NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST
NCAP-DRI-LDW-21-10

2021 Mercedes-Benz E350 Sedan

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

12 March 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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Prepared By: J. Lenkeit and J. Robel

Program Manager Test Engineer

Date: 12 March 2021

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16. Abstract These tests were conducted on the subject 2021 Mercedes-Benz E350 Sedan 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 the dashed yellow line. The vehicle also passed the requirements of the test for the solid line, but provided course-correcting brake intervention after the haptic alert was provided. This intervention cannot be disabled and caused the yaw rate and speed to exceed the validity requirements for this test scenario. Consultation with NHTSA resulted in a decision to consider these runs valid. The vehicle failed the Botts Dots test scenario in the left departure direction and passed in the right departure direction.			
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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 Mercedes-Benz E350 Sedan. The LDW system for this vehicle provides a tactile alert implemented via vibration felt in the steering wheel at approximately 22 Hz. The vehicle passed the requirements of the test for the dashed yellow line. The vehicle also passed the requirements of the test for the solid line, but provided a course correcting brake assistance right after the haptic alert was provided. This intervention cannot be disabled and caused the yaw rate and speed to exceed the validity requirements for this test scenario. The vehicle failed the Botts Dots test scenario in the left departure direction and passed in the right departure direction.

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 Mercedes-Benz E350 Sedan

VIN: *W1KZF8DB5MA91xxxx*

Test Date: *2/1/2021*

Lane Departure Warning setting: *On*

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

Overall: *Fail*

Notes:

LANE DEPARTURE WARNING

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2021 Mercedes-Benz E350 Sedan

TEST VEHICLE INFORMATION

VIN: *W1KZF8DB5MA91xxxx*

Body Style: *Sedan* Color: *Graphite Grey Metallic*

Date Received: *1/18/2021* Odometer Reading: *162 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *MERCEDES-BENZ AG STUTTGART*

Date of manufacture: *11/20*

Vehicle Type: *PASSENGER CAR*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *245/40 R19*

Rear: *245/40 R19*

Recommended cold tire pressure: Front: *270 kPa (39 psi)*

Rear: *320 kPa (46 psi)*

TIRES

Tire manufacturer and model: *Goodyear Eagle Sport RSC Extended All-Season*

Front tire size: *245/40R19 98H*

Rear tire size: *245/40R19 98H*

Front tire DOT prefix: *DM66 JAJR*

Rear tire DOT prefix: *DM66 JAJR*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2021 Mercedes-Benz E350 Sedan

GENERAL INFORMATION

Test date: *2/1/2021*

AMBIENT CONDITIONS

Air temperature: *11.1 C (52 F)*

Wind speed: *0.0 m/s (0.0 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: *270 kPa (39 psi)*

Rear: *320 kPa (46 psi)*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2021 Mercedes-Benz E350 Sedan

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*509.4 kg (1123 lb)*	Right Front:	*494.9 kg (1091 lb)*
Left Rear:	*460.8 kg (1016 lb)*	Right Rear:	*453.1 kg (999 lb)*
		Total:	*1918.2 kg (4229 lb)*

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 1 of 3)

2021 Mercedes-Benz E350 Sedan

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

Active Lane Keeping Assist is an optional upgrade; it is a part of the "Driver Assistance Package".

Type and location of sensor(s) used:

The LDW uses a stereo camera located on the top center of the windshield.

Lane Departure Warning Setting used in test: *On*

How is the Lane Departure Warning presented to the driver?

(Check all that apply)

_____ Warning light

_____ Buzzer or audible 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, audible, vibration, or combination), etc.

The LDW system for this vehicle provides a tactile alert implemented via vibration felt in the steering wheel at approximately 22 Hz.

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 can be accessed via the multimedia touch screen, buttons on the right side of the steering wheel, or a track pad located in the center console. The menu hierarchy for disabling the system is:

Home
- *Settings*
  - *Assistance*
    - *Active Lane Keeping Assist*
      - *Select "On" or "Off"*

An alternate hierarchy is:

Home
- *Settings*
  - *Quick Access*
    - *Active Lane Keeping Assist*
      - *Select "On" or "Off"*

See Appendix A, Figures A9 – A11.

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

If yes, please provide a full description.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 3 of 3)

2021 Mercedes-Benz E350 Sedan

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 on pages 206 and 207 of the Owner's Manual, shown in Appendix B, pages B-4 and B-5.

Notes:

The LDW system is incorporated with the LKAS system and is not an independent system. The system provides course correcting brake intervention when crossing solid white lines.

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.

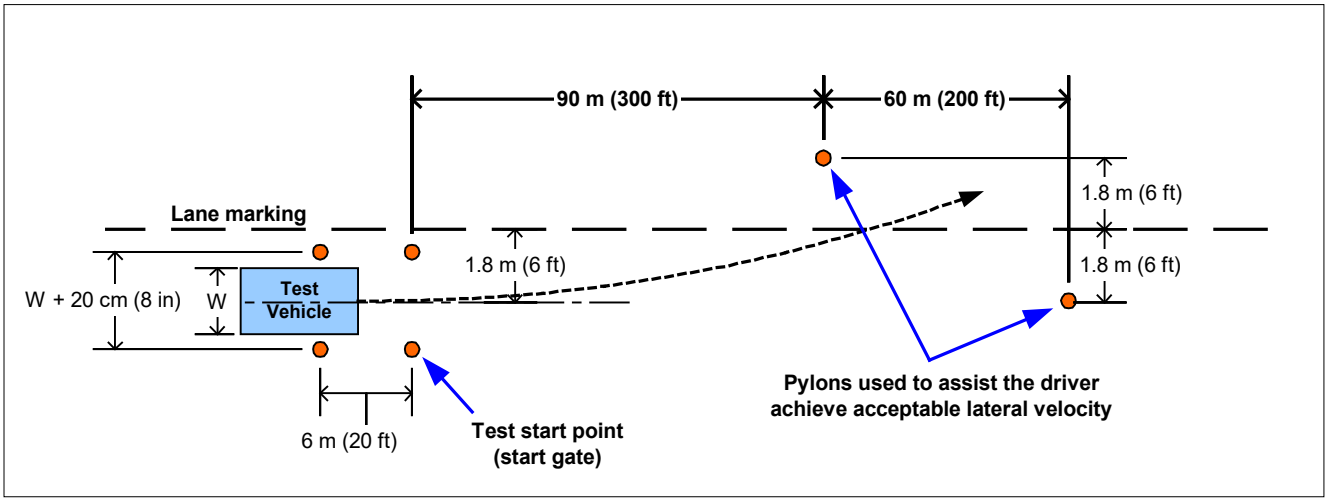

Figure 1. Position of Cones Used to Assist Driver

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.

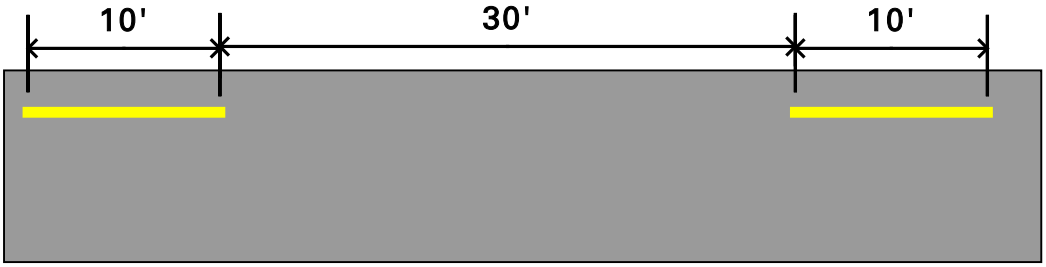

Figure 2. MUTCD Discontinuous Dashed Line Specifications

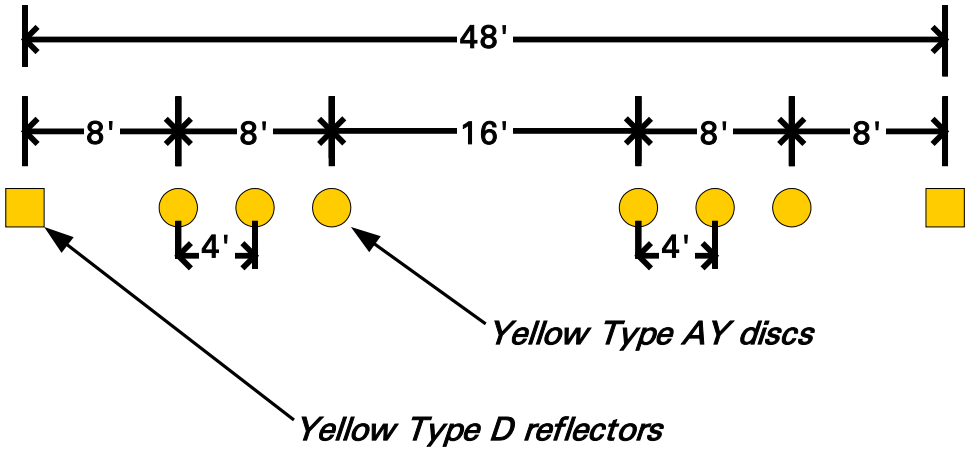

Figure 3. California Standard Plan A20A, Detail 4

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: 4/20/2020 Due: 4/20/2021
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+	2258	By: Oxford Technical Solutions[1] Date: 5/3/2019 Due: 5/3/2021
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 audible or haptic alerts, part of the pre-test instrumentation verification process is to determine the tonal frequency of the audible warning or the vibration frequency of the tactile warning through use of the PSD (Power Spectral Density) function in Matlab. This is accomplished in order to identify the center frequency around which a band-pass filter is applied to subsequent audible or tactile warning data so that the beginning of such warnings can be programmatically determined. The 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. Audible and Tactile Warning Filter Parameters

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

APPENDIX A

Photographs

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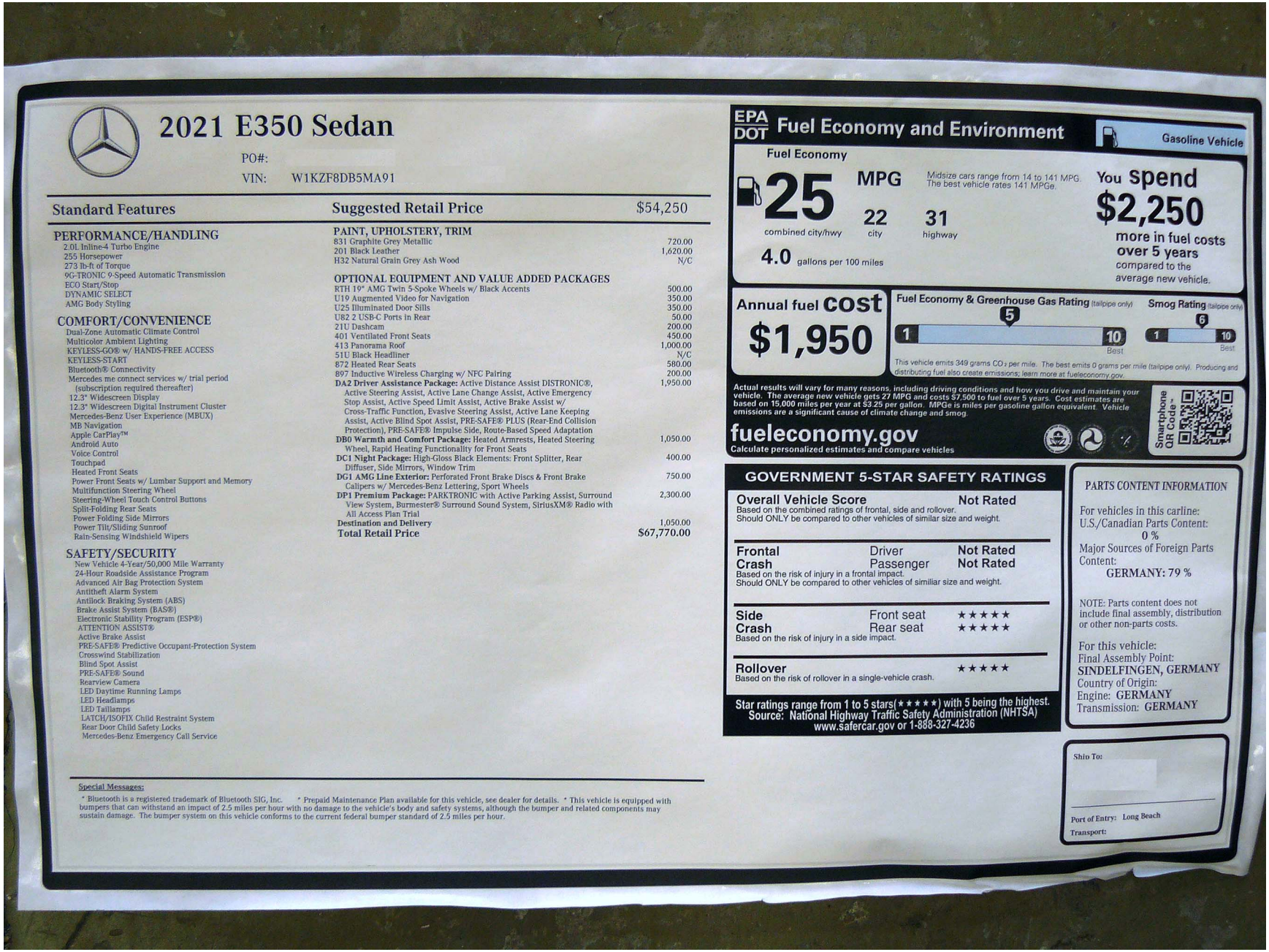
Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle



2021 E350 Sedan

PO#:

VIN: W1KZF8DB5MA91

Standard Features

PERFORMANCE/HANDLING
- 2.0L Inline-4 Turbo Engine
- 255 Horsepower
- 273 lb-ft of Torque
- 9G-TRONIC 9-Speed Automatic Transmission
- ECO Start/Stop
- DYNAMIC SELECT
- AMG Body Styling

COMFORT/CONVENIENCE
- Dual-Zone Automatic Climate Control
- Multicolor Ambient Lighting
- KEYLESS-GO® w/ HANDS-FREE ACCESS
- KEYLESS-START
- Bluetooth® Connectivity
- Mercedes me connect services w/ trial period (subscription required thereafter)
- 12.3" Widescreen Display
- 12.3" Widescreen Digital Instrument Cluster
- Mercedes-Benz User Experience (MBUX)
- MB Navigation
- Apple CarPlay™
- Android Auto
- Voice Control
- Touchpad
- Heated Front Seats
- Power Front Seats w/ Lumbar Support and Memory
- Multifunction Steering Wheel
- Steering-Wheel Touch Control Buttons
- Split-Folding Rear Seats
- Power Folding Side Mirrors
- Power Tilt/Sliding Sunroof
- Rain-Sensing Windshield Wipers

SAFETY/SECURITY
- New Vehicle 4-Year/50,000 Mile Warranty
- 24-Hour Roadside Assistance Program
- Advanced Air Bag Protection System
- Antitheft Alarm System
- Antilock Braking System (ABS)
- Brake Assist System (BAS®)
- Electronic Stability Program (ESP®)
- ATTENTION ASSIST®
- Active Brake Assist
- PRE-SAFE® Predictive Occupant-Protection System
- Crosswind Stabilization
- Blind Spot Assist
- PRE-SAFE® Sound
- Rearview Camera
- LED Daytime Running Lamps
- LED Headlamps
- LED Taillamps
- LATCH/ISOFIX Child Restraint System
- Rear Door Child Safety Locks
- Mercedes-Benz Emergency Call Service

Suggested Retail Price $54,250

PAINT, UPHOLSTERY, TRIM

831 Graphite Grey Metallic	720.00
201 Black Leather	1,620.00
H32 Natural Grain Grey Ash Wood	N/C

OPTIONAL EQUIPMENT AND VALUE ADDED PACKAGES

RTH 19" AMG Twin 5-Spoke Wheels w/ Black Accents	500.00
U19 Augmented Video for Navigation	350.00
U25 Illuminated Door Sills	350.00
U82 2 USB-C Ports in Rear	50.00
21U Dashcam	200.00
401 Ventilated Front Seats	450.00
413 Panorama Roof	1,000.00
51U Black Headliner	N/C
872 Heated Rear Seats	580.00
897 Inductive Wireless Charging w/ NFC Pairing	200.00
DA2 Driver Assistance Package: Active Distance Assist DISTRONIC®, Active Steering Assist, Active Lane Change Assist, Active Emergency Stop Assist, Active Speed Limit Assist, Active Brake Assist w/ Cross-Traffic Function, Evasive Steering Assist, Active Lane Keeping Assist, Active Blind Spot Assist, PRE-SAFE® PLUS (Rear-End Collision Protection), PRE-SAFE® Impulse Side, Route-Based Speed Adaptation	1,950.00
DB0 Warmth and Comfort Package: Heated Armrests, Heated Steering Wheel, Rapid Heating Functionality for Front Seats	1,050.00
DC1 Night Package: High-Gloss Black Elements: Front Splitter, Rear Diffuser, Side Mirrors, Window Trim	400.00
DG1 AMG Line Exterior: Perforated Front Brake Discs & Front Brake Calipers w/ Mercedes-Benz Lettering, Sport Wheels	750.00
DP1 Premium Package: PARKTRONIC with Active Parking Assist, Surround View System, Burmester® Surround Sound System, SiriusXM® Radio with All Access Plan Trial	2,300.00
Destination and Delivery	1,050.00
Total Retail Price	**$67,770.00**

Special Messages:

* Bluetooth is a registered trademark of Bluetooth SIG, Inc. * Prepaid Maintenance Plan available for this vehicle, see dealer for details. * This vehicle is equipped with bumpers that can withstand an impact of 2.5 miles per hour with no damage to the vehicle's body and safety systems, although the bumper and related components may sustain damage. The bumper system on this vehicle conforms to the current federal bumper standard of 2.5 miles per hour.

EPA DOT Fuel Economy and Environment

Gasoline Vehicle

Fuel Economy

25 MPG combined city/hwy — 22 city — 31 highway

4.0 gallons per 100 miles

Midsize cars range from 14 to 141 MPG. The best vehicle rates 141 MPGe.

You spend **$2,250** more in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost $1,950

Fuel Economy & Greenhouse Gas Rating (tailpipe only): 5 (1 — 10 Best)

Smog Rating (tailpipe only): 6 (1 — 10 Best)

This vehicle emits 349 grams CO_2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions; learn more at fueleconomy.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 $7,500 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $3.25 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov

Calculate personalized estimates and compare vehicles

Smartphone QR Code®

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score Not Rated

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	Not Rated
	Passenger	Not Rated

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

PARTS CONTENT INFORMATION

For vehicles in this carline:
U.S./Canadian Parts Content:
0 %
Major Sources of Foreign Parts Content:
GERMANY: 79 %

NOTE: Parts content does not include final assembly, distribution or other non-parts costs.

For this vehicle:
Final Assembly Point:
SINDELFINGEN, GERMANY
Country of Origin:
Engine: GERMANY
Transmission: GERMANY

Ship To:

Port of Entry: Long Beach
Transport:

Figure A3. Window Sticker (Monroney Label)

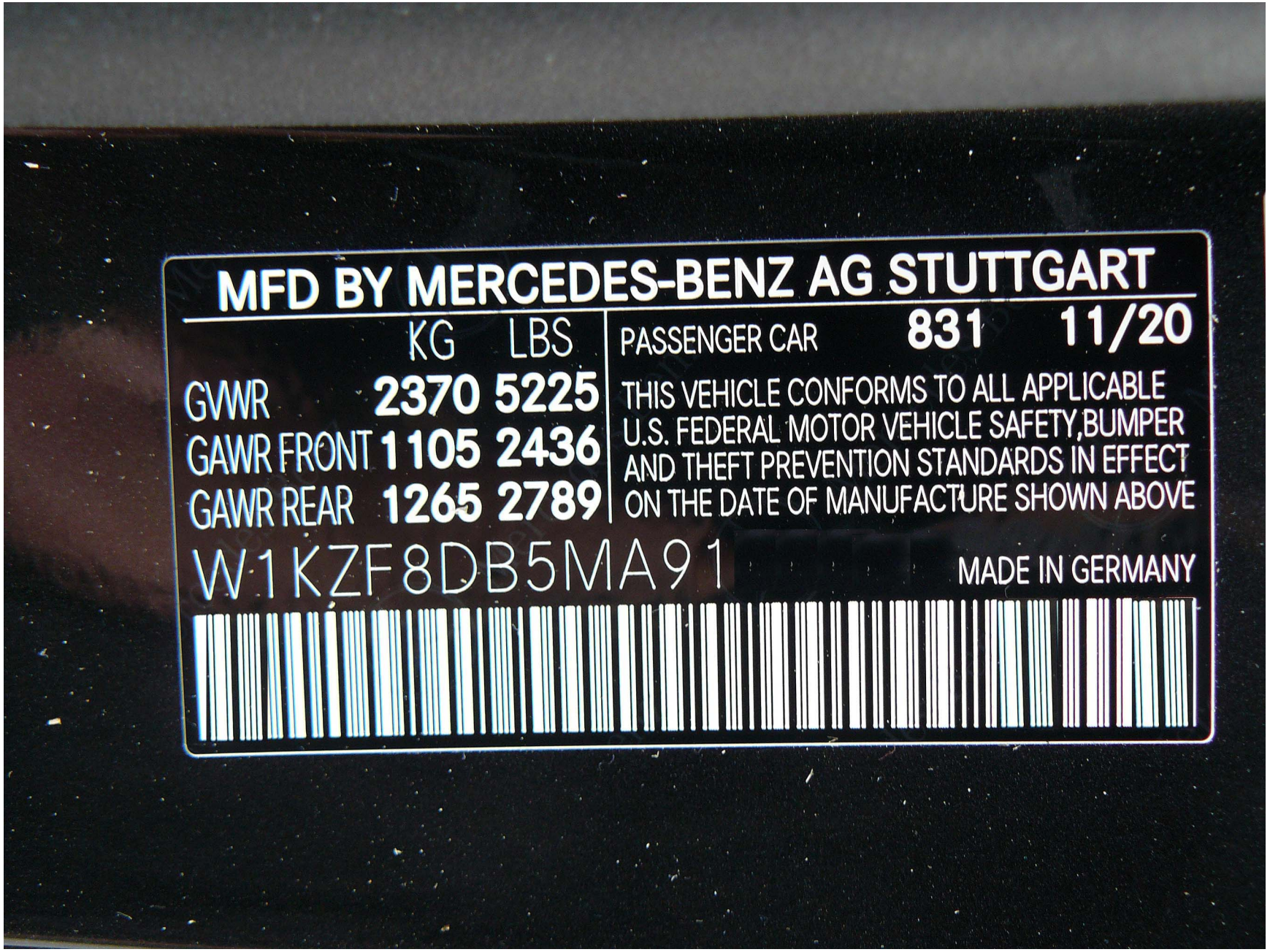


Figure A4. Vehicle Certification Label

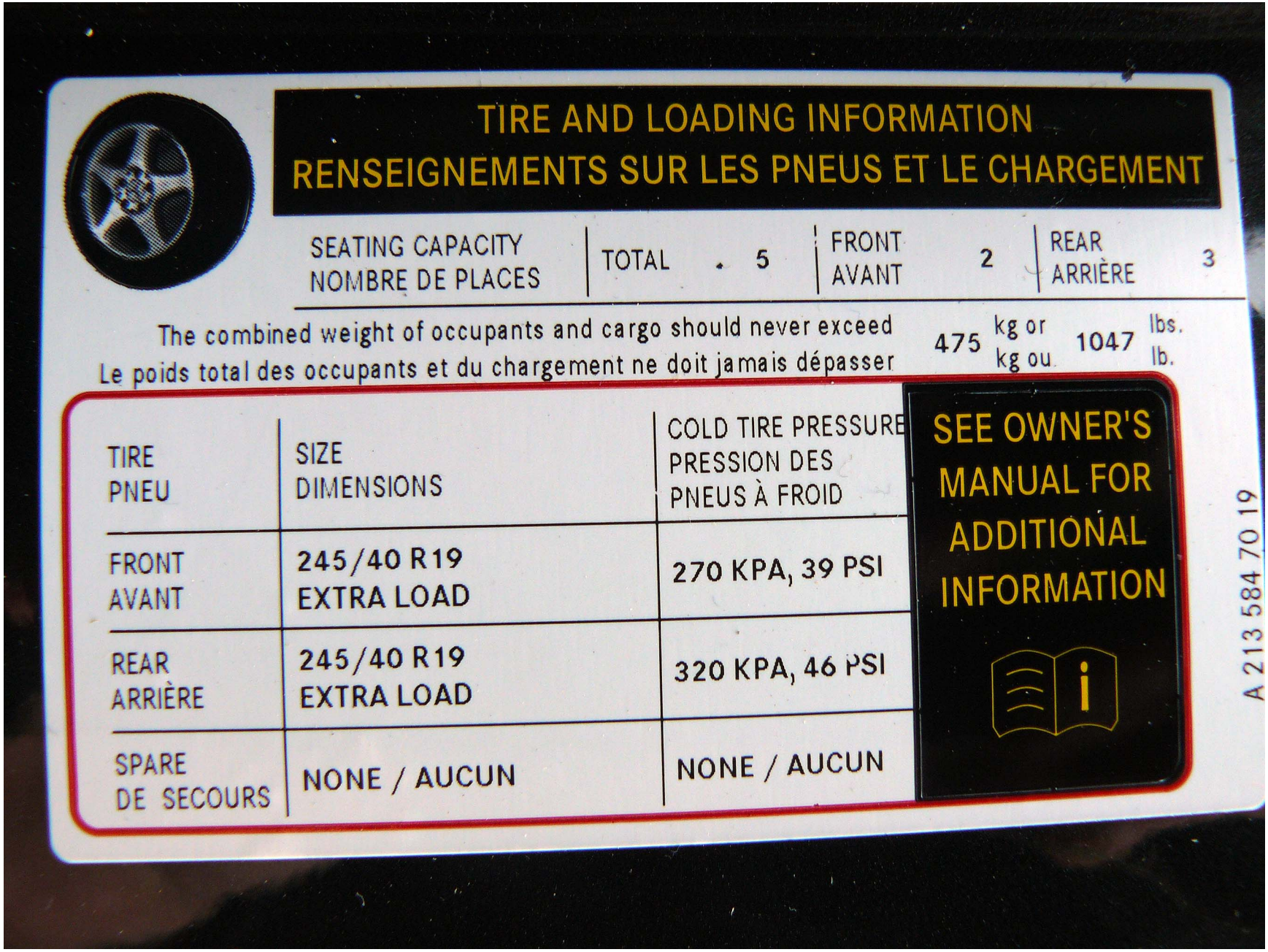


Figure A5. Tire Placard

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

Figure A7. Sensor for Detecting Haptic Alerts

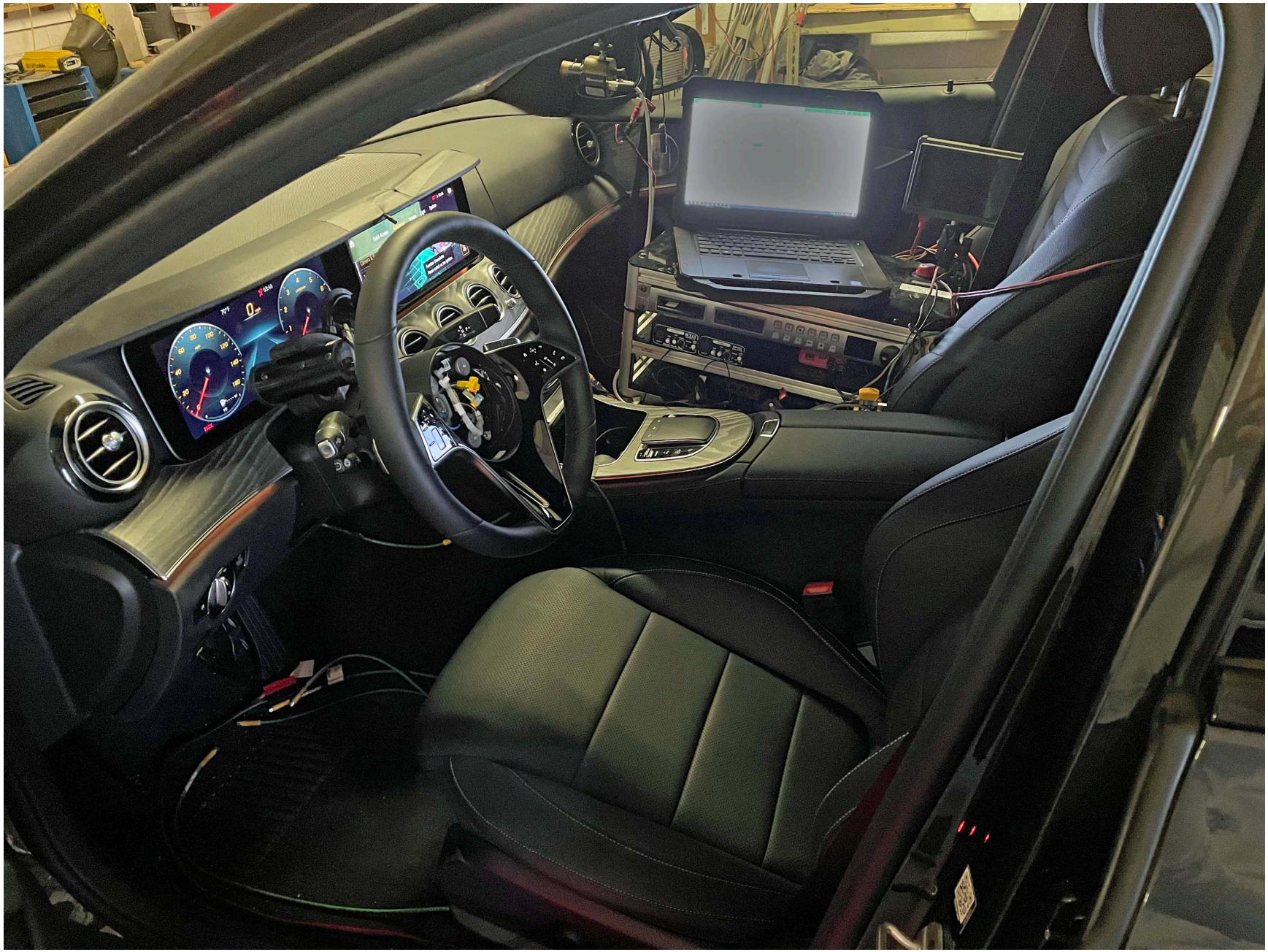


Figure A8. Computer Installed in Subject Vehicle

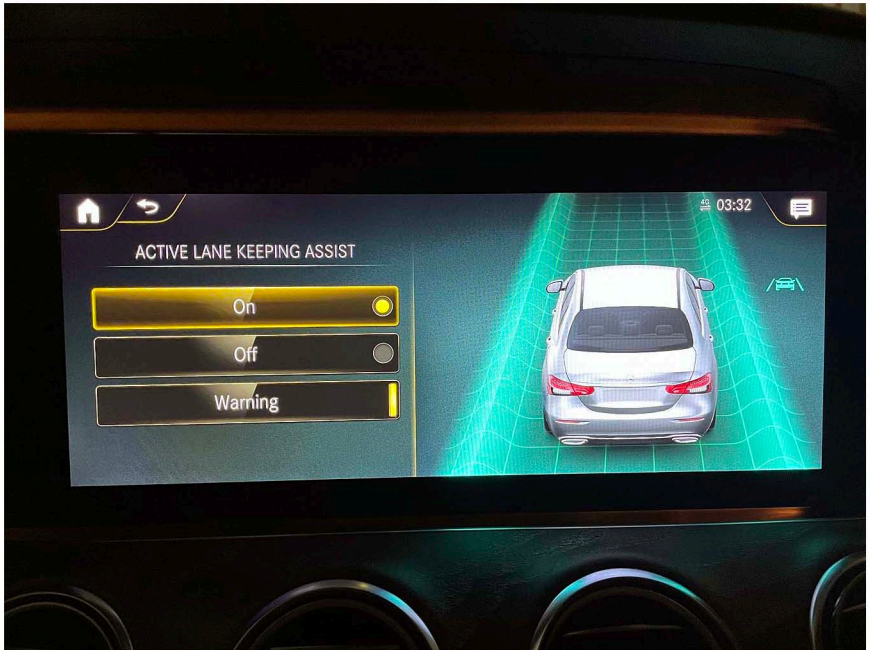
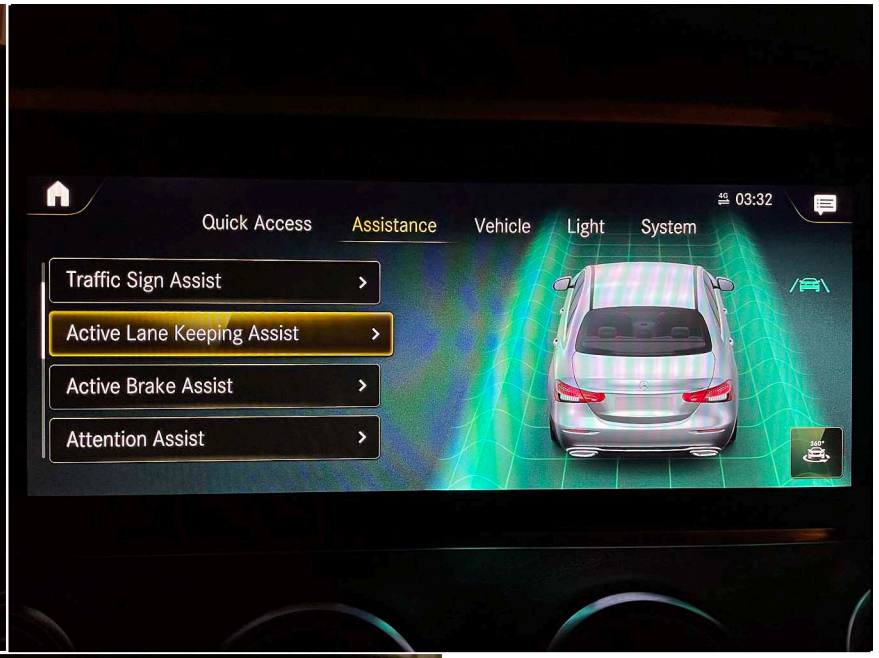


Figure A9. LDW Menus (1 of 2)



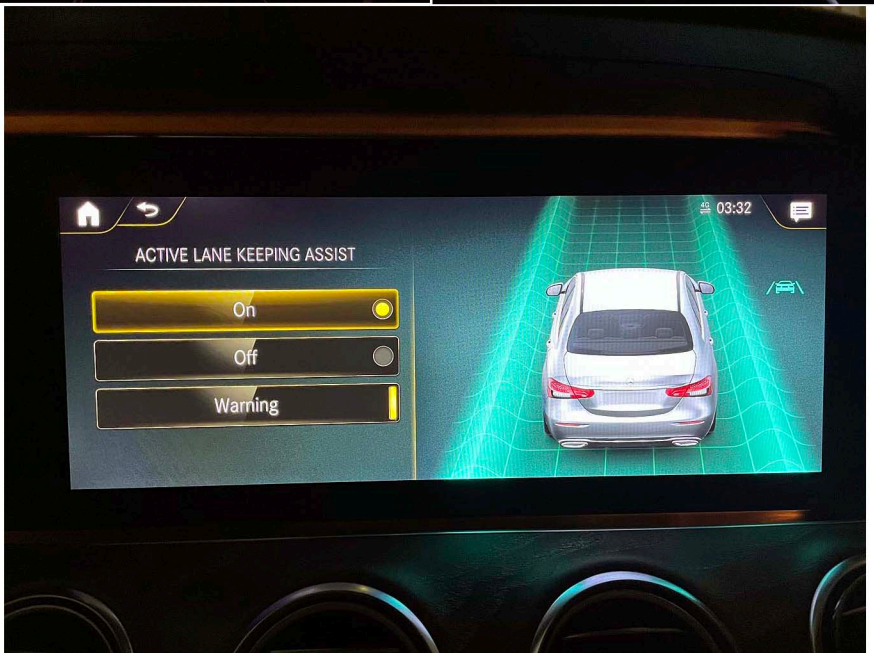


Figure A10. LDW Menus (2 of 2)

Figure A11. Controls for Interacting with System Menus

Figure A12. Visual Alert Showing (L-R): "Active, Not Operating", “Active, Operating", and "Deactivated or Malfunction"

APPENDIX B

Excerpts from Owner’s Manual

- Hill Start Assist (⟶ page 178)
- ATTENTION ASSIST (⟶ page 178)
- Cruise control (⟶ page 180)
- Traffic Sign Assist (⟶ page 198)
- DYNAMIC BODY CONTROL (⟶ page 207)
- AIR BODY CONTROL (⟶ page 207)

Driving Assistance package
The following functions are part of the Driving Assistance Package. Certain functions are only available in some countries. Some functions are also available without the Driving Assistance Package, albeit with restricted functionality.

- Active Distance Assist DISTRONIC (⟶ page 182)
- Active Speed Limit Assist (country-dependent) (⟶ page 187)
- Route-based speed adaptation (country-dependent) (⟶ page 188)
- Active Brake Assist (⟶ page 194)
- Active Steering Assist (country-dependent) (⟶ page 190)
- Active Emergency Stop Assist (country-dependent) (⟶ page 192)
- Active Lane Change Assist (country-dependent) (⟶ page 192)
- Active Stop-and-Go Assist (country-dependent) (⟶ page 189)
- Blind Spot Assist and Active Blind Spot Assist with exit warning (⟶ page 202)
- Active Lane Keeping Assist (⟶ page 205)

Parking Package

- Parking Assist PARKTRONIC (⟶ page 215)
- Rear view camera (⟶ page 210)
- Surround view camera (⟶ page 212)
- Active Parking Assist (country-dependent) (⟶ page 219)

Function of ABS

The Anti-lock Brake System (ABS) regulates the brake pressure in critical driving situations:

- During braking, e.g. at full brake application or insufficient tire traction, the wheels are prevented from locking.
- Vehicle steerability while braking is ensured.

If ABS intervenes when braking, you will feel a pulsing in the brake pedal. The pulsating brake pedal can be an indication of hazardous road conditions and can serve as a reminder to take extra care while driving.

Function of BAS

The Brake Assist System (BAS) supports your emergency braking situation with additional brake force.

If you depress the brake pedal quickly, BAS is activated:

- BAS automatically boosts the brake pressure.
- BAS can shorten the braking distance.
- ABS prevents the wheels from locking.

The brakes will function as usual once you release the brake pedal. BAS is deactivated.

ror and a warning tone sounds. In addition, display (1) indicating the danger of a side collision appears in the multifunction display.

In rare cases, the system may make an inappropriate brake application. This brake application may be interrupted at any time if you steer slightly in the opposite direction or accelerate.

System limits

Note the system limitations of Active Blind Spot Assist; you may otherwise not recognize the dangers (→ page 202).

Either a course-correcting brake application appropriate to the driving situation, or none at all, may occur in the following situations:

- Vehicles or obstacles, e.g. crash barriers, are located on both sides of your vehicle.
- A vehicle approaches too closely on the side.
- You have adopted a sporty driving style with high cornering speeds.
- You brake or accelerate significantly.
- A driving safety system intervenes, e.g. ESP® or Active Brake Assist.
- ESP® is deactivated.
- A loss of tire pressure or a faulty tire is detected.

Activating/deactivating Blind Spot Assist or Active Blind Spot Assist

Multimedia system:

→ ⌂ ▸▸ Settings ▸▸ Assistance

▶ Activate or deactivate Blind Spot Assist.

or

▶ Activate or deactivate Act. Blind Spot Assist.

Active Lane Keeping Assist

Function of Active Lane Keeping Assist

Active Lane Keeping Assist monitors the area in front of your vehicle by means of the multifunction camera (→ page 172). It serves to protect you against unintentionally leaving your lane. You will be warned by vibration pulses in the steering wheel and guided by a course-correcting brake application back into your lane.

Active Lane Keeping Assist is available in the speed range between 37 mph (60 km/h) and 124 mph (200 km/h).

Active Lane Keeping Assist can neither reduce the risk of an accident if you fail to adapt your driving style nor override the laws of physics. It cannot take into account road, weather or traffic conditions. Active Lane Keeping Assist is only an aid. You are responsible for maintaining a safe distance to the vehicle in front, for vehicle speed, for braking in good time and for staying in lane.

The status of Active Lane Keeping Assist is displayed in the on-board computer:

- (green): Active Lane Keeping Assist is active and operating.
- (gray): Active Lane Keeping Assist is active but not operating.
- OFF: Active Lane Keeping Assist is deactivated or there is a malfunction.

If a lane-correcting brake application occurs, display (1) appears in the multifunction display.

The system does not apply the brake if you activate the turn signal indicator.

Vehicles with Driving Assistance Package: if the system detects an obstacle, such as another vehicle in the adjacent lane, it will apply the brake regardless of the turn signal indicator.

You are warned by vibrations in the steering wheel in the following circumstances:

- Active Lane Keeping Assist detects a lane marking.
- A front wheel drives over this lane marking.

Conditions for a course-correcting brake application (vehicles without Driving Assistance Package)

Lane markings were detected on both sides of the lane. The front wheel drives over a continuous lane marking.

ⓘ A brake application may be interrupted at any time if you steer slightly in the opposite direction.

Conditions for a course-correcting brake application (vehicles with Driving Assistance Package)

- A continuous lane marking was detected and driven over with the front wheel.
- A lane marking and an approaching vehicle, an overtaking vehicle or vehicles driving parallel to your vehicle were detected in the adjacent lane. The front wheel drives over the lane marking.

ⓘ A brake application may be interrupted at any time if you steer slightly in the opposite direction.

System limits

No lane-correcting brake application occurs in the following situations:

- You clearly and actively steer, brake or accelerate.
- If a driving safety system intervenes, such as ESP®, Active Brake Assist or Active Blind Spot Assist.
- You have adopted a sporty driving style with high cornering speeds or high rates of acceleration.
- When ESP® is deactivated.
- If a loss of tire pressure or a faulty tire has been detected and displayed.

If you deactivate the Active Lane Keeping Assist warning and the lane markings cannot be clearly detected, it is possible that no lane correcting brake application takes place (→ page 207).

The system may be impaired or may not function particularly in the following situations:

- If there is poor visibility, e.g. due to insufficient illumination of the road, if there are

highly variable shade conditions or in rain, snow, fog or heavy spray.

- If there is glare, e.g. from oncoming traffic, the sun or reflections.
- If the windshield in the area of the multifunction camera is dirty, or if the camera is fogged up, damaged or covered.
- If there are no lane markings, or several unclear lane markings are present for one lane, e.g. around roadworks.
- If the lane markings are worn, dark or covered.
- If the distance from the vehicle in front is too short and thus the lane markings cannot be detected.
- If the lane markings change quickly, e.g. lanes branch off, cross one another or merge.
- If the road is very narrow and winding.
- **Vehicles with Driving Assistance Package:** if the radar sensors in the rear bumper are dirty or covered in snow and an obstacle is detected in your lane, no lane-correcting brake application takes place.

Activating/deactivating Active Lane Keeping Assist

Multimedia system:

→ ⌂ ▸▸ Settings ▸▸ Quick Access ▸▸ Active Lane Keeping Assist

▶ Activate or deactivate the function.

Setting Active Lane Keeping Assist

Multimedia system:

→ ⌂ ▸▸ Settings ▸▸ Assistance ▸▸ Active Lane Keeping Assist

Activating or deactivating the haptic warning

▶ Select Warning.
Activate or deactivate the function.

DYNAMIC BODY CONTROL function

DYNAMIC BODY CONTROL continuously adjusts the characteristics of the suspension dampers to the current operating and driving conditions.

The damping is tuned individually for each wheel and is affected by the following factors:

- The road surface conditions
- Vehicle load
- The drive program selected
- The driving style

The drive program can be adjusted using the DYNAMIC SELECT switch.

AIR BODY CONTROL

AIR BODY CONTROL function

NOTE Mercedes-AMG vehicles

▶ Observe the notes in the Supplement. You could otherwise fail to recognize dangers.

AIR BODY CONTROL is an air suspension system with variable damping for improved driving comfort. The all-round level control system ensures the best possible suspension and constant ground clearance, even with a laden vehicle.

Full-screen menus

You can display the following menus full-screen on the Instrument Display:

- Assistance
- Trip
- Navigation

▶ On the corresponding menu, use the left-hand Touch Control to scroll to the end of the list.

▶ Press the left-hand Touch Control. The selected menu will be displayed full-screen.

Overview of displays on the multifunction display

Displays on the multifunction display

- Active Parking Assist activated (→ page 221)
- Parking Assist PARKTRONIC deactivated (→ page 218)
- Cruise control (→ page 180)
- Active Distance Assist DISTRONIC (→ page 182)
- Active Brake Assist (→ page 198)
- Active Steering Assist (→ page 190)
- Active Traffic Jam Assist (→ page 189)
- Active Lane Keeping Assist (→ page 205)
- Active Lane Change Assist (→ page 192)
- ECO start/stop function (→ page 152)
- HOLD function (→ page 177)
- Adaptive Highbeam Assist (→ page 126)
- Adaptive Highbeam Assist Plus (→ page 127)

Vehicles with Traffic Sign Assist: Detected instructions and traffic signs (→ page 198).

For an overview of the indicator and warning lamps, see (→ page 399).

Head-up Display

Function of the Head-up Display

NOTE Mercedes-AMG vehicles

▶ Observe the notes in the Supplement. You could otherwise fail to recognize dangers.

The Head-up Display projects the following information into the driver's field of vision above the cockpit, for example:

- The vehicle speed
- Information from the navigation system
- Information from the driving systems and driving safety systems
- Some warning messages

Depending on the vehicle's equipment, different content can be shown in the three areas of the Head-up Display (→ page 231).

Display messages	Possible causes/consequences and ▶ Solutions
Active Lane Keeping Assist Currently Unavailable See Operator's Manual	* Active Lane Keeping Assist is temporarily unavailable. The ambient conditions are outside the system limits (→ page 205). As soon as the ambient conditions are within the system limits, the system will become available again. ▶ Drive on.
Active Lane Keeping Assist Inoperative	* Active Lane Keeping Assist is malfunctioning. ▶ Consult a qualified specialist workshop.
 Currently Unavailable Radar Sensors Dirty	* The radar sensor system is malfunctioning. Possible causes: • Dirt on the sensors • Heavy rain or snow • Extended country driving without other traffic, e.g. in the desert Driving systems and driving safety systems may be malfunctioning or temporarily unavailable. Once the cause of the problem is no longer present, the driving systems and driving safety systems will be available again. If the display message does not disappear: ▶ Pull over and stop the vehicle safely as soon as possible, paying attention to road and traffic conditions. ▶ Clean all sensors (→ page 285). ▶ Restart the engine.

APPENDIX C

Run Log

Subject Vehicle: **2021 Mercedes-Benz E350 Sedan** Test Date: **2/1/2021**

Driver: **J. Robel** **Note: For Distance at Warning, positive values indicate inside the lane**

Notes: For the solid line test scenario (runs 15 – 30), the vehicle provided course-correcting brake inputs that resulted in exceedance of the SV yaw rate and speed tolerances after the LDW alert was provided. The intervention could not be disabled. The plots for these runs indicate the exceedances, but in consultation with NHTSA, a decision was made to consider these runs valid.

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Haptic Alert (ft)	Pass/Fail	Notes
1	**Botts**	**Left**	Y		Fail	No warning issued
2			Y		Fail	No warning issued
3			Y		Fail	No warning issued
4			Y		Fail	No warning issued
5			Y		Fail	No warning issued
6			Y	0.04	Pass	
7			Y	0.04	Pass	
8	**Botts**	**Right**	Y	0.14	Pass	
9			Y	0.07	Pass	
10			Y	0.06	Pass	
11			Y	0.07	Pass	
12			Y	0.04	Pass	
13			Y		Fail	No warning issued
14			Y		Fail	No warning issued

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Haptic Alert (ft)	Pass/Fail	Notes
15	**Solid**	**Left**	Y	0.53	Pass	0.33 sec before invalid yaw rate
16			Y	0.47	Pass	0.26 sec before invalid yaw rate
17			Y	0.48	Pass	0.40 sec before invalid yaw rate
18			Y	0.49	Pass	0.55 sec before invalid yaw rate
19			Y	0.46	Pass	0.38 sec before invalid yaw rate
20			Y	0.51	Pass	0.43 sec before invalid yaw rate
21			Y	0.54	Pass	0.93 sec before invalid yaw rate
22	**Solid**	**Right**	Y	0.59	Pass	0.01 sec before invalid yaw rate
23			Y	0.58	Pass	0.01 sec before invalid yaw rate
24			N			SV Speed, yaw (coincident with alert)
25			Y	0.60	Pass	0.08 sec before invalid yaw rate
26			Y	0.68	Pass	0.04 sec before invalid yaw rate
27			N			SV Speed, yaw (coincident with alert)
28			Y	0.63	Pass	0.08 sec before invalid yaw rate
29			Y	0.61	Pass	0.06 sec before invalid yaw rate
30			Y	0.61	Pass	0.17 sec before invalid yaw rate
31	**Dashed**	**Right**	Y	0.16	Pass	
32			Y	0.13	Pass	
33			Y	0.20	Pass	
34			Y	0.25	Pass	
35			Y	0.18	Pass	
36			Y	0.18	Pass	
37			Y	0.16	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Haptic Alert (ft)	Pass/Fail	Notes
38	**Dashed**	**Left**	Y	0.12	Pass	
39			Y	0.16	Pass	
40			Y	0.07	Pass	
41			Y	0.00	Pass	
42			Y	0.12	Pass	
43			Y	0.06	Pass	
44			Y	0.08	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
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

For the solid line test scenario (runs 15 – 30), the vehicle provided course-correcting brake inputs that resulted in exceedance of the SV yaw rate and speed tolerances after the LDW alert was provided. The intervention could not be disabled. The plots for these runs indicate the exceedances, but in consultation with NHTSA, a decision was made to consider these runs valid.

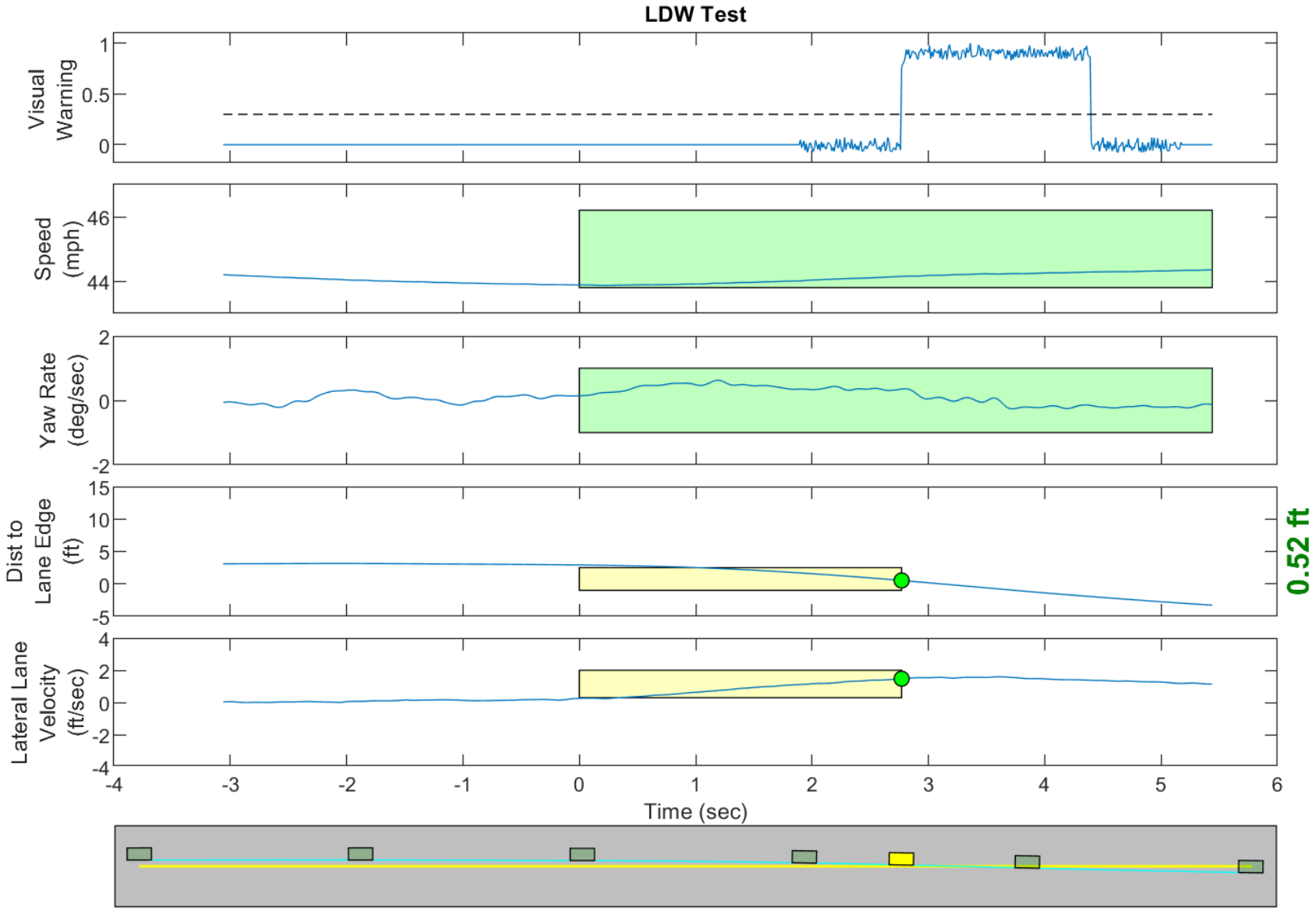

Figure D1. Example Time History for Lane Departure Warning Test, Passing

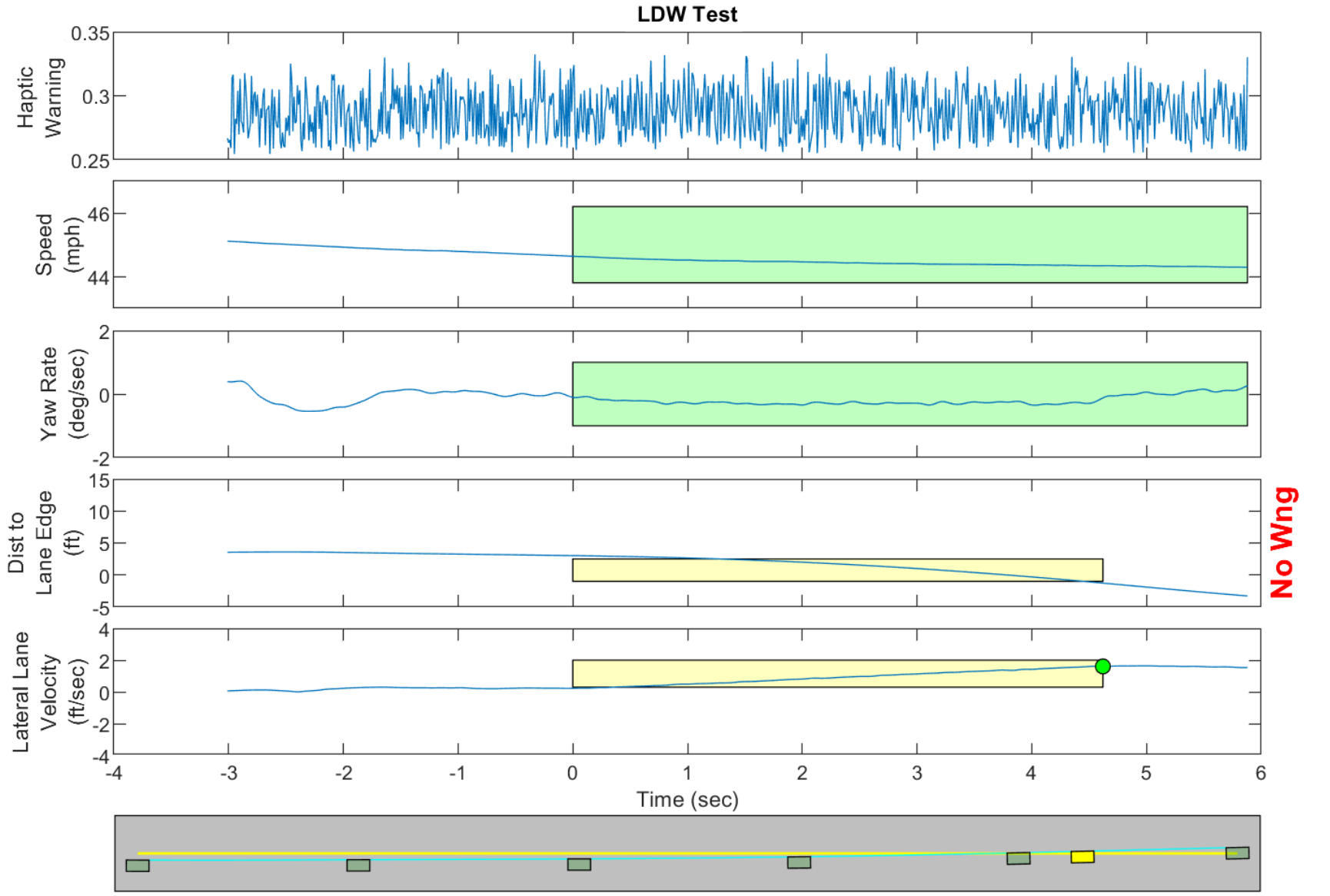

Figure D2. Example Time History for Lane Departure Warning Test, Failing, No Warning Issued

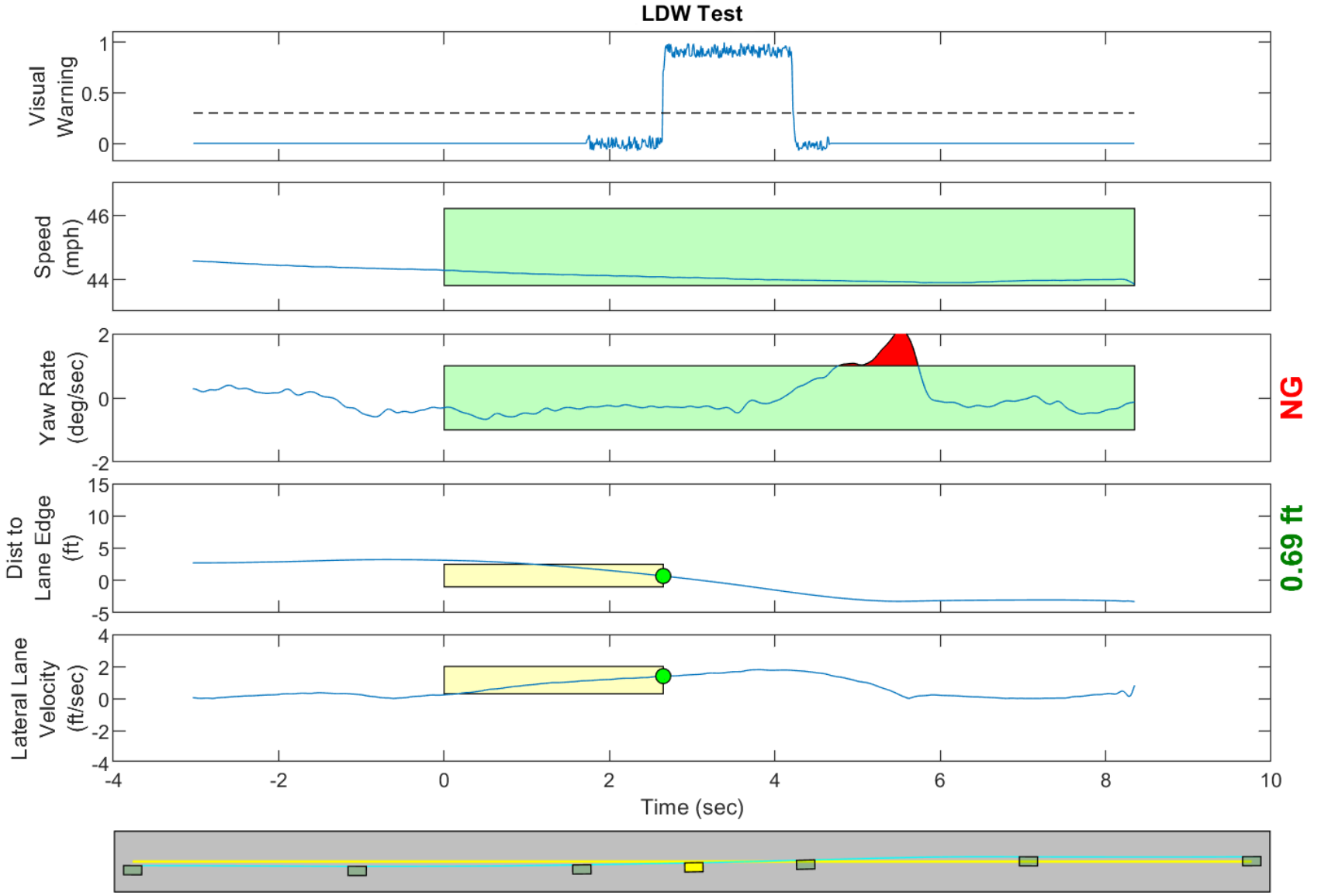

Figure D3. Example Time History for Lane Departure Warning Test, Invalid Run Due to Subject Vehicle Yaw Rate

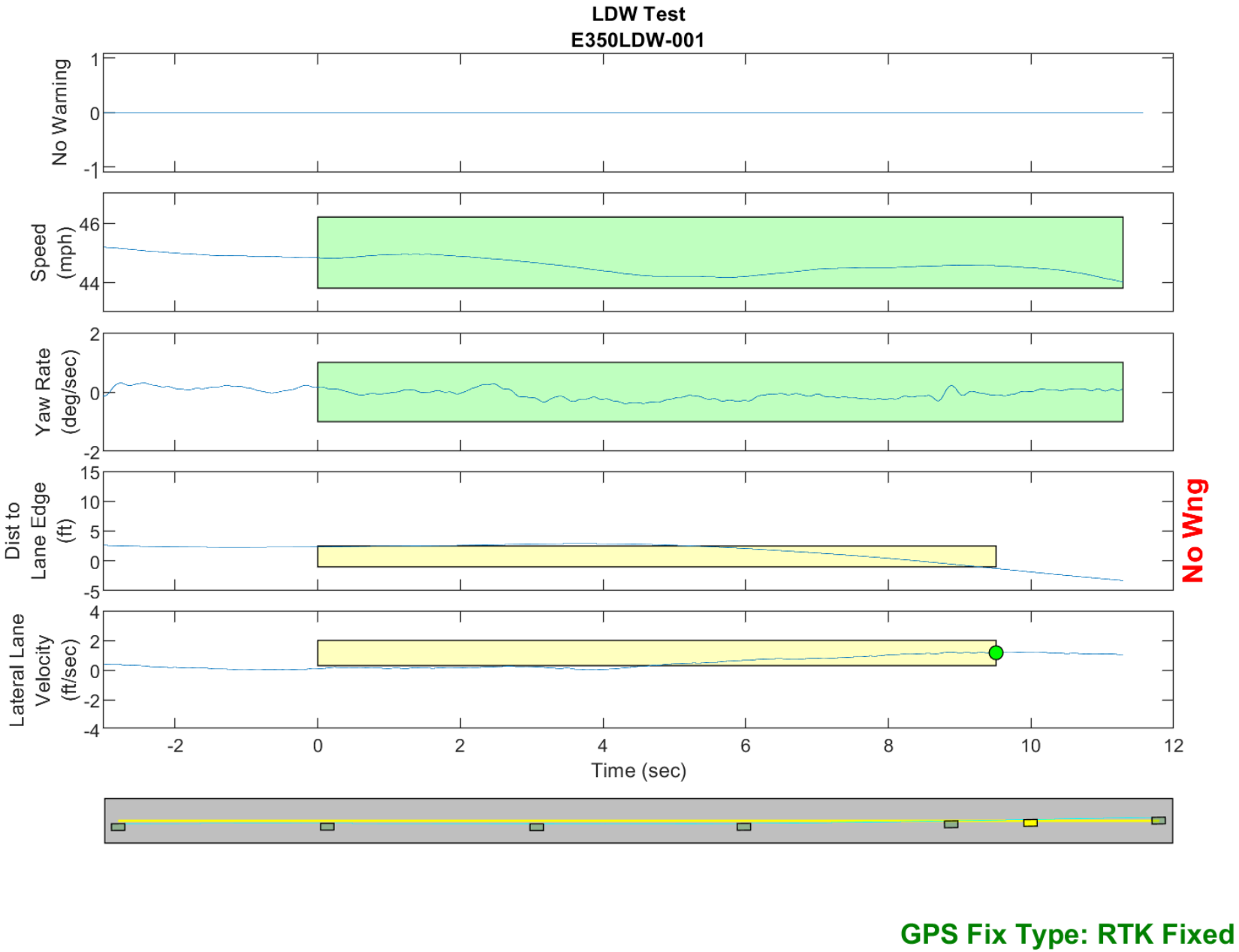

Figure D4. Time History for Run 01, Botts Dots, Left Departure, No Warning

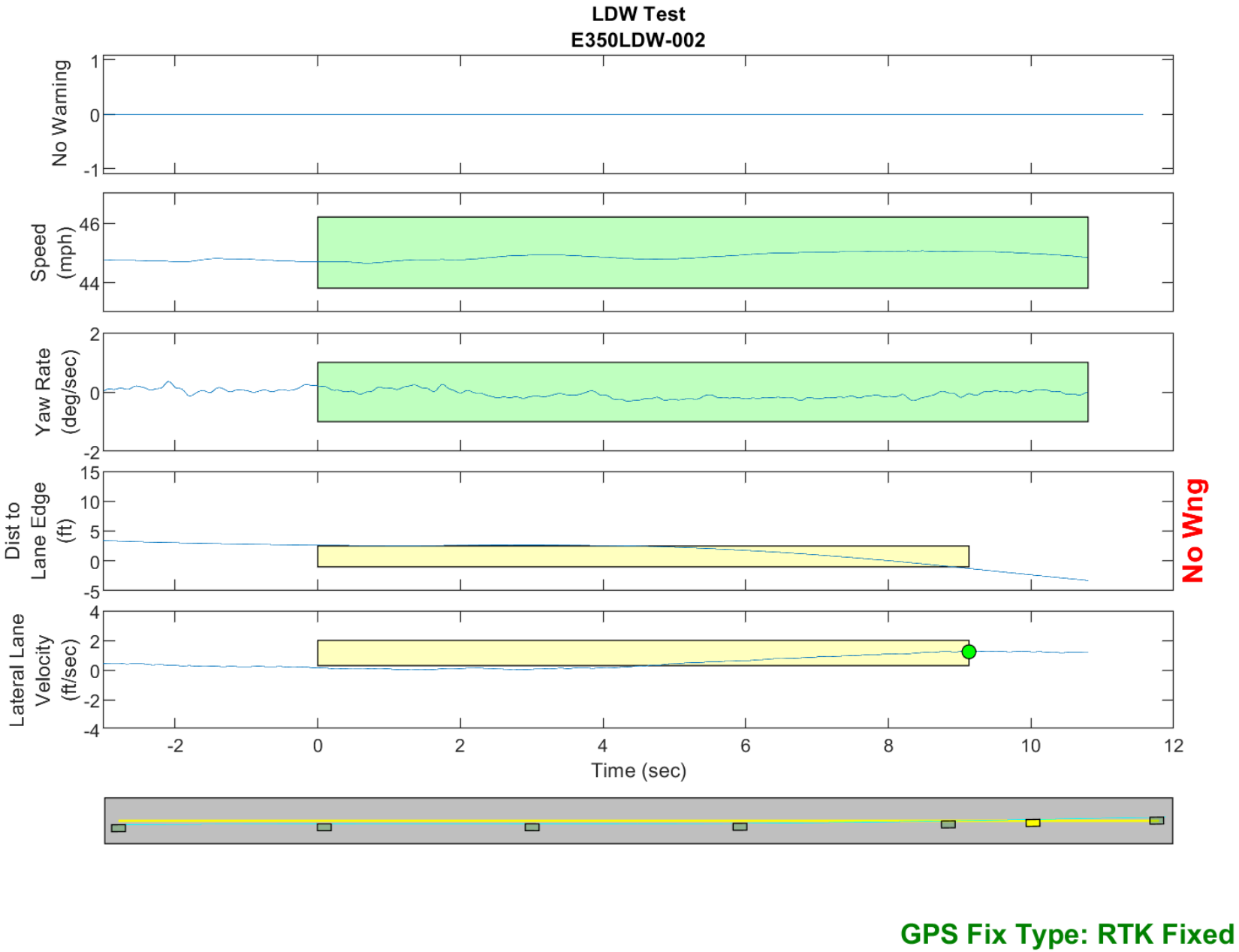

Figure D5. Time History for Run 02, Botts Dots, Left Departure, No Warning

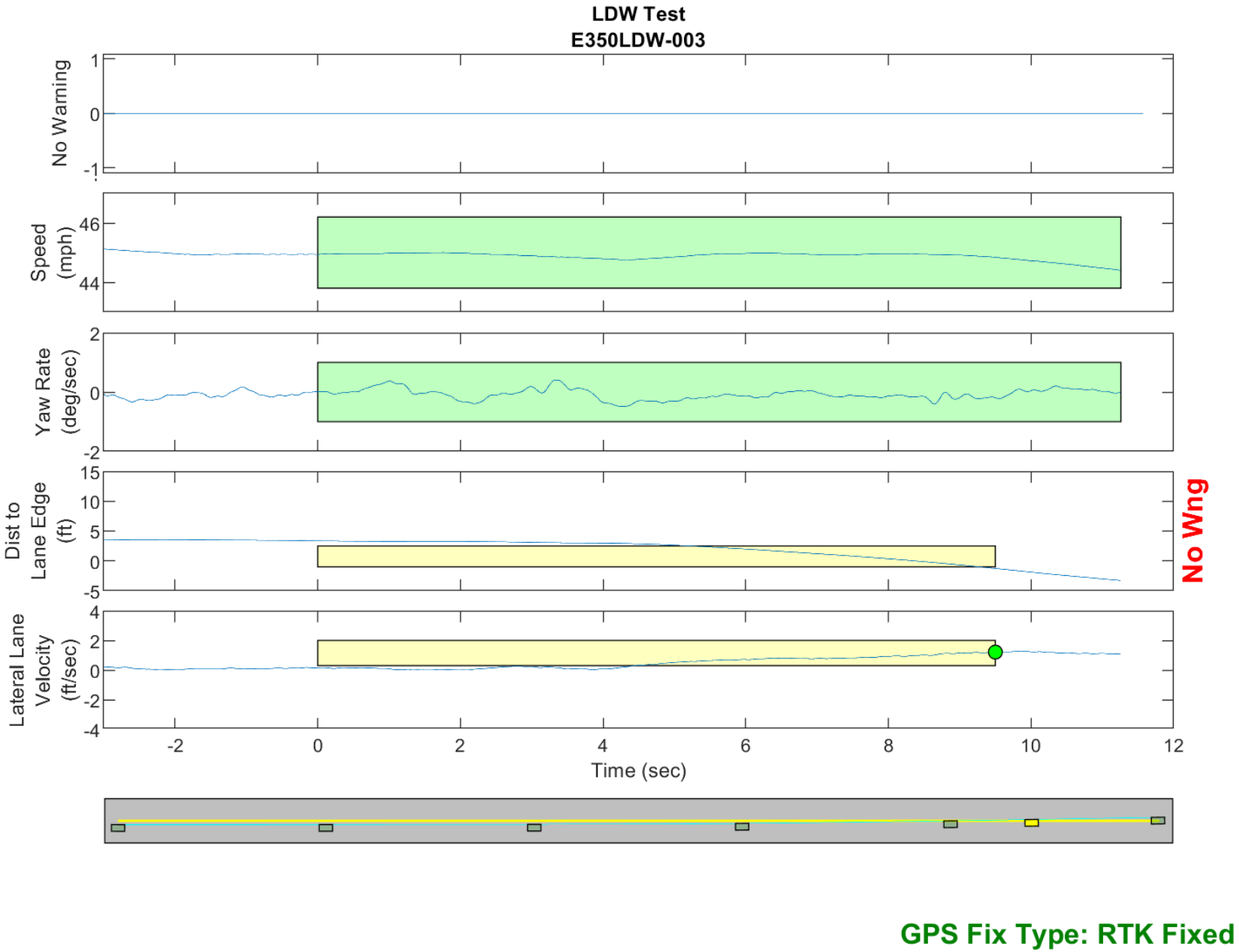

Figure D6. Time History for Run 03, Botts Dots, Left Departure, No Warning

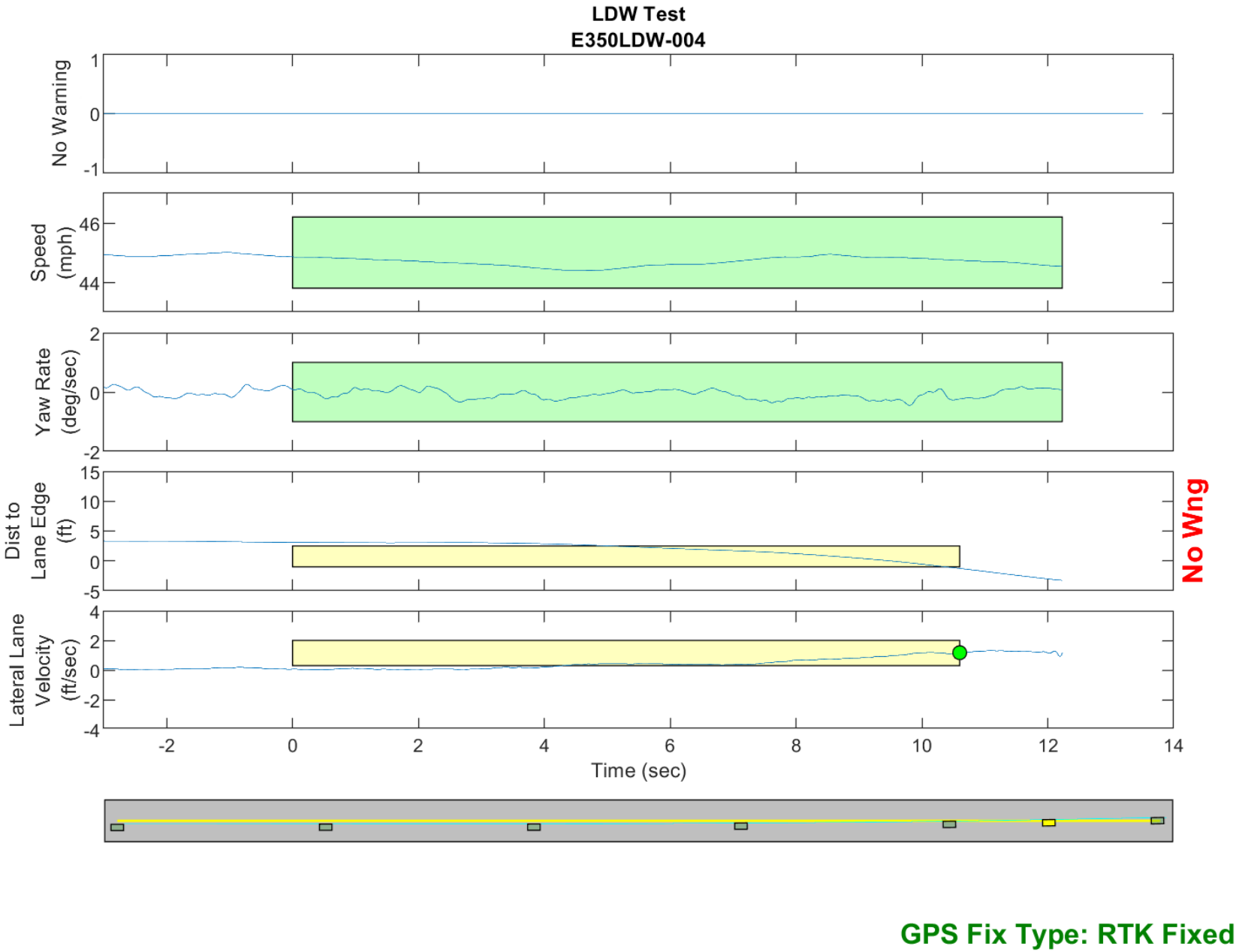

Figure D7. Time History for Run 04, Botts Dots, Left Departure, No Warning

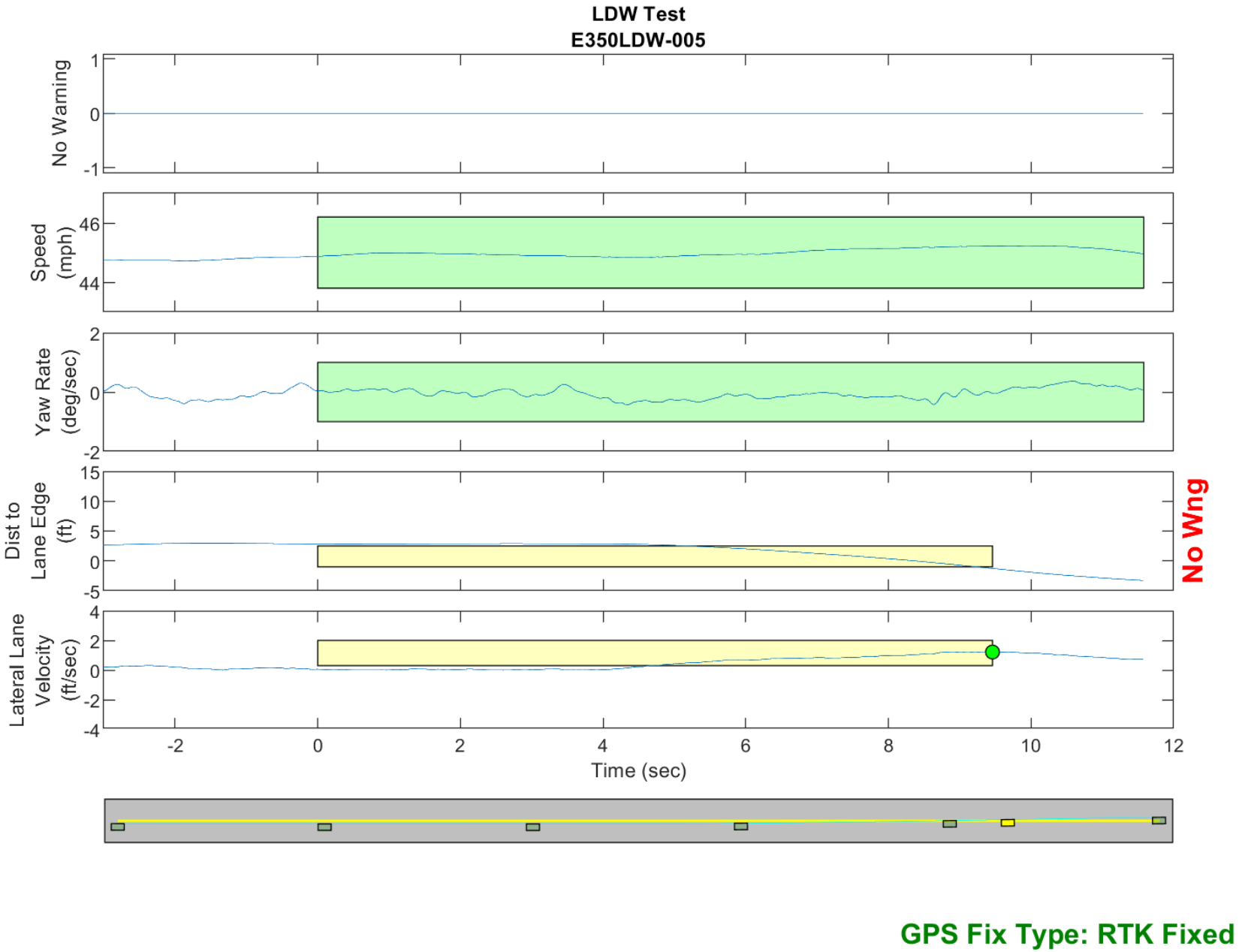

Figure D8. Time History for Run 05, Botts Dots, Left Departure, No Warning

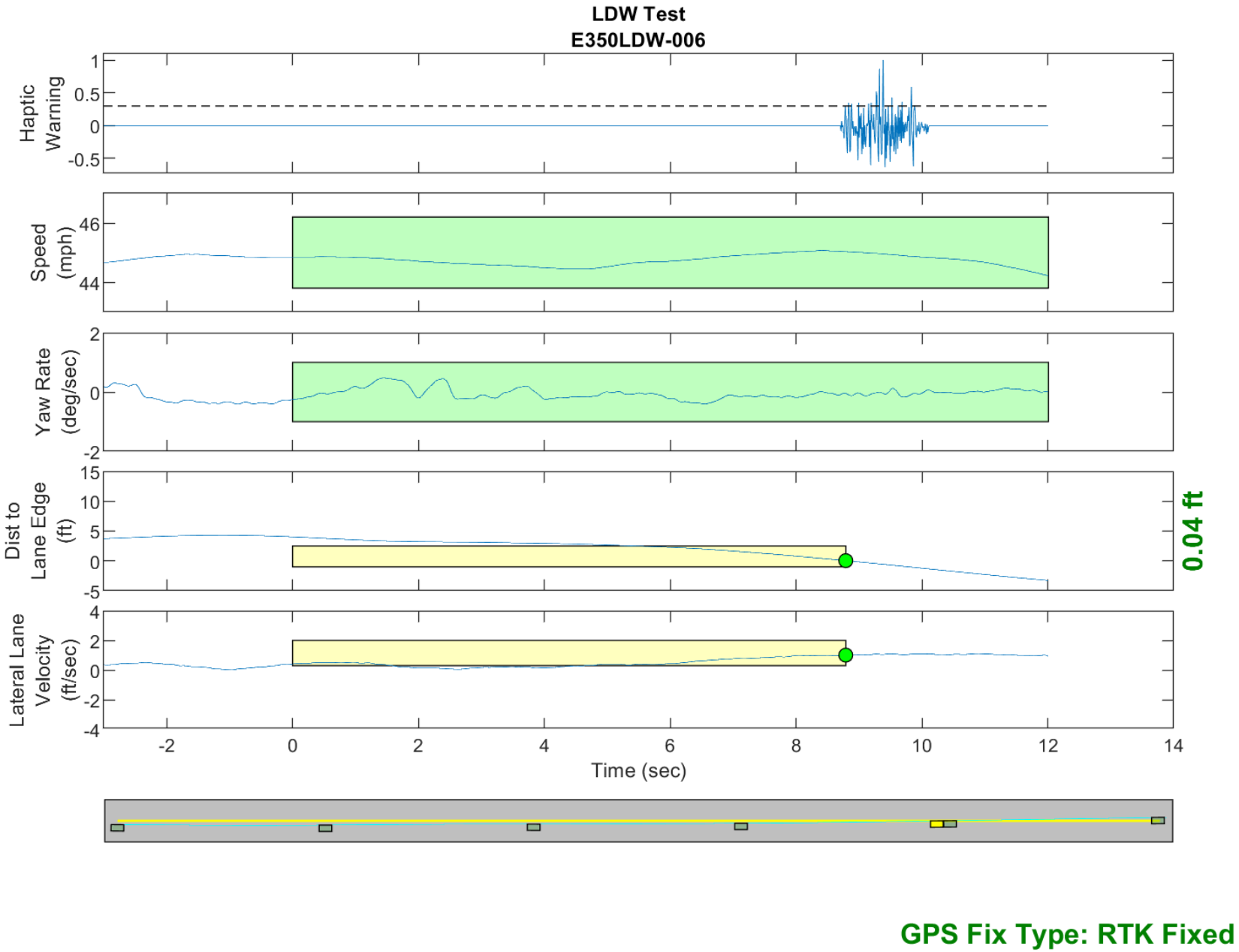

Figure D9. Time History for Run 06, Botts Dots, Left Departure, Haptic Warning

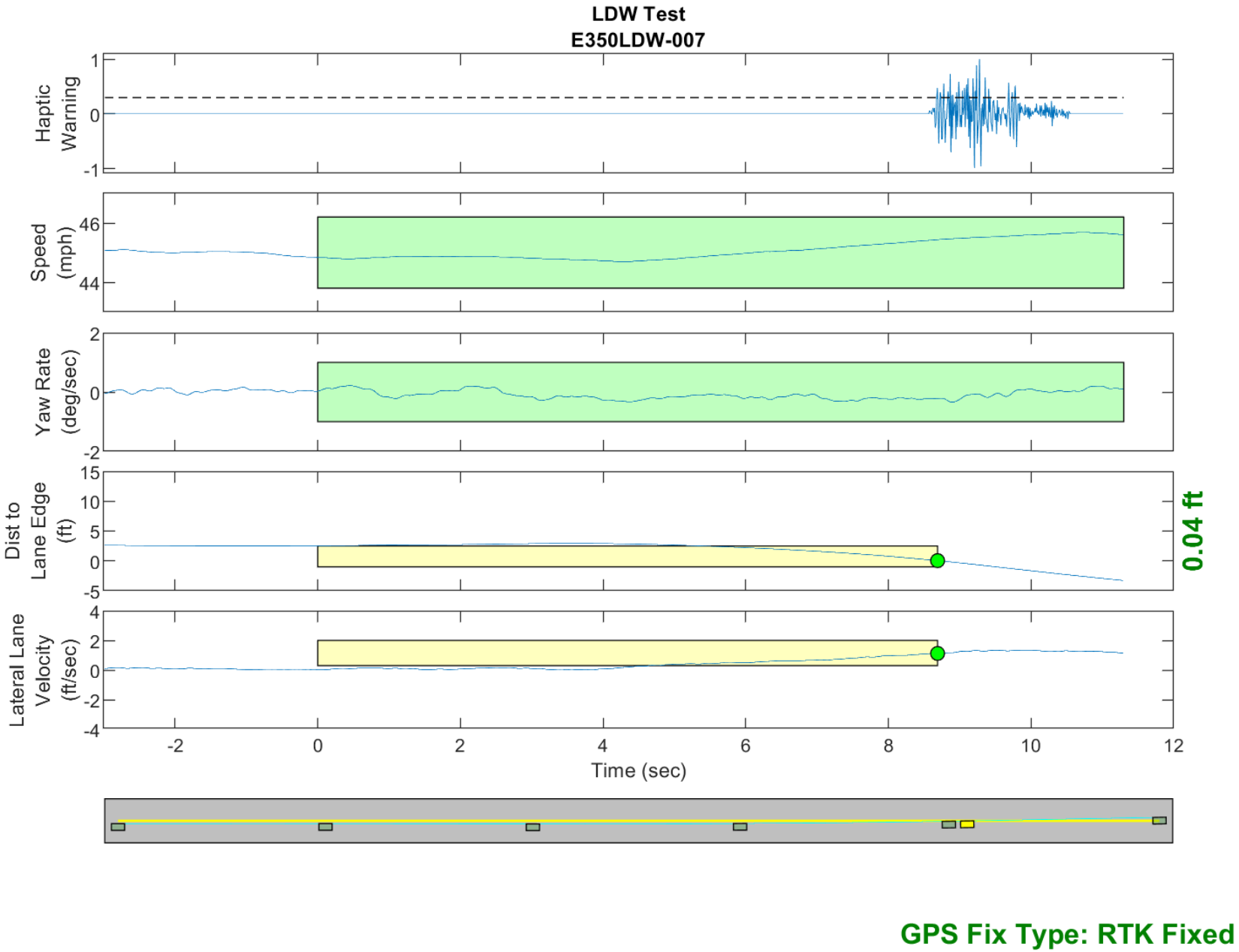

Figure D10. Time History for Run 07, Botts Dots, Left Departure, Haptic Warning

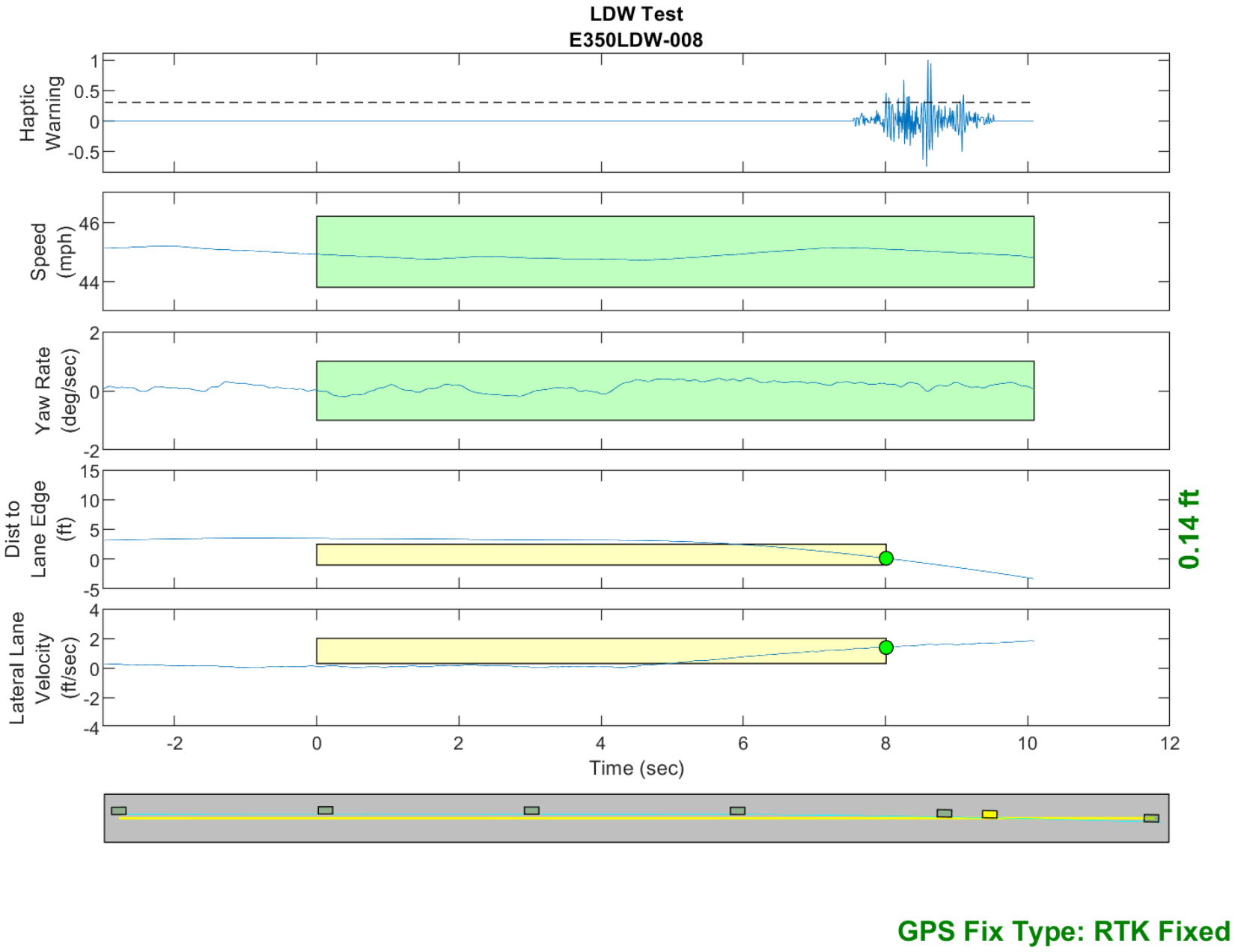

Figure D11. Time History for Run 08, Botts Dots, Right Departure, Haptic Warning

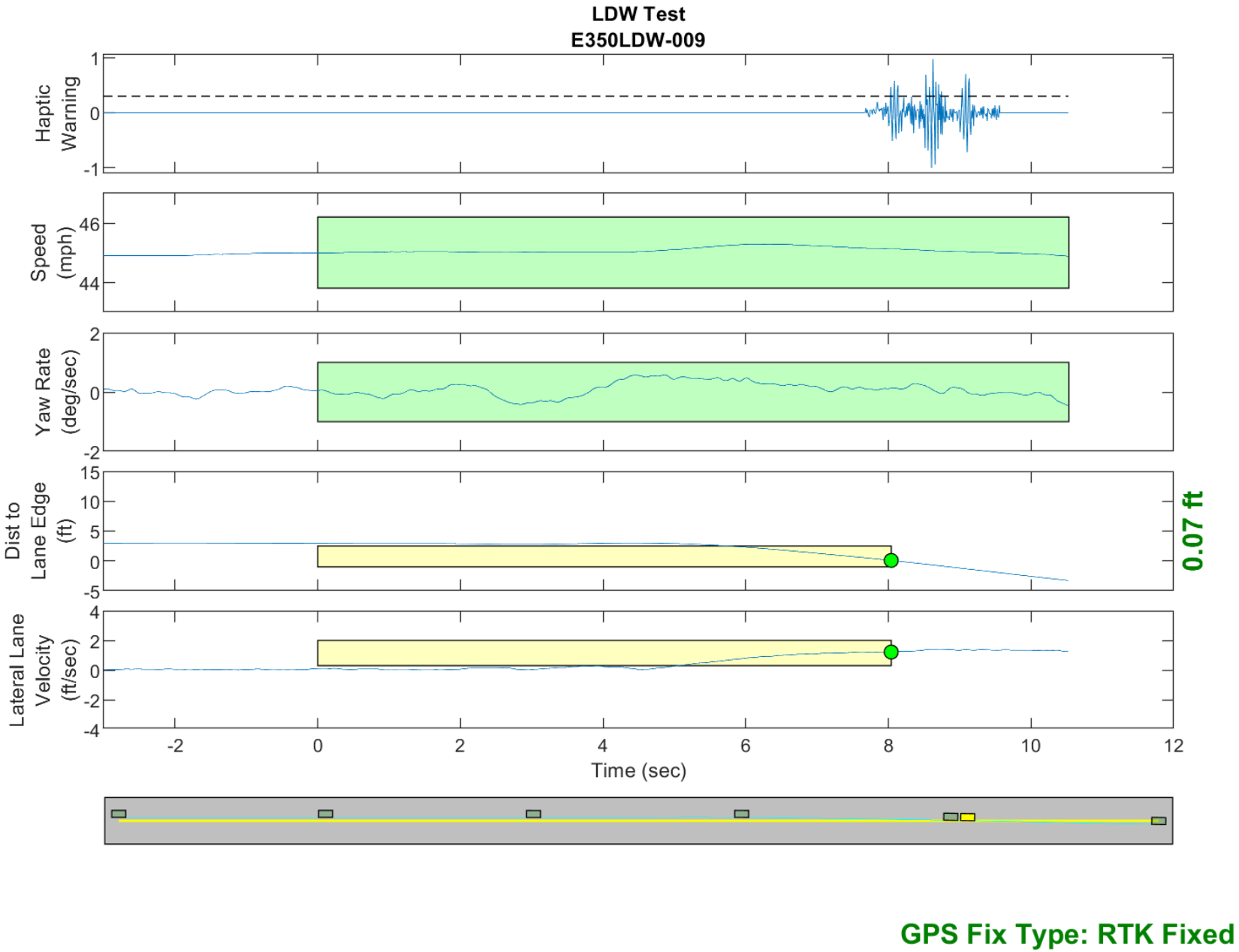

Figure D12. Time History for Run 09, Botts Dots, Right Departure, Haptic Warning

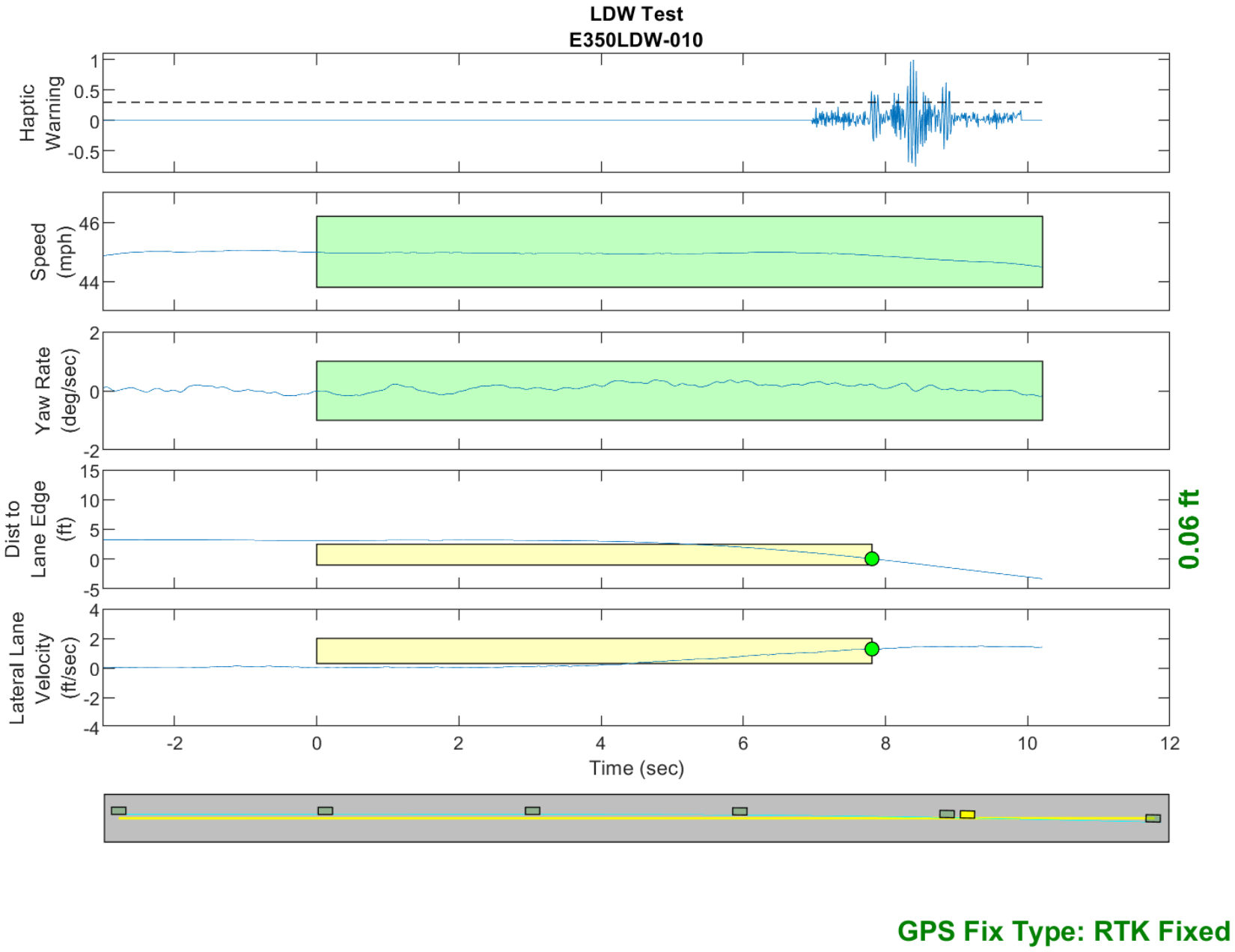

Figure D13. Time History for Run 10, Botts Dots, Right Departure, Haptic Warning

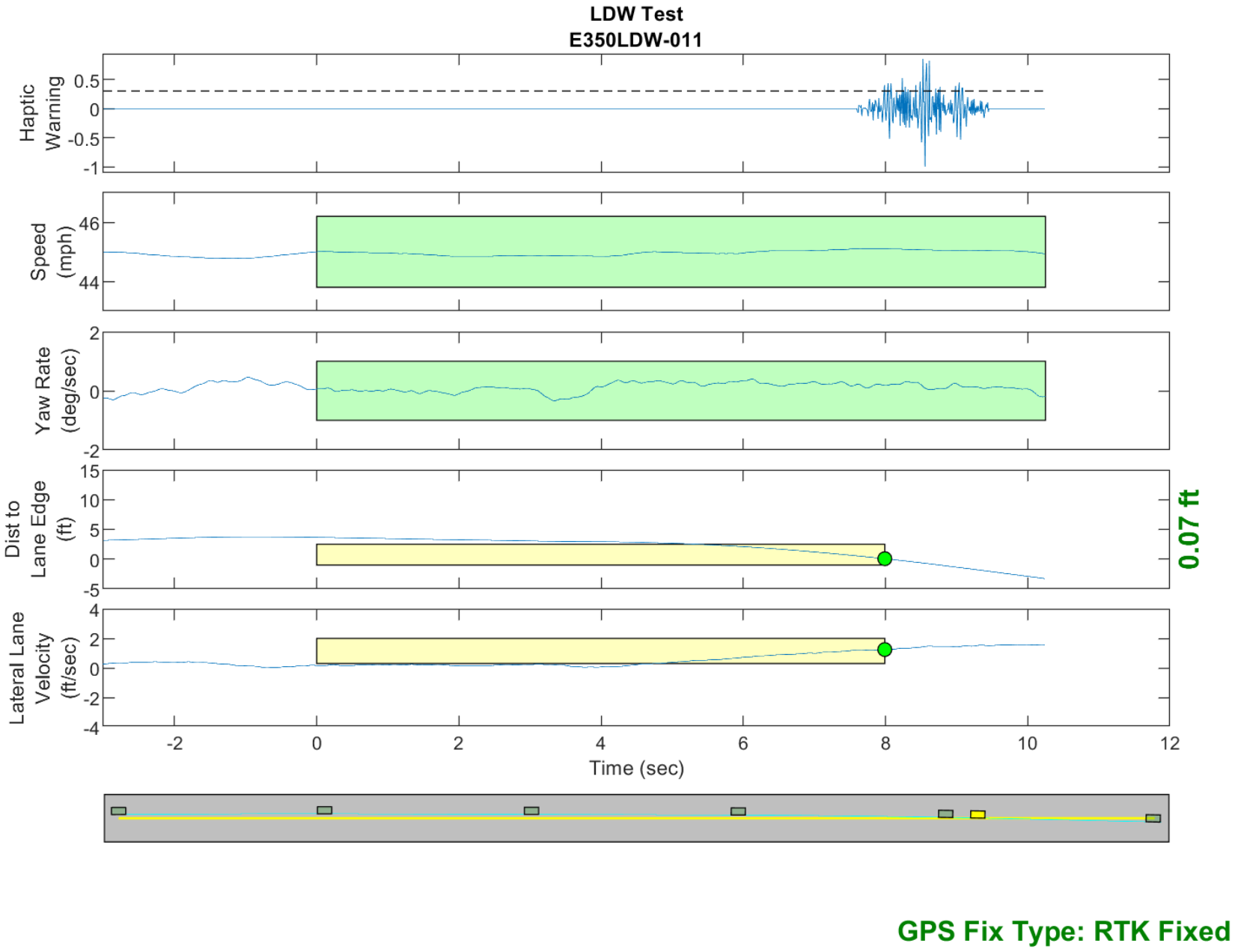

Figure D14. Time History for Run 11, Botts Dots, Right Departure, Haptic Warning

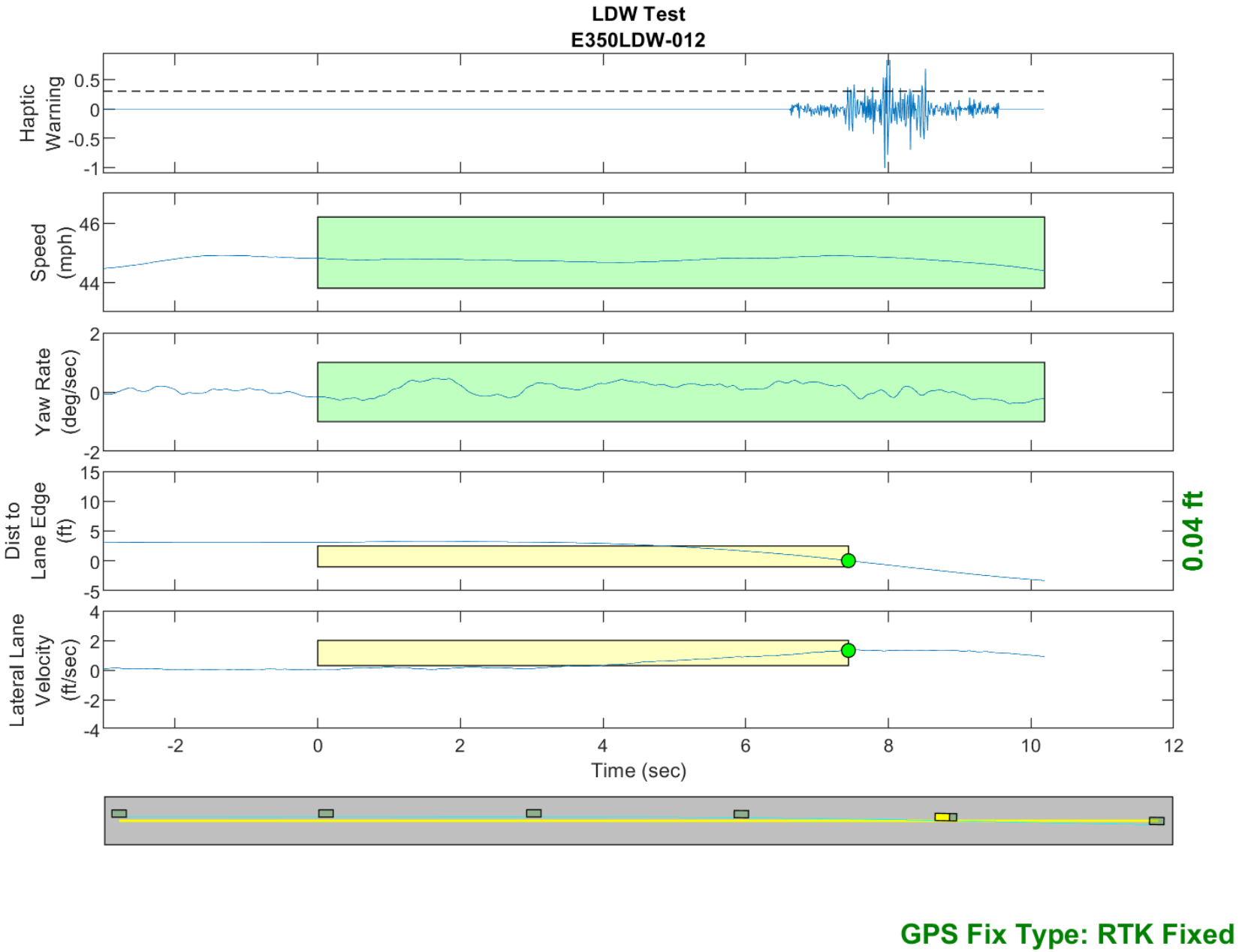

Figure D15. Time History for Run 12, Botts Dots, Right Departure, Haptic Warning

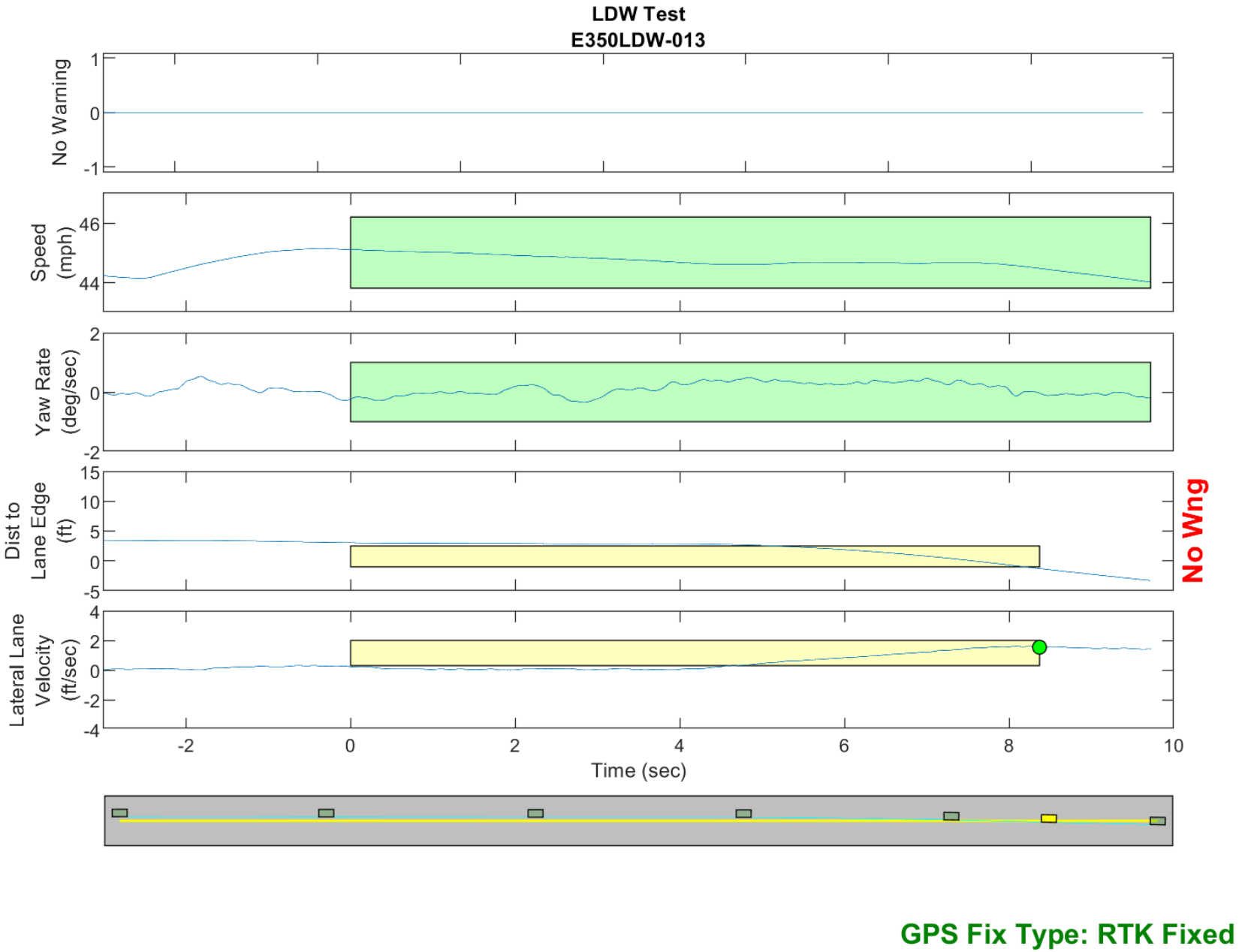

Figure D16. Time History for Run 13, Botts Dots, Right Departure, No Warning

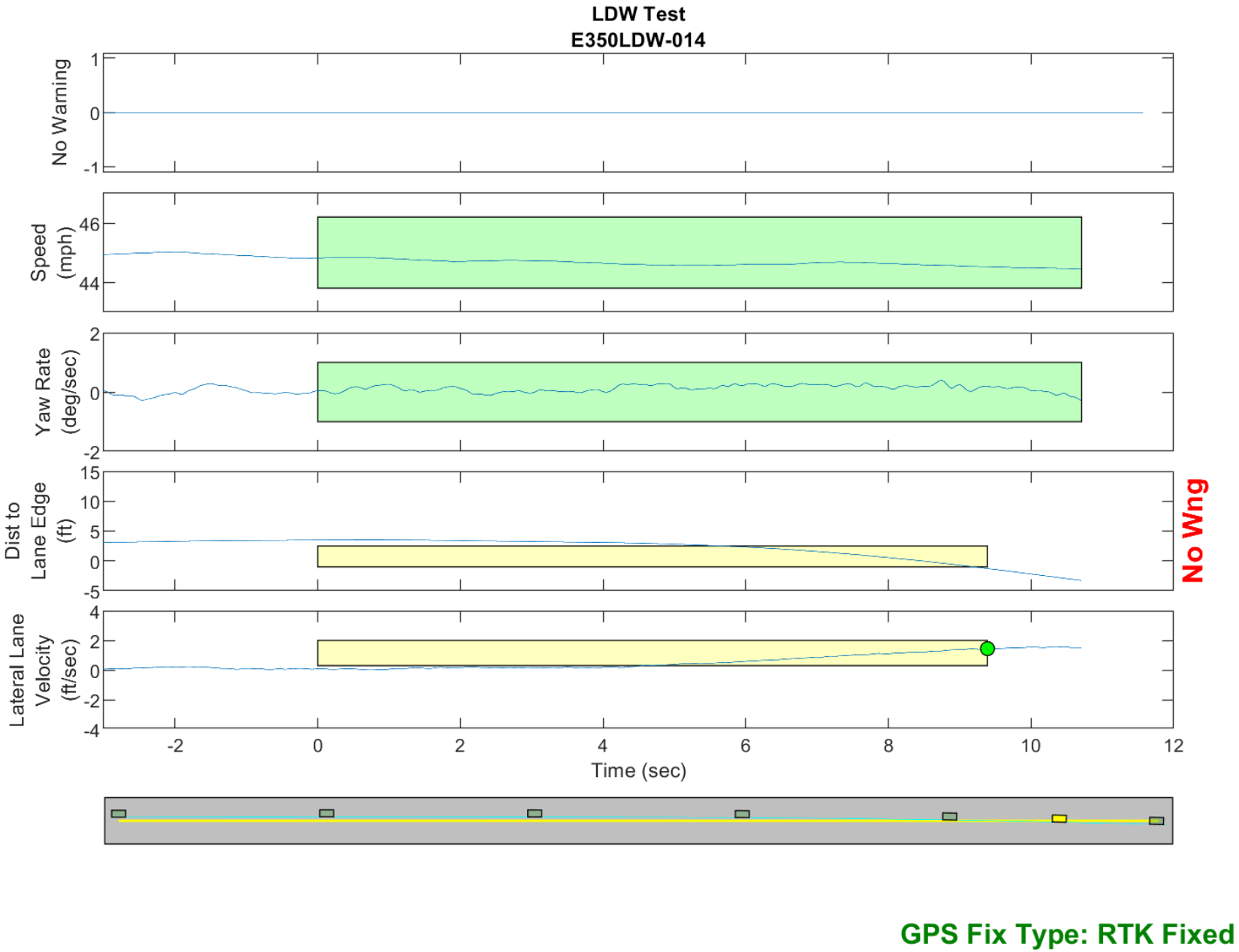

Figure D17. Time History for Run 14, Botts Dots, Right Departure, No Warning

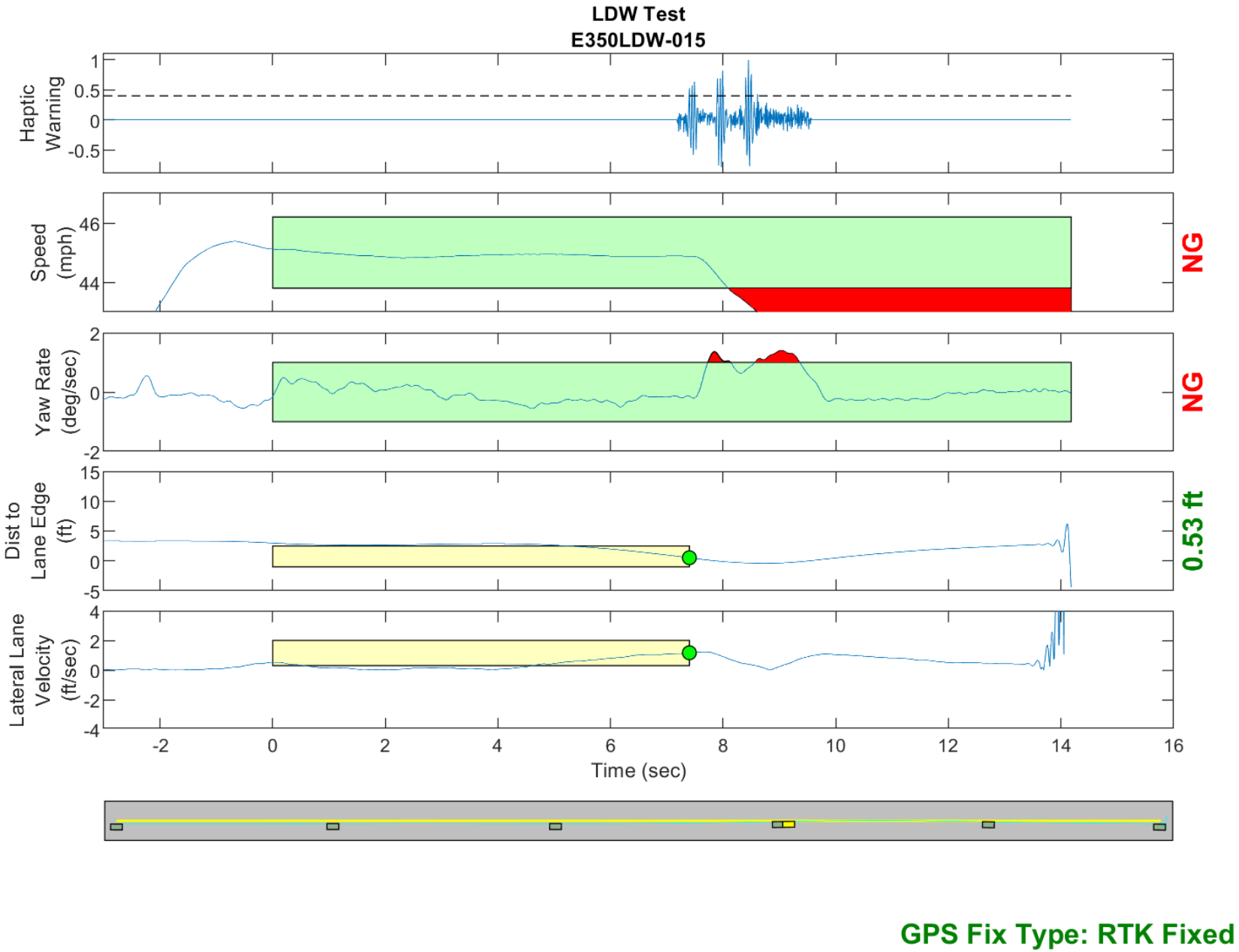

Figure D18. Time History for Run 15, Solid Line, Left Departure, Haptic Warning

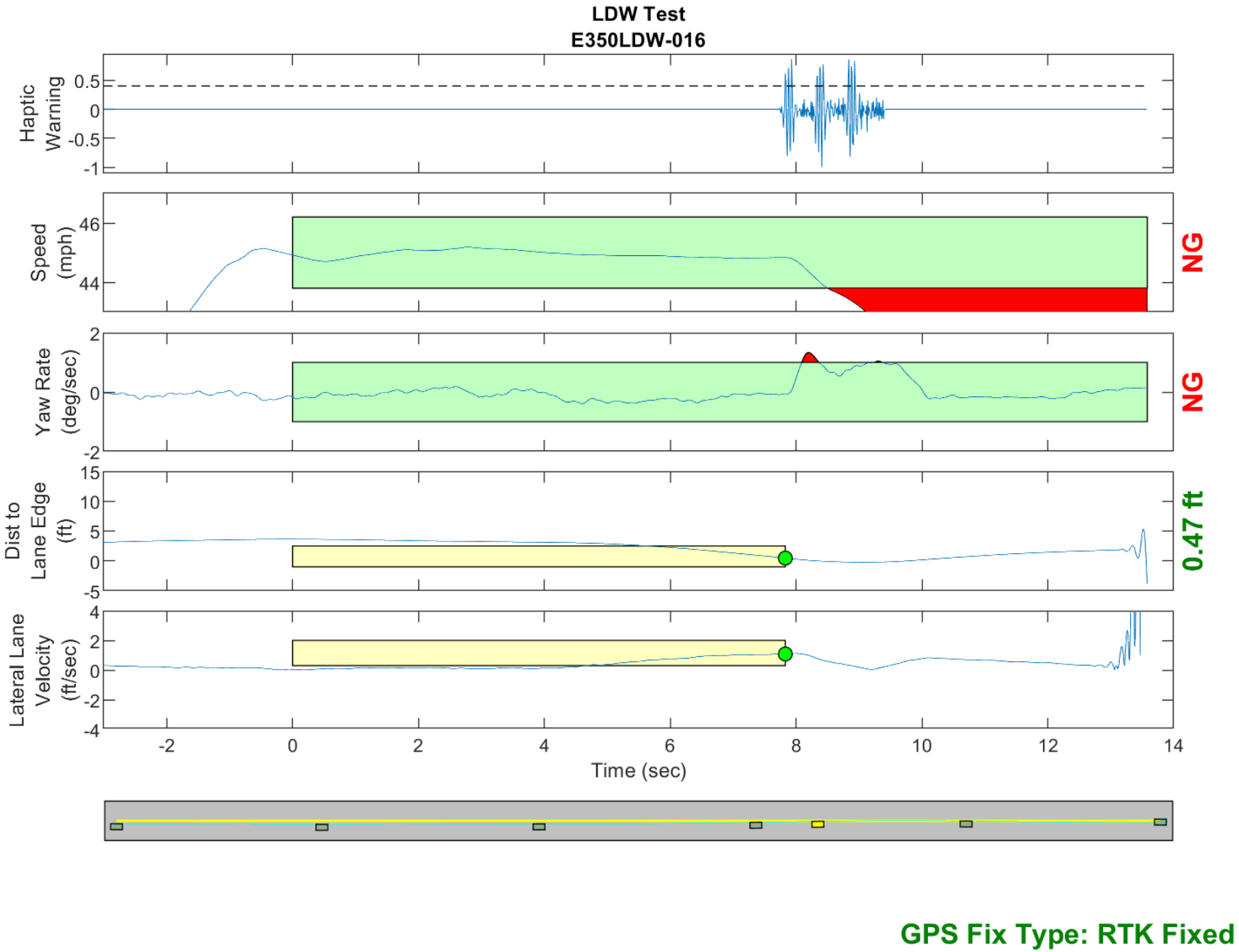

Figure D19. Time History for Run 16, Solid Line, Left Departure, Haptic Warning

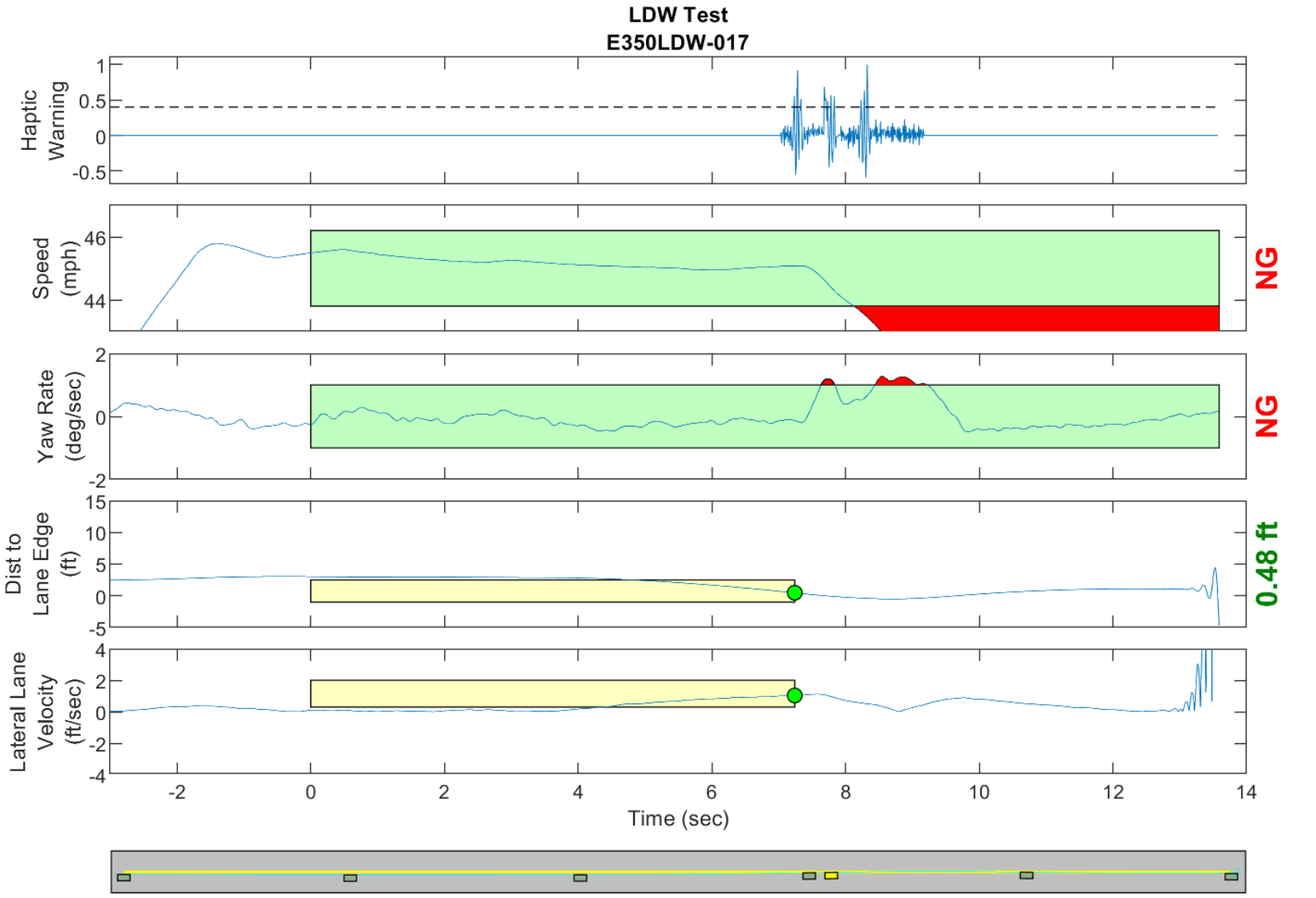

Figure D20. Time History for Run 17, Solid Line, Left Departure, Haptic Warning

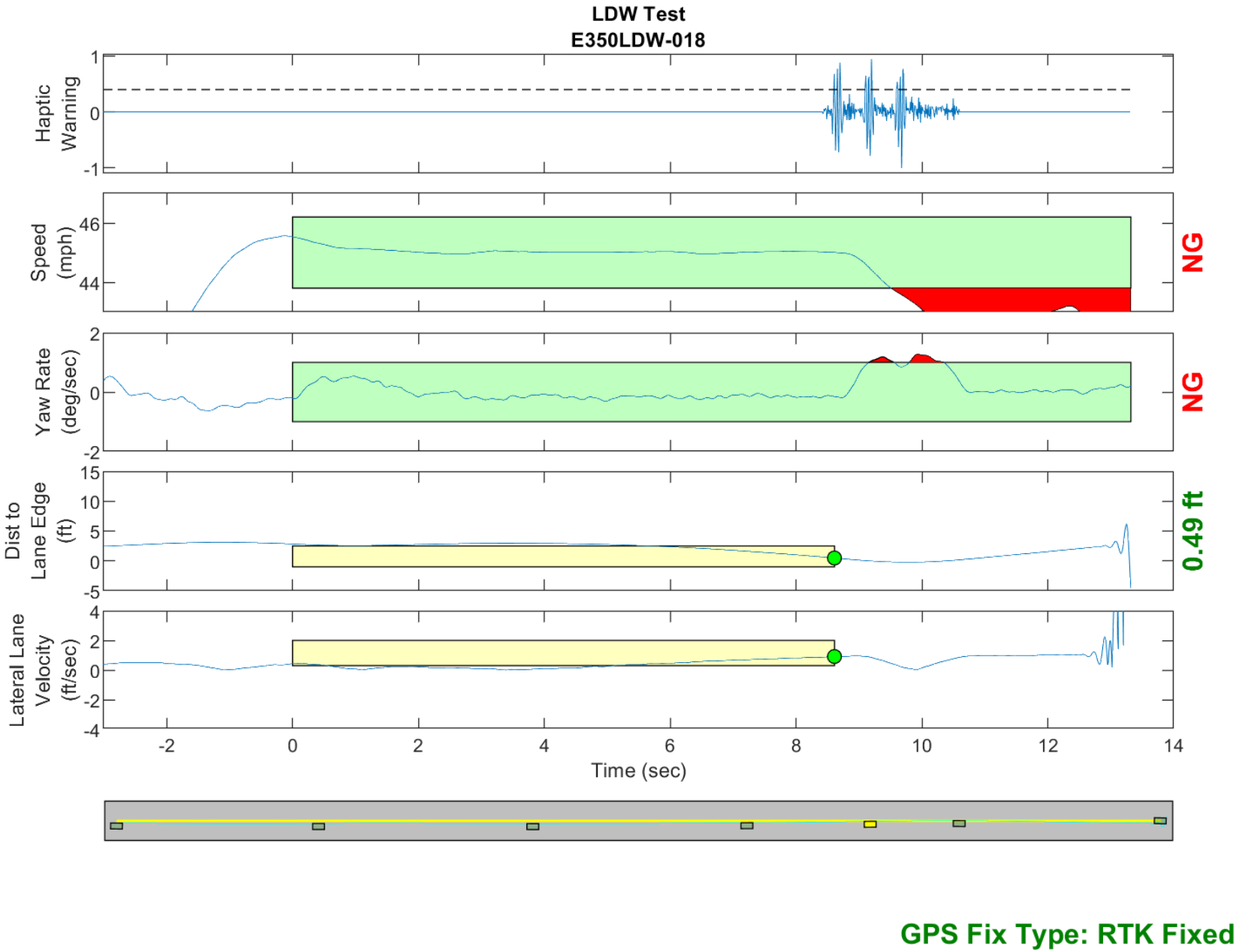

Figure D21. Time History for Run 18, Solid Line, Left Departure, Haptic Warning

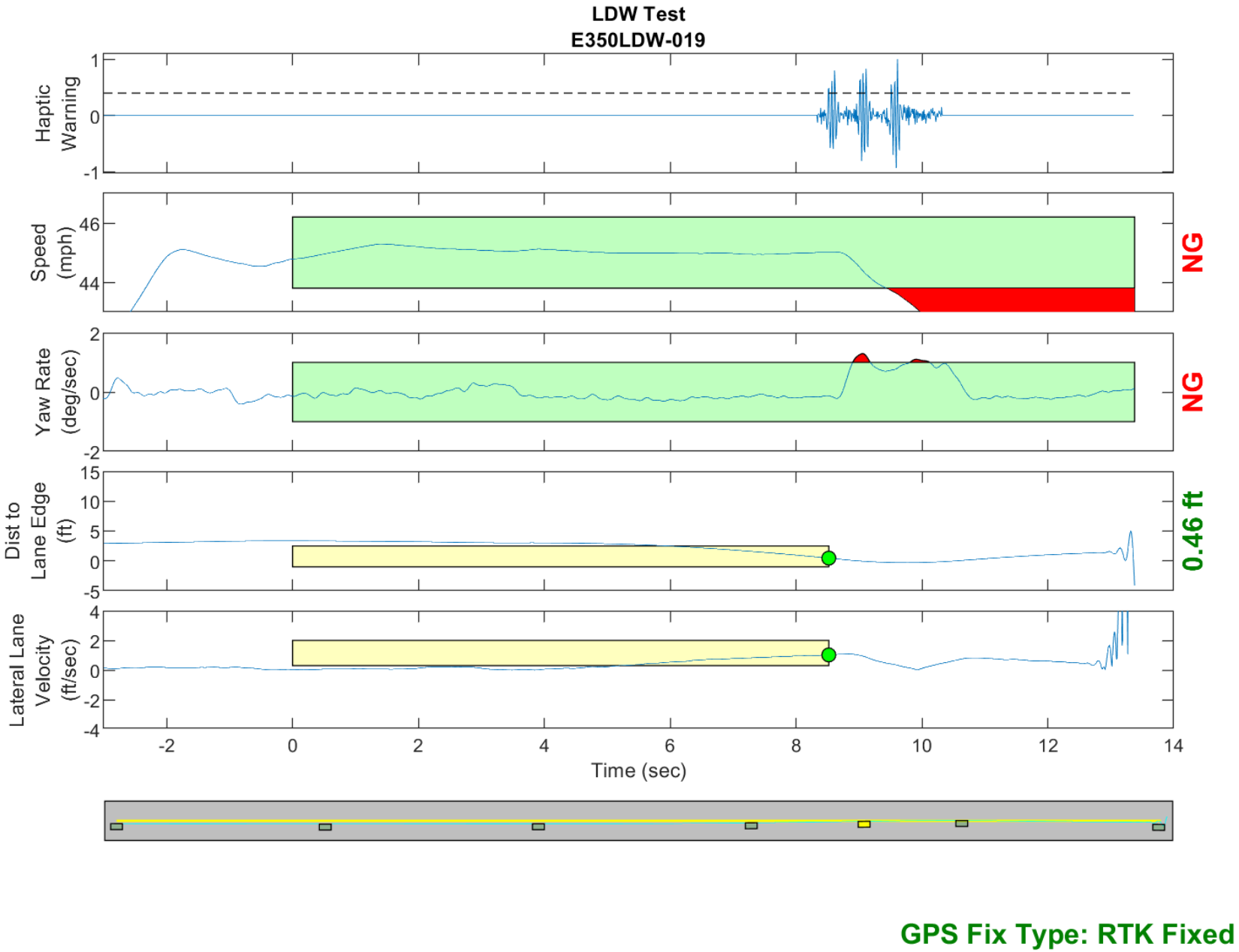

Figure D22. Time History for Run 19, Solid Line, Left Departure, Haptic Warning

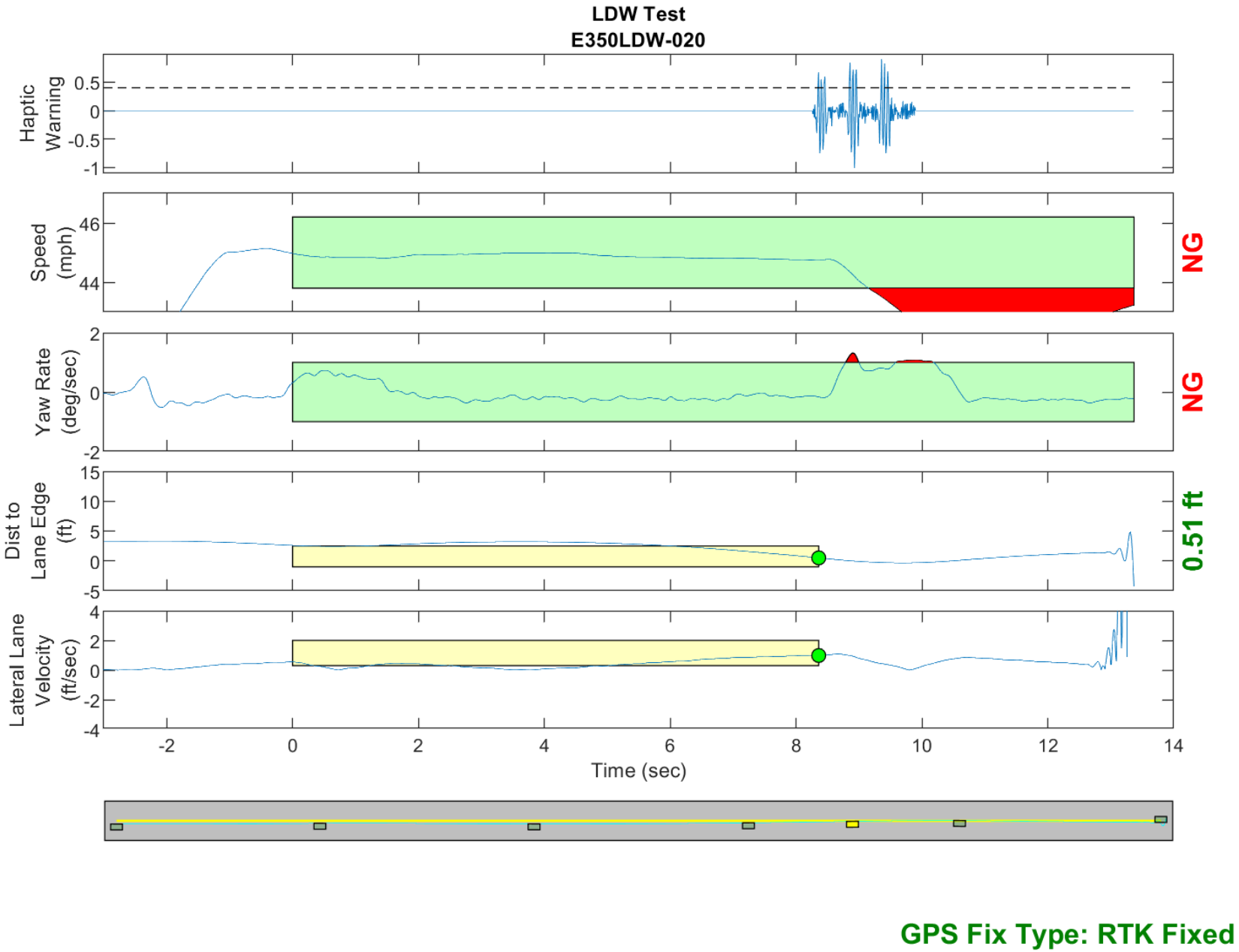

Figure D23. Time History for Run 20, Solid Line, Left Departure, Haptic Warning

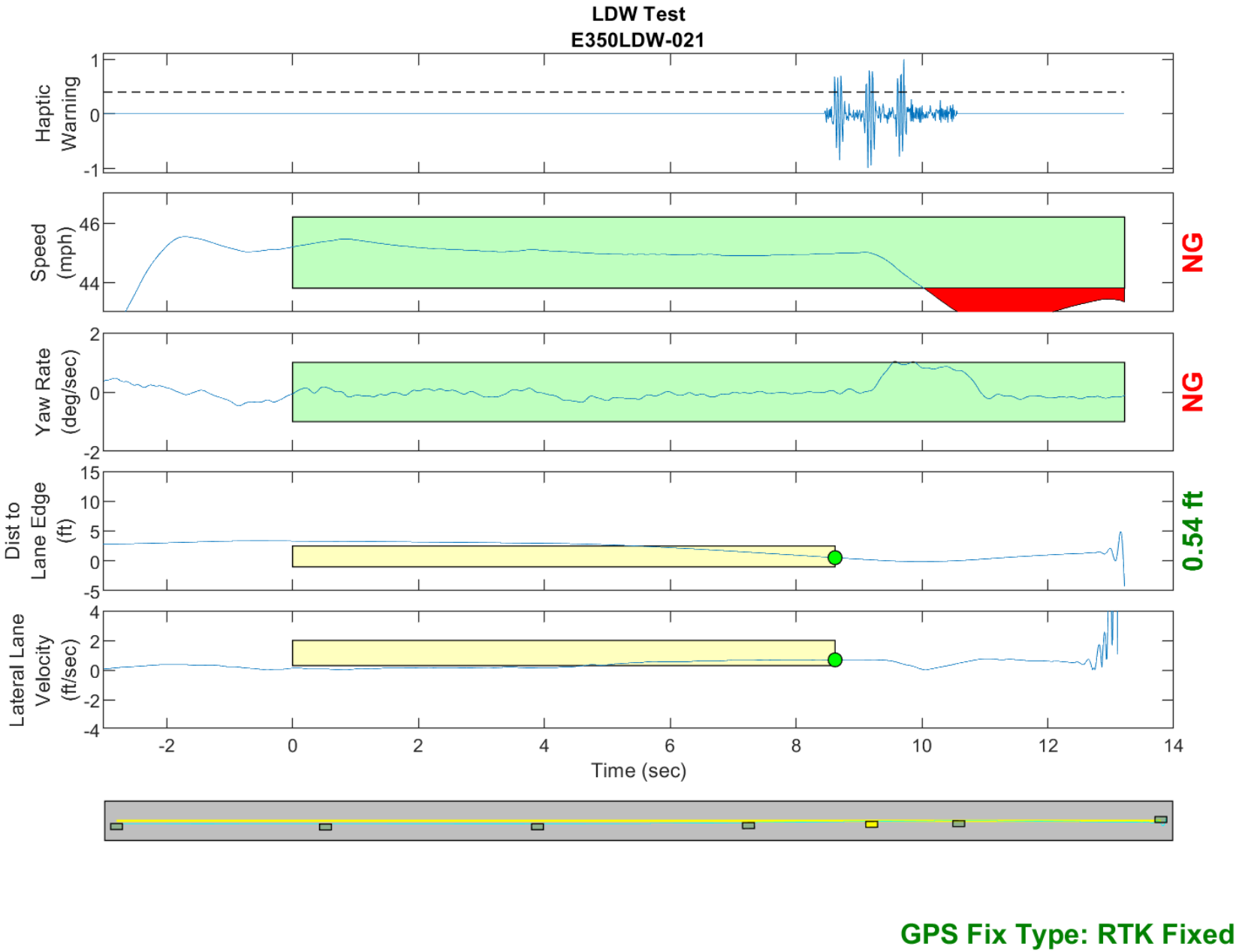

Figure D24. Time History for Run 21, Solid Line, Left Departure, Haptic Warning

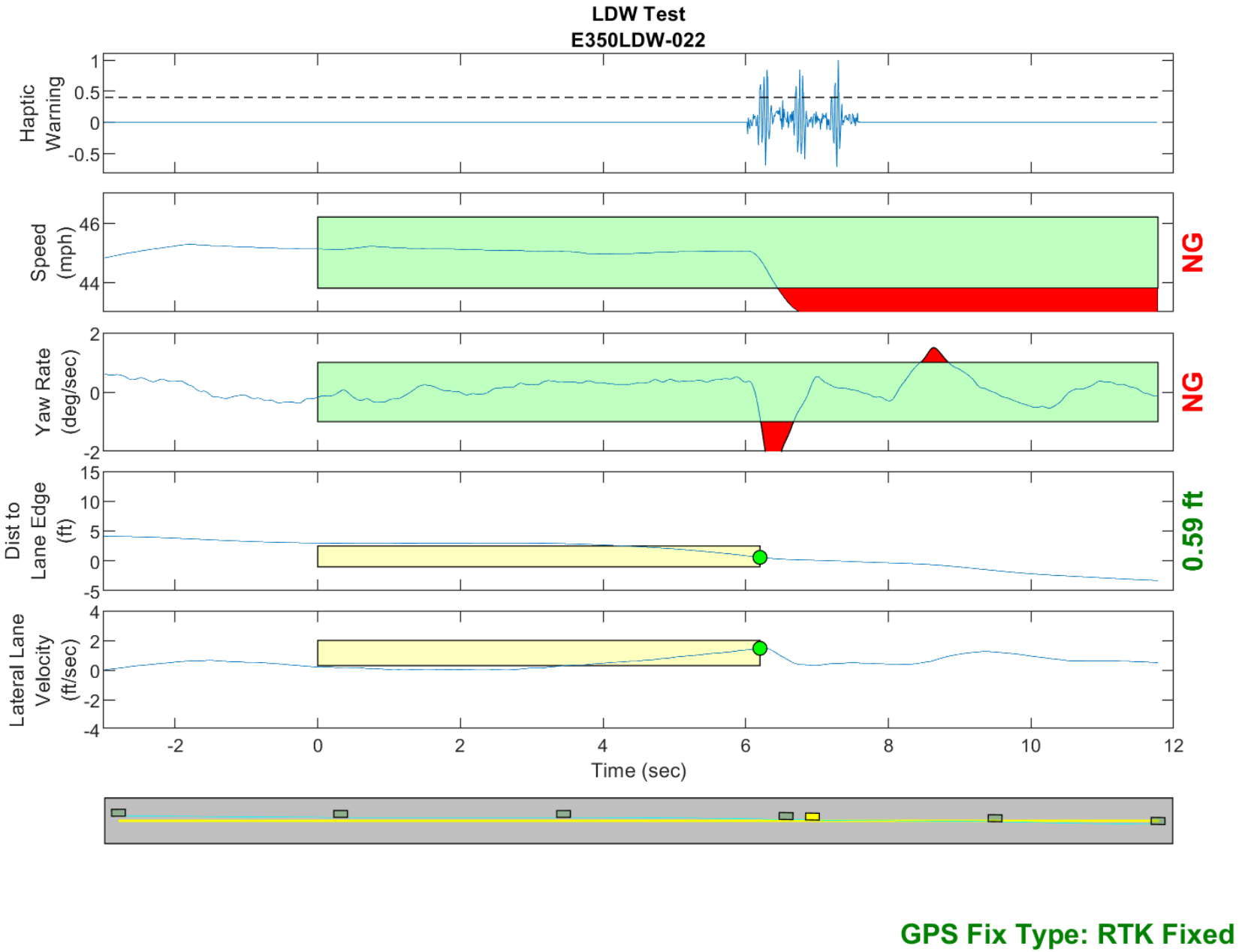

Figure D25. Time History for Run 22, Solid Line, Right Departure, Haptic Warning

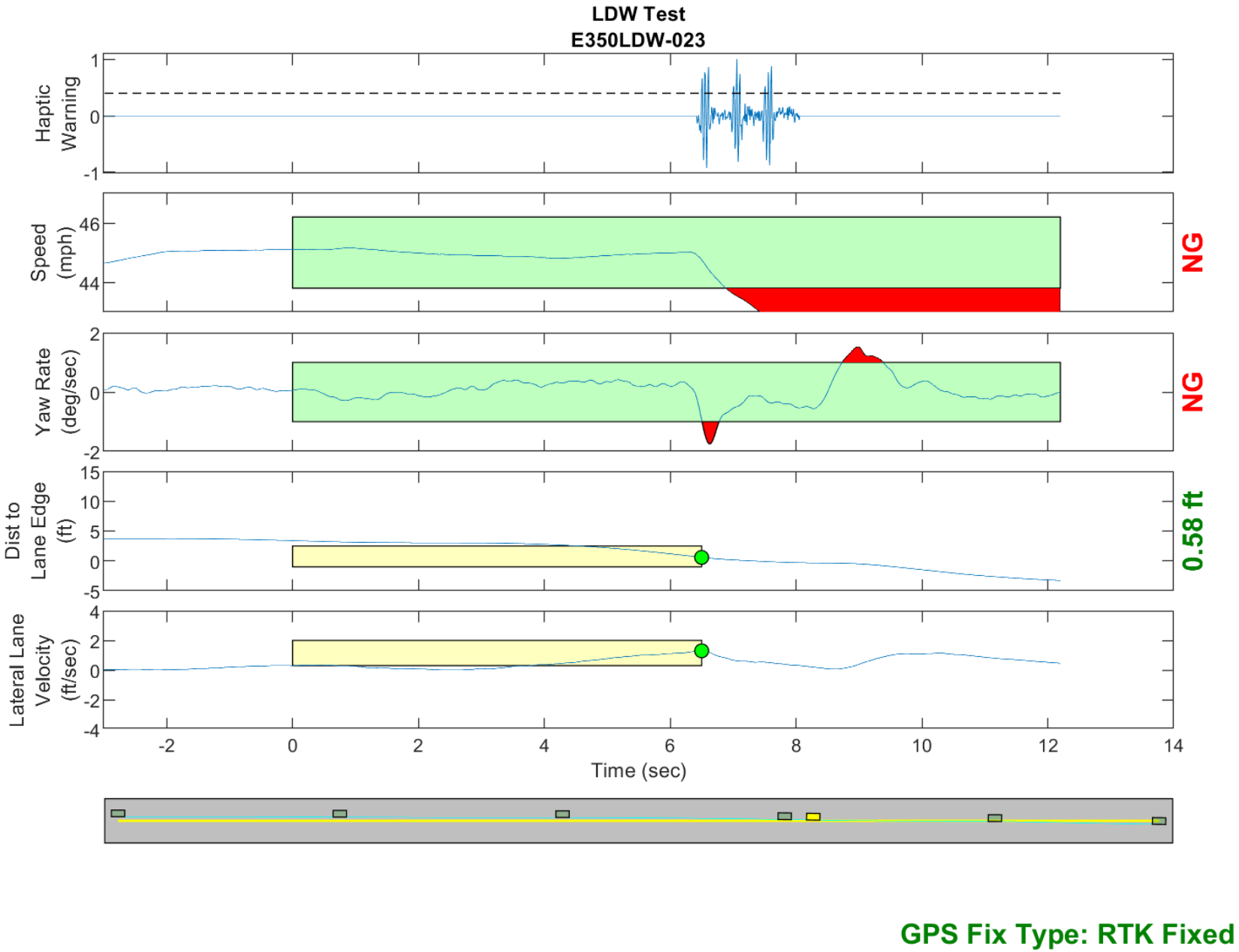

Figure D26. Time History for Run 23, Solid Line, Right Departure, Haptic Warning

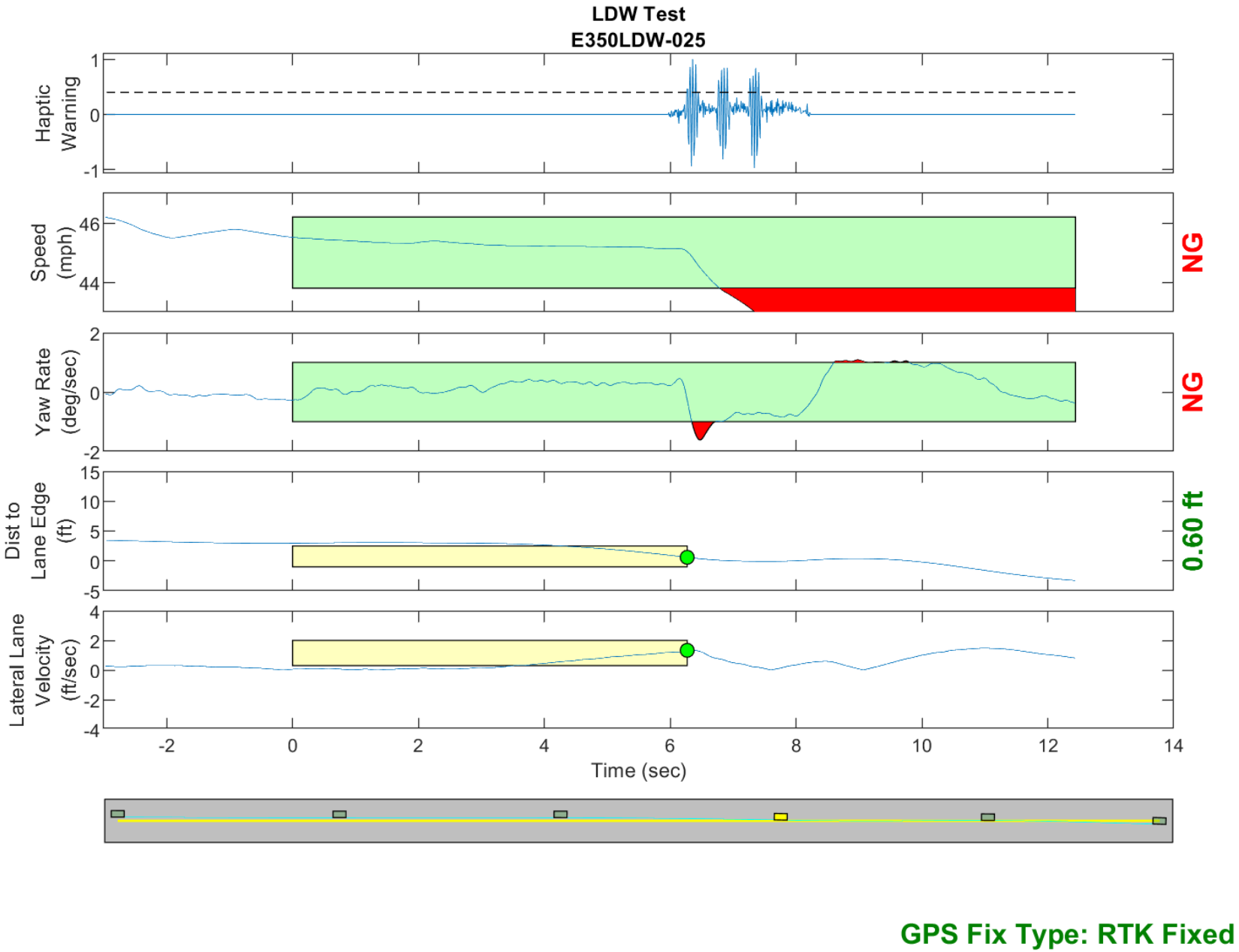

Figure D27. Time History for Run 25, Solid Line, Right Departure, Haptic Warning

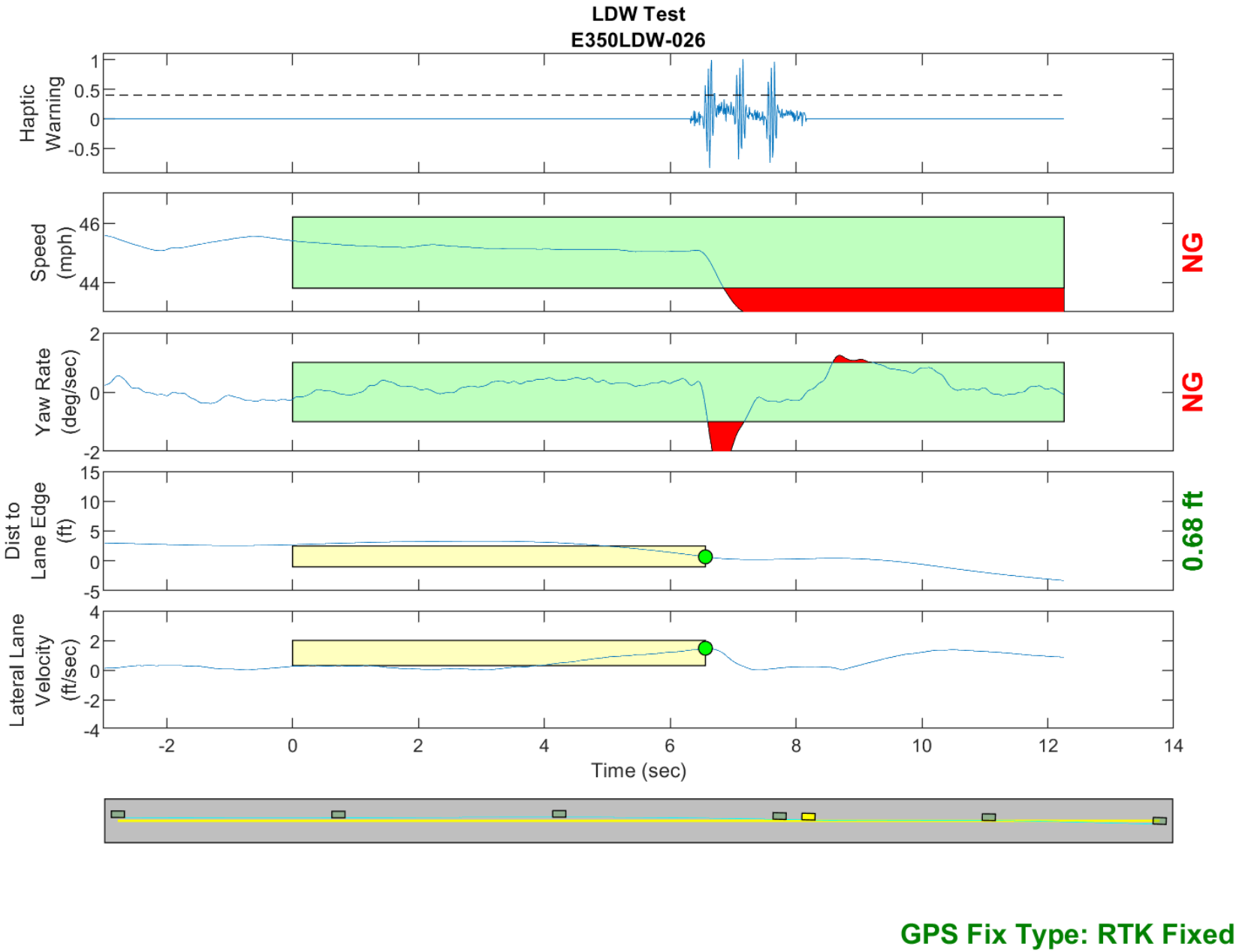

Figure D28. Time History for Run 26, Solid Line, Right Departure, Haptic Warning

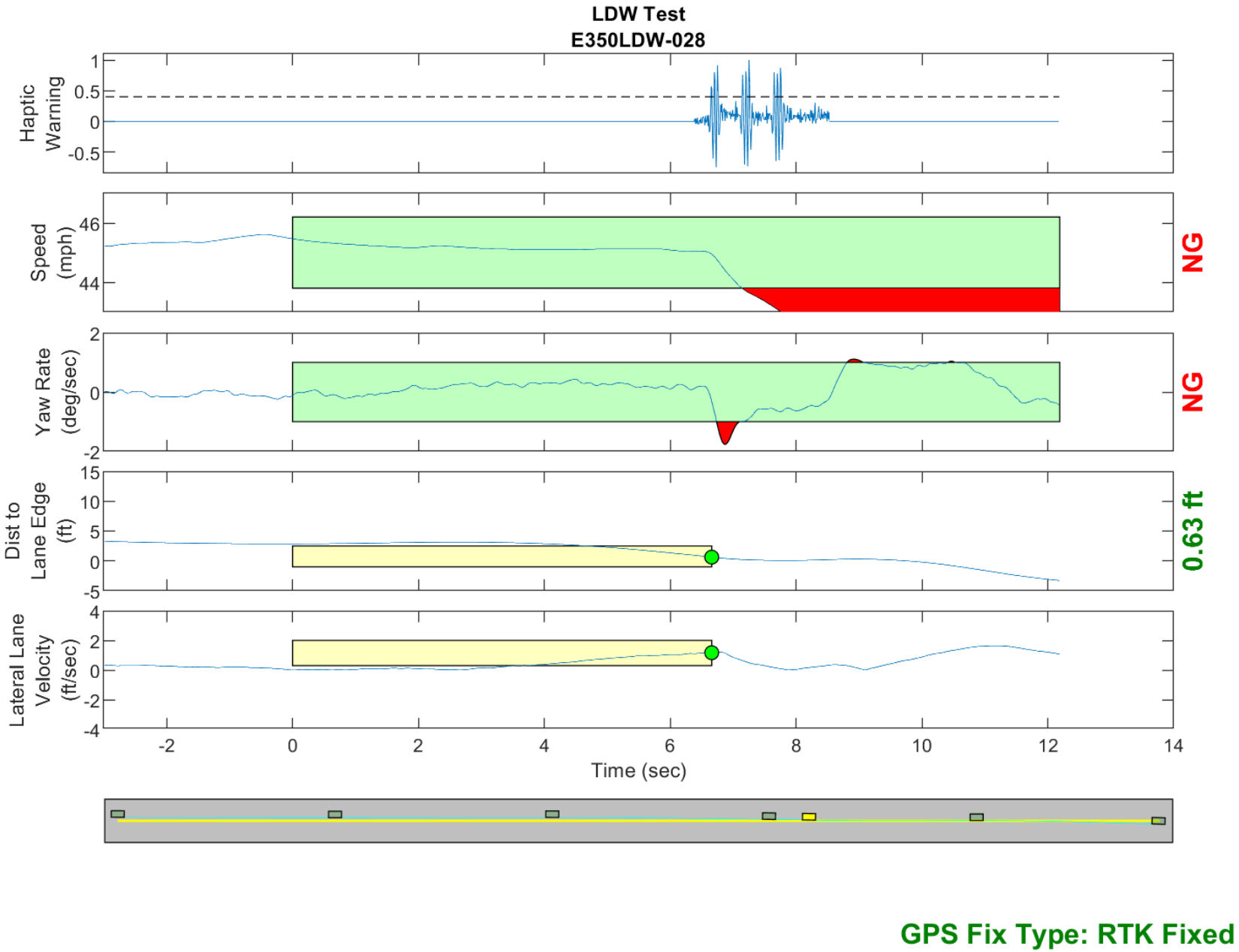

Figure D29. Time History for Run 28, Solid Line, Right Departure, Haptic Warning

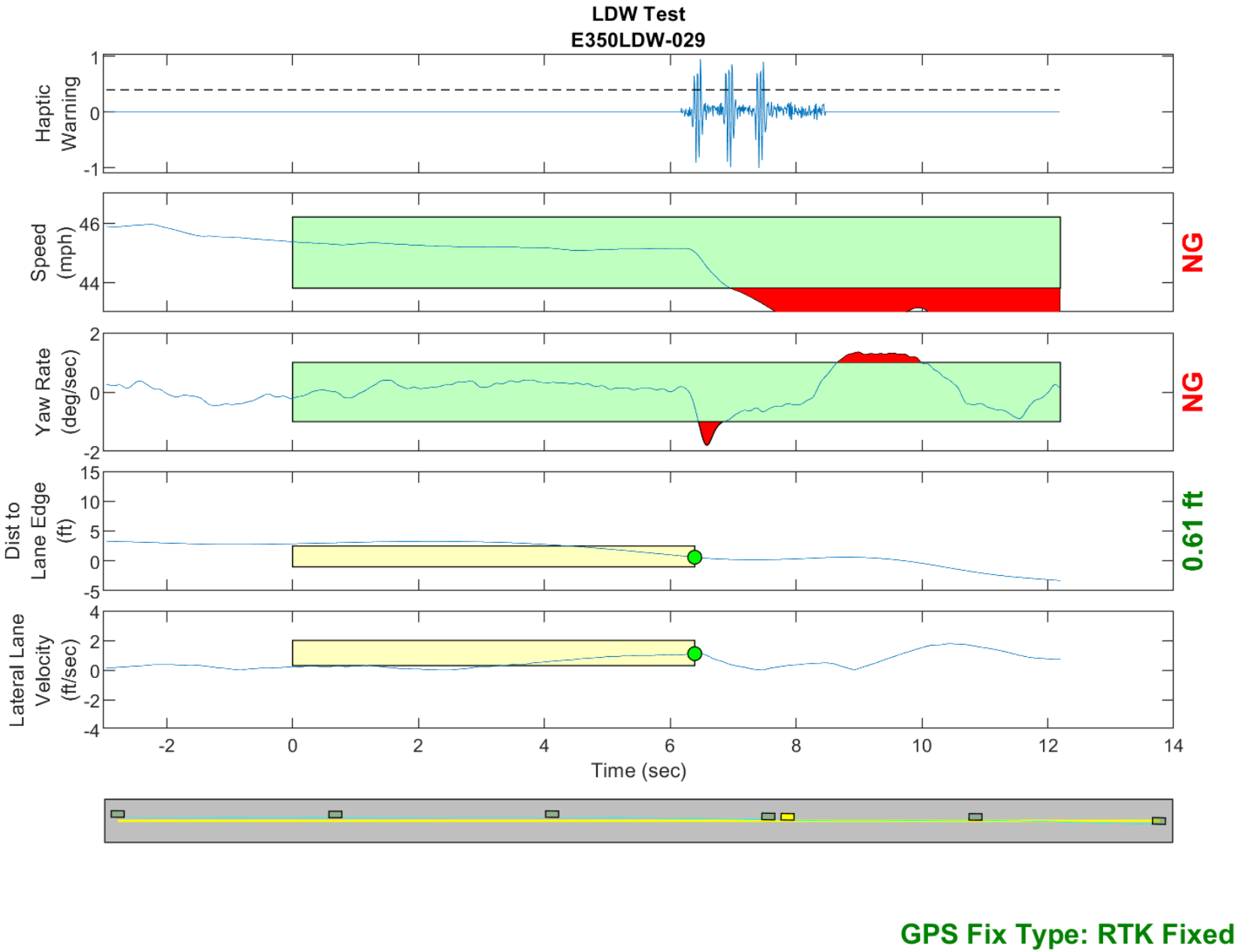

Figure D30. Time History for Run 29, Solid Line, Right Departure, Haptic Warning

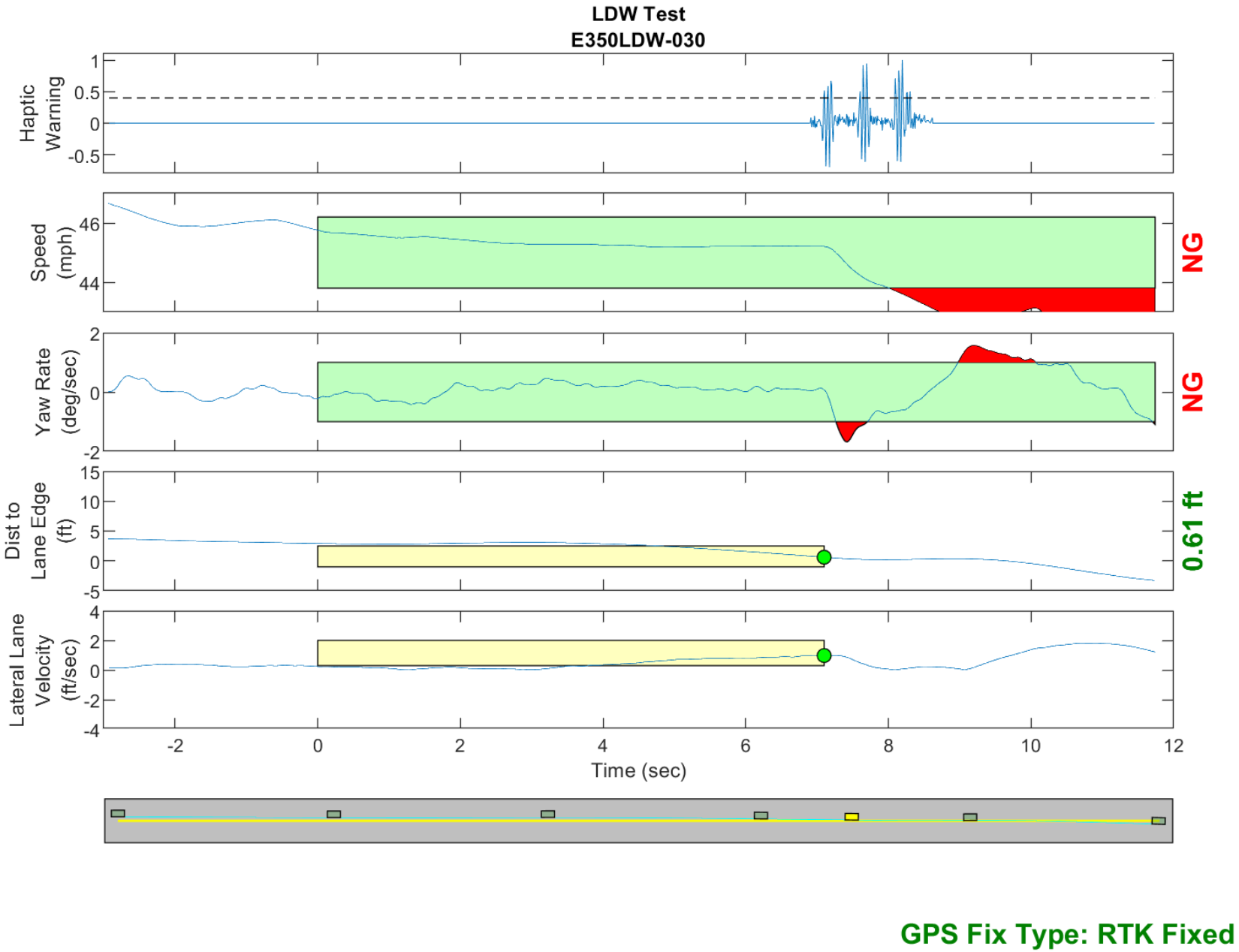

Figure D31. Time History for Run 30, Solid Line, Right Departure, Haptic Warning

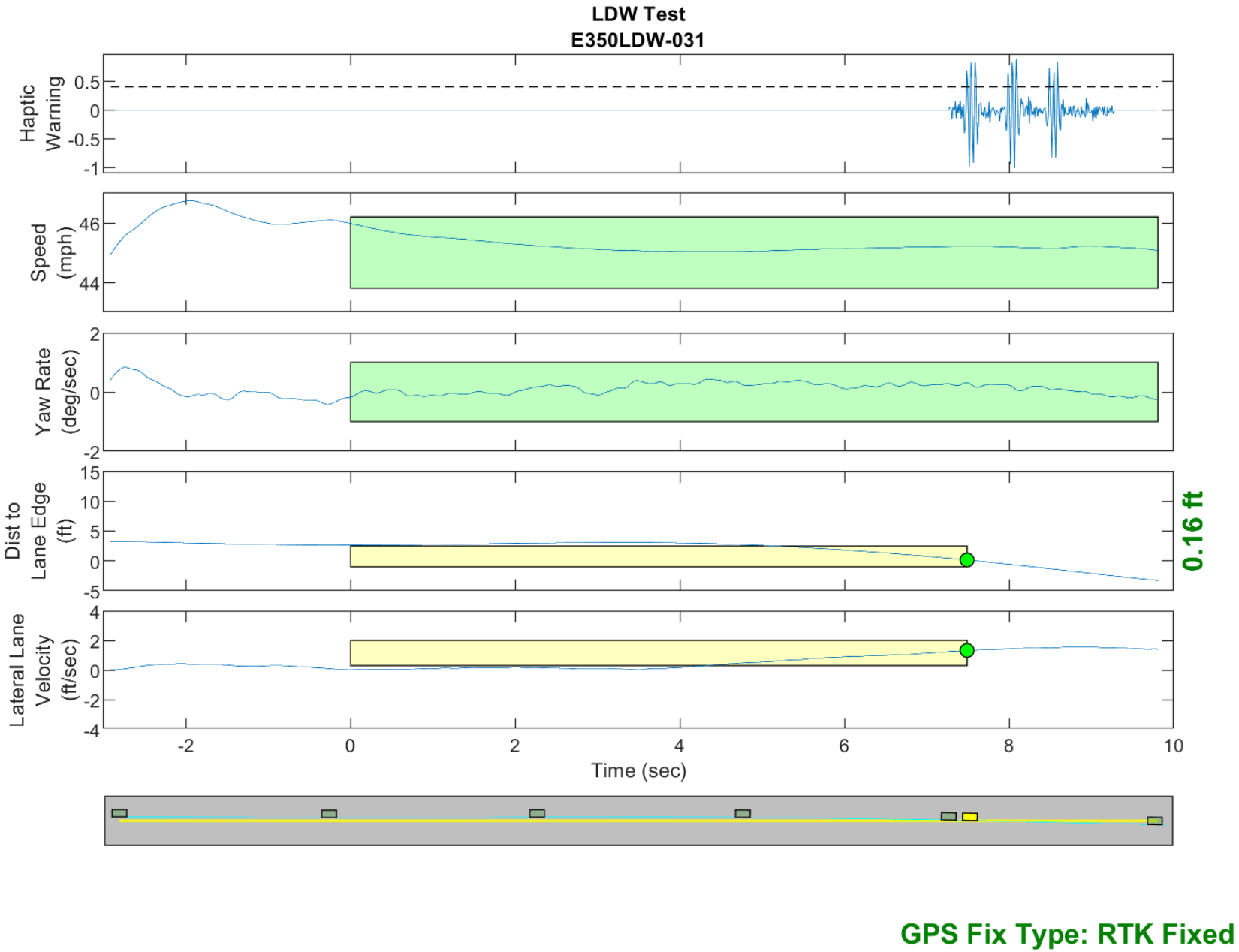

Figure D32. Time History for Run 31, Dashed Line, Right Departure, Haptic Warning

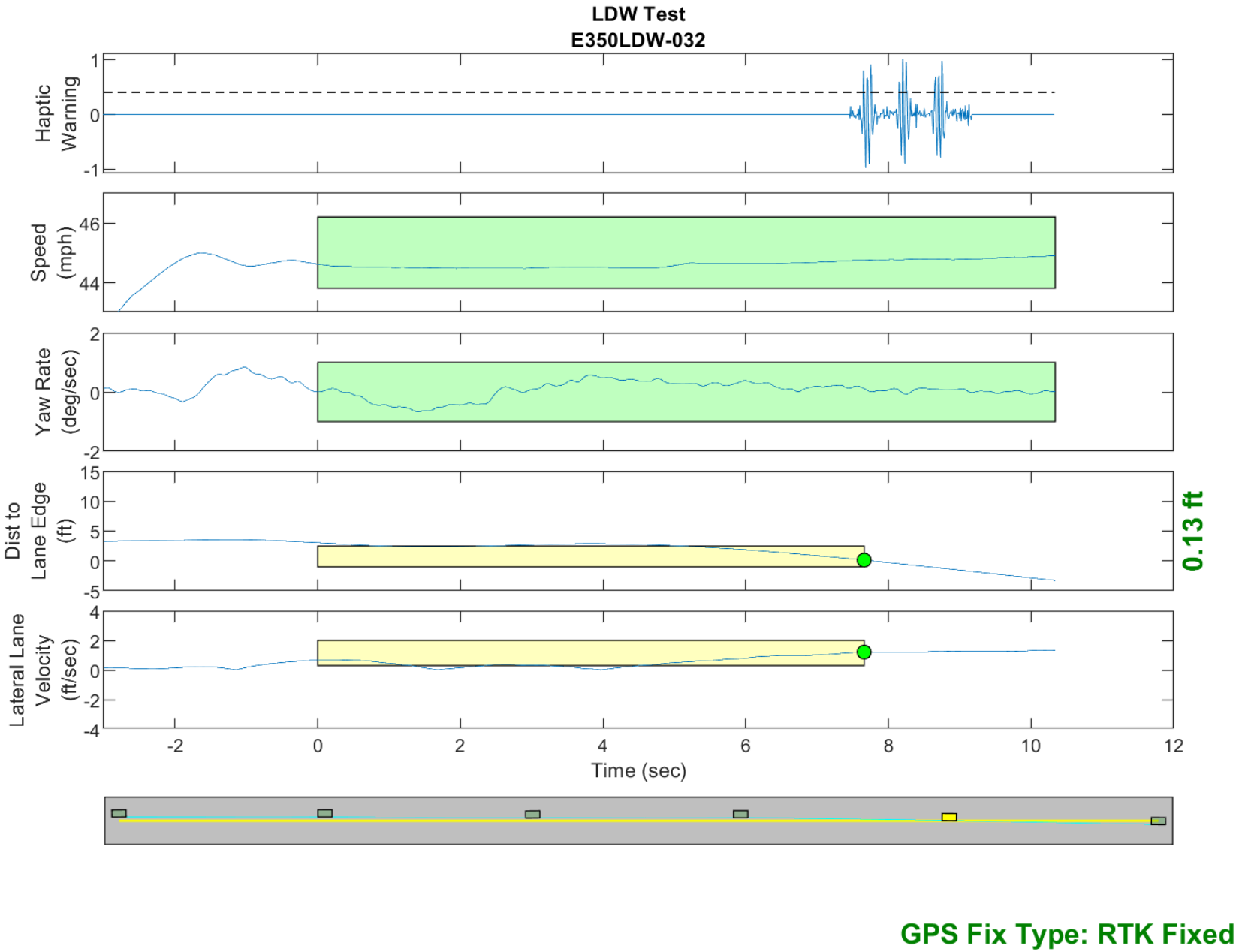

Figure D33. Time History for Run 32, Dashed Line, Right Departure, Haptic Warning

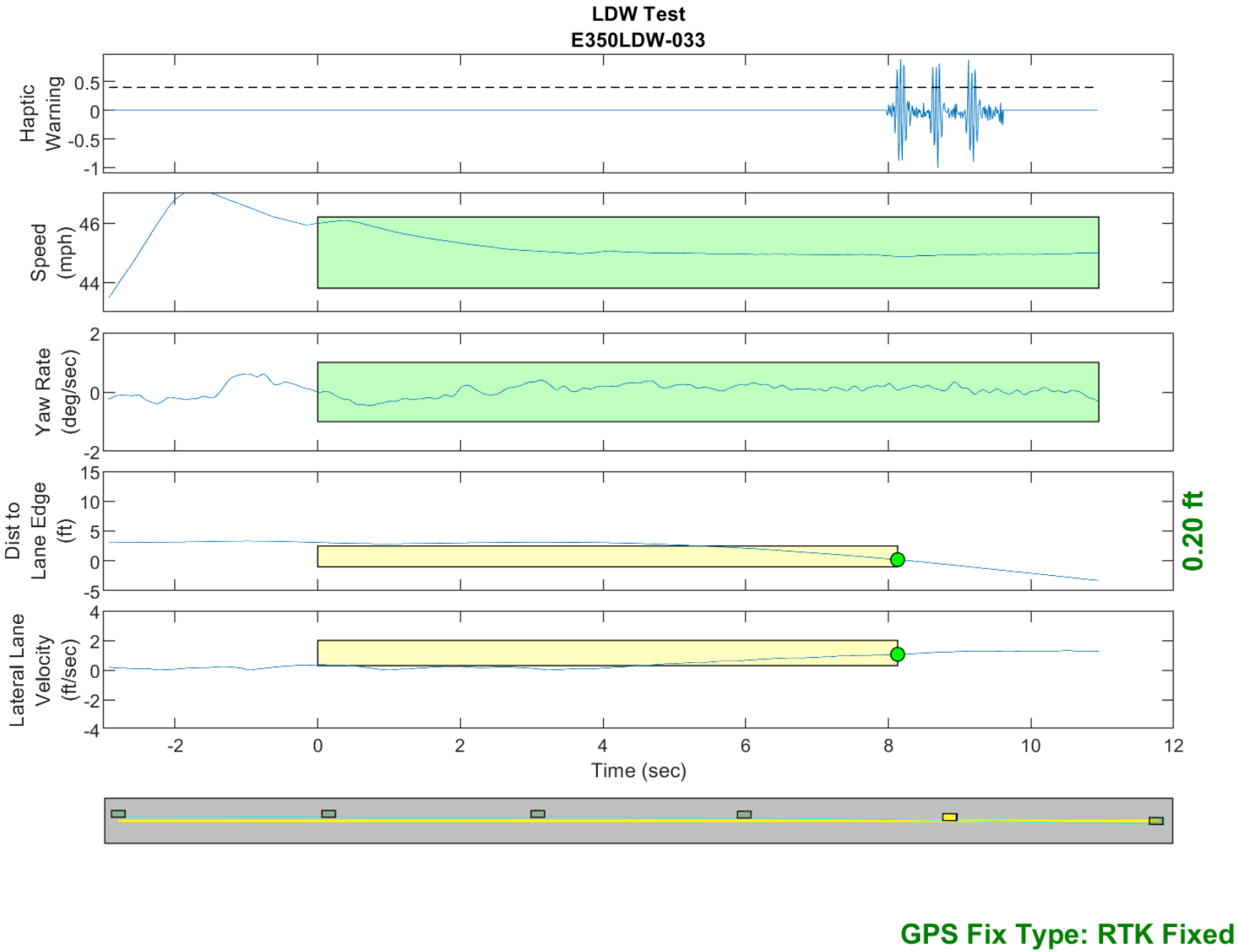

Figure D34. Time History for Run 33, Dashed Line, Right Departure, Haptic Warning

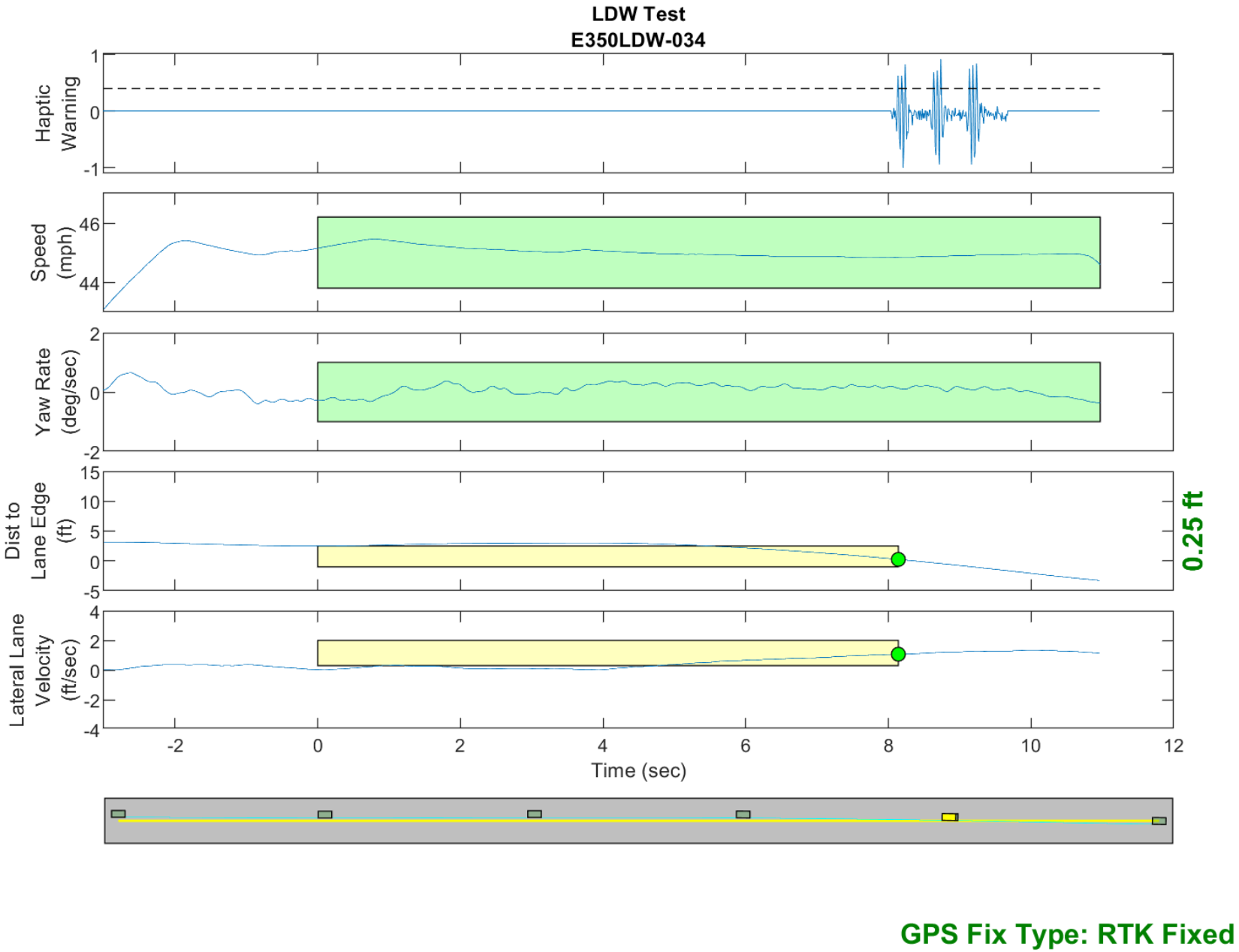

Figure D35. Time History for Run 34, Dashed Line, Right Departure, Haptic Warning

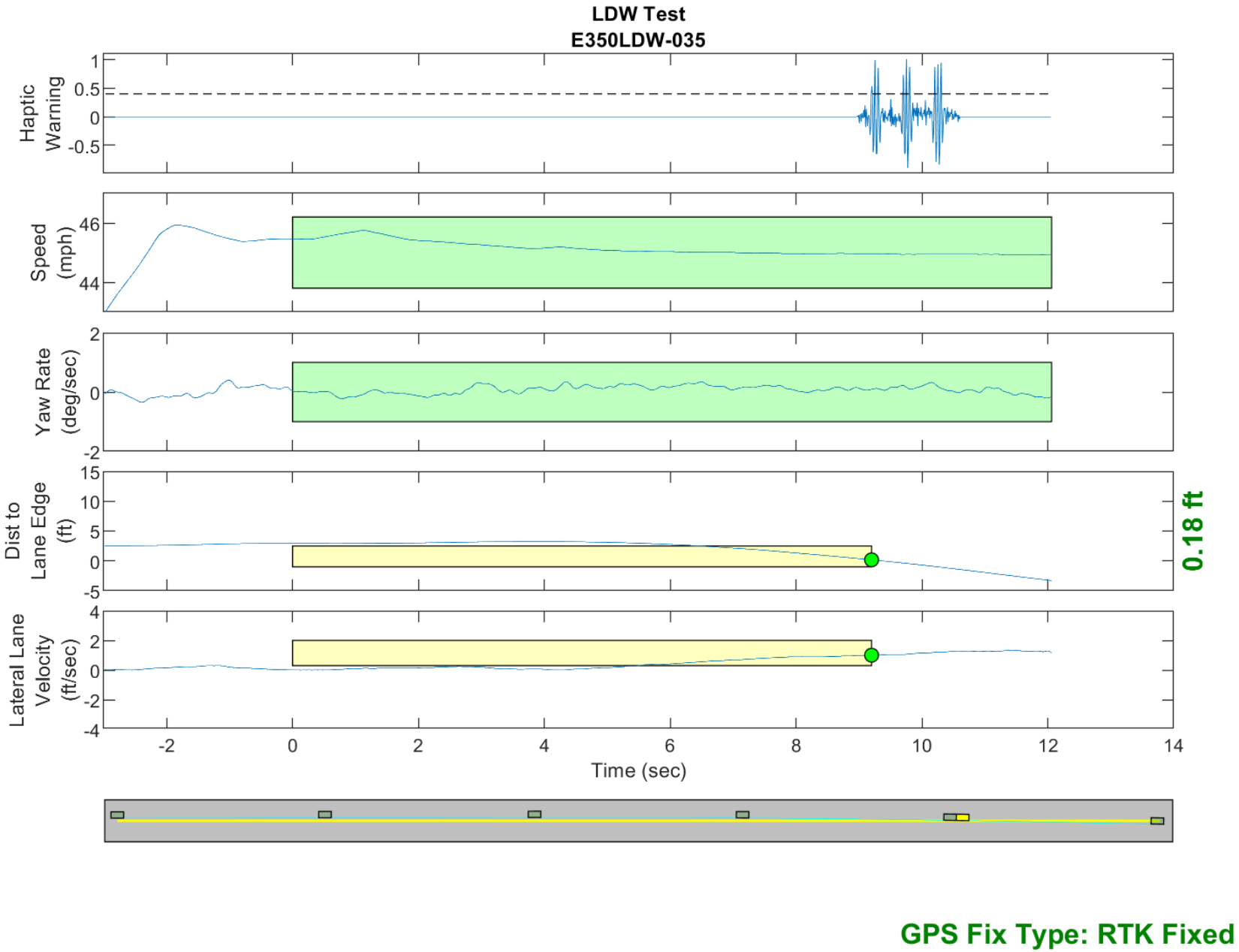

Figure D36. Time History for Run 35, Dashed Line, Right Departure, Haptic Warning

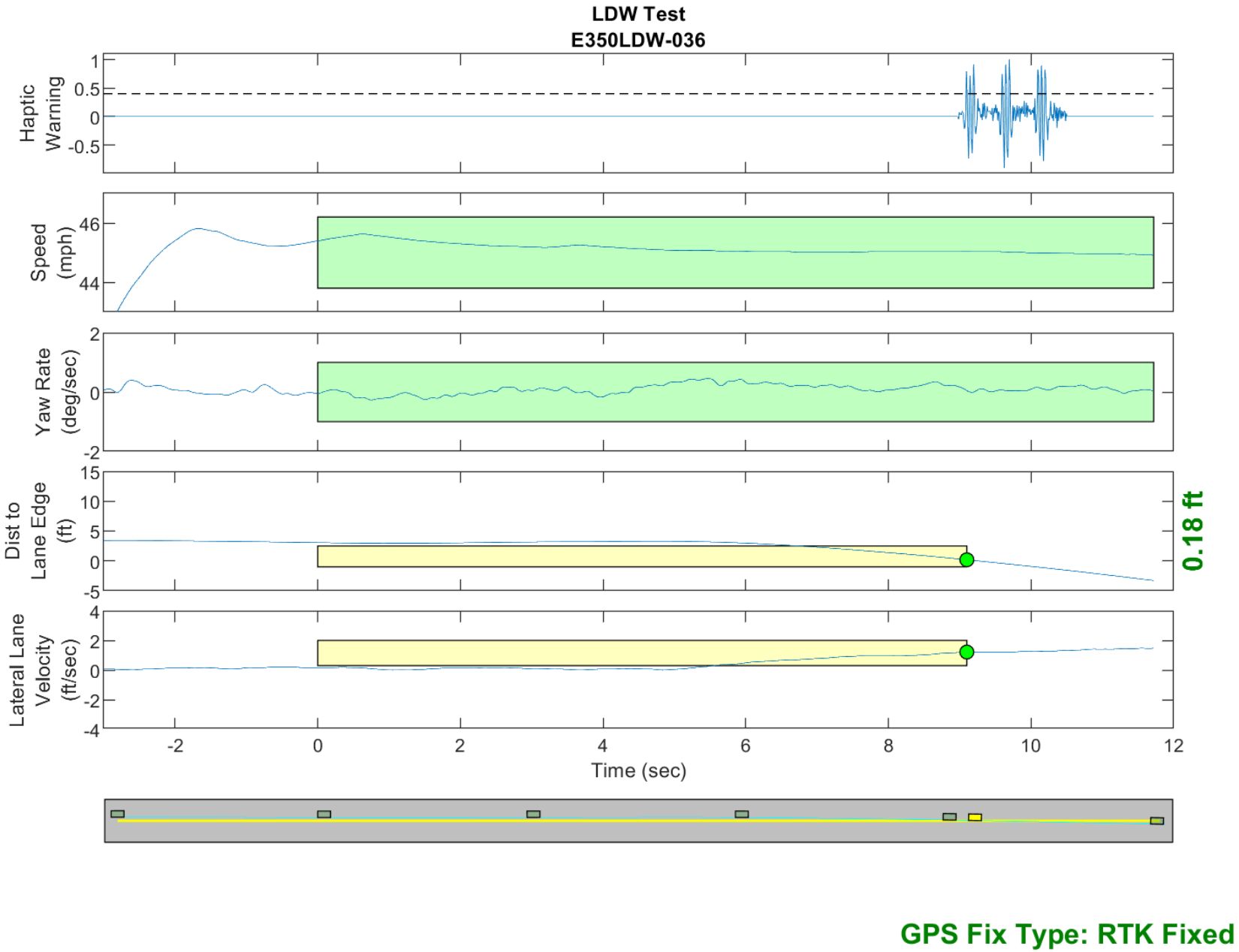

Figure D37. Time History for Run 36, Dashed Line, Right Departure, Haptic Warning

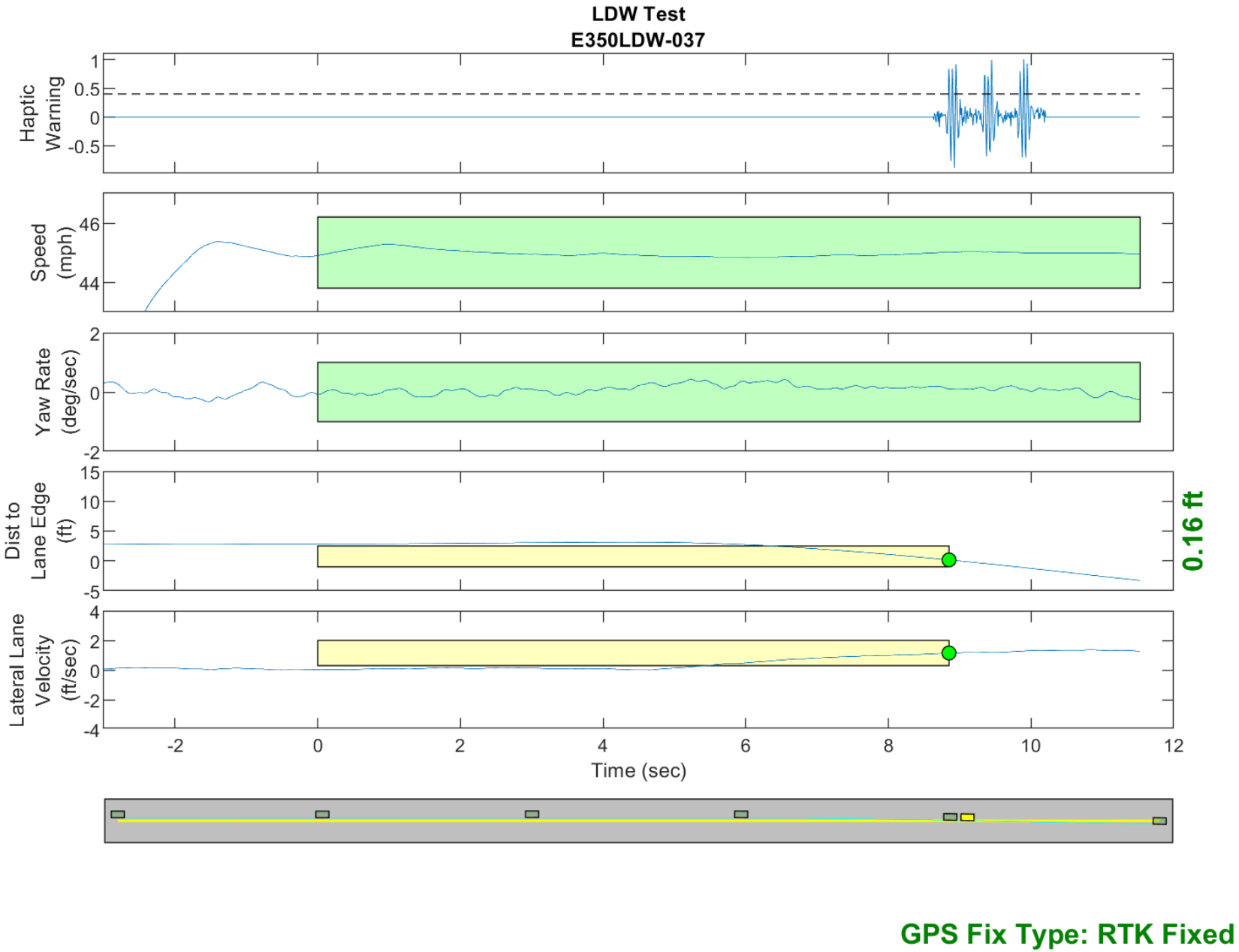

Figure D38. Time History for Run 37, Dashed Line, Right Departure, Haptic Warning

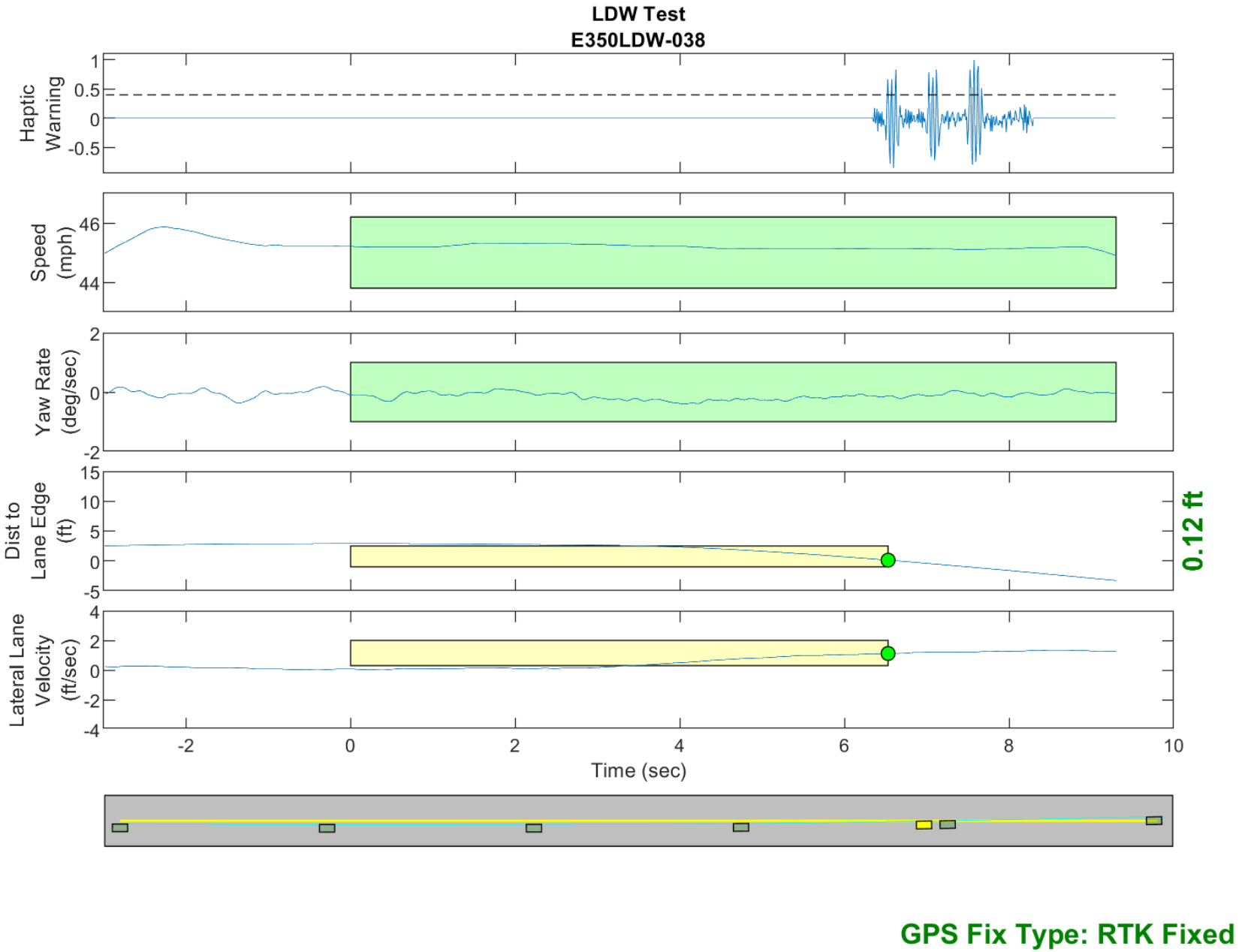

Figure D39. Time History for Run 38, Dashed Line, Left Departure, Haptic Warning

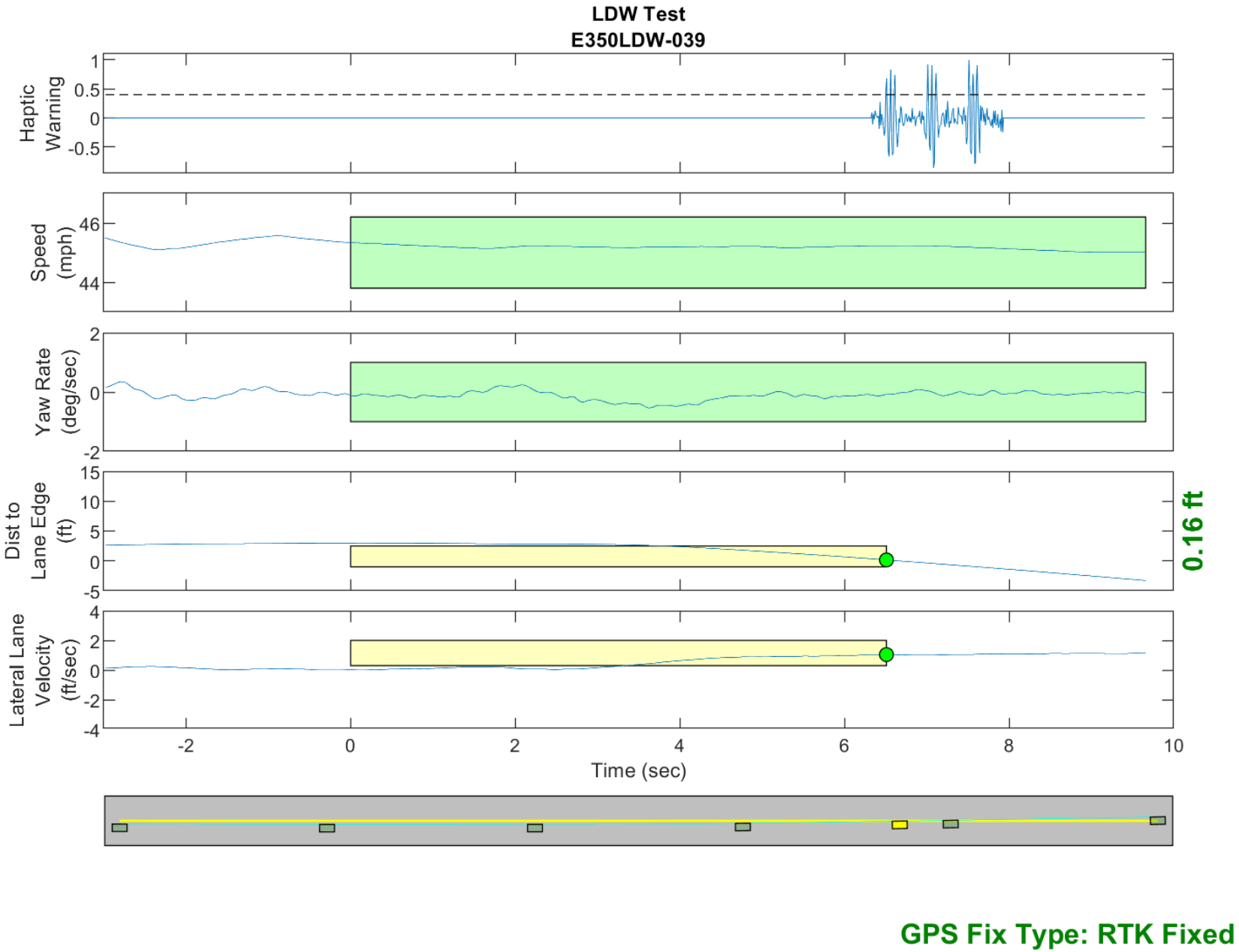

Figure D40. Time History for Run 39, Dashed Line, Left Departure, Haptic Warning

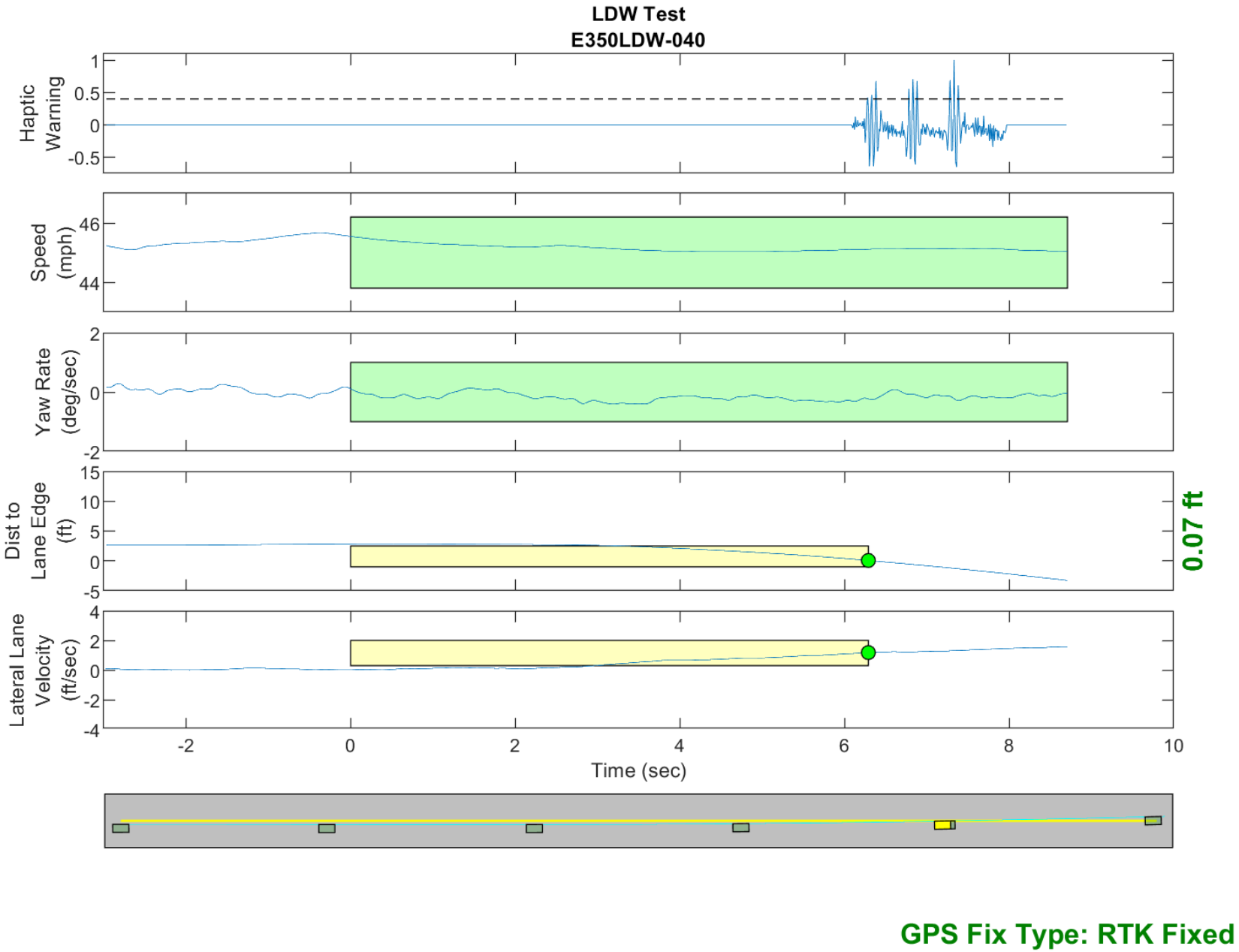

Figure D41. Time History for Run 40, Dashed Line, Left Departure, Haptic Warning

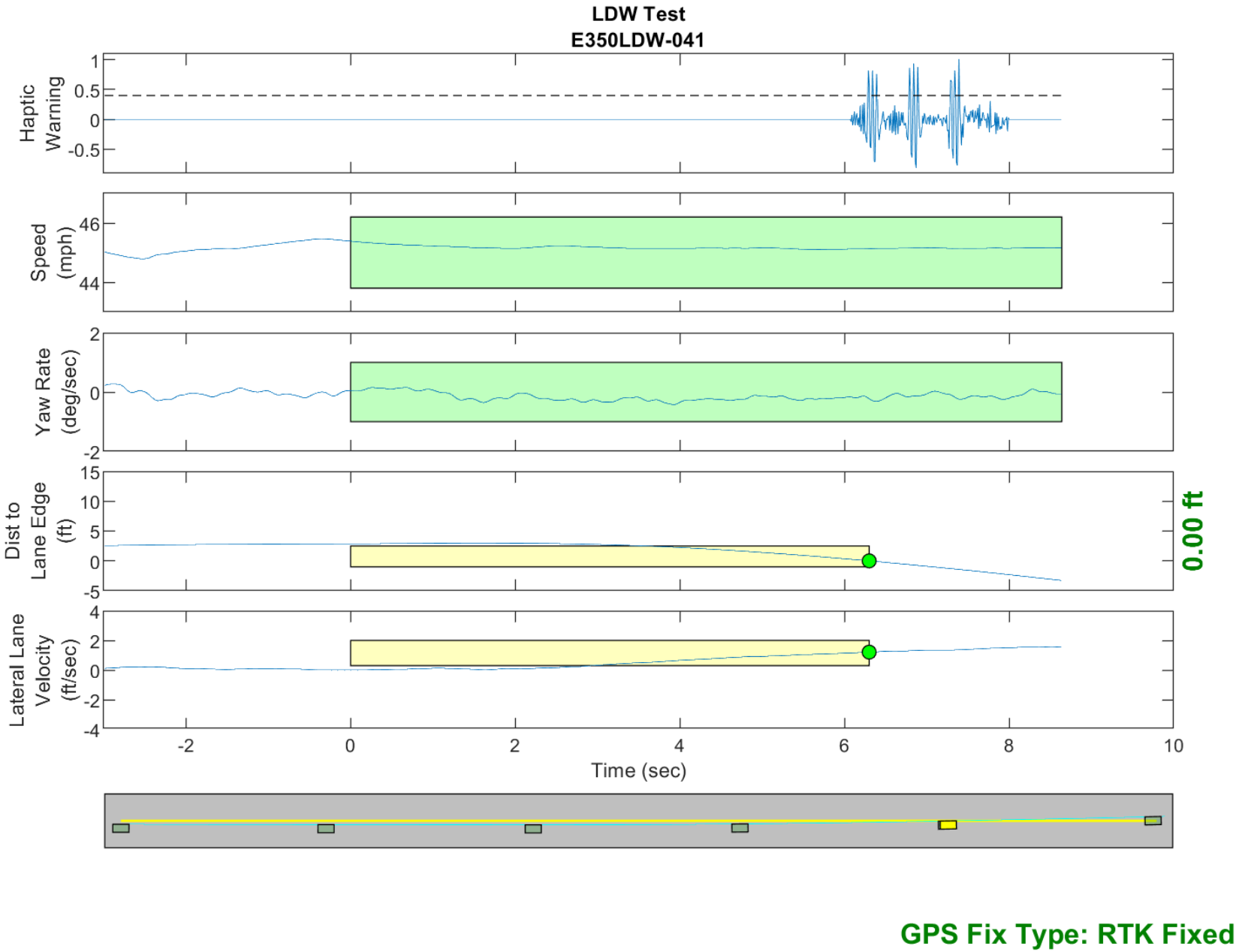

Figure D42. Time History for Run 41, Dashed Line, Left Departure, Haptic Warning

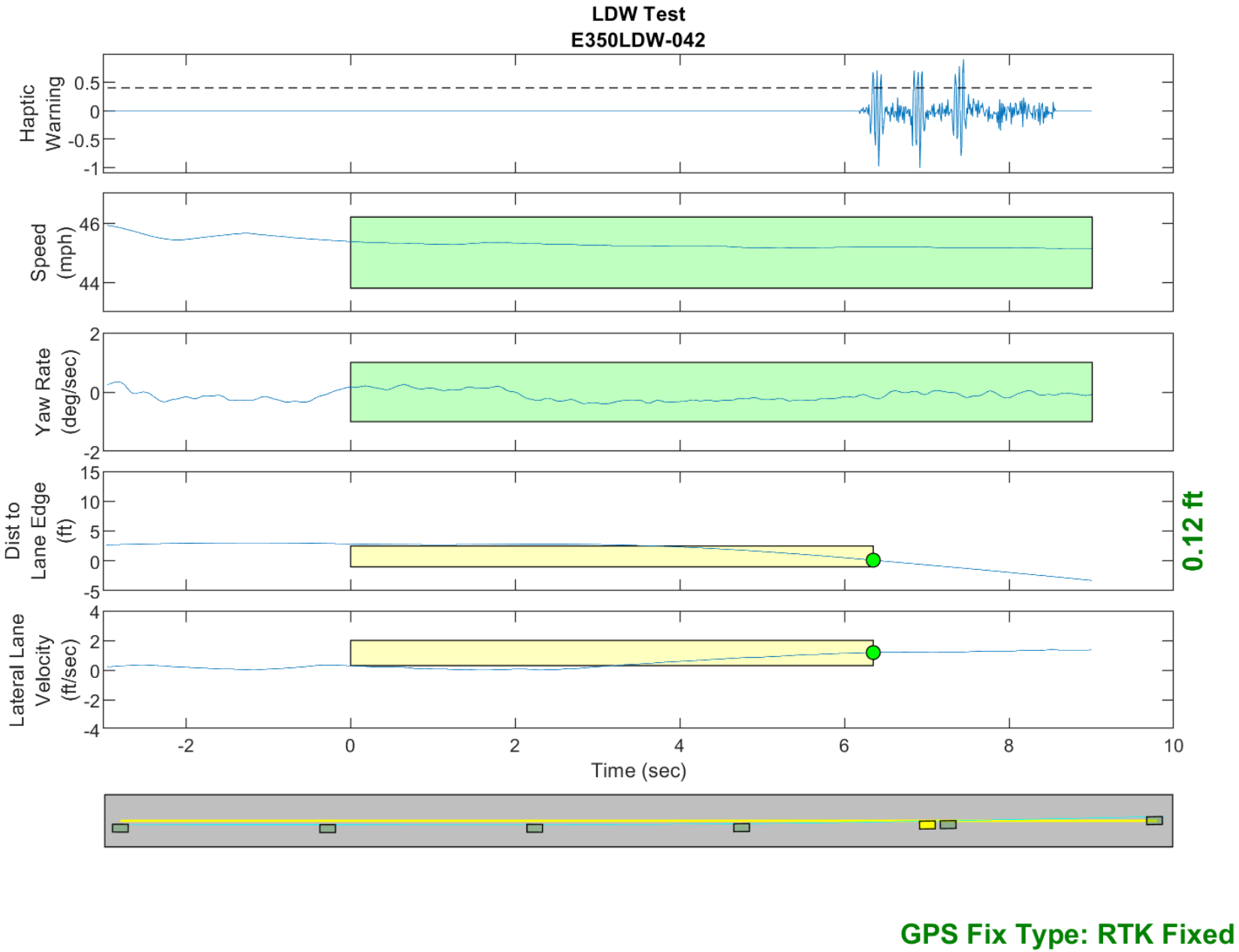

Figure D43. Time History for Run 42, Dashed Line, Left Departure, Haptic Warning

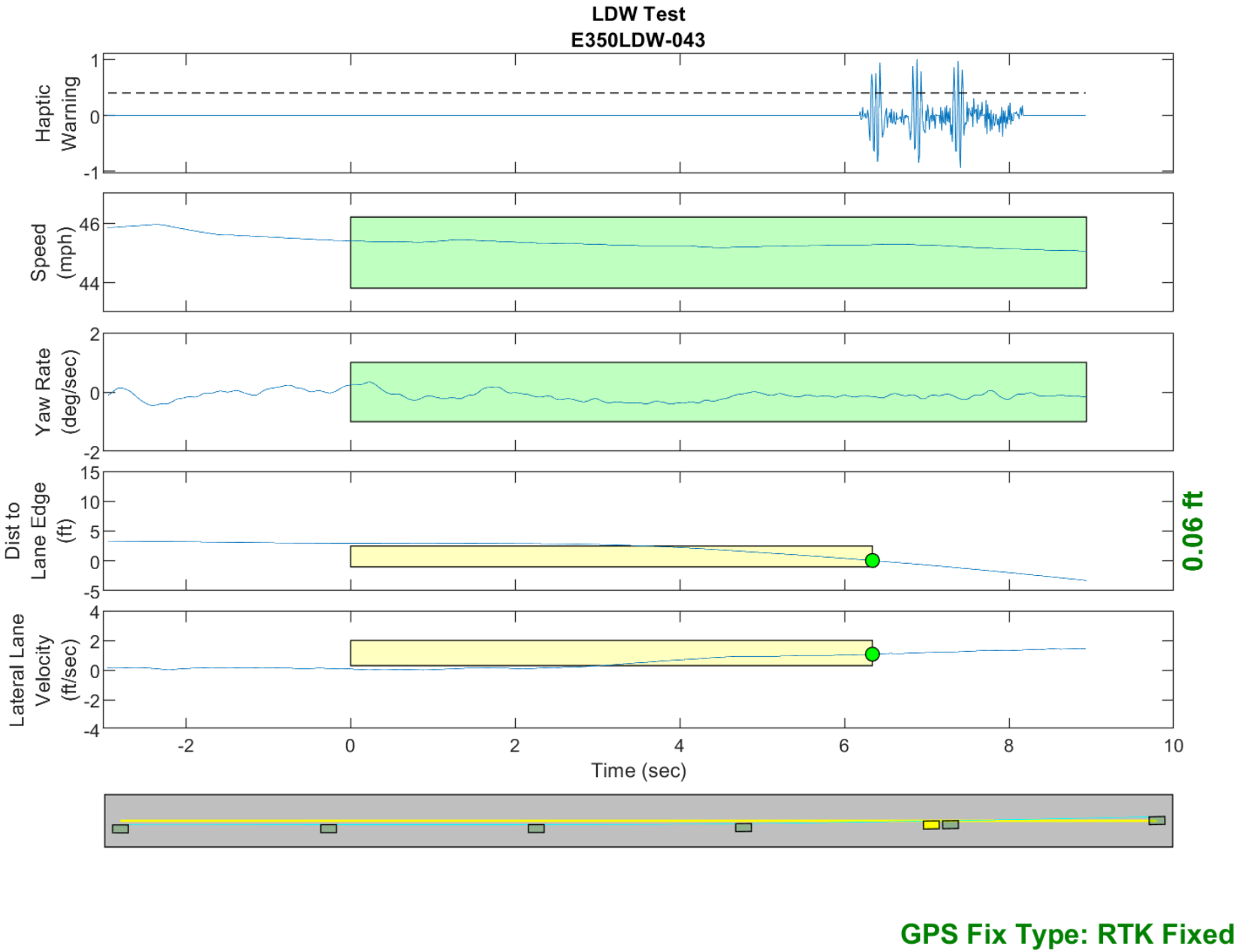

Figure D44. Time History for Run 43, Dashed Line, Left Departure, Haptic Warning

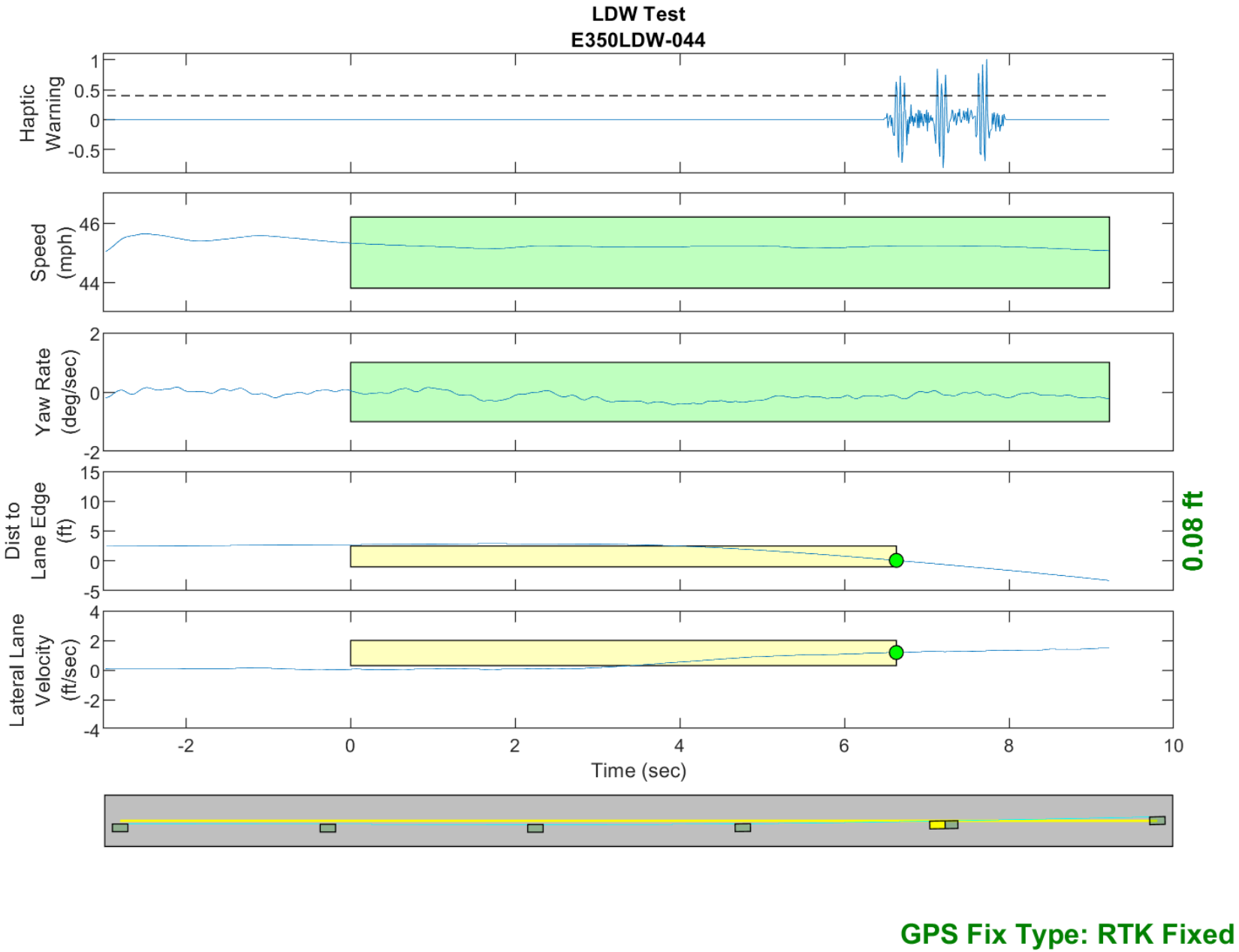

Figure D45. Time History for Run 44, Dashed Line, Left Departure, Haptic Warning