NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST
NCAP-DRI-LDW-20-14

2020 Mazda Mazda6 Sport

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28 May 2020

Final Report

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

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

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

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16. Abstract These tests were conducted on the subject 2020 Mazda Mazda6 Sport in accordance with the specifications of the New Car Assessment Program's (NCAP) most current Test Procedure in docket NHTSA-2006-26555-0135 to confirm the performance of a Lane Departure Warning system. The vehicle passed the requirements of the test for all three lane 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 2020 Mazda Mazda6 Sport. The LDW system for this vehicle provides both visual and aural 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)

2020 Mazda Mazda6 Sport

VIN: *JM1GL1UM1L151xxxx*

Test Date: *4/13/2020*

Lane Departure Warning setting: *Sensitivity - Before*
Warning – Often
Alert type - Beep (high volume)

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)

2020 Mazda Mazda6 Sport

TEST VEHICLE INFORMATION

VIN: *JM1GL1UM1L151xxxx*

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

Date Received: *4/6/2020* Odometer Reading: *5 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *MAZDA MOTOR CORPORATION*

Date of manufacture: *10/19*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *P225/55 R17*

Rear: *P225/55 R17*

Recommended cold tire pressure: Front: *250 kPa (36 psi)*

Rear: *250 kPa (36 psi)*

TIRES

Tire manufacturer and model: *Yokohama Advan A83*

Front tire size: *P225/55 R17 95V*

Rear tire size: *P225/55 R17 95V*

Front tire DOT prefix: *FDUPV24*

Rear tire DOT prefix: *FDUPV24*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2020 Mazda Mazda6 Sport

GENERAL INFORMATION

Test date: *4/13/2020*

AMBIENT CONDITIONS

Air temperature: *22.8 C (73 F)*

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

X Wind speed ≤10 m/s (22 mph)

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

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

VEHICLE PREPARATION

Verify the following:

All non-consumable fluids at 100% capacity: X

Fuel tank is full: X

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

Front: *250 kPa (36 psi)*

Rear: *250 kPa (36 psi)*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2020 Mazda Mazda6 Sport

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*490.3 kg (1081 lb)*	Right Front:	*470.4 kg (1037 lb)*
Left Rear:	*350.6 kg (773 lb)*	Right Rear:	*332.9 kg (734 lb)*
		Total:	*1644.2 kg (3625 lb)*

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 1 of 3)

2020 Mazda Mazda6 Sport

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

Lane-Keep Assist System (LAS) & Lane Departure Warning System (LDWS)

Lane Departure Warning Setting used in test:

Sensitivity – Before; Warning – Often; Alert type - Beep (high volume)

Type and location of sensor(s) used:

Mono camera. The Forward Sensing Camera (FSC) is installed at the top of the windshield near the rearview mirror

How is the Lane Departure Warning presented to the driver?

(Check all that apply)

X	Warning light
X	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 visual display is located within the instrument cluster. It depicts a rear view of a vehicle with lane lines on both sides. Lane lines that are not detected are shown as outlines, detected lanes are shown filled in. When the system detects that a line is being approached that lane line flashes on and off in yellow. See Appendix A, Figure A11 and Owner's Manual pages 4-166 through 4-172 shown in Appendix B, pages B-14 through B-20.

A secondary alert can be chosen as either a vibration in the steering wheel or a sound. The sound can be chosen as either a repeated beep or a rumble sound intended as a reproduction of the sound which occurs when a vehicle passes over a rumble strip.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

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2020 Mazda Mazda6 Sport

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.

A push button located to the left of the steering column can be used to switch the LAS and LDWS on and off. When switched off the LAS & LDWS OFF indicator light illuminates.

When the ignition is switched OFF, the system status before it was turned off is maintained. For example, if the ignition is switched OFF with the lane-keep system operable, the system will be operable when the ignition is switched ON the next time.

See Owner's Manual, Pages 4-169 and 4-171 shown in Appendix B, Pages B-17 and B-19, and also Appendix A, Figure A12.

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

If yes, please provide a full description.

A touchscreen located in the center of the dash panel provides an interface to the settings. The hierarchy is:

Settings

Safety - Select Lane-keep Assist System

Intervention - Select on or off (check or uncheck)

Alert Timing - Select "At" or "Before"

Warning - Select "Often" or "Rare"

Alert Type - Select "Vibration", "Beep" or "Rumbl."

Warning Intensity/Volume:

Vibration - Select "High" or "Low"

Rumbl. - Select "High", "Mid", or "Low"

Beep - Select "High" or "Low"

Refer to Owner's Manual, Pages 9-12 and 9-13 shown in Appendix B, Pages B-31 and B-32 and Appendix A, Figure A10.

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

X Yes

____ No

If yes, please provide a full description.

System limitations are described in the Owner's Manual on pages 4-163 through 4-165. These pages are shown in Appendix B, Pages B-11 through B-13.

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

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

Table 1. LDW Test Matrix

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

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

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

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

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

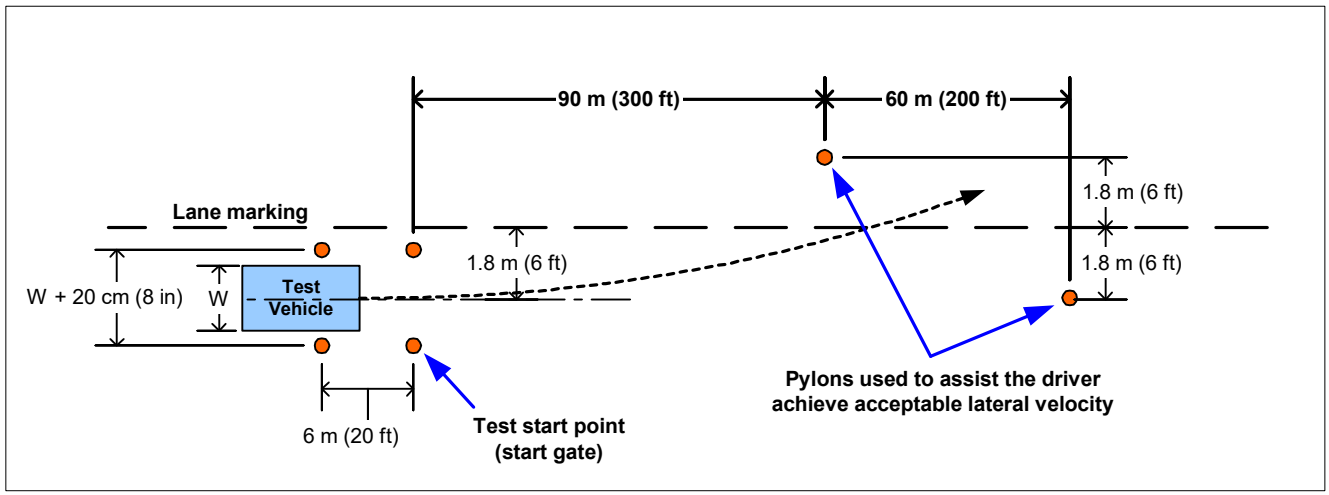


Figure 1. Position of Cones Used to Assist Driver

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

B. Lane Delineation Markings

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

1. Lane Marker Width

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

2. Line Marking Color and Reflectivity

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

3. Line Styles

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

- Continuous White Line

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

- Dashed Yellow Line

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

- Raised Pavement Marker Line (Botts Dots)

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

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

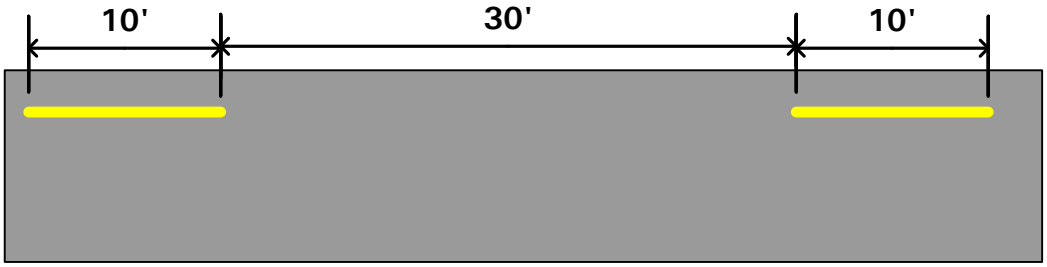


Figure 2. MUTCD Discontinuous Dashed Line Specifications

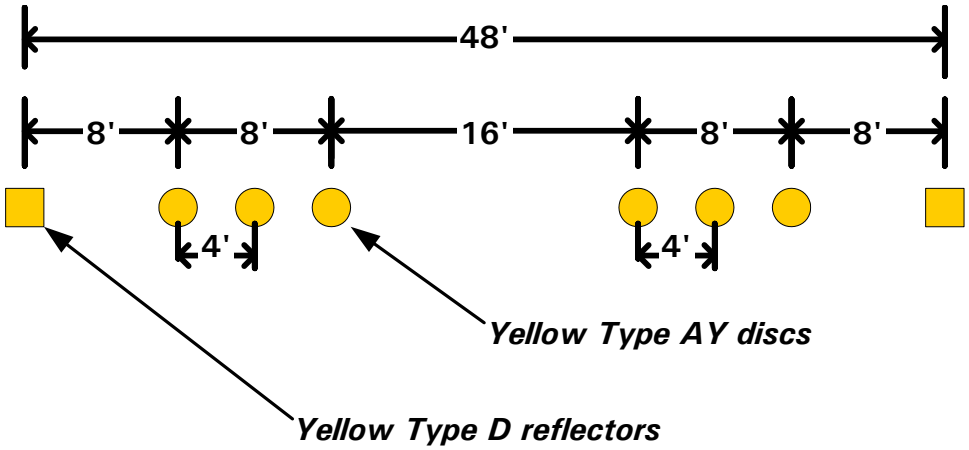


Figure 3. California Standard Plan A20A, Detail 4

C. Test Validity

1. Speed

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

2. Lateral Velocity

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

3. Yaw Rate

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

D. Pass/Fail Criteria

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

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

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

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

E. Instrumentation

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

Table 2. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	0.5 psi 3.45 kPa	Ashcroft, D1005PS	17042707002	By: DRI Date: 7/3/2019 Due: 7/3/2020
Platform Scales	Vehicle Total, Wheel, and Axle Load	8000 lb 35.6 kN	±1.0% of applied load	Intercomp, SWII	1110M206352	By: DRI Date: 1/6/2020 Due: 1/6/2021
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	NA
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots Accel: ±100 m/s^2 Angular Rate: ±100 deg/s Angular Disp: ±180 deg	Position: ±2 cm Velocity: 0.05 km/h Accel: ≤ 0.01% of full range Angular Rate: ≤ 0.01% of full range Roll/Pitch Angle: ±0.03 deg Heading Angle: ±0.1 deg	Oxford Technical Solutions (OXTS), Inertial+	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	NA

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

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2020 Due: 1/6/2021

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

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

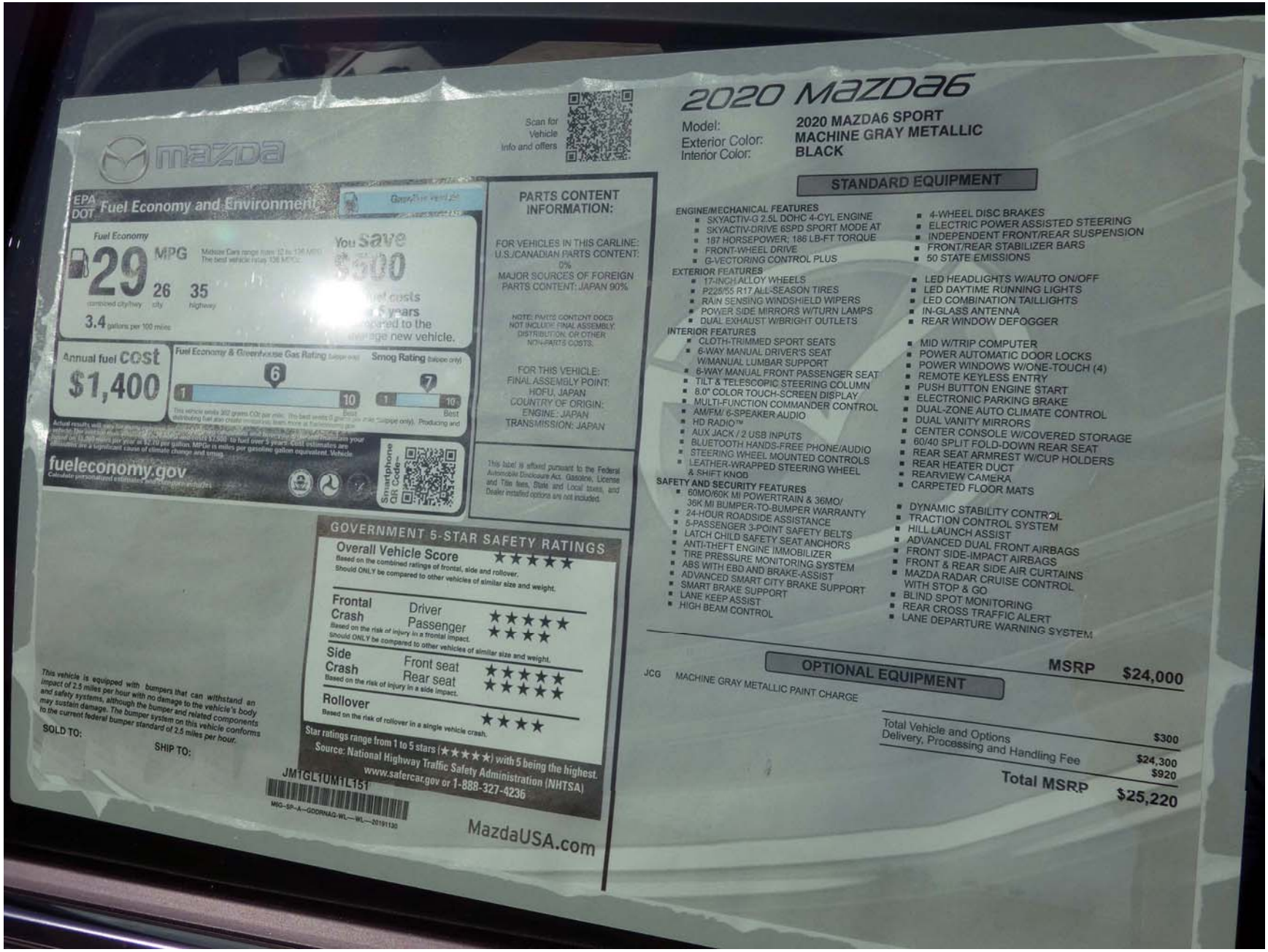


Figure A3. Window Sticker (Monroney Label)

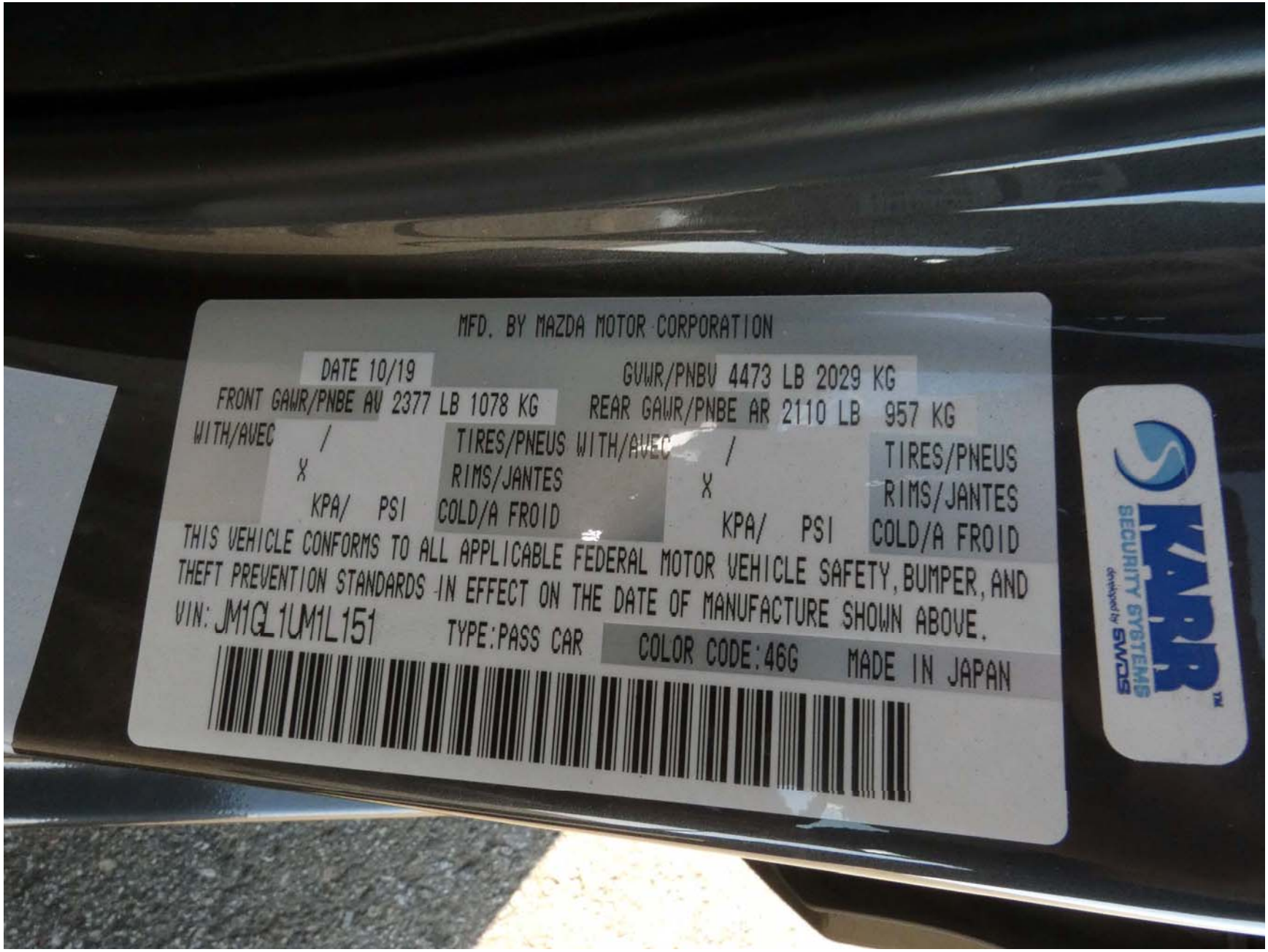


Figure A4. Vehicle Certification Label

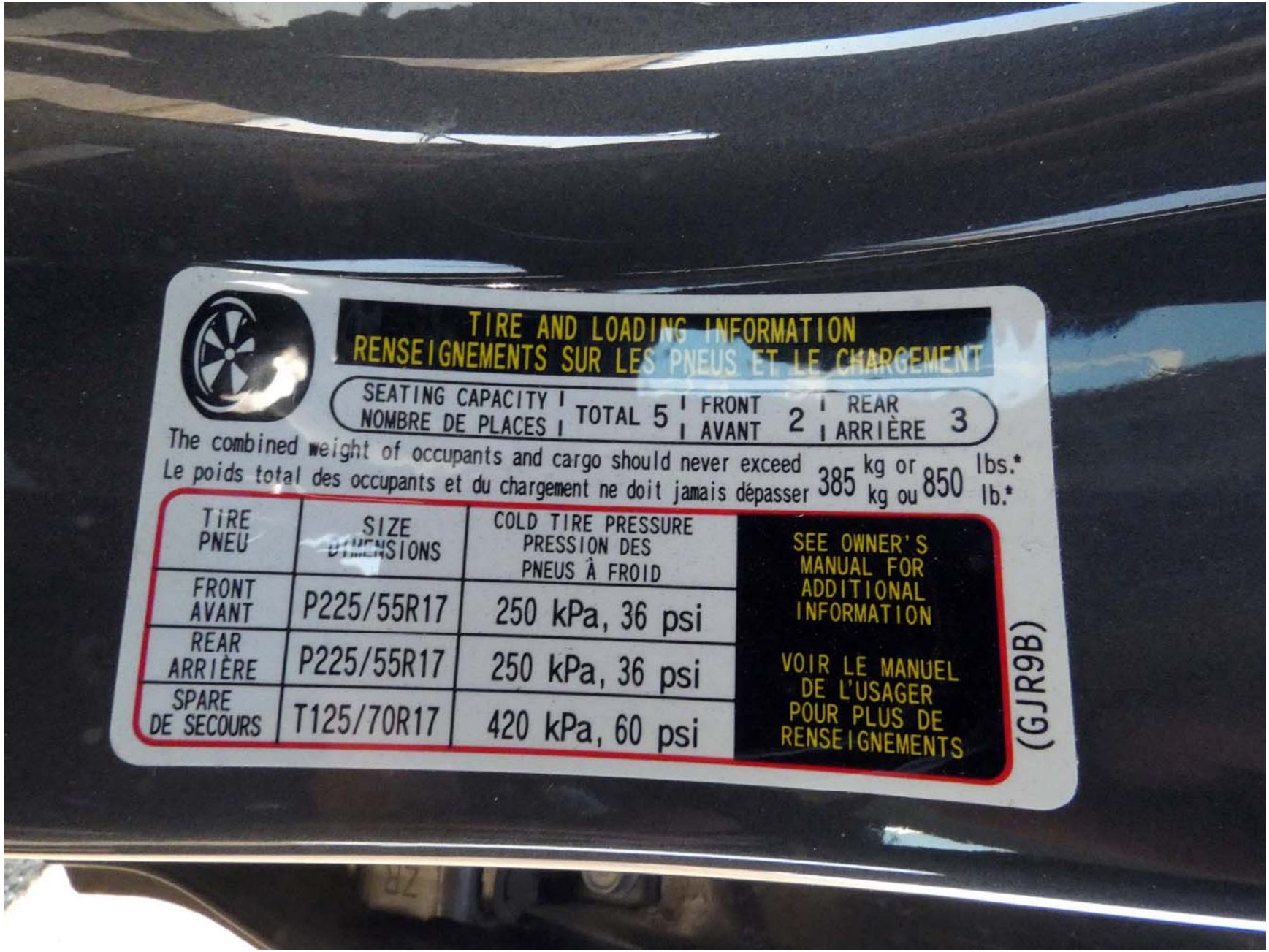


Figure A5. Tire Placard

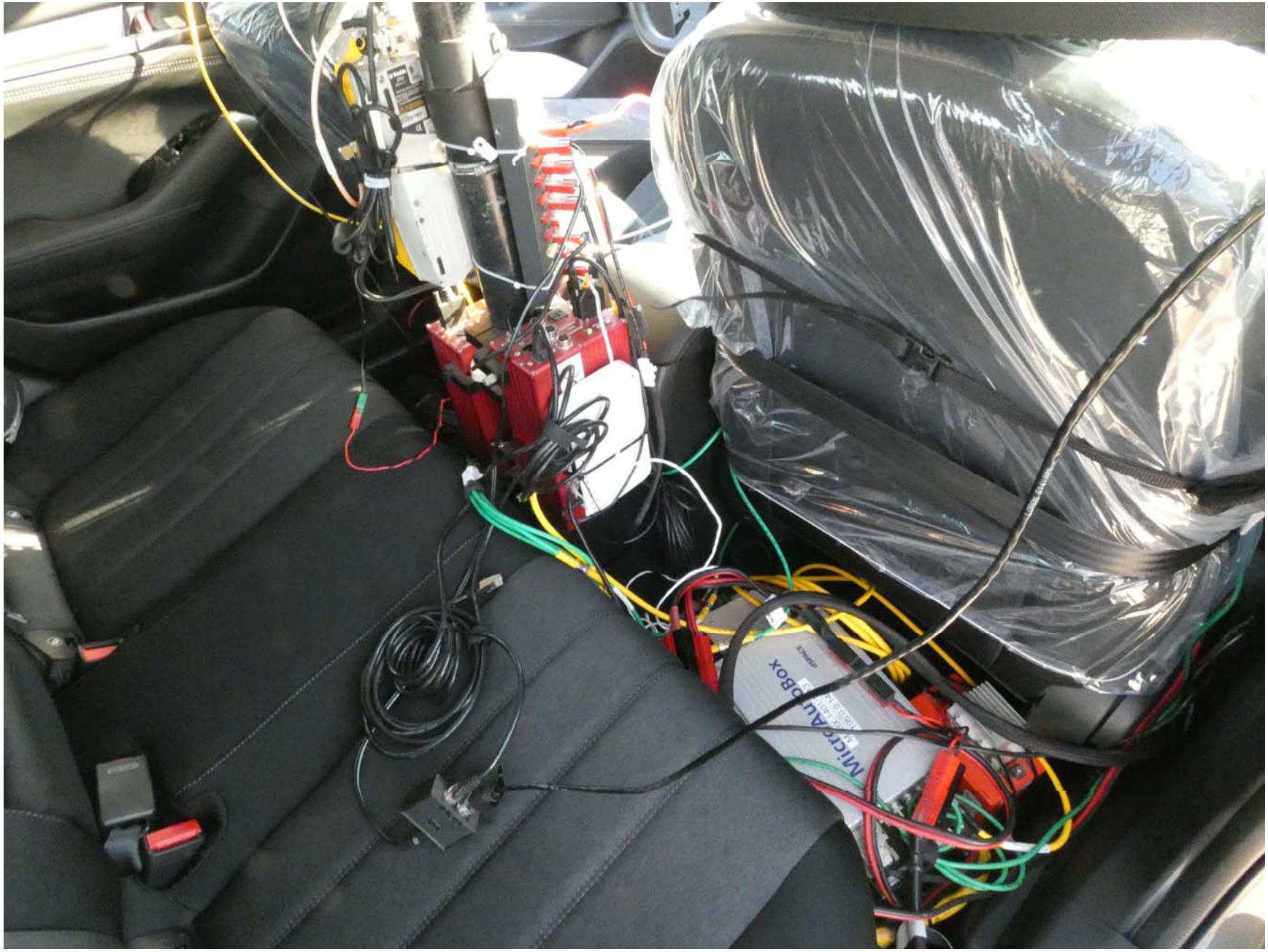


Figure A6. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A7. Sensor for Detecting Auditory Alerts

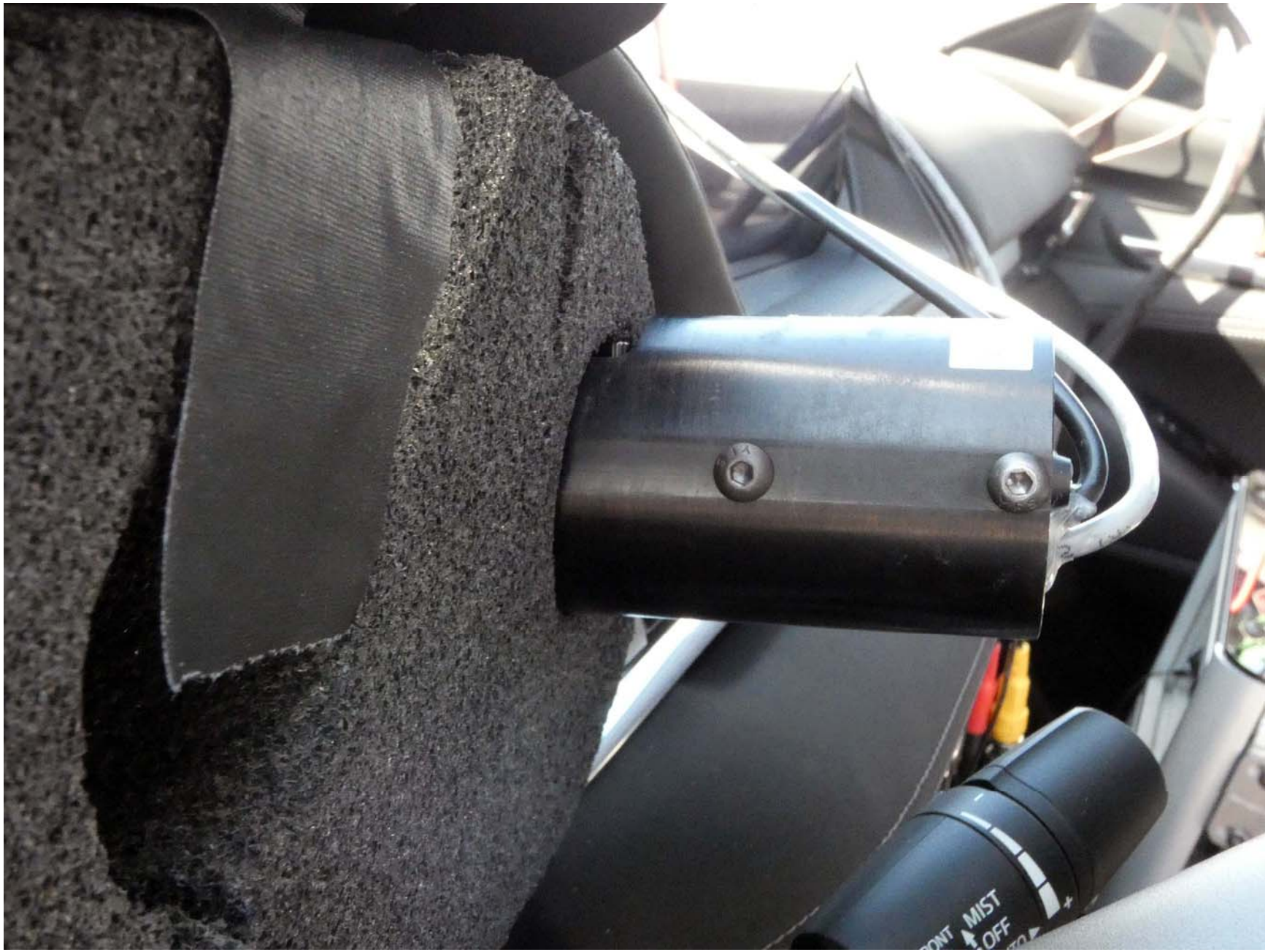


Figure A8. Sensor for Detecting Visual Alerts

Figure A9. Computer Installed in Subject Vehicle

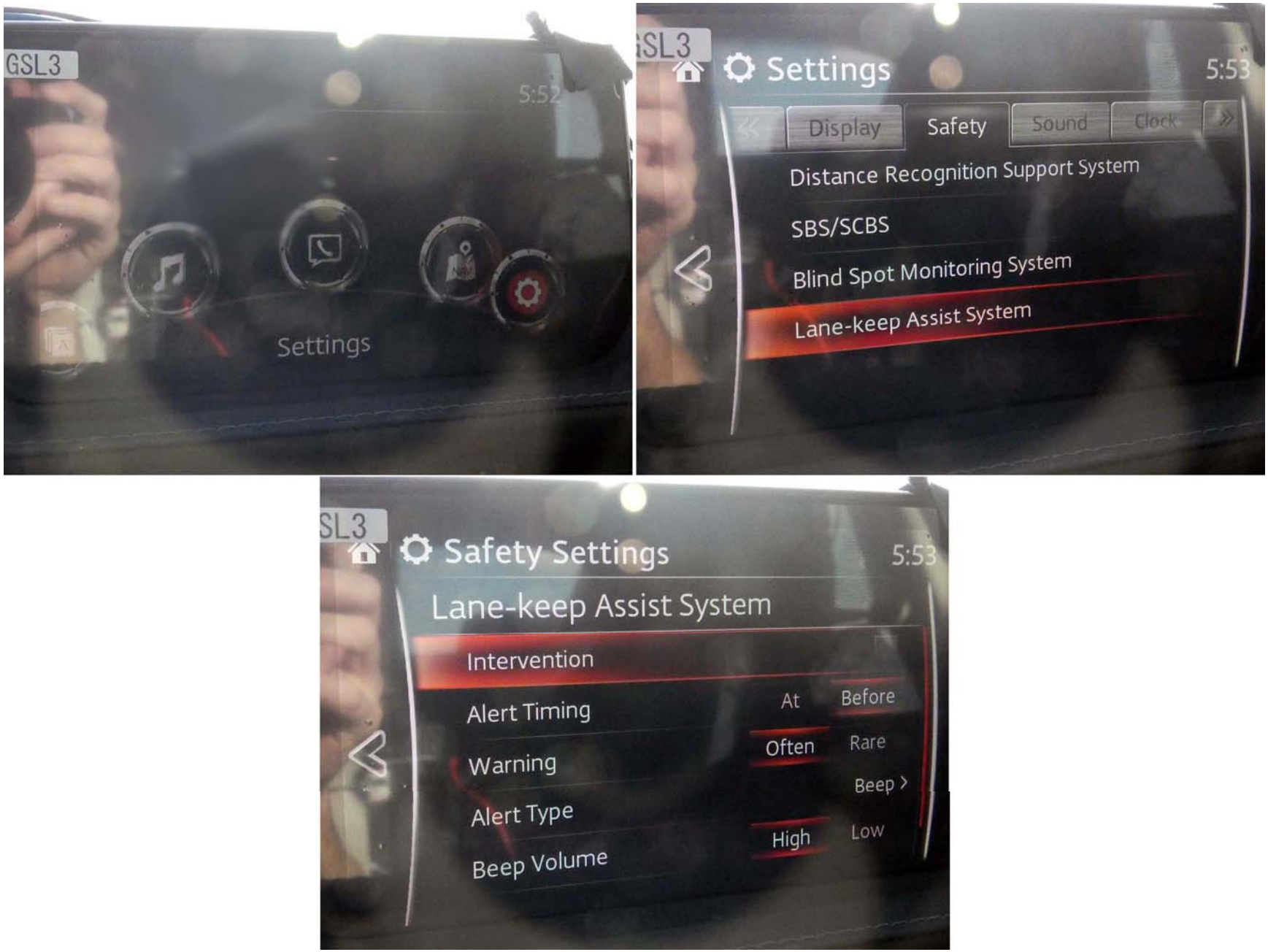


Figure A10. LDW (LDWS) Menus

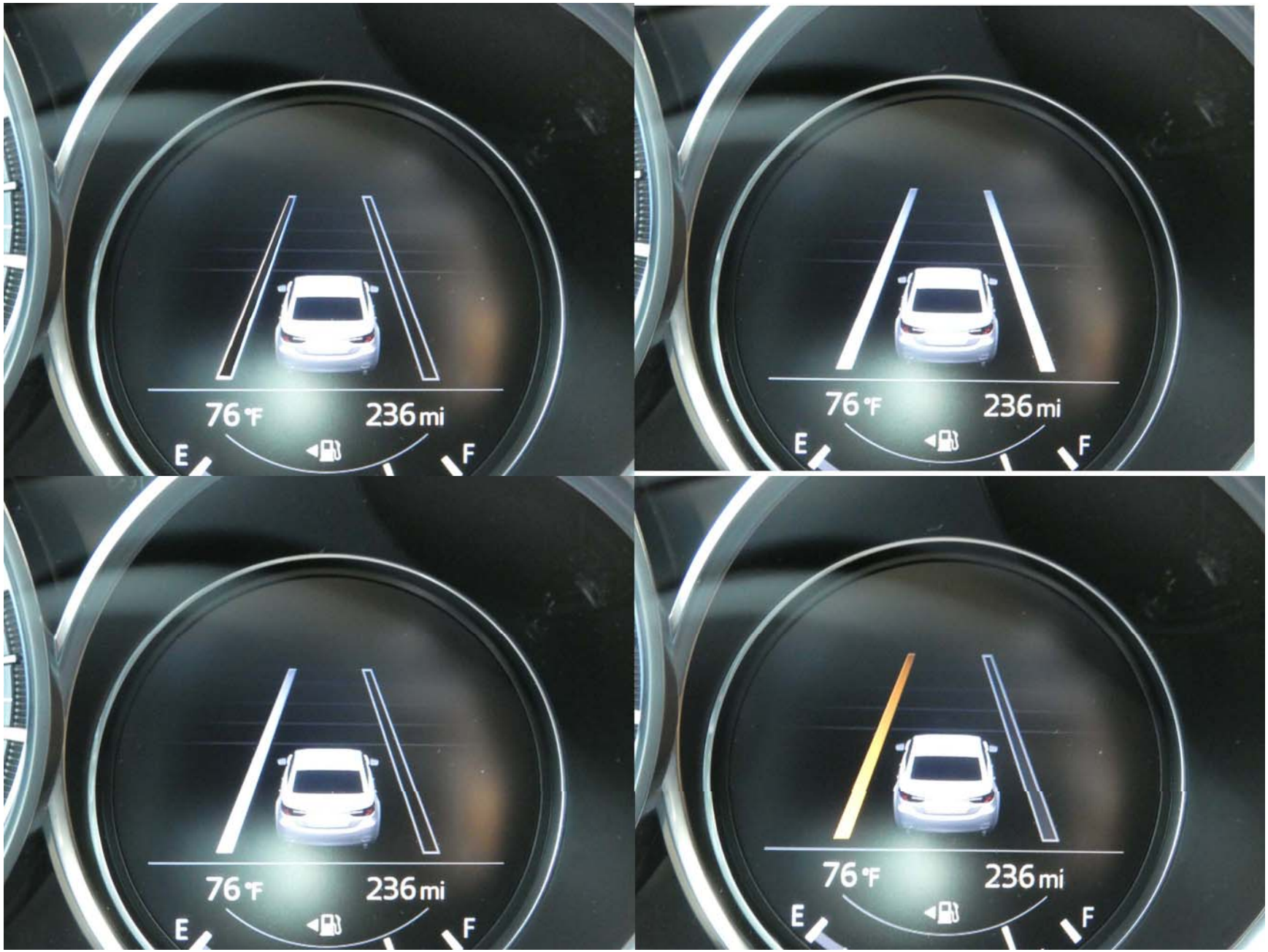


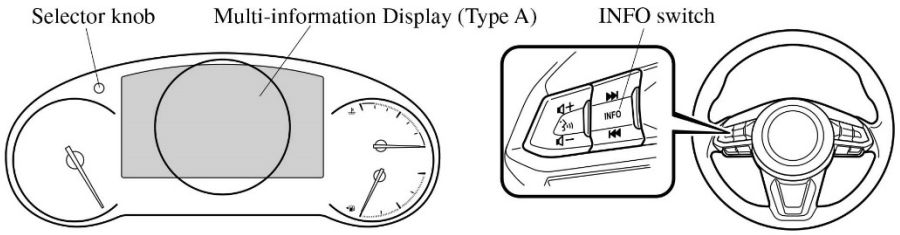
Figure A11. LDW (LDWS) Instrument Panel Visual Displays

Figure A12. LDW (LDWS) On/Off Switch

APPENDIX B

Excerpts from Owner’s Manual

▼ Multi-information Display (Type A)

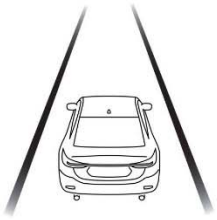


The multi-information display indicates the following information.

- Speedometer
- Odometer
- Trip meter
- Outside temperature
- Distance-to-empty
- Average fuel economy
- Current fuel economy
- Maintenance Monitor (Except SKYACTIV-D 2.2)
- Remaining Diesel Exhaust Fluid (DEF) and Maximum Driving Distance Display (SKYACTIV-D 2.2)
- Blind Spot Monitoring (BSM) Display
- Traffic Sign Recognition System (TSR) Display
- Distance Recognition Support System (DRSS) Display
- Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) System Display
- Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Display
- Cruise Control Display
- Compass Display
- Door-Ajar/Trunk lid-Ajar Warning Indication
- Message Display

▼ Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Display

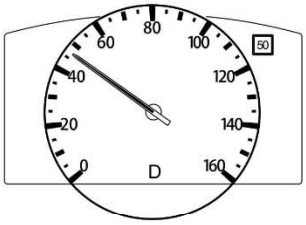
Displays the system status.



Refer to Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) on page 4-163.

▼ Traffic Sign Recognition System (TSR) Display*

Displays the traffic sign.



Refer to Traffic Sign Display Indication on page 4-137.

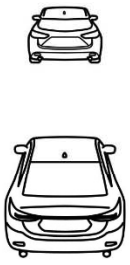
▼ Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) Display*

Displays the currently set system status.

Refer to Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) on page 4-149.

▼ Distance Recognition Support System (DRSS) Display*

Displays the distance between your vehicle and the vehicle ahead.



Refer to Distance Recognition Support System (DRSS) on page 4-141.

*Some models.

Signal	Warning	Page
	Master Warning Indication	7-28
	Electric Parking Brake (EPB) Warning Indication/Warning Light*1	7-28
	Check Engine Light*1	7-28
	*Selective Catalytic Reduction (SCR) system Warning Indication/Warning Light*1	7-28
AT	Automatic Transaxle Warning Indication	7-28
4WD	*AWD Warning Indication	7-28
	Air Bag/Front Seat Belt Pretensioner System Warning Light*1	7-28
	Tire Pressure Monitoring System Warning Light*1	Flashing 7-28 Turns on 7-35
 (Amber/White)	KEY Warning Indication	Amber 7-28 White 7-35
 (Amber)	High Beam Control System (HBC) Warning Indication/Warning Light*1	7-28
	Blind Spot Monitoring (BSM) Warning Indication	7-28
 (Amber)	*Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) Warning Indication	7-28
 (Amber)	Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Warning Indication	7-28
	LED Headlight Warning Light*1	7-28
	*Smart Brake Support/Smart City Brake Support (SBS/SCBS) Warning Indication	7-35
	Low Fuel Warning Indication/Warning Light	7-35
	Check Fuel Cap Warning Indication/Warning Light*1	7-35

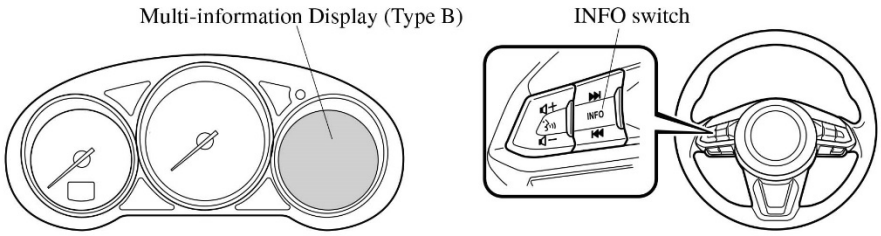
*Some models.

Instrument Cluster and Display

Signal	Indicator	Page
 (White)	*Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) Main Indication	4-154
 (Green)	*Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) Set Indication	4-154
	Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Indication	4-166
	*Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) OFF Indicator Light*1	4-171
	Smart City Brake Support (SCBS) Indication	Advanced Smart City Brake Support (Advanced SCBS) 4-176
		Smart City Brake Support (SCBS) 4-179
	*Smart Brake Support/Smart City Brake Support (SBS/SCBS) OFF Indicator Light*1	Advanced Smart City Brake Support (Advanced SCBS) 4-176
		Smart City Brake Support (SCBS) 4-180
		Smart Brake Support (SBS) System 4-182
 (White)	*Cruise Main Indication	4-222
 (Green)	*Cruise Set Indication	4-222

*1 The light turns on when the ignition is switched on for an operation check, and turns off a few seconds later or when the engine is started. If the light does not turn on or remains turned on, have the vehicle inspected at an Authorized Mazda Dealer.

▼ Multi-information Display (Type B)

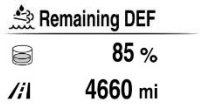


The multi-information display indicates the following information.

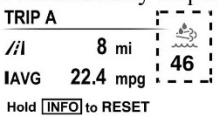
- Odometer
- Trip meter
- Engine coolant temperature gauge
- Fuel gauge
- Outside temperature
- Distance-to-empty
- Average fuel economy
- Current fuel economy
- Maintenance Monitor (Except SKYACTIV-D 2.2)
- Remaining Diesel Exhaust Fluid (DEF) and Maximum Driving Distance Display (SKYACTIV-D 2.2)
- Blind Spot Monitoring (BSM) Display
- Traffic Sign Recognition System (TSR) Display
- Distance Recognition Support System (DRSS) Display
- Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) System Display
- Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Display
- Cruise Control Display
- Compass Display
- Message Display

▼ Remaining Diesel Exhaust Fluid (DEF) and Maximum Driving Distance Display (SKYACTIV-D 2.2)

The remaining amount of DEF and the remaining-distance-to-empty indications are displayed when the ignition is switched ON.



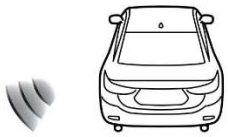
If the remaining amount of DEF is low or there is a problem with the Selective Catalytic Reduction (SCR) system and there is less maximum remaining driving distance, the remaining-distance-to-empty indication is continuously displayed.



If the remaining amount of DEF is low or there is a problem with the SCR system, the SCR warning light turns on/flashes and a warning message is displayed.
Refer to Selective Catalytic Reduction (SCR) System Indications on page 4-231.

▼ Blind Spot Monitoring (BSM) Display*

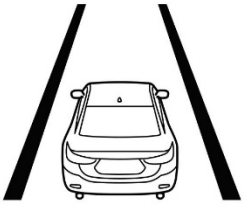
Displays the system status.



Refer to Blind Spot Monitoring (BSM) on page 4-127.

▼ Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Display*

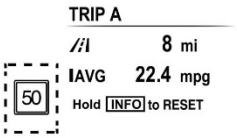
Displays the system status.



Refer to Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) on page 4-163.

▼ Traffic Sign Recognition System (TSR) Display*

Displays the traffic sign.



Refer to Traffic Sign Display Indication on page 4-137.

 *Some models.

Instrument Cluster and Display

Signal	Warning	Page
	Power Steering Malfunction Indication	7-25
	Master Warning Indication	7-28
	Electric Parking Brake (EPB) Warning Indication/Warning Light*1	7-28
	Check Engine Light*1	7-28
	*Selective Catalytic Reduction (SCR) system Warning Indication/Warning Light*1	7-28
AT	Automatic Transaxle Warning Indication	7-28
4WD	*AWD Warning Indication	7-28
	Air Bag/Front Seat Belt Pretensioner System Warning Light*1	7-28
	Tire Pressure Monitoring System Warning Light*1	Flashing 7-28
		Turns on 7-35
 (Amber/White)	KEY Warning Indication	Amber 7-28
		White 7-35
 (Amber)	*High Beam Control System (HBC) Warning Indication/Warning Light*1	7-28
	*Blind Spot Monitoring (BSM) Warning Indication	7-28
 (Amber)	*Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) Warning Indication	7-28
	*Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Warning Indication	7-28
	LED Headlight Warning Light*1	7-28
 (Amber)	*Smart Brake Support/Smart City Brake Support (SBS/SCBS) Warning Indication	7-35
	Low Fuel Warning Indication	7-35

 *Some models.

Signal	Indicator	Page
	*Blind Spot Monitoring (BSM) OFF Indicator Light*1	Malfunction 7-28
		Except malfunction 4-132
 (White)	*Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) Main Indication	4-154
 (Green)	*Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) Set Indication	4-154
	*Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Indication	4-166
	*Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) OFF Indicator Light*1	4-171
	*Smart City Brake Support (SCBS) Indication	Advanced Smart City Brake Support (Advanced SCBS) 4-176
		Smart City Brake Support (SCBS) 4-179
	*Smart Brake Support/Smart City Brake Support (SBS/SCBS) OFF Indicator Light*1	Advanced Smart City Brake Support (Advanced SCBS) 4-176
		Smart City Brake Support (SCBS) 4-180
		Smart Brake Support (SBS) System 4-182
 (White)	*Cruise Main Indication	4-222
 (Green)	*Cruise Set Indication	4-222

*Some models.

Collision damage reduction in low vehicle speed range

Forward driving

Smart City Brake Support (SCBS)..... page 4-177
Advanced Smart City Brake Support (Advanced SCBS).....page 4-174

Collision damage reduction in medium/high speed range

Smart Brake Support (SBS).....page 4-180

▼ Camera and Sensors

Forward Sensing Camera (FSC)

The Forward Sensing Camera (FSC) detects lane indications and recognizes headlights, taillights and city lights during nighttime driving. In addition, it also detects the vehicle ahead, pedestrians, or obstructions. The following systems also use the Forward Sensing Camera (FSC).

- High Beam Control system (HBC)
- Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS)
- Traffic Sign Recognition System (TSR)
- Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function)
- Advanced Smart City Brake Support (Advanced SCBS)
- Smart City Brake Support (SCBS)
- Smart Brake Support (SBS)

The Forward Sensing Camera (FSC) is installed at the top of the windshield near the rearview mirror.
Refer to Forward Sensing Camera (FSC) on page 4-210.

Radar sensor (front)

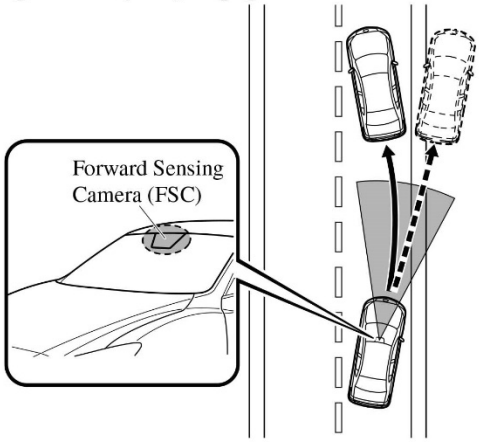
The radar sensor (front) functions by detecting the radio waves reflected off a vehicle ahead sent from the radar sensor. The following systems also use the radar sensor (front).

- Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function)
- Distance Recognition Support System (DRSS)
- Smart Brake Support (SBS)

The radar sensor (front) is mounted behind the radiator grille.
Refer to Radar Sensor (Front) on page 4-215.

Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS)*

The LAS & LDWS alerts the driver that the vehicle may be deviating from its lane and it provides steering assistance to help the driver stay within the vehicle lanes.
The Forward Sensing Camera (FSC) detects the white lines (yellow lines) of the vehicle lane in which the vehicle is traveling and if the system determines that the vehicle may deviate from its lane, it operates the electric power steering to assist the driver's steering operation. The system also alerts the driver by activating a lane departure warning sound, vibrating the steering wheel, and indicating an alert in the display. Use the system when you drive the vehicle on roads with white (yellow) lines such as expressways and highways.
Refer to Forward Sensing Camera (FSC) on page 4-210.



⚠ WARNING

Do not rely completely on the LAS & LDWS:

- *The LAS & LDWS is not an automatic driving system. In addition, the system is not designed to compensate for a driver's lack of caution, and over-reliance on the system could lead to an accident.*
- *The detection ability of the LAS & LDWS is limited. Always stay on course using the steering wheel and drive with care.*

Do not use the LAS & LDWS in the following cases:
The system may not operate adequately according to the actual driving conditions, resulting in an accident.

- *Driving on roads with tight curves.*
- *Driving under bad weather conditions (rain, fog, and snow).*
- *Slippery roads such as ice or snow-bound roads.*
- *Roads with heavy traffic and insufficient distance between vehicles.*
- *Roads with no white (yellow) lane lines.*
- *Narrow roads resulting from road construction or lane closures.*
- *The vehicle is driven on a temporary lane or section with a closed lane resulting from road construction where there may be multiple white (yellow) lane lines or they are interrupted.*
- *Vehicle is driven on roads other than expressways and highways.*
- *The tire pressures are not adjusted to the specified pressure.*
- *Tires of a different specified size are used, such as an emergency spare tire.*

⚠ CAUTION

Heed the following cautions so that the LAS & LDWS can operate normally.

- *Do not modify the suspensions.*
- *Always use wheels of the specified type and size for the front and rear wheels. Consult an Authorized Mazda Dealer for tire replacement.*

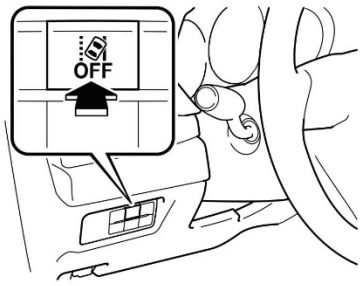
NOTE

- *When the turn signal lever is operated for a lane change, the LAS & LDWS is automatically disabled. The LAS & LDWS becomes operational again when the turn signal lever is returned and the system detects white (yellow) lane lines while the vehicle is being driven normally within its vehicle lane.*
- *If the steering wheel, accelerator pedal, or brake pedal is operated abruptly and the vehicle moves close to a white (yellow) line, the system determines that the driver is making a lane change and the LAS & LDWS operation is temporarily canceled. The LAS & LDWS becomes operational again when the system detects white (yellow) lane lines while the vehicle is being driven normally within its vehicle lane.*
- *If the vehicle deviates from its lane repeatedly within a short period of time, the LAS & LDWS may not operate.*
- *When white (yellow) lane lines are not detected, the LAS & LDWS does not operate.*
- *Under the following conditions, the LAS & LDWS may not be able to detect white (yellow) lane lines correctly and it may not operate normally.*
  - *If an object placed on the dashboard is reflected in the windshield and picked up by the camera.*
  - *Heavy luggage is loaded in the luggage compartment or on the rear seat and the vehicle is tilted.*
  - *The tire pressures are not adjusted to the specified pressure.*

- *Tires other than conventional tires are equipped.*
- *Vehicle is driven on an intersection or junction, or on a forked road.*
- *The white (yellow) lane lines are less visible because of dirt or fading/patchiness.*
- *A vehicle in front of your vehicle is running near a white (yellow) lane line making it less visible.*
- *A white (yellow) lane line is less visible because of bad weather (rain, fog, or snow).*
- *The vehicle is driven on a temporary lane or section with a closed lane resulting from construction where there may be multiple white (yellow) lane lines or they are interrupted.*
- *A misleading line is picked up on the road such as a temporary line for construction, or because of shade, lingering snow, or grooves filled with water.*
- *The surrounding brightness suddenly changes such as when entering or exiting a tunnel.*
- *The illumination of the headlights is weakened because of dirt or the optical axis is deviated.*
- *The windshield is dirty or foggy.*
- *The windshield, camera is fogged (water droplets).*
- *Back-light is reflected off the road surface.*
- *The road surface is wet and shiny after rain, or there are puddles on the road.*
- *The shade of a guardrail parallel to a white (yellow) lane line is cast on the road.*
- *The width of the driving lane is narrow or wide.*
- *Driving on roads with tight curves.*
- *The road is excessively uneven.*
- *The vehicle is shaken after hitting a road bump.*
- *There are 2 or more adjacent white (yellow) lane lines.*
- *There are various road markings or lane markings of various shapes near an intersection.*

▼ System Operation

Make sure that the LAS & LDWS OFF indicator light in the instrument cluster is turned off. When the LAS & LDWS OFF indicator light is turned on, press the switch and make sure that the indicator light turns off.



When the ignition is switched ON, the system goes on standby.
Drive the vehicle in the center of the vehicle lane while the system is on standby. When all of the following conditions are met, and the system becomes operational.

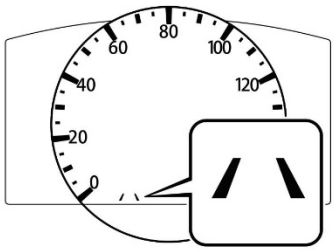
- The engine is running.
- The vehicle speed is about 60 km/h (37 mph) or faster.
- The system detects white (yellow) lane lines on both the right and left sides.
- The driver is operating the steering wheel.
- The driving lane is neither narrow nor wide.

When the system becomes operational, the LAS & LDWS indication (white) is displayed on the multi-information display or active driving display.

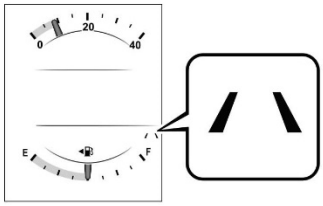
Active Driving Display

Multi-information Display

Instrument Cluster (Type A)



Instrument Cluster (Type B)



If the indication on the active driving display has been turned off using the personalization features, the LAS & LDWS indication (white) is displayed on the multi-information display.

NOTE

When only a vehicle lane line (yellow) on either the left or right is detected, the LAS & LDWS indication on the active driving display turns off.

Active Driving Display

Detection only on either left or right	Detects on both left and right sides
No indication	

Multi-information Display

Detection only on either left or right	Detects on both left and right sides
	
(Gray)	(White)

If the indication on the active driving display has been turned off using the personalization features, the LAS & LDWS indication on the multi-information display is displayed in gray and the system goes on standby.

The LAS & LDWS goes on stand-by status in the following cases:

- The system cannot detect white (yellow) lane lines.
- The vehicle speed is less than about 60 km/h (37 mph).
- The ABS/TCS/DSC is operating.
- The DSC is turned off.
  (If the DSC is turned off while the system is operational, a warning beep is heard and the system goes on standby.)
- The vehicle is making a sharp curve.
- The brake pedal is depressed.
- The steering wheel is operated abruptly.
- The width of a lane is excessively narrow or wide.

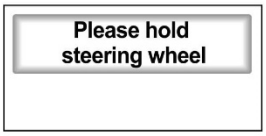
NOTE

- *The LAS & LDWS does not operate until the system detects white (yellow) lane lines on either the left or right.*
- *When the system detects a white (yellow) lane line on one side only, the system will not operate the steering wheel operation assist and the warning for the lane line on the side that is not being detected. The steering wheel operation assist and the warning is only for a lane deviation on the side that is being detected.*
- *If the driver takes his or her hands off the steering wheel (not holding the steering wheel), the warning sound is activated and an alert is indicated in the multi-information display or the active driving display.*

Multi-information Display

Lane-keep Assist System.
Please Hold Steering Wheel

Active Driving Display



If the steering wheel is held lightly, or depending on the road conditions, the system may detect that you have released the steering wheel (not holding the steering wheel) even if you are holding it, and display a message in the multi-information display or the active driving display.

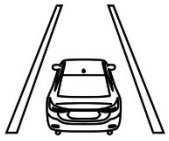
- *The timing at which the lane departure warning is activated and the steering wheel operation assist is performed varies.*
- *The following settings for the LAS & LDWS can be changed. Refer to Safety Equipment on page 9-12.*
  - *Steering operation assist operational/ non-operational*
  - *Cancel sensitivity (likelihood of steering assist)*

Vehicle lane line display

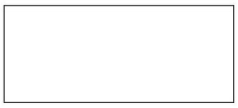
When the LAS & LDWS becomes operational while on standby, the vehicle lane lines are displayed in the multi-information display and the active driving display. In the vehicle lane lines display indicating the operation status, the color of the vehicle lane lines being detected changes to white.

(Stand-by status)

Multi-information Display



Active Driving Display



(Operational status)

Multi-information Display

Active Driving Display

Auto cancel

In the following cases, the LAS & LDWS is automatically canceled, the LAS & LDWS warning indication (amber) turns on, and an alert is displayed. When the LAS & LDWS become operational, the system turns back on automatically.

- The temperature inside the camera is high or low.
- The windshield around the camera is foggy.
- The windshield around the camera is blocked by an obstruction, causing poor forward visibility.

Auto cancel of warning/steering assist

When the following operations are performed, the LAS & LDWS operation is canceled automatically. The LAS & LDWS resumes automatically after the operation.

- The steering wheel is operated abruptly.
- The brake pedal is operated.
- The accelerator pedal is operated. (To cancel the automatic sensitivity cancel function, deselect “Cancel sensitivity” in the personalization features setting.)
- The turn signal lever is operated.

· The vehicle crosses a lane line.

NOTE

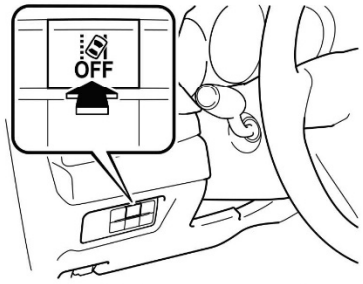
- *After the operation, the LAS & LDWS operation may not operate for a period of 5 seconds at the most until the lane lines are detected.*
- *Under the following conditions, the LAS & LDWS cancels the warning/steering assist automatically.*
  - *The driver takes his/her hands off the steering wheel.*
    (The LAS & LDWS is designed to assist the driver's steering operation and it will resume operation automatically when the driver holds the steering wheel.)
  - *The DSC OFF switch is pressed to cancel the DSC.*

Steering operation assist OFF (non-operational)

The steering operation assist for the LAS & LDWS can be changed to non-operational (OFF).
Refer to Setting Change (Safety Equipment) on page 9-12.
When the steering operation assist has been changed to inoperable (OFF), only the lane departure warning is operational.

System operation

Make sure that the LAS & LDWS OFF indicator light in the instrument cluster is turned off. When the LAS & LDWS OFF indicator light turns on, press the switch and make sure that the indicator light turns off.



Drive the vehicle in the center of the driving lane while the LAS & LDWS OFF indicator light in the instrument cluster is turned off.
The system becomes operational when all of the following conditions are met.

- The system detects white (yellow) lane lines on both the right and left sides or on either side.
- The vehicle speed is about 60 km/h (37 mph) or faster.
- The vehicle is driven on a straight road or road with gentle curves.
- The engine is running.

The LAS & LDWS goes on stand-by status in the following cases:

- The system cannot detect white (yellow) lane lines.
- The vehicle speed is less than about 60 km/h (37 mph).
- The vehicle is making a sharp curve.
- The vehicle is making a curve at an inappropriate speed.

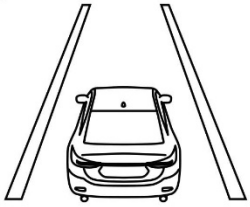
NOTE

- *The LAS & LDWS remains on stand-by until it detects white (yellow) lines on both the left and right sides, or on either side.*
- *When the system detects a white (yellow) lane line on one side only, the system will not activate warnings for the lane line on the side that is not being detected.*
- *The distance and warning sensitivity (likelihood of a warning) which the system uses to determine the possibility of a lane departure can be changed. Refer to Setting Change (Safety Equipment) on page 9-12.*

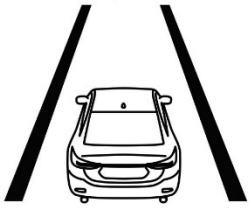
Vehicle lane line display

When the LAS & LDWS becomes operational while on standby, the vehicle lane lines are displayed in the multi-information display and the active driving display. The system changes to operational status display when the system detects a white (yellow) line on either the left or right.

(Stand-by status)



(Operational status)



Auto cancel

In the following cases, the LAS & LDWS is automatically canceled, the LAS & LDWS warning indication (amber) turns on, and an alert is displayed. When the LAS & LDWS become operational, the system turns back on automatically.

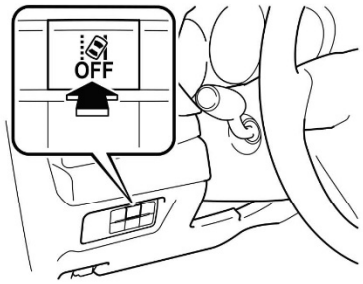
- The temperature inside the camera is high or low.
- The windshield around the camera is foggy.
- The windshield around the camera is blocked by an obstruction, causing poor forward visibility.

(Auto cancel of warnings)
When the following operations are performed, the LAS & LDWS determines that the driver intends to make a lane change and the system operation is canceled automatically. The LAS & LDWS resumes automatically after the operation.

- The steering wheel is operated abruptly.
- The brake pedal is depressed.
- The accelerator pedal is depressed. (To cancel the automatic sensitivity cancel function, deselect "Warning sensitivity" in the personalization features setting.)
- The turn signal lever is operated.
- The vehicle crosses a lane line.

▼ System Canceling

When the LAS & LDWS is turned off, press the LAS & LDWS OFF switch.



The LAS & LDWS OFF indicator light turns on.

NOTE

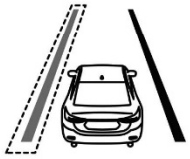
- *In the following cases, the LAS & LDWS is canceled automatically and the LAS & LDWS OFF indicator light turns on. Have your vehicle inspected at an Authorized Mazda Dealer.*
  - *There is a malfunction in the power steering.*
  - *There is a malfunction in the DSC.*
  - *There is a malfunction in the Forward Sensing Camera (FSC).*
- *When the ignition is switched OFF, the system status before it was turned off is maintained. For example, if the ignition is switched OFF with the lane-keep system operable, the system will be operable when the ignition is switched ON the next time.*

When the LAS & LDWS is turned off, the vehicle lane line indication in the multi-information display and the active driving display turn off.

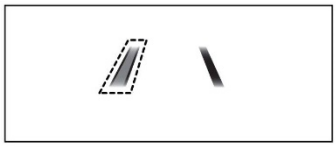
▼ Lane Departure Warning

If the system determines that the vehicle may deviate from its lane, the lane departure warning (beep sound, rumble sound*1, or steering wheel vibration) is activated and the direction in which the system determines that the vehicle may deviate is indicated in the multi-information display and the active driving display.
If the system determines that the vehicle may deviate from its lane, the color of the lane line on the side being detected by the system changes from white to amber, and flashes.

Multi-information Display



Active Driving Display

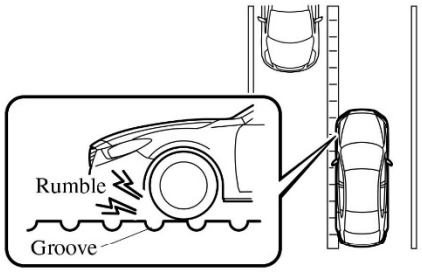


NOTE

- *If you have set the lane departure warning sound to the beep sound/rumble sound*1 setting, the warning sound may not be heard depending on the surrounding noise conditions.*
- *If you have set the lane departure warning system to the steering wheel vibrations setting, the vibration may not be felt depending on the road surface conditions.*
- *When the setting for the steering operation assist is changed to operational, the warnings can be set to activate/not activate. (When the setting for the steering operation assist is changed to non-operational, the warnings cannot be set to not activate.)*
  Refer to Setting Change (Safety Equipment) on page 9-12.
- *The LAS & LDWS can be changed to the following settings regardless of whether the steering operation assist has been set to operational/non-operational. Always check the setting status when driving the vehicle and make setting changes if necessary.*
  Refer to Setting Change (Safety Equipment) on page 9-12.
  - *Steering wheel vibration: Strong/weak*
  - *Warning sound volume*
  - *Types of warnings (steering wheel vibration/beep sound/rumble sound*1)*

*1 *A rumble strip is a series of grooves in the road pavement surface positioned at specific intervals, and when the vehicle passes over it a vibration and rumble sound is produced which alerts the driver that the vehicle is departing from the lane.*

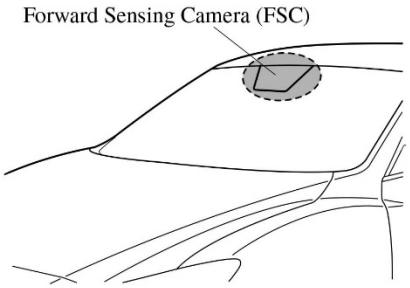
The rumble sound is a reproduction of the sound which occurs when a vehicle passes over a rumble strip.



Forward Sensing Camera (FSC)*

Your vehicle is equipped with a Forward Sensing Camera (FSC). The Forward Sensing Camera (FSC) is positioned near the rearview mirror and used by the following systems.

- High Beam Control System (HBC)
- Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS)
- Traffic Sign Recognition System (TSR)
- Advanced Smart City Brake Support (Advanced SCBS)
- Smart City Brake Support (SCBS)
- Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function)
- Smart Brake Support (SBS)



The Forward Sensing Camera (FSC) determines the conditions ahead of the vehicle while traveling at night and detects traffic lanes. The distance in which the Forward Sensing Camera (FSC) can detect objects varies depending on the surrounding conditions.

⚠ WARNING

Do not modify the suspension:
If the vehicle height or inclination is changed, the system will not be able to correctly detect vehicles ahead. This will result in the system not operating normally or mistakenly operating, which could cause a serious accident.

⚠ CAUTION

➢ *Do not apply accessories, stickers or film to the windshield near the Forward Sensing Camera (FSC).*
If the area in front of the Forward Sensing Camera (FSC) lens is obstructed, it will cause the system to not operate correctly. Consequently, each system may not operate normally which could lead to an unexpected accident.

 *Some models.

- *Do not disassemble or modify the Forward Sensing Camera (FSC).*
  Disassembly or modification of the Forward Sensing Camera (FSC) will cause a malfunction or mistaken operation. Consequently, each system may not operate normally which could lead to an unexpected accident.
- *Heed the following cautions to assure the correct operation of the Forward Sensing Camera (FSC).*
  - *Be careful not to scratch the Forward Sensing Camera (FSC) lens or allow it to get dirty.*
  - *Do not remove the Forward Sensing Camera (FSC) cover.*
  - *Do not place objects on the dashboard which reflect light.*
  - *Always keep the windshield glass around the camera clean by removing dirt or fogging. Use the windshield defroster to remove fogging on the windshield.*
  - *Consult an Authorized Mazda Dealer regarding cleaning the interior side of the windshield around the Forward Sensing Camera (FSC).*
  - *Consult an Authorized Mazda Dealer before performing repairs around the Forward Sensing Camera (FSC).*
  - *The Forward Sensing Camera (FSC) is installed to the windshield. Consult an Authorized Mazda Dealer for windshield repair and replacement.*
  - *When cleaning the windshield, do not allow glass cleaners or similar cleaning fluids to get on the Forward Sensing Camera (FSC) lens. In addition, do not touch the Forward Sensing Camera (FSC) lens.*
  - *When performing repairs around the rearview mirror, consult an Authorized Mazda Dealer.*
  - *Consult an Authorized Mazda Dealer regarding cleaning of the camera lens.*
  - *Do not hit or apply strong force to the Forward Sensing Camera (FSC) or the area around it. If the Forward Sensing Camera (FSC) is severely hit or if there are cracks or damage caused by flying gravel or debris in the area around it, stop using the following systems and consult an Authorized Mazda Dealer.*
    - *High Beam Control System (HBC)*
    - *Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS)*
    - *Traffic Sign Recognition System (TSR)*
    - *Advanced Smart City Brake Support (Advanced SCBS)*
    - *Smart City Brake Support (SCBS)*
    - *Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function)*
    - *Smart Brake Support (SBS)*
  - *The direction in which the Forward Sensing Camera (FSC) is pointed has been finely adjusted. Do not change the installation position of the Forward Sensing Camera (FSC) or remove it. Otherwise, it could result in damage or malfunction.*
- *Always use tires for all wheels that are of the specified size, and the same manufacturer, brand, and tread pattern. In addition, do not use tires with significantly different wear patterns on the same vehicle as the system may not operate normally.*

➢ *The Forward Sensing Camera (FSC) includes a function for detecting a soiled windshield and informing the driver, however, depending on the conditions, it may not detect plastic shopping bags, ice or snow on the windshield. In such cases, the system cannot accurately determine a vehicle ahead and may not be able to operate normally. Always drive carefully and pay attention to the road ahead.*

NOTE

- *In the following cases, the Forward Sensing Camera (FSC) cannot detect target objects correctly, and each system may be unable to operate normally.*
  - *The height of the vehicle ahead is low.*
  - *You drive your vehicle at the same speed as the vehicle ahead.*
  - *Headlights are not turned on during the night or when going through a tunnel.*
- *In the following cases, the Forward Sensing Camera (FSC) may not be able to detect target objects correctly.*
  - *Under bad weather condition, such as rain, fog and snow.*
  - *The window washer is being used or the windshield wipers are not used when it's raining.*
  - *Ice, fog, snow, frost, rainfall, dirt, or foreign matter such as a plastic bag is stuck on the windshield.*
  - *Trucks with low loading platforms and vehicles with an extremely low or high profile.*
  - *When driving next to walls with no patterning (including fences and longitudinally striped walls).*
  - *The taillights of the vehicle ahead are turned off.*
  - *A vehicle is outside the illumination range of the headlights.*
  - *The vehicle is making a sharp turn, or ascending or descending a steep slope.*
  - *Entering or exiting a tunnel.*
  - *Heavy luggage is loaded causing the vehicle to tilt.*
  - *Strong light is shone at the front of the vehicle (back light or high-beam light from on-coming vehicles).*
  - *There are many light emitters on the vehicle ahead.*
  - *When the vehicle ahead is not equipped with taillights or the taillights are turned off at nighttime.*
  - *Elongated luggage or cargo is loaded onto installed roof rails and covers the Forward Sensing Camera (FSC).*
  - *Exhaust gas from the vehicle in front, sand, snow, and water vapor rising from manholes and grating, and water splashed into the air.*
  - *When towing a malfunctioning vehicle.*
  - *The vehicle is driven with tires having significantly different wear.*
  - *The vehicle is driven on down slopes or bumpy roads.*
  - *There are water puddles on the road.*

- *The surroundings are dark such as during the night, early evening, or early morning, or in a tunnel or indoor parking lot.*
- *The illumination brightness of the headlights is reduced or the headlight illumination is weakened due to dirt or a deviated optical axis.*
- *The target object enters the blind spot of the Forward Sensing Camera (FSC).*
- *A person or object bursts onto the road from the shoulder or cuts right in front of you.*
- *You change lanes and approach a vehicle ahead.*
- *When driving extremely close to the target object.*
- *Tire chains or a temporary spare tire is installed.*
- *The vehicle ahead has a special shape. For example, a vehicle towing a trailer house or a boat, or a vehicle carrier carrying a vehicle with its front pointed rearward.*

- *If the Forward Sensing Camera (FSC) cannot operate normally due to backlight or fog, the system functions related to the Forward Sensing Camera (FSC) are temporarily stopped and the following warning lights turn on. However, this does not indicate a malfunction.*
  - *High Beam Control System (HBC) warning light (amber)*
  - *Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) warning indication*
  - *Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) warning indication*
  - *Smart Brake Support/Smart City Brake Support (SBS/SCBS) warning indication/ warning light (amber)*
- *If the Forward Sensing Camera (FSC) cannot operate normally due to high temperatures, the system functions related to the Forward Sensing Camera (FSC) are temporarily stopped and the following warning lights turn on. However, this does not indicate a malfunction. Cool down the area around the Forward Sensing Camera (FSC) such as by turning on the air conditioner.*
  - *High Beam Control System (HBC) warning light (amber)*
  - *Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) warning indication*
  - *Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) warning indication*
  - *Smart Brake Support/Smart City Brake Support (SBS/SCBS) warning indication/ warning light (amber)*

- *If the Forward Sensing Camera (FSC) detects that the windshield is dirty or foggy, the system functions related to the Forward Sensing Camera (FSC) are temporarily stopped and the following warning lights turn on. However, this does not indicate a problem. Remove the dirt from the windshield or press the defroster switch and defog the windshield.*
  - *High Beam Control System (HBC) warning light (amber)*
  - *Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) warning indication*
  - *Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) warning indication*
  - *Smart Brake Support/Smart City Brake Support (SBS/SCBS) warning indication/ warning light (amber)*
- *If there are recognizable cracks or damage caused by flying gravel or debris on the windshield, always have the windshield replaced. Consult an Authorized Mazda Dealer for replacement.*
- ***(With Advanced Smart City Brake Support (Advanced SCBS))***
  - *The Forward Sensing Camera (FSC) recognizes pedestrians when all of the following conditions are met:*
    - *The height of a pedestrian is about 1 to 2 meters.*
    - *An outline such as the head, both shoulders, or the legs can be determined.*
  - *In the following cases, the Forward Sensing Camera (FSC) may not be able to detect target objects correctly:*
    - *Multiple pedestrians are walking, or there are groups of people.*
    - *A pedestrian is close to a separate object.*
    - *A pedestrian is crouching, lying, or slouching.*
    - *A pedestrian suddenly jumps into the road right in front of the vehicle.*
    - *A pedestrian opens an umbrella, or is carrying large baggage or articles.*
    - *A pedestrian is in a dark location such as during the night, or blends into the background by wearing clothes matching the background color.*

Warning/Indicator Lights and Warning Sounds

Signal	Warning
 Blind Spot Monitoring (BSM) Warning Indication*	The Warning indication turns on if there is any malfunction in the Blind Spot Monitoring (BSM). Have your vehicle inspected by an Authorized Mazda Dealer. ***NOTE*** *If the vehicle is driven on a road with less traffic and few vehicles that the radar sensors can detect, the system may pause. However, it does not indicate a malfunction.*
 Blind Spot Monitoring (BSM) OFF Indicator Light*	A problem in the system may be indicated under the following conditions. Have your vehicle inspected at an Authorized Mazda Dealer. ・The light does not turn on when the ignition is switched ON. ・The light remains on even when the Blind Spot Monitoring (BSM) system can be operated. ・It turns on while driving the vehicle. ***NOTE*** *If the vehicle is driven on a road with less traffic and few vehicles that the radar sensors can detect, the system may pause (The Blind Spot Monitoring (BSM) OFF indicator light in the instrument cluster illuminates). However, it does not indicate a malfunction.*
 (Amber) Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) Warning Indication*	The message is displayed when the system has a malfunction. Have your vehicle inspected at an Authorized Mazda Dealer.
 Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) Warning Indication*	The message is displayed when the system has a malfunction. Have your vehicle inspected at an Authorized Mazda Dealer. The system does not operate when the warning message is displayed. **⚠ CAUTION** ➢ *Always use tires for all wheels that are of the specified size, and the same manufacture, brand, and tread pattern. In addition, do not use tires with significantly different wear patterns on the same vehicle. If such improper tires are used, the system may not operate normally.* ➢ *When an emergency spare tire is used, the system may not operate normally.*
 LED Headlight Warning Light	This light illuminates if there is a malfunction in the LED headlight. Have your vehicle inspected by an Authorized Mazda Dealer.

 *Some models.

If the warning light flashes/message is displayed and the beep sound is activated simultaneously, have your vehicle inspected at an Authorized Mazda Dealer.

▼ Power Steering Warning Buzzer

If the power steering system has a malfunction, the power steering malfunction indication/malfunction indicator light turns on or flashes and the buzzer operates at the same time.
Refer to Stop Vehicle in Safe Place Immediately on page 7-25.

▼ Tire Inflation Pressure Warning Beep

The warning beep sound will be heard for about 3 seconds if the tire pressures decrease.
Refer to Tire Pressure Monitoring System on page 4-226.

▼ Selective Catalytic Reduction (SCR) Warning Beep (SKYACTIV-D 2.2)

(When the SCR warning light turns off)
If the ignition is switched ON while the remaining amount of Diesel Exhaust Fluid (DEF) has decreased, a sound is activated. If the sound is activated when the ignition is switched ON, consult an Authorized Mazda Dealer.

(When the SCR warning light turns on/flashes)
A sound is activated under the following conditions:

- There is a problem with the SCR system.
- The ignition is switched ON when the remaining amount of Diesel Exhaust Fluid (DEF) is extremely low.

If the sound is activated at the same time the SCR warning light turns on/flashes, have your vehicle inspected by an Authorized Mazda Dealer.

▼ Blind Spot Monitoring (BSM) System Warning Beep*

Driving forward

The warning beep operates when the turn signal lever is operated to the side where the Blind Spot Monitoring (BSM) warning light is illuminated.

NOTE
A personalized function is available to change the Blind Spot Monitoring (BSM) warning beep sound volume.
Refer to Safety Equipment on page 9-12.

Reversing

The Blind Spot Monitoring (BSM) warning sound is activated if there is a possibility of collision with a vehicle approaching from behind and from the rear on the left and right sides of the vehicle.

▼ Lane Departure Warning Sound*

While the system is operating, if the system determines that the vehicle may depart from the lane, it sounds a warning sound.

NOTE

- *The volume of the Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) warning sound can be changed.*
  Refer to Safety Equipment on page 9-12.

 *Some models.

- *The type of the Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) warning sound can be changed.*
  Refer to Safety Equipment on page 9-12.

▼ Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) System Warnings*

The Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) system warnings notify the driver of system problems and precautions on use when required. Check after hearing a warning beep sound.

Warning beep	What to check
While the Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) system is operating, a single beep sound is heard when "Front Radar Sensor Blocked" is displayed in the multi-information display.	Cancel the Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) system if the radar sensor (front) becomes dirty. Clean the area around the radar sensor (front).
The beep sounds intermittently while the vehicle is being driven.	The distance between your vehicle and the vehicle ahead is too close. Verify the safety of the surrounding area and reduce vehicle speed.
While the Mazda Radar Cruise Control with Stop & Go function (MRCC with Stop & Go function) system is operating, a single beep sound is heard when " Front Radar Sensor System Malfunction" is displayed in the multi-information display.	A malfunction in the system may be indicated. Check the center display to verify the problem and then have your vehicle inspected by an Authorized Mazda Dealer.

▼ Excessive Speed Warning*

If the vehicle speed exceeds the speed limit sign displayed on the active driving display, the warning sound is activated and the area around the speed limit sign displayed on the active driving display flashes 3 times in amber, and if the vehicle speed continues to exceed the displayed speed limit sign, the indication stops flashing and remains on.

▼ Collision warning*

If there is a possibility of a collision with a vehicle ahead, a warning sound is activated at the same time as the warning indications are displayed in the instrument cluster or active driving display.

*Some models.

Personalization Features

▼ Changeable System Settings/Equipment List

Safety Equipment (page 9-12)

· Advanced Smart City Brake Support (Advanced SCBS)
· Smart City Brake Support (SCBS)
· Smart Brake Support (SBS)
· Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS)
· Blind Spot Monitoring (BSM)
· Distance Recognition Support System (DRSS)
· Traffic Sign Recognition System (TSR)

Vehicle Equipment (page 9-14)

· Illuminated entry system
· Auto-wiper control
· Auto headlight off
· Auto-light control
· High Beam Control System (HBC)
· Adaptive Front Lighting System (AFS)
· Lights-on reminder
· Coming home light
· Leaving home light
· Turn signal indicator
· Three-flash turn signal
· Ambient lights

Other Equipment/Functions (page 9-15)

· Door locks
· Keyless entry system
· Advanced keyless entry system
· Active Driving Display
· Fuel Economy Monitor
· Display
· Sound quality
· Clock
· Each system
· Daytime running lights
· Rear window defogger

Personalization Features

▼ Safety Equipment

You can change the function settings according to your preference.

- Personalization features which can be changed differ depending on the vehicle specification.
- Personalization features which can be changed may change without notice depending on software updates.

The following personalization features can be set or changed by the customer or an Authorized Mazda Dealer. Consult an Authorized Mazda Dealer for details.
Personalization features which can be changed differ depending on the specification.

Setting change method

1. Select  on the home screen and display the setting screen.
2. Switch the tab to [Safety] and select the setting item you want to change.

Function and how it can be changed (underlined item is initial setting)		
Advanced Smart City Brake Support (Advanced SCBS) (page 4-174) **Smart Brake Support (SBS) (page 4-180)**		
The system can be changed so that Advanced Smart City Brake Support (Advanced SCBS)/Smart Brake Support (SBS) does not operate.*1		On/Off
The distance at which the collision warning activates can be changed.		Far/Med./Near
The volume of the collision warning can be changed.		High/Low/Off
Smart City Brake Support (SCBS) (page 4-177)		
The system can be changed so that Smart City Brake Support (SCBS) does not operate.*1		On/Off
Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) (page 4-163)		
The system can be changed so that the steering wheel assist does not operate.		On/Off
The sensitivity of the warning for the Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) can be changed.		High/Low
When the steering wheel operation assistance is turned on	The system can be changed so that the Lane Departure Warning does not activate.	On/Off
When the steering wheel operation assistance is turned off	The warning timing in which the system determines that the vehicle may be deviating from its lane can be changed.	At/Before
	The sensitivity of the warning for the system can be changed.	Often/Rare

Function and how it can be changed (underlined item is initial setting)		
The type of Lane-keep Assist System (LAS) & Lane Departure Warning System (LDWS) warning can be changed.		Vibration/Beep/Rumbl.
The warning intensity/volume of the system can be changed.	Vibration	High/Low
	Rumbl.	High/Mid/Low
	Beep	High/Low
Blind Spot Monitoring (BSM) (page 4-127)		
The system can be changed so that Blind Spot Monitoring (BSM) does not operate.*1		On/Off
Warning beep volume*2		High/Low/Off
Distance Recognition Support System (DRSS) (page 4-141)		
The system can be changed so that Distance Recognition Support System (DRSS) does not operate.*1		On/Off
The distance at which the vehicle ahead and your vehicle indicated in the display flashes in white can be changed.		Far/Med./Near
Traffic Sign Recognition System (TSR)*3 (page 4-133)		
The Traffic Sign Recognition System (TSR) can be set to inoperable.*1		On/Off
The warning pattern of the excessive speed warning can be changed.		Off/Visual/Audio & Visual
The activation timing for the excessive speed warning can be changed.		+0 km/h (+0 mph)/+5 km/h (+5 mph)/+10 km/h (+10 mph)
360°View Monitor (page 4-183)		
Setting can be changed so that the 360° view monitor is automatically displayed when the ignition is switched to ON.		On/Off
Setting can be changed so that the display of the estimated forward line of progress is not displayed.		On/Off
Setting can be changed so that the top view/front view displayed while the vehicle is moving in the forward direction after reversing is not displayed.		On/Off
Parking sensor system (page 4-246)		
Display*4/non-display		On/Off

*1 Though these systems can be turned Off, doing so will defeat the purpose of the system and Mazda recommends that these systems remain On.

*2 Only the volume of the warning beep during Blind Spot Monitoring (BSM) operation can be changed. The volume of the warning beep during Rear Cross Traffic Alert (RCTA) operation cannot be changed.

*3 This system functions only when the navigation system is functioning.

*4 When the ultrasonic sensors detect an obstruction, the contents indicated on the center display switches to the 360°View Monitor.

APPENDIX C

Run Log

Subject Vehicle: **2020 Mazda Mazda6 Sport** Test Date: **4/13/2020**

Driver: **A. Ricci** **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	**Solid**	**Left**	Y	0.02		Pass	Unable to detect visual alert
2			Y	0.00	-0.10	Pass	
3			Y	0.01	-0.08	Pass	
4			Y	0.09	-0.05	Pass	
5			Y	0.13	0.08	Pass	
6			Y	0.12	-0.03	Pass	
7			Y	0.08	-0.02	Pass	
8	**Solid**	**Right**	Y	0.26	0.14	Pass	
9			Y	0.37	0.24	Pass	
10			Y	0.29	0.13	Pass	
11			Y	0.32	0.22	Pass	
12			Y	-1.02	-1.16	Fail	
13			Y	0.20	0.09	Pass	
14			Y	0.33	0.20	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Auditory Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
15	**Dashed**	**Right**	Y	0.15	0.04	Pass	
16			Y	0.24	0.11	Pass	
17			Y	0.15	0.04	Pass	
18			Y	0.33	0.18	Pass	
19			Y	0.22	0.05	Pass	
20			Y	0.22	0.08	Pass	
21			Y	0.25	0.13	Pass	
22	**Dashed**	**Left**	Y	-0.09	-0.22	Pass	
23			Y	-0.33	-0.44	Pass	
24			Y	0.28	0.16	Pass	
25			Y	0.36	0.27	Pass	
26			Y	0.29	0.15	Pass	
27			N				Speed, Yaw Rate
28			Y	0.27	0.20	Pass	
29			Y	0.25	0.09	Pass	
30	**Botts**	**Left**	N				Yaw Rate
31			Y	0.13	0.05	Pass	
32			Y	0.14	0.03	Pass	
33			Y	0.25		Pass	Light Sensor Moved prior to start of run
34			Y	0.22	0.06	Pass	
35			Y	0.22	0.12	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Auditory Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
36			N				Yaw Rate
37			Y	0.17	0.04	Pass	
38			Y	0.21	0.07	Pass	
39	**Botts**	**Right**	Y	0.03	-0.08	Pass	
40			Y	-0.67	-0.83	Pass	
41			Y	0.08	-0.03	Pass	
42			Y	0.19	0.11	Pass	
43			Y	0.03	-0.08	Pass	
44			Y	-0.03	-0.13	Pass	
45			Y			Fail	No Warning

APPENDIX D

Time History Plots

LIST OF FIGURES

Description of Time History Plots

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from the Subject Vehicle, as well as pass/fail envelopes and thresholds. The following is a description of data types shown in the time history plots, as well as a description of the color code for data envelopes.

Time History Plot Description

Time history figures include the following sub-plots:

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

Envelopes and Thresholds

Each of the time history plot figures can contain either green or yellow envelopes and/or black threshold lines. These envelopes and thresholds are used to programmatically and visually determine the validity of a given test run. Envelope and threshold exceedances are indicated with either red shading or red asterisks, and red text is placed to the right side of the plot indicating the type of exceedance.

Green envelopes indicate that the time-varying data should not exceed the envelope boundaries at any time within the envelope. Exceedances of a green envelope are indicated by red shading in the area between the measured time-varying data and the envelope boundaries.

Yellow envelopes indicate that the time-varying data should not exceed the envelope only at the right end. Exceedances at the right extent of a yellow envelope are indicated by red asterisks. Data within the boundaries at the right extent of a yellow envelope are indicated by green circles.

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

Color Codes

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

Color codes can be broken into three categories:

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

1. Validation envelope and threshold color codes:
   - Green envelope = time varying data must be within the envelope at all times in order to be valid
   - Yellow envelope = time varying data must be within limits at right end
   - Black threshold (Solid) = time varying data must not exceed this threshold in order to be valid
   - Black threshold (Dashed) = for reference only – this can include warning level thresholds which are used to determine the timing of the alert

2. Instantaneous sampling color codes:
   - Green circle = passing or valid value at a given moment in time
   - Red asterisk = failing or invalid value at a given moment in time

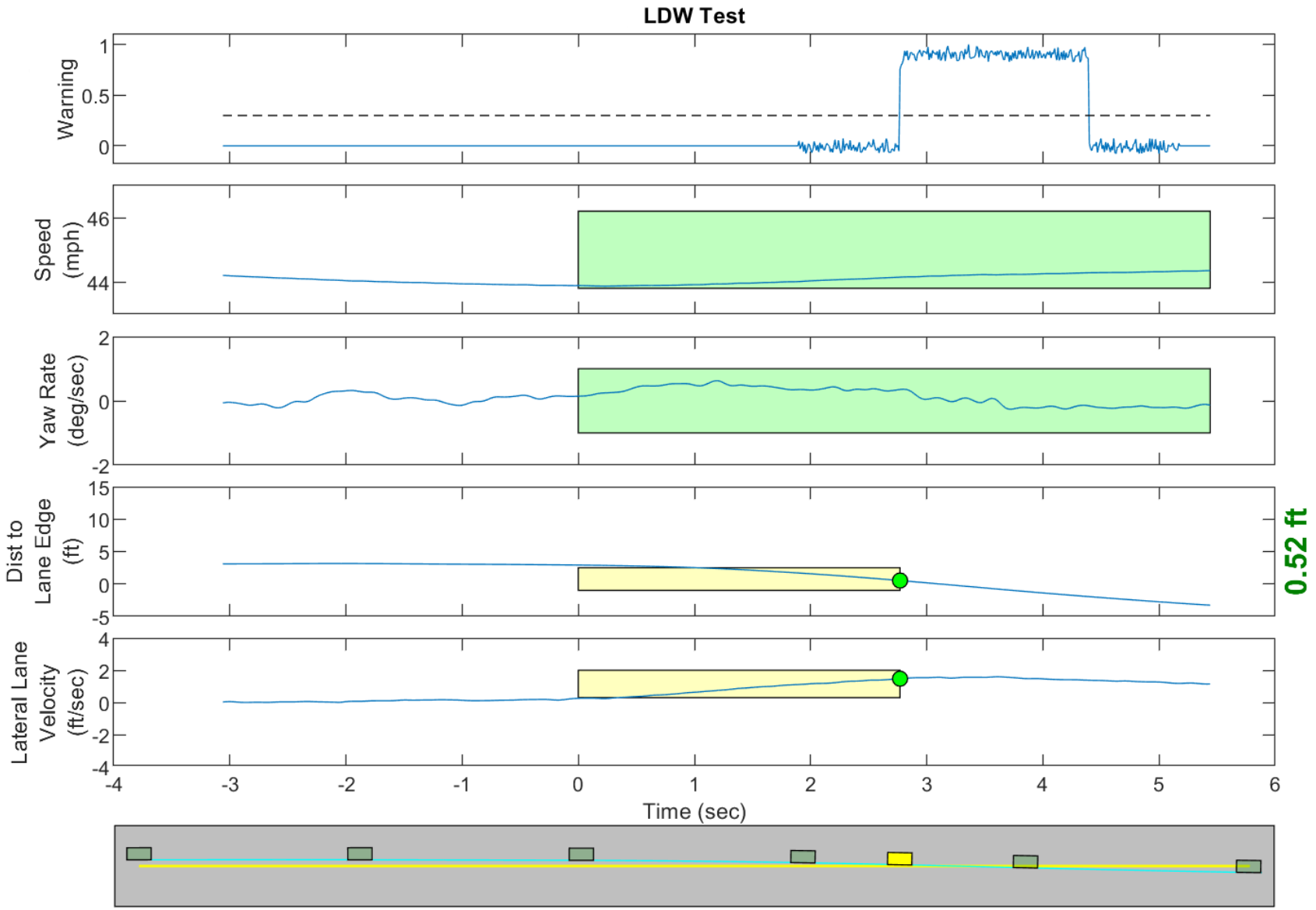
3. Text color codes:
    - Green = passing or valid value
    - Red = failing or invalid value

Other Notations

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

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

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



GPS Fix Type: RTK Fixed

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

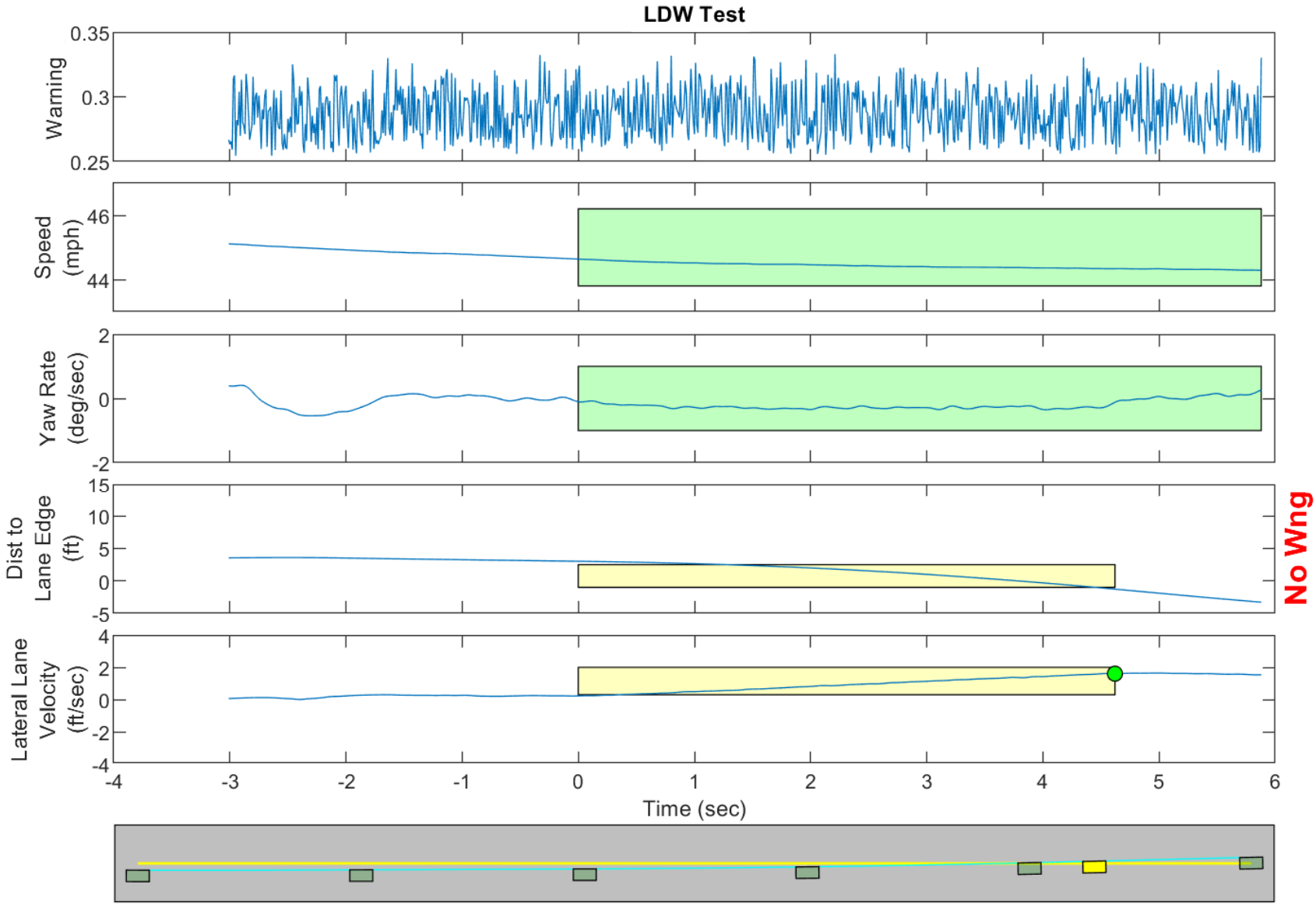


Figure D2. Example Time History for Lane Departure Warning Test, Failing, No Warning Issued

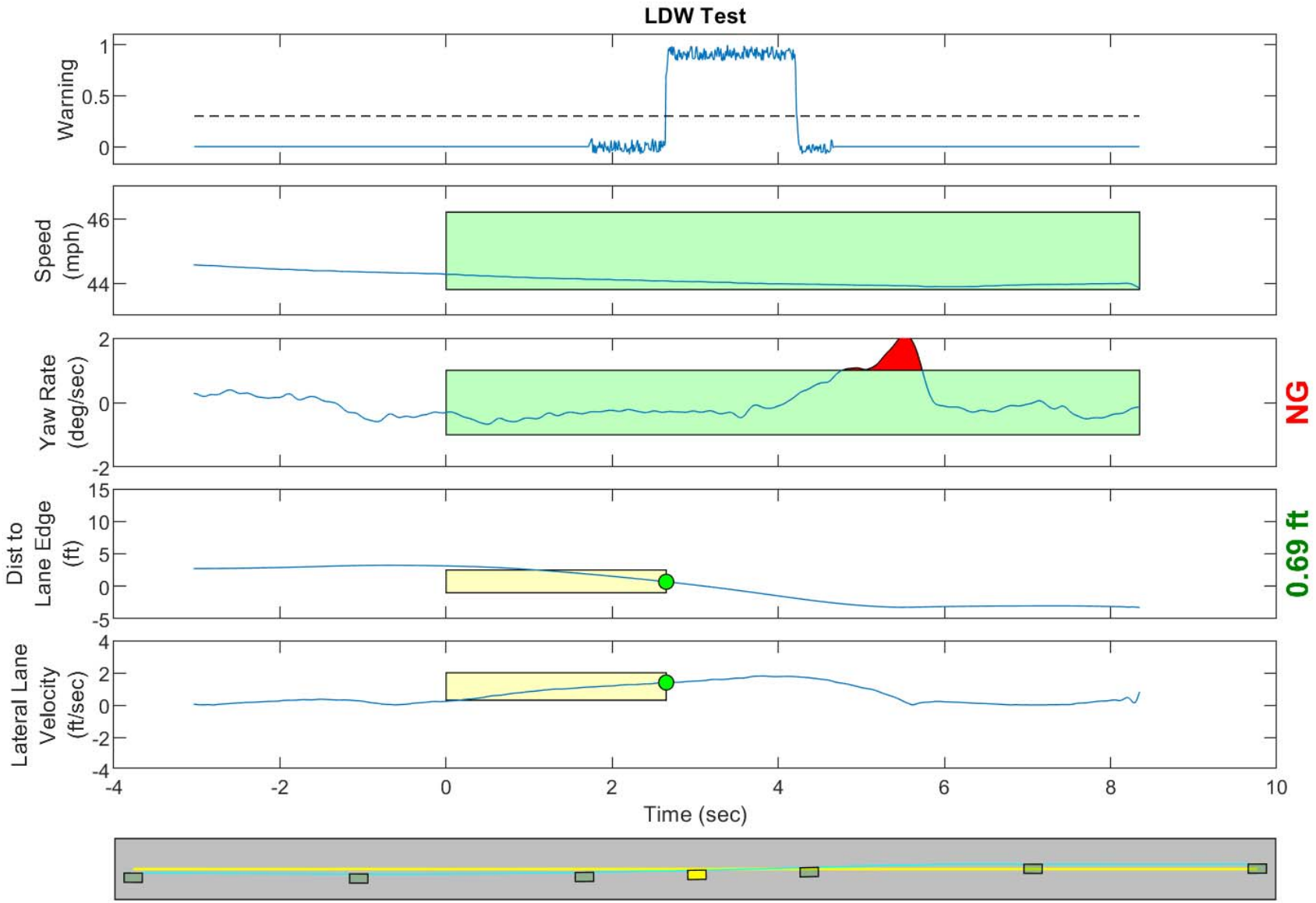


Figure D3. Example Time History for Lane Departure Warning Test, Invalid Run Due to Subject Vehicle Yaw Rate

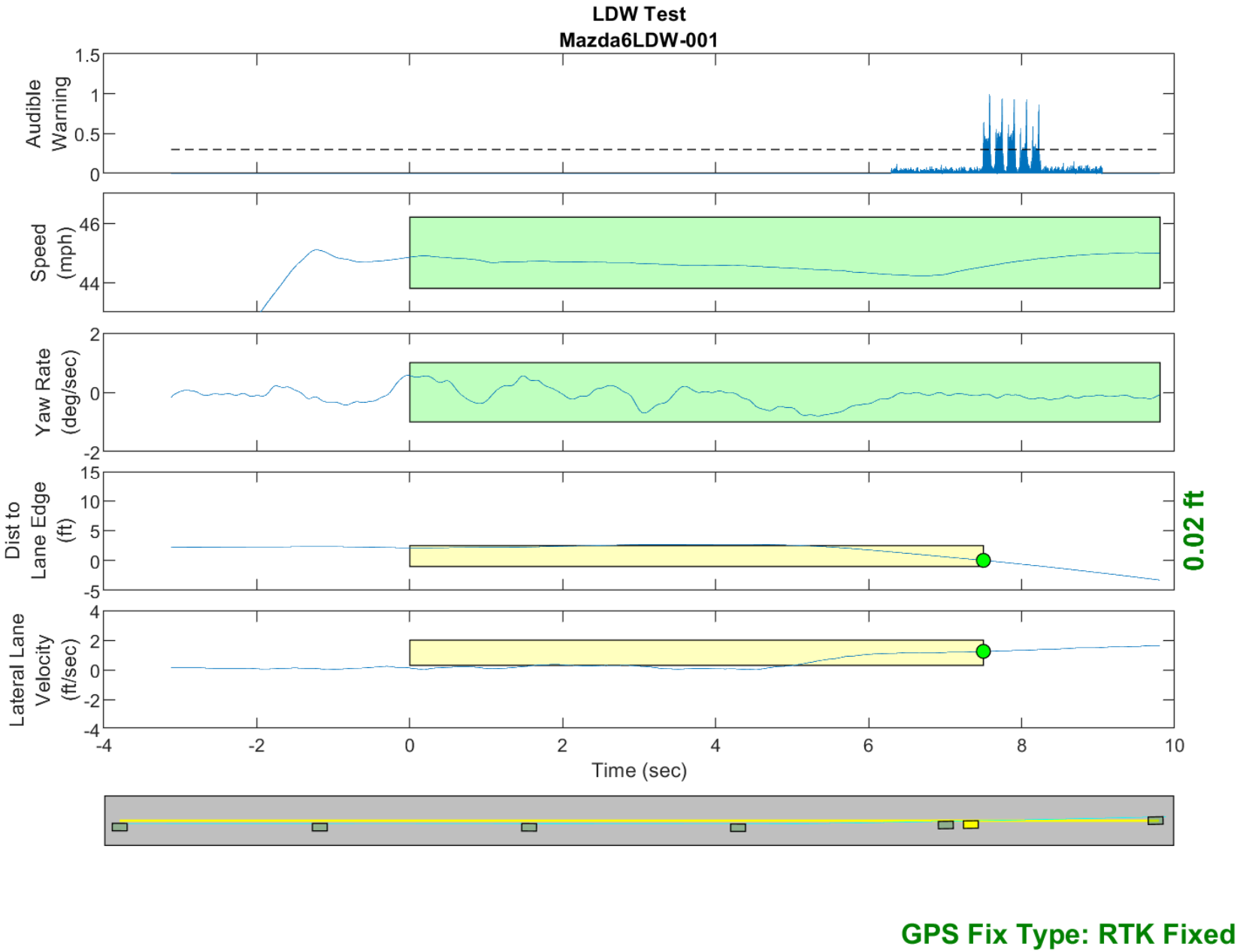


Figure D4. Time History for Run 01, Solid Line, Left Departure, Audible Warning

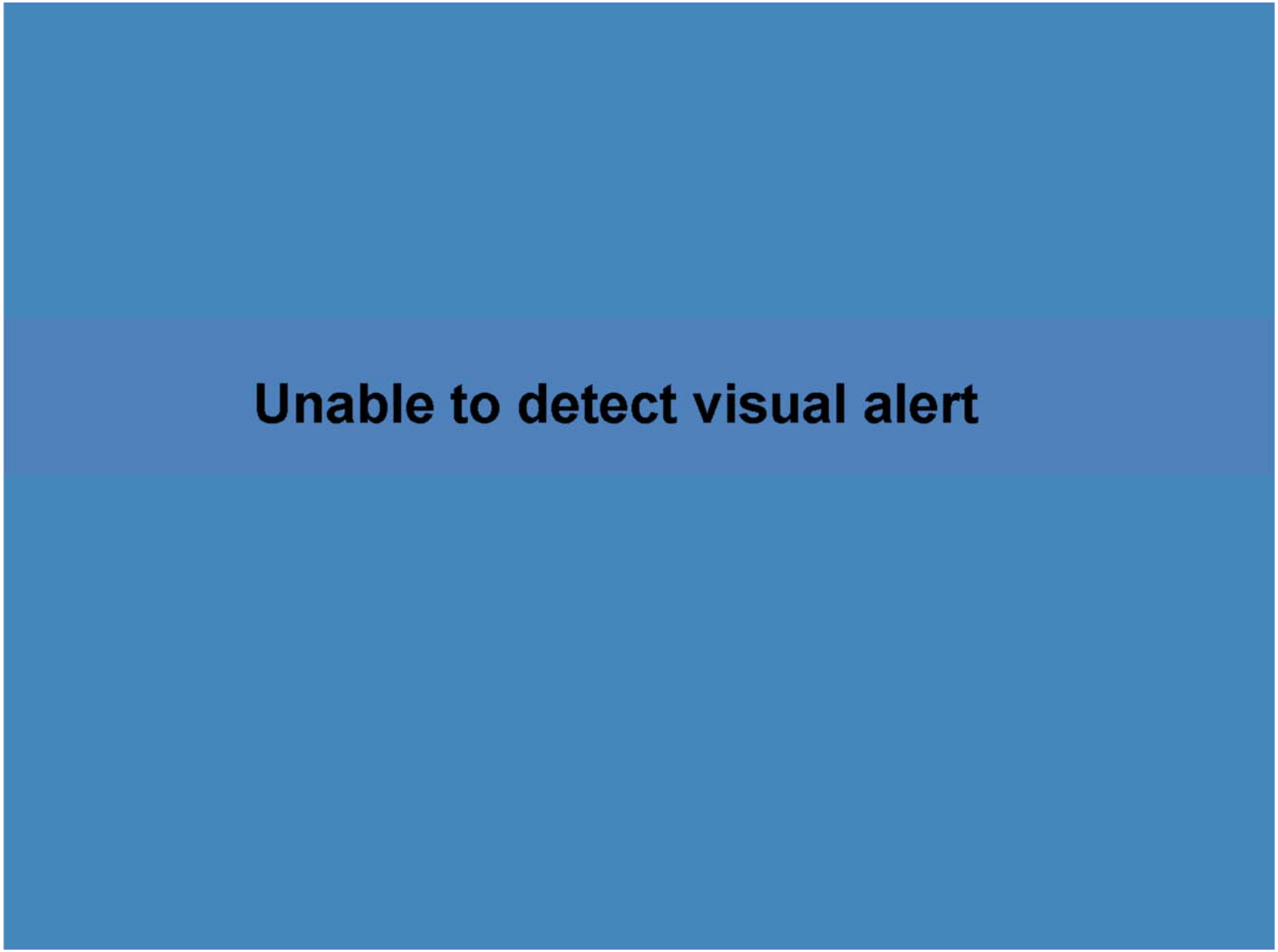


Figure D5. Time History for Run 01, Solid Line, Left Departure, Visual Warning

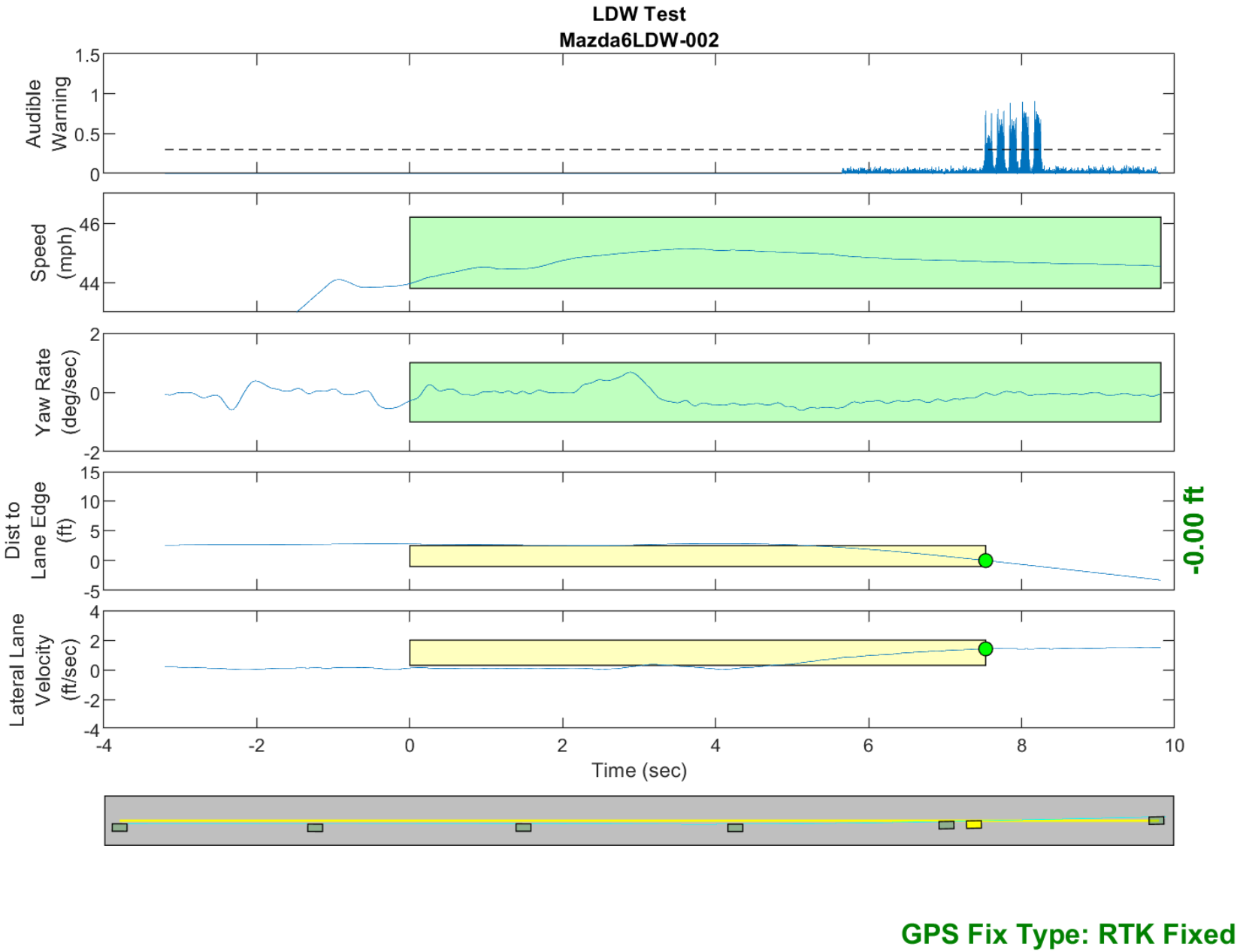


Figure D6. Time History for Run 02, Solid Line, Left Departure, Audible Warning

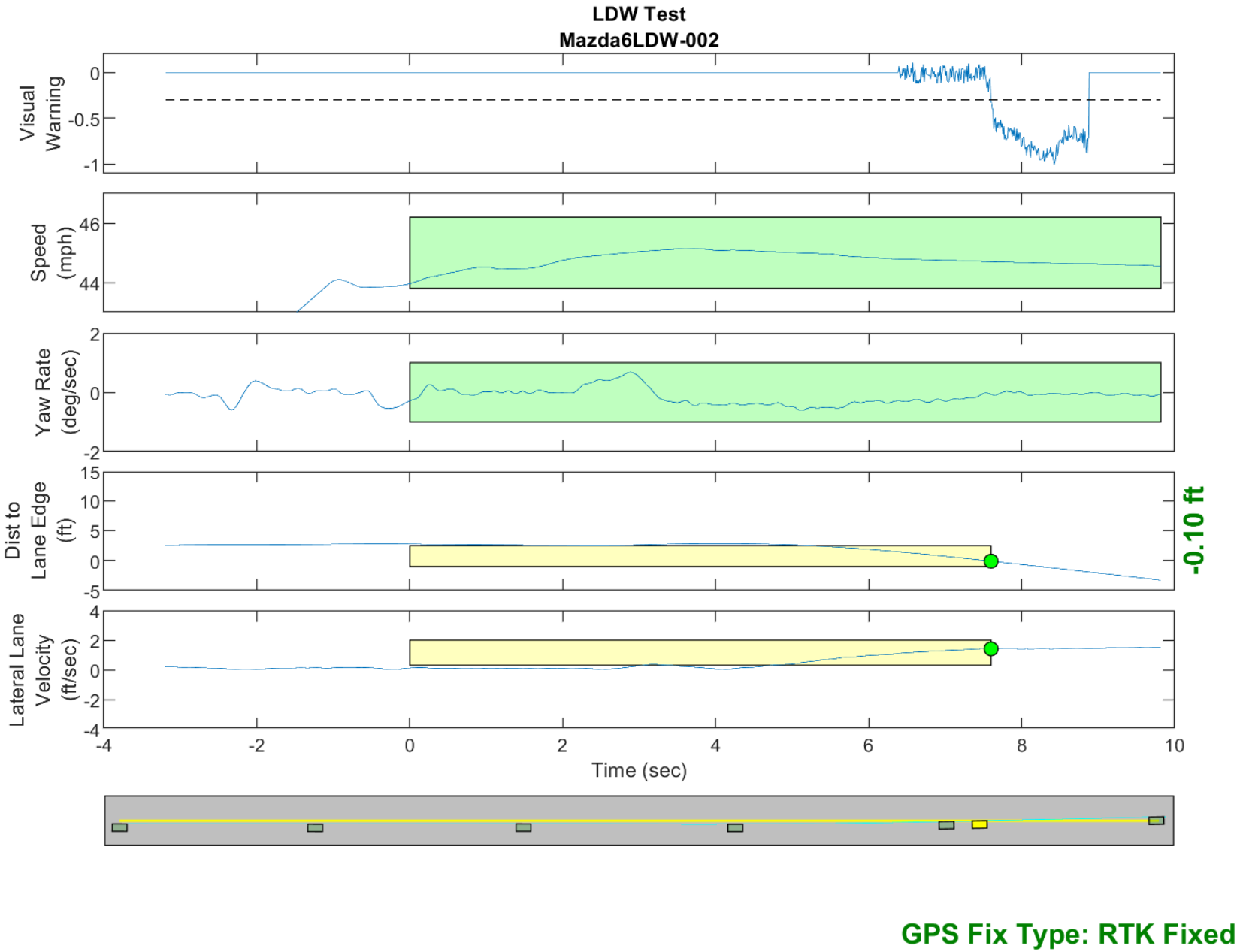


Figure D7. Time History for Run 02, Solid Line, Left Departure, Visual Warning

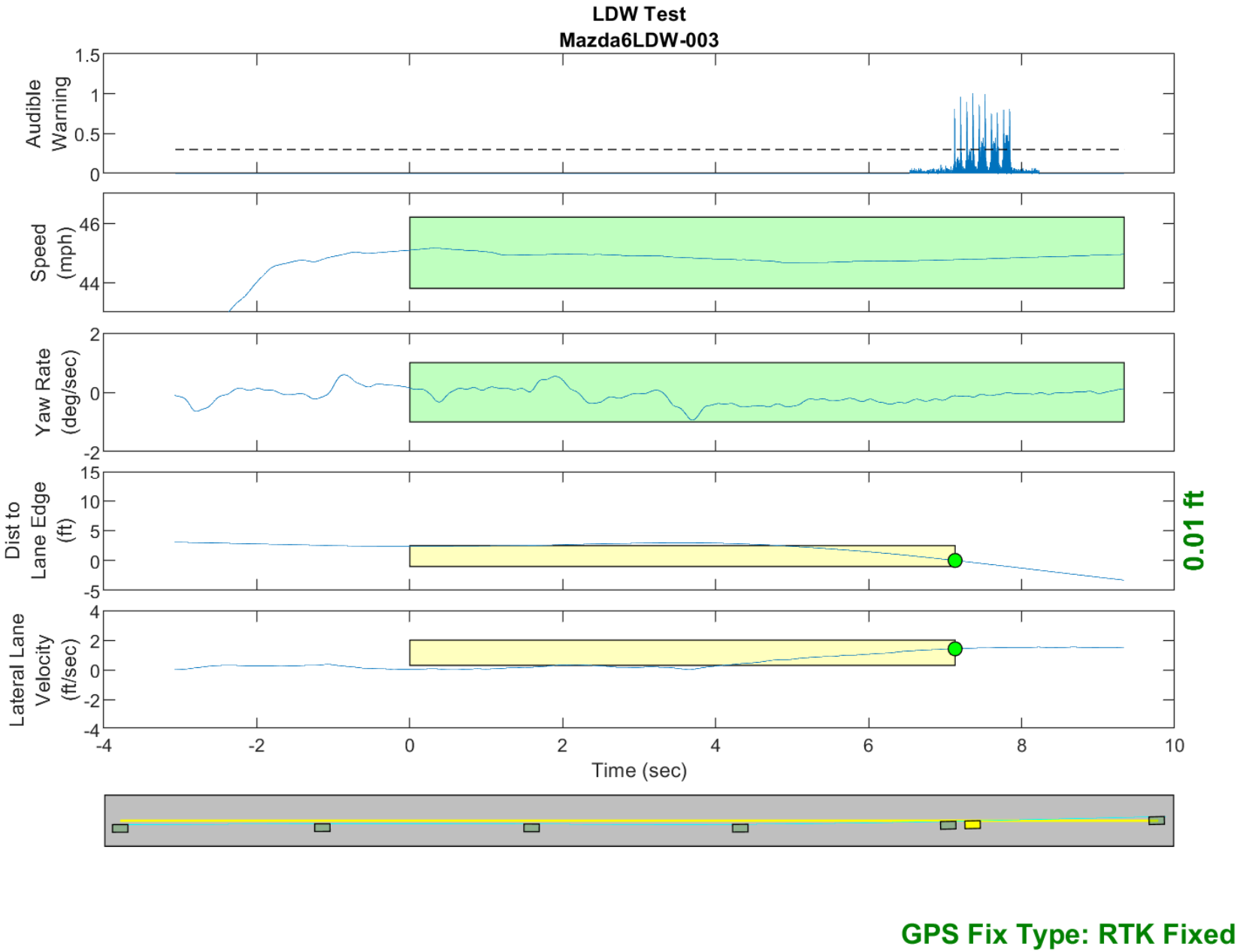


Figure D8. Time History for Run 03, Solid Line, Left Departure, Audible Warning

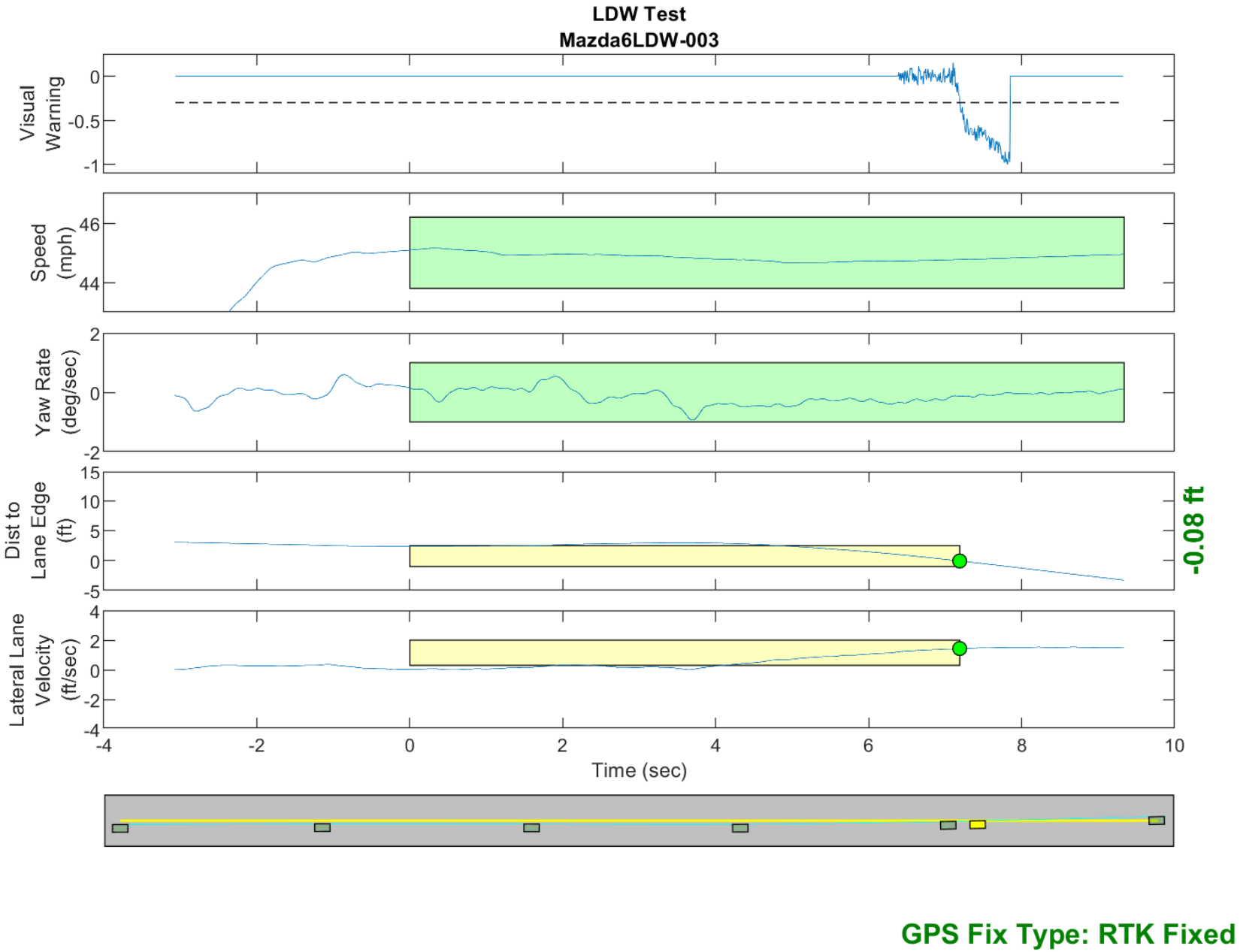


Figure D9. Time History for Run 03, Solid Line, Left Departure, Visual Warning

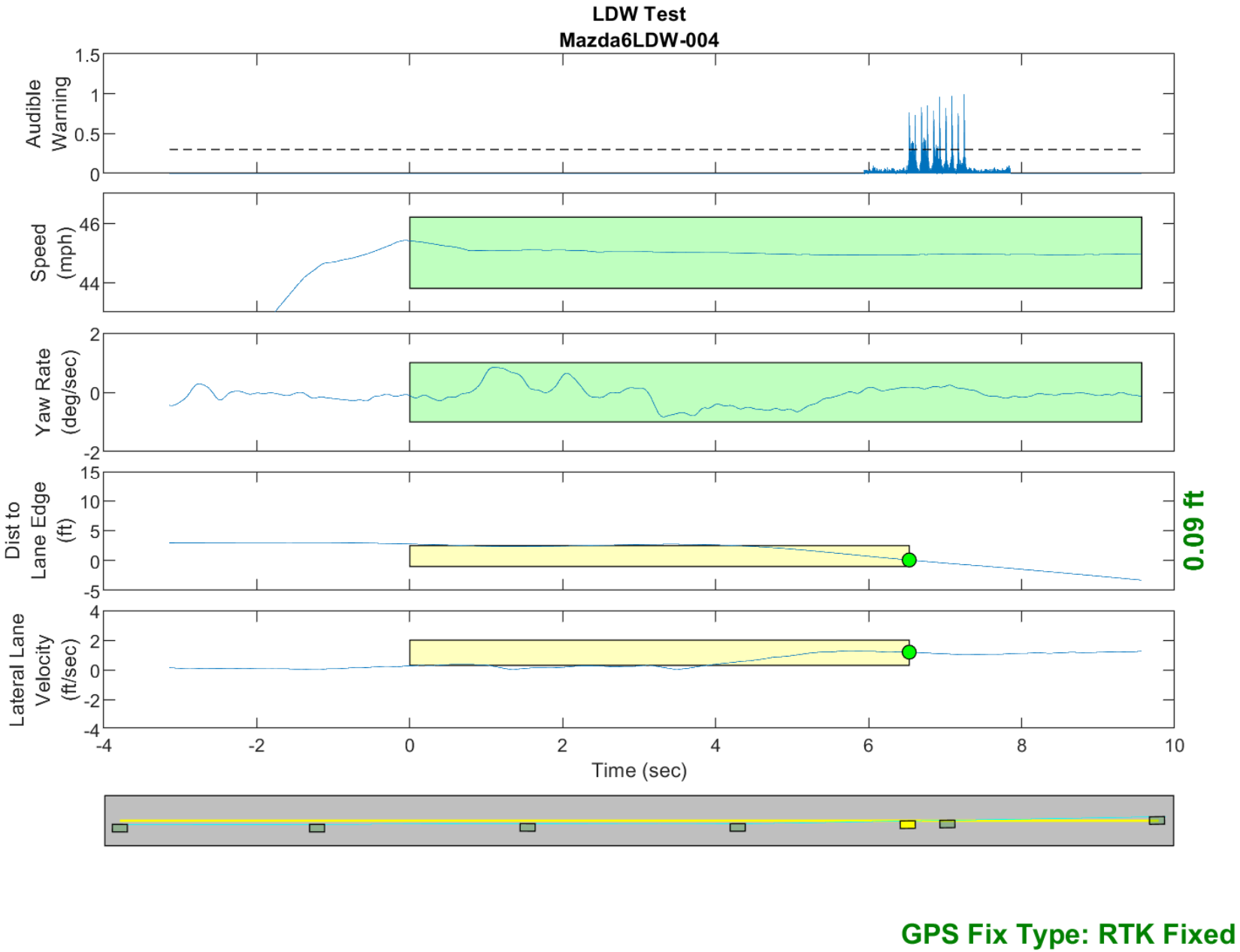


Figure D10. Time History for Run 04, Solid Line, Left Departure, Audible Warning

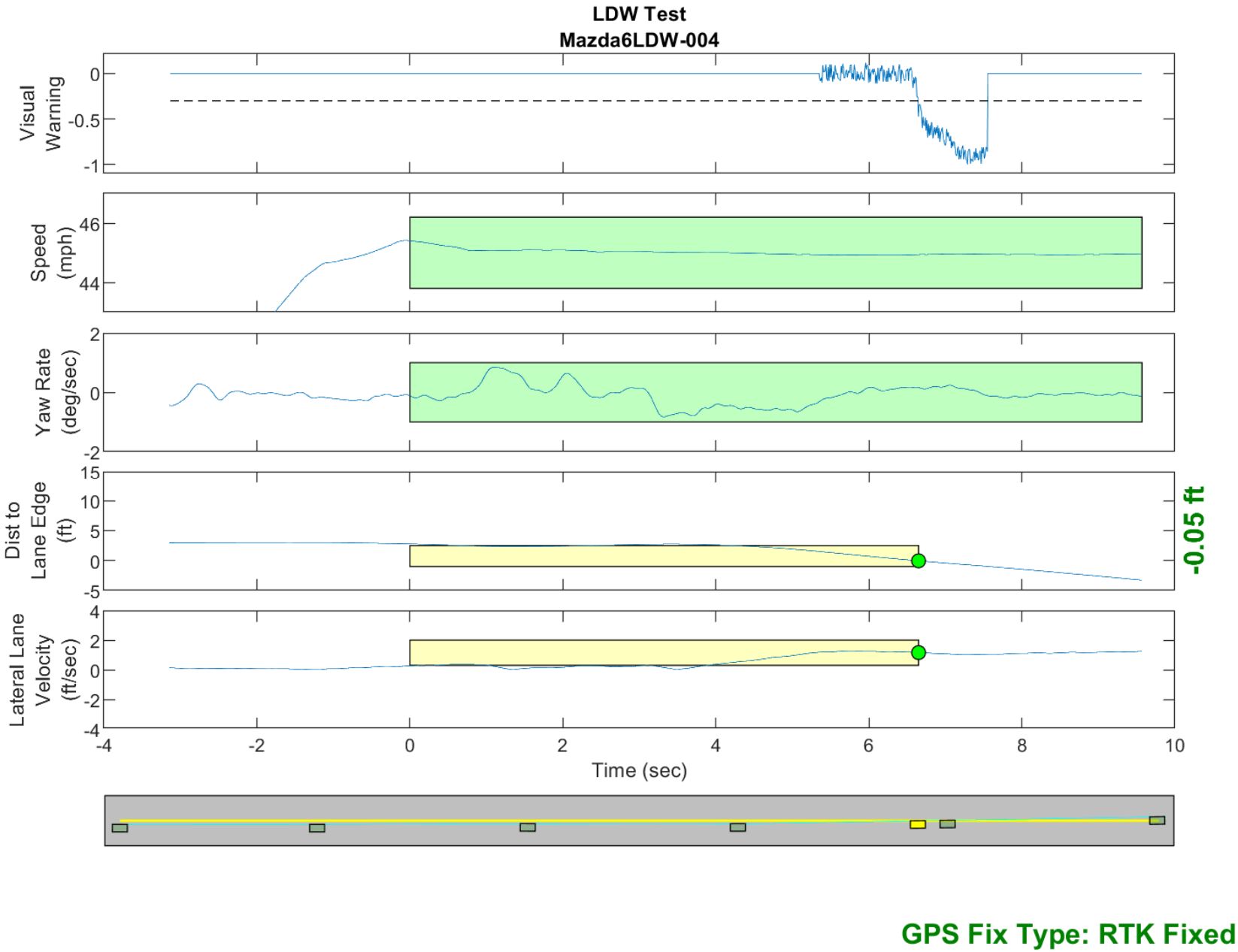


Figure D11. Time History for Run 04, Solid Line, Left Departure, Visual Warning

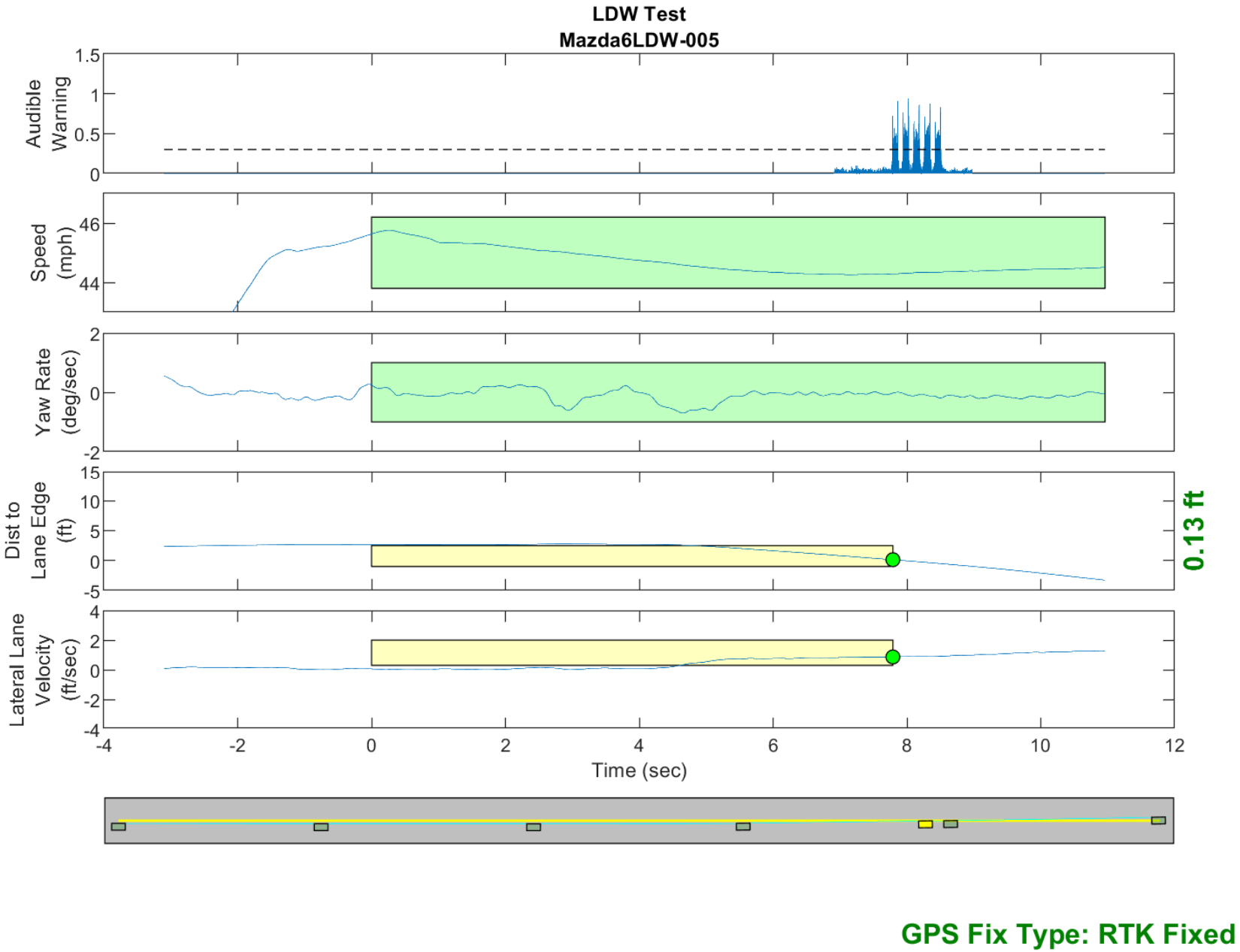


Figure D12. Time History for Run 05, Solid Line, Left Departure, Audible Warning

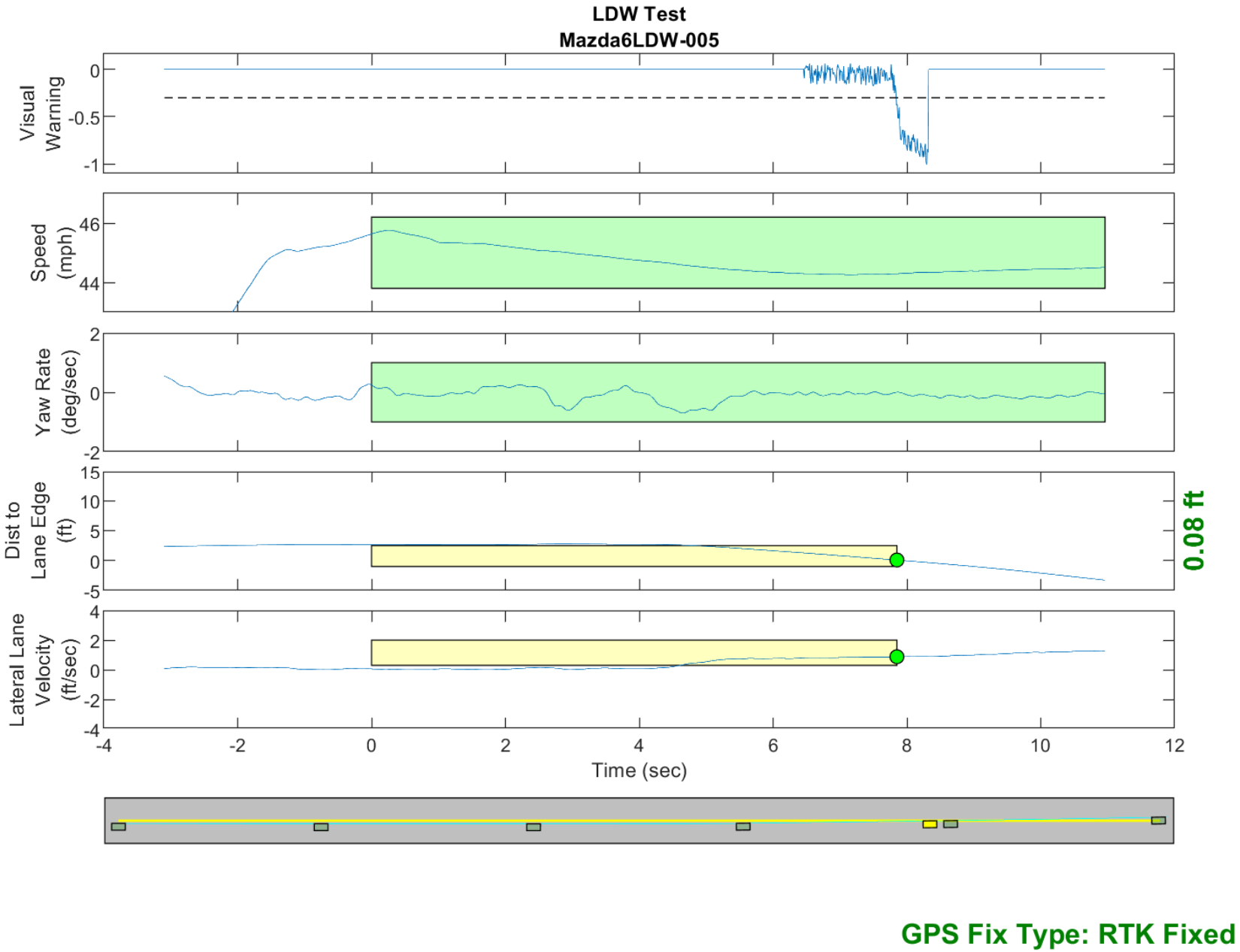


Figure D13. Time History for Run 05, Solid Line, Left Departure, Visual Warning

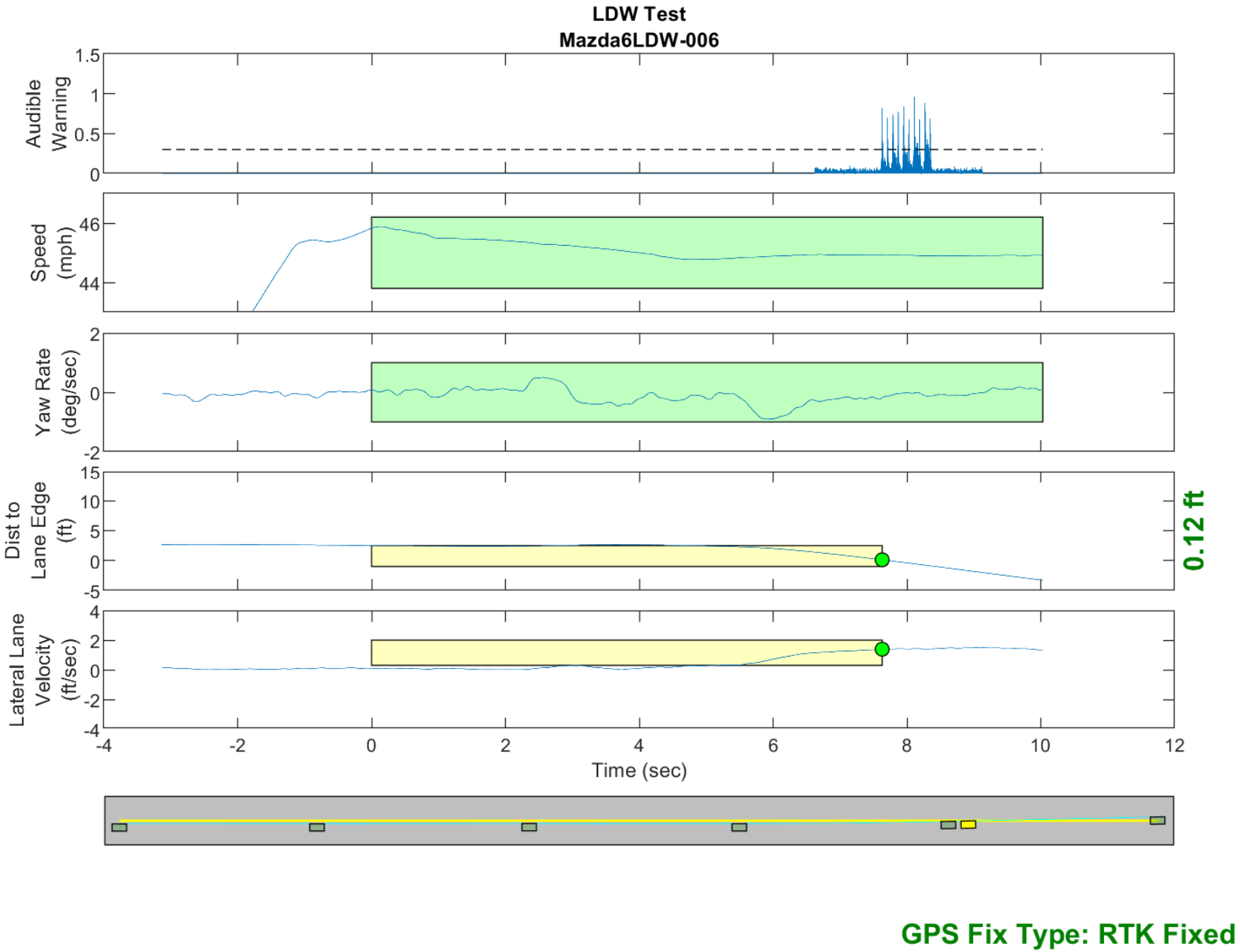


Figure D14. Time History for Run 06, Solid Line, Left Departure, Audible Warning

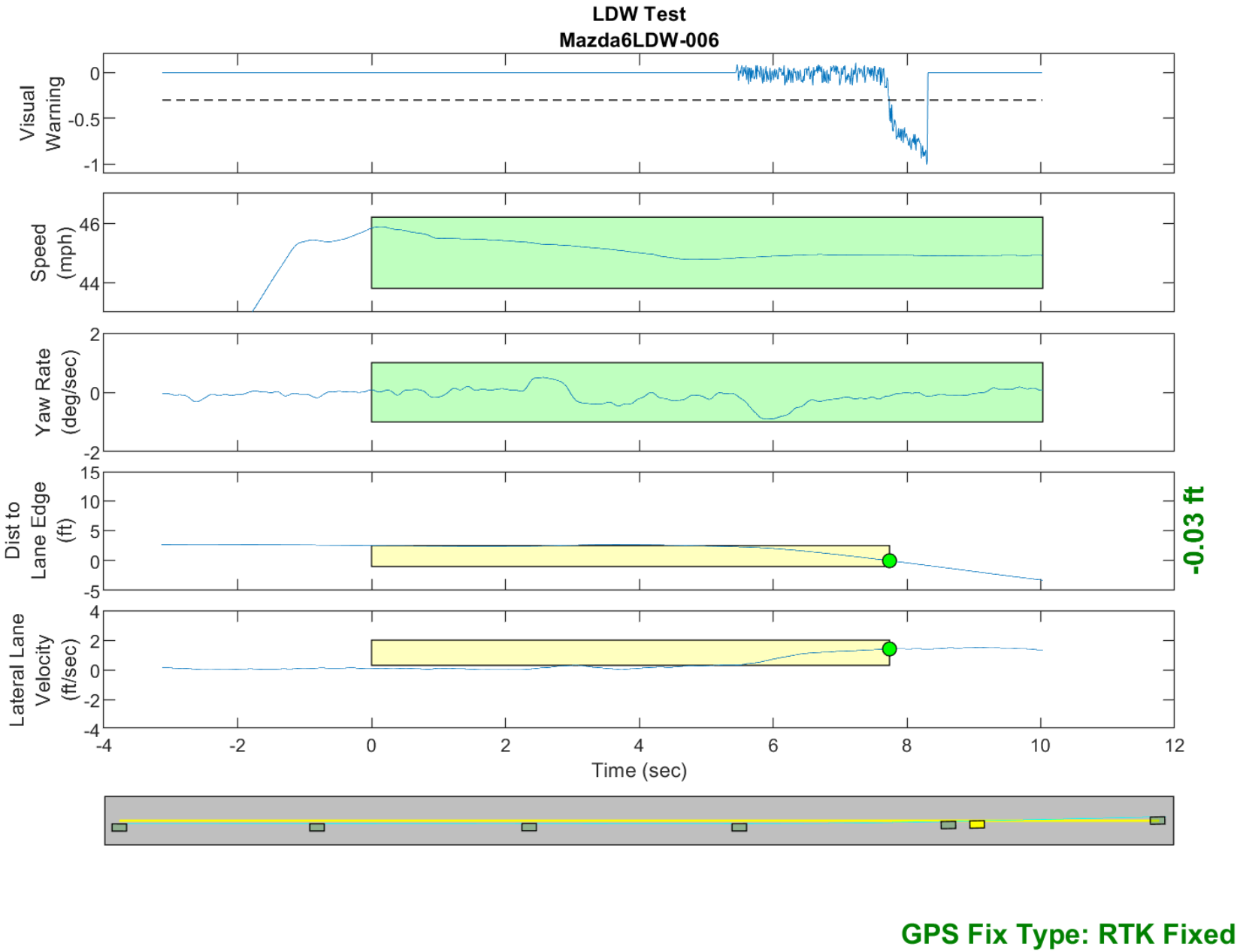


Figure D15. Time History for Run 06, Solid Line, Left Departure, Visual Warning

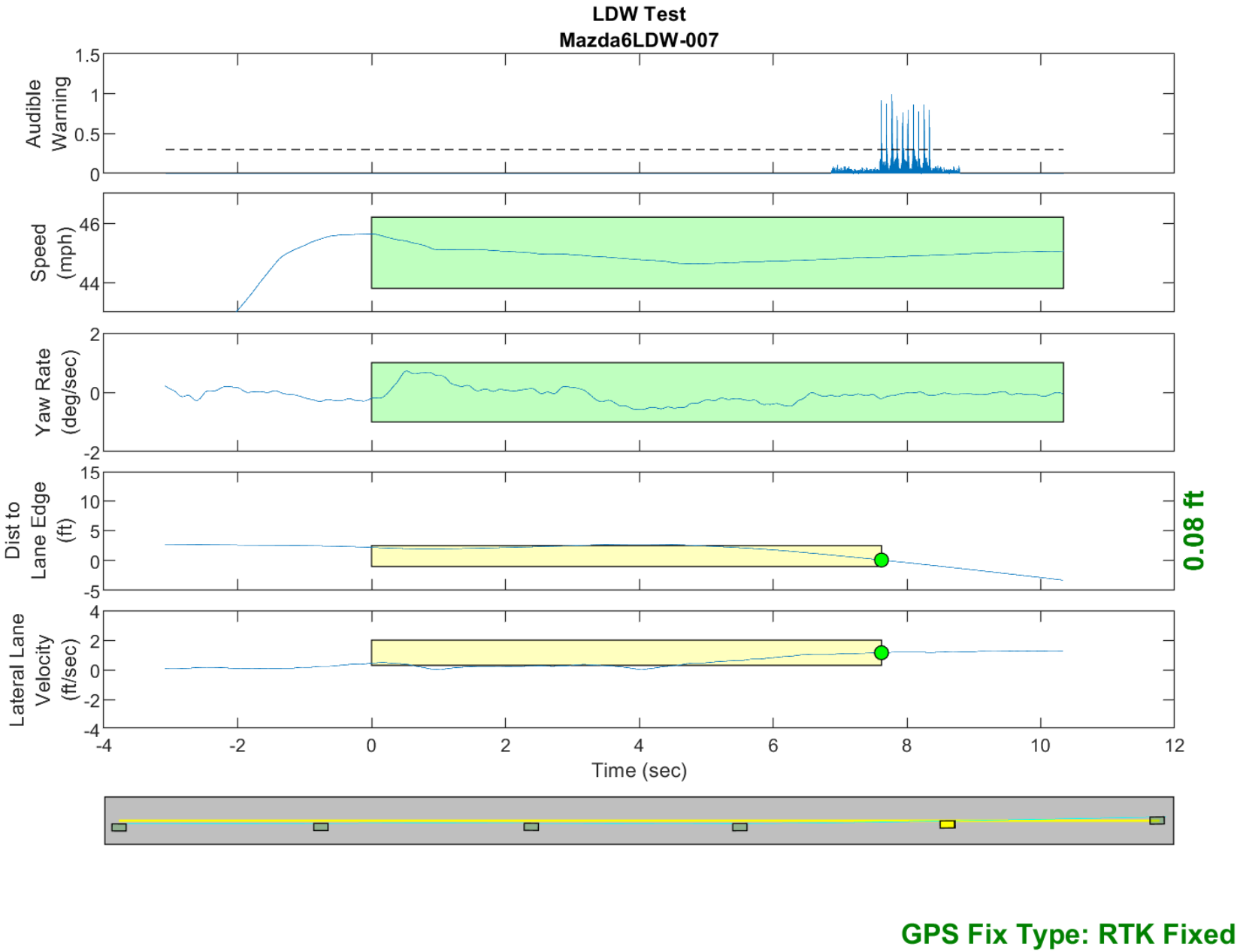


Figure D16. Time History for Run 07, Solid Line, Left Departure, Audible Warning

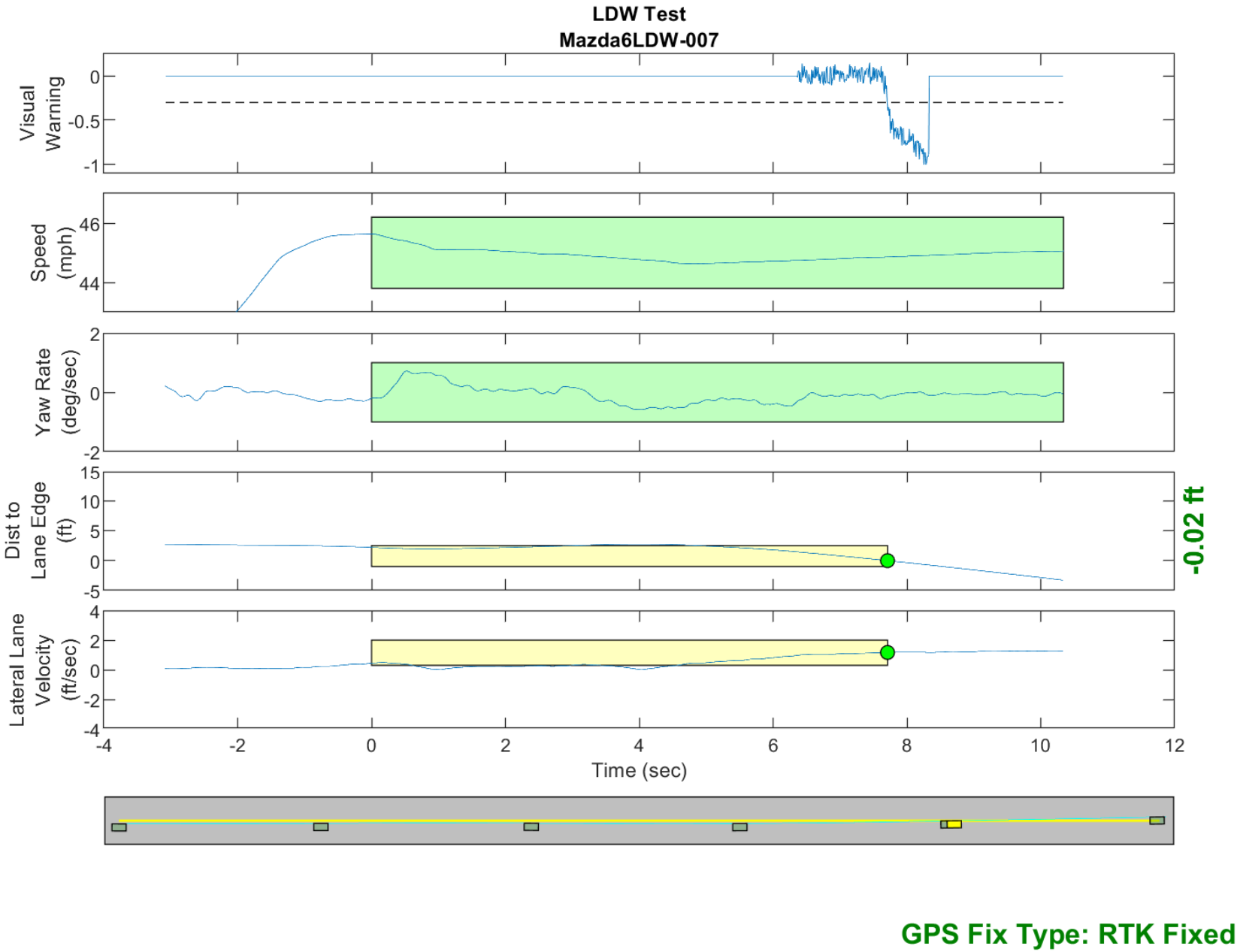


Figure D17. Time History for Run 07, Solid Line, Left Departure, Visual Warning

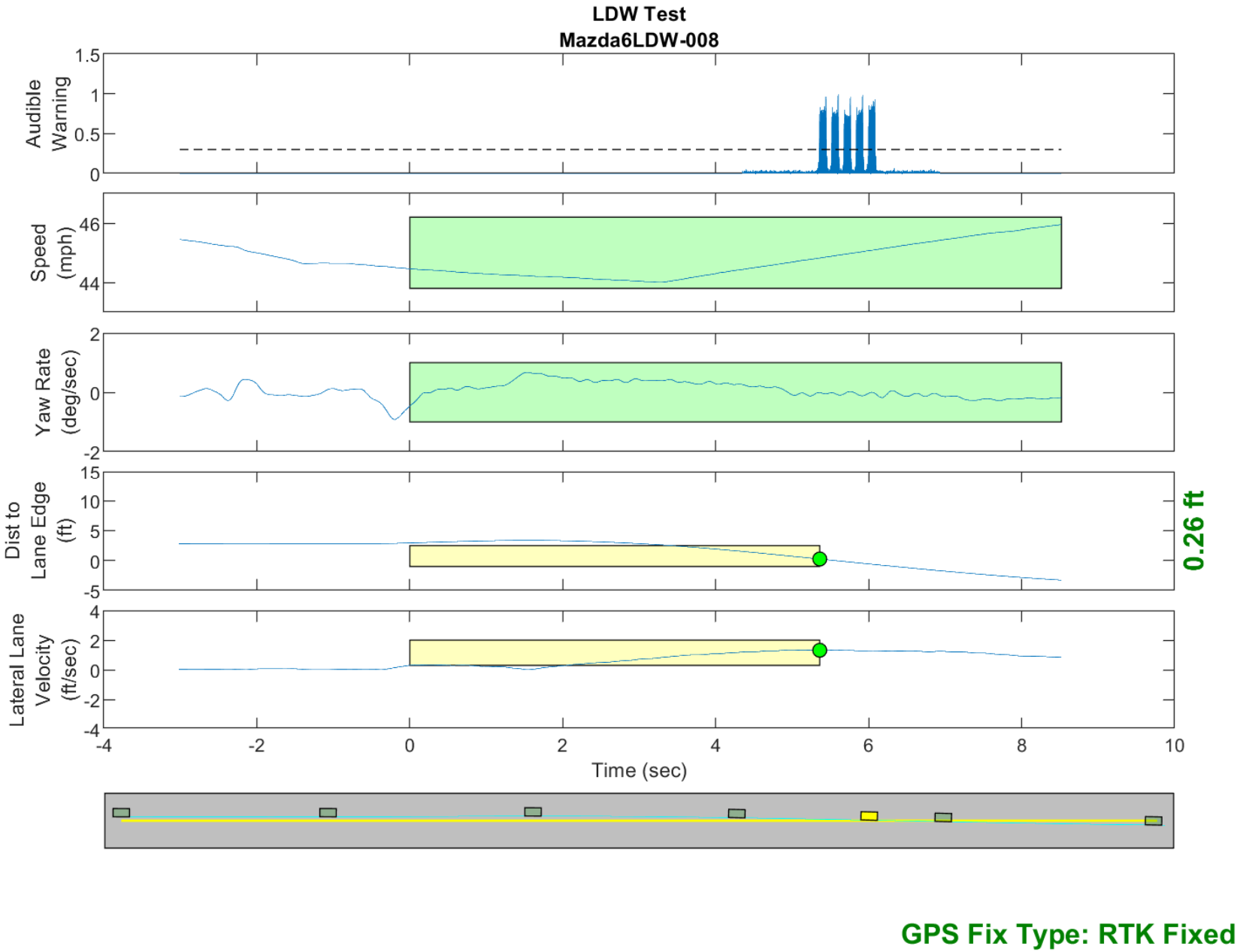


Figure D18. Time History for Run 08, Solid Line, Right Departure, Audible Warning

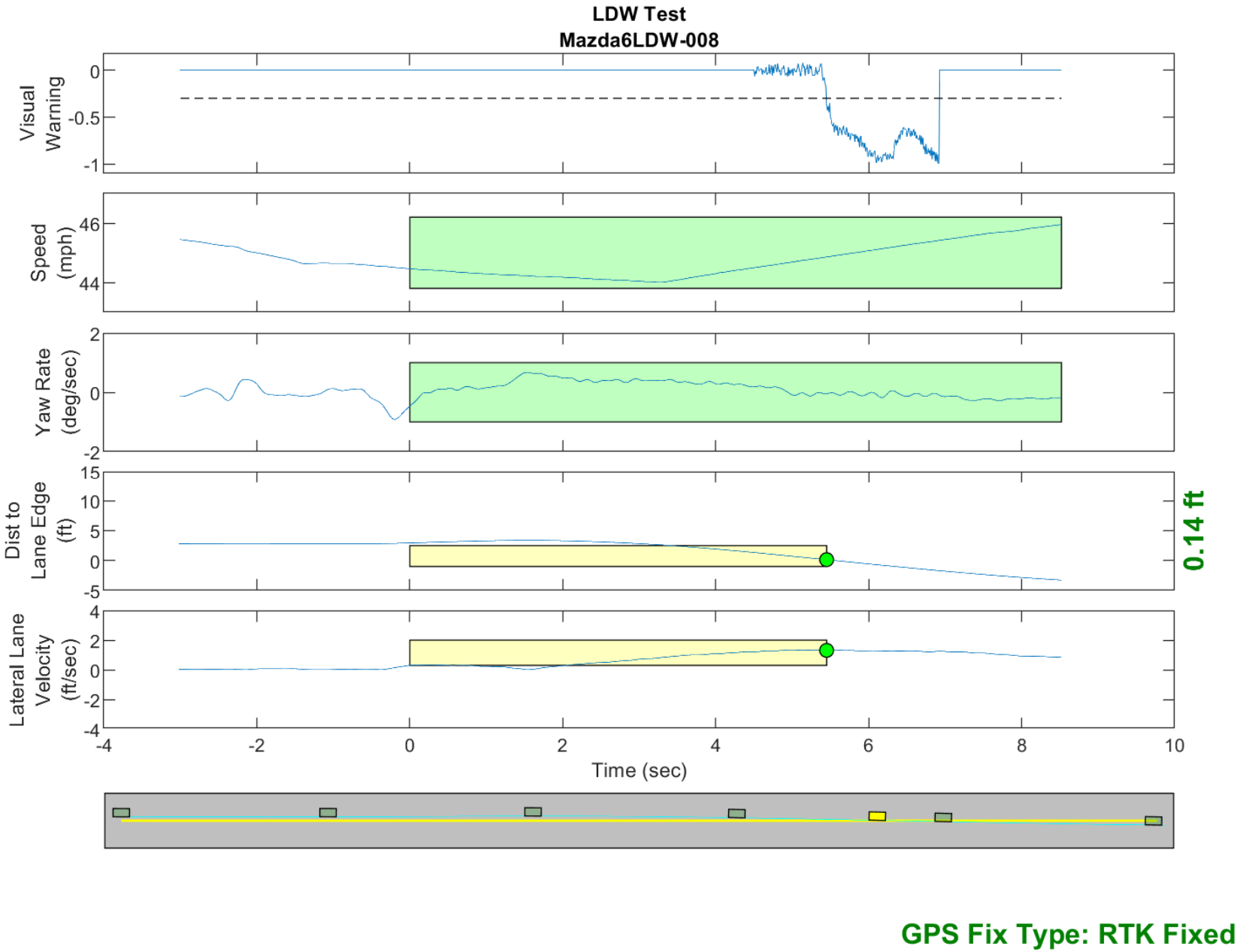


Figure D19. Time History for Run 08, Solid Line, Right Departure, Visual Warning

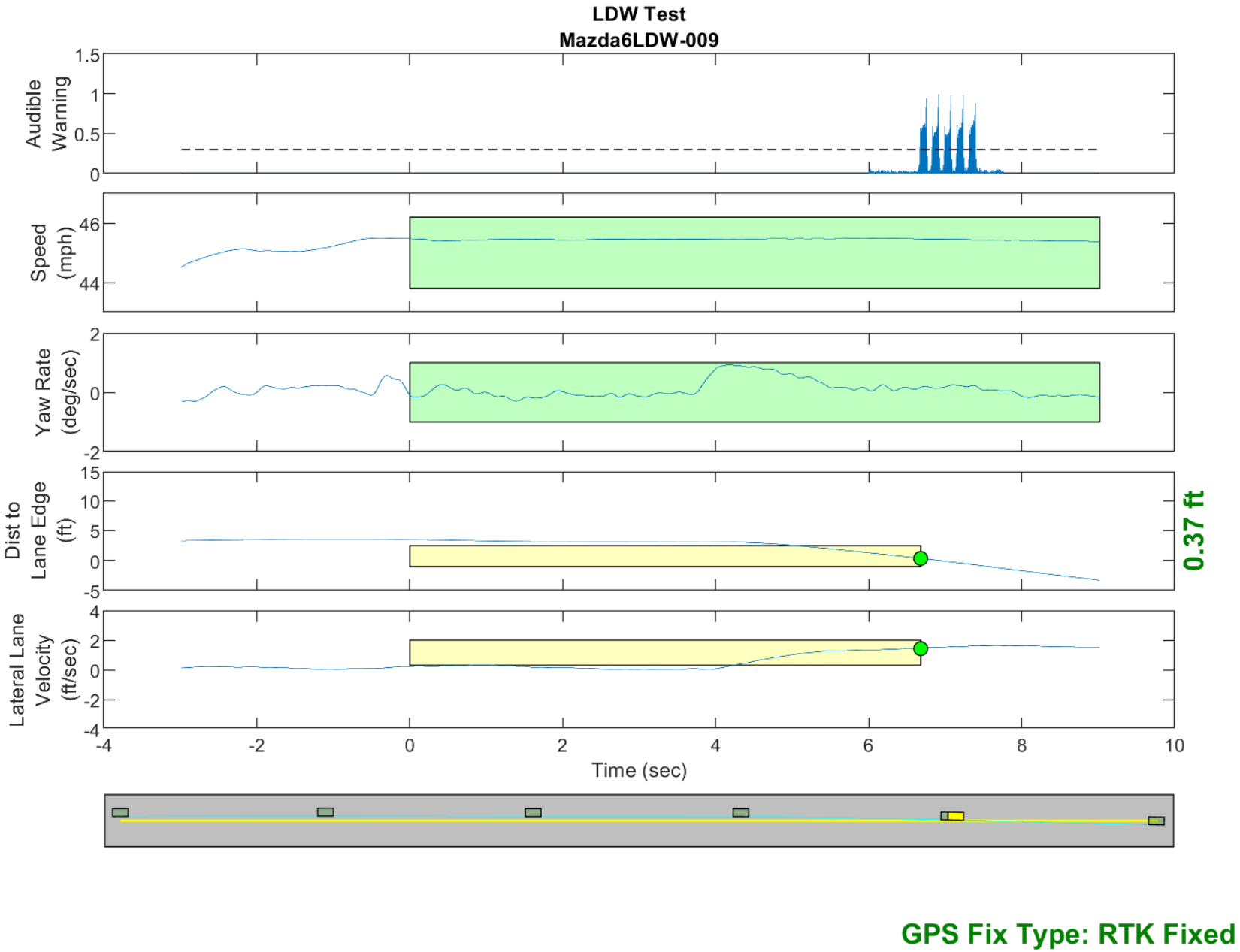


Figure D20. Time History for Run 09, Solid Line, Right Departure, Audible Warning

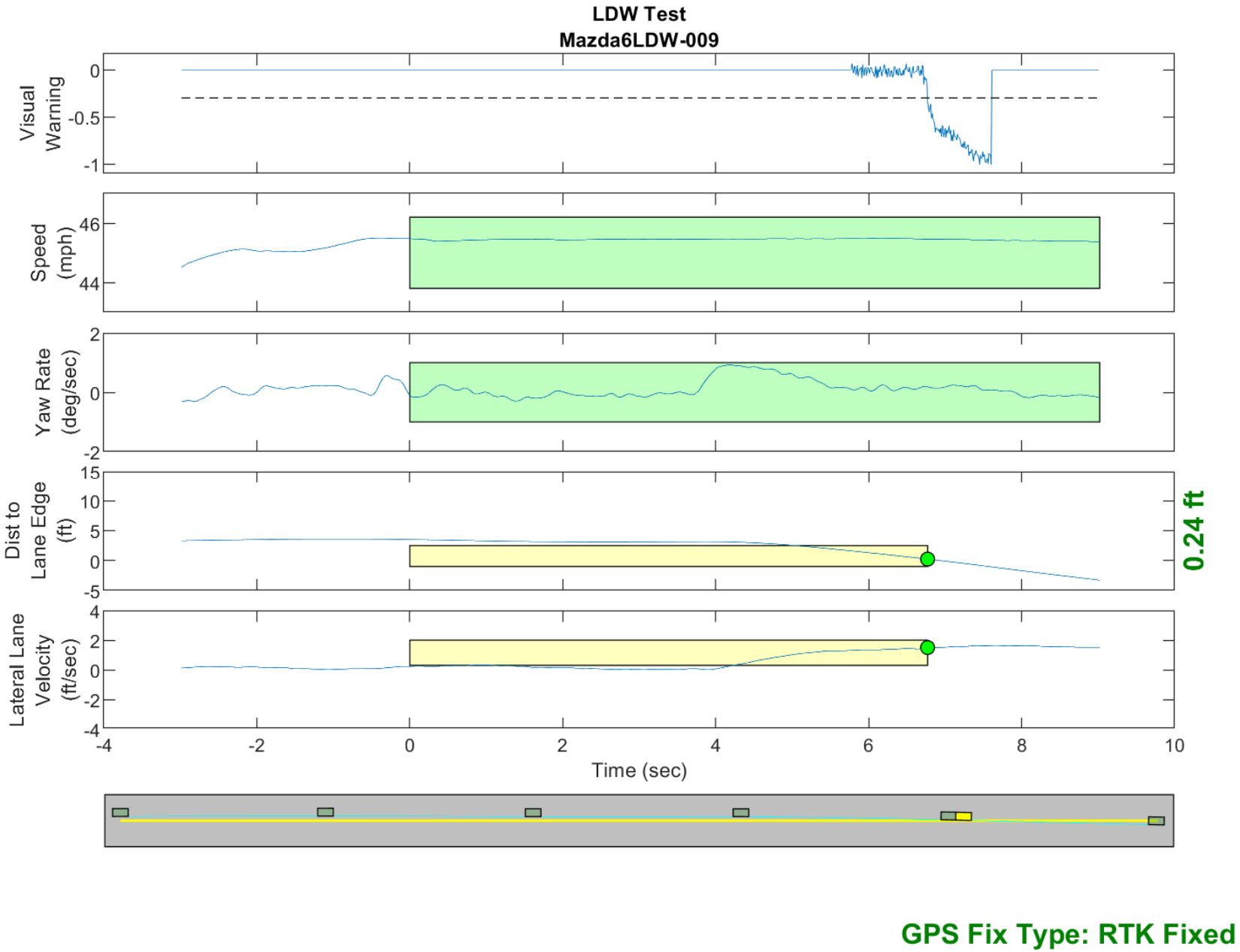


Figure D21. Time History for Run 09, Solid Line, Right Departure, Visual Warning

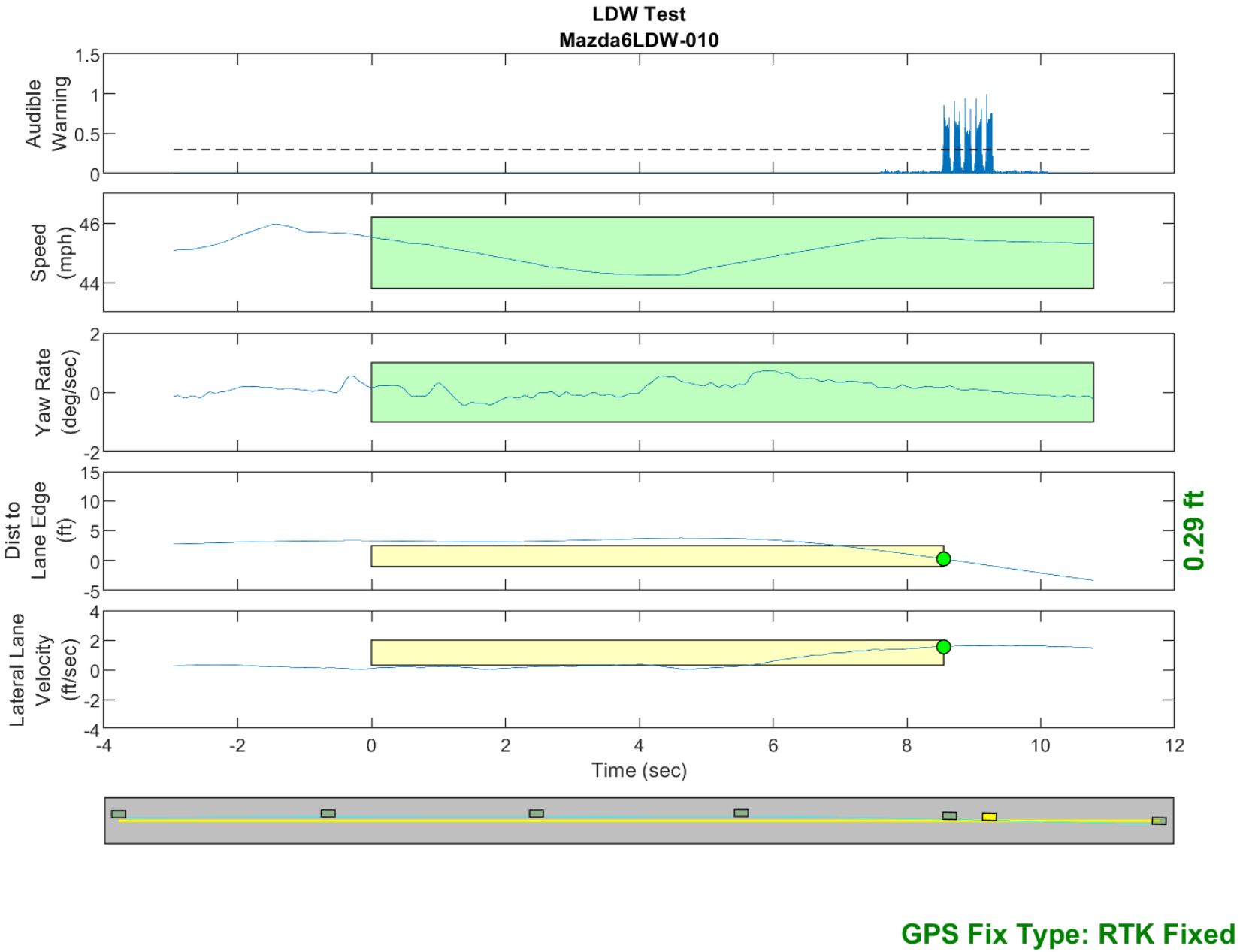


Figure D22. Time History for Run 10, Solid Line, Right Departure, Audible Warning

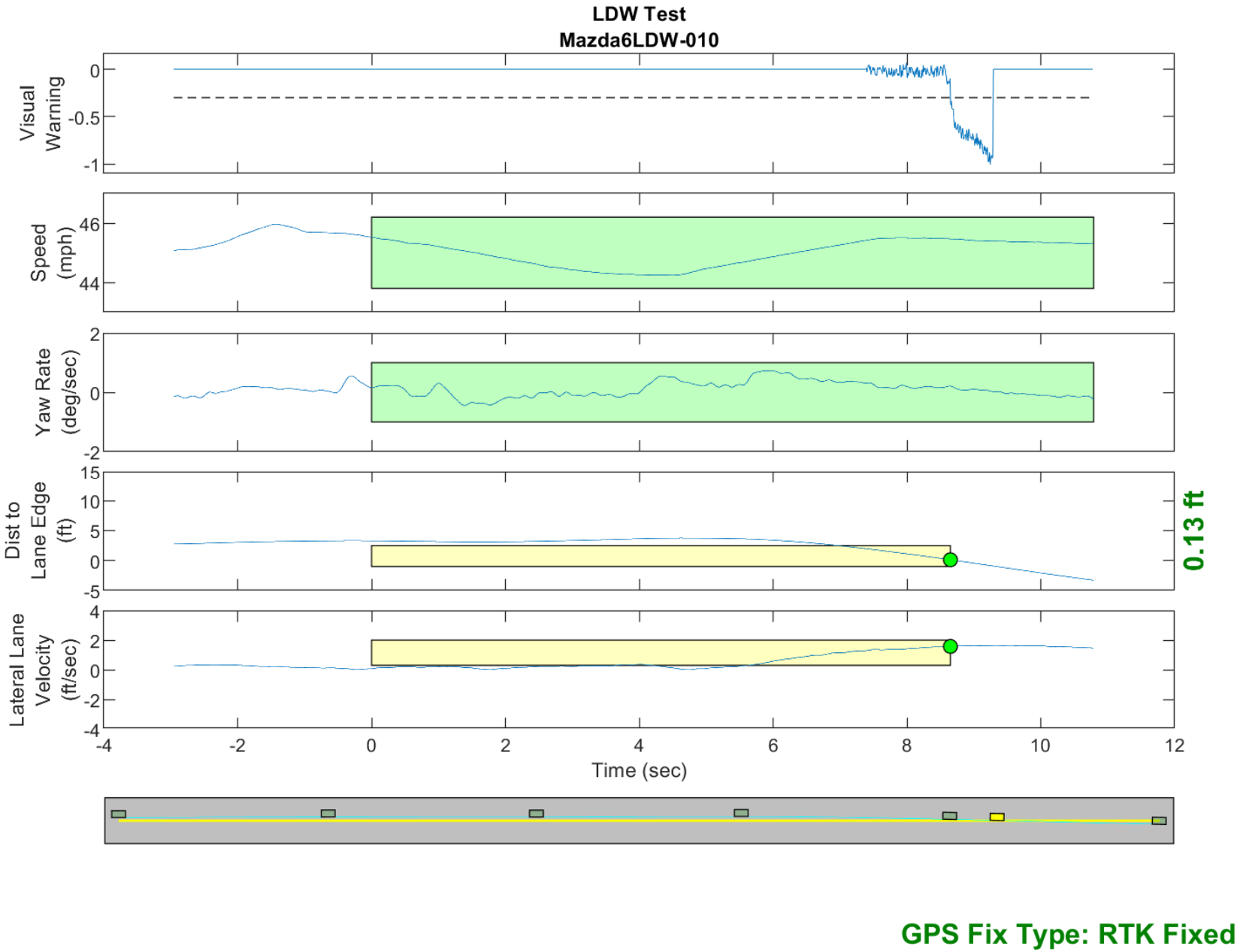


Figure D23. Time History for Run 10, Solid Line, Right Departure, Visual Warning

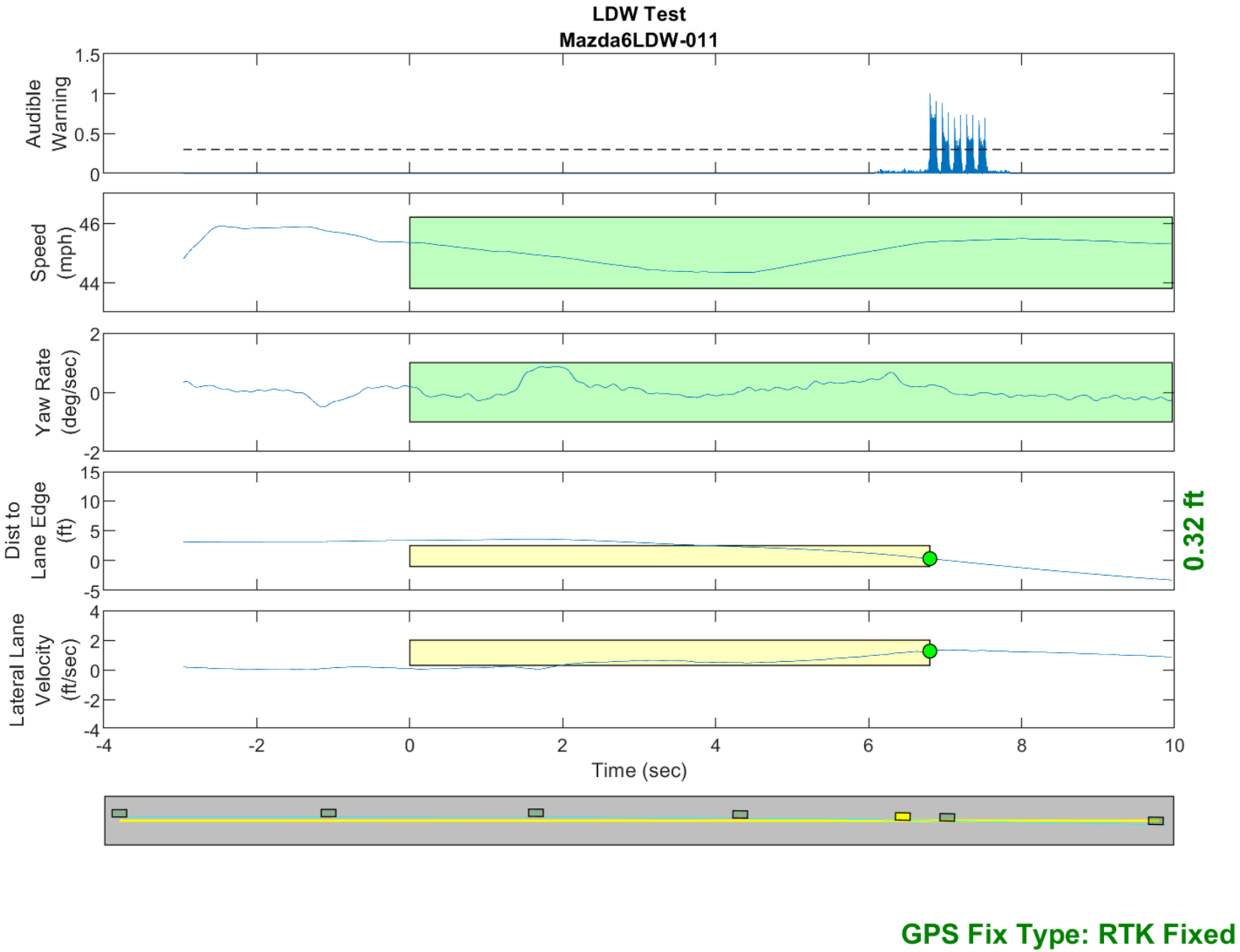


Figure D24. Time History for Run 11, Solid Line, Right Departure, Audible Warning

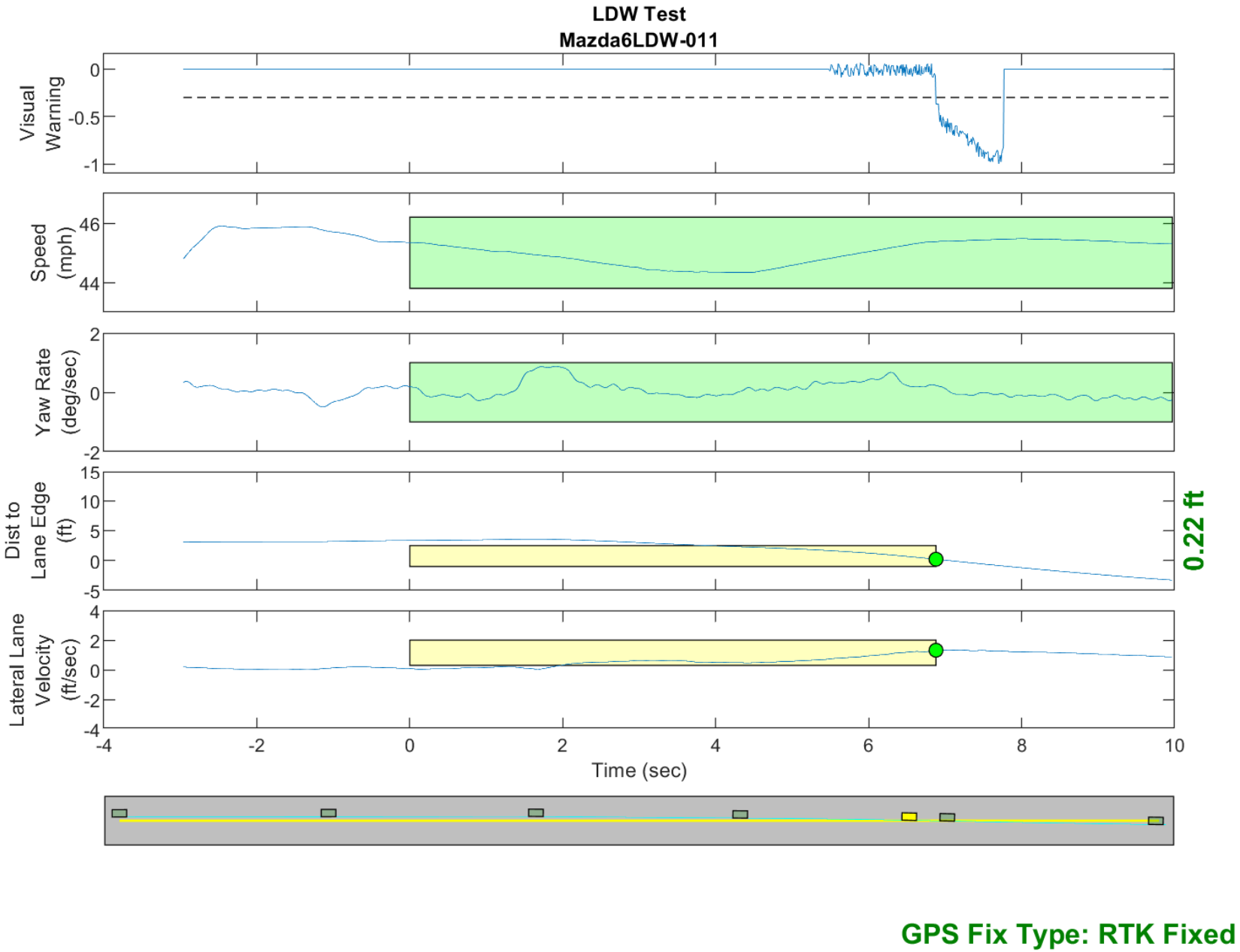


Figure D25. Time History for Run 11, Solid Line, Right Departure, Visual Warning

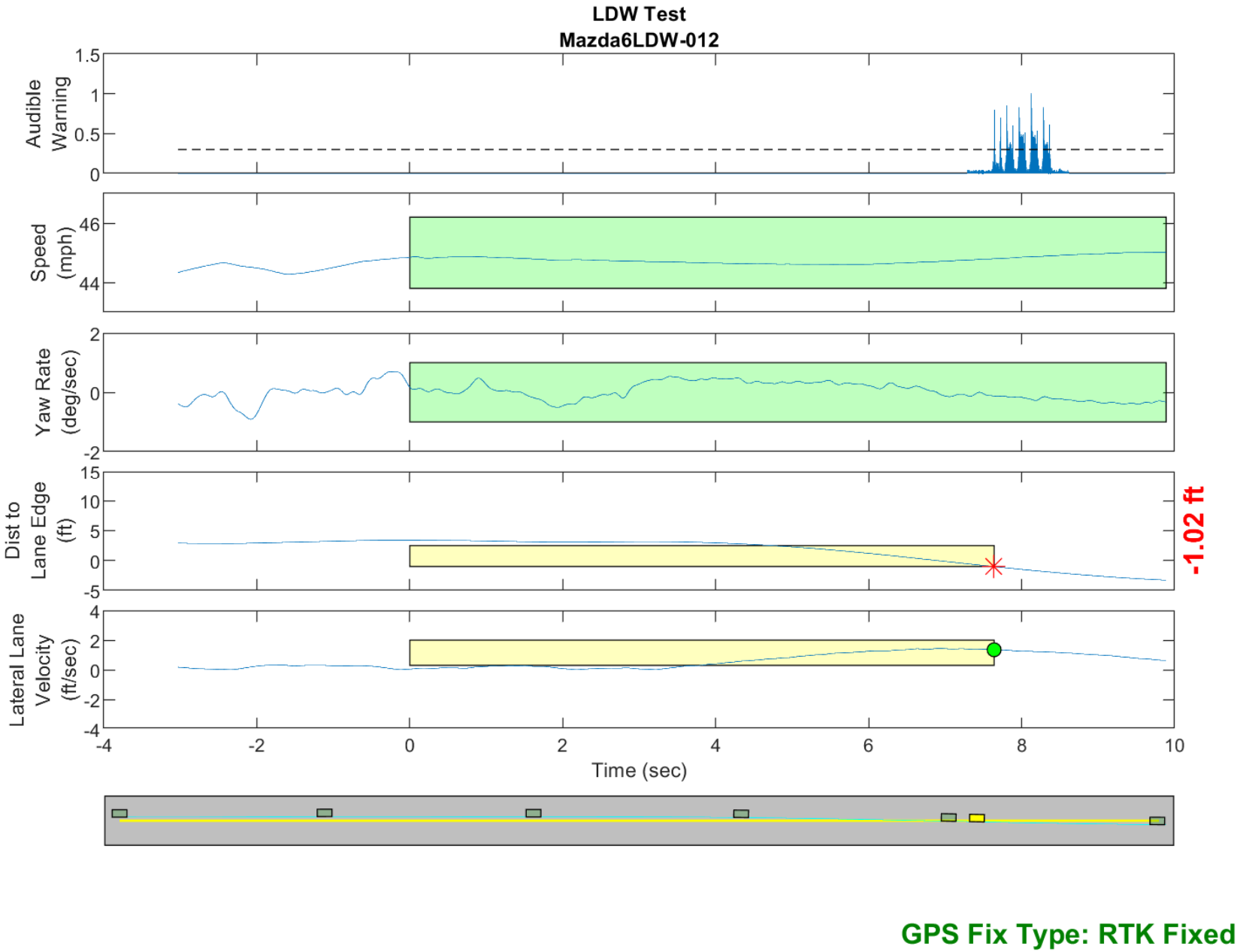


Figure D26. Time History for Run 12, Solid Line, Right Departure, Audible Warning

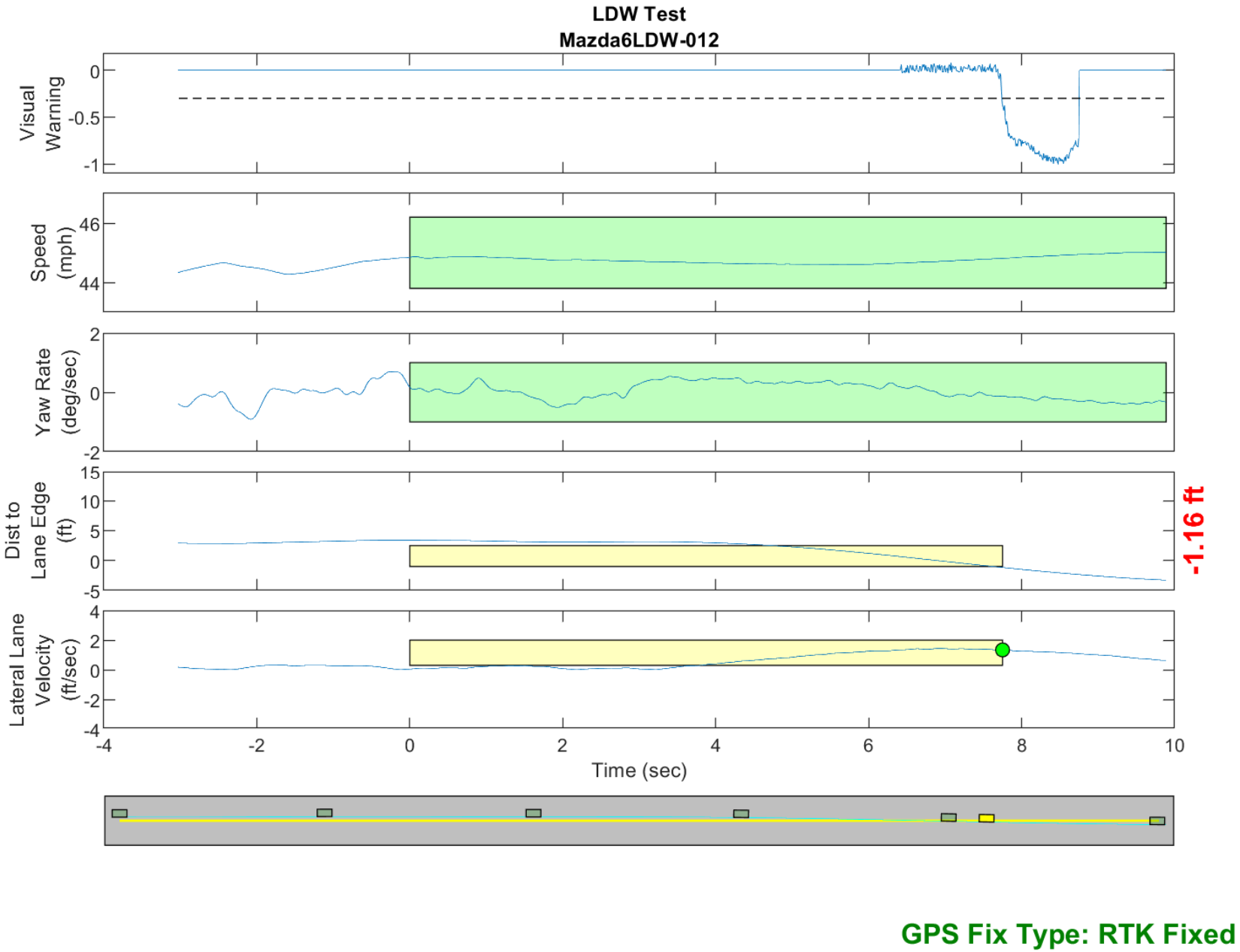


Figure D27. Time History for Run 12, Solid Line, Right Departure, Visual Warning

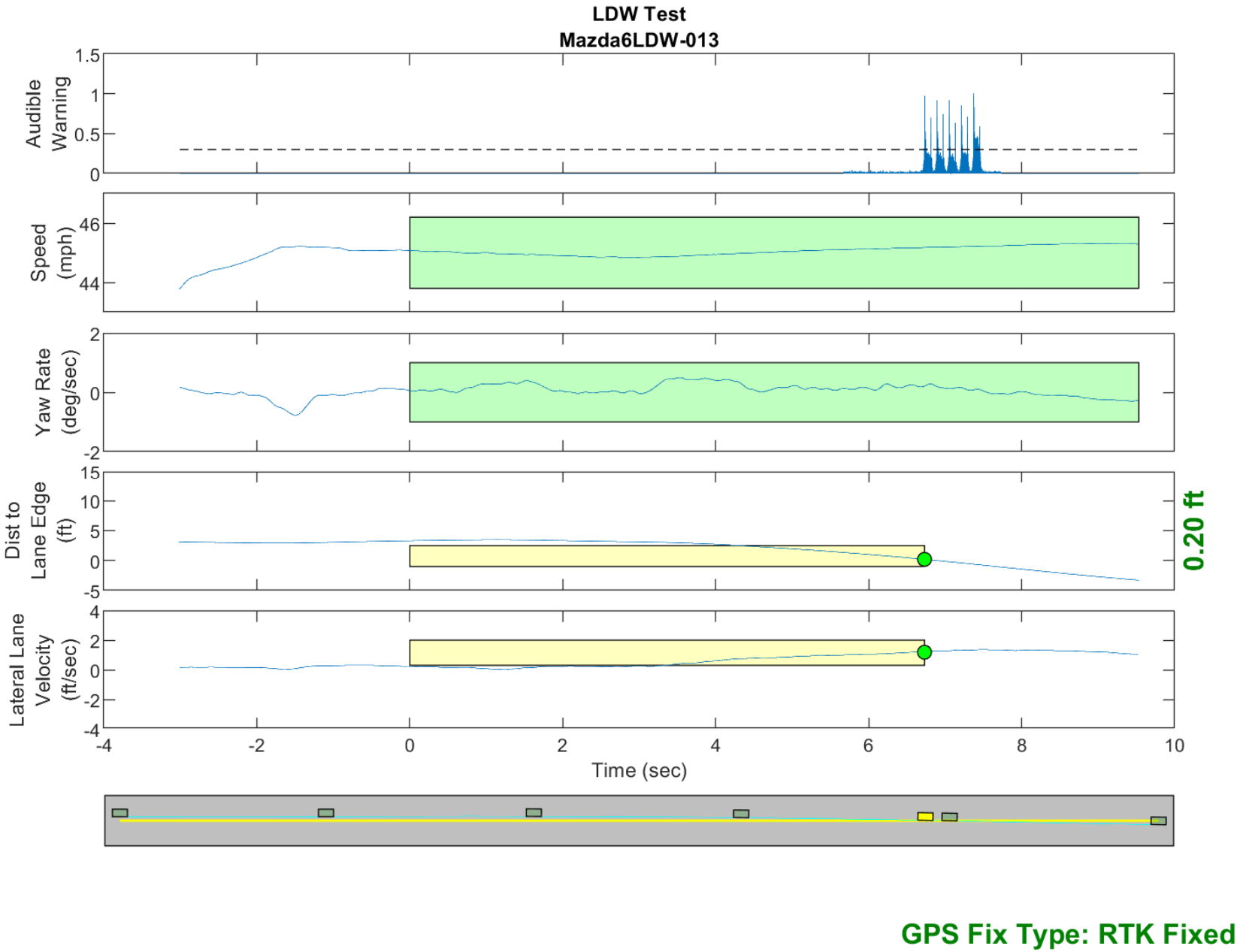


Figure D28. Time History for Run 13, Solid Line, Right Departure, Audible Warning

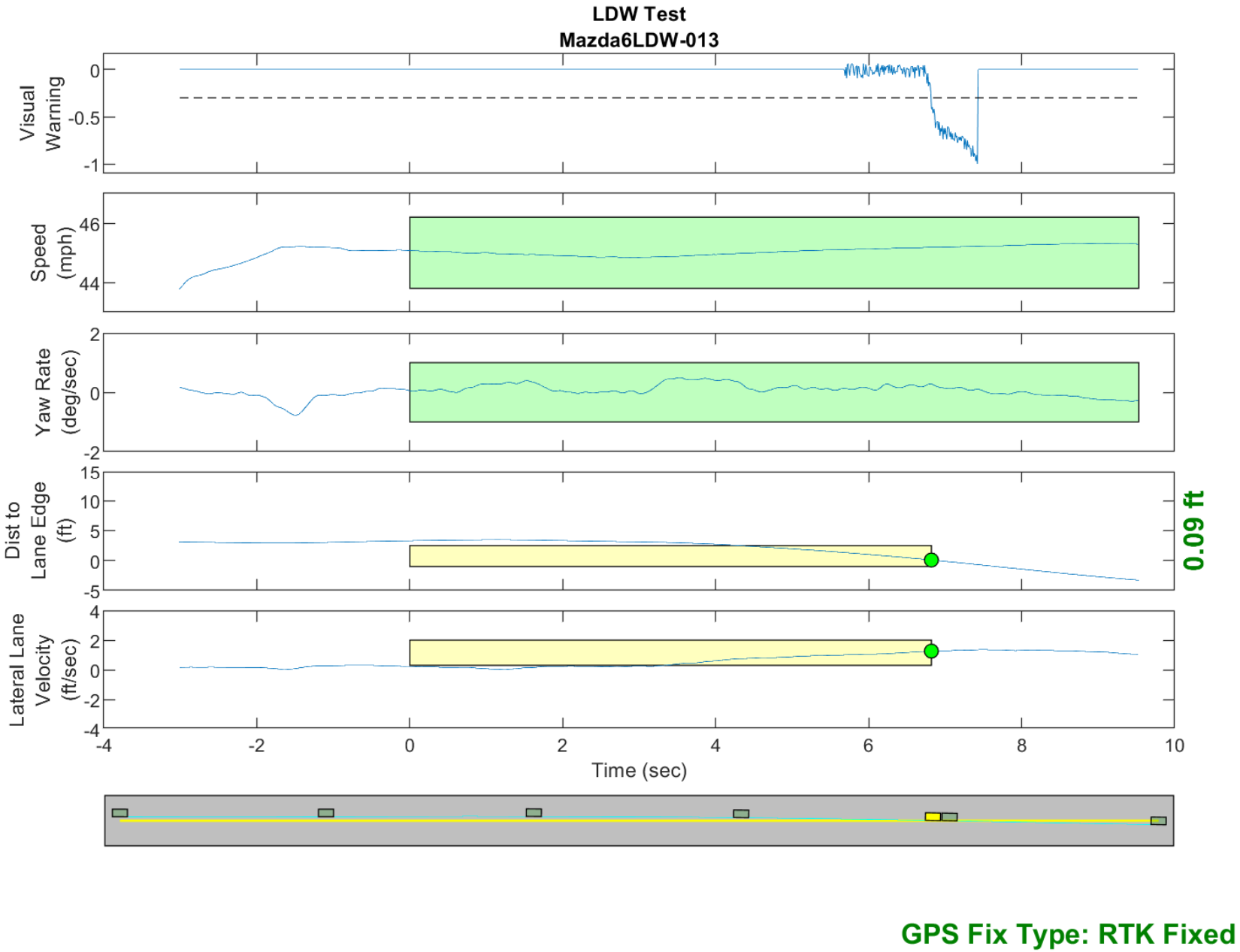


Figure D29. Time History for Run 13, Solid Line, Right Departure, Visual Warning

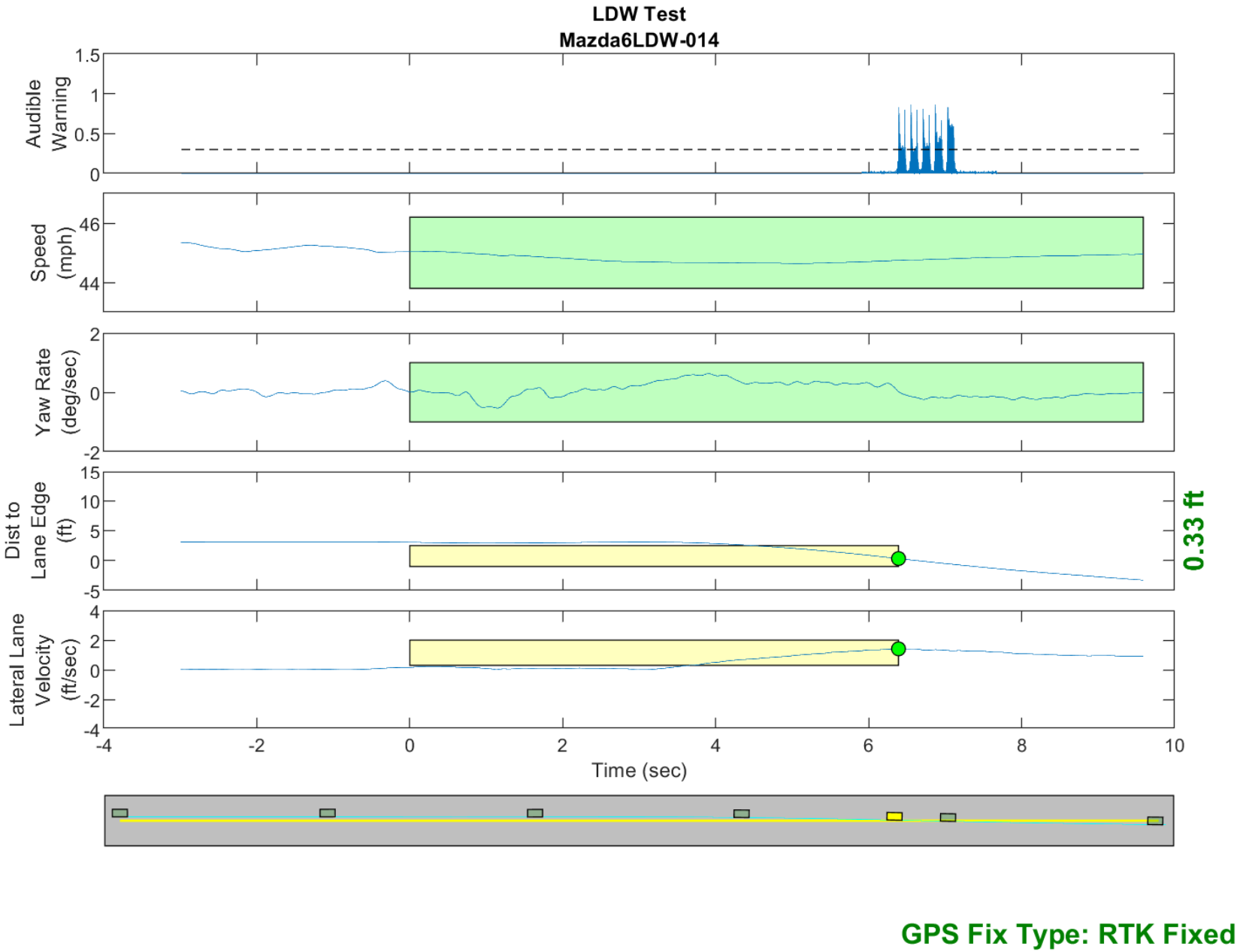


Figure D30. Time History for Run 14, Solid Line, Right Departure, Audible Warning

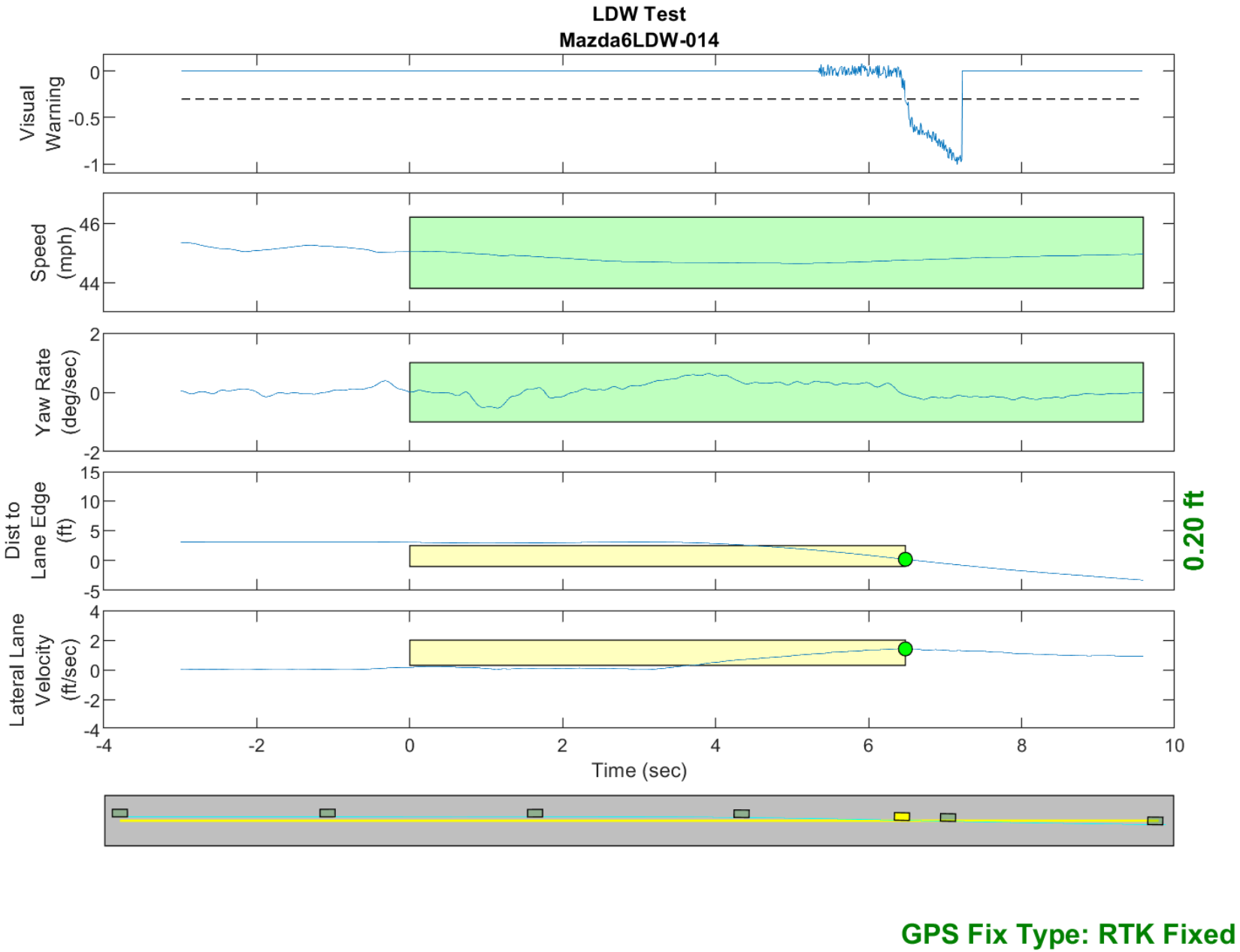


Figure D31. Time History for Run 14, Solid Line, Right Departure, Visual Warning

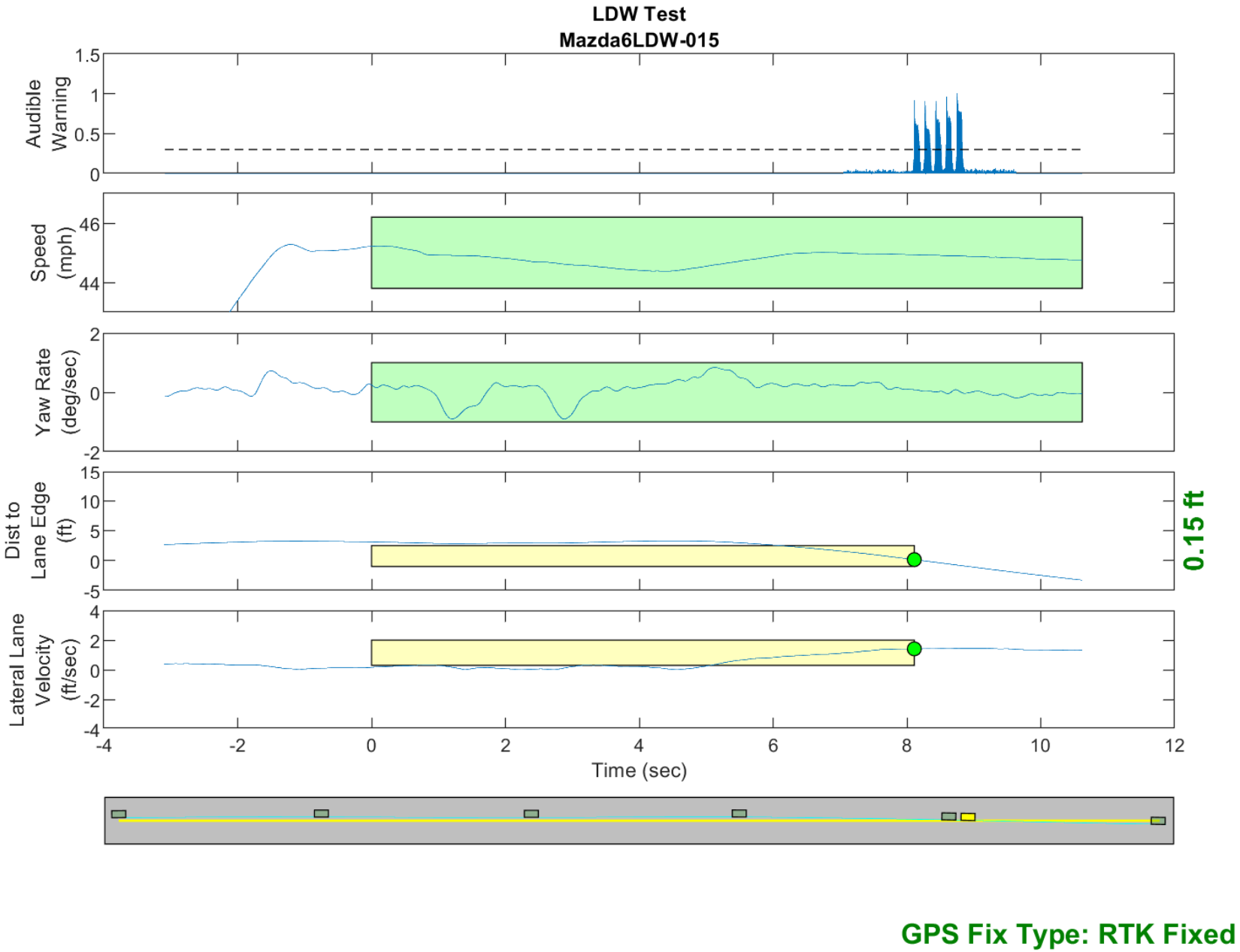


Figure D32. Time History for Run 15, Dashed Line, Right Departure, Audible Warning

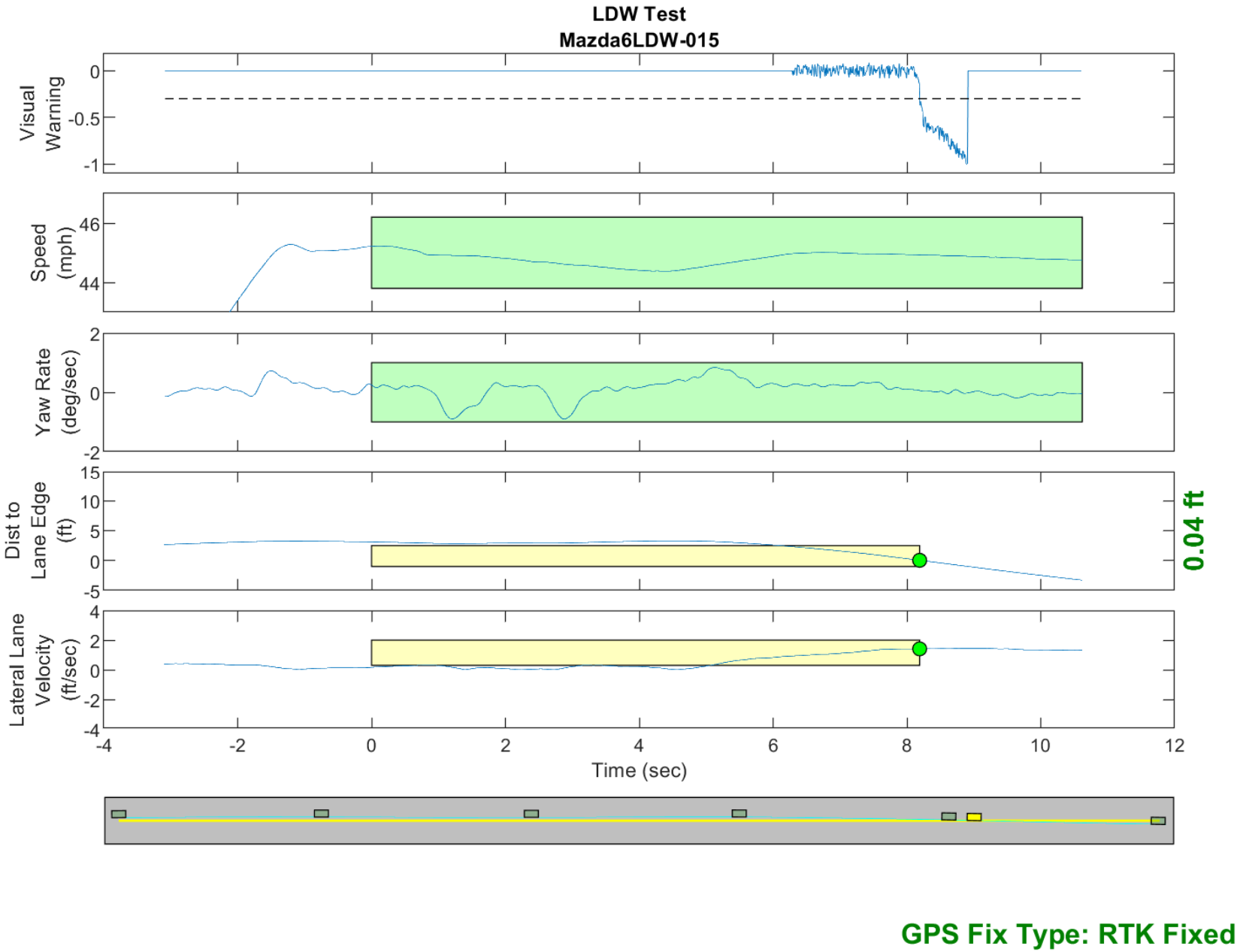


Figure D33. Time History for Run 15, Dashed Line, Right Departure, Visual Warning

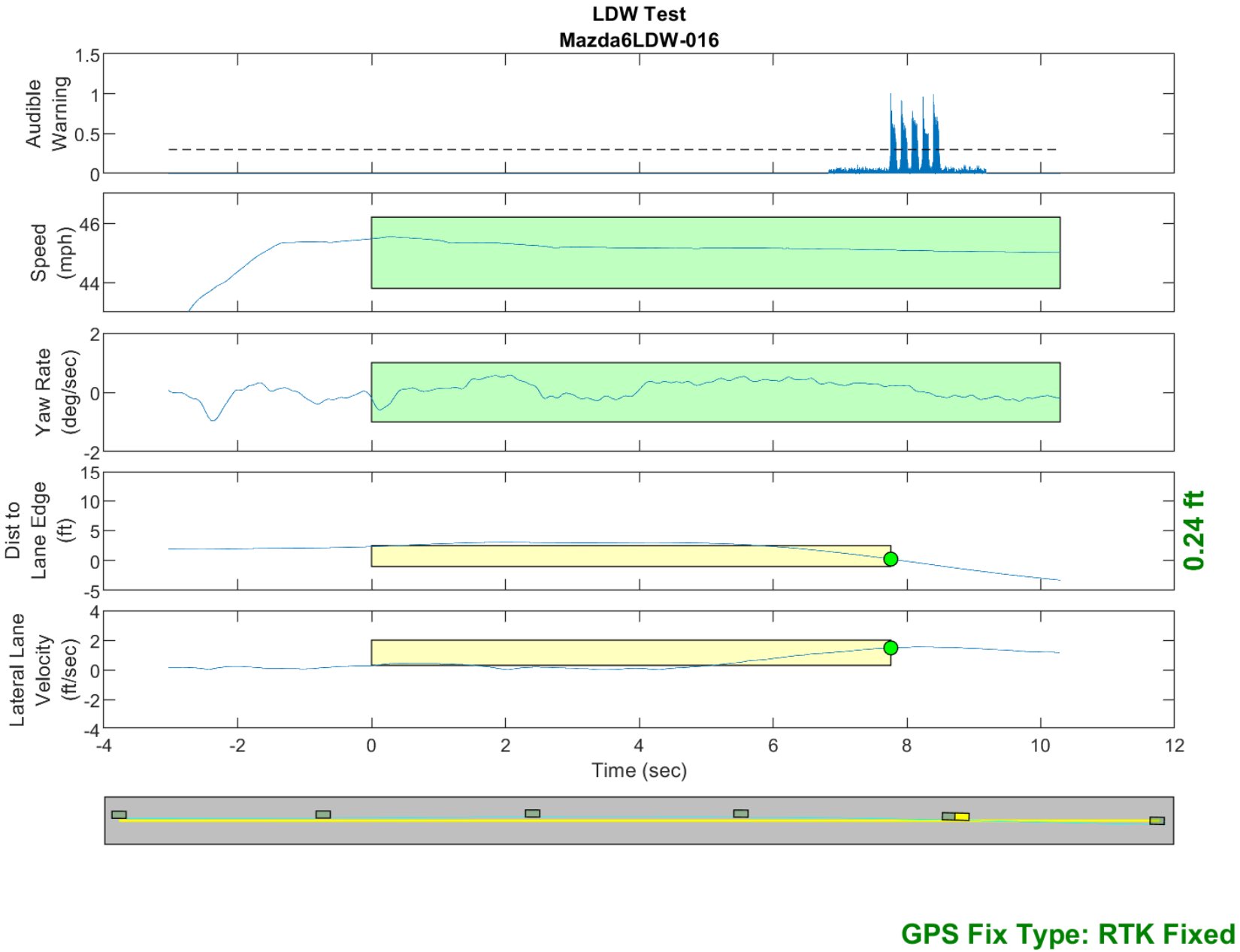


Figure D34. Time History for Run 16, Dashed Line, Right Departure, Audible Warning

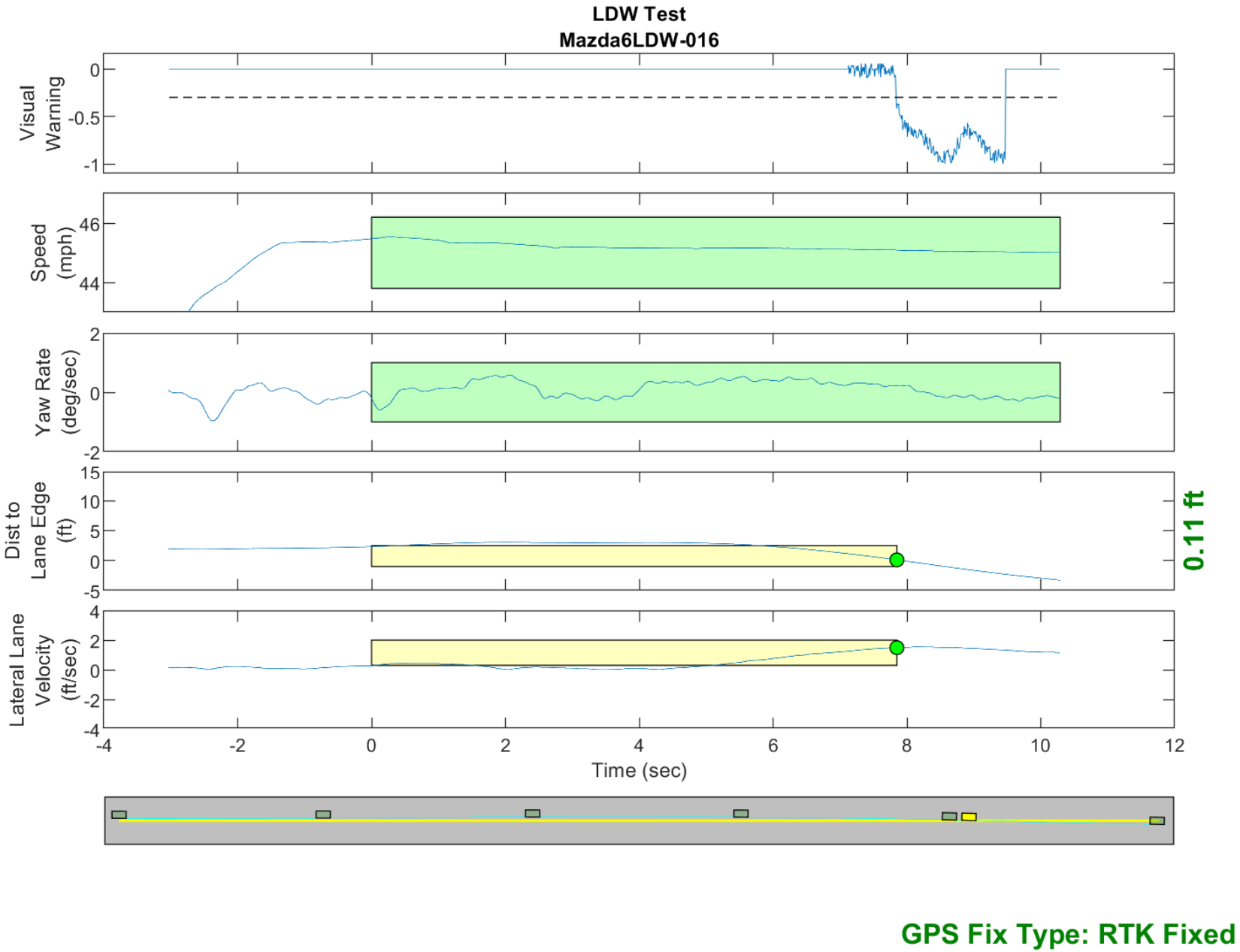


Figure D35. Time History for Run 16, Dashed Line, Right Departure, Visual Warning

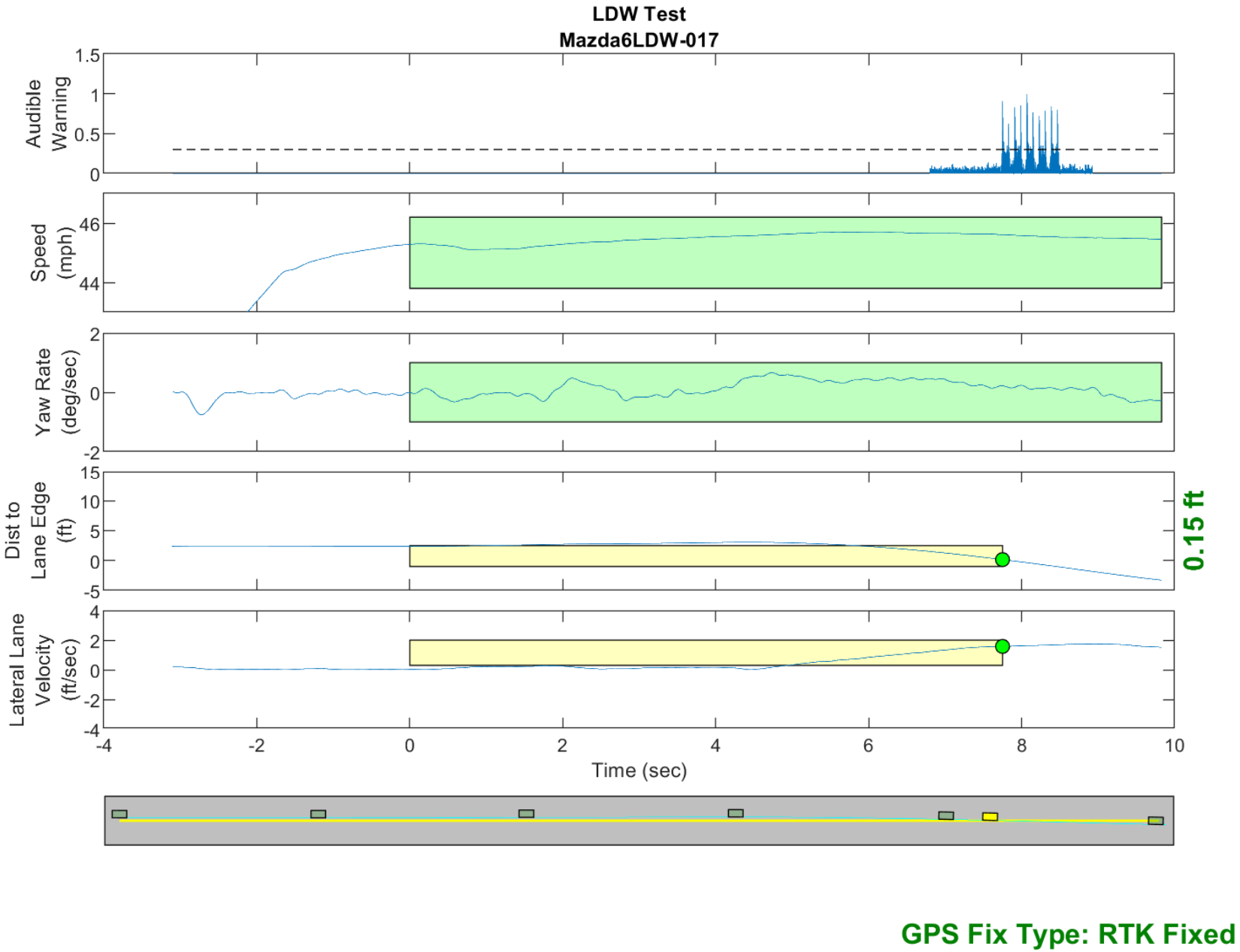


Figure D36. Time History for Run 17, Dashed Line, Right Departure, Audible Warning

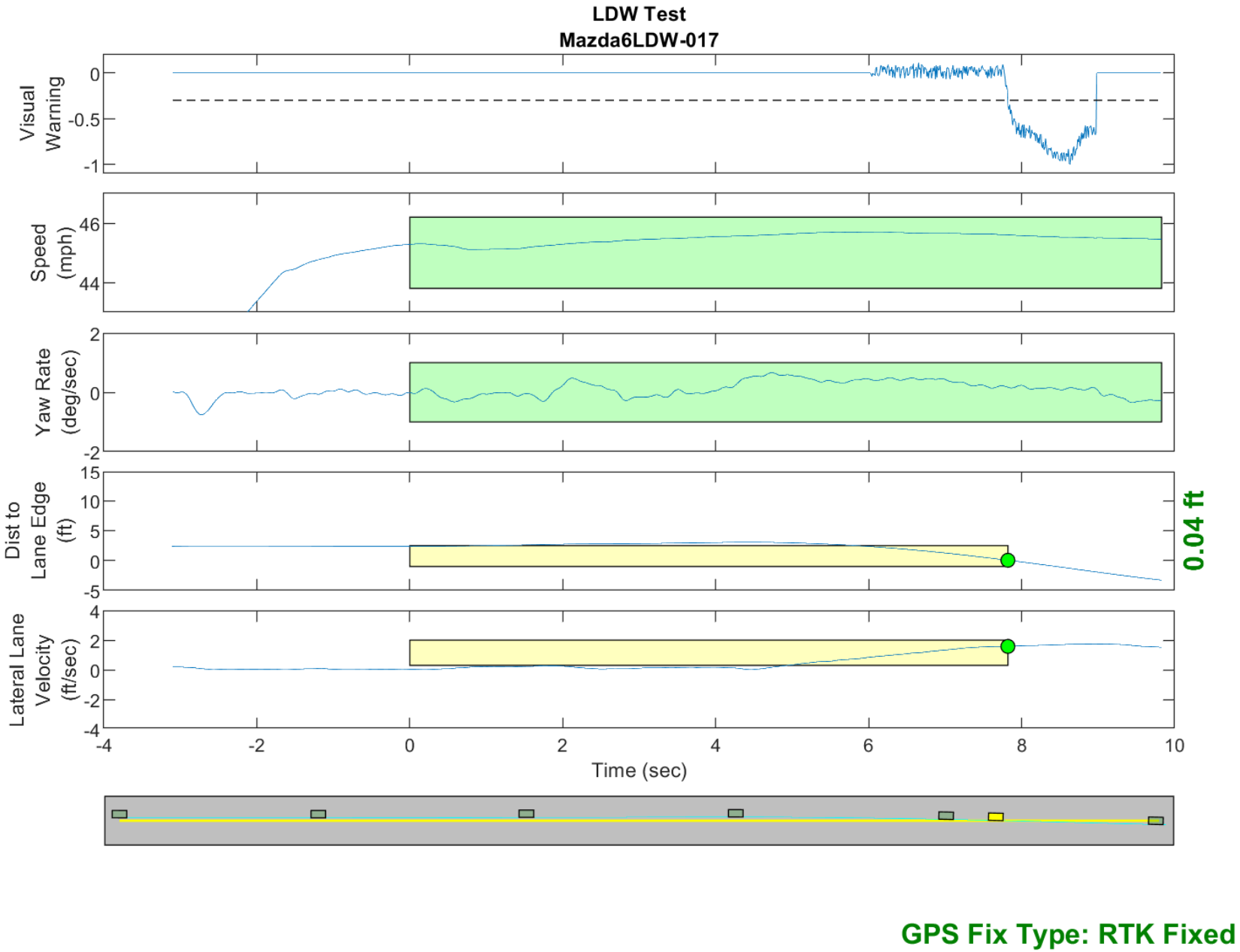


Figure D37. Time History for Run 17, Dashed Line, Right Departure, Visual Warning

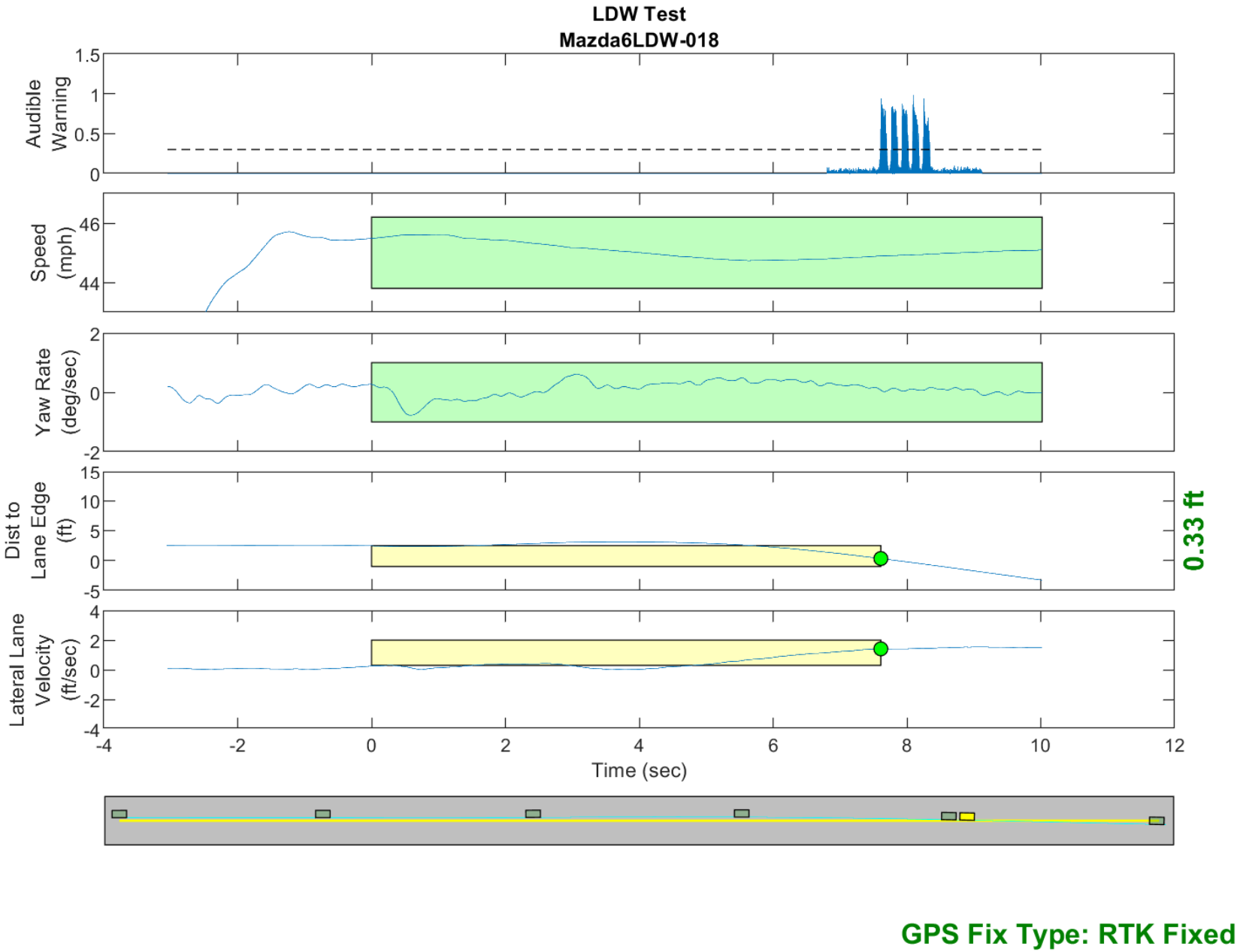


Figure D38. Time History for Run 18, Dashed Line, Right Departure, Audible Warning

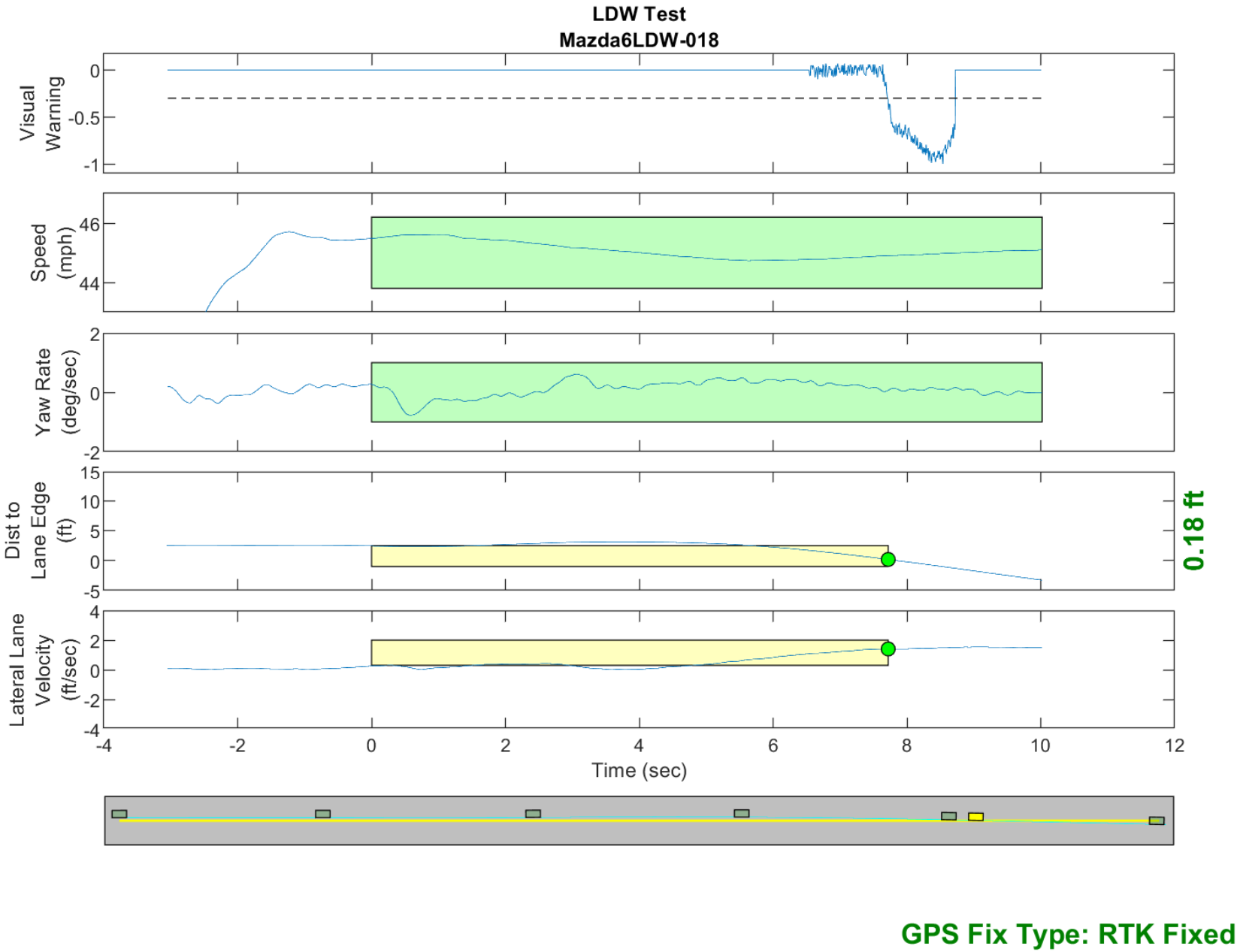


Figure D39. Time History for Run 18, Dashed Line, Right Departure, Visual Warning

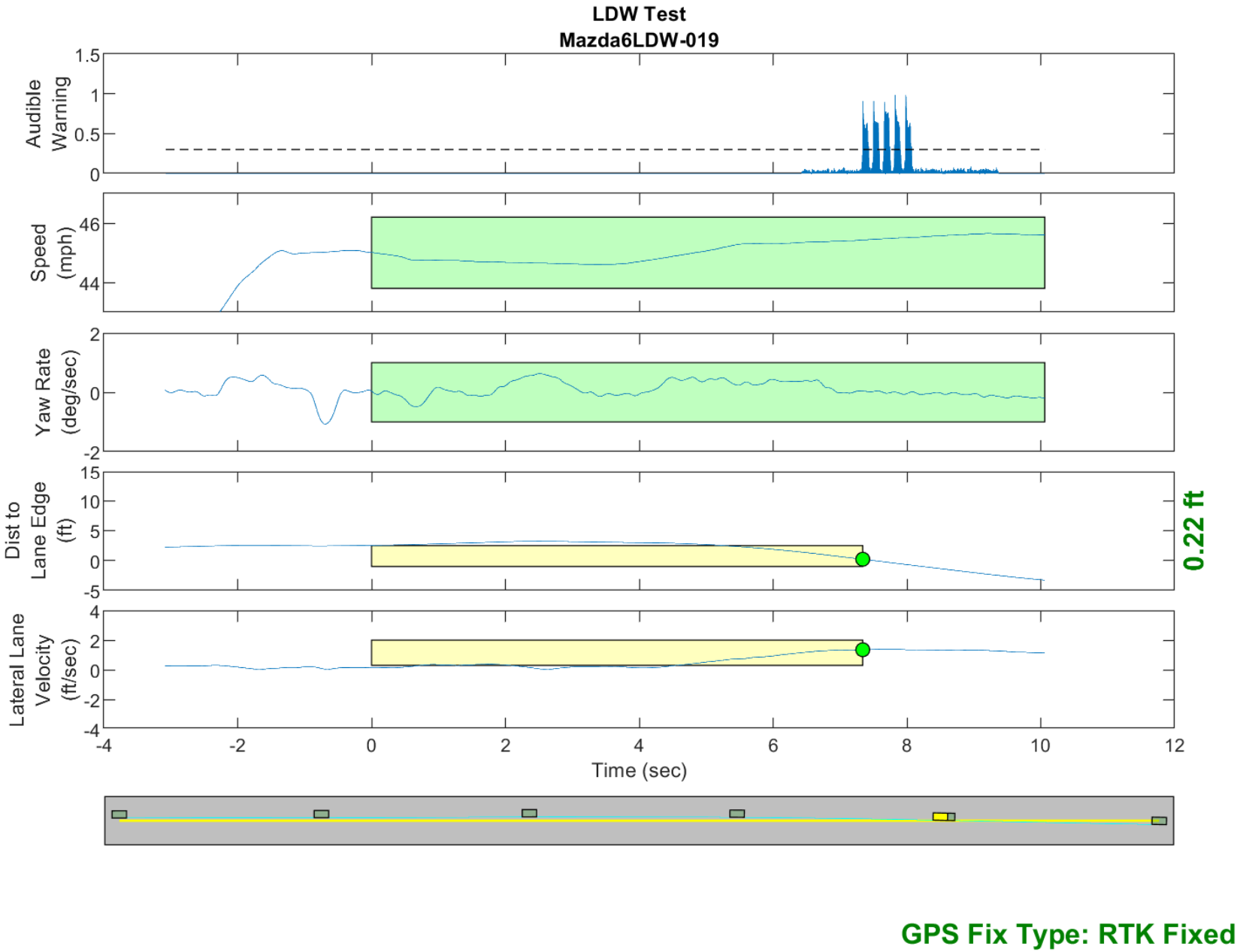


Figure D40. Time History for Run 19, Dashed Line, Right Departure, Audible Warning

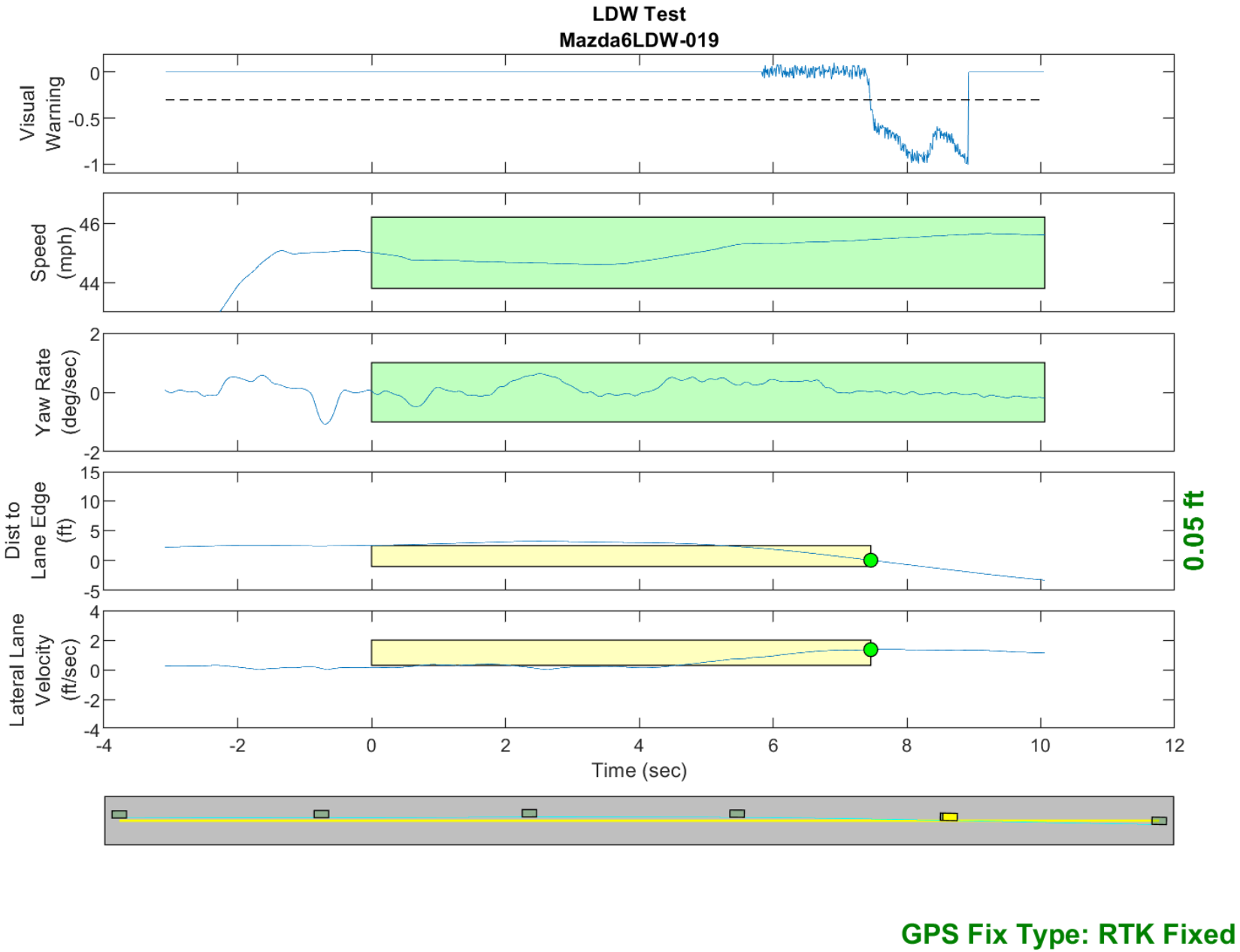


Figure D41. Time History for Run 19, Dashed Line, Right Departure, Visual Warning

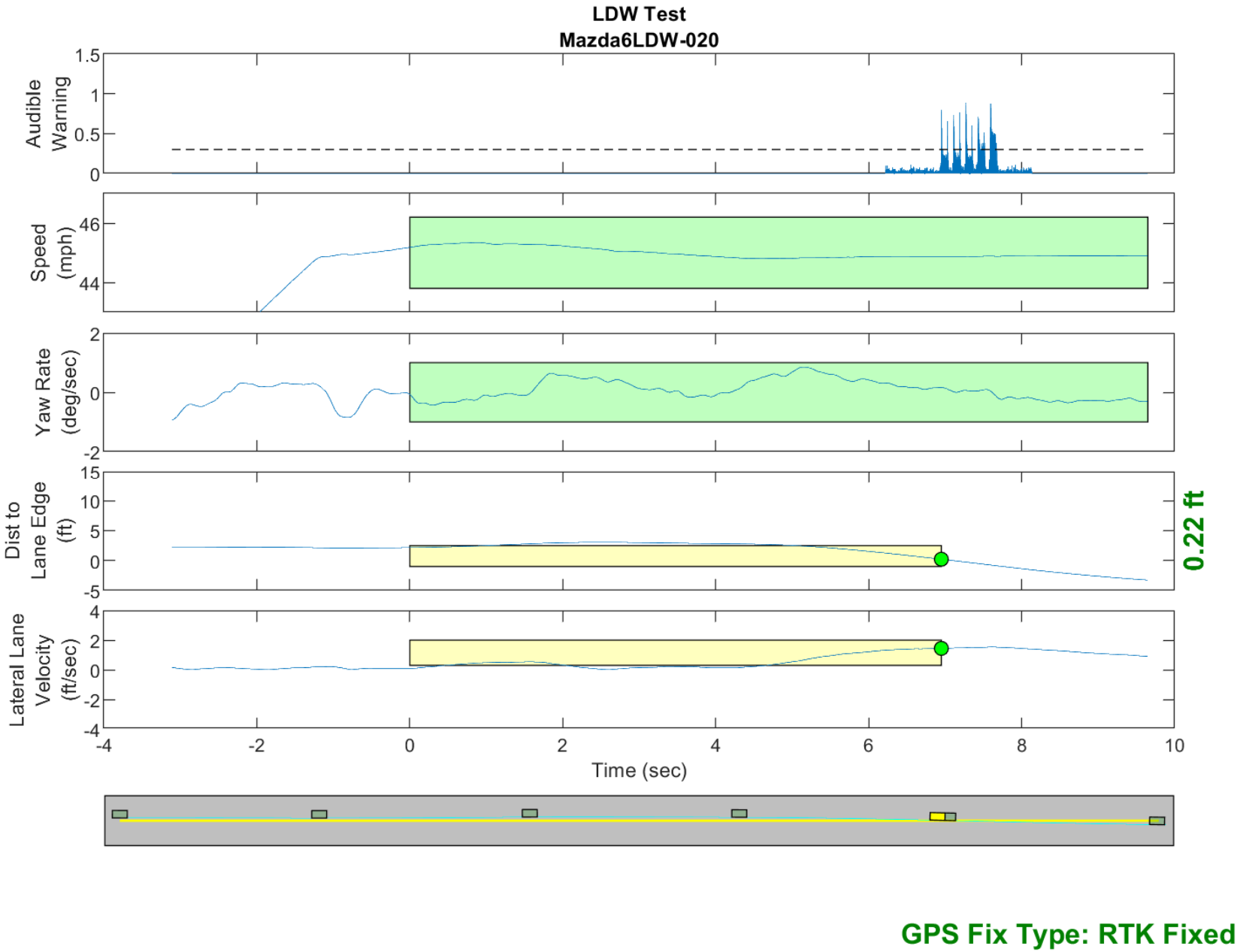


Figure D42. Time History for Run 20, Dashed Line, Right Departure, Audible Warning

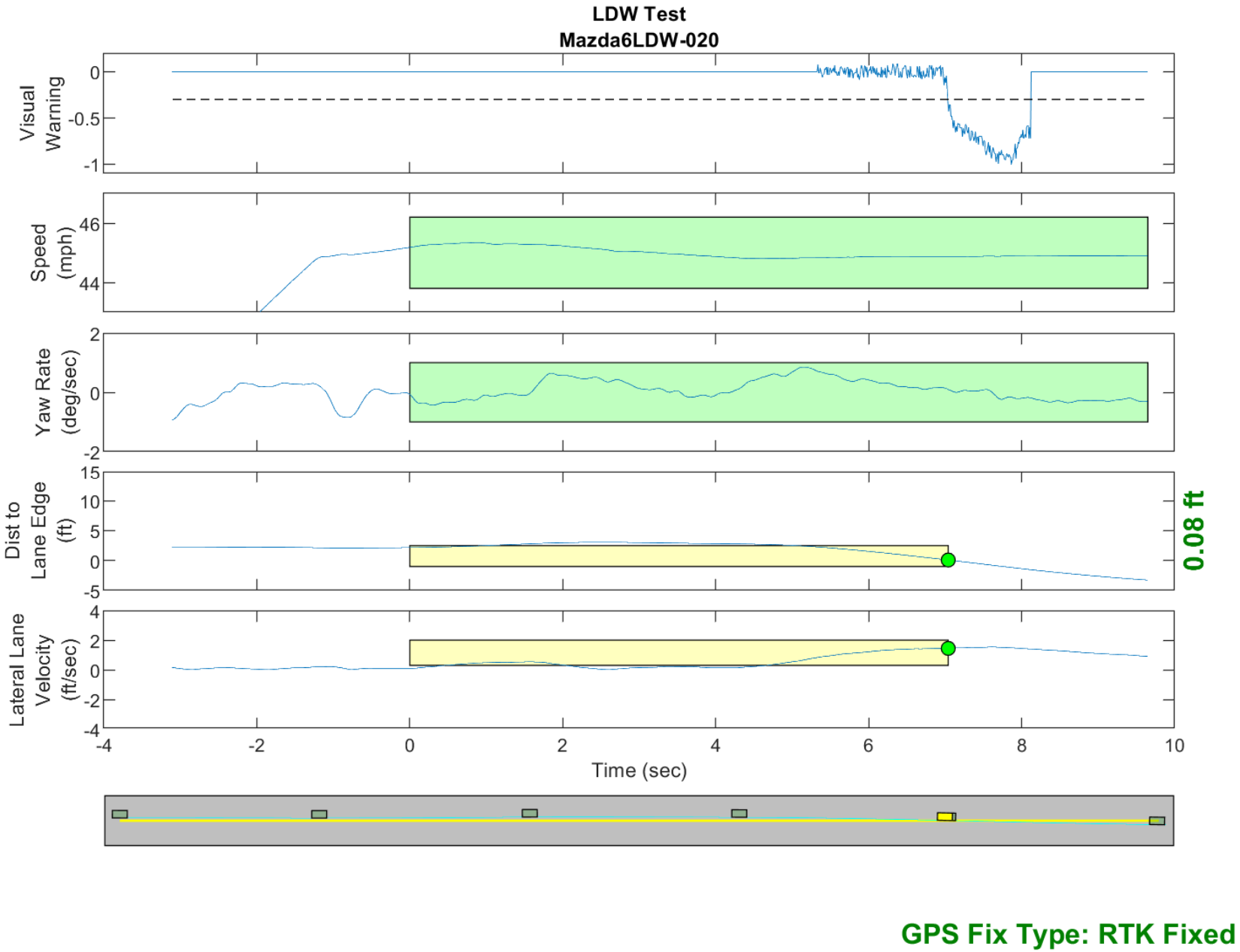


Figure D43. Time History for Run 20, Dashed Line, Right Departure, Visual Warning

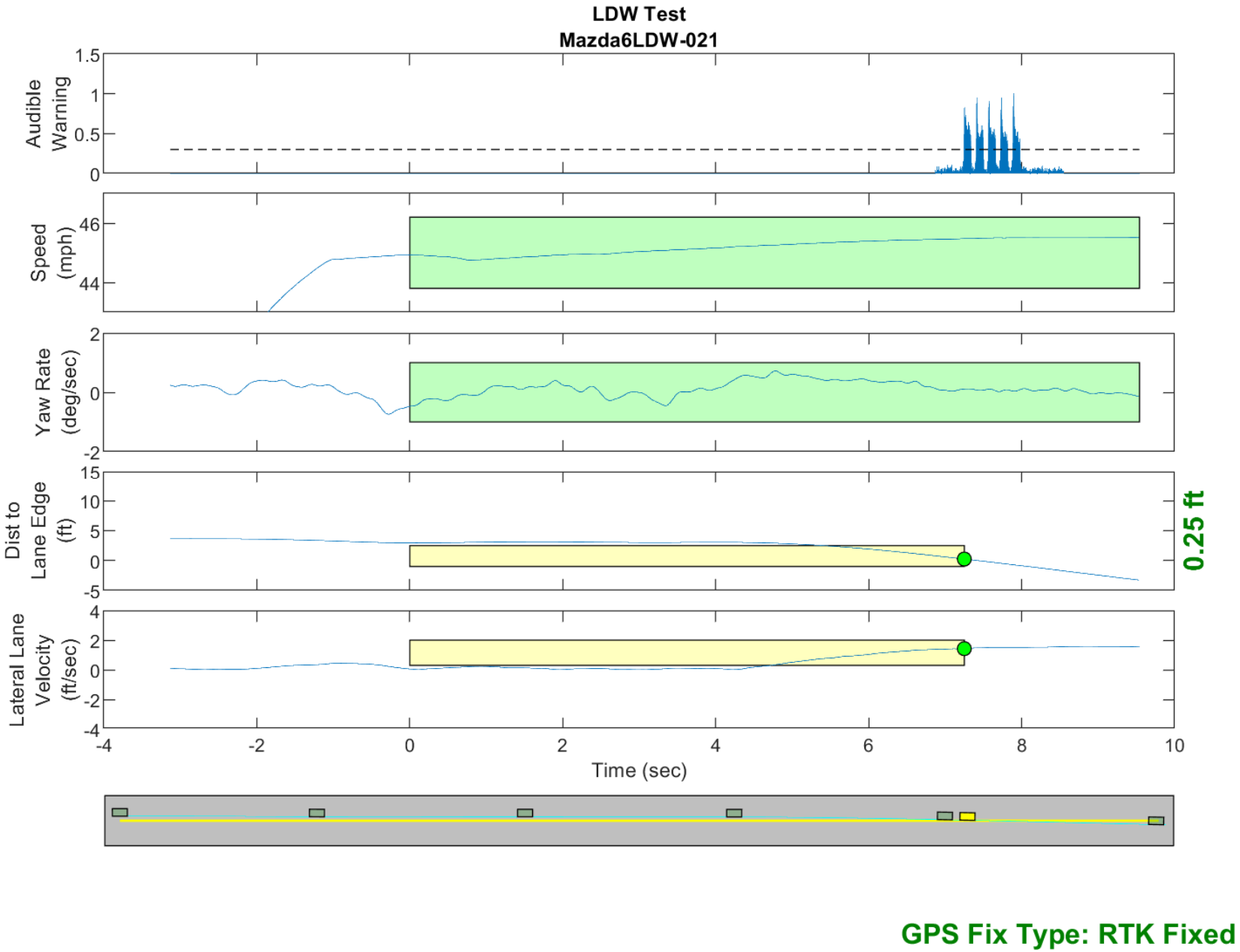


Figure D44. Time History for Run 21, Dashed Line, Right Departure, Audible Warning

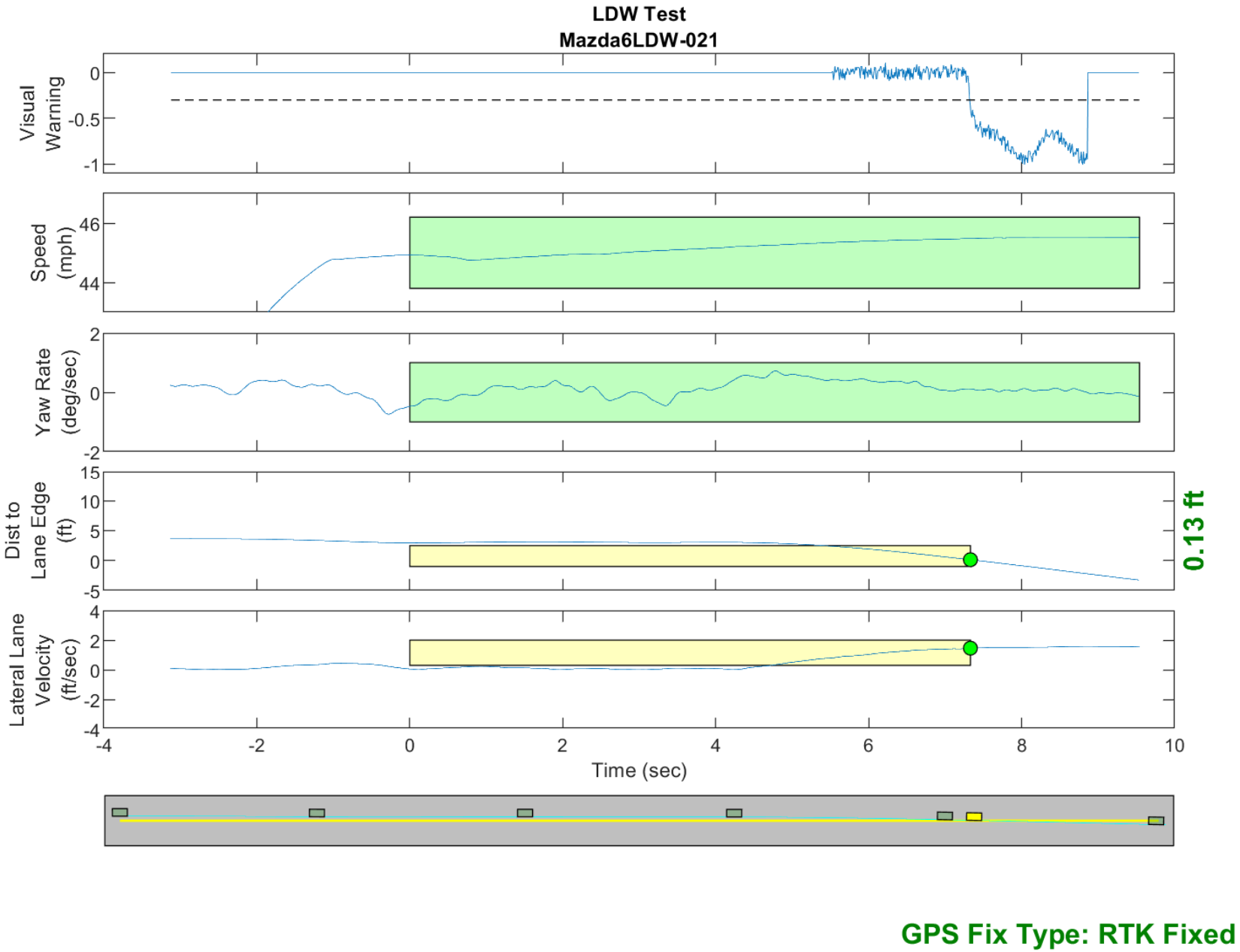


Figure D45. Time History for Run 21, Dashed Line, Right Departure, Visual Warning

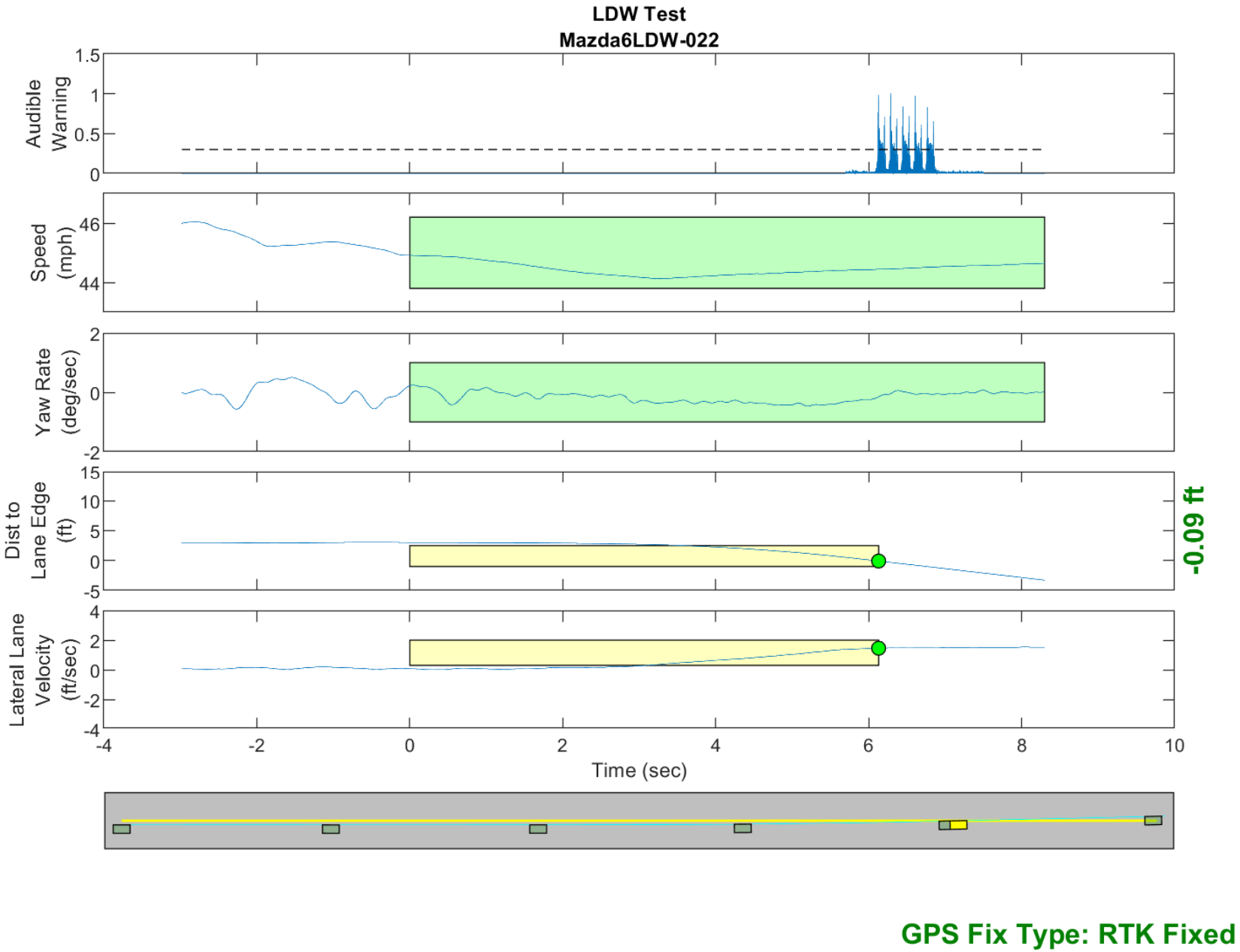


Figure D46. Time History for Run 22, Dashed Line, Left Departure, Audible Warning

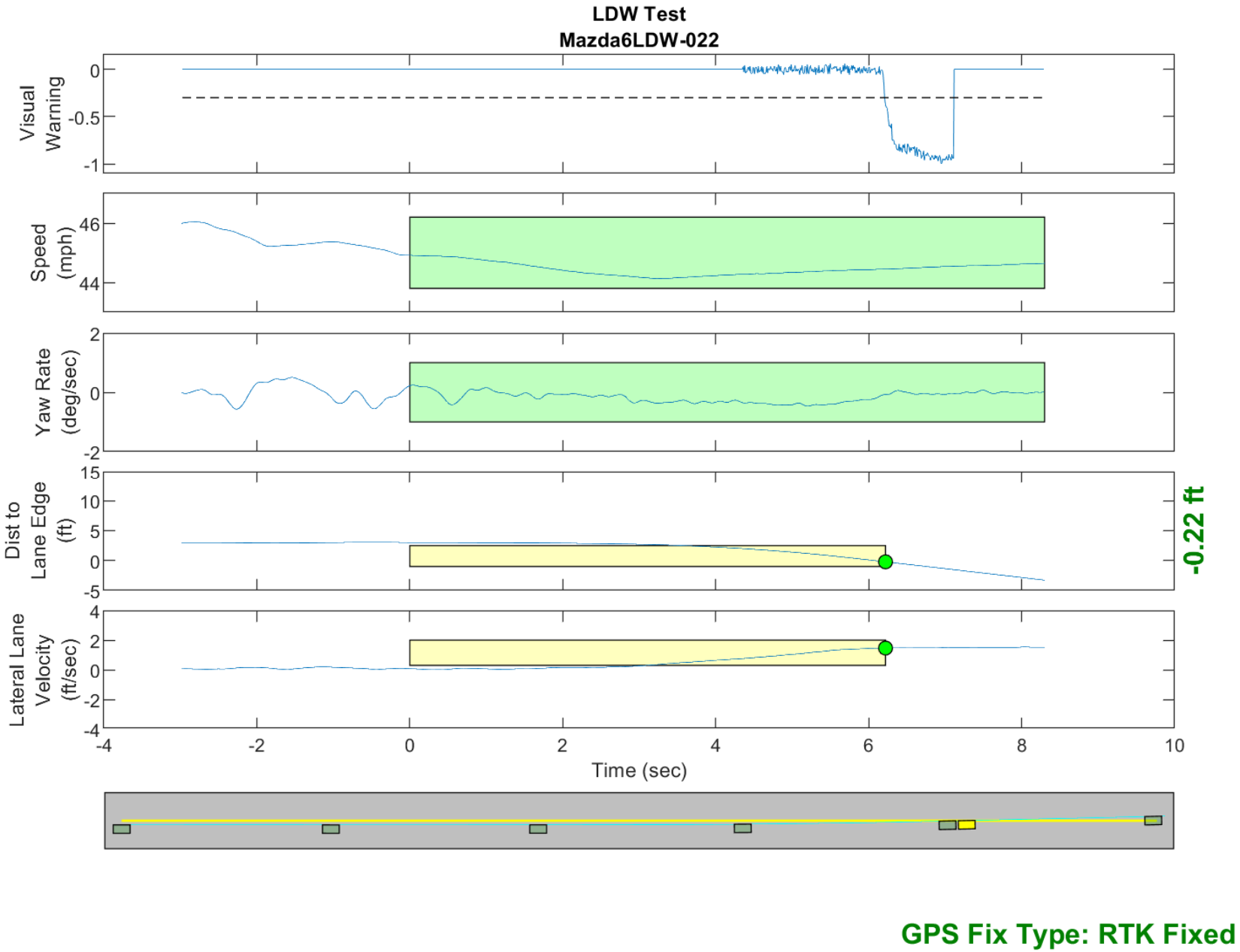


Figure D47. Time History for Run 22, Dashed Line, Left Departure, Visual Warning

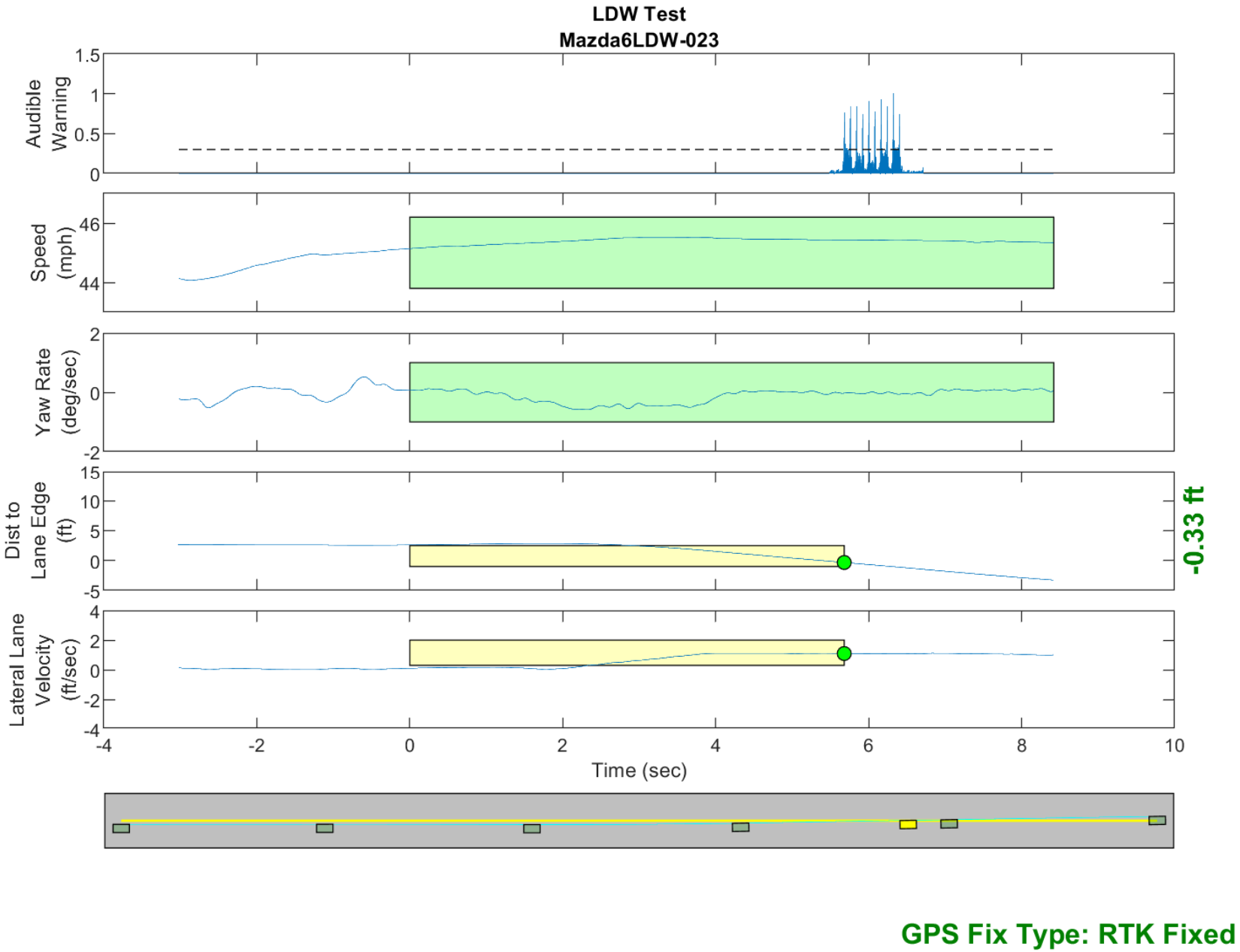


Figure D48. Time History for Run 23, Dashed Line, Left Departure, Audible Warning

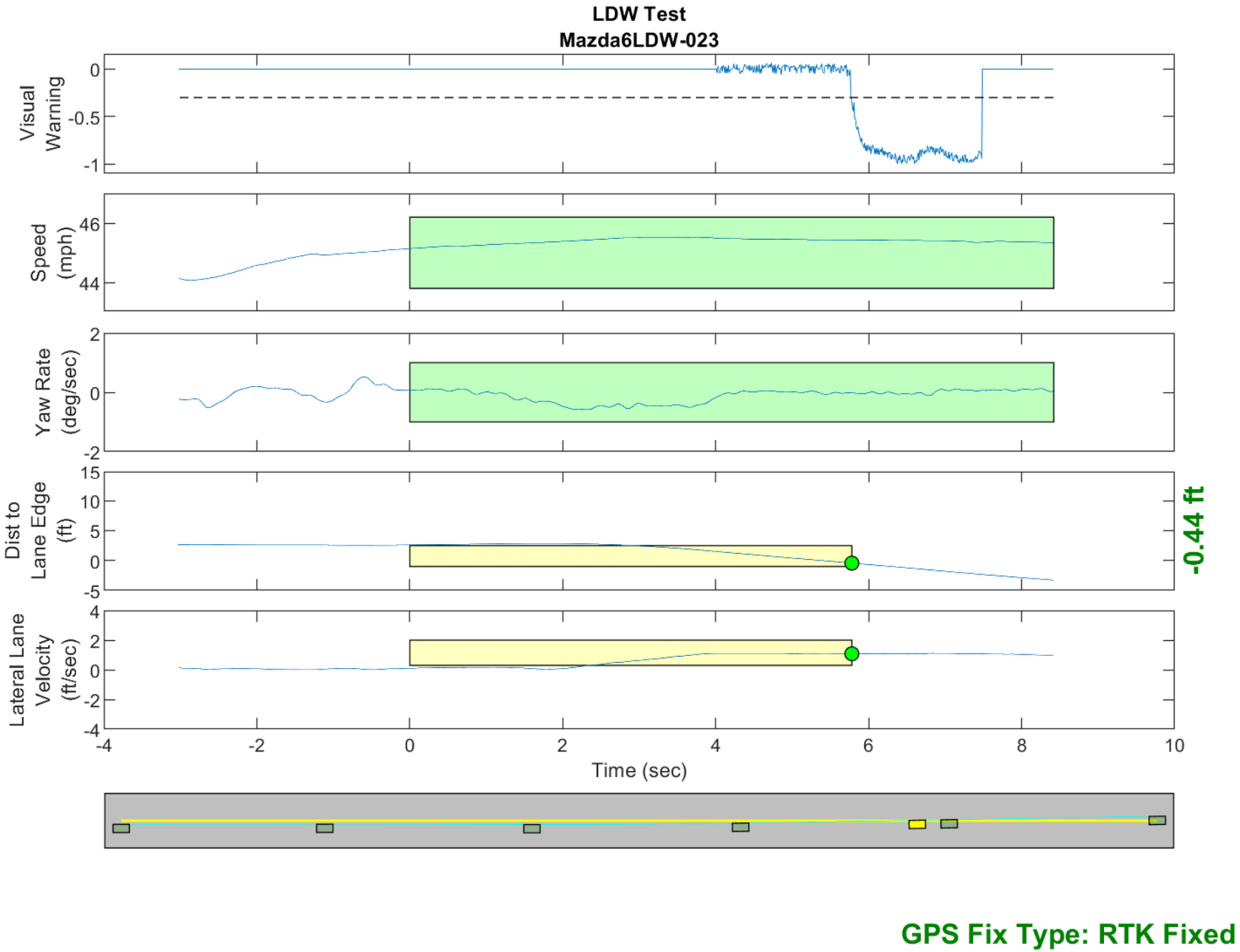


Figure D49. Time History for Run 23, Dashed Line, Left Departure, Visual Warning

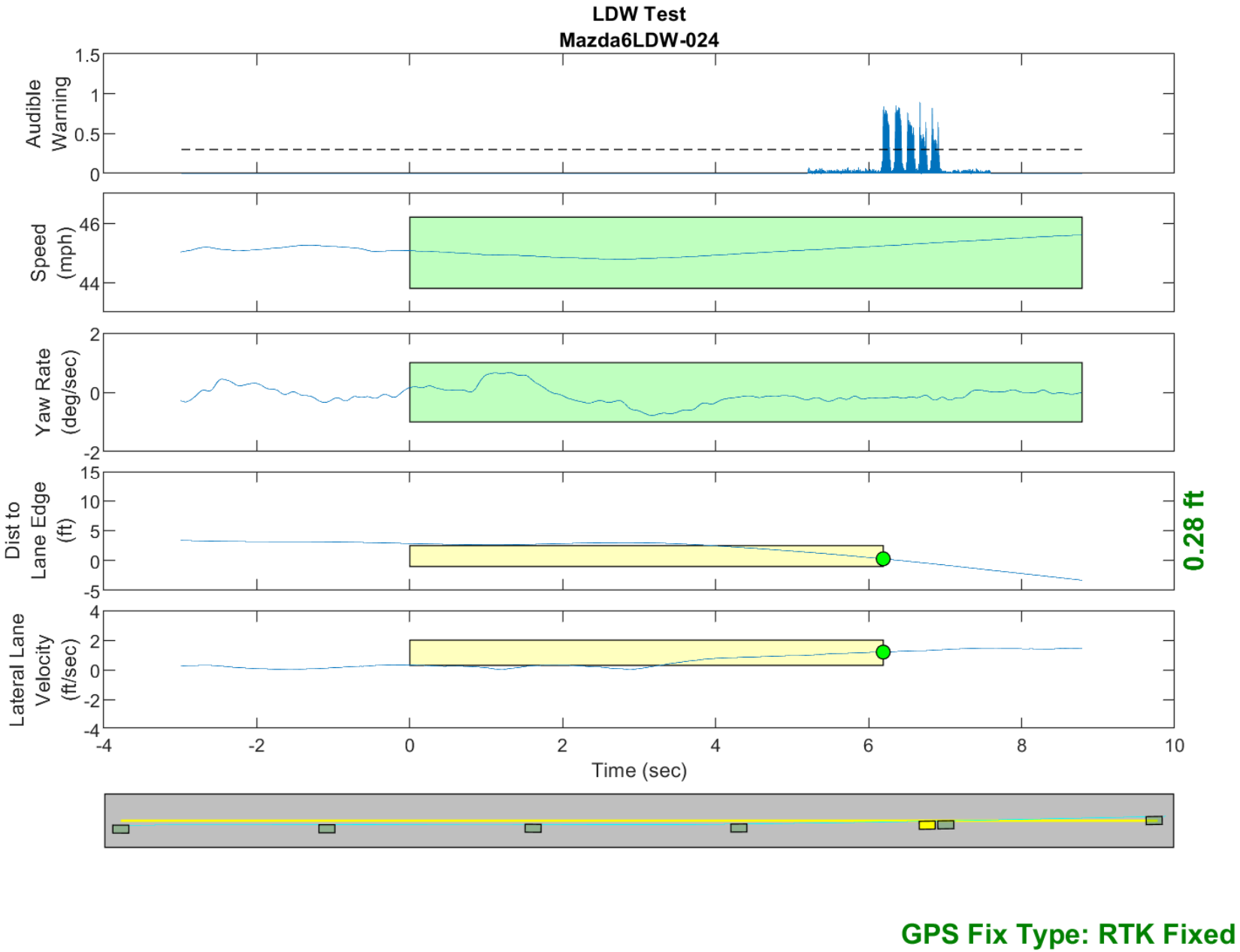


Figure D50. Time History for Run 24, Dashed Line, Left Departure, Audible Warning

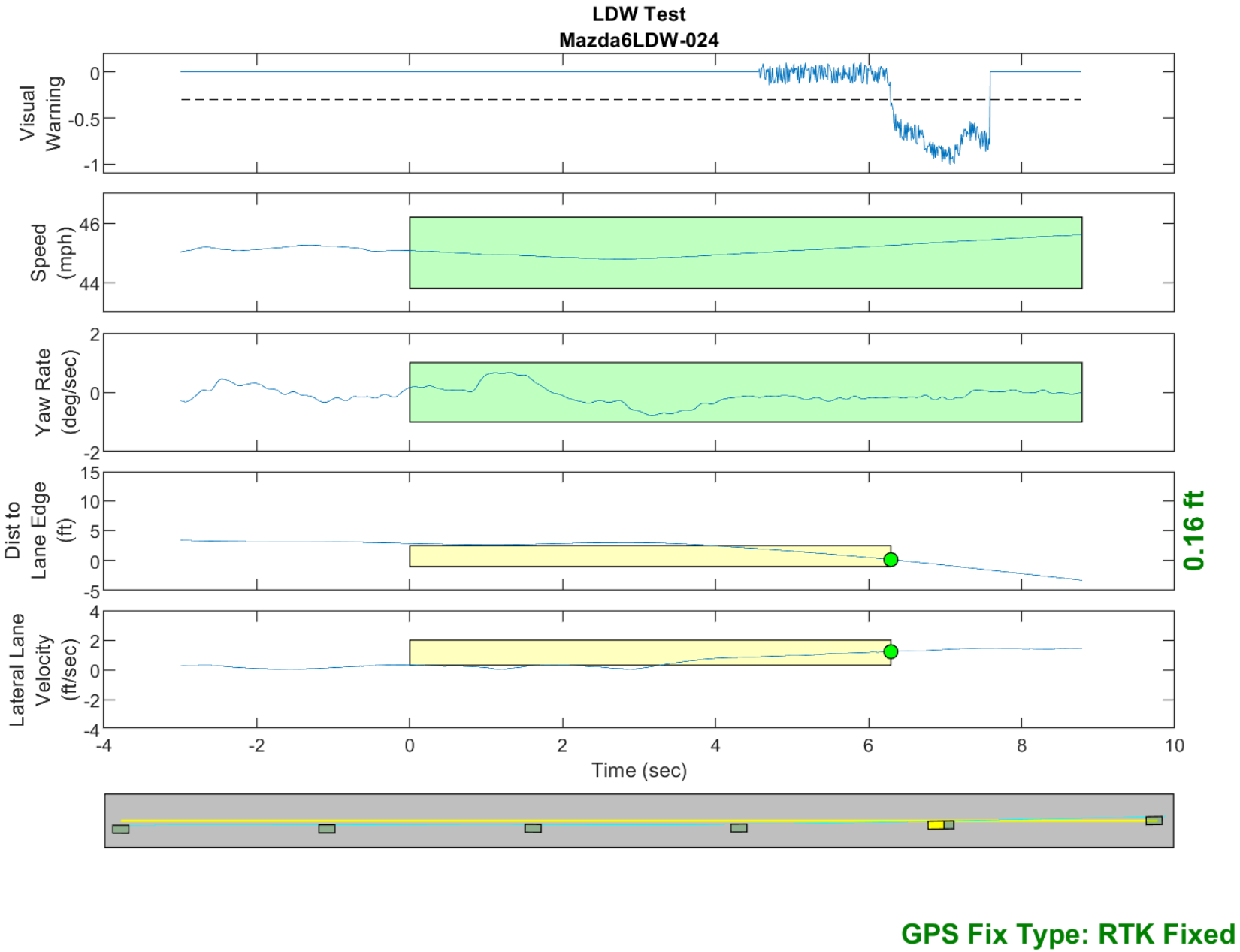


Figure D51. Time History for Run 24, Dashed Line, Left Departure, Visual Warning

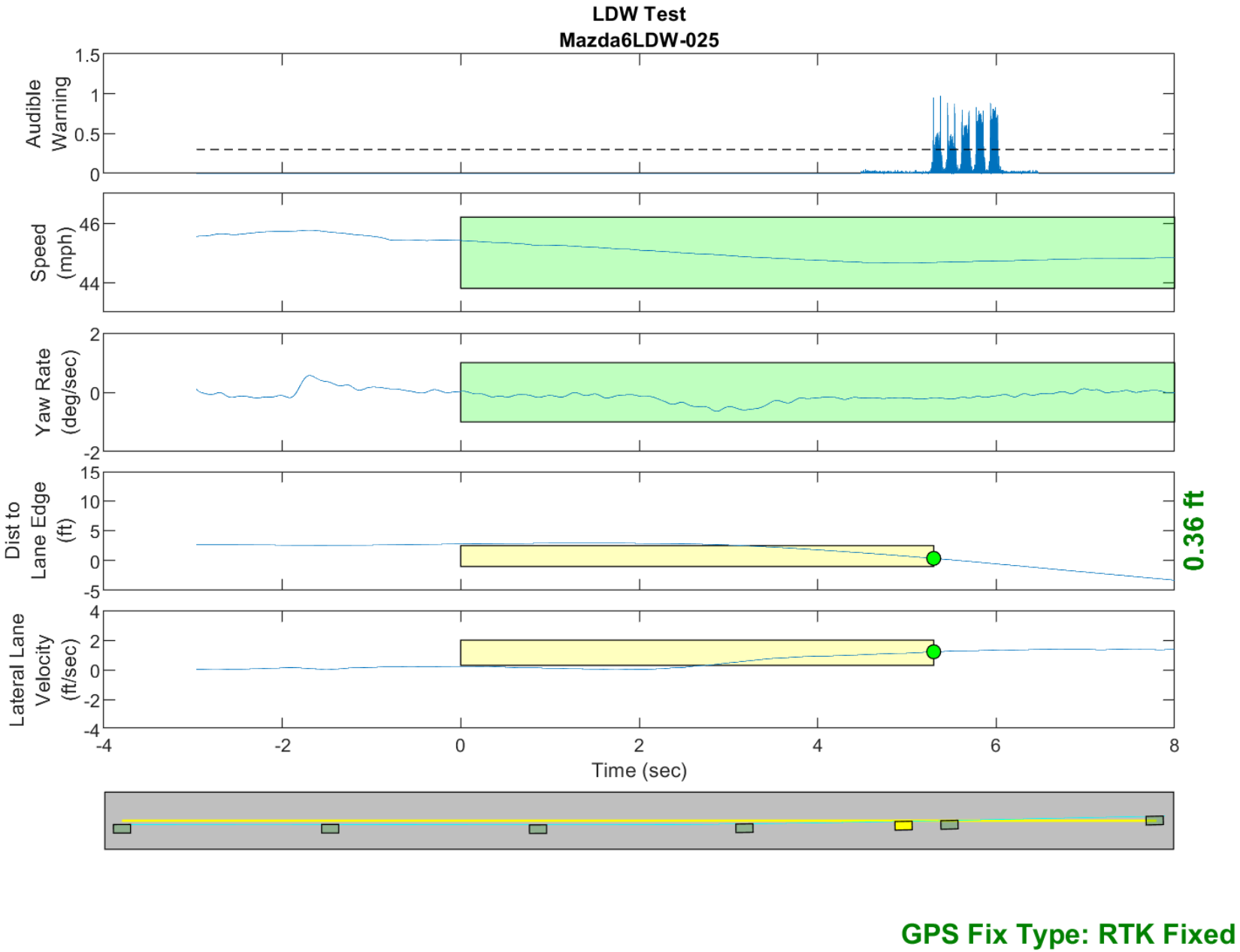


Figure D52. Time History for Run 25, Dashed Line, Left Departure, Audible Warning

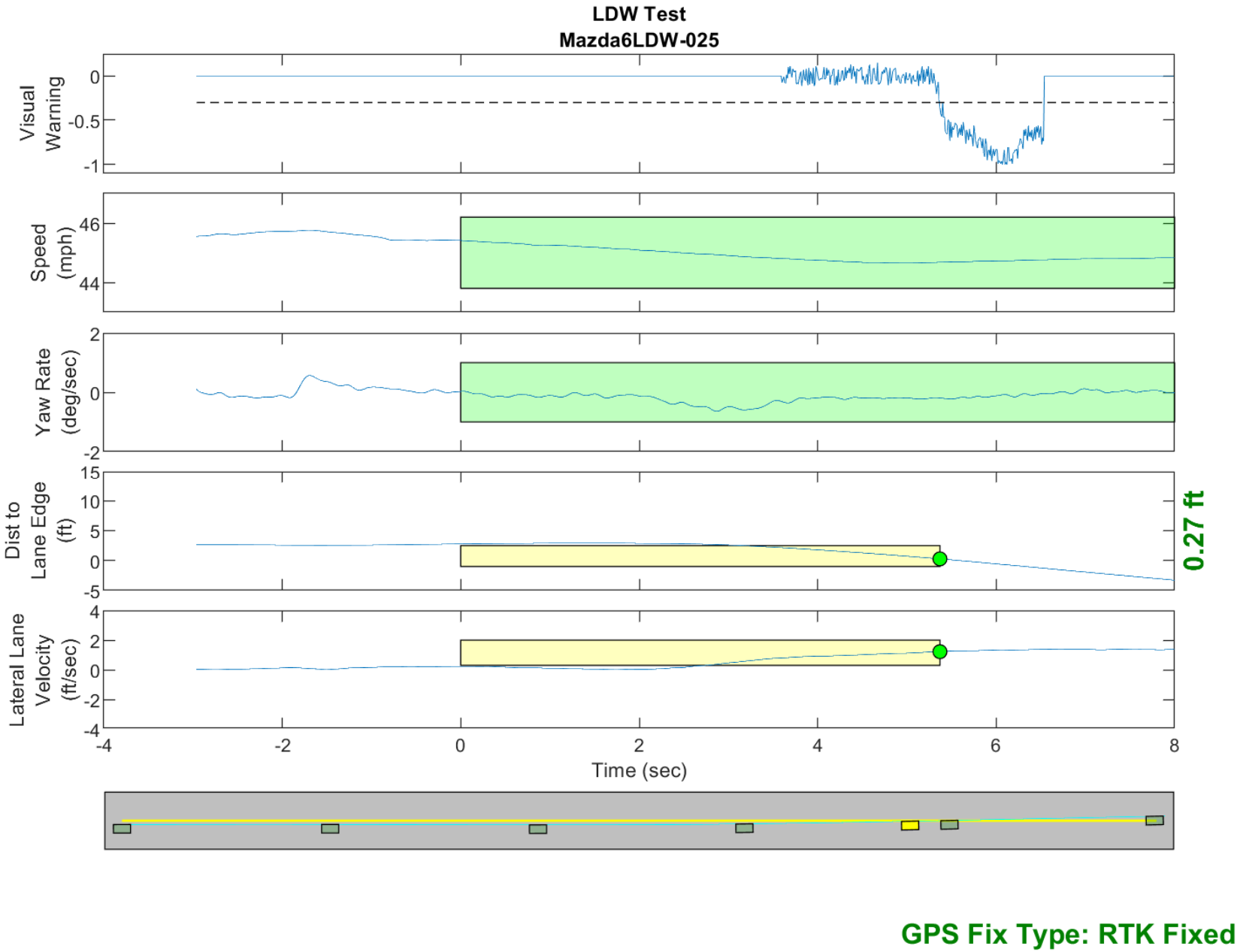


Figure D53. Time History for Run 25, Dashed Line, Left Departure, Visual Warning

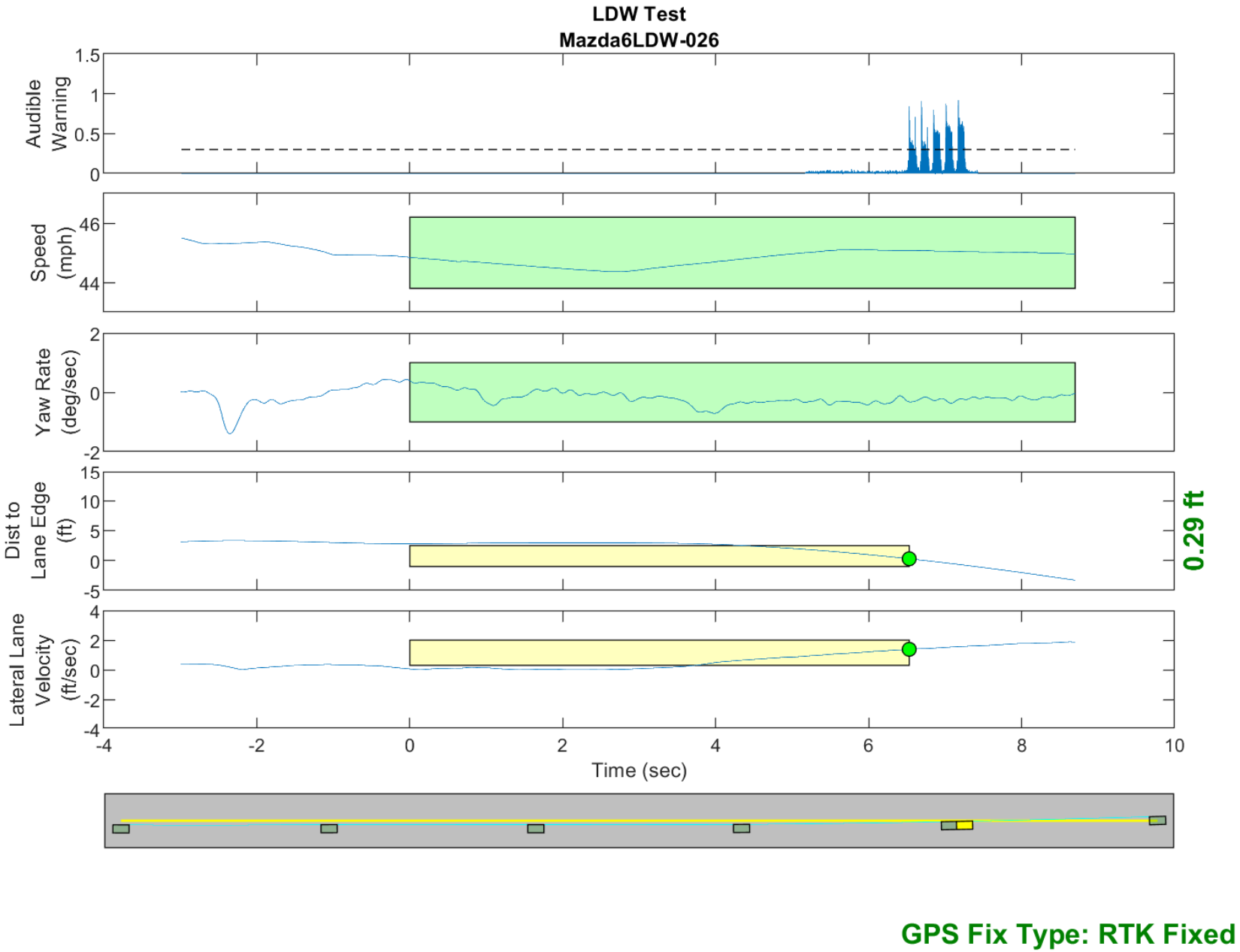


Figure D54. Time History for Run 26, Dashed Line, Left Departure, Audible Warning

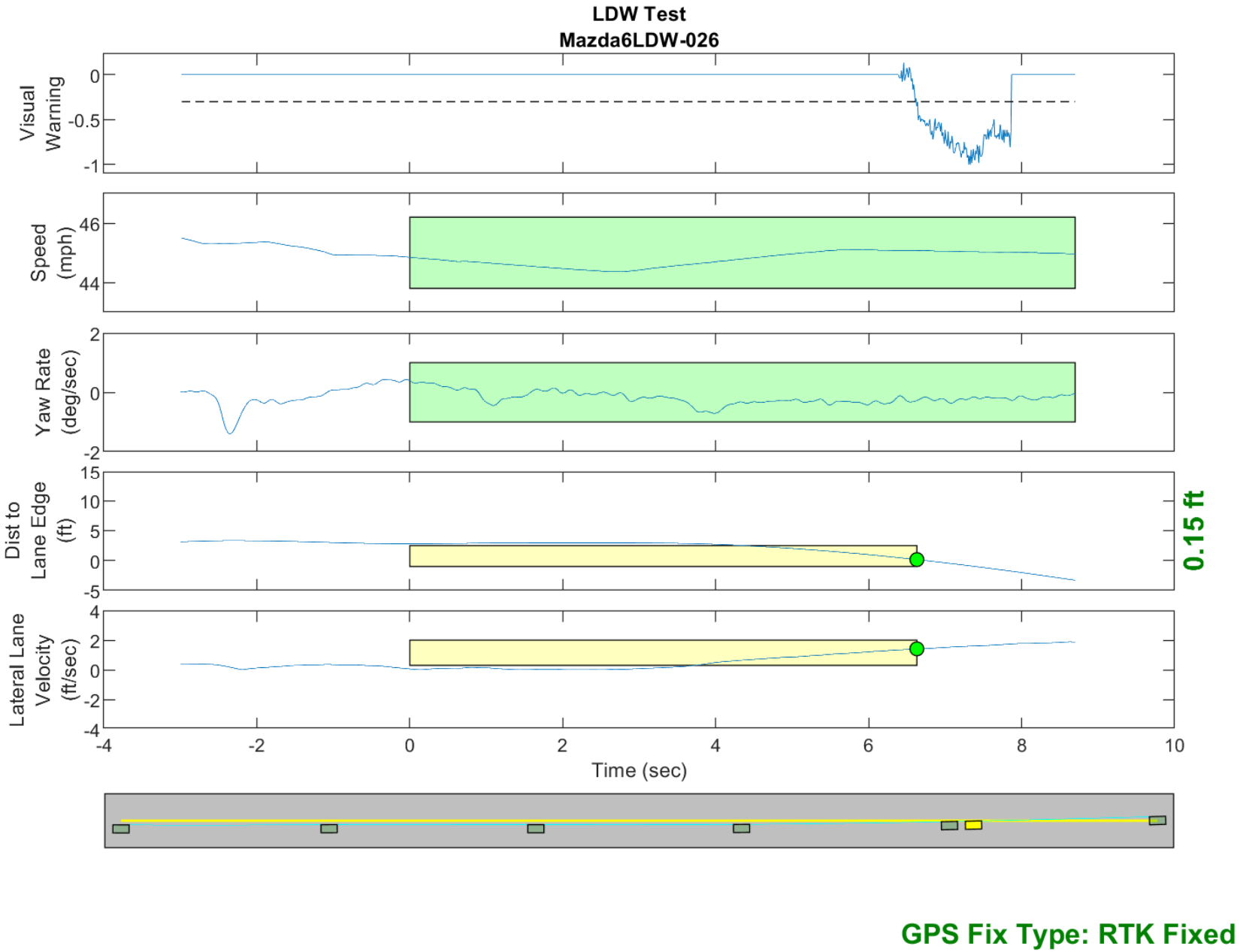


Figure D55. Time History for Run 26, Dashed Line, Left Departure, Visual Warning

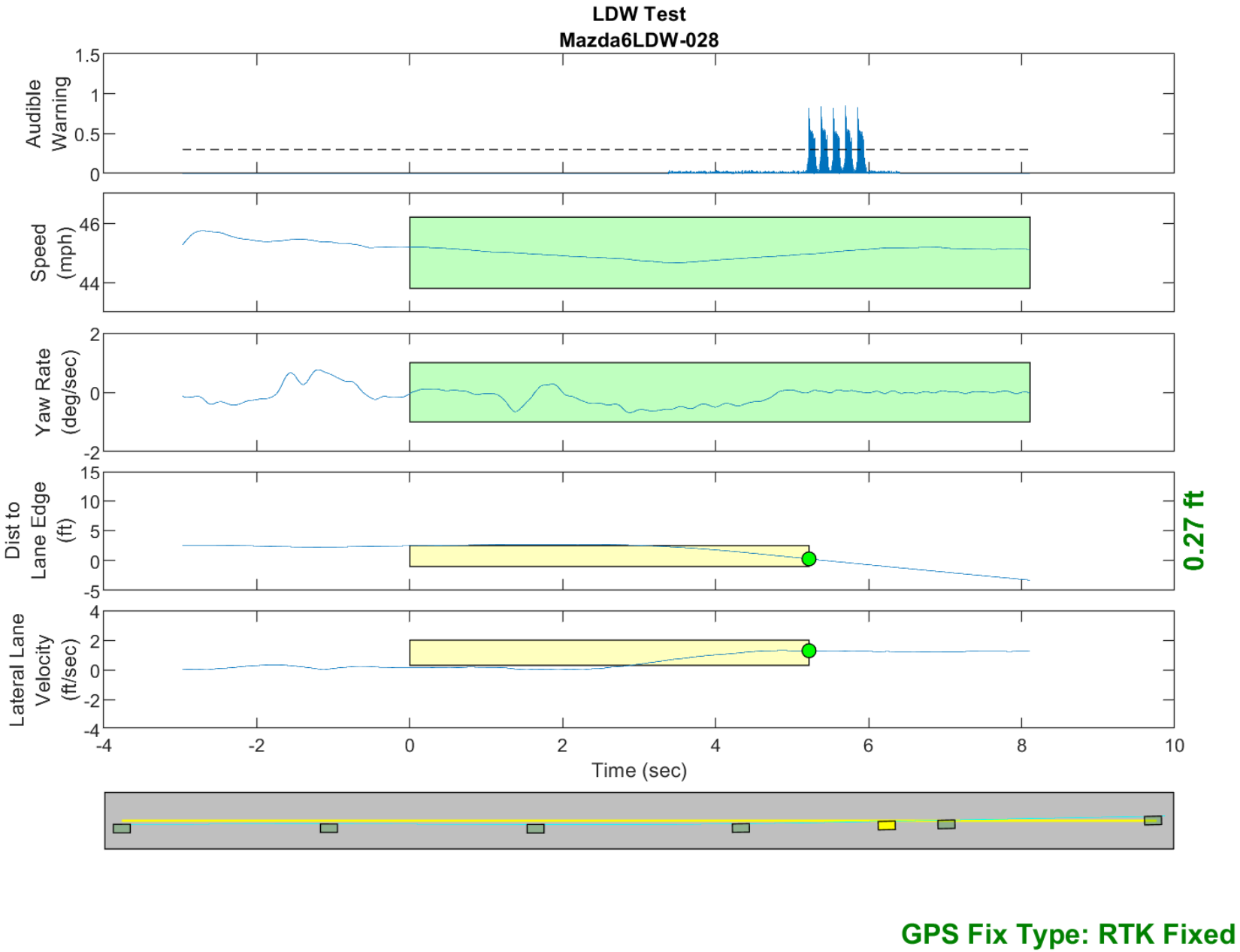


Figure D56. Time History for Run 28, Dashed Line, Left Departure, Audible Warning

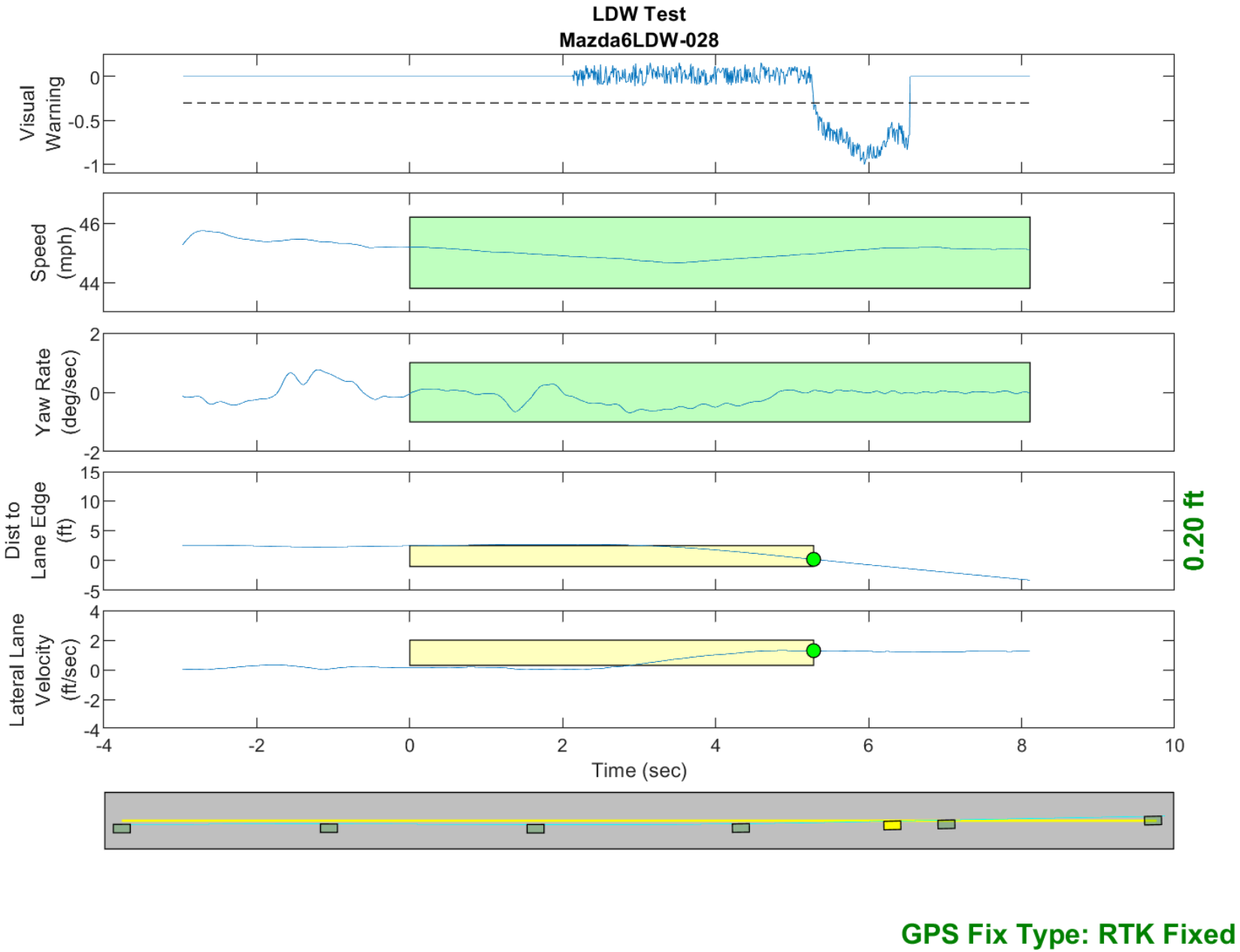


Figure D57. Time History for Run 28, Dashed Line, Left Departure, Visual Warning

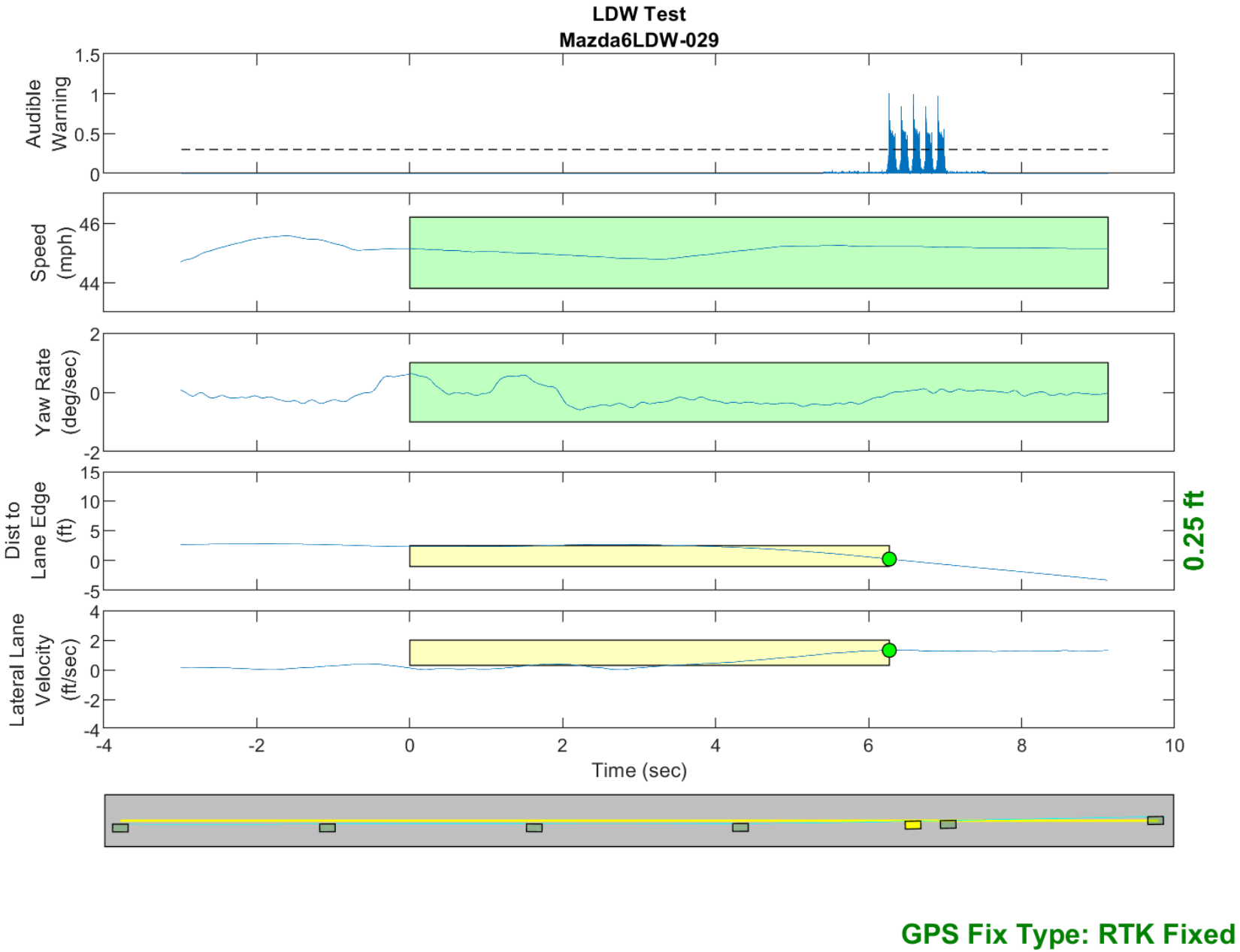


Figure D58. Time History for Run 29, Dashed Line, Left Departure, Audible Warning

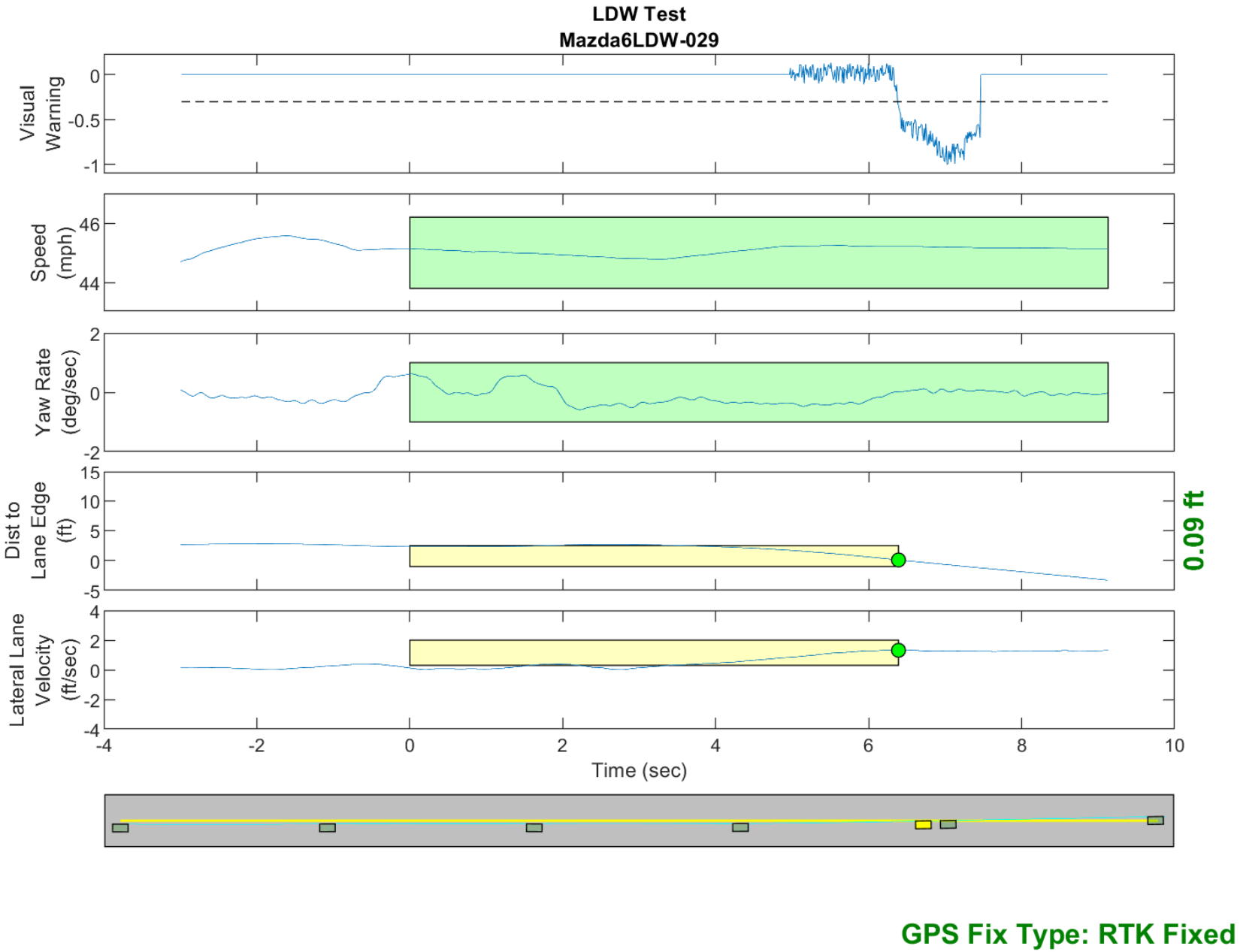


Figure D59. Time History for Run 29, Dashed Line, Left Departure, Visual Warning

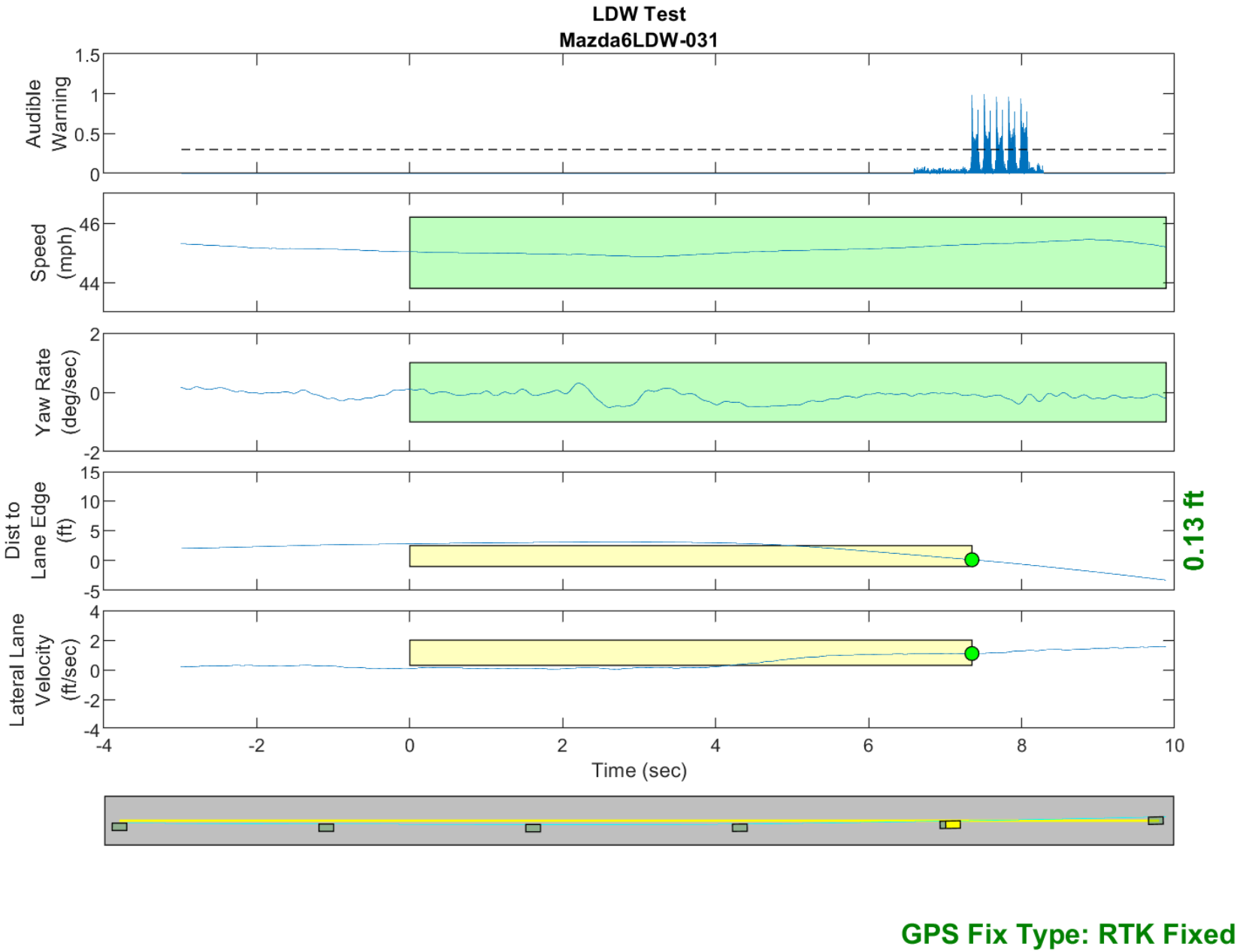


Figure D60. Time History for Run 31, Botts Dots, Left Departure, Audible Warning

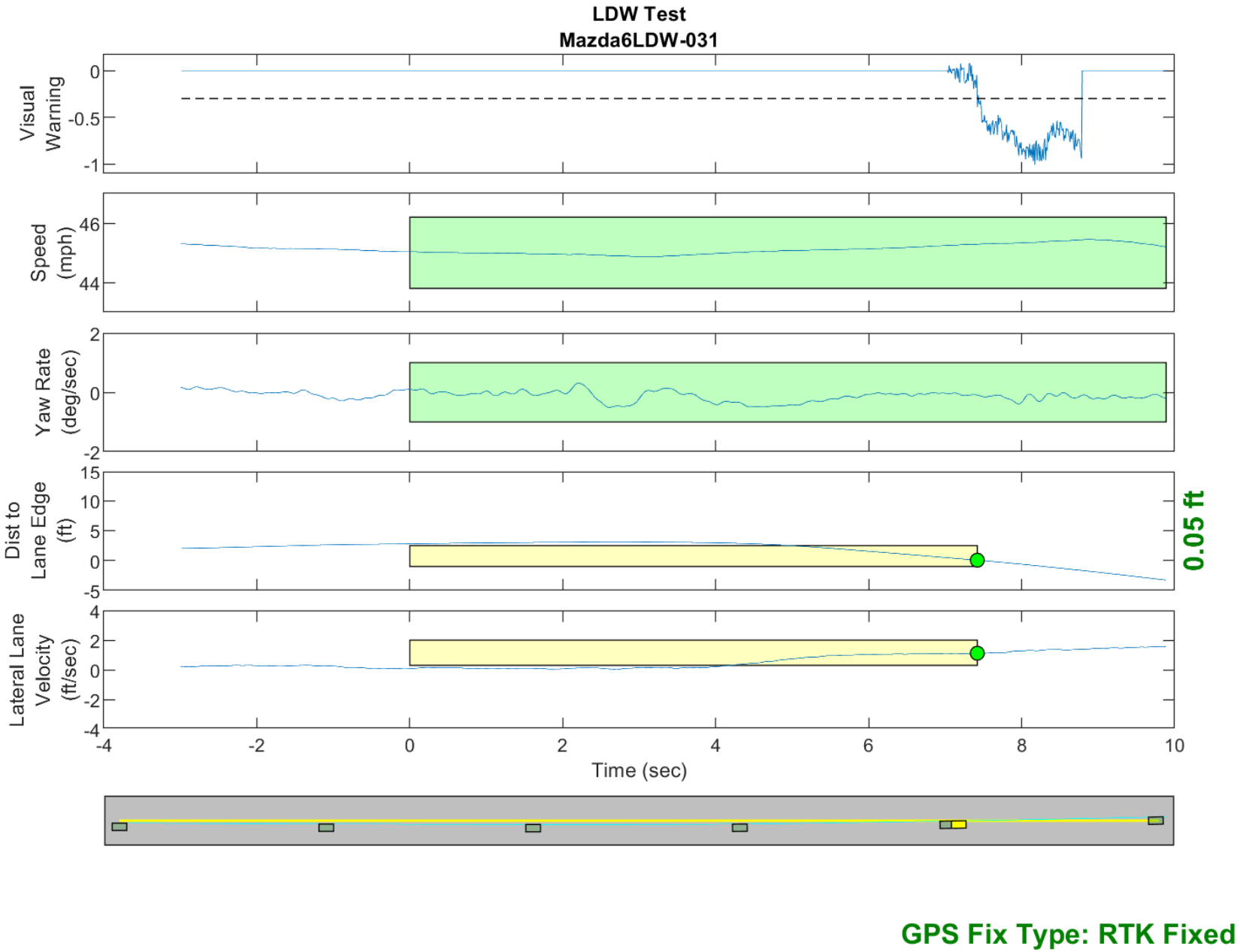


Figure D61. Time History for Run 31, Botts Dots, Left Departure, Visual Warning

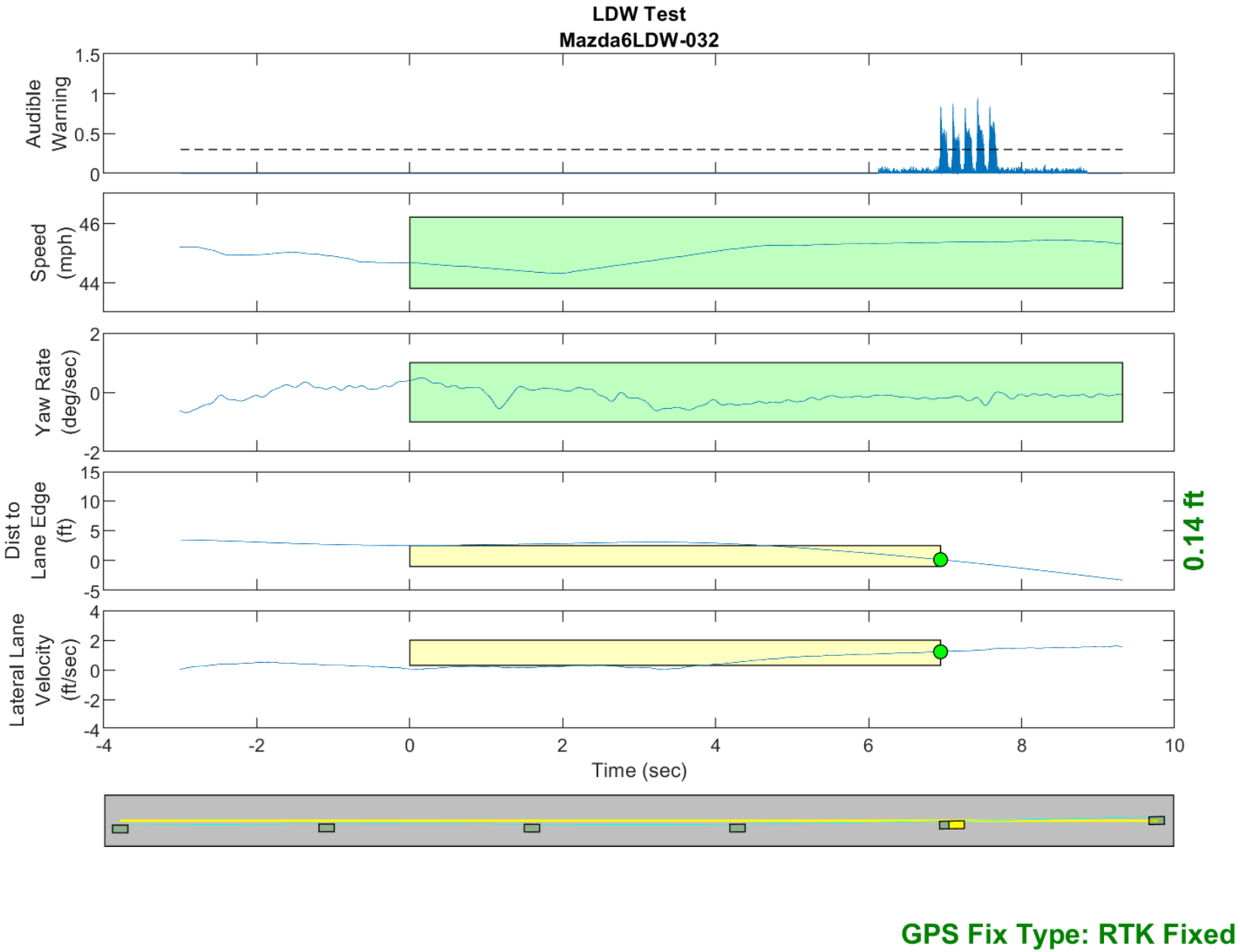


Figure D62. Time History for Run 32, Botts Dots, Left Departure, Audible Warning

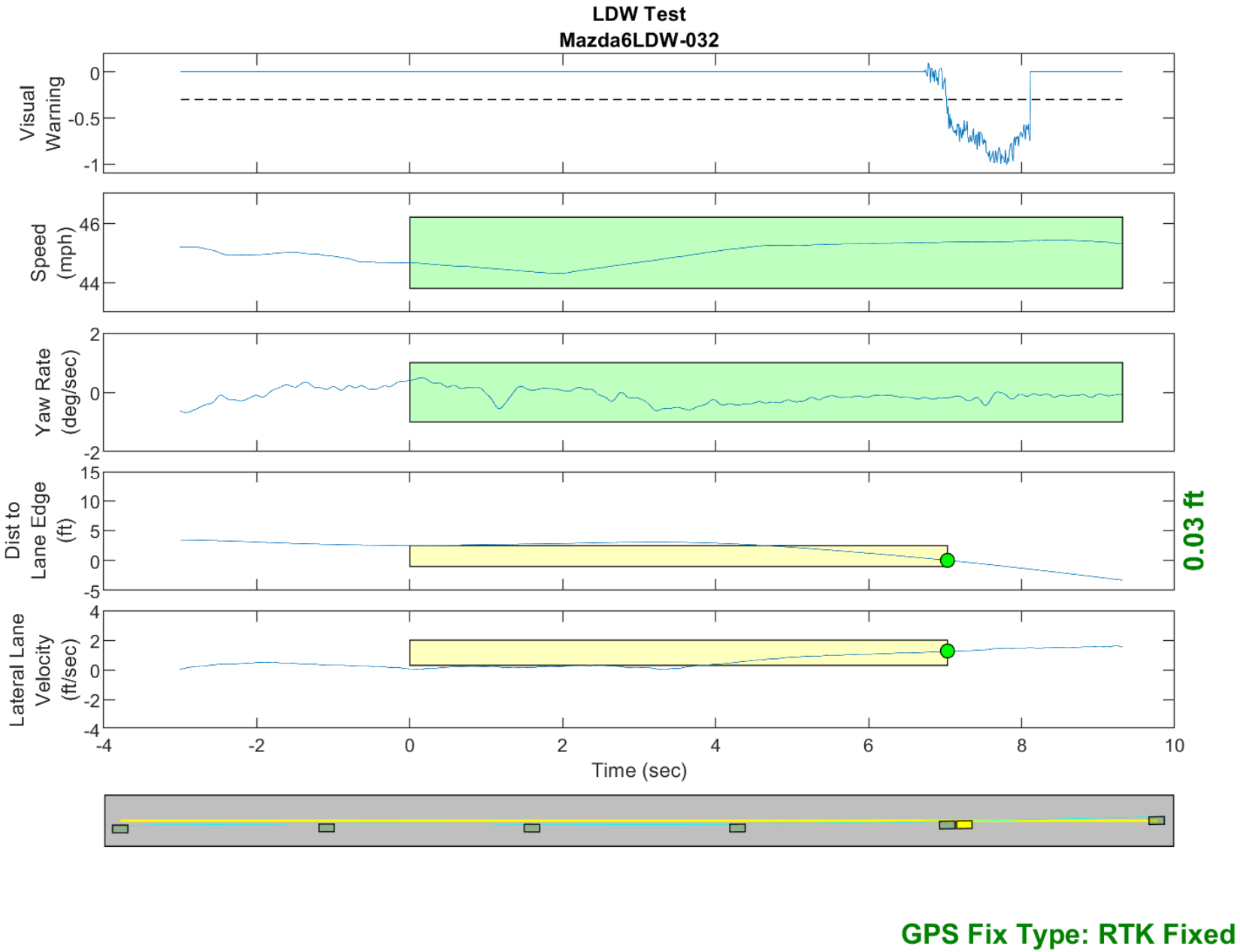


Figure D63. Time History for Run 32, Botts Dots, Left Departure, Visual Warning

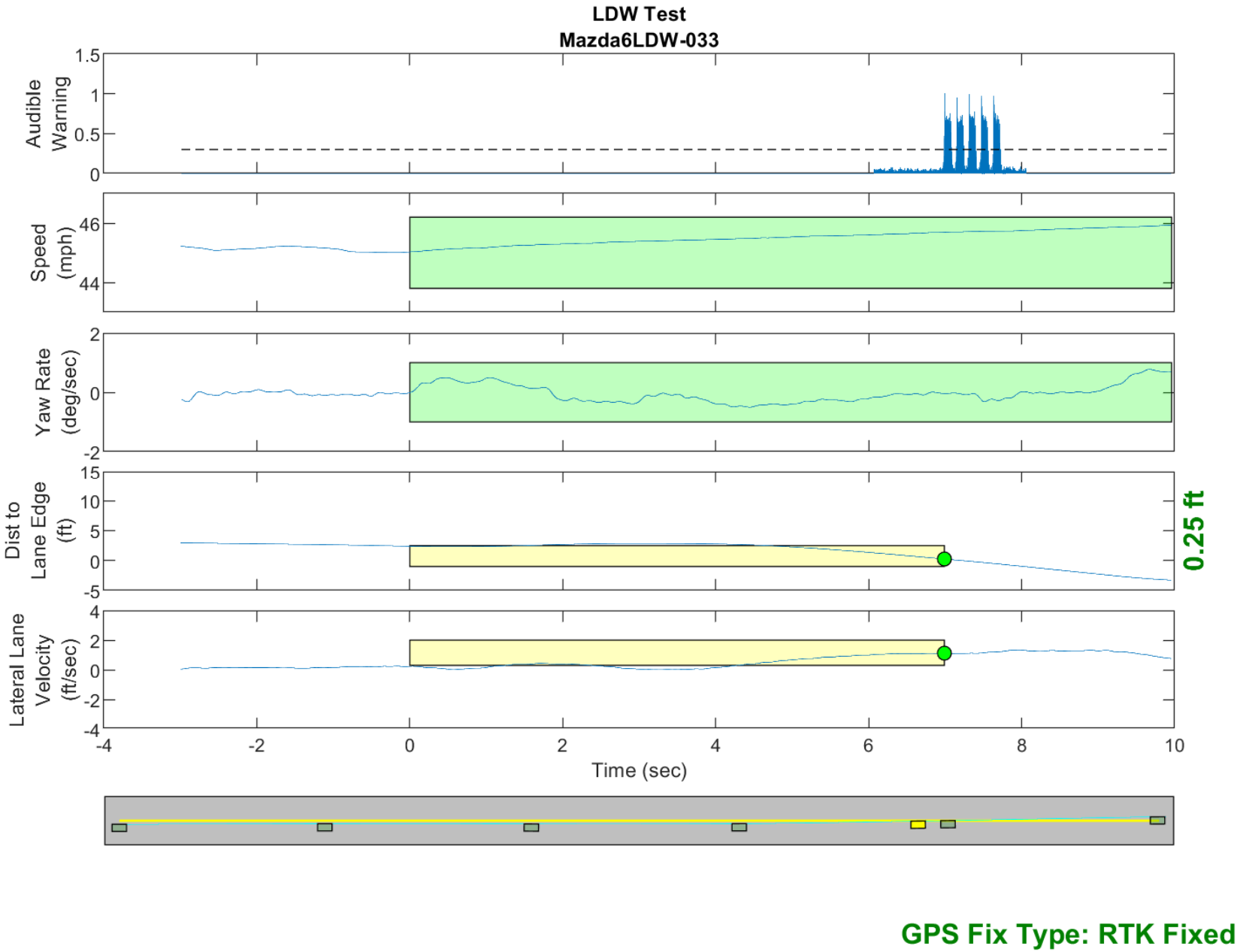


Figure D64. Time History for Run 33, Botts Dots, Left Departure, Audible Warning

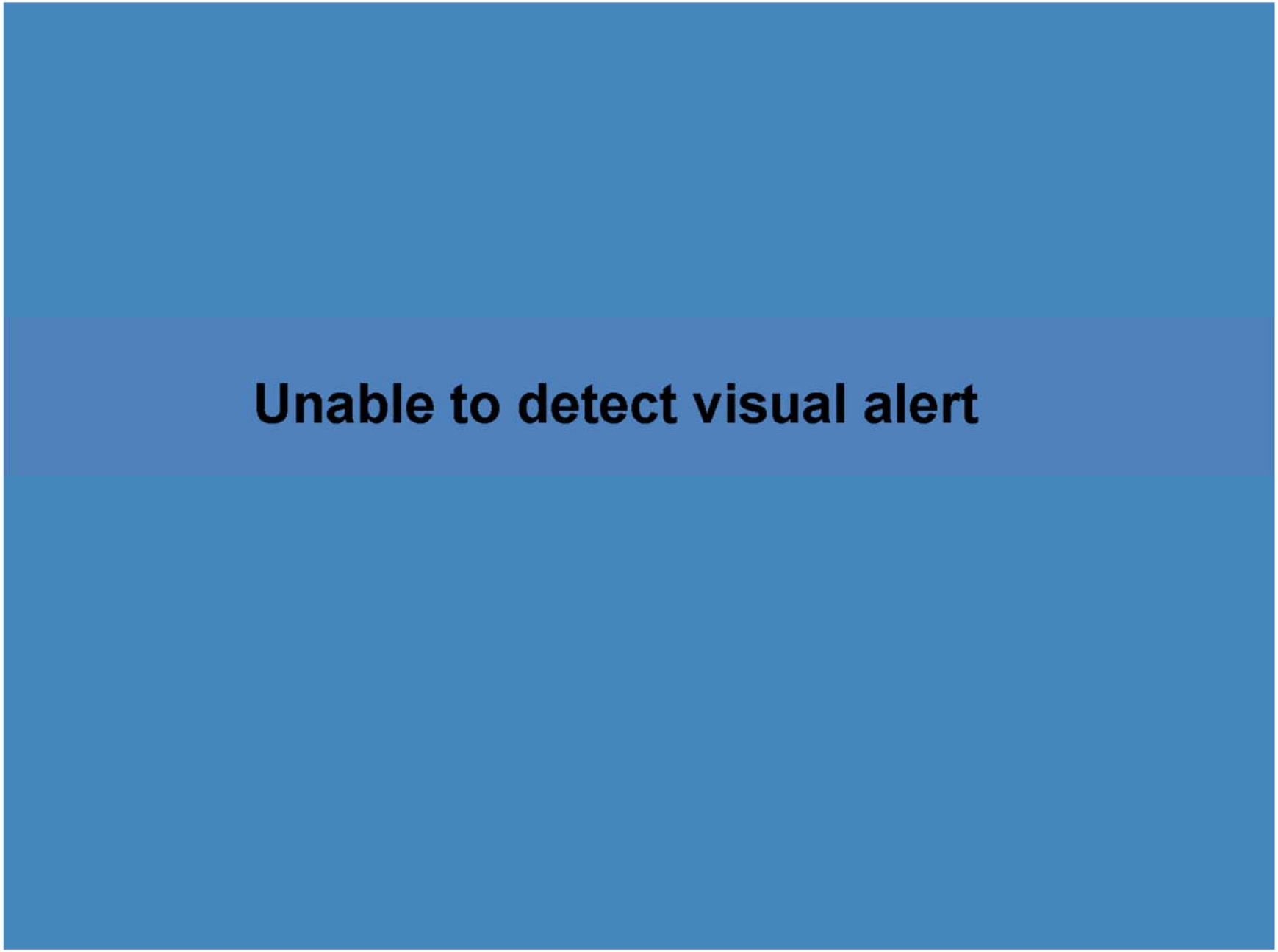


Figure D65. Time History for Run 33, Botts Dots, Left Departure, Visual Warning

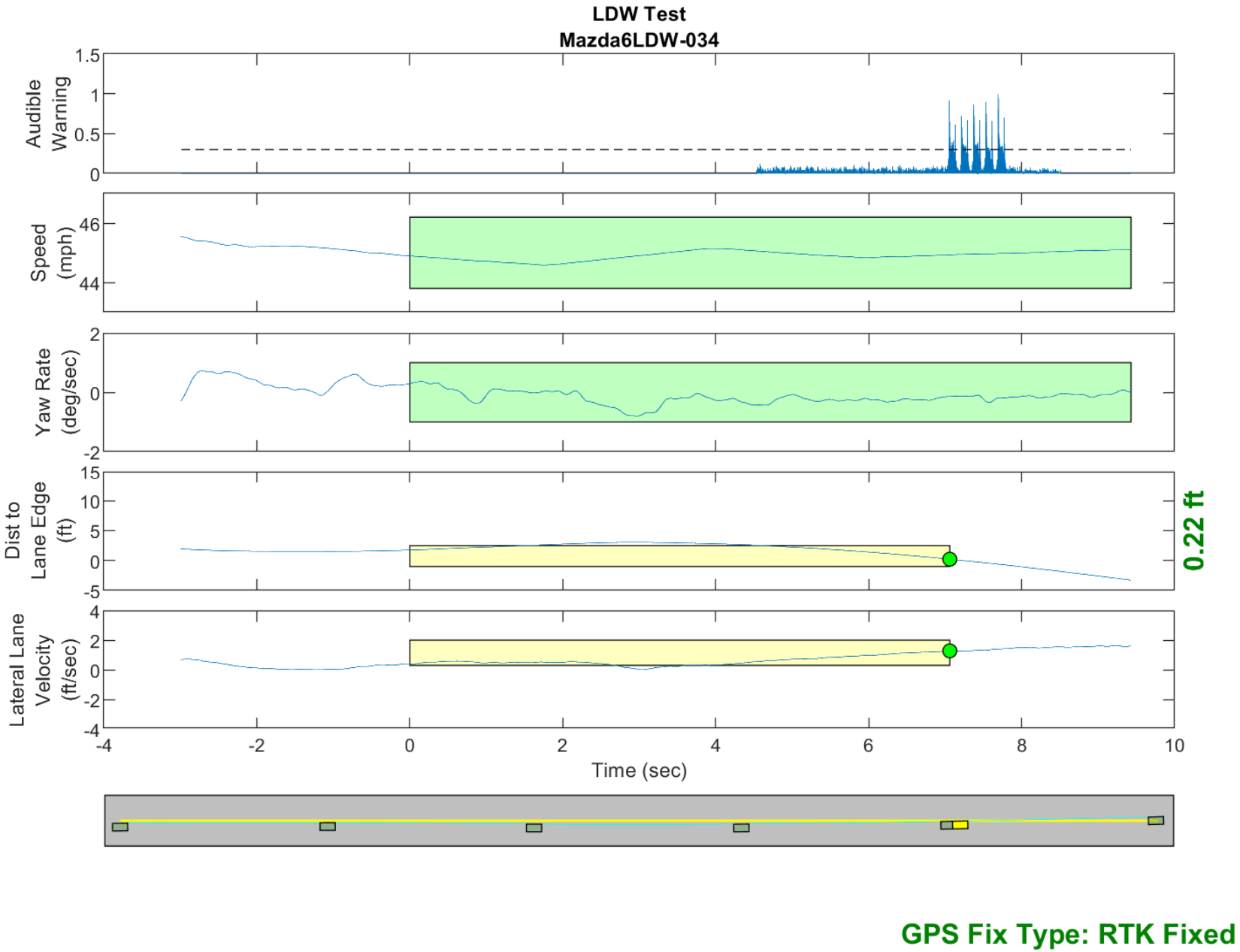


Figure D66. Time History for Run 34, Botts Dots, Left Departure, Audible Warning

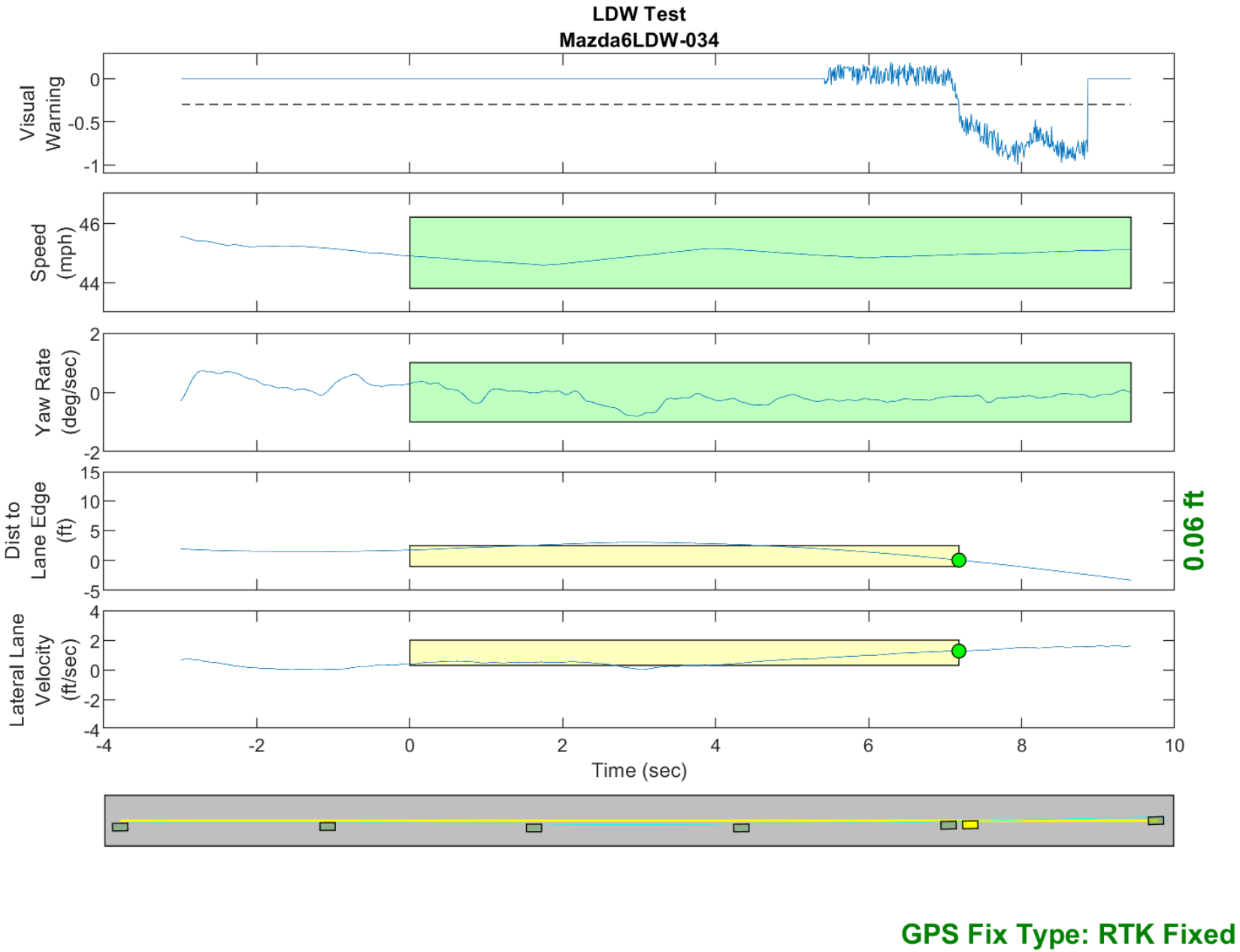


Figure D67. Time History for Run 34, Botts Dots, Left Departure, Visual Warning

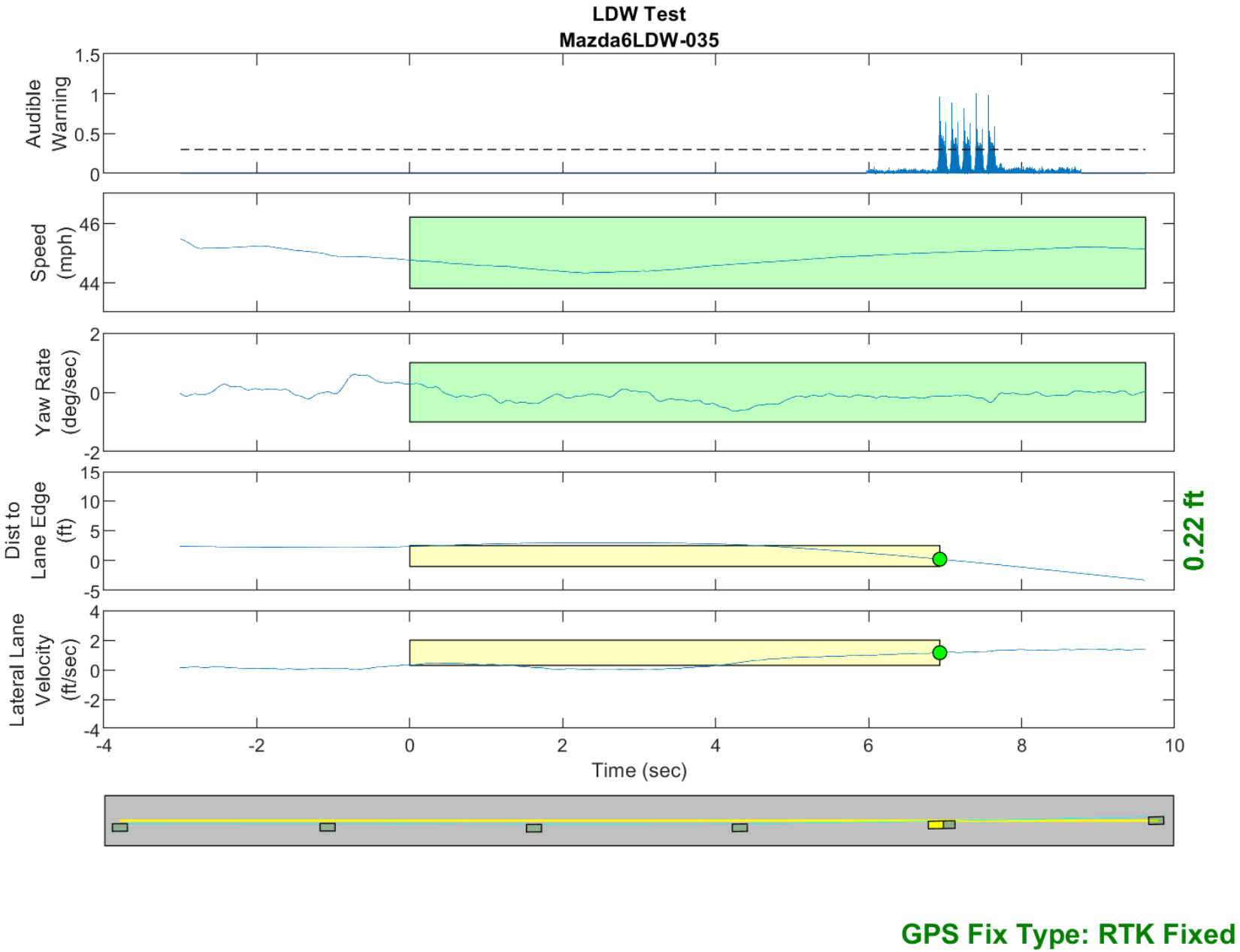


Figure D68. Time History for Run 35, Botts Dots, Left Departure, Audible Warning

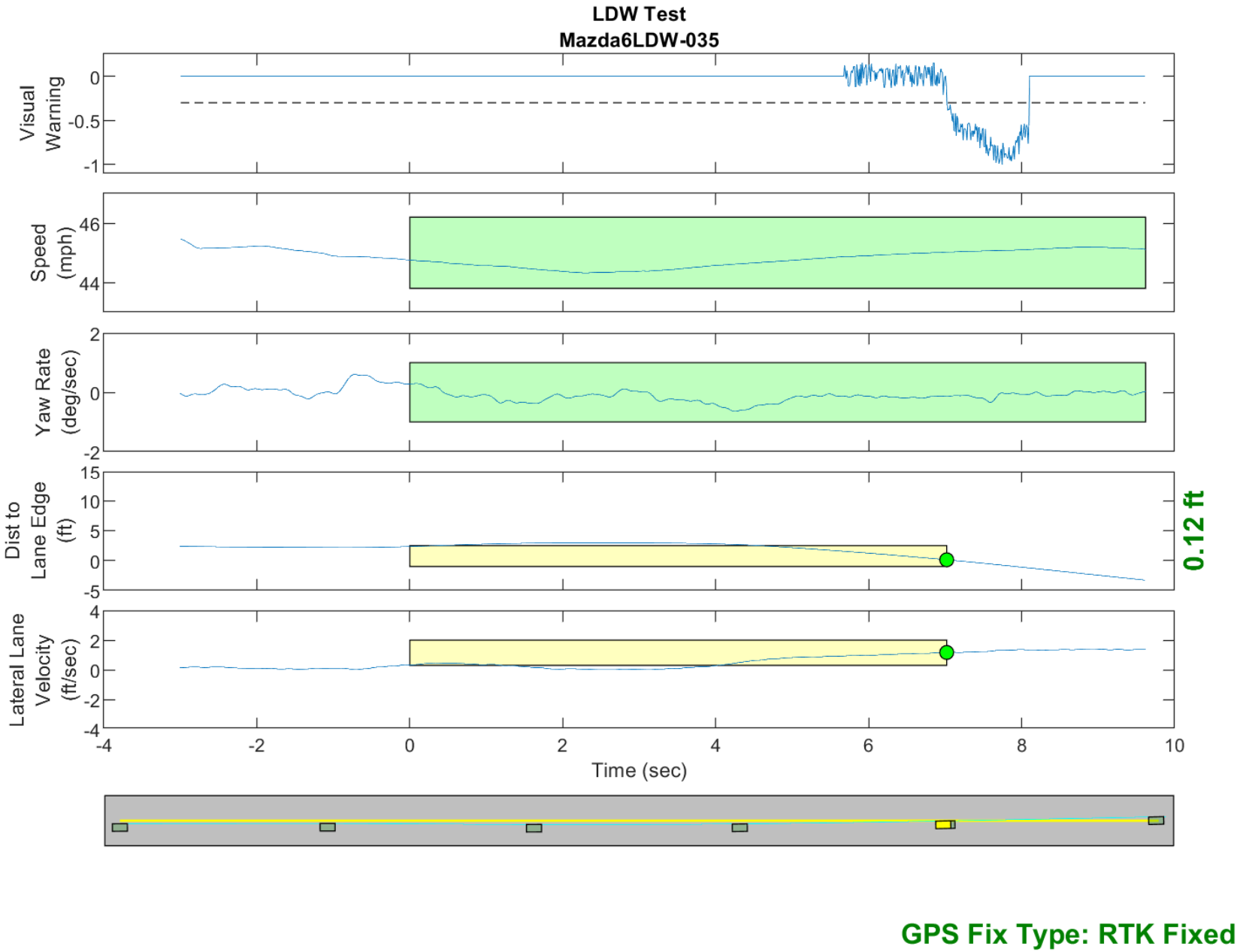


Figure D69. Time History for Run 35, Botts Dots, Left Departure, Visual Warning

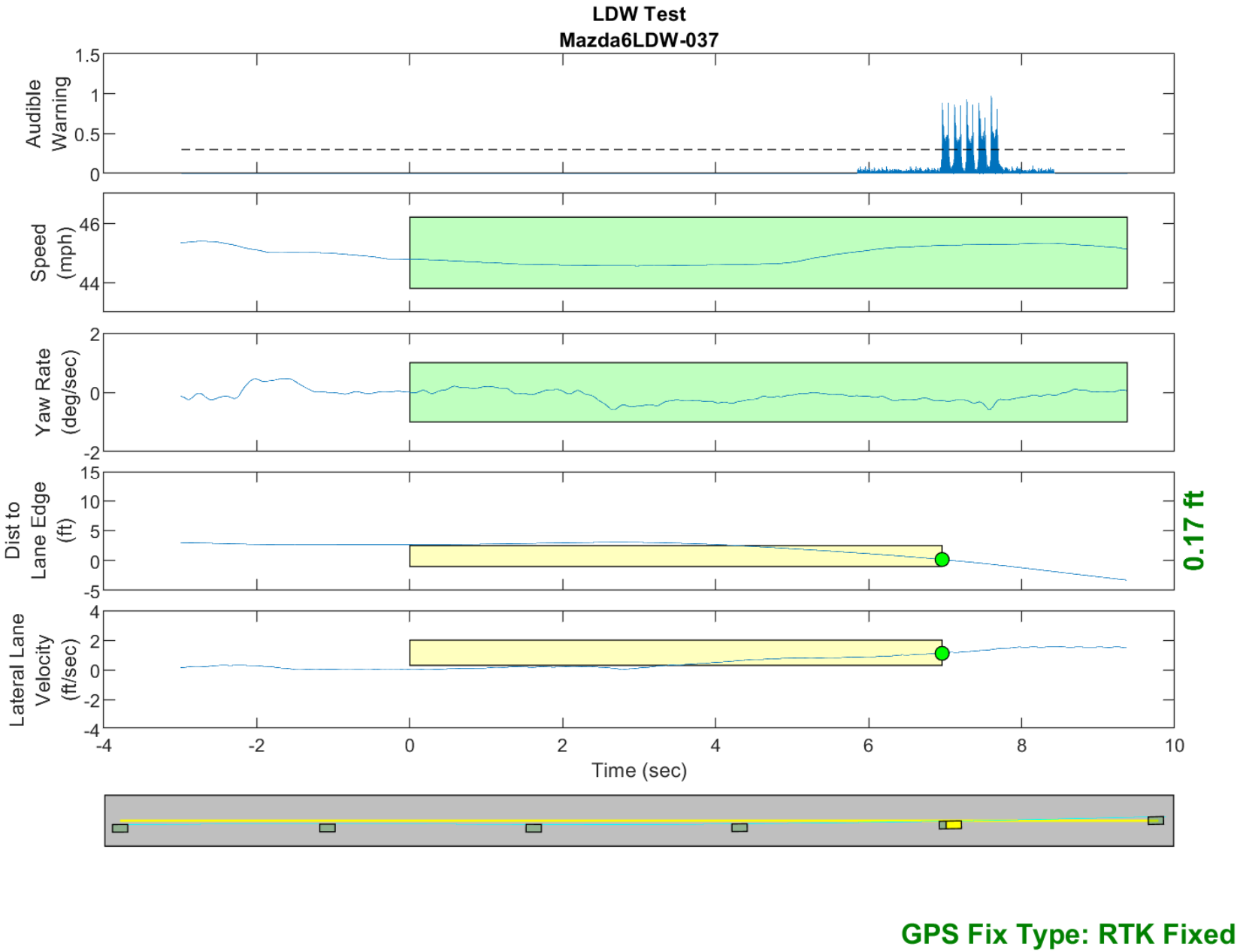


Figure D70. Time History for Run 37, Botts Dots, Left Departure, Audible Warning

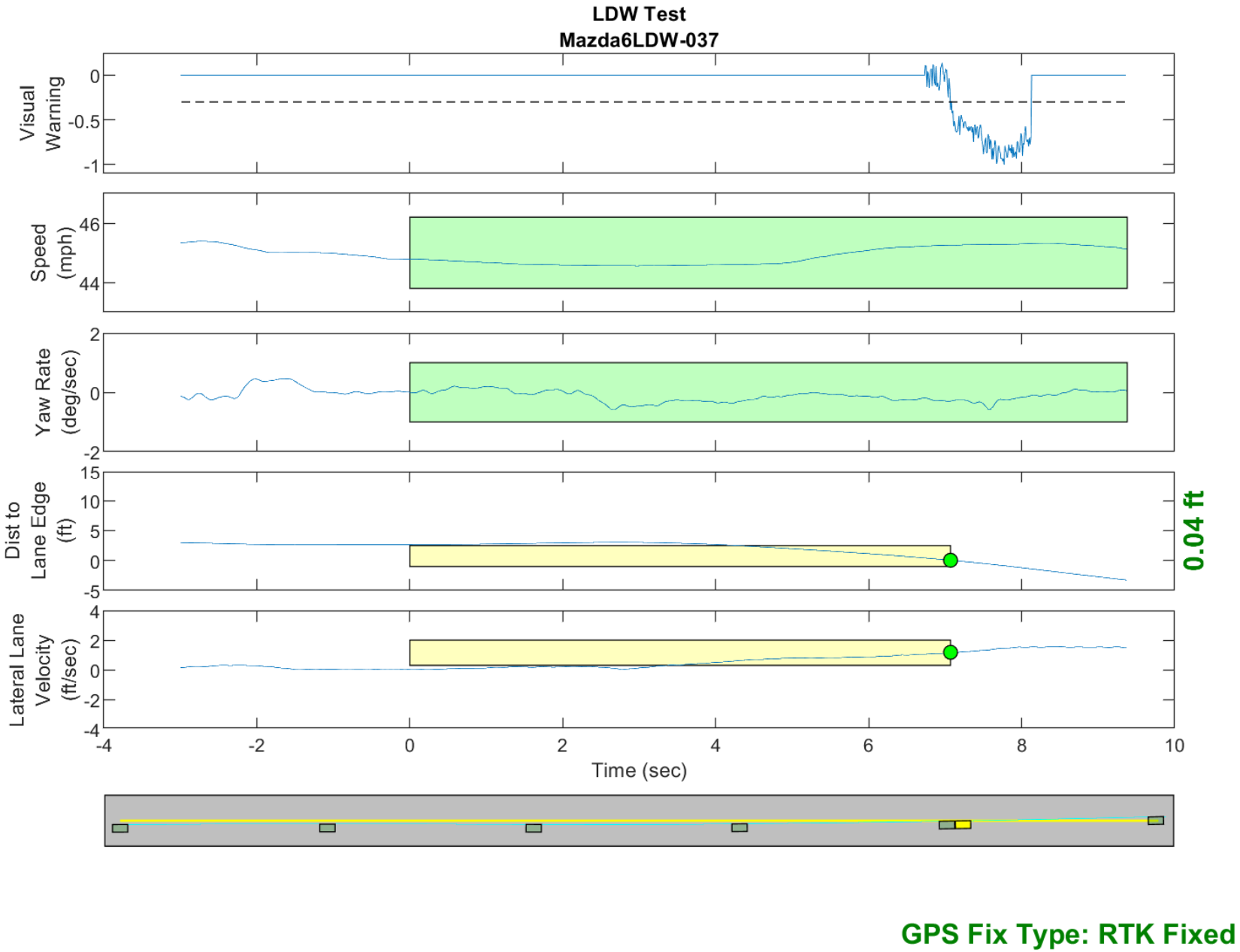


Figure D71. Time History for Run 37, Botts Dots, Left Departure, Visual Warning

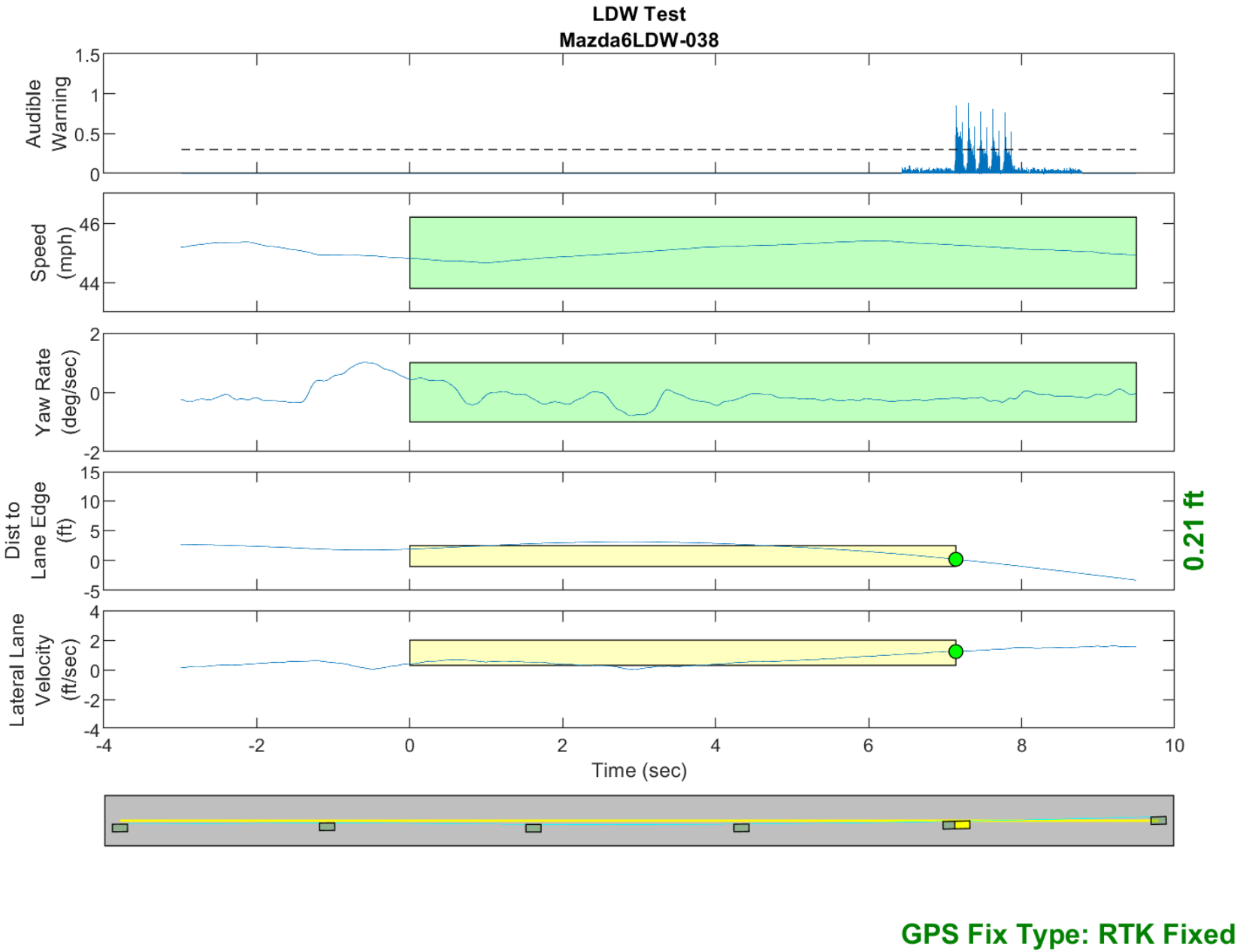


Figure D72. Time History for Run 38, Botts Dots, Left Departure, Audible Warning

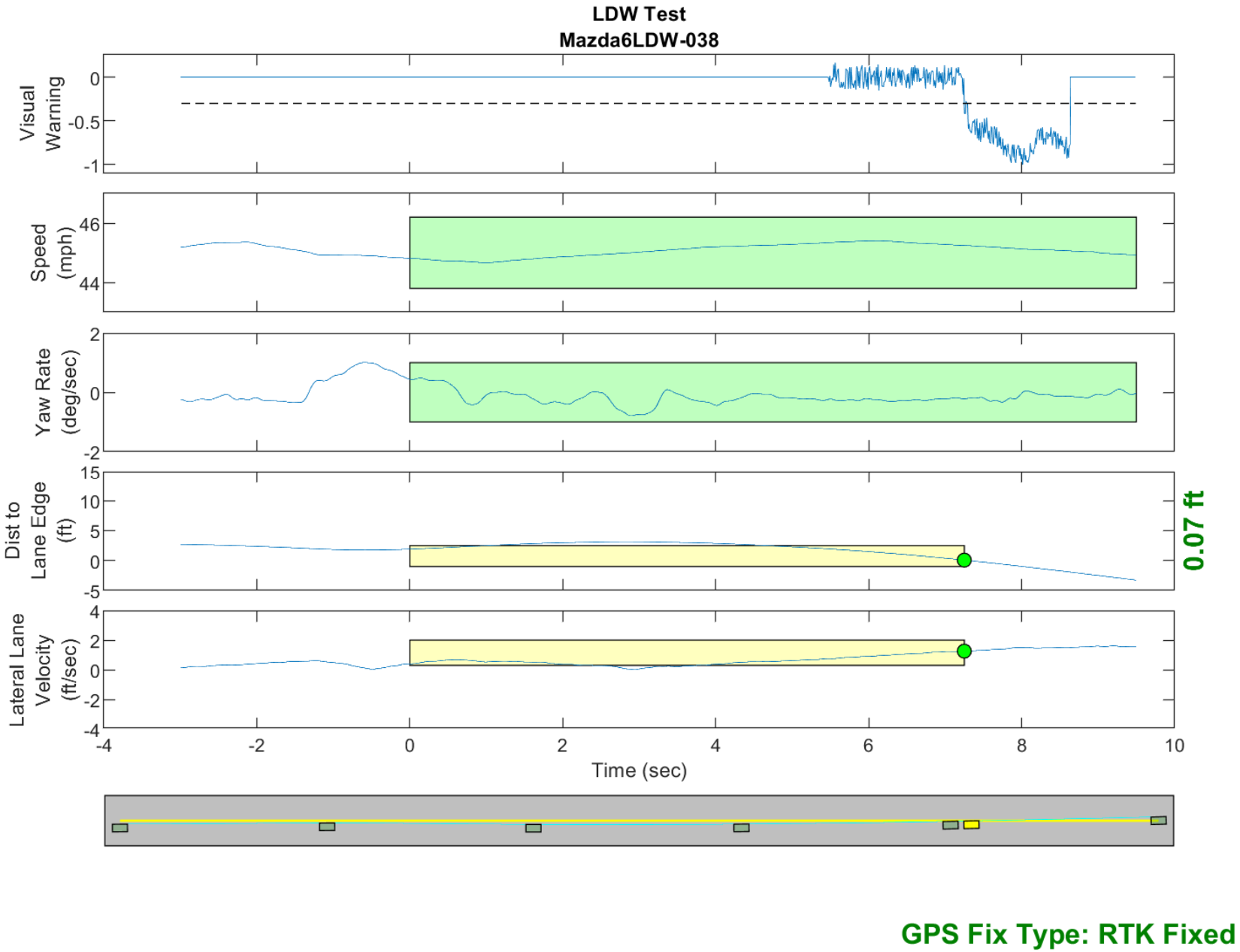


Figure D73. Time History for Run 38, Botts Dots, Left Departure, Visual Warning

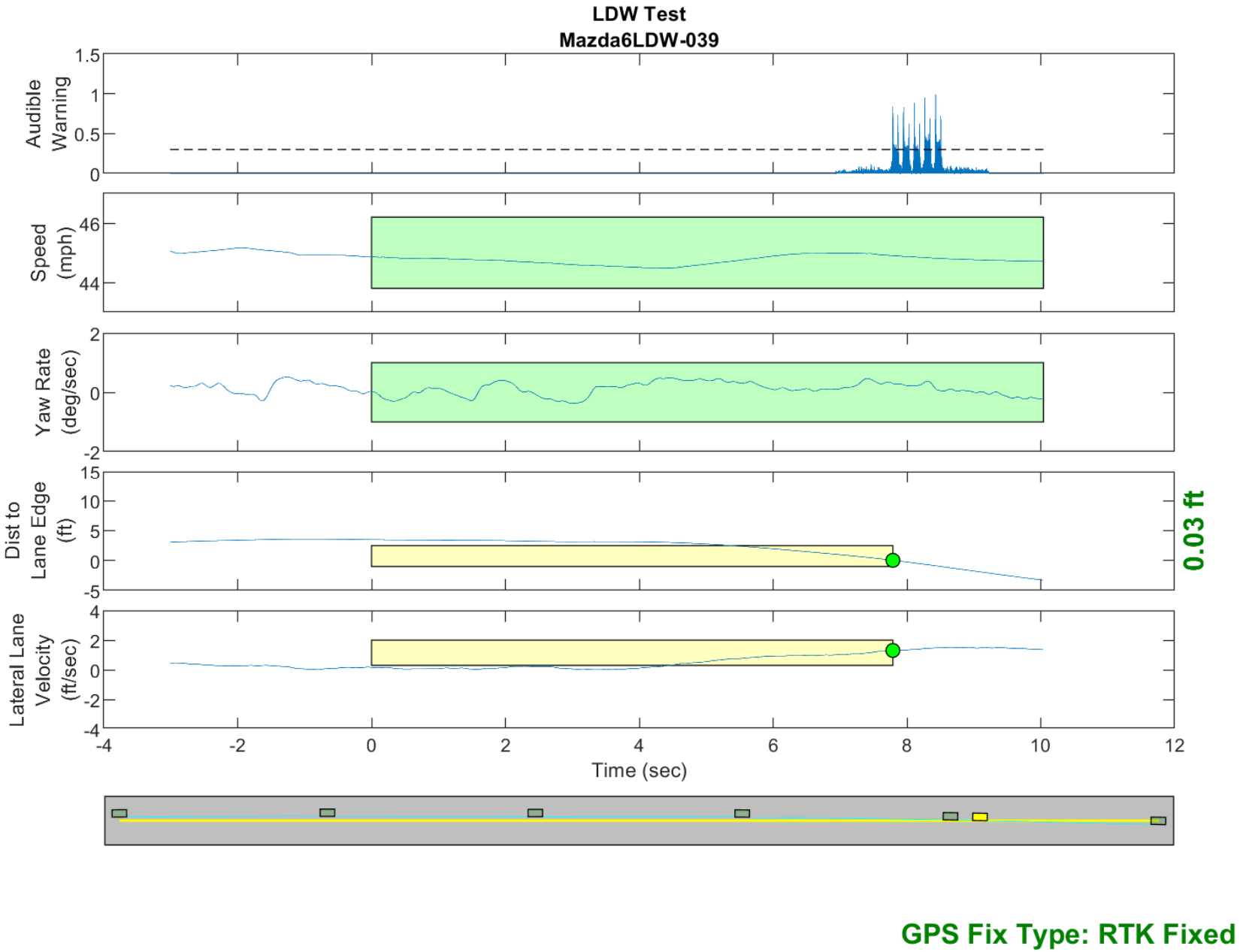


Figure D74. Time History for Run 39, Botts Dots, Right Departure, Audible Warning

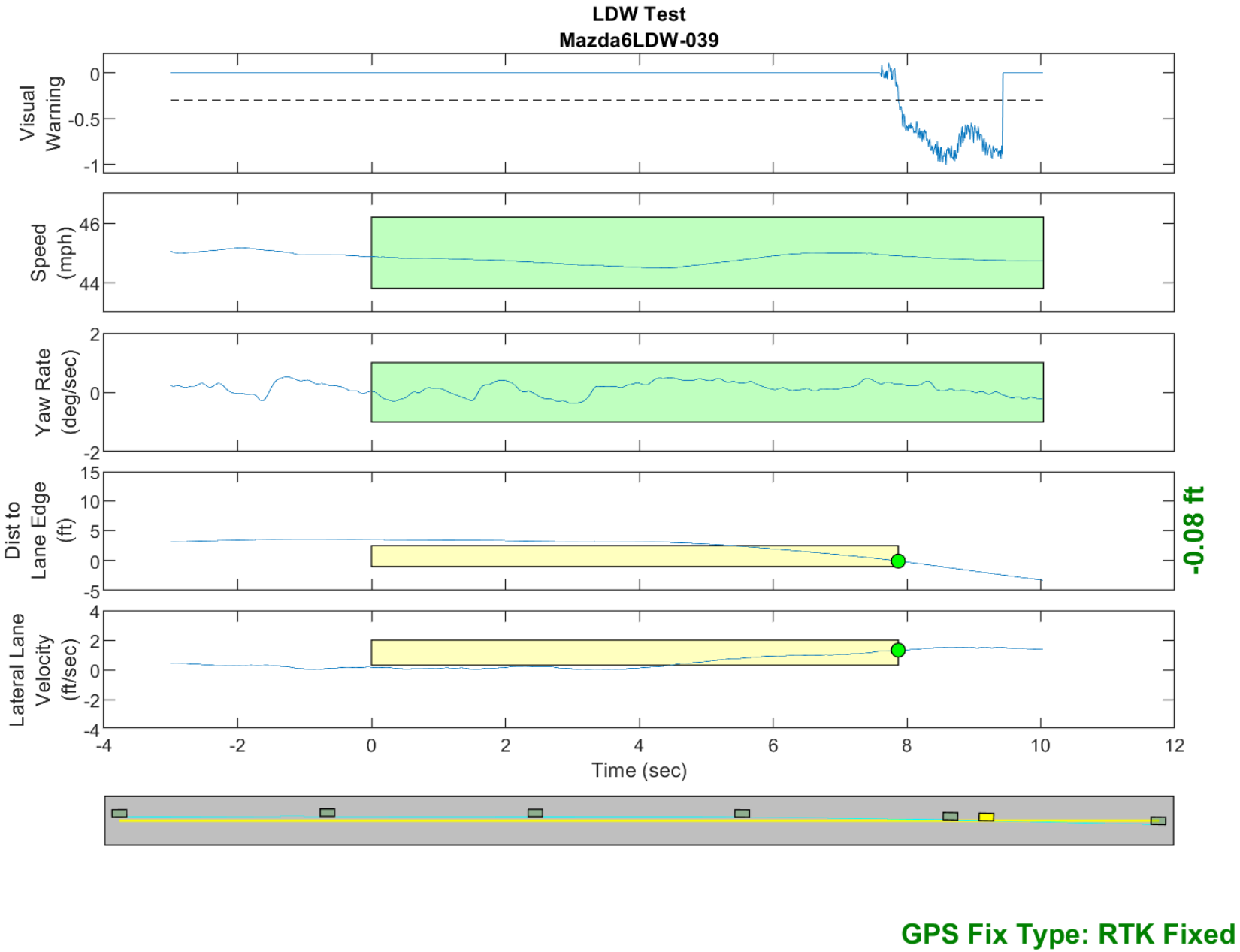


Figure D75. Time History for Run 39, Botts Dots, Right Departure, Visual Warning

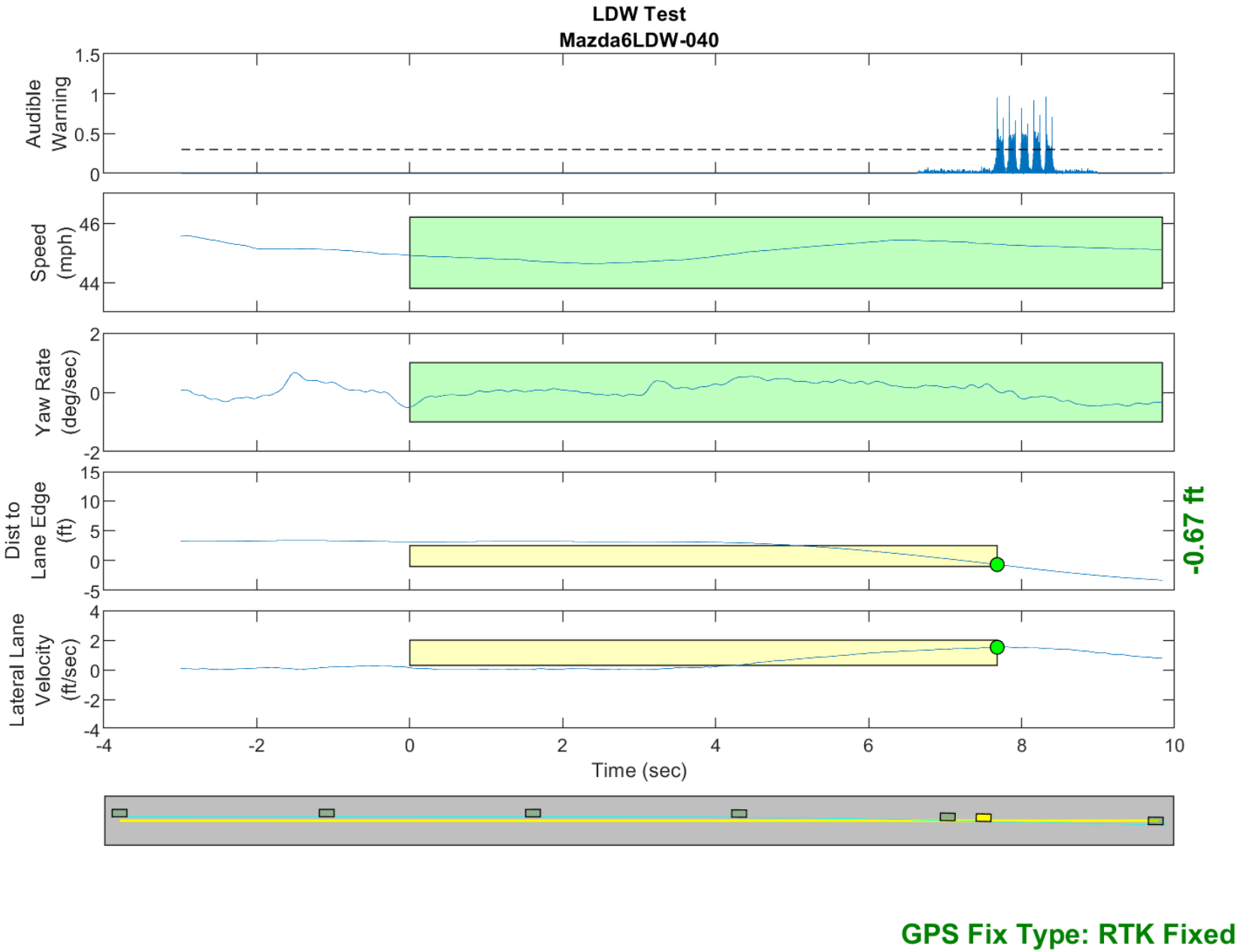


Figure D76. Time History for Run 40, Botts Dots, Right Departure, Audible Warning

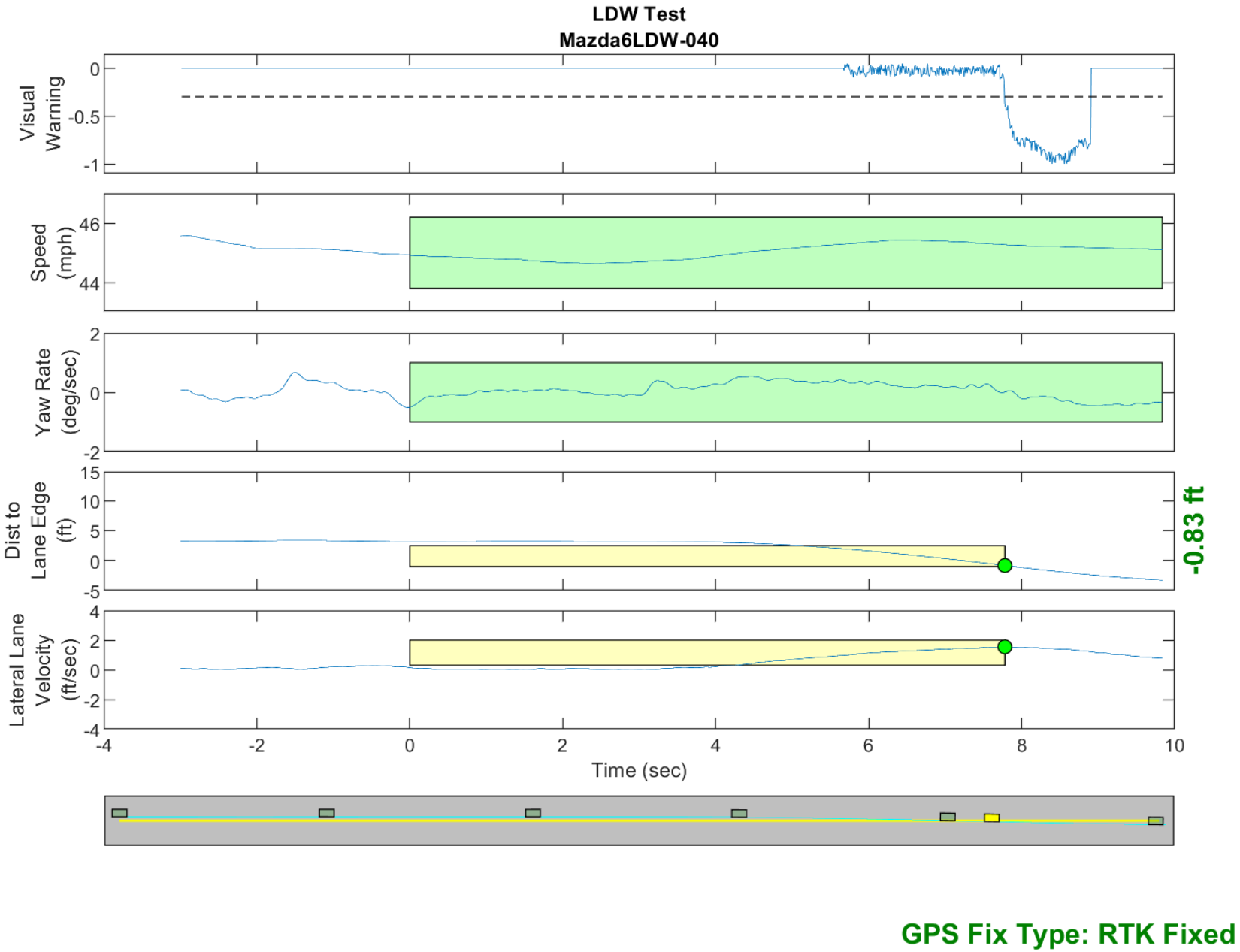


Figure D77. Time History for Run 40, Botts Dots, Right Departure, Visual Warning

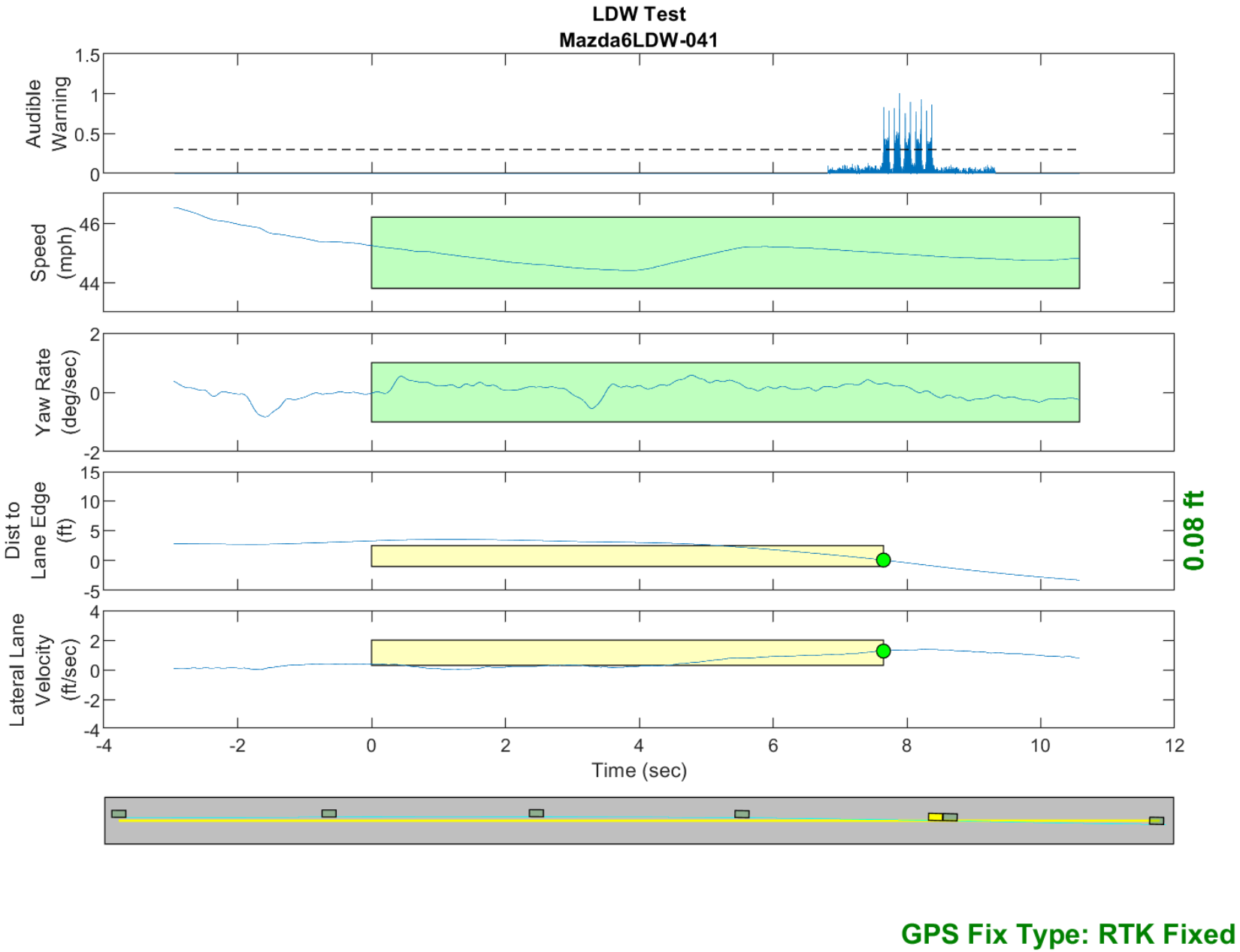


Figure D78. Time History for Run 41, Botts Dots, Right Departure, Audible Warning

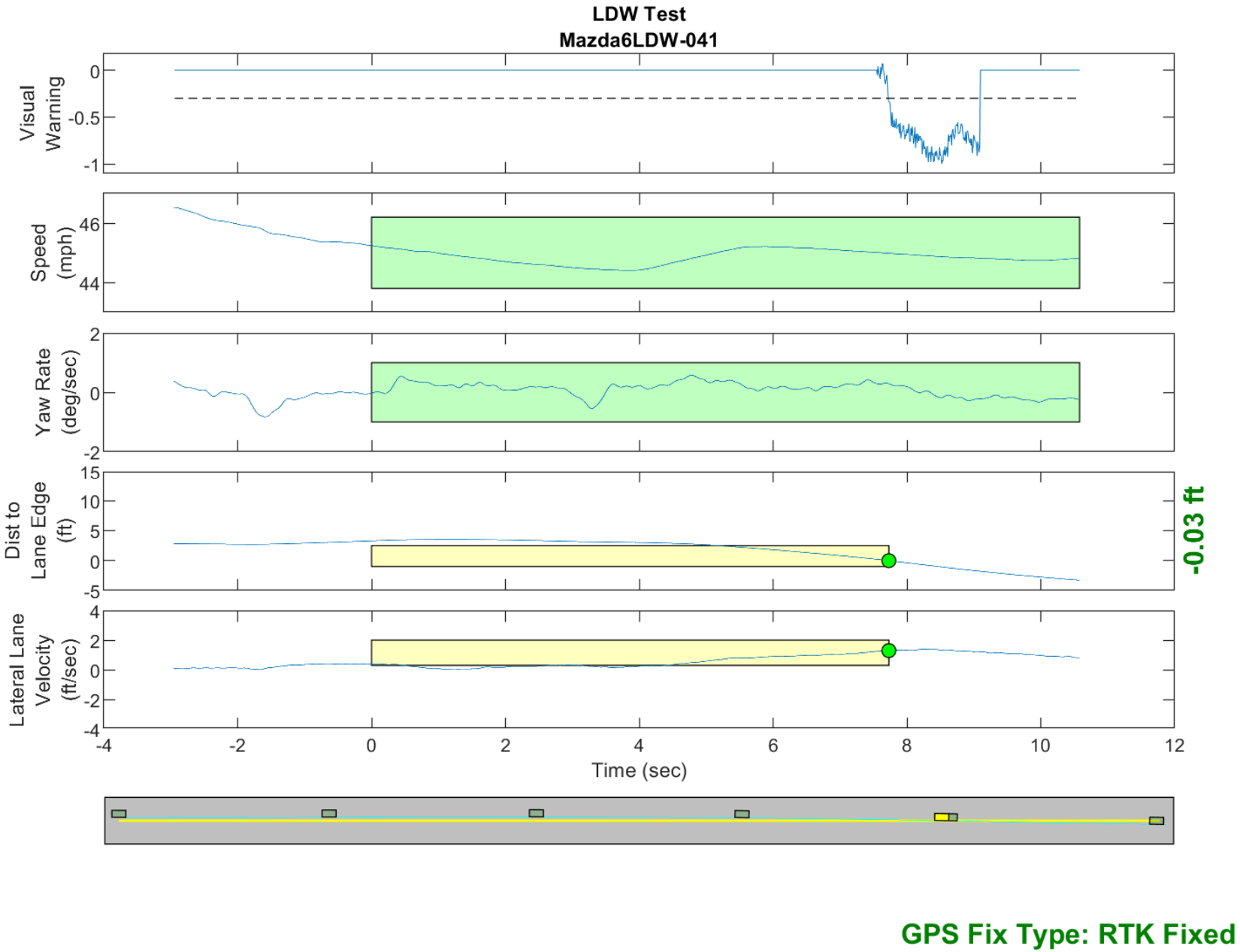


Figure D79. Time History for Run 41, Botts Dots, Right Departure, Visual Warning

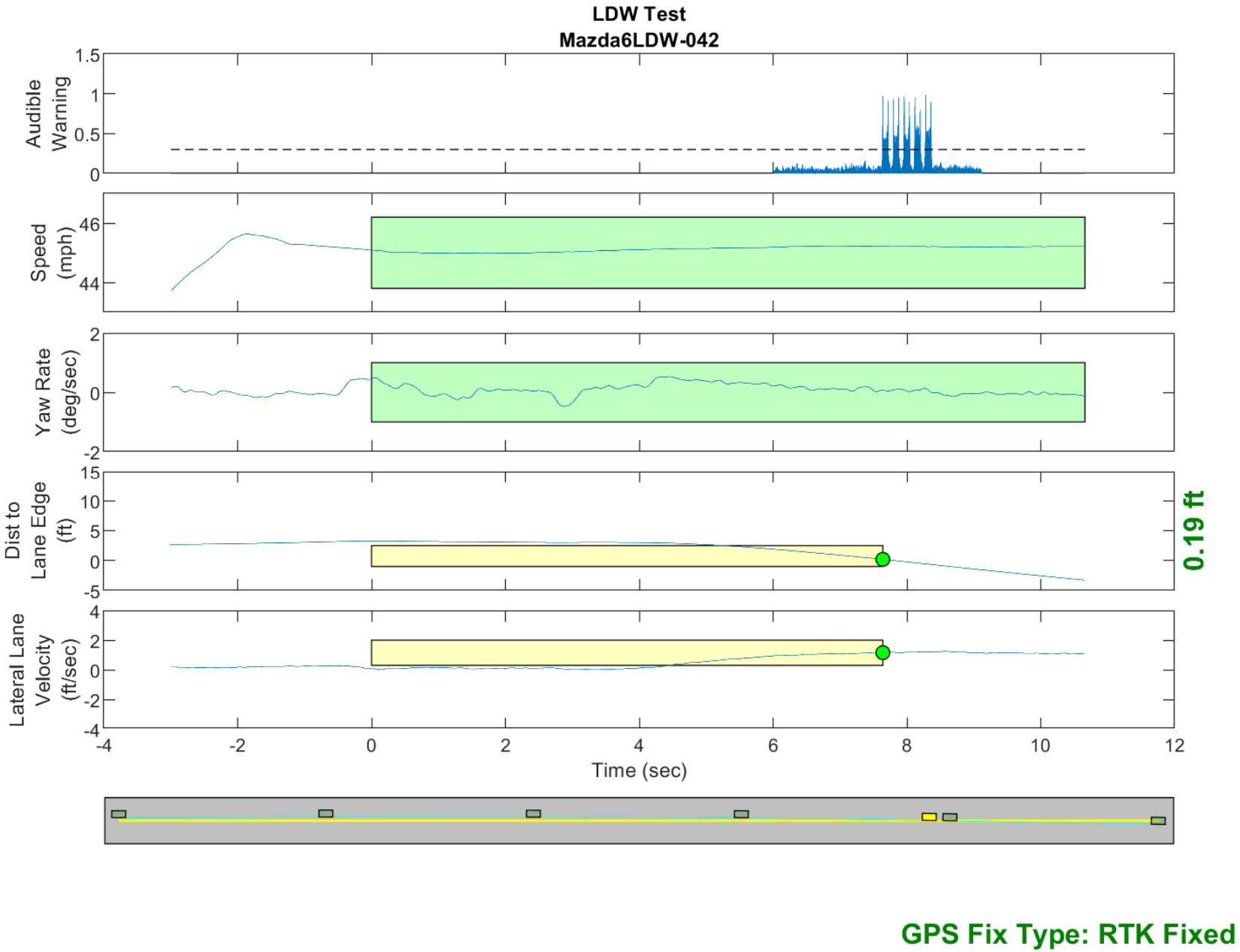


Figure D80. Time History for Run 42, Botts Dots, Right Departure, Audible Warning

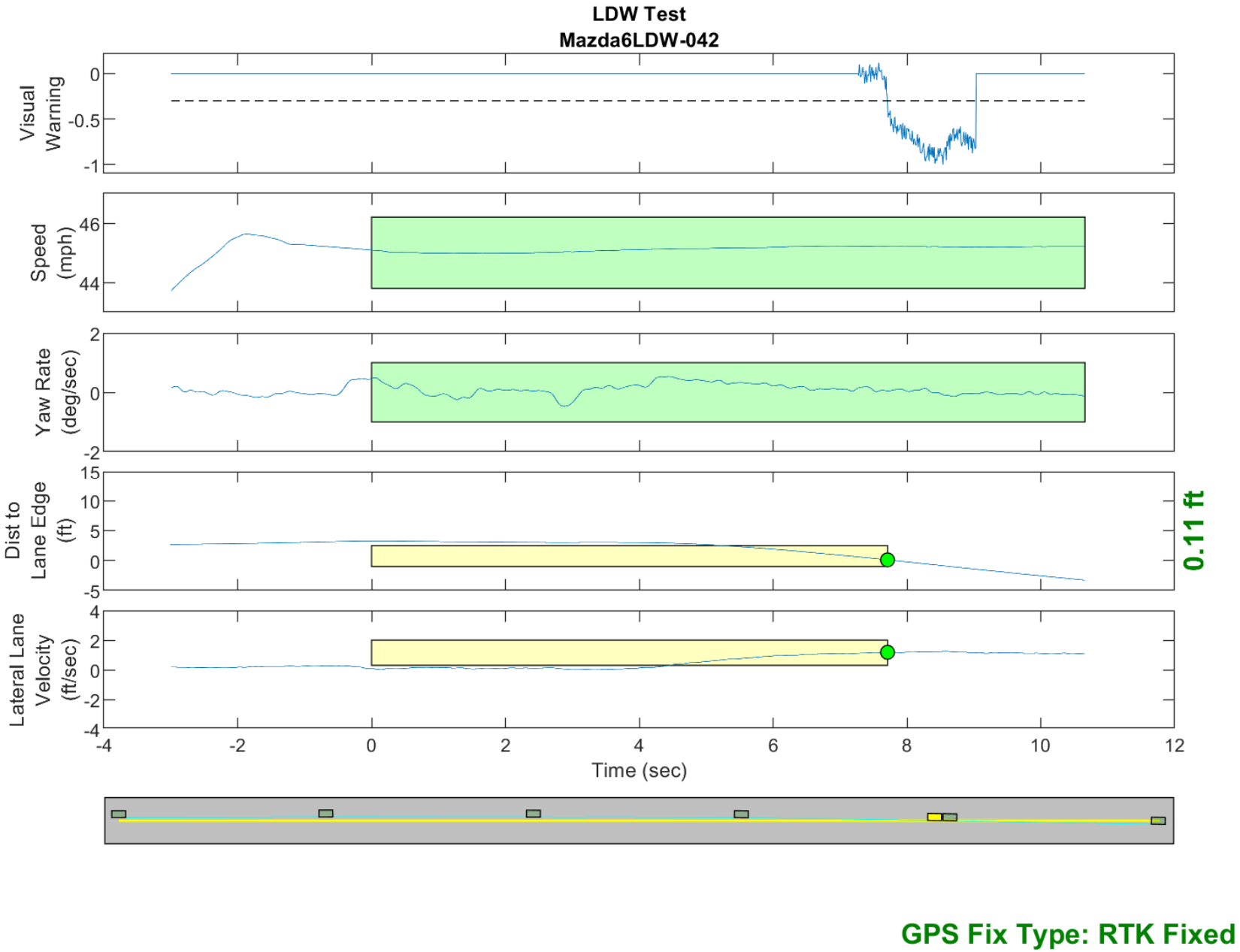


Figure D81. Time History for Run 42, Botts Dots, Right Departure, Visual Warning

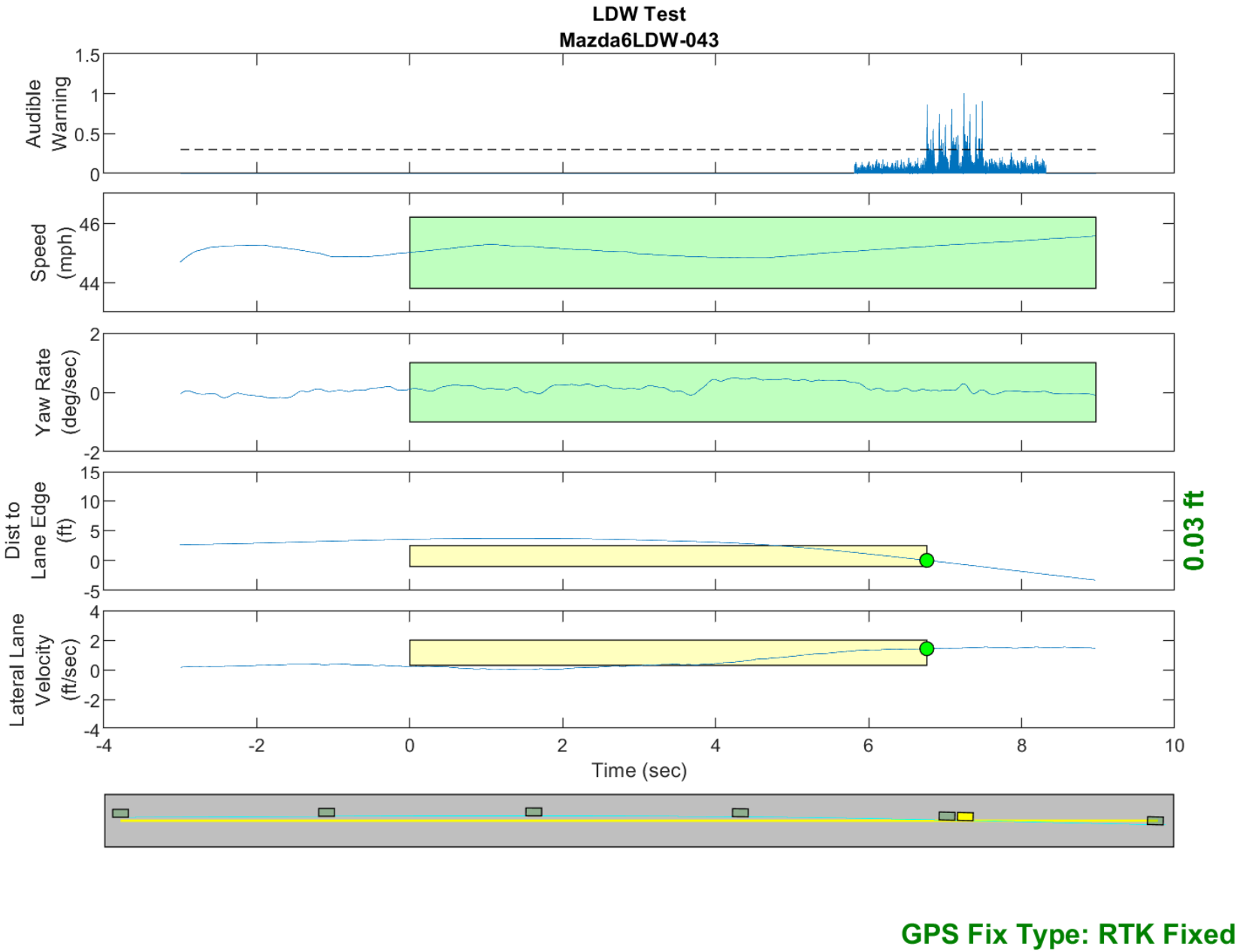


Figure D82. Time History for Run 43, Botts Dots, Right Departure, Audible Warning

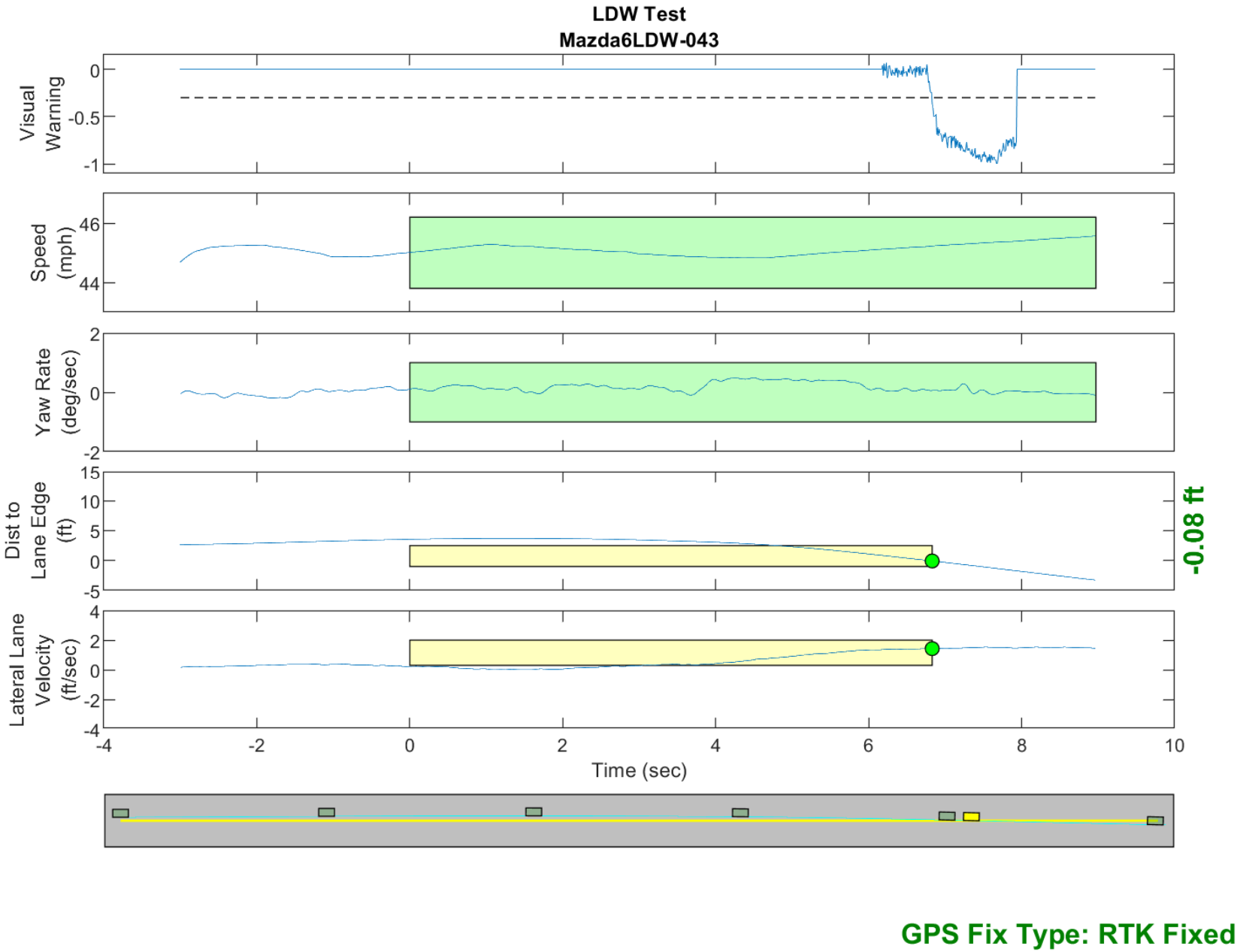


Figure D83. Time History for Run 43, Botts Dots, Right Departure, Visual Warning

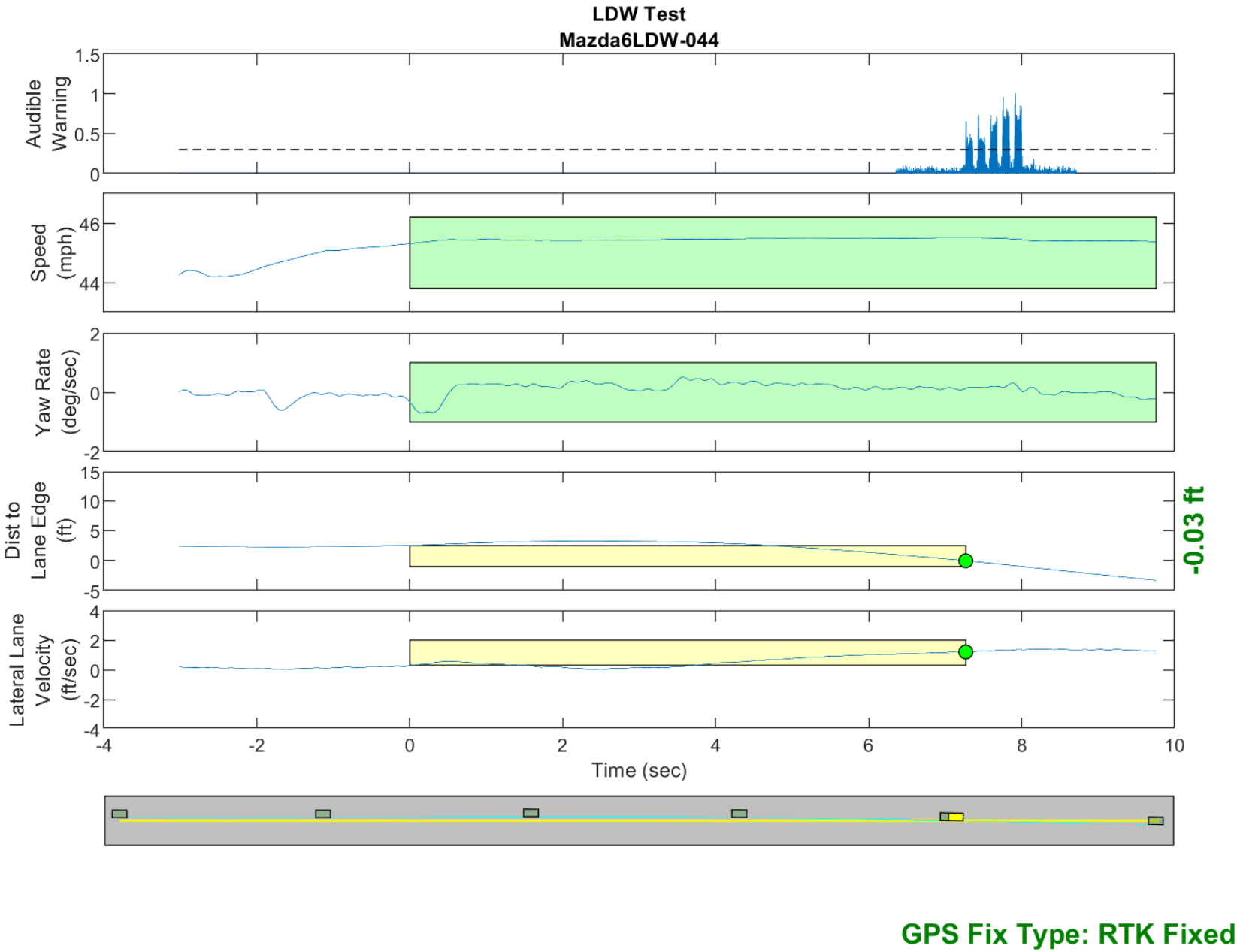


Figure D84. Time History for Run 44, Botts Dots, Right Departure, Audible Warning

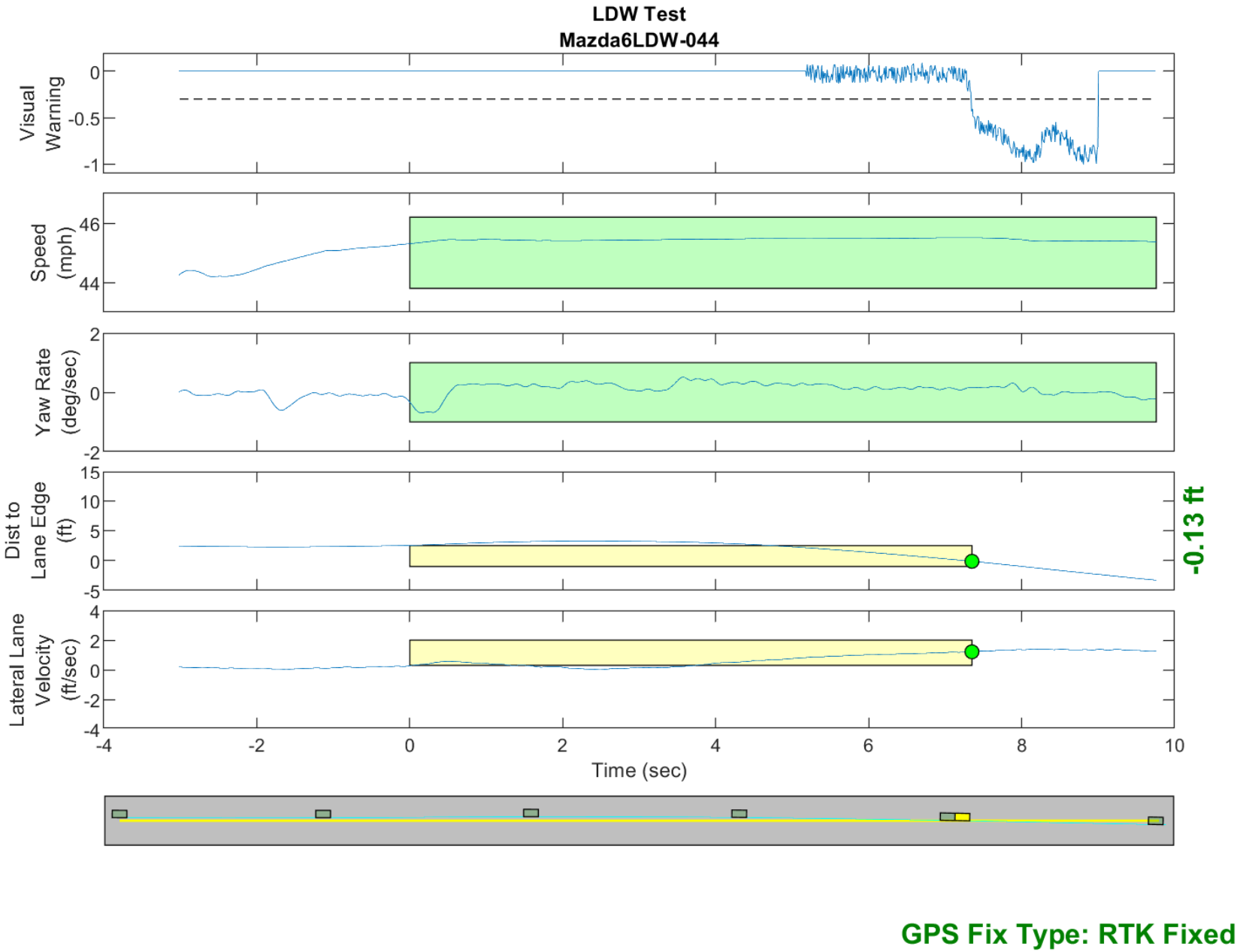


Figure D85. Time History for Run 44, Botts Dots, Right Departure, Visual Warning

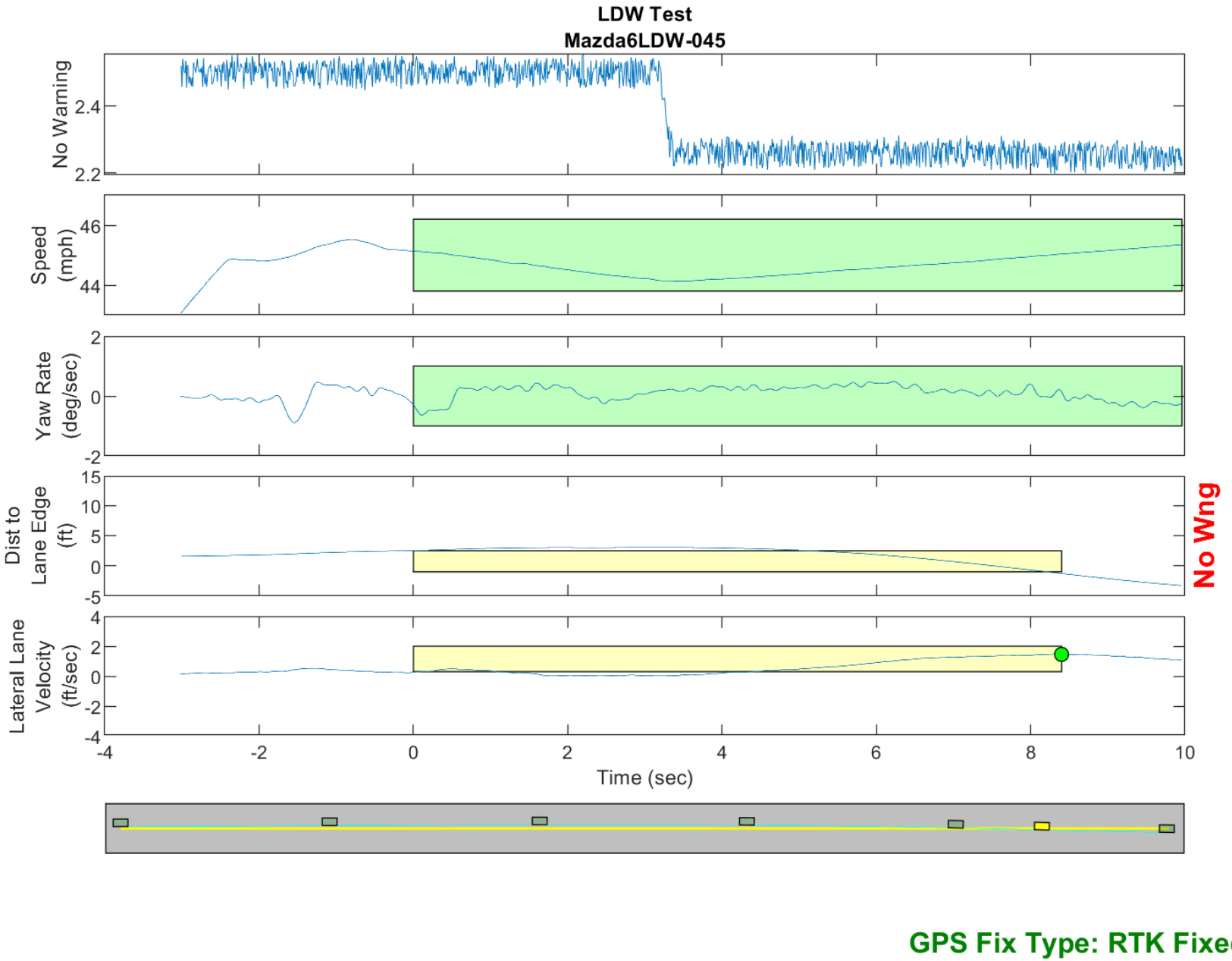


Figure D86. Time History for Run 45, Botts Dots, Right Departure, No Warning