



Disc Brake Corner Assembly Modal Analysis

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. To determine the grounded or in-situ brake corner assembly system natural frequencies and mode shapes from 1 to 17 kHz. This modal data is used to correlate and update analytical models. In addition, this procedure is also used to develop countermeasures for brake squeal identified in GMW14591.

1.2 Foreword. This standard is intended to quantify the brake corner assembly structural dynamics to benefit brake noise performance.

1.3 Applicability. This standard is applicable to all passenger car and light truck front and rear disc brake corners.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14228

GMW14591

GMW14229

3 Resources

3.1 Facilities. A bedplate/test room consisting of any interior environment with a hard level surface to mount the test piece and test equipment with background vibration levels that facilitate coherence values greater than 0.95 at all Frequency Response Function (FRF) maxima over the frequency range of interest.

3.2 Equipment. GMW14228 lists and describes the required equipment. Additional equipment includes an apparatus to provide a specified line pressure to brake corner assembly. A photograph of a possible corner actuation system is shown in Appendix A, Figure A1. Specific requirements for the shaker(s) and transducers are contained in Appendix A, Table A1 of this procedure.

3.3 Test Vehicle/Test Piece. Production representative brake corner hardware (knuckle, bearing, rotor, caliper, wheel attachment or equivalent) either mounted in vehicle or to a fixture following guidelines outlined in GMW14228. Rigid fixturing to the knuckle that is mounted to ground is the recommended practice. However, if driving point mobilities with 20 dB of separation cannot be achieved, the corner assembly should be mounted in the free-free condition.

3.4 Test Time.

Calendar Time: 5 days

Parts preparation time: 8 hours

Setup time: 4 hours

Test time: 40 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. One technician and/or one engineer trained in noise and vibration data acquisition, analysis, equipment use, and test setup is required.

4 Procedure

4.1 Preparation. Refer to GMW14228 (Preparation section) and follow instructions in Boundary Conditions and Component Preparation sections.

4.2 Conditions.

4.2.1 Environmental Conditions. The ambient temperature should be between 18 and 29 °C and temperatures shall not vary more than 6 °C during a given test unless otherwise specified.

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 Set and maintain the data acquisition parameters as recommended in GMW14228 in addition to the following:

4.3.1.1 Total acquisition bandwidth 0 to 17 kHz.

4.3.1.2 Frequency resolution 8 Hz (minimum recommended).

4.3.1.3 Approximately 80% burst length.

4.3.1.4 Overlap 0%.

4.3.2 Mount triaxial (or uniaxial in successive directions) accelerometers or specify laser Doppler vibrometer measurement points as appropriate to uniquely identify brake assembly and component (rotor, caliper, pad) modes up to 17 kHz. A sample disc brake corner geometry is shown in Appendix A, Figure A2. Measurement point placement guidelines (minimum number) are as follows:

4.3.2.1 Vented Rotor. One point at the inner diameter and outer diameter of each vane on each rotor cheek. One-third as many points should be used on the rotor hat section with points placed at the outer edge of the hat face and on those points near the pilot hole that are accessible (~40 measurement points).

4.3.2.2 Pad. One point at each corner and center of the backing plate, depending on accessibility (~5 measurement points per pad).

4.3.2.3 Caliper Housing. One point at each corner of the caliper bridge with several points across the interior of the bridge, one point on each finger, one on each caliper ear, and one near the piston housing (~10 measurement points).

4.3.2.4 Caliper Bracket. One point on each bend in the bracket and one point every 40 mm in between (~10 measurement points).

4.3.2.5 Others as necessary to define the brake corner geometry and prevent spatial aliasing and any extraneous components (such as axle tube and bracket) that significantly affect corner attachment stiffnesses.

4.3.3 Document the measurement geometry.

4.3.4 Apply line pressure equivalent to pressure required to generate squeal or 1000 kPa if pressure is unknown.

4.3.5 Attach one shaker to the brake rotor at a point where the rotor cheeks and hat section connect. Attach a second shaker to the caliper housing or bracket. The shaker stinger direction should be at an oblique angle such that the brake corner assembly is excited in the fore/aft, lateral and vertical directions.

4.3.6 Set shaker force levels and acquire FRFs per GMW14228.

5 Data

5.1 Calculations. Determine the natural frequencies and mode shapes of the brake corner assembly from 1 to 17 kHz using the process specified in GMW14229.

5.2 Interpretation of Results. Complete a mode summary table and produce summation FRF plots for the entire assembly and each of the corner components as outlined in GMW14229. In particular, the mode summary table should be completed for modes within 300 Hz of any squeal frequencies identified analytically or experimentally (GMW14591). Also include any pictures or animations of mode shapes of interest (e.g., near brake squeal frequency). An example mode summary table is shown in Figure A3 in Appendix A.