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Robot Friction Measurement for LSS

Crash Avoidance

Technical Bulletin CA 201

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PREFACE

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this protocol 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).

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INTRODUCTION

This Technical Bulletin outlines the friction requirements for steering robots used in the assessment of Lane Support Systems (LSS) and Emergency Steering Support (ESS) systems. Additionally, it provides a verification process to detect incorrect or constrained mounting of the steering robot, which could lead to excessive friction and negatively affect the performance of Lane Keep Assist (LKA), Emergency Lane Keeping (ELK), or ESS systems.

During Euro NCAP LSS testing, the steering robot is switched to "free mode" once a system reaction is anticipated. In this mode, the robot enters a passive state, where only residual friction remains. The lane support system must overcome this residual friction to steer the vehicle back into position.

If a vehicle exhibits abnormal performance during an LSS test, the Vehicle Manufacturer may request that the Euro NCAP test laboratory conducts a friction measurement following the procedure outlined in this document. If the measured friction level exceeds 0.9 Nm and the vehicle's performance deviates from the Vehicle Manufacturer’s expectations, the Euro NCAP Secretariat must be notified. In cases where the Vehicle Manufacturer can demonstrate that test equipment limitations are adversely affecting system performance, alternative test methods may be considered.

This document should be used in conjunction with the Euro NCAP Crash Avoidance – Lane Departure Collisions protocol.

1 SR 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.

1.1 Measuring device

A steering robot with accurate torque measurement is needed.

An example test execution is detailed in **Error! Reference source not found.**.

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

1.2 Procedure

Ensure that the vehicle remains stationary throughout the entire procedure.

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.

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

The recorded torque value must not exceed:

Tmax=0.9 Nm

The recorded torque value must exceed:

Tmin=0.2 Nm

(Simulating hands on situation during the LSS)

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

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

n= number of torque measurement samples

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

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.

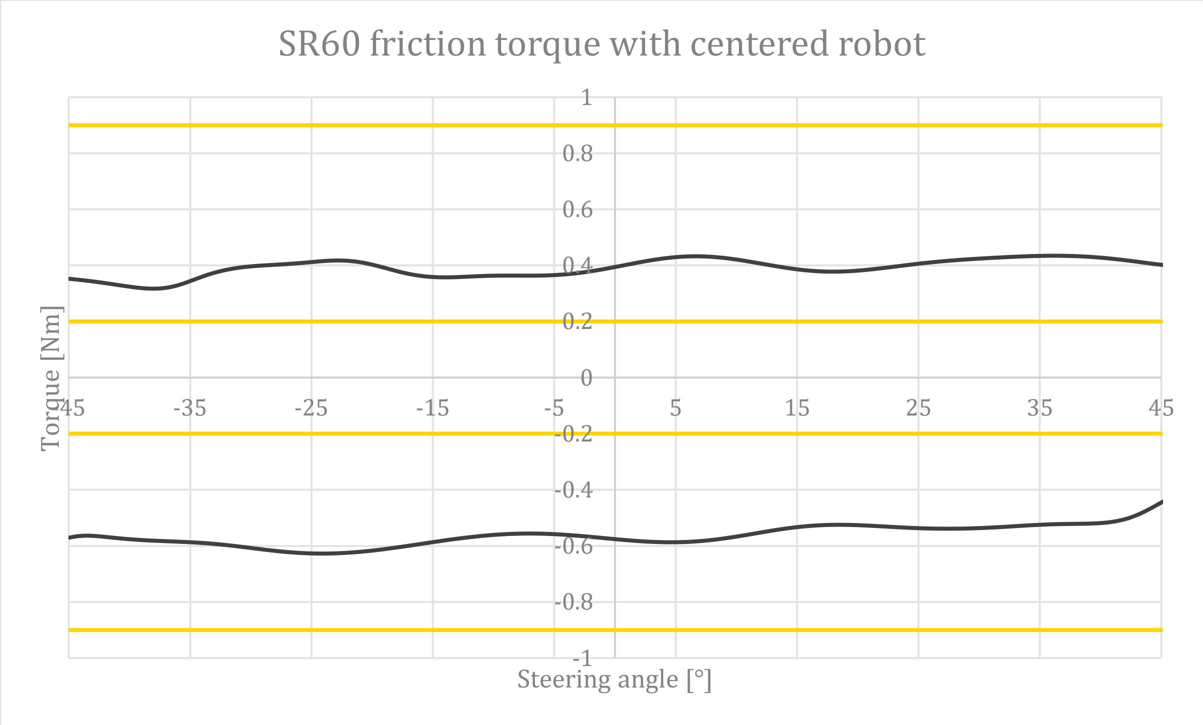

Figure 1: Example friction output

APPENDIX A EXAMPLE OF PROCEDURE

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: