OCAS-DRI-LDW-19-06
NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST

2018 Tesla Model 3

DYNAMIC RESEARCH, INC.
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9 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

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

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program Manager | Test Engineer

Date: 9 January 2020

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16. Abstract These tests were conducted on the subject 2018 Tesla Model 3 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 2018 Tesla Model 3. The LDW system provides a haptic alert implemented via a vibration felt in the steering wheel. The vehcile 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)

2018 Tesla Model 3

VIN: *5YJ3E1EB9JF0xxxx*

Test Date: *5/14/2019*

Lane Departure Warning setting: *Nominal*

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)

2018 Tesla Model 3

TEST VEHICLE INFORMATION

VIN: *5YJ3E1EB9JF0xxxx*

Body Style: *Sedan* Color: *Pearl White Multi Coat*

Date Received: *5/1/2019* Odometer Reading: *1396 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Tesla, inc.*

Date of manufacture: *08/18*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *235/40R19*

Rear: *235/40R19*

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

Rear: *290 kPa (42 psi)*

TIRES

Tire manufacturer and model: *Continental Procontact RX*

Front tire size: *235/40R19*

Rear tire size: *235/40R19*

Front tire DOT prefix: *AF18 WD4H*

Rear tire DOT prefix: *AF18 WD4H*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2018 Tesla Model 3

GENERAL INFORMATION

Test date: *5/14/2019*

AMBIENT CONDITIONS

Air temperature: *26.1 C (79 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: *290 kPa (42 psi)*

Rear: *290 kPa (42 psi)*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

2018 Tesla Model 3

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*501.2 kg (1105 lb)*	Right Front	*499.0 kg (1100 lb)*
Left Rear	*496.2 kg (1094 lb)*	Right Rear	*485.8 kg (1071 lb)*
		Total:	*1982.2 kg (4370 lb)*

2018 Tesla Model 3

Name of the LDW option: *Lane Assist*

Type of sensor(s) used: *Cameras*

How is the Lane Departure Warning presented to the driver?

(Check all that apply)

______ Warning light

______ Buzzer or audible alarm

__X__ Vibration

______ Other

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

There is a haptic warning in the form of vibration in the steering wheel upon lane departure.

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.

By default, Lane Departure Warning is turned on. To turn it off use touch screen and select:

> Controls

>Autopilot

> Settings

> Lane Departure Warning: On/Off

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.

Lane Assist cannot always clearly detect lane markings and you may experience unnecessary or invalid warnings in these situations:

- *Visibility is poor and lane markings are not clearly visible (due to heavy rain, snow, fog, etc.).*
- *Bright light (such as from oncoming headlights or direct sunlight) is interfering with the view of the camera(s).*
- *A vehicle in front of Model 3 is blocking the view of the camera(s).*
- *The windshield is obstructing the view of the camera(s) (fogged over, dirty, covered by a sticker, etc.).*
- *Lane markings are excessively worn, have visible previous markings, have been adjusted due to road construction, or are changing quickly (for example, lanes branching off, crossing over, or merging).*
- *The road is narrow or winding.*
- *Objects or landscape features are casting strong shadows on lane markers.*

(Continued next page)

Lane Assist may not provide warnings, or may apply inappropriate warnings, in these situations:

- *One or more of the ultrasonic sensors is damaged, dirty, or obstructed (such as by mud, ice, or snow).*
- *Weather conditions (heavy rain, snow, fog, or extremely hot or cold temperatures) are interfering with sensor operation.*
- *The sensors are affected by other electrical equipment or devices that generate ultrasonic waves.*
- *An object that is mounted to Model 3 is interfering with and/or obstructing a sensor (such as a bike rack or a bumper sticker).*

In addition, Lane Assist may not steer Model 3 away from an adjacent vehicle, or may apply unnecessary or inappropriate steering, in these situations:

- *You are driving Model 3 on sharp corners or on a curve at a relatively high speed.*
- *Bright light (such as from oncoming headlights or direct sunlight) is interfering with the view of the camera(s).*
- *You are drifting into another lane but an object (such as a vehicle) is not present.*
- *A vehicle in another lane cuts in front of you or drifts into your driving lane.*
- *Model 3 is traveling slower than 30 mph (48 km/h) or faster than 90 mph (145 km/h).*
- *One or more of the ultrasonic sensors is damaged, dirty, or obstructed (such as by mud, ice, or snow).*
- *Weather conditions (heavy rain, snow, fog, or extremely hot or cold temperatures) are interfering with sensor operation.*
- *The sensors are affected by other electrical equipment or devices that generate ultrasonic waves.*

(Continued next page)

- *An object mounted to Model 3 (such as a bike rack or a bumper sticker) is interfering with or obstructing a sensor.*
- *Visibility is poor and lane markings are not clearly visible (due to heavy rain, snow, fog, etc.).*
- *Lane markings are excessively worn, have visible previous markings, have been adjusted due to road construction or are changing quickly (for example, lanes branching off, crossing over, or merging).*

The lists above do not represent every possible situation that may interfere with Lane Assist warnings. Lane Assist may not operate as intended for many other reasons.

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.

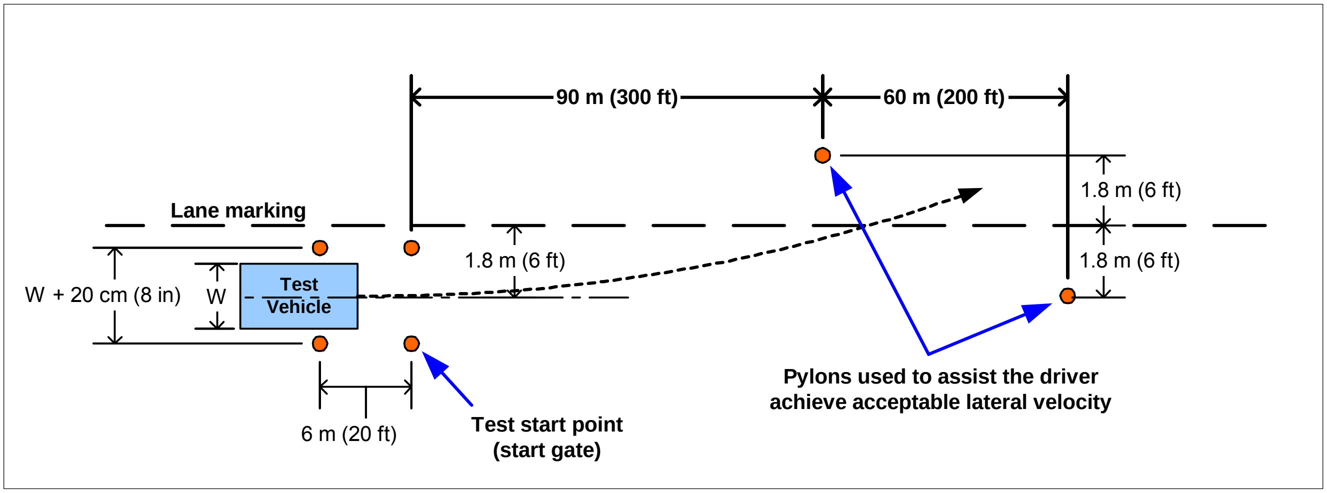


Figure 1. Position of Cones Used to Assist Driver

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.

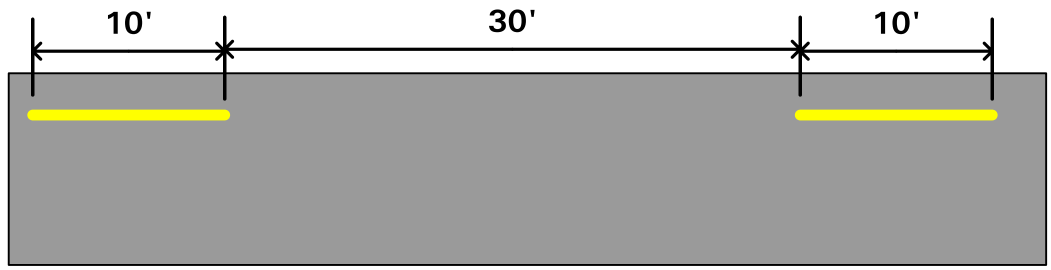


Figure 2. MUTCD Discontinuous Dashed Line Specifications

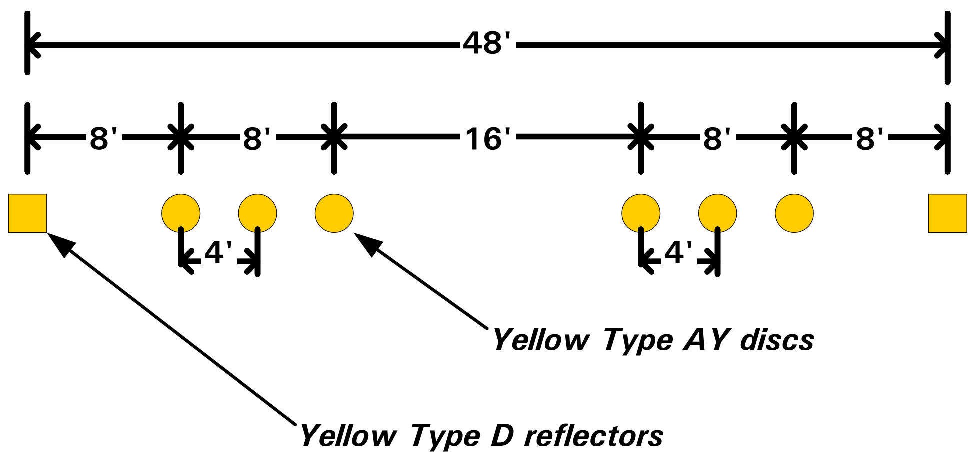


Figure 3. California Standard Plan A20A, Detail 4

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 Solutions[1] 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	5th	3 dB	60 dB	Identified Center Frequency ± 5%
Tactile	5th	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

Year: 2018 Make: Tesla Model: Model 3 AWD VIN: 5YJ3E1EB9JF06	Engine: Electric Motor Transmission: 1-Speed A/T Exterior: Pearl White Multi-Coat Interior: Black

MECHANICAL

· Dual Motor: Fr AC Induction/ Rr AC Permanent Magnet
· Automatic Full-Time All-Wheel Drive
· 9.00 Axle Ratio
· 33-Amp/Hr Maintenance-Free Battery
· 3 Skid Plates
· Gas-Pressurized Shock Absorbers
· Front Anti-Roll Bar
· Electric Power-Assist Speed-Sensing Steering
· Double Wishbone Front Suspension w/Coil Springs
· Multi-Link Rear Suspension w/Coil Springs
· Regenerative 4-Wheel Disc Brakes w/4-Wheel ABS, Front And Rear Vented Discs, Brake Assist, Hill Hold Control and Electric Parking Brake
· Lithium Ion Traction Battery w/12 Hrs Charge Time @ 220/240V

EXTERIOR

· Clearcoat Paint
· Body-Colored Front Bumper
· Body-Colored Rear Bumper
· Chrome Side Windows Trim
· Chrome Door Handles
· Fixed Rear Window w/Defroster
· Light Tinted Glass
· Variable Intermittent Wipers
· Galvanized Steel/Aluminum Panels
· Trunk Rear Cargo Access
· Fully Automatic Aero-Composite Led Low/High Beam Daytime Running Auto-Leveling Auto High-Beam Headlamps w/Delay-Off
· Perimeter/Approach Lights
· LED Brakelights

ENTERTAINMENT

· Radio: FM w/Premium Audio System -inc: 15" touchscreen, Bluetooth connectivity, on-demand and internet radio capability, 4 USB ports, docking for 2 smartphones and 1 year Premium Connectivity
· Regular Amplifier
· Window Grid Antenna
· 1 LCD Monitor In The Front

INTERIOR

· Heated Front Bucket Seats -inc: 12-way power adjustable front seats and custom driver profiles
· 8-Way Passenger Seat -inc: Power 4-Way Lumbar Support
· 60-40 Folding Bench Front Facing Heated Fold Forward Seatback Rear Seat
· Power Tilt/Telescoping Steering Column
· Leatherette Steering Wheel
· Front Cupholder
· Rear Cupholder
· Compass
· Valet Function
· Remote Releases -Inc: Power Cargo Access and Power Charge Port Door
· Homelink Garage Door Transmitter
· Cruise Control w/Steering Wheel Controls
· Dual Zone Front Automatic Air Conditioning w/Steering Wheel Controls
· HVAC -inc: Console Ducts
· Illuminated Locking Glove Box
· Driver Foot Rest
· Interior Trim -inc: Aluminum/Genuine Wood Instrument Panel Insert, Metal-Look Door Panel Insert, Piano Black/Aluminum Console Insert and Metal-Look Interior Accents
· Full Cloth Headliner
· Simulated Suede Door Trim Insert
· Day-Night Auto-Dimming Rearview Mirror
· Driver And Passenger Visor Vanity Mirrors w/Driver And Passenger Illumination, Driver And Passenger Auxiliary Mirror
· Full Floor Console w/Covered Storage and 1 12V DC Power Outlet
· Front And Rear Map Lights
· Fade-To-Off Interior Lighting
· Full Carpet Floor Covering -inc: Carpet Front And Rear Floor Mats
· Carpet Floor Trim
· Cargo Area Concealed Storage
· Cargo Space Lights
· Tracker System
· Smart Device Integration
· Instrument Panel Covered Bin, Driver / Passenger And Rear Door Bins
· Delayed Accessory Power
· Systems Monitor
· Outside Temp Gauge
· Digital Display
· Fixed Front Head Restraints and Fixed Rear Head Restraints
· Front Center Armrest and Rear Center Armrest
· 2 Seatback Storage Pockets
· 1 12V DC Power Outlet
· Air Filtration

SAFETY

· Side Impact Beams
· Dual Stage Driver And Passenger Seat-Mounted Side Airbags
· Front And Rear Parking Sensors
· Blind Spot Sensor
· Forward Collision Mitigation and Rear Collision Warning
· Tire Specific Low Tire Pressure Warning
· Dual Stage Driver And Passenger Front Airbags
· Curtain 1st And 2nd Row Airbags
· Airbag Occupancy Sensor
· Driver And Passenger Knee Airbag
· Power Rear Child Safety Locks
· Outboard Front Lap And Shoulder Safety Belts -inc: Rear Center 3 Point, Height Adjusters and Pretensioners
· Back-Up Camera
· Front Camera
· Left Side Camera
· Right Side Camera

CITY MPG	Fuel Economy Information	HIGHWAY MPG
136		123

Actual mileage will vary with options, driving conditions, driving habits and vehicle's condition

New

MSRP	**$53,000.00**
INSTALLED OPTIONS	
Pearl White Multi Coat	$2,000
Black, Synthetic Leather Seat Trim	$0
White & Black Premium Interior	$1,000
Enhanced Autopilot	$5,000
Wheels: 19" Sport	$1,500
Tires: 19"	included
Enhanced Autopilot	$7,000
Original Shipping Charge	$1,200
RETAIL PRICE (ORIGINALLY NEW)	$70,700.00

Get more information on your smartphone:

Figure A3. Window Sticker (Monroney Label)

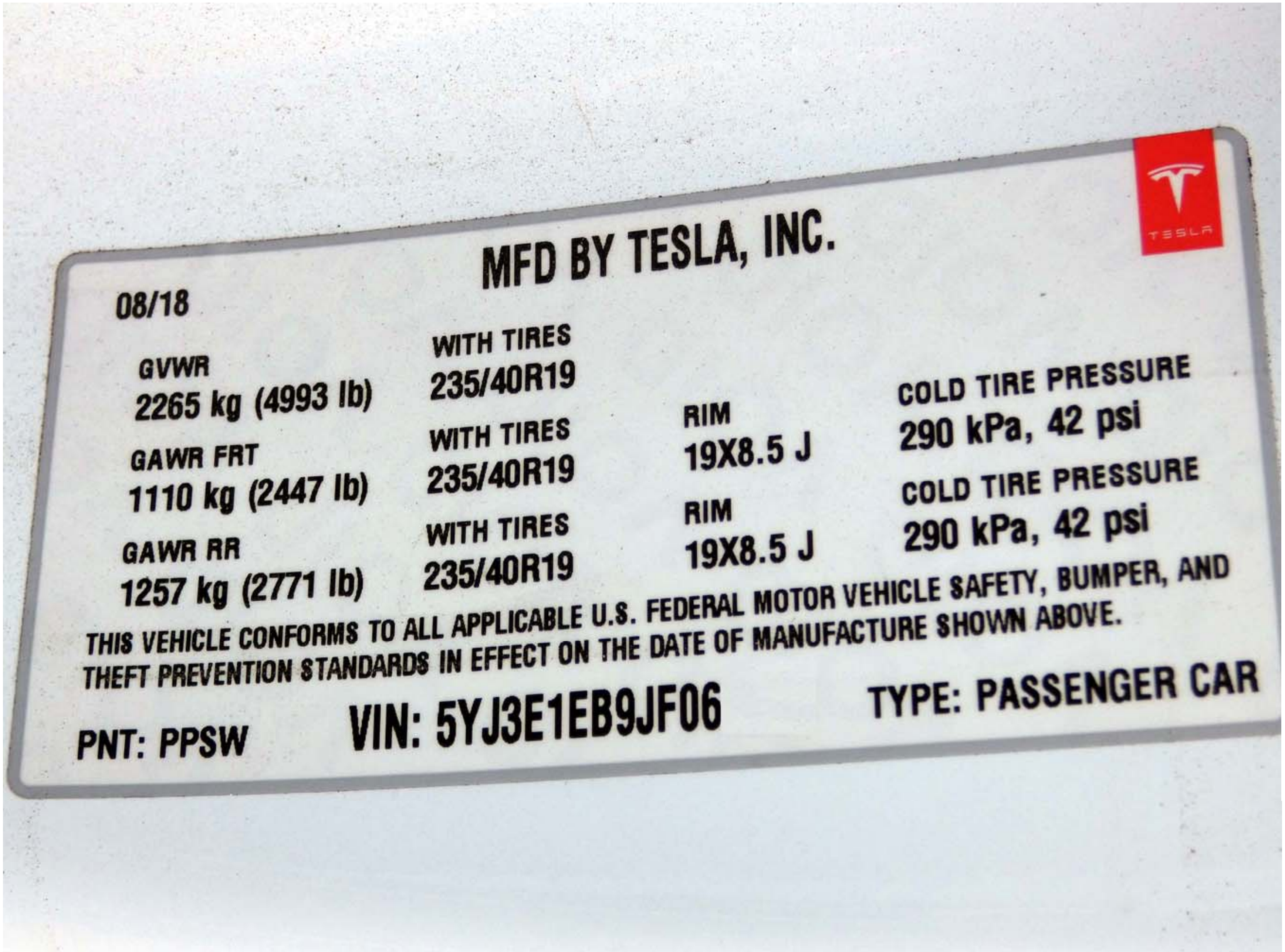


Figure A4. Vehicle Certification Label

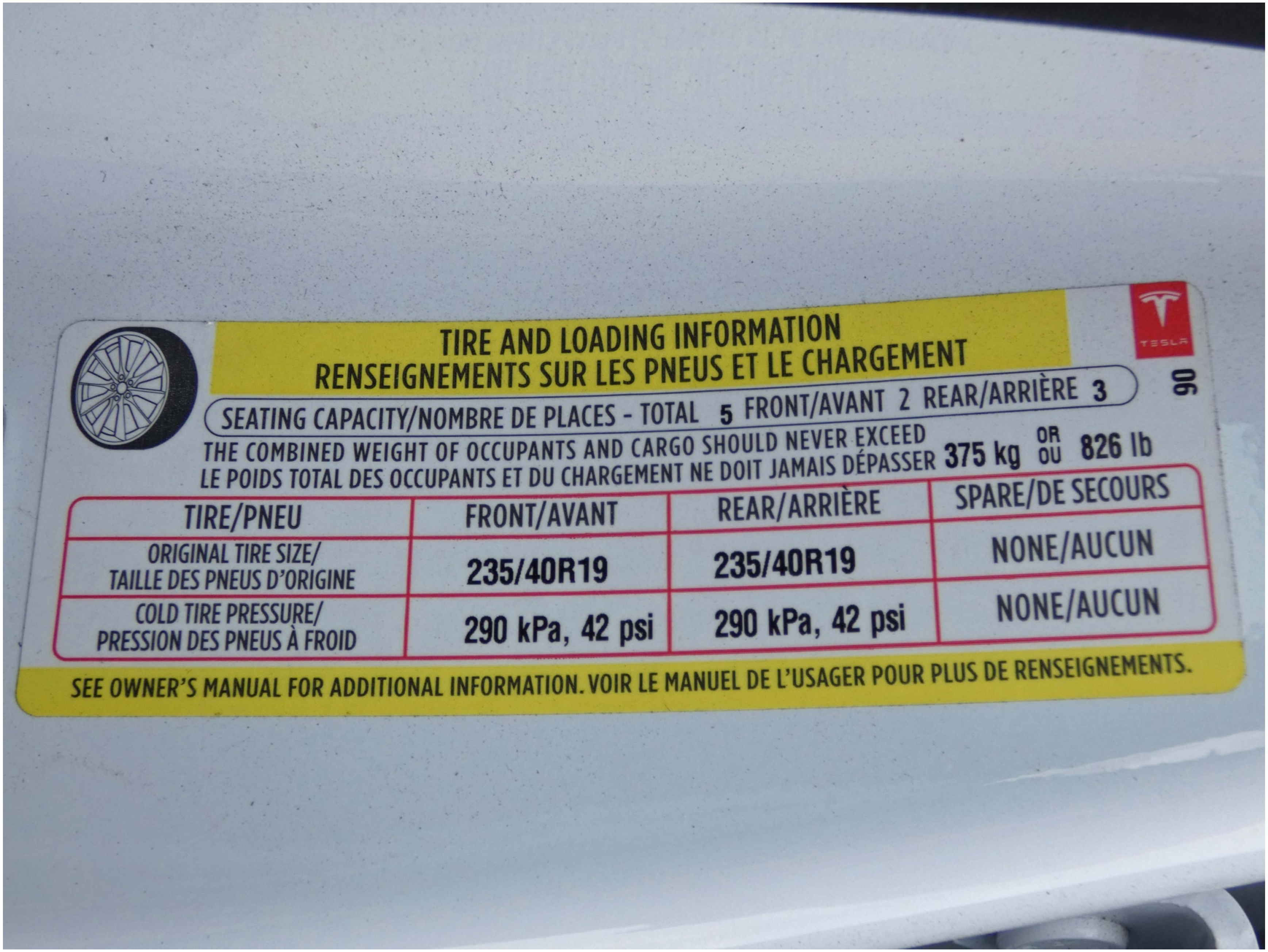


Figure A5. Tire Placard

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

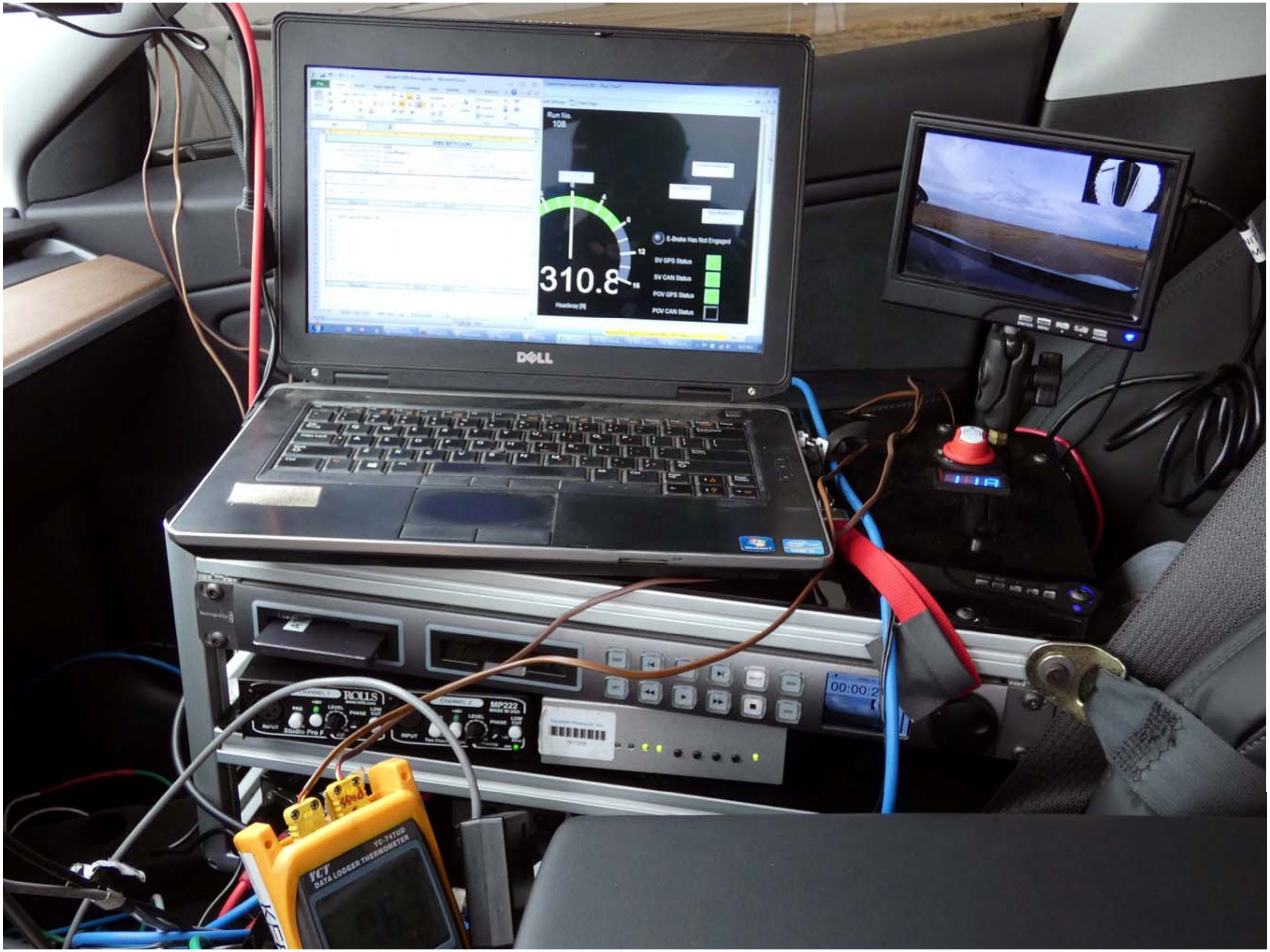


Figure A7. Computer Installed in Test Vehicle

Figure A8. Sensor for Detecting Haptic Alerts

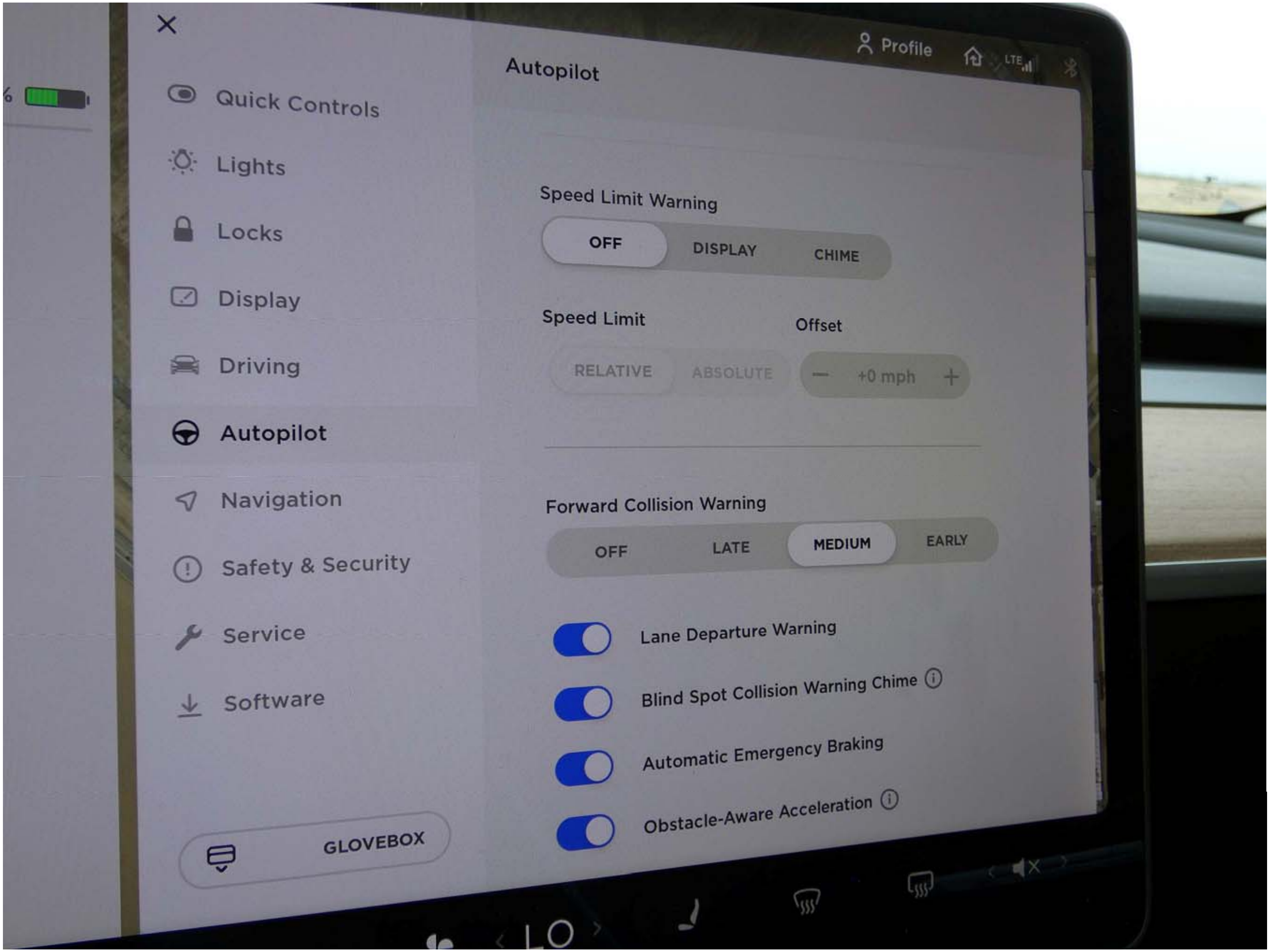


Figure A9. LDW On/Off Menu

APPENDIX B

Excerpts from Owner's Manual

The cameras monitor the markers on the lane you are driving in and the ultrasonic sensors and Autopilot cameras monitor the surrounding areas and the blind spot for the presence of a vehicle or other objects.

When an object is detected in your blind spot or close to the side of Model 3 (such as a vehicle, guard rail, etc.), colored lines radiate from the image of Model 3 on the touchscreen. The location of the lines correspond to the location of the detected object. The color of the lines (white, yellow, orange, or red) represents the object's proximity to Model 3, with white being the farthest and red being very close and requiring your immediate attention. These colored lines only display when driving between approximately 7 and 85 mph (12 and 140 km/h). When Autosteer is active, these colored lines also display if driving slower than 7 mph (12 km/h). However, the colored lines do not display if Model 3 is at a standstill (for example, in heavy traffic).

Lane Assist warns you of undesired lane departures by vibrating the steering wheel slightly if a front wheel passes over a lane marking and the associated turn signal is off. This warning is active only when driving between approximately 36 and 90 mph (59 and 150 km/h). To turn this warning on or off, touch **Controls** > **Autopilot** > **Lane Departure Warning**. Your chosen setting is retained until you manually change it.

Lane Assist also warns you when a desired lane departure is not appropriate. When you engage the turn signal and a vehicle or object is detected in the adjacent lane you are planning to move into, the touchscreen displays a red lane line to indicate that you should not change lanes. When the vehicle or object is no longer detected, the lane line returns to normal.

Lane Assist also provides steering interventions if Model 3 drifts into (or close to) an adjacent lane in which an object, such as a vehicle, is detected. In these situations, Model 3 automatically steers to a safer position in its driving lane. This steering is applied only when Model 3 is traveling between 30 and 85 mph (48 and 140 km/h) on major roadways with clearly visible lane markings. When Lane Assist applies a steering intervention, the touchscreen briefly displays a warning message.

Warning: Steering interventions are minimal and are not designed to move Model 3 out of its driving lane. Do not rely on steering interventions to avoid side collisions.

Warning: Lane Assist features are for guidance purposes only and are not intended to replace your own direct visual checks. Never depend on Lane Assist to inform you of unintentionally driving outside of the boundaries of the driving lane or informing you that an object or vehicle is in your blind spot or close to the side of your vehicle. Several external factors can reduce the performance of Lane Assist. It is the driver's responsibility to stay alert, pay attention to the driving lane and always be aware of other road users. Failure to do so can result in serious injury or death.

Warning: Lane Assist is designed to detect lane markings and may not detect the edge of a road, especially if the road has no curb. It is the driver's responsibility to drive attentively and stay within the boundaries of the driving lane.

Warning: Before changing lanes, always visually check the lane you are moving into by using side mirrors and performing the appropriate shoulder checks. Several factors can affect the performance of the Lane Assist warnings, resulting in lack of, or false warnings (see Limitations and Inaccuracies on page 84).

Limitations and Inaccuracies

Lane Assist cannot always clearly detect lane markings and you may experience unnecessary or invalid warnings in these situations:

- Visibility is poor and lane markings are not clearly visible (due to heavy rain, snow, fog, etc.). The exact detection zone of the ultrasonic sensors varies depending on environmental conditions.
- Bright light (such as from oncoming headlights or direct sunlight) is interfering with the view of the camera(s).
- A vehicle in front of Model 3 is blocking the view of the camera(s).
- The windshield is obstructing the view of the camera(s) (fogged over, dirty, covered by a sticker, etc.).
- Lane markings are excessively worn, have visible previous markings, have been adjusted due to road construction, or are changing quickly (for example, lanes branching off, crossing over, or merging).
- The road is narrow or winding.
- Objects or landscape features are casting strong shadows on lane markers.

Lane Assist may not provide warnings, or may apply inappropriate warnings, in these situations:

- One or more of the ultrasonic sensors is damaged, dirty, or obstructed (such as by mud, ice, or snow).
- Weather conditions (heavy rain, snow, fog, or extremely hot or cold temperatures) are interfering with sensor operation.
- The sensors are affected by other electrical equipment or devices that generate ultrasonic waves.
- An object that is mounted to Model 3 is interfering with and/or obstructing a sensor (such as a bike rack or a bumper sticker).

In addition, Lane Assist may not steer Model 3 away from an adjacent vehicle, or may apply unnecessary or inappropriate steering, in these situations:

- You are driving Model 3 on sharp corners or on a curve at a relatively high speed.
- Bright light (such as from oncoming headlights or direct sunlight) is interfering with the view of the camera(s).
- You are drifting into another lane but an object (such as a vehicle) is not present.
- A vehicle in another lane cuts in front of you or drifts into your driving lane.
- Model 3 is traveling slower than 30 mph (48 km/h) or faster than 90 mph (145 km/h).
- One or more of the ultrasonic sensors is damaged, dirty, or obstructed (such as by mud, ice, or snow).
- Weather conditions (heavy rain, snow, fog, or extremely hot or cold temperatures) are interfering with sensor operation.
- The sensors are affected by other electrical equipment or devices that generate ultrasonic waves.
- An object mounted to Model 3 (such as a bike rack or a bumper sticker) is interfering with or obstructing a sensor.
- Visibility is poor and lane markings are not clearly visible (due to heavy rain, snow, fog, etc.).
- Lane markings are excessively worn, have visible previous markings, have been adjusted due to road construction or are changing quickly (for example, lanes branching off, crossing over, or merging).

Warning: The lists above do not represent every possible situation that may interfere with Lane Assist warnings. Lane Assist may not operate as intended for many other reasons. To avoid a collision, stay alert and always pay attention to the roadway when driving Model 3 so you can anticipate the need to take corrective action as early as possible.

APPENDIX C

Run Log

Subject Vehicle: **2018 Tesla Model 3**

Test Date: **5/14/2019**

Driver: **A. Ricci**

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

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Haptic Alert (ft)	Pass/Fail	Notes
1	**Solid**	**Right**	Y	0.51	Pass	
2			Y	0.55	Pass	
3			Y	0.60	Pass	
4			N			Speed, yaw rate
5			N			Yaw rate
6			Y	0.48	Pass	
7			Y	0.64	Pass	
8			Y	0.55	Pass	
9			Y	0.46	Pass	
10	**Solid**	**Left**	Y	-0.51	Pass	
11			N			Yaw rate
12			Y	-0.37	Pass	
13			Y	-0.41	Pass	
14			Y	-0.41	Pass	
15			Y	-0.46	Pass	
16			Y	-0.39	Pass	
17			Y	-0.34	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Haptic Alert (ft)	Pass/Fail	Notes
18	**Dashed**	**Left**	Y	-0.85	Pass	
19			Y	-0.64	Pass	
20			Y	-0.71	Pass	
21			Y	-0.74	Pass	
22			Y	-0.87	Pass	
23			Y	-0.72	Pass	
24			Y	-0.91	Pass	
25	**Dashed**	**Right**	Y	0.13	Pass	
26			Y	0.11	Pass	
27			Y	0.17	Pass	
28			Y	0.15	Pass	
29			Y	0.25	Pass	
30			Y	0.13	Pass	
31			Y	0.13	Pass	
32	**Botts**	**Right**	Y	0.02	Pass	
33			Y	0.09	Pass	
34			N			Speed
35			Y	0.14	Pass	
36			Y	0.16	Pass	
37			Y	0.07	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Haptic Alert (ft)	Pass/Fail	Notes
38			Y	0.10	Pass	
39			Y	0.10	Pass	
40	**Botts**	**Left**	Y	-0.47	Pass	Start gate cones in normal position
41			Y	-0.55	Pass	Moved start gate cones earlier in run
42			Y	-0.39	Pass	
43			Y	-0.45	Pass	
44			Y	-0.46	Pass	
45			Y	-0.46	Pass	
46			Y	-0.49	Pass	
47			Y	-0.55	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.

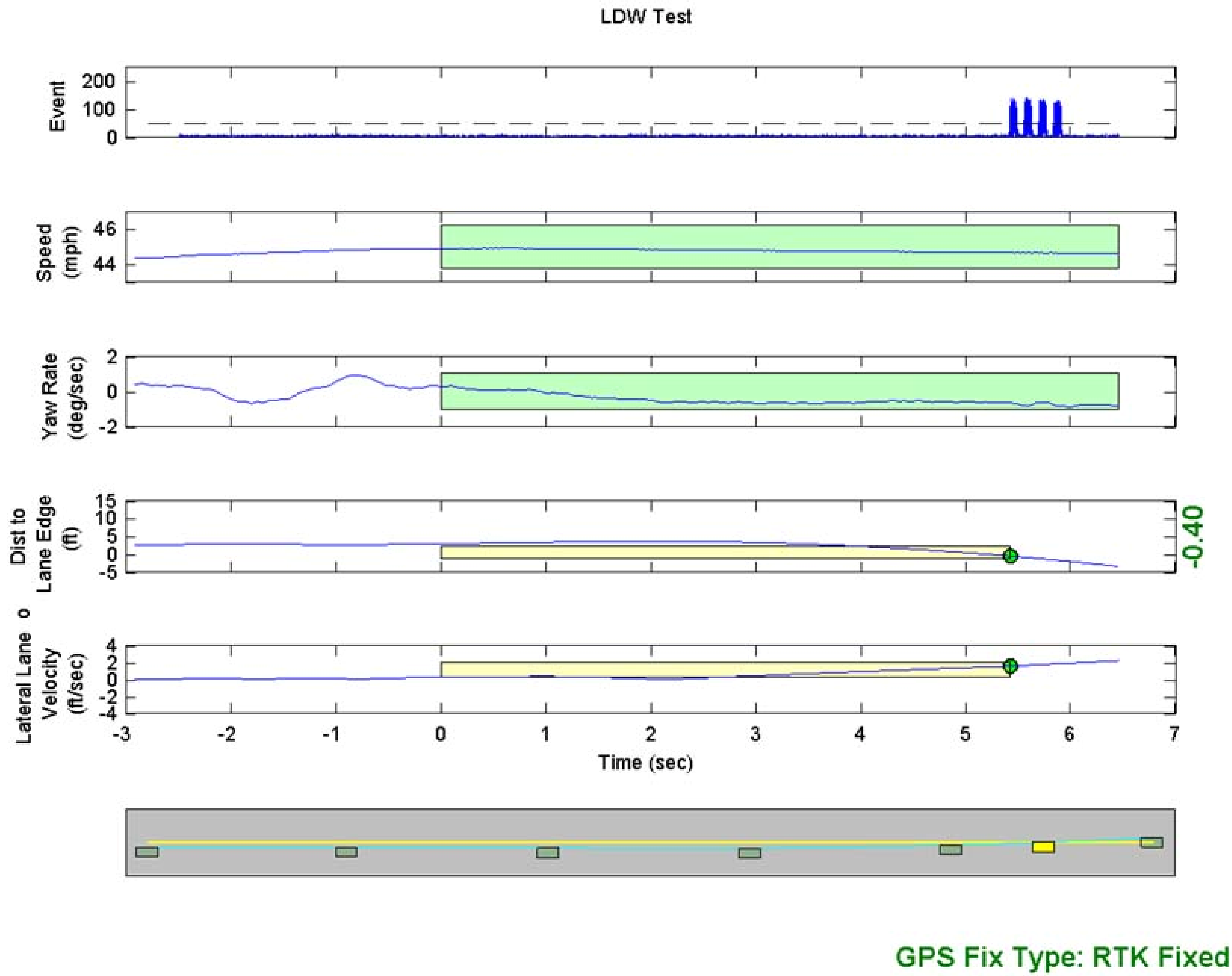


Figure D1. Example Time History for Lane Departure Warning Test, Passing

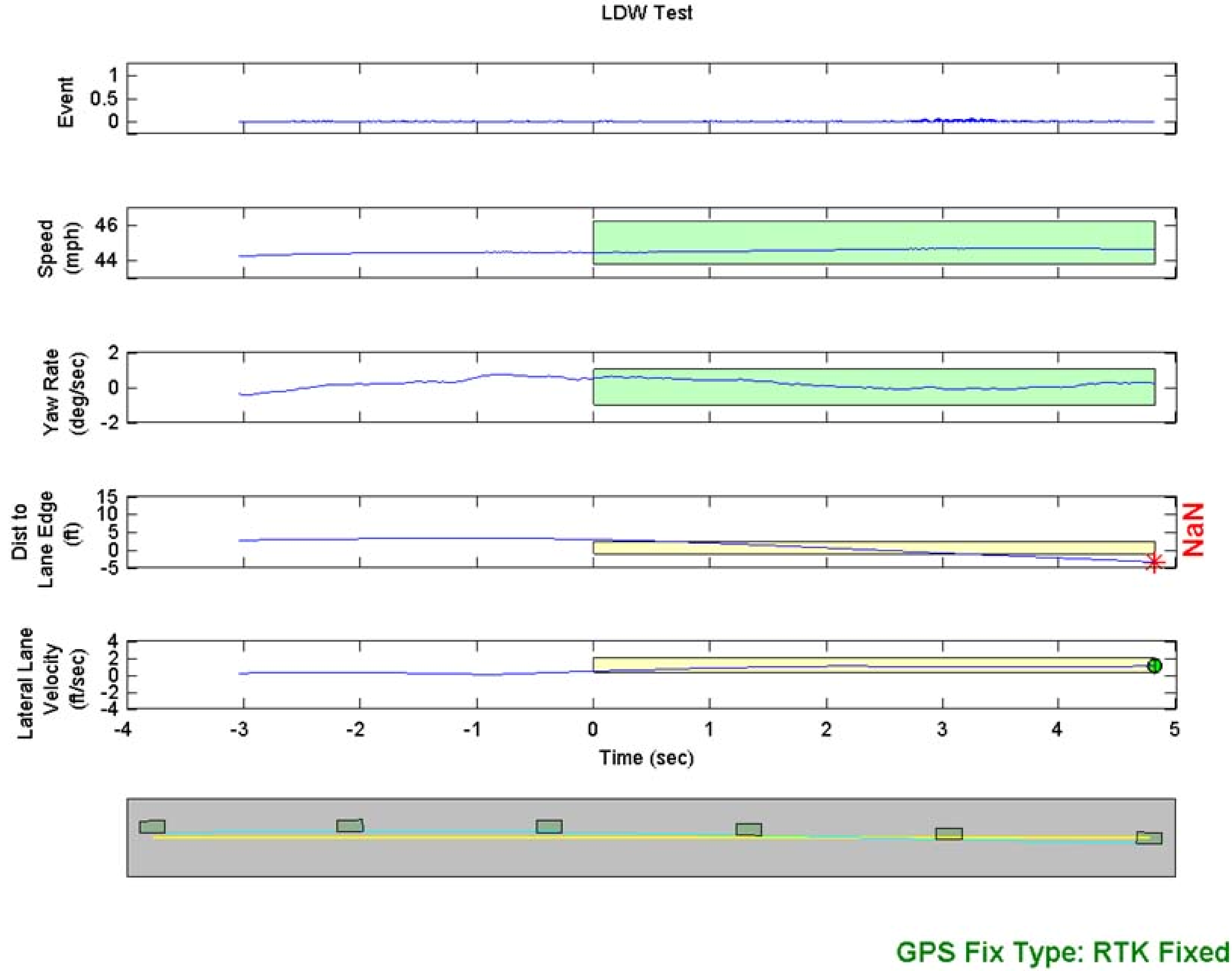


Figure D2. Example Time History for Lane Departure Warning Test, Failing, No Warning Issued

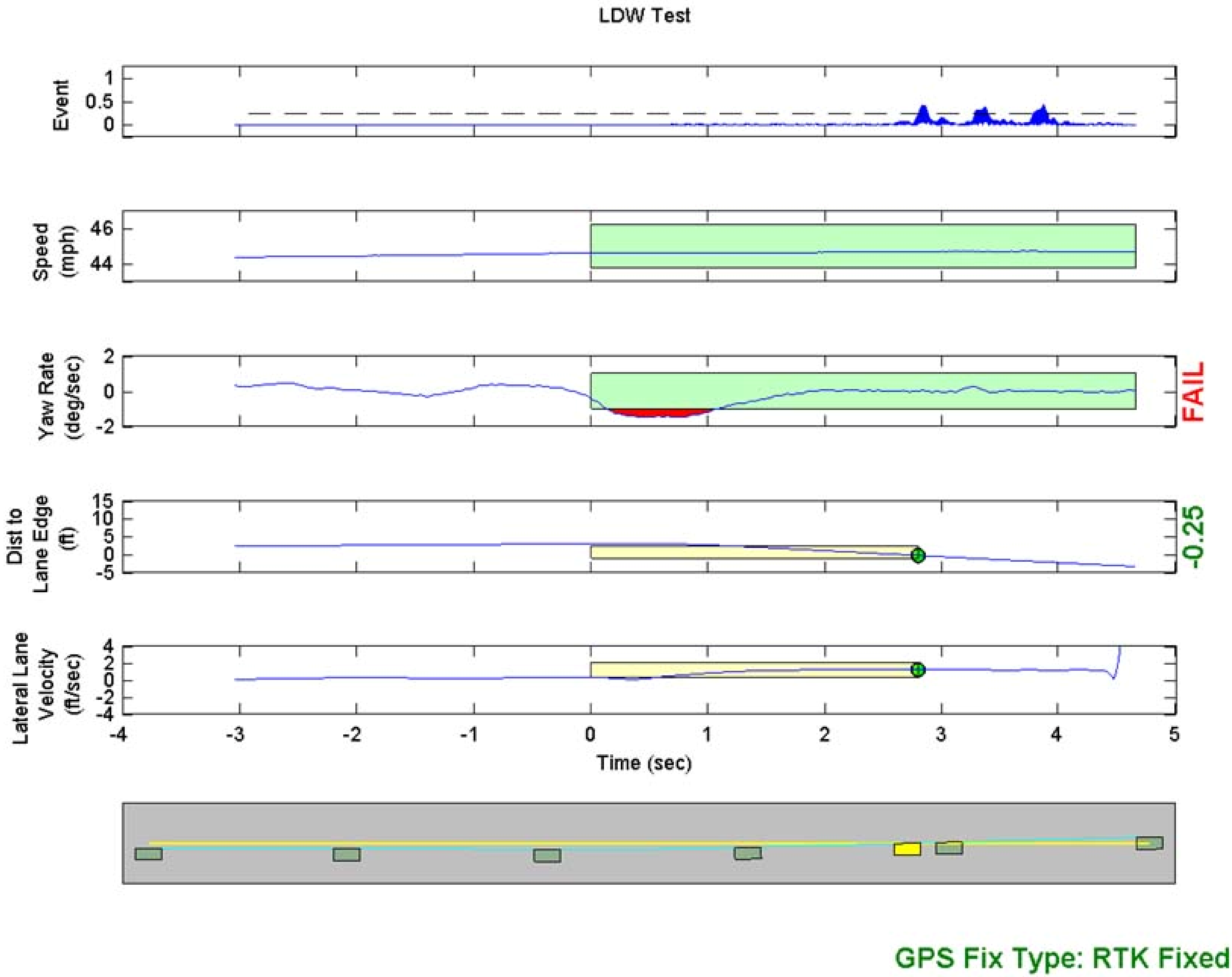
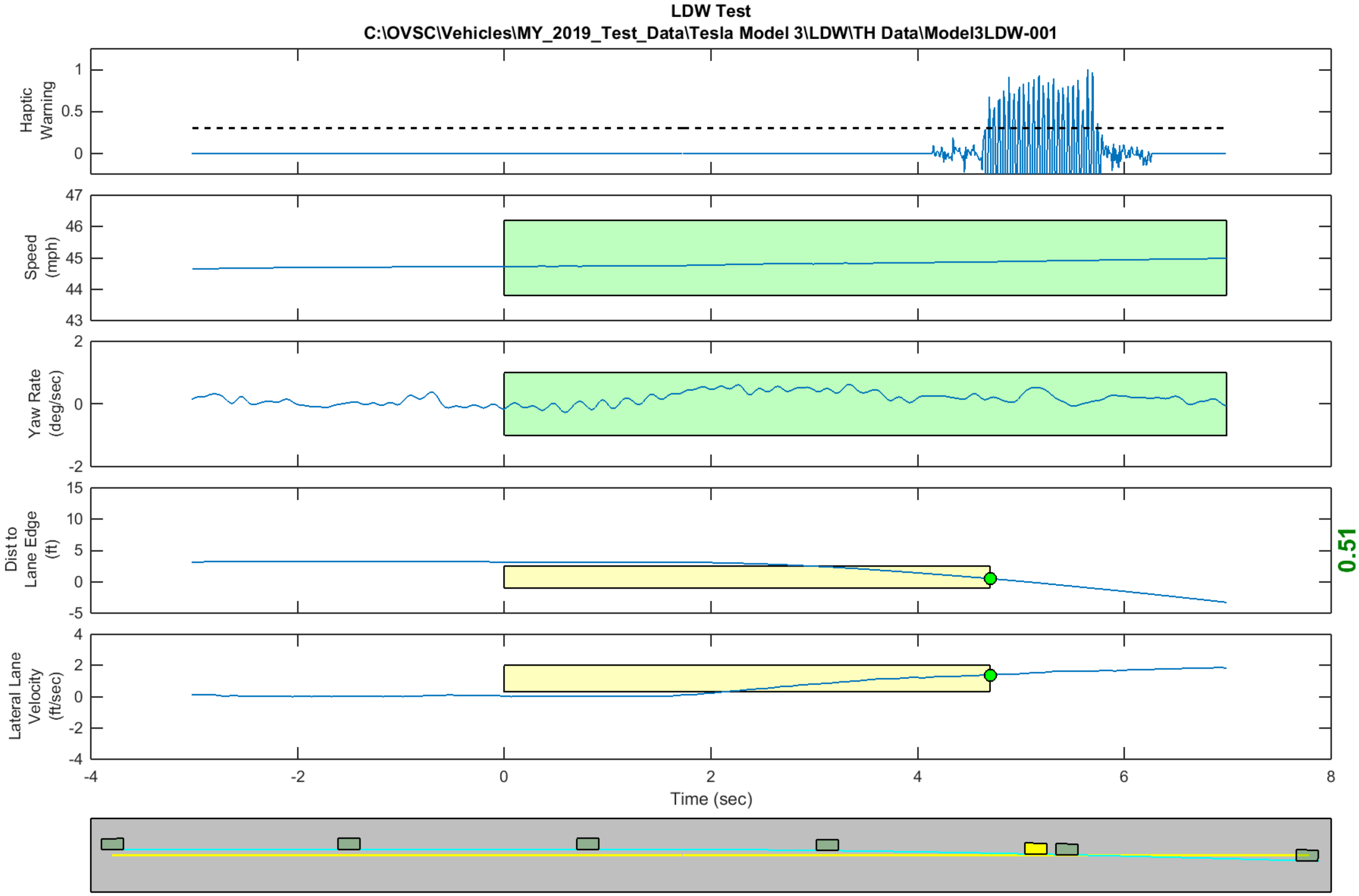
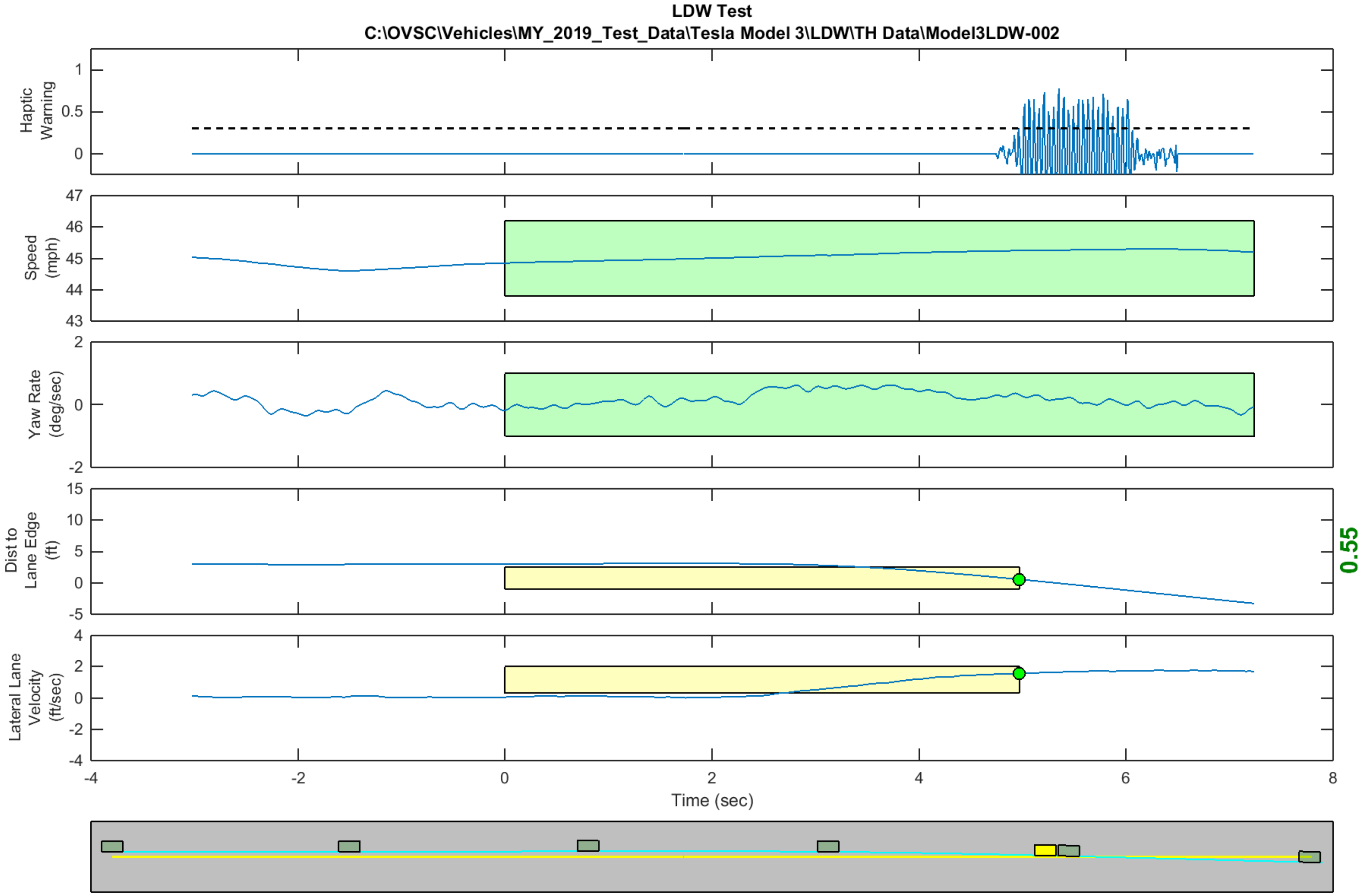


Figure D3. Example Time History for Lane Departure Warning Test, Invalid Run Due to Subject Vehicle Yaw Rate



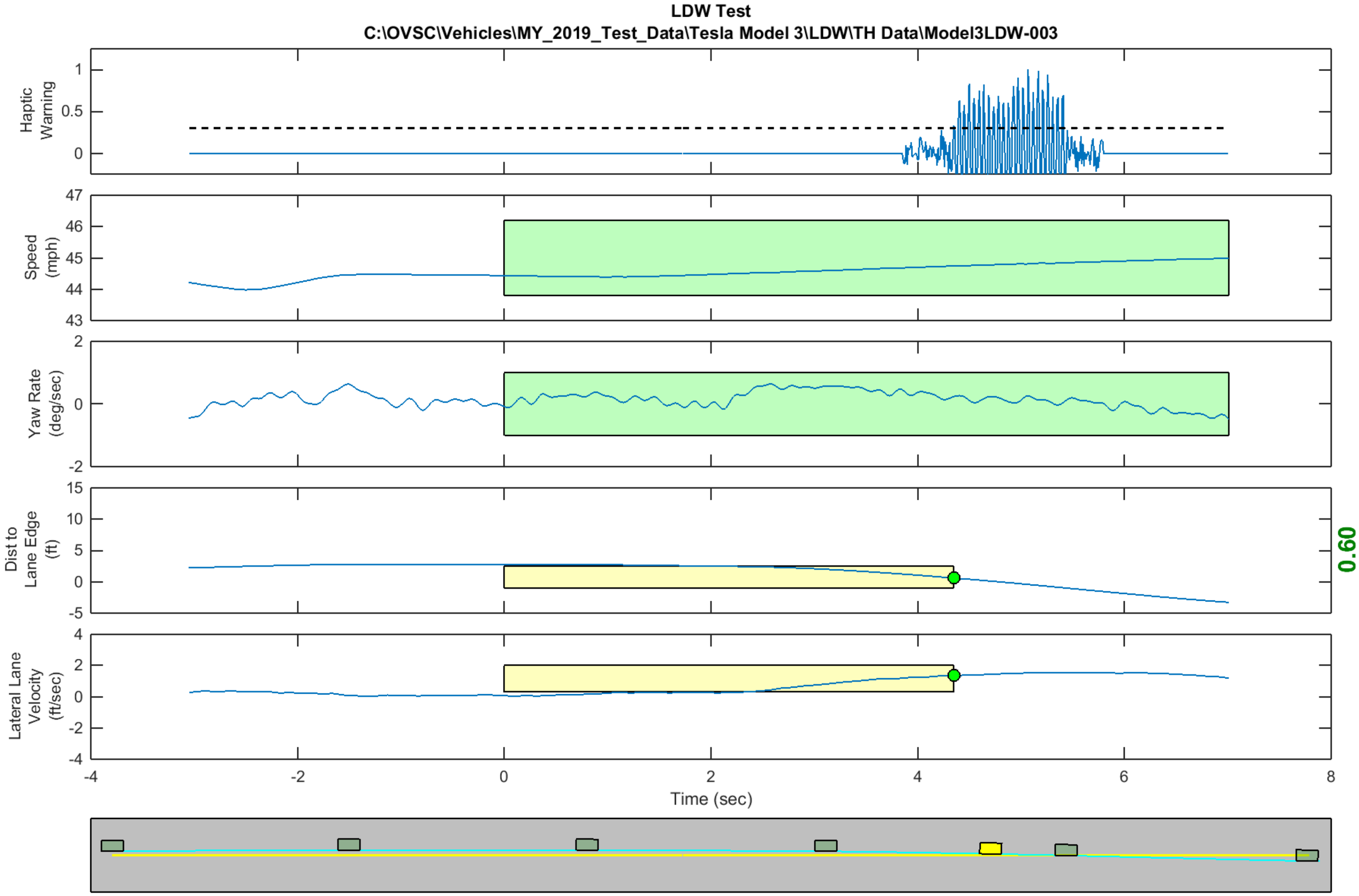
GPS Fix Type: RTK Fixed

Figure D4. Time History for Run 1, Solid Line, Right Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D5. Time History for Run 2, Solid Line, Right Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D6. Time History for Run 3, Solid Line, Right Departure, Haptic Warning

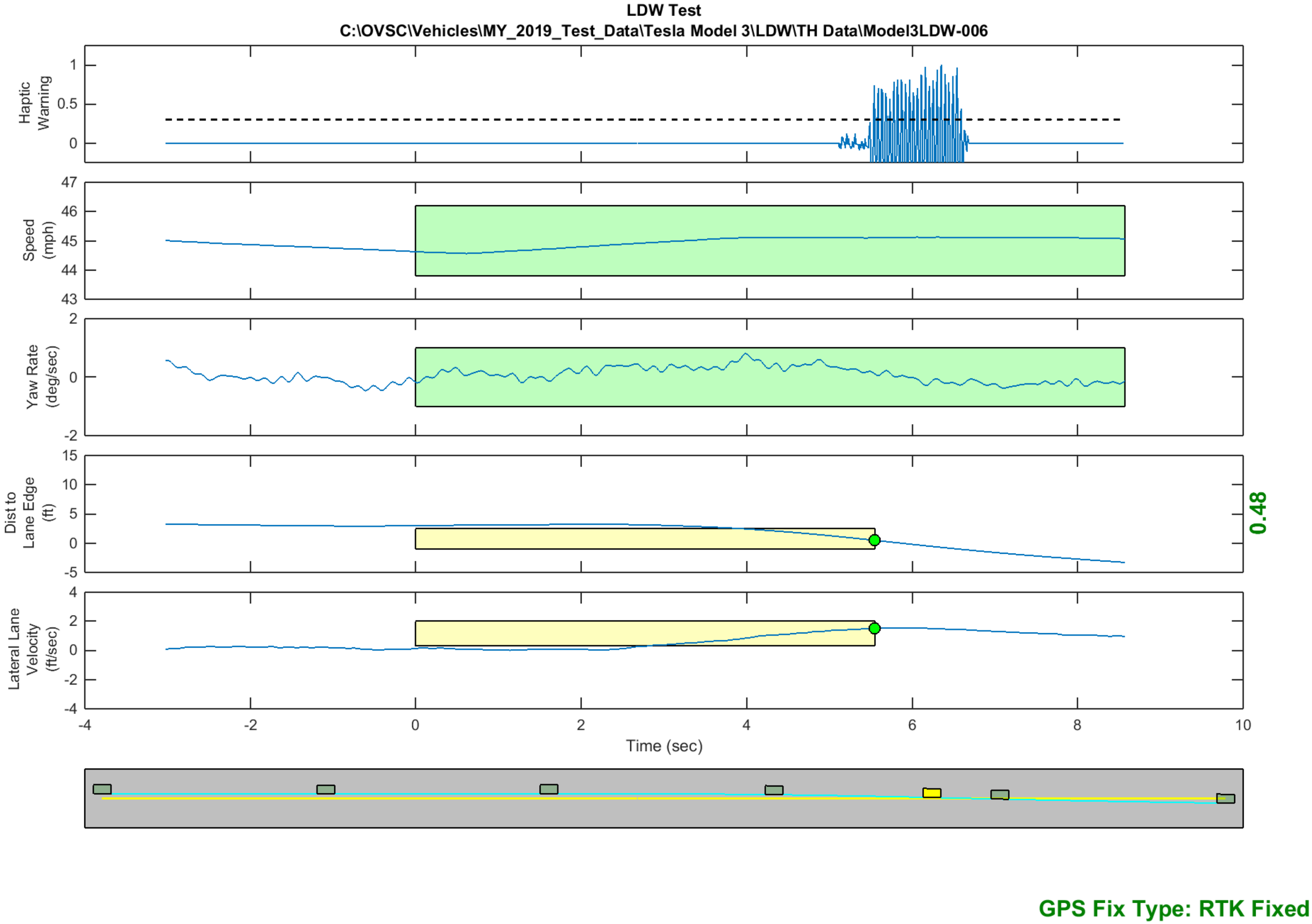


Figure D7. Time History for Run 6, Solid Line, Right Departure, Haptic Warning

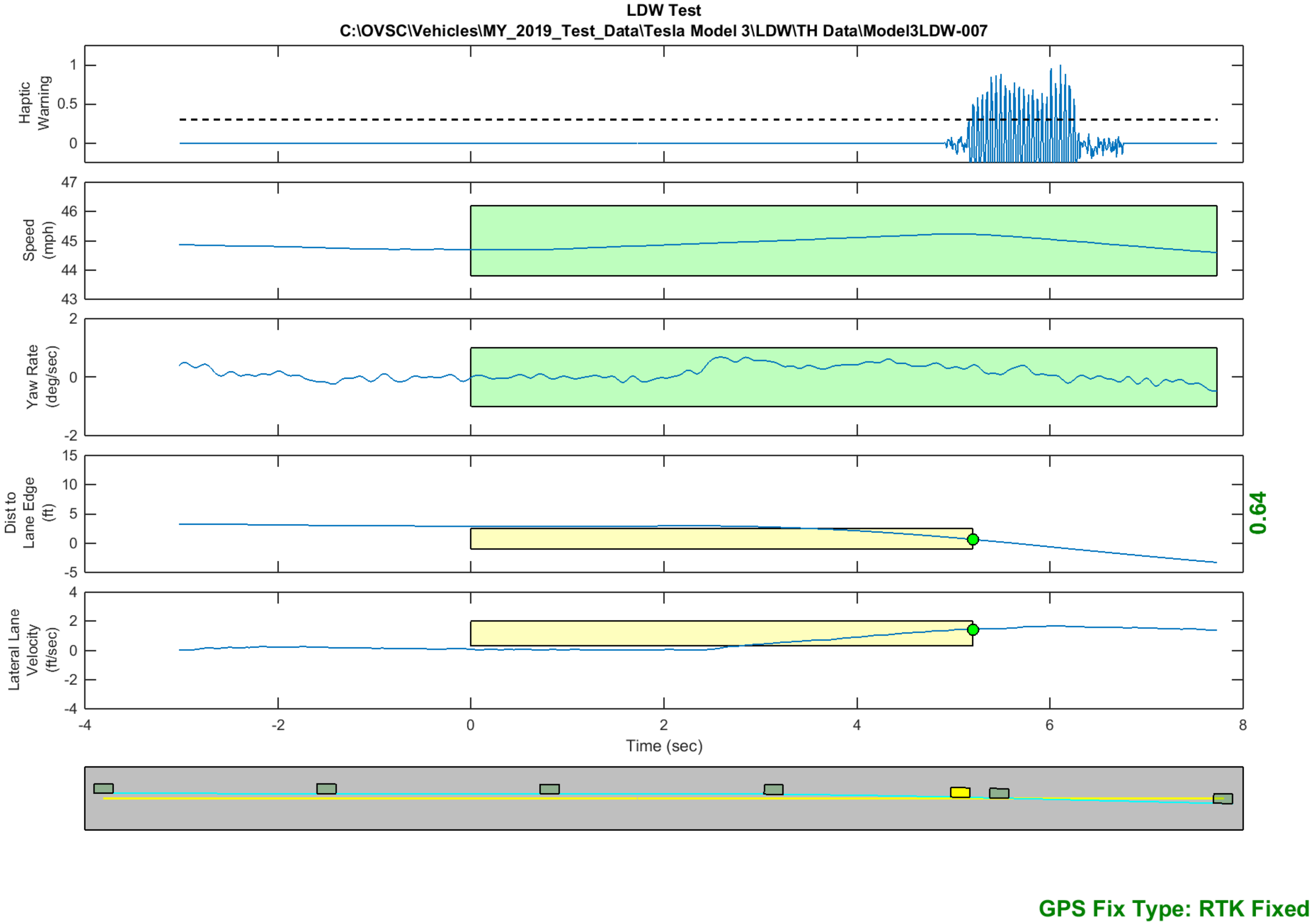


Figure D8. Time History for Run 7, Solid Line, Right Departure, Haptic Warning

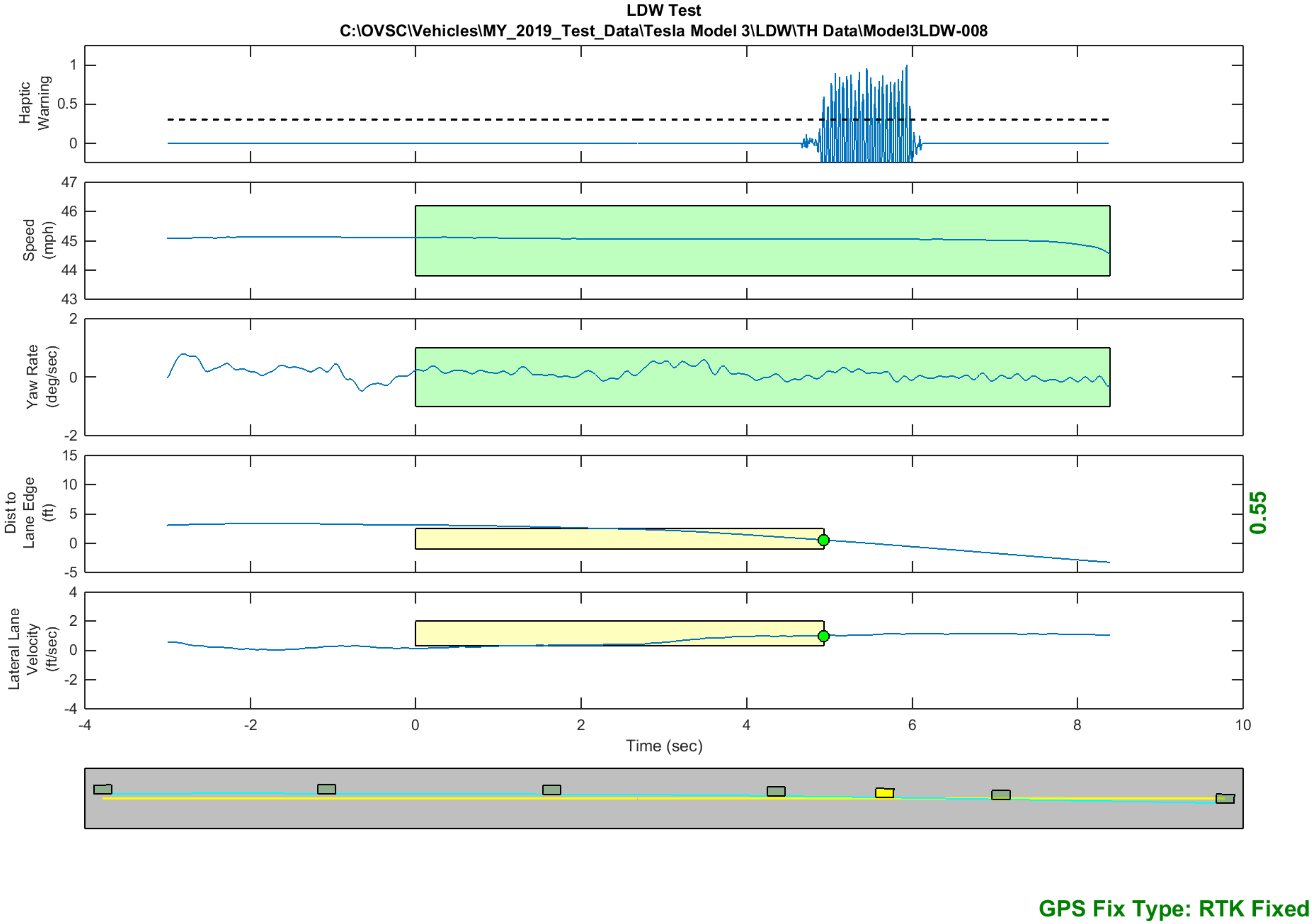


Figure D9. Time History for Run 8, Solid Line, Right Departure, Haptic Warning

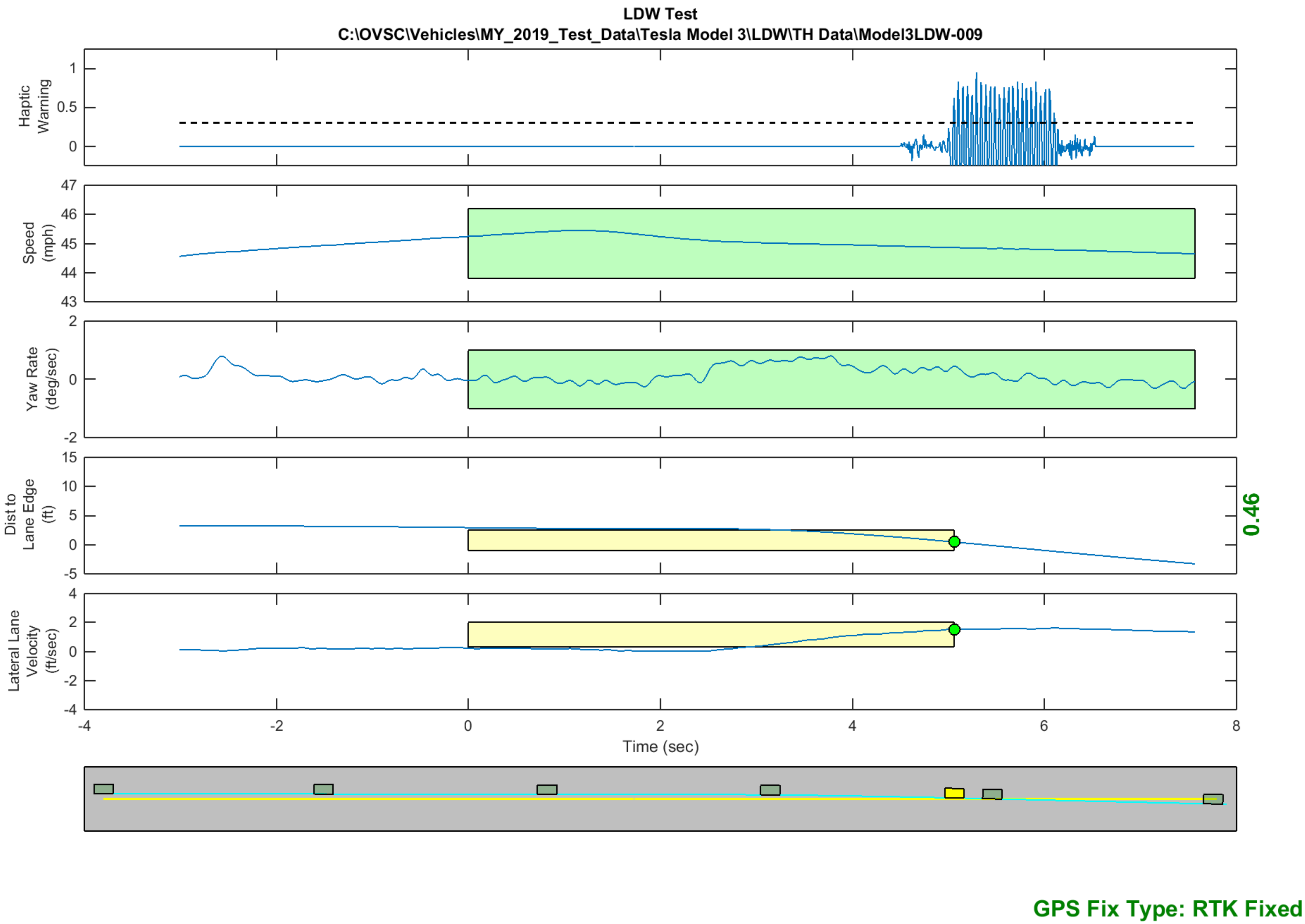


Figure D10. Time History for Run 9, Solid Line, Right Departure, Haptic Warning

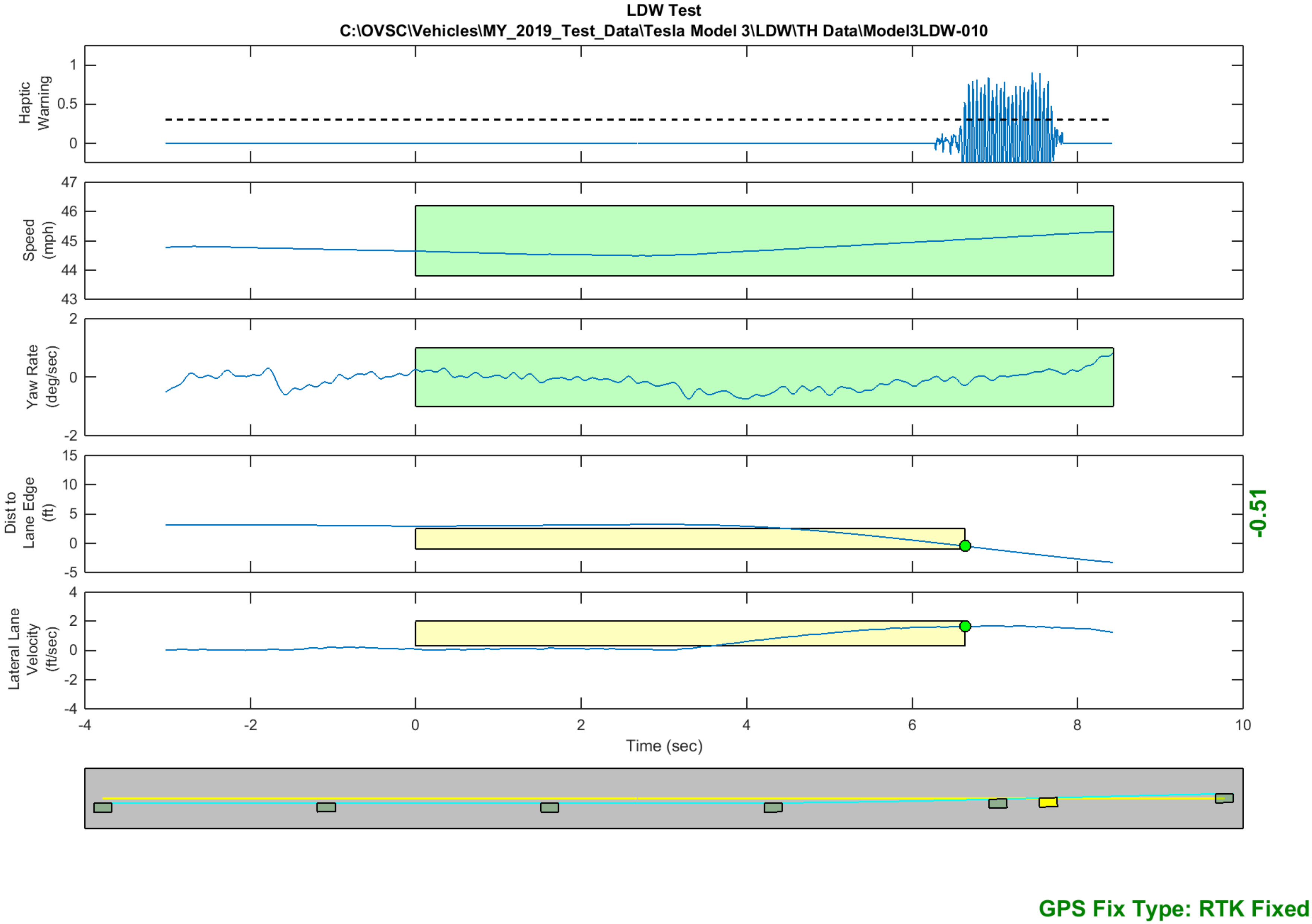
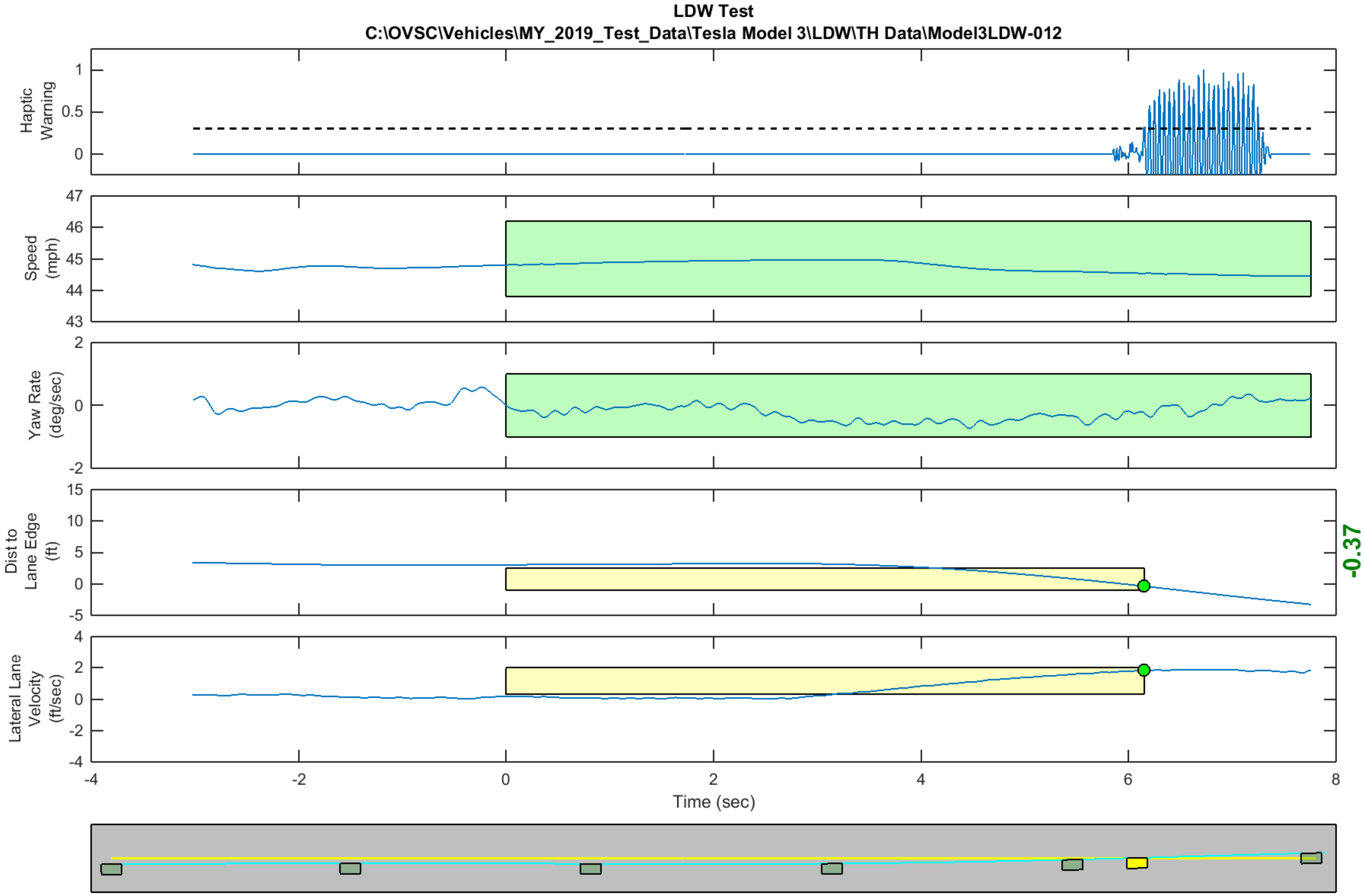
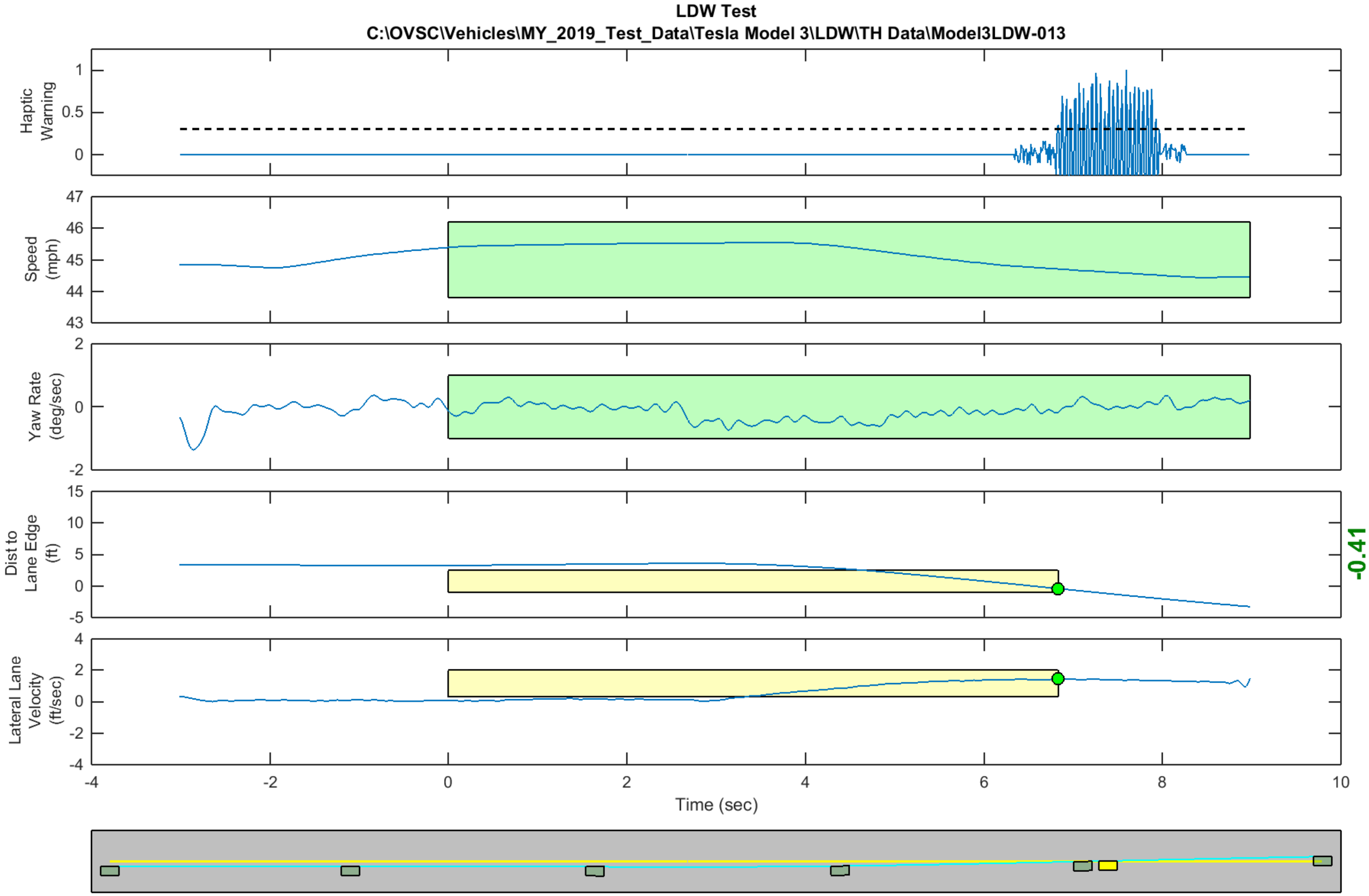


Figure D11. Time History for Run 10, Solid Line, Left Departure, Haptic Warning



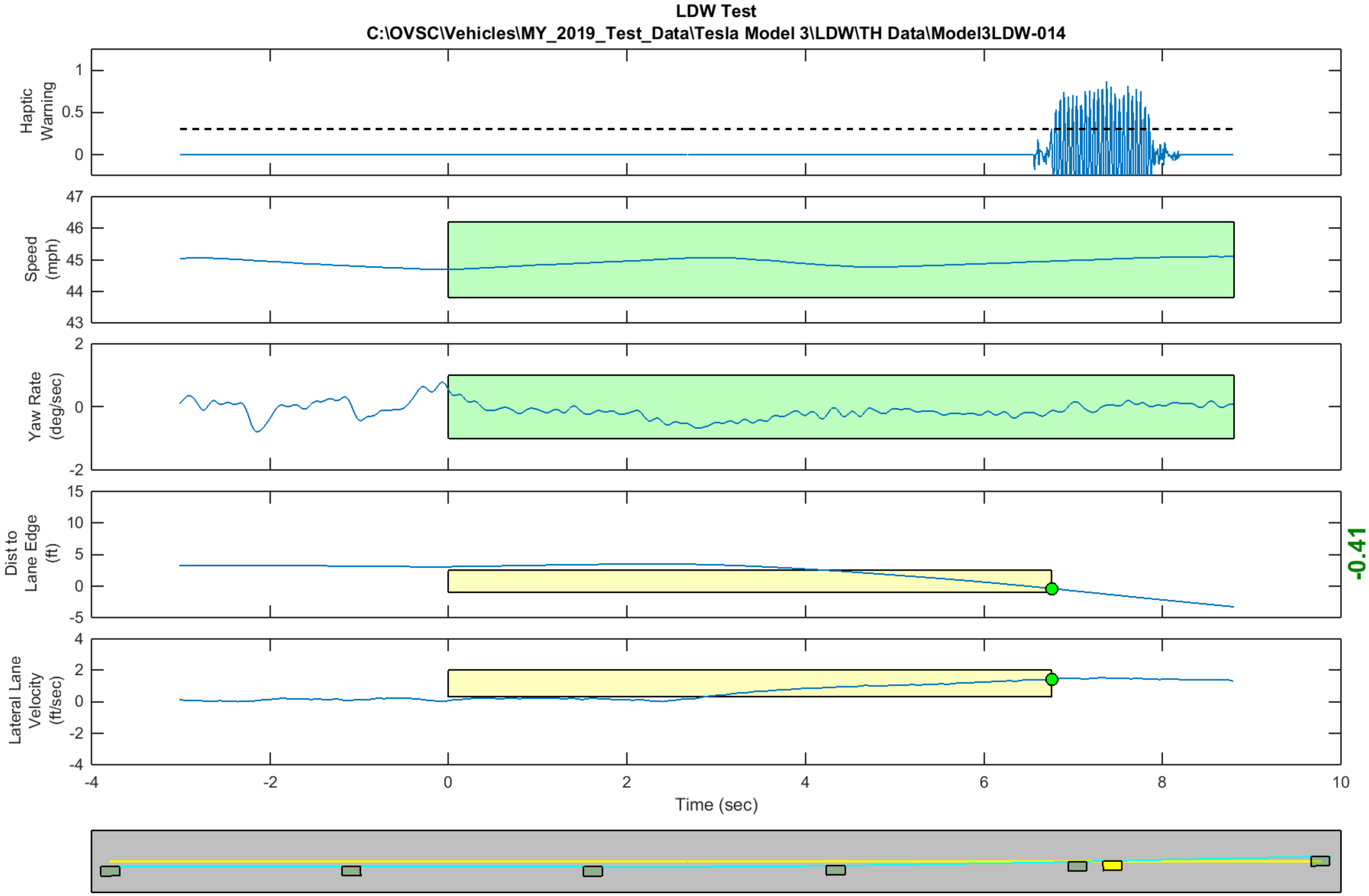
GPS Fix Type: RTK Fixed

Figure D12. Time History for Run 12, Solid Line, Left Departure, Haptic Warning



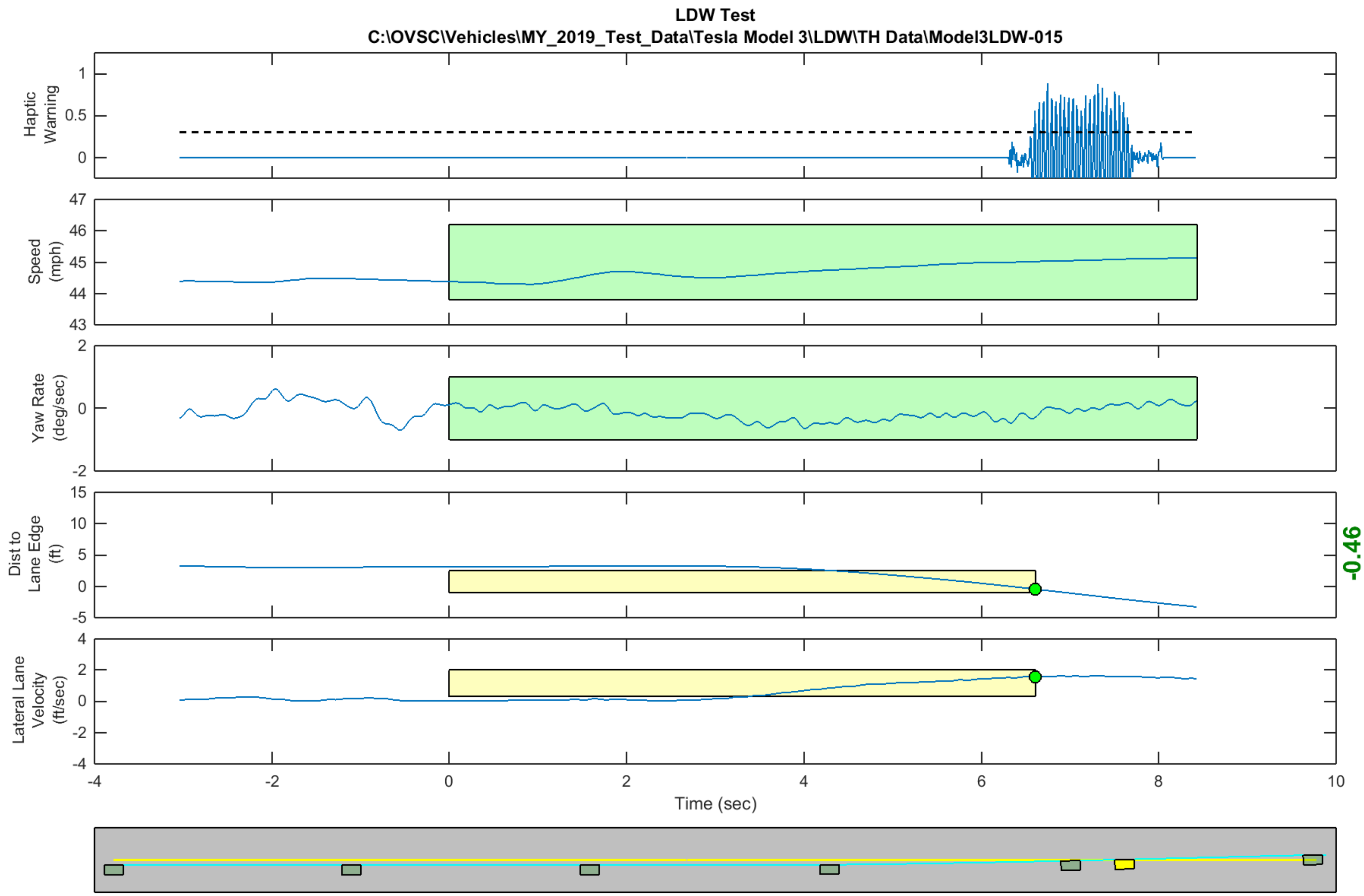
GPS Fix Type: RTK Fixed

Figure D13. Time History for Run 13, Solid Line, Left Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D14. Time History for Run 14, Solid Line, Left Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D15. Time History for Run 15, Solid Line, Left Departure, Haptic Warning

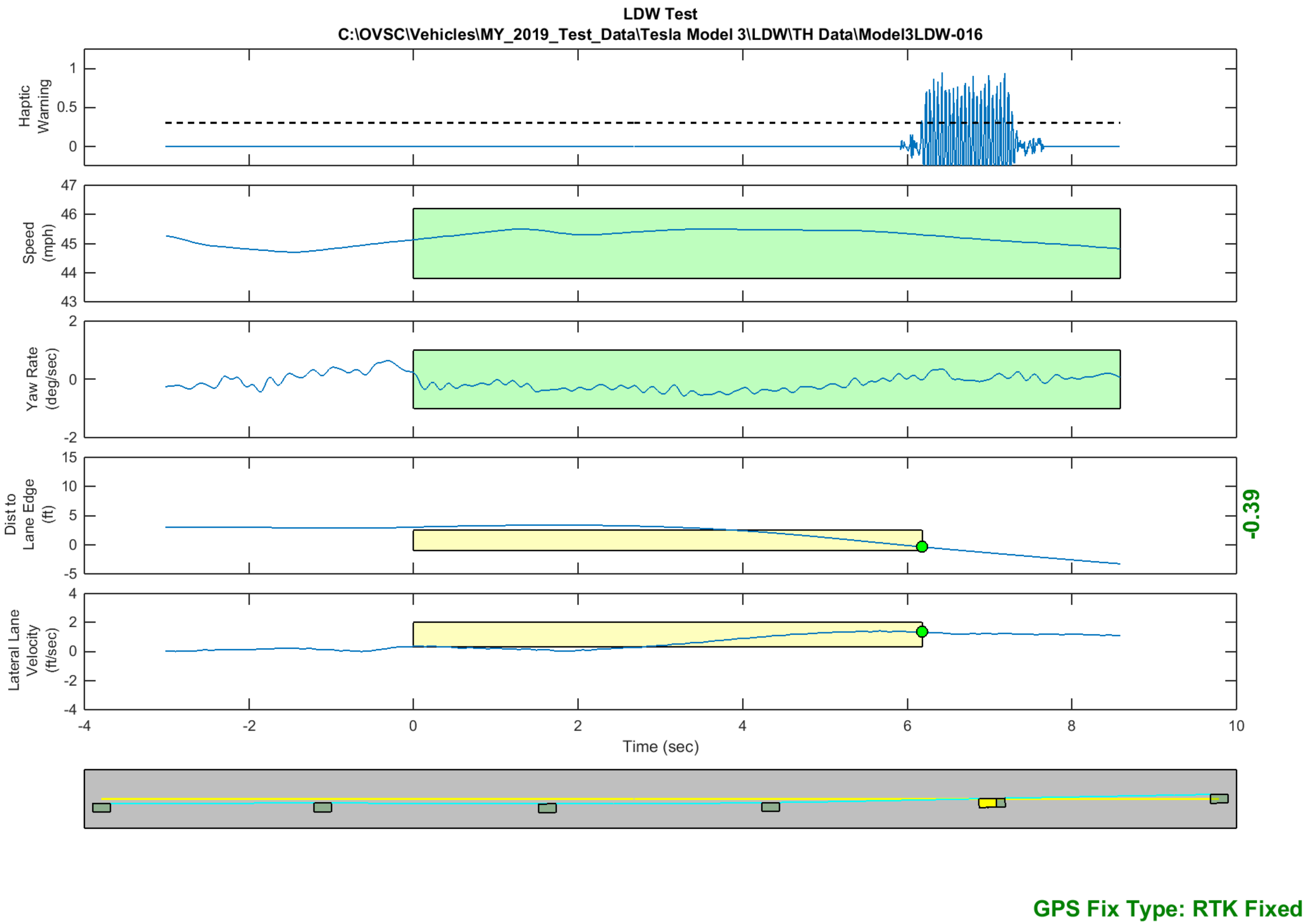


Figure D16. Time History for Run 16, Solid Line, Left Departure, Haptic Warning

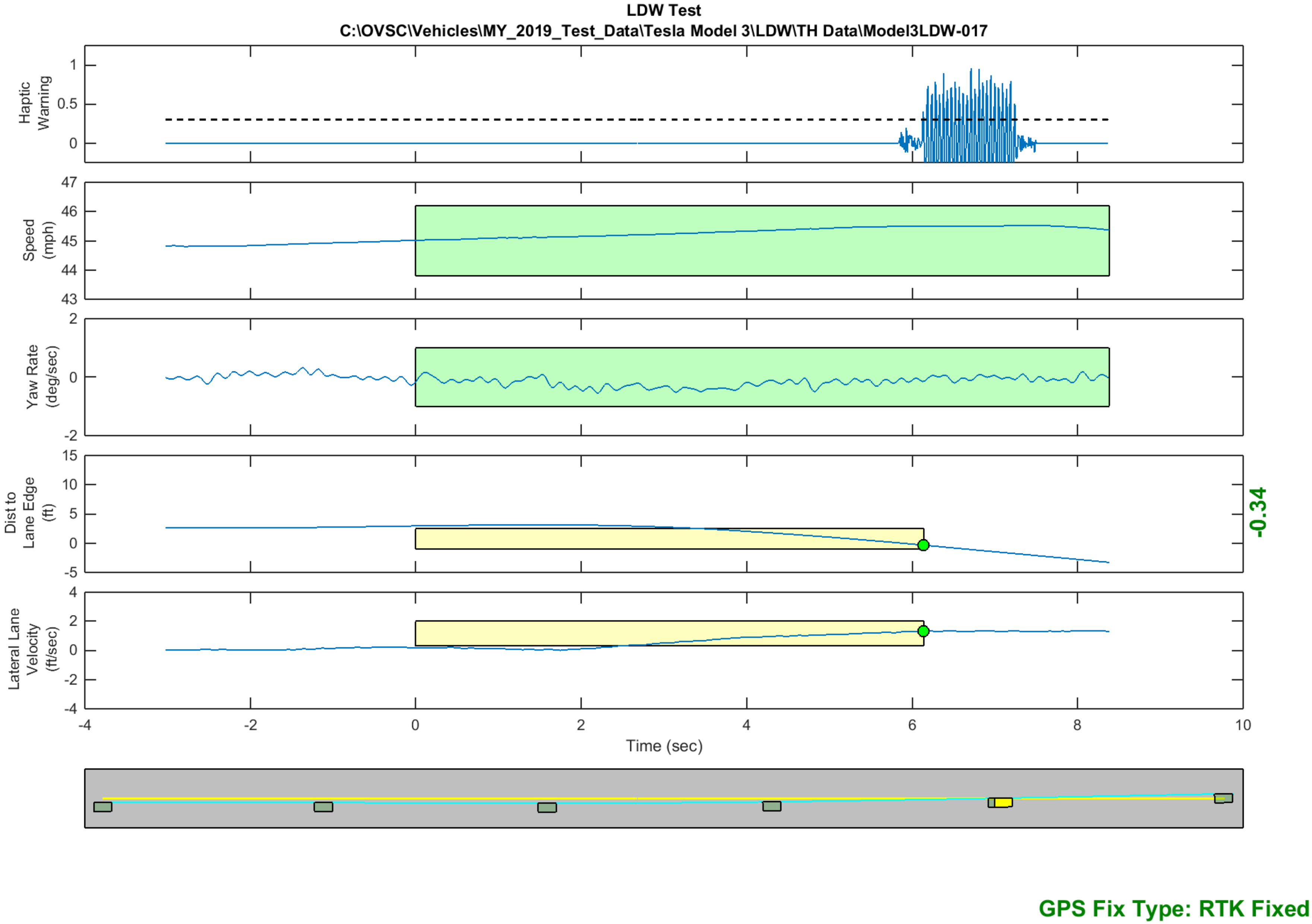
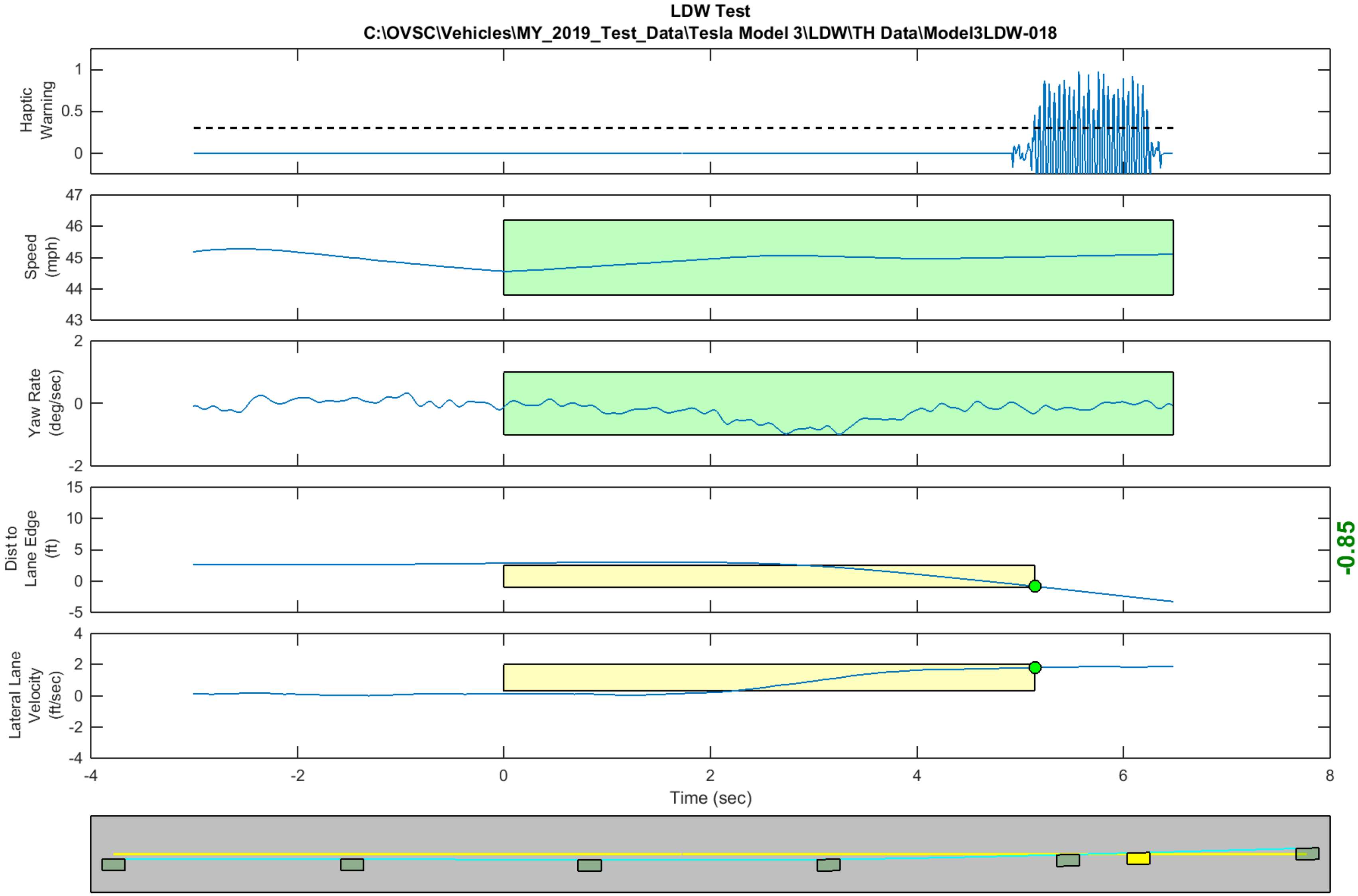


Figure D17. Time History for Run 17, Solid Line, Left Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D18. Time History for Run 18, Dashed Line, Left Departure, Haptic Warning

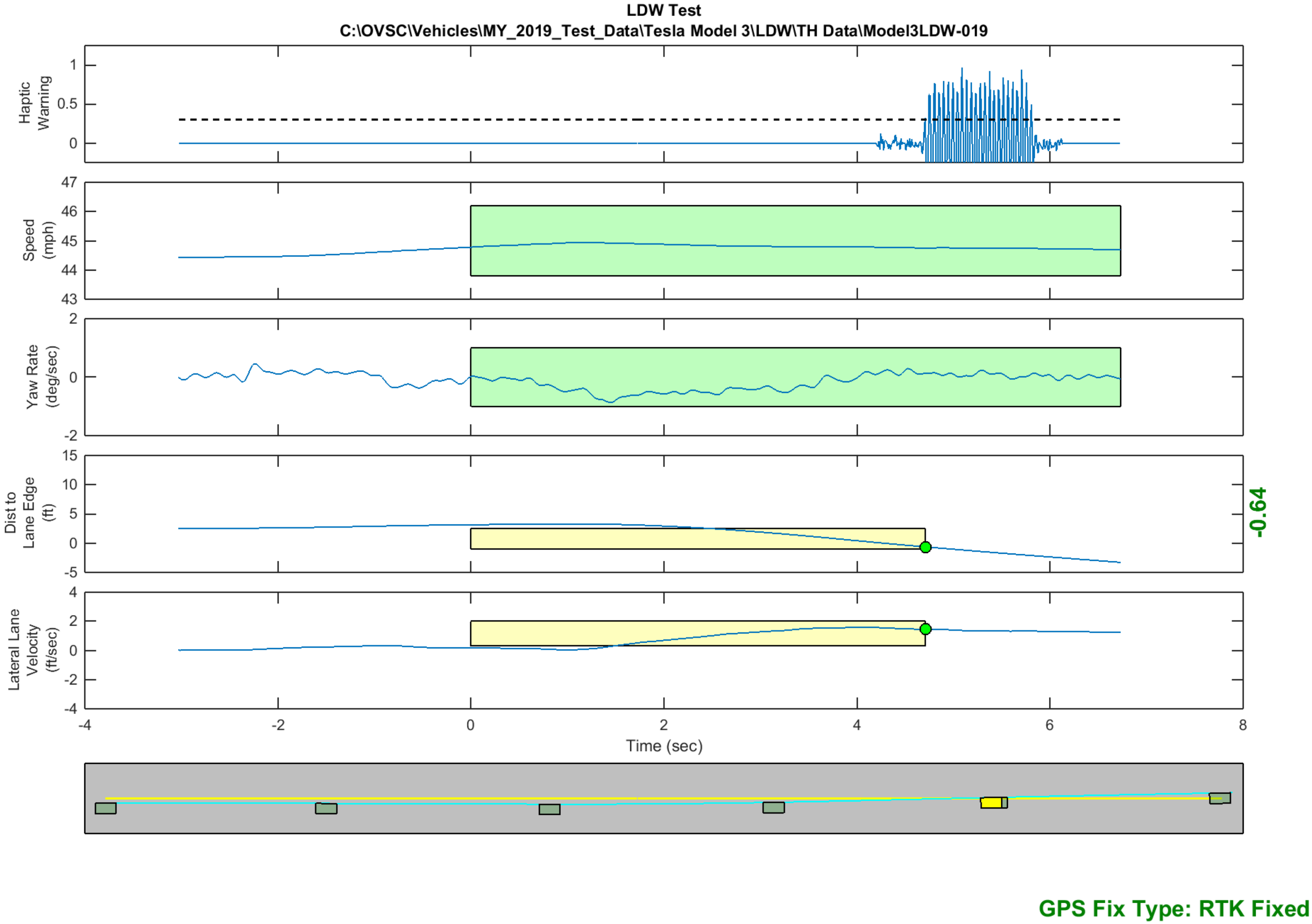


Figure D19. Time History for Run 19, Dashed Line, Left Departure, Haptic Warning

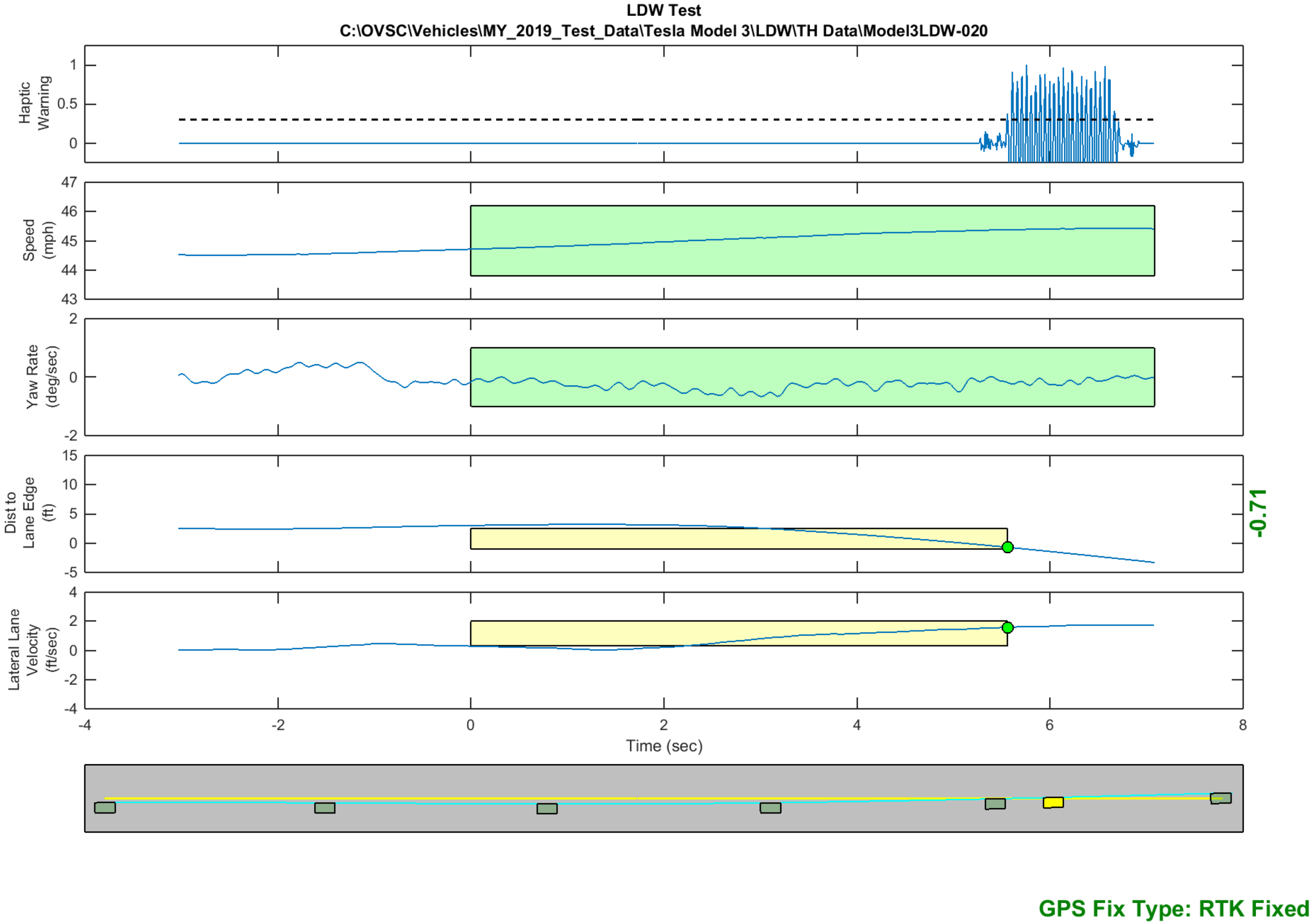
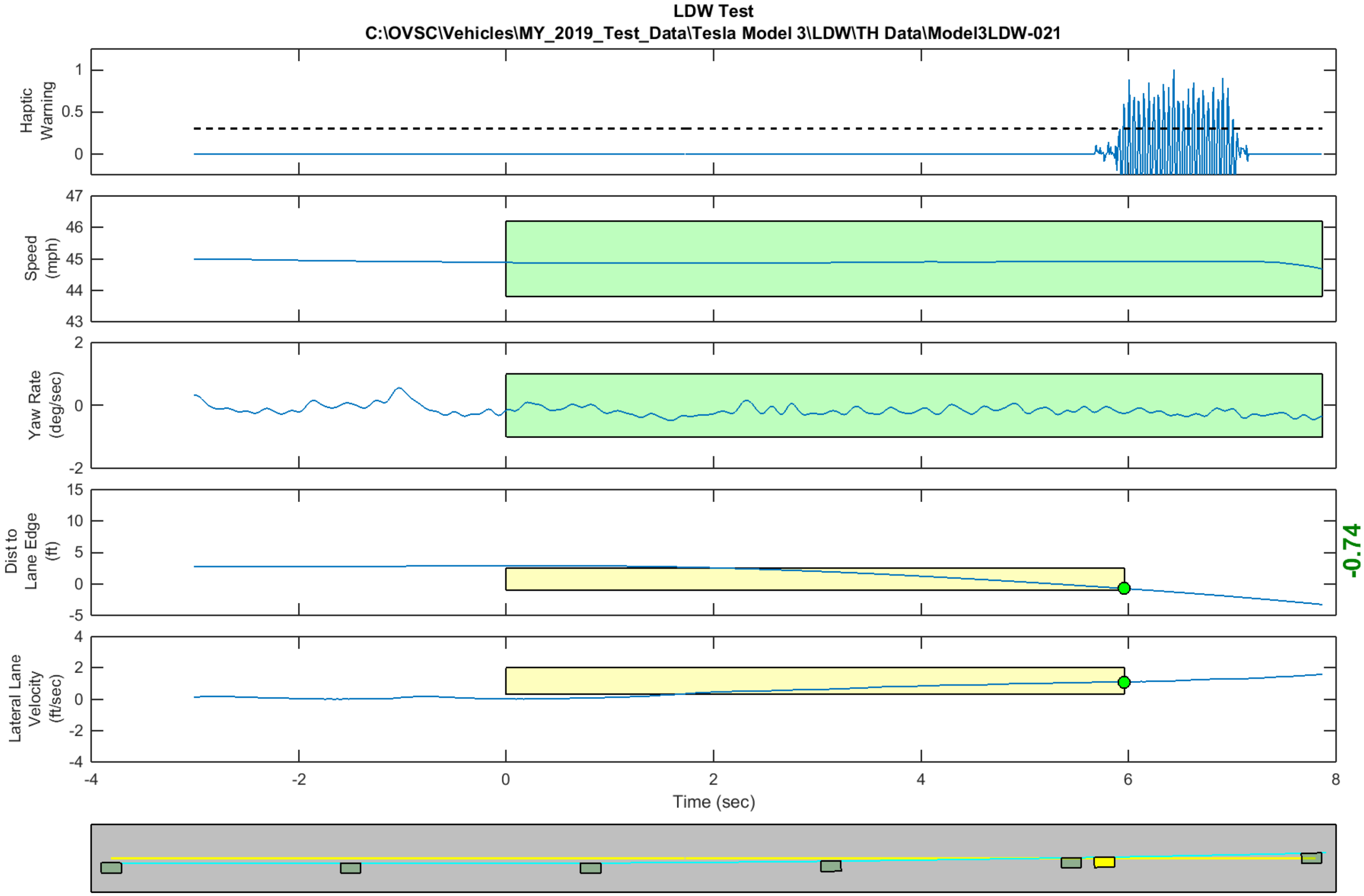
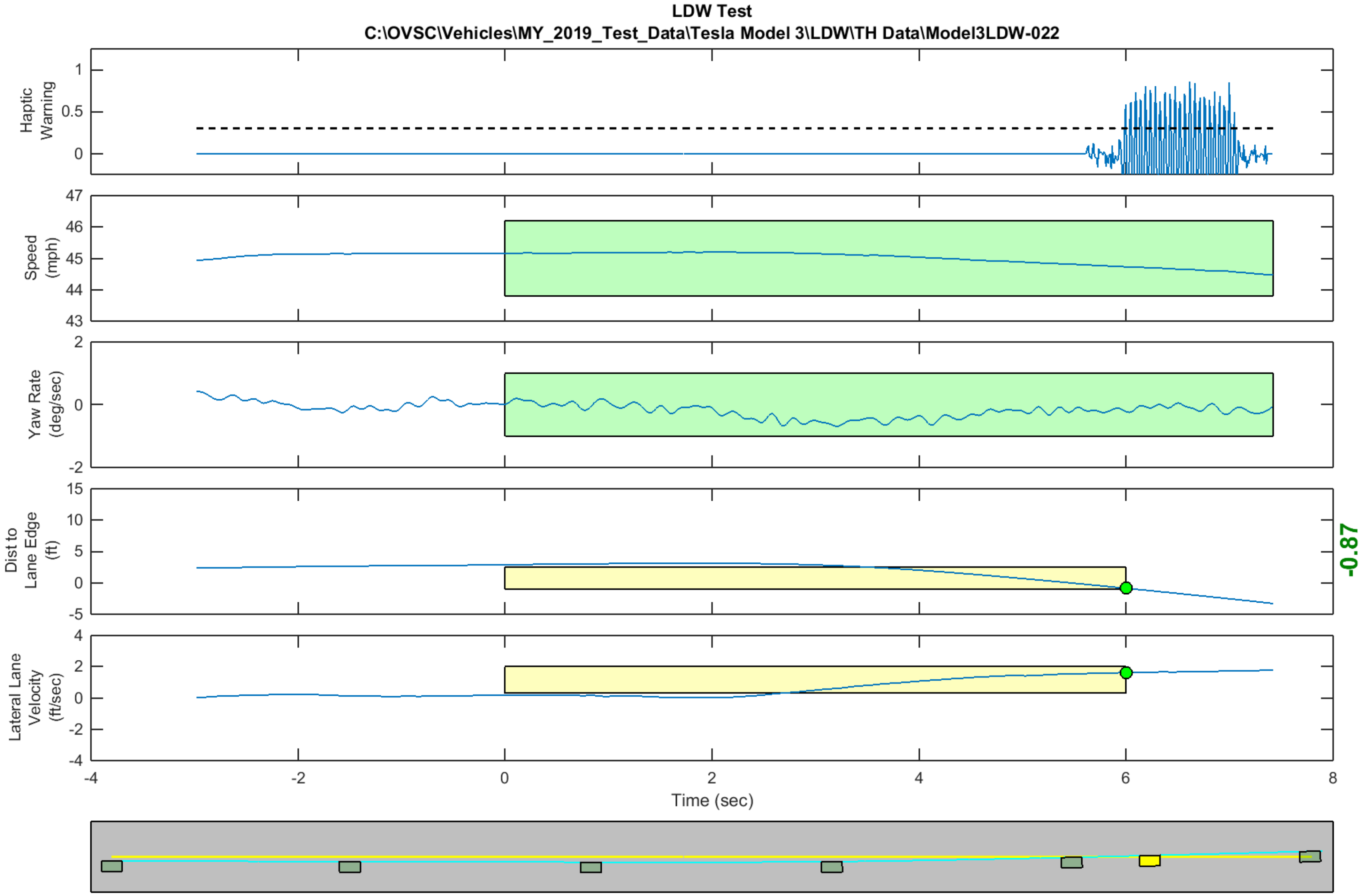


Figure D20. Time History for Run 20, Dashed Line, Left Departure, Haptic Warning



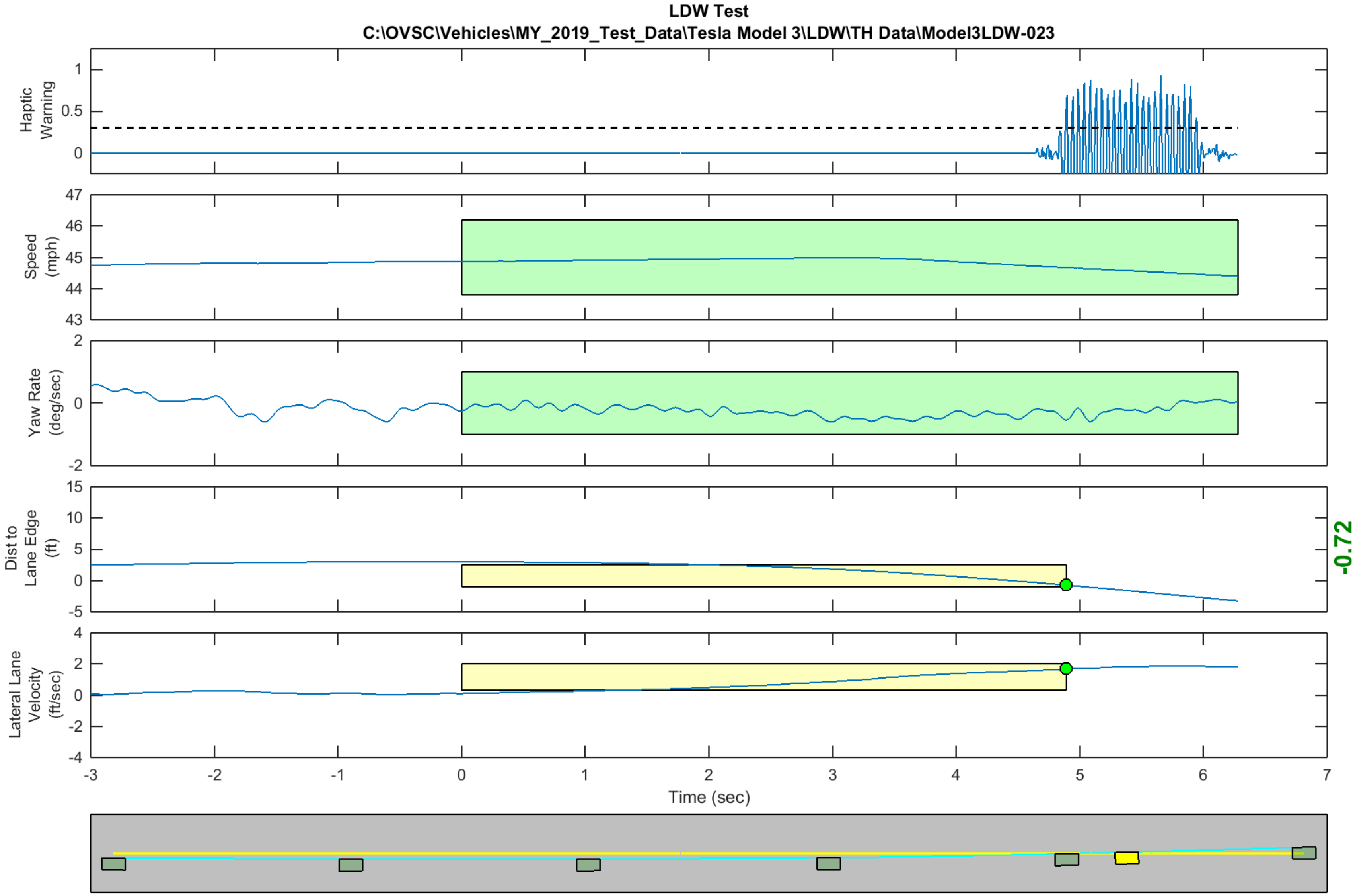
GPS Fix Type: RTK Fixed

Figure D21. Time History for Run 21, Dashed Line, Left Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D22. Time History for Run 22, Dashed Line, Left Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D23. Time History for Run 23, Dashed Line, Left Departure, Haptic Warning

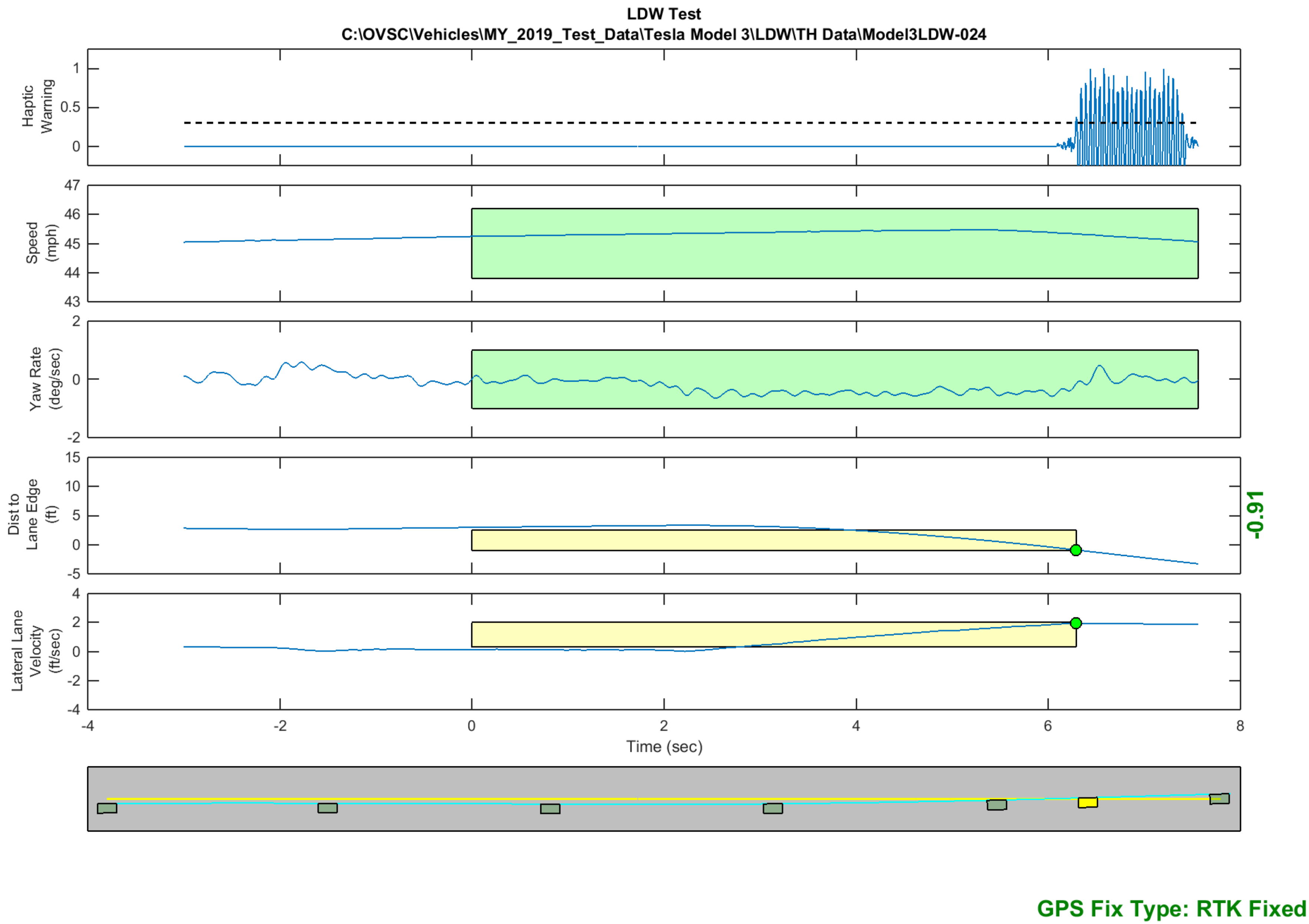


Figure D24. Time History for Run 24, Dashed Line, Left Departure, Haptic Warning

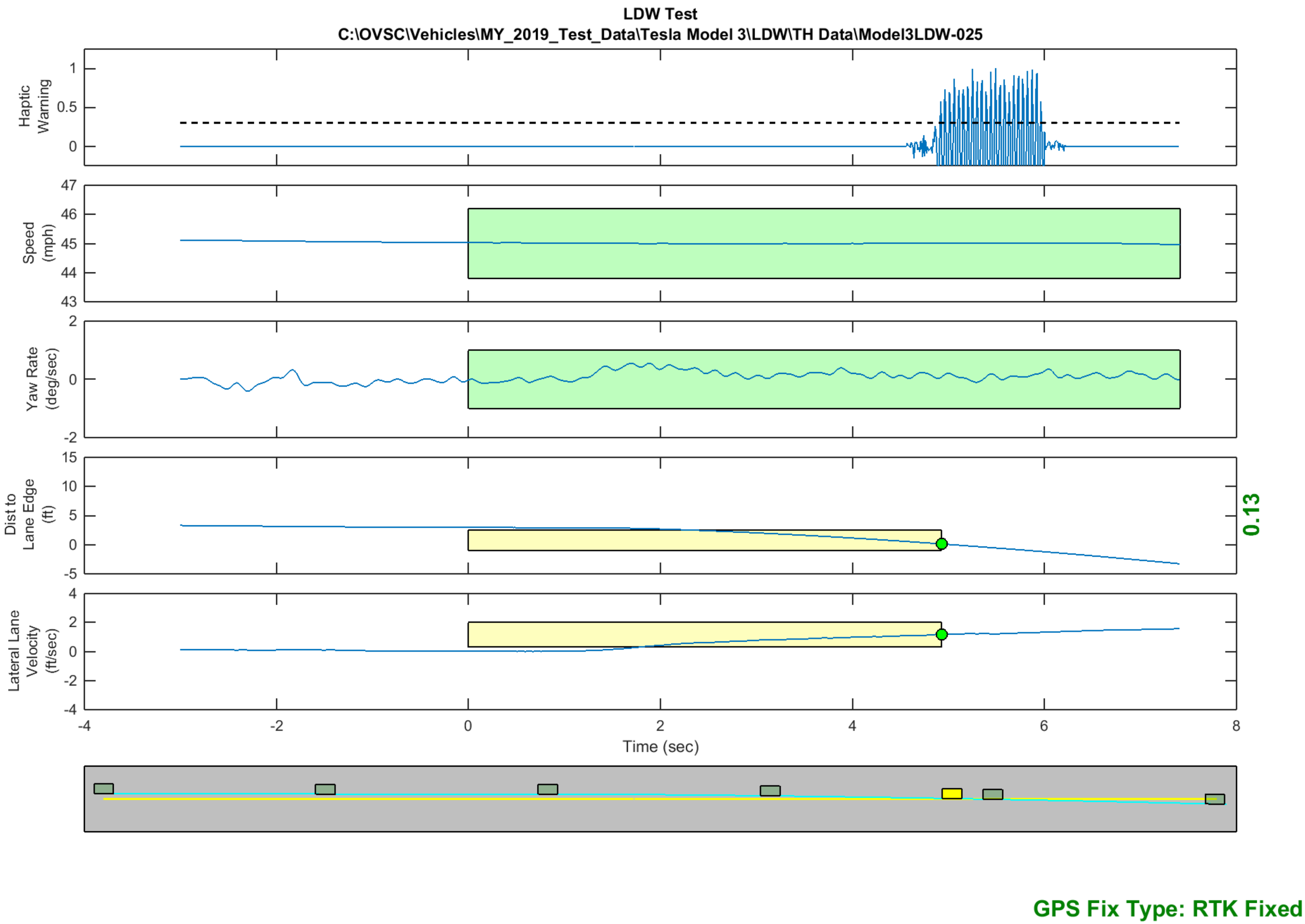


Figure D25. Time History for Run 25, Dashed Line, Right Departure, Haptic Warning

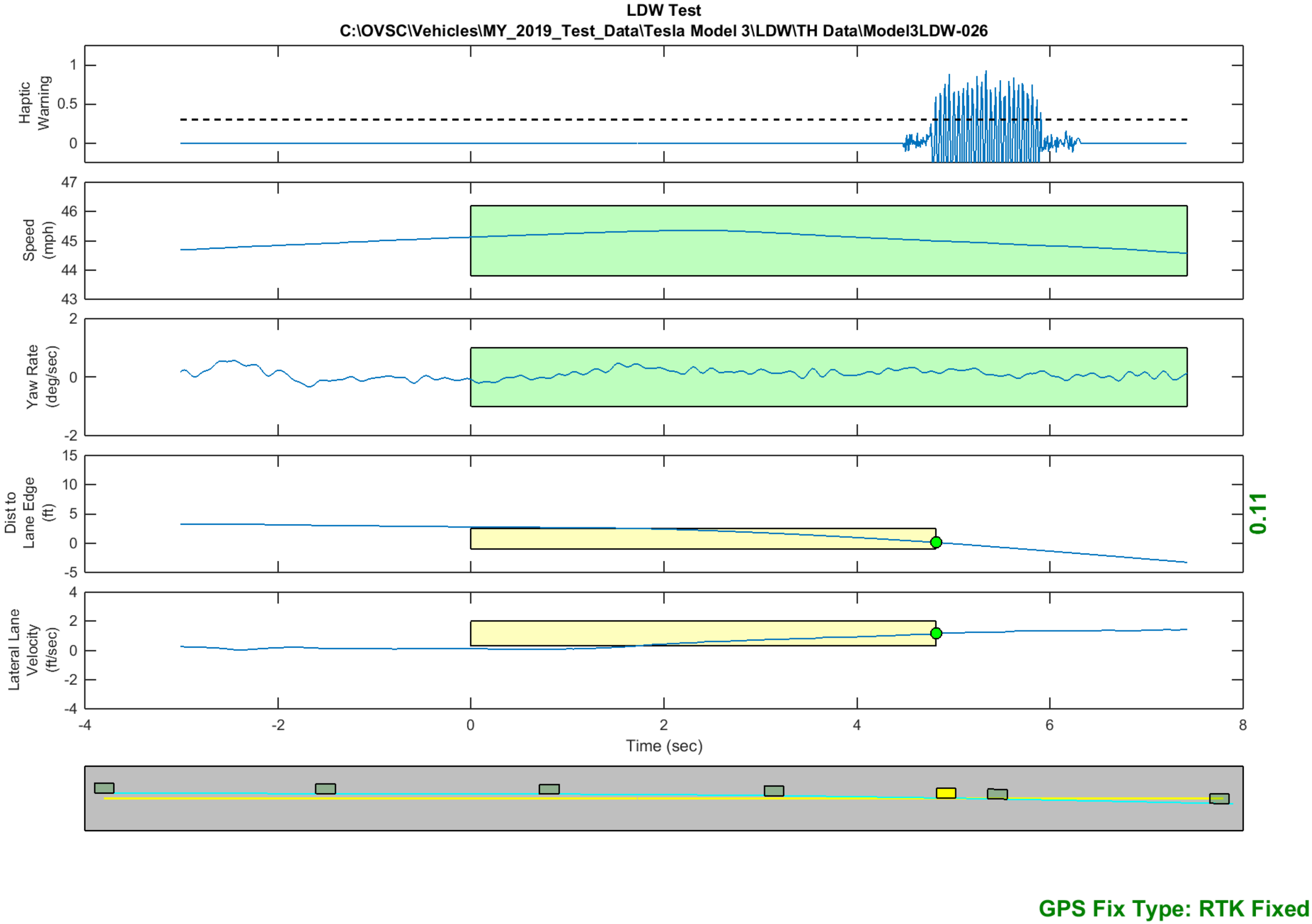


Figure D26. Time History for Run 26, Dashed Line, Right Departure, Haptic Warning

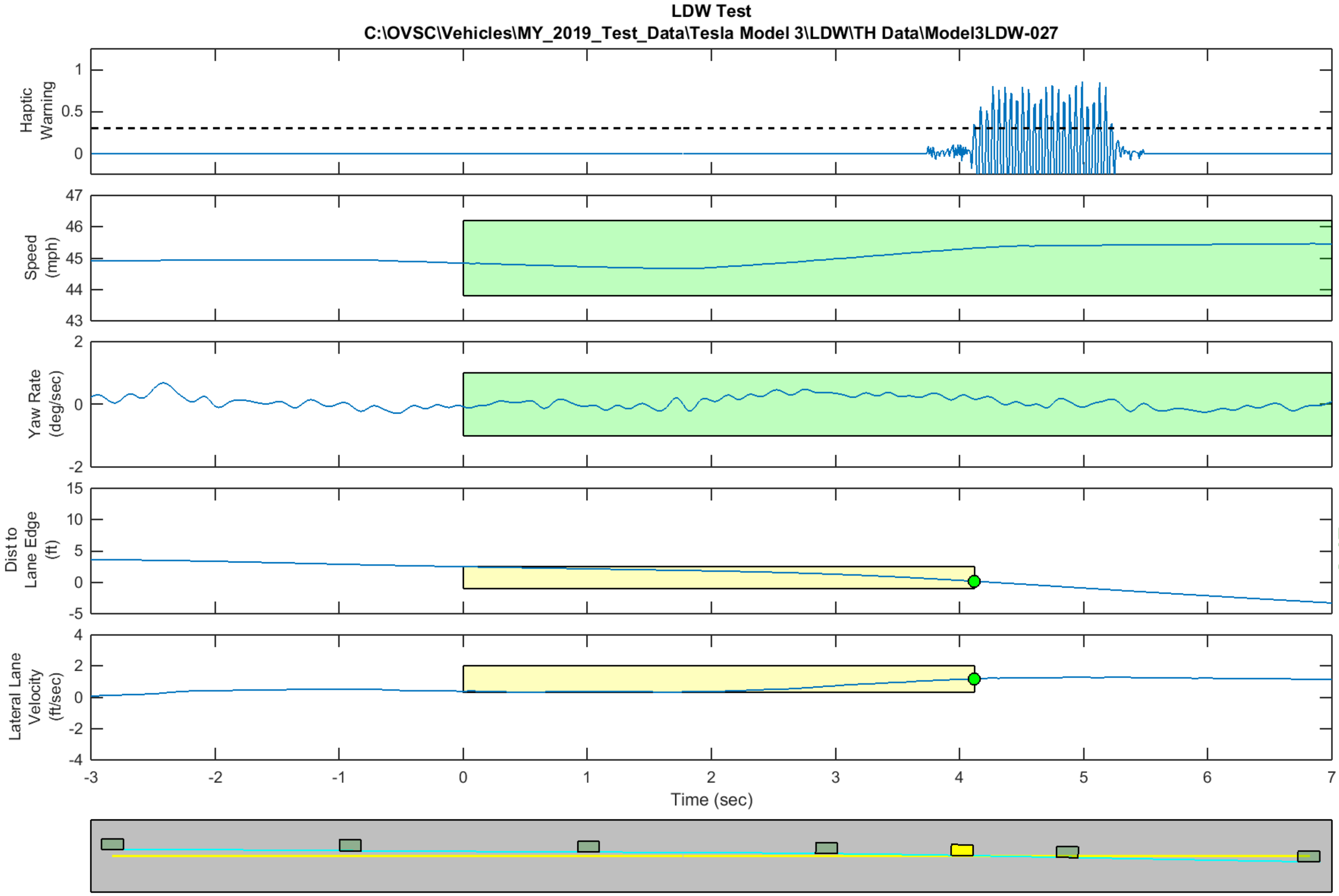


Figure D27. Time History for Run 27, Dashed Line, Right Departure, Haptic Warning

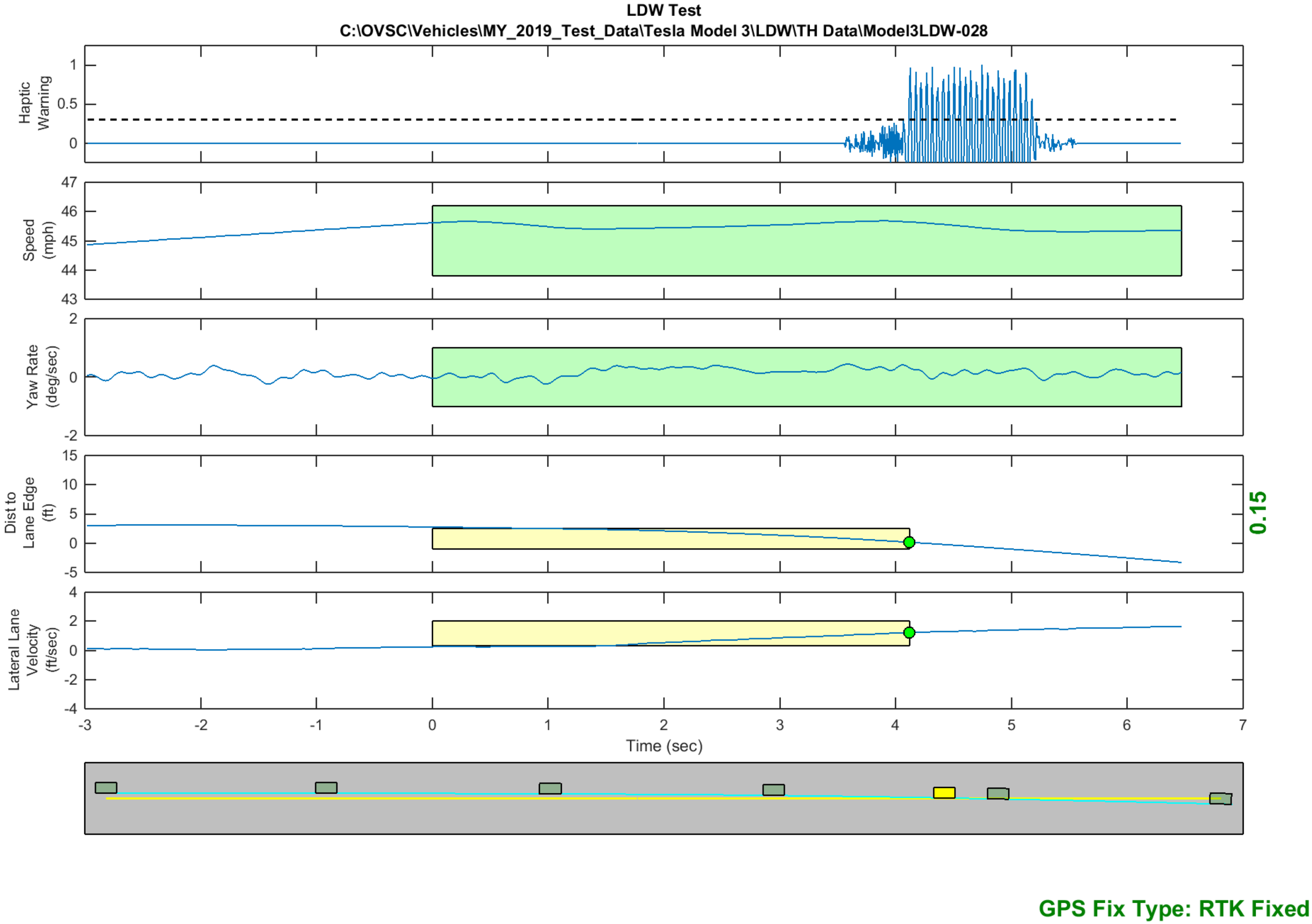
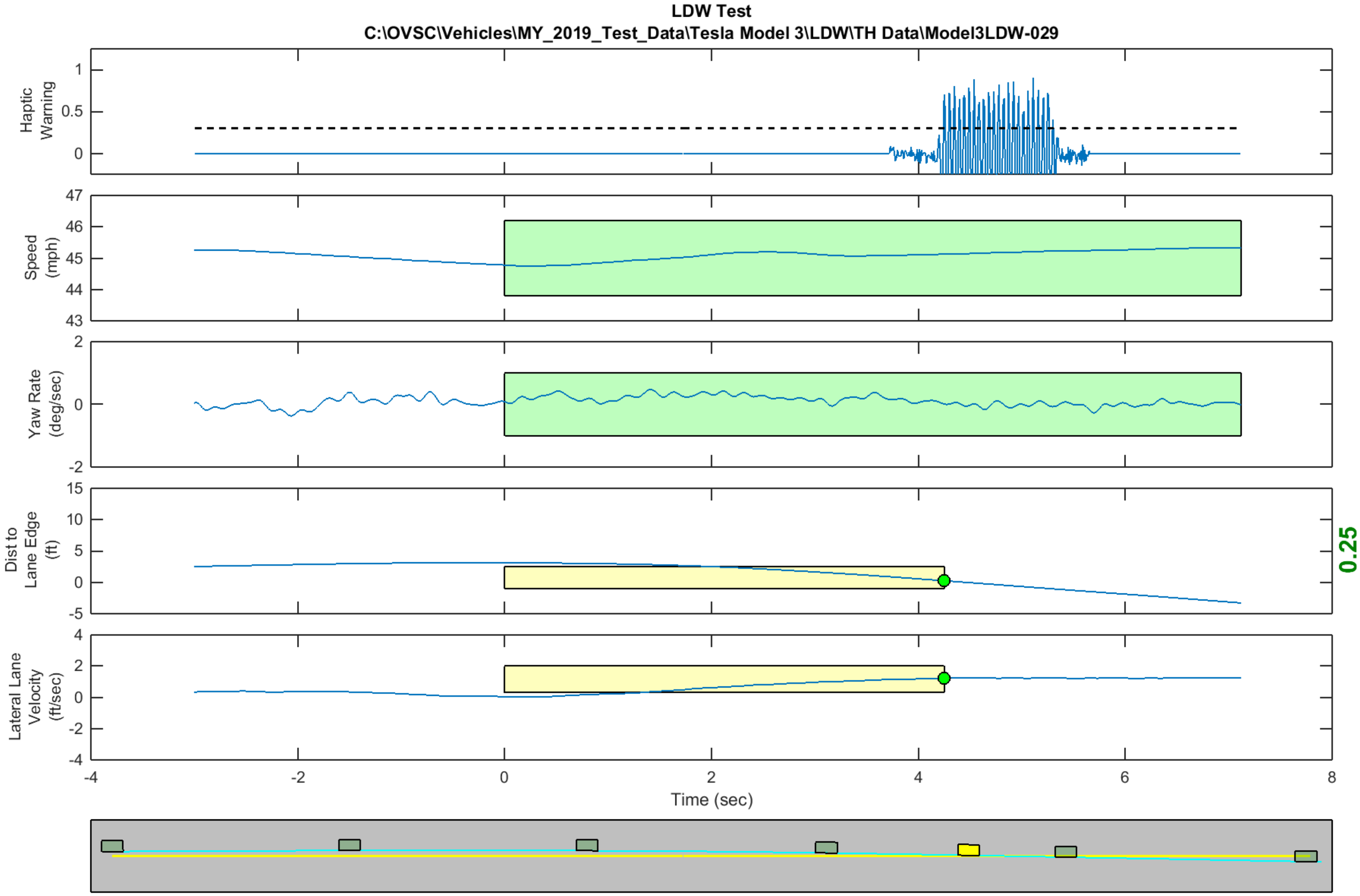
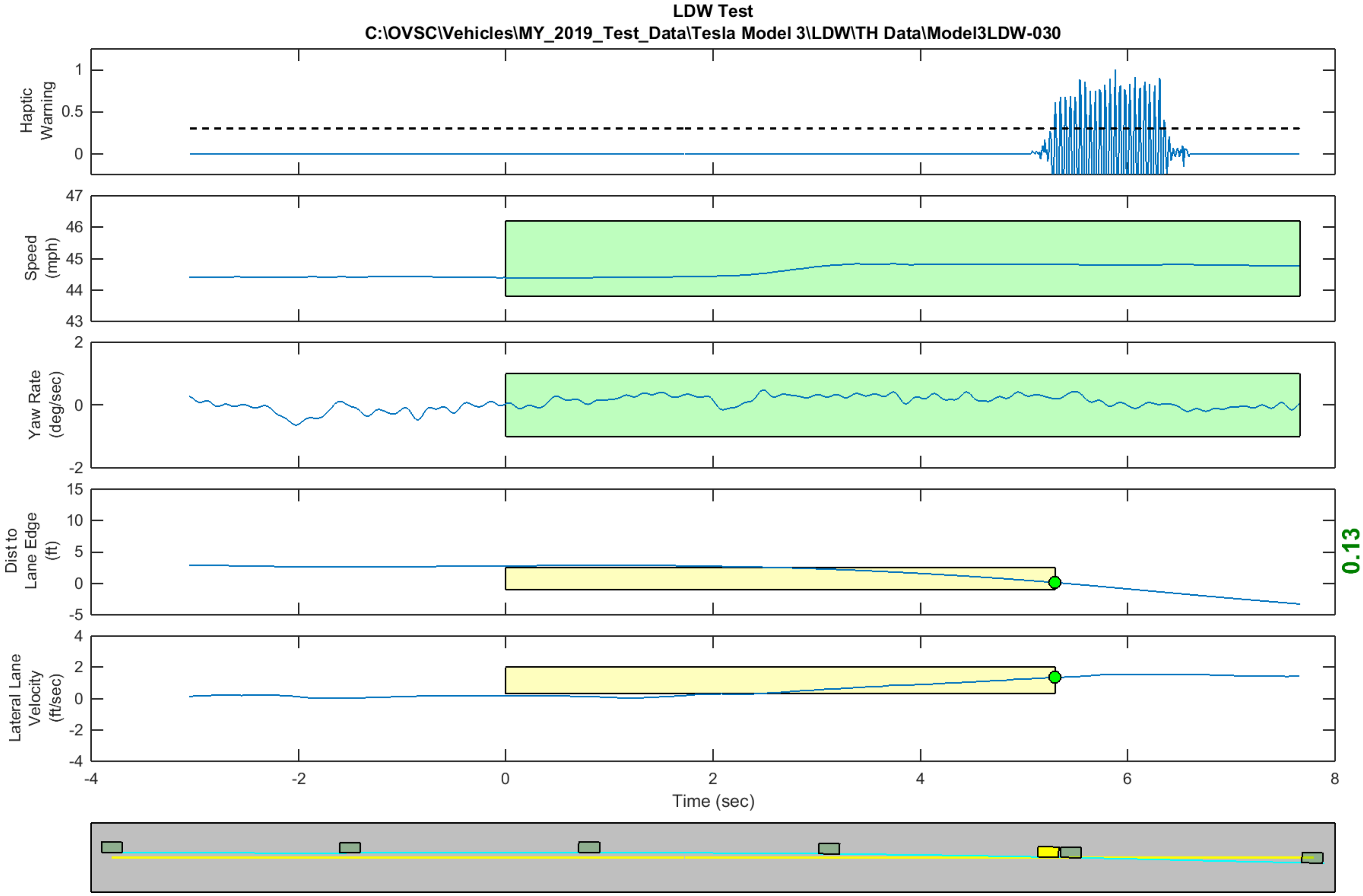


Figure D28. Time History for Run 28, Dashed Line, Right Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D29. Time History for Run 29, Dashed Line, Right Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D30. Time History for Run 30, Dashed Line, Right Departure, Haptic Warning

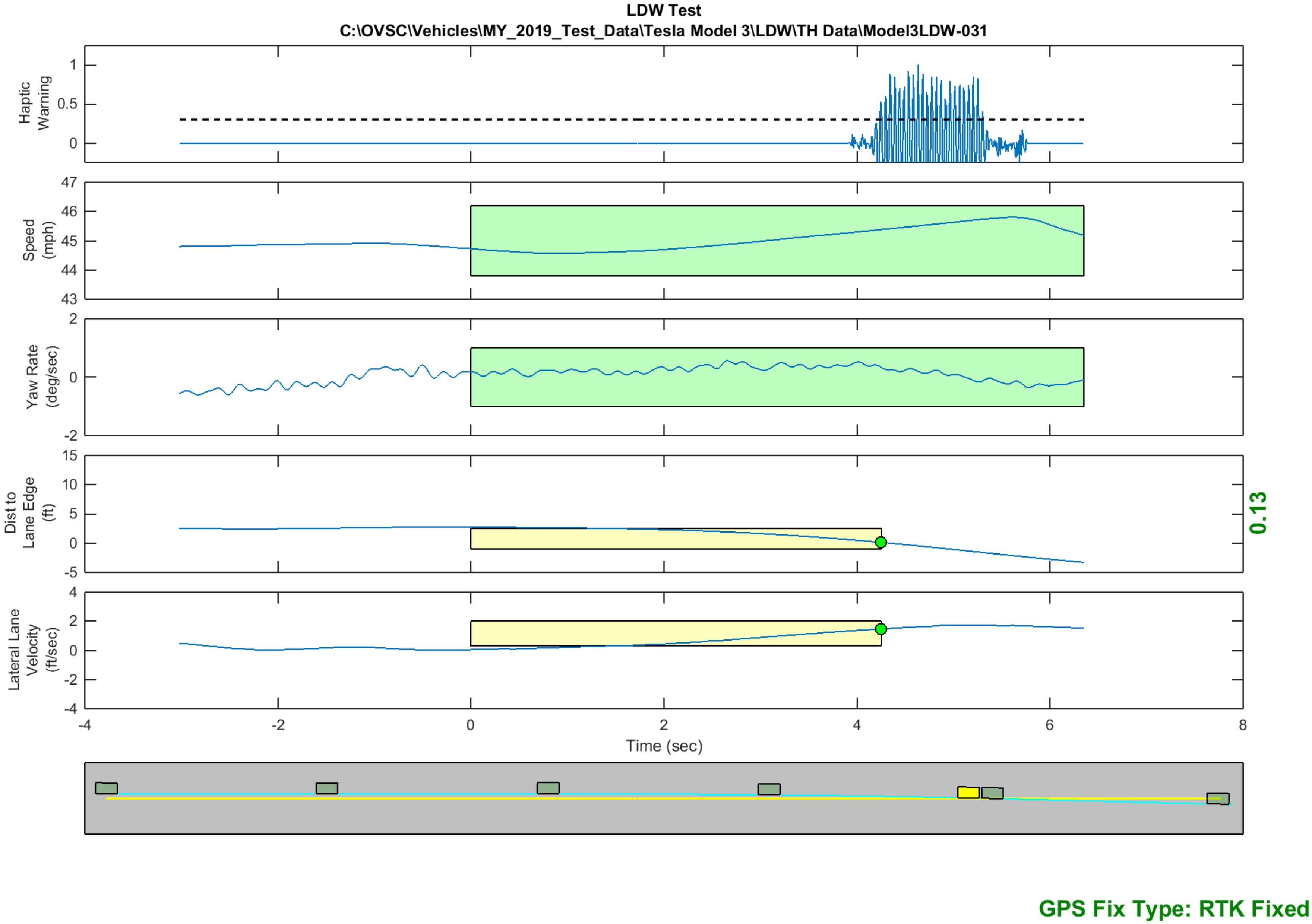
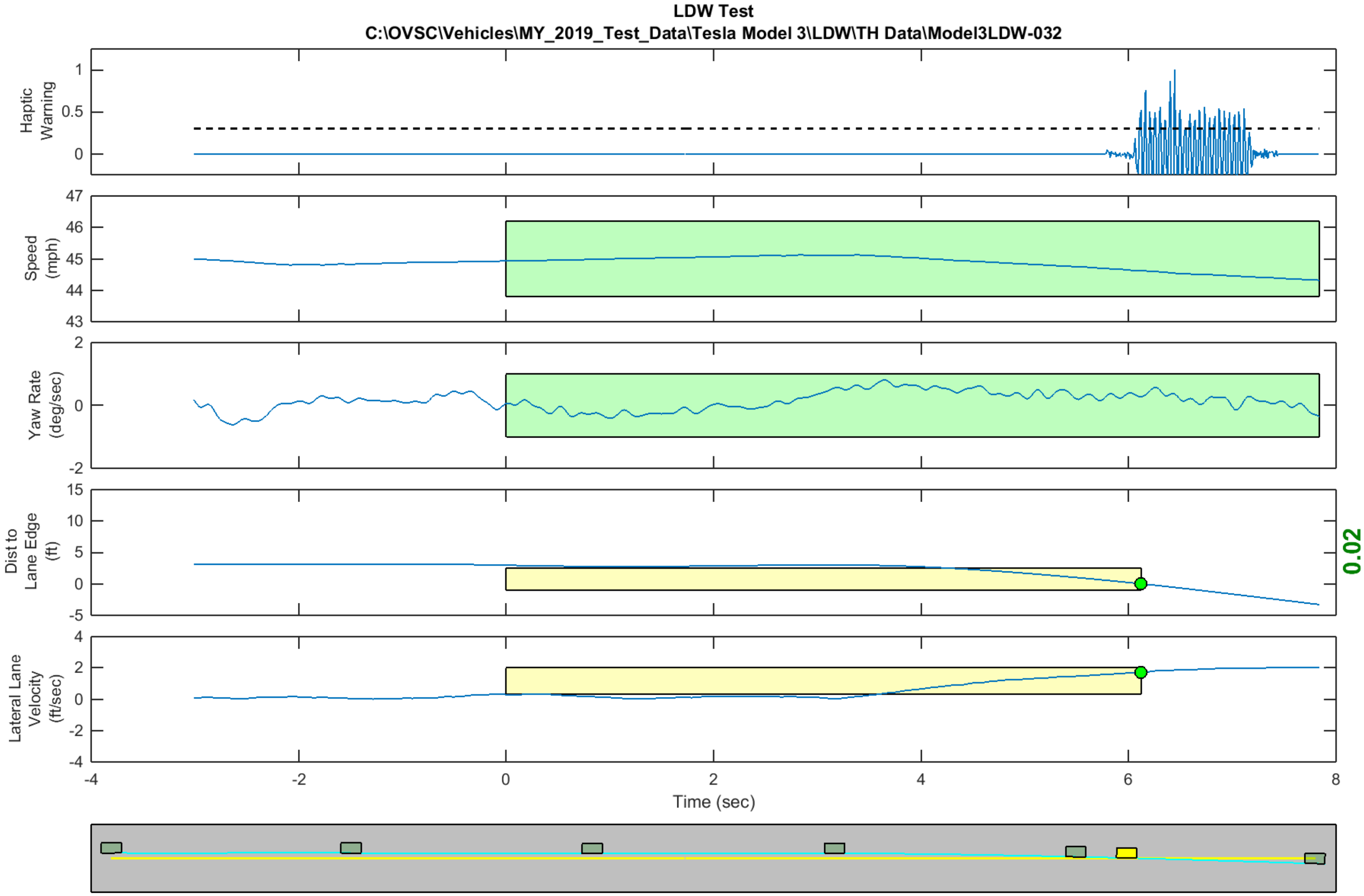
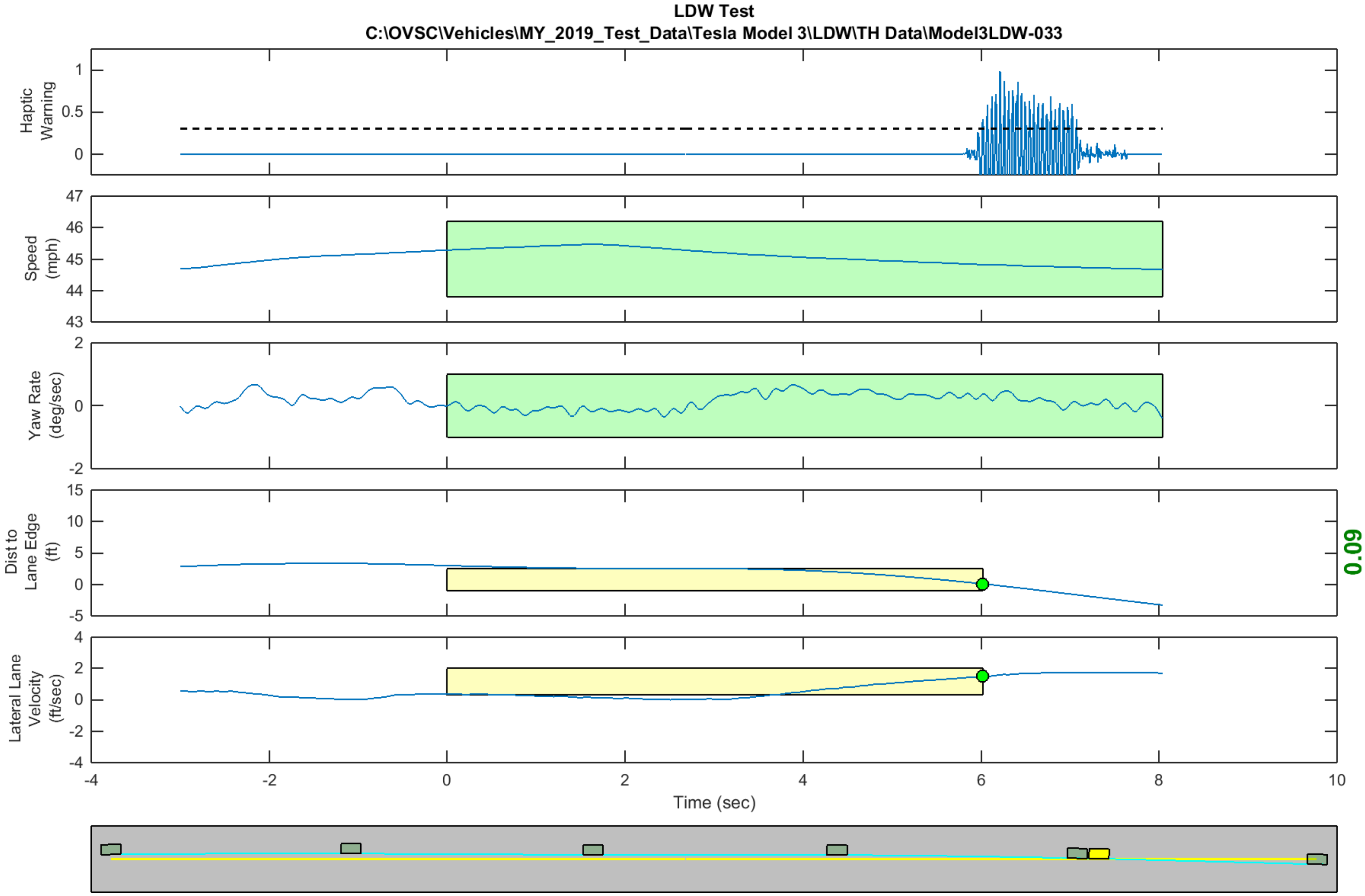


Figure D31. Time History for Run 31, Dashed Line, Right Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D32. Time History for Run 32, Botts Dots, Right Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D33. Time History for Run 33, Botts Dots, Right Departure, Haptic Warning

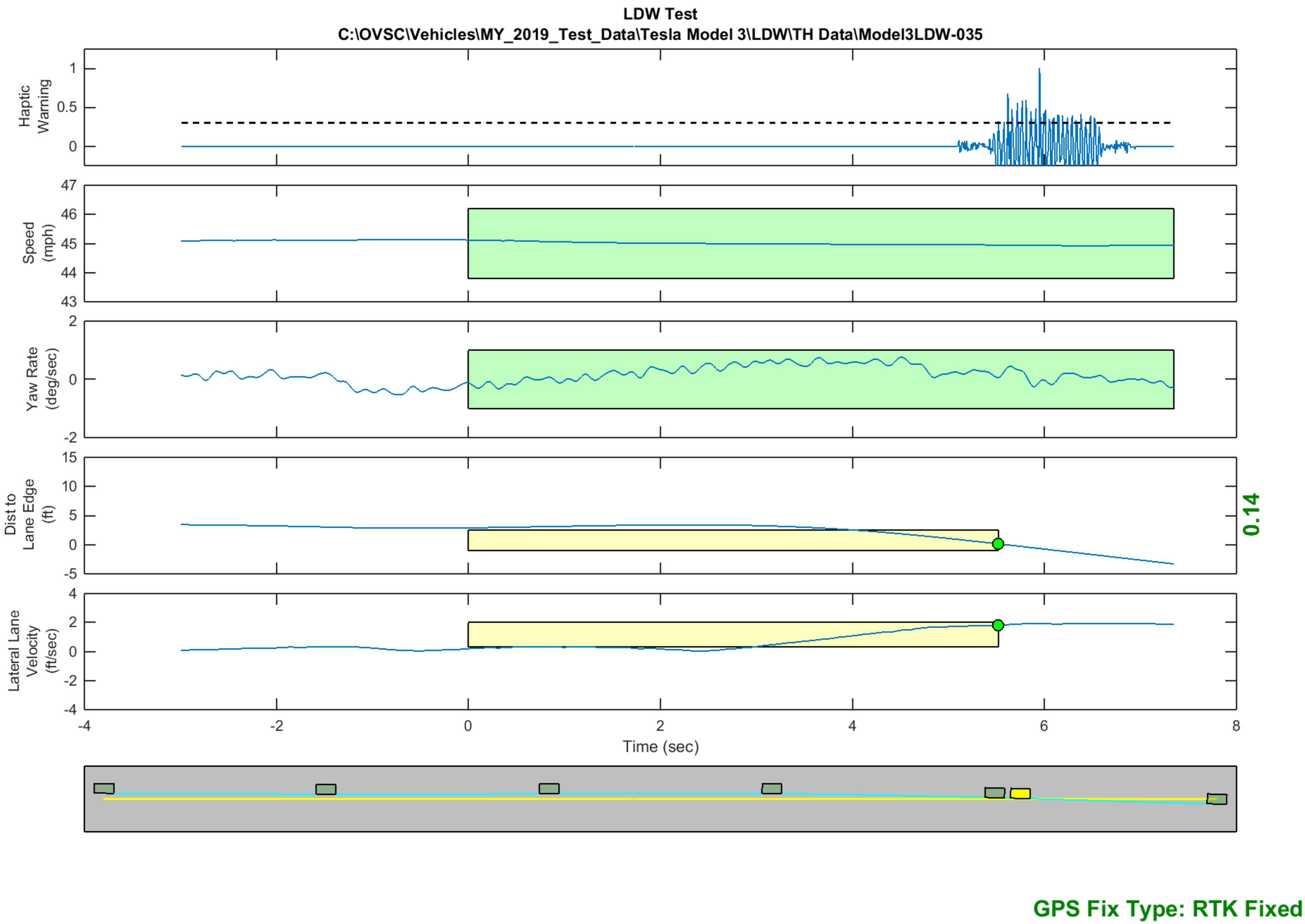


Figure D34. Time History for Run 35, Botts Dots, Right Departure, Haptic Warning

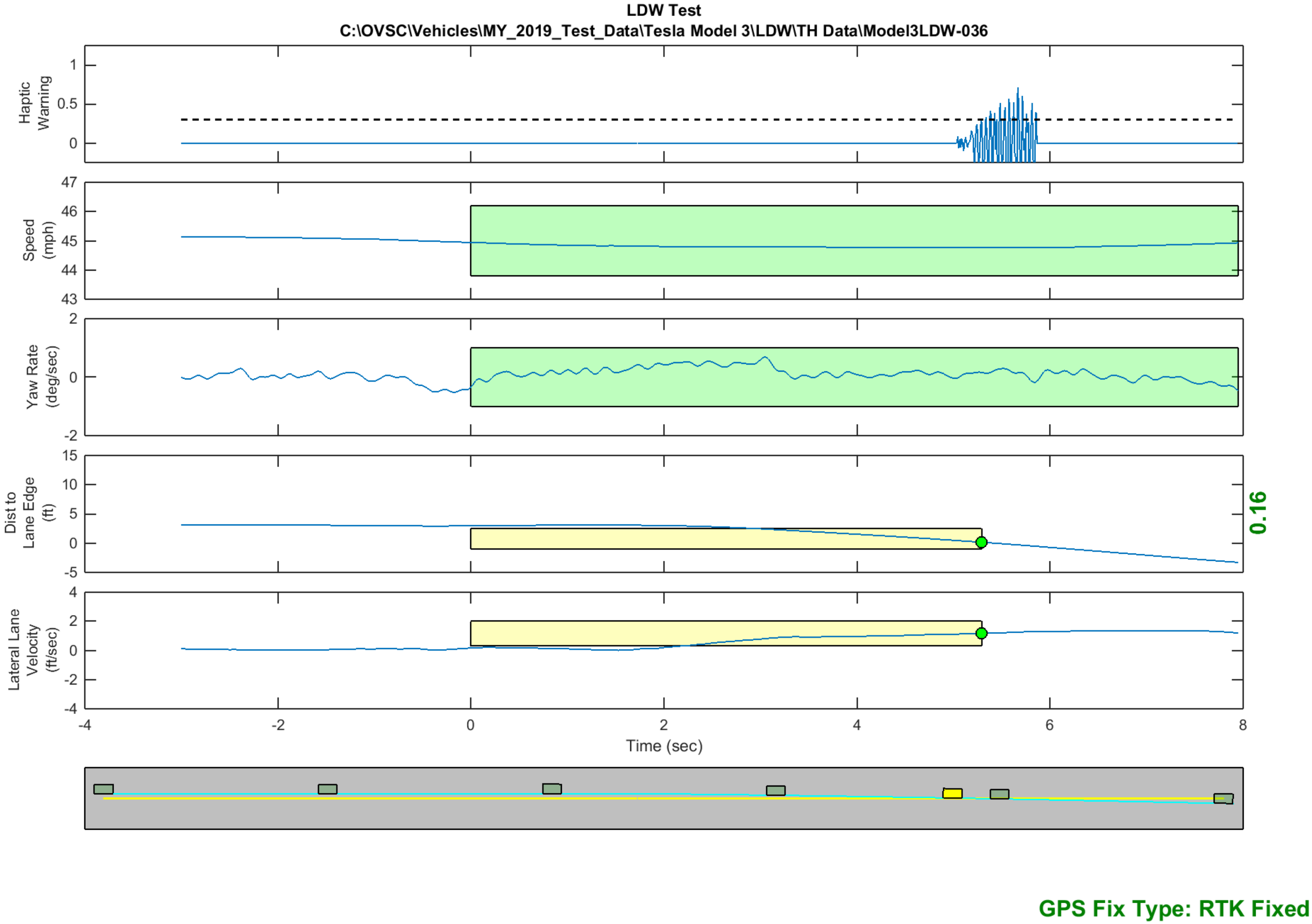


Figure D35. Time History for Run 36, Botts Dots, Right Departure, Haptic Warning

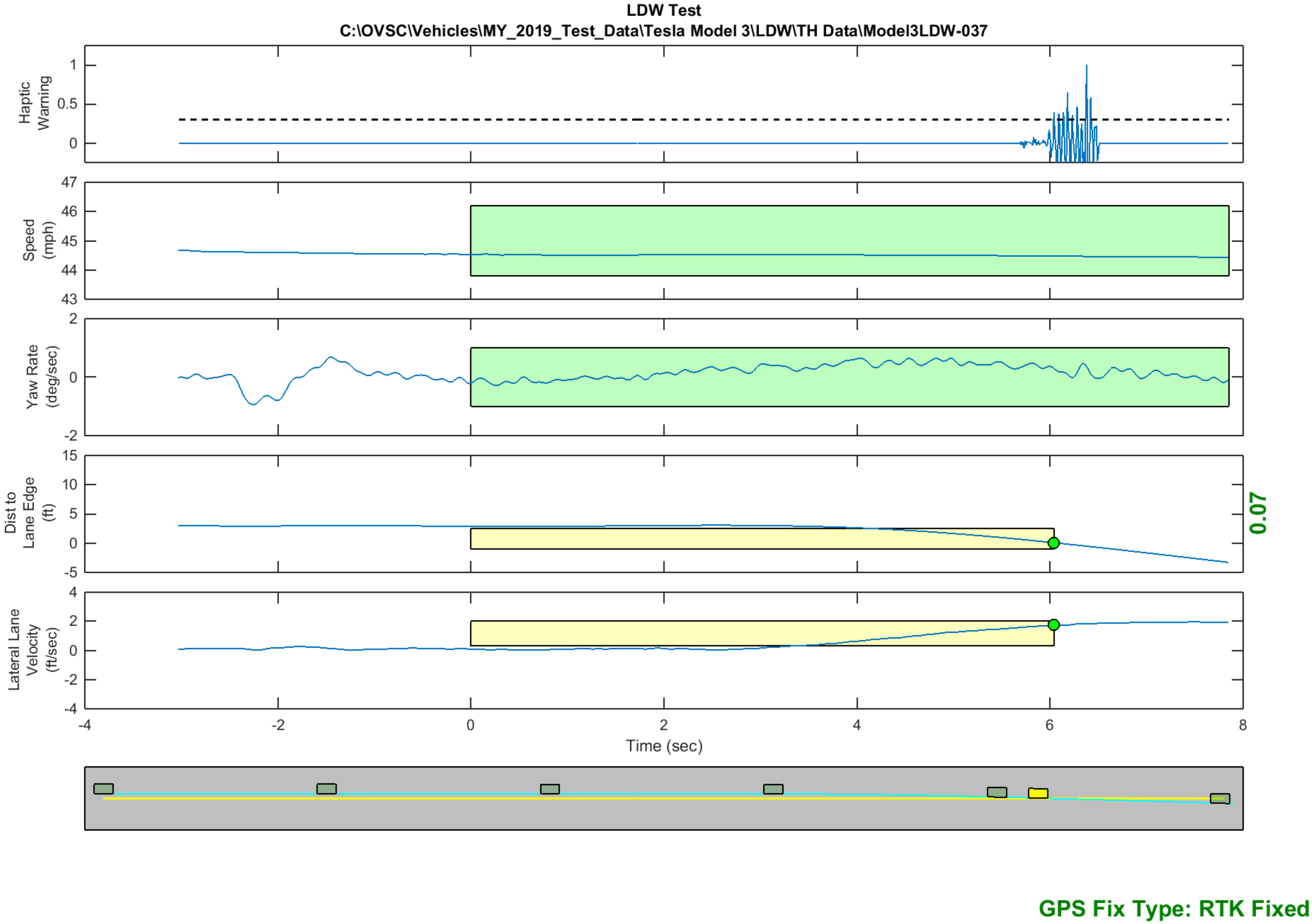
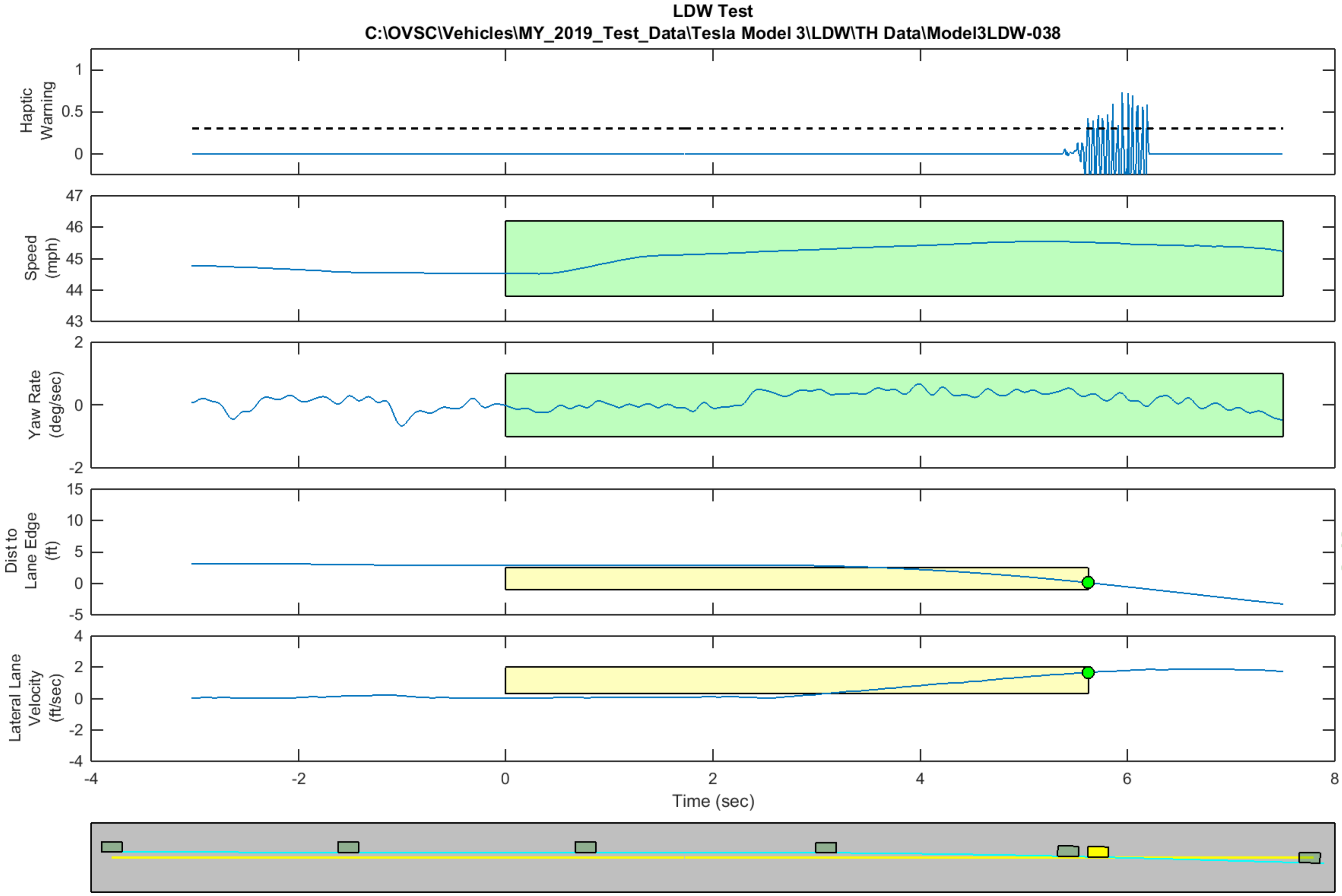


Figure D36. Time History for Run 37, Botts Dots, Right Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D37. Time History for Run 38, Botts Dots, Right Departure, Haptic Warning

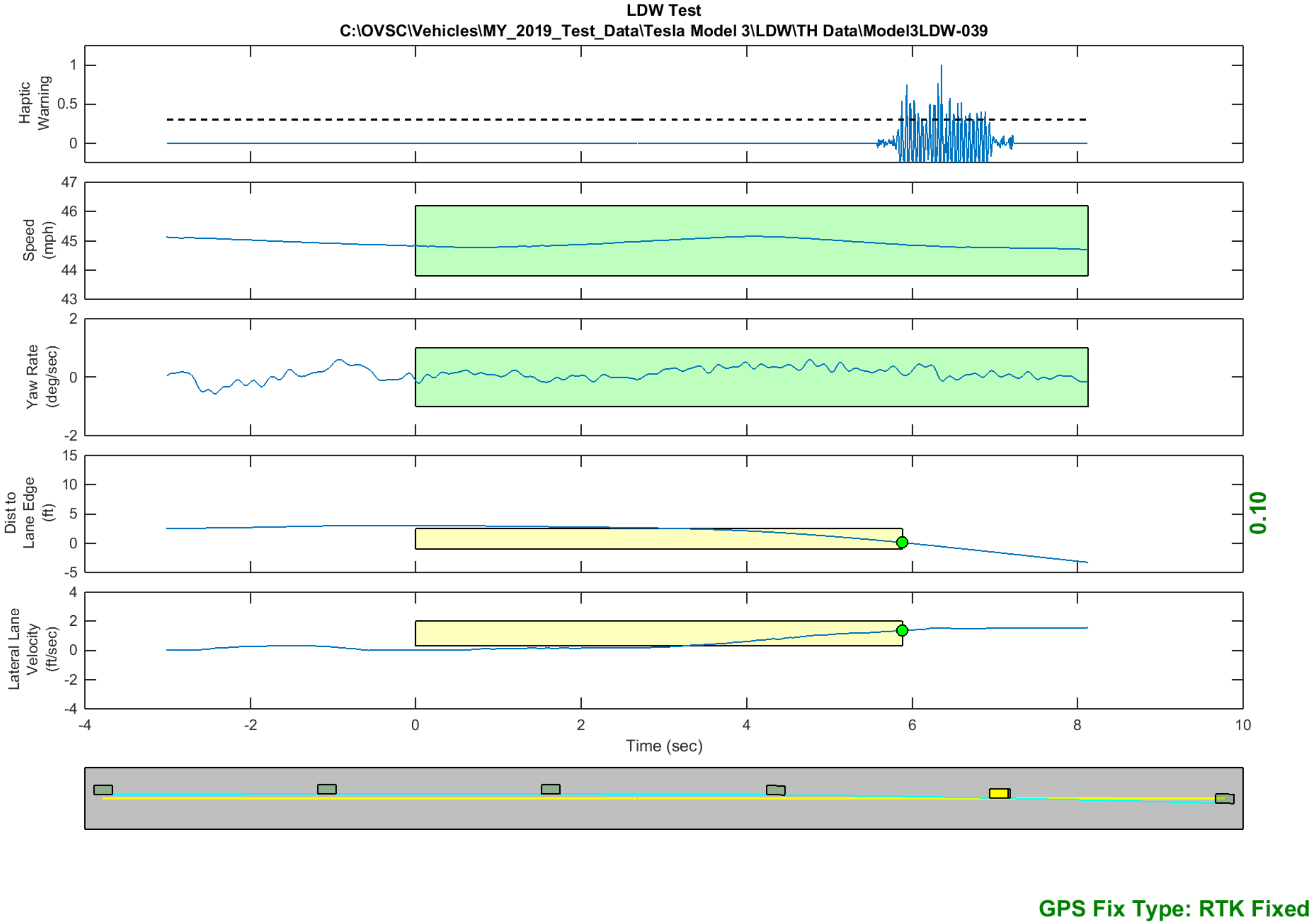


Figure D38. Time History for Run 39, Botts Dots, Right Departure, Haptic Warning

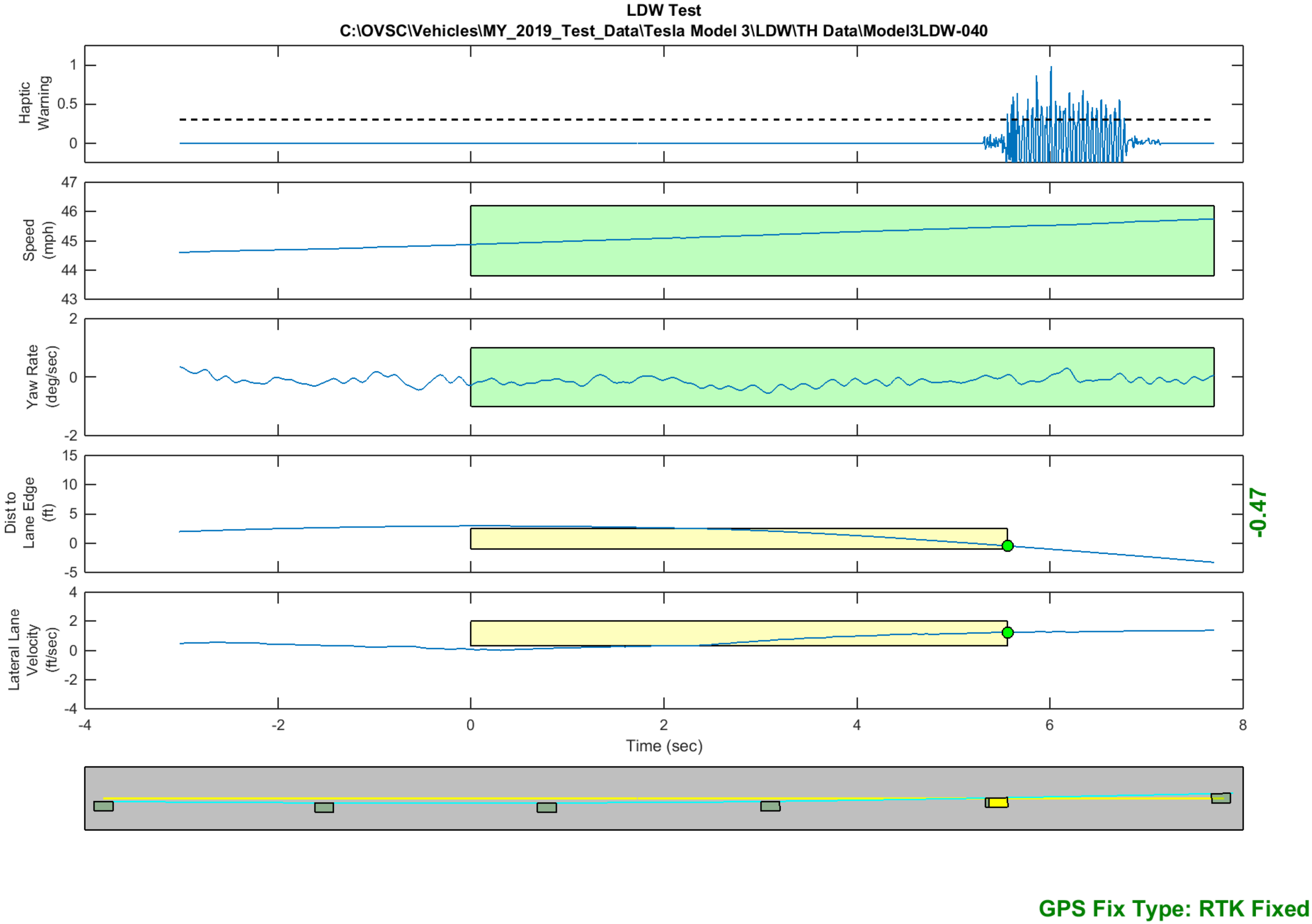
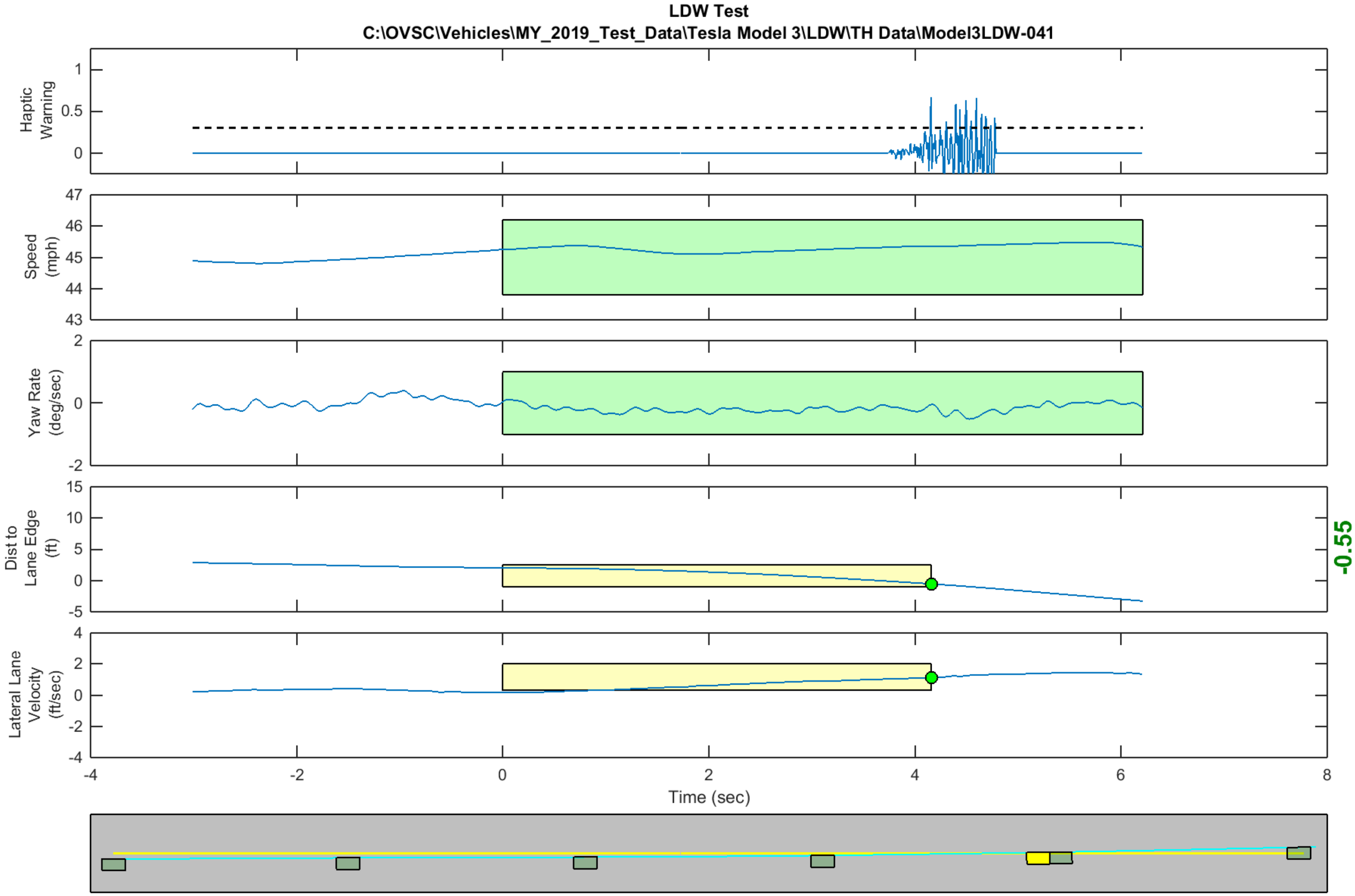
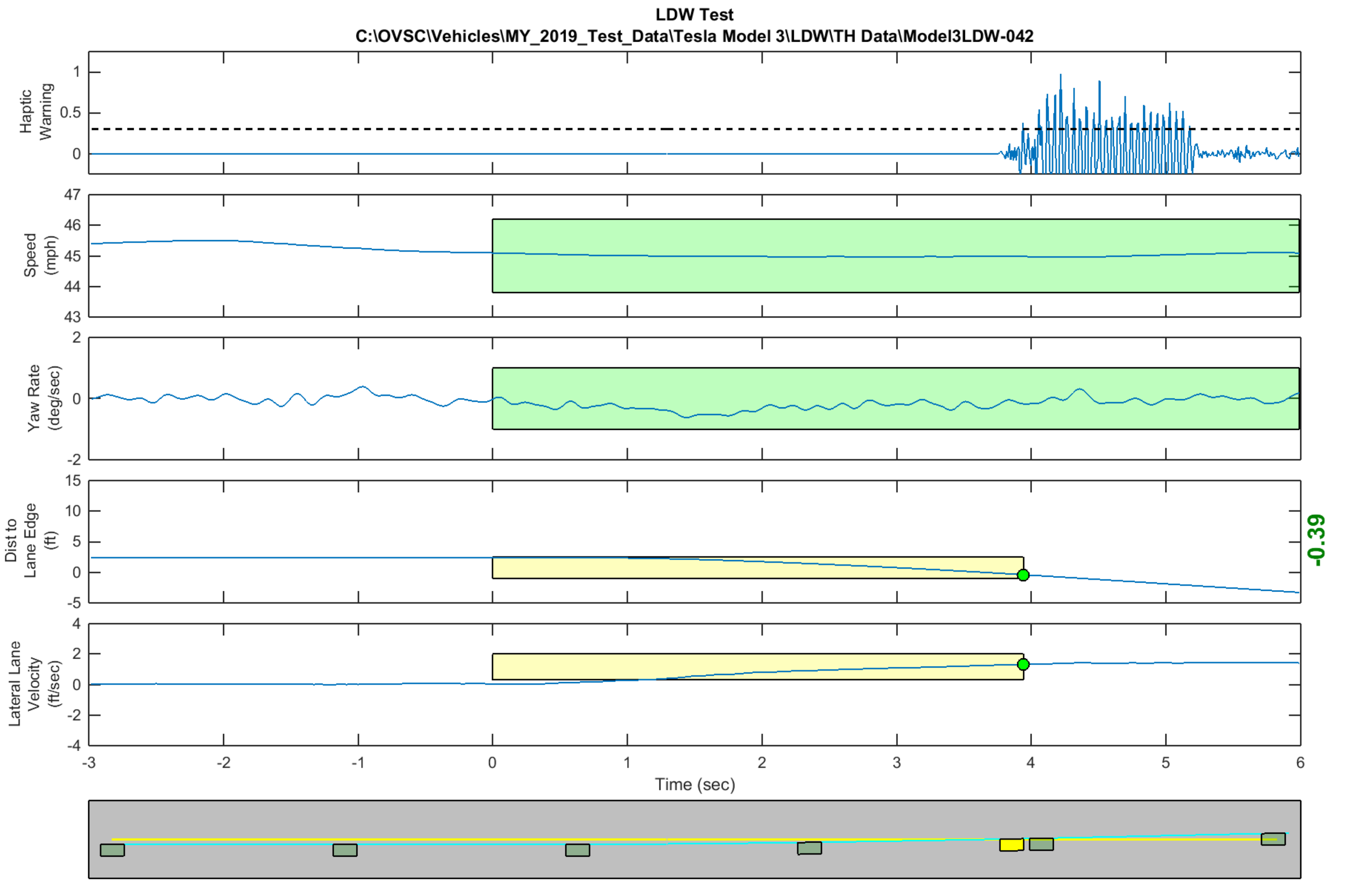


Figure D39. Time History for Run 40, Botts Dots, Left Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D40. Time History for Run 41, Botts Dots, Left Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D41. Time History for Run 42, Botts Dots, Left Departure, Haptic Warning

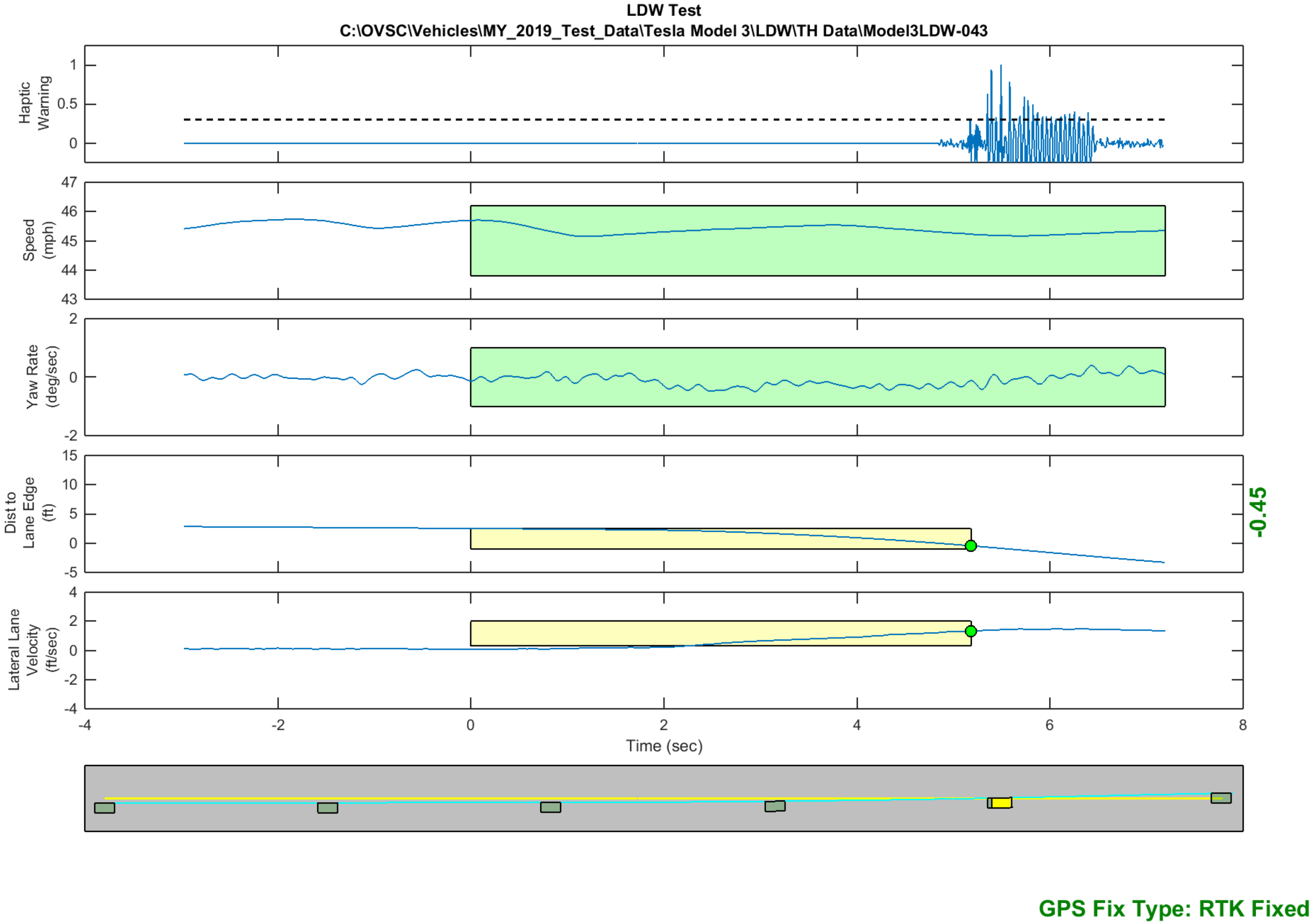


Figure D42. Time History for Run 43, Botts Dots, Left Departure, Haptic Warning

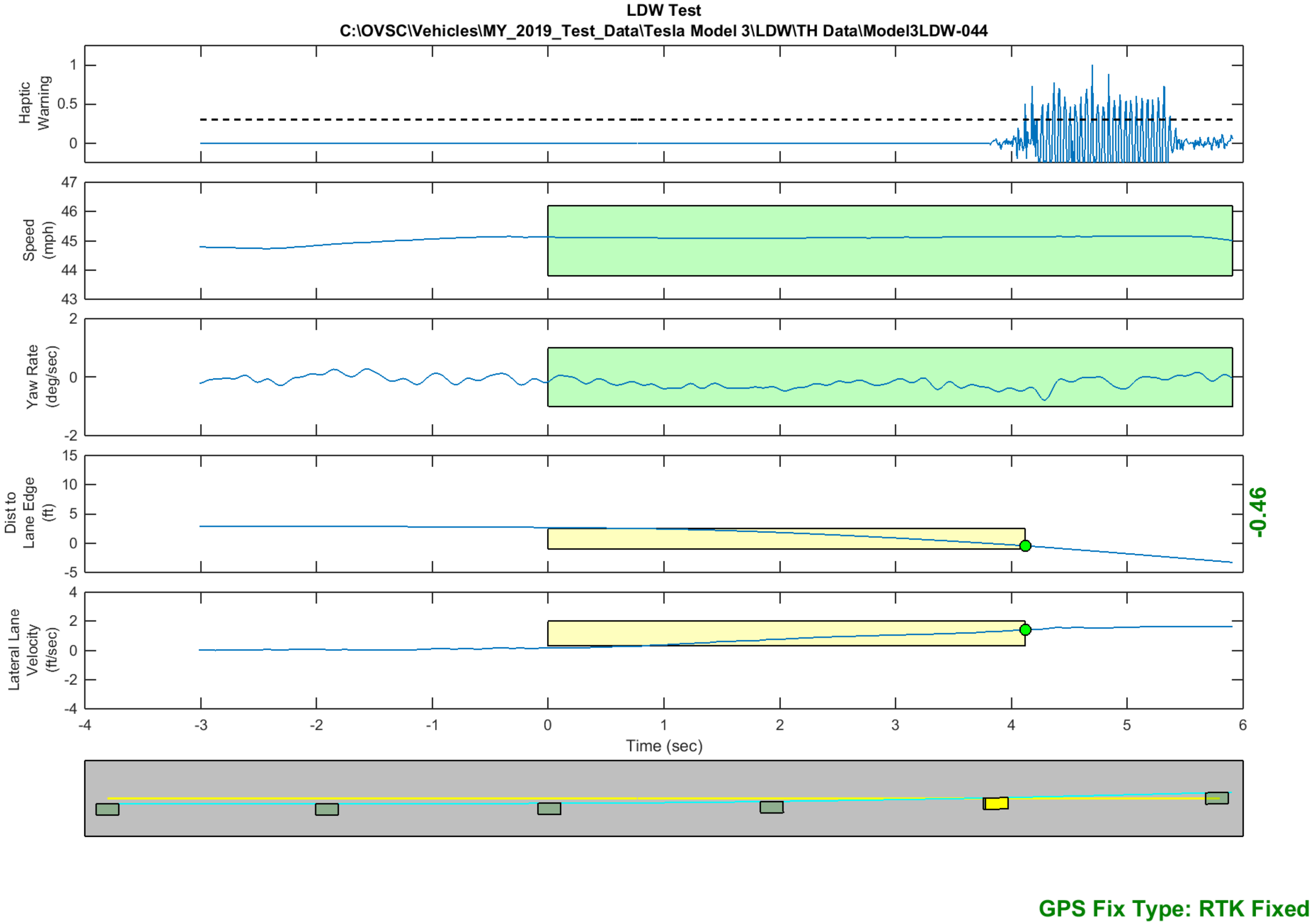


Figure D43. Time History for Run 44, Botts Dots, Left Departure, Haptic Warning

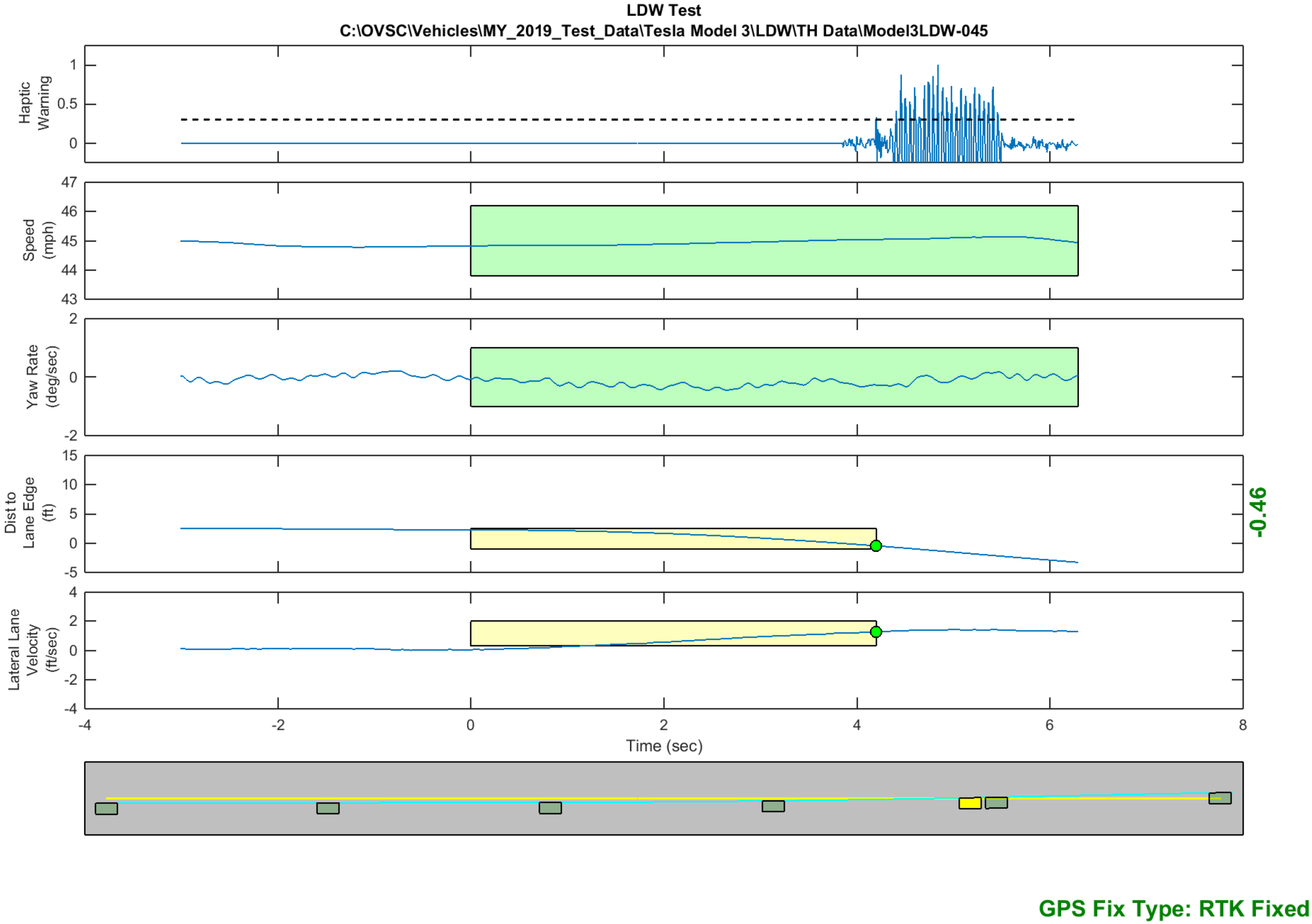
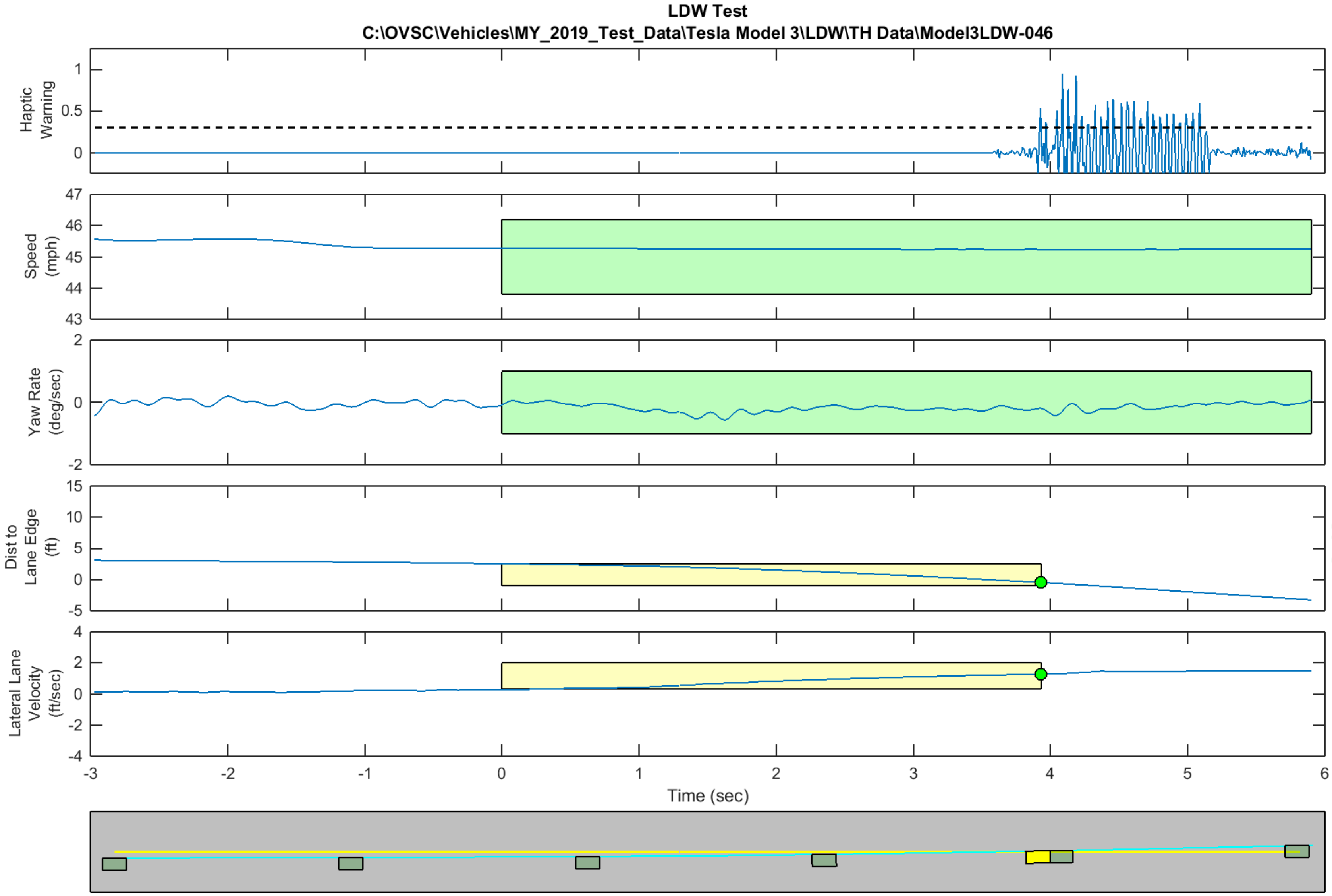


Figure D44. Time History for Run 45, Botts Dots, Left Departure, Haptic Warning



GPS Fix Type: RTK Fixed

Figure D45. Time History for Run 46, Botts Dots, Left Departure, Haptic Warning

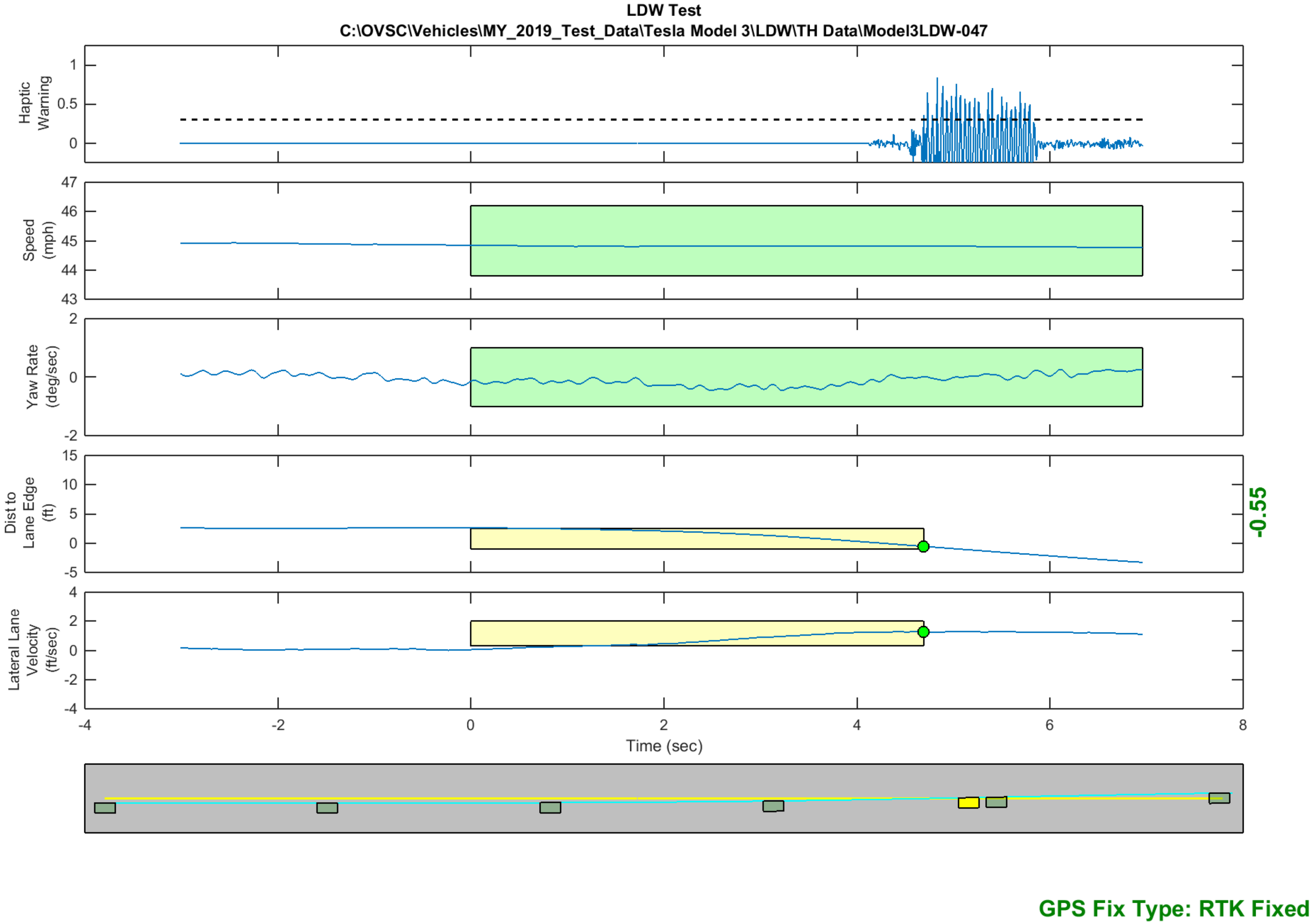


Figure D46. Time History for Run 47, Botts Dots, Left Departure, Haptic Warning