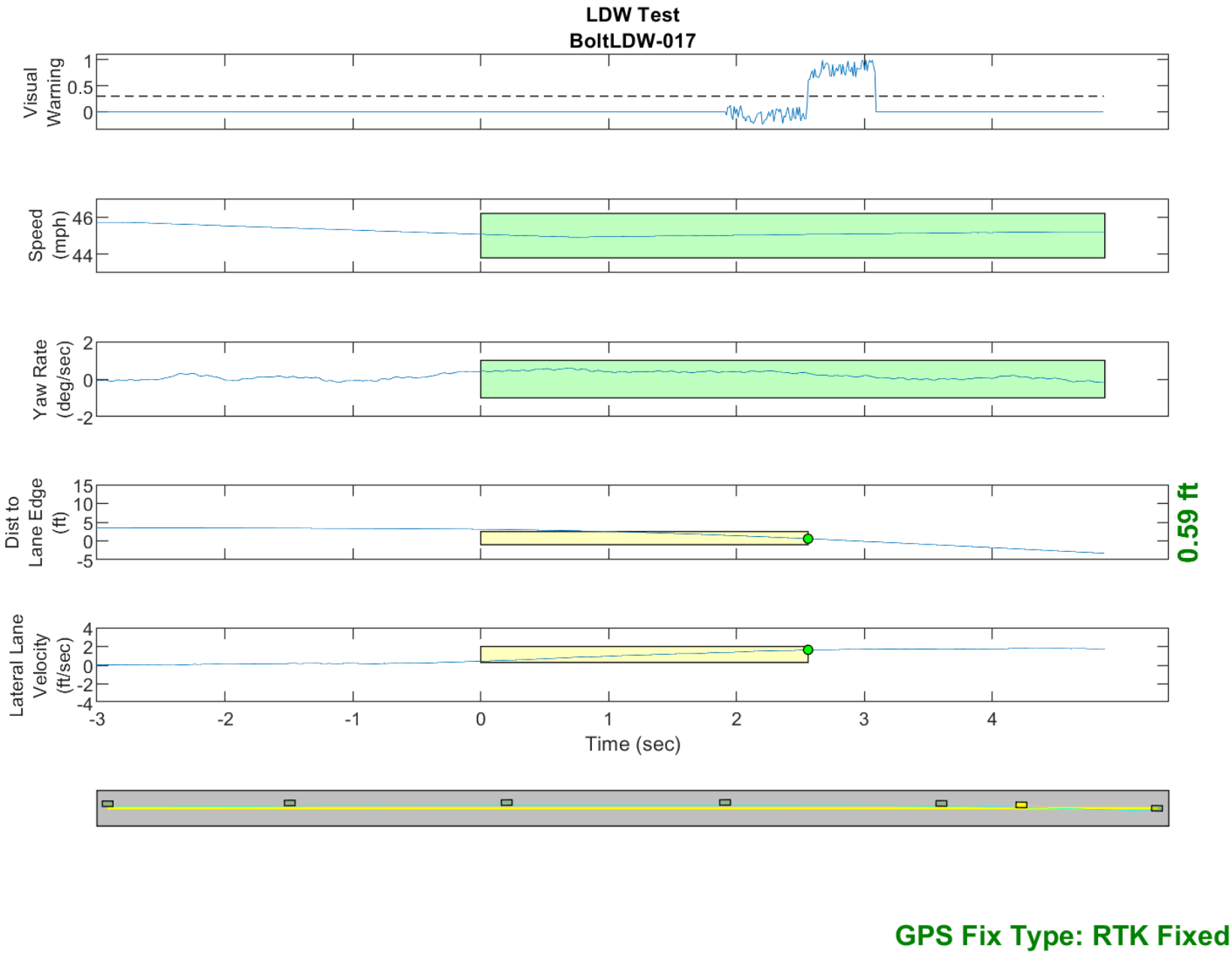

Figure D22. Time History for Run 17, Solid Line, Right Departure, Visual Warning

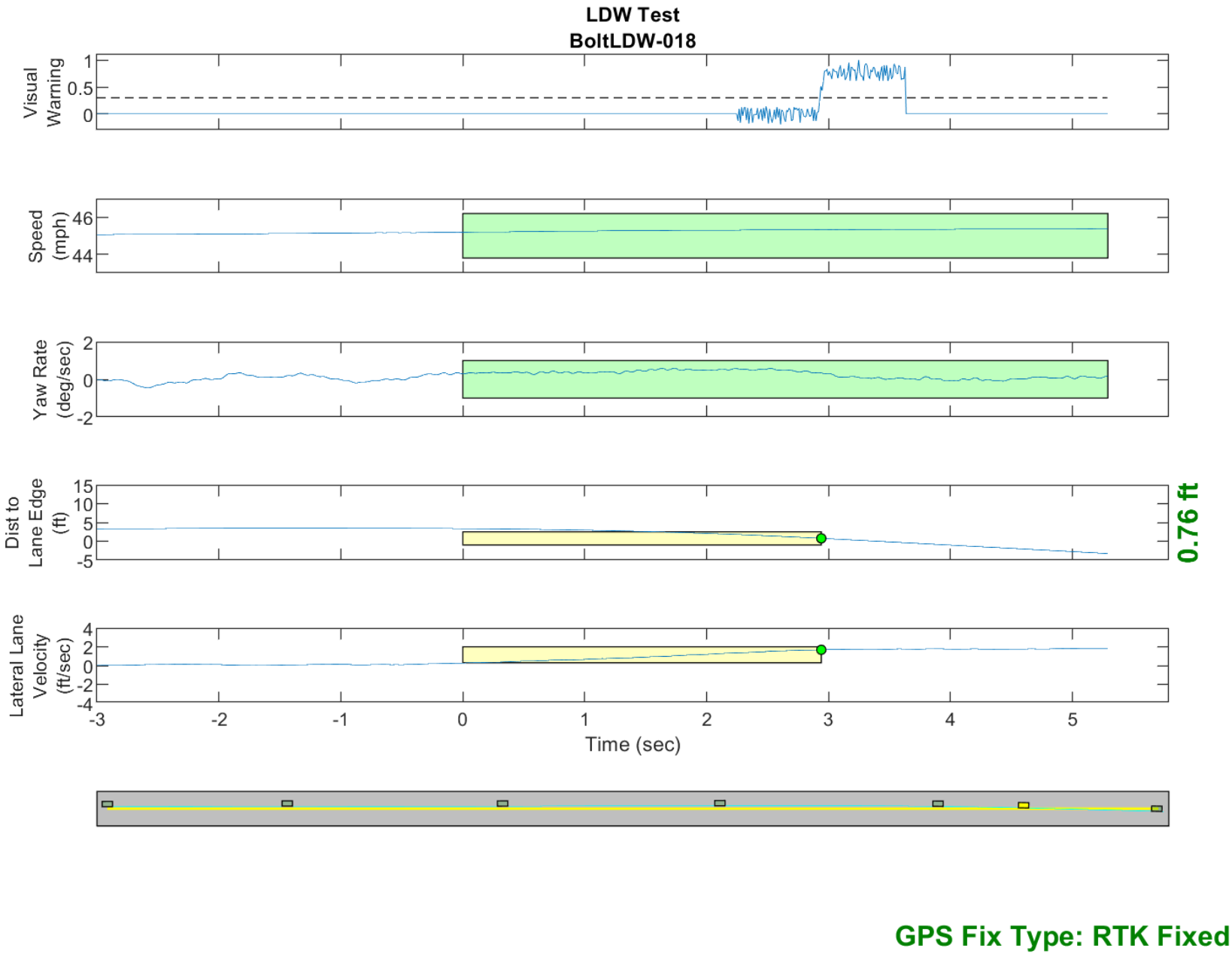

Figure D23. Time History for Run 18, Solid Line, Right Departure, Visual Warning

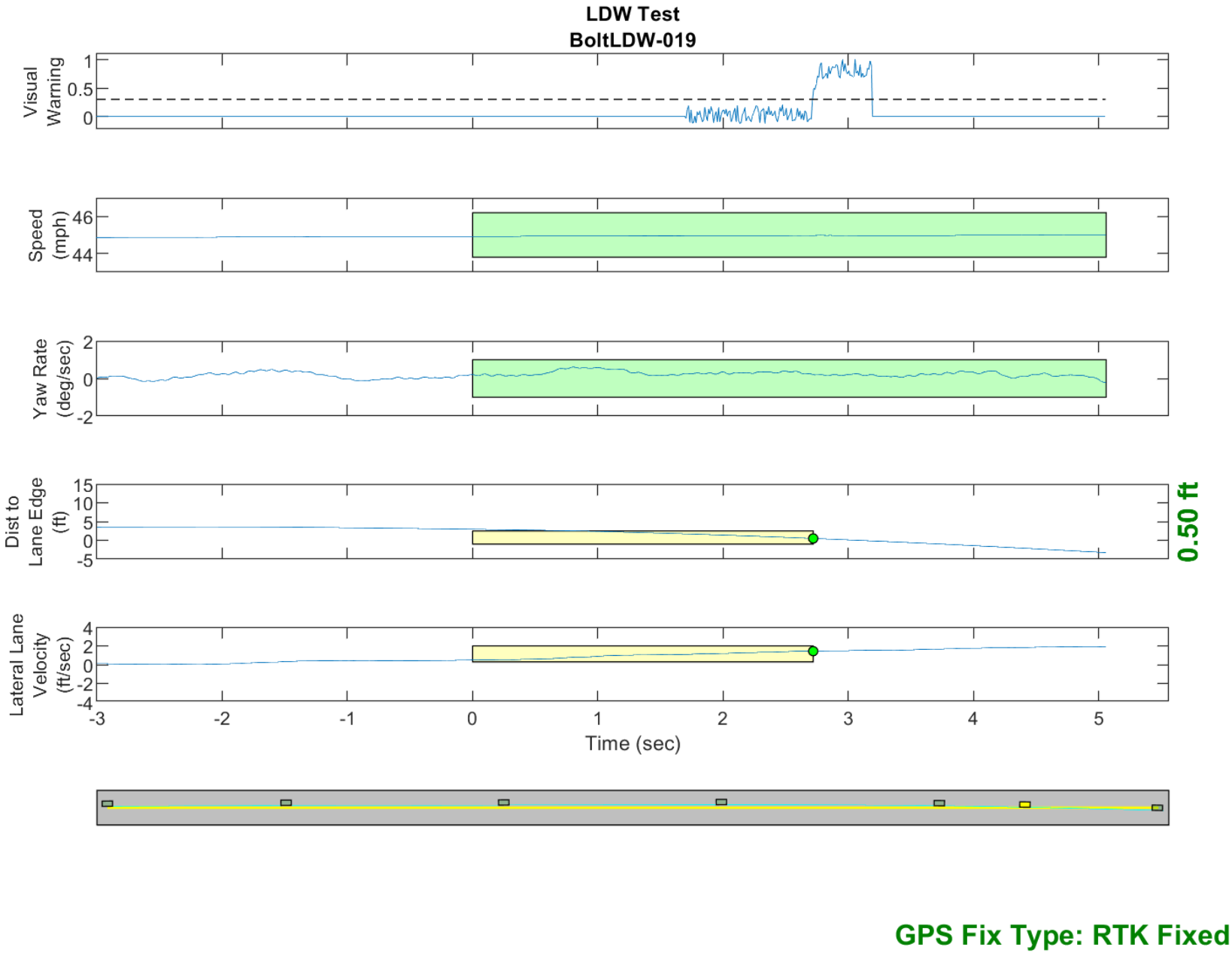

Figure D24. Time History for Run 19, Solid Line, Right Departure, Visual Warning

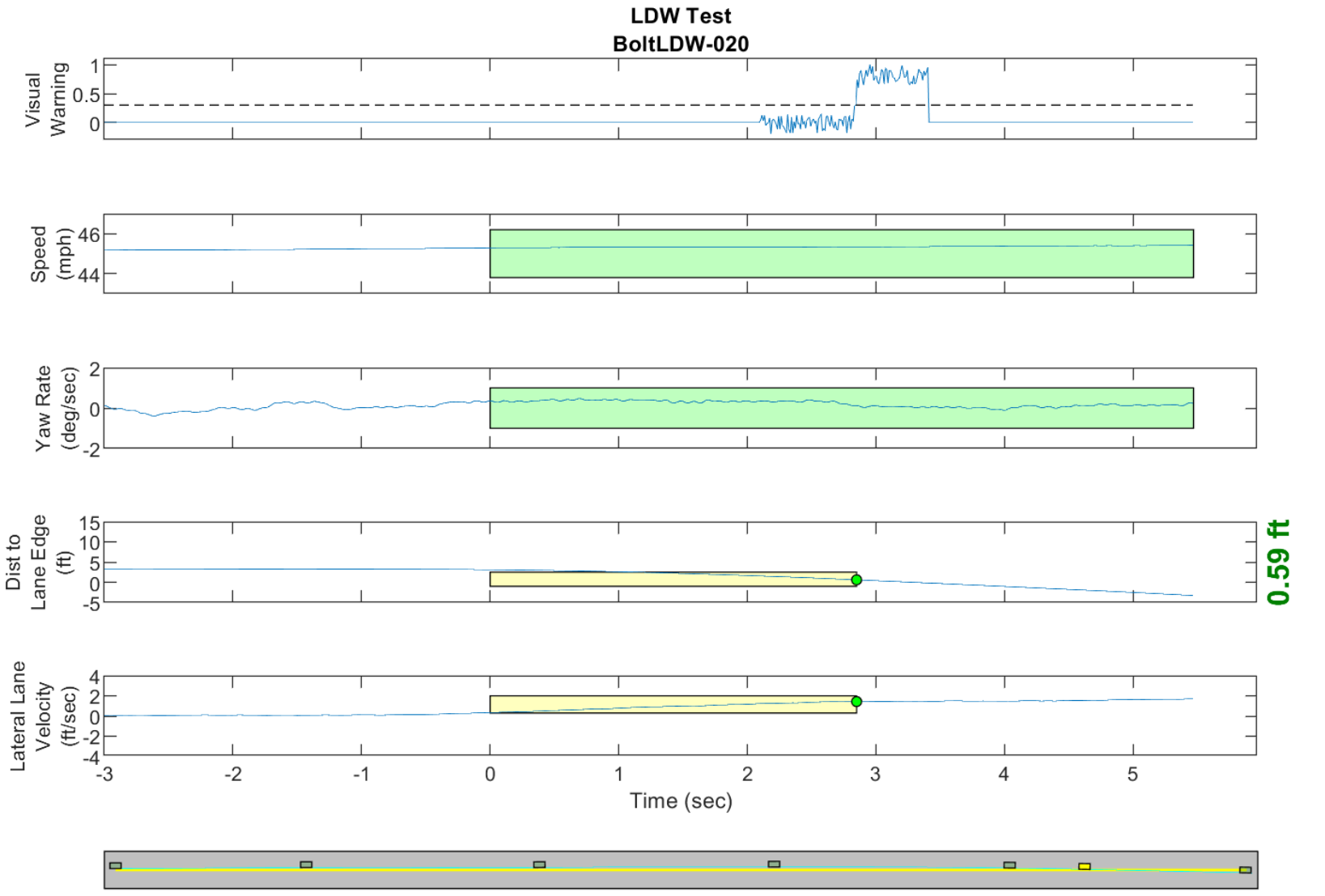

Figure D25. Time History for Run 20, Solid Line, Right Departure, Visual Warning

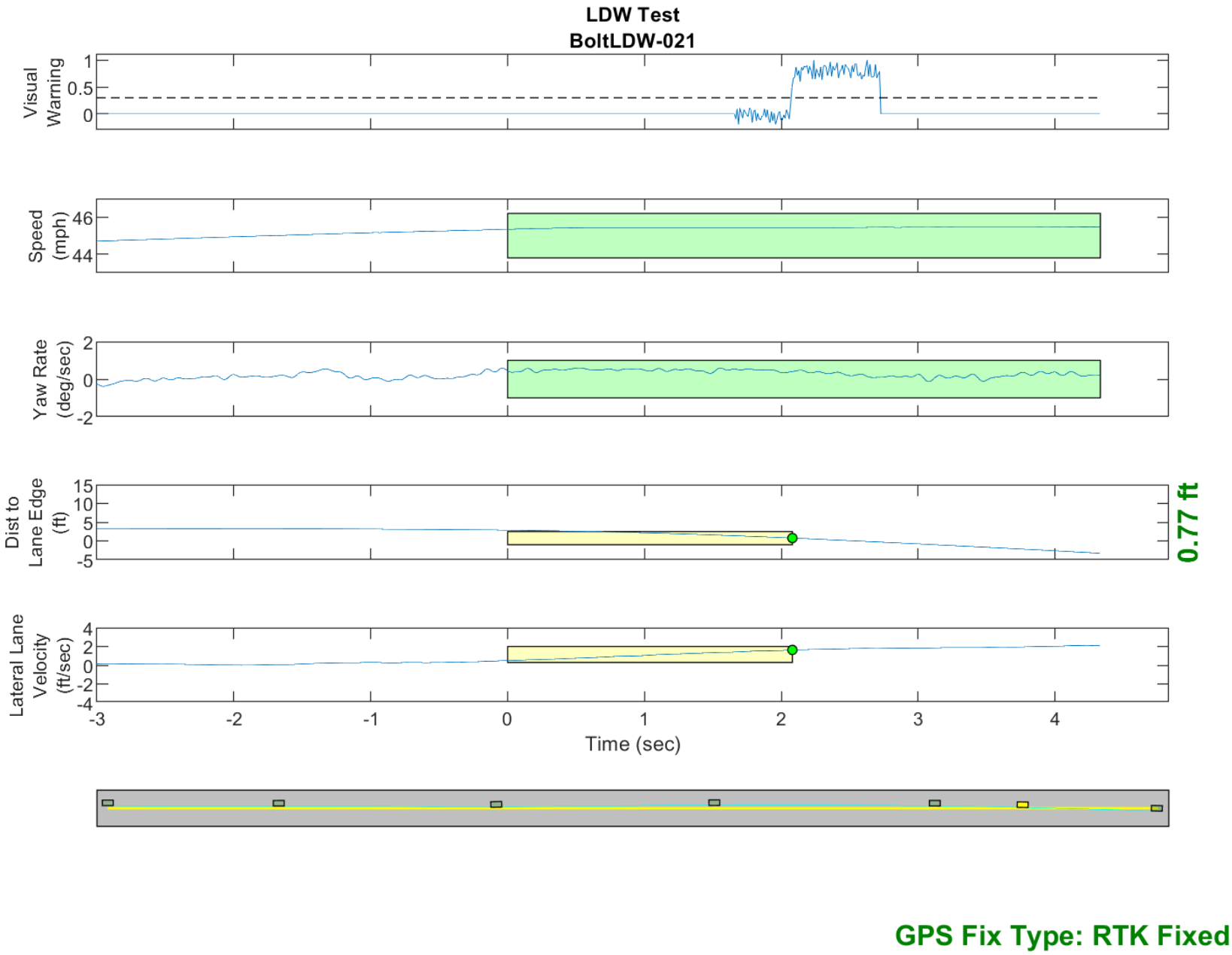

Figure D26. Time History for Run 21, Solid Line, Right Departure, Visual Warning

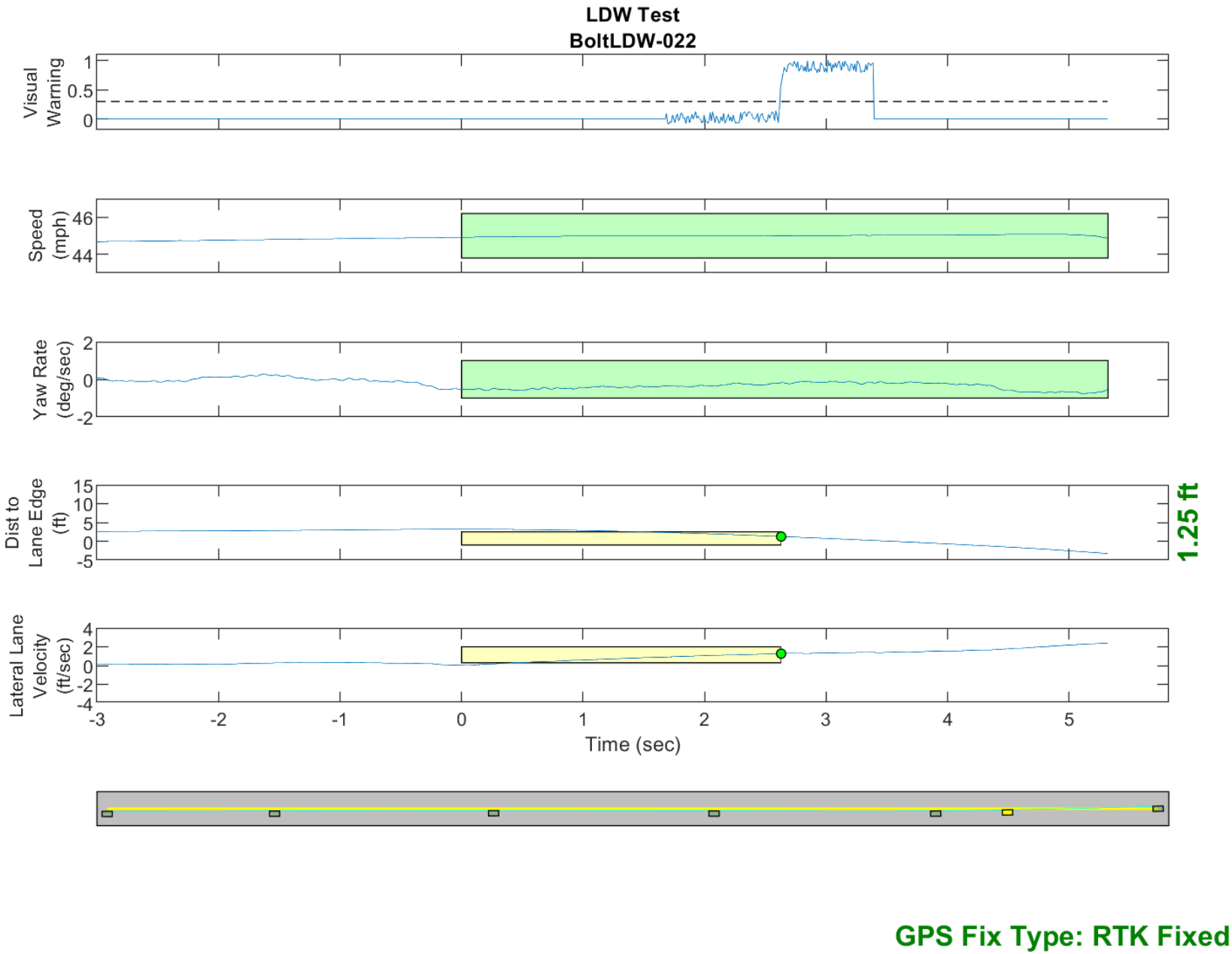

Figure D27. Time History for Run 22, Solid Line, Left Departure, Visual Warning

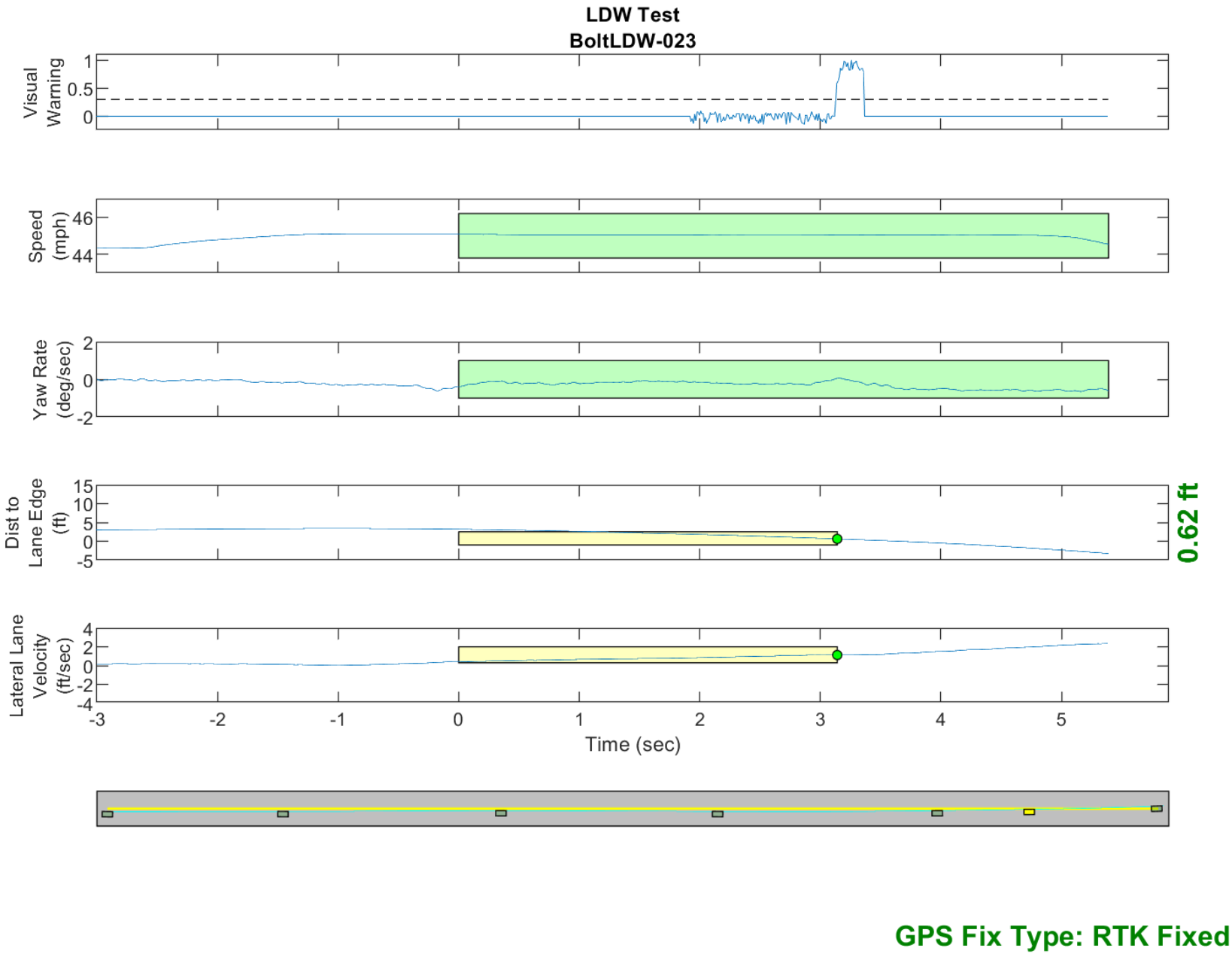

Figure D28. Time History for Run 23, Solid Line, Left Departure, Visual Warning

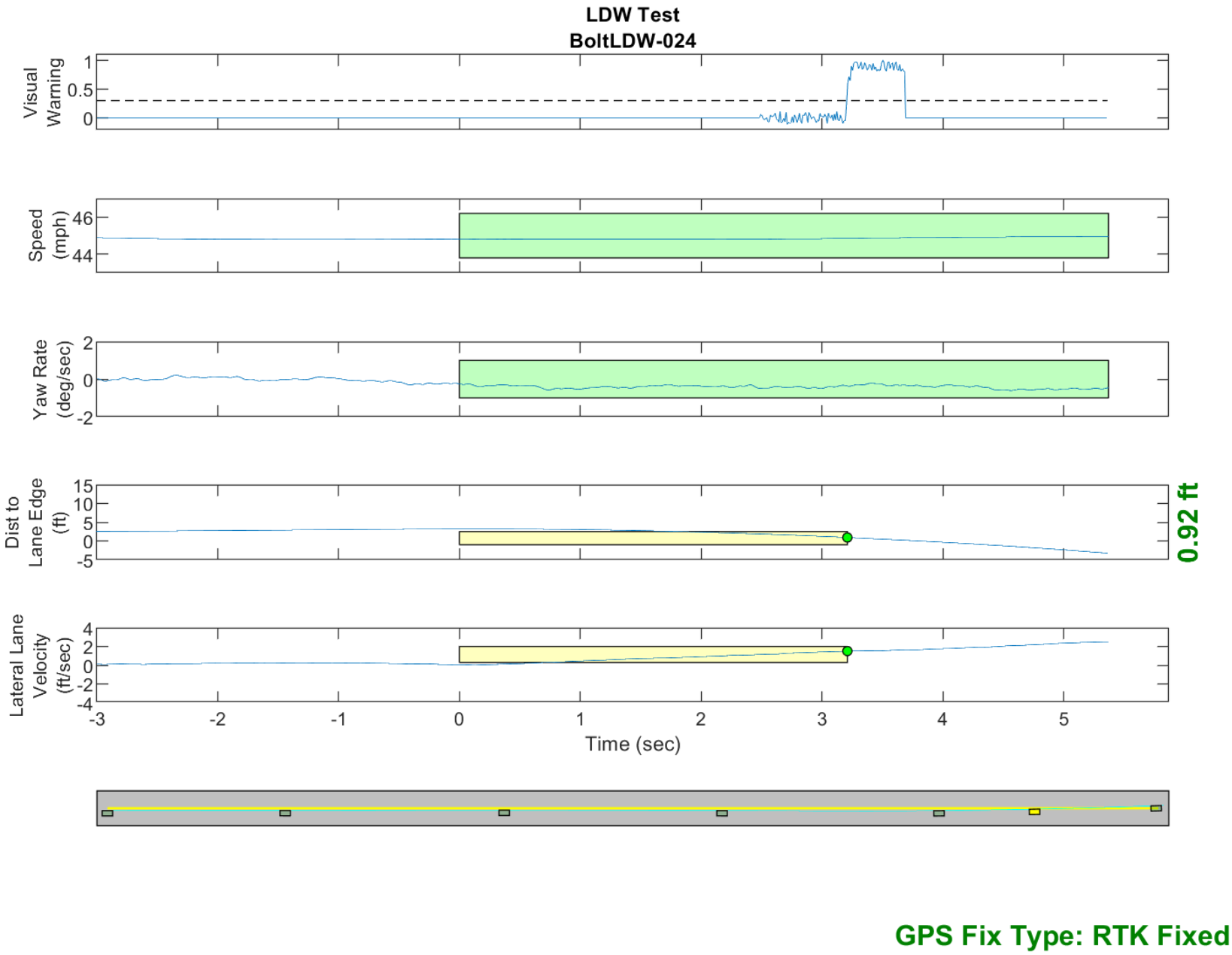

Figure D29. Time History for Run 24, Solid Line, Left Departure, Visual Warning

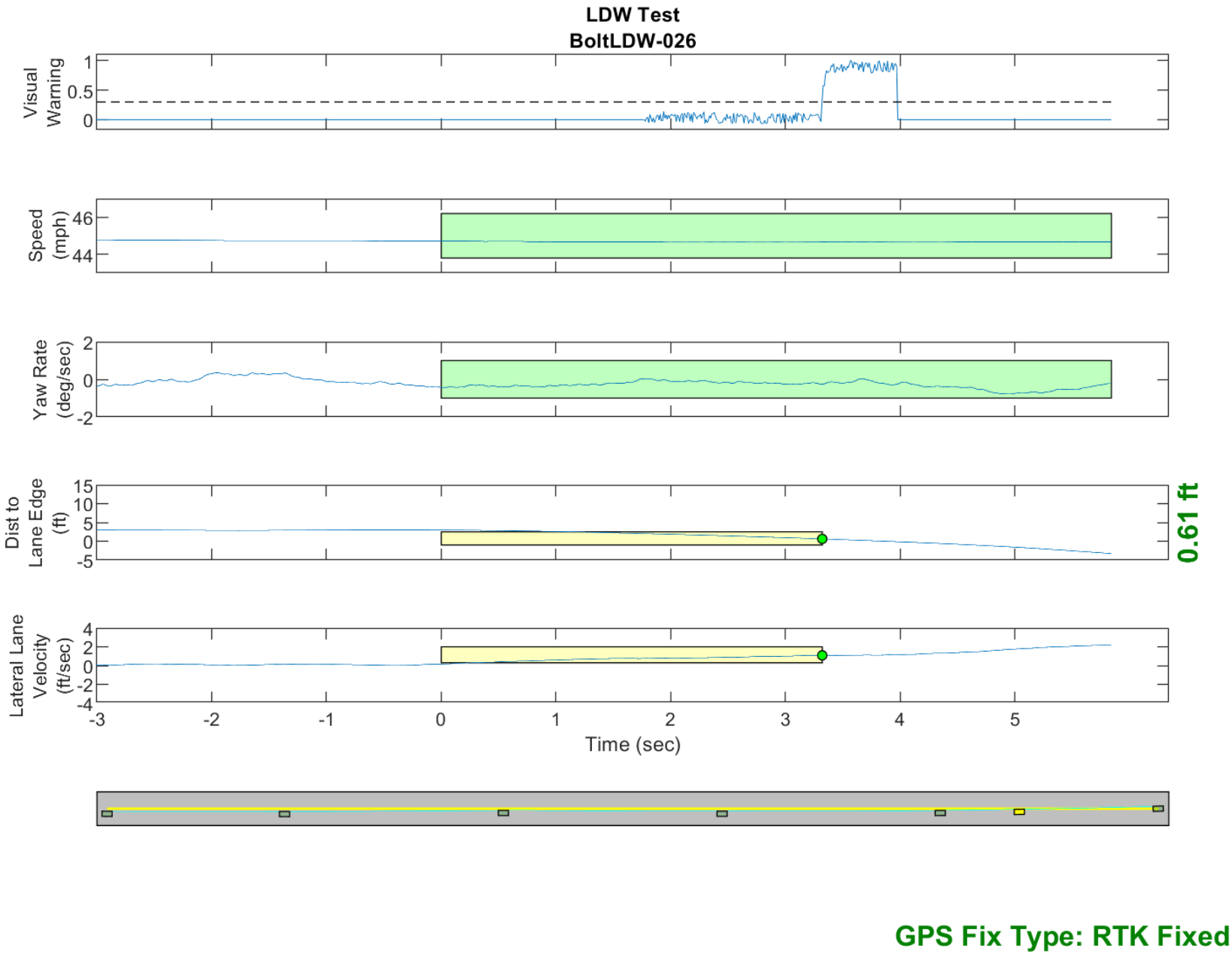

Figure D30. Time History for Run 26, Solid Line, Left Departure, Visual Warning

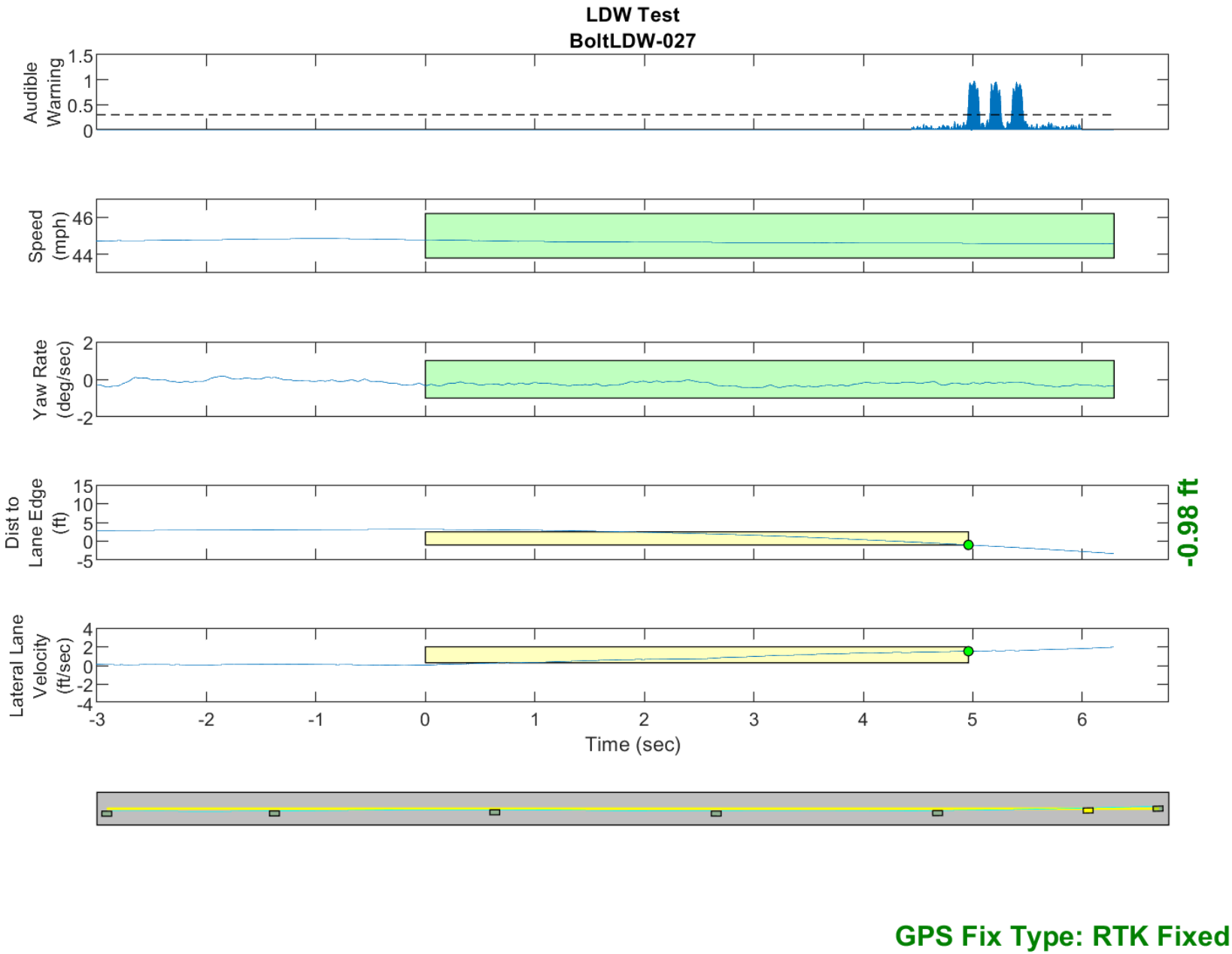

Figure D31. Time History for Run 27, Solid Line, Left Departure, Auditory Warning

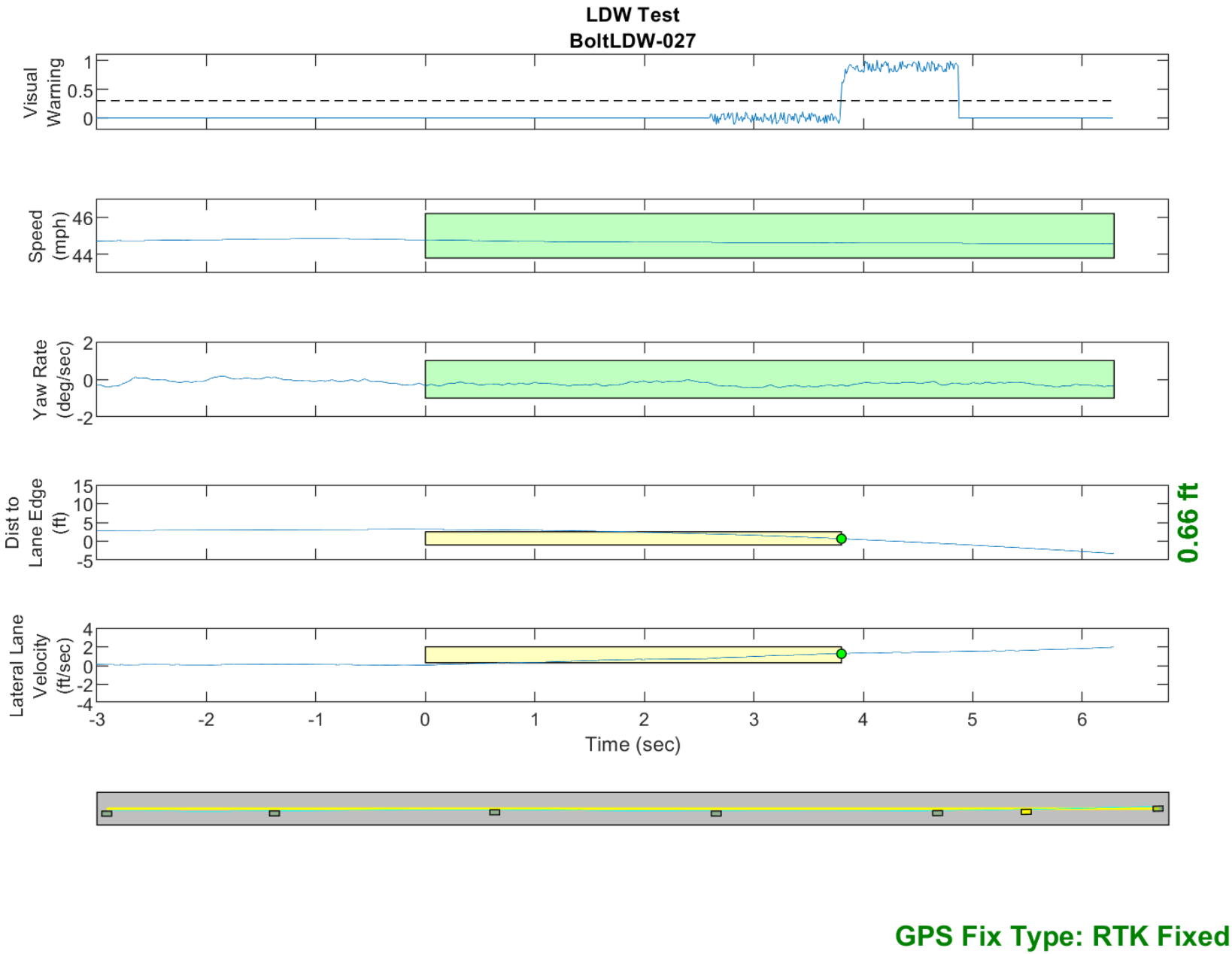

Figure D32. Time History for Run 27, Solid Line, Left Departure, Visual Warning

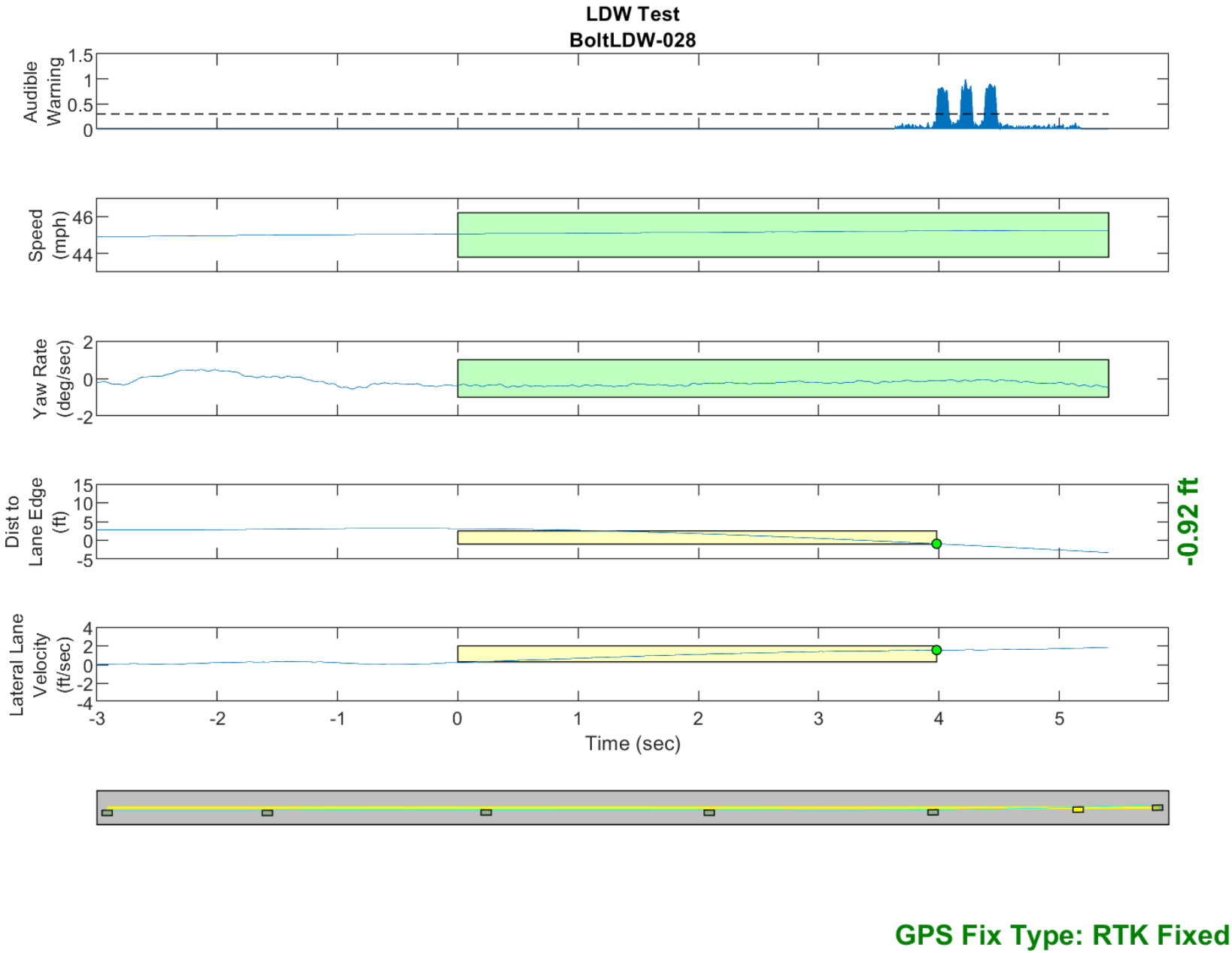

Figure D33. Time History for Run 28, Solid Line, Left Departure, Auditory Warning

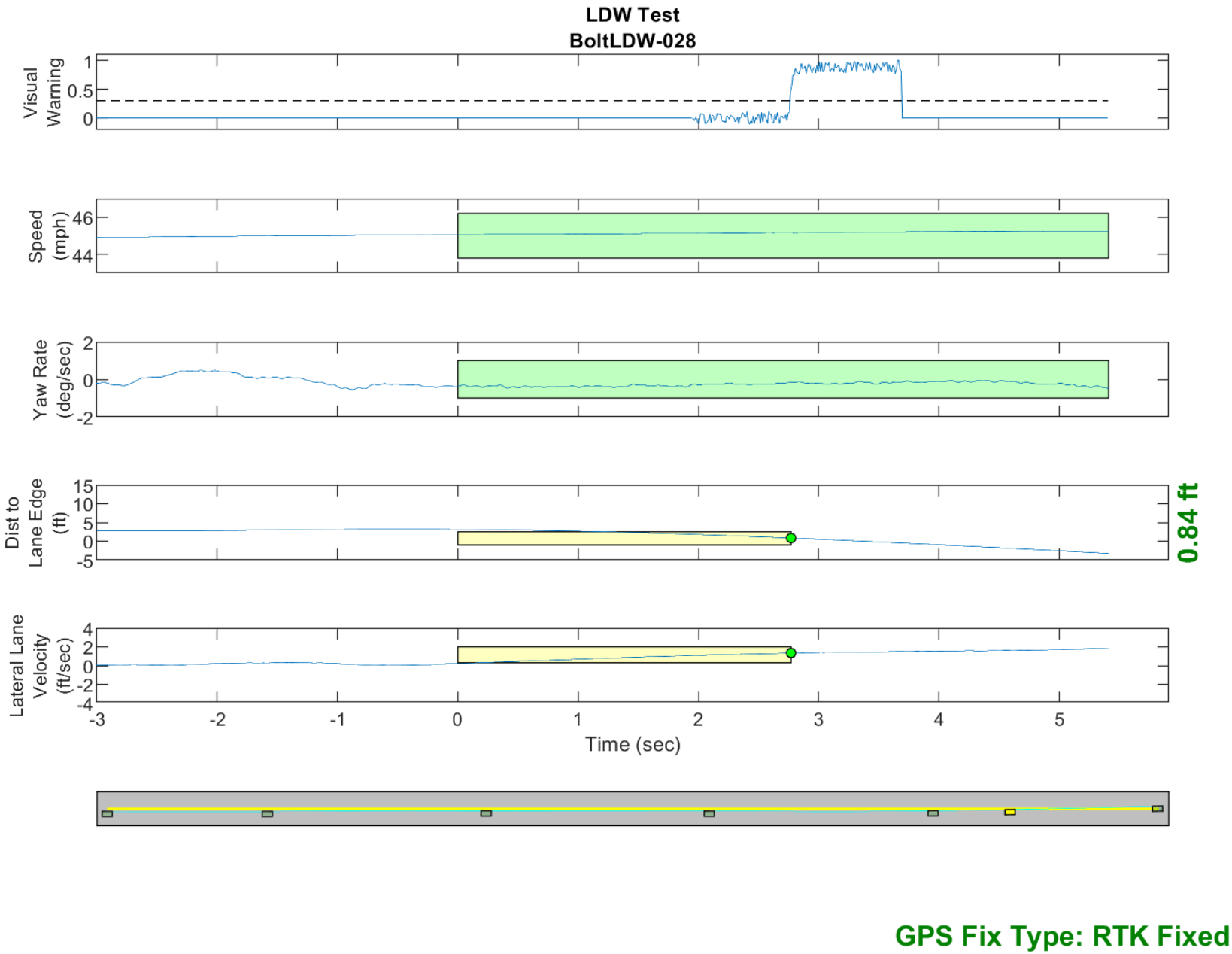

Figure D34. Time History for Run 28, Solid Line, Left Departure, Visual Warning

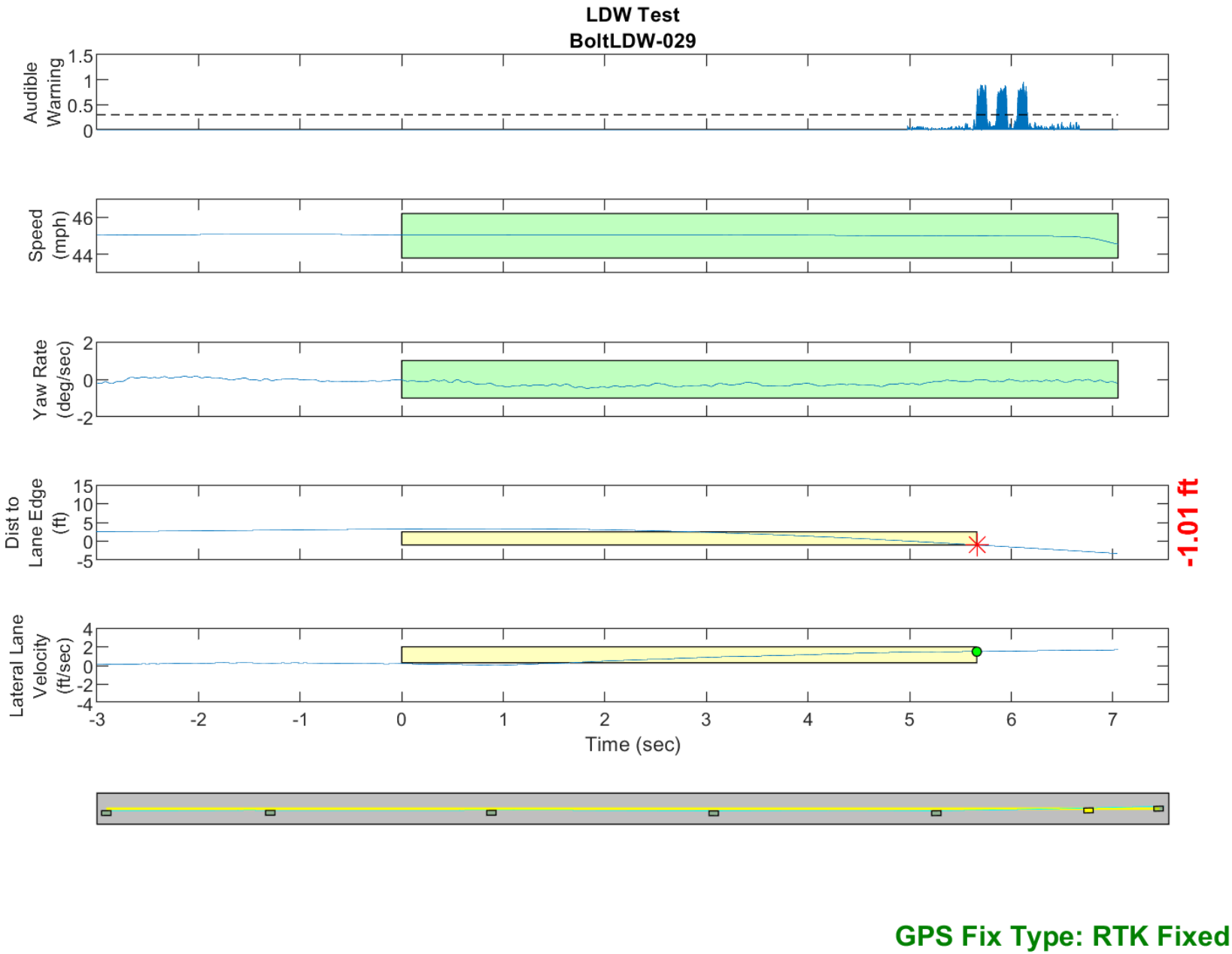

Figure D35. Time History for Run 29, Solid Line, Left Departure, Auditory Warning

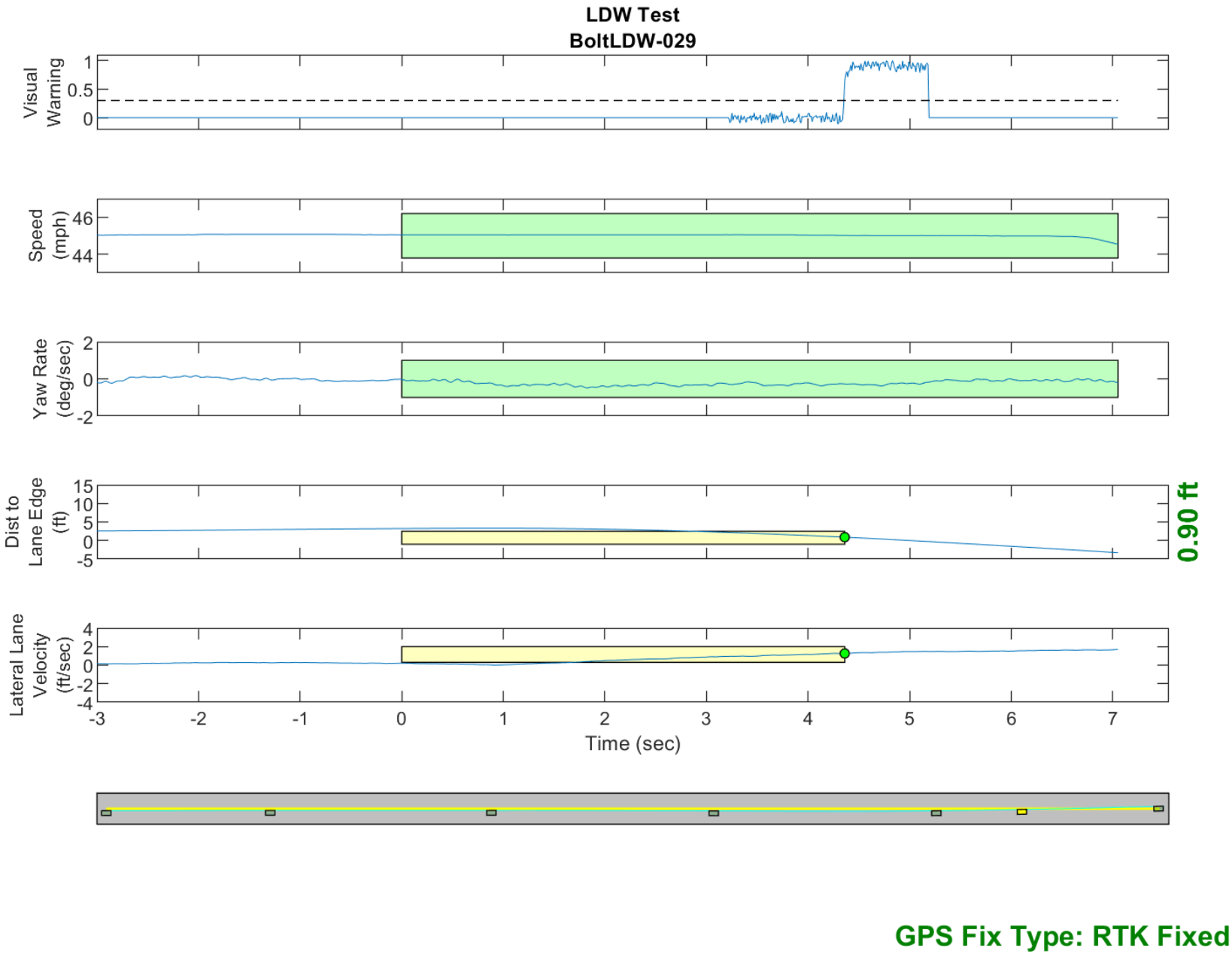

Figure D36. Time History for Run 29, Solid Line, Left Departure, Visual Warning

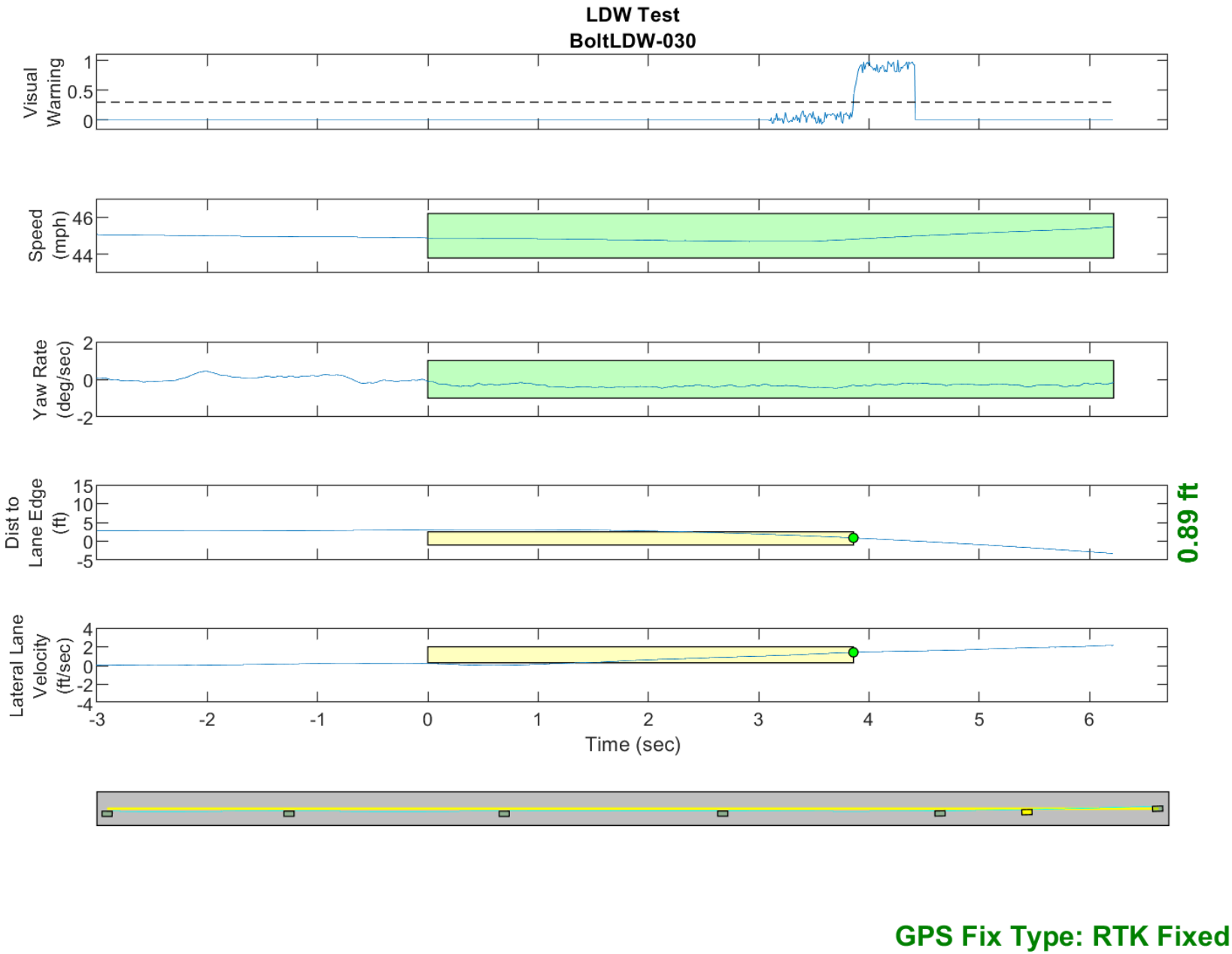

Figure D37. Time History for Run 30, Dashed Line, Left Departure, Visual Warning

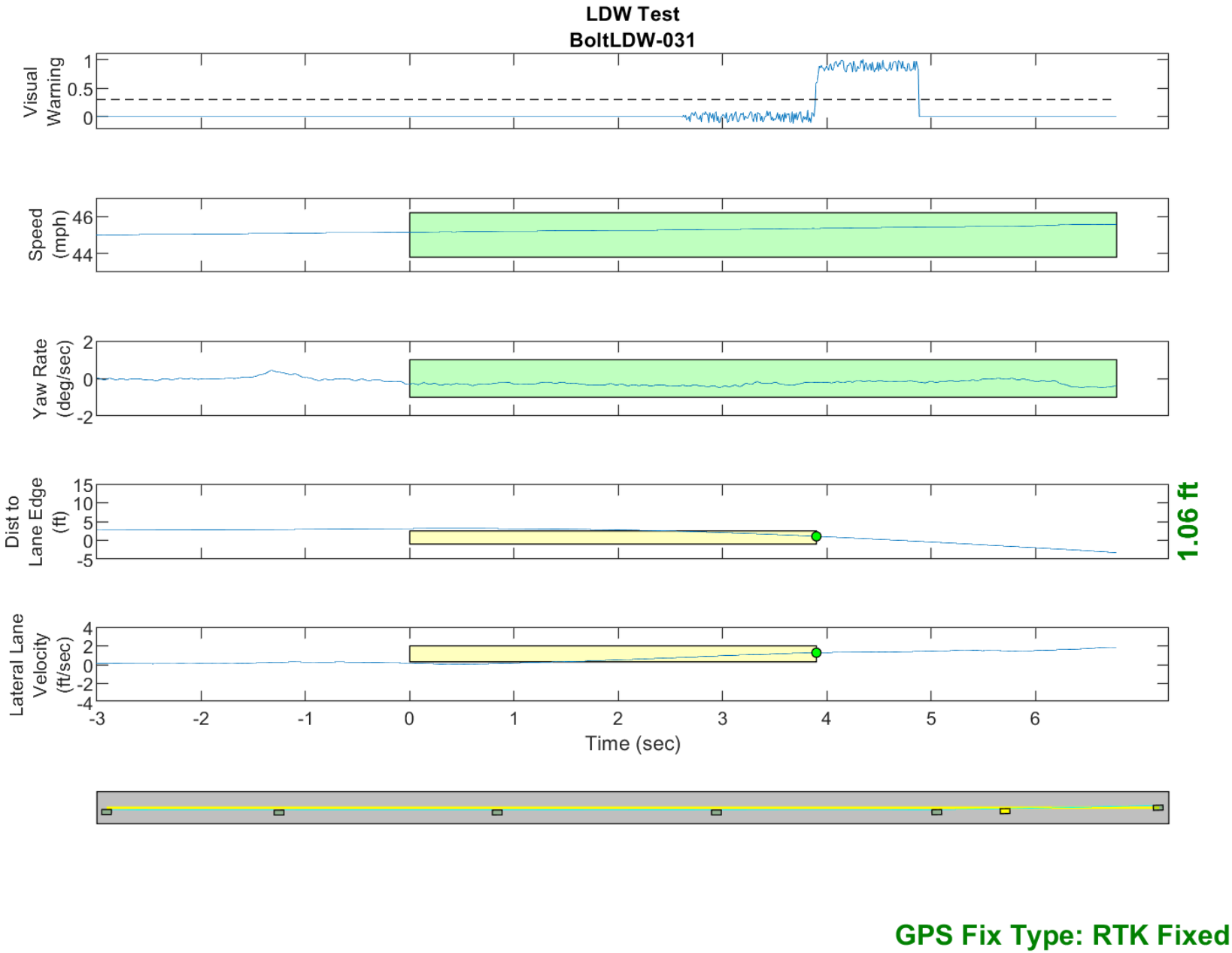

Figure D38. Time History for Run 31, Dashed Line, Left Departure, Visual Warning

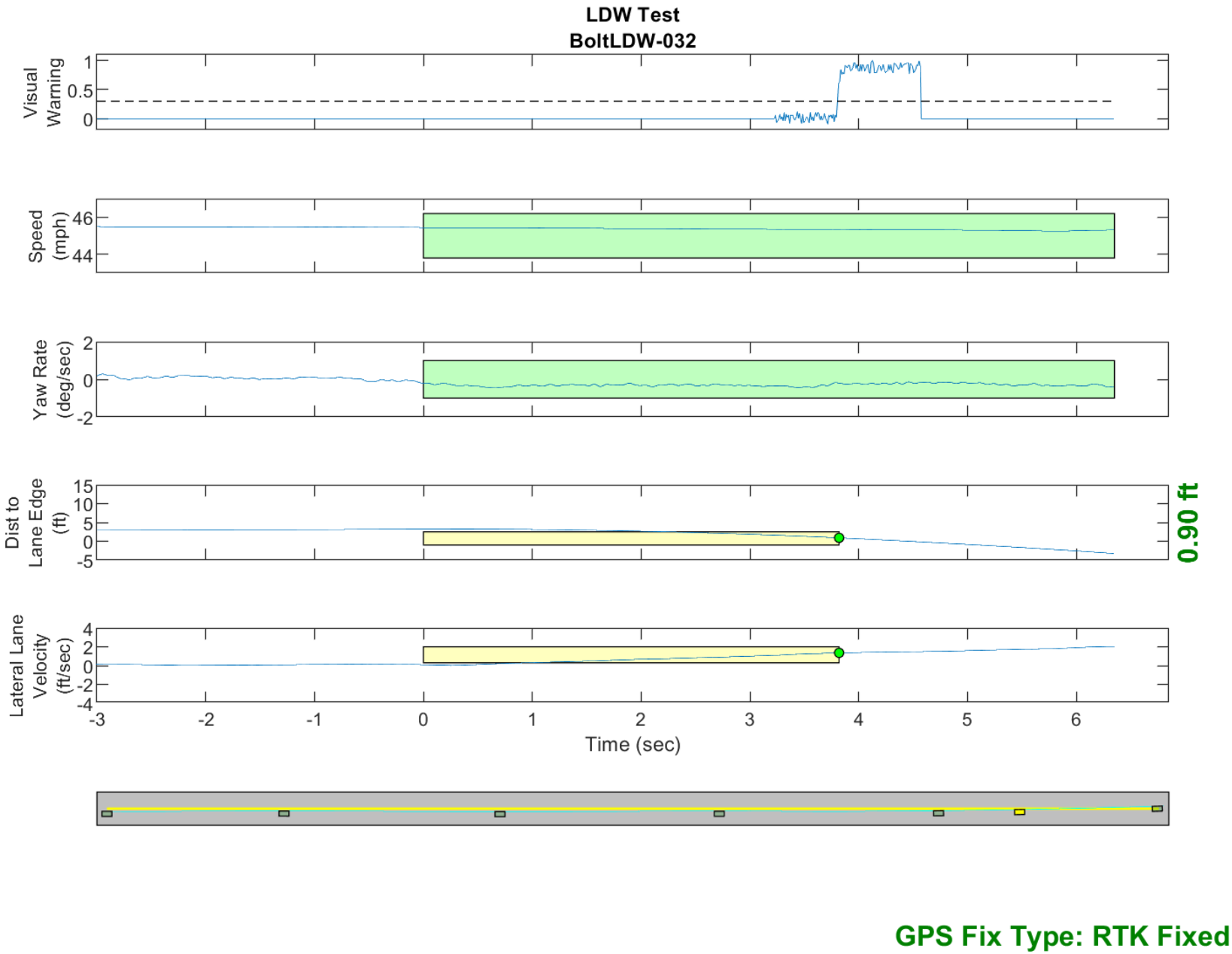

Figure D39. Time History for Run 32, Dashed Line, Left Departure, Visual Warning

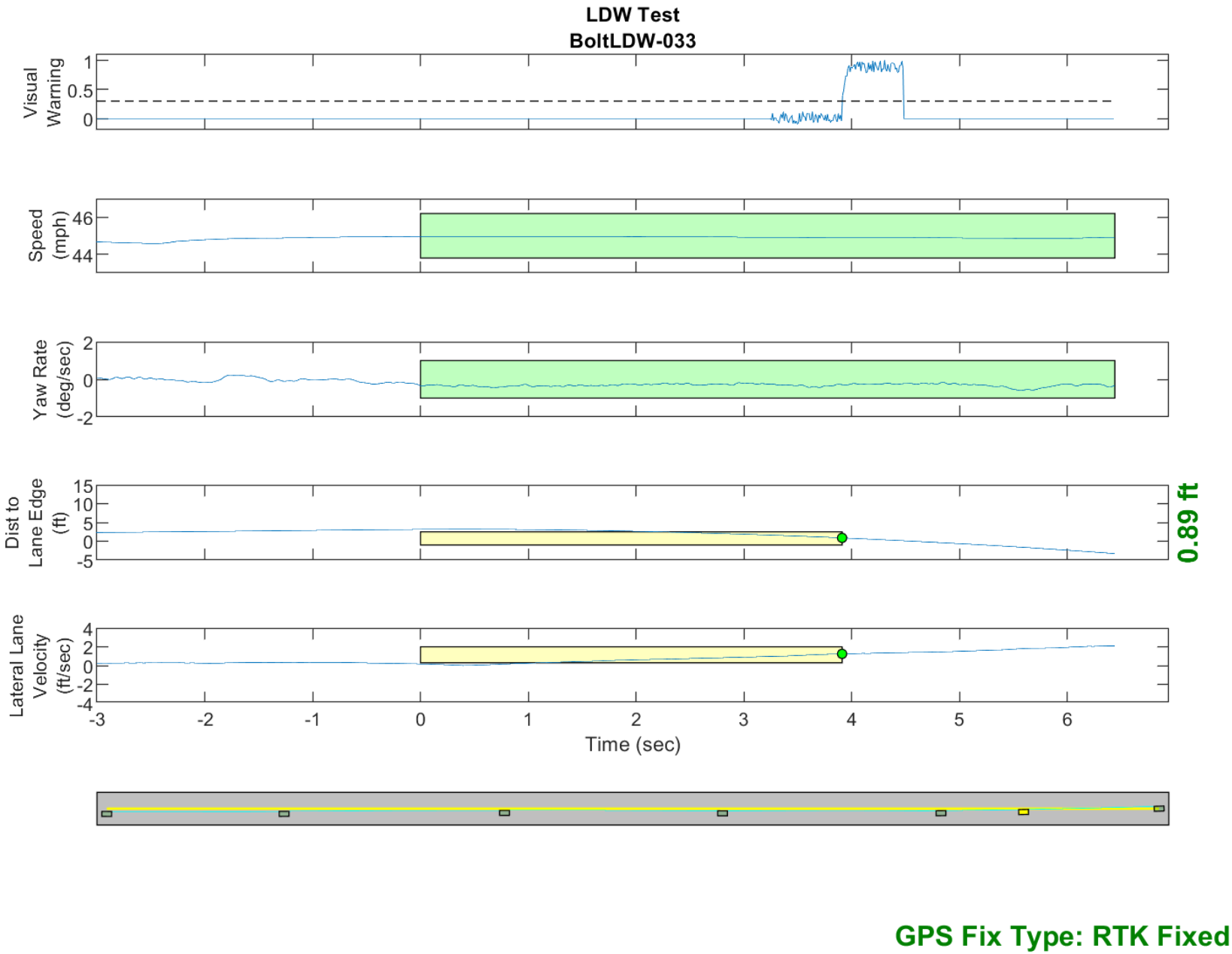

Figure D40. Time History for Run 33, Dashed Line, Left Departure, Visual Warning

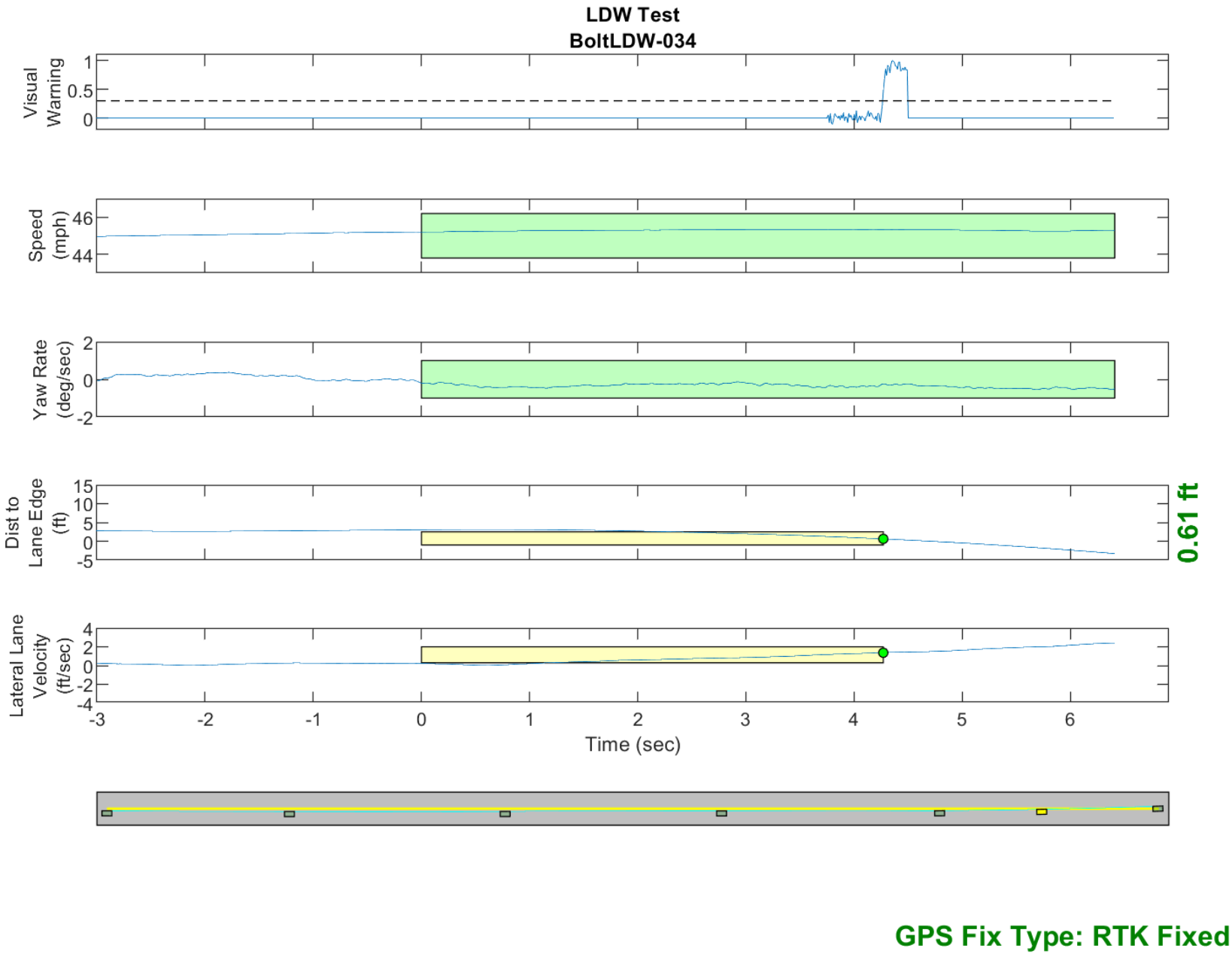

Figure D41. Time History for Run 34, Dashed Line, Left Departure, Visual Warning

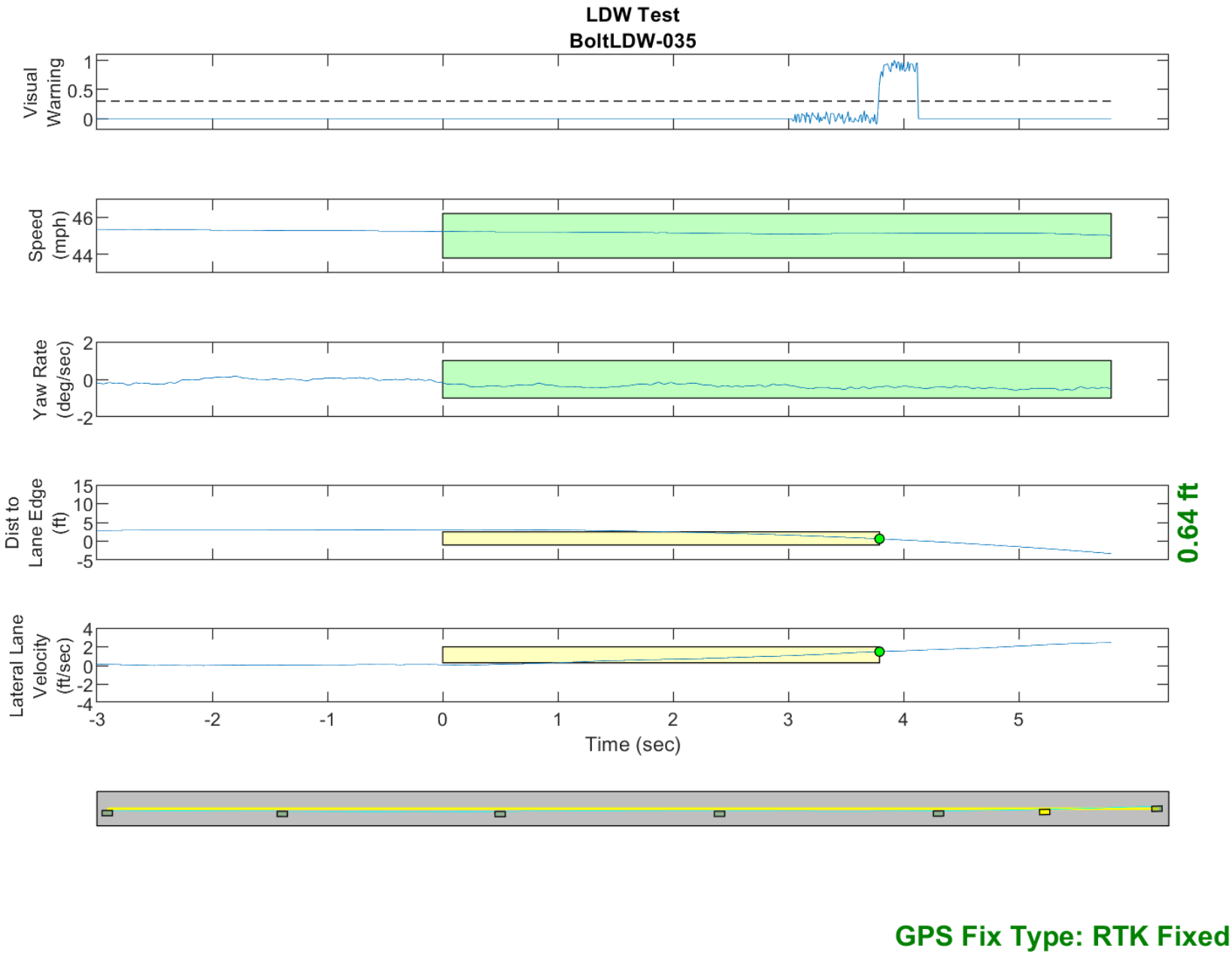

Figure D42. Time History for Run 35, Dashed Line, Left Departure, Visual Warning

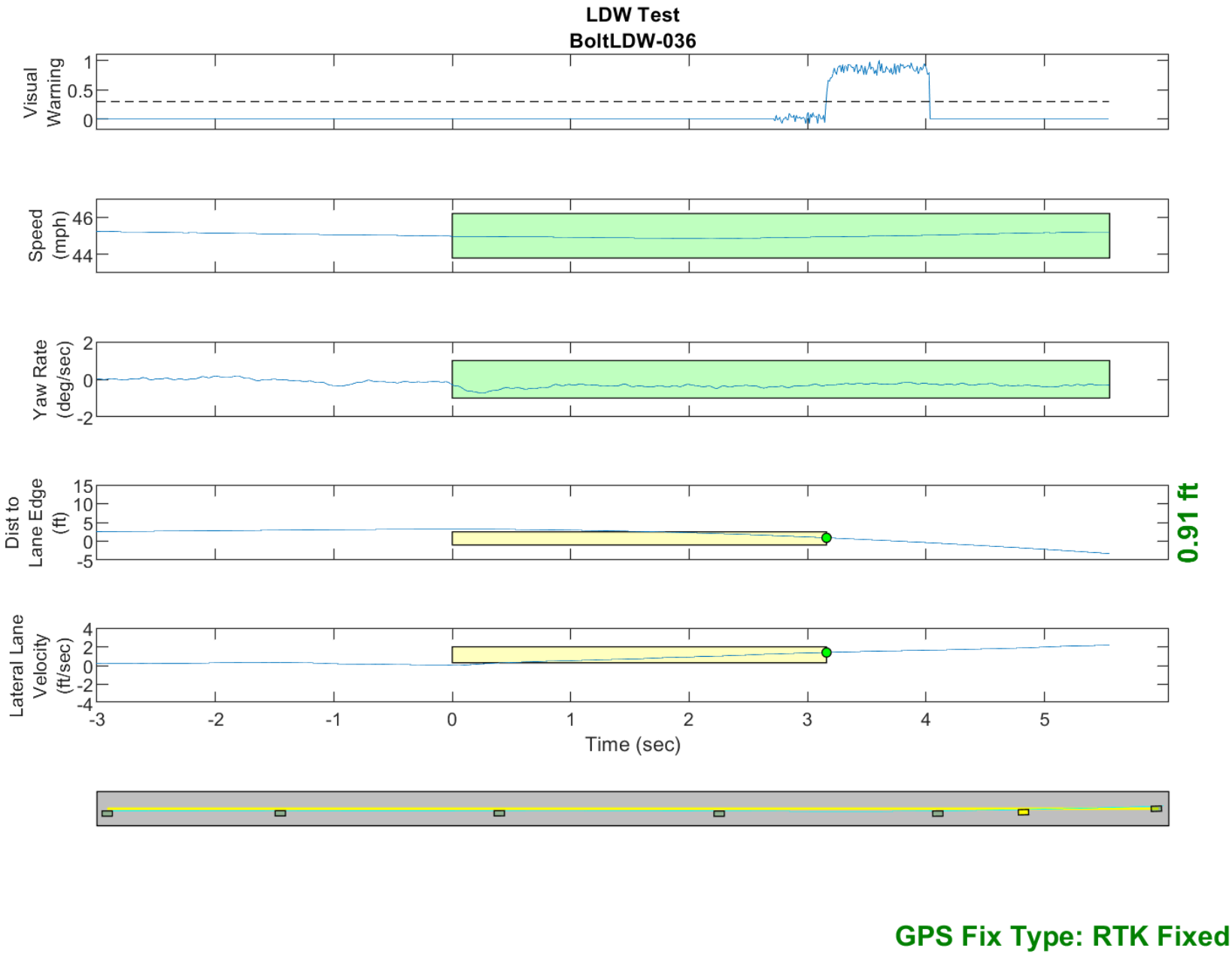

Figure D43. Time History for Run 36, Dashed Line, Left Departure, Visual Warning

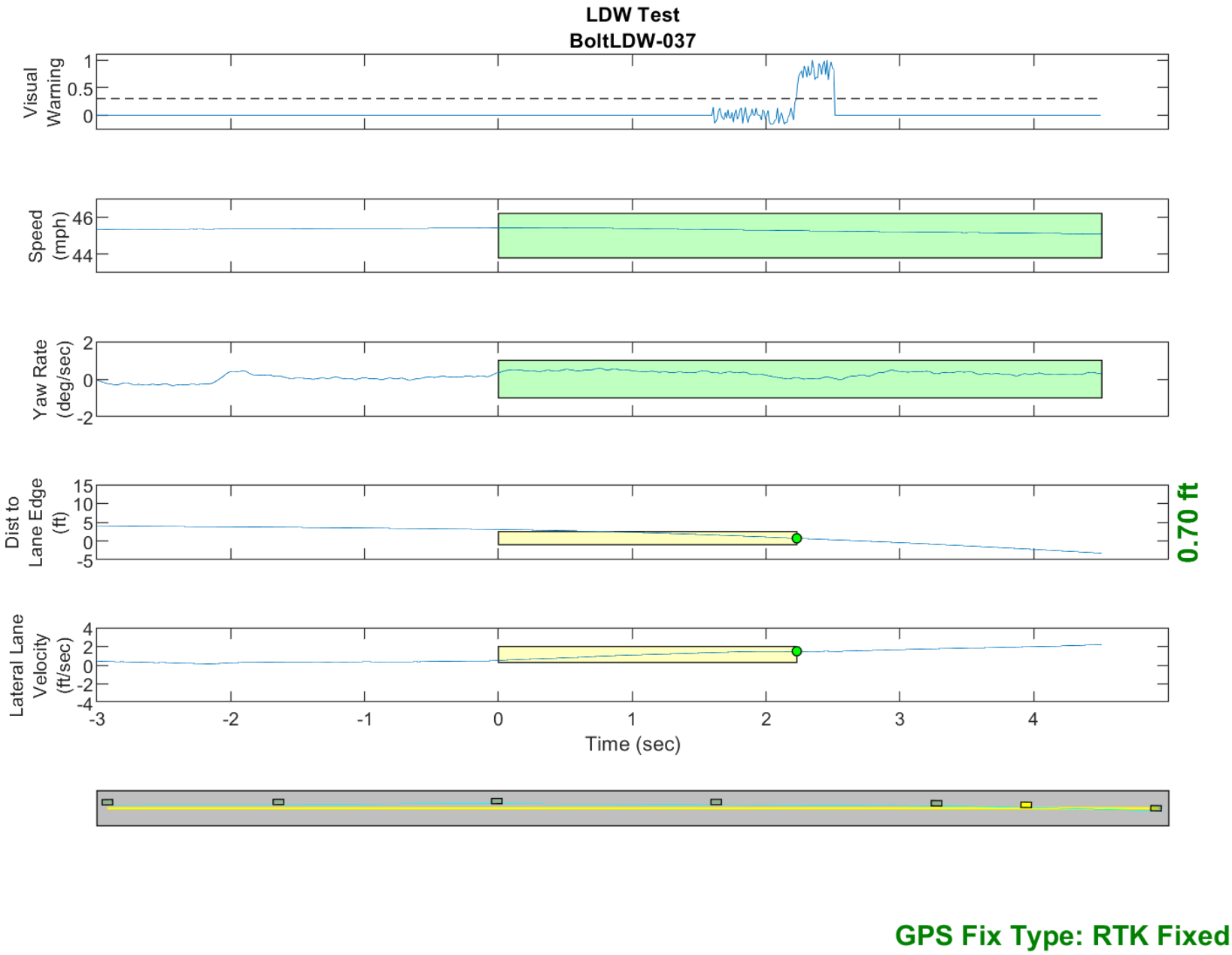

Figure D44. Time History for Run 37, Dashed Line, Right Departure, Visual Warning

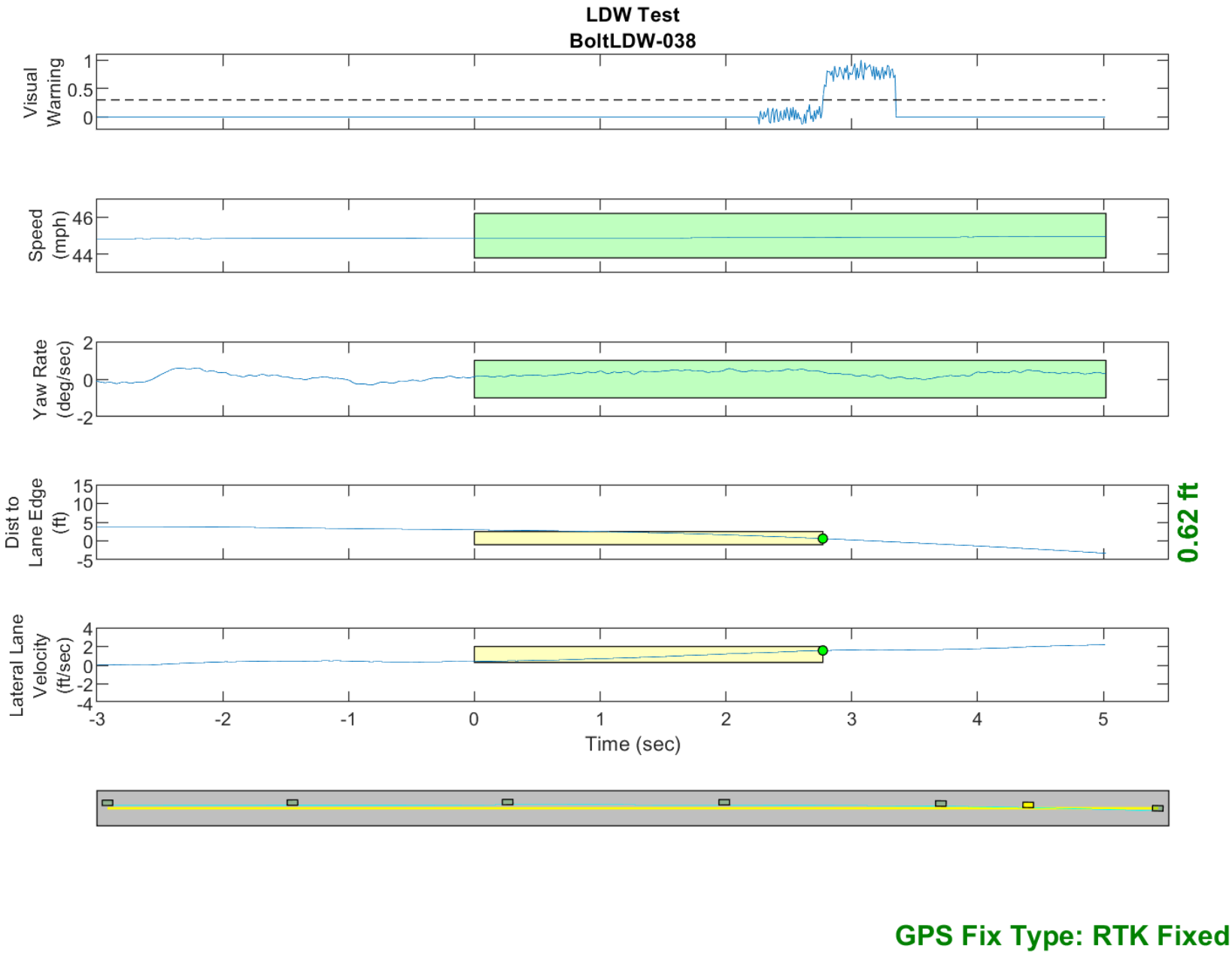

Figure D45. Time History for Run 38, Dashed Line, Right Departure, Visual Warning

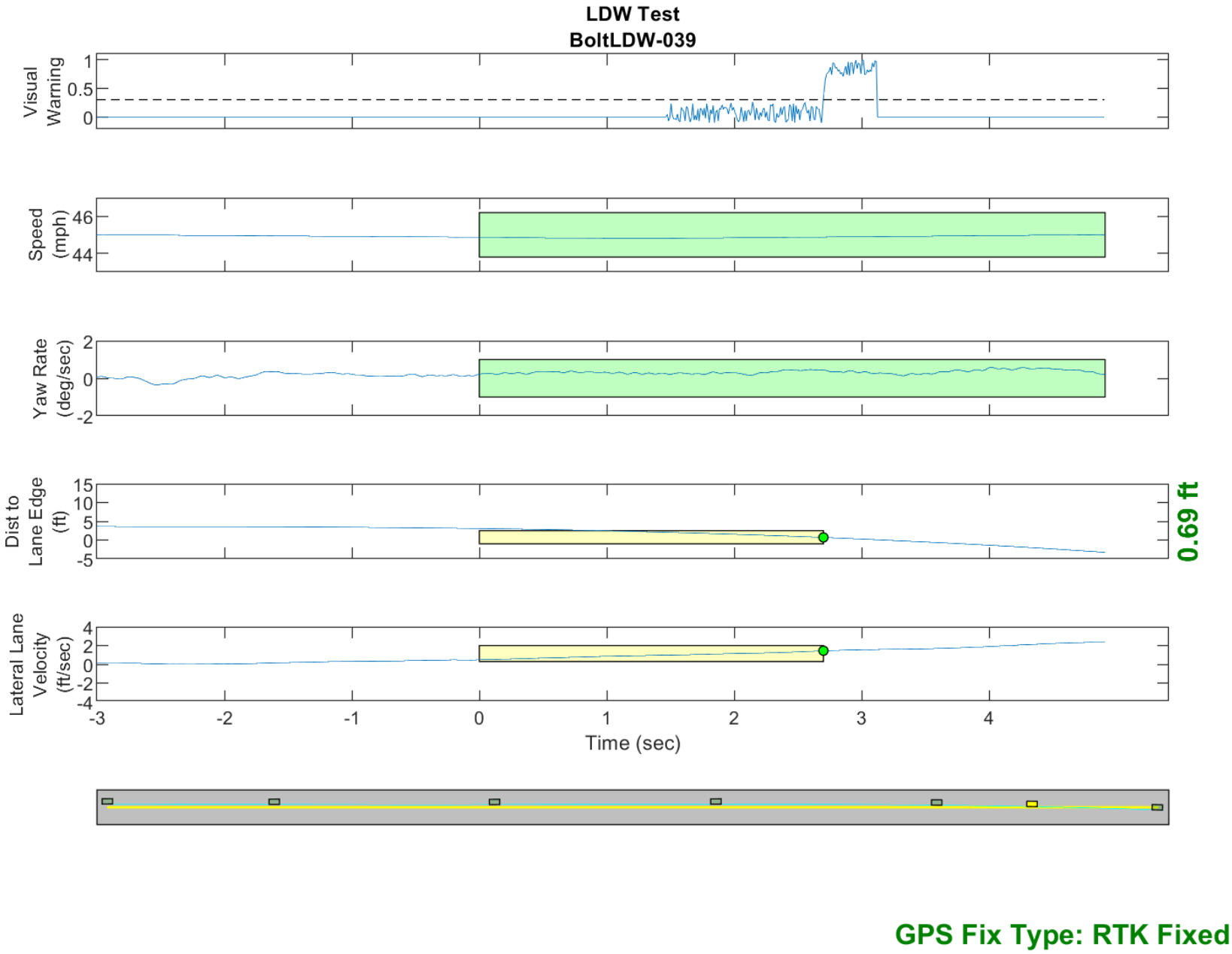

Figure D46. Time History for Run 39, Dashed Line, Right Departure, Visual Warning

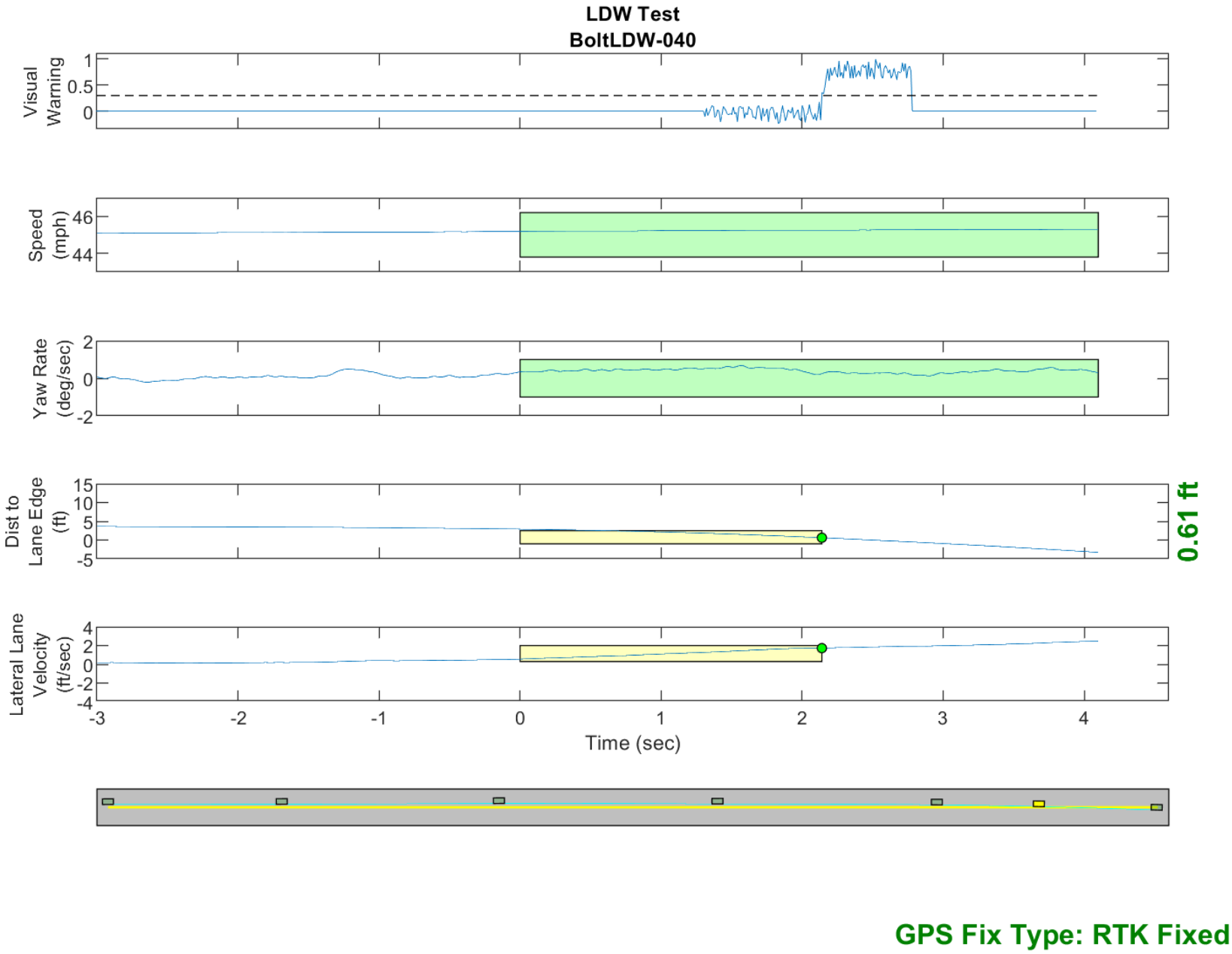

Figure D47. Time History for Run 40, Dashed Line, Right Departure, Visual Warning

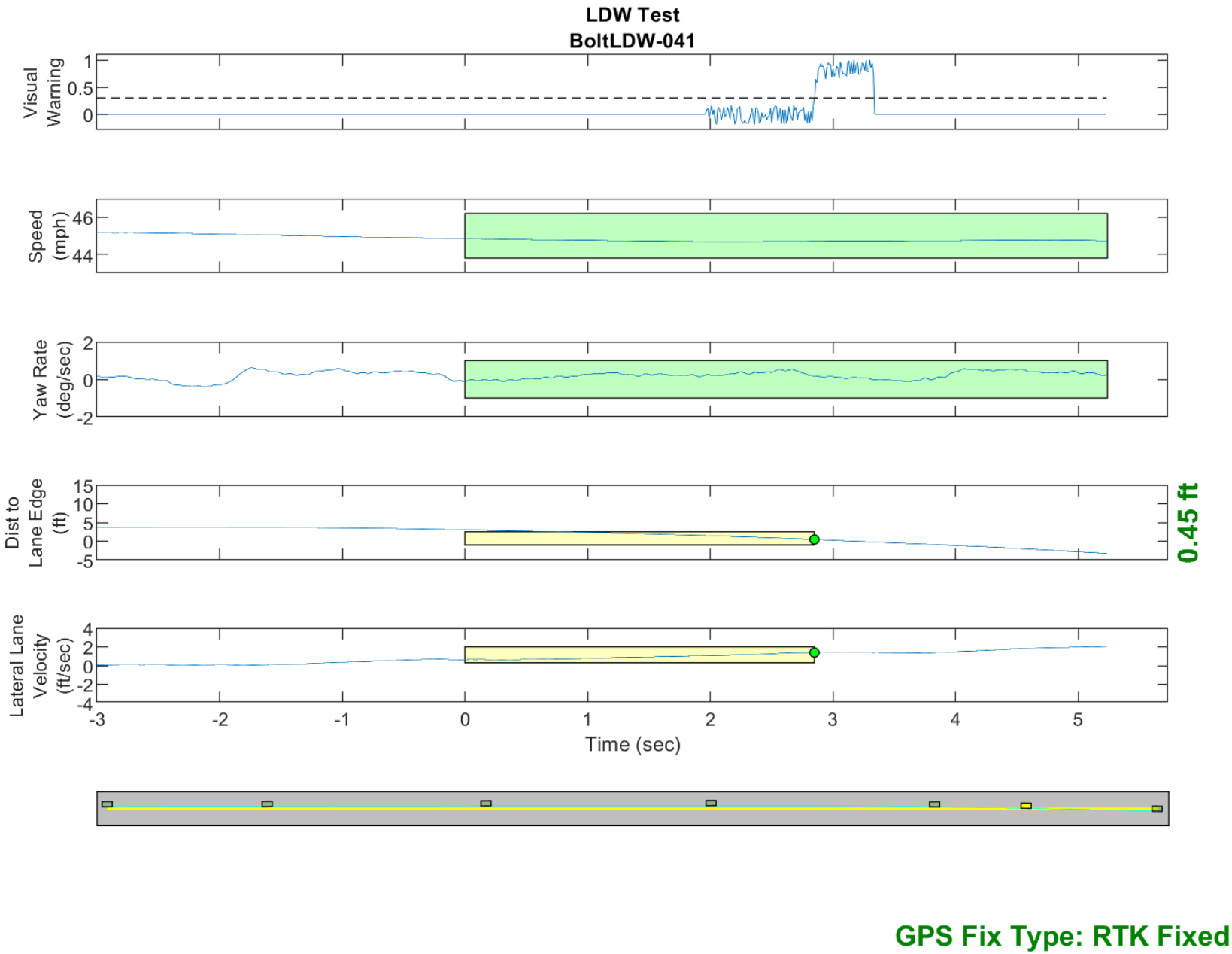

Figure D48. Time History for Run 41, Dashed Line, Right Departure, Visual Warning

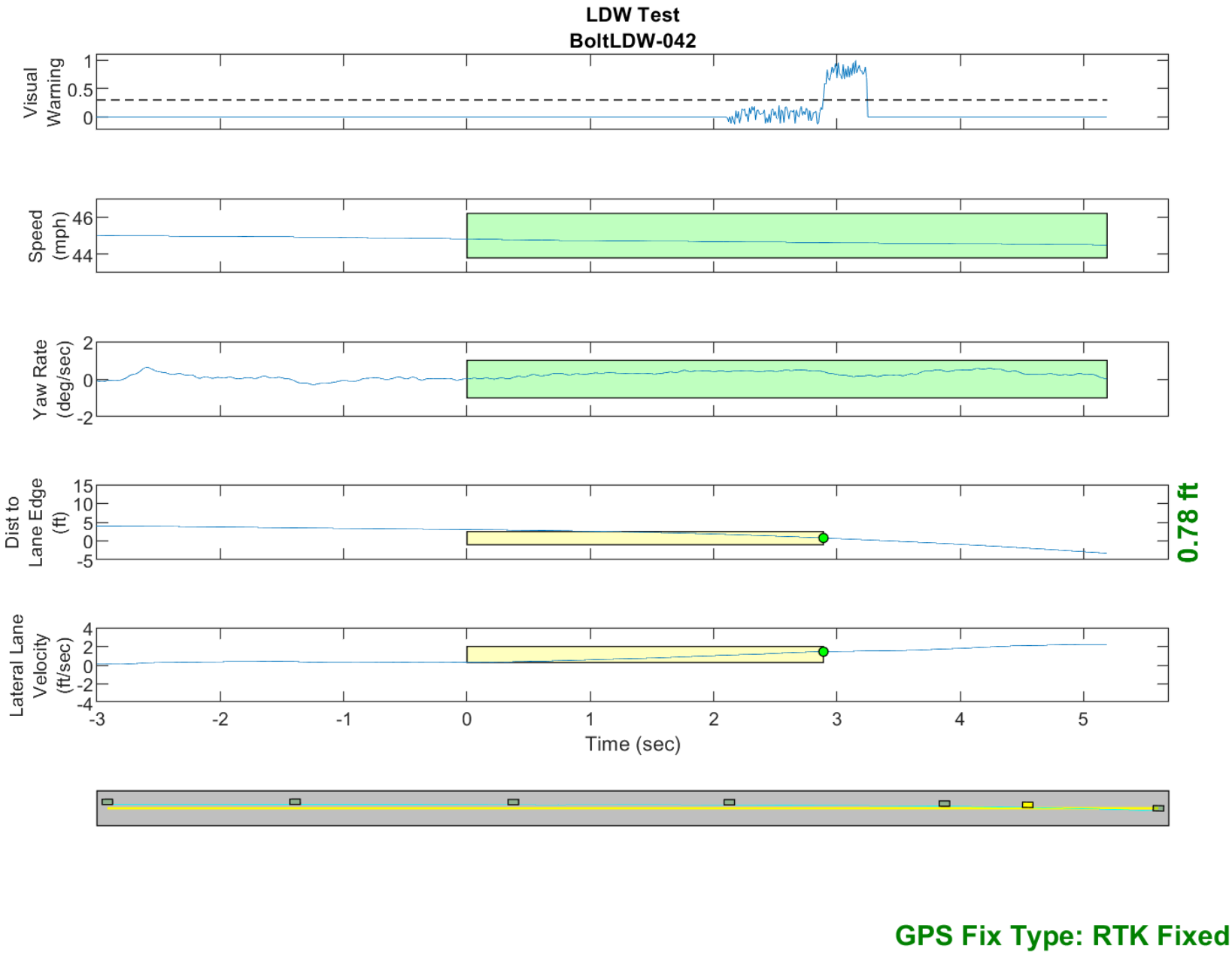

Figure D49. Time History for Run 42, Dashed Line, Right Departure, Visual Warning

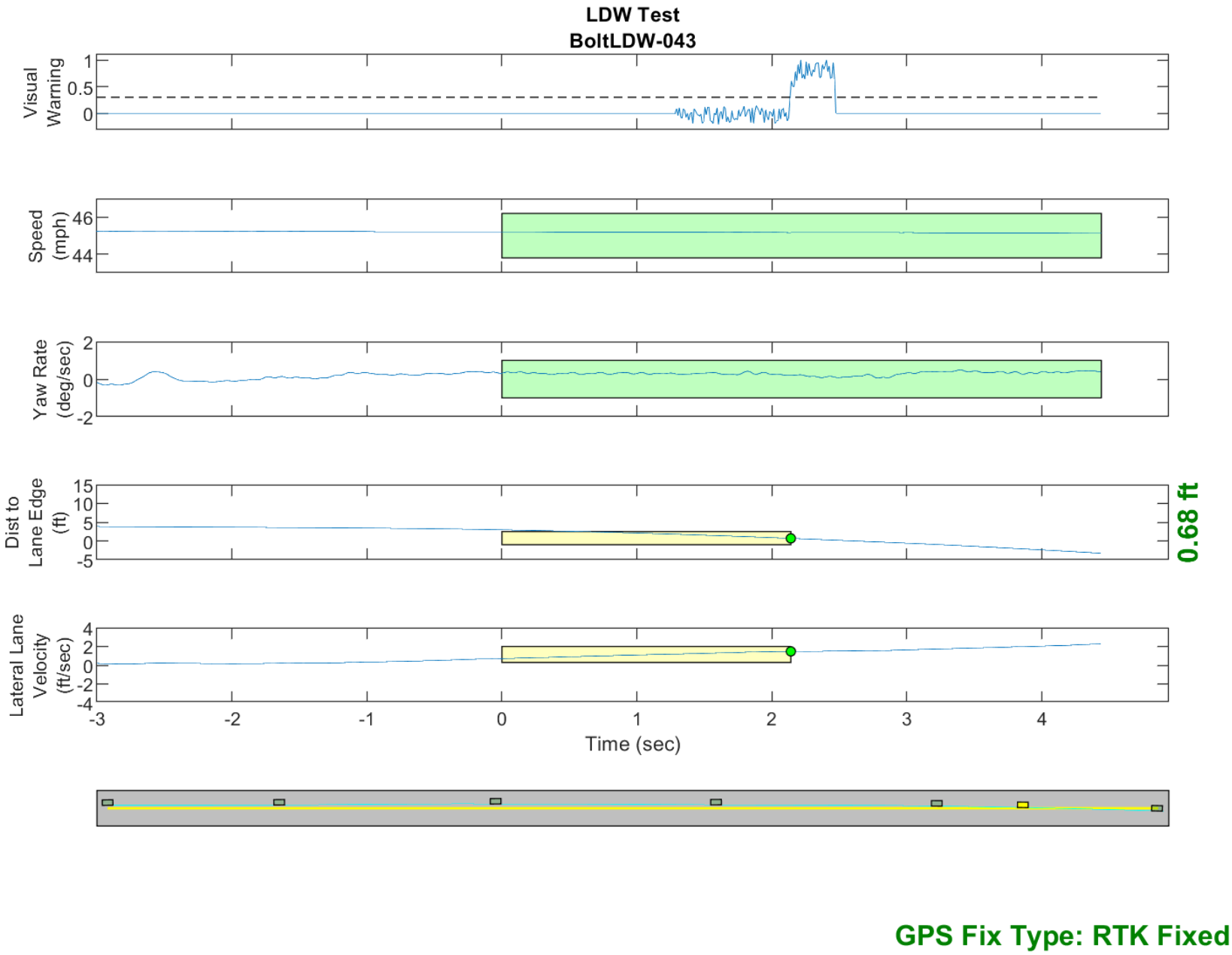

Figure D50. Time History for Run 43, Dashed Line, Right Departure, Visual Warning