Electronic Stability Control, ESC, Double Lane Change Maneuver on Concrete, Asphalt at 80 km/h

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The intent of this maneuver is to turn aggressively into the next lane in order to avoid an obstacle and to quickly return to the original lane. This type of maneuver will activate the Electronic Stability Control (ESC) system to assist the driver. The Steering Wheel Angle (SWA) inputs have been designed to force the driver to steer the vehicle in an open loop manner to avoid introducing test variation due to driver skill.

1.2 Foreword. Not applicable.

1.3 Applicability. This procedure is applicable at all permissible loading conditions to all ESC equipped passenger cars and light trucks with a Gross Vehicle Mass (GVM) up to 4354 kg (9600 lb). Trucks with GVM greater than 4354 kg (9600 lb) may use this procedure, but reduced test speeds may be necessary.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

2.3 Additional References.

Subsystem Technical Specification (SSTS)

Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.3 Laboratory for test vehicle build and instrumentation installation.

3.1.4 Surface area must be of sufficient size to accommodate test maneuvers without vehicle leaving surface.

3.1.3 Vehicle weigh station capable of measuring vehicle weight at each corner.

3.2 Equipment.

3.2.1 Brake pressure sensors located at each corner and at master cylinder.

3.2.2 Vehicle SWA sensor with stops.

3.2.3 Yaw rate sensor at the vehicle center of gravity, capable of measuring ± 75 degrees/s.

3.2.4 Lateral accelerometer at the vehicle center of gravity, capable of measuring ± 1.25g.

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3.2.5 Longitudinal accelerometer at the vehicle center of gravity, capable of measuring ± 1.25g.

3.2.6 Vehicle side slip sensor at the vehicle's center of gravity, capable of measuring speed accuracy to 0.05 km/h and with a Slip Angle to an accuracy of no less than 0.15° in its highest accuracy product/mode.

3.2.7 Wheel speed sensors at each corner.

3.2.8 Brake switch and throttle position.

3.2.9 Brake pad temperatures at each corner 65 °C to 93 °C (150 °F to 200 °F).

3.2.10 Sample rate is 10 ms.

3.2.11 Pedal force transducer installed at service brake.

3.3 Test Vehicle/Test Piece. See Section 4.

3.4 Test Time.

Calendar time:	Not applicable
Test hours:	4 hours
Coordination hours:	Not applicable

3.5 Test Required Information. See Section 4.

3.6 Personnel/Skills. Experienced chassis test technician for vehicle instrumentation. Chassis test driver certified for handling tests.

4 Procedure

4.1 Preparation.

4.1.1 All instrumentation must be securely fastened to the vehicle due to the nature of the test maneuver. Instrumentation should be located on the passenger seat or on a rear seat to avoid excessive ballast in the rear of the vehicle. Velocity sensors that are mounted outside the vehicle should be mounted on the front of the vehicle with protective shielding to protect the sensor from potential damage due to snow banks. The distance from the sensor to the centerline of the front axle must be measured in meters for use in post processing data in order to determine the vehicle's slip angle.

4.1.2 Vehicle Preparation. Ballast vehicle to curb weight before installation of instrumentation. After installation of instrumentation, the vehicle must be within suspension alignment specifications (toe) with a full tank of fuel. Tire pressures should be set to at least 240 kPa (35 psi) cold pressure to maintain tire/rim interface. Tires should be broken in, but must not have excessive wear. Brake system operation must not have excessive compliance due to worn brake pads or air in the hydraulic system. A roll cage should be considered for any vehicle with a high center of gravity.

4.1.3 Operator Precautions. All instrumentation must be securely fastened due to the nature of vehicle dynamics testing. The vehicle operator must use the vehicle restraint system at all times. The vehicle's air bag should be disarmed due to the SWA sensor installation. Vehicle dynamic testing must be done in the middle of a test surface to avoid leaving the boundaries of the test surface. Steering wheel angle stops will be used in both steering directions. The vehicle operator may want to use a pin to jam steering stop mechanism to allow SWA operation in a fluid manner which may be difficult if the operator has to hold the steering stop mechanism in place while performing the test maneuver.

4.2 Conditions.

4.2.1 Environmental Conditions. Wind speed should be less than 32 km/h (20 mph).

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

The test is to be performed on a large vehicle dynamics test pad. The surface friction coefficient is to be between 0.8 and 1.0.

4.3 Instructions.

4.3.1 Zero Instrumentation. Drive vehicle straight ahead. The velocity sensor V(y) signal should be at (0 ± 0.05) km/h with the vehicle travelling straight ahead. The yaw rate sensor and lateral accelerometer should be at (0 ± 0.5) degrees/s and (0 ± 0.02)g respectively with vehicle travelling straight ahead. The SWA

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sensor should be (0 ± 1.0) degrees with vehicle travelling straight ahead. Brake pressure sensors should be at (0 ± 69) kPa ((0 ± 10) psi) with no brake pedal input.

4.3.2 Measure the Surface Friction Coefficient. The surface friction coefficient is to be between 0.8 and 1.0, and should be measured by taking the average deceleration of two (2) opposite direction straight line Antilock Brake System (ABS) stop test runs.

4.3.3 Determine Maximum Lateral Acceleration Steering Wheel Angle (MLSWA). Steering wheel angle inputs are determined as a ratio of the SWA at the maximum vehicle lateral acceleration on the test surface at the initial test speed. The SWA at maximum vehicle lateral acceleration is determined by driving the vehicle with ESC turned off at the initial test speed on the test surface. At the initial test speed, the vehicle SWA is turned at a rate of less than 45 degrees/s while maintaining the test speed until the vehicle reaches maximum lateral acceleration. Special attention needs to be taken to utilize the test surface in a manner which allows the vehicle run off room. Two (2) left hand and two (2) right hand maneuvers should be performed. Each test maneuver will yield the SWA at which maximum vehicle lateral acceleration occurred. The four (4) SWA values will then be averaged to determine the Maximum Lateral Acceleration Steering Wheel Angle (MLSWA). Each maneuver should be scrutinized for possible test variation due to inconsistency in the test surface (rut in snow field for example). This may lead to possible omission of select test runs from the SWA average calculation.

4.3.4 Set SWA Sensor Stops. The steering stops should be located at 1.25 times the maximum lateral acceleration SWA input in the direction of the initial lane change and at 1.5 times the maximum lateral acceleration SWA input in the direction necessary to straighten vehicle into the next lane. A pin should be used holding the steering wheel stop mechanism. Performing the test maneuver in the middle of a test surface should eliminate the potential of leaving a test surface due to the steering stop mechanism being engaged.

4.3.5 Perform Test. Upon measuring and determining a valid surface friction coefficient and having properly set up the steering wheel stops, the test driver will achieve a constant test speed of 80 km/h and then perform the steering wheel inputs with no accelerator pedal input. See Table 1.

Table 1: Steering Wheel Inputs

	Steering Wheel Angle Movement Procedure	Ramp Time for SWA Input
1	0 degrees to ((-1.25) × MLSWA) degrees	0.25 s to 0.5 s
2	((-1.25) × MLSWA) degrees hold	0.15 s to 0.4 s
3	((-1.25) × MLSWA) degrees to (1.5 × MLSWA) degrees	0.5 s to 1.0 s
4	(1.5 × MLSWA) degrees hold	0.15 s to 0.4 s
5	(1.5 × MLSWA) degrees to ((-1.25) × MLSWA) degrees	0.5 s to 1.0 s
6	((-1.25) × MLSWA) degrees hold	0.15 s to 0.4 s
7	((-1.25) × MLSWA) degrees to (0 ± 45) degrees	0.3 s to 0.6 s

The time for the last steer input is to the zero degrees crossing point allowing for some corrective steer overshoot. Data for each test run must be reviewed for proper steering inputs. Four (4) test runs must be made for both left and right hand turns.

5 Data

5.1 Calculations.

5.1.1 If using an approved Inertial and Global Positioning System (GPS) sensor, the time delay of the Inertial and GPS sensor should be understood and correct offset applied to the data channels. If using other sensors the longitudinal and lateral velocity signals must be shifted forward the correct amount of time in the time domain to offset the lag in the sensor's output.

5.1.2 If measuring Vx and Vy the vehicle slip angle shall be calculated using the following formula: (This will calculate vehicle slip angle at the vehicle's center of gravity):

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