OCAS-DRI-LDW-19-05
NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST

2019 Subaru Crosstrek Hybrid

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17 January 2020

Final Report

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

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

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16. Abstract These tests were conducted on the subject 2019 Subaru Crosstrek Hybrid 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 2019 Subaru Crosstrek Hybrid. The driver is alerted with a yellow visual warning of the word "Lane Departure" flashing once, and the alert symbol flashing on/off. The driver is also alerted with a high-pitched, 3 short beeping audible warning. 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)

2019 Subaru Crosstrek Hybrid

VIN: *JF2GTDEC5KH3xxxx*

Test Date: *6/4/2019*

Lane Departure Warning setting: *N/A*

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

Overall: *Pass*

LANE DEPARTURE WARNING

DATA SHEET 2: GENERAL TEST AND VEHICLE PARAMETER DATA

(Page 1 of 1)

2019 Subaru Crosstrek Hybrid

TEST VEHICLE INFORMATION

VIN: *JF2GTDEC5KH3xxxx*

Body Style: *SUV* Color: *Crystal Black Silica*

Date Received: *5/20/2019* Odometer Reading: *156 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *SUBARU CORPORATION*

Date of manufacture: *02/19*

Vehicle Type: *MPV/VTUM*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *225/55R18*

Rear: *225/55R18*

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

Rear: *240 kPa (35 psi)*

TIRES

Tire manufacturer and model: *Falken Ziex ZE001 A/S*

Front tire size: *225/55R18*

Rear tire size: *225/55R18*

Front tire DOT prefix: *U200 DM2R*

Rear tire DOT prefix: *U200 DM2R*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2019 Subaru Crosstrek Hybrid

GENERAL INFORMATION

Test date: *6/4/2019*

AMBIENT CONDITIONS

Air temperature: *33.9 C (93 F)*

Wind speed: *0.0 m/s (0.0 mph)*

X Wind speed ≤10 m/s (22 mph)

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

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

VEHICLE PREPARATION

Verify the following:

All non-consumable fluids at 100 % capacity: X

Fuel tank is full: X

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

Front: *250 kPa (36 psi)*

Rear: *240 kPa (35 psi)*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2019 Subaru Crosstrek Hybrid

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*519.4 kg (1145 lb)*	Right Front	*467.2 kg (1030 lb)*
Left Rear	*425.0 kg (937 lb)*	Right Rear	*420.0 kg (926 lb)*
		Total:	*1831.6 kg (4038 lb)*

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 1 of 3)

2019 Subaru Crosstrek Hybrid

Name of the LDW option: *Eyesight - Lane Keep Assist*

Type of sensor(s) used: *Stereo cameras*

How is the Lane Departure Warning presented to the driver?

(Check all that apply)

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

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

The driver is alerted with a yellow visual warning of the word "Lane Departure" flashing once, and the alert symbol flashing on/off. The driver is also alerted with a high-pitched, 3 short beeping audible warning.

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.

The switch to render FCW inoperable is located on the center roof panel of the vehicle. To turn the system off, press and hold the Lane Departure Warning OFF switch for approximately 2 seconds or longer. After 1 short beep sound emits, the function is turned off and the OFF indicator light on the instrument panel illuminates.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 2 of 3)

2019 Subaru Crosstrek Hybrid

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

If yes, please provide a full description.

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

If yes, please provide a full description.

In the following situations, the Lane Departure Warning may not activate:

- *Vehicle speed is approximately 30 MPH (50 km/h) or less.*
- *When the steering wheel is turned significantly to either side.*
- *When the vehicle is driving around a curve whose radius is 0.18 miles (300 m) or smaller.*
- *When the brake pedal is depressed or immediately after it is depressed*
- *When the following distance behind a vehicle in front is short.*
- *While the turn signal is operating.*
- *For approximately 4 seconds after the turn signal lever has returned to its original position.*
- *When the vehicle has not returned to the inside of the lane after the Lane Departure Warning has activated.*
- *The lane is narrow.*
- *When it is difficult for the camera to detect lane markings.*

(Continued next page)

- *There are no lane markings or they are very worn.*
- *The lane markings are yellow.*
- *It is difficult to detect lane markings as they are similar in color to the road surface.*
- *The lane markings are narrow.*
- *The following situations may cause incorrect lane detection and a faulty Lane Departure Warning to occur.*
- *When there are tire tracks on a wet road or snow-covered road.*
- *When there are boundaries between snow and asphalt, or marks from road repair, etc.*
- *When there are the shadows of guardrails.*
- *When lane markings are drawn in double.*
- *When there are some lane markings left from roadwork or markings from the previous road.*
- *When the Lane Departure Warning OFF indicator light is illuminated, the Lane Departure Warning is inactive.*

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

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

Table 1. LDW Test Matrix

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

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

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

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

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

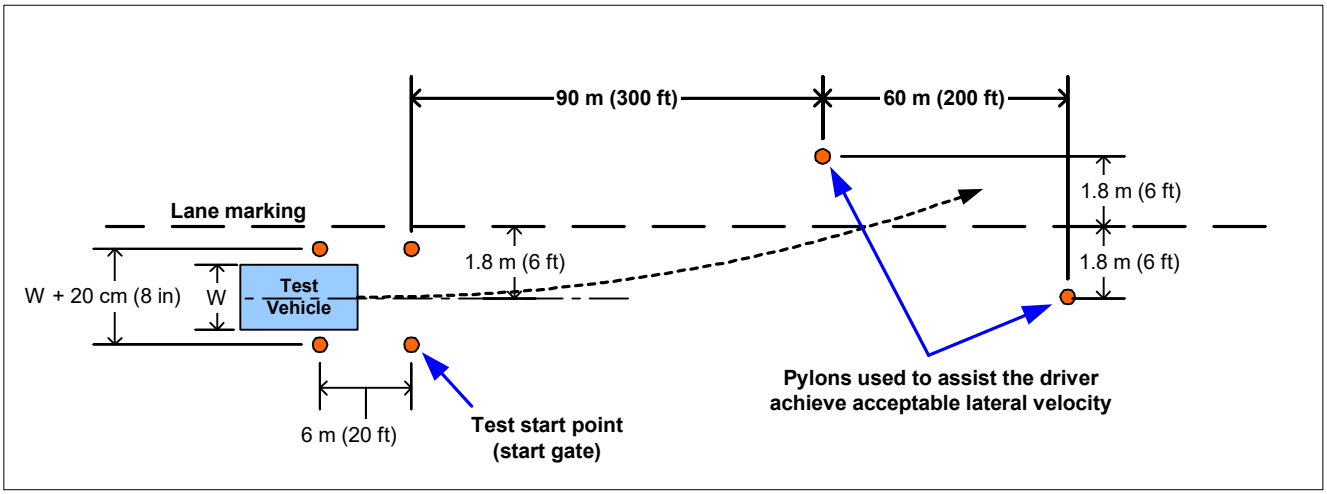


Figure 1. Position of Cones Used to Assist Driver

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

B. Lane Delineation Markings

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

1. Lane Marker Width

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

2. Line Marking Color and Reflectivity

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

3. Line Styles

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

- Continuous White Line

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

- Dashed Yellow Line

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

- Raised Pavement Marker Line (Botts Dots)

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

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

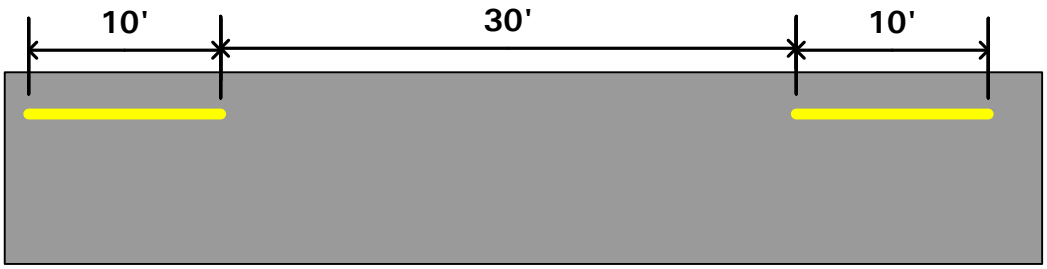


Figure 2. MUTCD Discontinuous Dashed Line Specifications

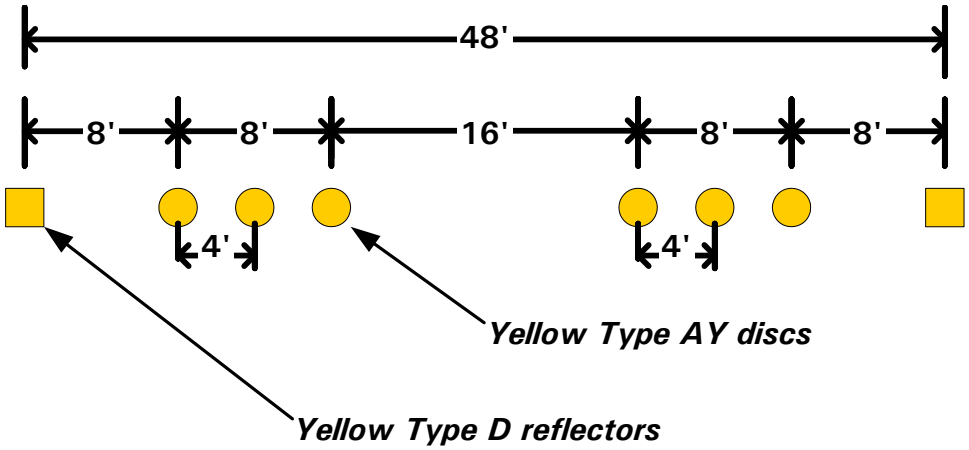


Figure 3. California Standard Plan A20A, Detail 4

A. Test Validity

1. Speed

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

2. Lateral Velocity

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

3. Yaw Rate

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

C. Pass/Fail Criteria

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

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

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

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

D. Instrumentation

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

Table 2. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	0.5 psi 3.45 kPa	Ashcroft, D1005PS	17042707002	By: DRI Date: 6/21/2018 Due: 6/21/2019
Platform Scales	Vehicle Total, Wheel, and Axle Load	8000 lb 35.6 kN	±1.0% of applied load	Intercomp, SWII	1110M206352	By: DRI Date: 1/3/2019 Due: 1/3/2020
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	NA
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots Accel: ±100 m/s^2 Angular Rate: ±100 deg/s Angular Disp: ±180 deg	Position: ±2 cm Velocity: 0.05 km/h Accel: ≤ 0.01% of full range Angular Rate: ≤ 0.01% of full range Roll/Pitch Angle: ±0.03 deg Heading Angle: ±0.1 deg	Oxford Technical Solutions (OXTS), Inertial+	2182	By: Oxford Technical Solutions1 Date: 10/16/2017 Due: 10/16/2019
Real-Time Calculation of Position and Velocity Relative to Lane Markings	Distance and velocity to lane markings	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	NA

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

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/2/2019 Due: 1/2/2020

Type	Description	Mfr, Model	Serial Number
Data Acquisition System	Data acquisition is achieved using a dSPACE MicroAutoBox II Data from the Oxford IMU, including Longitudinal, Lateral, and Vertical Acceleration, Roll, Yaw, and Pitch Rate, Forward and Lateral Velocity, Roll and Pitch Angle are sent over Ethernet to the MicroAutoBox. The Oxford IMUs are calibrated per the manufacturer's recommended schedule (listed above).	D-Space Micro-Autobox II 1401/1513	
		Base Board	549068
		I/O Board	588523

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

Table 3. Audible and Tactile Warning Filter Parameters

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

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

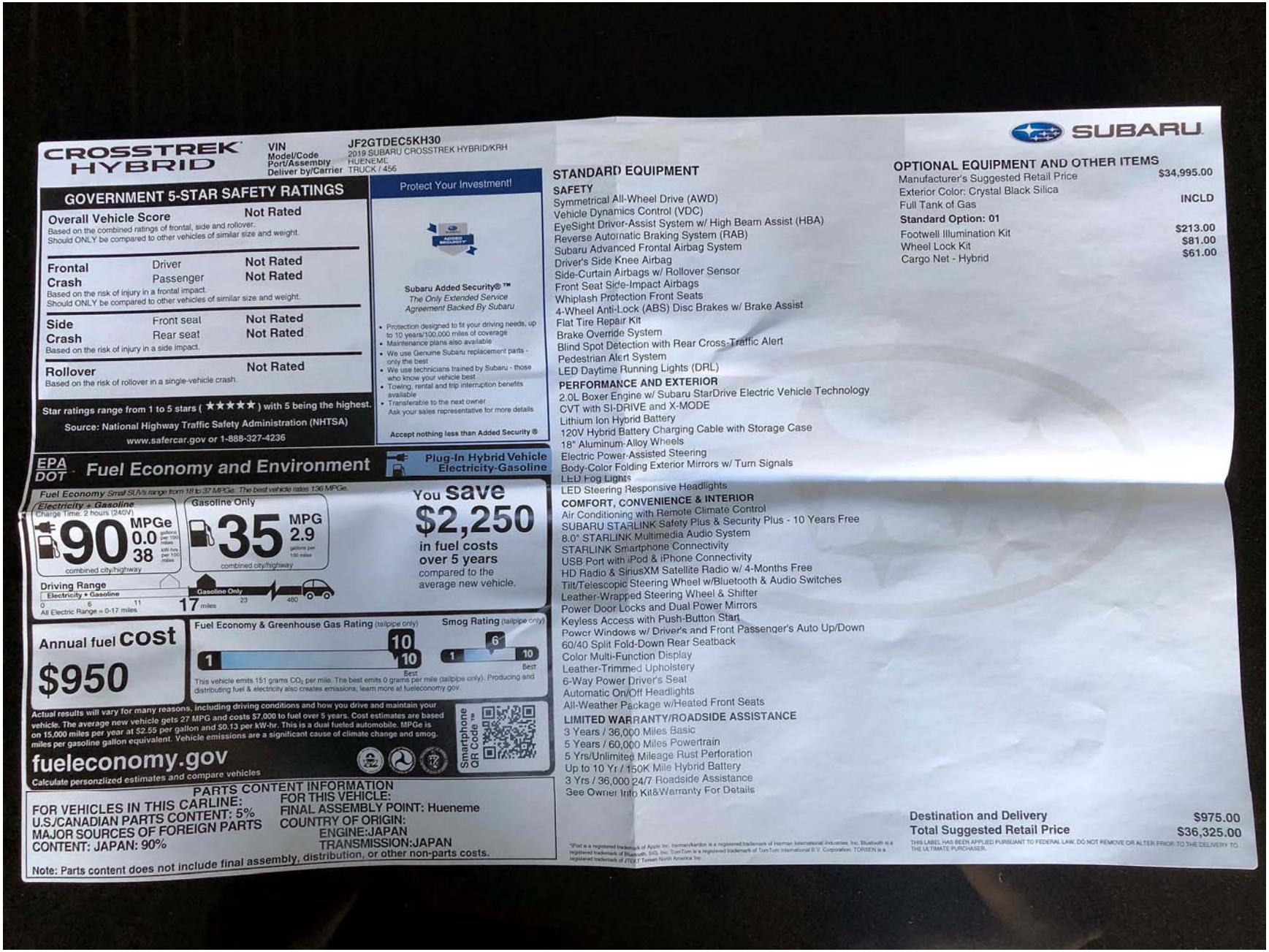


Figure A3. Window Sticker (Monroney Label)

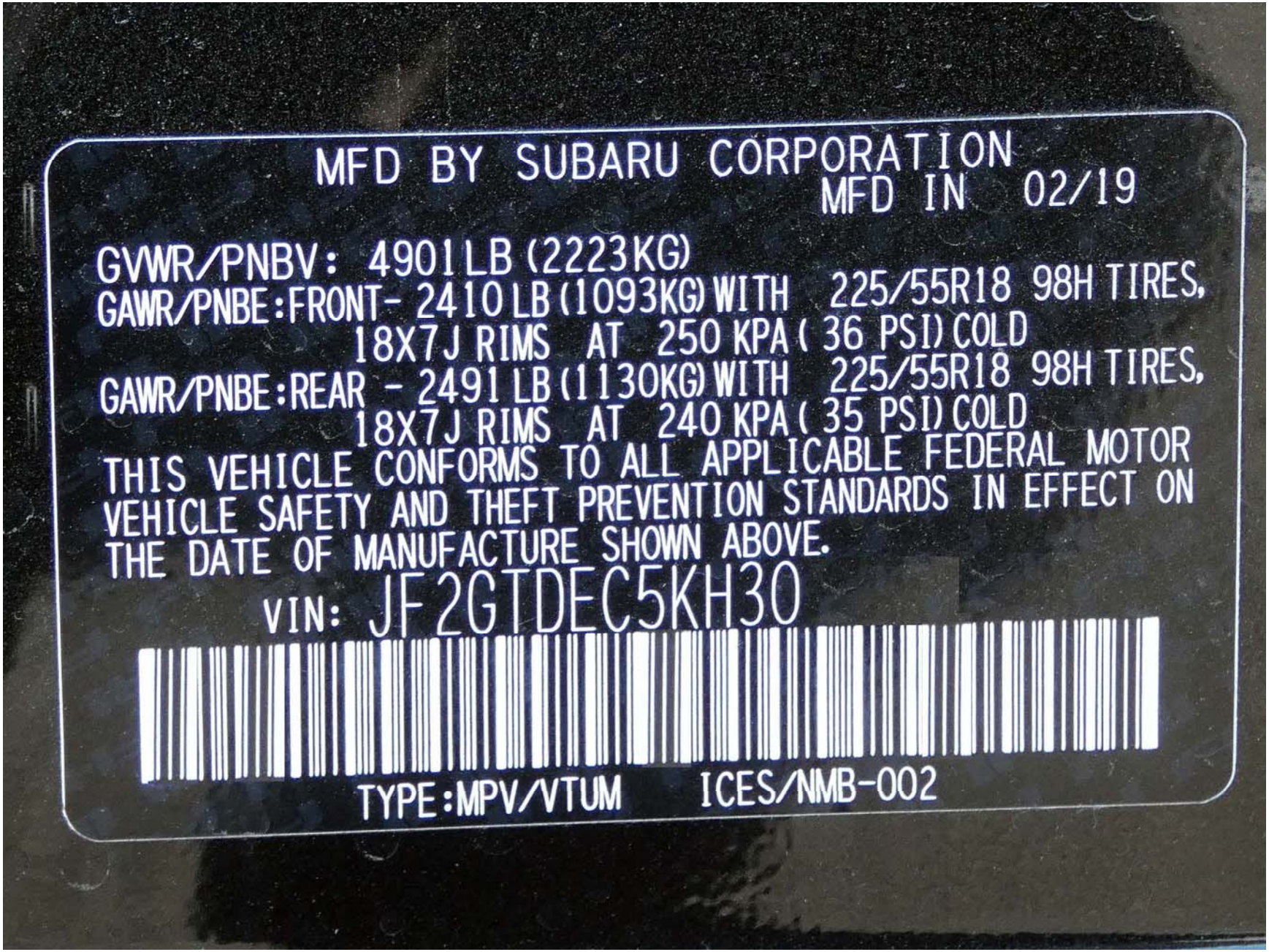


Figure A4. Vehicle Certification Label

Figure A5. Tire Placard

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

Figure A7. Computer Installed in Test Vehicle

Figure A8. Sensor for Detecting Auditory Alerts

Figure A9. Sensos for Detecting Visual Alerts

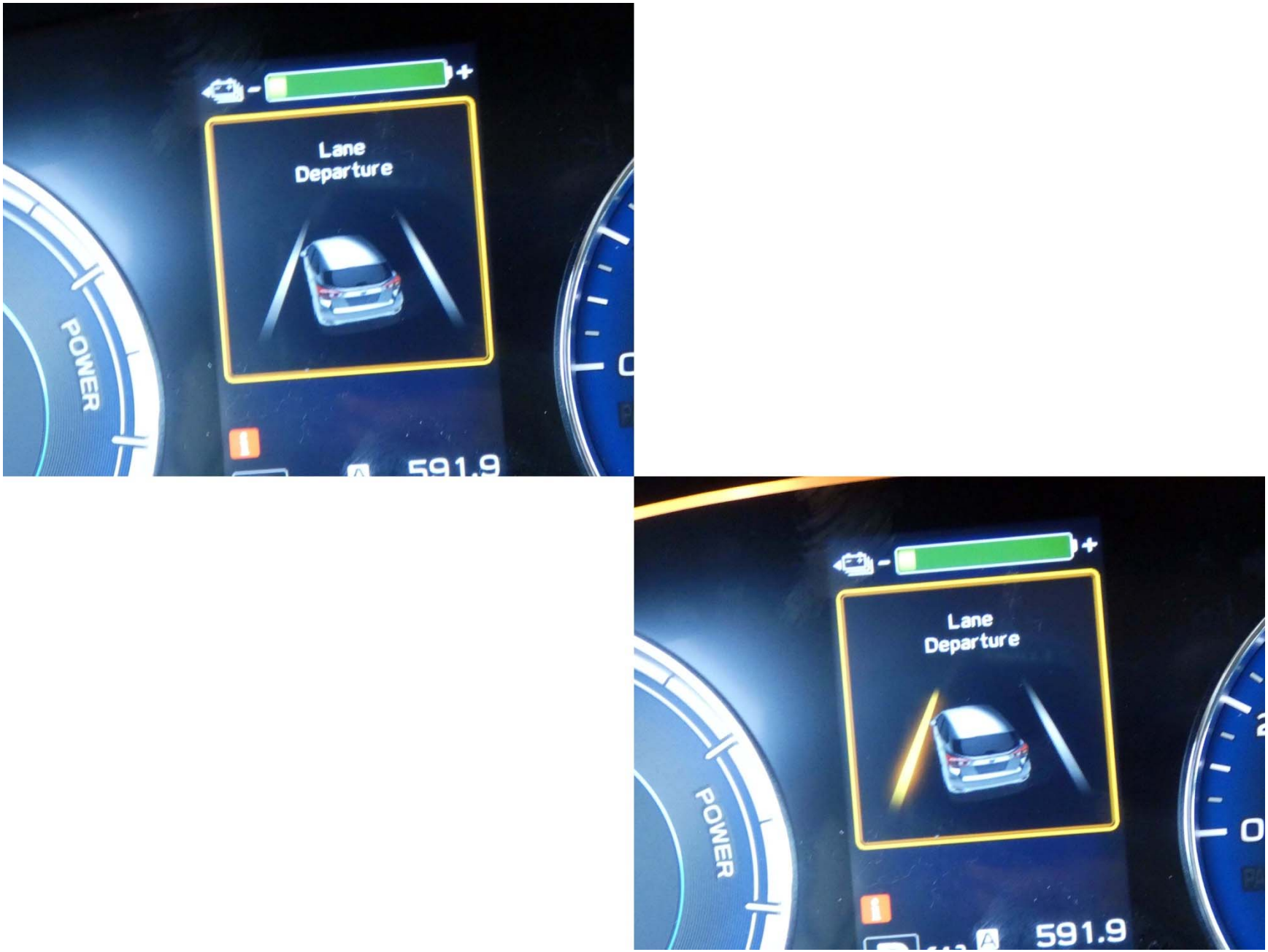


Figure A10. LDW Visual Alert

Figure A11. LDW On/Off Switcht

Figure A12. LDW Off Display

APPENDIX B

Excerpts from Owner’s Manual

EyeSight Functions

EyeSight includes the following functions.

■ Pre-Collision Braking System

This function uses a following distance warning feature to warn the driver to take evasive action when there is the possibility of a collision with a vehicle or obstacle in front of you. If the driver does not take evasive action, the brakes are applied automatically to help reduce vehicle collision damage or, if possible, help prevent a collision.
⇒ Refer to page 26.

■ Adaptive Cruise Control

This function maintains the set vehicle speed and when there is a vehicle in front in the same traffic lane, it follows the speed of the vehicle in front up to the maximum of the set vehicle speed.
⇒ Refer to page 41.

■ Lane Keep Assist

This function helps suppress lane drifting by detecting lane markings (e.g., white lines) on highways and roads, and by assisting steering operation.
⇒ Refer to page 67.

■ Pre-Collision Throttle Management

This function reduces accidental forward movement caused by the select lever being placed in the wrong position or the accelerator pedal being accidentally depressed, or depressed too strongly.
⇒ Refer to page 77.

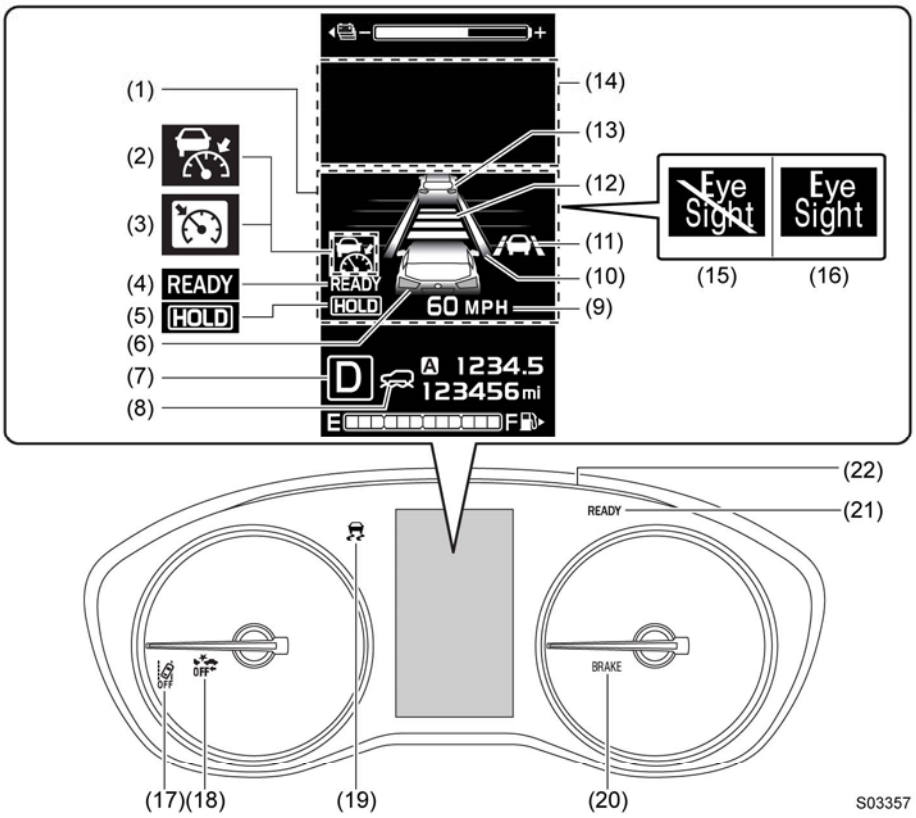
■ Lane Departure Warning

This function warns the driver when the vehicle is about to drift off the road.
⇒ Refer to page 83.

■ Lane Sway Warning

This function warns the driver when it detects vehicle drifting caused by driver fatigue, failure to concentrate on the road, inattention, strong crosswinds or other factors.
⇒ Refer to page 87.

Instrument panel display layout



* Display units can be changed in the Screen Settings. For details, refer to the Owner's Manual for your vehicle.

(1) EyeSight display area
(2) Adaptive Cruise Control indicator
(3) Conventional Cruise Control indicator
(4) READY indicator
(5) HOLD indicator
(6) Your vehicle indicator
(7) Select lever indicator
(8) X-MODE indicator
(9) Set vehicle speed display
(10) Lane indicator
(11) Lane Keep Assist indicator
(12) Following distance setting indicator
(13) Lead vehicle indicator
(14) Warning screen area
(15) EyeSight temporary stop indicator (white)
(16) EyeSight warning indicator (yellow)
(17) Lane Departure Warning OFF indicator light
(18) Pre-Collision Braking System OFF indicator light
(19) Vehicle Dynamics Control warning light
(20) Brake system warning light
(21) Hybrid READY indicator
(22) Driver Assist indicator

■ EyeSight warning indicator (yellow)

- This indicator illuminates or flashes when a malfunction occurs in the EyeSight system.
- When it is illuminated or flashing, none of the EyeSight functions can be used (including Adaptive Cruise Control and the Pre-Collision Braking System, etc.).
  ⇒ Refer to page 107.

■ EyeSight temporary stop indicator (white)

- This indicator illuminates when the EyeSight system is temporarily stopped.
- When the ignition switch is placed in the ON position, it will illuminate if the (CRUISE) switch or (Lane Keep Assist) switch is set to ON within approximately 7 seconds of the hybrid system starting. It turns off when approximately 7 seconds have elapsed since the hybrid system started.
- When it is illuminated, none of the EyeSight functions can be used except for Conventional Cruise Control.
  ⇒ Refer to page 108.

■ X-MODE indicator

(X-MODE indicator) illuminates when the X-MODE is ON.

⇒ Refer to the vehicle Owner's Manual for details.

■ Lane Departure Warning OFF indicator light

- This indicator illuminates when the Lane Departure Warning and Lane Sway Warning are off.
- It also illuminates when the ignition switch is turned to the ON position. Approximately 7 seconds after the hybrid system starts, the Lane Departure Warning OFF indicator light will turn off or remain illuminated depending on the current status (ON or OFF).

⇒ Refer to page 86.

■ Pre-Collision Braking System OFF indicator light

- Illuminates when the Pre-Collision Braking System and Pre-Collision Throttle Management are off.
- It also illuminates when the ignition switch is turned to the ON position, and then turns off approximately 7 seconds after the hybrid system starts.

⇒ Refer to page 40.

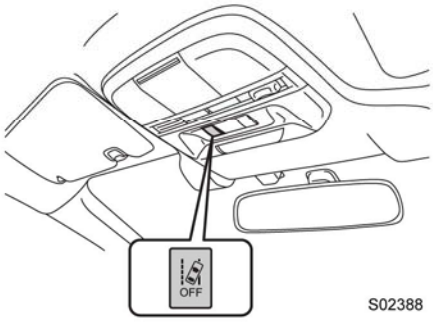
■ Lane indicator

This indicator illuminates in gray when the (Lane Keep Assist) switch is pressed. When the Lane Keep Assist is operational or operating, this indicator illuminates in white.

⇒ Refer to page 72.

■ (Lane Departure Warning OFF) switch

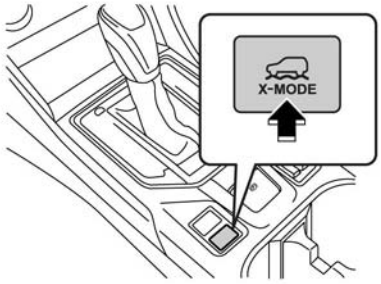
Press and hold this switch for approximately 2 seconds or longer to turn off the Lane Departure Warning and Lane Sway Warning functions.
When these functions are off, the Lane Departure Warning OFF indicator light on the instrument panel illuminates.
Press and hold the switch again to turn on the Lane Departure Warning and Lane Sway Warning functions. This turns off the Lane Departure Warning OFF indicator light.
⇒ Refer to page 85.



S02388

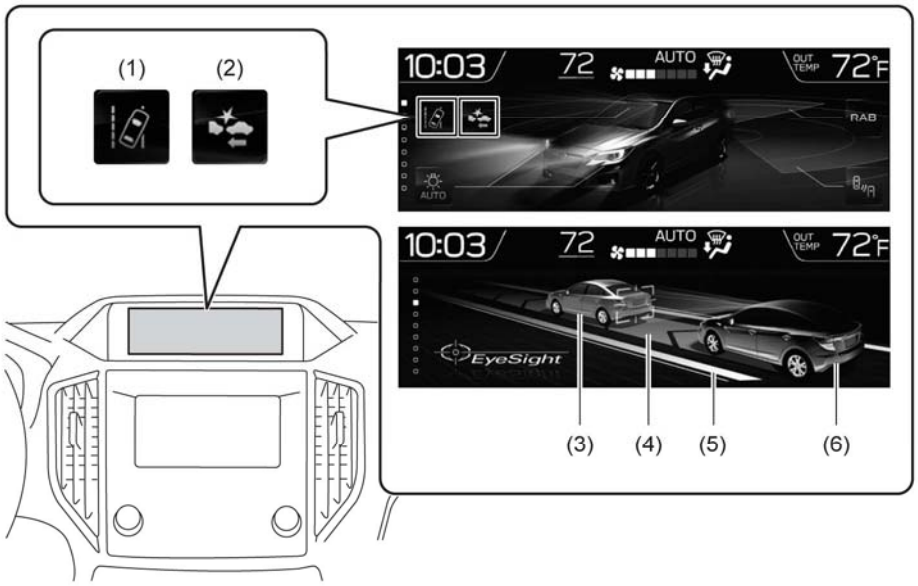
■X-MODE switch

Switches the X-MODE on/off.
While the X-MODE is activated, the X-MODE indicator illuminates.
When the X-MODE is deactivated,
the X-MODE indicator will turn off.
⇒ Refer to the vehicle Owner's Manual for details.



S03265

■Multi-function display



S03410

(1) Lane Departure/Sway Warning indicator
(2) Pre-Collision Braking System indicator
(3) Lead vehicle indicator
(4) Lane indicator
(5) Road line indicator
(6) Your own vehicle indicator

●Lane Departure/Sway Warning indicator

This indicator illuminates when the Lane Departure Warning and Lane Sway Warning are ON.

●Pre-Collision Braking System indicator

This indicator illuminates when the Pre-Collision Braking System is ON.

●Lead vehicle indicator

When the Adaptive Cruise Control is ON, and a vehicle is in front of you, the lead vehicle indicator is displayed. The lead vehicle indicator displays an image of the distance between your vehicle and the vehicle in front of you.

CAUTION

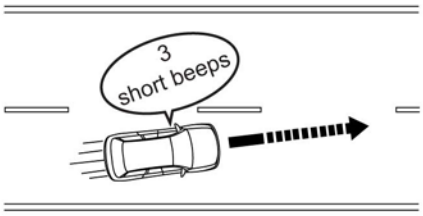
- When shifting the select lever to the [N] or [B] position, Adaptive Cruise Control will be automatically canceled. Do not shift the lever to the [N] position unless in an emergency. Otherwise the engine brake may not operate, which could cause an accident.
- When a vehicle stops, if an automatic cancellation is performed by the system before starting the stay-stopped function (⇒ refer to page 58), the electronic parking brake will not operate.

NOTE

- If the EyeSight operation has temporarily stopped, the Pre-Collision Braking System OFF indicator light and Lane Departure Warning OFF indicator light illuminate, and the EyeSight temporary stop indicator is displayed on the combination meter display.
  ⇒ Refer to page 108.
- If EyeSight is malfunctioning, the EyeSight warning indicator is displayed on the combination meter display, and the Pre-Collision Braking System OFF indicator light and Lane Departure Warning OFF indicator light will also illuminate. If this occurs, stop the vehicle in a safe location and then turn off the hybrid system and restart it. If the indicators remain illuminated after restarting the hybrid system, Adaptive Cruise Control cannot be used. This will not interfere with ordinary driving; however the system should be inspected by a SUBARU dealer as soon as possible.
  ⇒ Refer to page 107.
- When the operation of Adaptive Cruise Control has been automatically canceled, perform the Adaptive Cruise Control setting operation again after the condition that caused the cancellation has been corrected. If the Adaptive Cruise Control function cannot be activated even after the condition has been corrected, EyeSight may be malfunctioning. This will not interfere with ordinary driving; however contact a SUBARU dealer and have the system inspected.

Lane Departure Warning

When vehicle speed is approximately 30 MPH (50 km/h) or more, this function warns the driver if the system detects that the vehicle is likely to depart the traffic lane.
When the Lane Departure Warning activates, a buzzer sounds 3 short beeps, and an interruption screen will be displayed.



S02416

S02408

*: The illustration depicts a vehicle about to cross the left line.

WARNING

Lane Departure Warning will not operate in all conditions. It also will not automatically return the vehicle to the original lane. If the driver relies only on the Lane Departure Warning to keep the vehicle in the lane, lane departure may occur, resulting in an accident.
The Lane Departure Warning activates when it detects lane markings. However, it is not a function which can detect the edge of a road (shoulders or side ditches, etc.) and warn the driver.

CAUTION

In the following situations, the Lane Departure Warning may not activate:

- Vehicle speed is approximately 30 MPH (50 km/h) or less.
- When the steering wheel is turned significantly to either side
- When the vehicle is driving around a curve whose radius is 0.18 miles (300 m) or smaller.
- When the brake pedal is depressed or immediately after it is depressed
- When the following distance behind a vehicle in front is short
- While the turn signal is operating
- For approximately 4 seconds after the turn signal lever has returned to its original position
- When the vehicle has not returned to the inside of the lane after the Lane Departure Warning has activated
- The lane is narrow.
- When it is difficult for the camera to detect lane markings
  - There are no lane markings or they are very worn.
  - The lane markings are yellow.
  - It is difficult to detect lane markings as they are similar in color to the road surface.
  - The lane markings are narrow.

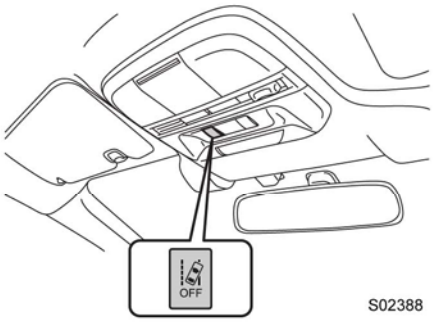
NOTE

- The following situations may cause incorrect lane detection and a faulty Lane Departure Warning to occur.
  - When there are tire tracks on a wet road or snow-covered road
  - When there are boundaries between snow and asphalt, or marks from road repair, etc.
  - When there are the shadows of guardrails
  - When lane markings are drawn in double
  - When there are some lane markings left from roadwork or markings from the previous road.
- When the Lane Departure Warning OFF indicator light is illuminated, the Lane Departure Warning is inactive.
  ⇒ Refer to page 86.

Turning off Lane Departure Warning

Press and hold the Lane Departure Warning OFF switch for approximately 2 seconds or longer to turn off the Lane Departure Warning. When 1 short beep sound emits, this function is turned off and the Lane Departure Warning OFF indicator light on the instrument panel will illuminate.

To turn the function back on, press and hold the Lane Departure Warning OFF switch again for approximately 2 seconds or longer. When the function is turned on, the Lane Departure Warning OFF indicator light turns off.



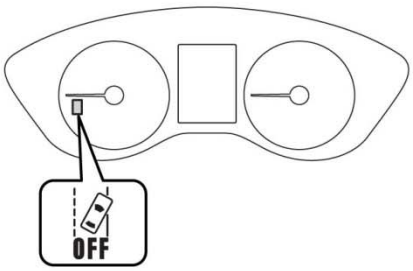
S02388

NOTE

- When the Lane Departure Warning is turned off, the Lane Sway Warning is also turned off.
- The ON/OFF status of the Lane Departure Warning is restored when you restart the hybrid system.

■Lane Departure Warning OFF indicator light

This indicator illuminates when the ignition switch is turned to the ON position, and then approximately 7 seconds after the hybrid system starts, it turns off or remains illuminated depending on the current status (ON or OFF). It turns on when the Lane Departure Warning is turned off.



S02409

It also illuminates under the following conditions.

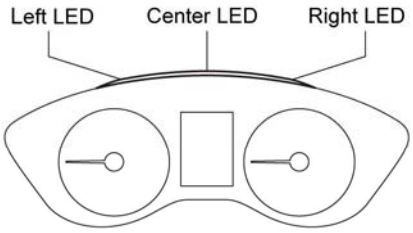
- When the EyeSight system has a malfunction.
  ⇒ Refer to page 107.
- When the EyeSight system has stopped temporarily.
  ⇒ Refer to page 108.

Driver Assist indicator

The operating status of the EyeSight system is indicated at the top of the combination meter.
This allows the driver to remain aware of warnings and displayed information without taking their eyes off the surrounding driving environment.
The LED indicators can be set to ON/OFF. Refer to “Customizing functions” for setting details.
⇒ Refer to page 110.

Driver Assist indicator operation

To inform the driver of the operation condition of EyeSight while driving, the LED indicators illuminate or flash at the top of the combination meter.



S03365

Display	Condition
Red indicators flash simultaneously (3 indicators)	The Following Distance Warning, Pre-Collision Braking System (first braking or secondary braking), Obstacle Detected Warning or Pre-Collision Throttle Management is operating.
Yellow indicator flashes (one side)	The Lane Departure Warning (The side where the vehicle has left its lane flashes, and the side that has not left its lane illuminates.) is operating.
Yellow indicators flash (alternately)	Lane Sway Warning is operating.
Yellow indicators flash simultaneously	Steering wheel operation could not be detected for a certain period of time.
Green indicator illuminates	A vehicle is detected ahead while Adaptive Cruise Control is operating.

List of buzzer sounds

Buzzer sound	Status	Reference page
Single continuous beep	Pre-Collision Braking System: Secondary Braking is active.	⇒ Refer to page 35.
1 short beep and 1 long beep	Adaptive Cruise Control or Conventional Cruise Control is canceled automatically.	⇒ Refer to pages 62 and 102.
	The stay-stopped function is canceled and the electronic parking brake is automatically applied.	⇒ Refer to page 60.
	Lane Keep Assist is canceled automatically.	⇒ Refer to page 75.
Repeated short beeps	Pre-Collision Braking System: First Braking is active.	⇒ Refer to page 35.
	Pre-Collision Braking System: The following distance warning is active.	
	The “Obstacle Detected” warning from Adaptive Cruise Control is active.	⇒ Refer to page 65.
	Pre-Collision Throttle Management is active.	⇒ Refer to page 77.
3 short beeps	The Lane Departure Warning is active.	⇒ Refer to page 83.
	The Lane Sway Warning is active.	⇒ Refer to page 87.
5 intermittent beeps, 1 short beep and 1 long beep	The stay-stopped function of Adaptive Cruise Control continued for 2 minutes and the electronic parking brake was automatically applied.	⇒ Refer to page 60.
3 short beeps and 1 long beep	Pre-Collision Braking System: Just before the automatic brake is slowly released by the system after the vehicle is stopped by the pre-collision braking.	⇒ Refer to page 26.
	Adaptive Cruise Control System: Just before the automatic brake is released by the system after the vehicle is stopped by the Adaptive Cruise Control System. Adaptive Cruise Control System will stop the vehicle according to the lead vehicle stops.	⇒ Refer to page 41.

List of buzzer sounds

Buzzer sound	Status	Reference page
1 short beep	Either of the following occurred while Adaptive Cruise Control was set. - A vehicle in front is detected*. - A vehicle in front is no longer detected*.	⇒ Refer to page 51.
	The cruise control mode (Adaptive Cruise Control ⟷ Conventional Cruise Control) is changed.	⇒ Refer to pages 96 and 98.
	EyeSight is malfunctioning.	⇒ Refer to pages 107 and 108.
	EyeSight operation is temporarily stopped.	
	Pre-Collision Braking System and Pre-Collision Throttle Management are turned on/off.	⇒ Refer to pages 39 and 82.
	The Lane Departure Warning and the Lane Sway Warning are turned on/off.	⇒ Refer to pages 85 and 89.
Two-tone beep	Lead Vehicle Start Alert is active*.	⇒ Refer to page 90.

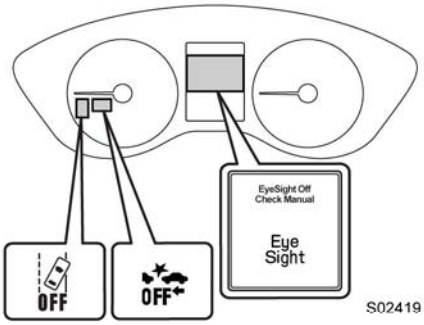
*: The buzzer that indicates when a lead vehicle is detected or when it is no longer detected (Lead Vehicle Acquisition Sound), as well as the Lead Vehicle Start Alert can be turned on or off.
⇒ Refer to page 110.

EyeSight malfunction and temporary stop

If a malfunction is detected in the EyeSight system, the indicators in the instrument panel and the combination meter display inform the driver of the malfunction. Check the displayed contents and take the appropriate action.

■Malfunction (including position/angle misalignment of stereo camera)

The buzzer sounds 1 short beep and the EyeSight warning indicator (yellow) flashes or illuminates. At the same time, the Pre-Collision Braking System OFF indicator light and the Lane Departure Warning OFF indicator light will illuminate. A message will also be displayed on the combination meter display.



S02419

Displayed screen	Cause	Action
EyeSight Off Check Manual S03005	An EyeSight malfunction or position/angle misalignment of stereo camera has occurred.	Inspection and adjustment is necessary. Contact your SUBARU dealer.

NOTE

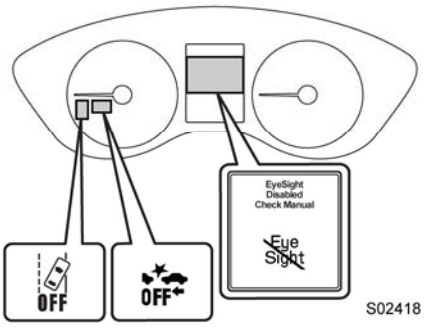
- If the EyeSight warning indicator illuminates or flashes, stop the vehicle in a safe location, turn off the hybrid system, and then restart it.
- If the indicator continues illuminating or flashing even after the hybrid system has been restarted, the EyeSight system has a malfunction. In this case, all EyeSight functions will be stopped. Normal driving will still be possible. However, contact a SUBARU dealer for an inspection.
- If the EyeSight warning indicator illuminates or flashes, the RAB system will not operate.

■Temporary stop

The buzzer will sound one short beep, and the EyeSight temporary stop indicator (white), Pre-Collision Braking System OFF indicator light and Lane Departure Warning OFF indicator light will illuminate at the same time.

A message will also be displayed on the combination meter display.

When the cause has been resolved, temporary stop will be canceled and the EyeSight system will automatically restart.

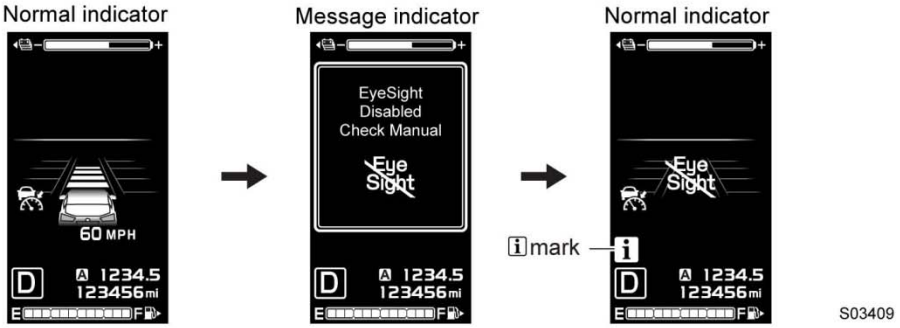


S02418

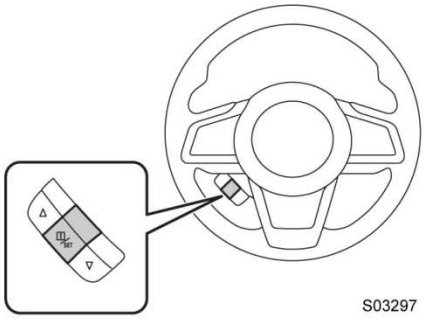
Displayed screen	Cause	Action
EyeSight Disabled No Camera View S02996	It is difficult for the stereo camera to detect objects in front • The windshield is dirty or fogged up • Poor weather conditions • Strong light from the front	• Clean the windshield. • In poor weather conditions or if there is strong light from the front, the EyeSight system will restart once you have driven your vehicle for a period of time and the conditions affecting the system have improved. If the system does not restart, even after the conditions have improved and a period of time has elapsed, contact your SUBARU dealer for an inspection.
EyeSight Disabled Temp Range S02997	In low or high temperatures	The system will restart once the temperature is within the operational range of the EyeSight system. If the system does not restart, even when the temperature inside the vehicle is within the operational range, contact your SUBARU dealer for an inspection.

Message screen list

If an EyeSight warning or malfunction is detected, a message will be displayed on the combination meter display. Depending on the message, a buzzer will sound at the same time.



If a message is displayed, refer to the message list and take the appropriate action. While the mark is illuminated, you can pull the (Info)/SET switch to display the message again.



■Message screen list (precautions and notices)

Item	Displayed screen	ℹ mark	Reference page
Pre-Collision Braking System		None	⇒ Refer to page 35.
The “Obstacle Detected” warning	Obstacle Detected S02999	None	⇒ Refer to page 65.
Pre-Collision Throttle Management		None	⇒ Refer to page 77.
Apply Brake	Apply Brake To Hold Position S03000	None	⇒ Refer to page 35.
Lane Departure Warning	Lane Departure S03002	None	⇒ Refer to page 83.
Lane Sway Warning	Stay Alert S03003	None	⇒ Refer to page 87.
Lead Vehicle Start Alert	Vehicle Ahead Has Moved S03004	None	⇒ Refer to page 90.
Steering operation is not detected by Lane Keep Assist	Keep Hands On Steering Wheel S03001	None	⇒ Refer to page 75.
Adaptive Cruise Control/Conventional Cruise Control automatic cancellation (when the grade of the road is very steep)	Steep Slope S02425	None	⇒ Refer to pages 62 and 102.

APPENDIX C

Run Log

Subject Vehicle: **2019 Subaru Crosstrek Hybrid**

Test Date: **6/4/2019**

Driver: **J. Robel**

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**	N				System off
2			N				Lateral Velocity, SV Speed
3			Y	0.17	-0.18	Pass	
4			Y	0.00	-0.41	Pass	
5			Y	-0.02	-0.25	Pass	
6			Y	0.06	-0.33	Pass	
7			Y	0.02	-0.29	Pass	
8			N				SV Speed
9			N				SV Speed
10			Y	0.03	-0.38	Pass	
11			Y	0.05	-0.36	Pass	
12	**Solid**	**Right**	N				SV Speed
13			N				Yaw Rate
14			N				Cone strike
15			Y	0.47	0.29	Pass	
16			N				SV Speed
17			Y	0.43	0.07	Pass	
18			Y	0.56	0.25	Pass	
19			Y	0.61	0.45	Pass	
20			N				SV Speed
21			Y	0.54	0.32	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Auditory Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
22			Y	0.61	0.40	Pass	
23			Y	0.38	0.27	Pass	
24	**Dashed**	**Right**	Y	0.41	0.18	Pass	
25			N				SV Speed
26			N				Cone Strike
27			Y	0.40	0.14	Pass	
28			Y	0.31	0.21	Pass	
29			N				SV Speed
30			Y	0.32	0.14	Pass	
31			Y	0.33	0.23	Pass	
32			N				Cone Strike
33			Y	0.20	-0.12	Pass	
34			Y	0.29	0.01	Pass	
35	**Dashed**	**Left**	Y	-0.18	-0.33	Pass	
36			Y	-0.09	-0.35	Pass	
37			Y	0.09	-0.32	Pass	
38			Y	-0.18	-0.45	Pass	
39			Y	-0.18	-0.61	Pass	
40			Y	0.00	-0.35	Pass	
41			Y	0.00	-0.24	Pass	
42	**Botts**	**Left**	N				Lat Lane Velocity
43			N				SV Speed, Lat Lane Velocity, Yaw Rate
44			N				SV Speed
45			N				SV Speed
46			Y	0.19	-0.06	Pass	
47			N				SV Speed

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Auditory Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
48			N				Cone Strike
49			Y	0.13	-0.06	Pass	
50			Y	0.21	-0.01	Pass	
51			Y	0.16	-0.14	Pass	
52			Y	0.08	-0.14	Pass	
53			Y	0.13	-0.06	Pass	
54			Y	0.16	-0.03	Pass	
55	**Botts**	**Right**	Y	0.11	-0.14	Pass	
56			Y	0.08	-0.10	Pass	
57			Y	0.05	-0.24	Pass	
58			Y	0.14	-0.01	Pass	
59			Y	0.19	0.00	Pass	
60			Y	0.19	0.04	Pass	
61			Y	0.14	-0.02	Pass	

APPENDIX D

Time History Plots

LIST OF FIGURES

Description of Time History Plots

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

Time History Plot Description

Time history figures include the following sub-plots:

- Warning – Indicates timing of warning issued by LDW system. Depending on the type of LDW alert or instrumentation used to measure the alert, this can be any of the following:
    - Filtered and rectified sound signal
    - Filtered and rectified acceleration (e.g., steering wheel vibration)
    - Light sensor signal
    - Discrete on/off value
- Speed (mph) – Speed of the Subject Vehicle
- Yaw Rate (deg/sec) – Yaw rate of the Subject Vehicle
- Distance to Lane Edge (ft) – Lateral distance (in lane coordinates) from the outer front tire bulge to the inside edge of the lane marking of interest for a given test (a positive value indicates the vehicle is completely within the lane while a negative value indicates that the outer front tire bulge has crossed over the inner lane marking edge). The distance to the lane edge at the moment the LDW alert is issued, is displayed to the right of subplot.
- Lateral Lane Velocity (ft/sec) – Lateral velocity (in lane coordinates) of the outer front tire bulge
- Bird's Eye View – Indicates the position of the Subject Vehicle with respect to the lane marking of interest for a given test. Green rectangles represent the Subject Vehicle's position at approximately 2 second intervals, while the yellow rectangle indicates the position of the Subject Vehicle at the time of LDW warning issuance. **Note:** The Bird's Eye View representation is not synchronized to the time history plots above it. It is a spatial, not temporal, representation.

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

Envelopes and Thresholds

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

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

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

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

Color Codes

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

Color codes can be broken into three categories:

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

1. Validation envelope and threshold color codes:
   - Green envelope = time varying data must be within the envelope at all times in order to be valid
   - Yellow envelope = time varying data must be within limits at right end
   - Black threshold (Solid) = time varying data must not exceed this threshold in order to be valid

- Black threshold (Dashed) = for reference only – this can include warning level thresholds which are used to determine the timing of the alert

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

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

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

Notes

In some cases, the red letters “NG” are shown at the right side of a plot. This indicates “No Good”, i.e. a run exceeded some boundary criteria. This indicator is usually used during testing to screen whether or not a test run is valid. While it is the case that invalid runs are not presented in this appendix there are circumstances where an NG plot may be presented. This can happen when the vehicle is being evaluated on more than one alert. A test run is valid and passing if it is valid and passing on any of its alerts. It need not pass based on all alerts. A typical case is where a run is valid and passing on the basis of an audible alert, but fails based on a late visual alert. The validity criteria are based on the alert timing so in the time between the valid and passing audible alert and the late visual alert, the vehicle may have exceeded some validity criteria, e.g. the lane lateral velocity criteria. In such a case the audible alert plot will indicate valid and passing and the visual alert plot will indicate failing and invalid (NG). For the case described, if the lateral velocity criteria were not exceeded in the time between the audible and visual alerts, the visual plot would indicate valid and failing.

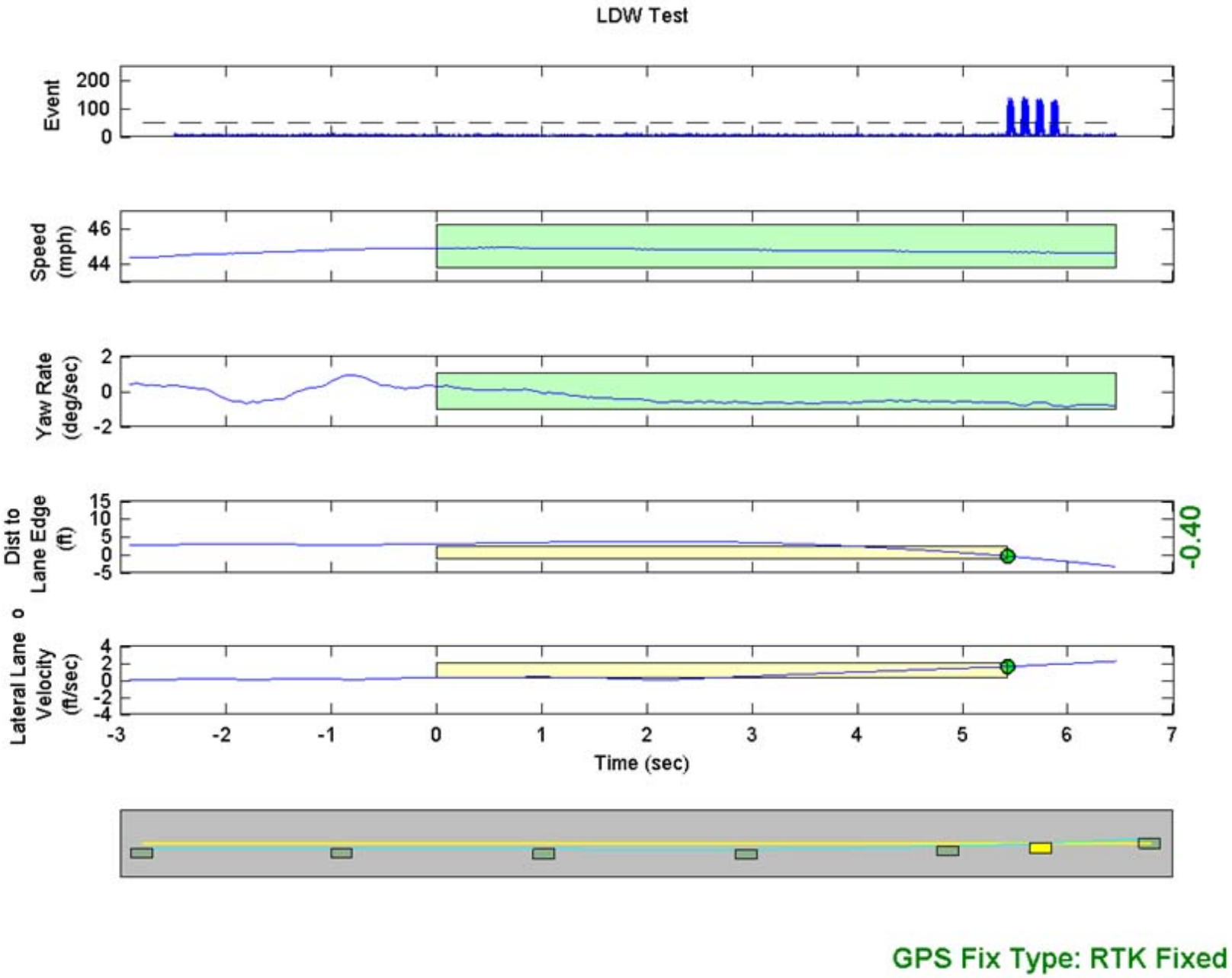


Figure D1. Example Time History for Lane Departure Warning Test, Passing

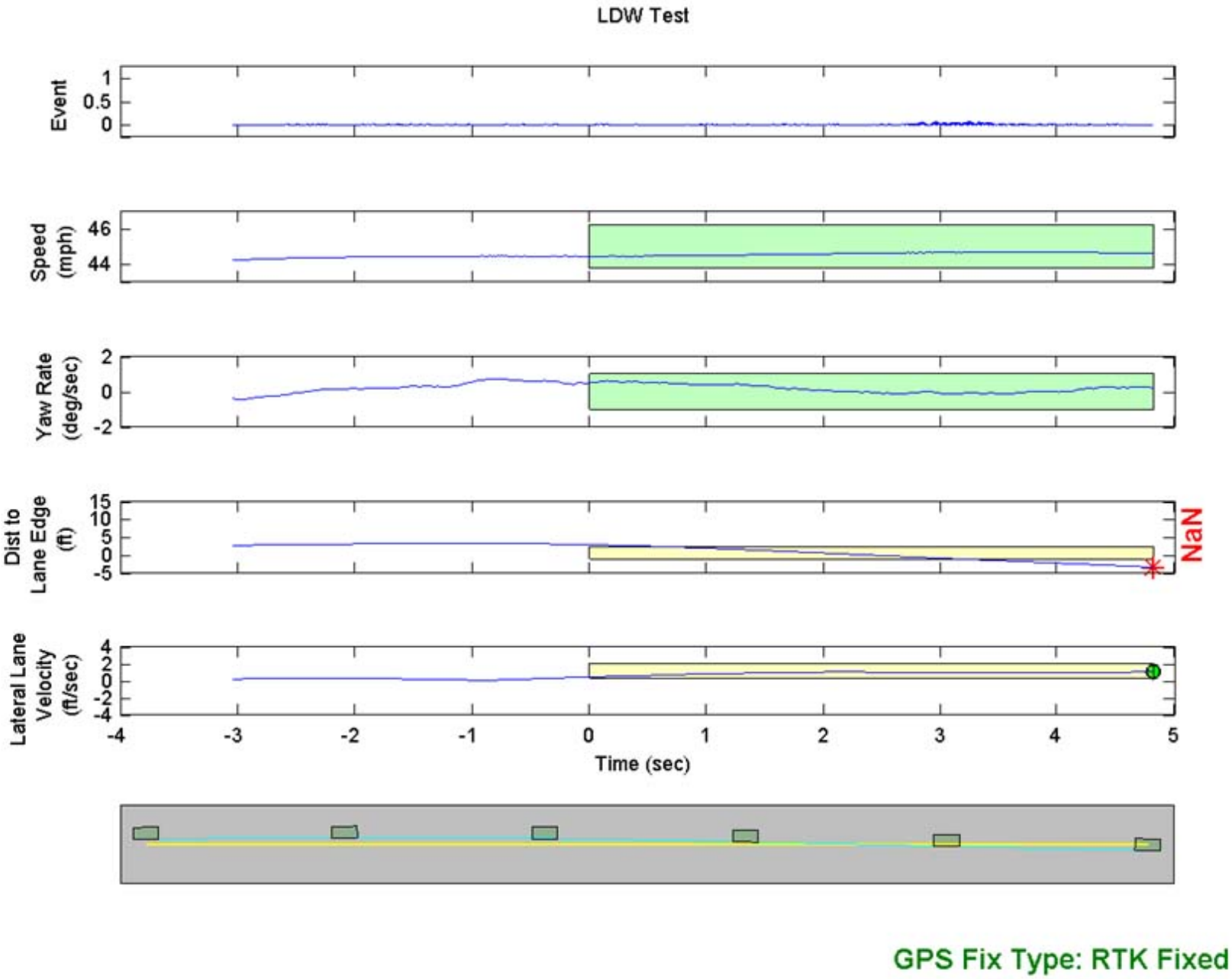


Figure D2. Example Time History for Lane Departure Warning Test, Failing, No Warning Issued

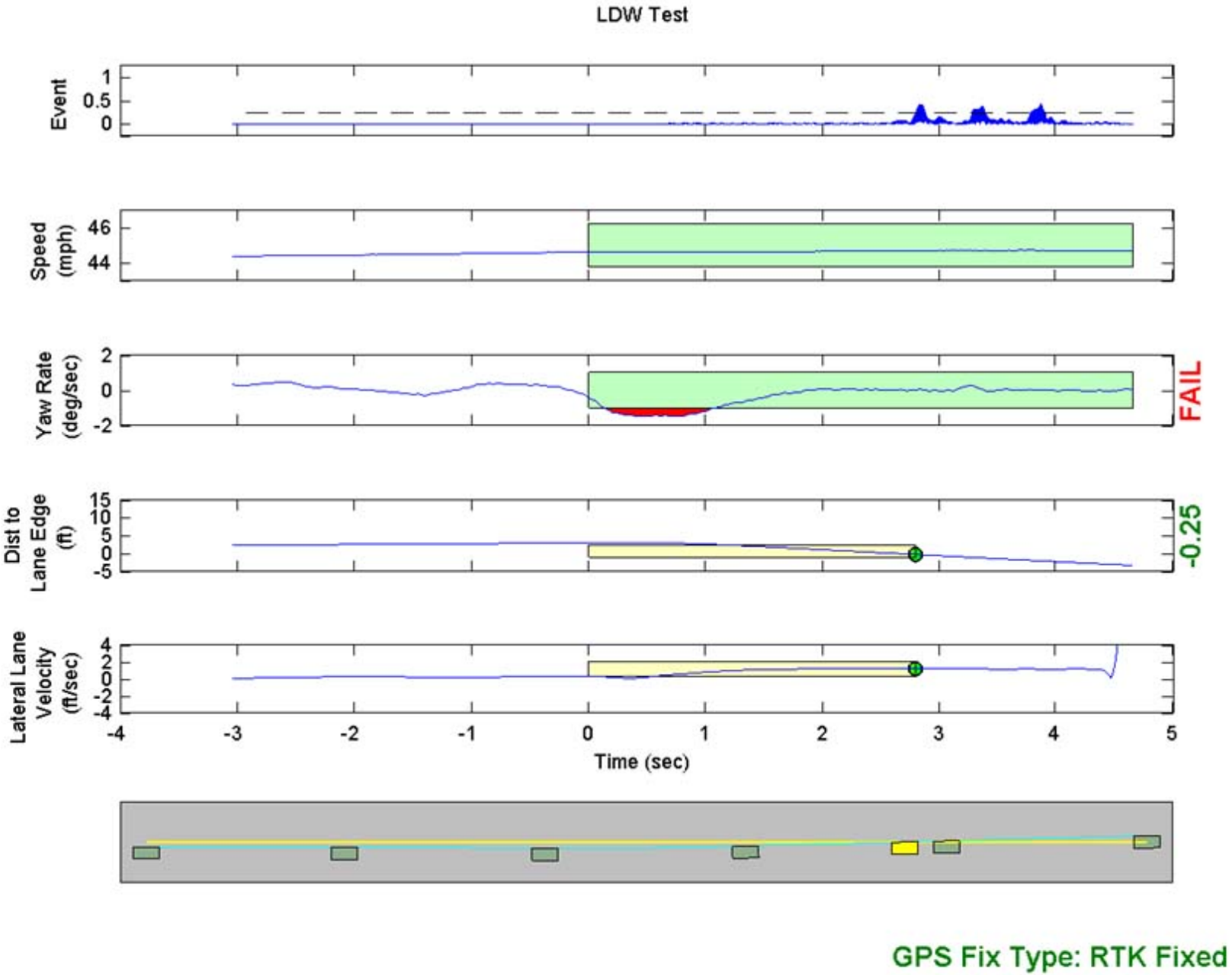


Figure D3. Example Time History for Lane Departure Warning Test, Invalid Run Due to Subject Vehicle Yaw Rate

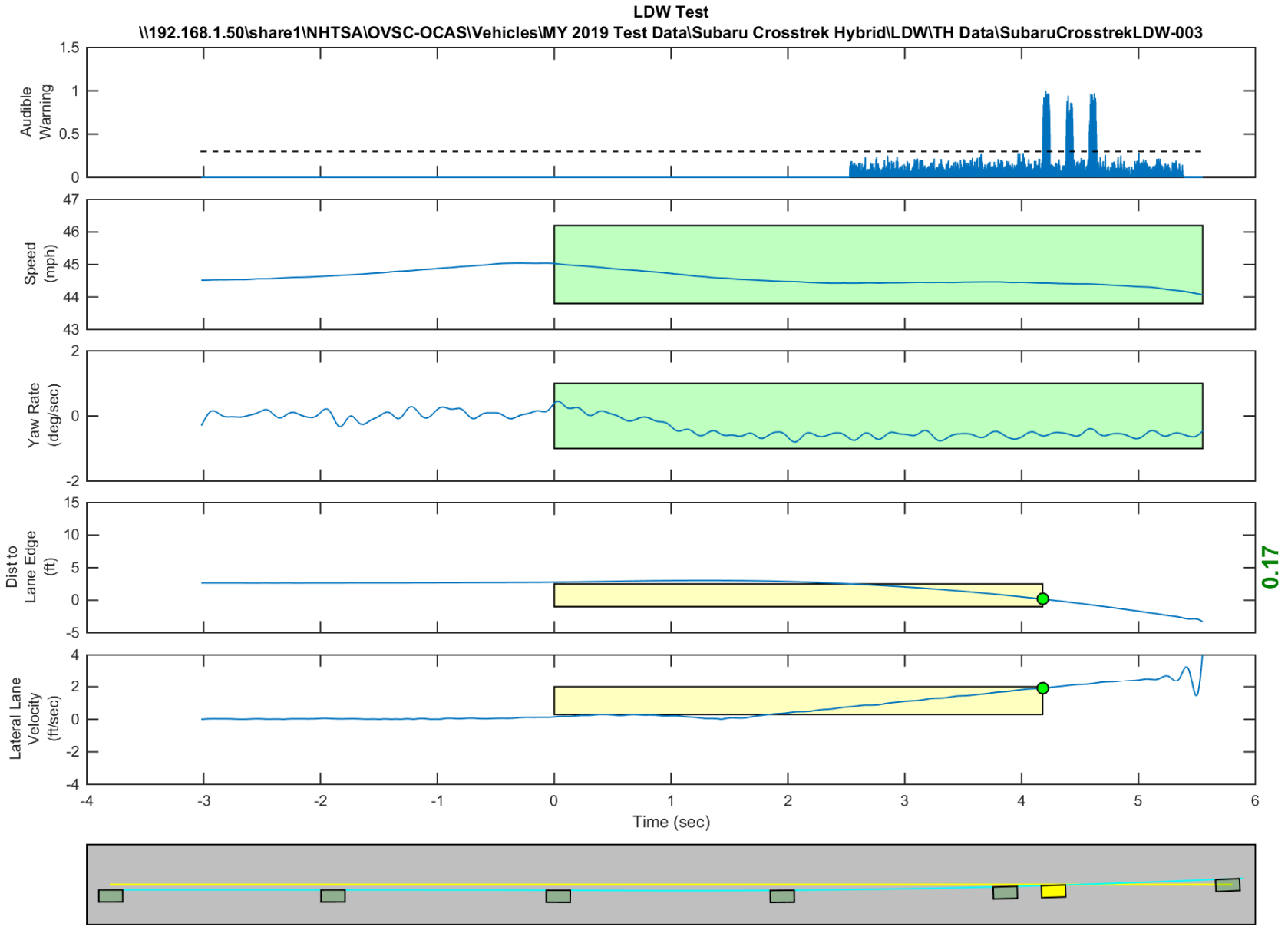


Figure D4. Time History for Run 3, Solid Line, Left Departure, Audible Warning

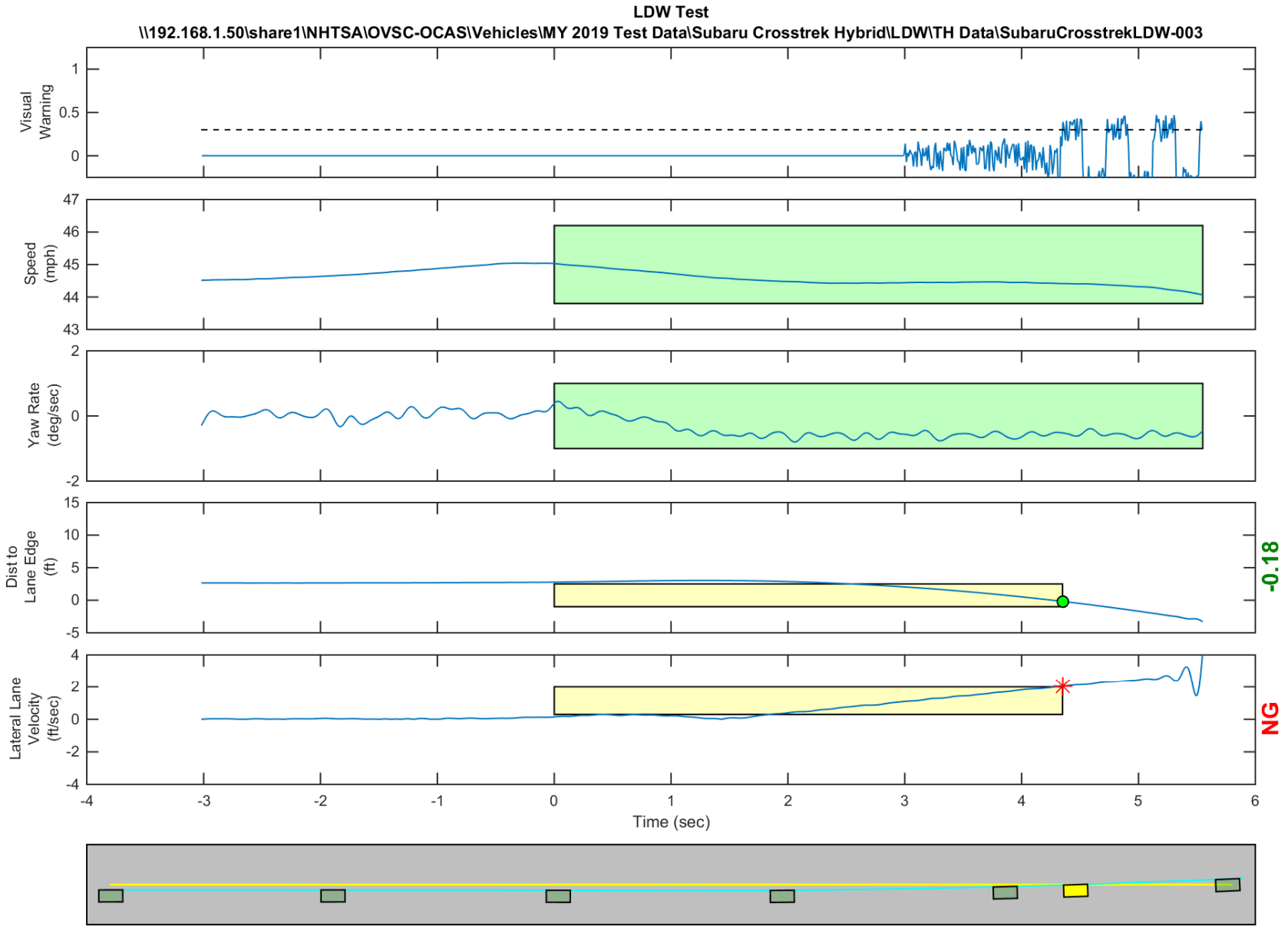


Figure D5. Time History for Run 3, Solid Line, Left Departure, Visual Warning

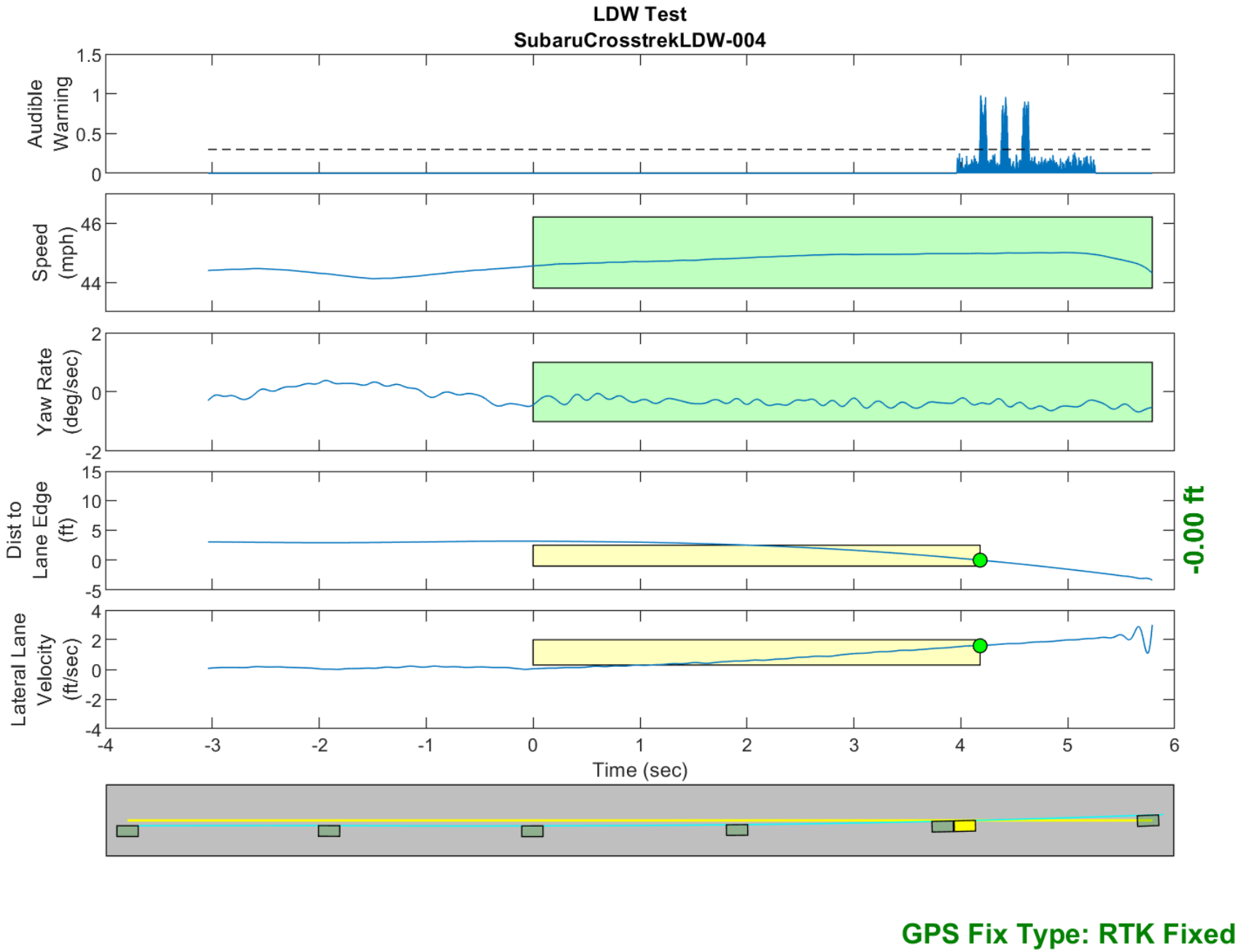


Figure D6. Time History for Run 4, Solid Line, Left Departure, Audible Warning

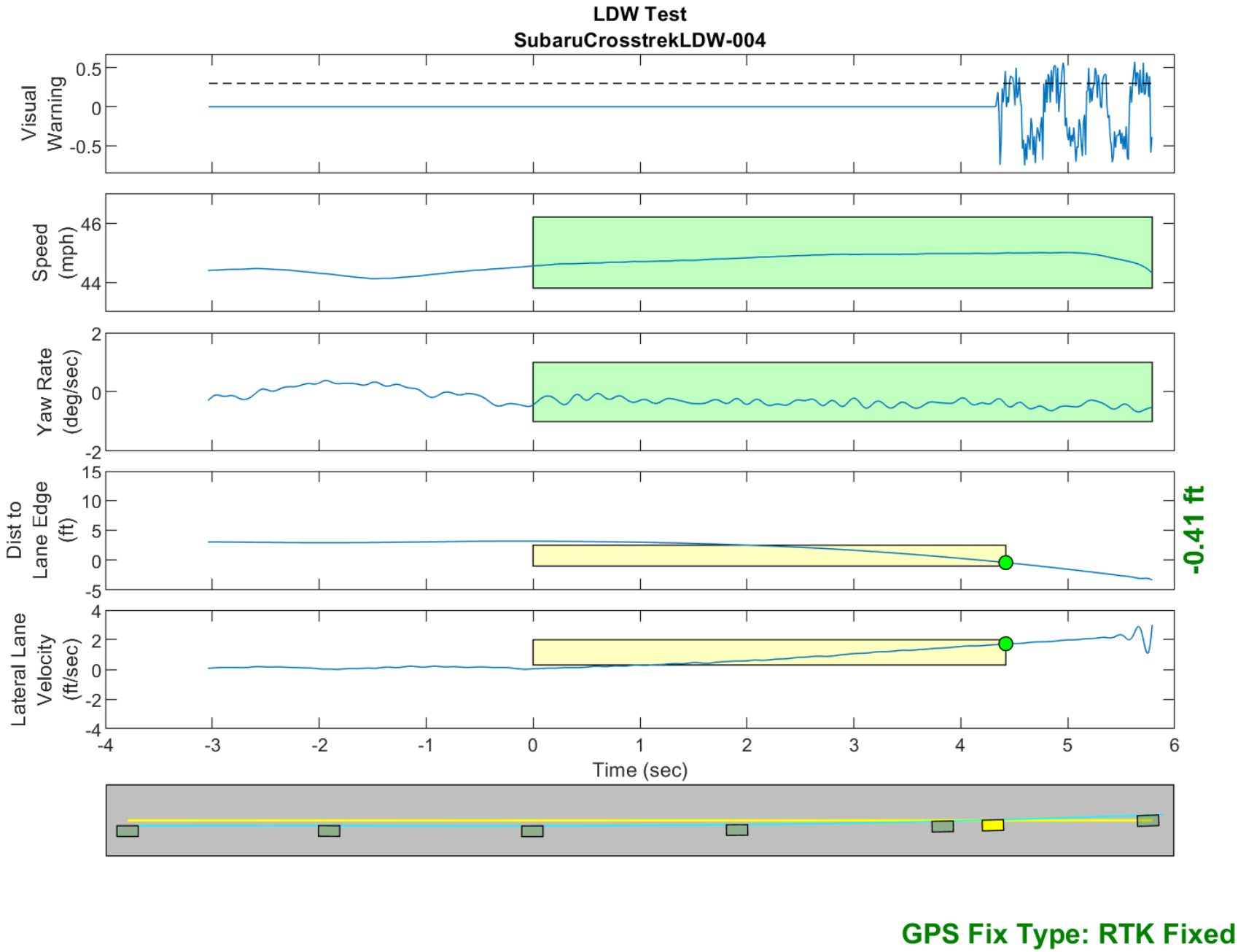


Figure D7. Time History for Run 4, Solid Line, Left Departure, Visual Warning

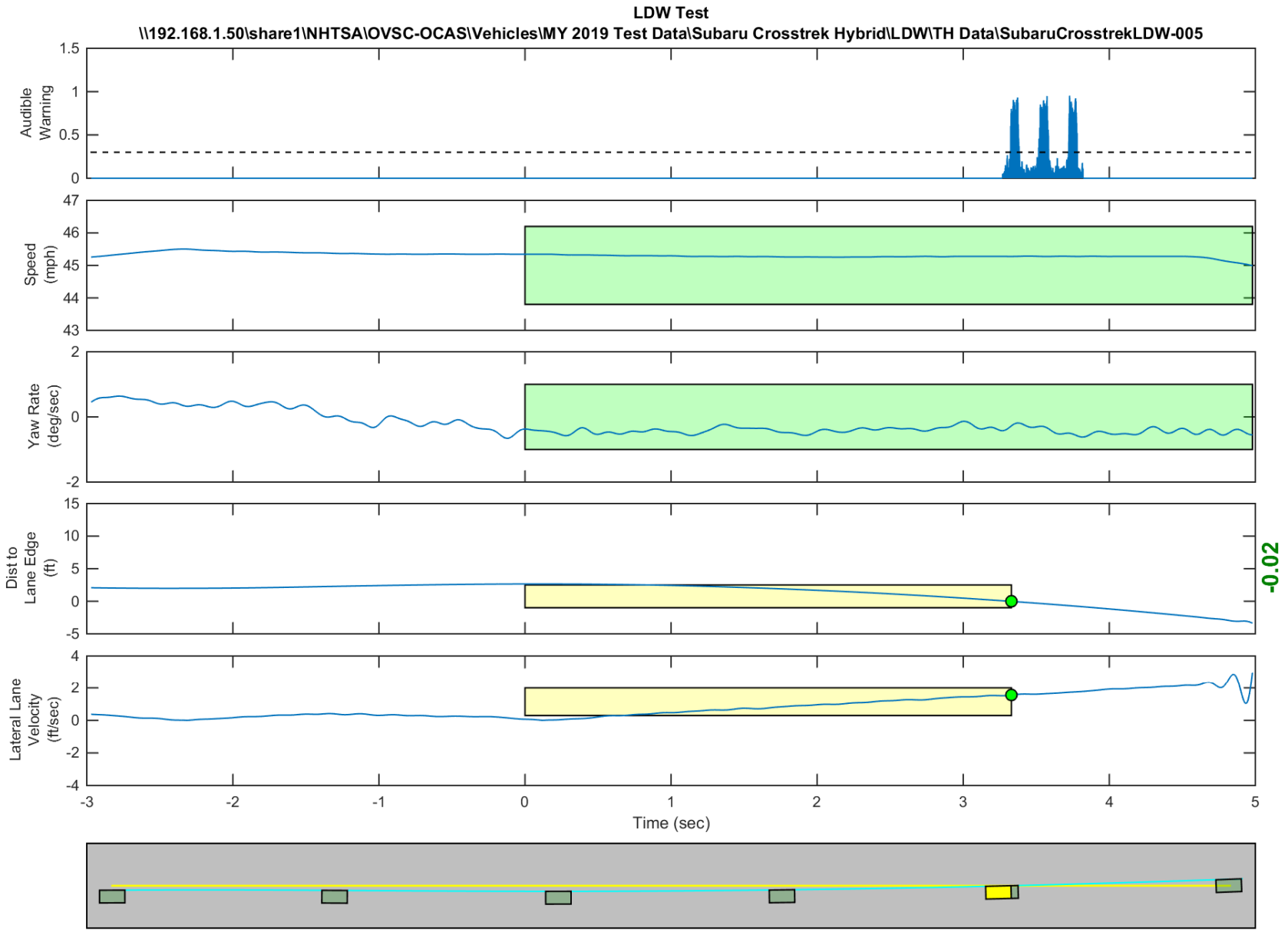


Figure D8. Time History for Run 5, Solid Line, Left Departure, Audible Warning

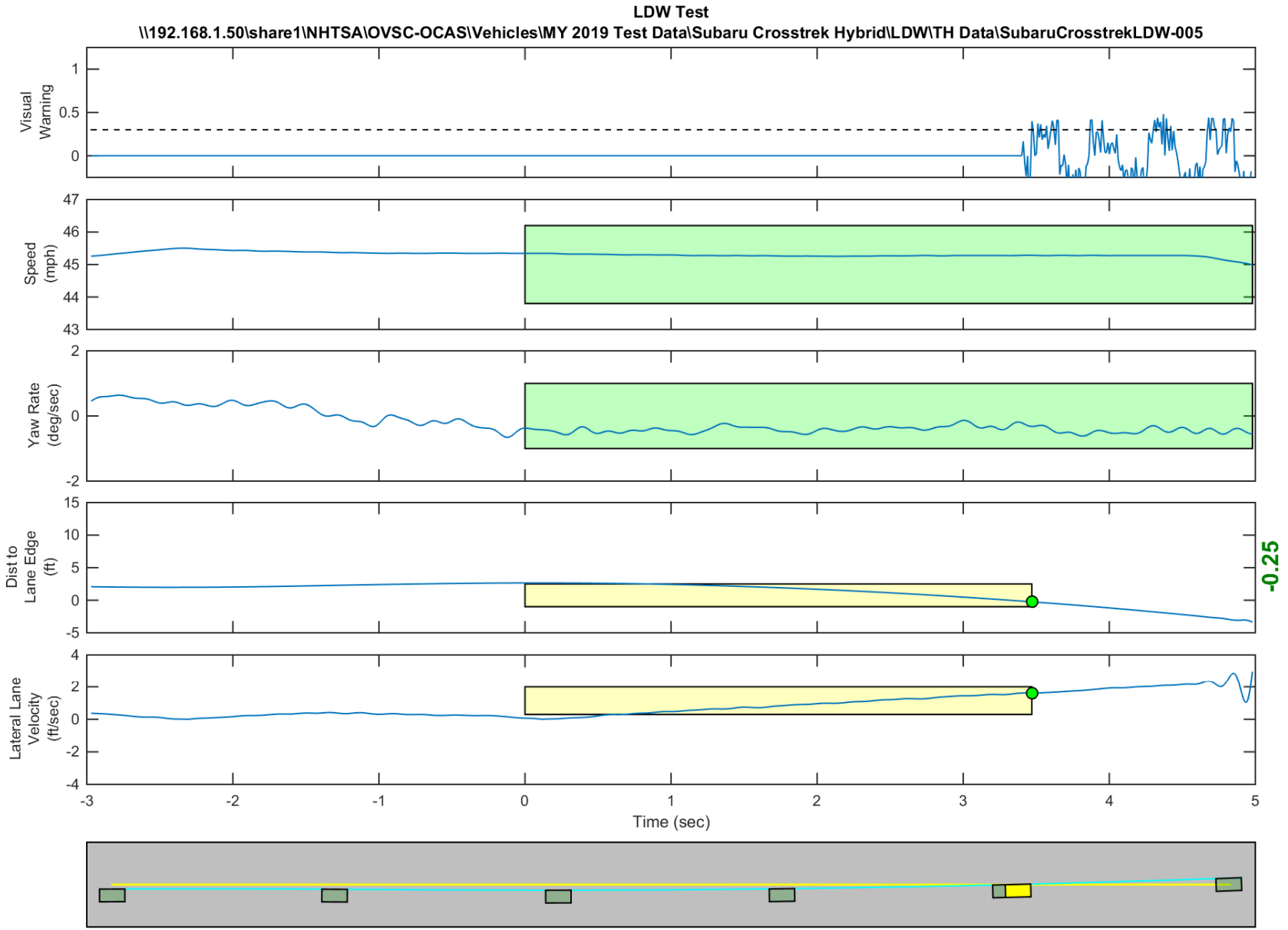


Figure D9. Time History for Run 5, Solid Line, Left Departure, Visual Warning

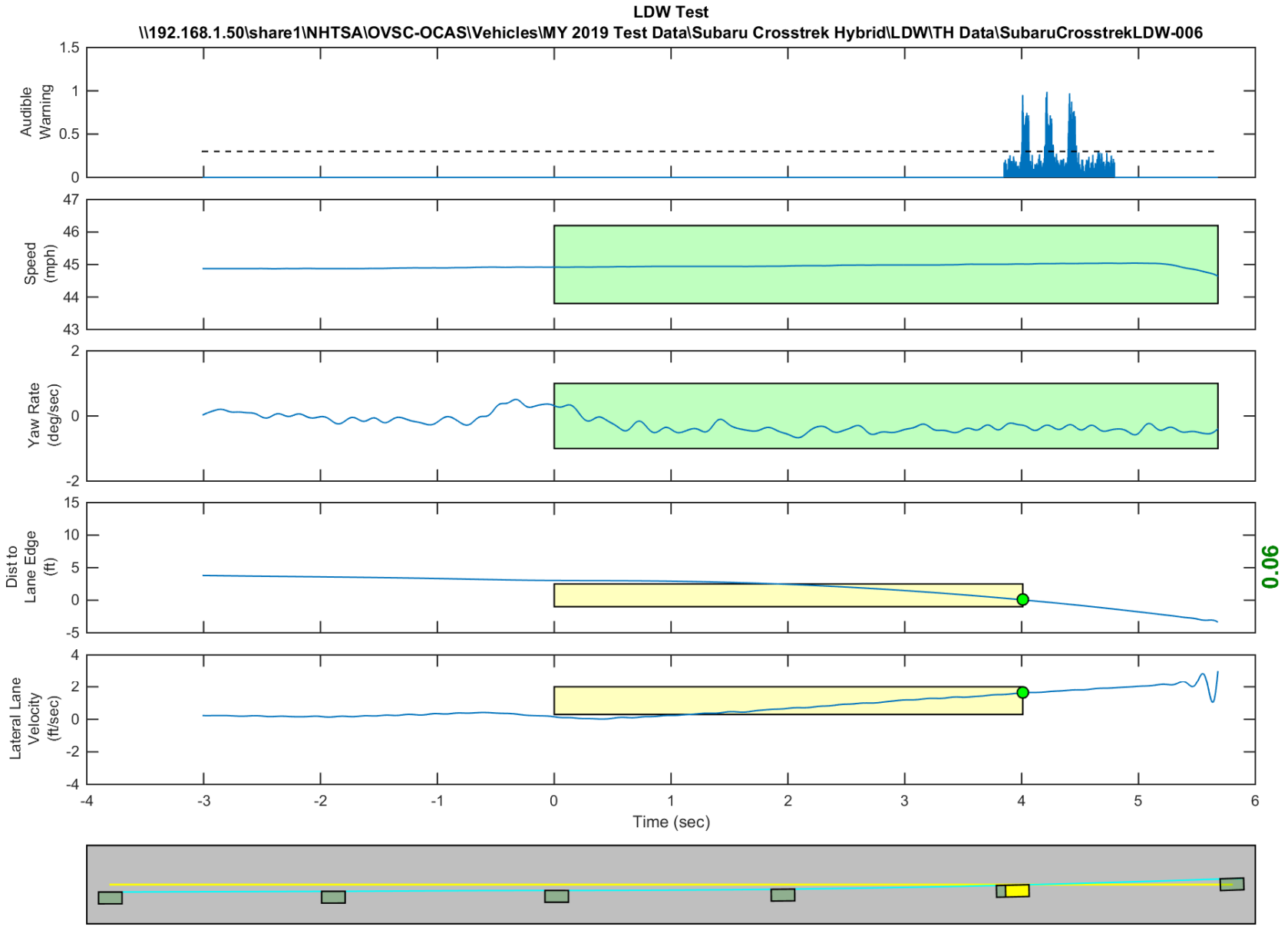


Figure D10. Time History for Run 6, Solid Line, Left Departure, Audible Warning

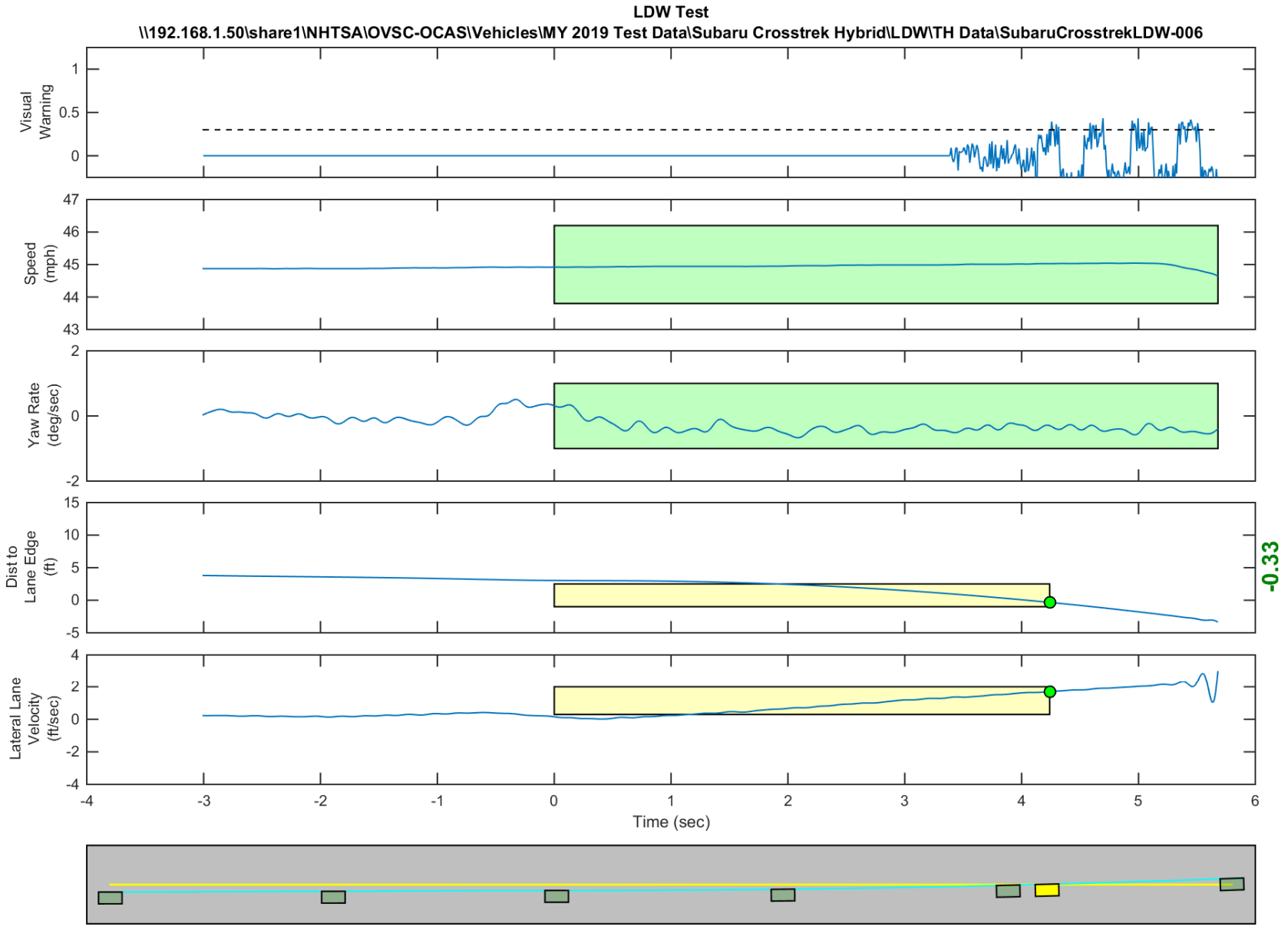


Figure D11. Time History for Run 6, Solid Line, Left Departure, Visual Warning

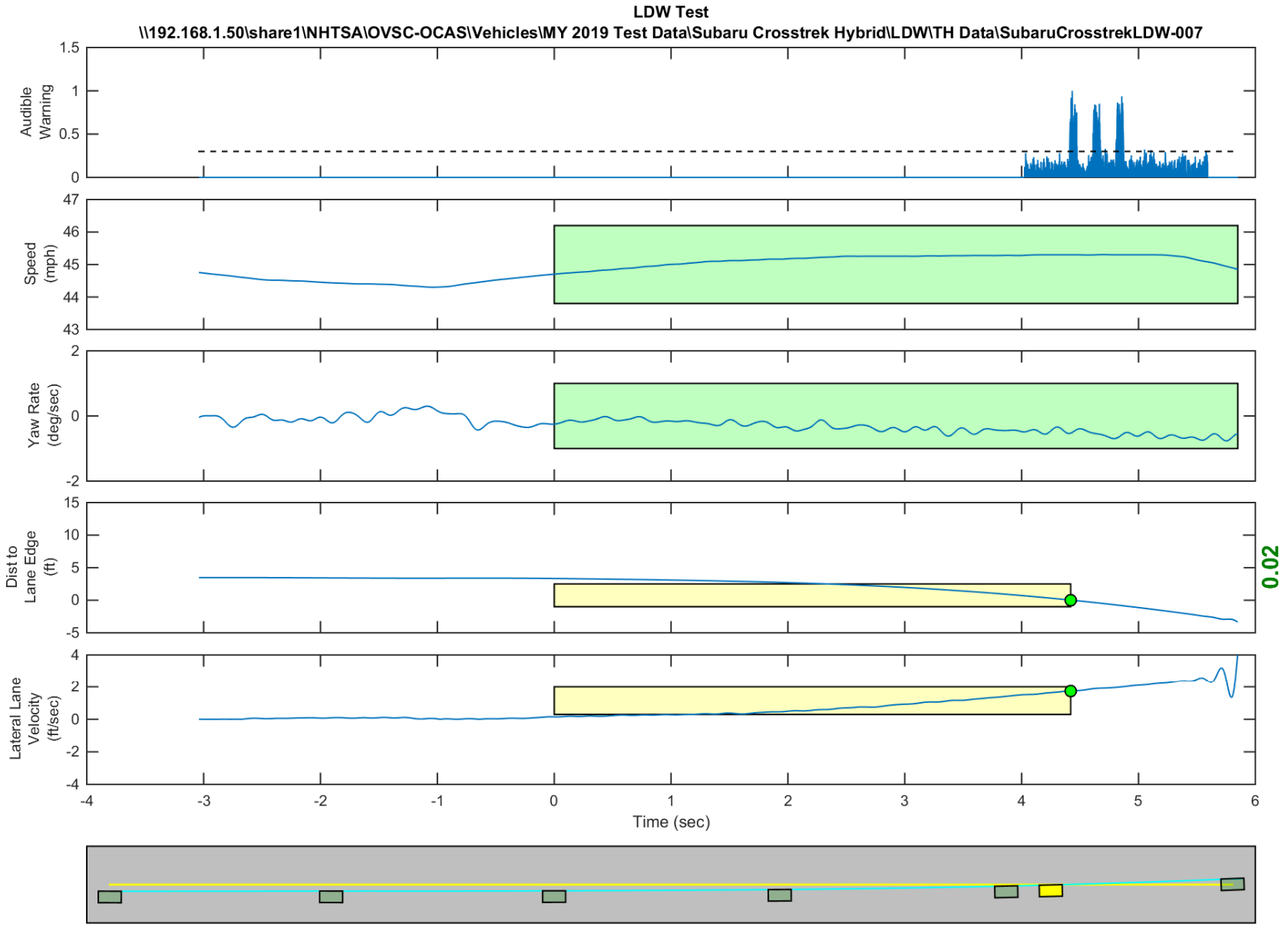


Figure D12. Time History for Run 7, Solid Line, Left Departure, Audible Warning

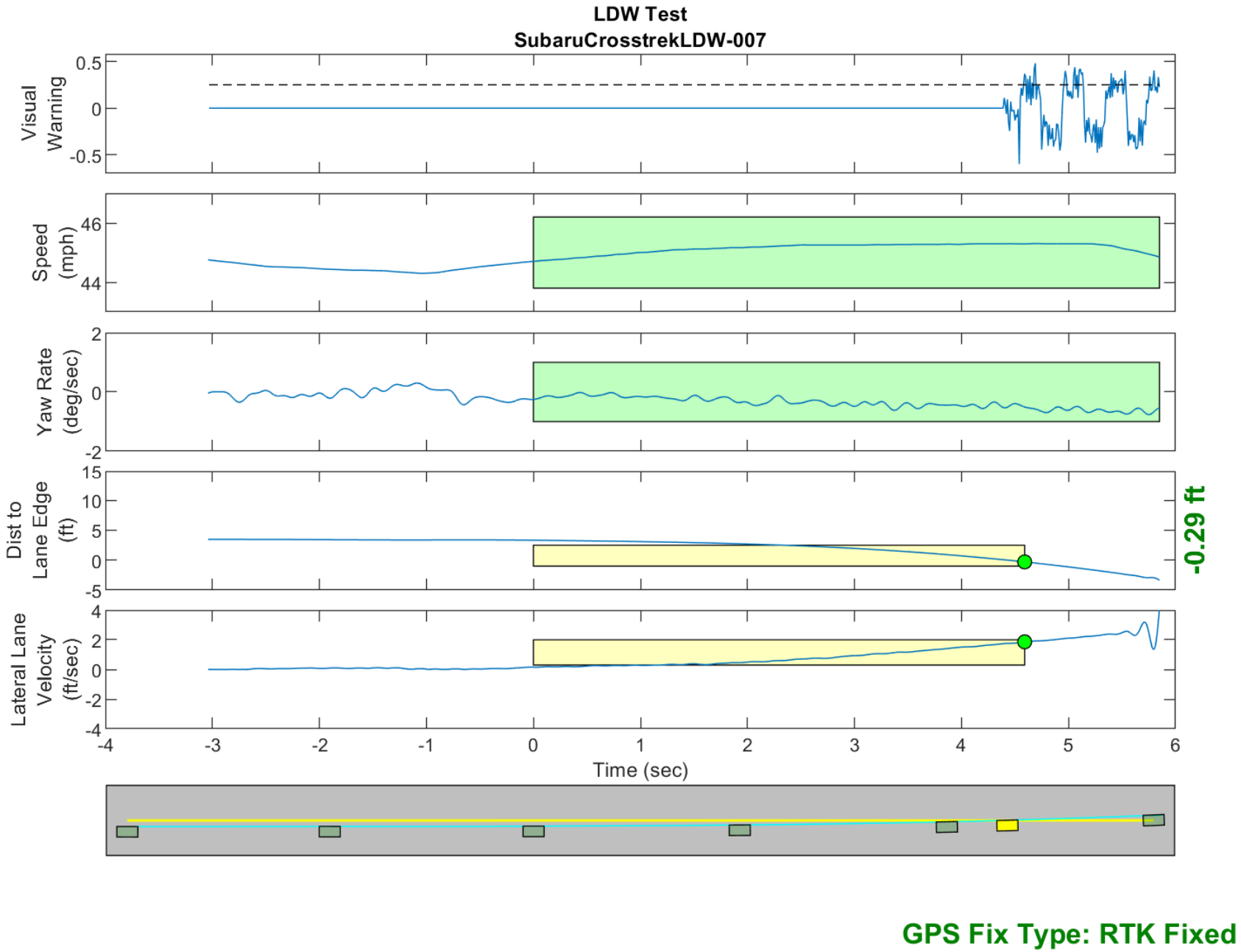


Figure D13. Time History for Run 7, Solid Line, Left Departure, Visual Warning

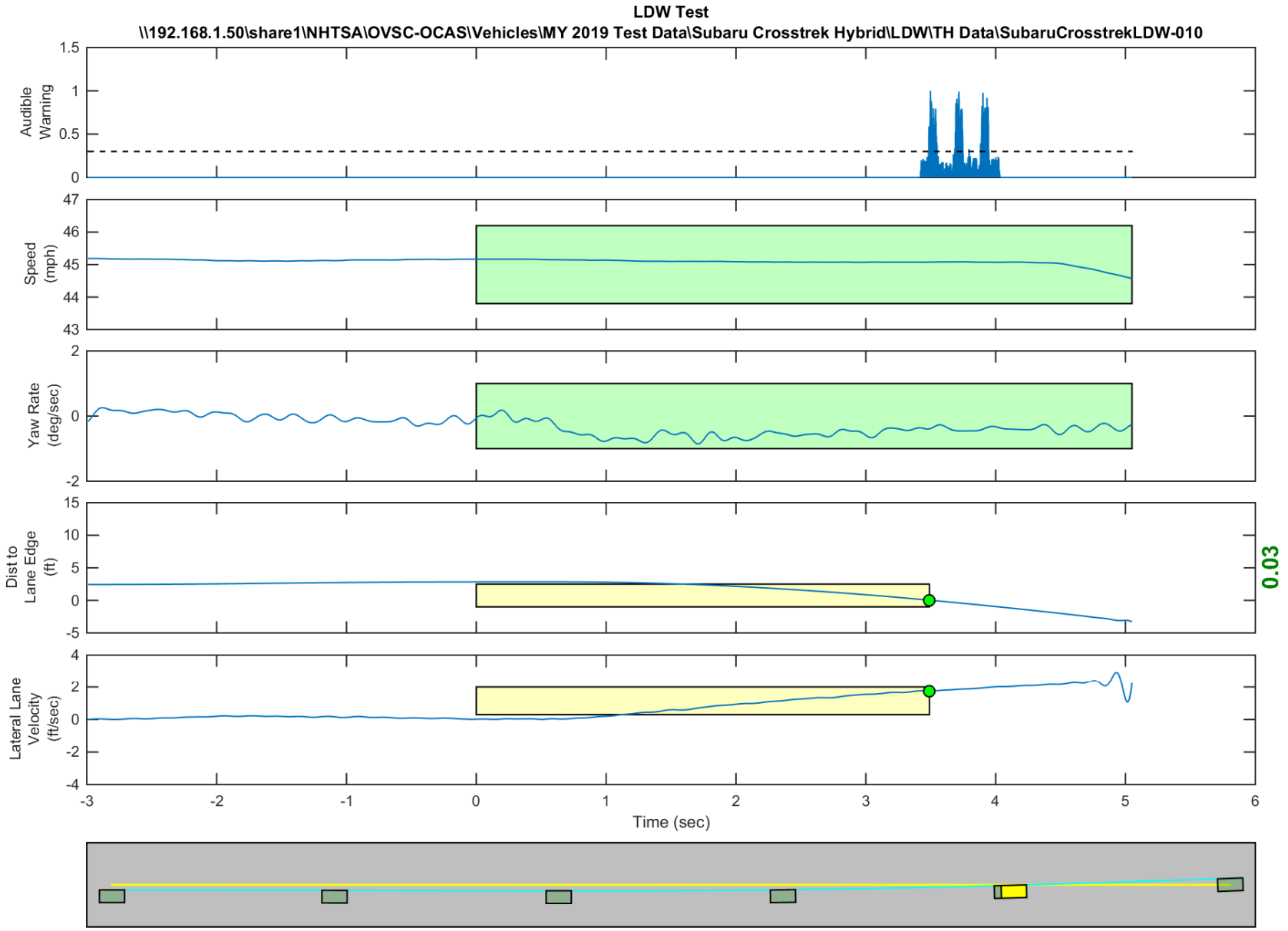


Figure D14. Time History for Run 10, Solid Line, Left Departure, Audible Warning

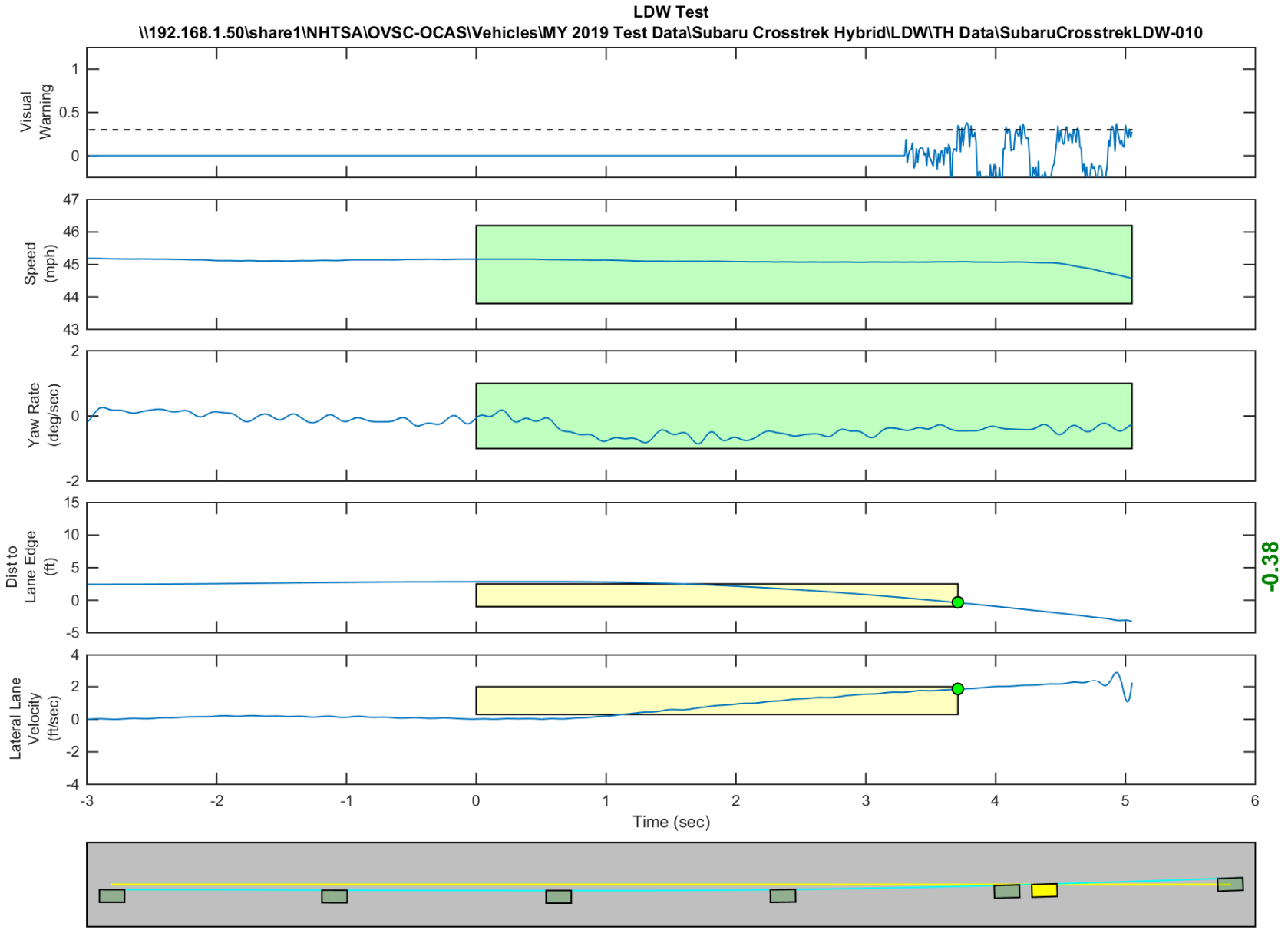


Figure D15. Time History for Run 10, Solid Line, Left Departure, Visual Warning

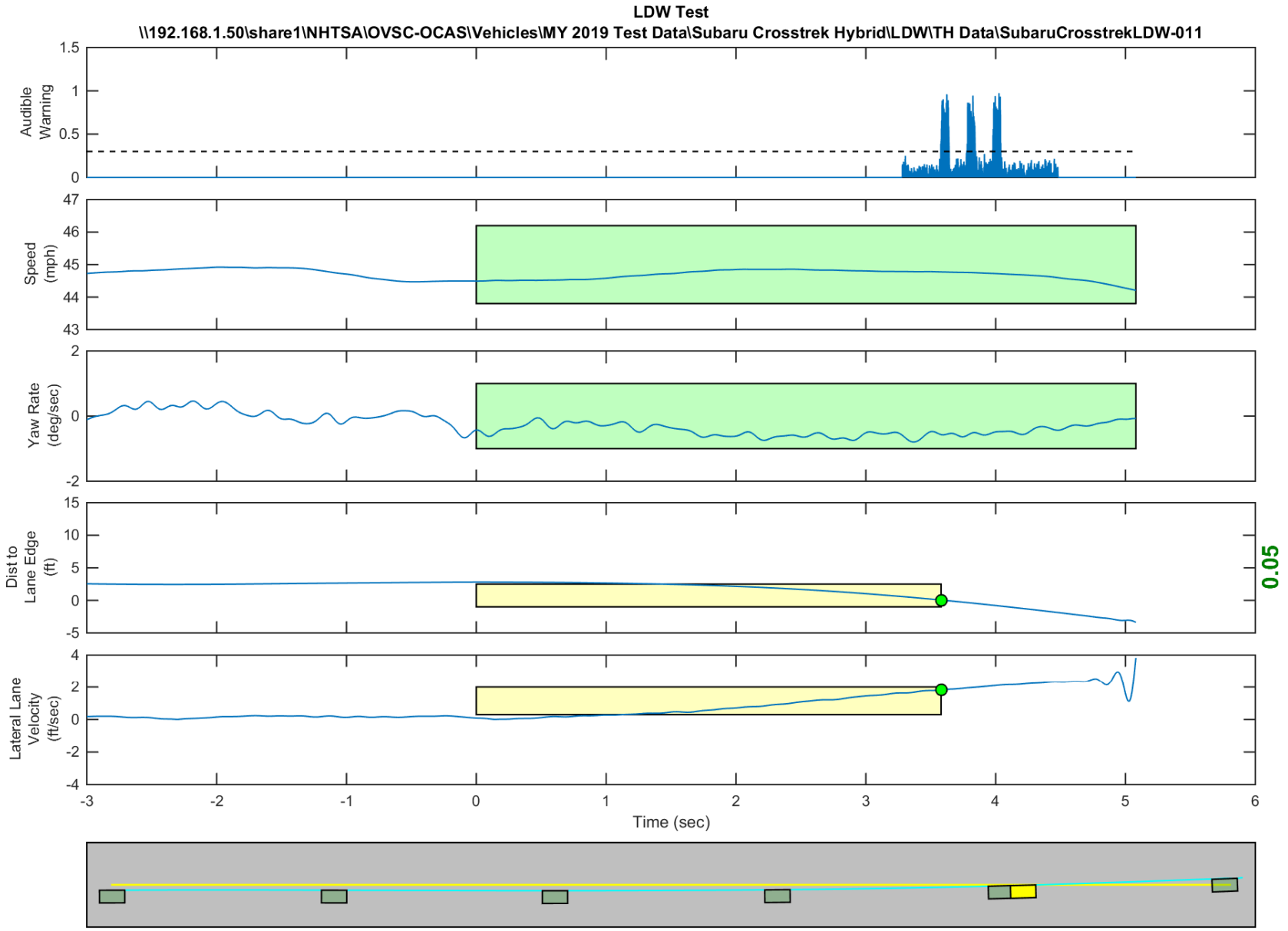


Figure D16. Time History for Run 11, Solid Line, Left Departure, Audible Warning

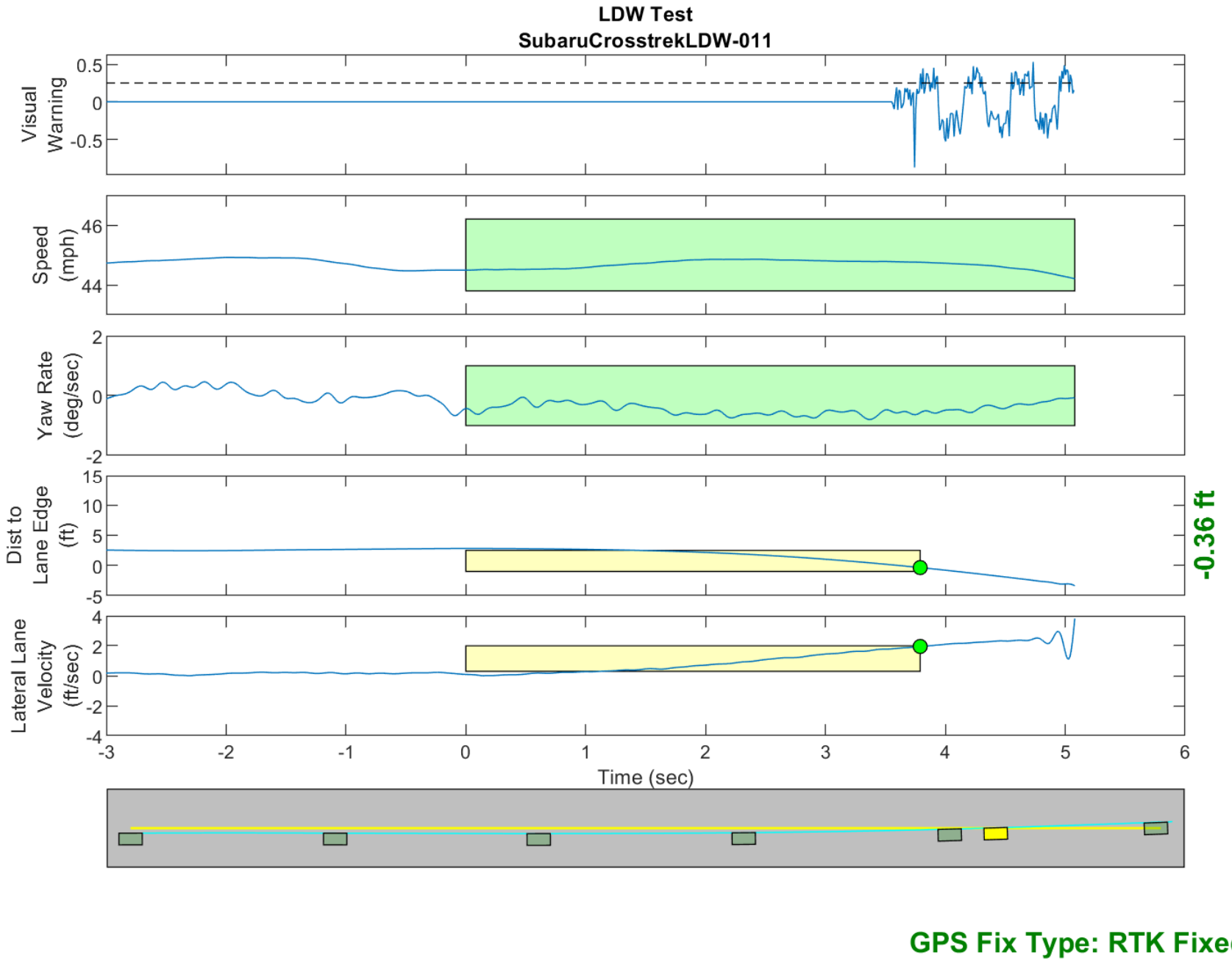


Figure D17. Time History for Run 11, Solid Line, Left Departure, Visual Warning

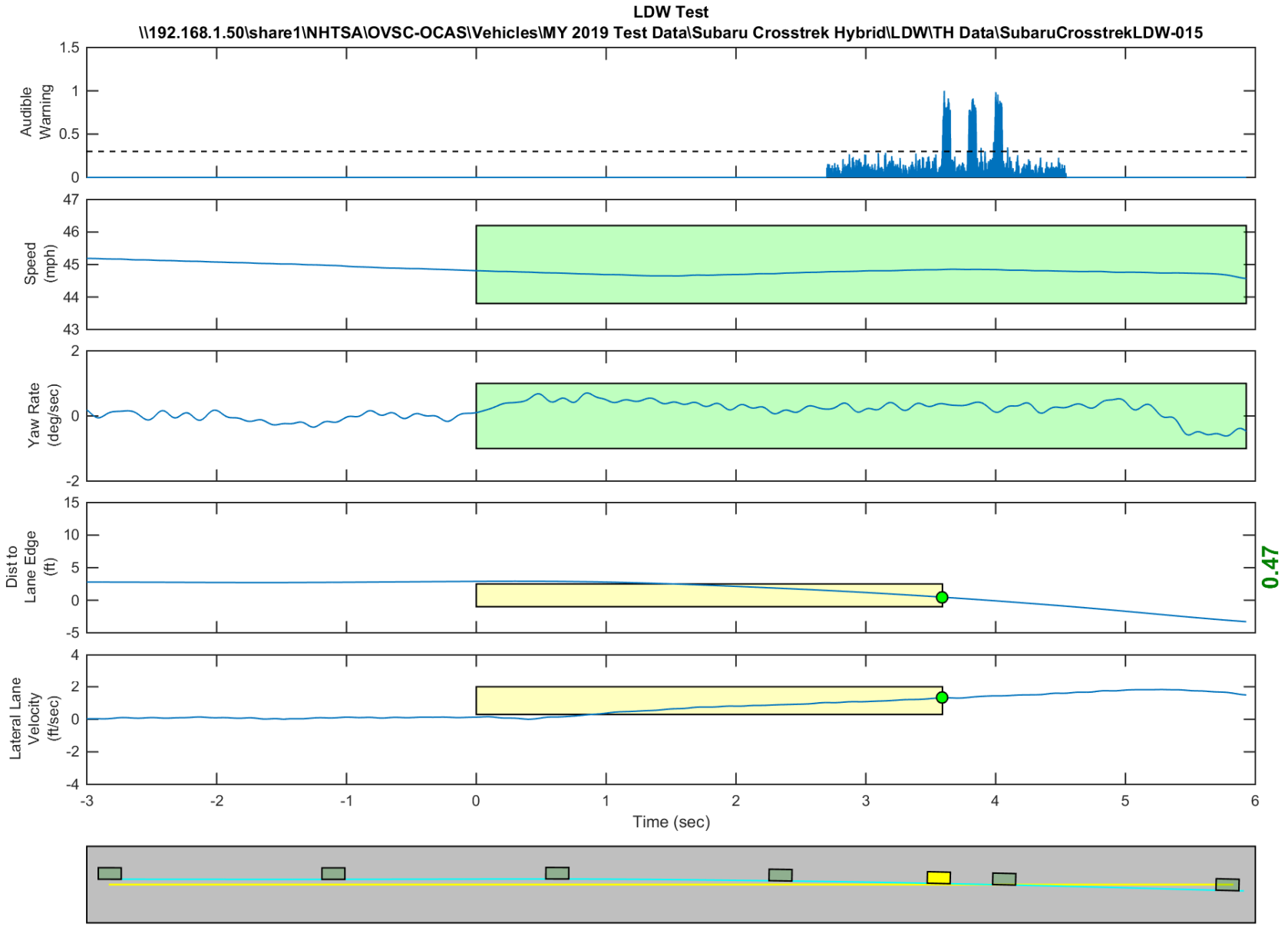


Figure D18. Time History for Run 15, Solid Line, Right Departure, Audible Warning

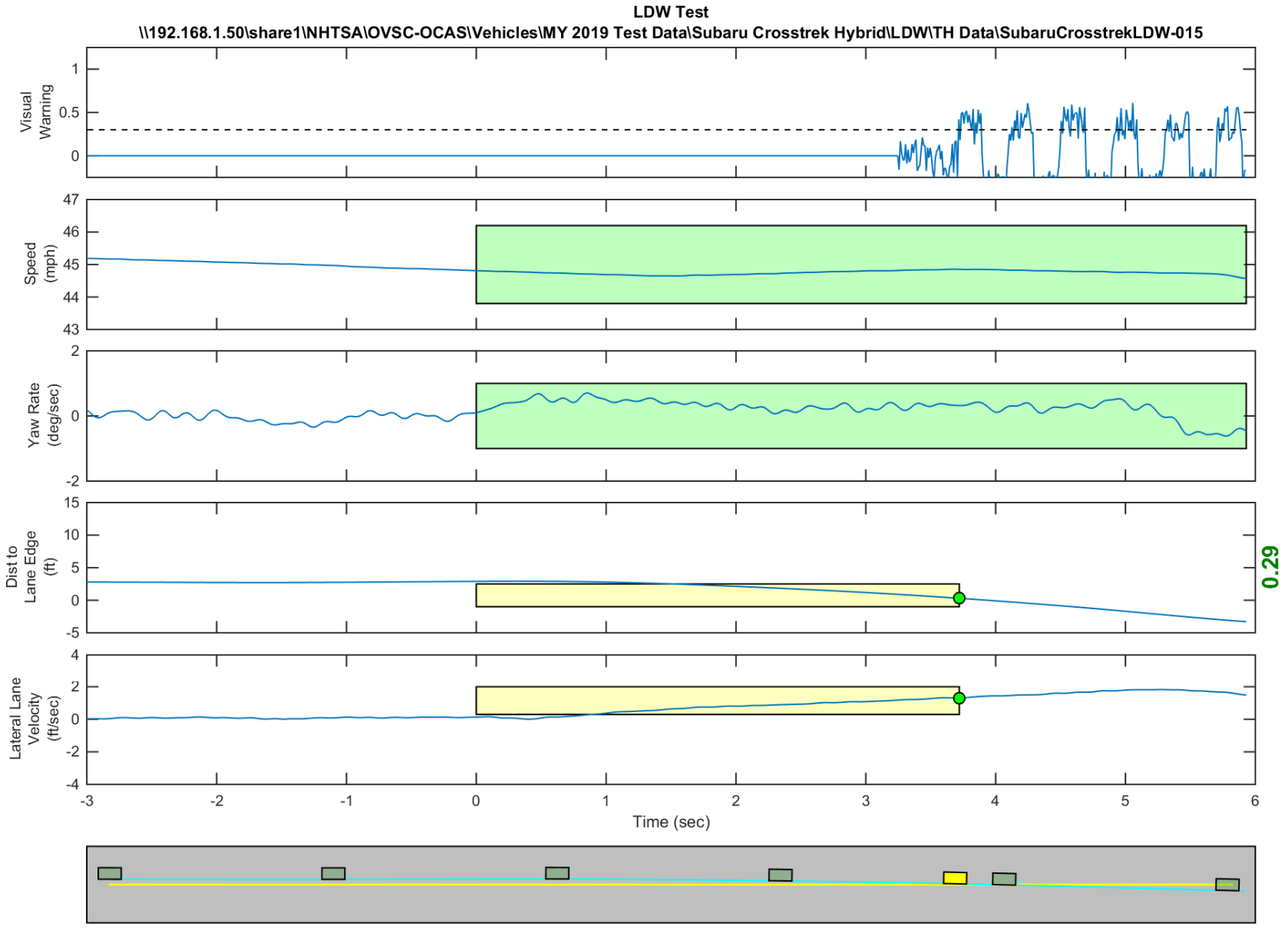


Figure D19. Time History for Run 15, Solid Line, Right Departure, Visual Warning

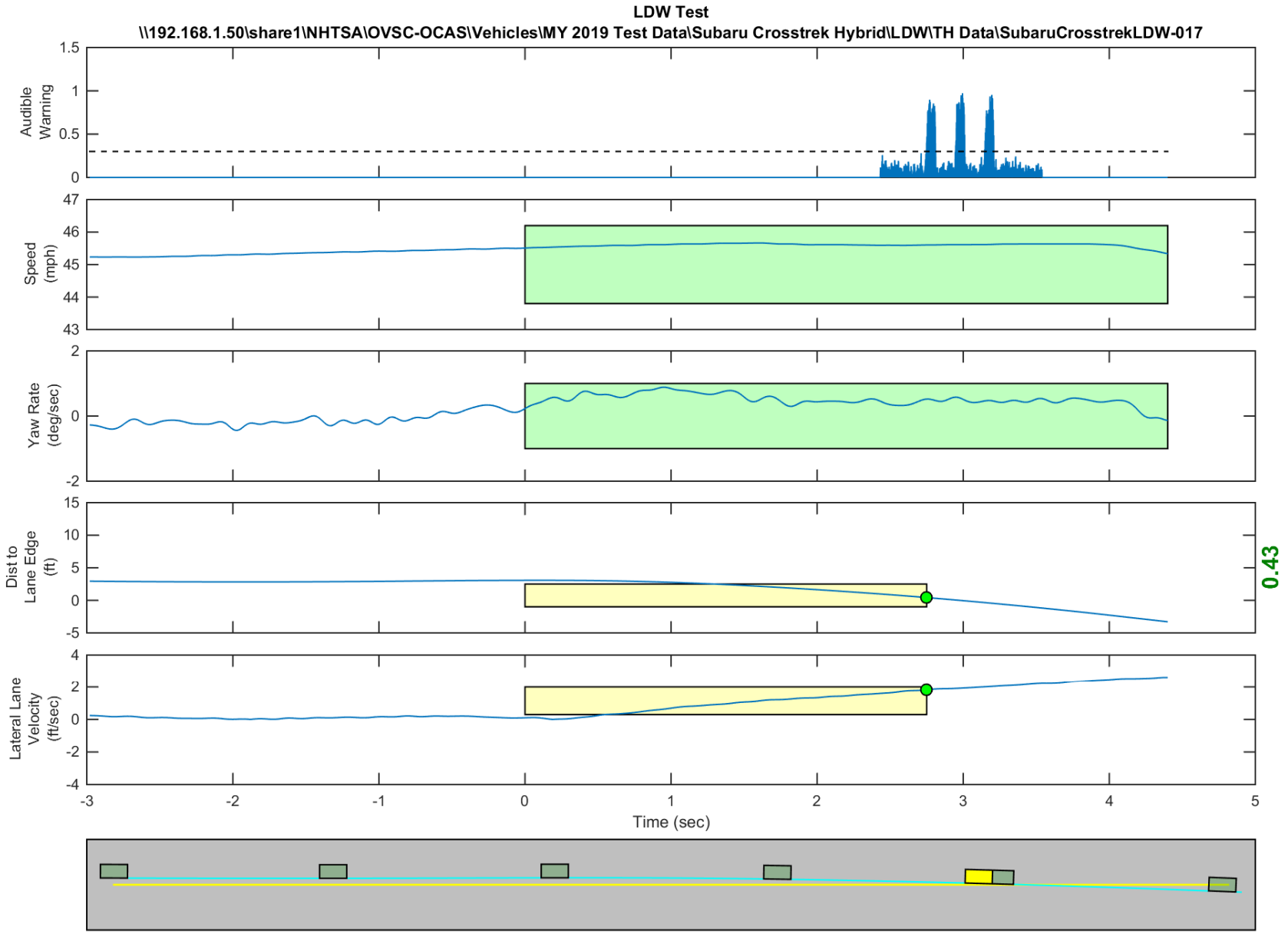


Figure D20. Time History for Run 17, Solid Line, Right Departure, Audible Warning

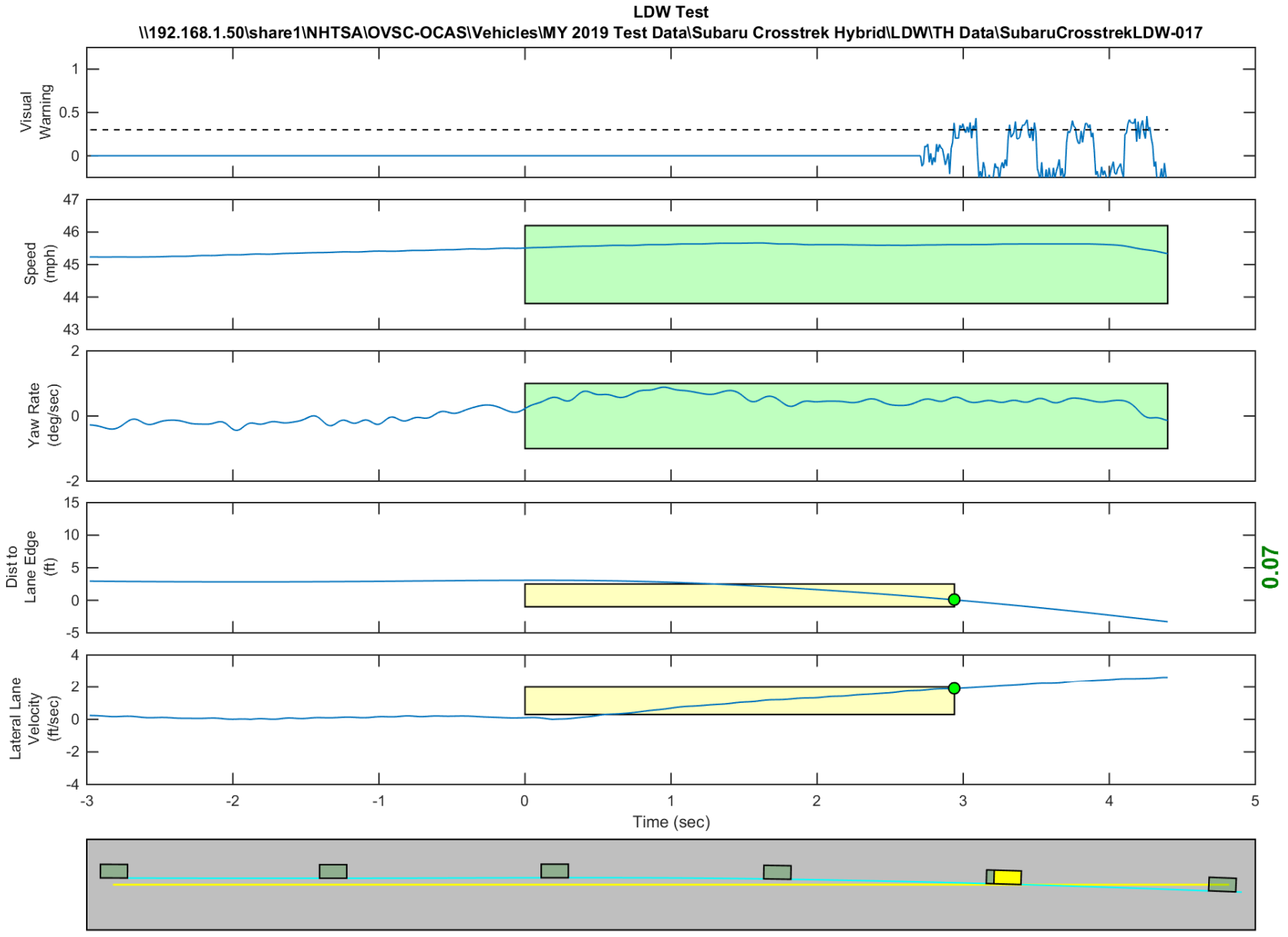


Figure D21. Time History for Run 17, Solid Line, Right Departure, Visual Warning

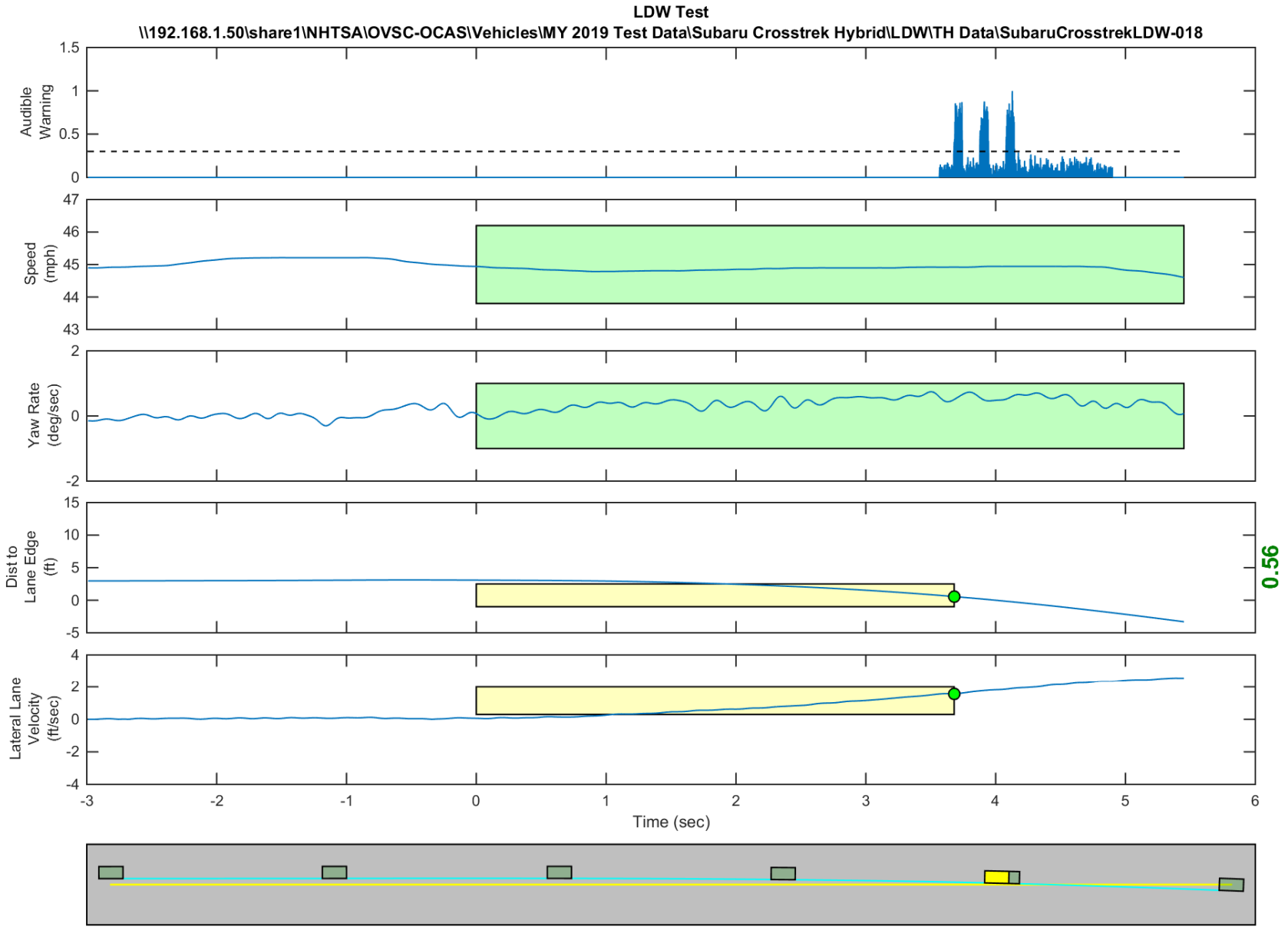


Figure D22. Time History for Run 18, Solid Line, Right Departure, Audible Warning

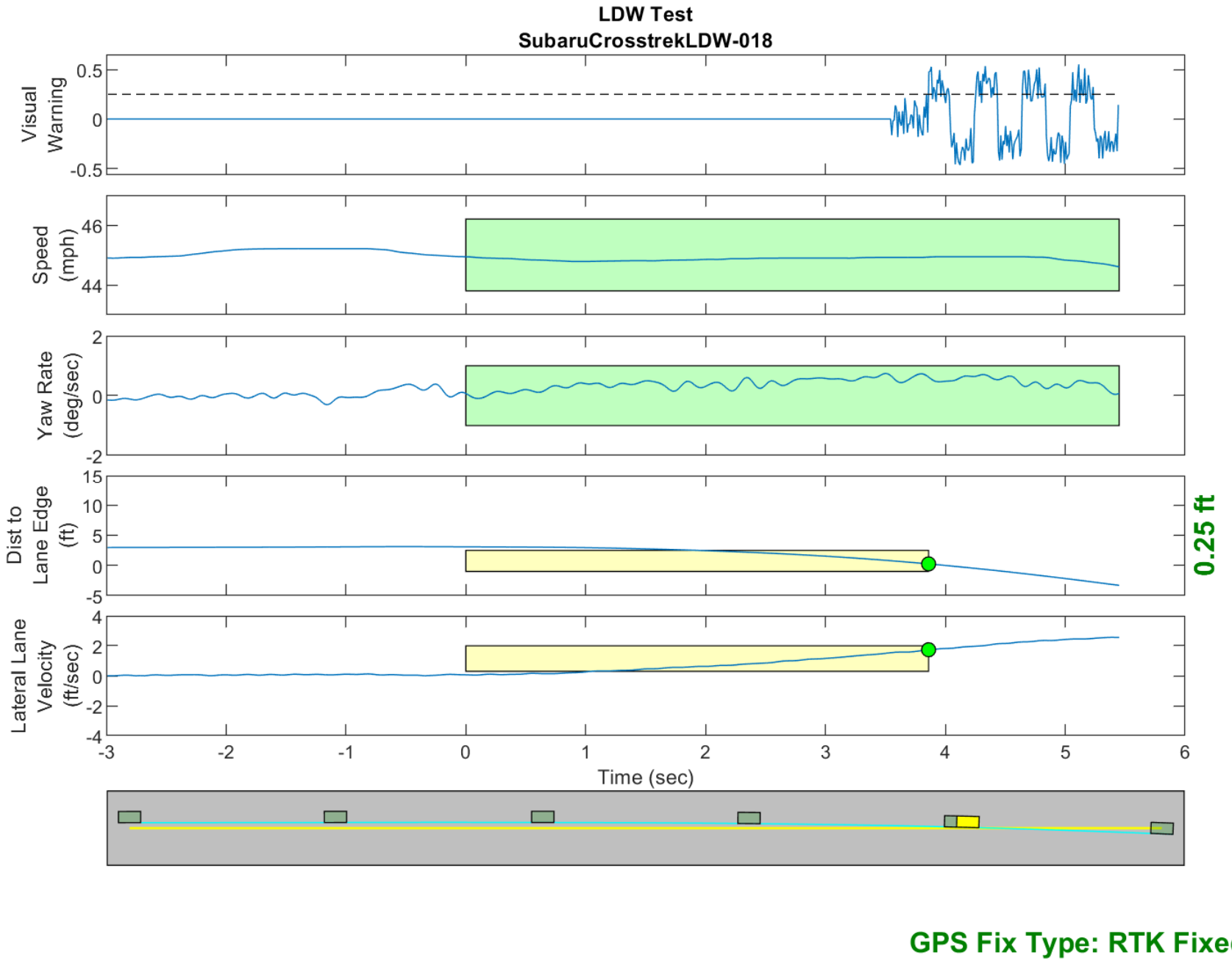


Figure D23. Time History for Run 18, Solid Line, Right Departure, Visual Warning

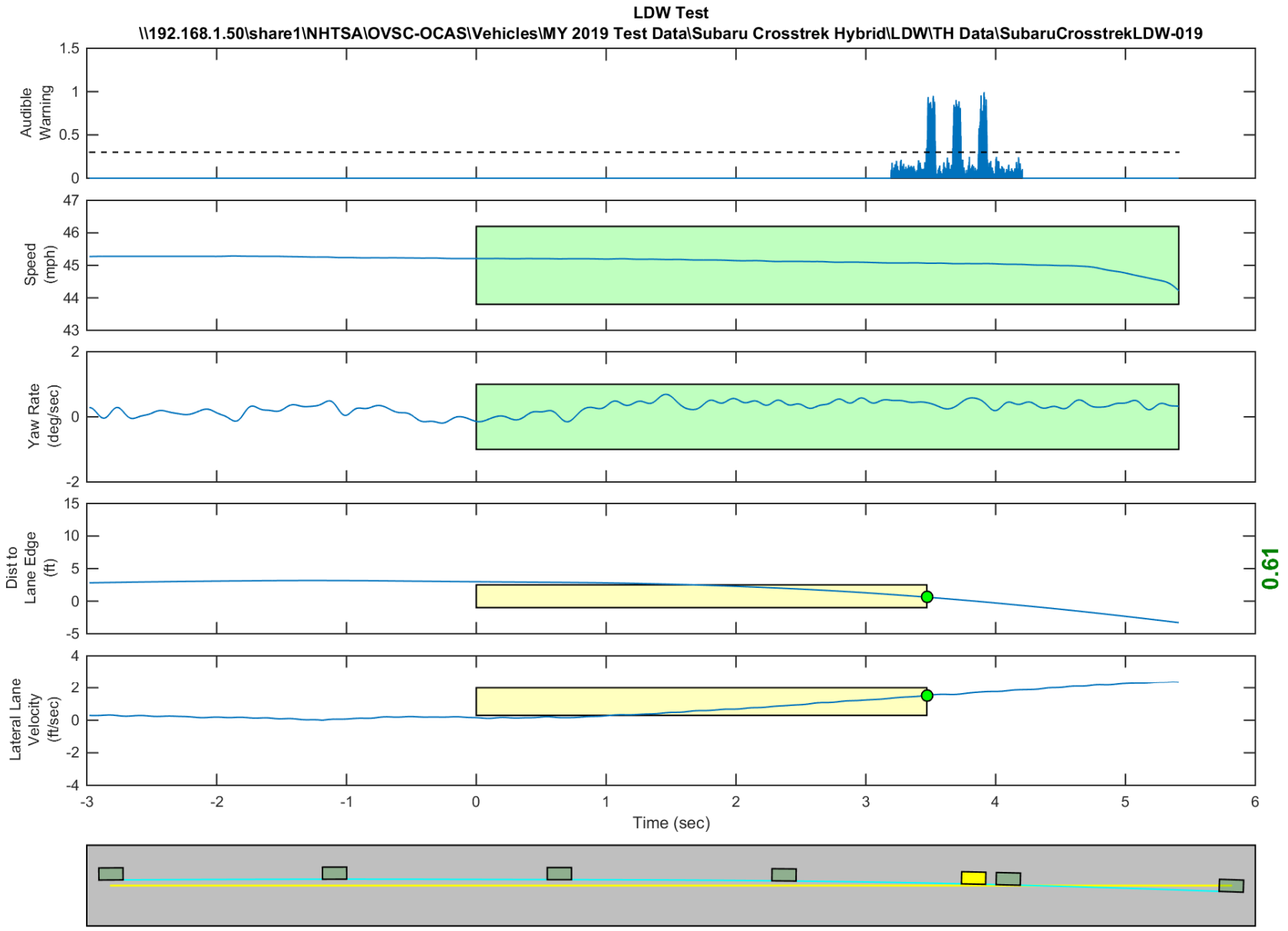


Figure D24. Time History for Run 19, Solid Line, Right Departure, Audible Warning

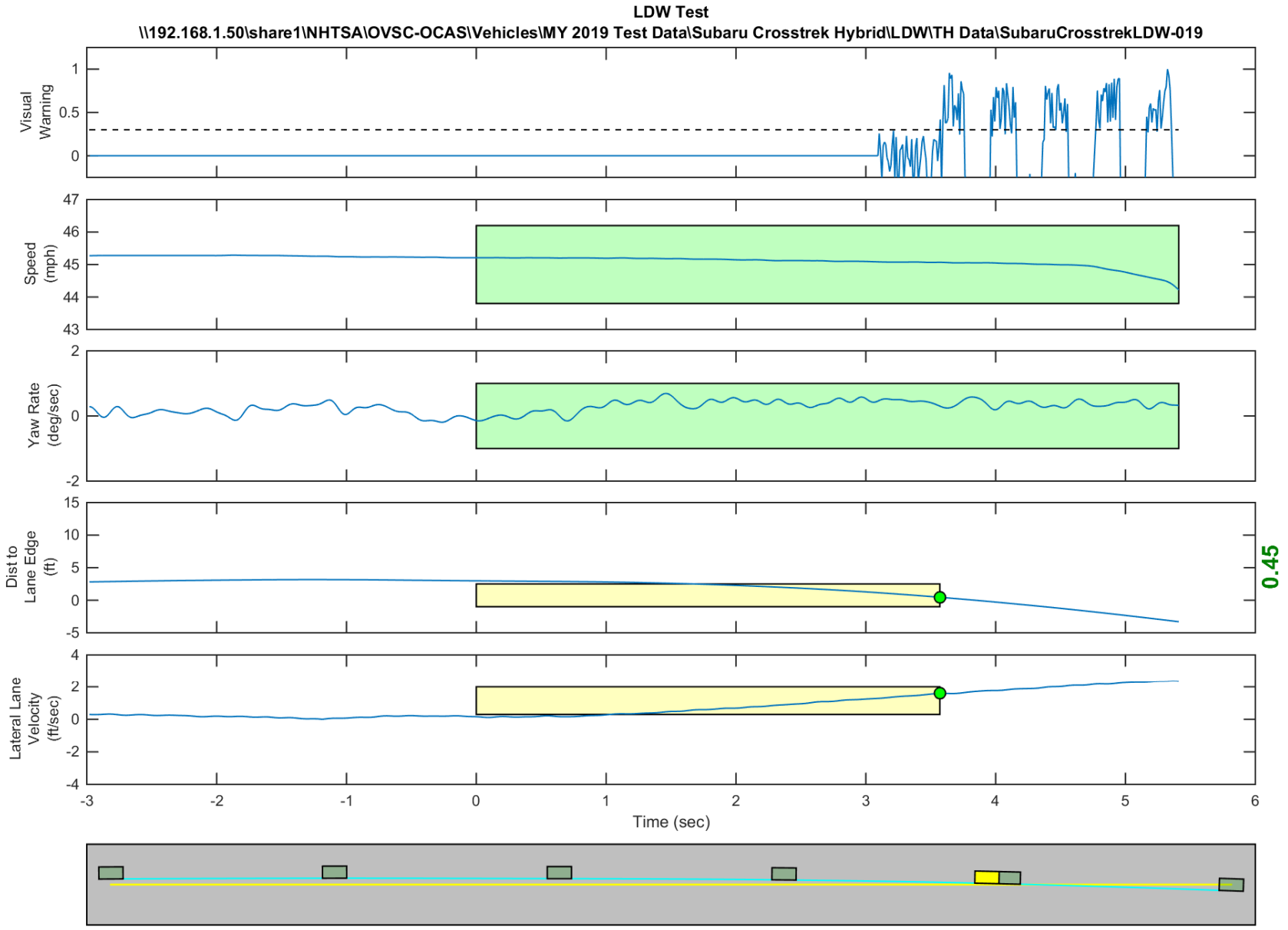


Figure D25. Time History for Run 19, Solid Line, Right Departure, Visual Warning

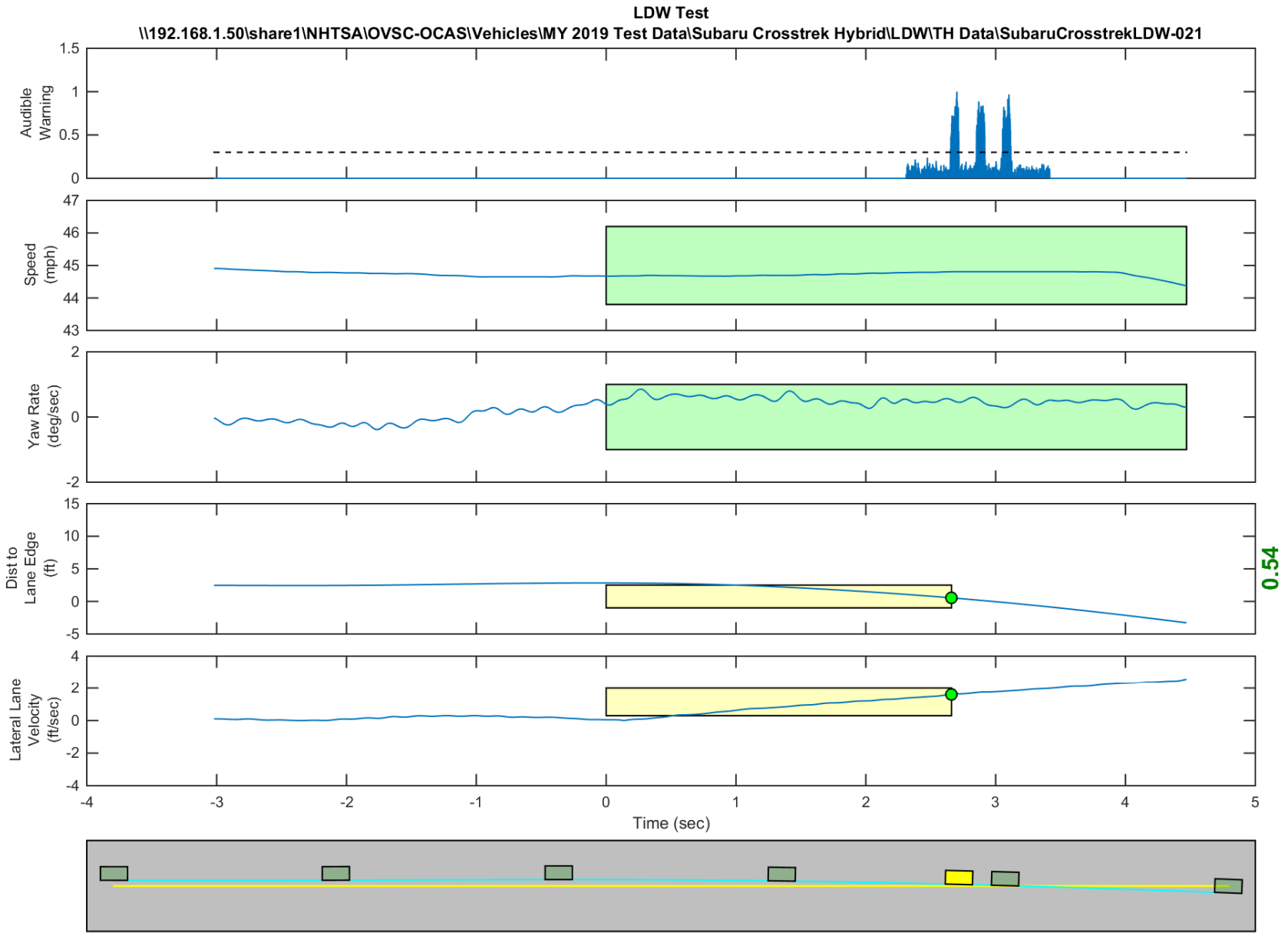


Figure D26. Time History for Run 21, Solid Line, Right Departure, Audible Warning

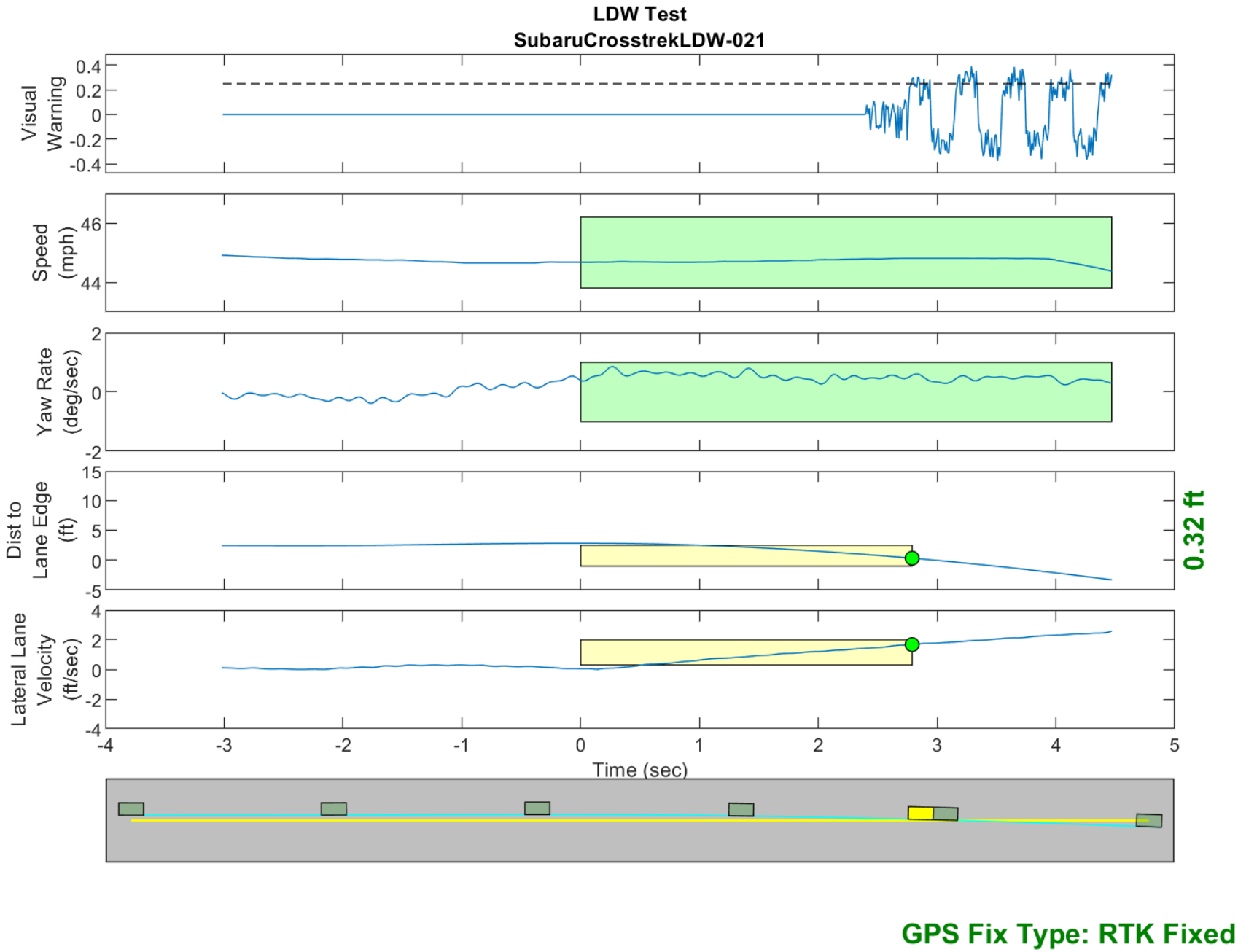


Figure D27. Time History for Run 21, Solid Line, Right Departure, Visual Warning

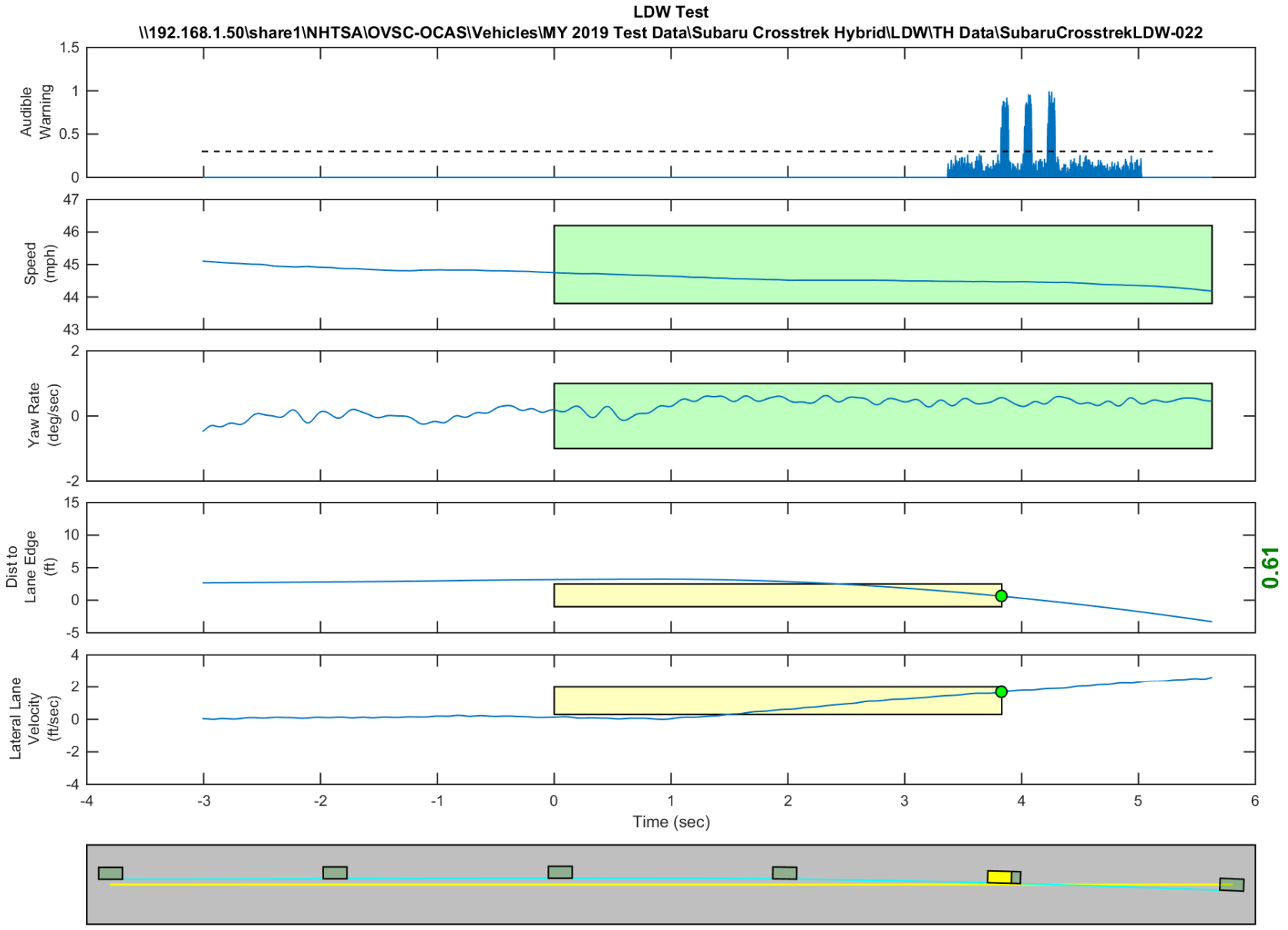


Figure D28. Time History for Run 22, Solid Line, Right Departure, Audible Warning

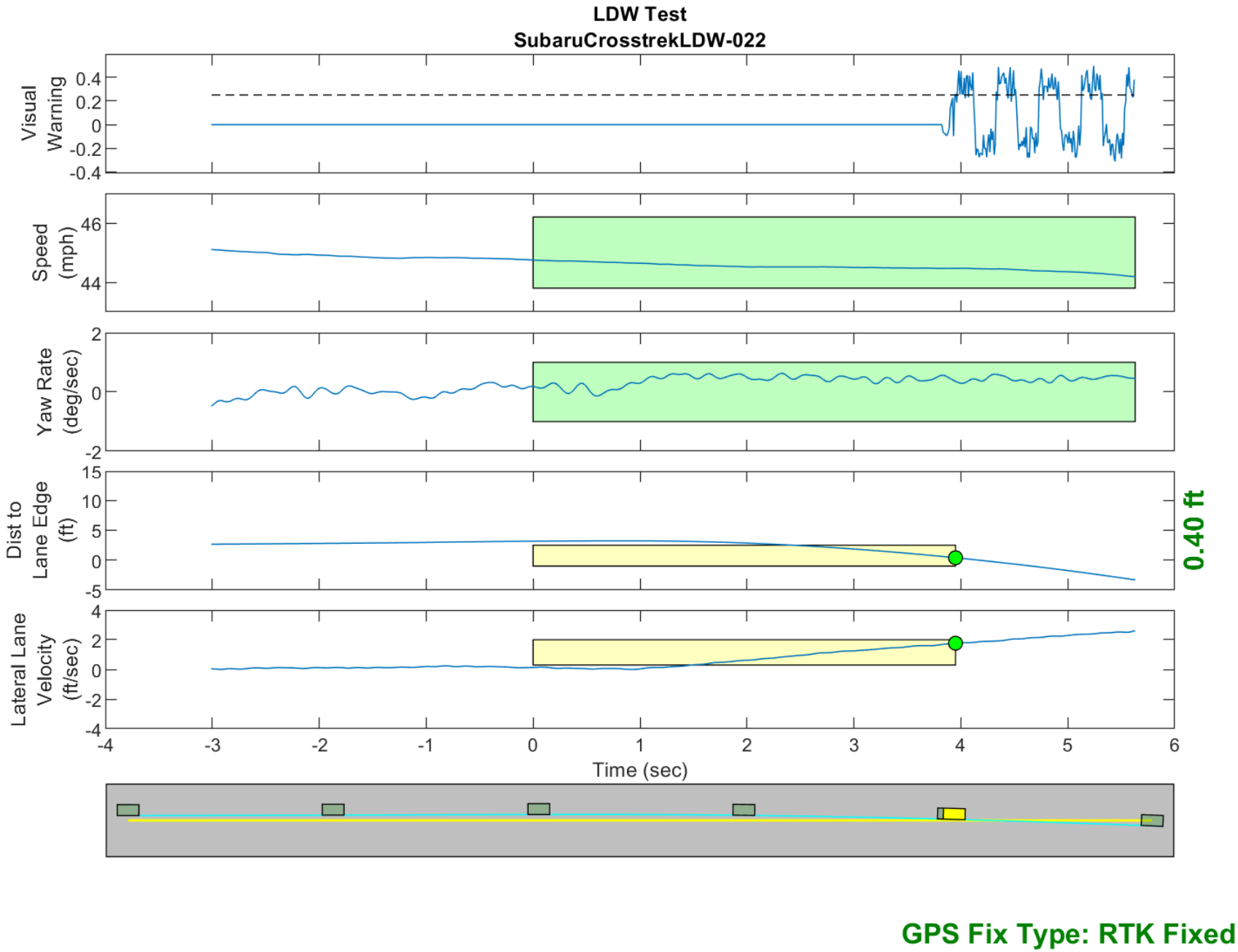


Figure D29. Time History for Run 22, Solid Line, Right Departure, Visual Warning

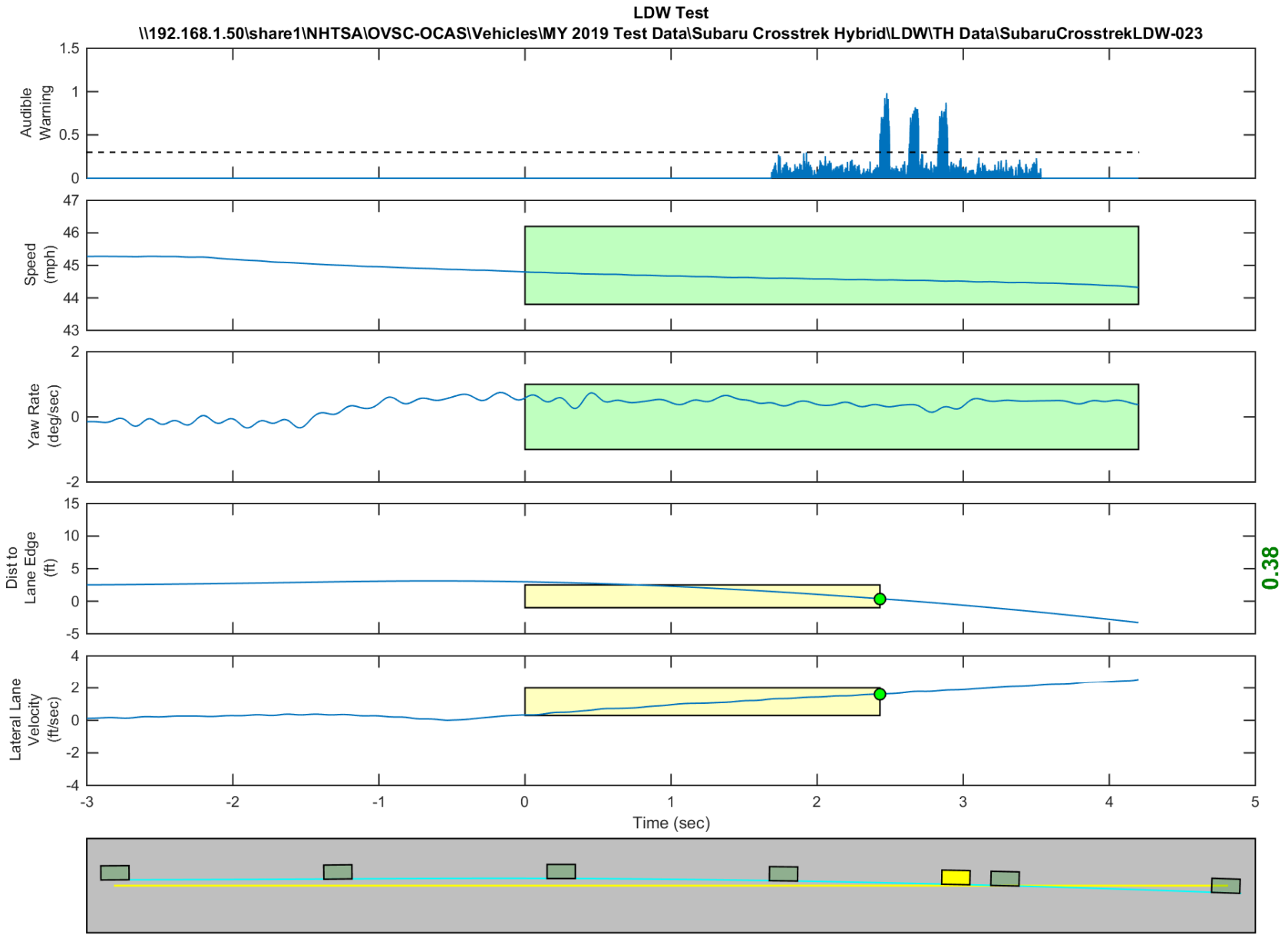


Figure D30. Time History for Run 23, Solid Line, Right Departure, Audible Warning

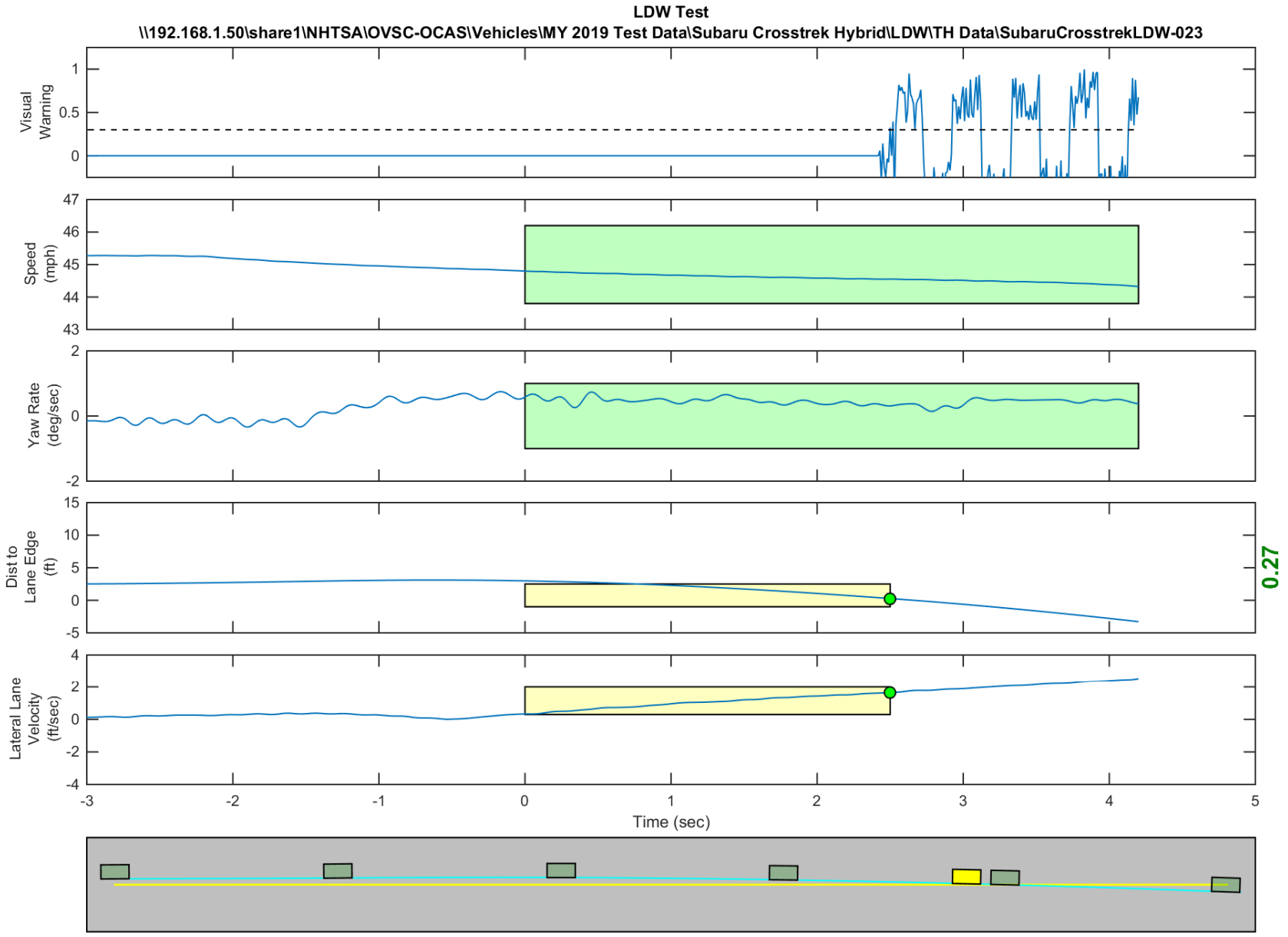


Figure D31. Time History for Run 23, Solid Line, Right Departure, Visual Warning

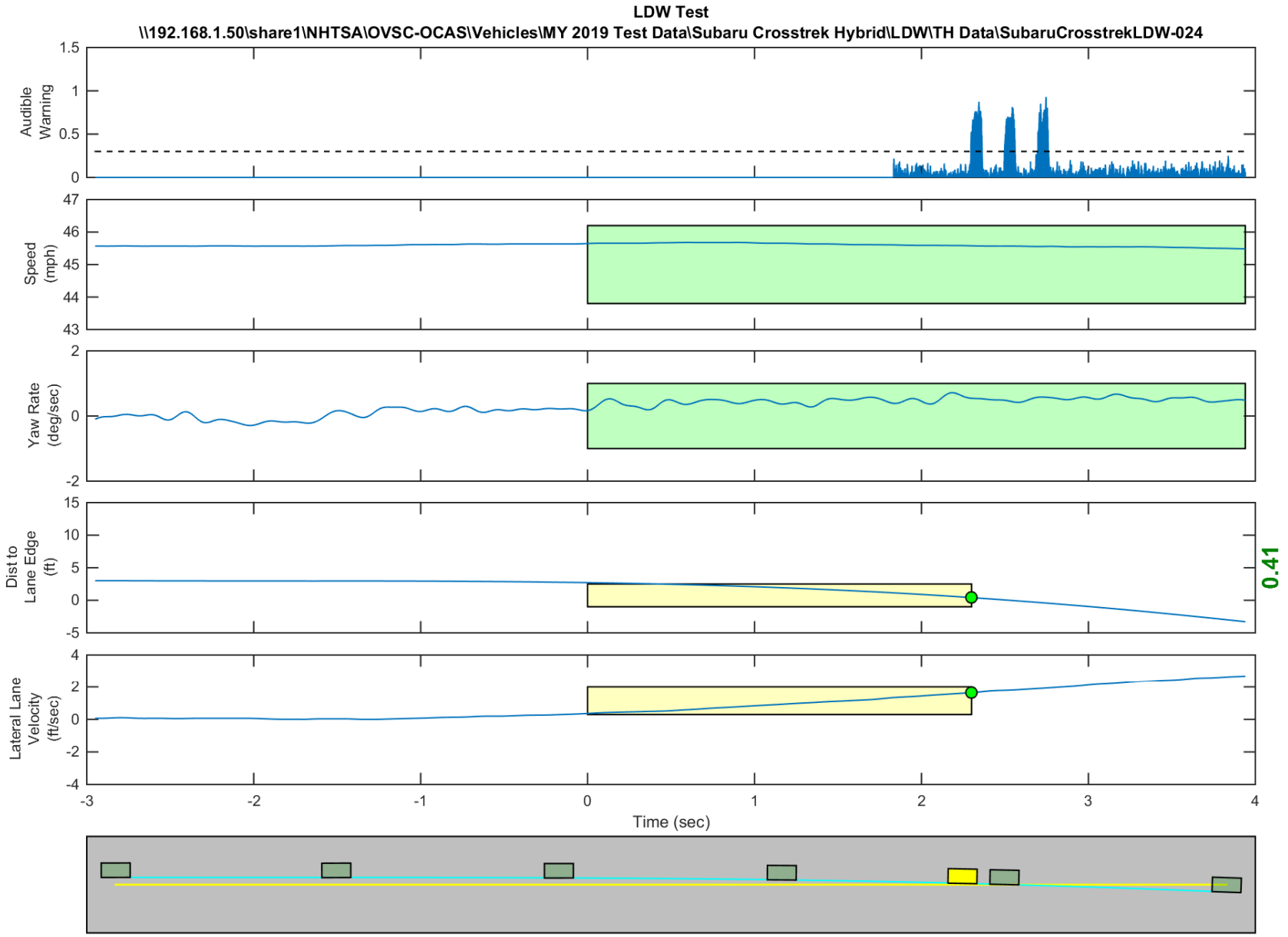


Figure D32. Time History for Run 24, Dashed Line, Right Departure, Audible Warning

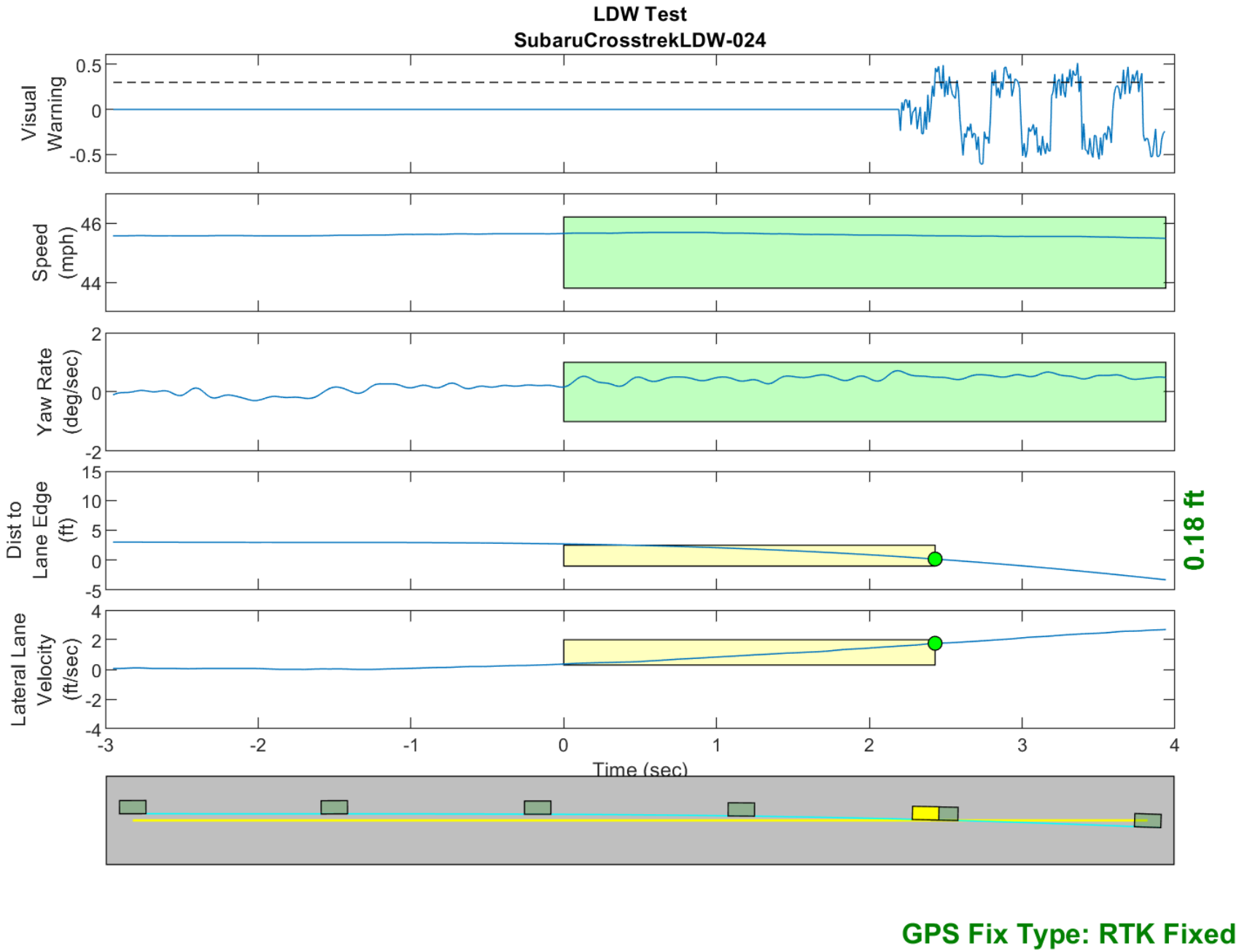


Figure D33. Time History for Run 24, Dashed Line, Right Departure, Visual Warning

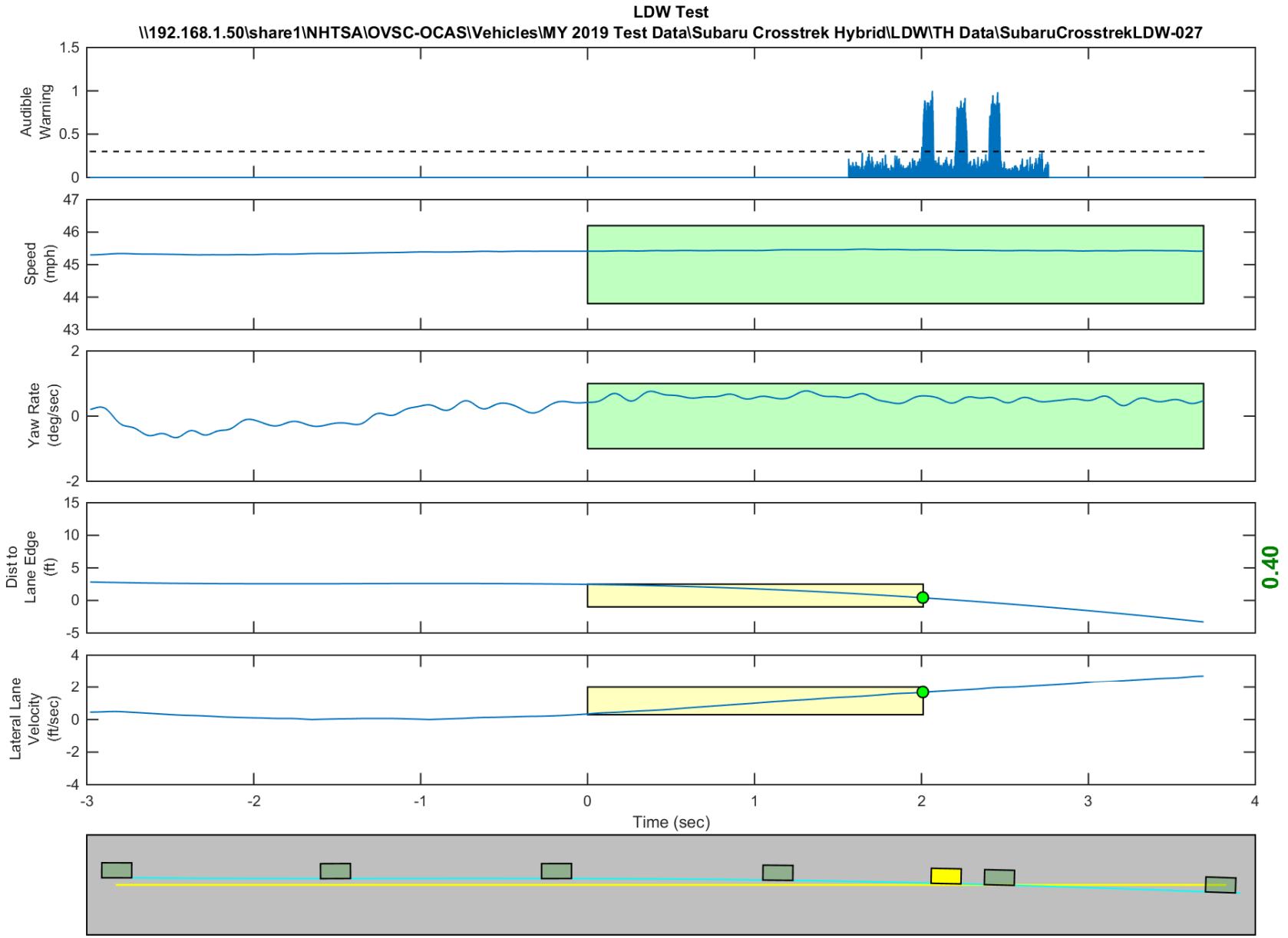


Figure D34. Time History for Run 27, Dashed Line, Right Departure, Audible Warning

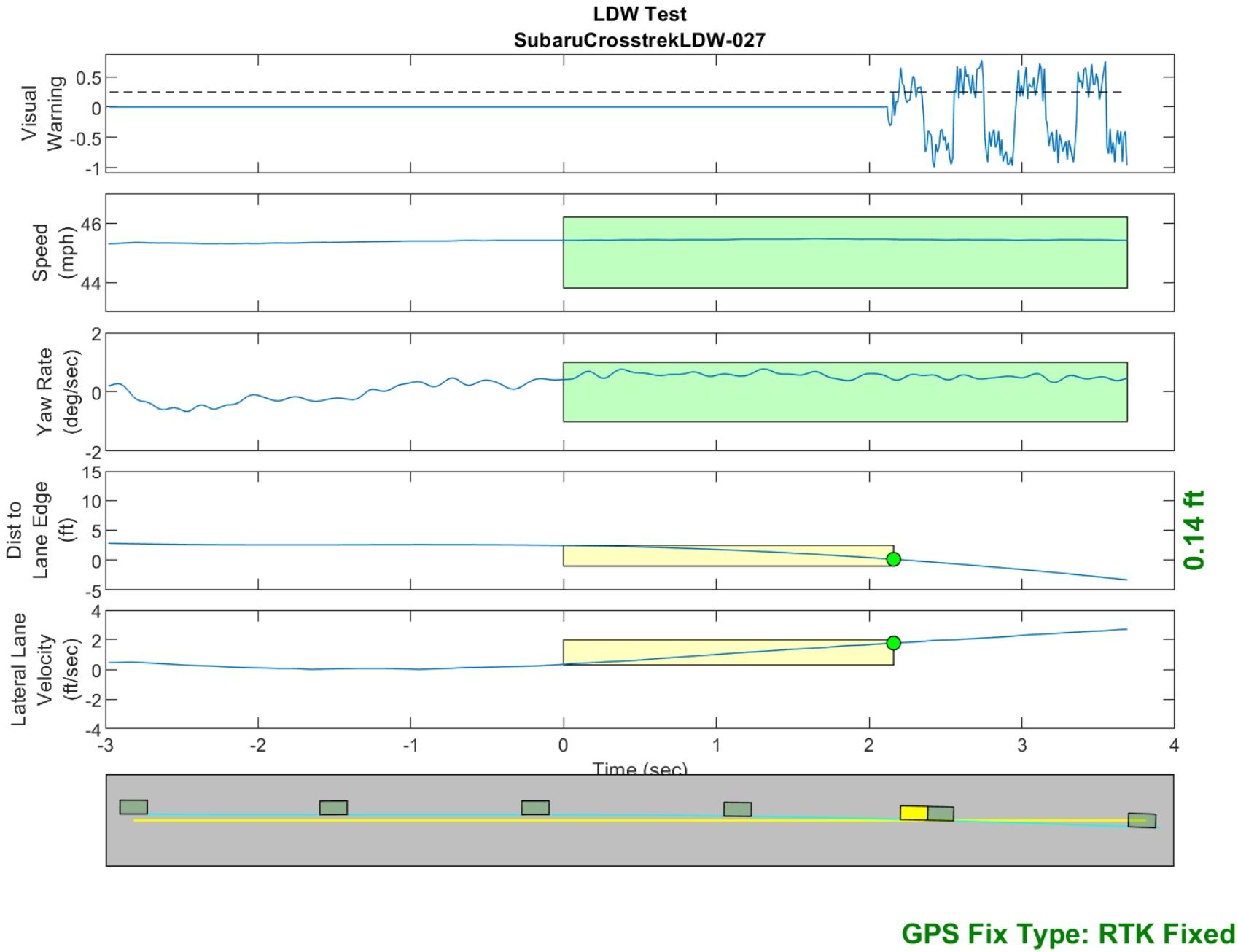


Figure D35. Time History for Run 27, Dashed Line, Right Departure, Visual Warning

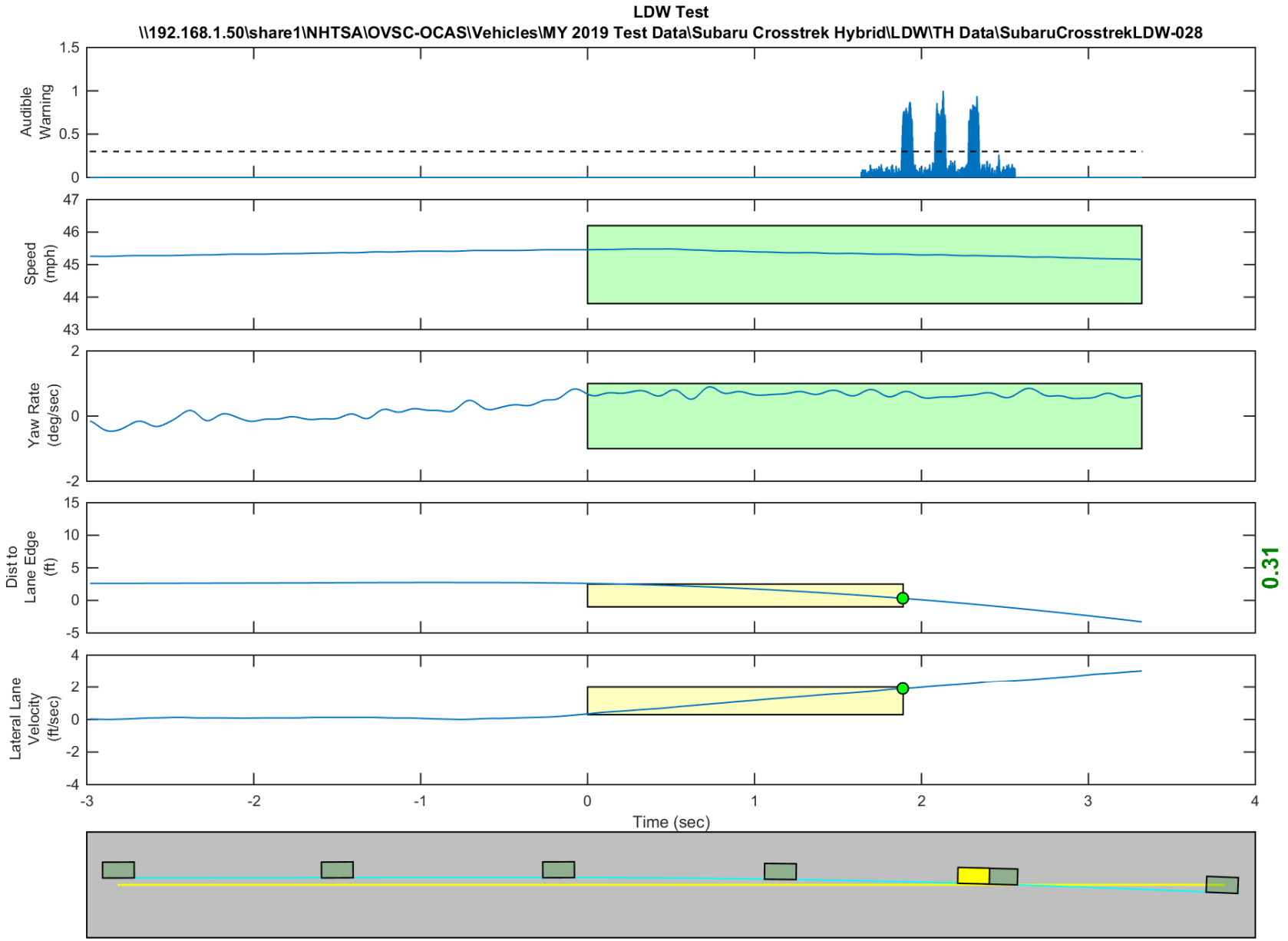


Figure D36. Time History for Run 28, Dashed Line, Right Departure, Audible Warning

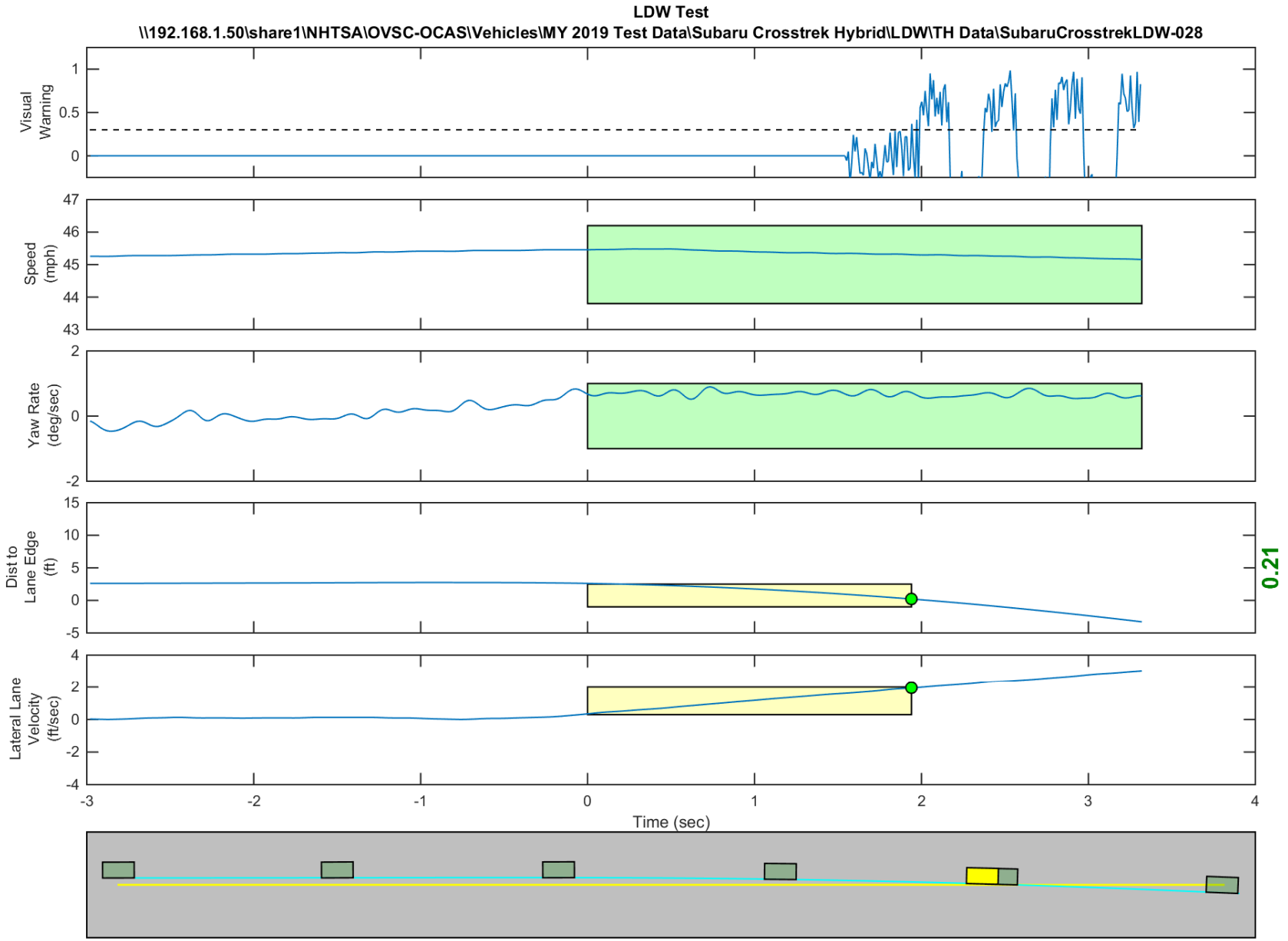


Figure D37. Time History for Run 28, Dashed Line, Right Departure, Visual Warning

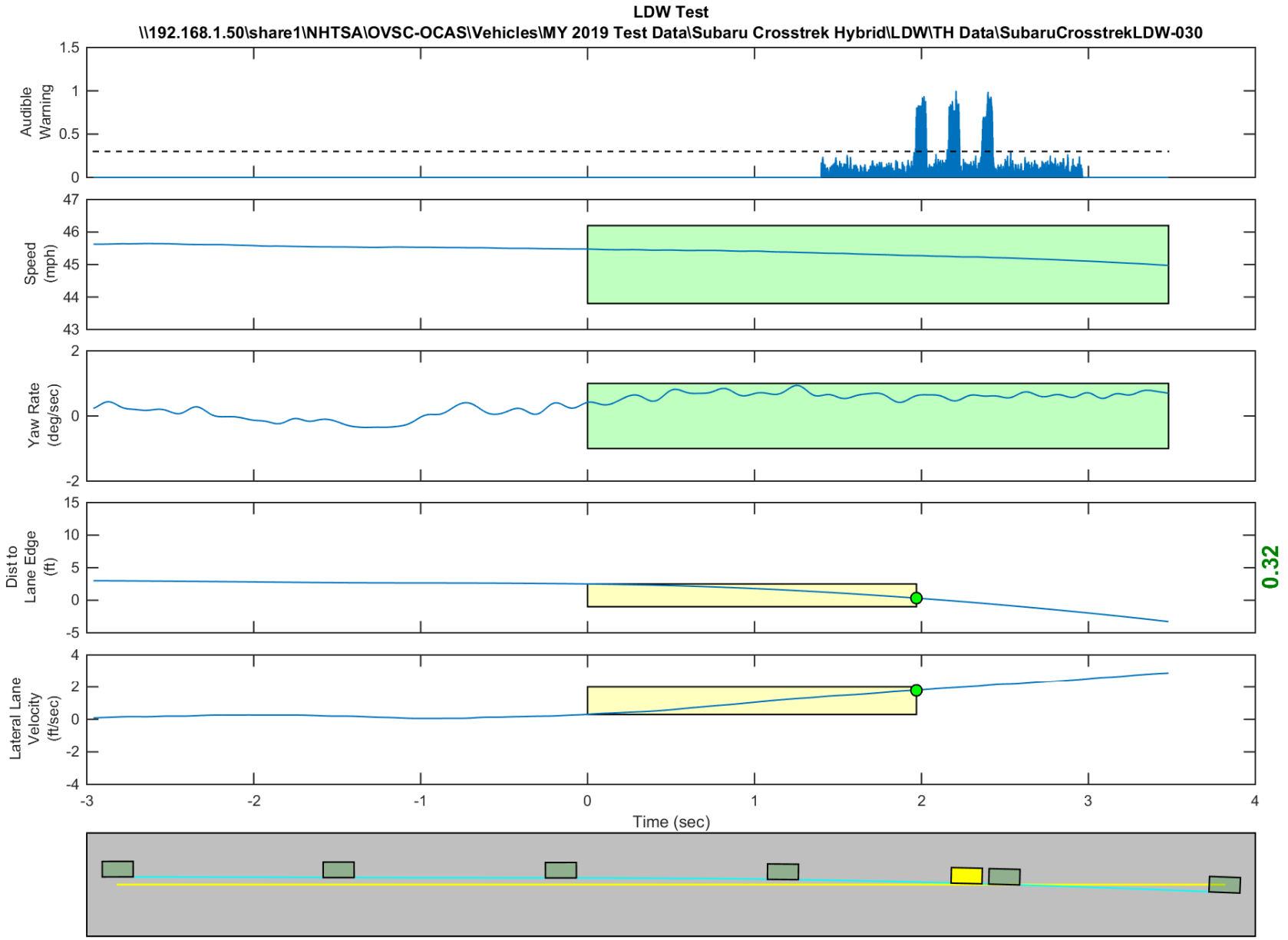


Figure D38. Time History for Run 30, Dashed Line, Right Departure, Audible Warning

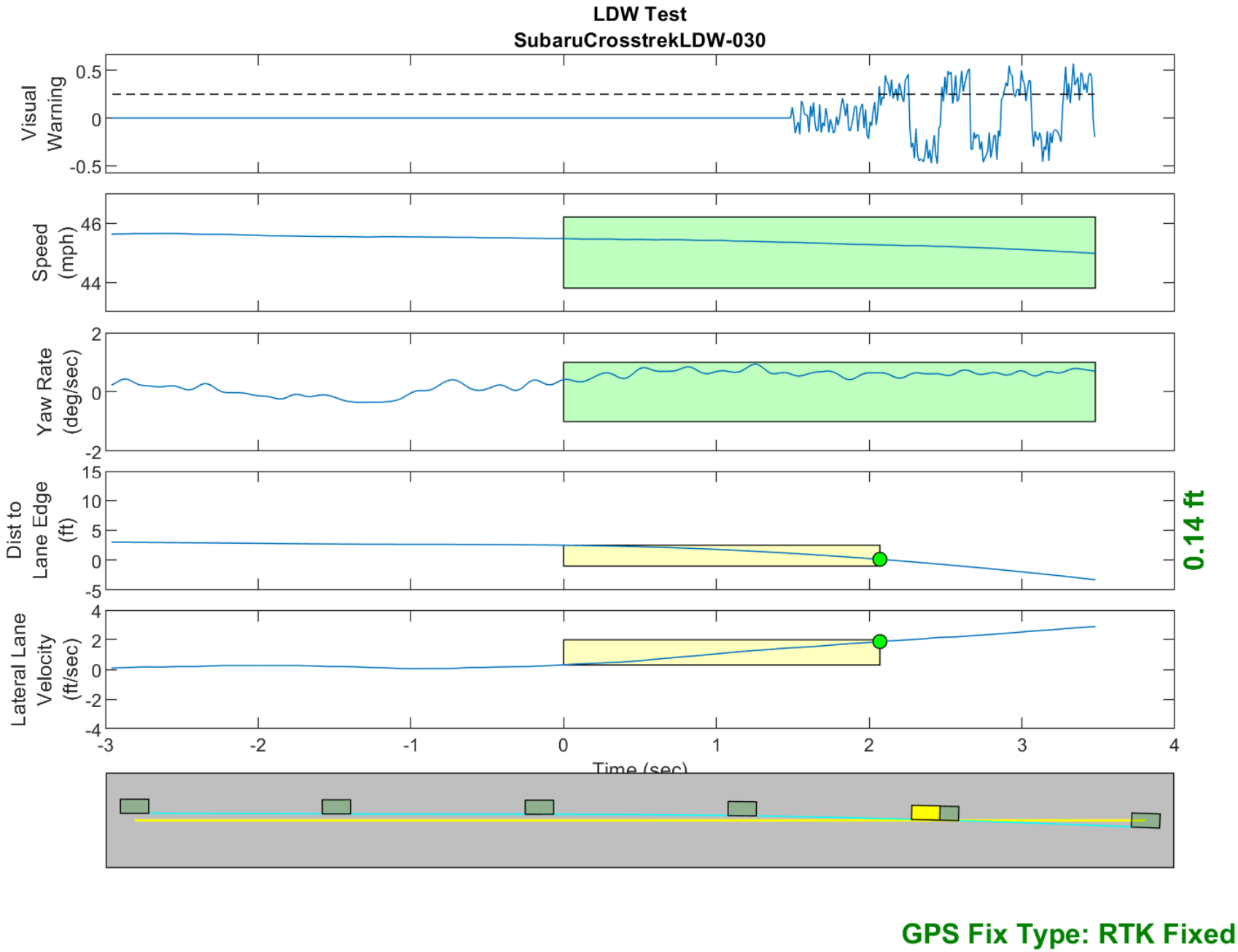


Figure D39. Time History for Run 30, Dashed Line, Right Departure, Visual Warning

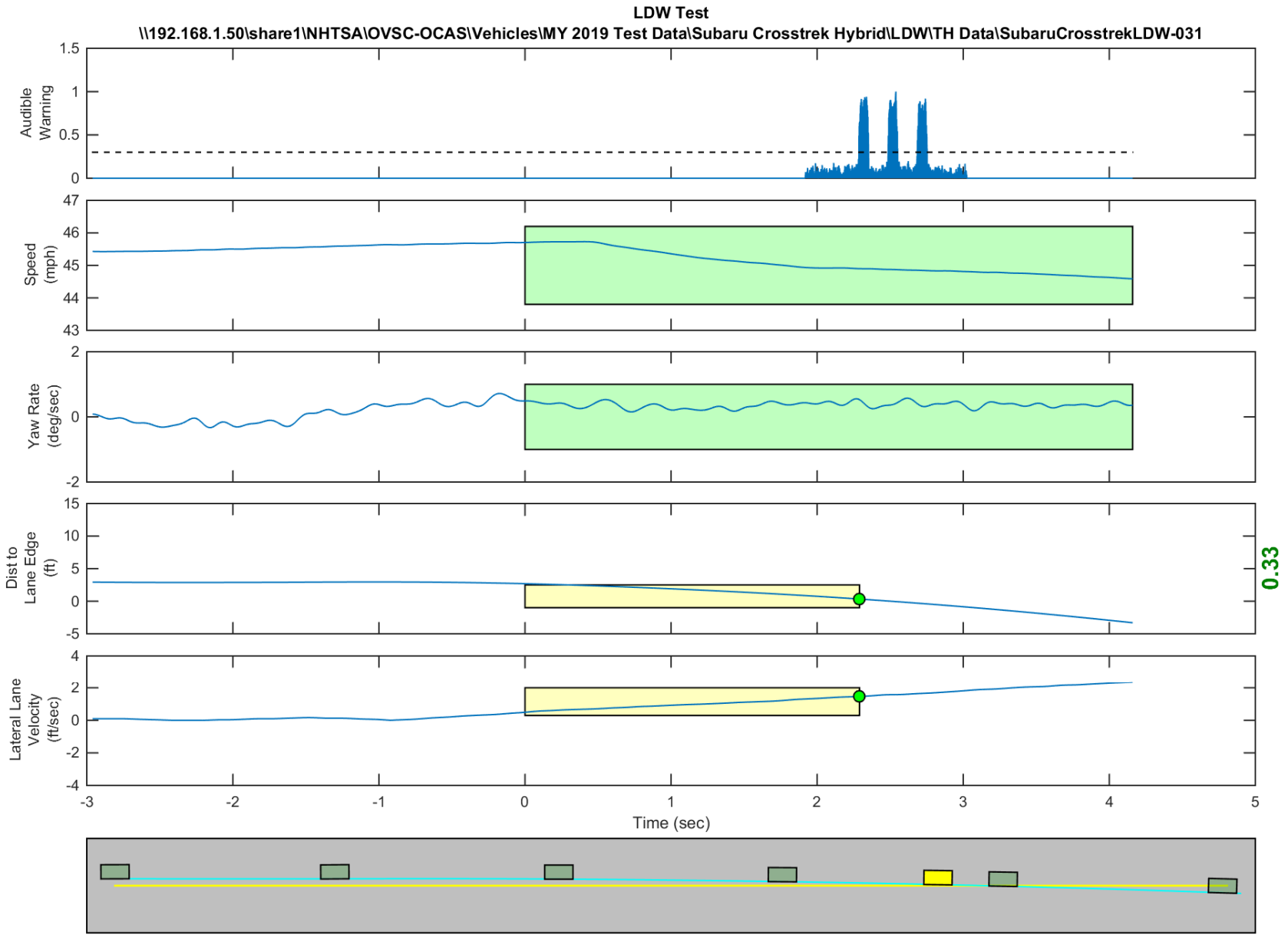


Figure D40. Time History for Run 31, Dashed Line, Right Departure, Audible Warning

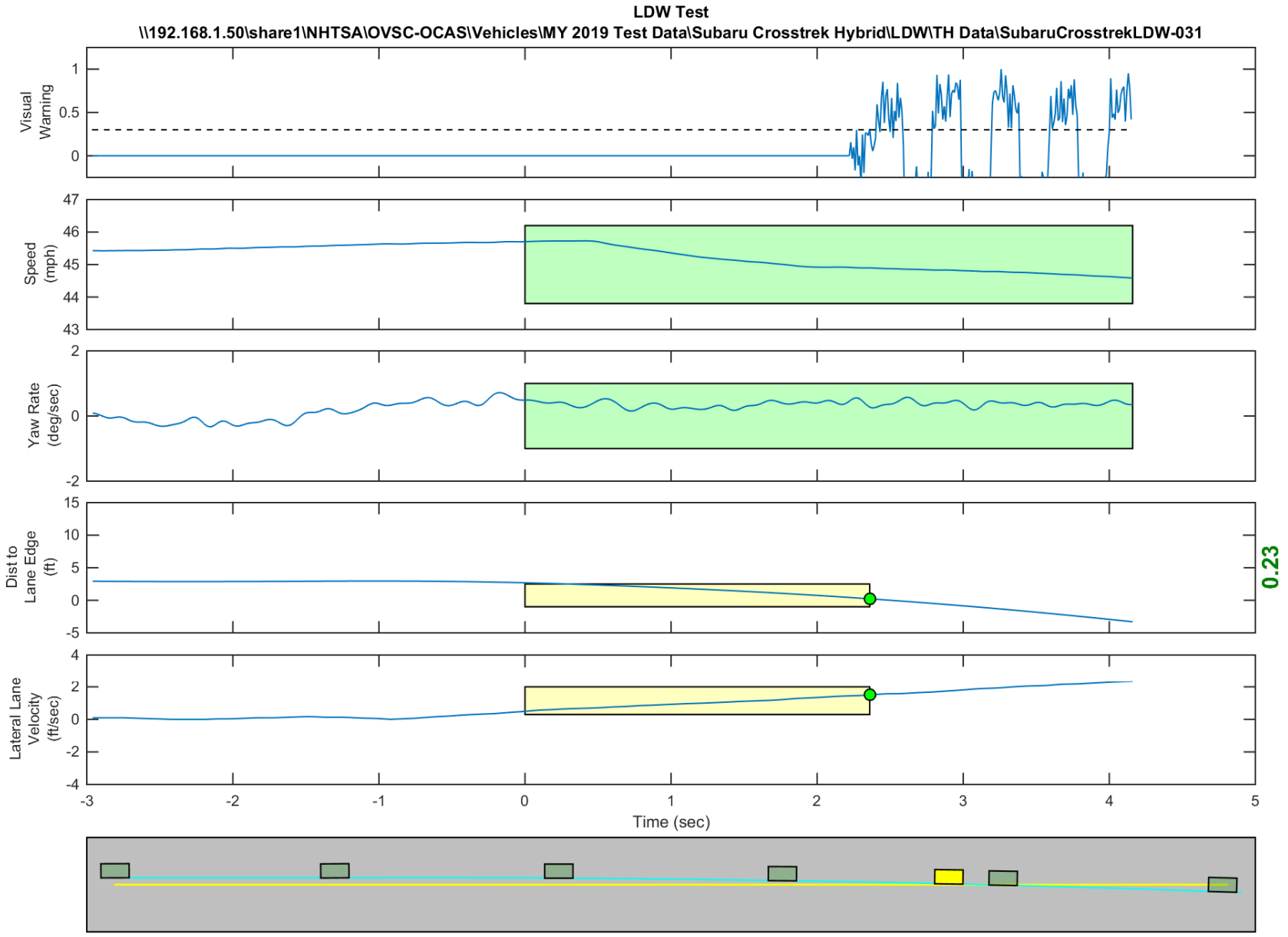


Figure D41. Time History for Run 31, Dashed Line, Right Departure, Visual Warning

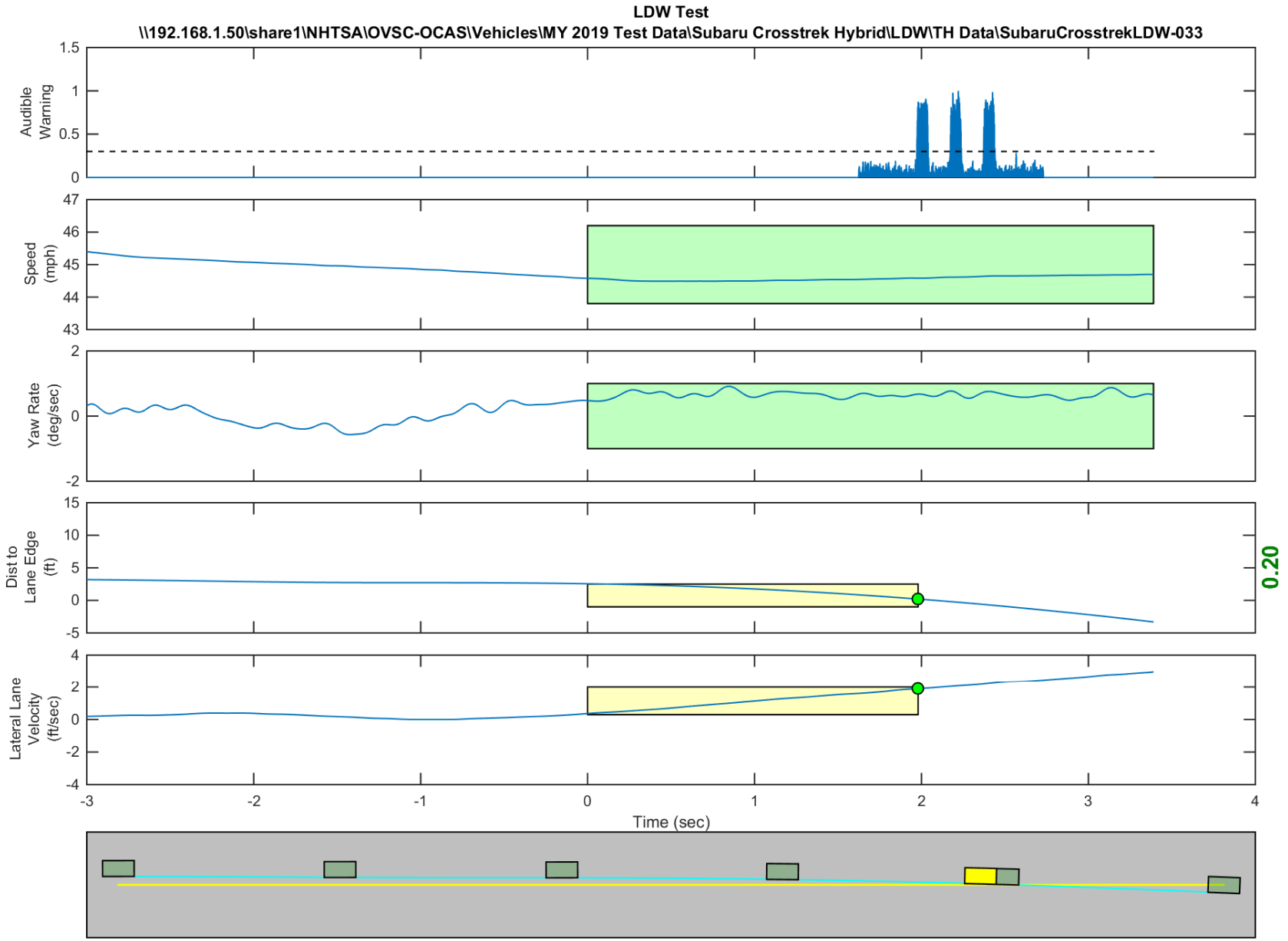


Figure D42. Time History for Run 33, Dashed Line, Right Departure, Audible Warning

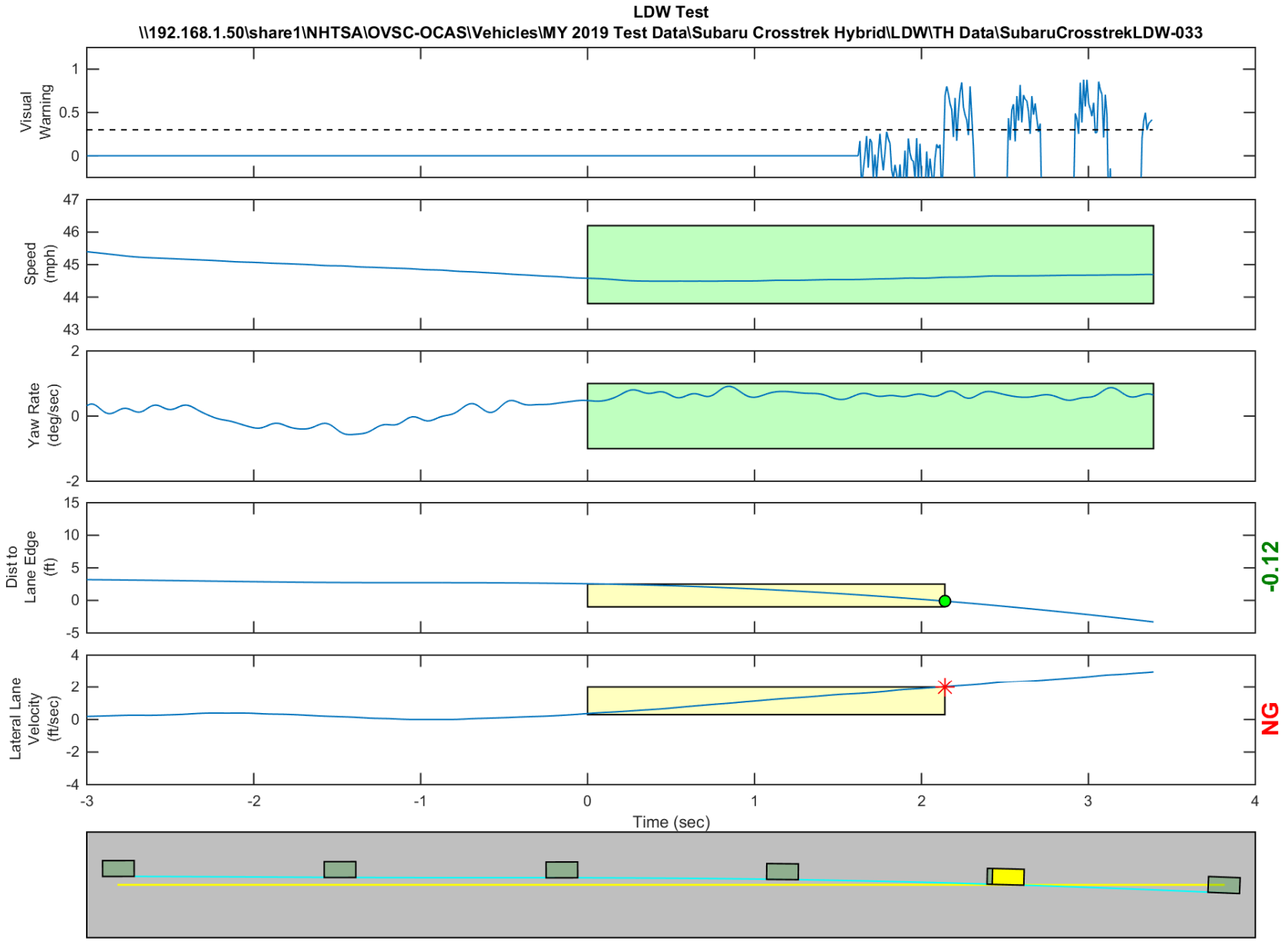


Figure D43. Time History for Run 33, Dashed Line, Right Departure, Visual Warning

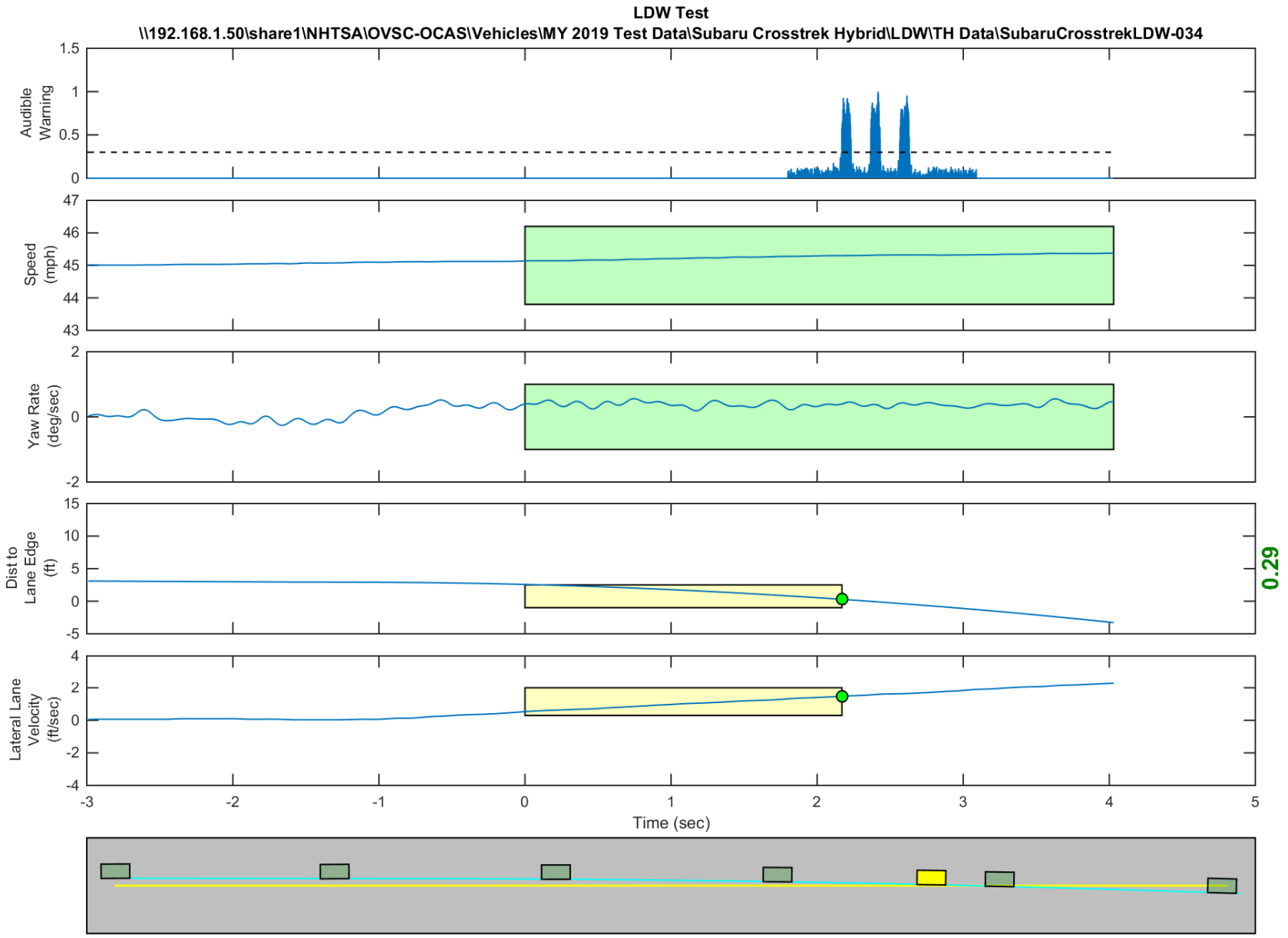


Figure D44. Time History for Run 34, Dashed Line, Right Departure, Audible Warning

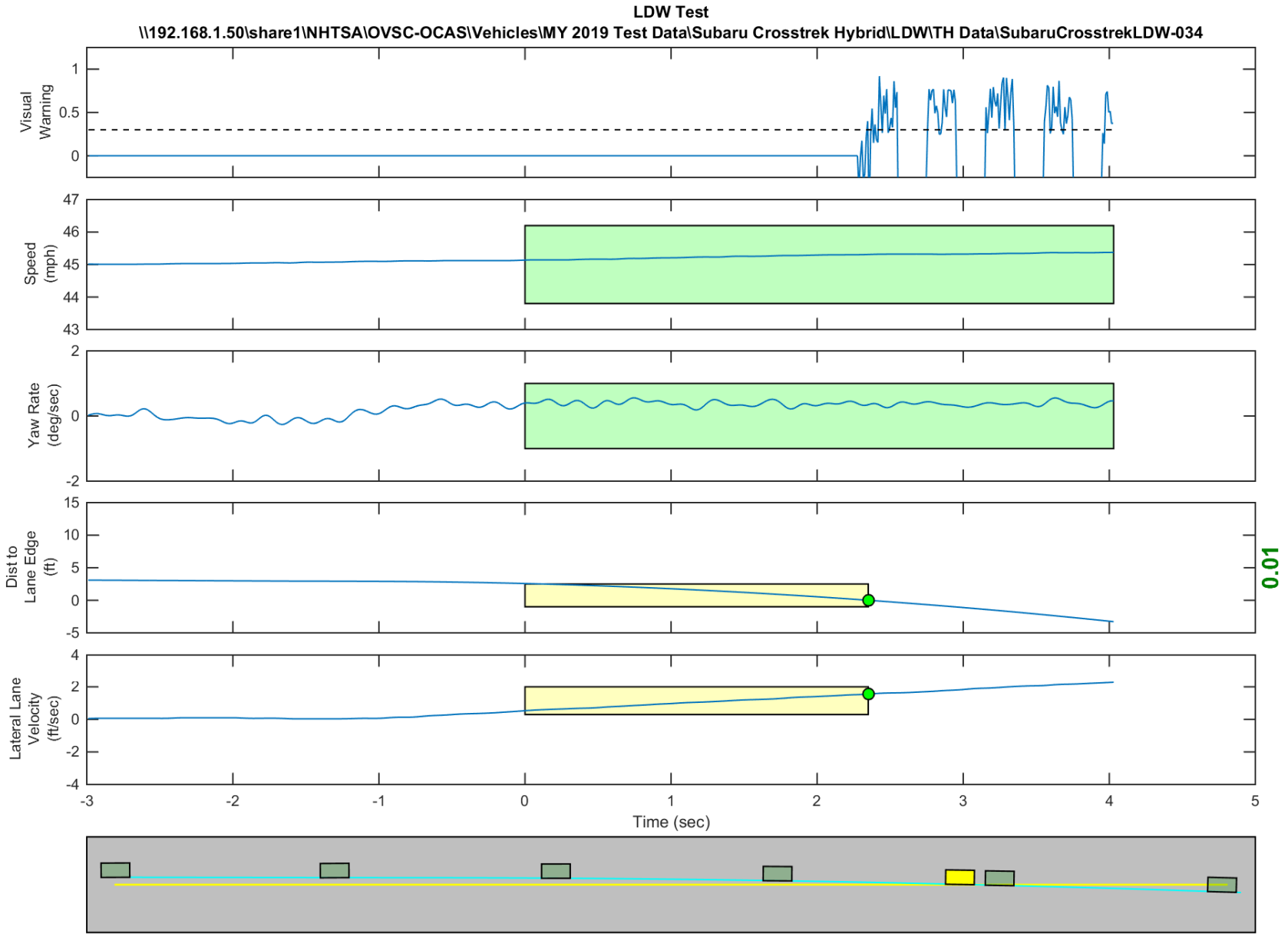


Figure D45. Time History for Run 34, Dashed Line, Right Departure, Visual Warning

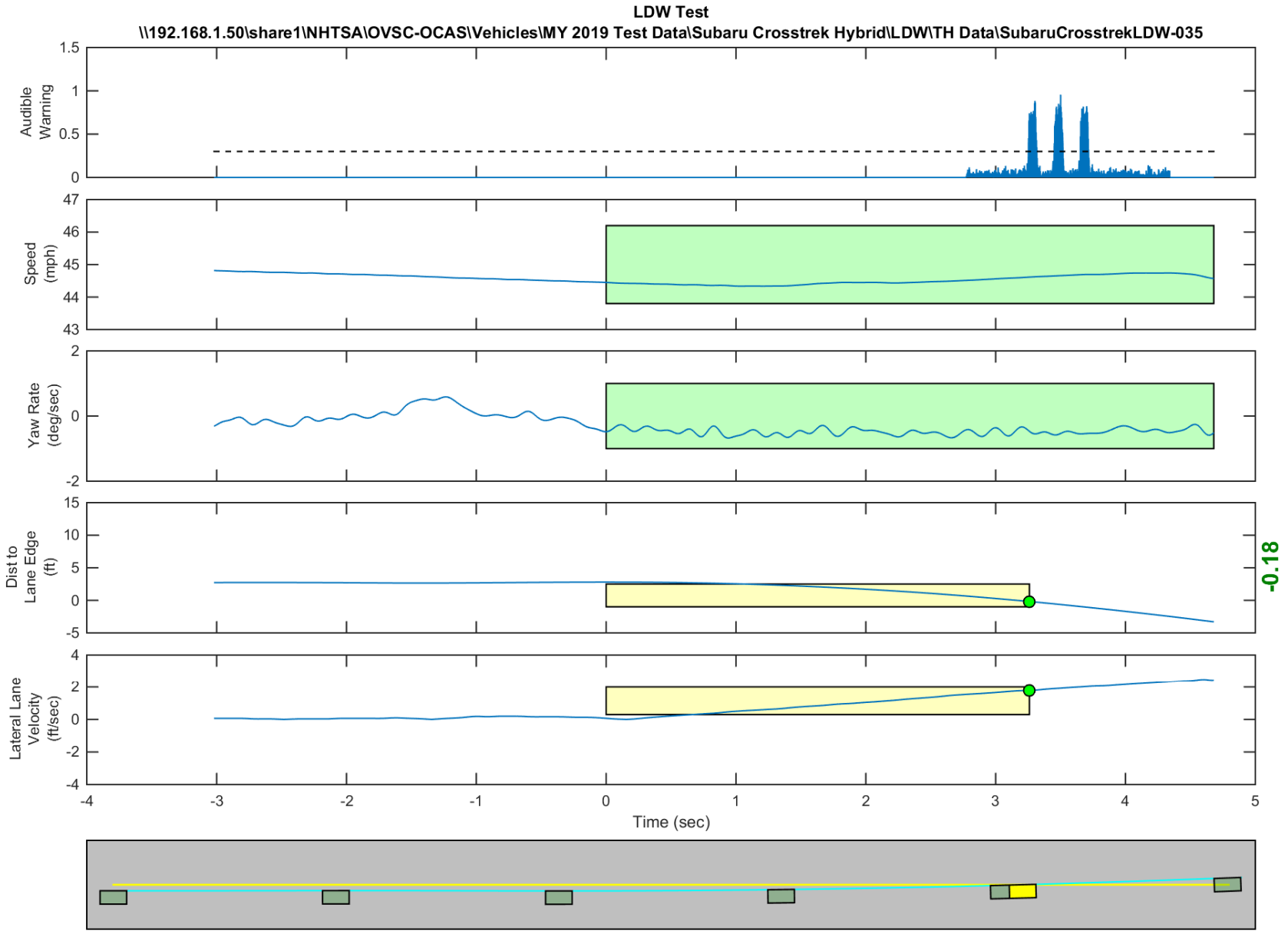


Figure D46. Time History for Run 35, Dashed Line, Left Departure, Audible Warning

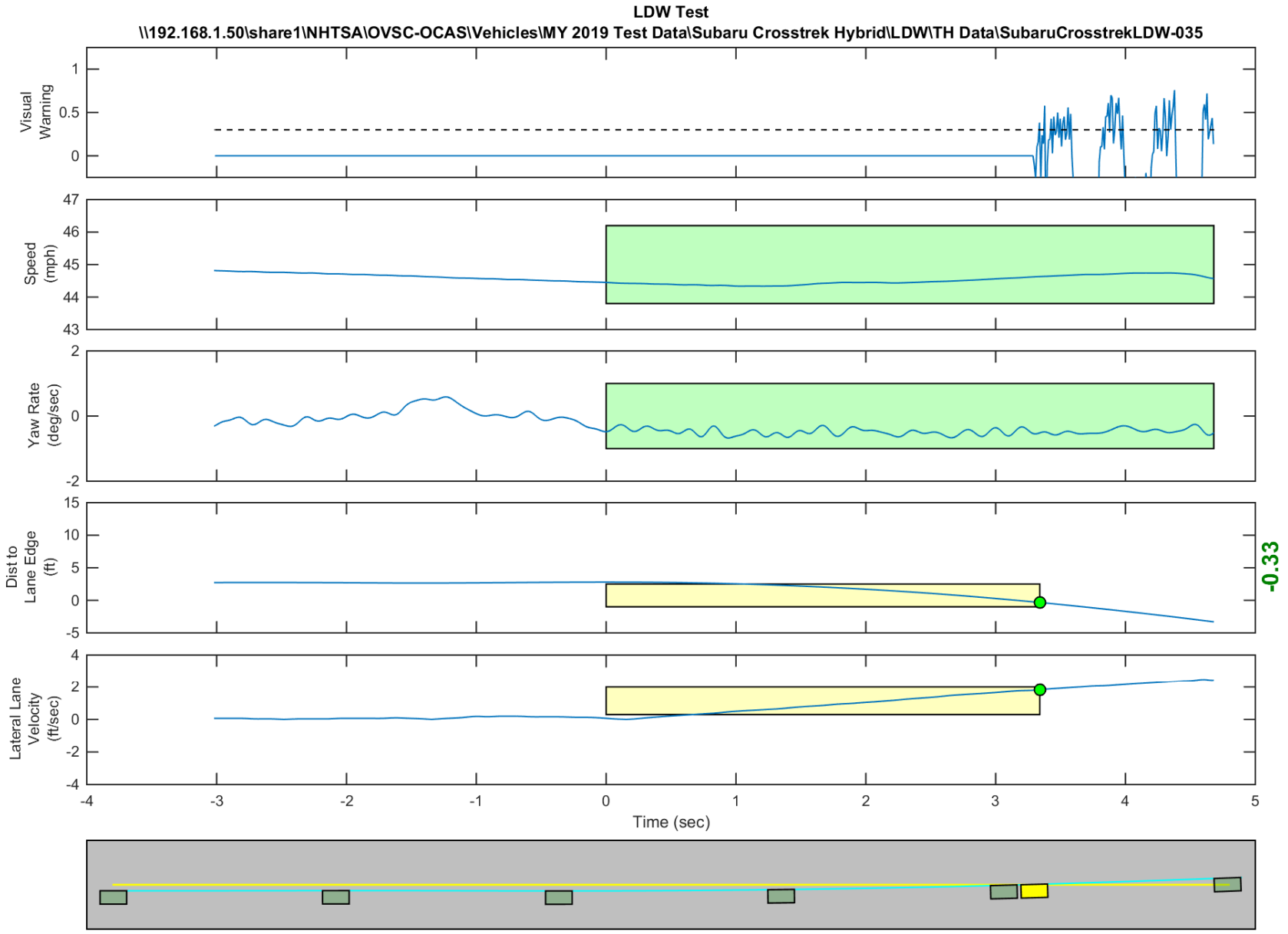


Figure D47. Time History for Run 35, Dashed Line, Left Departure, Visual Warning

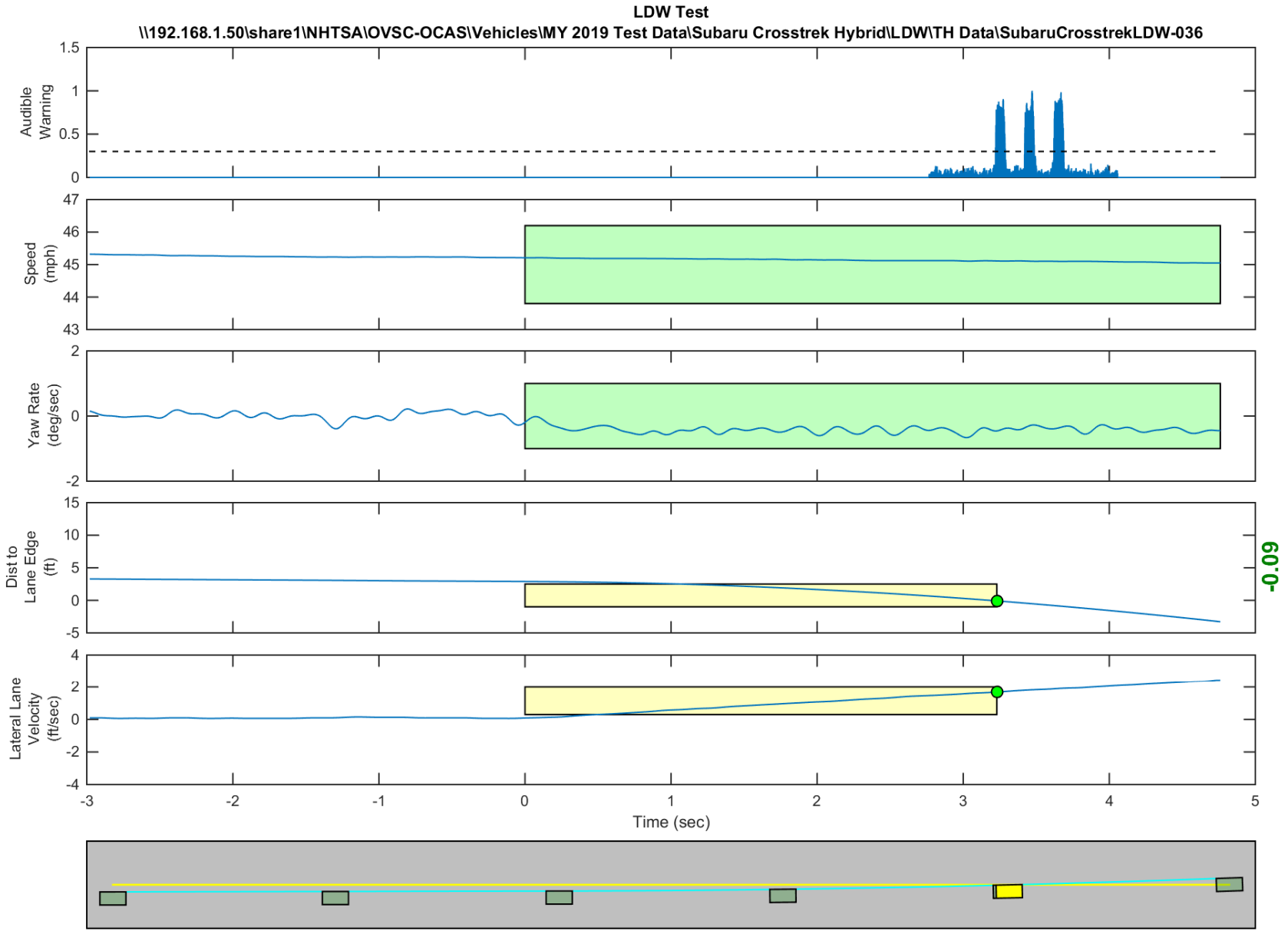


Figure D48. Time History for Run 36, Dashed Line, Left Departure, Audible Warning

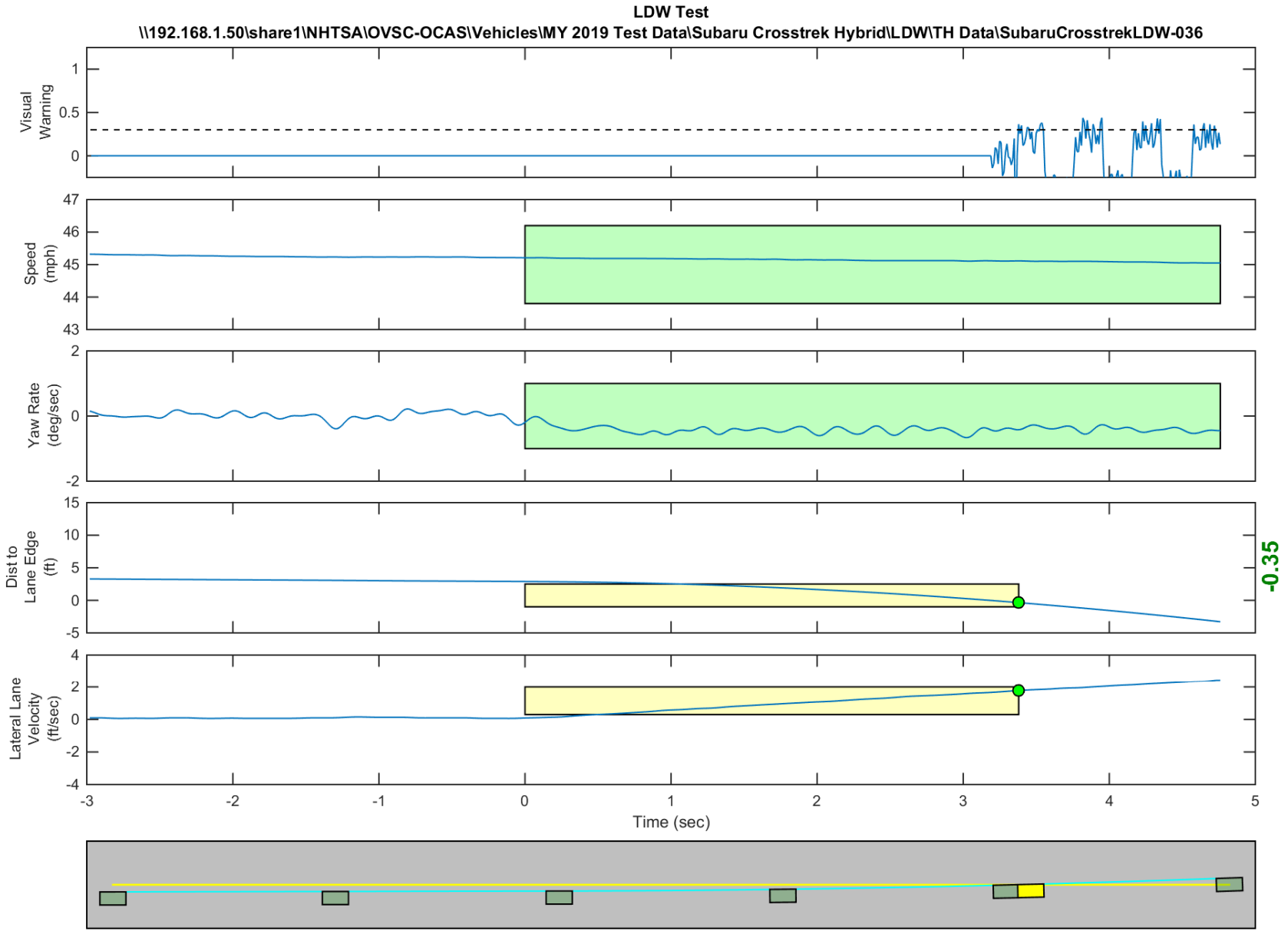


Figure D49. Time History for Run 36, Dashed Line, Left Departure, Visual Warning

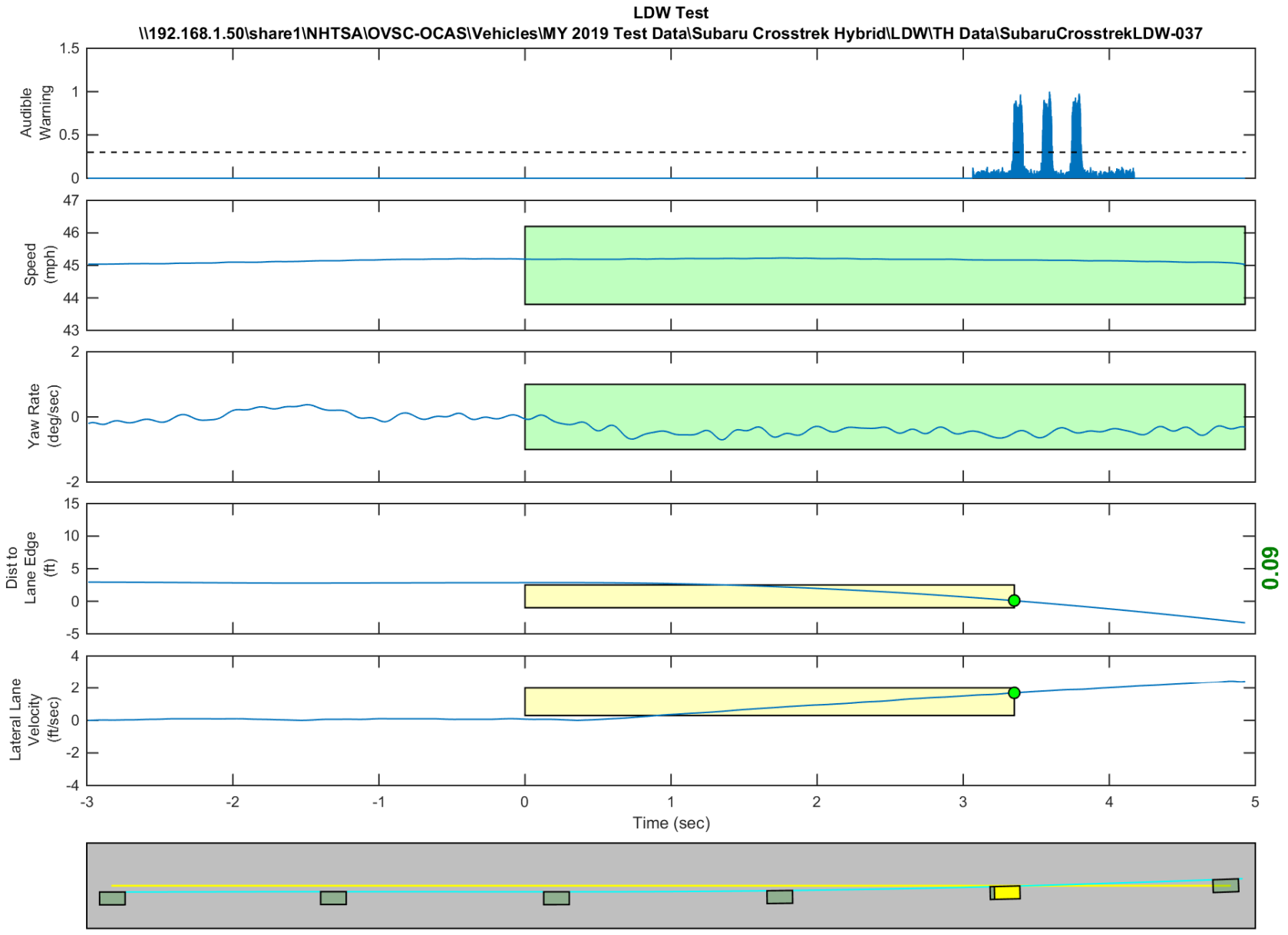


Figure D50. Time History for Run 37, Dashed Line, Left Departure, Audible Warning

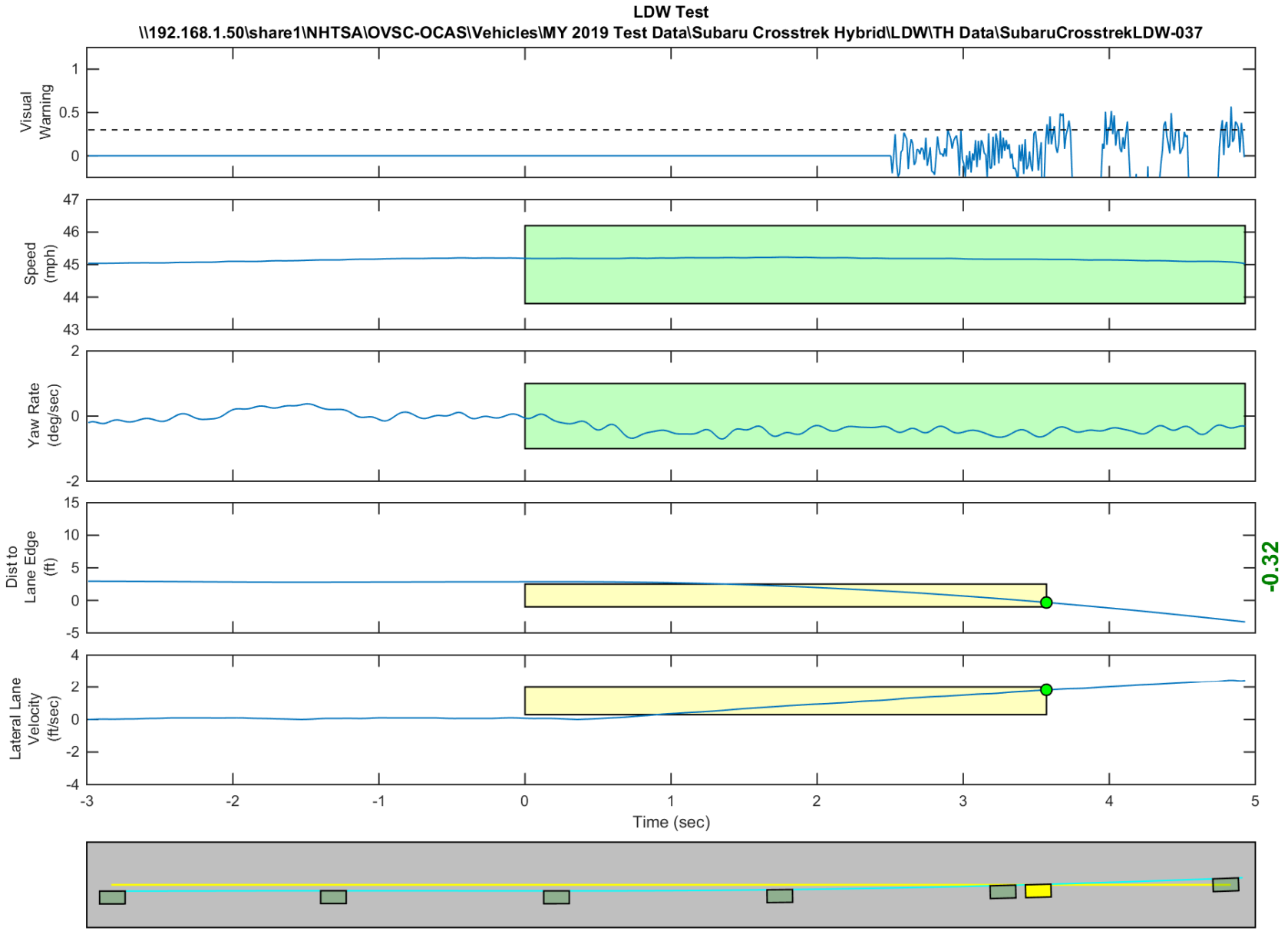


Figure D51. Time History for Run 37, Dashed Line, Left Departure, Visual Warning

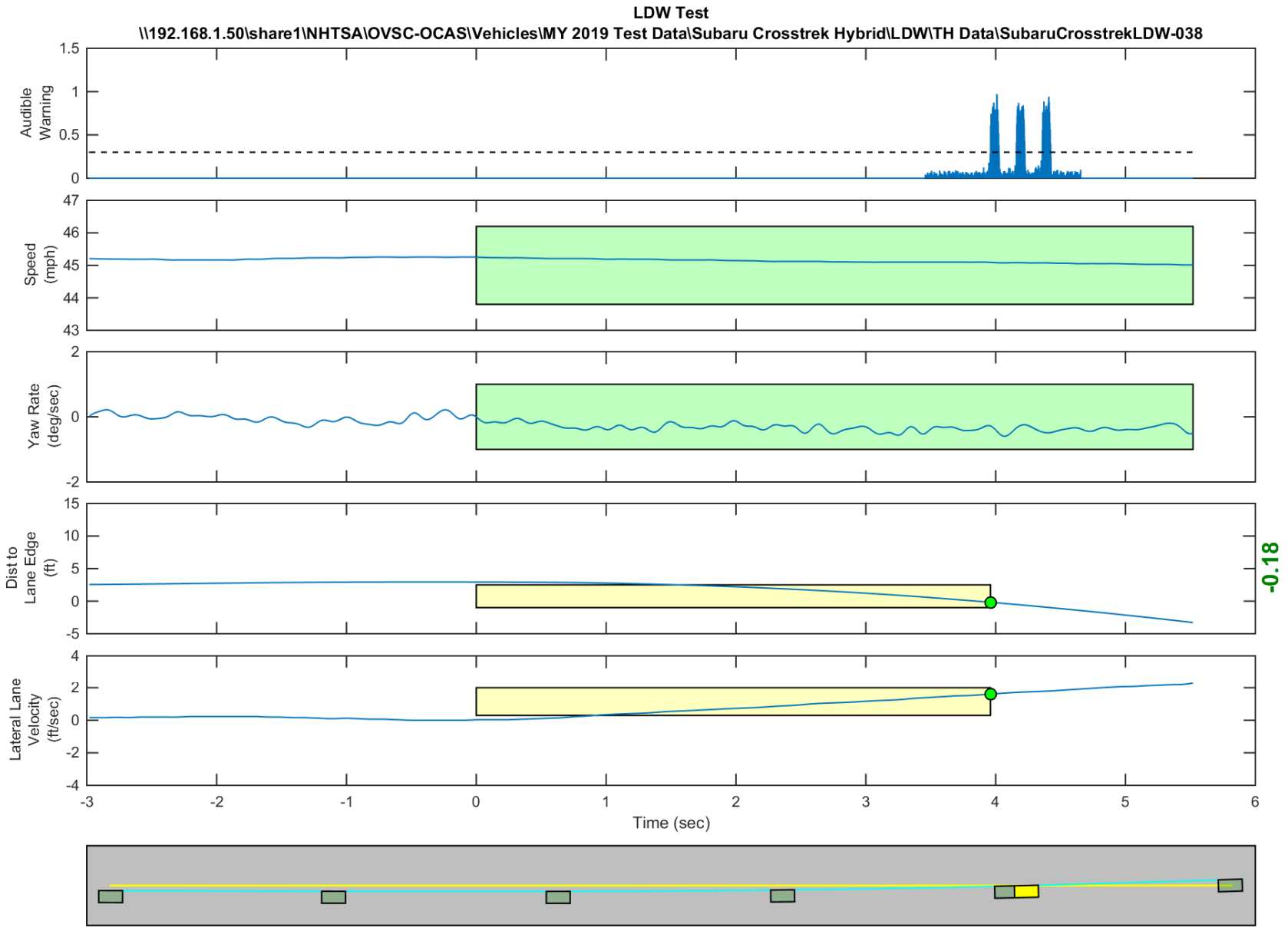


Figure D52. Time History for Run 38, Dashed Line, Left Departure, Audible Warning

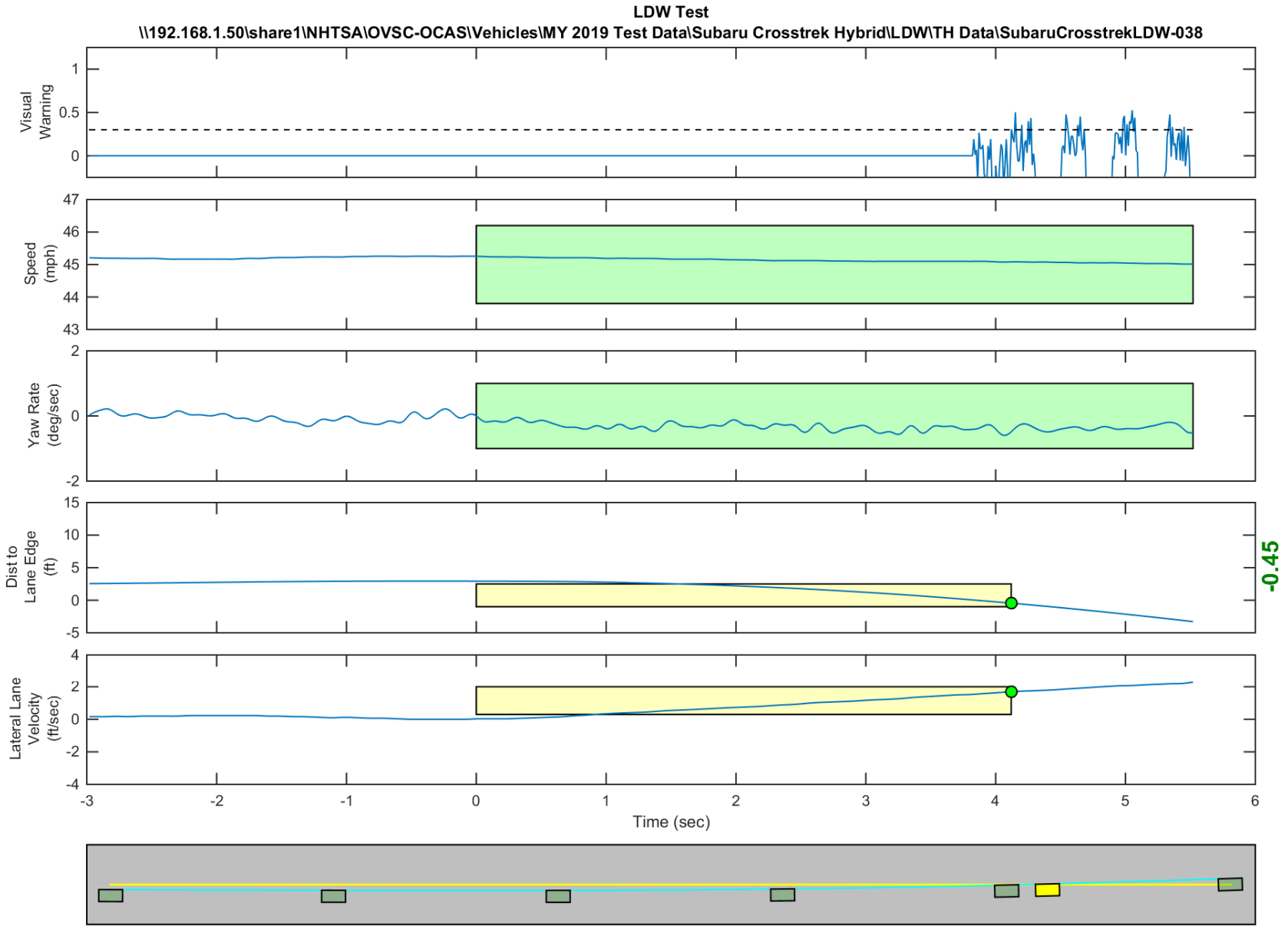


Figure D53. Time History for Run 38, Dashed Line, Left Departure, Visual Warning

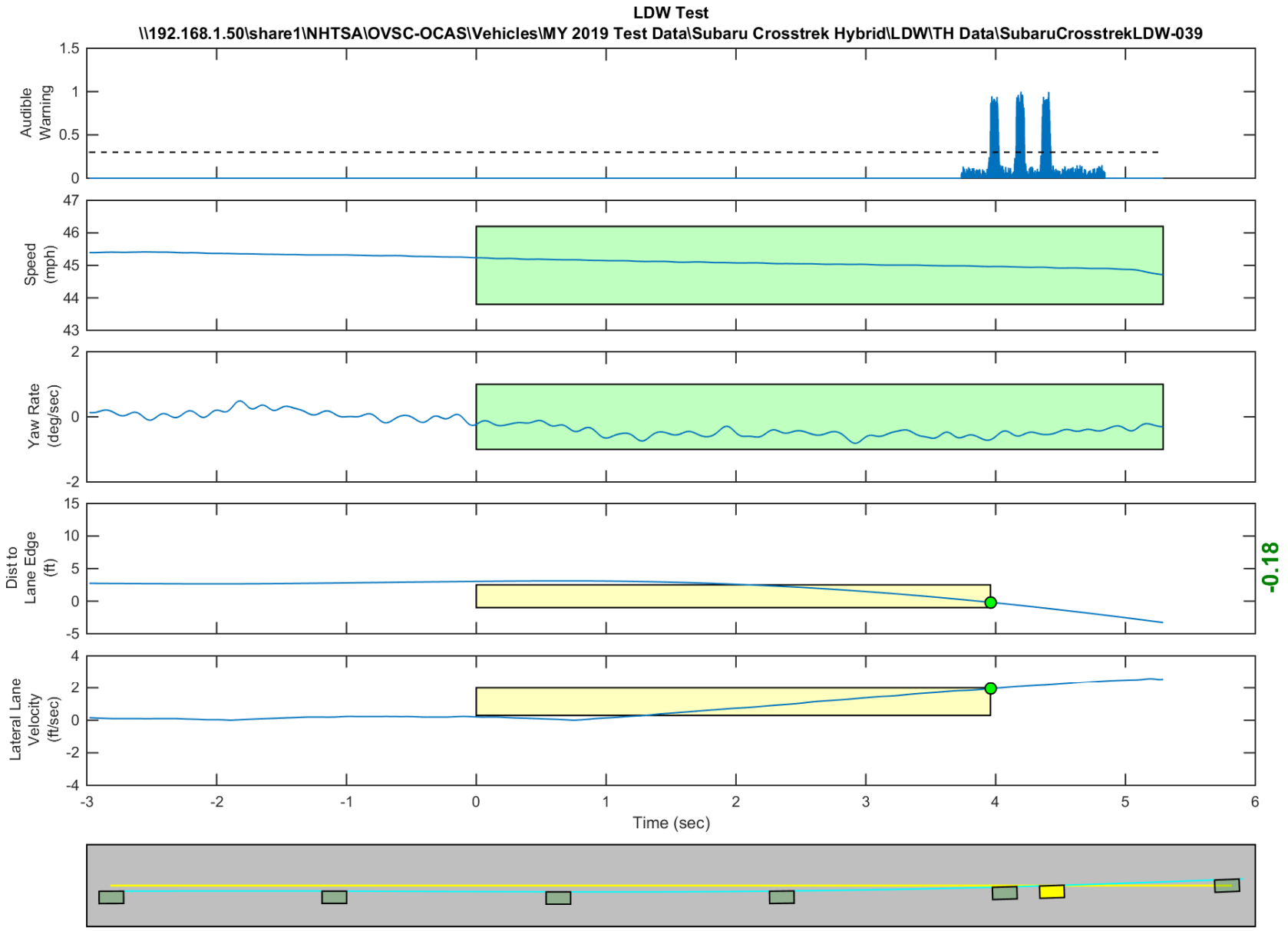


Figure D54. Time History for Run 39, Dashed Line, Left Departure, Audible Warning

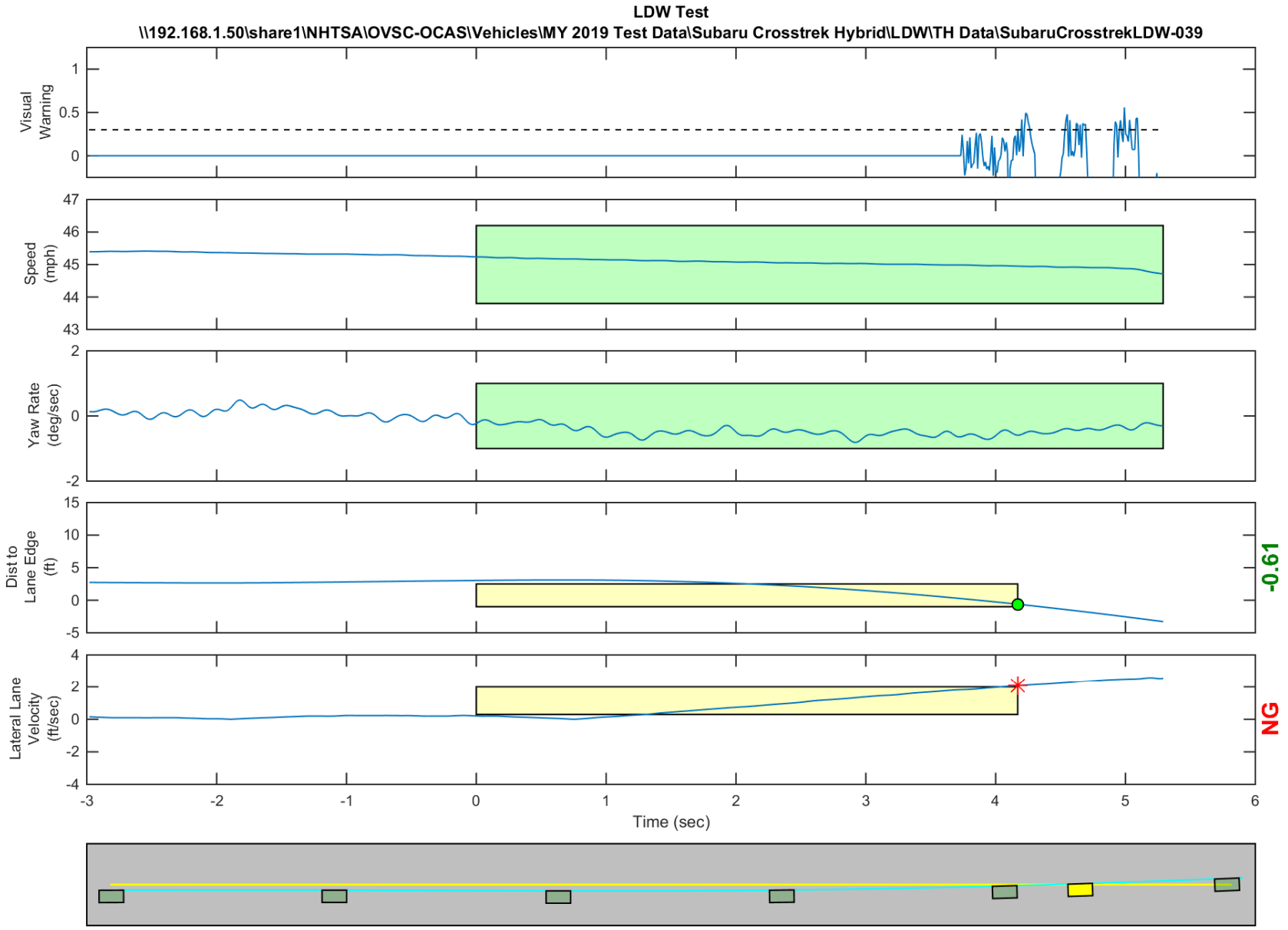


Figure D55. Time History for Run 39, Dashed Line, Left Departure, Visual Warning

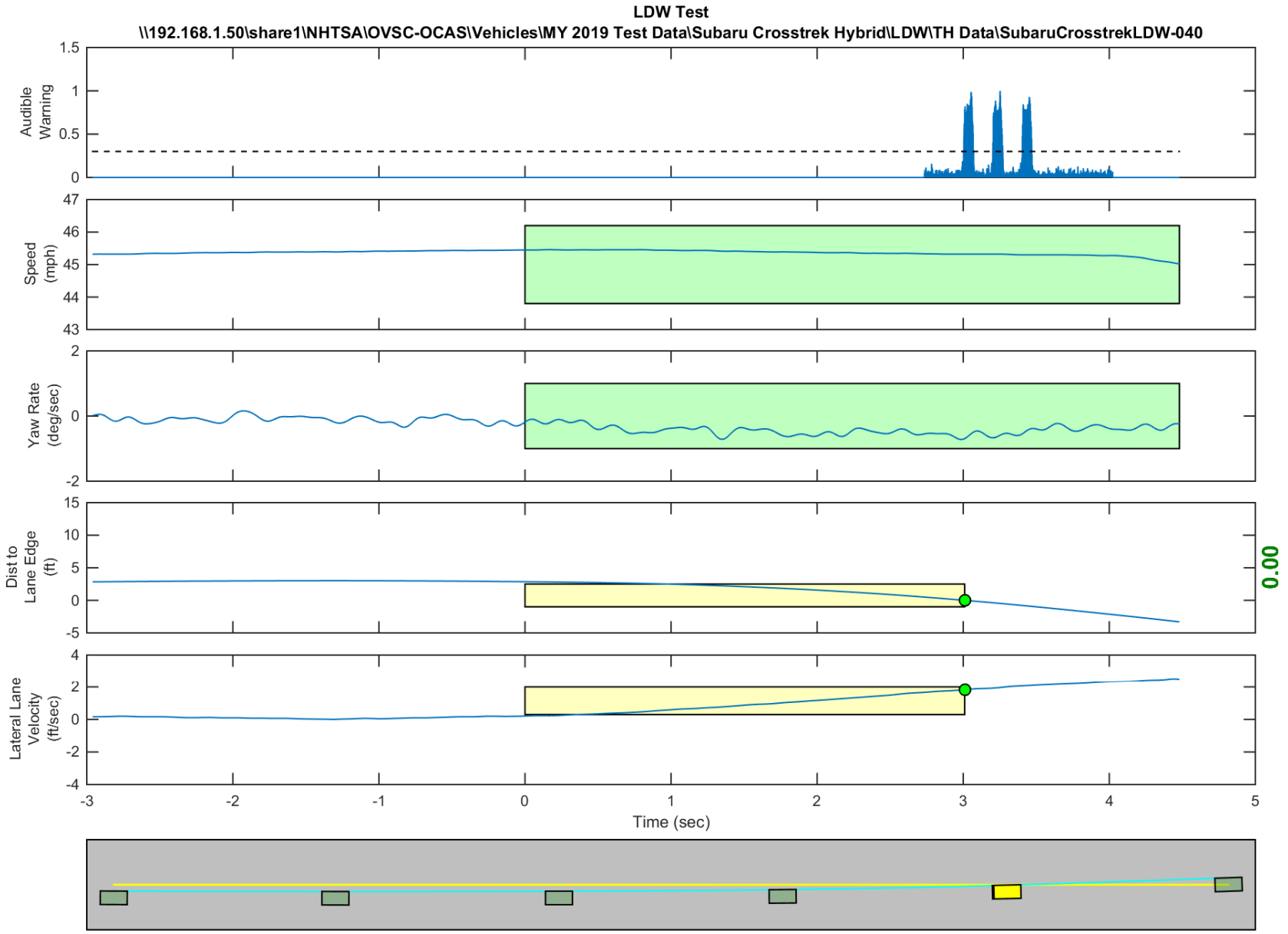


Figure D56. Time History for Run 40, Dashed Line, Left Departure, Audible Warning

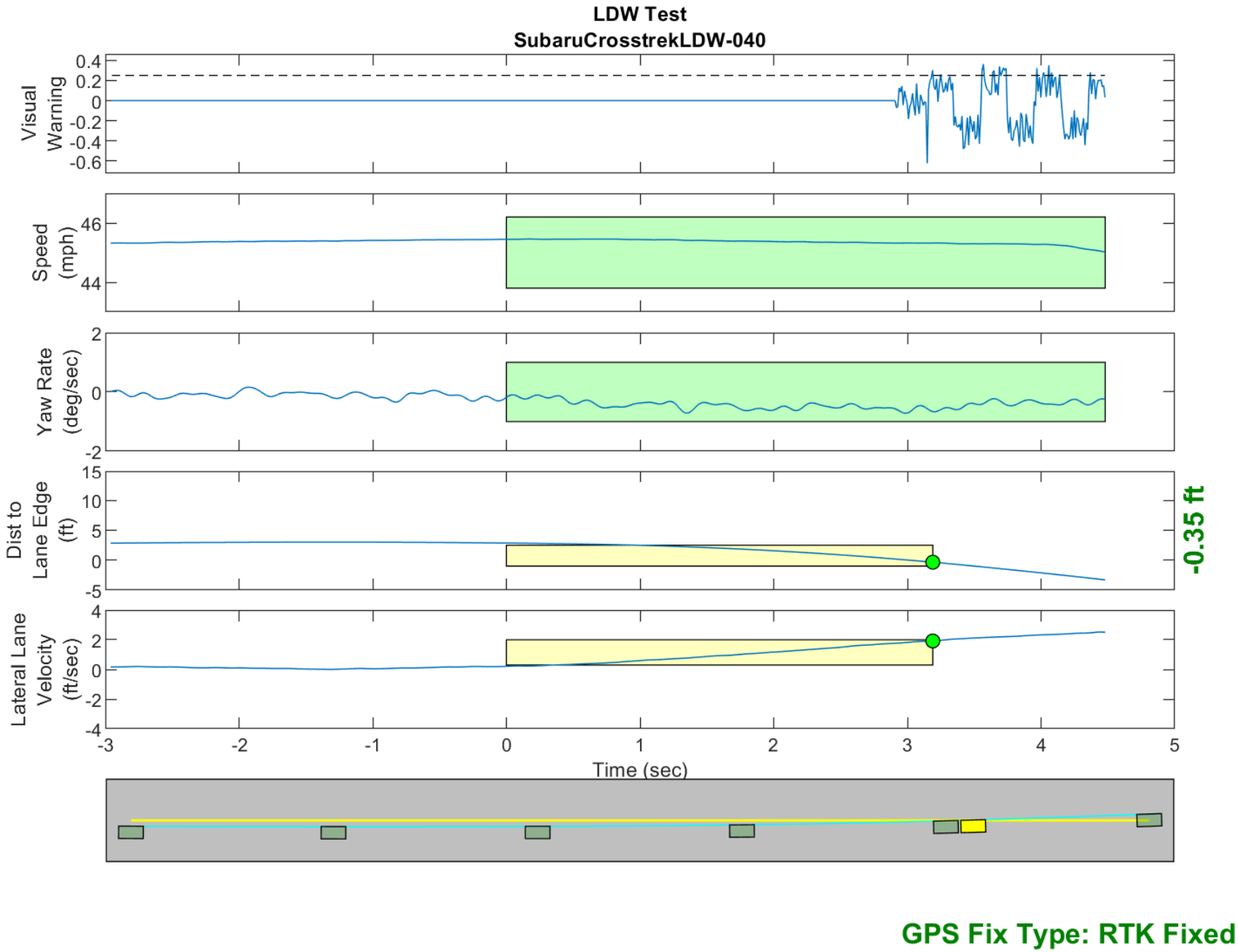


Figure D57. Time History for Run 40, Dashed Line, Left Departure, Visual Warning

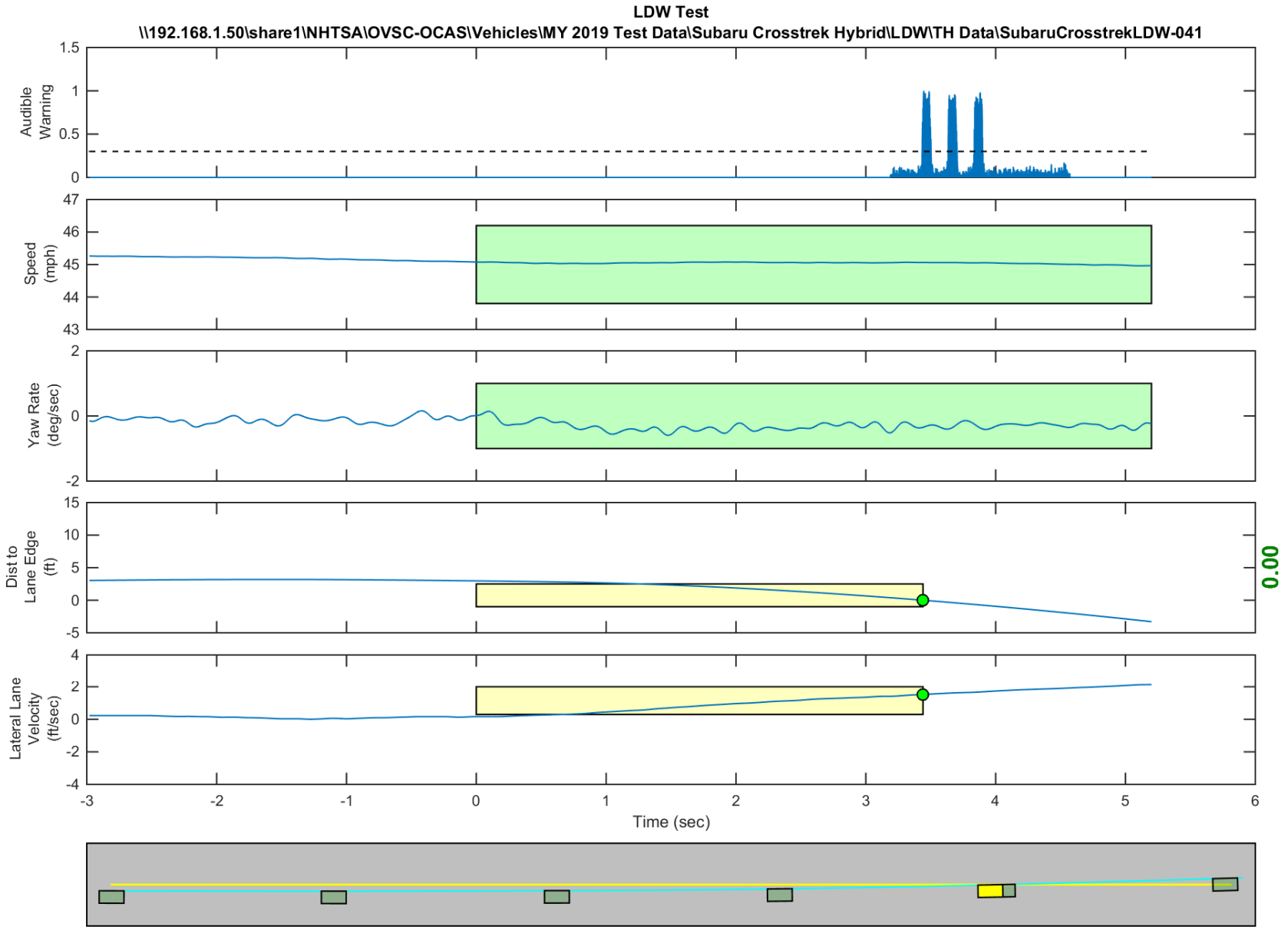


Figure D58. Time History for Run 41, Dashed Line, Left Departure, Audible Warning

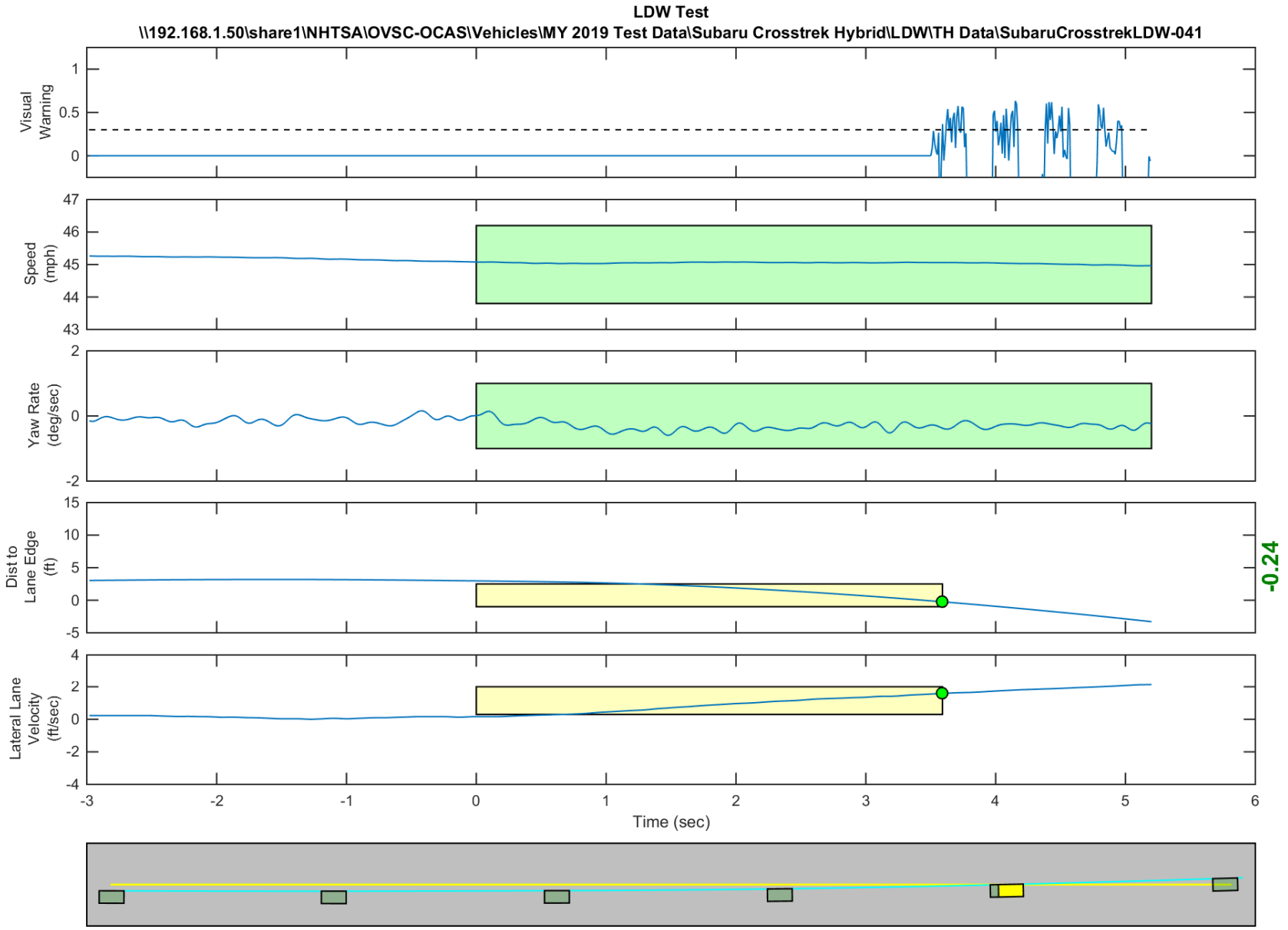


Figure D59. Time History for Run 41, Dashed Line, Left Departure, Visual Warning

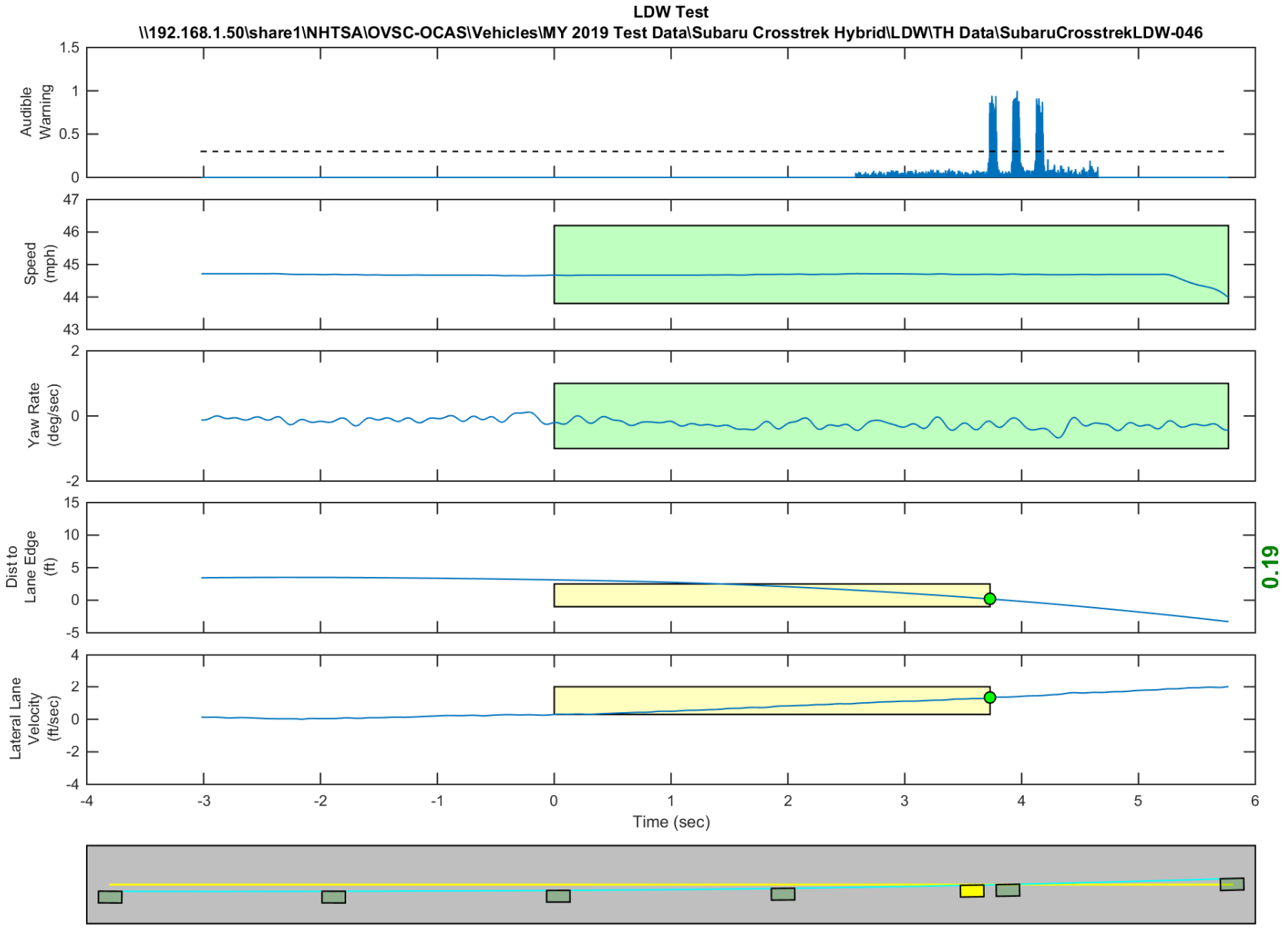


Figure D60. Time History for Run 46, Botts Dots, Left Departure, Audible Warning

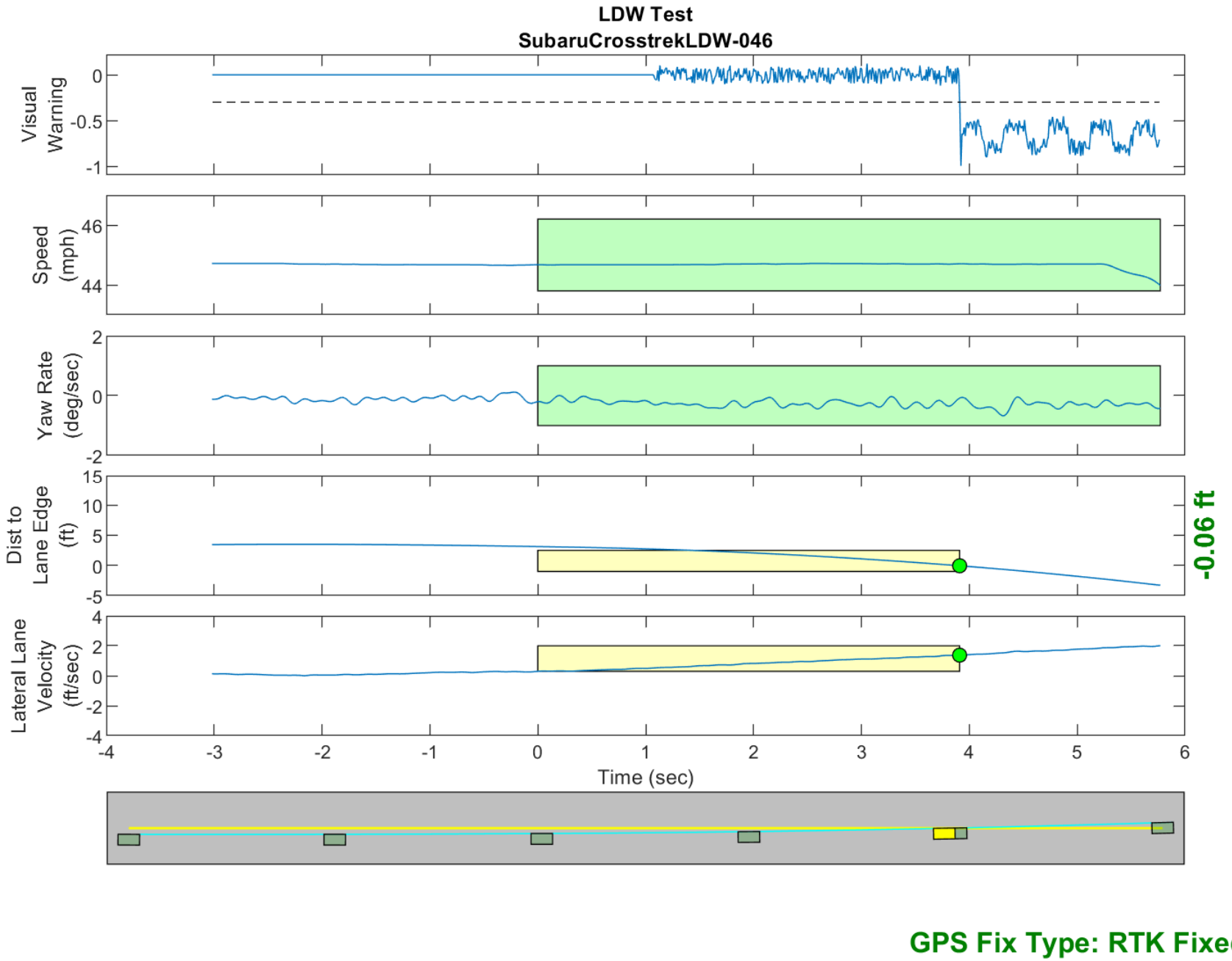


Figure D61. Time History for Run 46, Botts Dots, Left Departure, Visual Warning

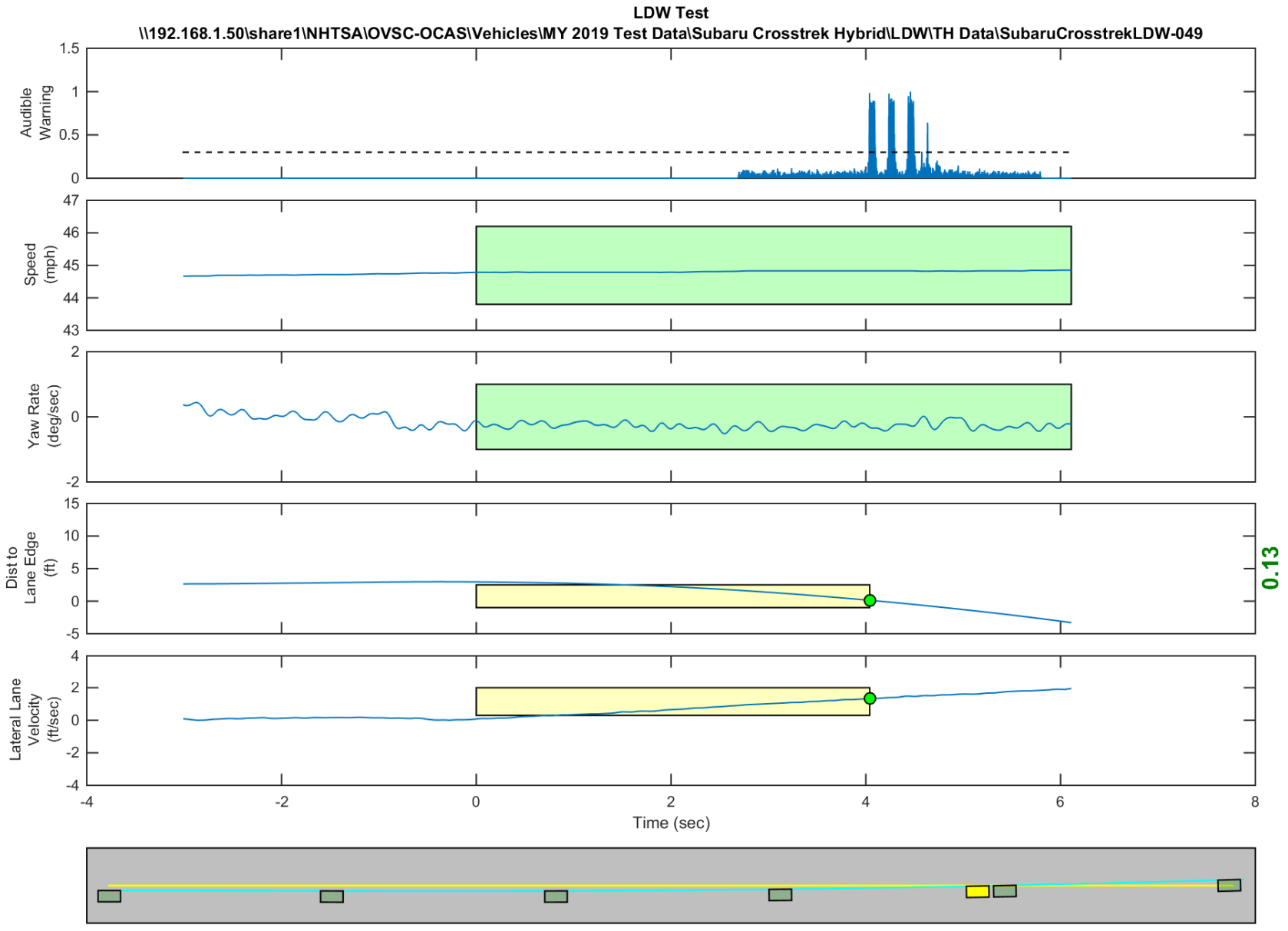


Figure D62. Time History for Run 49, Botts Dots, Left Departure, Audible Warning

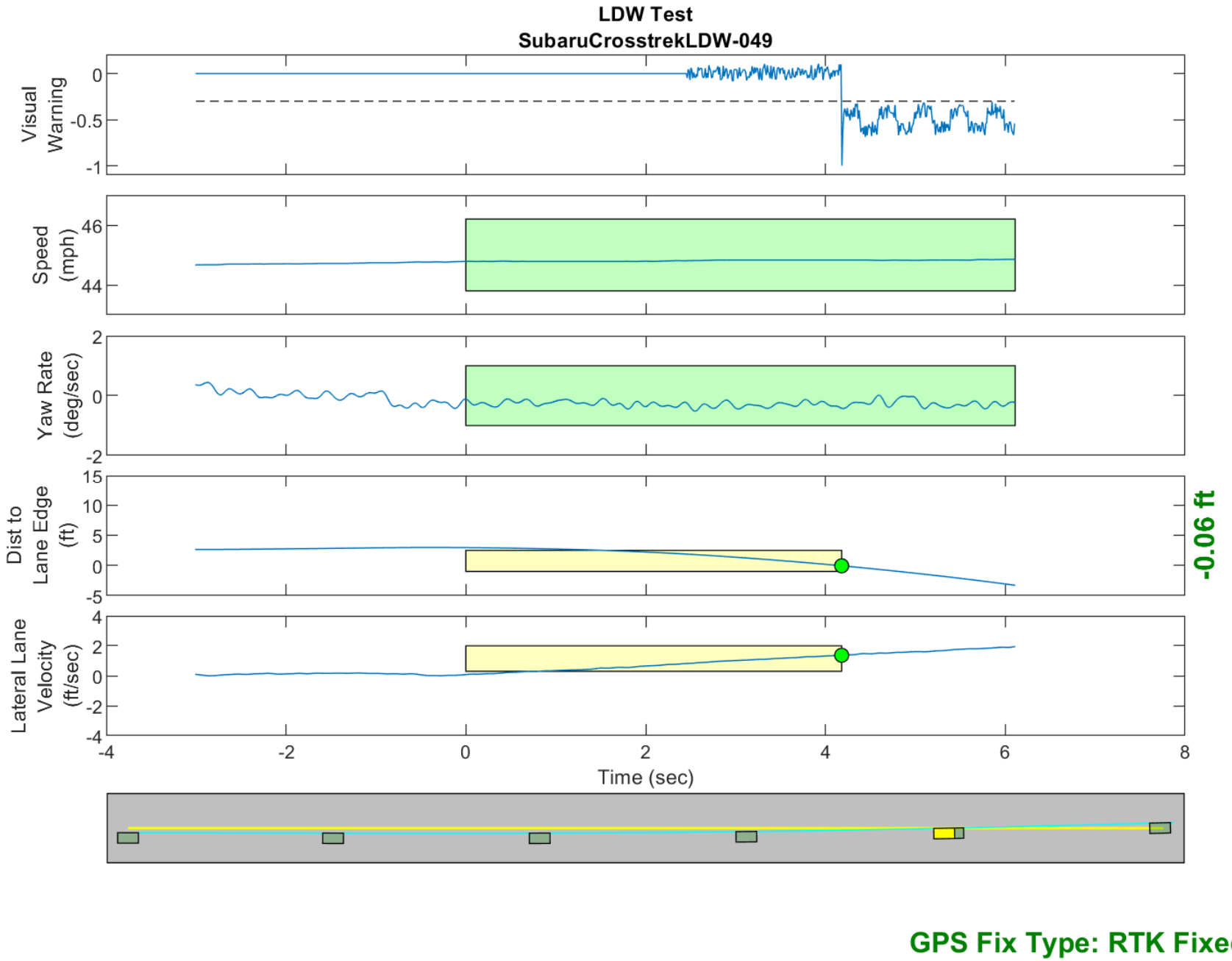


Figure D63. Time History for Run 49, Botts Dots, Left Departure, Visual Warning

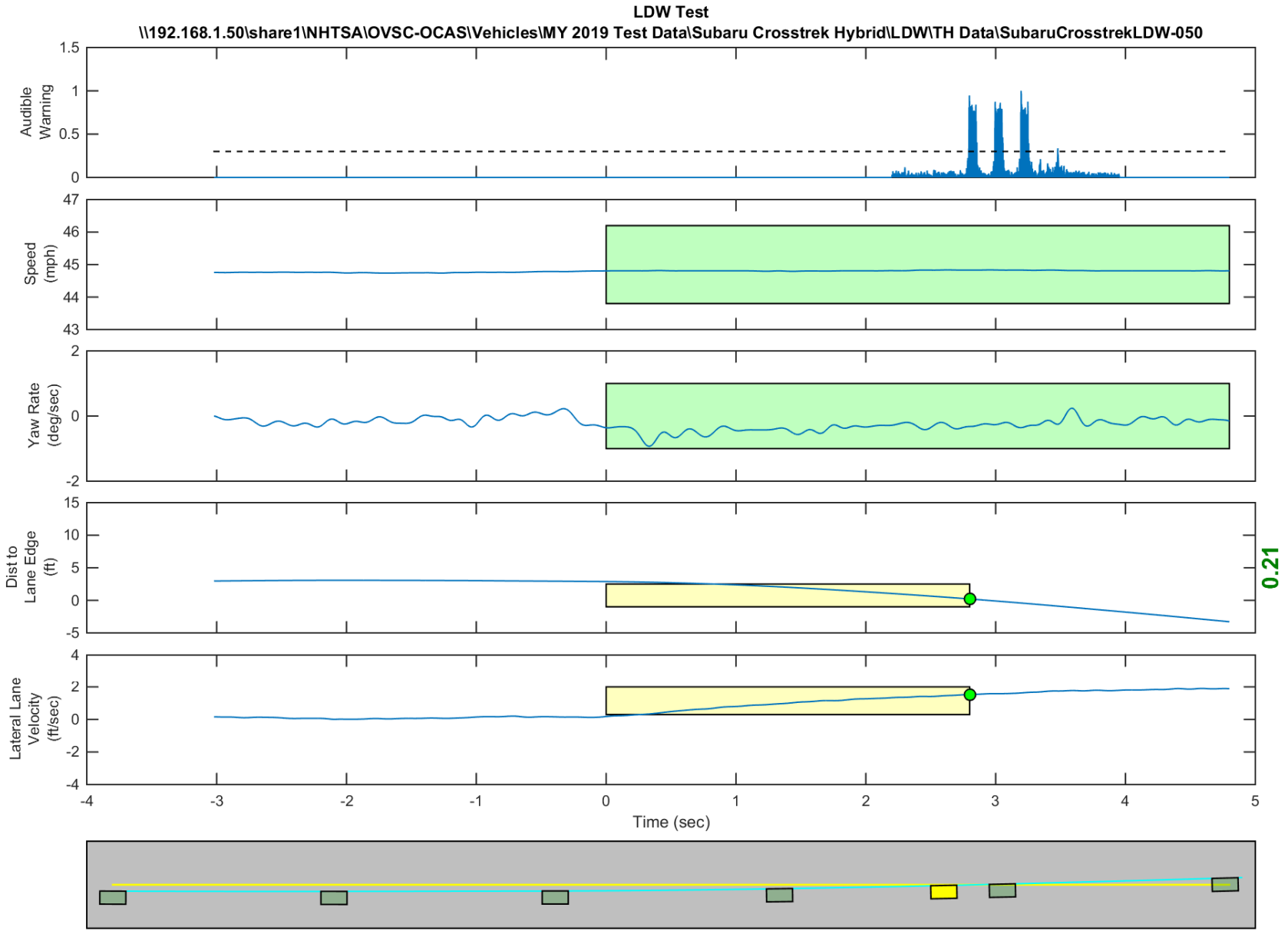


Figure D64. Time History for Run 50, Botts Dots, Left Departure, Audible Warning

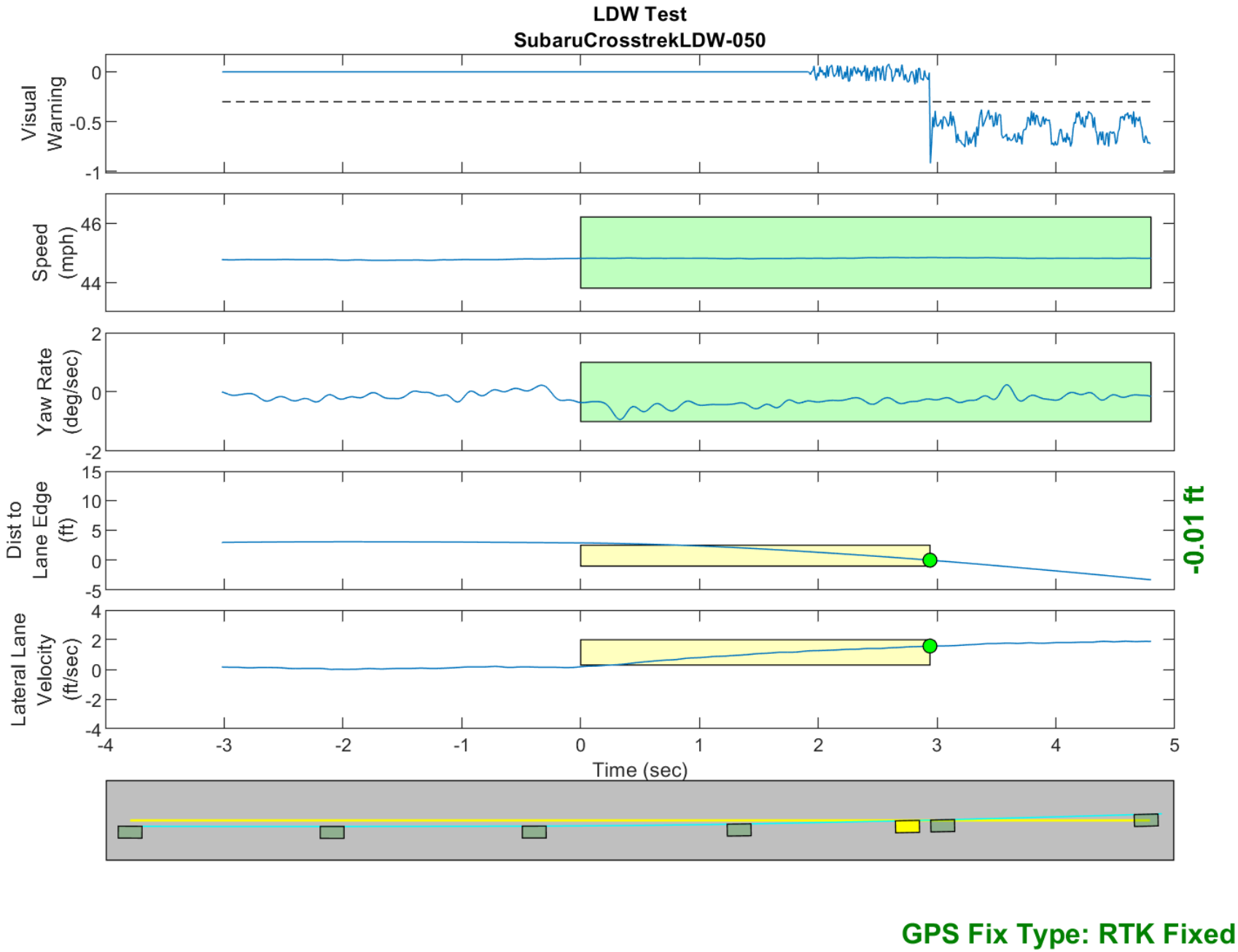


Figure D65. Time History for Run 50, Botts Dots, Left Departure, Visual Warning

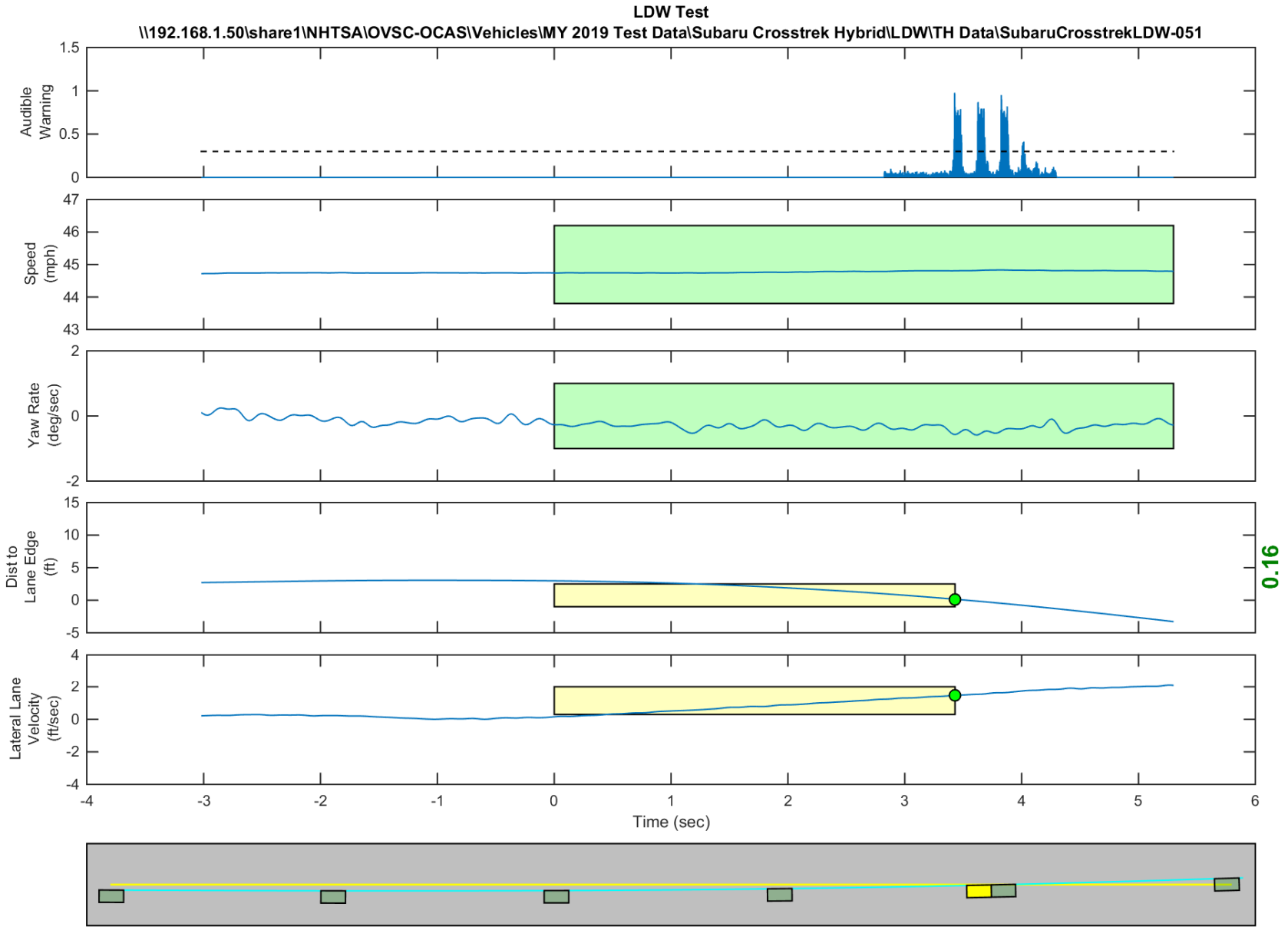


Figure D66. Time History for Run 51, Botts Dots, Left Departure, Audible Warning

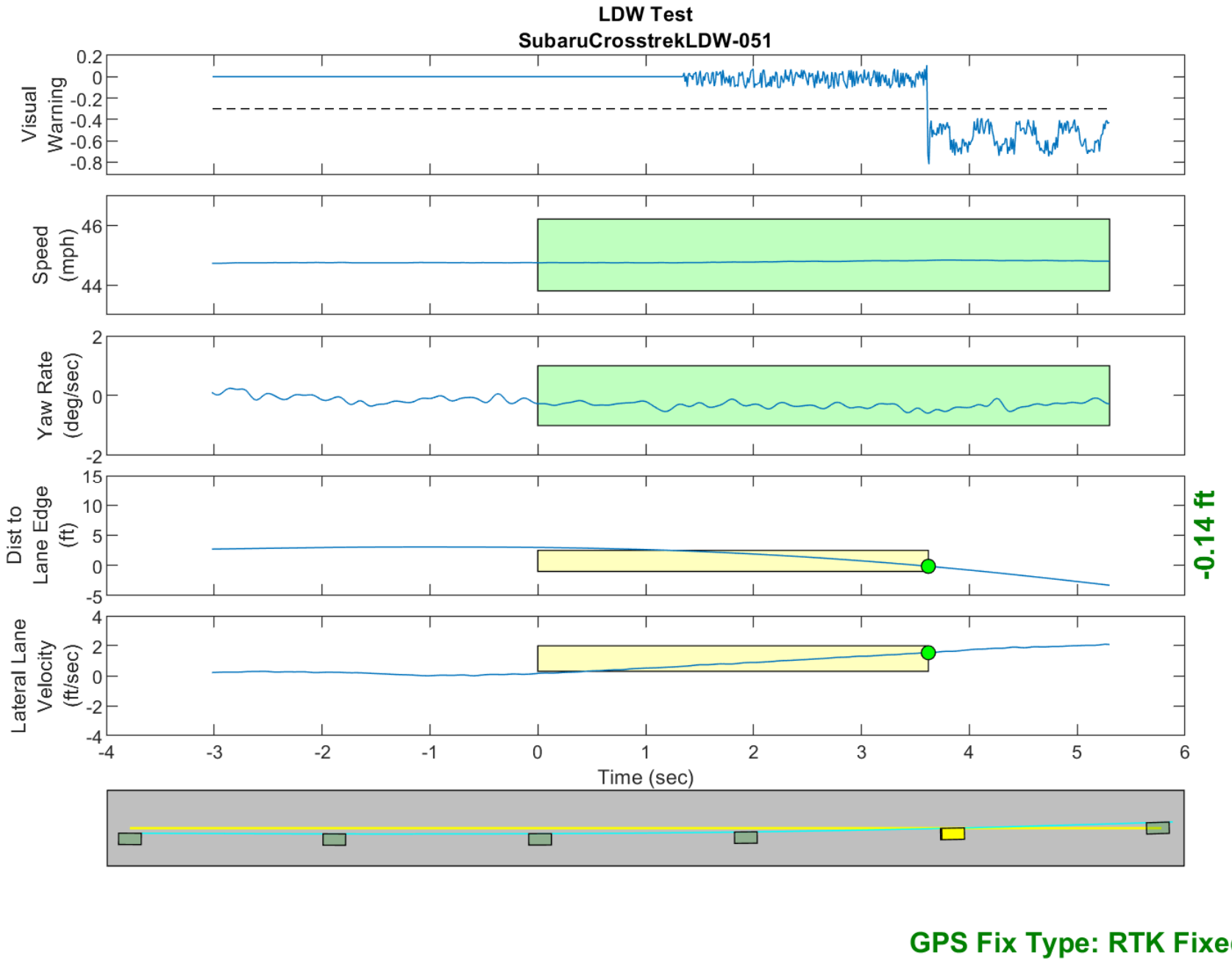


Figure D67. Time History for Run 51, Botts Dots, Left Departure, Visual Warning

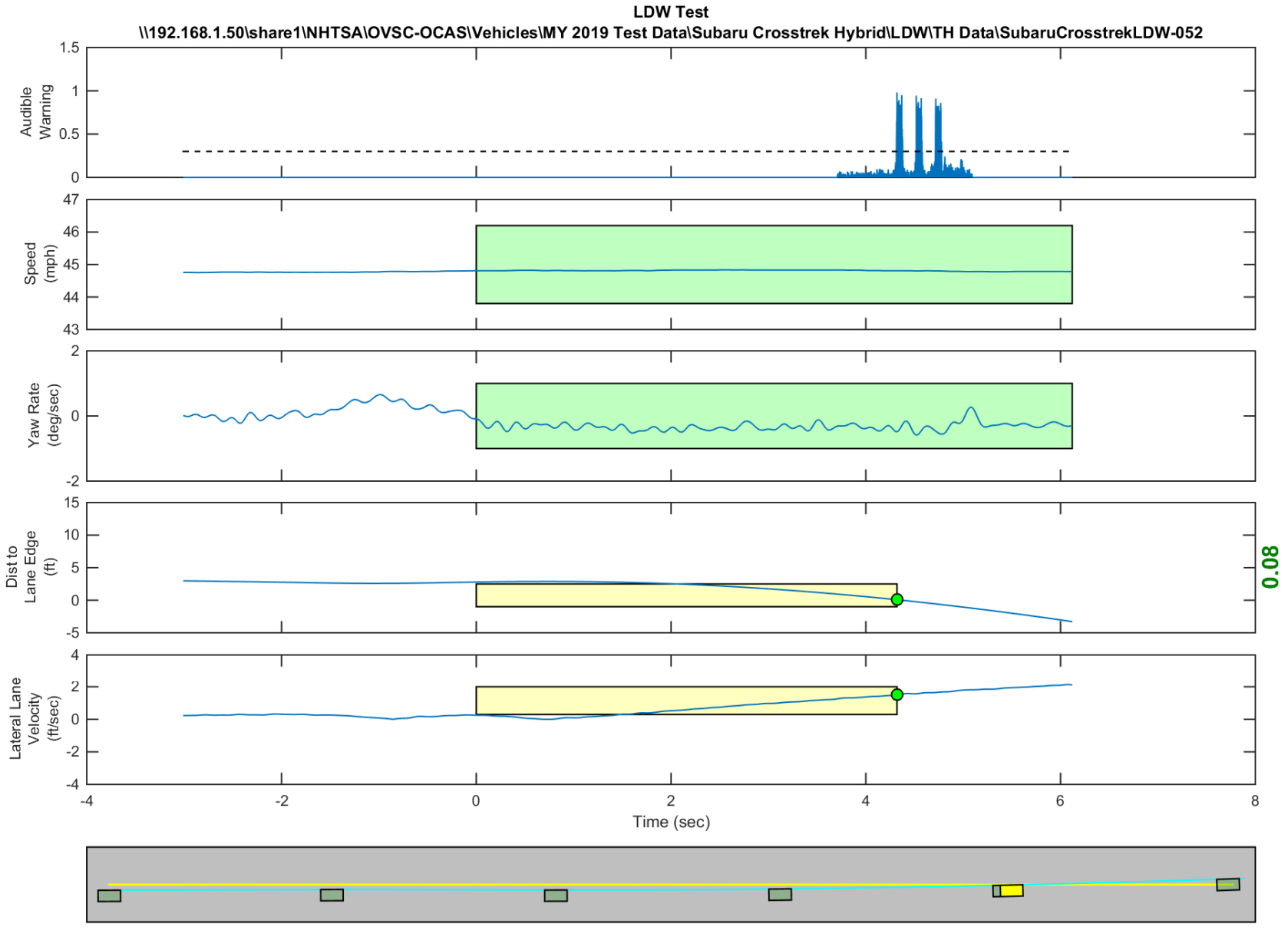


Figure D68. Time History for Run 52, Botts Dots, Left Departure, Audible Warning

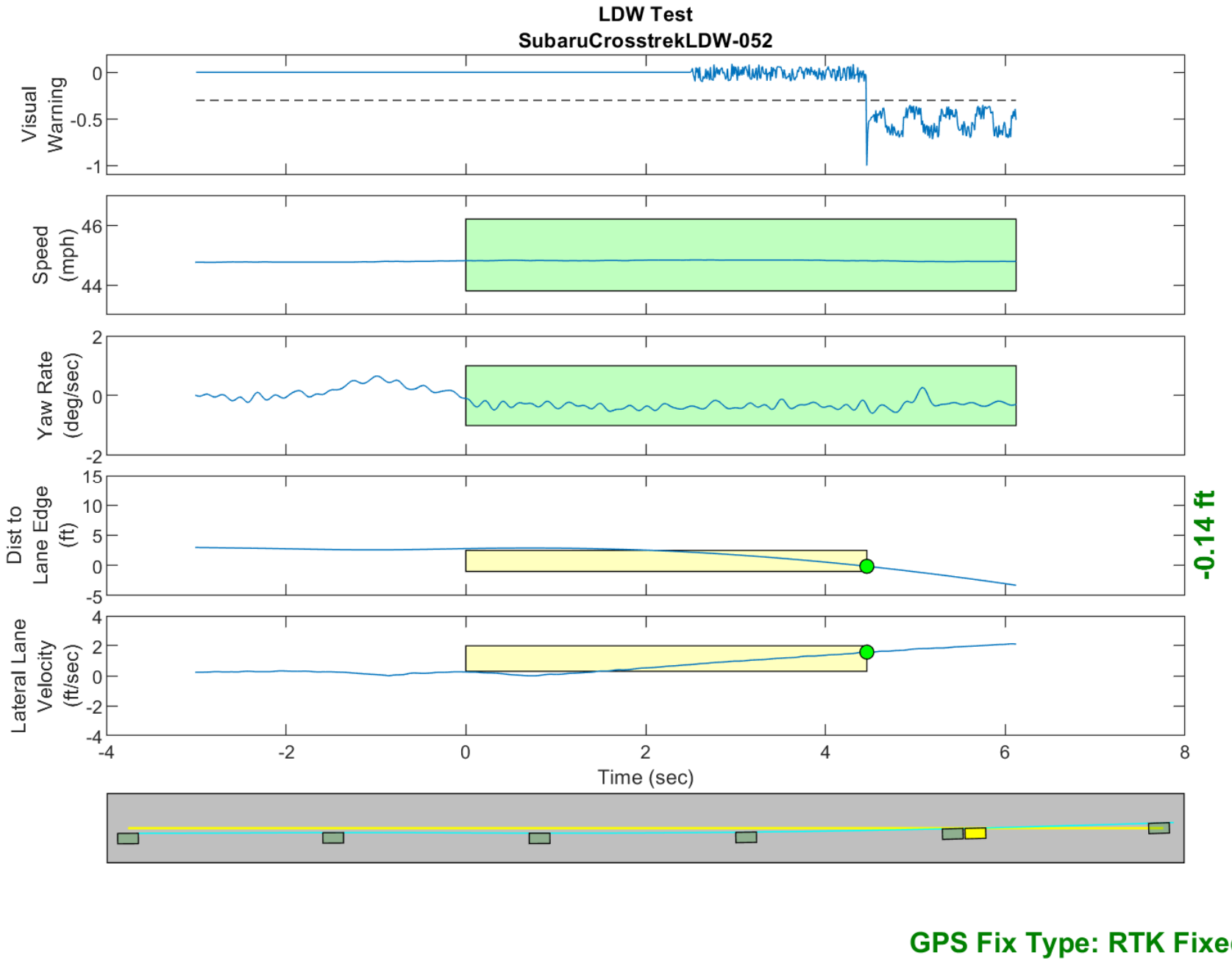


Figure D69. Time History for Run 52, Botts Dots, Left Departure, Visual Warning

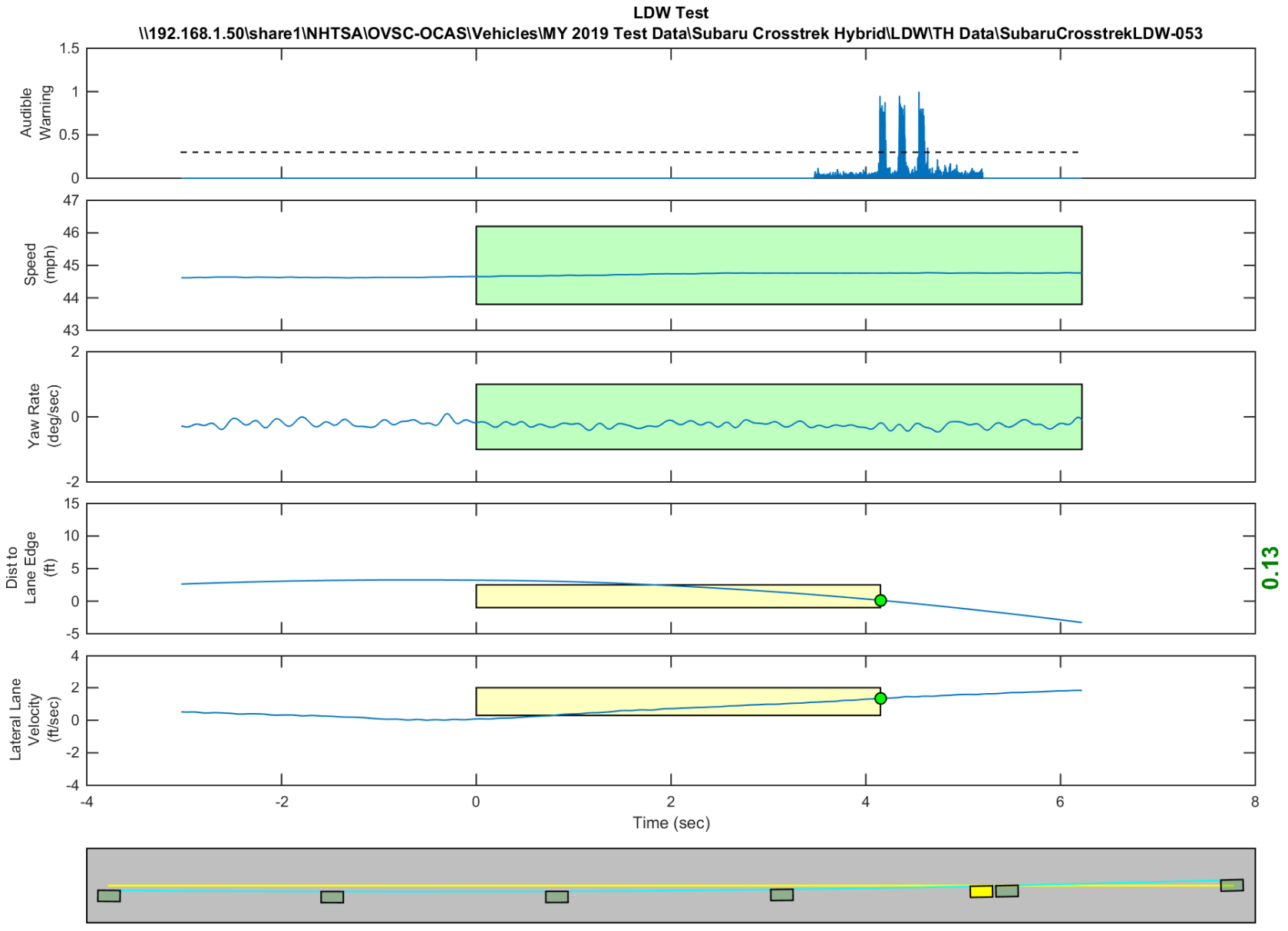


Figure D70. Time History for Run 53, Botts Dots, Left Departure, Audible Warning

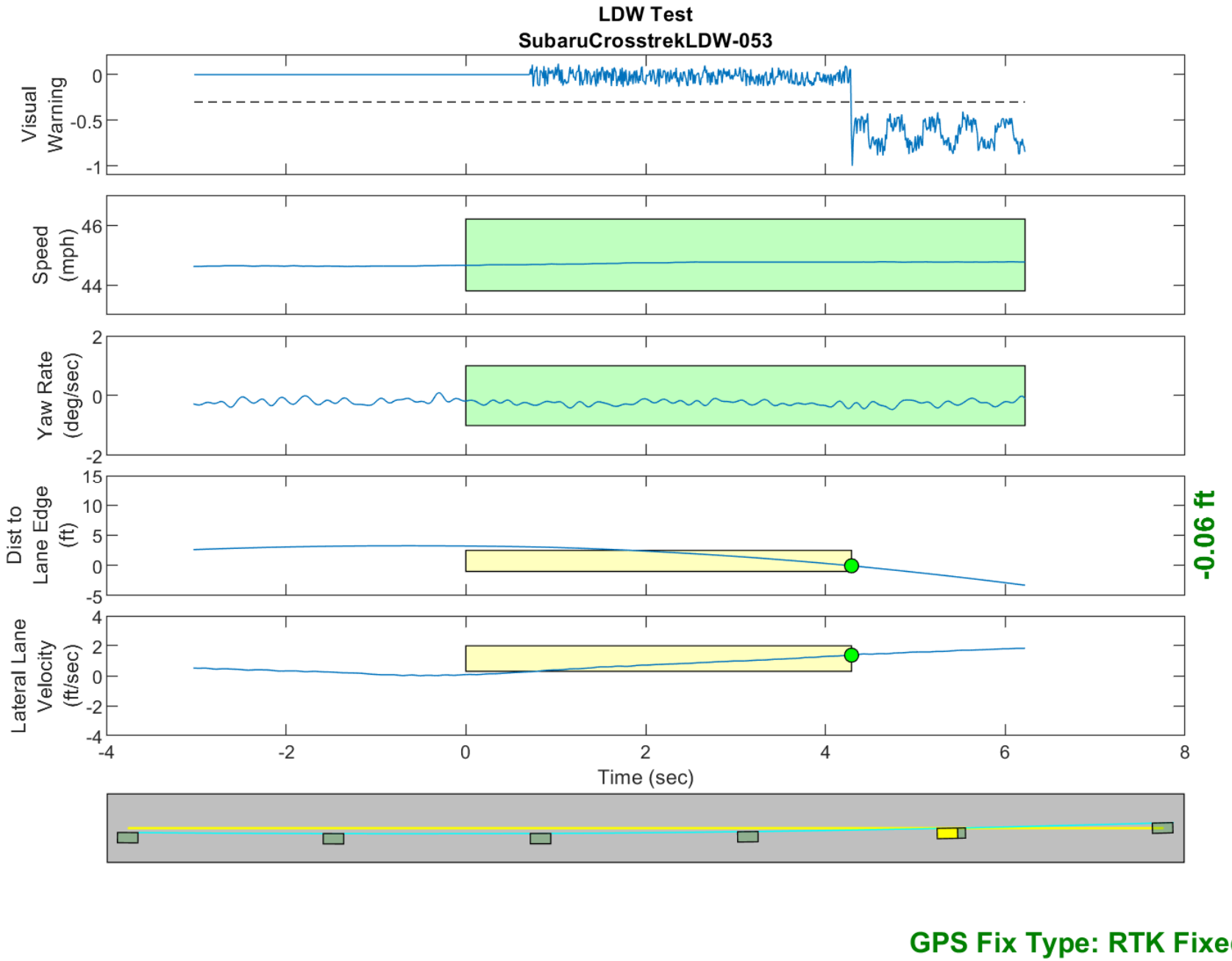


Figure D71. Time History for Run 53, Botts Dots, Left Departure, Visual Warning

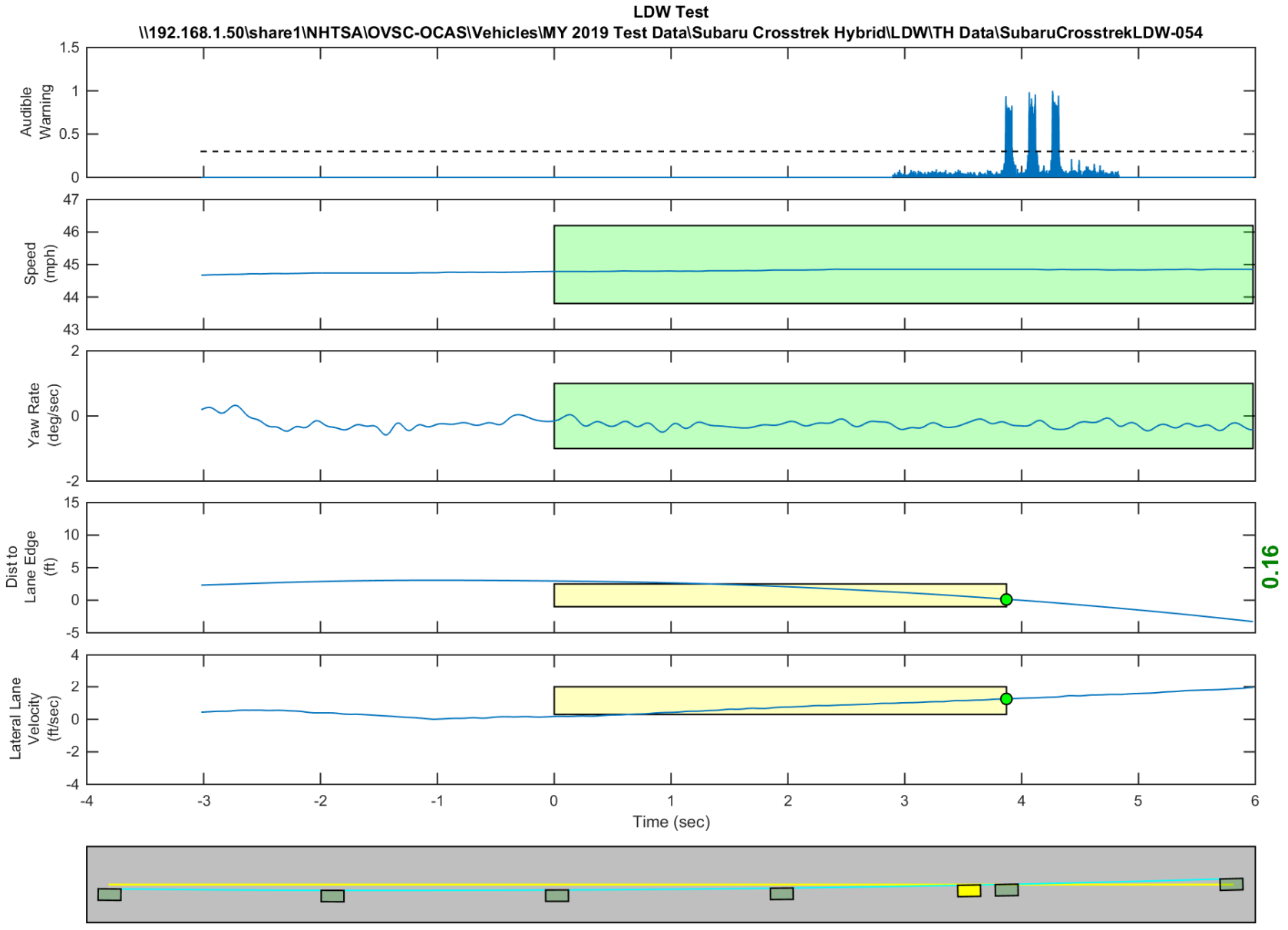


Figure D72. Time History for Run 54, Botts Dots, Left Departure, Audible Warning

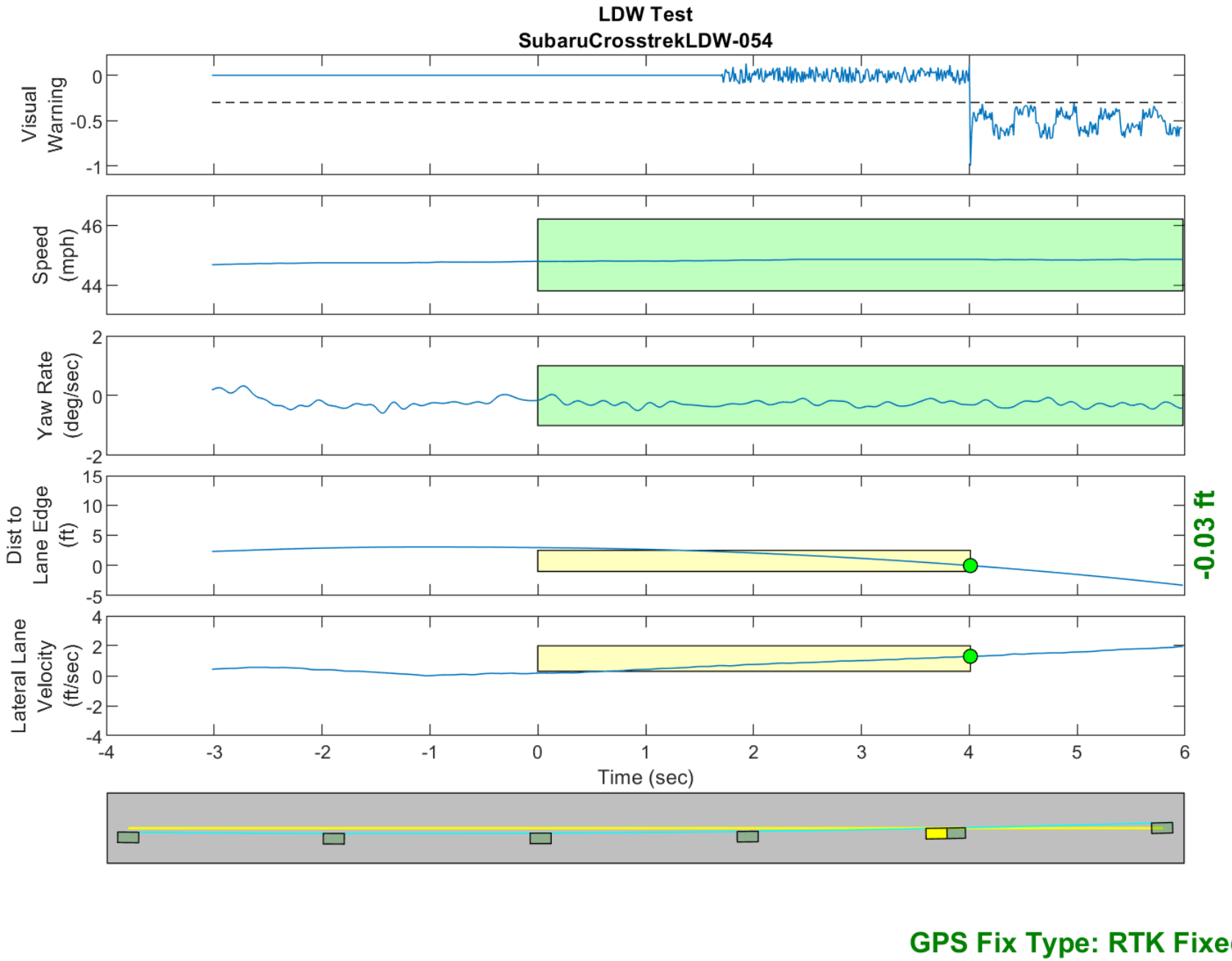


Figure D73. Time History for Run 54, Botts Dots, Left Departure, Visual Warning

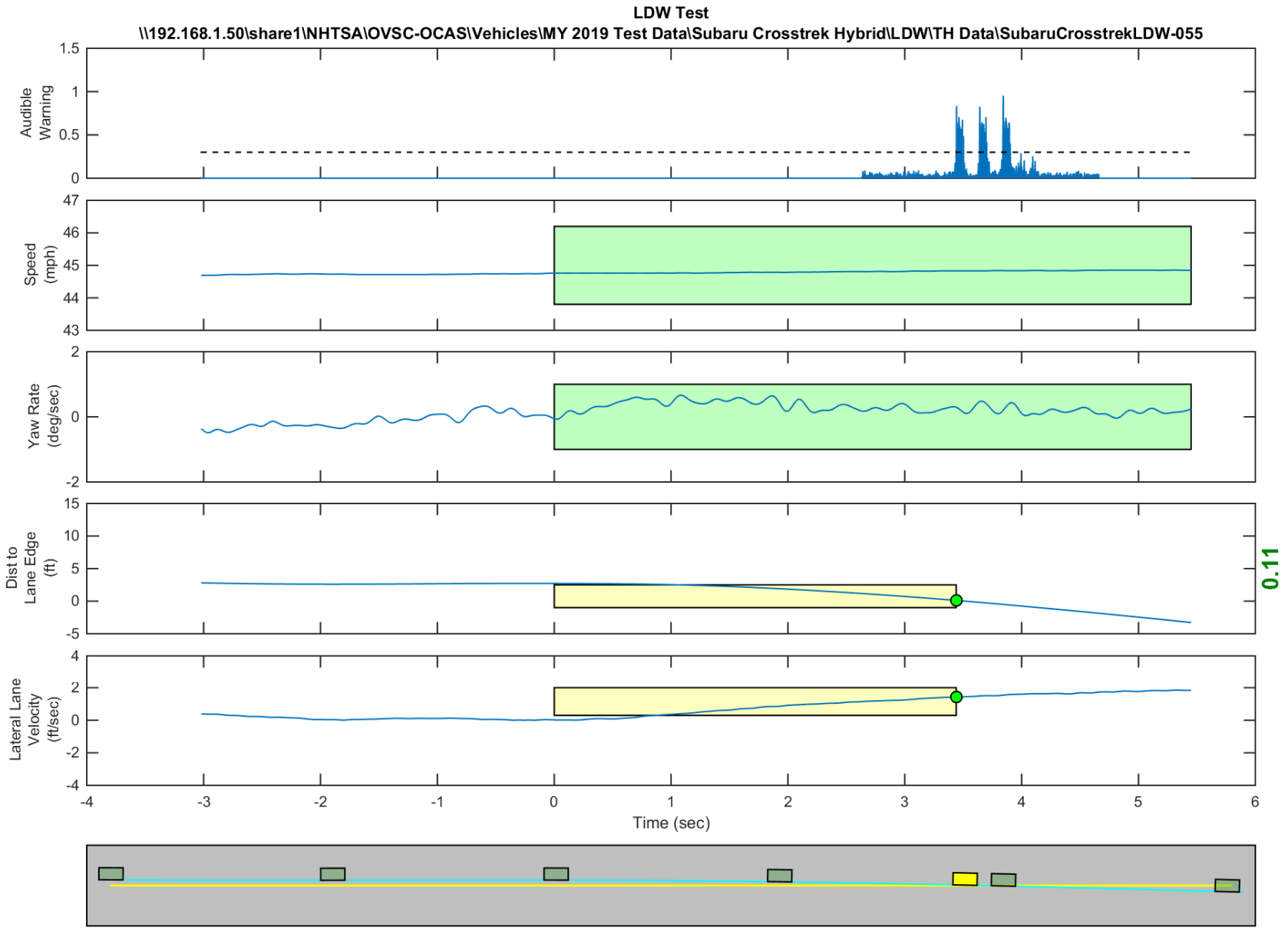


Figure D74. Time History for Run 55, Botts Dots, Right Departure, Audible Warning

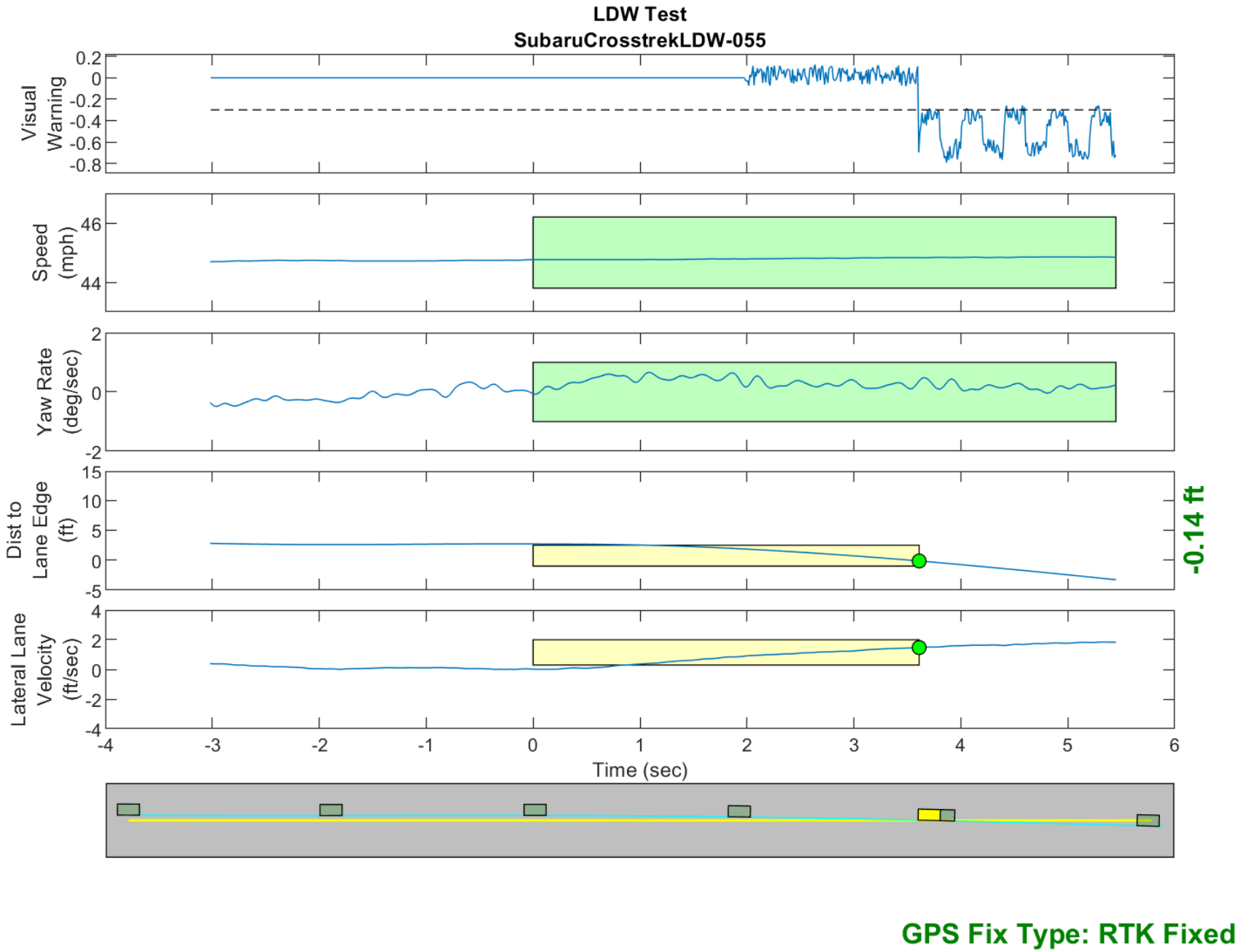


Figure D75. Time History for Run 55, Botts Dots, Right Departure, Visual Warning

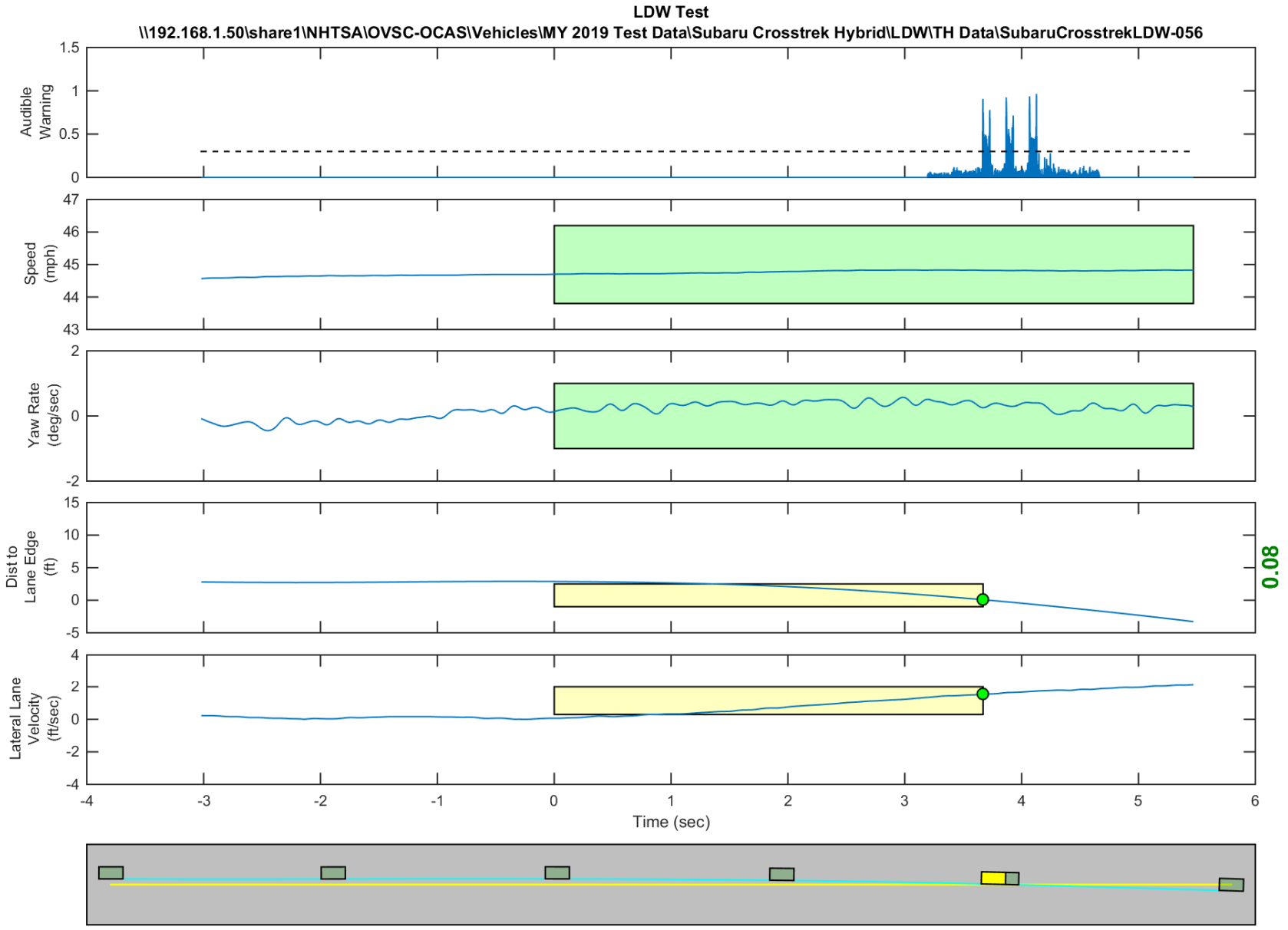


Figure D76. Time History for Run 56, Botts Dots, Right Departure, Audible Warning

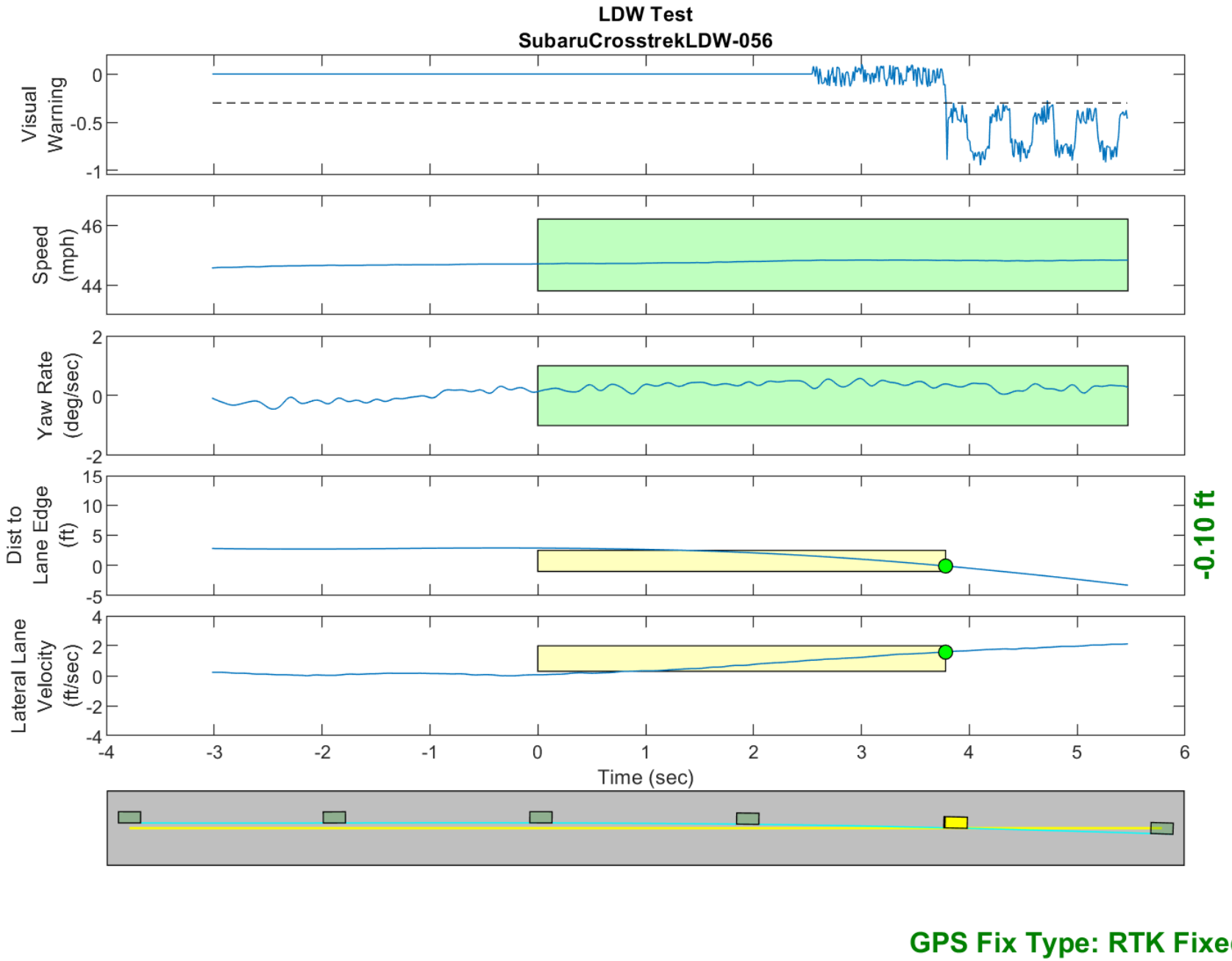


Figure D77. Time History for Run 56, Botts Dots, Right Departure, Visual Warning

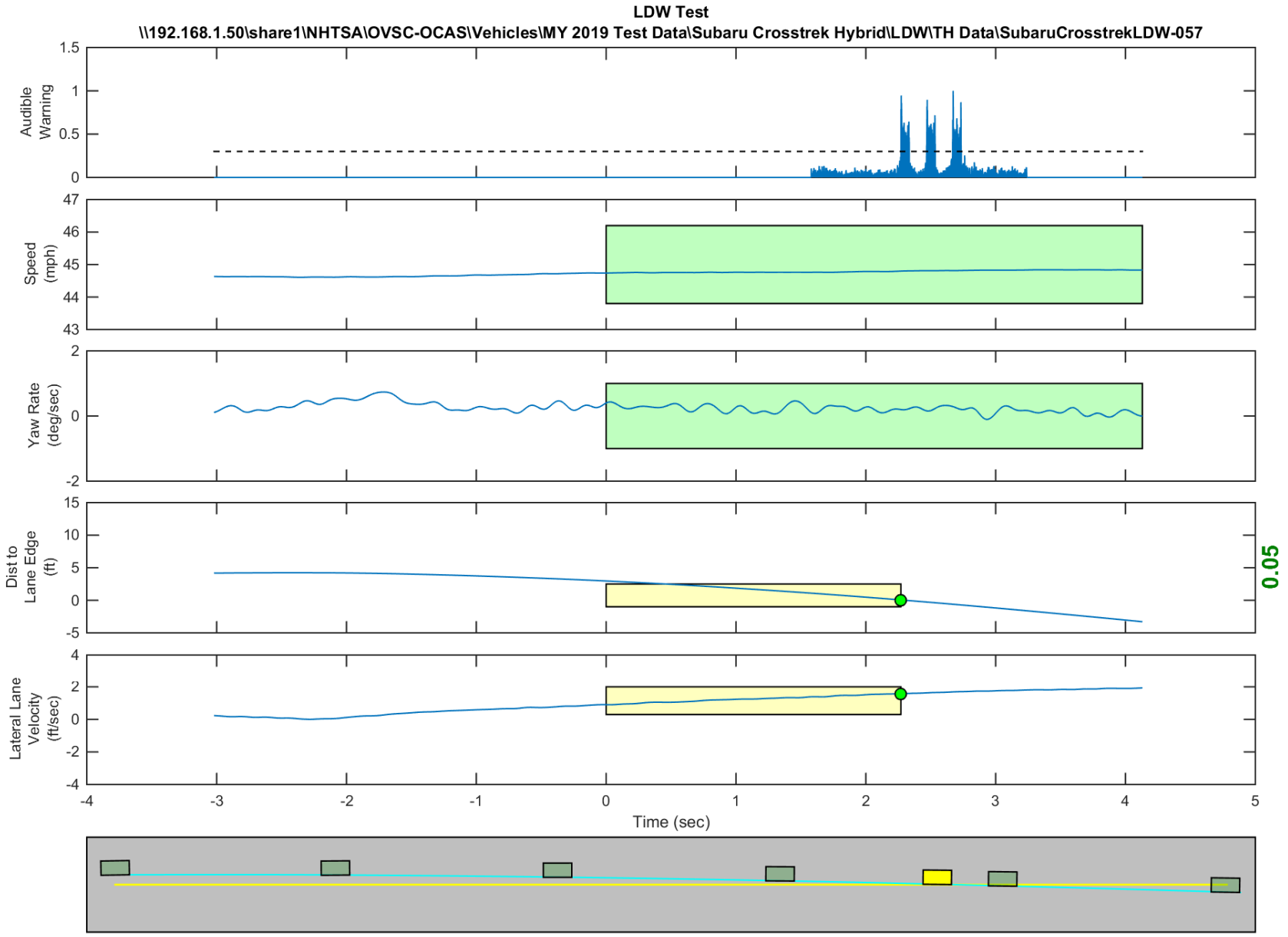


Figure D78. Time History for Run 57, Botts Dots, Right Departure, Audible Warning

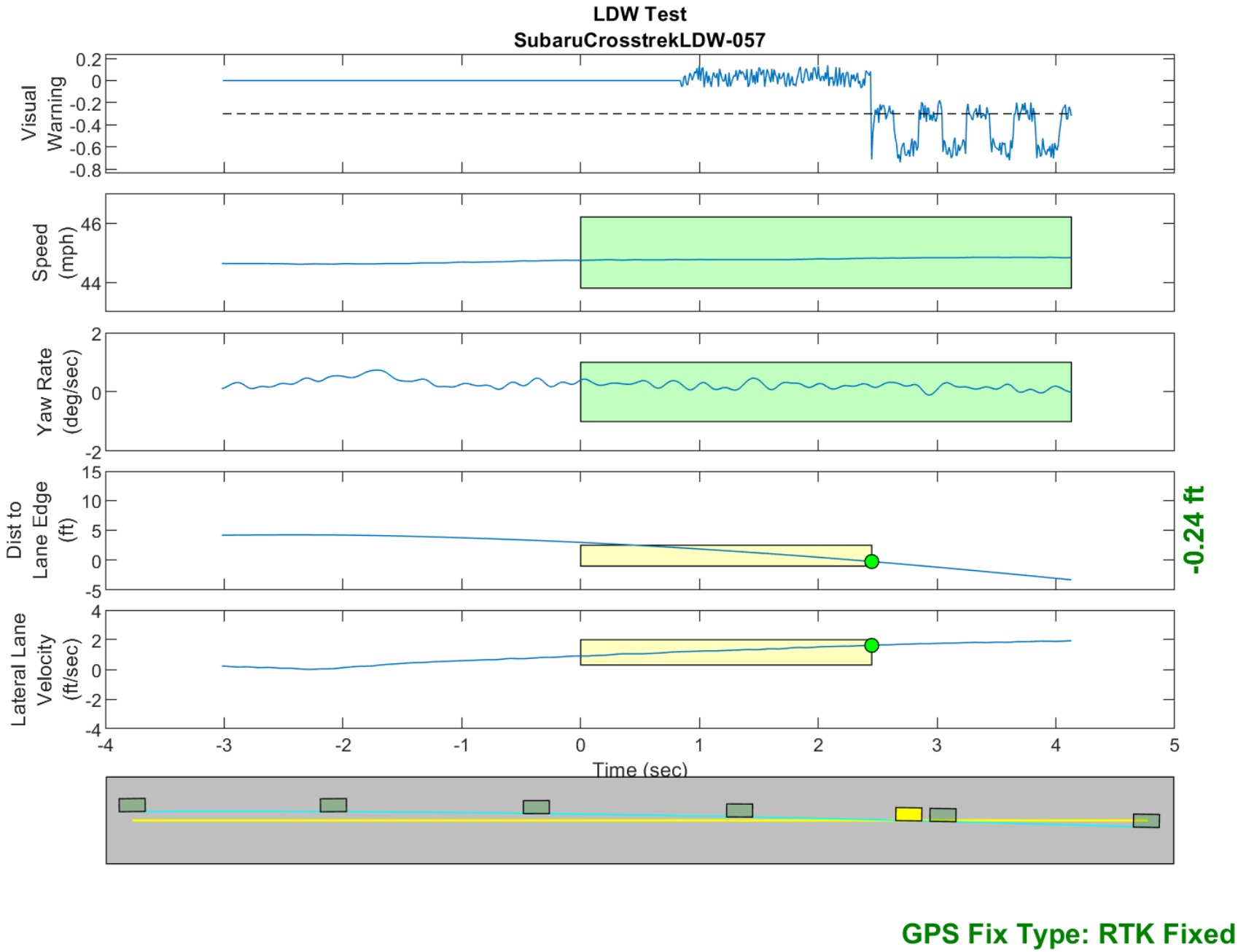


Figure D79. Time History for Run 57, Botts Dots, Right Departure, Visual Warning

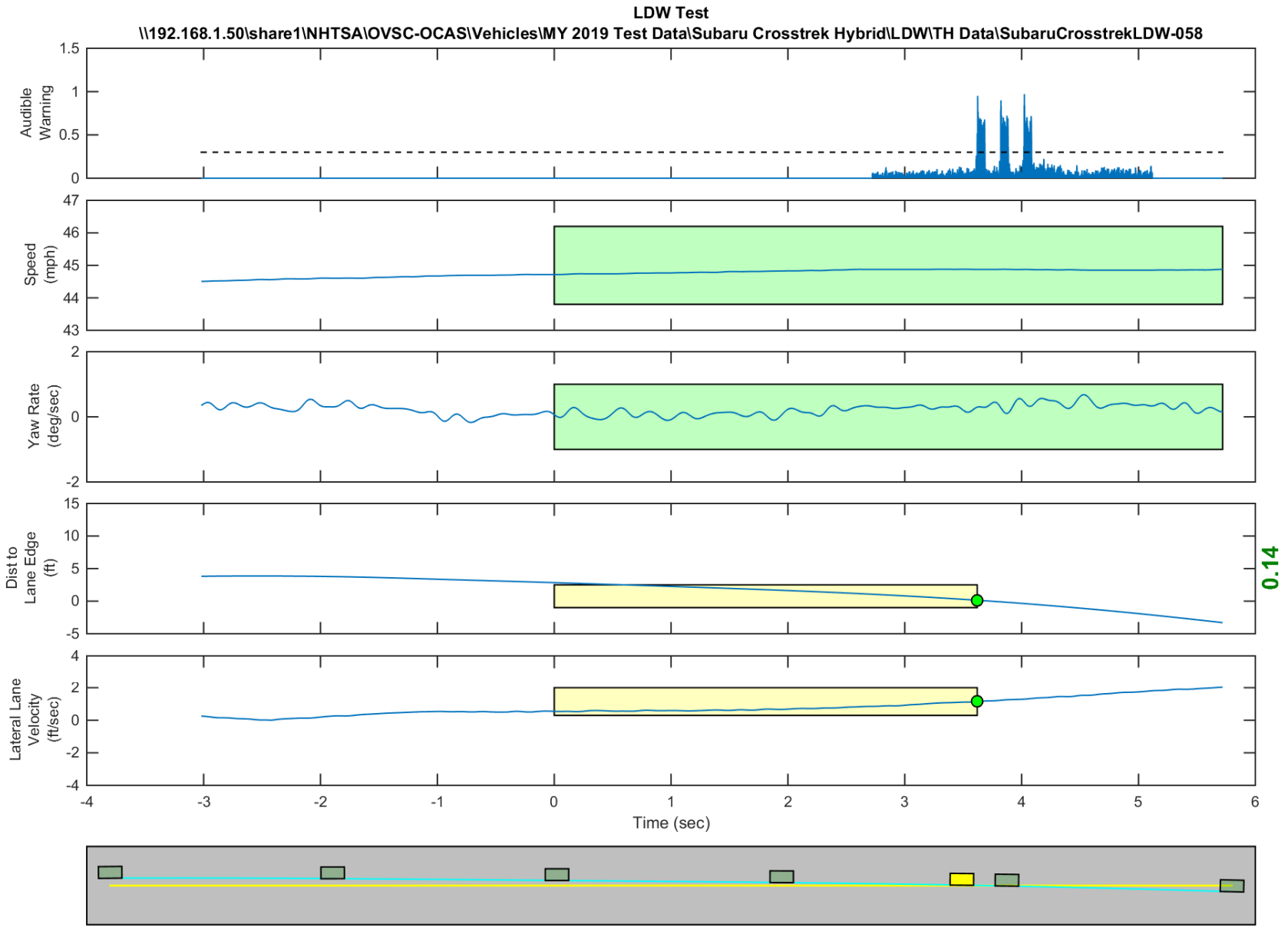


Figure D80. Time History for Run 58, Botts Dots, Right Departure, Audible Warning

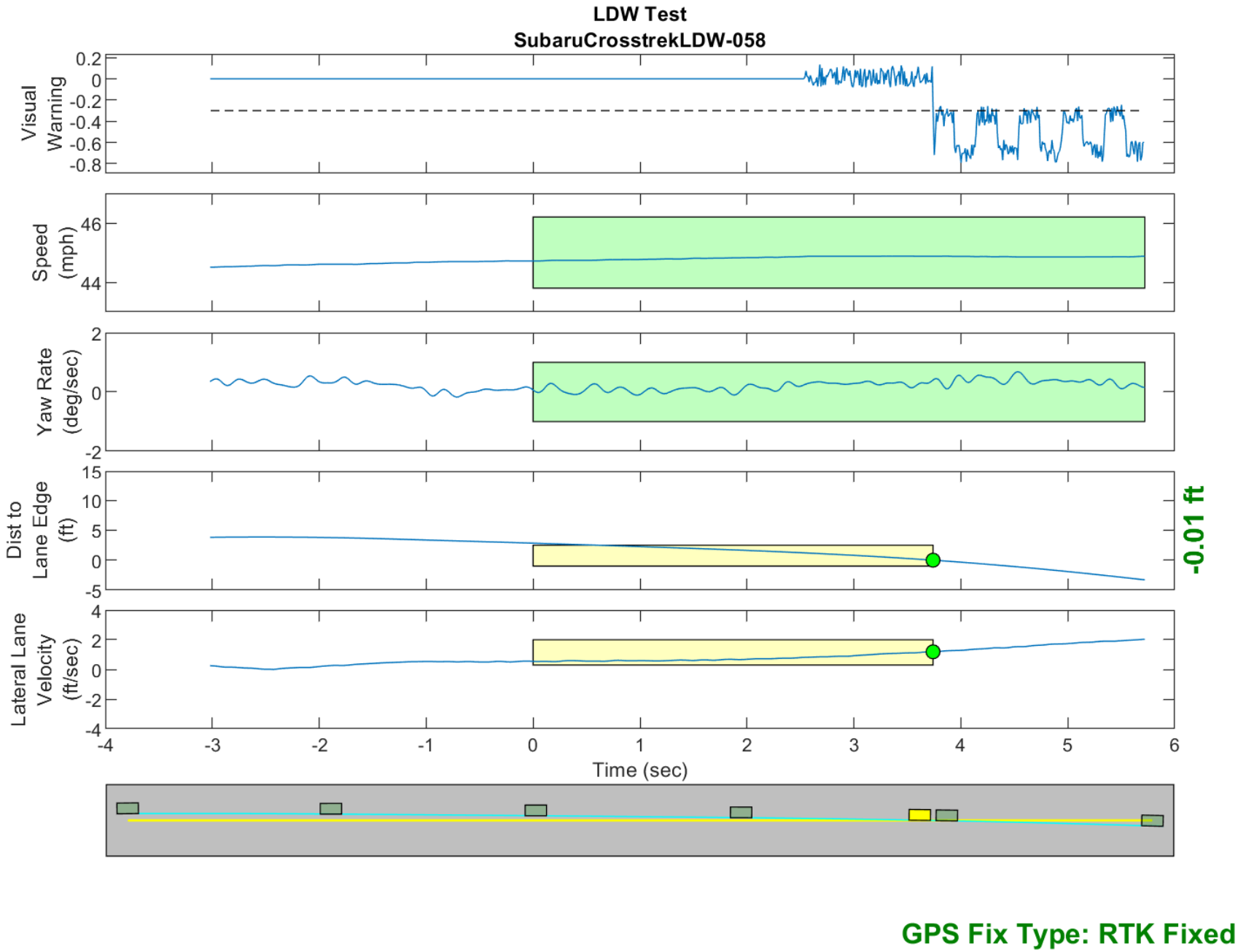


Figure D81. Time History for Run 58, Botts Dots, Right Departure, Visual Warning

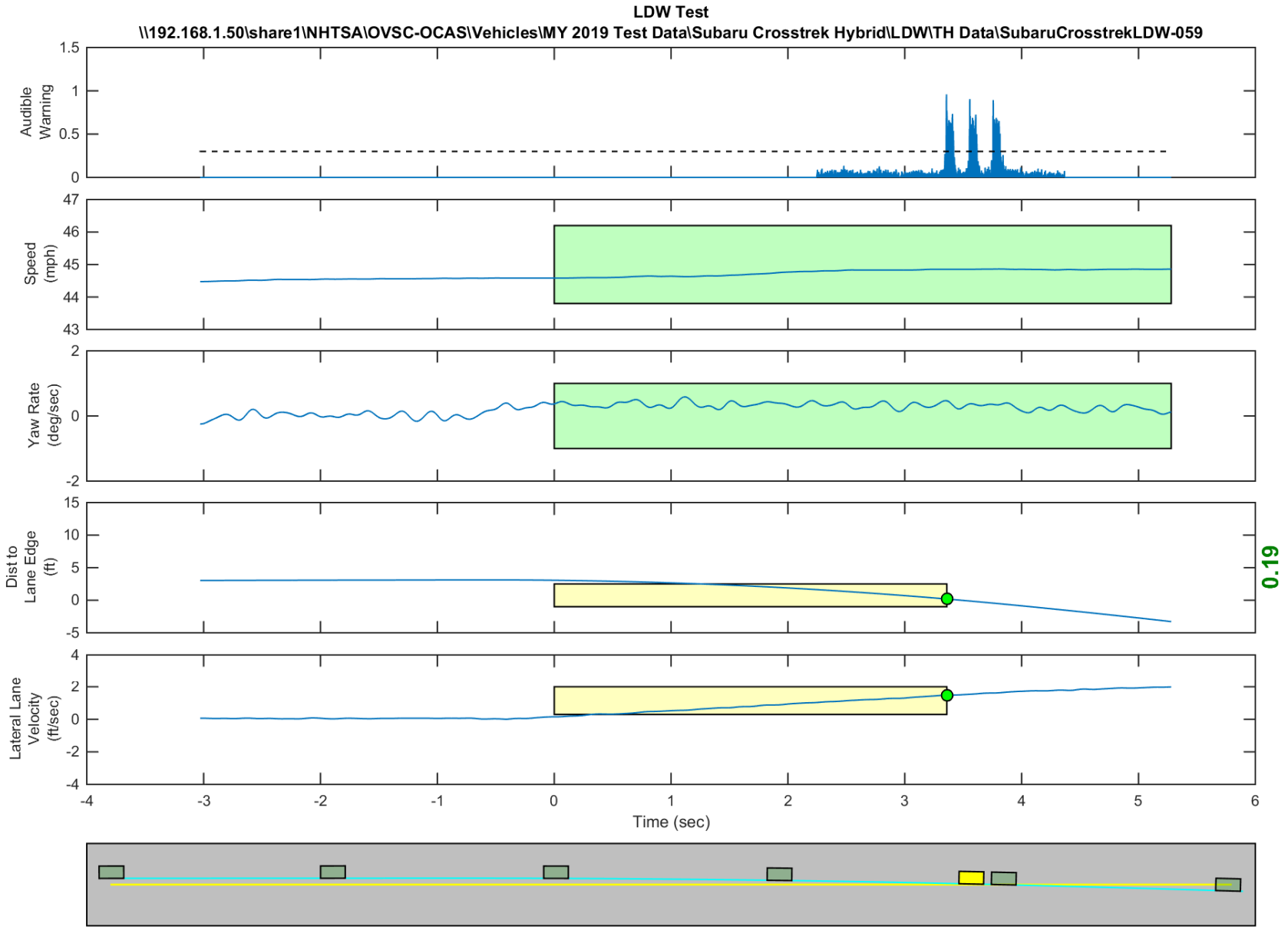


Figure D82. Time History for Run 59, Botts Dots, Right Departure, Audible Warning

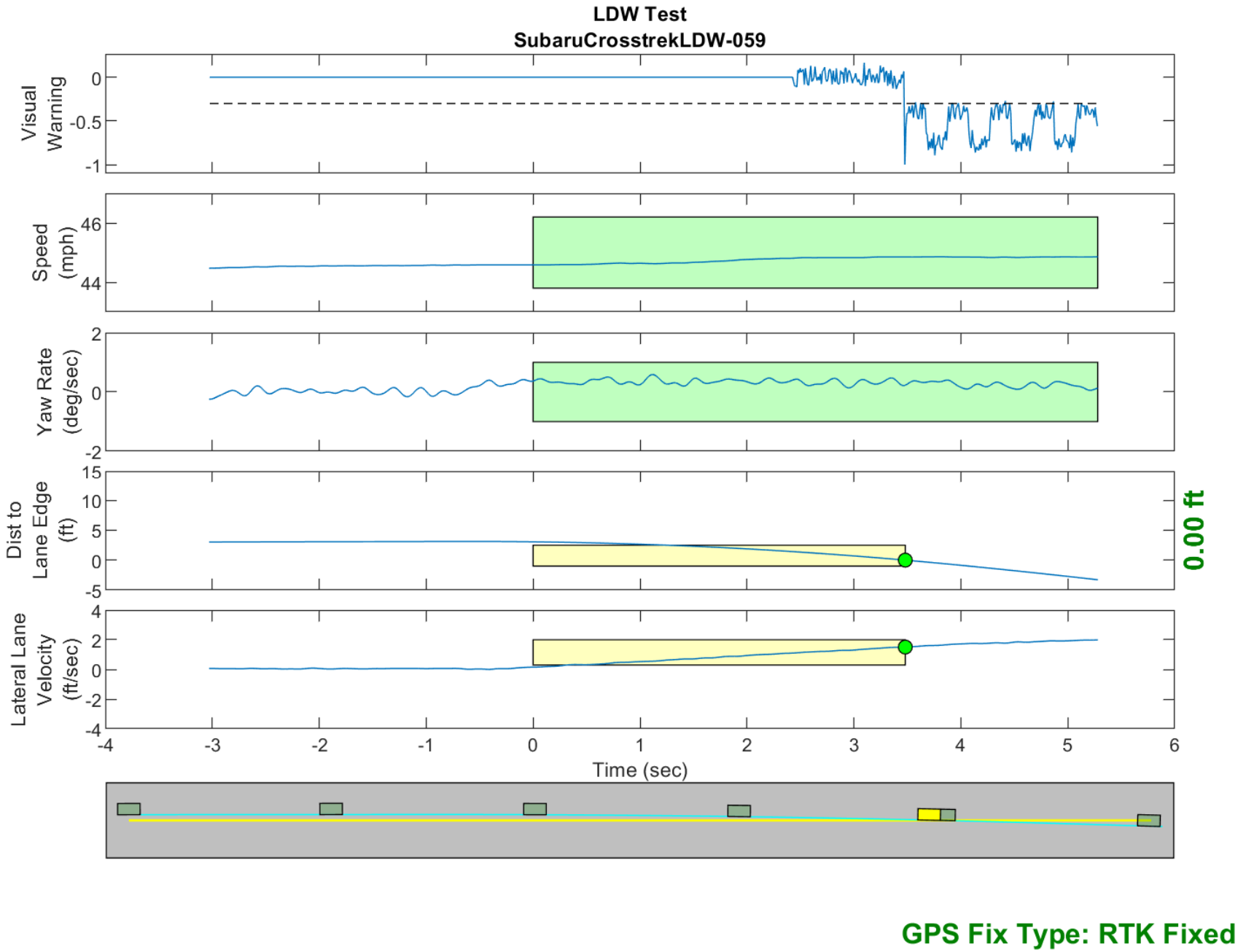


Figure D83. Time History for Run 59, Botts Dots, Right Departure, Visual Warning

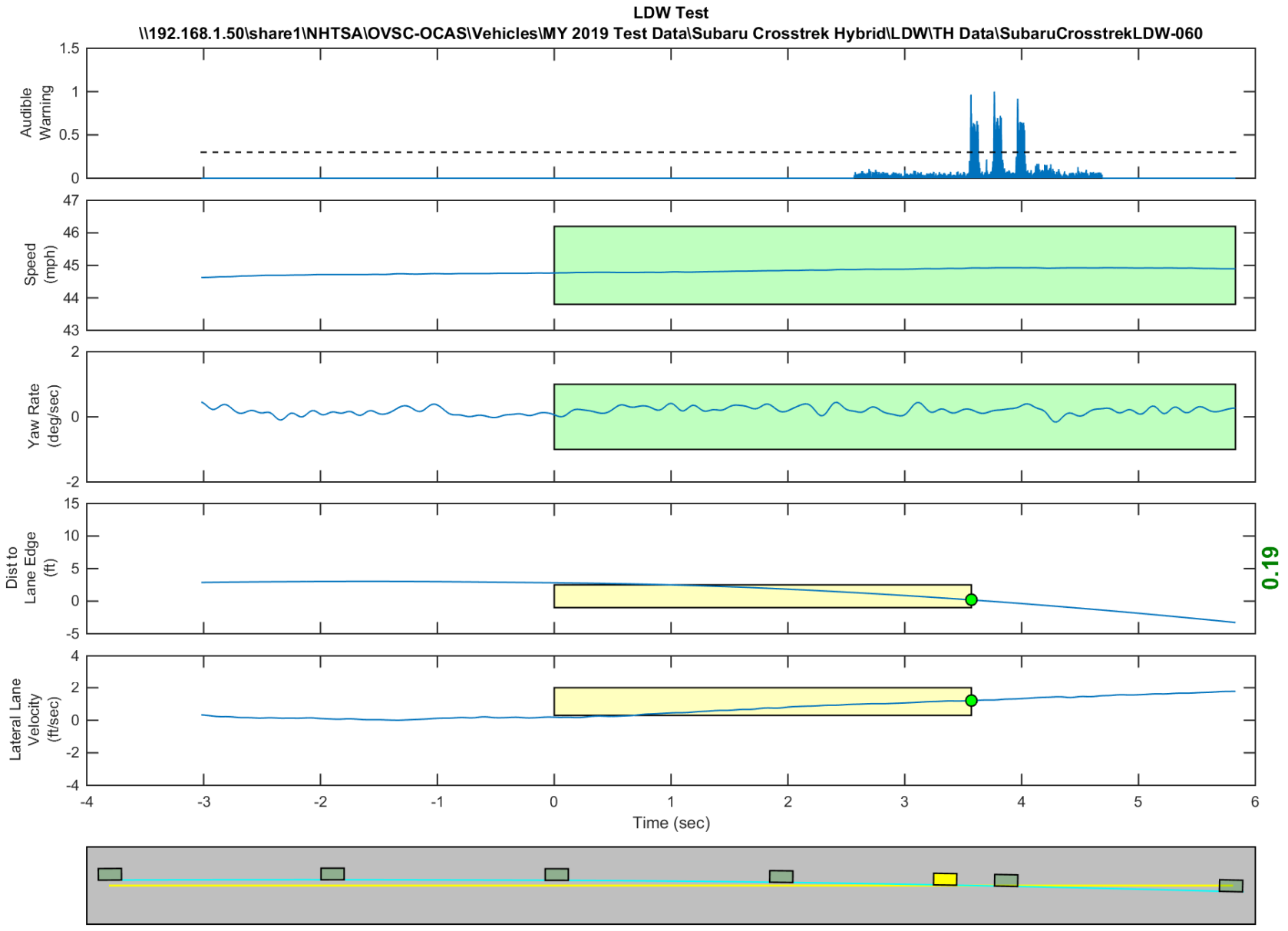


Figure D84. Time History for Run 60, Botts Dots, Right Departure, Audible Warning

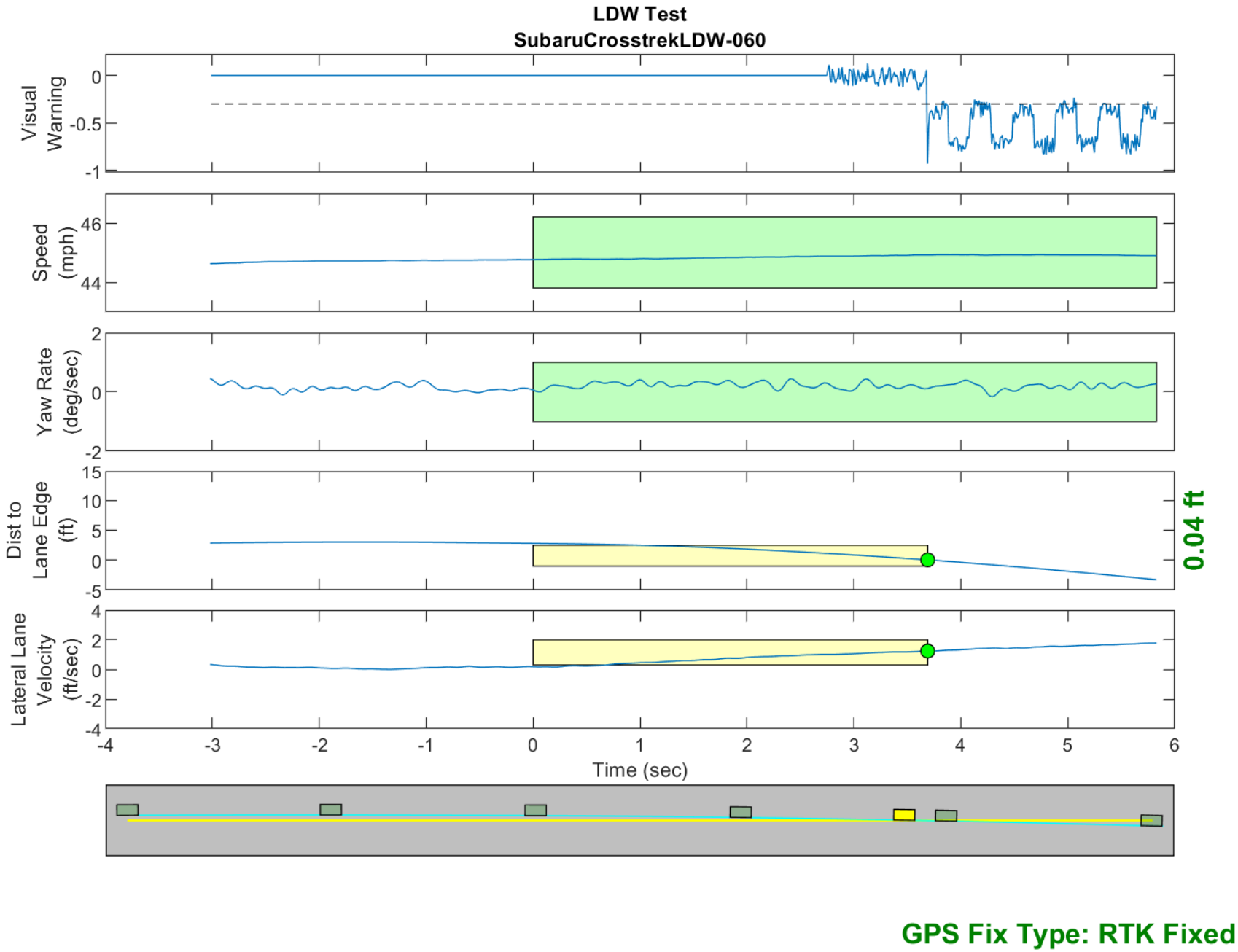


Figure D85. Time History for Run 60, Botts Dots, Right Departure, Visual Warning

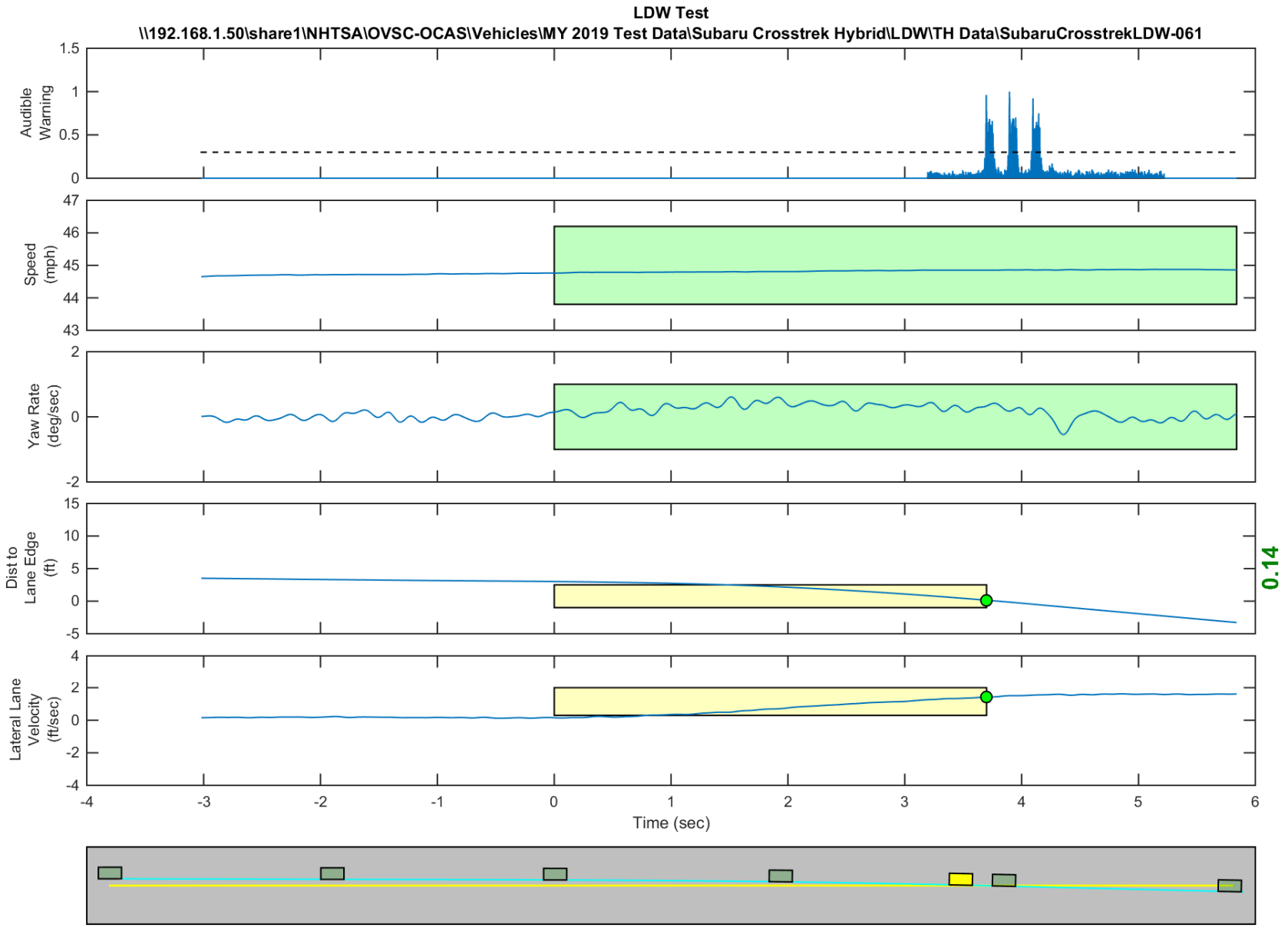


Figure D86. Time History for Run 61, Botts Dots, Right Departure, Audible Warning

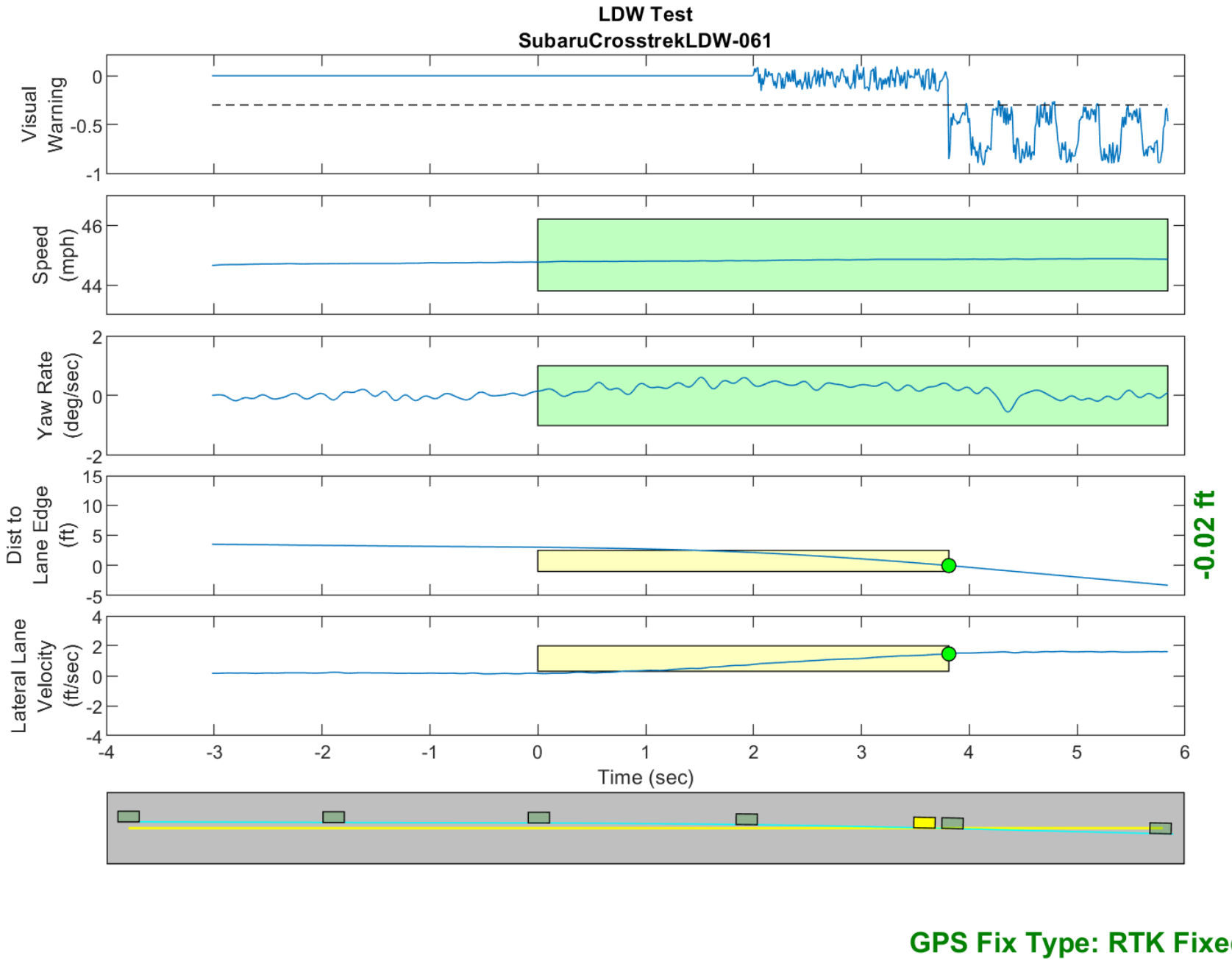


Figure D87. Time History for Run 61, Botts Dots, Right Departure, Visual Warning