

**NEW CAR ASSESSMENT PROGRAM (NCAP)  
DYNAMIC ROLLOVER RESISTANCE TEST**

Bayerische Motoren Werke AG

2015 BMW X5 AWD

TEST NUMBER: 15-07

Final Report  
6 November 2014



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Prepared for:

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Office of Crash Avoidance Standards  
1200 New Jersey Avenue S.E.  
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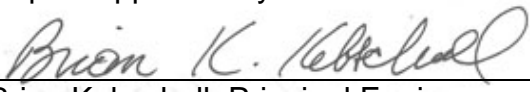
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Date: 6 November 2014

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16. Abstract  An NCAP Dynamic Rollover Maneuver (Fishhook) Test was conducted on a 2015 BMW X5 AWD at Dynamic Research, Inc. on October 21, 2014. The vehicle did not experience two-wheel lift. The vehicle's steering angle at 0.3 g lateral acceleration at 50 mph was 29.9 degrees.			
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## Section I INTRODUCTION

Beginning with the 2006 fiscal year, the National Highway Traffic Safety Administration (NHTSA) has engaged Dynamic Research, Inc. (DRI) of Torrance, CA to conduct dynamic rollover testing and gather data from that testing as part of NHTSA's New Car Assessment Program (NCAP).

The purpose of the testing reported herein was to determine if a typical 2015 BMW X5 AWD would experience tip-up, defined as simultaneous two-wheel lift of two inches or more at an entry speed of 50 mph or less in the Fishhook Procedure developed by NHTSA. This procedure may be found at [www.regulations.gov](http://www.regulations.gov), docket item NHTSA-2006-26555-0136.

The testing reported herein was accomplished under contract DTNH22-14-D-00332. The task order is entitled, "New Car Assessment Program (NCAP) Non-Destructive Vehicle Testing and Data Gathering."

## Section II VEHICLE PREPARATION

### A. TEST VEHICLE

The test vehicle was new or in as-new condition, meaning the vehicle had been driven no more than 500 miles prior to the start of dynamic rollover testing. It was acquired through a commercial rental/leasing company. Details of the test vehicle are given in Table 1.

### B. TIRES

All tires used were new, and of the same make, model, size, and DOT specification of those installed on the vehicle when purchased new. Tire inflation pressures were in accordance with the recommendations indicated on each vehicle's identification placard. To reduce the possibility of tire debanding during Fishhook testing, an appropriately sized inner tube was installed in each tire. To further reduce the possibility of tire debanding, the tires were mounted to the rims without the use of tire mounting lubricant. Tire specifications are listed in Table 2.

### C. VEHICLE LOADING

The multi-passenger load, described in the Fishhook Procedure, was used for all tests. The load and positioning of the load in the vehicle are listed in Table 3.

In addition to water dummies, the loading included instrumentation, a steering machine, and outriggers. Test vehicle bumper assemblies were removed for outrigger installation. The reduction in vehicle weight due to the removal of the bumpers was offset by the additional weight of the outriggers and their mounting system. The outrigger system typically outweighs the bumper assemblies.



Table 1. Test Vehicle Data

<b>General Data</b>					
Model year, make, model	2015 BMW X5 AWD				
VIN	5UXKROC52FOK5xxxx				
Body style	SUV				
Number of doors	4				
Trim level					
Seating positions	Front:	2 <sup>nd</sup> row	3 <sup>rd</sup> row	4 <sup>th</sup> row	5 <sup>th</sup> row
	2	3			
Electronic stability control	Yes				
4-Wheel ABS (Yes/No)	Yes				
Power steering (Yes/No)	Yes				
Major optional equipment					
Odometer at start of testing	140 miles				
<b>Drivetrain</b>					
Engine cylinder arrangement	Inline 6				
Engine displacement	3 L				
Transmission type	Automatic				
Drive arrangement	AWD				
<b>Chassis</b>					
Track width	F: 64.7 in (1643.4 mm) , R: 65 in (1651 mm)				
Wheelbase	115.5 in (2933.7 mm)				
Curb weight	4674 lb (2120.1 kg)				
<b>Certification Data from Vehicle's Label</b>					
Vehicle manufactured by	Bayerische Motoren Werke AG				
Date of manufacture	08/2014				
GVWR	6250 lb (2835 kg)				
GAWR Front	2820 lb (1279 kg)				
GAWR Rear	3580 lb (1624 kg)				

Table 2. Tire Information

Tire Manufacturer	Goodyear
Tire Model	Eagle LS2
Tire Size	Front: 255/55r18 Rear: 255/55r18
Load rating	Front: 109 Rear: 109
Speed rating	Front: H Rear: H
Treadwear grade	Front: 400 Rear: 400
Traction grade	Front: A Rear: A
Temperature grade	Front: A Rear: A
Location of "Recommended Tire Pressure" label	Driver side door jamb
Recommended cold tire pressure	Front: 33 psi, (230 kPa) Rear: 41 psi, (280 kPa)
First 8 digits of DOT code	Front: M62TKK1R Rear: M62TKK1R

Table 3. Vehicle Loading

Water dummy and other loading	3 water dummies in second row
Water dummy weight	175 lb (79.4 kg)
Fuel level	Full
<b>Weight as Tested</b>	
Left front	1307 lb (592.8 kg)
Right front	1297 lb (588.3 kg)
Left rear	1508 lb (684 kg)
Right rear	1523 lb (690.8 kg)

## D. STEERING CONTROLLER

A programmable steering machine was installed which generates handwheel steering inputs for all test maneuvers. The machine provides at least 35 lb-ft of torque at a handwheel rate of 720 deg/sec, is capable of actuating the vehicle's steering system through its full range, and accepts angular rate sensor feedback input for roll rate-induced steering reversals.

## E. INSTRUMENTATION AND DATA COLLECTION

The test vehicle was instrumented with an angle encoder, located in the steering controller; a 3-axis inertial measurement unit to measure roll, pitch, and yaw rates, and longitudinal, lateral, and vertical acceleration; two ultrasonic distance measuring sensors to measure vehicle roll angle; and a radar speed sensor to measure vehicle speed. The brake light circuit was monitored to verify that there was no brake pedal application during any test.

A list of the sensors is given in Table 4. A 3B signal conditioning and power rack was used to provide any necessary sensor power, excitation, gain, and offset. Two pole Butterworth anti-alias filters were used for all analog data channels, using a corner frequency of 20 Hz. Data were collected at 200 samples/sec, using a Measurement Computing Corp. PCI-DAS6402/16 A/D board.

Two video cameras were used to record the Fishhook runs. They were positioned nominally as shown in Figure 1. The recorded videotapes were reviewed after the Fishhook runs to check for any two wheel lift. If any two wheel lift was observed, eight infrared distance measuring sensors for measurement of wheel lift (two sensors at each wheel) were then mounted for use in subsequent confirmation Fishhook tests.

## F. OTHER VEHICLE PREPARATION

In addition to installation and preparation discussed above, the test vehicle was prepared as follows:

- Front and rear bumpers were removed
- Outrigger mounts were installed in the bumper locations and titanium outriggers were fastened to these mounts
- A five point safety harness was installed.
- Airbags were removed or otherwise disabled

Photographs of the vehicle tested are given in Appendix A.

Table 4. Sensors

Data Measured	Type	Range	Manufacturer	Model Number
Handwheel angle	Encoder	Infinite	Automotive Testing, Inc.	Angle encoder integral with steering controller
Brake pedal actuation	Tape Switch	On/Off	Vericom Computers	VC3000
Longitudinal, lateral, and vertical acceleration	Multi-axis inertial sensing system	$\pm 2$ g	BEI Technologies, Inc., Systron Donner Inertial Division	MP-1
Roll, pitch, and yaw rate		$\pm 100$ deg/s		
Left and right side vehicle ride height (to measure roll angle)	Ultrasonic distance measuring system	4 - 40 inches	Massa Products Corp.	M-5000/220kHz
Vehicle speed	Radar speed sensor	0.1 - 125 mph	B+S Software und Messtechnik GmbH	DRS-6
Wheel lift (via resolution of two measured distances spaced a known distance apart), used for confirmation tests only	Analog displacement measuring system (Infrared; 880 mm)	13.8 - 33.5 in	Wenglor Sensors, Ltd.	HT 66MGV80

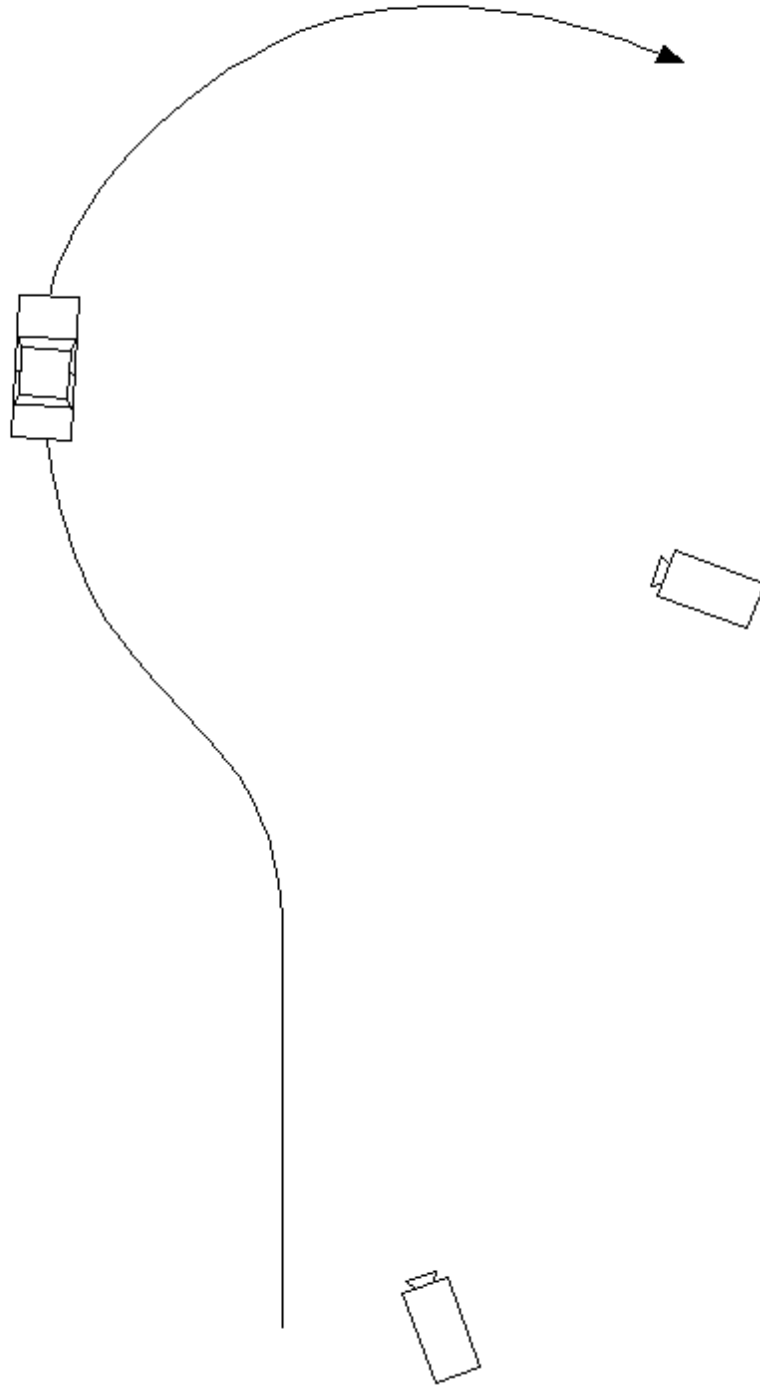


Figure 1. Nominal Position of Video Cameras for Fishhook Tests

### Section III TEST PROCEDURES

This section includes a general overview of the test procedures and details of the particular test.

#### A. TEST PROCEDURE OVERVIEW

This test was conducted in accordance with NHTSA's NCAP Rollover Resistance Test Procedure (Fishhook) as described in the Federal Register (68 FR 59250). Detailed descriptions of the test procedure, pass/fail criteria, and data acquisition specifications may be found at docket NHTSA-2001-9663.

There are two major components of the test procedure, the Slowly Increasing Steer (SIS) pre-test and the Fishhook test.

The Slowly Increasing Steer (SIS) maneuver was used to characterize the steady state lateral dynamics of each vehicle, and is based on the "Constant Speed, Variable Steer" test defined in SAE J266. The maneuver is used to determine the handwheel angle that produces a lateral acceleration of 0.3 g at 50 mph. This handwheel angle is then used to determine the magnitude of steering to be used for the NHTSA Fishhook maneuver.

SIS tests were performed at a constant speed of 50 mph. Handwheel angle was input at a rate of 13.5 deg/sec, from 0 to an angle that provided at least 0.55 g. Three tests were conducted in each direction, and the data for the six runs were averaged to obtain the handwheel angle that produced 0.3 g at 50 mph.

The Fishhook test is a programmed steering maneuver that is implemented via the steering controller. The vehicle was initially steered in one direction and then the steering was reversed. The timing, magnitude and rate of the steering were prescribed by the Fishhook Procedure.

To begin the maneuver, the vehicle was driven in a straight line at a speed slightly greater than the desired entrance speed. The driver then released the throttle. When the vehicle was at the target speed, the steering controller automatically initiated the steering maneuver. Following completion of the steering reversal the handwheel position was maintained for three seconds, and then returned to zero angle in 1 second.

The tests were conducted in both left-right and right-left directions. The “Default” test series used a handwheel angle equal to 6.5 times the handwheel angle that produced 0.3 g at 50 mph in the SIS tests, and initial vehicle speeds beginning at 35 mph and concluding up to 50 mph (if no two-wheel lift occurs). Supplemental tests were also done, as specified in the Fishhook Procedure.

## B. TEST CONDITIONS

### 1. Test Surface

The tests were conducted on the Vehicle Dynamics Area at DRI’s Minter Field facility, located near Bakersfield, California, on 10/21/2014. The VDA has a smooth, flat (slope less than 0.5% throughout) asphaltic concrete surface. Its dimensions are as shown in Figure 2. It was built in the spring of 2005.

VDA surface friction measurements were accomplished using the DRI Mobile Tire Tester. Three runs were done, one at each of three previously determined locations. Each run provided for a minimum of 3 seconds of tire friction at constant normal load, slip angle, and speed in a free rolling condition. The test was accomplished using an ASTM E1136 tire with an inflation pressure of 35 ( $\pm 0.5$ ) psi at a test speed of 40 ( $\pm 0.5$ ) mph. The net slip angle of the test tire for each test run was 7.5 deg. The test tire was no older than 6 months from the date of manufacture. The surface friction measurement results are shown in Table 5.

Table 5. Surface Friction

Date of surface friction measurements	10/21/2014
Average normalized lateral force	0.89

### 2. Fishhook Handwheel Angles

The 0.3g handwheel angle obtained from the SIS tests and the handwheel angles used in the Fishhook tests are shown in Table 6.

Table 6. Handwheel Angles

0.3g handwheel angle (from SIS tests at 50 mph)	29.9 °
5.5 scalar handwheel angle for Fishhook Test	164 °
6.5 scalar handwheel angle for Fishhook Test	194 °

### 3. Weather Conditions

The weather conditions, recorded at the end of testing, are shown in Table 7.

Table 7. Weather Conditions

Ambient temperature	69 °F ( 20.6 °C)
Wind Speed	0 mph (0 m/s)
Wind Direction	



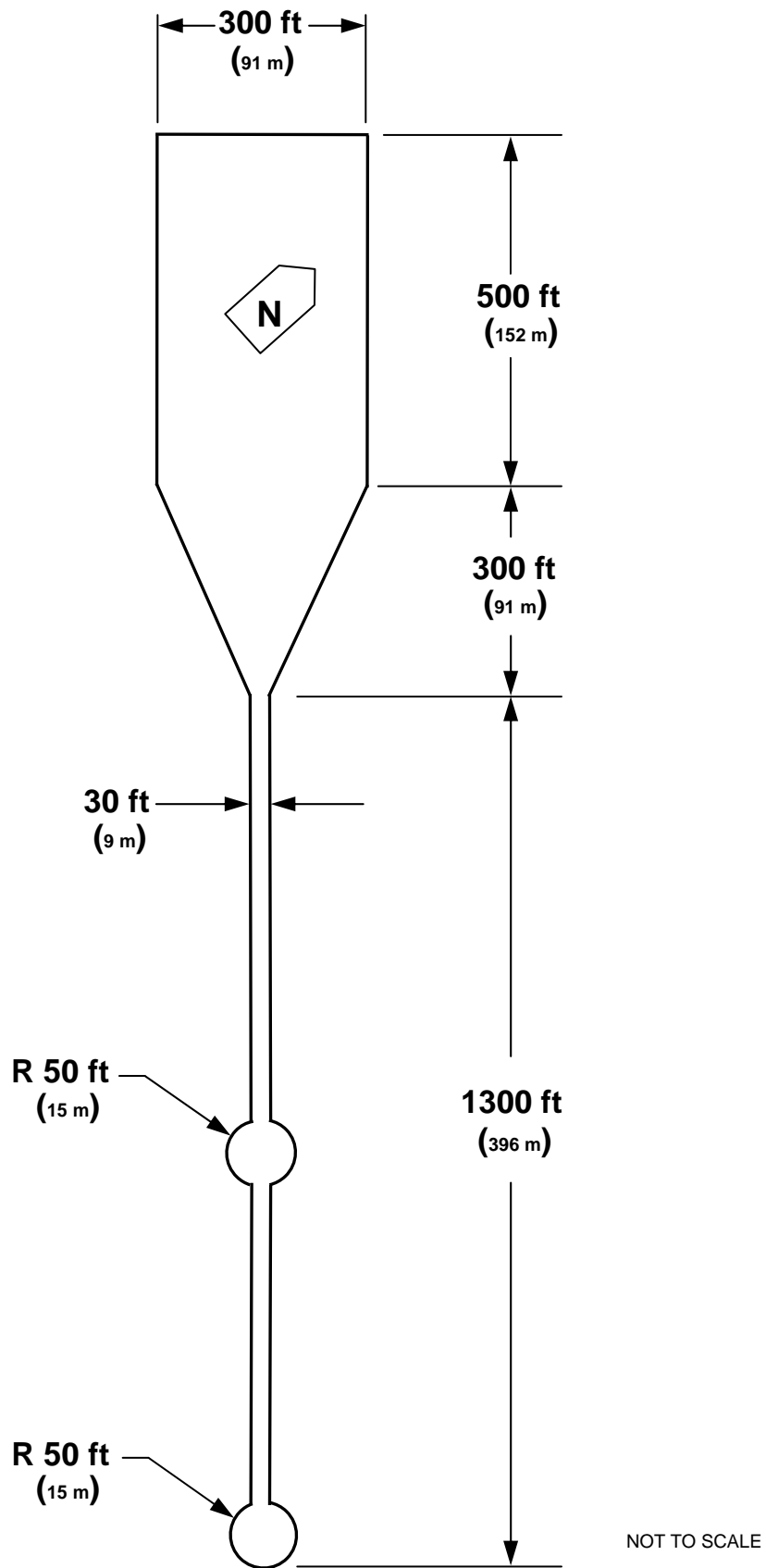


Figure 2. DRI-Minter Vehicle Dynamics Area

## Section IV RESULTS

The test run log is given in Appendix B. The Slowly Increasing Steer Test Worksheet is given in Appendix C. Appendix D contains time history plots for the 50 mph runs and any runs which resulted in two-wheel lift. For the 2015 BMW X5 AWD, there was no two-wheel lift at any test condition.

APPENDIX A

Photographs

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# The Ultimate Driving Machine®

2015 BMW X5 xDrive35i



<b>Manufacturer's Suggested Retail Price</b>	\$	55,500.00
<b>Options and Additional Charges:</b> (Optional equipment may supersede standard equipment; check with your authorized BMW center).		
Black Sapphire Metallic	\$	550.00
Black SensaTec		Included
<b>Lighting Package</b>	\$	1,900.00
- Adaptive Full LED Lights		
- Automatic high beams		
Power adj. steering column		Included
Sport leather steering wheel		Included
Universal garage-door opener		Included
Chrome Line exterior		Included
Roof rails black		Included
Auto-dimming mirrors		Included
Lumbar support		Included
Storage package		Included
Heated front seats		Included
Poplar Wood Trim		Included
Automatic PDC		Included
Automatic climate control		Included
Ambiance lighting		Included
LED Fog Lights		Included
Navigation system w/ touchpad		Included
BMW Assist eCall		Included
BMW TeleServices		Included
BMW Online and BMW Apps		Included
Advanced RTTI		Included
Remote Services		Included
Destination Charge	\$	950.00
<b>Total Suggested Retail Price</b>	\$	<b>58,900.00</b>

### Standard Features

**Performance and efficiency**

- 3.0-liter BMW TwinPower Turbo inline 6-cylinder, 24-valve engine with high-precision direct injection, Valvetronic and Double-VANOS with variable valve control
- Driving Dynamics Control with ECO PRO mode
- 8-speed STEPTRONIC automatic transmission with Sport and Manual shift modes

### Handling, ride and braking

- xDrive all-wheel-drive system
- Dynamic Stability Control (DSC), including Brake Fade Compensation, Start-off Assistant, Brake Drying, and Brake Stand-by features, with Dynamic Traction Control (DTC), and Dynamic Brake Control
- 4-wheel anti-lock ventilated disc brakes

### Exterior

- Xenon Adaptive Headlights with dynamic auto-leveling, Corona headlights-rings and Cornering Lights
- LED foglights
- Intermittent rain-sensing windshield wipers

### Interior seating and trim

- 10-way heated power front seats with 4-way lumbar support
- 400/40 split-folding rear seats

### Comfort and convenience

- Panoramic moonroof
- Power tailgate
- Park Distance Control, front and rear
- Power folding, heated exterior mirrors with auto-dimming function

### Instrumentation and controls

- 3-spoke leather-wrapped multi-function sport steering wheel
- Drive system with on-board computer and touchpad Controller, and 8 programmable memory buttons
- BMW Navigation system with 10.2" high-resolution screen, Voice command system and Advanced Real Time Traffic Information

### Audio system

- AM/FM/CD/MP3 player audio system with HD Radio

### Safety and security

- Driver's and passenger's front airbag supplemental restraint system (SRS) with advanced technology
- Front- and rear-compartment Head Protection System (HPS) with front side-impact airbags
- BMW Assist eCall with a 10-year subscription

### Warranty

- 4-year/50,000-mile New Vehicle/SAV Limited Warranty
- 12-year Rust Perforation Limited Warranty
- 4-year/Unlimited Mileage Roadside Assistance Program

### PARTS CONTENT INFORMATION

For Vehicles in this Car Line:  
US/Canadian Parts Content: **5%**  
Major Source of Foreign Parts Content:  
**GERMANY: 65%**

Note: Parts content does not include final assembly, distribution, or other non-parts costs.

For this Vehicle:  
Final Assembly Point: **SPARTANBURG, SC, USA**  
Country of Origin:  
Engine: **AUSTRIA**  
Transmission: **GERMANY**

### BMW Ultimate Service™

**\$0** Maintenance Program:  
For the first 4 years or 50,000 miles, whichever comes first on all factory-recommended services\*

### Your Maintenance Costs:

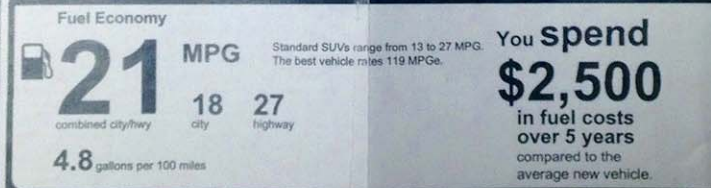
Engine Oil Services: \$0 Brake Pads: \$0  
Engine Drive Belts: \$0 Brake Disks: \$0  
Inspection Services: \$0 Brake Fluid: \$0

\*Coverage is not transferable to subsequent purchasers, owners, or lessees. Please see bmwusa.com/mpdisclaimer or ask your authorized BMW center for details.

### GOVERNMENT 5-STAR SAFETY RATINGS

<b>Overall Vehicle Score</b>	<b>Not Rated</b>	
Based on the combined ratings of frontal, side and rollover. Should ONLY be compared to other vehicles of similar size and weight.		
<b>Frontal Crash</b>	Driver Passenger	<b>Not Rated</b> <b>Not Rated</b>
Based on the risk of injury in a frontal impact. Should ONLY be compared to other vehicles of similar size and weight.		
<b>Side Crash</b>	Front seat Rear seat	<b>Not Rated</b> <b>Not Rated</b>
Based on the risk of injury in a side impact.		
<b>Rollover</b>	<b>Not Rated</b>	
Based on the risk of rollover in a single-vehicle crash.		

### EPA DOT Fuel Economy and Environment Gasoline Vehicle



Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 24 MPG and cost \$11,000 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at \$3.80 per gallon. MPG is miles per gasoline/gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

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VIN: 5UXKR0C52F0K5

Star ratings range from 1 to 5 stars (\*\*\*) with 5 being the highest. Source: National Highway Traffic Safety Administration (NHTSA) www.safercar.gov or 1-888-327-4236

This vehicle is equipped with bumpers that can withstand an impact of 2.5 miles per hour with no damage to the vehicle's body and safety systems, although the bumper and related components may sustain damage. The bumper system on this vehicle conforms to the current federal bumper standard of 2.5 miles per hour.

BMW of North America, LLC  
Woodcliff Lake, NJ 07677

VPC Location: OXNARD, CALIFORNIA

Port of Entry: GREENVILLE-SPARTANBURG  
Carrier: WAGGONERS TRUCKING

Sold To: \_\_\_\_\_ Ship To: \_\_\_\_\_

(20140815)

Figure A1. Window Sticker



Figure A2. Front View, Test Vehicle as Delivered



Figure A3. Rear View, Test Vehicle as Delivered



Figure A4. Front View, Test Vehicle in Test Condition





Figure A5. Rear View, Test Vehicle in Test Condition



Figure A6. Instrumentation in Test Vehicle



Figure A7. Ballast Condition

APPENDIX B

Test Run Log

Vehicle: **2015 BMW X5 AWD**Driver: **Theresa Cornwell**Date: **10/21/2014**

Run Number	Test Type	Speed (mph)	Handwheel Angle (deg)	Dir. of First Steer	2 Wheel Lift	Notes
	Distance		0	NA	NA	Distance Calibration (ft):
5	Tire Warm-Up	35	100	NA	NA	
6	Tire Warm-Up	35	100	NA	NA	
7	Tire Warm-Up	35	100	NA	NA	
8	Tire Warm-Up	35	100	NA	NA	2X angle on last cycle
9	Static	0	0	NA	NA	
10	Dynamic	50	0	NA	NA	
11	SIS	50	50	Left	NA	NG
12	SIS	50	50	Left	NA	
13	SIS	50	50	Left	NA	NG
14	SIS	51	50	Left	NA	
15	SIS	50	50	Left	NA	
16	SIS	50	50	Right	NA	
17	SIS	50	50	Right	NA	
18	SIS	50	50	Right	NA	
19	Fishhook	35	194	Left	No	6.5x scalar, NG
20	Fishhook	35	194	Left	No	
21	Fishhook	40	194	Left	No	NG
22	Fishhook	40	194	Left	No	
23	Fishhook	45	194	Left	No	
24	Fishhook	47.5	194	Left	No	
25	Fishhook	50	194	Left	No	
26	Fishhook	35	194	Right	No	
27	Fishhook	40	194	Right	No	
28	Fishhook	45	194	Right	No	

Vehicle: **2015 BMW X5 AWD**Driver: **Theresa Cornwell**Date: **10/21/2014**

Run Number	Test Type	Speed (mph)	Handwheel Angle (deg)	Dir. of First Steer	2 Wheel Lift	Notes
29	Fishhook	47.5	194	Right	No	
30	Fishhook	50	194	Right	No	
31	Fishhook	45	164	Right	No	5.5x scalar
32	Fishhook	47.5	164	Right	No	
33	Fishhook	50	164	Right	No	
34	Fishhook	45	164	Left	No	
35	Fishhook	47.5	164	Left	No	
36	Fishhook	50	164	Left	No	

APPENDIX C

Slowly Increasing Steer Test Worksheet

NCAP, 2015 BMW X5 AWD , Multi-Passenger Load, Test Date: 10/21/2014

SIS\_out\_v2

Run	Dir of Steer	Start Speed (mph)	End Speed (mph)	Speed Red. (%)	Index of ay @ 0.3g	HW Angle (deg) at 0.3g	ay (g) @ 0.3g index	6.5x HW Angle (deg)	Ramp Time (sec) at 6.5x	5.5x HW Angle (deg)	Ramp Time (sec) at 5.5x	R2	Zero Begin Index	Zero End Index
12	1	50.3	0.8	98.3	1124	-29.3	-0.293	-190.6	-0.2648	-161.3	-0.2241	0.9809	415	615
14	1	50.2	2.3	95.4	1141	-30.4	-0.305	-197.4	-0.2741	-167.0	-0.232	0.9848	517	717
15	1	50.4	1.1	97.9	1135	-29.7	-0.298	-193.0	-0.2681	-163.3	-0.2268	0.9885	516	716
16	0	49.7	4.1	91.8	1131	30.1	0.297	195.9	0.2721	165.7	0.2302	0.9891	492	692
17	0	50.5	3.2	93.6	1115	29.2	0.299	190.0	0.2639	160.8	0.2233	0.9900	479	679
18	0	50.1	1.8	96.4	1114	30.6	0.298	199.0	0.2763	168.4	0.2338	0.9798	453	653

Mean:            29.9        0.298        194        0.27        164        0.228

## Steering Controller Input Values

## Scalar 6.5 values:

Initial HW angle:        194    deg  
Initial time:            0.27    s  
Reversal HW angle:    -194    deg  
Reversal time:         0.54    s

## Scalar 5.5 values:

Initial HW angle:        164    deg  
Initial time:            0.228    s  
Reversal HW angle:    -164    deg  
Reversal time:         0.457    s



## APPENDIX D

### Time History Plots

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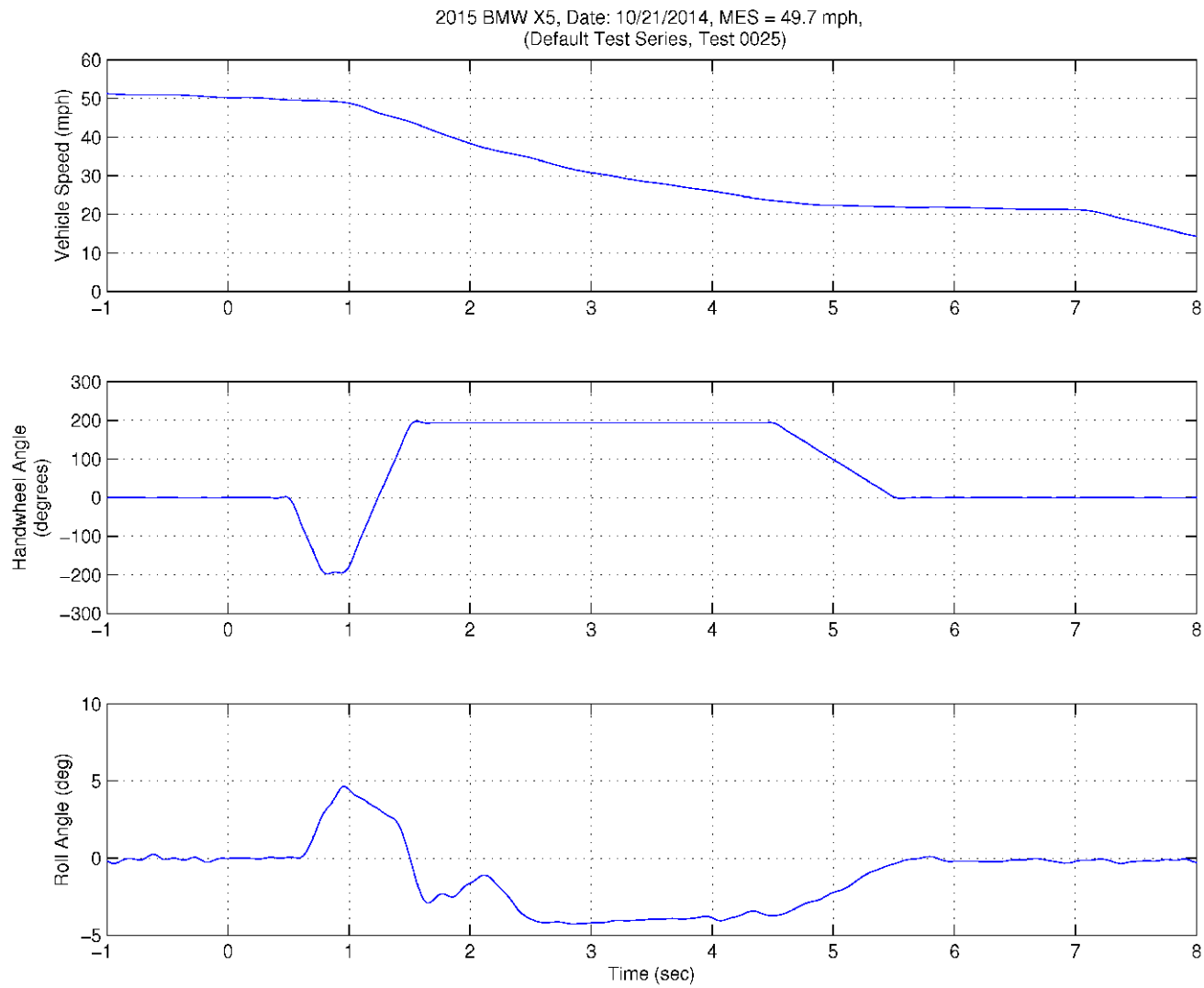


Figure D1. Vehicle Speed, Handwheel Angle, and Roll Angle Time History Plots for Default Test Series, L-R, 50 mph

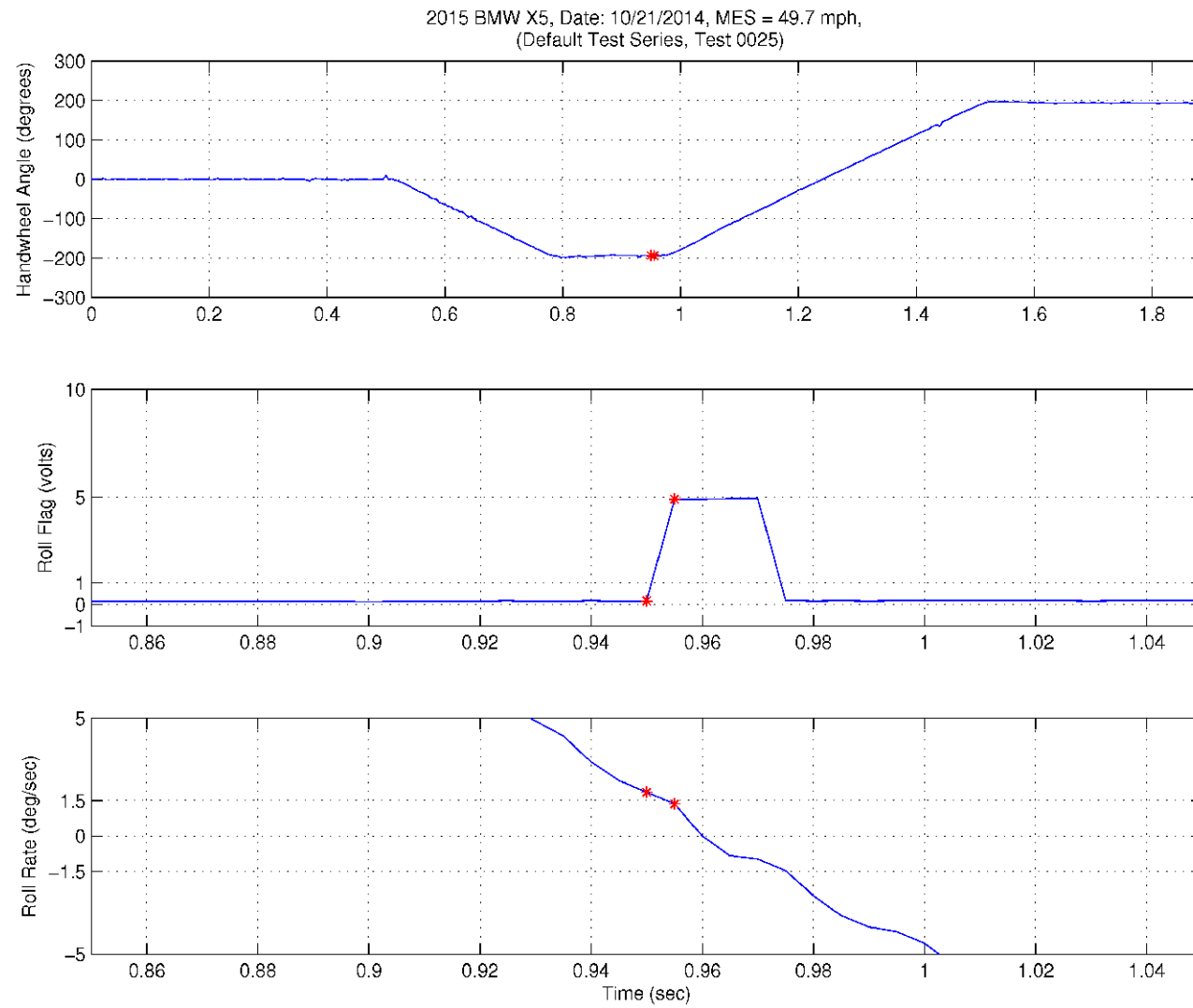


Figure D2. Steering Machine Operation Time History Plots for Default Test Series, L-R, 50 mph

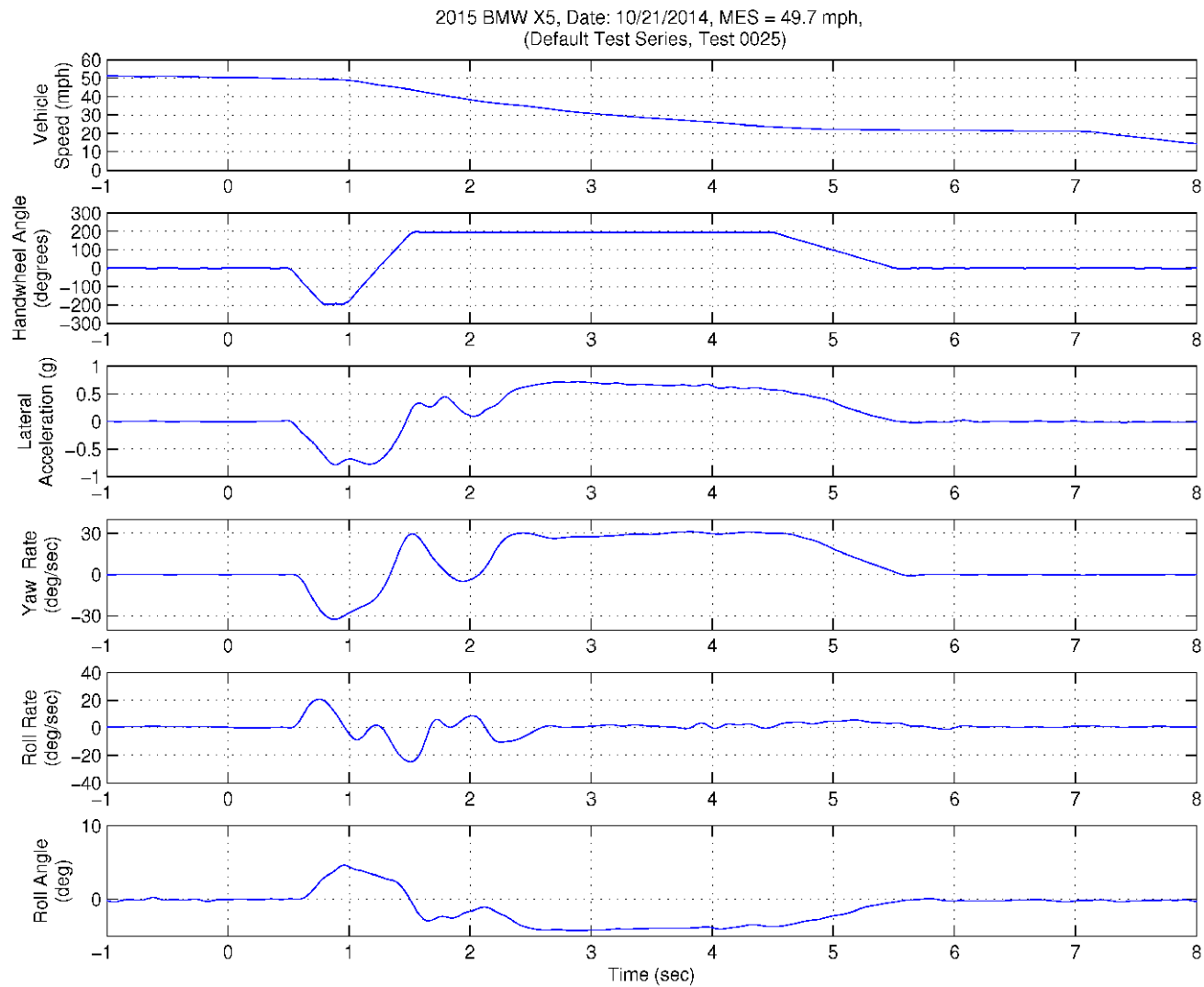


Figure D3. Yaw Rate, Roll Rate, and Lateral Acceleration Time History Plots For Default Test Series, L-R, 50 mph

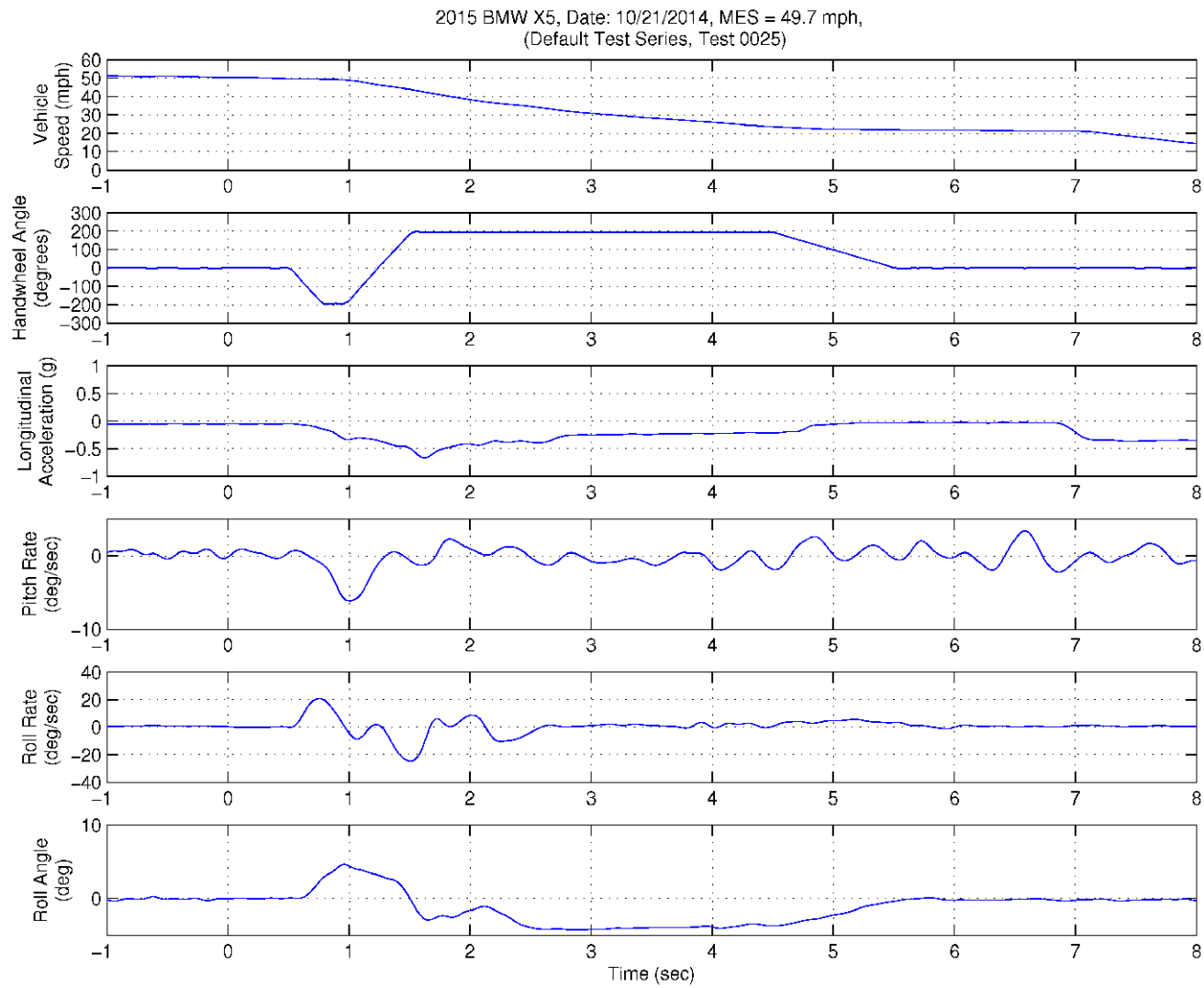


Figure D4. Pitch Rate and Longitudinal Acceleration Time History Plots for Default Test Series, L-R, 50 mph

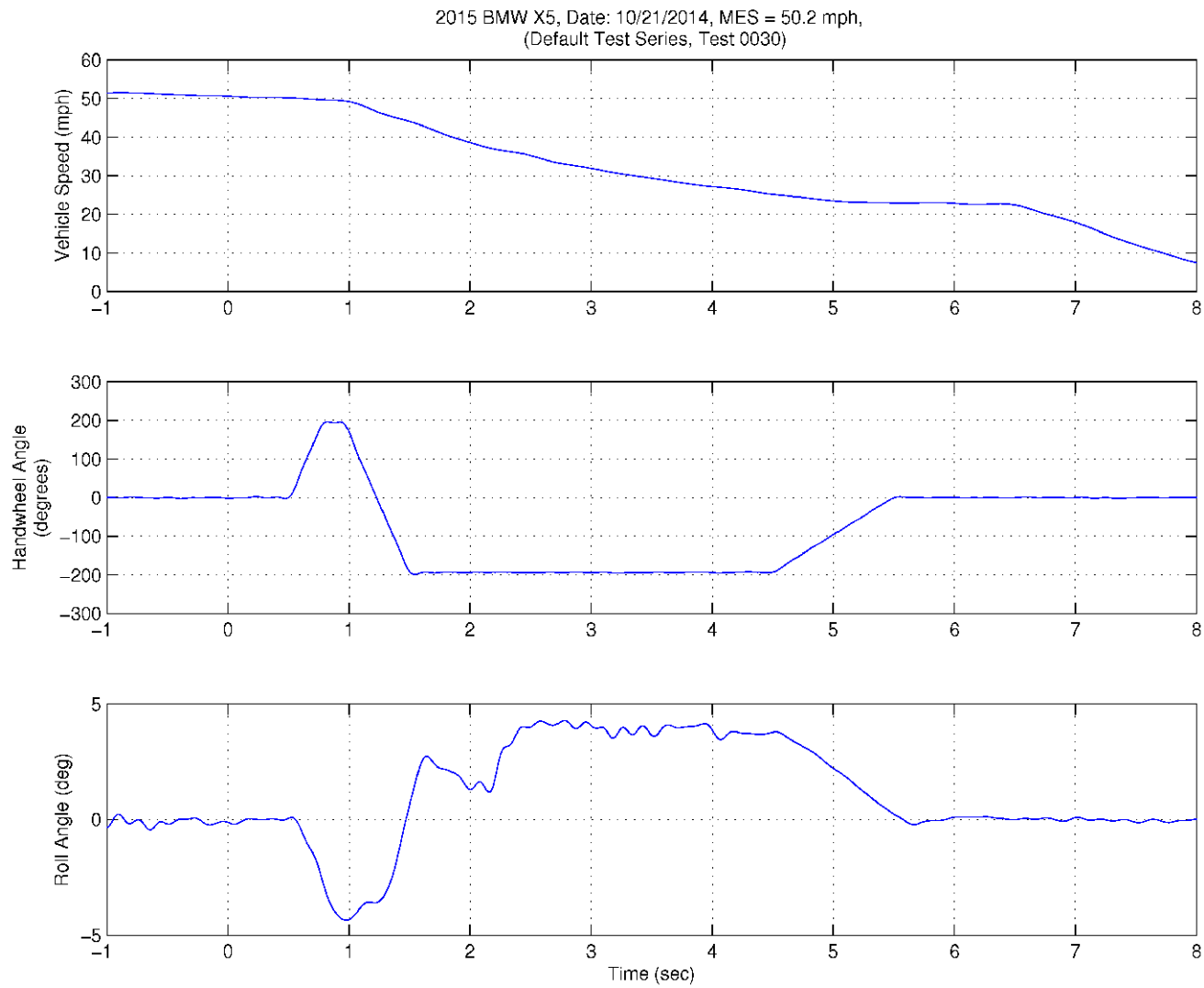


Figure D5. Vehicle Speed, Handwheel Angle, and Roll Angle Time History Plots for Default Test Series, R-L, 50 mph

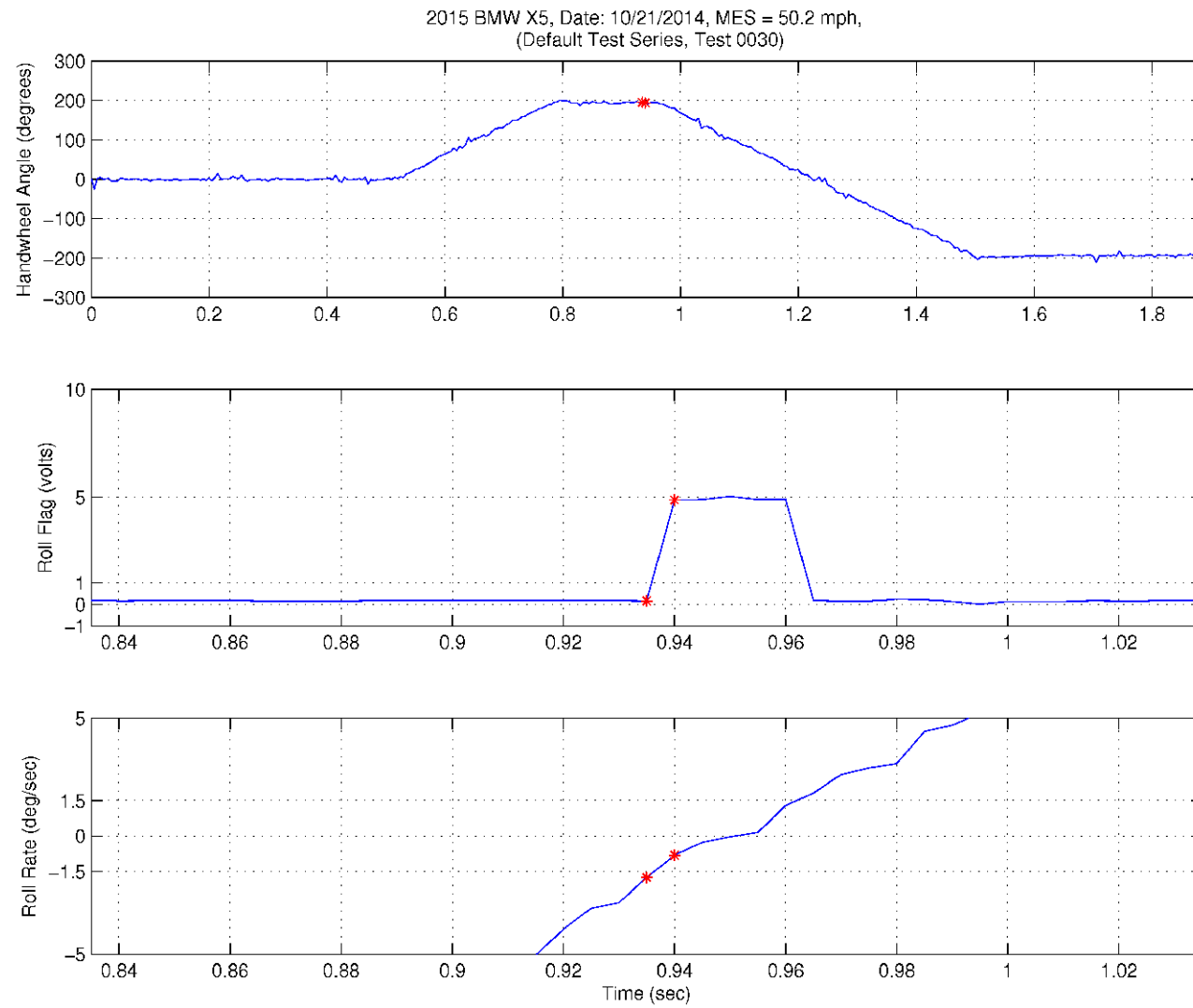


Figure D6. Steering Machine Operation Time History Plots for Default Test Series, R-L, 50 mph



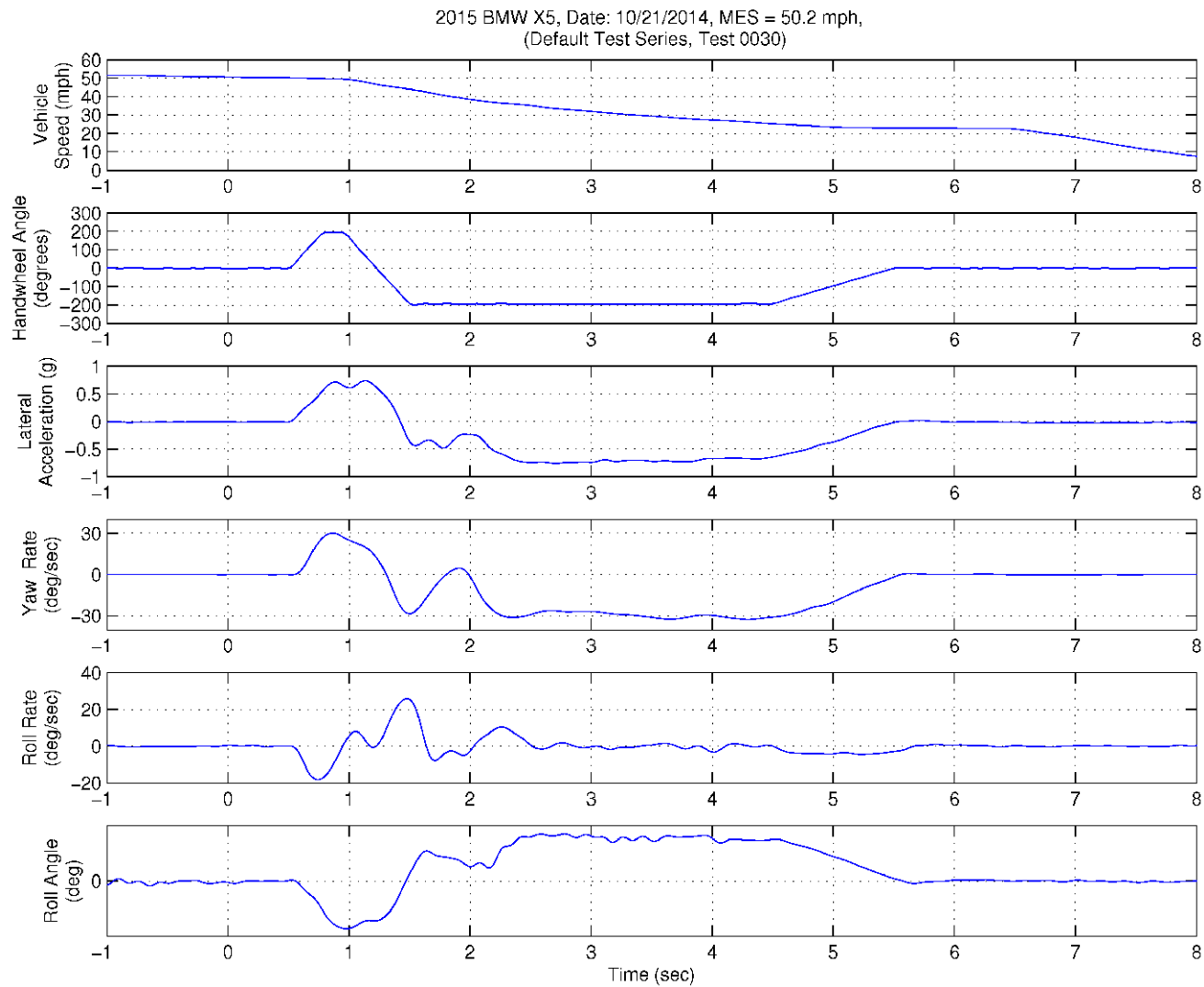


Figure D7. Yaw Rate, Roll Rate, and Lateral Acceleration Time History Plots for Default Test Series, R-L, 50 mph

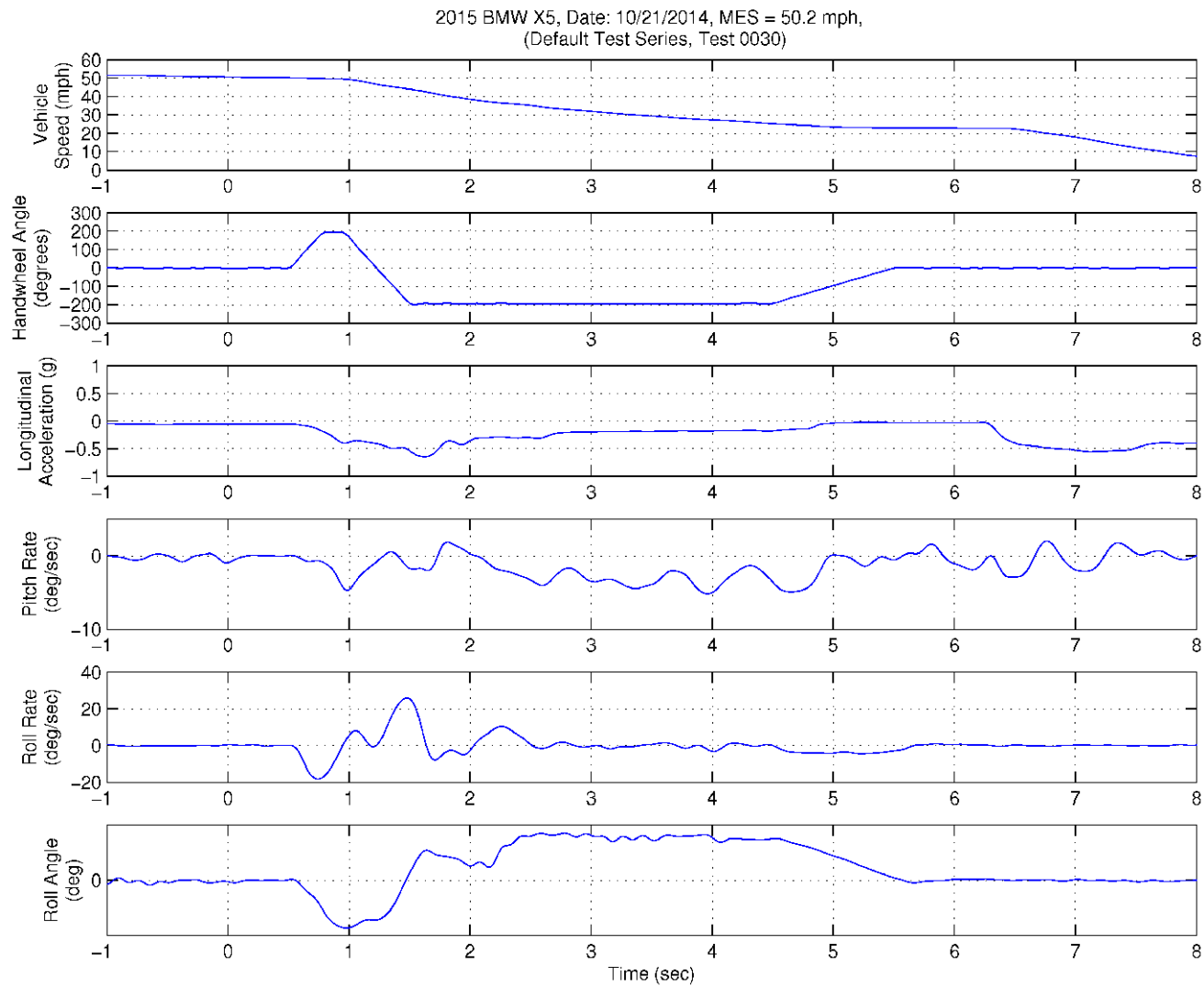


Figure D8. Pitch Rate and Longitudinal Acceleration Time History Plots or Default Test Series, R-L, 50 mph

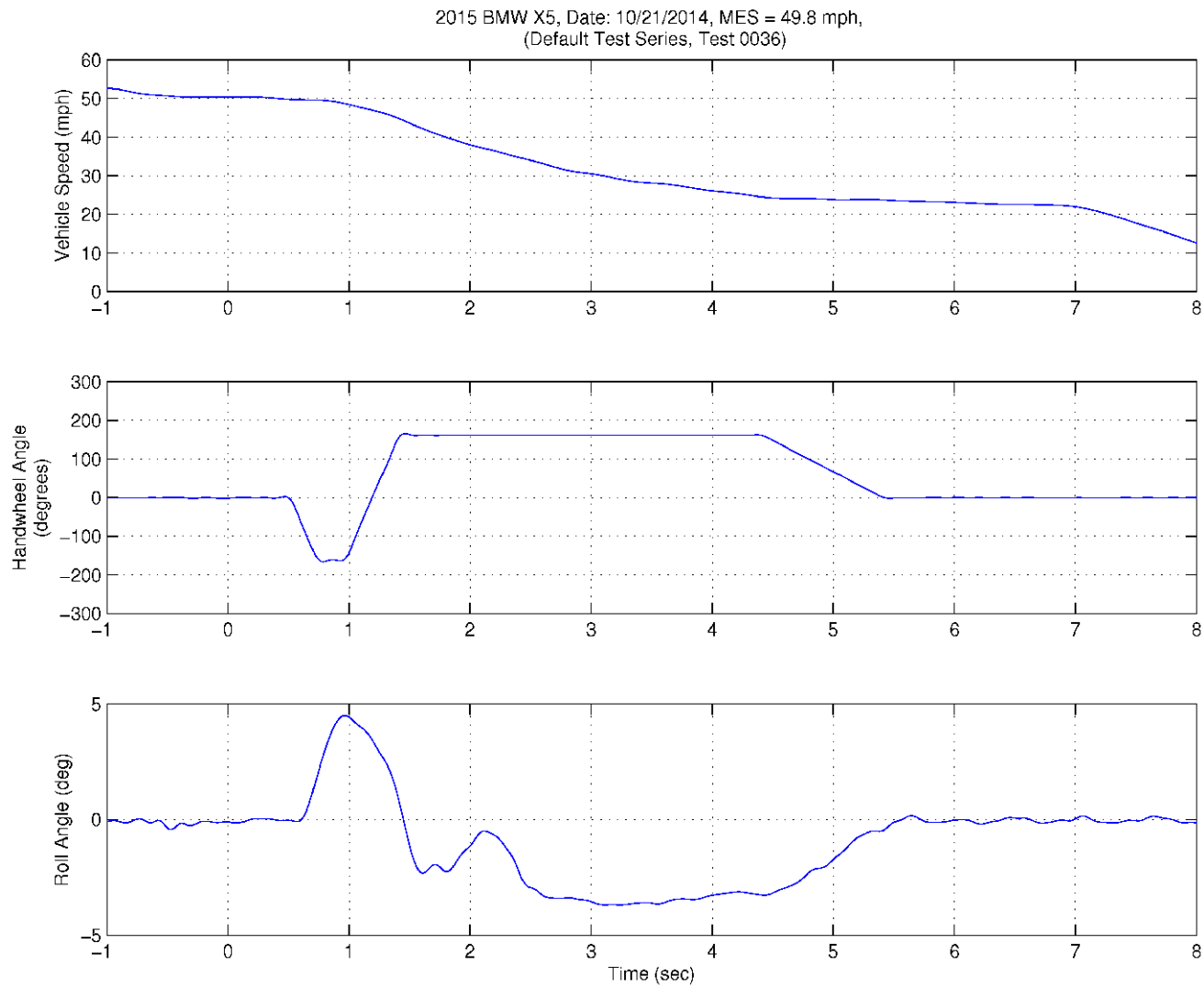


Figure D9. Vehicle Speed, Handwheel Angle, and Roll Angle Time History Plots for Supplemental 2 Test Series, L-R, 50 mph

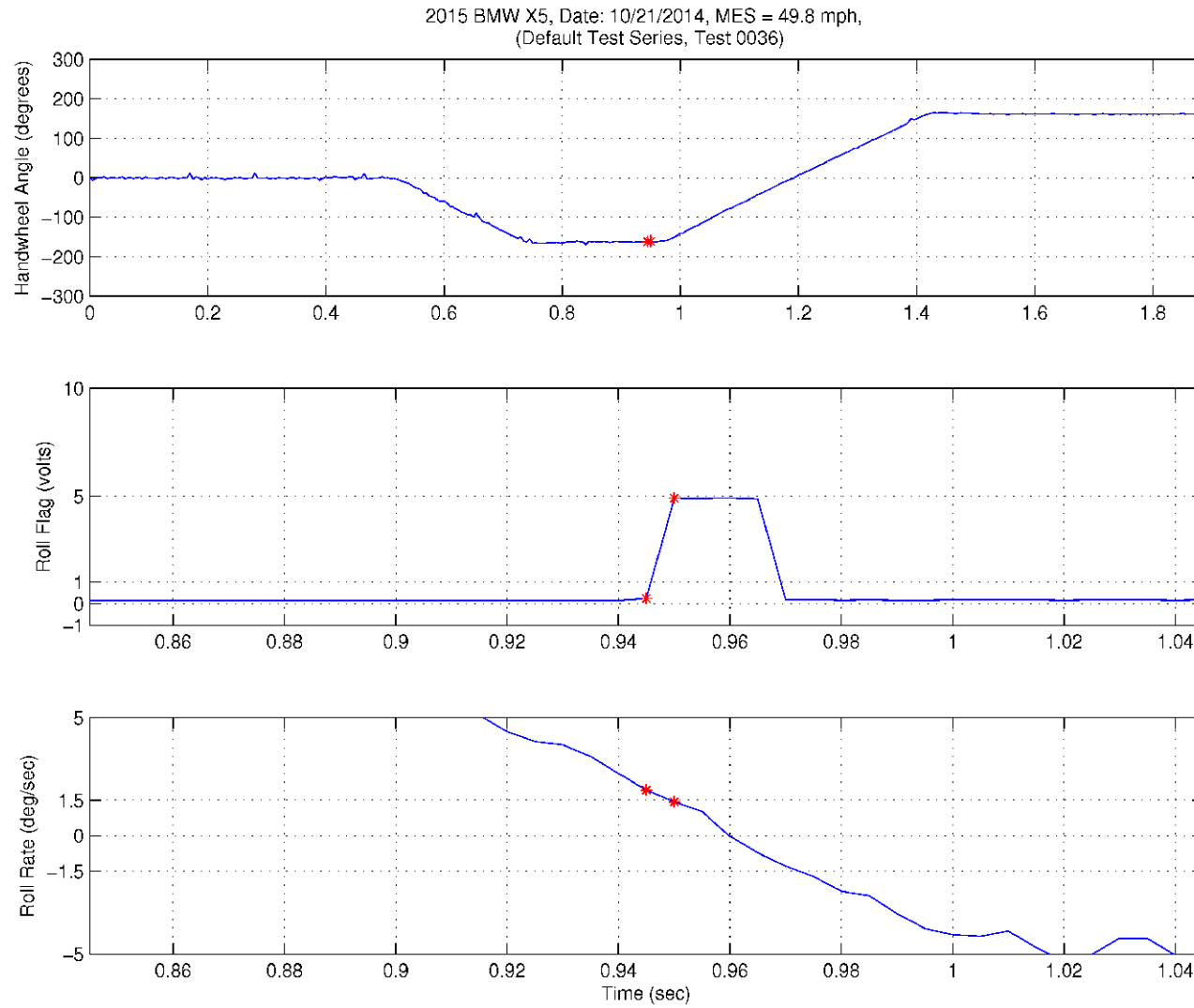


Figure D10. Steering Machine Operation Time History Plots for Supplemental 2 Test Series, L-R, 50 mph

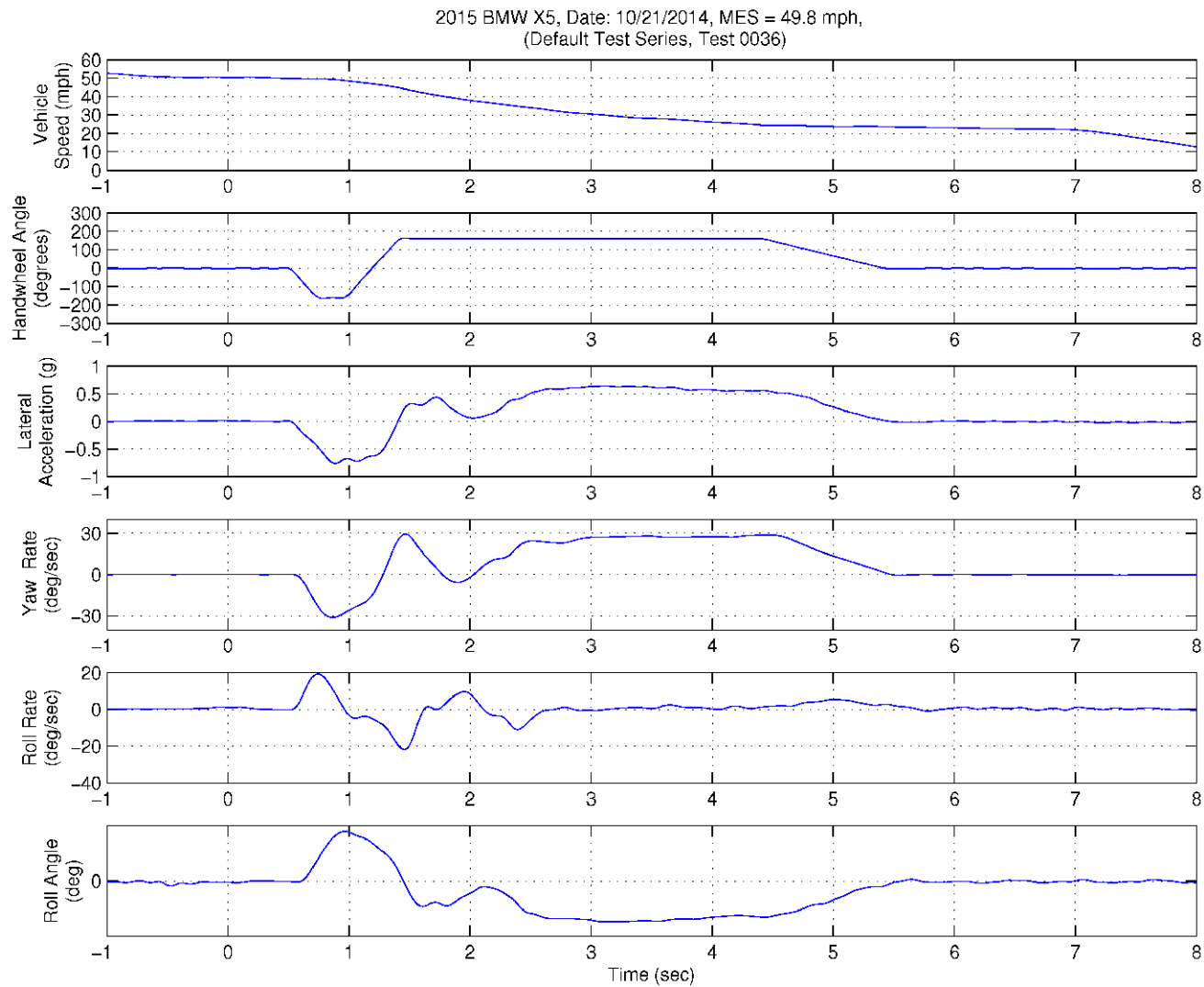


Figure D11. Yaw Rate, Roll Rate, and Lateral Acceleration Time History Plots for Supplemental 2 Test Series, L-R, 50 mph

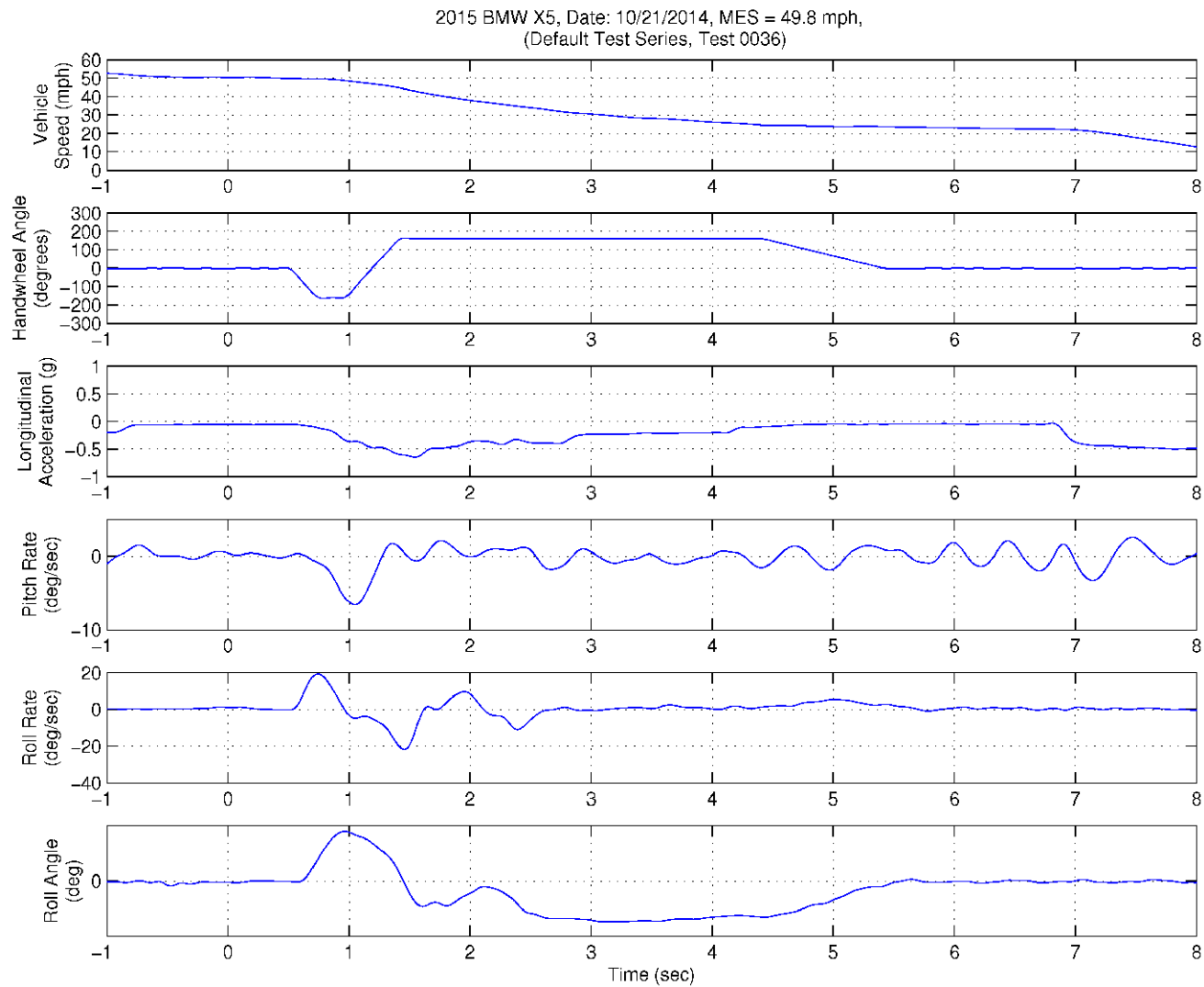


Figure D12. Pitch Rate and Longitudinal Acceleration Time History Plots for Supplemental 2 Test Series, L-R, 50 mph

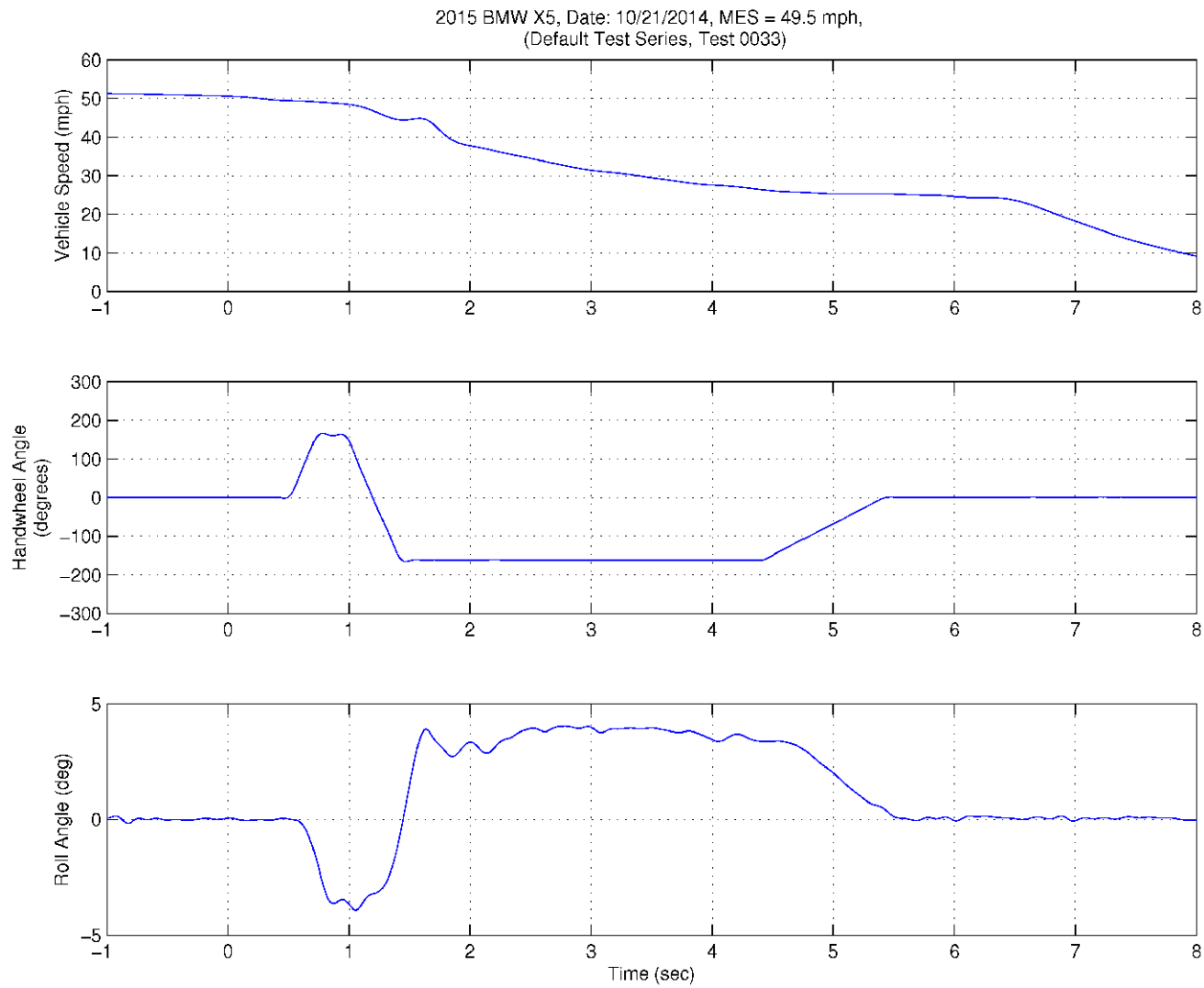


Figure D13. Vehicle Speed, Handwheel Angle, and Roll Angle Time History Plots for Supplemental 2 Test Series, R-L, 50 mph

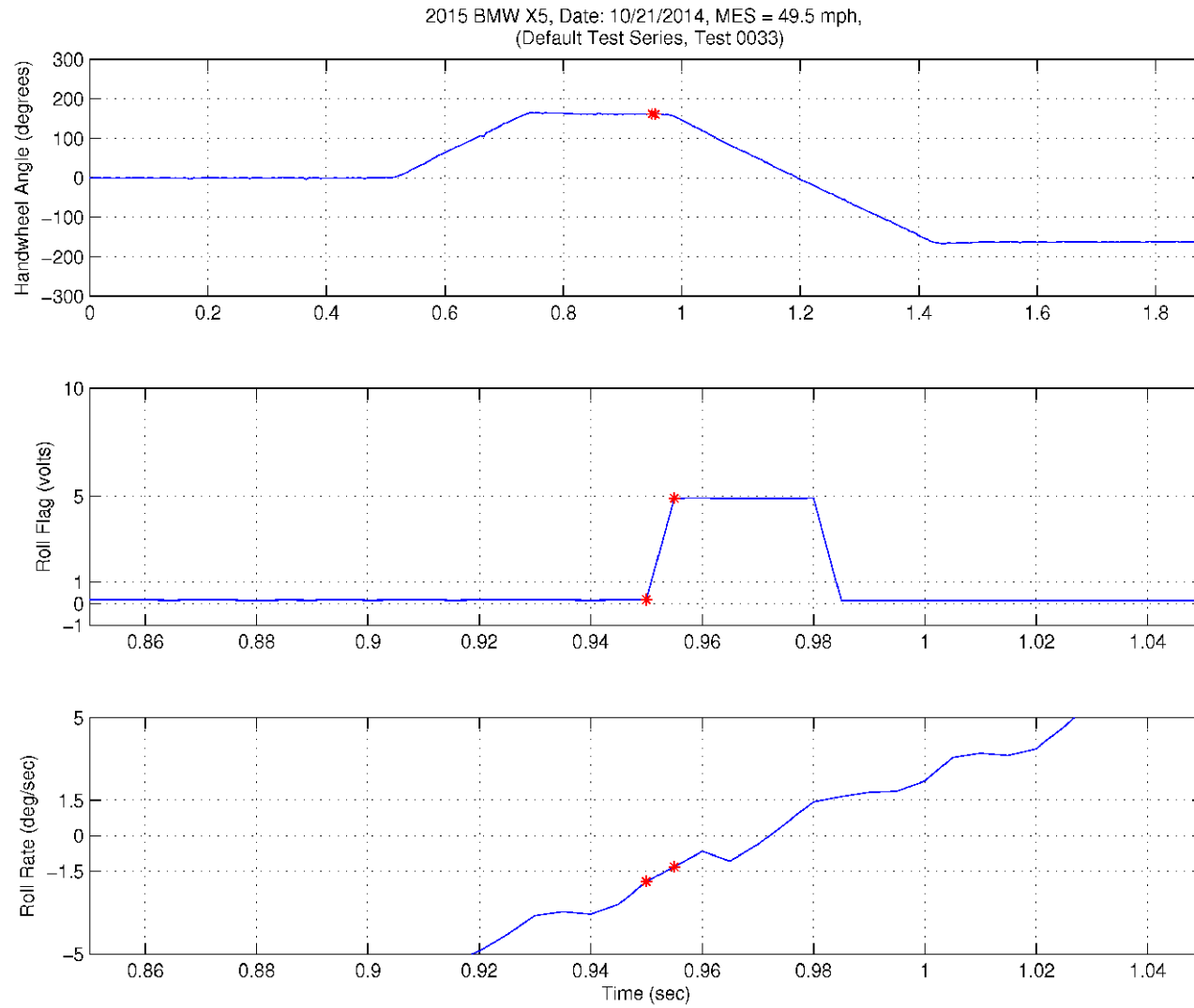


Figure D14. Steering Machine Operation Time History Plots for Supplemental 2 Test Series, R-L, 50 mph



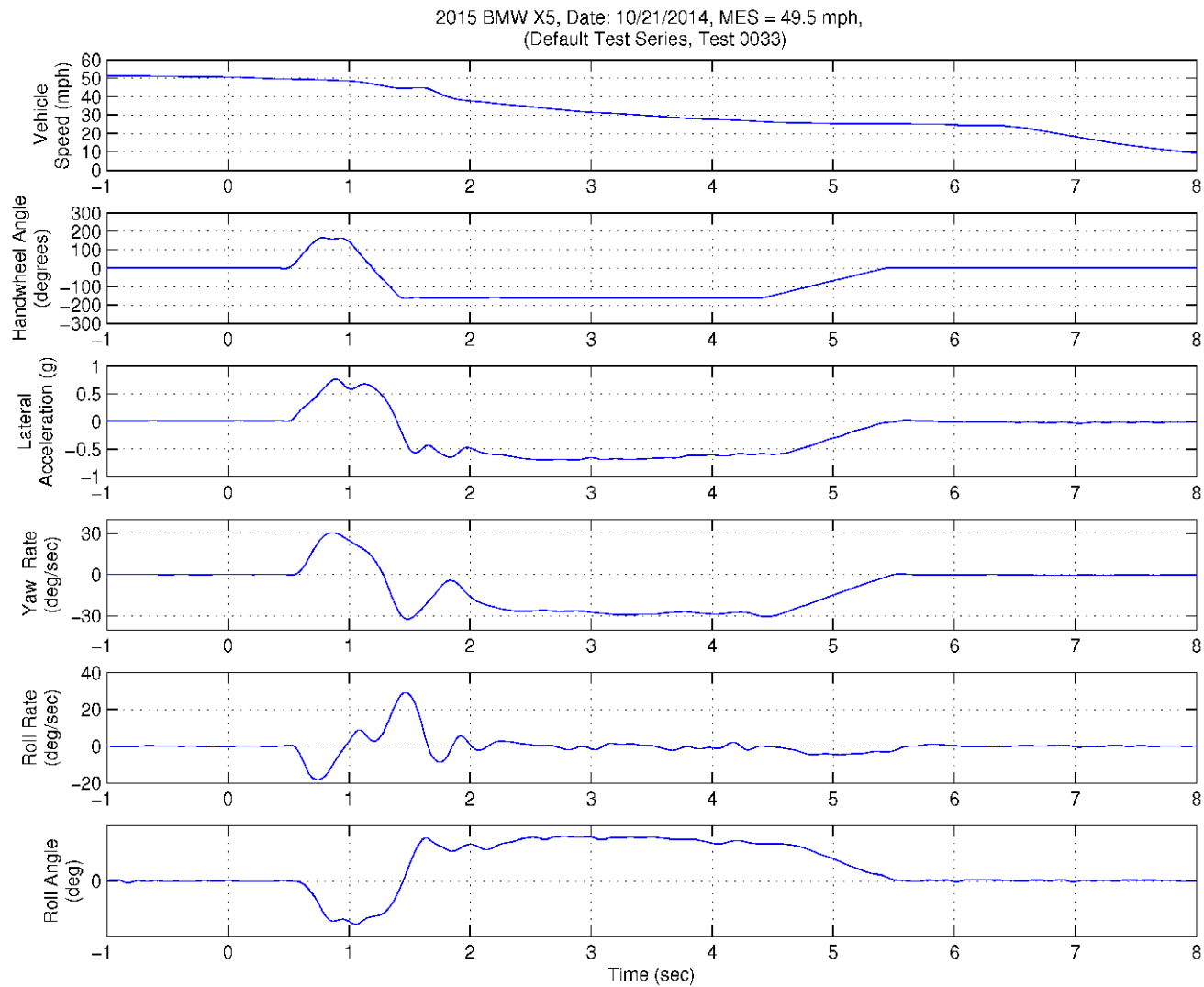


Figure D15. Yaw Rate, Roll Rate, and Lateral Acceleration Time History Plots for Supplemental 2 Test Series, R-L, 50 mph

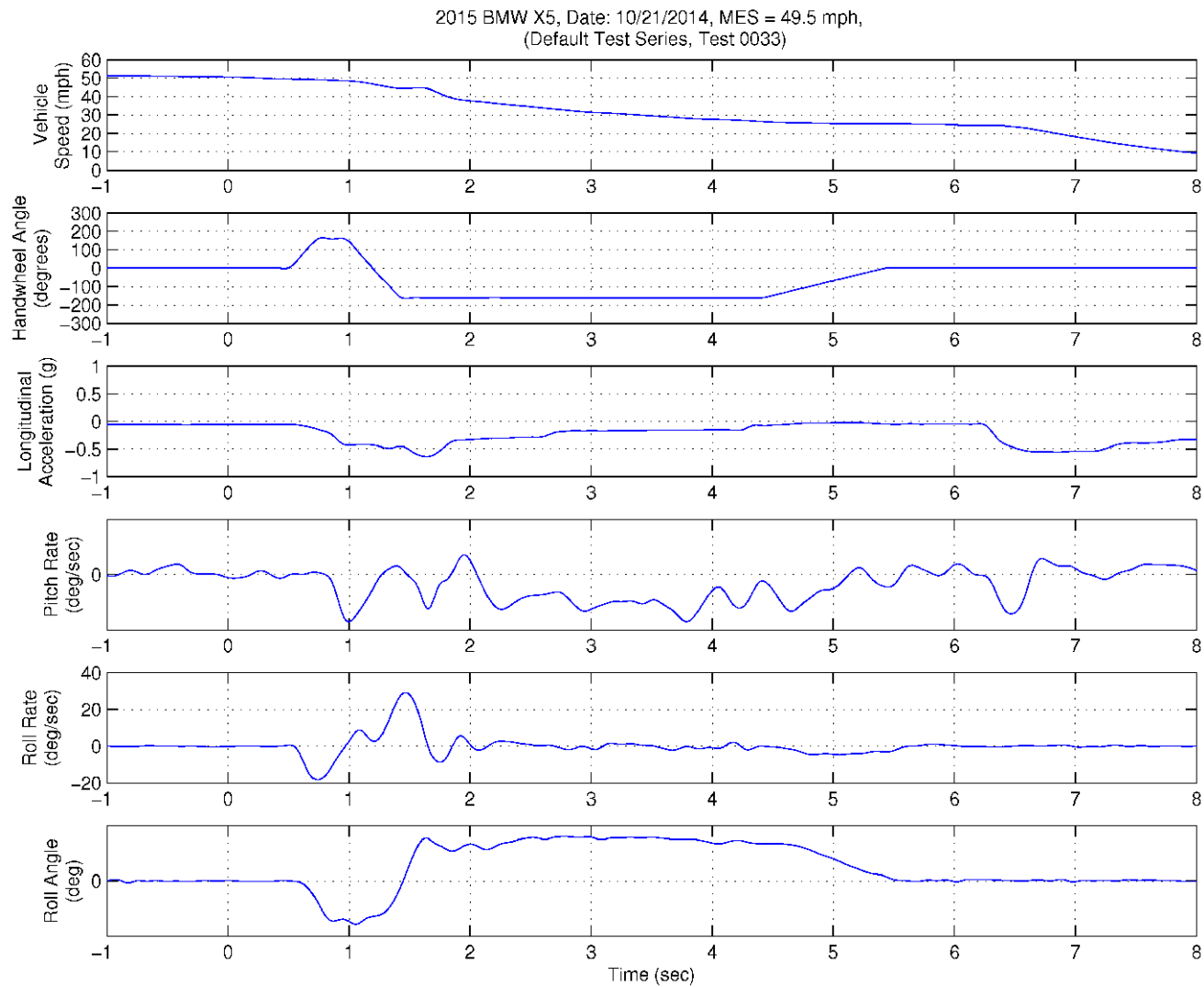


Figure D16. Pitch Rate and Longitudinal Acceleration Time History Plots for Supplemental 2 Test Series, R-L, 50 mph