



SURFACE VEHICLE RECOMMENDED PRACTICE

J2598™

DEC2020

Issued 2006-01
Revised 2020-12

Superseding J2598 JUL2012

Automotive Disc Brake Pad Natural Frequency and Damping Test

RATIONALE

In order to improve the repeatability and reproducibility of this document, the current revision adds a requirement to report the exact location of the excitation and measurement points and also defines the key characteristics of the foam used to simulate the free-free conditions.

FOREWORD

Natural frequencies and damping are important characteristics of a brake pad assembly. There are currently no recognized standards for measuring these quantities.

1. SCOPE

This procedure is applicable to brake pad modes between 500 Hz and 16 kHz. The parameters measured with this procedure are defined as the first three natural frequencies, f_n ($n = 1, 2, 3$), and the corresponding loss factors, η .

1.1 Purpose

This recommended test practice is intended to establish a standardized and repeatable method for performing natural frequency and damping measurements on a disc brake pad.

2. REFERENCES

2.1 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J3001 Brake Insulator Damping Measurement Procedure

Denys, E., "The Development of a Global Brake Insulator Damping Measurement Procedure," SAE Technical Paper 2011-01-1574, 2011, <https://doi.org/10.4271/2011-01-1574>.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2020 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

Full document details: SAE J2598_202012

For more information on this standard, visit
https://www.sae.org/standards/content/J2598_202012

Documents

Document Sharing Hub

2.1.2 Other Publications

Ewins, D.J., "Modal Testing Theory, Practice and Application," Second Edition, 2000, Research Studies Press LTD, England.

B&K Technical Review n°1, "Digital Filter Techniques vs. FFT Techniques for Damping Measurements," 1994, Svend Gade and Henrik Herlufsen.

3. GLOSSARY AND TERMINOLOGY

3.1 NATURAL FREQUENCY

One of the frequencies at which the pad naturally vibrates at when excited in a free-free condition.

3.2 LOSS FACTOR

The energy loss factor, η , which is the percent critical damping divided by 50.

3.3 DAMPING

This is generally expressed as the percentage of critical damping.

4. ORGANIZATION OF THIS DOCUMENT

This document separates the measurement procedures to obtain the brake pad natural frequencies and that required to obtain the loss factors. The reason for this separation is that in the development of this procedure significant differences were found in the repeatability of the results for these two measurements between different testers. The result is that highly accurate and consistent natural frequency data can be obtained with less rigorous measurement system and procedure requirements. This measurement procedure is presented in Part A.

The more rigorous loss factor measurement procedure is presented in Part B. It is important to note that although the requirements for this measurement are more stringent, there is still greater variability in the loss factor results. The magnitude of this variability will be discussed in some details in Part B.

The first step is to define the basic measurement configuration and the requirements common to both Parts A and B.

5. MEASUREMENT REQUIREMENTS

- Excitation:
 - A metal tipped impact hammer with force transducer is the preferred method of excitation. Other methods of excitation such as a shaker may be used with proper care and documentation of equivalent results.
- Response:
 - Typically a microphone or an accelerometer will be used to measure response. A single point laser vibrometer can also be used. If a transducer other than a microphone or accelerometer is used, a comparison test shall be run to show equivalence.
 - The recommended microphone is a 0.5 inch free-field condenser type. The recommended accelerometer is one with an integrated amplifier or a charge type.
 - The recommended accelerometer is different for Parts A and B. The specific requirements will be defined in these sections.
 - Frequency response from 500 to 16000 Hz $\pm$ 3 dB.
 - Dual-channel FFT analyzer capable of calculating a frequency response function (FRF) and simple correlation

6. TEST CONFIGURATION

The preferred measurement setup is shown in Figure 1. This configuration shows the use of a microphone for the response measurement and an impact hammer for excitation. The same setup can be used with an accelerometer. One may use equivalent non contacting measurements such as laser doppler vibrometer, if the results can be shown to be equivalent.

The pad is placed on a piece of foam, with the friction material facing down. However, the measurement can also be done with the friction material facing up.

To be sure that the lower three natural frequencies and their corresponding loss factors are measured, it is necessary to excite both torsional and bending modes. The lowest three natural frequencies may then be selected from these results with high confidence.

Figures 2 to 4 show three suggested measurement configurations. Using all three of these combinations of force input and response locations, one can be confident of that the lowest three natural frequencies will be measured.

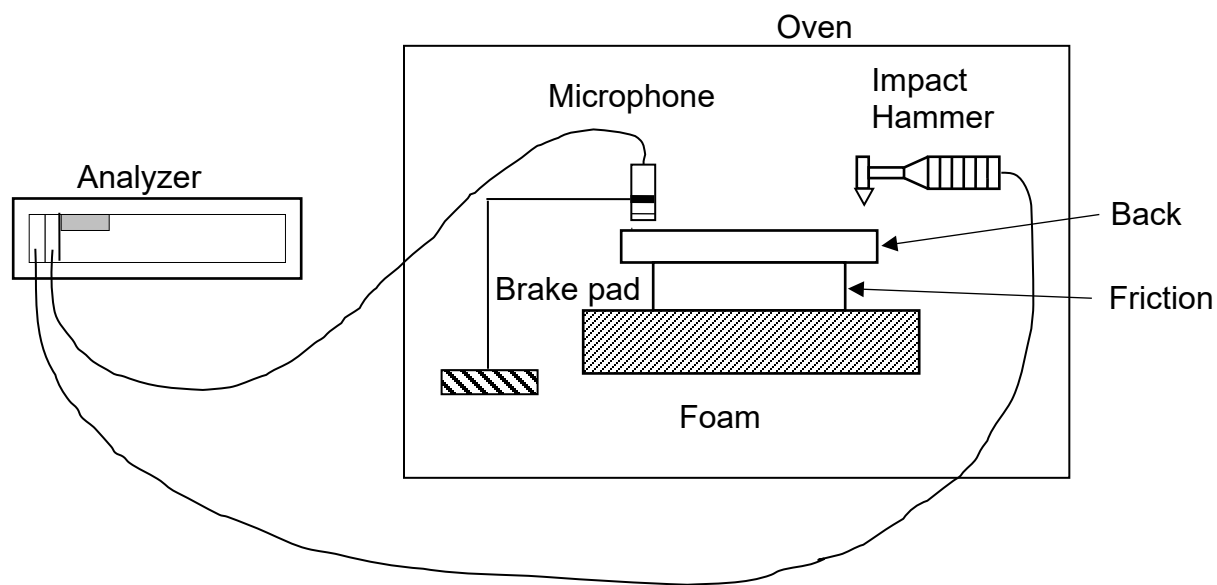


Figure 1 - Block diagram of a brake pad loss factor measurement setup

The Figure 2 setup will be prone to the excitation of the bending modes of the brake pad.

To assure that torsional modes are excited and measured, the configurations shown in Figures 3 and 4 can be used. In this arrangement, it is important to excite and measure at the farthest edges of the pad (even if it means exciting on chamfers).

Impact and measurement point for measurement of bending and torsion modes must be clearly defined (x/y values ± 5 mm) for every project/pad definition. These points must be communicated to every party involved in a project.



Figure 2 - Brake pad natural frequency and loss factor measurement configuration number 1