



Accelerator Control System - Response Time Evaluation

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. To determine return-to-idle-condition time for the accelerator systems when the vehicle is operating.

For hybrid, electrical, Brake Apply Sensor (BAS) and fuel cell vehicles, additional testing is required to determine no positive torque commanded from the electric motors condition time for the hybrid motor system when the vehicle is operating at various accelerator displacements, speeds and loads, temperature ranges, and disconnections consistent with the following requirements:

- Federal Motor Vehicle Safety Standard (FMVSS) 124.
- Canada Motor Vehicle Safety Standard (CMVSS) 124.
- Korean Motor Vehicle Safety Standard (KMVSS) Article 87 (Article 13).
- Indian Standard (IS) 14283: 1995.

1.2 Applicability. This procedure applies to all passenger cars, multi-purpose passenger vehicles, trucks, and buses.

1.3 Remarks. This standard is for testing of vehicle accelerator control systems to ensure that they meet requirements of various government requirements. See US Federal requirement FMVSS 124, and Canadian Government requirement CMVSS 124 for more detail if required.

1.3.1 From any accelerator position or speed, there shall be at least two energy sources capable of returning the accelerator control to the idle condition within the time limit specified in Table A1, Appendix A, whenever the driver removes the opposing actuating force.

1.3.2 In the event of a failure of one energy source, by a single severance or disconnection, the remaining energy source shall return the accelerator control to the idle condition within the times specified in Table A1, Appendix A.

1.3.3 In the event of a single point disconnection or severance of any one component of the system, mechanical or electrical, the accelerator control will return to the idle condition within the times specified in Table A1, Appendix A.

1.3.4 For hybrid, electric, BAS and fuel cell vehicle, in the event of a failure of the hybrid motor controller by a disconnection or severance, the hybrid motor controller shall command no positive torque to the motor output shaft going to the axle within the times specified in Table A1, Appendix A.

2 References

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

2.1 External Standards/Specifications.

CMVSS 124 FMVSS 124 IS 14283: 1995 KMVSS Article 87 (Article 13)

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- ETAS Incorporated, Ann Arbor, Michigan (www.etas.com)

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- Global Document Management (GDM) System FMVSS Pretest Checklist Template (<https://documents.naeng.gm.com/gdm3/drl/objectId/090163bc833220fd/chronicleId/090163bc833220fd>) (ID)
- Performance and Quality Management System (PQMS) Activity Request (https://pqms.gm.com/pqms/search-for-sg-create_request.do?typeOfRequest=PER_REQUEST&cacheMenuId=859) (ID)

(ID) = This web page is limited to internal access within General Motors and shall not be accessed outside this company. Contact the GM Lead Engineer for further instructions.

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 An environmentally controlled chamber with the minimum capability of maintaining the temperature of the air surrounding the vehicle as follows:

- US and Canada requirements: -40 °C for cold testing, +52 °C for hot testing, 20 ± 10 °C for ambient testing.
- Korea requirements: -18 °C for cold testing, +52 °C for hot testing, 20 ± 10 °C for ambient testing.
- India requirements: -10 °C for cold testing, +52 °C for hot testing, 20 ± 10 °C for ambient testing.

3.1.4 Dynamic Chassis Dynamometer inside of an environmentally controlled chamber as specified in 3.1.3, if applicable (see 4.3.1).

3.2 Equipment.

3.2.1 A device to apply a force, suddenly remove the force, and electrically indicate when the force has been removed from the driver-operated accelerator control system.

3.2.2 A vehicle diagnostic data acquisition system, including hardware and software that can record vehicle parameters vs. time. Examples are the ES690/ES1000 and ES600/610 hardware, and INCA software manufactured by ETAS Incorporated. The INCA system handles Controller Area Network (CAN) and GM Local Area Network (LAN) systems.

3.2.3 Laptop computer that is capable of interfacing with the vehicle diagnostic data acquisition system from 3.2.2 and recording vehicle parameter information.

3.2.4 Auxiliary starting equipment, for use when testing in the cold environment(s). This may include jump starters, block heaters, synthetic oil, additional replacement starter motor, and replacement spark plugs.

3.2.5 Instrumentation box that is used as the severance tool for the electrical inputs of the accelerator control system and/or the electric motor(s) torque controller system (e.g., pedal severance, throttle body severance and electric motor(s) torque controller severance, etc.) The instrumentation box shall enable and disable the relay severance boxes that will allow the simultaneous severance of multiple conductors from a single device input (e.g., pedal input, etc.) This box, therefore, simulates the severance of one or more electrical conductors at the instance when the release of the actuating force is detected. The conductors that are to be severed in a device during the test are listed in the checklist. (Reference Data Sheets A1, A2, A3, and A4 (Appendix A).)

3.2.6 Engine oil for the operating temperatures specified in this procedure (e.g., -40 °C to +52 °C for US and Canada), such as Mobil 1, 5W30 motor oil.

3.2.7 Fuel for the operating temperatures specified in this procedure (e.g., -40 °C to +52 °C for US and Canada), such as Reduced Vapor Pressure (RVP) 15 fuel for gasoline engines.

3.2.8 Mix of antifreeze/water for the operating temperatures specified in this procedure (e.g., -40 °C to +52 °C for US and Canada) per antifreeze concentrate product use directions.

3.2.9 Optional. Block or oil heater for cold environmental testing.

3.3 Test Vehicle/Test Piece.

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Note: The test vehicle must be received by the test facility a minimum of one (1) week (additional weeks are required for a hybrid, electric, BAS and fuel cell vehicles) prior to the desired test start date.

3.3.1 If all accelerator system components are identical between automatic and manual transmission vehicles, and the vehicle does **not** use an automatic transmission throttle/transmission valve cable, then either a manual or automatic transmission test vehicle can be used to represent both configurations.

3.3.2 If the vehicle application does use an automatic transmission throttle/transmission valve cable, which provides additional throttle return energy, and all other accelerator system energy sources are identical between an automatic and manual, then an engineering judgment can be made that the manual transmission vehicle will exhibit the longest response time (worst case), and therefore, only the manual needs to be tested. Otherwise both transmission configurations shall be tested to determine **worst case**.

3.3.3 On vehicles over 4536 kg Gross Vehicle Weight Rating (GVWR) that have accelerator control system differences between automatic and manual transmission configurations, modifications to simulate one configuration for the other is acceptable as agreed upon between the requesting engineer and the test engineer, provided all control system physical differences are incorporated as part of the simulation modification.

3.3.4 All accelerator control system and/or electric motor(s) torque controller parts used on the test vehicle shall be production intent. If the disconnection or severance is within the component, it is best to have the supplier of these components perform the disconnection or severance to the part before the parts are acquired by the test facility (e.g., pedals and throttles).

3.3.4.1 The number of throttle bodies required is one more than the number of throttle body return energy springs.

3.3.4.2 The number of pedals required is one more than the number of pedal return energy springs.

3.3.5 Software, engine calibration, Electronic Throttle Control (ETC) and for hybrid, electric, BAS and fuel cell vehicles, the electric motor(s) torque controller(s) all need to be at the 99% development state.

3.4 Test Time. This is an estimate of the amount of time (work hours) needed to perform this procedure.

Note: These time estimates are approximate averages. Actual times vary considerably depending on early component issues (and subsequent availability of replacement parts), varying requirements for frequency of environmental test conditions, scheduling problems for test facilities, test equipment malfunctions, scheduling of overtime and/or multiple shifts, scheduling of witnesses for tests, actual readiness of test samples upon receipt, unique or additional requests for detailed test information, running multiple samples (times shown are for one system), etc.

These times consider preparation and other downtime, actual test, and analysis of data in capturing a total calendar time. Report writing, approval, processing, etc., are not part of these times.

Calendar time: 10 days (additional 10 days for hybrid, electric, BAS and fuel cell)

Engineer hours: 40 hours (additional 40 hours for hybrid, electric, BAS and fuel cell)

Technician hours: 16 hours (additional 16 hours for hybrid, electric, BAS and fuel cell)

3.4.1 Prepare Vehicle. Two (2) days $\pm$ 1 day (16 man-hours $\pm$ 8 man-hours) (Additional time is required for hybrid, electric, BAS and fuel cell vehicles). Install instrumentation (e.g., vehicle diagnostic data acquisition system, laptop computer and instrumentation box) and replace parts as specified in 4.1 thru 4.1.8.

3.4.2 Actual Test Time Breakdown. Note: Additional time is required for Hybrid, Electric, BAS and Fuel Cell vehicles.

- Run worst case/analyze data, 8 h (1 day duration).
- Hot soak (52 °C), 12 h (overnight).
- Conduct hot test/analyze data, 4 h (1 day duration).
- Cold soak (-40 °C), 12 h (overnight).
- Conduct cold test/analyze data, 4 h (1 day duration).

3.4.3 Coordination Hours.

- Procure vehicle, 1 h (2 days duration).
- Schedule dyno/environmental chamber, 1 h.

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- Analyze data, 4 h.
- Obtain data signoff sheets, 1 h.

3.5 Test Required Information.

3.5.1 An Activity Request (through Performance and Quality Management System (PQMS)) must be turned in to the test facility a minimum of 30 calendar days prior to the desired start of test.

3.5.2 A FMVSS pretest vehicle checklist template must also be submitted to the test laboratory which includes, but is not limited to, controller and calibration information, data collection information, (e.g., vehicle parameters to be measured), required vehicle interface tools, signal database files, etc. The checklist template can be accessed through Global Document Management (GDM) system.

Note: The completed checklist must be turned in to the testing facility a minimum of 30 days prior to the test start date. The ultimate responsibility for populating the checklist with the proper information resides with the test requester.

3.6 Personnel/Skills. Prior experience in setting up and running similar tests, and experience in the use of the referenced test equipment are critical to achieving the estimated times shown in 3.4.

3.6.1 Test Engineer, project management skills, mechanical skills, basic electrical skills, accelerator control system familiarity, vehicle serial network operation familiarity, vehicle serial network diagnostic familiarity, ability to download software into an Electric Control Unit (ECU) using the serial network, and computer skills.

3.6.2 Engineering Technician, mechanical skills, basic electrical skills, accelerator control system familiarity, vehicle serial network operation familiarity, vehicle serial network diagnostic familiarity, ability to download software into an ECU using the serial network, computer skills, knowledge in environmental chamber and dynamometer operation.

4 Procedure

4.1 Preparation.

4.1.1 Record the requested test vehicle identifiers and vehicle configuration information in 4.1.1 on Data Sheet A1, Appendix A. This information can be obtained from the completed FMVSS pretest vehicle checklist template (accessed through GDM).

4.1.1.1 For hybrid, electrical, BAS and fuel cell vehicles, an additional Data Sheet A3, Appendix A, needs to be completed.

4.1.2 Prepare the vehicle by replacing the appropriate production intent components that have been identified under the Additional Test Parts and Information Required section of the FMVSS pretest vehicle checklist template (accessed through GDM) If production parts are not available, then an engineering judgment will need to be made as to whether the test can be performed with the existing parts.

Note: Use GM's recommended engine oil, fuel and antifreeze for that model at the appropriate temperature. Installation of a block heater may also be desirable for the cold environmental testing.

4.1.3 Update/verify Engine Control Module (ECM)/Powertrain Control Module (PCM) software and calibrations, and record these identifiers in 4.1.3 on Data Sheet A1, Appendix A.

4.1.3.1 For hybrid, electric, BAS and fuel cell vehicles, also update/verify electric motor controller software and calibrations, and record the information in 4.1.3.1 on Data Sheet A3, Appendix A.

4.1.4 Identify all accelerator pedal and throttle return energy sources, and record this information in 4.1.4 on Data Sheet A1, Appendix A. Consider if the automatic transmission version of the application to be tested uses a throttle/transmission valve cable, as this cable has been known to provide some level of return energy.

Note: On ETC/Coordinated Torque Control (CTC) vehicles, the throttle motor is considered an energy source and the potential system severance point can be considered to be at the connector.

4.1.5 Identify all potential severance or disconnection points of the accelerator control system. Consider if the automatic transmission version of the application to be tested uses a throttle/transmission valve cable. For ETC/CTC vehicles, include the Pedal Position Sensor(s) (PPS) connector, the throttle motor connector, and throttle assembly sensors as potential severance or disconnection points. Record this information in 4.1.5 on Data Sheet A1, Appendix A.

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4.1.5.1 For hybrid, electric, BAS and fuel cell vehicles, identify all connection points between the ECM, hybrid controller and the electric motors that control motor torque commands to the output shaft going to the axle. Record this information on Data Sheet A3, Appendix A.

4.1.6 The system can be examined or analyzed before testing to determine which of the identified energy sources, or potential severance or disconnection points, when removed, severed, or disconnected, would not affect closing time (see 4.1.4 and 4.1.5); these conditions do not have to be tested. Indicate this logic in 4.1.6 and 4.1.6.1 on Data Sheet A1 and Data Sheet A3 (Appendix A) respectively.

Note: It is important to understand the ETC/CTC system behavior when severing a single conductor to an energy source because of the complex nature of the closed loop control system. The predicted worst case severance mode of the ETC/CTC system should be determined by the ETC/CTC Design System Engineers (DSE) prior to testing.

4.1.7 Install Instrumentation.

4.1.7.1 For all measuring devices used for recording data while performing this test, record instrument description, data acquisition software version, instrument identification number, instrument calibration date, and the next instrument calibration due date.

4.1.7.2 Connect the vehicle diagnostic data acquisition system to the test vehicle.

4.1.7.2.1 In some applications, the data parameters and acquisition rates required in order to record data quickly enough during the evaluation may not be available using the standard vehicle serial network. An instrumented ECU allows the test engineers access to more detailed information, collected at a faster rate. An instrumented ECU contains a connector that can be directly plugged into the ECU, rather than the alternate method of recording information from the ECU elsewhere on the network.

4.1.7.3 If traction control, vehicle stability, and/or Anti-Lock Braking Systems (ABS) are present in the vehicle, determine if they need to be disabled, locked-out, or circumvented, and perform the appropriate action; this is done so the vehicle can perform on a single axle dynamometer system.

4.1.7.4 Determine if the vehicle has leveling and active suspension systems. If the vehicle has a pneumatic system, then disable the system to avoid burning out the pump system when the vehicle is strapped down to the dynamometer.

4.1.7.5 Install the instrumentation box (see 3.2.5 for a more descriptive explanation of the instrumentation box).

4.1.7.6 Install the force application rod (kick stick).

4.1.7.7 Verify the data acquisition system, e.g., Does the speed (rpm) value on the network match the visual gage on the instrument panel? Does the pedal position read from 0% to 100%?

4.1.7.7.1 Due to the variation in supported diagnostic modes and available diagnostic parameters associated with each calibration and ECU model, the data acquisition system is tested to verify that the required parameters are being collected by the equipment.

4.1.7.7.2 Verify that the vehicle diagnostic data acquisition system being used can clear diagnostic trouble codes that are set during each test run.

4.1.8 For instrumentation clearance purposes, the engine compartment may be left open during the testing.

4.2 Conditions.

4.2.1 Environmental Conditions. FMVSS 124 and CMVSS 124 state that the vehicle shall meet requirements when the engine is running under any load condition, and at any ambient temperature between -40 °C and +52 °C, after 12 h of conditioning in that environment. KMVSS Article 87 (Article 13) states that the vehicle shall meet requirements when tested to -18 °C and +52 °C.

Note: The vehicle shall be soaked at the specified test temperature for at least 12 h prior to test.

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 Test.

Note: This test can be performed without the use of a dynamometer (e.g., no torque on the driveline), providing none of the response times exceed 25% of the maximum allowable response times listed in Table A1, Appendix A. However, if a dynamic chassis dynamometer is readily available, then it should be used to perform

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this test. If the GVWR of the vehicle being tested is ≥ 4536 kg, then all testing can be performed with the drive wheels raised, and no dynamometer is required.

4.3.1.1 Worst Case Configuration Determination.

4.3.1.1.1 Soak the test vehicle at normal room temperature for at least 12 h, $20\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$. Record the actual ambient air test temperature on Data Sheet A2 and Data Sheet A3 (where applicable) (Appendix A).

4.3.1.1.2 With the accelerator control and driver-operated control systems in their nominal (e.g., rest) positions, begin recording, vs. time, for those vehicle parameters specified on the checklist. Shortly after recording begins, apply a load to the driver-operated accelerator control device to achieve the first test condition (NBASN3K0) listed in Data Sheet A2, Appendix A (Test Condition Matrix). When the condition is achieved, instantly remove the force being applied to the driver-operated accelerator control device. Continue to record data of the specified parameters until the engine rpm reaches a steady-state condition. Save the data as file name NBASN3K0. See examples in Data Sheet A4, Appendix A.

4.3.1.1.2.1 For hybrid, electric, BAS and fuel cell vehicles, the following additional testing is required. Make sure you are monitoring the torque commands and torque achieved from the electric motor control system. Start engine, ensure that there are no diagnostic failures and all remedial action variables are not set. If so, clear all codes prior to starting test.

Start driving the vehicle under test condition in Data Sheet A3, Appendix A. Begin within 2 s of data recording, disconnect/severe connection points according to Data Sheet A3, Appendix A for each engine operation and each transmission mode. Continue recording until there is no positive torque commanded or achieved at the electrical motor output shaft. Stop recording and save the data. Make sure the condition remains latched for one key cycle. After a key cycle, restore the vehicle to normal operation. Verify that the vehicle returns to normal mode. Repeat the above test conditions for all connection points on Data Sheet A3.

4.3.1.1.3 If performing the test without the use of a dynamometer, evaluate the response time against the time listed in Table A1, Appendix A. If the response time exceeds 25% of the allowed response time, then all testing must be performed on a dynamometer, except if the vehicle is ≥ 4536 kg.

Note: When running specific severance test cases, some ETC systems and/or electric motor torque system may detect some component disconnections and/or severances of the throttle system and/or electric motor torque system. When this occurs, the ETC system may turn on a driver information light, illuminate instrument panel lighting, and/or allow the throttle to go to a default position and then control engine speed via other engine parameters. The electric motor controller may turn on driver information light, and/or go to a no positive torque state (no propulsion) or shut down the system. Such vehicle actions may be normal remedial system responses to a detected component problem and are not necessarily a test of non-compliance. If one or more of the preceding occur, record these observations of the vehicle behavior. Engine power and torque must approximate or be below before-test idle values. The responsible Engine Management System Engineers and/or Electric Motor Controller System Engineer should be contacted regarding any questions.

4.3.1.1.4 Continue by repeating 4.3.1.1.2, 4.3.1.1.2.1 and 4.3.1.1.3 (if applicable) for the next test case, etc., until all normal room temperature test conditions have been completed. Save each test case file using the file names from Data Sheet A2 and/or Data Sheet A3 (Appendix A). Figure A1 (Appendix A) describes how the file naming convention operates for conventional vehicles; Figure A2 (Appendix A) describes how the file naming convention operates for non-conventional vehicles. If erratic rpm and/or vehicle operation exists due to an induced fault condition, then recording over 30 s of data is not uncommon in order to capture the complete event.

4.3.1.1.5 On Data Sheet A2 (Appendix A), write in the response times for all normal room temperature test conditions that have been completed. For mechanical/cable throttle systems, the response time is defined as the elapsed time between the release of the actuating force of the driver-operated acceleration control device and the throttle position sensor output to return to the initial idle position within tolerances. For ETC/CTC systems, the response time is the elapsed time between the release of the actuating force and the time when the controller idle flag is set to indicate idle control. If there are any questions regarding response time, contact the responsible engineer listed on the FMVSS pretest vehicle checklist template (accessed through GDM).

Note: For diesels, throttle opening (Throttle Position Sensor (TPS)) data is replaced by percent of maximum fuel injector on-time and voltage. For electric, hybrid and fuel cell vehicles, throttle opening (TPS) data is replaced by the driver requested torque and actual axle torque.

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