EUROPEAN NEW CAR ASSESSMENT PROGRAMME

Technical Bulletin

Robot Friction Measurement for LSS Testing

Version 1.1

December 2023

TB 038

Title	Robot Friction Measurement for LSS Testing
Version	1.1
Document Number	TB 038
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Date	December 2023
Related Documents	AEB C2C, AEB VRU & LSS testing protocols
Application Date	1st January 2023

Preface

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this document is accurate and reflects the technical decisions taken by the organisation. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, Euro NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

EUROPEAN NEW CAR ASSESSMENT PROGRAMME (Euro NCAP)

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1. Introduction

This Technical Bulletin (TB 038) defines the friction requirements for steering robots that are used in the assessment of Lane Support Systems (LSS) as well as Emergency Steering Support (ESS) systems. It also serves as a check for possible incorrect and constrained mounting of the steering robot resulting in high friction, which can negatively impact the performance of a Lane Keep Assist (LKA), ELK (Emergency Lane Keeping) or ESS systems.

During Euro NCAP LSS testing, the steering robot is switched to 'free-mode' once a system reaction has been anticipated. The 'free-mode' sets the robot to a passive status where only the residual friction remains to be overcome by the lane support system to redirect the car back.

In the event that a vehicle demonstrates abnormal performance during an LSS test, the OEM may request that the Euro NCAP test laboratory performs a friction measurement in accordance with the following procedure. In the event the performance was not as predicted by the OEM (with a friction level up to 0.9 Nm), the Euro NCAP Secretariat shall be informed. Where the OEM can demonstrate that the limitations with test equipment are adversely influencing the system performance, alternative test methods will be considered.

This document should be used in conjunction with the Euro NCAP AEB C2C, LSS VRU & LSS Testing protocols.

2. Steering Robot Friction Measurement Procedure

The procedure quantifies the influence of a steering robot during the critical part of a test run where the steering robot is deactivated, and the action of the lane support system is expected.

2.1 Measuring device

2.1.1 A steering robot with accurate torque measurement is needed.

2.1.2 An example test execution is detailed in Annex I.

2.1.3 The measured torque values shall be filtered with a low-pass 4 pole Butterworth filter and 6Hz cut-off frequency.

2.2 Procedure

2.2.1 Ensure that the vehicle remains stationary throughout the entire procedure.

2.2.2 The friction of the robot actuator is measured by manually turning the steering wheel with an amplitude of ±45 degrees, where 0 degrees being the centred steering wheel position (driving in a straight line), and the robot being in the same state as during the critical manoeuvre (‘free-mode’). Then the average torque T, considering the turning direction and the linked prefix is calculated.

2.2.3 This test must be executed three times, and the following must be checked:

2.2.4 The recorded torque value must not exceed:

Tmax=0.9 Nm

2.2.5 The recorded torque value must exceed:

Tmin=0.2 Nm

(Simulating hands on situation during the LSS)

2.2.6 To ensure constant and steady friction, the standard deviation must also be checked in accordance with the formula:

$$T_{stddev} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} T_i^2 - T_{mean}^2} < \ 0.4 \text{ Nm}$$

n= number of torque measurement samples

2.2.7 The measurement of friction must be verified for both rotation directions independently and for the 3 tests in each direction (6 verifications in total).

2.2.8 It is important to make sure the test starts with a steering angle greater than 45 degrees or less than -45 degrees to avoid any discontinuities in the measurement trace. See Figure 1.

Example of friction curve:

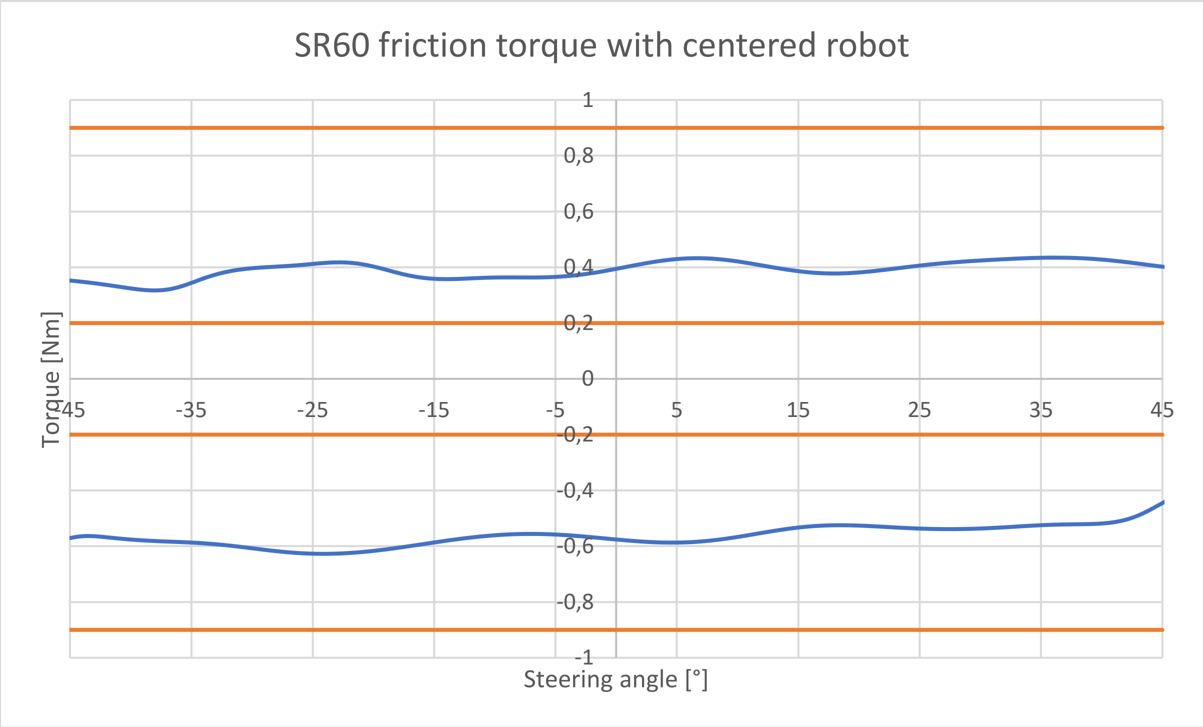
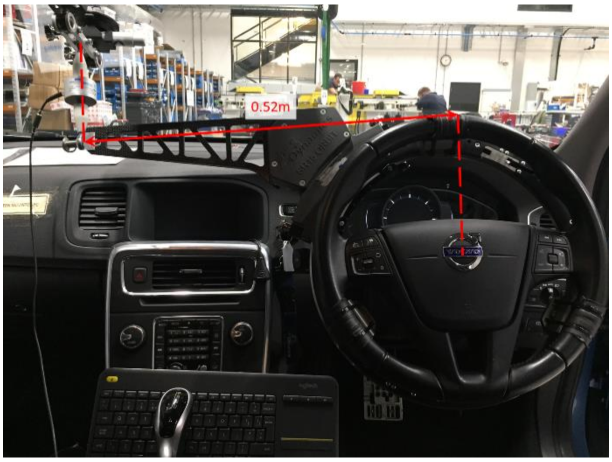


Figure 1: Example friction output

Annex I

Example procedure utilising SR15 Orbit or other similar steering robots

1. Ensure that the vehicle remains stationary throughout the entire procedure.
2. Attach robot according to normal installation instructions.
3. Swap tie-down rod for load cell & sucker mount assembly.
4. Ensure that load cell runs perpendicular to the arm of the robot and is in plane with the gear ring.



5. Power up robot with steering robot in '0' position to ensure the SR angle is zeroed.
6. Create a ‘Learn Test’ as a record of data.
7. Edit ADC channels by opening: *'Vehicle Edit/Test'* > *'Test & Results'* > *'Set up Transducers'* > *' ADC channels'.*
8. Find corresponding ADC channel for connected load cell and configure the sensitivity and units.
9. Zero the current reading to compensate for the force read due to the weight of the robot arm and load cell assembly.
10. Torque is calculated as:

$$T_{Friction} = Fd$$

Where F = Force in link (N)
And d = link separation (m)

Calculated channel:

$$T_{Friction} = N? * 0.52$$

Where "?" = ADC Channel number

11. Take an initial reading by slowly rotating (<40 °/s) the steering wheel by hand.
12. If there is a prominent sinusoidal torque pattern occurring once per cycle, recentre the Orbit gear ring to the steering column to reduce the effects of vertical force translated to the load cell.
13. Take a secondary reading. You may wish to centre the hysteresis curve about 0 by increasing or decreasing the analogue offset.
14. Take 3 further readings according to step 11.
15. Review data and a apply a filter to reduce noise that would likely not be detected by the vehicle's ADAS (in this report, a 6Hz, 4 pole Butterworth filter was applied).

16. Crop graph to area of interest (-45 to 45 degrees) for increasing SR angle and fit a trend line of least squares regression for each plot. This will be used to determine the average friction value.
17. Repeat step 12 for decreasing SR angle.
18. If the resultant friction torque is too high, try loosening the two thumb screws of the motor assembly by a ¼ turn (see image below) and repeat steps 11-17: