BLIND SPOT INTERVENTION SYSTEM CONFIRMATION TEST
NCAP-DRI-BSI-20-09

2020 Volkswagen Jetta 1.4T SEL

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

11 January 2021

Final Report

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Prepared By:	J. Lenkeit	N. Wong
	Program Manager	Test Engineer
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16. Abstract These tests were conducted on the subject 2020 Volkswagen Jetta 1.4T SEL in accordance with the specifications of the National Highway Traffic Safety Administration's most current Test Procedure in docket NHTSA-2019-0102-0001, BLIND SPOT INTERVENTION SYSTEM CONFIRMATION TEST, to confirm the performance of a Blind Spot Intervention system. The vehicle met the requirements of the test for SV Lane Change, Closing Headway and SV Lane Change, Constant Headway, False Positive, but did not meet the requirements for SV Lane Change, Constant Headway. Overall, the preliminary BSI requirements were met for 14 out of 21 valid trials.		
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Section I

INTRODUCTION

There are presently two commercially available crash avoidance technologies designed to directly address the "changing lanes/same direction" pre-crash scenario: Blind Spot Detection (BSD) and Blind Spot Intervention (BSI). BSD is a warning-based passive technology designed to help the driver recognize that another vehicle is approaching, or being operated within, the blind spot of their vehicle in an adjacent lane. Should the driver initiate a lane change towards this other vehicle, the BSD presents an alert before a collision is expected to occur. BSI systems are designed to actively help the driver avoid a collision with another vehicle that is approaching, or being operated within, the blind spot of their vehicle in an adjacent lane.

This research test evaluates BSI systems on light vehicles with SAE automation levels 0, 1, 2, or 3, as specified in the National Highway Traffic Safety Administration's "Blind Spot Intervention System Confirmation Test", July 2019. The subject light vehicles have gross vehicle weight ratings (GVWR) under 10,000 pounds. BSI technology uses sensors to detect the presence of other vehicles in the equipped vehicle's left and right blind spot and then intervene to avoid a collision. The procedures described herein emulate three straight-road, real-world scenarios in which the Subject Vehicle (SV) operating under SAE automation levels 0, 1, 2, or 3 attempts to perform a lane change. The adjacent destination lane is occupied by a single Principal Other Vehicle (POV) in the first two scenarios, and not in the third. Although it is impossible to predict what technologies could be used by future BSI systems, it is believed that minor modifications to these procedures, when deemed appropriate, could be used to accommodate the evaluation of alternative or more advanced BSI systems.

Section II

DATA SHEETS

BLIND SPOT INTERVENTION

DATA SHEET 1: TEST RESULTS SUMMARY

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2020 Volkswagen Jetta 1.4T SEL

VIN: *3VWEB7BU2LM02xxxx*

Test Date: *7/28/2020*

System Setting(s): *Enabled*

	Number of valid test runs for which acceptability[1] criteria were: Met	Not met	Valid trials
Test 1 - Subject Vehicle Lane Change, Constant Headway	*0*	*7*	*7*
Test 2 - Subject Vehicle Lane Change, Closing Headway	*7*	*0*	*7*
Test 3 - Subject Vehicle Lane Change, Constant Headway, False Positive	*7*	*0*	*7*
Overall:	***14***	***7***	***21***

Notes: *All tests were performed at Level 0 automation.*

[1] The acceptability criteria listed herein are used only as a guide to gauge system performance, and are identical to the Pass/Fail criteria given in NHTSA's most current Test Procedure in docket NHTSA-2019-0102-0001, BLIND SPOT INTERVENTION SYSTEM CONFIRMATION TEST.

BLIND SPOT INTERVENTION

DATA SHEET 2: VEHICLE DATA

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2020 Volkswagen Jetta 1.4T SEL

TEST VEHICLE INFORMATION

VIN: *3VWEB7BU2LM02xxxx*

Body Style: *Sedan* Color: *Deep Black Pearl*

Date Received: *7/16/2020* Odometer Reading: *13 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Volkswagen de Mexico S.A. de C.V.*

Date of manufacture: *01/20*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *205/55 R17*

Rear: *205/55 R17*

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

Rear: *250 kPa (36 psi)*

TIRES

Tire manufacturer and model: *Hankook Kinergy GT*

Front tire size: *205/55 R17 91H*

Rear tire size: *205/55 R17 91H*

Front tire DOT prefix: *15M581BHQ*

Rear tire DOT prefix: *15M581BHQ*

BLIND SPOT INTERVENTION

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2020 Volkswagen Jetta 1.4T SEL

GENERAL INFORMATION

Test date: *7/28/2020*

AMBIENT CONDITIONS

Air temperature: *40.0 C (104 F)*

Wind speed: *1.0 m/s (2.3 mph)*

X Windspeed ≤ 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.

All tests were also conducted such that there were no overhead signs, bridges, or other significant structures over, or near, the testing site. Except for the POV, each trial shall be conducted with no vehicles, obstructions, or stationary objects within one lane width of either side the SV path.

VEHICLE PREPARATION

Verify the following:

All non-consumable fluids at 100% capacity: **X**

Fuel tank is full: **X**

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

Front: *250 kPa (36 psi)*

Rear: *250 kPa (36 psi)*

BLIND SPOT INTERVENTION

DATA SHEET 3: TEST CONDITIONS

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2020 Volkswagen Jetta 1.4T SEL

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*466.3 kg (1028 lb)*	Right Front:	*433.6 kg (956 lb)*
Left Rear:	*334.8 kg (738 lb)*	Right Rear:	*325.2 kg (717 lb)*
		Total:	*1559.9 kg (3439 lb)*

DATA SHEET 4: BLIND SPOT INTERVENTION SYSTEM OPERATION

2020 Volkswagen Jetta 1.4T SEL

General Information

Name of the BSI option, option package, etc., as shown on the Monroney label:

Active Blind Spot Monitor

Standard on SEL and SEL Premium trims

Type and location of sensors the system uses:

Two Medium Range Radar sensors located in the rear bumper, front camera located behind the top center of the windshield.

System setting used for test (if applicable):

Default

Method(s) by which the driver is alerted

_X_ Visual

	Type	Location	Description
X	Symbol	*Outside mirrors*	*Blind Spot symbol*
___	Word		
___	Graphic		

___ Audible - Description

___ Haptic

___	Steering Wheel	___	Seatbelt
___	Pedals	___	Steering Torque
___	Seat	___	Brake Jerk

Description of alert:

> *If a vehicle is travelling alongside or approaching in the adjacent lane and the turn signal is not activated, the yellow LED symbol in the mirror will remain constantly on and dim while the adjacent vehicle is detected. If the turn signal is activated, the LED will flash bright yellow to indicate a critical situation.*

Please describe the method of intervention for the BSI system. For example, if the intervention is turning of the steering wheel, application of braking to one or more wheels of the vehicle, or a combination. If the intervention has different phases, please describe and provide information for each of these.

> *If Lane Assist is detecting lane markers and Active Blind Spot Monitor is actively detecting vehicles travelling alongside or approaching in the adjacent lane, the system will provide corrective steering if you attempt to leave your lane.*

System Function

What is the speed range over which the system operates?

Minimum: *65.6 km/h (41 mph) activation, deactivation if activated and speed drops below 60 km/h (37.5 mph)*

Maximum: *248 km/h (155 mph)*

If the system requires an initialization sequence/procedure, please provide a description of the process required to initialize the system.

> *No initialization is required.*

If the system requires the driver to operate their turn signal indicator during lane change in order to activate, please provide a description.

> *While Lane Assist is detecting lane markers and Active Blind Spot Monitor is actively detecting vehicles travelling alongside or approaching in the adjacent lane, the system will provide corrective steering if you attempt to leave your lane regardless of the status of the turn signal.*

If the vehicle is equipped with a method to activate/deactivate the system(s) please provide a description of how this is accomplished. If the system is deactivated by this method, does it reactivate upon each ignition cycle?

There are three methods for enabling/disabling the Blind Spot Monitoring system:

1. Using the Multi-Media (touch screen) Interface in the center of the console:

Select "Vehicle"

"Settings"

"Assistance Systems"

"Blind Spot Monitor"

Select or deselect to enable/disable

See Appendix A, Figure A13.

2. Push the button on the left side of the steering wheel; “Assist Systems" is displayed at the top-center of the instrument panel.

Use the down arrow on the right side of the steering wheel to select “Blind Spot Monitor”

Toggle the “OK” button on the right side of the steering wheel to enable/disable the Blind Spot Monitor system.

3. Use the button on the right side of the steering wheel to scroll through the menu items displayed in the instrument panel until "Assist Systems" is displayed at the top-center of the instrument panel.

Use the down arrow on the right side of the steering wheel to select “Blind Spot Monitor”

Toggle the “OK” button on the right side of the steering wheel to enable/disable the Blind Spot Monitor system.

See Appendix A, Figures A14 and A15.

If the vehicle is equipped with a method to adjust the range setting/sensitivity or otherwise influence the operation of BSI, please provide a description.

No range/sensitivity adjustment is possible.

If the system deactivates due to damage to the sensors, how is this indicated to the driver?

If the system is inoperable, a message will appear in the instrument cluster.

If the system deactivates due to repeated BSI activations:

- How is this indicated to the driver?
- Can deactivation be avoided (e.g., by cycling the ignition after each BSI activation)?
- How can the system be reactivated?

The system does not deactivate as a result of repeated activations.

If the system deactivates or its effectiveness is reduced due to periods of inactivity:

- How is this indicated to the driver?
- Can deactivation be avoided?
- How can the system be reactivated?

If the radars are blind, there is a message in the instrument cluster and the system suspends itself. The system is reactivated automatically after driving past stationary or moving metal objects for a sufficient period of time. System suspension can be avoided by making sure there are not extended periods of time without detectable objects within the sensor's field of vision.

2020 Volkswagen Jetta 1.4T SEL

If there are other driving modes or conditions (such as weather) that render the system inoperable or reduce its effectiveness please provide a description.

Only use the "Blind Spot" Monitor on paved roads.

Among other possibilities, see Owner's Manual, page 140 shown in Appendix B, page B-7, the "Blind Spot" Monitor may not interpret the traffic situation correctly in the following situations:

- *In tight curves*
- *When driving in the center of two lanes*
- *When lanes have different widths*
- *When the road is raised*
- *In poor weather conditions*
- *When there is equipment installed on the side of the road, such as high or offset guard rails*

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

Three test scenarios were used, as follows:

Test 1.	SV Lane Change with Constant Headway
Test 2.	SV Lane Change with Closing Headway
Test 3.	SV Lane Change with Constant Headway, False Positive

An overview of each of the test procedures follows.

1. TEST 1 – SV LANE CHANGE WITH CONSTANT HEADWAY

The SV Lane Change with Constant Headway (SVLC_Constant_HW) test evaluates the ability of the BSI system to detect and respond to a POV in an adjacent lane blind spot by preventing the SV from changing lanes or colliding with the POV. For this scenario, the POV resides in the SV blind spot with a constant headway. This test scenario is depicted in Figure 1.

The test begins with the POV in the left lane adjacent to the SV. After both vehicles have reached their designated speeds and headway overlap, the SV driver engages the left turn signal indicator and initiates a single lane change maneuver into the lane occupied by the POV. Specific details of the lane change method depended on the automation level as summarized in Table 1. The BSI system was then expected to intervene and prevent the SV from contacting the POV.

This test scenario was performed with the highest available SV automation level (0, 1, 2, or 3).

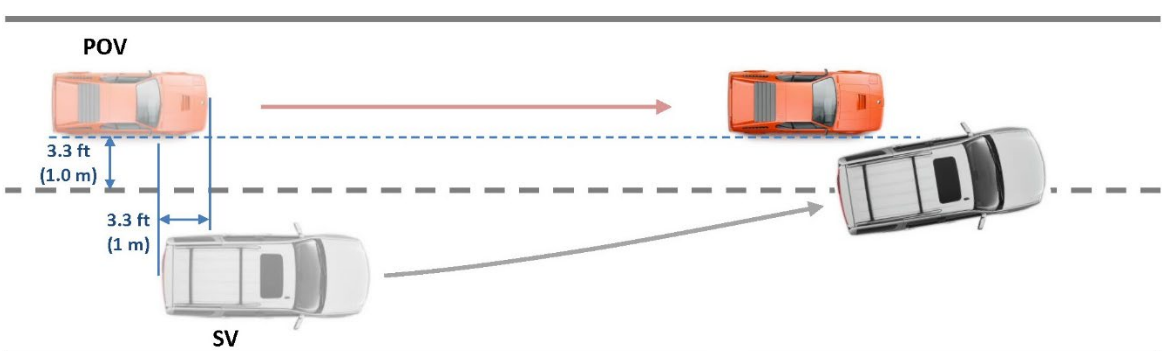

Figure 1. SV Lane Change with Constant Headway Test Scenario

a. Procedure for Automated Vehicle Level 0 or 1 Operation

The tests with SV automated vehicle level 0 or 1 were performed with manual steering input from a robotic steering controller. The SV and POV began in their respective travel lanes with their longitudinal axes oriented parallel to the roadway edge. The initial SV path was offset in the lane as shown in Figure 2 . Both vehicles then accelerated to an initial speed of 45 mph (72.4 km/h). This speed and specified headway overlap between the front-most point of the POV and the rear-most point of the SV were maintained throughout the test. The headway overlap is specified with the front bumper of the POV located 1.0 ± 0.5 m (3.3 ± 1.6 ft) ahead of the rear of the SV (therefore the specified headway distance is a negative value indicating longitudinal overlap).

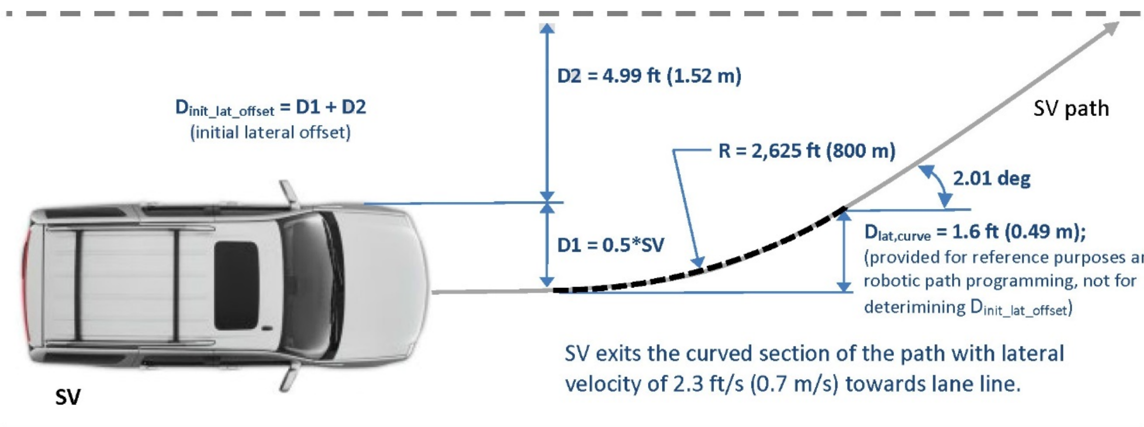

Figure 2. Input Parameters Used to Define the SV Path During the SV Level 0 and 1 Lane Change with Constant Headway Scenario

Once the speeds of both vehicles and the specified headway overlap were stabilized, the vehicles held this formation from the beginning of the test validity period until the SV lane change was initiated, as follows. After at least 3 seconds from the onset of the validity period, the SV driver activated the left turn signal indicator. Then within 1 ± 0.5 seconds after the turn signal was activated, the SV robotic steering controller began the lane change shown in Figure 2. The steer torque applied by the SV robotic steering controller stopped[2] within 250 ms of achieving the desired SV heading angle after the SV exited the 2,625 ft (800 m) radius curve during the lane change. The POV used open loop control to maintain the initial speed indicated in Table 1 (i.e., 45 mph).

[2] To emulate the situation where a human driver is operating the vehicle with their hands removed from the steering wheel.

b. Validity Period

The valid test interval began 3 seconds before the SV driver activated the left turn signal indicator.

For trials where the BSI system intervened, the valid test interval ended when one of the following conditions occurred:

- The SV impacted the POV; or
- five seconds after the SV had established a heading away from the POV and was completely within its original travel lane; or
- one second after the SV traveled ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the SV travel lane from the lane adjacent and to the right of it, as shown in Figure 3.

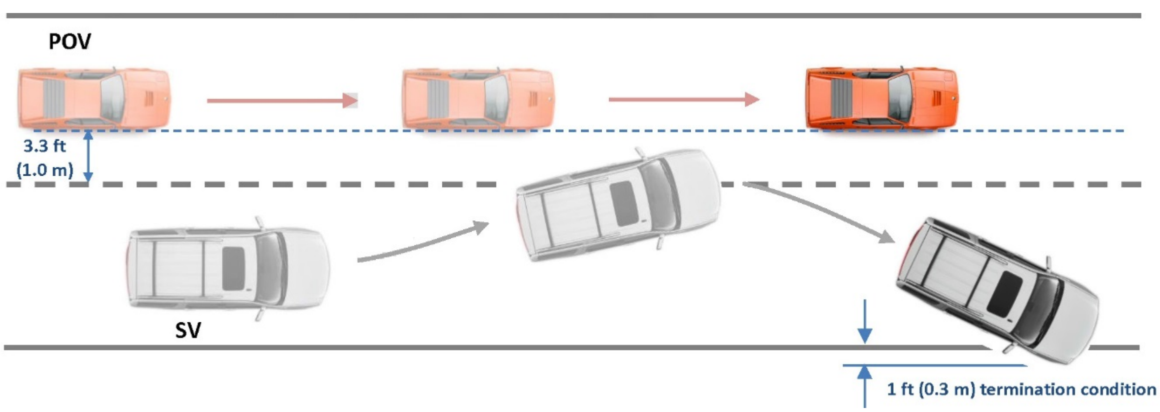

Figure 3. Valid SV Lane Change Intervention Test Interval End Condition 3

For trials where the BSI did not intervene, the valid test interval ended when the SV impacted the POV.

In addition to the procedure and timing described above, for an individual test trial to be valid, the following was required throughout the test:

- The general test validity criteria specified in Section III.B.1 were satisfied.
- The test parameters specified in Table 1 were within the allowable limits specified in Table 1 during the entire test interval or the epoch indicated.
- After initiation of the SV lane change, the POV used open loop control to maintain the constant speed specified in Table 1.

After the test validity period ended, the SV driver manually applied force to the brake pedal, bringing the vehicle to a stop, and placed the transmission in park. The POV also braked to a stop, and the SVLC_Constant_HW test trial was complete.

c. Number of Test Trials

Seven valid SVLC_Constant_HW test trials were performed for the SV automation condition listed in Data Sheet 1.

If no intervention was detected on the first three of the seven valid trials, testing was stopped after three trials in order to mitigate damage to both the POV and SV.

d. Evaluation Criteria

The BSI system performance requirements for the SVLC_Constant_HW tests depended on the level of automation the SV was operating in during that trial. Passing BSI test criteria were:

- The SV did not impact the POV during any valid test performed in automation level 0 or 1 (i.e., those performed with the timing and inputs described in Section III.A.1.a), or

- the SV did not initiate the lane change commanded by the turn signal indicator during any valid test performed with automation level 2 or 3 (i.e., those described in Section III.A.1.b), and

- the SV BSI intervention did not cause the SV to travel ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the SV travel lane from one adjacent and to the right of it within the validity period defined in Section III.A.1.b during any valid test (i.e., with automation level 1, 2, or 3).

Table 1. SV Lane Change with Constant Headway Test Specifications

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-POV Longitudinal Orientation	SV Left Turn Signal Activation	SV Lane Change			SV Path Tolerance	Number of Trials
	SV	POV	SV	POV			Initiation Timing	Steering Release Timing	Lateral Velocity		
Manual speed control, LCC off (Level 0)	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	Manually offset within travel lane, then manual lane change towards left adjacent lane	Constant; 3.3 ± 0.8 ft (1 ± 0.25 m) from the right side of the POV to the inboard edge of the lane line immediately to its right	Constant; front-most point of the POV 3.3 ± 1.6 ft (1 ± 0.5 m) ahead of the rear-most point of the SV	At least 3 seconds after all pre-SV lane change test validity criteria have been satisfied	1.0 ± 0.5 s after the SV turn signal is activated	Within 250 ms of achieving desired SV heading angle after exiting the 2,625 ft (800 m) radius curve during the lane change	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	± 0.8 ft (± 0.25 m) until SV steering wheel is released	7
Cruise control, LCC off (Level 0)											7
ACC on, LCC off (Level 1)											7

2. TEST 2 – SV LANE CHANGE WITH CLOSING HEADWAY

The SV Lane Change with Closing Headway (SVLC_Closing_HW) test evaluates the ability of the BSI system to detect a POV approaching a blind spot in an adjacent lane and prevent the SV from changing lanes and colliding with it. The POV is approaching the SV blind spot from the rear, as depicted in Figure 4. In this scenario, the test begins with the POV in the left lane adjacent to the SV. After both vehicles have reached their designated speeds, the SV driver engages the left turn signal indicator and initiates a single lane change maneuver into the lane occupied by the POV. Specific details of the lane change method depended on the automation level as summarized in Table 2. The BSI system was then expected to intervene and prevent the SV from contacting the POV.

This test scenario was performed with the highest available SV automation level (0, 1, 2, and 3).

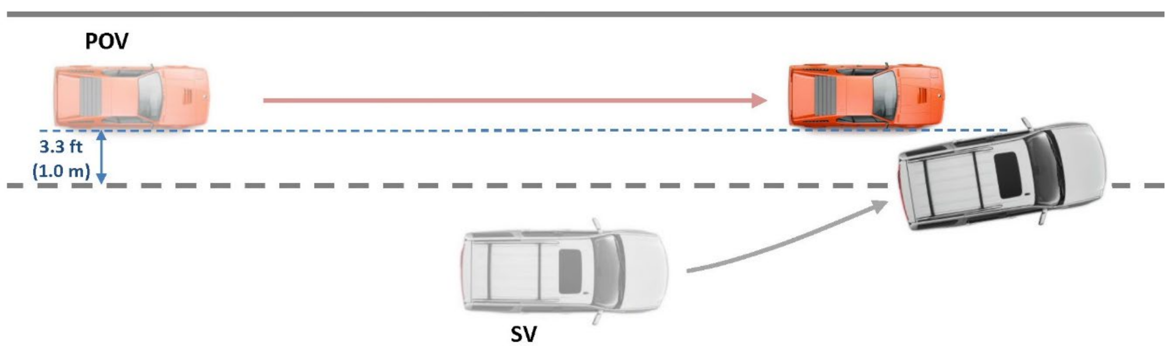

Figure 4. SV Lane Change with Closing Headway Test Scenario

a. Procedure for Automated Vehicle Level 0 or 1 operation

The tests with SV automated vehicle level 0 or 1 were performed with manual steering input from a robotic steering controller. The SV and POV began in their respective travel lanes with their longitudinal axes oriented parallel to the roadway edge, with the POV behind the SV as shown in Figure 4. The initial SV path was offset in the lane as shown in Figure 2 . The SV then accelerated to an initial speed of 45 mph (72.4 km/h) while the POV accelerated to an initial speed of 50 mph (80.5 km/h). These speeds were then maintained throughout the test.

The SV driver then activated the left SV turn signal indicator when the front of the POV was 4.9 ± 0.5 seconds from a vertical plane defined by the rear of the SV and perpendicular to the SV travel lane. This event nominally occurs when the longitudinal SV-to-POV headway is 35.6 ft (10.8 m) if the speed differential is 5 mph (8 km/h).

Then, when the POV is 3.9 ± 0.5 seconds from a vertical plane defined by the rear of the SV and perpendicular to the SV travel lane, the SV robotic steering controller began the lane change shown in Figure 2. This event nominally occurs when the longitudinal SV-to-POV headway is 28.2 ft (8.6 m) if the speed differential is 5 mph (8 km/h). The steer torque applied by the SV robotic steering controller stopped within 250 ms of achieving the desired SV heading angle after the SV exited the 2,625 ft (800 m) radius curve during the lane change. The POV used open loop control to maintain the initial speed indicated in Table 2 (i.e., 50 mph).

b. Validity Period

The valid test interval began 3 seconds before the SV driver activated the left turn signal indicator.

For trials where the BSI system intervened, the valid test interval ended when one of the following conditions occurred:

- The SV impacted the POV; or
- five seconds after the SV had established a heading away from the POV and was completely within its original travel lane; or
- one second after the SV traveled ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the SV travel lane from the lane adjacent and to the right of it, as shown in Figure 3.

For trials where the BSI did not intervene, the valid test interval ended when the SV impacted the POV.

In addition to the procedure and timing described above, for an individual test trial to be valid, the following was required throughout the test:

- The general test validity criteria specified in Section III.B.1 were satisfied.
- After the test validity period ended, the SV driver manually applied force to the brake pedal, bringing the vehicle to a stop, and placed the transmission in park. The POV was also braked to a stop, and the SVLC_Closing_HW test trial was complete.

c. Number of Test Trials

Seven valid SVLC_ Closing _HW test trial were performed for the SV automation condition listed in Data Sheet 1.

If no intervention was detected on the first three of the seven valid trials, testing was stopped after three trials in order to mitigate damage to both the POV and SV.

d. Evaluation Criteria

The BSI system performance requirements for the SVLC_Closing_HW tests depended on the level of automation the SV was operating in during that trial. Passing BSI test criteria were:

- The SV did not impact the POV during any valid test performed in automation level 0 or 1 (i.e., those performed with the timing and inputs described in Section III.A.2.a), or
- the SV did not initiate the lane change commanded by the turn signal indicator during any valid test performed with automation level 2 or 3 (i.e., those described in Section III.A.2.b), and
- the SV BSI intervention did not cause the SV to travel ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the SV travel lane from one adjacent and to the right of it within the validity period defined in III.A.2.b during any valid test (i.e., with automation level 1, 2, or 3).

Table 2. SV Lane Change with Closing Headway Test Specifications

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-POV Longitudinal Orientation	SV Left Turn Signal Activation	SV Lane Change			SV Path Tolerance	Number of Trials
	SV	POV	SV	POV			Initiation Timing	Steering Release Timing	Lateral Velocity		
Manual speed control, LCC off (Level 0)	45 ± 1 mph (72.4 ± 1.6 km/h)	50 ± 1 mph (80.5 ± 1.6 km/h)	Manually offset within travel lane, then manual lane change towards left adjacent lane	Constant; 3.3 ± 0.8 ft (1 ± 0.25 m) from the right side of the POV to the inboard edge of the lane line immediately to its right	POV approaches the rear of the SV with a constant 5 mph (8.1 km/h) relative velocity	When the front-most point of the POV is 4.9 ± 0.5 seconds from a vertical plane defined by the rear-most point of the SV and perpendicular to the SV travel lane	When the front-most point of the POV is 3.9 ± 0.5 seconds from a vertical plane defined by the rear-most point of the SV and perpendicular to the SV travel lane	Within 250 ms after exiting the 2,625 ft (800 m) radius curve during the lane change	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	± 0.8 ft (± 0.25 m) until SV steering wheel is released	7
Cruise control, LCC off (Level 0)											7
ACC on, LCC off (Level 1)											7

Note: Columns 3, 6, 7, and 8 in Table 2 are different from Table 1.

3. <u>TEST 3 – SV LANE CHANGE WITH CONSTANT HEADWAY, FALSE POSITIVE ASSESSMENT</u>

The SV Lane Change with Constant Headway, False Positive (SVLC_Constant_HW_FP) test assesses whether or not a BSI system detects and responds to a non-threatening POV during a single lane change. In this scenario, the POV is two lanes away from the SV, adjacent to the SV blind spot, and traveling with constant headway. This test scenario is depicted in Figure 5. In this scenario, the test begins with the POV in the second lane to the left of the SV After both vehicles have reached their designated speeds and headway overlap, the SV driver engages the left turn signal indicator and initiates a single lane change maneuver into the lane between the initial SV and POV travel lanes. Specific details of the lane change method depended on the automation level as summarized in Table 3a and 3b.

This test scenario was performed in two parts comprised of "baseline" and "evaluation" trials, with SV automation level 0, 1, 2, or 3 depending on the highest SAE automation level available on the SV. The main difference between the baseline and evaluation trials is that evaluation trials were performed with the POV present and the baseline trials were performed without the POV. The BSI system was expected to not respond any differently to the presence of the POV compared to a similar baseline test trial without the POV.

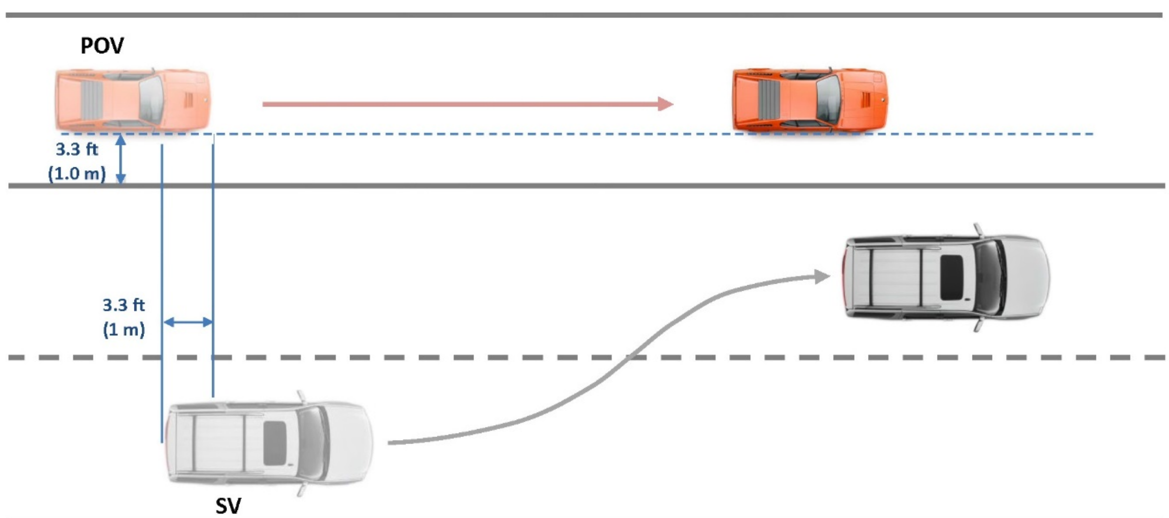

Figure 5. Lane Change with Constant Headway, False Positive Test Scenario

a. Procedure for Automated Vehicle Level 0 or 1 Operation

The SVLC_Constant_HW_FP tests with level 0 and 1 operation were performed in a similar manner as the SVLC_Constant_HW tests described in Section III.A.1.a with the following exceptions:

- The initial SV and POV lanes of travel were separated by a lane of travel in between them as shown in Figure 5.
- The SV driver did not release the steering wheel (or robotic steering control equivalent) at any time during the baseline test trial.
- The SV driver did not release the steering wheel (or robotic steering control equivalent) at any time during the evaluation test trial unless system intervention was detected.
- The manual steer input included a lane change completion phase as shown in Figure 6.
- The tests were conducted both with and without the POV present.
- There were 3 baseline trials without the POV, as specified in Table 3a. The SV was driven at the initial speed of 45 mph (72.4 km/h) either manually or using the cruise control after it was enabled and initialized. After maintaining this initial speed (there was no initial SV-POV vehicle formation as depicted in Figure 5 during the trial because the POV was not present), the SV driver engaged the left turn signal indicator and initiated the single lane change into the left adjacent lane. No BSI system interventions were expected in the baseline trials because no POV was present.
- There were 7 evaluation trials with the POV, as specified in Table 3b. The SV and POV were both driven at the initial speed of 45 mph (72.4 km/h) and established the initial longitudinal and lateral formation shown in Figure 5. The SV speed was achieved either manually or with the cruise control enabled and initialized. After maintaining the initial formation shown in Figure 5 for 3 seconds, the SV driver engaged the left turn signal indicator and initiated the single lane change into the left adjacent lane. No BSI system interventions were expected in the evaluation trial because a single lane change should not result in a collision with the POV.
- The validity period is defined in Section III.A.3.b.

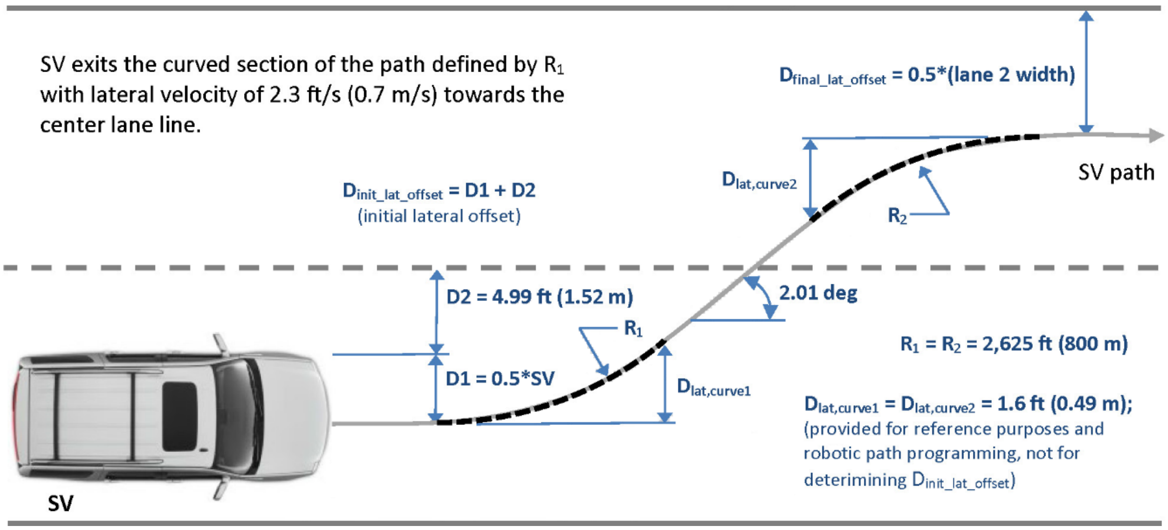

Figure 6. Input Parameters used to define the SV path during the SV Lane Change with Constant Headway, False Positive Scenario

b. Validity Period

The valid test interval began 3 seconds before the SV driver activated the left turn signal indicator.

The valid test interval ended when one of the following conditions occurred:

1. The SV impacted the POV; or

2. Five seconds after the SV had completed the single lane change into the left lane adjacent to the SV's original travel lane without a BSI intervention; or

3. One second after a BSI intervention caused the SV to travel ≥ 1 ft (0.3 m) beyond the inboard edge of the lane line separating the post lane change SV travel lane and the lane adjacent and to the right of it, as shown in Figure 7.

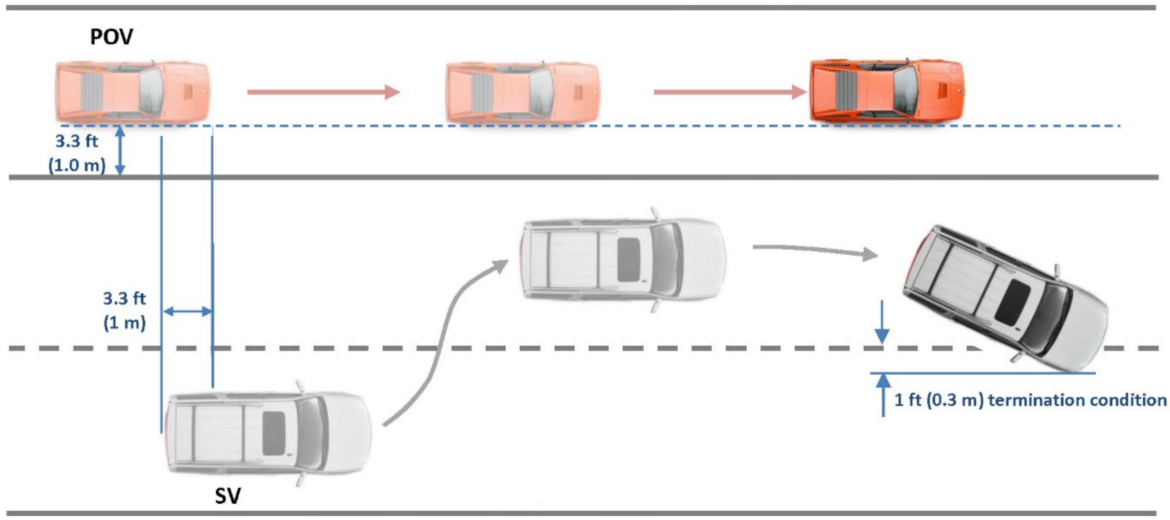

Figure 7. Valid SV Lane Change False Positive Test Interval End Condition 3

In addition to the procedure and timing described above, for an individual test trial to be valid, the following was required throughout the test:

- The general test validity criteria specified in Section III.B.1 were satisfied.
- The test parameters specified in Table 3a and 3b were within the allowable limits specified in Table 3a and 3b during the entire test interval or the epoch indicated.
- For evaluation trials, after initiation of the SV lane change, the POV used open-loop control to maintain the constant speed specified in Table 3b.

After the test validity period ended, the SV driver manually applied force to the brake pedal, bringing the vehicle to a stop, and placed the transmission in park. The POV was also braked to a stop for evaluation trials. The SVLC_Constant_HW_FP test trial was then complete.

c. Evaluation Method and Criteria

Determination of whether a false positive BSI intervention occurred during a SVLC_Closing_HW_FP evaluation required the comparison of the SV yaw rate data collected during the evaluation trial with the acceptability corridor defined by the corresponding composite data from the baseline trials. This was accomplished in two steps.

The first step was to determine an acceptable yaw rate time history corridor for each SV automation condition, as illustrated by the hypothetical example in Figure 8. The yaw rate time histories for the 3 baseline trials were first synchronized in time so that the onsets of the respective lane changes occurred within 20 ms of each other. The baseline composite yaw rate was then calculated by averaging the yaw rates from the 3 baseline trials, at each time point in the synchronized time history. The acceptability corridor was then the baseline composite yaw rate value ± 1 deg/s.

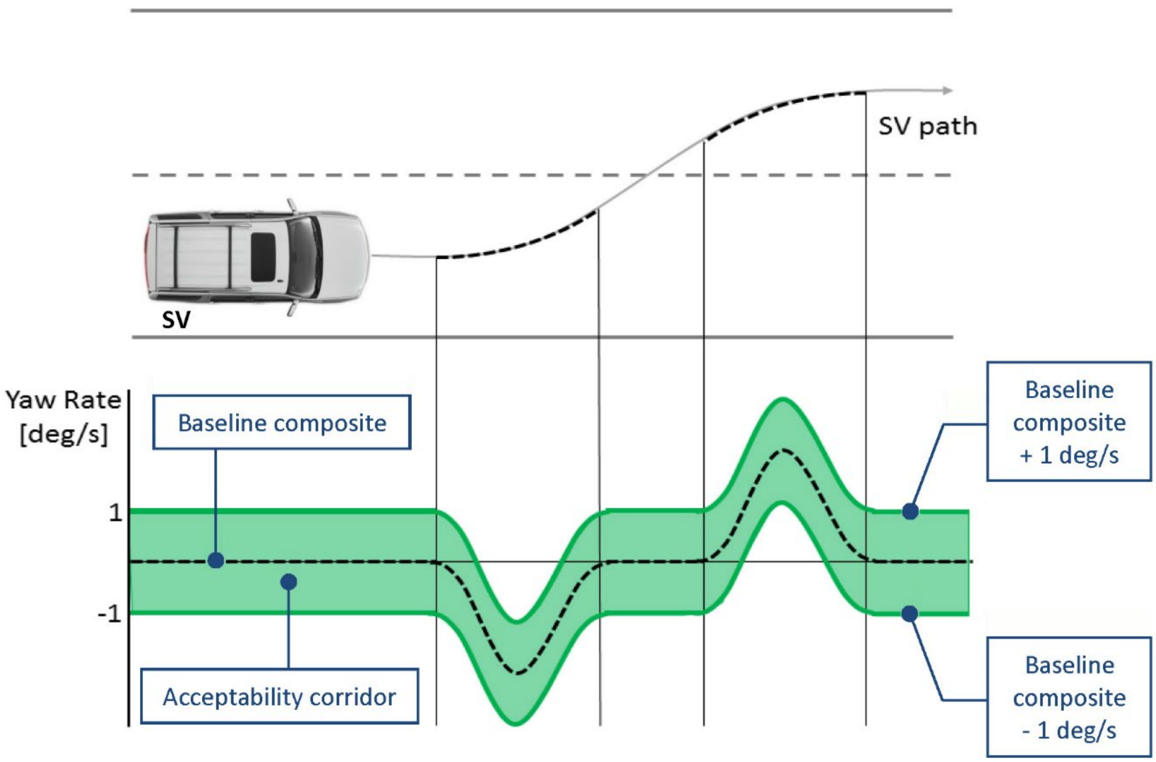

Figure 8. Definition of a Yaw Rate Acceptability Corridor

The second step was to compare the SV yaw rate from each evaluation trial to the acceptable yaw rate time history corridor, as illustrated by the hypothetical example in Figure 9. If, after data synchronization, the SV yaw rate exceeded the acceptability corridor any time during the test validity period defined in Section III.A.3.b, then a false positive intervention test result was determined to have occurred.

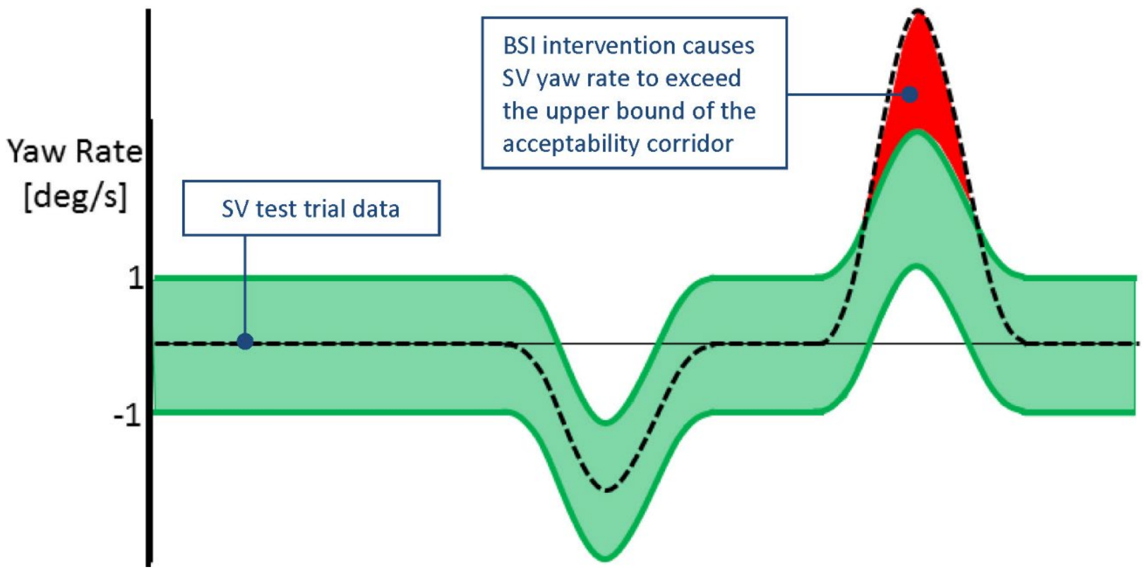

Figure 9. BSI False Positive Example

Table 3a. SV Lane Change with Constant Headway, False Positive Test Specifications (Baseline Trials)

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-POV Longitudinal Orientation	SV Left Turn Signal Activation	SV Lane Change			SV Path Tolerance	Number of Trials
	SV	POV	SV	POV			Initiation Timing	Steering Release Timing	Lateral Velocity		
Manual speed control, LCC off (Level 0)	45 ± 1 mph (72.4 ± 1.6 km/h)	N/A	Manually offset within travel lane, then manual lane change into a lane left and adjacent to that of the SV	N/A	N/A	At least 3 seconds after all pre-SV lane change test validity criteria have been satisfied	1.0 ± 0.5 s after the SV turn signal is activated	N/A (the SV driver does not release the steering wheel)	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	± 0.8 ft (± 0.25 m)	3
Cruise control, LCC off (Level 0)											3
ACC on, LCC off (Level 1)											3

Table 3b. SV Lane Change with Constant Headway, False Positive Test Specifications (Evaluation Trials)

SV Automation Condition	Initial Speed		Lateral Lane Position		SV-to-POV Longitudinal Orientation	SV Left Turn Signal Activation	SV Lane Change			SV Path Tolerance	Number of Trials
	SV	POV	SV	POV			Initiation Timing	Steering Release Timing	Lateral Velocity		
Manual speed control, LCC off (Level 0)	45 ± 1 mph (72.4 ± 1.6 km/h)	45 ± 1 mph (72.4 ± 1.6 km/h)	Manually offset within travel lane, then manual lane change into a lane left and adjacent to that of the SV	Constant; 3.3 ± 0.8 ft (1.0 ± 0.25 m) from the right side of the POV to the inboard edge of the lane line immediately to its right Note: The POV travel lane is two lanes to the left of the initial SV travel lane.	Constant; POV front located 3.3 ± 1.6 ft (1 ± 0.5 m) ahead of the SV rear	At least 3 seconds after all pre-SV lane change test validity criteria have been satisfied	1.0 ± 0.5 s after the SV turn signal is activated	N/A (SV driver does not release the steering wheel)	2.3 ± 0.3 ft/s (0.7 ± 0.1 m/s)	± 0.8 ft (± 0.25 m) unless a BSI intervention occurs	7
Cruise control, LCC off (Level 0)											7
ACC on, LCC off (Level 1)											7

B. General Information

1. GENERAL VALIDITY CRITERIA

In addition to any validity criteria described above for the individual test scenarios, for an individual trial to be valid, it must have met the following criteria throughout the test:

- The SV driver seatbelt was latched.
- If any load had been placed on the SV front passenger seat (e.g., for instrumentation), the vehicle's front passenger seatbelt was latched.
- When operating the SV in automation level 0 within the validity period, SV speed was maintained by (1) the SV driver manually modulating the SV accelerator pedal, or (2) use of conventional cruise control unless the SV BSI system automatically terminated its operation.
- Operating the SV in automation level 1 required the SV ACC (i.e., not the vehicle's lane centering system) to be enabled and in operation unless the SV BSI system automatically terminated its operation.
- Operating the SV in automation level 2 or 3 required the SV ACC and lane centering systems both be enabled and in operation.
- The SV driver did not provide manual inputs to the SV accelerator or brake pedals while the SV was being operated in automation level 1 (i.e., while ACC was actively modulating the SV speed), 2, or 3.
- The POV was driven at constant speed.
- The lateral distance between the right side of the POV and the inboard edge of the lane line immediately to its right was 3.3 ± 0.8 ft (1.0 ± 0.25 m).
- When the SV was being operated in automation level 0 or 1, the SV yaw rate did not exceed ± 1.0 deg/s from the onset of the validity period until the initiation of the SV lane change.

2. PRE-TEST INITIALIZATION AND CALIBRATION

A zero calibration was performed to align the lateral and longitudinal zero for the vehicles immediately before and after testing. The "zero position" was determined by positioning the SV and POV such that the centerline of the front-most location of the POV is aligned with the centerline of the rear-most location of the SV. Longitudinally, the front of the front bumper of the POV was placed at the rear of the rear bumper of the SV.

Static calibrations were then performed by placing the SV and POV transmissions in park, or with the system brake enabled, where applicable. Data were then collected for approximately 10 seconds using data from at least six GPS satellites.

C. Principal Other Vehicle

For tests in which a vehicle-to-vehicle collision will not occur, such as the False Positive tests, a high production, mid-sized passenger car was used as the POV. The tests reported herein made use of a 2006 Acura RL.

For tests in which a collision may occur, BSI testing requires a POV that realistically represents typical vehicles, does not suffer damage or cause damage to a test vehicle in the event of collision, and can be accurately positioned and moved during the tests. The tests reported herein made use of the Global Vehicle Target (GVT) secured to a low-profile robotic vehicle (LPRV).

This GVT system was designed for a wide range of pre-crash scenarios including scenarios which BSI systems address. The key components of the GVT system are:

- A soft GVT, which is visually and dimensionally similar to a 2013 Ford Fiesta hatchback. It is designed to appear realistic to the sensors used by automotive safety systems and automated vehicles: radar, camera, and lidar. Appropriate radar characteristics are achieved by using a combination of radar-reflective and radar-absorbing material enclosed within the GVT's vinyl covers. Internally, the GVT consists of a vinyl-covered foam structure. If a test vehicle impacts the GVT at low speeds, it is designed to separate, and is typically pushed off and away from the supporting LPRV platform. At higher impact speeds, the GVT breaks apart as the SV essentially drives through it. The GVT can be repeatedly struck from any approach angle without harm to those performing the tests or the vehicles being evaluated. Reassembly of the GVT occurs on top of the robotic platform and takes a team of 3 to 5 people approximately 7 to 10 minutes to complete.
- An LPRV platform that supports the GVT and provides for precisely controlled GVT motion. The LPRV contains the batteries, drive motors, GPS receiver, and the control electronics for the system. It has a top speed of 50 mph (80 km/h); a maximum longitudinal acceleration and deceleration of 0.12 g (1.18 m/s^2) and 0.8 g (7.8 m/s^2), respectively; and a maximum lateral acceleration of 0.5 g (4.9 m/s^2). The LPRV is preprogrammed and allows the GVT's movement to be accurately and repeatedly choreographed with the test vehicle and/or other test equipment required by a pre-crash scenario using closed-loop control. The LPRV is designed to be safely driven over by the SV without damage if the GVT is struck by the SV.

The key requirements of the POV element are to:

- Provide an accurate representation of a real vehicle to BSI and BSD sensors, including cameras and radar.
- Be resistant to damage and inflict little or no damage to the SV as a result of repeated SV-to-POV impacts.

The key requirements of the POV delivery system are to:

- Accurately control the nominal POV speed up to 50 mph (80 km/h).
- Accurately control the lateral position of the POV within the travel lane.
- Allow the POV to move away from the SV after an impact occurs.

Operationally, the GVT body is attached to LPRV using Velcro hook and loop fasteners. The GVT and LPRV are designed to separate if the GVT is struck by the SV. The GVT/LPRV system is shown in Figures A6 and A7 in Appendix A and a detailed description can be found in the NHTSA report: "A Test Track Comparison of the Global Vehicle Target (GVT) and NHTSA's Strikeable Surrogate Vehicle (SSV)".[3]

D. Throttle Controller

The actual vehicle POV was equipped with a programmable throttle controller, which was used for the False Positive Assessment test scenario to modulate the speed and headway overlap. The throttle controller system consisted of the following components:

- Electronically controlled servo motor, mounted on an aluminum rail system and installed in the vehicle.
- Real time computer (Arduino).

E. Instrumentation

Table 4 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

[3] Snyder, A.C., Forkenbrock, G.J., Davis, I.J., O'Harra, B.C., and Schnelle, S.C., A Test Track Comparison of the Global Vehicle Target (GVT) and NHTSA's Strikeable Surrogate Vehicle (SSV), DOT HS 812 698, Vehicle Research and Test Center, National Highway Traffic Safety Administration, Washington, DC, July 2019.

Table 4. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	N/A
Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Accels ± 10g, Angular Rate ±100 deg/s, Angle >45 deg, Velocity >200 km/h	Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h	SV IMU#1 Oxford Inertial +	2258	By: Oxford Technical Solutions Date: 5/3/2019 Due: 5/3/2021
				SV IMU#2 Oxford xNAV 550	015386	Date: 8/8/2019 Due: 8/8/2021
				POV IMU Oxford Inertial +	2182	Date: 9/16/2019 Due: 9/16/2021
				LPRV IMU Oxford RT3000 v3	40213	Date: 3/23/2020 Due: 3/23/2022
Real-Time Calculation of Position and Velocity Relative to Lane Markings (LDW) and POV (FCW)	Distance and Velocity to lane markings (LDW) and POV (FCW)	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec Longitudinal Range to POV: ±200 m Longitudinal Range Rate: ±50 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec Longitudinal Range: ±3 cm Longitudinal Range Rate: ±0.02 m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	N/A

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	N/A	N/A
Light Sensor	Light intensity (visual alert)	Spectral Bandwidth: 440 - 800 nm	Rise Time < 10 ms	DRI designed and developed light sensor	N/A	N/A
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	N/A	N/A
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi	< 1% error between 20 and 100 psi	Omega DPG8001	18111410000	Date: 5/4/2020 Due: 5/4/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	Date: 4/20/2020 Due: 4/20/2021
Coordinate Measurement Machine	Point x,y,z location	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	Date: 1/6/2020 Due: 1/6/2021

Type	Description	Mfr, Model	Serial Number
Data Acquisition System	Data acquisition is achieved using a dSPACE MicroAutoBox II. Data from the Oxford IMU, including Longitudinal, Lateral, and Vertical Acceleration, Roll, Yaw, and Pitch Rate, Forward and Lateral Velocity, Roll and Pitch Angle are sent over Ethernet to the MicroAutoBox.	dSPACE Micro-Autobox II 1401/1513	
		Base Board	549068
		I/O Board	588523
Steering Controller	Precise controlled steering is accomplished using a steering machine designed and constructed by DRI. DRI has used its Automated Vehicle Controller (AVC) steering machine for many vehicle tests including FMVSS 126 tests. It can provide up to 65 ft-lb torque and rates over 1300 deg/sec. The integrated angle encoder has an unlimited range with a resolution of 0.045 degrees and an accuracy of ±0.045 degrees. The steering motor is controlled by a MicroAutoBox II from dSPACE, which also acts as the data acquisition system.	DRI developed	N/A
Throttle Controller	Arduino based, servo actuated controller for managing POV speed	DRI developed	N/A

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. Front View of Principal Other Vehicle - GVT (Tests 1 and 2)

Figure A7. Rear View of Principal Other Vehicle - GVT (Tests 1 and 2)

Figure A8. Front View of Principal Other Vehicle (Test 3)

Figure A9. Rear View of Principal Other Vehicle (Test 3)

Figure A10. Computer and Steering Controller Installed in Subject Vehicle

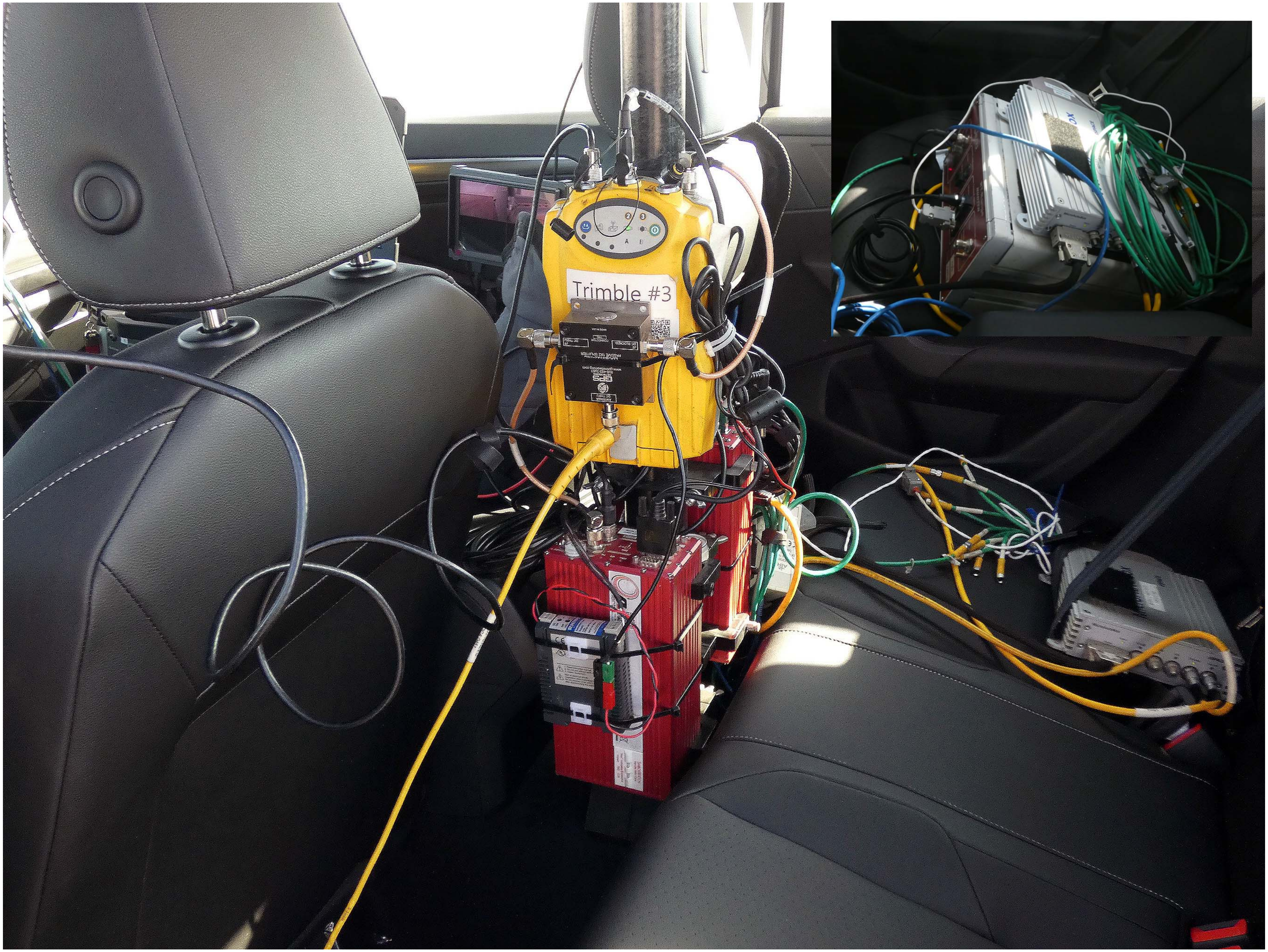

Figure A11. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A12. Sensors for Detecting Visual and Auditory Alerts

Figure A13. System Setup Menus (page 1 of 2)

Figure A14. System Setup Menus (page 2 of 2)

Figure A15. Controls for Interacting with System Menus

Figure A16. Visual Alert

APPENDIX B

Excerpts from Owner's Manual

Driver's side

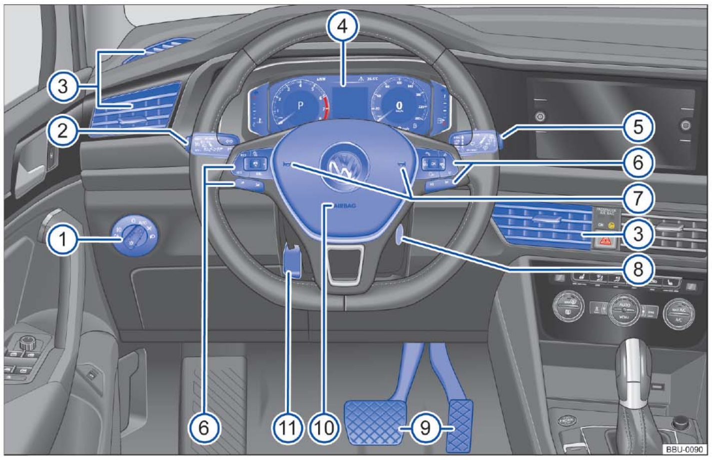

Fig. 7 Driver's side overview.

Key for fig. 7:

①	Light switch	86
②	Turn signal and high beam lever	86, 88
③	Vents	97
④	Instrument cluster	16
	— With warning and indicator lights	14
⑤	Windshield wiper/washer lever	92
⑥	Multifunction steering wheel controls:	
	— For driver assistance systems	130
	— For menu selection	25
	— For accepting telephone calls OK	
	— For audio, navigation ⏮ ⏭	
	— For adjusting the volume	
	— For voice operation activation (may not function depending on the equipment)	
	— In order to switch between the current and previous menus VIEW	17
⑦	Horn	
⑧	Ignition lock	110
⑨	Pedals	103
⑩	Location of driver's front airbag	
⑪	Lever for adjusting the steering wheel position	77

	Driving light failure → page 91
	Rain/light sensor malfunction → page 93
	Windshield wiper malfunction → page 93
	Washer fluid level too low → page 93
	Steering malfunction → page 126
	STOP Do not continue to drive! Tire pressure low → page 251
	STOP Do not continue to drive! Tire Pressure Monitoring System faulty → page 251
	Collision warning deactivated → page 138
	Adaptive cruise control (ACC) not available → page 135
	Lane Assist switched on, but not active → page 139
	Lane Assist switched on, but not active → page 139
	Blind Spot Monitor active → page 141
EPC	Engine control malfunction → page 115
	Exhaust system malfunction → page 220
	Particulate filter clogged with soot → page 219
	Engine RPM limited → page 115
	Transmission malfunction → page 118, → page 123
	Adaptive chassis control (DCC) malfunction → page 128
	Press the brake pedal. → page 123
	Turn signals → page 91
	Speed stored, regulation active → page 133

CRUISE	Speed stored, regulation active → page 130
	Lane Assist active → page 139
	Lane Assist active → page 139
	High beams or headlight flasher → page 88
	Outside temperature is below +39 °F (+4 °C) → page 20
	Start/Stop system active → page 116
	Start/Stop system not available → page 116
	Economical driving condition → page 21
	Service due → page 24
	Engine coolant temperature too high → page 19
	High beam control active → page 88
	Distance warning → page 137
	Cruise control switched on → page 130
	Cruise control system malfunction → page 131
	Adaptive Cruise Control (ACC) regulates, no vehicle driving ahead is detected → page 133
	Adaptive Cruise Control (ACC) regulates, vehicle driving ahead is detected → page 133
	Eco driving mode → page 128
	Comfort driving mode → page 128
	Normal driving mode → page 128
	Individual driving mode → page 128
	Sport driving mode → page 128
	Mobile phone connected via Bluetooth® → page 20

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Driver assistance systems button

📖 Please read the introductory information and heed the Warnings and Notice ⚠ on page 16.

Depending on the equipment, the driver assistance systems button is either located on the turn signal and high beams lever or on the multifunction steering wheel. Using this button, the driver assistance systems can be switched on or off in the **Assist systems** menu.

— Press the button briefly to open the **Assist systems** menu.

— Select the driver assistance system and switch it on or off. A “check mark” indicates if a driver assistance system is switched on.

— Confirm the selection with the **OK/RESET** button in the windshield wiper lever or the **OK** button in the multifunction steering wheel.

Or you can also switch the driver assistance systems on and off in the Infotainment system vehicle settings → page 27. ◁

Service menu

📖 Please read the introductory information and heed the Warnings and Notice ⚠ on page 16.

Depending on the equipment, settings can be applied in the service menu.

Opening the service menu

To open the service menu, select the **Range** information profile in the instrument cluster and press and hold the OK button on the multi-function steering wheel for approximately four seconds. You can now navigate in the menu as usual using the buttons on the multi-function steering wheel.

Resetting the service interval display

Select the **Service** menu and follow the instructions on the instrument cluster display.

Resetting the oil change service

Select the **Reset oil change service** menu and follow the instructions on the instrument cluster display.

Resetting the driving data

Select the **Reset trip** menu and follow the instructions on the instrument cluster display to reset the trip odometer.

Engine code

Select the **Engine code** menu. The engine code will appear in the instrument cluster display.

Setting the time

Select the **Time** menu and set the correct time using the △ or ▽ arrow buttons.

Copyright

Select the **Copyright** menu to access the copyright information. ◁

Service interval display

📖 Please read the introductory information and heed the Warnings and Notice ⚠ on page 16.

Displays about service events appear in the instrument cluster display and in the Infotainment system.

There are different versions of the instrument cluster and Infotainment system; therefore, the versions and appearances of the displays may vary.

Fixed service intervals are specified for vehicles with the **fixed oil change service**.

Intervals are determined individually on vehicles with the **flexible oil change service**. Oil change services only need to be performed if the vehicle requires it. The specific operating conditions and the personal driving style are also taken into consideration. The service early warning message is first displayed 30 days prior to the calculated service due date. The displayed remaining distance to be traveled is always rounded to 60 miles (100 km) and the remaining time is rounded to whole days.

Service notification

If a service or an inspection is due in the near future, a service notification will be displayed when the ignition is switched on.

The specified mileage or time is the distance or time until the next service can be completed.

Service event

When a **service is due** or an **inspection is due**, a warning chime will sound and a wrench symbol 🔧 may appear on the instrument cluster display for a few seconds together with one of the following messages when you switch on the ignition:

— **Inspection now!**

— **Oil change now!**

— **Oil change service and inspection now!**

thorized Volkswagen dealer or authorized Volkswagen Service Facility.

Some menu items can only be accessed when the vehicle is stationary.

Trip data → page 21.

Assistance systems.

Navigation.

Audio.

Telephone.

Vehicle status → page 22.
Views → page 17.
Driver personalization (user selection) → page 30. ◁

Operation using the multi-function steering wheel

Please read the introductory information and heed the Warnings and Notice ⚠ on page 25.

Fig. 17 Right side of the multi-function steering wheel: buttons for operating the menus and information displays in the instrument cluster

Menus cannot be accessed when a priority 1 warning message is displayed → page 22. Some warning messages can be confirmed and dismissed with the [OK] button on the multi-function steering wheel → fig. 17.

Selecting a menu or information display

— Switch the ignition on.

— Driver personalization: select a user.

— If a message or vehicle icon is displayed, press the [OK] → fig. 17 button, repeatedly if necessary.

— To display a menu and to scroll through the menu, press the [◁] or [▷] button → fig. 17.

— To open the displayed menu or information display, press the [OK] button → fig. 17 or wait until the menu or the information display opens automatically after several seconds.

Applying settings in the menus

— Press the [△] or [▽] arrow buttons → fig. 17 in the displayed menu until the desired menu item is marked. The item is marked with a frame around it.

— Press the [OK] → fig. 17 button to apply the desired changes. A "checkmark" indicates if the function or system is activated.

Returning to menu selection

— Press the [◁] or [▷] button → fig. 17.

VIEW button on the multi-function steering wheel

Vehicles with analog instrument cluster:

— You can switch between the current and previous menu using the [VIEW] button → fig. 17.

Vehicles with a digital instrument cluster:

— You can use the [VIEW] button → fig. 17 to switch between the classic display of dials, the large platform without information profiles, and the enhanced view with highlighted information profiles. The classic display shows the large dials on the right and left side, and the selected information profile is displayed in the center. Press and hold the [VIEW] button to select from the preset information profiles in the list:

Classic View without information profiles.

Automatic The information profiles adjust to the selected driving mode. Only for vehicles with Driving Mode Selection.

Preset 1 Individual selection of information profiles

Preset 2 Individual selection of information profiles

Preset 3 Only on vehicles with standard factory-installed navigation system

ℹ If warning messages about malfunctions appear when the ignition is switched on, settings or information displays may not appear as described. If this is the case, have malfunctions corrected by an authorized Volkswagen dealer or authorized Volkswagen Service Facility. ◁

Operation and displays in the Infotainment system

Introduction

This Infotainment system consolidates essential vehicle systems in a central control panel, such as menu settings, radio, or a navigation system.

General information for operation

The relevant information for the settings in the Vehicle settings menu is included in the following section.

System settings and vehicle information display

Depending on the version, you can press the MENU and open the menu vehicle **or** after pressing the button CAR, open the menu settings and tap the respective function keys to display information or to adjust settings:

— Vehicle settings (setup) → page 27.

— Think Blue. Trainer → page 105.

— Depending on vehicle equipment: Performance monitor → page 28.

— Depending on vehicle equipment: Lap timer → page 29.

— Volkswagen Digital Cockpit.

— Active media

— Trip data

— Vehicle status

— Energy consumers

— Radio station selection

WARNING

Driver distraction can cause accidents and injuries. Operating the Infotainment system can distract you from traffic.

- Always drive attentively and responsibly.

After starting the engine when the 12 V vehicle battery is severely drained or is a replacement, system settings (time, date, personal convenience settings, and programming) and user profiles may be adjusted or deleted. Check and correct the settings after the 12 V vehicle battery is sufficiently recharged.

Vehicle settings menu

Please read the introductory information and heed the Warnings and Notice on page 27.

You can switch individual functions and systems on and off and adjust settings in the vehicle settings menu in the Infotainment system.

Opening the Vehicle settings menu

— Switch the ignition on.

— If necessary, switch the Infotainment system on.

— Depending on how your vehicle is equipped, press the MENU button or function key → page 27 and open the Vehicle menu in the Infotainment system.

— **OR:** Depending on how your vehicle is equipped, press the CAR button or function key.

— Depending on how your vehicle is equipped, open the Settings menu.

— To open other menus in the Settings menu or to adjust settings in the menu items, tap on the respective function keys.

If the checkbox in the function key is activated ☑, that function is switched on.

Tap the ⮌ function key to return to the previous menu.

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If the driver does not respond to this, the system warns the driver with a brief braking action and then becomes passive.

Steering wheel vibration

The following situations may cause the steering wheel to vibrate:

— The corrective steering intervention is not sufficient to keep the vehicle in the lane.

— A lane is no longer detected during a sharp corrective steering intervention by the system. ◁

Troubleshooting

Please read the introductory information and heed the Warnings and Notice ⚠ on page 138.

Malfunction message, system switches off

— Clean the windshield → page 287.

— Check the windshield for damage in the camera lens area.

The system is functioning differently than expected

— The camera view area should be cleaned regularly and kept free of snow and ice.

— Do not cover the camera view area.

— Check the windshield for damage in the camera lens area.

— Do not mount any objects on the steering wheel.

If you are uncertain or have questions, get professional assistance. ◁

"Blind Spot" Monitor

Introduction

Radar sensors monitor the area behind the vehicle. The system measures the distance and difference in speed to other vehicles and informs the driver through visual signals in the exterior mirrors.

System limitations

Only use the "Blind Spot" Monitor on paved roads.

Among other possibilities, the "Blind Spot" Monitor may not interpret the traffic situation correctly in the following situations:

— In tight curves

— When driving in the center of two lanes

— When lanes have different widths

— When the road is raised

— In poor weather conditions

— When there is equipment installed on the side of the road, such as high or offset guard rails

⚠ WARNING

The intelligent technology of the "Blind Spot" Monitor cannot overcome the natural laws of physics and it can only operate within the limits of the system. Do not allow the increased convenience provided by the "Blind Spot" Monitor to tempt you into taking risks. Careless or unintended use of the "Blind Spot" Monitor can cause accidents and serious injuries. The system cannot replace the driver's attention.

- Always adapt your speed and distance to vehicles ahead based on the visual, weather, road, and traffic conditions.
- Always keep your hands on the steering wheel so that you are prepared to steer at any time.
- Pay attention to the indicator lights in the exterior mirrors and in the instrument cluster display and act accordingly.
- Always pay attention to the area around your vehicle.
- Never use the "Blind Spot" Monitor if the radar sensors are dirty, covered, or damaged. The function of the system may be impaired in such cases.
- Sunlight may reduce the visibility of the indicator light in the exterior mirrors.

ℹ Some settings can be saved in the driver personalization user profiles and can be changed automatically when the user account is switched → page 30. ◁

Driving with the "Blind Spot" Monitor

Please read the introductory information and heed the Warnings and Notice ⚠ on page 140.

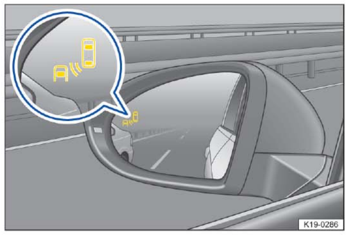

Fig. 115 In the exterior mirror: Blind Spot Monitor indicator.

Switching on and off

— Depending on the equipment, use the button for driver assistance systems → page 26.

— **OR:** use the Assist systems menu in the instrument cluster.

— **OR:** depending on the equipment, go to the Driver assistance menu in the Infotainment system → page 27.

When the "Blind Spot" Monitor is ready for operation, the yellow indicator light turns on one time briefly in the mirrors.

The last saved system setting is also kept after the ignition is switched off and back on.

System function

The activated "Blind Spot" Monitor is active at speeds above 9 mph (15 km/h).

The faster another vehicle approaches, the sooner the display in the exterior mirror will turn on.

The yellow indicator light → fig. 115 *turns on* in the respective exterior mirror in the following situations:

— When your vehicle is passed.

— When passing another vehicle and the difference in speed between the two vehicles is up to approximately 6 mph (10 km/h). There is no indicator if the passing speed is clearly faster.

If a vehicle was detected in the blind spot and the turn signal on the side where the vehicle was detected is activated → page 140, then the yellow indicator light *flashes*.

On vehicles with Lane Assist, the yellow indicator light will *flash* even without activating the turn signal when leaving a lane if Lane Assist is switched on (Active "Blind Spot" Monitor). You will be notified of a potential critical situation (information level, warning level) with corrective steering. Corrective steering also occurs if the turn signal is activated for the respective side. If the corrective steering is overridden by the driver, an additional warning is given with a steering wheel vibration.

Automatic deactivation

The radar sensors for the "Blind Spot" Monitor switch off automatically if, for example, a permanent obstruction over a radar sensor is detected. For example, this could be from ice or snow covering the radar sensor.

A message will appear in the instrument cluster display.

If the "Blind Spot" Monitor was deactivated automatically, the system can only be reactivated after switching the ignition off and back on. ◁

Troubleshooting

Please read the introductory information and heed the Warnings and Notice ⚠ on page 140.

"Blind Spot" Monitor malfunction

The yellow indicator light turns on.

— Get professional assistance.

System is malfunctioning

— Clean the radar sensors or remove the sticker or attachments from the radar sensors, exterior mirrors, and the bumper → page 287.

— Check if there is any noticeable damage.

The system is functioning differently than expected

There are several possible causes:

— The radar sensors could be dirty. The sensor range could also be impaired by soap residue, coatings, dirt, or snow → page 287.

— The system conditions are not met → page 140.

— The radar sensors could be covered by water.

— The vehicle could be damaged in the radar sensor area, for example from parking barriers.

— The coverage areas of the radar sensors could be blocked by attachments, for example by bicycle carriers.

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— The paint may have been changed or other structural modifications may have bee made near the radar sensors, for example to the front of the vehicle or to the suspension.
— The rear bumper must only be painted with vehicle paint that is approved by Volkswagen. Other types of paint may impair the function or cause it to malfunction.
— The side mirrors may be covered with after-market tinting films. ◁

APPENDIX C

Run Log

Subject Vehicle: **2020 Volkswagen Jetta 1.4T SEL** Date: **7/28/2020**

Test Engineer: **N. Wong**

Notes: A one second average window that covered the period of 0.5 seconds before crossing the lane line to 0.5 seconds after crossing the lane line was used to determine lateral velocity during this testing. For subsequent BSI research testing on other vehicle models, lateral velocity was measured at the moment of steering wheel release, and results were processed per this specification. When the runs for this testing were re-processed per the amended criteria for determining lateral velocity, the lateral velocities measured for most of the Closing Headway and Constant Headway runs included herein did not conform to the tolerance specified. However, the test path given in the test procedure was followed, as confirmed by the SV Path Dev channel.

Run	Test Type	Valid Run	Minimum Distance to POV (ft)	Minimum Distance to Left Lane Edge (ft)	BSI Activated (Y/N)	Contact (Y/N)	Meets Criteria [4]	Notes
33	SV Lane Change Constant Headway	N						Headway
34		N						Headway
35		N						Headway, lateral velocity
36		N						Headway, SV speed
37		N						Headway, lateral velocity
38		N						Lateral velocity
39		Y	0.00	-3.51	N	Y	N	
40		Y	0.00	-3.07	N	Y	N	
41		Y	0.00	-3.27	N	Y	N	

[4] The acceptability criteria listed herein are used only as a guide to gauge system performance, and are identical to the Pass/Fail criteria given in NHTSA's most current Test Procedure in docket NHTSA-2019-0102-0001, BLIND SPOT INTERVENTION SYSTEM CONFIRMATION TEST.

Run	Test Type	Valid Run	Minimum Distance to POV (ft)	Minimum Distance to Left Lane Edge (ft)	BSI Activated (Y/N)	Contact (Y/N)	Meets Criteria 4	Notes
42	SV Lane Change Constant Headway	Y	0.00	-3.17	N	N	N	Data says collision; however, video does not indicate collision. Driver turned vehicle away
43		Y	0.00	-3.14	N	Y	N	
44		Y	0.00	-3.12	N	Y	N	
45		Y	0.00	-3.22	N	Y	N	
46	SV Lane Change Closing Headway	N						POV, SV Speed
47		N						POV, SV Speed,
48		N						POV, SV Speed, Turn Signal
49		N						Speed, POV Lateral
50		Y	2.47	0.13	Y	N	Y	POV lateral good until braking. By time POV brakes, the BSI has already activated.
51		N						POV lateral
52		N						POV headway, speed, lateral
53		N						Speed, POV Lateral
54		N						POV speed
55		N						SV speed
56		Y	3.28	-0.24	Y	N	Y	All valid until POV brakes
57		N						All valid until POV brakes, however POV brakes before BSI
58		Y	3.11	-0.45	Y	N	Y	All valid until POV brakes
59		Y	3.02	-0.22	Y	N	Y	All valid until POV brakes

Run	Test Type	Valid Run	Minimum Distance to POV (ft)	Minimum Distance to Left Lane Edge (ft)	BSI Activated (Y/N)	Contact (Y/N)	Meets Criteria [4]	Notes
60	**SV Lane Change Closing Headway**	Y	3.09	-0.34	Y	N	Y	All valid until POV brakes
61		N						POV speed, lateral
62		N						POV lateral
63		Y	3.41	-0.09	Y	N	Y	All valid until POV brakes
64		Y	3.40	-0.27	Y	N	Y	All valid until POV brakes
1	**SV Lane Change Constant Headway False Positive Baseline**	Y						
2		N						PP issue
3		N						Lateral velocity high
4		N						Lateral velocity high
5		Y						
6		N						Lateral velocity high
7		N						Lateral velocity high
8		N						Lateral velocity high
9		N						SV speed
10		Y						
11		N						Lateral velocity
12		Y						
13		Y						
14		Y						
15		Y						

Run	Test Type	Valid Run	Minimum Distance to POV (ft)	Minimum Distance to Left Lane Edge (ft)	BSI Activated (Y/N)	Contact (Y/N)	Meets Criteria [4]	Notes
16	SV Lane Change Constant Headway False Positive Assessment	N						SV distance to lane line
17		N						SV distance to lane line
18		N						POV distance to lane line
19		N						SV turn signal
20		N						POV speed, headway
21		N						POV speed, headway
22		N						POV speed, headway
23		N						POV speed, headway
24		Y			N		Y	
25		Y			N		Y	
26		Y			N		Y	
27		Y			N		Y	
28		N						Lateral velocity
29		Y			N		Y	
30		Y			N		Y	
31		N						Headway
32		Y			N		Y	

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 both the Subject Vehicle (SV) and Principal Other Vehicle (POV), as well as pass/fail envelopes and thresholds. Plots shown herein are grouped by test type and are presented sequentially within a given test type. The following is a description of data types shown in the time history plots, as well as a description of the color code indicating to which vehicle the data pertain.

Each time history plot consists of data relevant to the test type under consideration, and therefore the data channels plotted vary according to test type. The test types (shown in the plot titles) include:

- SV Lane Change with Constant Headway
- SV Lane Change with Closing Headway
- SV Lane Change with Constant Headway, False Positive Assessment – Baseline
- SV Lane Change with Constant Headway, False Positive Assessment – Evaluation

Time history figures include the following sub-plots:

- SV Turn Signal – Displays the cycling of the SV turn signal indicator. The bold vertical line indicates the time at which the turn signal is activated.

- Headway (ft) – Longitudinal separation between the rear of the SV and the front of the POV. A negative value for headway indicates that the front-most point of the POV is forward relative to the rear-most point of the SV.

- SV/POV Speed (mph) – Indicates the speed of the SV and POV.

- SV Ax (g) (Vehicles for which the BSI system operates using a brake intervention.) – Displays the SV lateral acceleration. A vertical bold line marked “BSI Onset” indicates the time at which BSI intervention first occurred.

- SV SWA (deg) (Vehicles for which the BSI system operates using a steering intervention.) – Displays the SV steer wheel angle as measured by a steer wheel encoder. A vertical bold line marked “BSI Onset” indicates the time at which the BSI intervention first occurred.

- Yaw Rate (deg/sec) – Yaw rate of the SV. A vertical bold line marked “SW Release” indicates the point at which the control of the steering wheel by the robotic controller is released allowing for free response of the vehicle. If the BSI system operates using a steering wheel input, a vertical bold line marked “BSI Onset” indicates the time at which BSI intervention first occurred.

- Lateral Velocity (ft/s) – Lateral velocity of the SV. For the False Positive scenario, the average lateral velocity calculated from half a second before the lane line crossing to half a second after the lane line crossing is noted. For the other scenarios, the lateral velocity at the time of steering wheel release is noted.

- Distance to Lane Line (ft) – For both the SV and POV, the distance from the outer-most (not including side mirrors) part of the vehicle to the edge of the lane line. The minimum distance from the left side of the SV to the adjacent left side lane is shown. A negative value indicates that the SV has crossed over the left side lane line.

- Minimum Distance (ft) – Distance between the outer-most (not including side mirrors) parts of the SV and POV. The minimum distance between the SV and POV is shown on the right of the plot. Note that this is not shown for False Positive Baseline cases.

- SV Path Deviation (ft) – The SV deviation from its intended path.

Envelopes and Thresholds

Some of the time history plot figures 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. Such exceedances indicate either that the test was invalid or that the requirements of the test were not met (i.e., failure of the BSI system).

For plots with green envelopes, in order for the test to be valid, the time-varying data must 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.

For plots with yellow envelopes, the yellow envelope is used to signify an area of interest over which the data is being averaged. The data may exceed the envelope at any point during this envelope with no impact on the test validity.

For SV Lane Change with Constant Headway, False Positive – Evaluation tests only, a dashed boundary line is shown on the yaw rate plot. This dashed boundary line indicates the allowable yaw rate threshold used to determine the presence of a BSI intervention as defined in the test procedure. Exceedances of this boundary will display red text to the right of the plot.

Color Codes

Color codes have been adopted to easily identify which data correspond to which vehicle, as well as to indicate the types of envelopes and thresholds used in the plots.

Color codes can be broken into four categories:

1. Time-varying data
2. Validation envelopes and thresholds
3. Individual data points
4. Text

1. Time-varying data color codes:
    - Blue = Subject Vehicle data
    - Magenta = Principal Other Vehicle data
    - Brown = Relative data between SV and POV (i.e., TTC, lateral distance and headway distance)

2. Validation envelope and threshold color codes:
    - Green envelope = time varying data must be within the envelope at all times in order to be valid
    - Black threshold (Solid) = define points of interest during the run (i.e., steering wheel release, BSI onset, etc.)

3. Individual data point 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

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

Other Notations

- NG – Indicates that the value for that variable was outside of bounds and therefore “No Good”.
- POV – Indicates that the value for the Principal Other Vehicle was out of bounds.
- SV – Indicates that the value for the Subject Vehicle was out of bounds.
- Lane Early – Indicates that the lane change was initiated too early relative to the timing criteria listed for the scenario.
- Lane Late – Indicates that the lane change was initiated too late relative to the timing criteria listed for the scenario.
- Collision – Indicates that the SV and POV collided.

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

Examples of time history plots for each test type (including passing, failing, and invalid runs) are shown in Figures D1 through D3. Time history data plots for the tests of the vehicle under consideration herein are provided beginning with Figure D4.

Notes

A one second average window that covered the period of 0.5 seconds before crossing the lane line to 0.5 seconds after crossing the lane line was used to determine lateral velocity during this testing. For subsequent BSI research testing on other vehicle models, lateral velocity was measured at the moment of steering wheel release, and results were processed per this specification. When the runs for this testing were re-processed per the amended criteria for determining lateral velocity, the lateral velocities measured for most of the Closing Headway and Constant Headway runs included herein did not conform to the tolerance specified. However, the test path given in the test procedure was followed, as confirmed by the SV Path Dev channel.

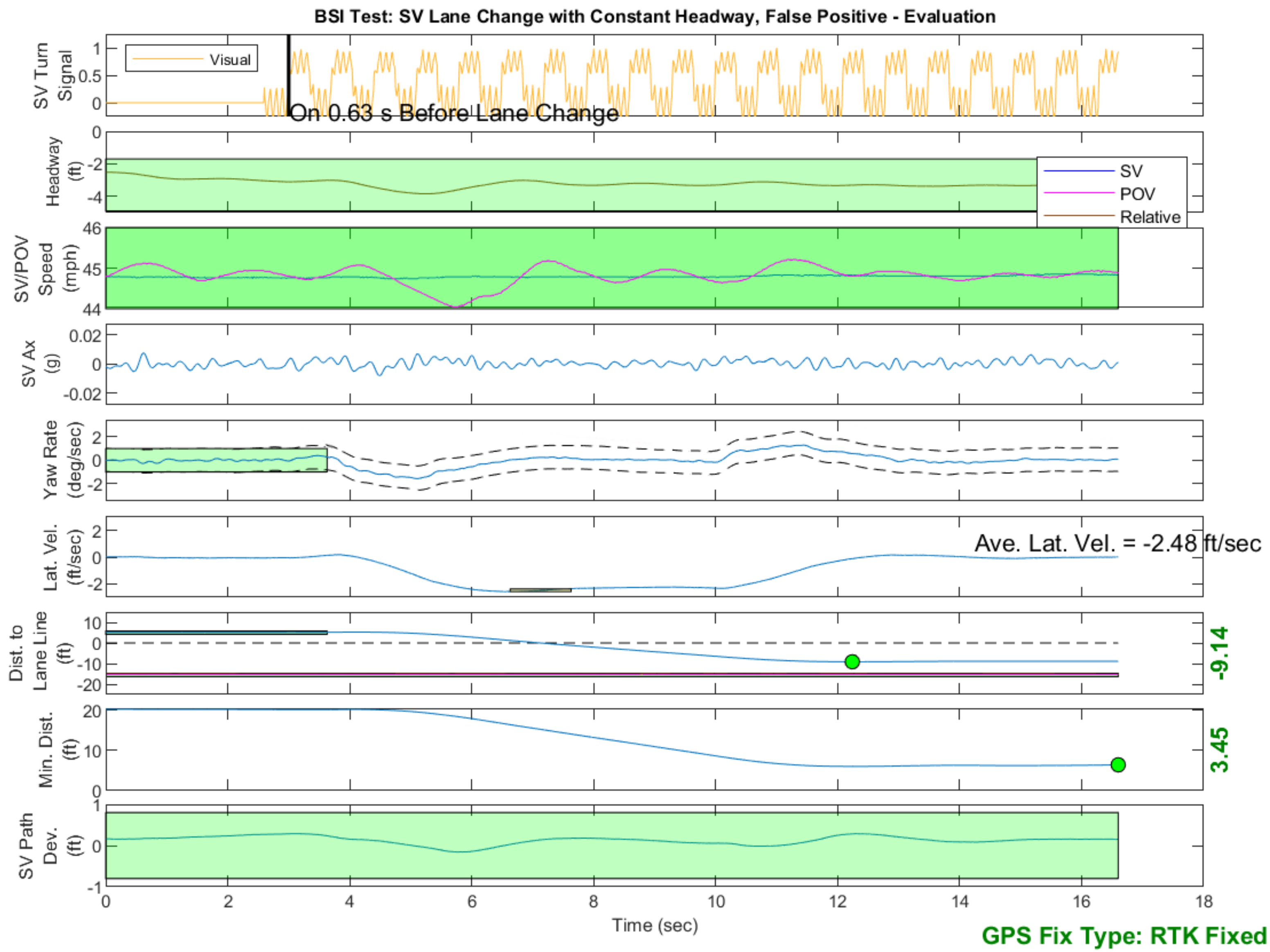

Figure D1. Example Time History for False Positive Evaluation, Passing

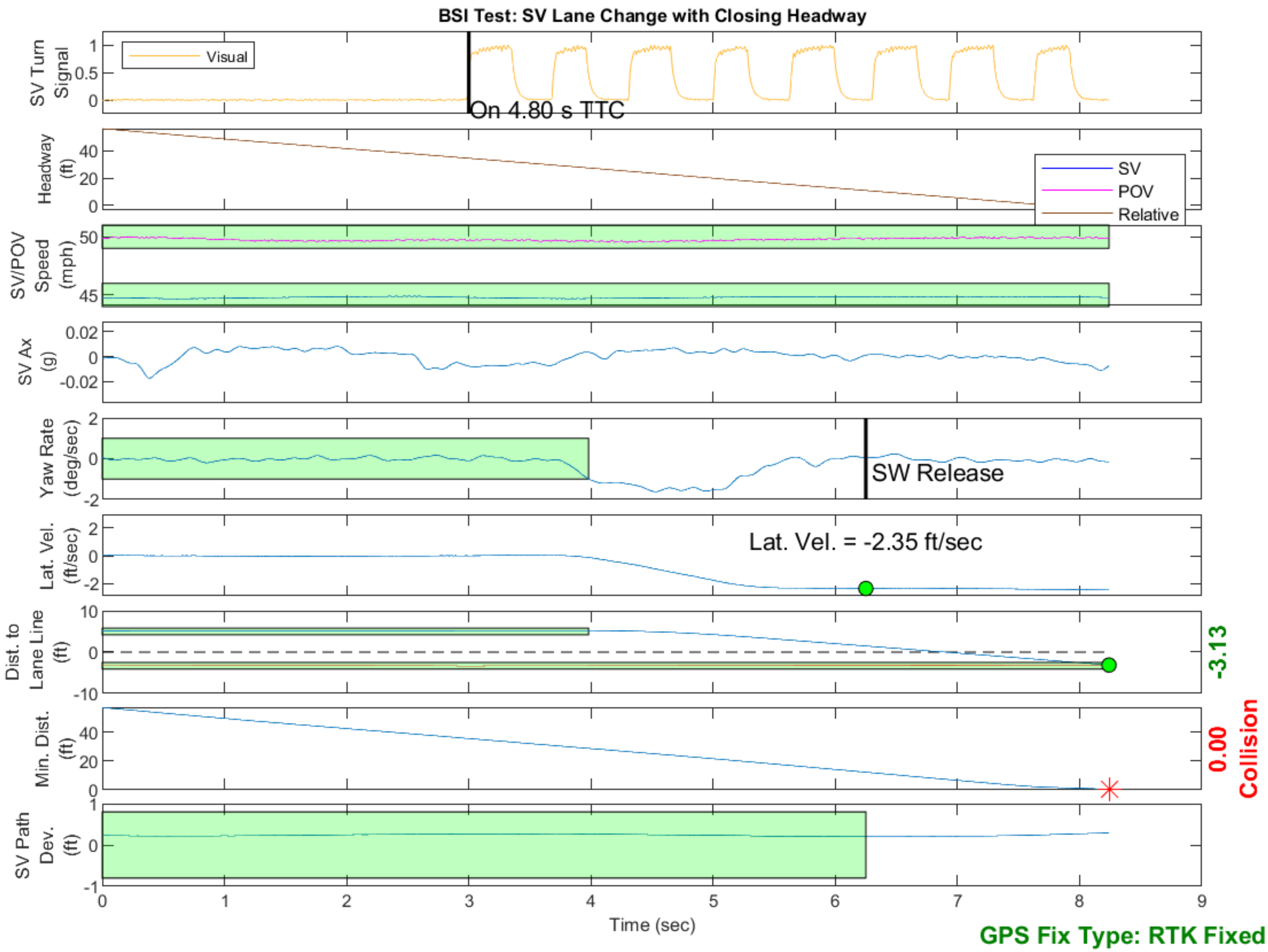

Figure D2. Example Time History for Subject Vehicle with Closing Headway Test, Failing

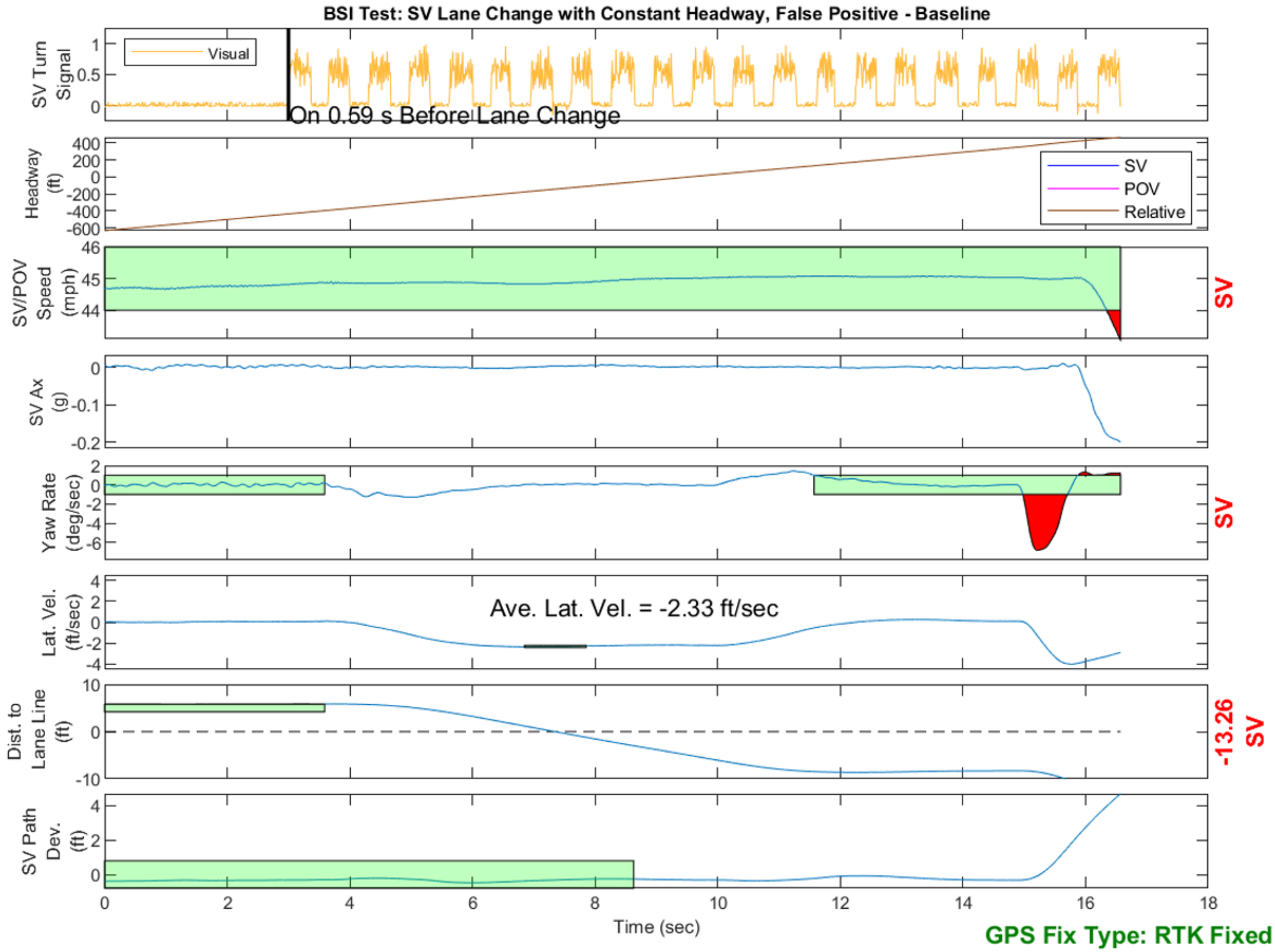

Figure D3. Example Time History for Subject Vehicle with Constant Headway Test, Invalid POV Speed Criteria

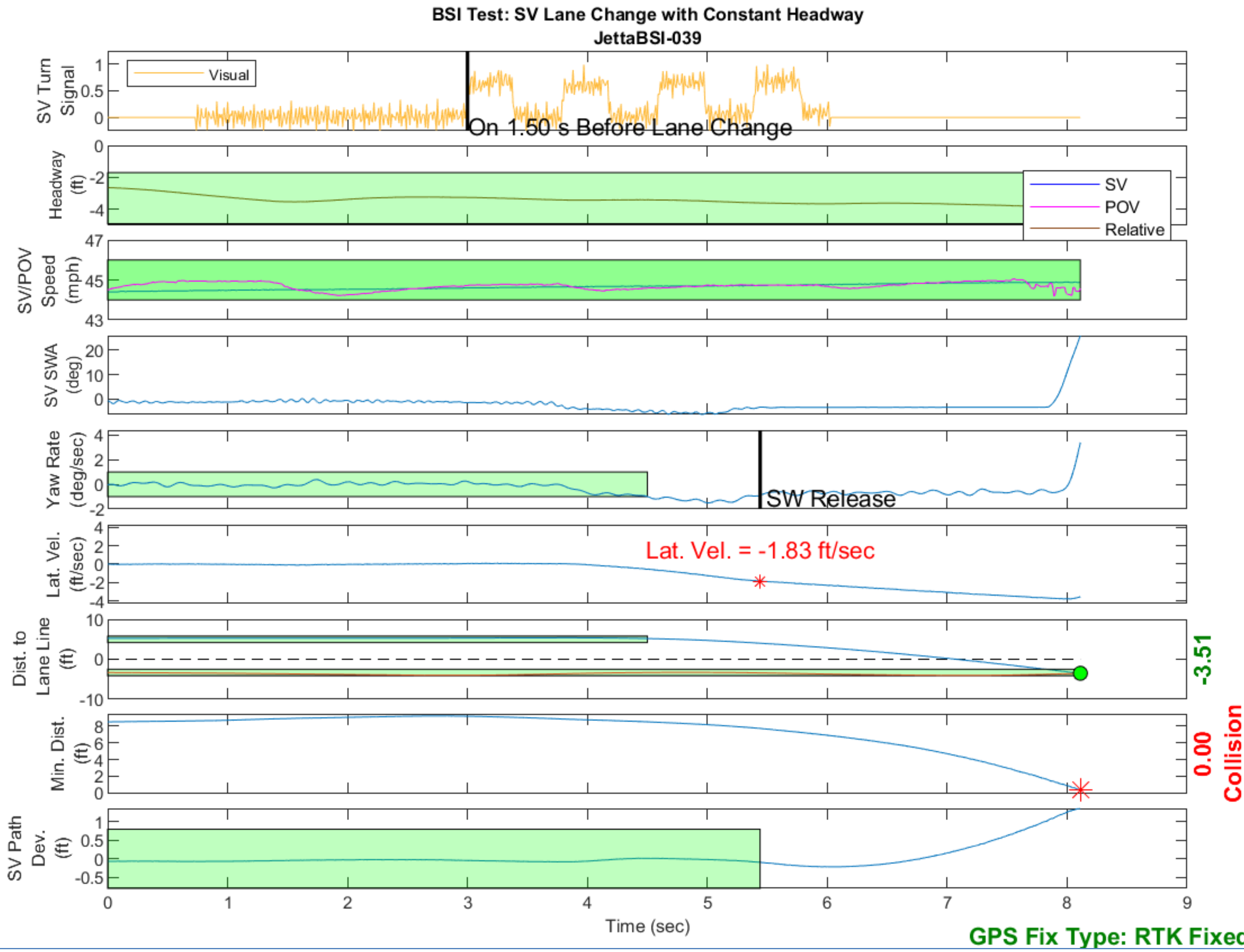

Figure D4. BSI Run 39, Subject Vehicle Lane Change with Constant Headway

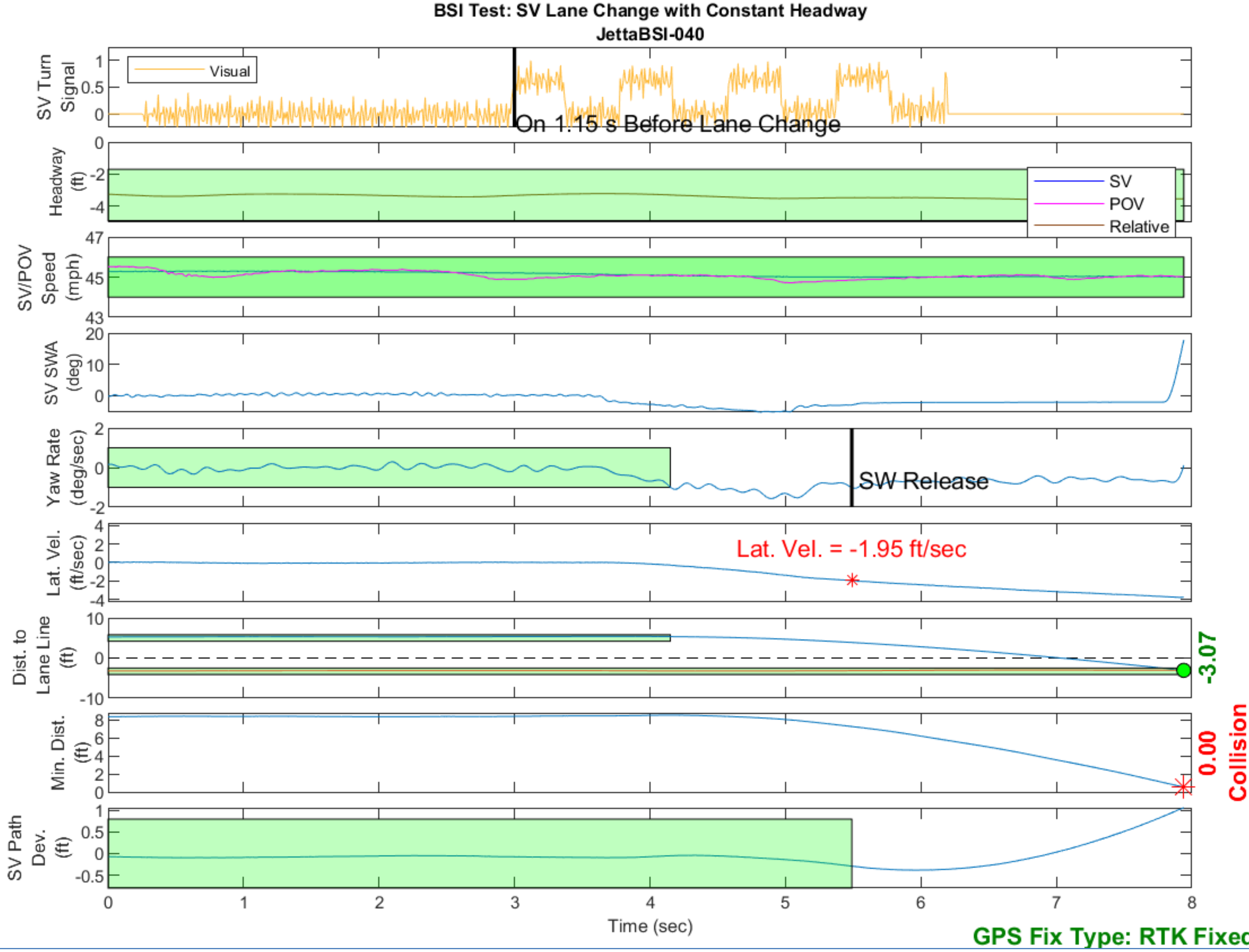

Figure D5. BSI Run 40, Subject Vehicle Lane Change with Constant Headway

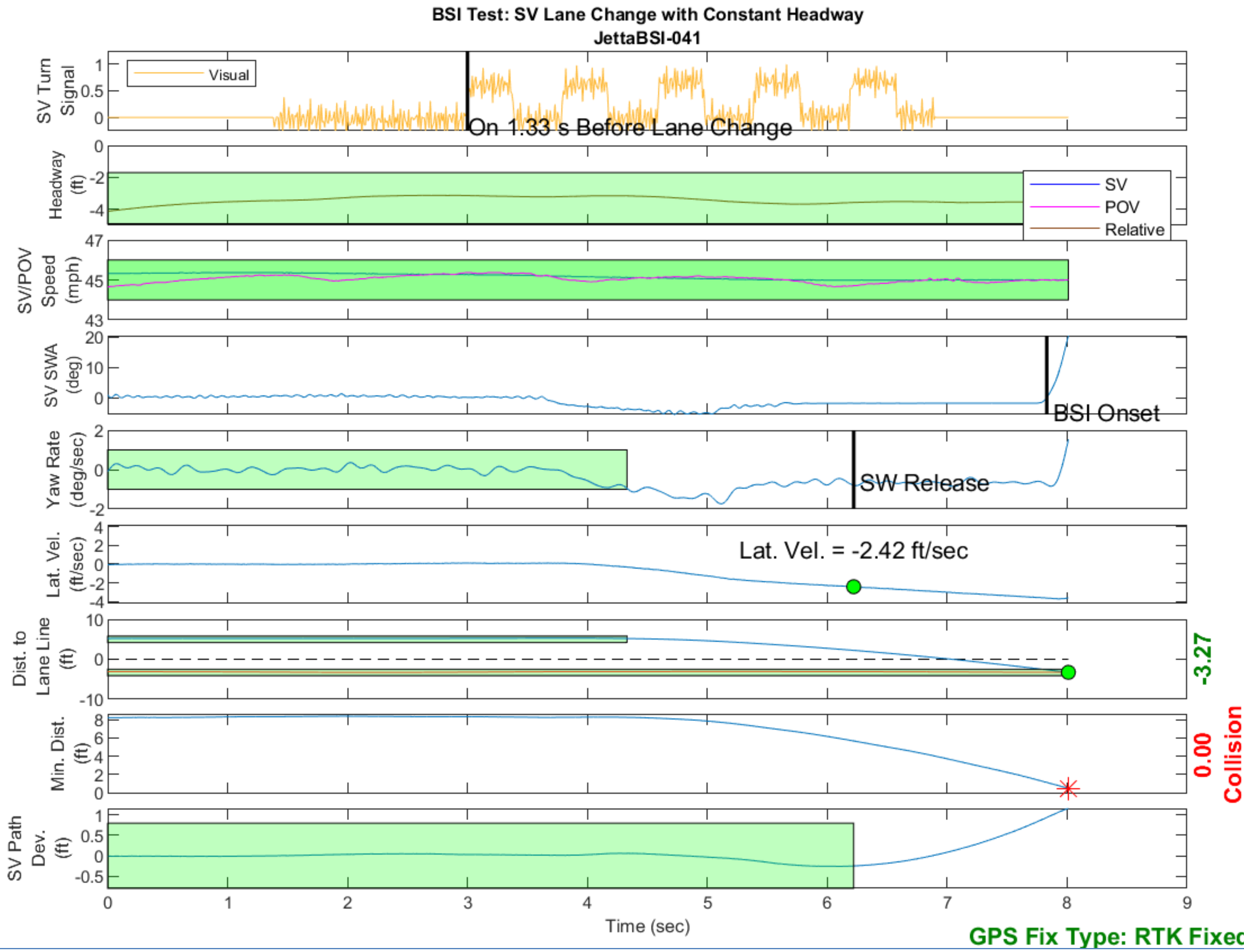

Figure D6. BSI Run 41, Subject Vehicle Lane Change with Constant Headway

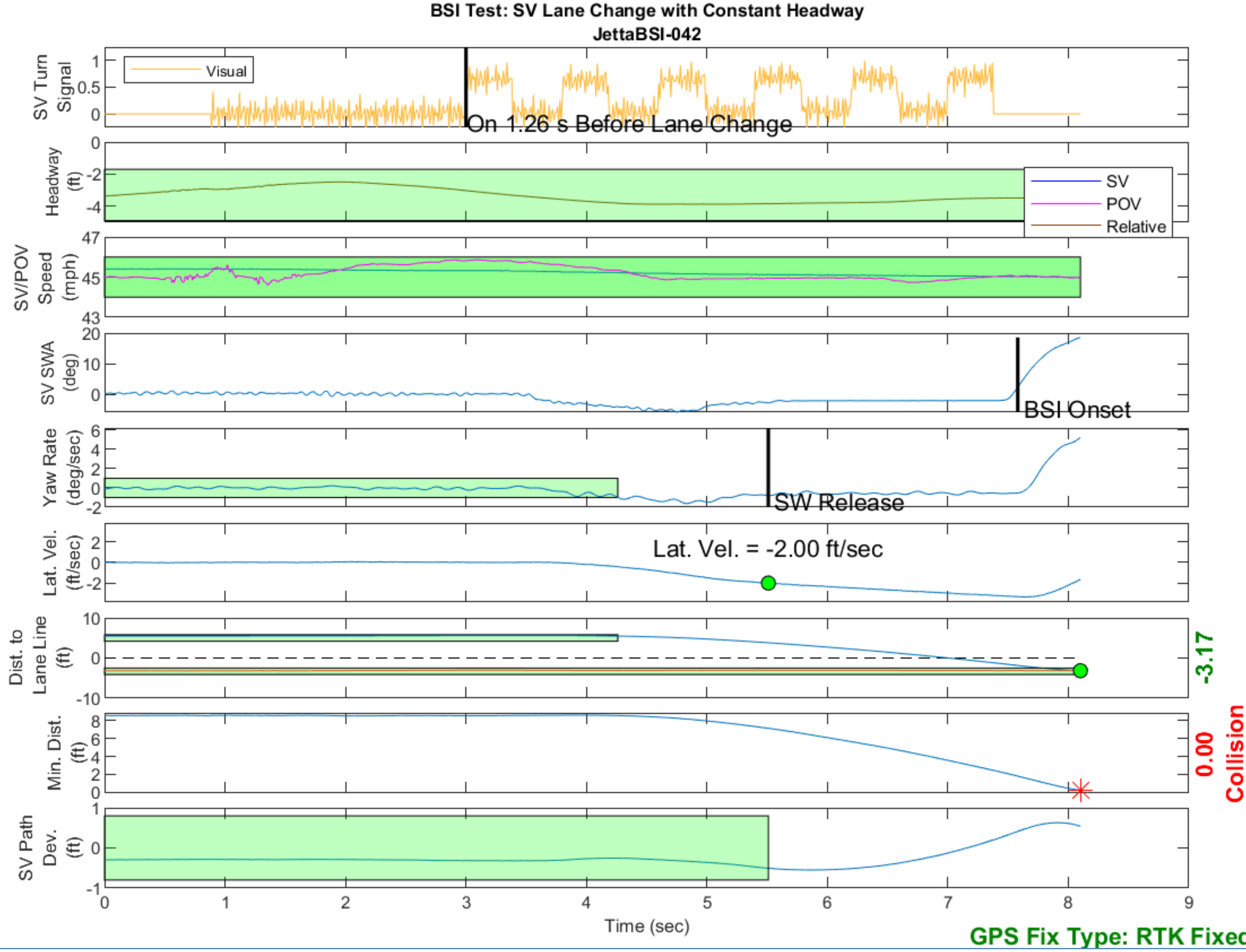

Figure D7. BSI Run 42, Subject Vehicle Lane Change with Constant Headway

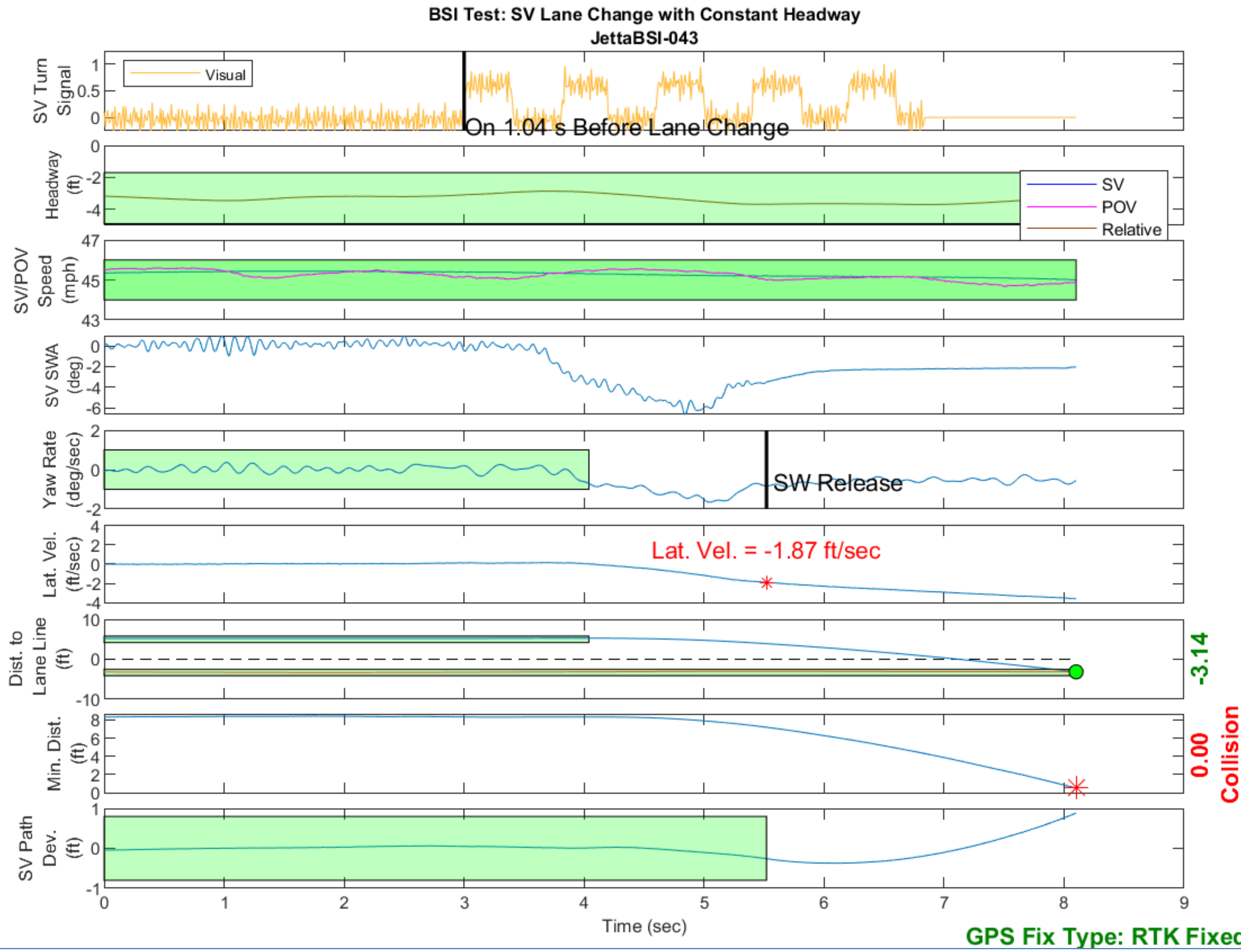

Figure D8. BSI Run 43, Subject Vehicle Lane Change with Constant Headway

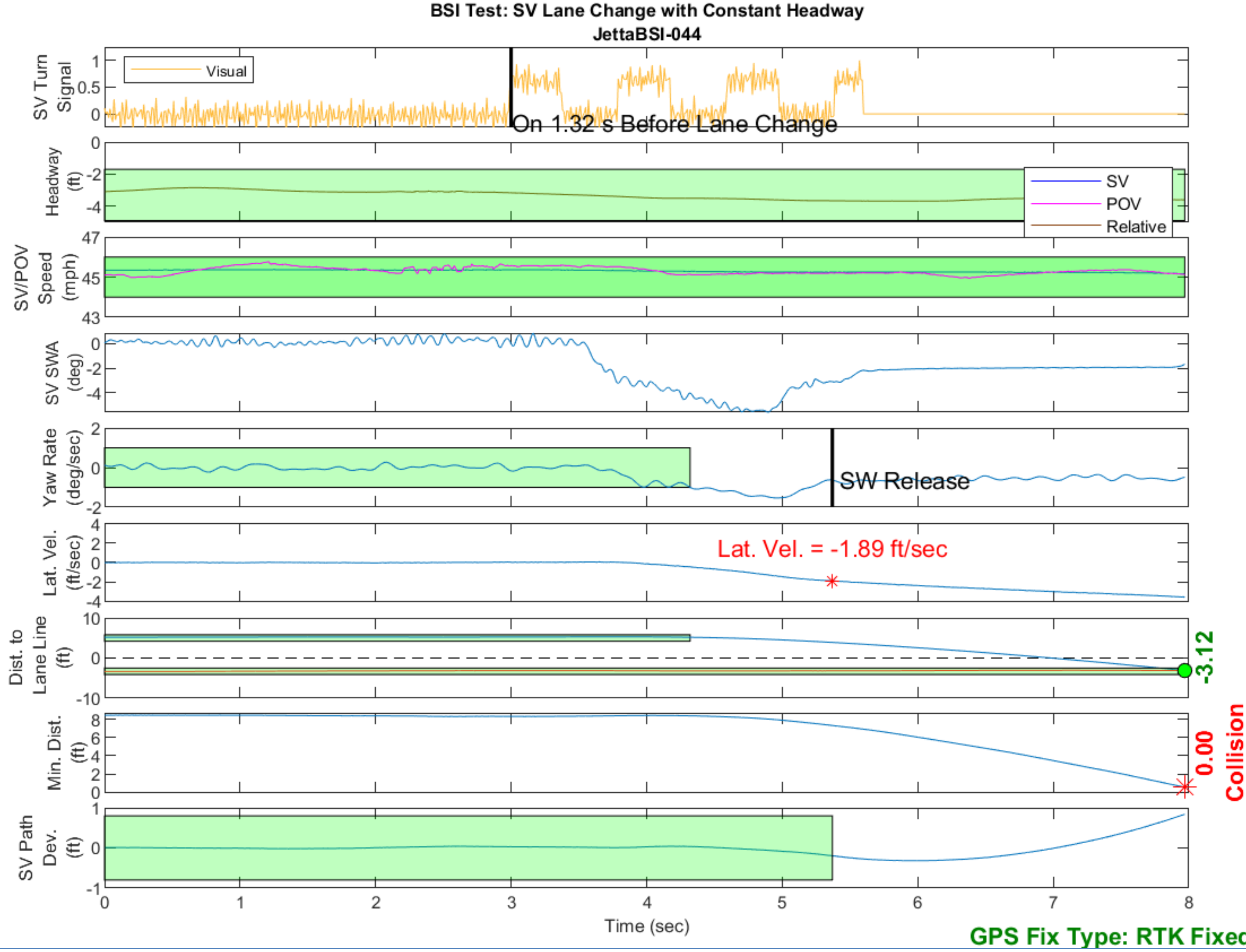

Figure D9. BSI Run 44, Subject Vehicle Lane Change with Constant Headway

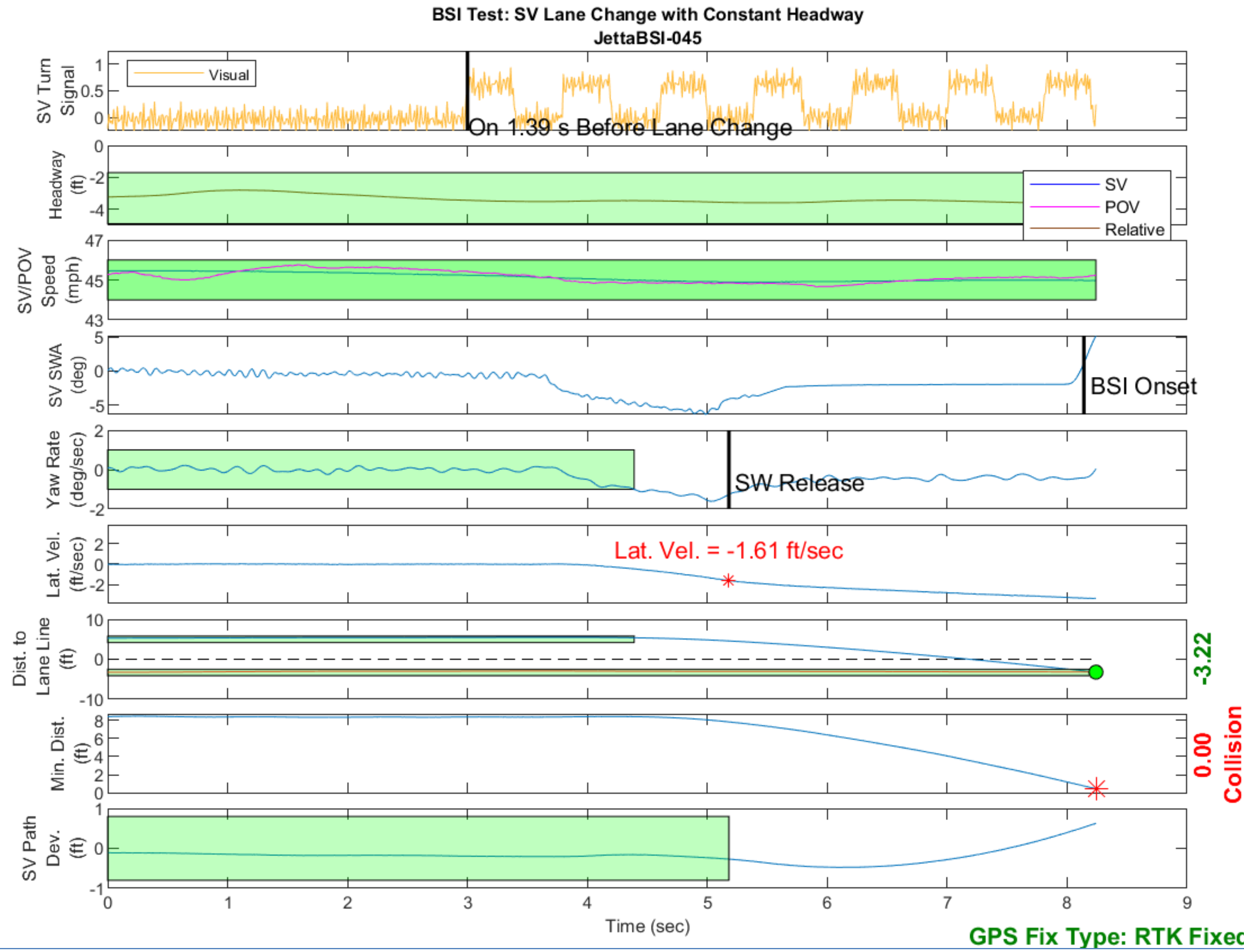

Figure D10. BSI Run 45, Subject Vehicle Lane Change with Constant Headway

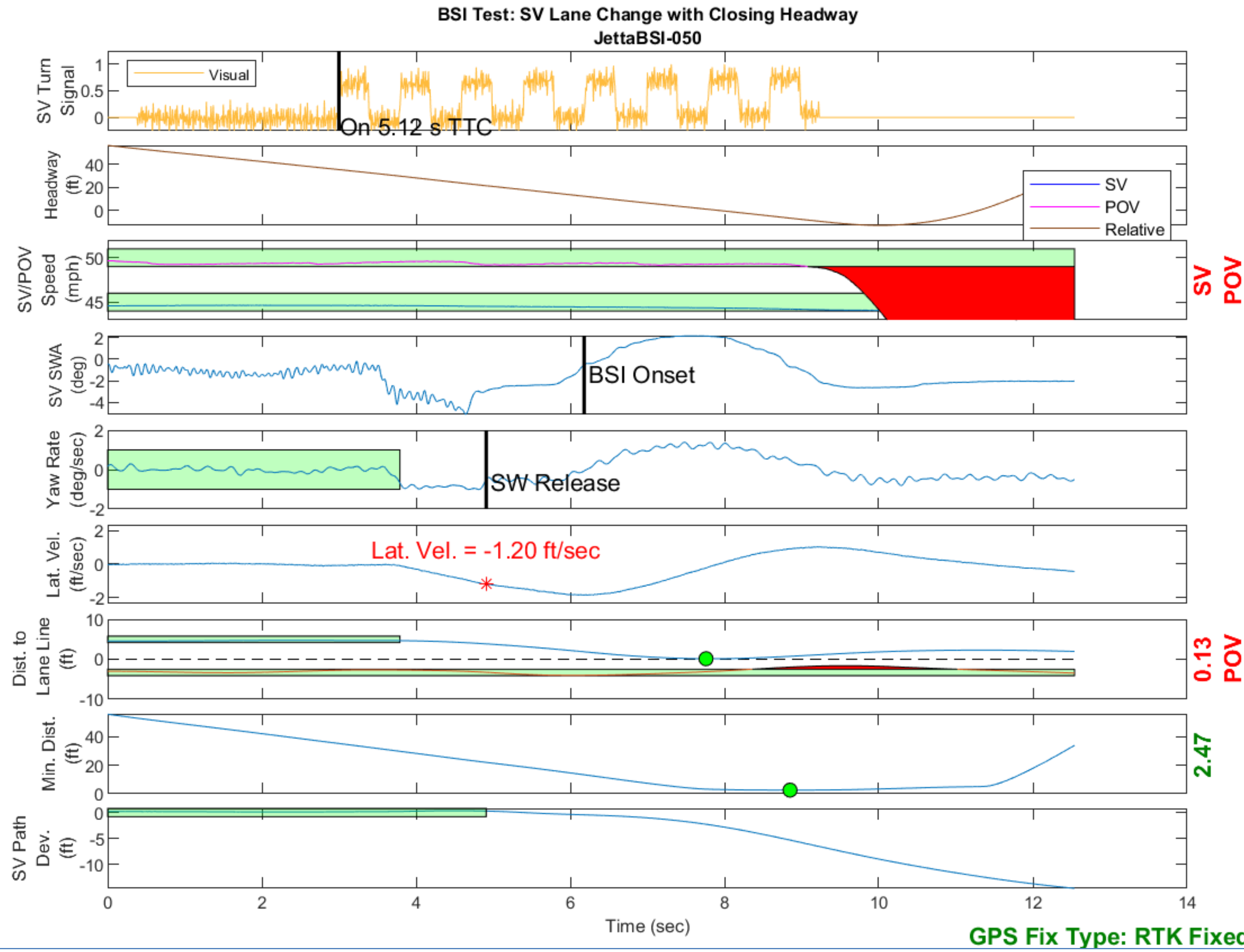

Figure D11. BSI Run 50, Subject Vehicle Lane Change with Closing Headway

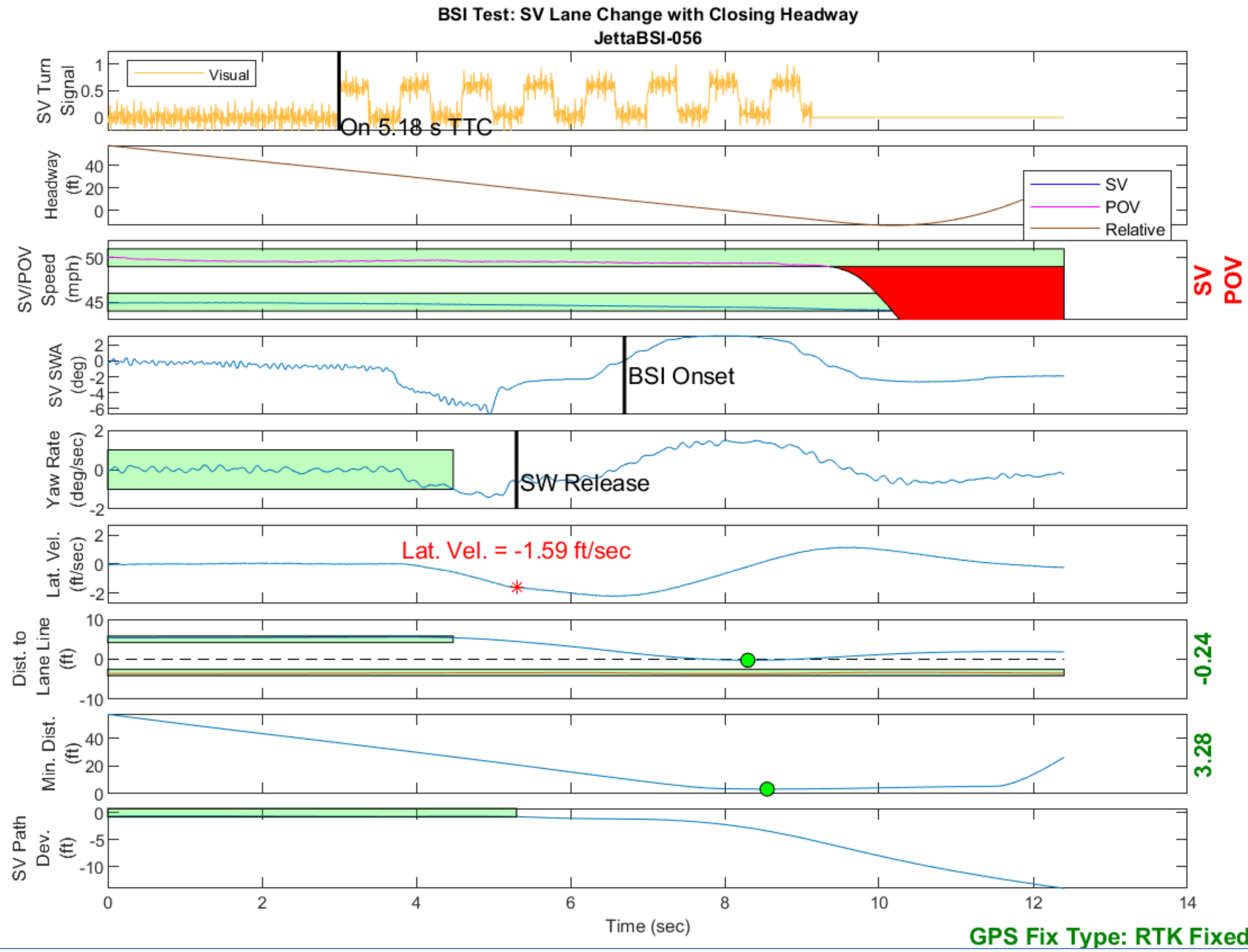

Figure D12. BSI Run 56, Subject Vehicle Lane Change with Closing Headway

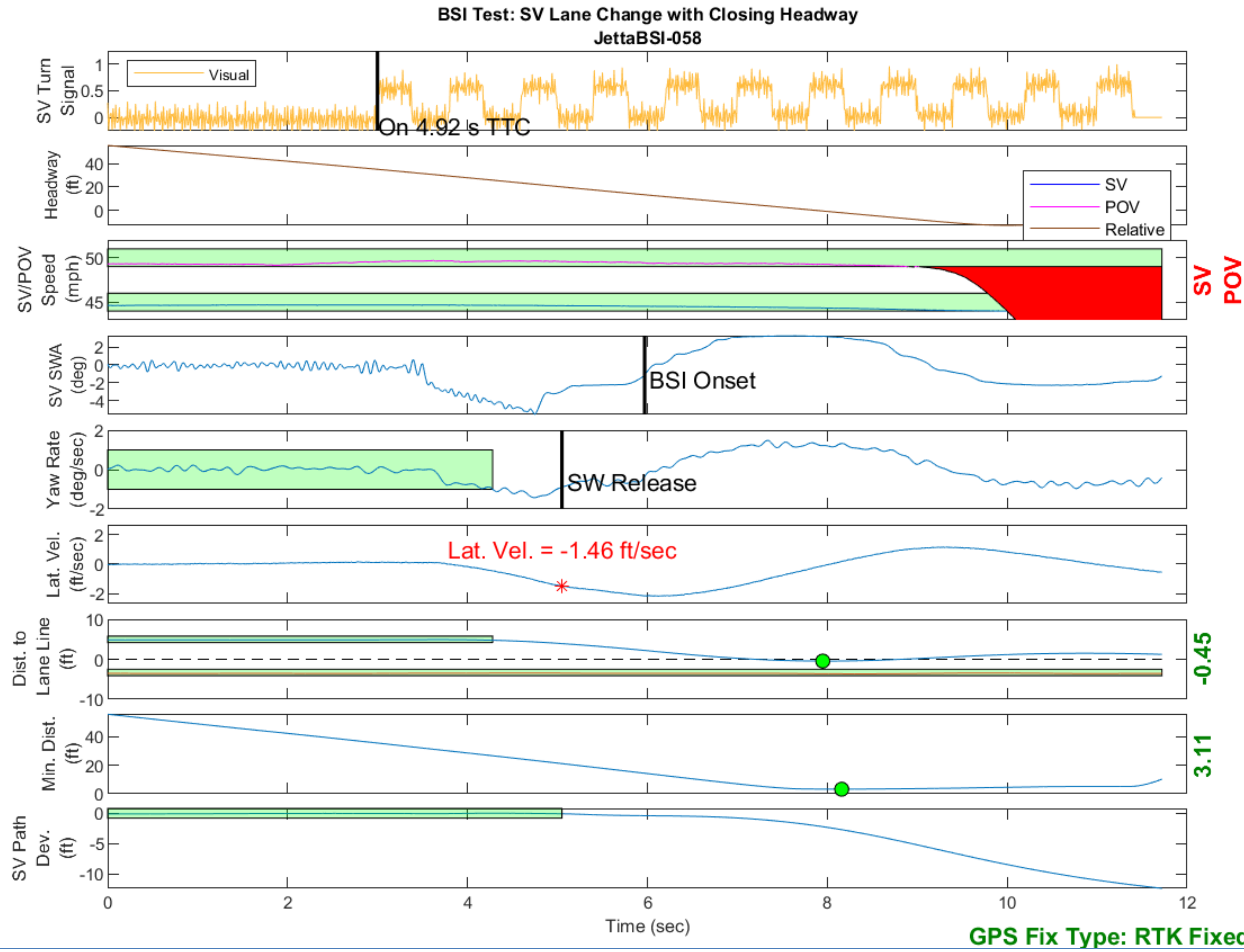

Figure D13. BSI Run 58, Subject Vehicle Lane Change with Closing Headway

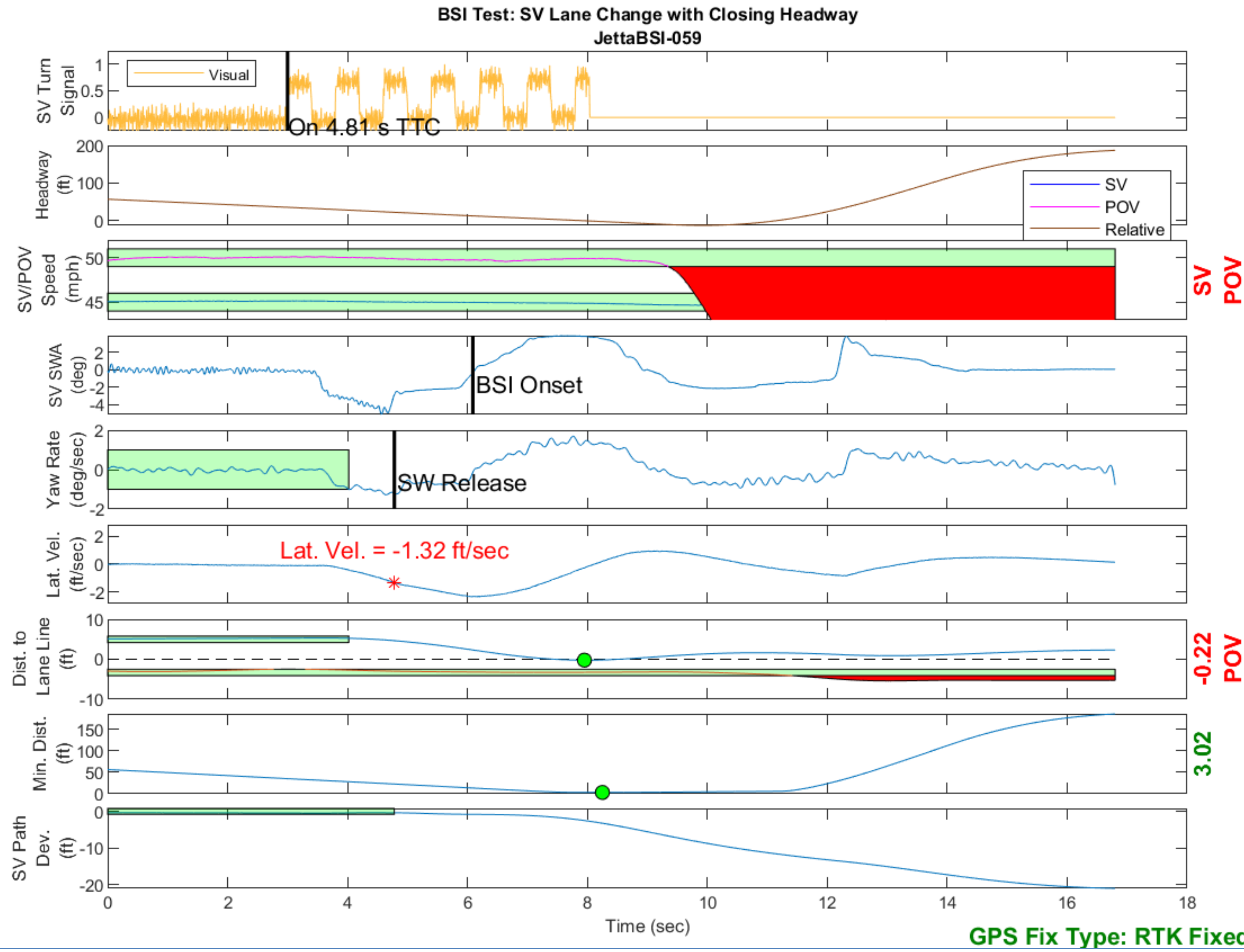

Figure D14. BSI Run 59, Subject Vehicle Lane Change with Closing Headway

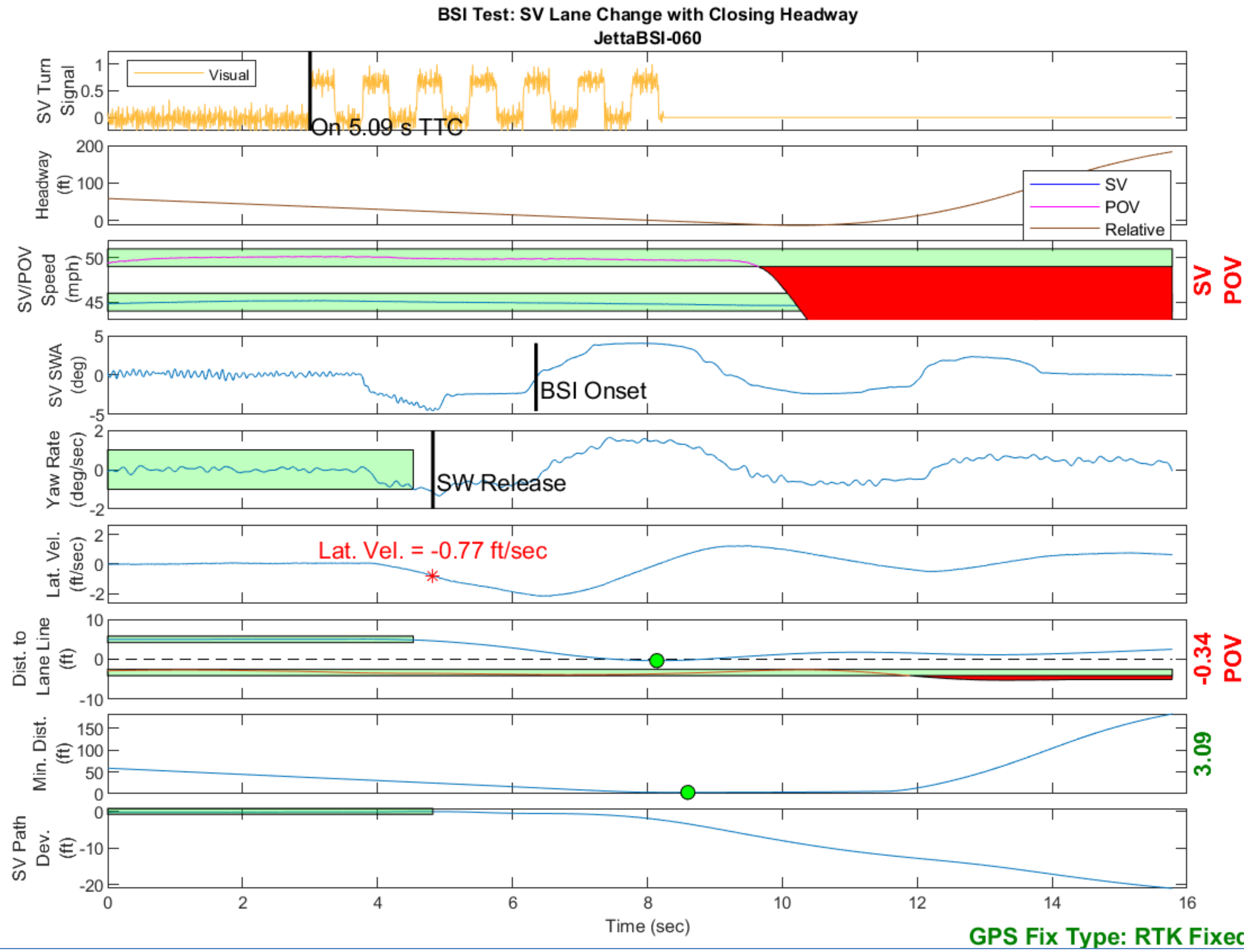

Figure D15. BSI Run 60, Subject Vehicle Lane Change with Closing Headway

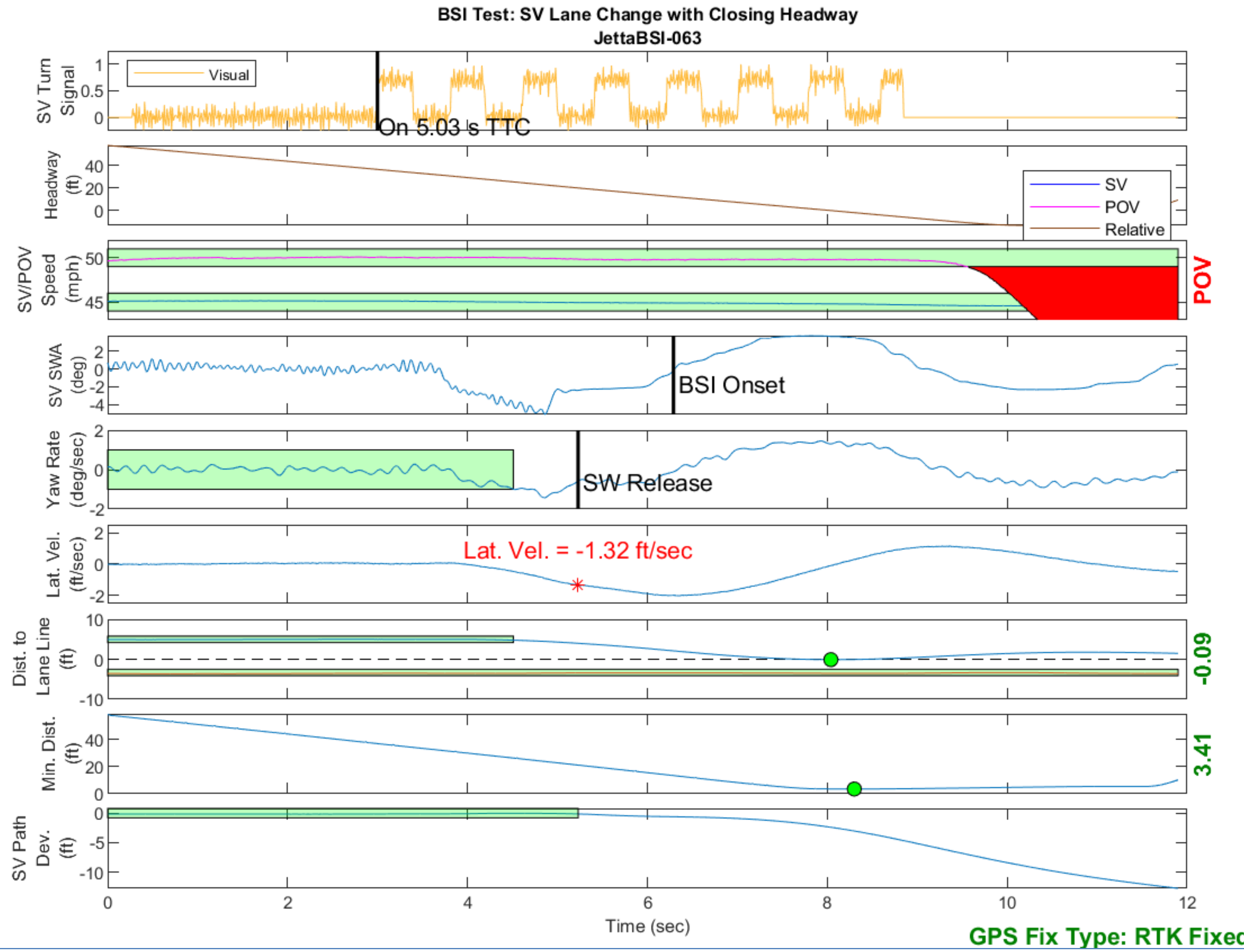

Figure D16. BSI Run 63, Subject Vehicle Lane Change with Closing Headway

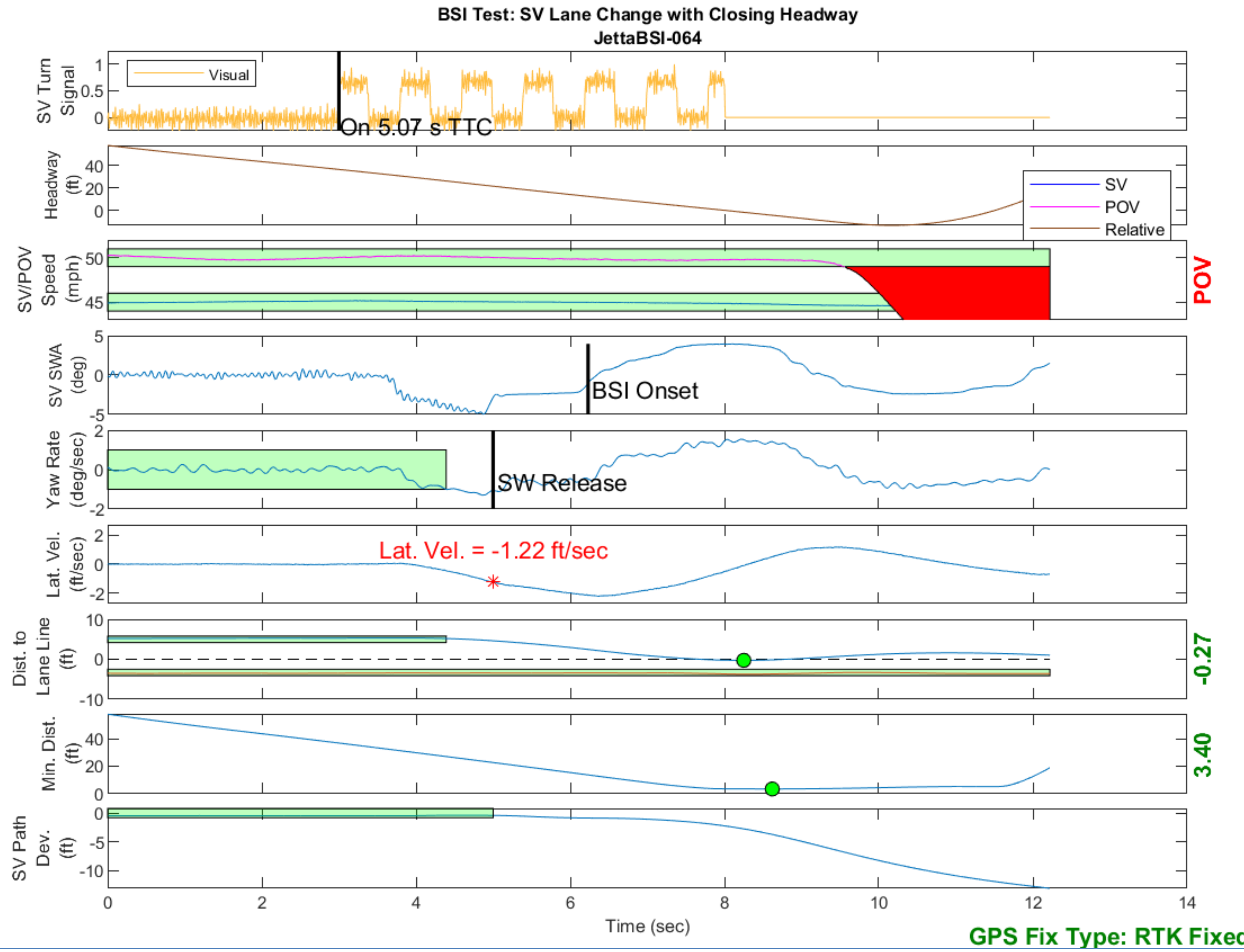

Figure D17. BSI Run 64, Subject Vehicle Lane Change with Closing Headway

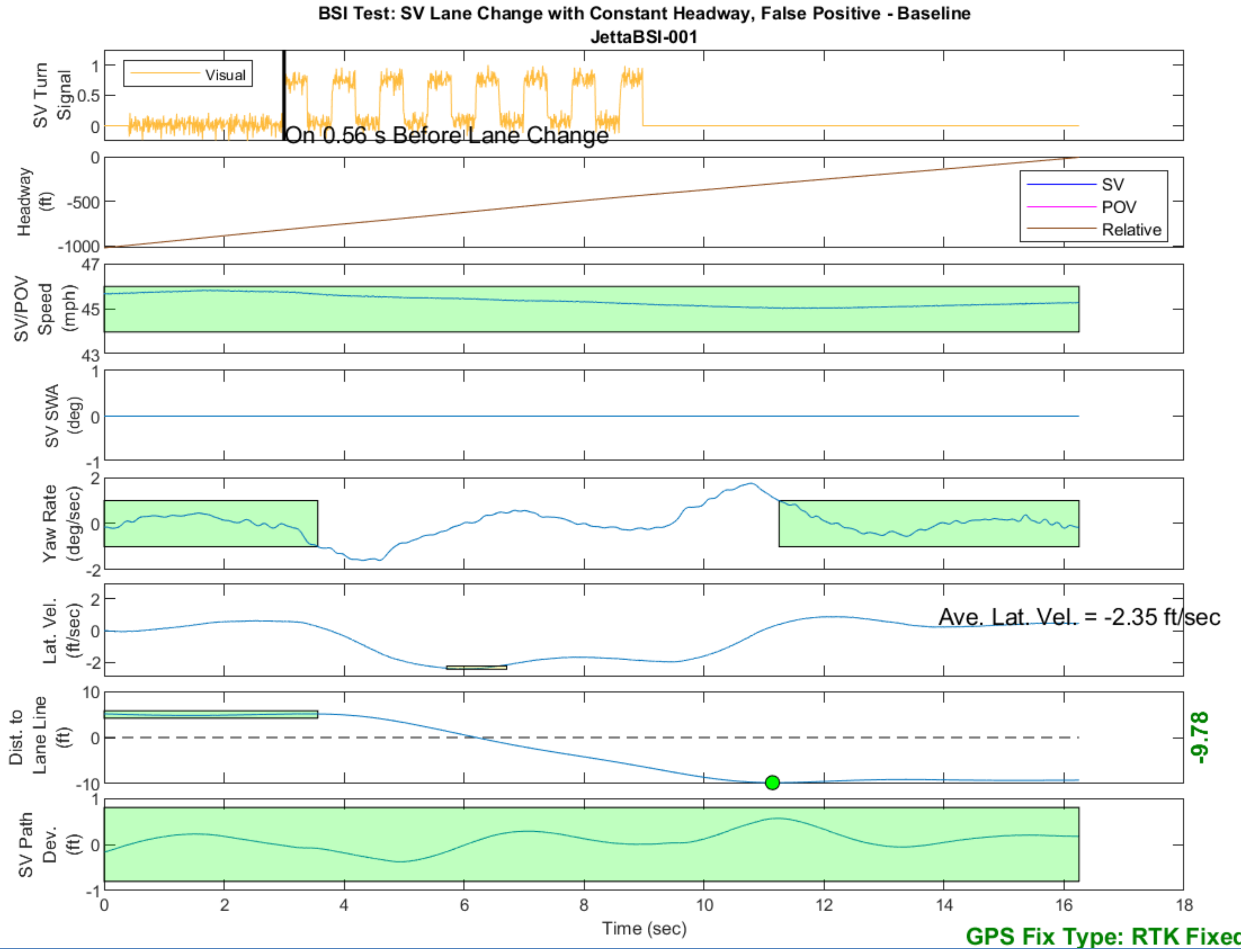

Figure D18. BSI Run 1, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

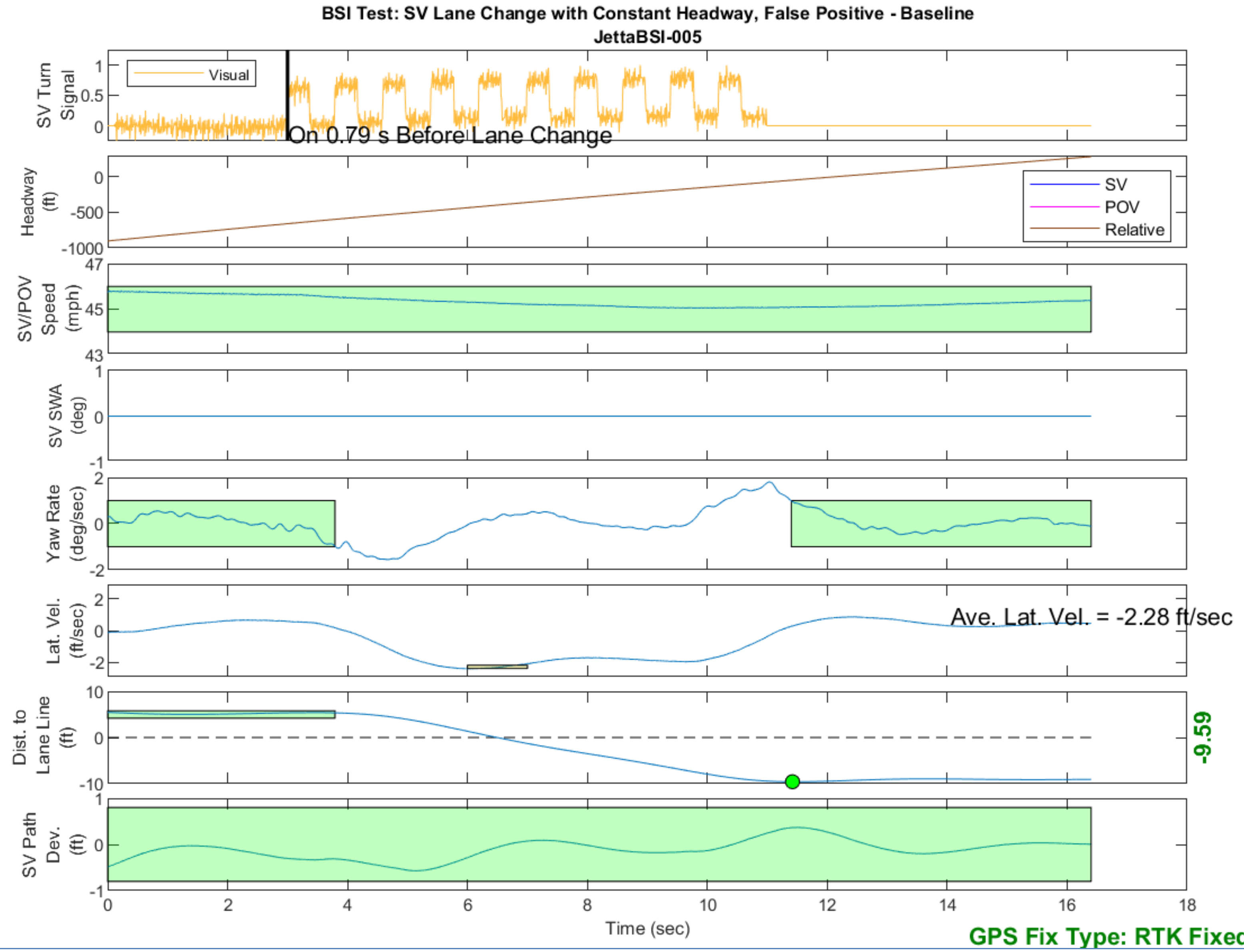

Figure D19. BSI Run 5, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

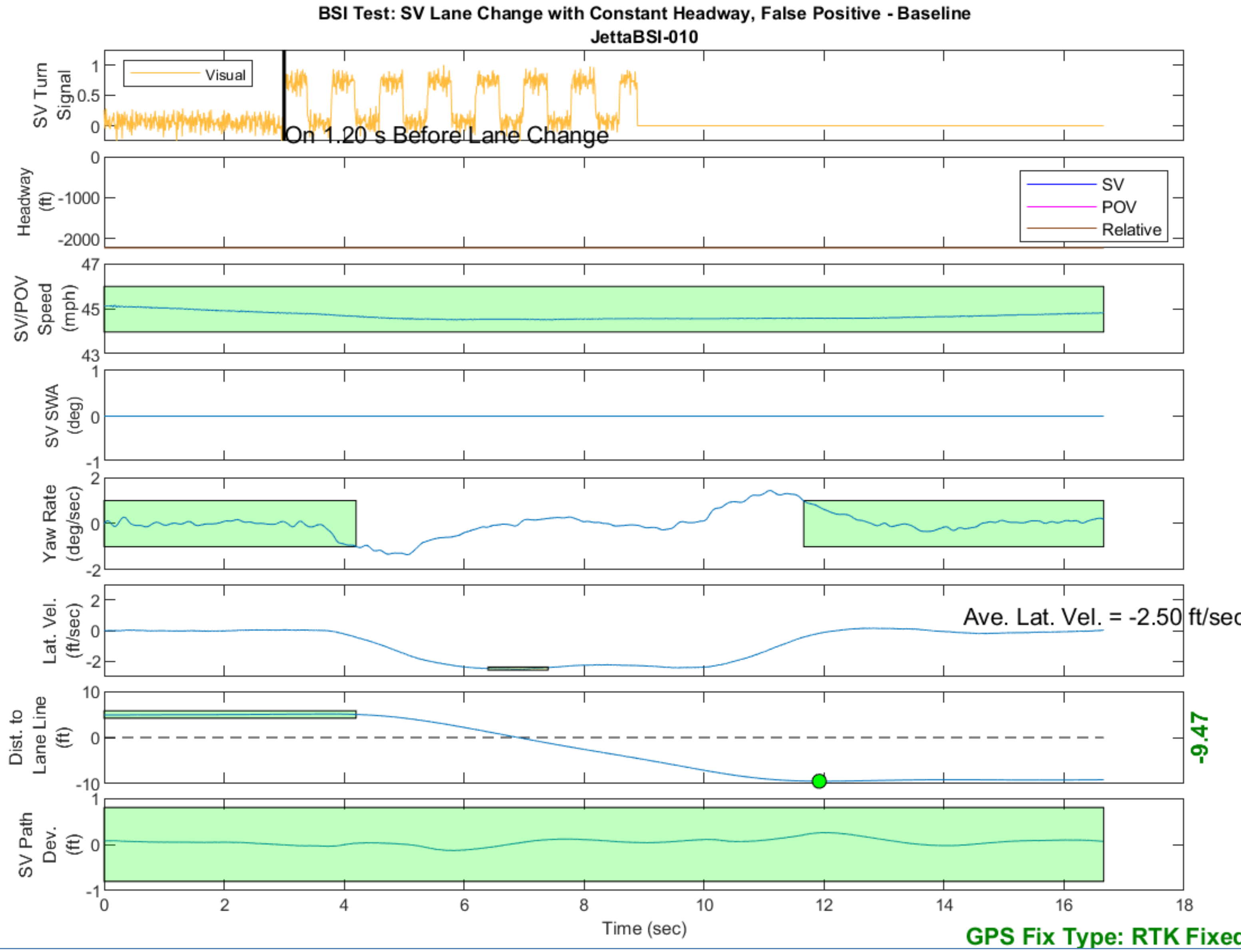

Figure D20. BSI Run 10, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

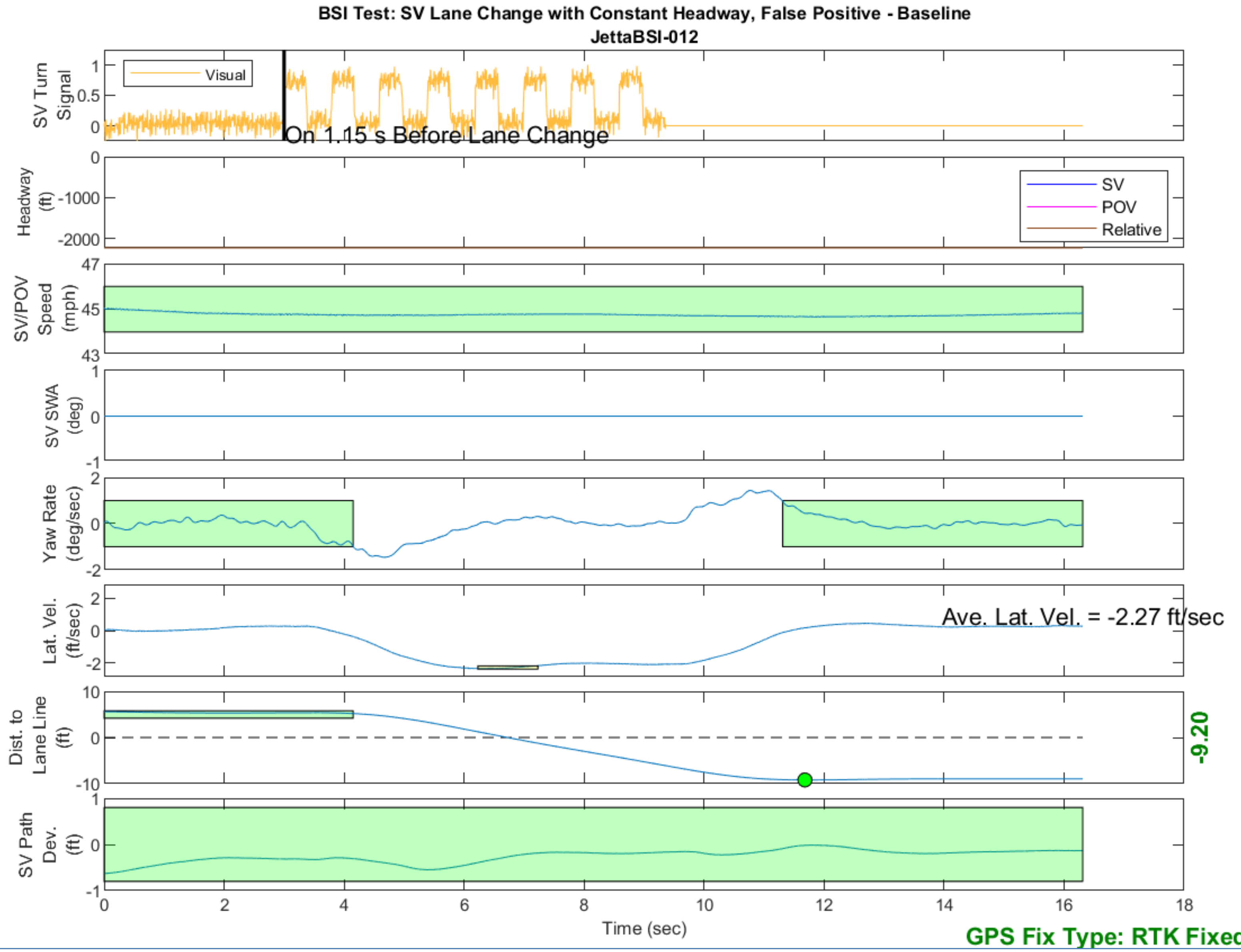

Figure D21. BSI Run 12, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

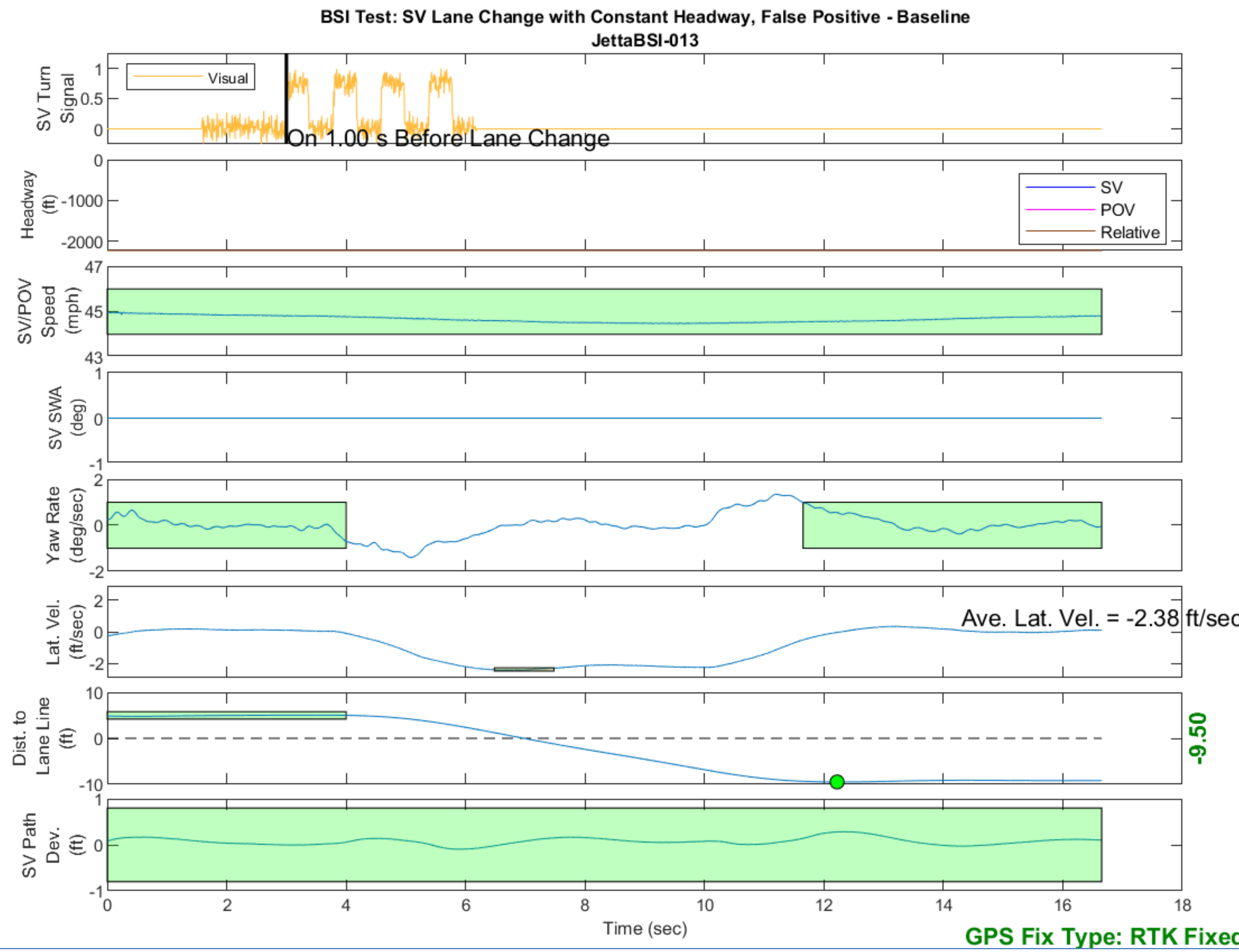

Figure D22. BSI Run 13, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

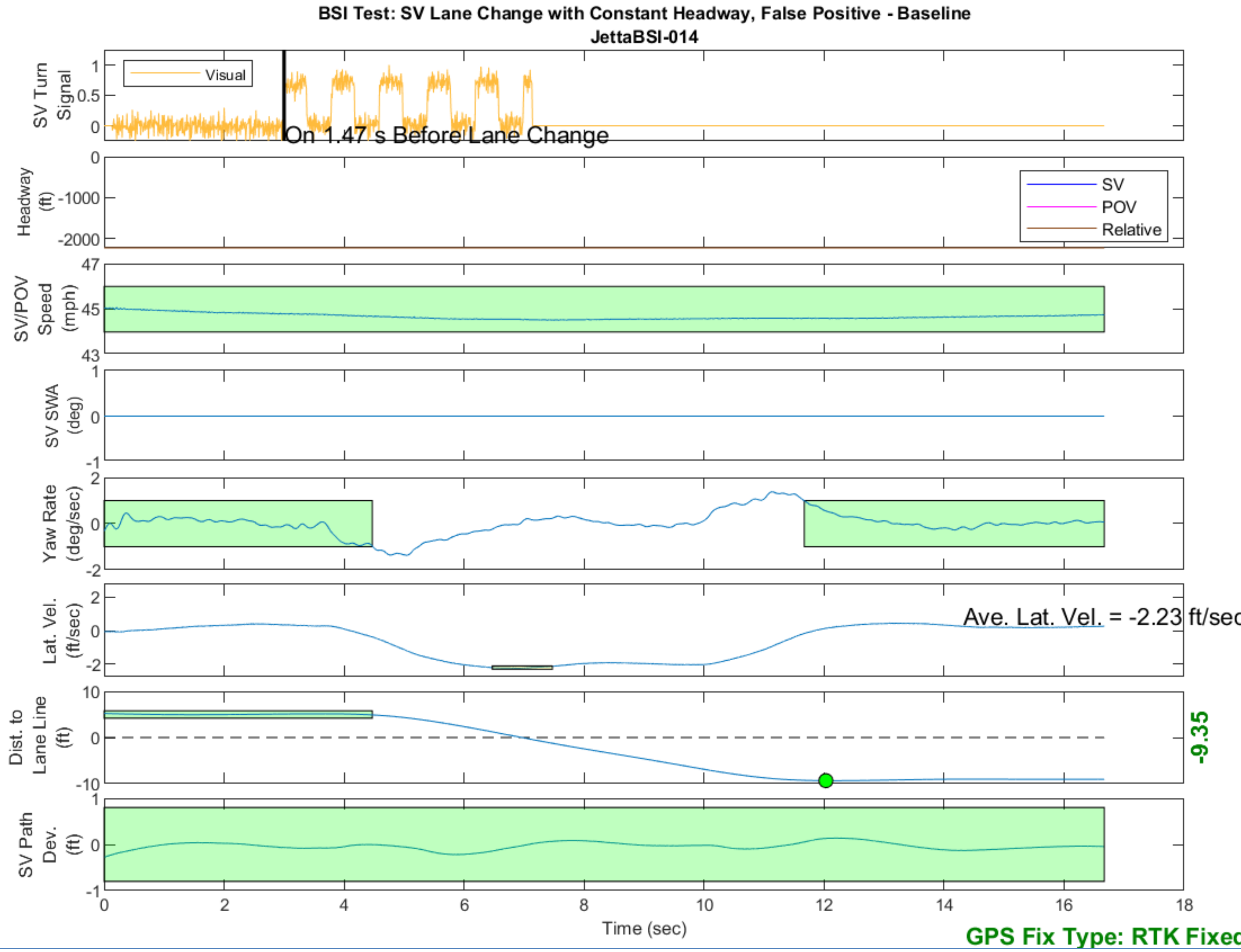

Figure D23. BSI Run 14, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

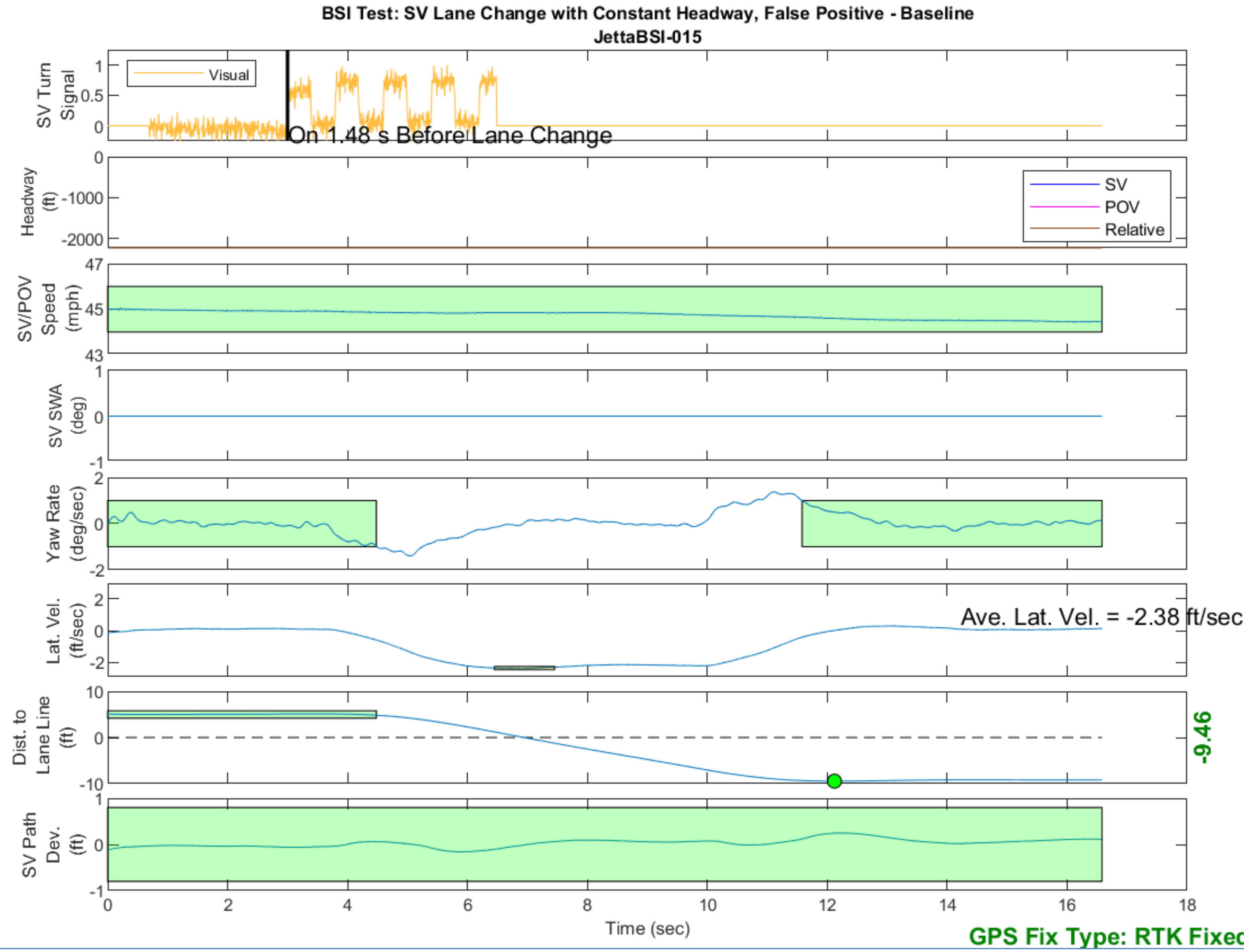

Figure D24. BSI Run 15, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

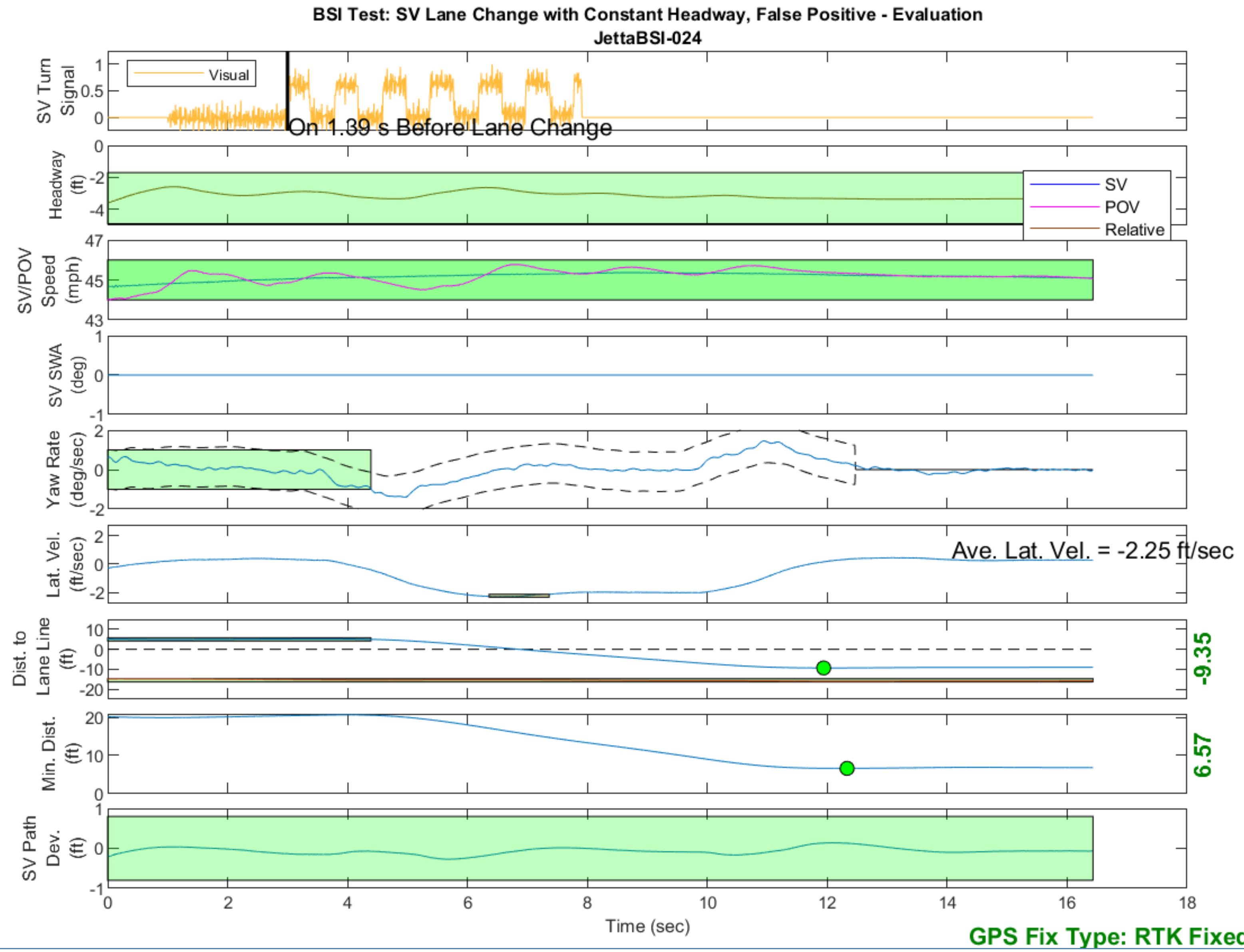

Figure D25. BSI Run 24, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

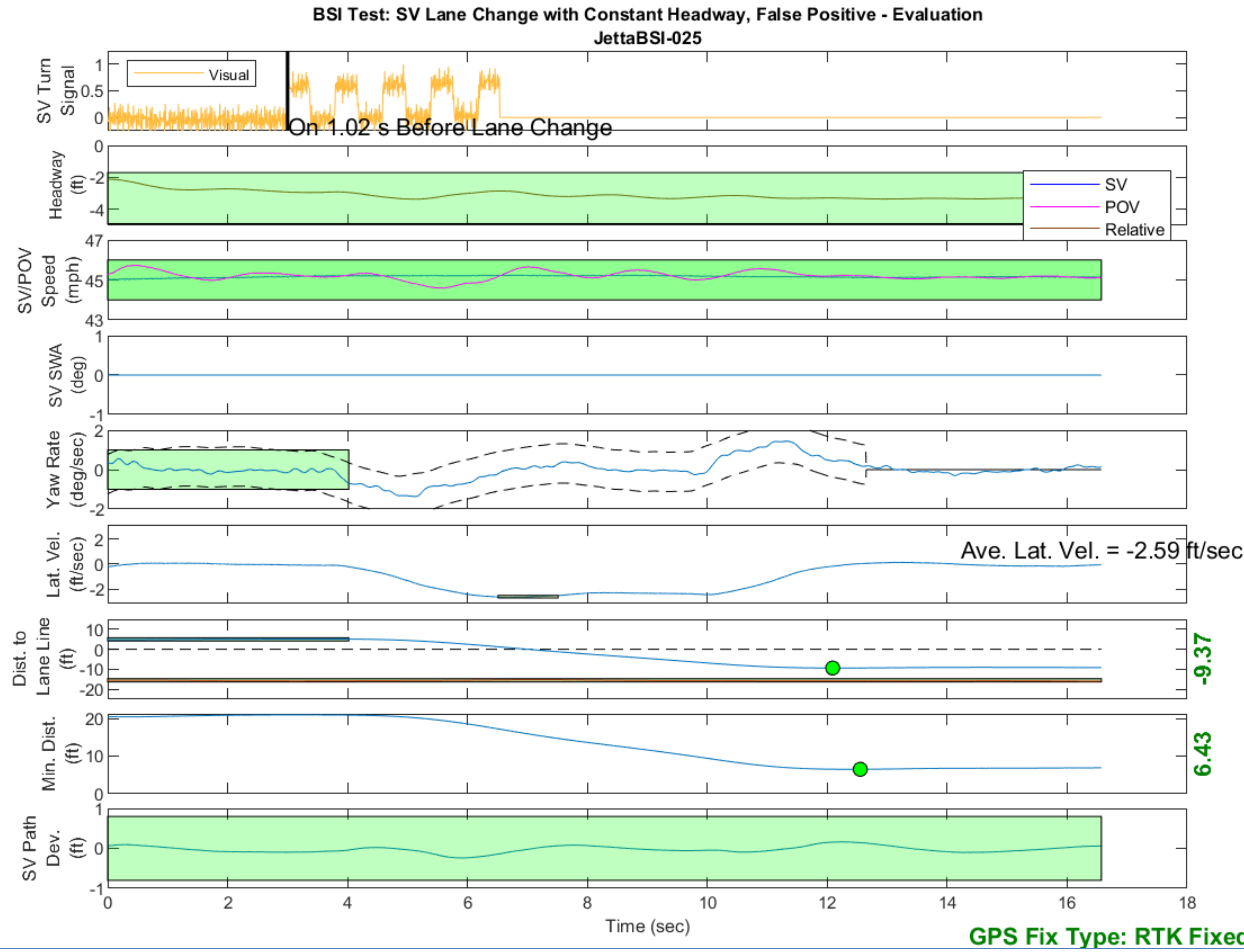

Figure D26. BSI Run 25, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

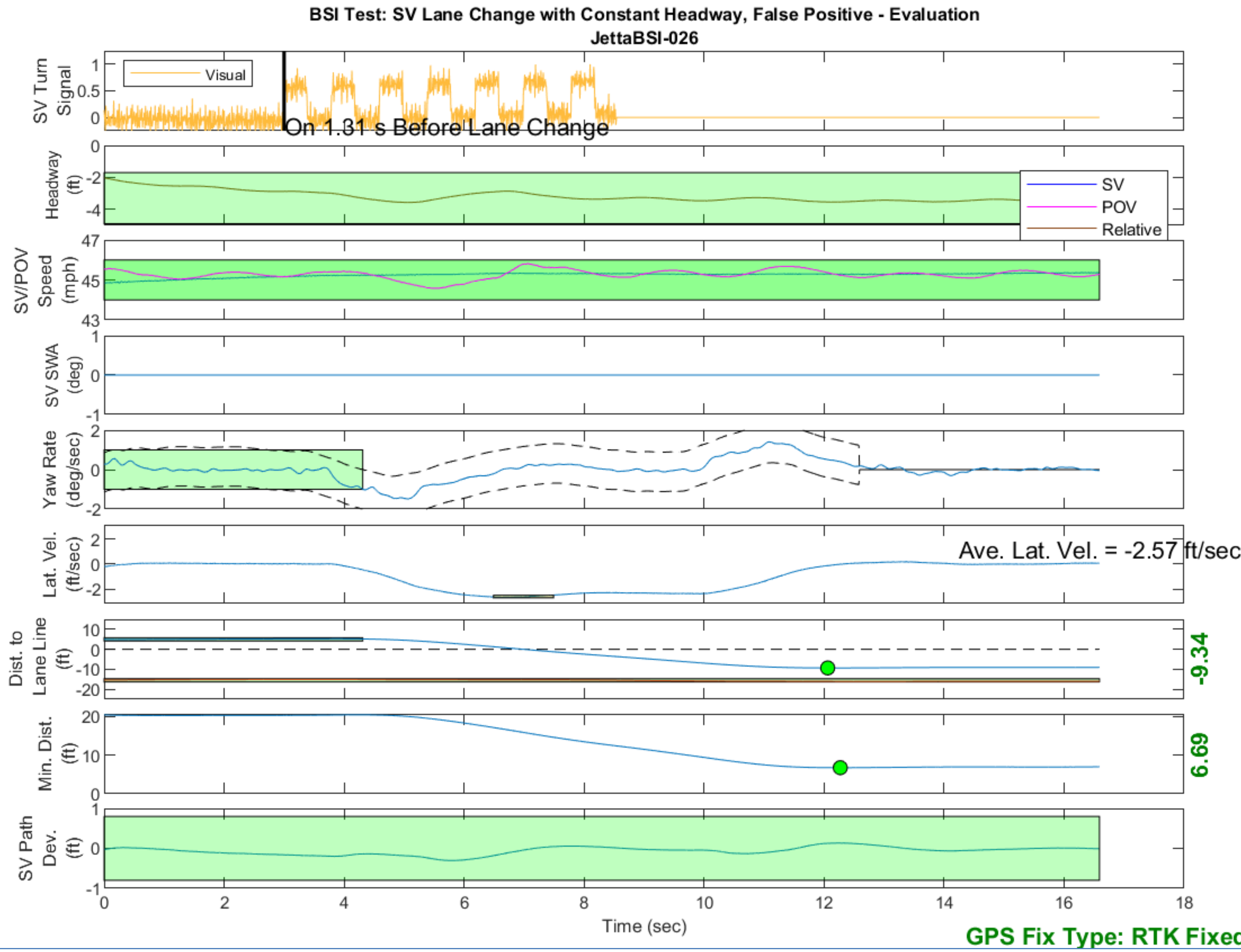

Figure D27. BSI Run 26, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

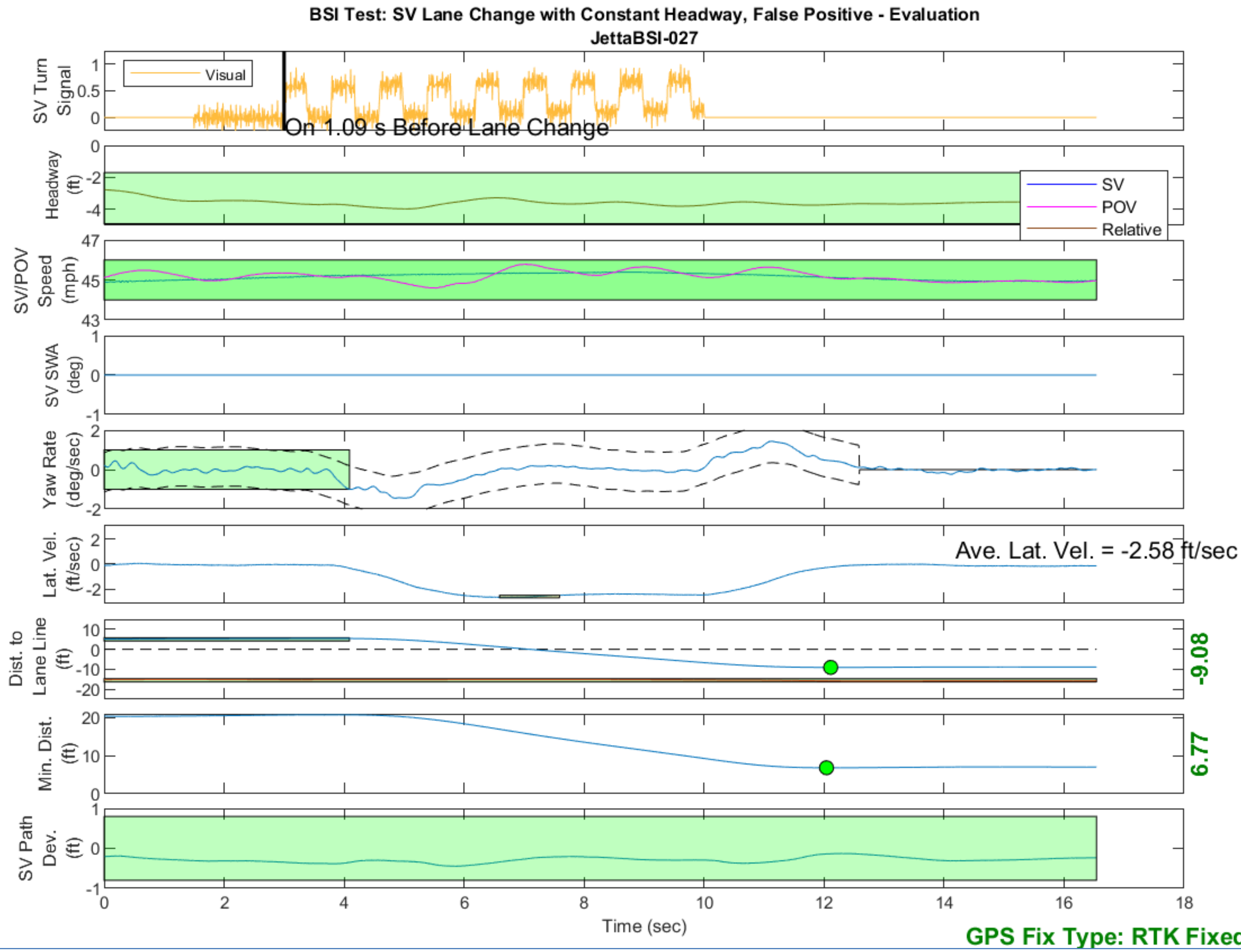

Figure D28. BSI Run 27, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

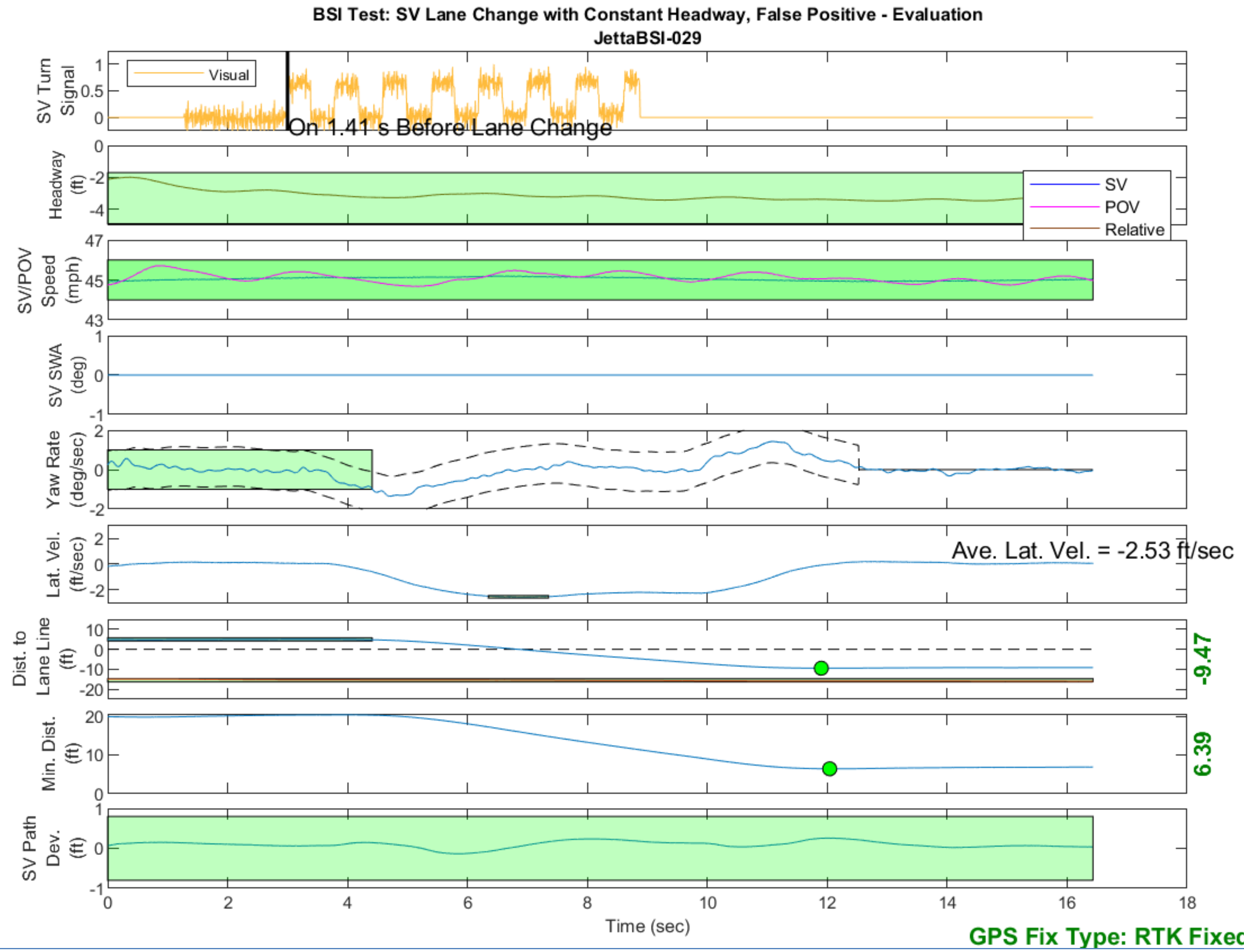

Figure D29. BSI Run 29, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

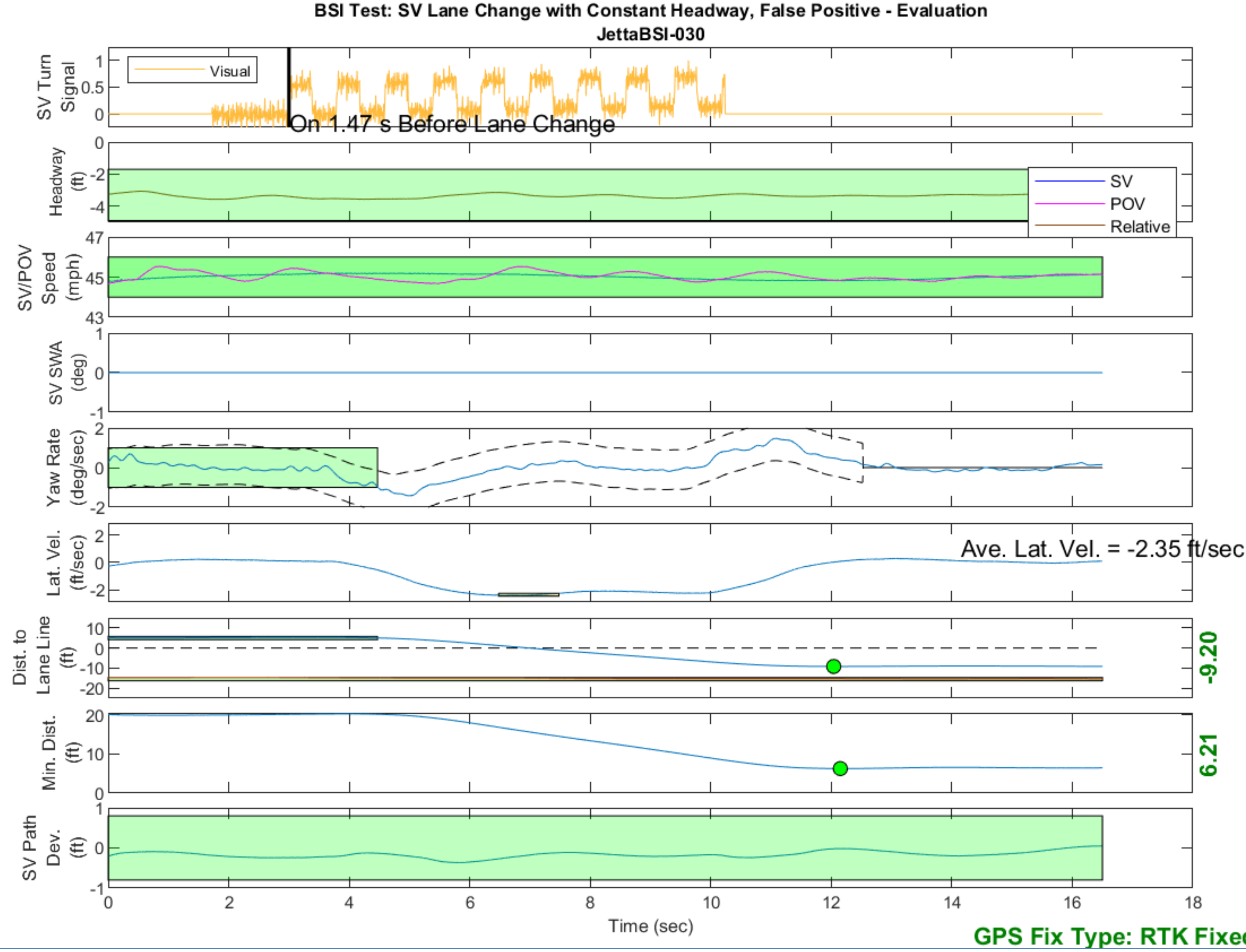

Figure D30. BSI Run 30, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

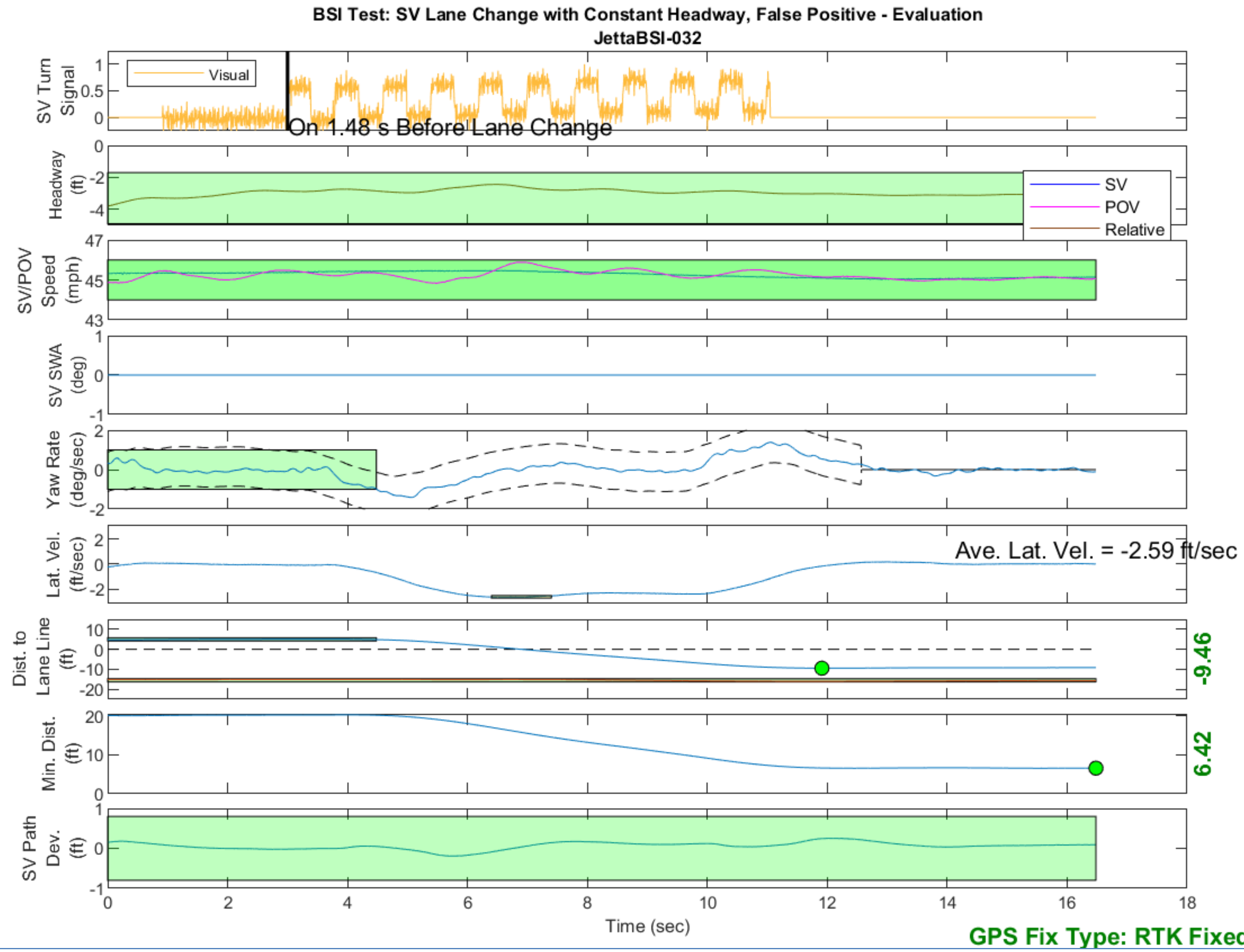

Figure D31. BSI Run 32, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation