

SYSTEM DATA

Sound Quality System — Type 3801



For an increasing number of products ranging from sports cars to household appliances, the noise or sound the product makes is part of its attraction to the customer. The wrong sound can lead to reduced sales. A "luxury" car that, when you slam its door, sounds like someone dropping a dustpan, or a shaver that sounds as if it's shredding steel are probably not going to sell very well.

For this reason, Brüel & Kjær offers a complete measurement and analysis system for sound quality, with facilities for the determination of objective metrics and for the subjective evaluation of sound quality via jury testing. From entry-level systems with a single microphone to systems based on PULSE™, the Multi-analyzer System Type 3560, Brüel & Kjær can help you find a system to meet your needs.

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Brüel & Kjær 

Uses and Features

- USES:*
- Designing and tailoring of product sound
 - Subjective evaluation of product sound
 - Objective measurements of product sound
 - Competitive product analysis

- FEATURES:*
- Complete PC-based system solution
 - Calibrated input and output for accurate sound reproduction and analysis
 - Frequency- and time-domain editing tools
 - High-quality headphones specially selected for frequency response and sensitivity

What is Sound Quality?

*Using sound quality is not simply a matter of reducing the noise of your product, nor is it a matter of making a totally silent product. It is a question of what is attractive to a potential customer and what qualities of the sound will make them buy **your** product – sound has become an important product parameter.*

You want to be able to eliminate undesirable sounds while keeping those which are appropriate. That is, you want to design the product's sound so that it enhances the perceived quality of the product while signalling that the product and its components are functioning perfectly.

Although sound quality first made its mark in the automotive industry, it is now finding application in other industries. As consumers are becoming more concerned with the quality of their purchases, they are consciously or subconsciously becoming more influenced by the quality of the sound a product produces. This is true regardless of the industry you are in, be it household appliances, aircraft design and manufacture, power tools, agricultural equipment, or the manufacture of any product that makes a sound. Whether you are a manufacturer in one of these industries or are a sub-supplier of products and components to the industry, you will be able to enhance your ability to compete in the marketplace by using the facilities provided by Brüel & Kjær's Sound Quality Systems.

Objective Measurements and Subjective Evaluations

Although your customer will pass final judgement on the sound quality of your products, you can anticipate that judgement. You will find that both objective psychoacoustic measurement parameters (also known as metrics) and subjective listening tests are useful tools on the way to producing the ultimate sound. Brüel & Kjær believes that these are equally important.

For objective measurements, standard analysis methods such as FFT are available. However, based on psychoacoustic research, Zwicker Loudness has been developed and has also been found to be an important analysis tool. It provides the foundation for the calculation of quantities, or metrics, such as Sharpness, Fluctuation Strength and Roughness.

These metrics are an attempt to obtain a numerical value that will correspond to the result from a subjective listening test. For example, sharpness is an attempt to measure the irritating high-frequency component of a sound. How it correlates to a subjective listening test is difficult to predict because of the complexity of the human perception

of sound and because different listeners have different expectations of different products. But time and money can be saved when an objective measurement is compared with subjective evaluations and there is good correlation between the results. You then know that for a particular product and situation you can reduce or even eliminate the need for a subjective jury test.

In addition, sound quality is a product parameter and is therefore subject to QC evaluations. In this case, subjective evaluations are neither practical nor acceptable; for QC purposes you need a simple, repeatable test which can produce results quickly and reliably. Therefore, the open architecture for customised metrics allows you to develop combinations of weighted metrics that are specific to the product being tested and have a good correlation with a subjective judgement by jury.

What Makes a Complete and Flexible Sound Quality System?

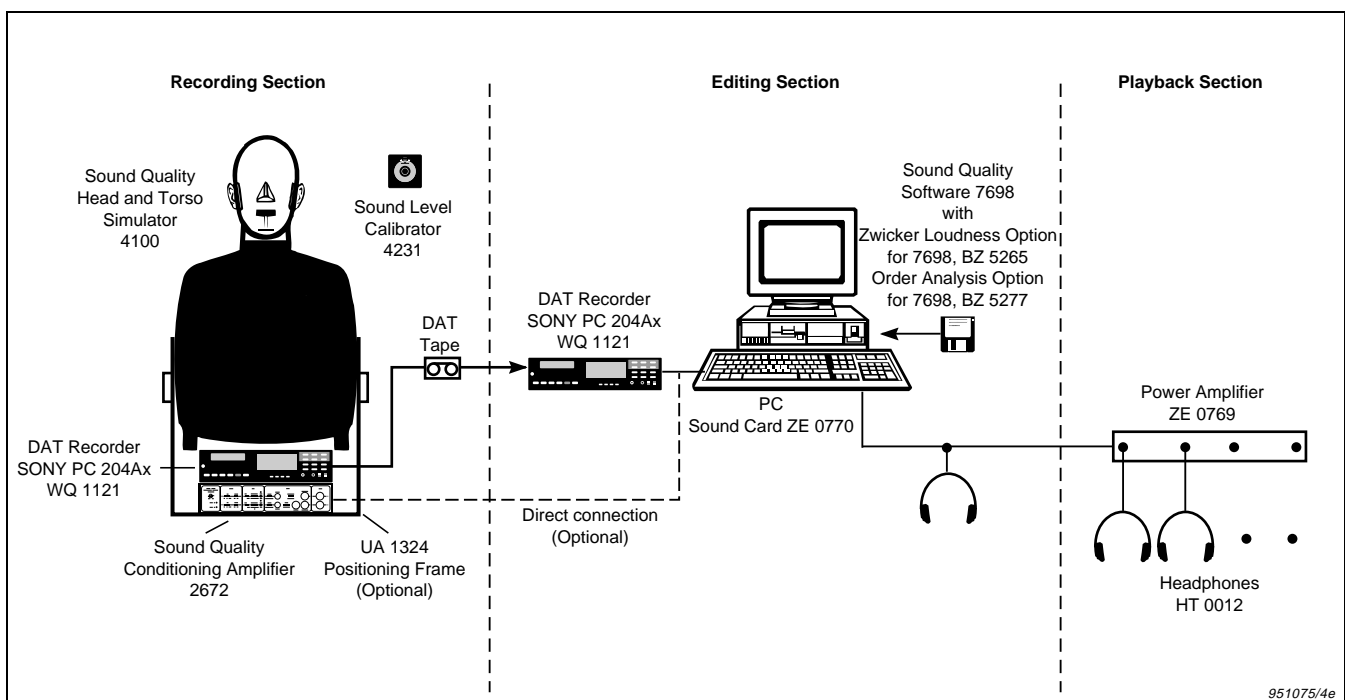
A complete and flexible sound quality system must include:

- a robust and reliable, calibrated recording/input section and a calibrated playback/output section – without both of these neither the recording of the original signal nor playback of an edited signal can be directly compared with the original sound due to unknown changes in the sound level
- an analysis and editing section for signal modification and synthesis and objective measurement providing single-figure measures of performance
- a link to other tools for further analysis and product engineering

The sound quality system available from Brüel & Kjær fulfils all of these requirements. Sound Quality Program Type 7698, the software central to the system:

- runs on a standard PC without a DSP card

Fig. 1 Sound Quality System Type 3801



- has a standardised interface with data export/import in ASCII, WAV or Universal File Format
- interfaces with PULSE, the Multi-analyzer System Type 3560

Recording/Input

For recording, you will require a calibrator, transducer(s), some form of signal conditioning and, for measurements in the field, a DAT recorder.

Sound Level Calibrator Type 4231

The small size of this calibrator makes it the most convenient choice for calibration of the recording system. It provides an SPL of 94 or 114 dB at 1 kHz and allows you to record a calibration signal on DAT prior to making recordings of the sound you want to investigate.

Single Microphone/Preamplifier

Brüel & Kjær supplies a wide range of microphones and preamplifiers from which you can select those that best suit your requirements. Using a single microphone, you will not get any information about the direction of a sound, but you will have the simplest and least expensive system. Choose a free-field microphone for measurements in a free field and a diffuse-field (random-incidence) microphone for measurements in a diffuse field.

Head and Torso Simulator

Fig. 2 Head and Torso Simulator Type 4100 situated in a Positioning Frame UA 1324 with Sound Quality Conditioning Amplifier Type 2672 and a SONY DAT recorder



A head and torso simulator allows you to make binaural recordings that sound realistic and include all the directional clues. When played back using headphones, recordings sound as they would if you were present instead of the head and torso. The acoustics of the test environment are faithfully reproduced and, because directional information is accurately recorded, you can, when listening, distinguish a number of sound sources from each other. In many cases,

such as for measurements in a car, it would be far too time consuming to have each jury member listen to the actual sound source in turn. A binaural recording allows realistic playback over headphones with identical exposure to all members of the jury simultaneously.

Type 4100

This contains Preamplifiers Type 2669 L with Brüel & Kjær's patented charge injection calibration (CIC) facilities.

Type 4100 D

Here, the preamplifiers are DeltaTron® Preamplifiers Type 2671. These are less expensive, but do not have the CIC facilities.

Sound Quality Conditioning Amplifier

Type 2672

This conditioning amplifier features analogue diffuse-field correction filters and CIC facility. The correction filters compensate for the diffuse field frequency response of the head and torso simulator, increase the dynamic range and allow correct calculation of Zwicker Loudness and editing. The CIC technique lets you make an electronic check of the entire microphone, preamplifier and cable assembly. In this way, deviations from an earlier acoustic calibration using a reference sound source such as Sound Level Calibrator Type 4231 are easily identified. You can simply record the CIC tone(s) between sound recordings. If there is no change in level, the calibration is still valid.

For actual recordings, Type 2672 can be fitted into a frame with a SONY® PC 204 Ax measurement grade DAT recorder. The instruments are the same size and use the same type of battery. This allows them to be combined into a compact, portable, battery-operated unit.

DAT Recorder

SONY PC 204 Ax DAT

The (WQ 1121) recorder has four channels (8-, 16- and 32-channel versions are also available). This means that you can simultaneously record binaural sound and two auxiliary signals such as tacho signals or a reference vibration.

Professional Audio DATs

These are only two-channel, but data can be transferred to the Sound Quality Program with AES/EBU and or SPDIF interface.

Positioning Frame

UA 1324

If your measurements are meant to simulate a seated person, a combined recording unit comprising SONY DAT recorder and sound quality conditioning amplifier can be fitted into Positioning Frame UA 1324 along with a head and torso simulator (see Fig. 2). The entire assembly is light and easy to install and adjust, and gives you even greater measurement reproducibility by controlling the position of the head and torso's ears. So if you need to repeat a test or measurement you can do it with exactly the same physical position of the ears.

Analysis and Editing

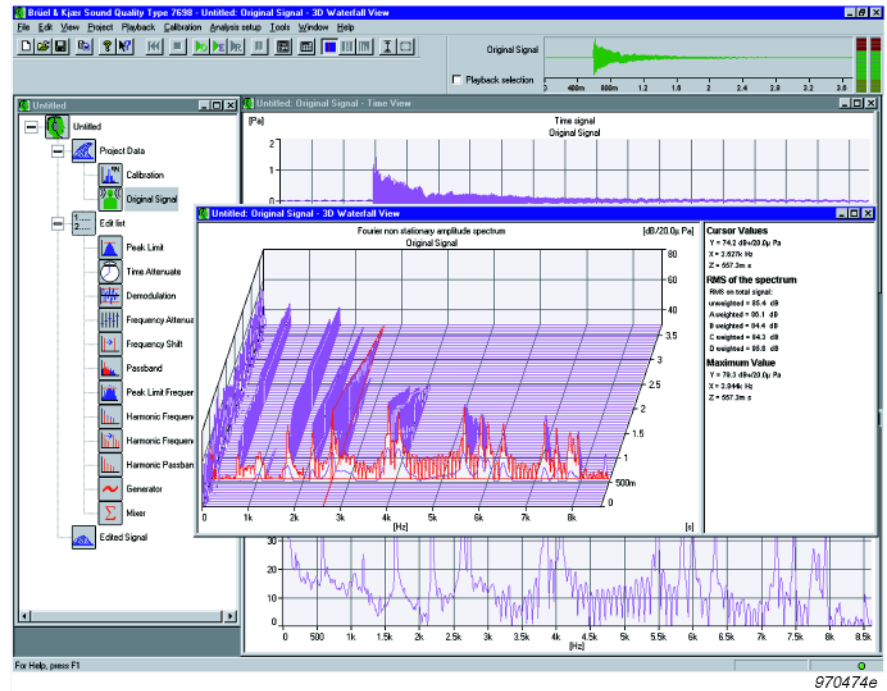
Brüel & Kjær offers PC-based solutions for editing and analysing sound quality. These can be dedicated purely to sound quality or, if you already have a PULSE multi-analyzer system, the program can be installed in a PULSE environment.

Sound Quality Program Type 7698

This software package that lets you edit, analyse and play back binaural and other signals. Combined with the necessary hardware, Type 7698 is the central part of a complete PC-based sound quality system.

Besides offering powerful tools for both objective and subjective analysis of sound quality, Type 7698 software provides complete facilities for every other step of the sound quality evaluation and optimization process. From calibration, recording, and playback to editing and display, Type 7698 does it all.

Fig. 3 Sound Quality Program
Type 7698



Zwicker Loudness Option BZ5265

This lets you use the PC's processor to make Loudness calculations for both stationary and non-stationary signals.

Order Analysis Option BZ5277

This option adds order analysis functionality to Type 7698 to allow sound quality work on rotating machinery under transient conditions.

BZ5277 adds order related display and analysis functions to allow detection, quantification and editing of order related sound components. Order edits allow attenuating or filtering out specific orders or sets of orders, either for troubleshooting or simulation of design changes.

Sound Card ZE0770

This is a Windows compatible sound card with both analog and digital input.

Using Sound Quality with PULSE

Sound Quality Program Type 7698

See above. The program can import data from PULSE, the Multi-analyzer System Type 3560, giving you greater flexibility.

Zwicker Loudness Option BZ5265

See above.

Order Analysis Option BZ5277

See above. BZ5277 adds two tacho channels to supplement the two existing sound channels. Data for the tacho channels may either be directly measured, transferred from a digital recorder or imported from files. If the file format permits (for example UFF or multitrack wave), two sound channels and two tacho channels may be selected.

Recommended components in a PULSE system

*Noise and Vibration Analysis
Type 7700*

This is the basis software for a PULSE measurement system. You can use all of PULSE's multichannel capabilities to make recordings. With a signal generator and FFT, CPB and Overall Level analyzers that can be used simultaneously, you can use other methods of analysis with your recorded time signals.

*Data Recorder Type 7701 with
Throughput-to-disk Option UL0112*

This LabShop Tool pack allows you to use PULSE to record time data directly to a dedicated hard disk installed in your PC. You can later move these data to the Sound Quality Program.

Zwicker Loudness Analysis Type 7704

This LabShop Tool pack allows you to use PULSE for monitoring Loudness in real time in up to 8 channels.

Front-ends: Types 2816, 2825

These signal conditioning front-ends are used to input data to PULSE.

Playback/Output

The system for playback of original or edited sound signals consists of power amplifier(s) and headphones.

Power Amplifier ZE0769

This is the recommended power amplifier for driving multiple headphones. The amplifier has an attenuator calibrated in 6 dB steps and each of its four outputs can drive up to 24 sets of headphones with 300 Ω impedance via “break-out boxes”.

Headphones HT0012

For playback and jury testing it is important that the sound you play back is directly comparable to the original recording, that is, that the output is calibrated. But the quality of headphones can have a large impact on the perceived sound. We have therefore chosen Sennheiser HD 580 headphones for use in our sound quality systems. These headphones not only have an excellent reproduction quality, but each set is specially selected for Brüel & Kjær by the manufacturer, ensuring that the frequency response and sensitivity are within specified limits. This means that you can interchange headphones without continually having to recalibrate.

Services

7698-MS1

If you have purchased any or all of Sound Quality Program Type 7698, Zwicker Loudness Option BZ 5265 or Order Analysis Option BZ 5277, this maintenance and upgrade agreement will ensure that you always have the latest software and documentation for your PC-based sound quality system. (Similar agreements are available for PULSE.)

Further Reading

Further information on products described here can be found in the following Product Data:

- BP1589* Sound Quality Program Type 7698 (including Zwicker Loudness Option BZ 5265)
- BP1794* Order Analysis Option for Type 7698, BZ 5277
- BP1436* Sound Quality Head and Torso Simulators Types 4100 and 4100 D
- BP1588* Sound Quality Conditioning Amplifier Type 2672
- BP1587* Positioning Frame UA 1324

- BP 1611** PULSE, the Multi-analyzer Type 3560 (including Noise and Vibration Analysis Type 770)
- BP 1633** Data Recorder Type 7701 (including Throughput-to-disk Option UL 0112-00x)
- BP 1761** Zwicker Loudness Analysis Type 7704
- BP 1636** Multichannel Data Acquisition Unit Type 2816
- BP 1635** Acquisition Front-end Type 2825
- BP 1311** Sound Level Calibrator Type 4231

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