OCAS-DRI-LDW-19-09
NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST

2019 Volkswagen Tiguan

DYNAMIC RESEARCH, INC.
355 Van Ness Avenue, STE 200
Torrance, California 90501

9 January 2020

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

Prepared for the Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DTNH22-14-D-00333.

Prepared By: J. Lenkeit and N. Wong

Program Manager Test Engineer

Date: 9 January 2020

1. Report No. OCAS-DRI-LDW-19-09	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Final Report of Lane Departure Warning Testing of a 2019 Volkswagen Tiguan.		5. Report Date 9 January 2020	
		6. Performing Organization Code DRI	
7. Author(s) J. Lenkeit, Program Manager N. Wong, Test Engineer		8. Performing Organization Report No. DRI-TM-18-172	
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. DTNH22-14-D-00333	
12. Sponsoring Agency Name and Address 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, D.C. 20590		13. Type of Report and Period Covered Final Test Report April 2019 - January 2020	
		14. Sponsoring Agency Code NRM-110	
15. Supplementary Notes			
16. Abstract These tests were conducted on the subject 2019 Volkswagen Tiguan in accordance with the specifications of the New Car Assessment Program's (NCAP) 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 markings and for both directions.			
17. Key Words Lane Departure Warning, LDW, 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 95	22. Price

TABLE OF CONTENTS

Section I

INTRODUCTION

The purpose of the testing reported herein was to confirm the performance of a Lane Departure Warning (LDW) system installed on a 2019 Volkswagen Tiguan. The LDW system for this vehicle provides just a visual alert. The vehicle passed the requirements of the test for all three lane markings and for both directions.

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.

Section II

DATA SHEETS

LANE DEPARTURE WARNING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 1)

2019 Volkswagen Tiguan

VIN: *3VV4B7AX2KM0xxxx*

Test Date: *5/13/2019*

Lane Departure Warning setting: *Active*

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*

LANE DEPARTURE WARNING

DATA SHEET 2: GENERAL TEST AND VEHICLE PARAMETER DATA

(Page 1 of 1)

2019 Volkswagen Tiguan

TEST VEHICLE INFORMATION

VIN: *3VV4B7AX2KM0xxxx*

Body Style: *SUV* Color: *Platinum Gray Metallic*

Date Received: *4/29/2019* Odometer Reading: *65 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Volkswagen De Mexico S.A. De C.V. Mexico*

Date of manufacture: *10/18*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *235/50R19*

Rear: *235/50R19*

Recommended cold tire pressure: Front: *280 kPa (41 psi)*

Rear: *280 kPa (41 psi)*

TIRES

Tire manufacturer and model: *Pirelli Scorpion Verde All Season*

Front tire size: *235/50R19*

Rear tire size: *235/50R19*

Front tire DOT prefix: *UN LF W441*

Rear tire DOT prefix: *UN LF W441*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2019 Volkswagen Tiguan

GENERAL INFORMATION

Test date: *5/13/2019*

AMBIENT CONDITIONS

Air temperature: *27.8 C (82 F)*

Wind speed: *1.5 m/s (3.5 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: *280 kPa (41 psi)*

Rear: *280 kPa (41 psi)*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2019 Volkswagen Tiguan

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*551.6 kg (1216 lb)*	Right Front	*524.4 kg (1156 lb)*
Left Rear	*435.0 kg (959 lb)*	Right Rear	*432.7 kg (954 lb)*
		Total:	*1943.6 kg (4285 lb)*

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 1 of 2)

2019 Volkswagen Tiguan

Name of the LDW option: *Lane Keeping System (Lane Assist)*

Type of sensor(s) used: *Camera*

How is the Lane Departure Warning presented to the driver?

(Check all that apply)

- **X** Warning light
- _____ Buzzer or audible alarm
- _____ Vibration
- _____ Other

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

When lane markings are detected, the indicator light for LDW, which appears in the instrument cluster, changes in color from orange to green.
The lane detection is also displayed in the middle of the instrument cluster.
While leaving the lane, a visual alert appears in the middle of the instrument cluster.
An activated lane departure warning results in a slight change of the display notification from grey to white at the side where the lane departure occurred.

Is the vehicle equipped with a switch whose purpose is to render LDW inoperable?

- **X** Yes
- _____ No

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 2 of 2)

2019 Volkswagen Tiguan

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

To turn the system off, use the touch screen on the center console:

Menu

Vehicle Settings

Assist System Settings

Lane Keeping System (Lane Assist); select or deselect Active

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.

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.

- *If the velocity is below 40 mph (64 km/h).*
- *When you drive in bad weather (rain, fog, etc.).*
- *When the windshield is blocked by dirt, mud, leaves, wet snow, etc.*
- *When there is snow or wheel tracks on the side of the road.*
- *When the direction indicator is in use.*
- *If the driver remains inactive for longer time (In order to prevent to chauffeur the driver).*
- *If the system cannot recognize lane markings correctly, for example, in construction zones, on bad roads, when visibility is bad, or when the camera area is covered.*
- *When ESC is switched off or when ESC Sport mode is switched on.*

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.

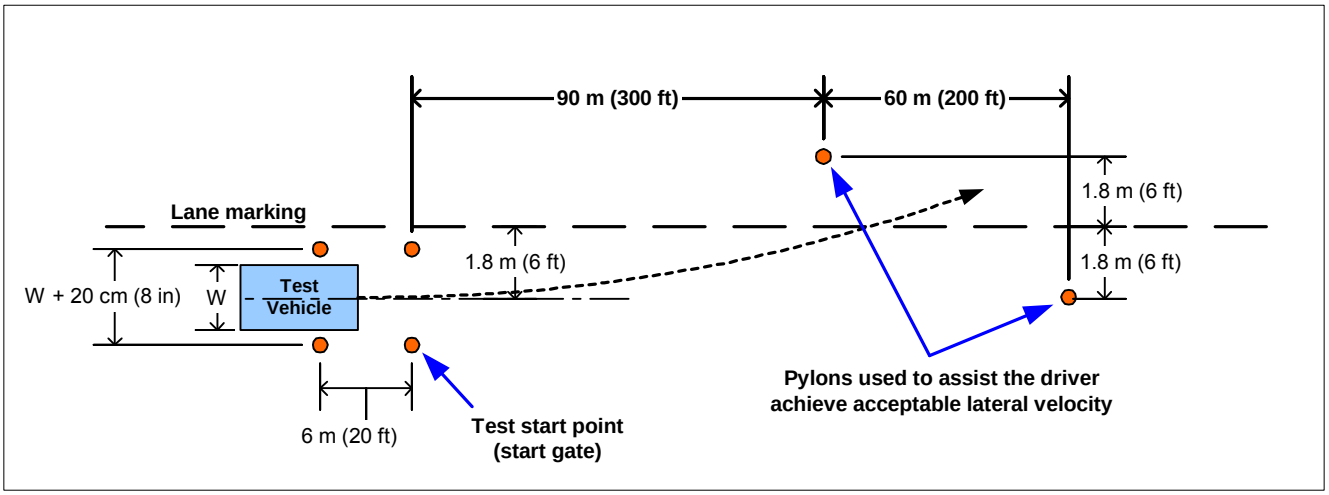

Figure 1. Position of Cones Used to Assist Driver

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.

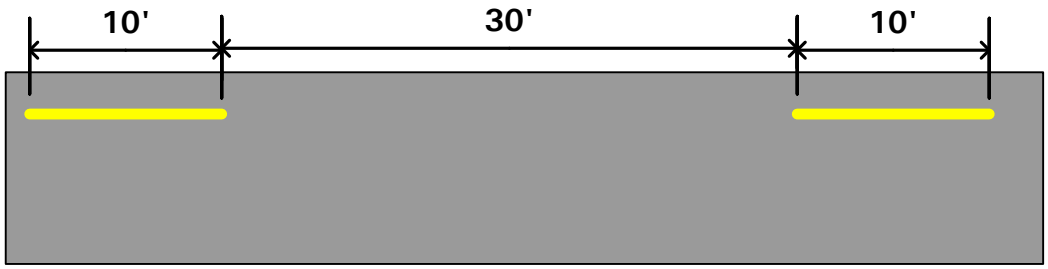

Figure 2. MUTCD Discontinuous Dashed Line Specifications

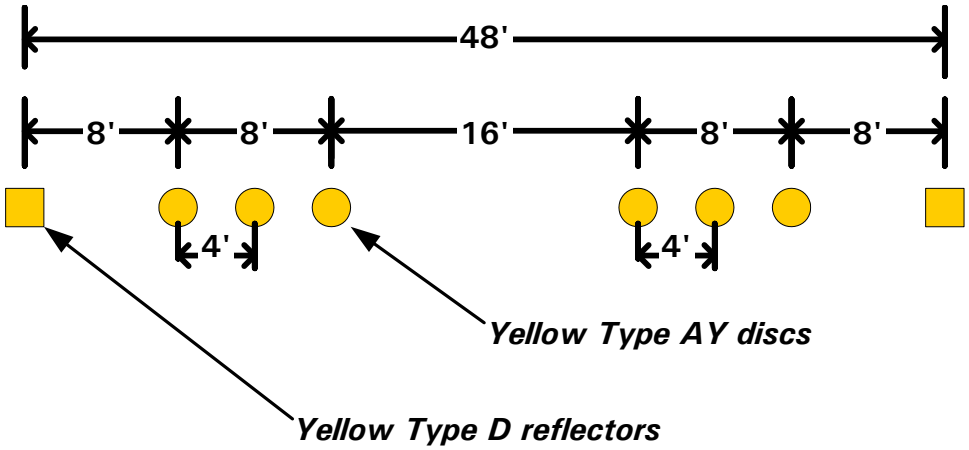

Figure 3. California Standard Plan A20A, Detail 4

A. 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).

C. 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 percent), and pass 20 of the 30 trials overall (66 percent).

D. 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	0.5 psi 3.45 kPa	Ashcroft, D1005PS	17042707002	By: DRI Date: 6/21/2018 Due: 6/21/2019
Platform Scales	Vehicle Total, Wheel, and Axle Load	8000 lb 35.6 kN	±1.0% of applied load	Intercomp, SWII	1110M206352	By: DRI Date: 1/3/2019 Due: 1/3/2020
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	NA
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+	2182	By: Oxford Technical Solutions1 Date: 10/16/2017 Due: 10/16/2019
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	NA

[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	NA	NA
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
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: 1/2/2019 Due: 1/2/2020

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 audible or haptic alerts, part of the pre-test instrumentation verification process is to determine the tonal frequency of the audible warning or the vibration frequency of the tactile warning through use of the PSD (Power Spectral Density) function in Matlab. This is accomplished in order to identify the center frequency around which a band-pass filter is applied to subsequent audible or tactile warning data so that the beginning of such warnings can be programmatically determined. The bandpass 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. Audible and Tactile Warning Filter Parameters

Warning Type	Filter Order	Peak-to-Peak Ripple	Minimum Stop Band Attenuation	Pass-Band Frequency Range
Audible	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

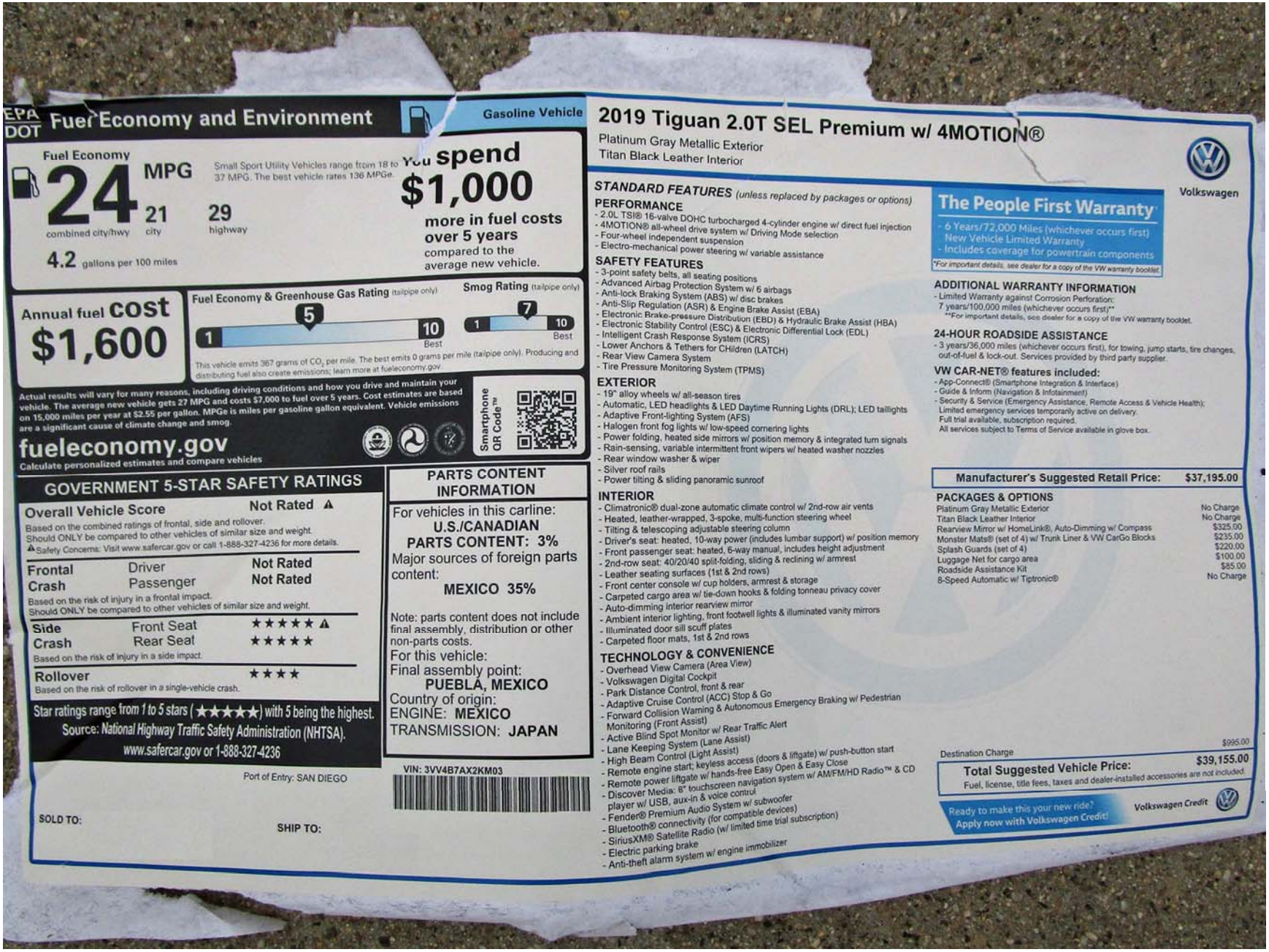

Figure A3. Window Sticker (Monroney Label)

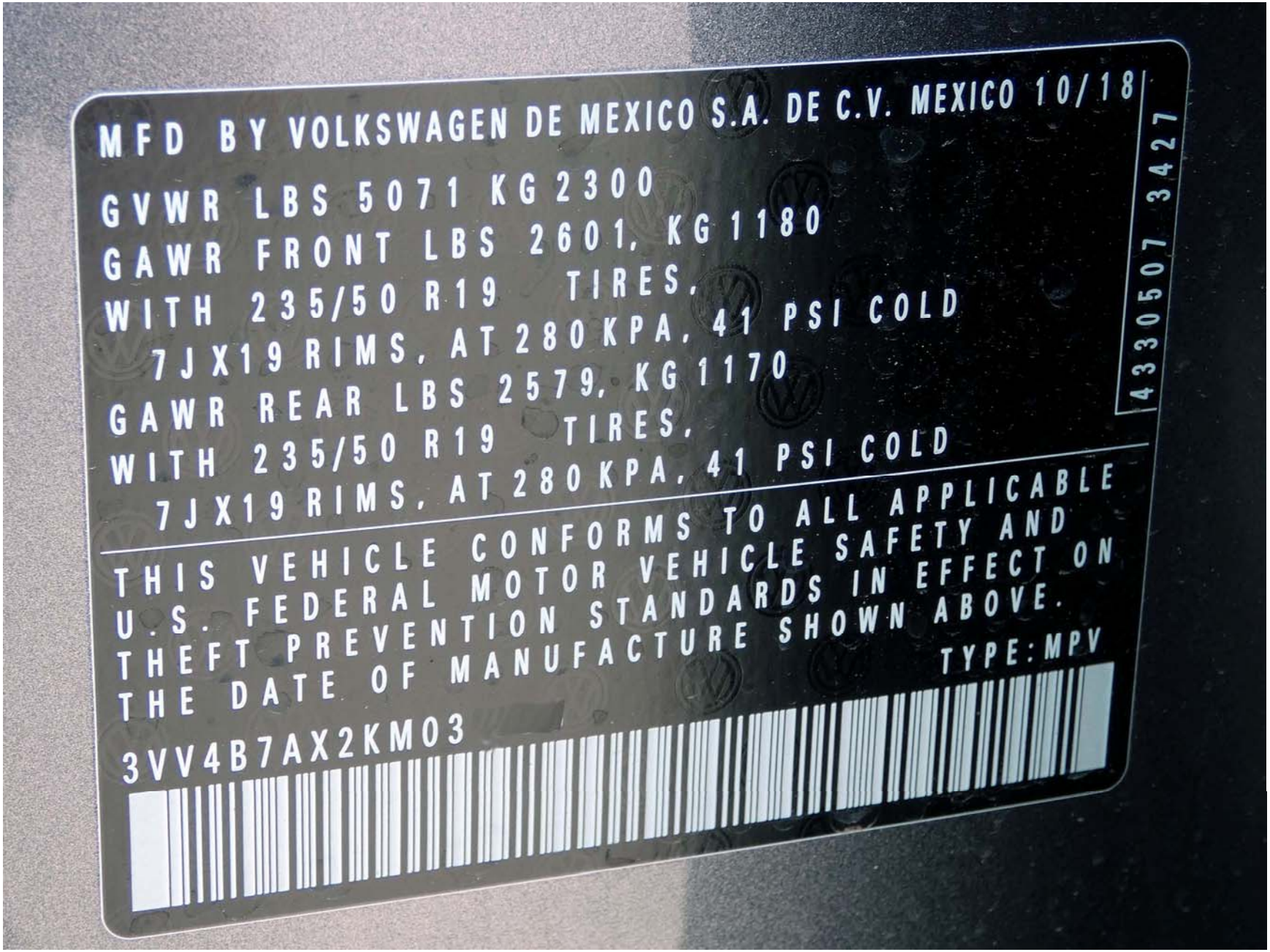

Figure A4. Vehicle Certification Label

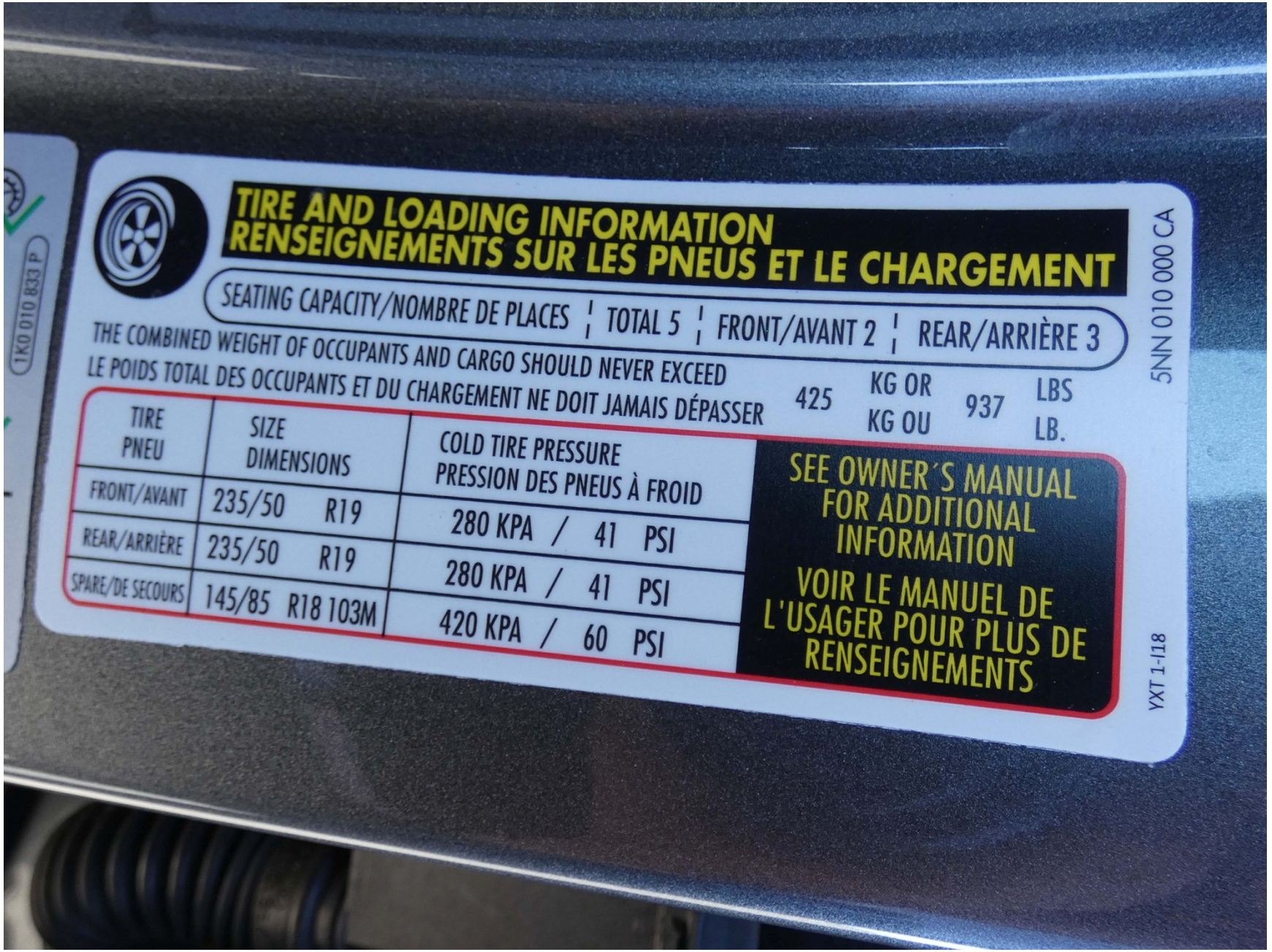

Figure A5. Tire Placard

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

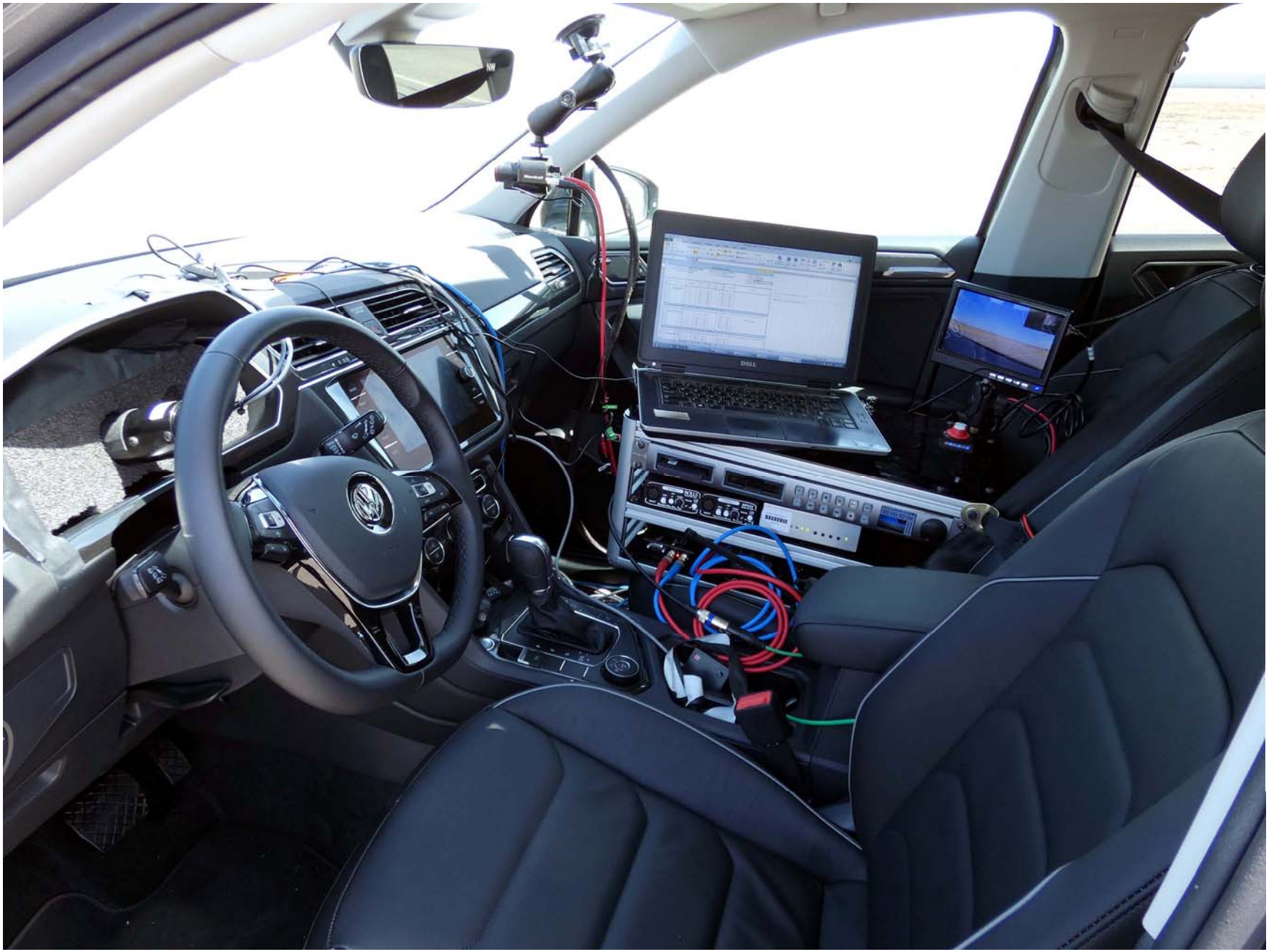

Figure A7. Computer Installed in Test Vehicle

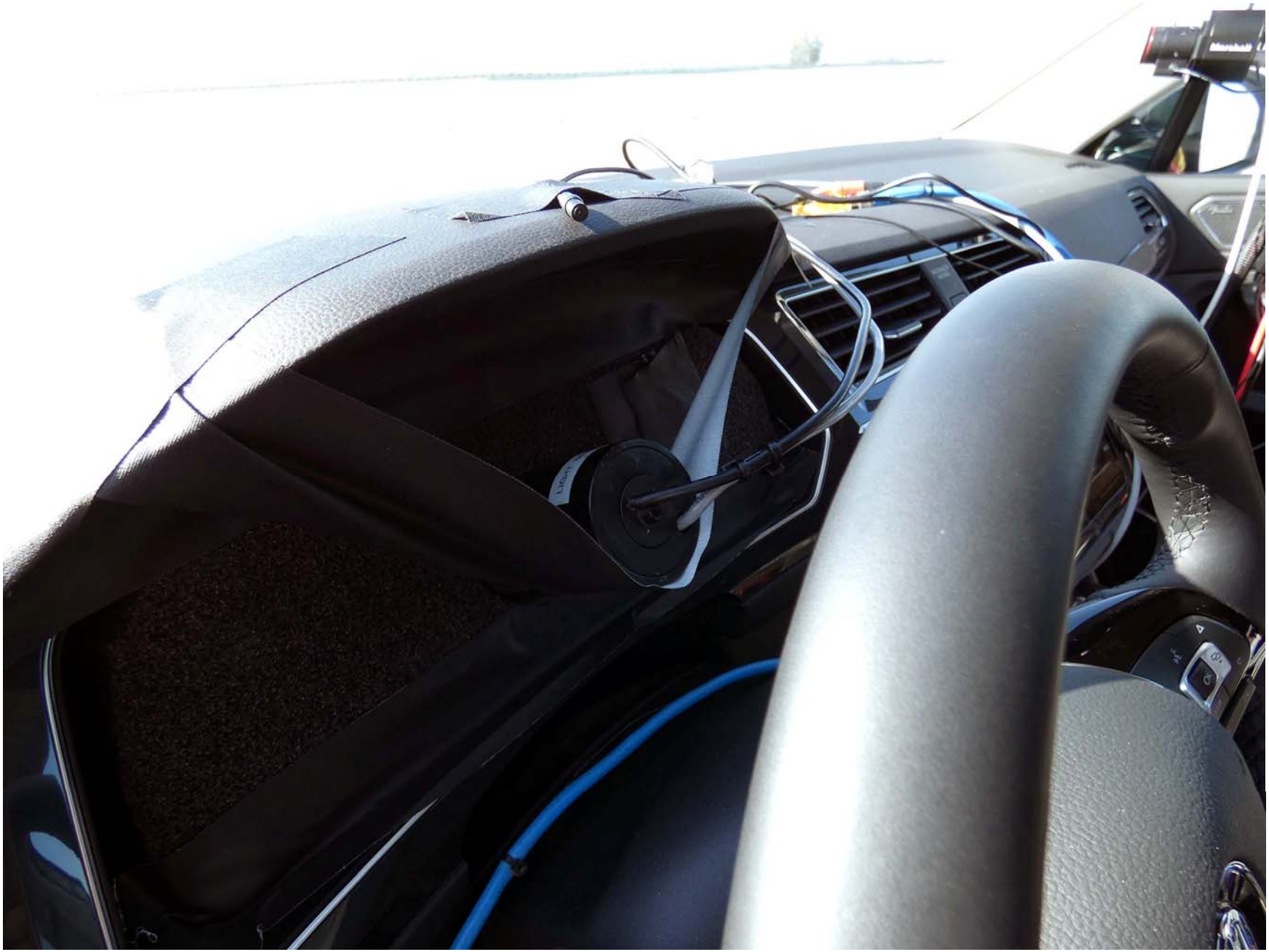

Figure A8. Sensor for Detecting Visual Alerts

Figure A9. LDW Instrument Panel Visual Alerts

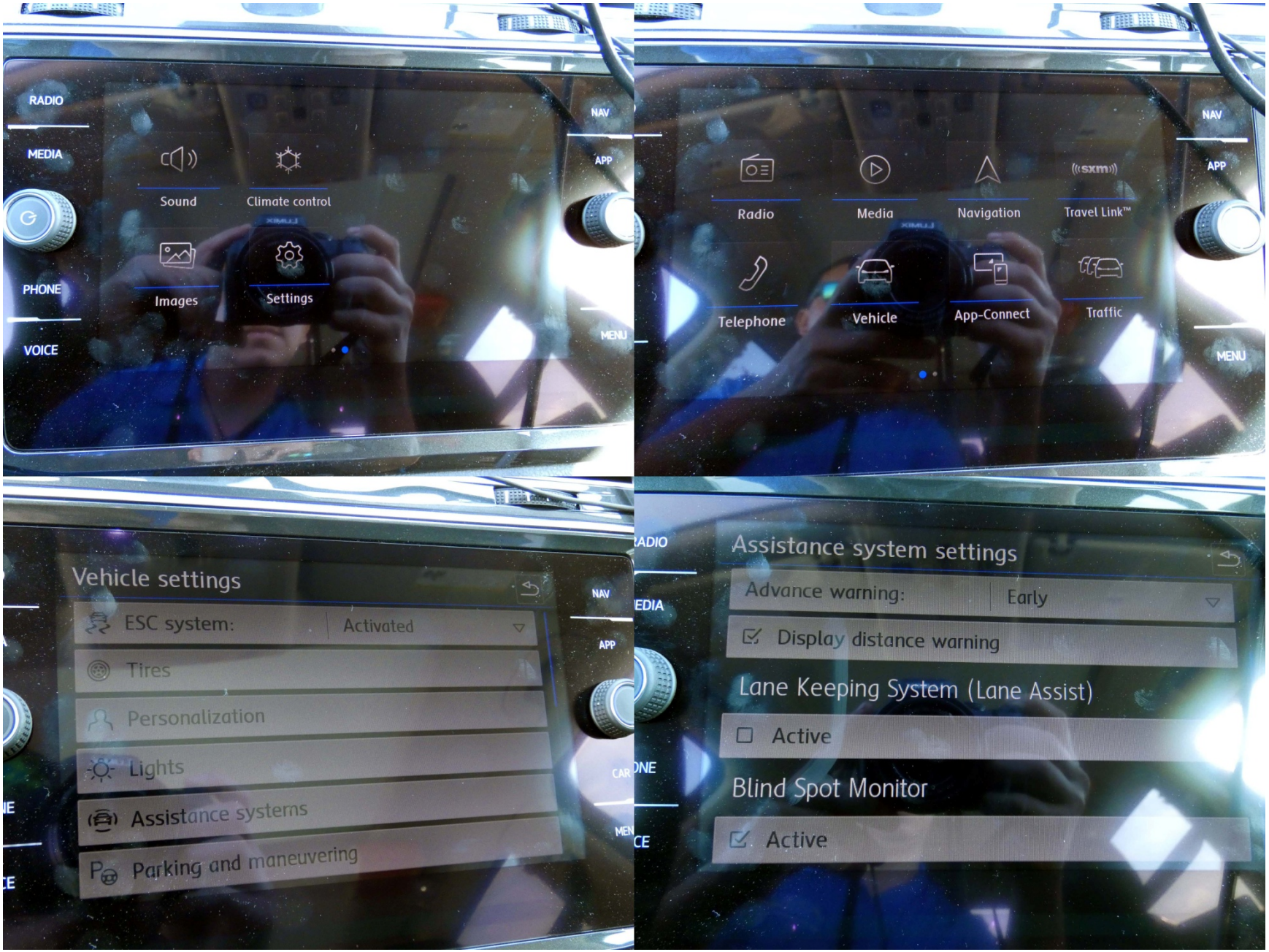

Figure A10. LDW Settings Menu Options

APPENDIX B

Excerpts from Owner's Manual

Vehicle overview

Front view

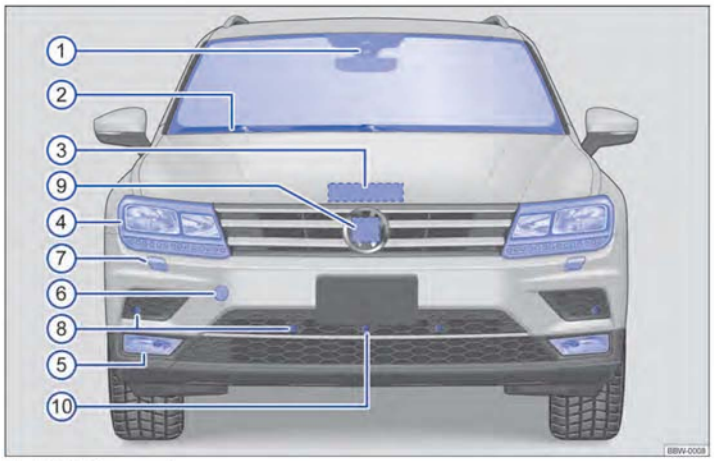

Fig. 1 Vehicle front overview.

Key to fig. 1:

1. Inside mirror with sensor or camera on the mirror base for:
   - Rain sensor (if equipped) ... 140
   - Low-light sensor (if equipped) ... 132
   - Lane Assist (if equipped) ... 211
   - Light Assist (if equipped) ... 132
2. Windshield wipers ... 139
3. Engine hood release ... 287
4. Headlights (on left and right) ... 132
5. Fog lights/static cornering lights (on left and right, if equipped) ... 132
6. Threaded hole for the front towing eye (behind cover) ... 282
7. Headlight washers (on left and right, if equipped) ... 139
8. Sensors for Park Distance Control (PDC) (if equipped) ... 219
9. Radar sensor for:
   - Adaptive Cruise Control System (ACC) (if equipped) ... 200
   - Front Assist (if equipped) ... 205
10. Camera for Area View (if equipped) ... 229 ◁

5NM012723AD

Symbol	Meaning → ⚠, → ⓘ
	One or more driving lights burned out → page 275.
	Light malfunction, excluding AFS[a] → page 132.
	Lights up: Engine control malfunction → page 170.
	Flashes: Misfire → page 270.
EPC	Engine control malfunction → page 270.
	Engine speed (rpm) limited (if equipped, to help prevent overheating) → page 270.
	Lights up: Problem with the steering → page 179.
	Flashes: Steering column not locked/unlocked → page 179.
	Lights up: Hill Start Assist is deactivated → page 178.
	Lights up: Tire pressure too low → page 306.
	Flashes: Tire Pressure Monitoring System (TPMS) malfunction → page 306.
	Rain and light sensor malfunction → page 139, → page 135.
	Windshield wiper malfunction → page 139.
	Not enough windshield washer fluid → page 139.
	Fuel tank almost empty → page 266, → page 23.
	Fuel filler cap not properly closed → page 266, → page 23.
	Lights up: Engine oil level too low → page 292.
	Flashes: Engine oil system malfunction → page 292.
	Airbag and safety belt pretensioner system malfunction → page 45.
OFF	Passenger front airbag turned off (PASSENGER AIR BAG OFF light) → page 45.
	Transmission malfunction or transmission overheating → page 173.
	Lane Assist switched on, not active → page 211.
	Adaptive cruise control (ACC) currently not available → page 200.

Symbol	Meaning → ⚠, → ⓘ
	Front Assist switched off (if equipped) → page 205.
	Blind Spot Monitor malfunction → page 213.
	Turn signals, left or right → page 132.
	Emergency flashers switched on → page 91.
	Lights up: Brake pedal not depressed → page 173.
	Flashes: The release button in the selector lever is not engaged → page 173.
	Cruise control is regulating the vehicle speed → page 198.
CRUISE	**OR:** Adaptive Cruise Control (ACC) switched on → page 200.
	Lane Assist is switched on and active → page 211.
	High beams switched on or headlight flashers in use → page 136.
	Increase the distance between your vehicle and the vehicle ahead. Front Assist Distance Warning (if equipped) → page 205.
	Light Assist high beam control switched on (if equipped) → page 136.
	When displayed in white: Hill Descent Control active → page 185.
	When displayed in gray: Hill Descent Control not active. System is turned on, but not regulating → page 185.
	The **Off-road** driving mode is active (if equipped) → page 181, *4MOTION Active Control*.
	ACC is active. No vehicle has been detected ahead. The system is regulating vehicle speed → page 200.
	When displayed in white or green: ACC active. Vehicle detected ahead. ACC regulates the speed and the distance from the vehicle ahead → page 200.
	When displayed in gray: ACC not active. System switched on, does not regulate.
	Cruise control malfunction → page 198 ▶

WARNING

Failure to heed warning lights or other warnings can result in a collision and serious personal injury.

- Never ignore warning lights or text WARNINGS.
- Always stop the vehicle as soon as it is safe to do so.
- Park the vehicle at a safe distance from moving traffic and where no part of the hot catalytic converter and exhaust system can come into contact with flammable materials under the vehicle, such as dry grass, brush, spilled fuel, etc.
- A broken down vehicle presents a high accident risk for itself and others. Switch on emergency flashers and set up a warning triangle to warn oncoming traffic.

WARNING

Roads and bridges may be dangerously icy even if the outside air temperature is above freezing.

- If you use the outside temperature display to tell you about frost conditions, remember that roads can even ice over at temperatures above +39 °F (+4 °C). Always remember: even if the "snowflake symbol" is not displayed, there could still be black ice on the road.
- Never rely exclusively on the outside temperature display.

NOTICE

Failure to heed warning lights or text WARNINGS can result in vehicle damage.

The instrument cluster displays and their arrangement may vary depending on the vehicle model and engine. For displays without warning and information messages, malfunctions are only signaled with indicator lights.

Depending on vehicle equipment, some settings and displays may also appear in the Infotainment system. ◁

Instrument cluster menus

Please read the introductory information and heed the Warnings and Notice ⚠ on page 15.

The following list shows how the Volkswagen Information System menus in the instrument cluster display are structured. The size and layout of the Volkswagen Information System menu depends on vehicle equipment.

Certain menus may only be displayed while the vehicle is completely stopped.

Driving data → page 20, *Driving data (Multi-Function Display)*

Assist systems (if equipped) → page 198, *Driver assistance systems*

- ACC (display only)
- Lane Assist
- Blind Spot Monitor
- Rear Traffic Alert
- Front Assist

Navigation or Compass → booklet *Infotainment System*

Audio → booklet *Infotainment System*

Telephone → booklet *Infotainment System*

Vehicle status ◁

Driving data (Multi-Function Display)

Please read the introductory information and heed the Warnings and Notice ⚠ on page 15.

When the ignition is on, the **Driving data** menu provides a variety of travel and fuel consumption data. Navigate through the data as described on → page 27, *Using the instrument cluster menus*.

Switching between the displays

Use the arrow up and down buttons (△ and ▽) on the right side of the steering wheel → fig. 17.

Trip memories

The display has 3 automatic memories:

– **Since start**

– **Since refuel**

– **Extend. period** ▶

Driver assistance systems button

Please read the introductory information and heed the Warnings and Notice ⚠ on page 28.

Fig. 18 On the multi-function steering wheel: Driver assistance systems button.

Your vehicle may have a driver assistance systems button on the multi-function steering wheel, which lets you switch some driver assistance systems on or off in the **Assist systems** menu → page 20, *Instrument cluster menus*.

Switching individual driver assistance systems on or off

– Press the button → fig. 18 Ⓐ to open the **Assist systems** menu.
– Using the arrow up and down buttons △ or ▽ on the multi-function steering wheel, select the driver assistance system (for example, Lane Assist, if equipped). A "check mark" indicates if the selected driver assistance system is switched on.
– Confirm the selection by pressing the OK button on the multi-function steering wheel.

You can also switch driver assistance systems on and off in the **Vehicle settings** menu in the Infotainment system → page 30, *Vehicle settings menu*. ◁

Infotainment system operation and displays

Introduction

General information on operating the unit

The following section contains information on the settings that can be adjusted in the **Vehicle settings** menu. You can find information on operating the Infotainment system as well as warning and safety instructions in a separate manual. See → booklet *Infotainment System*.

Some Infotainment features can only be accessed and operated when the vehicle is standing still and the automatic transmission selector lever is in park **(P)**.

Vehicle settings and information

After pressing the CAR button, you can tap the corresponding function key on the Infotainment screen to display information or adjust the following settings:

Selection (Vehicle information)

- **Active Info Display** (Settings for the Volkswagen Digital Cockpit, if equipped) → page 17
- **Offroad** View the off-road display (if equipped) → page 184
- **Energy consumers** → page 20, *Driving data (Multi-Function Display)*
- **Driving data** (Since start, extend. period, since refuel) → page 20, *Driving data (Multi-Function Display)*
- **Think Blue. Trainer.** (if equipped) → page 158, *Think Blue. Trainer.*
- **Vehicle status** (Current warning and information messages)

Radio or Media (Radio station or media selection) → booklet *Infotainment System*

Settings or Setup → page 30, *Vehicle settings menu*

⚠ WARNING

Driving on today's roads demands the full attention of the driver at all times. Driver distraction causes accidents, collisions and serious personal injury! ▶

5NM012723AD

- See an authorized Volkswagen dealer or authorized Volkswagen Service Facility for assistance and have the Front Assist system checked. ◁

Lane Keeping system (Lane Assist)

Introduction

Your vehicle may be equipped with a Lane Assist system, which can warn you if your vehicle unintentionally leaves the current drive lane.

With the help of a camera → page 5, *Front view*, Lane Assist can recognize certain lane markings for the lane in which the vehicle is moving. Should the vehicle leave this area unintentionally, for example, when leaving the lane without activating a turn signal, the system will warn you with a *steering correction*. The driver can override the steering correction at any time.

Vehicles without Blind Spot Monitor: Lane Assist will not warn you of a lane change if you activate the turn signal, because the system will assume that the lane change is intended.

System limits

Only use Lane Assist on highways and well-maintained roads.

Lane Assist may deactivate temporarily under certain circumstances:

– When the speed of your vehicle is less than about 40 mph (65 km/h).
– If the system cannot recognize lane markings correctly, for example, in construction zones, on bad roads, when visibility is bad, or when the camera area is covered.
– When ESC is switched off or when ESC Sport mode is switched on → page 234, *Switching Anti-Slip Regulation (ASR) and ESC Sport mode on and off*.

⚠ WARNING

Always remember that Lane Assist has limits – using Lane Assist when it is not possible to drive safely can be dangerous and can lead to an accident and serious personal injury.

- Always adjust your speed and the distance you keep between you and the vehicles ahead of you to the road, traffic, weather, and visibility conditions.
- Always keep both hands on the steering wheel so that you are prepared to steer at any time. The driver is always responsible for controlling the vehicle.
- Always pay attention to the messages in the instrument cluster display and act accordingly.
- Always pay close attention to what is happening around your vehicle.

⚠ WARNING

Not deactivating Lane Assist in the situations mentioned above can cause collisions, other accidents and serious personal injury.

Certain settings are automatically saved by the driver personalization feature → page 30, *Driver personalization*. ◁

Driving with Lane Assist

Please read the introductory information and heed the Warnings and Notice ⚠ on page 211.

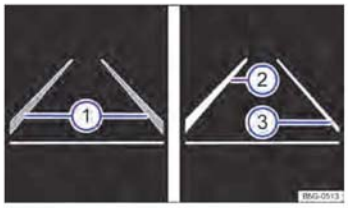

Fig. 129 In the instrument cluster display: Lane Assist display (displayed in color on an instrument cluster with color display). ▶

5NM012723AD

Switching Lane Assist on and off

– You can turn Lane Assist on or off in the **Vehicle settings** menu in the Infotainment system → page 29, *Infotainment system operation and displays*.
– **OR:** In the **Assist systems** menu in the instrument cluster display → page 20, *Instrument cluster menus*.
– **OR:** Press the driver assistance systems button on the multi-function steering wheel to open the **Assist systems** menu → page 29, *Driver assistance systems button*.

The indicator light in the instrument cluster shows the status of the system.

If the yellow indicator light comes on, Lane Assist is switched on but is not active.

Lane Assist works at speeds above about 40 mph (65 km/h) when lane markings can be identified → fig. 129. The green indicator light comes on.

Displays

Lane Assist display in the instrument cluster fig. 129:

① Lane marking detected (shown in gray). No regulation is necessary.
② Lane marking detected (shown in white). System is actively regulating.
③ No lane marking detected. System is not regulating.

Switching Lane Assist off temporarily

Lane Assist should be switched off in the following situations:

– When driving with a sporty or dynamic driving style.
– When weather conditions and/or visibility are poor.
– When the vehicle is off road, for example, in construction zones or on race tracks.
– Before reaching the top of a hill.

Reminder to resume steering

If the system does not detect steering activity by the driver, a warning chime and a message in the instrument cluster display remind you to resume steering the vehicle.

If the driver does not respond to the reminder, the system may deactivate temporarily.

Steering wheel vibration

Certain situations will cause the steering wheel to vibrate and demand active steering intervention by the driver:

– If the corrective steering intervention is not sufficient to keep the vehicle in its lane.
– If the system no longer detects a lane during a strong corrective steering intervention.

WARNING

Failure to heed warning lights or other warnings can result in a collision and serious personal injury.

- Never ignore warning lights or text WARNINGS.
- Always stop the vehicle as soon as it is safe to do so.

NOTICE

Failure to heed warning lights or text WARNINGS can result in vehicle damage.

If there is a malfunction, Lane Assist is automatically deactivated. ◁

Tips and troubleshooting

Please read the introductory information and heed the Warnings and Notice ⚠ on page 211.

If there is no camera image, an error message, or the system switches itself off

– Clean the windshield → page 356, *Exterior care and cleaning*.
– Check for visible damage on the windshield in the camera's field of view.

If the system is not responding as expected

– Regularly clean the camera and keep it free from snow and ice.
– Do not cover the camera's field of view.
– Check the windshield for damage in the camera's field of view.
– Do not attach objects to the steering wheel.

WARNING

If the camera's field of view is covered or dirty, Lane Assist may not work properly. ▶

- Always make sure that the camera area is free of dirt or snow and not covered.

NOTICE

In order to help keep Lane Assist working properly:

- Always keep the windshield in front of the camera free of ice, dirt, snow, and other things that could reduce its field of view.
- Regularly check the windshield and especially the area around the camera for damage.
- Never attach or mount any accessories or other items to the steering wheel.

If Lane Assist does not work properly and as described here or if there is a system fault, have the system checked by an authorized Volkswagen dealer or authorized Volkswagen Service Facility. ◁

Blind Spot Monitor

Introduction

Depending on vehicle equipment, the vehicle may be equipped with the Blind Spot Monitor system.

The Blind Spot Monitor monitors the area next to and behind your vehicle, with the help of radar sensors behind the rear bumper on the left and right → page 7, *Rear view*. The system measures the distance and the speed difference to the other vehicles around you. If the Blind Spot Monitor detects one or more vehicles in the monitored area, indicator lights come on in the outside mirrors.

Physical and system limitations

Use the Blind Spot Monitor only on paved roads.

In certain situations, the Blind Spot Monitor may not interpret the traffic situation correctly. These situations may include:

- When driving around sharp curves.
- When driving between two lanes.
- When the width of the lanes is not the same.
- When there is a bump in the road surface.
- When driving at the top of a hill.
- When the weather conditions are poor.
- When certain things are on the side of the road, such as high or offset guard rails.

WARNING

The Blind Spot Monitor technology cannot overcome the laws of physics and the limits of the system. Careless or unintentional use of the Blind Spot Monitor may result in accidents and severe injuries.

- The Blind Spot Monitor is not a substitute for careful and attentive driving.
- Always adjust your driving style to road, traffic, weather, and visibility conditions.
- Always keep both hands on the steering wheel so that you are prepared to steer at any time.
- Pay attention to and heed the indicator lights in the outside mirrors and in the instrument cluster display.
- The Blind Spot Monitor may react to certain things on the side of the road, such as high or offset guardrails. False warnings may result.
- Never use the Blind Spot Monitor on unpaved roads. The Blind Spot Monitor was designed only for paved roads.
- Always pay attention to the area surrounding your vehicle.
- Never use the Blind Spot Monitor if the radar sensors are dirty, covered, or damaged; the system may not work properly.
- Sunlight may reduce the visibility of the indicator light in the outside mirror.

If the system does not work as described in this chapter or if your vehicle was involved in a collision, do not use the Blind Spot Monitor. See an authorized Volkswagen dealer or an authorized Volkswagen Service Facility to have the system checked.

Certain settings are automatically saved by the driver personalization feature → page 30, *Driver personalization*.

A Declaration of Compliance with the United States FCC and Industry Canada regulations is on → page 369, *Declaration of Compliance, Telecommunications and Electronic Systems*. ◁

5NM012723AD

APPENDIX C

Run Log

Subject Vehicle: **2019 Volkswagen Tiguan** Test Date: **5/13/2019**

Driver: **N. Wong**

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

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Visual Alert (ft)	Pass/Fail	Notes
1	**Botts**	**Left**	Y	0.87	Pass	
2			Y	1.20	Pass	
3			Y	0.93	Pass	
4			Y	1.29	Pass	
5			Y	1.34	Pass	
6			Y	1.19	Pass	
7			Y	1.16	Pass	
8	**Botts**	**Right**	Y	1.70	Pass	
9			Y	1.57	Pass	
10			Y	1.47	Pass	
11			Y	1.54	Pass	
12			Y	0.39	Pass	
13			Y	0.91	Pass	
14			N			Speed
15			Y	1.16	Pass	
16	**Solid**	**Right**	Y	1.59	Pass	
17			Y	1.34	Pass	
18			Y	1.76	Pass	
19			Y	1.52	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Visual Alert (ft)	Pass/Fail	Notes
20			Y	1.73	Pass	
21			Y	1.51	Pass	
22			Y	1.61	Pass	
23	**Solid**	**Left**	Y	0.10	Pass	
24			Y	0.24	Pass	
25			Y	0.51	Pass	
26			Y	0.60	Pass	
27			Y	0.57	Pass	
28			Y	0.45	Pass	
29			Y	0.12	Pass	
30	**Dashed**	**Left**	Y	0.91	Pass	
31			Y	0.53	Pass	
32			Y	0.88	Pass	
33			Y	0.42	Pass	
34			Y	0.63	Pass	
35			Y	0.82	Pass	
36			Y	0.69	Pass	
37	**Dashed**	**Right**	Y	0.48	Pass	
38			Y	0.43	Pass	
39			Y	0.77	Pass	
40			Y	0.40	Pass	
41			Y	0.26	Pass	
42			Y	0.75	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Visual Alert (ft)	Pass/Fail	Notes
43			Y	0.38	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. **Note:** The Bird's Eye View representation is not synchronized to the time history plots above it. It is a spatial, not temporal, representation.

Note that 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.

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

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.

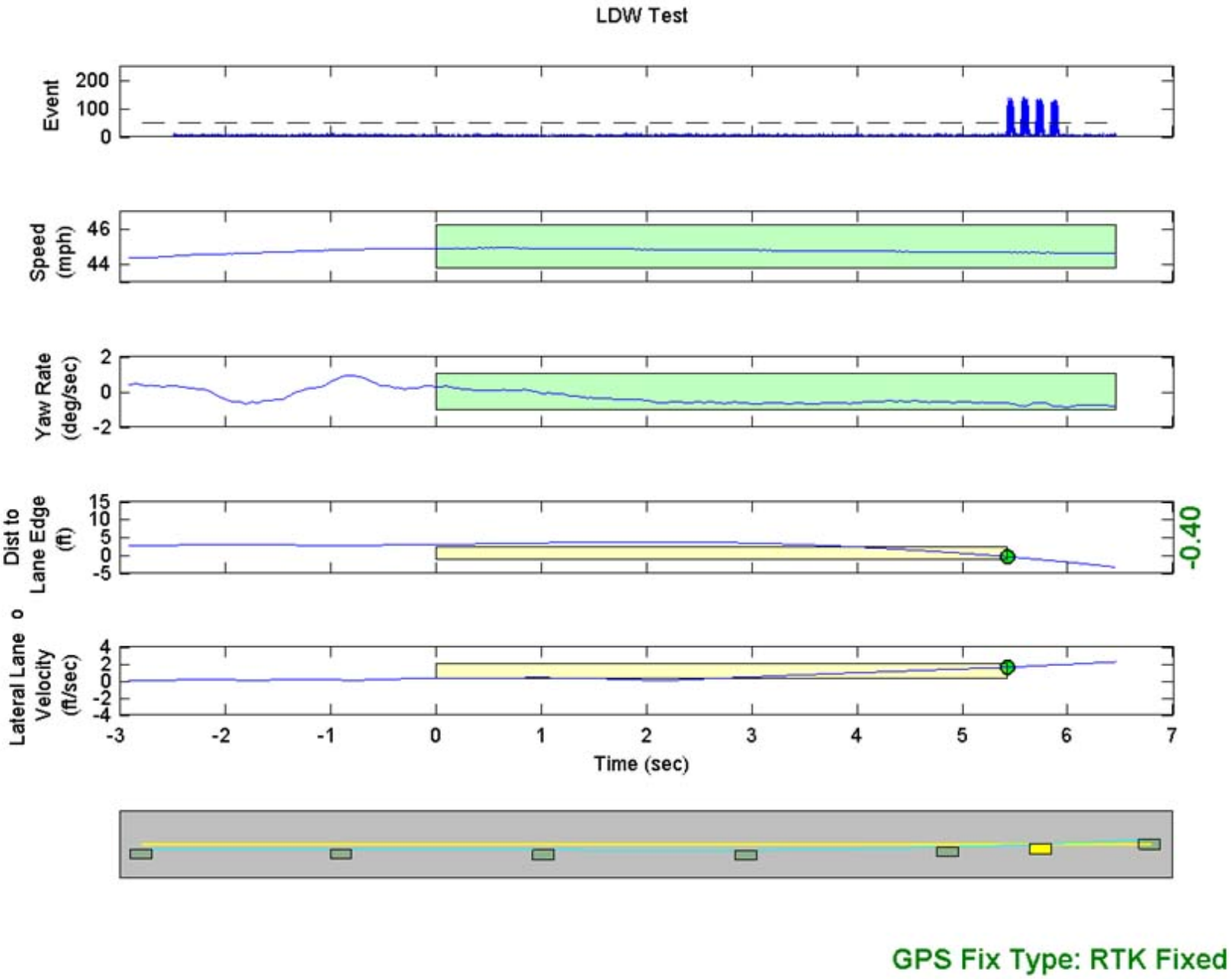

Figure D1. Example Time History for Lane Departure Warning Test, Passing

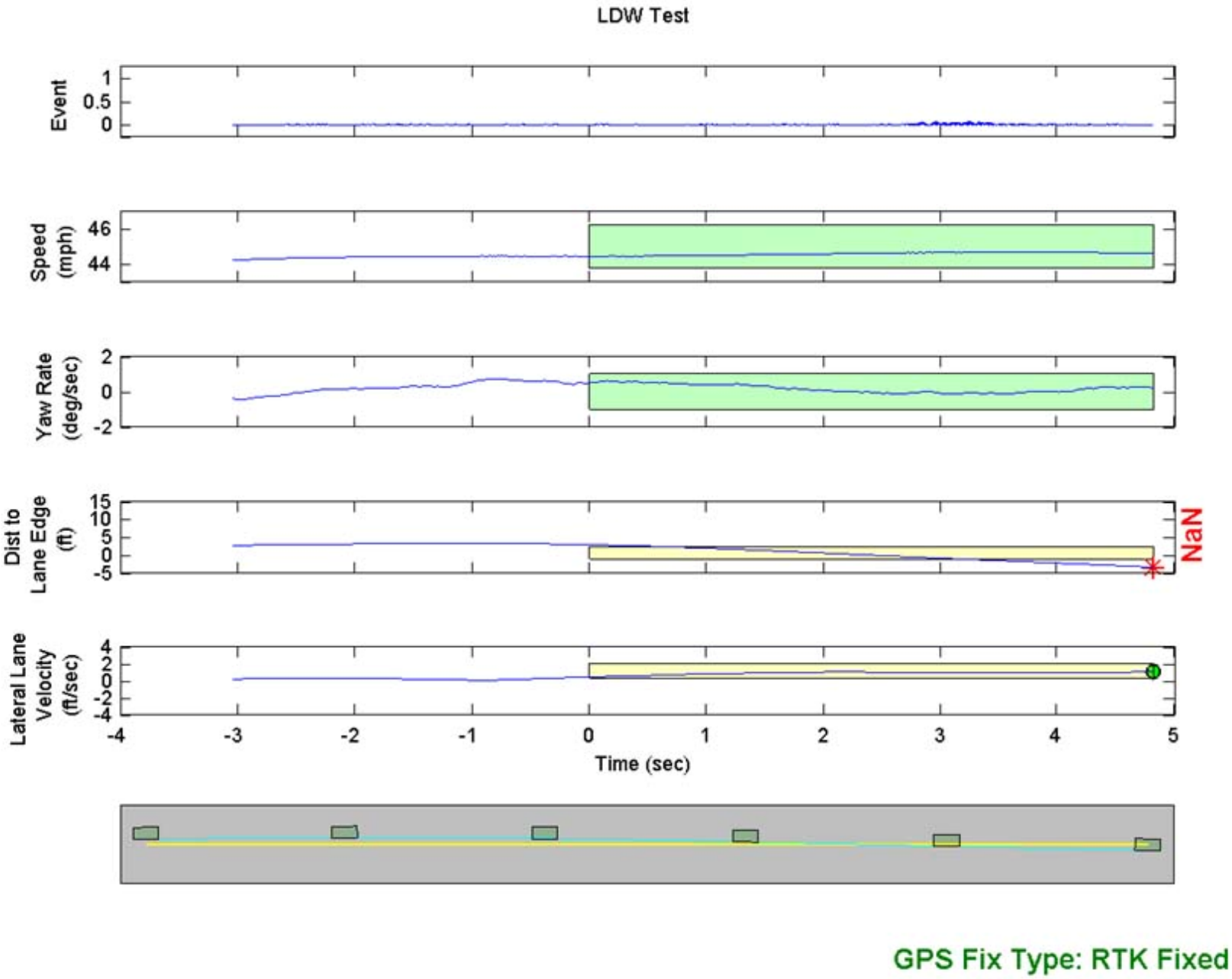

Figure D2. Example Time History for Lane Departure Warning Test, Failing, No Warning Issued

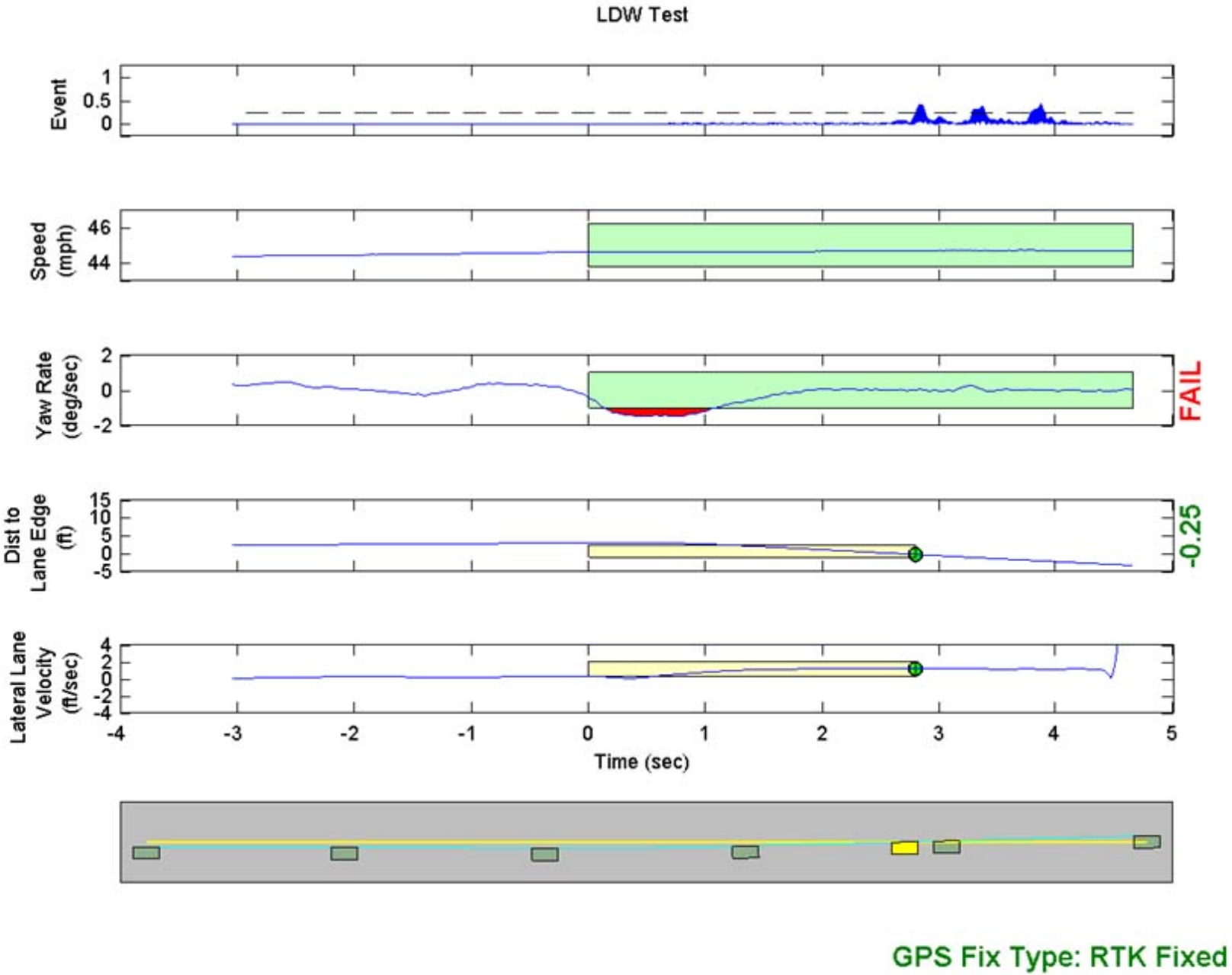

Figure D3. Example Time History for Lane Departure Warning Test, Invalid Run Due to Subject Vehicle Yaw Rate

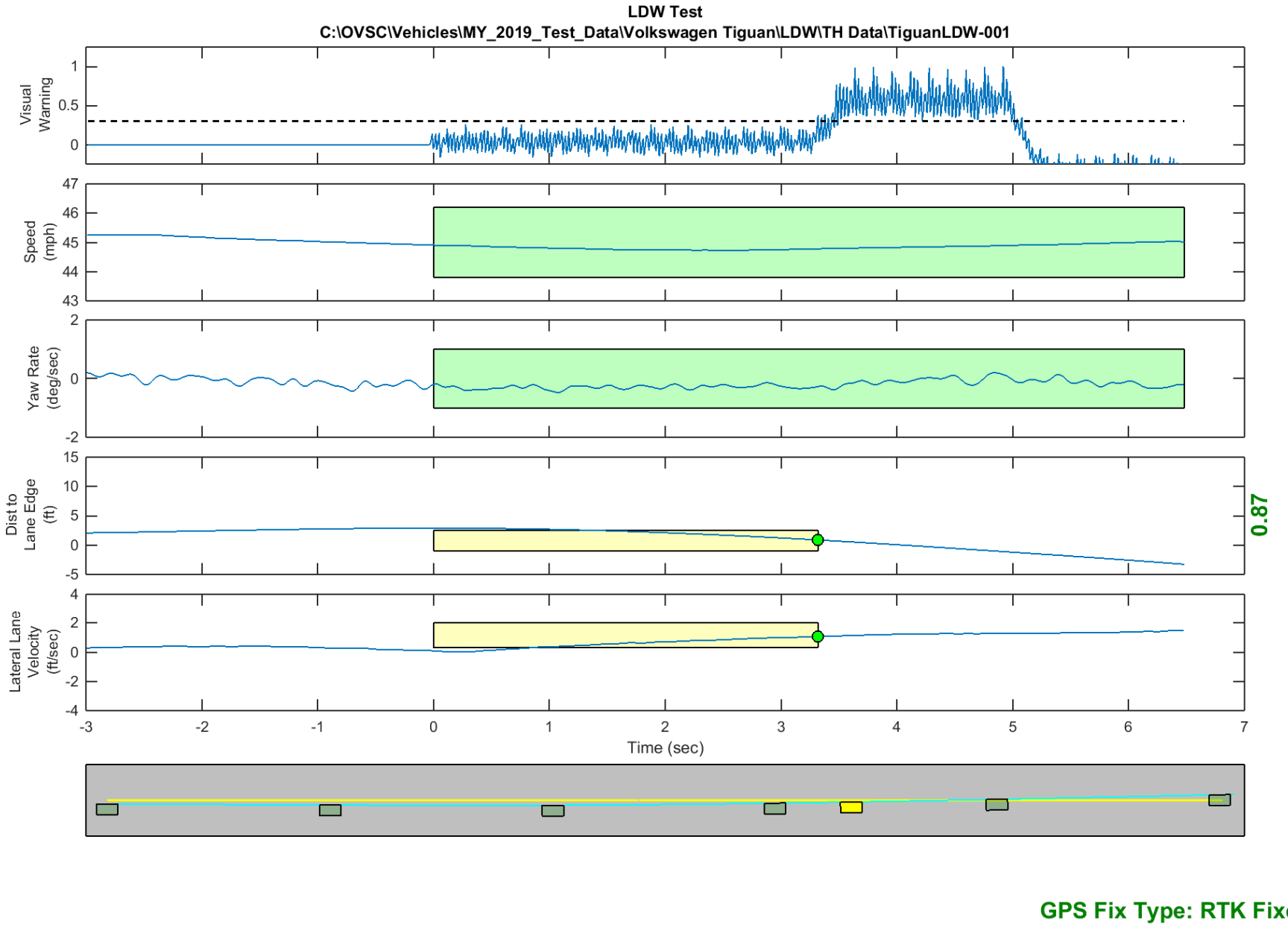

Figure D4. Time History for Run 1, Botts Dots, Left Departure, Visual Warning

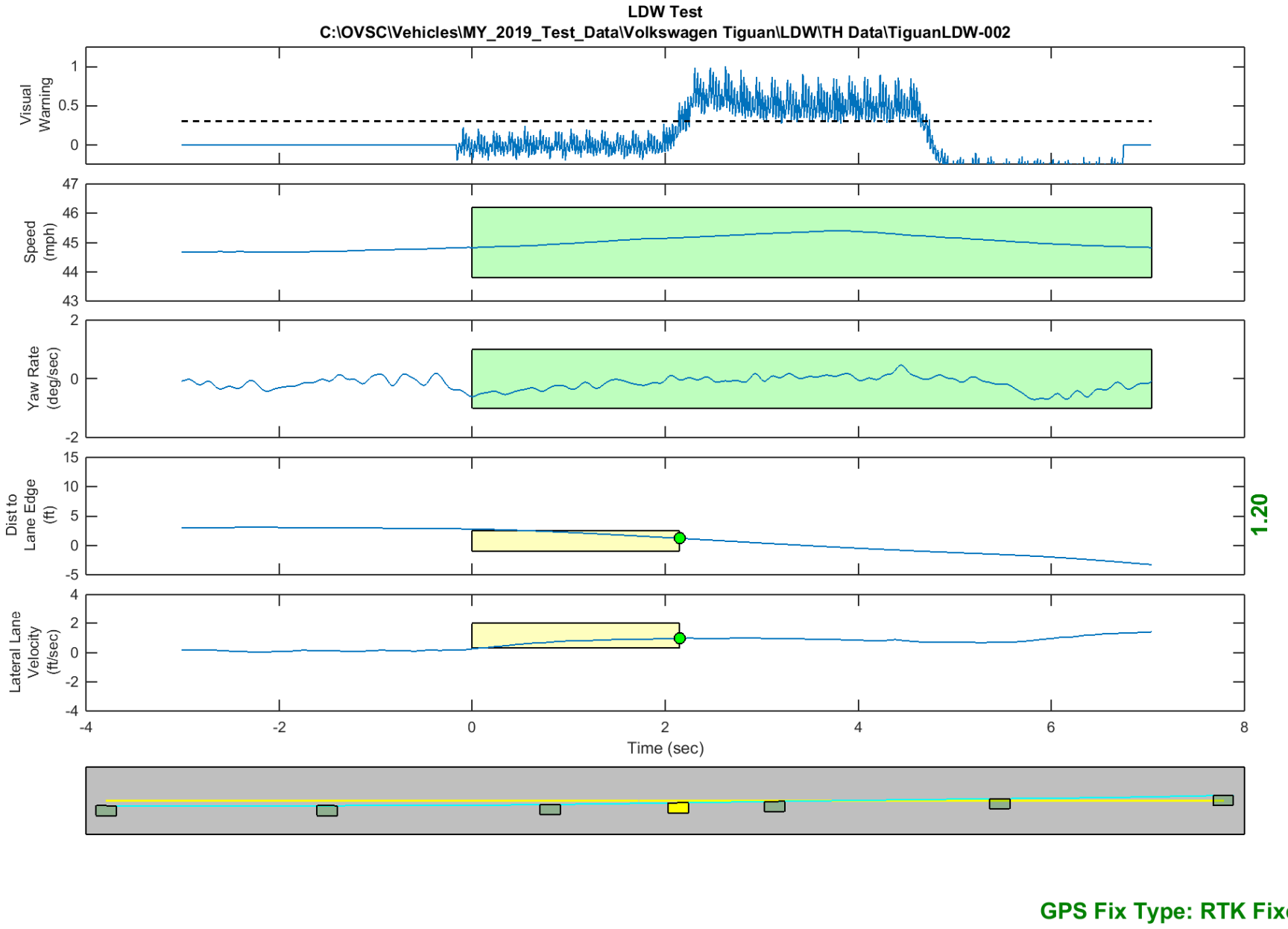

Figure D5. Time History for Run 2, Botts Dots, Left Departure, Visual Warning

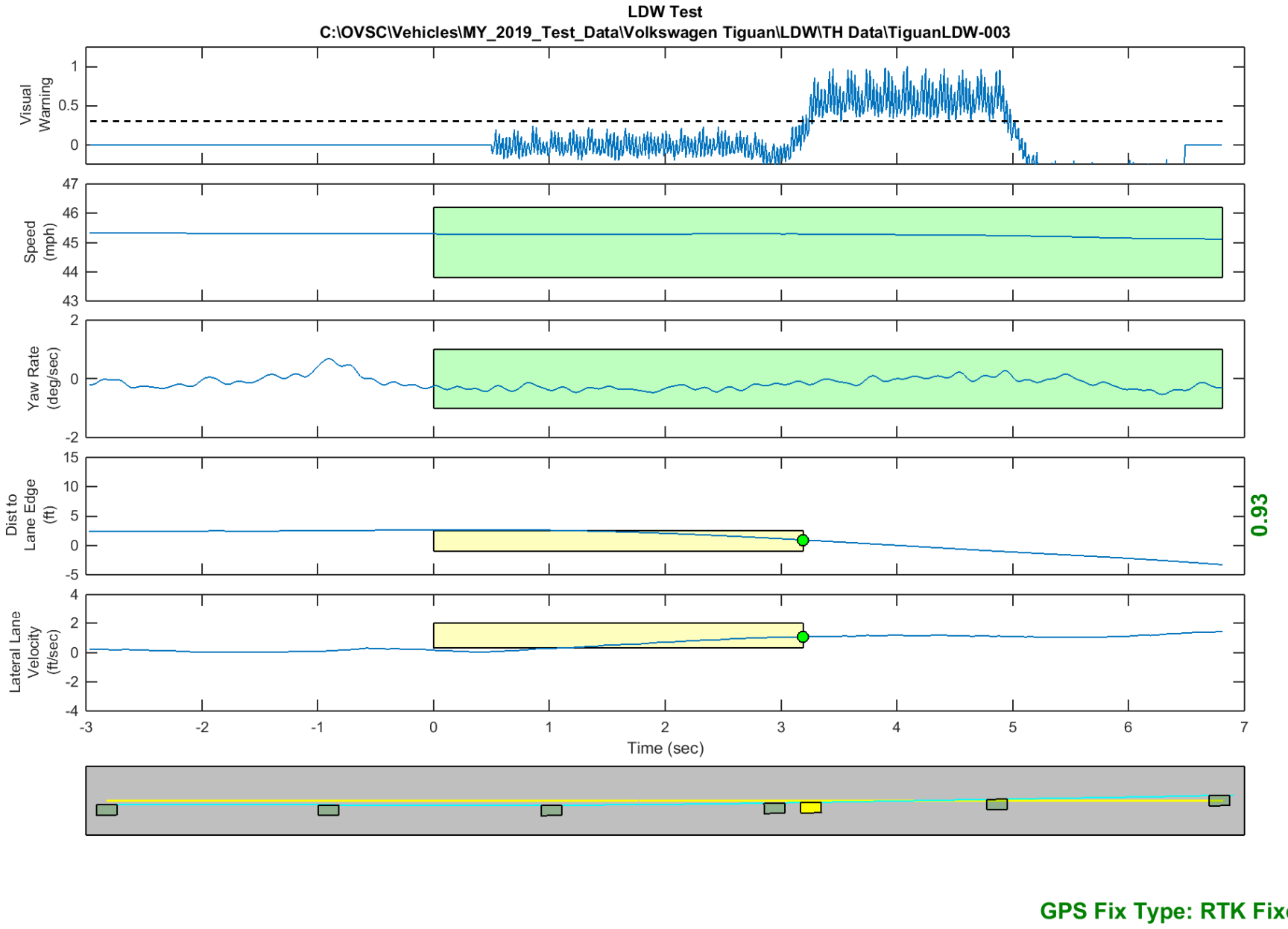

Figure D6. Time History for Run 3, Botts Dots, Left Departure, Visual Warning

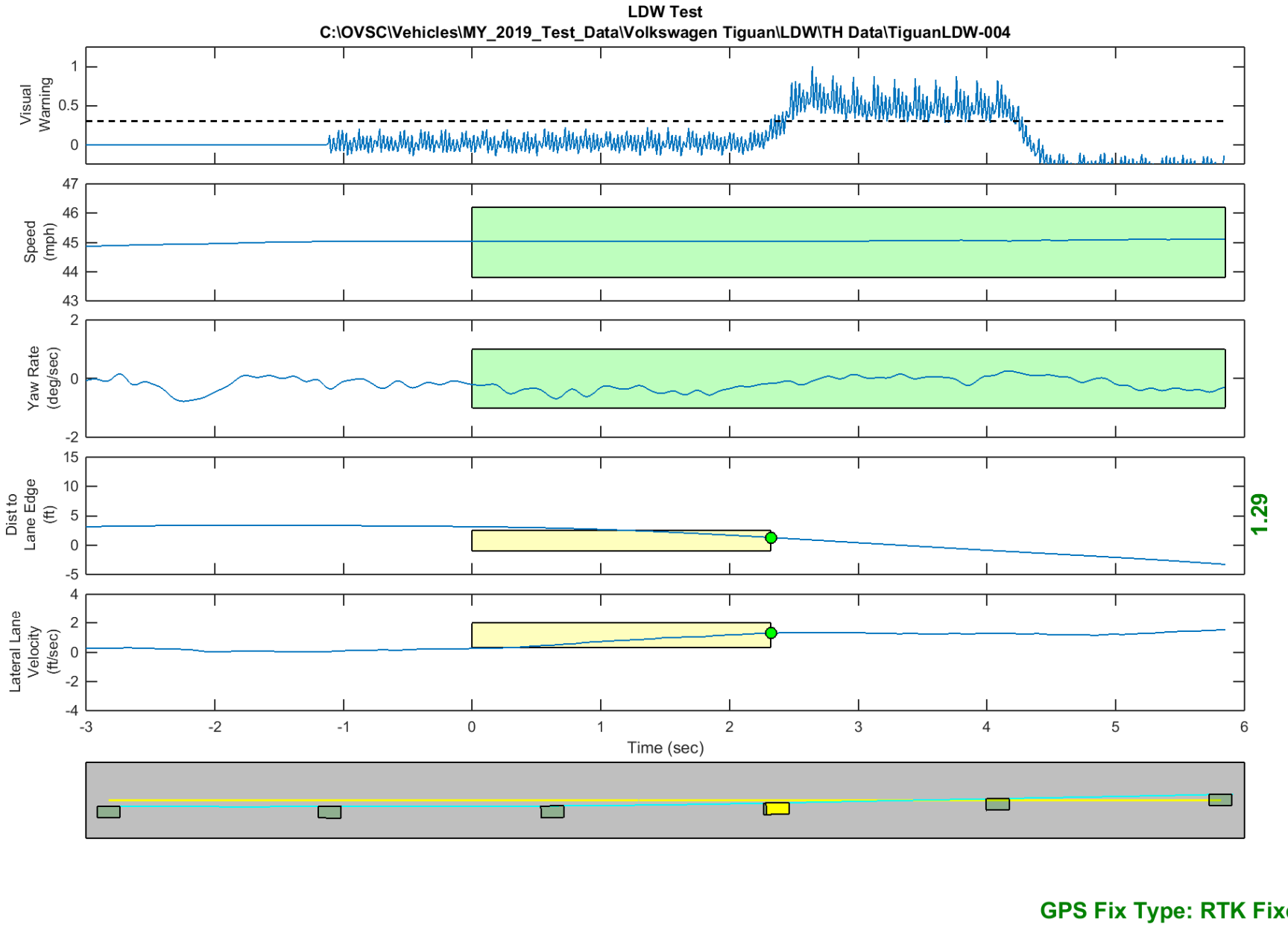

Figure D7. Time History for Run 4, Botts Dots, Left Departure, Visual Warning

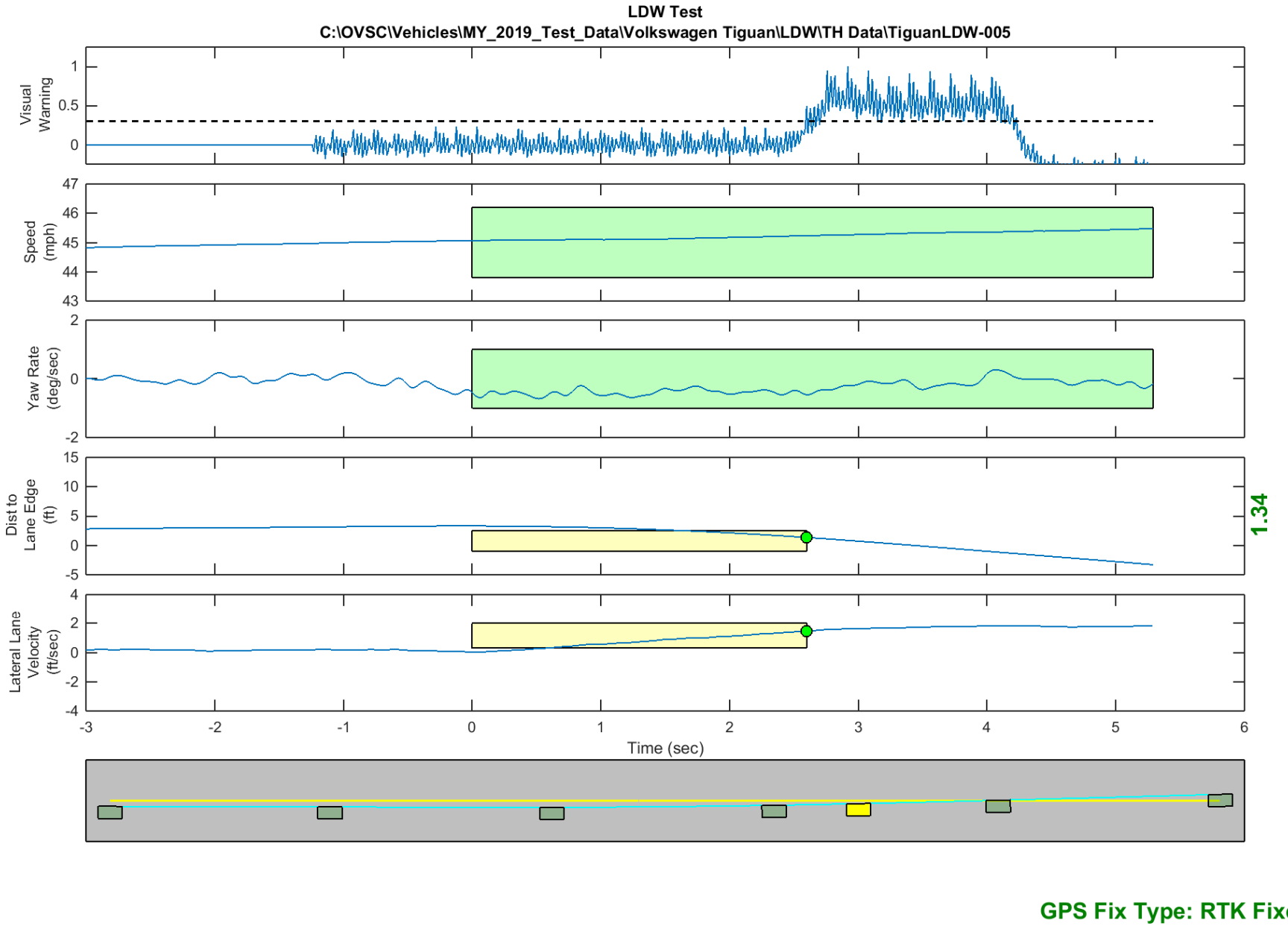

Figure D8. Time History for Run 5, Botts Dots, Left Departure, Visual Warning

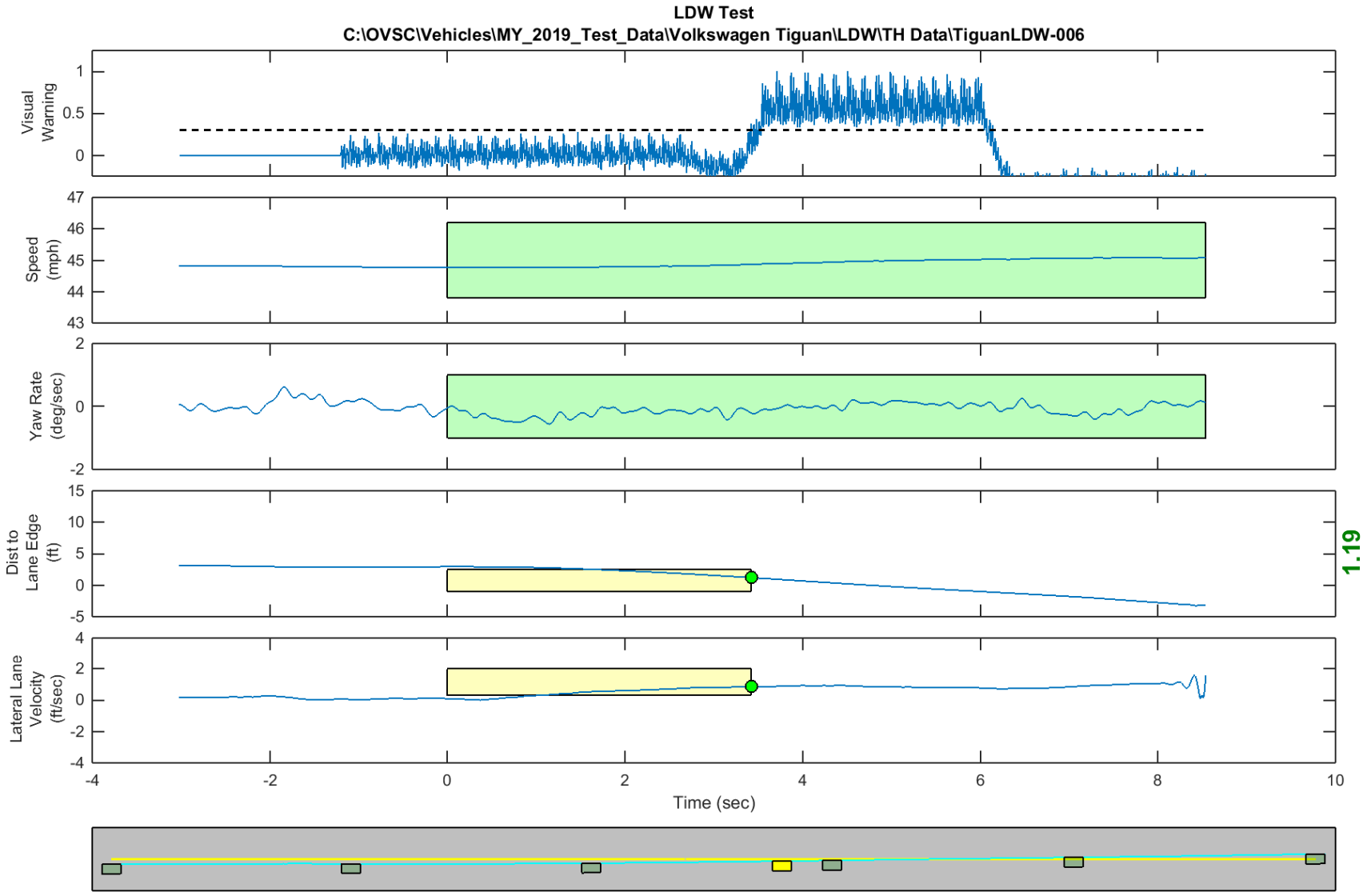

Figure D9. Time History for Run 6, Botts Dots, Left Departure, Visual Warning

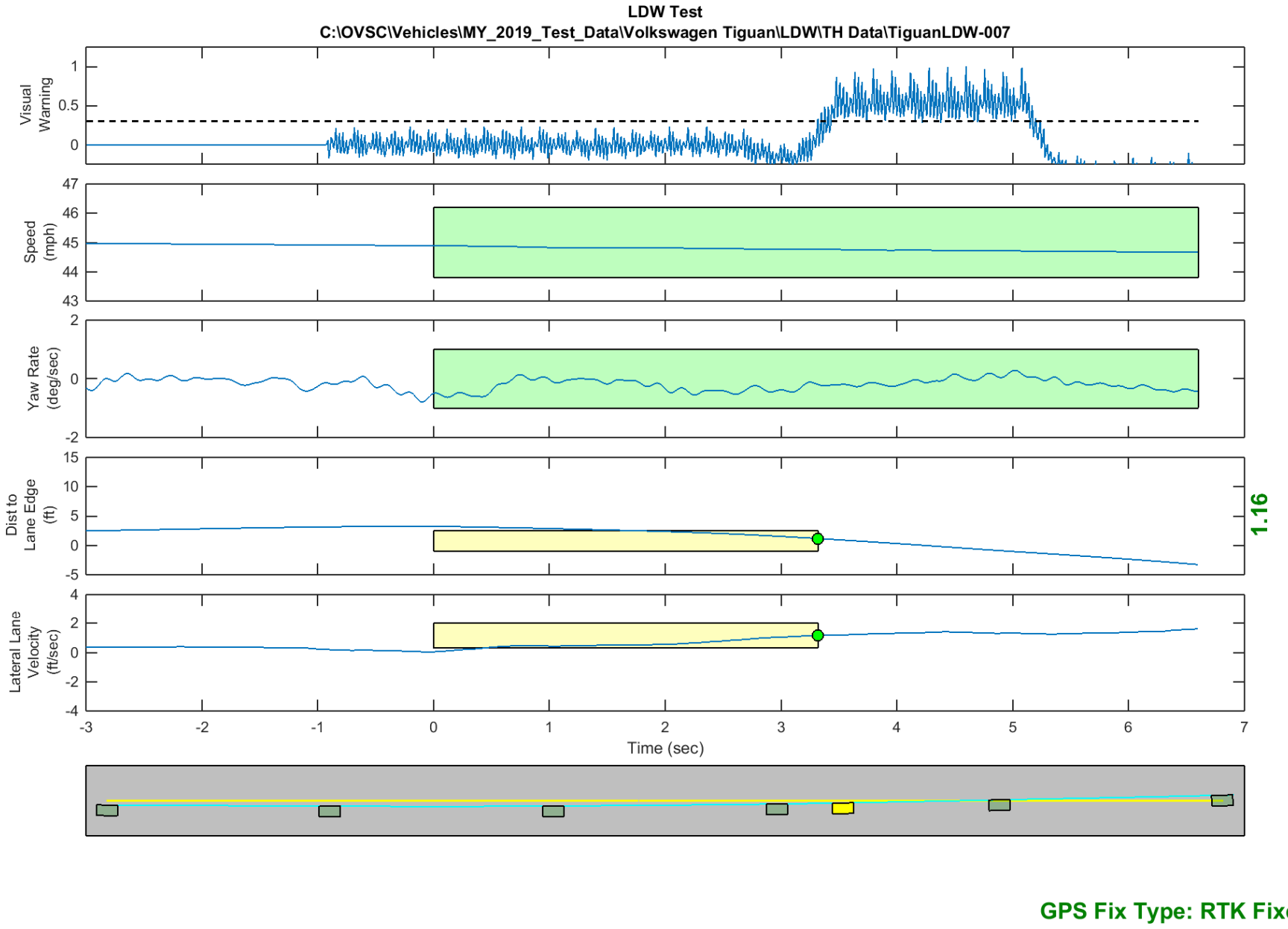

Figure D10. Time History for Run 7, Botts Dots, Left Departure, Visual Warning

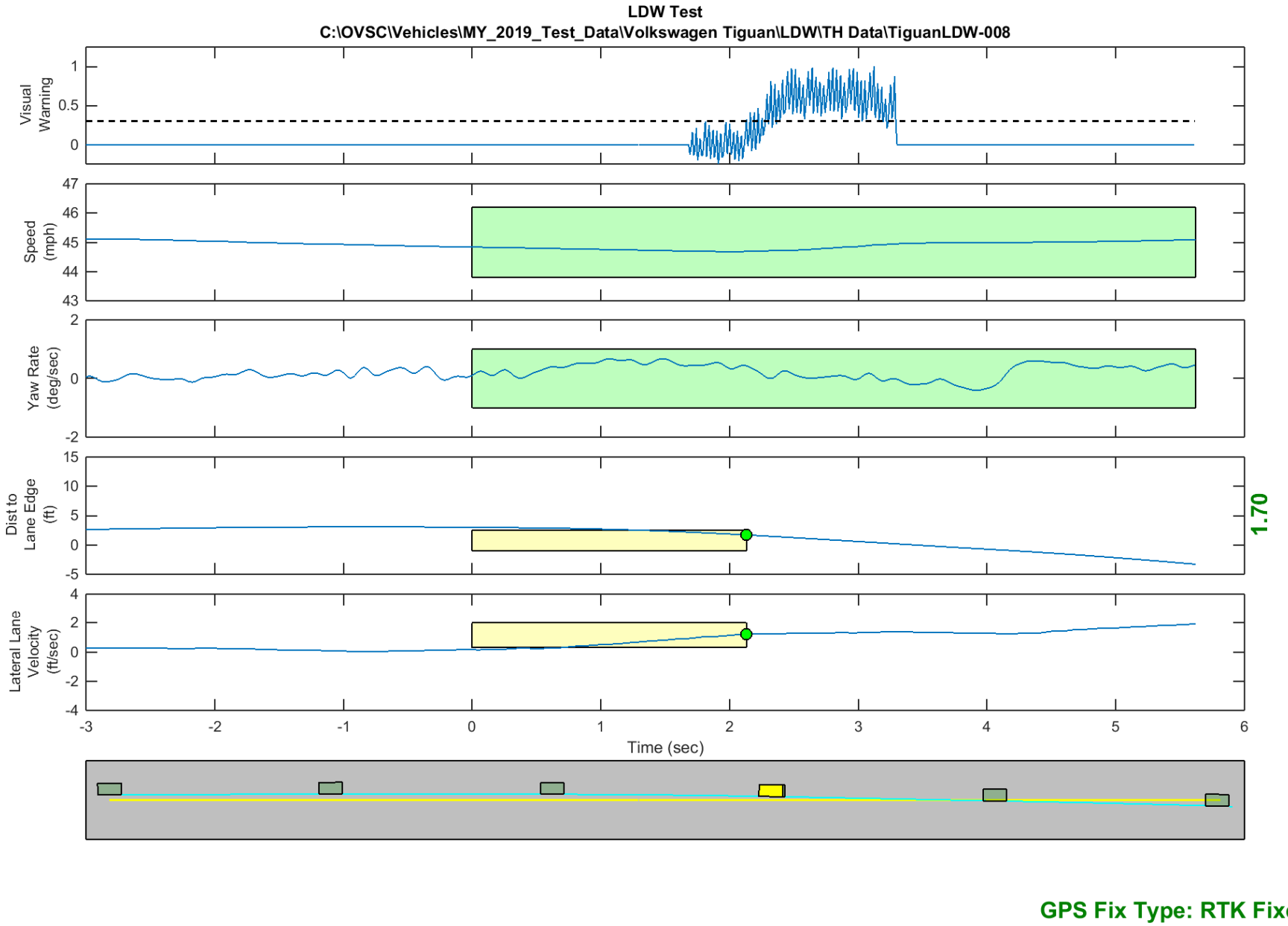

Figure D11. Time History for Run 8, Botts Dots, Right Departure, Visual Warning

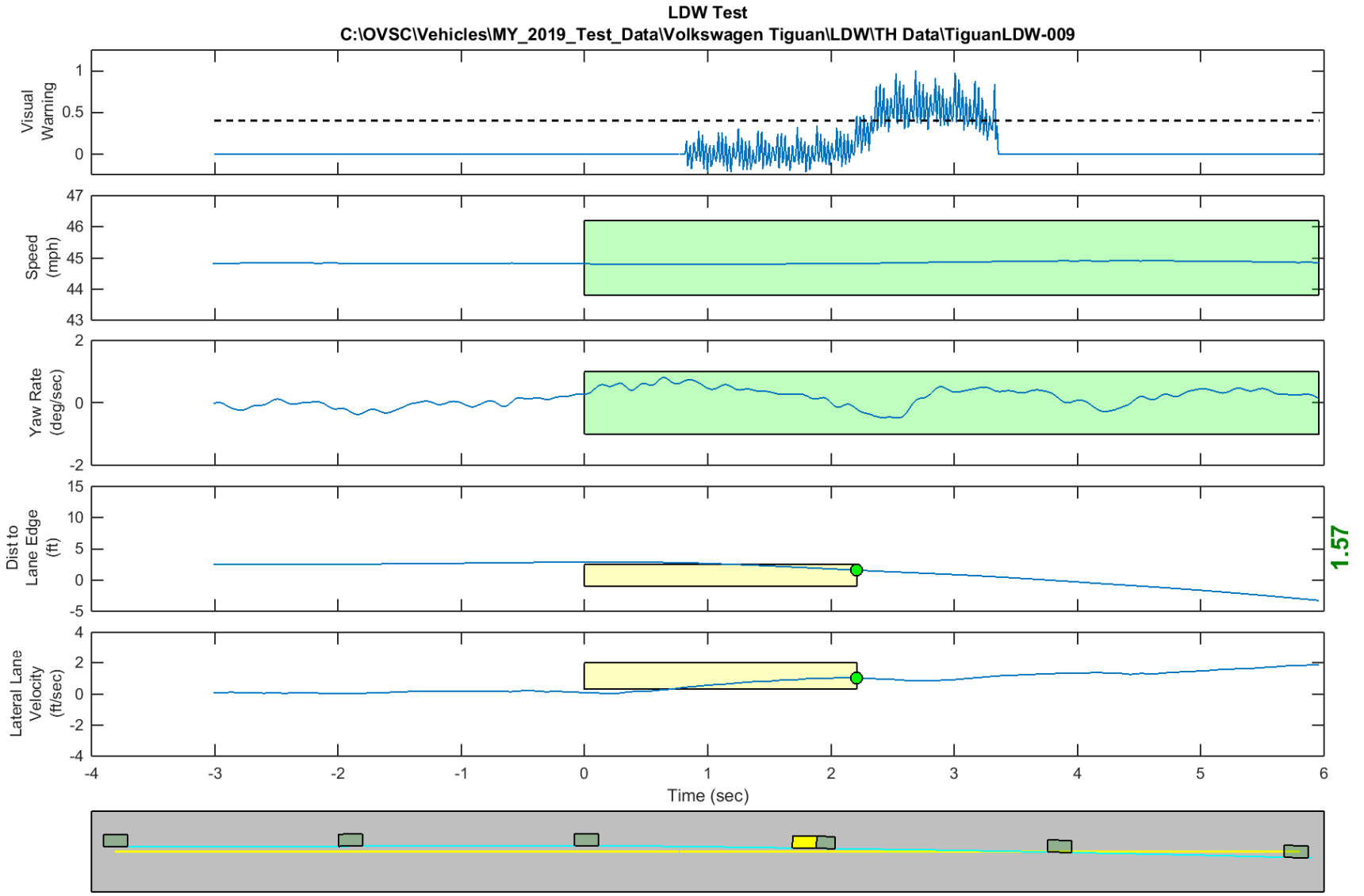

Figure D12. Time History for Run 9, Botts Dots, Right Departure, Visual Warning

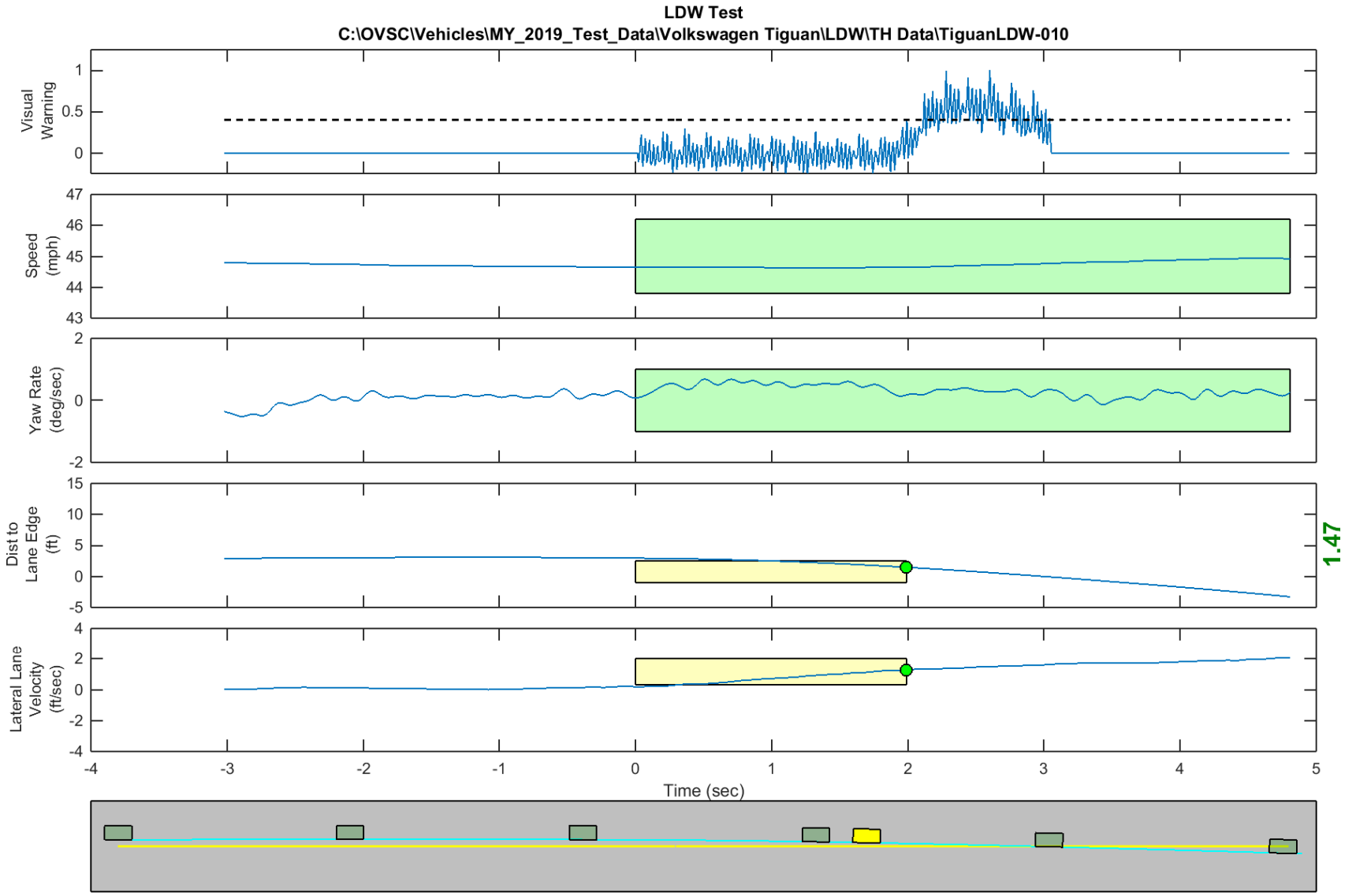

Figure D13. Time History for Run 10, Botts Dots, Right Departure, Visual Warning

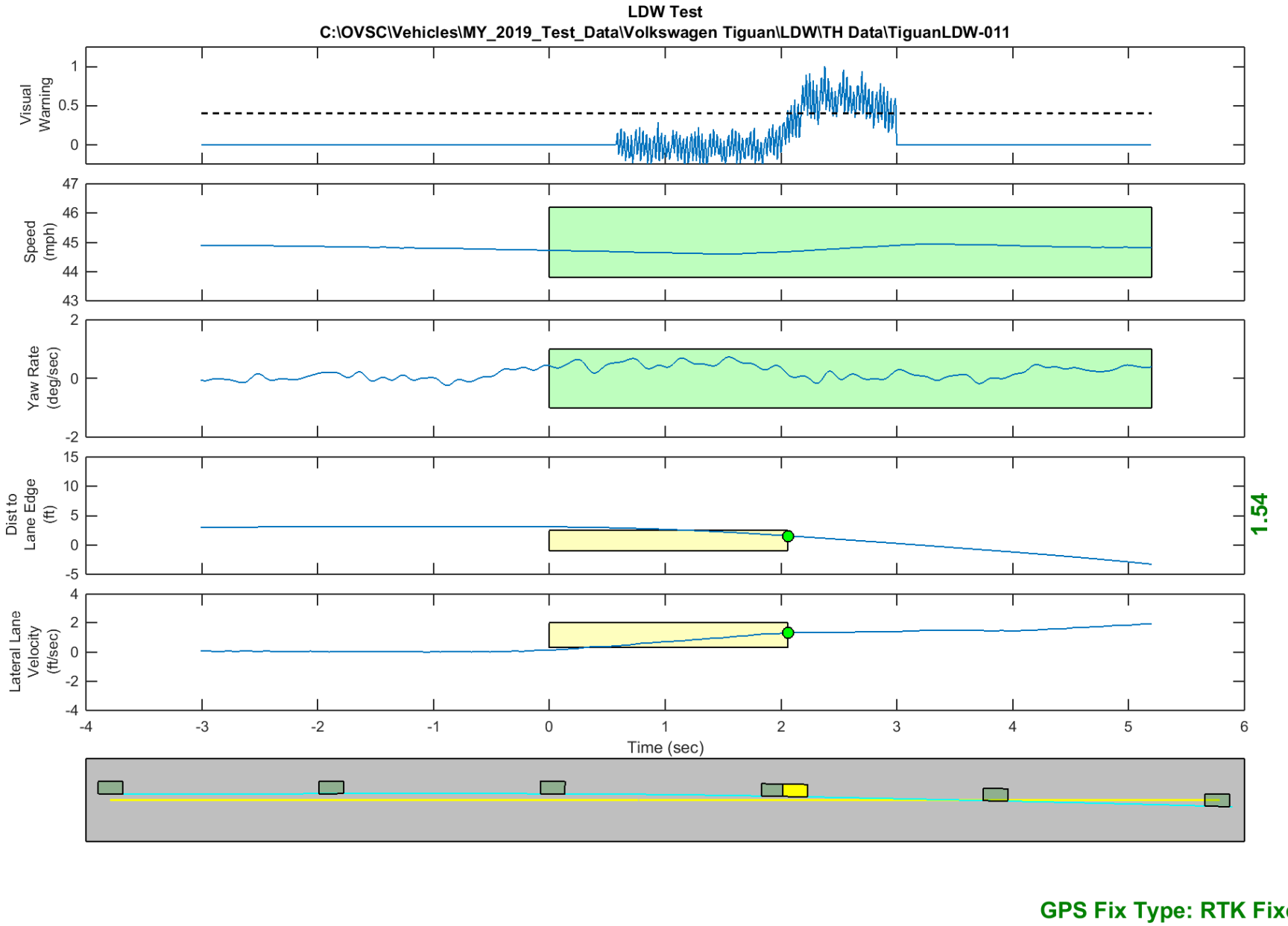

Figure D14. Time History for Run 11, Botts Dots, Right Departure, Visual Warning

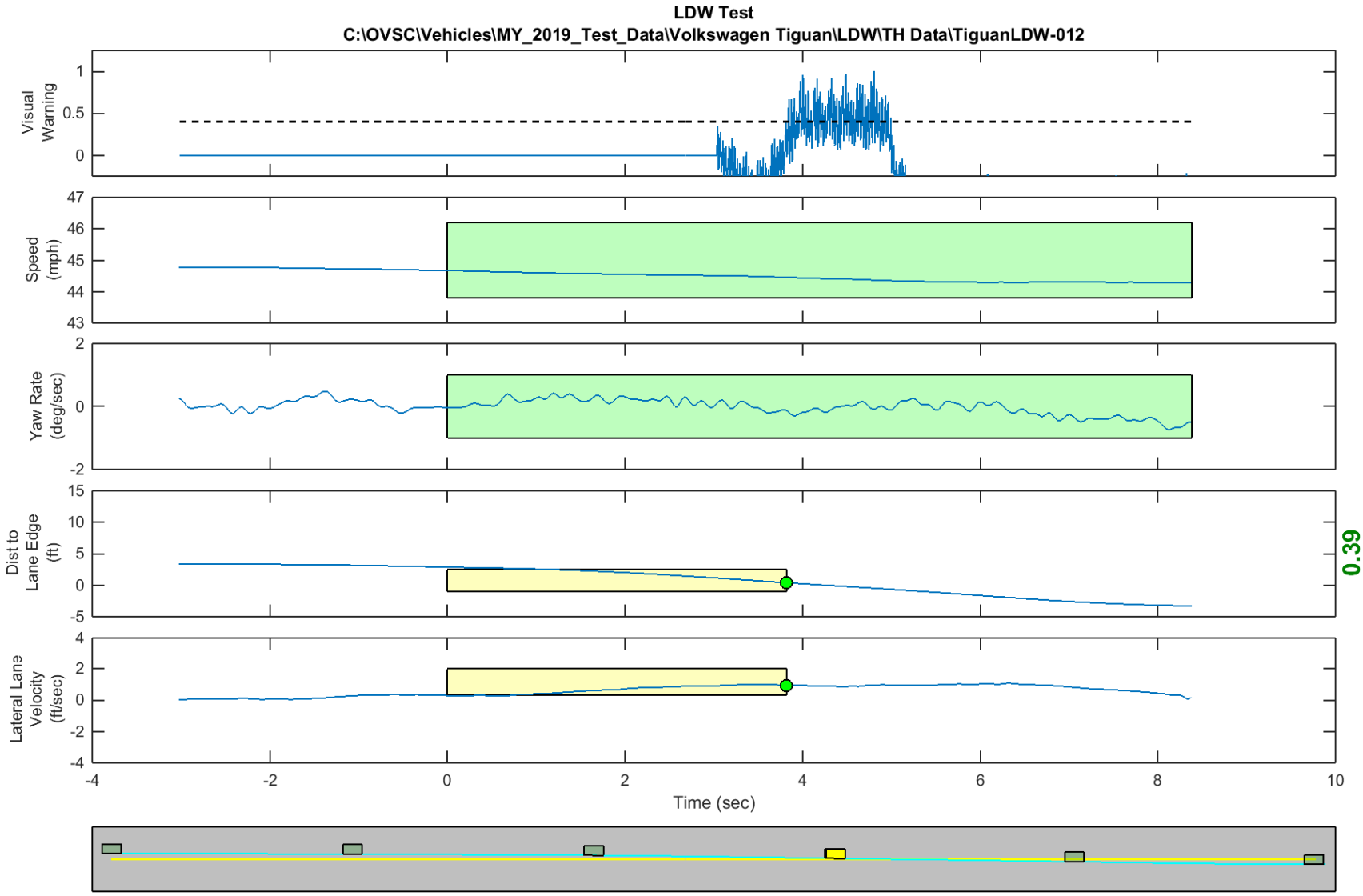

Figure D15. Time History for Run 12, Botts Dots, Right Departure, Visual Warning

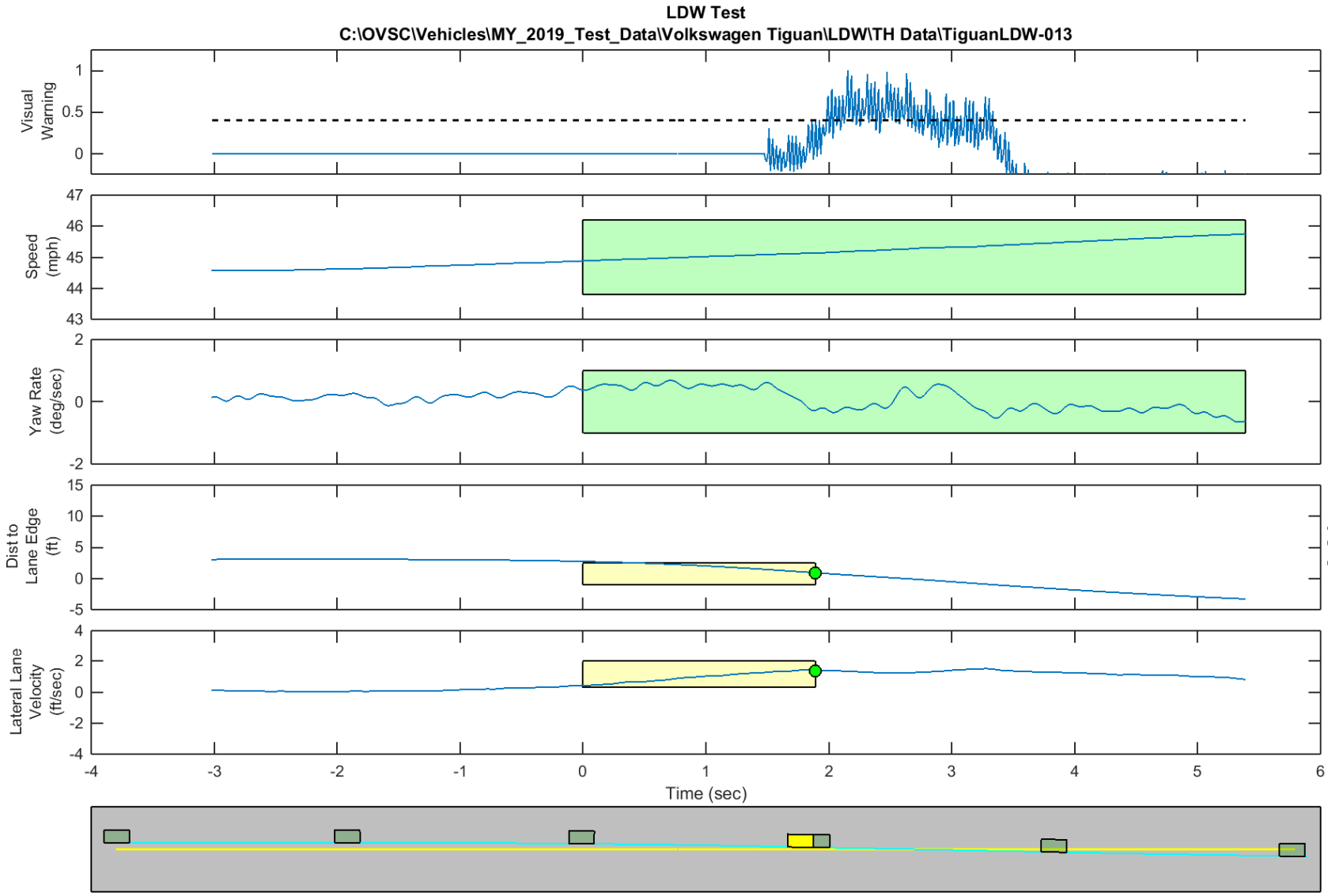

Figure D16. Time History for Run 13, Botts Dots, Right Departure, Visual Warning

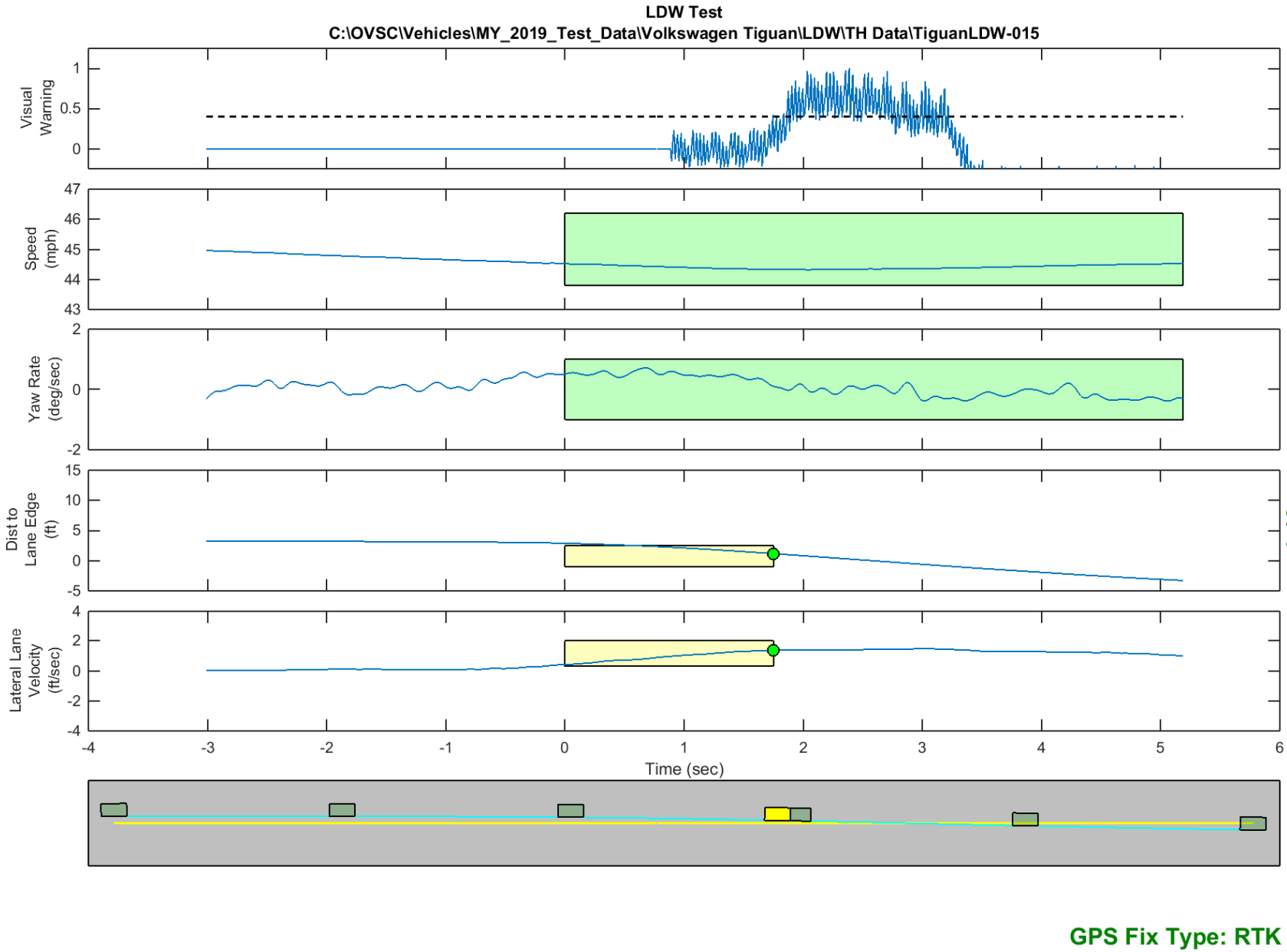

Figure D17. Time History for Run 15, Botts Dots, Right Departure, Visual Warning

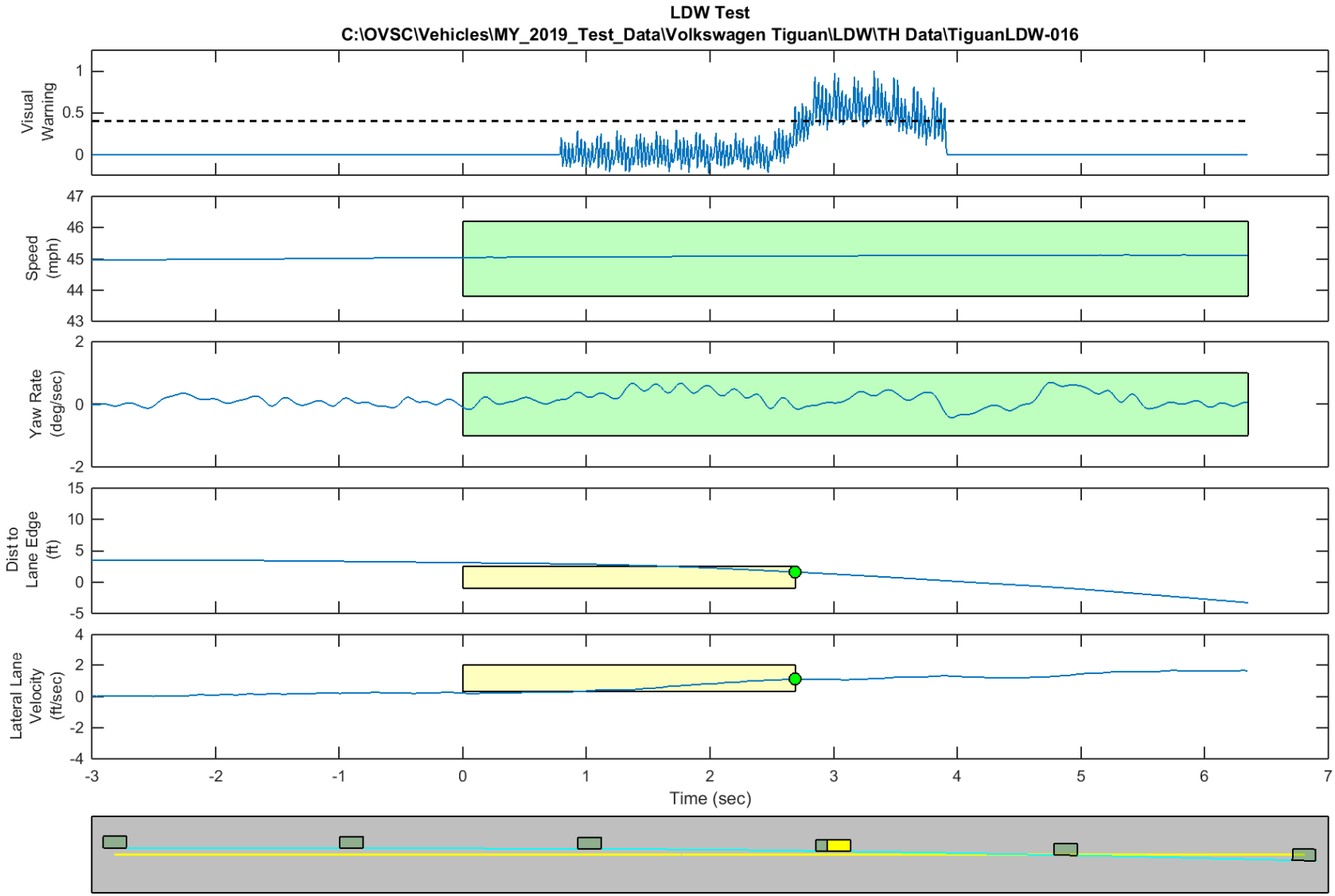

Figure D18. Time History for Run 16, Solid Line, Right Departure, Visual Warning

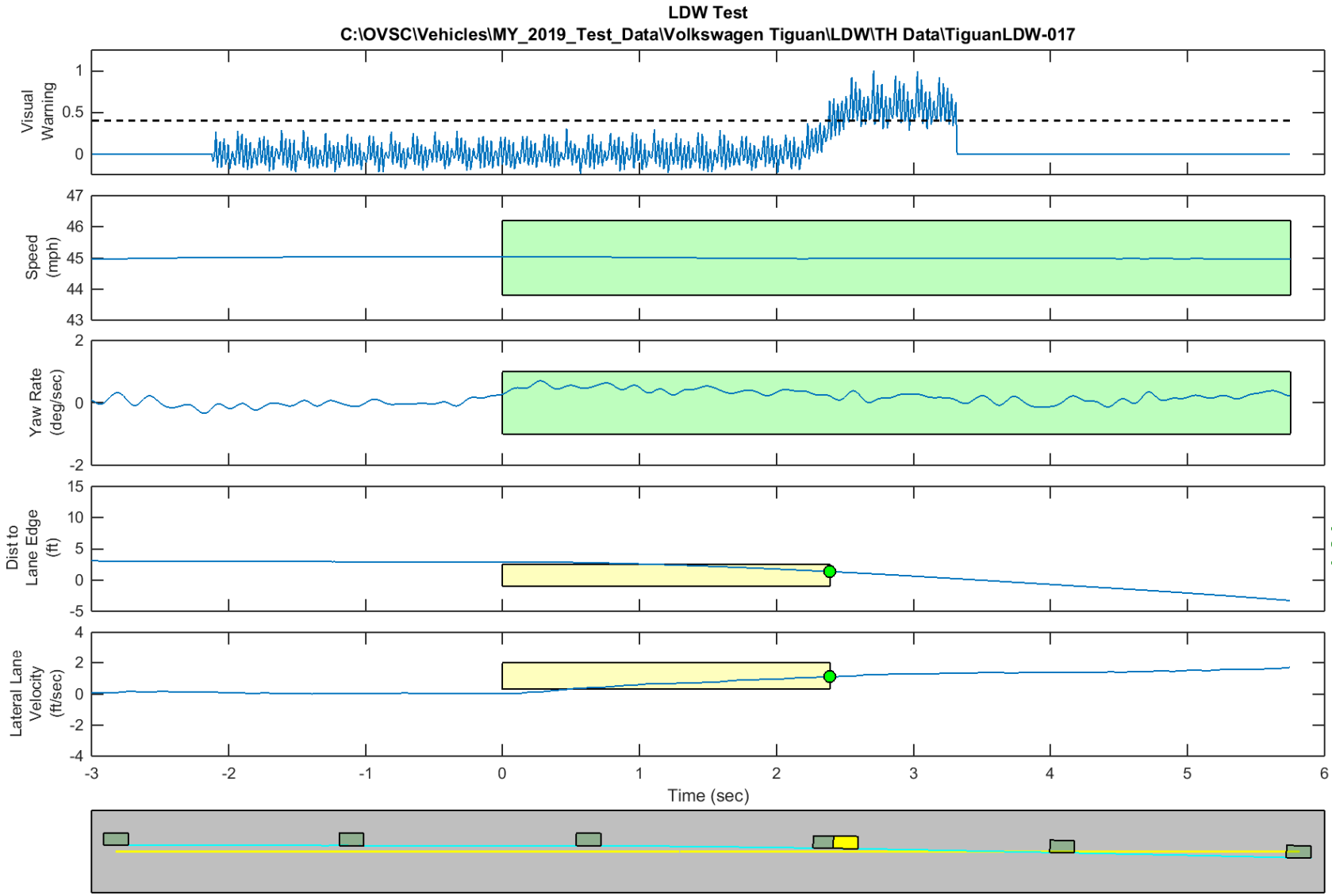

Figure D19. Time History for Run 17, Solid Line, Right Departure, Visual Warning

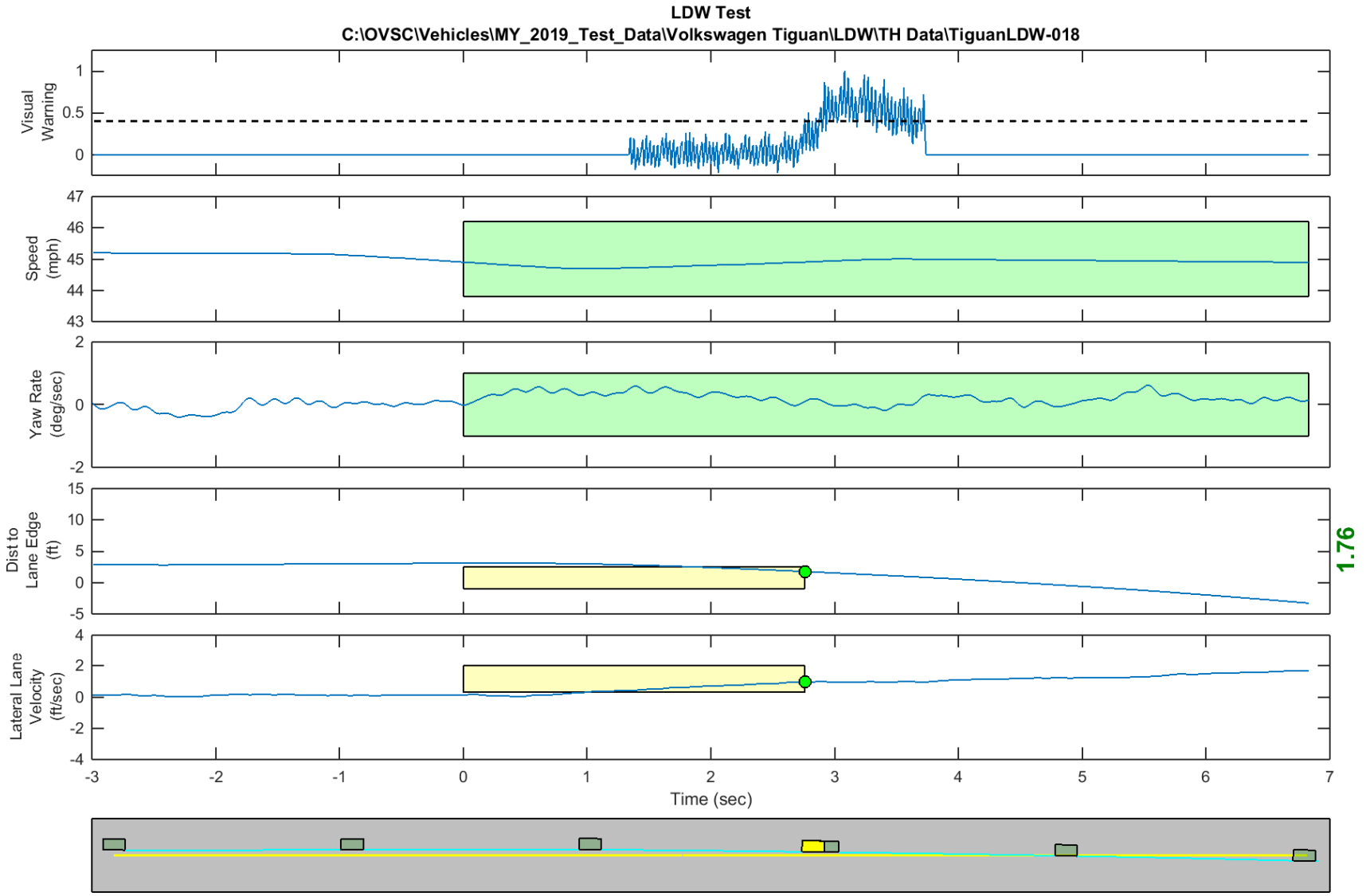

Figure D20. Time History for Run 18, Solid Line, Right Departure, Visual Warning

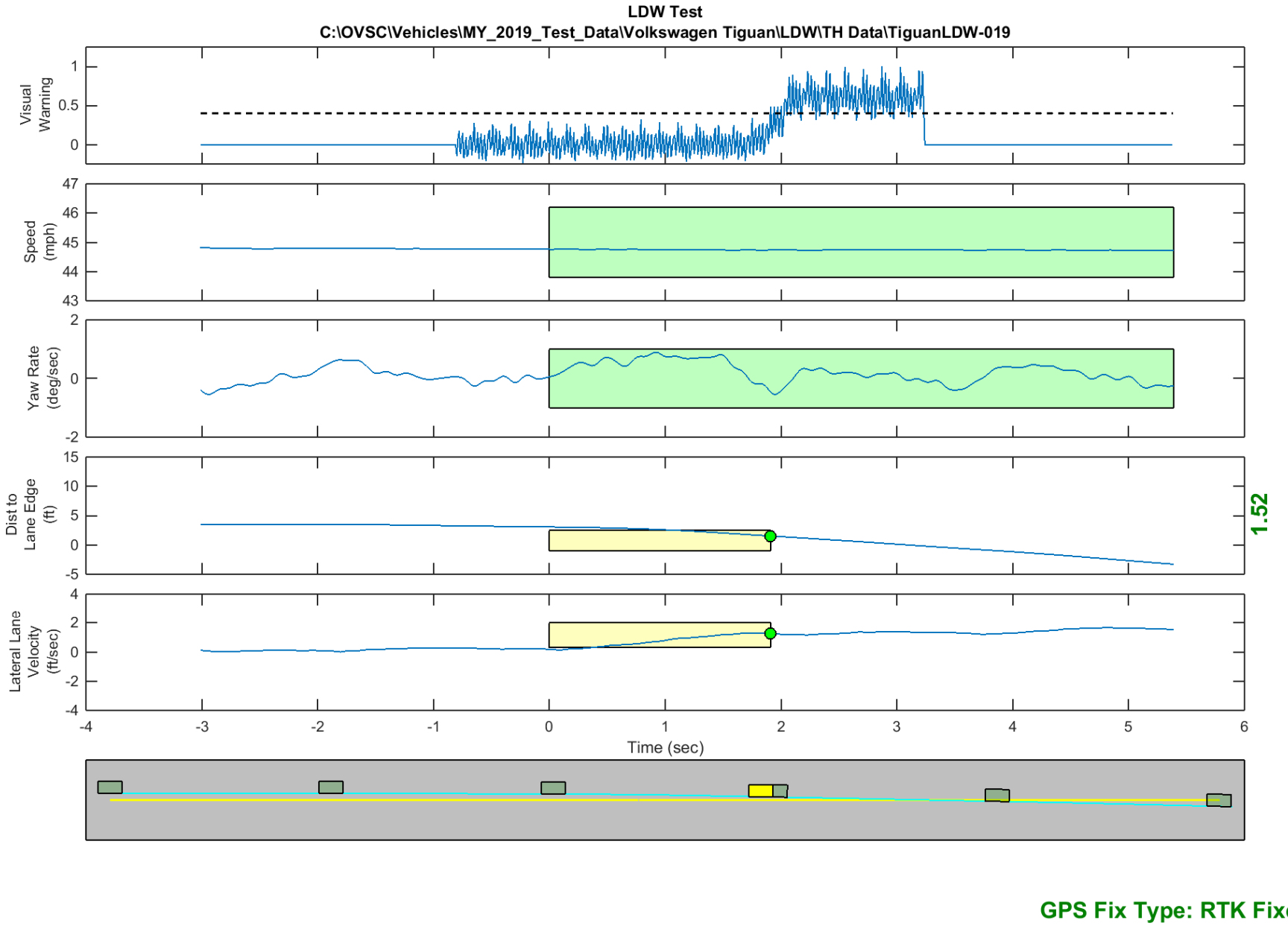

Figure D21. Time History for Run 19, Solid Line, Right Departure, Visual Warning

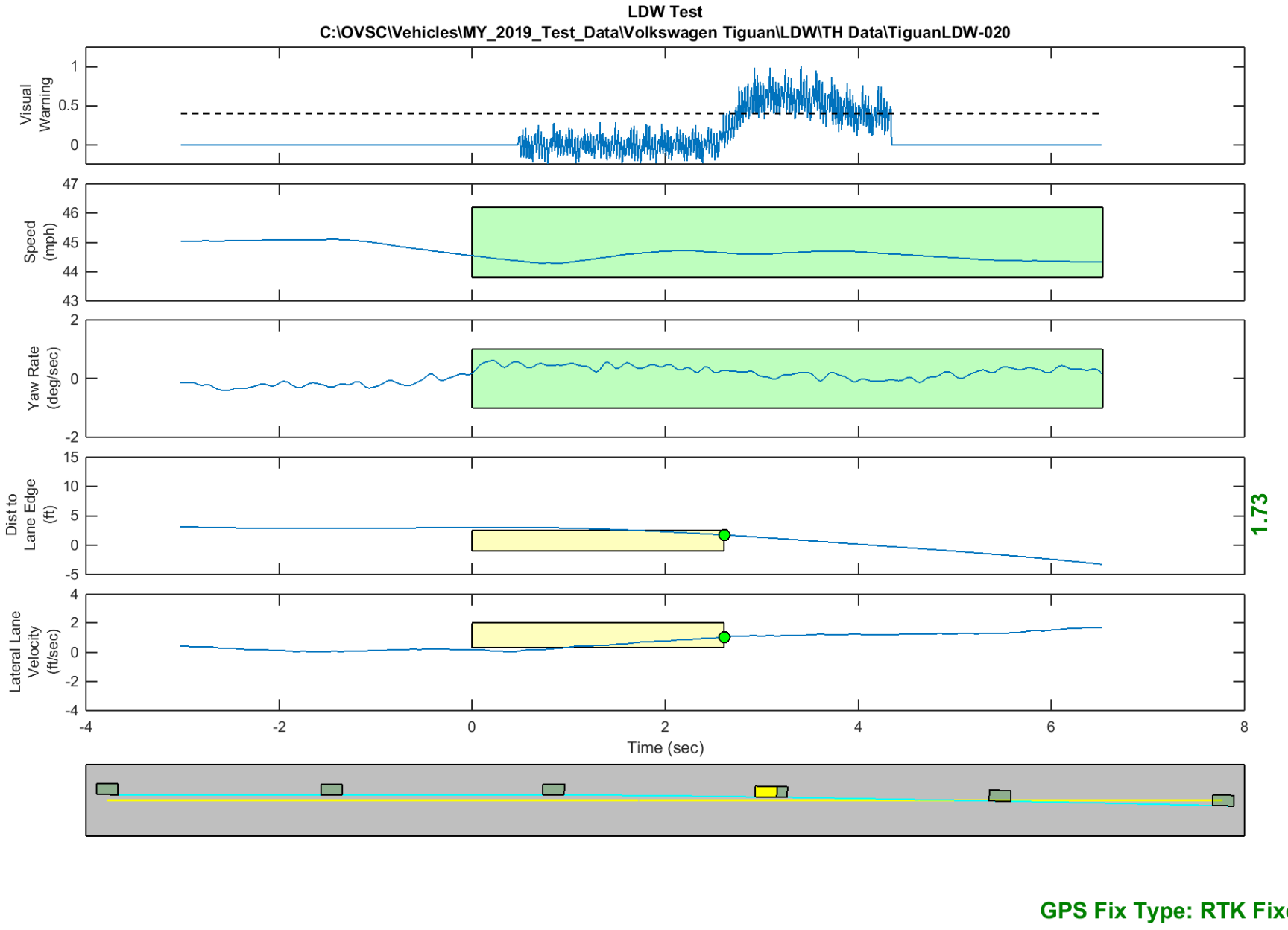

Figure D22. Time History for Run 20, Solid Line, Right Departure, Visual Warning

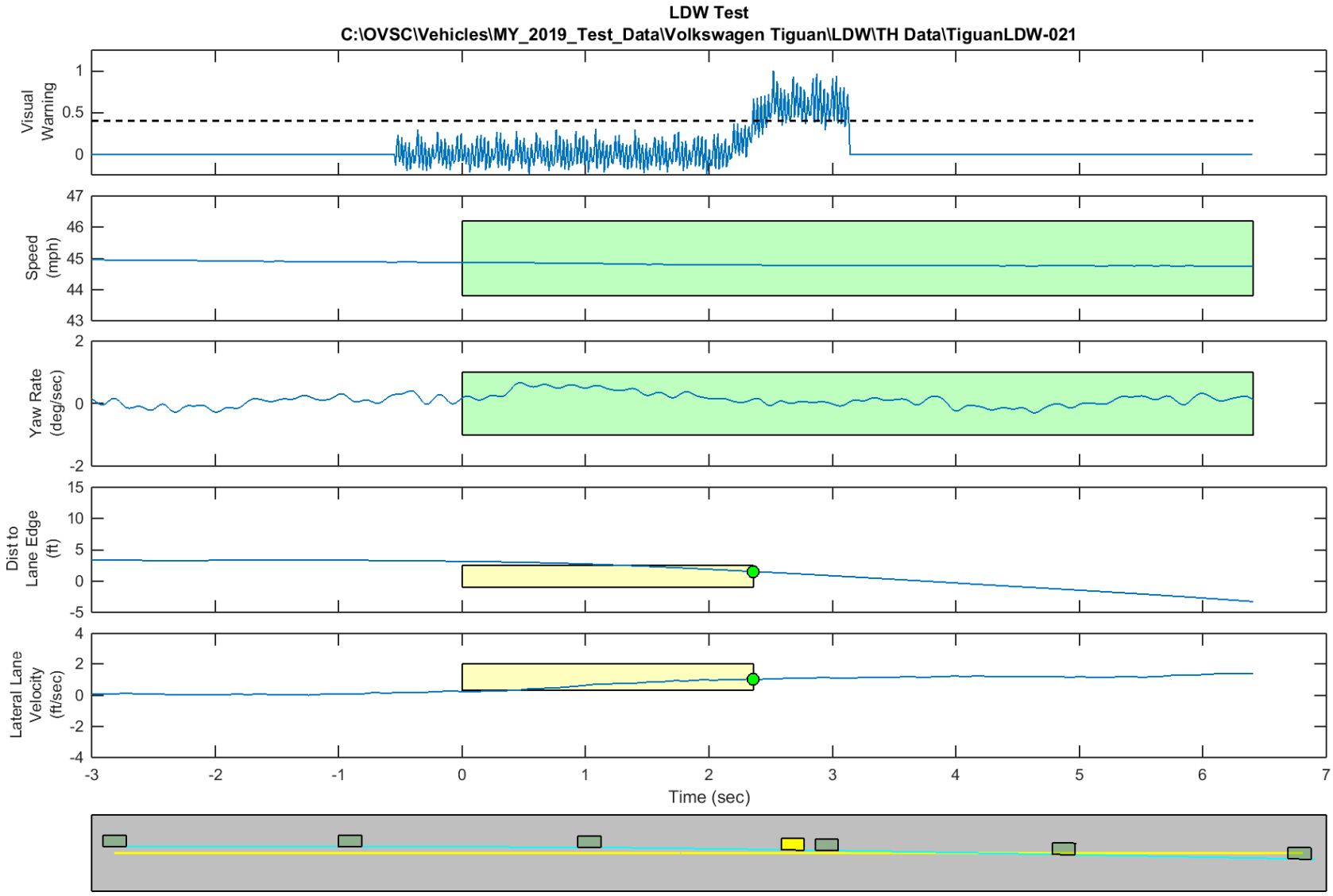

Figure D23. Time History for Run 21, Solid Line, Right Departure, Visual Warning

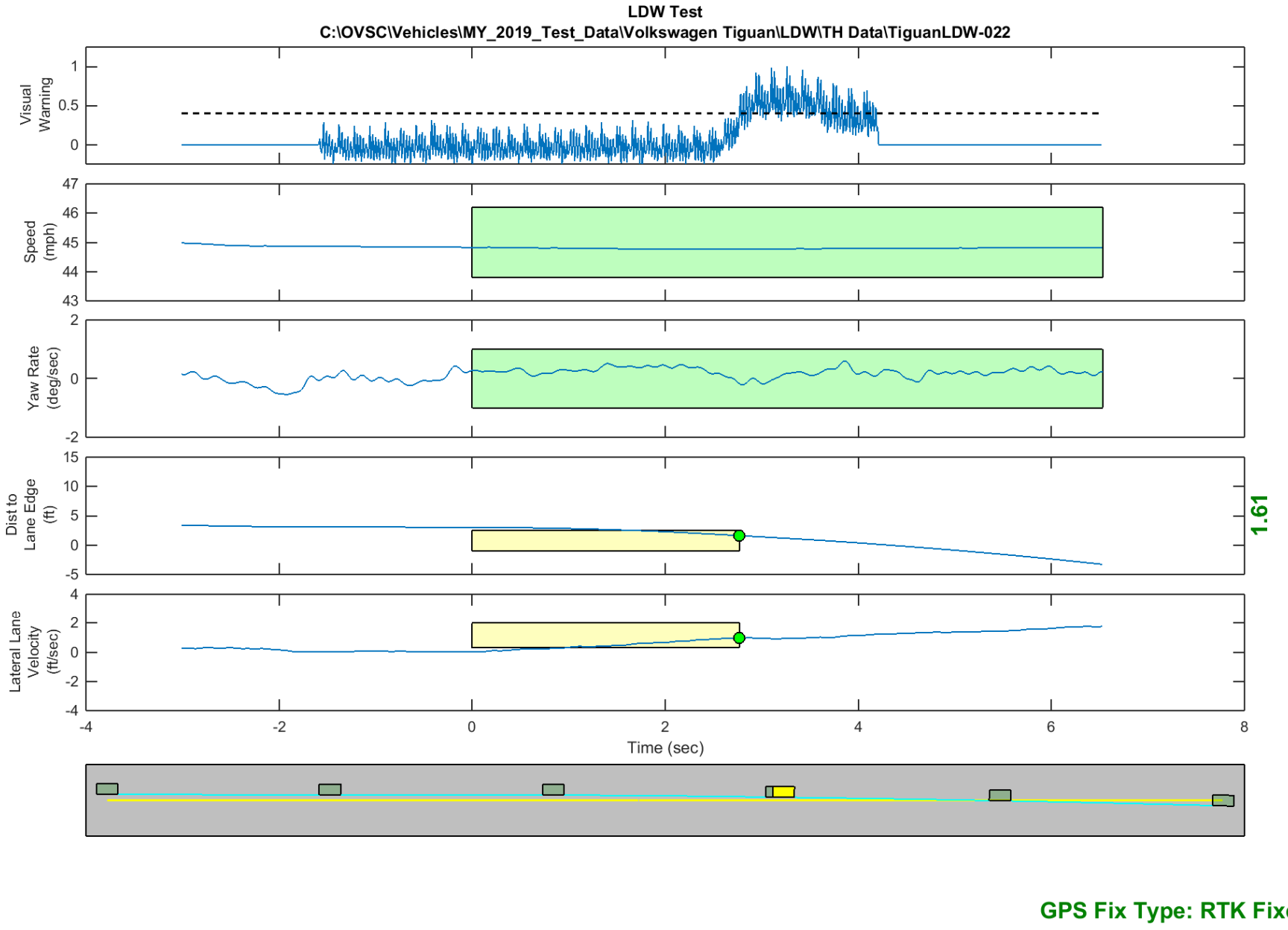

Figure D24. Time History for Run 22, Solid Line, Right Departure, Visual Warning

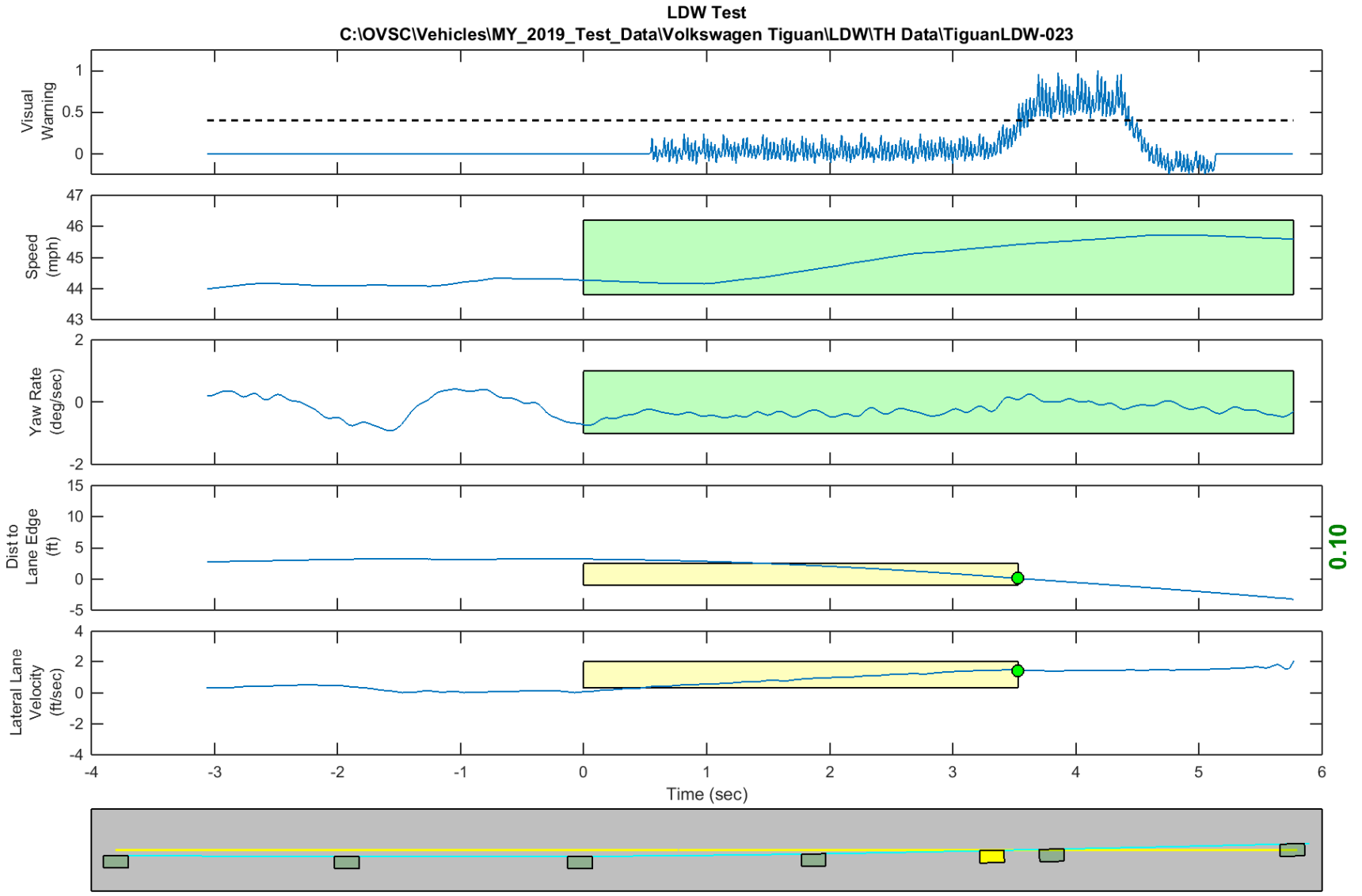

Figure D25. Time History for Run 23, Solid Line, Left Departure, Visual Warning

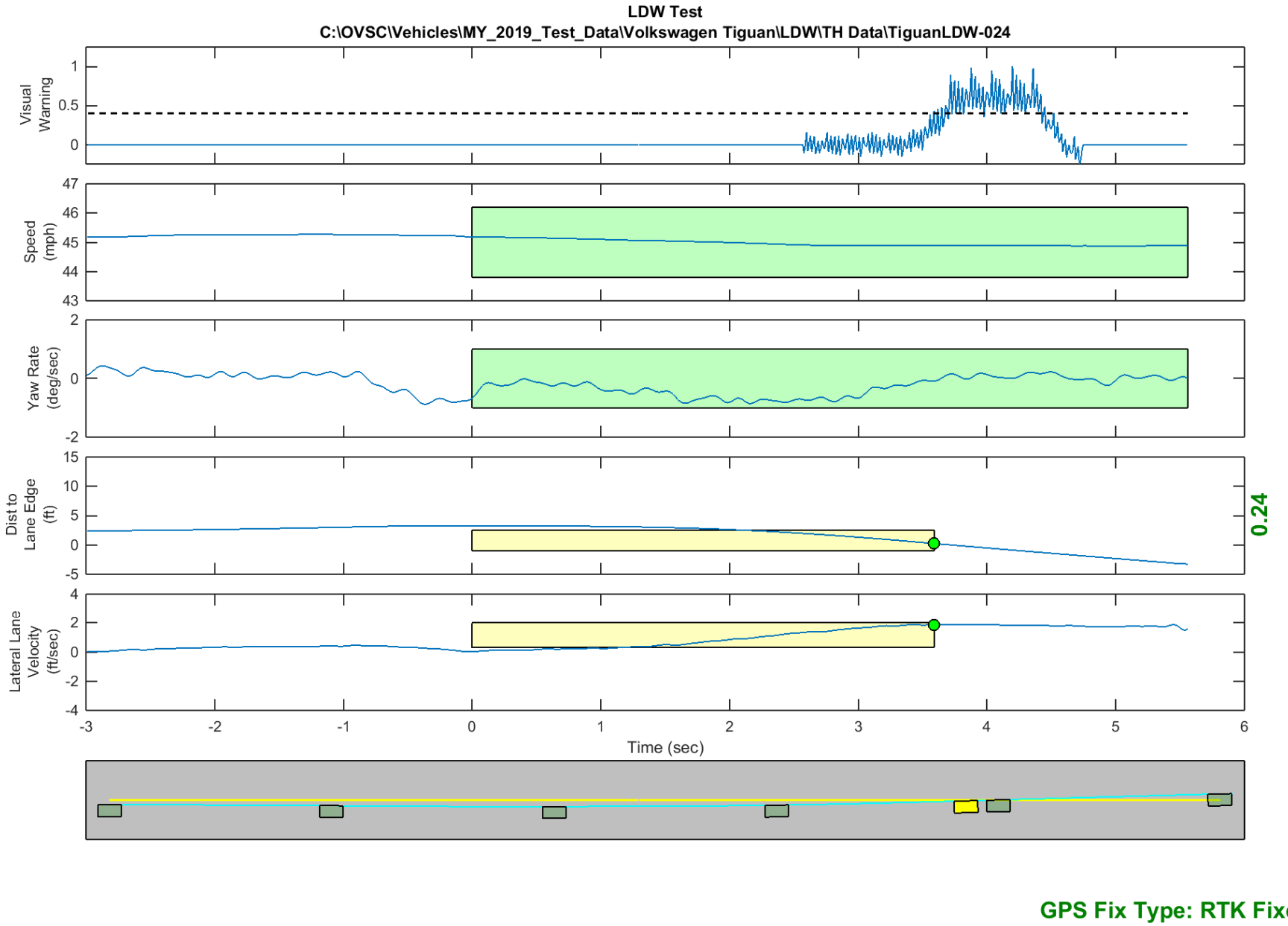

Figure D26. Time History for Run 24, Solid Line, Left Departure, Visual Warning

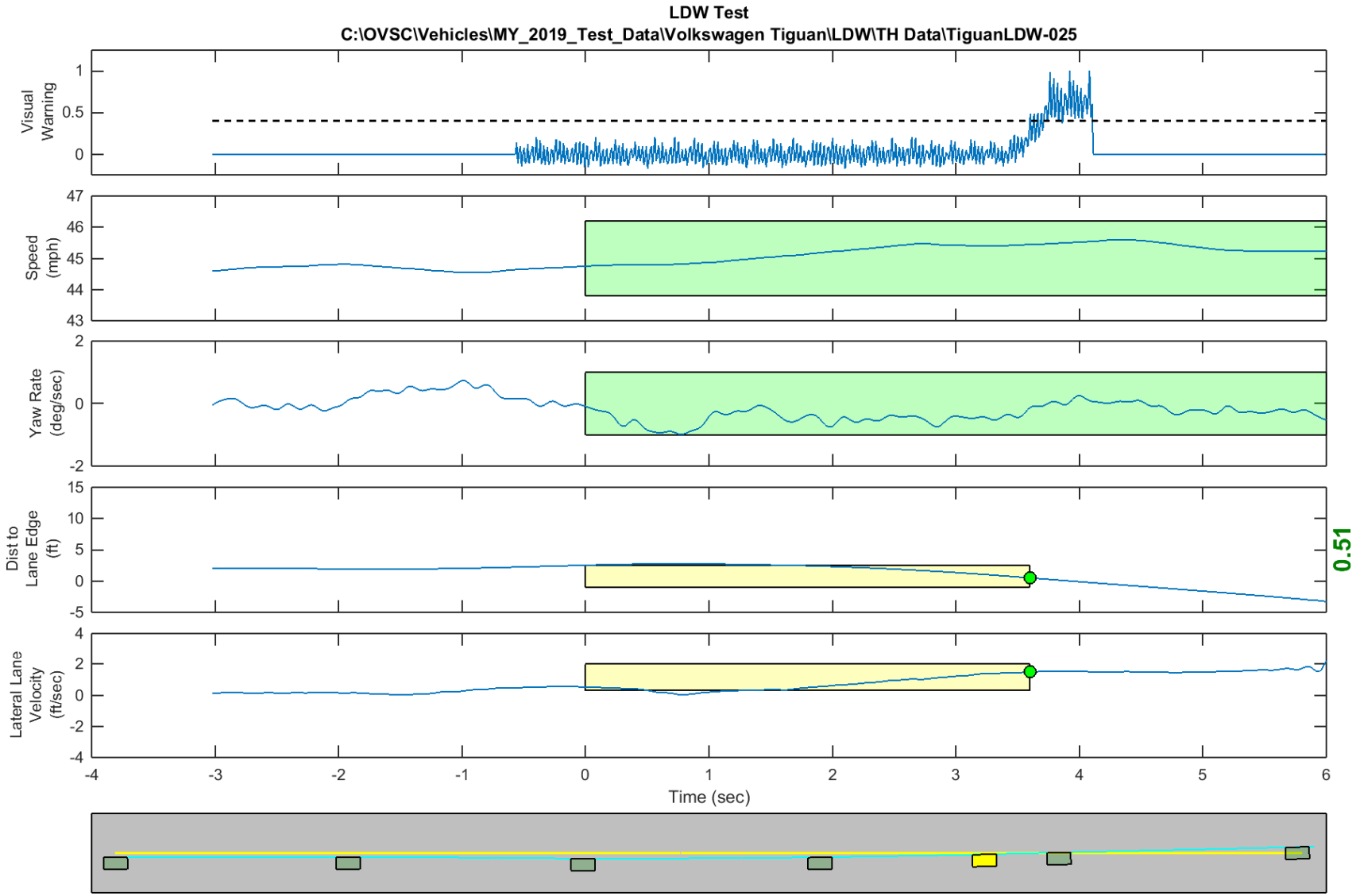

Figure D27. Time History for Run 25, Solid Line, Left Departure, Visual Warning

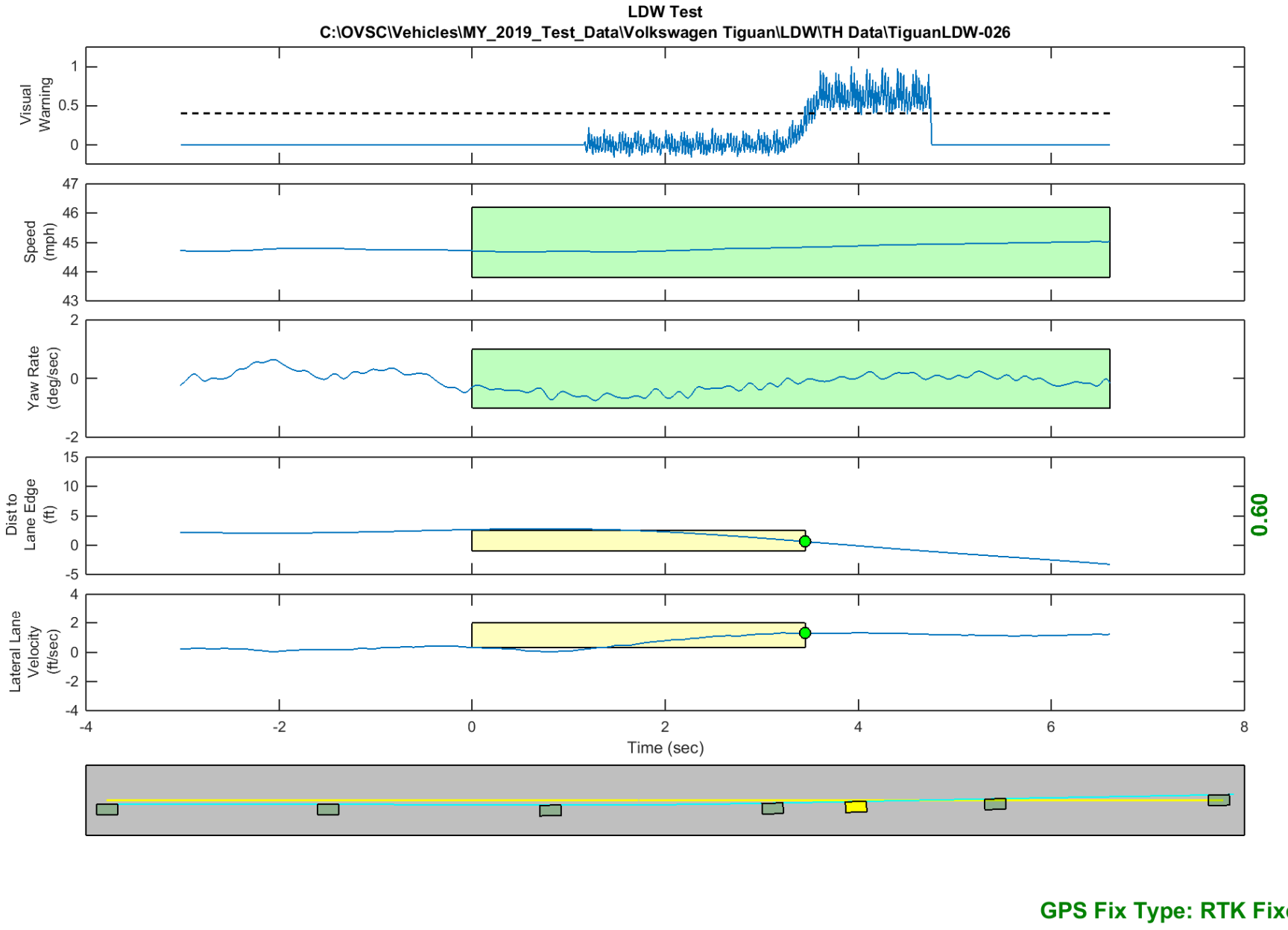

Figure D28. Time History for Run 26, Solid Line, Left Departure, Visual Warning

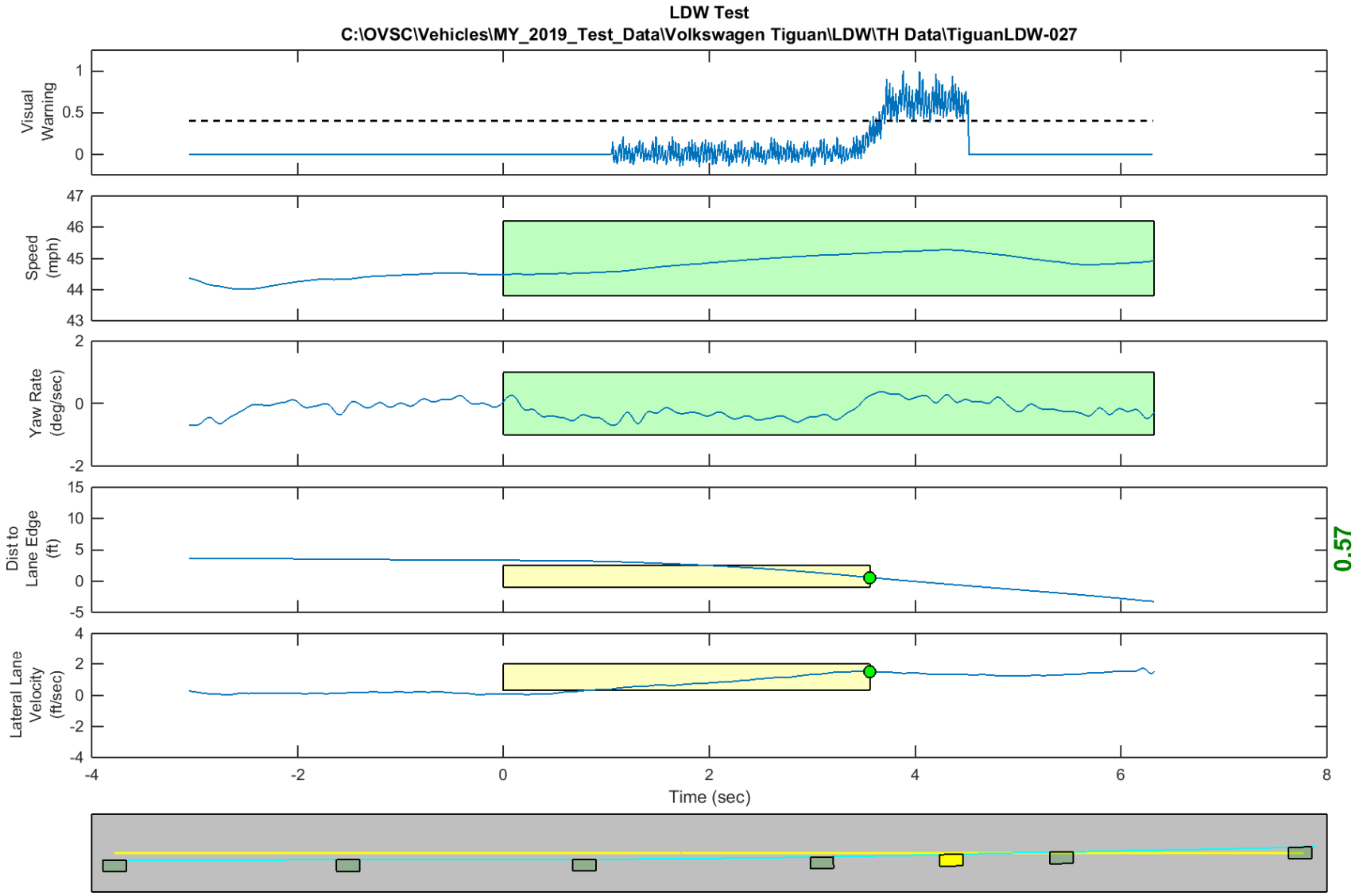

Figure D29. Time History for Run 27, Solid Line, Left Departure, Visual Warning

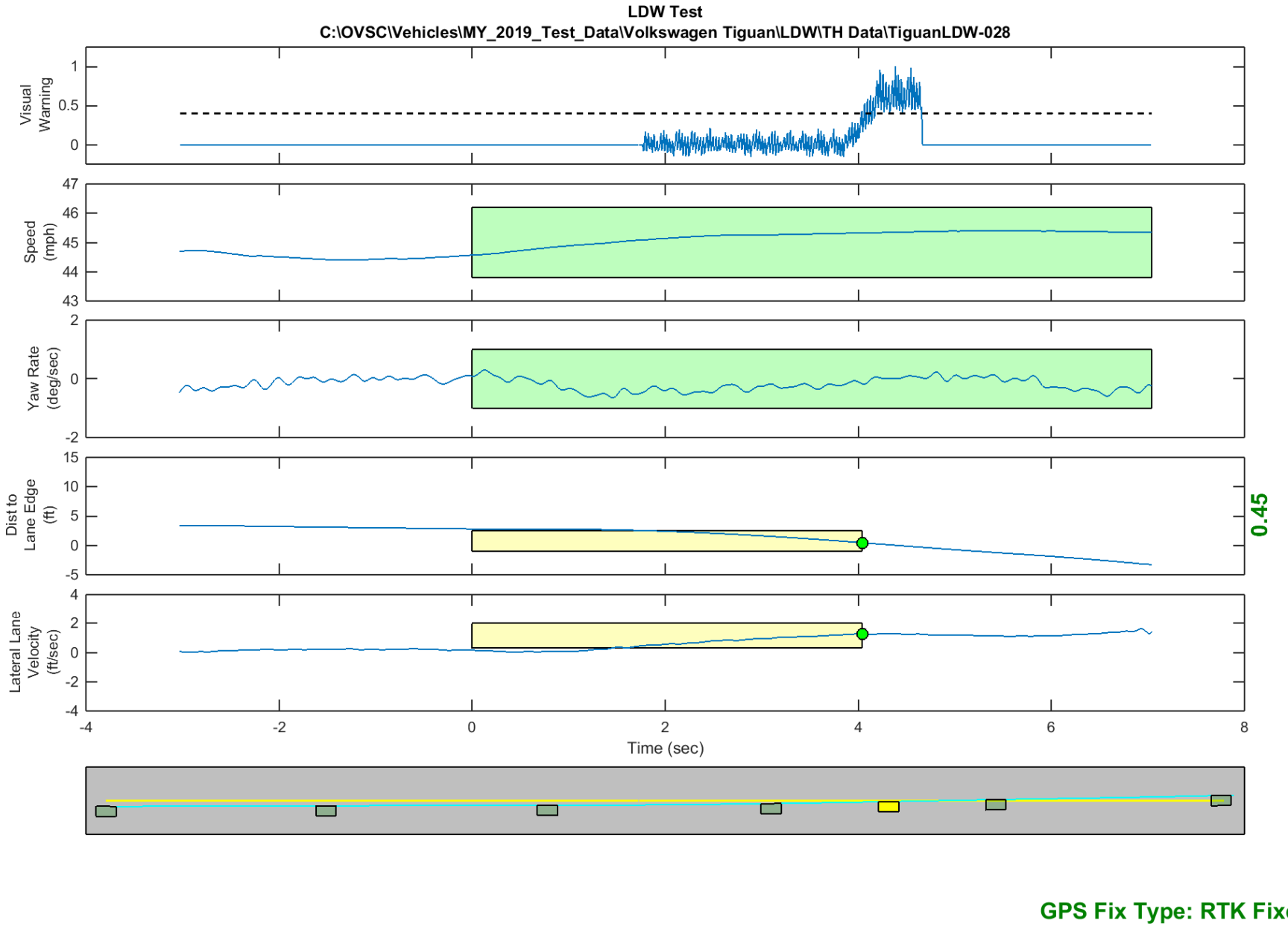

Figure D30. Time History for Run 28, Solid Line, Left Departure, Visual Warning

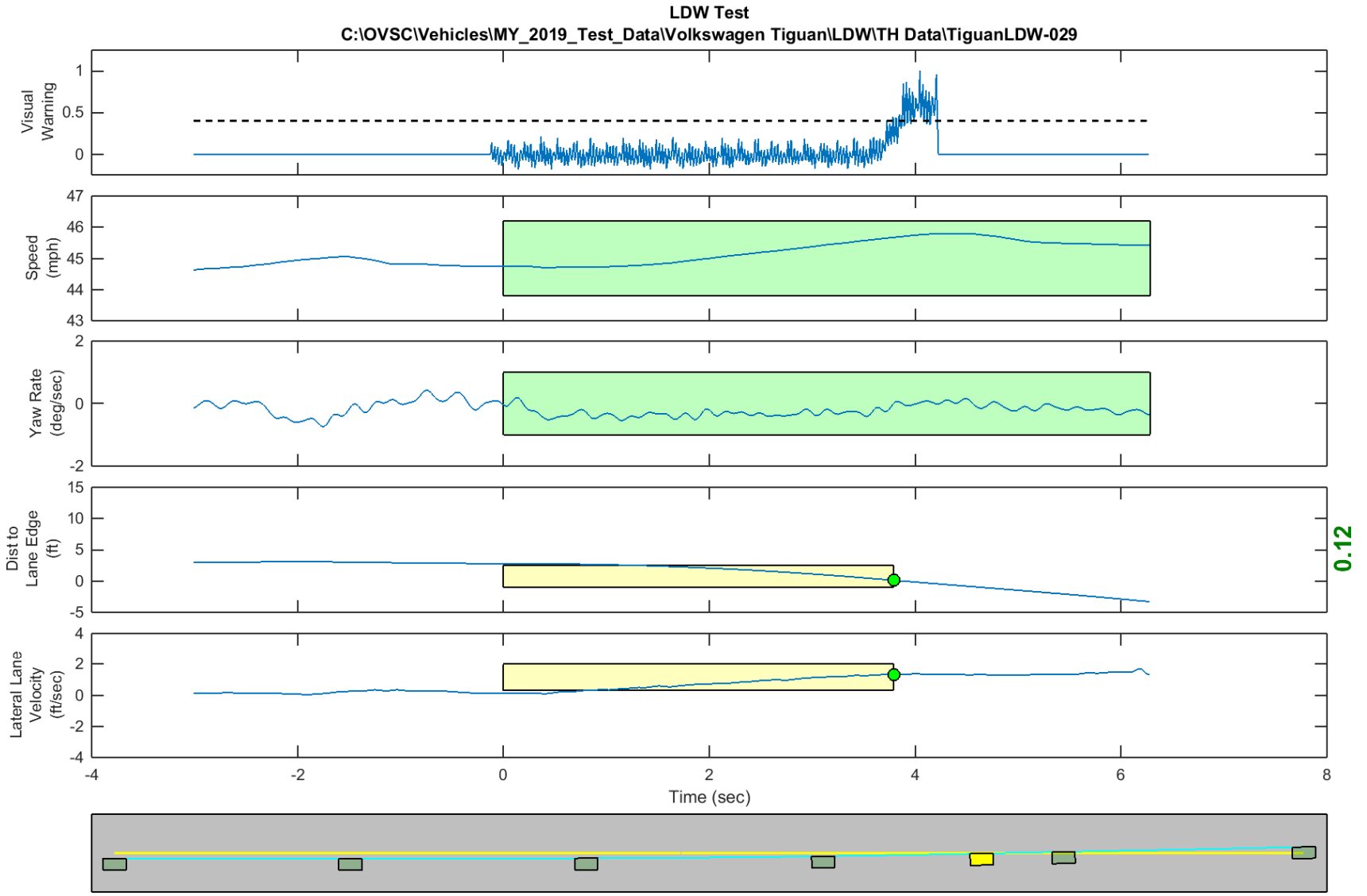

Figure D31. Time History for Run 29, Solid Line, Left Departure, Visual Warning

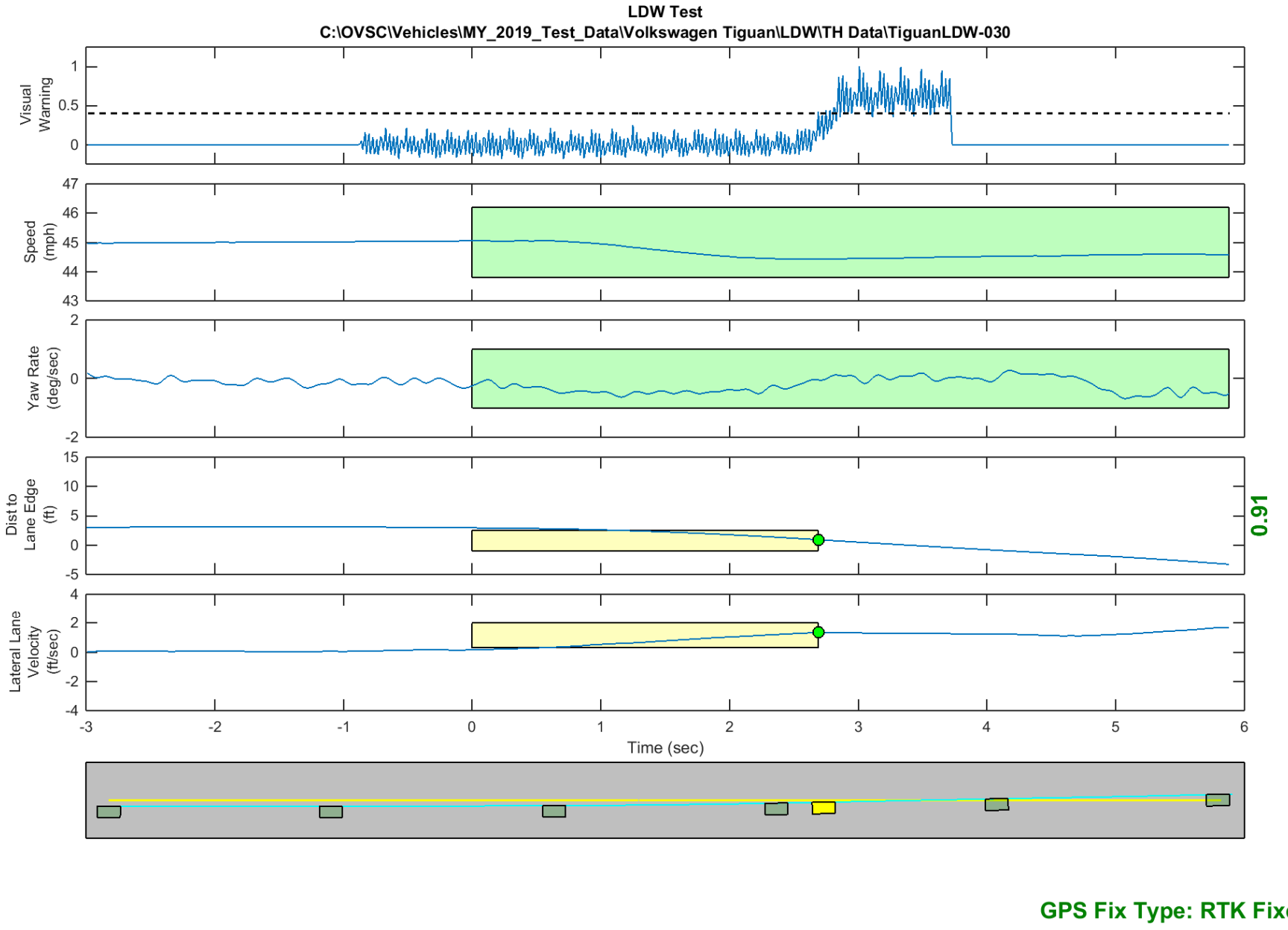

Figure D32. Time History for Run 30, Dashed Line, Left Departure, Visual Warning

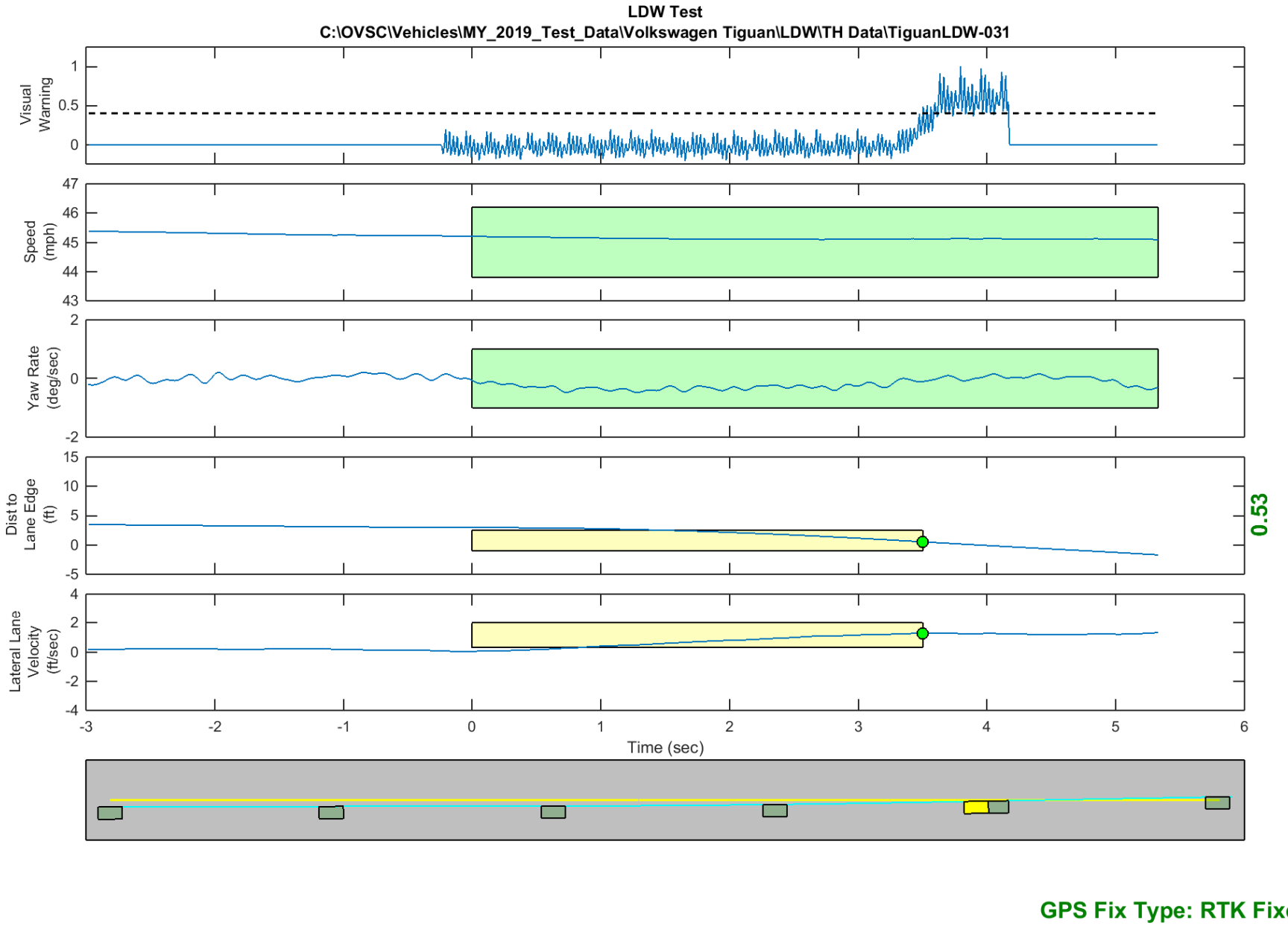

Figure D33. Time History for Run 31, Dashed Line, Left Departure, Visual Warning

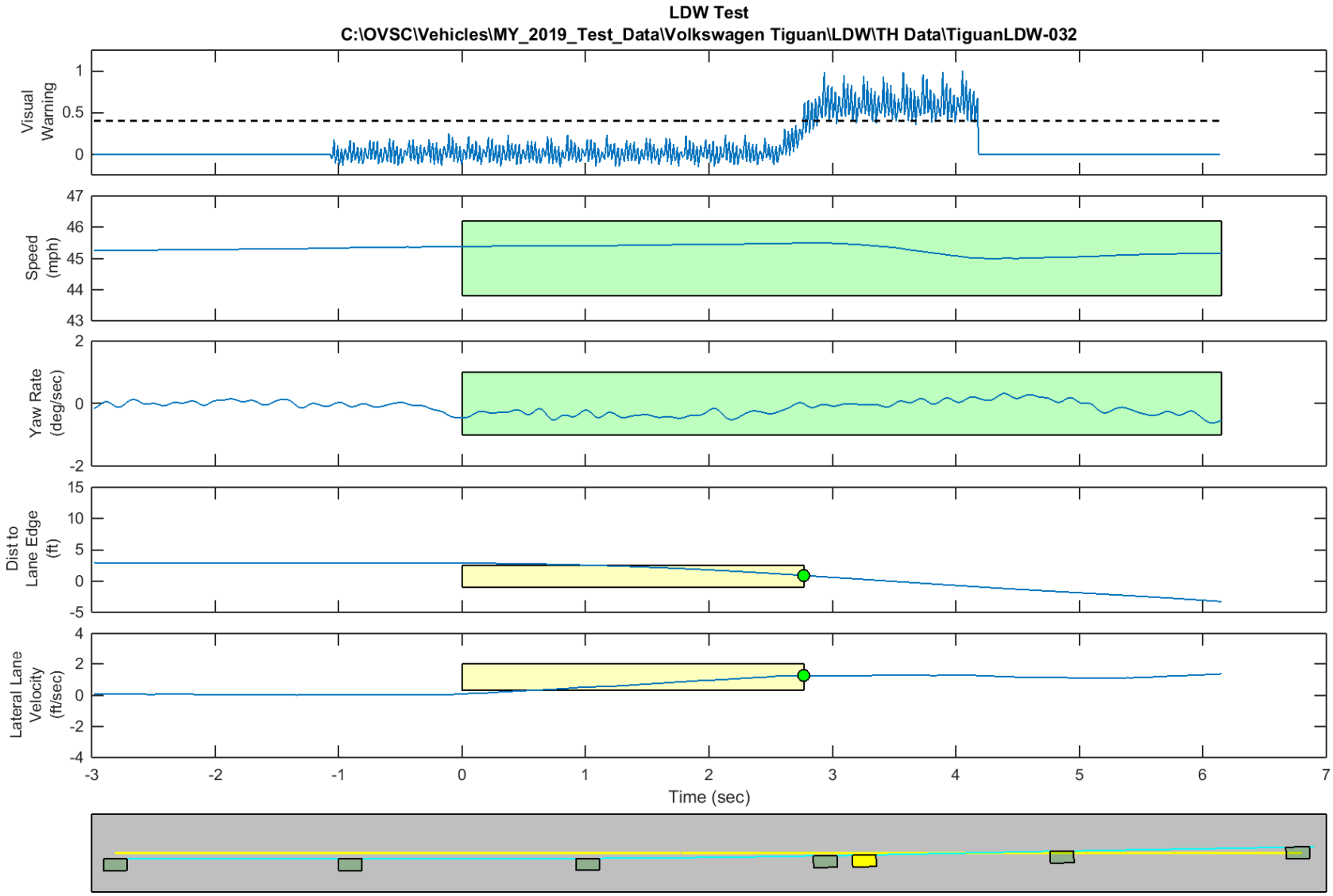

Figure D34. Time History for Run 32, Dashed Line, Left Departure, Visual Warning

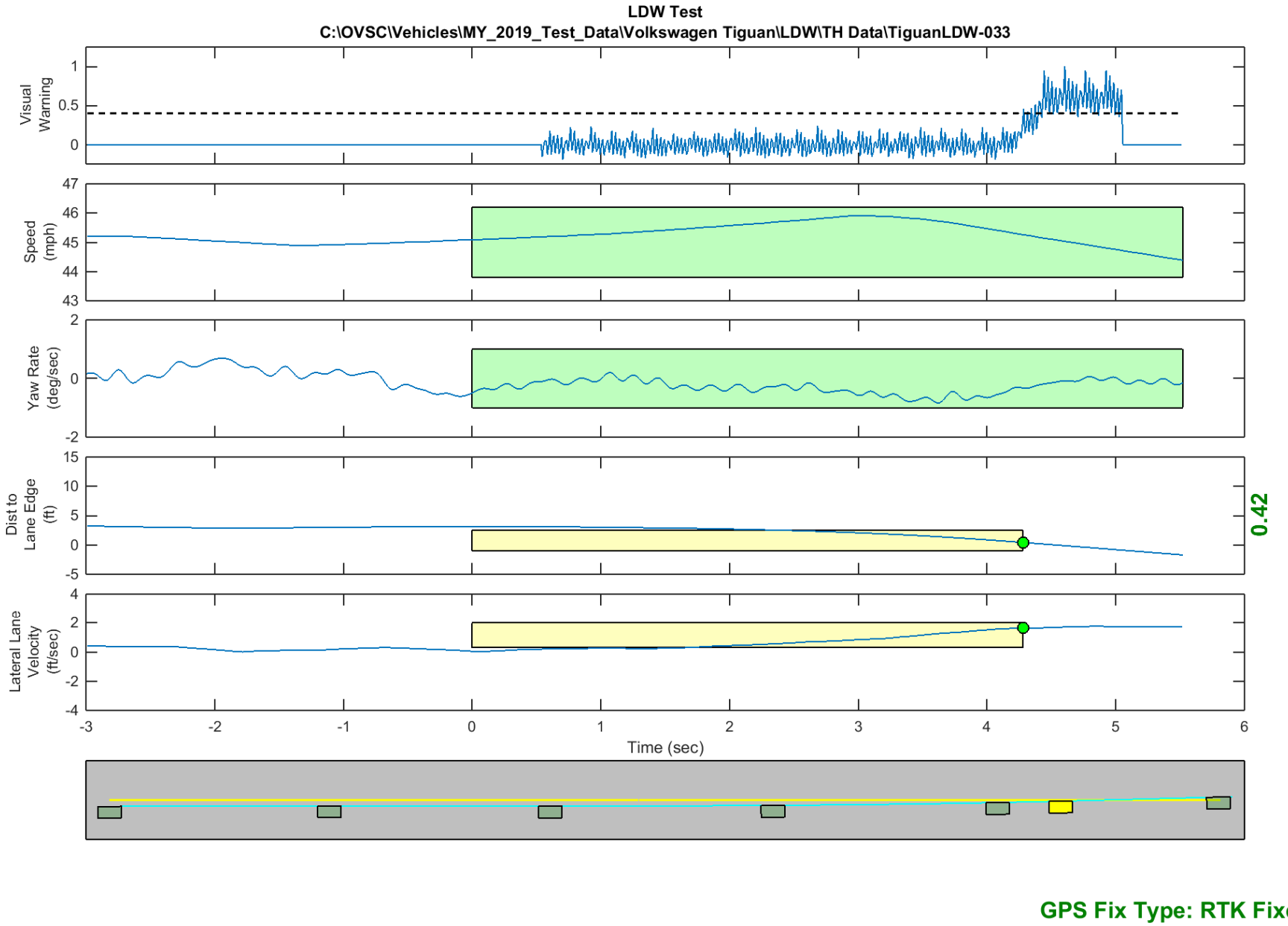

Figure D35. Time History for Run 33, Dashed Line, Left Departure, Visual Warning

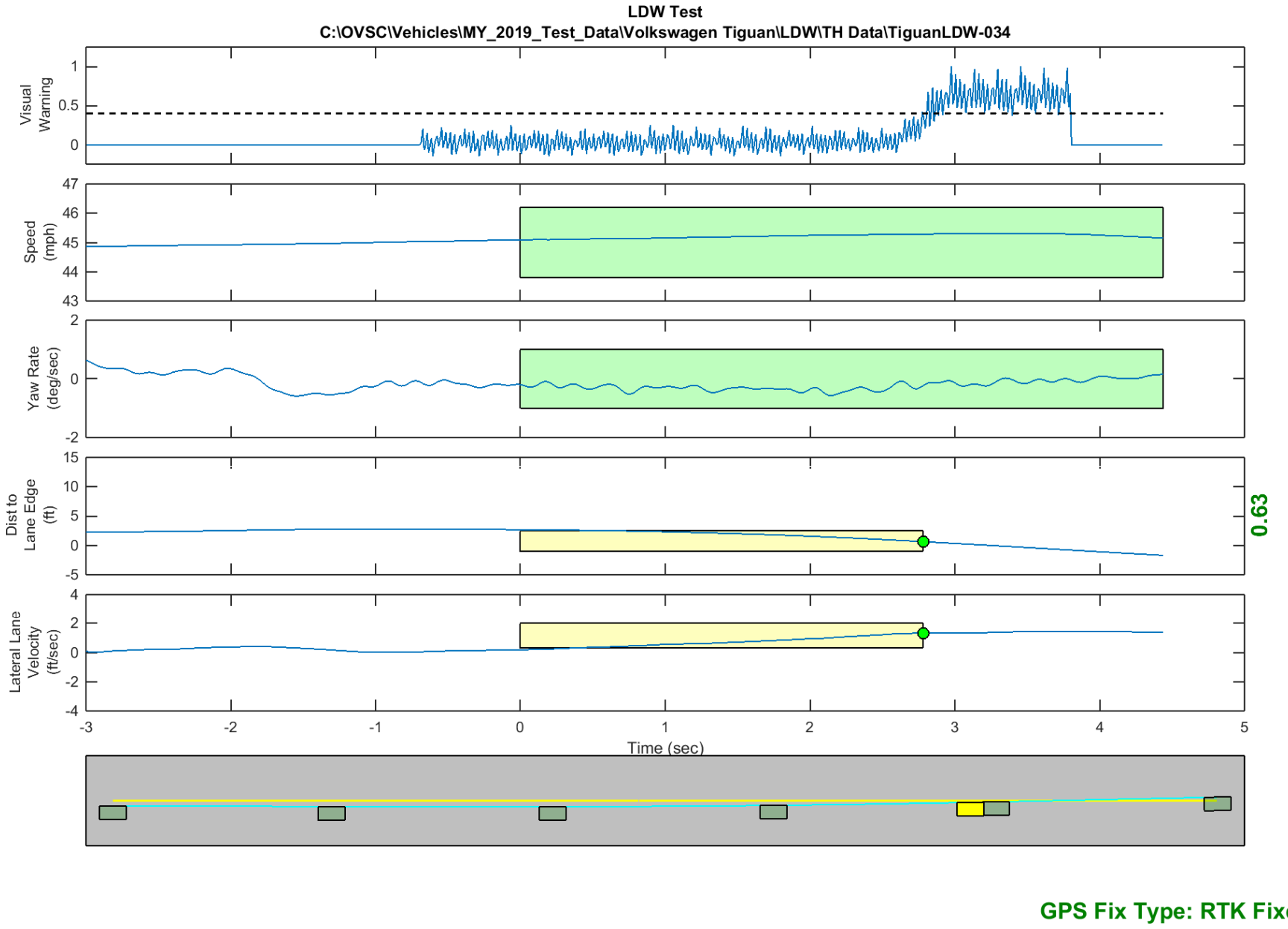

Figure D36. Time History for Run 34, Dashed Line, Left Departure, Visual Warning

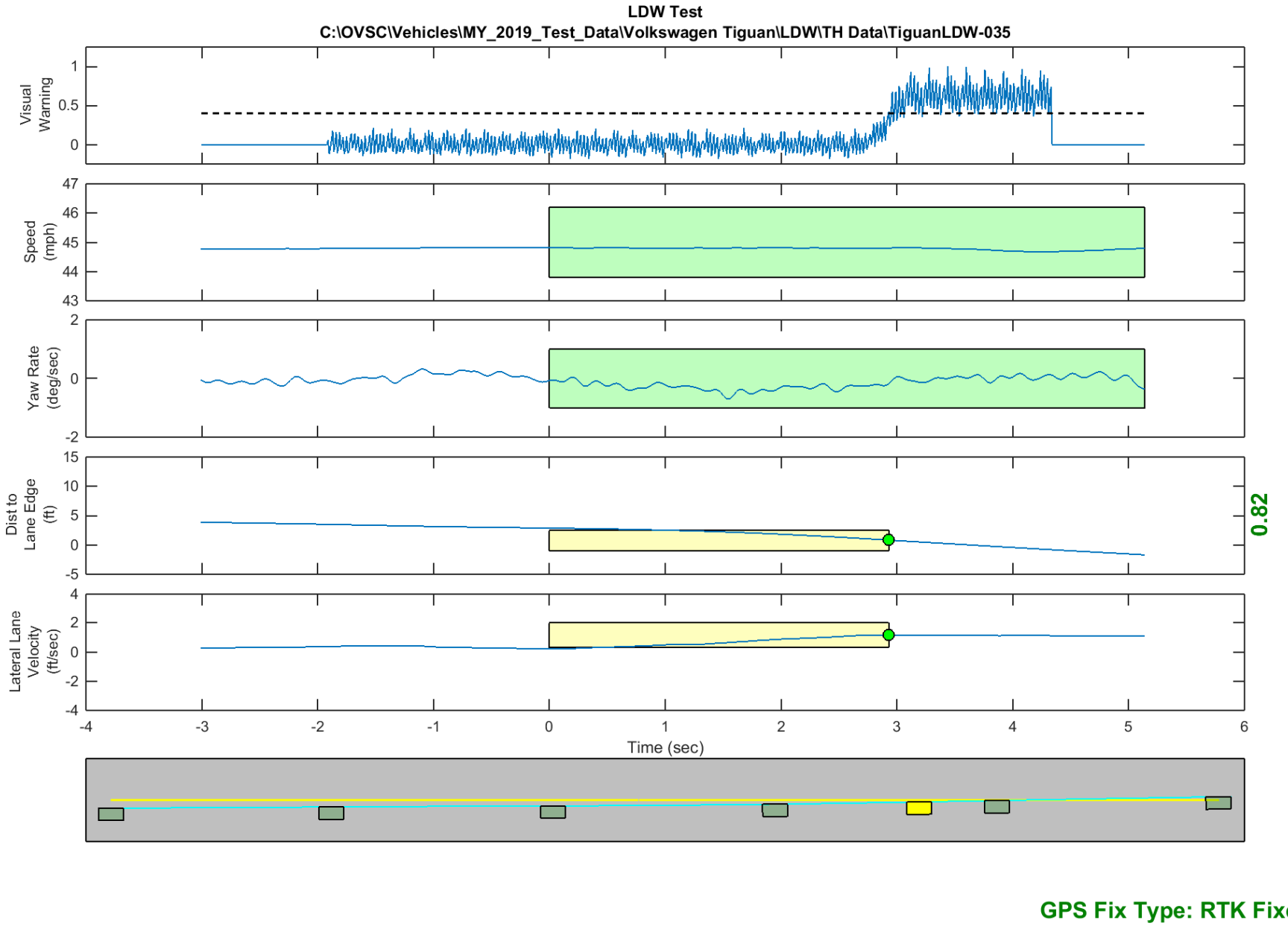

Figure D37. Time History for Run 35, Dashed Line, Left Departure, Visual Warning

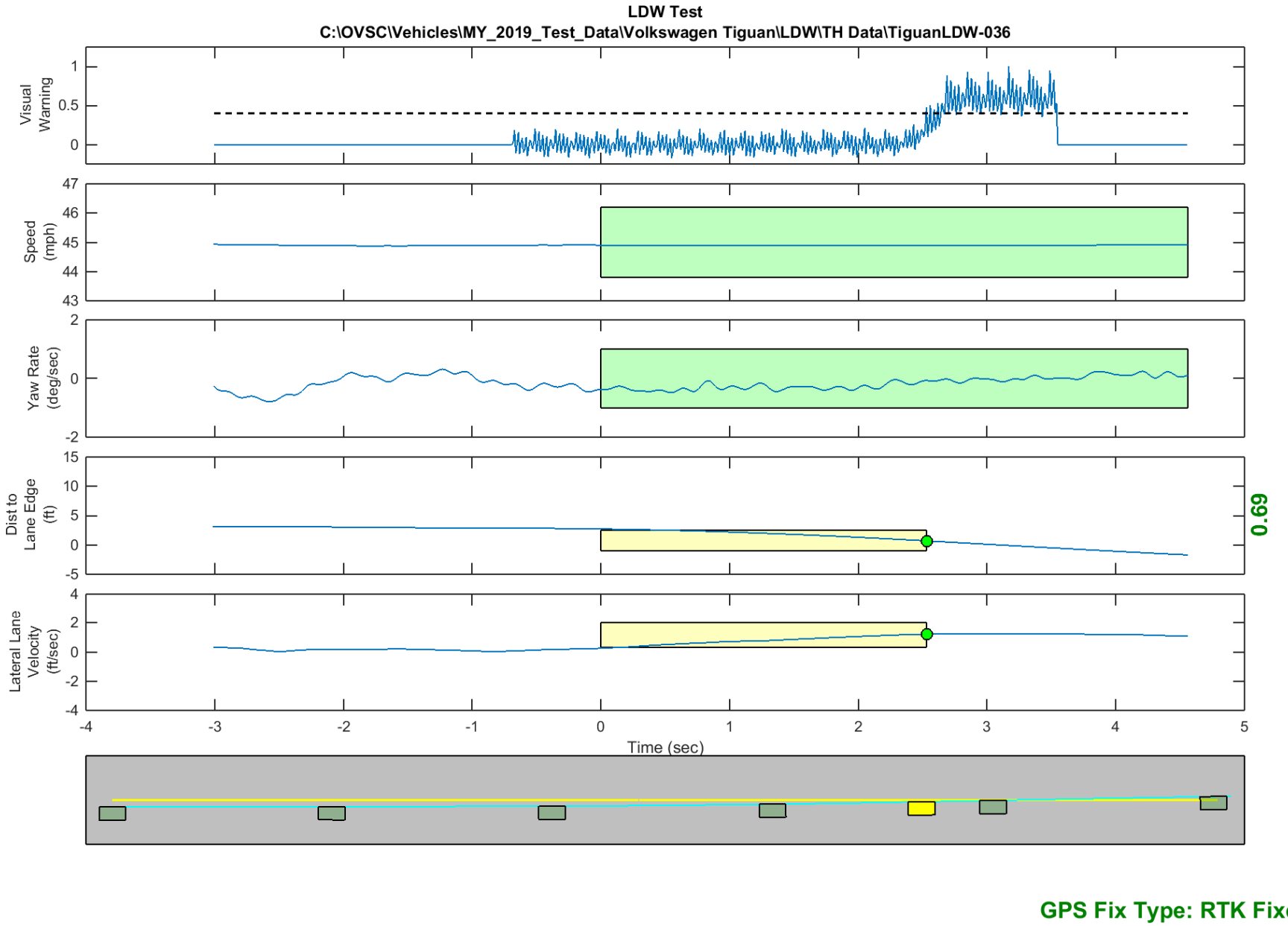

Figure D38. Time History for Run 36, Dashed Line, Left Departure, Visual Warning

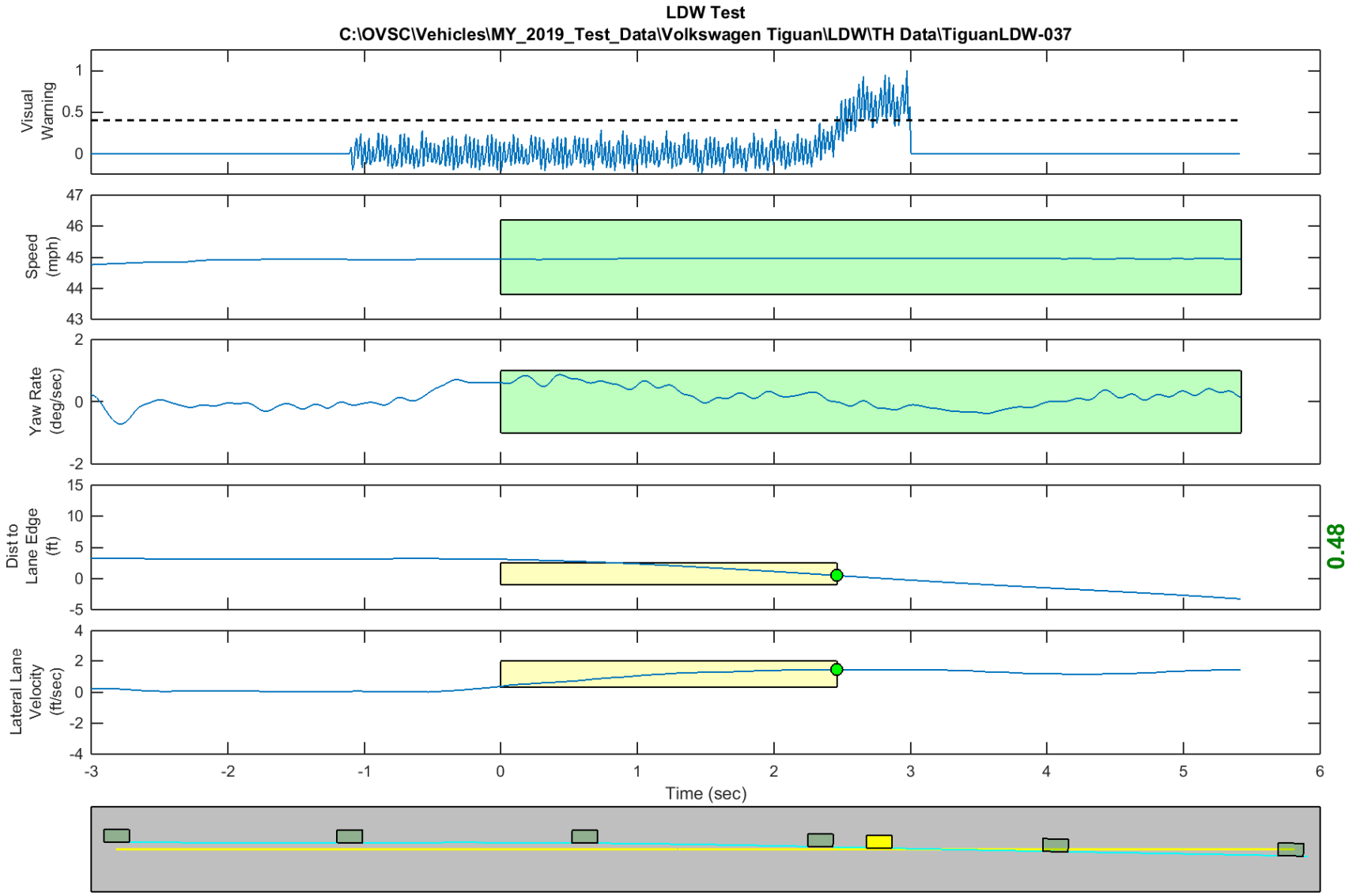

Figure D39. Time History for Run 37, Dashed Line, Right Departure, Visual Warning

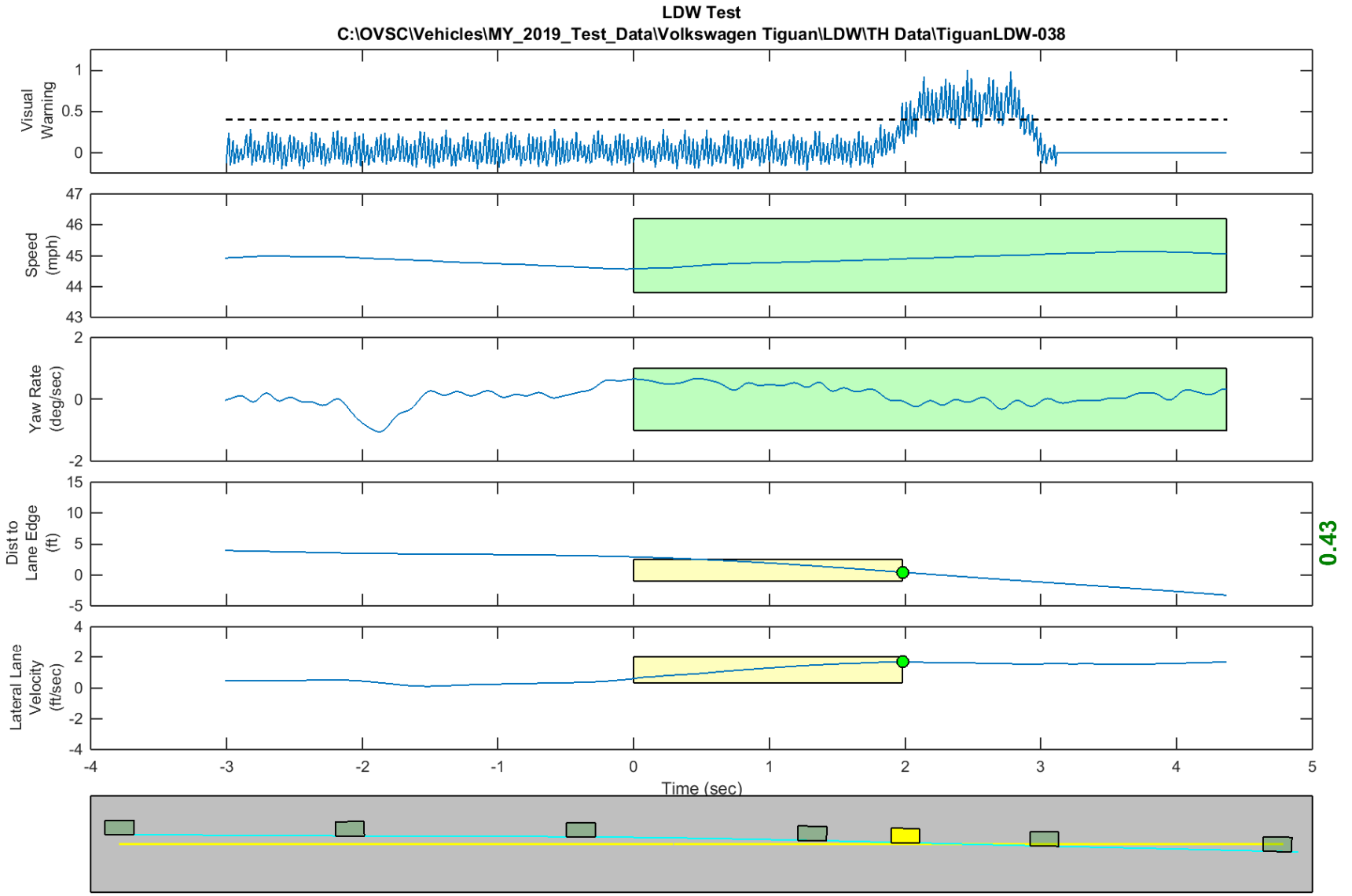

Figure D40. Time History for Run 38, Dashed Line, Right Departure, Visual Warning

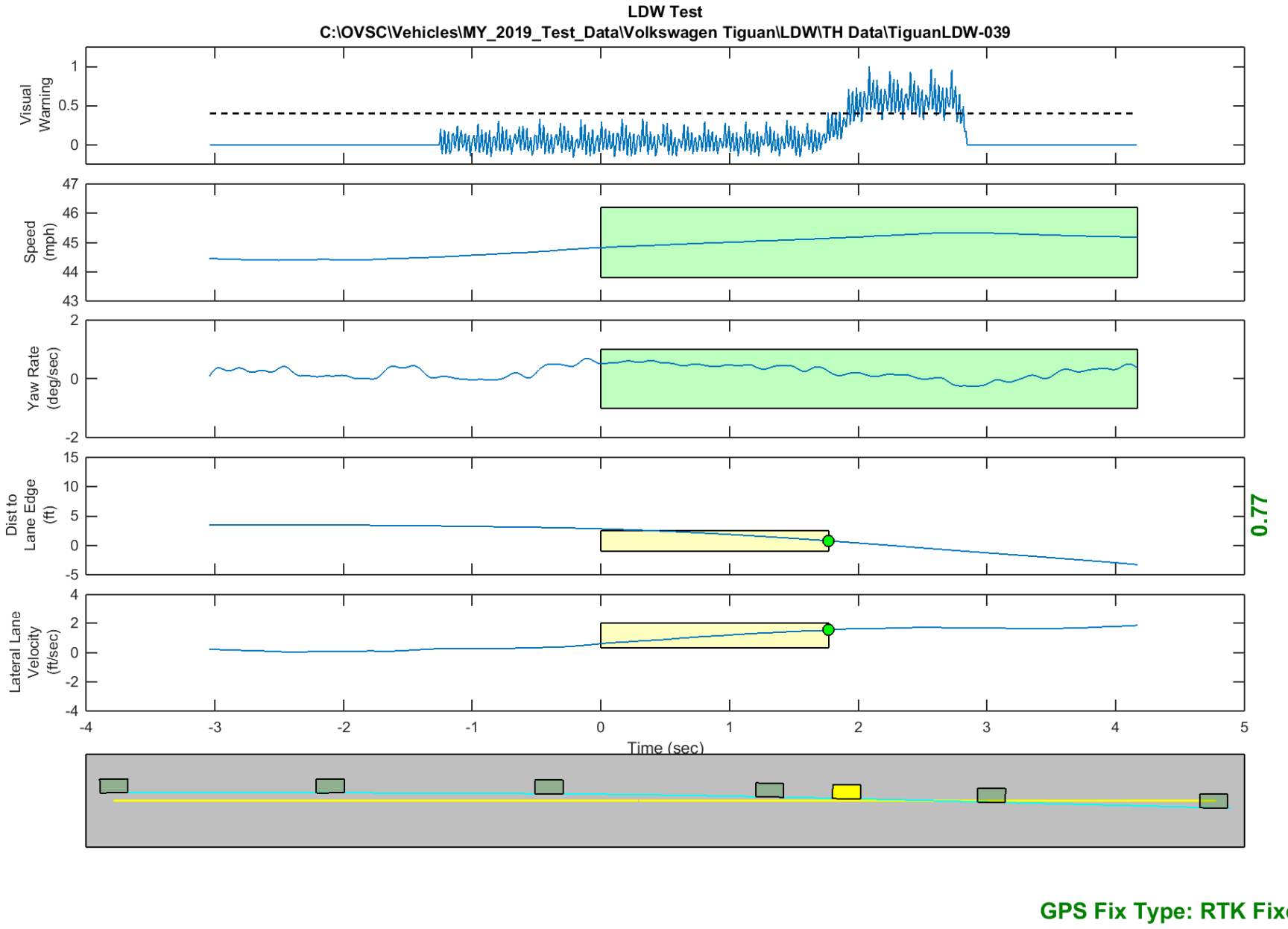

Figure D41. Time History for Run 39, Dashed Line, Right Departure, Visual Warning

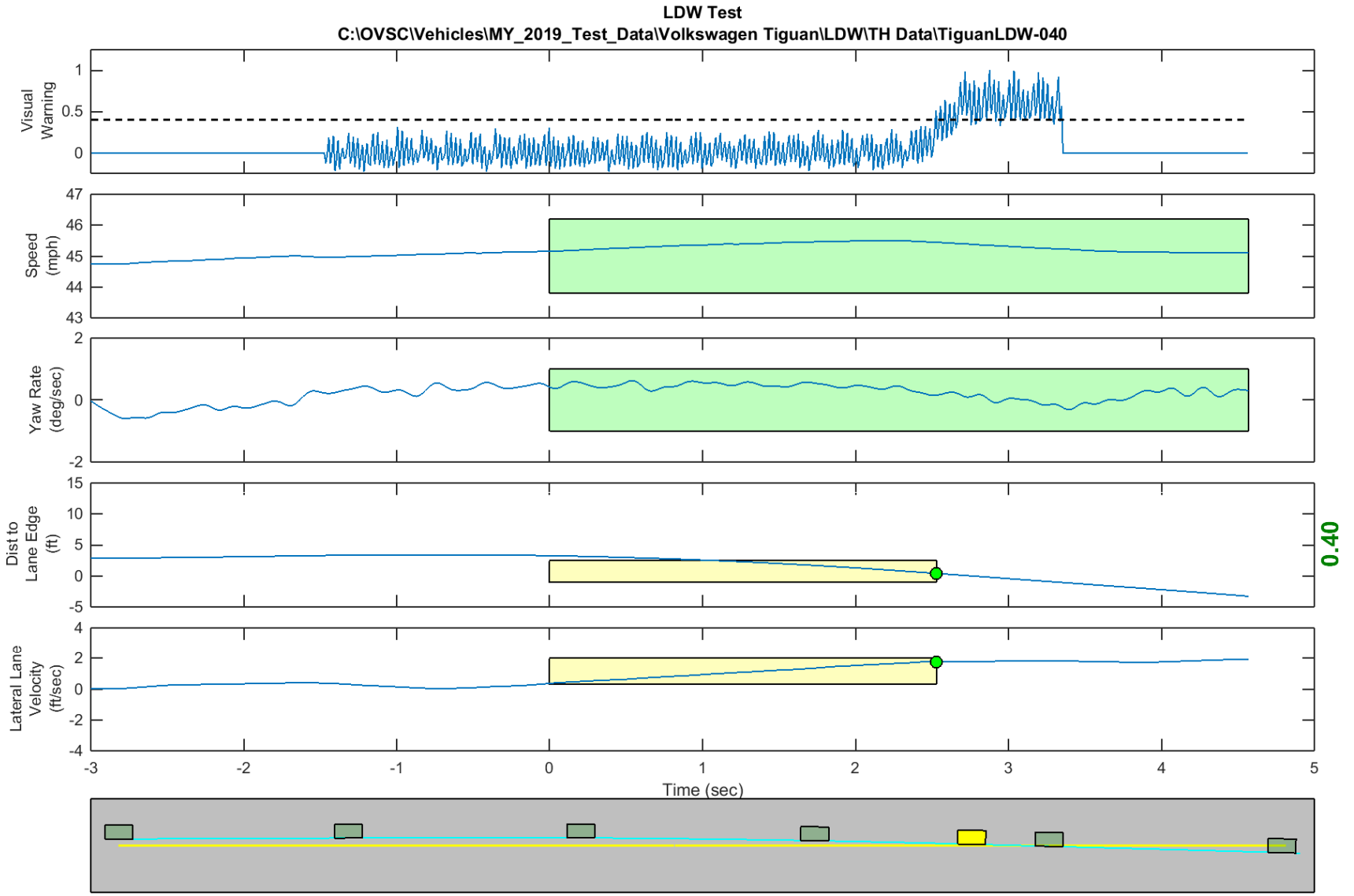

Figure D42. Time History for Run 40, Dashed Line, Right Departure, Visual Warning

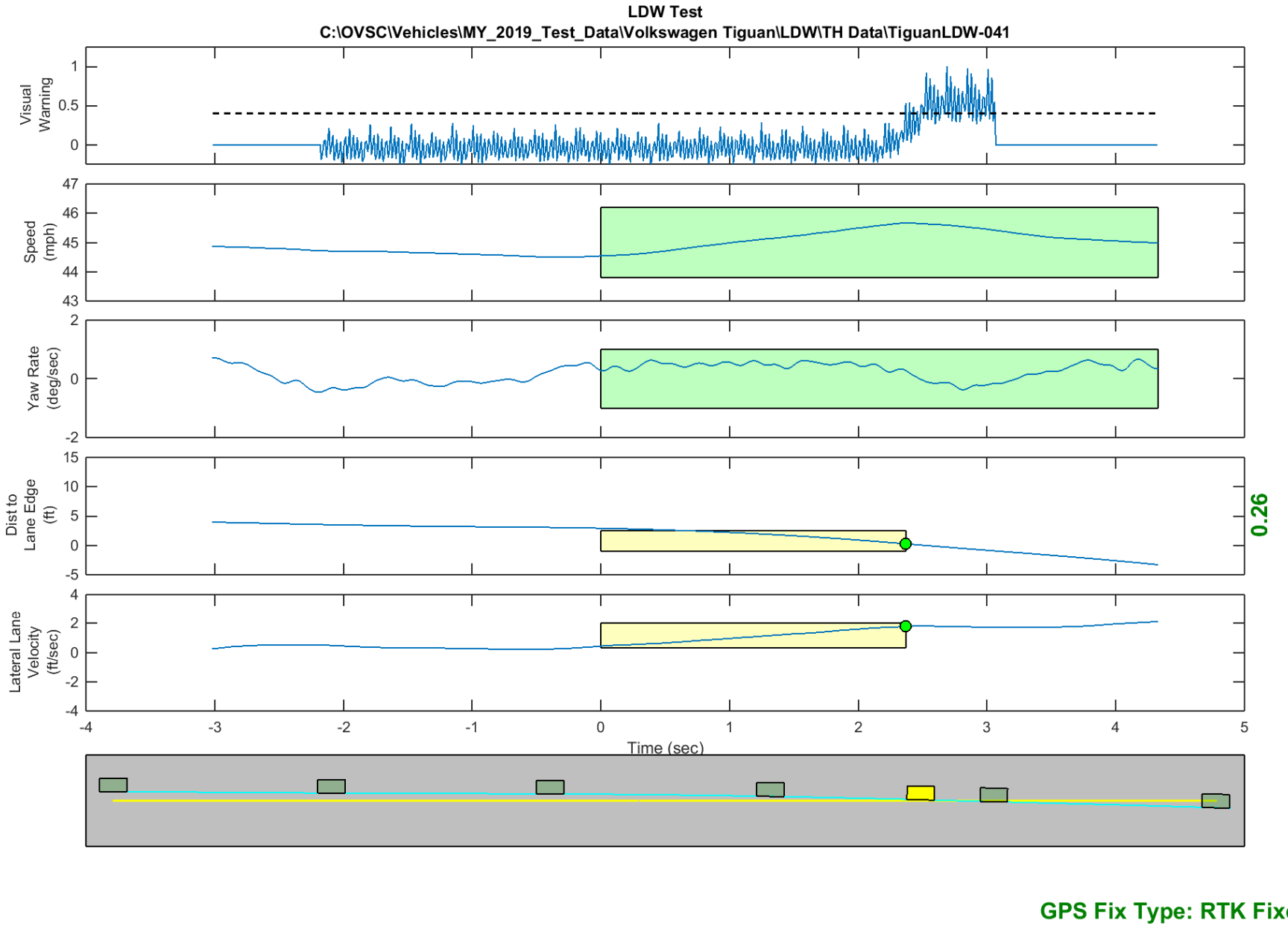

Figure D43. Time History for Run 41, Dashed Line, Right Departure, Visual Warning

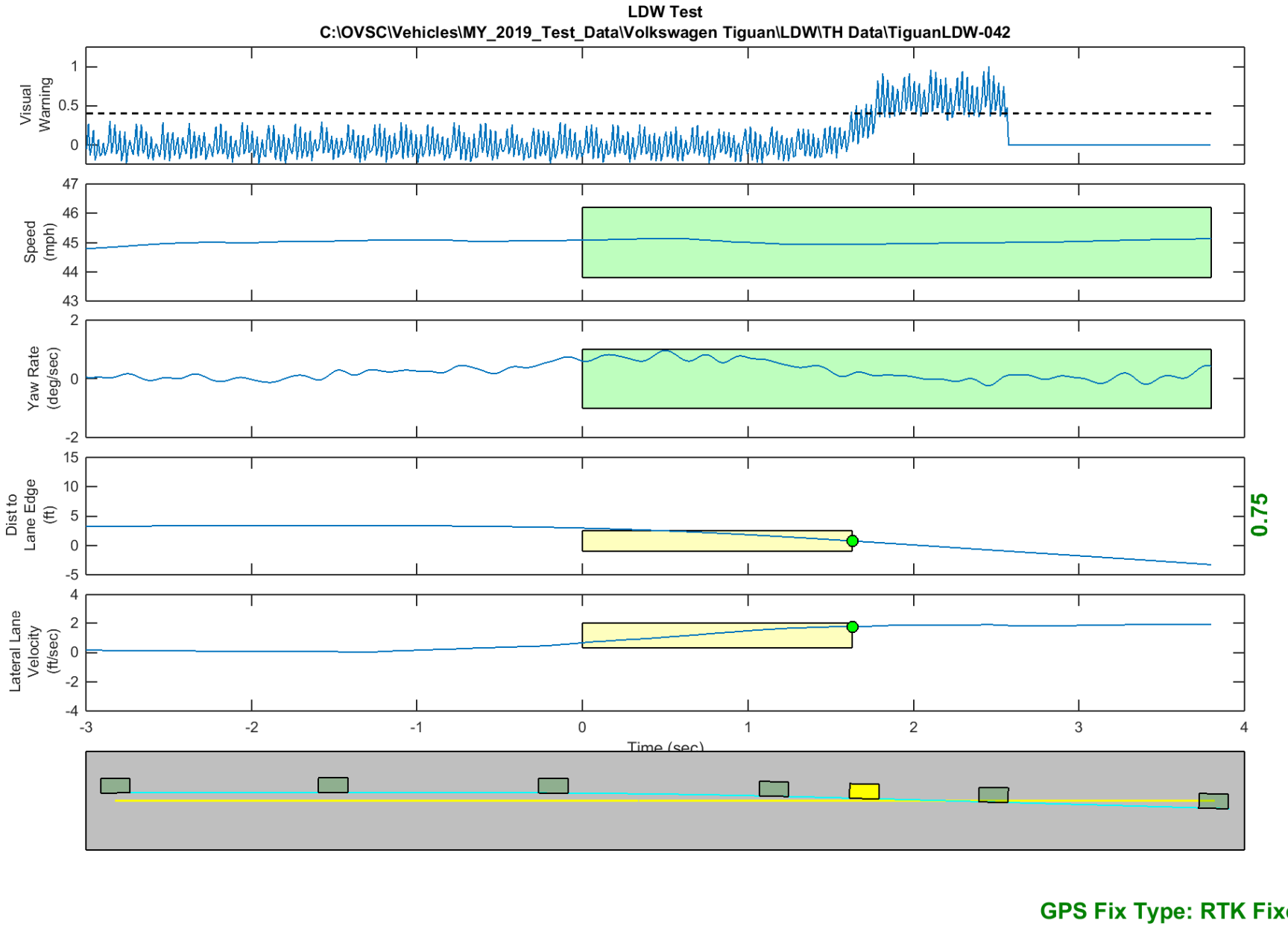

Figure D44. Time History for Run 42, Dashed Line, Right Departure, Visual Warning

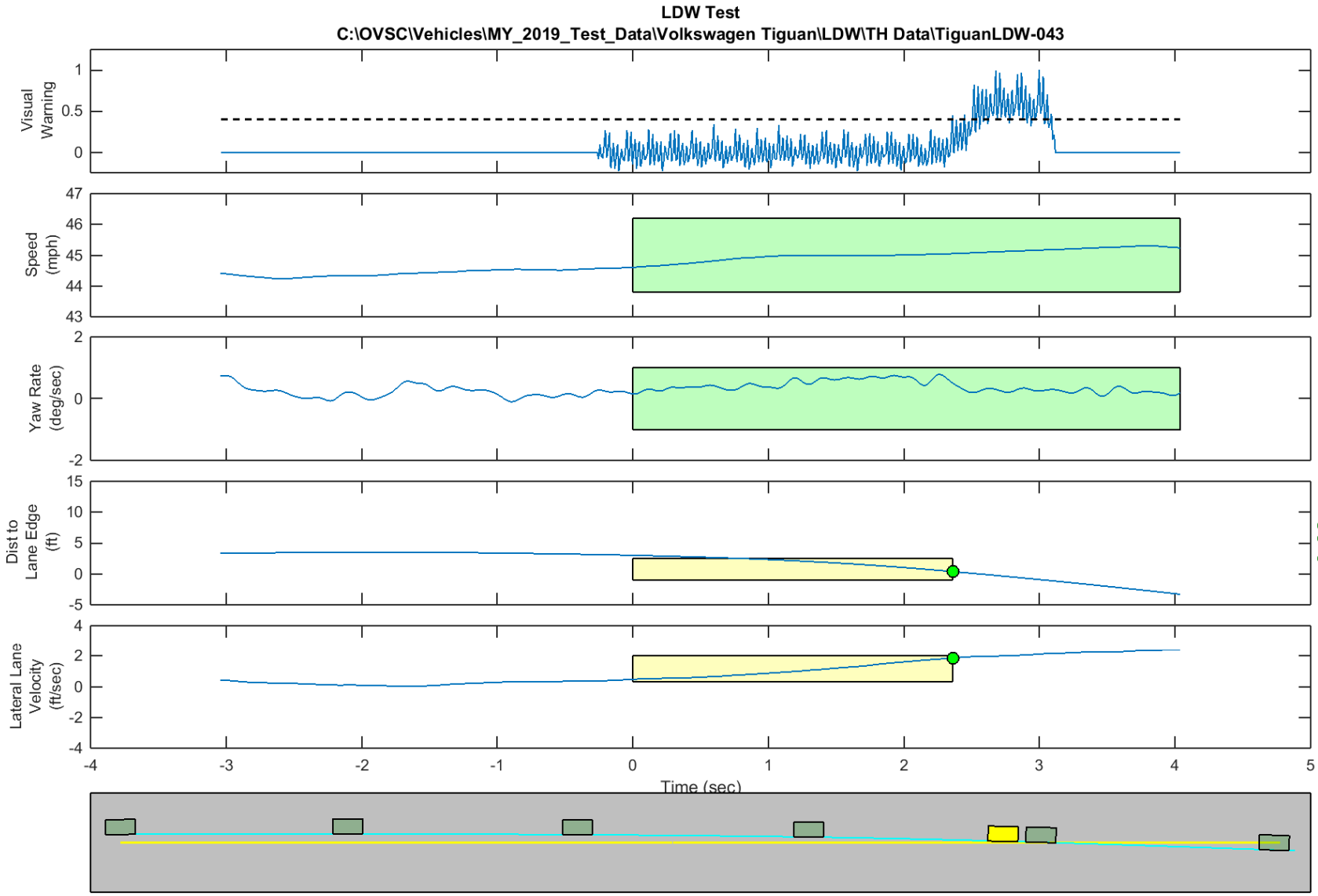

Figure D45. Time History for Run 43, Dashed Line, Right Departure, Visual Warning