NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST
NCAP-DRI-LDW-21-12

2021 Volkswagen ID.4 Pro S (Statement)

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20 July 2021

Final Report

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

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

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16. Abstract These tests were conducted on the subject 2021 Volkswagen ID.4 Pro S (Statement) 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 marking types and for both directions.			
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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 2021 Volkswagen ID.4 Pro S (Statement). The vehicle passed the requirements of the test for all three marking types 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)

2021 Volkswagen ID.4 Pro S (Statement)

VIN: *WVGTMPE21MP03xxxx*

Test Date: *7/7/2021*

Lane Departure Warning settings:

Lane Keeping System (Lane Assist): On

Active: On

Steering wheel vibration: On

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)

2021 Volkswagen ID.4 Pro S (Statement)

TEST VEHICLE INFORMATION

VIN: *WVGTMPE21MP03xxxx*

Body Style: *SUV* Color: *Dusk Blue Metallic*

Date Received: *5/31/2021* Odometer Reading: *17 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *VOLKSWAGEN AG*

Date of manufacture: *03/21*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *235/55 R19 105T XL*

Rear: *255/50 R19 107T XL*

Recommended cold tire pressure: Front: *290 kPa (42 psi)*

Rear: *290 kPa (42 psi)*

TIRES

Tire manufacturer and model: *Hankook Kinergy AS x ev*

Front tire size: *235/55R19 105T*

Rear tire size: *255/50R19 107T*

Front tire DOT prefix: *15M98 9U HO*

Rear tire DOT prefix: *15M7F 9U HO*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2021 Volkswagen ID.4 Pro S (Statement)

GENERAL INFORMATION

Test date: *7/7/2021*

AMBIENT CONDITIONS

Air temperature: *35.0 C (95 F)*

Wind speed: *4.6 m/s (10.4 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: *290 kPa (42 psi)*

Rear: *290 kPa (42 psi)*

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*543.4 kg (1198 lb)*	Right Front:	*527.1 kg (1162 lb)*
Left Rear:	*601.5 kg (1326 lb)*	Right Rear:	*586.9 kg (1294 lb)*
		Total:	*2258.9 kg (4980 lb)*

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

2021 Volkswagen ID.4 Pro S (Statement)

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

Lane Keeping System (Lane Assist) is part of the IQ.Drive feature that is standard equipment.

Type and location of sensor(s) used:

Camera located near the rearview mirror

Lane Departure Warning settings used in test:

Lane Keeping System (Lane Assist): On
Active: On
Steering wheel vibration: On

How is the Lane Departure Warning presented to the driver?

(Check all that apply)

X	Warning light
	Buzzer or auditory alarm
X	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 status and alert indicators are shown in Appendix A, Figure A11.

Yellow line: road lane marking detected. System is actively intervening on the indicated side.

White line: road lane marking detected. The system is ready to intervene on the side shown.

Green Icon: System is active and ready to perform control intervention.

Yellow icon: System intervention (corrective steering intervention).

When the lane is being crossed, there is a steering correction applied and a slight vibration in the steering wheel.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 2 of 3)

2021 Volkswagen ID.4 Pro S (Statement)

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.

System menus are accessed by pressing the "Assist" button in the center console. An image appears in the center touchscreen showing a vehicle, two adjacent blue vehicle and blue lane lines. To disable the system:

Navigate to the Lane Keeping assist menu by either:

- *Touching one of the blue lane lines or*
- *Touching the button in the upper right of the screen, which will bring up the Assistance system settings menu*
- *Select Lane Keeping System (Lane Assist)*
    - *Select or deselect Active to disable/enable the system.*

See Appendix A, Figures A9 and A10.

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

If yes, please provide a full description.

The options for the Lane Keeping System are:

- *Activate/deactivate the system*
- *Activate/deactivate the steering wheel vibration*

System menus are accessed by pressing the "Assist" button in the center console. An image appears in the center touchscreen showing a vehicle, two nearby blue vehicle and blue lane lines. Navigate to the Lane Keeping assist menu by either:

- *Touching one of the blue lane lines or*
- *Touching the button in the upper right of the screen, which will bring up the Assistance system settings menu*
    - *Select Lane Keeping System (Lane Assist)*
        - *Select or deselect "Active" to disable/enable the system*
        - *Select or deselect "Steering wheel vibration" to disable/enable the steering wheel haptic warning*

See Appendix A, Figures A9 and A10.

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.

System limitations are described in the Owner's Manual on page 166, shown in Appendix B, page B-4.

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.

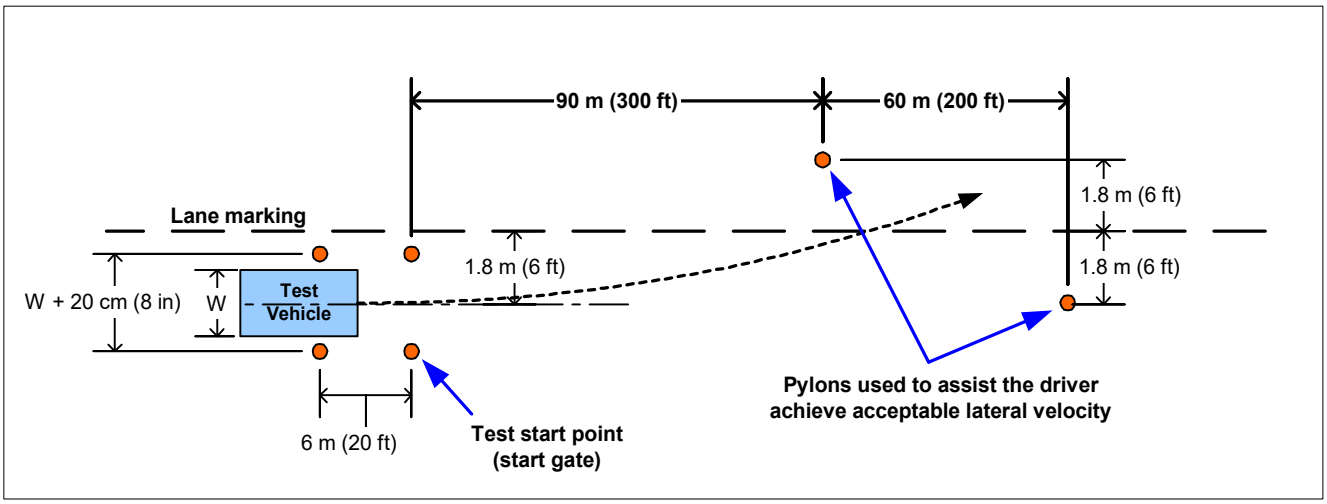

Figure 1. Position of Cones Used to Assist Driver

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

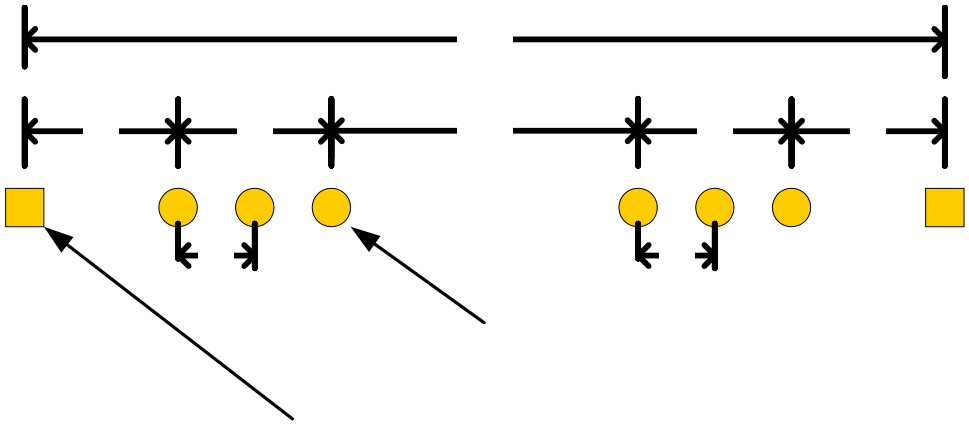

Figure 3. California Standard Plan A20A, Detail 4

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	0.5 psi 3.45 kPa	Ashcroft, D1005PS	17042707002	By: DRI Date: 8/18/2020 Due: 8/18/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	8000 lb 35.6 kN	±1.0% of applied load	Intercomp, SWII	0410MN20001	By: DRI Date: 2/10/2021 Due: 2/10/2022
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	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 Solutions[1] Date: 9/16/2019 Due: 9/16/2021
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: 1/6/2021 Due: 1/6/2022

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

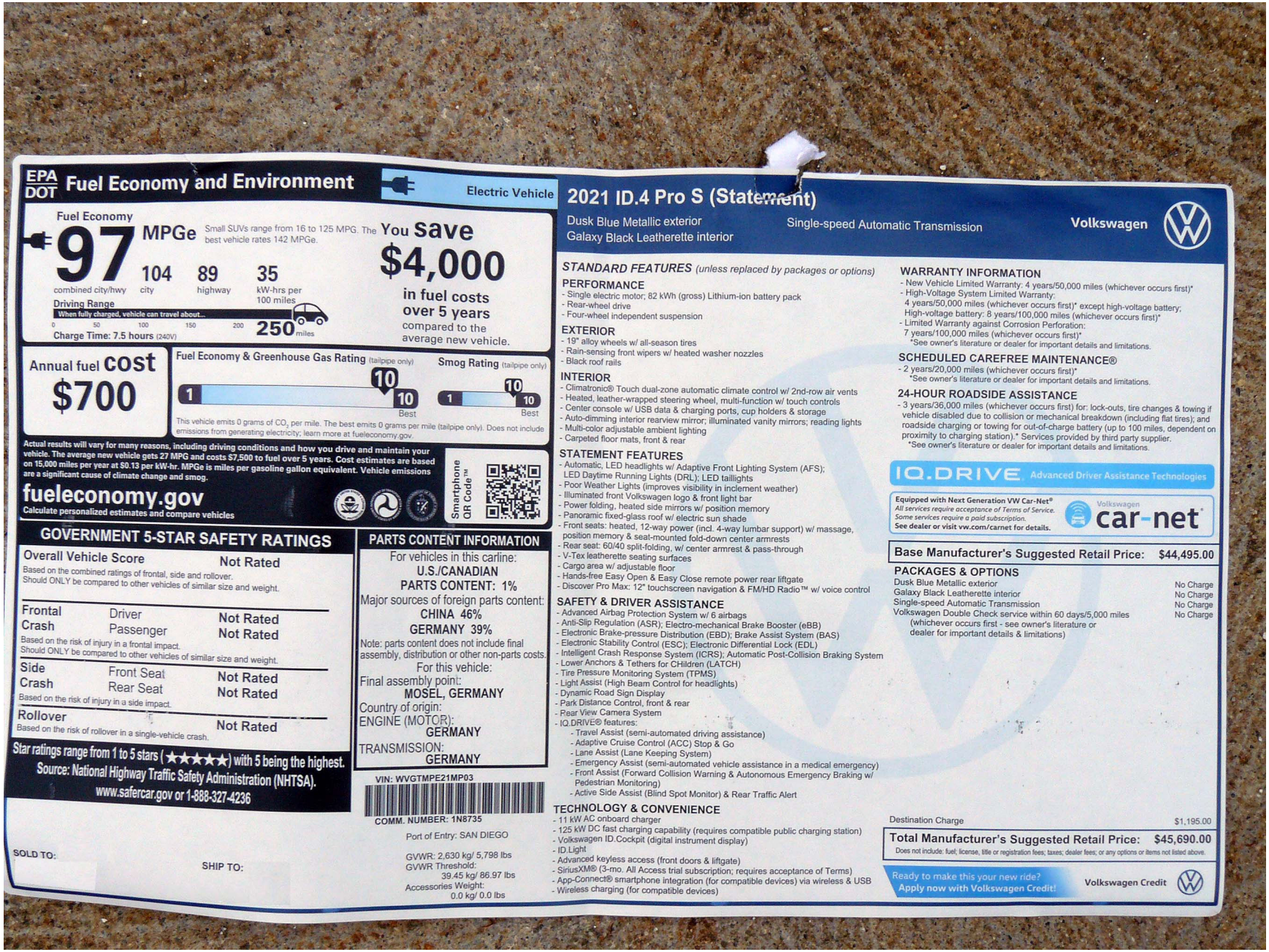

Figure A3. Window Sticker (Monroney Label)

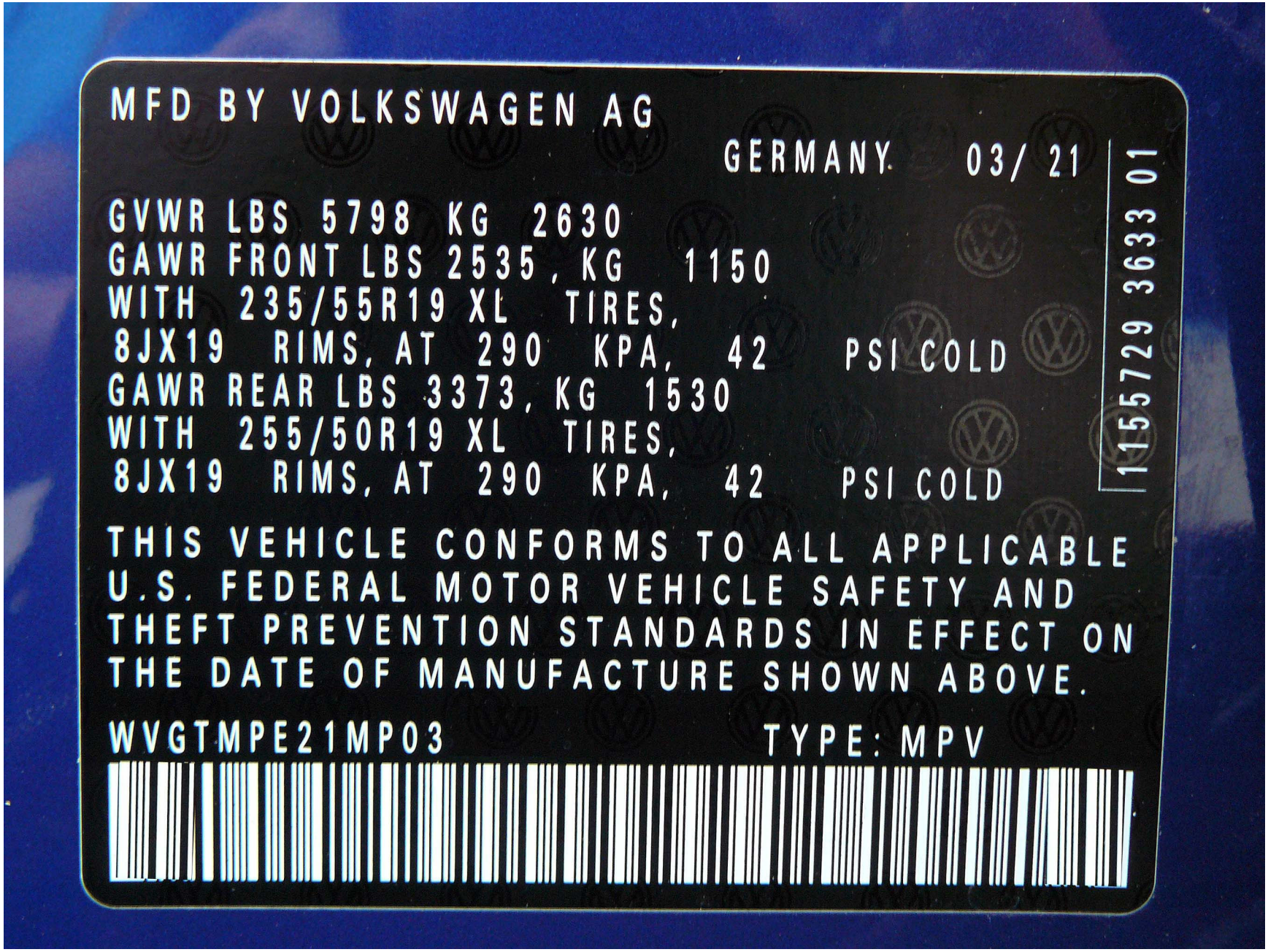

Figure A4. Vehicle Certification Label

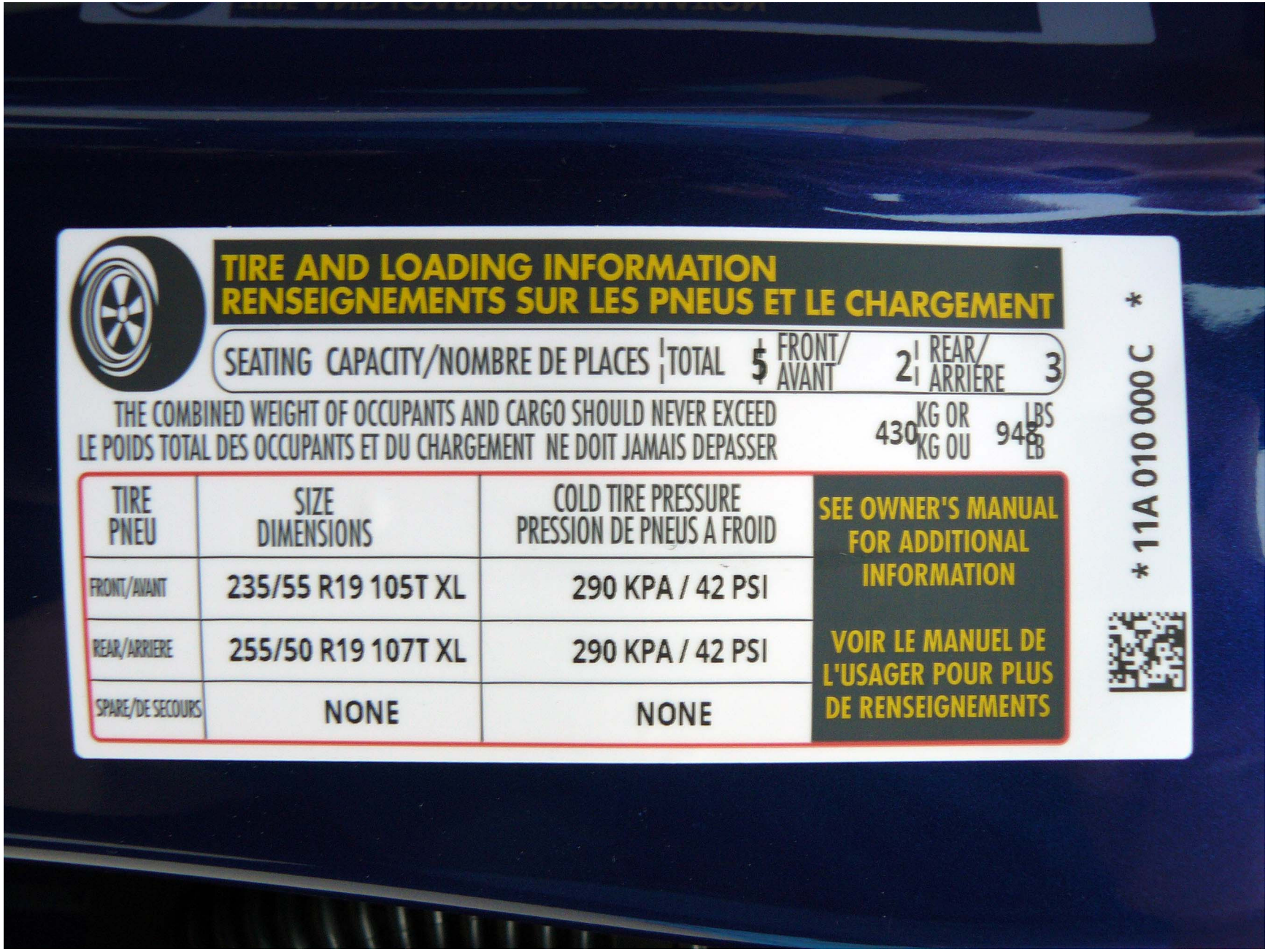

Figure A5. Tire Placard

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

Figure A7. Computer Installed in Subject Vehicle

Figure A8. Sensor for Detecting Visual Alert

Figure A9. Button for Accessing System Menus

Figure A10. LDW System Menus

Figure A11. LDW Status Indicator and Visual Alert

APPENDIX B

Excerpts from Owner’s Manual

Symbol	Meaning
	 Do not drive on! Low tyre pressure → page 327
	 Do not drive on! Fault in the Tyre Pressure Monitoring System → page 327
	Fault in electric drive system → page 139, → page 142
	Reduced power → page 137
	Electronic engine sound fault → page 140
	Front Assist not available → page 165
	Front Assist switched off → page 164
	Speed limiter not available → page 148
	Fault in the Cruise Control System → page 147
	Adaptive Cruise Control (ACC) is not available → page 156
	Emergency Assist not available → page 172
	Lane keeping system (Lane Assist) not available → page 167
	Lane keeping system (Lane Assist) is regulating → page 167
	Emergency Assist intervention → page 171
	Fault in the lane change system (Side Assist) → page 174
	Rear Traffic Alert braking intervention → page 189
	Rear Traffic Alert fault → page 189

Symbol	Meaning
	12-volt vehicle battery → page 323
	Low charge level of the high-voltage battery → page 285
	High-voltage battery empty → page 285
	Adaptive chassis control fault → page 144
	Ball head of the towing bracket is not locked → page 273
	The vehicle is held stationary → page 179
	Turn signals → page 110
	Trailer turn signal → page 111
	Cruise control system switched on, control active. → page 145
	Speed limiter active → page 147
	Lane Assist active → page 167
	Travel Assist active → page 169
	The ACC is regulating, no vehicle detected in front → page 154
	The ACC is regulating, vehicle in front detected → page 154
	Speed regulation due to the road layout → page 158
	Speed regulation due to a roundabout → page 158
	Speed regulation due to a junction → page 158
	Speed regulation due to cancellation of the speed limit → page 158
	Speed regulation due to the end of a traffic jam → page 158

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Troubleshooting

Please refer to ⚠ at the start of the chapter on page 159.

Front Assist is starting up.

The indicator lamp lights up.

— Front Assist is temporarily unavailable or limited. Front Assist is available after driving straight ahead for a short time, and the indicator light goes out. When the vehicle is not in motion, the indicator lamp lights up continuously.

Front Assist not available or functions restricted.

The indicator lamp lights up yellow and a text message is also displayed.

— The radar sensor or camera window is dirty. Clean the radar sensor and windscreen → page 355.

— The view of the radar sensor or camera is impaired due to the weather conditions, e.g. snow, or due to detergent deposits or coatings. Clean the radar sensor and windscreen → page 355.

— The view of the radar sensor is impaired by add-on parts, the trim frames of number plate holders or stickers. Keep the area around the radar sensor free.

— The view of the camera is impaired by add-on parts or stickers. Keep the area around the camera window free.

— The radar sensor or camera has been displaced or damaged, e.g. due to damage to the front of the vehicle or the windscreen. Check whether damage is visible → page 362.

— Paint work or structural modifications were carried out on the front of the vehicle.

— If the problem persists, switch off Front Assist and go to a qualified workshop.

Front Assist does not function as expected or is triggered unnecessarily several times.

— The radar sensor or camera window is dirty. Clean the radar sensor and windscreen → page 355.

— The system limits have been exceeded → page 162.

— Low sun or darkness.

— If the problem persists, switch off Front Assist and go to a qualified workshop.

Touch panels react differently than expected.

Moisture, dirt and grease can impede the functioning of the touch panels.

— Make sure the touch panels are always clean and dry. ◁

Lane keeping system (Lane Assist)

Introduction to the topic

Within the system limits, the lane keeping system (Lane Assist) helps the driver to stay in lane. The function is not designed to keep the vehicle in lane automatically, nor is it suited to this purpose.

Using a camera in the windscreen, the lane keeping system detects road lane markings on the road. If your vehicle moves too close to a recognised road lane marking, the system will warn the driver with a corrective steering intervention. The corrective steering intervention can be overridden by the driver at any time.

System limits

Use the lane keeping system only on motorways and well-developed country roads.

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The system is not ready to intervene on both sides under the following conditions (passive system status):

– The vehicle speed is under 55 km/h (approximately 30 mph).
– The lane keeping system has not detected a road lane marking on either side.
– In tight bends.
– Temporarily if the driving style is very dynamic.
– When the turn signal is switched on before changing lane manually.
– If the driver vigorously oversteers a system intervention.
– A road lane marking is crossed despite a system intervention.
– The driver does not react to a driver intervention prompt.

⚠ WARNING

The intelligent technology used in the lane keeping system cannot overcome physical limitations, and functions only within the limits of the system. Always take care when using the lane keeping system otherwise you could cause accidents or injuries. The system is not a substitute for the full concentration of the driver and their steering.

- Adapt your speed and distance from the vehicles ahead to suit visibility, weather, road and traffic conditions.
- Your hands should always be on the steering wheel so that you can steer at any time. The driver is always responsible for staying in the lane.
- The lane keeping system cannot recognise all road lane markings. In certain circumstances, the lane keeping system may detect poor road surfaces, road structures or objects incorrectly as road lane markings. Immediately override any undesired intervention by the system.
- Observe the information on the instrument cluster display and respond according to the prompts, if permitted by the traffic situation.
- In the following situations undesired intervention by the lane keeping system can occur or no control assistance is provided by the lane keeping system. This means that it is crucial that the driver is attentive in these situations. It may be necessary to switch off the lane keeping system temporarily:
  – Very sporty driving.
  – In poor weather conditions and when driving on poor roads.
  – Driving through road works.
  – Over hill tops or through dips.
- Always observe the area around the vehicle with care and watch the road ahead while driving.
- If the camera's field of view is dirty, covered or damaged, the function of the lane keeping system may be impaired. ◁

Driving with the lane keeping system

🕮 Please refer to ⚠ at the start of the chapter on page 165.

Switching on and off

Depending on country, the lane keeping system is always switched on when the ignition is switched on. You can also switch the lane keeping system on and off in the Assist systems menu of the Infotainment system and view the current system status there.

The lane keeping system (Lane Assist) is also switched on when the comfort drive function (Travel Assist) is switched on.

If there is a system fault, the lane keeping system can deactivate itself automatically.

Speed range

When road lane markings can be detected, the lane keeping system is ready to intervene at speeds above around 60 km/h (35 mph)

within the system limits (system status active).

Displays

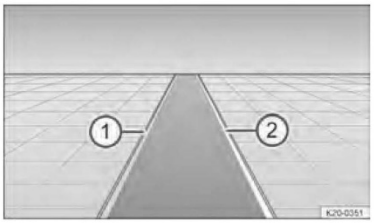

Fig. 110 On the instrument cluster display: lane keeping system displays.

① Yellow line: road lane marking detected. System is actively intervening on the indicated side.

② White line: road lane marking detected. The system is ready to intervene on the side shown.

With some equipment levels, additional details about the road lane marking may also be shown on the instrument cluster display, e.g. dashed lane markings.

With some equipment levels, a display is also shown on the Head-up Display → page 21.

The following indicator lamps light up, depending on the driving situation:

System is active and ready to perform control intervention.

System intervention (corrective steering intervention).

If no warning lamp lights up, the system is not ready to intervene on either side (passive system status) or is switched off.

If the comfort drive function (Travel Assist) is actively performing a control operation, there is no steering intervention and the lane keeping system is not displayed.

Driver intervention prompt

If there is no steering activity, the system prompts you to drive in the middle of the lane by means of acoustic warnings and a display on the instrument cluster.

If you do not react, the system will switch to passive state.

Depending on the vehicle equipment, Emergency Assist will be activated if Emergency Assist is switched on in the Infotainment system.

Independently of steering activity, you will be additionally requested to drive in the middle of the lane again with a display on the instrument cluster display and with acoustic warnings if the corrective steering intervention takes place for an extended time.

Steering wheel vibration

The following situations can lead to vibration of the steering wheel:

— The system can no longer detect a lane during a major steering intervention.

You can also select the option **Vibration** or **Steering wheel vibration** in the Assist systems menu of the Infotainment system. In this case, the steering wheel will vibrate if the vehicle drives over a detected road lane marking when the lane keeping system is active. ◁

Troubleshooting

📖 Please refer to ⚠ at the start of the chapter on page 165.

Lane keeping system not available.

The indicator lamp lights up yellow. A message will also appear on the instrument cluster display.

— The camera window is dirty. Clean the windscreen → page 355.

— The view of the camera is impaired due to the weather conditions, e.g. snow, or due

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to detergent deposits or coatings. Clean the windscreen → page 355.

- The view of the camera is impaired by add-on parts or stickers. Keep the area around the camera window free.
- The camera has been displaced or damaged, e.g. due to damage to the windscreen. Check whether damage is visible → page 362.
- Fault or malfunction. Deactivate and reactivate the vehicle's drive system.
- If the problem persists, go to a qualified workshop.

It can take a few seconds before a system fault is detected after the ignition is switched on.

If the lane keeping system is not available, Emergency Assist is also not available.

If the lane keeping system is not available, Travel Assist is also not available.

The system is not responding as expected.

- Do not attach any objects to the steering wheel.

Touch panels react differently than expected.

Moisture, dirt and grease can impede the functioning of the touch panels.

- Make sure the touch panels are always clean and dry. ◁

Travel Assist

Introduction to the topic

Travel Assist combines Adaptive Cruise Control (ACC) with adaptive lane guidance. Within the system limits, this enables the driver to keep the vehicle at a preselected distance from the vehicle in front and stay in a predefined position within the lane.

Travel Assist uses the same sensors as the Adaptive Cruise Control (ACC) and the lane keeping system (Lane Assist). You should therefore read the information on ACC and Lane Assist carefully and observe the listed system limits and instructions.

Speed range

Travel Assist performs control as from around 20 km/h (around 15 mph), with extended operation for adaptive lane guidance from 0 km/h (0 mph). This speed range may differ in certain markets.

Driving with Travel Assist

Travel Assist automatically regulates the speed and steers the vehicle. Within the system limits, Travel Assist can decelerate the vehicle to a standstill behind a vehicle that is stopping. It can also start driving again by itself.

You can override Travel Assist regulation at any time.

Does the vehicle have Travel Assist?

The vehicle is equipped with Travel Assist if the button is available on the multifunction steering wheel.

APPENDIX C

Run Log

Subject Vehicle: **2021 Volkswagen ID.4 Pro S (Statement)** Test Date: **7/7/2021**

Driver: **N. Watanabe** **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	**Solid**	**Left**	Y	0.80	Pass	
2			Y	1.11	Pass	
3			Y	1.05	Pass	
4			Y	0.93	Pass	
5			Y	0.62	Pass	
6			Y	0.80	Pass	
7			Y	0.79	Pass	
8	**Solid**	**Right**	Y	0.77	Pass	
9			Y	0.39	Pass	
10			Y	0.69	Pass	
11			Y	0.77	Pass	
12			Y	0.82	Pass	
13			Y	0.90	Pass	
14			Y	0.82	Pass	
15	**Dashed**	**Right**	Y	0.35	Pass	
16			Y	0.65	Pass	
17			Y	0.50	Pass	
18			Y	0.78	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Visual Alert (ft)	Pass/Fail	Notes
19	**Dashed**	**Right**	Y	0.28	Pass	
20			Y	0.52	Pass	
21			Y	0.96	Pass	
22	**Dashed**	**Left**	Y	0.81	Pass	
23			Y	0.86	Pass	
24			Y	0.84	Pass	
25			Y	0.88	Pass	
26			Y	0.90	Pass	
27			Y	0.88	Pass	
28			Y	0.91	Pass	
29	**Botts**	**Left**	Y	0.64	Pass	
30			Y	0.52	Pass	
31			Y	0.64	Pass	
32			Y	0.66	Pass	
33			Y	0.71	Pass	
34			Y	0.86	Pass	
35			N			Hit cone
36			Y	0.32	Pass	
37	**Botts**	**Right**	Y	0.75	Pass	
38			Y	0.76	Pass	
39			Y	0.87	Pass	
40			Y	0.32	Pass	
41			Y	0.45	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Visual Alert (ft)	Pass/Fail	Notes
42	**Botts**	**Right**	Y	0.89	Pass	
43			Y	0.66	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.

Notes

The variability in the lateral lane velocity traces for the Botts Dots scenarios is a result of using an unsmoothed lateral location reference file for the lane line positioning on the test track. Unfortunately, it is not possible to smooth the test data in post-processing, but the variability shown in the traces does not affect test validity.

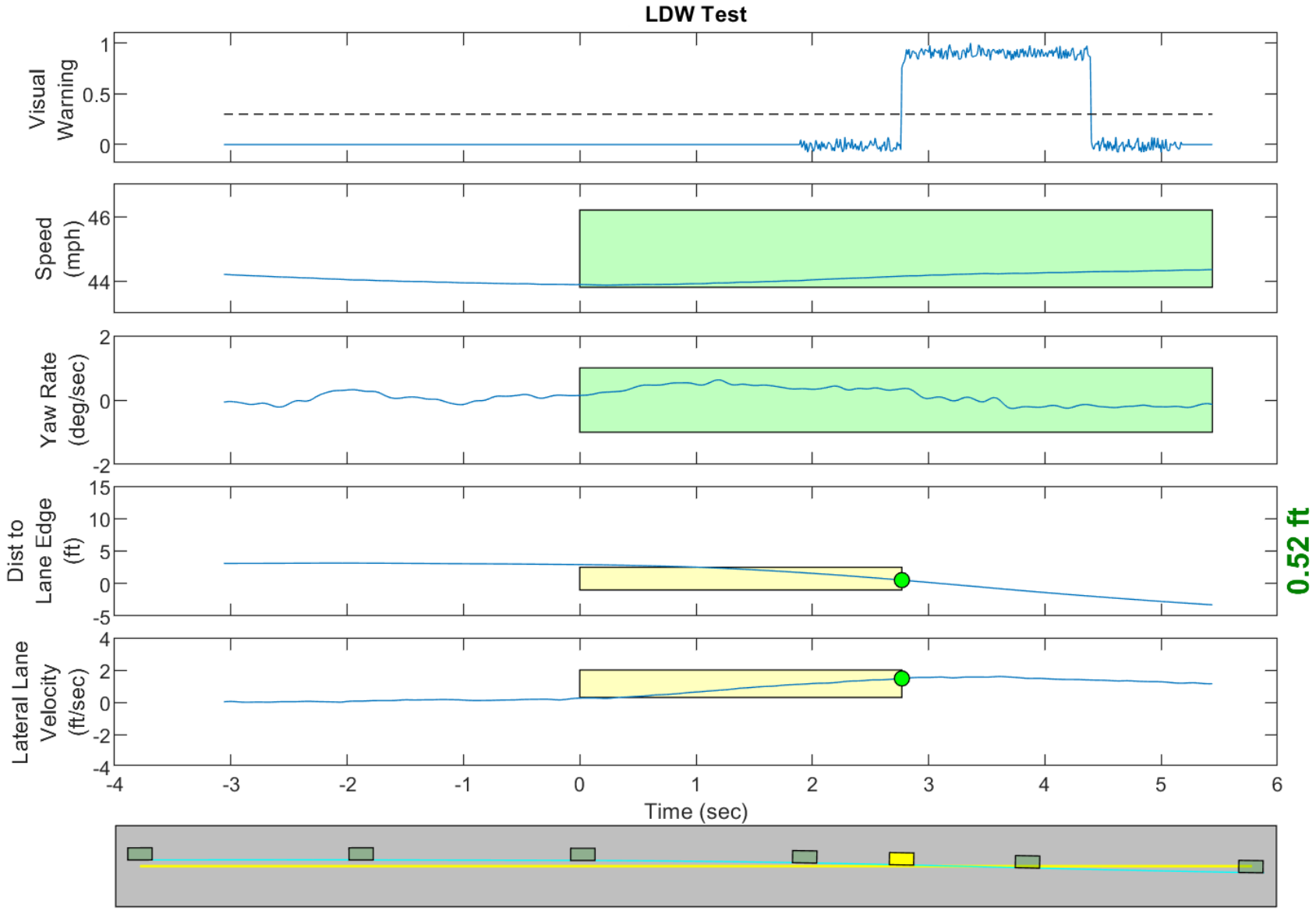

Figure D1. Example Time History for Lane Departure Warning Test, Passing

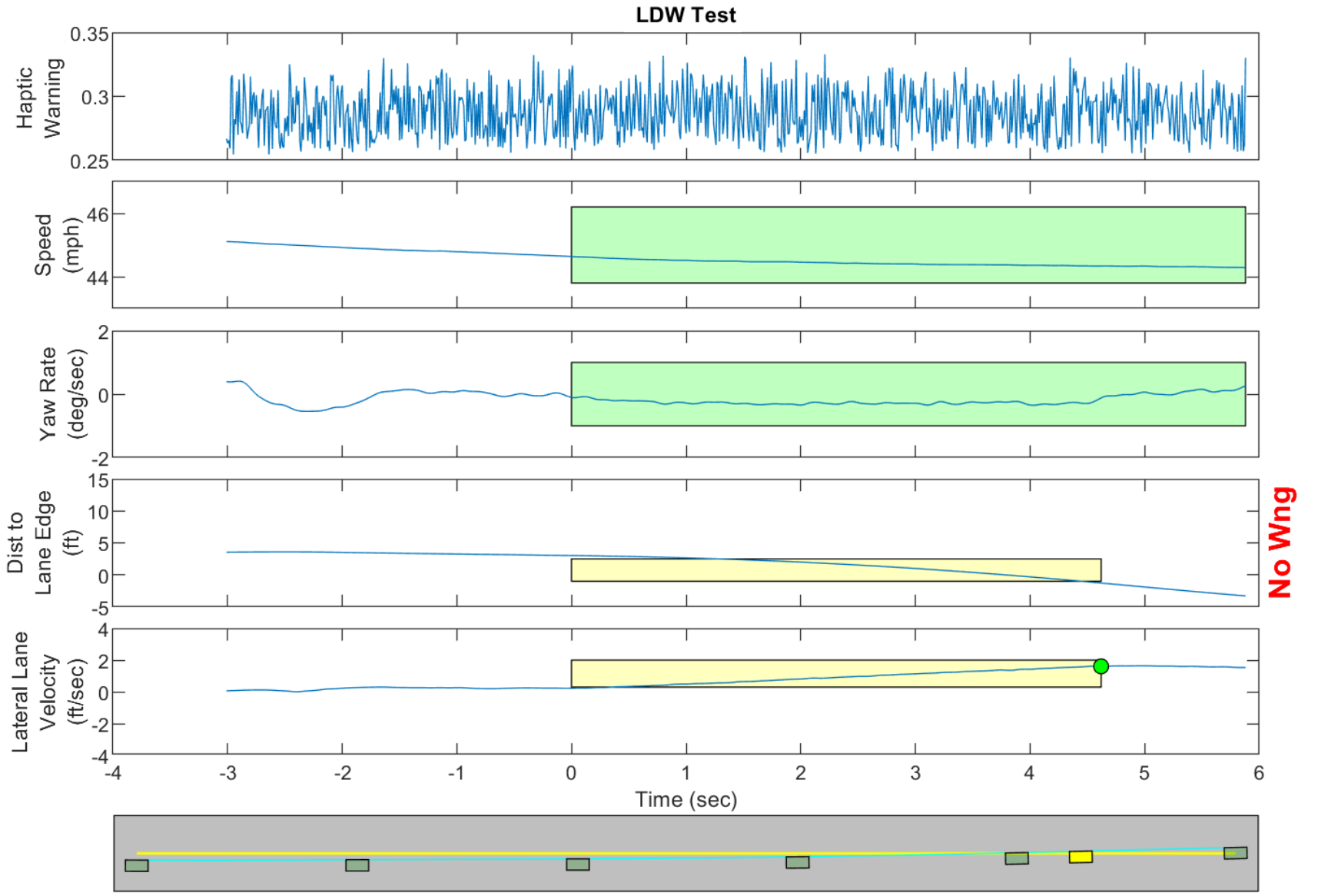

Figure D2. Example Time History for Lane Departure Warning Test, Failing, No Warning Issued

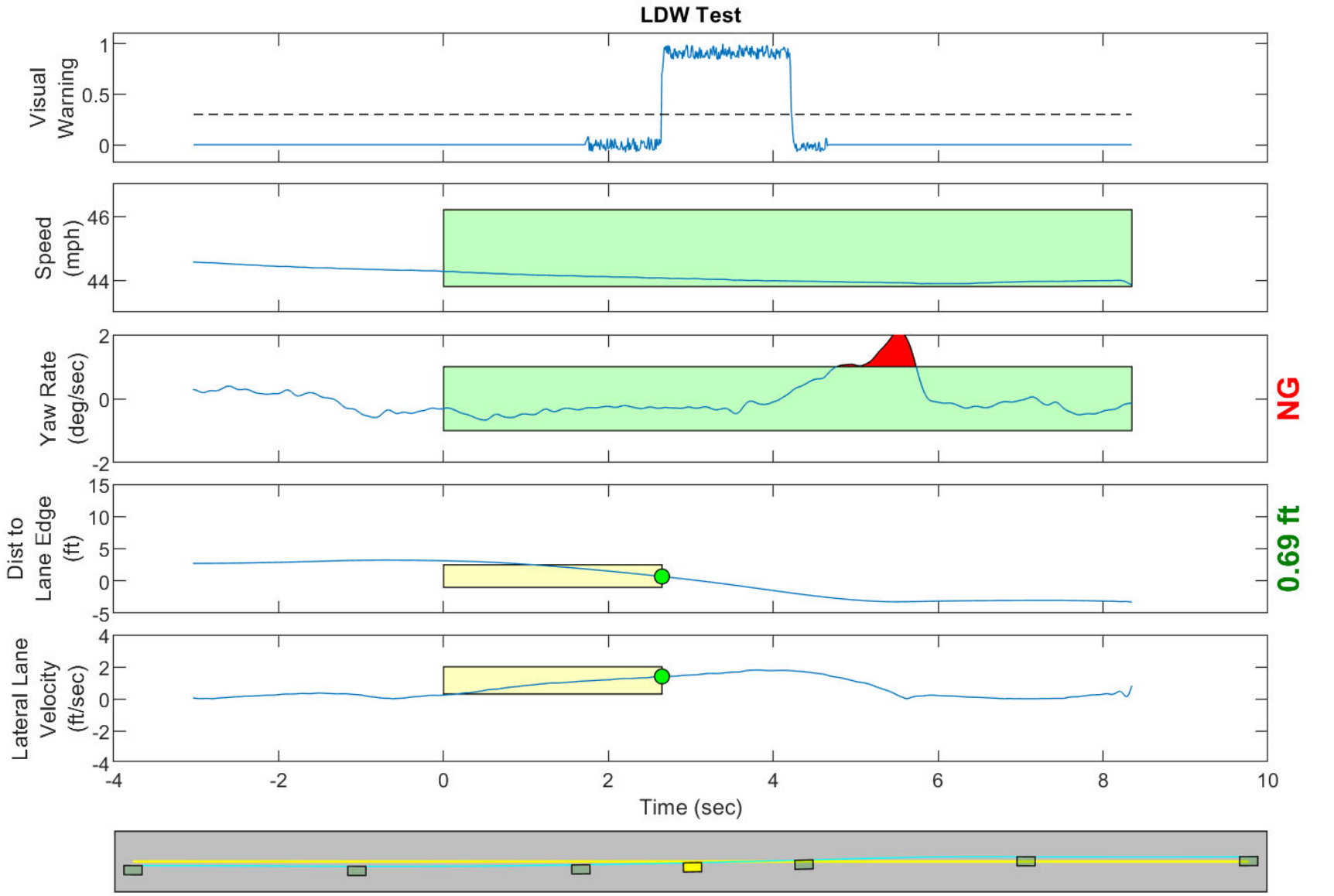

Figure D3. Example Time History for Lane Departure Warning Test, Invalid Run Due to Subject Vehicle Yaw Rate

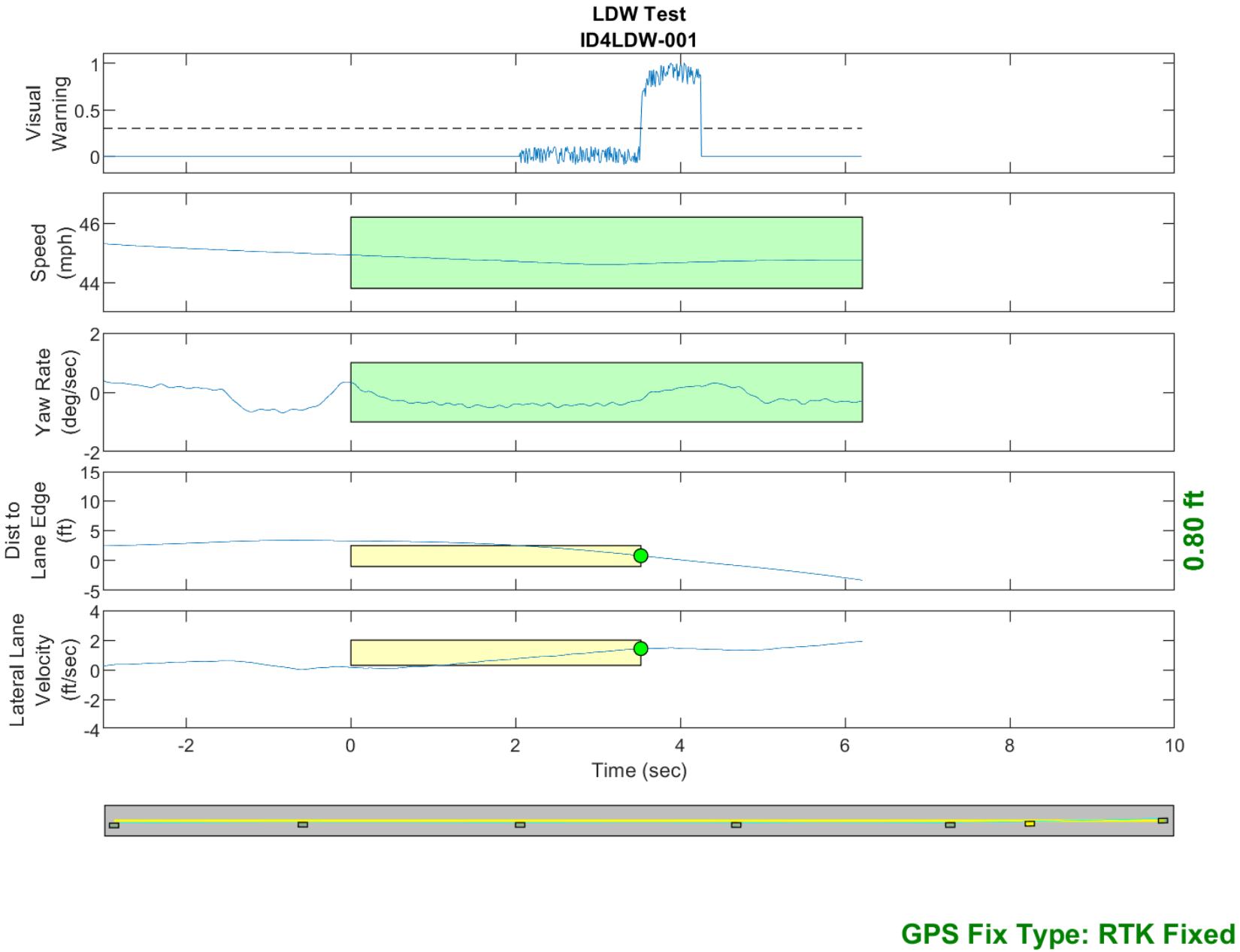

Figure D4. Time History for Run 01, Solid Line, Left Departure, Visual Warning

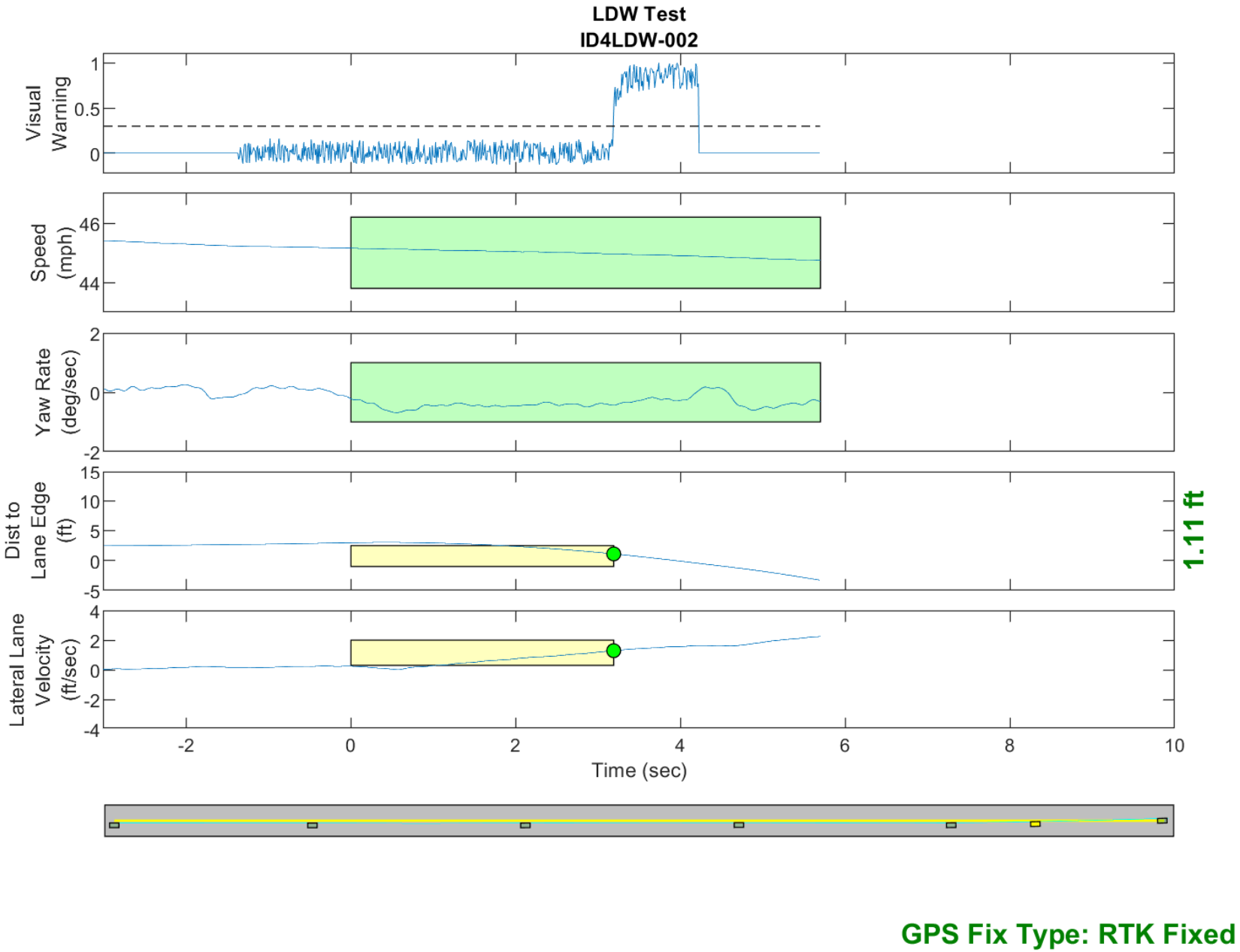

Figure D5. Time History for Run 02, Solid Line, Left Departure, Visual Warning

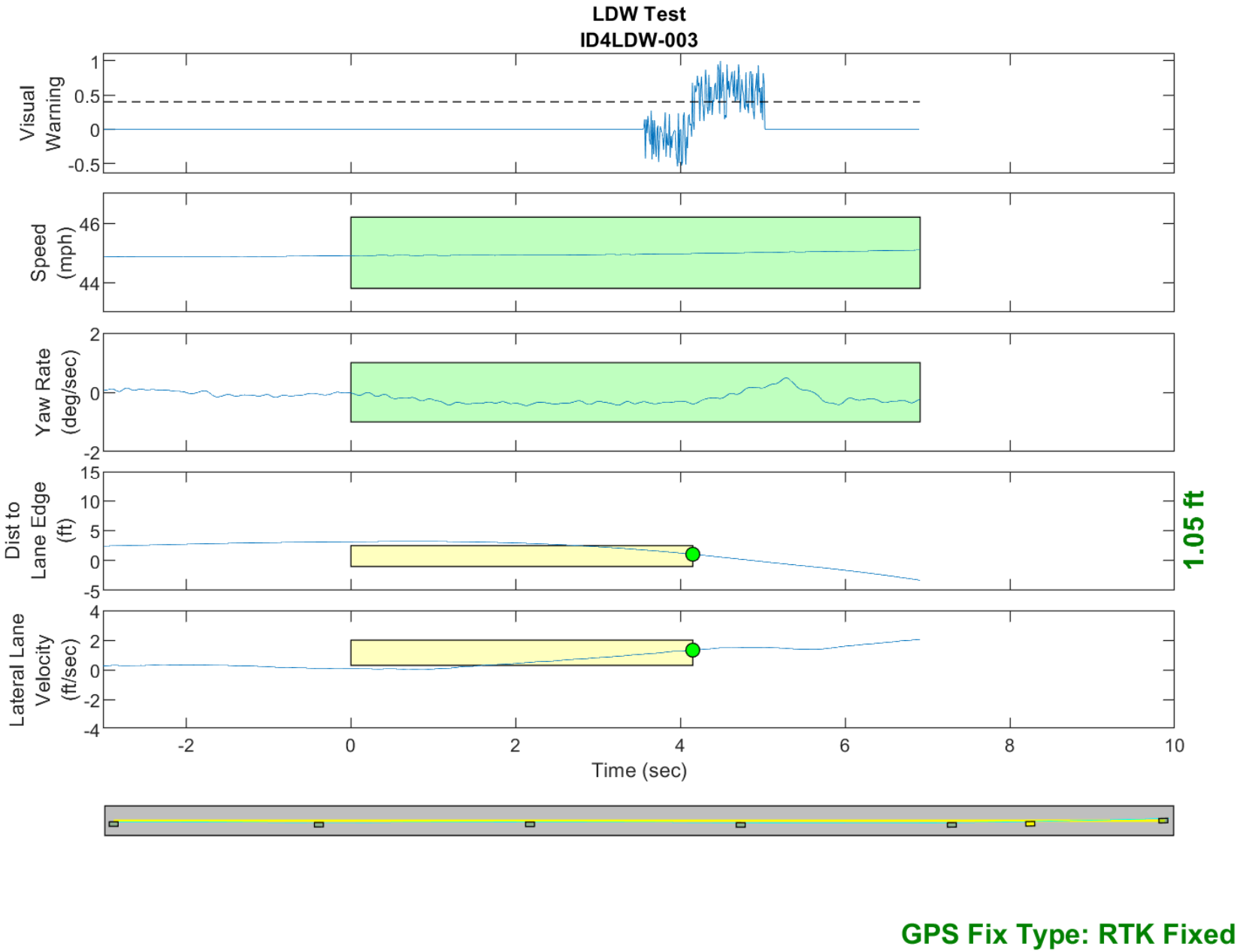

Figure D6. Time History for Run 03, Solid Line, Left Departure, Visual Warning

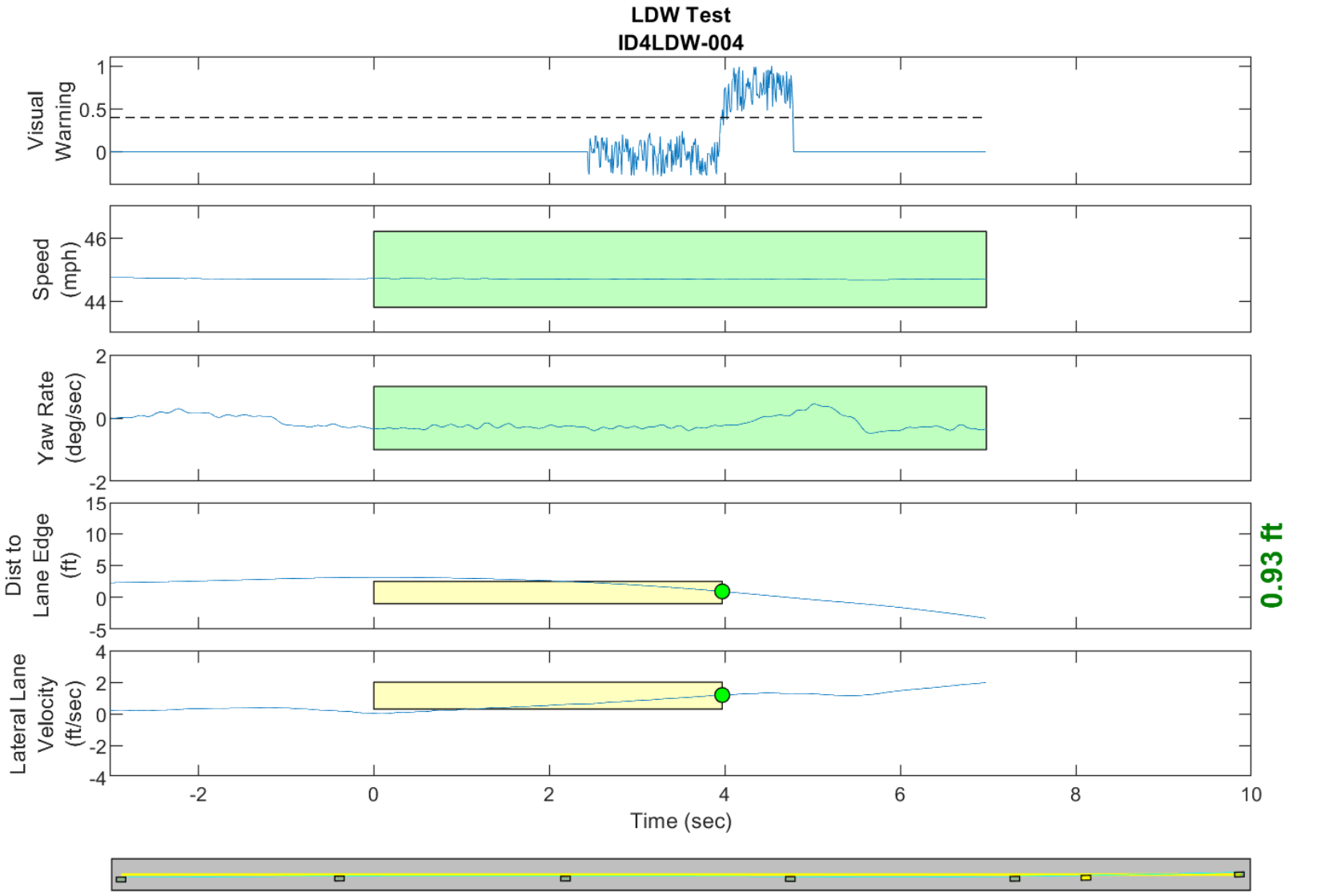

Figure D7. Time History for Run 04, Solid Line, Left Departure, Visual Warning

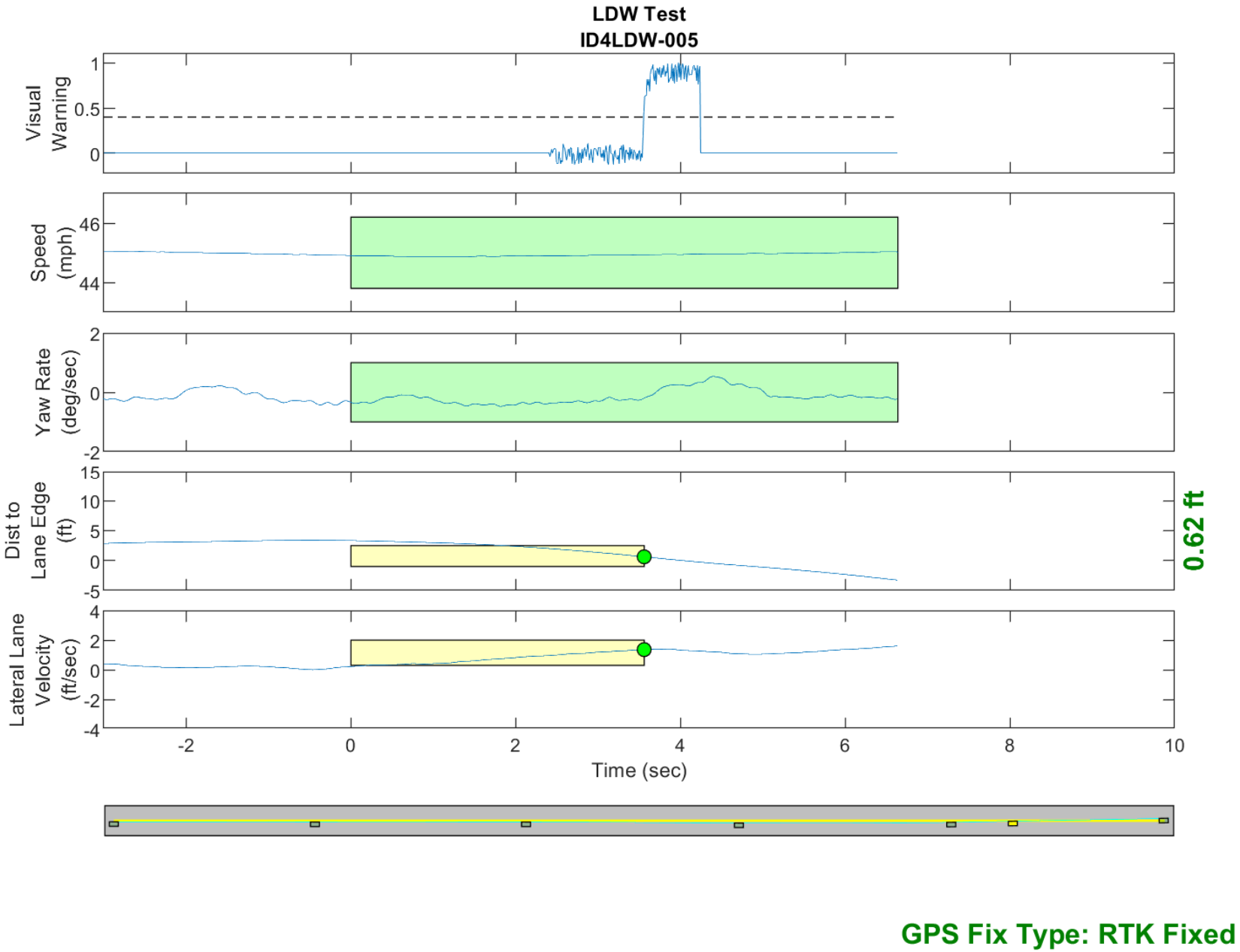

Figure D8. Time History for Run 05, Solid Line, Left Departure, Visual Warning

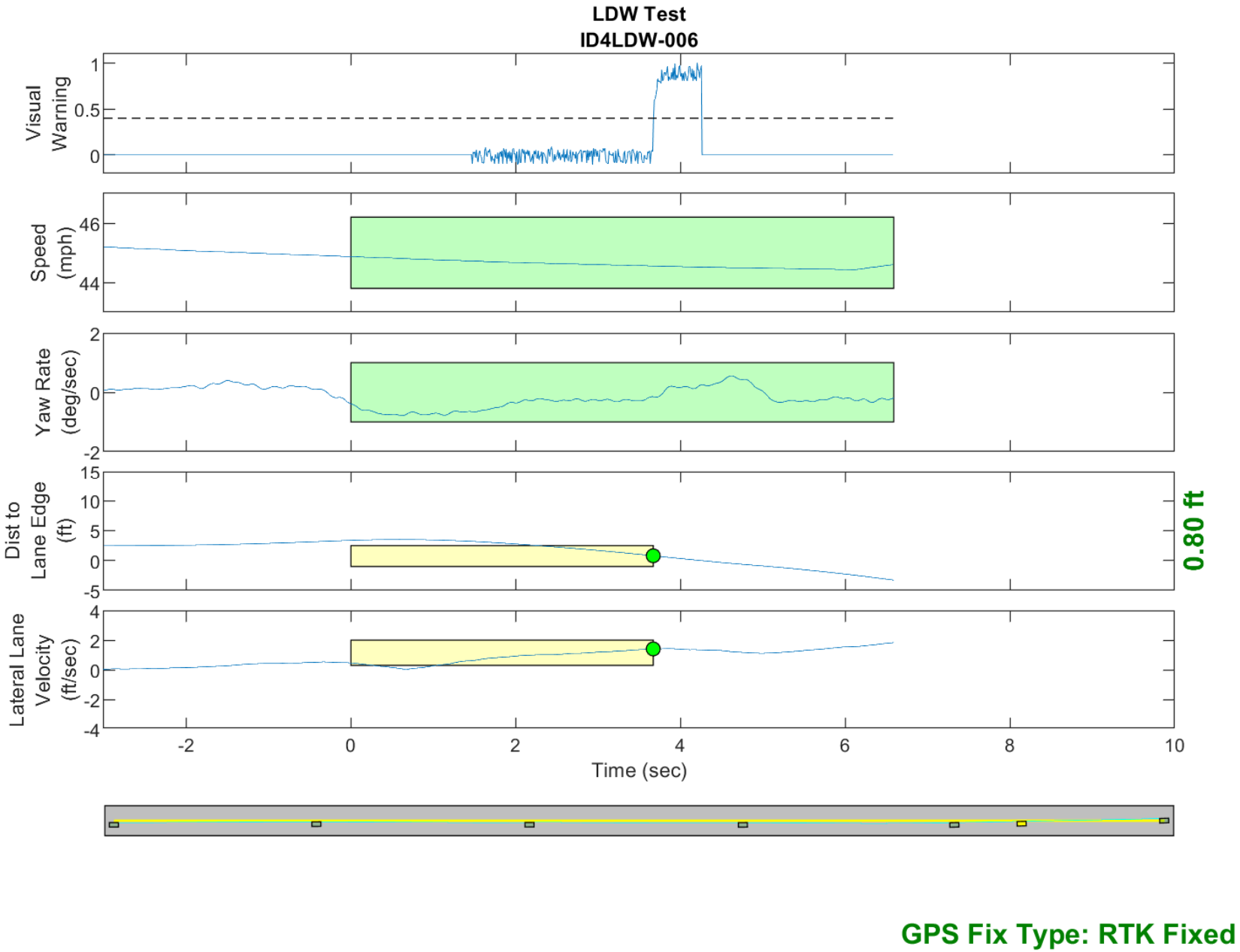

Figure D9. Time History for Run 06, Solid Line, Left Departure, Visual Warning

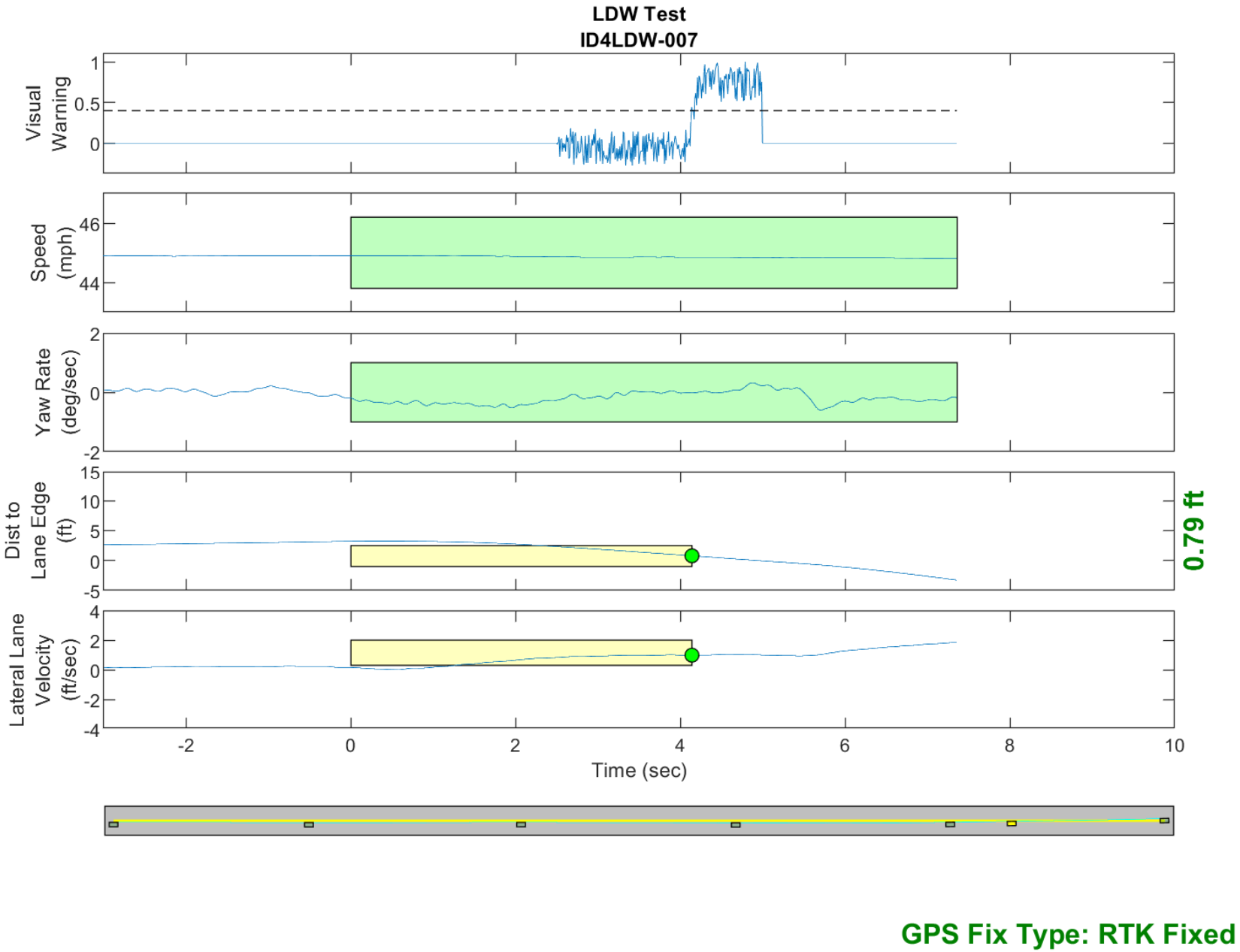

Figure D10. Time History for Run 07, Solid Line, Left Departure, Visual Warning

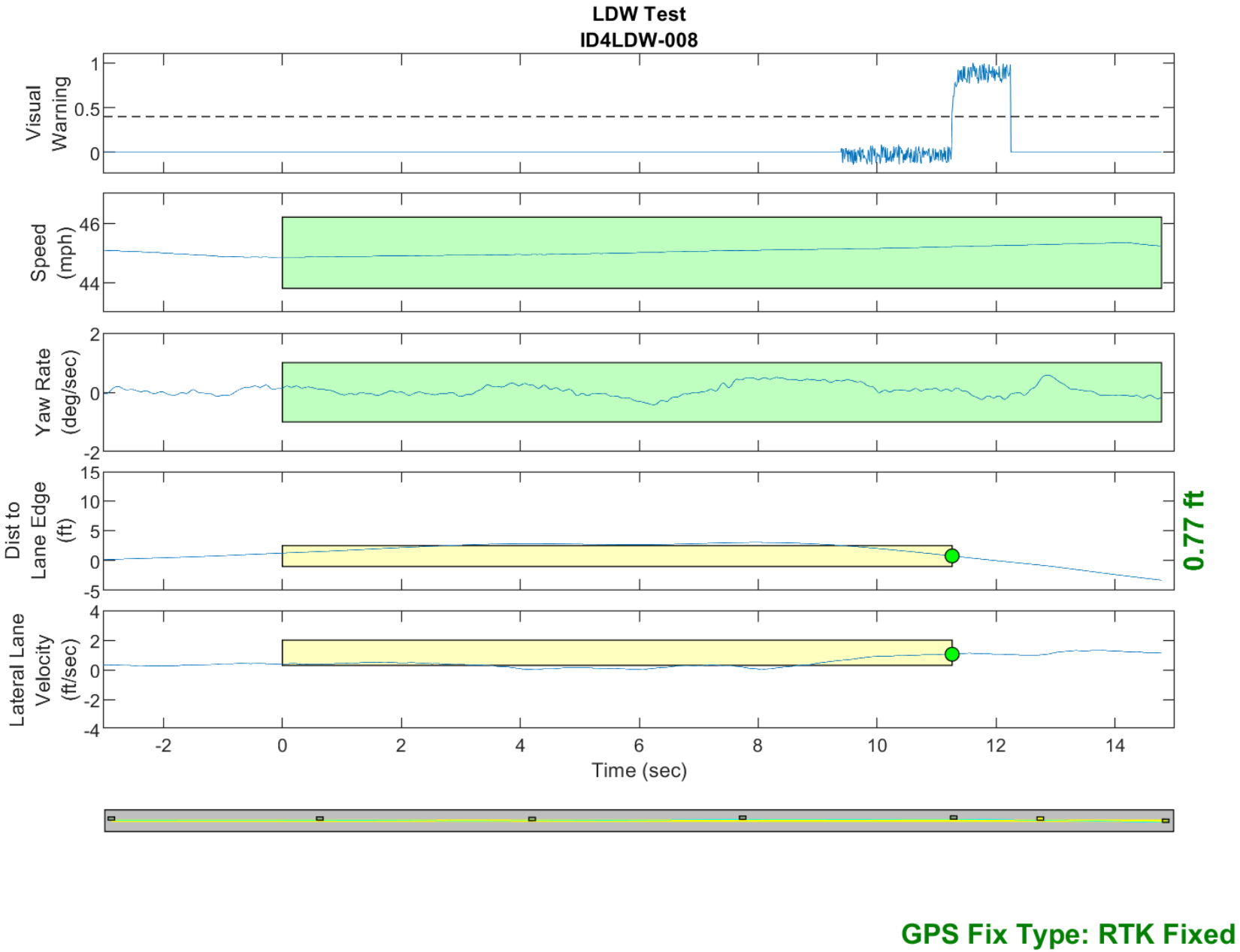

Figure D11. Time History for Run 08, Solid Line, Right Departure, Visual Warning

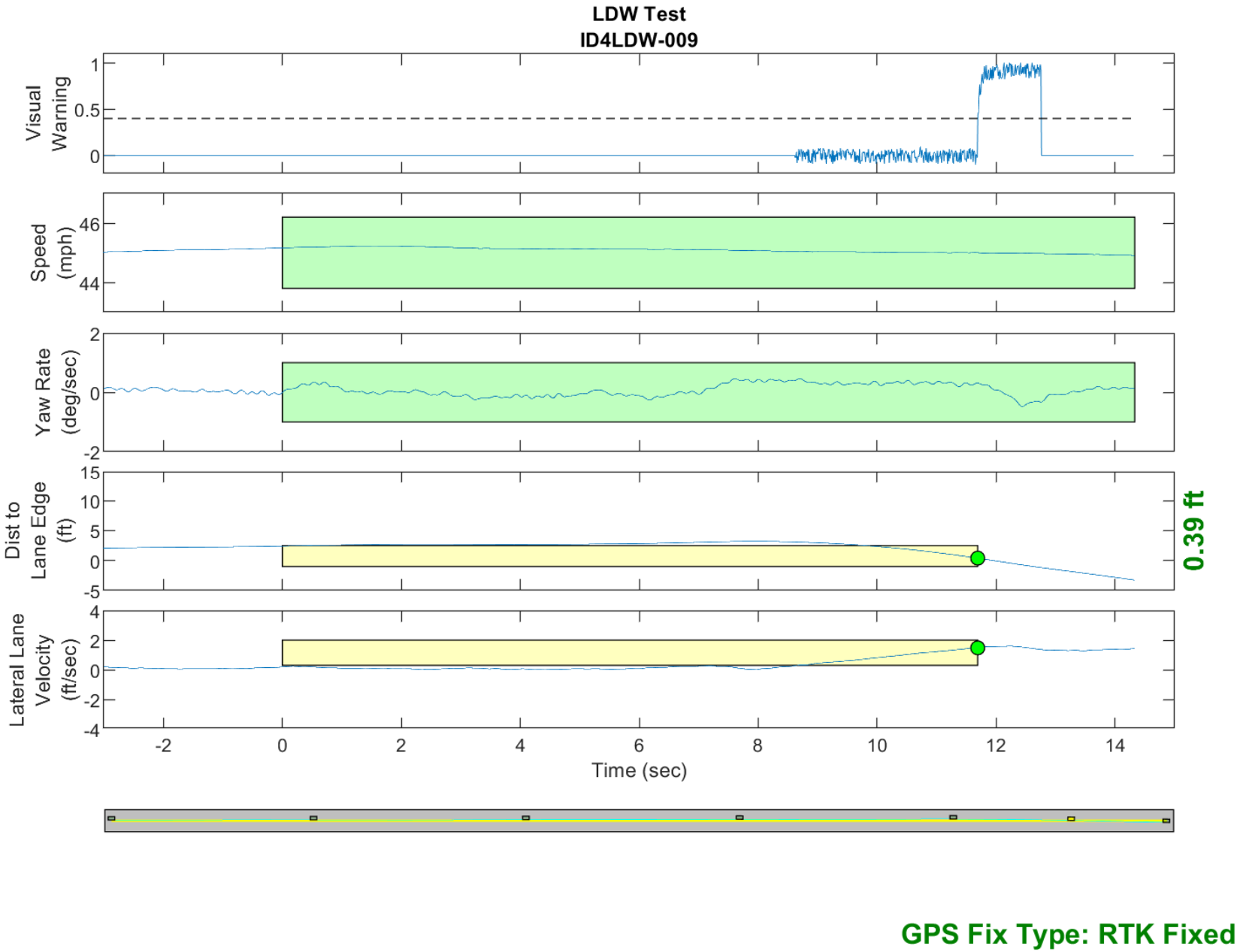

Figure D12. Time History for Run 09, Solid Line, Right Departure, Visual Warning

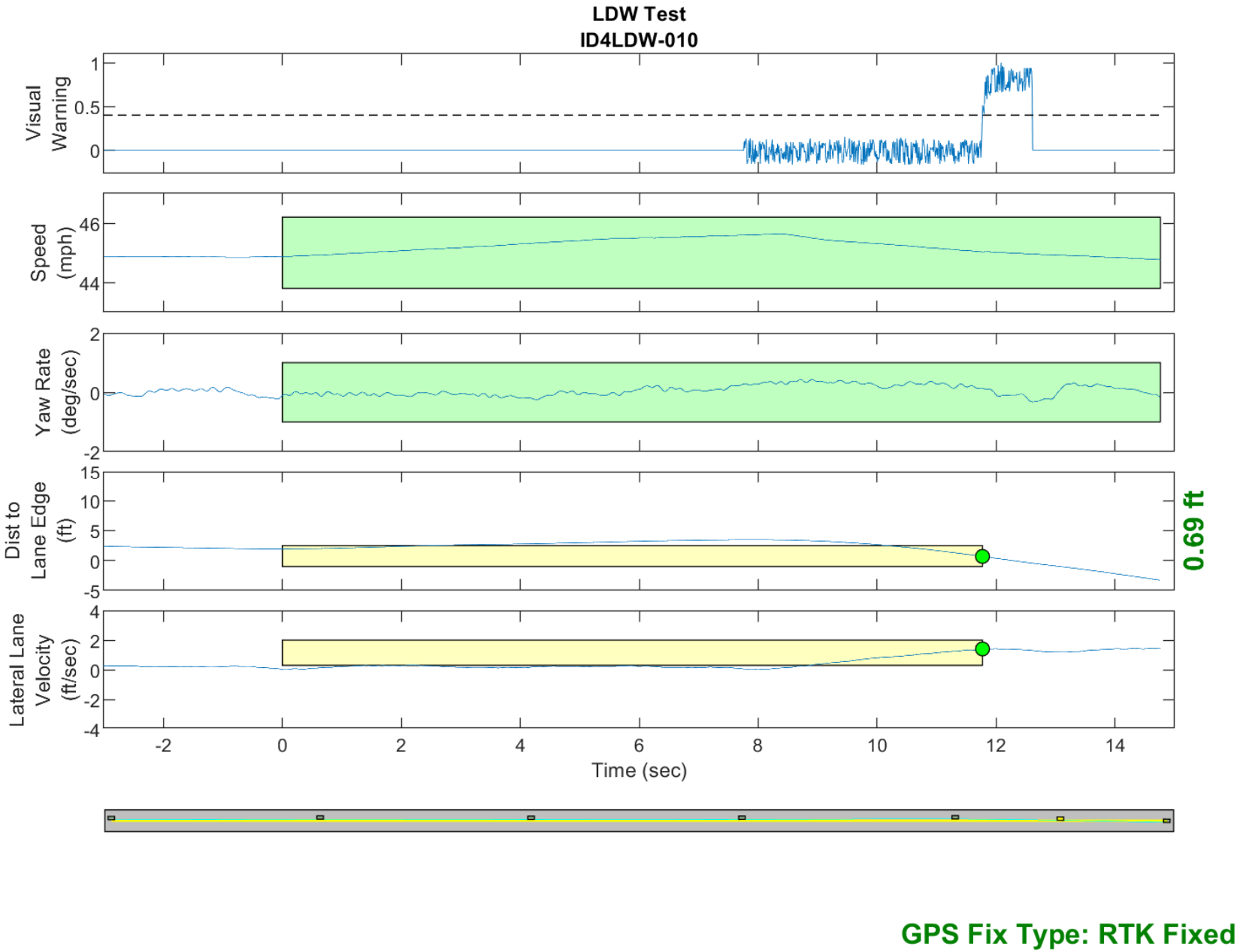

Figure D13. Time History for Run 10, Solid Line, Right Departure, Visual Warning

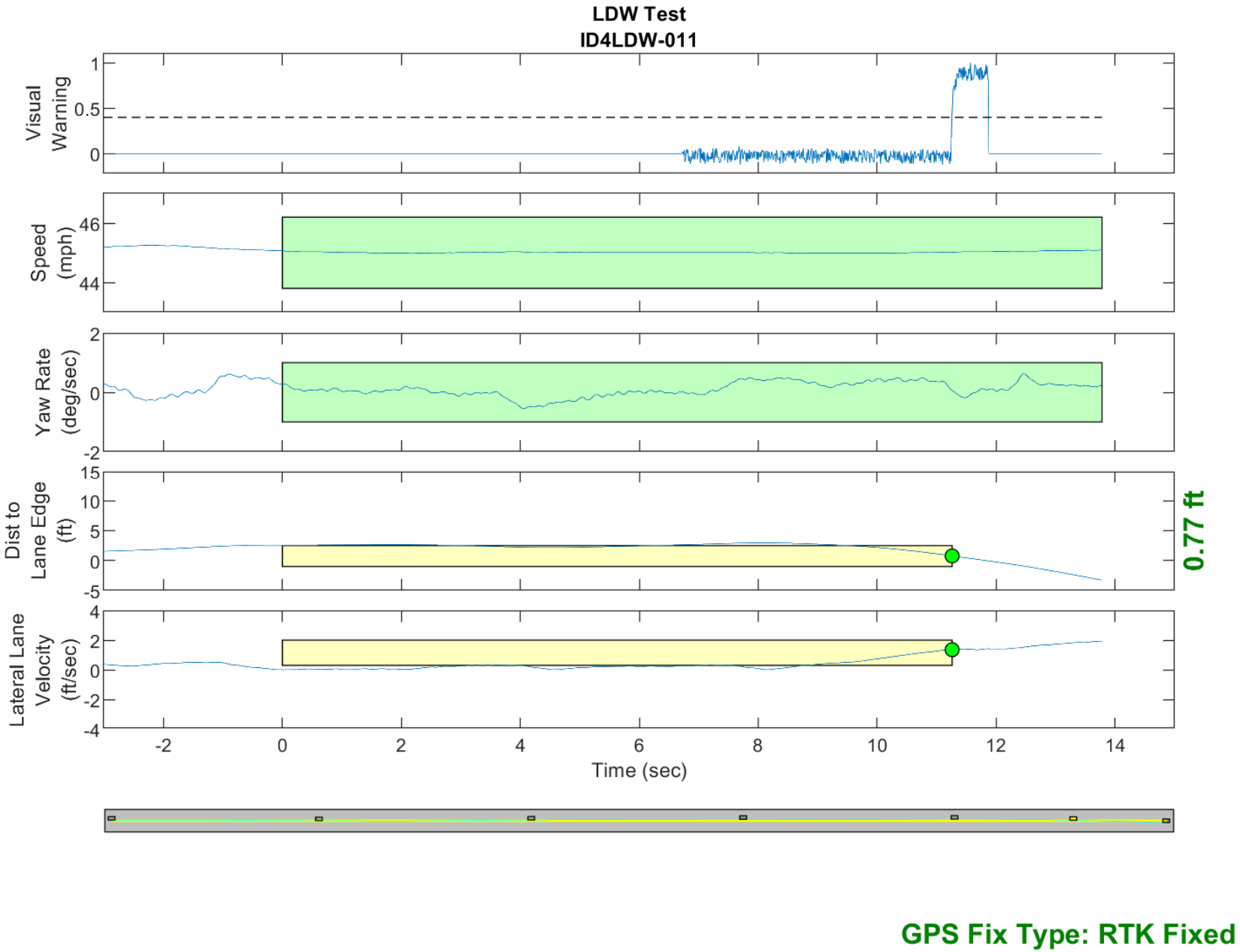

Figure D14. Time History for Run 11, Solid Line, Right Departure, Visual Warning

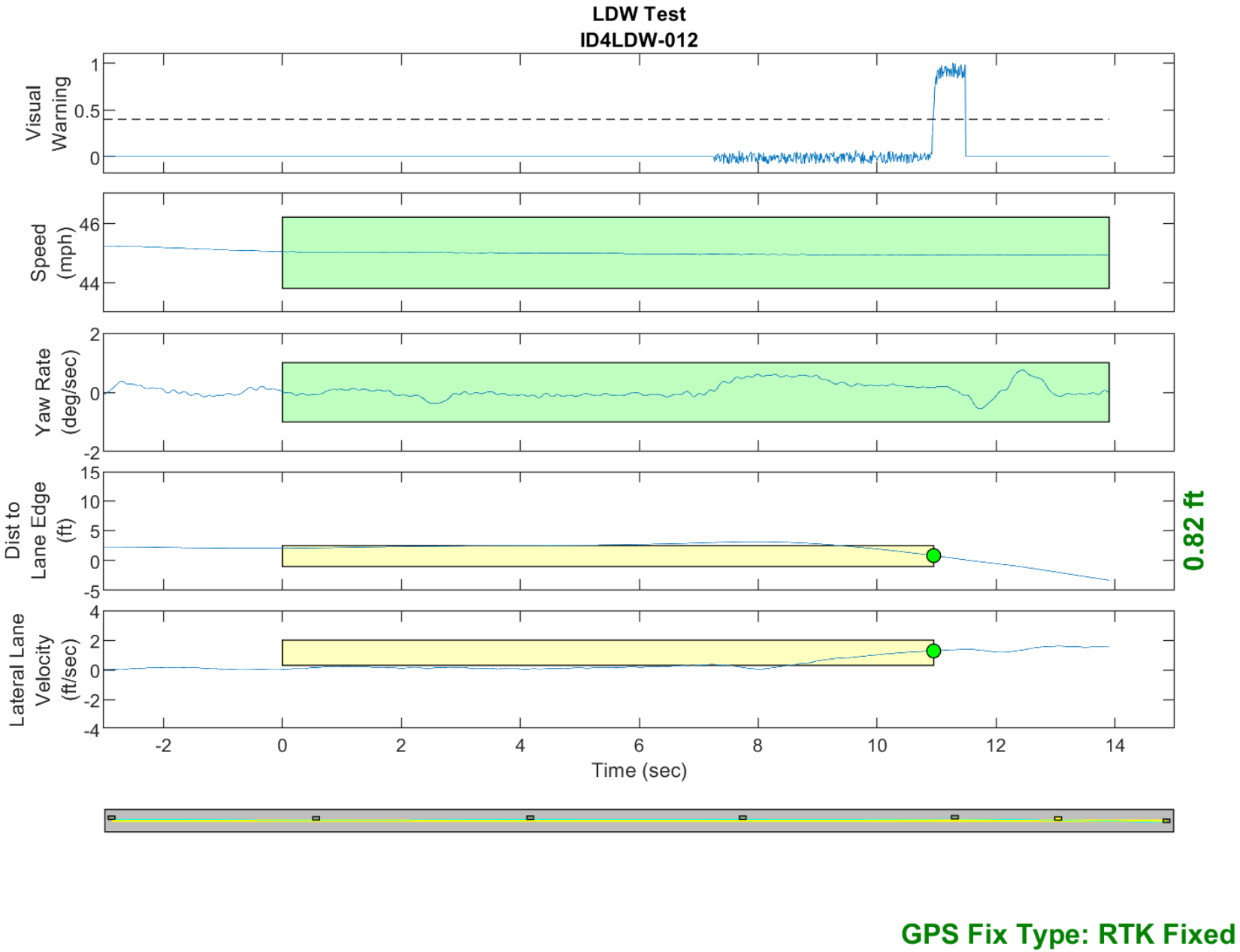

Figure D15. Time History for Run 12, Solid Line, Right Departure, Visual Warning

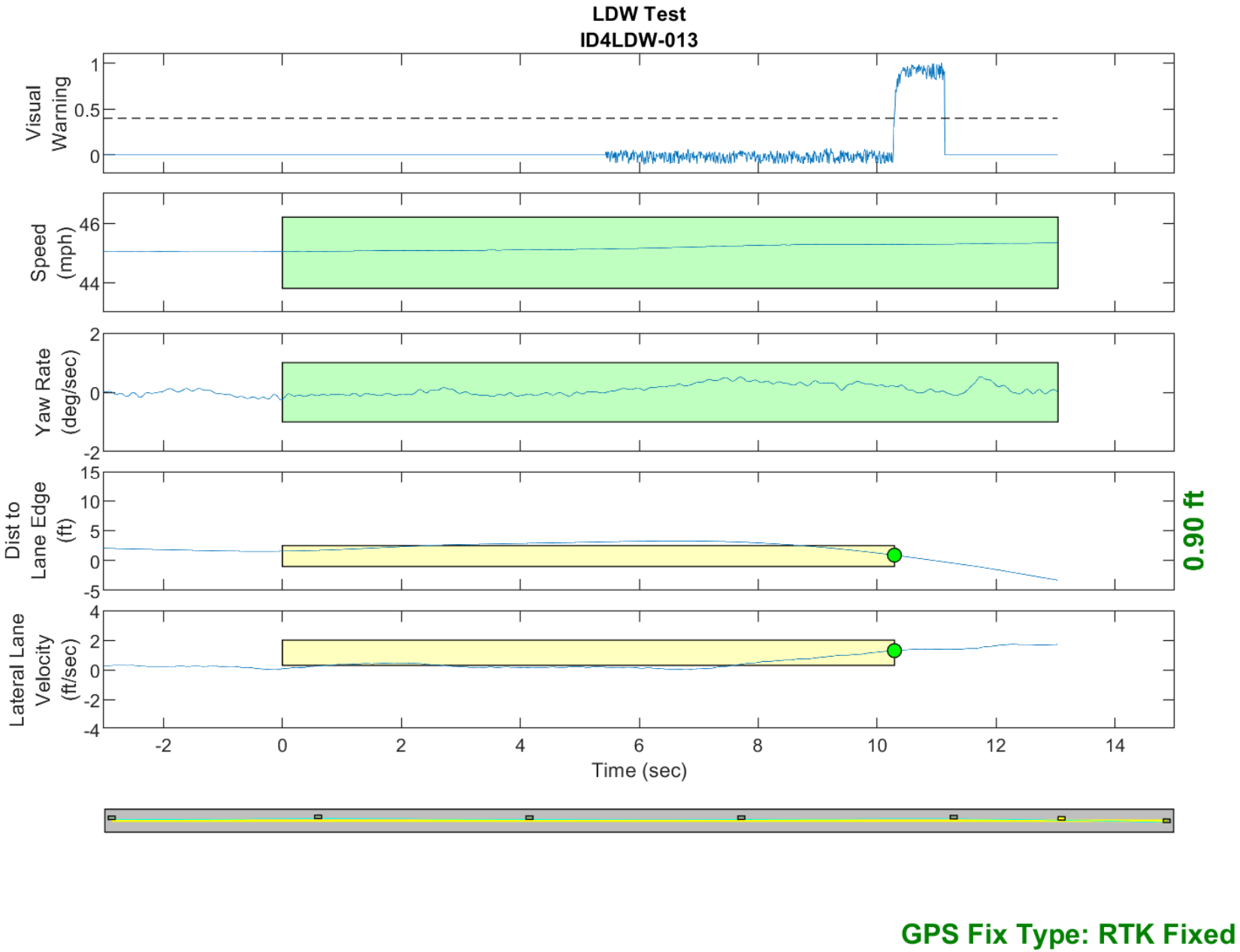

Figure D16. Time History for Run 13, Solid Line, Right Departure, Visual Warning

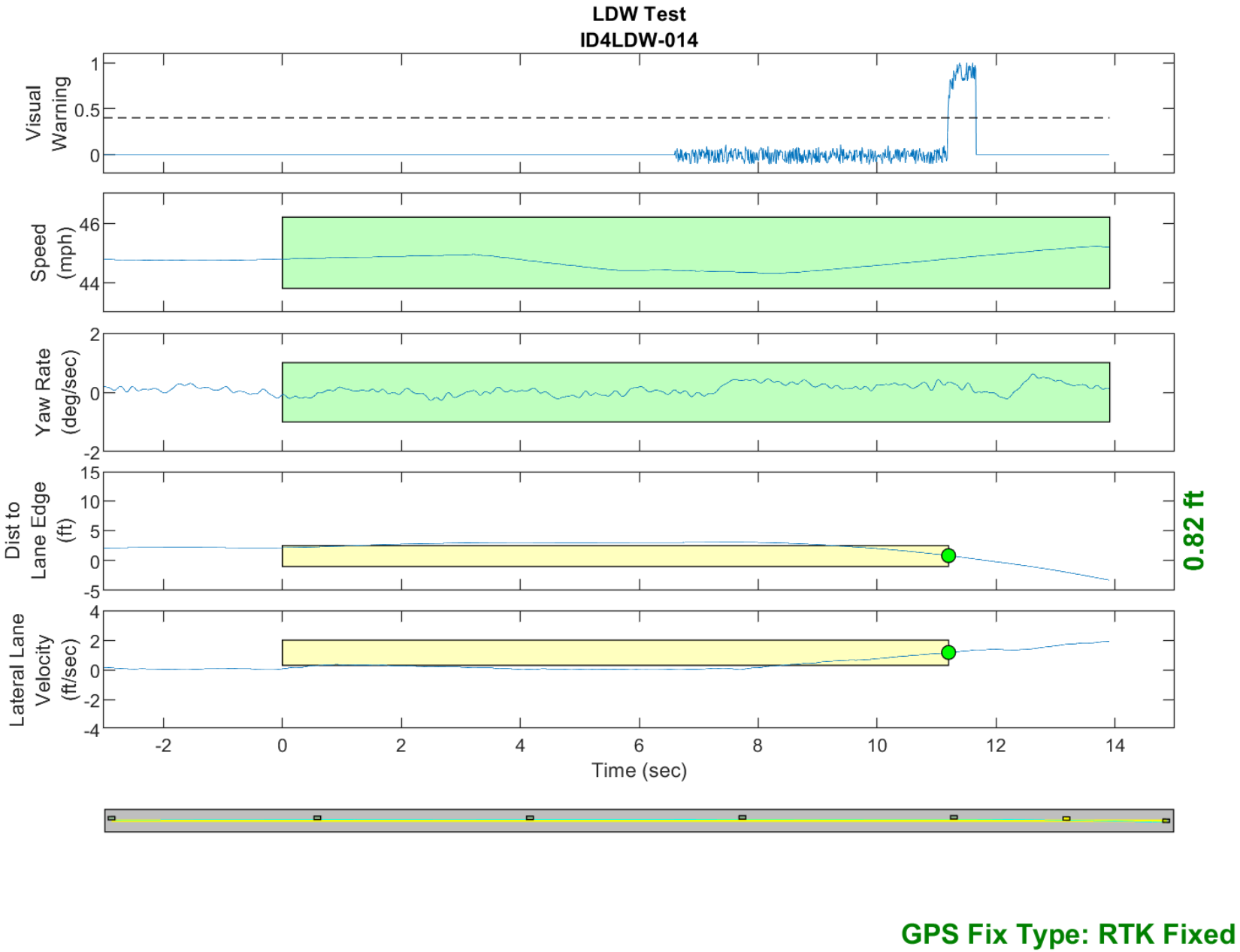

Figure D17. Time History for Run 14, Solid Line, Right Departure, Visual Warning

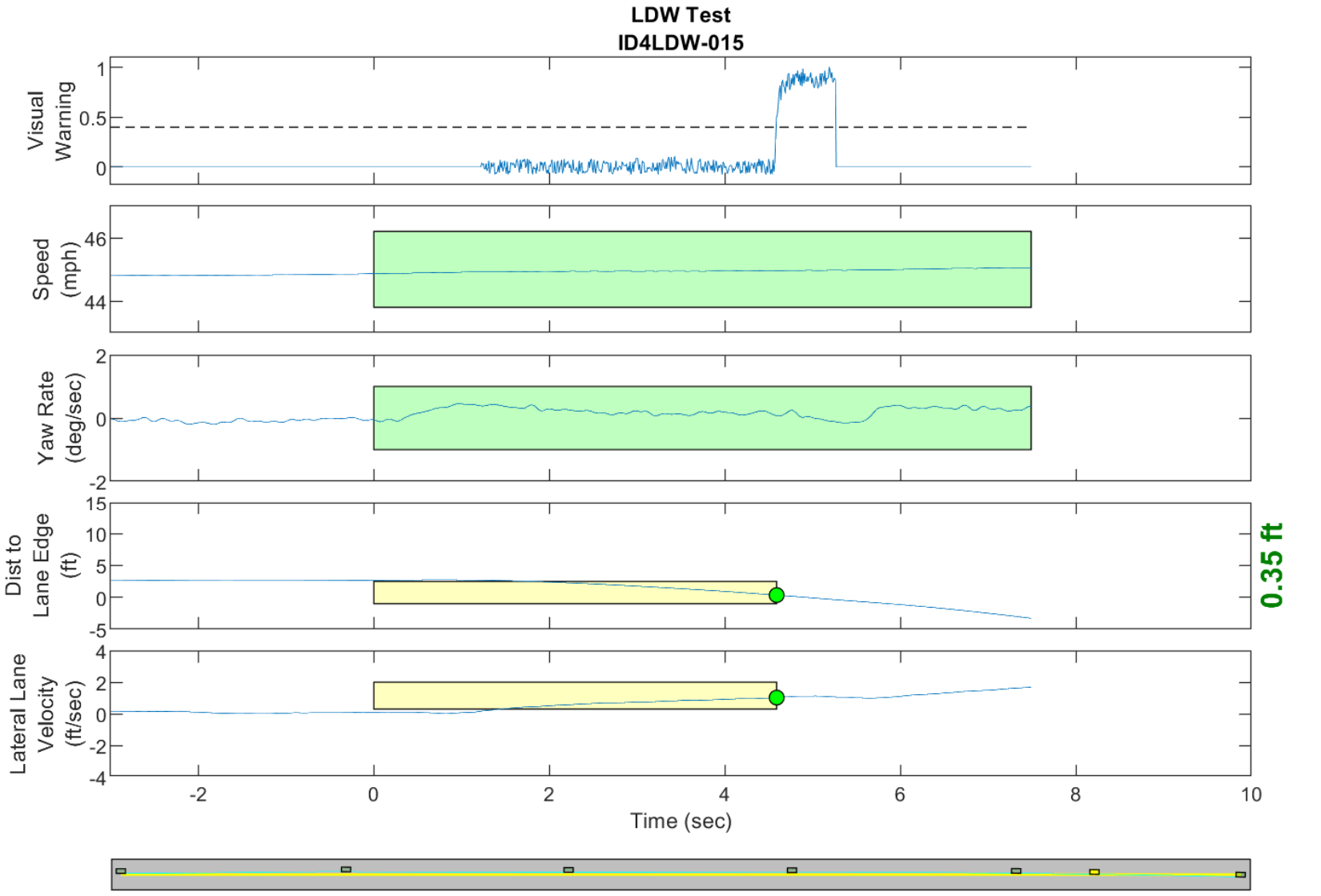

Figure D18. Time History for Run 15, Dashed Line, Right Departure, Visual Warning

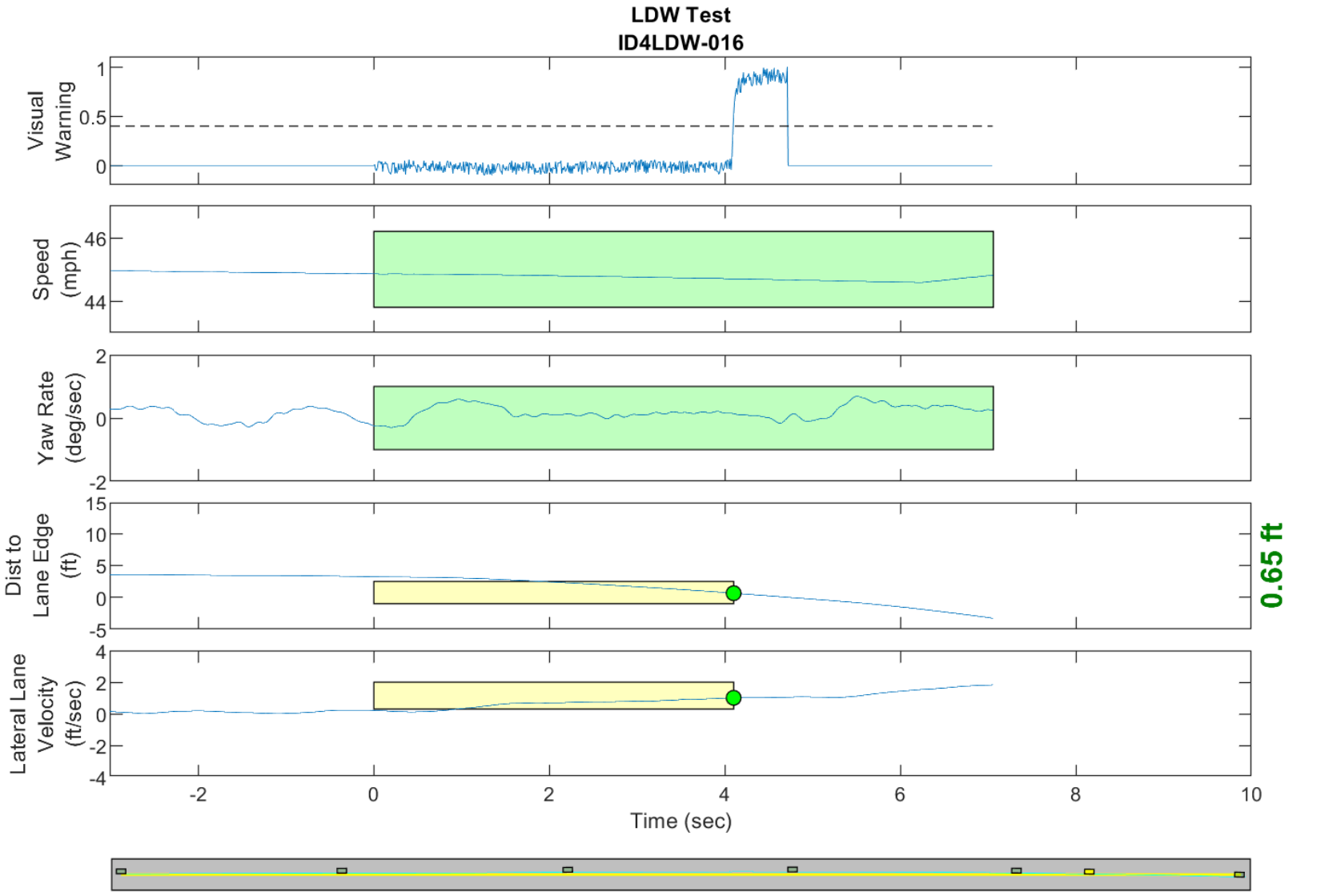

Figure D19. Time History for Run 16, Dashed Line, Right Departure, Visual Warning

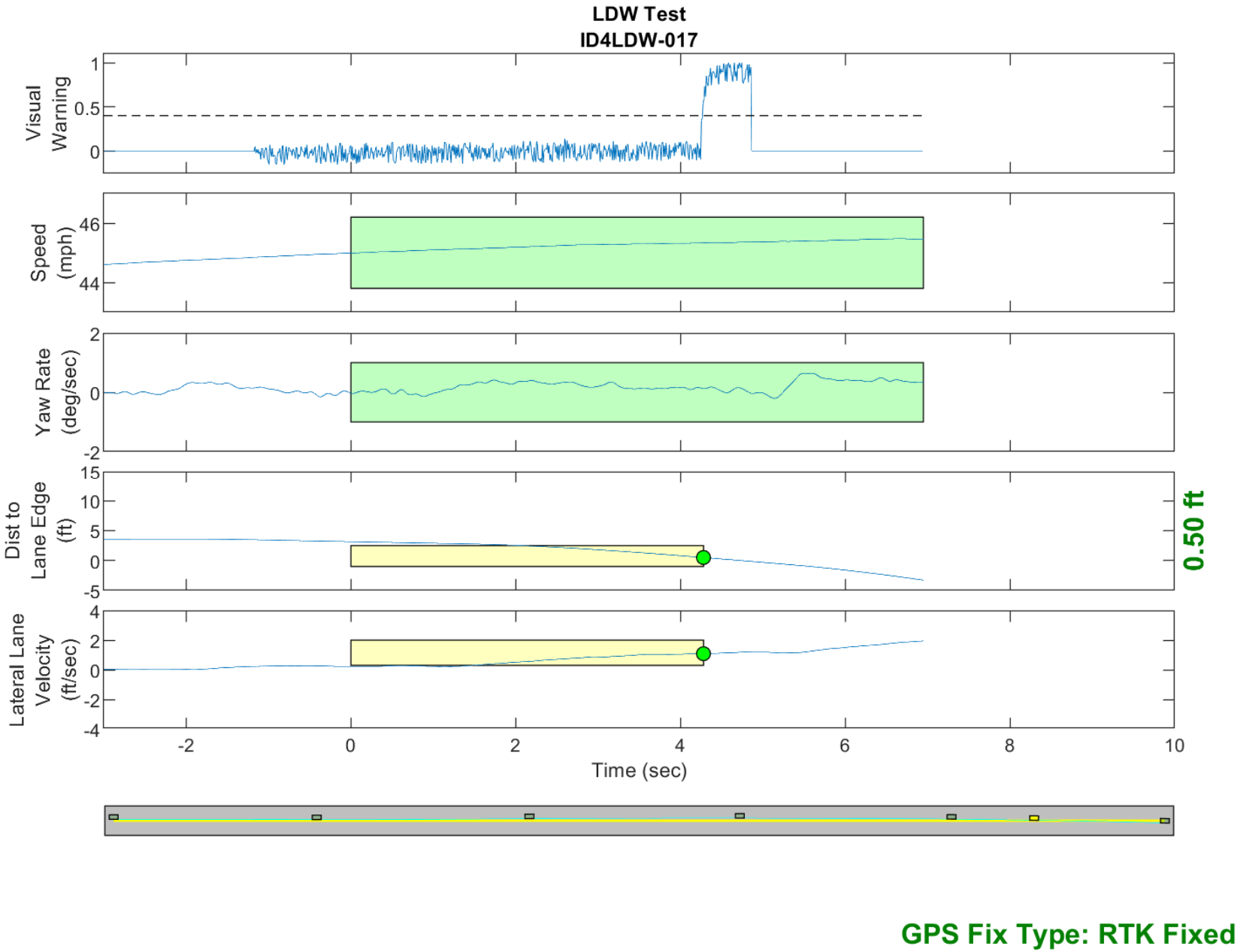

Figure D20. Time History for Run 17, Dashed Line, Right Departure, Visual Warning

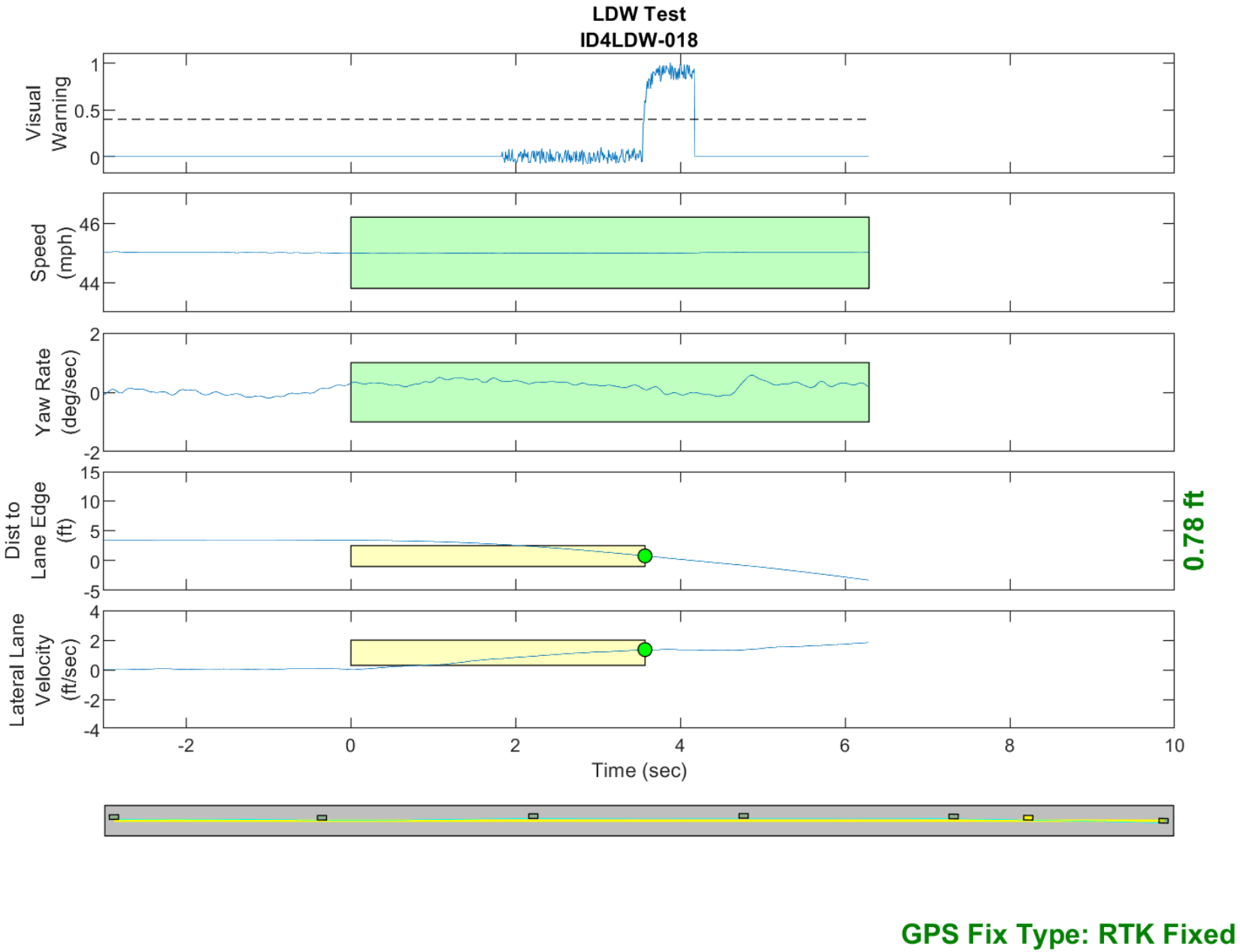

Figure D21. Time History for Run 18, Dashed Line, Right Departure, Visual Warning

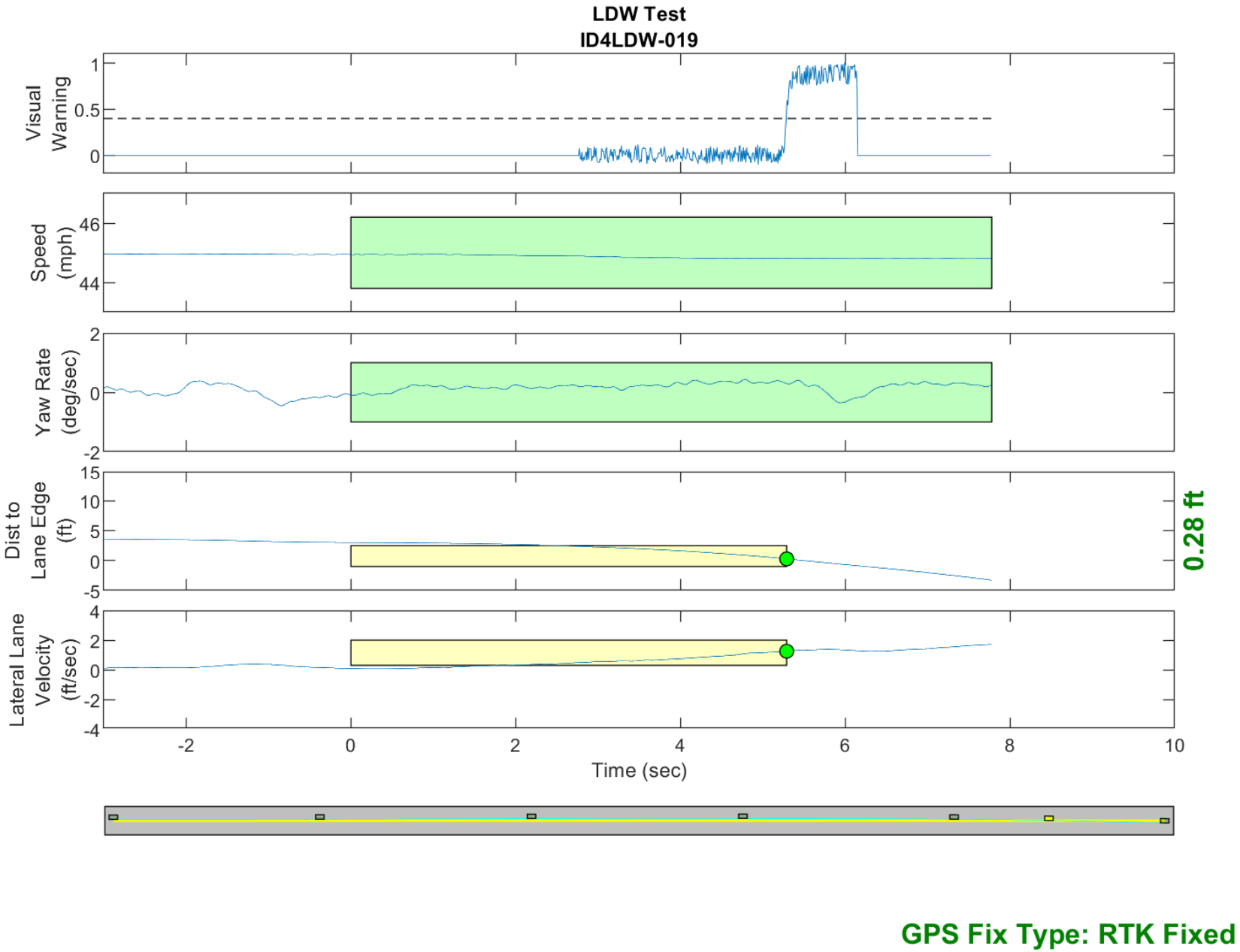

Figure D22. Time History for Run 19, Dashed Line, Right Departure, Visual Warning

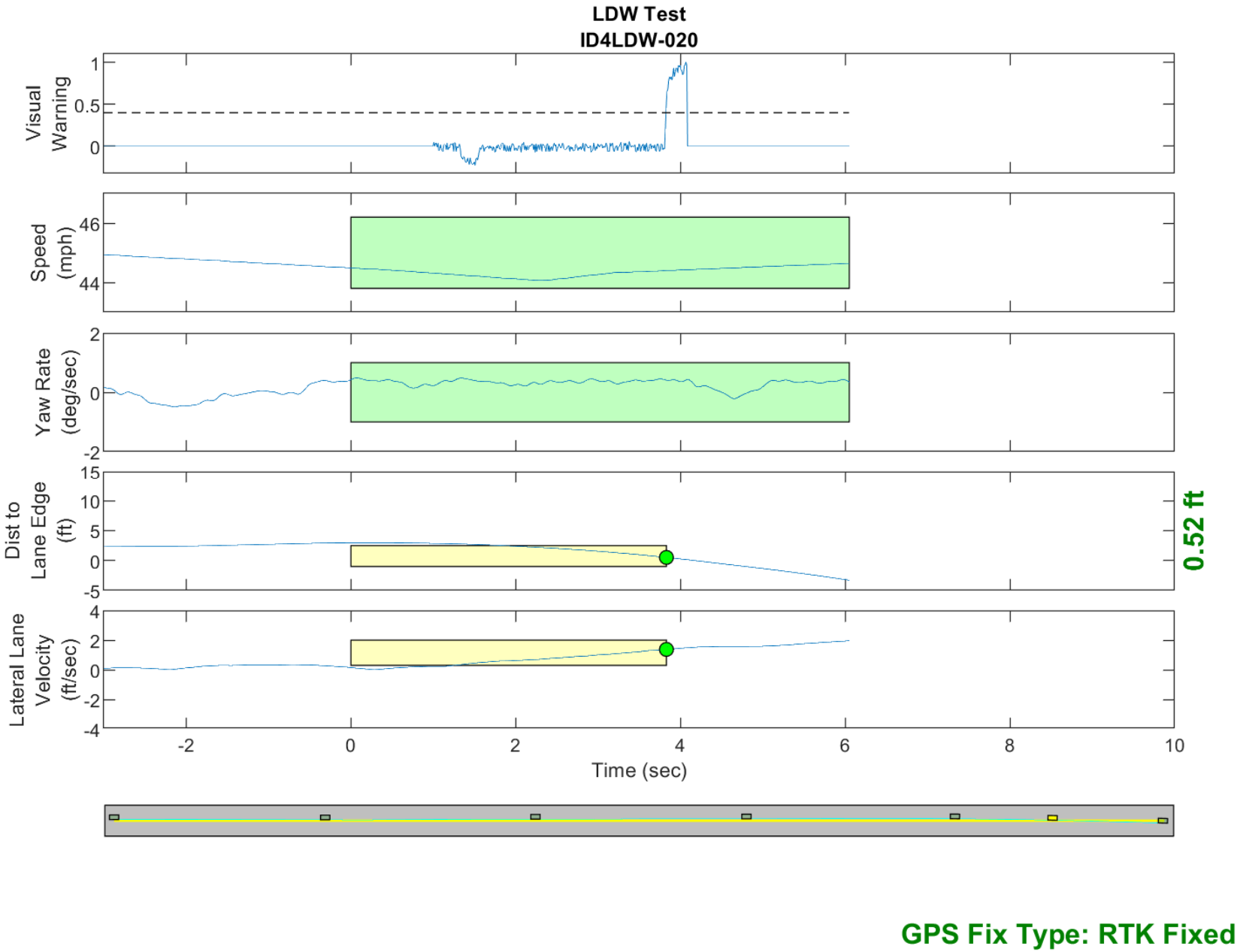

Figure D23. Time History for Run 20, Dashed Line, Right Departure, Visual Warning

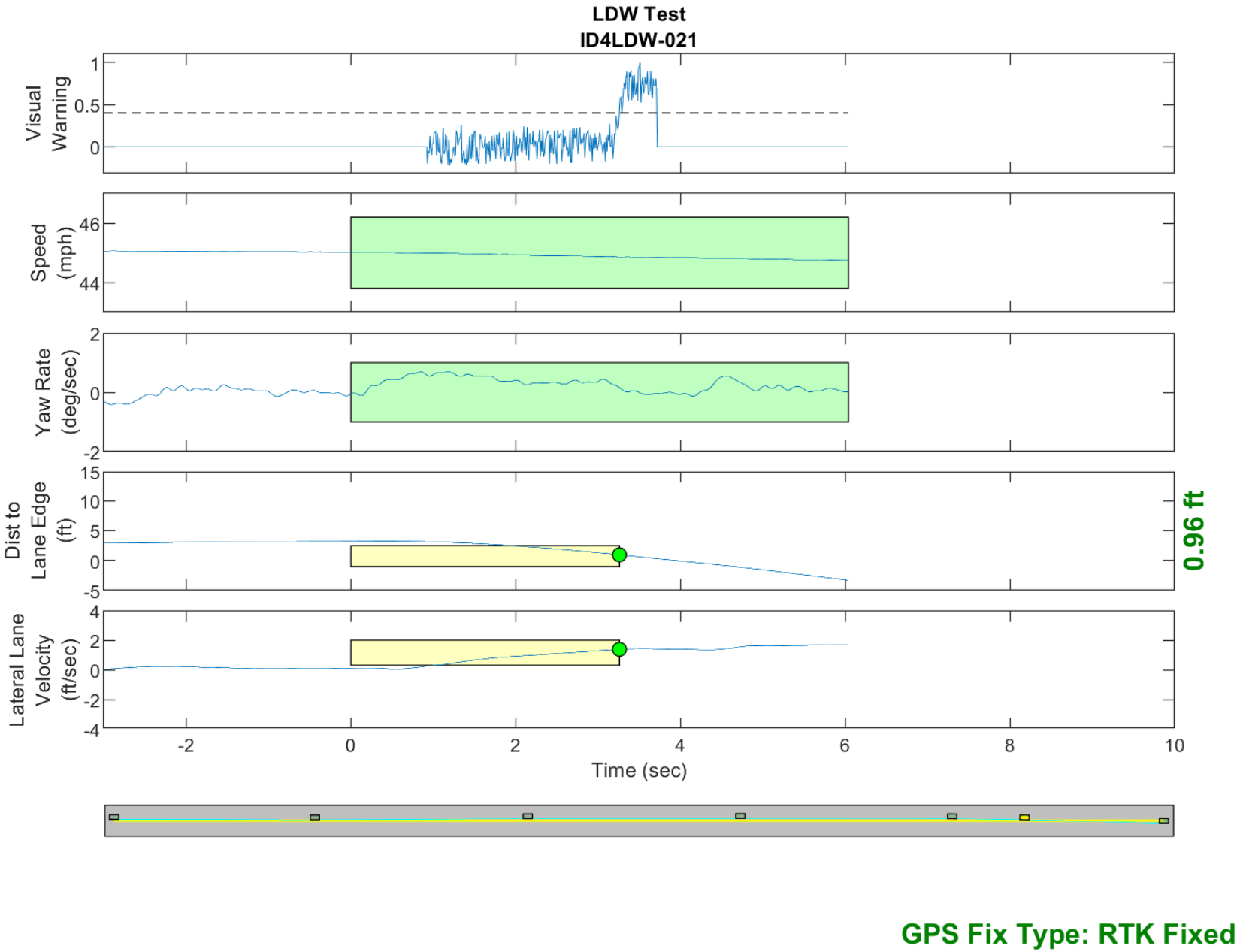

Figure D24. Time History for Run 21, Dashed Line, Right Departure, Visual Warning

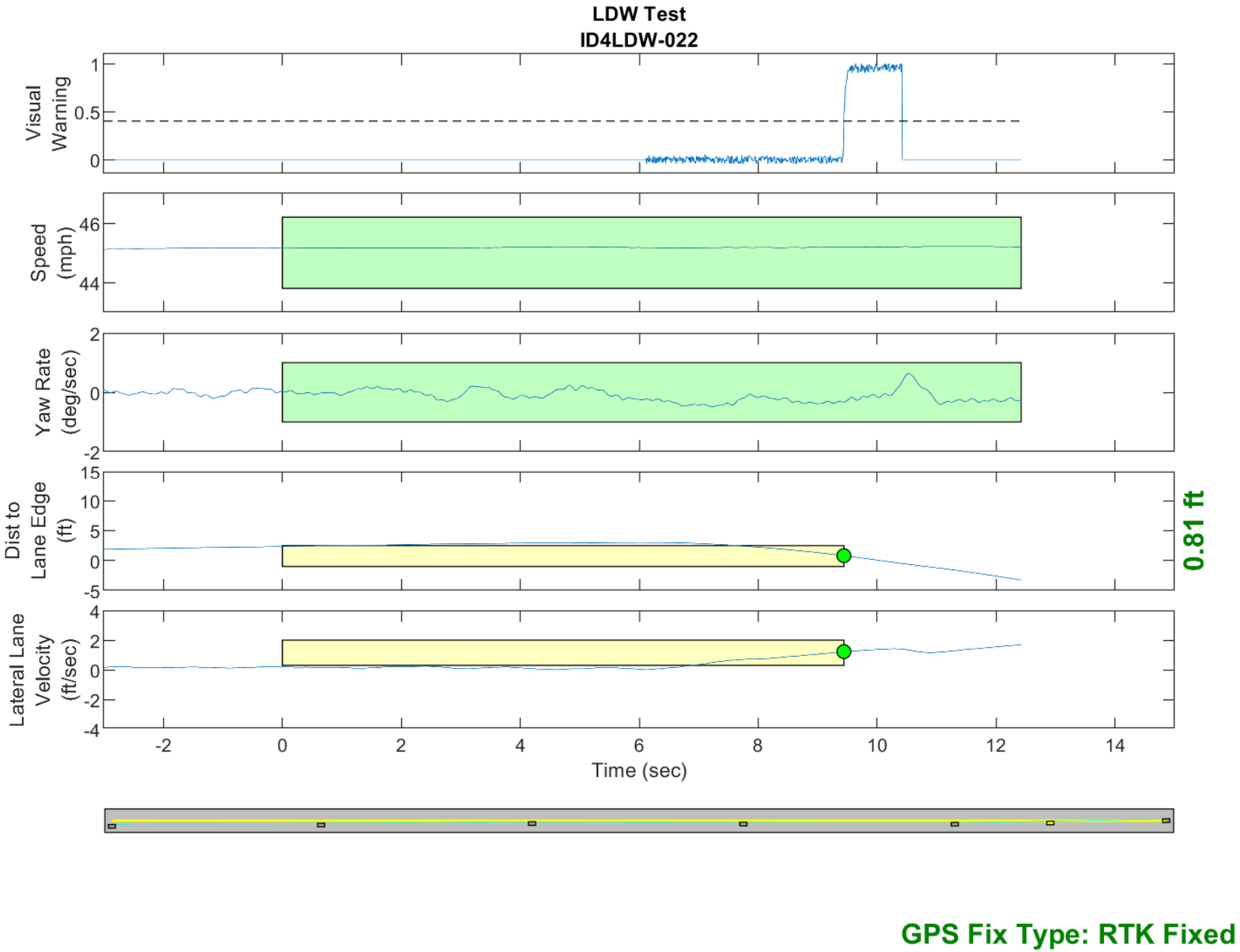

Figure D25. Time History for Run 22, Dashed Line, Left Departure, Visual Warning

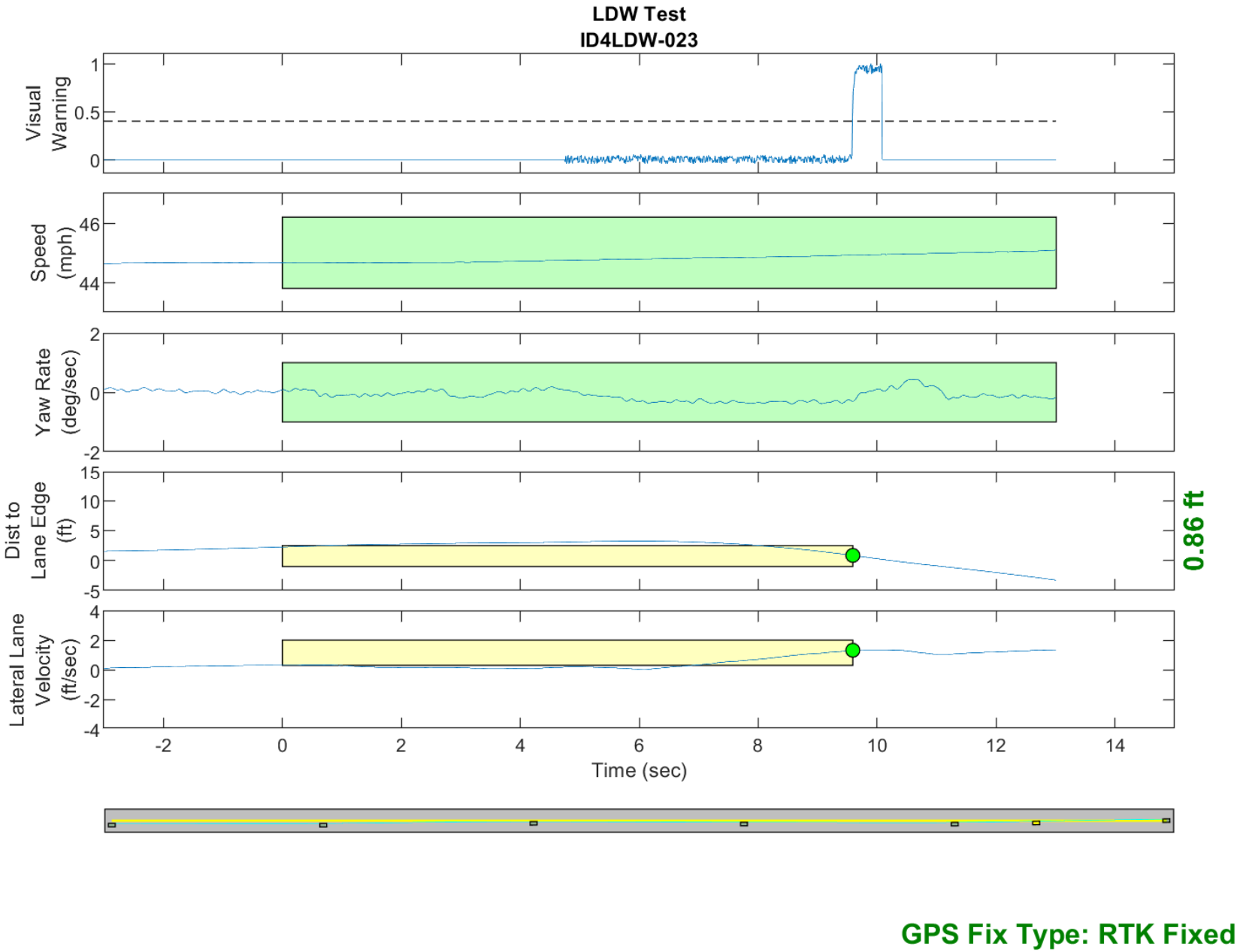

Figure D26. Time History for Run 23, Dashed Line, Left Departure, Visual Warning

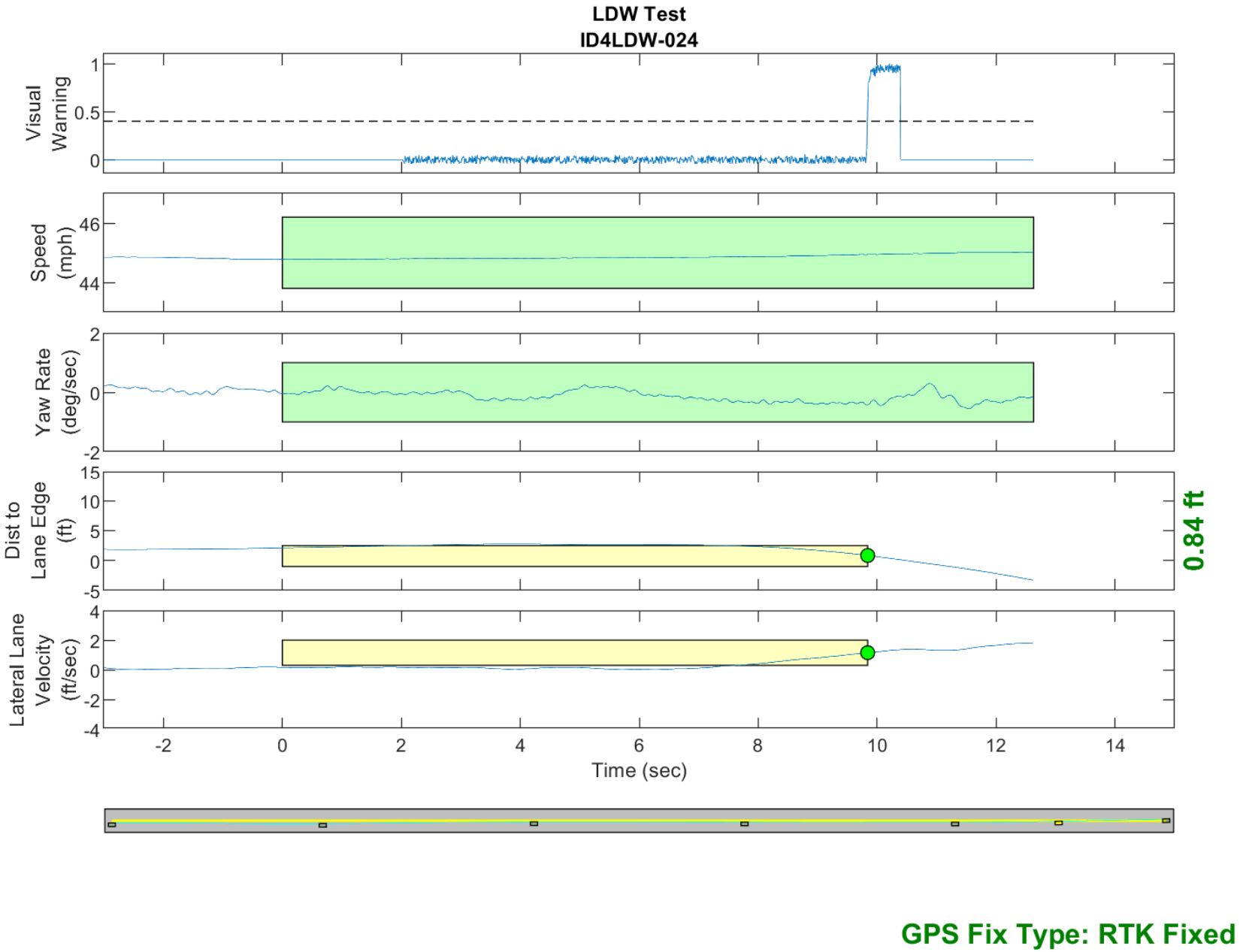

Figure D27. Time History for Run 24, Dashed Line, Left Departure, Visual Warning

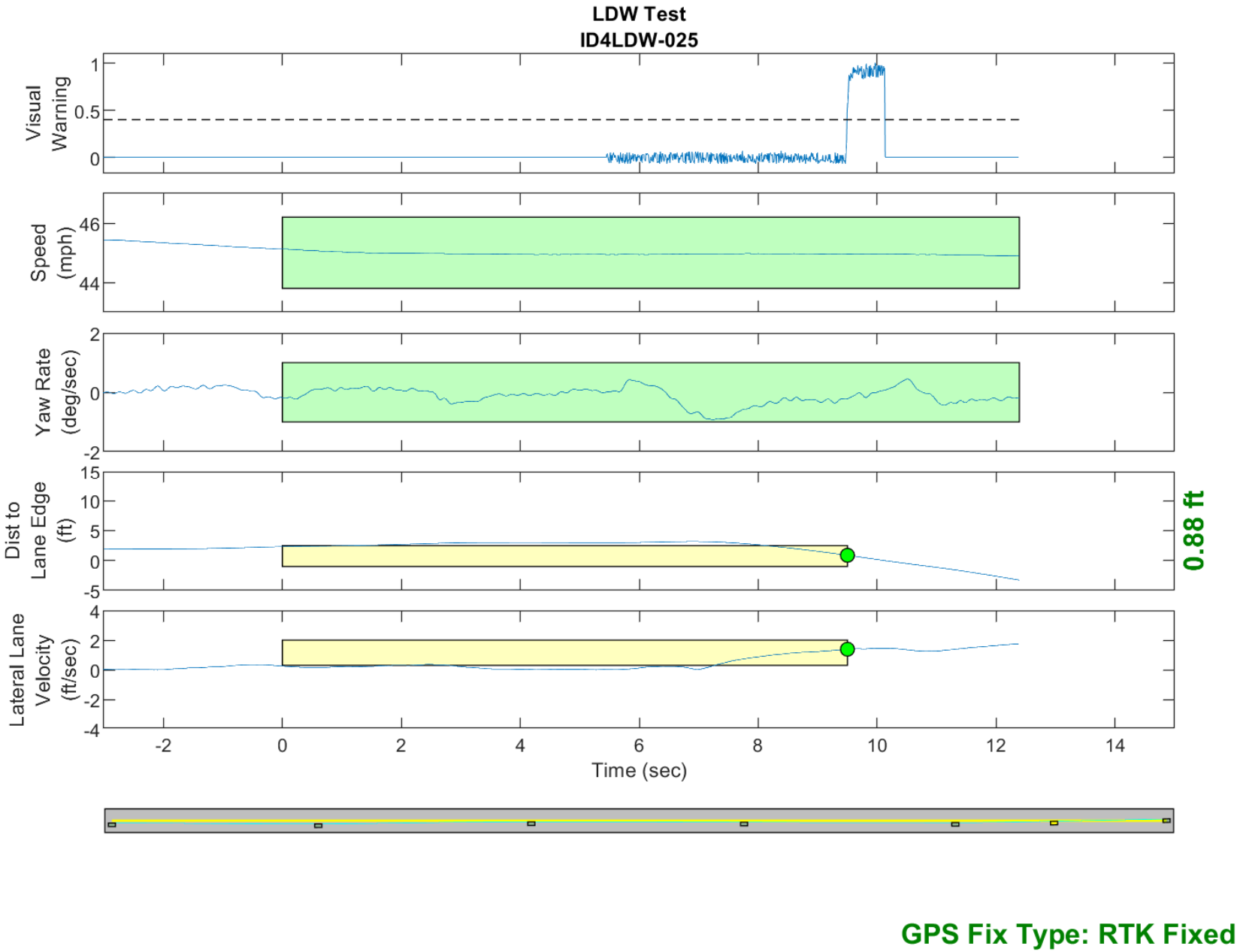

Figure D28. Time History for Run 25, Dashed Line, Left Departure, Visual Warning

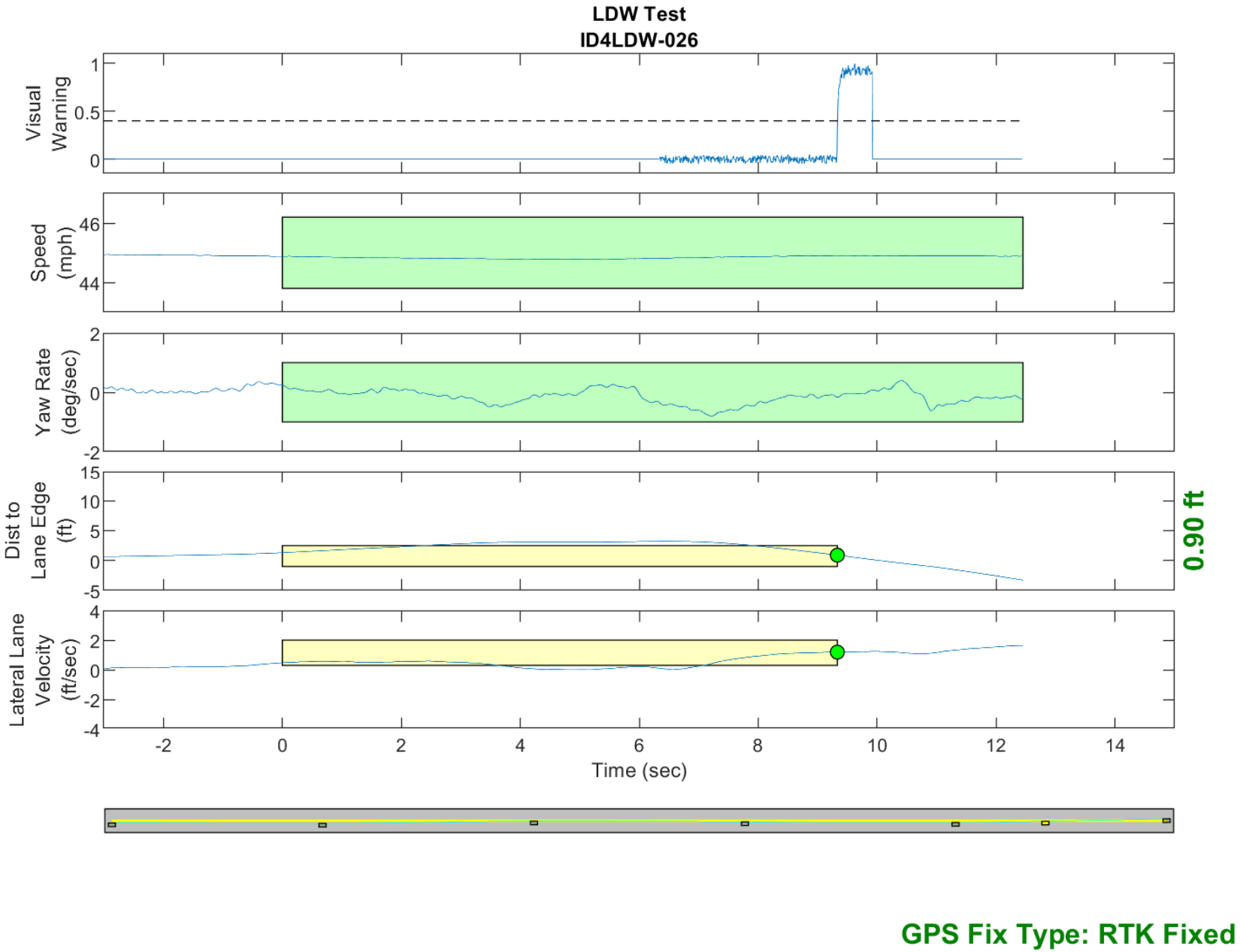

Figure D29. Time History for Run 26, Dashed Line, Left Departure, Visual Warning

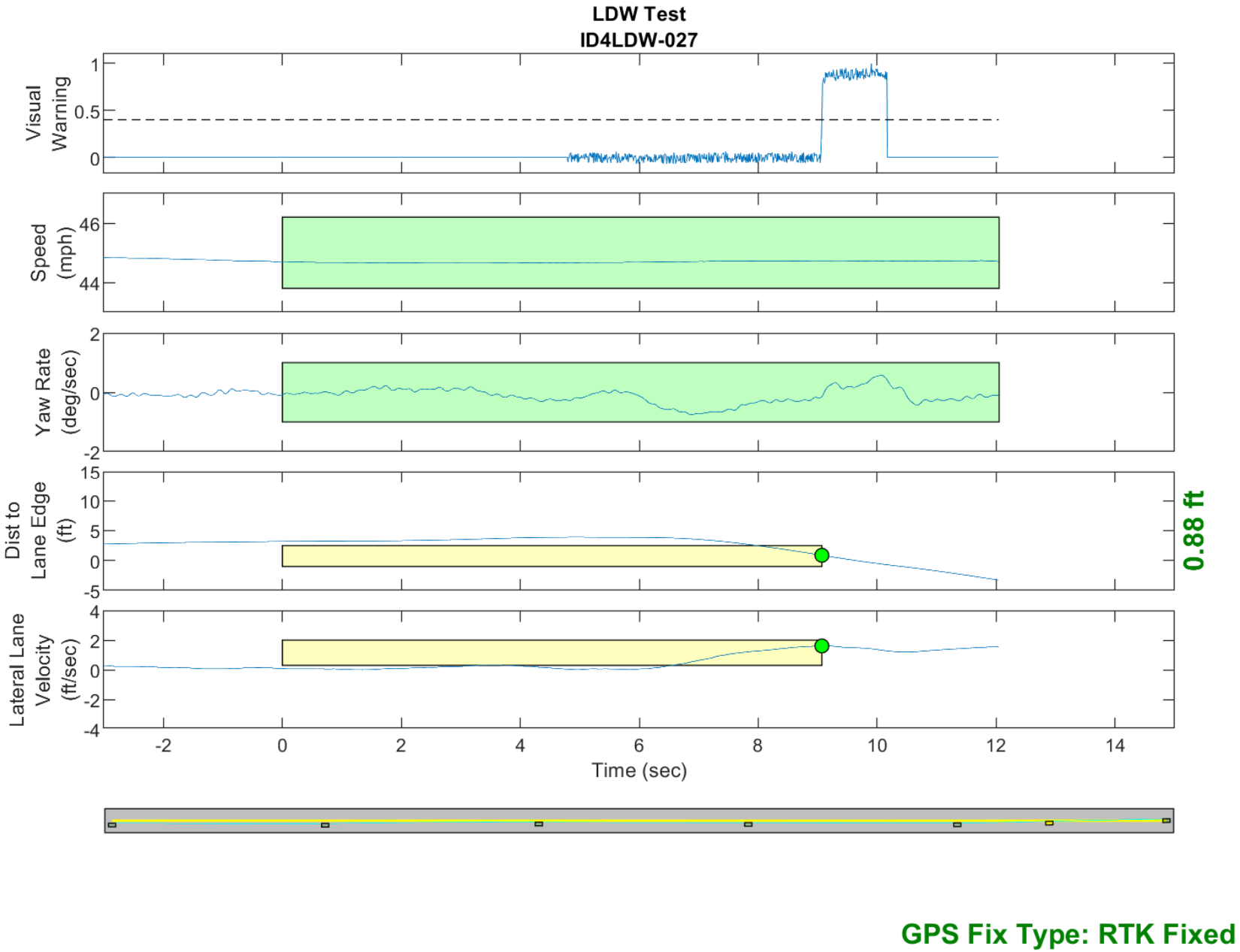

Figure D30. Time History for Run 27, Dashed Line, Left Departure, Visual Warning

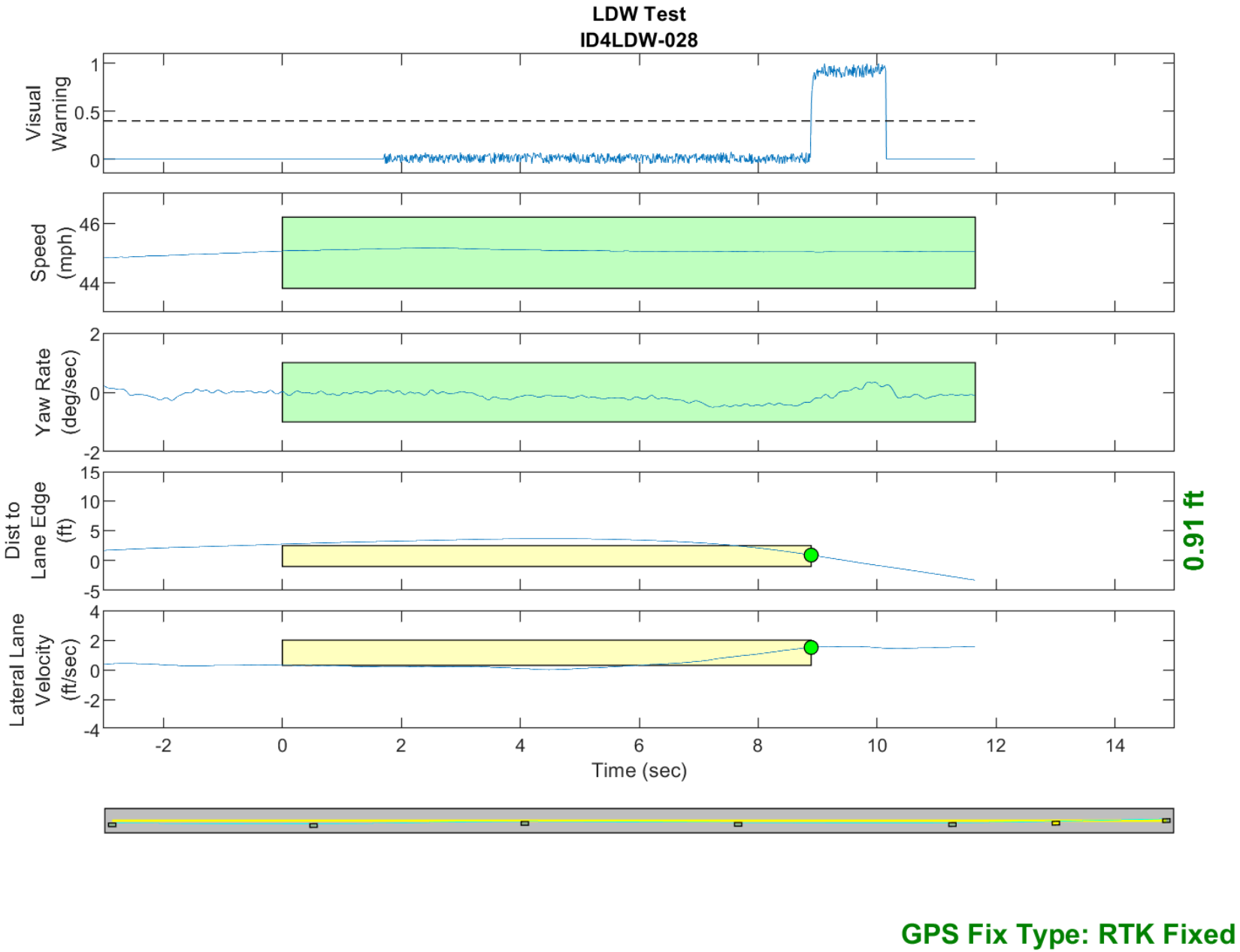

Figure D31. Time History for Run 28, Dashed Line, Left Departure, Visual Warning

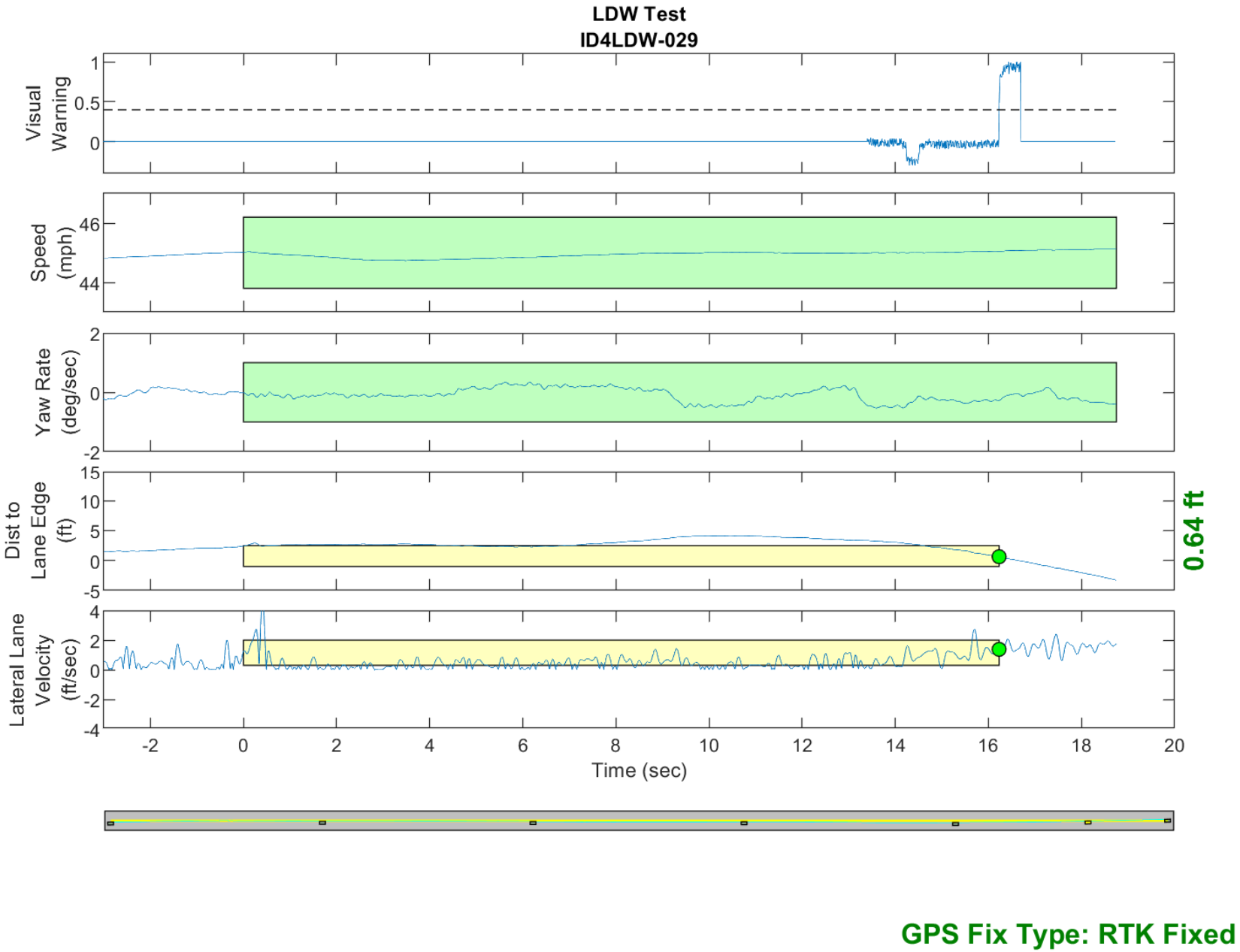

Figure D32. Time History for Run 29, Botts Dots, Left Departure, Visual Warning

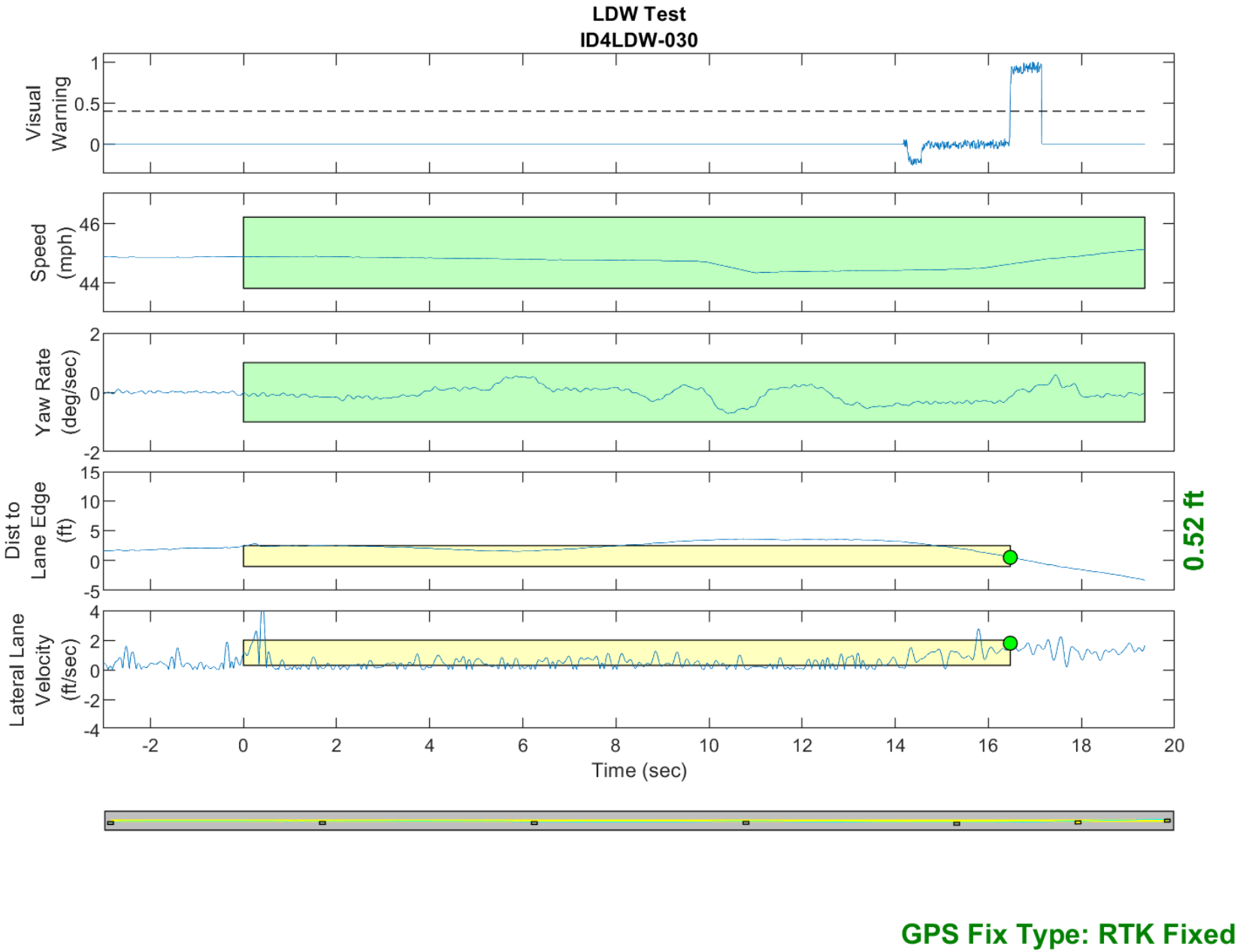

Figure D33. Time History for Run 30, Botts Dots, Left Departure, Visual Warning

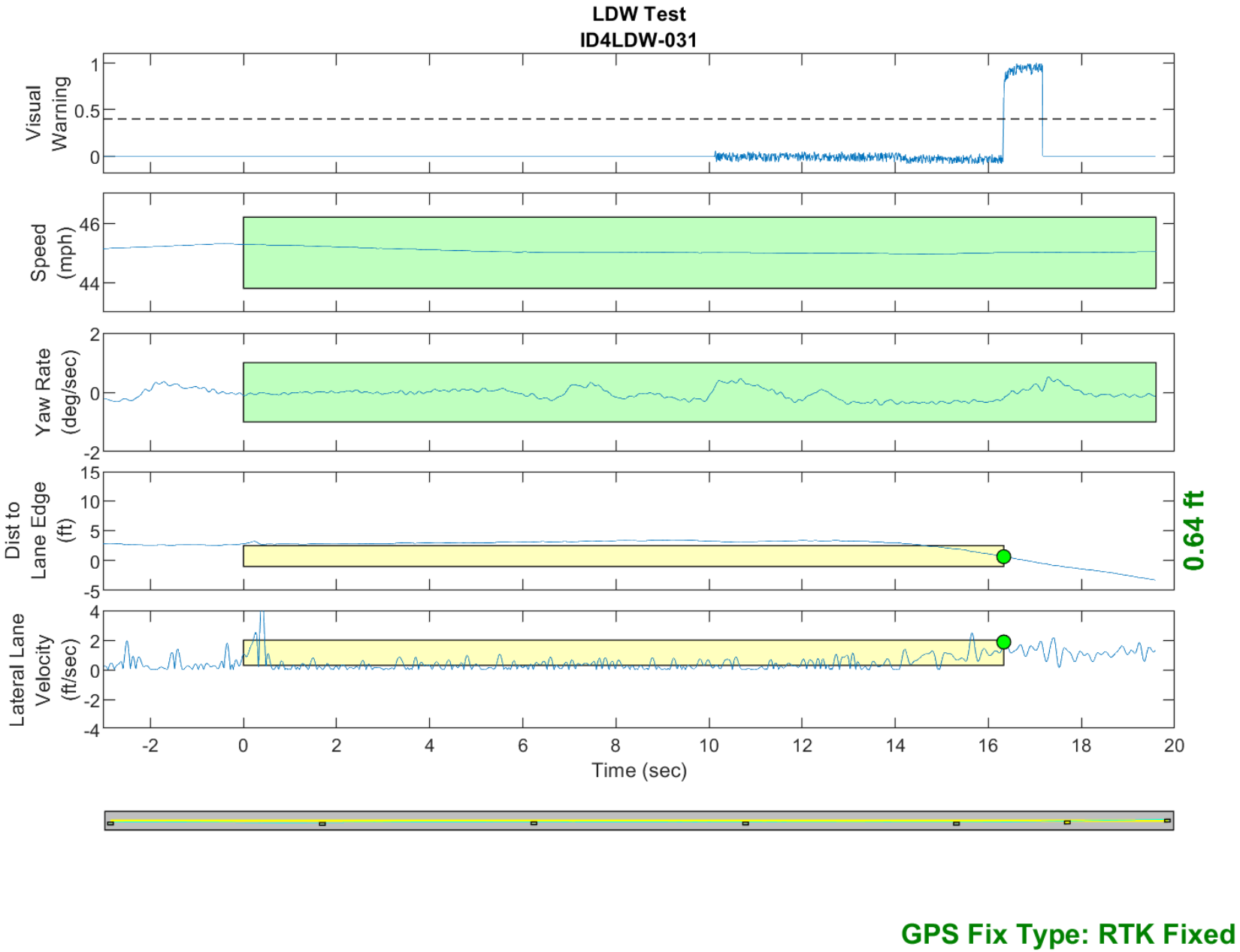

Figure D34. Time History for Run 31, Botts Dots, Left Departure, Visual Warning

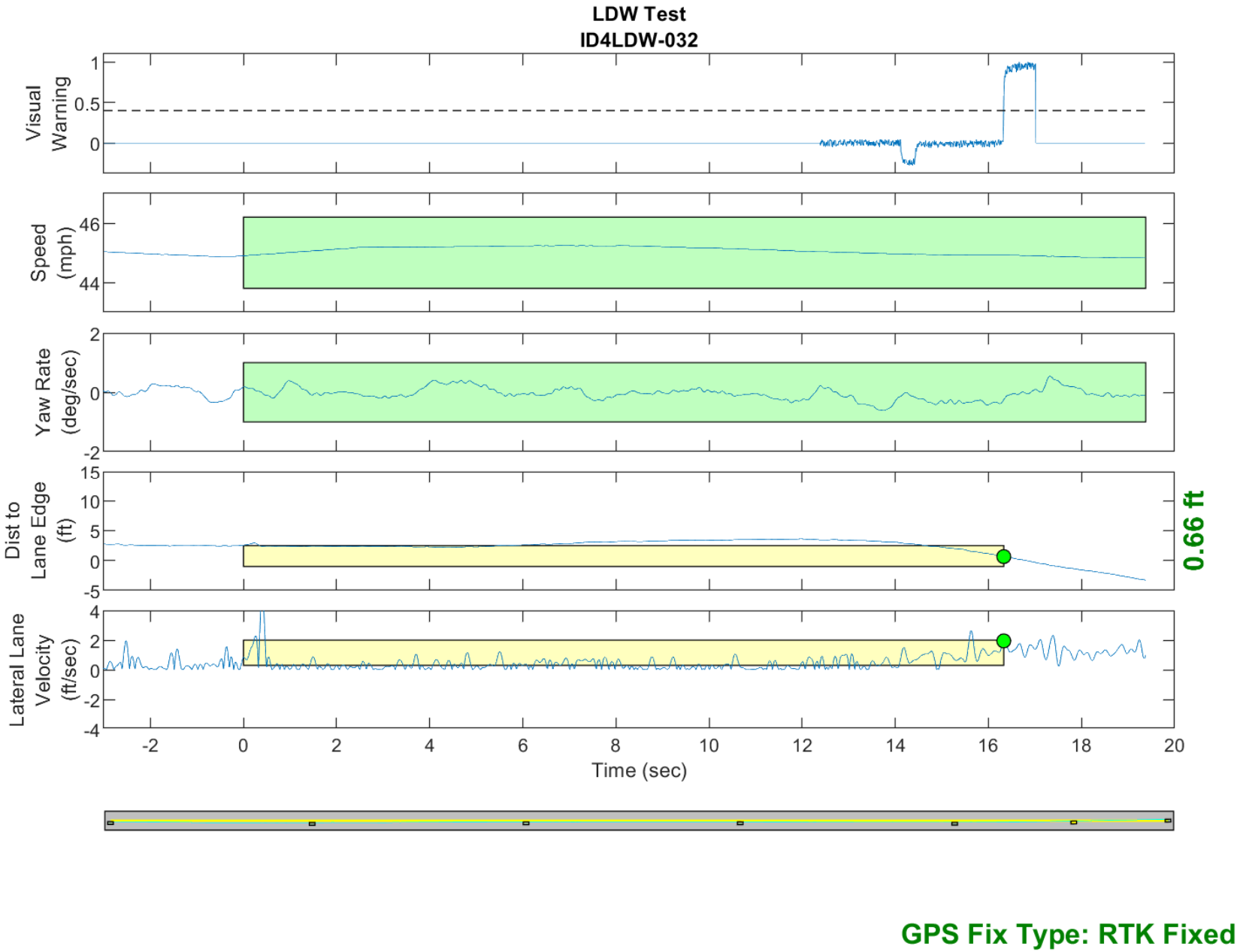

Figure D35. Time History for Run 32, Botts Dots, Left Departure, Visual Warning

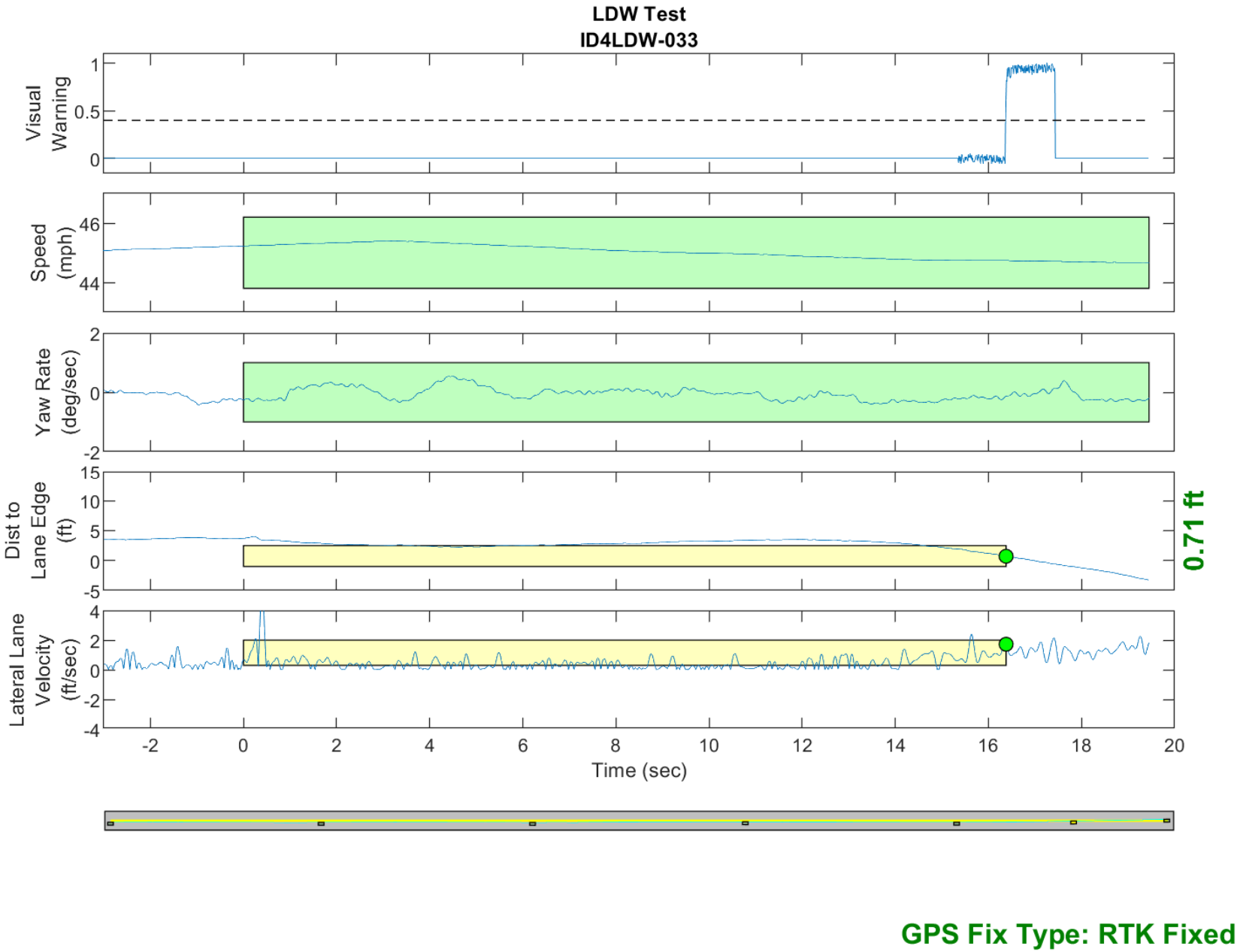

Figure D36. Time History for Run 33, Botts Dots, Left Departure, Visual Warning

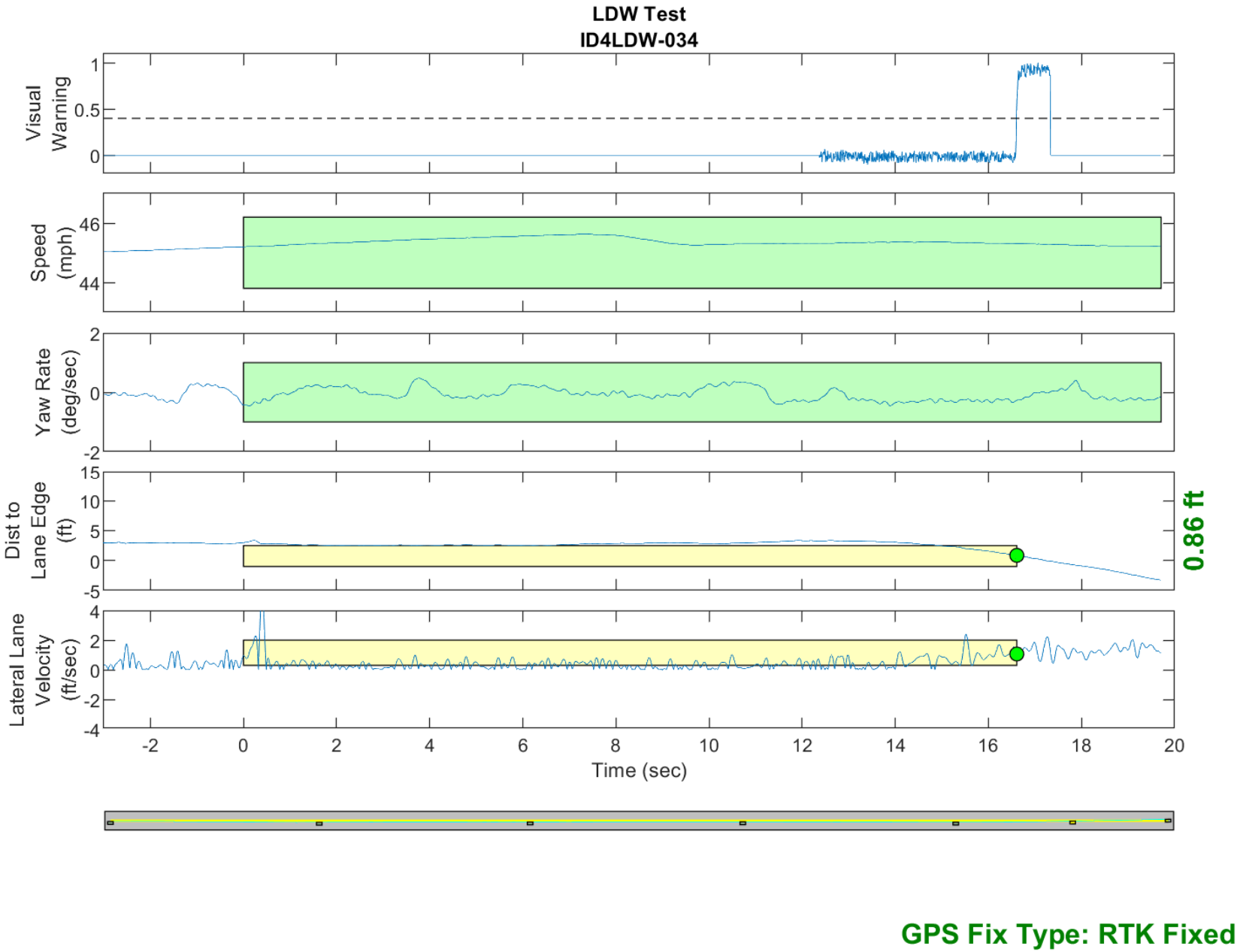

Figure D37. Time History for Run 34, Botts Dots, Left Departure, Visual Warning

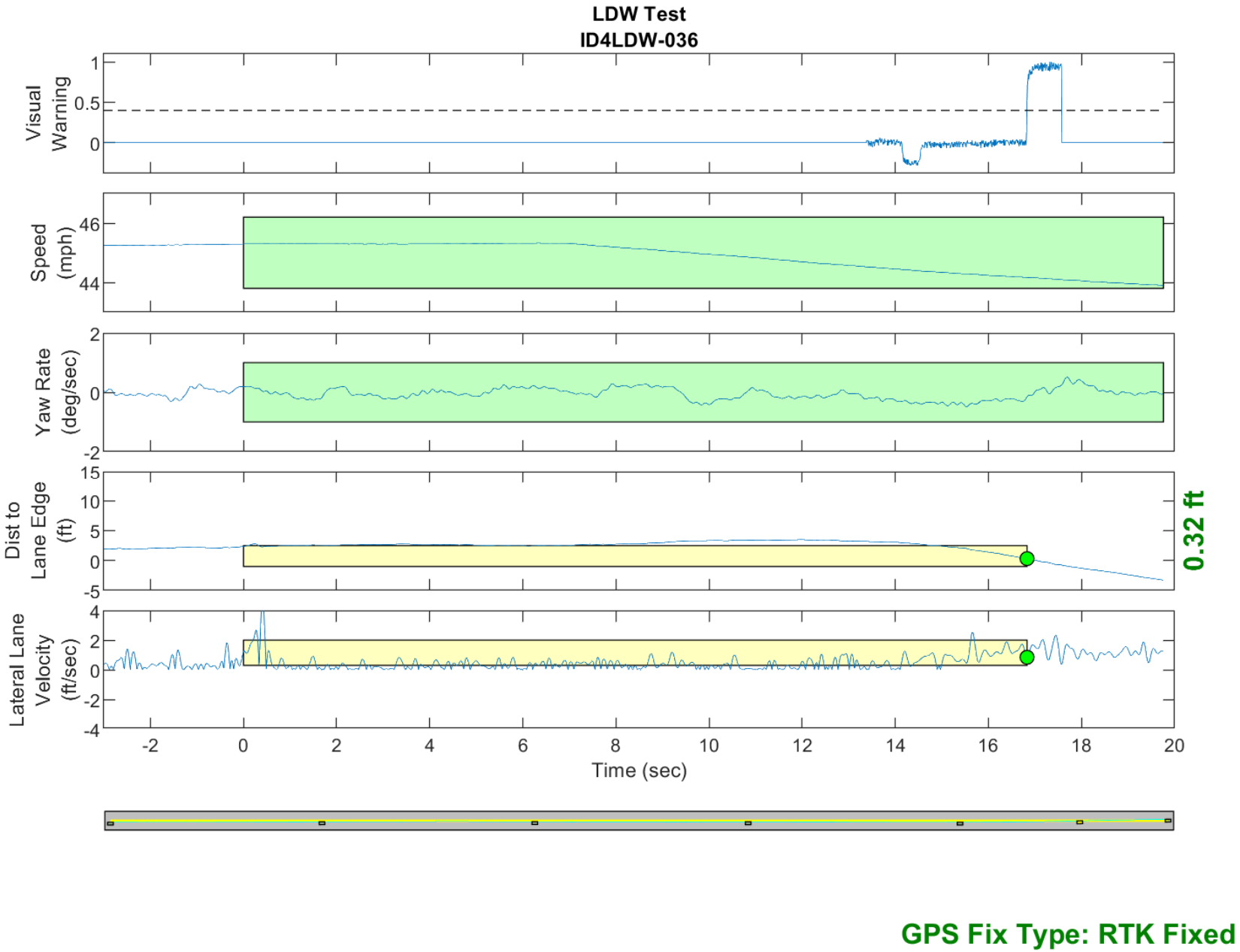

Figure D38. Time History for Run 36, Botts Dots, Left Departure, Visual Warning

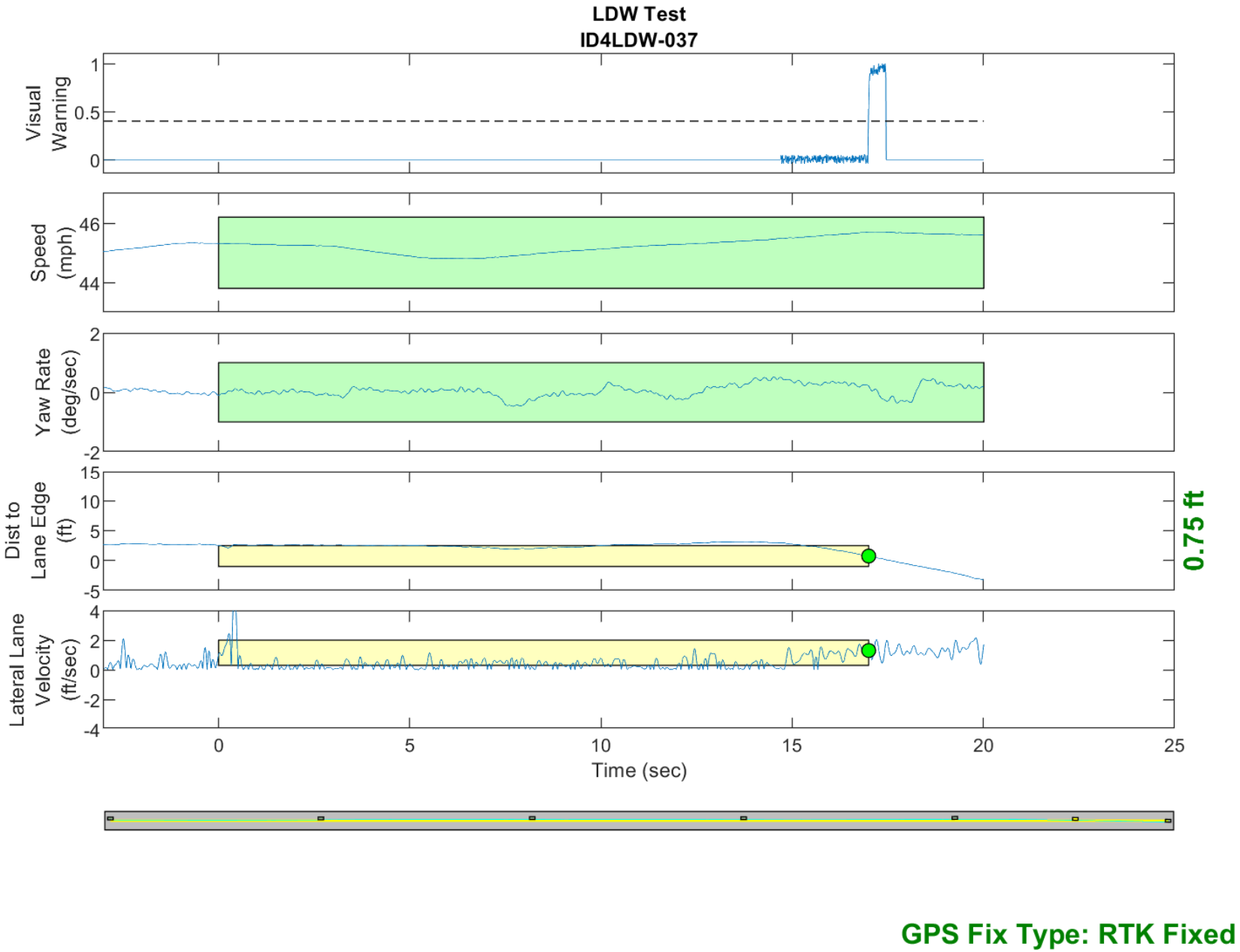

Figure D39. Time History for Run 37, Botts Dots, Right Departure, Visual Warning

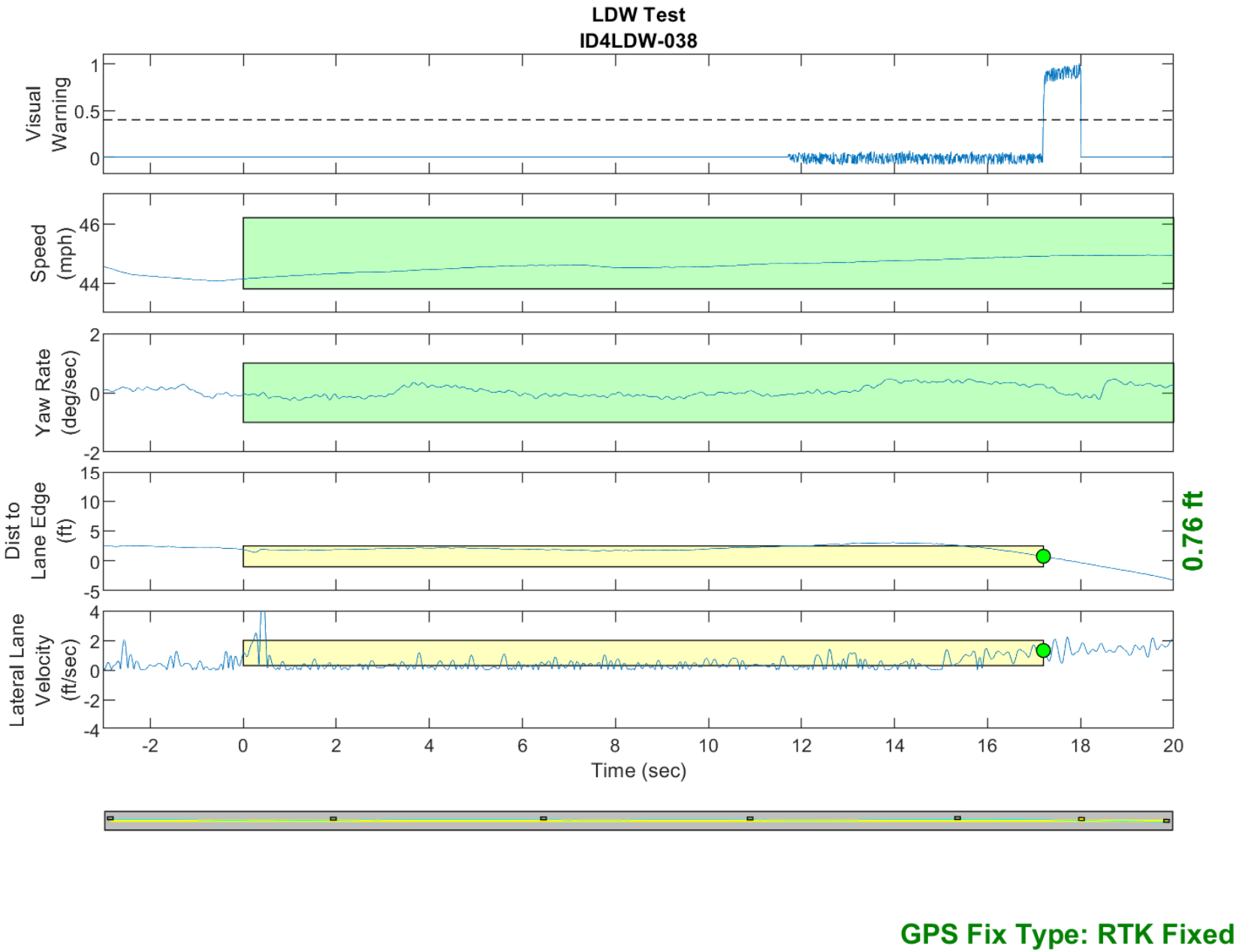

Figure D40. Time History for Run 38, Botts Dots, Right Departure, Visual Warning

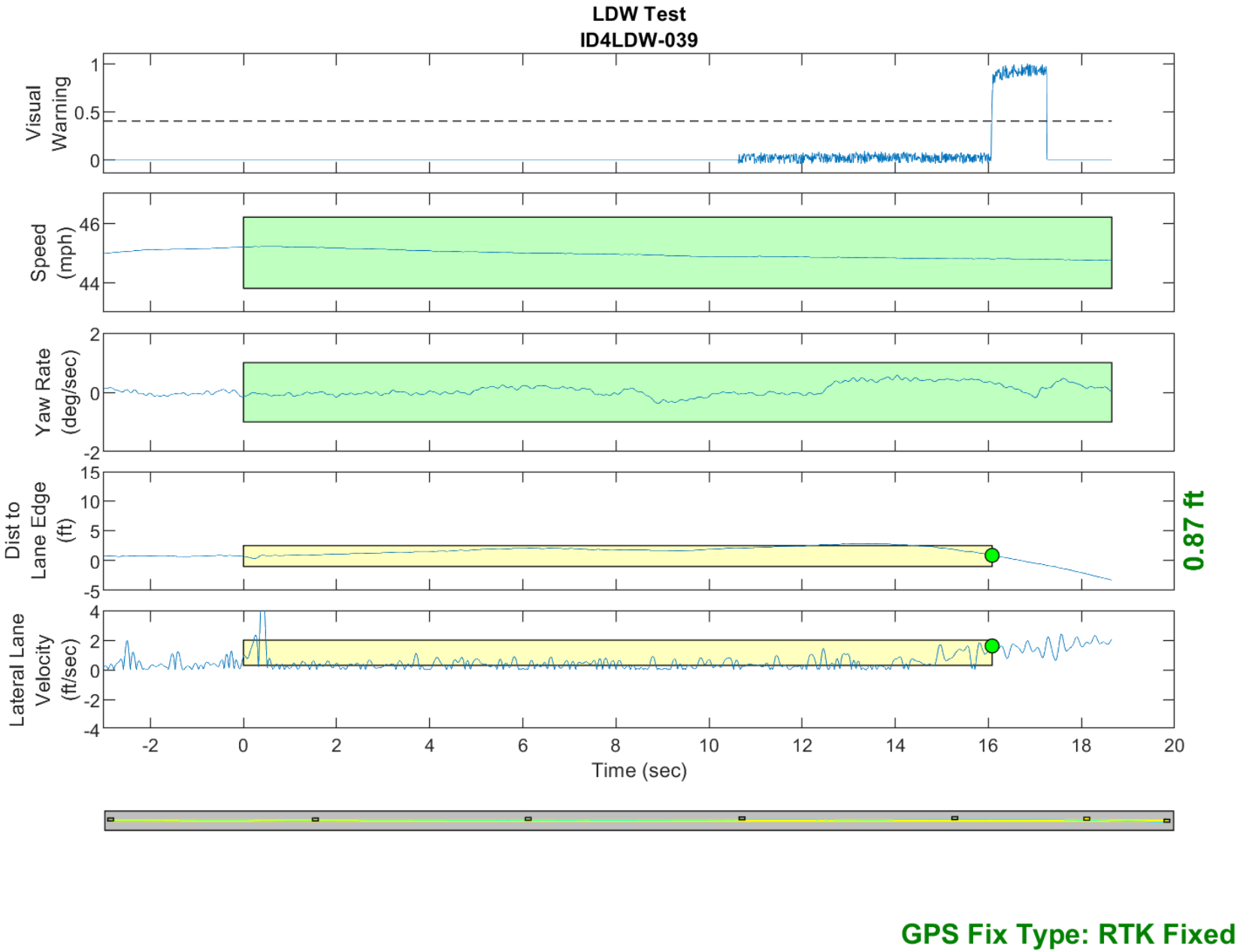

Figure D41. Time History for Run 39, Botts Dots, Right Departure, Visual Warning

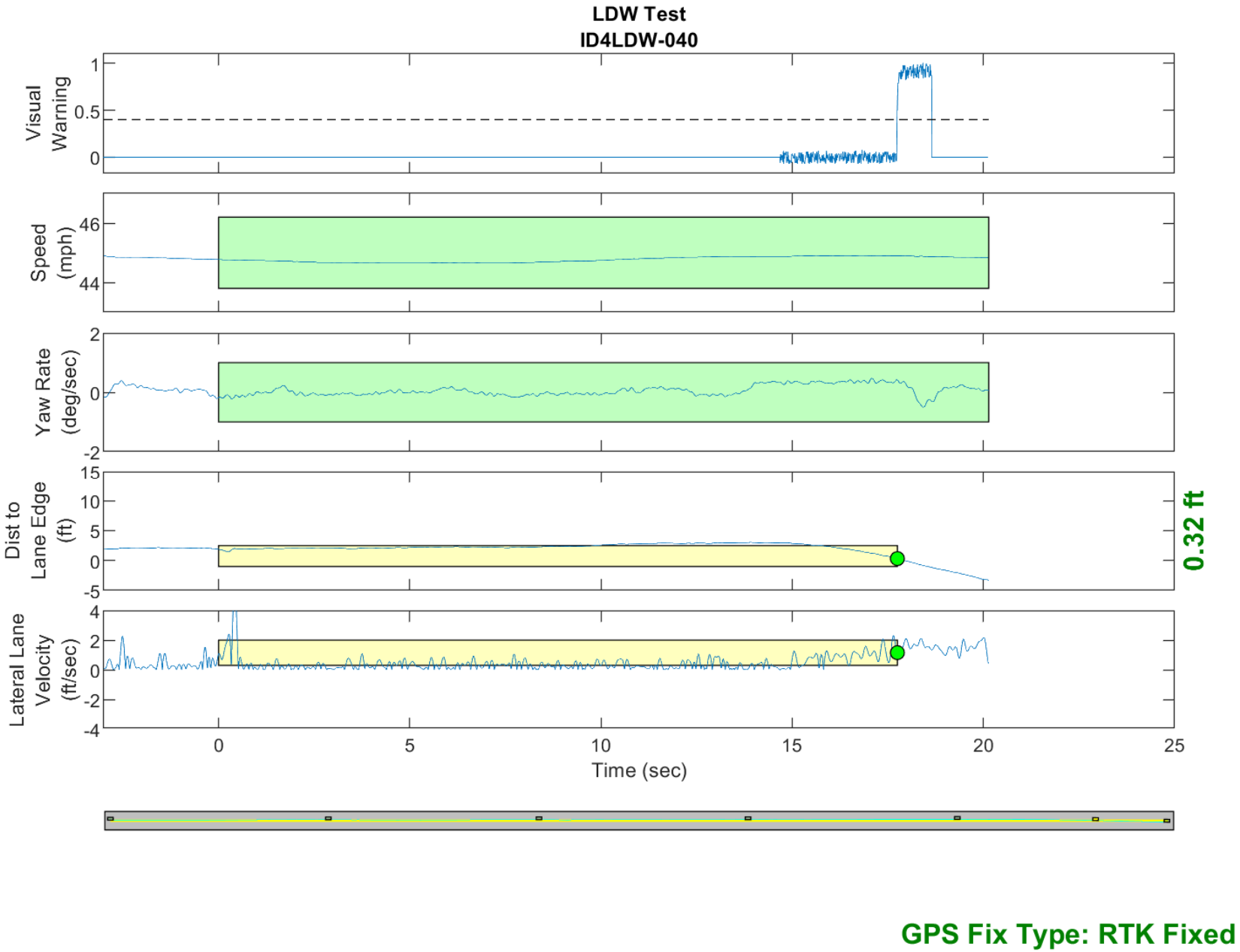

Figure D42. Time History for Run 40, Botts Dots, Right Departure, Visual Warning

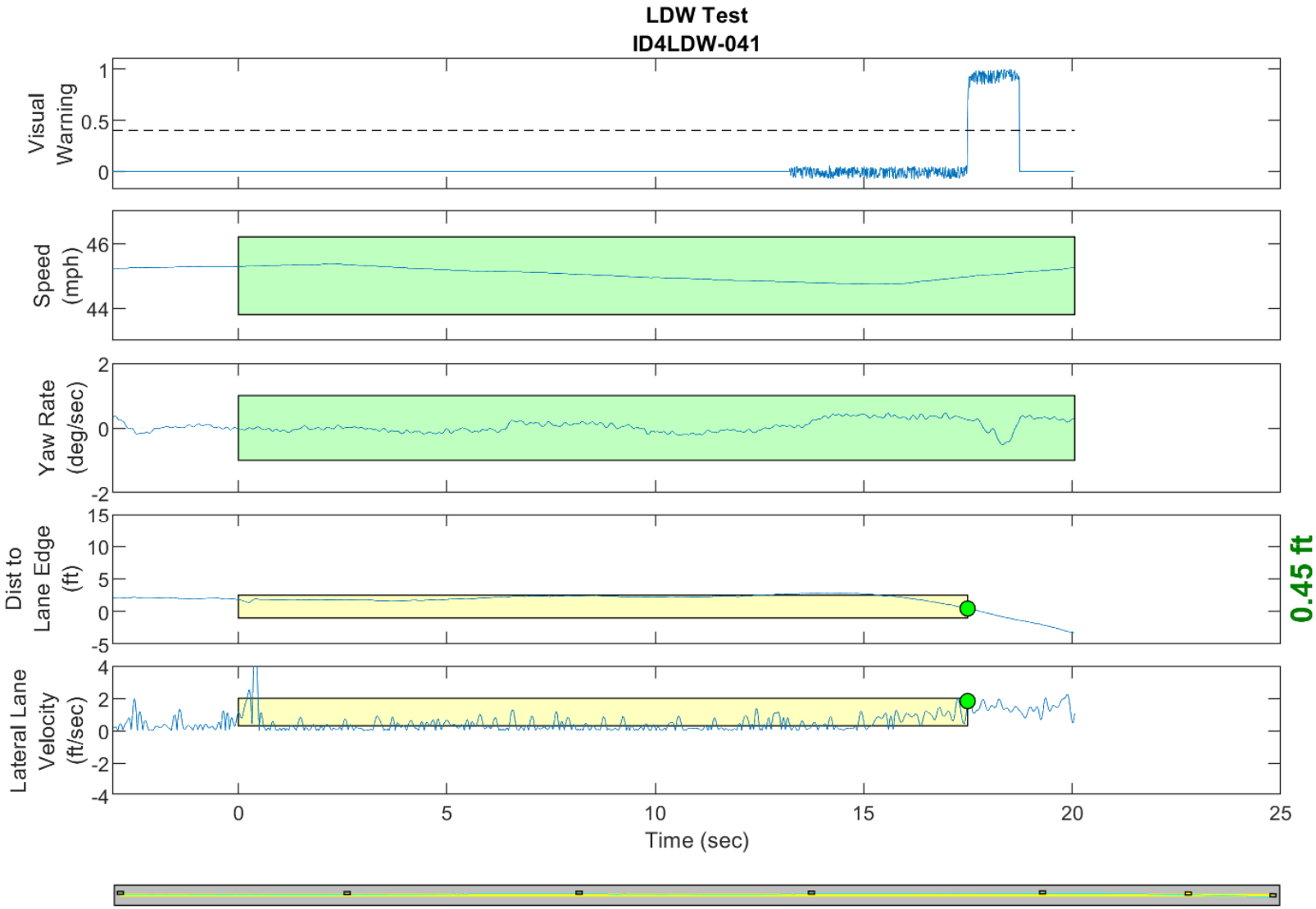

Figure D43. Time History for Run 41, Botts Dots, Right Departure, Visual Warning

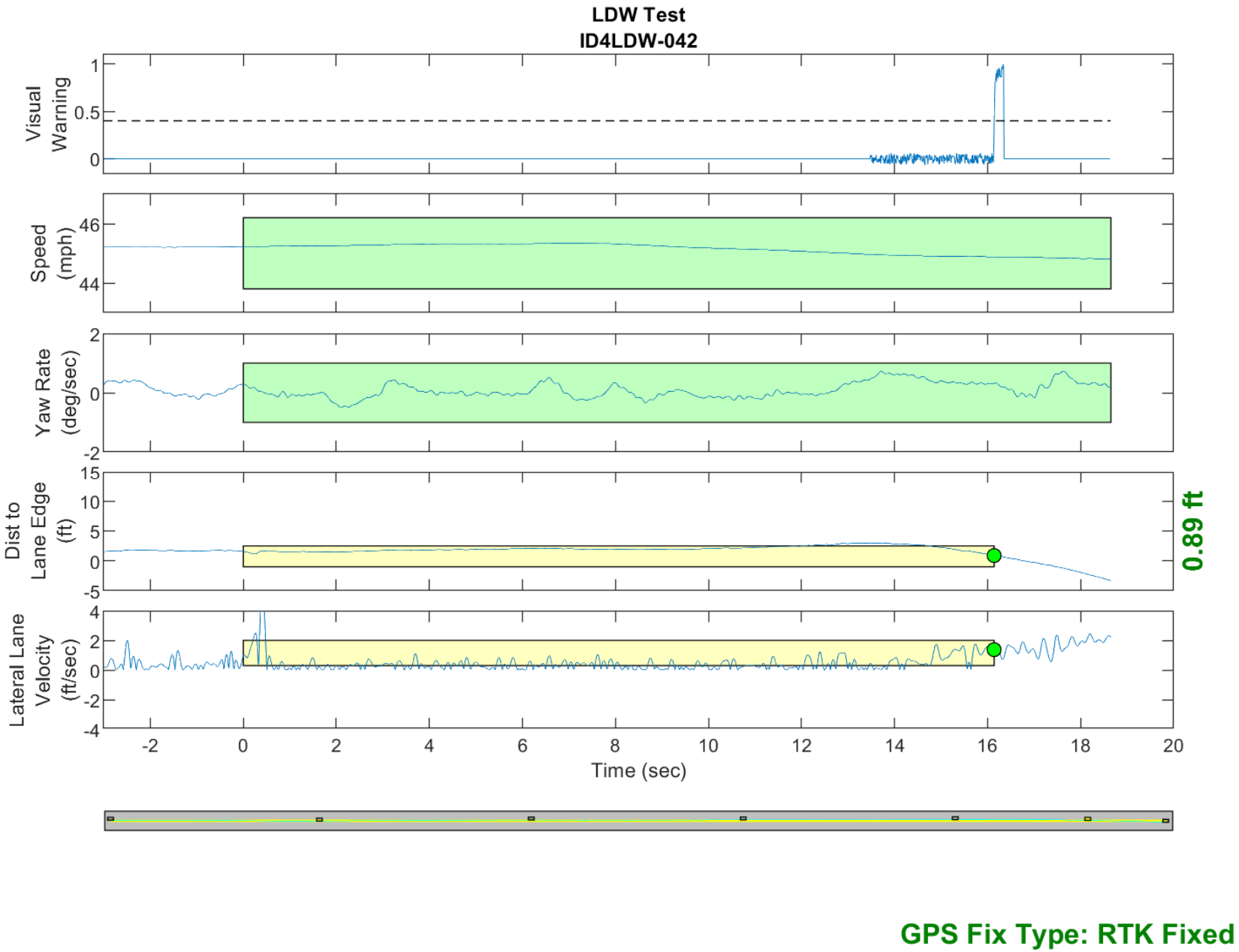

Figure D44. Time History for Run 42, Botts Dots, Right Departure, Visual Warning

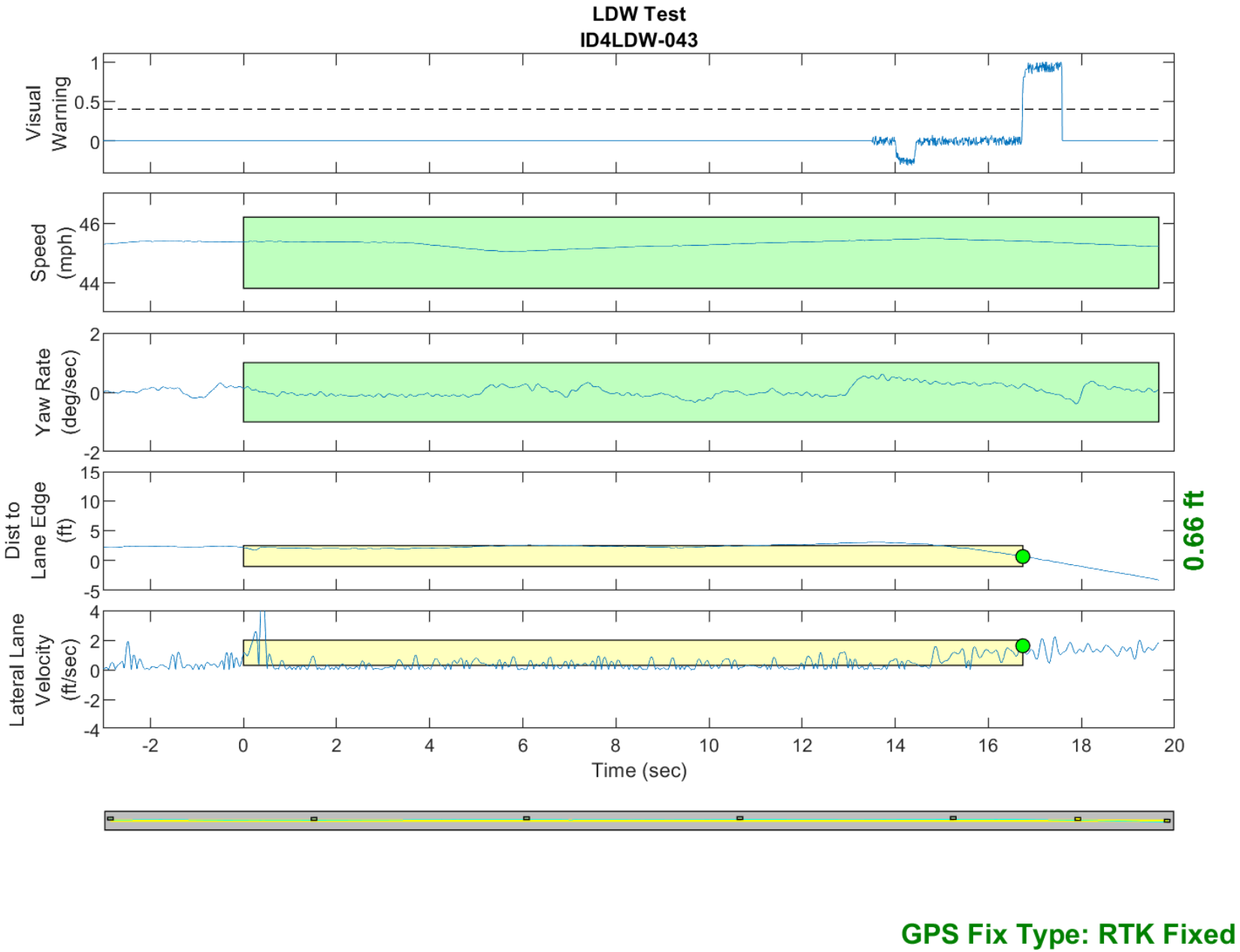

Figure D45. Time History for Run 43, Botts Dots, Right Departure, Visual Warning