



Reverse Gear Synchronizer Durability 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. Reverse gear synchronizer durability.

1.2 Applicability. Cars and light duty trucks equipped with Front Wheel Drive (FWD) or Rear Wheel Drive (RWD) manual transmissions with a reverse gear synchronizer.

1.3 Remarks. This test procedure is based on in-vehicle measured data. See Appendix A for details.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW16790

2.3 Additional References.

- Transmission in vehicle installed angle.
- Transmission recommended fill oil and fill level.

3 Resources

3.1 Facilities. Manual transmission bench test laboratory.

- Pneumatically, electronically or hydraulically actuated synchronizer test bench (see Appendix B, Figure B1).

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 Control and monitoring system.

3.2.2 Acceleration transducer and noise monitoring unit.

3.2.3 Heating blower with temperature adjustment (Including transmission sump temperature sensor.)

3.2.4 Utilize the delta analyzer or equivalent equipment to monitor for failure of synchronizer system.

3.3 Test Vehicle/Test Piece. For Product Validation (PV), a minimum of three (3) production intent manual transmissions shall complete this test.

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3.4 Test Time.

Calendar time: 12 d
Test time: 167 h
Coordination time: 20 h

3.5 Test Required Information. Familiarity with GMW16790.

3.6 Personnel/Skills. Person familiar with manual transmission bench testing.

4 Procedure

4.1 Preparation.

4.1.1 Determine the essential dimensional parameters for the reverse gear synchronizer and complete measurement inspection prior to assembly. Ensure wear gap measurement is included. (Examples of what may be included: Cone angle, cone straightness, cone roundness, surface roughness etc.)

4.1.2 Install all components into the transmission according to specifications of installation.

4.1.3 Assemble the clutch plate to the input shaft using nearly maximum level disc inertia (J) (in kilograms per meters squared (kg/m^2)) according to the worse case application inertia parameters.

4.1.4 Install the transmission assembly onto the test bench.

4.1.5 Determine the amount and grade of transmission oil and fill the bench unit accordingly.

4.1.6 Install the transmission into the dynamometer and the external shift control to the transmission to measure the shift force (F_s).

4.2 Conditions.

4.2.1 Environmental Conditions. The transmission oil temperature shall be at $80\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

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. See Figure 1 and Figure 2.

4.3.1 Drive the transmission according GMW16790.

4.3.2 Start the test stand.

4.3.3 Start the acceleration meter.

4.3.4 Adjust the shift force F_s (see 4.3.8) by the pressure regulator or the control unit of the shift robot.

(For indication of F_s refer to the testing system data displayed.) As a reference, the suggested initial rate of shift applies as measured at the pinball should be approximately 17 mm/s.

4.3.5 Establish the baseline acceleration value, meter per second squared (m/s^2), during a successful synchronization event.

4.3.6 Record the synchronizing time (t_{syn}) every time you check the shift force.

4.3.7 Check F_s after 100 cycles at first. Then check it again after 500 cycles and again after 1000 cycles.

Adjust if necessary. Maximum allowable deviation of the shift force during the test is $\pm 5\%$.

4.3.8 Conduct 50 000 shifts into reverse (45 000 low energy shifts and 5000 high energy shifts), applying the command sequence defined per the following:

- Initiate the output dynamometer at a speed of ~20 output RPM while the transmission is in Neutral.
- Once the output speed has reached ~20 RPM, initiate a shift into 1st gear.
- While in 1st gear, accelerate the output shaft such that the speed of the input shaft reaches ~3000 RPM (Low Energy shift), or ~6000 RPM (High Energy Shift.) Suggested acceleration on output = 400 RPM/s.
- Once the target input shaft speed has been acquired, shift back into neutral, which will result in the input shaft decelerating. Then disengage the output dynamometer driven speed, which will result in the output shaft decelerating also.

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- Once the decelerating input shaft reaches the target shift speed, (800 RPM with Low Energy Shift or 2450 RPM with High Energy Shift), command the shift robot to shift into Reverse gear at a load that equates to 300 N at the sleeve.
 - After successfully shifted into Reverse gear for a period of approximately 2 s, shift back into Neutral and re-engage the output dynamometer to adjust the output speed to 20 RPM to continue with the next cycle.
- a. Low energy shifts.
- 45 000 shifts.
 - 800 RPM transmission input speed.
 - 300 N force (load at the sleeve.)
 - FWD, e.g.,

$$\frac{300 \text{ N sleeve load}}{2.4:1 \text{ pinball ratio}} = \frac{125 \text{ N}}{2.7:1 \text{ shift lever ratio}} = 46 \text{ N (at knob lap)}$$

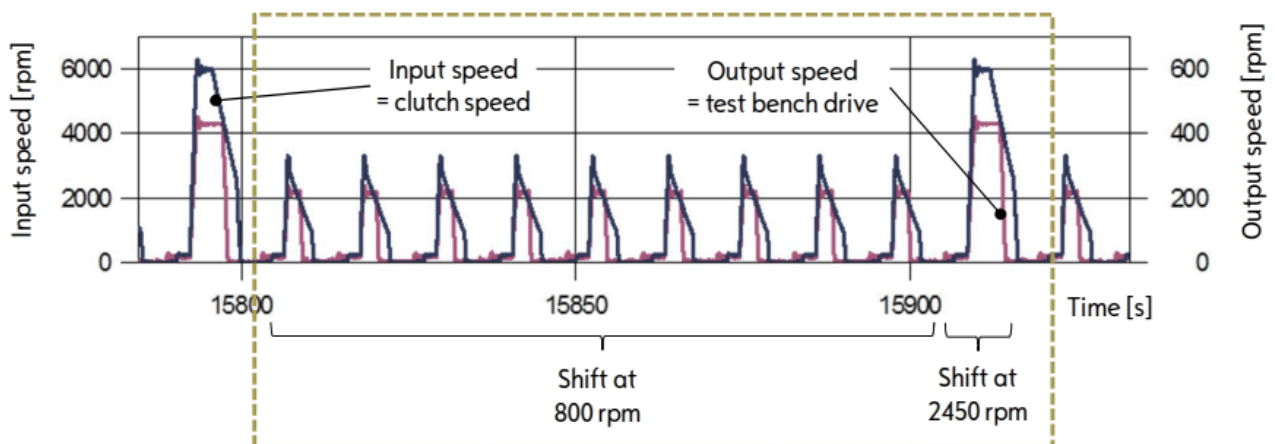
- b. High energy shifts.
- 5000 shifts.
 - 2450 RPM transmission input speed.
 - 300 N force (load at the sleeve.)
 - FWD, e.g.,

$$\frac{300 \text{ N sleeve load}}{2.4:1 \text{ pinball ratio}} = \frac{125 \text{ N}}{2.7:1 \text{ shift lever ratio}} = 46 \text{ N (at knob lap)}$$

Note: To ensure proper lubrication, ramp the input speed to 6000 RPM for 2 s after each high-energy shift. Maintain transmission fill oil at $80^\circ\text{C} \pm 5^\circ\text{C}$.

4.3.9 Record transmission input and output speed, shift system force and travel.

Figure 1: Example Transmission Input and Output Speeds During Shifting



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