
Brake Squeal

Binder - Advanced Technical Information
 This bulletin replaces bulletin Group 4,
 #1801.2, dated 10/27/2020.

Attention: **Service Managers/Service Technicians**

Vehicle Type: **All**

Model Year: **All**

Concern: Customer reports that vehicle brakes squeal.

Information: Understanding brake squeal, addressing the concern and warranty claiming requirements

Customer Information: Remember that brake squeal is a normal result of different factors acting upon the brake system and does not constitute a defect.

- Normal brake noises, such as squeal, occur under a narrow set of operating conditions.
 - An example would be low speed, light brake pedal application.
- Abnormal brake noises occur under wider operating conditions.
 - An example would be during light or heavy braking at any speed or temperature

Warranty Note: **No defect Found:** In the interest of customer satisfaction and to support proper analysis for brake noise concerns, additional labor time for test drive and verification to assure the customer that there are no safety or performance issues associated with the brake noise will be reimbursed under warranty (page 17).

Warranty Defect Determined: If a warranty defect is determined, additional time for the required documentation to support the failure as outlined in this bulletin will be reimbursed. **This additional test drive, verification and documentation is required for all brake squeal claims reimbursed under warranty**" (page 17).

The customer may also refer to the Owner's Manual section on Driving and Driving Safety regarding brake squeal.

Disclaimer

Porsche vehicles have high performance brake systems. Due to the stresses to which Porsche vehicles are oftentimes subjected, Porsche vehicles presented for brake service may exhibit exceptional wear at earlier than expected times compared to wear found typically on other vehicles. All the conditions described below are the result of normal brake system wear and are therefore not warrantable.

Reference: There is a book published by the Society of Automotive Engineers that may be a helpful tool with customers that are more academic thinkers.

Disc brake squeal: Mechanism, Analysis, Evaluation, and Reduction/Prevention / [edited by] Frank Chen, Chin An Tan, and Ronald L. Quaglia. SAE)
www.SAE.org

Quote from Text: **“However, disc brake squeal remains an elusive problem, and there is not yet a method to completely suppress it.”**

Two videos have been produced to aid you in your work.

- Customer Video
- Technical Video

Brake Friction Materials are Different

There is a common misconception that all brakes should exhibit the same characteristics. In the North American Market (U.S. & Canada), one brake friction material is used more than any other. It is called Non Asbestos Organic (NAO). The dominance of this friction material in the market has aided this misconception.

The characteristics of this material are:

- Excellent Noise, Vibration, & Harshness (NVH) characteristics
- Excellent lining wear
- Produces low amounts of wheel dust
- Friction level fades at high temperature

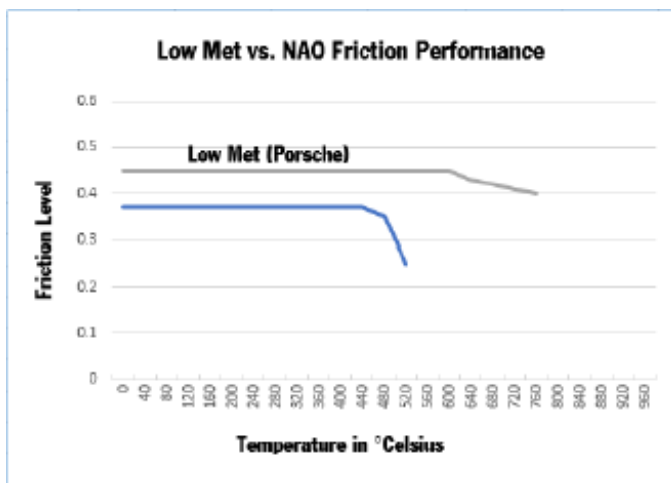
This list matches customer expectations pretty well. However, the last characteristic about friction level fading at high temperature makes it unsuitable for Porsche.

Porsche uses a Low Met friction material to meet our high performance standards. The characteristics of this material are:

- High coefficient of friction
- Excellent fade characteristics (friction level does not fade at high temperature)
- Very effective at stopping the vehicle
- Noise can be more than other friction materials

- Wheel dust is a normal by product
- Lining life is low (compared to NAO for example)

The graph below illustrates the difference in fade characteristics between NAO & Low Met friction materials:



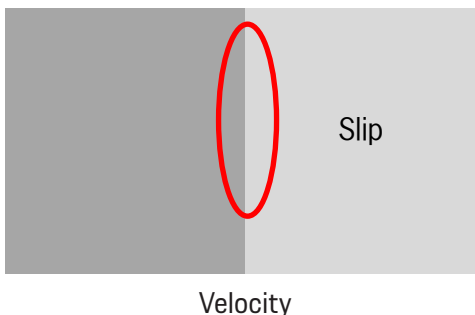
Low met performance characteristics are necessary to maintain the balance of performance in the Porsche vehicle as a whole.

What is Brake Squeal?

Brake squeal is a noise that is the result of minute vibrations. The minute vibrations occur as the rotor moves in relation to the pad. A combination of high friction levels and low pedal pressure create ideal conditions for noise.

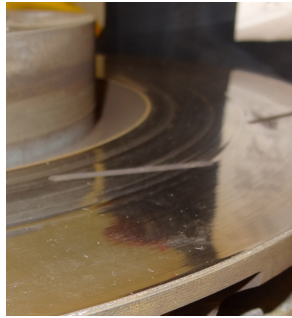
The condition that is creating the noise is called "stick-slip".

This stick-slip condition is most prevalent during light braking. Light braking smooths the rotor and the pad surfaces. When this is coupled with imperfect pressure distribution on the pad (due to low pedal pressure), the conditions for stick-slip exist. The noise occurs as the transition is made from stick to slip.



Some clear indications of a normal brake squeal resulting from the conditions described are:

- When the squeal occurs, applying more brake pressure makes it go away
- The rotor has a polished mirror like finish on it
- The pads have a smooth surface finish, like a glaze



Other Contributing Factors

Other factors also contribute to brake squeal. All components (even the bolts) have what are called “bending and twisting modes.” As force is applied to a component, it will bend and twist in different ways. The bending and twisting modes change as brake pressure and temperature changes. As the components are mounted together, coupling effects also become a factor.

The amount of bending and twisting is so small as not to be visible to the naked eye. It is a normal characteristic of all components. It is determined through Frequency Response Testing.

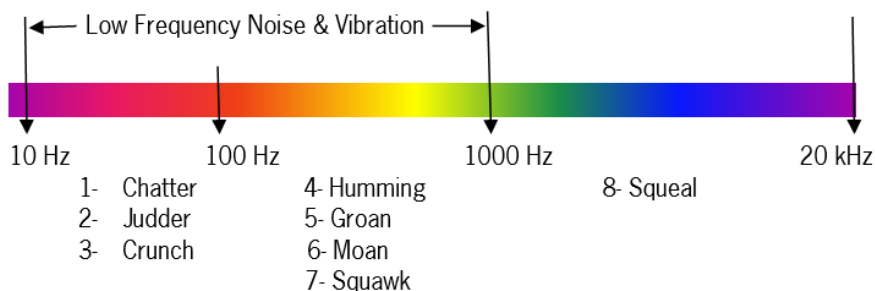
This is why proper torque on fasteners is critical. Other factors include component temperature, mass, geometry, insulation, and lubrication. Weather and driving conditions are also major factors.

Countermeasure Limitations

Brake squeal can fall into a very wide frequency range. The range is divided into three groups:

1. Low Range 1 - 3 KHz
2. Mid-Range 3 – 6 KHz
3. High Range 6 – 20 KHz (above 14KHz can be very difficult to hear)

Noises below 1kHz are not squeal noises. This is the range where other noises are heard.



The frequency of the noise will determine what countermeasure to use. Some common design countermeasures are listed below:

- Pad Chamfers
- Various slot configurations in the pad
- Pad slippers
- Shims of various types
- Tuned mass dampers
- Fixed calipers

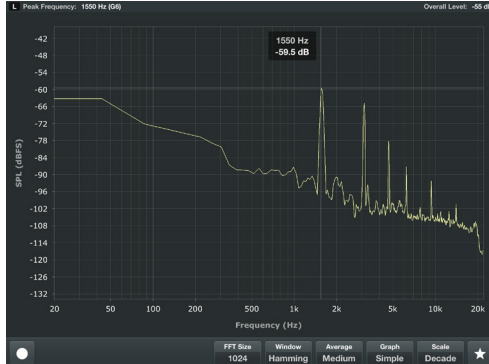
Countermeasures are limited on a given brake system due to limitations with space and performance. Testing must be performed to determine if a countermeasure is effective without deteriorating performance.

Measuring the Noise

Since the frequency of the noise determines the countermeasure, it is not possible to know if you are addressing the same issue without knowing the frequency.

This is why it is necessary to capture the information using an FFT (Fast Fourier Transform). There are apps for smartphones and tablets that will do this.

Two real life examples from Porsche vehicles are illustrated:



The base frequency shown (1550 Hz) is the noise where the problem is coming from. The other five peaks are all harmonics. This means that if the base frequency is eliminated, the others will go away as well.

In a second example, we see a squeal frequency without harmonics. This frequency is over five times higher than the last example. The countermeasure required for this noise will be completely different from the last example.



As mentioned above, the apps are available for smartphones and tablets. Two apps are listed below:

- iOS**
FFT Plot
- Android**
Speedy Spectrum Analyzer

Note: FFT plots are required for brake noise warranty cases; please refer to the procedure below.

Procedure

1. Test drive with the customer to verify the noise. The customer should be able to reproduce the noise on the test drive.



- This will help ensure you are addressing the same concern.

FFT Plot (Required for Warranty)

2. Take an FFT plot of the noise during the test drive with the customer.

- This is important because the frequency of the noise can vary widely
- The frequency helps point to the source of the noise
- The intensity (measured in decibels dB) helps us know how bad it is and how much we have improved it after our work
- **The plot needs to be recorded from inside the vehicle where the noise is heard by the customer.**
- **An omnidirectional microphone with a greater sensitivity can be attached to a tablet or smart-phone to improve recording ability**

3. The third step is to perform a thorough visual inspection.

4. Perform repair work as necessary.

5. A final FFT confirms that the noise has been improved or eliminated.

Component Inspection Guidelines

Fluid

Fluid replacement is required every two years by the maintenance schedule.

- WM 470855 Changing the brake fluid
- There is also a section in the Owner Maintenance booklet dedicated to recording the brake flushes every 2 years

Moisture in the fluid is heavier than the fluid, and accumulates in the calipers.

- Moisture affects the viscosity of the fluid and its ability to lubricate
- Corrosion and damage to the caliper can also result

The right rear caliper is the farthest from the reservoir and may be affected more than the other calipers.

- This is due to the larger volume of fluid in that circuit and therefore a larger amount of moisture can settle in that caliper

If squeal is occurring on one wheel in particular, fluid condition is likely to be a part of the problem.

Countermeasure

Flushing the fluid is necessary to get rid of the moisture accumulation.

Tip: Warming the fluid by driving and braking before flushing it, can help get a more thorough flush of the fluid. Using a heat gun and rubber mallet on the caliper can improve the effectiveness of this procedure.

Brake Pads

- Glazed surface
- Cracks from overheating
- Dust buildup at edges
- Contamination from sprays such as tire dressings
- Wear at contact points
 - Piston contact on pad shows even or uneven pressure distribution
 - Pad to caliper contact points show how pad moves in caliper
 - Spring to pad contact shows how well spring tensions pad

Countermeasure

- Sanding the pad and chamfering the edges
- Insuring the contact points are smooth
- Lubricating contact points with optimol grease
- Insure proper fit and lubrication of shims and/or dampers



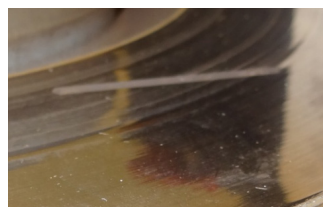
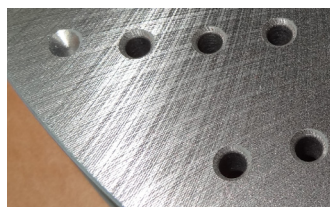
Note: Take photos as you inspect. Remember that part numbers and batch numbers must also be readable. It is required on the PCSS job/warranty claim.

Rotors

- Lips develop at outer and inner edges of pad contact area



- Corrosion
- Contamination by sprays, fluids, road salt, grime, and small particles becoming embedded between the pad and rotor
- Glazed surface



Rotor Finish: The non-directional finish of a new rotor is better for noise than the polished rotor resulting from light-footed braking.

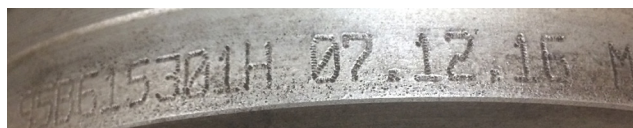
Glazed pads and rotors are the fingerprint of the normal, light-footed, slow speed brake squeal. Replacement of the pads and rotors with the same pads and rotors that are already on the vehicle, will not improve the situation. As the new parts are subjected to the same conditions, the squeal will return.

A glazed rotor is not a safety or performance issue.

Countermeasure

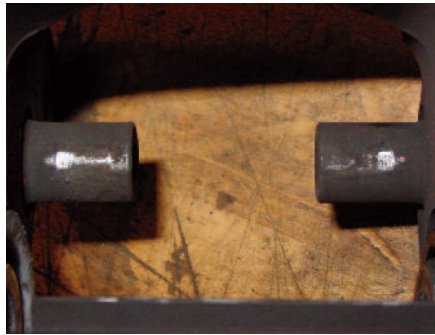
It is not possible to sand or hone the rotor due to the possibility of introducing judder because of imperfect sanding or honing. Altering the driving habit by using a little more pedal force is sufficient to improve the noise.

NOTE: Also, remember to photograph the rotor production information for the PCSS job/Warranty claim.



Calipers

- Pad Mounting Pins – witness marks indicate movement between pad and caliper pin

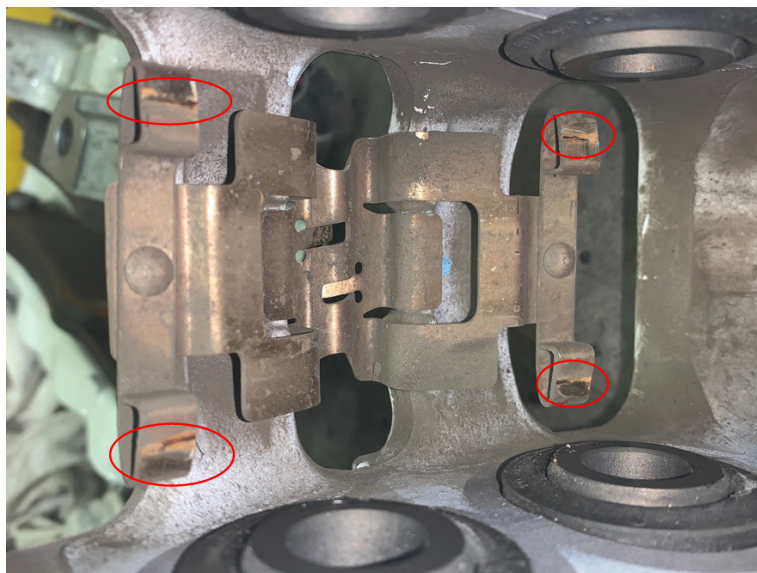


Countermeasure

- Make sure the pins are smooth first
- Lubricate contact points with a small amount of optimoly grease and insure proper fit of components

Tension spring

- Movement between spring and pads will vary as spring tension varies. The witness marks will reflect this.
- Push upwards on pad against spring, release the pad and you should hear a clack. Excessive stiffness or weakness in the spring is not acceptable.



- Notice how the witness marks vary between the different sides.
 - On the upper left the witness mark traverses the whole spring and on the lower left it is just over half.
 - On the upper right the witness is almost twice as long as the lower right.
- The inner and outer pads are not being tensioned similarly. There is enough variation here to contribute to brake noise.

Caliper Pistons

- Wear marks from movement of pad against piston. This is an indication of pressure distribution from the piston to the pad. Brake squeal is affected by pressure distribution, especially at low pedal pressures.



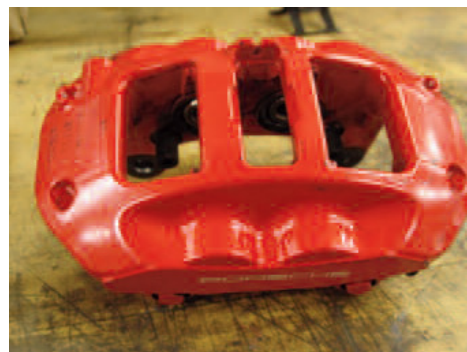
- Inspect pistons to see if there are any that may not be returning completely.
- Exercising the caliper pistons can restore the movement of the piston to normal operation (the brake fluid must also be clean).

Exercising Brake Caliper Pistons

- Remove brake caliper
- Remove pads and hardware
- Have the following parts on hand:
 - Caliper paste 000.043.117.00
 - Optimoly paste 000.043.020.00 (the 100g tube should last through several repairs)
 - New hardware kit
 - New dust seals



- Clean brake caliper so that there are no contaminants present when the dust seals are removed



- Remove dust seals from the caliper pistons



- Extend the pistons against a block of wood to keep them from coming out of the caliper. (It may be necessary to retract and extend the pistons several times to free up the movement)
- Apply brake caliper paste to the piston and install new dust seals on the pistons
- Retract the pistons and seat the dust seals
- Install pads and new hardware
- Install caliper on vehicle
- Flush brake fluid
- Test-drive the vehicle

In cases where additional help is needed, please create a PRMS ticket to Techline Support.

Warranty
Information:



Warranty Coding Information

NOTE: Documentation requirements include:

- FFT plots with the frequency and dB level highlighted as in the examples given
- Clear photographs illustrating fluid condition, contact points, wear, defects or abnormalities properly labeled according to their location
- Part number data from pads and rotors must be photographed as in the examples shown

Labor Operations

The labor operations below are unique labor operations that the dealer creates. They do not already exist in the system. Though test drive, inspection and documentation is already built into all published labors, this additional time is due to the extensive nature of the documentation to support proper analysis for these elusive brake noise concerns. A separate identifiable punch is required to support the a-time claimed for this additional documentation.

(Noise is Normal)

Test Drive & Verification 47010299 up to 35TU

Includes: Test drive, FFT capture, and documentation (20 minutes)

Labor Operations (Noise is NOT Normal)

Test Drive, Verification & Photo Documentation 47010399 up to 100TU

Includes: Test drive, FFT capture, and documentation (20 minutes)
Visual inspection time with photos (10 minutes per wheel)

Labor Operations (Noise is a known issue per a Porsche publication)

An SY, TI, or ATI specifically addresses it

**Test Drive, Verification, & Photo Documentation on one Axle only
47010399 up to 60 TU**

Includes Test drive, FFT capture, and documentation (Approx. 20 minutes)
Visual inspection time with photos (Approx. 10 minutes per wheel)

The following operations are claimed separately:

- Remove and Reinstall wheels
- Remove and Reinstall Front Brake Pads*
- Remove and Reinstall Rear Brake Pads*

*Includes: Remove and Reinstall Brake Caliper (**Note: New caliper bolts must be installed**)

PQIS Coding Information

Part IDs

Calipers – Front – 4739

Rear - 4741

Rotors – Front – 4650 (4651 PCCB) (4652 PSCB)

Rear - 4653 (4654 PCCB) (4655 PSCB)

Pads – Front – 4636 (4634 PCCB) (4632 PSCB)

Rear - 4638 (4635 PCCB) (4633 PSCB)

Damage Codes (most common)

3013 Damaged – Damage to brake components

3031 Flaked off – PCCB material separation

1041 Foreign Object – Small rocks or other debris get into rotor/pad interface

1319 Lateral Runout – Lateral runout causing vibration

1417 Overheated, too hot – Rotors with bluing, pads with cracks

1316 Rubs – Backing plate rubs rotor or another object rubs against brake component

2019 Squeaks – Glazed pads/rotors, normal squeal

3311 Surface Corrosion – Corrosion on rotor surface causing noise/vibration

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