

**NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST
NCAP-DRI-LDW-22-12**

2022 Toyota RAV4 XLE

DYNAMIC RESEARCH, INC.

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Torrance, California 90501



1 February 2022

Draft 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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Senior Staff Engineer Test Engineer

Date: 1 February 2022

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16. Abstract These tests were conducted on the subject 2022 Toyota RAV4 XLE in accordance with the specifications of the New Car Assessment Program's (NCAP's) most current Test Procedure in docket NHTSA-2006-26555-0135 to confirm the performance of a Lane Departure Warning system. The vehicle passed the requirements of the test for all three lane marking types and for both directions.			
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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 2022 Toyota RAV4 XLE. The LDW system for this vehicle provides both visual and auditory alerts. The vehicle passed the requirements of the test for all three lane 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)

2022 Toyota RAV4 XLE

VIN: 2T3W1RFV3NC17xxxx

Test start date: 1/26/2022

Test end date: 1/27/2022

Lane Departure Warning setting: Early

Test 1 – Continuous White Line Left: Pass Right: Pass

Test 2 – Dashed Yellow Line Left: Pass Right: Pass

Test 3 – Botts Dots Left: Pass Right: Pass

Overall: Pass

Notes:

LANE DEPARTURE WARNING
DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2022 Toyota RAV4 XLE

TEST VEHICLE INFORMATION

VIN: 2T3W1RFV3NC17xxxx

Body Style: SUV

Color: White

Date Received: 1/11/2022

Odometer Reading: 226 mi

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: Toyota Motor Manufacturing Canada Inc.

Date of manufacture: 12/21

Vehicle Type: MPV

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: 225/65R17

Rear: 225/65R17

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

Rear: 240 kPa (35 psi)

TIRES

Tire manufacturer and model: Dunlop Grandtrek PT20

Front tire size: 225/65R17 102H

Rear tire size: 225/65R17 102H

Front tire DOT prefix: R8F5 DM9R

Rear tire DOT prefix: R8F5 DM9R

LANE DEPARTURE WARNING
DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2022 Toyota RAV4 XLE

GENERAL INFORMATION

Test start date: 1/26/2022

Test end date: 1/27/2022

AMBIENT CONDITIONS

Air temperature: 13.3 C (56 F)

Wind speed: 2.4 m/s (5.3 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: 240 kPa (35 psi)

Rear: 240 kPa (35 psi)

LANE DEPARTURE WARNING
DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2022 Toyota RAV4 XLE

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front: 504.8 kg (1113 lb)

Right Front: 526.2 kg (1160 lb)

Left Rear: 367.0 kg (809 lb)

Right Rear: 355.6 kg (784 lb)

Total: 1753.6 kg (3866 lb)

LANE DEPARTURE WARNING
DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 1 of 2)

2022 Toyota RAV4 XLE

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

Toyota Safety Sense 2.0: Lane Departure Alert w/ Steering Assist

Type and location of sensor(s) used:

The LDW system uses a millimeter wave radar mounted behind the front bumper grill and a mono camera in the top center of the windshield.

Lane Departure Warning Setting used in test:

Early

How is the Lane Departure Warning presented to the driver? Warning light
(Check all that apply) Buzzer or auditory alarm
 Vibration
 Other _____

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

The LDW system alerts the driver with a visual and auditory alert. The visual alert is displayed in the multi-information display and consists of a primary image of two white lane lines and a secondary icon of a vehicle crossing a lane line. When the lane departure warning activates, the lane line corresponding to the side in which the vehicle crossed flashes on/off in orange, along with the secondary icon. The auditory alert consists of three consecutive beeps with an approximate primary frequency of 1571 Hz.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 2 of 2)

2022 Toyota RAV4 XLE

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

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

The LDW system as part of the overall Lane Tracing Assist (LTA) system can be turned on/off using the button on the right side of the steering wheel. When the system is turned on, an icon of a vehicle crossing a lane line will illuminate continuously in white in the multi-information display and message will briefly be displayed. When the system is turned off, the icon will not be displayed.

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

If yes, please provide a full description.

The range setting for the LDW system (part of the Lane Tracing Assist (LTA) system) can be adjusted using the buttons on the left side of the steering wheel. The procedure is as follows:

1. Press the < > button until the gear icon is selected in the multi-information display.
2. Scroll down until "Sensitivity" is outlined and press the "OK" button to select the desired sensitivity.

Are there other driving modes or conditions that render LDW inoperable or reduce its effectiveness? Yes
 No

If yes, please provide a full description.

Refer to the owner's manual pages 236-238 shown in Appendix B pages B-3 to B-5.

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

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

Table 1. LDW Test Matrix

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

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

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

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

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

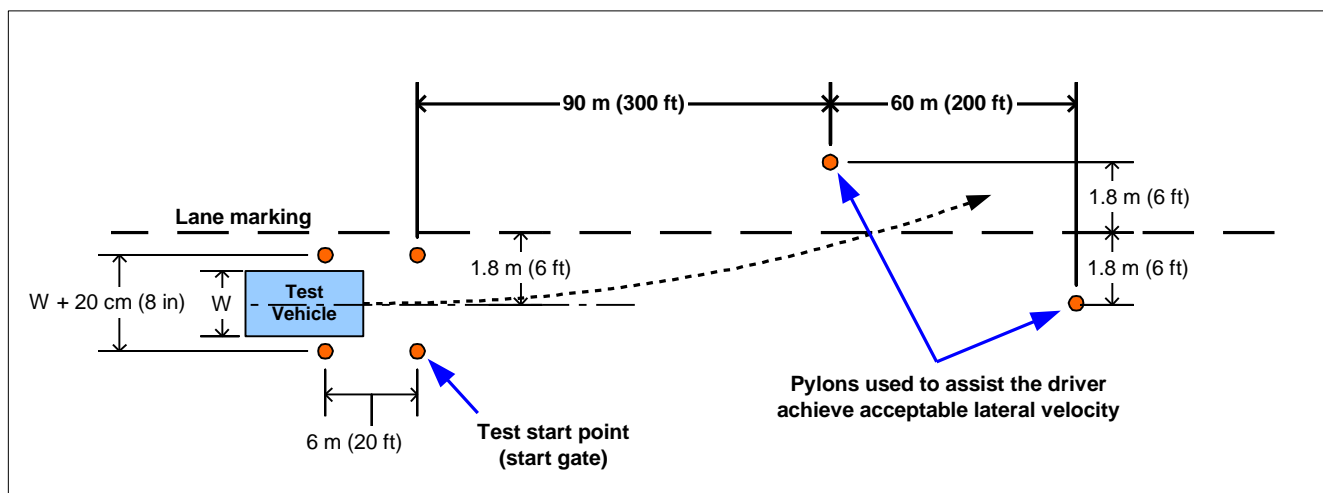


Figure 1. Position of Cones Used to Assist Driver

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

B. Lane Delineation Markings

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

1. Lane Marker Width

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

2. Line Marking Color and Reflectivity

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

3. Line Styles

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

- Continuous White Line

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

- Dashed Yellow Line

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

- Raised Pavement Marker Line (Botts Dots)

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

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

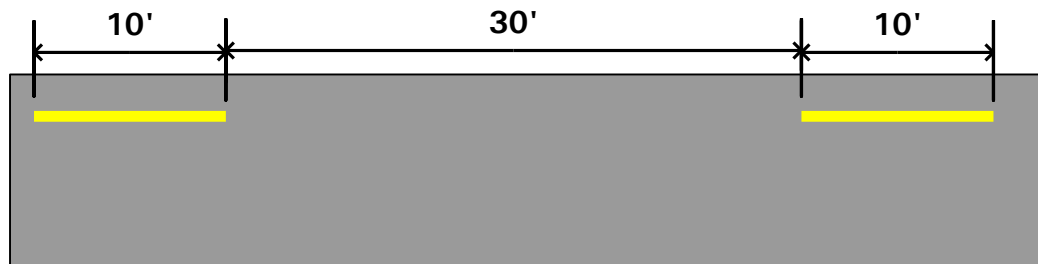


Figure 2. MUTCD Discontinuous Dashed Line Specifications

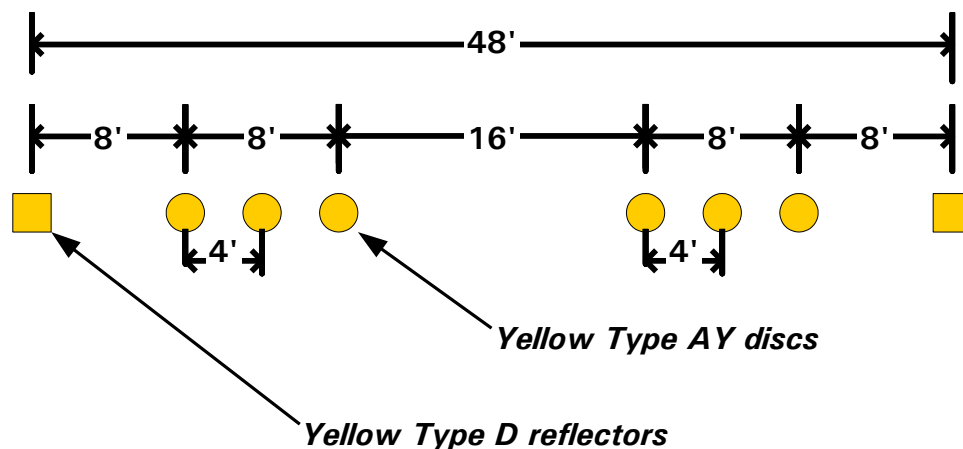


Figure 3. California Standard Plan A20A, Detail 4

C. Test Validity

1. Speed

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

2. Lateral Velocity

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

3. Yaw Rate

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

D. Pass/Fail Criteria

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

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

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

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

E. Instrumentation

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

Table 2. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and 100 psi	Omega DPG8001	17042707002	By: DRI Date: 10/5/2021 Due: 10/5/2022
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 2/10/2021 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	Accels $\pm 10g$, Angular Rate ± 100 deg/s, Angle > 45 deg, Velocity > 200 km/h	Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h	Oxford Inertial +	2176	By: Oxford Technical Solutions ¹ Date: 6/26/2020 Due: 6/26/2022
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: ± 0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	N/A

¹ Oxford Technical Solutions recommends calibration every two years.

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	N/A	N/A
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	N/A	N/A
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2022 Due: 1/6/2023
Type	Description			Mfr, Model	Serial Number	
Data Acquisition System	Data acquisition is achieved using a dSPACE MicroAutoBox II Data from the Oxford IMU, including Longitudinal, Lateral, and Vertical Acceleration, Roll, Yaw, and Pitch Rate, Forward and Lateral Velocity, Roll and Pitch Angle are sent over Ethernet to the MicroAutoBox. The Oxford IMUs are calibrated per the manufacturer's recommended schedule (listed above).			D-Space Micro-Autobox II 1401/1513		
				Base Board	549068	
				I/O Board	588523	

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

Table 3. Auditory and Tactile Warning Filter Parameters

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

APPENDIX A

Photographs

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Figure A1. Front View of Subject Vehicle



Figure A2. Rear View of Subject Vehicle



DESC.: **RAV4** XLE FWD SUV
 VIN: **2T3W1RFV3NC17**
 YR/MDL: 2022/444DA
 CLR: WHITE/FA20 (0040/20)
 FINAL ASSEMBLY POINT: CAMBRIDGE, ONTARIO, CANADA

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score ★★★★★
 Based on the combined ratings of frontal, side and rollover. Should ONLY be compared to other vehicles of similar size and weight.

Frontal Crash Driver Passenger ★★★★★
 Based on the risk of injury in a frontal impact. Should ONLY be compared to other vehicles of similar size and weight.

Side Crash Front seat Rear seat ★★★★★
 Based on the risk of injury in a side impact.

Rollover ★★★★★
 Based on the risk of rollover in a single-vehicle crash.

Star ratings range from 1 to 5 stars (★ ★ ★ ★ ★) with 5 being the highest.
 Source: National Highway Traffic Safety Administration (NHTSA)
www.safercar.gov or 1-888-327-4236

STANDARD EQUIPMENT
 UNLESS REPLACED BY OPTIONAL EQUIPMENT

MECHANICAL & PERFORMANCE
 - 2.5L 4-Cylinder Engine w/ Start-Stop
 - 203 hp @ 6600 rpm / 184 lb-ft @ 5000 rpm
 - 8-Speed Automatic Transmission
 - Front-Wheel Drive

SAFETY & CONVENIENCE
 - Toyota Safety Sense 2.0: Pre-Collision Sys w/ Pedestrian Detection, Full-Speed Range Dynamic Radar Cruise Control, Lane Departure Alert w/ Steering Assist, Lane Tracing Assist, Automatic High Beams, Road Sign Assist
 - 8 Airbags: Star Safety System
 - Backup Camera
 - LATCH-Lower Anchor & Tether for Children
 - Blind Spot Monitor w/ Rear Cross-Traffic Alert

EXTERIOR
 - LED Projector Headlights
 - LED Daytime Running Lights
 - 17-in Five-Spoke Silver Alloy Wheels

INTERIOR
 - Audio - 7-in Touchscreen, 6 Speakers, Hands-Free Bluetooth Phone/Music, USB-A, Media Port, 4 USB-C Charge Ports, SiriusXM w/ 3-Month Platinum Plan Trial, Android Auto & Apple CarPlay Compatible
 - Dual Zone Auto A/C w/ Rear Air Vents
 - Fabric-Trimmed Seats
 - Power Driver's Seat
 - Smart Key System w/ Push Button Start

MANUFACTURER'S SUGGESTED RETAIL PRICE \$27,995.00

OPTIONAL EQUIPMENT

FE	50 State Emissions	
3J	Blackout Emblem Overlays	129.00
3T	Cross Bars	315.00
CF	Carpet Floor Mats/Cargo Mat	269.00
DS	Door Edge Guard	140.00
DK	Owner's Portfolio	
MF	Mudguard	129.00

EPA DOT Fuel Economy and Environment

Fuel Economy
 Small SUVs range from 16 to 125 MPG. The best vehicle rates 142 MPG.
30 MPG combined city/hwy
 27 city 35 highway
 3.3 gallons per 100 miles

You save \$500
 in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost \$1,200

Fuel Economy & Greenhouse Gas Rating (tailpipe only) **6** **Smog Rating** (tailpipe only) **7**
 This vehicle emits 292 grams CO₂ per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions. Learn more at fuelconomy.gov.

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and costs \$6,500 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at \$2.35 per gallon. MPG is miles per gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fuelconomy.gov
 Calculate personalized estimates and compare vehicles



DELIVERY, PROCESSING AND HANDLING FEE 1,215.00

TOTAL \$30,192.00

The New Vehicle Limited Warranty provides 3-year/36,000-mile basic coverage, 5-year/60,000-mile powertrain coverage, plus 3-year/unlimited-mile corrosion-perforation coverage. See Warranty and Maintenance Guide for details. An extended service contract may be available for the vehicle. Ask dealer for details. Manufacturer's suggested retail price includes manufacturer's recommended pre-delivery service. Gasoline, license and title fees, applicable federal, state and local taxes and dealer and distributor installed options and accessories are not included in the manufacturer's suggested retail price. ToyotaCare, which covers normal factory scheduled maintenance for two years or 25,000 miles, whichever occurs first, is included as part of the sales price of the vehicle for qualifying buyers. See participating dealer for eligibility and coverage details.


Delivered by Truck to: 04836



TML1E1N150F0W0

Figure A3. Window Sticker (Monroney Label)

MFD. BY: TOYOTA MOTOR MANUFACTURING CANADA INC. 12/21
 GVWR: 2090KG (4610LB)
 GAWR: FRT. 1150KG (2535LB) WITH 225/65R17 TIRES,
 17x7.0J RIMS.
 RR. 1150KG (2535LB) WITH 225/65R17 TIRES,
 17x7.0J RIMS.
 THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
 VEHICLE SAFETY AND THEFT PREVENTION STANDARDS IN EFFECT ON
 THE DATE OF MANUFACTURE SHOWN ABOVE.
 2T3W1RFV3NC17 MPV



C/TR: 040/FA20 AXAA52L-CNZMBA A
 A/TM: /UB80E MADE IN CANADA 010

Figure A4. Vehicle Certification Label



TIRE AND LOADING INFORMATION

SEATING CAPACITY : TOTAL 5
FRONT 2 : REAR 3
The combined weight of occupants and cargo should never exceed 410kg or 900lbs.

SEE OWNER'S
MANUAL FOR
ADDITIONAL
INFORMATION.

TIRE	SIZE	COLD TIRE PRESSURE
FRONT	225/65R17	240kPa, 35PSI
REAR	225/65R17	240kPa, 35PSI
SPARE	T165/80D17	420kPa, 60PSI

RENSEIGNEMENTS SUR LES PNEUS ET LE CHARGEMENT

NOMBRE DE PLACES: TOTAL 5
AVANT 2 : ARRIÈRE 3
Le poids total des occupants et du chargement ne doit jamais dépasser 410kg ou 900lb.

PNEU	DIMENSIONS	PRESSION DES PNEUS À FROID
AVANT	225/65R17	240kPa, 35PSI
ARRIÈRE	225/65R17	240kPa, 35PSI
DE SECOURS	T165/80D17	420kPa, 60PSI

VOIR LE MANUEL
DE L'USAGER
POUR PLUS DE
RENSEIGNEMENTS

PZ
OR160

Figure A5. Tire Placard



Figure A6. MicroAutoBox Installed in Subject Vehicle



Figure A7. Computer Installed in Subject Vehicle



Figure A8. Sensors for Detecting Visual and Auditory Alerts



Figure A9. Button for Accessing System Setup Menus



Figure A10. System Setup Menus and Alert Sensitivity

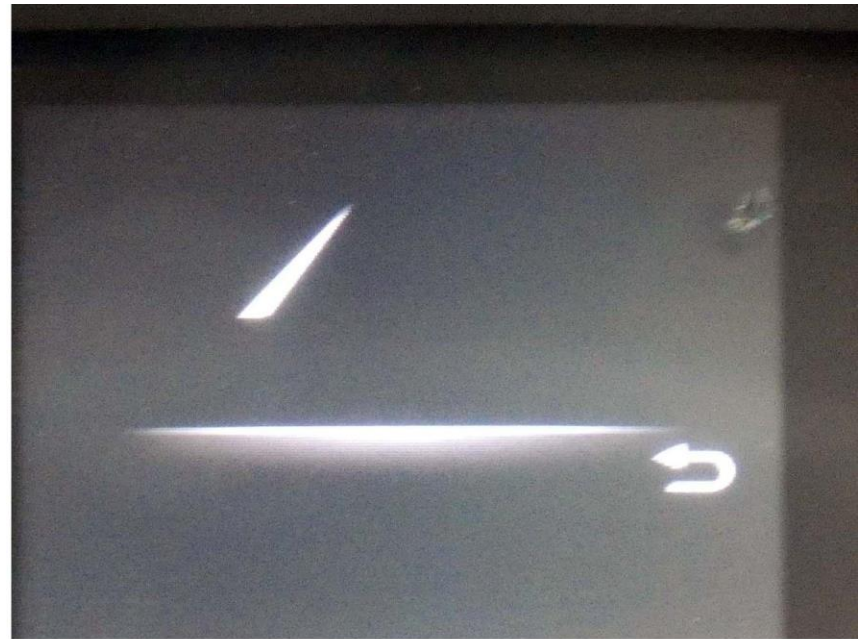
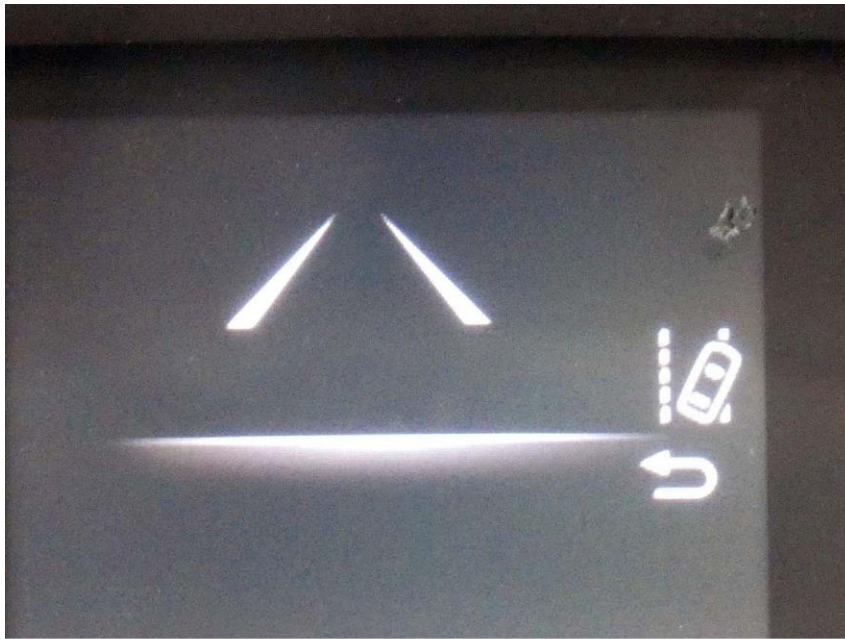


Figure A11. LDW Visual Alert

APPENDIX B

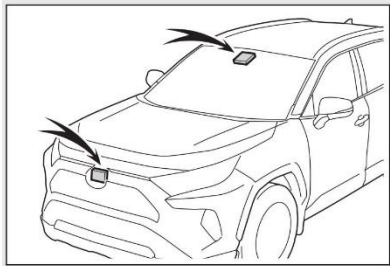
Excerpts from Owner's Manual

LTA (Lane Tracing Assist)

While driving on a road with clear white (yellow) lane lines, the LTA system warns the driver if the vehicle may deviate from the current lane or course*, and also can slightly operate the steering wheel to help avoid deviation from the lane or course*. Also, while the dynamic radar cruise control with full-speed range is operating, this system will operate the steering wheel to maintain the vehicle's lane position.

The LTA system recognizes white (yellow) lane lines or a course* using the front camera. Additionally, it detects preceding vehicles using the front camera and radar.

*: Boundary between asphalt and the side of the road, such as grass, soil, or a curb



⚠ WARNING

- **Before using LTA system**
 - Do not rely solely upon the LTA system. The LTA system does not automatically drive the vehicle or reduce the amount of attention that must be paid to the area in front of the vehicle. The driver must always assume full responsibility for driving safely by paying careful attention to the surrounding conditions and operating the steering wheel to correct the path of the vehicle. Also, the driver must take adequate breaks when fatigued, such as from driving for a long period of time.
 - Failure to perform appropriate driving operations and pay careful attention may lead to an accident, resulting in death or serious injury.
 - When not using the LTA system, use the LTA switch to turn the system off.
- **Situations unsuitable for LTA system**

In the following situations, use the LTA switch to turn the system off. Failure to do so may lead to an accident, resulting in death or serious injury.

 - Vehicle is driven on a road surface which is slippery due to rainy weather, fallen snow, freezing, etc.
 - Vehicle is driven on a snow-covered road.
 - White (yellow) lines are difficult to see due to rain, snow, fog, dust, etc.
 - Vehicle is driven in a temporary lane or restricted lane due to construction work.

⚠ WARNING

- Vehicle is driven in a construction zone.
- A spare tire, tire chains, etc. are equipped.
- When the tires have been excessively worn, or when the tire inflation pressure is low.
- When your vehicle is towing a trailer or during emergency towing

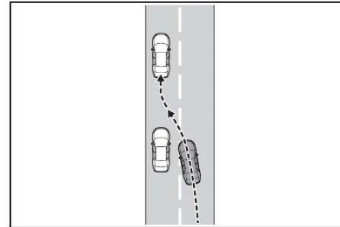
■ Preventing LTA system malfunctions and operations performed by mistake

- Do not modify the headlights or place stickers, etc. on the surface of the lights.
- Do not modify the suspension etc. If the suspension etc. needs to be replaced, contact your Toyota dealer.
- Do not install or place anything on the hood or grille. Also, do not install a grille guard (bull bars, kangaroo bar, etc.).
- If your windshield needs repairs, contact your Toyota dealer.

■ Conditions in which functions may not operate properly

In the following situations, the functions may not operate properly and the vehicle may depart from its lane. Drive safely by always paying careful attention to your surroundings and operate the steering wheel to correct the path of the vehicle without relying solely on the functions.

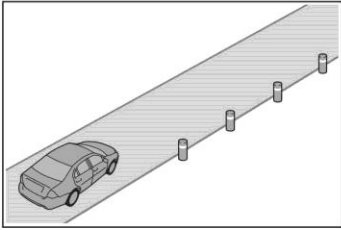
- When the follow-up cruising display is displayed (→P.241) and the preceding vehicle changes lanes. (Your vehicle may follow the preceding vehicle and also change lanes.)



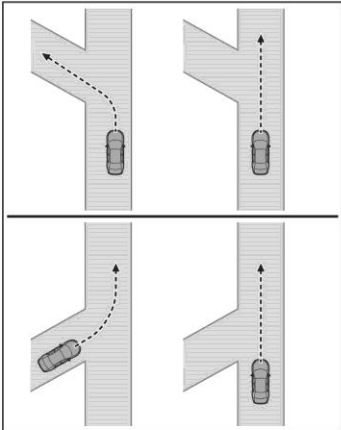
- When the follow-up cruising display is displayed (→P.241) and the preceding vehicle is swaying. (Your vehicle may sway accordingly and depart from the lane.)
- When the follow-up cruising display is displayed (→P.241) and the preceding vehicle departs from its lane. (Your vehicle may follow the preceding vehicle and depart from the lane.)
- When the follow-up cruising display is displayed (→P.241) and the preceding vehicle is being driven extremely close to the left/right lane line. (Your vehicle may follow the preceding vehicle and depart from the lane.)
- Vehicle is being driven around a sharp curve.

⚠ WARNING

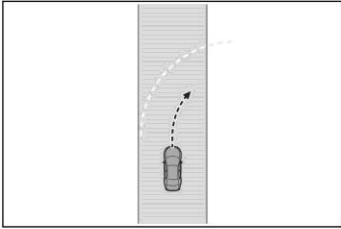
- Objects or patterns that could be mistaken for white (yellow) lines are present on the side of the road (guardrails, reflective poles, etc.).



- Vehicle is driven where the road diverges, merges, etc.



- Repair marks of asphalt, white (yellow) lines, etc. are present due to road repair.



- There are shadows on the road that run parallel with, or cover, the white (yellow) lines.

- The vehicle is driven in an area without white (yellow) lines, such as in front of a tollgate or checkpoint, or at an intersection, etc.
- The white (yellow) lines are cracked, "Botts' dots", "Raised pavement marker" or stones are present.
- The white (yellow) lines cannot be seen or are difficult to see due to sand, etc.
- The vehicle is driven on a road surface that is wet due to rain, puddles, etc.
- The traffic lines are yellow (which may be more difficult to recognize than lines that are white).
- The white (yellow) lines cross over a curb, etc.
- The vehicle is driven on a bright surface, such as concrete.
- If the edge of the road is not clear or straight.
- The vehicle is driven on a surface that is bright due to reflected light, etc.
- The vehicle is driven in an area where the brightness changes suddenly, such as at the entrances and exits of tunnels, etc.
- Light from the headlights of an oncoming vehicle, the sun, etc. enters the camera.
- The vehicle is driven on a slope.
- The vehicle is driven on a road which tilts left or right, or a winding road.
- The vehicle is driven on an unpaved or rough road.

⚠ WARNING

- The traffic lane is excessively narrow or wide.
- The vehicle is extremely tilted due to carrying heavy luggage or having improper tire pressure.
- The distance to the preceding vehicle is extremely short.
- The vehicle is moving up and down a large amount due to road conditions during driving (poor roads or road seams).
- When driving in a tunnel or at night with the headlights off or when a headlight is dim due to its lens being dirty or it being misaligned.
- The vehicle is struck by a cross-wind.
- The vehicle is affected by wind from a vehicle driven in a nearby lane.
- The vehicle has just changed lanes or crossed an intersection.
- Tires which differ by structure, manufacturer, brand or tread pattern are used.
- When tires of a size other than specified are installed.
- Snow tires, etc. are equipped.
- The vehicle is being driven at extremely high speeds.

Functions included in LTA system

■ **Lane departure alert function**

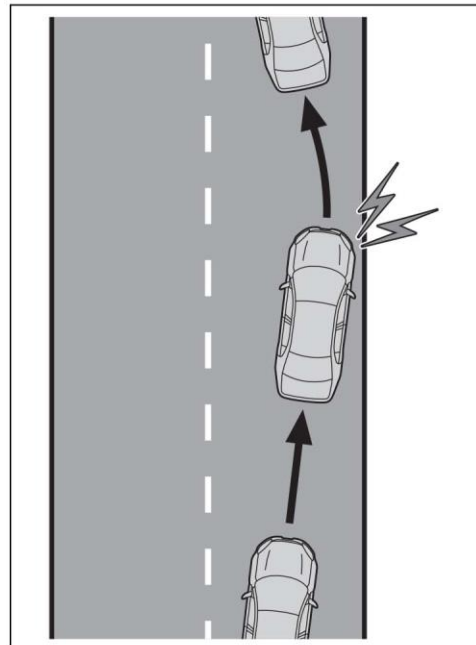
When the system determines

that the vehicle might depart from its lane or course*, a warning is displayed on the multi-information display, and a warning buzzer will sound to alert the driver.

When the warning buzzer sounds, check the area around your vehicle and carefully operate the steering wheel to move the vehicle back to the center of the lane.

Vehicles with BSM: When the system determines that the vehicle might depart from its lane and that the possibility of a collision with an overtaking vehicle in the adjacent lane is high, the lane departure alert will operate even if the turn signals are operating.

*: Boundary between asphalt and the side of the road, such as grass, soil, or a curb



■ **Steering assist function**

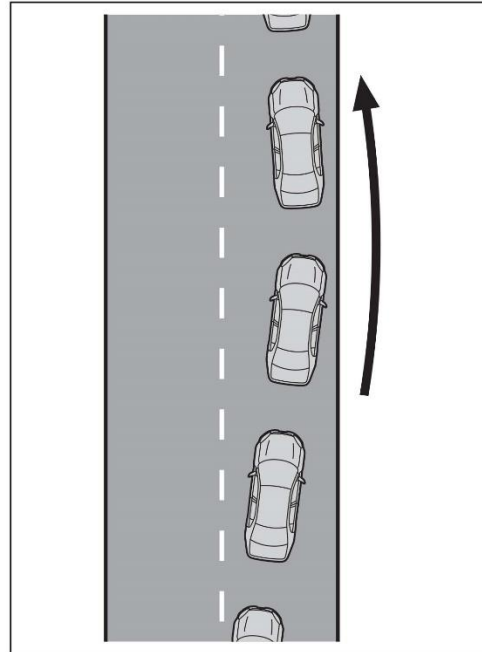
When the system determines

that the vehicle might depart from its lane or course^{*}, the system provides assistance as necessary by operating the steering wheel in small amounts for a short period of time to keep the vehicle in its lane.

If the system detects that the steering wheel has not been operated for a fixed amount of time or the steering wheel is not being firmly gripped, a warning is displayed on the multi-information display and the function is temporarily canceled.

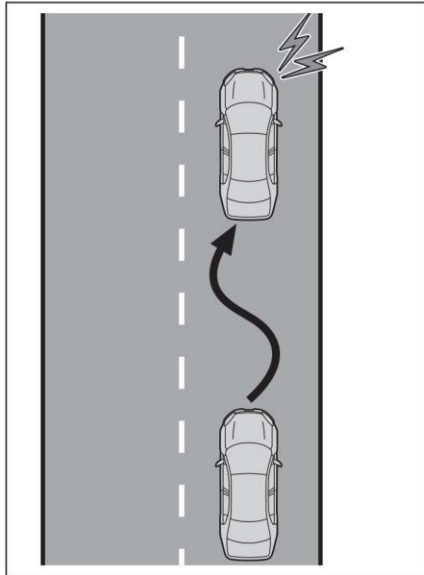
Vehicles with BSM: When the system determines that the vehicle might depart from its lane and that the possibility of a collision with an overtaking vehicle in the adjacent lane is high, the steering assist function will operate even if the turn signals are operating.

^{*}: Boundary between asphalt and the side of the road, such as grass, soil, or a curb



■ Vehicle sway warning function

When the vehicle is swaying within a lane, the warning buzzer will sound and a message will be displayed on the multi-information display to alert the driver.



■ **Lane centering function**

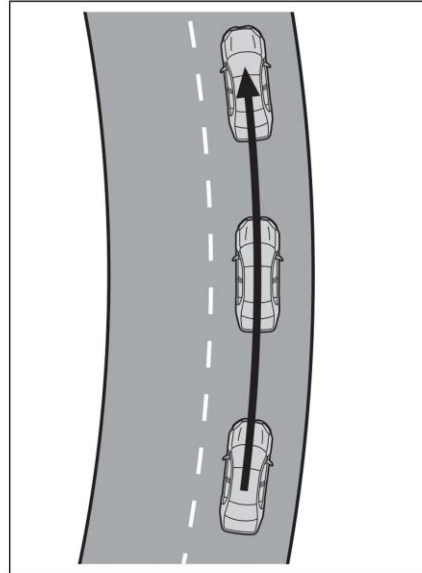
This function is linked with dynamic radar cruise control with full-speed range and provides the required assistance by operating the steering wheel to keep the vehicle in its current lane.

When dynamic radar cruise control with full-speed range is not operating, the lane centering function does not operate.

In situations where the white (yellow) lane lines are difficult to see or are not visible, such as when in a traffic jam, this function will operate to help follow a preceding vehicle by monitoring the position of the preceding vehicle.

If the system detects that the steering wheel has not been operated for a fixed amount of time or the steering wheel is not being firmly gripped, a warning is displayed on

the multi-information display and the function is temporarily canceled.



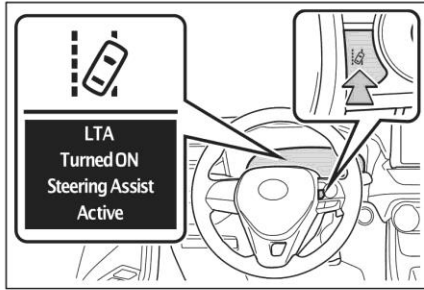
Turning LTA system on

Press the LTA switch to turn the LTA system on.

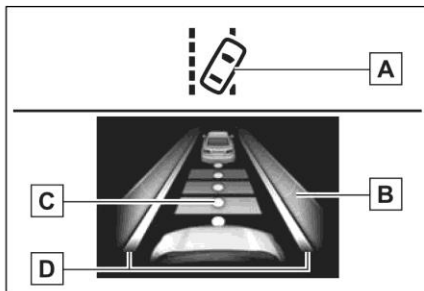
The LTA indicator illuminates and a message is displayed on the multi-information display.

Press the LTA switch again to turn the LTA system off.

When the LTA system is turned on or off, operation of the LTA system continues in the same condition the next time the engine is started.



Indications on multi-information display



- A** LTA indicator
The illumination condition of the indicator informs the driver of the system operation status.
Illuminated in white: LTA system is operating.
Illuminated in green: Steering wheel assistance of the steering assist function or lane centering function is operating.
Flashing in orange: Lane departure alert function is operating.
- B** Operation display of steering wheel operation support
Displayed when the multi-information display is switched to the driving support system information display.
Indicates that steering wheel assistance of the steering assist function

or lane centering function is operating.

Both outer sides of the lane are displayed: Indicates that steering wheel assist of the lane centering function is operating.

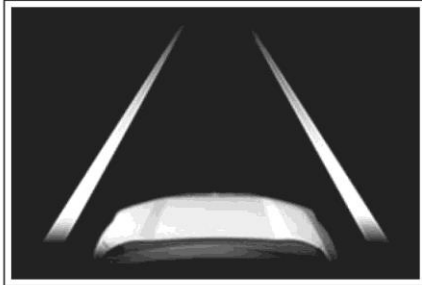
One outer side of the lane is displayed: Indicates that steering wheel assist of the steering assist function is operating.

Both outer sides of the lane are flashing: Alerts the driver that their input is necessary to stay in the center of the lane (lane centering function).

- C** Follow-up cruising display
Displayed when the multi-information display is switched to the driving support system information display.
Indicates that steering assist of the lane centering function is operating by monitoring the position of a preceding vehicle.
When the follow-up cruising display is displayed, if the preceding vehicle moves, your vehicle may move in the same way. Always pay careful attention to your surroundings and operate the steering wheel as necessary to correct the path of the vehicle and ensure safety.

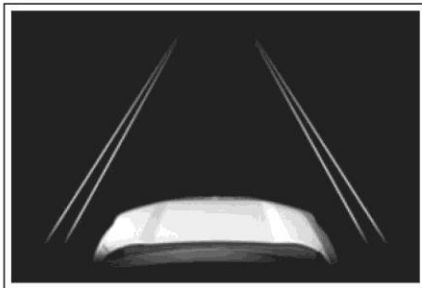
- D** Lane departure alert function display
Displayed when the multi-information display is switched to the driving support system information display.

- ▶ Inside of displayed lines is white



Indicates that the system is recognizing white (yellow) lines or a course*. When the vehicle departs from its lane, the white line displayed on the side the vehicle departs from flashes orange.

- ▶ Inside of displayed lines is black



Indicates that the system is not able to recognize white (yellow) lines or a course* or is temporarily canceled.

*: Boundary between asphalt and the side of the road, such as grass, soil, or a curb

■ **Operation conditions of each function**

- Lane departure alert function
This function operates when all of the following conditions are met.


- LTA is turned on.
- Vehicle speed is approximately 32 mph (50 km/h) or more.*¹
- System recognizes white (yellow) lane lines or a course*². (When a white [yellow] line or course*² is recognized on only one side, the system will operate only for the recognized side.)
- Width of traffic lane is approximately 9.8 ft. (3 m) or more.
- Turn signal lever is not operated. (Vehicles with BSM: Except when another vehicle is in the lane on the side where the turn signal was operated)
- Vehicle is not being driven around a sharp curve.
- No system malfunctions are detected. (→P.244)

*¹: The function operates even if the vehicle speed is less than approximately 32 mph (50 km/h) when the lane centering function is operating.


*²: Boundary between asphalt and the side of the road, such as grass, soil, or a curb

- Steering assist function


This function operates when all of the following conditions are met in addition to the operation conditions for the lane departure alert function.

- Setting for “Steering Assist” in the  screen of the multi-information display is set to “ON”. (→P.94)
- Vehicle is not accelerated or decelerated by a fixed amount or more.
- Steering wheel is not operated with a steering force level suitable for changing lanes.
- ABS, VSC, TRAC and PCS are not operating.
- TRAC or VSC is not turned off.
- Hands off steering wheel warning is not displayed. (→P.244)
- Vehicle sway warning function

This function operates when all of the following conditions are met.

- Setting for “Sway Warning” in the  screen of the multi-information display is set to “ON”. (→P.89)
- Vehicle speed is approximately 32 mph (50 km/h) or more.
- Width of traffic lane is approximately 9.8 ft. (3 m) or more.
- No system malfunctions are detected. (→P.244)
- Lane centering function

This function operates when all of the following conditions are met.

- LTA is turned on.
- Setting for “Steering Assist” and “Lane Center” in the  screen of the multi-information display is set to “ON”. (→P.89)
- This function recognizes white (yellow) lane lines or the position of a preceding vehicle (except when the preceding vehicle is small, such as a motorcycle).
- The dynamic radar cruise control with full-speed range is operating in vehicle-to-vehicle distance control mode.
- Width of traffic lane is approximately 10 to 13 ft. (3 to 4 m).
- Turn signal lever is not operated.
- Vehicle is not being driven around a sharp curve.
- No system malfunctions are detected. (→P.244)
- Vehicle does not accelerate or decelerate by a fixed amount or more.
- Steering wheel is not operated with a steering force level suitable for changing lanes.
- ABS, VSC, TRAC and PCS are not operating.
- TRAC or VSC is not turned off.
- Hands off steering wheel warning is not displayed. (→P.244)
- The vehicle is being driven in the center of a lane.
- Steering assist function is not operating.

■ **Temporary cancelation of functions**

- When operation conditions are no longer met, a function may be temporarily canceled. However, when the operation conditions are met again, operation of the function is automatically restored. (→P.242)
- If the operation conditions (→P.242) are no longer met while the lane centering function is operating, the buzzer may sound to indicate that the function has been temporarily canceled.

■ **Steering assist function/lane centering function**

- Depending on the vehicle speed, lane departure situation, road conditions, etc., the driver may not feel the function is operating or the function may not operate at all.
- The steering control of the function is overridden by the driver’s steering wheel operation.
- Do not attempt to test the operation of the steering assist function.

■ **Lane departure alert function**

- The warning buzzer may be difficult to hear due to external noise, audio playback, etc.
- If the edge of the course* is not clear or straight, the lane departure alert function may not operate.
- Vehicles with BSM: It may not be possible for the system to determine if there is a danger of a collision with a vehicle in an adjacent lane.
- Do not attempt to test the operation of the lane departure alert function.

*: Boundary between asphalt and the side of the road, such as grass, soil, or a curb

■ **Hands off steering wheel warning**

In the following situations, a warning message urging the driver to hold the steering wheel and the symbol shown in the illustration are displayed on the multi-information display to warn the driver. The warning stops when the system determines that the driver holds the steering wheel. Always keep your hands on the steering wheel when using this system, regardless of warnings.



- When the system determines that the driver is driving without holding the steering wheel while the system is operating

If the driver continues to keep their hands off of the steering wheel, the buzzer sounds, the driver is warned and the function is temporarily canceled. This warning also operates in the same way when the driver continuously operates the steering wheel only a small amount.

- When the system determines that the vehicle may deviate from the lane while driving around a curve while the lane centering function is operating.

Depending on the vehicle condition and road conditions, the warning may not operate. Also, if the system determines that the vehicle is driving around a curve, warnings will occur earlier than during straight-lane driving.

- When the system determines that the driver is driving without hold-

ing the steering wheel while the steering wheel assist of the steering assist function is operating.

If the driver continues to keep their hands off of the steering wheel and the steering wheel assist is operating, the buzzer sounds and the driver is warned. Each time the buzzer sounds, the continuing time of the buzzer becomes longer.

■ **Vehicle sway warning function**

When the system determines that the vehicle is swaying while the vehicle sway warning function is operating, a buzzer sounds and a warning message urging the driver to rest and the symbol shown in the illustration are simultaneously displayed on the multi-information display.



Depending on the vehicle and road conditions, the warning may not operate.

■ **Warning message**

If the following warning message is displayed on the multi-information display and the LTA indicator illuminates in orange, follow the appropriate troubleshooting procedure. Also, if a different warning message is displayed, follow the instructions displayed on the screen.

- “LTA Malfunction Visit Your Dealer”

The system may not be operating properly. Have the vehicle inspected by your Toyota dealer.

- “LTA Unavailable”

The system is temporarily canceled

due to a malfunction in a sensor other than the front camera. Turn the LTA system off, wait for a little while, and then turn the LTA system back on.

- “LTA Unavailable at Current Speed”

The function cannot be used as the vehicle speed exceeds the LTA operation range. Drive slower.

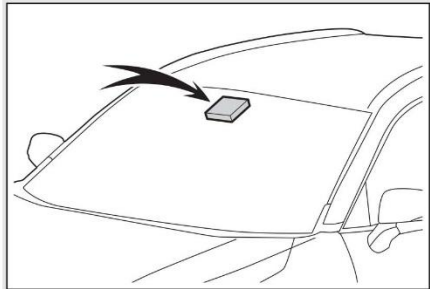
■ **Customization**

Function settings can be changed. (→P.94)

RSA (Road Sign Assist)*

*: If equipped

The RSA system recognizes specific road signs using the front camera to provide information to the driver via the display.



If the system judges that the vehicle is being driven over the speed limit, performing prohibited actions, etc. according to the recognized road signs, it notifies the driver through a visual notification and notification buzzer.

⚠ WARNING

■ **Before using the RSA**

Do not rely solely upon the RSA system. RSA is a system which supports the driver by providing information, but it is not a replacement for a driver's own vision and awareness. Drive safely by always paying careful attention to the traffic rules.

APPENDIX C

Run Log

Subject Vehicle: **2022 Toyota RAV4 XLE**

Test start date: **1/26/2022**

Test end date: **1/27/2022**

Driver: **Stephen Rhim**

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

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Auditory Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
1	Botts	Left	Y	-0.47	-0.66	Pass	
2			N				Did not cross end of map file
3			Y	-0.36	-0.49	Pass	
4			N				Lane exceedance error
5			N				Did not cross end of map file
6			Y	-0.39	-0.52	Pass	
7			N				Did not cross end of map file
8			Y	-0.63	-0.81	Pass	
9			N				Data Error
10			Y	-0.53	-0.63	Pass	
11			Y	-0.45	-0.56	Pass	
12	Botts	Right	N				Data Error
13			Y	-0.16	-0.37	Pass	
14			Y	-0.16	-0.34	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Auditory Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
15			Y	-0.27	-0.41	Pass	
16			Y	-0.10	-0.26	Pass	
17			Y	-0.18	-0.30	Pass	
18			Y	-0.11	-0.28	Pass	
19	Dashed	Left	N				Data Error
20			Y	-0.22	-0.35	Pass	
21			Y	-0.30	-0.42	Pass	
22			Y	-0.24	-0.35	Pass	
23			Y	-0.33	-0.45	Pass	
24			Y	-0.15	-0.26	Pass	
25			N				Speed
26			Y	-0.17	-0.33	Pass	
27	Dashed	Right	Y	0.07	-0.11	Pass	
28			Y	0.04	-0.10	Pass	
29			Y	0.22	0.09	Pass	
30			Y	0.06	-0.12	Pass	
31			Y	0.20	0.10	Pass	
32			Y	-0.04	-0.22	Pass	
33			Y	0.05	-0.10	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Auditory Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
34	Solid	Right	N				Data Error
35			N				Did not cross end of map file
36			Y	-0.06	-0.19	Pass	
37			Y	-0.12	-0.28	Pass	
38			Y	0.08	-0.09	Pass	
39			Y	-0.25	-0.40	Pass	
40			Y	-0.30	-0.43	Pass	
41			Y	0.04	-0.10	Pass	
42	Solid	Left	Y	-0.16	-0.30	Pass	
43			Y	-0.18	-0.30	Pass	
44			Y	-0.21	-0.33	Pass	
45			Y	-0.46	-0.65	Pass	
46			Y	-0.06	-0.27	Pass	
47			Y	-0.46	-0.61	Pass	
48			Y	-0.34	-0.51	Pass	

APPENDIX D

Time History Plots

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Description of Time History Plots

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

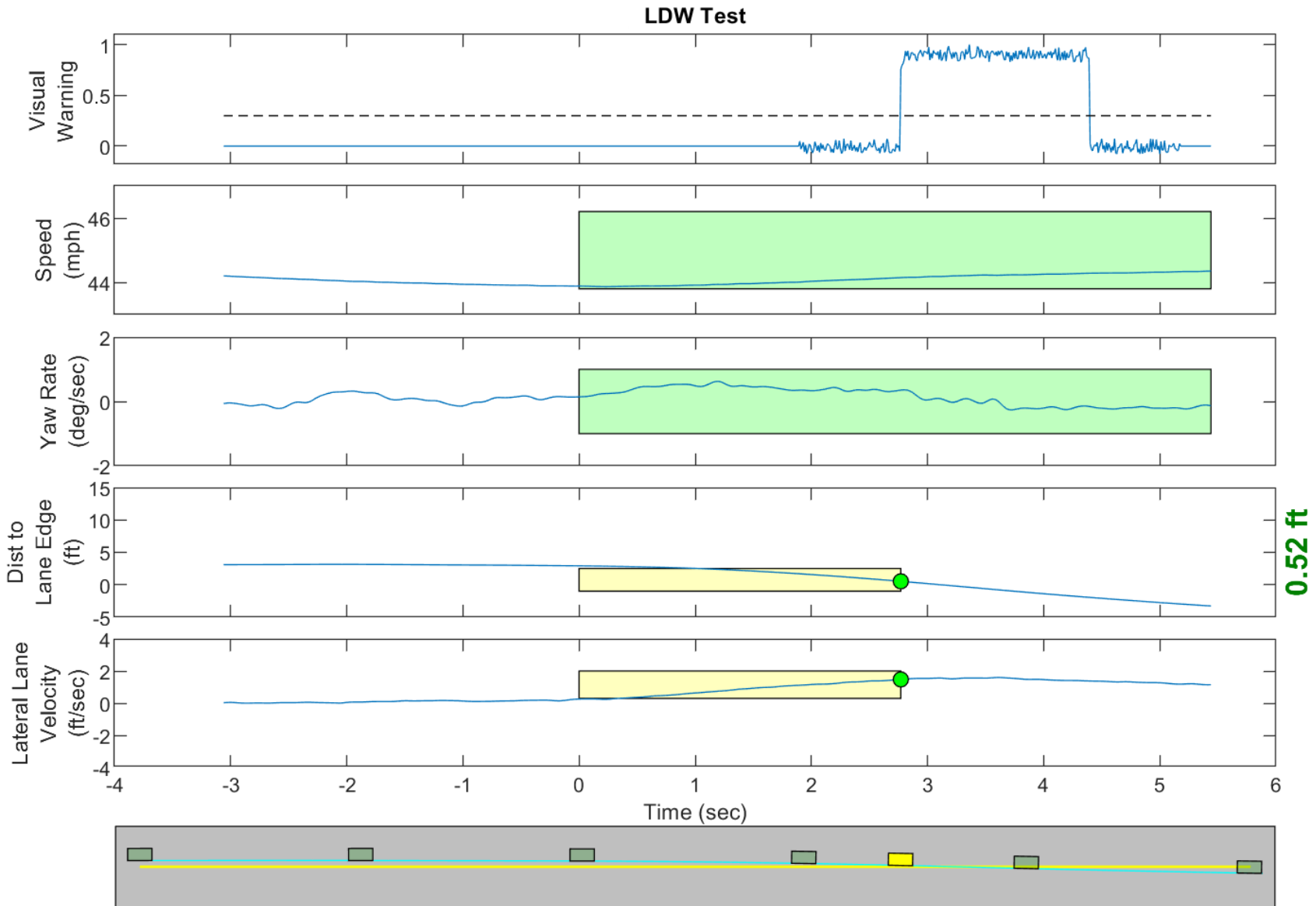
- Green = passing or valid value
- Red = failing or invalid value

Other Notations

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

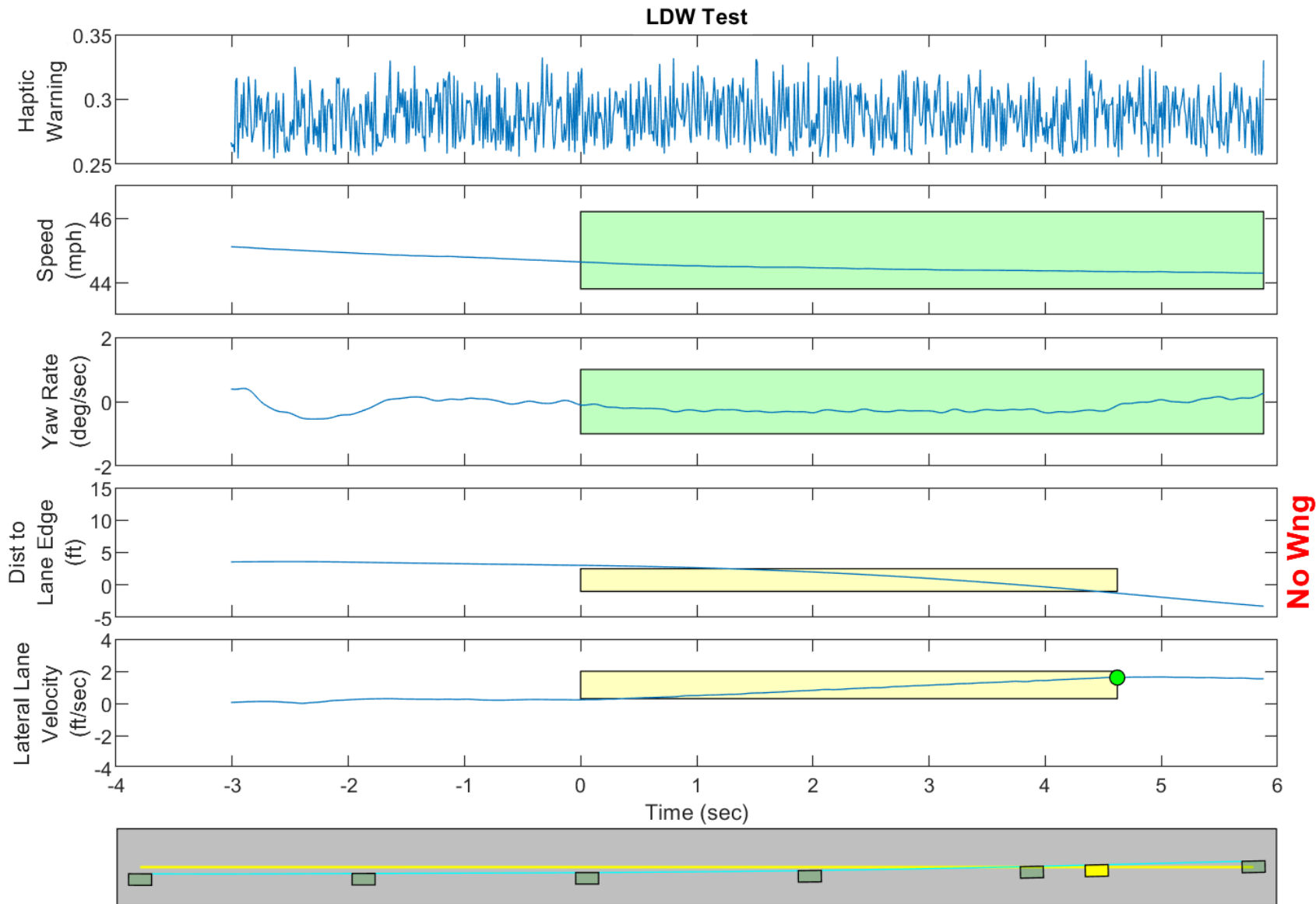
The minimum (worst) GPS fix type is displayed in the lower right corner of each page. The only valid fix type is RTK fixed (displayed in green). If the fix type during any portion of the test was anything other than RTK fixed, then “RTK Fixed OR LESS!!” is displayed in red.

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.



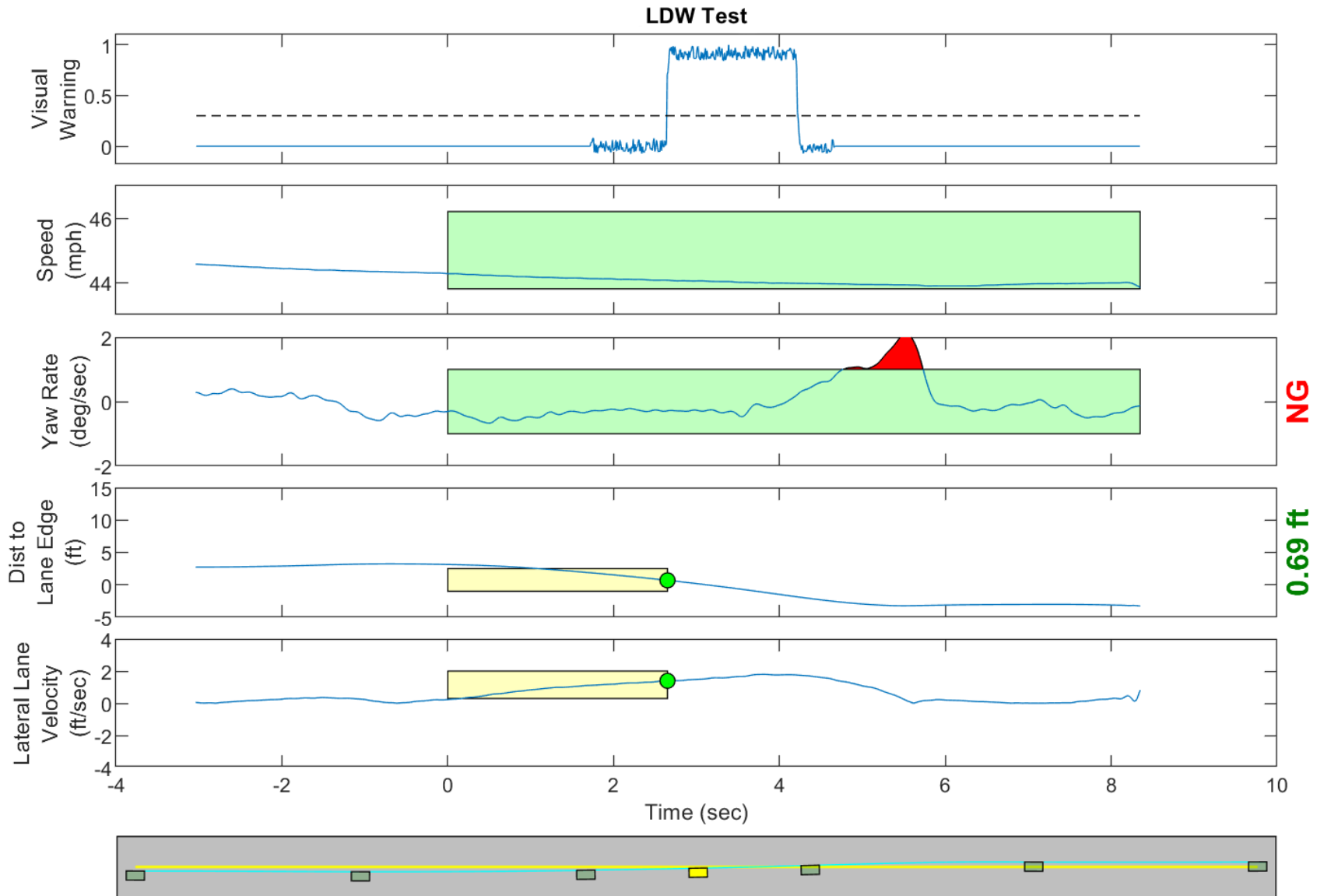
GPS Fix Type: RTK Fixed

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



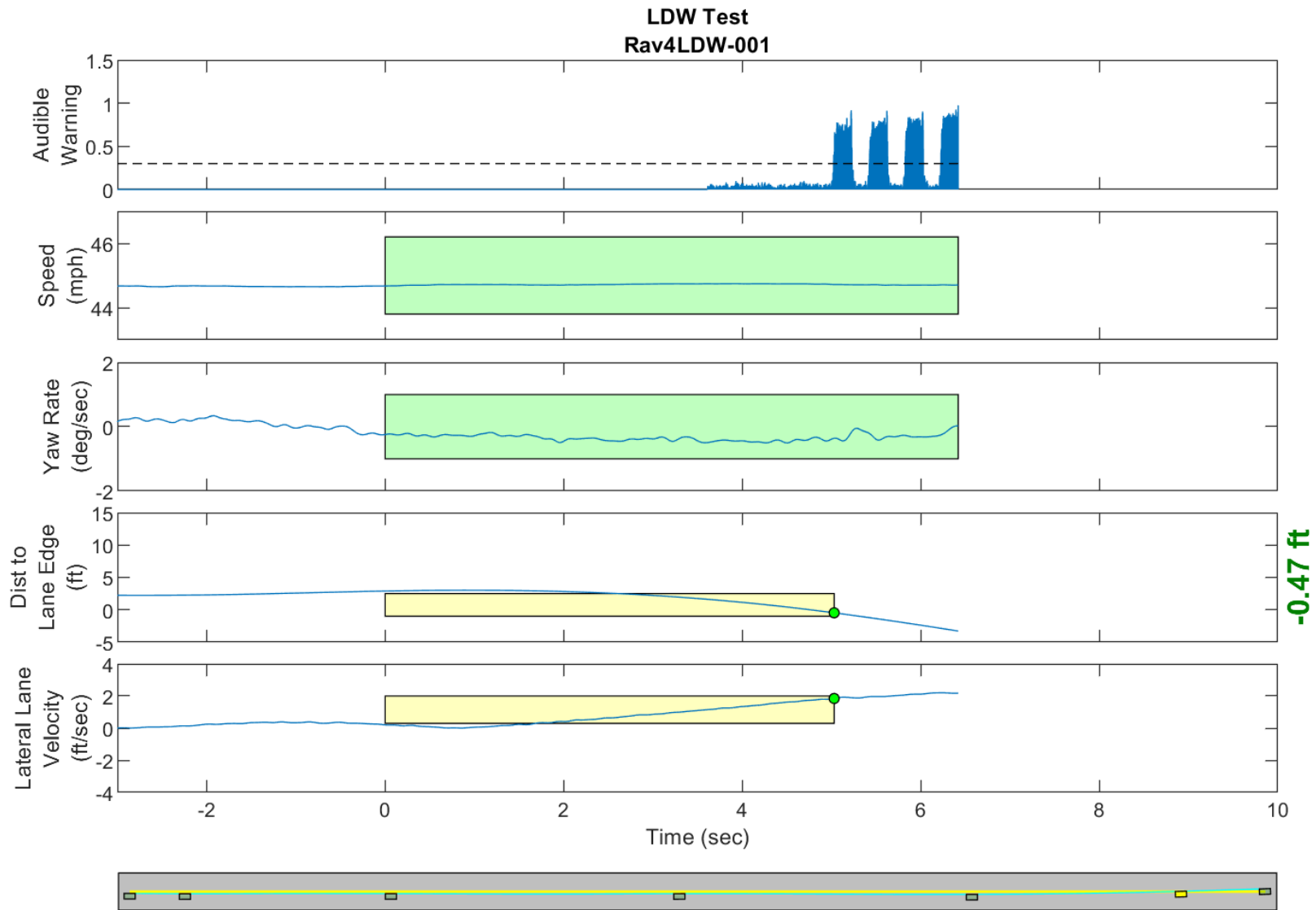
GPS Fix Type: RTK Fixed

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



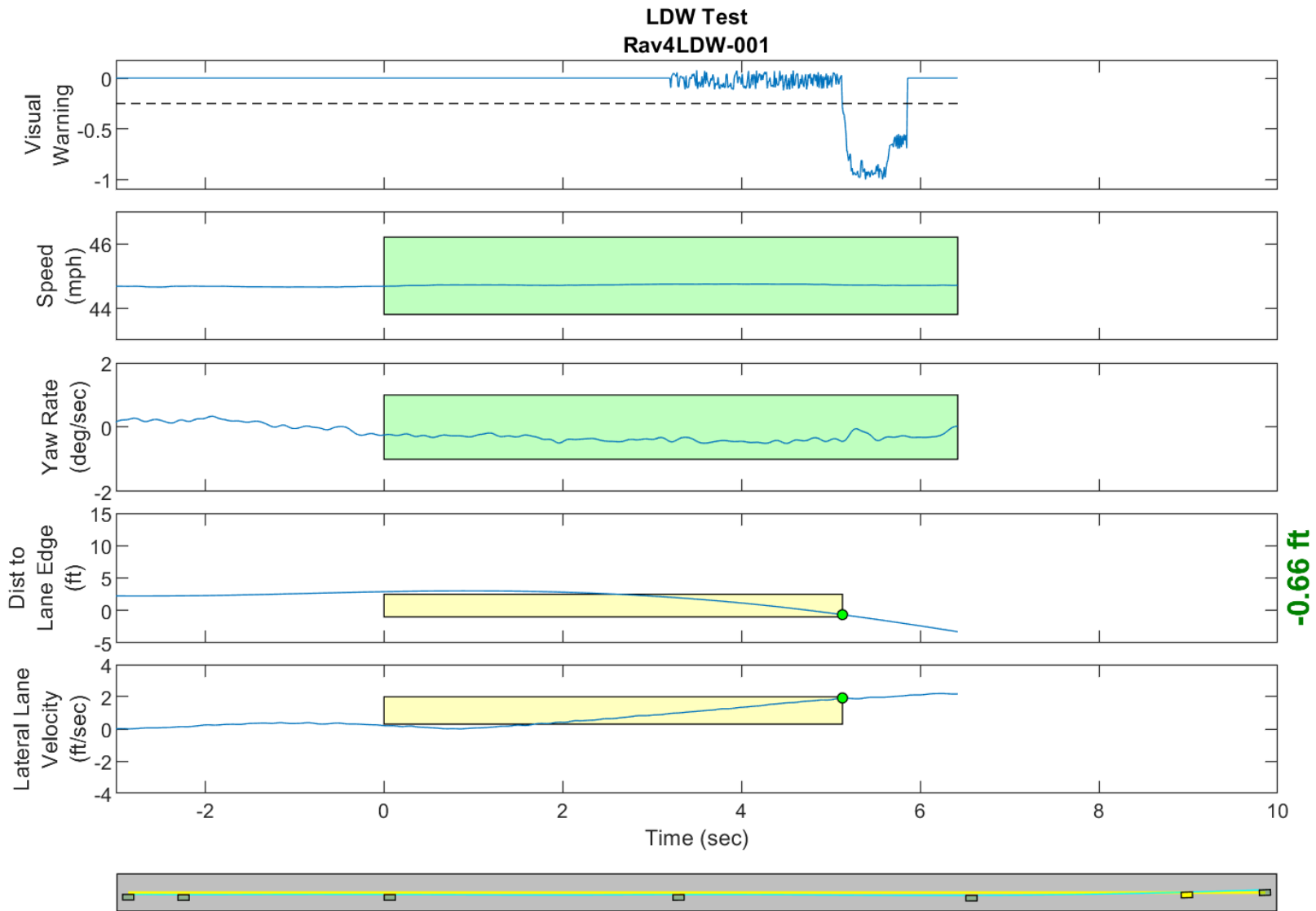
GPS Fix Type: RTK Fixed

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



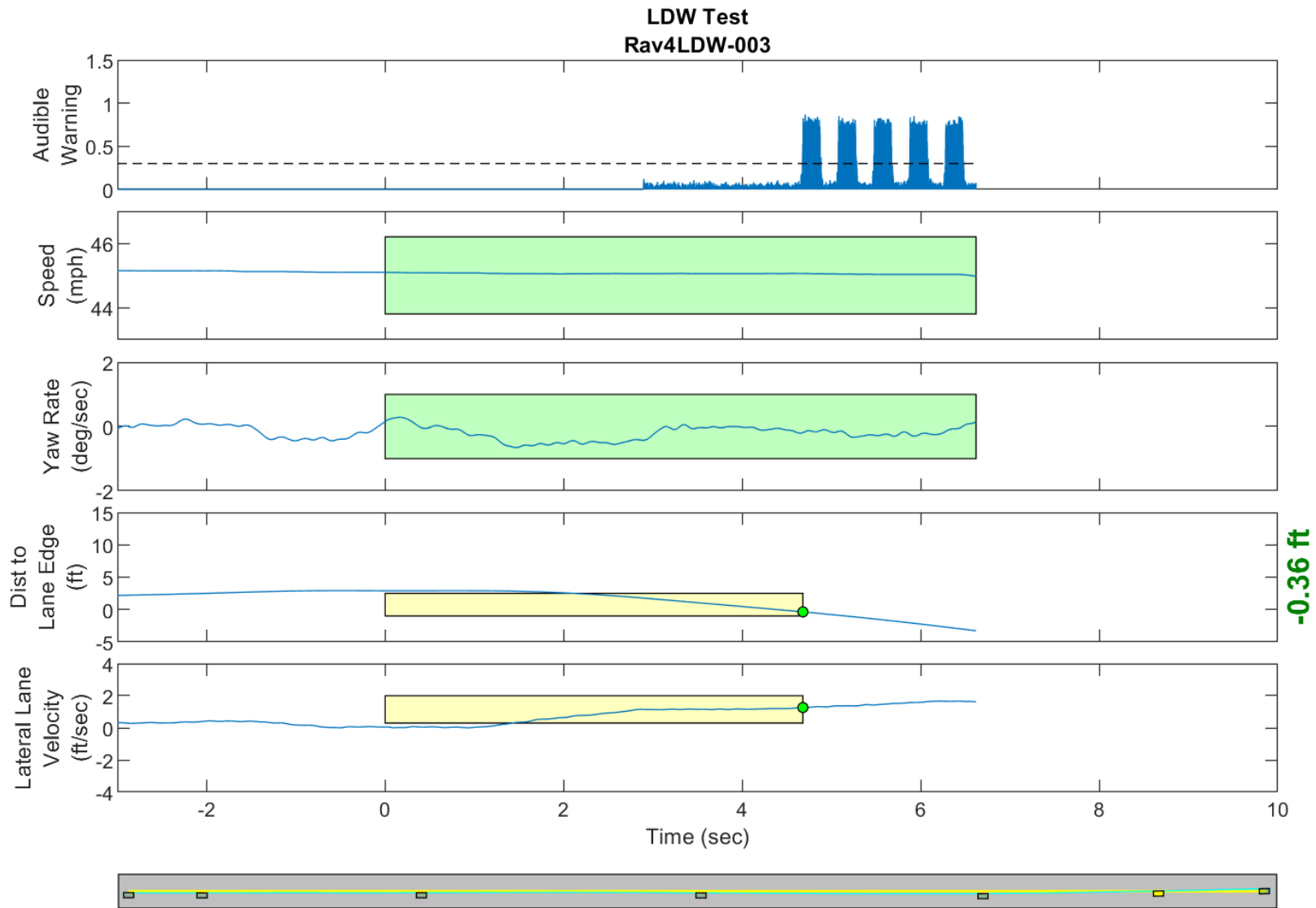
GPS Fix Type: RTK Fixed

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



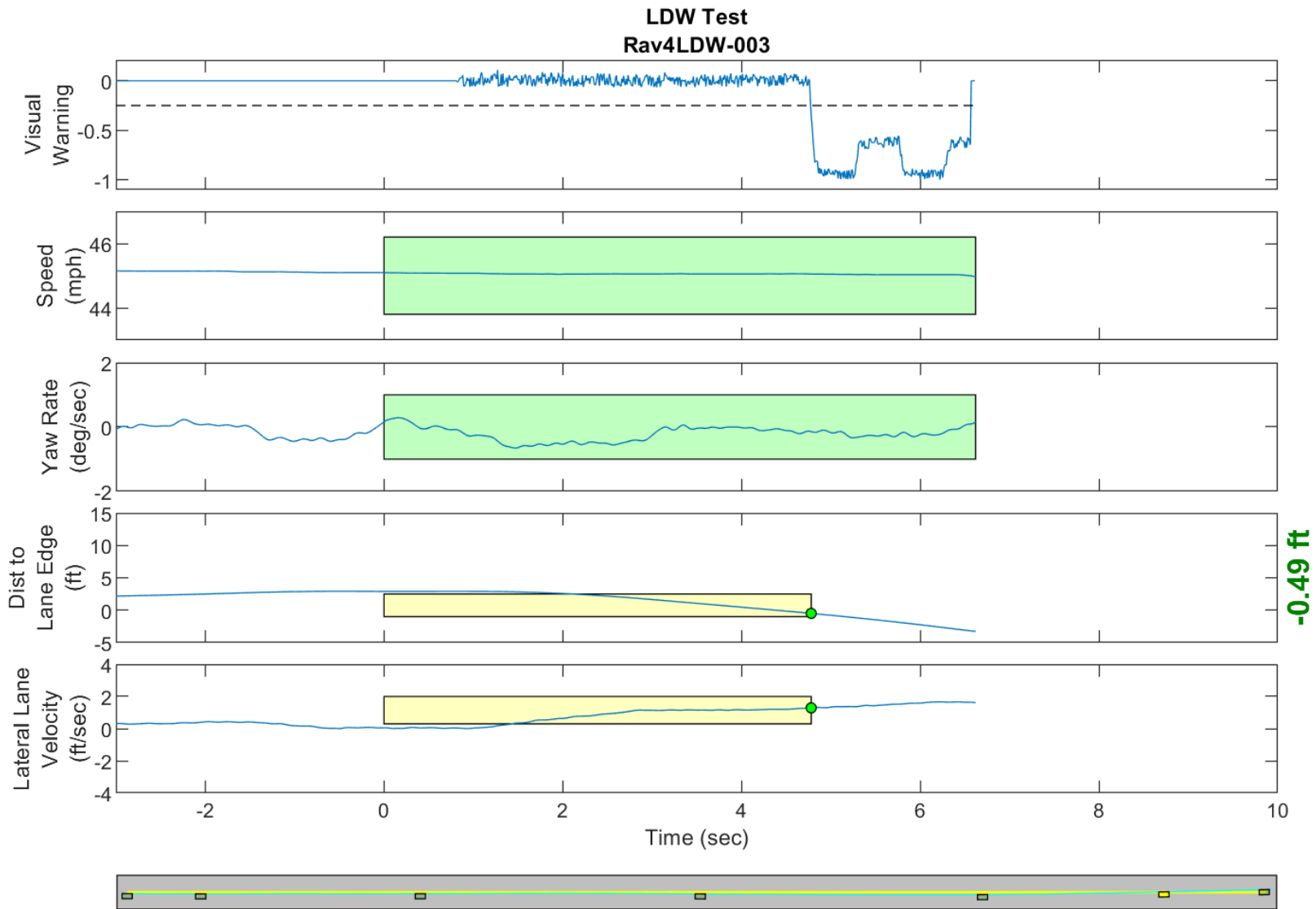
GPS Fix Type: RTK Fixed

Figure D5. Time History for Run 01, Botts Dots, Left Departure, Visual Warning



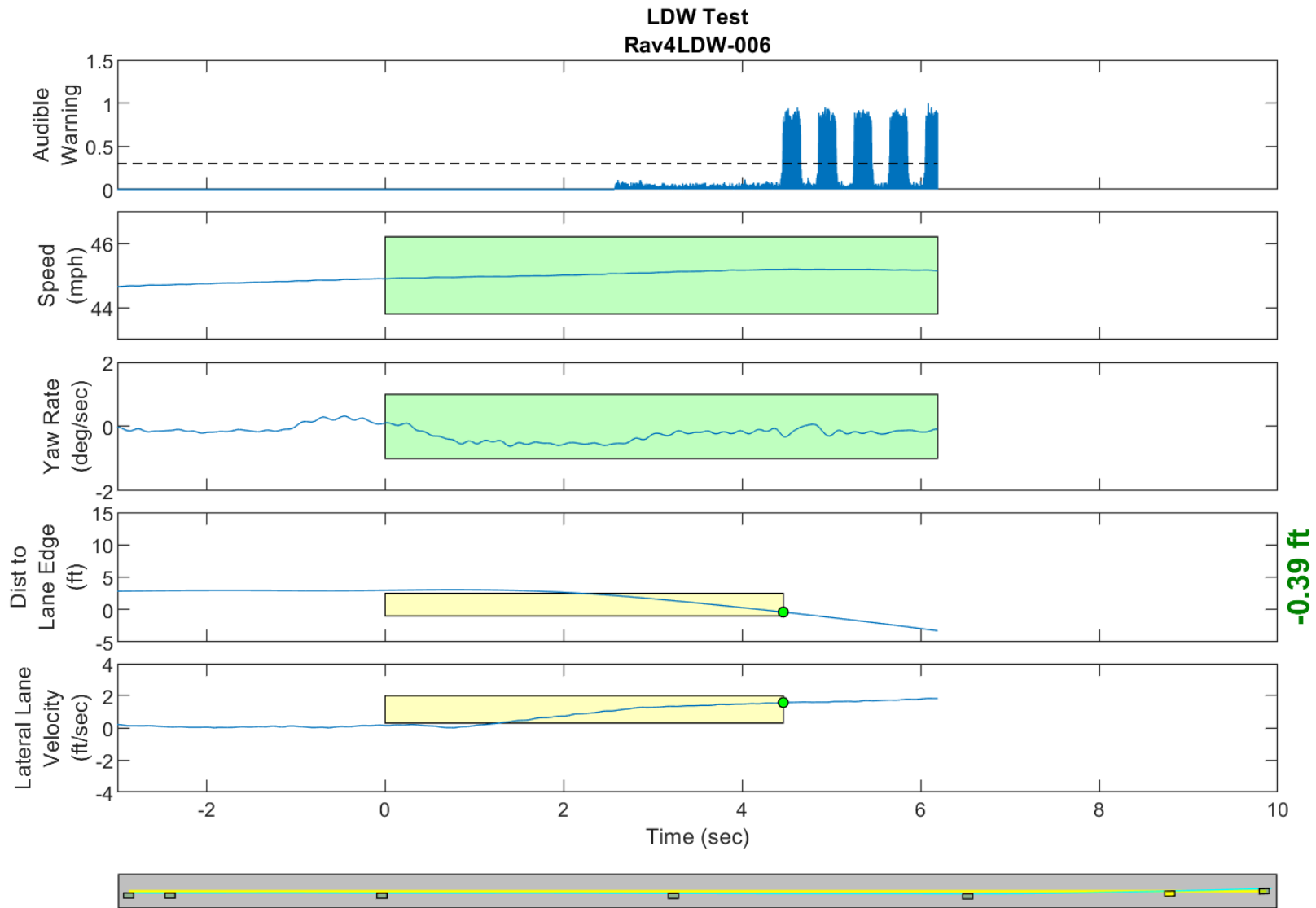
GPS Fix Type: RTK Fixed

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



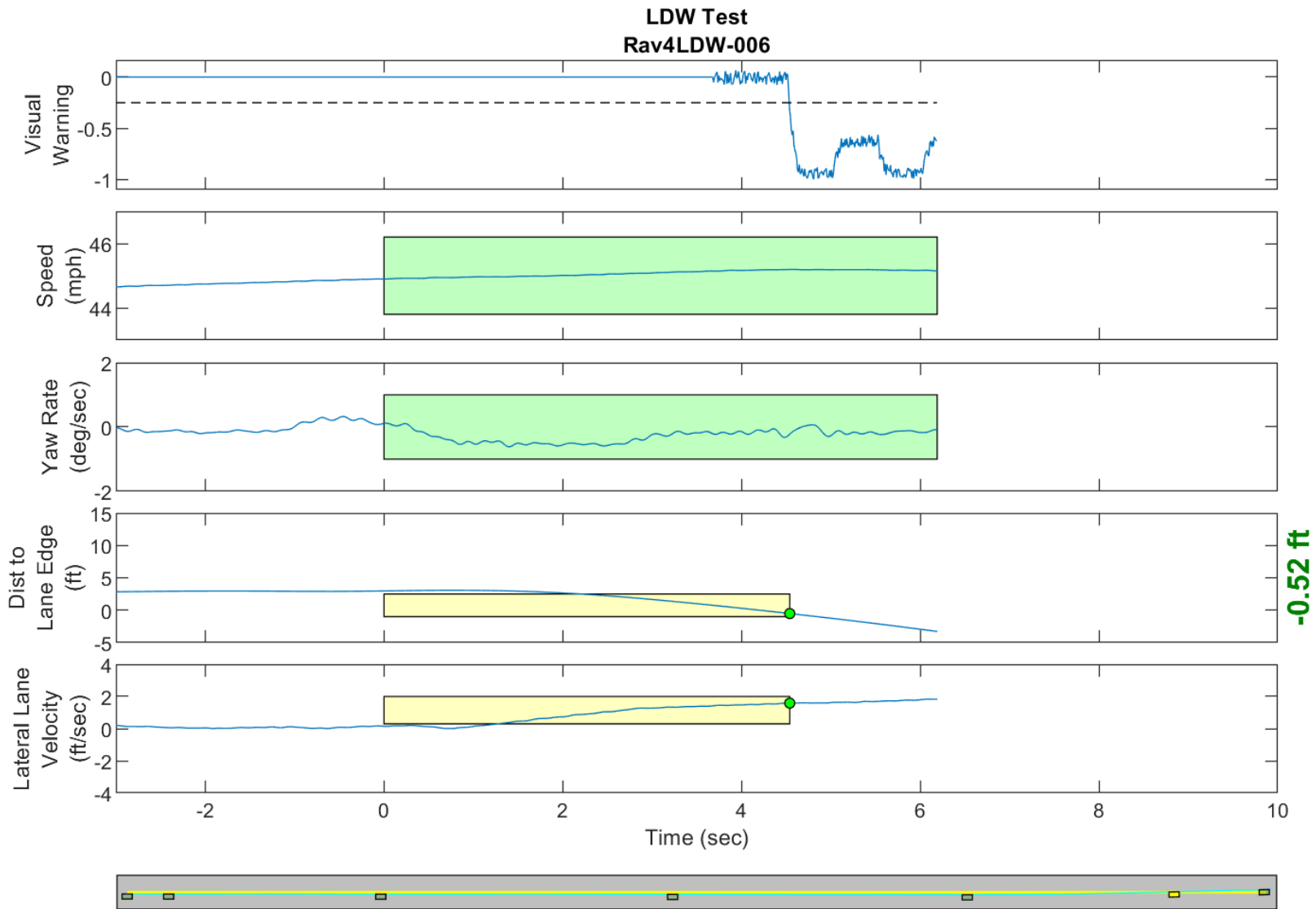
GPS Fix Type: RTK Fixed

Figure D7. Time History for Run 03, Botts Dots, Left Departure, Visual Warning



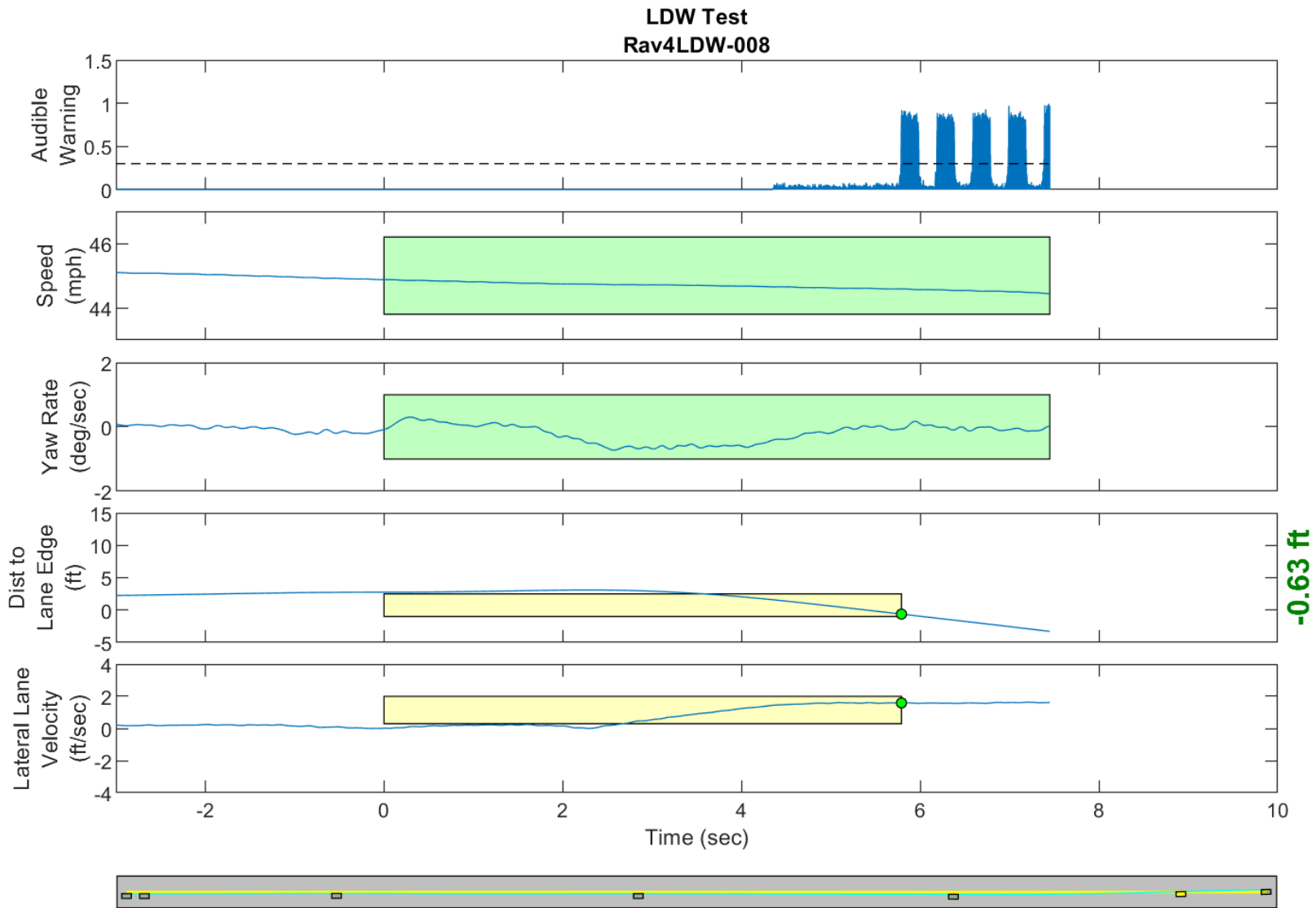
GPS Fix Type: RTK Fixed

Figure D8. Time History for Run 06, Botts Dots, Left Departure, Auditory Warning



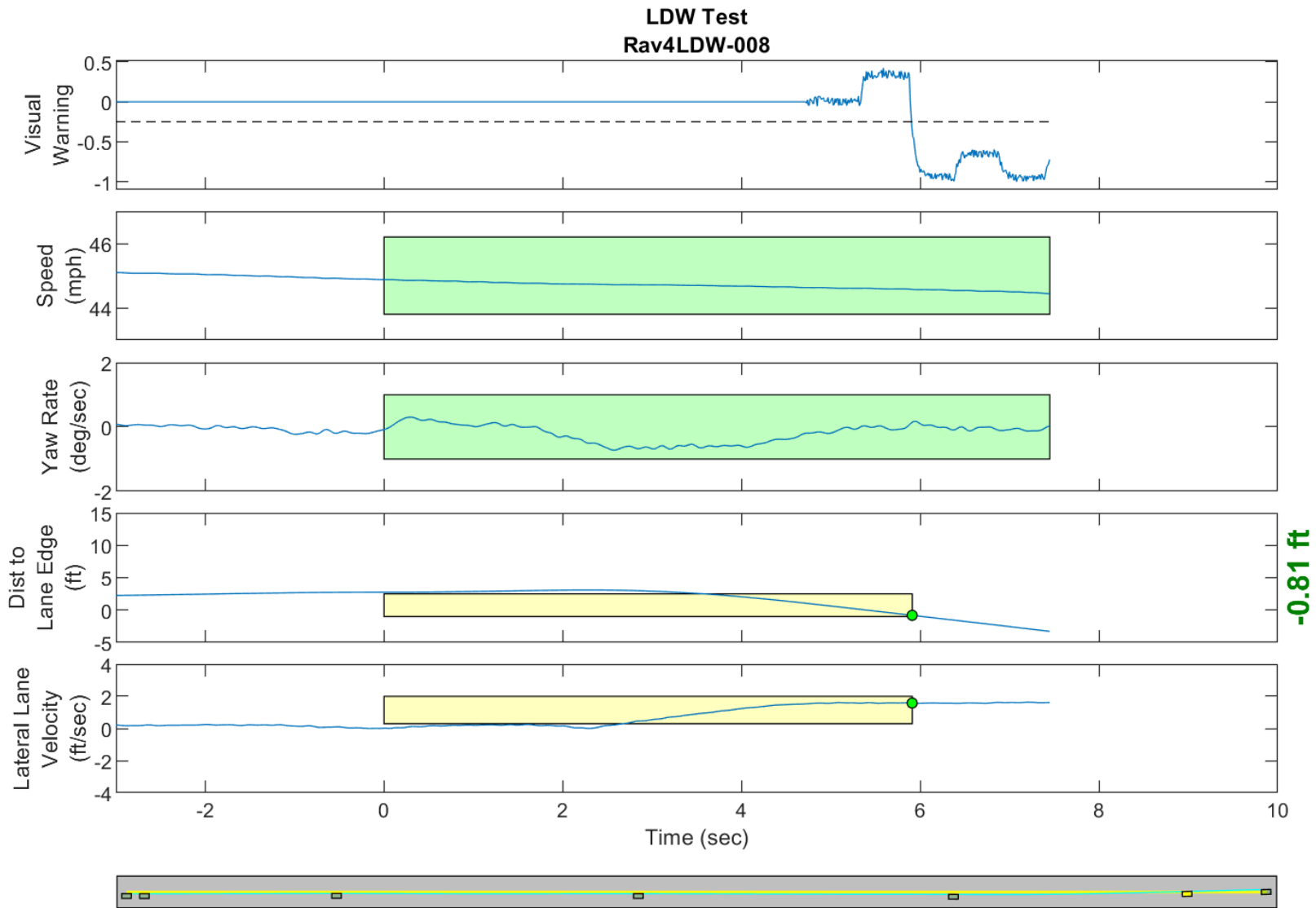
GPS Fix Type: RTK Fixed

Figure D9. Time History for Run 06, Botts Dots, Left Departure, Visual Warning



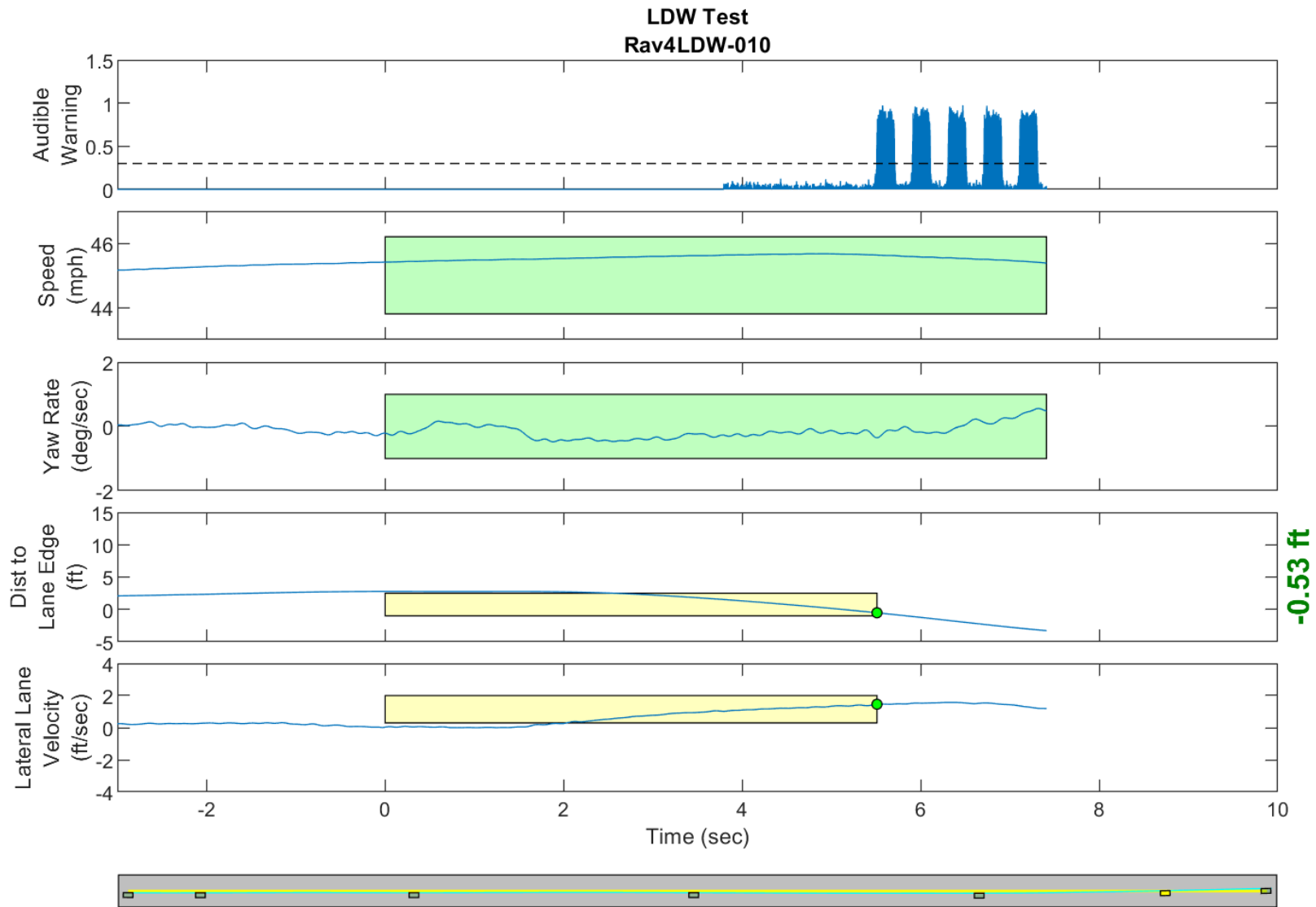
GPS Fix Type: RTK Fixed

Figure D10. Time History for Run 08, Botts Dots, Left Departure, Auditory Warning



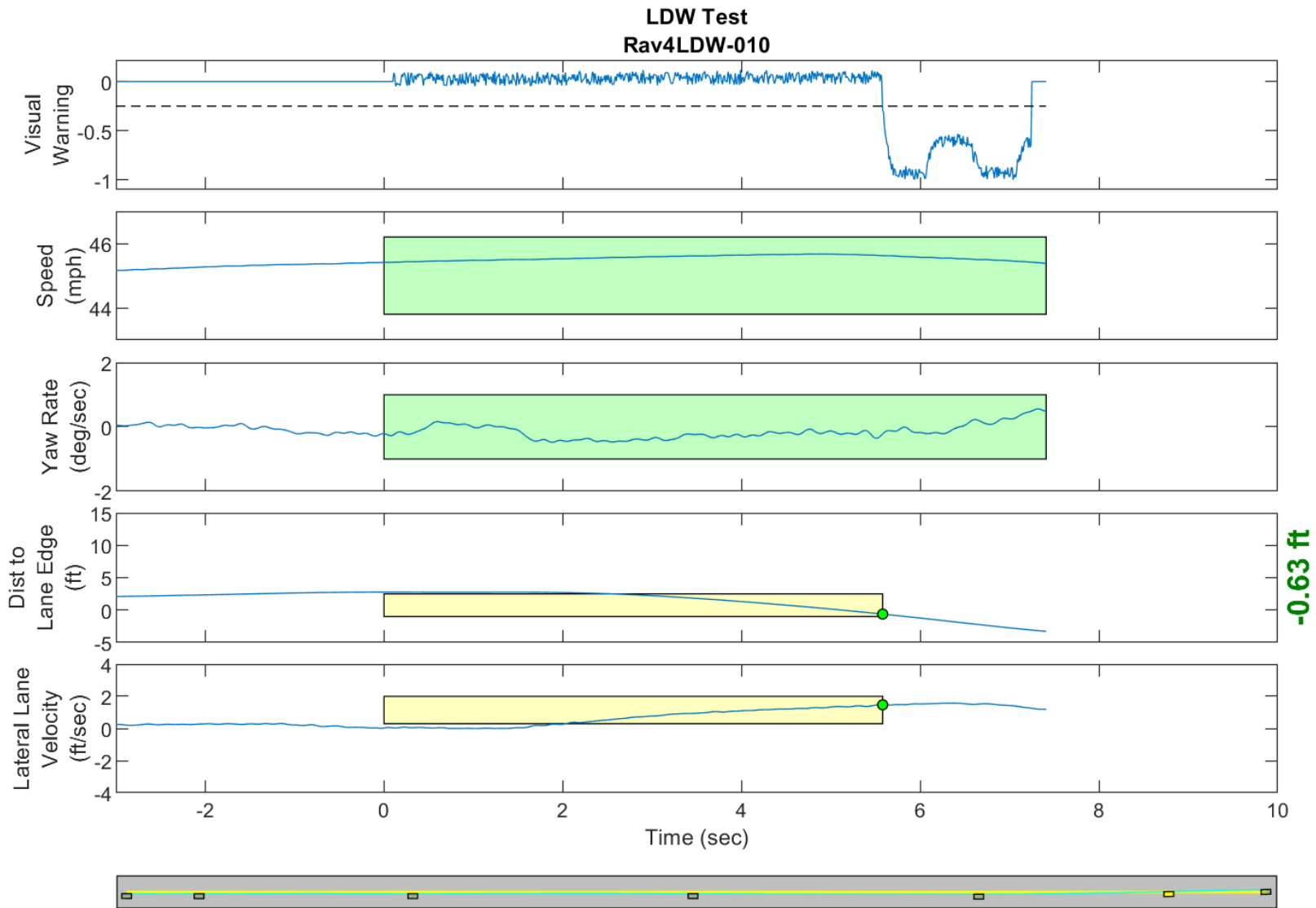
GPS Fix Type: RTK Fixed

Figure D11. Time History for Run 08, Botts Dots, Left Departure, Visual Warning



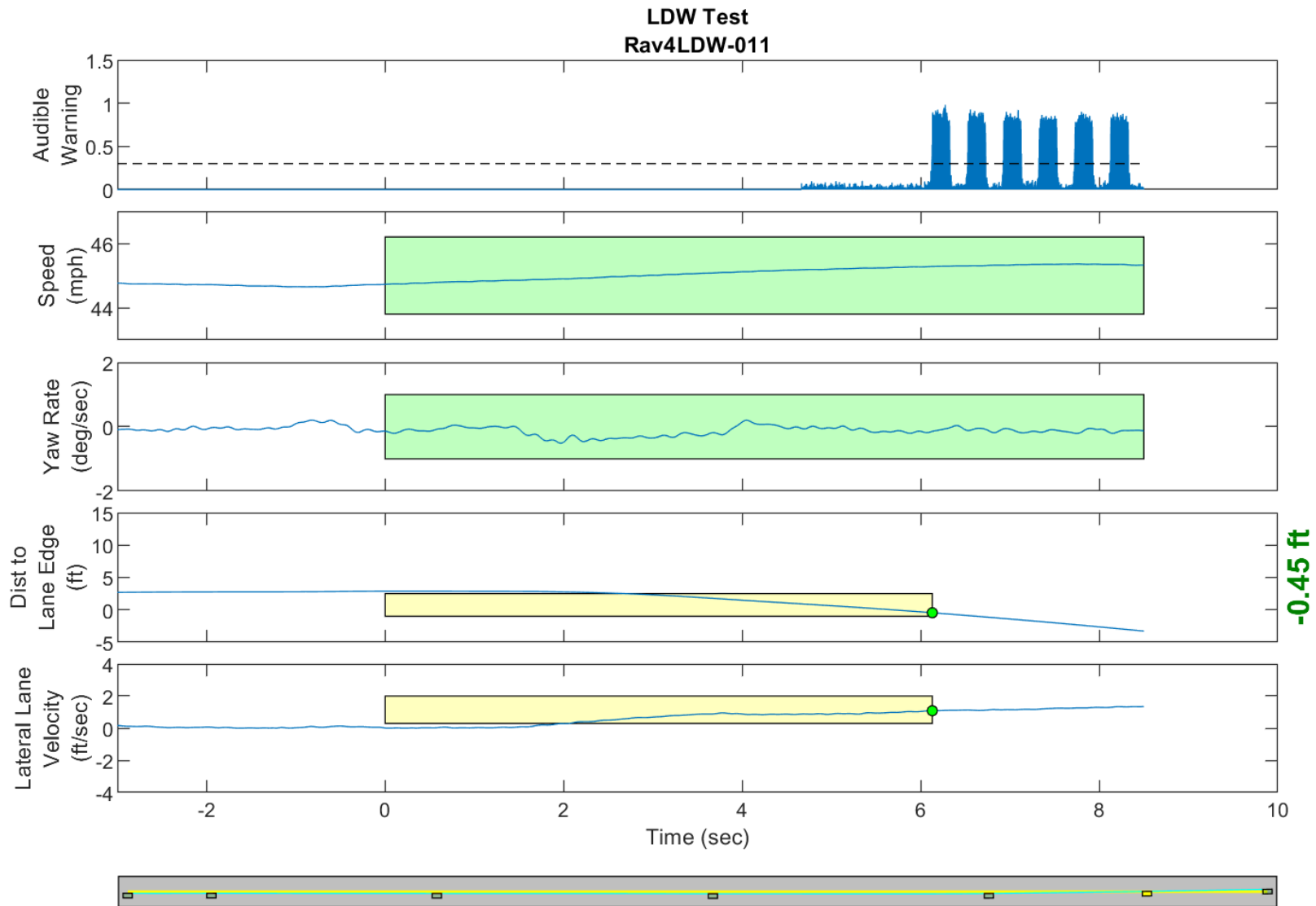
GPS Fix Type: RTK Fixed

Figure D12. Time History for Run 10, Botts Dots, Left Departure, Auditory Warning



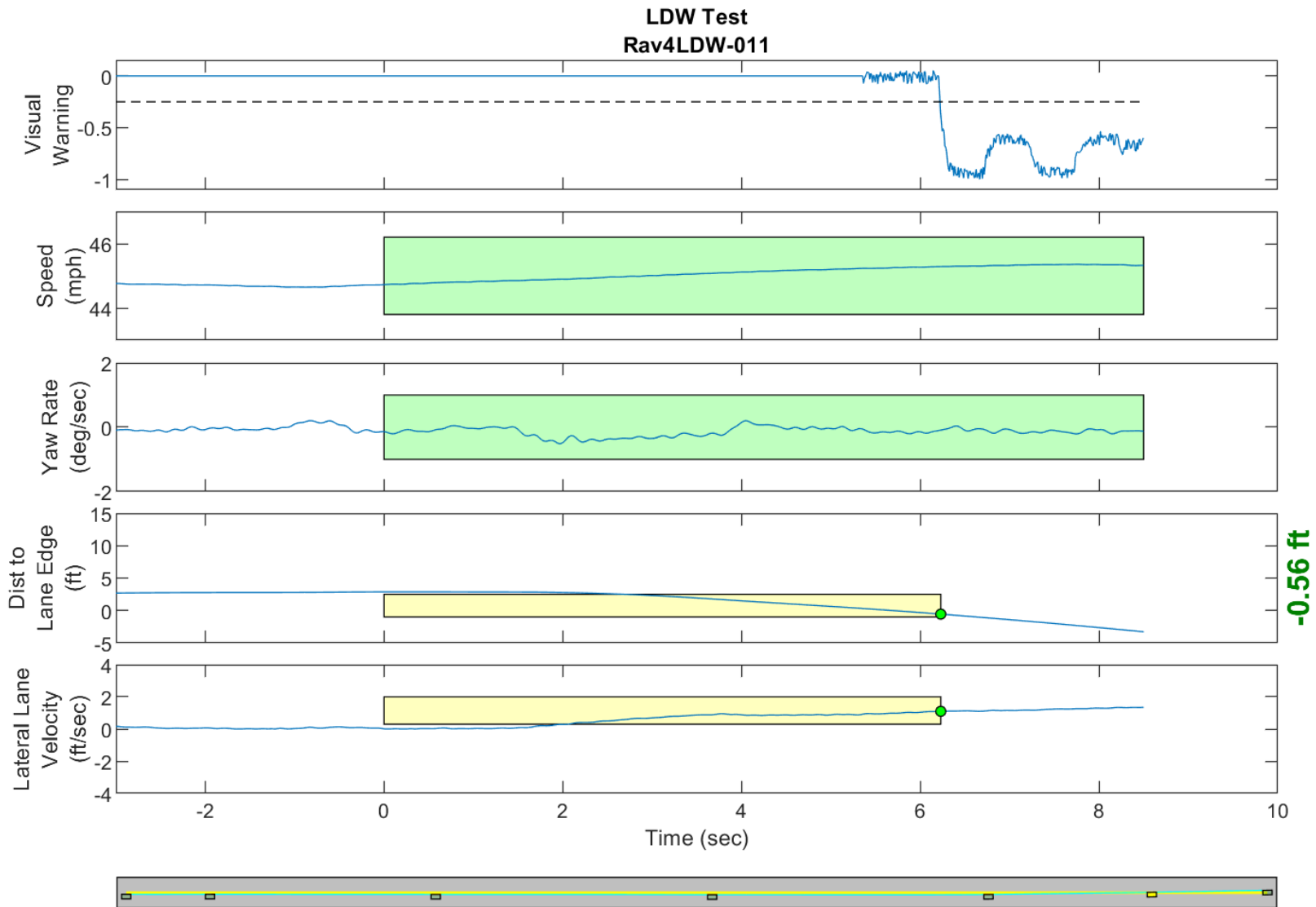
GPS Fix Type: RTK Fixed

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



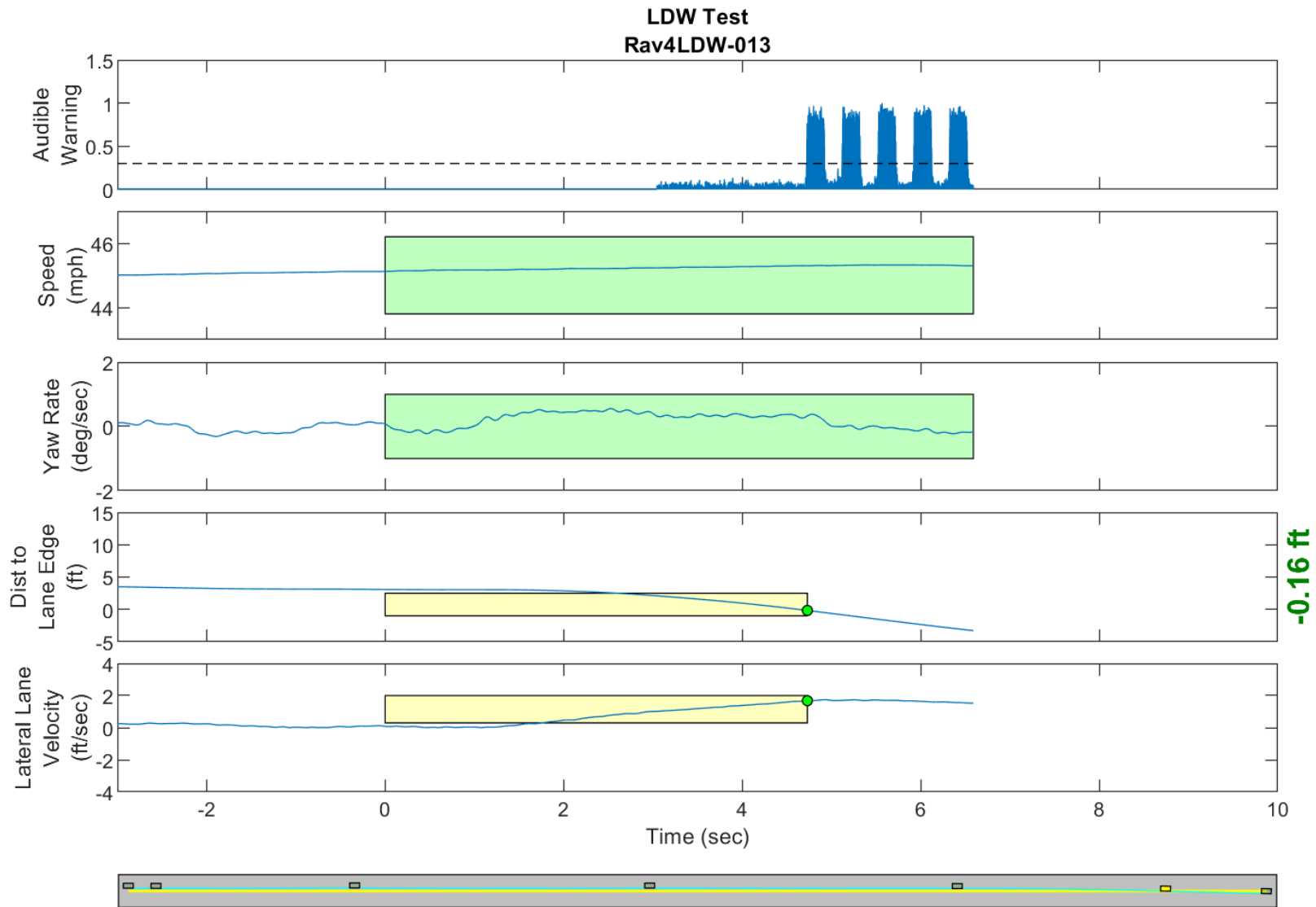
GPS Fix Type: RTK Fixed

Figure D14. Time History for Run 11, Botts Dots, Left Departure, Auditory Warning



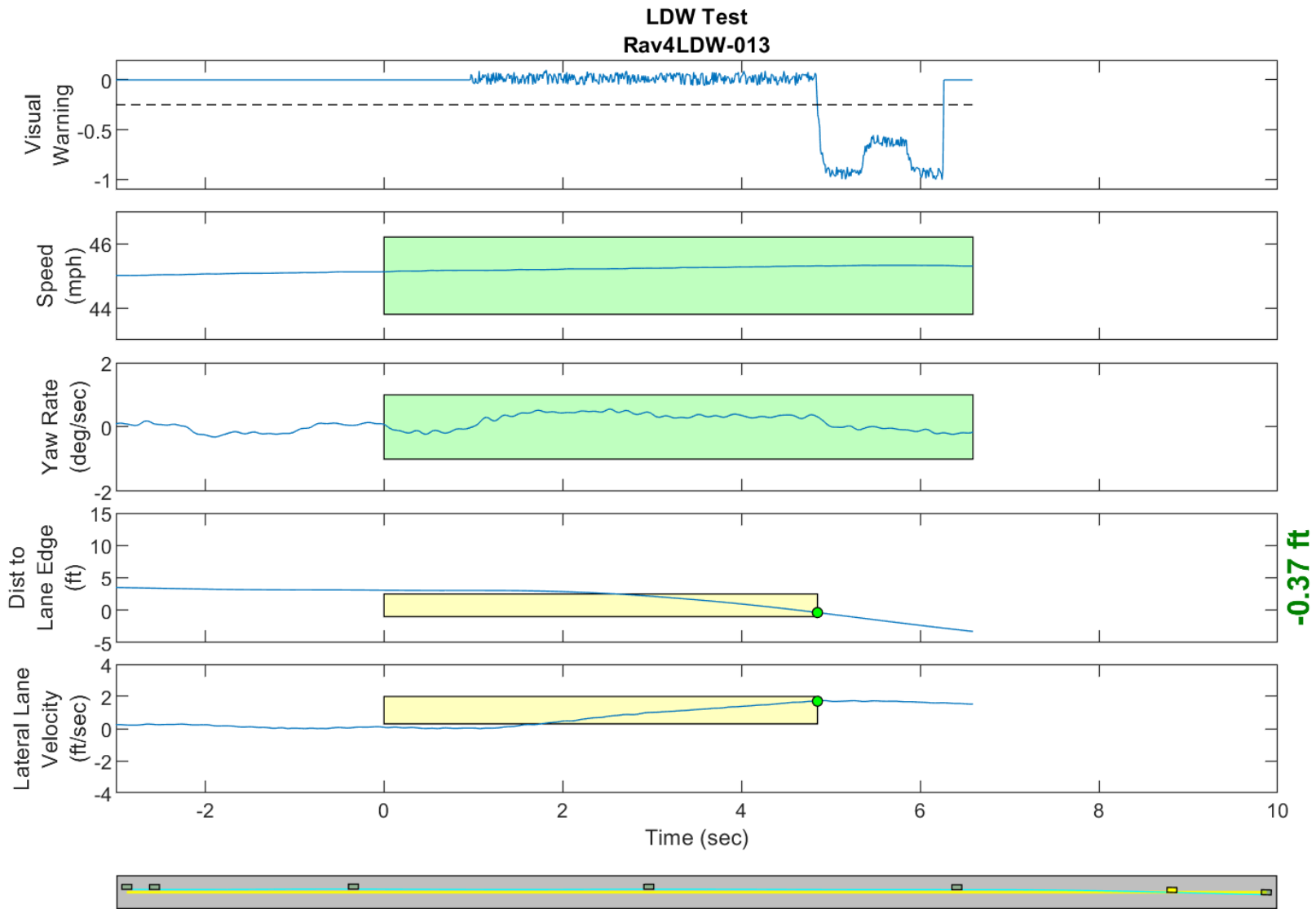
GPS Fix Type: RTK Fixed

Figure D15. Time History for Run 11, Botts Dots, Left Departure, Visual Warning



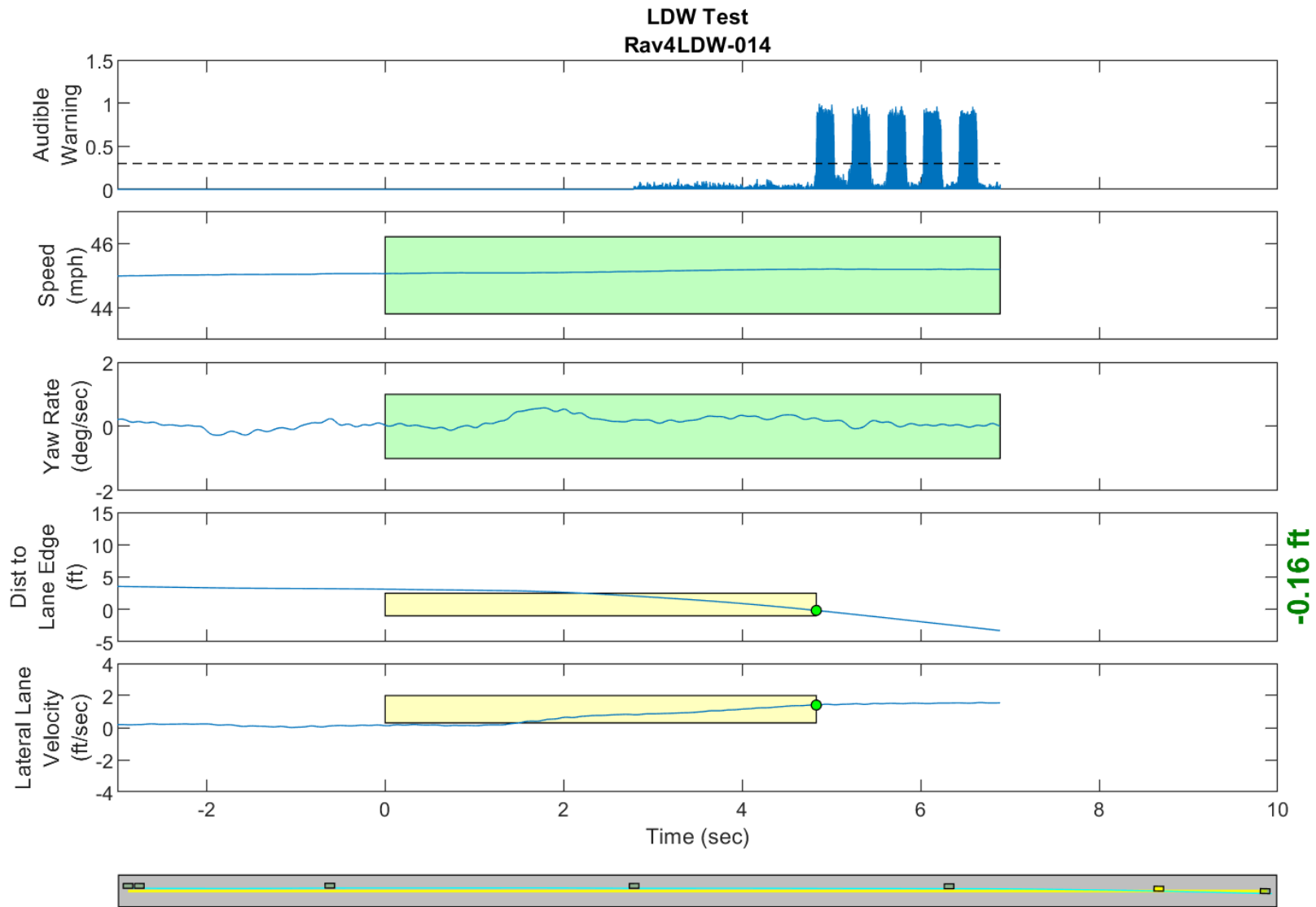
GPS Fix Type: RTK Fixed

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



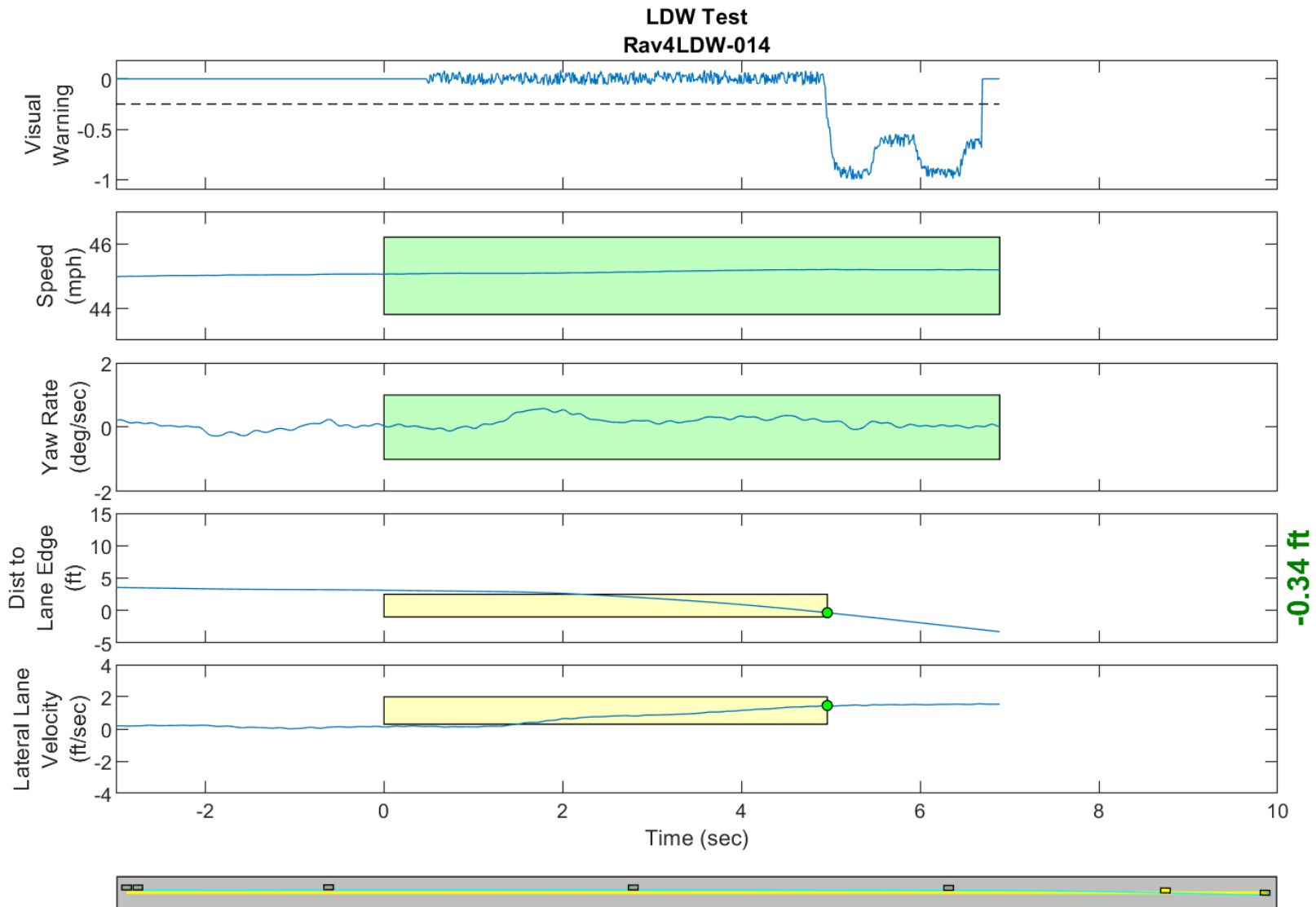
GPS Fix Type: RTK Fixed

Figure D17. Time History for Run 13, Botts Dots, Right Departure, Visual Warning



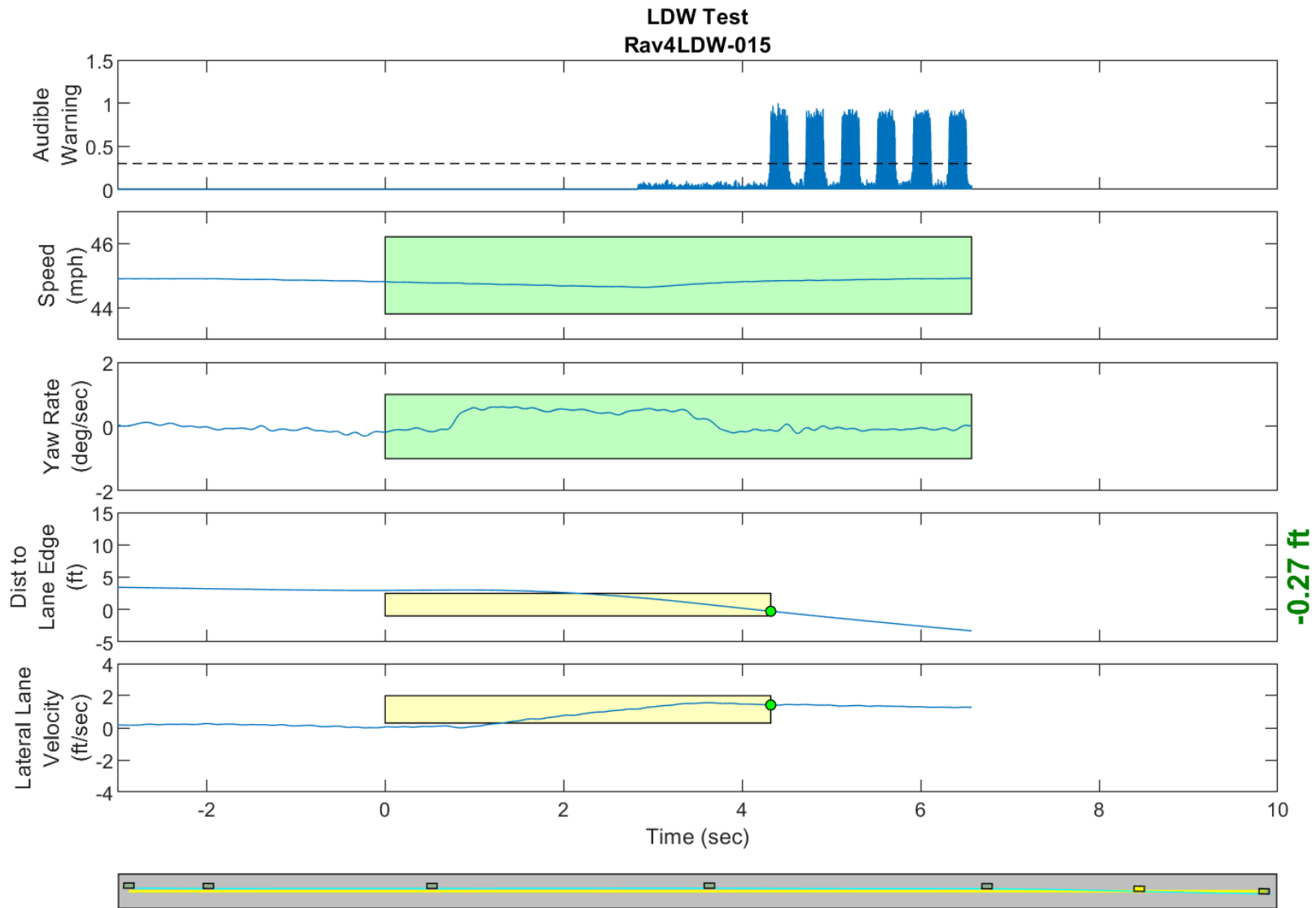
GPS Fix Type: RTK Fixed

Figure D18. Time History for Run 14, Botts Dots, Right Departure, Auditory Warning



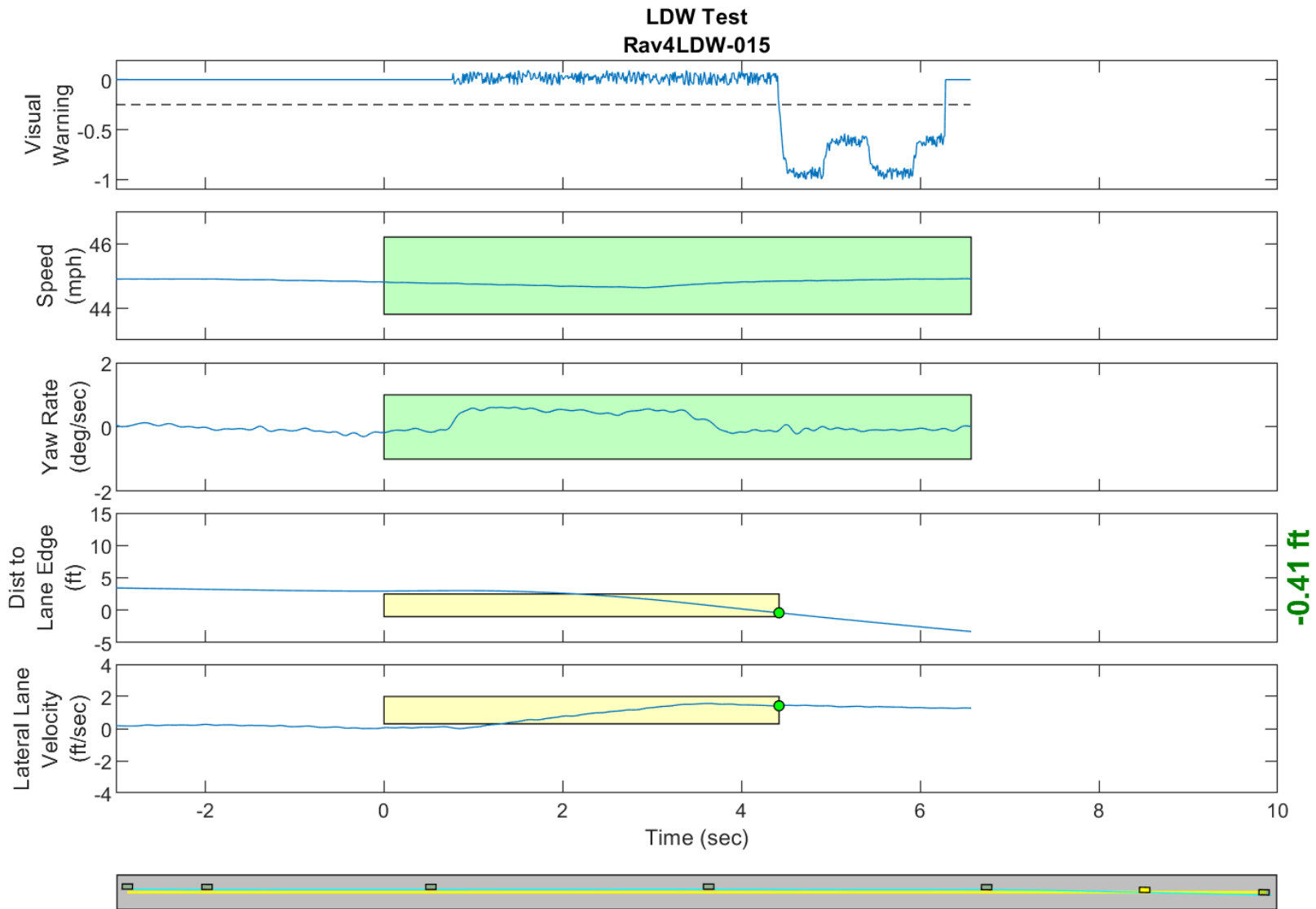
GPS Fix Type: RTK Fixed

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



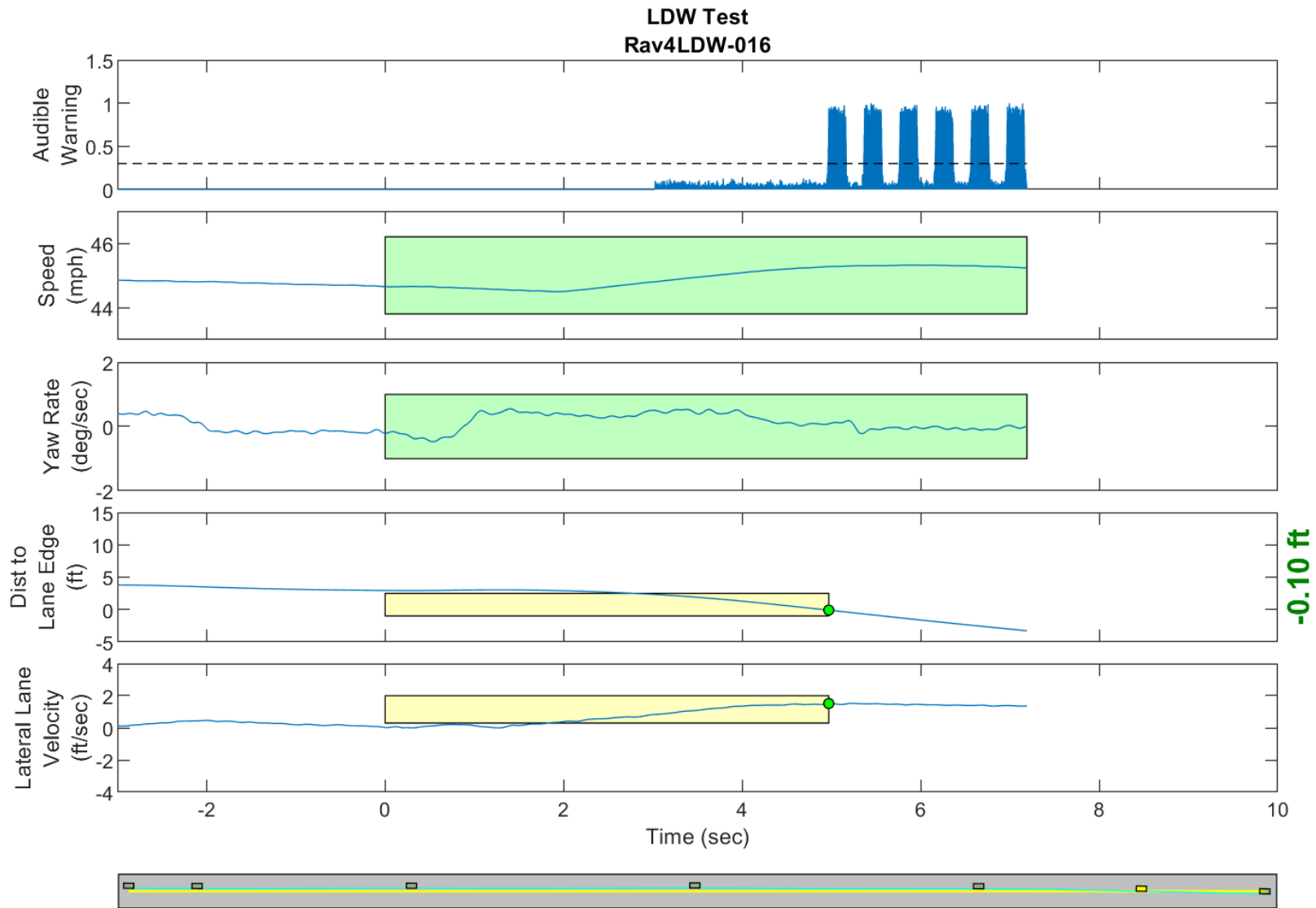
GPS Fix Type: RTK Fixed

Figure D20. Time History for Run 15, Botts Dots, Right Departure, Auditory Warning



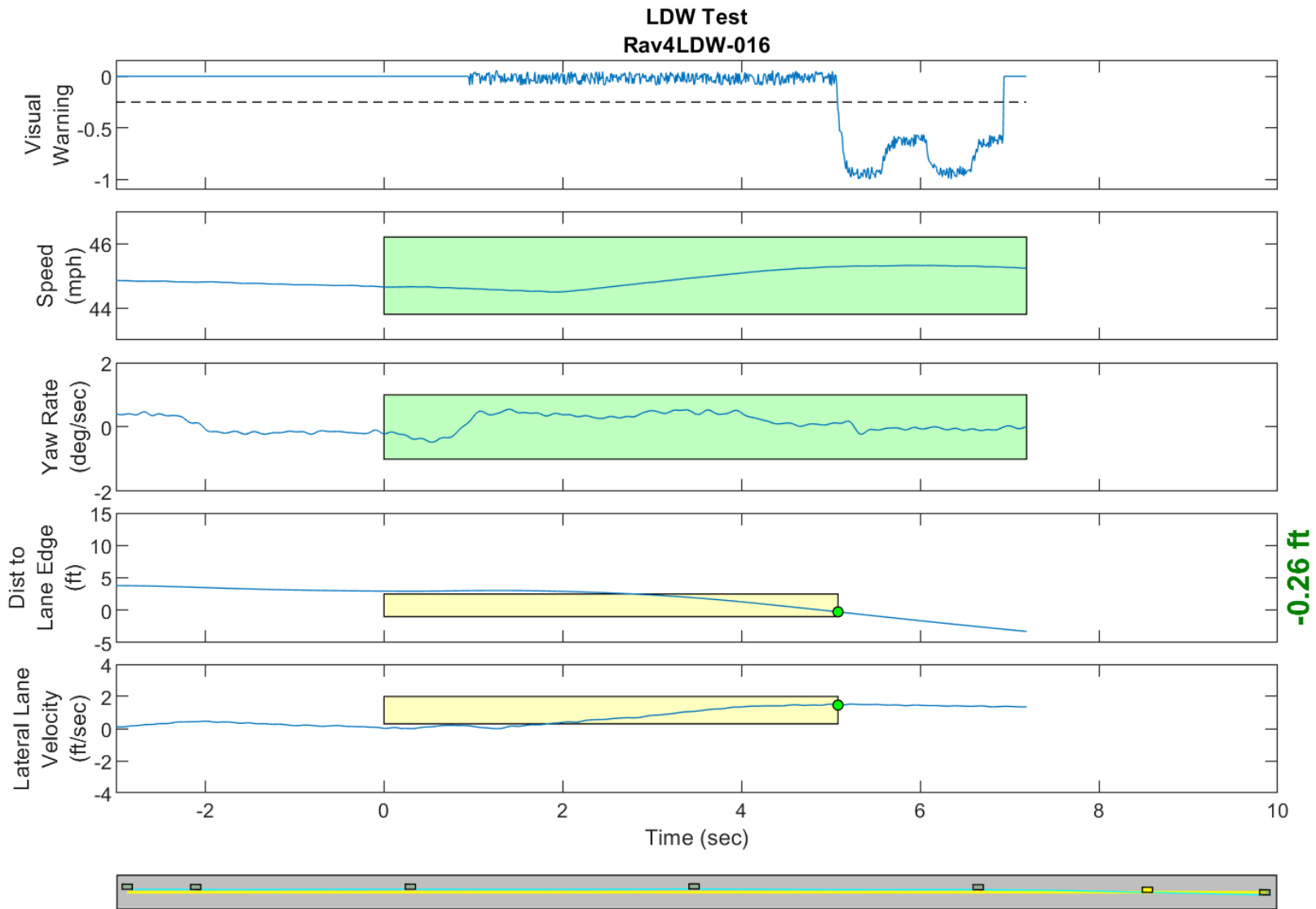
GPS Fix Type: RTK Fixed

Figure D21. Time History for Run 15, Botts Dots, Right Departure, Visual Warning



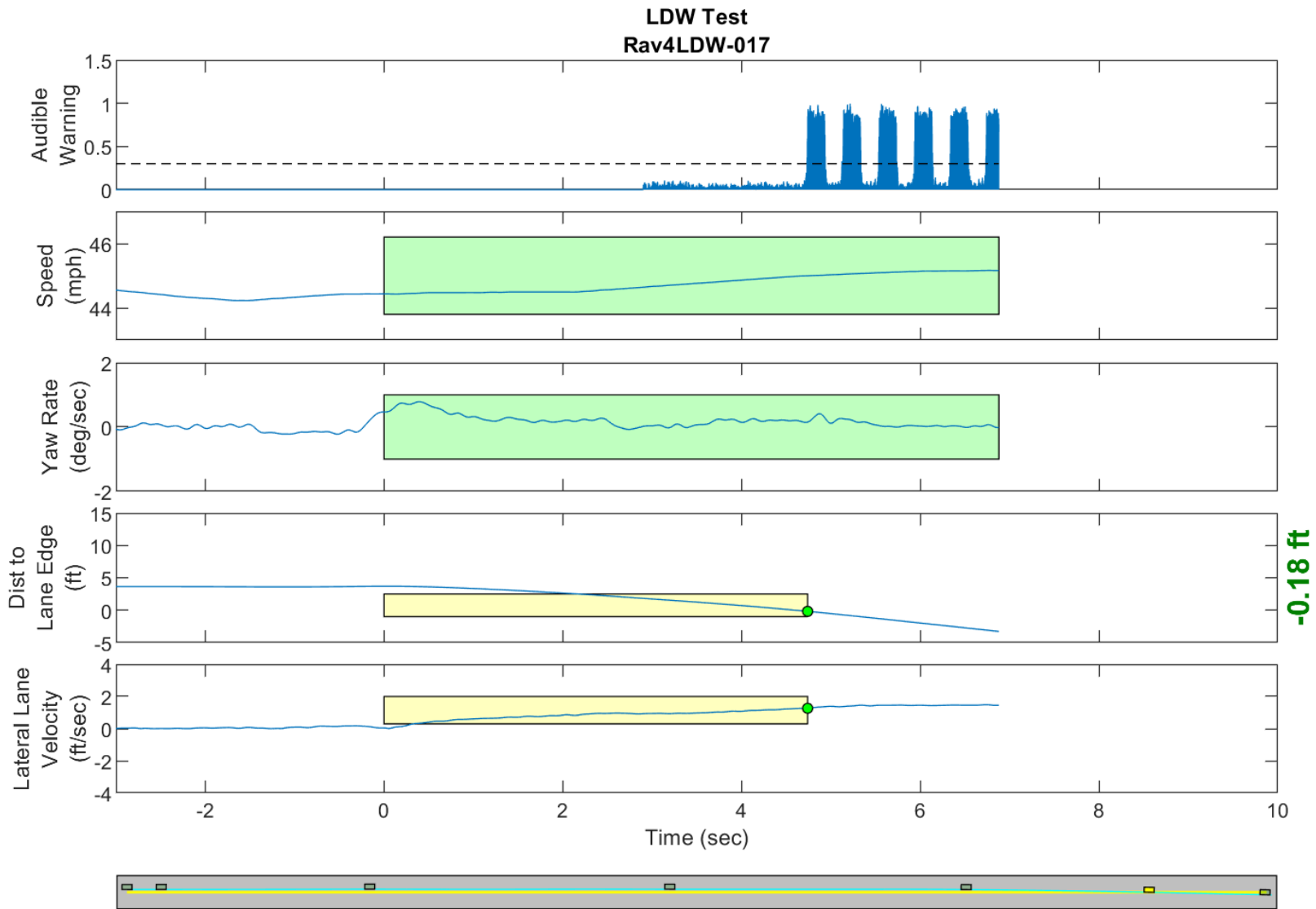
GPS Fix Type: RTK Fixed

Figure D22. Time History for Run 16, Botts Dots, Right Departure, Auditory Warning



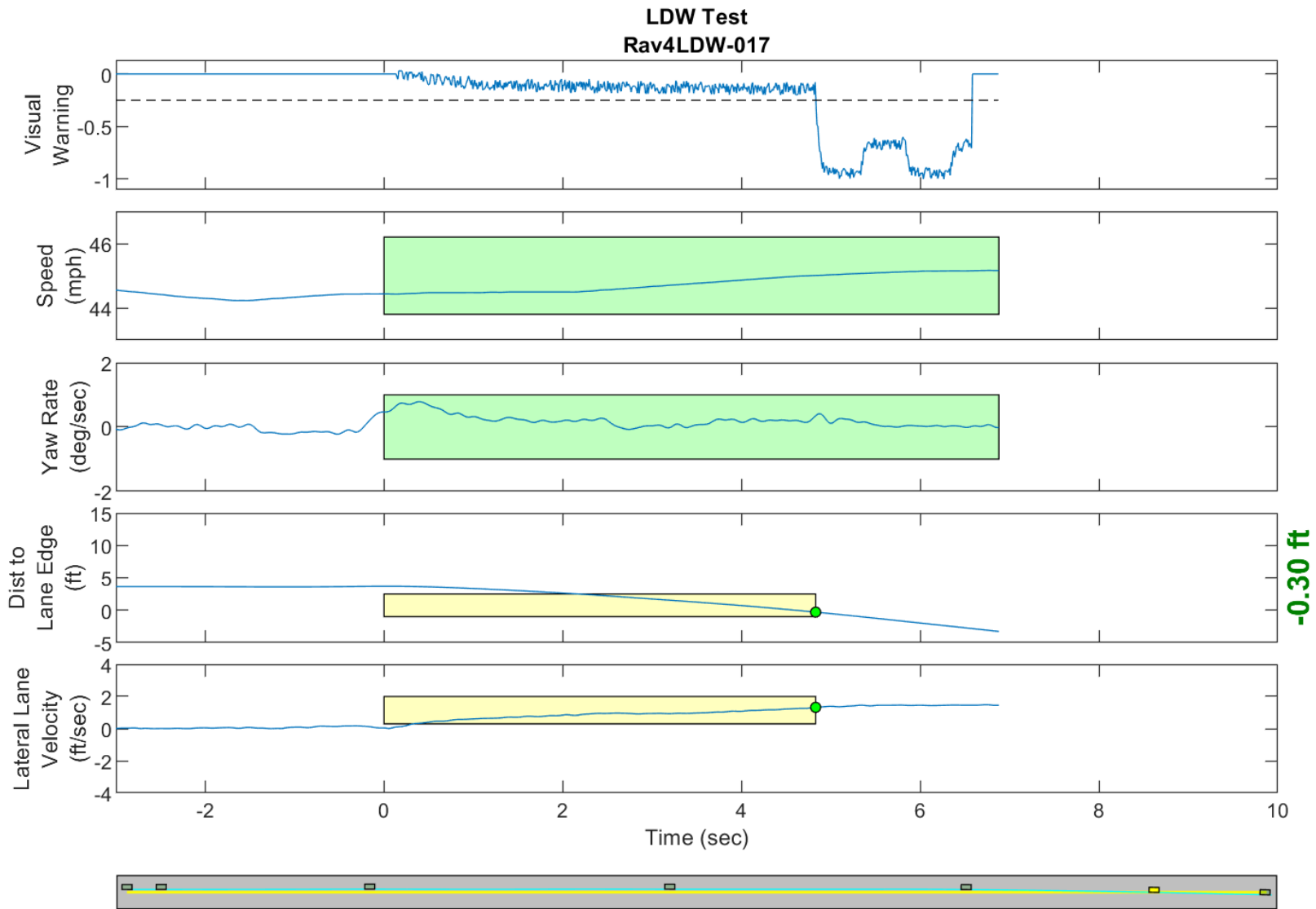
GPS Fix Type: RTK Fixed

Figure D23. Time History for Run 16, Botts Dots, Right Departure, Visual Warning



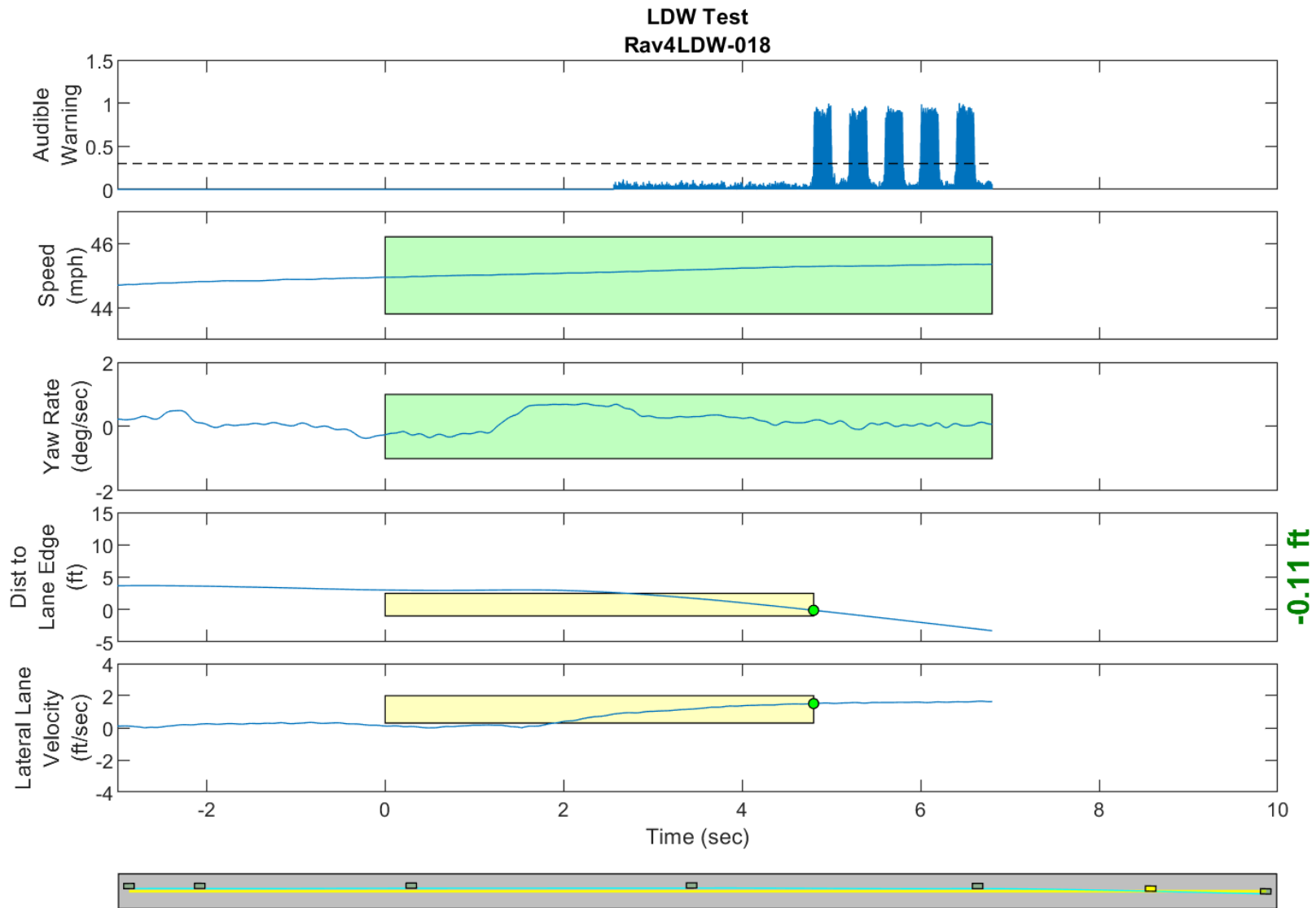
GPS Fix Type: RTK Fixed

Figure D24. Time History for Run 17, Botts Dots, Right Departure, Auditory Warning



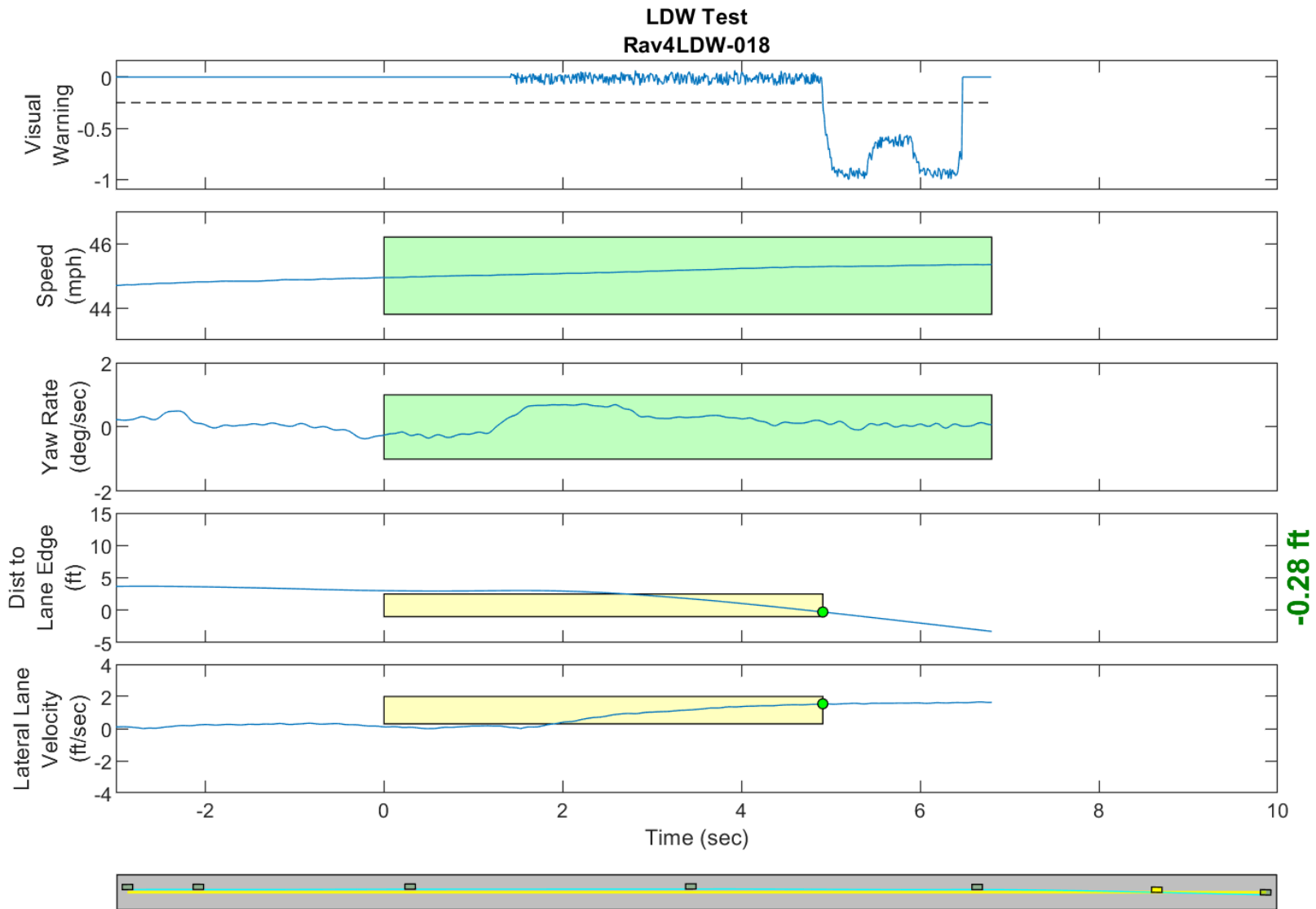
GPS Fix Type: RTK Fixed

Figure D25. Time History for Run 17, Botts Dots, Right Departure, Visual Warning



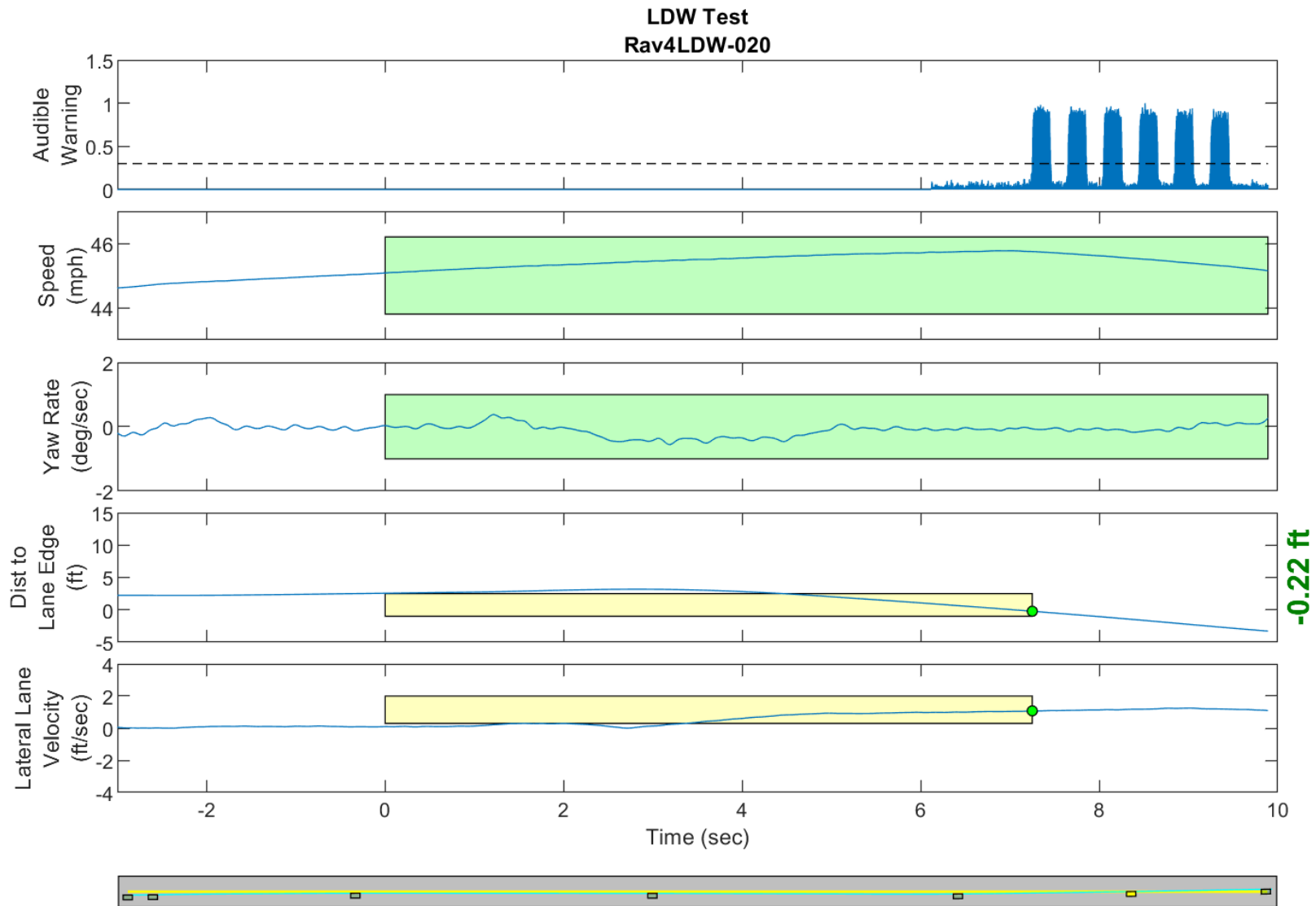
GPS Fix Type: RTK Fixed

Figure D26. Time History for Run 18, Botts Dots, Right Departure, Auditory Warning



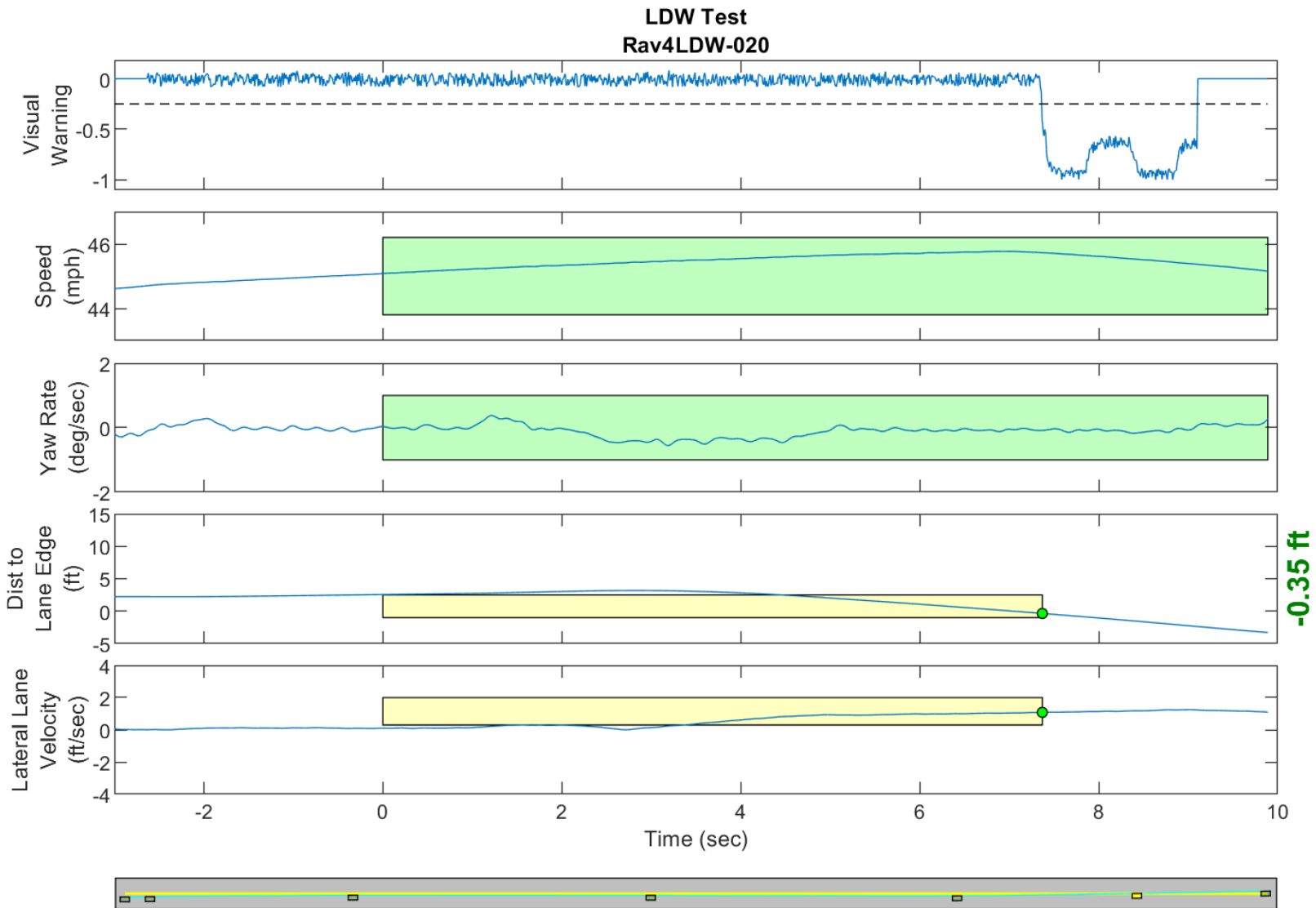
GPS Fix Type: RTK Fixed

Figure D27. Time History for Run 18, Botts Dots, Right Departure, Visual Warning



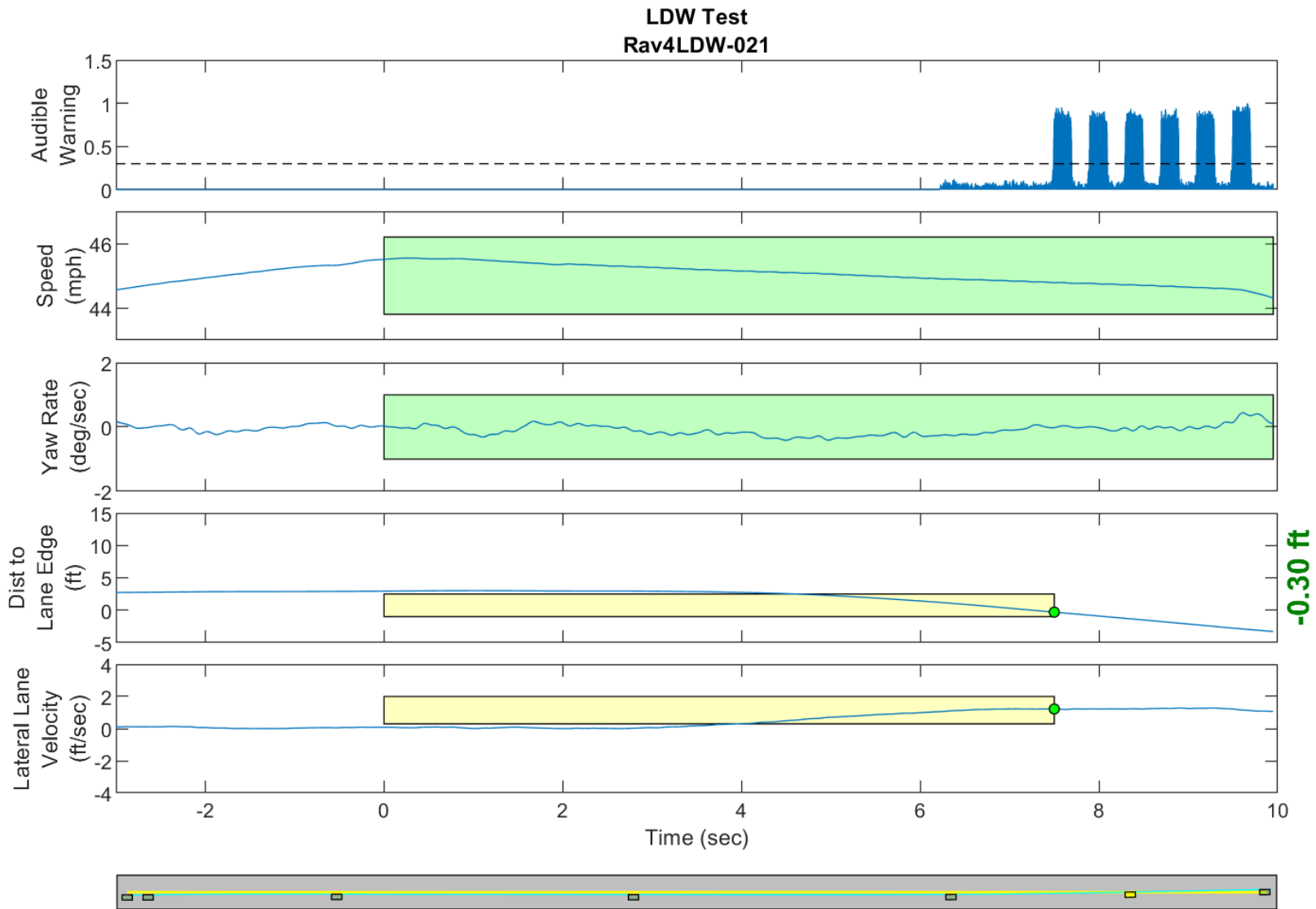
GPS Fix Type: RTK Fixed

Figure D28. Time History for Run 20, Dashed Line, Left Departure, Auditory Warning



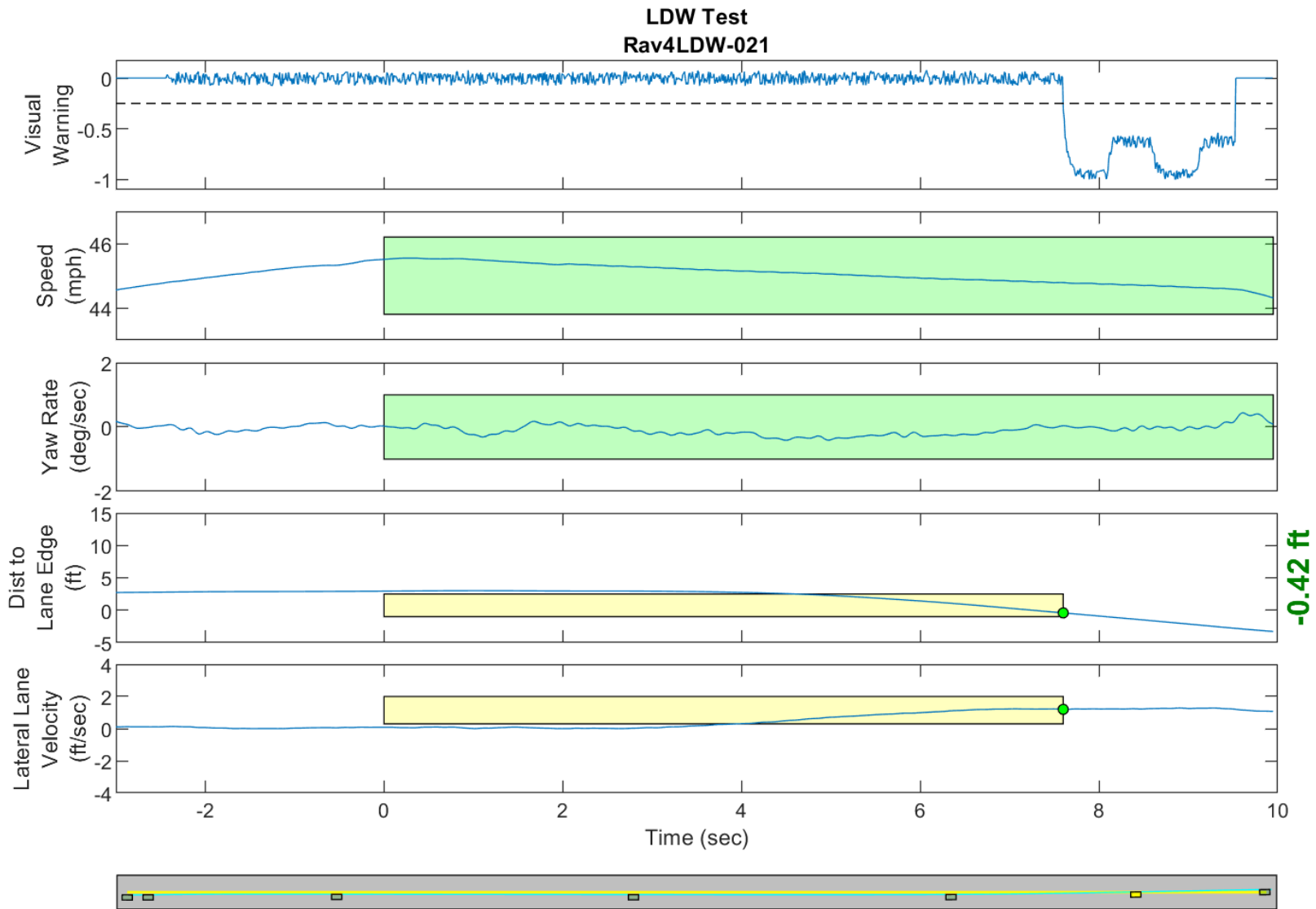
GPS Fix Type: RTK Fixed

Figure D29. Time History for Run 20, Dashed Line, Left Departure, Visual Warning



GPS Fix Type: RTK Fixed

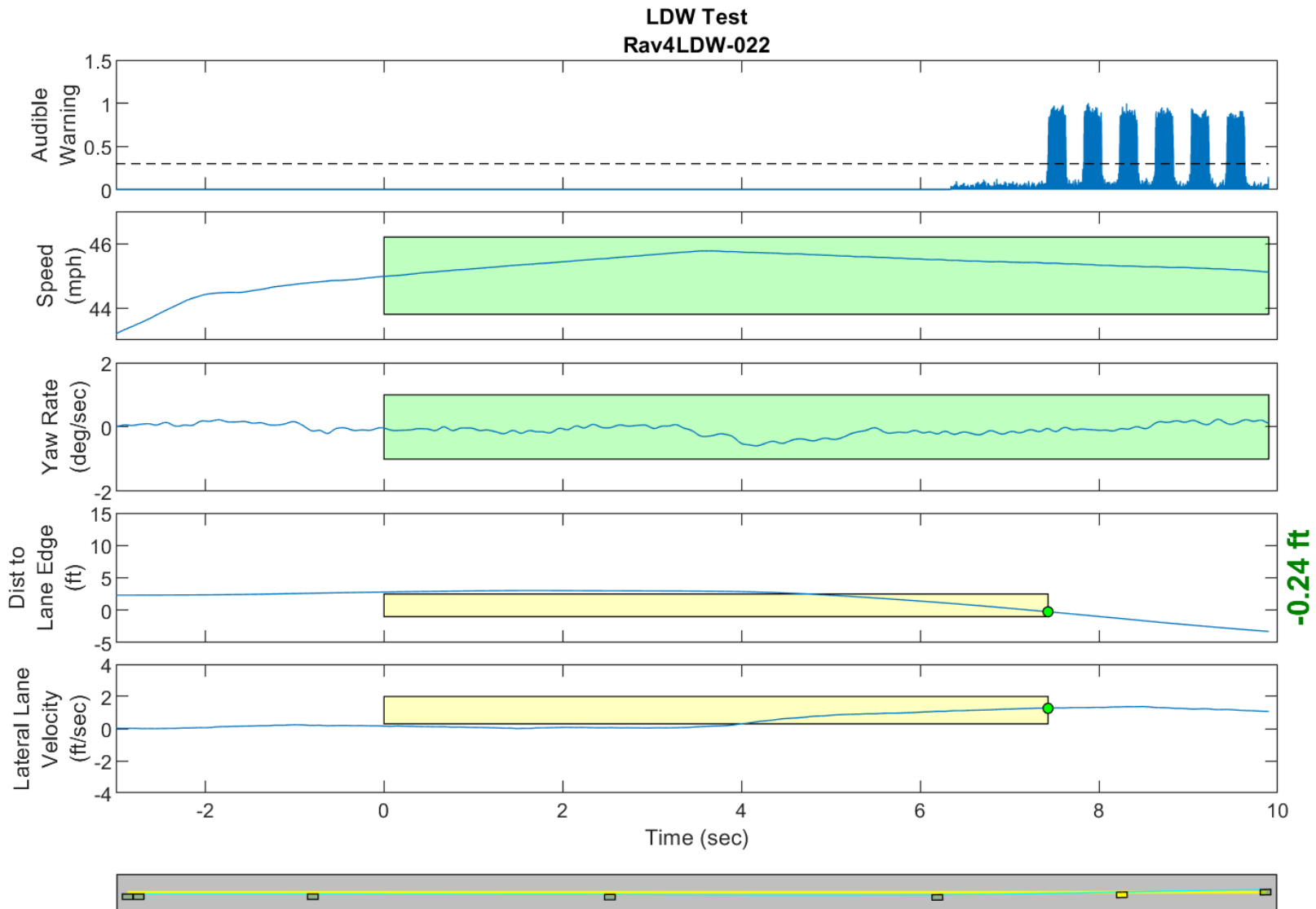
Figure D30. Time History for Run 21, Dashed Line, Left Departure, Auditory Warning



-0.42 ft

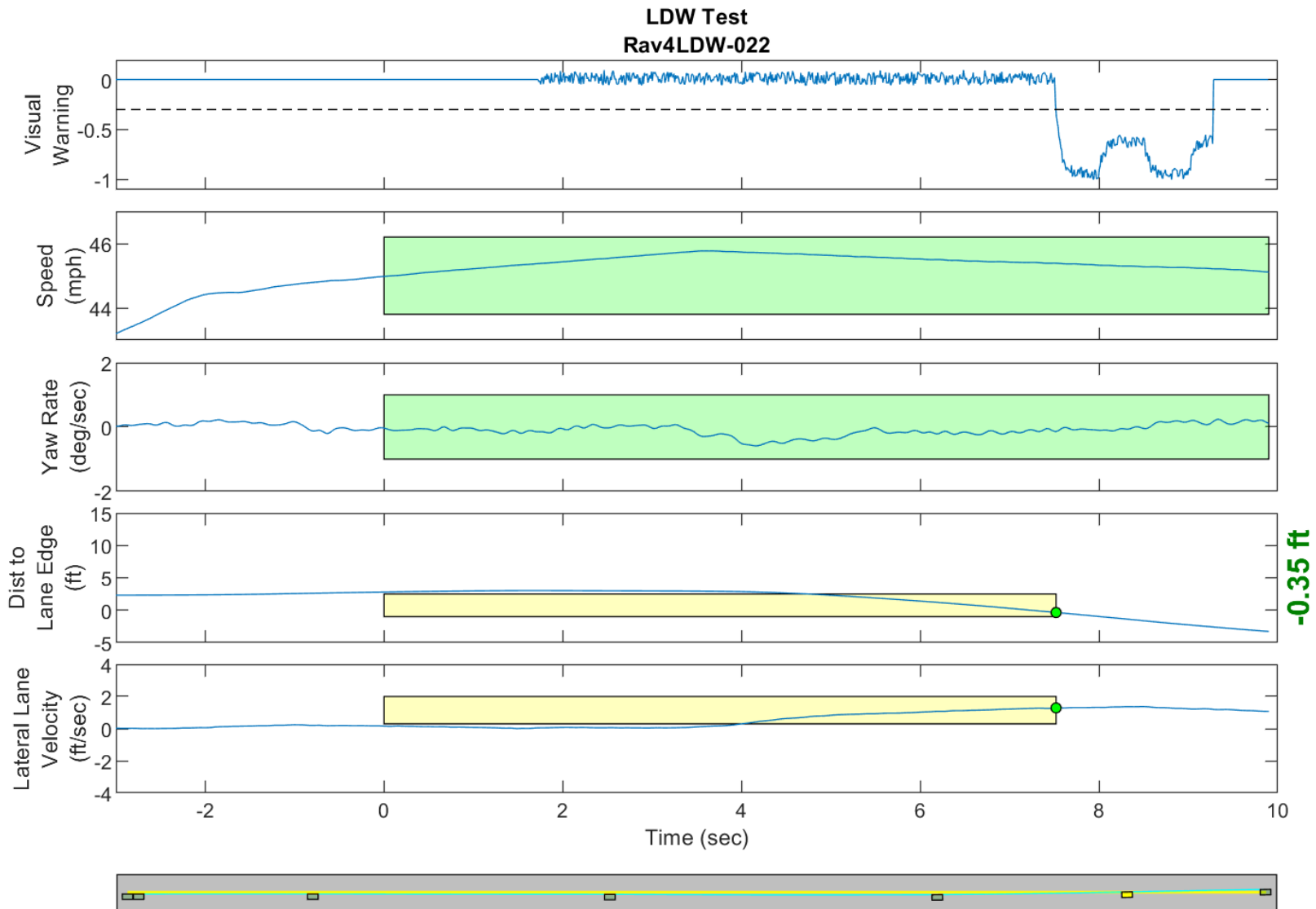
GPS Fix Type: RTK Fixed

Figure D31. Time History for Run 21, Dashed Line, Left Departure, Visual Warning



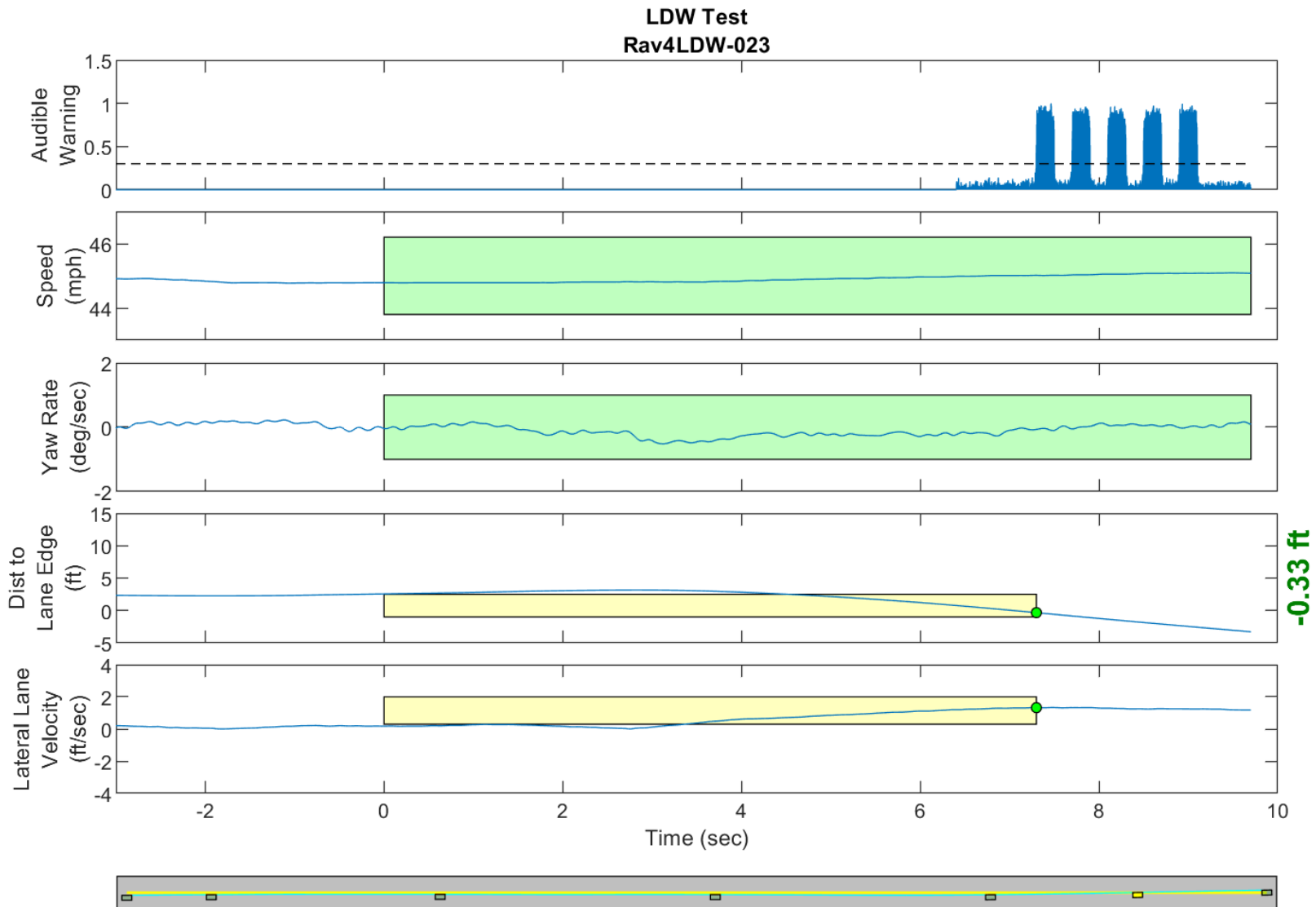
GPS Fix Type: RTK Fixed

Figure D32. Time History for Run 22, Dashed Line, Left Departure, Auditory Warning



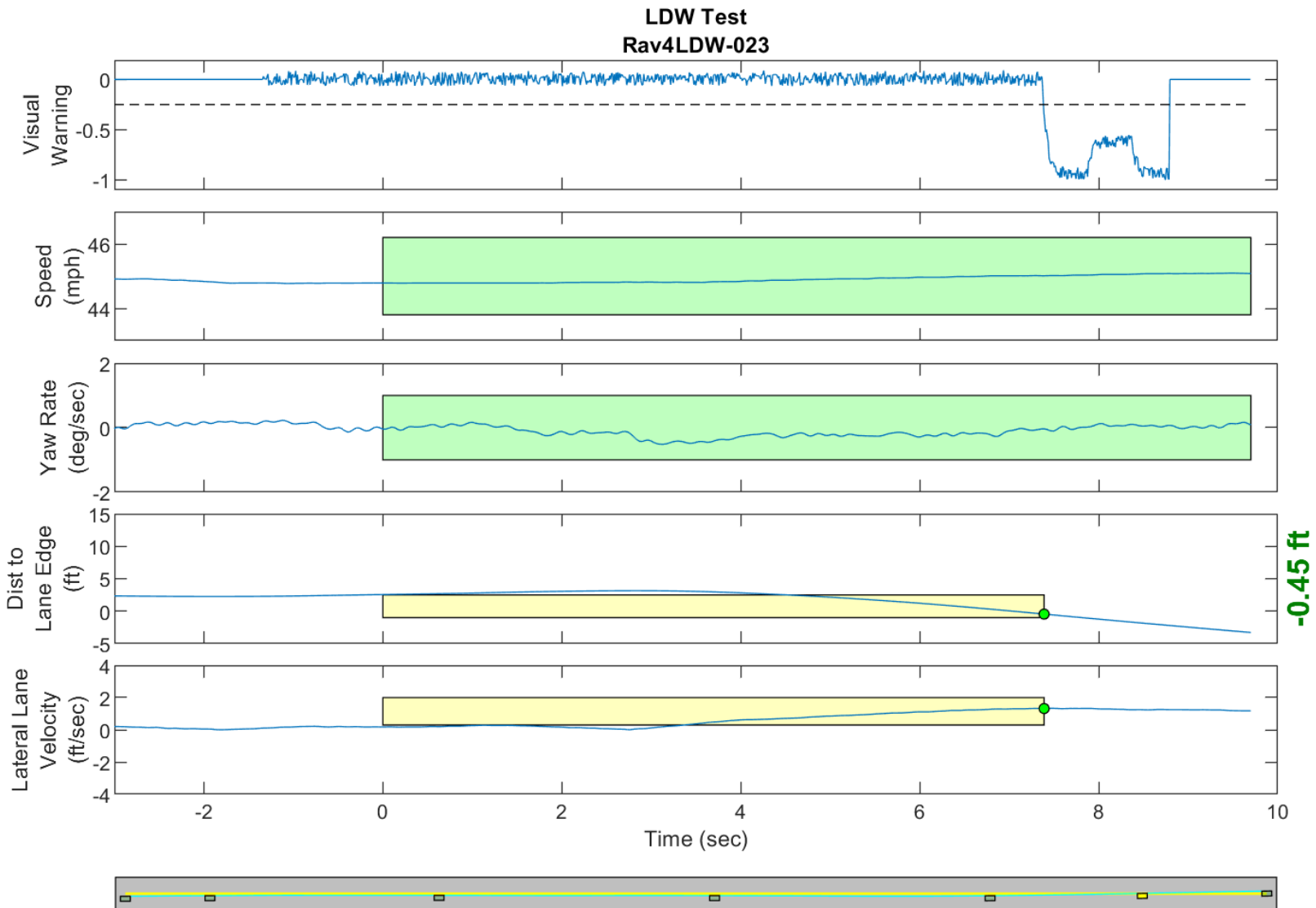
GPS Fix Type: RTK Fixed

Figure D33. Time History for Run 22, Dashed Line, Left Departure, Visual Warning



GPS Fix Type: RTK Fixed

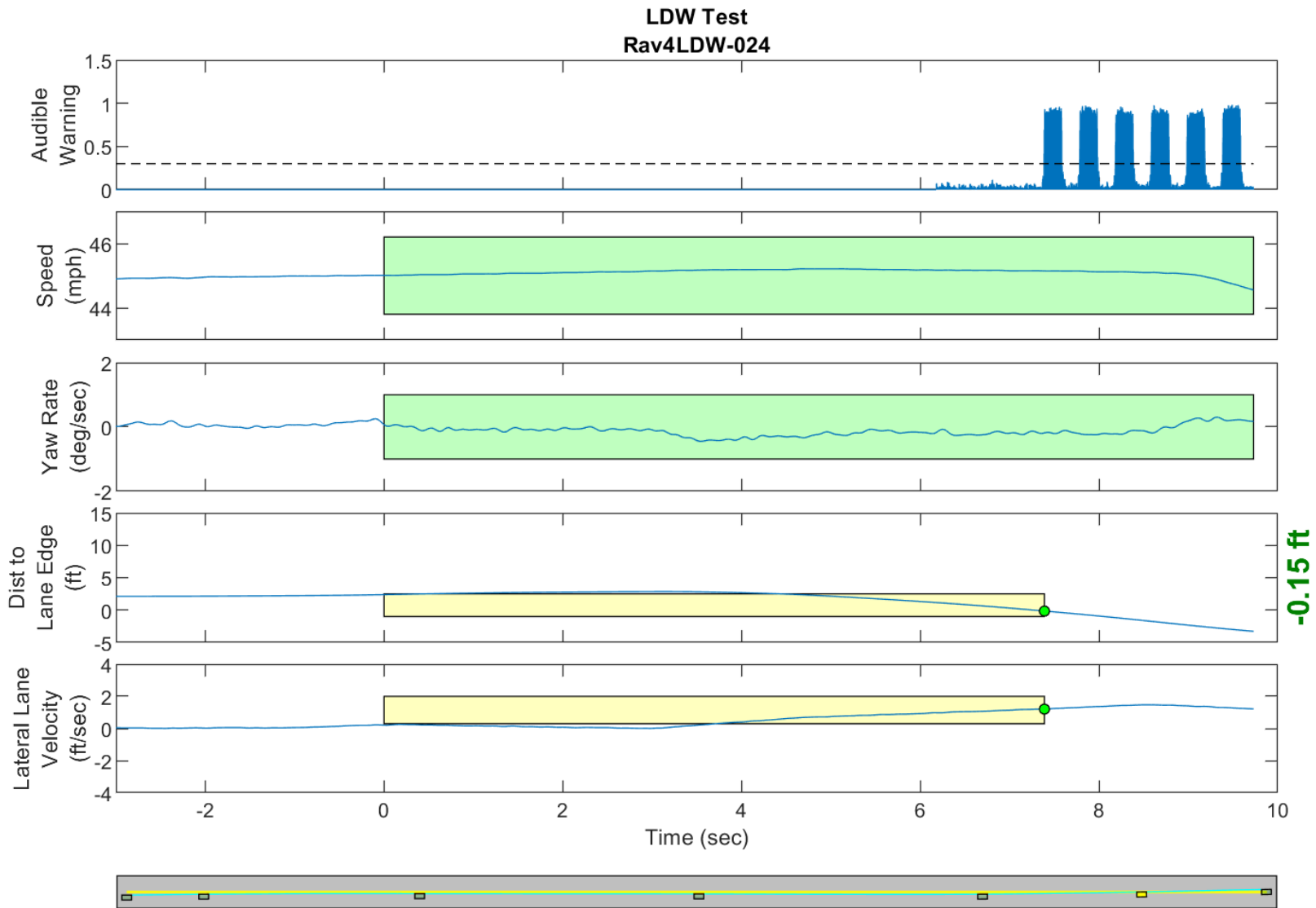
Figure D34. Time History for Run 23, Dashed Line, Left Departure, Auditory Warning



-0.45 ft

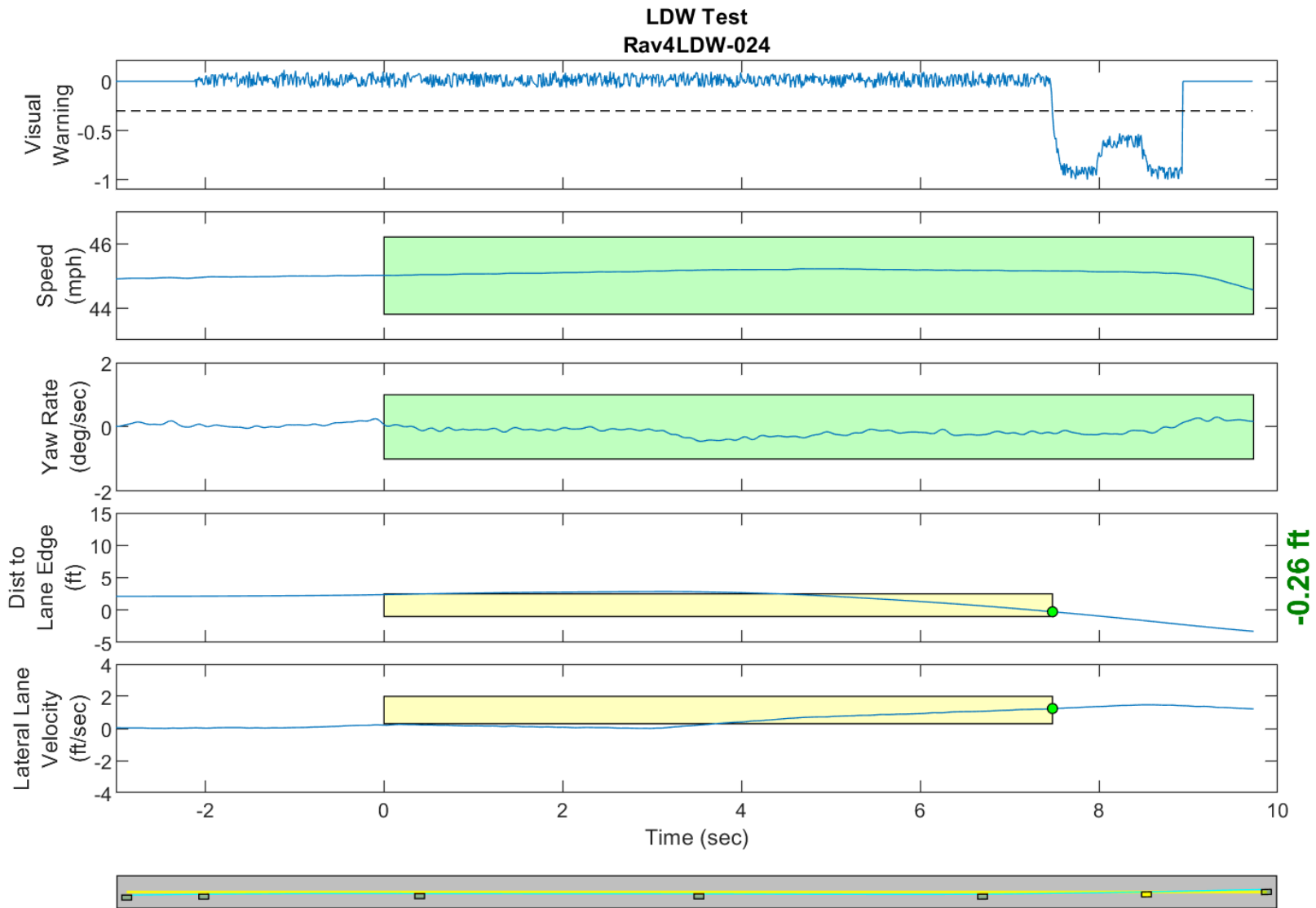
GPS Fix Type: RTK Fixed

Figure D35. Time History for Run 23, Dashed Line, Left Departure, Visual Warning



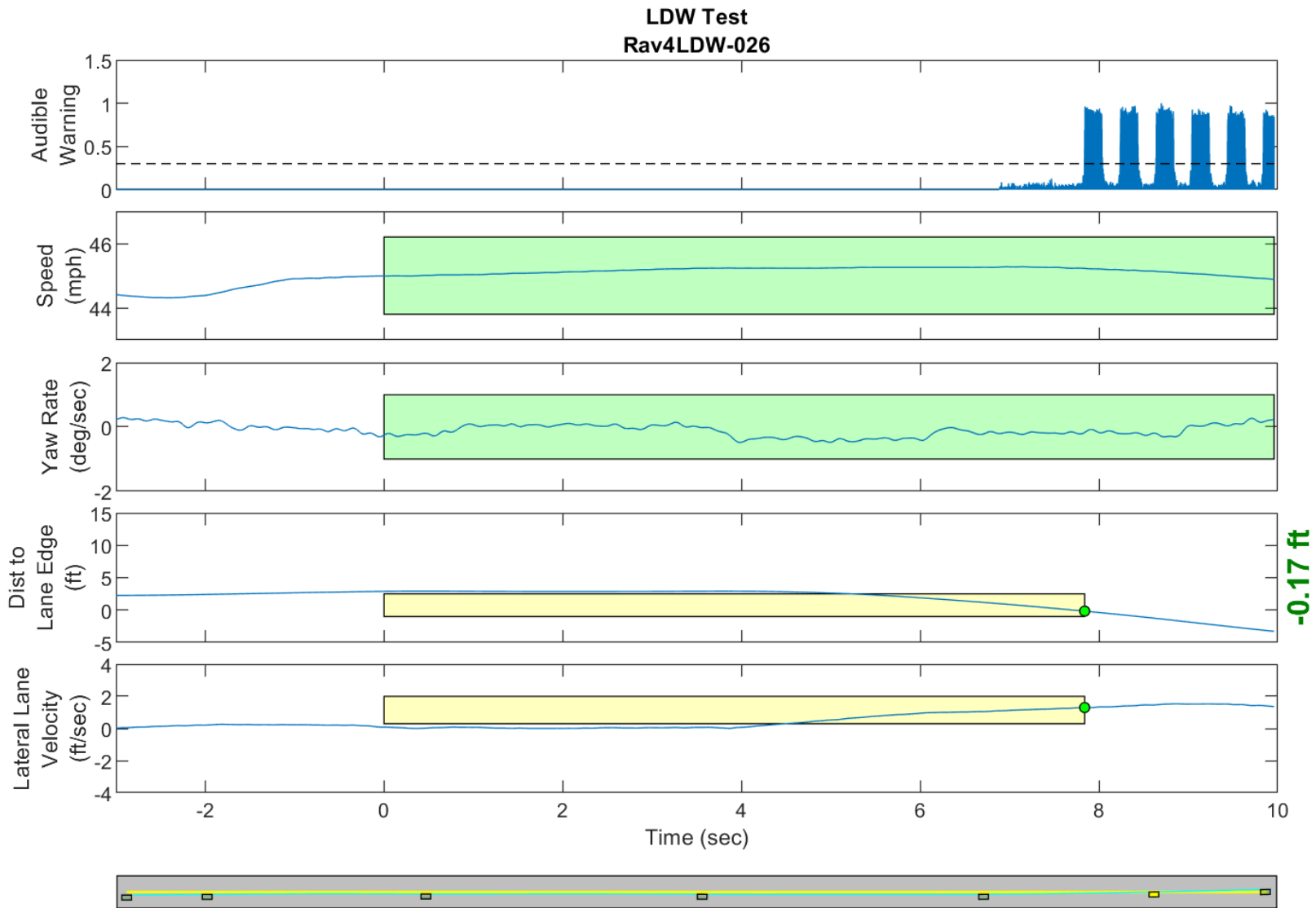
GPS Fix Type: RTK Fixed

Figure D36. Time History for Run 24, Dashed Line, Left Departure, Auditory Warning



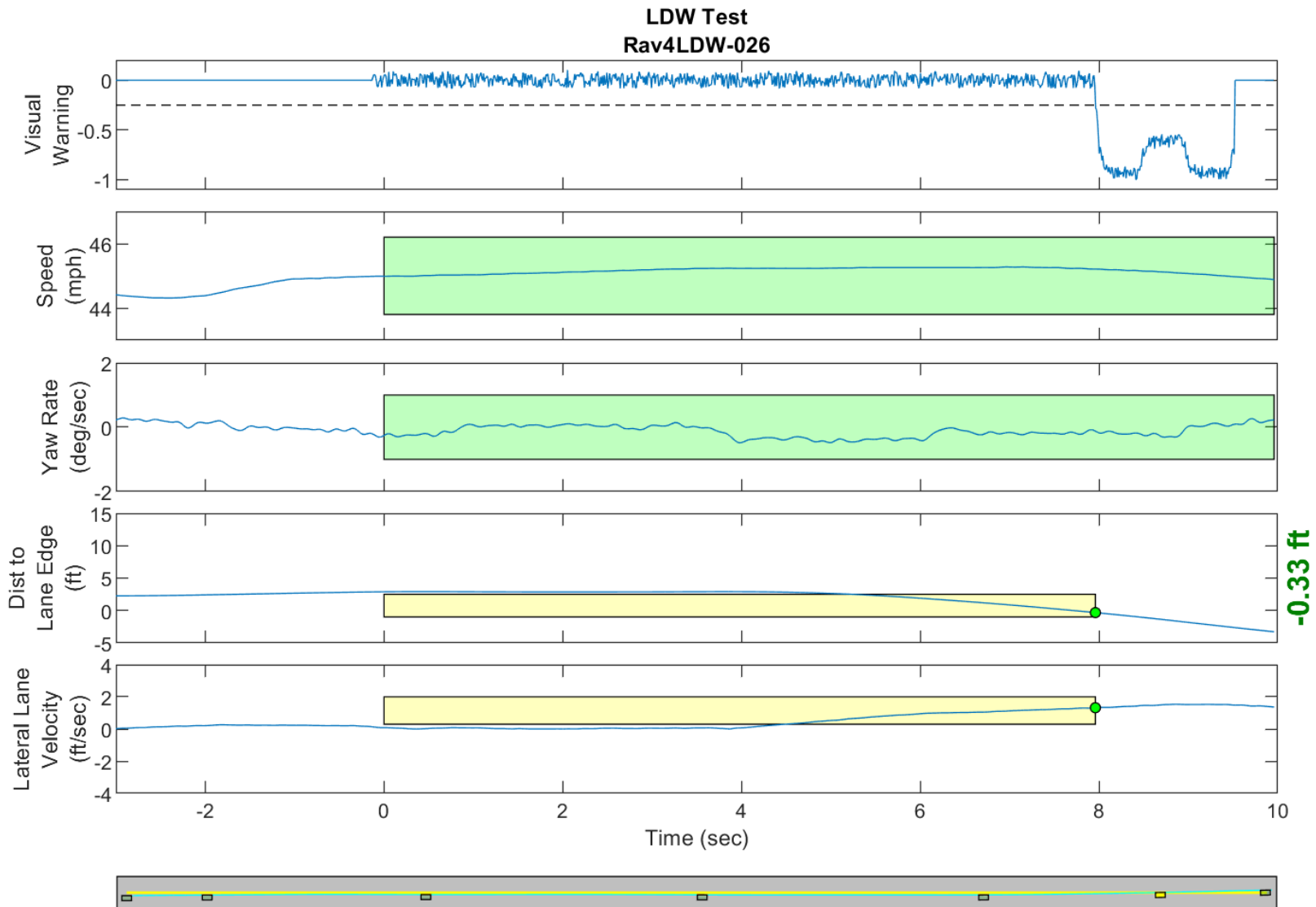
GPS Fix Type: RTK Fixed

Figure D37. Time History for Run 24, Dashed Line, Left Departure, Visual Warning



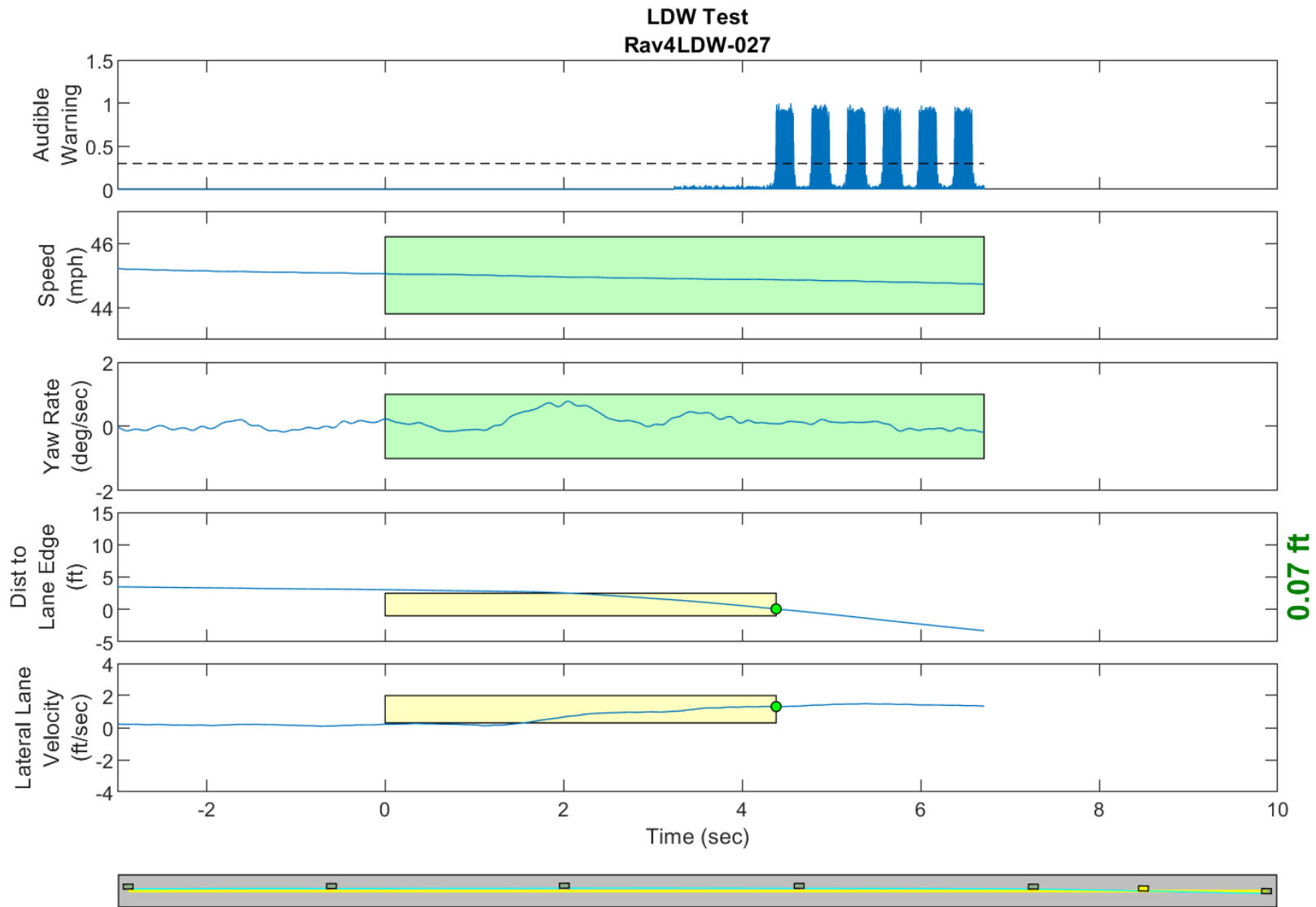
GPS Fix Type: RTK Fixed

Figure D38. Time History for Run 26, Dashed Line, Left Departure, Auditory Warning



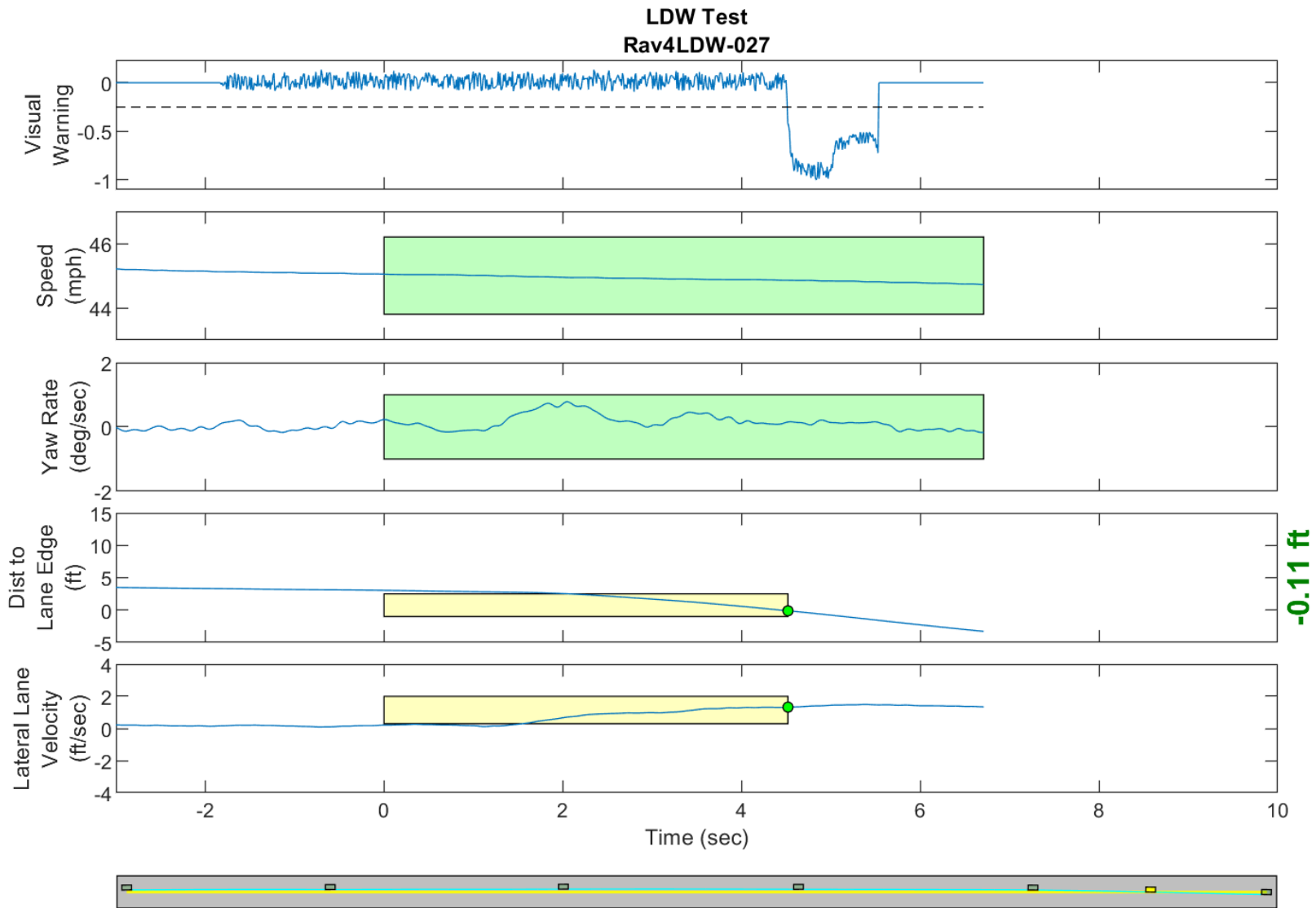
GPS Fix Type: RTK Fixed

Figure D39. Time History for Run 26, Dashed Line, Left Departure, Visual Warning



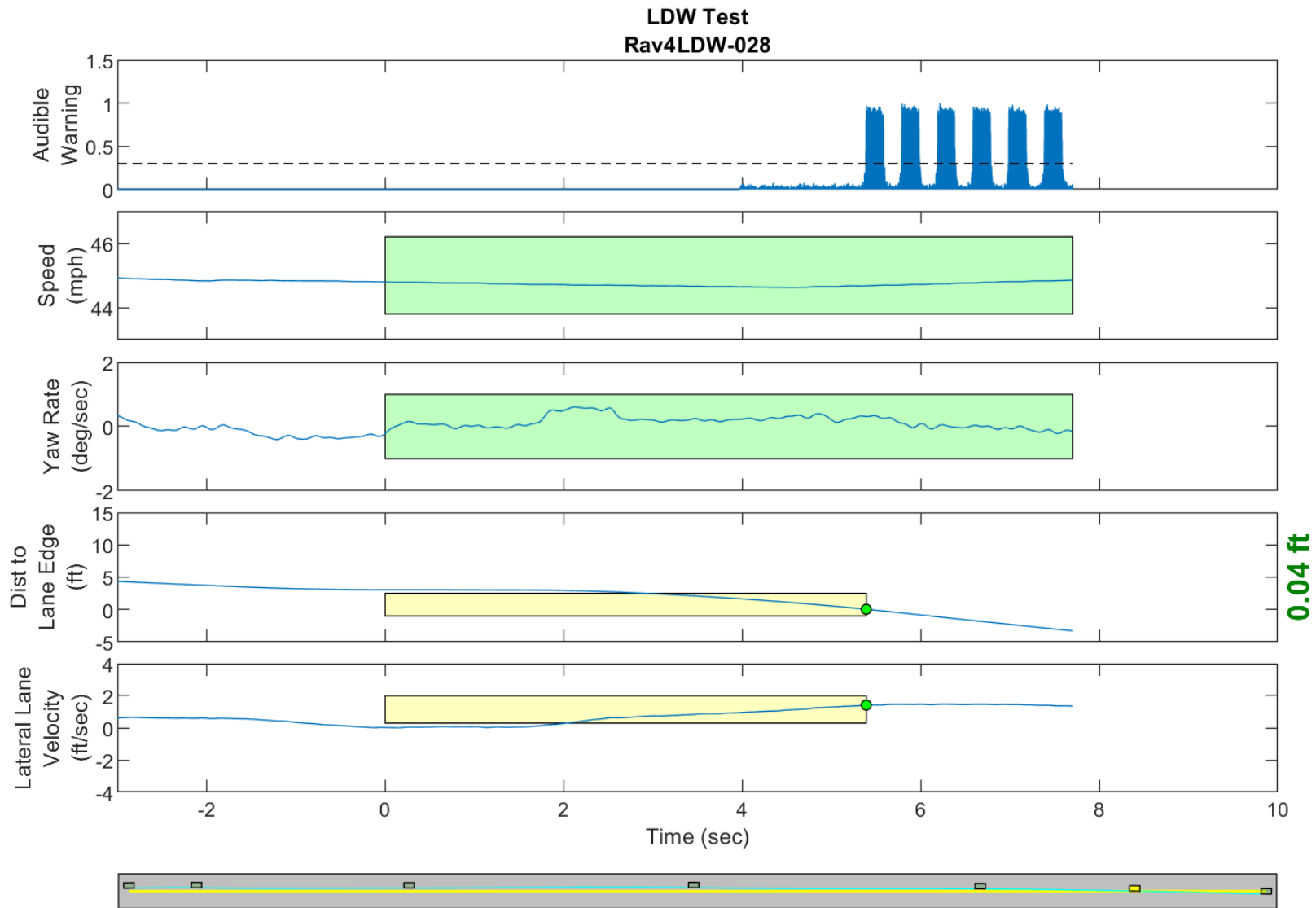
GPS Fix Type: RTK Fixed

Figure D40. Time History for Run 27, Dashed Line, Right Departure, Auditory Warning



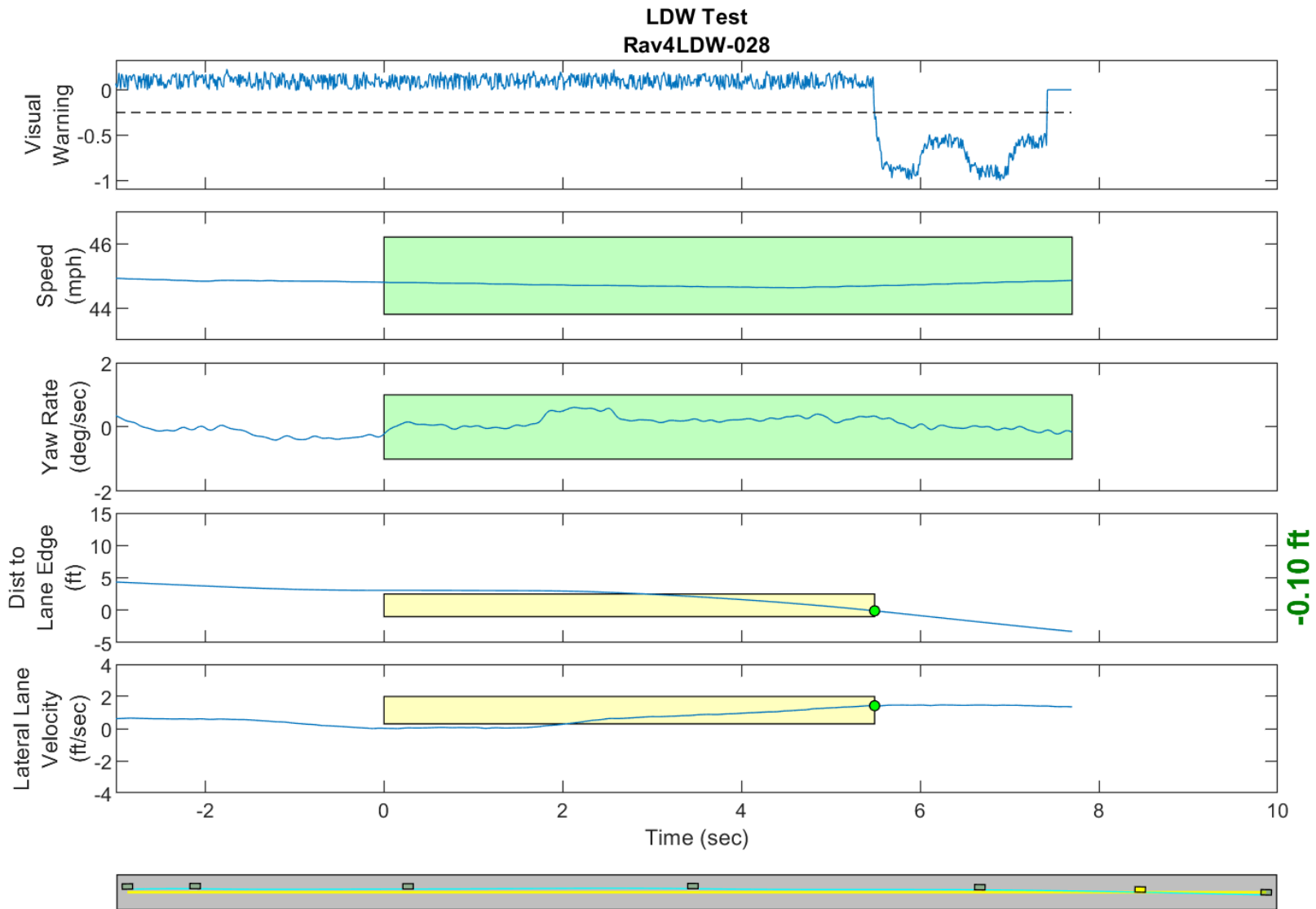
GPS Fix Type: RTK Fixed

Figure D41. Time History for Run 27, Dashed Line, Right Departure, Visual Warning



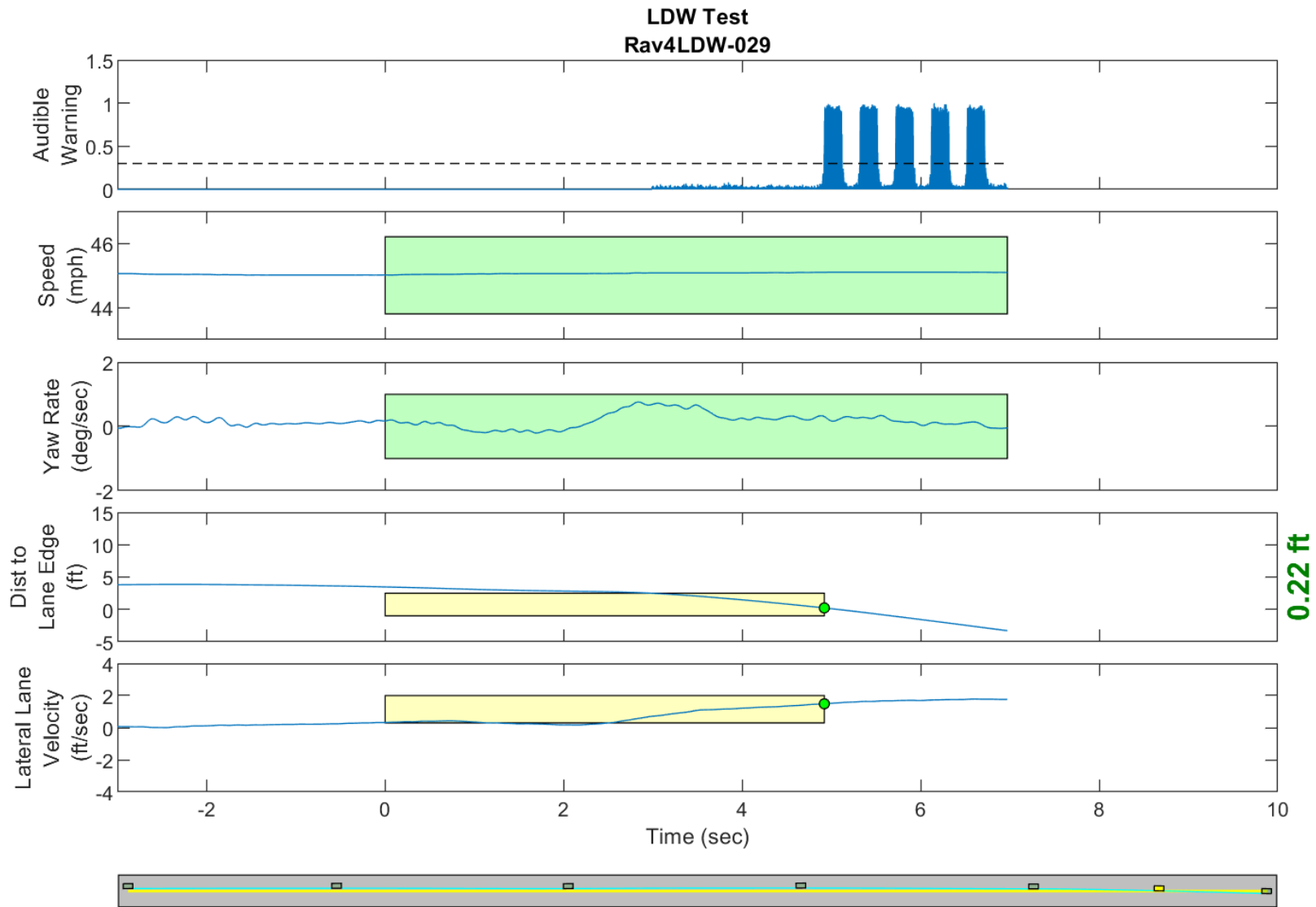
GPS Fix Type: RTK Fixed

Figure D42. Time History for Run 28, Dashed Line, Right Departure, Auditory Warning



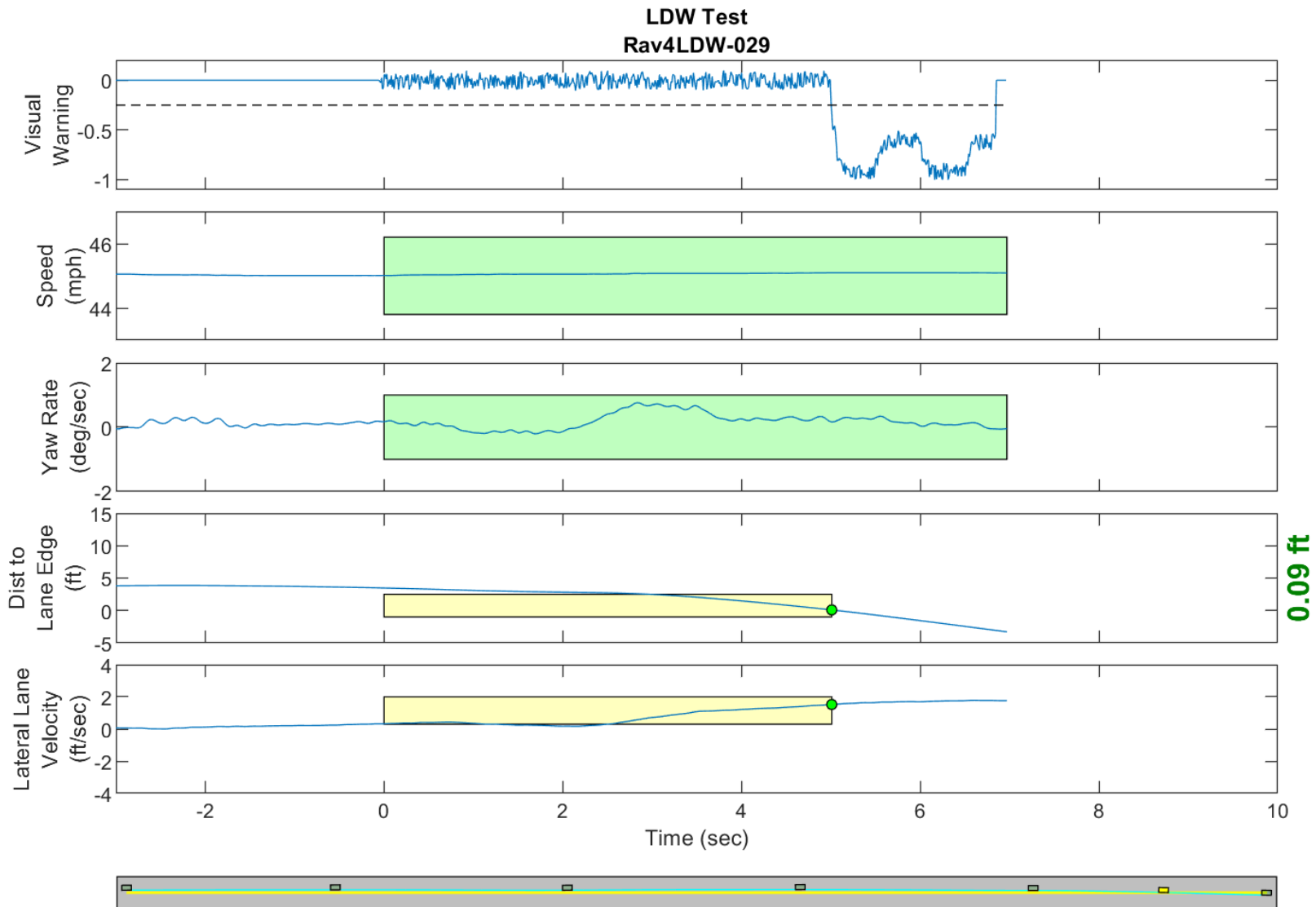
GPS Fix Type: RTK Fixed

Figure D43. Time History for Run 28, Dashed Line, Right Departure, Visual Warning



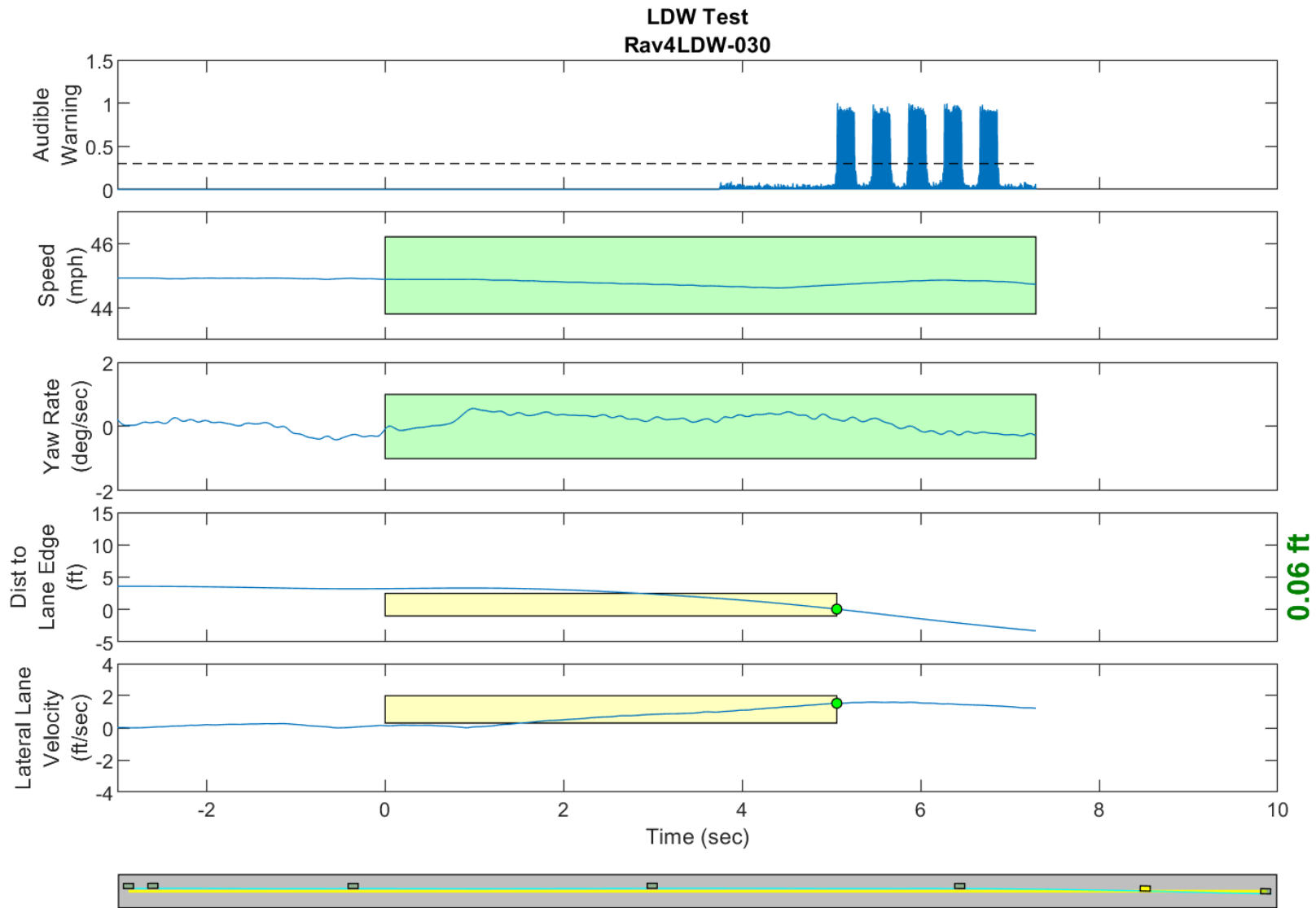
GPS Fix Type: RTK Fixed

Figure D44. Time History for Run 29, Dashed Line, Right Departure, Auditory Warning



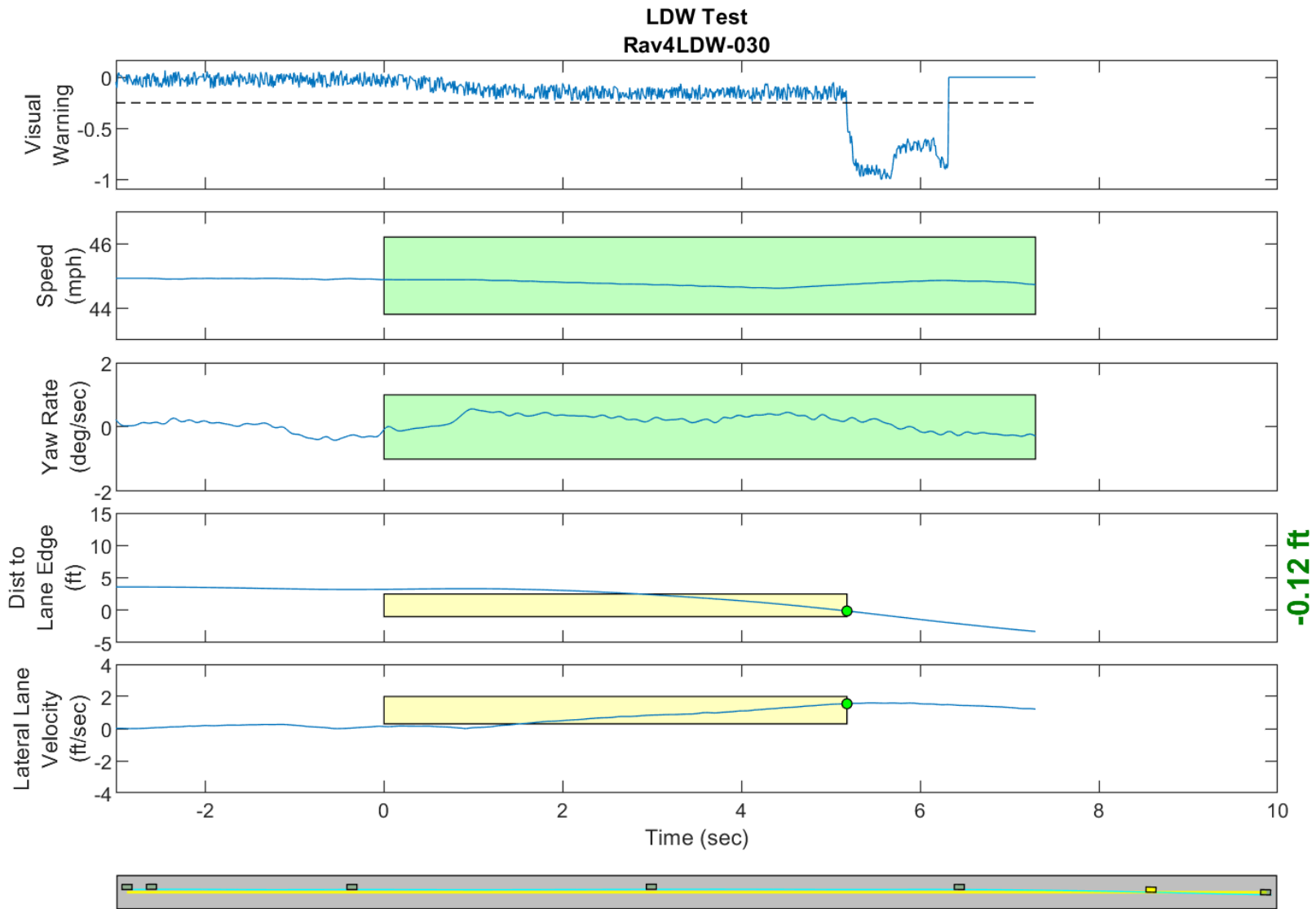
GPS Fix Type: RTK Fixed

Figure D45. Time History for Run 29, Dashed Line, Right Departure, Visual Warning



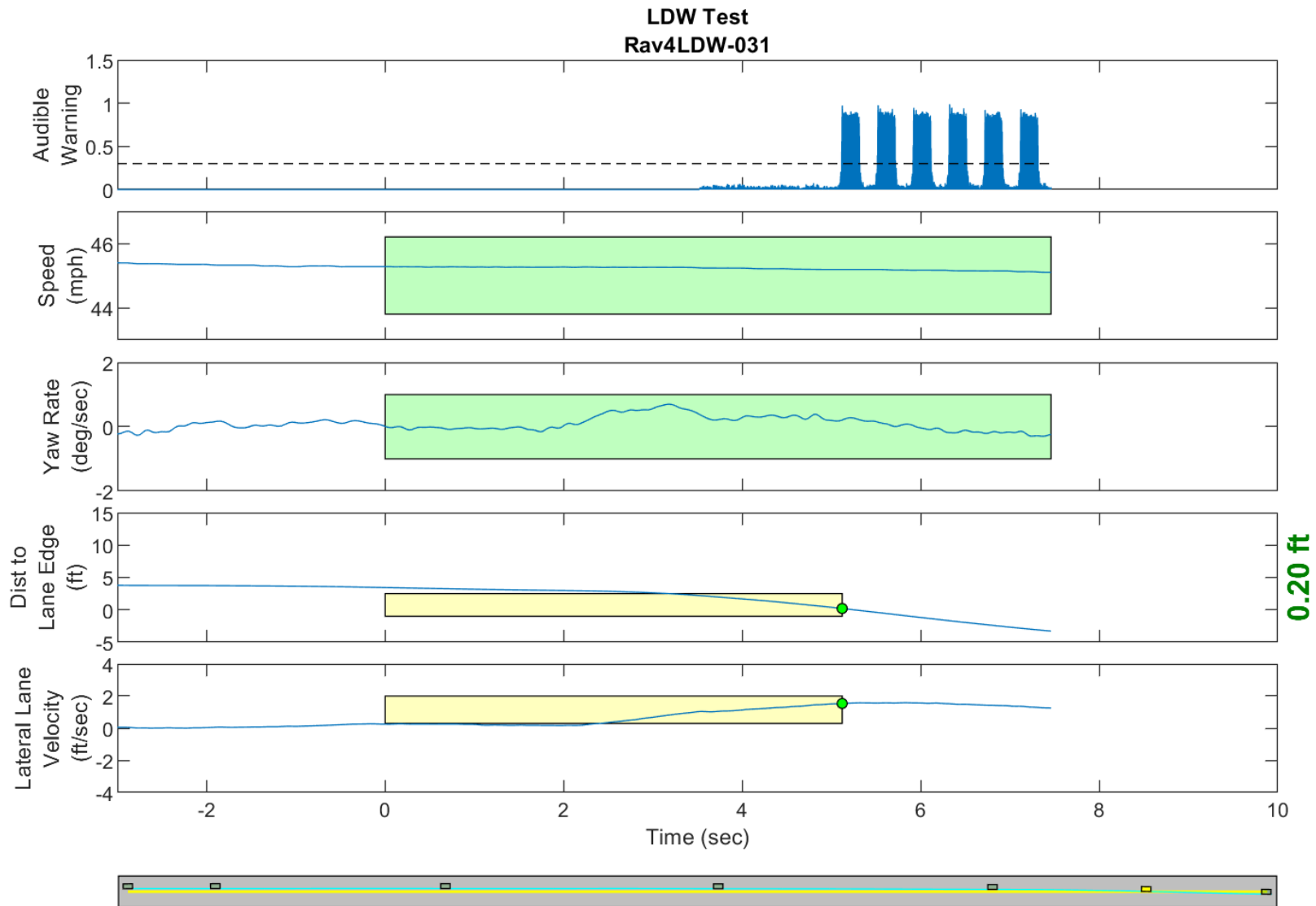
GPS Fix Type: RTK Fixed

Figure D46. Time History for Run 30, Dashed Line, Right Departure, Auditory Warning



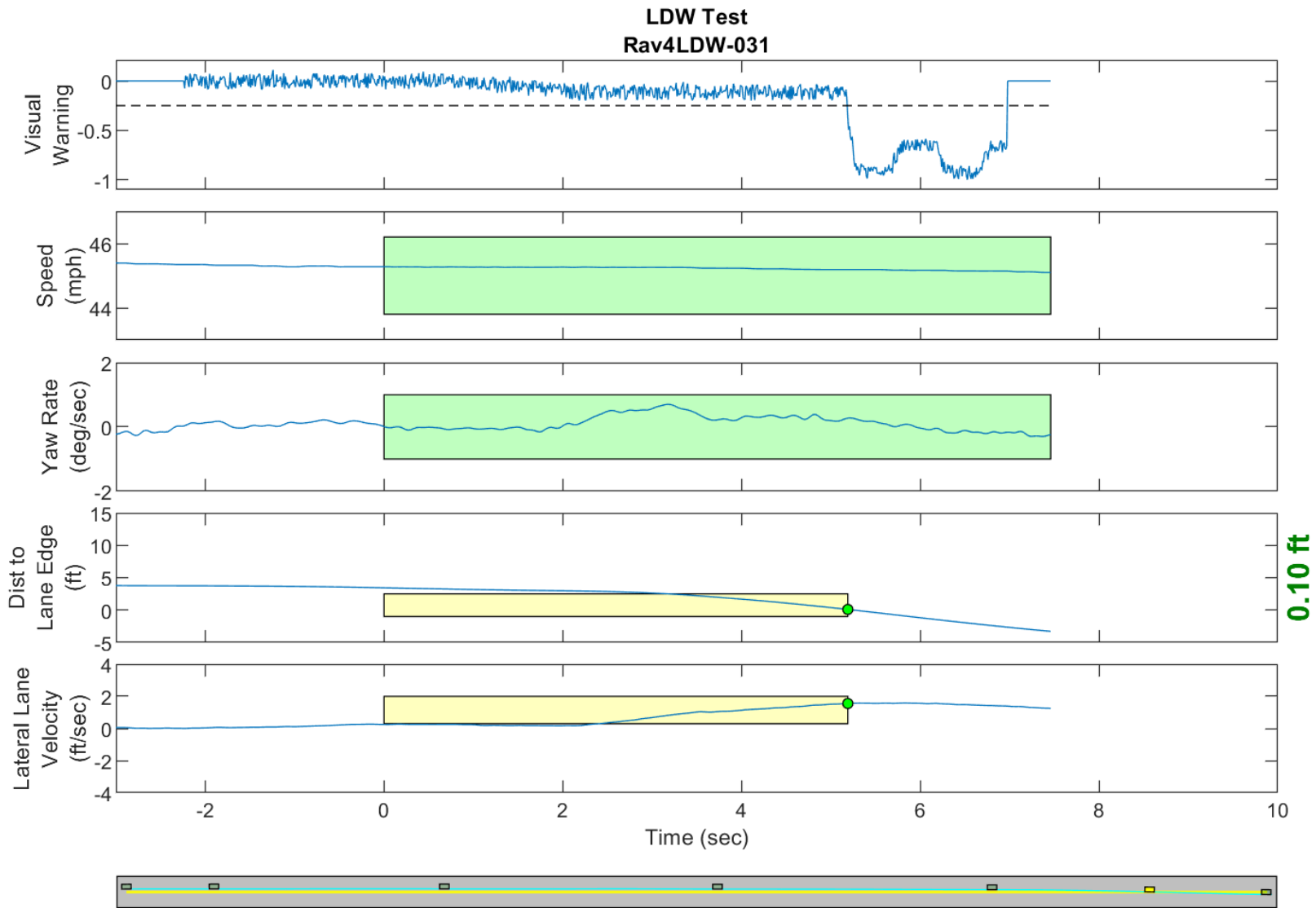
GPS Fix Type: RTK Fixed

Figure D47. Time History for Run 30, Dashed Line, Right Departure, Visual Warning



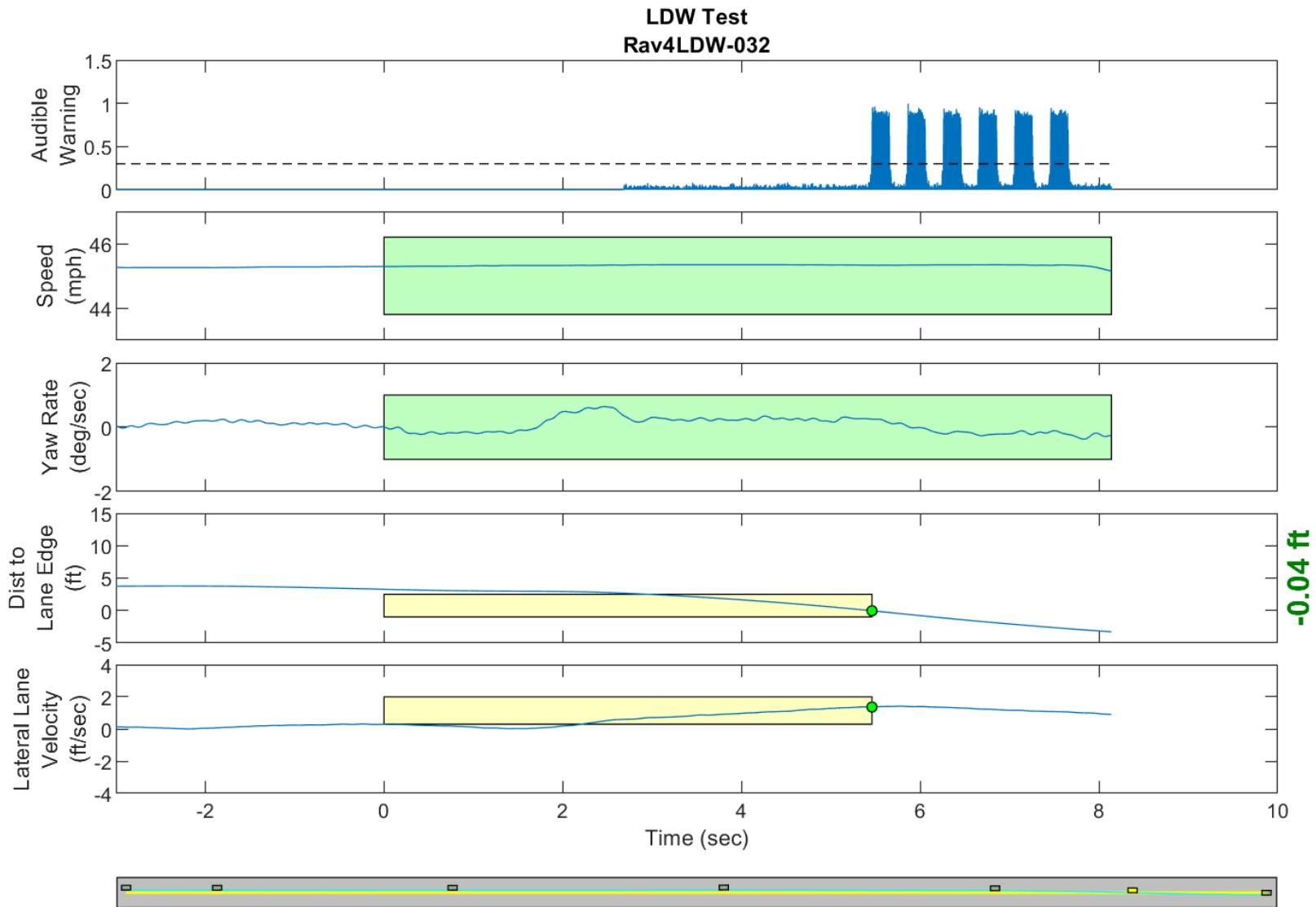
GPS Fix Type: RTK Fixed

Figure D48. Time History for Run 31, Dashed Line, Right Departure, Auditory Warning



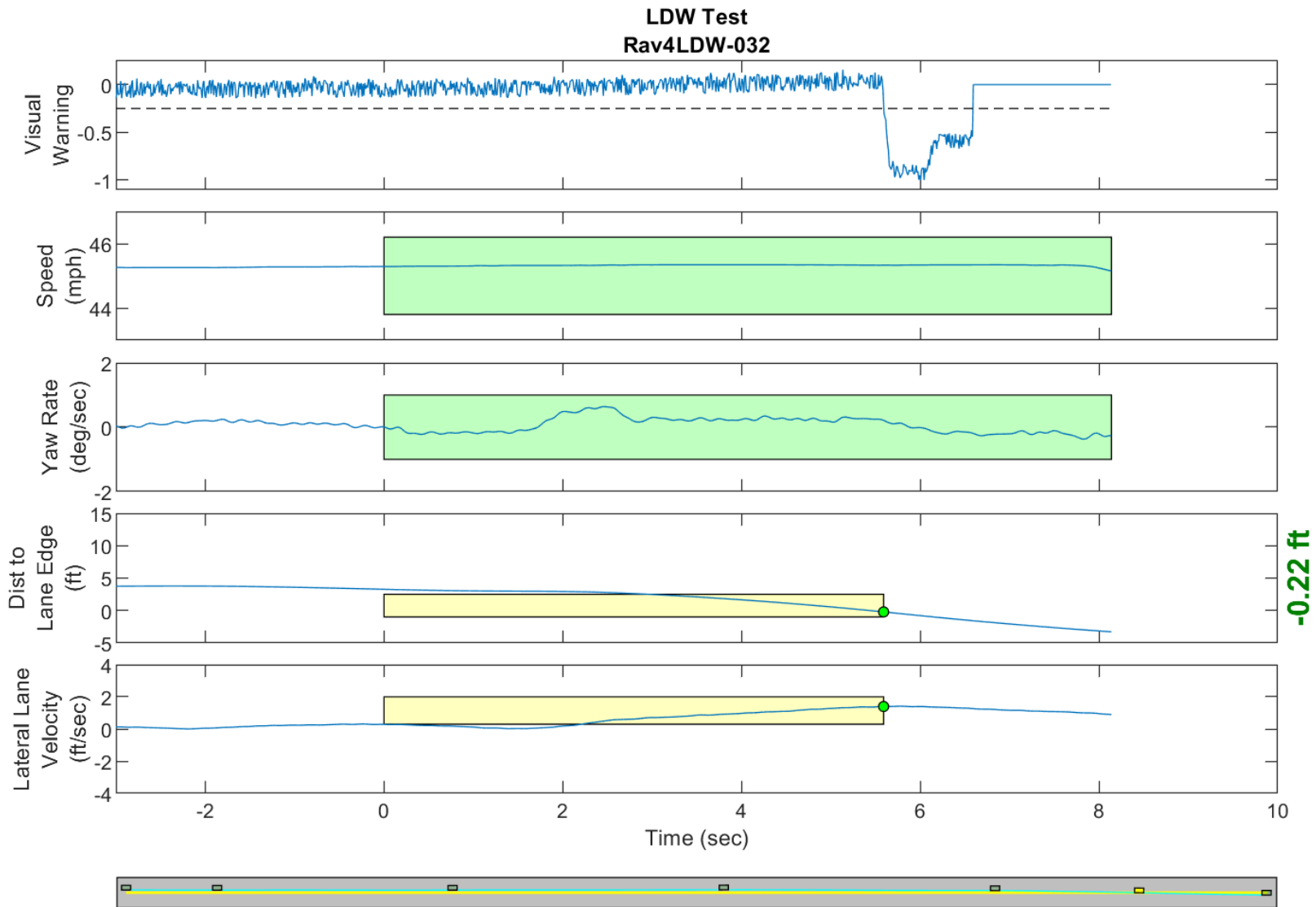
GPS Fix Type: RTK Fixed

Figure D49. Time History for Run 31, Dashed Line, Right Departure, Visual Warning



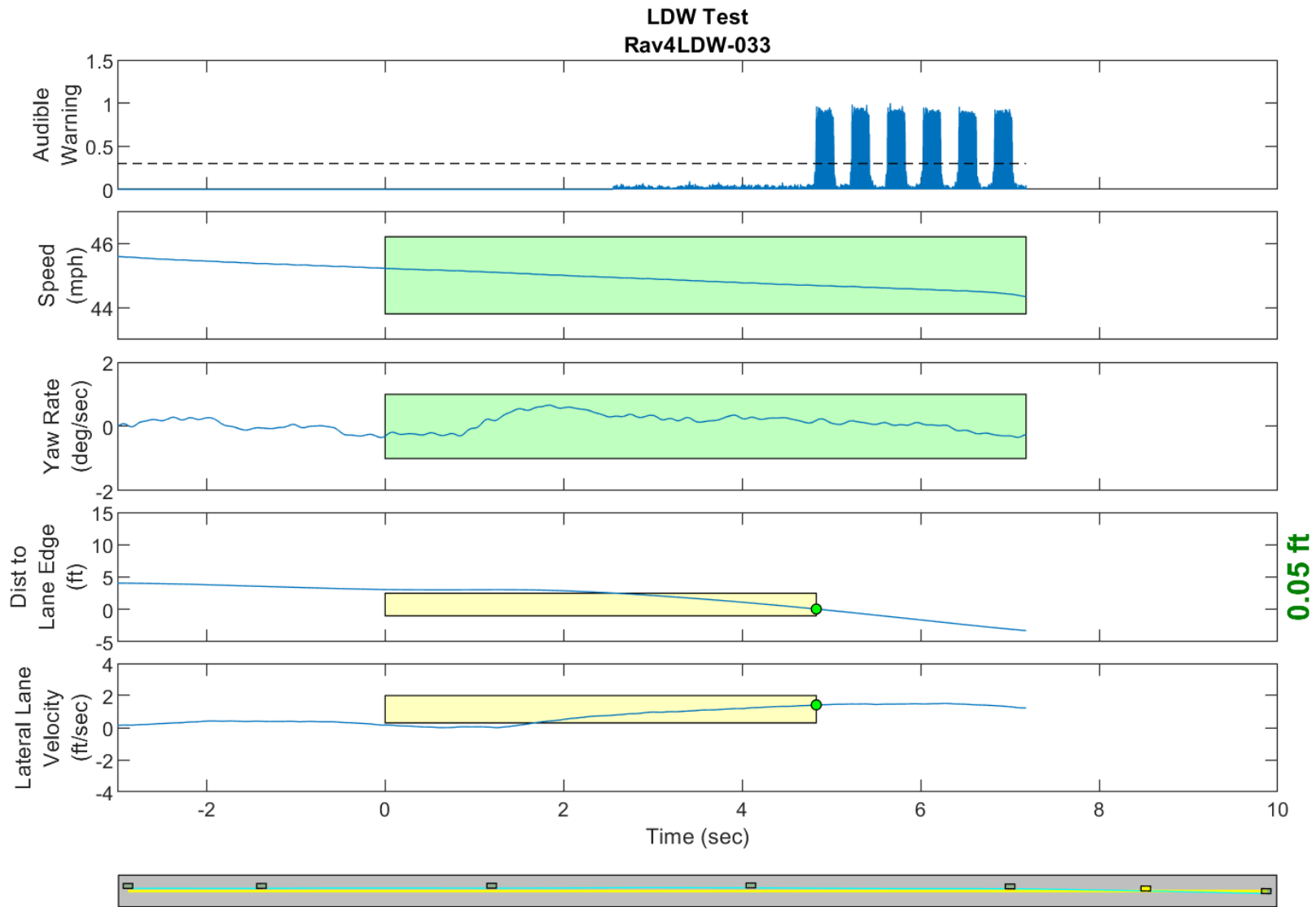
GPS Fix Type: RTK Fixed

Figure D50. Time History for Run 32, Dashed Line, Right Departure, Auditory Warning



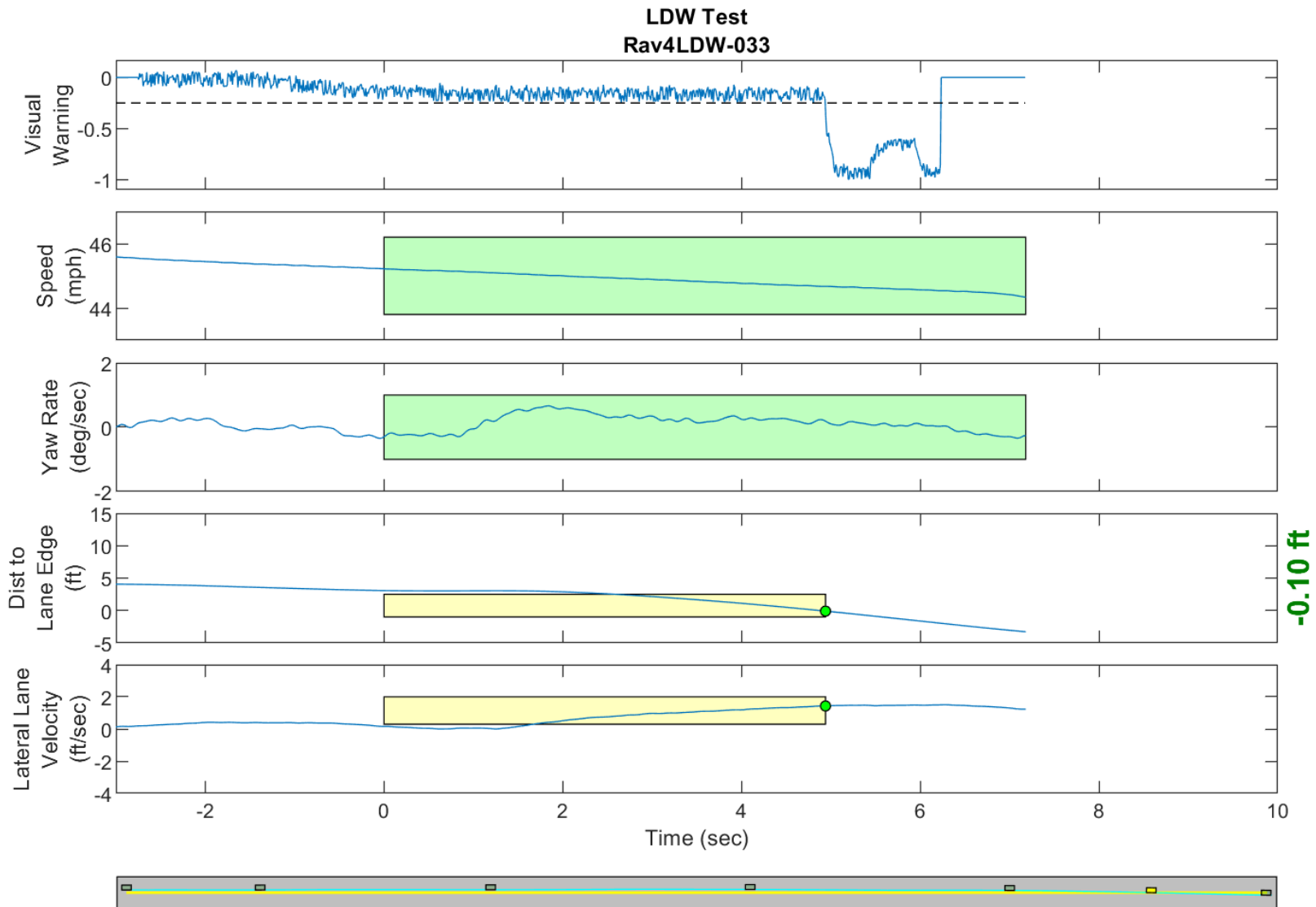
GPS Fix Type: RTK Fixed

Figure D51. Time History for Run 32, Dashed Line, Right Departure, Visual Warning



GPS Fix Type: RTK Fixed

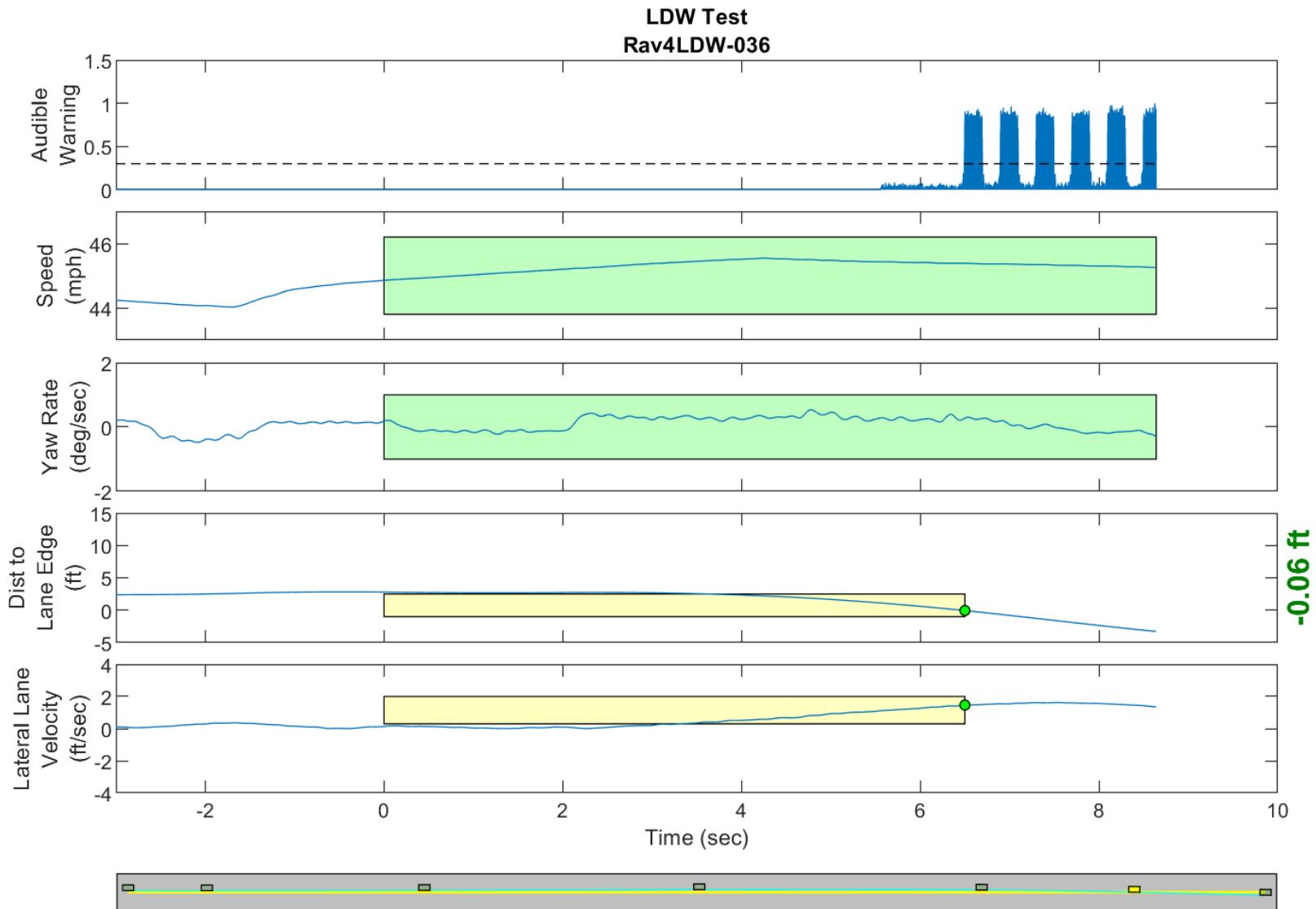
Figure D52. Time History for Run 33, Dashed Line, Right Departure, Auditory Warning



-0.10 ft

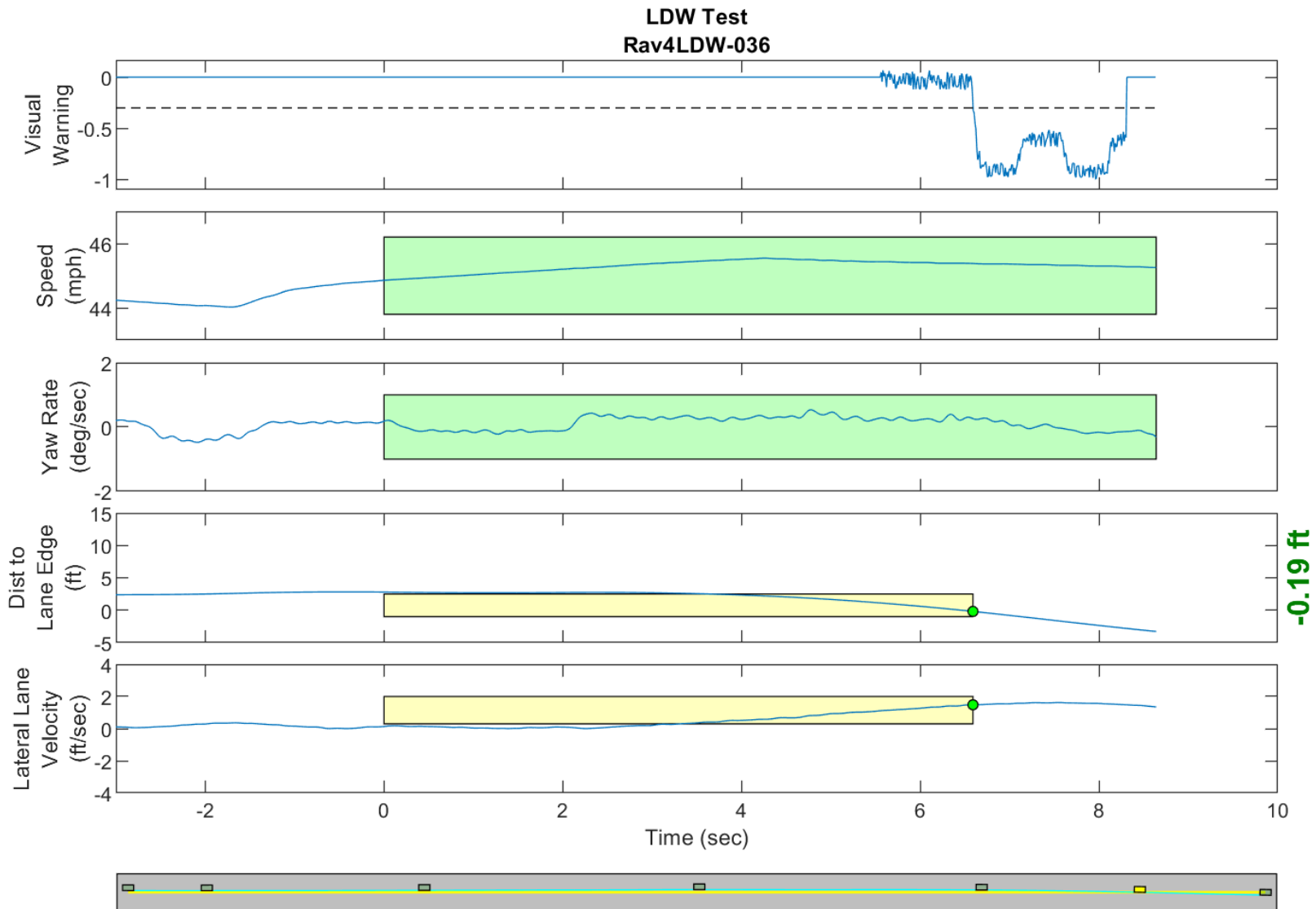
GPS Fix Type: RTK Fixed

Figure D53. Time History for Run 33, Dashed Line, Right Departure, Visual Warning



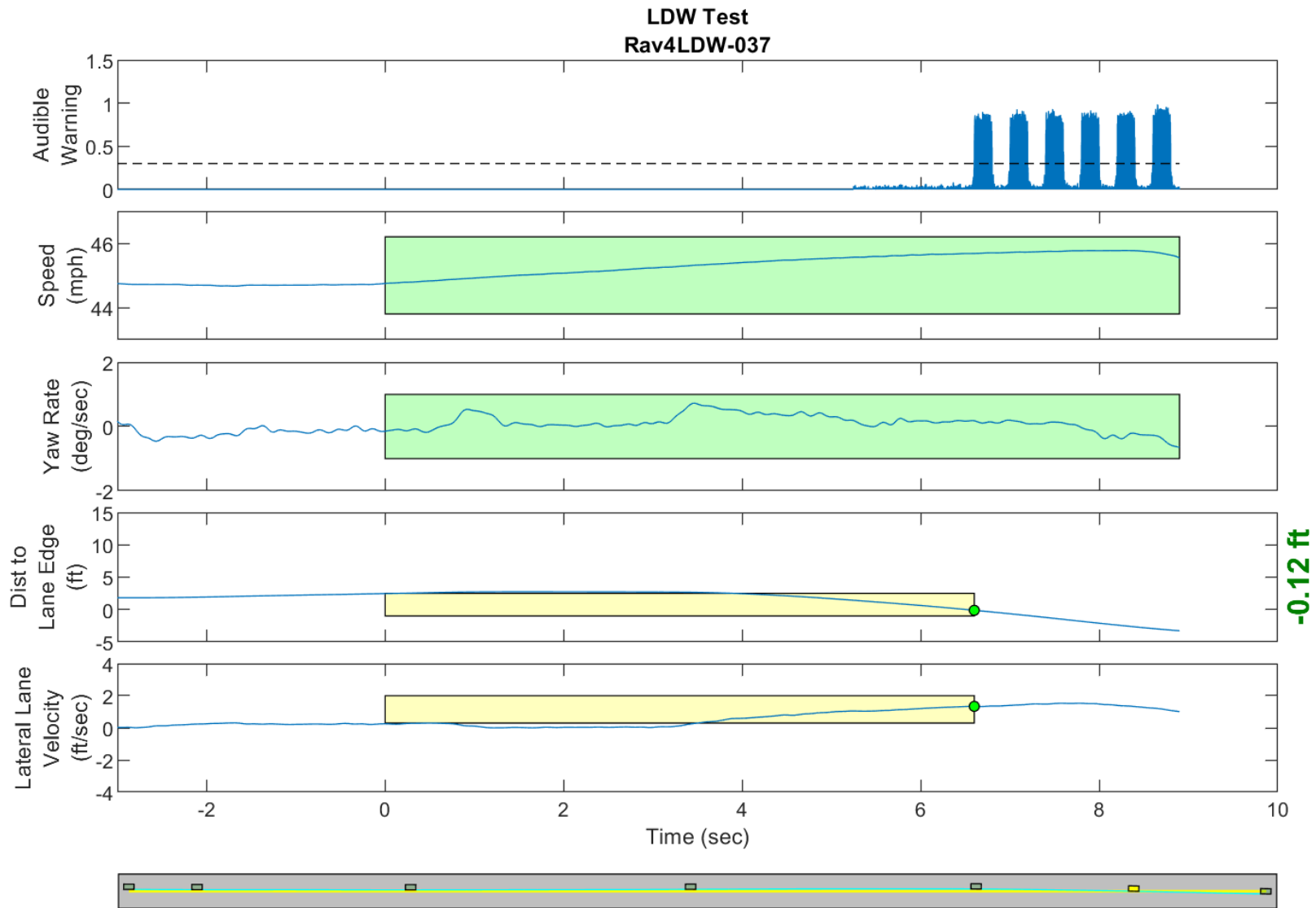
GPS Fix Type: RTK Fixed

Figure D54. Time History for Run 36, Solid Line, Right Departure, Auditory Warning



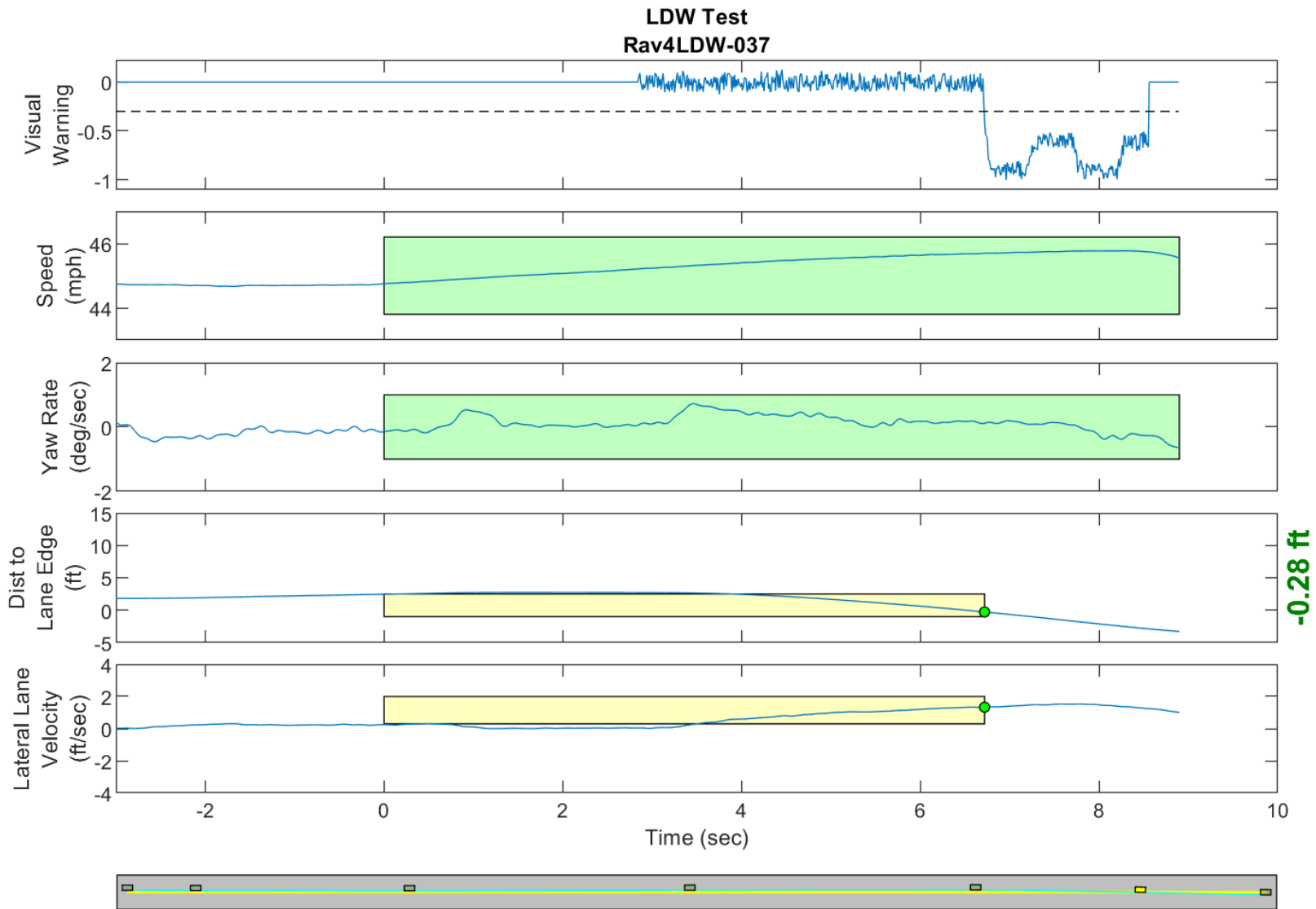
GPS Fix Type: RTK Fixed

Figure D55. Time History for Run 36, Solid Line, Right Departure, Visual Warning



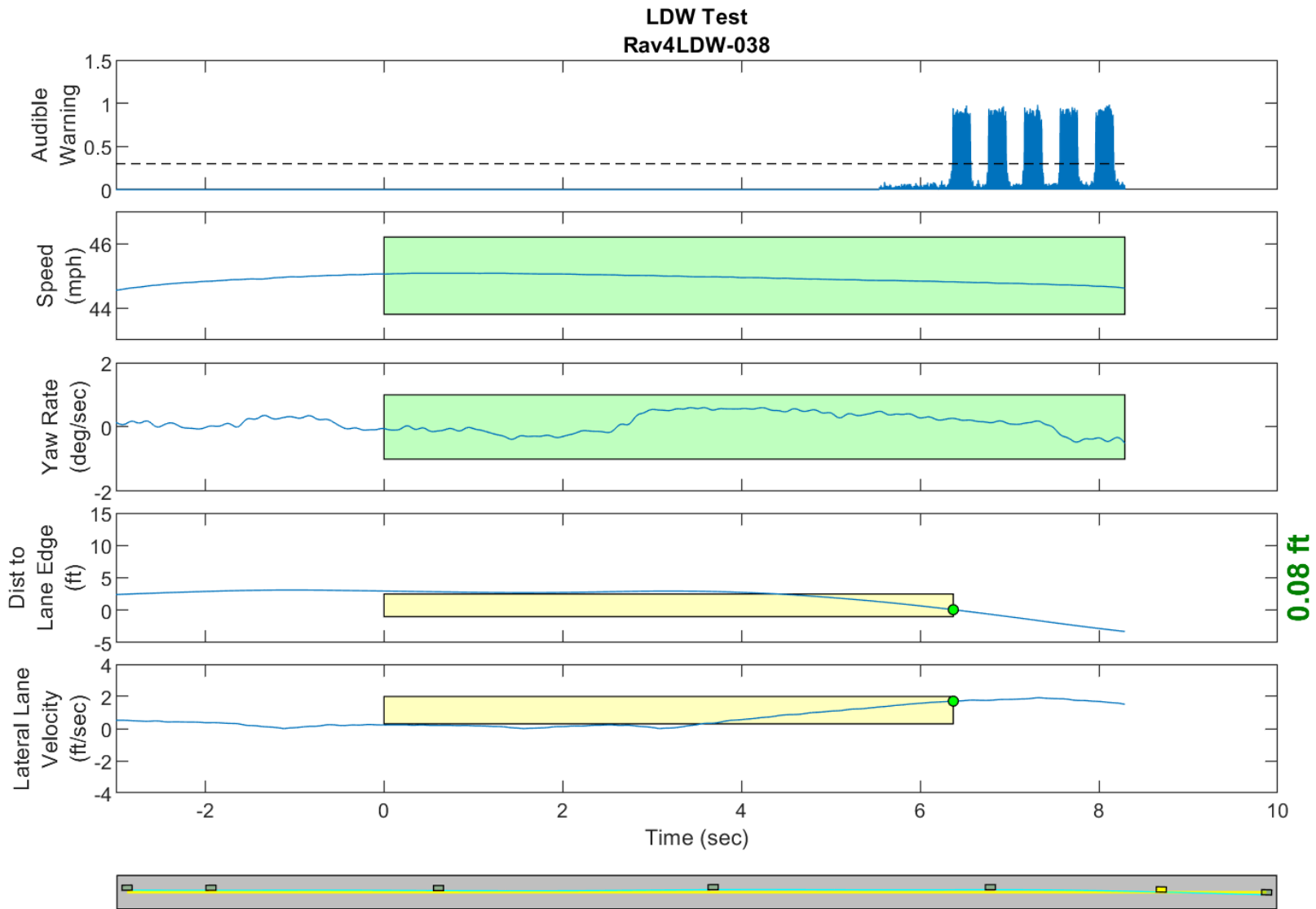
GPS Fix Type: RTK Fixed

Figure D56. Time History for Run 37, Solid Line, Right Departure, Auditory Warning



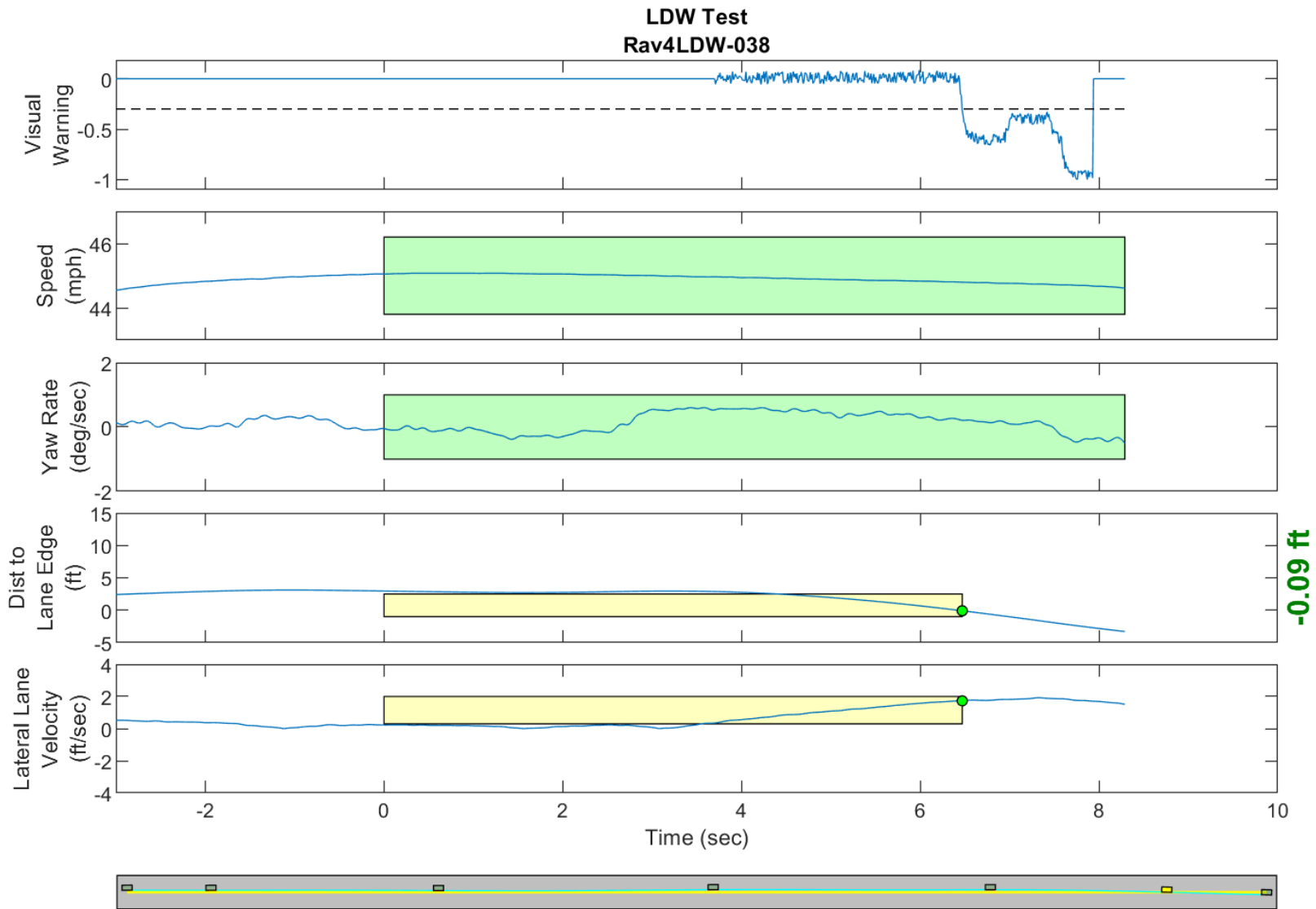
GPS Fix Type: RTK Fixed

Figure D57. Time History for Run 37, Solid Line, Right Departure, Visual Warning



GPS Fix Type: RTK Fixed

Figure D58. Time History for Run 38, Solid Line, Right Departure, Auditory Warning



GPS Fix Type: RTK Fixed

Figure D59. Time History for Run 38, Solid Line, Right Departure, Visual Warning

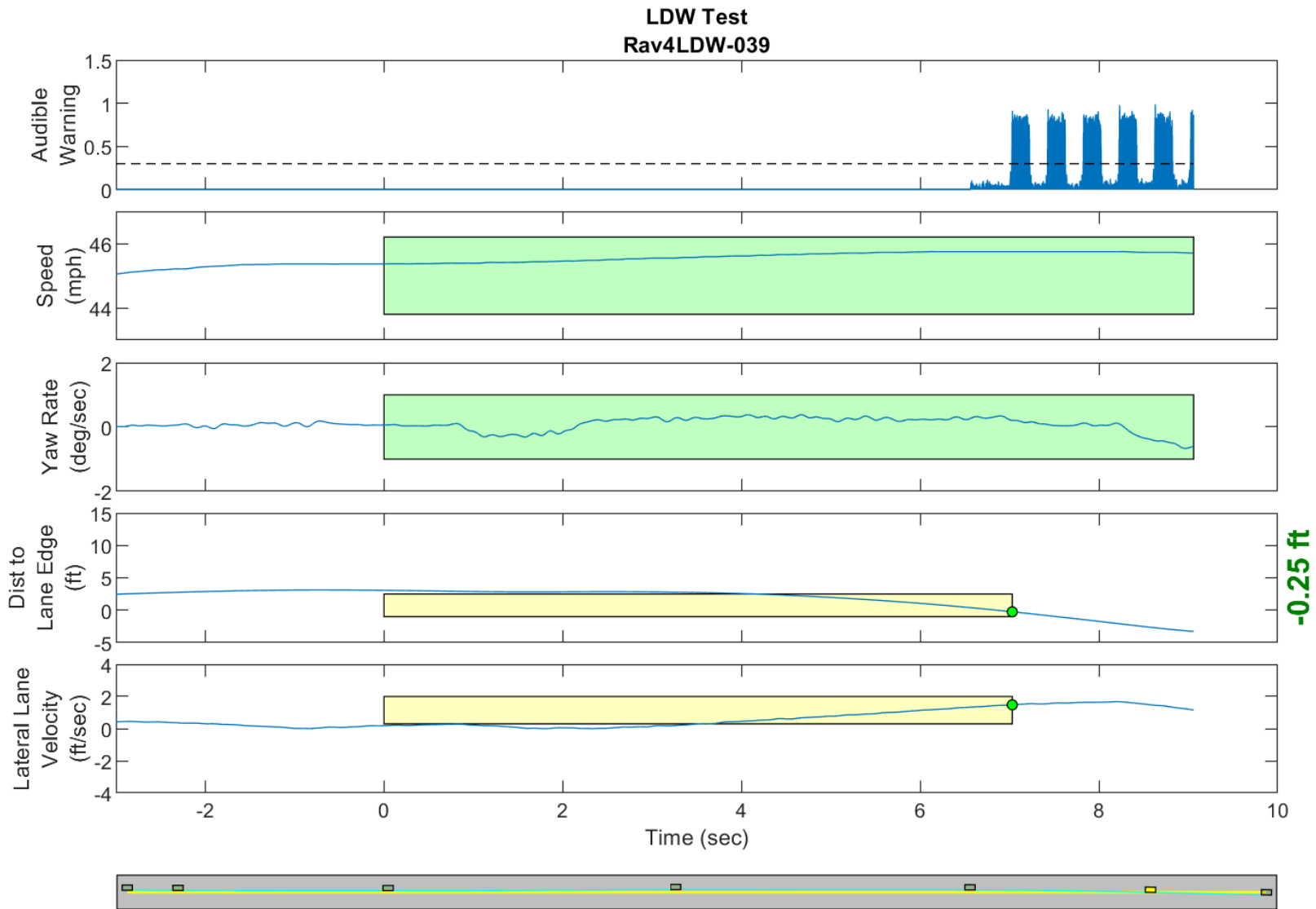
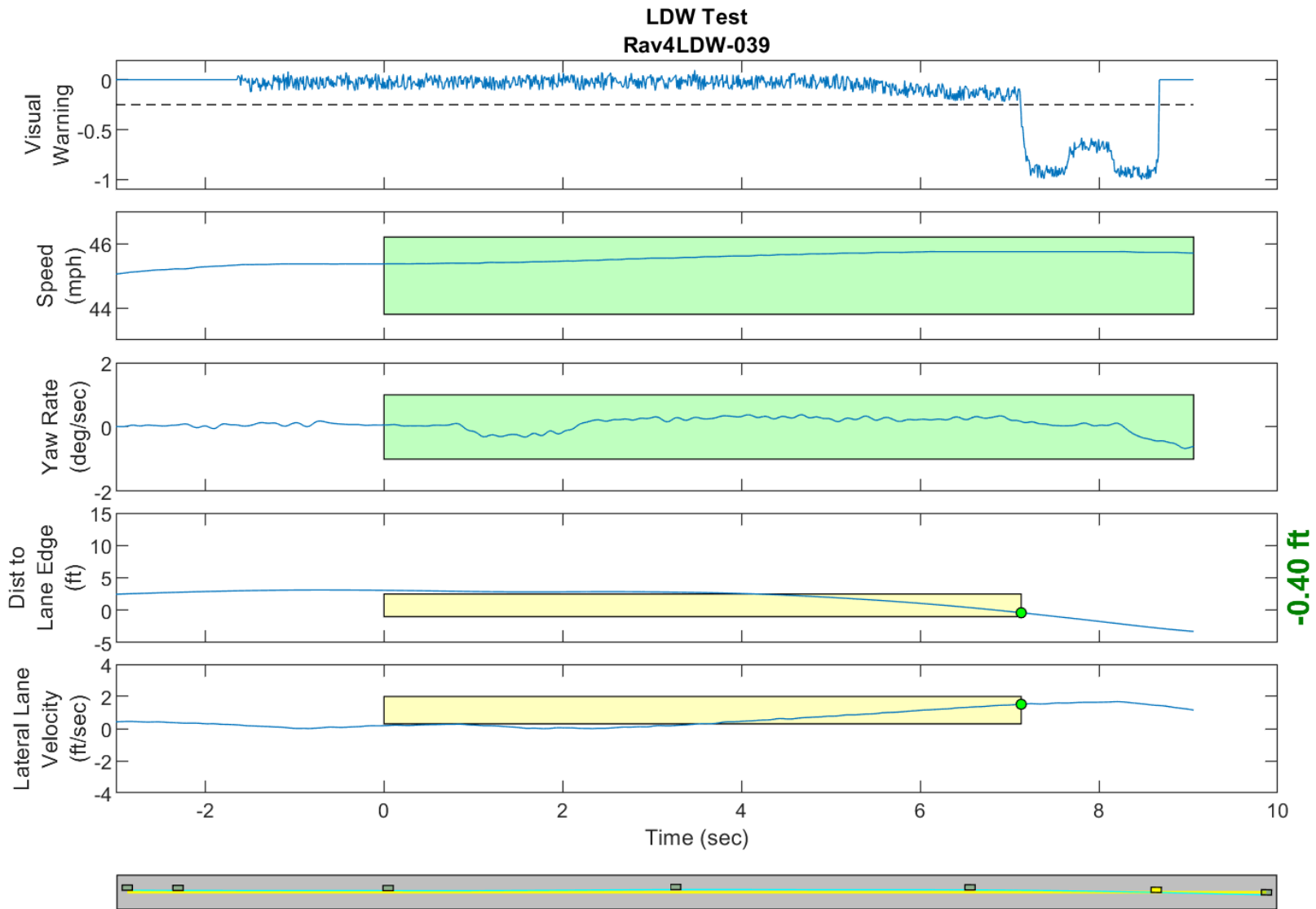
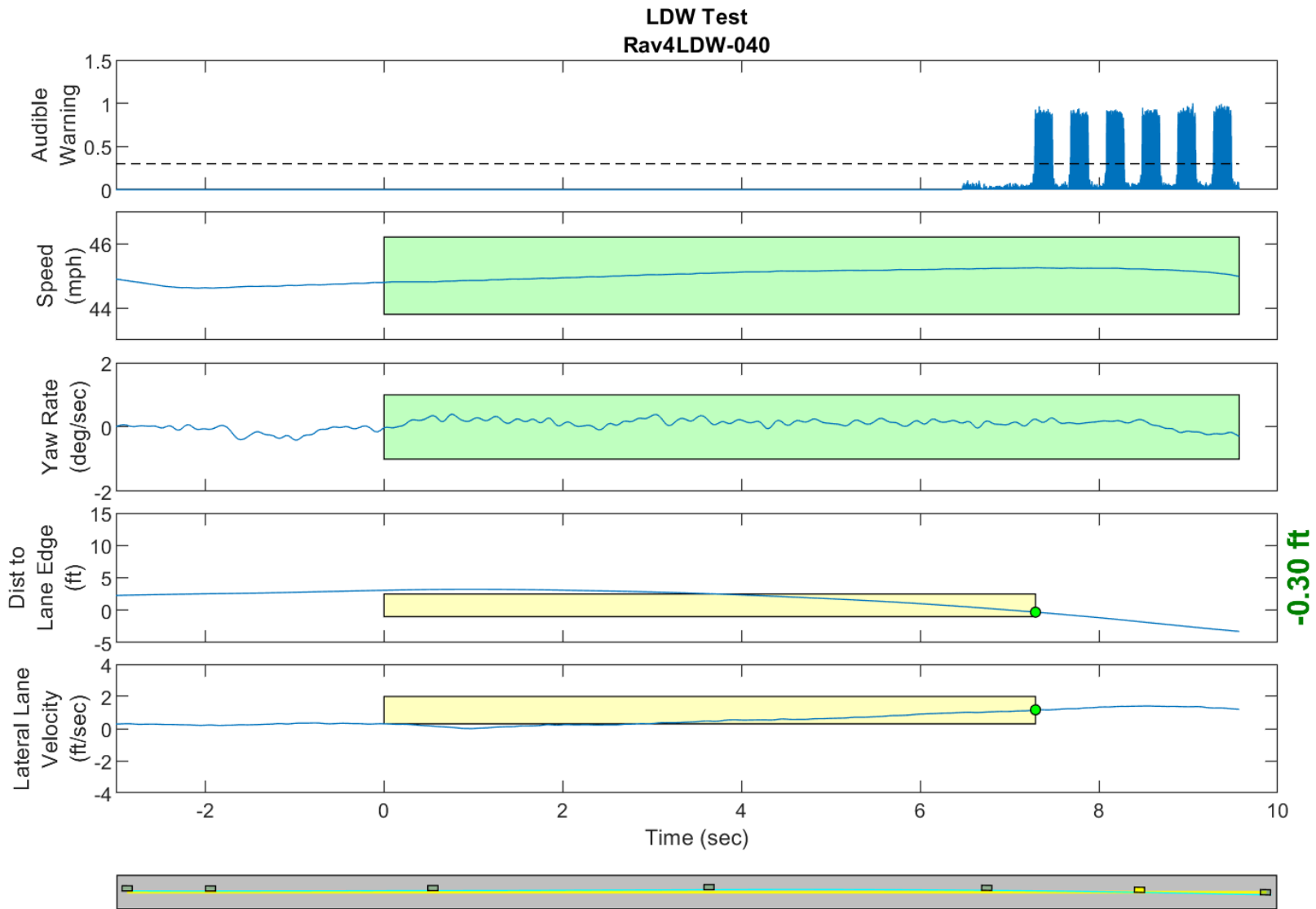


Figure D60. Time History for Run 39, Solid Line, Right Departure, Auditory Warning



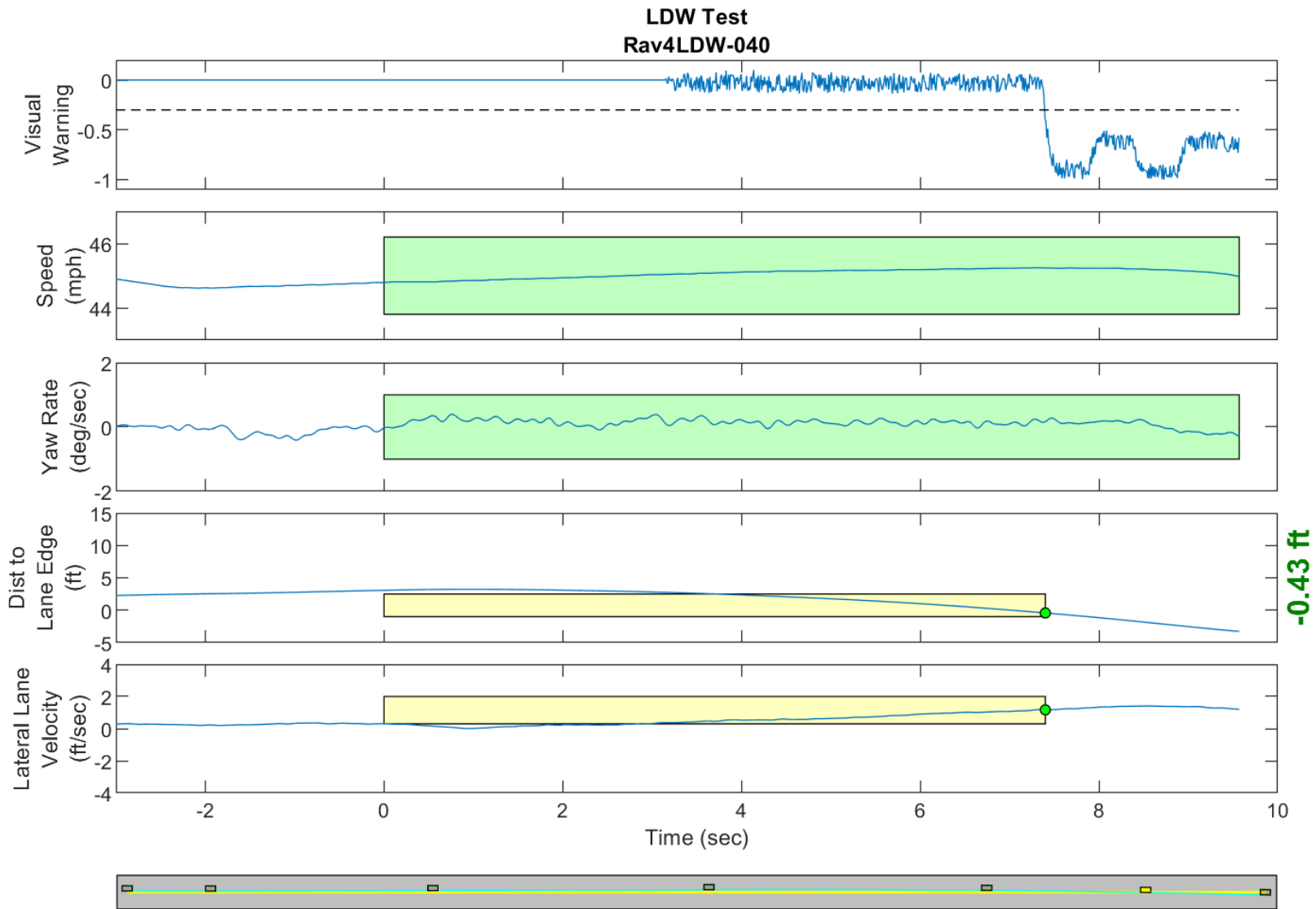
GPS Fix Type: RTK Fixed

Figure D61. Time History for Run 39, Solid Line, Right Departure, Visual Warning



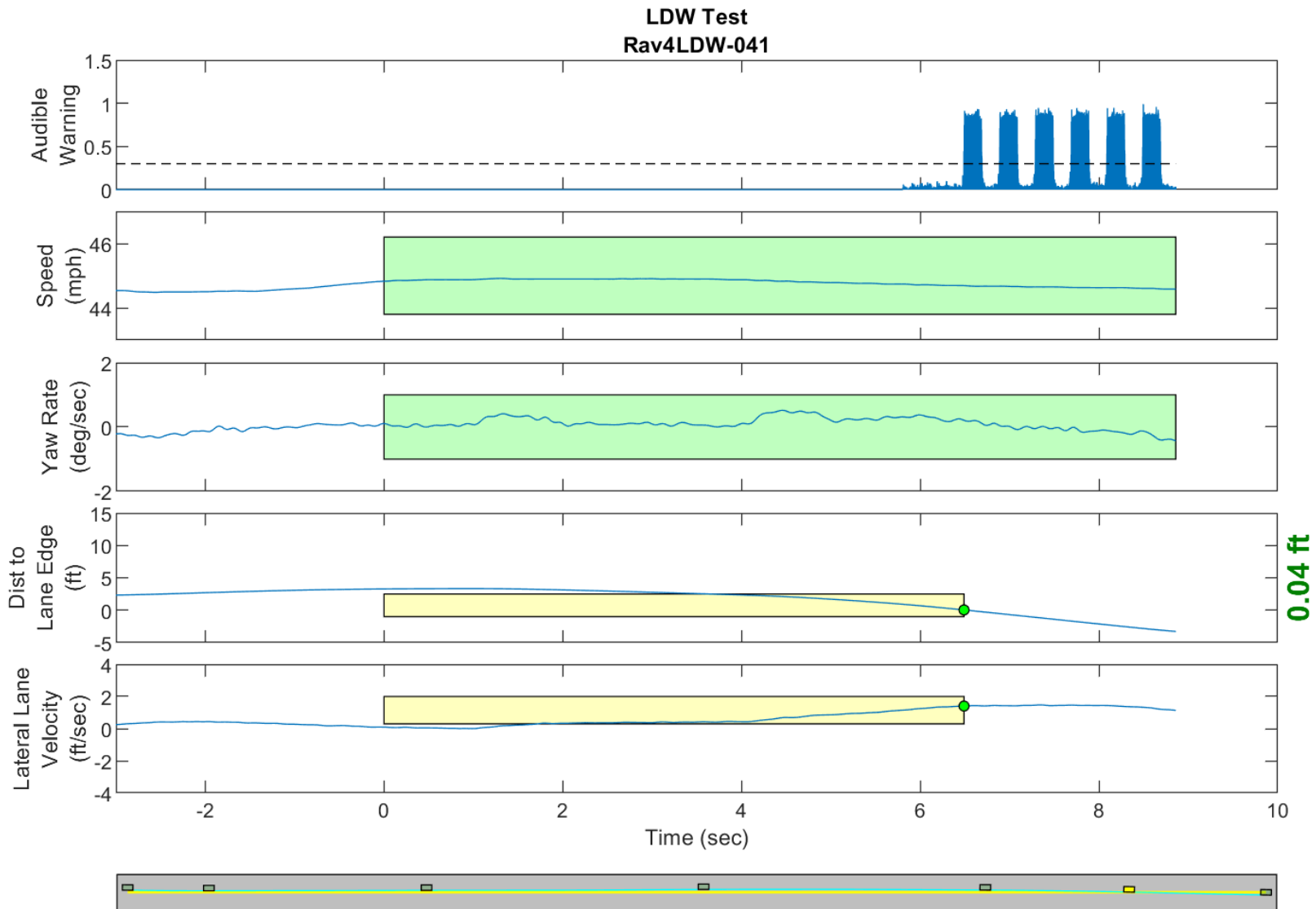
GPS Fix Type: RTK Fixed

Figure D62. Time History for Run 40, Solid Line, Right Departure, Auditory Warning



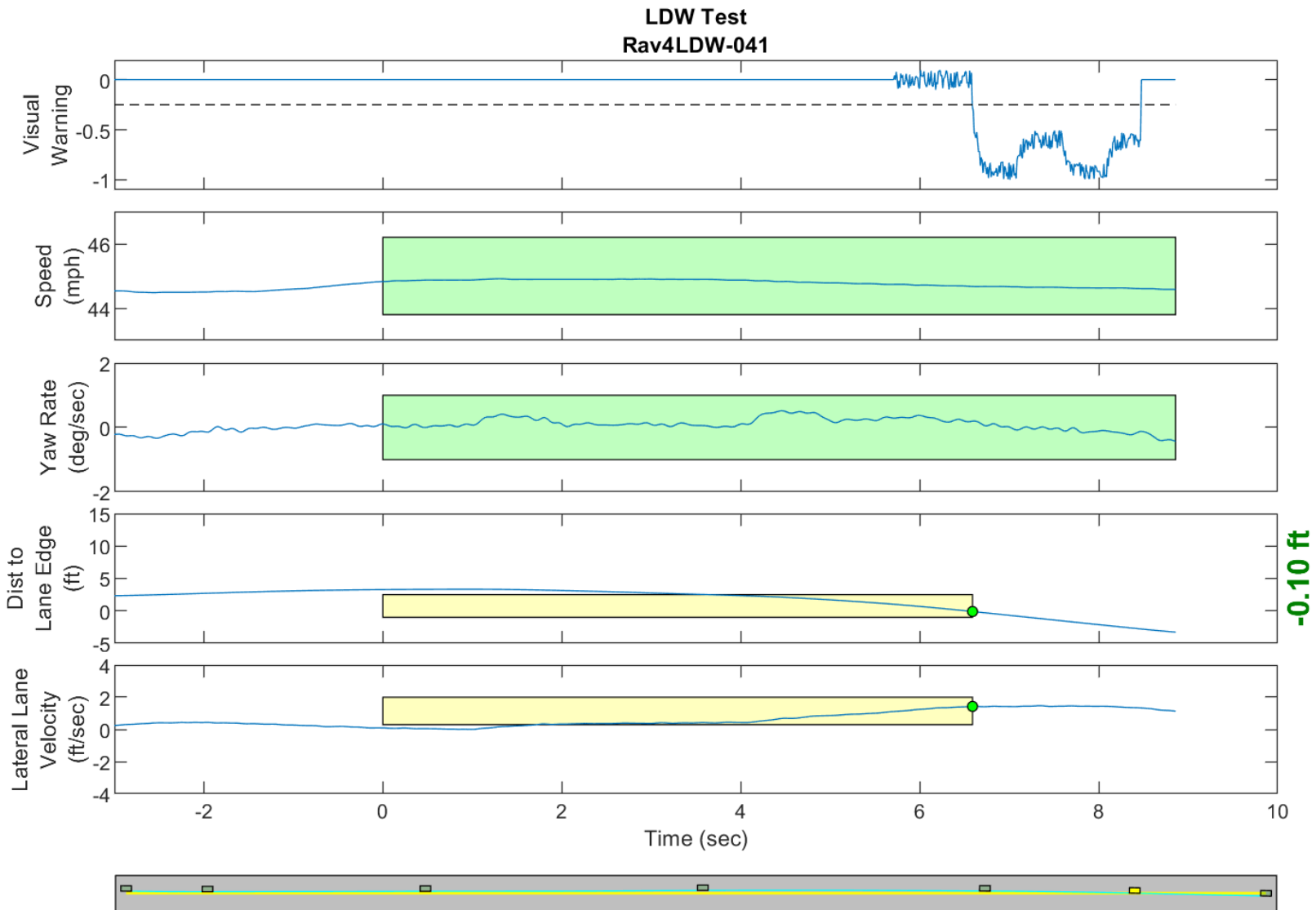
GPS Fix Type: RTK Fixed

Figure D63. Time History for Run 40, Solid Line, Right Departure, Visual Warning



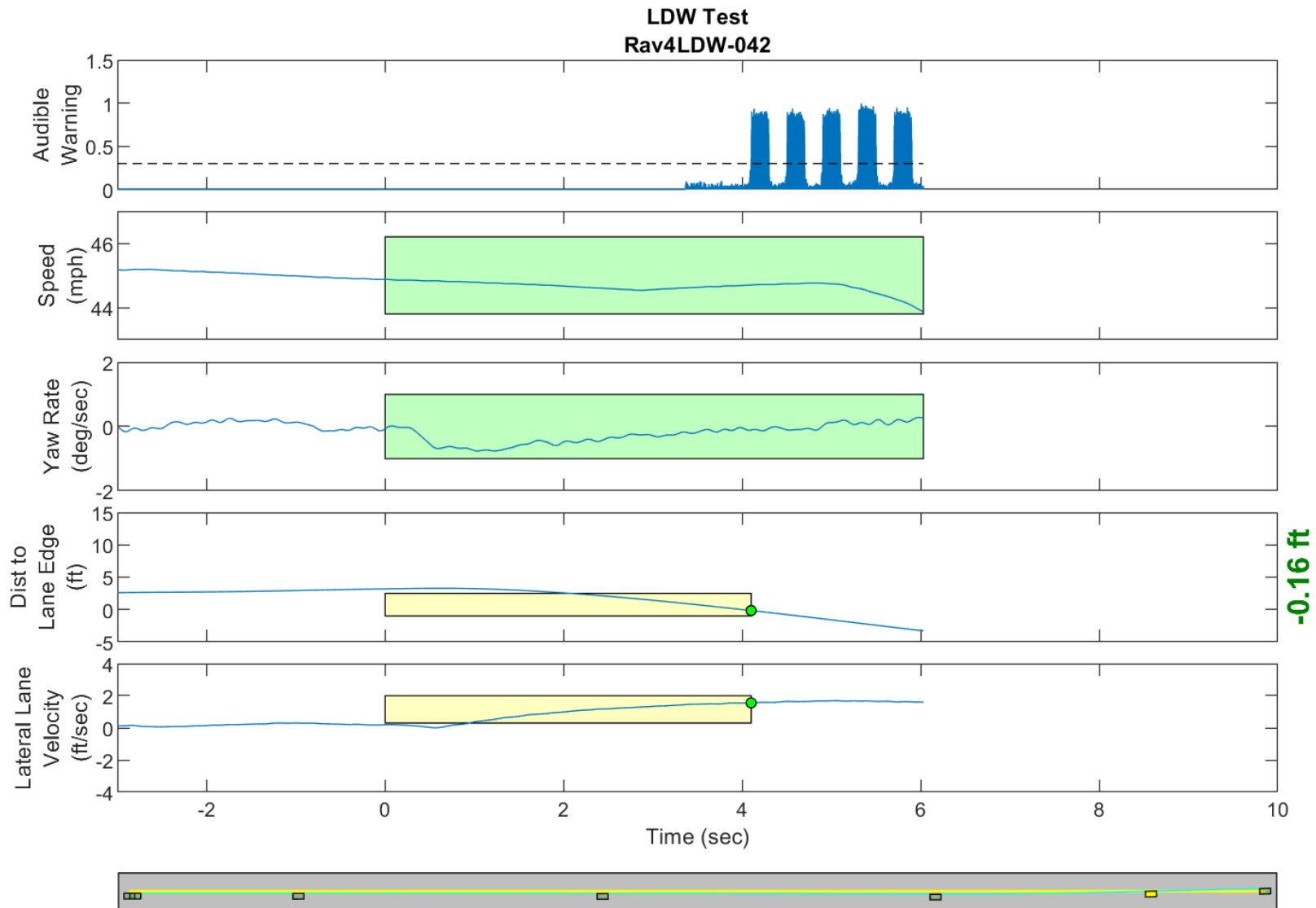
GPS Fix Type: RTK Fixed

Figure D64. Time History for Run 41, Solid Line, Right Departure, Auditory Warning



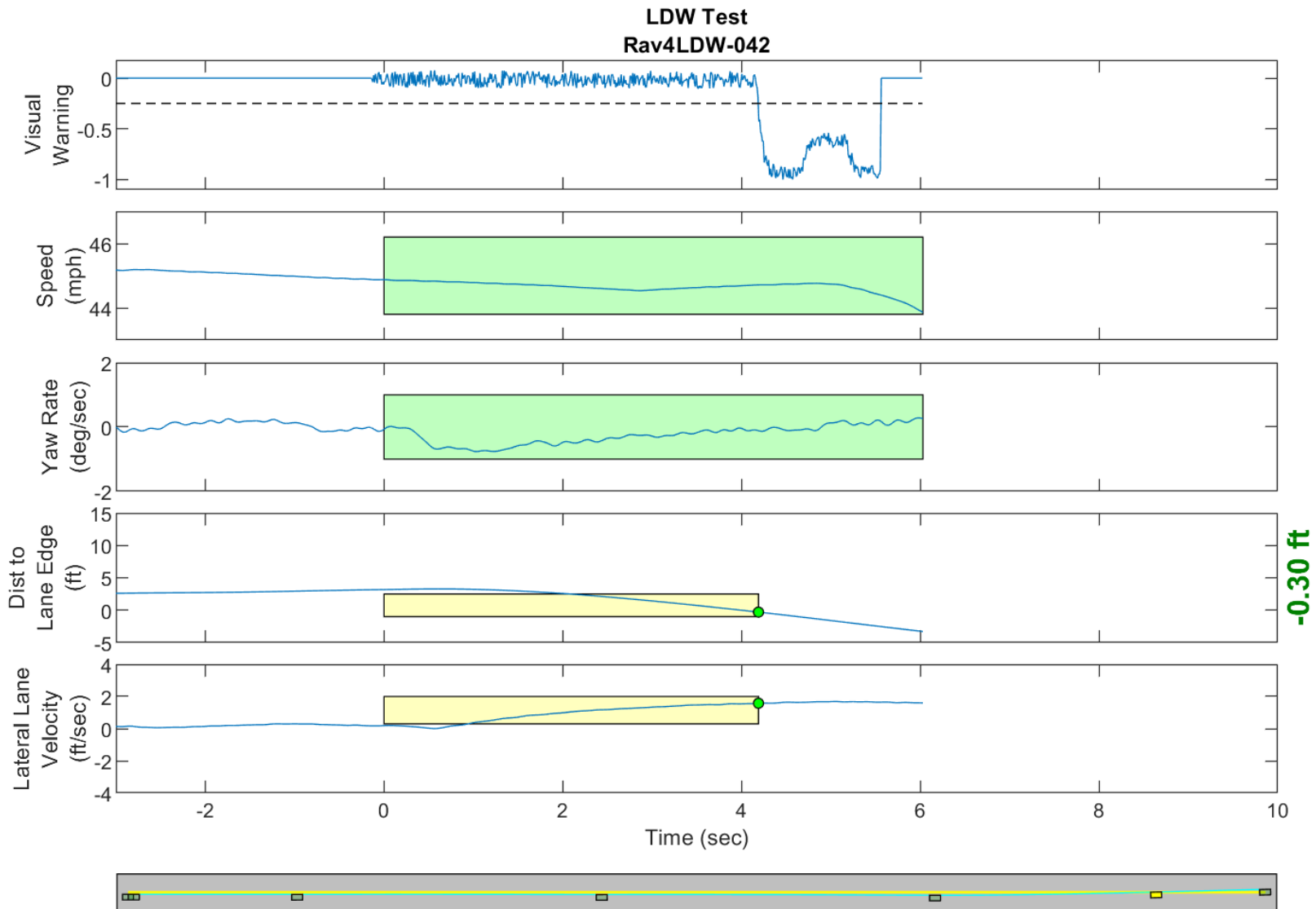
GPS Fix Type: RTK Fixed

Figure D65. Time History for Run 41, Solid Line, Right Departure, Visual Warning



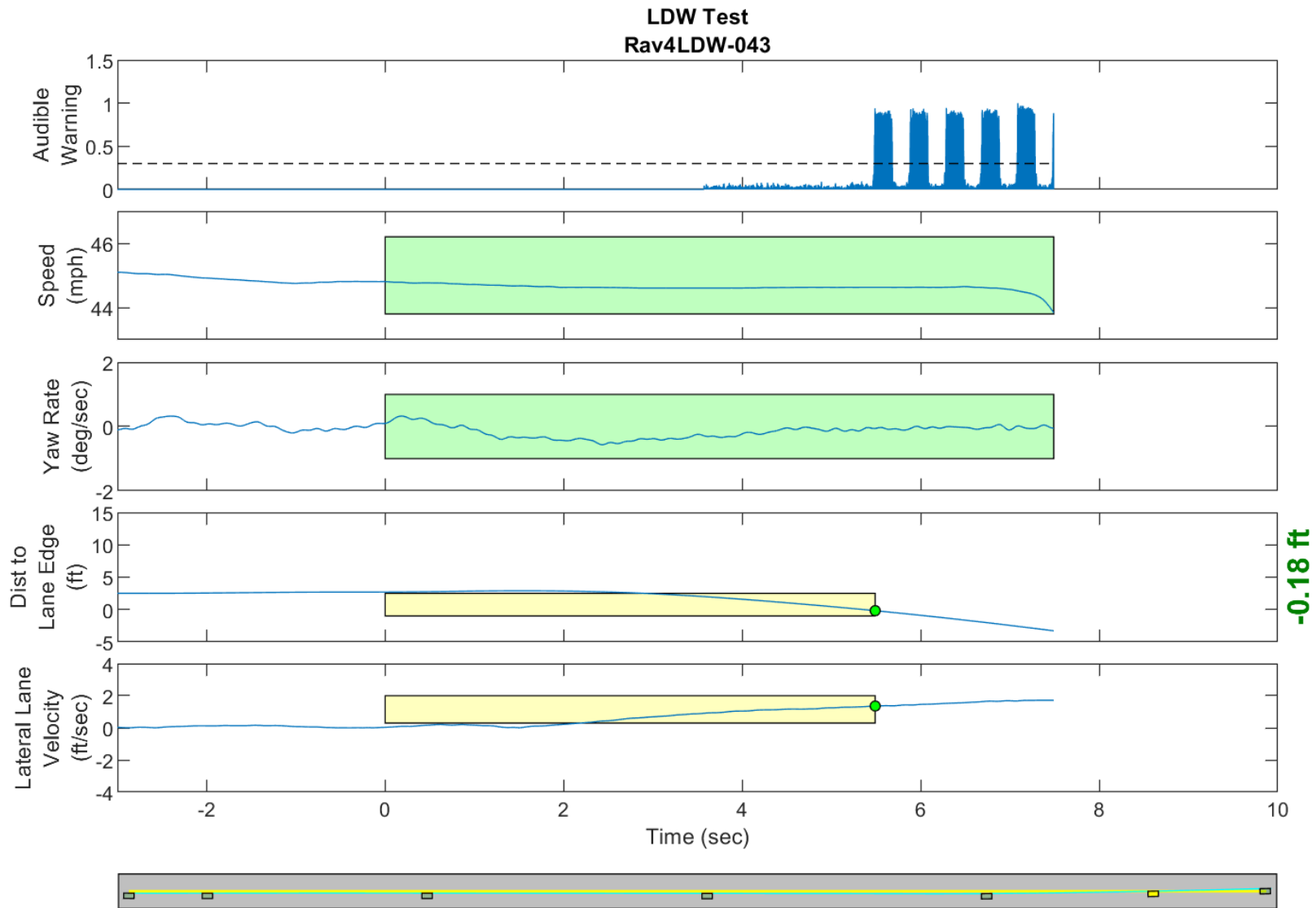
GPS Fix Type: RTK Fixed

Figure D66. Time History for Run 42, Solid Line, Left Departure, Auditory Warning



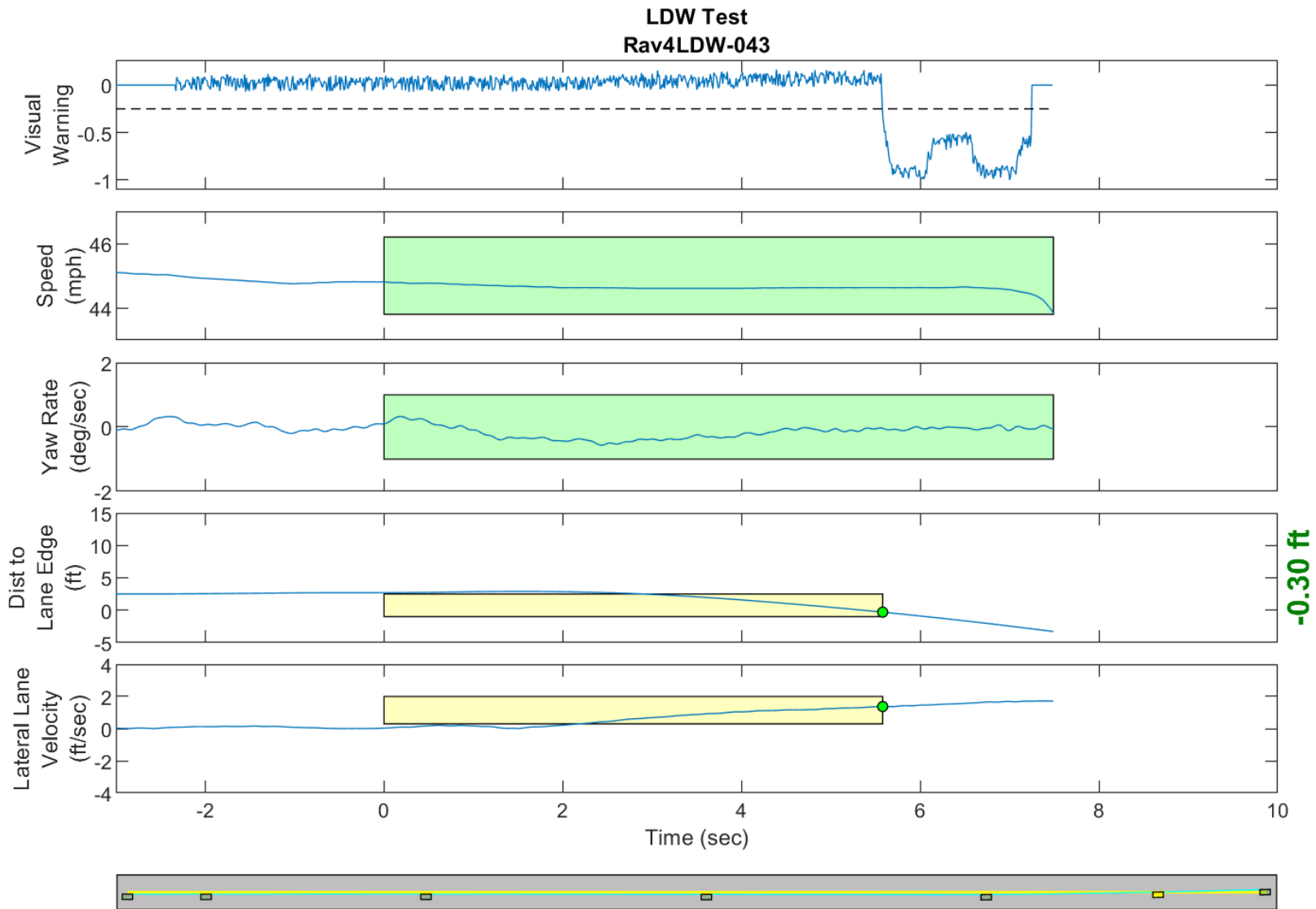
GPS Fix Type: RTK Fixed

Figure D67. Time History for Run 42, Solid Line, Left Departure, Visual Warning



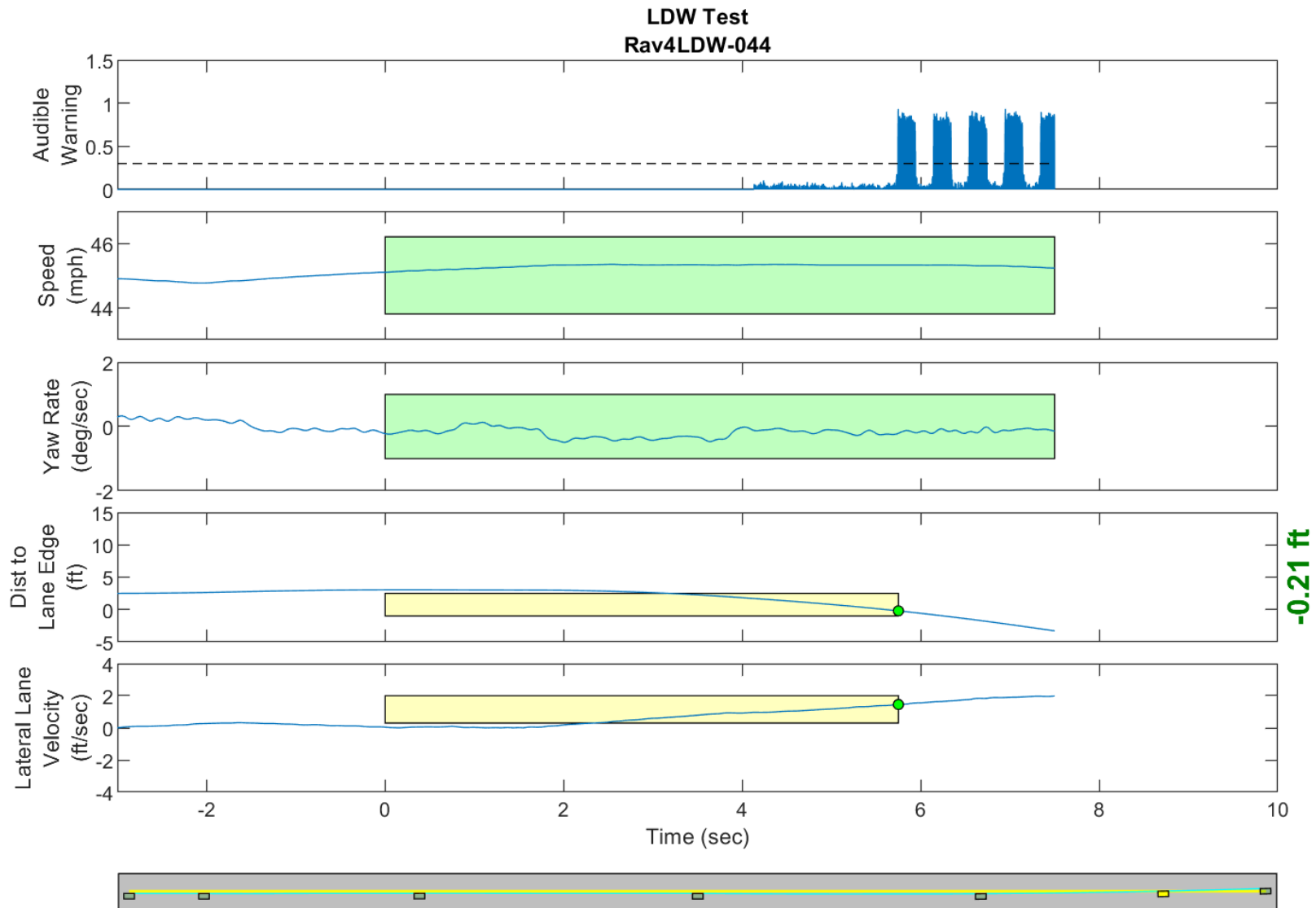
GPS Fix Type: RTK Fixed

Figure D68. Time History for Run 43, Solid Line, Left Departure, Auditory Warning



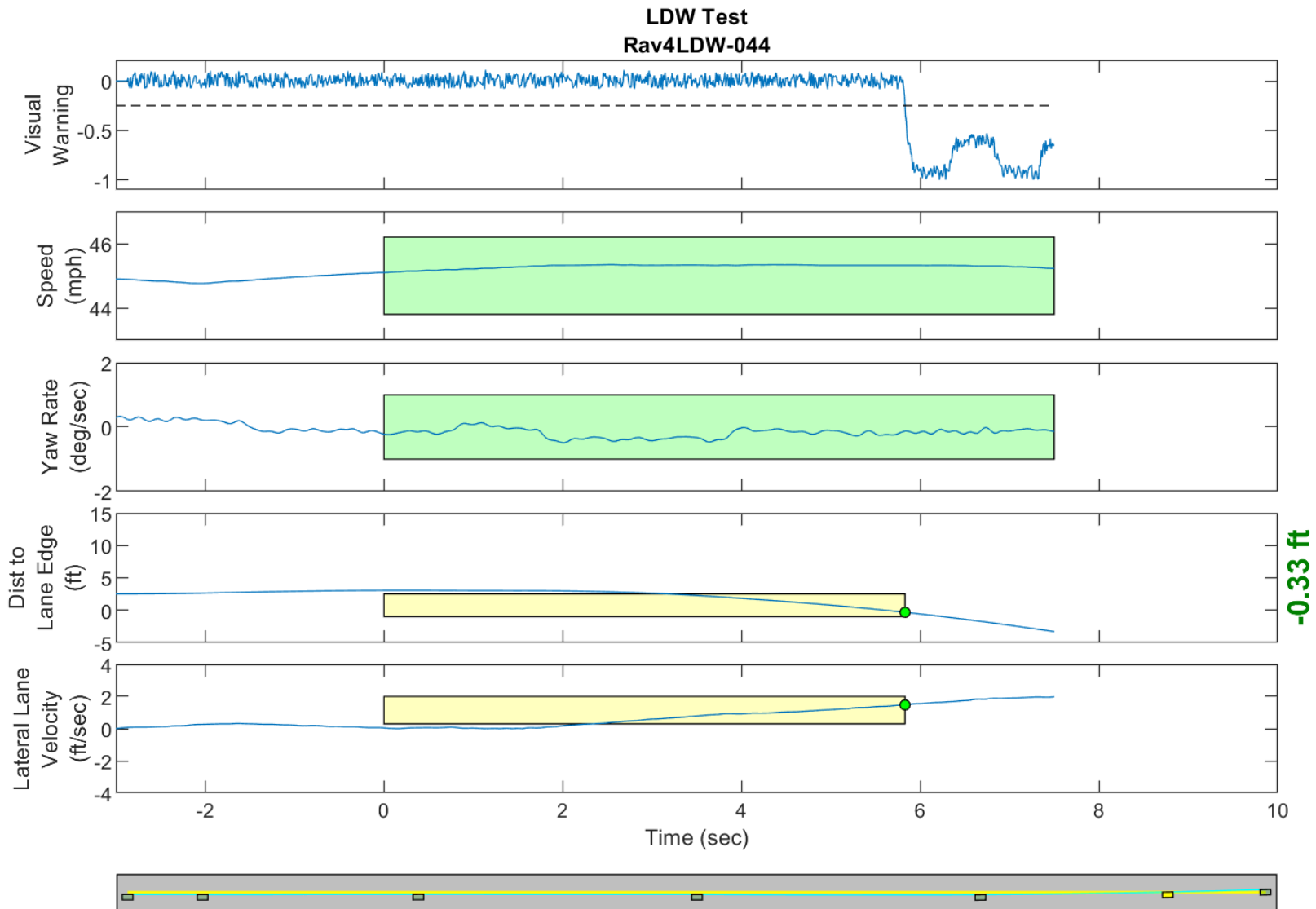
GPS Fix Type: RTK Fixed

Figure D69. Time History for Run 43, Solid Line, Left Departure, Visual Warning



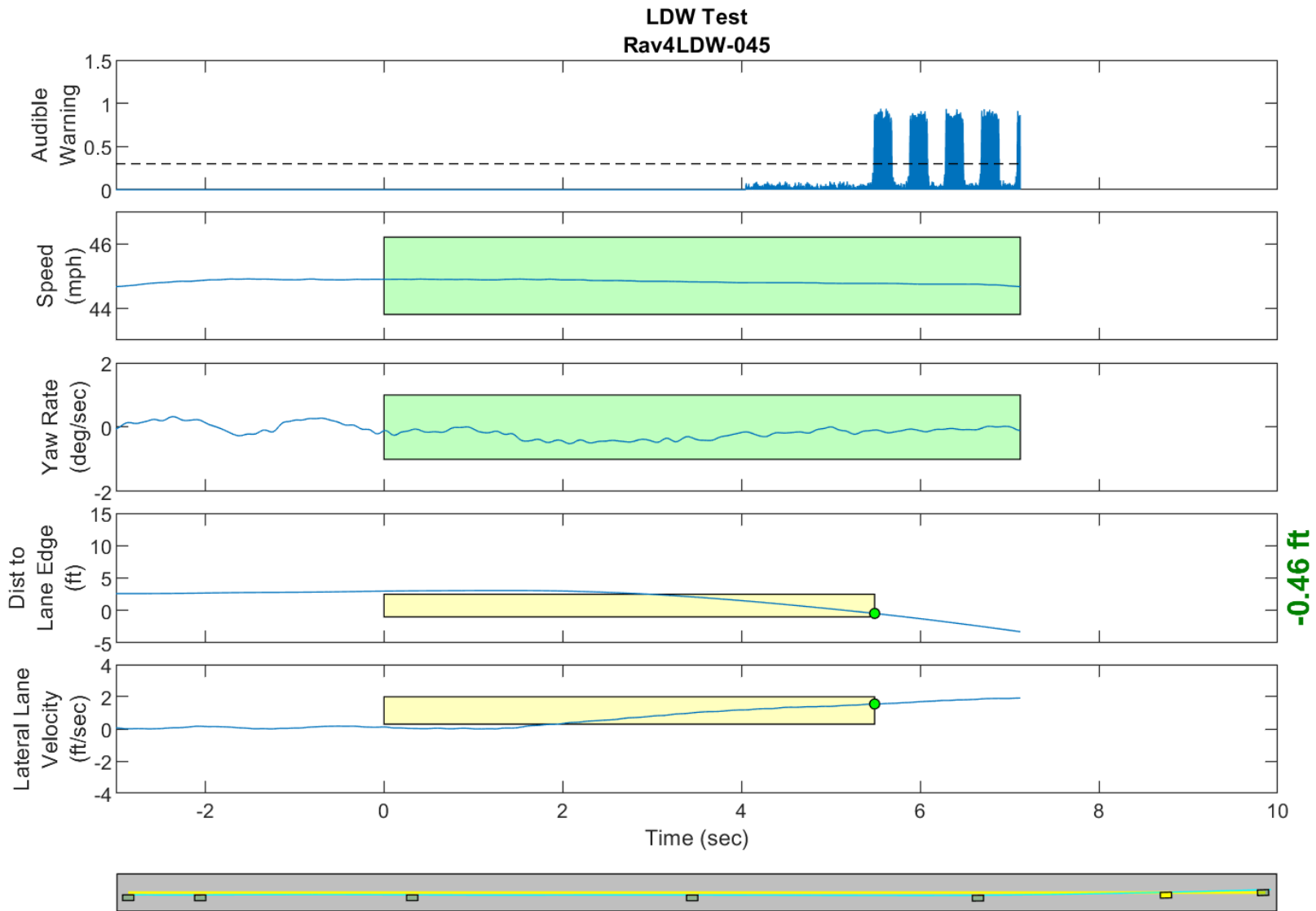
GPS Fix Type: RTK Fixed

Figure D70. Time History for Run 44, Solid Line, Left Departure, Auditory Warning



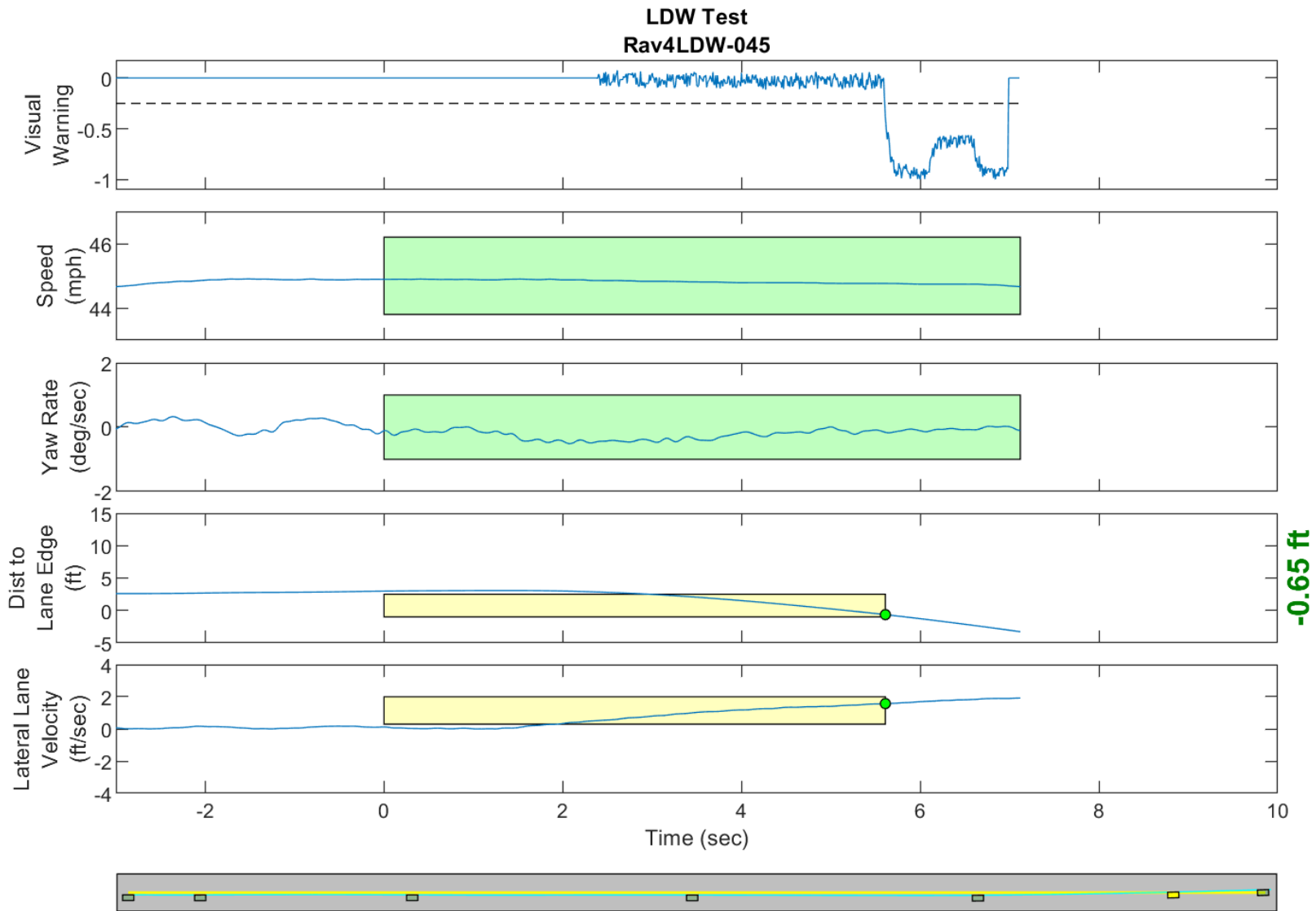
GPS Fix Type: RTK Fixed

Figure D71. Time History for Run 44, Solid Line, Left Departure, Visual Warning



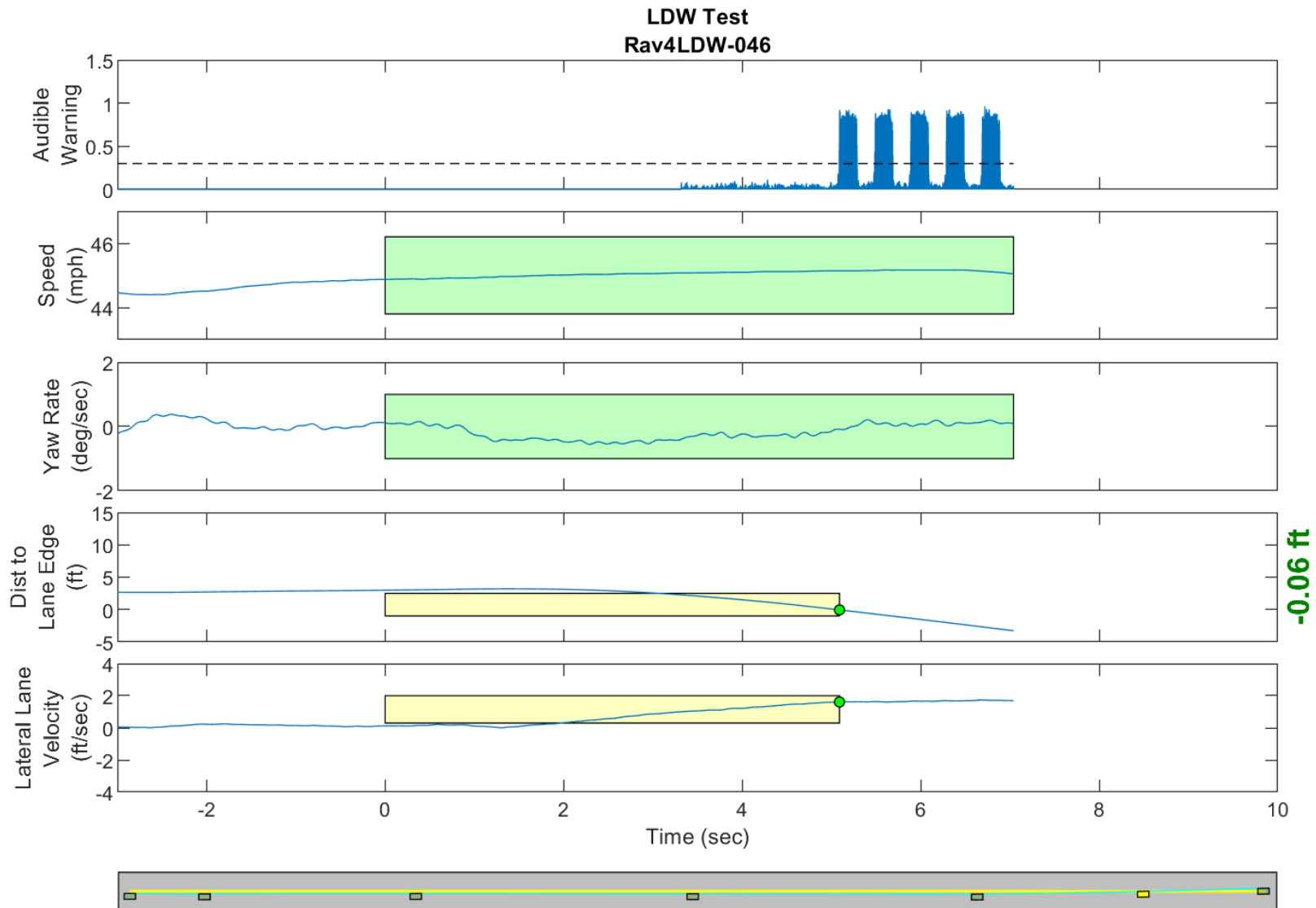
GPS Fix Type: RTK Fixed

Figure D72. Time History for Run 45, Solid Line, Left Departure, Auditory Warning



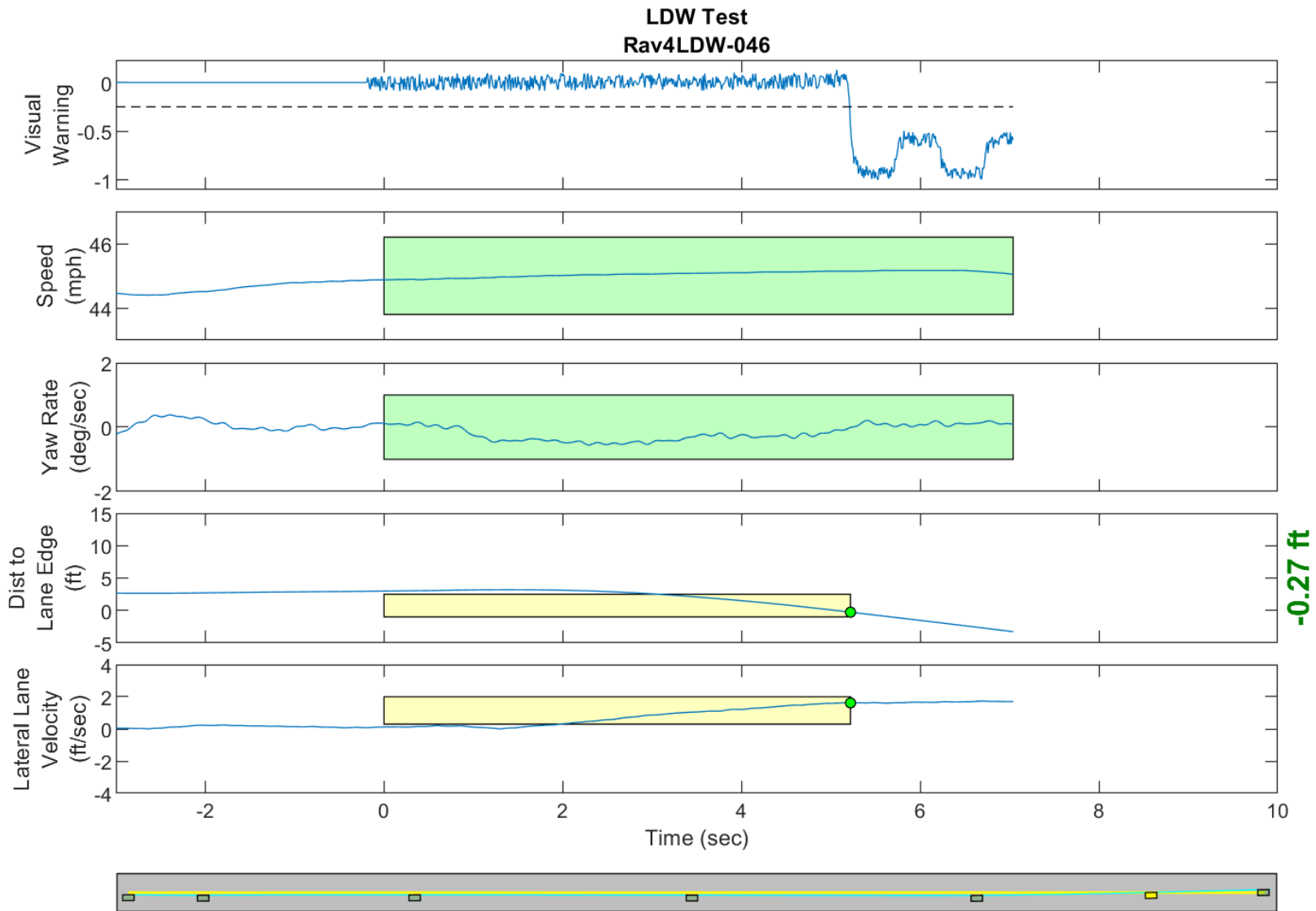
GPS Fix Type: RTK Fixed

Figure D73. Time History for Run 45, Solid Line, Left Departure, Visual Warning



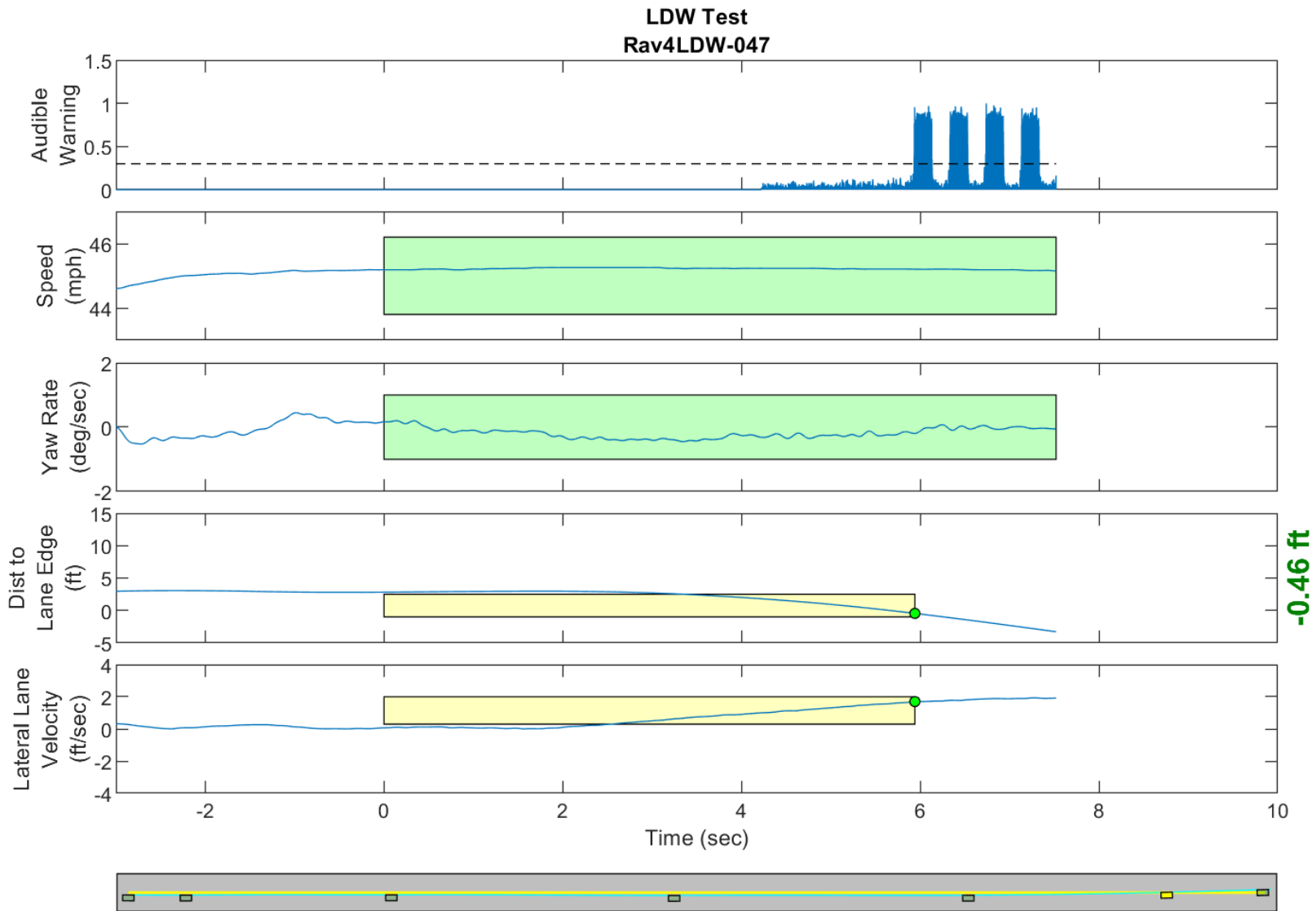
GPS Fix Type: RTK Fixed

Figure D74. Time History for Run 46, Solid Line, Left Departure, Auditory Warning



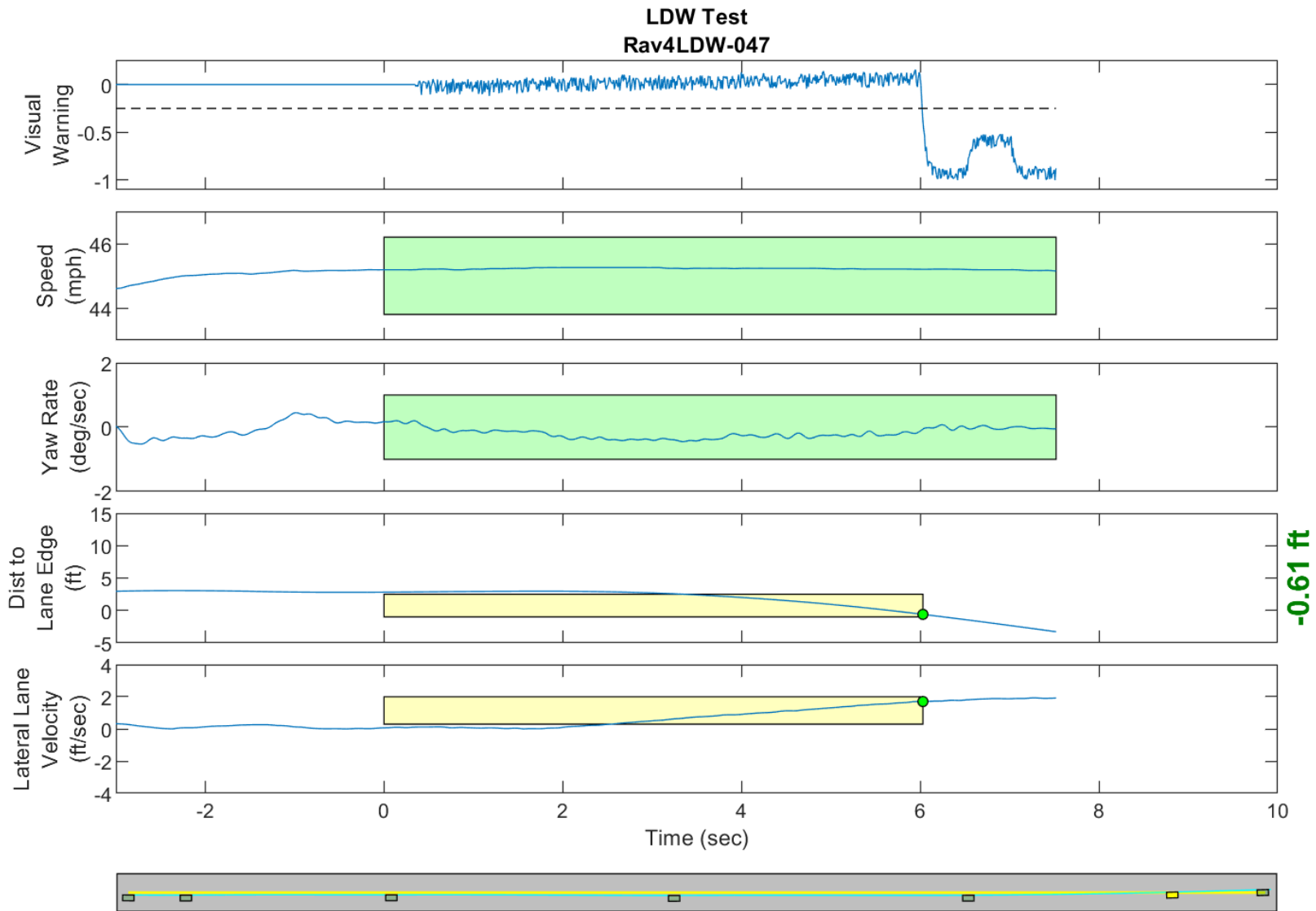
GPS Fix Type: RTK Fixed

Figure D75. Time History for Run 46, Solid Line, Left Departure, Visual Warning



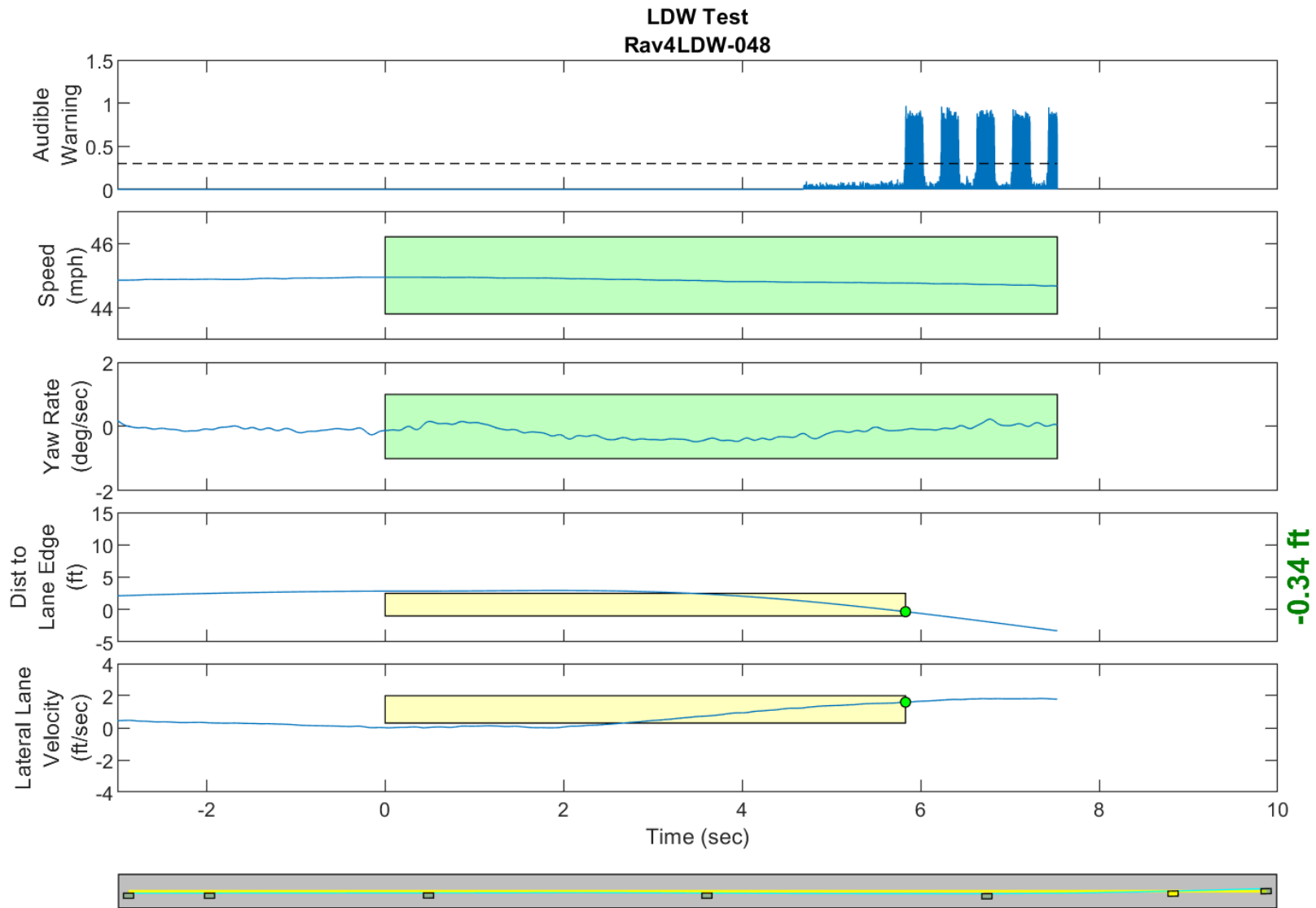
GPS Fix Type: RTK Fixed

Figure D76. Time History for Run 47, Solid Line, Left Departure, Auditory Warning



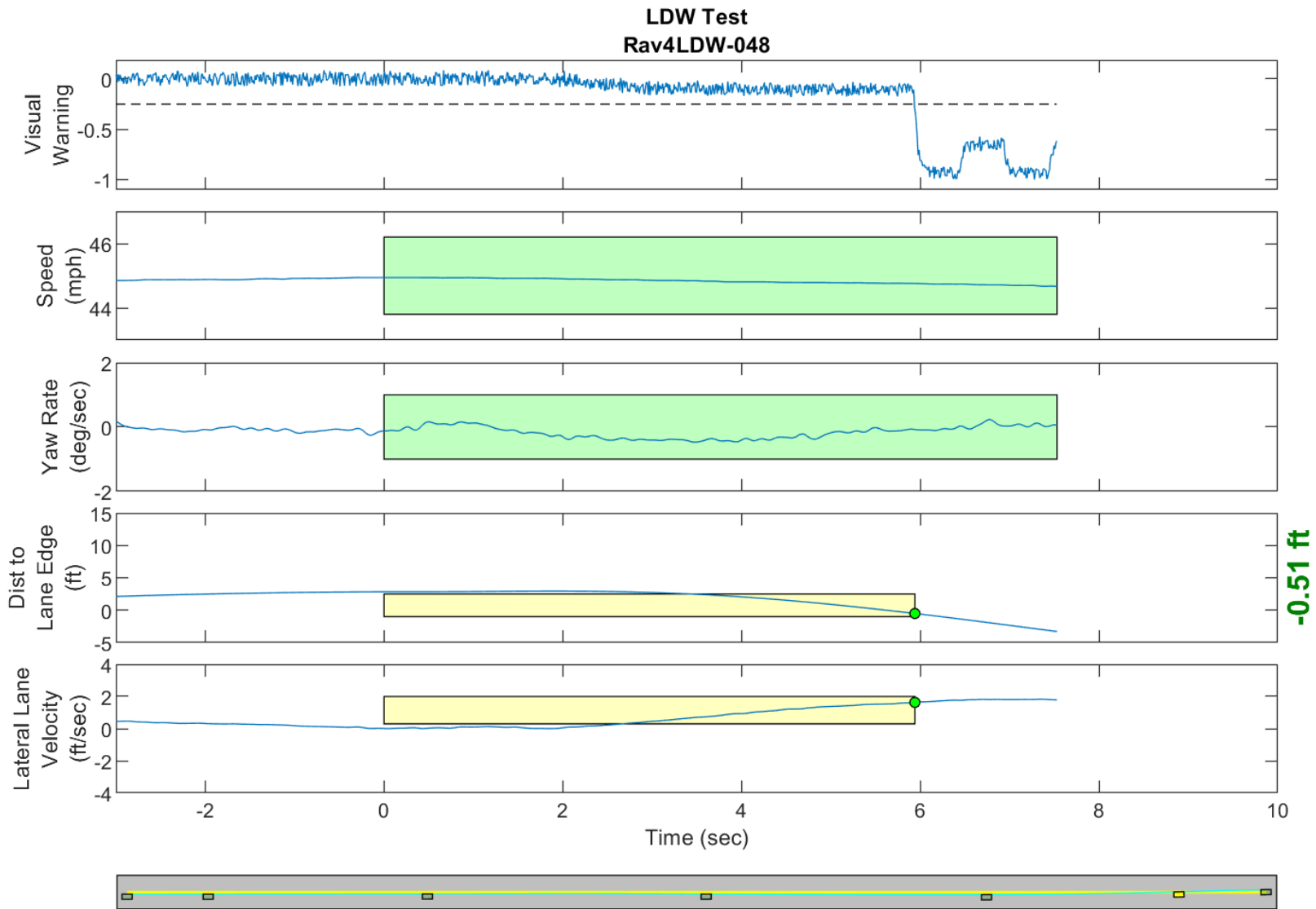
GPS Fix Type: RTK Fixed

Figure D77. Time History for Run 47, Solid Line, Left Departure, Visual Warning



GPS Fix Type: RTK Fixed

Figure D78. Time History for Run 48, Solid Line, Left Departure, Auditory Warning



GPS Fix Type: RTK Fixed

Figure D79. Time History for Run 48, Solid Line, Left Departure, Visual Warning