BLIND SPOT INTERVENTION SYSTEM CONFIRMATION TEST
NCAP-DRI-BSI-20-08

2020 Nissan Leaf SV

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Final Report

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16. Abstract

These tests were conducted on the subject 2020 Nissan Leaf SV 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 preliminary BSI requirements for 7 out of 21 valid trials. It did not meet the Subject Vehicle Lane Change requirements for the either the constant or closing headway cases.

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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 Nissan Leaf SV

VIN: *1N4AZ1CP0LC30xxxx*

Test Date: *8/7/2020*

System Setting(s): *System on*

		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**	*0*	*7*	*7*
Test 3 -	**Subject Vehicle Lane Change, Constant Headway, False Positive**	*7*	*0*	*7*
	Overall:	***7***	***14***	***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 Nissan Leaf SV

TEST VEHICLE INFORMATION

VIN: *1N4AZ1CP0LC30xxxx*

Body Style: *Hatchback* Color: *Gun Metallic*

Date Received: *7/27/2020* Odometer Reading: *18 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Nissan Motor Co. Ltd.*

Date of manufacture: *02/20*

Vehicle Type: *Passenger Car*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard:	Front:	*P215/50R17*
	Rear:	*P215/50R17*
Recommended cold tire pressure:	Front:	*250 kPa (36 psi)*
	Rear:	*250 kPa (36 psi)*

TIRES

Tire manufacturer and model: *Michelin Energy Saver A/S*

Front tire size: *P215/50R17 90V*

Rear tire size: *P215/50R17 90V*

Front tire DOT prefix: *B338 00KX*

Rear tire DOT prefix: *B338 00KX*

BLIND SPOT INTERVENTION

DATA SHEET 3: TEST CONDITIONS

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2020 Nissan Leaf SV

GENERAL INFORMATION

Test date: *8/7/2020*

AMBIENT CONDITIONS

Air temperature: *28.3 C (83 F)*

Wind speed: *1.5 m/s (3.5 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 Nissan Leaf SV

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*515.3 kg (1136 lb)*	Right Front:	*480.8 kg (1060 lb)*
Left Rear:	*375.1 kg (827 lb)*	Right Rear:	*367.4 kg (810 lb)*
		Total:	*1738.6 kg (1136 lb)*

DATA SHEET 4: BLIND SPOT INTERVENTION SYSTEM OPERATION

2020 Nissan Leaf SV

General Information

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

Blind Spot Intervention (BSI); standard equipment on all trim levels.

Type and location of sensors the system uses:

The BSW system uses two radar sensors installed near the rear bumper.

The BSI also uses a single camera mounted behind the front windshield.

System setting used for test (if applicable):

System on

Method(s) by which the driver is alerted

X Visual

	Type	Location	Description
____	Symbol	*Upper outside corners of outside mirrors*	*Yellow car symbol*
____	Word		
____	Graphic		

X Audible - Description

Repeated high pitched beep

____ Haptic

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

Description of alert:

If the radar sensors detect a vehicle in the detection zone, the side indicator light illuminates. If the turn signal is then activated, the system chimes (twice), the side indicator light flashes, and the BSW indicator illuminates (yellow) in the vehicle information display. The side indicator light continues to flash until the detected vehicle leaves the detection zone.

If a vehicle comes into the detection zone after the driver activates the turn signal, then only the side indicator light flashes and no chime sounds

A side indicator light is shown in Appendix A, Figure A13 and the BSW indicator is illustrated in the Owner's Manual, page 5-38, shown in Appendix B, page B-3.

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.

The system applies the brakes on one side of the vehicle for a moment.

System Function

What is the speed range over which the system operates?

Minimum: *59.5 km/h (37 mph)*

Maximum: *No upper speed limit*

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

The camera used for BSI requires initialization. Drive for approximately 20 minutes at speeds between 40-50 km/h with traffic on both sides and the vehicle typically loaded.

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

If the radar sensors detect a vehicle in the detection zone, the side indicator light illuminates. If the turn signal is then activated, the system chimes (twice), the side indicator light flashes, and the BSW indicator illuminates (yellow) in the vehicle information display. The side indicator light continues to flash until the detected vehicle

leaves the detection zone.

If a vehicle comes into the detection zone after the driver activates the turn signal, then only the side indicator light flashes and no chime sounds

The side indicator lights are shown in Appendix A, Figure A16 and the BSW indicator is illustrated in the Owner's Manual, page 5-38, shown in Appendix B, page B-3.

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?

Buttons located on the left side of the steering wheel are used to interact with the system menus. The hierarchy is:

Settings

Driver Assistance

Blind Spot

Blind Spot Intervention - select or deselect

OK

See Appendix A, Figures A14 and A15.

The system automatically turns on every time the EV system is started, as long as it is activated using the settings menu on the vehicle information display.

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 provision for adjustment is provided.

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

If the system malfunctions, it will turn off automatically. The BSW indicator will illuminate (yellow) in the vehicle information display. The indicator next to "Blind spot" in the "Driving Aids" menu will also illuminate (yellow).

When radar blockage is detected, the system will be deactivated automatically. The BSW indicator will blink (yellow) in the vehicle information display. The indicator next to "Blind spot" in the "Driving Aids" menu will also blink (yellow).

The system is not available until the conditions no longer exist.

The radar sensors may be blocked by temporary ambient conditions such as splashing water, mist, or fog. The blocked condition may also be caused by objects such as ice, frost, or dirt obstructing the radar sensors.

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 due to repeated activity.

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?

The system is not affected by periods of inactivity.

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

System limitations are described in the Owner's Manual, page 5-51 through 5-52, shown in Appendix B, Pages B-16 through B-17.

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).

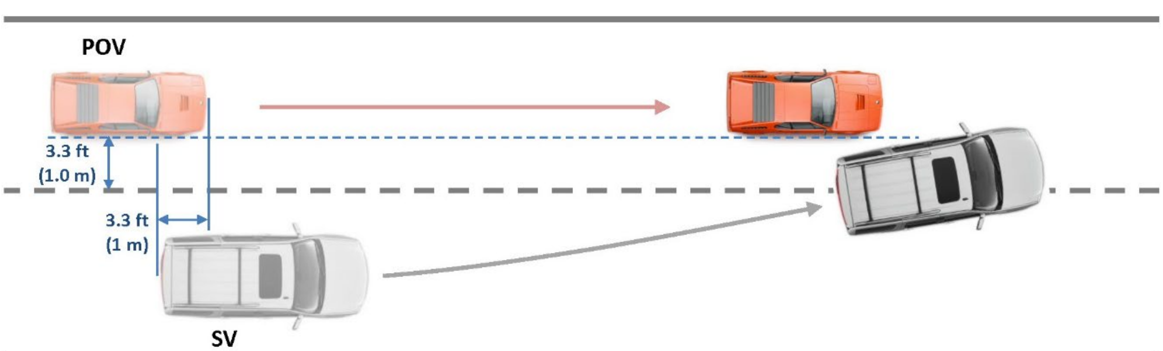


Figure 1. SV Lane Change with Constant Headway Test Scenario

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).

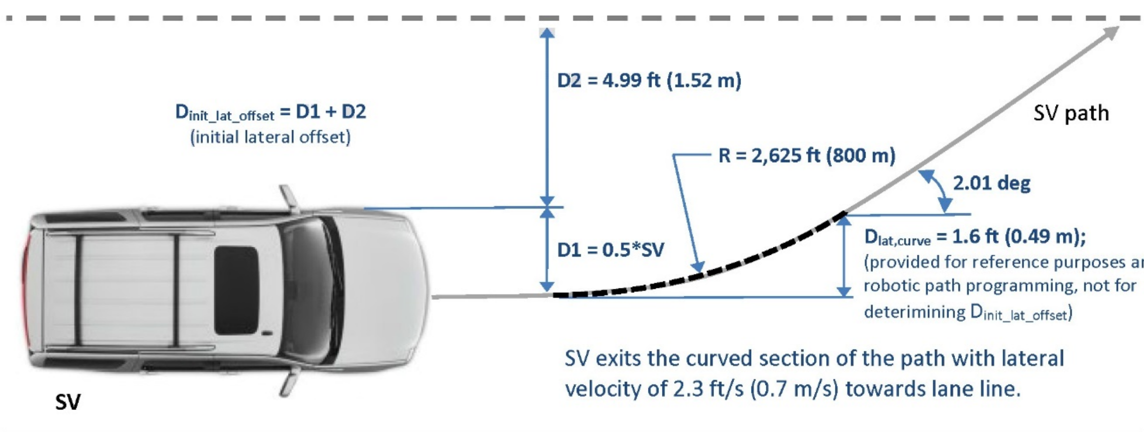


Figure 2. Input Parameters Used to Define the SV Path During the SV Level 0 and 1 Lane Change with Constant Headway Scenario

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.

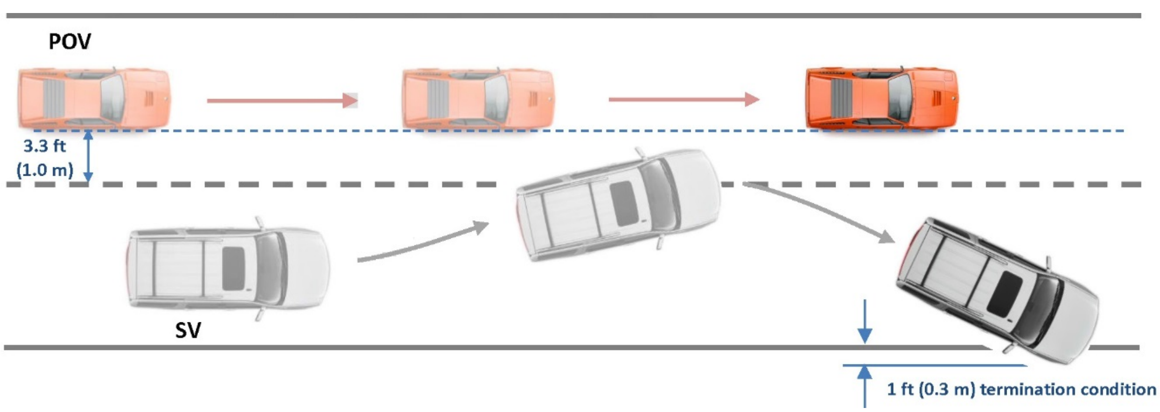


Figure 3. Valid SV Lane Change Intervention Test Interval End Condition 3

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 criterial 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.c 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).

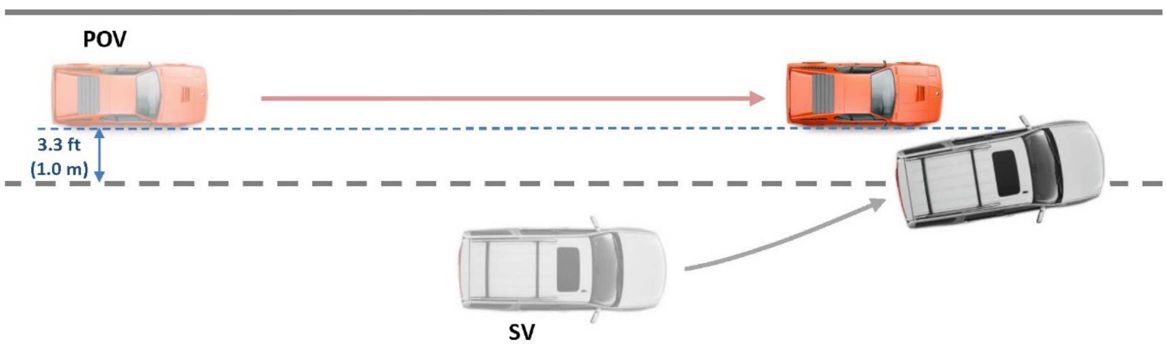


Figure 4. SV Lane Change with Closing Headway Test Scenario

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 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 criterial 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.c 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, and 7 and 8 in Table 2 are different from Table 1.

3. TEST 3 – SV LANE CHANGE WITH CONSTANT HEADWAY, FALSE POSITIVE ASSESSMENT

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.

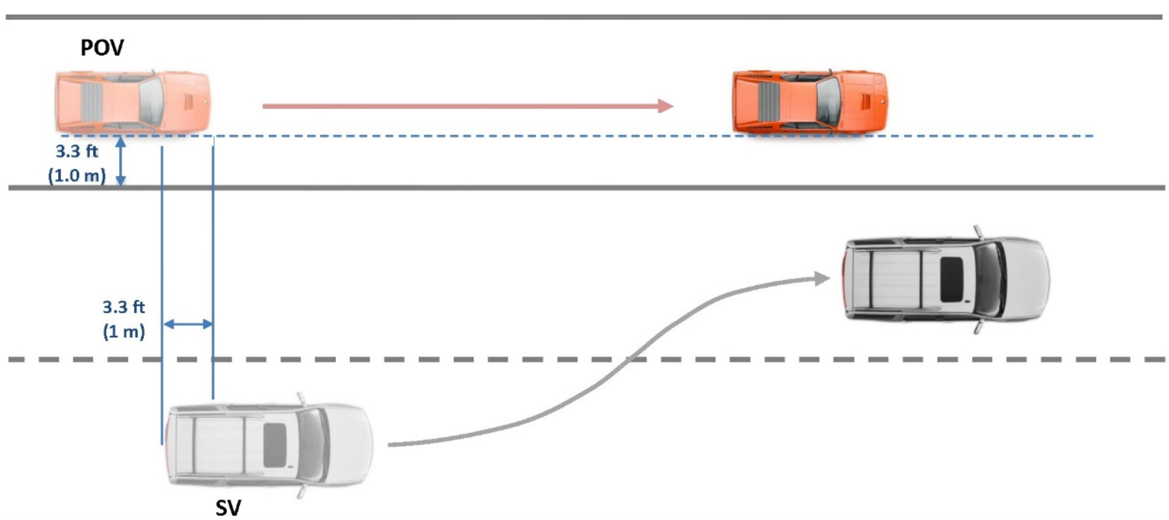


Figure 5. Lane Change with Constant Headway, False Positive Test Scenario

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.c.

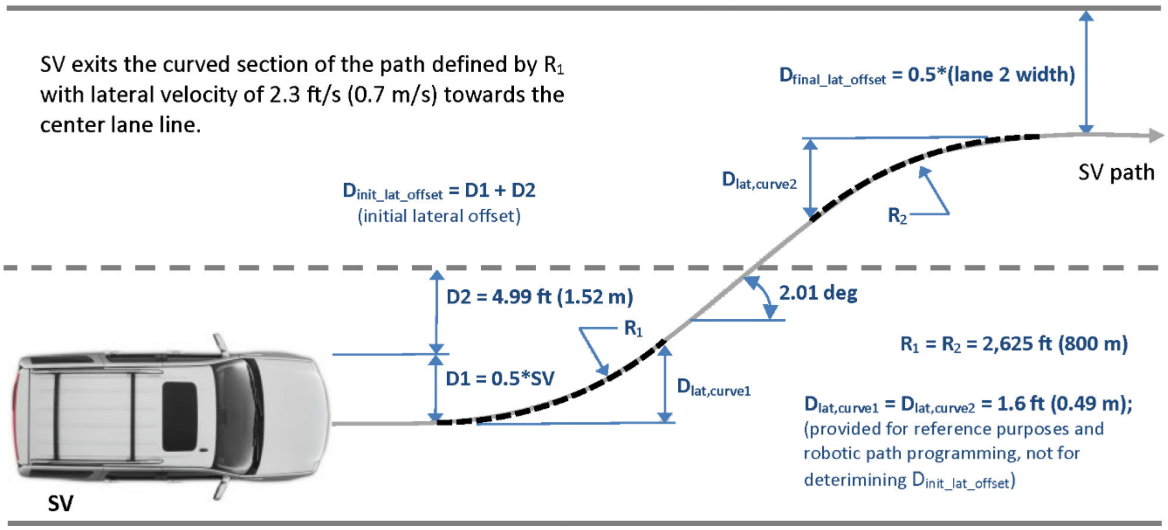


Figure 6. Input Parameters used to define the SV path during the SV Lane Change with Constant Headway, False Positive Scenario

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.

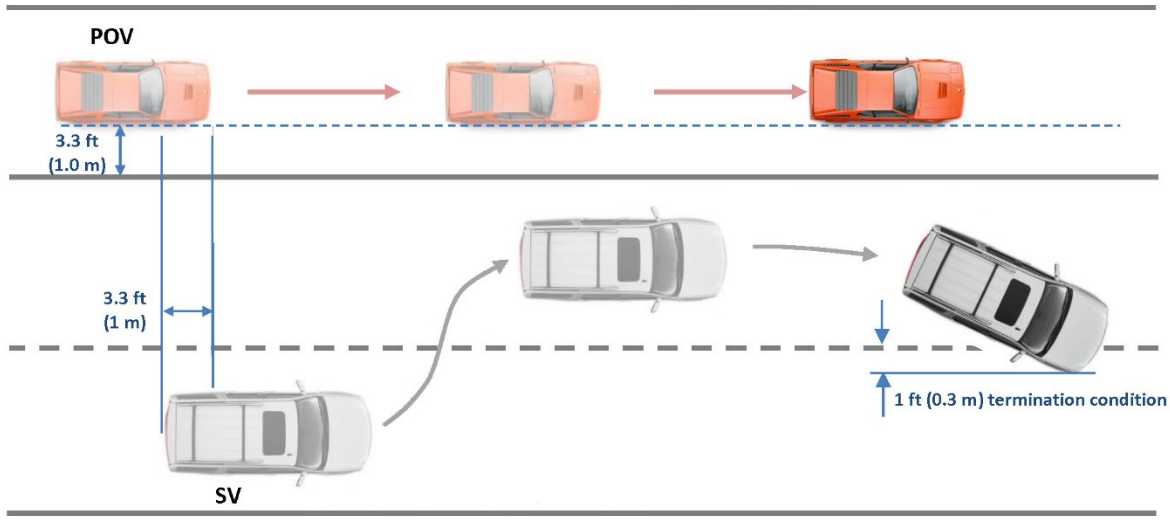


Figure 7. Valid SV Lane Change False Positive Test Interval End Condition 3

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 Tables 3a and 3b were within the allowable limits specified in Tables 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.

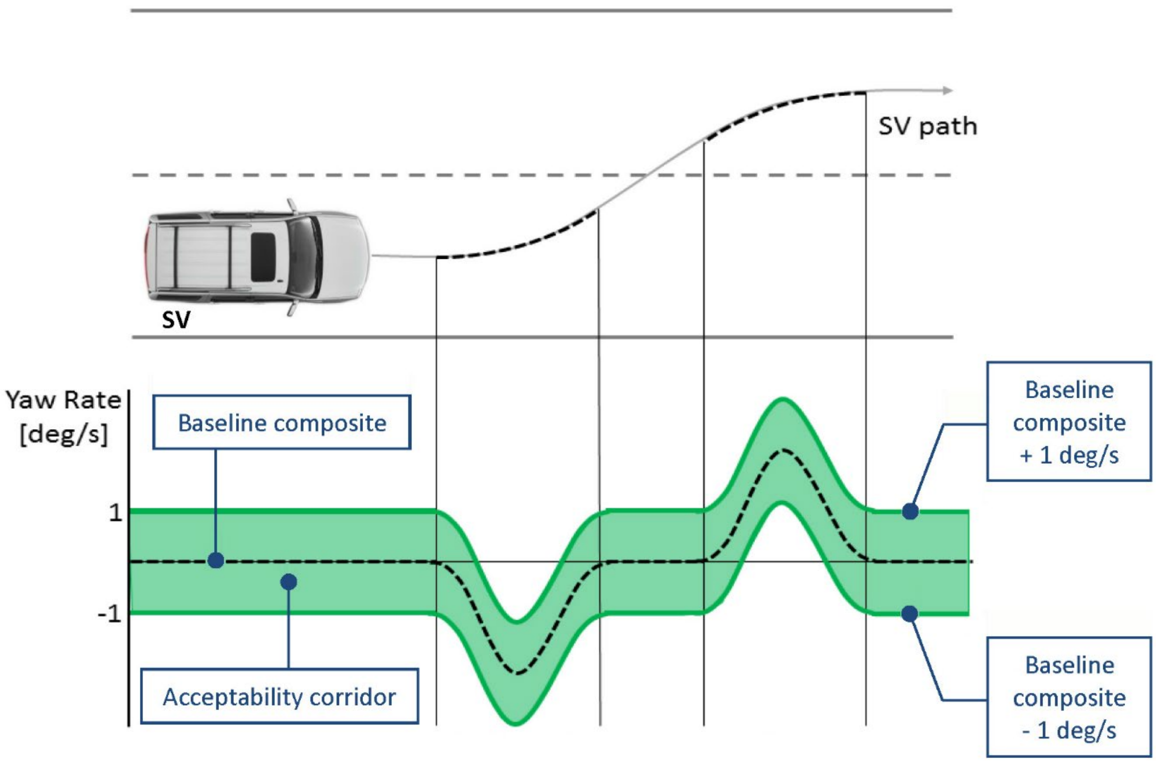


Figure 8. Definition of a Yaw Rate Acceptability Corridor

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.c, then a false positive intervention test result was determined to have occurred.

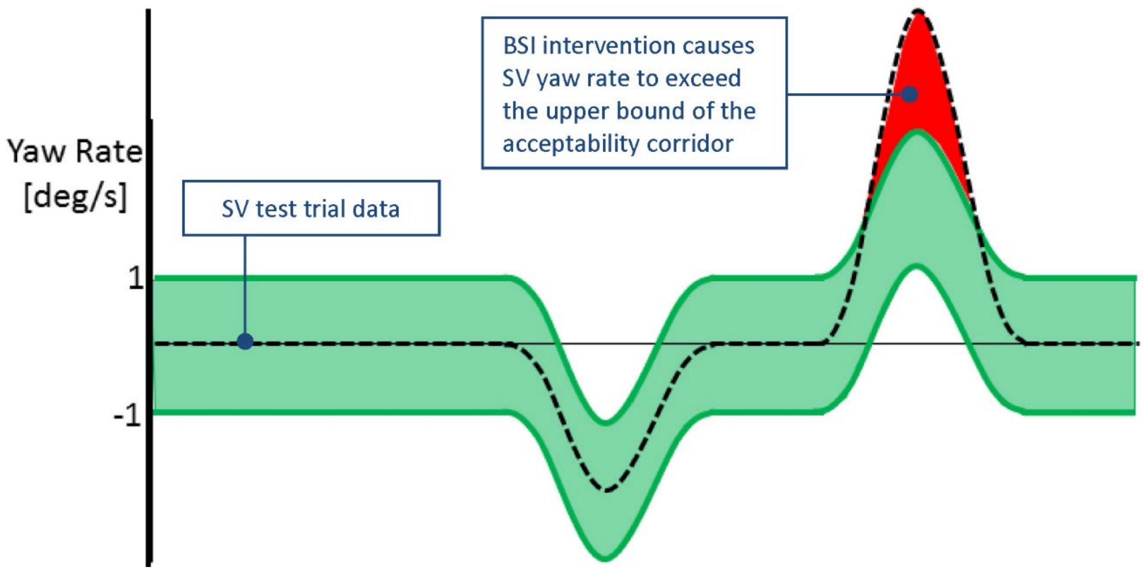


Figure 9. BSI False Positive Example

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	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	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			By: Oxford Technical Solutions
				SV IMU#1 Oxford Inertial +	2258	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	NA

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 (visual alert)	Spectral Bandwidth: 440 - 800 nm	Rise Time < 10 ms	DRI designed and developed light sensor	NA	NA
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA
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	NA
Throttle Controller	Arduino based, servo actuated controller for managing POV speed	DRI developed	NA

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

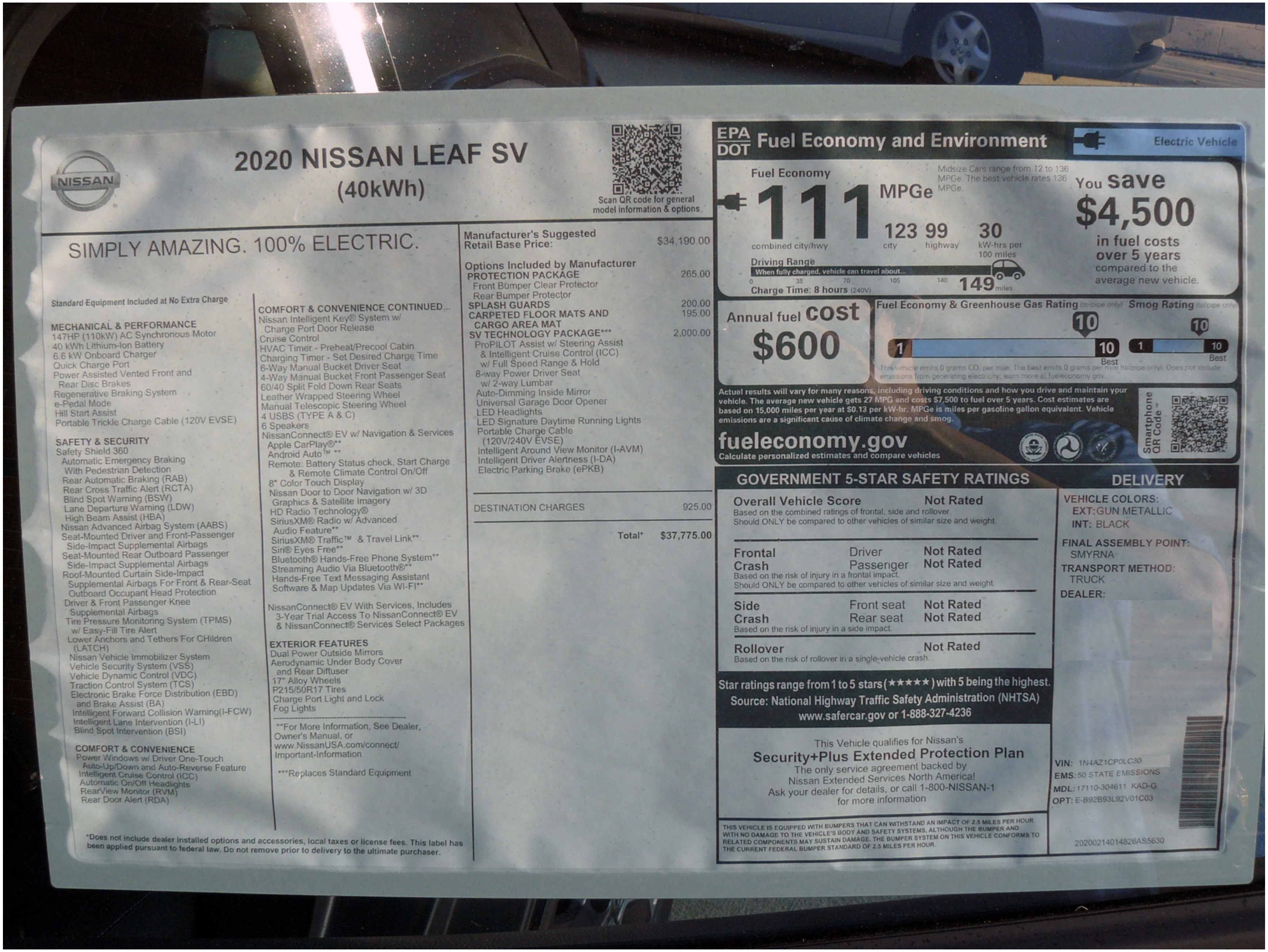


Figure A3. Window Sticker (Monroney Label)

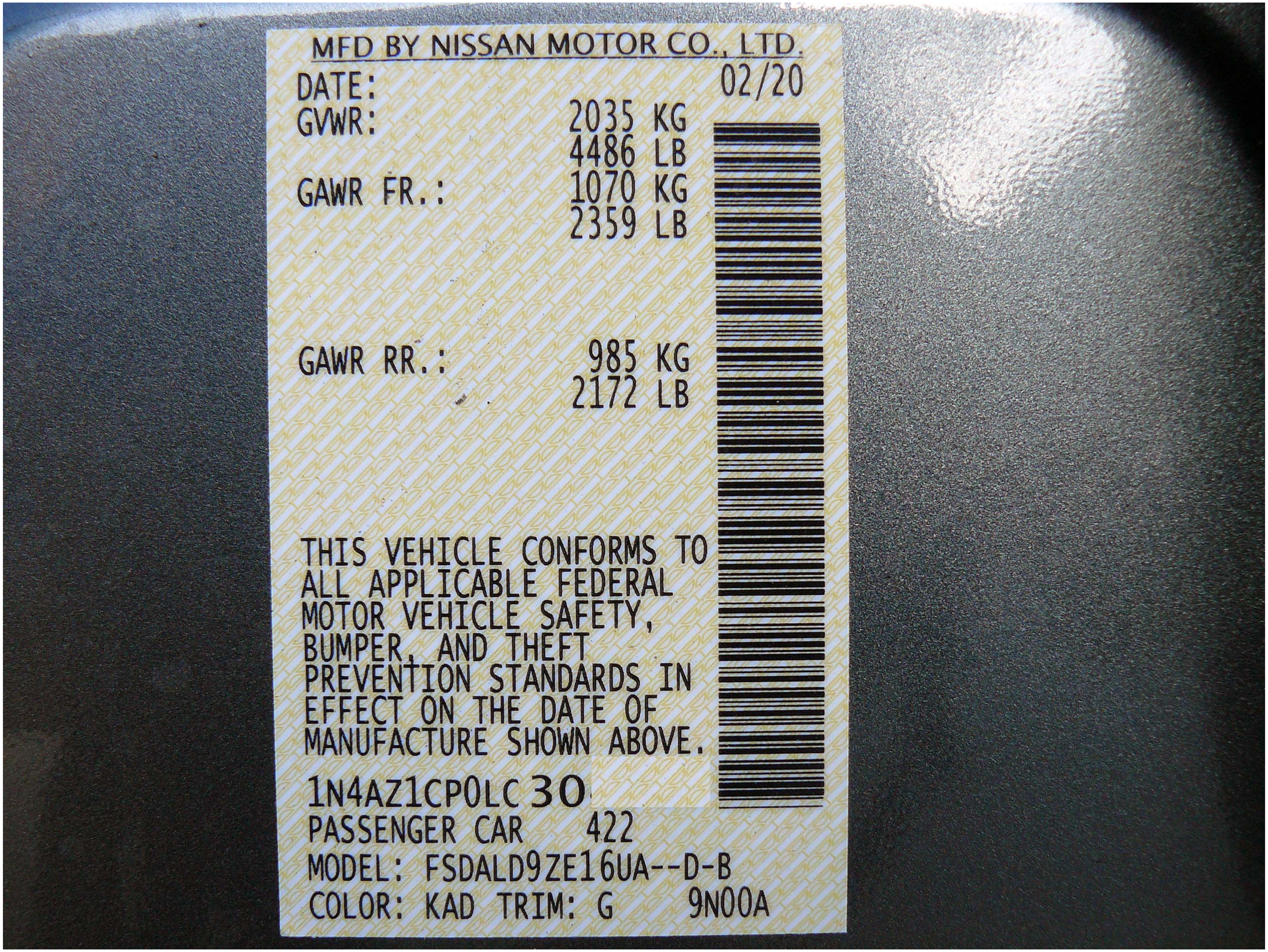


Figure A4. Vehicle Certification Label

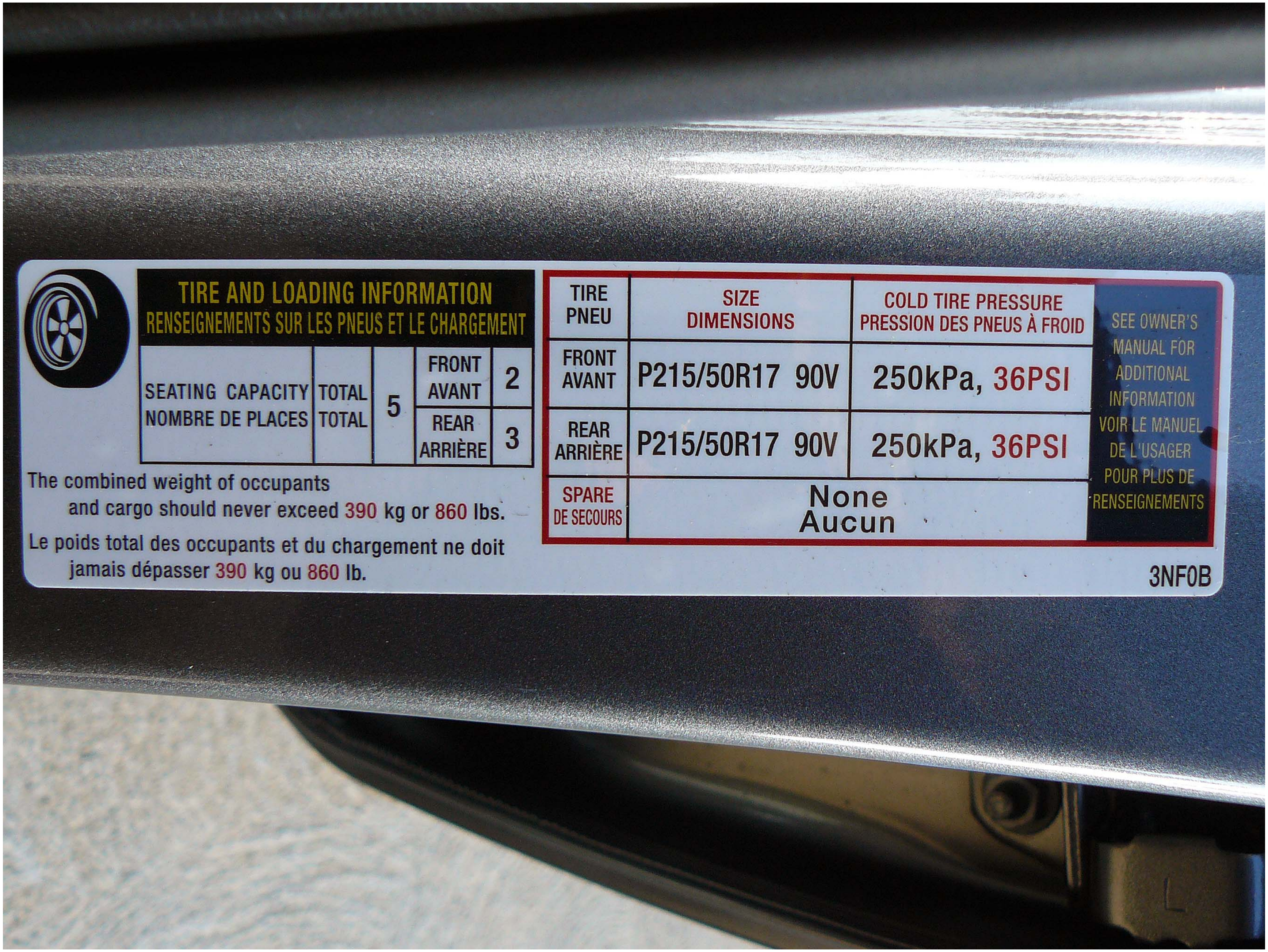


Figure A5. Tire Placard

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. Sensor for Detecting Visual Alerts

Figure A13. Sensor for Detecting Auditory Alerts

Figure A14. System Setup Menus

Figure A15. Controls for Interacting with System Menus

Figure A16. Visual Alert

APPENDIX B

Excerpts from Owner's Manual

- Do not place reflective materials, such as white paper or a mirror, on the instrument panel. The reflection of sunlight may adversely affect the camera unit's capability of detecting the lane markers.
- Do not strike or damage the areas around the camera unit. Do not touch the camera lens or remove the screw located on the camera unit. If the camera unit is damaged due to an accident, it is recommended that you visit a NISSAN certified LEAF dealer.

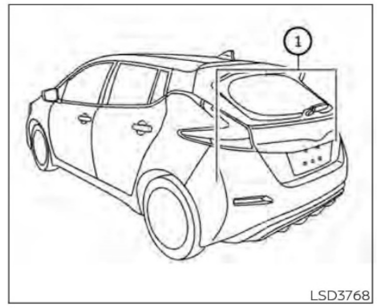
BLIND SPOT WARNING (BSW)

WARNING

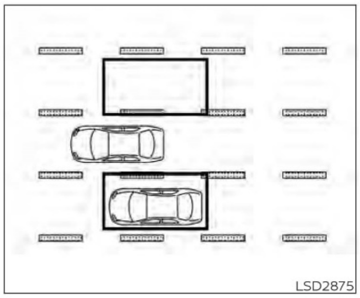
Failure to follow the warnings and instructions for proper use of the BSW system could result in serious injury or death.

- **The BSW system is not a replacement for proper driving procedures and is not designed to prevent contact with vehicles or objects. When changing lanes, always use the side and rear mirrors and turn and look in the direction your vehicle will move to ensure it is safe to change lanes. Never rely solely on the BSW system.**

The BSW system helps alert the driver of other vehicles in adjacent lanes when changing lanes.

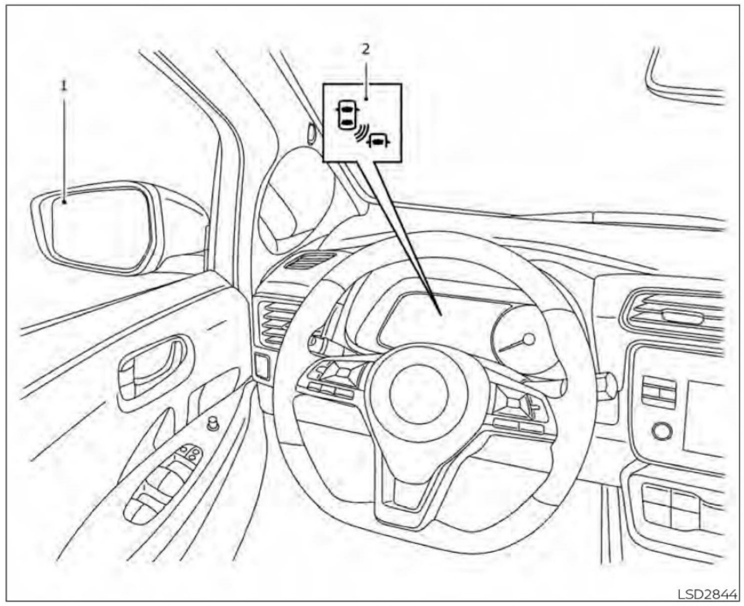


The BSW system uses radar sensors ① installed near the rear bumper to detect other vehicles in an adjacent lane.



Detection zone

The radar sensors can detect vehicles on either side of your vehicle within the detection zone shown as illustrated. This detection zone starts from the outside mirror of your vehicle and extends approximately 10 ft (3.0 m) behind the rear bumper, and approximately 10 ft (3.0 m) sideways.



BSW SYSTEM OPERATION

1. Side Indicator Light
2. BSW Indicator

The BSW system operates above approximately 20 mph (32 km/h).

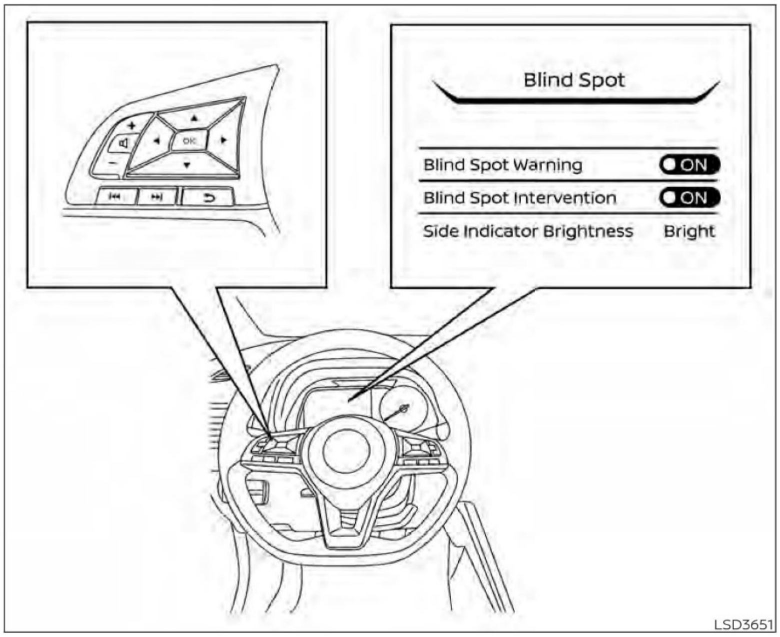
If the radar sensors detect a vehicle in the detection zone, the side indicator light (1) illuminates. If the turn signal is then activated, the system chimes (twice), the side indicator light flashes, and the BSW indicator (2) illuminates (yellow) in the vehicle information display. The side indicator light continues to flash until the detected vehicle leaves the detection zone.

The side indicator light illuminates for a few seconds when the power switch is placed in the ON position.

The brightness of the side indicator light is adjusted automatically depending on the brightness of the ambient light.

If a vehicle comes into the detection zone after the driver activates the turn signal, then only the side indicator light flashes and no chime sounds. For additional information, refer to "BSW driving situations" in this section

The BSW system automatically turns on every time the EV system is started, as long as it is activated using the settings menu on the vehicle information display.



HOW TO ENABLE/DISABLE THE BSW SYSTEM

Perform the following steps to enable or disable the BSW system:

1. Press the ◀▶ button until "Settings" displays in the vehicle information display. Use the ▲▼ button to select "Driver Assistance." Then press the OK button.
2. Select "Blind Spot" and press the OK button.
3. Select "Blind Spot Warning" and use the OK button to turn the system on or off.

NOTE:

When enabling/disabling the system, the system will retain current settings even if the EV system is restarted.

BSW SYSTEM LIMITATIONS

WARNING

Listed below are the system limitations for the BSW system. Failure to operate the vehicle in accordance with these system limitations could result in serious injury or death.

- **The BSW system cannot detect all vehicles under all conditions.**
- **The radar sensors may not be able to detect and activate BSW when certain objects are present such as:**
  - **Pedestrian, bicycles, animals.**
  - **Vehicles such as motorcycles, low height vehicles, or high ground clearance vehicles.**
  - **Oncoming vehicles.**
  - **Vehicles remaining in the detection zone when you accelerate from a stop.**
  - **A vehicle merging into an adjacent lane at a speed approximately the same as your vehicle.**
  - **A vehicle approaching rapidly from behind.**
  - **A vehicle which your vehicle overtakes rapidly.**
  - **A vehicle that passes through the detection zone quickly.**
  - **When overtaking several vehicles in a row, the vehicles after the first vehicle may not be detected if they are traveling close together.**
- **The radar sensor's detection zone is designed based on a standard lane width. When driving in a wider lane, the radar sensors may not detect vehicles in an adjacent lane. When driving in a narrow lane, the radar sensors may detect vehicles driving two lanes away.**
- **The radar sensors are designed to ignore most stationary objects; however, objects such as guardrails, walls, foliage and parked vehicles may occasionally be detected. This is a normal operation condition.**
- **The following conditions may reduce the ability of the radar to detect other vehicles:**
  - **Severe weather**
  - **Road spray**
  - **Ice/frost/dirt/snow build-up on the vehicle**
- **Do not attach stickers (including transparent material), install accessories or apply additional paint near the radar sensors. These conditions may reduce the ability of the radar to detect other vehicles.**
- **Excessive noise (for example, audio system volume, open vehicle window) will interfere with the chime sound, and it may not be heard.**

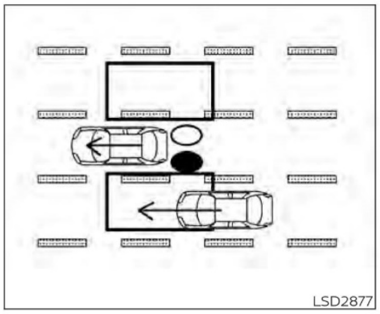


Illustration 1 – Approaching from behind

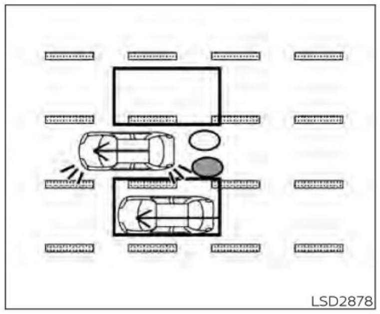


Illustration 2 – Approaching from behind

BSW DRIVING SITUATIONS

Illustration 1: The side indicator light illuminates if a vehicle enters the detection zone from behind in an adjacent lane.

Indicator on

Indicator off

Indicator flashing

Another vehicle approaching from behind

Illustration 2: If the driver activates the turn signal when another vehicle is in the detection zone, then the system chimes (twice) and the side indicator light flashes.

NOTE:

- **The radar sensors may not detect vehicles which are approaching rapidly from behind.**
- **If the driver activates the turn signal before a vehicle enters the detection zone, the side indicator light will flash but no chime will sound when the other vehicle is detected.**

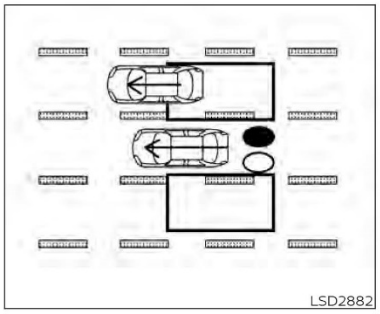


Illustration 3 – Overtaking another vehicle

Overtaking another vehicle

Illustration 3: The side indicator light illuminates if you overtake a vehicle and that vehicle stays in the detection zone for approximately 2 seconds.

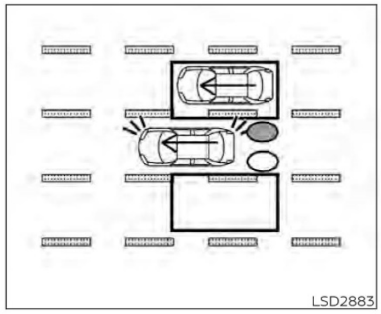


Illustration 4 – Overtaking another vehicle

Illustration 4: If the driver activates the turn signal while another vehicle is in the detection zone, then the system chimes (twice) and the side indicator light flashes.

NOTE:

- **When overtaking several vehicles in a row, the vehicles after the first vehicle may not be detected if they are traveling close together.**
- **The radar sensors may not detect slower moving vehicles if they are passed quickly.**
- **If the driver activates the turn signal before a vehicle enters the detection zone, the side indicator light will flash but no chime will sound when the other vehicle is detected.**

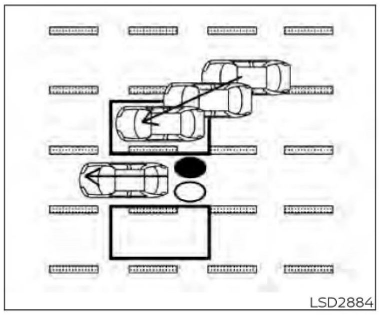

LSD2884

Illustration 5 – Entering from the side

Entering from the side

Illustration 5: The side indicator light illuminates if a vehicle enters the detection zone from either side.

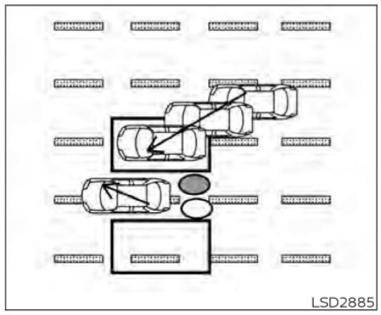
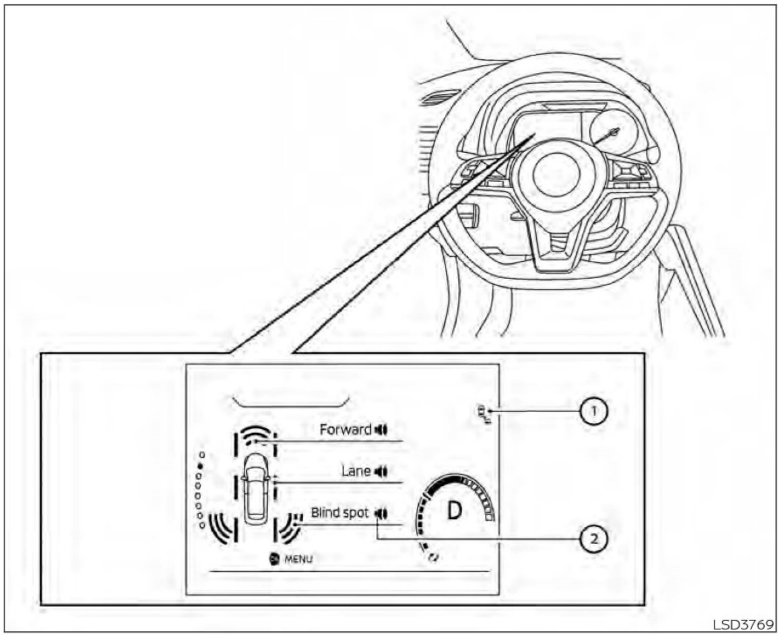

LSD2885

Illustration 6 – Entering from the side

Illustration 6: If the driver activates the turn signal while another vehicle is in the detection zone, then the system chimes (twice) and the side indicator light flashes.

NOTE:

- **If the driver activates the turn signal before a vehicle enters the detection zone, the side indicator light will flash but no chime will sound when the other vehicle is detected.**
- **The radar sensors may not detect a vehicle which is traveling at about the same speed as your vehicle when it enters the detection zone.**



SYSTEM TEMPORARILY UNAVAILABLE

When radar blockage is detected, the system will be deactivated automatically. The BSW indicator ① will blink (yellow) in the vehicle information display. The indicator next to "Blind spot" in the "Driving Aids" menu ② will also blink (yellow).

The system is not available until the conditions no longer exist.

The radar sensors may be blocked by temporary ambient conditions such as splashing water, mist or fog. The blocked condition may also be caused by objects such as ice, frost or dirt obstructing the radar sensors.

NOTE:

If the BSW system stops working, the RCTA system will also stop working.

Action to take:

When the above conditions no longer exist, the system will resume automatically.

Malfunction

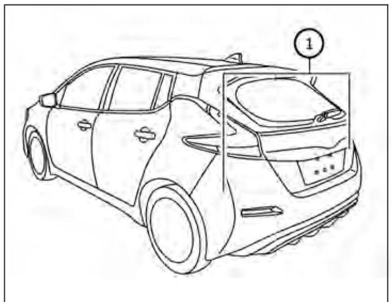
If the BSW system malfunctions, it will turn off automatically. The BSW indicator will illuminate (yellow) in the vehicle information display. The indicator next to "Blind spot" in the "Driving Aids" menu will also illuminate (yellow).

NOTE:

If the BSW system stops working, the RCTA system will also stop working.

Action to take:

Stop the vehicle in a safe location, place the vehicle in the P (Park) position, turn the EV system off and restart the EV system. If the indicators continue to appear, have the system checked. It is recommended that you visit a NISSAN certified LEAF dealer for this service.



LSD3768

SYSTEM MAINTENANCE

The two radar sensors ① for the BSW and RCTA systems are located near the rear bumper. Always keep the area near the radar sensors clean.

The radar sensors may be blocked by temporary ambient conditions such as splashing water, mist or fog.

The blocked condition may also be caused by objects such as ice, frost or dirt obstructing the radar sensors.

Check for and remove objects obstructing the area around the radar sensors.

Do not attach stickers (including transparent material), install accessories or apply additional paint near the radar sensors.

Do not strike or damage the area around the radar sensors. It is recommended that you visit a NISSAN certified LEAF dealer if the area around the radar sensors is damaged due to a collision.

Radio frequency statement

For USA

FCC : OAYSRR3B

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Warning

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For Canada

Applicable law: Canada 310

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Frequency bands: 24.05 – 24.25GHz

Output power: less than 20 milliwatts

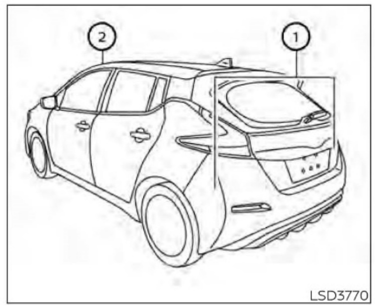
INTELLIGENT BLIND SPOT INTERVENTION (I-BSI)

⚠WARNING

Failure to follow the warnings and instructions for proper use of the I-BSI system could result in serious injury or death.

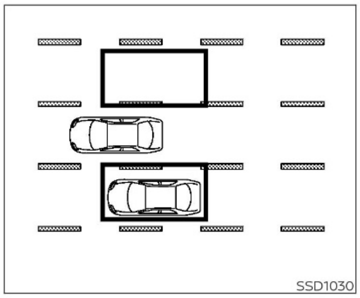
- **The I-BSI system is not a replacement for proper driving procedure and is not designed to prevent contact with vehicles or objects. When changing lanes, always use the side and rear mirrors and turn and look in the direction you will move to ensure it is safe to change lanes. Never rely solely on the I-BSI system.**
- **There is a limitation to the detection capability of the radar or the sonar. Not every moving object or vehicle will be detected. Using the I-BSI system under some road, ground, lane marker, traffic or weather conditions could lead to improper system operation. Always rely on your own operation to avoid accidents.**

The I-BSI system helps alert the driver of other vehicles in adjacent lanes when changing lanes, and helps assist the driver to return the vehicle to the center of the traveling lane.



LSD3770

The I-BSI system uses radar sensors ① installed near the rear bumper to detect other vehicles in an adjacent lane. In addition to the radar sensors, the I-BSI system uses a camera ② installed behind the windshield to monitor the lane markers of your traveling lane.

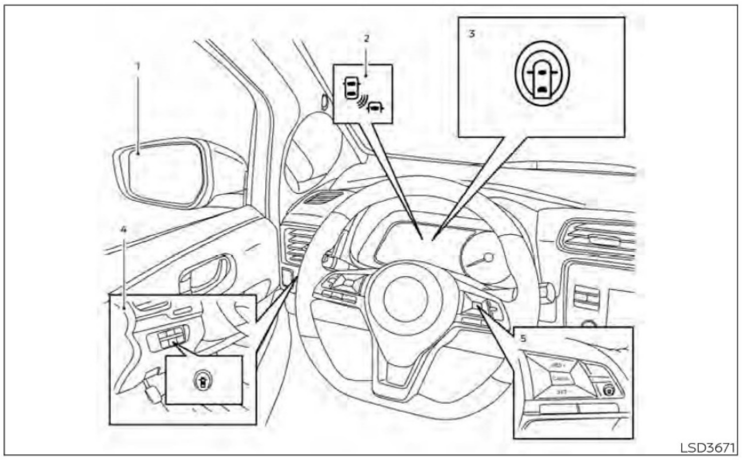


SSD1030

Detection zone

The radar sensors can detect vehicles on either side of your vehicle within the detection zone shown as illustrated.

The detection zone starts from the outside mirror of your vehicle and extends approximately 10ft (3.0m) behind the rear bumper, and approximately 10ft (3.0 m) sideways.



LSD3671

1. Side indicator light
2. Blind Spot Warning (BSW) indicator
3. Intelligent Blind Spot Intervention (I-BSI) indicator
4. Dynamic driver assistance switch (models without ProPILOT Assist)
5. ProPILOT Assist switch (models with ProPILOT Assist)

I-BSI SYSTEM OPERATION

The I-BSI system operates above approximately 37 mph (60 km/h).

If the radar sensors detect a vehicle in the detection zone, the side indicator light ① illuminates.

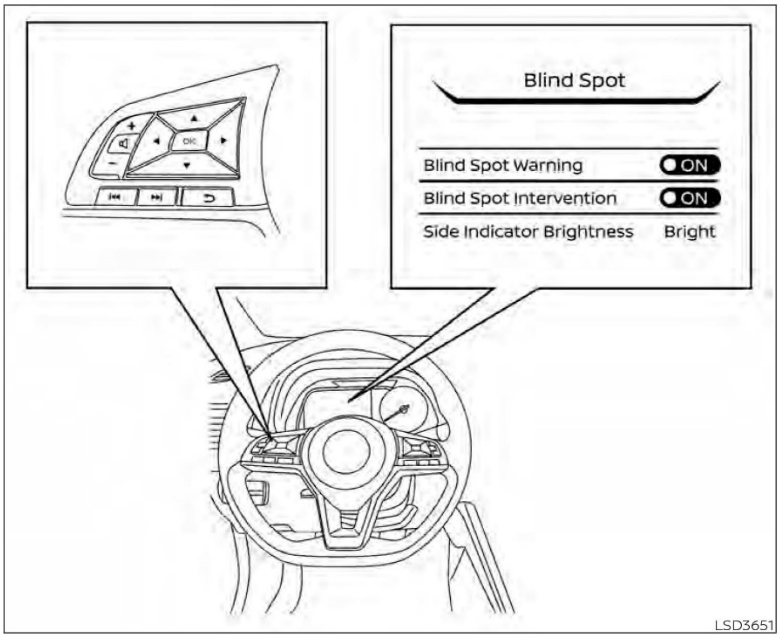
If the turn signal is then activated, the system chimes (twice) and the side indicator light flashes. The side indicator light continues to flash until the detected vehicle leaves the detection zone. The brightness of the side indicator light is adjusted automatically depending on the brightness of the ambient light.

If the I-BSI system is ON and your vehicle approaches a lane marker while another vehicle is in the detection zone, the system chimes (three times) and the side indicator light flashes. The I-BSI system activates to help return the vehicle back to the center of the driving lane. The I-BSI system operates regardless of turn signal usage.

NOTE:

- **I-BSI warning and system application will only be activated if the side indicator light is already illuminated when your vehicle approaches a lane marker. If another vehicle comes into the detection zone after your vehicle has crossed a lane marker, no I-BSI warning or system application will be activated. (For additional information, see "I-BSI driving situations" (P.5–52).).**
- **The I-BSI system is typically activated earlier than the Intelligent Lane Intervention (I-LI) system when your vehicle is approaching a lane marker.**

To turn on the I-BSI system, push the ProPILOT Assist switch on the steering wheel (models with ProPILOT Assist) or the dynamic driver assistance switch (models without ProPILOT Assist) after starting the EV system. The I-BSI indicator will illuminate. Push the ProPILOT Assist switch or the dynamic driver assistance switch again to turn off the I-BSI system. The I-BSI indicator will turn off.



HOW TO ENABLE/DISABLE THE I-BSI SYSTEM

Perform the following steps to enable or disable the I-BSI system:

1. Press the ◀▶ button until "Settings" displays in the vehicle information display. Use the ▲▼ button to select "Driver Assistance." Then press the OK button.
2. Select "Blind Spot" and press the OK button.
3. Select "Blind Spot Intervention" and use the OK button to turn the system on or off.
4. Push the ProPILOT Assist switch (models with ProPILOT Assist) or the dynamic driver assistance switch (models without ProPILOT Assist) to turn the system on or off.

NOTE:

When Blind Spot Intervention is ON in the settings menu, turning the ProPILOT Assist switch (if so equipped) ON will activate the Intelligent Blind Spot Intervention (I-BSI) system at the same time. For additional information, refer to "Intelligent Lane Intervention (I-LI)" in this section.

I-BSI SYSTEM LIMITATIONS

WARNING

Listed below are the system limitations for the I-BSI system. Failure to operate the vehicle in accordance with these system limitations could result in serious injury or death.

- **The I-BSI system cannot detect all vehicles under all conditions.**
- **The radar sensors may not be able to detect and activate I-BSI when certain objects are present such as:**
  - **Pedestrians, bicycles, or animals.**
  - **Vehicles such as motorcycles, low height vehicles, or high ground clearance vehicles.**
  - **Vehicles remaining in the detection zone when you accelerate from a stop. For additional information, refer to "BSI driving situations" in this section.**
  - **Oncoming vehicles.**
  - **A vehicle merging into an adjacent lane at a speed approximately the same as your vehicle.**
  - **A vehicle approaching rapidly from behind.**
  - **A vehicle which your vehicle overtakes rapidly.**
  - **A vehicle that passes through the detection zone quickly.**
- **The radar sensors' detection zone is designed based on a standard lane width. When driving in a wider lane, the radar sensors may not detect vehicles in an adjacent lane. When driving in a narrow lane, the radar sensors may detect vehicles driving two lanes away.**
- **The radar sensors are designed to ignore most stationary objects; however, objects such as guardrails, walls, foliage and parked vehicles may occasionally be detected. This is a normal operation condition.**
- **The camera may not detect lane markers in the following situations and the I-BSI system may not operate properly.**
  - **On roads where there are multiple parallel lane markers; lane markers that are faded or not painted clearly; yellow painted lane markers; non-standard lane markers; lane markers covered with water, dirt, snow, etc.**
  - **On roads where discontinued lane markers are still detectable.**
  - **On roads where there are sharp curves.**
  - **On roads where there are sharply contrasting objects, such as shadows, snow, water, wheel ruts, seams or lines remaining after road repairs.**
  - **On roads where the traveling lane merges or separates.**
  - **When the vehicle's traveling direction does not align with the lane markers.**
  - **When traveling close to the vehicle in front of you, which obstructs the lane camera unit detection range.**
  - **When rain, snow or dirt adheres to the windshield in front of a lane camera unit.**
  - **When the headlights are not bright due to dirt on the lens or if aiming is not adjusted properly.**
  - **When strong light enters a lane camera unit. (For example: light directly shines on the front of the vehicle at sunrise or sunset.)**

- When a sudden change in brightness occurs. (For example: when the vehicle enters or exits a tunnel or under a bridge.)

- **Do not use the I-BSI system under the following conditions because the system may not function properly.**
  - **During bad weather (for example: rain, fog, snow, etc.).**
  - **When driving on slippery roads, such as on ice or snow, etc.**
  - **When driving on winding or uneven roads.**
  - **When there is a lane closure due to road repairs.**
  - **When driving in a makeshift or temporary lane.**
  - **When driving on roads where the lane width is too narrow.**
  - **When driving with a tire that is not within normal tire conditions (e.g., tire wear, low tire pressure, installation of spare tire, tire chains, nonstandard wheels).**
  - **When the vehicle is equipped with non-original brake parts or suspension parts.**
- **Excessive noise (e.g., audio system volume, open vehicle window) will interfere with the chime sound, and it may not be heard.**

I-BSI DRIVING SITUATIONS

Indicator on

Indicator off

Indicator flashing

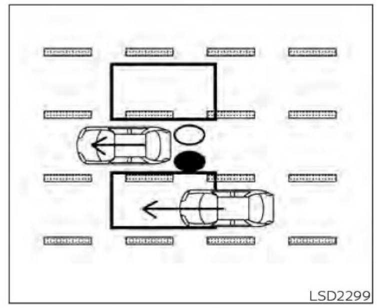


Illustration 1 – Approaching from behind

Another vehicle approaching from behind

Illustration 1: The side indicator light illuminates if a vehicle enters the detection zone from behind in an adjacent lane.

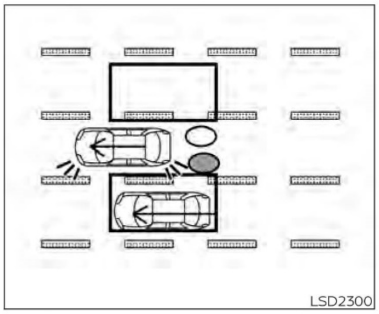


Illustration 2 – Approaching from behind

Illustration 2: If the driver activates the turn signal then the system chimes a sound (twice) and the side indicator light flashes.

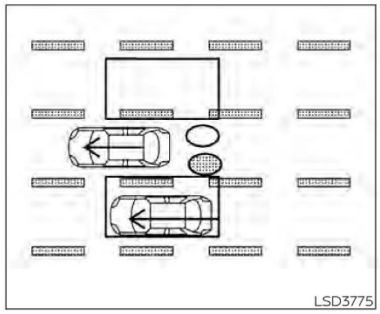


Illustration 3 – Approaching from behind

Illustration 3: If the I-BSI system is on and your vehicle approaches a lane marker while another vehicle is in the detection zone, the system chimes (three times) and the side indicator light flashes. Then the I-BSI system activates to help return the vehicle back to the center of the driving lane.

NOTE:

- The radar sensors may not detect vehicles which are approaching rapidly from behind.
- If the driver activates the turn signal before a vehicle enters the detection zone, the side indicator light will flash but no chime will sound when the other vehicle is detected.

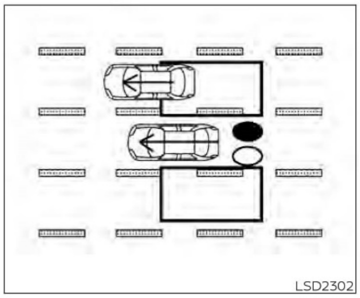


Illustration 4– Overtaking another vehicle

Overtaking another vehicle

Illustration 4: The side indicator light illuminates if you overtake a vehicle and that vehicle stays in the detection zone for approximately 3 seconds.

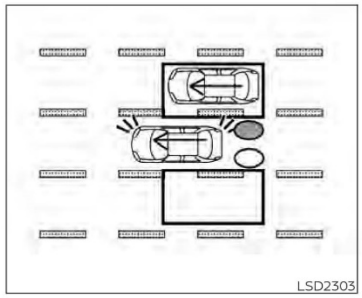


Illustration 5– Overtaking another vehicle

Illustration 5: If the driver activates the turn signal while another vehicle is in the detection zone, then the system chimes (twice) and the side indicator light flashes.

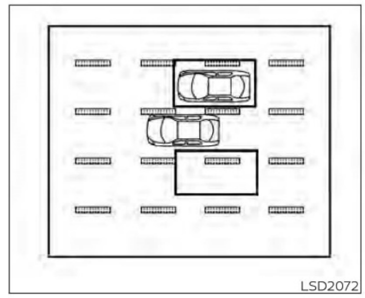


Illustration 6– Overtaking another vehicle

Illustration 6: If the I-BSI system is on and your vehicle approaches a lane marker while another vehicle is in the detection zone, the system chimes (three times) and the side indicator light flashes. The I-BSI system activates to help return the vehicle back to the center of the driving lane.

NOTE:

- When overtaking several vehicles in a row, the vehicles after the first vehicle may not be detected if they are traveling close together.
- The radar sensors may not detect slower moving vehicles if they are passed quickly.
- If the driver activates the turn signal before a vehicle enters the detection zone, the side indicator light will flash but no chime will sound when the other vehicle is detected.

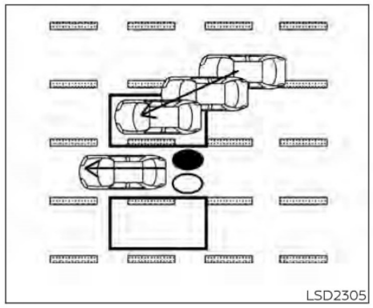


Illustration 7– Entering from the side

Entering from the side

Illustration 7: The side indicator light illuminates if a vehicle enters the detection zone from either side.

NOTE:

The radar sensors may not detect a vehicle which is traveling at about the same speed as your vehicle when it enters the detection zone.

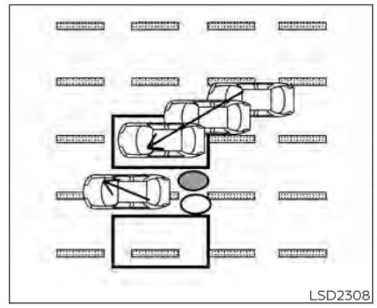


Illustration 8– Entering from the side

Illustration 8: If the driver activates the turn signal while another vehicle is in the detection zone, then the side indicator light flashes and a chime will sound twice.

NOTE:

If the driver activates the turn signal before a vehicle enters the detection zone, the side indicator light will flash but no chime will sound when another vehicle is detected.

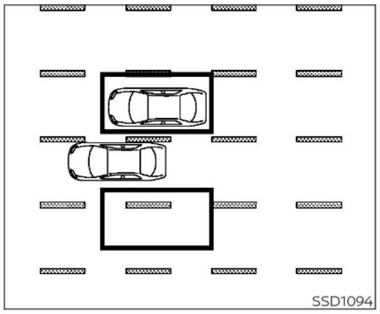


Illustration 9– Entering from the side

Illustration 9: If the I-BSI system is on and your vehicle approaches the lane marker while another vehicle is in the detection zone, the system chimes (three times) and the side indicator light flashes. The I-BSI system activates to help return the vehicle back to the center of the driving lane.

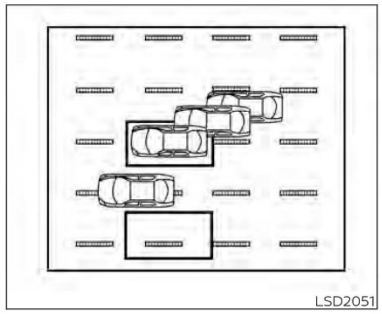


Illustration 10: – Entering from the side

Illustration 10: The I-BSI system will not operate if your vehicle is on a lane marker when another vehicle enters the detection zone. In this case only the BSW system operates.

NOTE:

- **The radar sensors may not detect a vehicle which is traveling at about the same speed as your vehicle when it enters the detection zone.**
- **If the driver activates the turn signal before a vehicle enters the detection zone, the side indicator light will flash but no chime will sound when the other vehicle is detected.**
- **I-BSI will not operate or will stop operating and only a warning chime will sound under the following conditions:**
  - **When the brake pedal is depressed.**
  - **When the vehicle is accelerated during I-BSI system operation.**
  - **When steering quickly.**
  - **When the ICC, I-FCW or AEB with Pedestrian Detection warnings sound.**
  - **When the hazard warning flashers are operated.**
  - **When driving on a curve at a high speed.**

SYSTEM TEMPORARILY UNAVAILABLE

Under the following conditions, a chime will sound, the following message will appear in the vehicle information display and the I-BSI system will be turned off automatically. The I-BSI system will not be available until the conditions no longer exist.

- "Not available Poor Road Conditions"
- When the VDC system (except TCS function) or ABS operates.
- "Currently not available"
- When the VDC system is turned off.

Action to take:

When the above conditions no longer exist, push the ProPILOT Assist switch (models with ProPILOT Assist) or the dynamic driver assistance switch (models without ProPILOT Assist) again to turn the I-BSI system back on.

When radar blockage is detected, the I-BSI system will be turned off automatically, a chime will sound and the "Unavailable: Side Radar Obstruction" warning message will appear in the vehicle information display.

The I-BSI system is not available until the conditions no longer exist. For additional information, refer to "System maintenance" in this section.

Action to take:

When the above conditions no longer exist, turn the I-BSI system on again. If the "Unavailable: Side Radar Obstruction" warning message appears even after the I-BSI system is turned on again, stop the vehicle in a safe location, place the vehicle in the P (Park) position and turn the EV system off. Check for and remove objects obscuring the radar sensors on the rear bumper, and restart the EV system.

If the vehicle is parked in direct sunlight under high temperature conditions (over approximately 104°F (40°C)) and then the I-BSI system is turned on, the I-BSI system may be deactivated automatically. The "Unavailable: High Cabin Temperature" warning message will appear in the vehicle information display.

Action to take:

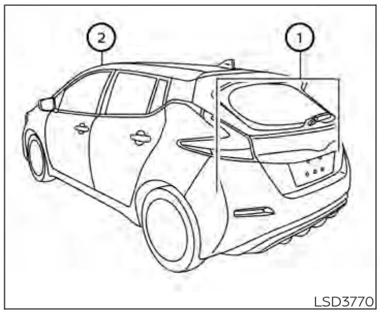
When the interior temperature is reduced, push the ProPILOT Assist switch (models with ProPILOT Assist) or the dynamic driver assistance switch (models without ProPILOT Assist) again to turn the I-BSI system back on.

SYSTEM MALFUNCTION

When the I-BSI system malfunctions, it will be turned off automatically, a chime will sound, and the "Not available System Malfunction" warning message with the BSW indicator (orange) will appear in the vehicle information display.

Action to take:

Stop the vehicle in a safe location, place the vehicle in the P (Park) position, turn the EV system off and restart the EV system. If the "Not available System Malfunction" warning message with the BSW indicator (orange) continues to be displayed, have the I-BSI system checked. It is recommended you visit a NISSAN certified LEAF dealer for this service.



LSD3770

SYSTEM MAINTENANCE

The two radar sensors ① for the I-BSI system are located near the rear bumper. Always keep the area near the radar sensors clean.

The radar sensors may be blocked by temporary ambient conditions such as splashing water, mist or fog.

The blocked condition may also be caused by objects such as ice, frost or dirt obstructing the radar sensors.

Check for and remove objects obstructing the radar sensors.

Do not attach stickers (including transparent material), install accessories or apply additional paint near the radar sensors.

Do not strike or damage the area around the radar sensors.

It is recommended you visit a NISSAN certified LEAF dealer if the area around the radar sensors is damaged due to a collision.

The lane camera unit ② for I-BSI system is located above the inside mirror. To keep the proper operation of I-BSI and prevent a system malfunction, be sure to observe the following:

- Always keep the windshield clean.
- Do not attach a sticker (including transparent material) or install an accessory near the camera unit.
- Do not place reflective materials, such as white paper or a mirror, on the instrument panel. The reflection of sunlight may adversely affect the camera unit's capability of detecting the lane markers.
- Do not strike or damage the areas around the camera unit. Do not touch the camera lens or remove the screw located on the camera unit. It is recommended that you contact a NISSAN certified LEAF dealer if the camera unit is damaged due to an accident.

Radio frequency statement

For USA

FCC ID: OAYSRR3B

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Warning

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

APPENDIX C

Run Log

Subject Vehicle: **2020 Nissan Leaf SV** Date: **8/7/2020**

Test Engineer: **J. Robel**

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
21	**SV Lane Change Constant Headway**	N						POV Speed
22		N						POV Speed
23		N						Headway
24	Static Run							
25	**SV Lane Change Constant Headway**	N						POV Speed, Driver intervention before collision
26		N						POV Speed
27		N						POV Speed
28		N						SV Speed drops due to BSI, Headway drops due to BSI, Early BSI so average lateral velocity looks low. Lateral velocity
29		N						Headway
30		N						Driver steering before impact
31		Y	0.00	-3.53	Y	Y	N	
32		Y	0.00	-3.47	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
33	SV Lane Change Constant Headway (cont'd)	Y	0.00	-3.61	N	Y	N	POV GPS status goes bad when contact happens, check collision checker. Verified in MABX Data Plotter
34		N						Headway
35		Y	0.00	-3.45	Y	Y	N	
36		N						Headway, Turn Signal Late
37		Y	0.00	-3.60	Y	Y	N	
38		Y	0.00	-3.22	N	Y	N	
39		N						Headway, POV Speed
40		Y	0.00	-3.36	Y	Y	N	
41	SV Lane Change Closing Headway	N						Early lane change
42		N						Early lane change
43		Y	0.00	-3.28	Y	Y	N	
44		N						Turn signal TTC, turned away early
45		N						POV speed, ran out of path
46		N						POV speed, lateral velocity
47		Y	0.00	-3.62	N	Y	N	
48		Y	0.00	-3.53	Y	Y	N	
49		N						GST lagged behind
50		N						Turn signal late
51		Y	0.00	-3.69	N	Y	N	

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
52	**SV Lane Change Closing Headway (cont'd)**	N						POV lateral position
53		N						POV lateral position
54		N						Turn signal early, POV was lagging
55		N						POV lateral position
56		N						POV lateral position, Aborted run
57		Y	0.00	-3.45	Y	Y	N	
58		N						POV lateral position
59		Y	0.00	-3.38	Y	Y	N	
60		Y	0.00	-3.63	Y	Y	N	
1	Static Run - RL							
2	**SV Lane Change Constant Headway False Positive Baseline**	N						SV path deviation
3		Y						
4		Y						
5		Y						
6	**SV Lane Change Constant Headway False Positive Assessment**	N						Selected different scenario
7		N						Selected different POV
8		N						SV path deviation, headway
9		Y			N	N	Y	
10		Y			N	N	Y	
11		Y			N	N	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
12	**SV Lane Change Constant Headway False Positive Assessment (cont'd)**	Y			N	N	Y	
13		Y			N	N	Y	
14		N						POV path
15		N						SV, POV path
16		Y			N	N	Y	
17		N						Avg lateral velocity
18		N						Headway
19		Y			N	N	Y	
20	Static Run - GST							

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:

- Subject Vehicle Lane Change with Constant Headway
- Subject Vehicle Lane Change with Closing Headway
- Subject Vehicle Lane Change with Constant Headway, False Positive Assessment – Baseline
- Subject Vehicle 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) – Subject vehicle longitudinal acceleration. If the BSI system operates using a brake intervention, a vertical bold line marked “BSI Onset” indicates the time at which 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.

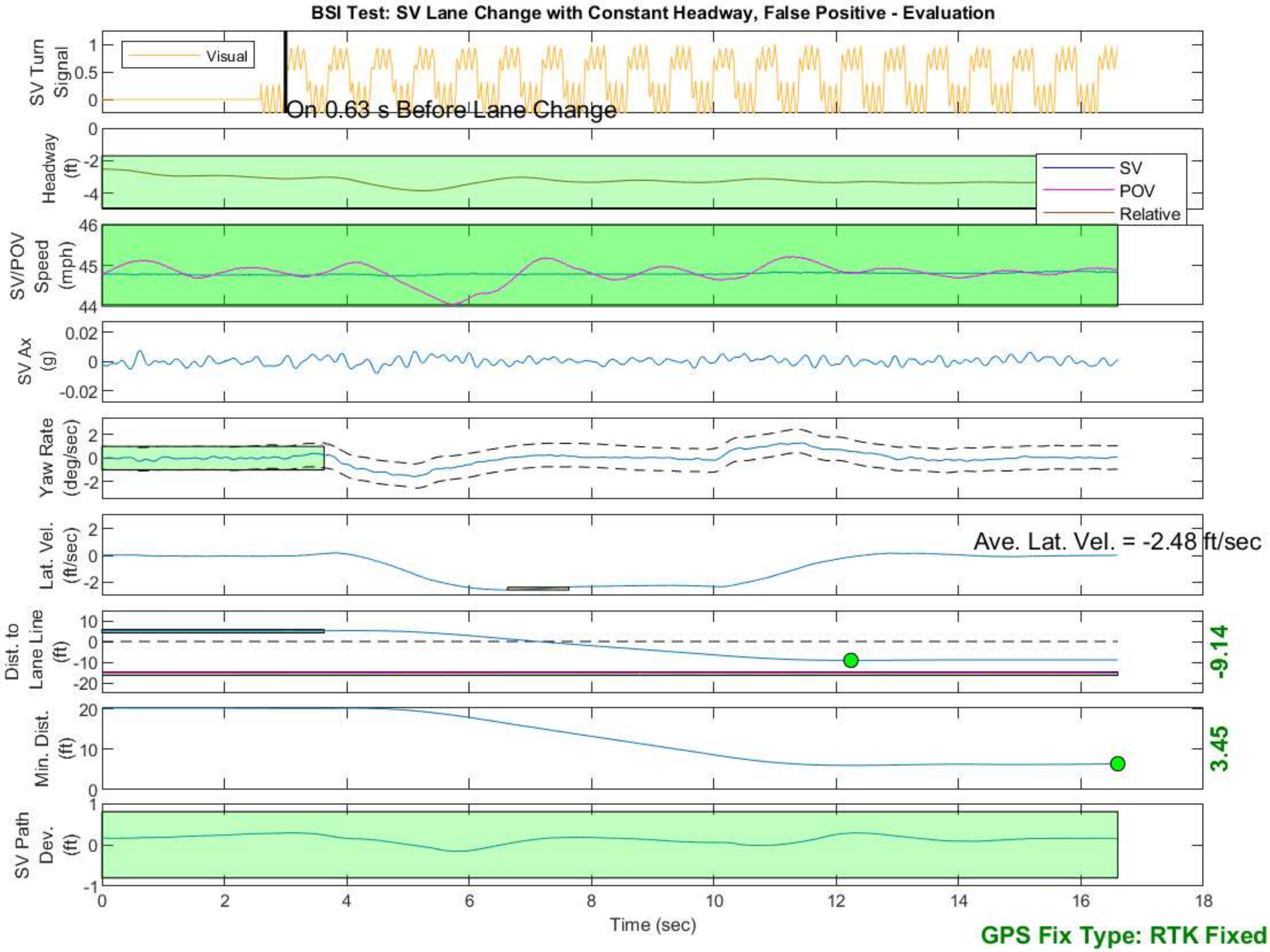


Figure D1. Example Time History for False Positive Evaluation, Passing

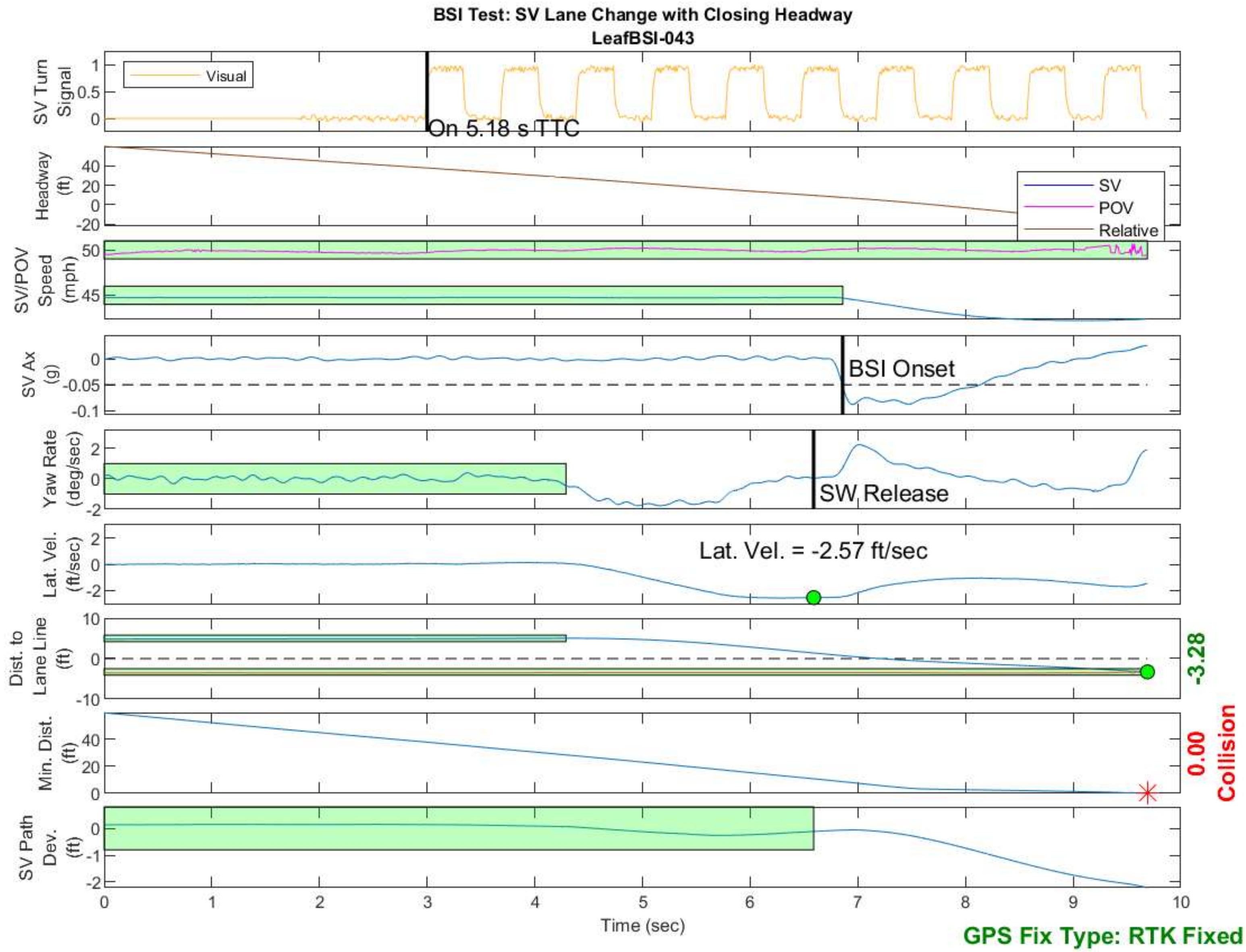


Figure D2. Example Time History for Subject Vehicle with Closing HeadwayTest, Failing

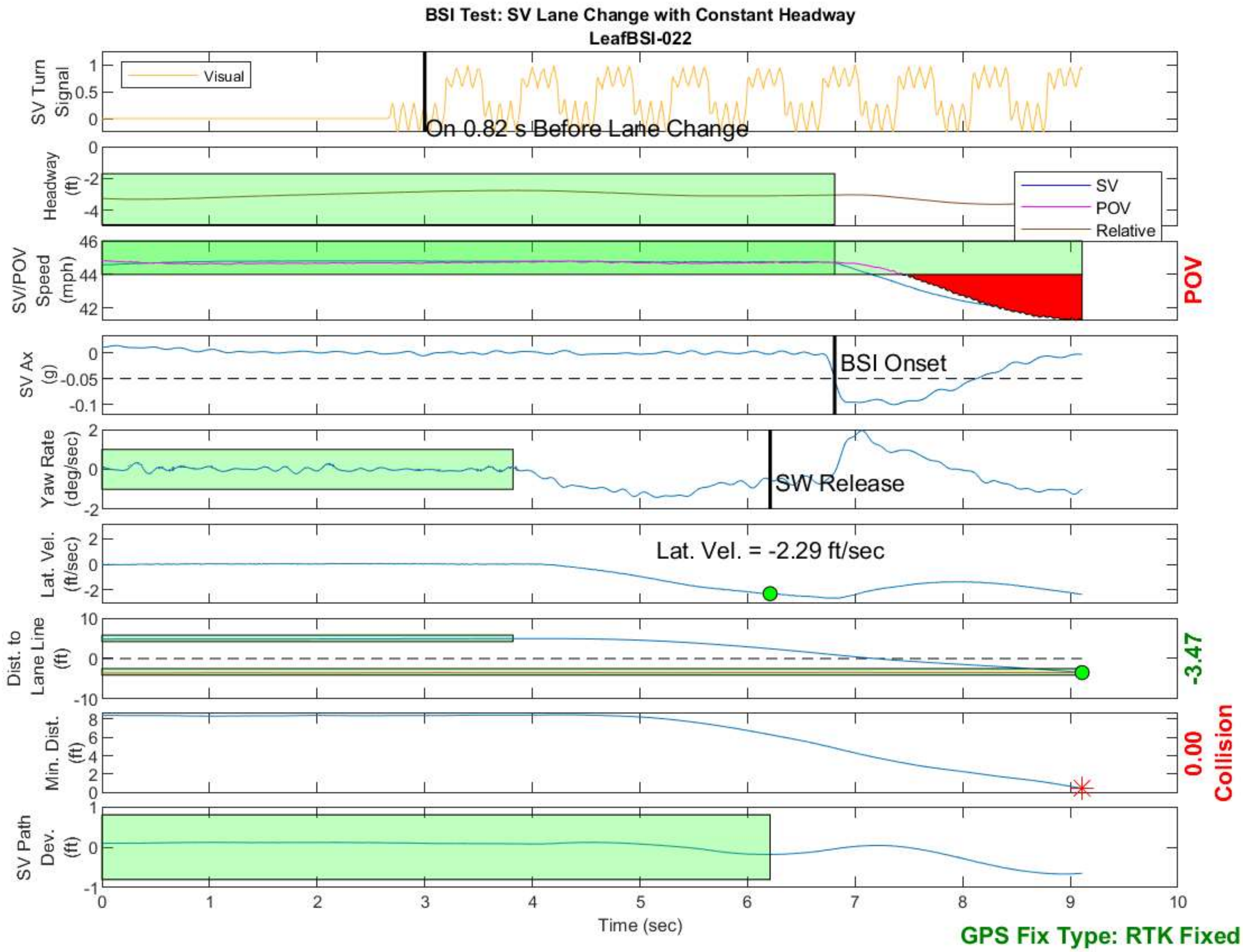


Figure D3. Example Time History for Subject Vehicle with Constant HeadwayTest, Invalid POV SpeedCriteria

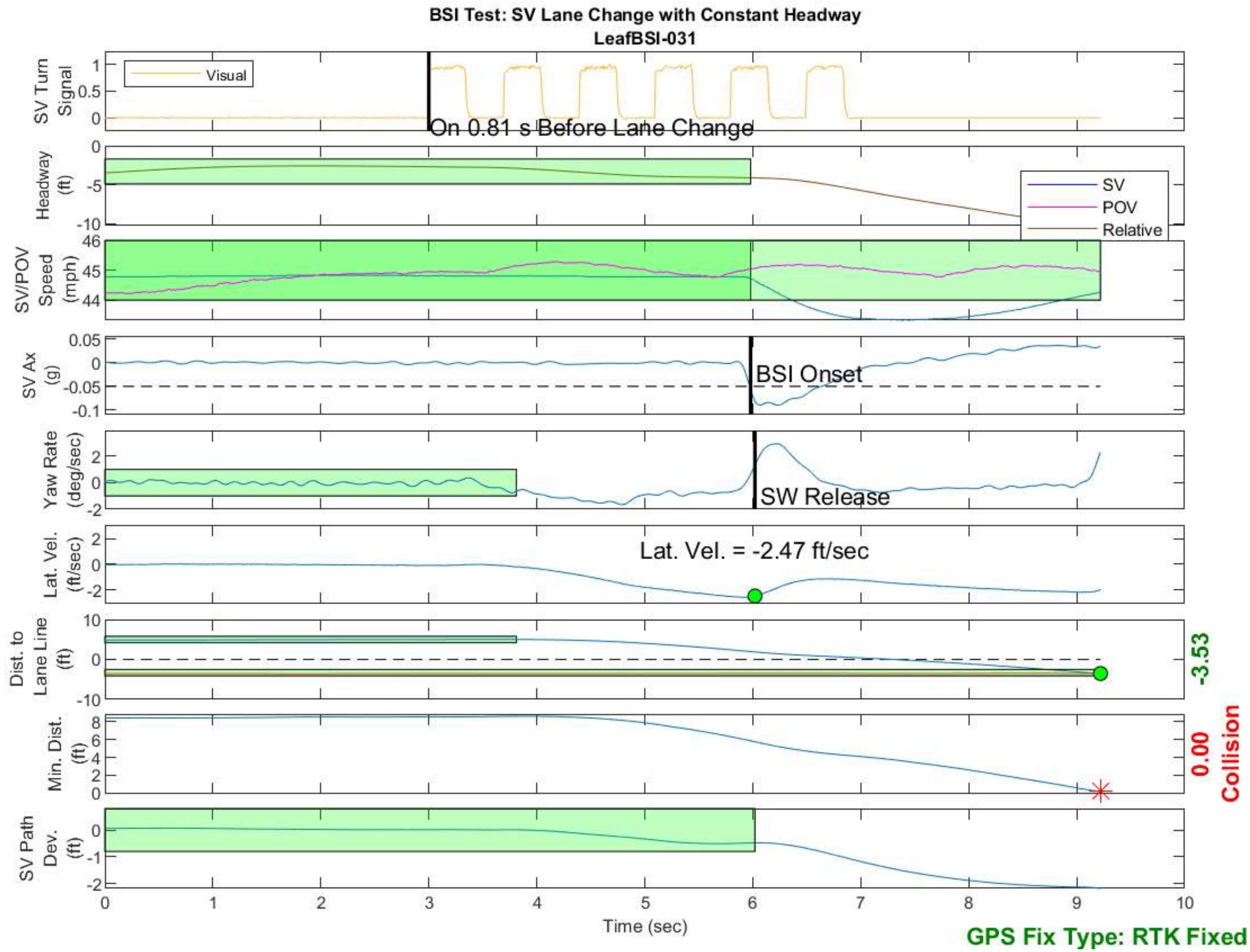


Figure D4. BSI Run 31, Subject Vehicle Lane Change with Constant Headway

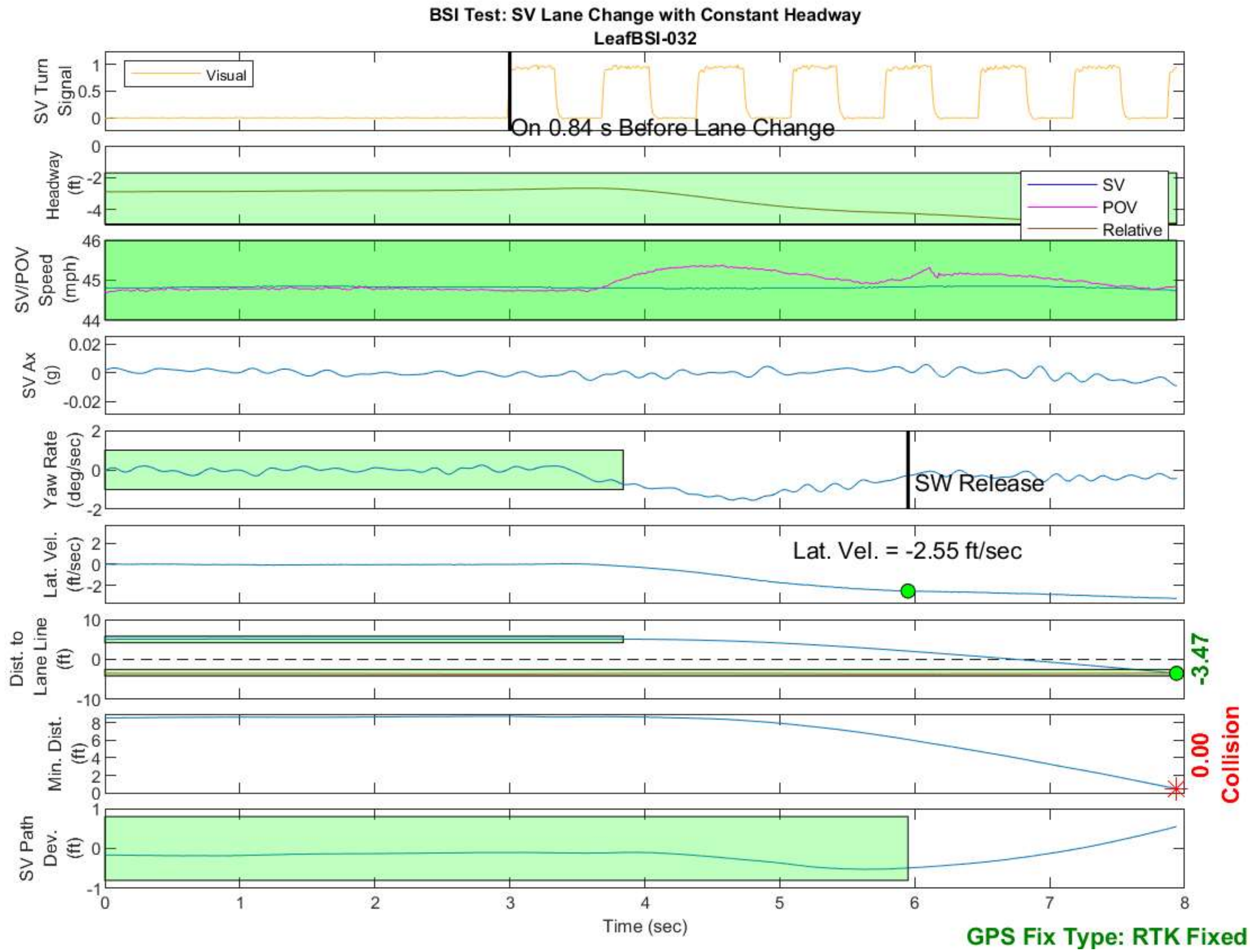


Figure D5. BSI Run 32, Subject Vehicle Lane Change with Constant Headway

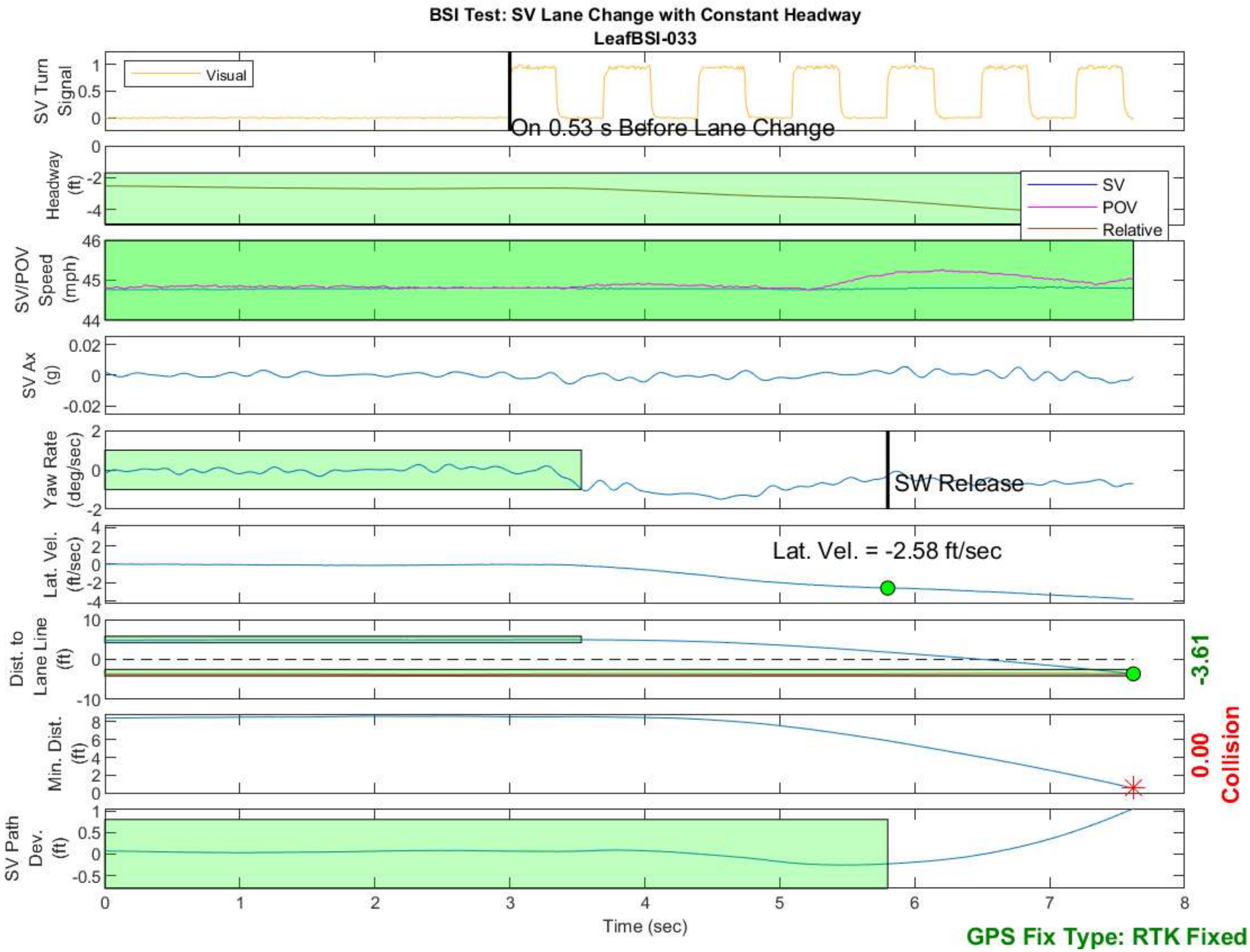


Figure D6. BSI Run 33, Subject Vehicle Lane Change with Constant Headway

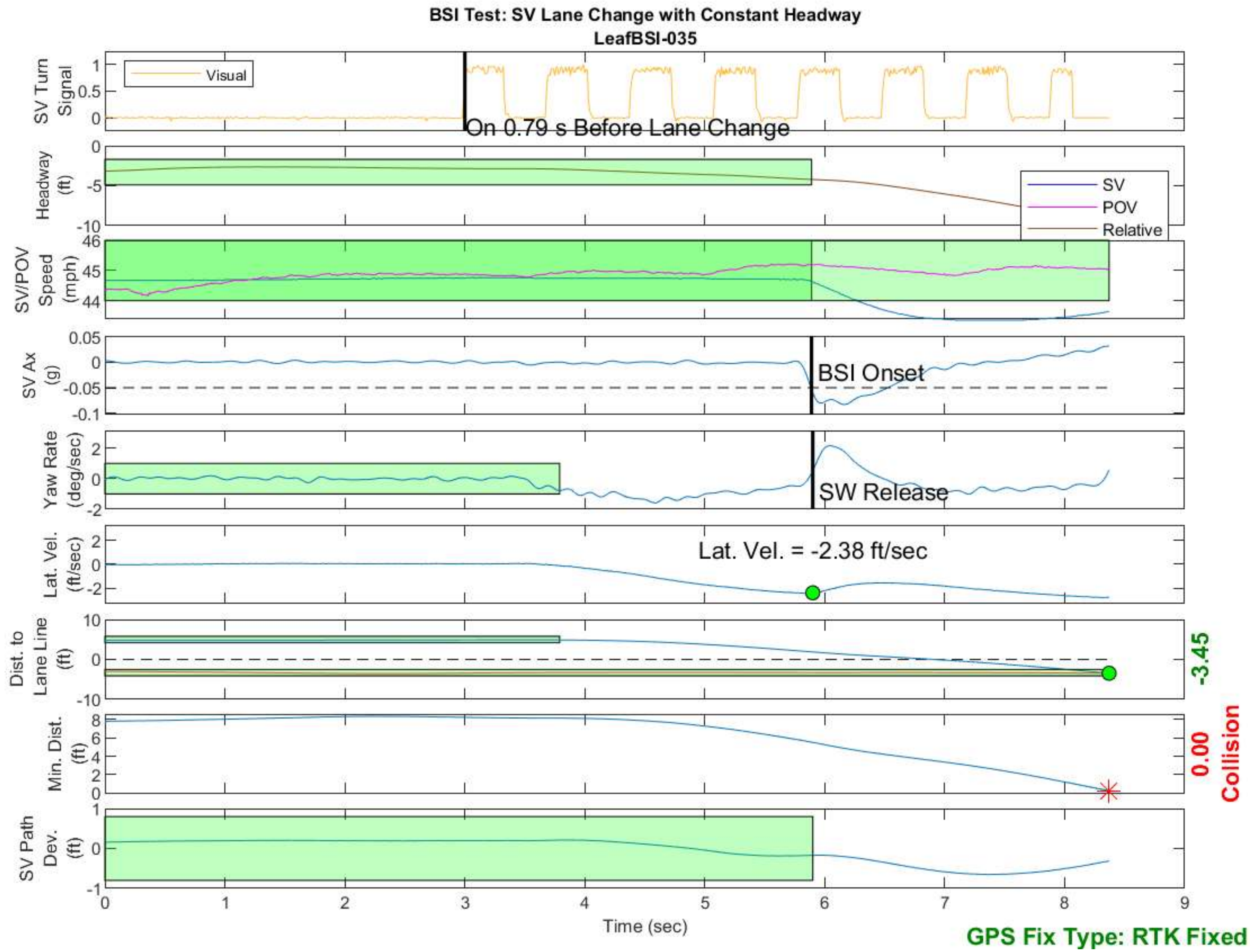


Figure D7. BSI Run 35, Subject Vehicle Lane Change with Constant Headway

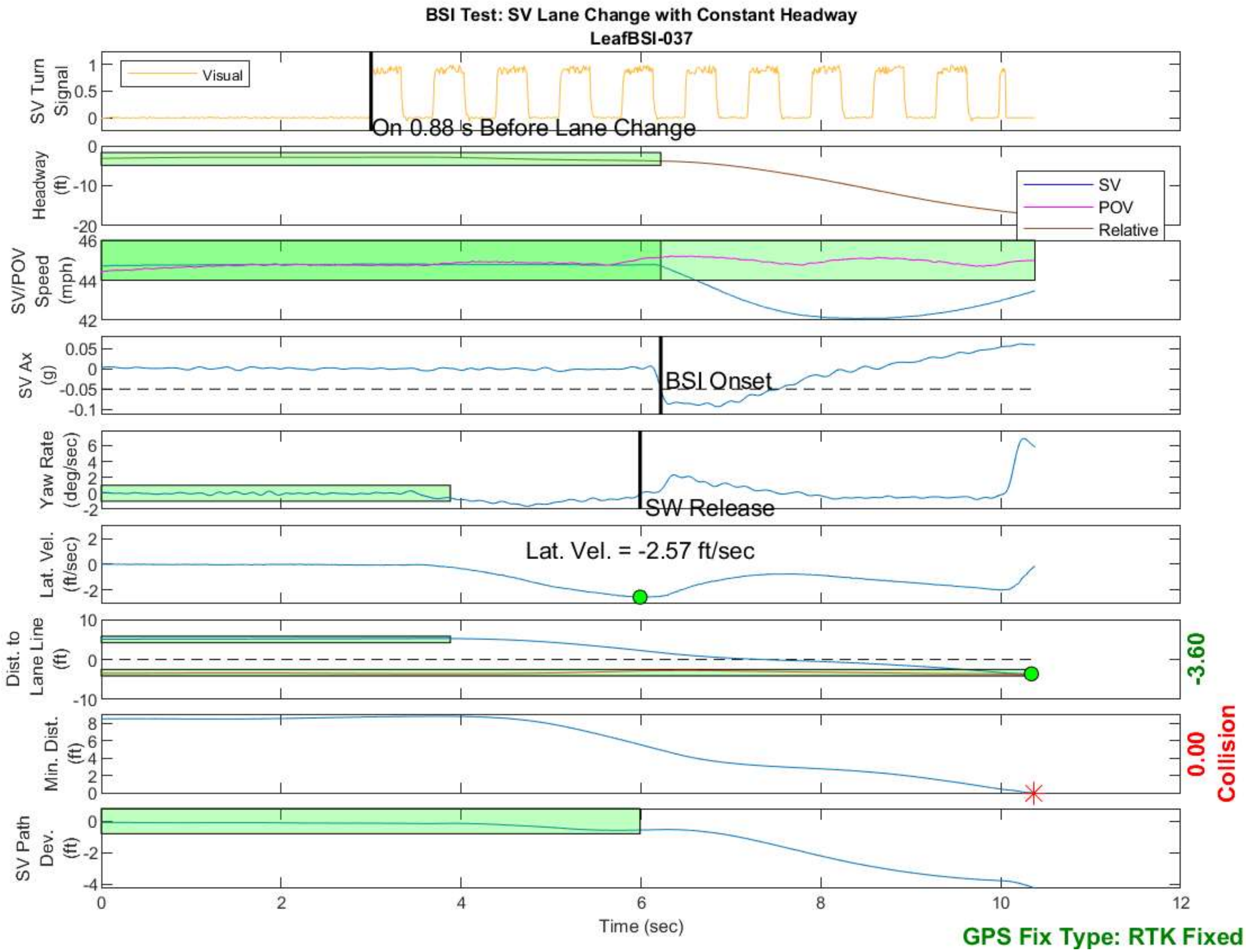


Figure D8. BSI Run 37, Subject Vehicle Lane Change with Constant Headway

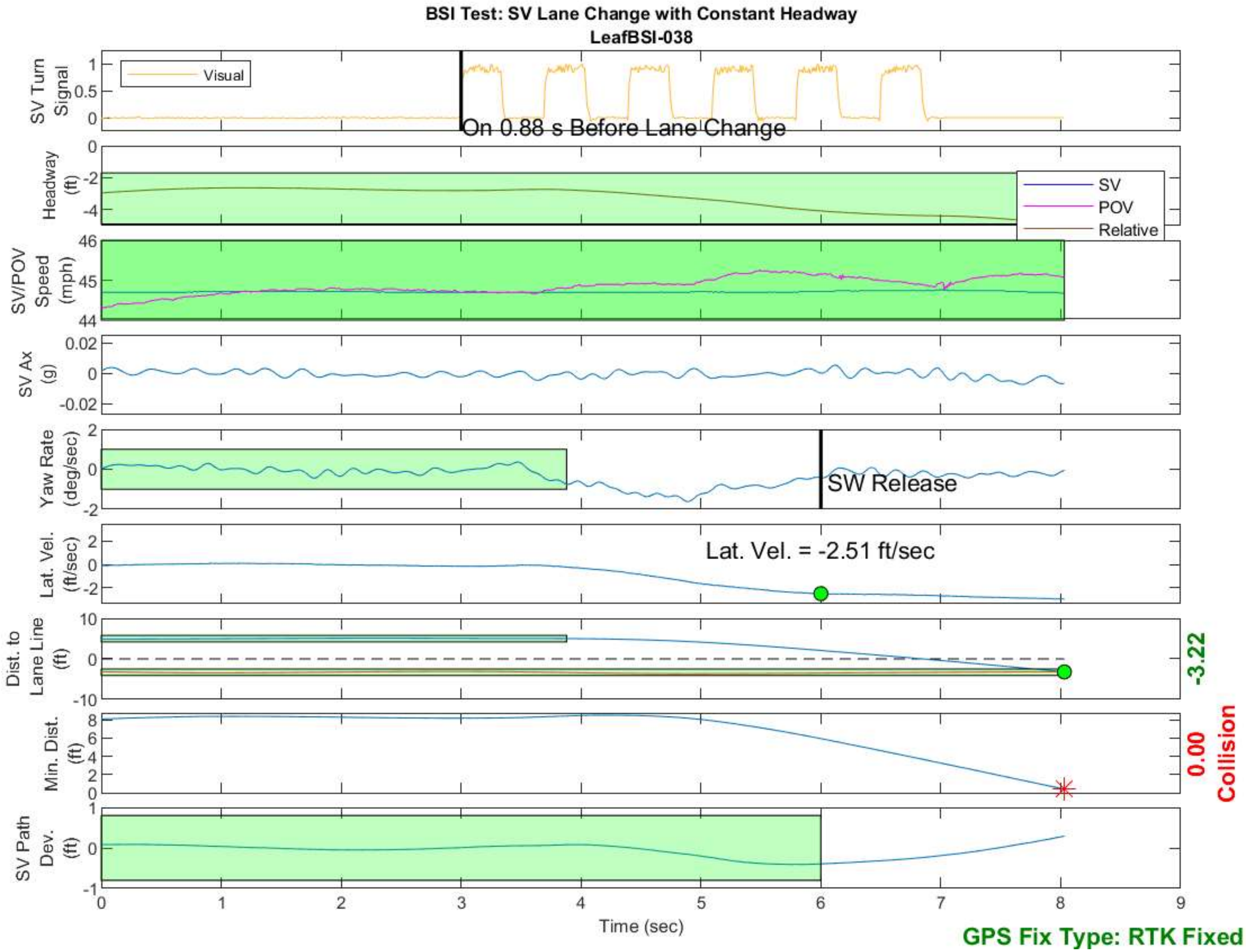


Figure D9. BSI Run 38, Subject Vehicle Lane Change with Constant Headway

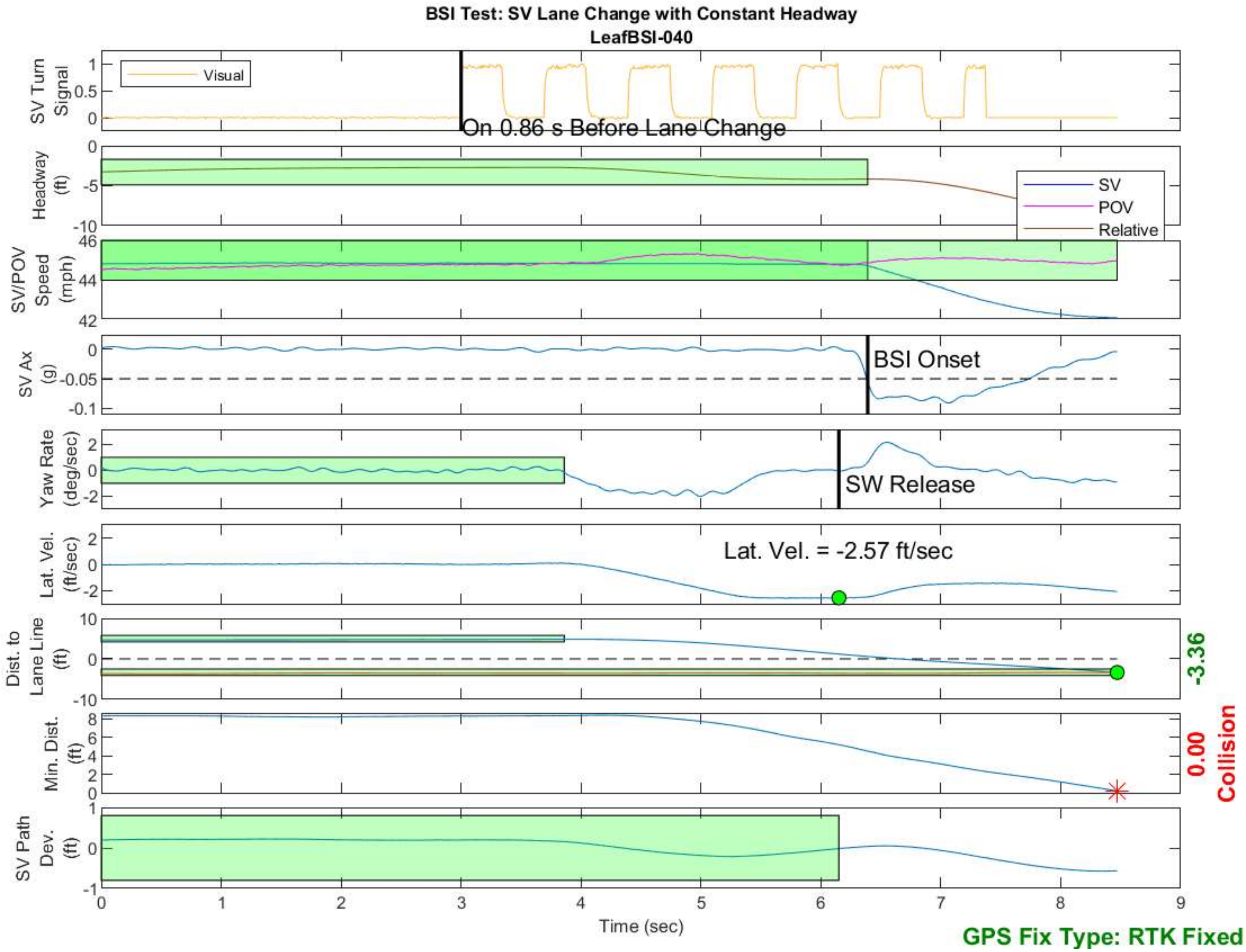


Figure D10. BSI Run 40, Subject Vehicle Lane Change with Constant Headway

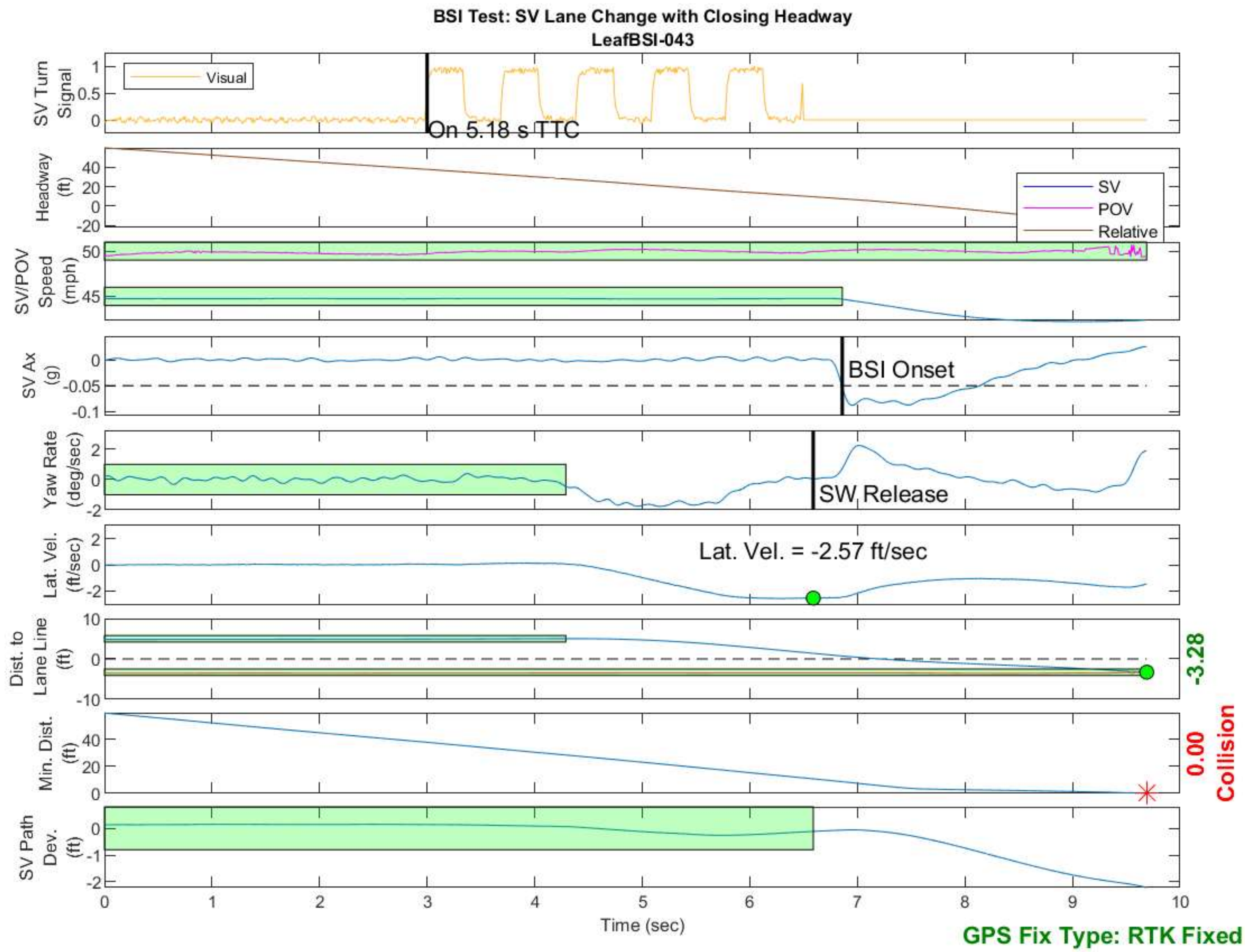


Figure D11. BSI Run 43, Subject Vehicle Lane Change with Closing Headway

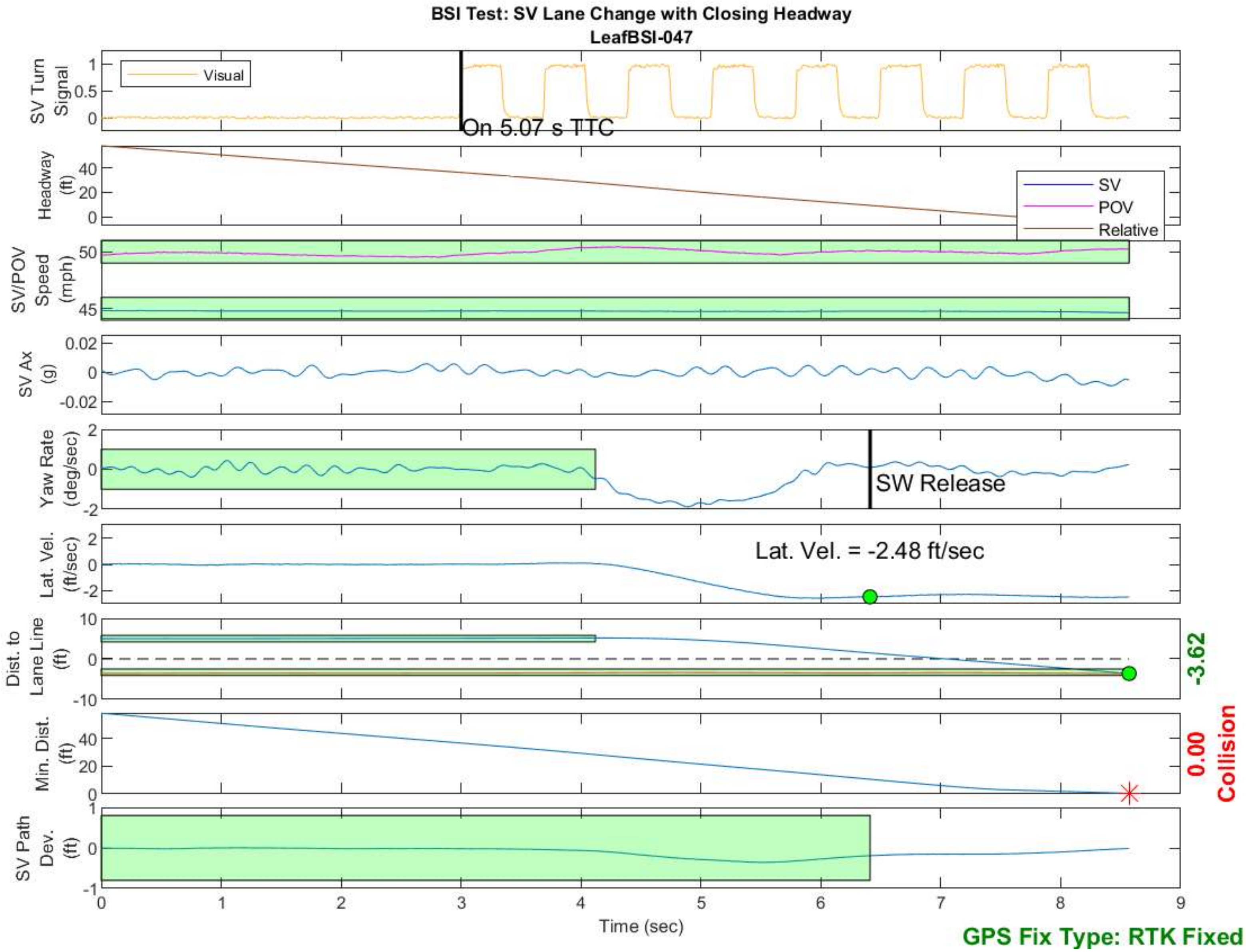


Figure D12. BSI Run 47, Subject Vehicle Lane Change with Closing Headway

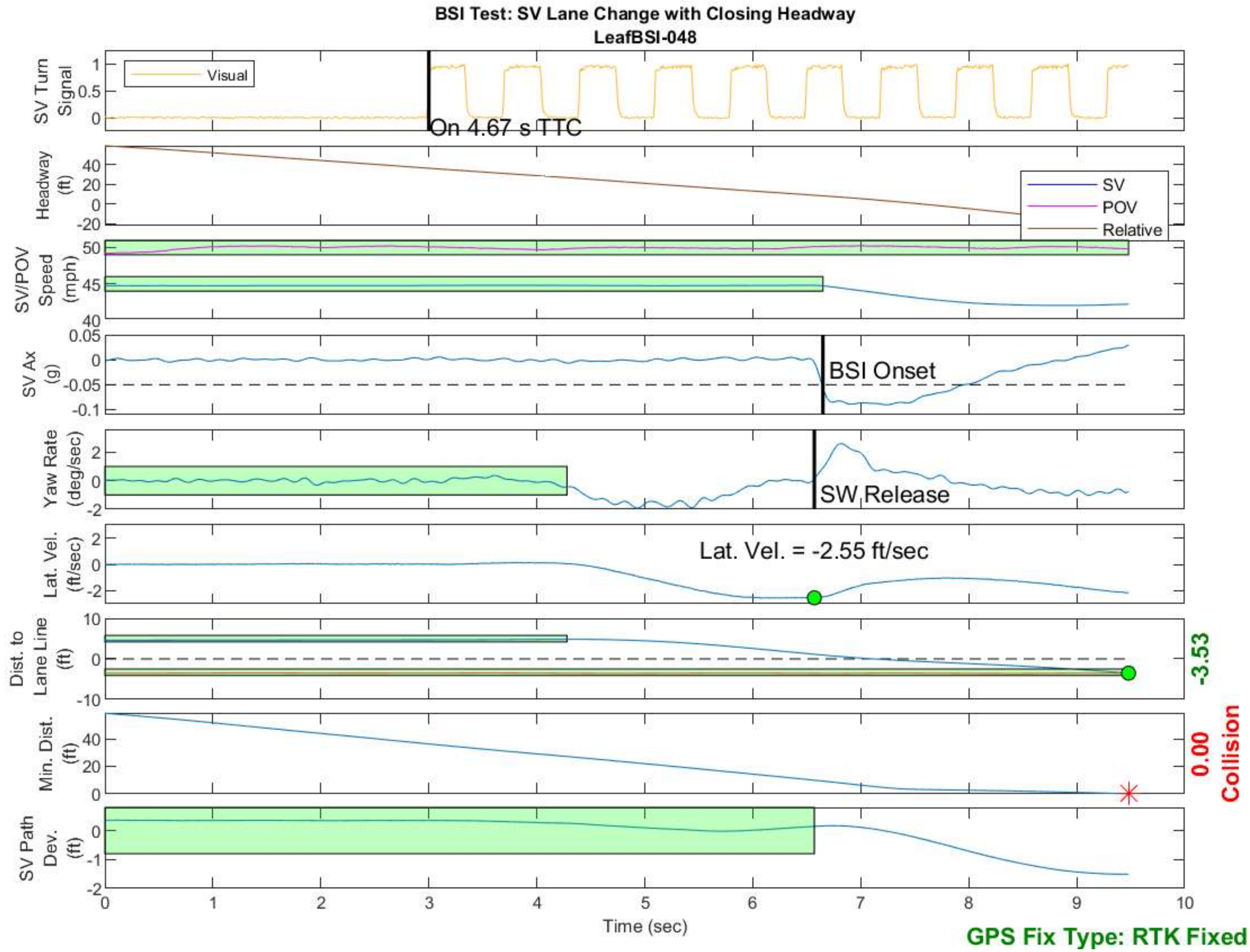


Figure D13. BSI Run 48, Subject Vehicle Lane Change with Closing Headway

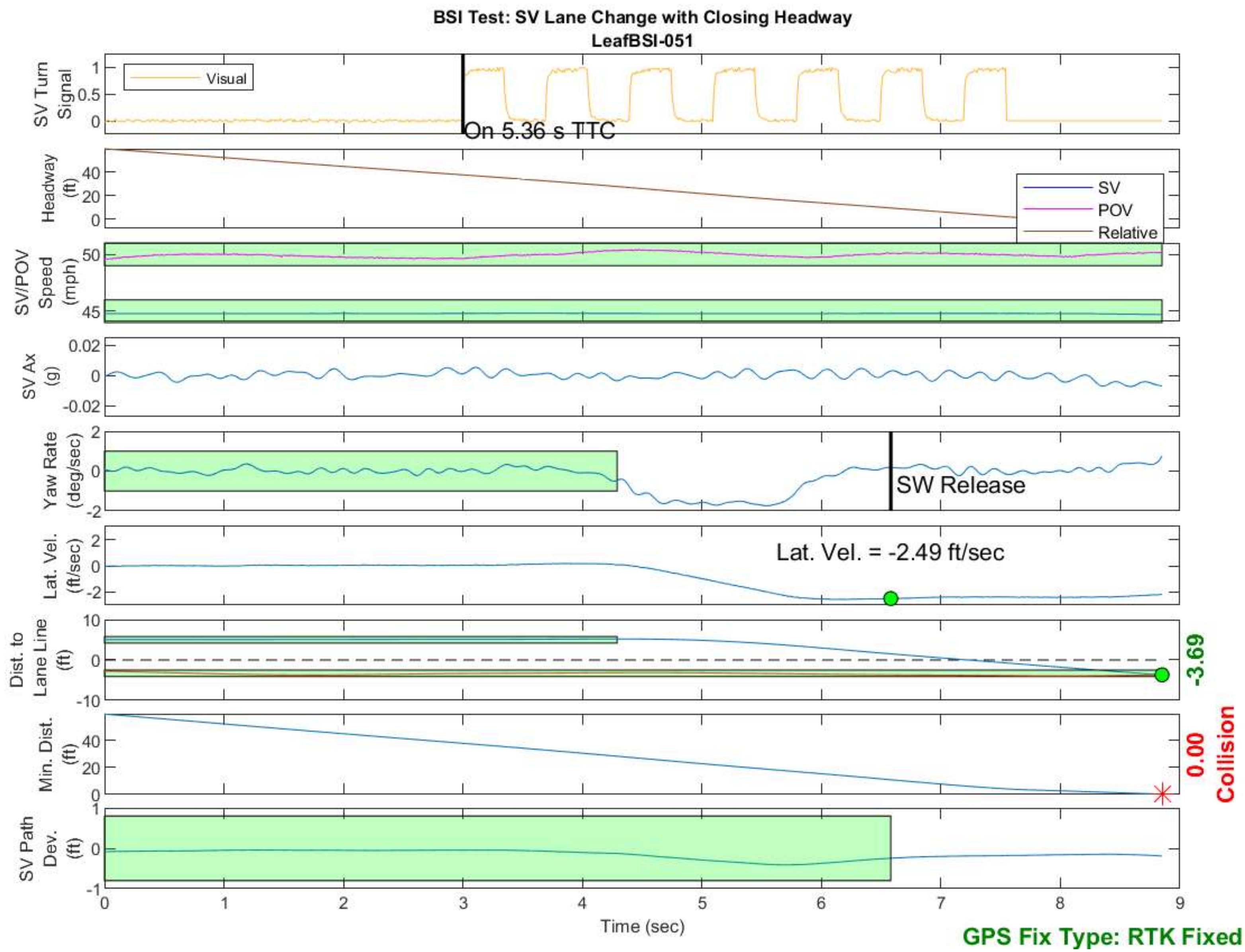


Figure D14. BSI Run 51, Subject Vehicle Lane Change with Closing Headway

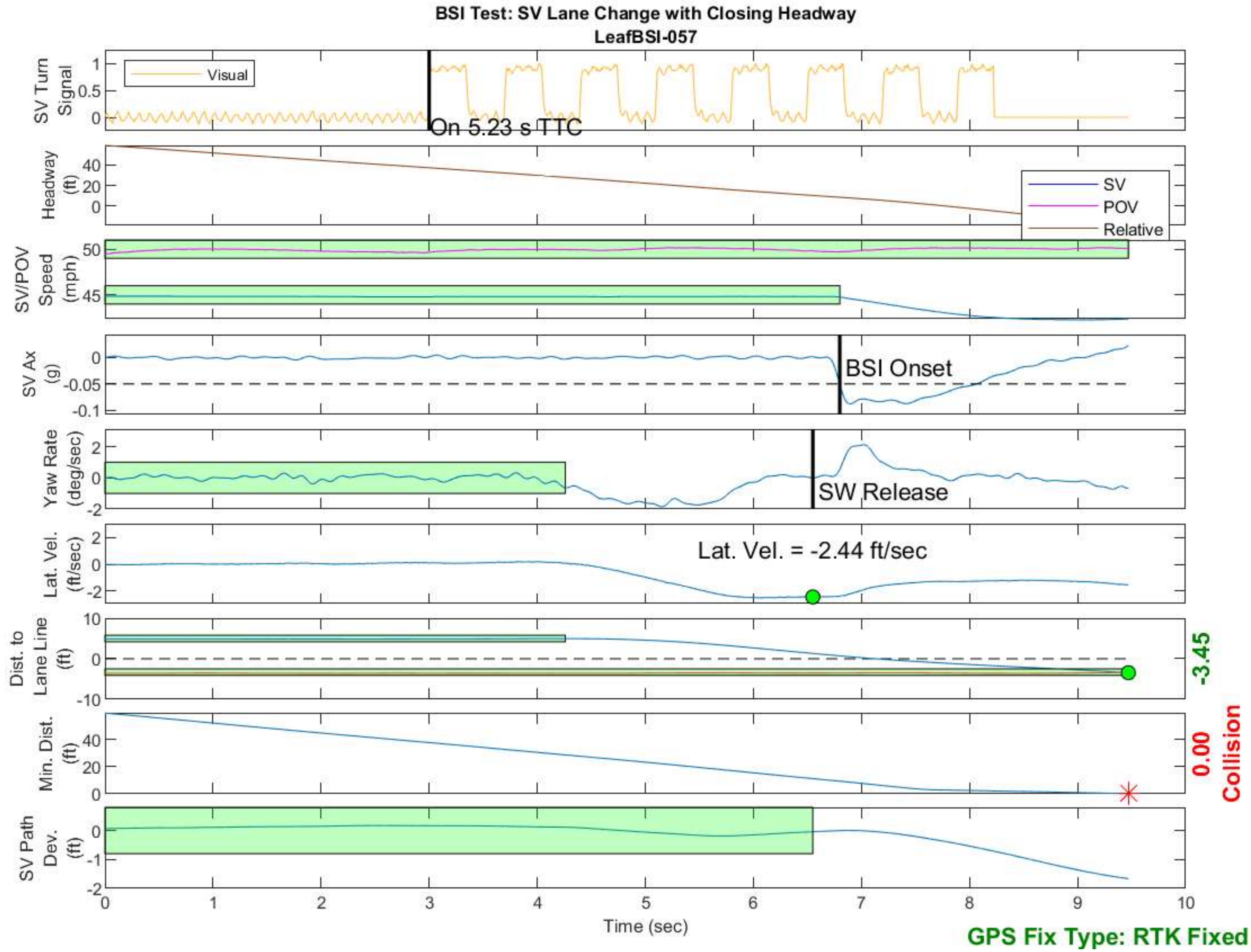


Figure D15. BSI Run 57, Subject Vehicle Lane Change with Closing Headway

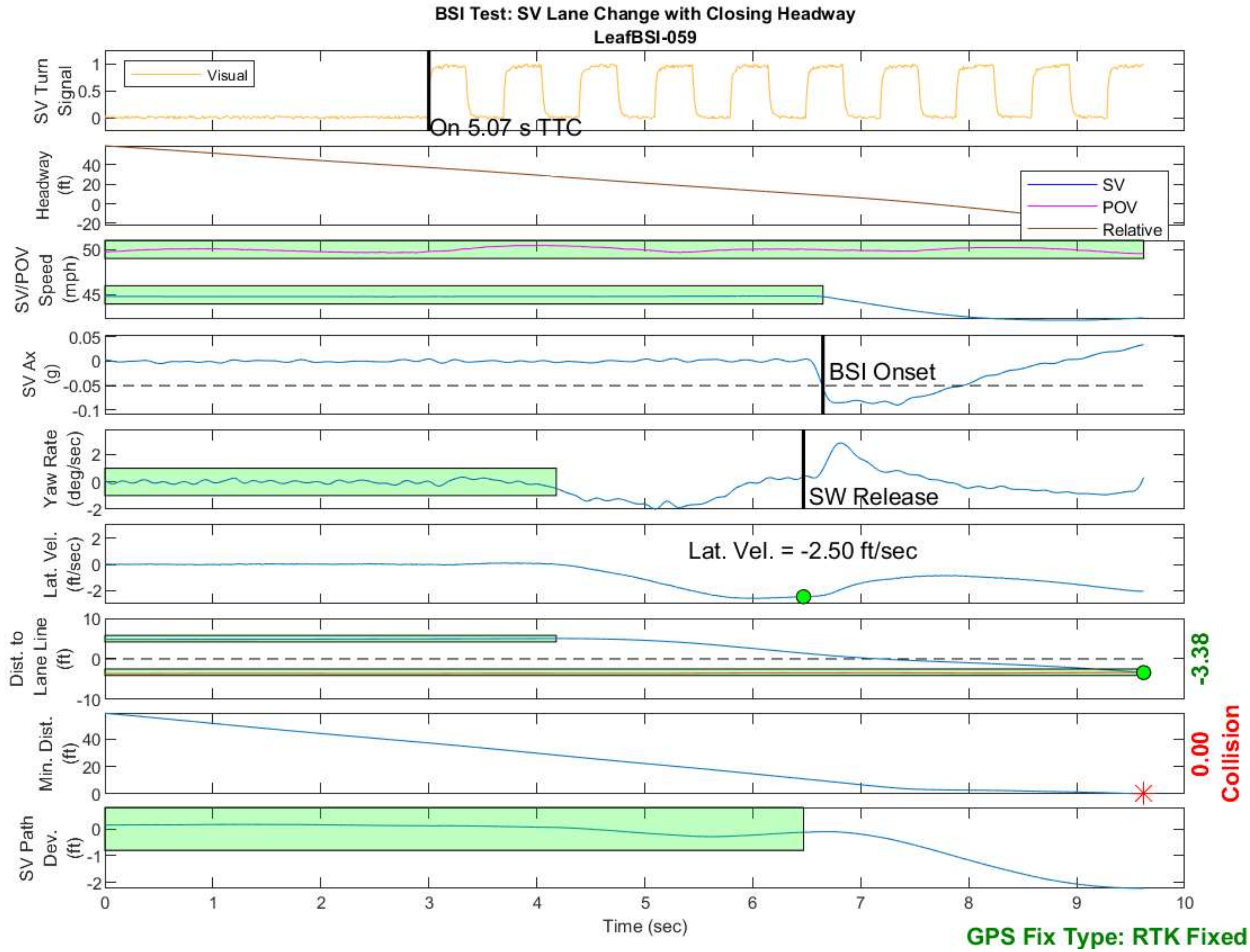


Figure D16. BSI Run 59, Subject Vehicle Lane Change with Closing Headway

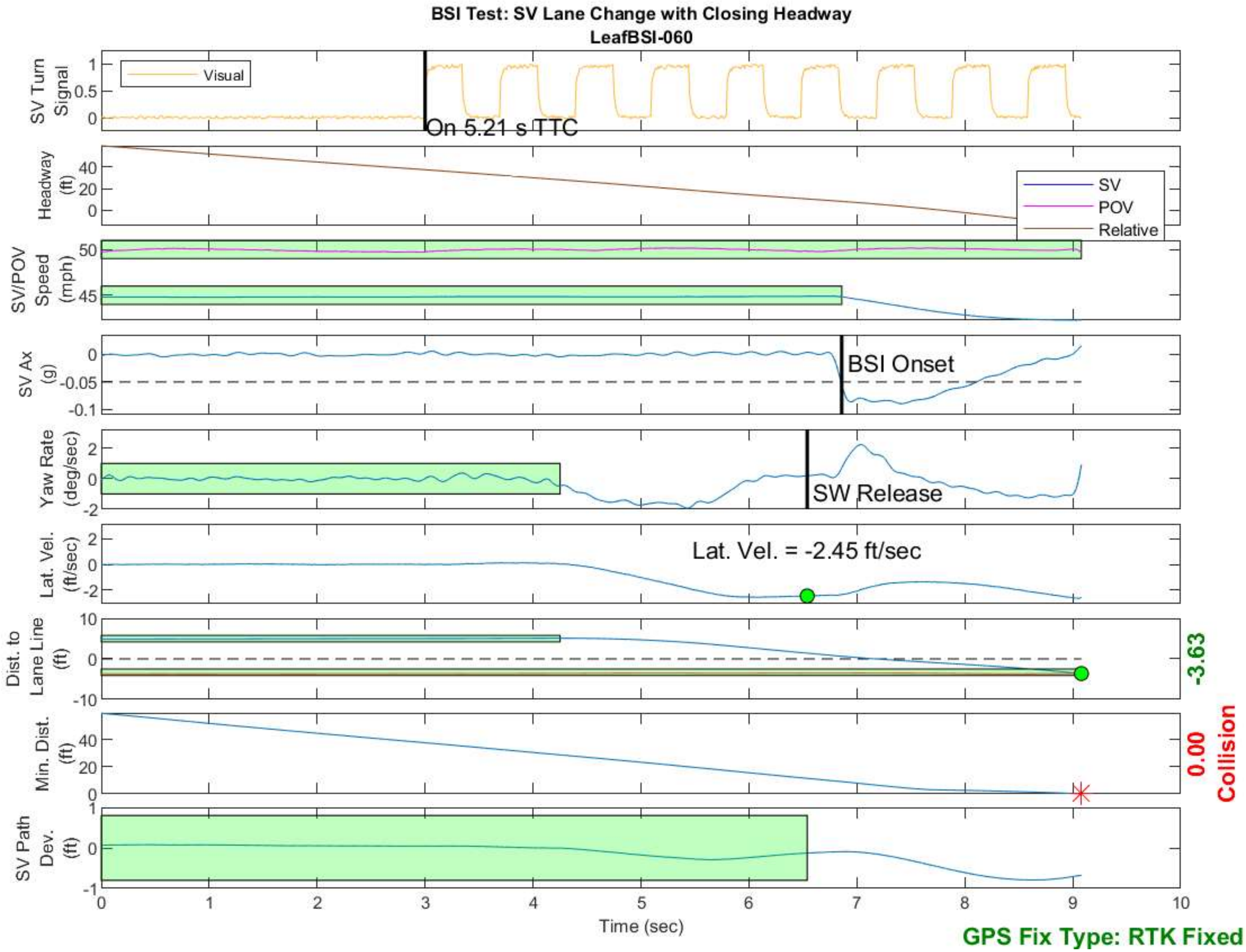


Figure D17. BSI Run 60, Subject Vehicle Lane Change with Closing Headway

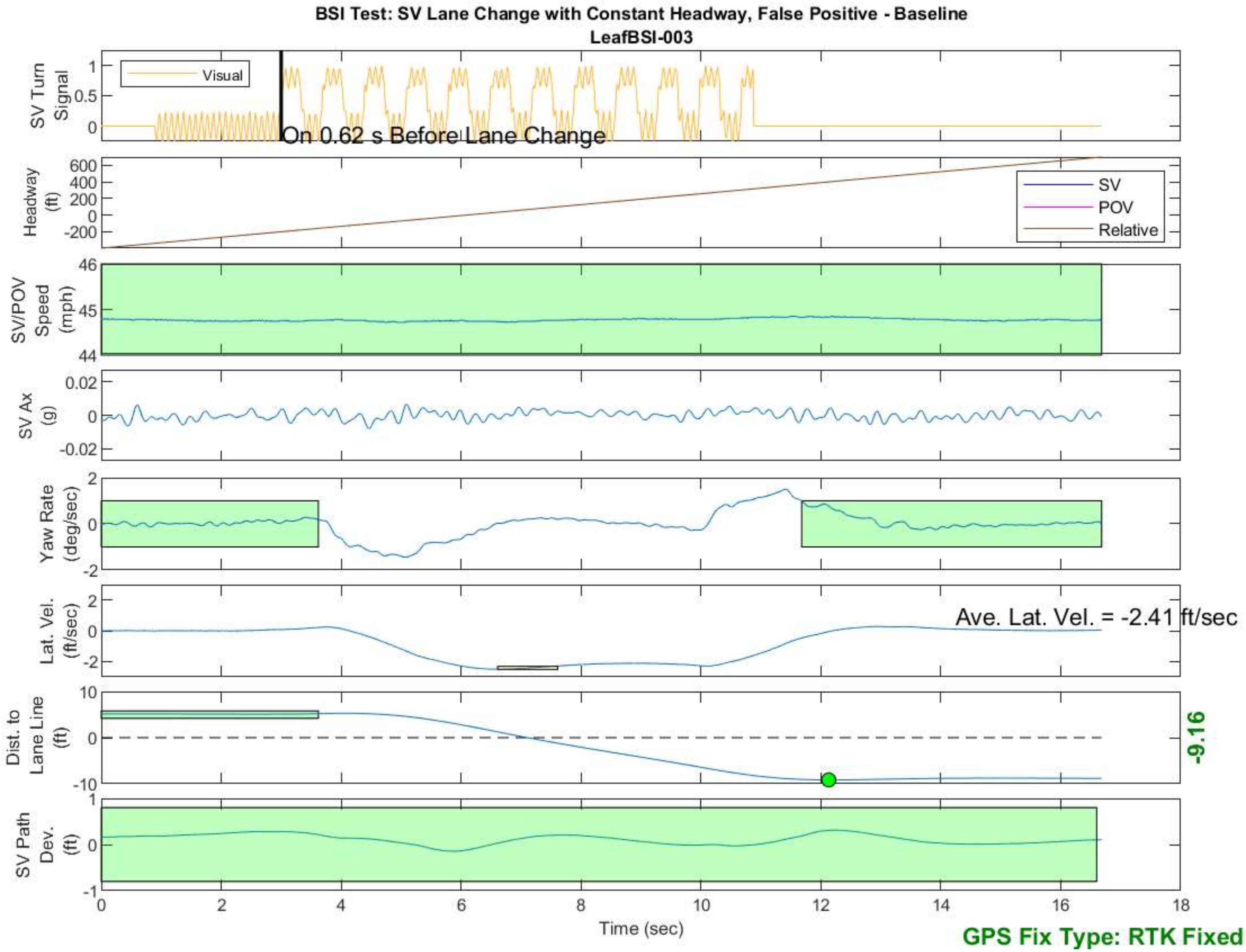


Figure D18. BSI Run 3, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

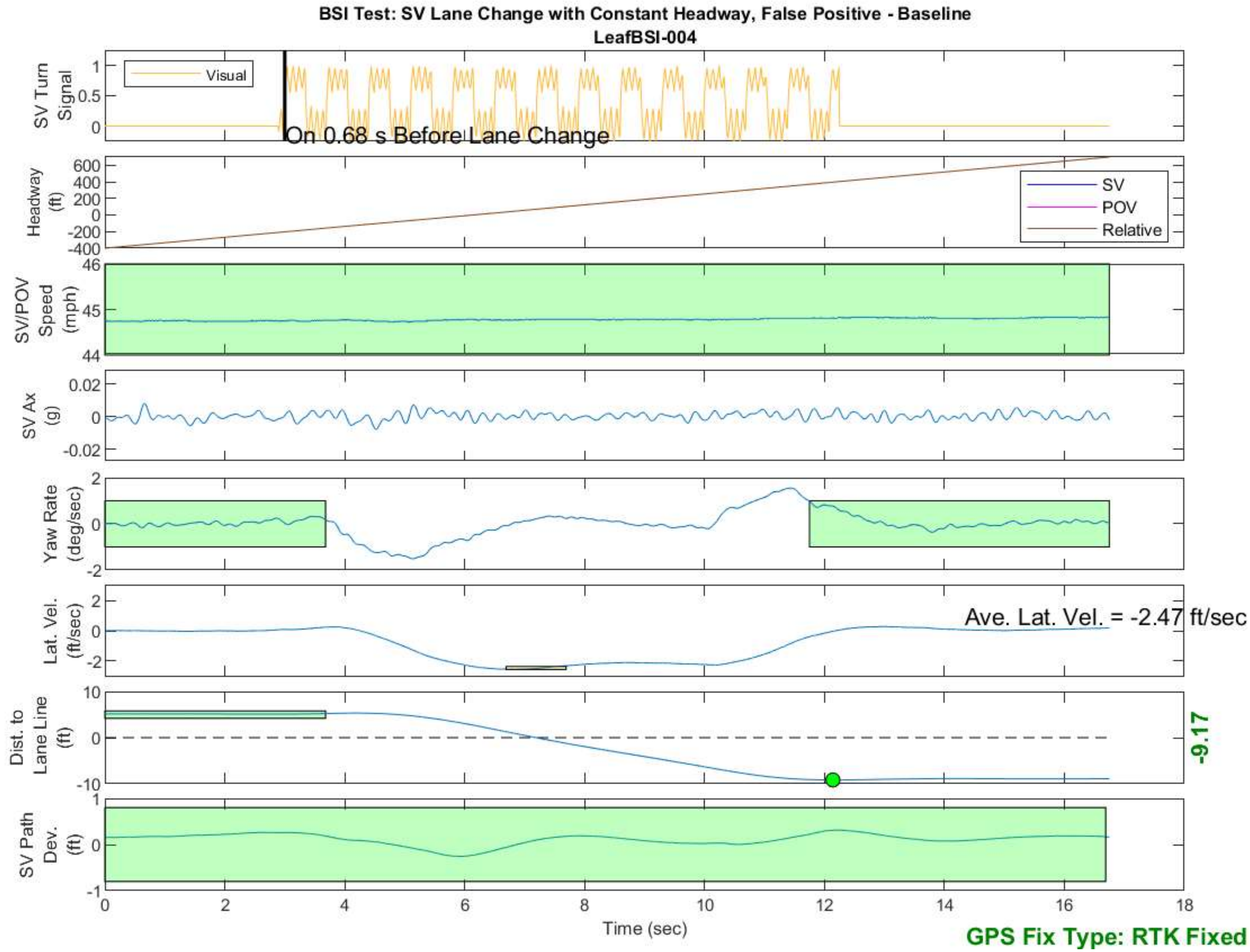


Figure D19. BSI Run 4, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

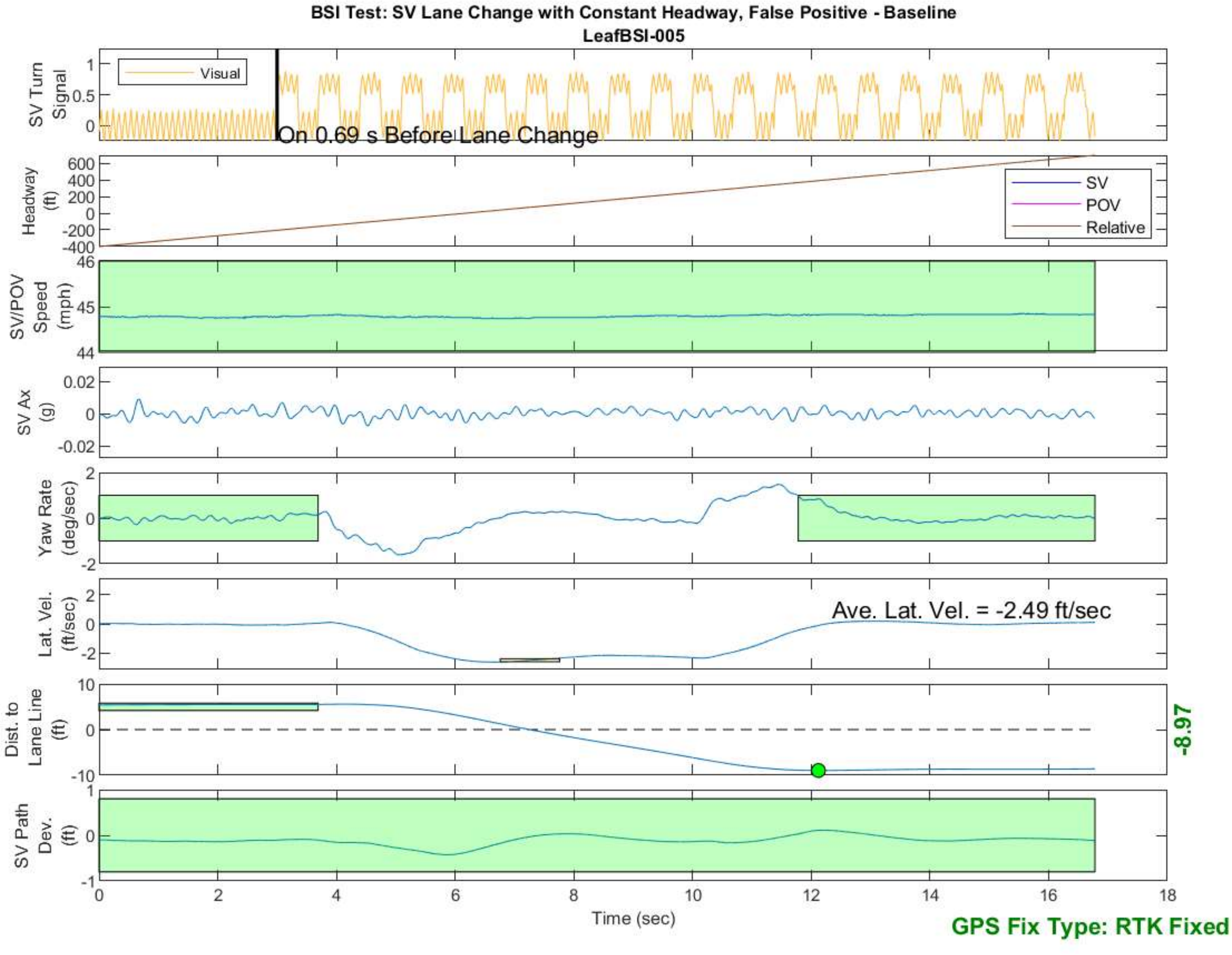


Figure D20. BSI Run 5, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Baseline

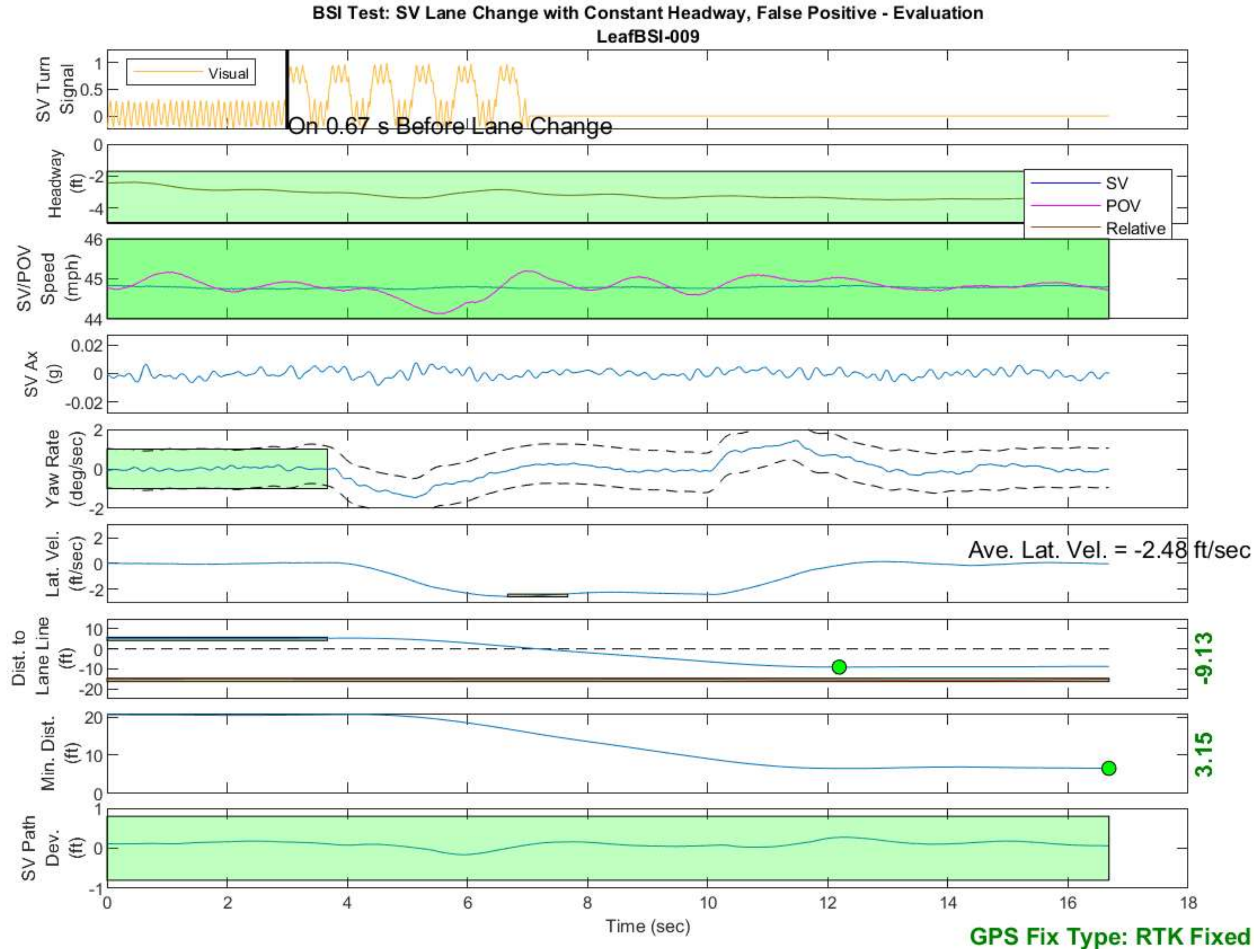


Figure D21. BSI Run 9, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

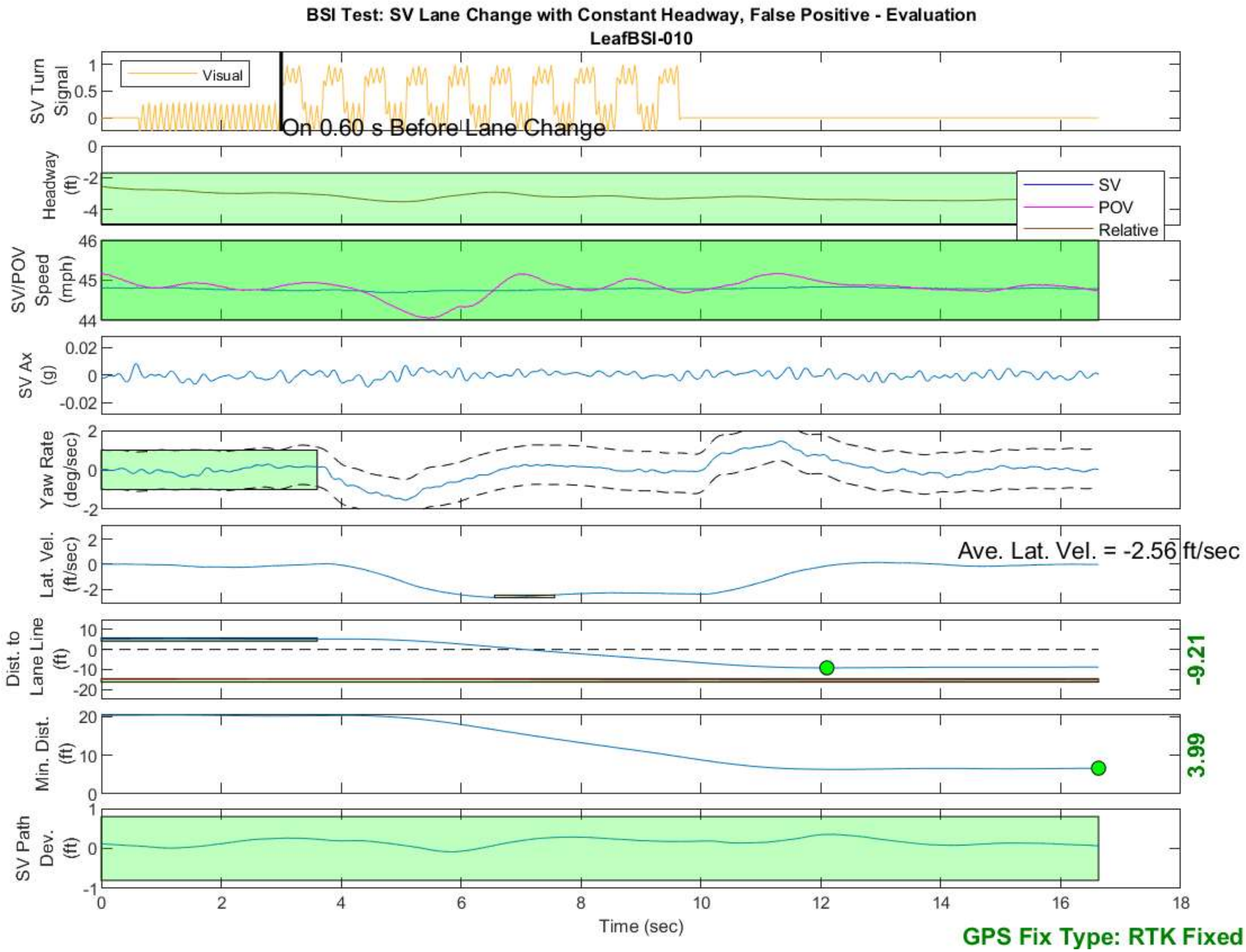


Figure D22. BSI Run 10, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

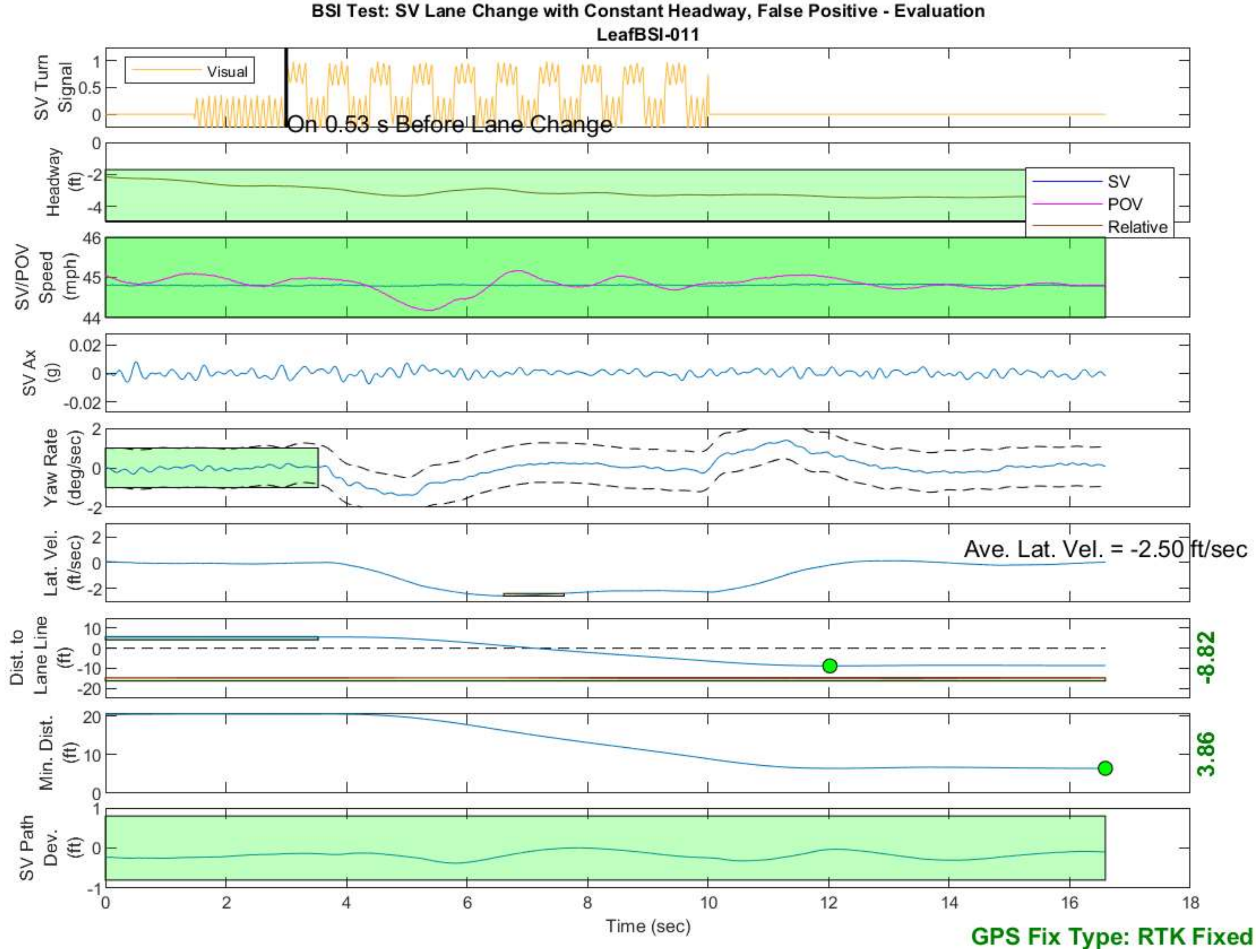


Figure D23. BSI Run 11, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

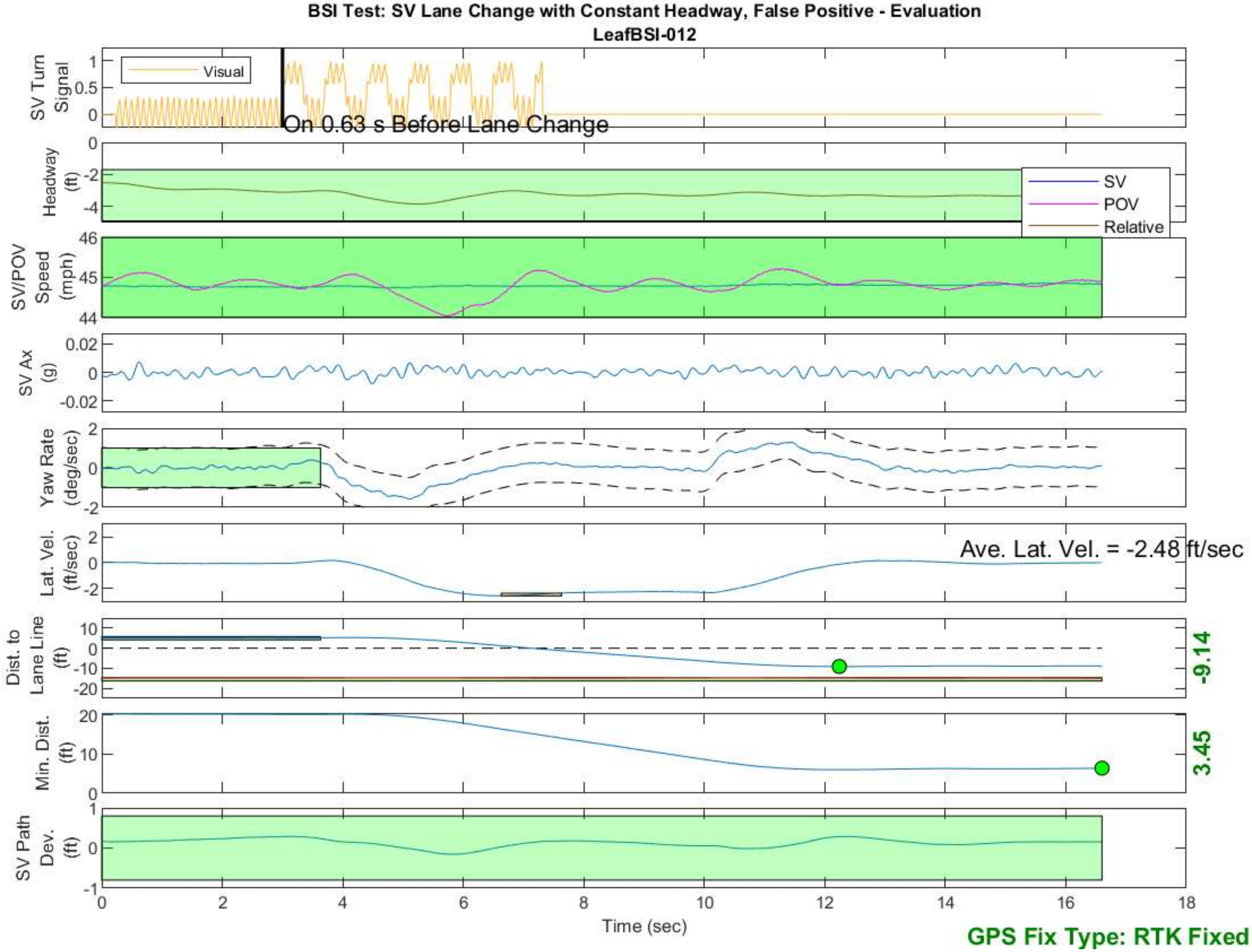


Figure D24. BSI Run 12, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

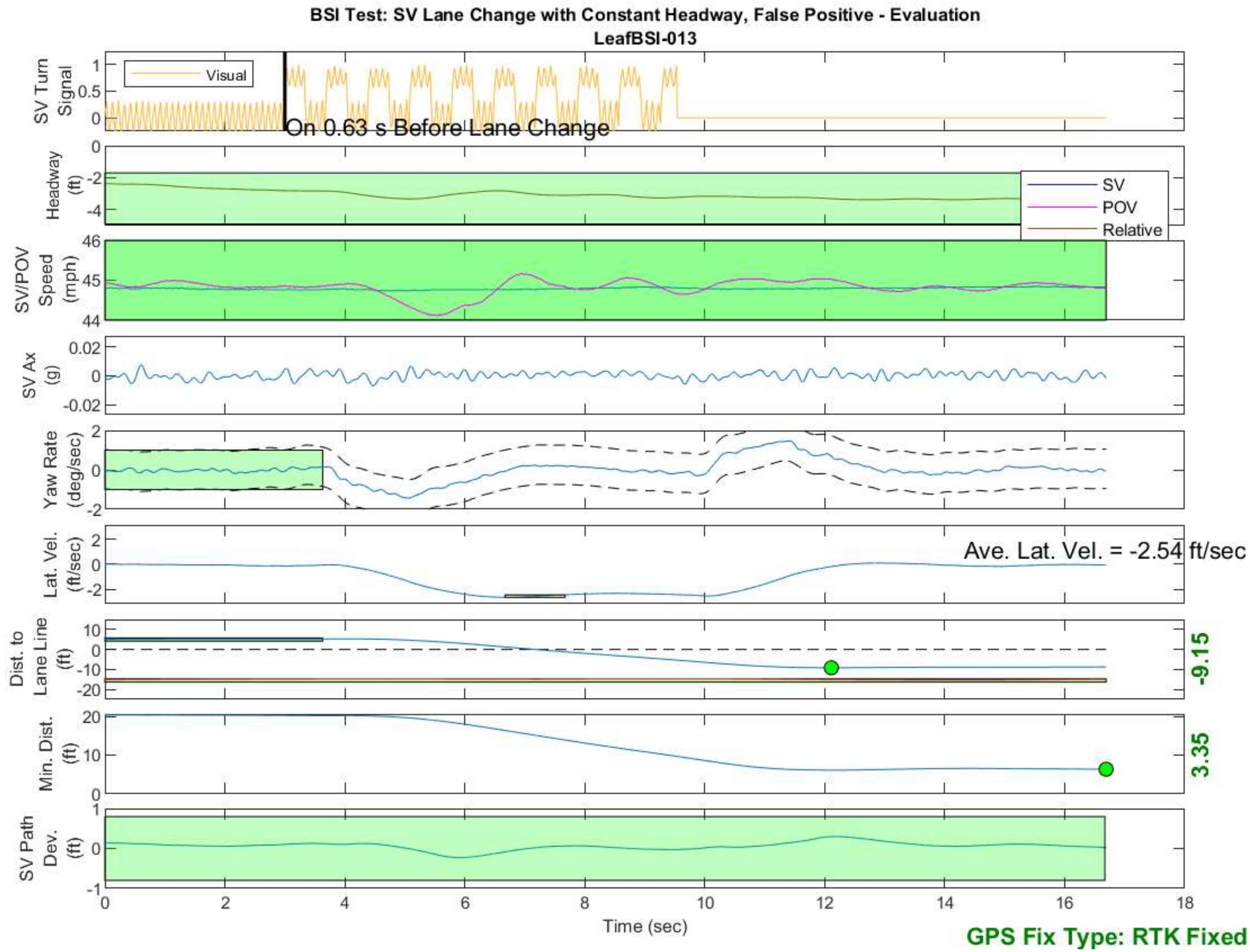


Figure D25. BSI Run 13, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

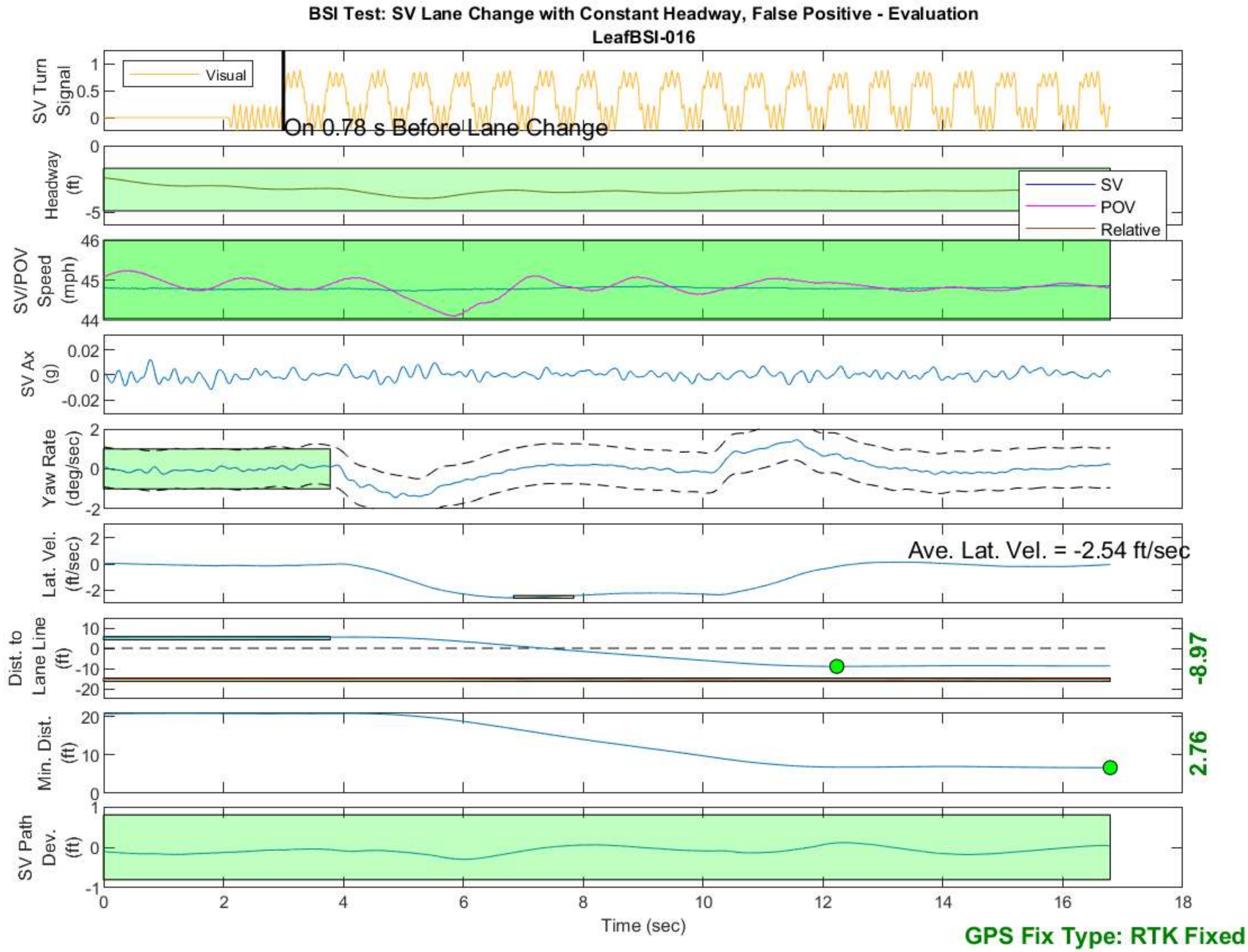


Figure D26. BSI Run 16, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation

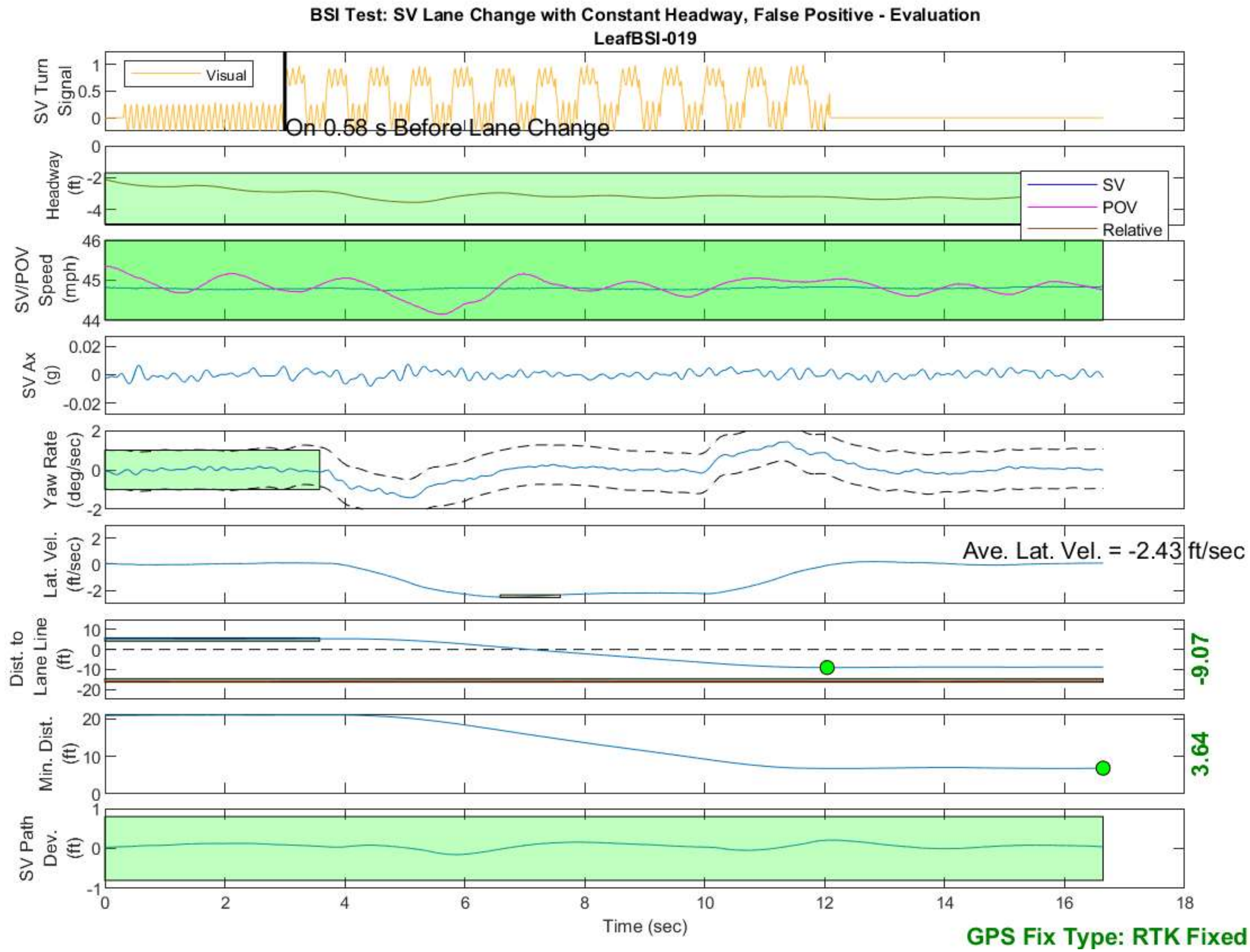


Figure D27. BSI Run 19, Subject Vehicle Lane Change with Constant Headway, False Positive Assessment - Evaluation