

CASE STUDY

LINK Engineering Company Inc.

United States of America

Automotive

NVH Brake Testing – An Industry Standard

PULSE, Transducers

Since its foundation, Link Engineering Company has focused on the design and manufacture of state-of-the art test systems for the automotive, aerospace, railway and general industries. Today, with special emphasis on brake testing solutions, Link Engineering is a global leader and delivers complete turnkey projects to many of the world major automotive manufacturers and their suppliers.

Link Model 3900 Brake Noise Dynamometer has become an industry standard. Brüel & Kjær's PULSE™ data acquisition and analysis system is Link's preferred NVH analyzer platform, and more than 50 systems have been delivered during the past five years.

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Brake Testing Expertise – A Global Leader

For more than 65 years, Link Engineering Company has been deeply involved in the design and manufacture of test systems for the automotive, aerospace, railway and general industries. Its solutions are used by many of the world's major vehicle manufacturers and their component suppliers.

Link's experience includes the development and manufacture of a wide range of NVH (Noise, Vibration and Harshness) test systems. Brake NVH testing is one of Link's specialities and it is the world leader in the development of NVH brake test systems and brake analysis.

More than Fifty PULSE Systems

Dr. James Thompson, Link's Executive Director of NVH, Sales and Marketing says, "Brüel & Kjær's PULSE system is our preferred NVH data acquisition and analysis platform and we have ordered more than 50 systems in the last five years. The constantly evolving PULSE platform is a major factor in the development and marketing of our NVH solutions. We can offer a wide range – for those companies just starting to investigate in-vehicle and brake noise, to large and advanced turnkey projects for the world's major brake manufacturers."

Fig. 1

To celebrate the occasion, Karl Kristian Hvidt Nielsen, Brüel & Kjær's President, presented a "Georg Jensen" engraved fruit bowl to Dr. James Thompson, Executive Director of NVH, Sales and Marketing, Link Engineering



"Our partnership with Brüel & Kjær over the last five years has been highly successful. Both companies are fastidious about the use of state-of-the-art technology and product quality. This factor, combined with Brüel & Kjær's outstanding local service, backup and support from the Detroit office has led to our success".

Jim continues, "Our customers demand ever more sophistication in NVH testing and our growth comes from constantly offering new and innovative

products. Brake noise is highly important. It is the number one warranty issue for automotive manufacturers throughout the world, it's a critical product differentiator, and brake repairs and replacement are hugely expensive. Noise makes a customer aware of the vehicle's brakes and affects the customers perception of the vehicle because brake noise immediately causes safety concerns".

Brake NVH Test Procedure

Jim explains, "Over the last decade there have been many different dynamometers developed for brake noise testing. Early designs eliminated the hard inertia used on performance dynamometers. During the same period there were also numerous methods for NVH data acquisition and analysis. However, the development of the SAE J2521 procedure has led to a standardised apparatus for brake noise testing".

Developed by the US Working Group on Brake NVH, the SAE J2521 procedure was the international standard for brake noise testing. The adoption of this standard has been so widespread that it has lead to a standard dynamometer configuration.

In the US, General Motors developed its own test procedure based on SAE J2521. This procedure was developed from General Motors's experience with their NVH dynamometer and key aspects of this dynamometer design are prescribed in the test procedure.

Link Model 3900 Brake Noise Dynamometer Becomes an Industry Standard



Since the General Motors dynamometer was designed and built by Link Engineering, its Model 3900 Brake Noise Dynamometer has become the standard configuration.

General Motors requires that its suppliers demonstrate their ability to correlate with General Motors' noise test results. Therefore, when General Motors' suppliers need a new dynamometer, the Link Model 3900 is their first preference. In fact, this dynamometer has earned such a good reputation that it is now preferred by a wide range of vehicle manufacturers and brake suppliers.

The Standard Brake NVH Dynamometer

Fig. 2
The interior of General Motor' Link Model 3900 Brake Testing Dynamometer

Brake noise test dynamometers have become sophisticated test platforms for identifying the propensity of a brake to generate squeal, and to diagnose noise problems.

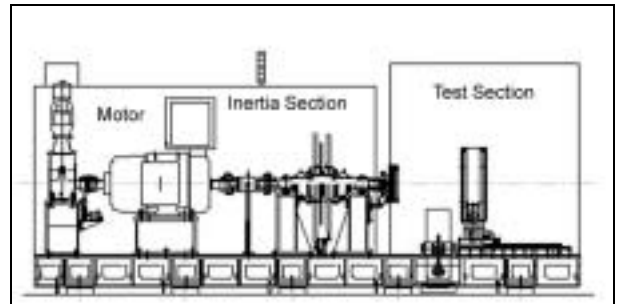
However, the implementation of SAE J2521, the first internationally recognised brake noise test procedure, has made many of these dynamometers outdated.

The SAE J2521 test procedure requires both drag and regular stops. A typical example of such a shaft type dynamometer is shown in the Fig. 3.



Fig. 3
Diagram of a shaft-type, brake testing dynamometer

The traditional approach to representing the vehicle inertia is to include discs on the rotating shaft whose rotational inertia is equivalent to the linear inertia of the vehicle. In the Link Model 3900, state-of-the-art inertia simulation is used to more accurately represent the inertia of the vehicle.



NVH Data Acquisition System

Jim continues, “Our Model 3900 provides both physical inertia and inertia simulation to give the user maximum flexibility in simulating the vehicle braking system. A key part of any noise dynamometer is the NVH data acquisition and analysis system. The standard system for the Model 3900 is the Brüel & Kjær PULSE system. This provides a full range of data acquisition capabilities. For brake squeal testing, typically one or more channels are used with sampling rates of 52 kHz. The analysis capabilities of PULSE are almost endless. One can perform simple spectral analysis, coherence, coherent output power, order tracking, and even modal analysis with this one platform”.

ProLink

“The Brüel & Kjær PULSE system is fully integrated in the Model 3900. It runs under the ProLink software package that operates the dynamometer, performs data acquisition, executes data analysis, and provides complete data reporting capabilities. ProLink makes it very straight forward for the user to configure and run a noise test.”

This combination of Link’s ProLink software, and Brüel & Kjær’s PULSE platform provides state-of-the-art capabilities in one easy-to-use package.

Testing Methodology

Jim explains, “There is clear agreement that the principal brake hardware must be utilised on the dynamometer to replicate squeal. To achieve maximum accuracy one should include the full suspension system of the vehicle corner on the dynamometer. Previous studies have shown that having all the suspension components back to the connection with the vehicle structure including the bushings in the system is necessary for an accurate representation of noise”.

Fig. 4

Dr. James Thompson, Link's Executive Director of NVH, Sales and Marketing says, "Brake noise is the number one warranty issue for vehicle manufacturers – In the future, the best situation for them will be that brake noise will be a non-issue"

Link's Model 3900 provides the ability to utilise the full corner section of the vehicle and to run in a standard or inverted configuration. The inverted configuration is useful when carrying out laser doppler or holographic imaging of the brake rotor.

The environment in which the brake is operating is also important as it is necessary to reproduce the noise found on the vehicle. This includes both the acoustical environment and the environmental conditions. Acoustically, the environment of the vehicle operating on the road must be reproduced. This means a free acoustical field above a reflecting plane. At the frequencies of concern, the road surfaces act much like a reflecting plane. The brake sound energy is free to radiate with little obstruction in all other directions.



To approximate the free acoustic field, the walls of the test enclosure are lined with an acoustically absorptive material. To provide a sufficiently low background sound level to detect squeals. The walls of this enclosure are also designed to provide high sound transmission loss. Typically, these rooms provide background sound levels below 60 dB(A). Model 3900 enclosure, as shown in Fig. 2 meets, or exceeds, all these requirements.

It is also necessary to accurately represent the environmental conditions under which the brake is operating. This may include both the temperature and relative humidity conditions. Model 3900 provides the ability to control these parameters. With standard capabilities, including temperature control over a range of -10 to 50°C and relative humidity from 20 to 90%, Links Model 3900 dynamometer provides highly accurate control of the test environment.

Jim concludes, "In the future, the best situation for vehicle manufacturers will be that brake noise will be a non-issue. Our solutions are helping them and their suppliers to achieve this goal".

Key Facts

- Link is a world leader in the development of NVH brake test systems
- The Brüel & Kjær PULSE system is Link's preferred NVH data acquisition and analysis platform
- More than 50 PULSE systems have been delivered in the last five years
- Noise is the leading brake related customer issue for automotive manufacturers
- General Motors has developed its own test procedure based on SAE J2521
- Model 3900 is now preferred by General Motors and by a wide range of vehicle manufacturers and brake suppliers – it has become the standard configuration
- The combination of Link ProLink software and the PULSE platform provides state-of-the-art capabilities in one easy-to-use package
- "In the future, the best situation for vehicle manufacturers will be that brake noise will be a non-issue. Our solutions are helping them and their suppliers to achieve this goal"

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