# Environmental *Solutions*

**Brüel & Kjær**

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# WELCOME

*Welcome to Brüel & Kjær's Environmental Solutions Catalogue covering our full range of solutions for assessment of environmental noise, monitoring of noise, assessment of noise and vibration at work, calculation of environmental noise, and measurement and calculation of building and room acoustics.*



## Innovative Solutions

At Brüel & Kjær we are in the business of innovation. We always have been – from the first range of measurement microphones to the first multi-analyzer and the first Non-stationary STSF system. We're proud of this tradition and continue to face the challenges posed to us by our customers. In fact we're focusing more and more on our customers' needs to cover the whole measurement chain – from a single transducer to a complete turnkey system. We have made strategic alliances to find newer and more efficient ways for our customers to improve their products' quality and stay at the cutting edge of competitiveness. Technology has no limits – if our customers can imagine it then we will strive to develop it.

## Wealth of Experience

Knowledge and experience go hand-in-hand and we have accumulated over 60 years' worth. In fact, many of our employees are world-renowned experts in their respective fields and are often asked to speak at seminars, conferences, advise on new Standards, etc. But our expertise doesn't only come from within our organisation; it also comes from working closely together with our partners. In this way we can further our declared mission – to enhance the environment, the quality and the joy of life for everyone by improving sound and reducing vibration. With all this expertise we have been able to establish our knowledge centre – the Brüel & Kjær University – from which we can build and spread sound and vibration related knowledge worldwide for the benefit of our partners, employees and, not least, our customers.

## Top Quality

In all aspects of sound and vibration there are challenges to be met. For example, making sure that the car, bus or train that one takes to work each day can withstand the mechanical shocks imposed on it demands measurements of great accuracy and precision. This requires instruments with the performance and quality to match. All our products are thoroughly tested, often in the harshest environmental conditions. Documented standards are met in all aspects of product and service provision, as reflected in our status as an ISO 9001 certified company. In fact, you'll find that our products usually come with a service period of 5 years after the end of production, such is their reliability, quality and robustness. And it is not only customer demands that need to be satisfied – legislation also sets exacting standards. This often means documented results that are traceable to known sources, such as a national calibration laboratory. And it goes without saying that the support customers receive must always be the most reliable they can find. If things go wrong, Brüel & Kjær is there to help.

## Brüel & Kjær's Vision

Our vision is to be the preferred partner and solution provider to all leading companies and institutions who care about sound and vibration, and be the global competence centre for sound and vibration.

# ENVIRONMENTAL NOISE

## ISO 1996 – RATING LEVEL

**The International Standard for Assessment of Environmental Noise**

ISO 1996 "Acoustics – Description and Measurement of Environmental Noise" is a central standard within environmental noise assessment, acting as a reference work on the subject. It is divided into 3 parts:

- ISO 1996 Part 1 1982: Basic quantities and procedures
- ISO 1996 Part 2 1987: Acquisition of data pertinent to land use (amended 1998)
- ISO 1996 Part 3 1987: Application to noise limits

It defines the basic terminology including the Rating Level parameter and describes best practices for assessing environmental noise.

**ISO 1996 – Latest Developments**

ISO 1996 is currently under revision with focus on updating measurement techniques to modern instrumentation, improving procedures, such as for identifying tones, and providing information on research in the effects of noise levels from different sources.

**Rating Level – Annoyance and Penalties**

The annoyance due to a given noise source is perceived very differently from person to person, and is also dependent upon many non-acoustic factors such as the prominence of the source, its importance to the listener's economy and his or her personal opinion of the source. For many years, acousticians have attempted to quantify this to enable objective assessment of noise nuisances and implement acceptable noise limits. When large numbers of people are involved, reactions tend to be distributed around a mean, and the Rating Level ($L_R$) parameter has been developed in an attempt to put a numerical value on a noise that describes its annoyance in relation to a population.

Rating Level is defined in the ISO 1996 – 2 standard. It is basically a measure of the noise exposure corrected for factors known to increase annoyance. It is used to compare measured levels with noise limits that usually vary depending on the use of the property under investigation (see Section 15 of the standard). The basic parameter is the A-weighted equivalent continuous sound pressure level or $L_{Aeq}$. The formula for the Rating Level is (in general terms):

$$L_R = L_{Aeq} + K_I + K_T + K_R + K_S$$
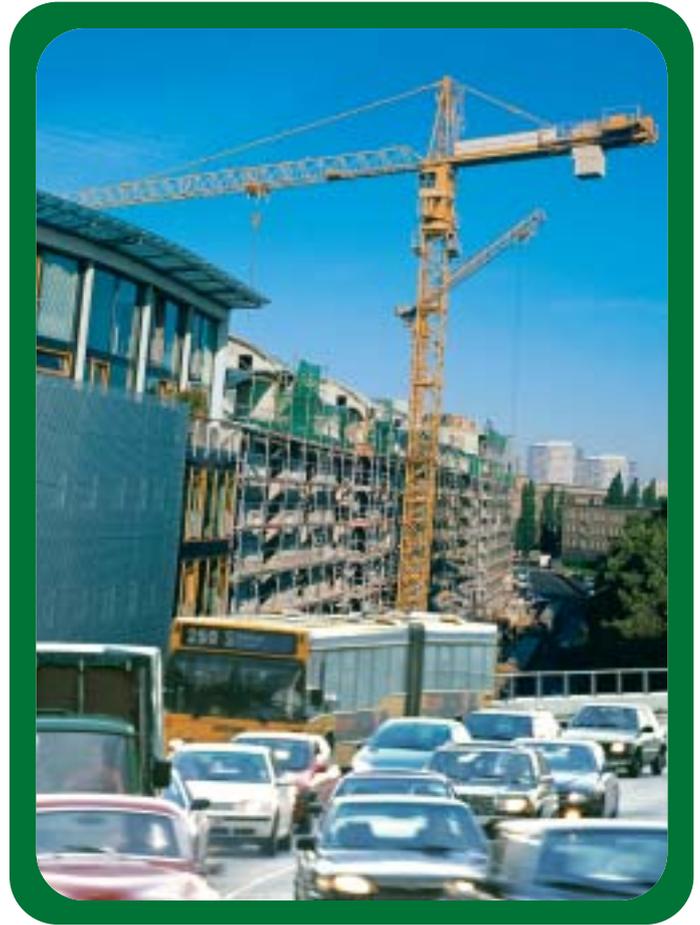
where:
$K_I$ is a penalty for impulses
$K_T$ is a penalty for tone and information content
$K_R$ is a penalty for time of day
$K_S$ is a penalty (positive or negative) for certain sources and situations

ISO 1996 – 2 states that the Rating Level has to be determined over reference time intervals related to the characteristics of the source(s) and receiver(s). These reference time intervals are often defined in national/local legislation and standards.

The way to measure and evaluate the penalties is different from country to country, but the basic principles are the same.

## Environmental Noise Sources

When assessing noise, the noise source determines which standard and limits are to be used. The most common noise sources (sometimes called applications) in the environment are:

- Traffic noise
  (road, rail, aircraft)
- Industrial noise
  (from plants and industries)
- Recreational noise
- Noise from neighbours
- Noise from construction sites

## Road Traffic Noise

Road traffic is the most widespread source of noise in all countries and the most prevalent cause of annoyance and interference. Therefore, traffic noise reduction measures have the highest priority.

$L_{Aeq}$ is the preferred noise index, but Rating Level $L_R$ and percentile levels $L_{AF10}$ and $L_{AF50}$ are also used. For dense traffic, it can be assumed that $L_{AF10}$ is about 3 dB above $L_{Aeq}$, and $L_{AF50}$ about 1–2 dB lower. Assessment is carried out using various reference time intervals depending on the country. These intervals range from one 24-hour period to three separate intervals for day, rest and night. Generally the night limits are the most difficult to fulfill. The planning limits for new roads in various countries are often above the level of 50–55 dB(A) recommended by WHO (World Health Organisation), so the expansion of "grey" areas is inevitable almost everywhere.

## Rail Traffic Noise

As with road traffic noise, $L_{Aeq}$ is the preferred index for rail traffic noise. In some countries, Rating Levels are calculated from $L_{Aeq}$ by subtracting (normally) 5 dB, the so-called railway bonus. In Japan, $L_{ASmax}$ is used for the Shinkansen high-speed line. Generally, using maximum levels as the only limit has the disadvantage of disregarding the number of trains. Assessment is carried out using various reference time intervals depending on country. These intervals range from one 24-hour period to three separate intervals for day, rest and night. The noise limits for new lines in residential areas vary between 60 and 70 dB. In some countries, the railway bonus is included in the limit values. The railway bonus is based on social surveys from several countries, comparing the annoyance from road and rail traffic. The effect is more pronounced at higher levels.

The graph below shows dose-effect relationships for air, rail and road traffic. The percentage of highly annoyed persons is plotted against $L_{DEN}$ levels ($L_{Aeq}$ with a 10 dB penalty for night-time exposure between 22:00 and 07:00). It illustrates the lower annoyance caused by railway noise and the higher annoyance caused by air traffic noise, compared to road traffic noise for the same value of $L_{DEN}$. Due to the large spread of the underlying data, the graph is for illustration only.



% Highly annoyed

Annoyance vs. noise level

$L_{DEN}$ dB (A)

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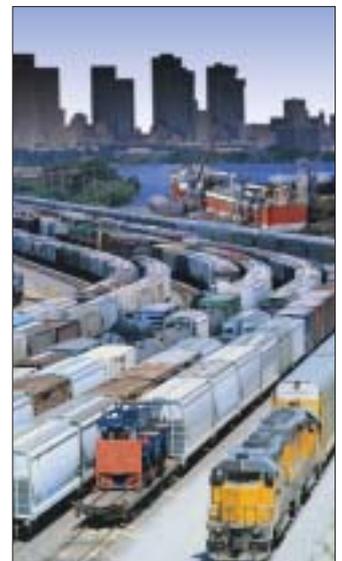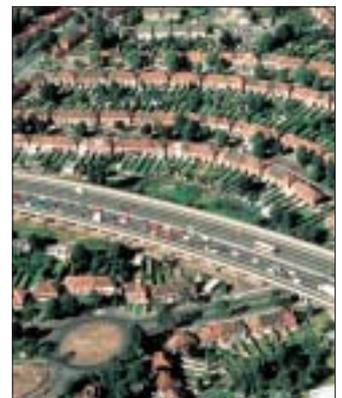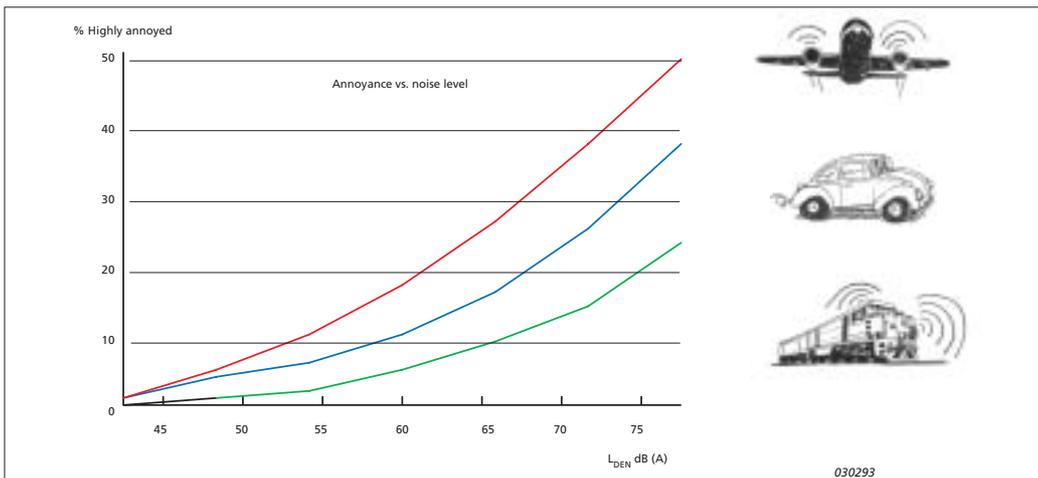
# ENVIRONMENTAL NOISE

### Aircraft Noise

The most important tool for noise control at airports is noise zoning for land-use, planning and noise insulation programmes. Noise from commercial aircraft is primarily a problem around airports as this is where aircraft converge at low altitude and high engine power. Increasing air traffic and city expansion will exacerbate the noise problems, while aircraft noise reduction, and traffic and flight path restrictions can alleviate them. As a last resort, existing dwellings can be protected against noise by improving windows and roofs.
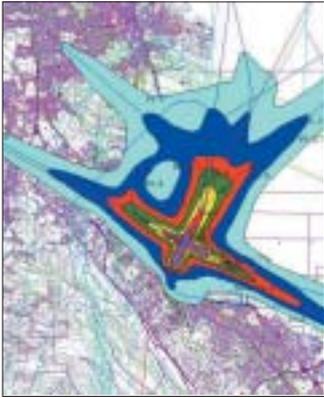
Noise contours are used to show the extent and location of noise problem areas. The number shown with each contour indicates the noise level exceeded within that contour. Superimposed on a map, and compared to noise limits, they pinpoint areas in need of noise reduction measures.

Noise footprints show the noise contours for a single aircraft or class of aircraft. Noise footprints can be calculated from noise data for each aircraft and take into consideration flight path, aircraft operation and landscape features. They serve to assess the present and projected noise impact and help plan noise reduction measures.

### Industrial Noise

Almost all countries use the Rating Level $L_R$ according to ISO 1996 when assessing industrial noise. However, in Japan, $L_{AF50}$ is used, while Belgium uses $L_{AF95}$. The limit is normally in the 50 – 55 dB(A) range.

The **reference time periods** vary from country to country. Some use just day and night, some combine day and night, and others have resting periods as well. Different assessment procedures are used for each reference time period. A **loudest time period** is used in some countries to penalise intermittent noise. The duration of this period ranges from 5 minutes to one hour, depending on the country.

The **penalty for tones** varies between 0 dB (no penalty) and 6 dB. Some countries use a single penalty value of 5 dB, while other countries use two or more steps. In most cases, the presence of tones is determined subjectively, but objective methods are increasingly used. These methods are based on $\frac{1}{3}$-octave or FFT (Fast Fourier Transform) analysis.

The **maximum penalty for impulsiveness** can vary up to 7 dB between countries, and both subjective and objective methods are used. The objective methods are based on the difference between a fast reacting and a slower reacting measurement parameter (for example, between Impulse and Fast A-weighted levels) or it can be based on the type of source, using a list enumerating noise sources (such as hammering, explosives, etc.).

### Other Noise Sources

Recreational noise (noise coming from recreational activities such as rock concerts, motor cross and football), noise from neighbours and noise from construction sites are handled in ways similar to those described above, but are not described in detail here.

**Product Guide**

Brüel & Kjær offers solutions to all the previously mentioned applications. Please use this table as a guide to relevant products.

| Application | Key Features | Products and their Key Features |
|---|---|---|
| Road Traffic Noise<br>Rail Traffic Noise<br>Aircraft Noise*<br>Industrial Noise<br>Recreational Noise<br>Noise from Neighbours<br>Noise from Construction Sites | 1) $L_{Aeq}$, $L_{max}$<br>2) Statistics $L_N$<br>3) Event markers<br>4) 1/3-octave spectra<br>5) FFT spectra<br>6) Event trigger<br>7) Sound recording | 2240 Integrating Sound Level Meter [1]<br>2238 Mediator [1] [2] [3] [4]<br>2250 Hand-held Analyzer [1] [2] [3] [4] [6]<br>2260 Observer [1] [2] [3] [4]<br>2260 Investigator [1] [2] [3] [4] [5] [6] |
| Rating Level $L_R$ | Penalties $K_I$, $K_T$, $K_R$, $K_S$<br>Sound Recording | 7820 Evaluator, 7821 Evaluator Light |
|  | Unattended measurement | UA1404 Outdoor Microphone Kit<br>3592 Outdoor Gear _030240_ |

*See also Noise Monitoring Systems on page 60*

# UNATTENDED NOISE MONITORING

## General

For a quick, on the spot estimate nothing beats a competent operator having the equipment to measure and describe the noise situation. However, to assess the noise in an area for a week, a month or a year, you need a monitoring system that measures and logs data 24 hours a day with a number of noise monitoring terminals (NMTs) placed strategically. The system ensures automatic, round-the-clock data transfer and post-processing including noise parameters as well as meteorological data. Reliable measurement data, secure communication between the NMTs and the server, database integrity and openness are key to a successful system.

Data from noise monitoring is useful also to support noise maps made by modelling and calculation. Such maps are required under the EU Directive 2002/49/EC, including noise from major roads, railways, airports and industrial activities. Guidelines are under way for the integration of noise monitoring and noise mapping, to ensure the quality and credibility of the maps.



## The Noise Monitoring Terminal

A noise-monitoring terminal consists of weatherproof microphone equipment for noise measurement, data storage and communication. A range of noise parameters are measured: $L_{Aeq}$ and $L_N$ levels as well as noise-event detection and weather information. Some provide $1/3$-octave band frequency analysis in real-time allowing immediate calculation of indices such as EPNL (perceived noise levels) of each aircraft flyover. Some allow you to listen to the recorded noise events at your leisure. Connection of a positioning system (GPS) unit to the noise monitoring station can identify the position of the measurement.

## Database Handling

Permanent monitoring systems have extensive databases for analysis, impact research and status evaluation including periodical results. Noise events and complaints can be correlated and combined with GIS (Geographic Information System) digital cartography to show population exposure and allow high-quality presentation. The data stored in the system can be used to maintain and update maps, to enforce noise legislation and to evaluate complaints. It can be linked to other indicators such as traffic flow or air quality recorded from general environmental monitoring stations. Measurement results obtained via the noise database could even link up with an authority's case notes in the relevant database allowing electronic reporting, archiving, retrieval or web communication to the public.

## Airport Noise and Flight Track Monitoring

Public demands for quieter airports have brought about strict legislation that has made airport noise monitoring compulsory in many countries. Indeed, growing environmental concerns constitute one of the most serious obstacles to capacity expansion of airports. Interfacing radar information from the airport with a noise monitoring system allows flight tracking. This provides data on track violations and singles out offending aircraft and airlines. Knowing aeroplanes' positions and identification is useful to correlate aircraft movements with noise events and other factors: airport information, weather con-

ditions, and location of complainants. By taking the step of monitoring airport noise you can:

• Enforce legislation
• Identify and document noise events correlated with aircrafts
• Detect aircraft violating allowed tracks
• Create and publish environmental noise reports
• Minimise the noise impact caused by aircraft in both the present and the future
• Deal effectively with noise complaints, by adding statistics, location and plane detection
• Improve the environmental image of your airport
• Predict and optimise air traffic by integrating real flight traffic into calculation models

**Urban Noise Monitoring**
Permanent, 24 hour a day, 365 days a year, urban noise monitoring oversees adherence to noise limits and allows a wide range of additional benefits. It can indicate noise trends and help produce noise maps. GIS offers the ability to combine noise data with other factors such as air pollution, population density or property prices and present them professionally.

As alternatives to permanent monitoring, semi-permanent or mobile monitoring can be useful – for complaint assessment, for surveys, or to cover multiple positions using a single terminal.

Urban noise monitoring covers:

**Road noise monitoring** to assess statistic evaluation of noise annoyance created by taking into consideration different factors: number, types and speed of vehicles, road surface and weather conditions.

**Railway noise monitoring** to assess statistic evaluation of noise annoyance created by taking into consideration different factors: types, speed and length of trains and weather conditions.

**Construction-site noise and vibration monitoring** to prevent excessive vibration levels at low frequencies, to make sure that authorised working times are

respected, and to provide the right tools to identify the source creating annoyance, for example, sound and/or video recordings with noise events.

**Concert, exhibition and sports arena** noise monitoring to manage neighbourhood noise assessment by determining ambient noise, particular noise and residual noise, precisely evaluating noise annoyance (broadband and small band, especially low frequencies at concerts) and alerting the event manager if the remote noise level exceeds allowed limits.

**Industrial plant noise monitoring** to determine noise created by the different operating conditions.

*Product Guide*
*Brüel & Kjær offers solutions to all the above-mentioned applications.*
*Please use this table as a guide to relevant products.*

| Application | Key Features | Products and their Key Features |
|---|---|---|
| Airport Noise Monitoring | 1) $L_{Aeq}$, $L_{max}$ | 4198 Outdoor Microphone Unit [6] |
| Urban Noise Monitoring | 2) Statistics $L_N$ | 4184 Weatherproof Microphone Unit [6] |
| Plant Noise Monitoring | 3) 1/3 Octave spectra | 3631 Portable Noise Monitoring Terminal [1) 2) 16) 17] |
| | 4) Event trigger | 3637 Portable Noise Monitoring Terminal [1) 2) 3) 4) 5) 6) 7) 9) 16) 17] |
| | 5) Sound/Video recording | 3597 Permanent Noise Monitoring Terminal [1) 2) 3) 4) 5) 6) 7) 9) 16] |
| | 6) Automatic Calibration (CIC) | 7802 Noise Monitoring Software [4) 8) 10) 14) 15) 16] |
| | 7) Automatic location (GPS) | 7840 Noise Monitoring Software [8) 10) 14) 15) 16] |
| | 8) Communication with NMT | 7832 Reporting Module [11] |
| | 9) EPNL | 7833 Complaints Module [12] |
| | 10) Database management | 7804 Flight Tracking Option [13) 14] |
| | 11) Reporting | 7834 INM Link [15] |
| | 12) Complaints handling | |
| | 13) Correlation with flights | |
| | 14) GIS Interface | |
| | 15) Prediction | |
| | 16) Weather information | |
| | 17) Portable | *030280* |

# ENVIRONMENTAL NOISE CALCULATION

## CALCULATION AND MODELLING

### Environmental Noise Calculation
Noise levels can be calculated instead of being measured. In some cases, calculation is preferable and may be the only practical method, for example, where there are relatively high residual noise levels, where future levels need to be predicted or alternative scenarios need to be compared. Calculation is also useful for large-scale noise mapping and where there is limited access to the measurement position. Calculation is normally performed in accordance with a national, source-specific standard.



### Input Data
Calculations are made using a computer model of the environment with defined noise sources, topography and features that affect the propagation of the noise to (receiver) points of interest. Input data for the model can be available from various sources, for example:
- GIS or AutoCAD® files for buildings and topography
- Databases of traffic flow data
- Airborne laser scanners for topographic height information

- Sound level measurements for source levels and levels at receiver points used for calibration

In many cases, input data can be incomplete, out of date, inconsistent, or over-complex. So, in order to optimise calculations, data often needs to be processed prior to calculation. By linking input data to databases, dynamic noise maps can be made that reflect the change in the input data in the noise contours.

### Optimising Calculations
Results need to be accurate, even for strategic noise maps, as the consequences can be far-reaching and the actions based on these results expensive. Accuracy is influenced by any simplifications used to speed up the calculation:
- Maximum source-receiver distance (a fetching radius) for calculation (for example, 2 – 3 km). However, result quality needs to be checked as sources might occur in clusters
- For steady results at the edge of any "calculation tile" of a larger area the relevant model area should exceed the result area by the size of this fetching radius. Thus, for a calculation area of 1 km², 25 km² of model area may be required
- Neglect irrelevant emitters. This can be done by defining an acceptable maximal total error margin
- Maximum reflection distance (reflector fetching radius). The major influence of reflectors is close to a source or receiver – thus reflections further away can be omitted. Typically, a 30 m reflector fetching radius produces sufficiently good results with optimal calculation time

## Validation Ensures Optimal Accuracy

Like measurements, the calculation should also be calibrated. This usually involves some form of valid measurements at selected positions where the measured long-term levels can be compared to the calculated ones. However, unlike measurements, calibration of a calculation is performed after the first calculation and used to refine results to the optimal accuracy.

Care should be taken that the measurement data is equivalent to that calculated. The calculation normally results in long-term, average $L_{Aeq}$ levels, and using results from a single day's measurement can give systematic errors caused by non-representative wind conditions and the state of ground cover. This error can be up to 10 dB. In addition, measured data is not source-specific and includes contributions from sources other than those under investigation. Longer-term monitoring and post-processing of the results to "remove" unwanted contributions are recommended.

Two approaches can be taken. The first is global correction of noise levels where the map can be adjusted "en-masse" to optimise the difference between calculated and measured values.

Alternatively, local correction of noise levels – by measuring close to the sources under investigation, the source levels can be estimated. A calculation model that describes the whole ambient condition is defined. Sources with unknown emission are roughly estimated. The calculation software then uses an iterative technique to find emission values which best fit the measured data at the receptor positions while considering effects such as other sources, reflections and diffraction. This method shows acceptable results, and is preferred as good quality calculation results are not adjusted to the worse (as may happen with global correction).

In some cases, for example when investigating possible future scenarios, validation with measurements is not possible. Here, careful analysis of the results, or comparison with similar situations, is required to ensure optimal accuracy.

*Product Guide*
*Brüel & Kjær offers solutions to all the above-mentioned applications.*
*Please use this table as a guide to relevant products.*

| Application | Key Features | Products and their Key Features |
|---|---|---|
| Modelling outdoor noise | Noise level mapping Environmental impact assessments Scenario comparison Fulfil EU IPPC 1996/61/EEC | 7810 Predictor 7812 Lima |
| Large-scale noise mapping | Fulfil EU END 2002/49/EC (for example, interim methods) Large-scale data handling Interface with external databases and software | 7812 Lima |
| Measuring sound powers of noise sources<br><br>Validating calculations | 1) Sound intensity method 2) Sound pressure method 3) $L_{Aeq}$ 4) $L_{DEN}$ 5) GPS position | 2260 Investigator [1) 2) 3) 5)] 2260 Observer [2) 3) 5)] 2250 Hand-held Analyzer [2) 3)] 7816 Acoustic Determinator [2) 3)] 3637 Noise Monitoring Terminal [3) 5)] 3631 Noise Monitoring Terminal [3)] 3597 Noise Monitoring Terminal [3) 5)] 7802/40 Noise Monitoring Software [3) 4) 5)] |
| Airport noise maps | Noise level mapping Import of actual flight information | 7834 INM Link |
| Modelling aircraft noise | Noise level mapping Footprints and time histories | 7812 Lima |

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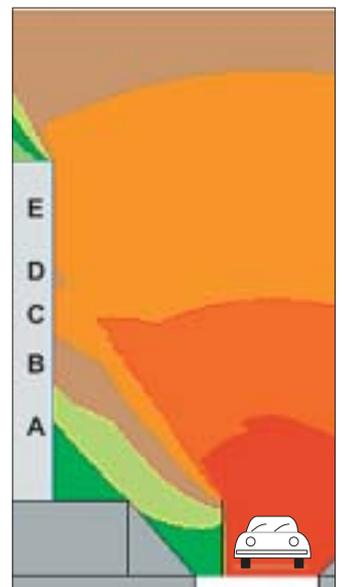
# BUILDING ACOUSTICS

## SOUND INSULATION – A UNIVERSAL PROBLEM

Sound energy does not remain in the room where it is produced, but propagates throughout the building by any available path, intruding into other rooms as noise. Each country has its own standards of sound insulation in buildings, but it is measured in the same way all over the world.

### Airborne Sound Insulation

Airborne sound insulation is a measure of how well sound from acoustical sources (for example, voices) is reduced from one room to another room. To measure sound insulation, a loudspeaker producing pink noise is located in one room (the source room). The noise levels in the two rooms under investigation are measured and subtracted, and the level difference is corrected for the influence of the absorption (measured by reverberation time) and background noise level in the receiving room. The measurements and calculations are made in $\frac{1}{1}$- or $\frac{1}{3}$-octave bands and averaged over a number of positions in the rooms. Finally a single-number index is calculated over all the frequency bands.

### Façade Sound Insulation

Façade sound insulation is measured like sound insulation between rooms, except that one "room" is open space. The sound level is measured inside the receiving room and outside the façade of the building. The level difference is then corrected for the influence of the reverberation time and background noise level in the receiving room. Finally a single number index is calculated by averaging over all the frequency bands. A loudspeaker source can be used for the measurement, giving a choice of sound incidence angle.

### Two Channels for Façade Sound Insulation

Instead of using a loudspeaker source, it is sometimes better to use existing traffic noise. The measurement then relates to actual conditions for source type and sound incidence. But since the sound level varies over time, the levels outside and inside the room must be measured at the same time. Two-channel measurement is essen-

tial to achieve this. For several measurement positions, the average of the outdoor-indoor level differences is taken rather than the difference of the average levels in each room.
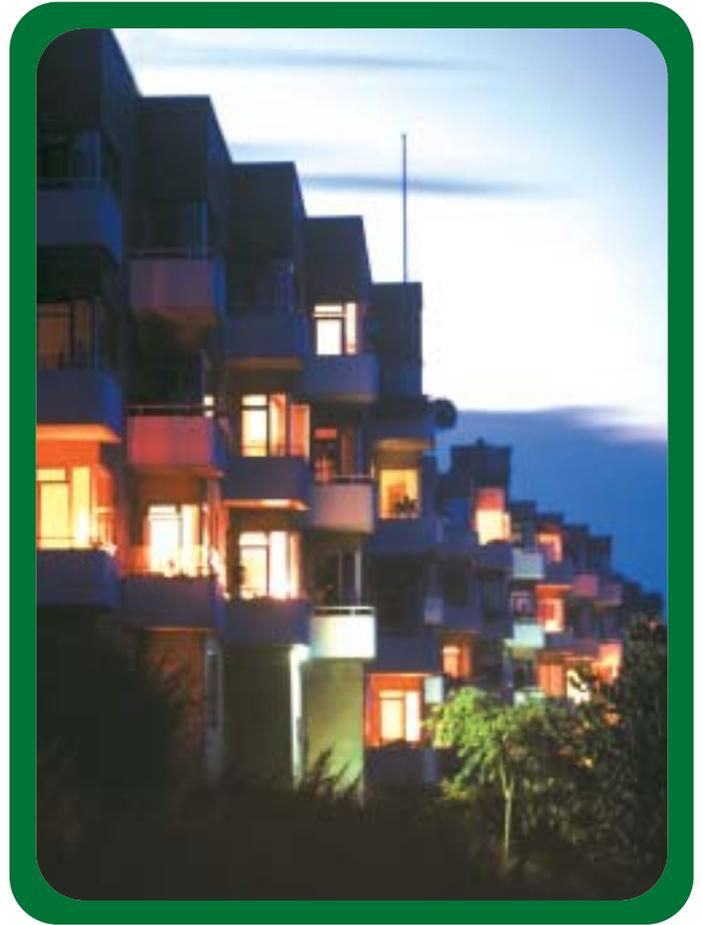
### Impact Sound Level

Impact sound, such as the noise made by footsteps, is simulated using a standardised tapping machine. When measuring, the tapping machine is placed in the source room and the level is measured in the receiving room and corrected for influence of reverberation time and background noise. A single-number index is calculated as above. Sometimes it is also necessary to correct for the produced airborne sound from the tapping machine. In this case the source room level also has to be measured.

### Reverberation Time in Practice

Reverberation time is measured using either interrupted noise (pink or white) from a loudspeaker source, or impulsive noise from a starting pistol. It is measured in $\frac{1}{1}$- or $\frac{1}{3}$-octaves, serially or simultaneous-

ly in all bands. It is usually averaged over several positions in the room and over several decays in each position. Quite often a wide-band average is calculated by mathematically averaging the reverbertion time for a range of frequency bands. For critical applications, the shape of the decay curve is also important. Deviations from the straight line can reveal acoustical defects.

## Laboratory Versus Field Measurements

For checking constructions such as windows, floors and walls, laboratories use test suites consisting of two adjoining rooms. The test sample is mounted in a test opening between the two rooms. The two rooms are designed to eliminate the influence of flanking transmission and background noise. This ensures that results truly reflect the sound reduction of the sample. When checking sound insulation in actual buildings (field or in situ situations), the results are often influenced by flanking transmission. To indicate this, results are often identified by adding a prime (like in R').

## Troubleshooting Sound Insulation using Sound Intensity

Quite often, traditional measurement will show that the sound insulation is not as good as expected or required by law. If this is the case, a measurement using sound intensity can diagnose the fault by showing the contribution of each surface element to the sound reduction index. If you suspect a certain weak area, the contribution for that area can be measured and checked separately.

Or you can divide the partition into smaller sections and check each section until you find the fault. This measurement method also eliminates flanking transmission (or, by subtraction, lets you estimate its influence), and is ideal for detecting and measuring the influence of leaks. To measure the sound reduction index for a surface element you have to measure the level in the source room and scan the probe over the measurement surface in the receiving room.

*Product Guide*
*Brüel & Kjær offers solutions to all the above-mentioned applications.*
*Please use this table as a guide to relevant products.*

| Application | Key Features | Products and their Key Features |
|---|---|---|
| Airborne Sound Insulation<br>Façade Sound Insulation<br>Impact Sound Level<br>Reverberation Time | 1) $^1/_1$- and $^1/_3$-octave Spectra<br>2) $T_{20}$, $T_{30}$<br>3) Two-channel Measurement<br>4) Calculate Sound Insulation<br>5) Documentation | 2260 Observer [1] [2]<br>2260 Investigator [1] [2] [3] [4]<br>7830 Qualifier [4] [5]<br>7842 Classifier [1] [2] [3] [4] [5] |
| Troubleshooting Sound Insulation using Sound Intensity | Intensity Spectra<br>$L_W$ and $L_W$ Mapping | 2260 Investigator<br>3560 PULSE<br><span style="float:right">*030241*</span> |

# ROOM ACOUSTICS – MEASUREMENTS

In a concert hall, lecture room or control room, the sound produced by an orchestra, speaker or loudspeaker not only reaches the listener directly, but also through reflections. The listener's judgement of the acoustic quality depends on the temporal and geometrical sound energy distribution as well as the spectral changes the sound is subjected to. Room acoustics focuses on the impact of sound reflections on the perceived acoustic quality of a room.

The oldest room acoustic parameter is reverberation time, defined by Sabine in 1898 as the time for residual sound to decay by 60 dB. It relates to the perceived liveliness of a room. Over the past decades, many quality measures have been added. This makes it possible to measure the acoustical quality of a room.

Examples of acoustic quality measures are:
- Transparency
- Definition – how well successive tones or vowels are distinguishable and not "smeared" out in time
- Spaciousness – experience of a large enclosure
- Sound colouration – emphasis of certain frequencies
- Intimacy – to what extent it seems the orchestra is playing in the same room as the listener and not behind a sheet of glass
- Speech intelligibility
- Liveliness – related to the reverberation time
- Loudness
- Feedback – how well performers on stage can hear themselves and each other

By measuring the acoustics in a room, it is possible to predict how listeners will judge the acoustic quality of the room. For instance, it is possible to determine whether the speech intelligibility in a church or railway station is sufficient or how many loudspeakers are needed to raise the speech intelligibility to a satisfactory level. Other examples include measuring lateral reflections, which are important for an agreeable spaciousness, and the reverberation time as a measure of liveliness.

All room acoustic parameters can be determined from the room's response to an impulsive signal. These so-called impulse responses can be viewed in many ways, and help, for example, to find flutter-echoes in certain frequency bands and the walls responsible for these echoes.

It is also possible to perform room acoustic measurements in a scaled-down model of a room. The measurements are then carried out at scaled-up frequencies and the resulting impulse response can be scaled back to a real-world impulse response. If necessary, the design can be changed at an early stage of the development process. In this way, the risk of expensive changes to, for example, a new concert hall, are greatly reduced.

*Product Guide*

The right solution for handling this application is DIRAC Room Acoustics Software Type 7841 together with, for example, 2238 Mediator, Sound Level Meter

# ROOM ACOUSTICS – MODELLING

## Modelling Sound in Rooms

Eminent concert halls, ships and bridges were built in the past without modelling. However, failures that could have been avoided if a model had been built and tested were, and still are, common. The first room acoustics models used ultrasonic waves, water ripples, or light beams. Today, any laptop computer can generate the signals and process the sounds needed in a physical 1:20 scale model.

However, modern computers have the power to simulate the acoustics of a virtual model, and can even simulate sound that is hard to distinguish from the sound in the actual room when built. Modelling using computers is no longer an exotic form of art. It is used for offices, factory halls, classrooms, foyers, airport terminals, train stations and stadiums. It predicts the acoustics of new designs and evaluates planned improvements in existing buildings.

## Computer Models

Wave equation models such as FEM (Finite Element Method) and BEM (Boundary Element Method) are very accurate at single frequencies. However, the number of modal frequencies in rooms restrict FEM and BEM to low frequencies and small spaces.

Image Source models are based on specular reflection and may be useful for simple shapes like a box, but with complex rooms like a concert hall the number of image sources becomes excessive.

Ray Tracing models were used for the first practical design of auditoriums. Sound rays are traced from a source point up to a high order of reflection. At a receiver surface an energy-reflectogram can be traced for estimating room acoustic parameters.

Hybrid models combine the best features of two or more methods. ODEON Room Acoustics Software combines the Image Source method with Ray Tracing to optimise modelling accuracy and efficiency.

## Building your Model

Often a 3D CAD model is available, and your computer can create the acoustics model geometry from an appropriate file (.dxf). But if you start from scratch, you define the geometry using a simple modelling language provided with the modelling software.

The model can be surprisingly simple and yet give reliable results. Details that are small compared to the wavelength of sound increase the calculation time and do not improve accuracy.

Once you have created the model geometry, you assign materials to all surfaces from the materials library supplied in the software, and place suitable sound sources and receivers in the room. Now is the time to verify your model, using the tools provided in the software. You can quickly identify warped, duplicate, overlapping or missing surfaces, and check your surface materials.
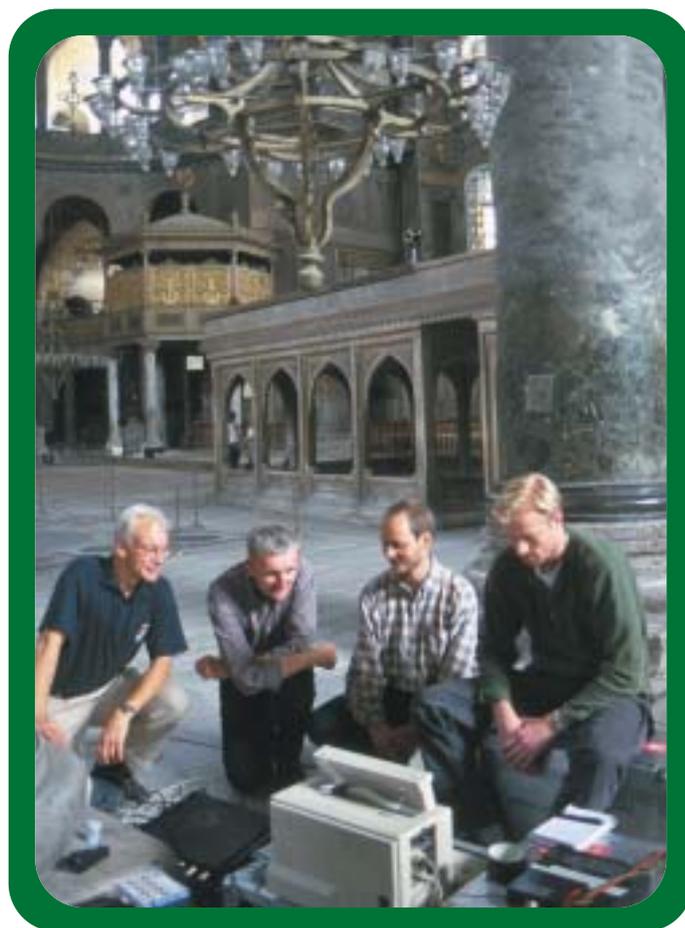
## Results

The actual simulation is often done in seconds, or minutes for more complex jobs. As a result, you get the reverberation time as well as sound levels, speech intelligibility and special concert or factory hall parameters. This can be for a single position, several positions, or mapped for an entire surface. Of course, the ultimate goal is to convince decision makers. With computer modelling you can show "what if" scenarios using impressive graphic displays and played back sound, CD recordings or live sound through the model.

### Product Guide

A product that solves this application is ODEON Room Acoustics Modelling Software Types 7835, 7836 and 7837.

# NOISE AND VIBRATION AT WORK

Occupational safety and health are major concerns throughout the world. Problems such as broken limbs, the loss of an eye, or persistent backache have to be dealt with and measures taken to minimise the risk of these things happening at work. However, it comes as a surprise to many that loss of hearing caused by noise at work is second only to the broad category "disorders of the locomotor system" on the list of occupational diseases. Millions of people suffer from noise-induced hearing loss (NIHL), resulting in a reduced quality of life. The costs of compensation and early retirement payments are immense.

Hearing conservation programmes are implemented in most countries and governed by international and national standards and legislation. Such programmes involve an assessment of the noise problem, noise control, and noise reduction measures. Important aspects of hearing conservation programs include the management of data, reporting of progress and the retrieval of data.

## ASSESSING PERSONAL NOISE EXPOSURE

The essential issue in fighting noise-induced hearing loss is the assessment of noise exposure. Hearing loss can be immediate with extreme sound levels, but, in general, the problem is exposure to noise day after day, year after year. Harmful noise levels do not always cause pain, so there are often no immediate symptoms or complaints from the person under risk. Unfortunately, however, when a person does realise that his/her hearing is severely impaired, the damage is irreversible.

The permitted noise level for a working day is, in most countries, set at 85 dB, but in some 90 dB. However, in many cases, actions, such as making hearing-protection equipment available, must be taken at 80 dB. There is a worldwide trend to lower the permitted noise exposure.

### Measuring Personal Noise Exposure

One method for evaluating the noise exposure for a particular person is to use a noise dose meter. This is a small, lightweight instrument worn throughout the working day. The microphone is placed close to the ear, often attached to the collar. The noise exposure of the person is then measured and is usually recorded directly as a percentage of the allowed daily exposure. This method is indispensable when workers move from place to place with no fixed schedule.

### Measuring Sound Levels at the Working Point

In the many cases where working points are fixed (for example, a punch press or pneumatic nailing machine) and work schedules known, the noise exposure can be computed from the data gathered at those wor-

king points using an integrating sound level meter. Noise levels are measured at each working point and assigned according to each worker's schedule (for example, 3 hours at one task, 4 hours at another). From this data, each worker's noise exposure can be computed.
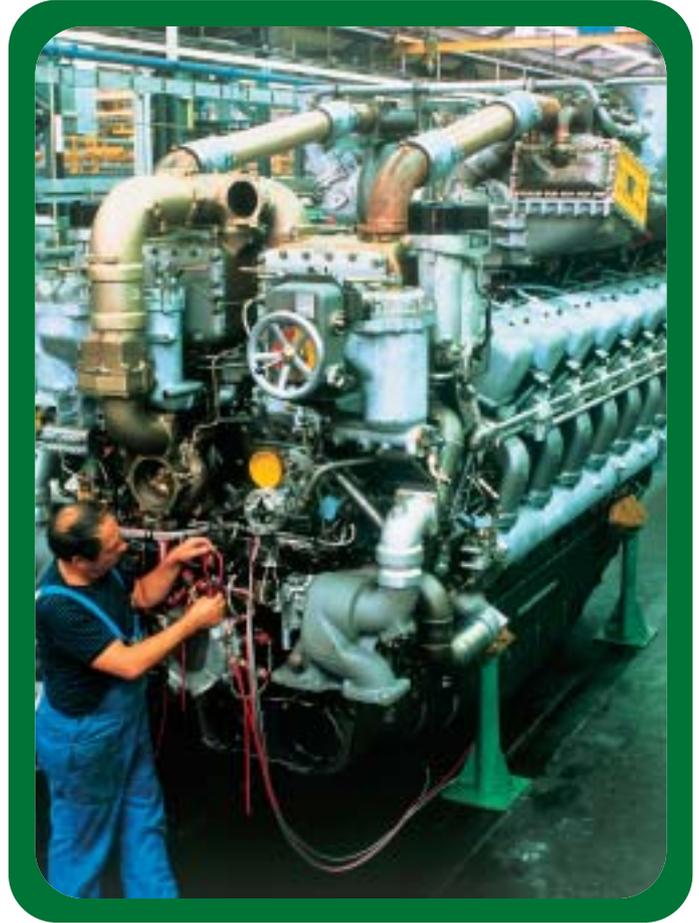
### Mapping Noise Levels

For a hearing protection program to be successful, it is important to know how noise levels are distributed in the factory hall or throughout a complex. Authorities often request a noise map from companies where excessive noise levels are suspected. It is important to make a survey of noise levels and create a noise map before setting up a large-scale protection program. This allows you to concentrate your efforts on problem areas and avoid gathering unnecessary data.

### Managing Data

Noise generated by a single machine affects all people in a working area and individual data must be kept for all of them. The data is archived in accordance with legislative requirements and must be easily accessible when compensation claims are made. Companies that run hearing-conservation programs do more than file data. Reports have to be prepared for the management, the authorities and the workforce.

# TROUBLESHOOTING OCCUPATIONAL NOISE

### Modelling Noise

Sometimes it is difficult, impossible or even hazardous to make routine measurements. This can be the case, for example, at refineries and chemical plants. In order to assess outdoor noise problems, a computer model of the sound field can be built on the basis of the sound power generated by the noise sources.

### Measuring Factory Hall Acoustics

The sound levels in a factory hall do not depend on the noise emitted from machinery and manufacturing processes alone. Noise levels depend very much on the acoustic properties of the hall. The essential parameter is the Reverberation Time that tells how quickly a high level of sound decays when it is switched off.

### The Problem

Many factory halls have very long reverberation time. Concrete floors and large surfaces (walls and roof) with little sound absorption material cause sound to linger. Noisy machinery placed close to reflecting walls, or even in corners, can result in excessive sound levels throughout the factory hall. In a factory hall with better acoustic properties, the same machinery may not cause the same problems because the noise levels will only be high close to the source.

### Measuring Reverberation Time

Reverberation Time is measured by either using interrupted sound (a powerful sound source abruptly stopped) or impulsive sound (most often a shot with a starting pistol). In industrial settings, the latter is a common method.

### Measuring Spatial Decay

The spatial decay shows how a constant level from a sound source decays with distance from the source. In a factory hall with hard reflecting floor, ceiling and walls, the level decays very slowly with distance. So a noisy machine at one end of a factory hall can produce deafening noise levels at the other end of the hall. If you measure sound levels, you can map the spatial decay, determine whether more sound absorption is needed, and measure the effect after making improvements.
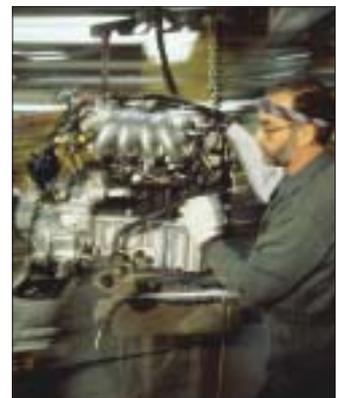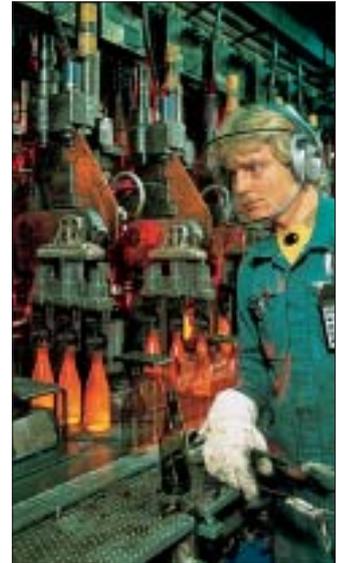
# NOISE AND VIBRATION AT WORK

## Measuring Speech Intelligibility

In many working situations it is important to understand what is being said (for example, over a loudspeaker system) and to be able to react to acoustic signals of different kinds. An objective measure of these conditions is the Speech Transmission Index (STI).

## Selecting Hearing Protection

An obvious and frequently used means of fighting excessive noise exposure is the use of hearing protectors. These are worn throughout a plant or in restricted areas. Protectors come in a variety of forms and offer widely varying noise reduction effects. In order to select the right hearing protection it is necessary to make a frequency analysis of the sound. This is the only way to choose protectors that are effective at the dominant frequencies. Suppliers of hearing protectors generally specify the attenuation in octave bands, making it easy to choose the appropriate ear defender once the spectrum is known.

## Changing the Work Schedule

In many factories only a few of the manufacturing processes pose serious noise problems. And often only a fraction of the workforce is affected by excessive noise exposure. This situation makes a simple and elegant noise control measure a feasible option – simply change the work schedule so that none of the workforce exceeds a 100% noise dose. Those workers exposed to too much noise can be identified from a database of measurements and the work schedule investigated. A change in the work schedule can be entered in a "what-if" analysis and the resulting exposure recalculated. This means that you can estimate the result of rotating workers between noisy and less noisy workplaces.

## Locating the Noise Source and Measuring the Sound Power

Fighting noise problems is ideally done by locating the noise sources and reducing the emitted noise. While it can be easy to identify a noisy piece of machinery, it can be much more difficult to pinpoint exactly where and how the noise is generated. Measuring sound intensity makes the job easier, by measuring not just the sound level but also the direction in which the sound propagates. Using the same equipment, the sound power of machinery can be determined in-situ.

*Effects of changing the work schedule*
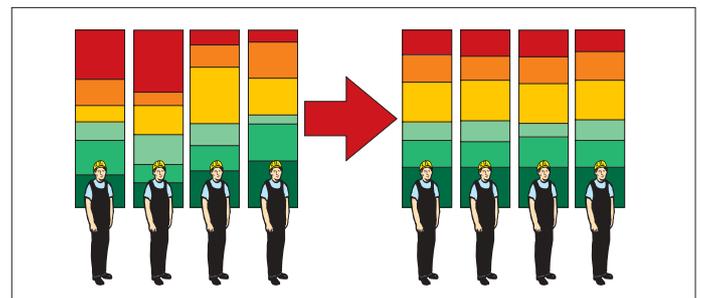
# HUMAN VIBRATION

Human vibration is defined as the effect of mechanical vibration on the human body. The effect might be on the body as a whole, whole-body vibration, or on parts of the body, of which the hand-arm system is the most important.

## Hand-arm Vibration

Hand-held power tools, such as chisels, drills and pressure hammers, expose the user to vibration. The vibration transmitted to the hand-arm system is called Hand-arm Vibration (HAV) and can be a major health concern. Excessive exposure over long periods can result in the so-called "white finger" syndrome, also known as Reynaud's syndrome. As is the case for noise-induced hearing loss, this disease is often diagnosed too late. Early symptoms are cold-induced white fingers, followed by permanent loss of feeling and dexterity.

## Whole-body Vibration (WBV)

In many cases, vibration of the whole-body system arises from vehicles, land-based or otherwise, from vibrating floors in buildings, or from big machines where the operator is seated on the machine. The effects on the body as a whole are less specific than with hand-arm vibration, but the most pronounced long-term effect is found in the lumbar region of the spine, where spine deformation, lumbago and sciatica can develop. Short-term effects of whole-body vibration are those felt during or after the working day and can be fatigue, headaches, slower reactions, nausea and insomnia, all symptoms caused by vascular disorders and nervous malfunctions.

*Product Guide*

*Brüel & Kjær offers solutions to all the above-mentioned applications. Please use this table as a guide to relevant products.*

| Application | Key Features | Products and their Key Features |
|---|---|---|
| Measuring Personal Noise Exposure | 1) $L_{Aeq}$, $L_{Cpeak}$<br>2) Logging<br>3) Statistics $L_N$ | 4442 Noise Dose Meter [1]<br>4443 Logging Noise Dose Meter [1,2,3] |
| Measuring Sound Levels at the Working Point<br>Mapping Noise Levels | 1) $L_{Aeq}$, $L_{Cpeak}$<br>2) Logging<br>3) Statistics $L_N$ | 2239 Integrating Sound Level Meter [1]<br>2240 Integrating Sound Level Meter [1]<br>2238 Mediator [1,2,3] |
| Managing Data and Reporting<br>Changing the Work Schedule<br>Calculate Noise Exposure | Import measurement data<br>Calculate noise exposure<br>Present and report results | 7825 Protector |
| Modelling Indoor Noise | Noise level mapping,<br>Auralisation | 7837 ODEON |
| Modelling Outdoor Noise | Noise level mapping | 7810 Predictor |
| Measuring Spatial Decay<br>Selecting Hearing Protection<br>Measuring Reverberation Time | 1) $L_{Aeq}$<br>2) $T_{20}$, $T_{30}$<br>3) $^1/_1$ octave spectra | 2260 Observer [1,2,3]<br>2260 Investigator [1,2,3]<br>2250 Hand-held Analyzer [1,3] |
| Measuring Speech Intelligibility | STI, RASTI | 7841 DIRAC |
| Locating the Noise Source and Measuring the Sound Power | Sound intensity | 2260 Investigator |
| 1) Hand-arm Vibration<br>2) Whole-body Vibration | | 2537 Hand-arm Vibration Meter [1]<br>2239B [1]<br>1700 3-channel Human Vibration Front-end [1,2] |

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# INDUSTRIAL APPLICATIONS

## SOUND POWER MEASUREMENTS

The sound power of products ($L_W$) needs to be measured in order to adhere to international standards and legislations such as ISO 3744 and 2000/14/EG. Product noise has also become an important criterion for customers when choosing products and, therefore, must be optimsed at the design stage.

The sound power of a product is the acoustic power emitted by the product and, unlike sound pressure, does not depend on the acoustics of the surroundings, the noise from other sources or one particular measurement position. This is why sound power is useful to quantify the noise of a product.

Traditionally, sound power has been calculated from sound pressure measurements made in anechoic or reverberation rooms in order to take into account the influence of the surroundings. The background noise level must be much lower than the level emitting from the product.

More recently, sound intensity measurements provide a more direct method of measuring sound power. Sound intensity is the acoustic power per unit area, and by multiplying the average sound intensity by the area over which the intensity is measured, sound power is calculated. Sound intensity is measured using a directional probe; therefore, sound power determined this way is, in principle, insensitive to background noise and sound reflected by the surroundings.
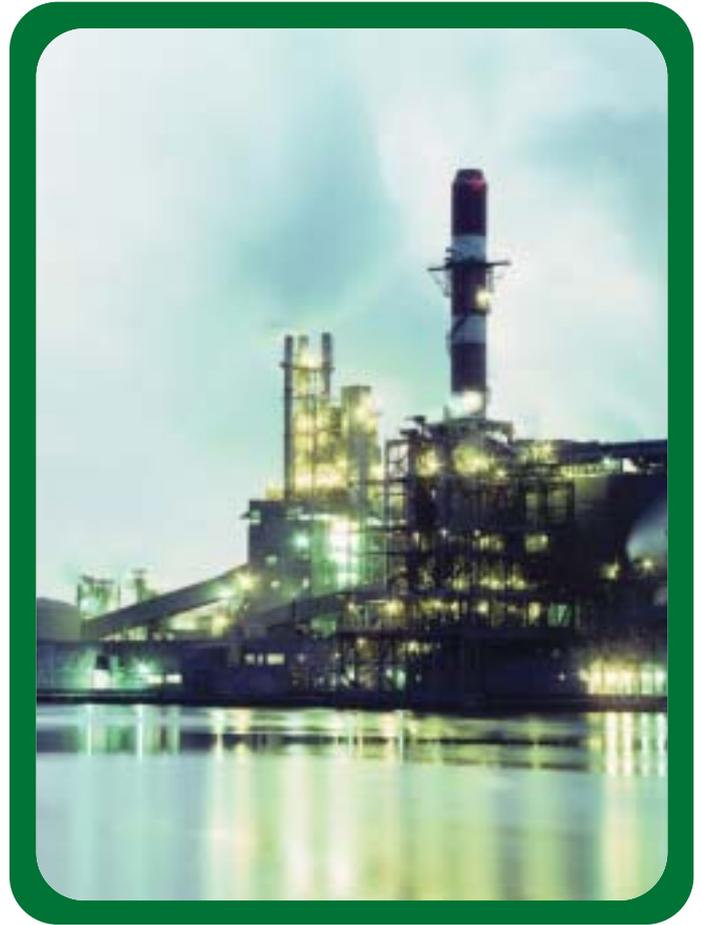


### Pressure-based

The object is placed in a well-defined acoustic environment (anechoic, reverberant or semi-reverberant depending on the standard followed). A measurement surface (for example, a hemisphere) is defined, and the sound level measured at a number of surface positions to obtain a representative average. Background noise must also be checked to control its influence. Next the influence of the environment (room correction) is determined using calibrated sound sources or reverberation time measurements. Finally the sound power is calculated taking into account the measurement surface, background noise and room correction.
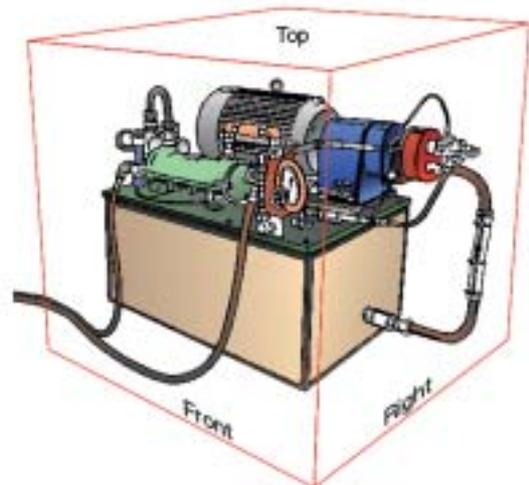
## Intensity-based

No special environment is required, making this method suitable for in-situ measurements of sound power for equipment that is difficult to move or install in a special measurement location. The measurement surface is subdivided to suit the size and shape of the object, thus providing a result for each sub-surface as well as the total sound power. Following the ISO 9614 standard, quality indicators are inherent in the measurement procedure to ensure accurate results.

The features of intensity-based sound power are:
- Insensitive to the acoustics of the environment
- Background noise level can be up to 10 dB higher than source level
- Partial sound power determination possible (for example, transmission and motor)
- Noise source identification (mapping)

# RESEARCH & DEVELOPMENT

### Product Noise Reduction

In the effort to reduce product noise and vibration, frequency analysis can be a helpful tool. Identifying the offending frequency bands is the key to locating the source and paths of noise and vibration. With this knowledge, the design can be changed to improve the product.

### Noise Source Identification (NSI)

Visualisation of noise can give you vital clues to improving the product design. A colour map shows how different noise sources contribute to the total. Using software tools you can focus on trouble areas and make further analysis of sound power levels and frequency ranges.

### Machine Vibrations

Machine vibrations are often measured because of standard and legislative requirements. Machine vibrations affect human comfort and can harm buildings. A suitable sound level meter equipped with a vibration transducer can give you vibration results on-site.

### Troubleshooting

A case of excessive noise or vibration can relate to a new design as well as one already in production, but it usually takes intuition, knowledge and versatile tools to solve it. The symptom could be a rattle, a tone, or simply too much noise. Measurements like frequency analysis, logging or sound intensity can give a troubleshooter the evidence needed to solve the case.

### Hand-arm Vibration (HAV) and Whole-body Vibration (WBV)

Manufacturers of equipment like hand-held power tools, fork lifts and earth-moving equipment must fulfil the requirements of international vibration standards for their products. Measurements have to be made during development and production to ensure conformance to standards. WBV measurements differ from HAV measurements in filter characteristics and the use of a seat pad accelerometer instead of a simple vibration transducer.
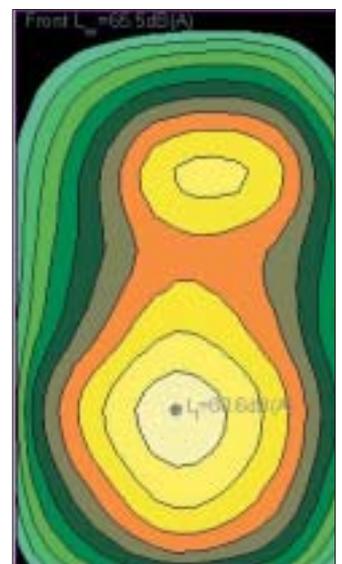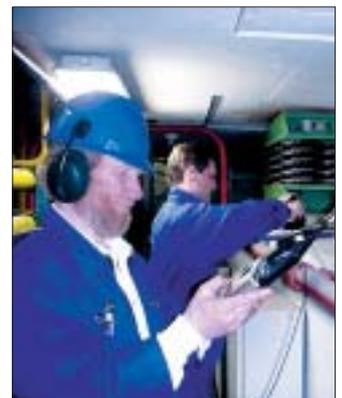
# INDUSTRIAL APPLICATIONS

## QUALITY CONTROL IN PRODUCTION

At the end of an assembly line, unusual noise in a product can lead to rejection or rework. The noise is a symptom of faults in design, assembly or components, and an automatic noise check can help maintain the required quality level. It can also give rapid feedback to production planning and engineering if adjustment to design or production process is needed. The equipment for checking noise must be accurate, robust, and remotely controlled.

## PRODUCT LABELLING

Legislative, standard or EU directive requirements often demand that products be labelled with sound and vibration levels. Products with the lowest levels will usually have a marketing advantage. Parameters required in labelling include $L_{Aeq}$, $L_{Cpeak}$ and $L_W$ , besides those of HAV and WBV.

*Product Guide*
*Brüel & Kjær offers solutions to all the above-mentioned applications. Please use this table as a guide to relevant products.*

| Application | Key Features | Products and their Key Features |
|---|---|---|
| Sound Power, Pressure-based | 1) $L_{Aeq}$<br>2) $^1/_1$- and $^1/_3$-octave spectra<br>3) Multichannel<br>4) $L_W$ and $L_W$ mapping | 2240 Integrating Sound Level Meter [1]<br>2238 Mediator [1] [2]<br>2239 Integrating Sound Level Meter [1]<br>2260 Observer [1] [2]<br>3560 PULSE [1] [2] [3] [4] |
| Sound Power, Intensity-based<br>Noise Source Identification | Intensity Spectra<br>$L_W$ and $L_W$ mapping | 2260 Investigator<br>3560 PULSE |
| Research & Development<br>Product Noise Reduction<br>Machine Vibrations<br>Troubleshooting | 1) $L_{Aeq}$, $L_{max}$<br>2) Logging<br>3) Event markers<br>4) $^1/_1$- and $^1/_3$-octave spectra<br>5) Vibration input and FFT | 2240 Integrating Sound Level Meter [1]<br>2238 Mediator [1] [2] [3] [4]<br>2239 Integrating Sound Level Meter [1]<br>2250 Hand-held Analyzer [1] [2] [3] [4]<br>2260 Observer [1] [2] [3] [4]<br>2260 Investigator [1] [2] [3] [4] [5] |
| Hand-arm Vibration [1]<br>Whole-body Vibration [2] | Vibration level | 2537 Hand-arm Vibration Meter [1]<br>2239B Integrating Sound Level Meter [1]<br>1700 3-channel Human Vibration Front-end [1] [2] |
| Quality Control in Production | 1) $L_{Aeq}$, $L_{max}$<br>2) $^1/_1$- and $^1/_3$-octave spectra<br>3) Remote control<br>4) Event trigger | 2238 Mediator [1] [2] [3]<br>2250 Hand-held Analyzer [1] [2] [3]<br>2260 Observer [1] [2] [3]<br>2260 Investigator [1] [2] [3] [4]          *030243* |

# ROADSIDE NOISE TESTING

## CARS AND MOTORCYCLES

The noise from road vehicles – cars, trucks and motorcycles – is a nuisance to many city dwellers, and the exhaust systems of some vehicles are too noisy due to wear, maladjustment or modification. EU Directive 70/157/EEC and ISO standard ISO 5130 describe how to check the exhaust noise of a stationary vehicle at the roadside.

A microphone is placed at a well-defined position close to the exhaust; the engine speed is gradually increased from idle to a specified engine speed, and briefly held constant at that speed. The throttle control is then quickly released and the engine speed returned to idle. During the entire cycle, the sound level is measured and the maximum reading recorded. The maximum level is then compared to the level permitted for the vehicle in question, and suitable action taken if the level is exceeded.

The basic instrumentation for acoustical measurement is a Class 1 Sound Level Meter and a sound calibrator. In addition, the engine speed must be measured accurately.

### Product Guide

*Exhaust Noise Inspector Type 3638 A measures and documents the exterior exhaust sound levels from stationary road vehicles, simultaneously with engine speed detection. As an all-in-one automatic system, it minimises the inconvenience to traffic and drivers, and helps the user make accurate measurements.*

Microphone positions for roadside exhaust noise measurement



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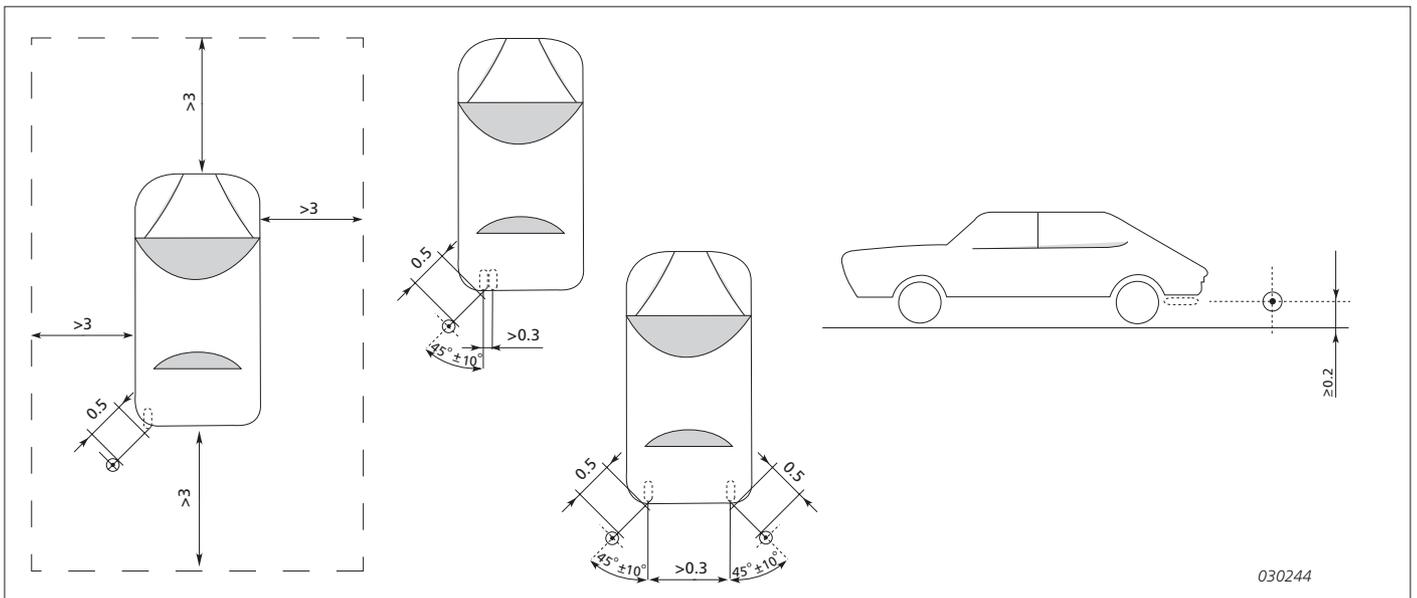
# TYPE 2250

## HAND-HELD ANALYZER WITH APPLICATION SOFTWARE
## BZ 7222, BZ 7223, BZ 7224, BZ 5503

**Designed by You, for You**

Development of Type 2250 was instigated and greatly inspired by the requirements of customers participating in extensive workshops around the world. These concluded that the instrument should be easy and safe to use, while at the same time incorporating clever features.

The hardware has been designed to meet the specific ergonomic requirements defined by users, and the application software covers everything expected of a sound and vibration analyzer in this class. The application software can be licensed separately, so you can get what you need when you need it and won't get left behind if your requirements change. This way, Type 2250 ensures the safety of your investment now and in the future.

Created, built and made for you personally, you'll find it will make a difference to your work and all your measurement tasks.

For more information go to **www.type2250.com**

**A Natural Part of the Environment**

Armed with Type 2250 in the palm of your hand, measurement tasks become uncomplicated. With Type 2250 Brüel & Kjær offers you the same look and feel for system and application software both in your hand and on your desk – encouraging familiarity and reducing the burden of learning new user interfaces. You change the system's functionality by simply selecting the appropriate software application for your task. So whether you're measuring on the factory floor, by a busy road, in a theatre, or reviewing data at your desk, there is dedicated software to provide you with exactly what you need.

Much more than an instrument that simply measures relevant parameters correctly, it will make the difficult aspects of your work easier and the more tedious aspects faster. Type 2250 lends a helping hand to all your measurement tasks allowing you to concentrate your efforts on investigating and solving your sound or vibration problem.

## Uniquely User-friendly

The real uniqueness of Type 2250 lies in its extreme user-friendliness.

Type 2250 is **easy** to use – its robustness, lightness and ergonomic design make it easy to grip, hold and operate single-handedly. Ingenious software ensures you can start measuring quickly. The pushbuttons are easy to use and the large, colour touch-screen is visible in both sunlight and in difficult lighting conditions. Type 2250 incorporates a simple user interface that can be controlled using the stylus, or by using the pushbuttons. It has an easy and intuitive data-storage concept and on-line guidance is included to help you get familiar with the instrument quickly.

Type 2250 is **safe** to use – it was built for use outdoors and in difficult environmental conditions, so it is powered by rechargeable batteries and the casing incorporates non-slip materials to ensure a safe grip. The software guides you safely through each measurement and status indicators show measurement progress.

Type 2250 is **clever** – it incorporates various smart features for field use, including:
- Specially positioned pushbuttons to allow vital start-stop-save actions to be done by feel
- A separate built-in microphone, giving you the option of recording your personal comments while measuring and automatically attaching them to your on-going measurement
- "Traffic light" indicators to give you a quick indication of your measurement's status – visible at a distance
- A calibration history, allowing you to document your measurement's validity
- Built-in functions that automatically detect and correct for windscreen effects
- Modem connection and parallel measurement/downloading makes it highly suitable as a remote datalogger

## FEATURES
- Large, high-resolution, touch-sensitive colour screen
- Rechargeable, high-capacity Li-Ion battery pack
- Data storage on plug-in memory-cards (Secure Digital and Compact Flash)
- Standard USB interface
- Built-in commentary microphone to voice-tag your data
- Traffic-light indicator for instant measurement status
- Lit keys

## BRIEF SPECIFICATIONS
**Weight and Dimensions**
650 g (23 oz) including rechargeable battery
300 × 93 × 50 mm
(11.8 × 3.7 × 1.9")

**Accessories Included**
**BZ 7222:** 2250 Sound Level Meter Software
**BZ 5503:** PC Software for Hand-held Analyzers
**Type 4189:** Microphone
**ZC 0032:** Microphone preamplifier
**ZG 0486:** Mains Power Supply
**DH 0696:** Wrist Strap

**KE 0440:** Travel Bag
**KE 0441:** Protective Cover
**UA 1651:** Tripod Extension
**AO 1476:** USB Cable
**QB 0061:** Pack Battery
**UA 1650:** 90 mm Windscreen with Autodetect
**HT 0015:** Earphones

**Optional Accessories**
**BZ 7223:** 2250 Frequency Analysis Software
**BZ 7224:** 2250 Logging Software

# 2250 SOFTWARE

The application software used with Type 2250 can be considered as blocks of optional functionality that can be enabled by licence codes. Whichever software you choose, you can be assured that a planned growth path is developing continuously with the product.

## BZ 7222 – 2250 SOUND LEVEL METER SOFTWARE

(Included with every Type 2250)

**USES/FEATURES**
- Environmental noise
- Research and development
- Gathering field-data for further analyses
- Appraisal of noise reduction efforts
- 120 dB dynamic range – no need for range switching
- Sound levels up to 140 dB with supplied Microphone Type 4189 (up to 152 dB using Microphone Type 4191)
- Broadband statistics
- Remote operation via USB link
- IEC/ANSI SLM standards Type/Class 1
- Weightings: A, C, Z and F, S, I
- Statistics based on $L_{Aeq}$ or $L_{AF}$
- Frequency range: 3 Hz – 20 kHz

- Free-field/diffuse-field correction
- Automatic windscreen correction
- Pre-set time start/stop
- Back-erase
- Multi-language user interface (English, French, German, Italian, Spanish)
- Context-sensitive on-line help
- Voice and text annotation of measurements
- Display colour-schemes optimised for day, night, indoor and outdoor use
- Personal login
- Personal setup

**ORDERING INFORMATION**
**Hardware and Software**
**Type 2250 A:** 2250 Hand-held Analyzer with Sound Level Meter Software

**Accessories**
**Type 4231:** Sound Level Calibrator
**AO 0440:** Signal Cable, AC/DC Input/Output, Triaxial LEMO to BNC
**AO 0441:** 10-pin LEMO Microphone Extension Cable, 3 m
**AO 0442:** 10-pin LEMO Microphone Extension Cable, 10 m
**AO 0586:** Sound Cable, Triaxial LEMO to 3.5 mm jack
**UA 0237:** Large Round Windscreen
**UA 1317:** Microphone Holder
**UA 1404:** Outdoor Microphone Kit
**UA 0801:** Lightweight Tripod
**QB 0061:** Battery Pack
**ZG 0444:** Battery Charger for QB 0061 Battery Pack
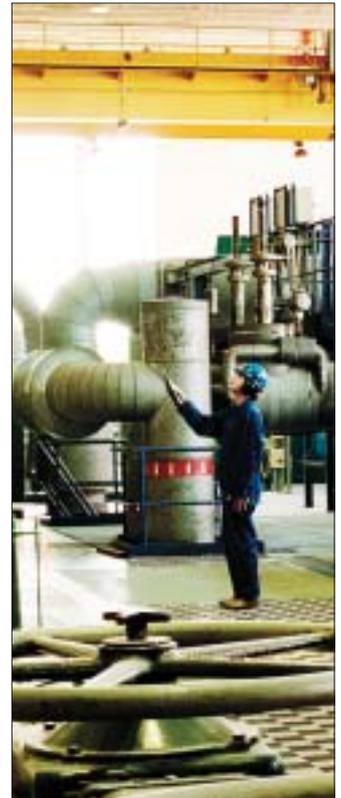
## BZ 5503 – PC SOFTWARE FOR HAND-HELD ANALYZERS

(Included with every Type 2250)

**USES/FEATURES**
- Synchronisation of data and setups between Type 2250 and PC
- On-line or off-line setup of instrument
- Advanced data management

- Remote instrument display via USB connection
- Type 2250 measurement data compatible with PC software Type 7815, Type 7820, Type 7825

# BZ 7223 – 2250 FREQUENCY ANALYSIS SOFTWARE

BZ 7223 – 2250 Frequency Analysis Software allows real-time measurements in $\frac{1}{1}$- and $\frac{1}{3}$-octave bands. With the frequency analysis software enabled, it is a simple matter to obtain frequency spectra in order to, for example, select suitable hearing protection, assess tonality in environmental noise, or qualify noise from heat and ventilation systems.

**FEATURES**
- IEC/ANSI filter standards
- $\frac{1}{1}$-octave (centre frequencies 8 Hz to 16 kHz)
- $\frac{1}{3}$-octave (centre frequencies 6.3 Hz to 20 kHz)
- 120 dB dynamic range

**ORDERING INFORMATION**
**Hardware and Software**
**Type 2250 B:** 2250 Hand-held Analyzer with Sound Level Meter and Frequency Analysis Software
**Type 2250 D:** 2250 Hand-held Analyzer with Sound Level Meter, Frequency Analysis and Logging Software

**Software Only**
**BZ 7223:** 2250 Frequency Analysis Software

# BZ 7224 – 2250 LOGGING SOFTWARE

BZ 7224 – 2250 Logging Software extends the functionality of Type 2250 to allow automatic storage of discrete measurements in a log file. Sequential examination of the individual elements of the log file, either on the screen of Type 2250 or using application software on a PC, reveals the trend, or profile, of the measured parameters. Noise profile analysis is indispensable when considering situations with fluctuating ambient environmental noise, such as measurement of industrial and construction site noise, residential noise, or road and rail traffic noise.

**FEATURES**
- Logging of broadband parameters
- Logging of statistics
- Logging of spectra (if frequency analysis software is present)
- Logging interval 1 s to 24 h
- $L_{Aeq}$ or $L_{AF}$ logged every 100 ms
- Profile display
- Markers on profile
- Voice markers
- Local or remote control of start/stop
- Remote control using Compact Flash modem
- Transfer of data while measuring (USB or modem)

**ORDERING INFORMATION**
**Hardware and Software**
**Type 2250 C:** 2250 Hand-held Analyzer with Sound Level Meter and Logging Software
**Type 2250 D:** 2250 Hand-held Analyzer with Sound Level Meter, Frequency Analysis and Logging Software

**Software Only**
**BZ 7224:** 2250 Logging Software

**Accessories**
**Type 3592:** Outdoor Measuring Gear
**UA 1404:** Outdoor Microphone Kit
**Type 7820:** Evaluator software
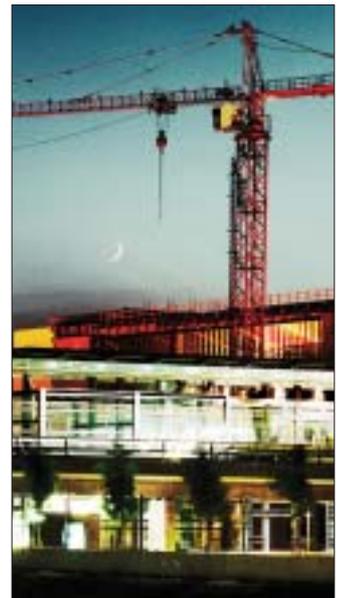
# 2260 INVESTIGATOR

## MODULAR PRECISION SOUND ANALYZER WITH APPLICATION SOFTWARE BZ 7210, BZ 7203, BZ 7204, BZ 7205, BZ 7206, BZ 7207, BZ 7208

### Where Do I Begin?
When looking for a sound analyzer, the hand-held 2260 Investigator™ is your natural starting point.

### What's Special about 2260 Investigator?
2260 Investigator is programmable. Based on a standard PC architecture and file system, you change 2260 Investigator's current role as easily as swapping from using a word processor to a spreadsheet. One acoustics engineer, equipped with a 2260 Investigator and a full set of application software, can highlight most sound problems and find effective solutions to them. A group of engineers can share one 2260 Investigator, each using their preferred application package as required. 2260 Investigator is cost-effective because you invest in one hardware platform that does it all.

2260 Investigator has an uncomplicated user interface with menu-driven software available in several languages. This makes using 2260 Investigator very easy, saving a lot of time when learning to use it and when setting it up from job to job, thus eliminating wrong measurement setups. 2260 Investigator is all you need to unravel your sound problems.



### Why Shouldn't Life be Easy?
Gone are the days of lugging cumbersome, heavy equipment to make real-time, on-site sound analysis. With the battery-operated, hand-held 2260 Investigator, you make on-the-spot evaluations of the sound in question. Once back in the office, review and document the results at your leisure by connecting the analyzer to your own PC via an RS–232 link, or give the results to a colleague using a PC-card.

### Chameleon Qualities
Every 2260 Investigator is supplied with internal Basic Sound Analysis Software. The full range of application software is supplied on CD-ROM, and, depending on your licences, you can download one or several applications into the instrument. If you have more than one 2260 Investigator, you can even move applications between them to make the most efficient use of your investment and manpower.





Auxilliary output #1  
Auxilliary output #2  
External power 10-14V  
Serial interface  
A/C input/output #2  
AC input/output #1  
PC-card disk drive  
*970360*
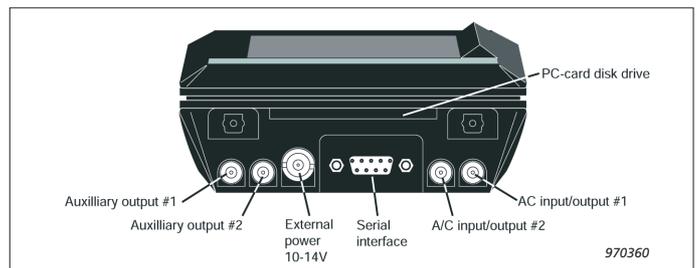
## Buried Treasure

Every 2260 Investigator is supplied with Basic Sound Analysis Software. With this software, 2260 Investigator becomes a Class 1 sound level meter with real-time displays of frequency analysis, $\frac{1}{3}$-octave spectra and statistical distributions. To extend the capabilities of 2260 Investigator, load a new application from the range available, for example, community noise, building acoustics, pure tone detection, sound power/intensity or FFT.

2260 Investigator has the CIC (Charge Injection Calibration) facility that enables you to regularly monitor the microphone's condition, and hence confirm the calibration reliability. The unique Multi-D™ analysis technique used by 2260 Investigator saves time and improves data consistency by concurrently measuring broadband, spectral and statistical parameters. For those jobs that require long sampling periods in outlying places, use the modem dial-up facility to remotely interrogate 2260 Investigator, thus saving a site visit.

## Beneath the Surface

Once you've completed your measurement, the data is safely stored on 2260 Investigator's internal disk or external PC-cards. Transfer your data via the RS–232 serial interface or move the PC-card to your office computer. Depending on your application, use Evaluator™ Type 7820, Qualifier™ Type 7830, Protector™ Type 7825 or Noise Explorer™ Type 7815 software to view and manage your measurements. The data is displayed graphically or as tables, and the powerful editing facilities allow removal of unwanted data and combining several samples into one – for example, when producing an overall Rating Level ready for comparison with local limits. When satisfied with the results, print them out, or export the data to other Windows® applications to create an impressive document of your work.

# 2260 INVESTIGATOR PLATFORM

## USES

The following applications are available for 2260 Investigator:
**BZ 7210** Basic Sound Analysis (included in every 2260)
**BZ 7203** Noise Profile
**BZ 7204** Building Acoustics
**BZ 7205** Sound Intensity
**BZ 7206** Enhanced Sound Analysis
**BZ 7207** Room Acoustics
**BZ 7208** FFT Analysis

## FEATURES

- Multi-language (GB, D, F, I, E) user interface
- Context-sensitive, on-line help

## BRIEF SPECIFICATIONS

**Weight and Dimensions**
1.2 kg (2.6 lb.) with batteries
375 × 120 × 52 mm
(14.8 × 4.7 × 2.0")

**Accessories Included**
**BZ 7210:** Basic Sound Analysis Software

**Type 4189:** Prepolarized Free-field ½" Microphone
**ZC 0026:** Input Preamplifier
**ZF 0023:** 20 dB Capacitive Attenuator
**UA 1236:** Protective Cover
**DH 0696:** Wrist Strap
**KE 0342:** Shoulder Bag (with room for 2260 and 4231)
**6 × QB 0009:** 1.5V LR 14/C size alkaline cells
**UA 0237:** Large Round Windscreen
**AO 1442:** Serial Interface Cable
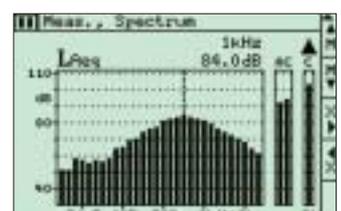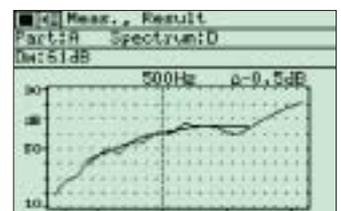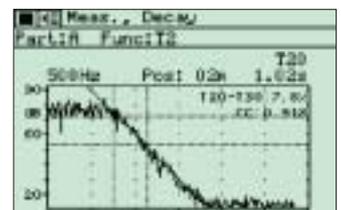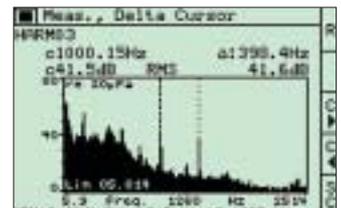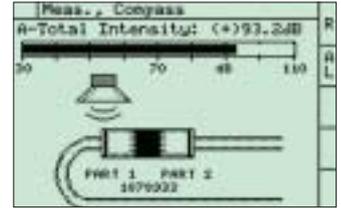
# 2260 INVESTIGATOR SOFTWARE

## BZ 7210 BASIC SOUND ANALYSIS – TYPE 2260

**USES**
- Noise and vibration at work
- Environmental noise
- Research and development
- Gathering field-data for further analysis
- Appraisal of noise reduction efforts

**FEATURES**
- Real-time octave and $\frac{1}{3}$-octave (6.3 Hz – 20 kHz) band analysis
- Logging of noise profiles and setting manual markers
- Control of sound recording on a PC
- Lightweight, hand-held, real-time analyzer
- Broadband statistics
- Remote operation via modem link

**ORDERING INFORMATION**
**Type 2260:** Modular Precision Sound Analyzer

**Accessories**
**Type 4231:** Sound Level Calibrator
**2260 CAI:** Accredited Initial Calibration of Type 2260
**AO 0440:** AC Input/Output Cable
**AO 0441:** 3 m Microphone Extension Cable
**AO 0442:** 10 m Microphone Extension Cable
**AO 0543:** 2260 to Jack Cable
**AO 0586:** Cable from 2260 to Audio Input on a PC
**KE 0371:** Carrying Case for 2260 and Accessories
**UA 0237:** Large Round Windscreen

**UA 0459:** Small Round Windscreen
**UA 1317:** Microphone Holder
**UA 1404:** Outdoor Microphone Kit
**OA 0522:** Headphones Adaptor
**UA 0587:** Tripod
**UA 0801:** Lightweight Tripod
**Type 3592:** Outdoor Gear
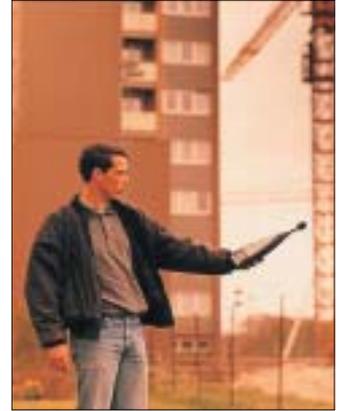
## BZ 7203 NOISE PROFILE – TYPE 2260 C

**A Powerful Combination**
Consisting of the 2260 platform and Noise Profile Software BZ 7203, Investigator Type 2260C is effectively an electronic level recorder which measures and logs noise levels over a 110 dB dynamic range. It also has extensive capabilities for on-the-spot, meaningful data processing, including measurement annotation. Together with the dedicated post-measurement PC software (Evaluator Type 7820) it is a powerful combination for analysing, evaluating and re-porting on the fluctuations of ambient noise in any community.

**USES**
Evaluation of noise in the envi-ronment according to interna-tional and national legislation Noise profile measurement, for example:
- Industrial and construction site noise
- Residential noise
- Road and rail traffic noise

**FEATURES**
- Continuous logging of up to 19 noise parameters
- Periodic reports of levels and statistics

- On-line annotation and data exclusion (logging of noise profiles and setting manual markers)
- 110 dB dynamic range
- Logging rates down to 10 ms
- Broadband statistics
- Remote operation via modem link

**ORDERING INFORMATION**
**Type 2260 C:** Modular Precision Sound Analyzer (with Noise Profile Software BZ 7203)

**Accessories**
Same as for BZ 7210
7820 Evaluator is highly recom-mended for post-processing
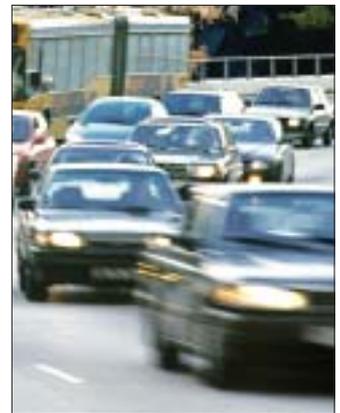
# BZ 7204 BUILDING ACOUSTICS – TYPE 2260 D

The combined features of Investigator Type 2260 D with Qualifier Type 7830 PC software, or 2260 G with Qualifier Light Type 7831 provide ideal facilities for architectural and building acoustic measurements. The combination of well-proven, reliable hardware and tailor-made software effectively avoids the necessity of a PC in the field. In addition, the calculation of sound insulation curves and indexes are provided on the spot.

## USES

Architectural and building acoustic measurements of:
- Airborne sound insulation
- Impact sound insulation
- Reverberation time

## FEATURES

- Complete hand-held building acoustics analyzer
- Measures level and reverberation time spectra
- Built-in pink and white noise generator
- On the spot calculation of airborne sound insulation curves and indexes
- Façade insulation calculations
- Satisfies ISO and national standards
- Two-channel measurements
- Measures reverberation time with impulse or interrupted noise excitation
- Displays reverberation time and decay curves
- Serial measurement
- Complete system using available accessories

## ORDERING INFORMATION

**Type 2260 D:** Modular Precision Sound Analyzer with Building Acoustic Software BZ 7204

**Accessories**
**UA 0587:** Tripod
**UA 1317:** Microphone Holder
**AO 0441:** 3 m Microphone Extension Cable
**AO 0442:** 10 m Microphone Extension Cable
**JP 1041:** Dual 10-pole Adaptor
**ZC 0026:** Input Preamplifier for 2260
**Type 4189:** Prepolarized Free-field ½-inch Microphone
**AR 0199:** 10-pin Flat Cable
**AO 0522:** Headphones Adaptor
**UA 0801:** Lightweight Tripod
**Type 3207:** Tapping Machine
**Type 4296:** OmniPower Sound Source with Tripod
**Type 2716:** Power Amplifier
**KE 0358:** Flight Case
**AO 0523:** 10 m Cable from 2260 to 2716
**AQ 0667:** Bridging Cable for 2716 output
**AQ 0622:** 10 m Cable from 2716 to 4296

# 2260 INVESTIGATOR SOFTWARE

## BZ 7205 INTENSITY SOFTWARE – TYPE 2260 E

Portable and battery-operated, the Hand-held Sound Intensity System makes it easy for one person to make and follow through a sound intensity measurement from beginning to end. The powerful combination of 2260 Investigator, BZ 7205 software, and Sound Intensity Probe Kit Type 3595 makes it possible for you to make intensity measurements for sound power, source location and sound reduction. Automatic measurement guidance and aural feedback during measurements enable you to concentrate on making a smooth scan of the area under investigation. The system produces on-the-spot analysis of sound power and sound reduction.

### USES
- Determines sound power with or without predefined surfaces and segmentation

- Sound power measurements in accordance with ISO 9614 – 2, ECMA – 160, and ANSI S12.12
- Noise source location and noise mapping
- Building acoustics measurements (Sound Reduction index) in accordance with ISO/DIS 15186 – 1 and ISO 717 – 1

### FEATURES
- Complete, hand-held, single unit sound intensity system
- Designed for practical field measurements
- Segmentation of the measurement surfaces
- Visual and aural feedback during measurements
- Detailed information regarding the quality of the sound field
- On-site calculation and display of measurement results
- Real-time octave and $\frac{1}{3}$-octave analysis
- General dual-channel analyzer

- Frequency range of 50 Hz to 10 kHz using a 12 mm spacer
- Built-in noise generator for building acoustics measurements
- Visual data manager for easy bookkeeping

### ORDERING INFORMATION
**Type 2260 E:** Modular Precision Sound Analyzer with Sound Intensity Software BZ 7205

**Accessories (Type 3595)**
**Type 4197:** Sound Intensity Microphone Pair
**Type 2683:** Dual Preamplifier
**UA 1439:** Extension Stem
**UA 1440:** Handle with Integral Cable
**UA 0781:** Ellipsoidal Windscreen
**DP 0888:** Intensity Adaptor for Type 4231
**HT 0015:** Earphones
**AO 0522:** Headphone Adaptor
**QA 0224:** Chalk
**QA 0225:** Tape Measure
**QA 0226:** Tool for 2260
**KE 0379:** Carrying Case for 2260 and Probe Kit
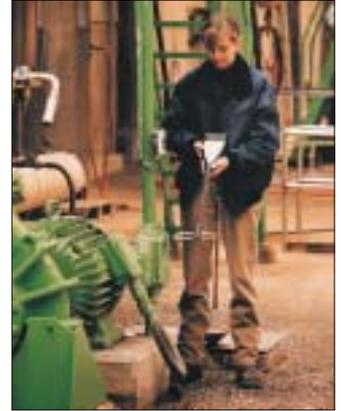
## BZ 7206 ENHANCED SOUND ANALYSIS – TYPE 2260 F

### USES
As for BZ 7210 Basic Sound Analysis (see page 32), plus:
- Unattended measurements

### FEATURES:
As for BZ 7210 Basic Sound Analysis (see page 32), plus:
- $\frac{1}{1}$- or $\frac{1}{3}$-octave statistics
- 100 ms logging
- Trigger
- Event Recording
- Automatic CIC

### ORDERING INFORMATION
**Type 2260 F:** Modular Precision Sound Analyzer with Enhanced Sound Analysis Software BZ 7206

# BZ 7207 ROOM ACOUSTICS – TYPE 2260 G

Type 2260 G (including BZ 7207 software) is ideal for applications that only require measurement of reverberation time, such as acceptance test of rooms, noise reduction in the workplace or determination of room corrections. Type 2260 G works like Type 2260 D but with the reverberation time task only. For these applications, you need to carry no more than Type 2260 G and a starting pistol. You can, of course, also use the built-in generator and a sound source. For reviewing, editing and reporting, Qualifier Light Type 7831 is recommended, and when ordered with Type 2260 G or BZ 7207, forms an economical total solution.

## USES
- Measurements of reverberation time

## FEATURES – TYPE 2260 G
- Measures reverberation time with impulse or interrupted noise excitation
- Displays reverberation time and decay curves
- Interrupted noise or impulse excitation
- Calculates broadband average reverberation time
- Economical and compact solution

## ORDERING INFORMATION
**Type 2260 G:** Modular Precision Sound Analyzer with Room Acoustics Software BZ 7207
**Type 7831:** Qualifier Light

**Accessories**
As for Type 2260 D (BZ 7204)

# BZ 7208 FFT SOFTWARE – TYPE 2260 H

With FFT Software BZ 7208, 2260 Investigator becomes a single-channel FFT analyzer. It is suitable for measuring continuous and transient signals (for both sound and vibration) in environmental and industrial applications. A flexible internal trigger is provided, as well as an external trigger for transients. The software can identify tones and calculate their audibility.

For vibration measurements 2260 Investigator uses a DeltaTron® Adaptor ZG 0423 that accepts DeltaTron accelerometers and, via Charge Converter Type 2647, also accommodates charge accelerometers. Most importantly, all the functions you need in the field (for example, frequency span, zoom and cursors) are easily activated from 2260 Investigator's front panel. The combination of sound and vibration capability draws on Brüel & Kjær's long experience in FFT for sound and vibration applications.

## USES
- FFT analysis of sound or vibration
- Machinery troubleshooting
- Tone assessment for environmental noise measurements
- Product development
- Quality control
- Building vibration analysis

## FEATURES
- Hand-held FFT analysis of sound or vibration
- Single-channel analysis
- Real-time operation (no data loss)
- Internal and external trigger
- Measures transient and continuous signals
- Max. frequency span 20 kHz; min. 156 Hz
- Over 400 lines (better than 50 Hz resolution @ 20 kHz span)
- Zoom down to better than 0.5 Hz resolution
- FFT autospectrum Lin or A-weighted
- Compare spectrum to stored reference

## ORDERING INFORMATION
**Type 2260 H:** Modular Precision Analyzer with FFT Software BZ 7208

# 2260 APPLICATION SOFTWARE

## BRIEF SPECIFICATIONS

| Specifications/Tool — 2260 SOFTWARE | Basic Sound Analysis BZ 7210[1] BZ 7219[2] | Enhanced Sound Analysis BZ 7206 | Noise Profile BZ 7203 | Sound Intensity BZ 7205 | Building Acoustics BZ 7204 | Room Acoustics BZ 7207 BZ 7220[3] | FFT Analysis BZ 7208 |
|---|---|---|---|---|---|---|---|
| IEC/ANSI/ISO standards: see table on page 37 | X | X | X | | X[4] | X[4] | |
| Dynamic / Linearity Range | 80 dB | 80 dB | 110 dB | 5) | 90 dB | 90 dB | 5) |
| Inherent Noise Level (A-weighted) | 16.6 dB | 16.6 dB | 16.6 dB | | 2 dB at 1 kHz (1/3-oct.) | 2 dB at 1 kHz (1/3-oct.) | |
| Real-time 1/1-octave Analysis | 8 Hz–16 kHz | 8 Hz–16 kHz | | 31.5 Hz–8 kHz | 63 Hz–8 kHz | 63 Hz–8 kHz | |
| Real-time 1/3-octave Analysis | 6.3 Hz–20 kHz | 6.3 Hz–20 kHz | | 25 Hz–10 kHz | 50 Hz–10 kHz | 50 Hz–10 kHz | |
| Manual Charge Injection Calibration | X | X | X | | X | X | X |
| Automatic Charge Injection Calibration | X | X | | | | | |
| Frequency weighting: A, C and Linear | Two in parallel | Two in parallel | Two in parallel | | Linear | Linear | |
| Time Weighting: Fast, Slow, Impulse | In parallel | In parallel | In parallel | | | | |
| Measured Parameters, broad band | $L_{eq}$, $L_{max}$, $L_{min}$, $L_{Peak}$, $L_{T3}$, $L_{T5}$, $L_N$, $L_{AE}$, $L_{EP, d}$ | $L_{eq}$, $L_{max}$, $L_{min}$, $L_{Peak}$, $L_{T3}$, $L_{T5}$, $L_N$, $L_{AE}$, $L_{EP, d}$ | $L_{eq}$, $L_{max}$, $L_{min}$, $L_{Peak}$, $L_{T3}$, $L_{T5}$, $L_N$, $L_{AE}$, $L_{EP, d}$ | | $L_{AF}$ (displayed, not stored) | $L_{AF}$ (displayed, not stored) | |
| Measured parameters, 1/1-and 1/3-octave bands | $L_{eq}$, $L_{max}$, $L_{min}$ | $L_{eq}$, $L_{max}$, $L_{min}$, $L_N$ | | | $L_{eq}$ | $L_{eq}$ | |
| Broadband Statistics | X | X | X | | | | |
| 1/1- or 1/3-octave Statistics | | X | | | | | |
| Back-erase | X | X | | | | | |
| Data Logging | X | X | X | | | | |
| Profile with Periodic Reports | | | X | | | | |
| Markers in Profile | X | X | X | | | | |
| Event Recording | | X | | | | | |
| DAT Recorder Control | X | X | | | | | |
| PC Sound Recorder Control | X | X | | | | | |
| Measurement Time Resolution | | 100 ms | 10 ms | | 8 ms | 8 ms | 21.33 ms |
| Timer Control | X | X | X | | | | |
| Reverberation Time | | | | | X | X | |
| Real-time Sound Intensity | | | | X | | | |
| Sound Insulation Calculation | | | | X | X | | |
| 2-channel Measurement | | | | X | X | | |
| Sound Power Calculation | | | | X | | | |
| Real-time FFT Analysis | | | | | | | X |
| Trigger | | X | | | | | X |
| Autospectrum | | | | | | | X |
| Tonal Audibility Calculation | | | | | | | X |
| RS – 232 Interface | X | X | X | X | X | X | X |
| Two Aux. Outputs (DC Output) | X | X | X | X | X | X | X |
| AC Output | X | X | X | X | X | X | X |

1) Included with 2260 Investigator
2) Included with 2260 Observer
3) Option for 2260 Observer
4) Not all parameters
5) For dynamic range, see Product Data Sheet

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# 2260 APPLICATION SOFTWARE

## PC PROGRAMS

| 2260 SOFTWARE / PC PROGRAM | BZ 7210* | BZ 7206 | BZ 7203 | BZ 7205 | BZ 7204 | BZ 7207 | BZ 7208 |
|---|---|---|---|---|---|---|---|
| Predictor 7810 Prediction and Management Software | X | X | | X | | | |
| Lima 7812 Environmental Noise Calculation and Mapping Software | X | X | | X | | | |
| Acoustic Determinator 7816 Calculation of Sound Power Level | X | X | X | | | | |
| Noise Explorer 7815 Data Viewing Management and Archiving Software | X | X | X | X | | | X |
| Evaluator 7820 Environmental Noise Evaluation Software | X | X | X | | | | X |
| Protector 7825 Personal Noise Exposure Software | X | X | X | | | | |
| Qualifier 7830 Building Acoustics Software | | | | | X | X | |
| Qualifier Light 7831 Room Acoustics Software | | | | | | X | |
| DIRAC 7841 Room Acoustic Measurement Software | X | X | X | X | X | X | X |

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## CONFORMANCE TO STANDARDS

The following table shows how hand-held instruments and noise monitoring terminals conform to relevant standards

| STANDARD | 2238 BZ7126 2238 A,B,C,D,E,F,G,H | 2238 BZ7125 2238B,C,E,G | 2238 BZ7124 2238 C,E,F,H | 2238 BZ7123 2238 D,E,G,H | 2239 2239A | 2239 2239B | 2239 2537 | 2240 | 2250 BZ7223 SLM 2250 A,B,C,D | 2250 BZ7224 Freq. 2250B,D | 2250 BZ7222 Logging 2250 C,D | 2260 BZ7219 2260I | 2260 BZ7220 2260 J | 2260 BZ7210 2260C,D,E,F,G,H | 2260 BZ7203 2260C | 2260 BZ7204 2260D | 2260 BZ7205 2260E | 2260 BZ7206 2260F | 2260 BZ7207 2260G | 2260 BZ7208 2260H | Dose Meters 4442, 4443 | NMT 3597, 3596 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEC/EN 61672 (2002) Class 1 | x | x | x | x | x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x |
| IEC 60651 Type 1 (1979) and Amendment 1 (1993) and Amendment 2 (2000) | x | x | x | x | x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x |
| IEC 60804 Type 1 (2000) | x | x | x | x | x | x | | x | x | x | x | x | x | x | x | | | x | | x | | |
| IEC 61260 (1995) and Amendment1 2001 | x* | x* | x* | x | | | | | | | x | x | x | x | | | x | x | x | x | | x |
| IEC 61043 (1993) | | | | | | | | | | | | | | | | | | x | | | | |
| EN 60651 Type 1 and Amendment 1 (2000) | x | x | x | x | x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x | | |
| EN 60804 Type 1 and Amendment 1 (2000) | | | | | x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x | | |
| ANSI S1.4 –1983 Type S1 and amendment S1.4A 1995 | x | x | x | x | x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x | | x |
| ANSI S1.43 – 1997 Type 1 | x | x | x | x | x | x | | x | x | x | x | x | | x | x | | | x | | | | x |
| ANSI S1.11 – 1986 | x* | x* | x* | x | | | | | | | x | x | x | x | | x | x | x | x | | | x |
| ISO 8041 | | | | | | x | x | | | | | | | | | | | | | | | |
| ISO 5349 | | | | | | x | x | | | | | | | | | | | | | | x | |

* 2238-x-F versions only

*030268*

# 2260 OBSERVER

## MODULAR PRECISION SOUND ANALYZER WITH APPLICATION SOFTWARE BZ 7219 SOUND ANALYSIS AND BZ 7220 REVERBATION TIME

**Modular Precision Sound Analyzer**

2260 Observer™ is a state-of-the-art sound level meter and real-time sound analyzer. It's a hand-held instrument capable of doing all the measurements and analysis that are typically used when assessing community noise and noise in the workplace.

All broadband parameters and statistical values are measured at the same time, so you will never miss a beat. All parameters are there – you just choose what you want to examine, now or later. Additionally, and simultaneously, real-time frequency analysis in $^1/_1$- or $^1/_3$-octave bands is carried out. Broadband and frequency spectral data can all be logged to obtain a time history (profile) for later analysis. As an option to these standard facilities, you can add measurements of reverberation time. Using this option, acceptance tests of rooms, noise reduction in the workplace and similar tasks are carried out conveniently. Reverberation time can be measured using impulsive noise (for example, using a starting pistol), or you can use the built-in generator and a sound source. 2260 Observer can be upgraded to include the full range of advanced applications from the 2260 Investigator range of products, for example, sound intensity, two-channel building acoustics, and FFT analysis.

## USES
- Environmental noise assessment
- Octave or $^1/_3$-octave band analysis
- Noise monitoring
- Appraisal of sound reduction work
- Gathering field data for further analysis
- Research and development
- Reverberation time measurement (BZ 7220 only)

## FEATURES
- Real-time octave and $^1/_3$-octave (6.3 Hz – 20 kHz) band analysis
- On-line annotation and data exclusion
- Control of sound recording on a PC
- Remote operation via modem link
- Measures reverberation time with impulse or interrupted noise excitation (BZ 7220 only)
- Displays reverberation time and decay curves (BZ 7220 only)
- Calculates broadband average reverberation time (BZ 7220 only)

## BRIEF SPECIFICATIONS FOR 2260 PLATFORM

**Standards**
IEC/ANSI/ISO standards:
See table on page 37

**Batteries**
**Type:** 6 × LR14/C-size

1.5 V alkaline
**Lifetime (at 20°C):** 5 to 9 hours
continuous operation

**Weight and Dimensions**
1.2 kg (2.6 lb.) with batteries

375 × 120 × 52 mm
(14.8 × 4.7 × 2.0")

**Help**
Concise context-sensitive help in
English, German, French, Italian,
Spanish or Czech

## BRIEF SPECIFICATIONS WITH BZ 7219 SOUND ANALYSIS SOFTWARE

The specifications are the same as
for BZ 7210 for 2260 Investigator
– please see table on page 36
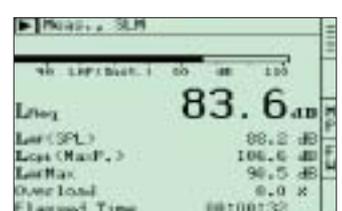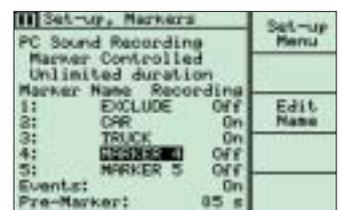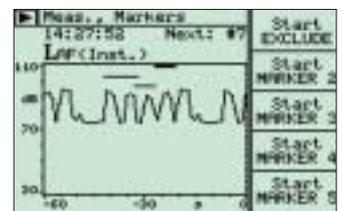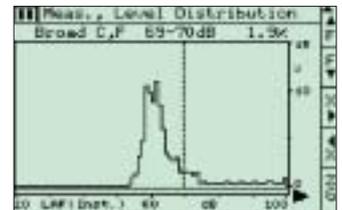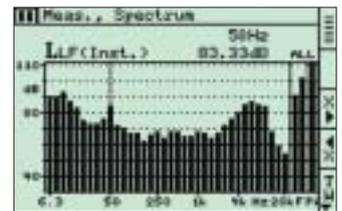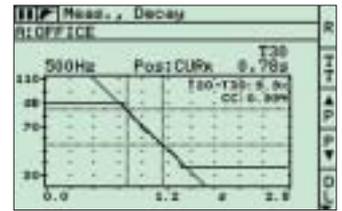
## BRIEF SPECIFICATIONS WITH BZ 7220 REVERBATION TIME SOFTWARE

The specifications are the same as
for BZ 7207 for 2260 Investigator
– please see table on page 36

## ORDERING INFORMATION
**Type 2260 I:** Modular Precision
Sound Analyzer with Sound
Analysis Software BZ 7219
**Type 2260 J:** Modular Precision
Sound Analyzer with Sound
Analysis Software BZ 7219 and
Reverberation Time Software
BZ 7220
**BZ 7220:** Reverberation Time
Software

**Accessories Included**
**BZ 7219:** Sound Analysis
Software
**Type 4189:** Prepolarized Free-
field ½-inch Microphone
**ZC 0026:** Input Stage
**ZF 0023:** 20 dB Capacitive
Attenuator
**UA 1236:** Protective Cover
**DH 0696:** Wrist Strap
**KE 0342:** Shoulder Bag (with
room for Type 2260 and
Calibrator Type 4231)

**6 × QB 0009:** 1.5 V LR 14/C size
alkaline cells
**UA 0237:** Large Round
Windscreen
**AO 1442:** Serial Interface Cable

# 2238 MEDIATOR

## INTEGRATING SOUND LEVEL METER WITH APPLICATION SOFTWARE
### BZ 7126, BZ 7125, BZ 7124, BZ 7123

When it comes to investing in a sound level meter, it's important to get an instrument that can keep up with you as your measurement requirements expand. 2238 Mediator™ does just that. Mediator can host a set of dedicated software packages that you can combine in any way you like. As a result you get the functionality you need now, plus the option of adding more later – and your investment is securely protected.

2238 Mediator is the modern interpretation of the classic sound level meter. While providing, high-precision measurements, the many talents of Mediator come fully into play by installing software modules turning the instrument into a dedicated solution for measurement tasks in environmental, occupational and industrial applications. Mediator comes with Basic Sound Level Meter Software installed, and other functions like statistics, logging and frequency analysis are added through easily installed software options – or you get exactly what you need installed from new.

The hardware comes with two independently frequency-weighted detectors. These can be used for RMS/Peak measurements or as two RMS detectors in parallel. All time-weighted parameters (using Fast, Slow and Impulse time constants) can be computed in parallel and stored in the internal memory. All versions can be fully controlled via the serial interface. Effects of sound incidence (frontal or random) can be corrected by a built-in filter, as can the effects of a windscreen, thus giving you Class 1 precision in all situations.

## USES
- Environmental noise:
  - Assessment
  - Monitoring
  - Complaints
- Occupational noise evaluation
- Selection of hearing protection
- Noise reduction
- Product quality control
- General purpose Class 1 sound measurements

## BZ 7126 Basic
All instruments come with Basic Sound Level Meter software BZ 7126 installed. This makes the unit a modern precision integrating sound level meter with simultaneous RMS and Peak measurements, ideal for noise measurements at the workplace and for level checks in any situation. Three additional standard software packages can be ordered factory-installed or they can be ordered separately at a later date for an instrument upgrade (the software is easily downloaded from any standard PC).

## BZ 7125 Enhanced
Enhanced Sound Level Meter Software BZ 7125 adds statistics, back-erase and periodic reports, plus the choice between independently frequency-weighted RMS/RMS or RMS/Peak measurements. This is especially valuable for assessments of environmental noise.

## BZ 7124 Logging
Logging Sound Level Meter Software BZ 7124 allows free selection of up to 12 parameters to log at intervals from 1 second to 1 hour (including two external DC values). Alternatively, you can log the $L_{eq}$ plus two external values at 100 ms intervals. Results can be logged to a file in Mediator or to the interface. This allows time histories for use in environmental noise applications as well as workplace noise.

**BZ 7123 Frequency Analysis**

Frequency Analysis Software BZ 7123 provides automatic scans of the $^1/_1$- and $^1/_3$-octave filter bands. Time/accuracy optimised dwell times are available as well as the option of averaging up to 99 spectra.

**Install All Four Software Modules**

You can install all four 2238 Mediator software packages. Choose the one to suit your current measurements and start measuring. If your application changes, just switch to a different software package – there is no need to load it into the instrument since it is already resident in the internal memory.
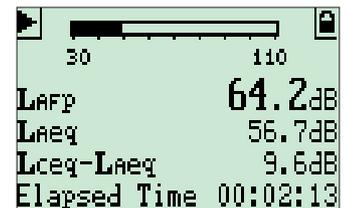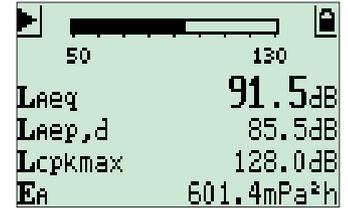
**BRIEF SPECIFICATIONS FOR 2238 PLATFORM**

**Standards**
IEC/ANSI/ISO standards:
See table on page 37

**Batteries**
Four 1.5 V LR6/AA alkaline cells
**Lifetime (at room temperature):**
Typically > 10 h (with filter set selected typically > 7 h)

**External DC Power Supply**
**Voltage:** Regulated 7 to 15 V
**Power:** Approximately 150 mA at 7 V (approximately 210 mA with filter set selected)

**Weight and Dimensions**
460 g (1 lb. 2 oz) (with batteries), 257 × 97 × 41 mm
(10.1 × 3.8 ×1.6")

**Language**
Each instrument is loaded with English, German, French, Italian and Spanish text. You can select one of these languages at any time

# 2238 MEDIATOR SOUND LEVEL METER

## APPLICATION SOFTWARE – BRIEF SPECIFICATIONS

| Specifications/Tool    2238 Software | BZ 7126 Basic SLM | BZ 7125 Enhanced SLM | BZ 7124 Logging SLM | BZ 7123 Frequency Analysis |
|---|---|---|---|---|
| IEC/ANSI/ISO standards | See table on page 37 | | | |
| Dynamic / Linearity Range | 80 dB | 80 dB | 80 dB | 80 dB |
| Inherent Noise Level (A-weighted) | 17.1 dB | 17.1 dB | 17.1 dB | 3 dB at 1 kHz ($1/3$-oct.) |
| Serial $1/1$-octave Analysis | | | | 31.5 Hz–8 kHz |
| Serial $1/3$-octave Analysis | | | | 20 Hz–12.5 kHz |
| Frequency weighting: A, C, Linear | A, C or L | Two in parallel | Two in parallel | A, C or L |
| Time weighting: Fast, Slow, Impulse | F, S or I | In Parallel | In Parallel | F, S |
| Measured Parameters, broad band | $L_p$, $L_{inst.}$, $L_{eq}$, $L_{max}$, $L_{min}$, $L_{peak}$, $L_{AE}$, $L_{EP,d}$, Dose% | $L_p$, $L_{inst.}$, $L_{eq}$, $L_{max}$, $L_{min}$, $L_{peak}$, $L_{AE}$, $L_{EP,d}$, Dose%, $L_{T5}$, $L_N$ | $L_p$, $L_{inst.}$, $L_{eq}$, $L_{max}$, $L_{min}$, $L_{peak}$, $L_{T5}$, $L_N$, $L_{AE}$ | $L_p$, $L_{inst.}$, $L_{eq}$, $L_{max}$, $L_{min}$ |
| Broadband Statistics | | x | x | |
| $L_{Ceq}$–$L_{Aeq}$, $L_{Aleq}$–$L_{Aeq}$, $L_{AFT}m^5$–$L_{Aeq}$ | | x | | |
| Measured parameters, $1/1$- and $-1/3$ octave bands | | | | $L_{eq}$, $L_{max}$, $L_{min}$ |
| Automatic scan of $1/1$- and $1/3$-octave bands | | | | x |
| Time/accuracy optimised dwell times | | | | x |
| Fixed dwell times, 1 s to 1 h | | | | x |
| Bar-graph display with cursor read-out | | | | x |
| Averaging of spectra | | | | x |
| 4 setups can be stored (for each software | x | x | x | x |
| 4 auto-starts up to one month in advance | x | x | x | x |
| Automatic data storage with preset measurement time | x | x | x | x |
| Calibration history, initial and 20 latest calibrations | x | x | x | x |
| Frontal/random and windscreen correction filters | x | x | x | x |
| Criterion level (70 –100 dB), threshold level (0 –100 dB) | x | x | | |
| Measurement sequence, periodic reports | | x | | |
| Data Logging | | | x | |
| Markers in Profile | | | x | |
| Logging of up to 12 parameters, 1 s to 1 h intervals | | | x | |
| Logging of $L_{eq}$ and DC inputs, 100 ms interval | | | x | |
| PC Sound Recorder Control | | | x | |
| Data output to file or interface | | | x | |
| Trigger input/output for synchronizing | | x | x | x |
| Back-erase | | x | | x |
| Measurement Time Resolution | 1 s | 1 s | 100 ms | 1 s |
| Timer Control | x | x | x | x |
| RS–232 Interface | x | x | x | x |
| Two DC inputs for external parameters | | x | x | |
| Aux-Output (DC-output) | x | x | x | x |
| AC-Output | x | x | x | x |

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## ORDERING INFORMATION

Type 2238-X (for exact order number see table below)

**Accessories Included**
**Type 4188:** Prepolarized Free-field ½-inch Condenser Microphone
**AO 1442:** Serial Interface Cable
**KE 0323:** Shoulder Bag
**4 × QB 0013:** Alkaline Batteries
**UA1236:** Protective Cover
**ZC 0030:** Microphone Preamplifier

**Services Available with Delivery**
**2238 CAF** Accredited Calibration
**2238 CAI** Accredited Initial Calibration
For models with an installed filter set, order **ZT 0328 CAI** as well

**Optional Accessories**
**Type 4231:** Sound Level Calibrator
**Type 3592:** Outdoor Gear
**AO 0560:** Microphone Extension Cable (10 m)
**AO 0561:** Microphone Extension Cable (3 m)
**AO 0585:** Cable from Type 2238 to Audio Input on a PC

**AO 0403:** LEMO to BNC Cable (Output/Input Cable)
**KE 0325:** Carrying Case (with insert for Sound Level Meter, Sound Level Calibrator Type 4231, Portable Printer Type 2322 or Windscreen UA 0237, and Tripod UA 1251)
**UA 1404:** Outdoor Microphone Kit
**UA 1251:** Lightweight Tripod
**UA 0237:** Windscreen (90 mm)
**UA 1254:** Microphone Cable Holder (for Tripod)

**Hardware and New Software**
**2238 MUF:** $\frac{1}{1}$- and $\frac{1}{3}$-octave band filter set with installation (Upgrade of models 2238 A, B, C and F)
Must be installed at a Brüel & Kjær Service Centre

New software is delivered on disk, and include an installation program that can be installed by the user. A License Certificate and an additional manual are also included. The serial number of the instrument must be stated when ordering new software.

| Order Number | BZ 7126 Basic SLM | BZ 7125 Enhanced SLM | BZ 7124 Logging SLM | BZ 7123 Frequency Analysis |
|---|---|---|---|---|
| 2238-A*  Mediator | x | | | |
| 2238-B*  Mediator | x | x | | |
| 2238-C*  Mediator | x | x | x | |
| 2238-D*  Mediator | x | | | x |
| 2238-E   Mediator | x | x | x | x |
| 2238-F*  Mediator | x | | x | |
| 2238-G   Mediator | x | x | | x |
| 2238-H   Mediator | x | | x | x  030246 |

* Add "-F" to include a $\frac{1}{1}$- and $\frac{1}{3}$-octave band filter set allowing you to select a frequency band as a frequency weighting. Select Types 2238 D, E, G, or H to include automatic frequency analysis with a pre-installed filter set.

Later upgrade with the frequency analysis software BZ 7123 possible for other models with a filter set installed. In addition to the above order numbers, complete systems can be ordered at special prices.

# TYPE 2239 A

## INTEGRATING SOUND LEVEL METER

Type 2239 A is a Class 1 sound level meter that is designed to be quick and easy to use when making environmental and occupational noise measurements. A large LCD screen displays measurements and includes a quasi-analog bar showing the current sound pressure level. The clearly marked arrows and symbols on the front panel, combined with the large LCD screen (with back light), make the sound level meter very easy to use. The display is clear and concise. Clear instructions and warnings guide you through your measurement. The instrument is capable of storing up to 40 records of measurement results. Each record stores the date, measurement time, $L_{eq}$, MaxP, MaxL, MinL and overload status. These results can be transferred to a PC using standard communications software. Measurement results can also be output to a portable printer as you take them.



**BRIEF SPECIFICATIONS**
**Standards**
IEC/ANSI/ISO standards:
See table on page 37

**Detectors and Frequency Weightings**
Simultaneous RMS and Peak with independent frequency weightings
**Linearity Range:** 70dB
**RMS:** A or C
**Peak**: C

**Microphone**
**Type 4188:** Prepolarized Free-field ½-inch Microphone

**Frequency Range**
8 Hz to 16 kHz ±2 dB

**Time Weightings**
F, S, I (Fast, Slow, and Impulse)

**Parameters**
**Types:** $L_{eq}$, MaxP, MaxL, MinL, Peak, SPL, Inst.
**Resolution:** 0.1dB

**ORDERING INFORMATION**
**Type 2239 A:** Integrating Sound Level Meter includes the following accessories:
**Type 4188:** Prepolarized Free-field ½-inch Microphone
**KE 0323:** Shoulder Bag
**UA 1236:** Protective Cover
**4 × QB 0013:** 1.5V LR6/AA Alkaline Cells

**Optional Accessories**
**Type 4231:** Sound Level Calibrator
**AO 1442:** Serial Interface Cable
**Type 4188:** Prepolarized Free-field ½-inch Microphone
**KE 0323:** Shoulder Bag
**UA 1236:** Protective Cover
**4 × QB 0013:** 1.5 V LR6/AA Alkaline Cells
**KE 0325:** Carrying Case with Insert for Sound Level Meter, Sound Level Calibrator Type 4231 and Tripod UA 1251 and Printer Type 2322

# TYPE 2239 B / 2537

## INTEGRATING SOUND LEVEL METER AND HAND-ARM VIBRATION METER/ HAND-ARM VIBRATION METER

### Type 2239 B

Type 2239 B is identical to Type 2239 A as a sound level meter but adds the hand-arm vibration functions conveniently in one and the same instrument. To change from a sound level meter to a vibration meter, simply unscrew the microphone/preamplifier assembly and replace it with the accelerometer/charge amplifier assembly. The instrument detects the change automatically.

Two weightings are available: hand-arm and linear. The hand-arm weighting makes the instrument sensitive to frequencies that most affect the human body when working with hand-held tools. The linear setting provides a flat frequency response. Like the sound level meter function, the vibration meter function features two parallel detectors. This enables it to display and record both RMS and Peak readings simultaneously. During measurement, the following parameters are available on the screen:

- Equivalent constant acceleration (Aeq)
- Equivalent 8 hour constant exposure (Aeq8)
- Equivalent 4 hour constant exposure (Aeq4)
- Maximum RMS acceleration (Amax)
- Minimum RMS acceleration (Amin)
- Maximum peak acceleration (Amp)
- Maximum peak acceleration from last 1 s (Peak)
- Instantaneous RMS acceleration (Inst)

## BRIEF SPECIFICATIONS

**Standards**
IEC/ANSI/ISO standards:
See table on page 37
**Input**
$0.35\,pC/ms^{-2}$ for Accelerometer Type 4505A
**Frequency Weightings**
**Linear (unweighted):** 8 – 5000 Hz
**Hand-arm Vibration:** 8 – 1000 Hz
**Measuring Ranges**
**Hand-arm:** 5 – 1500 Hz
**Linear:** 6.3 – 5000 Hz (– 3 dB)
**Inst., Low Range Setting:**
$0.1 – 316\,m/s^2$
**Inst., High Range Setting:**
$1 – 3160\,m/s^2$

**Peak, Low Range Setting:**
$0.14 – 447.2\,m/s^2$
**Peak, High Range Setting:**
$1.4 – 4472\,m/s^2$

**Detectors**
**RMS Averaging Time:** 1 s
**Peak Rise Time:** <100 μs

**Transducer**
Accelerometer Type 4505 A

## ORDERING INFORMATION

**Type 2239 B** Sound Level and Hand-Arm Vibration Meter includes the following accessories:
**Type 4188:** Prepolarized Free-field ½-inch Condenser Microphone
**ZC 0027:** Preamplifier
**Type 4505 A:** Accelerometer
**ZE 0777:** Charge Amplifier
**DB 3585:** Mounting Stud
**KE 0323:** Shoulder Bag
**UA 1236:** Protective Cover
**4 × QB0013:** 4 × 1.5V LR6/AA Size Alkaline Cells
**AO 0038:** Low-noise Cable

## TYPE 2537

Type 2537 is a dedicated Hand-arm Vibration meter. All its functions are identical to the vibration functions of Type 2239 B

## ORDERING INFORMATION

**Type 2537:** Hand-Arm Vibration Meter
All accessories as for Type 2239 B (except microphone and preamplifier)

# TYPE 2240

## INTEGRATING-AVERAGING SOUND LEVEL METER

If you're working in the field of community comfort or occupational health controlling noise levels, then Class 1 Integrating-averaging Sound Level Meter Type 2240 is a well-suited companion. Not just good looking, Type 2240 has an extremely easy to use interface for quick and simple measurements. Noise parameters $L_{AF}$, $L_{Aeq}$, $L_{AFmax}$, $L_{Cpeak}$ are all measured simultaneously and you can toggle between the different sound level readings during and after measurements. Accurate, reliable and affordable, Type 2240 measures time-averaged sound level as defined by the latest sound level meter standards.

Type 2240 is as straightforward as a sound level meter can get. With three pushbuttons you control everything, and the front panel's sliding cover reveals a quick guide to all functions. The power and calibration switches are found on the side panel.



**BRIEF SPECIFICATIONS**
**Standards:**
IEC/ANSI/ISO standards:
See table on page 37

**Measuring Ranges**
**RMS:** Total range: 30 – 140 dB
**Two Manually Selected Ranges:**
30 – 110 dB and 60 – 140 dB
**Peak:** 60 – 143 dB

**Detectors**
Simultaneous RMS and Peak with independent frequency weightings
**Linear Operating Range:** 80 dB

**Frequency Range**
20 Hz to 16 kHz
**Frequency Weightings**
A-weighting (RMS)
C-weighting (Peak)
**Time Weighting**
'F' (Fast)

**Microphone**
**Type 4188** Prepolarized Free-field ½-inch Microphone
**Sensitivity:** –30 dB re 1 V/Pa ± 2 dB (corresponding to 31.6 mV/Pa)

**ORDERING INFORMATION**
**Type 2240:** Integrating-averaging Sound Level Meter

**Accessories Included**
**Type 4188:** Prepolarized Free-field ½-inch Microphone
**DZ 9566:** Random-incidence Corrector
**KE 0443:** Pouch
**UA 1236:** Protective Cover
**UA 0229:** Screwdriver
Two alkaline batteries

**Type 2240 A** Integrating-averaging Sound Level Meter with Sound Level Calibrator Type 4231

**Optional Accessories**
**Type 4231:** Sound Level Calibrator (included with Type 2240A)

# NOISE DOSE METERS

## TYPE 4442 NOISE DOSE METER
## TYPE 4443 LOGGING NOISE DOSE METER

A good noise dose meter is an indispensable tool in the fight against noise-induced hearing loss. Long-term exposure to a high average noise level is the number one cause of occupational hearing loss, yet people cannot feel the damage occurring, which means that they often fail to protect their hearing adequately. Noise Dose Meters Types 4442 and 4443 are rugged, easy to use and comfortable to wear for an entire working day. They provide a simple, effective solution for evaluating noise exposure and preventing hearing loss in the workplace.

The basic result provided by a noise meter is the dose percentage, which is sufficient to determine whether a person's work environment is in compliance with regulations. Noise Dose Meter Type 4442 and Logging Noise Dose Meter Type 4443 both provide this information in a simple and very convenient package. However, when an overdose problem is discovered, it is convenient to employ the additional analytical power of Logging Noise Dose Meter Type 4443 to identify the sources of the problem and eliminate them.

### BRIEF SPECIFICATIONS
**Standards**
IEC/ANSI/ISO standards:
See table on page 37

**Microphone**
$\frac{1}{4}$-inch prepolarized condenser microphone
**Connector:** 5-pin LEMO

**Measurement Ranges**
70 – 140 dB, 50 – 120 dB,
30 – 100 dB (Type 4443 only)

**Frequency Weightings**
**RMS detector:** A and C,
**Peak detector:** C and Lin

**Time Weightings**
Fast, Slow, and Impulse
(RMS detector)

### Measurement Parameters
**Measured parameters, as applicable:** Dose Percentage, 8 Hour Projected Dose, Sound Exposure (Pa$^2$h), Time Weighted Average (TWA), Sound Pressure Level (SPL), Maximum Sound Pressure Level ($L_{max}$), Sound Exposure Level ($L_{EP,d}$), Maximum Peak ($L_{pkmax}$), Equivalent Continuous Sound Level ($L_{eq}$, exchange rate 3 dB), Impulse Weighted Average Sound Level ($L_{Ieq}$, exchange rate 3 dB), Average Sound Level ($L_{avg}$, exchange rate 4, 5 or 6 dB (as, applicable according to setup)

### Additional Parameters for Type 4443
Statistical noise levels ($L_N$), five values selected by the user in 1 dB steps (default: $L_{10}$, $L_{50}$, $L_{90}$, $L_{95}$, $L_{99}$)
A statistical distribution with 0.5 dB resolution is stored
**Logging:** One or two values can be logged, selected from these parameters: $L_{eq}$, $L_{Ieq}$, $L_{avg}$, $L_{max}$, $L_{pkmax}$, $L_N$
**Logging Interval:** 1 s, 5 s, 15 s, 30 s, 1 min, 5 min, 10 min, 15 min, 30 min or 60 min
**Logging Capacity:** More than 53,000 values can be stored at any one time (more than 14 h for 1 parameter at a 1 s interval)

### ORDERING INFORMATION
**Type 4442:** Noise Dose Meter
**Type 4443:** Logging Noise Dose Meter include the following accessories:
**MM 0111:** $\frac{1}{4}$-inch Prepolarized Condenser Microphone with Integrated Cable
**KE 0428:** Carrying Case with Inlay
**DP 0952:** $\frac{1}{4}$-inch Adaptor for Sound Level Calibrator Type 4231
**AO 0577:** Serial Interface Cable
**VP 7790:** Disk with software for download and setup
**2 × QB 0016:** 9V Alkaline Batteries

# PULSE MULTICHANNEL PLATFORM

Developed as an advanced solution for sound and vibration measurements, Brüel & Kjær's PULSE™ is the analyzer platform of the future. With its vast range of software applications and hardware configurations PULSE is today probably the most popular analyzer solution in the world.

## Real-time

The real-time capability of PULSE means that there is the closest possible link between cause and effect. You see your analysis results instantaneously on-screen as they are measured, thus enabling you to validate your data immediately.

## Multi-analysis

The multi-analysis side of PULSE means that you can perform FFT, 1/n-octave (CPB), order and overall analysis simultaneously on the same or different channels/signals while displaying real-time results on screen.

## PC-based – Your PC is your Analyzer!

PULSE gives you the freedom to make measurements in the field and process your data wherever you want. PULSE makes your PC your personal analyzer by leveraging rapidly growing PC-processor performance for real-time signal processing. Using standard PC hardware and software, PULSE is easily upgraded with off-the-shelf components.

Types of Multichannel Analysis on PULSE:
- FFT analysis
- 1/n-octave (CPB) analysis
- Order tracking analysis
- Intensity testing
- Time recording and editing
- Auxiliary parameter analysis
- SSR electroacoustic testing

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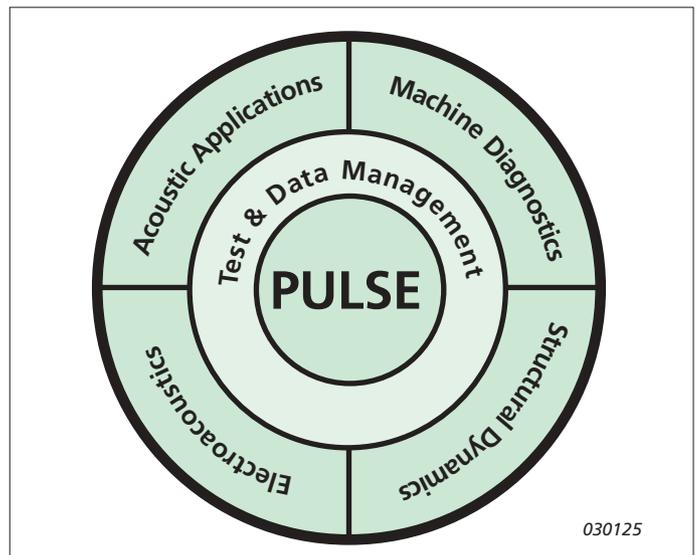
## Noise Source Identification

**Stationary signals**
- Intensity
- Selective intensity
- Spatial Transformation of Sound Fields (STSF) also known as Near-field Acoustic Holography (NAH)

**Non-stationary signals**
- Non-stationary STSF
- Beamforming

## Sound Power

Sound Power Test Systems to:
- ISO 374x by serial or parallel measurements
- EU Directive 2000/14/EC
- ISO 9614–2 scanning intensity method

## Sound Quality

- Binural recording of sounds on site, for example in a car on a test track
- Analysis of sounds by traditional methods and specific objective methods such as Zwicker loudness
- Simulating changes in the sounds using a number of edits
- Subjective listening tests
- Creation of combination metrics

## Pass-by

- Scalable from simple 1- channel survey systems up to multichannel with in-car noise/vibration and auxiliary parameters
- One-man operation
- Recording of time data for detailed post-analysis
- Built-in database solution for improved data handling
- Optional PDA-based remote control

## Human Vibration

(with 3-channel Human Vibration Front-end Type 1700)
- Whole-body vibration according to ISO 2631 and hand-arm vibration according to ISO 5349 standards on multiple channels
- Measurements weighted in compliance to ISO 8041 standard
- Uses analogue filters allows for measurements to GOST standards

## Building Acoustics

- Calculation of Reverberation Time by interrupted or impulse method (Standard PULSE and Classifier Type 7842)
- Calculation of Reverberation Time by Maximum Length Sequence, MLS (Classifier Type 7842)
- Airborne sound insulation, impact sound insulation, and absorption coefficient (Classifier Type 7842)

## Recording

- Make recording directly to the PC hard-drive
- Very high channel × bandwidths (> 1 GHz) for multi-channel recordings (>200) to high frequencies (frequency dependant on input module)
- Ability to record and analyse data simultaneously for data verification
- Faster than real-time playback and analyses reduces post-processing time

More information on PULSE systems can be found on www.bksv.com or in the PULSE Analyzers & Solutions Catalogue BF 0209.
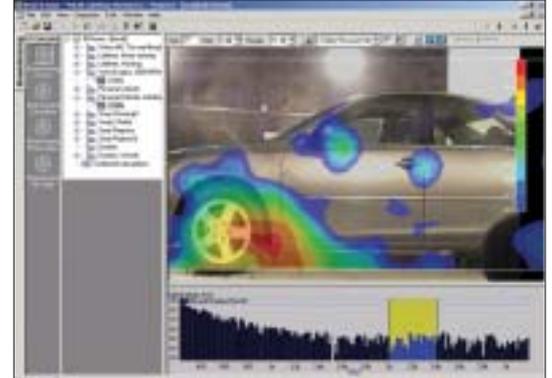
# CALIBRATORS

## TYPES 4231, 4226, 4228 SOUND LEVEL CALIBRATORS
## TYPE 4294 VIBRATION CALIBRATOR
## TYPES 3541 AND 4297 SOUND INTENSITY CALIBRATORS

The most important parameter for any measurement device is sensitivity. Sensitivity can be defined as the ratio of the output parameter to the input parameter. To determine the sensitivity is to calibrate the measurement device.

A calibration is performed:
- To ensure that your measurements are correct
- To prove that measurement methods and the equipment used are accurate, for example, to prove that a measurement complies with the requirements of national legislation, standard bodies and customers
- To verify the stability of the measurement equipment, including equipment used to perform calibration
- To account for local measurement conditions, for example, variations in ambient pressure and temperature
- To ensure product quality
- To build confidence in measurement results

## SOUND LEVEL CALIBRATOR TYPE 4231

Sound Level Calibrator Type 4231 is a handy, portable sound source for calibration of sound level meters and other sound measurement equipment.

**FEATURES:**
- Robust pocket-size design with highly stable level and frequency
- Sound pressure independent of microphone equivalent volume
- Switches off automatically when removed from the microphone

**ORDERING INFORMATION**
**Type 4231:** Sound Level Calibrator
**Accessories includes:**
**KE 0317:** Leather Case
**2 × QB 0013:** Alkaline Batteries Type LR6
**UC 0210:** Adaptor for ½-inch microphones

*4231*

# MULTIFUNCTION ACOUSTIC CALIBRATOR TYPE 4226

This device is a portable calibrator for sound level meters, dose meters, microphones and related instruments. It is able to give 3 different output levels at $\frac{1}{1}$-octave frequencies from 31.5 Hz to 16 kHz, and at 12.5 kHz.


*4226*

# PISTONPHONE TYPE 4228

The Pistonphone is for calibration of sound level meters and other acoustic instruments using $\frac{1}{8}$", $\frac{1}{4}$", $\frac{1}{2}$" and 1" microphones. Based on mechanical production of sound pressure using oscillating pistons, the sound pressure level delivered by the Pistonphone can be very accurately defined.

## BRIEF SPECIFICATIONS

| Type Number | | 4231 | 4226 | 4228 |
|---|---|---|---|---|
| Description | | Sound Level Calibrator | Multifunction Acoustic Calibrator | Pistonphone |
| Standards | | IEC 60942 (1998) Class 1 ANSI S1.4–1984 | IEC 60942 (1998) Class 1 Ansi S1.4–1984 | IEC 60942 (1998) Class 1 |
| Calibration Pressure | dB SPL | 94 and 114 | 94, 104 and 114 | 124 |
| Calibration Frequencies | Hz | 1000 | 31.5Hz to 16 kHz in octave steps. 12.5 kHz | 251.2 |
| Calibration Accuracy | dB | ±0.2 | ±0.2 at 94 dB | ±0.2 |
| Transducer | | 1-inch and 1/2-inch (1/4-inch and 1/8-inch with adaptor) | 1/2-inch and 1/4-inch | 1-inch, 1/2-inch, 1/4-inch and 1/8-inch |

*030250*


*4228*

# VIBRATION CALIBRATOR TYPE 4294

Vibration Calibrator Type 4294 is a small, handy, completely self-contained vibration reference source. It is intended for rapid calibration and checking of vibration measurement, monitoring and recording systems.

## FEATURES
- Small, lightweight and battery-driven
- Leather case with impact protection – designed for everyday use in harsh environment

## BRIEF SPECIFICATIONS
**Vibration System**
Electromagnetic exciter with internal built-in accelerometer for servo regulation of vibration amplitude.
**Frequency**
159.15 Hz ±0.02% (1000 rads$^{-1}$)
**Acceleration**
10 ms$^{-2}$ (RMS) ±3%
**Velocity**
10 mms$^{-1}$ (RMS) ±3%
**Displacement**
10 µm (RMS) ±3%

**Accessories**
**KE 0278:** Leather Case
**QB 0016:** 9 V Battery
**YQ 2962:** 10–32 UNF Steel Stud
**DB 2996:** Mounting Disc Adaptor


*4294*

# CALIBRATORS

## SOUND INTENSITY CALIBRATORS TYPES 3541 AND 4297

Requirements for laboratory and field use are different. Brüel & Kjær, therefore, offers two instruments for sound intensity calibration – Type 3541 for laboratory use and Type 4297 for field use. Both calibrators fulfil IEC 61043, 1993 Class 1.



*3541*

### BRIEF SPECIFICATIONS

| Type Number | | 3541 | 4297 |
|---|---|---|---|
| Main Application | | In the laboratory | In the field |
| Dismantling of Probe | | Necessary | Unnecessary (up to 3 kHz) |
| Calibration of Sound Intensity Level | $L_I$ | Yes | No |
| Calibration of Sound Pressure Level | $L_p$ | Yes | Yes |
| Calibration of Particle Velocity Level | $L_v$ | Yes | No |
| Pressure-Residual Intensity Index | $L_p$–$L_I$ | 20 to 5 kHz | 20 to 3 kHz with spacer<br>20 to 6.3 kHz without spacer |
| Spacings Accommodated | | Irrelevant as spacer must be removed from probe | Probe must be based on 12 mm spacer |
| Sound Pressure Source | | Separate pistonphone | Integrated |
| Noise Generator | | Separate pink and white noise generator | Integrated pink noise generator |
| Microphones Accomodated | inch | $^1/_4$ and $^1/_2$ | $^1/_2$ |
| Number of Mechanical Parts | | 4 | 1 |

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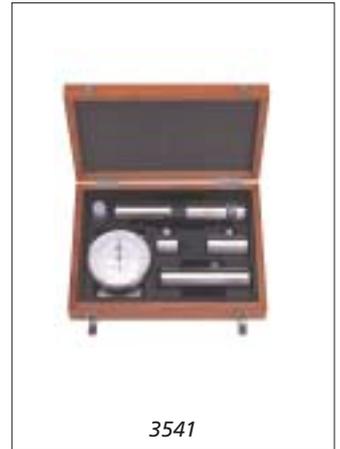


*4297*



*4297*

# PC SOFTWARE

## NOISE EXPLORER TYPE 7815

Noise Explorer[TM] is a Windows®-based software package for downloading and reporting noise and vibration data measured with Brüel & Kjær hand-held instruments. Sound intensity measurements made with the 2260 Investigator sound intensity system can be viewed and manipulated in Noise Explorer. With Noise Explorer, you can also record sound directly onto your PC's hard drive.

### USES
• Formatting data for export to spreadsheets, noise mapping software or the Windows® clipboard

• Displaying/printing measurement results in graphical or tabular form
• Calculating Sound Power or Sound Reduction Index from sound intensity measurements.

### Supported Instruments
**Type 2236** (all variants)
**Type 2237** (A and B variants)
**Type 2238** (all variants)
**Type 2239** (A and B variants)
**Type 4436**
**Type 4442**
**Type 4443**
**Type 2231** with BZ 7112
**Type 2250** (via PC Software)
**Type 2260** with BZ 7201/02/03/05/06/08/10
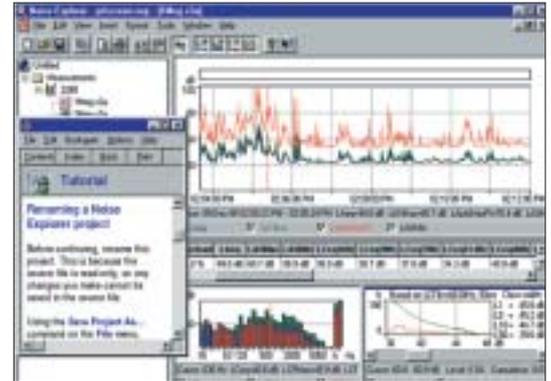


### ORDERING INFORMATION
**Type 7815:** Noise Explorer

**Optional Accessories**
For use with Types 2236, 2237, 2238, 2239 and 2260:

**AO 1442:** Serial Interface Cable
**AO 0586:** Cable from 2260 to Audio Input on a PC
**AO 0585:** Cable from 2238 to Audio Input on a PC

## EVALUATOR TYPE 7820

### Calculation of Rating Level
Evaluator[TM] Type 7820 and Evaluator Light Type 7821 are Windows®-based software packages for environmental noise evaluation. They provide versatile tools for analysing measured data from Brüel & Kjær Sound Level Meters, and are a complete solution for the determination of Rating Levels according to various national standards. Evaluator boasts many advanced features, including recording and replaying sound, tonal assessment using FFT spectra and the option of remote downloading data from Brüel & Kjær Sound Level Meters through a modem connection.

### ORDERING INFORMATION
**Type 7820:** Evaluator software
**Type 7821:** Evaluator Light software
**Type 7820-X-100:** Upgrade from Type 7696 to Type 7820
**Type 7820-X-200:** Upgrade from Type 7821 to Type 7820

**Optional Accessories**
**AO 0586:** Cable from 2260 to Audio Input on a PC
**AO 0585:** Cable from 2238 to Audio Input on a PC
**ZE 0770:** PCI Soundcard (for desktop PCs)
**ZE 0770A:** PCM-CIA Soundcard (for laptop PCs)
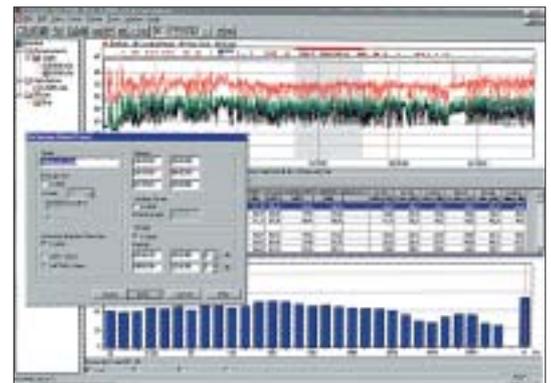


*Supported instruments*

| Type Number | 7820 | 7821 |
|---|---|---|
| Type 2236 (all variants) | x | x |
| Type 2237 (A and B variants) | x | x |
| Type 2238 (all variants) | x | x |
| Type 2239 (A and B variants) | x | x |
| Type 2231 with BZ 7112 | x | |
| Type 2250 | x | |
| Type 2260 Observer with BZ 7219 | x | |
| Type 2260 Investigator | | *030253* |

# PC SOFTWARE

## PROTECTOR TYPE 7825

**PC Software for Calculating Personal Noise Exposure**

Protector™ is a Windows®-based software package for post-processing, simulating and archiving noise exposure data. Designed to work with Brüel & Kjær sound level meters, noise dose meters and sound level analyzers, Protector allows you to quickly download sample noise profiles for specific locations or persons. Protector can use this data to calculate noise exposure for people or positions under investigation. Protector calculates noise exposure according to ISO 9612–2. For situations where only work-point noise measurements are available, and workers move about, Protector can combine workpoint measurements with a profile of a person's movements, to simulate their personal noise exposure.

**Supported Instruments**
**Type 2236** (all variants)
**Type 2237** (A and B variants)
**Type 2238** (all variants)
**Type 2239** (A and B variants)
**Type 4436**
**Type 4442**
**Type 4443**
**Type 2250** (via PC Software)
**Type 2260** with BZ 7201/02/03/06/10
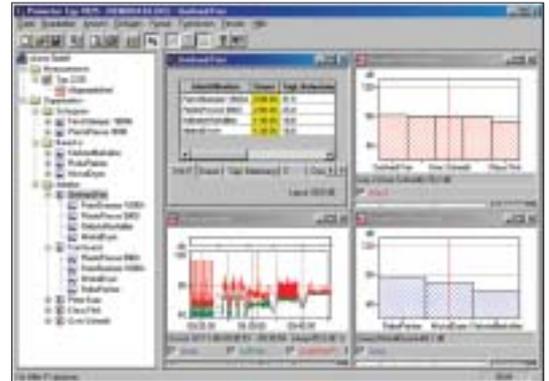


**ORDERING INFORMATION**
**Type 7825:** Protector

**Optional Accessories**
For use with Types 2236, 2237, 2238 and 2260:

**AO 1442:** Serial Interface Cable
For use with Type 4436:
**AO 0498:** LEMO to 25-pin Interface Cable
**AO 0507:** LEMO to LEMO Interface Cable

## QUALIFIER TYPE 7830, 7831

**PC Software for Calculating Reverberation Time and Building Acoustics**

Qualifier™ Type 7830 works with the same bookkeeping system as Type 2260. This means that when data has been transferred to the PC, you see the same results as in Type 2260, including selected standard, excluded positions and other setup parameters. Using Qualifier's spreadsheet-like data sheets, it is also possible to manually adjust data used in calculations, for example, to change levels or reverberation times. The result can be observed immediately. Reverberation times can be modified by drawing a new slope line with the mouse across a displayed decay curve. For diagnostic purposes, the reduction curve can be modified and the single value will adjust accordingly. And because manual input of data is possible, modifications for walls and rooms can be simulated.

**FEATURES (7830)**
• Calculates sound insulation curves and indexes
• Edits measurement results, including manual input of data
• Documentation and reporting facilities

**FEATURES (7831)**
• Calculates reverberation time
• Edits measurement results, including manual input of data
• Documentation and reporting facilities
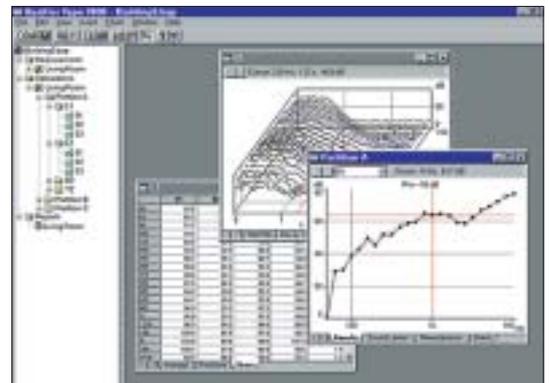


**Supported Instruments**
**Type 7830:** 2260 Investigator with BZ 7204/07
2260 Observer with BZ 7220
**Type 7831:** 2260 Investigator with BZ 7207
2260 Observer with BZ 7220

**ORDERING INFORMATION**
**Type 7830:** Qualifier
**Type 7831:** Qualifier Light

# ACOUSTIC DETERMINATOR TYPE 7816

**Software for the Determination of the Sound Power Level of Industrial Sources based on Noise Measurements**

Acoustic Determinator calculates the sound power level in real-time and checks if the entered data meets the restrictions of the method used.

With the built-in acoustic spreadsheet it is possible to collect, save and process spectral noise levels – for example, to energetically add, average or subtract two spectra. This data can be entered manually, imported using extensive clipboard possibilities, or imported directly from 2260 Investigator/Observer. With the clipboard functionality, data can be entered, saved, printed and exported. It is also possible to copy selected data from other spreadsheet programs, word-processing programs, and from measurements in Acoustic Determinator itself. Once processed in Acoustic Determinator, sound power levels can be exported to prediction software for use in environmental noise calculations.

**FEATURES**
- Complies with ISO 3744, ISO 3746, ISO 8297, HMRI-II.2/3/4/6/7
- Well-organised data management
- Import of measured data from 2260 Investigator/Observer
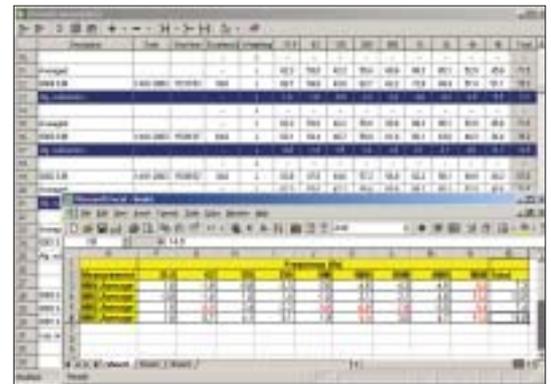


- Acoustic spreadsheet for processing sound levels
- Export to other Windows® applications

**ORDERING INFORMATION**
**Type 7816:** Acoustic Determinator

**Optional Accessories**
**M1 – 7816:** Software Maintenance, Upgrade and Support
**Type 2260:** Investigator
**Type 2260:** Observer
**Type 7810:** Predictor Software
**Type 7812:** Lima Software

# DIRAC TYPE 7841

**Room Acoustic Measurements using DIRAC**

DIRAC is PC software for measuring room acoustic parameters using MLS, sweep or impulsive sources. It employs a PC soundcard for single or dual-channel signal input and output. A sound level meter is well suited as a front-end for DIRAC.

**USES**
- Room acoustic measurements including STI and RASTI
- Scale model measurements

**FEATURES**
- Measures room acoustic parameters according to ISO 3382
- Measures STI and RASTI according to IEC 60268–16
- MLS, sweep and impulsive source signals

- Export to ODEON Room Acoustics Modelling software Types 7835, 7836, 7837

**BRIEF SPECIFICATIONS**
**Internal Source Signals:** MLS, lin-Sweep, e-Sweep
**External Source Signals:** MLS, lin-Sweep, e-Sweep, Noise, Impulse
**MLS and Sweep Lengths:** 0.34 – 21.8s
**Pre-average:** 1 – 999 times
**Filters:** None, Pink and Blue, Female, Male, RASTI
**Frequency Range:** ⅓-octave 31.5 Hz to 16 kHz, ½-octave 20 Hz to 20 kHz
**Calibrations:** Soundcard, System, Speech Level, Input Level
**Results:** EDT, T10, T20, T30, G, Grel, SPL, Ts, C80, D50, LF, LFC,
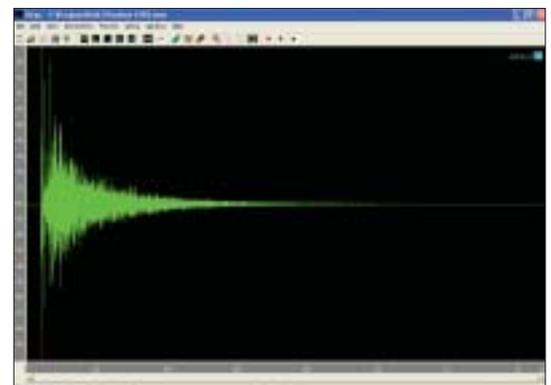


IACC, STI, RASTI, STITEL, ALC, STearly, STlate, STtotal, INR, SNR

**ORDERING INFORMATION**
**Type 7841:** DIRAC
**Optional Accessories**
**ZE 0770:** PCM-CIA Sound Card
**Type 2238 Mediator:** Integrating Sound Level Meter

**Type 2239:** Integrating Sound Level Meter
**Type 2260 Investigator:** Modular Precision Sound Analyzer
**AO 0585:** 3 m Cable for Types 2238, 2239
**AO 0586:** 3 m Cable for Type 2260
**AO 0592:** 10 m Extension Cable for AO 0585 and AO 0586

# PC SOFTWARE

## CLASSIFIER TYPE 7842

**Building Acoustics Measurements using Classifier**
Classifier Laboratory Type 7842 A and Classifier Field Type 7842 B are two versions of a PC-based software package for building acoustics measurements using the Brüel & Kjær PULSE platform.

**USES**
• Measurement of
  Airborne Sound Insulation
• Impact Sound Insulation
• Reverberation Time
• Absorption Coefficient

**FEATURES**
• Supports a comprehensive
  selection of national and
  international standards
• Multichannel support
• Controls rotating microphone
  boom(s)
• Intensity method
  (7842 A Classifier Laboratory)
• Maximum Length Sequence
  (MLS) methods

**This PULSE-based solution particularly suits:**
• Proving facilities
• Research laboratories
• Consultants
• Larger industries with own
  test facilities
• Universities
• Field measurement use where
  a PC-based solution is preferred

Comprehensive validation features combined with a high degree of automation ensure that final results, including report/documentation are obtained quickly.

Using a multichannel setup can significantly reduce the measurement time as several positions in different rooms can be measured simultaneously. In laboratory environments, a fixed installation will also aid in the task of making reproducible measurements.

Wireless LAN can also be used to simplify cable installations. Especially in field measurements, the potential problem of getting cables from one room to another can be solved quickly and easily with a wireless connection between the PC and one or more PULSE front-ends (multiple PULSE front-ends will be supported in future versions).

**BRIEF SPECIFICATIONS**
For detailed specifications of the recommended PULSE hardware, please refer to the System Data for PULSE Hardware, BU 0228.

**Measurements and Calculation Standards**
Classifier Type 7842 measures according to various national and international standards: ISO (International), JIS (Japan), CNS



(China), SS (Sweden), DIN (Germany), ÖNORM (Austria), BS (UK), Sia (Switzerland), UNI (Italy), NF-S31(France), NBE (Spain), NEN (Netherlands), ASTM (USA).

**ORDERING INFORMATION**
**Type 7842 A-N:** Classifier Laboratory version – 5-channel version optimised for laboratory measurements
**Type 7842 B-N:** Classifier Field version – 2-channel version optimised for field measurements

**Services Available**
**M1–7842–A:** 1-year Software Maintenance & Support Agreement for Classifier Laboratory version
**M1–7842–B:** 1-year Software Maintenance & Support Agreement for Classifier Field version
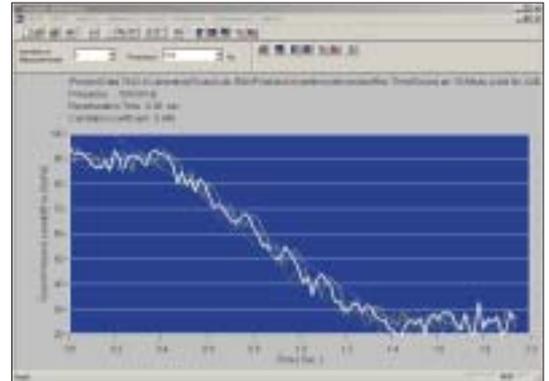
# MODELLING SOFTWARE

## PREDICTOR TYPE 7810

**Noise Calculation Software for the Prediction, Presentation and Management of Environmental Noise**

Predictor™ Type 7810 is a well-organised Windows®-based, multi-user noise modelling and calculation software package. It allows you to make electronic models of the acoustic environment of a geographical area, for assessment of outdoor noise from various noise sources such as industry or traffic.

Predictor's data management facilities allow you to concentrate on your job rather than on where files are stored, or even if they are saved. And, as a multi-user system, several people can work on different parts of the same Predictor project simultaneously, completing projects efficiently. It is possible to speed calculations by optimising them so that less relevant source-receiver combinations are ignored.

Multiple sources and other model items can be edited simultaneously for rapid model adjustment while other simple but powerful tools such as cross-sections, distance measurement and 3D visualisations help you build an accurate model.

Predictor guards all modifications in a model. Only the results that become invalid due to acoustic-relevant modifications need to be recalculated. This unique 'acoustic eye' feature of Predictor not only reduces calculation time but, more importantly, ensures consistency between input and results.

Predictor provides on-line user guidance for fulfilling calculation standards, allowing even inexperienced users to get accurate results.

**FEATURES**
- Complies with ISO 9613, NMPB/XPS 31–133, RMR/SRM II, CRTN ($L_{10}$ and $L_{Aeq}$), DAL 32
- Up to 250,000 points/grid
- Integrated sound power database for the creation of your own database of standard sources
- Automatic creation and positioning of sources and receiver points with measured data ($L_W$, $L_{eq}$, $L_{10}$ and $L_{90}$) taken with 2260 Investigator and GPS unit
- Sources defined in $L_W$ or by operational features (for example, traffic types and flows)
- Receiver points defined at fixed positions or relative to other model items

**ORDERING INFORMATION**
**Type 7810:** Predictor
**Optional Accessories**
**M1 – 7810:** Predictor Software Maintenance, Upgrade and Support
**Type 2260 Investigator:** Modular Precision Sound Analyzer
**Type 2260 Observer:** Modular Precision Sound Analyser
**Type 7816:** Acoustic Determinator Software
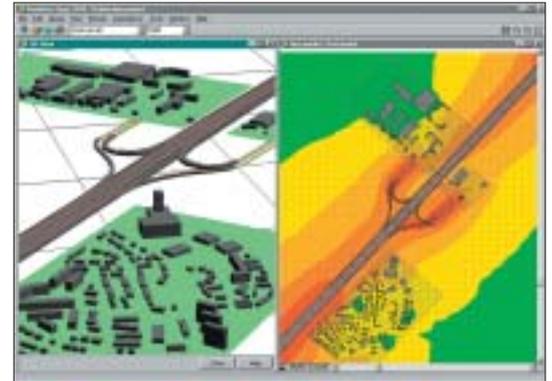
# MODELLING SOFTWARE

## LIMA TYPE 7812

**Environmental Noise Calculation and Mapping Software**

Lima<sup>TM</sup> Type 7812 is PC software for environmental analysis based on 3D modelling for noise emission and propagation analysis. Lima is suitable for environmental impact assessment, urban planning and large-scale noise mapping. The generated 3D model can also be used for other environmental assessments, such as air pollution.

**FEATURES**
- Wide range of national and international (EU) regulations
- Handles complex geometries
- Proven ability to produce large scale noise maps
- Support of various GIS and database formats
- Powerful GIS data post-processing tools
- Easy customisation due to user-defined objects and attributes
- Fix emission quotas based on optimisation
- Source emissions calculated from measurements
- Emission based on extra studies of user functions for user functions
- Working with average, $1/1$- or $1/3$-octave data
- Barrier optimisation
- Simulation of moving point source for air traffic and other sources
- Automatic tiling of large areas for efficient calculation
- Parallel calculation of <32 emission data per source object
- Multiple source grouping

- Stand-alone or GIS background application
- Cost-efficient distribution of software over several workstations

**BRIEF SPECIFICATIONS**

**Emitter Types:** Road, rail and industry, sport, leisure

**Regulations:** RLS 90, DIN 18005, RVS 3.02, NMPB/XPS 31–133 (NMPB), CRTN, VDI 2714/2720/2571, ÖAL 28, SCHALL 03, AKUSTIK 04, TRANSRAPID, ÖAL 30, CRN, RMR/SRM IIS RM2 (or RLM2), AzB, ISO 9613–2 (for all emitter types)

**Data Import Format:** DXF, MapInfo, ArcInfo, ArcGIS (SHAPE), SICAD SD, SQD, Intergraph (DGN), GeoMedia, XML, DES, VISUM

**Data Export Format:** DXF, MapInfo, ArcInfo, ArcGIS (SHAPE)

**Model Capability (Obstacles):** 20,000 (7812 A) to >1,000,000 (7812 C)

**Supported Spectrum:** Main, octave or $1/3$-octave

**Results:** $L_{Day}$, $L_{Night}$, $L_{Evening}$, $L_{DEN}$, $L_{10}$, $L_{Aeq}$, 9 different forms of annoyance assessment, statistics on results

**ORDERING INFORMATION**

**Type 7812 A:** Lima – For small to medium scale models. All specified road, rail and industry methods. Data import and export in DXF format
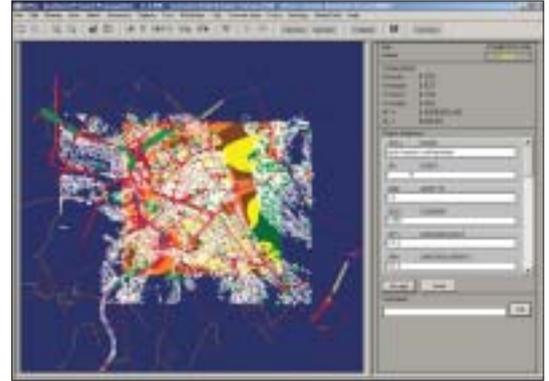


**Type 7812 B:** Lima Plus – For medium to large scale models. Includes all Lima Type 7812 A functions, 3D graphics, superposition, statistics, conflict maps, barrier optimisation and best/worst-case analysis, one additional data exchangeformat

**Type 7812 C:** Lima Advanced – For large to very large scale models. Includes all Lima Plus Type 7812 B functions, all supplementary tools, annoyance analysis, fixing emission quotas, moving-point analysis, all available data-exchange formats. Configurable to customer hardware

**BZ 5441:** Lima Aircraft Module – Calculation according to AzB, simulation of moving point source

**BZ 5442:** Lima Data Exchange Module – Import/export of data in all defined data-exchange formats

Lima is also available in other configurations – contact your local Brüel & Kjær representative for more information.

# ODEON TYPES 7835, 7836, 7837

## Modelling using ODEON

ODEON Types 7835, 7836 and 7837 PC software simulates the interior acoustics of buildings. From the geometry and properties of surfaces, the acoustics are calculated, illustrated and auralised.

## USES
- Predicting room acoustics of planned buildings
- Improving the acoustics of existing buildings

## FEATURES
- Fast modelling with ODEON editor or imported CAD file
- Verification of model
- Flexible choice of sources, receivers and materials
- Modest calculation times
- Visual results – reflectograms, 3D reflection paths, 3D maps
- High-quality auralisation
- Effective project management
- Easy copy and export of results for project reports or presentations
- Comparisons with measured data from DIRAC Type 7841

## BRIEF SPECIFICATIONS
**Frequency Range:** 8 octave bands from 63 Hz to 8 kHz
**Size:** Max. 2000 × 2000 × 2000 m
**Points:** Max. 500 per surface
**Surfaces:** Max. 50000
**Corners:** Max. 100000
**Sources:** Point, Line or Surface sources, Max. total 99 sources
**Receivers:** Virtually no limit

## Results
**Ray Tracing:** Dynamic display of rays during calculation
**Quick Estimate:** Fast estimate of reverberation time assuming diffuse-field
**Global Estimate:** Reverberation time estimate accounting for room details
**Single-point Response:** Detailed results and auralisation
**Multi-point Response:** Results for a specified number of receivers
**Grid Response:** Map of room acoustical parameters
**Reflector coverage:** 3D display of first reflection hits for reflectors

## Result Parameters
SPL, SPL(A), DL2, $T_{30}$, EDT, STI, Ts, G, $C_{80}$, $D_{50}$, $LF_{80}$, $ST_{early}$, $ST_{late}$, $ST_{total}$, LLSPL(A)

## Auralisation
**Input Format:** Anechoic or semi-anechoic .wav format
**Processing:** Convolution of input file with BRIR (Binaural Room Input Response), correcting for HRTFs for each reflection
**Output Format:** Binaural .wav format optimised for headphones
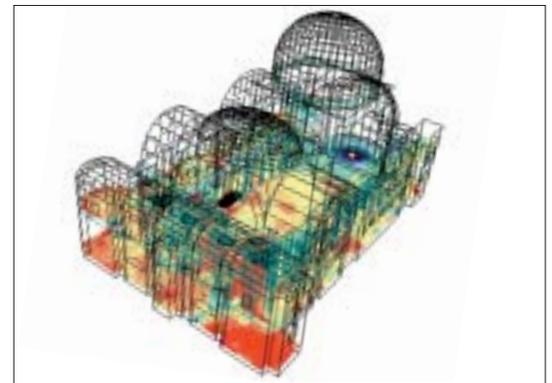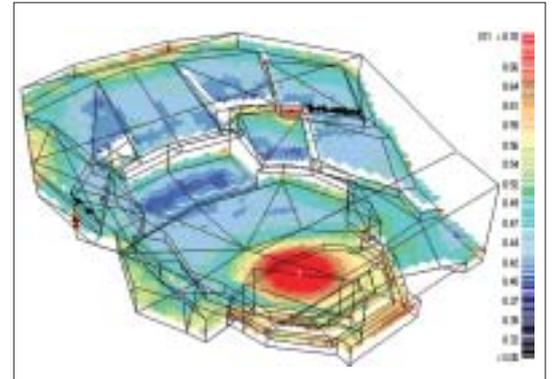




## ORDERING INFORMATION
**Type 7835:** Industrial Edition
Line and Surface sources
**Type 7836:** Auditorium Edition
Reflectogram
3D reflection paths
3D reflector coverage
Additional auditorium parameters
Auralisation
**Type 7837:** Combined Edition
All features of Auditorium and Industrial Editions

**Services Available**
**M1 – 7835/6/7:** 1-year support and upgrade agreement
**7835/6/7-X-100:** Upgrade from ODEON versions 4.0 and later
**7835/6/7-X-200:** Upgrade from ODEON versions 3.x and earlier

# UNATTENDED NOISE MONITORING

## NOISE MONITORING TERMINAL (NMT) TYPES 3597 C AND 3637 A/B

An NMT consists of a weatherproof microphone unit, a microphone power supply, a noise level analyzer, a system controller and a weatherproof cabinet. The NMT is the front-end of an unattended noise-monitoring system, and monitors environmental noise from airports, construction sites, and densely trafficked areas where noise is a major concern.

**Types 3597 C and 3637 A/B:**
- Check the calibration of the weatherproof microphone unit
- Correctly measure the signal from the weatherproof microphone unit
- Provide the necessary frequency and time weightings
- Process noise data
- Store the results of several months of monitoring
- Transmit data via RS–232, modem or LAN interface

**USES**
- Airport noise monitoring
- City noise monitoring
- Train noise monitoring
- Industrial noise monitoring
- Noise surveys

**FEATURES**
- Continuous all-weather monitoring
- $\frac{1}{2}$- or 1-second $L_{eq}$ and SPL measurements
- Dynamic range of 110 dB
- Automatic event detection on absolute or floating triggers
- $\frac{1}{3}$-octave real-time analysis
- Sound recording
- Weather-data monitoring (optional)
- Remote verification of the measurement chain using CIC check and/or a built-in loudspeaker (except 3637 B)
- On-site operation via RS–232

- Remote operation via public telephone lines, cellular phones, ISDN

**BRIEF SPECIFICATIONS**
**Dynamic Range:** 110 dB
**Memory Capacity:** Standard configuration consists of a 10 GB hard disk giving at least three months storage space
**Modem Interface:** RS–232
**Optional:** Configuration for ISDN

**Ambient Conditions**
**Weatherproof Microphone Unit Type 4184:**
**Operating Temperature Range:** –40 to +50°C (–40 to 122°F)
**Operating Relative Humidity Range:** < 100%
**Maximum Relative Humidity:** 90% at +40°C

**Weatherproof Cabinet and Contents**
**Operating Temperature Range:** –30 to +50°C (–22 to 122°F); lower limit extended down to –40°C (–40°F) with optional extra heating unit WB 1128
**Operating Relative Humidity:** Max. 90% at +30°C
Contents weather-protected to IP 55 of IEC 529 and NEMA 3R

**ORDERING INFORMATION**
**Type 3597 C** Permanent Noise Monitoring Terminal consists of:
**Type 3597 C-001:** Basic NMT*
**Type 4184:** Weatherproof Microphone Unit
**UA 1635 A:** Temperature-controlled NMT Cabinet and battery, cables etc.

**Type 3637 A** Portable Noise Monitoring Terminal consists of:
**Type 3597 C-001:** Basic NMT*
**Type 4184:** Weatherproof Microphone Unit
**KE 1008:** Black Suitcase Pelican 1620 and GPS Receiver, batteries, cables

**Type 3637 B** Portable Noise Monitoring Terminal consists of:
**Type 3597 C-001:** Basic NMT*
**Type 4198:** Outdoor Microphone Unit (10 m Cable included)
**KE 1008:** Black Suitcase Pelican 1620 and GPS Receiver, batteries, cables

*Type 3597C-001 is the analyzer and controller consisting of:
**Type 4441:** Noise Level Analyzer
**UL 0219:** Computer
**ZM 0069:** Modem
**VU 1033:** LCD Display
and power supplies and cables

**Accessories**
Quoted on request

## WEATHERPROOF MICROPHONE UNIT TYPE 4184

Weatherproof Microphone Unit Type 4184 is an outdoor unit that complies with Type 1 requirements. It functions correctly at up to 96% relative humidity, and in temperatures from –40 to +50°C. Its precision condenser microphone is buried and fully protected within the unit's body. It has spikes placed at the top of its windscreen to deter birds.

The weatherproof microphone unit, which is powered by Microphone Power Supply ZG 0418, has built-in charge injection calibration (CIC) and test sound-check facilities, making use of the 1000 Hz calibration signal provided by Type 4441 to perform routine electrical and acoustical calibrations and checks. CIC is a patented technique used for remotely moni-

toring the entire measurement setup including the microphone, preamplifier and connecting cable. The actual attenuation of the return signal relative to the calibration signal is indicated on the calibration chart. The system controller can initiate up to four automatic, routine calibrations and probe checks per day at user-specified times. Results are stored in its database.


*4198      4184*

## OUTDOOR MICROPHONE UNIT TYPE 4198
## AND OUTDOOR MICROPHONE KIT UA1404

Type 4198 is a weatherproof microphone and preamplifier assembly that meets IEC 651 Type 1 and ANSI S1.4 Type 2 specifications. Use it in any situation where you have to make precise outdoor sound measurements.

Type 4198 is suitable for semi-permanent, unsupervised outdoor installation. In addition, Outdoor Microphone Kit UA 1404 includes all of the protective features of Type 4198, but without the microphone and

preamplifier. It enables you to weatherproof your Falcon Range® microphones and pre-amplifiers. Both the unit and kit enable you to make measurements that are protected against wind, rain, and perching birds.


*3637 A*

## NOISE MONITORING TERMINAL TYPE 3631

For simple broadband monitoring, Type 3631 offers an NMT based on Sound Level Meter Type 2238F and low-cost Weatherproof Microphone Type 4198. The system's dynamic range is 80dB and the sound level meter complies with the Type 1 standard. The SLM meas-

ures 1 second broadband $L_{eq}$ and is able to store 3 days' worth of measurements. It also includes 2 auxiliary channels that can be used for recording weather information. Normally, downloads occur 3 times a day. Type 7802 or Type 7840 monitoring software installed in the

system controller can be set up to calculate the 1 hour reports and detect events from the data. The SLM must be calibrated by hand. Additionally, the SLM in Type 3631 is powered from a rechargeable battery, allowing it to run for 3 days.

**BRIEF SPECIFICATIONS**
As for Noise Monitoring Terminal Type 3597
**Dynamic Range:** 80 dB
**Broadband Values:** $L_{Aeq}$, $L_{Ceq}$ or $L_{Lineq}$
**Auxiliary Input:** 2 × DC-input channels for weather information
**Memory Capacity:** 3 days (7 with Aux. channels deactivated)

**Modem Interface:** RS–232
Capacity of 12 V Rechargeable
**Battery:** 3 days

**ORDERING INFORMATION**
Type 3631 Portable Noise Monitoring Terminal with Type 2238 F consists of:
**Type 2238 F:** Logging Sound Level Meter

**UA 1404:** Outdoor Microphone Kit
**Type 3592:** Yellow Suitcase and battery, tripod, cables, etc.

**Optional Accessories**
**Type 7802:** Noise Monitoring Software
**Type 7804:** Radar Data Option
**WQ 0989:** Weather Station


*3631*

# UNATTENDED NOISE MONITORING

## NOISE MONITORING SOFTWARE TYPES 7802 AND 7840

The basic software packages – Noise Monitoring Software Types 7802 and 7840 – are the central point in any Brüel & Kjær noise monitoring system. Data from permanently installed NMTs are downloaded at user-defined time periods, to the server via standard modems and public telephone lines. All data are sorted and stored in the system's database, ready for immediate presentation.

### USES
• Monitors airport, city, road, train and other environmental noise

### FEATURES
• Runs under Microsoft®

Windows® 2000 or XP
• Economical use of public telephone lines
• Statistical reports based on fixed and user-definable periods
• Multi-user access via networking
• Supports the use of a GPS unit for location information
• Event reports – Type 7802 only
• Event spectra – Type 7802 only and only for NMTs Type 3597 and 3637
• Downloads data automatically or manually from outdoor Noise Monitoring Terminals
• Stores downloaded data in a database
• Presents tabular and graphical
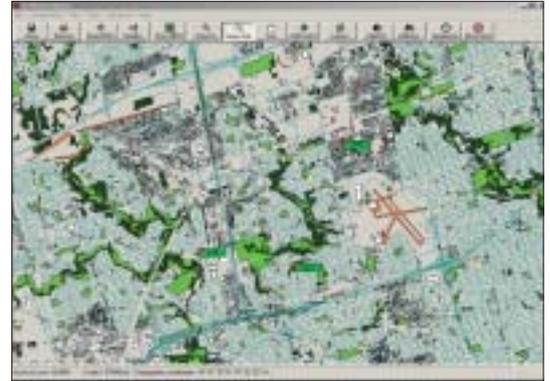


reports on airport, city, road, train and other environmental noise
• Displays real-time noise situations at any site monitored by an on-line Noise Monitoring Terminal
• Provides weather data to

accompany noise data (requires Weather Data Option)

## FLIGHT TRACKING SOFTWARE TYPE 7804

Flight Tracking Software Type 7804 enables the noise monitoring system to correlate aircraft movements with noise events recorded by Brüel & Kjær's range of Noise Monitoring Terminals. It provides data on track violations and singles out offending aircraft and airlines. It also provides data for comparative studies, for example, between two airlines operating with similar aircraft. Real-time and historical displays of flight tracks provide quantitative evidence of compliance or violation of noise abatement procedures. Type 7804 software is able to interface to existing radar systems

and also via disk or other communication channel.

### USES
• Correlates aircraft noise with aircraft movements
• Identifies track violations

### FEATURES
• Runs under Microsoft® Windows® 2000 or XP
• Multi-user access via network
• Fully integrated with ArcView® GIS from ESRI
• Monitors noise abatement procedures
• Displays Gates, Corridors and Cylinders
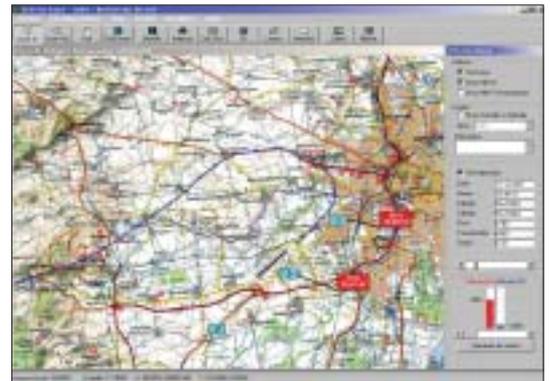


• Calculates aircraft/airline noise statistics
• Displays flight tracks on detailed layer-based maps
• Presents real-time flight tracks

# REPORTING MODULE TYPE 7832

Reporting Module Type 7832 provides dedicated data management and reporting for Brüel & Kjær Noise Monitoring Systems. A reporting wizard function guides you all the way – from report selection, through creating data selection criteria, to the end result. The reports can be attached to an e-mail or saved in html format so they can be used on the Internet.

**USES**
- Reporting based on the data collected by Noise Monitoring Software Type 7802 and Flight-data Option Type 7804

**FEATURES**
- Fast Reporting – Report Wizards guide you though each step
- Displays measurement results in graphical or tabular format

- Generates, views and prints impressive reports in colour
- Exports reports internally or externally in all well-known Microsoft® Office formats
- Additional reports can easily be added
- Reports are created in the Crystal Reports™ environment
- Company logo can be shown on each report

- Reports can be dragged and dropped into a list that can be printed for a chosen time period
- Create or modify all reports (requires Crystal Reports™ license), or let Brüel & Kjær create additional customised reports

# COMPLAINTS MODULE TYPE 7833

Complaints Module Type 7833 provides dedicated data management, analysis and reporting of noise complaints made to airport operators. The reports can be easily exported to other applications, attached to an e-mail or saved in html format.

**USES**
- Systematic registration of complaints in a database
- Manages the workflow of the airport's noise abatement office

**FEATURES**
- 32-bit software running under Windows® 2000

- Link to Microsoft® Word
- Tabular and graphical reports made in Crystal Reports™ environment
- Address matching using ArcView® GIS maps
- Built-in analysis tool to identify aircraft creating excessive noise – link the information to the stored complaint record

(requires installation of Noise Monitoring Software Type 7802 and Flight Tracking Module Type 7804)
- Produces complaint reports and statistics
- Customises report layouts to your own corporate design

# INM LINK TYPE 7834

INM Link Type 7834 builds a bridge between two worlds – real measurements made by Brüel & Kjær's Airport Noise Monitoring System (ANM) and the Integrated Noise Model (INM) developed by the FAA. INM is the prediction tool most widely used by airports throughout the world. INM Link extracts the flight data collected by the ANM system and inputs it into the INM prediction program. It is possible to calculate a far more accurate noise contour

map based on the real flight traffic at the airport rather than traditional maps based on simplistic information such as SIDs and STARs. INM Link offers a variety of data selection and integration options. The Flight Distribution Editor allows you to make simulations. For example, you can change the flight or runway parameters, change the flight mix or simulate the effect of increased traffic, special types of flight, or check-out the effect of moving traffic from one run-

way to another. And all based on real flight traffic data!

**USES**
Link between Brüel & Kjær's Airport Noise Monitoring System and the Federal Aviation Administration's Integrated Noise Model, version 6.1

**FEATURES**
- Calculates a far more realistic noise contour map based on the real flight traffic at the airport

- Imports all flight tracks into the INM prediction model, or divide the total flight into a number of mean tracks thus speeding up the calculations when generating a noise contour map in the INM program
- Uses the Flight Distribution Editor to make fast simulations. Choose more simplistic analysis modes to make simulations of the "what/if?" type.

# CALIBRATION SYSTEM FOR SOUND LEVEL METERS

## CALIBRATION PLATFORM TYPE 3630 WITH SLM CALIBRATION APPLICATION TYPE 7763

The calibration of sound level meters is driven by legislative require-ments. As the number of instruments requiring calibration increases, so the need for an efficient calibration system becomes more and more obvious. The Sound Level Meter (SLM) Calibration application for Type 3630 calibration platform complies with all relevant interna-tional standards and recommendations and is equally well-suited for use in national calibration laboratories and commercial calibration centres. The system combines state-of the-art IT with Brüel & Kjær's proven experience in the calibration of instrumentation for sound and vibration measurement. Type 7763 SLM calibration application is not just an effective tool. The fact that the system is globally sup-ported, easy to recalibrate and, not least, comes with a comprehen-sive user manual (that even includes the uncertainty budgets need-ed for accreditation purposes), means that customers get an impres-sive package for their investment.

### FEATURES
- Automatic, semi-automatic or manual calibration of sound level meters
- Runs under Windows® 2000
- Flexible test-execution man-ager
- Integrated Calibration Manager's Workbench with traceability control customer database
- Predefined or user-defined calibration sequences
- Transparent user interface
- Test signals comply with IEC 60651 and IEC 60804

- IEC 61672 tests available as an upgrade
- Default acceptance limits set in accordance with IEC-type Sound Level Meters
- User-adaptable acceptance limits (OIML requirements)
- Taktmaximal Tests (DIN 45657)
- External electrical traceability via system's digital voltmeter
- External acoustic traceability via Multifunction Acoustic Calibrator Type 4226

- Built-in system verification of measurement quality
- Flexible Certificate of Calibra-tion with detailed test report
- Fully integrated in the Microsoft® Office environment
- Tool to add new SLM types

### OPTIONS
- On-site installation and training
- Maintenance contracts (hardware and software)

## MAJOR SYSTEM ELEMENTS

**Type 3560 C:** Portable PULSE Analyzer with input/output and LAN module

**Type 7700-N2:** 2-channel PULSE CPB & FFT Analysis license

**UL 0216-GB:** System controller (Powerful Pentium® PIII computer with network card)

**UL 0217-GB:** Colour monitor

**UL 0207-GB:** Microsoft® Office XP Professional Edition

**Type 2978:** DMM Agilent 34970 (digital voltmeter)

**2978 CAI:** Accredited Initial Calibration of DMM

**ZH 0246:** Multiplexer Agilent model 37901 (set of 3)

**KK 0055:** System Rack

**Type 3111:** Output Module

**Type 7762:** Define new type and procedure for 3630 (software)

**Type 7763:** SLM Calibration Software

**WA 0302-A:** $\frac{1}{2}$-inch Input Adaptor 12 pF

**WA 0302-B:** $\frac{1}{2}$-inch Input Adaptor 15 pF

**WA 0302-C:** $\frac{1}{2}$-inch Input Adaptor 18 pF

**WA 0302-D:** $\frac{1}{2}$-inch Input Adaptor 20 pF

**WA 0267:** $\frac{1}{2}$-inch Input Adaptor

**Type 4226:** Multifunction Acoustic Calibrator

**4226 CAI:** Accredited Initial Calibration of Type 4226

Set of cables for system interconnection

Complete System Manual including Uncertainty Budgets

## OPTIONS

**4226 CAF:** Accredited Recalibration of Type 4226

**2978 CAF:** Accredited Recalibration of DMM

**BK 0058:** On-site installation

**BK 0060:** On-site training
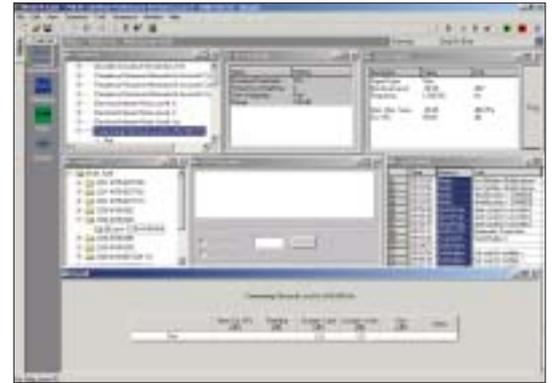
# OUTDOOR GEAR TYPE 3592

## FOR TYPES 2260, 2250 AND 2238

Noise monitoring outdoors need no longer be problematic. Outdoor Gear Type 3592 offers security and weather-protection for 2260 Investigator and 2260 Observer, converting it into an all-weather noise monitoring system. Safe and dry in its robust, heat-reflecting, bright yellow case, the analyzer will operate unattended for more than 3 days (for Type 2260). For longer periods, the battery can be changed without interrupting measurements. You can also save yourself a site visit by using the modem dial-up facility to collect your results.

The system consists of a weatherproof case, outdoor microphone kit, microphone extension cable, microphone tripod or user-supplied mast, sealed lead-acid battery, charger for battery, and optional DAT recorder (not supplied by Brüel & Kjær) and cables for interconnection. All components of the system may be ordered at once, or just those required for a specific application.

Type 2231, Type 2236, Type 2238, Type 2250 or 2260 Observer can be used instead of 2260 Investigator, but they cannot control the DAT recorder.

## USES
- All-weather measurements using 2260 Investigator (or alternative sound level meter)
- Semi-permanent noise monitoring
- Area planning
- Complaint investigation
- Plant noise measurement
- Tamper-proof workplace noise analysis
- Research

## FEATURES
- Weatherproof case and microphone system
- Fulfils IEC Type 1 and ANSI Type 2 requirements

- Sound recording for documenting noise events
- 3 days monitoring using auxiliary 12 V battery (for 2260)
- Battery change without downtime
- CIC check for reliable measurements
- One case for easy transport and setup
- Modular design – order what you need

## ORDERING INFORMATION
**Type 3592:** consists of case with inlay, pocket lamp and cable straps

**Optional Accessories**
**Type 2260:** Investigator
**BZ 7206:** Enhanced Sound Analysis 20 kHz Software
**UA 1404:** Outdoor Microphone Kit
**UA 0801:** Lightweight Tripod (space in case inlay)
**AO 0441:** 3 m Microphone Extension Cable
**AO 0442:** 10 m Microphone Extension Cable
**QB 0051:** 12 V Battery
**AQ 1698:** Cable for 12 V Supply
**AQ 1700:** Cable for DAT Remote
**AO 0543:** Cable 2260 to Jack
**ZG 0404:** Battery Charger, 100–240 V AC

**ZH 0631:** Hand switch

**DAT Recorder**
**TCD–D8:** DAT Recorder from SONY® (not supplied by Brüel & Kjær)
**DCC–E260HG:** SONY® Car Battery Cord (not supplied by Brüel & Kjær)
**Type 7820:** Evaluator

19 Ørestad
Bella Center

# ACCESSORIES FOR BUILDING ACOUSTICS

## OMNIPOWER SOUND SOURCE TYPE 4296

This powerful sound source has 12 loudspeakers in a compact dodecahedral enclosure. It radiates sound omnidirectionally as required by national and ISO standards. A lightweight, adjustable stand is included. A transport flight case is also available.

**BRIEF SPECIFICATIONS**
**Standards**
Conforms to the following: ISO 140–3, ISO 3382, DIN 52210
**Power Handling**
300 W continuous
1000 W short duration (duty cycle ¹⁄₁0)

**Operating Frequency Range**
100 – 5000 Hz (¹⁄₃-octave band centre frequencies)
**Sound Power Level**
(with Power Amplifier Type 2716, bridge configuration, duty cycle ¹⁄₃, 100 – 3150 Hz pink noise signal)
**Broadband:** 122 dB re 1 pW
**Spectral:** Min. 100 dB re 1 pW in each ¹⁄₃-octave band
**Diameter**
Speaker Enclosure: 35 cm (13.8")
**Weight**
Speaker Enclosure: 14 kg (30.8 lb.)
**Tripod:** 2.4 kg (5.3 lb.)

**Accessories Included**
**Tripod:** Adjustable to give a speaker height of between 130 and 200 cm

**Optional Accessories**
**KE 0365:** Carrying Case for Type 4296
**KE 0364:** Carrying Case for Tripod of Type 4296
**AQ 0622:** 10 m Cable from Type 2716 to Type 4295, Type 4296 or equivalent



*4296*

## OMNISOURCE SOUND SOURCE TYPE 4295

OmniSource Sound Source Type 4295 presents a new solution to omnidirectional sound source design. OmniSource is optimised for the measurement of room acoustic quantities, such as reverberation time, sound distribution and spatial decay. The patented principle of OmniSource uses a single, high-power loudspeaker, radiating through a conical coupler to a circular orifice. Despite its compact dimensions and low weight, OmniSource is still capable of emitting a sound power of 105 dB re 1 pW.

**BRIEF SPECIFICATIONS**
**Standards**
Conforms to the following: ISO 140–3, ISO 3382, DIN 52210, ISO 14257 (Draft)

**Operating Frequency Range**
80 – 6300 Hz
**Power Handling**
50 W continuous
Accepts full power from Power Amplifier Type 2716, one channel, 80 – 6300 Hz pink noise
**Sound Power Level**
(with Power Amplifier Type 2716, one channel, 80 – 6300 Hz pink noise signal)
**Broadband:** 105 dB re 1 pW
**Spectral:** Min. 85 dB re 1 pW in each ¹⁄₃-octave band
**Dimensions**
Ø 145 × 56.0 cm (Ø 5.7 × 22")
**Weight**
3.5 kg (7.7 lb.)

**Optional Accessories**
**KE 0392:** Carrying Case for Type 4295
**UA 0801:** Tripod
**AQ 0622:** 10 m cable from Type 2716 to Type 4295, Type 4296 or equivalent



*4295*

## POWER AMPLIFIER TYPE 2716

Power Amplifier Type 2716 fits in a 19" rack or in Flight Case KE 0358. It has two channels that can be used independently or jointly (using Bridging Cable AQ 0667). Signals enter electronically balanced inputs via XLR and jack connectors. Total output power is around 300 W and is relatively independent of load.

**Extensive Protection**
Power Amplifier Type 2716 has circuits that protect it against short circuits, DC, overheating, VHF and clipping (clip limiter can be switched off).

**BRIEF SPECIFICATIONS**
**Maximum Output**
8 Ω stereo 100 W
4 Ω stereo 150 W
8 Ω bridged 300 W
4 Ω bridged 320 W

**Dimensions**
**W × H × D:** 48.3 × 4.4 × 25.5 cm (19.0 × 1.7 × 10.0")
**Weight**
7.5 kg (16.5 lb.)

**Optional Accessories**
**KE 0358:** Flight Case


*2716 mounted in KE 0358*

## TAPPING MACHINE TYPE 3207

Tapping Machine Type 3207 is an impact sound generator. It can be used for impact sound measurements to national and international standards. Type 3207 uses five hammers each weighing 500 g operating at 2 Hz and dropping from a height of 40 mm, giving an operating frequency of 10 Hz. This fulfils national and international standards. The unit is powered via the supplied mains adaptor, or the optional battery kit. The unit can be remotely switched on and off with cable AQ 0633 or Wireless Remote Control Option UA 1476.

**BRIEF SPECIFICATIONS**
**Standards:** ISO 140, ISO 717, DIN 52210, BS 5821, ASTM E 492
**Dimensions:**
**W×H× D:** 471 × 227 × 14.1 cm (18.5 × 8.9 × 5.6") (feet retracted)
**Weight:**
10 kg (22 lb.) with Mains Adaptor

**Accessories Included**
**ZG 0400:** Mains Adaptor (mains cable country dependent)
2 Gauges for drop height adjustment
Oil canister for maintenance

**Optional Accessories**
**AQ 0633:** 10 m Remote Cable for Type 2260 to Type 3207
**UA 1476:** Wireless Remote Control for Type 3207 (includes AO 1439 Cable for Type 2260)
**UA 1477:** Battery Kit for Type 3207
**QB 0055:** Replacement Battery for Type 3207


*3207*


*3923*

## ROTATING MICROPHONE BOOM TYPE 3923

The rotating boom performs spatial averaging by moving the microphone in a circular path with a diameter of up to 2 m. The plane of rotation is adjustable in steps of 10 degrees. For information on how to connect to 2260 Investigator, please contact Brüel & Kjær.

## SOUND SOURCE TYPE 4224

This powerful sound source has built-in power amplifier and noise generator. Its directional response and battery operation make it suited for special applications such as façade sound insulation. To connect to Type 2260 Investigator, use Cable AO 0524.


*4224*

# OTHER PRODUCTS

## 3-CHANNEL HUMAN VIBRATION FRONT-END TYPE 1700

**Human Vibration Measurements using Type 1700**

Type 1700 is a 3-channel Human Vibration Front-end that allows triaxial accelerometer measurements to be made with ⅓-octave sound measuring instruments, for example, 2260 Investigator, 2260 Observer, Portable PULSE Type 3560 C and 2238 Mediator.

### USES
- Triaxial accelerometer measurements
- Occupational health surveys
- Product certification
- Hand-arm vibration risk assessment
- Whole-body vibration risk assessment

### FEATURES
- Whole-body filters (2 × $W_d$, $W_k$) in X, Y, and Z channels respectively
- Hand-arm filter (Wh) available in each channel
- Battery powered

### BRIEF SPECIFICATIONS
**Standards:** ISO 5349:1986, ISO 5349 – 1:2001, ISO 5349 – 2:2001, ISO 2631 – 1:1997, EC Physical Agents (Vibration) Directive

**Measurement Modes:** HAV-lin (X or Y or Z), HAV-wtd (X or Y or Z), WBV-lin, WBV-wtd.

**Measured Parameters:** 2260 with BZ 7210 ver. 2.0, BZ 7219 ver. 1.0 or BZ 7206 ver. 2.1:
**WBV:** $a_{wx}$, $a_{wy}$, $a_{wz}$, $a_v$;
**HAV:** $a_{hw}$

Type 2238 with BZ 7123 ver. 1.1.0:
**WBV:** $Leq_x$, $Leq_y$, $Leq_z$,
**HAV\*** : $Leq_{hw}$

**Inputs:** DeltaTron® compatible, max. 0.78 VRMS (1.1 V peak)
**Overloads:** Overload detector on all three input channels. For HAV, overload condition is latched for 1 s, for WBV 8 s.

**\*NOTE:** This does not conform to ISO 5349, but can be used for explorative measurements

*1700*

### ORDERING INFORMATION
**Type 1700 A:** 3-channel Human Vibration Front-end for use with 2260 Investigator, 2260 Observer or PULSE Type 3560 C
**Type 1700 B:** 3-channel Human Vibration Front-end for use with 2238 Mediator

**Also required for use with 2260:**
Software BZ 7219 or BZ 7210 version 2.0 or BZ 7206 version 2.1
AO 0440 BNC – Triaxial LEMO Cable (1.5 m)

**Also required for use with 2238:**
Software BZ 7123 and a Filter Set
**JP 0145:** Microdot to BNC Connector
**AO 1382:** Microdot Cable (1.2 m)
**WA 0302A:** ½" Microphone Adaptor, 12 pF

**Accessories**
**Type 4506:** Miniature Triaxial Accelerometer
**EE 0388:** Seat Pad ISOTRON® Triaxial Accelerometer
**AO 0526:** 4-pin Microtech to 3 × BNC Cable (5 m)

# SEAT PAD ISOTRON TRIAXIAL ACCELEROMETER EE 0388

**Whole-body Vibration Measurements using EE 0388**

EE 0388 is specially designed for the measurement of whole-body vibration. It consists of a triaxial accelerometer housed in a semi-rigid, nitrile rubber disc and complies with ISO 10326–1. It can be placed under a seated person, on a vibrating surface with a suitable weight on top, or strapped onto the body. It detects vibration in directions along the body, back-to-front and side-to-side.

**USES**
- Occupational health surveys
- Whole-body vibration risk assessment

**FEATURES**
- Nylon straps allowing the user to directly attach the accelerometer to the subject
- Low impedance output
- 100 mV/g sensitivity

**BRIEF SPECIFICATIONS**

**Range:** ±10 g

**Voltage Sensitivity:** Typically 100 mV/g

**Amplitude Response:** 0.5 Hz to 3000 Hz ±1 dB

**Resonance Frequency:** >15 kHz

**Output Impedance:** 100 Ω

**Full-scale Output Voltage:** ±5 V DC DeltaTron® compatible

**ORDERING INFORMATION**

**EE 0388:** Seat Pad ISOTRON® Triaxial Accelerometer

*EE 0388*

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# BUILDING VIBRATION FILTER WB 1438

**Building Vibration Measurements using WB 1438**

WB 1438 is a single-channel front-end that allows building vibrations to be measured with Type 2260. Typically, building vibrations are measured in the frequency range from 0.8 Hz to 100 Hz. This frequency range is much lower than the normal range that can be measured by Type 2260. To overcome this, WB 1438 is designed to convert the vibration signal to a frequency range that lies within the normal sound range and that can be measured and displayed by Type 2260.

**USES**
- Whole-body vibration risk assessment
- Building vibration measurements

**FEATURES**
- Internal Whole-body combined filter
- Powered directly from Type 2260
- Charge amplifier input, connects directly to a charge type accelerometer

**BRIEF SPECIFICATIONS**

**Input Socket:** Microdot (10–32 UNF)

**Weighting Filter:** Whole-body Vibration Combined Filter, according to ISO 2631–2 (First edition, 1989-02-15) and described in ISO 8041 (First edition, 1990-07-15)

**Display:** The RMS acceleration level is shown as a single $\frac{1}{3}$-octave spectrum column in the 8 kHz band

**Sensitivity:** 1 mV/pC (0 dB range)

**Gain:** 0, 10, 20 or 30 dB ±0.3 dB

**Dynamic Range:** Using Type 2260 in the 43.7 – 123.7 dB range > 60 dB. By using the amplification of WB 1438, the dynamic range is increased to > 90 dB

**Dimensions:**

**W × H × D:** 40 ×95 ×120 mm (1.6 × 3.7 × 4.7″)

**ORDERING INFORMATION**

**WB 1438:** Building Vibration Filter. Included with WB 1438

**AO 0441:** 10-pin LEMO cable, 3 m

**Required Extras**

Type 2260 with BZ 7219, BZ 7210, or BZ 7206 software

**Optional Accessories**

**Type 4381:** Piezoelectric Delta-Shear® Accelerometer

**AO 0122:** 10 – 32 UNF Cable

*WB 1438*

# OTHER PRODUCTS

## EXHAUST NOISE INSPECTOR TYPE 3638

### Type 3638

Exhaust Noise Inspector is a complete, all-in-one system, designed for automatic measurement of exterior exhaust sound levels from road vehicles under stationary conditions, simultaneously with RPM detection. The noise level and engine RPM are measured using the same microphone. A large display and indicator lights, showing all the necessary information, allow extremely simple and quick measurements, in accordance with standards. Local authorities and police inspectors will appreciate the ergonomics of the system, allowing measurements to be performed by a single operator.

### USES

- Measurement of exterior exhaust sound level from motorbikes, cars, trucks and mopeds under stationary conditions according to 70/157/EEC and ISO 5130 (engine sweep test)

### FEATURES

- Intuitive setup menu using four keys
- Non-contact measurements of engine RPM – computed from the exhaust noise signal
- Simultaneous measurement and display of sound level and engine RPM
- Non-invasive test – no need to open the engine compartment
- Acoustic detection of engine RPM for gasoline and diesel engines
- Red and green lights indicator for throttle control setup
- All in one suitcase for easy transport by motorcycle police
- Automatic triggering of the noise level measurement when the correct RPM is reached
- Battery operated
- Integral printer for on the spot measurement reports
- Optional Electromagnetic Tachometer Type 2979, with "Plug and Play" interface



*3638*

### BRIEF SPECIFICATIONS

**Types of Engine**
2- or 4-stroke
**Number of Cylinders**
1, 2, 3, 4, 5, 6, 8, 10, 12
**Accuracy of the Acoustic Detection RPM Meter**
Error < 2%
**Dimensions**
**L × W × H:**
426.7 × 337.8 × 111.7 mm
(16.8 × 13.3 × 44")
**Weight:**
6 kg ( 13 lb. 3 oz)

### ORDERING INFORMATION

**Type 3638 A:** Complete system including Type 2238 A and Type 4231
**Type 3638 B:** System without Sound Level Meter and calibrator; to be used with Types 2238 and 2239
**Type 2979:** Optional Electromagnetic Tachometer

# SOUNDEAR 2000 / POCKETEAR

### VU 2509

SoundEar® is an attractively designed sound level indicator that displays a simple warning when noise levels reach uncomfortable or harmful levels. It can be adjusted to indicate the chosen threshold level between 40 and 115 dB.

The green rim of the ear is always displayed. If you set the warning level at, for example, 85 dB, the yellow ring lights up at 5 dB below the warning level, that is, 80 dB. As soon as the noise reaches 85 dB the red eardrum lights up together with the word "WARNING". SoundEar® is available in six languages and was awarded the Danish Design Prize in 2000.

**SoundEar® can be used to:**
• Warn you about uncomfortably high noise levels, for example, 60 dB or over in an office environment
• Teach people, including children, to keep noise levels down for the benefit of all, for example, in educational institutions or in hospitals
• Warn you about harmful noise levels in excess of 85 dB in a working environment or 105 dB in a music rehearsal room

### VU 2511

PocketEar® is a smartly designed noise indicator containing a pair of good quality earplugs. In other words, it's a quick and easy sound check you can carry around in your pocket. If the sound level exceeds the pre-set level (you can choose between 65, 85 or 105 dB) a red light will appear.
• The 65 dB level should be used for situations where concentration and effortless conversation are required, for example, schools and offices
• The 85 dB level is the noise-at-work limit for 8-hour exposure. If you are exposed to more than 85 dB, the risk of hearing damage is significantly increased and it would be a good idea to use hearing protection
• The 105 dB level is useful at concerts, music rehearsals, etc.

PocketEar® can be attached to your key ring. It comes in a small display box that also includes two high-quality earplugs from Alpine MusicSafe, a multilingual instruction leaflet, a Type CR 2430/3V battery, and a black keystrap.
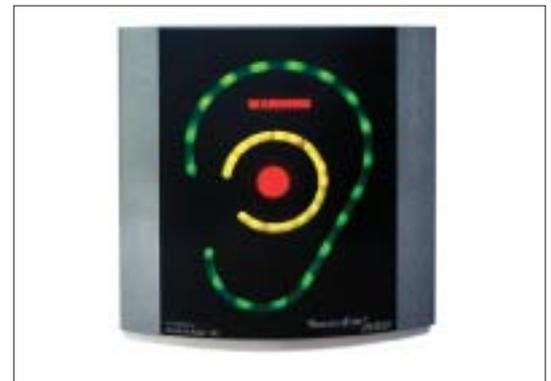




**BRIEF SPECIFICATIONS**

**SoundEar 2000 VU 2509**
**Threshold Tolerance:** ±1 dB
**Power Supply**
Connect to normal electrical socket using the supplied transformer
**Power Consumption**
Approximately 3 W
**Dimensions**
28 × 28 × 6 cm
(11.0 × 11.0 × 2.3")
**Weight**
Approximately 1.5 kg (3 lb. 5 oz)

**PocketEar VU 2511**
**Accuracy:** ±3 dB
**Battery**
Type CR 2430/3 V
**Lifetime**
Approximately 2500 5-second measurements
**Dimensions**
70 × 47 × 23 mm (2.8 × 1.9 × 0.9")
**Weight**
25 g (0.9 oz) with battery

# ACCESSORIES

Brüel & Kjær's hand-held measuring instruments are able to perform most measurements without extra hardware.

However, you sometimes need some extra hardware to make measurements within certain applications. Only a selection of the most common accessories is shown on these pages. If you cannot find what you need to make your measurement, please contact us.

## PRINTER

| Type Number | Description | |
|---|---|---|
| 2322 | Portable Printer with Serial Interface | *030296* |

## CALIBRATORS

| Type Number | Description | |
|---|---|---|
| 4231 | Hand-held Sound Level Calibrator | |
| 4226 | Multifunction Acoustic Calibrator | |
| 4228 | Pistonphone Calibrator | |
| 4297 | Hand-held Sound Intensity Calibrator | |
| 3541 | Sound Intensity Calibrator | |
| 4294 | Hand-held Vibration Calibration | *030297* |

## TRACEABLE CALIBRATIONS

| Order Number | Description | |
|---|---|---|
| 2238 CAI/CAF | Accredited Initial / Accredited Calibration of Sound Level Meter Type 2238 | |
| ZT 0328 CAI/CAF | Accredited Initial / Accredited Calibration of Type 2238 Filter Set | |
| 2260 CAI/CAF | Accredited Initial / Accredited Calibration of Type 2260 Sound Analyzer | |
| 2260 ECVI | Initial Pressure-Residual Intensity Index Verification of Types 2260 E and 3595 | |
| 2260 ECVF | Pressure-Residual Intensity Index Verification of Types 2260 E and 3595 | |
| 4231 CAI/CAF | Accredited Initial / Accredited Calibration of Calibrator Type 4231 | |
| 4228 CAI/CAF | Accredited Initial / Accredited Calibration of Calibrator Type 4228 | |
| 4297 CAI/CAF | Accredited Initial / Accredited Calibration of Calibrator Type 4297 | |
| 4294 CAICAF | Accredited Initial / Accredited Calibration of Calibrator Type 4294 | *030298* |

## MAINS POWER SUPPLIES

| Order Number | Description | For Types 2260, 2239, 2238 and 2237 |
|---|---|---|
| ZG 0386 | Mains Power Supply (EU) | |
| ZG 0387 | Mains Power Supply (UK) | |
| ZG 0388 | Mains Power Supply (US) | |
| | | **For Type 2250** |
| ZG 0486 | Mains Power Supply | *030299* |

## EXTERNAL MEMORY CARD FOR TYPE 2260

| Order Number | Description | |
|---|---|---|
| UL 1008 | 32 MB ATA Flash Memory Card | *030301* |

# CABLES

| Order Number | Description/Use For Type 2260 | 2260 | Length | Connectors |
|---|---|---|---|---|
| AO 0441 | Microphone Extension Cable | | 3 m | 10-pin LEMO male to 10-pin LEMO female |
| AO 0442 | Microphone Extension Cable | | 10 m | 10-pin LEMO male to 10-pin LEMO female |
| EL 4018-V | Microphone Extension Cable (from preamplifier to Type 2250/2260) | | Custom | 10-pin LEMO male to 10-pin LEMO female |
| AO 0440 | Signal Cable, (AC input/output) | | 1.5 m | Triaxial LEMO to BNC |
| AO 0440-V | Signal Cable, (AC input/output) | | Custom | Triaxial LEMO to BNC |
| AO 0586 | Sound Cable, (for example, from SLM to audio input on a personal or laptop PC, line in) | | 3 m | Triaxial LEMO to 3.5 mm stereo Jack male |
| AO 0522 | Headphones Signal Adaptor, from Type 2260 to Headphones | | 0.13 m | Triaxial LEMO to 3.5 mm stereo Jack female |
| AO 0543 | Output Cable, from Type 2260 to Sony® TCD-D7/8/100 DAT-recorders | | 1.5 m | Triaxial LEMO to 3.5 mm stereo Jack male |
| AQ 1700 | Remote Control Cable, from Type 2260 to SONY® TCD - D7/D8 | | 1.5 m | Triaxial LEMO to 7-pin SONY® |
| AQ 1698 | From QB0051 12V Battery to Type 2260 and DAT Power in | | 2 m | Spade/Cigar to 2.1/5.5 mm DC |
| For Building Acoustics with Type 2260 | | 2260 BA | | |
| AO 0523 | Signal Cable, (for example, from Type 2260 to Type 2716 Amplifier) | | 10 m | Triaxial LEMO to XLR3 male |
| WL 1253-X | Signal Cable, from Type 2260 to Type 2716 Amplifier | | Custom | Triaxial LEMO to XLR3 male |
| AO 0524 | Signal Cable, (for example, from Type 2260 to Type 4224 Sound Source) | | 10 m | Triaxial LEMO to BNC |
| AO 0524-V | Signal Cable, (for example, from Type 2260 to Type 4224 Sound Source) | | Custom | Triaxial LEMO to BNC |
| AQ 0621 | From Type 2716 output to Type 4296 Bridging Cable | | 0.3 m | 2 × Speakon to 1 × Speakon |
| AQ 0622 | From Type 2716 to Type 4296 or Type 4295 | | 10 m | Speakon to Speakon |
| AR 0199 | Flat Cable, (use under doors and windows) | | 1 m | 10-pin LEMO male to 10-pin LEMO female |
| JP 1041 | From Type 2260 to two 10-pin LEMO female (for 2-ch. measurement) | | 0.2 m | 10-pin LEMO male to 2 × 10-pin LEMO female |
| For Type 2250 | | 2250 | | |
| AO 0441 | Microphone Extension Cable | | 3 m | 10-pin LEMO male to 10-pin LEMO female |
| AO 0442 | Microphone Extension Cable | | 10 m | 10-pin LEMO male to 10-pin LEMO female |
| EL 4018-V | Microphone Extension Cable (from preamplifier to Type 2250/2260) | | Custom | 10-pin LEMO male to 10-pin LEMO female |
| AO 0440 | Signal Cable, (AC input/output) | | 1.5 m | Triaxial LEMO to BNC |
| AO 0440-V | Signal Cable, (AC input/output) | | Custom | Triaxial LEMO to BNC |
| AO 0586 | Sound Cable, (for example, from SLM to audio input on a Personal or laptop PC, Line In) | | 3 m | Triaxial LEMO to 3.5 mm stereo Jack male |
| AO 1476 | USB Interface cable | | 3 m | Standard A to mini B |
| For Types 2237, 2238, 2239 Sound Level Meter | | 2237, 2238 & 2239 | | |
| AO 0561 | Microphone Extension Cable | | 3 m | 5-pin DIN female to 5-pin DIN male |
| AO 0560 | Microphone Extension Cable | | 10 m | 5-pin DIN female to 5-pin DIN male |
| AO 0561-V | Microphone Extension Cable | | Custom | 5-pin DIN female to 5-pin DIN male |
| AO 0585 | Audio Signal Cable, from Type 2238 to Audio Input on a PC (Line In), or to DAT | | 3 m | Coaxial LEMO to 3.5mm stereo Jack male |
| AO 0403 | Input/Output Cable, from SLM to BNC | | 1.5 m | Coaxial LEMO to BNC |
| EL 4031-X | Input/Output Cable, from SLM to BNC | | Custom | Coaxial LEMO to BNC |
| For Types 2237, 2238, 2239 and 2260 | | 2237, 2238, 2239 & 2260 | | |
| AO 1442 | Serial Interface Cable, from Types 2237/2238/2239/2260 to Serial Port on PC | | 3 m | 9-pin Sub-D to 9-pin Sub-D |
| AO 0567 | From Types 2237/2238/2239/2260 to Field Modem | | 1.8 m | 9-pin Sub-D to 25-pin Sub-D |
| AO 1440 | From Types 2237/2238/2239/2260 to GSM Modem | | 2 m | 9-pin Sub-D to 9-pin Sub-D |

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# ACCESSORIES

## TRIPODS, WINDSCREENS, MICROPHONE HOLDERS

| Order/Type Number | Description |
|---|---|
| UA 0587 | Heavy Duty Tripod for Type 3923 Rotating Boom, maximum height 1.46 m |
| UA 0801 | Lightweight Tripod, maximum height 1.25 m, for example for Type 2260 |
| UA 1251 | Lightweight Tripod, maximum height 1.22 m, for example, for Type 2238 |
| UA 0237 | Large Round Windscreen (ø 90 mm) |
| UA 1650 | 90 mm Windscreen with Autodetect (for 2250) |
| UA 0459 | Small Round Windscreen (ø 65 mm) |
| UA 1236 | Protective Cover for Microphone |
| UA 0588 | Microphone Holder for Tripod, for use with Type 2260 |
| UA 1317 | Microphone Holder (for use with ½-inch preamplifiers) |
| UA 1254 | Microphone Holder (for AO 0560) |
| UA 1451 | Telescopic Boom for Type 2260 Intensity Kit, 4.2 m long            *030274* |

## CARRYING CASES

| OrderTyoe Number | Description |
|---|---|
| KE 0371 | Carrying Case for Type 2260 and Accessories |
| KE 0379 | Carrying Case for Type 2260 and Type 3595 Probe Kit |
| KE 0325 | Carrying Case with Insert for Sound Level Meter Types 2237/2238/2239, Sound Level Calibrator Type 4231 and Tripod UA 1251 and Printer Type 2322 |
| KE 0358 | Flight Case for Types 2716, 2260, Cable, etc. |
| KE 0364 | Shoulder Bag for Type 4296 Stand |
| KE 0365 | Flight Case for Type 4296 |
| KE 0392 | Case for Type 4295 |
| 3592 | Outdoor Gear (case only) for Sound Level Meters            *030275* |

## ACCESSORIES FOR OUTDOOR NOISE MONITORING

| Order/Type Number | Description |
|---|---|
| UA 1404 | Outdoor Microphone Kit |
| DB 3611 | Extension for using Type 2231 with UA 1404 |
| 3592 | Outdoor Gear (case only) for Sound Level Meters |
| QB 0051 | 12 V Battery |
| AQ 1698 | Cable for 12 V Battery |
| ZG 0404 | Battery Charger, 100 – 240 V AC, for QB 0051 |
| AO 0442 | Microphone Extension Cable, 10-pin LEMO, 10 m |
| | DAT Recorder (not supplied by Brüel & Kjær) |
| AO 0543 | From Type 2260 to DAT Recorder |
| AQ 1700 | From Type 2260 to SONY® TCD – D7/D8 (Remote Control) |
| UA 0801 | Lightweight Tripod, maximum height 1.25 m, for monitoring UA 1404 Outdoor Microphone Kit |
| 4231 | Sound Level Calibrator |
| AO 1442 | Serial Interface Cable from Types 2260/2239/2238/2237 to Serial Port on PC |
| ZH 0631 | Event Hand Switch |
| ZH 0457 | Modem Hand Switch |
| AO 0567 | From Types 2260/2239/2238/2237 to Field Modem |
| AO 1440 | Interface Cable from Types 2260/2239/2238/2237 to GSM Modem |
| | Field Modem or GSM Modem suitable for use in your country (not supplied by Brüel & Kjær)            *030279* |

# ACCESSORIES FOR VIBRATION MEASUREMENTS – 2260

| Order/Type Number | Description |
|---|---|
| JJ 2617 | Adaptor, ½-inch Preamplifier to Microplug |
| AO 0038 | 10 – 32 UNF/10 – 32 UNF Cable, 1.2 m, −75˚ to +250˚C, Super Low Noise |
| 4384 S | UniGain®, DeltaShear® accelerometer, 1 pC/ms$^{-2}$ |
| 2647 A | Charge to DeltaTron® Converter (1 mV/pC) |
| 2647 B | Charge to DeltaTron® Converter (10 mV/pC) |
| ZG 0423 | DeltaTron® Adaptor for Type 2260 |
| EE 0103 | General Purpose ISOTRON® Accelerometer |
| JP 0145 | 10 – 32 UNF to BNC Plug Adaptor |
| AO 0463 | 10 – 32 UNF/10 – 32 UNF, 1.2 m, −20˚ to +70˚C |
| UA 1219 | Mounting Kit for Accelerometers |
| 4294 | Hand-held Calibration Exciter |

*030276*

# ACCESSORIES FOR HUMAN VIBRATION MEASUREMENTS

| Order/Type Number | Description |
|---|---|
| 1700 A | 3-channel Human Vibration Front-end for use with 2260 Investigator, 2260 Observer or PULSE Type 3560 C |
| 1700 B | 3-channel Human Vibration Front-end for use with 2238 Mediator |
| 4506 | Miniature Triaxial Accelerometer |
| 4392 | Monoaxial Hand-arm Transducer Set (includes Type 4374 L Monoaxial Accelerometer and Handle/Hand Adaptors) |
| WA 0302 A | ½-inch Microphone Adaptor, 12 pF (with Type 2238) |
| EE 0388 | Seat Pad Triaxial Accelerometer (including 3 m Cable) |
| AO 0526 | 4-pin Microtech to 3 × BNC Cable (5 m) |
| 4322 | Triaxial Seat Accelerometer (including DIN-microdot Cable WL 0547) |
| 2647 B | Charge to DeltaTron® Converter |
| AO 1382 | Microdot Cable (1.2 m) |
| JP 0145 | 10 – 32 UNF to BNC Plug Adaptor |

*030277*

# ACCESSORIES FOR BUILDING ACOUSTICS MEASUREMENTS

| Order/Type Number | Description |
|---|---|
| 4295 | OmniSource Sound Source |
| 4296 | OmniPower Sound Source with Tripod |
| 2716 | Power Amplifier (300 W) for 4296 OmniPower Sound Source |
| 4224 | Sound Source (including Amplifier) |
| 7830 | Qualifier PC software for professional presentation of sound insulation results |
| 3207 | Standard Tapping Machine |
| UA 1476 | Wireless Remote Control of Tapping Machine Type 3207 |
| UA 1477 | Battery Option for Tapping Machine Type 3207 |
| 3923 | Rotating Microphone Boom |
| WL 1330 | Cable from Type 2260 Preamplifier to Type 3923, 1.5 m, 10-pin LEMO female to 7-pin B&K male |
| WL 1331 | Cable from Type 3923 to Type 2260, 10 m, 10-pin LEMO male to 7-pin B&K female |
| UA 1426 | Kit for Wireless Transmission (excluding Wireless Transmission System) |
| | Wireless Transmission System (not supplied by Brüel & Kjær) |
| AO 0523 | Signal Cable, Triaxial LEMO to XLR3M, 10 m (for example, from Type 2260 to Type 2716) |
| AO 0524 | Signal Cable, Triaxial LEMO to BNC, 10 m (for example, from Type 2260 to Type 4224 Sound Source) |
| AQ 0667 | Bridging Cable for Type 2716 |
| AQ 0622 | Cable from Type 2716 to Type 4296, 10 m, Speakon to Speakon |

*030278*

# MICROPHONES FOR HAND-HELD EQUIPMENT

## MICROPHONE SELECTION

Basically there are three different kinds of sound fields for which a microphone can be calibrated/optimised (free-field, diffuse-field and pressure-field). Free-field microphones are the choice for most sound level meters. Optimisation for diffuse (random) fields can be done either by mounting a mechanical random-incidence corrector on the microphone, or by simply selecting a suitable random-incidence microphone. Some sound level meters have a built-in filter that compensates for the difference between the free-field and diffuse-field response, thus also allowing the use of a free-field microphone for diffuse-field measurements.

## MICROPHONES FOR SOUND LEVEL METER

| Sound Level Meter Type | Original Microphone Type | Replacement Type (if needed) |
|---|---|---|
| 2221 | 4176 | 4176 |
| 2222 | 4176 | 4176 |
| 2225 | 4129 | 4176 |
| 2226 | 4129 | 4176 |
| 2230 | 4155 | 4940 |
| 2231 | 4155 | 4940 |
| 2234 | 4155 | 4940 |
| 2235 | 4176 | 4176 |
| 2236 | 4188 | 4188 |
| 2237 | 4137/4176 | 4137/4176 |
| 2238 | 4188 | 4188 |
| 2239A | 4188 | 4188 |
| 2240 | 4188 | 4188 |
| 2250 | 4189 | 4189 |
| 2260 | 4189 | 4189 |
| Other Replacements | | |
| | 4155 | 4189 |
| | 4165 | 4190 |
| | 4133/4149 | 4191 |
| | 4134 | 4192 |
| | 4147 | 4193 |

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# MICROPHONES

| Type Number | | 4137 | 4176 | 4188 | 4189 | 4190 | 4191 |
|---|---|---|---|---|---|---|---|
| Diameter | Inch | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 |
| Optimised | | Free-field | Free-field | Free-field | Free-field | Free-field | Free-field |
| Nominal Open-circuit Sensitivity | mV/Pa | 31.6 | 50 | 31.6 | 50 | 50 | 12.5 |
| Polarization Voltage* | V | 0 | 0 | 0 | 0 | 200 | 200 |
| Optimised Frequency Response ±2 dB | Hz | 8 to 12500 | 7 to 12500 | 8 to 12500 | 6.3 to 20000 | 3.15 to 20000 | 3.15 to 40000 |
| Dynamic Range with Preamplifier Type | dB(A) to dB | 15.8 to146 (2669) | 14 to 142 (2669) | 15.8 to146 (2669) | 15.2 to 146 (2669) | 15 to 147 (2669) | 21.4 to 161 (2669) |
| Inherent Noise | dB (A) | 14.2 | 13.5 | 14.2 | 14.6 | 14.5 | 20 |
| Capacitance | pF | 12 | 12.5 | 12 | 13 | 16 | 18 |
| Venting | | Rear | Rear | Rear | Rear | Rear | Side |
| Lower Limiting Frequency(−3dB) | Hz | 1 to 5 | 5 to 5 | 1to 5 | 2 to 4 | 1 to 2 | 1 to 2 |
| Operating Temperature Range | °C | −30 to 125 | −30 to 100 | −30 to 125 | −30 to 150 | −30 to 150 | −30 to 300 |
| Temperature Coefficient | dB/°C | +0.005 | −0.004 | +0.005 | −0.001 | −0.007 | −0.002 |
| Pressure Coefficient | dB/kPa | −0.021 | −0.02 | −0.021 | −0.01 | −0.01 | −0.007 |

\* 0 V    Prepolarized

*030270*

| Type Number | | 4192 | 4193 | 4940 |
|---|---|---|---|---|
| Diameter | Inch | 1/2 | 1/2 | 1/2 |
| Optimised | | Pressure-field | Low-frequency | Free-field |
| Nominal Open-circuit Sensitivity | mV/Pa | 12.5 | 12.5 | 50 |
| Polarization Voltage* | V | 200 | 200 | 0 |
| Optimised Frequency Response ±2 dB | Hz | 3.15 to 20000 | 0.07** to 20000 | 6.3 to20000 |
| Dynamic Range with Preamplifier Type | dB(A) to dB | 20.7 to 161 (2669) | 20.7 to 161 (2669) | 15.2 to 146 (2669) |
| Inherent Noise | dB (A) | 19 | 19 | 14.6 |
| Capacitance | pF | 18 | 18 | 14 |
| Venting | | Side | Side | Rear |
| Lower Limiting Frequency(−3dB) | Hz | 1 to 2 | 0.01 to 0.05 | 2 to 4 |
| Operating Temperature Range | °C | −30 to 125 | −30 to 150 | −30 to 150 |
| Temperature Coefficient | dB/°C | −0.002 | −0.002 | −0.001 |
| Pressure Coefficient | dB/kPa | −0.007 | −0.005 | −0.01 |

\* 0 V Prepolarized

*030271*

# BRÜEL & KJÆR SERVICE

**Maximise the Return on your Investment**

When you buy software, instruments or transducers from Brüel & Kjær, you buy products that meet the highest standards in quality and performance. In addition, Brüel & Kjær offers a range of services to help you maintain your equipment and the integrity of your measurements through the entire lifetime of the products. A Brüel & Kjær service agreement is the best way to ensure that you get the full benefit of your investment for many years to come.

## Installation

It is very important to Brüel & Kjær that our customers get up and running successfully with their new equipment. To achieve this we supply all products with detailed product documentation and we strive to make our products easy and intuitive to use. However, in some cases, especially with our more comprehensive systems, it may be beneficial to get the assistance of Brüel & Kjær project engineers and application specialists. Therefore, we offer on-site installation and site acceptance test if required.

## Education

We have made 60 years of knowledge and experience available to our customers through our knowledge centre, Brüel & Kjær University, from which we can build and spread sound and vibration related knowledge worldwide by means of seminars, advanced courses and product training covering a broad range of applications, theories and products. Through this knowledge-sharing program, we believe that we can truly help our customers and their employees maximise the benefits gained from using Brüel & Kjær equipment.

## Support

In addition, Brüel & Kjær offers a variety of technical literature ranging from Product Data to reference books that help you to understand the applications, the products and the theory behind sound and vibration measurements. Most of this literature is available not only as printed matter but also in electronic form and can be found on our website www.bksv.com. Customers with a Help Line agreement also get access to technical support through Brüel & Kjær's worldwide service network, where a team of technical specialists is ready to answer, by telephone, mail or fax, any questions that you have about our products.

**Global Service**
Brüel & Kjær can provide these services wherever our customers are found. We employ approximately 100 people in 21 service centres throughout America, Europe and Asia. We're never further away than your local sales representative or service centre, so help is always at hand in your local language.



## Calibration

Measuring with properly calibrated equipment is the only way of knowing that your readings or results are correct. Regular calibration of your measuring equipment is not just an investment in quality. It can also be a source of real cost savings by minimising the cost of errors due to faulty or inaccurate measurements.

We offer a comprehensive range of calibration services, and all Brüel & Kjær calibrations are documented traceable as well as being performed in accordance with the relevant national and international standards. Our calibration laboratories are accredited in many regions, fulfilling the requirements of ISO and other standards. We are also able to offer primary calibrations for transducers through the Danish Primary Laboratory of Acoustics (DPLA), operated by Brüel & Kjær in association with the Technical University of Denmark.

## Maintenance

Reliable measurements can only be made with properly calibrated instruments in good working order. We know our products better than anyone else, and if an instrument requires repair or adjustment, our skilled engineers are on hand to do the necessary work. By signing an extended warranty agreement, you can eliminate the risk of unexpected repair costs and extend the factory warranty period up to five years after purchase.

## Upgrade

As manufacturers of PC-based measurement systems, we know that software is of prime importance. As a result, we are continuously improving our software with new features, enhancements and updates and including these improvements in new releases. Subscribing to a Software Maintenance and Upgrade Agreement gives you access to the latest news and software releases from the Brüel & Kjær family of software applications, with new features, improved functionality, bug fixes and error corrections. This will help you keep your equipment at the highest level of performance for many years to come.

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# TYPE NUMBER INDEX

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# NOTES

# LITERATURE OVERVIEW

## COMPANY PROFILE AND MARKET SEGMENT BROCHURES

Company Profile – BG 1527

Automotive – BG 1530

Aerospace & Defence – BG 1533

Telecom & Audio – BG 1534

### CD-ROM

Master Catalogue – BJ 0234

Transducer & Conditioning Selection Guide
– BJ 0239

## PRODUCT CATALOGUES
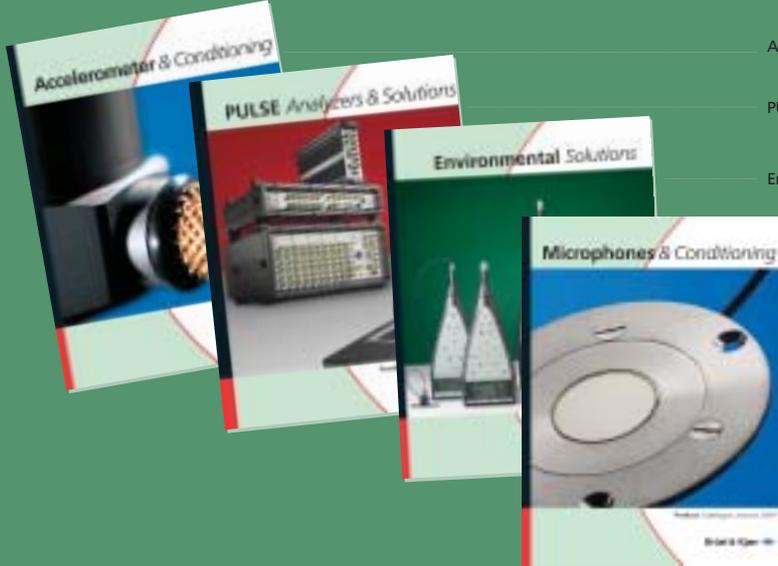
Accelerometers & Conditioning – BF 0212

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