



Steering Gear Rattle 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 provide general guidelines for operating the Rack Rattle Test Stand.

1.2 Applicability. This test procedure is applicable to any hydraulically or electrically assisted rack and pinion steering system.

1.3 Remarks. This document describes the general operating procedure for conducting a test on the Rack Rattle Test Stand. It is not a user's guide to the test machine or its control software.

2 References

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

2.1 External Standards/Specifications.

ISO 9001

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- HEAD acoustics, Incorporated, Brighton, Michigan, www.head-acoustics.de
- Intrepid Control Systems, Incorporated, Madison Heights, Michigan, www.intrepidcs.com
- MathWorks, Incorporated, Natick, Massachusetts, www.mathworks.com
- MB Dynamics, Cleveland, Ohio, www.mbdynamics.com
- Subsystem Technical Specification (SSTS)

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.

3.2 Equipment. MB Dynamics Rack Rattle Test Stand, MB Dynamics Dual Energizer Controller, a computer with MB Dynamics Time History Control and Application software installed and HEAD acoustics Squad Riga data acquisition device.

3.3 Test Vehicle/Test Piece. This test procedure applies to any hydraulically or electrically assisted rack and pinion steering system.

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3.4 Test Time. Time shown is typical per test and per test specimen.

Calendar time: 1 day

Test hours: 1 hour

Coordination hours: 0.5 hour

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Operator must be qualified and documented as capable to run this test as required by ISO 9001.

4 Procedure

4.1 Preparation.

4.1.1 Required Parts.

4.1.1.1 Electric Power Steering (EPS). The following parts are required to test an EPS system:

- Manual, Dual Pinion, or Belt Drive Steering Gear complete with inner and outer tie rods
- Intermediate (I)-Shaft (I-Shaft upper and lower mounting screws)
- Steering Column (with Electric Power Steering motor for Column EPS (CEPS))
- Steering Wheel
- Gear Mounting Bolts
- Proper Wire Harness

4.1.1.2 Hydraulic Power Steering (HPS). The following parts are required to test an HPS system:

- Hydraulic Steering Gear complete with inner and outer tie rods
- I-Shaft (I-Shaft upper and lower mounting screws)
- Steering Column
- Steering Wheel
- Gear Mounting Bolts
- Power Steering Pump and Lines

4.1.2 Gear Mounting.

4.1.2.1 Vehicle Position. Before evaluating the steering system on the Rack Rattle Test Stand, it is important to mount the gear as close to in car position as possible. To do this, brackets may need to be designed to accommodate the systems varying geometry to fit the spacing of the test stand fixtures.

Some crucial information is needed from the requestor in order to set up the gear to reflect in-vehicle positioning. All of these dimensions are usually given in the vehicle's global coordinates, reflecting the position from the vehicle's global origin. The directions are as viewed as sitting in the driver's position: X is Fore-Aft (+ toward rear of vehicle), Y is Lateral (+ being right), and Z is Vertical (+ being up).

- P0: Pinion/Rack intersect on rack centerline, this is the position where the pinion contacts the rack on the rack centerline.
- P1: Pinion/Rack intersect on pinion centerline, this is the position where the pinion contacts the rack on the pinion centerline.
- P2: Lower Joint Pivot Point, this is the lower Universal (U)-Joint on the I-Shaft. The dimensions should be given in the vehicle's distance from the global origin. This position is the exact center of the U-Joint.
- P3: Upper Joint Pivot Point, this is the upper U-Joint on the I-Shaft. The dimensions should be given in the vehicle's distance from the global origin. This position is the exact center of the U-Joint.
- P4: Point on column shaft, this is the point on the column shaft where the steering wheel connects to the column shaft.

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With all of these dimensions known, the test requestor can correctly set up the steering system. The Global Steering Lab has a Faro Arm that can be used to precisely measure the dimensions in a three (3) dimensional space to help with setting up the gear.

4.1.2.2 Steering Component Installation.

4.1.2.2.1 Steering Column.

4.1.2.2.1.1 Steering Column Mounting. Secure the test column to the column stand to the rear of the Rack Rattle Test bench using the supplied hardware and mounting brackets. Once the column is mounted to the column stand, the correct angle can be adjusted for by loosening the bolts that restrict the rotation of the column fixture. The angle has to be measured with the column shaft/shaft housing. Sometimes this can be simplified by making sure the column is mounted parallel to the mounting plate. This will allow measurement from the plate instead of the intricate column surfaces.

4.1.2.2.1.2 Intermediate Shaft. The initial placement of the I-Shaft should be mounted at the half travel plunging position. If the test requestor does not require the steering system to be at in-vehicle position, the half travel position is used. If the system is required to be at in-vehicle position, connect the upper and lower U-Joints to the pinion and the column and use the steering coordinate worksheet or solve by hand to finalize the necessary location of the upper U-joint. The height of the upper U-joint can be manipulated independent of the column angle with the hand crank at the bottom of the column stand. Move the entire column assembly up or down until it matches the supplied upper U-joint in-vehicle coordinate.

4.1.2.2.2 Steering Gear.

4.1.2.2.2.1 Steering Gear to Bench Mounting. The gear is to be mounted to the elevated slotted bedplate table using mounting plates that accommodate the gear mounting bolt locations. Remove the production driver side outer tie rod end, if attached. Thread the appropriate slotted adapter plug on the tie rod so the outer end is visible and able to reach the shaker petal clamp and collar.

4.1.2.2.2.2 Steering Gear to Shaker Mounting. Hydraulic and manual gears should be tested only with the driver side tie rod attached to a shaker while Dual Pinion EPS (DPEPS) and Belt Drive EPS (BDEPS) gears should be tested with both tie rod ends attached to the shaker. With the driver side tie rod adapter plug slipped into the petal clamp (it should be a slip fit), loosely mount the plate/socket and transducer assembly to the Jounce-Rebound-Fore-Aft Mounting Plate (JRFAMP) (in MB Dynamics terminology). Next, center the steering gear by finding the halfway point in stop-to-stop movement of the rack. Following gear centering, the driver side tie rod should not bottom in the petal clamp, and the adapter plug should not be exposed. If either issue is present, thread the adapter plug up or down the outer tie rod to a more appropriate location. Set the shaker to its zero position by adjusting the pneumatic bags in the Air Spring Control Applet on the Personal Computer (PC) by changing the available shaker voltages and lining up the piston centering sticker, and move the test apparatus so that the driver side tie rod adapter plug is approximately centered axially in the petal clamp by assuring the petal clamp collar is loose. Torque the M8 × 1.25 screws (at least four (4)) to 35 N·m (26 ft·lb) holding the plate/socket to the JRFAMP. Lastly, tighten the collar around the petal clamp near the center of the tie rod adapter plug so that the plug cannot plunge in the petal clamp. Repeat the same procedure for DPEPS and BDEPS for the passenger side tie rod and JFRAMP, so that both tie rod end adapter plugs are simultaneously mounted to their respective shakers.

4.1.2.2.2.3 Steering Gear to Mounting Post. Hydraulic and manual steering gears should be tested with only the driver side tie rod attached to its shaker. The passenger side tie rod will retain its production outer tie rod end and mount compliantly onto a rubber isolation pad attached to a steel mounting post. Mount the passenger outer tie rod end to the steel mounting post by hand tightening the retaining nut. Secure the mounting post to the bedplate so that the tie rod ball joint is in line (along the Y-axis) and at the correct height (Z-axis) as the plate/socket transducer assembly on the opposite shaker. This is done so that the tie rods will always be oriented at the same relative angles.

4.1.2.2.2.4 Setting Tie Rod Angles. Test requests typically call for certain front and plan view tie rod angles. Once the gear has been fully mounted to the test stand, loosen the bedplate mounting plate nuts so that the gear can travel along the slots. Move the gear fore or aft to achieve the necessary plan view angle in both tie rods. The angles are kept equal by assuring that the gear itself is kept square to the elevated bedplate (rack gear travel is parallel to Y-axis). Front view angles are achieved through vertical manipulation of the mounting post and plate/socket. These angles should be confirmed with the Faro arm.

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4.1.2.2.3 Steering Wheel. With the steering rack centered by determining the half way travel point from stop-to-stop, mount the steering wheel to the splined column shaft. Next, attach the two (2) bungees from the column stand to the steering wheel. The bungees should be tight enough to allow for installation but not tight enough to restrict movement of the system. The intent of the bungees is to apply compliance similar to drivers' hands on the steering wheel (5 N·m).

4.1.3 Accelerometer Mounting. Accelerometers are used to collect quantifiable data to understand the severity of rack rattle in a gear. Each steering gear type requires different mounting locations. After the gear is mounted in the desired test orientation, the accelerometers should be installed.

4.1.3.1 Hydraulic and Manual Gears. Hydraulic and manual gear systems have two important locations where accelerations should be measured; the input pinion and the passenger side bushing. Try to locate the accelerometers so that they will be level, though this may not always be possible. Each gear will be different, but try to keep a uniform system for setting up each gear. Figure 1, Figure 2 and Figure 3 show how some accelerometers have been placed in testing.

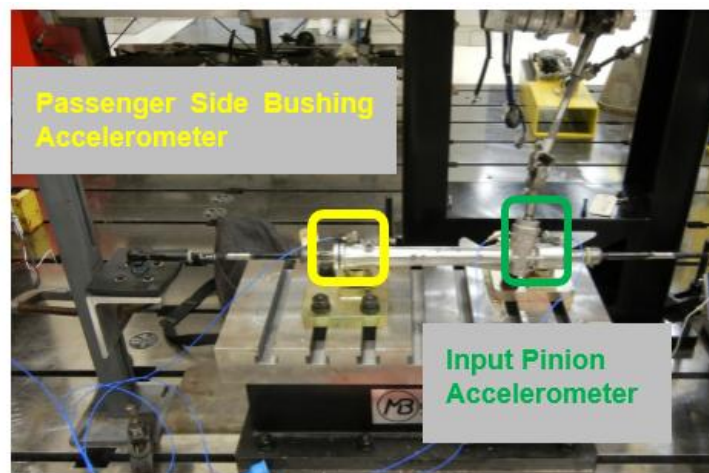


Figure 1: Column EPS Accelerometer Placement Overview



Figure 2: Column EPS Input Pinion Accelerometer Placement

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Figure 3: Column EPS Passenger Side Bushing Accelerometer Placement

4.1.3.2 DPEPS. DPEPS systems have three (3) important locations where accelerations should be measured; the input pinion, assist pinion, and worm wheel/gear. Try to locate the accelerometers so that they will be level, though this may not always be possible. Each gear will be different, but try to keep a uniform system for setting up each gear. Figure 4, Figure 5 and Figure 6 show how some accelerometers have been placed in testing.

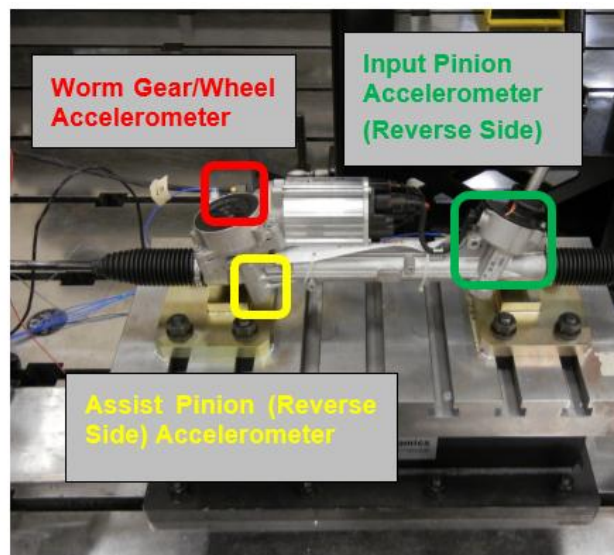


Figure 4: Dual Pinion EPS Accelerometer Placement Overview

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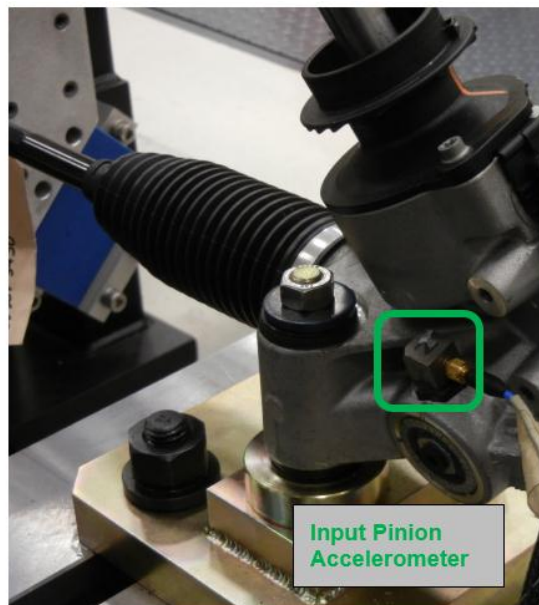


Figure 5: Dual Pinion EPS Input Pinion Accelerometer Placement

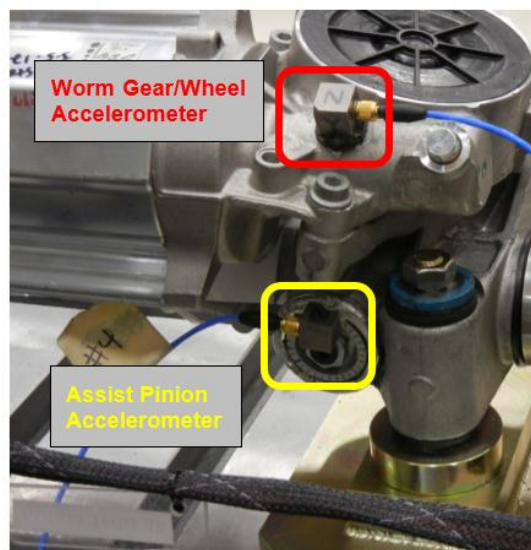


Figure 6: Dual Pinion EPS Assist Pinion and Worm Gear/Wheel Accelerometer Placement

4.1.3.3 BDEPS. BDEPS systems have three (3) important locations where accelerations should be measured; input pinion, belt housing, and ball nut housing. Try to locate the accelerometers so that they will be level, though this may not always be possible. Each gear will be different, but try to keep a uniform system for setting up each gear. Figure 7, Figure 8, Figure 9, and Figure 10 show how some accelerometers have been placed in testing.

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