



Active All Wheel Drive/Four Wheel Drive (AWD/4WD) High Coefficient of Friction (Summer) Test

1 Introduction

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. Provide a common global development and validation performance evaluation of a passenger vehicle that utilizes All Wheel Drive (AWD) or active Four Wheel Drive (4WD) technology.

1.2 Applicability. For vehicles equipped with AWD systems and Active Transfer (T) Cases.

The procedures contained in this document are specific to high coefficient of friction (μ) conditions and should not be considered all-inclusive for AWD systems and Active Transfer Case validation requirements.

1.3 Remarks. This procedure defines the vehicle maneuvers required to develop/validate the software and calibrations that are used to control the active coupling technology transfer cases that transfer torque from the primary drive axle to the secondary drive axle.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14264

2.3 Additional References.

- Analysis/Development/Validation (ADV) Plan
- CANape Software Tools, Vector Informatik, based in Stuttgart, Germany, www.vector.com
- CG3940 Data Log - Active AWD 4WD Hi-Co (summer) Test.xlsx
- Engineering Tools, Application and Services (ETAS) Group, based in Stuttgart, Germany, www.etas.com
- Statement of Requirements (SOR)
- Subsystem Technical Specification (SSTS) for electronic Limited Slip Differential (eLSD)/Rear Drive Module (RDM) (active)/T Case (active)
- Validation Cross-Reference Index (VCRI)
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities. Closed test facility that includes the following:

- a. Large, flat, smooth, high μ (concrete or asphalt) area (46 m $\times$ 92 m (150 ft $\times$ 300 ft)).
- b. Hill, 12%, split μ (high μ /low μ) front/rear and left/right.
- c. Hill, 20%, split μ (high μ /low μ) front/rear and left/right.
- d. Gravel/Sand pit.
- e. City course.

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- f. Highway course.
- g. Off Road gravel hills.

Note: High μ should be pavement, asphalt, or equivalent; low μ should be ice, wet tile or equivalent.

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.

3.2 Equipment.

3.2.1 CANape (software tool) Data system or equivalent (available from Vector Informatik).

3.2.2 ETAS Data system (optional) (available from ETAS Group).

3.2.3 Strain-gauged half shaft(s) to measure driveline torque. Calibrate each shaft to two times yield strength and make sure instrumentation gain is also set to account for these higher than normal loads.

3.3 Test Vehicle/Test Piece. Test vehicle with production representative driveline.

3.3.1 Test Vehicle. Vehicle shall be equipped with specific driveline configuration requested. It may be possible to interchange driveline, chassis controls, wheels/tires and powertrain hardware/software to accomplish multiple test configurations on the same vehicle.

3.3.1.1 All available combinations of engine, transmission, final drive ratios, tires and propulsion combinations may need to be tested separately due to differences in driveline reactions and other hardware/electronic influences. Consult requesting engineer to determine objective of test and required combination(s) of the systems to meet test objectives.

3.3.1.2 Wheels and tires used during testing should be the Original Equipment Manufacturer (OEM) recommended/required type (brand, size, construction, etc.)

3.3.2 Vehicle Ballast. Production intent vehicle curb weight plus driver and equipment. Other ballast/trailer conditions can be tested if requested. Document vehicle mass condition on CG3940 data log.

3.3.3 Drivetrain Hardware. All drivetrain hardware that is being tested for validation purposes should be **new** or have less than 500 km of accumulated general usage (without abuse testing). If hardware has greater than 250 km of usage, no additional break-in is required. Otherwise, see 4.1.4 for break-in procedure. Evaluations using this test procedure can be performed using hardware with higher mileage for informational or development purposes.

3.4 Test Time.

Calendar time: 5 days
Test hours: 16 hours
Coordination hours: 8 hours

3.5 Test Required Information.

Possible sources are:

- Analysis/Development/Validation (ADV) Plan.
- Application Engineer.
- Development Groups.
- Drawings.
- Statement of Requirements (SOR).
- Subsystem Technical Specification (SSTS).
- Validation Cross-Reference Index (VCRI).
- Vehicle Technical Specification (VTS).

3.6 Personnel/Skills. A trained driver/technician or engineer should conduct this test evaluation who is able to maneuver the vehicle according to the driving sequences listed herein, and induce behavior on test vehicle for the purposes of evaluating the response. In addition, a person who has the ability to evaluate vehicle response

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with respect to calibration of Active Clutch Control System and who has the ability to conduct end of test inspection of test parts if required.

4 Procedure

4.1 Preparation.

4.1.1 Set tire pressure to specifications.

4.1.2 Check all fluid levels. Fill as required.

4.1.3 Put vehicle on hoist and conduct inspection on all driveline torque carrying components. Inspection should note any leaks, or unusual conditions.

4.1.4 Determine and record the wheel speeds, torque values, throttle pedal positions, gear state, estimated torque signals, vehicle acceleration, and Traction Control System (TCS)/Antilock Brake System (ABS)/Vehicle Stability Control (VSC) status vs. time for the maneuvers in the chassis/driveline mode combinations to be tested, based on requirements in 3.5 or as required by Requesting Engineer.

4.1.5 Break-In. A break-in is recommended for new engines and transmissions. Break-in is mandatory if a new axle is installed for test or the test vehicle/axle has accumulated less than 200 km of usage.

4.1.5.1 Complete Break-In as Follows:

- Accelerate lightly to 100 km/h, and then vary vehicle speed between 100 km/h and 125 km/h for a total of 10 km.
- Use light braking to bring vehicle to a stop.
- Repeat cycles as above until a distance of 200 km is attained. A minimum of 200 km is mandatory if rear axle is included in the validation.

4.2 Conditions.

4.2.1 Environmental Conditions. Dry roads.

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.

4.3 Instructions.

4.3.1 Selectable Transfer Cases, AWD Mode. Shift the transfer case into the AWD mode. Perform 4.3.1.1 through 4.3.1.22 with TCS and VSC both active and deactivated.

4.3.1.1 High μ Accelerations.

4.3.1.1.1 Forward Accelerations from Stop. On a high μ surface, from a stationary position in a straight line:

- Accelerate 10 km/h to 40 km/h, make a right full lock turn and coast to a stop.
- Accelerate 10 km/h to 40 km/h, make a right half ($\frac{1}{2}$) lock turn and coast to a stop.
- Make a right full lock turn, accelerate Wide Open Throttle (WOT) (until tires squeal) and coast to a stop.
- Accelerate 10 km/h to 40 km/h, make a left full lock turn and coast to a stop.
- Accelerate 10 km/h to 40 km/h, make a left half ($\frac{1}{2}$) lock turn and coast to a stop.
- Make a left full lock turn, accelerate WOT (until tires squeal) and coast to a stop.

4.3.1.1.2 Reverse Accelerations from Stop. On a high μ surface, from a stationary position in a straight line:

- Accelerate 10 km/h to 40 km/h, make a right full lock turn and coast to a stop.
- Accelerate 10 km/h to 40 km/h, make a right half ($\frac{1}{2}$) lock turn and coast to a stop.
- Make a right full lock turn, accelerate WOT (until tires squeal) and coast to a stop.
- Accelerate 10 km/h to 40 km/h, make a left full lock turn and coast to a stop.
- Accelerate 10 km/h to 40 km/h, make a left half ($\frac{1}{2}$) lock turn and coast to a stop.
- Make a left full lock turn, accelerate WOT (until tires squeal) and coast to a stop.

4.3.1.1.3 Gradually Increasing Diameter Circles.

- Drive in gradually increasing diameter circles with a constant throttle.

4.3.1.1.4 More Forward Accelerations. With the vehicle at a complete stop and in AWD mode:

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