
# Electronic Stability Control Assessment Methods – A Study in the Correlation Between Subjective Assessment and Objective Measurement in Vehicle Testing

Master's thesis in Automotive Engineering

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Department of Mechanics and Maritime Sciences
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2019

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## Abstract

This report describes the work to include objective measurement methods in real car electronic stability control testing, conducted at CEVT vehicle dynamics department. Current testing methodology is focused on subjective assessment by the driver, with no objective way to judge test data. By post processing logged test data from single and double lane change maneuvers and correlating it to the subjective assessment of the test driver, objective rating methods were established. To gather reliable data, dedicated vehicle testing of both Lynk & Co and competitor cars was carried out at Volvo Hällered Proving Ground by expert drivers. To measure the performance of competitor cars, a new measurement equipment set-up was created for benchmark testing, consisting of steering effort sensor and inertial measurement unit.

As part of the project, a simulation study of single lane change was also carried out, to enhance understanding of the vehicle's behavior and to bridge the gap between simulation and real car testing. The simulation drive case was also tested in the real vehicle.

The result of these processes is rating limits on side slip, yaw rate, longitudinal jerk and longitudinal velocity delta for both single and double lane change. When verified these limits can be the foundation for objective requirements on single and double lane change performance.

Key words:

Vehicle dynamics, Electronic stability control, ESC, Electronic stability program, ESP, Subjective assessment, Objective measurement, Vehicle rating, Lane change, Vehicle testing

# Contents

# Preface

This master thesis has been conducted at the division of Vehicle Engineering and Autonomous Systems under the examination of Professor of the Practice Ingemar Johansson. The project was based at CEVT Vehicle Dynamics Department in Lindholmen, Gothenburg.

I would like to express my gratitude to the entire department for their involvement and interest in my work. In particular, Peter Wiborg was an excellent supervisor who provided the project with experience, wisdom and driving skills. I would also like to thank Niclas Harbig and Karl-Johan Hagelin who took time out their day to partake in vehicle testing for this project. Thanks to Jan Hellberg who provided CAE simulations in the beginning of the project. Thank you to the mechanics at Säve and Hällered Proving Grounds for preparing, servicing and retrieving the test cars. Finally, thanks to Ingemar for your dedicated involvement and interest for my work throughout the project.

# Notations and Abbreviations

## Notations

| | | |
|---|---|---|
| $a_x$ | Longitudinal acceleration | [m/s$^2$] |
| $\beta$ | Body side slip | [deg] |
| $j_x$ | Longitudinal jerk | [m/s$^3$] |
| $v_y$ | Lateral velocity | [m/s] |
| $v_x$ | Longitudinal velocity | [km/h, unless else is states] |
| $\omega_z$ | Yaw rate | [deg/s] |
| $\dot{\omega}_z$ | Yaw acceleration | [deg/s$^2$] |

## Abbreviations

| | |
|---|---|
| A | Aggressive |
| CAE | Computer Aided Engineering |
| CAN | Controller Network Area |
| DLC | Double Lane Change |
| ESC | Electronic Stability Control |
| ESP | Electronic Stability Program |
| HPG | Volvo Hällered Proving Ground |
| IMU | Inertial Measurement Unit |
| M | Medium |
| NHTSA | National Highway Traffic Safety Administration |
| NVH | Noise Vibration Harshness |
| S | Smooth |
| SAE | Society of Automotive Engineers |
| SLC | Single Lane Change |
| SUV | Sport Utility Vehicle |
| SWA | Steering Wheel Angle |
| VDDM | Vehicle Dynamics Domain Master |
| VER | Vehicle Engineering Rating |

# 1 Introduction

Electronic Stability Control (ESC) is a legal requirement to assist the driver if the vehicle is not following the driver´s request, e.g. over- or understeering. It can also be referred to as Electronic Stability Program (ESP). United States National Highway Traffic Safety Administration (NHTSA) defines ESC as a system [1]

- That augments vehicle directional stability by applying and adjusting the vehicle brake torques individually to induce a correcting yaw moment to a vehicle
- That is computer-controlled with the computer using a closed-loop algorithm to limit vehicle oversteer and to limit vehicle understeer
- That has a means to determine the vehicle's yaw rate and to estimate its side slip or side slip derivative with respect to time
- That has means to monitor driver steering inputs
- That has an algorithm to determine the need, and a means to modify engine torque, as necessary, to assist the driver in maintaining control of the vehicle
- That is operational over the full speed range of the vehicle (except at vehicle speeds less than 20 km/h (12.4 mph), when being driven in reverse, or during system initialization)

For high cars, including Sport Utility Vehicles (SUV), ESC also protects against roll-over in severe driving scenarios. In addition, ESC includes value adding functions to enhance vehicle dynamics. The way the ESC is engaged by the driver's input will impact the driver's perception of the car. Companies can utilize this to enhance the brand or model identity, ranging from stable and safe with a lot of brake engagement to loose and sporty with less help from the system.

The final stages of ESC development are carried out in complete vehicle tests and includes calibration, tuning and validation of the ESC software. The testing is performed by expert drivers in isolated maneuvers representing specific driving scenarios, as well as more freely based on the limit driving. The isolated tests include single and double lane changes, sine with dwell, slalom, throttle release in turn etc. Vehicle performance is currently evaluated on the driver's subjective assessment in terms of chassis balance and the quality of ESC engagement. During development testing, the car's internal CAN (Controller Area Network) communication is logged on a laptop computer and external equipment is used for more accurate measurement of vehicle state variables. Competitor cars are also driven in benchmark testing.

CEVT wishes to include objective measurement methods as a complement to subjective assessment when rating ESC tests. Quantifiable targets on the parameters that are already logged are required. This is to improve the test documentation and communication of test results to related departments and suppliers and to establish objective requirements on ESC performance. To provide complementary objective test rating the valid parameters and target values need to be identified and a data post processing tool will be created. In the current rating system, the test driver gives a subjective assessment according to the scale in Figure 1 after each performed test. The scale is derived from the Society of Automotive Engineers (SAE) vehicle engineering rating (VER) scale for ride and handling [2].

| **Subjective rating** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle Engineering Rating (VER) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Evaluation of Attr. Performance | Very Bad | | Bad | | OK | | Good | | Very Good | |
| Customer Satisfaction | Customer wants repurchase | | Average customer complains. | | Critical customer complains | | Satisfied customers | | World Class | |

*Figure 1: Rating scale for subjective assessment*

## 1.1 Scope

The envisioned solution to include objective measurement methods in ESC testing is to create a data post processing rating tool, using signals from the CAN system and additional measurement equipment. The tool shall complement the subjective assessment of test performance. The algorithm will include different vehicle state parameters to judge if the test is pass/failed and guide the final test rating.

## 1.2 Deliverables

The following deliverables are expected from the master thesis project:

- Literature study
- Computer Aided Engineering (CAE) study of one test maneuver (with the purpose to learn more about the vehicle and assess the correlation between simulation and testing)
- Select the software to be used for the rating tool
- Post processing tool for test rating
- Input data format to suit different driving scenarios and vehicle models
- Output format to suit the expected parameters to be presented
- Instructions on how to use the rating tool
- Vehicle test (including planning and execution)
- Master thesis presentation
- Master thesis report

## 1.3 Limitations

The following limitations are defined for the project:

- The analysis tool to use software which is available for the vehicle dynamics development department
- Rating tool to suit only single and double lane change
- External measurement equipment limited to external inertial measurement unit (IMU) and steering effort sensor
- Tests only to be performed by experienced test drivers
- Driving robots will not be used
- Existing simulation models will be used in CAE study
- Only high mu (summer conditions) will be assessed
- Objective measurements of Noise Vibration Harshness (NVH) will not be made
- The VER rating principle currently used by the test and development group will be used
- Rating limits to suit cars of compact SUV/crossover class

## 1.4 Problem Definition

Vehicle project development loops require extensive real vehicle testing to reach the desired and required performance. As real vehicle testing loops are highly cost and time consuming, the strive for increased testing efficiency is important. Testing is always limited by the costs of producing prototype vehicles, track rent and measurement equipment. Subjective assessment has historically been a primary vehicle dynamics performance indicator. The inherent drawbacks with subjective testing is that it always influenced by the tester's values, skill and experience. The use of objective measure methods can increase the ability to predict a new vehicle's behavior in the simulation design loops and the project can reach a higher maturity stage at the start of real car testing. Objective data is more consistent between test drivers and is also easier communicated outside the test group compared to subjective data.

A challenge for the project is to develop a tool that is generic enough to be usable for a variety of test drivers with different rating sensibilities and vehicles with different characteristics. Other questions for the project are:

- Select software for the post processing
- Establish the relevant parameters for test rating
- Establish the input and output formats
- Will data from external measurement equipment be enough to base the algorithm on?

The rating tool needs to be compatible with current logging output formats and be forward compatible with various other logging outputs. Different data logging programs might be used in the future by the testing team, for instance, when only external equipment is used for a test or if a different ESC supplier is used.

# 2 Background

Performing lane changes is a major task in ESC testing. Different variations of the lane change maneuver are carried out throughout the automotive industry, including vehicle development but also test drives by journalists and verification tests during certification of the vehicle.

Two examples of test maneuvers with cone tracks are ISO 3888 and the Teknikens Värld moose test [3], [4]. ISO 3888 is a standardized test procedure which includes two tracks for high vs. low entry speed. The tracks represent the car having to maneuver around an obstacle in the current lane of the road. The car is steered to the adjacent lane and then returned to the first lane in a continuous motion. The entire maneuver is performed off-throttle. The width of the tracks is scaled proportionally to the track width of the car. The tests are judged on entry speed into the first gate and on average speed through the track, as well as on subjective assessment. Objective measurement has not been recommended for test rating according to the description in the ISO standard, since the timing and corrections made by the driver greatly affects test performance. ISO 3888-2 states:

"*Owing to driver influence (driving strategy) in this closed loop test, there is no possibility of an objective measurement of vehicle dynamics data, only subjective evaluation is recommended*."

This project aims to establish objective measured lane change testing with the use of open track testing and state of the art measurement equipment.

A similar cone track test has also been popularized by the Swedish motor magazine Teknikens Värld. A difference in test procedure in this test is the width of the track is kept constant for all vehicles. This test is only measured on entry speed when performed by Teknikens Värld and subjectively assessed. In both test procedures knocked over or moved cones results in a failed test pass.

Legislation in most automotive markets include passing an objectified double lane change test, commonly known as the sine with dwell test. The test is performed with a steering robot which is programmed to follow a specific open loop steering curve, see Figure 2. The steering wheel angle (SWA) follows a sine curve with an extra dwell time on the second peak value, to counteract the inertia of the vehicle when returning it the first lane. The steering curve has a frequency of 0.7 Hz and dwell time, $t_d$, of 0.5 seconds. The amplitude is dependent on the vehicle's behavior in several pre-test maneuvers, but is usually in the range of 270 to 300 degrees. To pass the test, yaw rate and lateral displacement must be within a certain range at specified times. The sine with dwell test does not follow a specific cone track, it only specifies a minimum lateral displacement of the vehicle's center of gravity during the maneuver, representing the vehicle fully leaving the first lane.

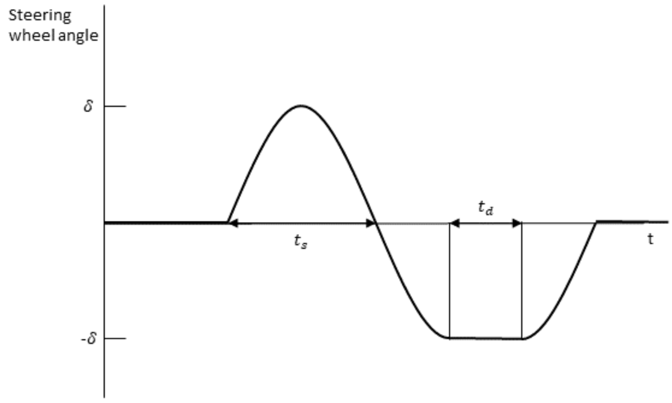



*Figure 2: Sine with dwell steering curve*

In development work at CEVT the majority of lane change tests are carried out without a cone track in an open handling area. Test are carried out at specified entry speeds and with a predefined steering pattern. The steering pattern is originally derived from the ISO 3888 tests, as the fastest way to drive through the track with a well-tuned ESC is to follow a curve similar to the sine with dwell curve, e.g. a smooth curve with no corrections. Not making corrections to the SWA input allows the brake controllers to be utilized to maximum extent. Compared to the sine with dwell curve, the ISO 3888 curve has three peaks (the first and third peak has the same sign). The third peak comes from straightening out the car when returning into the first lane. Figure 3 shows the measured SWA in a ISO 3888 test performed at CEVT. The curve can be estimated as a sine wave up to the negative peak, where it stays at the peak value for approximately 1.5 seconds. The third peak is similar in amplitude to the first two but has a slightly lower frequency when ramping out back to zero.

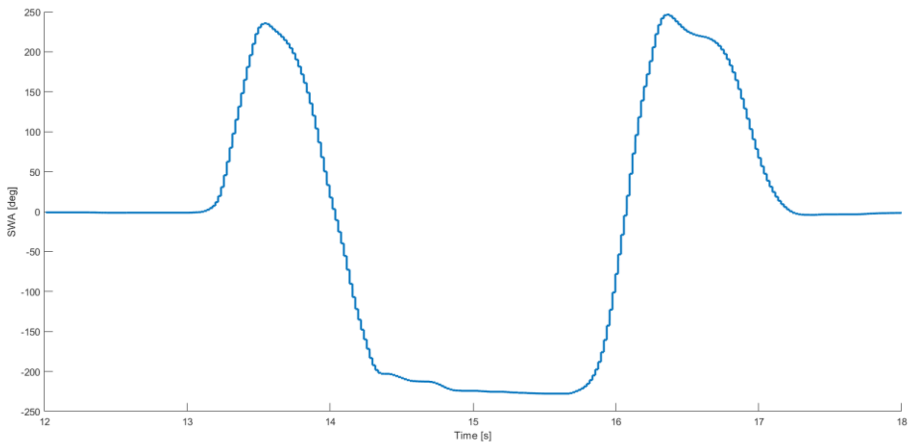



*Figure 3: ISO 3888/TV SWA*

## 2.1 Double and Single Lane Change Maneuver

The curve in Figure 3 is the base for the free hand double lane change (DLC). Of the previous mentioned tests, the double lane change is the one most commonly run during ESC development. Tests are run with initial speed 80, 100, 120 and 150 km/h. For each speed, tests with three different levels of steering application (smooth, medium and aggressive) are run. The aggressive (A) steering application level is derived from curve type showed in the figure above. It also follows a sine wave with a dwell at the second peak. The dwell time in this case is not dependent on making the return to the first lane within the track limits but rather on the vehicle's rotational response in the second lane. The third peak's amplitude and frequency is dependent on the counter measure to the last oversteer. The smooth (S) level should follow the same curve but with significantly lower amplitude and frequency. It should be hard enough to just cause a slight ESC intervention. The medium (M) level can be a purely intermediate step between the smooth and aggressive levels, but can also be used as a robustness test with a more asymmetrical SWA curve. For instance, a smooth turn-in to the second lane with an aggressive return might be used to create a more randomized use case. For the work in this project the medium drive case is treated purely as an intermediate step.

The maneuver can be divided into an open loop part and a reactive part. Up to the point $t_4$ (start of dwell, see Figure 4) there are no corrections made by the driver and the steering curve follows the sine wave. The dwell time and counter steer back in the first lane will however depend on the car's reaction to the open loop part. An understeered car will have a longer dwell time while an oversteered car should have shorter dwell time and larger counter steer amplitude.

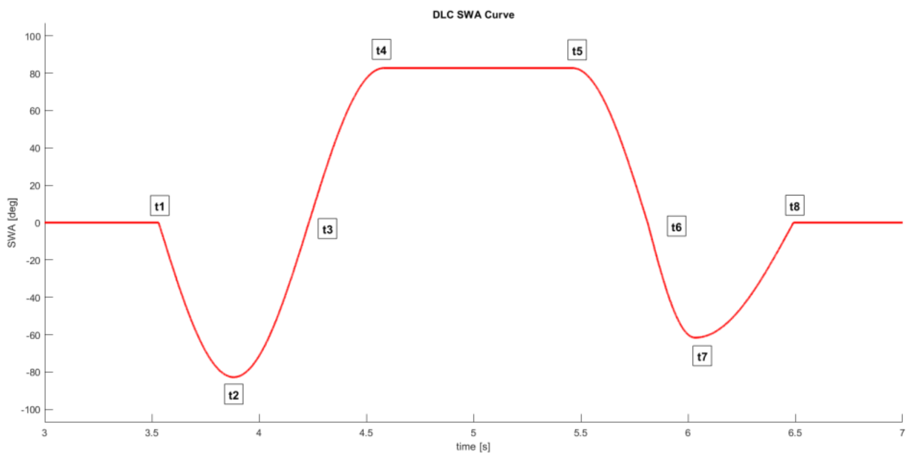



*Figure 4: Ideal DLC steering curve*

Both single and double lane change maneuvers are part of the ESC test catalog. In the single lane change the car does not return to the first lane and the steering curve is just a single period sine wave with no dwell component to it, see Figure 5. It is run at the same speeds as the DLC and has the same three levels of steering input. During ESC development the focus is on double lane change maneuvers as it a more complete maneuver. Single lane changes are mostly run in the final validation phase of each vehicle project.

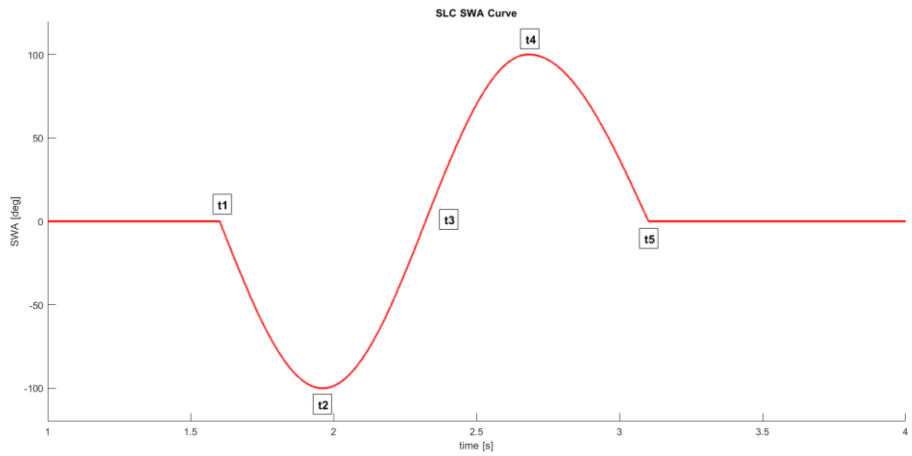



*Figure 5: Ideal SLC steering curve*

# 3 Methodology

The following section is a description of the methods used throughout this master thesis project. A basic outline of the project workflow is depicted in Figure 6.

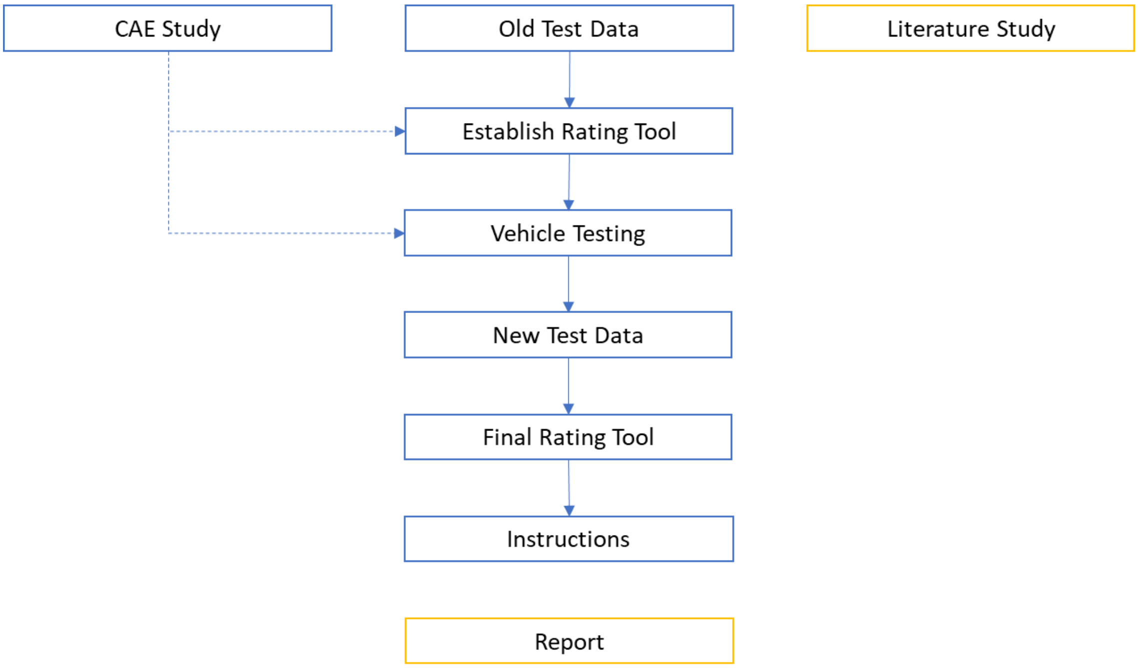



*Figure 6: Project workflow*

## 3.1 Literature Study

A literature study was carried out in the early stages of the project. It covered research on subjective and objective vehicle testing as well as the legal requirements on ESC systems and related ISO standards, see list of papers in section 8 References.

## 3.2 Tool Development

For each maneuver a rating algorithm was developed. The algorithm uses logged parameters to place the test on the current rating scale for subjective assessment, see Figure 1 in section 1. The algorithm is not required to give the final test score. It should rather work as tool to limit the rating scale with the final grade still being decided trough subjective assessment. The tool should also identify what part of the maneuver triggered the rating limitation. The output of the rating tool could either be included directly in the logging program or run through an auxiliary application. Automatic test rating is not required.

At the start of the project, logged data from previous validation testing was used to develop the algorithm before the vehicle testing described in section 3.3 was carried out. Comments on vehicle behavior and an overall test grade is typically attached to the log file and test case matrix. The validation log files did not contain IMU signals which limited their relevance as foundation for rating limits.

Reif states in the book *Brakes, Brake Control and Driver Assistance Systems* as part of the Bosch Professional Automotive Information-series that the primary parameters of dynamic handling assessment are [5]:

- Steering wheel angle
- Lateral Acceleration
- Longitudinal Acceleration
- Yaw rate
- Side slip and roll angle

This statement combined with know-how from CEVT ESC calibrators formed the rating assessment system stated in this section.

### 3.2.1 Data Logging

Data from ESC tuning is logged on a laptop computer using Bosch MM6 and Bosch Uniview. All internal CAN-signals in the Vehicle Dynamics Domain Master (VDDM), which is the data node that contains the ESC controllers, are logged. The propulsion and chassis CAN-network communication is also logged from the OBD-2 sockets. In Uniview, both vehicle state variables and controller parameters can be displayed graphically, see Figure 7. For most of the data analysis in this project the log files were exported to .mat format and analyzed in MATLAB. For more accurate measurements of vehicle state variables an external IMU is often used. However, none of the log files in the validation data sets available at the start if this project contained IMU signals.

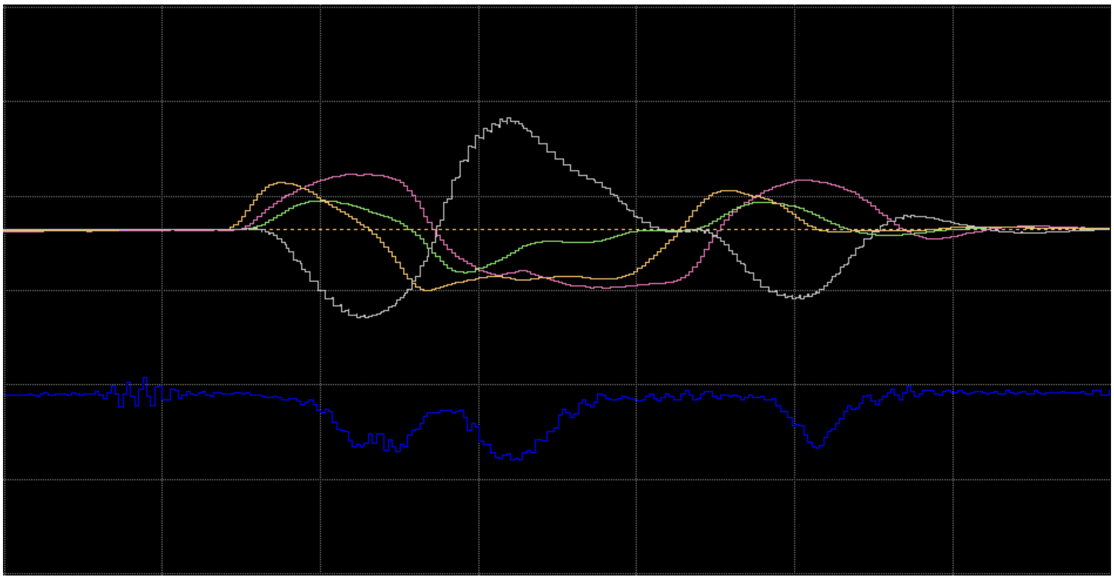


*Figure 7: Bosch Uniview graphic interface, showing SWA (orange), lateral acceleration (pink), yaw rate (green), side slip (white) and longitudinal acceleration (blue)*

### 3.2.2 Steering Curve

The steering input for each log file in the validation data sets was analyzed to find the steering curve for each aggressiveness level of each single and double lane change maneuver. The measured SWA was estimated as the ideal sine curves described in section 2.1, to find the amplitude and frequency of the steering input. For DLC, the amplitude for turn-in and dwell is the mean of any peaks in SWA between $t_1$ and $t_5$ (see Figure 4, section 2.1) while the estimated counter amplitude is the measured SWA counter peak value. The frequency is calculated using the time passed between SWA passing through 0 degrees (with a tolerance of +/- 2 degrees). See Figure 8 for measured and ideal steering curves. The plot also shows a reference curve (dotted line) which is the average steering curve for that particular maneuver.

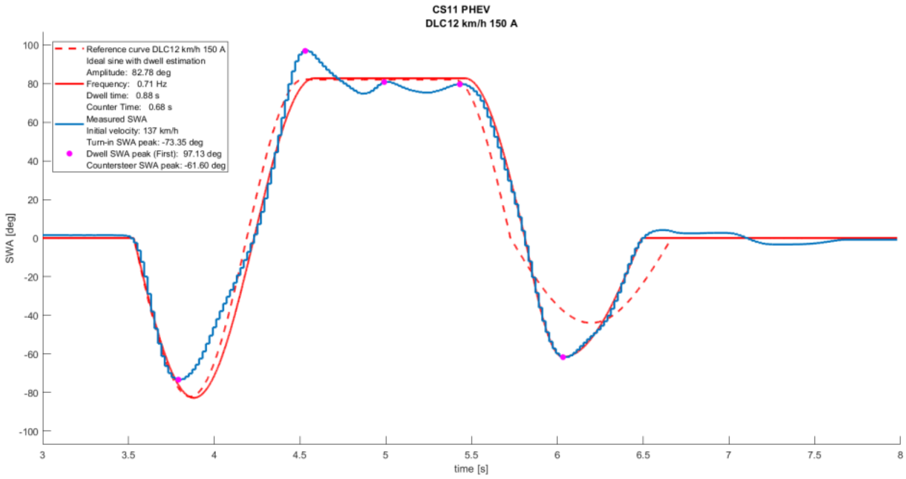



*Figure 8: Measured, estimated and reference steering curves for DLC*

The reference curve is based on the average steering across all validation data sets available at the start of the project. The data is shown in Table 1.

*Table 1: DLC steering data across all data sets*

| Ref. Curve | SWA Amp Mean [deg] | SWA Amp Std Dev | Fq Mean [Hz] | Fq Std Dev | Dwell Time Mean [s] | Dwell Std Dev | Counter SWA Mean [deg] | Counter Std Dev | Counter Time Mean [s] | Counter Time Std Dev |
|---|---|---|---|---|---|---|---|---|---|---|
| DLC01 80 S | 90 | 9 | 0.6 | 0.06 | 0.2 | 0.1 | -65 | 5 | 0.9 | 0.10 |
| DLC02 80 M | 140 | 20 | 0.7 | 0.09 | 0.7 | 0.3 | -50 | 15 | 0.9 | 0.3 |
| DLC03 80 A | 200 | 25 | 0.7 | 0.08 | 0.7 | 0.2 | -60 | 20 | 1.0 | 0.4 |
| DLC04 100 S | 70 | 6 | 0.6 | 0.04 | 0.3 | 0.1 | -40 | 30 | 1.0 | 0.1 |
| DLC05 100 M | 125 | 25 | 0.7 | 0.08 | 0.9 | 0.5 | -30 | 15 | 1.0 | 0.3 |
| DLC06 100 A | 165 | 35 | 0.8 | 0.08 | 1.0 | 0.4 | -50 | 35 | 0.9 | 0.4 |
| DLC07 120 S | 65 | 10 | 0.6 | 0.03 | 0.6 | 0.6 | -40 | 20 | 1.0 | 0.1 |
| DLC08 120 M | 100 | 20 | 0.6 | 0.08 | 0.8 | 0.3 | -35 | 15 | 0.9 | 0.2 |
| DLC09 120 A | 135 | 30 | 0.7 | 0.04 | 1.0 | 0.3 | -45 | 25 | 1.2 | 0.6 |
| DLC10 150 S | 45 | 5 | 0.6 | 0.02 | 0.30 | 0.2 | -35 | 5 | 1.0 | 0.1 |
| DLC11 150 M | 70 | 25 | 0.7 | 0.1 | 0.5 | 0.3 | -45 | 15 | 1.0 | 0.2 |
| DLC12 150 A | 85 | 20 | 0.8 | 0.1 | 0.5 | 0.2 | -45 | 15 | 0.9 | 0.5 |

The same method was used for the single lane change. Figure 9 shows how the ramp out frequency back to 0 degrees SWA often is lower than for the rest of the maneuver.

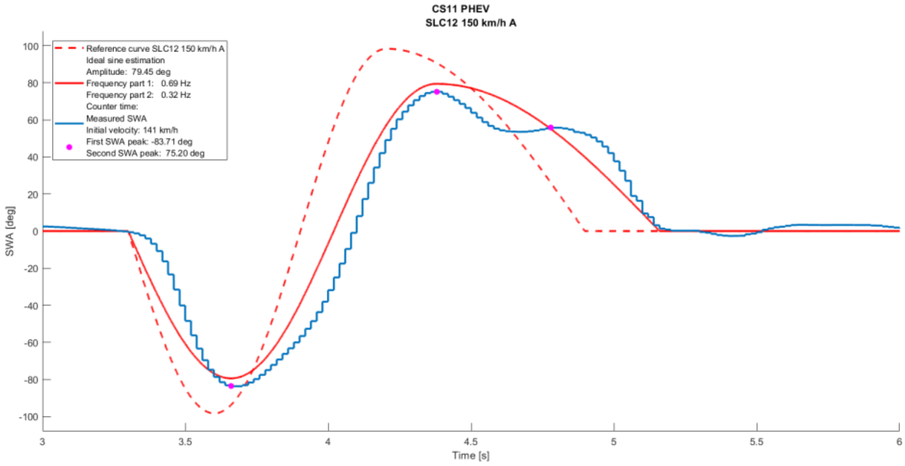



*Figure 9: Measured, estimated and reference steering curves for SLC*

The data for the single lane change reference curves is shown in Table 2.

*Table 2: SLC steering data across all data sets*

| Ref. Curve | SWA Mean [deg] | SWA Mean Std Dev | Fq 1 Mean [Hz] | Fq 1 Std Dev | Fq 2 Mean [Hz] | Fq 2 Std Dev |
|---|---|---|---|---|---|---|
| SLC01 80 S | 75 | 12 | 0.7 | 0.1 | 0.5 | 0.1 |
| SLC02 80 M | 120 | 15 | 0.8 | 0.1 | 0.3 | 0.1 |
| SLC03 80 A | 180 | 25 | 0.8 | 0.1 | 0.3 | 0.1 |
| SLC04 100 S | 65 | 10 | 0.7 | 0.1 | 0.5 | 0.1 |
| SLC05 100 M | 105 | 15 | 0.9 | 0.2 | 0.2 | 0.1 |
| SLC06 100 A | 150 | 20 | 0.8 | 0.1 | 0.3 | 0.1 |
| SLC07 120 S | 50 | 5 | 0.8 | 0.2 | 0.4 | 0.2 |
| SLC08 120 M | 90 | 15 | 0.9 | 0.1 | 0.4 | 0.2 |
| SLC09 120 A | 140 | 25 | 0.9 | 0.1 | 0.2 | 0.1 |
| SLC10 150 S | 45 | 5 | 0.8 | 0.2 | 0.4 | 0.2 |
| SLC11 150 M | 65 | 5 | 0.8 | 0.1 | 0.3 | 0.1 |
| SLC12 150 A | 100 | 20 | 0.8 | 0.1 | 0.4 | 0.1 |

### 3.2.3 Data Processing

Rating of both single and double lane changes was divided into a lateral and longitudinal sub rating. The idea behind it is to separate yaw damping and side slip build-up into one rating category and the quality of brake application into another. A factor which has been disregarded in this analysis is brake noise. Noise measurements are not made during ESC tuning even though noise and vibrations from the brake system is subjectively assessed while testing.

#### 3.2.3.1 Lateral performance

The vehicle's lateral performance in lane change maneuvers is based on how well the system mitigates oversteer. Critical measures include maximum rear axle side slip, which describes how large the slide is allowed to become. It is also important to consider how fast the car build into a slide, e.g. how well it is yaw damped.

Roll angle was not considered as the validation data sets available at the start of the project did not contain roll measurement. There should be a maximum allowed value on lateral displacement of the vehicle's center of gravity during lane changes. This correlates to being able to stay within the road limits in a real traffic scenario. FMVSS126 stipulates a minimum lateral displacement for the sine with dwell test [1]. This has not yet been implemented.

##### 3.2.3.1.1 Side Slip

The side slip signal is defined according to Equation (1).

$$\beta = \frac{180}{\pi} * \operatorname{atan}\left(\frac{\left(v_y - \frac{l_r * \pi * \omega_z}{180}\right)}{\max[v_x, 1]}\right) \; [deg] \qquad (1)$$

With $v_x$ and $v_y$ in m/s and $\omega_z$ in deg/s. $l_r$ is the distance (in meter) between the IMU and the car's rear axle. Test drivers often describe the car as too loose when the side slip becomes exceedingly large.

For DLC, the three side slip peaks corresponding to SWA turn-in, dwell and counter steer peaks are used as rating variables, see Figure 10.

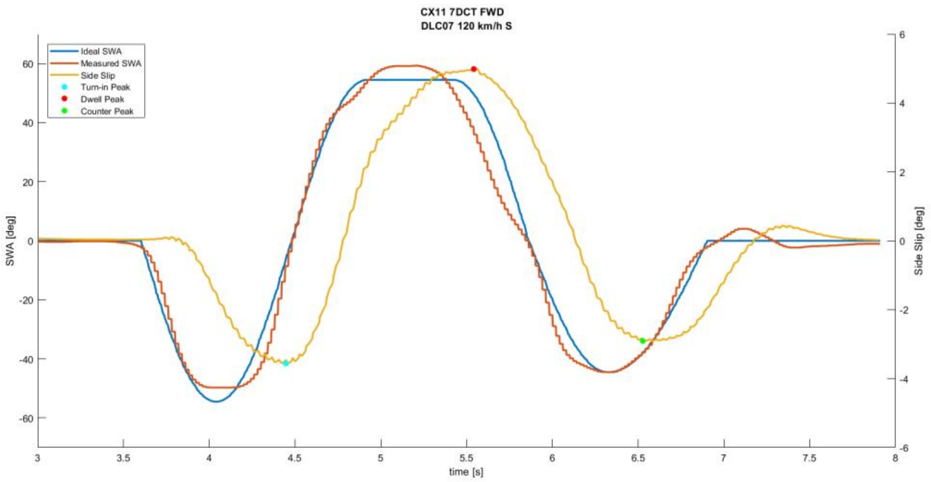



*Figure 10: DLC side slip curve*

For SLC, the two side slip peaks corresponding to each SWA peak are used rating variables, see Figure 11.

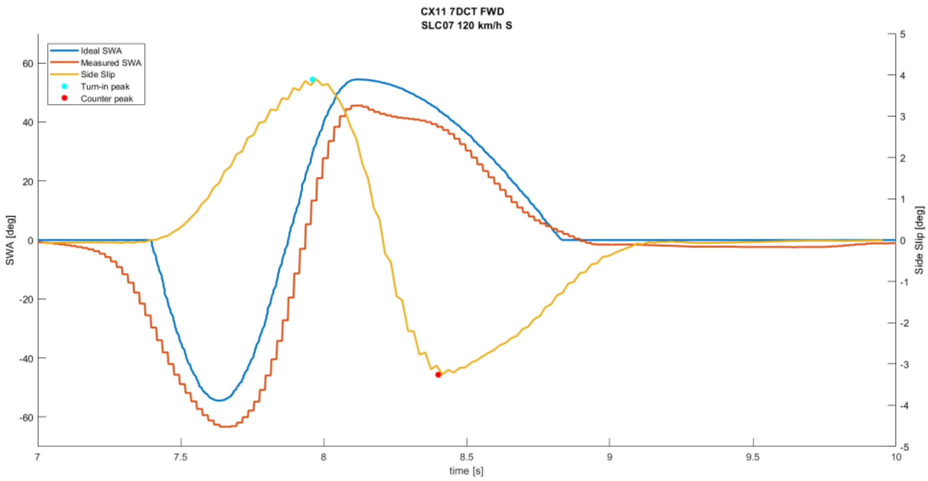



*Figure 11: SLC side slip curve*

#### 3.2.3.1.2 Yaw Rate and Yaw Acceleration

Similarly to side slip, yaw rate peaks are used as rating variables, see Figure 12.

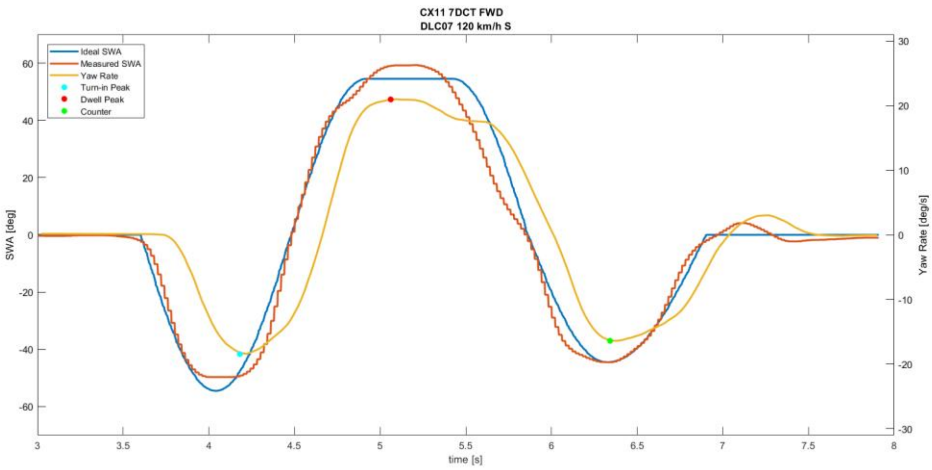



*Figure 12: DLC yaw rate curve*

Yaw acceleration is defined as the derivative of Yaw Rate, Equation (2):

$$\dot{\omega}_z(t) = \frac{d\omega}{dt} \quad \left[\frac{deg}{s^2}\right] \tag{2}$$

A car with little yaw damping can perceived as having a "snappy" and uncontrollable oversteer behavior, instead of linearly and predictably building oversteer. As there is more noise and shorter time steps on the IMU yaw rate signal compared to the internal signal, it had to be filtered with a time average filter (Equation (3)) with $windowsize = 5$:

$$\dot{\omega}_{z,IMU}(n) = \frac{1}{windowsize}\Big(\dot{\omega}_z(n) + \dot{\omega}_z(n-1) + \cdots + \dot{\omega}_z\big(n - (windowsize - 1)\big)\Big) \tag{3}$$

Yaw acceleration at two locations is chosen as a measure of the vehicles yaw damping. First location is the first peak in yaw acceleration, which correspond to the initial slide when turning into the adjacent lane. The second location is where yaw rate changes sign, e.g. how aggressive the car is in its switch of rotational direction, according to Equation (4).

$$\dot{\omega}_{z,2} = \left.\frac{d\omega_z}{dt}\right|_{\omega_z=0} \tag{4}$$

This is located close to the second SWA peak. Both locations are defined in the same manner for single and double lane change, see Figure 13.

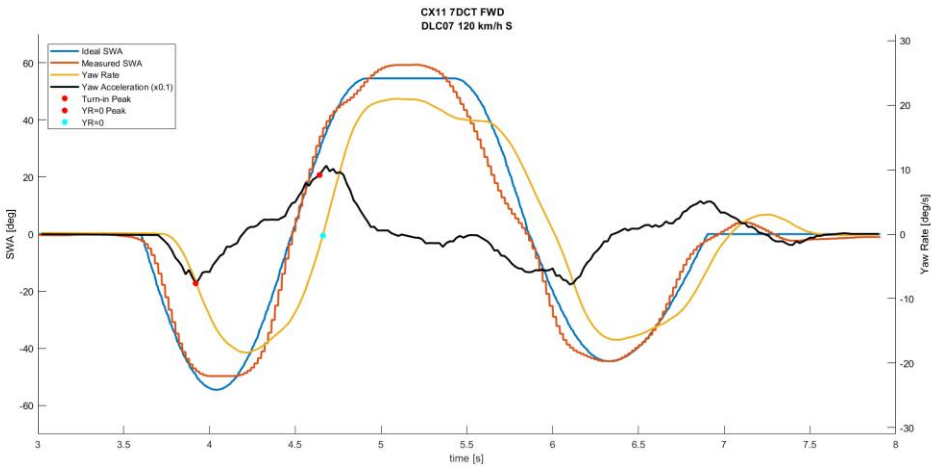



*Figure 13: DLC yaw rate and acceleration curves*

#### 3.2.3.2 Longitudinal Performance

The vehicle's longitudinal performance is defined by the quality of the ESC intervention. The ESC might limit oversteer and roll over risk in a safe way by over-braking the vehicle throughout the maneuver. Even though legal requirements are met, an over-braked car will reduce customer satisfaction in terms of comfort and handling. This can be caused by the brakes being applied too harshly, causing a sudden jerk in the vehicle or by braking for too long while the car feels stable.

##### 3.2.3.2.1 Longitudinal Jerk

Jerk is used as measure to see how smooth the brakes decelerate the vehicle during the maneuver. The longitudinal acceleration signal is differentiated with respect to time to find the jerk levels, according to Equation (5). High jerk levels are related to intrusive ESC intervention.

$$j_x(t) = \frac{da_x}{dt} \quad \left[\frac{m}{s^3}\right] \tag{5}$$

As there is noise on the longitudinal acceleration signal, the jerk signal is filtered with a time average filter according to Equation (6):

$$j_{x,filtered}(n) = \frac{1}{windowsize}\Big(j_x(n) + j_x(n-1) + \cdots + j_x\big(n - (windowsize - 1)\big)\Big) \tag{6}$$

For the internal acceleration signal $windowsize = 5$ was used. As there was more noise on the IMU acceleration signal, $windowsize = 25$ was used for IMU logging. The longitudinal acceleration and jerk curves can be seen in Figure 14.

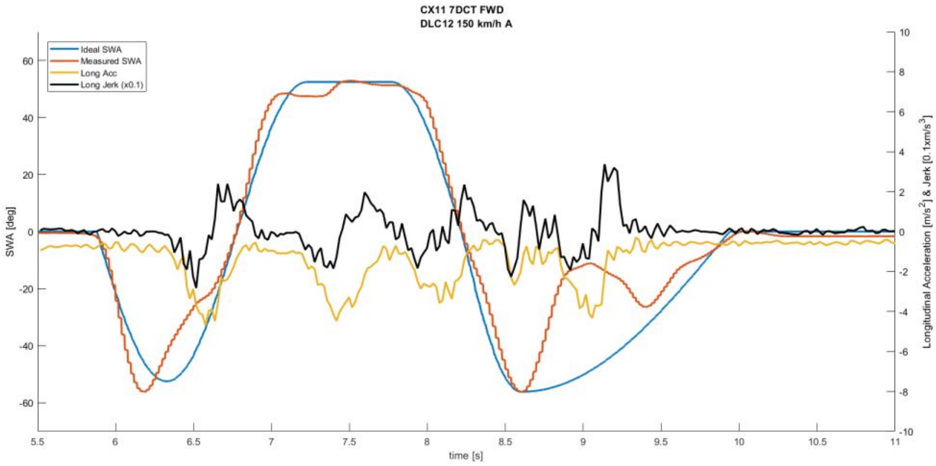



*Figure 14: DLC longitudinal acceleration and jerk curves*

### 3.2.3.2.2 Speed Loss

Another issue that can lower the lane change performance is the brakes being applied too early or not releasing fast enough when the car is stabilized, scrubbing off too much speed during the maneuver. Therefore, the longitudinal velocity difference between the beginning and end of the maneuver is also considered. The speed loss is defined as the longitudinal velocity difference between the start and end of steering, see Equation (7). A longitudinal velocity plot in a double lane change is shown in Figure 15.

$$\Delta v_x = v_x(t_1) - v_x(t_8) \qquad (7)$$

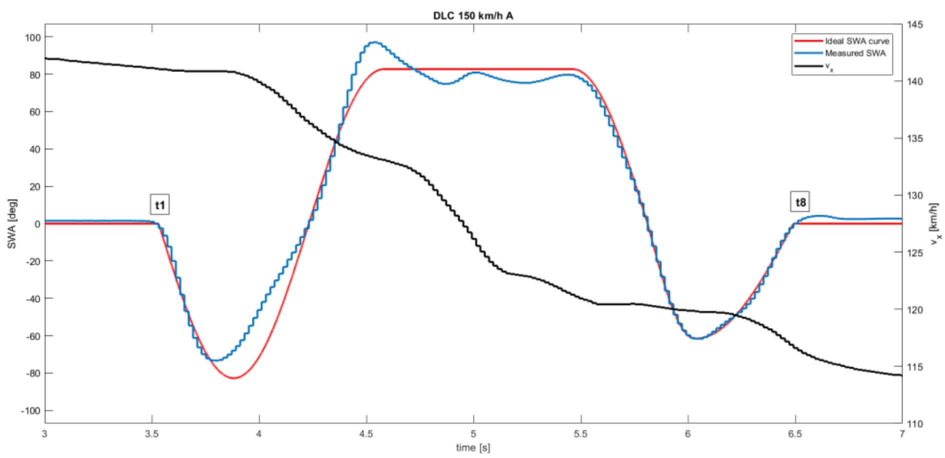



*Figure 15: DLC longitudinal velocity curve*

## 3.3 Vehicle Testing

To gather relevant and up to date data and get an opportunity to collect subjective assessment in real time, a test session dedicated for this master thesis was performed. Three experienced test drivers performed tests and gave their subjective assessment. Test planning, including vehicles, equipment and track time was done by the student. This was the first ESC benchmarking at CEVT to include objective measurement which meant a new measurement set-up had to be created.

The usual ESC validation test catalog for single and double lane changes was used. Both Lynk & Co and competitor cars were tested. A test questionnaire was created to gather subjective assessment for each test run.

### 3.3.1 Questionnaire

To formalize the gathering of subjective assessment for each test, a questionnaire (see Appendix A) was created in Microsoft Excel. Assessment of single and double lane change maneuvers were divided in three categories; ESC intervention, Chassis and Steering input with further sub assessments. ESC intervention has the following subcategories:

**Intrusiveness**
Measure of how hard the brake interventions feel in the car. Judged both in terms of comfort and performance. No intervention means that no braking force can be registered by the driver.

**Stability**
Assessment of side slip. A stable car should follow the driver's steering input well, while a loose car is sliding a lot.

**Pressure release**
Measure of how fast the brakes pressure is released after the car has been stabilized.

**Noise**
Assessment of NVH level during maneuver. Including pump noise and brake squeal.

The basic chassis character is also considered, to be able to derive if a certain test performance is due the car's chassis or brake control tuning. For instance, a very soft chassis tuning combined with harsh brake interventions might exaggerate an unwanted behavior.

**Balance**
General assessment of chassis balance. Understeered (below 5), neutral (5) or oversteered (above 5).

**Ride**
General assessment of ride character. Hard (below 5), neutral (5) or soft (above 5).

A self-assessment of the driver's steering input is also made. The idea is to estimate how well the steering curve is tracking to the ideal sine curves. This can then be compared to the plotted curves in the rating program.

**Corrections**
Were there any corrections made to the steering input during the maneuver? This would show up as "sawing" or steps in the steering curve.

**Curve symmetry**
Was the SWA amplitude the same in both directions and was the steering wheel at zero degrees at the start and end of the maneuver?

The SAE scale for verification engineering rating is used with incremental 0.25 steps in accordance with previous CEVT rating methodology [2]. Gaspar Gil used a manual questionnaire (pen & paper) and found that rating by marking a dot on a horizontal line instead of just writing down the number caused test drivers to utilize incremental rating steps to further extent [6]. Therefore, horizontal scroll bars were implemented in the Excel sheet to select rating grade. Some categories range linearly from very bad (0) to very good (10), while others have a middle optimum, such as understeered – neutral – oversteered. There are also comment fields for each rating category as not all information in the subjective assessment can be documented with just the rating grades.

### 3.3.2 Test plan

Three cars (competitor cars C1 and C2 and CEVT project B1) were tested at Volvo Hällered Proving Ground (HPG) in Västra Götaland, Sweden. All three cars are in the compact SUV/crossover class. The competitor cars were kept to their standard specification apart from tires, which had to be changed to not wear out the only set of standard tires. Vehicle C1 was changed from Bridgestone Alenza 235/55 R18 to a new set of Continental Premium Contact 235/55 R18 and C2 was changed from Bridgestone Dueler 225/60 R18 to a scrubbed set of Continental Eco Contact 235/55 R18.

Each car was tested in a single work day at the HPG brake & handling area. Three experienced ESC test drivers of CEVT vehicle dynamics department were scheduled to drive the cars. To keep track conditions and tire wear as consistent as possible between the different drivers, SLC was tested by all drivers before starting DLC testing. This meant the driver’s made two 45-minute test sessions during the day. The original plan was let all three test drivers drive each car, but planning issues meant only vehicle C2 was driven by everyone, C1 was driven by two drivers and B1 was driven by only one. The daily test plan followed the routine stated below:

- Equipment installation and shakedown

- SLC 80 km/h S
- SLC 80 km/h M
- SLC 80 km/h A
- SLC 100 km/h S
- SLC 100 km/h M
- SLC 100 km/h A
- SLC 120 km/h S
- SLC 120 km/h M
- SLC 120 km/h A
- SLC 150 km/h S
- SLC 150 km/h M
- SLC 150 km/h A

- Driver change
- Repeat SLC for each driver

- DLC 80 km/h S
- DLC 80 km/h M
- DLC 80 km/h A
- DLC 100 km/h S
- DLC 100 km/h M
- DLC 100 km/h A
- DLC 120 km/h S
- DLC 120 km/h M
- DLC 120 km/h A
- DLC 150 km/h S
- DLC 150 km/h M
- DLC 150 km/h A

- Driver change
- Repeat DLC for each driver

Vehicle C1 tests were only carried out to 120 km/h M level as it was not deemed safe to perform the most extreme drive cases after poor results in SLC 80 km/h A and SLC 100 km/h A. 150 km/h was therefore not carried out for C2 either to save testing time.

### 3.3.3 Test Equipment

Vehicle B1 was equipped with standard ESC test equipment. The standard measurement setup includes:

- VDDM D5 XCP Test Unit
- Inertial Measurement Unit OxTS RT3100
- 4x Brake Pressure Transducers
- 2x Vector VX1132 VxBox
- GI-Electronic GmbH DS2 M8/6 MBox

As there was no existing measurement set-up for competitor cars, a new set-up was created for this test. The set-up consisted of OxTS RT3100 IMU, Sensor Developments steering effort sensor 01184 and an Vector VX1132 VxBox. Both vehicle B1 and competitor cars were logged through Bosch MM6. The measurement set-up is shown in Figure 16. The steering effort sensor includes an auxiliary steering wheel mounted to the cars original steering wheel. The auxiliary steering wheel has a smaller radius than the original and when mounted does not allow adjustment of steering wheel position, both of which will impact the driver's comfort and perception of steering feedback. The steering effort sensor can also measure steering torque, but it was decided to not log this signal since it would require an extra software calibration when installed in a new vehicle. With a stressed test schedule and no apparent reason to log steering torque logging was limited to only steering wheel angle. The installation time for the competitor car setup was approximately 1.5 hours for two persons.

*Figure 16: Competitor car measurement set-up, including steering effort sensor, IMU, measurement laptop and VxBox*

During each run at speeds 80, 100 and 120 km/h lane changes in both directions were made. These maneuvers were divided into two data sets to produce more data in a time efficient manner. Figure 17 shows an MM6 log of one run which will produce two data points. A consequence of this is the subjective assessment carried out after the run will be the same for both data points, so if there is a large variance between the maneuvers, there is a risk of mismatch between the measured data and subjective assessment. In most cases of large difference between the maneuvers, it was noted in the comments and the subjective rating was changed accordingly.

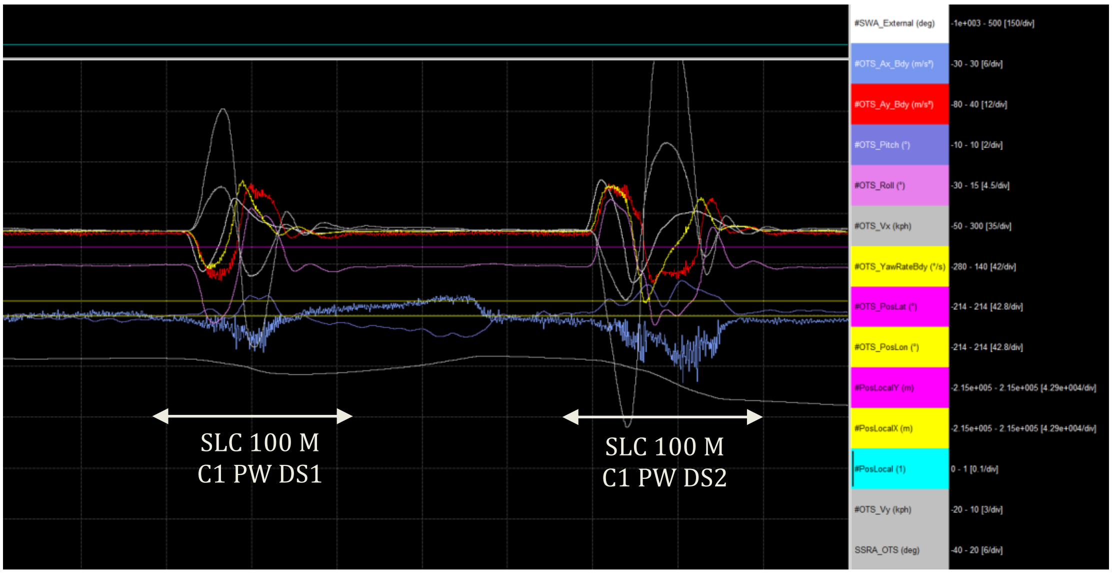



*Figure 17: MM6 log of one run containing maneuvers in both directions*

The data sets are summarized in Table 3.

*Table 3: Data set summary*

| Car | Driver | Date | DLC Data Sets | SLC Data Sets |
|---|---|---|---|---|
| C1 | Peter Wiborg | 20190409 | 2 | 2 |
| C1 | Niclas Harbig | 20190409 | 2 | 2 |
| C2 | Peter Wiborg | 20190410 | 2 | 2 |
| C2 | Niclas Harbig | 20190410 | 2 | 2 |
| C2 | Karl-Johan Hagelin | 20190410 | 2 | 1 |
| B1 | Peter Wiborg | 20190411 & 20190416 | 2 | 4 |

## 3.4 CAE Study

To gain more understanding of how the vehicle behaves in the different stages of the maneuver, CAE simulation of single lane change was studied. Simulating the tests in an ideal environment provided a good platform to try the algorithms at an early stage of the project and to remove the influence of erroneous signals due to measurement inaccuracy, signal noise etc. It was also a way to include vehicle dynamics theory in the project. As the scope of this project is not focused on CAE, it should only support the testing activity. Therefore, existing CAE models was used.

ADAMS full car simulations were obtained from CEVT Chassis & Powertrain CAE department. The CAE models are of vehicle project A1 and does not include ESC control systems. The simulations follow a different test catalog compared to the ESC testing. The maneuver with the most similarity between the test catalogs is the single lane change (denoted VLC in the simulations). All simulations are carried out with initial velocity 80 km/h and SWA frequency 0.5 Hz. SWA amplitude increases in increments between 25 to 225 degrees, see Table 4. Simulations of lane change in both directions (left and right) are made.

*Table 4: ADAMS full car simulation test catalog*

| Name | Velocity | SWA Amplitude | SWA Frequency |
|---|---|---|---|
| VLC01 L/R | 80 km/h | 25° | 0.5 Hz |
| VLC02 L/R | 80 km/h | 37.5° | 0.5 Hz |
| VLC03 L/R | 80 km/h | 50° | 0.5 Hz |
| VLC04 L/R | 80 km/h | 62.5° | 0.5 Hz |
| VLC05 L/R | 80 km/h | 75° | 0.5 Hz |
| VLC06 L/R | 80 km/h | 100° | 0.5 Hz |
| VLC07 L/R | 80 km/h | 125° | 0.5 Hz |
| VLC08 L/R | 80 km/h | 150° | 0.5 Hz |
| VLC09 L/R | 80 km/h | 175° | 0.5 Hz |
| VLC10 L/R | 80 km/h | 200° | 0.5 Hz |
| VLC11 L/R | 80 km/h | 225° | 0.5 Hz |

When analyzing the simulation results, it was found that runs VLC07-11 caused the car to spin making the results invalid. To find a similar ESC test the steering input and lateral performance of the simulation was compared to the ESC test logs from various vehicle project B models. Table 5 shows vehicle state variables at their first and second peaks (denoted 1 and 2). Side slip signal was not included in the simulation results and was calculated according to the same formula (Equation (1)) used in Bosch MM6 for measurements in the real vehicle.

$$\beta = \frac{180}{\pi} * \operatorname{atan}\left(\frac{\left(v_y - \frac{l_r * \pi * \omega_z}{180}\right)}{\max[v_x, 1]}\right) \; [deg] \qquad (1)$$

With $v_x$ and $v_y$ in m/s and $\omega_z$ in deg/s. $l_r$ is the distance (in meter) between the IMU and the car's rear axle.

*Table 5: VLC Simulation results, green rows show the most similarity to ESC 80 km/h S test*

| Name | SWA amp [deg] | Lat Acc 1 [m/s$^2$] | Lat Acc 2 [m/s$^2$] | Side Slip 1 [deg] | Side Slip 2 [deg] | Yaw Rate 1 [deg/s] | Yaw Rate 2 [deg/s] |
|---|---|---|---|---|---|---|---|
| VLC L 3 | 50 | 5.79 | -5.77 | -3.49 | 3.43 | 17.17 | -16.84 |
| VLC L 4 | 62.5 | 6.77 | -6.74 | -4.47 | 4.35 | 20.87 | -20.23 |
| VLC L 5 | 75 | 7.54 | -7.64 | -5.51 | 5.35 | 24.20 | -23.35 |
| VLC L 6 | 100 | 8.41 | -9.24 | -8.03 | 9.31 | 29.77 | -34.25 |
| VLC R 3 | 50 | -5.83 | 5.72 | 3.51 | -3.40 | -17.33 | 16.70 |
| VLC R 4 | 62.5 | -6.84 | 6.70 | 4.50 | -4.32 | -21.04 | 20.06 |
| VLC R 5 | 75 | -7.61 | 7.59 | 5.46 | -5.31 | -24.35 | 23.21 |
| VLC R 6 | 100 | -8.47 | 9.10 | 8.08 | -9.29 | -29.88 | 34.35 |

Analyzing the valid simulation results (VLC01-VLC06) shows side slip (in red) phase time increases with steering wheel angle amplitude, see Figure 18.

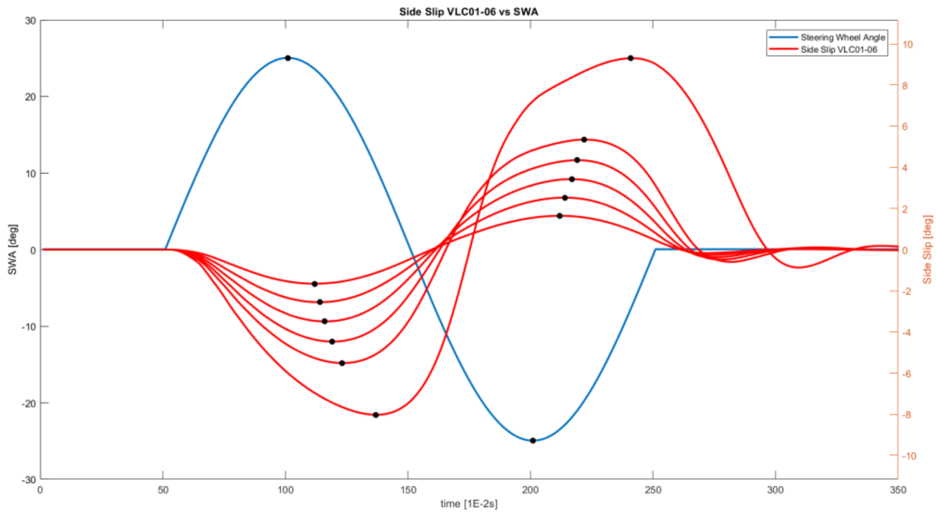



*Figure 18: Simulation side slip curves for VLC01-06*

Yaw rate (Figure 19) does not have the same linear increase of phase time and at high SWA the phase time decreases. At higher SWA angles the tires leave the linear range which might contribute to the inconsistent phase times.

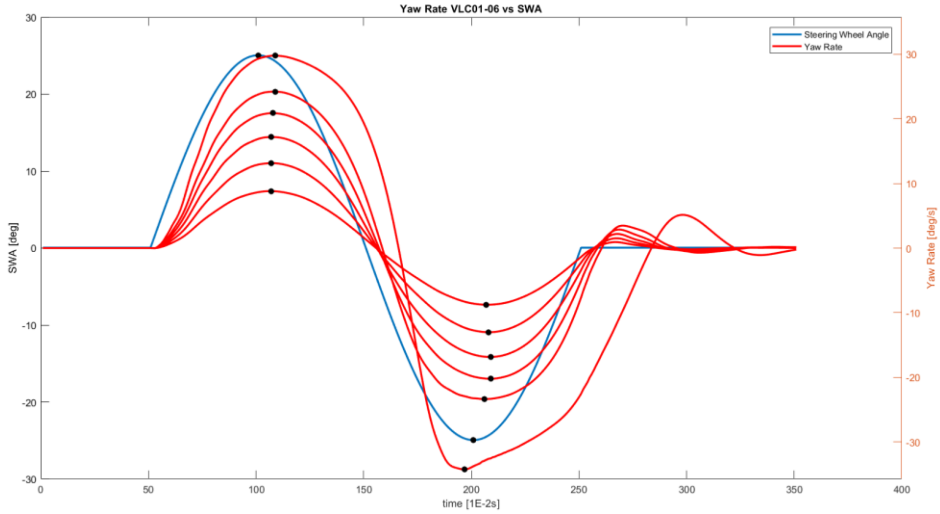



*Figure 19: Simulation yaw rate results for VLC01-06*

The lateral acceleration curves show some inconsistencies, which can be attributed to the aggressive entry and exit to the sine wave, see Figure 20.

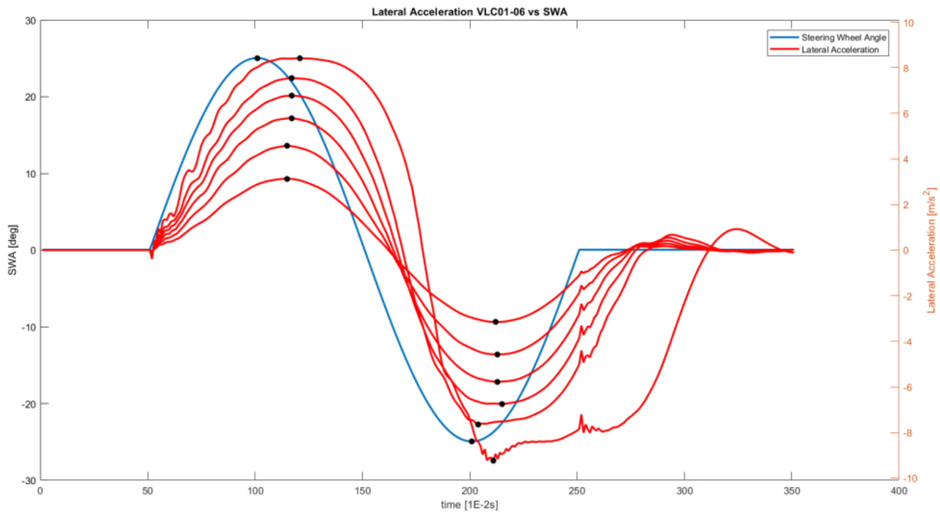



*Figure 20: Simulation lateral acceleration results for VLC01-06*

The results from real vehicle testing in vehicle B2 and B3 with ESC are shown in Table 6 below. The values shown are the mean across three data sets.

*Table 6: Real car results for 80 km/h single lane changes*

| Run | SWA Mean [deg] | Fq Mean [Hz] | Lat Acc 1 Mean [m/s$^2$] | Lat Acc 2 Mean [m/s$^2$] | Side Slip 1 Mean [deg] | Side Slip 2 Mean [deg] | Yaw Rate 1 Mean [deg/s] | Yaw Rate 2 Mean [deg/s] |
|---|---|---|---|---|---|---|---|---|
| SLC 80 S | 68.23 | 0.78 | -6.74 | 6.42 | -3.64 | 3.14 | -21.22 | 19.79 |
| SLC 80 M | 127.27 | 0.84 | -8.33 | 7.08 | -6.52 | 5.16 | -33.98 | 31.50 |
| SLC 80 A | 186.85 | 0.81 | -8.34 | 6.03 | -6.42 | 5.04 | -35.38 | 32.99 |

Judging from these results SLC 80 km/h S is the only real car test that can be compared to simulation test runs. The most interesting simulation drive cases for comparison to real vehicle performance are VLC4 and 5 which are in the range of the ESC 80 km/h S test.

The simulation results show how increasing SWA amplitude increases the "severity" of the maneuver, which is why it is important to cover a wide range of amplitudes. SWA amplitudes around 62.5 to 75 is where the tires are believed to enter the non-linear range the car is less stable throughout the maneuver. With SWA amplitude 100 degrees the car is close to losing control. It is interesting to note that ESC 80 km/h S level is also in the range of 62.5 to 75 degrees SWA amplitude, which is described as an easy maneuver barely requiring ESC intervention. At ESC 80 km/h M level, the SWA amplitude is around 125 degrees. Comparatively, in VLC07 (125 degrees) the simulated vehicle (without ESC) has already lost control and spun. As seen in Figure 21 side slip continues to increase to 35 degrees a second after the steering input is stopped and the yaw rate is continuously high indicating that the car is about to spin.

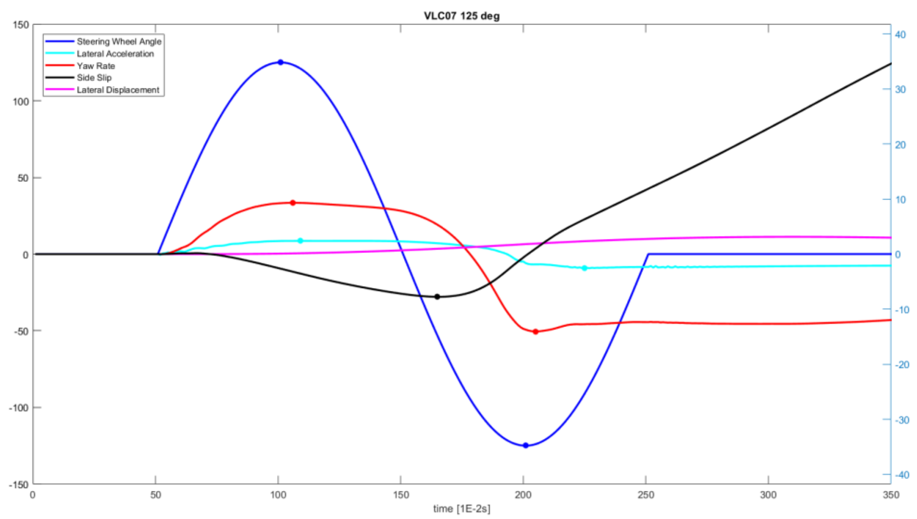



*Figure 21: VLC07 simulation results*

### 3.4.1 Simulation – Real Car Correlation Testing

To compare real vehicle performance to the simulated model and see the effect of ESC, a test session where the simulation runs were recreated in the real vehicle was conducted. Vehicle A2 was tested at Säve Proving Ground March 27th, 2019. The sinusoidal steering curve of the simulation input was recreated by an experienced test driver. To achieve a frequency of 0.5 Hz a metronome set to 60 bpm (beats per minute) was used to time the steering input. The steering tempo should match the metronome such that each SWA peak should come at the metronome tick. Both VLC 4 (62.5 degrees SWA) and VLC 5 (75 degrees SWA) was run with and without ESC. The ESC was disabled by disconnecting one of the wheel speed sensors. The external IMU was not available for this test session so the car's internal logging had to be used.

The simulation vehicle is A1 with Michelin Primacy 235/55R18 100 V tires. At the time of this test only A2 on Continental Sport Contact 235/50 R19 99 V tires was available for testing. Table 7 shows the weights for vehicle A1 and A2. Curb 0 is vehicle weight without any passengers and curb 2 is loaded with driver (68 kg) and one passenger (68 kg) in front seats + 14 kg in luggage compartment. The simulation model is loaded at curb 2. Vehicle A2 had been loaded to match the control model curb 0 weight. It was not possible to check the curb 2 weight, as there are no permanent scales at Säve Proving Ground.

*Table 7: Vehicle weight for different vehicle configurations*

| | Simulation | A1 (Weight Book) | A1 (Actual) | A2 (Weight Book) | A2 (Actual) |
|---|---|---|---|---|---|
| Weight Total Curb0/Curb2 | N/A / 2123 kg | 1979 kg / 2129 kg | | 1915 kg/ 2065 kg | 1918 kg/ ~2090 kg |
| Weight Front Curb0/Curb2 | N/A / 1177 kg | 1114 kg/ 1186 kg | | 1089 kg/ 1162 kg | 1093 kg/ N/A |
| Weight Rear Curb0/Curb2 | N/A / 946 kg | 865 kg/ 943 kg | | 829 kg/ 903 kg | 825 kg/ N/A |
| Weight Dist. Curb0/Curb2 | N/A / 55 % | 56 %/ 56 % | | 57 %/ 56% | 57 %/ N/A |

# 4 Results

This section covers the results from the test session specifically dedicated for this project and the simulation correlation testing.

## 4.1 Testing Results

The results from the dedicated test session was post-processed and analyzed to find subjective and objective data trends.

The steering curves for all test maneuvers were checked against the reference curves defined in section 3.2.2 to make sure the steering input was representative for the maneuver. If the steering amplitude was outside the standard deviation for that particular maneuver, the result was disregarded. In some cases, the result was moved from one level to another, for instance from 80 km/h A to 80 km/h M if the amplitude was within the medium range.

The valid runs were post-processed in MATLAB according to section 3.2.3 and further analyzed in Microsoft Excel, where the measured data was compared to the subjective assessments. Table 8 shows the data input for C2 PW DS1. Data points that exceed rating limits (see section 5.1) show in red (failed) or orange (bad). Tables for all DLC data sets can be found in Appendix C and SLC in Appendix F.

*Table 8: C2 PW DS1 data input, green SWA amplitude is within the standard deviation, yellow is on the limit but OK. Orange and red data points have exceeded rating limits.*

| Trace | SWA Amp | Lat Acc 1 | Lat Acc 2 | Lat Acc 3 | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AN_20190410_050A | 92,32 | -8,28 | 9,18 | -5,89 | 2,66 | -3,46 | 1,78 | -20,32 | 24,21 | -14,11 | -88,93 | 74,93 | -1,29 | -2,24 | 8,57 | 7,5 |
| AN_20190410_051A | 143,69 | -11,02 | 10,97 | -6,82 | 4,66 | -5,82 | 2,83 | -31,87 | 32,46 | -19,67 | -180,53 | 156,93 | -2,31 | -4,49 | 8,10 | 6,75 |
| AN_20190410_052A | 180,62 | -11,81 | 13,21 | -8,51 | 6,20 | -10,78 | 4,22 | -36,64 | 52,10 | -35,16 | -190,27 | 256,27 | -4,68 | -12,32 | 25,92 | 6,75 |
| AN_20190410_053A | 75,76 | -8,65 | 8,80 | -7,43 | 3,23 | -3,02 | 2,47 | -20,28 | 20,48 | -16,14 | -90,13 | 42,53 | -1,35 | -2,21 | 8,53 | 6,75 |
| AN_20190410_054A | 106,79 | -10,82 | 10,88 | -5,11 | 4,54 | -4,73 | 1,86 | -25,75 | 32,40 | -10,35 | -140,13 | 123,20 | -4,59 | -7,35 | 14,36 | 6,75 |
| AN_20190410_055A | 152,98 | -11,95 | 13,67 | -5,50 | 7,17 | -11,62 | 1,99 | -37,19 | 59,80 | -15,94 | -180,93 | 176,93 | -6,24 | -10,99 | 30,74 | 6,75 |
| AN_20190410_056A | 70,40 | -9,01 | 8,94 | -5,46 | 2,91 | -2,97 | 1,41 | -19,39 | 15,24 | -11,74 | -85,47 | 46,80 | -1,65 | -3,60 | 9,47 | 7,5 |
| AN_20190410_057A | 92,92 | -11,09 | 12,83 | -7,31 | 6,63 | -6,09 | 2,56 | -32,73 | 43,97 | -23,50 | -146,00 | 143,73 | -6,26 | -12,24 | 27,32 | 6,5 |
| AN_20190410_058A | 120,44 | -11,71 | 14,28 | -9,28 | 6,99 | -12,75 | 3,96 | -30,46 | 55,47 | -29,82 | -171,07 | 163,07 | -6,42 | -16,00 | 28,37 | 6,5 |
| AN_20190410_060A | 57,82 | -6,31 | 10,09 | -5,82 | 1,70 | -3,82 | 1,46 | -11,99 | 17,72 | -11,24 | -55,20 | 32,00 | -1,75 | -5,68 | 10,08 | 7,5 |
| AN_20190410_061A | 65,74 | -8,94 | 10,28 | -6,03 | 2,99 | -3,32 | 2,04 | -18,21 | 16,48 | -14,57 | -81,47 | 68,27 | -2,26 | -5,20 | 9,32 | 7,5 |
| AN_20190410_063A | 82,48 | -10,88 | 12,21 | -5,83 | 5,51 | -4,68 | 1,89 | -26,95 | 32,32 | -12,43 | -152,40 | 88,80 | -6,12 | -15,23 | 16,63 | 7 |

Table 9 shows the corresponding subjective assessments. See Appendix B for all DLC data sets and Appendix E for SLC.

*Table 9: C2 PW DS1 subjective assessment*

| Trace | Intrusiveness | Stability | Pressure Release | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|
| AN_20190410_050A | 2 | 10 | 4 | 10 | 5 | 8 | 7,5 | Smooth interv., slow exit speed |
| AN_20190410_051A | 7,5 | 8,5 | 2,75 | 3,25 | 5 | 8 | 6,75 | Intrus., safe |
| AN_20190410_052A | 7,5 | 4 | 2,5 | 2,5 | 6 | 8 | 6,75 | Intrus, initial OS |
| AN_20190410_053A | 3 | 8 | 2,75 | 8,5 | 4 | 8 | 6,75 | Intrus., long interv. US |
| AN_20190410_054A | 8 | 8,5 | 2 | 3 | 5 | 8 | 6,75 | Hard and long interv. |
| AN_20190410_055A | 7 | 4 | 1,5 | 1,5 | 3,5 | 8 | 6,75 | Hard and long interv., US, slow release |
| AN_20190410_056A | 2 | 8 | 4 | 8,75 | 4 | 8 | 7,5 | Too much braking |
| AN_20190410_057A | 7 | 3 | 2,75 | 3 | 7,5 | 8 | 6,5 | Intrus |
| AN_20190410_058A | 7,5 | 4 | 2,5 | 3 | 7,5 | 8 | 6,5 | Initial OS |
| AN_20190410_060A | 2 | 8 | 4 | 8,75 | 4 | 8 | 7,5 | Lot of braking |
| AN_20190410_061A | 7,25 | 3,75 | 3,75 | 3,75 | 2,75 | 8 | 7,5 | Lot of braking |
| AN_20190410_063A | 5 | 4 | 4 | 10 | 6 | 8 | 7 | Initial OS, no confidence |

The data points were then plotted against subjective assessment to find correlating factors. Most noteworthy, side slip and yaw rate was plotted against balance, jerk and delta $v_x$ was plotted against intrusiveness. As an example, Figure 22 - Figure 25 shows the scatter plots for DLC 80 km/h A. This method was used on all peak values and on all test cases. All DLC scatter plots can be found in Appendix D and SLC in Appendix G.

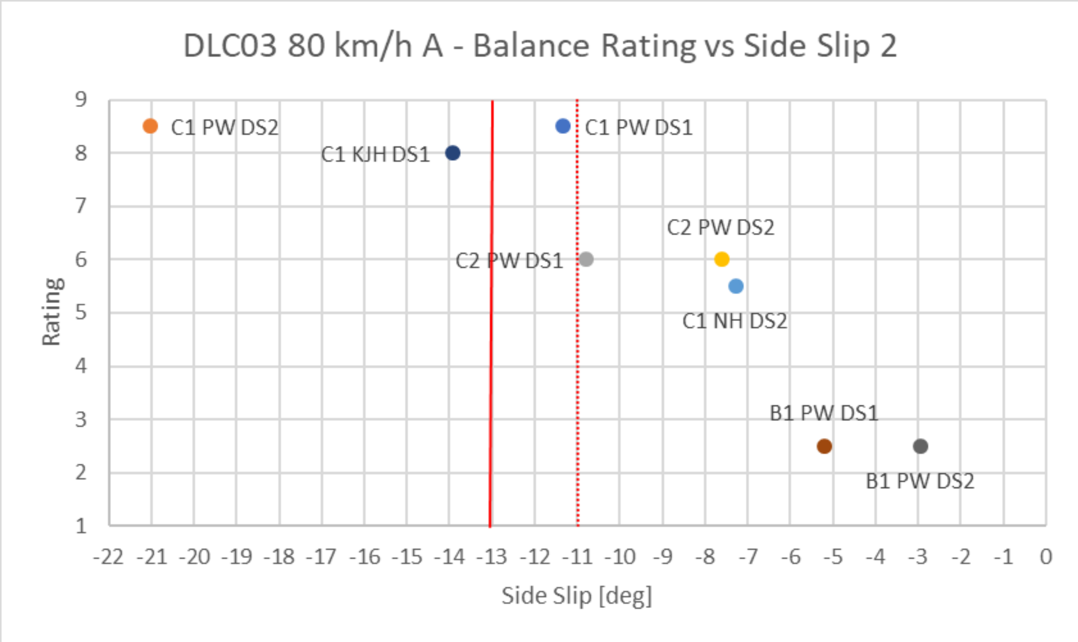



*Figure 22: Balance rating plotted against dwell side slip peak. 5 is neutral behavior, above oversteered, below understeered. Red lines indicate rating limits*

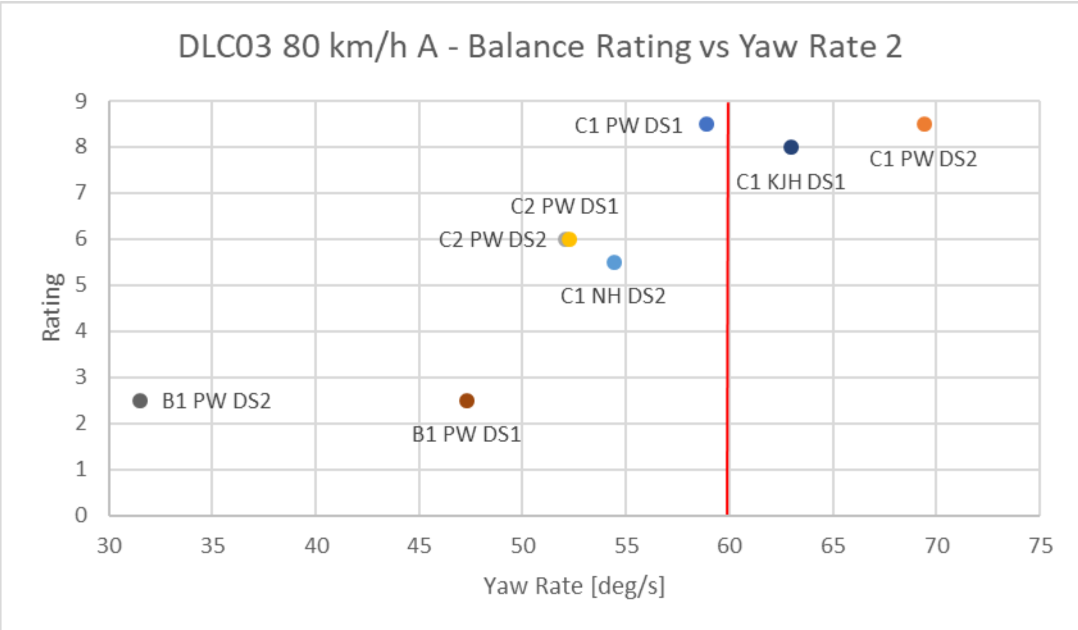



*Figure 23: Balance rating plotted against dwell yaw rate peak. 5 is neutral behavior, above oversteered, below understeered. Red lines indicate rating limits*

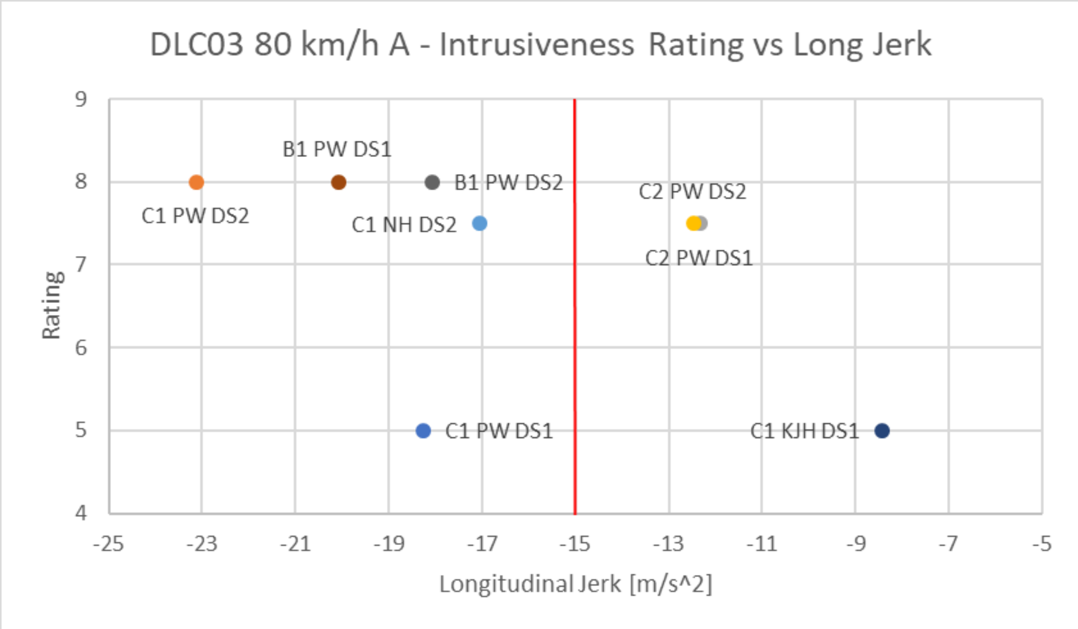



*Figure 24: Intrusiveness rating plotted against longitudinal jerk. Red line indicates rating limit*

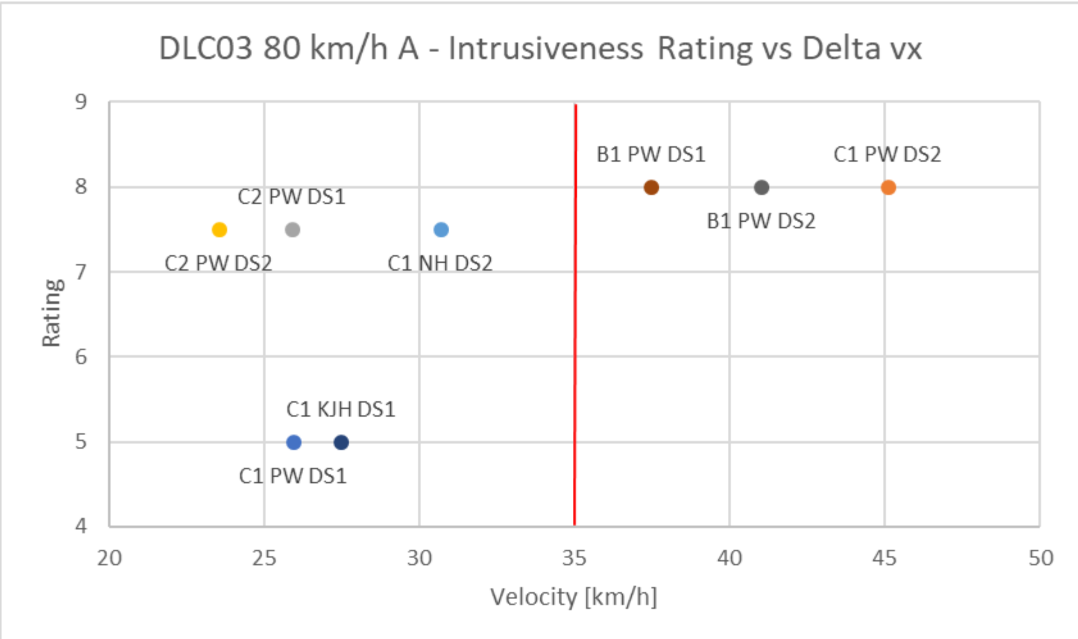



*Figure 25: Intrusiveness rating plotted against delta $v_x$. Red line indicates rating limit*

The general trends across all data sets and both maneuvers are that vehicle C1 is very oversteered with the highest side slip and yaw rate values. This behavior was most noticeable in SLC. Vehicle C2 had overall good remarks but had 11 runs in total where it was too oversteered and exceeded the lateral performance limits. Vehicle B1 was over-braked and intrusive across most runs. The hard brake interventions caused the car to understeer at the end of the maneuvers, but the car felt safe across all runs and oversteer limits were only exceeded once across six data sets.

## 4.2 Simulation – Real Car Correlation Testing

Figure 26 - Figure 29 shows comparisons between simulation results and the result in the real vehicle. It had previously been identified that side slip estimation calculated with the internal logging signals underestimates the side slip compared to the IMU measurements. This might explain why the simulation and real car side slip curves (in black) differ from each other. In total, nine runs where made in order to achieve a representative steering curve for each drive case. The run with best steering curve tracking for each drive case is shown in the figures below. A slight reduction in peak values can be observed with the ESC ON.

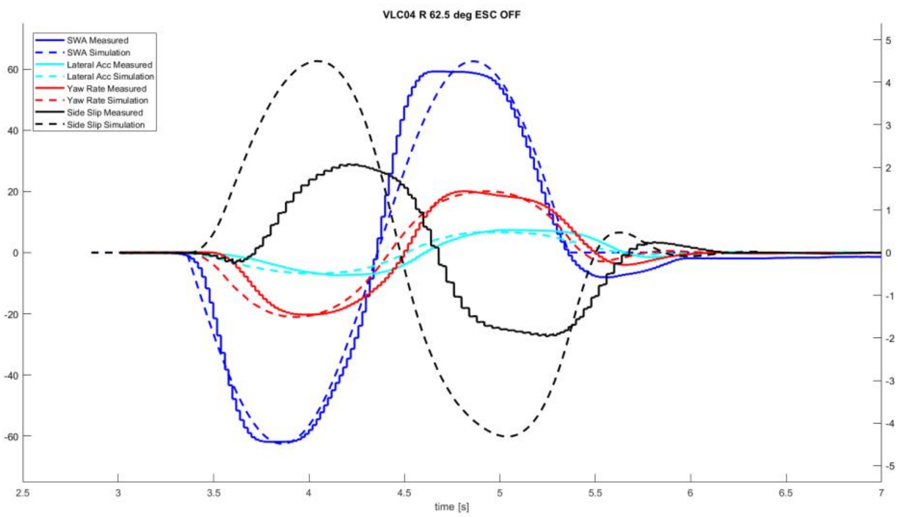



*Figure 26: VLC04 Real car test result ESC OFF*

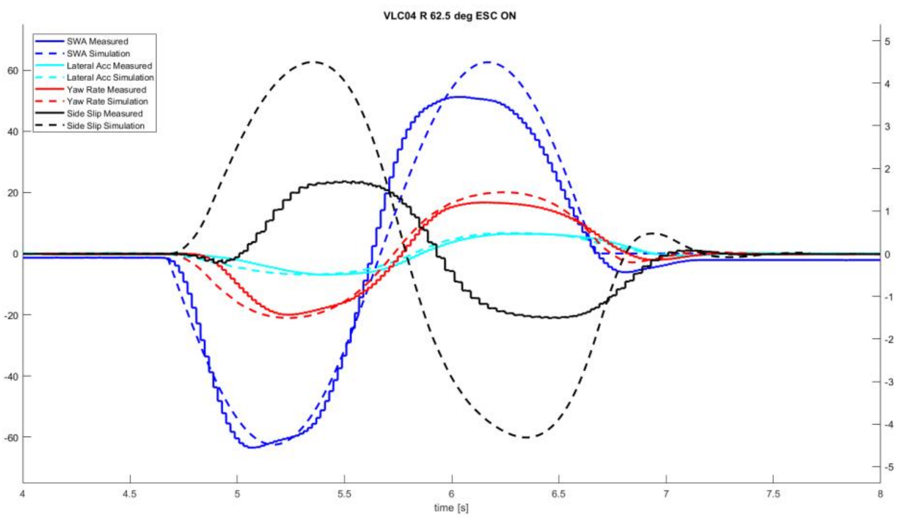



*Figure 27: VLC04 Real car test result ESC ON*

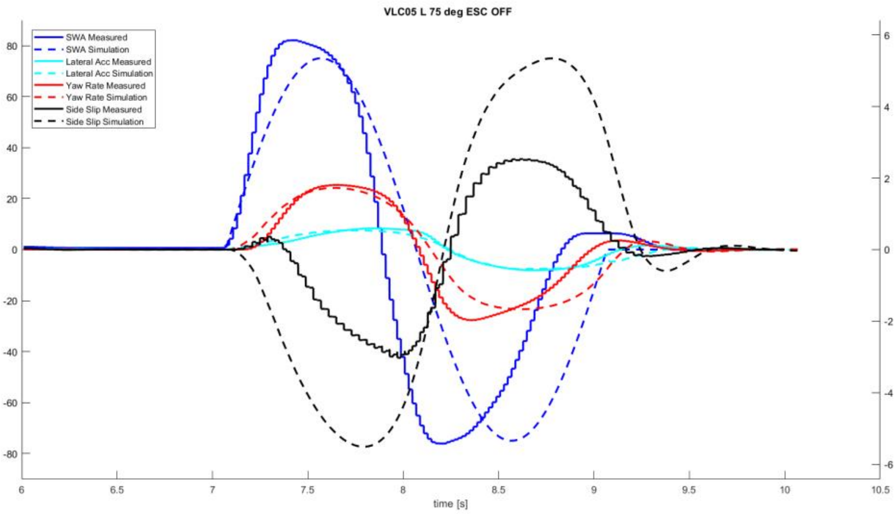



*Figure 28: VLC05 Real car test result ESC OFF*

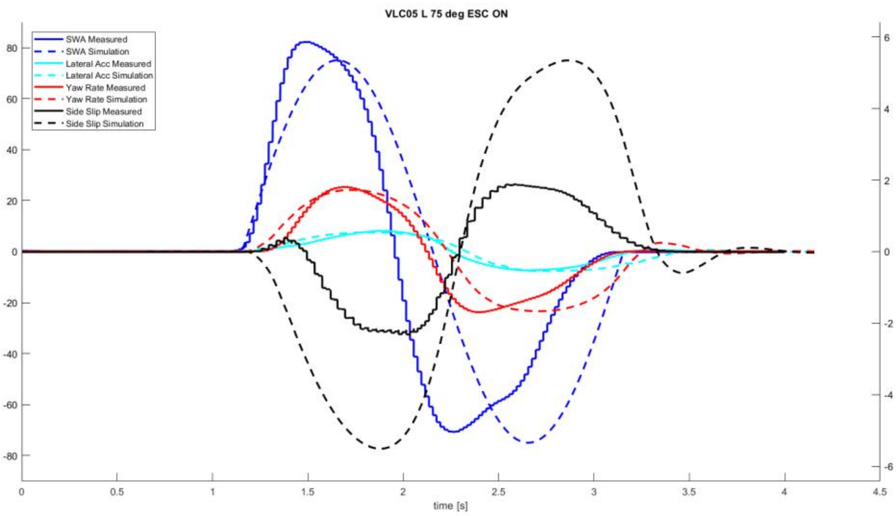



*Figure 29: VLC05 Real car test result ESC ON*

The peak values of the logged variables are shown in Table 10. All variables show a reduction in peak value with ESC ON, especially at the second peak. It should be noted that the ESC software was in early development at the time of this test and not properly tuned yet. The subjective assessment was that the ESC intervention was a bit intrusive and mistimed during the lane changes.

*Table 10: Simulation vs real car VLC results comparison*

| Run | Lat Acc 1 | Lat Acc 1 | Yaw Rate 1 | Yaw Rate 2 | Side Slip 1 | Side Slip 2 |
|---|---|---|---|---|---|---|
| VLC 4 Sim | -6.84 $m/s^2$ | 6.70 $m/s^2$ | -21.04 deg/s | 20.05 deg/s | 4.50 deg | -5.51 deg |
| VLC 4 ESC OFF | -7.38 $m/s^2$ | 7.41 $m/s^2$ | -20.26 deg/s | 20.09 deg/s | 2.08 deg | -1.96 deg |
| VLC 4 ESC ON | -6.89 $m/s^2$ | 6.47 $m/s^2$ | -20.00 deg/s | 16.73 deg/s | 1.70 deg | -1.51 deg |
| VLC 5 Sim | 7.54 $m/s^2$ | -7.64 $m/s^2$ | 24.20 deg/s | -23.35 deg/s | -4.32 deg | 5.35 deg |
| VLC 5 ESC OFF | 8.38 $m/s^2$ | -8.11 $m/s^2$ | 25.35 deg/s | -27.64 deg/s | -3.02 deg | 2.53 deg |
| VLC 5 ESC ON | 8.09 $m/s^2$ | -7.36 $m/s^2$ | 25.35 deg/s | -23.72 deg/s | -2.32 deg | 1.88 deg |

# 5 Conclusion

The testing results described in the section 4.1 was also used to find objective rating limits for each maneuver. Furthermore, the steering curve estimation, performance post-processing and rating limits were included in a standalone MATLAB application to collect all aspects of this project in one format.

## 5.1 Rating Limits

The scatter plots showed in section 4.1 was used to find cut-off values where the test is failed. With the trends showed by the graphs combined with the comments on the runs, rating limits for DLC was established, see Table 11.

The dwell side slip *bad* rating of 11 degrees is derived from a rule of thumb previously used by ESC calibrators as a maximum acceptable value. A *failed* limit at 13 degrees was also implemented. A limit on the counter slide when returning to the first lane (peak 3) was established. Side slip is allowed to be maximum 5 degrees and yaw rate 40 deg/s at this peak. The smooth drive cases do not push the lateral performance of the vehicle to the point that any clear trends could be identified, therefore only longitudinal performance limits are implemented for these drive cases. Yaw acceleration limits could only be found in 80 and 100 km/h aggressive drive cases.

Longitudinal jerk was more critically rated by the drivers in 80 km/h S compared to other drive cases and was given a limit of 10 $m/s^3$. The remaining drive cases were given the limit 15 $m/s^3$. Delta $v_x$ naturally increases with each steering level and velocity increase. As 150 km/h testing was limited, there was not sufficient data to find proper limits, instead the 120 km/h was used in 150 km/h as well.

*Table 11: DLC rating limits*

| Rating | Side Slip 2 Failed | Side Slip 2 Bad | Side Slip 3 Failed | Yaw Rate 2 Failed | Yaw Rate 3 Failed | Yaw Acc 1 Failed | Yaw Acc 2 Failed | Long Jerk Failed | Delta $v_x$ Failed |
|---|---|---|---|---|---|---|---|---|---|
| DLC01 80 S | | | | | | | | -10 $m/s^3$ | 15 km/h |
| DLC02 80 M | 13 deg | 11 deg | 5 deg | 50 deg/s | 40 deg/s | | | -15 $m/s^3$ | 25 km/h |
| DLC03 80 A | 13 deg | 11 deg | 5 deg | 60 deg/s | 40 deg/s | 220 $deg/s^2$ | 300 $deg/s^2$ | -15 $m/s^3$ | 35 km/h |
| DLC04 100 S | | | | | | | | -15 $m/s^3$ | 20 km/h |
| DLC05 100 M | 13 deg | 11 deg | 5 deg | 50 deg/s | 40 deg/s | | | -15 $m/s^3$ | 25 km/h |
| DLC06 100 A | 13 deg | 11 deg | 5 deg | 60 deg/s | 40 deg/s | 220 $deg/s^2$ | 300 $deg/s^2$ | -15 $m/s^3$ | 35 km/h |
| DLC07 120 S | | | | | | | | -15 $m/s^3$ | 20 km/h |
| DLC08 120 M | 13 deg | 11 deg | 5 deg | 50 deg/s | 40 deg/s | | | -15 $m/s^3$ | 30 km/h |
| DLC09 120 A | 13 deg | 11 deg | 5 deg | 60 deg/s | 40 deg/s | | | -15 $m/s^3$ | 40 km/h |
| DLC10 150 S | | | | | | | | -15 $m/s^3$ | 20 km/h |
| DLC11 150 M | 13 deg | 11 deg | 5 deg | 50 deg/s | 40 deg/s | | | -15 $m/s^3$ | 30 km/h |
| DLC12 150 A | 13 deg | 11 deg | 5 deg | 60 deg/s | 40 deg/s | | | -15 $m/s^3$ | 40 km/h |

The SLC did not generate as clear results as DLC for finding lateral performance limits, see Table 12. Lateral limits could only be identified on the aggressive drive cases. The same jerk levels as in DLC was used. Delta $v_x$ also follows an increasing trend with steering input and velocity. As in DLC, 150 km/h uses the same limits as 120 km/h.

*Table 12: SLC rating limits*

| Rating | Side Slip 1 Failed | Side Slip 2 Failed | Side Slip 2 Bad | Yaw Rate 1 Failed | Yaw Rate 2 Failed | Long Jerk Failed | Delta $v_x$ Failed |
|---|---|---|---|---|---|---|---|
| SLC01 80 S | | | | | | -10 m/s³ | 10 km/h |
| SLC02 80 M | | | | | | -15 m/s³ | 20 km/h |
| SLC03 80 A | 8 deg | 11 deg | 8 deg | | 60 deg/s | -15 m/s³ | 25 km/h |
| SLC04 100 S | | | | | | -15 m/s³ | 10 km/h |
| SLC05 100 M | | | | | | -15 m/s³ | 20 km/h |
| SLC06 100 A | 8 deg | 11 deg | 8 deg | | 60 deg/s | -15 m/s³ | 25 km/h |
| SLC07 120 S | | | | | | -15 m/s³ | 10 km/h |
| SLC08 120 M | | | | | | -15 m/s³ | 25 km/h |
| SLC09 120 A | 9 deg | 11 deg | 8 deg | | 60 deg/s | -15 m/s³ | 30 km/h |
| SLC10 150 S | | | | | | -15 m/s³ | 10 km/h |
| SLC11 150 M | | | | | | -15 m/s³ | 25 km/h |
| SLC12 150 A | 9 deg | 11 deg | 8 deg | | 60 deg/s | -15 m/s³ | 30 km/h |

## 5.2 Rating Application

The steering curve estimation, rating limits and rating documentation was integrated into a standalone application, using MATLAB App Designer. This was done to have a single interface for that includes all aspects of test performance that would be easier to use in test vehicle.

### 5.2.1 Input Tab

The first tab shown when the application is opened is an input tab (Figure 30). A .mat log file can be loaded into the program with the *Open* button. When the log file is selected the SWA is automatically plotted in the window to the right as a visual indication that the log file has been loaded into the program. In this tab the maneuver (DLC/SLC), car type (High/Low), measurement equipment (IMU/SWA meter) and velocity and steering level can be chosen by the user.

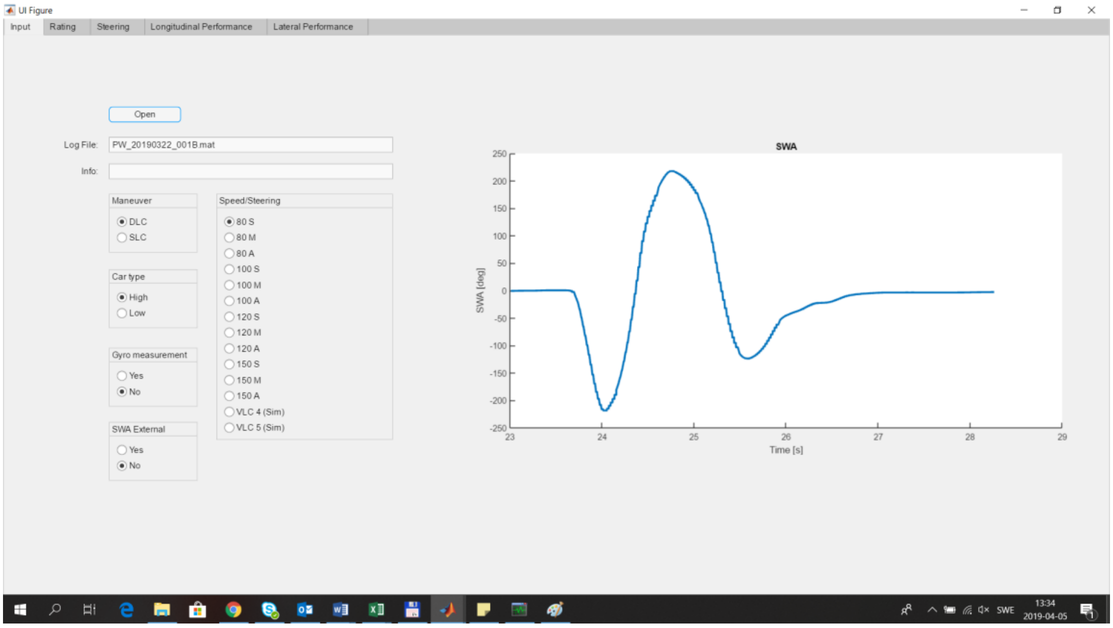



*Figure 30: Rating program input tab*

### 5.2.2 Rating Tab

The rating tab (Figure 31) has three sliders that is used to give subjective assessment of the test run. Longitudinal and lateral rating can be given separately, as well as an overall rating. There is also a comment field for each rating which is automatically loaded with the objective and subjective ratings. The user's comments can be added and saved as a .txt file in a selected directory together with all ratings in .csv format.

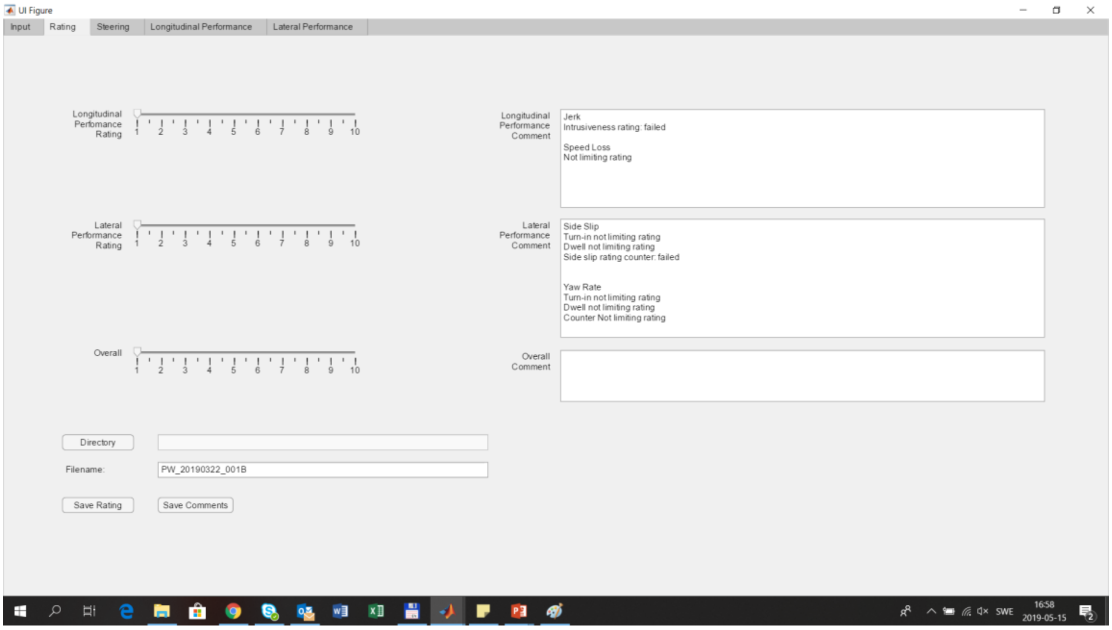



*Figure 31: Rating program rating tab*

### 5.2.3 Steering Tab

The steering tab (Figure 32) shows the measured, estimated and reference steering curves. The reference is updated based on the selected speed and steering level in the input tab.

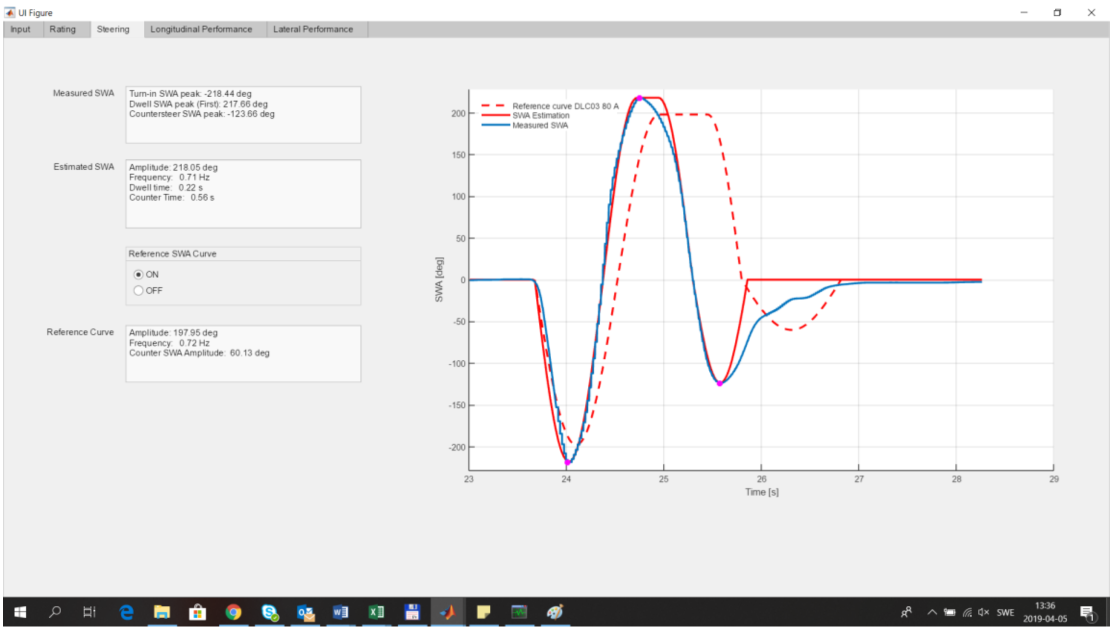



*Figure 32: Rating program steering tab*

## 5.2.4 Longitudinal Performance Tab

In the longitudinal performance tab (Figure 33) the longitudinal acceleration (blue) and jerk (black) is plotted over the measured and estimated steering curves (grey). In the text boxes the deceleration and jerk peak values are shown as well as the velocity delta. The rating limits for the selected test case are displayed and if they are exceeded a text message is displayed.

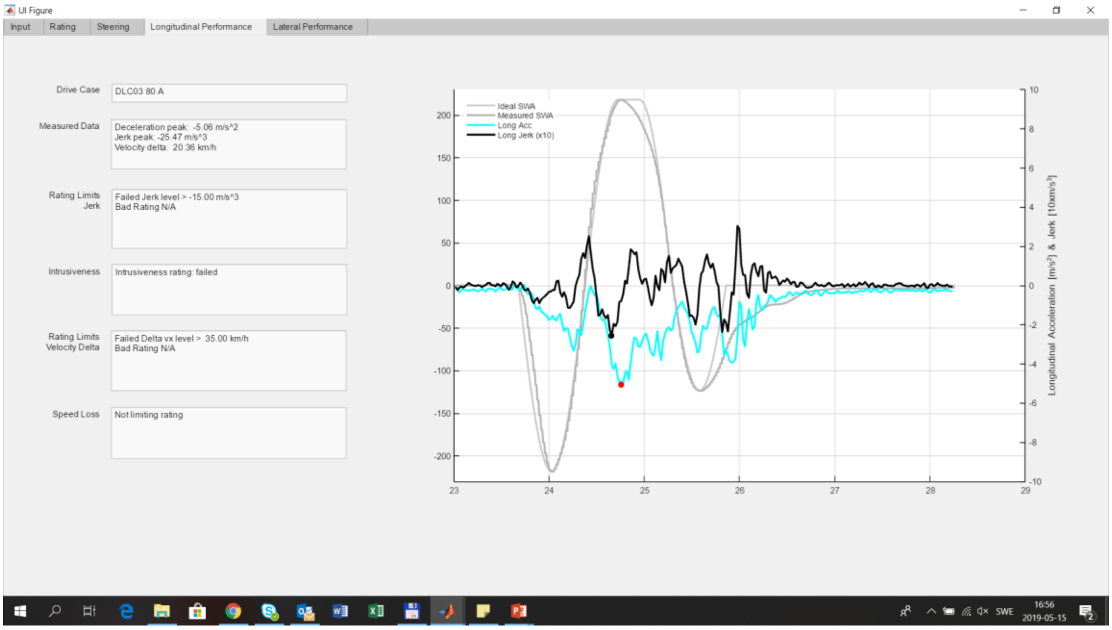



*Figure 33: Rating program longitudinal performance tab*

## 5.2.5 Lateral Performance Tab

The lateral performance tab (Figure 34) displays the lateral acceleration, side slip, yaw rate and yaw acceleration curves. The text boxes show the peak values of all signals and the rating limits. If the limits are exceeded, an information message is displayed.

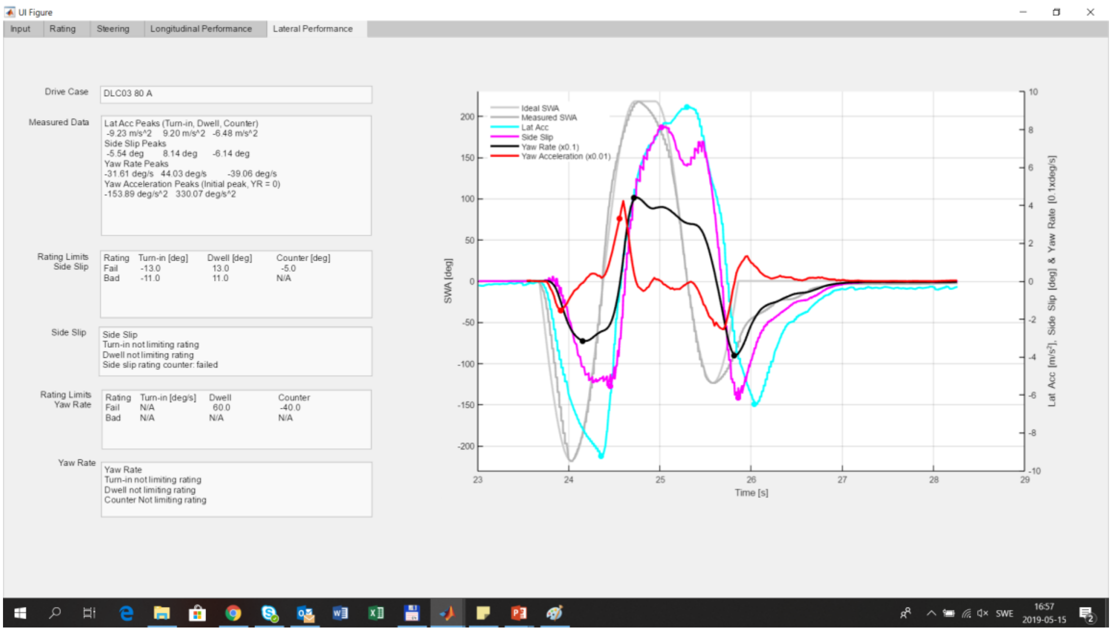



*Figure 34: Rating program lateral performance tab*

# 6 Discussion

The following discussion points have been raised on the methods, results and conclusion of this project.

## 6.1 Simulation Testing

Section 3.4.1 describes the testing performed to correlate real car performance with the full car simulation results. When the tests were performed the correct vehicle model and test equipment was not available, therefore it was only seen as a "beta" test to see if the metronome timing and wheel speed sensor removal would work as intended. A proper test would be to drive the correct vehicle model with its reference tires (Michelin Primacy 235/55 R18) and correct load. The IMU should also be utilized for accurate measurements. To make sure the that the entry speed is the same for each run, the cars speed limiter should be used as it is hard for the driver to find the timing of the metronome and the same time keep the correct speed at the start of the maneuver. Furthermore, more test runs should be made so that there are at least three traces with acceptable steering curve for each drive case, in order to trust the repeatability of the results. To fully correlate the simulation model to real car performance objective testing with a steering robot also should be made.

## 6.2 Verification

The rating limits that has been established in this report are inherently consistent with the available data, since this data has been the foundation for the rating limits. To verify that the limits are reasonable over larger data sets further testing should be conducted, preferably with vehicle projects and competitor cars that have not yet been tested. The testing has only included competitor cars from the Asian market so a natural progression would be to test European cars in the same class to see if different cultural vehicle performance trends are identifiable.

If these limits survive a similar test session, they can act as foundation for objective ESC requirements. If the limits turn out to be false, the methodology described in this report can still be used to find new limits. The rating limits for 150 km/h are at this stage an engineering judgement estimation and requires extra scrutiny during verification.

## 6.3 Lateral Performance Limits

Yaw acceleration measurement did not result in clear correlation with lateral performance assessment. A contributing factor might be the non-equidistant sampling rate, which is described further in section 6.8. With larger data sets, a correlation curve might be found after future testing.

Roll angle did not exist as a measured parameter in the validation data sets and is not usually used assessment parameter in current testing and was therefore also overlooked as a rating parameter. Some OEMs use roll angle as a control variable in the stability controllers, so an investigation in roll limits is recommended. The test drivers also commented on excessive roll in both competitor cars during lane changes.

Lateral displacement criteria were also disregarded as the local position signals from the IMU were faulty in the measurement set-up and no solution had been found at the time of testing.

The lateral performance limits only act on too high oversteer and not understeer. In the current data sets, the instances where cars have understeered in the maneuver have been caused by a too hard brake intervention. The ESC counters the slide by mainly braking the front outside wheel, if the brake torque is too high it will saturate the front axle grip and the car will start to understeer. Therefore, the dwell part of the DLC often is understeered in an intrusively tuned car. In high mu conditions it is assumed that understeer due to chassis balance is rare enough that lateral understeer limits are not needed. For wet weather or winter conditions this might not be the case.

## 6.4 Steering Ratio

Steering ratio has not been accounted for when analyzing the steering curves. All Lynk & Co cars used in this project has the same steering ratio, so the only difference in wheel angle between cars would be due to suspension and steering geometry, which was assumed to be neglectable. The windows for correct steering amplitude are also quite large. A correction factor for steering ratio could be implemented for different vehicle projects and competitor cars.

## 6.5 Questionnaire

After processing the test data and plotting it against subjective assessments, the balance rating proved more usable than the stability rating. The balance rating includes all information of the stability rating as well as over- or understeer characteristic. A five (neutral) in balance basically equaled a ten in stability, while a slightly oversteered or highly understeered car both would end up with a stability rating of around five. Severe oversteer would give stability rating below 2.5. An improvement would be to only give balance ratings, but to one for each turn of the maneuver. For DLC turn-in, dwell and counter balance and SLC first and second turn balance.

The steering input assessment ended up not being used to save time during testing. If large corrections were made it was noted in the comments. Checking the steering curves against the reference curves in post analysis was enough to judge the steering input.

## 6.6 VER Scale Usage

For this project CEVT's use routines of the SAE VER was applied. Rather than using the entire range of the scale (from 1 to 10) it effectively ranges from 5 to 9 in 0.25 step increments, with 7 being assessed as "OK" or production ready. The use of the SAE scale in its traditional sense was discussed but not implemented in the project, mainly to avoid confusion with using two different scales in parallel.

## 6.7 Testing

Due to measurement equipment limitations, only one car could be tested each day. Ideally all cars would have been tested simultaneously and letting drivers rotate between cars to keep track conditions as consistent as possible. It was originally planned to drive one test cycle in vehicle B1 every day as and use its VDDM logging as a daily reference. However, issues with its data logging equipment meant it was not ready at the first two days of testing and was therefore not driven as a daily reference.

## 6.8 Differentiated Signals

Late in the project it was found out that the sampling time for the IMU signal is not equidistant, which means a differentiation with respect to time will result in a false signal in some sense (according to Bosch MM6 Help section). The moving average filter should counter this in some measure, but the signal cannot be trusted to the same degree as the pure signals. This applies to both the yaw acceleration and jerk signals.

## 6.9 High Cars

The rating limits have been established for high cars in the compact SUV/crossover class and in accordance with CEVT/Lynk & Co brand identity. It reasonable to assume that low cars (sedans, hatchbacks etc.) will require a different set of limits. Goméz Gil states that subjective assessment is vehicle class dependent and even if the same measurements are used, the results in one class may not be extrapolated onto the next. The result may serve as a hint on how to rate the next class [7]. Low cars do not carry the risk of rolling over in lane change maneuvers and are therefore not equipped with roll-over mitigation controllers, which often causes the intrusive ESC interventions. This will probably lead to stricter limits on delta $v_x$ for low cars. Cars with a "sporty" branding might also require higher lateral performance limits.

## 6.10 Implementation

The limits on side slip and yaw rate peaks along with delta $v_x$ can easily be implemented in the current ESC testing routines without having to use extra Excel-sheets or MATLAB programs. Log files are usually checked in between runs and the signals needed are part of the standard plot display. There is no perceived increase in workload or time to manually check the side slip, yaw rate and delta $v_x$ values in Bosch Uniview in between runs. The rating application can be used in the later sign-off and validation stages of a project when deeper analysis needed. Even though the program was intended to for usage in the test vehicle on track, it is perhaps more effectively used for desktop post analysis in conjunction with testing. The time and effort to "cut" the maneuver part out of the log file, resave it and open it in the rating program is a bit too long of a process for the test vehicle environment. It is a useful tool for inexperienced test drivers to learn the drive cases and the steering effort required.

## 6.11 Subjective Assessments Age

The subjective assessment of vehicle performance will age over time, while the objective measurement will stay the same [8]. What was state of the art performance when ESC was introduced in the mid 1990's will be perceived as unrefined and probably unsafe by today's standards [5]. At the same time objective measurements of the same maneuver in the same car will basically look the same if it was performed 1995 or yesterday. This means that as performance evolves across the automotive industry the requirements and rating limits need to evolve too. It is unclear how long the results of this project will stay relevant, but at some point, the current limits will become dated.

## 6.12 Expert Drivers

The preferred use of expert drivers over normally skilled drivers is common in automotive research and development [6]. Even though expert drivers do not represent the average customer, the highly technical nature of vehicle testing requires deep knowledge of vehicle dynamics. The high intensity maneuvers also require skill and experience to perform the test correctly while still having the mental capacity to feel what is happening with the car at all times.

# 7 Recommendations/Future Work

To improve the maturity level of the vehicle when real car testing is begun, increasing correlation and understanding between simulation and real car performance and CAE simulation is continually strived for. The idea being that the more work can be carried out prior to real car testing the more effective the sessions will become. Currently, ESC is not simulated in terms of vehicle dynamics performance in house at CEVT. When that simulation step is implemented the result of this project can help predict the subjective vehicle assessment from CAE simulation results. This project's main benefit for the CAE team is the definition of ESC drive cases that can be used as simulation input. SLC A for each velocity is the most recommended maneuver as it is closer to an open loop maneuver than DLC, and is the only SLC level with defined lateral performance limits. Correlation between CAE and testing results have not been shown with this project. As mentioned in section 6.1 objective measurements with steering robot and subjective testing with the correct vehicle model are needed.

The rating tool and methods developed in this project can also be utilized in a ESC equipped driver in the loop simulator. In the virtual environment different ESC concepts and calibrations could be tested at a higher rate and with more freedom compared to real car testing. Given the correct data output format, the application could be modified to suit simulator testing as well.

This project begun the work to find the correlation between subjective assessments and objective measurement at a basic level. The process to find rating limits has been a strictly manual task. The state of the art solution for this would be to utilize machine learning to find actual correlation curves. This is of course a highly complex and non-linear task which require both advanced mathematical models and extensive testing.

The recommended continuation of this project would be to perform a second compact SUV/crossover class test to verify the current rating limits. Secondly, two similar test sessions should be performed with low cars to find a second set rating limits. Similar methodology used in this project could also be implemented for more maneuvers such as slalom and throttle release in turn, to provide a wider picture of ESC performance. Furthermore, rating limits for winter conditions could also be established using the same methodology.

# 8 References


[1] NHTSA, "FMVSS 126 Electronic Stability Control Systems for Light Vehicles," NHTSA, 2015.

[2] SAE International, "Subjective Rating Scale for Vehicle Ride and Handling," SAE International, 2016.

[3] ISO, "ISO 3888: Passenger cars: Test track for a severe lane-change manoeuvre," ISO, 2011.

[4] Rabe, "Teknikens Värld Moose Test," Bonnier, [Online]. Available: https://teknikensvarld.se/taggar/moose-test/. [Accessed 6 April 2019].

[5] K. Reif, Brakes, Brake Control and Driver Assistance Systems (Bosch Professional Automotive Information), Friedrichschafen: Springer Fachmedien, 2014.

[6] G. L. N. B. D. Gil Goméz, "Findings from subjective evaluations and driver ratings of vehicle dynamics: steering and handling," *International Journal of Vehicle Mechanics and Mobility,* vol. 53, no. 10, pp. 1416-1438, 2015.

[7] G. L. Gil Goméz, "Correlations of subjective assessments and objective metrics for vehicle handling and steering: a walk through history," *Int. J. Vehicle Design,* vol. 72, no. 1, pp. 17-67, 2016.

[8] G. L. Gil Goméz, "Towards efficient vehicle dynamics development: From subjective assessments to objective metrics, from physical to virtual testing," KTH Royal Institute of Technology, Stockholm, 2017.

# A Questionnaire

**DLC 80 km/h S**

**ESC Intervention** — **Rating**

**Intrusiveness** 5

| No intervention | | Neutral | | Harsch |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

**Stability** 5

| Loose | | | | Stable |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

**Pressure release** 5

| Slow | | Neutral | | Fast |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

**Noise** 5

| High noise | | Slight | | No noise |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

**Comment:**

**Chassis**

**Balance** 5

| Understeered | | Neutral | | Oversteered |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

**Ride** 5

| Hard | | Neutral | | Soft |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

**Comment:**

**Steering Input** 5

**Corrections**

| Large | | Small | | None |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

**Curve Symmetry** 5

| Very Bad | Bad | Neutral | Good | Very Good |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

**Comment:**

**Overall score**

5

| Very Bad | Bad | Neutral | Good | Very Good |
|---|---|---|---|---|
| 1 | 2.5 | 5 | 7.5 | 10 |

# B DLC Subjective Assessment

C1 PW DS1

| Test | Trace | Intrusiveness | Stability | Pressure Release | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190409_033A | 0 | 10 | 5 | 10 | 5 | 7 | 9 | OK |
| DLC 80 km/h M | PW_20190409_034A | 5 | 3,5 | 5 | 10 | 7,5 | 8,5 | 6 | Loose, soft chassis (roll) |
| DLC 80 km/h A | PW_20190409_036 | 5 | 2 | 5 | 7,25 | 8,5 | 9 | 6,5 | Loose, soft chassis (roll) |
| DLC 100 km/h S | PW_20190409_038A | 0 | 10 | 5 | 10 | 5 | 7 | 9 | Good |
| DLC 100 km/h M | PW_20190409_039 | 7 | 2,5 | 5 | 5 | 8 | 8 | 7 | Intrus. End of maneuever |
| DLC 100 km/h A | PW_20190409_040 | 5 | 2 | 5 | 7,5 | 7,5 | 8 | 5,5 | Loose had to abort |
| DLC 120 km/h S | PW_20190409_041A | 0 | 10 | 5 | 10 | 5 | 6 | 9 | OK |
| DLC 120 km/h M | PW_20190409_042 | 5 | 2,5 | 5 | 7,25 | 7,5 | 8 | 7,5 | OK |
| DLC 120 km/h A | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | |

C1 PW DS2

| Test | Trace | Intrusivenes | Stability | Pressure R | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190409_033B | 0 | 10 | 5 | 10 | 5 | 7 | 9 | OK |
| DLC 80 km/h M | PW_20190409_034B | 5 | 3,5 | 5 | 10 | 7,5 | 8,5 | 6 | Loose, soft chassis (roll) |
| DLC 80 km/h A | PW_20190409_037 | 8 | 2 | 5 | 7,25 | 8,5 | 9 | 6,5 | Loose, soft chassis (roll) |
| DLC 100 km/h S | PW_20190409_038B | 0 | 10 | 5 | 10 | 5 | 7 | 9 | Good |
| DLC 100 km/h M | | | | | | | | | |
| DLC 100 km/h A | | | | | | | | | |
| DLC 120 km/h S | PW_20190409_041B | 0 | 10 | 5 | 10 | 5 | 7 | 9 | OK |
| DLC 120 km/h M | PW_20190409_043 | 5 | 2,5 | 5 | 7,25 | 7,5 | 8 | 7,5 | Had to abort during dwell |
| DLC 120 km/h A | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | |

C1 NH DS1

| Test | Trace | Intrusivene | Stability | Pressure R | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190409_045A | 5 | 7,5 | 5 | 9 | 5 | 8 | 7 | OK, lots of roll |
| DLC 80 km/h M | PW_20190409_046A | 7,25 | 7,25 | 5 | 7,5 | 4 | 8 | 5,5 | OK, lots of roll |
| DLC 80 km/h A | | | | | | | | | Lots of roll, feels uncontrollable |
| DLC 100 km/h S | PW_20190409_047A | 2 | 7 | 5 | 9 | 4 | 9 | 7 | Lots of roll, US |
| DLC 100 km/h M | PW_20190409_048A | 5 | 7,5 | 5 | 9 | 4 | 9 | 7 | Lots of roll, US |
| DLC 100 km/h A | PW_20190409_049 | 8 | 2 | 5 | 2,5 | 7,5 | 9 | 5 | Lots of roll, loose |
| DLC 120 km/h S | PW_20190409_050 | 2 | 7,5 | 5 | 9 | 4 | 9 | 7 | Lots of roll, US |
| DLC 120 km/h M | PW_20190409_051A | 8 | 3 | 5 | 2 | 7 | 9 | 6 | Intrus., no confidence, late interventions |
| DLC 120 km/h A | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | |

C1 NH DS2

| Test | Trace | Intrusivene | Stability | Pressure R | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190409_044B | 0 | 10 | 5 | 10 | 5 | 8 | 7 | OK, lots of roll |
| DLC 80 km/h M | PW_20190409_046B | 7,25 | 7,25 | 5 | 7,5 | 4 | 8 | 5,5 | Lots of roll, feels uncontrollable |
| DLC 80 km/h A | | | | | | | | | |
| DLC 100 km/h S | PW_20190409_047B | 2 | 7 | 5 | 9 | 4 | 9 | 7 | Lots of roll, US |
| DLC 100 km/h M | PW_20190409_048B | 5 | 7,5 | 5 | 9 | 4 | 9 | 7 | Lots of roll, US |
| DLC 100 km/h A | | | | | | | | | |
| DLC 120 km/h S | | | | | | | | | |
| DLC 120 km/h M | PW_20190409_051B | 8 | 3 | 5 | 2 | 7 | 9 | 6 | Intrus., no confidence, late interventions |
| DLC 120 km/h A | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | |

C2 PW DS1

| Test | Trace | Intrusiveness | Stability | Pressure Release | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_050A | 2 | 10 | 4 | 10 | 5 | 8 | 7,5 | Smooth interv., slow exit speed |
| DLC 80 km/h M | AN_20190410_051A | 7,5 | 8,5 | 2,75 | 3,25 | 5 | 8 | 6,75 | Intrus., safe |
| DLC 80 km/h A | AN_20190410_052A | 7,5 | 4 | 2,5 | 2,5 | 6 | 8 | 6,75 | Intrus, initial OS |
| DLC 100 km/h S | AN_20190410_053A | 3 | 8 | 2,75 | 8,5 | 4 | 8 | 6,75 | Intrus., long interv. US |
| DLC 100 km/h M | AN_20190410_054A | 8 | 8,5 | 2 | 3 | 5 | 8 | 6,75 | Hard and long interv. |
| DLC 100 km/h A | AN_20190410_055A | 7 | 4 | 1,5 | 1,5 | 3,5 | 8 | 6,75 | Hard and long interv., US, slow release |
| DLC 120 km/h S | AN_20190410_056A | 2 | 8 | 4 | 8,75 | 4 | 8 | 7,5 | Too much braking |
| DLC 120 km/h M | AN_20190410_057A | 7 | 3 | 2,75 | 3 | 7,5 | 8 | 6,5 | Intrus |
| DLC 120 km/h A | AN_20190410_058A | 7,5 | 4 | 2,5 | 3 | 7,5 | 8 | 6,5 | Initial OS |
| DLC 150 km/h S | AN_20190410_060A | 2 | 8 | 4 | 8,75 | 4 | 8 | 7,5 | Lot of braking |
| DLC 150 km/h M | AN_20190410_061A | 7,25 | 3,75 | 3,75 | 3,75 | 2,75 | 8 | 7,5 | Lot of braking |
| DLC 150 km/h A | AN_20190410_063A | 5 | 4 | 4 | 10 | 6 | 8 | 7 | Initial OS, no confidence |

| Test | C2 PW DS2<br>Trace | Intrusivene | Stability | Pressure R | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_050B | 2 | 10 | 4 | 10 | 5 | 8 | 7,5 | Smooth interv., slow exit speed |
| DLC 80 km/h M | AN_20190410_051B | 7,5 | 8,5 | 2,75 | 3,25 | 5 | 8 | 6,75 | Intrus., safe |
| DLC 80 km/h A | AN_20190410_052B | 7,5 | 4 | 2,5 | 2,5 | 6 | 8 | 6,75 | Intrus, initial OS |
| DLC 100 km/h S | AN_20190410_053B | 3 | 8 | 2,75 | 8,5 | 4 | 8 | 6,75 | Intrus., long interv. US |
| DLC 100 km/h M | AN_20190410_054B | 8 | 8,5 | 2 | 3 | 5 | 8 | 6,75 | Hard and long interv. |
| DLC 100 km/h A | AN_20190410_055B | 7 | 4 | 1,5 | 1,5 | 3,5 | 8 | 6,75 | Hard and long interv., US, slow release |
| DLC 120 km/h S | AN_20190410_056B | 2 | 8 | 4 | 8,75 | 4 | 8 | 7,5 | Too much braking |
| DLC 120 km/h M | AN_20190410_057B | 7 | 3 | 2,75 | 3 | 7,5 | 8 | 6,5 | Intrus |
| DLC 120 km/h A | AN_20190410_058B | 7,5 | 4 | 2,5 | 3 | 7,5 | 8 | 6,5 | Initial OS |
| DLC 150 km/h S | AN_20190410_059B | 2 | 8 | 4 | 8,75 | 4 | 8 | 7,5 | Lot of braking |
| DLC 150 km/h M | AN_20190410_060B | 7,25 | 3,75 | 3,75 | 3,75 | 2,75 | 8 | 7,5 | Lot of braking |
| DLC 150 km/h A | AN_20190410_061B | 5 | 4 | 4 | 10 | 6 | 8 | 7 | Initial OS, no confidence |

| Test | C2 NH DS1<br>Trace | Intrusivene | Stability | Pressure | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_011A | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Good, soft chassis |
| DLC 80 km/h M | AN_20190410_013A | 8 | 7,5 | 4 | 2,5 | 5,5 | 7 | 7,5 | Initial OS, saves it good, slight intrus. |
| DLC 80 km/h A | | | | | | | | | |
| DLC 100 km/h S | AN_20190410_014A | 3 | 8 | 5 | 9 | 5 | 7 | 8 | Slight intrus., soft chassis |
| DLC 100 km/h M | AN_20190410_016A | 8,75 | 4,25 | 2,75 | 2,25 | 5,75 | 8 | 7 | Initial OS, safe, intrus. |
| DLC 100 km/h A | | | | | | | | | |
| DLC 120 km/h S | AN_20190410_017A | 0 | 10 | 5 | 9 | 5 | 7 | 8,5 | Good |
| DLC 120 km/h M | AN_20190410_019A | 8,5 | 8 | 2 | 2 | 5,5 | 8 | 6,5 | Intrus., initial OS, safe |
| DLC 120 km/h A | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | |

| Test | C2 NH DS2<br>Trace | Intrusiveness | Stability | Pressure Release | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_011B | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Good, soft chassis |
| DLC 80 km/h M | AN_20190410_012B | 2,5 | 8,5 | 5 | 7,75 | 4,5 | 7 | 8 | Soft chassis, US |
| DLC 80 km/h A | AN_20190410_013B | 8 | 7,5 | 4 | 2,5 | 5,5 | 7 | 7,5 | Initial OS, saves it good, slight intrus. |
| DLC 100 km/h S | AN_20190410_014B | 3 | 8 | 5 | 9 | 5 | 7 | 8 | Slight intrus., soft chassis |
| DLC 100 km/h M | AN_20190410_016B | 8,75 | 4,25 | 2,75 | 2,25 | 5,75 | 8 | 7 | Initial OS, safe, intrus. |
| DLC 100 km/h A | | | | | | | | | |
| DLC 120 km/h S | AN_20190410_017B | 0 | 10 | 5 | 9 | 5 | 7 | 8,5 | Good |
| DLC 120 km/h M | AN_20190410_019B | 8,5 | 8 | 2 | 2 | 5,5 | 8 | 6,5 | Intrus., initial OS, safe |
| DLC 120 km/h A | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | |

| Test | C2 KJH DS1<br>Trace | Intrusiveness | Stability | Pressure Release | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_039 | 0 | 10 | 5 | 10 | 5 | 6 | 8 | Good |
| DLC 80 km/h M | AN_20190410_040 | 3 | 4 | 5 | 10 | 6,5 | 8 | 6,75 | OS return to first lane |
| DLC 80 km/h A | AN_20190410_041 | 5 | 3,5 | 5 | 7,5 | 8 | 8 | 7,5 | OS |
| DLC 100 km/h S | AN_20190410_042 | 0 | 10 | 5 | 9 | 5 | 8 | 7,75 | Good |
| DLC 100 km/h M | AN_20190410_043 | 7 | 5 | 4 | 5 | 6,5 | 8 | 6,5 | Intrusive return, loose second lane |
| DLC 100 km/h A | AN_20190410_044 | 6 | 0,5 | 5 | 7,25 | 9 | 8,25 | 3 | Loose |
| DLC 120 km/h S | AN_20190410_045 | 2 | 8 | 5 | 8,75 | 4 | 8 | 7 | US second lane |
| DLC 120 km/h M | AN_20190410_046 | 5 | 7,5 | 5 | 5 | 2,75 | 8 | 7,25 | US second lane |
| DLC 120 km/h A | AN_20190410_047 | 7 | 8 | 4 | 5 | 3 | 8 | 7 | Harsh interv. second lane |
| DLC 150 km/h S | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | |

| Test | B1 PW DS1<br>Trace | Intrusiv | Stability | Pressur | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190416_016A | 8,5 | 4,5 | 2 | 2 | 3 | 7 | 5,5 | Intrusive US |
| DLC 80 km/h M | PW_20190416_016A_18 | 8 | 4,5 | 3 | 2,5 | 2,75 | 7 | 6,5 | Intrusive US |
| DLC 80 km/h A | PW_20190416_017A | 8 | 4 | 3 | 2,5 | 2,5 | 7 | 6 | Intrusive US |
| DLC 100 km/h S | PW_20190416_019A | 6 | 4 | 3 | 2,5 | 2,75 | 7 | 5,5 | Intrusive US |
| DLC 100 km/h M | PW_20190416_019A_22 | 8 | 4 | 2 | 2,5 | 2,5 | 7 | 6 | Intrusive US |
| DLC 100 km/h A | PW_20190416_020A | 8 | 4,5 | 2,75 | 2,75 | 3,75 | 7 | 6 | Intrusive US |
| DLC 120 km/h S | PW_20190416_023A | 7,5 | 4,5 | 2,5 | 3 | 2,5 | 7,5 | 7 | Intrusive US |
| DLC 120 km/h M | PW_20190416_023A_25 | 8 | 4 | 2 | 2,5 | 2,5 | 7 | 6 | Intrusive US |
| DLC 120 km/h A | PW_20190416_024A | 9 | 3 | 1,5 | 2 | 2 | 7,5 | 6 | Intrusive US |
| DLC 150 km/h S | PW_20190416_026 | 5 | 5 | 5 | 8 | 5 | 7 | 6,75 | Loose initially |
| DLC 150 km/h M | PW_20190416_026_28 | 5 | 6 | 4 | 7,5 | 4,5 | 7,5 | 7 | US in second lane |
| DLC 150 km/h A | PW_20190416_027 | 5,5 | 5 | 4 | 5 | 4 | 7 | 7 | US in second lane |

| | B1 PW DS2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Test | Trace | Intrusiv | Stability | Pressur | Noise | Balance | Ride | VER | Comment |
| DLC 80 km/h S | PW_20190416_016B | 8,5 | 4,5 | 2 | 2 | 3 | 7 | 5,5 | Intrusive US |
| DLC 80 km/h M | PW_20190416_016B_18 | 8 | 4,5 | 3 | 2,5 | 2,75 | 7 | 6,5 | Intrusive US |
| DLC 80 km/h A | PW_20190416_017B | 8 | 4 | 3 | 2,5 | 2,5 | 7 | 6 | Intrusive US |
| DLC 100 km/h S | PW_20190416_019B | 8 | 4 | 3 | 2,5 | 2,75 | 7 | 5,5 | Intrusive US |
| DLC 100 km/h M | PW_20190416_019B_22 | 8 | 4 | 2 | 2,5 | 2,5 | 7 | 6,5 | Intrusive US |
| DLC 100 km/h A | PW_20190416_020B | 8 | 4,5 | 2,75 | 2,75 | 3,75 | 7 | 6 | Intrusive US |
| DLC 120 km/h S | PW_20190416_023B | 7,5 | 4,5 | 2,5 | 3 | 2,5 | 7,5 | 7 | Intrusive US |
| DLC 120 km/h M | PW_20190416_023B_25 | 8 | 4 | 2 | 2,5 | 2,5 | 7 | 6 | Intrusive US |
| DLC 120 km/h A | PW_20190416_024B | 9 | 3 | 1,5 | 2 | 2 | 7,5 | 6 | Intrusive US |
| DLC 150 km/h S | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | |

# C DLC Test Results

C1 PW DS1

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190409_033A | 78,69 | 2,06 | -2,38 | 1,70 | -17,85 | 20,37 | -14,23 | -73,60 | 82,20 | -1,28 | -3,92 | 8,53 | 9 |
| DLC 80 km/h M | PW_20190409_034A | 130,95 | 5,30 | -9,51 | 5,29 | -35,13 | 49,56 | -43,51 | -206,20 | 268,60 | -3,86 | -12,52 | 15,23 | 6 |
| DLC 80 km/h A | PW_20190409_036 | 156,79 | 8,08 | -11,33 | 4,14 | -37,64 | 58,87 | -33,59 | -211,80 | 340,60 | -4,79 | -18,25 | 25,96 | 6,5 |
| DLC 100 km/h S | PW_20190409_038A | 71,13 | 1,95 | -3,14 | 2,12 | -14,29 | 23,17 | -15,73 | -67,20 | 79,00 | -2,19 | -9,10 | 6,26 | 9 |
| DLC 100 km/h M | PW_20190409_039 | 96,99 | 3,71 | -5,82 | 2,21 | -26,29 | 34,83 | -16,86 | -133,20 | 173,60 | -3,58 | -10,24 | 14,26 | 7 |
| DLC 100 km/h A | | | | | | | | | | | | | | 5,5 |
| DLC 120 km/h S | | | | | | | | | | | | | | 9 |
| DLC 120 km/h M | PW_20190409_042 | 83,66 | 3,17 | -4,83 | 4,00 | -20,39 | 27,57 | -29,31 | -148,87 | 107,80 | -3,44 | -10,88 | 15,88 | 7,5 |
| DLC 120 km/h A | | | | | | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | | | | | | |

C1 PW DS2

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190409_033B | 81,54 | 2,39 | -2,35 | 1,89 | -19,20 | 22,76 | -14,05 | -87,40 | 79,60 | -1,51 | -4,48 | 8,82 | 9 |
| DLC 80 km/h M | PW_20190409_034B | 167,44 | 6,21 | -13,04 | 5,46 | -36,53 | 55,68 | -44,29 | -191,60 | 275,80 | -4,26 | -18,01 | 18,72 | 6 |
| DLC 80 km/h A | PW_20190409_037 | 190,44 | 9,06 | -21,04 | 5,71 | -40,44 | 69,44 | -46,61 | -245,60 | 315,00 | -6,30 | -23,13 | 45,14 | 6,5 |
| DLC 100 km/h S | PW_20190409_038B | 74,66 | 2,77 | -2,79 | 2,43 | -19,38 | 19,59 | -17,02 | -99,00 | 80,00 | -1,69 | -6,25 | 9,36 | 9 |
| DLC 100 km/h M | | | | | | | | | | | | | | |
| DLC 100 km/h A | | | | | | | | | | | | | | |
| DLC 120 km/h S | PW_20190409_041B | 65,11 | 2,55 | -2,56 | 1,44 | -17,52 | 19,05 | -9,84 | -82,73 | 87,33 | -1,50 | -6,68 | 11,63 | 9 |
| DLC 120 km/h M | | | | | | | | | | | | | | 7,5 |
| DLC 120 km/h A | | | | | | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | | | | | | |

C1 NH DS1

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190409_045A | 98,54 | 3,26 | -3,88 | 3,28 | -25,49 | 27,84 | -23,11 | -159,07 | 124,00 | -1,63 | -5,55 | 9,54 | 7 |
| DLC 80 km/h M | PW_20190409_046A | 143,99 | 7,38 | -11,33 | 5,29 | -37,81 | 53,20 | -37,67 | -210,60 | 274,80 | -4,05 | -17,95 | 24,88 | 5,5 |
| DLC 80 km/h A | | | | | | | | | | | | | | |
| DLC 100 km/h S | PW_20190409_047A | 70,29 | 2,40 | -3,04 | 2,51 | -18,66 | 21,89 | -18,55 | -89,40 | 96,20 | -1,71 | -6,52 | 10,58 | 7 |
| DLC 100 km/h M | PW_20190409_048A | 88,74 | 3,26 | -3,47 | 3,84 | -24,53 | 25,28 | -26,95 | -135,20 | 62,00 | -1,88 | -7,07 | 12,67 | 7 |
| DLC 100 km/h A | PW_20190409_049 | 130,91 | 7,88 | -15,36 | 6,64 | -35,43 | 57,44 | -54,08 | -218,00 | 200,20 | -6,10 | -15,08 | 39,20 | 5 |
| DLC 120 km/h S | PW_20190409_050 | 61,54 | 2,58 | -2,81 | 2,81 | -21,08 | 19,05 | -20,47 | -108,00 | 63,00 | -1,81 | -5,95 | 12,02 | 7 |
| DLC 120 km/h M | PW_20190409_051A | 81,68 | 3,57 | -3,77 | 5,06 | -23,80 | 25,13 | -32,20 | -128,20 | 104,80 | -2,61 | -7,48 | 15,08 | 6 |
| DLC 120 km/h A | | | | | | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | | | | | | |

C1 NH DS2

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | | | | | | | | | | | | | | 7 |
| DLC 80 km/h M | PW_20190409_046B | 138,01 | 5,44 | -7,41 | 3,90 | -33,91 | 42,68 | -27,03 | -177,40 | 231,20 | -2,98 | -9,80 | 15,44 | 5,5 |
| DLC 80 km/h A | | | | | | | | | | | | | | |
| DLC 100 km/h S | PW_20190409_047B | 67,80 | 2,22 | -2,80 | 2,38 | -16,92 | 19,67 | -16,99 | -86,80 | 85,60 | -1,71 | -7,01 | 12,02 | 7 |
| DLC 100 km/h M | PW_20190409_048B | 100,85 | 4,17 | -5,29 | 4,46 | -26,55 | 31,25 | -30,48 | -161,80 | 125,00 | -2,82 | -8,51 | 16,42 | 7 |
| DLC 100 km/h A | | | | | | | | | | | | | | |
| DLC 120 km/h S | | | | | | | | | | | | | | |
| DLC 120 km/h M | PW_20190409_051B | 93,39 | 4,96 | -4,52 | 5,42 | -25,68 | 32,63 | -33,42 | -127,60 | 186,80 | -4,10 | -10,52 | 22,82 | 6 |
| DLC 120 km/h A | | | | | | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | | | | | | |

C2 PW DS1

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_050A | 92,32 | 2,66 | -3,46 | 1,78 | -20,32 | 24,21 | -14,11 | -88,93 | 74,93 | -1,29 | -2,24 | 8,57 | 7,5 |
| DLC 80 km/h M | AN_20190410_051A | 143,69 | 4,66 | -5,82 | 2,83 | -31,87 | 32,46 | -19,67 | -180,53 | 156,93 | -2,31 | -4,49 | 8,10 | 6,75 |
| DLC 80 km/h A | AN_20190410_052A | 180,62 | 6,20 | -10,78 | 4,22 | -36,64 | 52,10 | -35,16 | -190,27 | 256,27 | -4,68 | -12,32 | 25,92 | 6,75 |
| DLC 100 km/h S | AN_20190410_053A | 75,76 | 3,23 | -3,02 | 2,47 | -20,28 | 20,48 | -16,14 | -90,13 | 42,53 | -1,35 | -2,21 | 8,53 | 6,75 |
| DLC 100 km/h M | AN_20190410_054A | 106,79 | 4,54 | -4,73 | 1,86 | -25,75 | 32,40 | -10,35 | -140,13 | 123,20 | -4,59 | -7,35 | 14,36 | 6,75 |
| DLC 100 km/h A | AN_20190410_055A | 152,98 | 7,17 | -11,62 | 1,99 | -37,19 | 59,80 | -15,94 | -180,93 | 176,93 | -6,24 | -10,99 | 30,74 | 6,75 |
| DLC 120 km/h S | AN_20190410_056A | 70,40 | 2,91 | -2,97 | 1,41 | -19,39 | 15,24 | -11,74 | -85,47 | 46,80 | -1,65 | -3,60 | 9,47 | 7,5 |
| DLC 120 km/h M | AN_20190410_057A | 92,92 | 6,63 | -6,09 | 2,56 | -32,73 | 43,97 | -23,50 | -146,00 | 143,73 | -6,26 | -12,24 | 27,32 | 6,5 |
| DLC 120 km/h A | AN_20190410_058A | 120,44 | 6,99 | -12,75 | 3,96 | -30,46 | 55,47 | -29,82 | -171,07 | 163,07 | -6,42 | -16,00 | 28,37 | 6,5 |
| DLC 150 km/h S | AN_20190410_060A | 57,82 | 1,70 | -3,82 | 1,46 | -11,99 | 17,72 | -11,24 | -55,20 | 32,00 | -1,75 | -5,68 | 10,08 | 7,5 |
| DLC 150 km/h M | AN_20190410_061A | 65,74 | 2,99 | -3,32 | 2,04 | -18,21 | 16,48 | -14,57 | -81,47 | 68,27 | -2,26 | -5,20 | 9,32 | 7,5 |
| DLC 150 km/h A | AN_20190410_063A | 82,48 | 5,51 | -4,68 | 1,89 | -26,95 | 32,32 | -12,43 | -152,40 | 88,80 | -6,12 | -15,23 | 16,63 | 7 |

### C2 PW DS2

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_050B | 93,41 | 2,43 | -3,76 | 2,44 | -19,94 | 25,90 | -17,07 | -61,73 | 99,20 | -1,63 | -2,40 | 9,14 | 7,5 |
| DLC 80 km/h M | AN_20190410_051B | 133,83 | 5,55 | -5,50 | 1,30 | -34,88 | 40,21 | -12,49 | -156,00 | 160,13 | -5,00 | -11,73 | 18,72 | 6,75 |
| DLC 80 km/h A | AN_20190410_052B | 159,13 | 7,43 | -7,59 | 0,63 | -40,90 | 52,29 | -7,32 | -182,80 | 215,47 | -5,69 | -12,45 | 23,58 | 6,75 |
| DLC 100 km/h S | AN_20190410_053B | 85,49 | | | | | | | | | | | | 6,75 |
| DLC 100 km/h M | AN_20190410_054B | 102,14 | 5,07 | -5,24 | 1,73 | -30,20 | 36,35 | -14,55 | -128,80 | 152,13 | -5,59 | -10,96 | 25,78 | 6,75 |
| DLC 100 km/h A | AN_20190410_055B | 157,72 | 7,57 | -12,84 | 1,94 | -36,59 | 61,59 | -16,61 | -167,33 | 242,53 | -5,96 | -12,24 | 33,05 | 6,75 |
| DLC 120 km/h S | | | | | | | | | | | | | | 7,5 |
| DLC 120 km/h M | | | | | | | | | | | | | | 6,5 |
| DLC 120 km/h A | AN_20190410_058B | 116,21 | 7,67 | -8,87 | 2,30 | -35,85 | 50,68 | -18,26 | -188,13 | 205,87 | -6,08 | -11,32 | 31,57 | 6,5 |
| DLC 150 km/h S | AN_20190410_060B | 45,46 | 1,98 | -3,68 | 1,58 | -11,18 | 19,12 | -9,39 | -58,13 | 8,67 | -1,47 | -3,63 | 9,50 | 7,5 |
| DLC 150 km/h M | AN_20190410_062B | 74,54 | 5,79 | -5,13 | 2,23 | -25,54 | 39,67 | -13,08 | -148,40 | 161,60 | -5,74 | -13,52 | 18,40 | 7,5 |
| DLC 150 km/h A | AN_20190410_063B | 80,48 | 6,02 | -5,43 | 1,76 | -27,76 | 40,04 | -11,39 | -156,00 | 146,67 | -6,28 | -14,11 | 22,43 | 7 |

### C2 NH DS1

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_011A | 79,38 | 2,61 | -2,47 | 1,59 | -20,19 | 20,59 | -13,98 | -77,00 | 69,20 | -1,50 | -5,30 | 8,78 | 9 |
| DLC 80 km/h M | AN_20190410_013A | 141,28125 | 5,96 | -6,09 | 2,16 | -36,21 | 44,88 | -14,05 | -211,73 | 274,20 | -5,48 | -12,61 | 23,44 | 7,5 |
| DLC 80 km/h A | | | | | | | | | | | | | | |
| DLC 100 km/h S | AN_20190410_014A | 65,37 | 2,04 | -3,29 | 2,24 | -15,63 | 20,80 | -16,34 | -71,40 | 76,20 | -1,61 | -6,25 | 10,76 | 8 |
| DLC 100 km/h M | AN_20190410_016A | 117,84 | 5,57 | -6,58 | 2,29 | -34,81 | 44,83 | -18,76 | -177,40 | 201,00 | -5,96 | -17,56 | 26,35 | 7 |
| DLC 100 km/h A | | | | | | | | | | | | | | |
| DLC 120 km/h S | AN_20190410_017A | 55,36 | 2,26 | -2,75 | 1,39 | -14,96 | 17,38 | -10,27 | -64,00 | 90,53 | -1,59 | -10,09 | 9,83 | 8,5 |
| DLC 120 km/h M | AN_20190410_019A | 91,85 | 5,74 | -5,83 | 1,14 | -29,52 | 40,98 | -9,84 | -209,20 | 104,20 | -7,27 | -21,87 | 27,47 | 6,5 |
| DLC 120 km/h A | | | | | | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | | | | | | |

### C2 NH DS2

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_011B | 82,73 | 2,51 | -2,95 | 2,44 | -18,86 | 21,70 | -20,02 | -82,60 | 71,20 | -1,67 | -4,84 | 10,26 | 9 |
| DLC 80 km/h M | AN_20190410_012B | 115,40 | 4,51 | -4,23 | 3,37 | -29,62 | 29,17 | -22,73 | -141,60 | 144,80 | -2,51 | -10,44 | 12,24 | 8 |
| DLC 80 km/h A | AN_20190410_013B | 160,20 | 8,00 | -7,29 | 0,87 | -39,19 | 54,44 | -12,60 | -174,40 | 183,00 | -6,68 | -17,04 | 30,71 | 7,5 |
| DLC 100 km/h S | AN_20190410_014B | 74,22 | 2,95 | -3,03 | 1,55 | -18,50 | 19,83 | -11,77 | -66,20 | 50,60 | -2,00 | -5,80 | 10,98 | 8 |
| DLC 100 km/h M | AN_20190410_016B | 104,15 | 6,13 | -3,90 | 1,98 | -31,60 | 32,47 | -14,54 | -163,20 | 165,20 | -6,43 | -17,03 | 26,82 | 7 |
| DLC 100 km/h A | | | | | | | | | | | | | | |
| DLC 120 km/h S | AN_20190410_017B | 59,08 | 2,13 | -2,76 | 1,91 | -13,12 | 17,08 | -14,69 | -54,80 | 93,60 | -2,20 | -14,41 | 11,59 | 8,5 |
| DLC 120 km/h M | AN_20190410_019B | 93,66 | 6,02 | -5,59 | 2,28 | -26,09 | 40,68 | -20,46 | -139,80 | 127,80 | -7,38 | -21,00 | 40,36 | 6,5 |
| DLC 120 km/h A | | | | | | | | | | | | | | |
| DLC 150 km/h S | | | | | | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | | | | | | |

### C2 KJH DS1

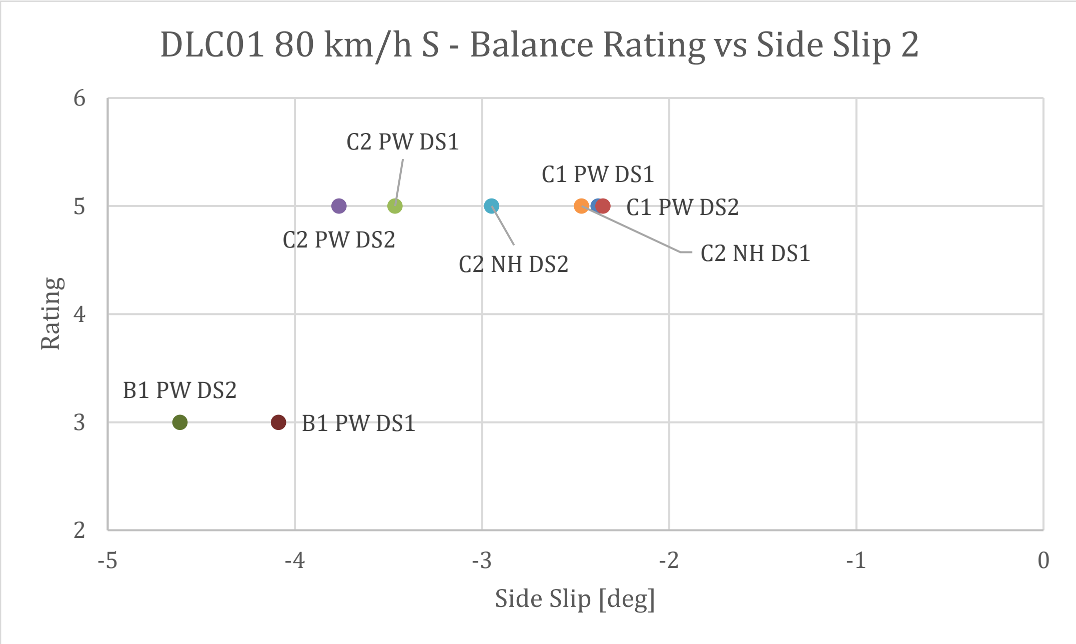
| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | AN_20190410_039 | 103,54 | | | | | | | | | | | | 8 |
| DLC 80 km/h M | AN_20190410_040 | 136,23 | 3,89 | -6,83 | 6,88 | -29,47 | 31,67 | -43,31 | -117,60 | 170,53 | -2,55 | -5,44 | 14,26 | 6,75 |
| DLC 80 km/h A | AN_20190410_041 | 161,20 | 7,77 | -13,91 | 6,00 | -39,02 | 62,96 | -41,31 | -170,00 | 215,20 | -5,26 | -8,43 | 27,50 | 7,5 |
| DLC 100 km/h S | AN_20190410_042 | 67,18 | 2,08 | -2,80 | 1,88 | -14,90 | 18,85 | -14,72 | -50,13 | 68,67 | -1,59 | -3,60 | 10,22 | 7,75 |
| DLC 100 km/h M | AN_20190410_043 | 114,09 | 4,47 | -8,22 | 4,75 | -29,14 | 36,69 | -35,33 | -74,13 | 142,13 | -5,21 | -12,99 | 26,03 | 6,5 |
| DLC 100 km/h A | AN_20190410_044 | 196,84 | 8,49 | -21,29 | 4,89 | -35,60 | 69,36 | -44,22 | -183,07 | 239,73 | -8,90 | -16,69 | 49,68 | 3 |
| DLC 120 km/h S | AN_20190410_045 | 48,93 | 1,66 | -1,83 | 1,72 | -11,72 | 11,69 | -12,92 | -33,20 | 42,27 | -1,50 | -2,67 | 11,23 | 7 |
| DLC 120 km/h M | AN_20190410_046 | 80,37 | 3,95 | -3,91 | 3,69 | -22,89 | 27,34 | -23,41 | -79,33 | 103,60 | -2,98 | -6,85 | 15,62 | 7,25 |
| DLC 120 km/h A | AN_20190410_047 | 101,26 | 8,07 | -7,85 | 2,42 | -31,06 | 50,96 | -19,43 | -155,47 | 208,27 | -6,44 | -11,47 | 34,85 | 7 |
| DLC 150 km/h S | | | | | | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | | | | | | |

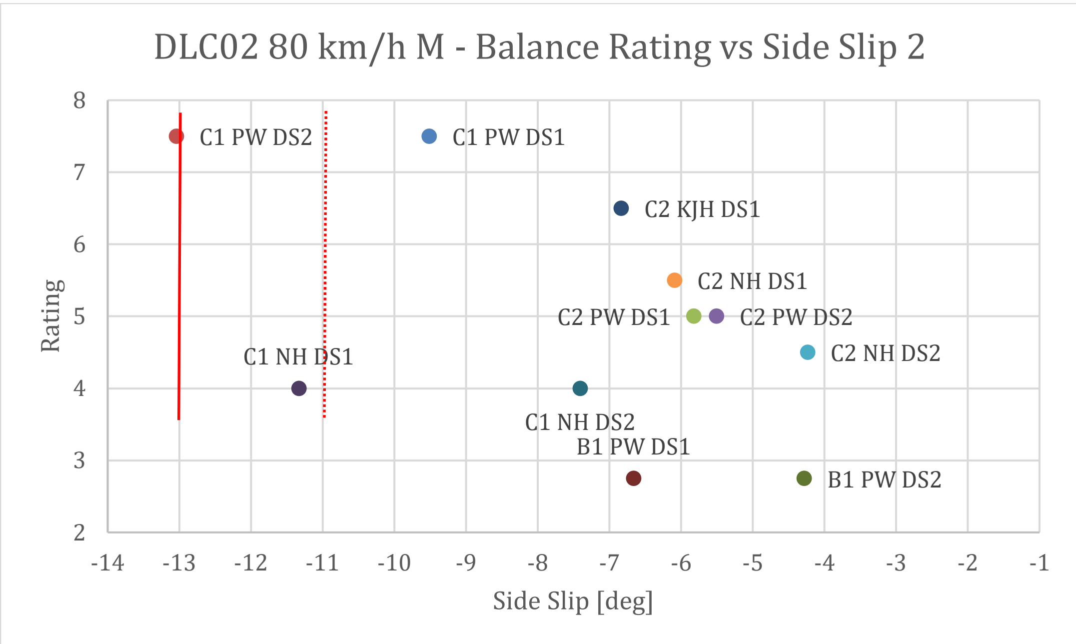
### B1 PW DS1

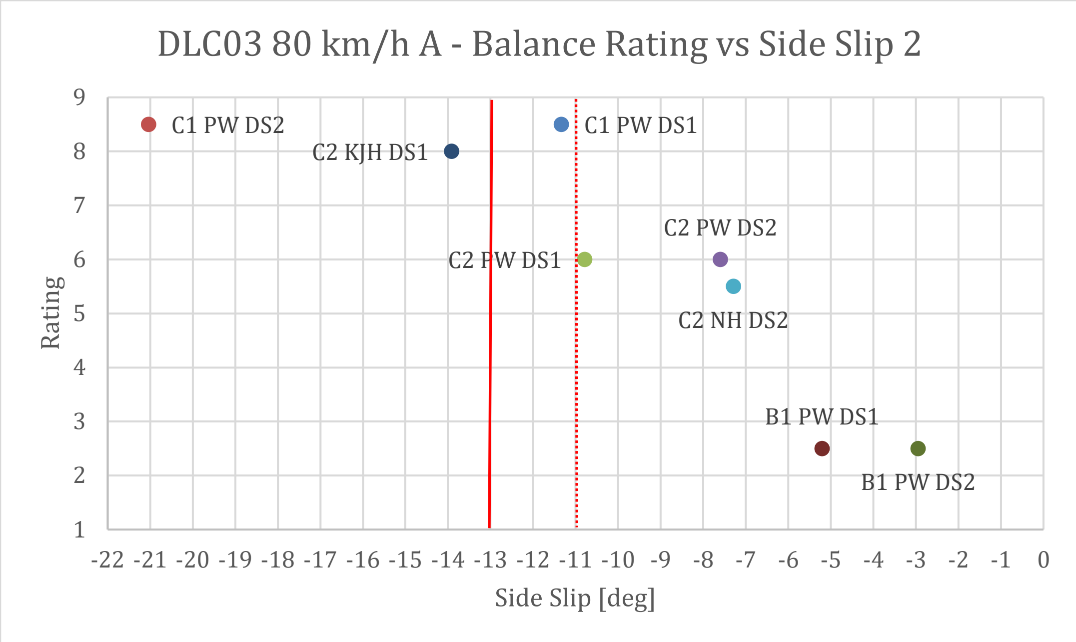
| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DLC 80 km/h S | PW_20190416_016A | 88,24 | 2,56 | -4,09 | 1,07 | -21,48 | 29,89 | -10,52 | -92,50 | 141,80 | -5,53 | -13,57 | 23,58 | 5,5 |
| DLC 80 km/h M | PW_20190416_016A_18 | 127,29 | 5,93 | -6,66 | 3,07 | -32,17 | 47,32 | -12,94 | -119,10 | 287,20 | -5,76 | -14,14 | 32,22 | 6,5 |
| DLC 80 km/h A | PW_20190416_017A | 207,27 | 6,31 | -5,20 | 1,97 | -39,92 | 47,33 | -10,24 | -200,10 | 198,70 | -6,75 | -20,09 | 37,48 | 6 |
| DLC 100 km/h S | PW_20190416_019A | 71,13 | 2,85 | -5,12 | 3,19 | -20,44 | 27,96 | -23,91 | -70,98 | 130,70 | -3,59 | -10,87 | 12,46 | 5,5 |
| DLC 100 km/h M | PW_20190416_019A_22 | 89,97 | 4,74 | -4,43 | 3,06 | -27,18 | 27,58 | -24,82 | -118,60 | 145,60 | -5,10 | -16,63 | 16,96 | 6 |
| DLC 100 km/h A | PW_20190416_020A | 173,48 | 5,58 | -4,57 | 1,42 | -35,63 | 40,44 | -8,60 | -178,40 | 140,60 | -7,89 | -19,58 | 42,55 | 6 |
| DLC 120 km/h S | PW_20190416_023A | 49,29 | 2,95 | -3,68 | 2,70 | -16,46 | 18,99 | -16,96 | -68,33 | 96,75 | -1,64 | -7,92 | 9,54 | 7 |
| DLC 120 km/h M | PW_20190416_023A_25 | 81,78 | 4,79 | -4,30 | 0,65 | -25,77 | 32,56 | -6,66 | -103,40 | 206,60 | -6,13 | -14,02 | 38,30 | 6 |
| DLC 120 km/h A | PW_20190416_024A | 141,80 | 6,70 | -3,52 | 1,83 | -32,75 | 38,56 | -7,37 | -153,60 | 131,80 | -9,19 | -16,64 | 49,72 | 6 |
| DLC 150 km/h S | | | | | | | | | | | | | | 6,75 |
| DLC 150 km/h M | PW_20190416_026_28 | 57,72 | 4,44 | -3,91 | 1,46 | -22,27 | 30,16 | -6,88 | -92,22 | 138,40 | -5,84 | -16,52 | 34,20 | 7 |
| DLC 150 km/h A | PW_20190416_027 | 90,28 | 6,45 | -5,06 | 1,35 | -28,50 | 33,90 | -15,24 | -155,60 | 130,00 | -7,61 | -11,49 | 48,06 | 7 |

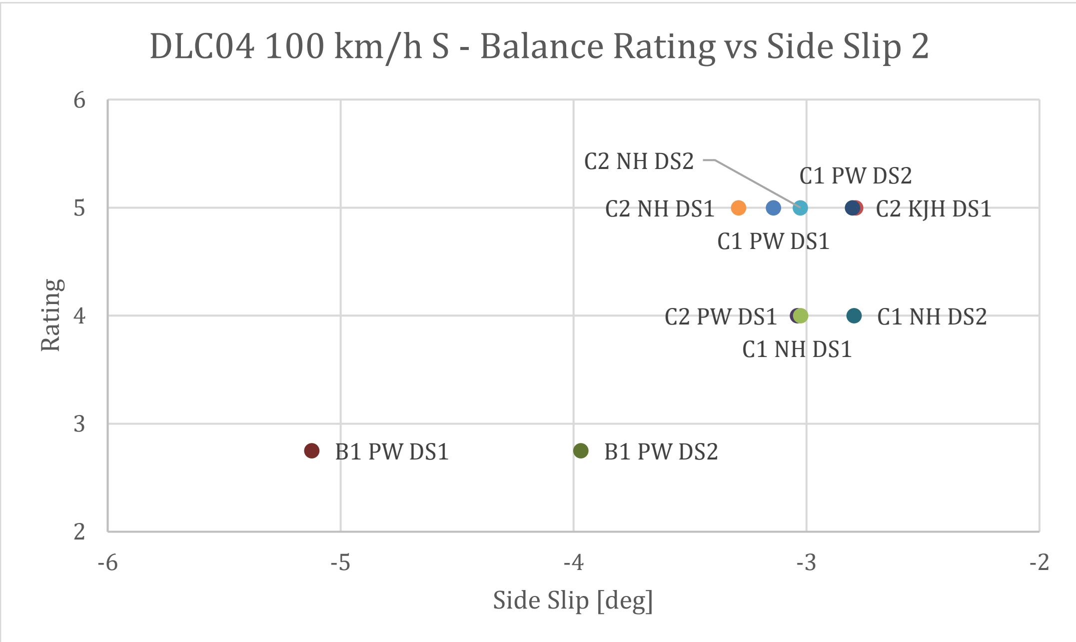
| | B1 PW DS2 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Side Slip 3 | Yaw Rate 1 | Yaw Rate 2 | Yaw Rate 3 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
| DLC 80 km/h S | PW_20190416_016B | 101,01 | 3,84 | -4,61 | 1,08 | -25,71 | 36,28 | -7,22 | -93,48 | 204,50 | -5,89 | -20,00 | 26,24 | 5,5 |
| DLC 80 km/h M | PW_20190416_016B_18 | 130,63 | 4,53 | -4,28 | 1,68 | -28,63 | 36,54 | -8,17 | -124,60 | 221,40 | -5,89 | -12,87 | 33,19 | 6,5 |
| DLC 80 km/h A | PW_20190416_017B | 209,10 | 5,55 | -2,94 | 1,88 | -35,18 | 31,53 | -11,32 | -184,80 | 133,10 | -8,16 | -18,06 | 41,04 | 6 |
| DLC 100 km/h S | PW_20190416_019B | 78,09 | 3,65 | -3,97 | 1,17 | -22,99 | 29,47 | -9,12 | -77,28 | 163,40 | -5,88 | -15,63 | 39,38 | 5,5 |
| DLC 100 km/h M | | | | | | | | | | | | | | 6,5 |
| DLC 100 km/h A | PW_20190416_020B | 185,04 | 5,90 | -3,49 | 1,17 | -35,30 | 38,72 | -8,17 | -173,40 | 171,40 | -7,48 | -14,76 | 47,05 | 6 |
| DLC 120 km/h S | PW_20190416_023B | 58,30 | 2,96 | -6,01 | 4,26 | -18,69 | 23,84 | -32,28 | -63,18 | 85,24 | -4,16 | -17,58 | 20,12 | 7 |
| DLC 120 km/h M | PW_20190416_023B_25 | 75,26 | 3,77 | -3,86 | 1,71 | -19,53 | 28,86 | -8,95 | -76,61 | 126,40 | -6,13 | -15,72 | 44,96 | 6 |
| DLC 120 km/h A | PW_20190416_024B | 150,60 | 6,38 | -3,63 | 1,27 | -32,52 | 39,79 | -13,15 | -167,10 | 116,00 | -8,63 | -15,48 | 49,75 | 6 |
| DLC 150 km/h S | | | | | | | | | | | | | | |
| DLC 150 km/h M | | | | | | | | | | | | | | |
| DLC 150 km/h A | | | | | | | | | | | | | | |

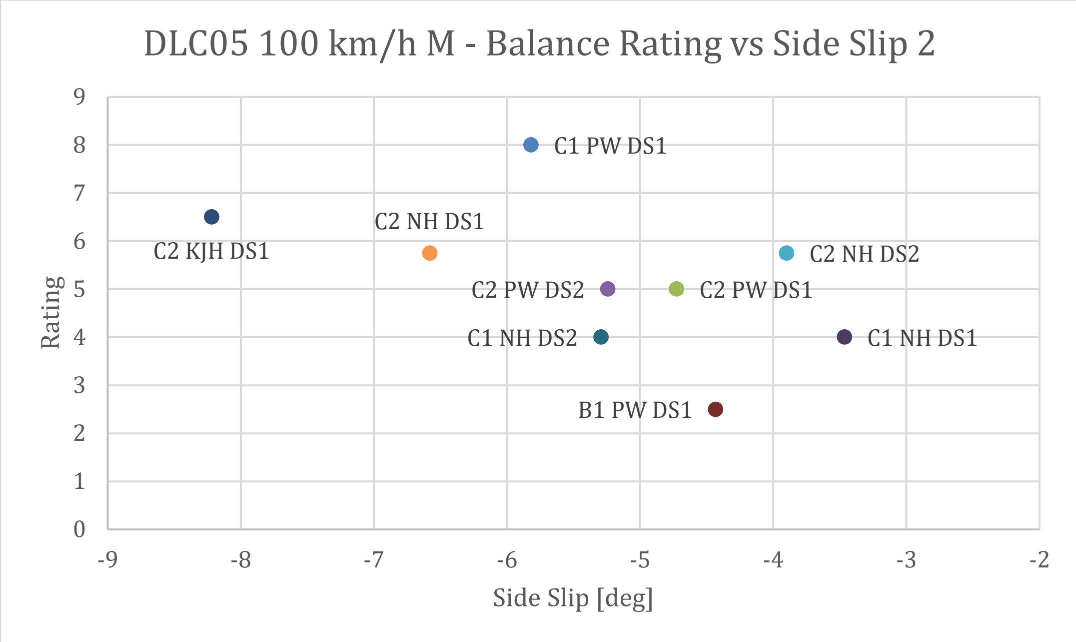
# D DLC Subjective vs Objective Scatter Plots

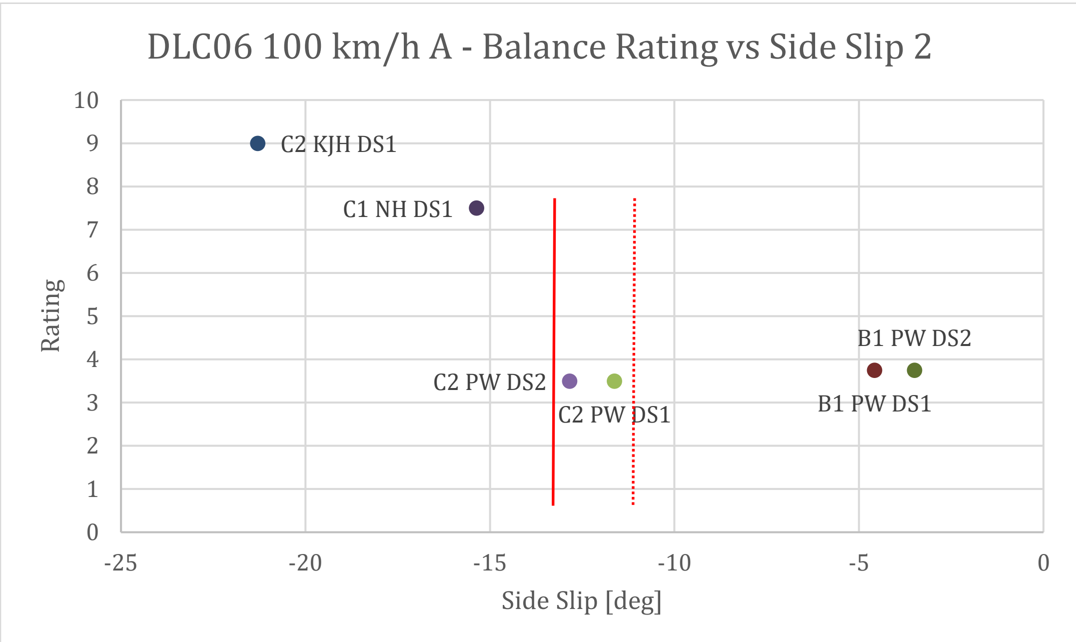


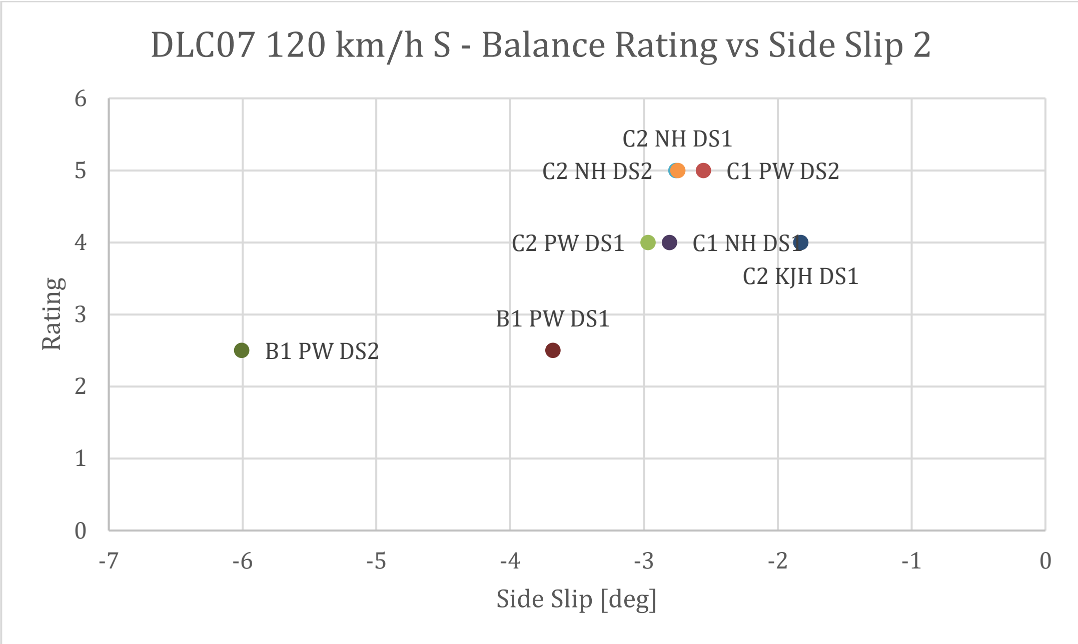



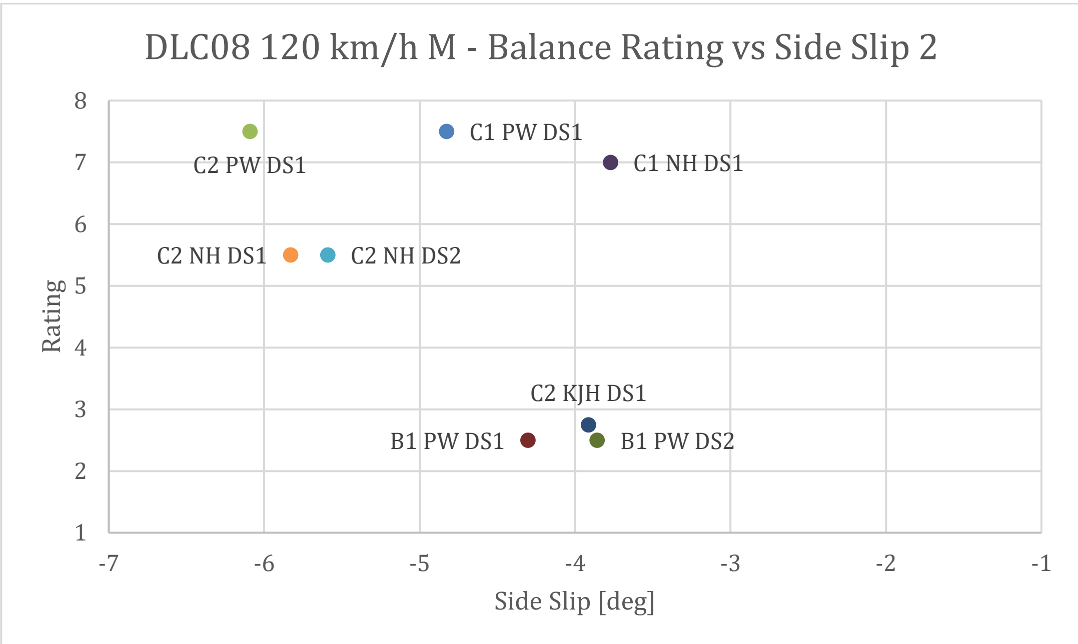

DLC03 80 km/h A - Balance Rating vs Side Slip 2
C1 PW DS2
C1 PW DS1
C2 KJH DS1
C2 PW DS2
C2 PW DS1
C2 NH DS2
B1 PW DS1
B1 PW DS2
Rating
Side Slip [deg]

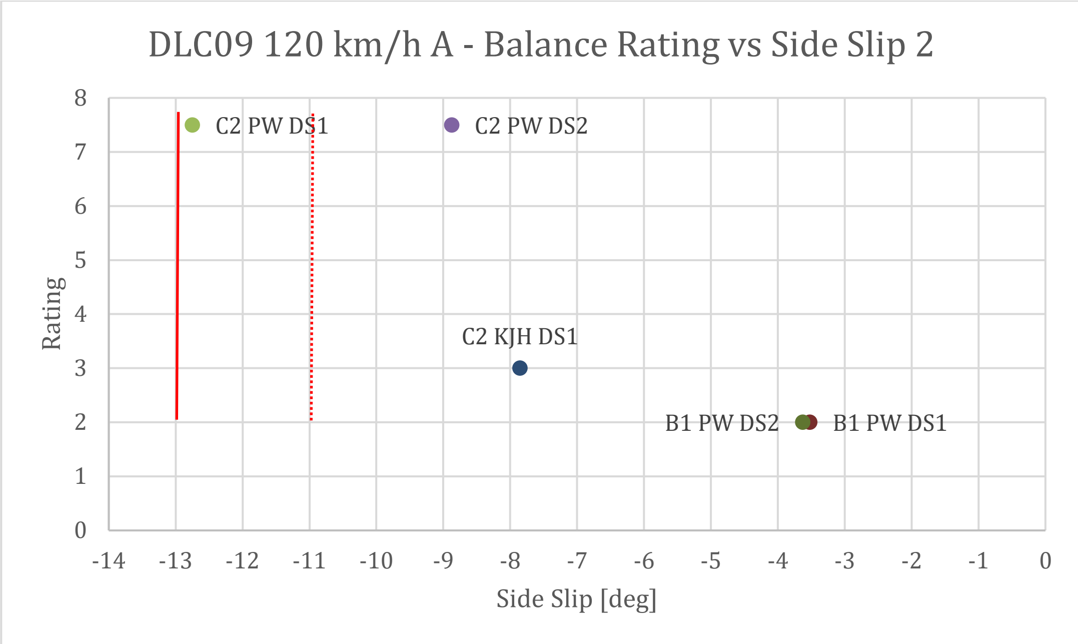

DLC04 100 km/h S - Balance Rating vs Side Slip 2
C2 NH DS2
C1 PW DS2
C2 NH DS1
C2 KJH DS1
C1 PW DS1
C2 PW DS1
C1 NH DS2
C1 NH DS1
B1 PW DS1
B1 PW DS2
Rating
Side Slip [deg]

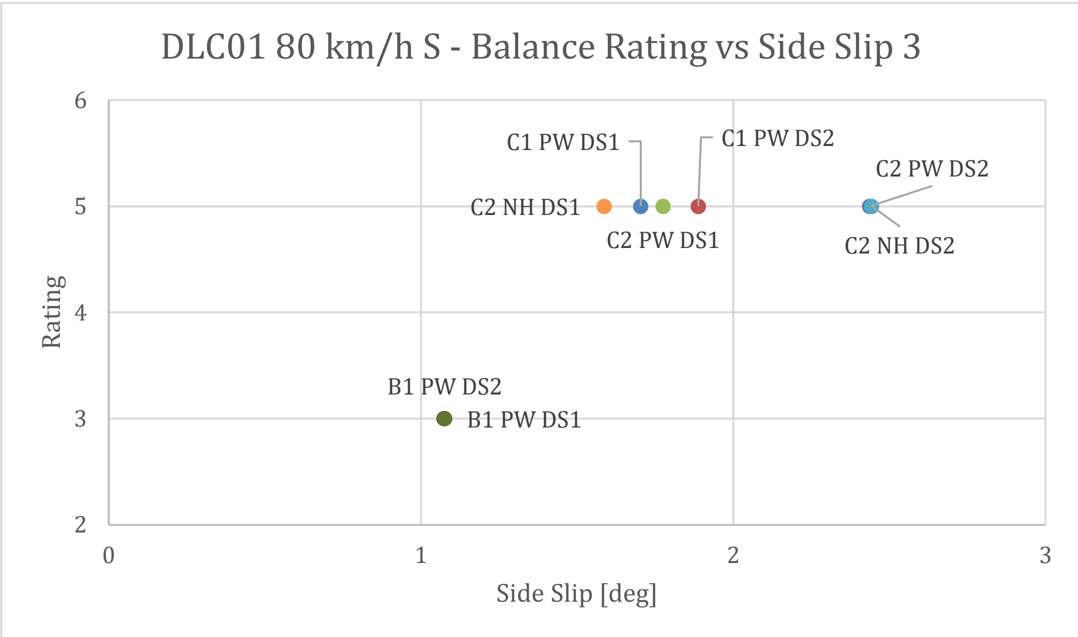

DLC05 100 km/h M - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C1 PW DS1
C2 KJH DS1
C2 NH DS1
C2 NH DS2
C2 PW DS2
C2 PW DS1
C1 NH DS2
C1 NH DS1
B1 PW DS1

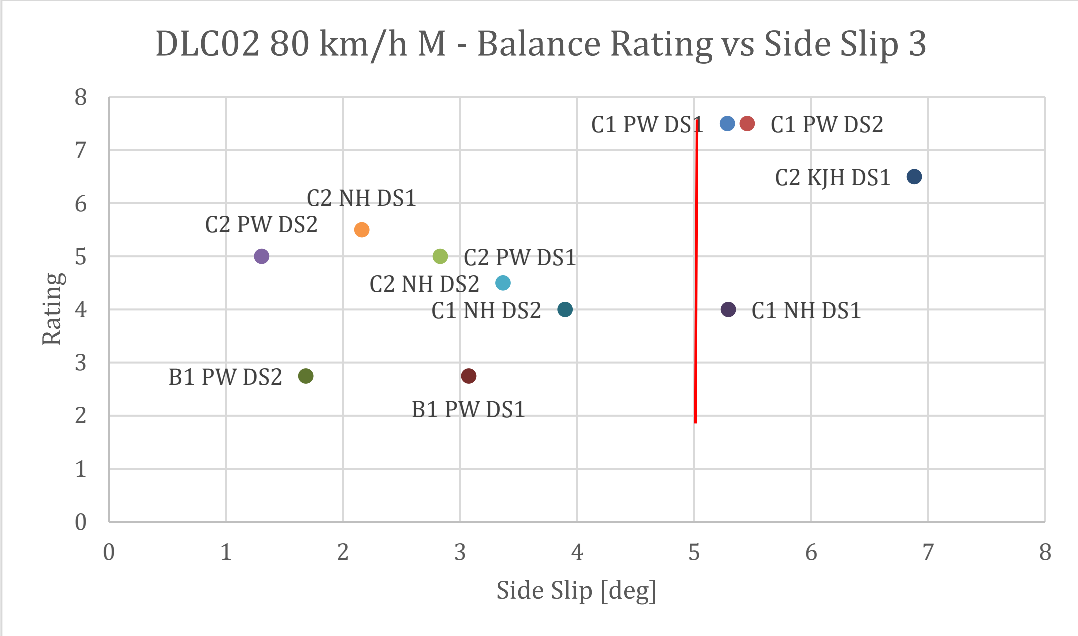

DLC06 100 km/h A - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C2 KJH DS1
C1 NH DS1
B1 PW DS2
C2 PW DS2
C2 PW DS1
B1 PW DS1

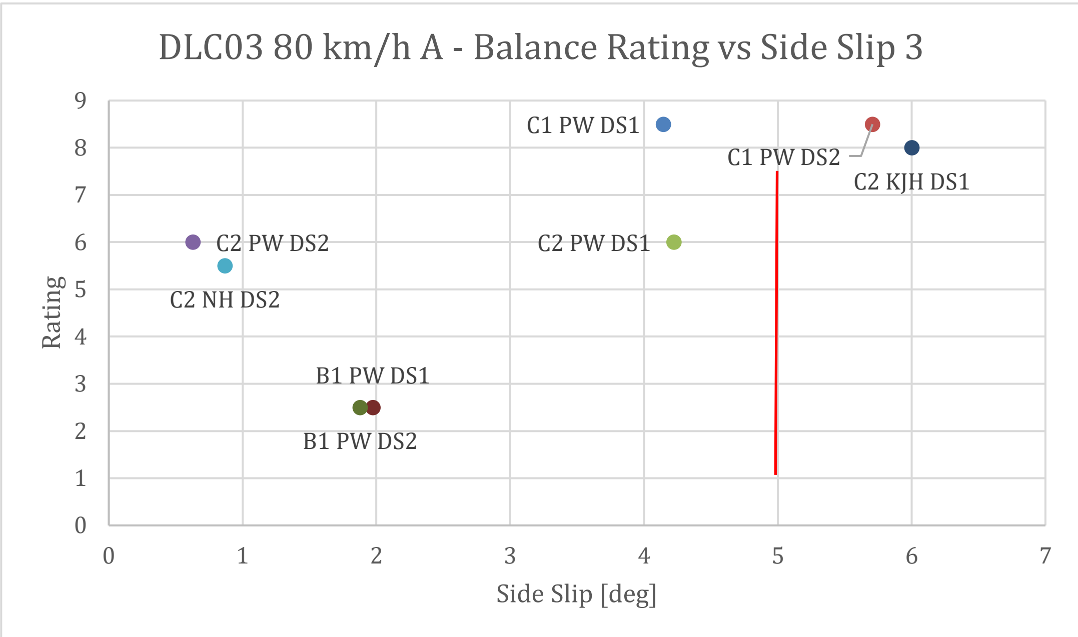

DLC07 120 km/h S - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C2 NH DS1
C2 NH DS2
C1 PW DS2
C2 PW DS1
C1 NH DS1
C2 KJH DS1
B1 PW DS1
B1 PW DS2

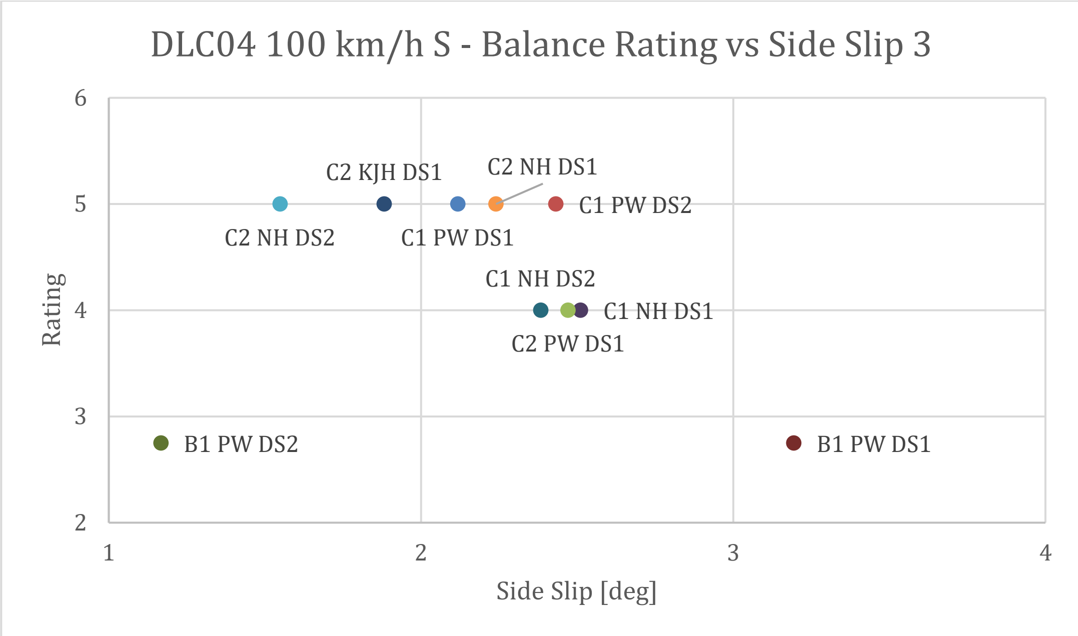

DLC08 120 km/h M - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C1 PW DS1
C2 PW DS1
C1 NH DS1
C2 NH DS1
C2 NH DS2
C2 KJH DS1
B1 PW DS1
B1 PW DS2

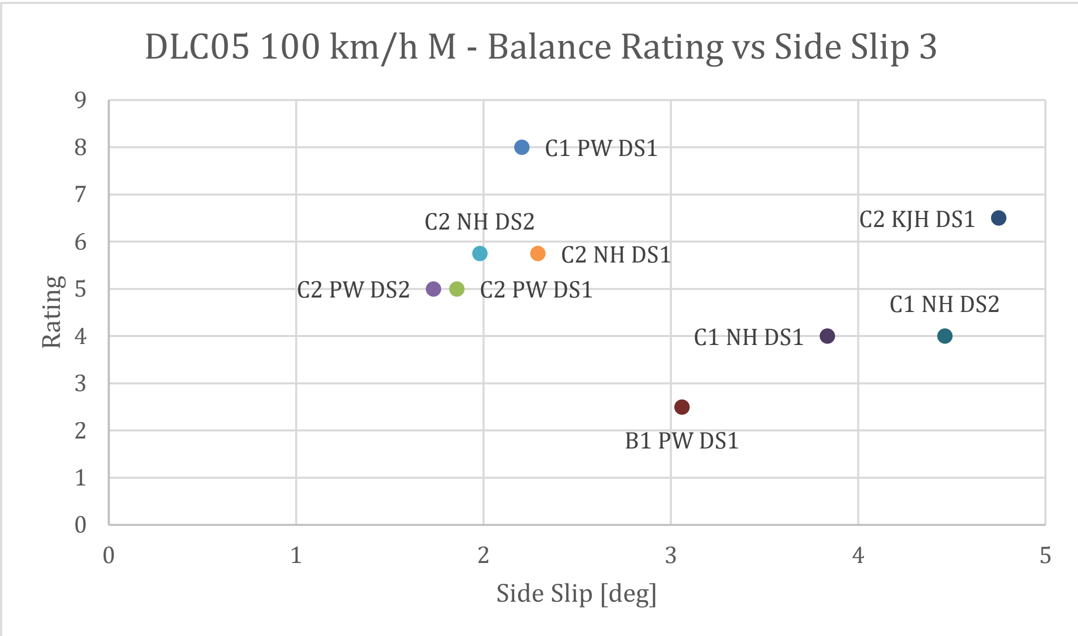

DLC09 120 km/h A - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C2 PW DS1
C2 PW DS2
C2 KJH DS1
B1 PW DS2
B1 PW DS1

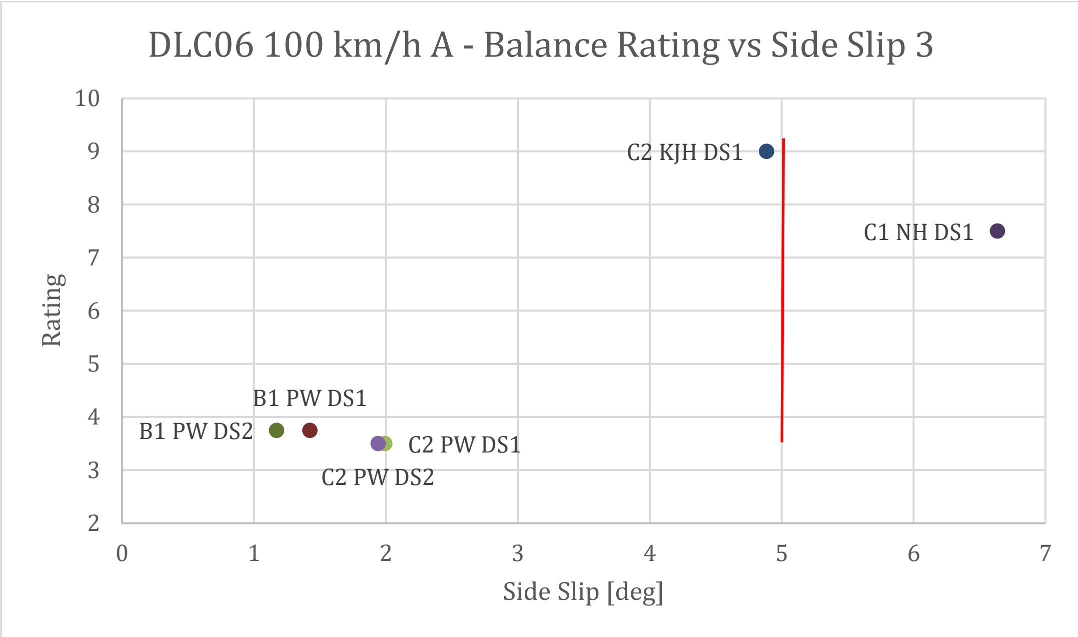

DLC01 80 km/h S - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
C1 PW DS1
C1 PW DS2
C2 PW DS2
C2 NH DS1
C2 PW DS1
C2 NH DS2
B1 PW DS2
B1 PW DS1


DLC02 80 km/h M - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
C1 PW DS1
C1 PW DS2
C2 KJH DS1
C2 NH DS1
C2 PW DS2
C2 PW DS1
C2 NH DS2
C1 NH DS2
C1 NH DS1
B1 PW DS2
B1 PW DS1

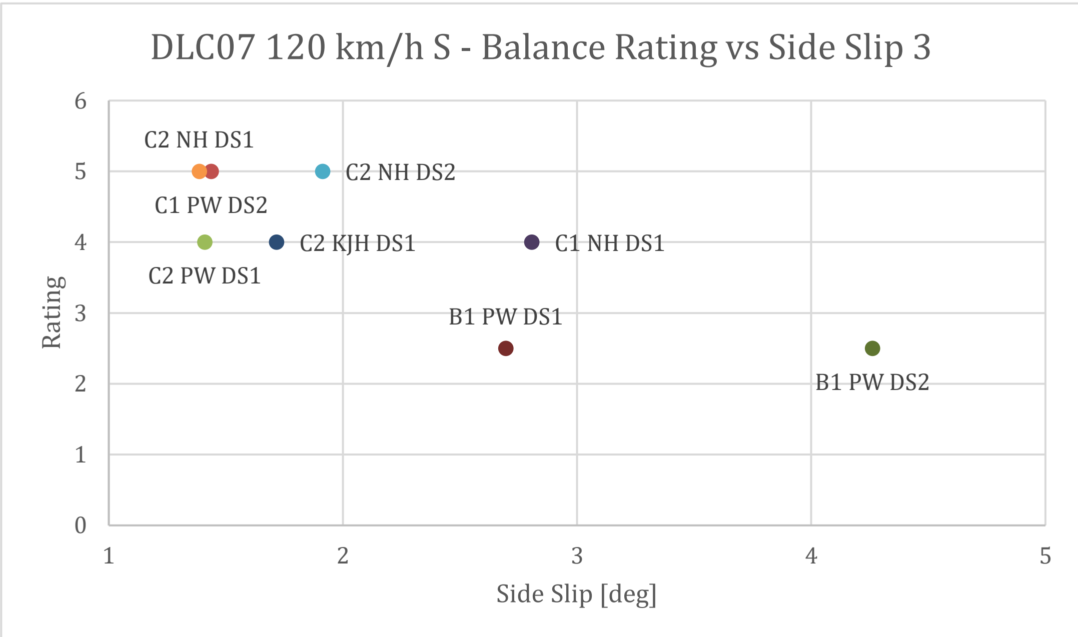

DLC03 80 km/h A - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
C1 PW DS1
C1 PW DS2
C2 KJH DS1
C2 PW DS2
C2 PW DS1
C2 NH DS2
B1 PW DS1
B1 PW DS2


DLC04 100 km/h S - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
6
5
4
3
2
1
2
3
4
C2 KJH DS1
C2 NH DS1
C1 PW DS2
C2 NH DS2
C1 PW DS1
C1 NH DS2
C1 NH DS1
C2 PW DS1
B1 PW DS2
B1 PW DS1

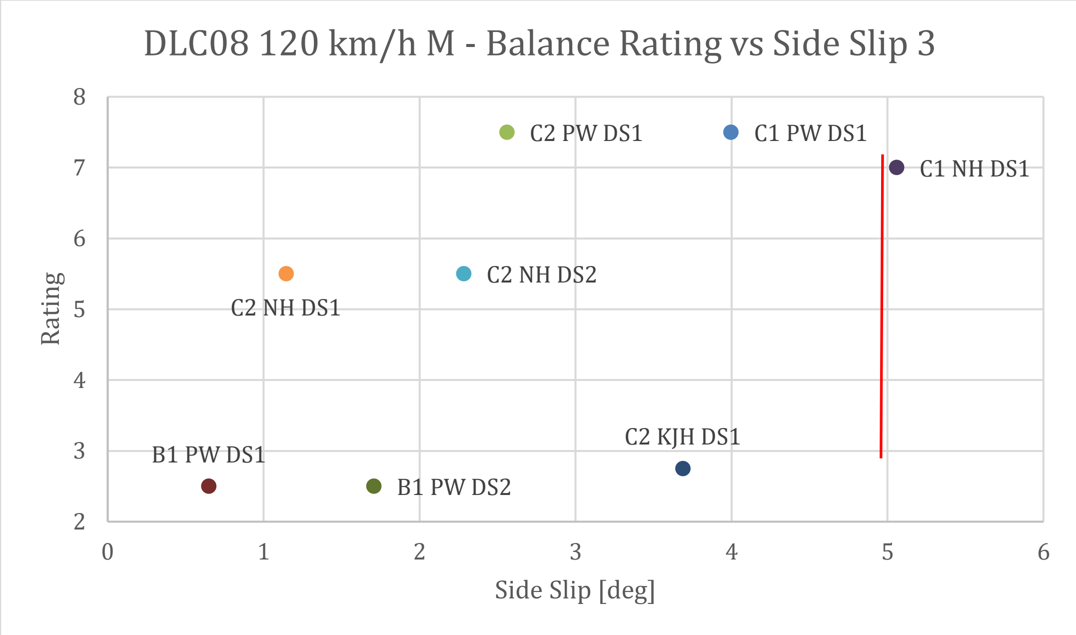

DLC05 100 km/h M - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
9
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
C1 PW DS1
C2 NH DS2
C2 KJH DS1
C2 NH DS1
C2 PW DS2
C2 PW DS1
C1 NH DS2
C1 NH DS1
B1 PW DS1

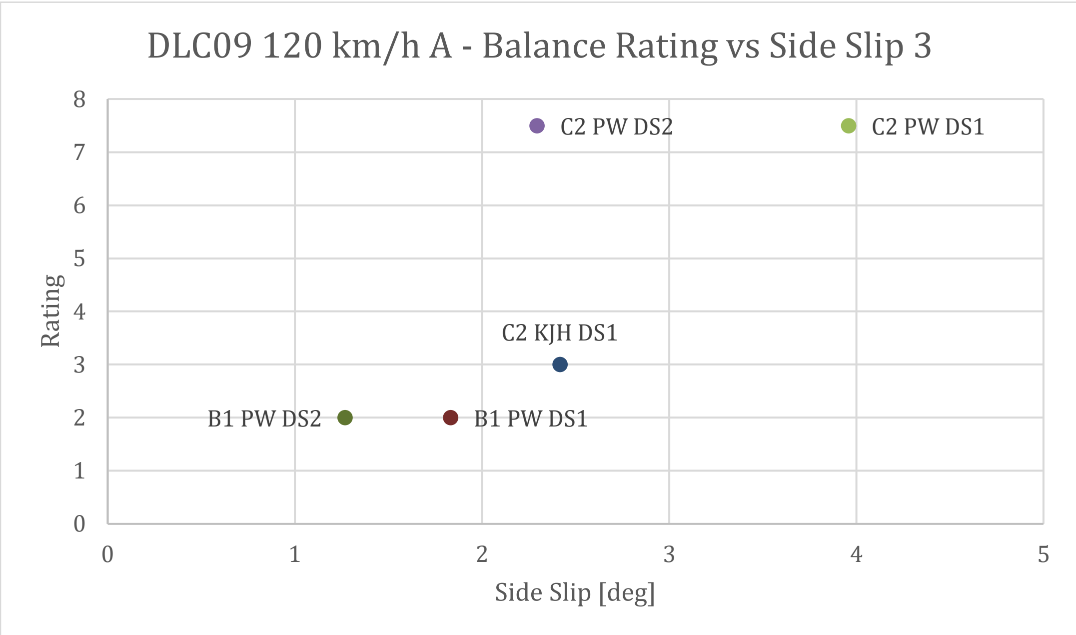


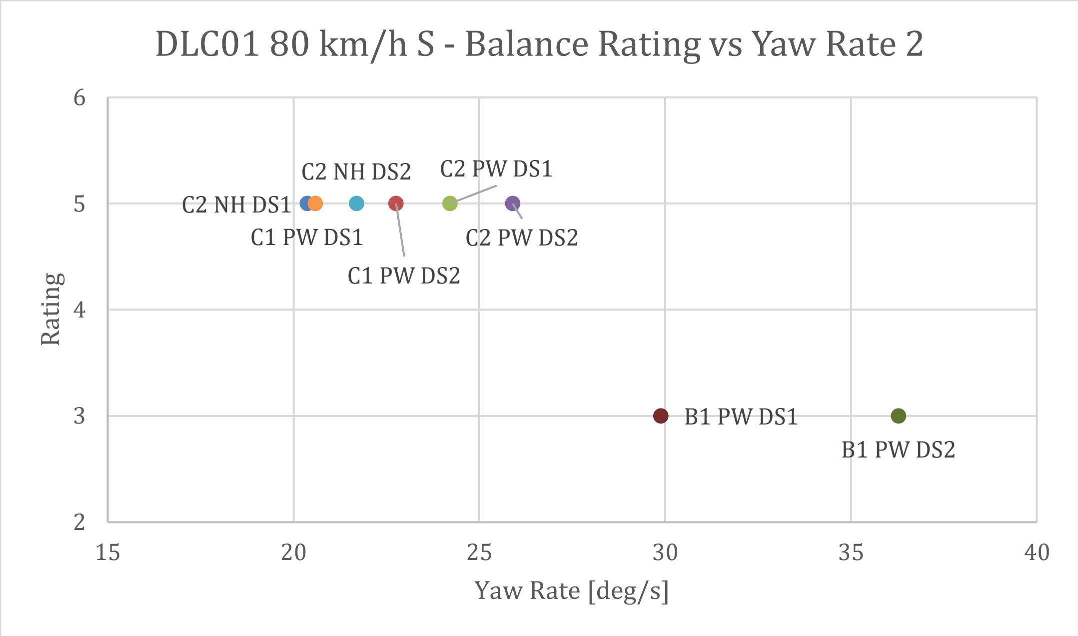
DLC06 100 km/h A - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
C2 KJH DS1
C1 NH DS1
B1 PW DS1
B1 PW DS2
C2 PW DS1
C2 PW DS2

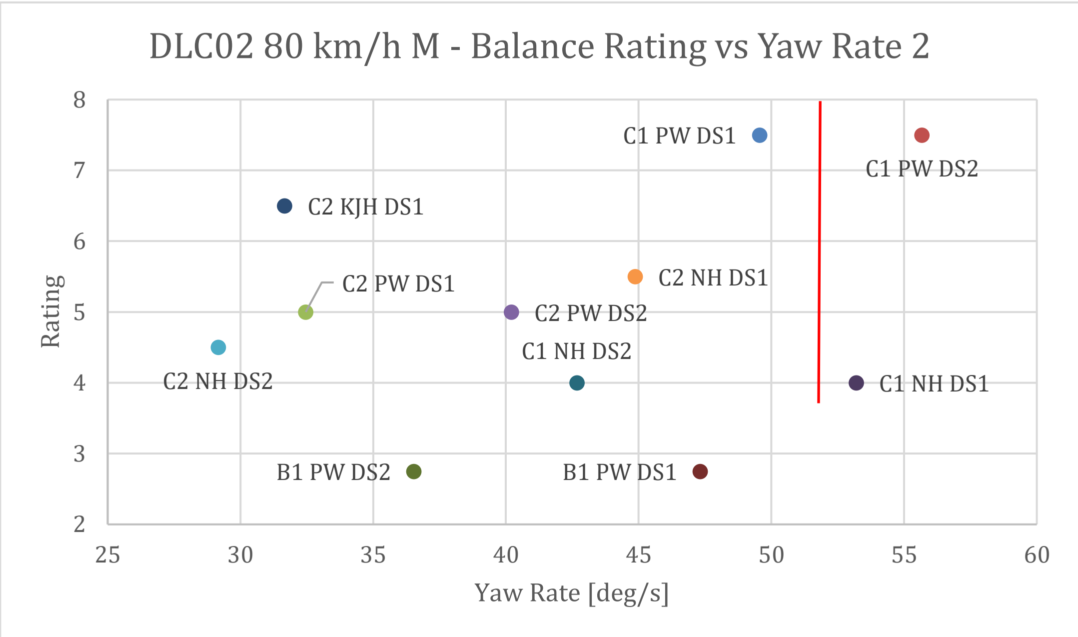



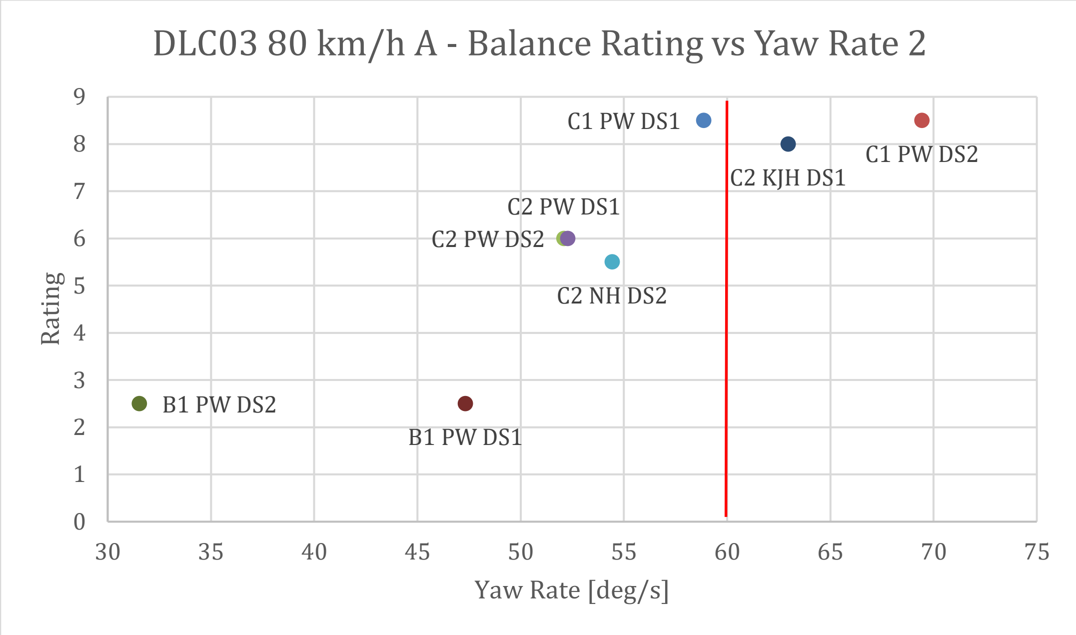
DLC07 120 km/h S - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
C2 NH DS1
C2 NH DS2
C1 PW DS2
C2 KJH DS1
C1 NH DS1
C2 PW DS1
B1 PW DS1
B1 PW DS2

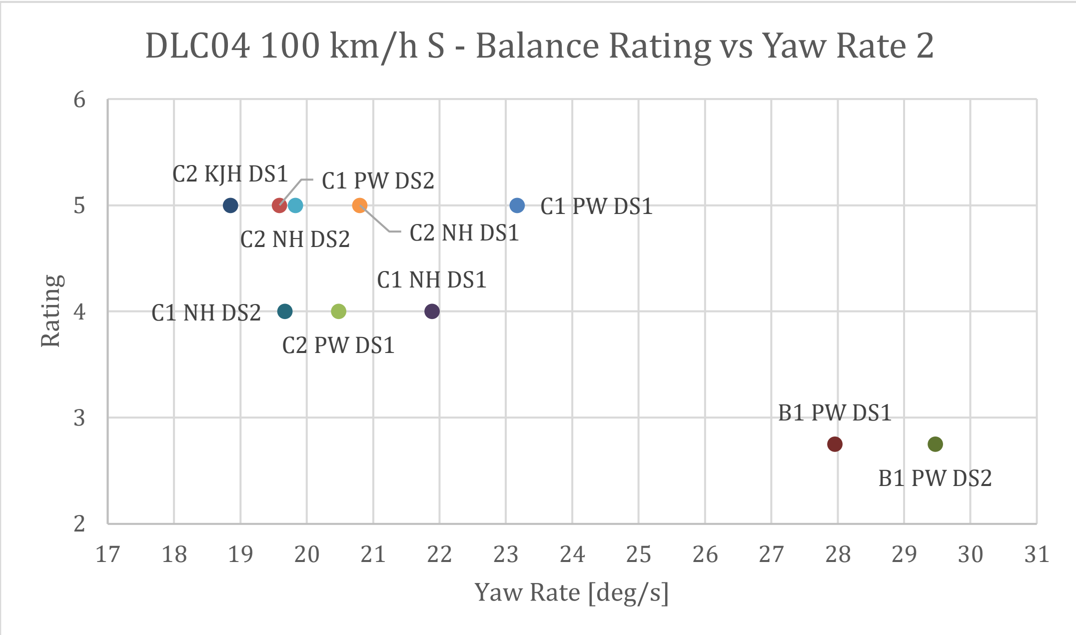

DLC08 120 km/h M - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
C2 PW DS1
C1 PW DS1
C1 NH DS1
C2 NH DS1
C2 NH DS2
B1 PW DS1
B1 PW DS2
C2 KJH DS1
0
1
2
3
4
5
6
7
8

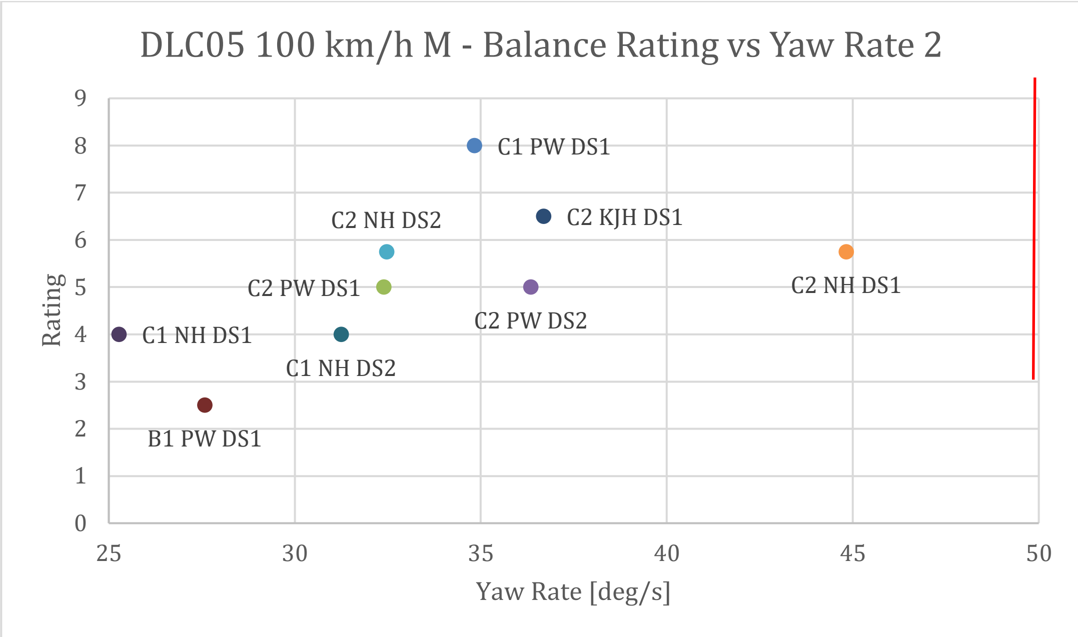

DLC09 120 km/h A - Balance Rating vs Side Slip 3
Rating
Side Slip [deg]
C2 PW DS2
C2 PW DS1
C2 KJH DS1
B1 PW DS2
B1 PW DS1
0
1
2
3
4
5
6
7
8


DLC01 80 km/h S - Balance Rating vs Yaw Rate 2
Rating
6
5
4
3
2
15
20
25
30
35
40
Yaw Rate [deg/s]
C2 NH DS2
C2 PW DS1
C2 NH DS1
C1 PW DS1
C2 PW DS2
C1 PW DS2
B1 PW DS1
B1 PW DS2

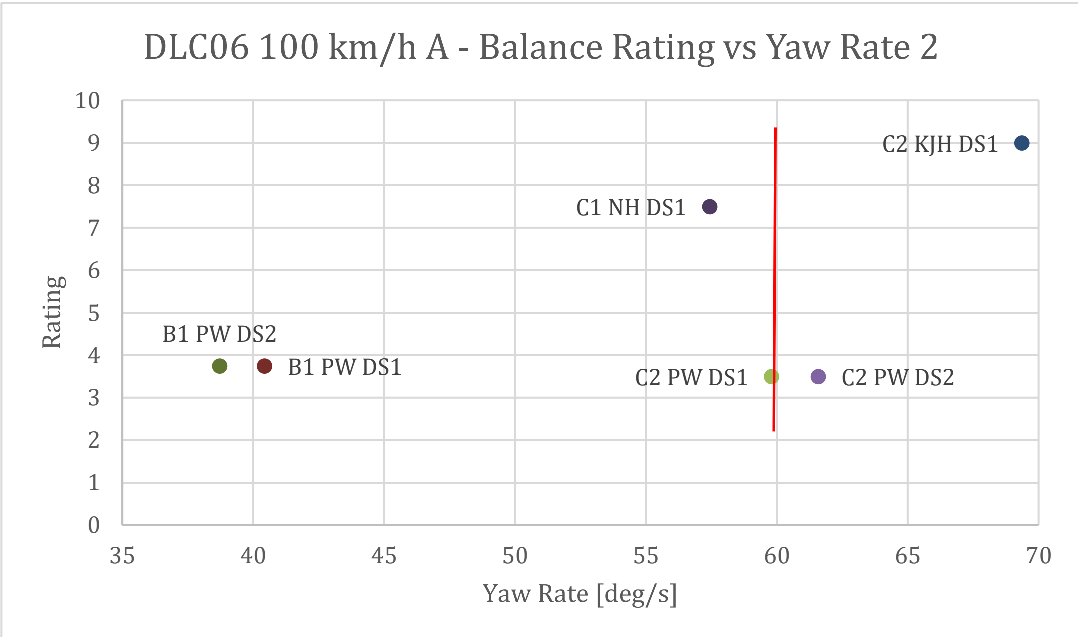

DLC02 80 km/h M - Balance Rating vs Yaw Rate 2
Rating
8
7
6
5
4
3
2
25
30
35
40
45
50
55
60
Yaw Rate [deg/s]
C1 PW DS1
C1 PW DS2
C2 KJH DS1
C2 PW DS1
C2 NH DS1
C2 PW DS2
C1 NH DS2
C2 NH DS2
C1 NH DS1
B1 PW DS2
B1 PW DS1


DLC03 80 km/h A - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C1 PW DS1
C2 KJH DS1
C1 PW DS2
C2 PW DS1
C2 PW DS2
C2 NH DS2
B1 PW DS2
B1 PW DS1

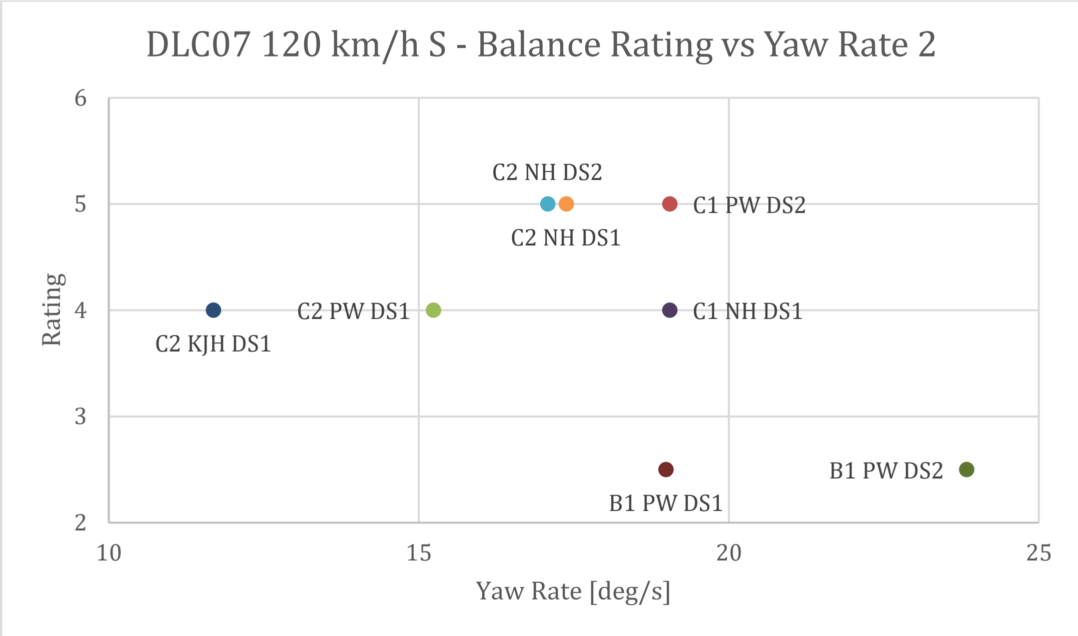

DLC04 100 km/h S - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C2 KJH DS1
C1 PW DS2
C1 PW DS1
C2 NH DS2
C2 NH DS1
C1 NH DS1
C1 NH DS2
C2 PW DS1
B1 PW DS1
B1 PW DS2

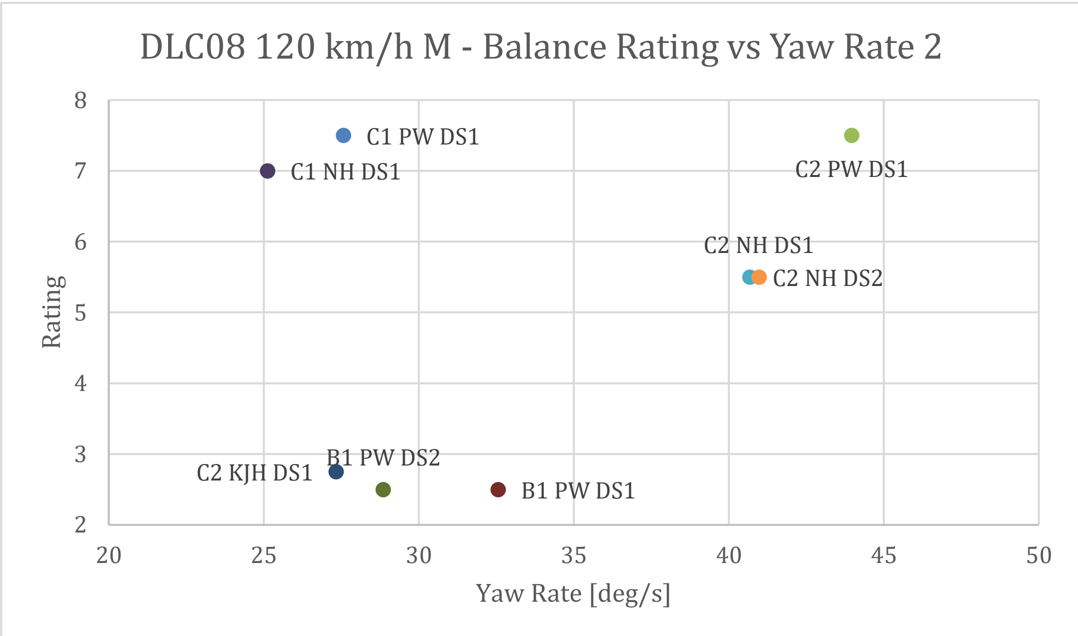


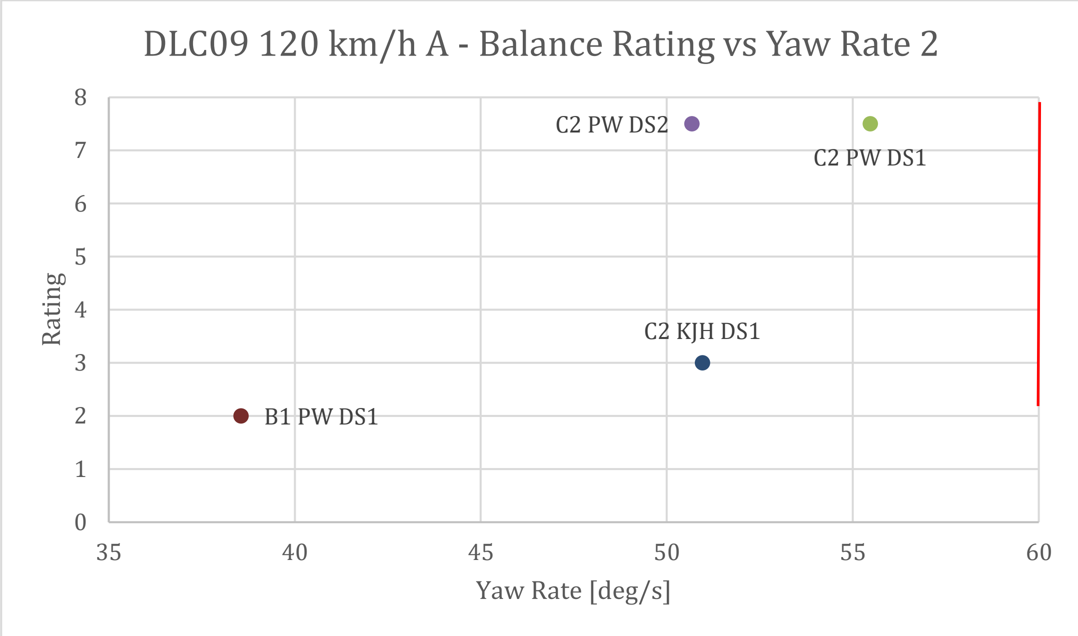
DLC05 100 km/h M - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
0
1
2
3
4
5
6
7
8
9
25
30
35
40
45
50
C1 PW DS1
C2 KJH DS1
C2 NH DS2
C2 PW DS1
C2 PW DS2
C2 NH DS1
C1 NH DS1
C1 NH DS2
B1 PW DS1

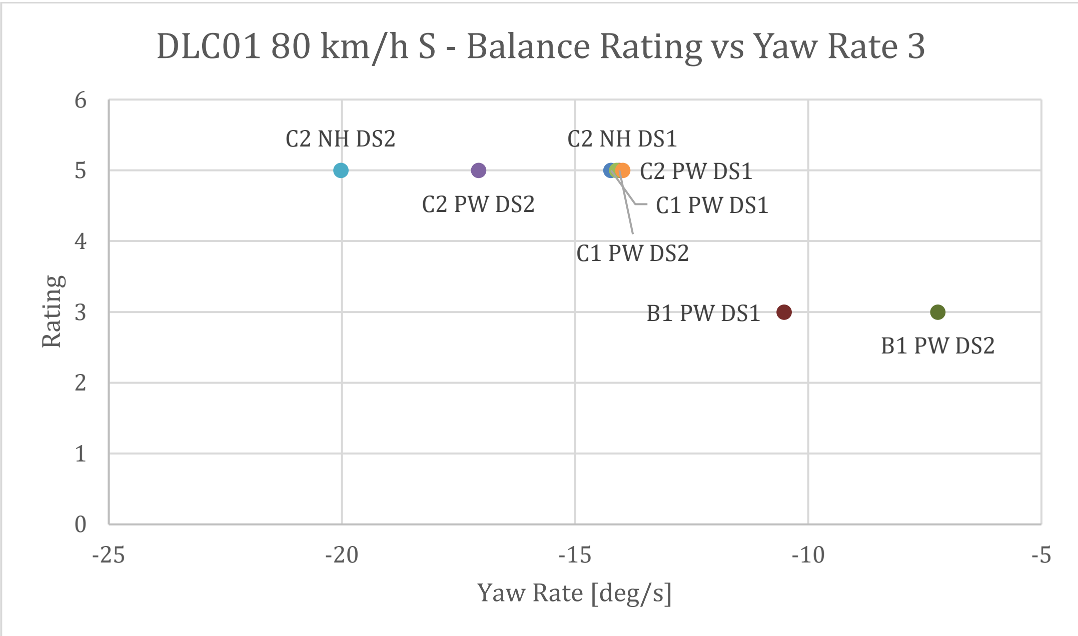



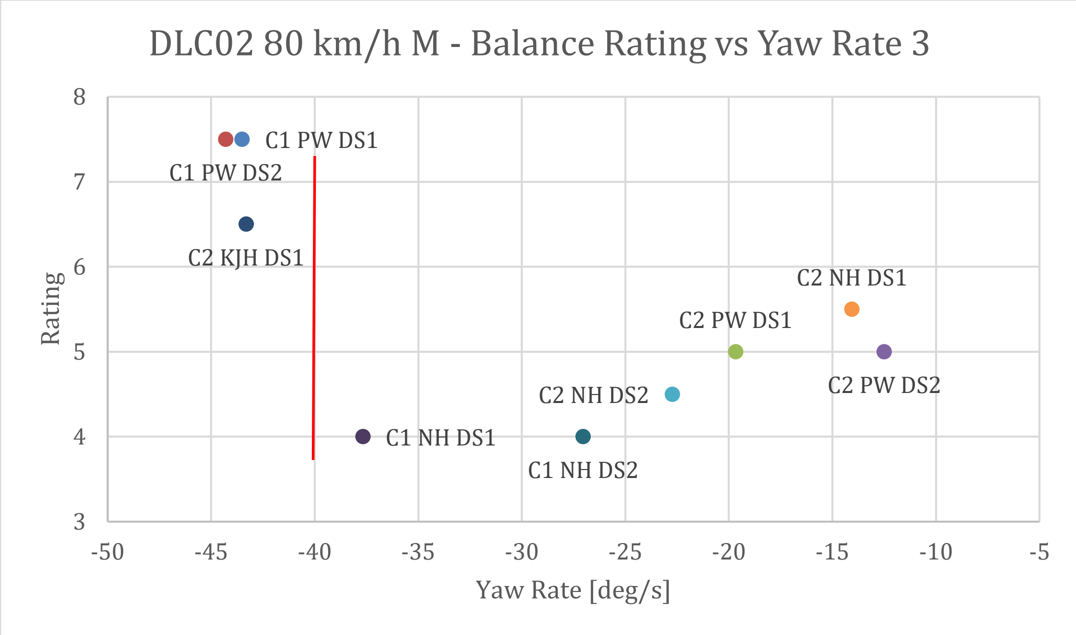
DLC06 100 km/h A - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
0
1
2
3
4
5
6
7
8
9
10
35
40
45
50
55
60
65
70
C2 KJH DS1
C1 NH DS1
B1 PW DS2
B1 PW DS1
C2 PW DS1
C2 PW DS2

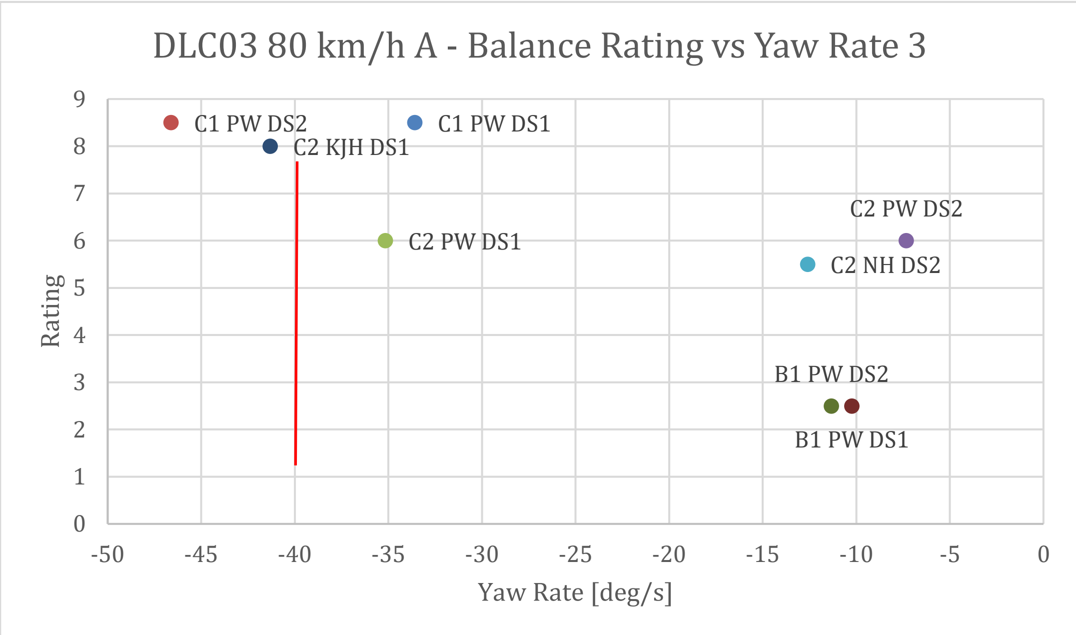

DLC07 120 km/h S - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
6
5
4
3
2
10
15
20
25
C2 NH DS2
C2 NH DS1
C1 PW DS2
C2 KJH DS1
C2 PW DS1
C1 NH DS1
B1 PW DS1
B1 PW DS2

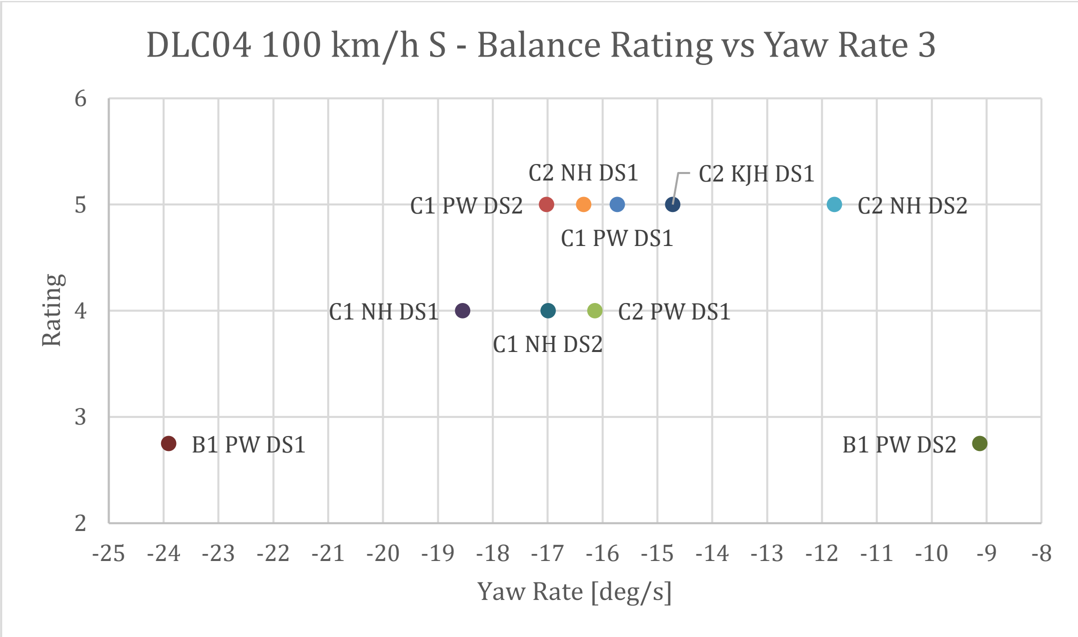

DLC08 120 km/h M - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
8
7
6
5
4
3
2
20
25
30
35
40
45
50
C1 PW DS1
C1 NH DS1
C2 PW DS1
C2 NH DS1
C2 NH DS2
B1 PW DS2
C2 KJH DS1
B1 PW DS1

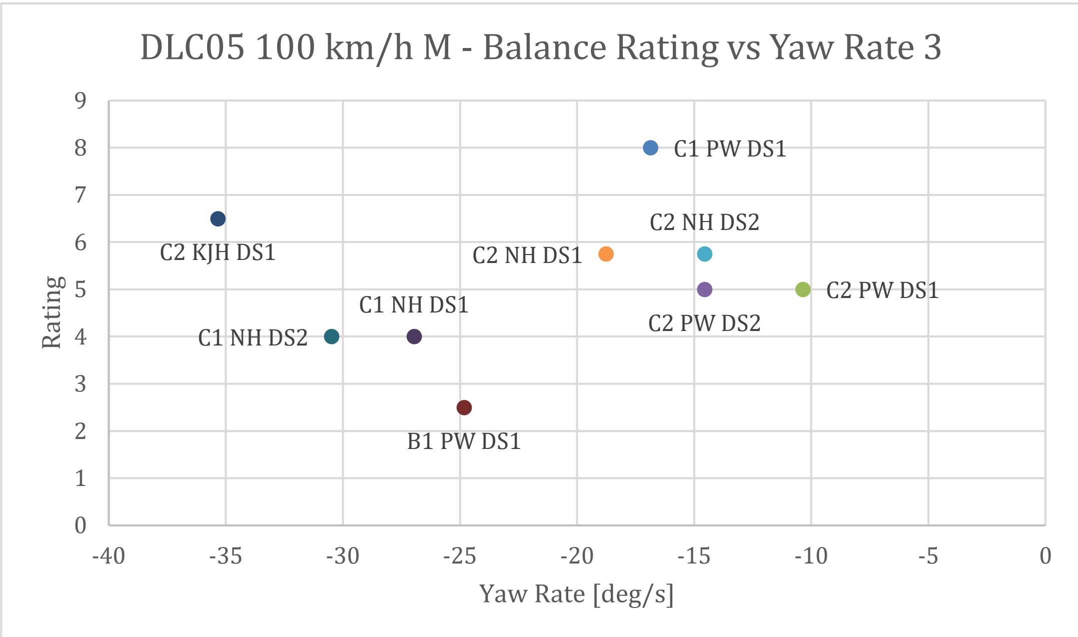

DLC09 120 km/h A - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C2 PW DS2
C2 PW DS1
C2 KJH DS1
B1 PW DS1
0
1
2
3
4
5
6
7
8
35
40
45
50
55
60

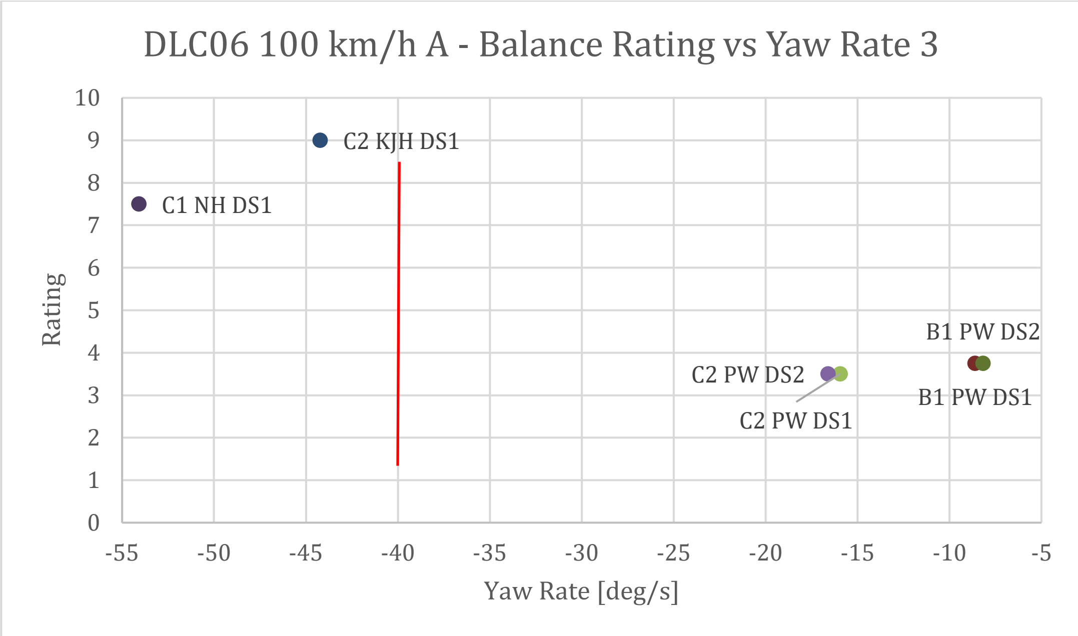

DLC01 80 km/h S - Balance Rating vs Yaw Rate 3
Rating
Yaw Rate [deg/s]
C2 NH DS2
C2 NH DS1
C2 PW DS1
C2 PW DS2
C1 PW DS1
C1 PW DS2
B1 PW DS1
B1 PW DS2
0
1
2
3
4
5
6
-25
-20
-15
-10
-5


DLC02 80 km/h M - Balance Rating vs Yaw Rate 3
Rating
Yaw Rate [deg/s]
C1 PW DS1
C1 PW DS2
C2 KJH DS1
C2 NH DS1
C2 PW DS1
C2 PW DS2
C2 NH DS2
C1 NH DS1
C1 NH DS2
8
7
6
5
4
3
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5

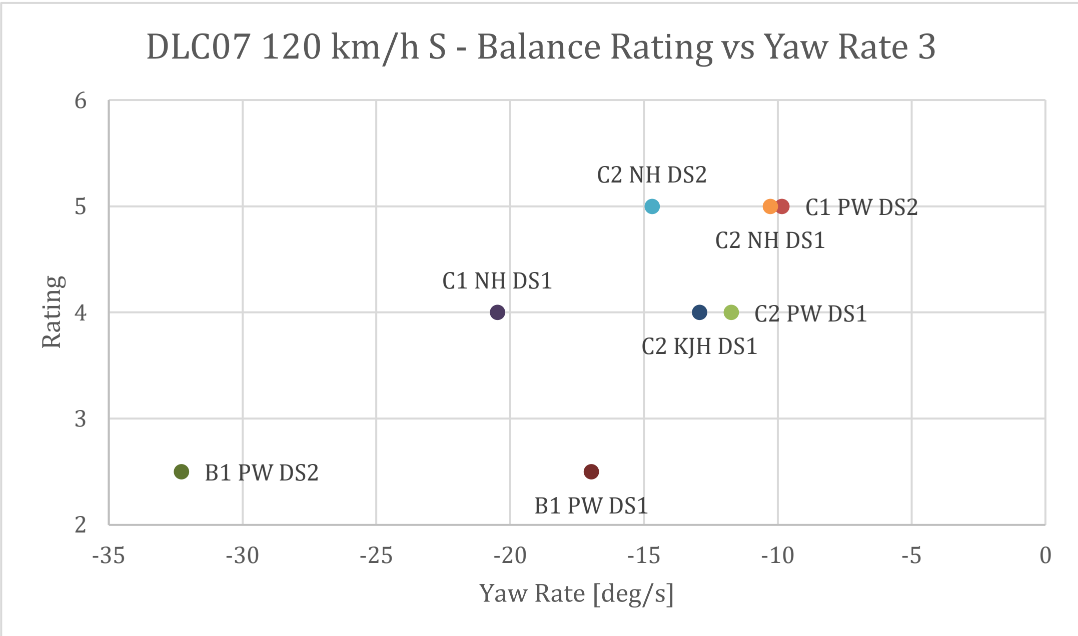

DLC03 80 km/h A - Balance Rating vs Yaw Rate 3
Rating
Yaw Rate [deg/s]
C1 PW DS2
C1 PW DS1
C2 KJH DS1
C2 PW DS1
C2 PW DS2
C2 NH DS2
B1 PW DS2
B1 PW DS1
9
8
7
6
5
4
3
2
1
0
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0


DLC04 100 km/h S - Balance Rating vs Yaw Rate 3
Rating
6
5
4
3
2
C2 NH DS1
C2 KJH DS1
C1 PW DS2
C2 NH DS2
C1 PW DS1
C1 NH DS1
C2 PW DS1
C1 NH DS2
B1 PW DS1
B1 PW DS2
-25 -24 -23 -22 -21 -20 -19 -18 -17 -16 -15 -14 -13 -12 -11 -10 -9 -8
Yaw Rate [deg/s]

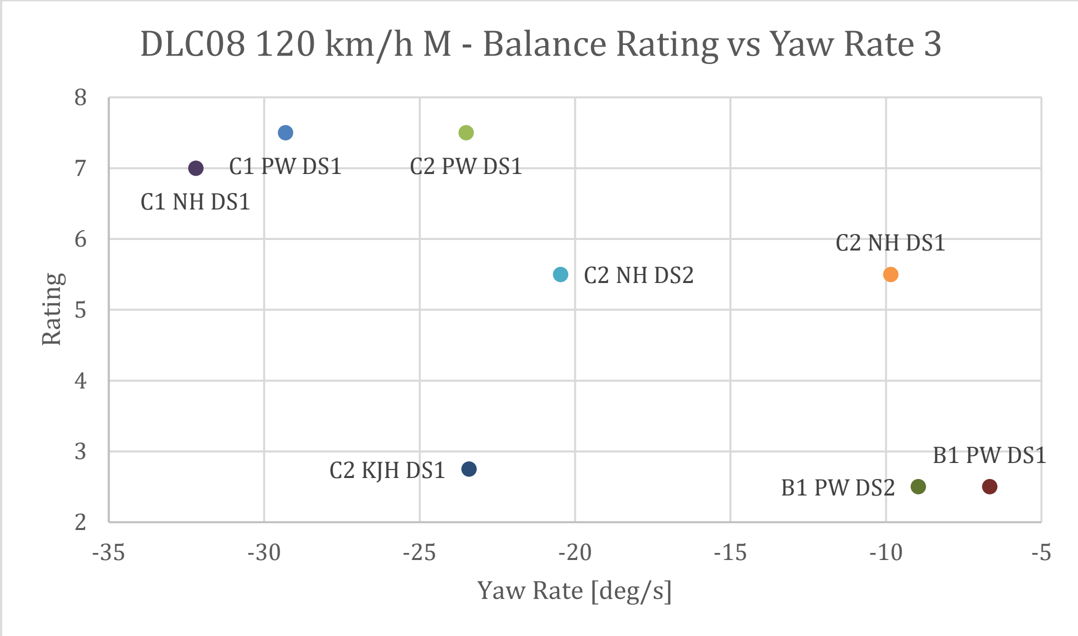

DLC05 100 km/h M - Balance Rating vs Yaw Rate 3
Rating
9
8
7
6
5
4
3
2
1
0
C1 PW DS1
C2 KJH DS1
C2 NH DS2
C2 NH DS1
C2 PW DS1
C1 NH DS1
C2 PW DS2
C1 NH DS2
B1 PW DS1
-40 -35 -30 -25 -20 -15 -10 -5 0
Yaw Rate [deg/s]

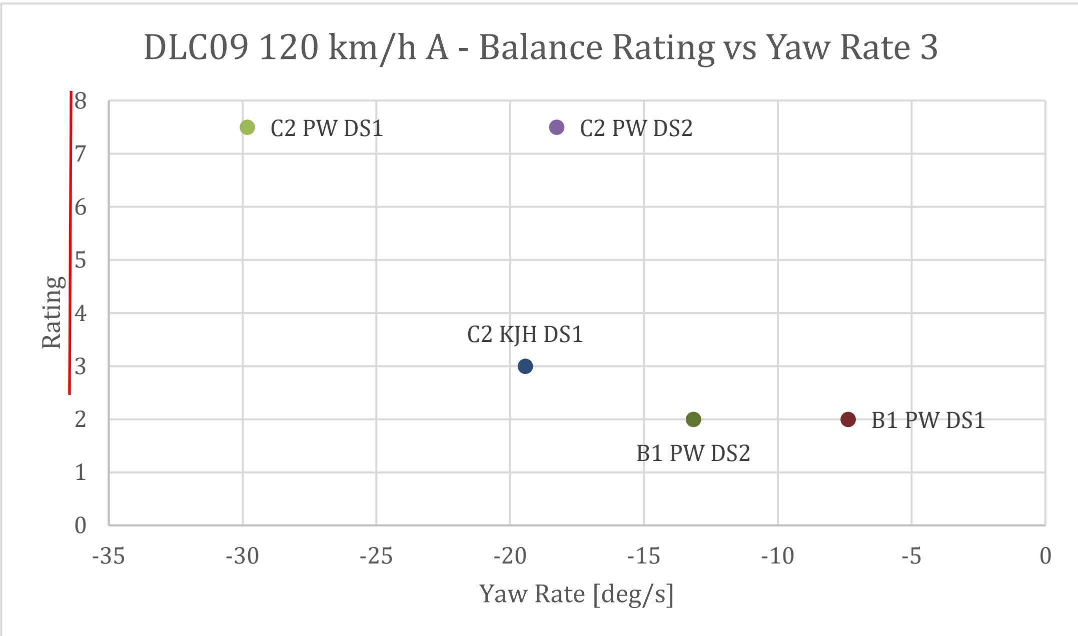


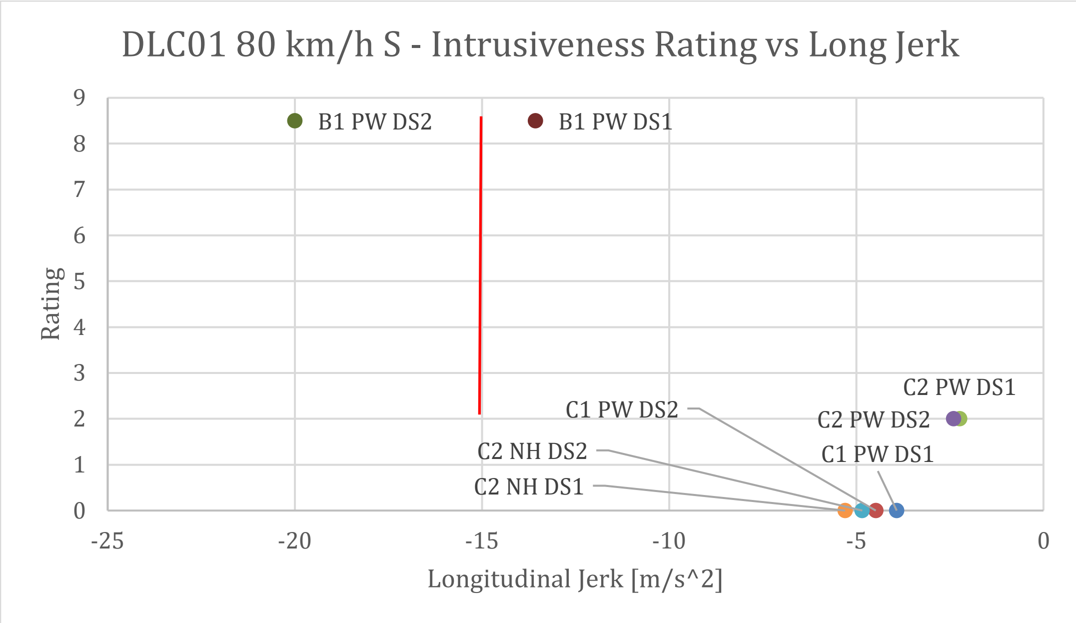
DLC06 100 km/h A - Balance Rating vs Yaw Rate 3
Rating
Yaw Rate [deg/s]
C2 KJH DS1
C1 NH DS1
B1 PW DS2
C2 PW DS2
B1 PW DS1
C2 PW DS1

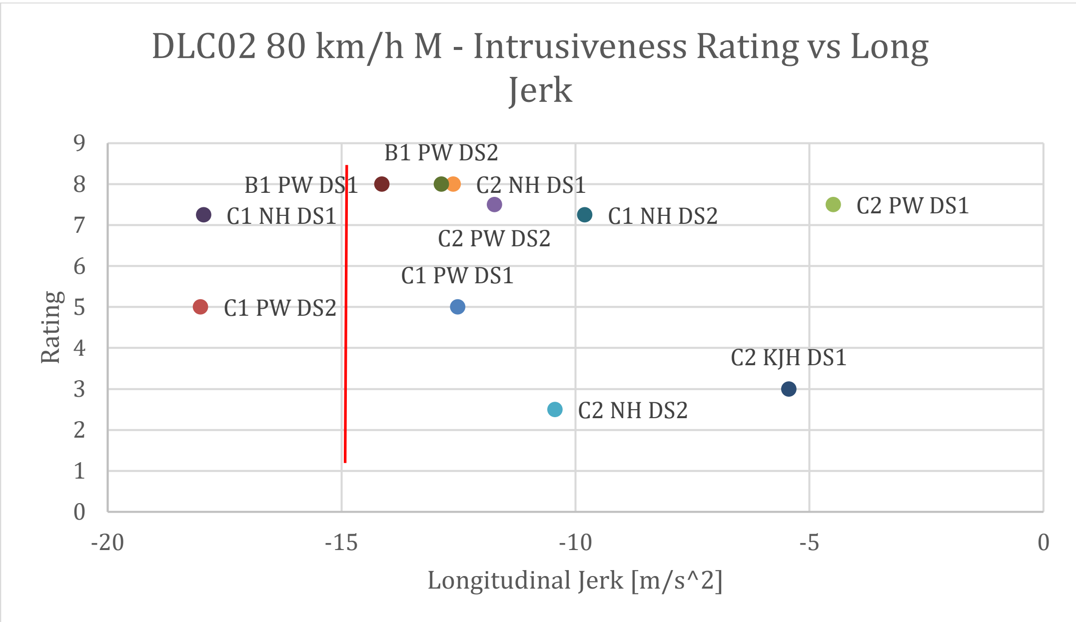
DLC07 120 km/h S - Balance Rating vs Yaw Rate 3
Rating
Yaw Rate [deg/s]
C2 NH DS2
C1 PW DS2
C2 NH DS1
C1 NH DS1
C2 PW DS1
C2 KJH DS1
B1 PW DS2
B1 PW DS1


DLC08 120 km/h M - Balance Rating vs Yaw Rate 3
Rating
8
7
6
5
4
3
2
C1 PW DS1
C2 PW DS1
C1 NH DS1
C2 NH DS1
C2 NH DS2
C2 KJH DS1
B1 PW DS1
B1 PW DS2
-35
-30
-25
-20
-15
-10
-5
Yaw Rate [deg/s]

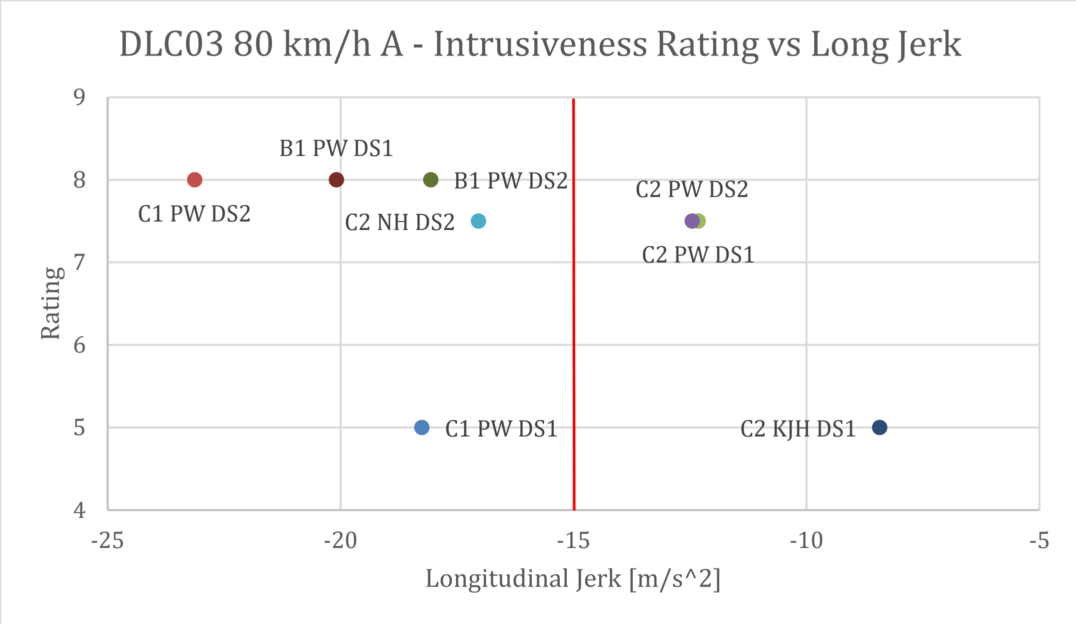

DLC09 120 km/h A - Balance Rating vs Yaw Rate 3
Rating
8
7
6
5
4
3
2
1
0
C2 PW DS1
C2 PW DS2
C2 KJH DS1
B1 PW DS1
B1 PW DS2
-35
-30
-25
-20
-15
-10
-5
0
Yaw Rate [deg/s]



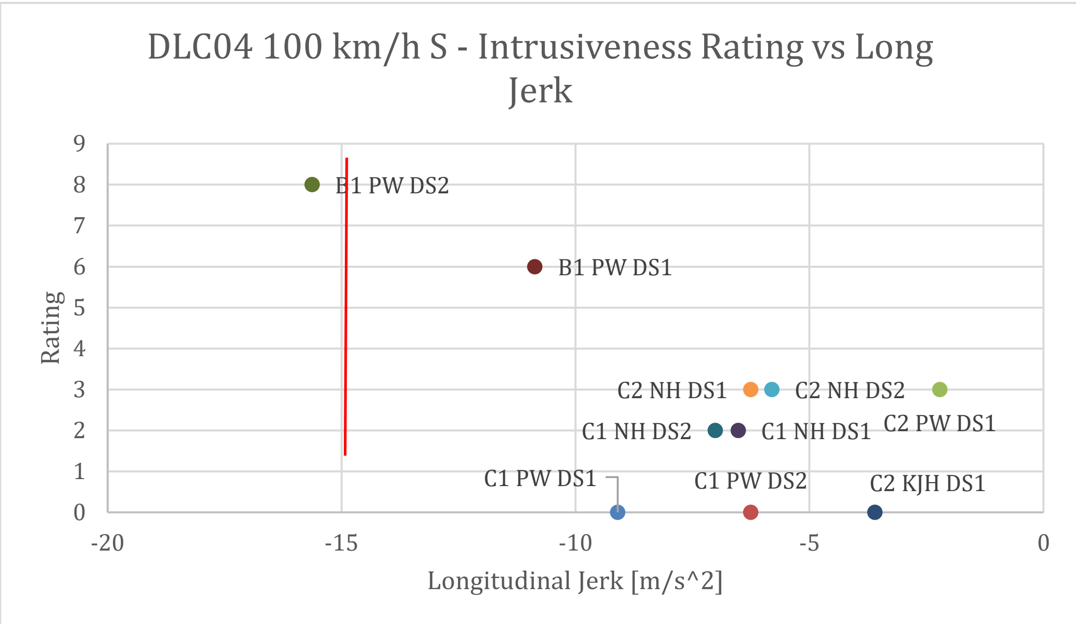
DLC01 80 km/h S - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
0
1
2
3
4
5
6
7
8
9
-25
-20
-15
-10
-5
0
B1 PW DS2
B1 PW DS1
C2 PW DS1
C1 PW DS2
C2 PW DS2
C2 NH DS2
C1 PW DS1
C2 NH DS1

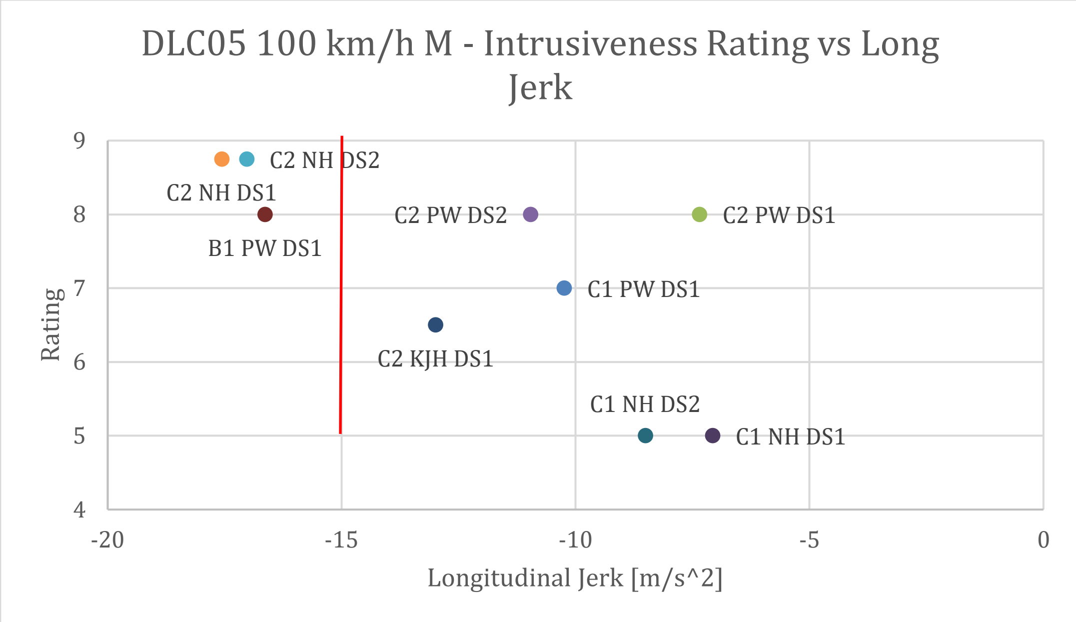
DLC02 80 km/h M - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
0
1
2
3
4
5
6
7
8
9
-20
-15
-10
-5
0
B1 PW DS2
B1 PW DS1
C2 NH DS1
C1 NH DS1
C1 NH DS2
C2 PW DS1
C2 PW DS2
C1 PW DS1
C1 PW DS2
C2 KJH DS1
C2 NH DS2

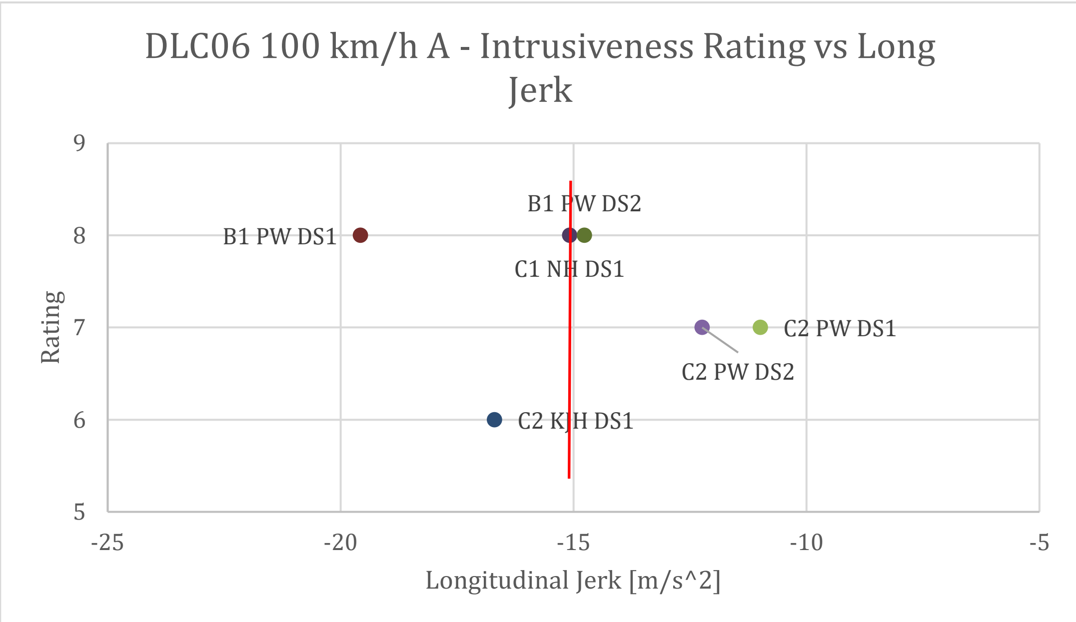


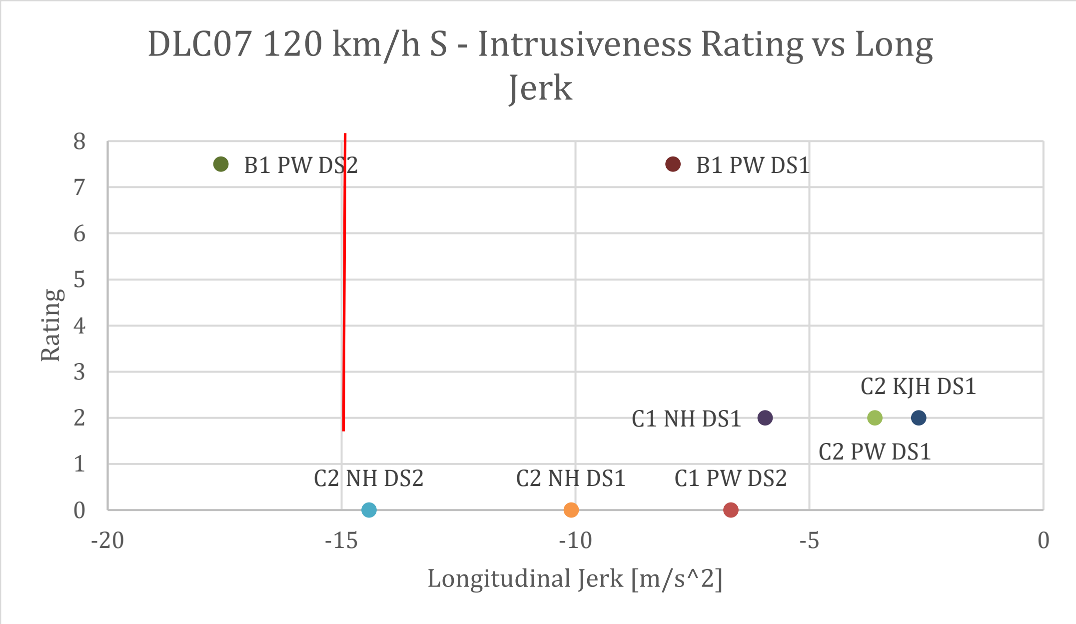
DLC03 80 km/h A - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
9
8
7
6
5
4
-25
-20
-15
-10
-5
B1 PW DS1
B1 PW DS2
C1 PW DS2
C2 NH DS2
C2 PW DS2
C2 PW DS1
C1 PW DS1
C2 KJH DS1

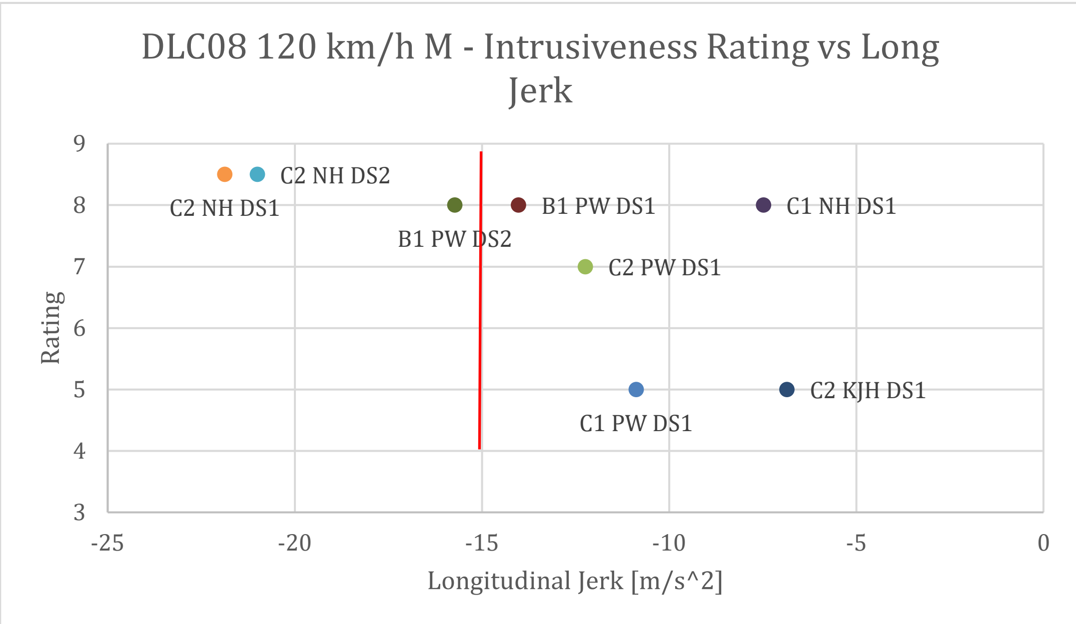



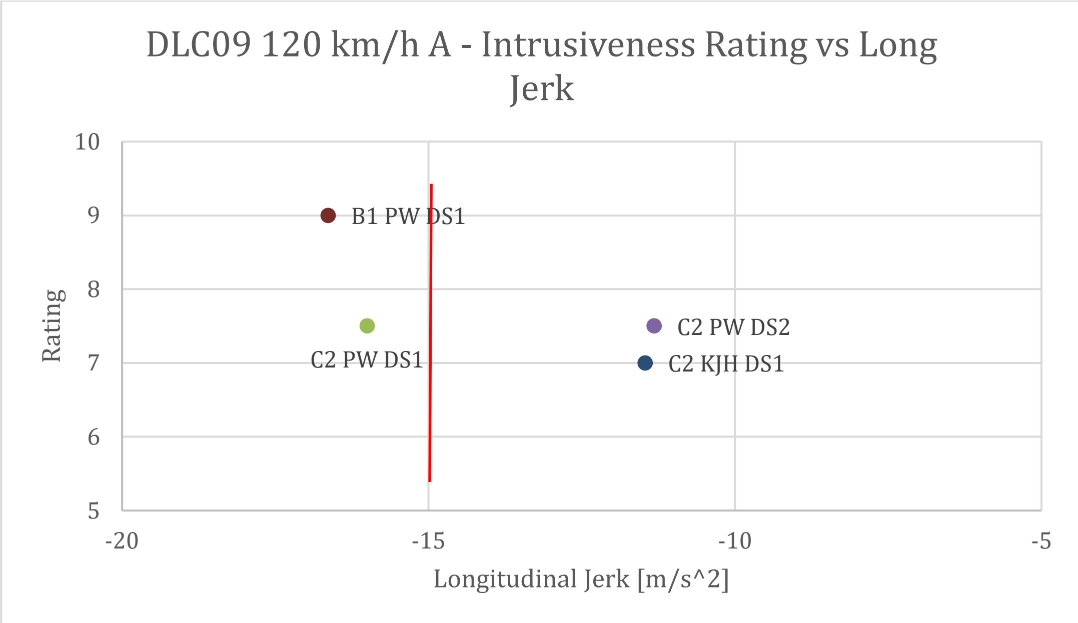
DLC04 100 km/h S - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
9
8
7
6
5
4
3
2
1
0
-20
-15
-10
-5
0
B1 PW DS2
B1 PW DS1
C2 NH DS1
C2 NH DS2
C1 NH DS2
C1 NH DS1
C2 PW DS1
C1 PW DS1
C1 PW DS2
C2 KJH DS1

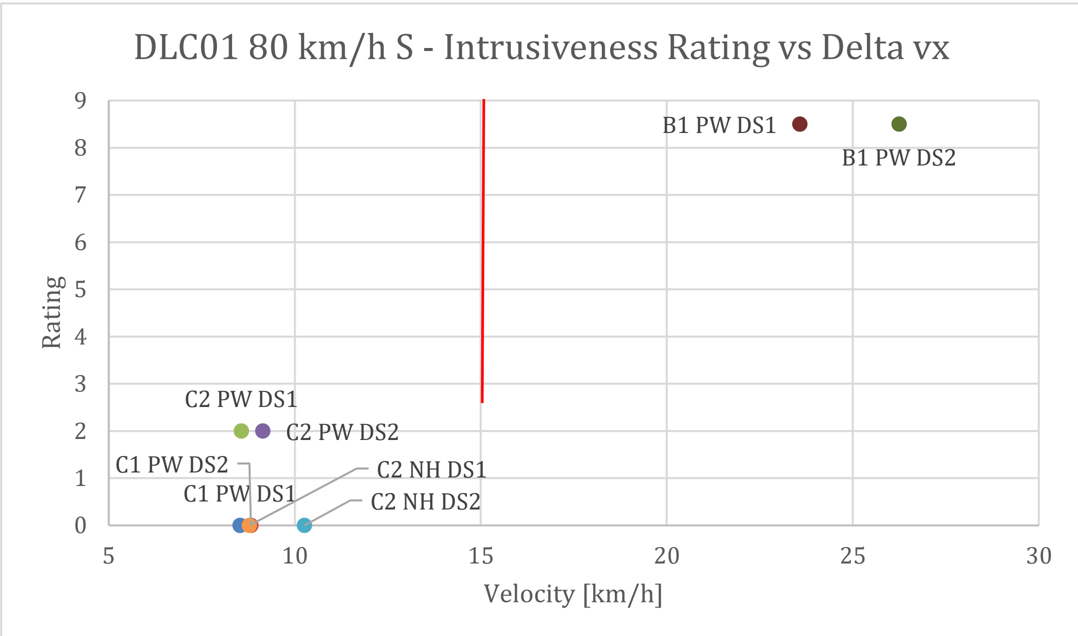

DLC05 100 km/h M - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
C2 NH DS2
C2 NH DS1
B1 PW DS1
C2 PW DS2
C2 PW DS1
C1 PW DS1
C2 KJH DS1
C1 NH DS2
C1 NH DS1
9
8
7
6
5
4
-20
-15
-10
-5
0

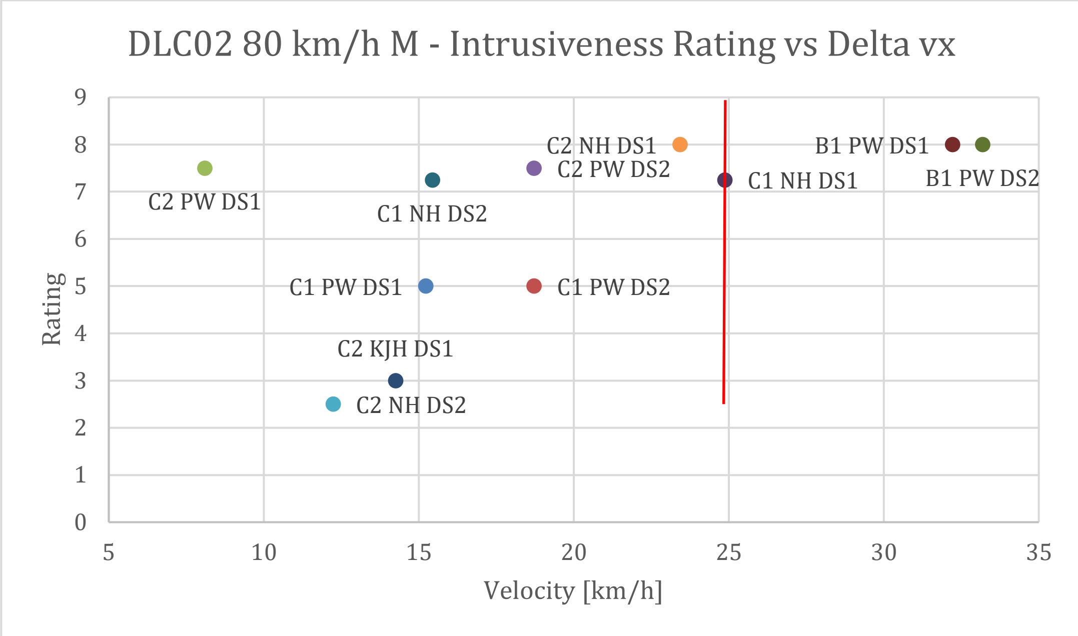

DLC06 100 km/h A - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
B1 PW DS2
B1 PW DS1
C1 NH DS1
C2 PW DS1
C2 PW DS2
C2 KJH DS1
9
8
7
6
5
-25
-20
-15
-10
-5

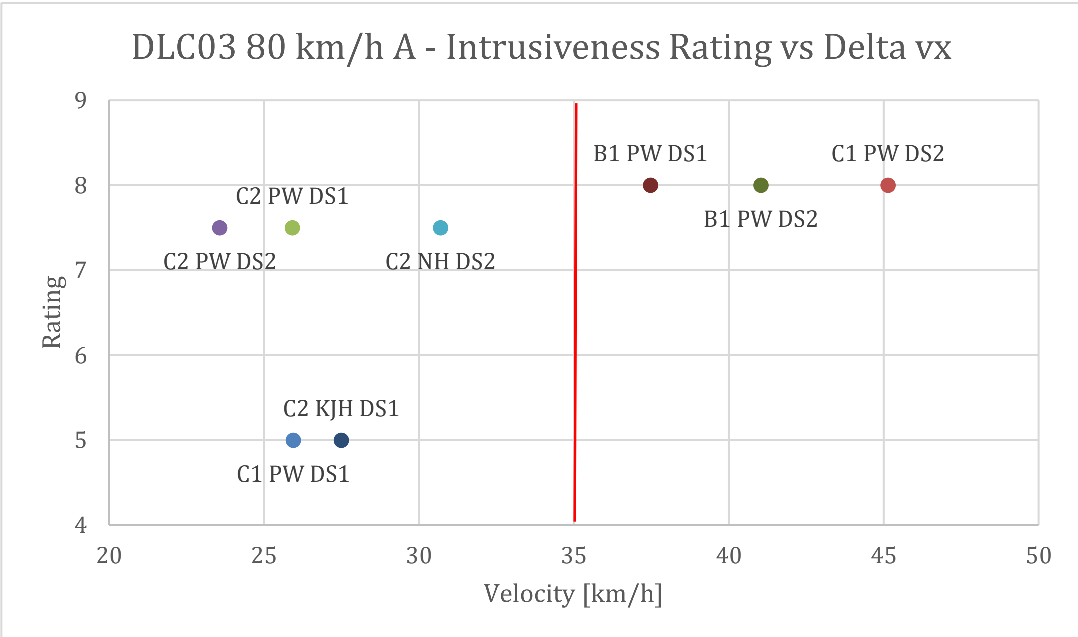

DLC07 120 km/h S - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
B1 PW DS2
B1 PW DS1
C2 KJH DS1
C1 NH DS1
C2 PW DS1
C2 NH DS2
C2 NH DS1
C1 PW DS2
8
7
6
5
4
3
2
1
0
-20
-15
-10
-5
0

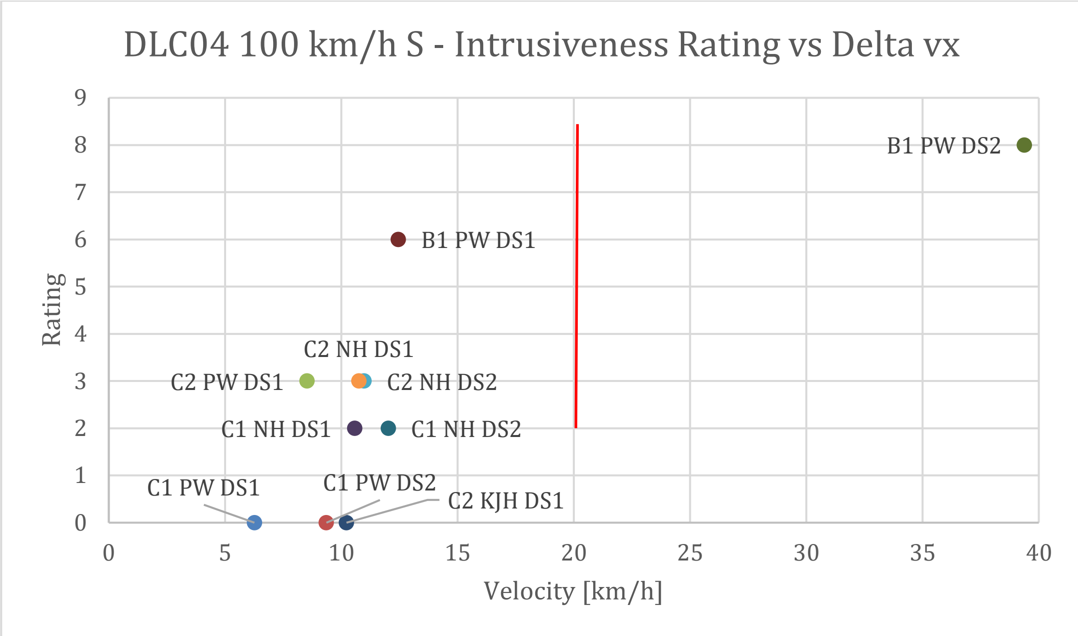

DLC08 120 km/h M - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
C2 NH DS2
C2 NH DS1
B1 PW DS1
C1 NH DS1
B1 PW DS2
C2 PW DS1
C2 KJH DS1
C1 PW DS1
9
8
7
6
5
4
3
-25
-20
-15
-10
-5
0

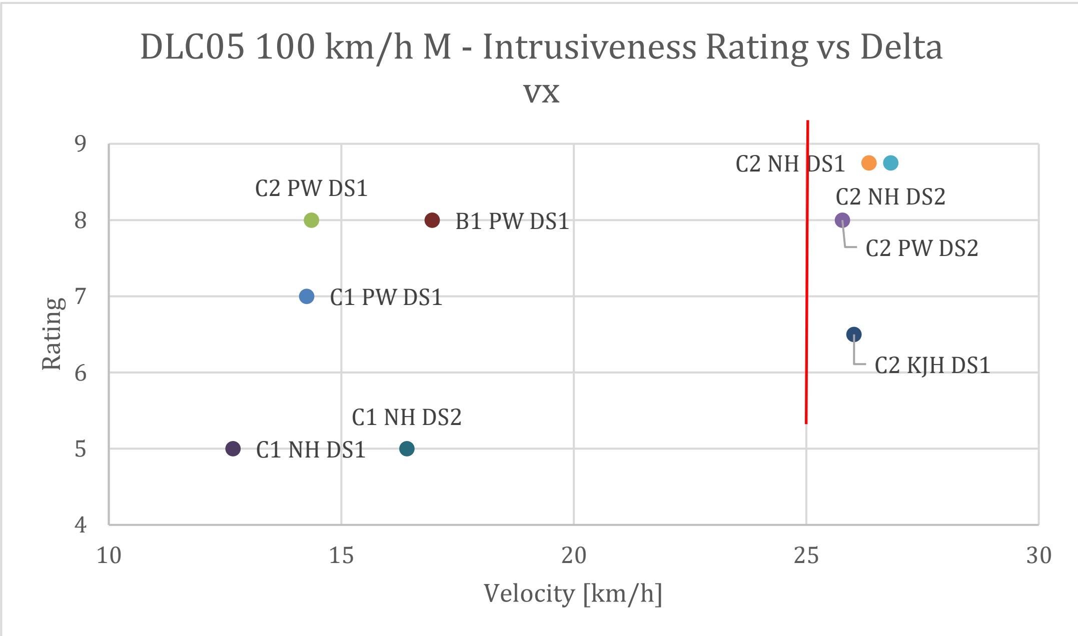

DLC09 120 km/h A - Intrusiveness Rating vs Long Jerk
Rating
Longitudinal Jerk [m/s^2]
10
9
8
7
6
5
-20
-15
-10
-5
B1 PW DS1
C2 PW DS1
C2 PW DS2
C2 KJH DS1

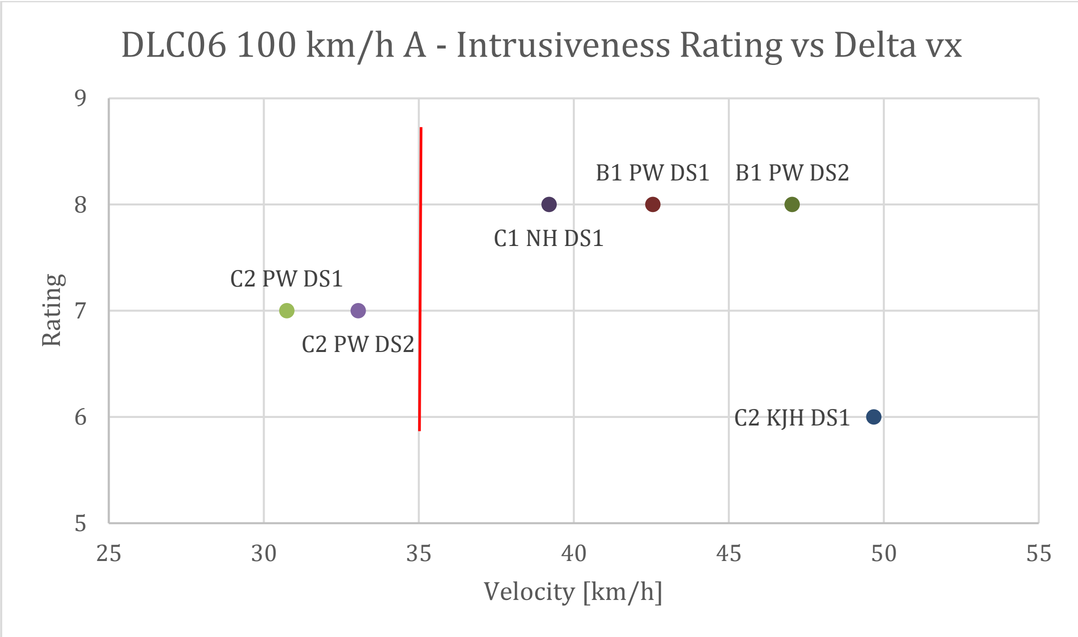

DLC01 80 km/h S - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
9
8
7
6
5
4
3
2
1
0
5
10
15
20
25
30
B1 PW DS1
B1 PW DS2
C2 PW DS1
C2 PW DS2
C1 PW DS2
C1 PW DS1
C2 NH DS1
C2 NH DS2

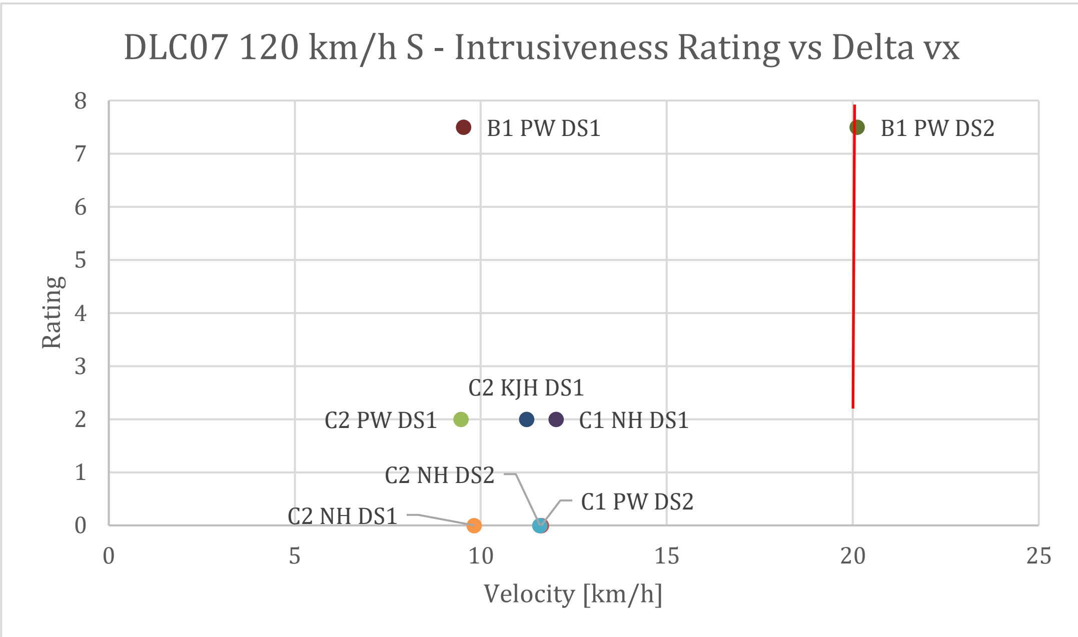

DLC02 80 km/h M - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
0
1
2
3
4
5
6
7
8
9
5
10
15
20
25
30
35
C2 NH DS1
C2 PW DS2
B1 PW DS1
B1 PW DS2
C1 NH DS1
C2 PW DS1
C1 NH DS2
C1 PW DS1
C1 PW DS2
C2 KJH DS1
C2 NH DS2

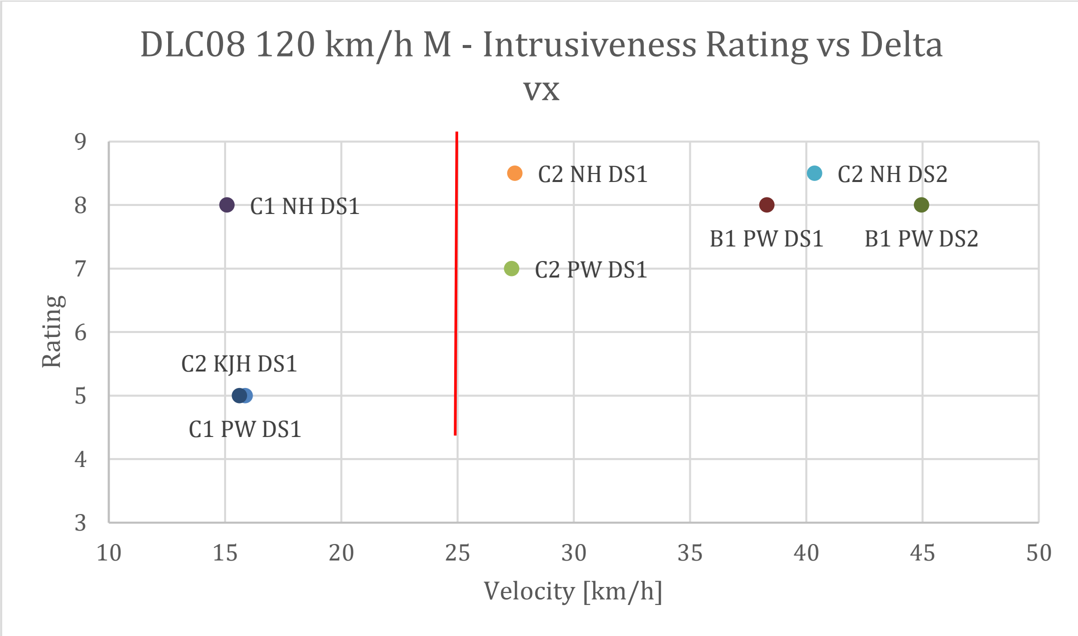

DLC03 80 km/h A - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
4
5
6
7
8
9
20
25
30
35
40
45
50
B1 PW DS1
C1 PW DS2
B1 PW DS2
C2 PW DS1
C2 PW DS2
C2 NH DS2
C2 KJH DS1
C1 PW DS1

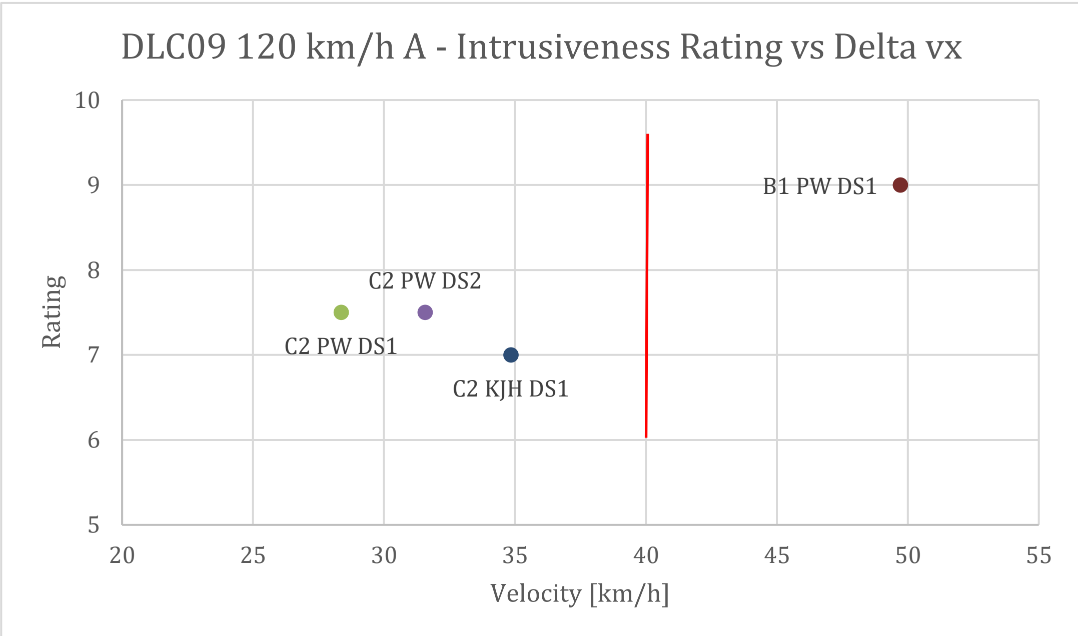

DLC04 100 km/h S - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
B1 PW DS2
B1 PW DS1
C2 NH DS1
C2 PW DS1
C2 NH DS2
C1 NH DS1
C1 NH DS2
C1 PW DS1
C1 PW DS2
C2 KJH DS1
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40


DLC05 100 km/h M - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
C2 NH DS1
C2 NH DS2
C2 PW DS2
C2 PW DS1
B1 PW DS1
C1 PW DS1
C2 KJH DS1
C1 NH DS2
C1 NH DS1
4
5
6
7
8
9
10
15
20
25
30


DLC06 100 km/h A - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
9
8
7
6
5
25
30
35
40
45
50
55
B1 PW DS1
B1 PW DS2
C1 NH DS1
C2 PW DS1
C2 PW DS2
C2 KJH DS1


DLC07 120 km/h S - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
8
7
6
5
4
3
2
1
0
0
5
10
15
20
25
B1 PW DS1
B1 PW DS2
C2 KJH DS1
C2 PW DS1
C1 NH DS1
C2 NH DS2
C1 PW DS2
C2 NH DS1


DLC08 120 km/h M - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
C1 NH DS1
C2 NH DS1
C2 NH DS2
B1 PW DS1
B1 PW DS2
C2 PW DS1
C2 KJH DS1
C1 PW DS1
9
8
7
6
5
4
3
10
15
20
25
30
35
40
45
50


DLC09 120 km/h A - Intrusiveness Rating vs Delta vx
Rating
Velocity [km/h]
B1 PW DS1
C2 PW DS2
C2 PW DS1
C2 KJH DS1
10
9
8
7
6
5
20
25
30
35
40
45
50
55

# E SLC Subjective Assessment

| | C1 PW DS1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | PW_20190409_005A | 0 | 10 | 5 | 10 | 5 | 5 | 9 | No intervention |
| **SLC 80 km/h M** | | | | | | | | | |
| **SLC 80 km/h A** | PW_20190409_007A | 8,5 | 4 | 4,5 | 2,75 | 6 | 5 | 6,5 | Intrusive |
| **SLC 100 km/h S** | PW_20190409_008A | 0 | 10 | 5 | 10 | 5 | 5 | 9 | No intervention |
| **SLC 100 km/h M** | PW_20190409_009A | 7 | 4 | 3,5 | 2 | 7 | 7 | 7,5 | OK |
| **SLC 100 km/h A** | PW_20190409_010 | 3,5 | 0 | 5 | 10 | 10 | 10 | 4 | Had to abort, too loose |
| **SLC 120 km/h S** | PW_20190409_012A | 0 | 10 | 5 | 10 | 5 | 5 | 9 | No intervention |
| **SLC 120 km/h M** | PW_20190409_013A | 5 | 2,5 | 4,75 | 2,5 | 8 | 7,5 | 7 | Little intrusive |
| **SLC 120 km/h A** | | | | | | | | | |
| **SLC 150 km/h S** | | | | | | | | | |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C1 PW DS2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | PW_20190409_005B | 0 | 10 | 5 | 10 | 5 | 5 | 9 | No intervention |
| **SLC 80 km/h M** | | | | | | | | | |
| **SLC 80 km/h A** | PW_20190409_007B | 7 | 4 | 4,5 | 2,75 | 6 | 5 | 6,5 | |
| **SLC 100 km/h S** | PW_20190409_008B | 0 | 10 | 5 | 10 | 5 | 5 | 9 | No intervention |
| **SLC 100 km/h M** | | | | | | | | | |
| **SLC 100 km/h A** | PW_20190409_009B | 7 | 4 | 3,5 | 2 | 7 | 7 | 6 | Too loose |
| **SLC 120 km/h S** | PW_20190409_012B | 0 | 10 | 5 | 10 | 5 | 5 | 9 | No intervention |
| **SLC 120 km/h M** | | | | | | | | | |
| **SLC 120 km/h A** | | | | | | | | | |
| **SLC 150 km/h S** | | | | | | | | | |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C1 NH DS1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | PW_20190409_021A | 5 | 10 | 5 | 10 | 5 | 8 | 8 | Very soft chassis |
| **SLC 80 km/h M** | PW_20190409_022A | 4 | 3 | 5 | 5 | 6,5 | 8 | 6,5 | Bit loose |
| **SLC 80 km/h A** | | | | | | | | | |
| **SLC 100 km/h S** | PW_20190409_023A | 0 | 10 | 5 | 9 | 5 | 8 | 7 | Soft chassis |
| **SLC 100 km/h M** | PW_20190409_027A | 9,5 | 2,75 | 3 | 3,5 | 6,75 | 7,75 | 4 | Loose, harsh, mistimed interv. |
| **SLC 100 km/h A** | | | | | | | | | |
| **SLC 120 km/h S** | PW_20190409_029A | 5 | 7 | 4,75 | 5 | 6 | 8,5 | 7 | OK |
| **SLC 120 km/h M** | | | | | | | | | |
| **SLC 120 km/h A** | | | | | | | | | |
| **SLC 150 km/h S** | | | | | | | | | |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C1 NH DS2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | | 0 | 10 | 5 | 10 | 5 | 7 | 9 | Good |
| **SLC 80 km/h M** | PW_20190409_022B | 4 | 3 | 5 | 5 | 6,5 | 8 | 6,5 | OK |
| **SLC 80 km/h A** | | | | | | | | | |
| **SLC 100 km/h S** | PW_20190409_023B | 0 | 10 | 5 | 9 | 5 | 8 | 7 | Soft chassis |
| **SLC 100 km/h M** | PW_20190409_027B | 9,5 | 2,75 | 3 | 3,5 | 6,75 | 7,75 | 4 | Loose, harsh, mistimed interv. |
| **SLC 100 km/h A** | | | | | | | | | |
| **SLC 120 km/h S** | PW_20190409_028B | 0 | 10 | 5 | 10 | 5 | 8 | 6,5 | OK |
| **SLC 120 km/h M** | | 5 | 7 | 4,75 | 5 | 6 | 8,5 | 7 | OK |
| **SLC 120 km/h A** | | | | | | | | | |
| **SLC 150 km/h S** | | | | | | | | | |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C2 PW DS1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | AN_20190410_020A | 2 | 10 | 5 | 9 | 5 | 6 | 8 | Small interv. |
| **SLC 80 km/h M** | AN_20190410_021A | 7 | 9 | 3 | 5 | 4,5 | 6,5 | 7 | Intrusive |
| **SLC 80 km/h A** | AN_20190410_022A | 6 | 8,5 | 2,5 | 3 | 4,5 | 6,5 | 7,5 | Intrus., slow to release, safe |
| **SLC 100 km/h S** | AN_20190410_023A | 0 | 10 | 5 | 10 | 5 | 6,5 | 8,5 | Good |
| **SLC 100 km/h M** | AN_20190410_024A | 6,5 | 8 | 2,5 | 2,5 | 5 | 6,5 | 7 | Bit hard interv., slow to release |
| **SLC 100 km/h A** | AN_20190410_025A | 9,25 | 4,5 | 1,75 | 1,25 | 6,25 | 6,5 | 7 | Harsh and late interv. |
| **SLC 120 km/h S** | AN_20190410_026A | 5 | 7,5 | 5 | 8,75 | 5 | 6 | 7 | Bit intrusive |
| **SLC 120 km/h M** | AN_20190410_027A | 5,25 | 9 | 5 | 2,5 | 5 | 6,5 | 7,75 | Hard but fast interv. |
| **SLC 120 km/h A** | AN_20190410_028A | 7,5 | 4 | 2,5 | 2,5 | 7 | 6,5 | 6,75 | Loose and high roll |
| **SLC 150 km/h S** | AN_20190410_029A | | | | | | | 7 | Loose initially then harsh |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C2 PW DS2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | AN_20190410_020B | 2 | 10 | 5 | 9 | 5 | 6 | 8 | Small interv. |
| **SLC 80 km/h M** | AN_20190410_021B | 7 | 9 | 3 | 5 | 4,5 | 6,5 | 7 | Intrusive |
| **SLC 80 km/h A** | AN_20190410_022B | 6 | 8,5 | 2,5 | 3 | 4,5 | 6,5 | 7,5 | Intrus., slow to release, safe |
| **SLC 100 km/h S** | AN_20190410_023B | 0 | 10 | 5 | 10 | 5 | 6,5 | 8,5 | Good |
| **SLC 100 km/h M** | AN_20190410_024B | 6,5 | 8 | 2,5 | 2,5 | 5 | 6,5 | 7 | Bit hard interv., slow to release |
| **SLC 100 km/h A** | AN_20190410_025B | 9,25 | 4,5 | 1,75 | 1,25 | 6,25 | 6,5 | 7 | Harsh and late interv. |
| **SLC 120 km/h S** | AN_20190410_026B | 5 | 7,5 | 5 | 8,75 | 5 | 6 | 7 | Bit intrusive |
| **SLC 120 km/h M** | AN_20190410_027B | 5,25 | 9 | 5 | 2,5 | 5 | 6,5 | 7,75 | Hard but fast interv. |
| **SLC 120 km/h A** | AN_20190410_028B | 7,5 | 4 | 2,5 | 2,5 | 7 | 6,5 | 6,75 | Loose and high roll |
| **SLC 150 km/h S** | AN_20190410_029B | | | | | | | 7 | Loose initially then harsh |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C2 NH DS1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | AN_20190410_002A | 2 | 10 | 5 | 10 | 5 | 6 | 8 | Small intervention but good |
| **SLC 80 km/h M** | AN_20190410_003A | 7,5 | 8 | 7,25 | 5 | 5 | 6 | 7,5 | Better stability than Toyota |
| **SLC 80 km/h A** | | | | | | | | | |
| **SLC 100 km/h S** | AN_20190410_005A | 5 | 8 | 5 | 10 | 3,5 | 6 | 7,5 | Slight US, feels like soft side wall tires |
| **SLC 100 km/h M** | | | | | | | | | |
| **SLC 100 km/h A** | AN_20190410_006A | 6,5 | 8 | 2,75 | 4,25 | 5 | 6 | 7,5 | Long interv., brake on inside wheel, safe |
| **SLC 120 km/h S** | AN_20190410_007A | 0 | 10 | 5 | 8,75 | 5 | 6 | 7,5 | Good, soft chassis |
| **SLC 120 km/h M** | AN_20190410_009A | 7 | 10 | 3 | 4 | 4 | 7,5 | 7,5 | Safe, intrusive, soft chassis |
| **SLC 120 km/h A** | | | | | | | | | |
| **SLC 150 km/h S** | AN_20190410_010 | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Good |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C2 NH DS2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | AN_20190410_001B | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Good and stable |
| **SLC 80 km/h M** | AN_20190410_003B | 7,5 | 8 | 7,25 | 5 | 5 | 6 | 7,5 | Better stability than Toyota |
| **SLC 80 km/h A** | | | | | | | | | |
| **SLC 100 km/h S** | AN_20190410_004B | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Stable |
| **SLC 100 km/h M** | AN_20190410_006B | 6,5 | 8 | 2,75 | 4,25 | 5 | 7,5 | 7,5 | Long interv., brake on inside wheel, safe |
| **SLC 100 km/h A** | | | | | | | | | |
| **SLC 120 km/h S** | AN_20190410_007B | 0 | 10 | 5 | 8,75 | 5 | 6 | 7,5 | Good, soft chassis |
| **SLC 120 km/h M** | AN_20190410_009B | 7 | 10 | 3 | 4 | 4 | 7,5 | 7,5 | Safe, intrusive, soft chassis |
| **SLC 120 km/h A** | | | | | | | | | |
| **SLC 150 km/h S** | | | | | | | | | |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C2 KJH DS1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | AN_20190410_030A | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Good |
| **SLC 80 km/h M** | AN_20190410_031A | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Good |
| **SLC 80 km/h A** | AN_20190410_032A | 8 | 4 | 5 | 2 | 6 | 6 | 7 | Harsh |
| **SLC 100 km/h S** | AN_20190410_033A | 0 | 8 | 5 | 10 | 5 | 7 | 8 | Lots of roll, controllable |
| **SLC 100 km/h M** | AN_20190410_034A | 8 | 8 | 3,5 | 2 | 5 | 7 | 6,5 | Harsh, faulty interv. |
| **SLC 100 km/h A** | AN_20190410_035 | 8 | 8 | 5 | 1,75 | 5 | 6,75 | 7,5 | Harsh, safe |
| **SLC 120 km/h S** | AN_20190410_036 | 0 | 10 | 5 | 10 | 5 | 6 | 8 | Good |
| **SLC 120 km/h M** | AN_20190410_037 | 6,5 | 7,5 | 4 | 3 | 5 | 8 | 7,5 | Good, slow to release |
| **SLC 120 km/h A** | AN_20190410_038 | 4,75 | 7,25 | 4,75 | 8,75 | 6 | 6 | 6 | Turn-in OS, harsh |
| **SLC 150 km/h S** | | | | | | | | | |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

| | C2 KJH DS2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **Intrusiveness** | **Stability** | **Pressure Release** | **Noise** | **Balance** | **Ride** | **VER** | **Comment** |
| **SLC 80 km/h S** | AN_20190410_030B | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Good |
| **SLC 80 km/h M** | AN_20190410_031B | 0 | 10 | 5 | 10 | 5 | 6 | 9 | Good |
| **SLC 80 km/h A** | AN_20190410_032B | 8 | 4 | 5 | 2 | 6 | 6 | 7 | Harsh |
| **SLC 100 km/h S** | AN_20190410_033B | 0 | 8 | 5 | 10 | 5 | 7 | 8 | Lots of roll, controllable |
| **SLC 100 km/h M** | AN_20190410_034B | 8 | 8 | 3,5 | 2 | 5 | 7 | 6,5 | Harsh, faulty interv. |
| **SLC 100 km/h A** | | | | | | | | | |
| **SLC 120 km/h S** | | | | | | | | | |
| **SLC 120 km/h M** | | | | | | | | | |
| **SLC 120 km/h A** | | | | | | | | | |
| **SLC 150 km/h S** | | | | | | | | | |
| **SLC 150 km/h M** | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | |

B1 PW DS1

| Test | Trace | Intrusiveness | Stability | Pressure Release | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190411_005A | 8,5 | 7,5 | 2 | 2 | 4 | 6 | 6 | Intrusive, US |
| SLC 80 km/h M | PW_20190411_006A | 8 | 7,5 | 2 | 2 | 4 | 6 | 5,5 | Intrusive, US |
| SLC 80 km/h A | PW_20190411_007A | 8 | 7,5 | 2 | 2 | 4 | 6 | 6 | Intrusive, US |
| SLC 100 km/h S | PW_20190411_008A | 5 | 7,5 | 3 | 2,5 | 4 | 6 | 7 | OK |
| SLC 100 km/h M | PW_20190411_009A | 8,5 | 3 | 2 | 2 | 2 | 6 | 5 | Intrusive, US |
| SLC 100 km/h A | PW_20190411_010A | 7,5 | 5 | 2,75 | 2,75 | 3,25 | 6 | 6 | Intrusive, US |
| SLC 120 km/h S | PW_20190411_011A | 6,5 | 7,5 | 2,5 | 2,5 | 4 | 6 | 6,5 | Intrusive, US |
| SLC 120 km/h M | PW_20190411_012A | 7,75 | 4 | 2,5 | 2,5 | 2,5 | 6 | 7 | Intrusive, US |
| SLC 120 km/h A | PW_20190411_013A | 7,5 | 4,5 | 3 | 3 | 3,5 | 6 | | |
| SLC 150 km/h S | PW_20190411_015 | 6 | 8,5 | 4 | 4 | 4,5 | 6 | 7 | Bit harsh |
| SLC 150 km/h M | | 6 | 5 | 4 | 4 | 5 | 7 | 6 | Loose |
| SLC 150 km/h A | PW_20190411_020 | 6 | 2,5 | 4 | 7,25 | 8 | 7,5 | 5,5 | Woobly |

B1 PW DS2

| Test | Trace | Intrusiveness | Stability | Pressure Release | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190411_005B | 8,5 | 7,5 | 2 | 2 | 4 | 6 | 6 | Intrusive, US |
| SLC 80 km/h M | PW_20190411_006B | 8 | 7,5 | 2 | 2 | 4 | 6 | 5,5 | Intrusive, US |
| SLC 80 km/h A | PW_20190411_007B | 8 | 7,5 | 2 | 2 | 4 | 6 | 6 | Intrusive, US |
| SLC 100 km/h S | PW_20190411_008B | 5 | 7,5 | 3 | 2,5 | 4 | 6 | 6,5 | OK |
| SLC 100 km/h M | PW_20190411_009B | 8,5 | 3 | 2 | 2 | 2 | 6 | 5 | Intrusive, US |
| SLC 100 km/h A | PW_20190411_010B | 7,5 | 5 | 2,75 | 2,75 | 3,25 | 6 | 6 | Intrusive, US |
| SLC 120 km/h S | PW_20190411_011B | 6,5 | 7,5 | 2,5 | 2,5 | 4 | 6 | 6,5 | Intrusive, US |
| SLC 120 km/h M | PW_20190411_012B | 7,75 | 4 | 2,5 | 2,5 | 2,5 | 6 | 6,5 | Intrusive, US, wide |
| SLC 120 km/h A | PW_20190411_014 | 7,5 | 4,5 | 3 | 3 | 3,5 | 6 | 7 | Intrusive, US |
| SLC 150 km/h S | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | |

B1 PW DS3

| Test | Trace | Intrusiv | Stability | Pressur | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190416_002A | 8,5 | 7,5 | 2 | 2 | 4 | 6 | 8 | Intrusive |
| SLC 80 km/h M | PW_20190416_002A_4 | 7,5 | 8 | 2,5 | 2,5 | 4 | 6 | 6 | Intrusive |
| SLC 80 km/h A | PW_20190416_003A | 7,5 | 8 | 2,5 | 2,5 | 4 | 6 | 6,5 | Intrusive |
| SLC 100 km/h S | PW_20190416_005A | 8,5 | 7,5 | 2,5 | 2,5 | 4 | 6 | 6 | Intrusive |
| SLC 100 km/h M | PW_20190416_005A_7 | 8,5 | 4,5 | 2 | 2 | 2 | 7,5 | 5,5 | Intrusive, US |
| SLC 100 km/h A | PW_20190416_006A | 8 | 5 | 2,75 | 2,75 | 2 | 7,25 | 6 | Intrusive, US |
| SLC 120 km/h S | PW_20190416_008A | 7,25 | 4,75 | 2,5 | 2,5 | 4 | 7 | 6 | Intrusive, US |
| SLC 120 km/h M | PW_20190416_009A | 8,5 | 4 | 2,5 | 2,5 | 3,5 | 7,5 | 5,5 | Intrusive, US |
| SLC 120 km/h A | | | | | | | | | |
| SLC 150 km/h S | PW_20190416_011 | 5,5 | 8,5 | 4,75 | 4 | 5 | 6 | 7,5 | Intrusive, OK for speed |
| SLC 150 km/h M | PW_20190416_011_14 | 5,25 | 8 | 4 | 4 | 5 | 7 | 7 | OK |
| SLC 150 km/h A | PW_20190416_012 | 6 | 2,5 | 4 | 7,25 | 8 | 7,5 | 6,75 | Loose initially, wide |

B1 PW DS4

| Test | Trace | Intrusiveness | Stability | Pressure Release | Noise | Balance | Ride | VER | Comment |
|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190416_002B | 8,5 | 7,5 | 2 | 2 | 4 | 6 | 8 | Intrusive |
| SLC 80 km/h M | PW_20190416_002B_4 | 7,5 | 8 | 2,5 | 2,5 | 4 | 6 | 6 | Intrusive |
| SLC 80 km/h A | PW_20190416_003B | 7,5 | 8 | 2,5 | 2,5 | 4 | 6 | 6,5 | Intrusive |
| SLC 100 km/h S | PW_20190416_005B | 8,5 | 7,5 | 2,5 | 2,5 | 4 | 6 | 6 | Intrusive |
| SLC 100 km/h M | | 8,5 | 4,5 | 2 | 2 | 2 | 7,5 | 5,5 | Intrusive, US |
| SLC 100 km/h A | PW_20190416_006B | 8 | 5 | 2,75 | 2,75 | 2 | 7,25 | 6 | Intrusive, US |
| SLC 120 km/h S | PW_20190416_008B | 7,25 | 4,75 | 2,5 | 2,5 | 4 | 7 | 6 | Intrusive, US |
| SLC 120 km/h M | PW_20190416_008B_10 | 8 | 4 | 2,5 | 2,5 | 4,5 | 7,5 | 6 | Intrusive, US |
| SLC 120 km/h A | PW_20190416_009B | 8,5 | 4 | 2,5 | 2,5 | 3,5 | 7,5 | 5,5 | Intrusive, US |
| SLC 150 km/h S | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | |

# F SLC Test Results

C1 PW DS1

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190409_005A | 63,00 | 1,82 | -1,84 | -18,96 | 14,41 | -65,60 | 88,80 | -1,28 | -4,36 | 3,35 | 9 |
| SLC 80 km/h M | | | | | | | | | | | | |
| SLC 80 km/h A | PW_20190409_007A | 203,89 | 9,05 | -9,71 | -43,85 | 63,69 | -272,20 | 406,80 | -7,03 | -19,25 | 9,32 | 6,5 |
| SLC 100 km/h S | PW_20190409_008A | 52,43 | 1,99 | -2,17 | -16,00 | 17,15 | -78,80 | 95,80 | -1,29 | -8,18 | 4,03 | 9 |
| SLC 100 km/h M | PW_20190409_009A | 108,36 | 5,26 | -5,35 | -31,06 | 41,70 | -210,20 | 257,80 | -4,31 | -14,72 | 10,62 | 7,5 |
| SLC 100 km/h A | PW_20190409_010 | 160,01 | 7,77 | -28,22 | -38,28 | 67,37 | -225,60 | 297,60 | -5,42 | -13,92 | 14,04 | 4 |
| SLC 120 km/h S | PW_20190409_012A | 48,30 | 2,45 | -2,07 | -17,21 | 14,39 | -89,80 | 72,60 | -2,41 | -4,88 | 7,34 | 9 |
| SLC 120 km/h M | PW_20190409_013A | 78,06 | 3,54 | -5,41 | -23,30 | 32,03 | -114,00 | 89,60 | -4,35 | -8,24 | 14,11 | 7 |
| SLC 120 km/h A | | | | | | | | | | | | |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

C1 PW DS2

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190409_005B | 72,93 | 2,67 | -1,50 | -22,14 | 15,89 | -104,00 | 77,40 | -1,12 | -3,10 | 4,57 | 9 |
| SLC 80 km/h M | | | | | | | | | | | | |
| SLC 80 km/h A | PW_20190409_007B | 159,23 | 5,77 | -7,60 | -36,77 | 52,62 | -270,73 | 232,40 | -6,61 | -12,83 | 7,13 | 6,5 |
| SLC 100 km/h S | PW_20190409_008B | 67,74 | 3,22 | -2,62 | -22,69 | 20,37 | -110,40 | 135,40 | -2,07 | -10,24 | 5,47 | 9 |
| SLC 100 km/h M | | | | | | | | | | | | |
| SLC 100 km/h A | PW_20190409_009B | 151,75 | 8,23 | -10,41 | -37,40 | 59,40 | -264,53 | 480,80 | -7,86 | -49,54 | 11,45 | 6 |
| SLC 120 km/h S | PW_20190409_012B | 46,93 | 2,34 | -1,85 | -17,54 | 12,80 | -84,40 | 66,20 | -1,55 | -4,96 | 8,35 | 9 |
| SLC 120 km/h M | | | | | | | | | | | | |
| SLC 120 km/h A | | | | | | | | | | | | |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

C1 NH DS1

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190409_021A | 84,01 | 3,22 | -3,37 | -26,21 | 23,83 | -143,20 | 126,40 | -1,41 | -5,99 | 3,64 | 8 |
| SLC 80 km/h M | PW_20190409_022A | 107,86 | 4,59 | -5,24 | -33,80 | 37,55 | -202,40 | 231,60 | -2,09 | -6,29 | 6,48 | 6,5 |
| SLC 80 km/h A | | | | | | | | | | | | |
| SLC 100 km/h S | PW_20190409_023A | 53,26 | 1,76 | -2,41 | -16,90 | 16,85 | -112,47 | 72,00 | -1,83 | -8,88 | 3,85 | 7 |
| SLC 100 km/h M | PW_20190409_027A | 93,66 | 5,01 | -5,42 | -30,10 | 39,08 | -224,44 | 213,20 | -2,94 | -11,22 | 9,54 | 4,00 |
| SLC 100 km/h A | | | | | | | | | | | | |
| SLC 120 km/h S | PW_20190409_029A | 57,84 | 2,90 | -2,77 | -21,57 | 19,15 | -102,80 | 72,80 | -1,77 | -4,62 | 6,05 | 7 |
| SLC 120 km/h M | | | | | | | | | | | | |
| SLC 120 km/h A | | | | | | | | | | | | |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

C1 NH DS2

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | | | | | | | | | | | | 9 |
| SLC 80 km/h M | PW_20190409_022B | 115,72 | 5,36 | -4,83 | -34,17 | 38,40 | -278,33 | 228,00 | -4,82 | -15,92 | 10,30 | 6,5 |
| SLC 80 km/h A | | | | | | | | | | | | |
| SLC 100 km/h S | PW_20190409_023B | 64,58 | 2,54 | -2,58 | -18,98 | 19,01 | -82,40 | 40,00 | -1,49 | -4,77 | 6,80 | 7 |
| SLC 100 km/h M | PW_20190409_027B | 100,74 | 4,78 | -6,51 | -29,10 | 35,91 | -174,00 | 103,40 | -3,86 | -9,18 | 9,29 | 4 |
| SLC 100 km/h A | | | | | | | | | | | | |
| SLC 120 km/h S | PW_20190409_028B | 51,71 | 2,26 | -2,72 | -15,86 | 19,52 | -79,00 | 83,00 | -1,71 | -9,04 | 6,88 | 6,5 |
| SLC 120 km/h M | | | | | | | | | | | | |
| SLC 120 km/h A | | | | | | | | | | | | |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

C2 PW DS1

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | | | | | | | | | | | | 8 |
| SLC 80 km/h M | AN_20190410_021A | 107,32 | 4,98 | -3,80 | -32,19 | 30,49 | -146,40 | 191,60 | -2,19 | -9,11 | 3,46 | 7 |
| SLC 80 km/h A | AN_20190410_022A | 151,03 | 6,38 | -5,85 | -40,91 | 47,20 | -219,73 | 270,20 | -7,39 | -36,45 | 13,00 | 7,5 |
| SLC 100 km/h S | AN_20190410_023A | 63,19 | 2,91 | -2,19 | -19,97 | 16,85 | -87,60 | 125,80 | -1,64 | -4,04 | 4,46 | 8,5 |
| SLC 100 km/h M | AN_20190410_024A | 92,76 | 4,35 | -4,24 | -28,87 | 30,48 | -170,67 | 165,20 | -4,94 | -15,28 | 9,40 | 7 |
| SLC 100 km/h A | AN_20190410_025A | 166,77 | 7,79 | -11,44 | -41,88 | 66,32 | -187,27 | 432,53 | -5,72 | -25,59 | 12,35 | 7 |
| SLC 120 km/h S | AN_20190410_026A | 46,38 | 2,37 | -1,75 | -14,26 | 12,27 | -77,40 | 47,80 | -1,60 | -9,67 | 5,18 | 7 |
| SLC 120 km/h M | AN_20190410_027A | 85,57 | 4,83 | -4,57 | -28,99 | 34,01 | -197,87 | 160,00 | -5,97 | -14,53 | 10,12 | 7,75 |
| SLC 120 km/h A | AN_20190410_028A | 142,69 | 8,79 | -8,83 | -34,79 | 60,36 | -155,60 | 280,40 | -7,67 | -22,52 | 21,46 | 6,75 |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

C2 PW DS2

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | AN_20190410_020B | 76,56 | 2,90 | -2,65 | -22,12 | 18,97 | -93,20 | 123,60 | -1,16 | -6,61 | 3,92 | 8 |
| SLC 80 km/h M | AN_20190410_021B | 124,70 | 5,08 | -5,14 | -35,58 | 41,64 | -214,90 | 183,40 | -5,02 | -26,85 | 9,79 | 7 |
| SLC 80 km/h A | AN_20190410_022B | 167,02 | 6,65 | -6,73 | -38,45 | 54,79 | -171,40 | 313,20 | -7,78 | -32,07 | 17,53 | 7,5 |
| SLC 100 km/h S | AN_20190410_023B | 63,79 | 3,44 | -2,59 | -23,06 | 19,55 | -92,20 | 63,20 | -1,56 | -6,03 | 5,26 | 8,5 |
| SLC 100 km/h M | AN_20190410_024B | 96,41 | 5,44 | -4,52 | -30,84 | 34,26 | -153,80 | 234,60 | -7,12 | -18,06 | 14,26 | 7 |
| SLC 100 km/h A | AN_20190410_025B | 169,04 | 8,75 | -7,87 | -39,32 | 61,12 | -225,80 | 338,60 | -6,53 | -13,56 | 11,45 | 7 |
| SLC 120 km/h S | AN_20190410_026B | 58,54 | 3,00 | -2,81 | -18,53 | 19,69 | -96,80 | 116,00 | -2,42 | -7,84 | 6,59 | 7 |
| SLC 120 km/h M | AN_20190410_027B | 87,86 | 5,06 | -4,35 | -29,05 | 34,76 | -150,80 | 160,80 | -6,24 | -22,24 | 11,95 | 7,75 |
| SLC 120 km/h A | AN_20190410_028B | 139,59 | 8,67 | -10,49 | -35,63 | 62,02 | -206,20 | 208,40 | -5,65 | -16,24 | 13,00 | 6,75 |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

**C2 NH DS1**

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | AN_20190410_002A | 75,34 | 2,42 | -2,57 | -22,02 | 19,90 | -98,20 | 92,40 | -1,68 | -5,92 | 4,86 | 8 |
| SLC 80 km/h M | AN_20190410_003A | 102,24 | 4,49 | -4,26 | -30,97 | 30,68 | -169,20 | 192,20 | -1,93 | -5,60 | 6,34 | 7,5 |
| SLC 80 km/h A | | | | | | | | | | | | |
| SLC 100 km/h S | AN_20190410_005A | 72,94 | 3,22 | -2,96 | -23,03 | 22,32 | -112,00 | 103,40 | -1,60 | -8,81 | 5,08 | 8 |
| SLC 100 km/h M | | | | | | | | | | | | |
| SLC 100 km/h A | AN_20190410_006A | 124,71 | 7,53 | -6,47 | -36,06 | 49,98 | -196,40 | 229,40 | -7,24 | -17,16 | 20,23 | 7,5 |
| SLC 120 km/h S | AN_20190410_007A | 50,39 | 2,57 | -1,90 | -16,94 | 11,94 | -95,00 | 68,40 | -2,00 | -7,45 | 6,16 | 8,5 |
| SLC 120 km/h M | AN_20190410_009A | 95,13 | 5,30 | -6,06 | -28,58 | 43,29 | -179,00 | 148,00 | -7,50 | -19,40 | 15,91 | 7,5 |
| SLC 120 km/h A | | | | | | | | | | | | |
| SLC 150 km/h S | AN_20190410_010 | 34,09 | 1,71 | -1,95 | -10,45 | 11,46 | -63,67 | 34,00 | -1,52 | -12,63 | 3,71 | 9 |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

**C2 NH DS2**

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | AN_20190410_001B | 52,58 | 1,71 | -1,41 | -13,66 | 14,14 | -56,80 | 53,20 | -1,36 | -13,57 | 6,59 | 9 |
| SLC 80 km/h M | AN_20190410_003B | 129,36 | 6,49 | -6,07 | -36,44 | 47,24 | -180,00 | 240,60 | -5,68 | -12,08 | 15,37 | 7,5 |
| SLC 80 km/h A | | | | | | | | | | | | |
| SLC 100 km/h S | AN_20190410_004B | 57,48 | 2,20 | -2,50 | -16,40 | 17,50 | -60,00 | 58,00 | -1,52 | -6,45 | 6,95 | 9 |
| SLC 100 km/h M | AN_20190410_006B | 105,99 | 5,58 | -5,99 | -30,59 | 42,60 | -171,20 | 190,80 | -5,90 | | 15,08 | 7,5 |
| SLC 100 km/h A | | | | | | | | | | | | |
| SLC 120 km/h S | AN_20190410_007B | 51,34 | 2,49 | -2,50 | -15,38 | 16,98 | -61,40 | 75,00 | -1,55 | -3,32 | 6,91 | 8,5 |
| SLC 120 km/h M | AN_20190410_009B | 93,21 | 6,13 | -5,04 | -29,30 | 39,75 | -154,40 | 169,40 | -5,97 | -13,48 | 26,64 | 7,5 |
| SLC 120 km/h A | | | | | | | | | | | | |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

**C2 KJH DS1**

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | AN_20190410_030A | 35,51 | 0,98 | -0,87 | -9,07 | 9,03 | -63,20 | 48,00 | -1,05 | -6,16 | 3,02 | 9 |
| SLC 80 km/h M | AN_20190410_031A | 96,63 | 3,20 | -3,18 | -24,30 | 23,26 | -116,07 | 107,20 | -0,91 | -4,44 | 2,81 | 9 |
| SLC 80 km/h A | AN_20190410_032A | 174,36 | 6,64 | -9,60 | -39,81 | 59,31 | -167,00 | 355,60 | -7,31 | -25,51 | 8,21 | 7 |
| SLC 100 km/h S | AN_20190410_033A | 64,73 | 3,22 | -1,73 | -20,96 | 12,99 | -121,07 | 67,20 | -1,34 | -3,68 | 5,15 | 8 |
| SLC 100 km/h M | AN_20190410_034A | 95,12 | 4,28 | -5,51 | -26,67 | 37,83 | -117,60 | 210,20 | -3,51 | -12,68 | 6,19 | 6,5 |
| SLC 100 km/h A | AN_20190410_035 | 148,36 | 8,17 | -6,15 | -35,62 | 54,24 | -169,20 | 273,60 | -6,37 | -17,32 | 21,82 | 7,5 |
| SLC 120 km/h S | AN_20190410_036 | 50,30 | 2,19 | -1,98 | -14,67 | 13,32 | -59,40 | 46,60 | -1,46 | -5,07 | 5,98 | 8 |
| SLC 120 km/h M | AN_20190410_037 | 67,21 | 3,50 | -2,76 | -21,25 | 18,35 | -120,13 | 98,80 | -2,37 | -6,07 | 7,38 | 7,5 |
| SLC 120 km/h A | AN_20190410_038 | 140,64 | 8,68 | -6,42 | -32,23 | 54,08 | -189,13 | 266,80 | -7,56 | -20,13 | 21,74 | 6 |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

**C2 KJH DS2**

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | AN_20190410_030B | 54,41 | 1,43 | -1,26 | -14,02 | 13,08 | -49,60 | 46,60 | -0,72 | -3,00 | 2,52 | 9 |
| SLC 80 km/h M | AN_20190410_031B | 112,40 | 4,19 | -4,98 | -28,29 | 38,64 | -123,80 | 213,60 | -1,52 | -7,51 | 3,38 | 9 |
| SLC 80 km/h A | AN_20190410_032B | 207,97 | 9,66 | -5,57 | -41,22 | 58,47 | -176,60 | 246,40 | -8,52 | -23,88 | 26,93 | 7 |
| SLC 100 km/h S | AN_20190410_033B | 72,43 | 3,07 | -2,69 | -22,59 | 18,14 | -93,20 | 90,80 | -1,30 | -4,00 | 5,15 | 8 |
| SLC 100 km/h M | AN_20190410_034B | 94,51 | 4,19 | -4,97 | -25,75 | 33,96 | -99,20 | 172,60 | -3,18 | -10,04 | 8,82 | 6,5 |
| SLC 100 km/h A | | | | | | | | | | | | |
| SLC 120 km/h S | | | | | | | | | | | | |
| SLC 120 km/h M | | | | | | | | | | | | |
| SLC 120 km/h A | | | | | | | | | | | | |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

**B1 PW DS1**

| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190411_005A | 58,64 | 2,43 | -2,05 | -21,42 | 19,69 | -79,00 | 129,57 | -1,23 | -4,31 | 3,74 | 6 |
| SLC 80 km/h M | PW_20190411_006A | 103,71 | 4,84 | -2,78 | -35,09 | 32,87 | -177,76 | 172,62 | -8,01 | -18,60 | 20,70 | 5,5 |
| SLC 80 km/h A | PW_20190411_007A | 155,61 | 6,18 | -2,17 | -36,44 | 35,92 | -229,39 | 114,38 | -9,22 | -24,35 | 29,09 | 6 |
| SLC 100 km/h S | PW_20190411_008A | 55,23 | 3,18 | -2,94 | -22,56 | 22,71 | -152,77 | 191,42 | -1,67 | -8,84 | 4,61 | 7 |
| SLC 100 km/h M | PW_20190411_009A | 120,24 | 6,26 | -2,70 | -36,81 | 36,80 | -173,63 | 108,60 | -10,25 | -20,92 | 38,99 | 5 |
| SLC 100 km/h A | PW_20190411_010A | 172,84 | 7,66 | -5,10 | -36,88 | 47,11 | -187,24 | 101,34 | -9,58 | -18,65 | 33,37 | 6 |
| SLC 120 km/h S | PW_20190411_011A | 48,34 | 3,60 | -3,40 | -20,45 | 26,35 | -74,62 | 238,50 | -4,17 | -13,27 | 9,04 | 6,5 |
| SLC 120 km/h M | PW_20190411_012A | 85,86 | 5,73 | -3,33 | -32,84 | 33,77 | -186,60 | 143,60 | -7,49 | -21,56 | 26,75 | 7 |
| SLC 120 km/h A | PW_20190411_013A | 170,66 | 9,33 | -4,39 | -36,55 | 44,81 | -208,69 | 171,66 | -10,14 | | 37,76 | |
| SLC 150 km/h S | PW_20190411_015 | 47,73 | 4,04 | -3,90 | -20,49 | 30,36 | -80,56 | 122,24 | -5,43 | -17,22 | 14,08 | 7 |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | PW_20190411_020 | 120,72 | 8,26 | -11,96 | -37,22 | 56,51 | -202,39 | 83,81 | -8,38 | -22,93 | 18,61 | 5,5 |

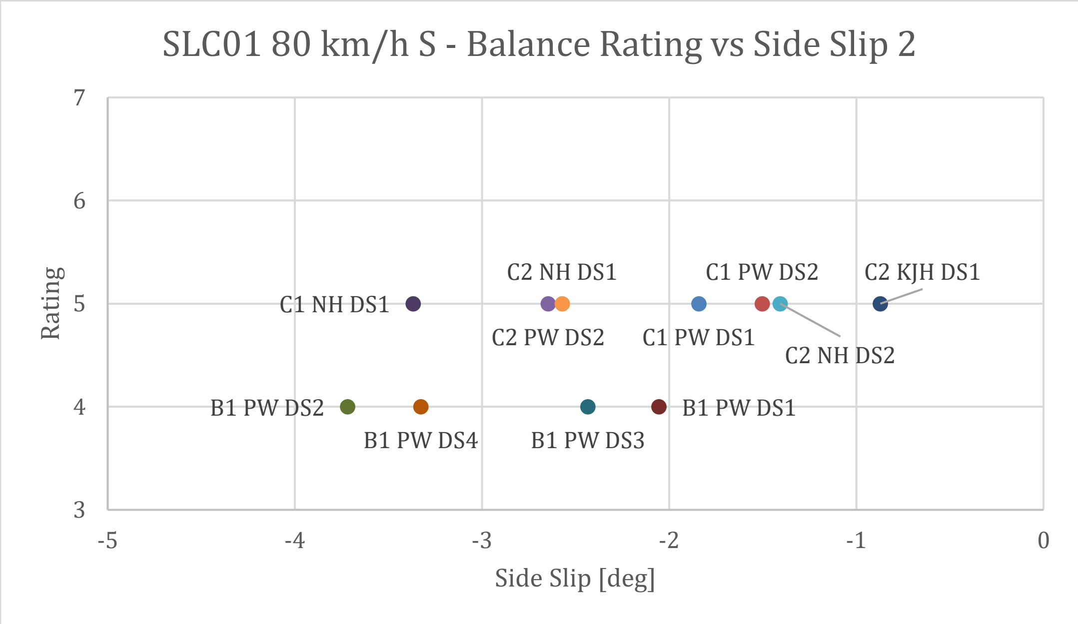
**B1 PW DS2**

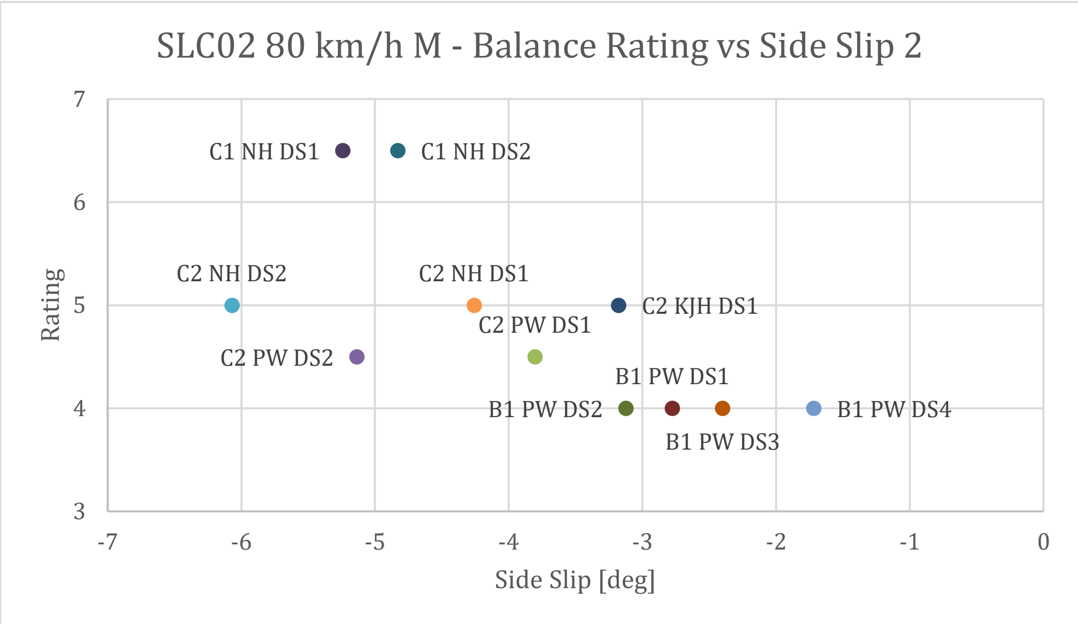
| Test | Trace | SWA Amp | Side Slip 1 | Side Slip 2 | Yaw Rate 1 | Yaw Rate 2 | Yaw Acc 1 | Yaw Acc 2 | Long Acc | Long Jerk | Delta vx | VER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SLC 80 km/h S | PW_20190411_005B | 76,57 | 3,42 | -3,72 | -25,92 | 29,22 | -98,60 | 221,65 | -6,55 | -19,98 | 13,68 | 6 |
| SLC 80 km/h M | PW_20190411_006B | 98,20 | 4,87 | -3,12 | -32,45 | 31,97 | -160,09 | 182,82 | -7,48 | -18,39 | 21,13 | 5,5 |
| SLC 80 km/h A | PW_20190411_007B | 169,87 | 5,52 | -2,82 | -37,62 | 38,05 | -232,98 | 197,38 | -7,91 | -22,60 | 24,77 | 6 |
| SLC 100 km/h S | PW_20190411_008B | 62,05 | 3,77 | -3,07 | -25,42 | 26,96 | -105,83 | 186,23 | -6,52 | -20,46 | 13,07 | 6,5 |
| SLC 100 km/h M | PW_20190411_009B | 130,23 | 7,08 | -2,28 | -35,80 | 30,72 | -151,23 | 176,43 | -10,09 | -20,61 | 36,76 | 5 |
| SLC 100 km/h A | PW_20190411_010B | 171,24 | 6,92 | -3,78 | -36,01 | 46,48 | -211,16 | 224,44 | -8,78 | -19,56 | 30,13 | 6 |
| SLC 120 km/h S | PW_20190411_011B | 50,50 | 3,19 | -3,26 | -20,39 | 25,15 | -81,27 | 95,82 | -6,89 | -22,44 | 12,89 | 6,5 |
| SLC 120 km/h M | PW_20190411_012B | 122,59 | 8,07 | -4,00 | -32,61 | 40,62 | -177,25 | 102,41 | -9,39 | -19,55 | 39,85 | 6,5 |
| SLC 120 km/h A | PW_20190411_014 | 158,91 | 7,24 | -3,90 | -33,45 | 42,80 | -209,45 | 179,17 | -9,20 | -25,03 | 34,34 | 7 |
| SLC 150 km/h S | | | | | | | | | | | | |
| SLC 150 km/h M | | | | | | | | | | | | |
| SLC 150 km/h A | | | | | | | | | | | | |

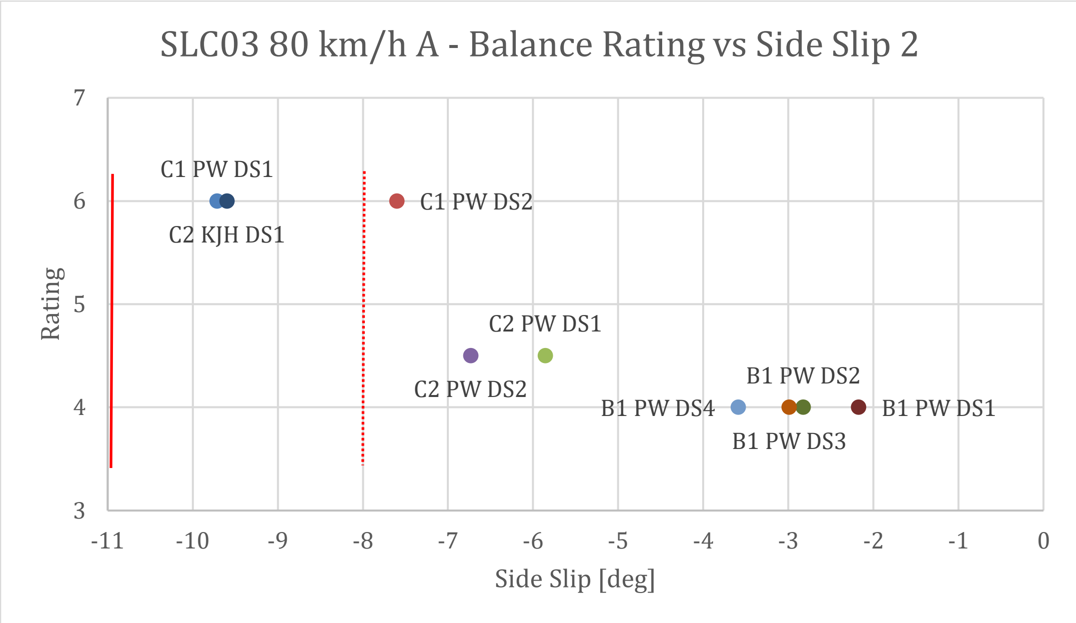
| | B1 PW DS3 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **SWA Amp** | **Side Slip 1** | **Side Slip 2** | **Yaw Rate 1** | **Yaw Rate 2** | **Yaw Acc 1** | **Yaw Acc 2** | **Long Acc** | **Long Jerk** | **Delta vx** | **VER** |
| **SLC 80 km/h S** | PW_20190416_002A | 61,88 | 2,41 | -2,43 | -21,53 | 21,24 | -82,58 | 133,56 | -1,28 | -3,46 | 2,74 | 9 |
| **SLC 80 km/h M** | PW_20190416_002A_4 | 140,81 | 4,95 | -2,40 | -36,64 | 31,07 | -189,01 | 160,22 | -9,56 | -17,36 | 23,29 | 6 |
| **SLC 80 km/h A** | PW_20190416_003A | 152,61 | 5,64 | -2,99 | -37,69 | 34,72 | -196,99 | 185,21 | -10,74 | -19,10 | 27,43 | 6,5 |
| **SLC 100 km/h S** | PW_20190416_005A | 66,58 | 3,47 | -3,37 | -23,38 | 27,44 | -99,61 | 168,34 | -6,79 | -18,79 | 14,90 | 6 |
| **SLC 100 km/h M** | PW_20190416_005A_7 | 80,57 | 4,50 | -2,59 | -28,51 | 28,50 | -132,61 | 283,88 | -8,20 | | 21,71 | 5,5 |
| **SLC 100 km/h A** | PW_20190416_006A | 152,81 | 6,56 | -3,03 | -35,77 | 38,31 | -192,46 | 161,82 | -10,13 | | 32,90 | 6 |
| **SLC 120 km/h S** | PW_20190416_008A | 51,95 | 3,29 | -3,18 | -19,69 | 25,59 | -64,20 | 190,47 | -6,57 | -18,44 | 10,66 | 6 |
| **SLC 120 km/h M** | PW_20190416_009A | 100,41 | 5,30 | -2,08 | -30,44 | 27,85 | -153,81 | 94,41 | -9,61 | -23,69 | 28,40 | 5,5 |
| **SLC 120 km/h A** | | | | | | | | | | | | |
| **SLC 150 km/h S** | PW_20190416_011 | 49,80 | 3,99 | -3,69 | -18,98 | 28,29 | -47,60 | 131,87 | -5,72 | -13,67 | 13,64 | 7,5 |
| **SLC 150 km/h M** | PW_20190416_011_14 | 55,39 | 4,04 | -4,35 | -20,98 | 31,09 | -88,69 | 171,38 | -6,15 | -18,68 | 15,66 | 7 |
| **SLC 150 km/h A** | PW_20190416_012 | 97,75 | 7,85 | -4,29 | -31,08 | 43,07 | -152,84 | 169,32 | -9,61 | -37,59 | 19,48 | 6,75 |

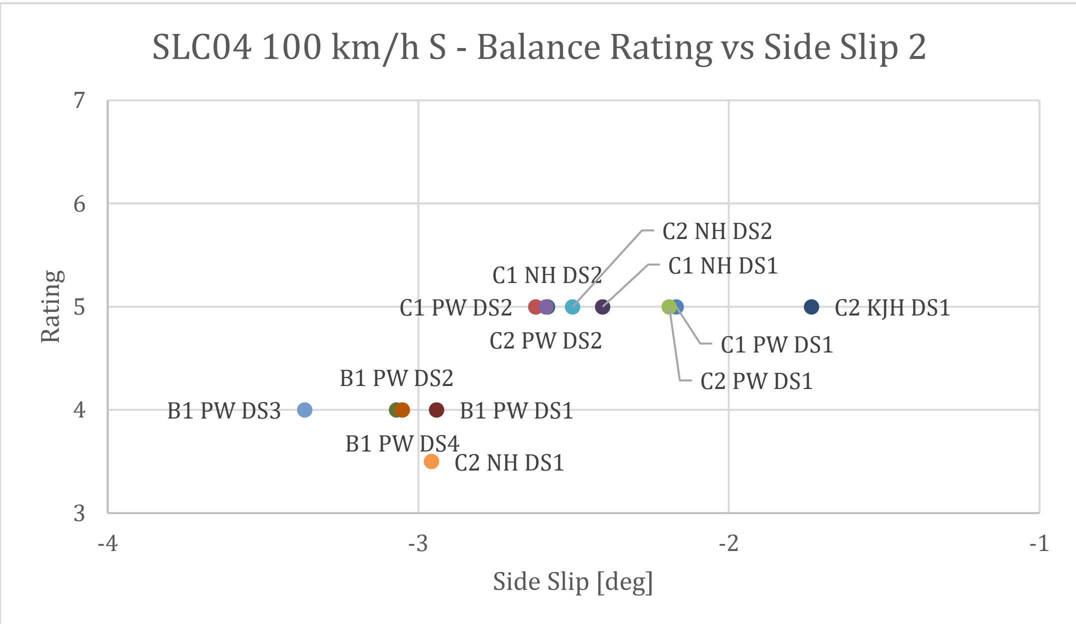
| | B1 PW DS4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Test** | **Trace** | **SWA Amp** | **Side Slip 1** | **Side Slip 2** | **Yaw Rate 1** | **Yaw Rate 2** | **Yaw Acc 1** | **Yaw Acc 2** | **Long Acc** | **Long Jerk** | **Delta vx** | **VER** |
| **SLC 80 km/h S** | PW_20190416_002B | 73,47 | 3,12 | -3,33 | -24,64 | 25,20 | -93,19 | 172,96 | -1,38 | -3,84 | 4,21 | 9 |
| **SLC 80 km/h M** | PW_20190416_002B_4 | 134,09 | 4,70 | -1,72 | -33,98 | 27,09 | -190,00 | 114,22 | -9,68 | -28,17 | 24,88 | 6 |
| **SLC 80 km/h A** | PW_20190416_003B | 179,39 | 5,95 | -3,59 | -37,66 | 39,90 | -199,58 | 206,73 | -9,15 | -19,16 | 29,66 | 6,5 |
| **SLC 100 km/h S** | PW_20190416_005B | 61,44 | 3,81 | -3,05 | -24,61 | 27,00 | -96,49 | 185,54 | -7,39 | -19,24 | 13,39 | 6 |
| **SLC 100 km/h M** | | | | | | | | | | | | |
| **SLC 100 km/h A** | PW_20190416_006B | 143,41 | 5,35 | -2,50 | -33,13 | 37,85 | -178,81 | 154,80 | -9,10 | -19,43 | 31,61 | 6 |
| **SLC 120 km/h S** | PW_20190416_008B | 52,68 | 3,65 | -2,49 | -21,50 | 21,65 | -71,36 | 154,61 | -6,66 | -19,88 | 12,20 | 6 |
| **SLC 120 km/h M** | PW_20190416_008B_10 | 77,91 | 4,75 | -2,86 | -28,51 | 32,50 | -132,81 | 173,07 | -9,90 | -18,30 | 24,62 | 6 |
| **SLC 120 km/h A** | PW_20190416_009B | 118,90 | 5,80 | -2,93 | -32,79 | 36,20 | -155,20 | 138,02 | -10,47 | -18,00 | 34,31 | 5,5 |
| **SLC 150 km/h S** | | | | | | | | | | | | |
| **SLC 150 km/h M** | | | | | | | | | | | | |
| **SLC 150 km/h A** | | | | | | | | | | | | |

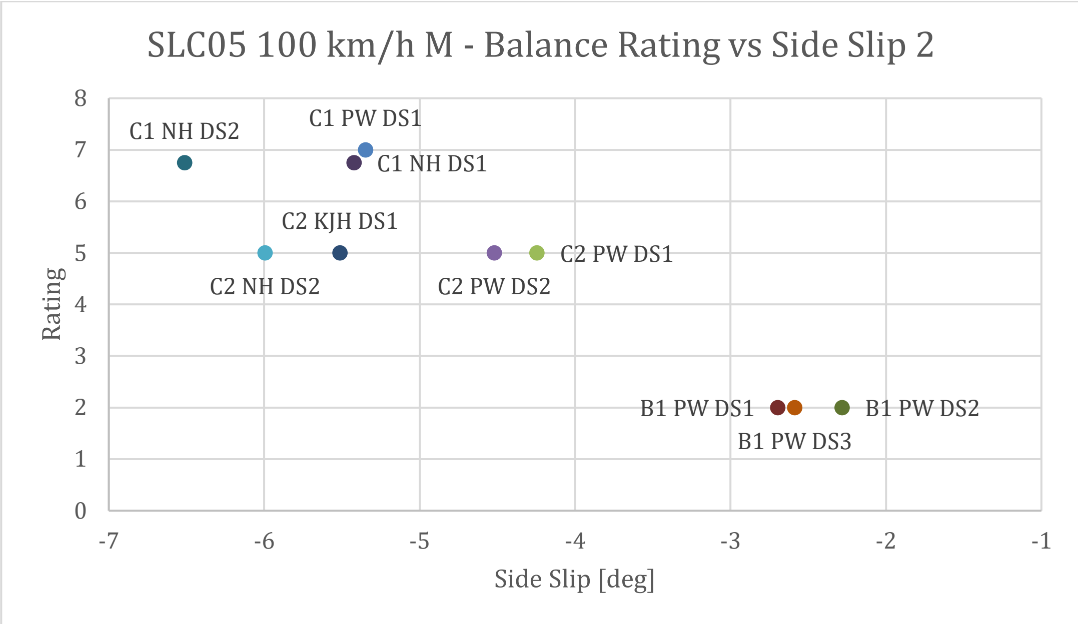
# G SLC Subjective vs Objective Scatter Plots

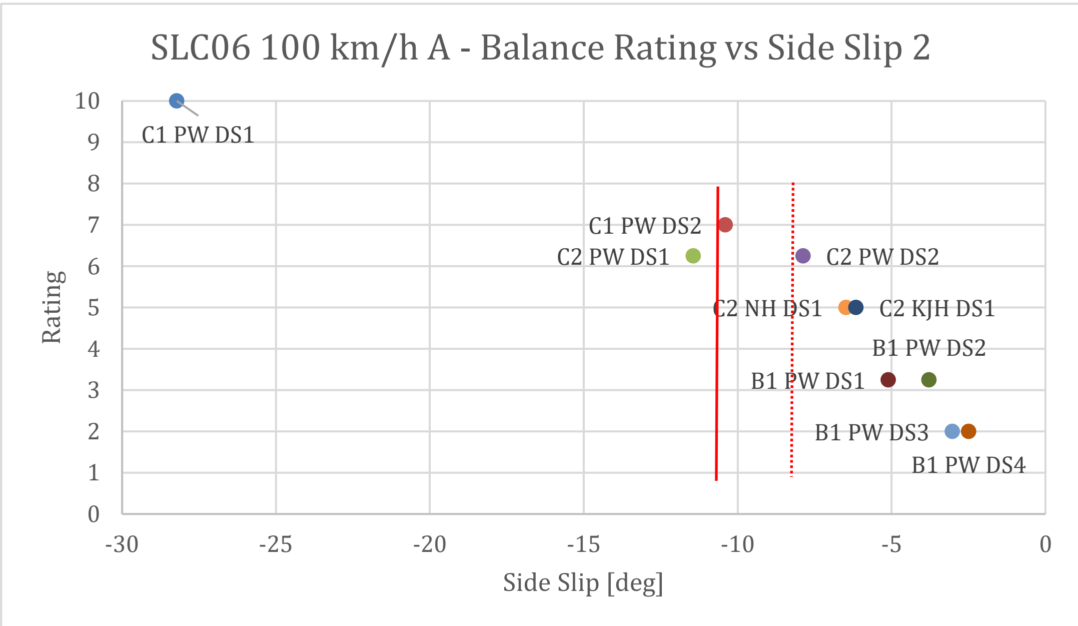


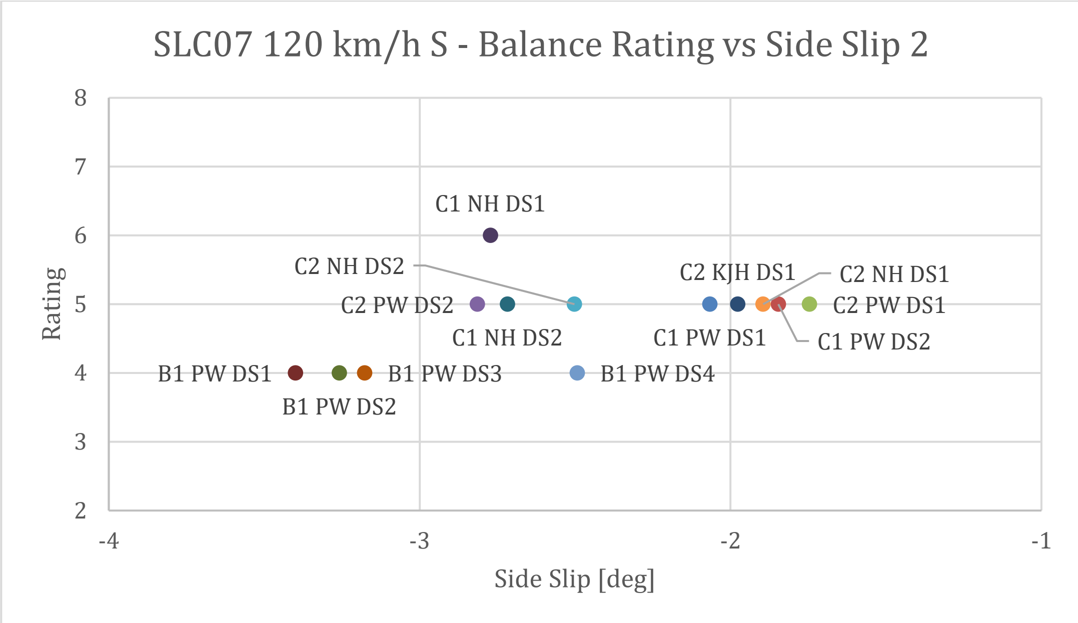



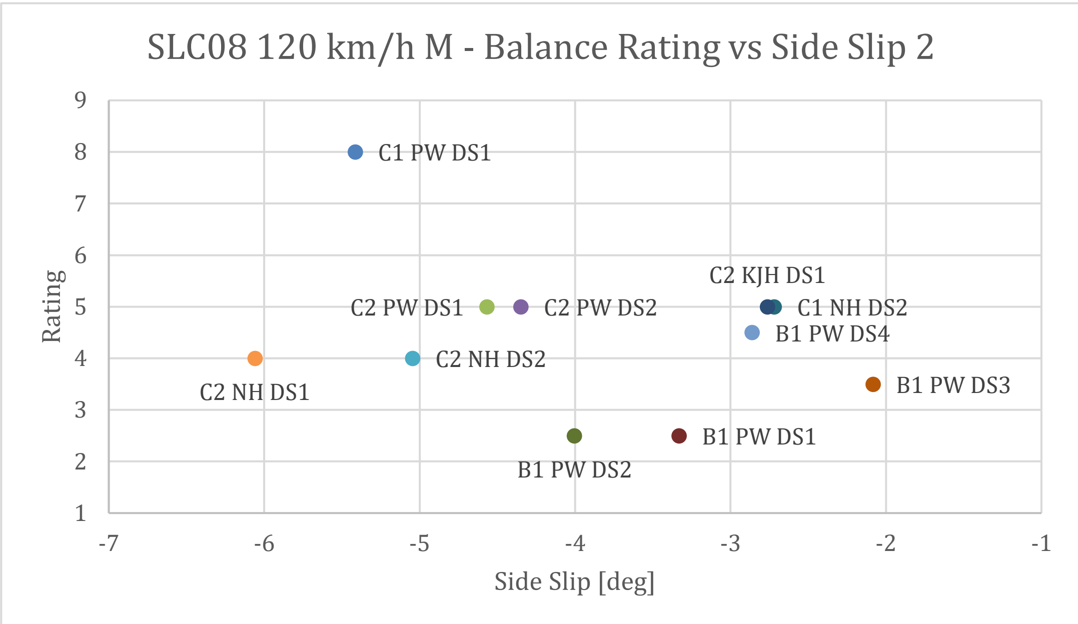

SLC03 80 km/h A - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
7
6
5
4
3
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
C1 PW DS1
C2 KJH DS1
C1 PW DS2
C2 PW DS1
C2 PW DS2
B1 PW DS2
B1 PW DS4
B1 PW DS1
B1 PW DS3

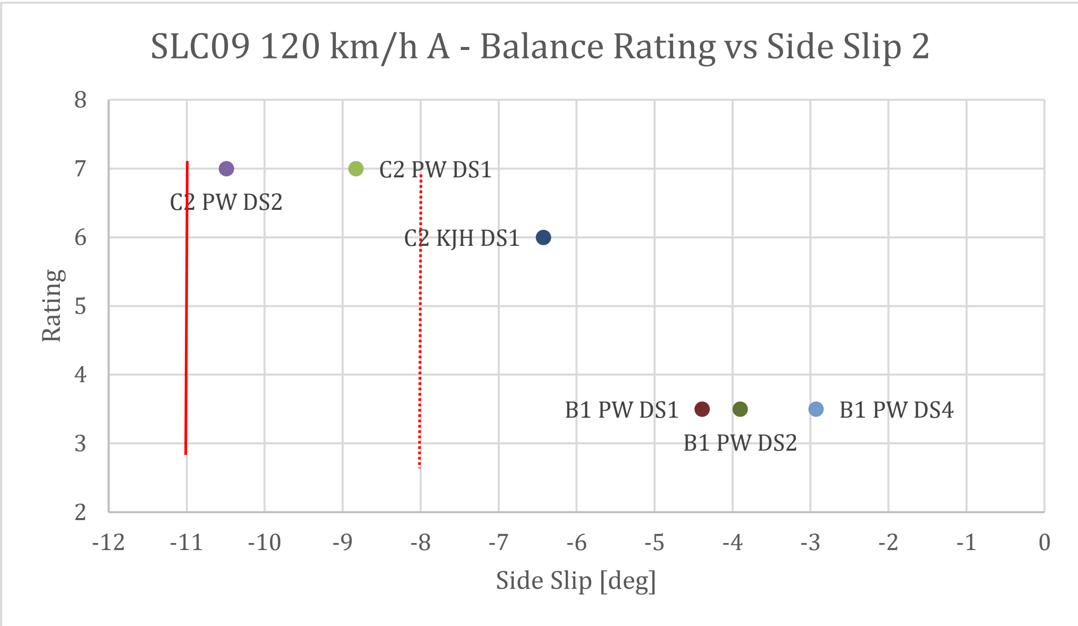

SLC04 100 km/h S - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
7
6
5
4
3
-4
-3
-2
-1
C2 NH DS2
C1 NH DS1
C1 NH DS2
C1 PW DS2
C2 KJH DS1
C2 PW DS2
C1 PW DS1
C2 PW DS1
B1 PW DS2
B1 PW DS3
B1 PW DS1
B1 PW DS4
C2 NH DS1

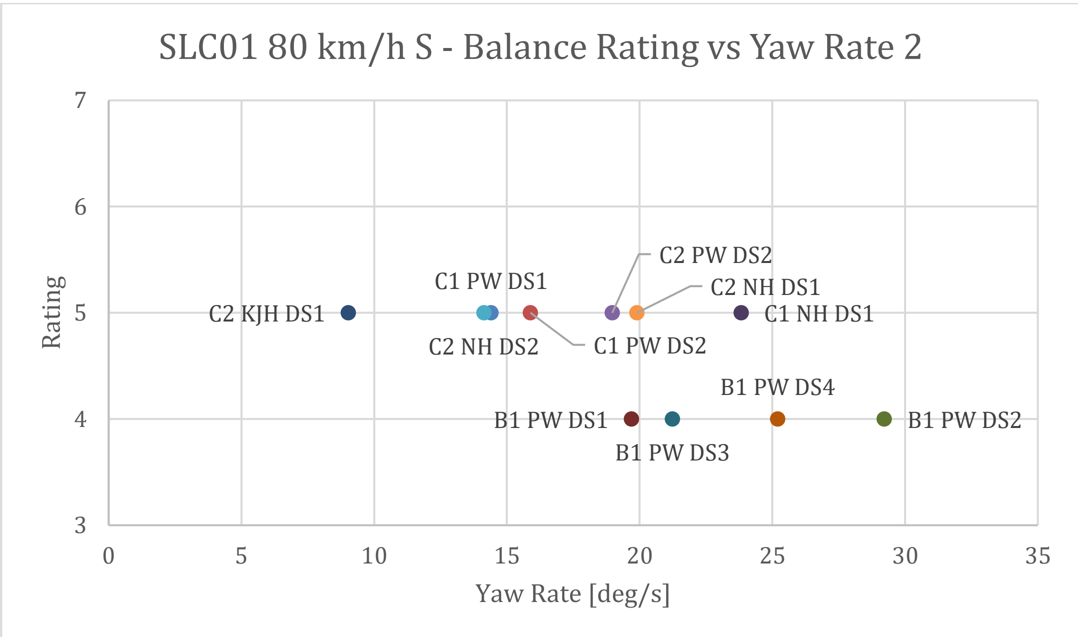

SLC05 100 km/h M - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C1 NH DS2
C1 PW DS1
C1 NH DS1
C2 KJH DS1
C2 NH DS2
C2 PW DS1
C2 PW DS2
B1 PW DS1
B1 PW DS2
B1 PW DS3
0
1
2
3
4
5
6
7
8
-7
-6
-5
-4
-3
-2
-1

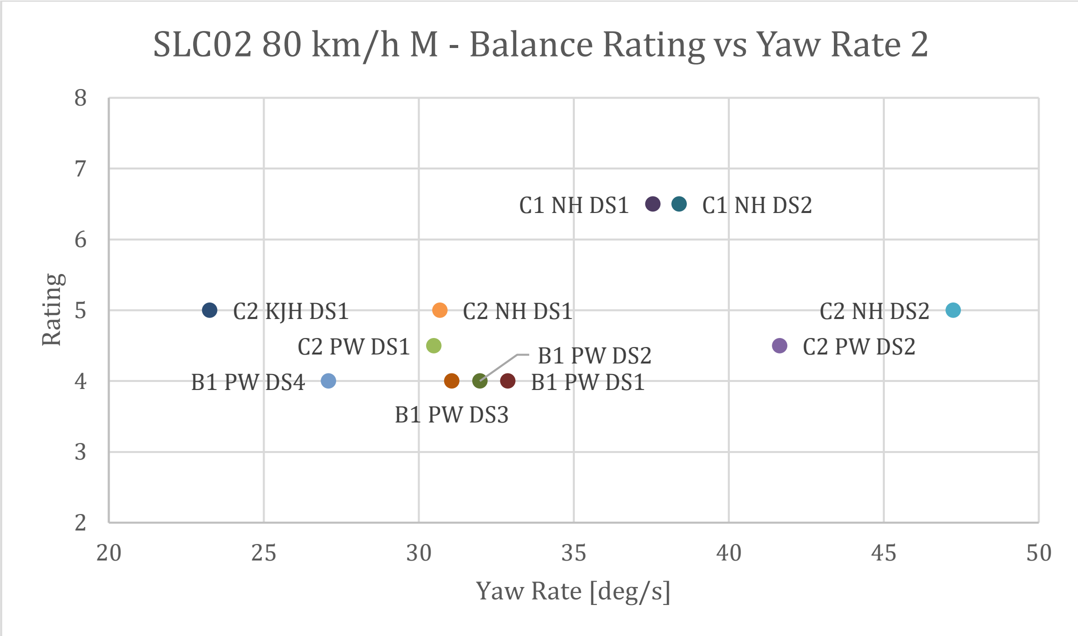

SLC06 100 km/h A - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C1 PW DS1
C1 PW DS2
C2 PW DS1
C2 PW DS2
C2 NH DS1
C2 KJH DS1
B1 PW DS2
B1 PW DS1
B1 PW DS3
B1 PW DS4
0
1
2
3
4
5
6
7
8
9
10
-30
-25
-20
-15
-10
-5
0


SLC07 120 km/h S - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C1 NH DS1
C2 NH DS2
C2 PW DS2
C1 NH DS2
C2 KJH DS1
C2 NH DS1
C2 PW DS1
C1 PW DS1
C1 PW DS2
B1 PW DS1
B1 PW DS3
B1 PW DS4
B1 PW DS2

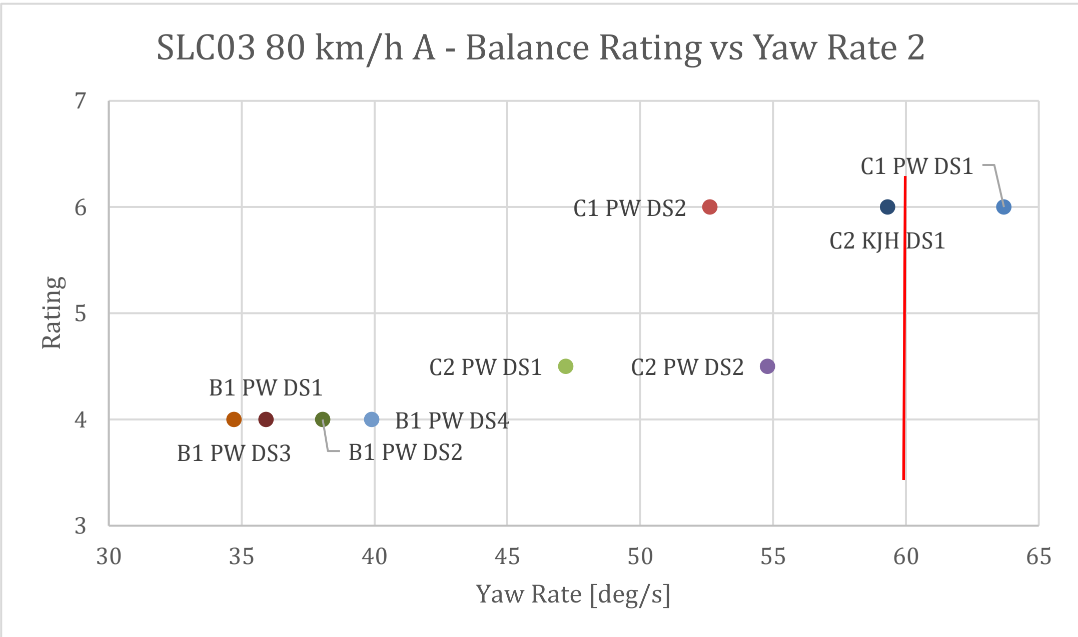

SLC08 120 km/h M - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
C1 PW DS1
C2 KJH DS1
C2 PW DS1
C2 PW DS2
C1 NH DS2
B1 PW DS4
C2 NH DS2
C2 NH DS1
B1 PW DS3
B1 PW DS1
B1 PW DS2


SLC09 120 km/h A - Balance Rating vs Side Slip 2
Rating
Side Slip [deg]
8
7
6
5
4
3
2
-12
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
C2 PW DS1
C2 PW DS2
C2 KJH DS1
B1 PW DS1
B1 PW DS4
B1 PW DS2

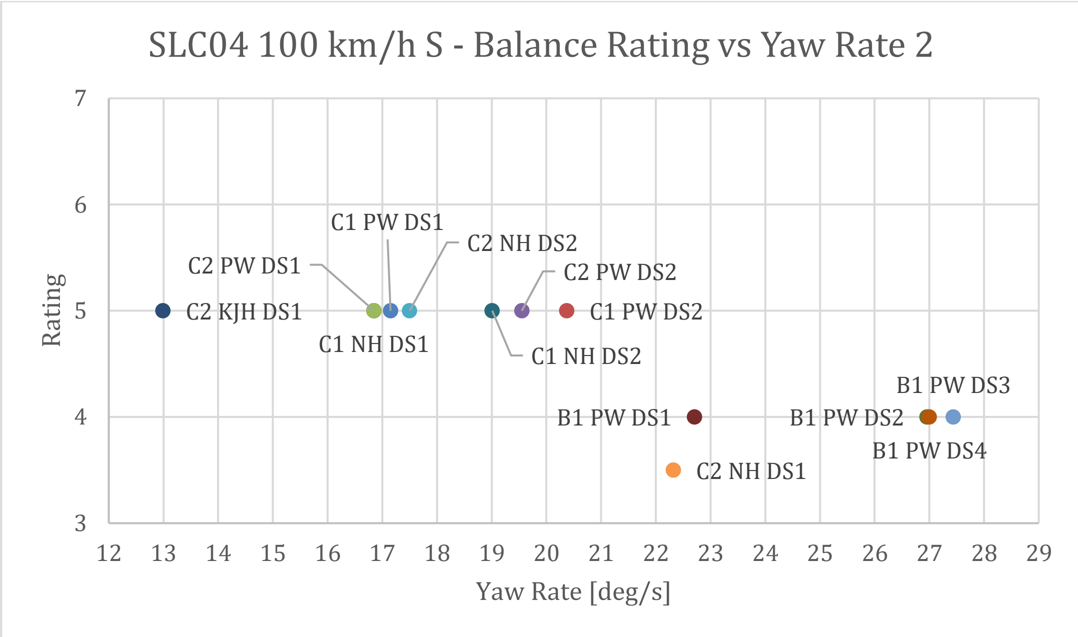

SLC01 80 km/h S - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
7
6
5
4
3
0
5
10
15
20
25
30
35
C2 PW DS2
C1 PW DS1
C2 NH DS1
C2 KJH DS1
C1 NH DS1
C2 NH DS2
C1 PW DS2
B1 PW DS4
B1 PW DS1
B1 PW DS2
B1 PW DS3

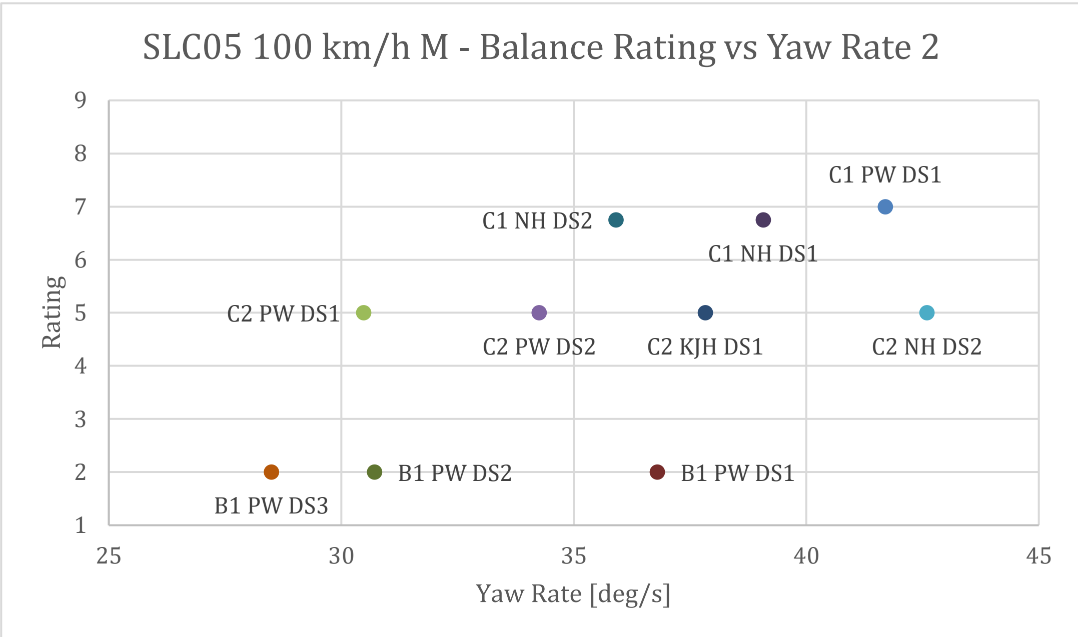


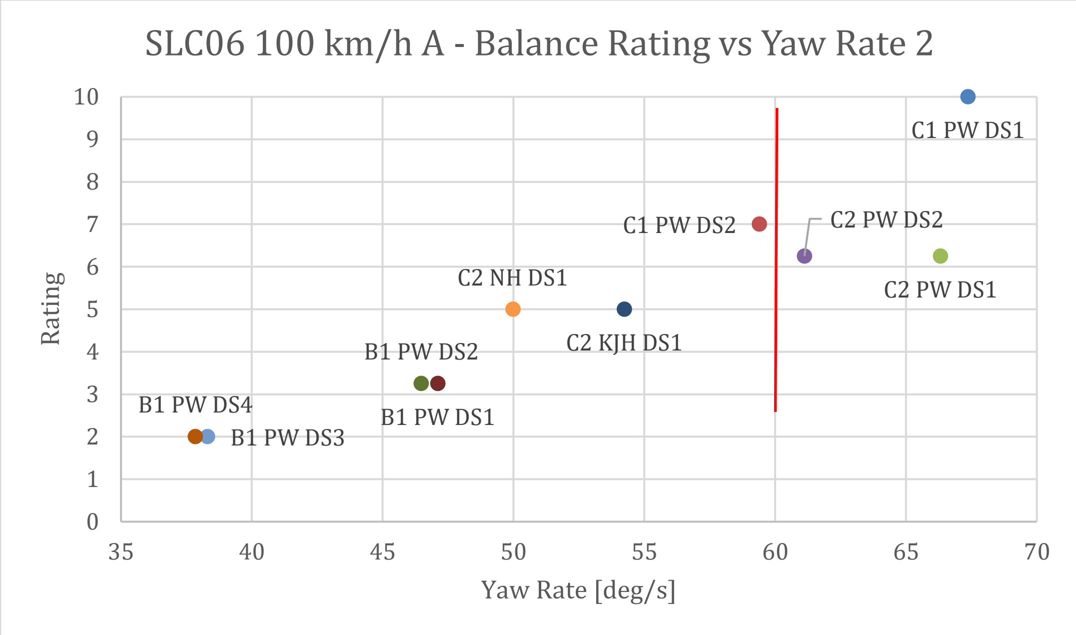
SLC02 80 km/h M - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
8
7
6
5
4
3
2
20
25
30
35
40
45
50
C1 NH DS1
C1 NH DS2
C2 KJH DS1
C2 NH DS1
C2 NH DS2
C2 PW DS1
B1 PW DS2
C2 PW DS2
B1 PW DS4
B1 PW DS1
B1 PW DS3

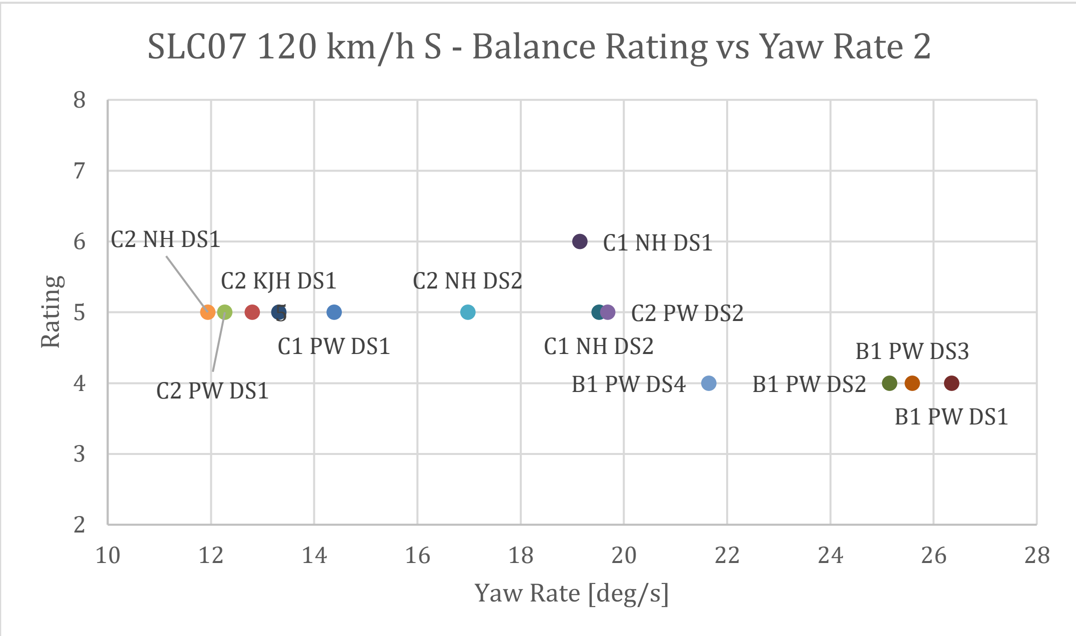



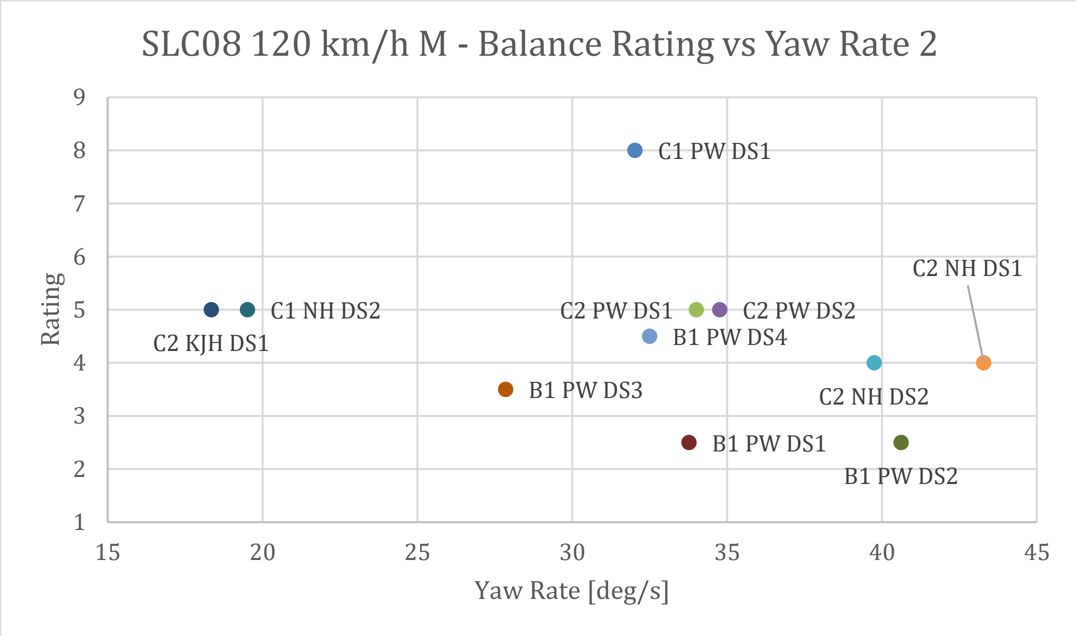
SLC03 80 km/h A - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
7
6
5
4
3
30
35
40
45
50
55
60
65
C1 PW DS1
C1 PW DS2
C2 KJH DS1
C2 PW DS1
C2 PW DS2
B1 PW DS1
B1 PW DS4
B1 PW DS3
B1 PW DS2

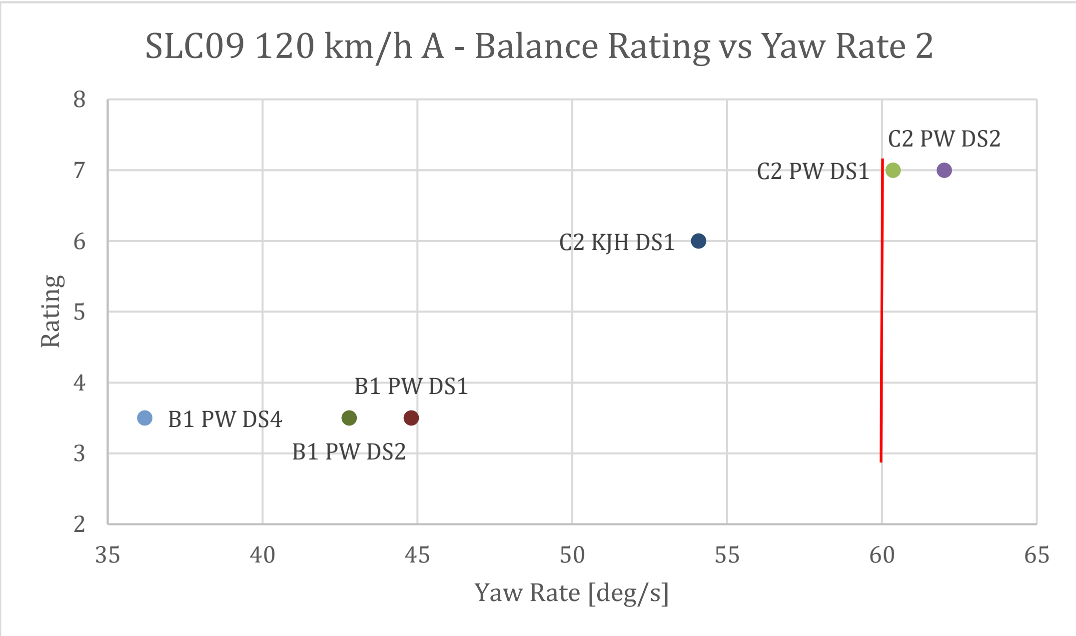

SLC04 100 km/h S - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C1 PW DS1
C2 NH DS2
C2 PW DS1
C2 PW DS2
C2 KJH DS1
C1 PW DS2
C1 NH DS1
C1 NH DS2
B1 PW DS3
B1 PW DS1
B1 PW DS2
B1 PW DS4
C2 NH DS1

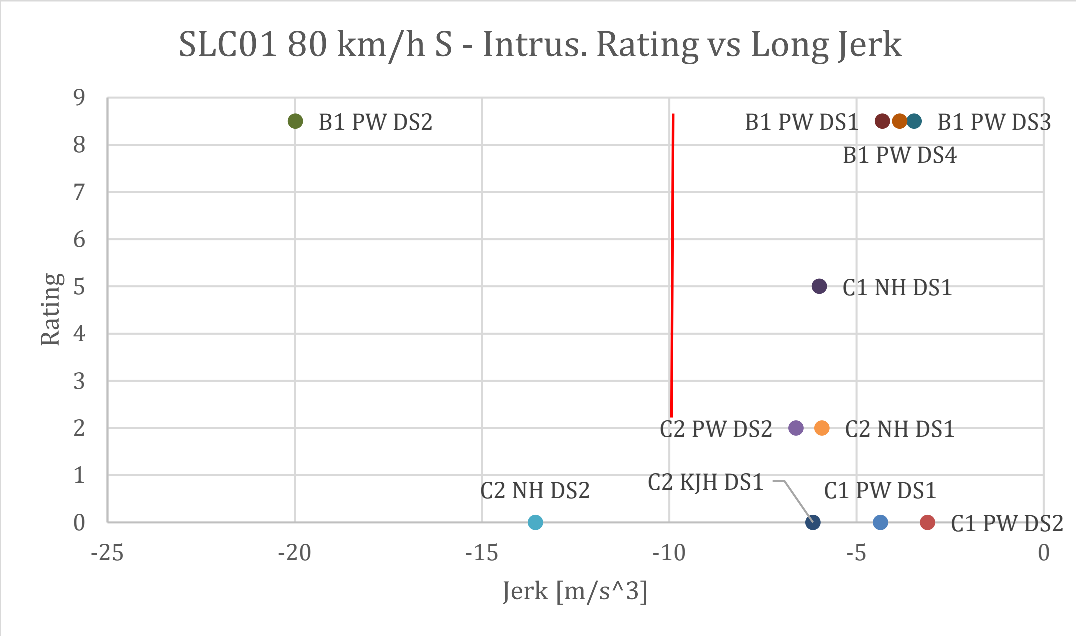

SLC05 100 km/h M - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C1 PW DS1
C1 NH DS2
C1 NH DS1
C2 PW DS1
C2 PW DS2
C2 KJH DS1
C2 NH DS2
B1 PW DS2
B1 PW DS1
B1 PW DS3

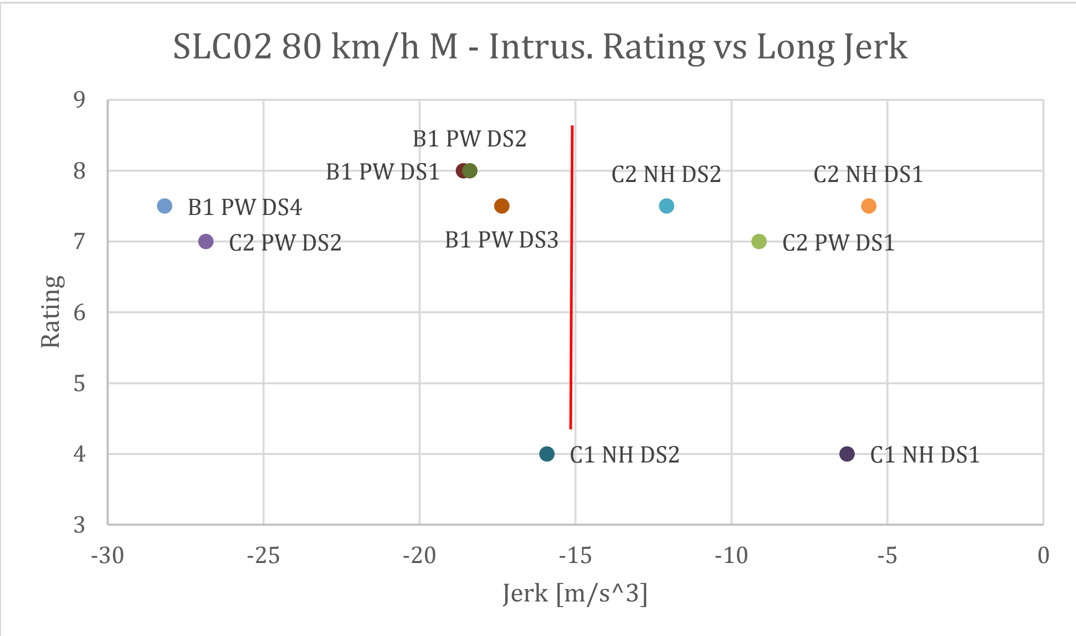

SLC06 100 km/h A - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C1 PW DS1
C1 PW DS2
C2 PW DS2
C2 PW DS1
C2 NH DS1
C2 KJH DS1
B1 PW DS2
B1 PW DS1
B1 PW DS4
B1 PW DS3
0
1
2
3
4
5
6
7
8
9
10
35
40
45
50
55
60
65
70

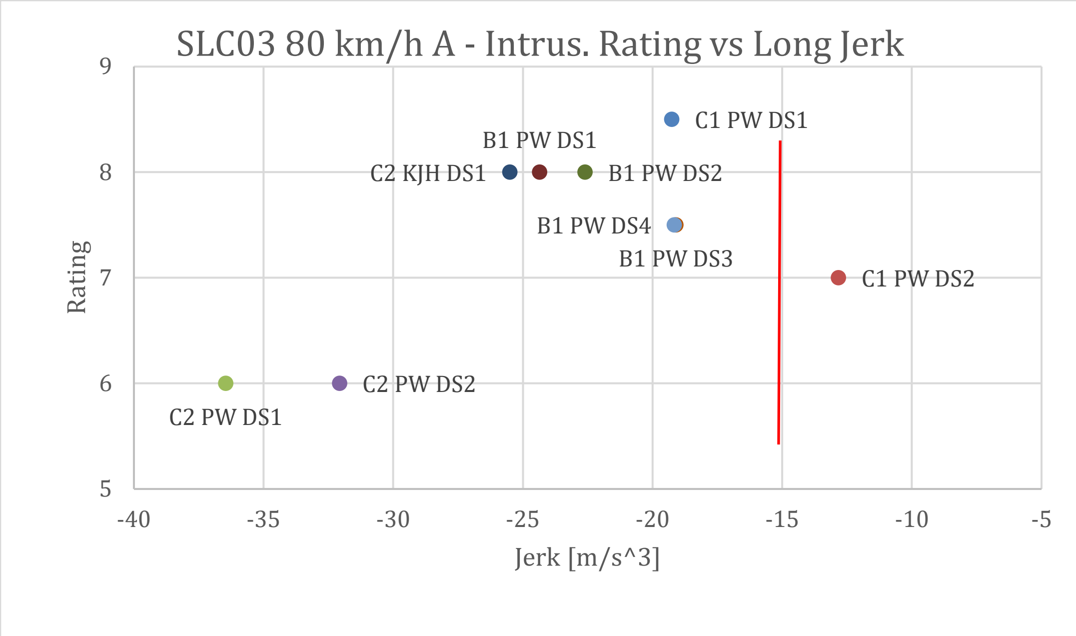

SLC07 120 km/h S - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C2 NH DS1
C2 KJH DS1
C2 NH DS2
C1 NH DS1
C2 PW DS2
C1 PW DS1
C1 NH DS2
C2 PW DS1
B1 PW DS4
B1 PW DS2
B1 PW DS3
B1 PW DS1
2
3
4
5
6
7
8
10
12
14
16
18
20
22
24
26
28

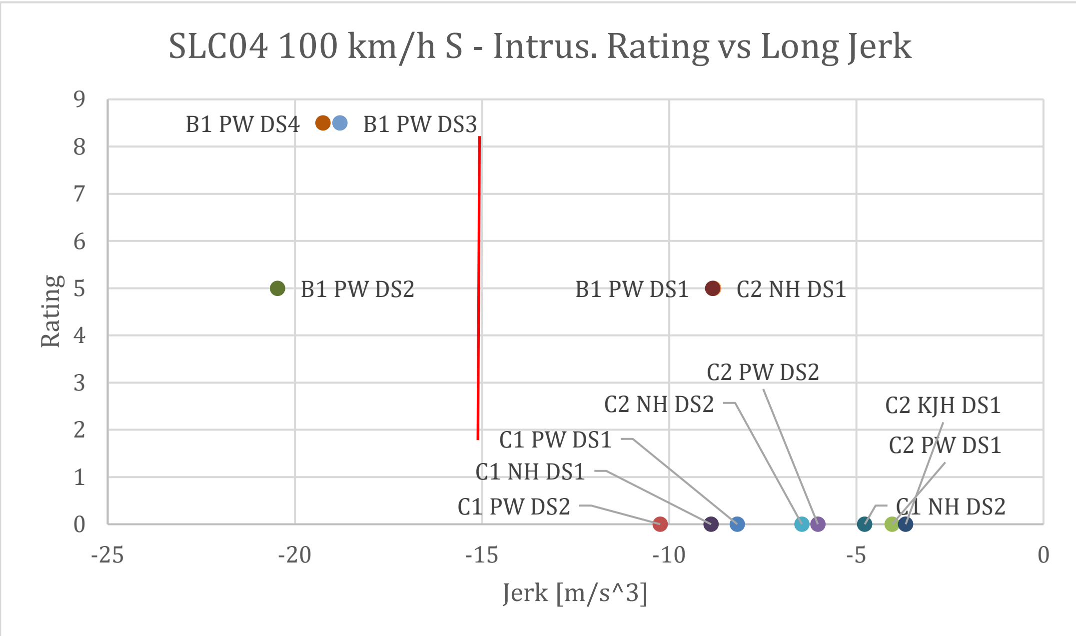

SLC08 120 km/h M - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C1 PW DS1
C2 NH DS1
C1 NH DS2
C2 KJH DS1
C2 PW DS1
C2 PW DS2
B1 PW DS4
B1 PW DS3
C2 NH DS2
B1 PW DS1
B1 PW DS2

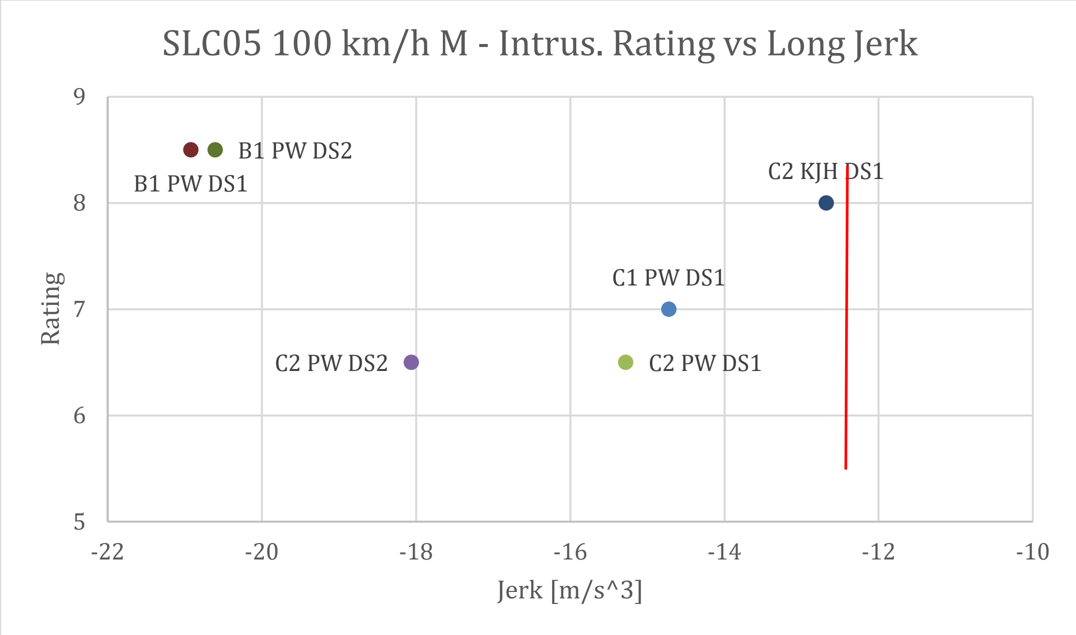

SLC09 120 km/h A - Balance Rating vs Yaw Rate 2
Rating
Yaw Rate [deg/s]
C2 PW DS2
C2 PW DS1
C2 KJH DS1
B1 PW DS1
B1 PW DS4
B1 PW DS2


SLC01 80 km/h S - Intrus. Rating vs Long Jerk
Rating
Jerk [m/s^3]
B1 PW DS2
B1 PW DS1
B1 PW DS3
B1 PW DS4
C1 NH DS1
C2 PW DS2
C2 NH DS1
C2 NH DS2
C2 KJH DS1
C1 PW DS1
C1 PW DS2
9
8
7
6
5
4
3
2
1
0
-25
-20
-15
-10
-5
0

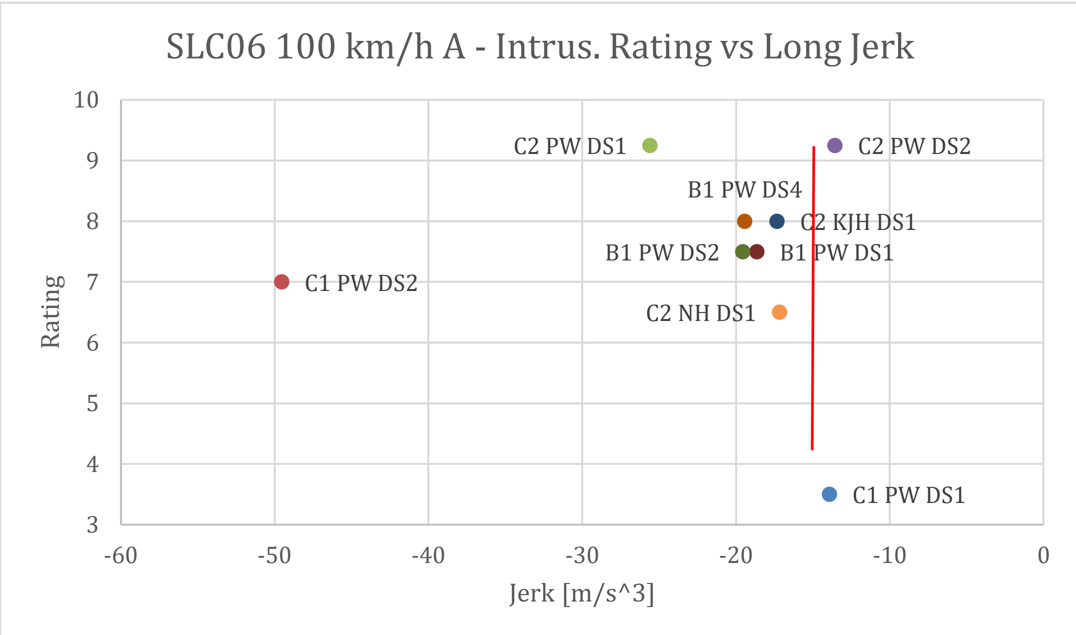

SLC02 80 km/h M - Intrus. Rating vs Long Jerk
Rating
Jerk [m/s^3]
B1 PW DS2
B1 PW DS1
B1 PW DS4
C2 PW DS2
B1 PW DS3
C2 NH DS2
C2 NH DS1
C2 PW DS1
C1 NH DS2
C1 NH DS1
9
8
7
6
5
4
3
-30
-25
-20
-15
-10
-5
0


SLC03 80 km/h A - Intrus. Rating vs Long Jerk
Rating
Jerk [m/s^3]
C1 PW DS1
B1 PW DS1
C2 KJH DS1
B1 PW DS2
B1 PW DS4
B1 PW DS3
C1 PW DS2
C2 PW DS2
C2 PW DS1
9
8
7
6
5
-40
-35
-30
-25
-20
-15
-10
-5

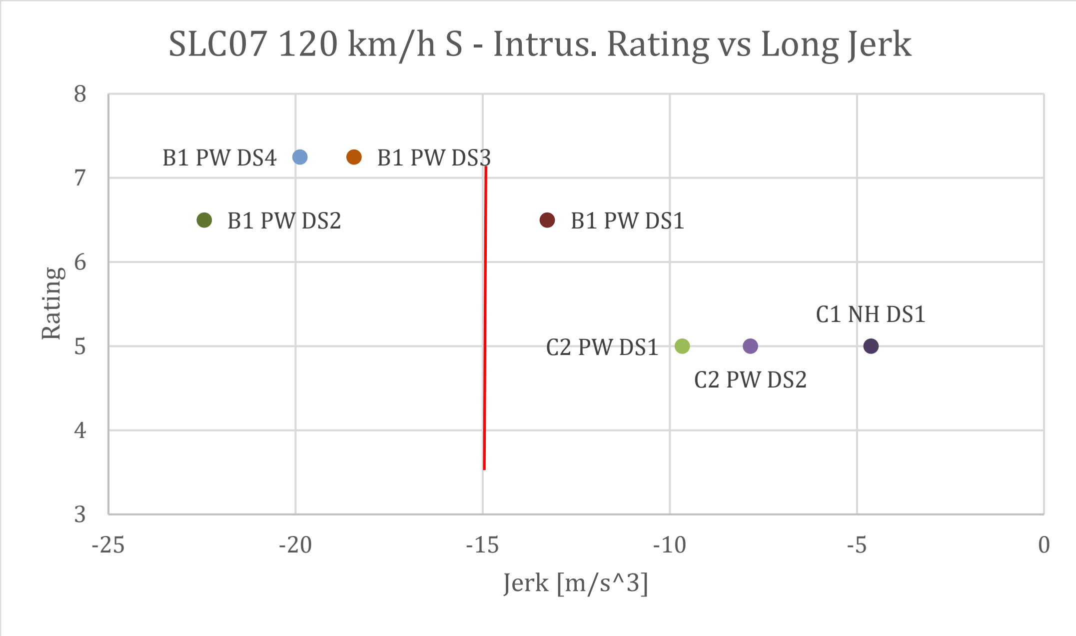

SLC04 100 km/h S - Intrus. Rating vs Long Jerk
Rating
Jerk [m/s^3]
B1 PW DS4
B1 PW DS3
B1 PW DS2
B1 PW DS1
C2 NH DS1
C2 PW DS2
C2 NH DS2
C2 KJH DS1
C1 PW DS1
C2 PW DS1
C1 NH DS1
C1 PW DS2
C1 NH DS2
9
8
7
6
5
4
3
2
1
0
-25
-20
-15
-10
-5
0

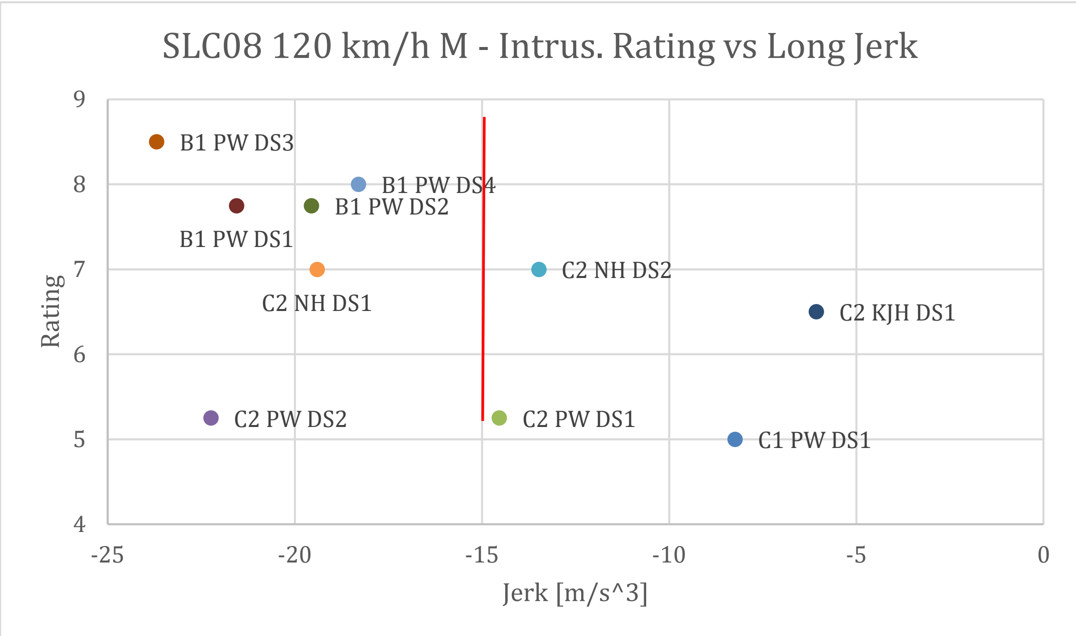


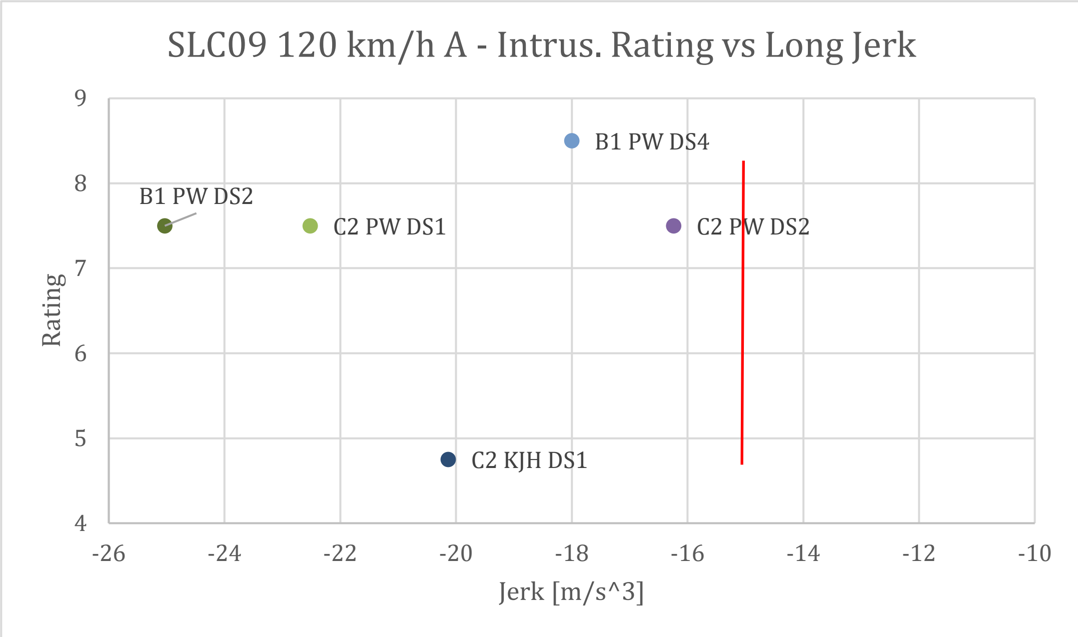
SLC05 100 km/h M - Intrus. Rating vs Long Jerk
B1 PW DS2
B1 PW DS1
C2 KJH DS1
C1 PW DS1
C2 PW DS2
C2 PW DS1
Rating
Jerk [m/s^3]

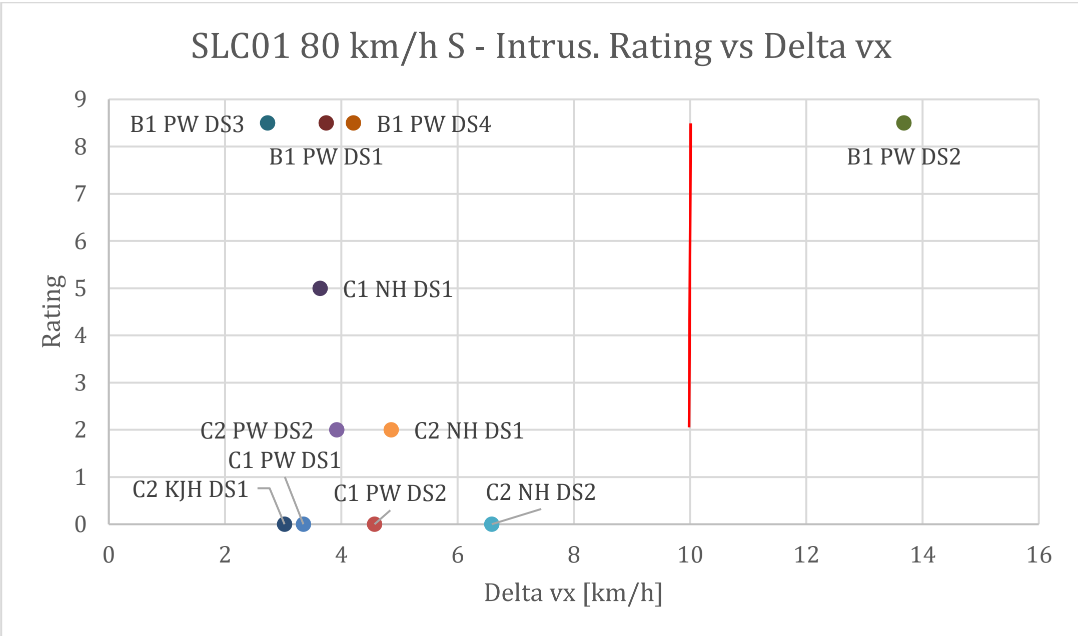



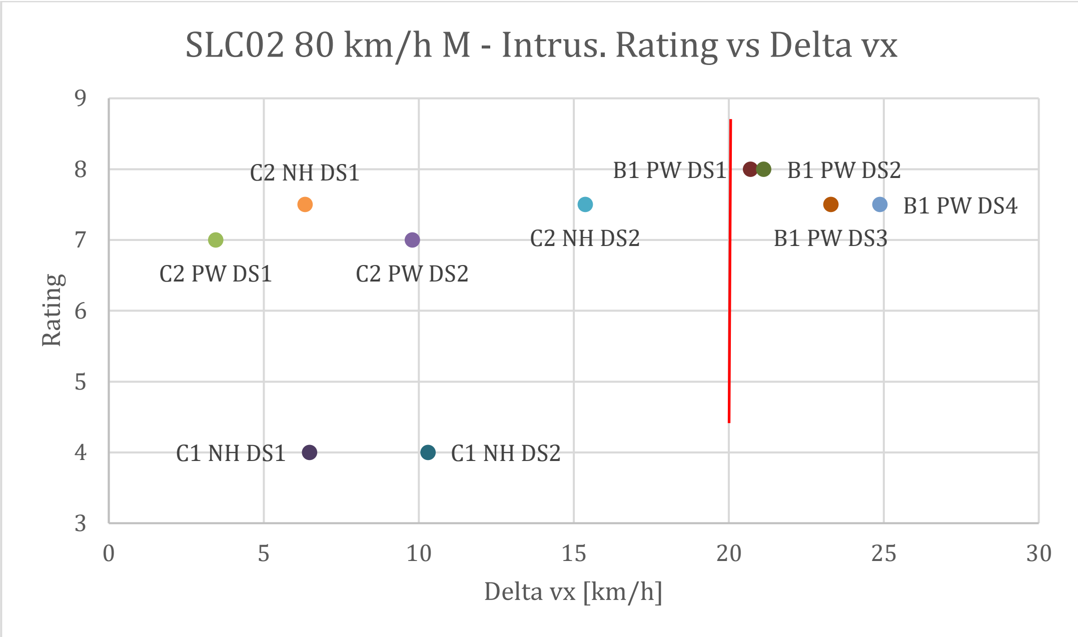
SLC06 100 km/h A - Intrus. Rating vs Long Jerk
C2 PW DS1
C2 PW DS2
B1 PW DS4
C2 KJH DS1
B1 PW DS2
B1 PW DS1
C1 PW DS2
C2 NH DS1
C1 PW DS1
Rating
Jerk [m/s^3]


SLC07 120 km/h S - Intrus. Rating vs Long Jerk
Rating
Jerk [m/s^3]
8
7
6
5
4
3
-25
-20
-15
-10
-5
0
B1 PW DS4
B1 PW DS3
B1 PW DS2
B1 PW DS1
C1 NH DS1
C2 PW DS1
C2 PW DS2

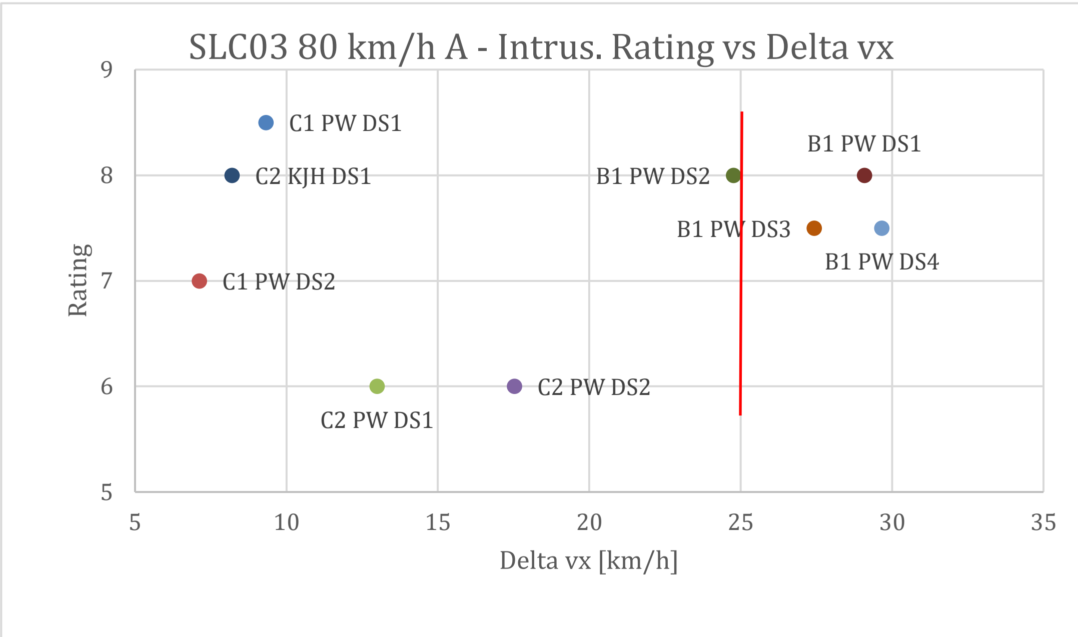

SLC08 120 km/h M - Intrus. Rating vs Long Jerk
Rating
Jerk [m/s^3]
9
8
7
6
5
4
-25
-20
-15
-10
-5
0
B1 PW DS3
B1 PW DS4
B1 PW DS2
B1 PW DS1
C2 NH DS2
C2 NH DS1
C2 KJH DS1
C2 PW DS2
C2 PW DS1
C1 PW DS1


SLC09 120 km/h A - Intrus. Rating vs Long Jerk
Rating
Jerk [m/s^3]
B1 PW DS4
B1 PW DS2
C2 PW DS1
C2 PW DS2
C2 KJH DS1
9
8
7
6
5
4
-26
-24
-22
-20
-18
-16
-14
-12
-10

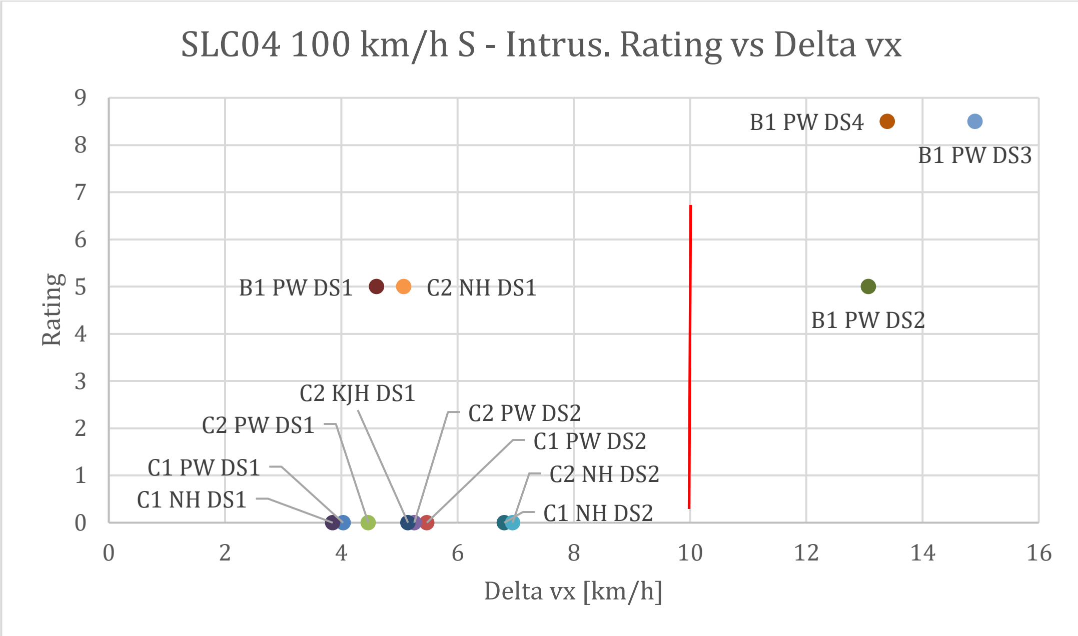

SLC01 80 km/h S - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
B1 PW DS3
B1 PW DS4
B1 PW DS1
B1 PW DS2
C1 NH DS1
C2 PW DS2
C2 NH DS1
C1 PW DS1
C2 KJH DS1
C1 PW DS2
C2 NH DS2
9
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
16



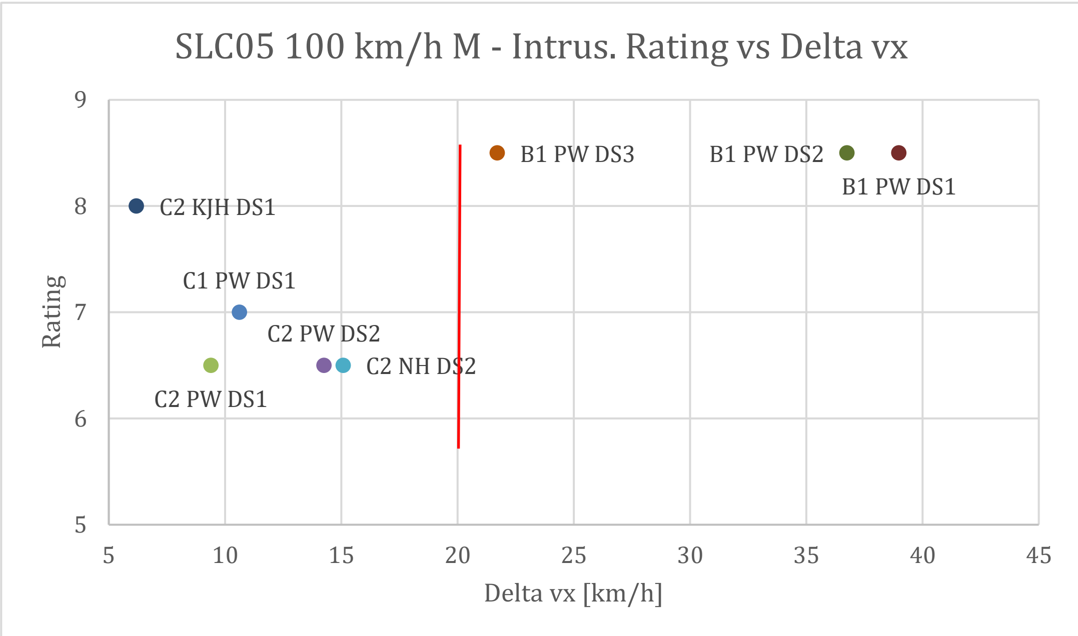
SLC02 80 km/h M - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
9
8
7
6
5
4
3
0
5
10
15
20
25
30
C2 NH DS1
C2 PW DS1
C2 PW DS2
C2 NH DS2
B1 PW DS1
B1 PW DS2
B1 PW DS3
B1 PW DS4
C1 NH DS1
C1 NH DS2

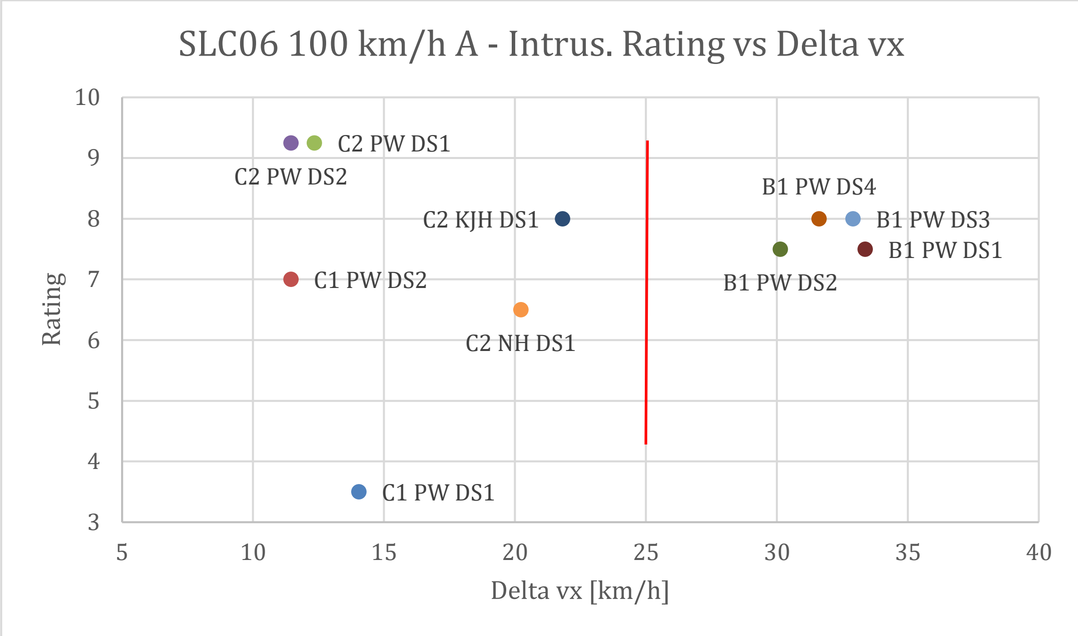
SLC03 80 km/h A - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
9
8
7
6
5
5
10
15
20
25
30
35
C1 PW DS1
C2 KJH DS1
C1 PW DS2
C2 PW DS1
C2 PW DS2
B1 PW DS1
B1 PW DS2
B1 PW DS3
B1 PW DS4

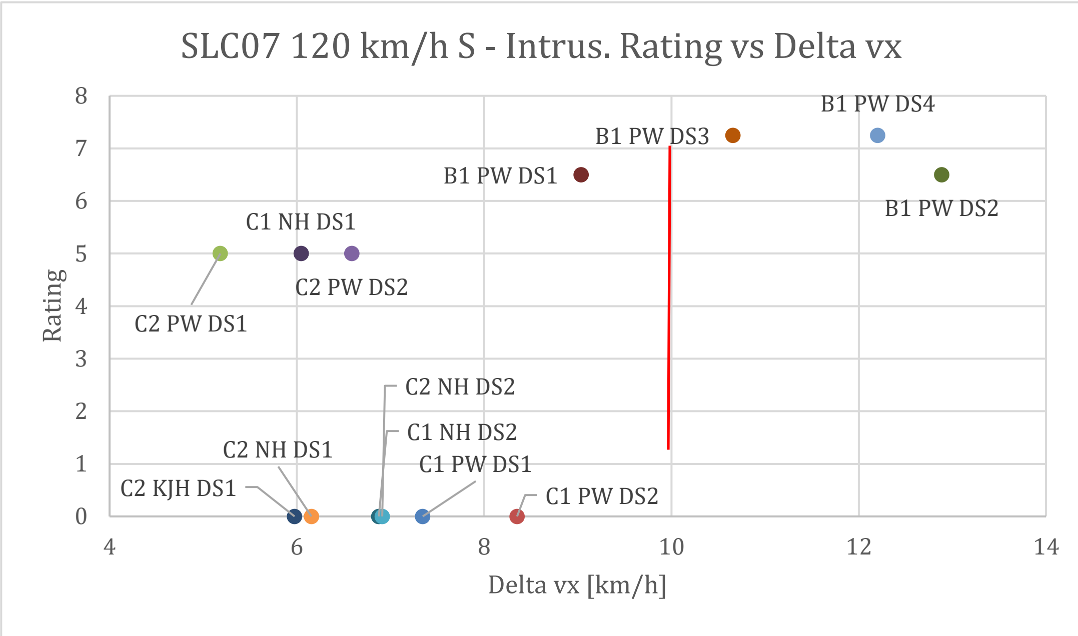


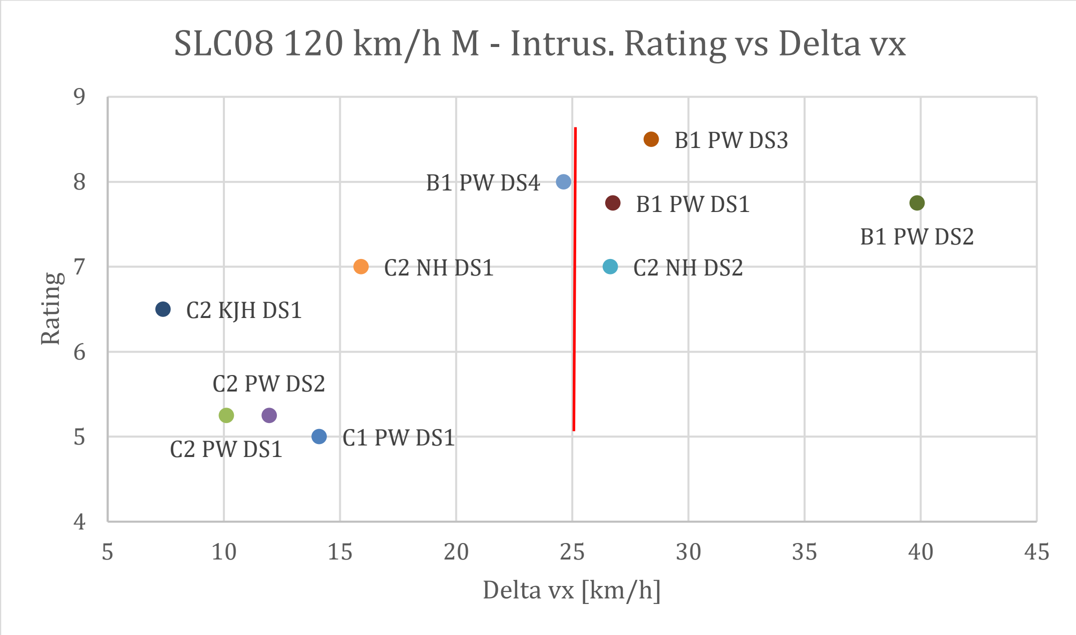
SLC04 100 km/h S - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
B1 PW DS4
B1 PW DS3
B1 PW DS1
C2 NH DS1
B1 PW DS2
C2 KJH DS1
C2 PW DS1
C2 PW DS2
C1 PW DS2
C1 PW DS1
C2 NH DS2
C1 NH DS1
C1 NH DS2

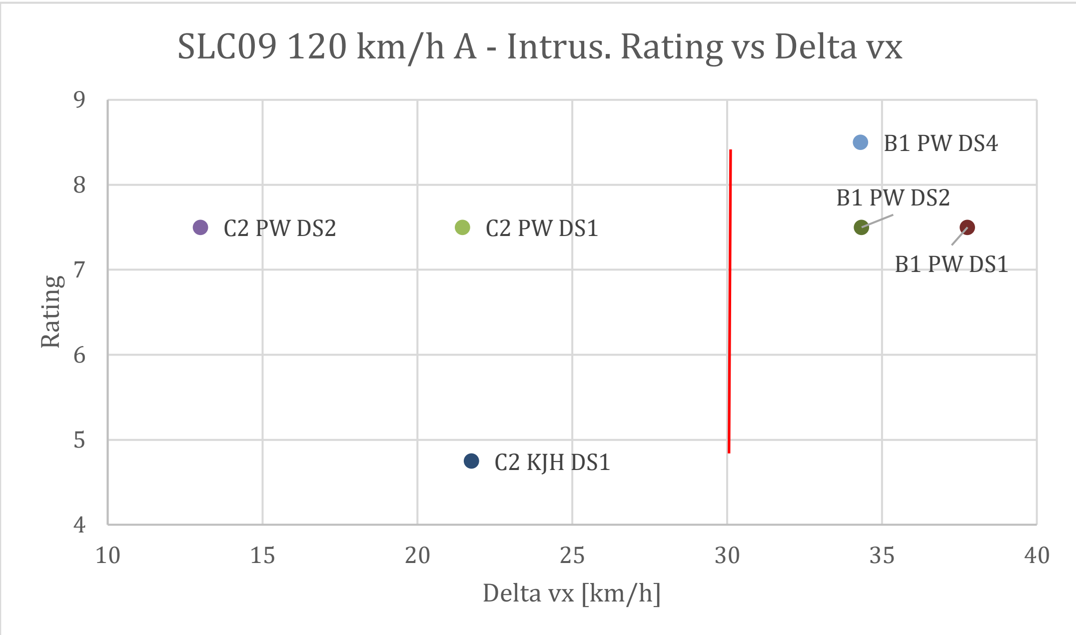



SLC05 100 km/h M - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
B1 PW DS3
B1 PW DS2
B1 PW DS1
C2 KJH DS1
C1 PW DS1
C2 PW DS2
C2 NH DS2
C2 PW DS1


SLC06 100 km/h A - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
10
9
8
7
6
5
4
3
5
10
15
20
25
30
35
40
C2 PW DS1
C2 PW DS2
C2 KJH DS1
C1 PW DS2
C2 NH DS1
C1 PW DS1
B1 PW DS4
B1 PW DS3
B1 PW DS1
B1 PW DS2


SLC07 120 km/h S - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
8
7
6
5
4
3
2
1
0
4
6
8
10
12
14
B1 PW DS4
B1 PW DS3
B1 PW DS1
B1 PW DS2
C1 NH DS1
C2 PW DS2
C2 PW DS1
C2 NH DS2
C1 NH DS2
C2 NH DS1
C1 PW DS1
C2 KJH DS1
C1 PW DS2


SLC08 120 km/h M - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
9
8
7
6
5
4
5
10
15
20
25
30
35
40
45
B1 PW DS3
B1 PW DS4
B1 PW DS1
B1 PW DS2
C2 NH DS1
C2 NH DS2
C2 KJH DS1
C2 PW DS2
C2 PW DS1
C1 PW DS1


SLC09 120 km/h A - Intrus. Rating vs Delta vx
Rating
Delta vx [km/h]
9
8
7
6
5
4
10
15
20
25
30
35
40
B1 PW DS4
B1 PW DS2
C2 PW DS2
C2 PW DS1
B1 PW DS1
C2 KJH DS1