PRODUCT DATA

PULSE™ Sound Power Type 7799

PULSE Sound Power Type 7799 is software for determining noise emission quantities of machinery, equipment and their sub-assemblies.

It includes the determination of sound power levels as described in international standards, as well as the measurement of emission sound pressure levels at specified positions in the vicinity of a machine.

Moreover, to evaluate the annoyance of tonal components in noise emissions, the calculation of two complementary parameters, Tone-to-Noise Ratio and Prominence Ratio, is seamlessly integrated in the solution.

Uses and Features

Uses

- To determine whether a product complies with noise specifications (legislation, voluntary awards)
- To compare the noise emissions of machinery and equipment of the same and different types (for example, when benchmarking, or in engineering work, when developing quieter products)
- To analyse product sound in terms of identification and evaluation of prominent discrete tones and impulsive noise

Features

- Comprehensive solution for determining noise emission quantities such as sound power levels and emission sound pressure levels
- Measurement procedures and calculations based on basic International Standards ISO 3741, ISO 3743 (comparison method), ISO 3744, ISO 3745, ISO 3746, ISO 9614-2 and ISO 11201, and noise test codes for information technology ISO 7779 and ECMA 74
- Measurement procedures and calculations based on International Standard IEC 60704-2-4:2001 Household and similar electrical appliances. Test code for the determination of airborne acoustical noise. Particular requirements for washing machines and spin extractors (identical to European Standard EN 60704-2-4:2001)
- Interactive measurement setup and information windows guide you through the measurement process
- Measurement data and results can be conveniently saved to familiar Microsoft® Excel® workbooks for customised reporting and further post-processing
- PULSE platform ensures exceptional measurement accuracy
- Scalable solution

Introduction

Legislation

Noise emission quantities of machinery and equipment are increasingly becoming the subject of national and international regulations for a safer and healthier working place and for the protection of the environment. For example, the European Union laid down Directives 98/37/EEC (Machinery), 2000/14/EC (Outdoor Equipment) and 2009/125/EC (Ecodesign requirements for household washing machines), which require manufacturers of many types of machinery and equipment to declare noise emissions (determined according to standardised methods) as a prerequisite for placing them on the EU market.

Such noise declarations are meant to help interested buyers (for example, employers who are required to reduce noise risks at the workplace to a minimum) to compare machinery on the market on the basis of noise emissions and thus to choose comparatively quiet machines. At the same time, any company that manufactures certified products fulfilling the EU noise emission requirements has the opportunity to enter a bigger market with fewer import barriers.

Voluntary Awards

The process of globalisation and economic liberalisation has led to the creation of new global markets for companies who are striving to be competitive. At the same time, awareness among consumers regarding noise issues has substantially increased. It is no surprise then that voluntary awards for companies who meet acoustical criteria (for example, the German eco-label Blue Angel) are becoming an element of global strategy for companies in order to differentiate their products, especially in the consumer products market (appliances and information technology).

Voluntary awards are intended to provide effective means of making known the noise emissions determined according to standardised methods. They serve as a sign to consumers and business partners that the product meets certain quality standards and they also make it possible for purchasers to make buying decisions according to the criterion of low-noise emission. Voluntary awards represent an innovative approach to addressing the concerns of consumers and at the same time help companies to be more competitive.

Product Sound

When speaking of product sound and sound quality, noise emissions are not the only cause for concern. Characteristics of sound (prominent discrete tones and impulsive noise) can also cause great human discomfort. Discrete tones are audible sounds of a single frequency; impulsive noise is noise of short duration and relatively high amplitude.

In cases where the noise emissions of products have been significantly reduced (for example, in the information technology and telecommunications industries), customer acceptability of the product is mostly related to absence/minimal presence of tonal components.

Description of Type 7799

This section describes how Type 7799 software allows you to determine, store and report noise emission quantities, using six different PULSE templates.

Free-field: for Sound Power Determination in a Free or Essentially Free Sound Field

This solution provides measurement and calculation procedures based on ISO 3744, ISO 3745 and ISO 3746. This set of basic International Standards give the methods for determining the sound power of noise sources operating in a free (or essentially free) sound field.

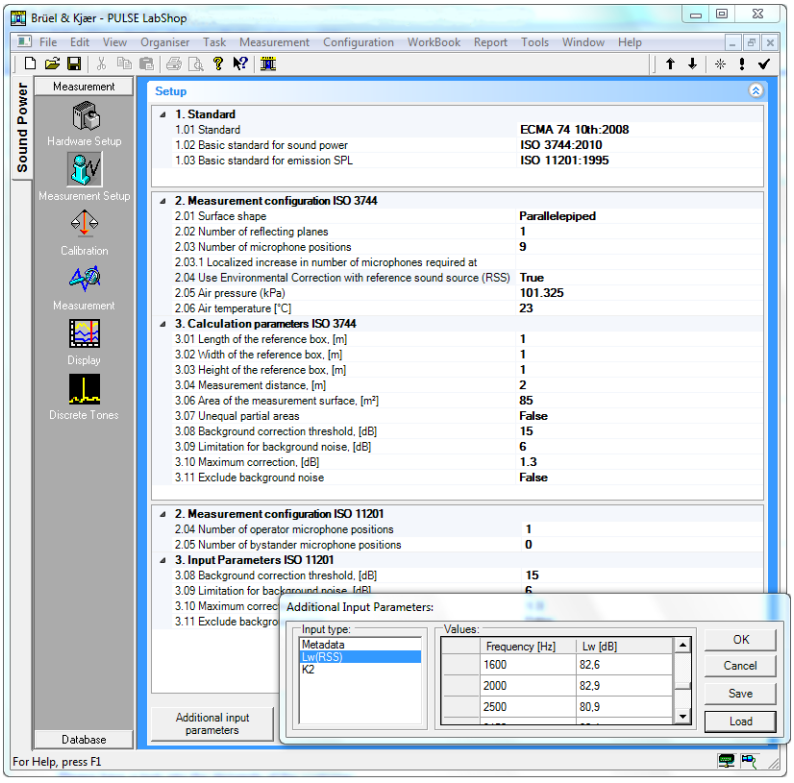
Sound pressure levels have to be measured at a number of microphone positions over a measurement surface enveloping the noise source. Depending on the number of microphones, measurements can be carried out simultaneously at all microphone positions, or in several steps. If the number of microphone positions required by the selected standard is greater than the available number of microphones, you can move the microphones or test object between measurements.

Provisions are available to allow additional microphones and additional localised microphones to be added to the setup. The software application provides flexible access to different stages of the procedure for optimising time and to avoid unnecessary time-consuming measurement repetitions (for example, background noise measurements).

An interactive setup table guides you through the measurement setup (for an example, see Fig. 1). Measurement setup, calibration values and background noise measurements can be stored in PULSE projects for future use.

The calibration procedure, with two consecutive measurements to check the calibration reproducibility, is not included in the template. This can be performed separately, if required.

Fig. 1
An interactive setup table, shown here for the Free-field with Emission SPL template, assists with the measurement setup phase



Measurement data and results can be saved to Microsoft® Excel® workbooks where they are clearly organised in a series of worksheets.

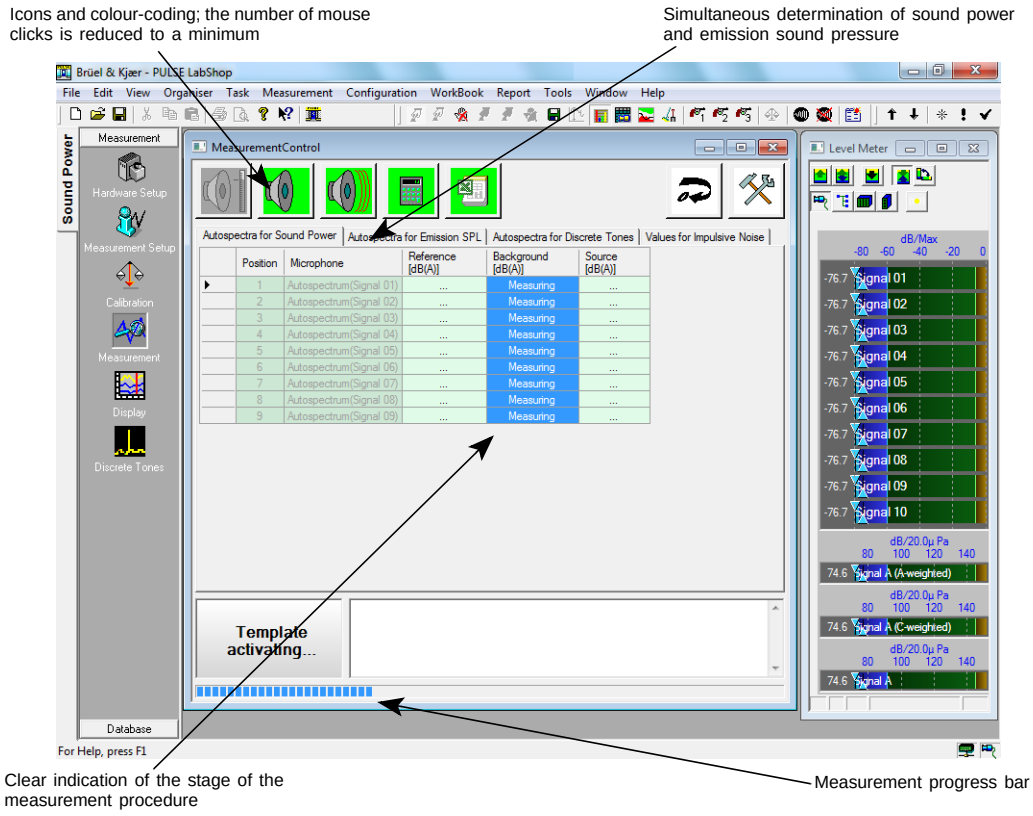
In addition to archiving using Excel® workbooks, data can be stored in a dedicated database for easy search/retrieve. Using PULSE Data Manager Type 7767, statistical quantities can be calculated on batch measurements stored in the database (such as mean and standard deviation).

Free-field with Emission SPL: for Sound Power and Emission Sound Pressure Determination in a Free or Essentially Free Sound Field

This solution combines the determination of sound power levels based on ISO 3744, ISO 3745, ISO 3746 (see above) and the measurement of emission sound pressure levels (at specified positions in the vicinity of the machinery, in an essentially free-field) based on ISO 11201.

Depending on the number of microphones, measurements can be carried out simultaneously at all microphone positions over a measurement surface enveloping the noise source, and at all operator and/or bystander positions, see Fig. 2.

Fig. 2
Graphic user interface is seamlessly integrated into PULSE LabShop



Along with the emission sound pressure levels, the Tone-to-Noise Ratio and Prominence Ratio are also calculated to identify and evaluate prominent discrete tones. Quantities used to identify impulsive noise are also measured.

Directive 2000-14-EC

This solution provides measurement and calculation procedures for the determination of the sound power in accordance with provisions of the EU Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors.

A predefined Excel® workbook containing Visual Basic® for Applications macros serves to enter measurement setup parameters, to control PULSE during the measurement process, to store data and to make the report.

For those types of equipment where measurements at different operating conditions are required, formulas are used to calculate the total sound power levels from measurements at each operating condition. The required weighting factor for each operating condition can be adjusted accordingly in the Excel® workbook.

Reverberation Room: for Sound Power Determination in Reverberation or Special Rooms

This solution provides measurement and calculation procedures based on the comparison method* as described in ISO 3741, ISO 3743-1 and ISO 3743-2. This set of basic International Standards give methods and specify the acoustical conditions for determining the sound power of noise sources operating in a reverberation or special room.

Depending on the number of microphones, such measurements can be performed simultaneously at all microphone positions, or in several steps. If the number of microphone positions required by the selected standard is greater than the available number of microphones, you can move the microphones or test object between measurements.

A predefined Excel® workbook containing Visual Basic® for Applications macros serves to enter measurement setup parameters, to control PULSE during the measurement process, to store data and to make the report.

Both microphone array and traversing microphone methods are supported. You are guided in the determination of additional microphone and/or source positions to meet the selected standard.

* The comparison method requires the use of a Reference Sound Source Type 4204, see Fig. 3.

Fig. 3
Reference Sound Source Type 4204

120457

Intensity-based: for Sound Power Determination using Intensity (Scanning Method)

This solution, based on the scanning method as described in ISO 9614-2, provides measurement and calculation procedures for the determination of the sound power using sound intensity.

A predefined Excel® workbook containing Visual Basic® for Applications macros serves to enter measurement setup parameters, to control PULSE during the measurement process, to store data and to make the report.

A tree structure allows you to edit the measurement surface geometry by adding new, user-defined, planar surfaces, and by segmenting previously defined surfaces. Surfaces can be sub-segmented up to seven times to obtain the desired accuracy. This is also possible between individual measurements during the measurement procedure.

The pressure-residual intensity index can be calculated, and the dynamic capability index stored. The surface pressure-intensity indicator, F_{pI}, and the negative partial-power indicator, $F_{+/-}$, for the measurement surface are calculated and compared with the standard requirements. When the repeated scan method is selected, a partial-power repeatability check is performed for each segment. The measurements are recorded automatically, following the structure of the tree, or manually, and a display indicates the status of each measurement position.

Washing Machines and Spin Extractors

This solution, based on IEC 60704-2-4 (identical to EN 60704-2-4) provides measurement and calculation procedures for determination of the sound power of washing machines in accordance with the EU Directive 2009/125/EC related to the ecodesign of washing machines. It is primarily based on the free-field methods described in ISO 3744 but with additional procedures to take into account the increase in noise during the spinning phase and also the measurement of the maximum rpm. The report provides the sound power for the washing period and the sound power for the region of the rinsing and final spin extraction period where the highest A-weighted 50 seconds time-averaged level occurs.

Making a Complex Process Simple

Graphical features, such as pop-up text, colour coding and warnings, allow quick updates on measurement status, determination of pending actions, and validation of specific parameters within the standard. The flexibility of the program allows you to skip repetitive tasks.

Customisable Reports

Measurement data and results can be exported to pre-defined Microsoft® Excel® workbooks where they are clearly organised in a series of worksheets, including a predefined report. Using Excel, the report can be easily adapted to accommodate corporate styles and personal touches.

Scalable Solution, Common Platform

PULSE Sound Power Type 7799 software runs with various configurations of microphones and geometries, making the solution scalable to match current budgets and requirements. Built on the powerful PULSE platform, it is quite feasible to combine Type 7799 with other PULSE sound and vibration measurement applications for a complete and flexible product testing program aimed at standards compliance and non-conformance problem resolution.

Specifications – PULSE Sound Power Type 7799

Type 7799 is an application for use with PULSE

SYSTEM REQUIREMENTS
The PC requirements for PULSE must be fulfilled.
The following licenses are required:
- PULSE CPB Analysis Type 7771
  or
- PULSE FFT & CPB Analysis Type 7700 (for the identification of prominent discrete tones and narrow-band analysis (FFT))
- Microsoft® Office 2007, 2010 or 2013

Screen resolution of 1400 × 1050 pixels (or better) is recommended

CALIBRATION
Calibration is performed using PULSE's integrated Calibration Master, which automatically initiates calibration while moving the calibrator from one microphone to the next. The full calibration history for a transducer can be retained in the Transducer Database, which allows monitoring calibration data variations over a period of time.
Global calibration allows building up a calibration database that is shared across all PULSE projects.

Free-field (PULSE Template)

Provides measurement and calculation procedures for the determination of the sound power of noise sources as described in the following international standards.

STANDARDS
ISO 3744:2010
ISO 3745:2012
ISO 3746:1995

SUITABLE TEST ENVIRONMENTS
- Anechoic or hemi-anechoic rooms as specified in ISO 3745:2012
- Essentially free-field over a reflecting plane as specified in ISO 3744:2010

MEASUREMENT

$L'_{p(B)\,i}$ *	time-averaged sound pressure level produced by background noise
$L'_{p(S)\,i}$	time-averaged sound pressure level from the noise source under test

* Throughout these specifications subscript *i* means that the quantity is measured or calculated at the *i*th microphone position over the measurement surface

Quantities Specific to ISO 3745:

$L'_{E(B)\,i}$	single-event sound pressure level produced by background noise
$L'_{E(S)\,i}$	single-event sound pressure level from the noise source under test

- All quantities can be measured in 1/3-octave band for any range with nominal midband frequencies from 50 Hz to 20 kHz, in 1/1-octave band for any range with nominal midband frequencies from 63 Hz to 16 kHz or in narrow-band (FFT) for any range with nominal midband frequencies from 50 Hz to 20 kHz
  If microphone frequency range and available number of beats allow. For information on microphone frequency range, please refer to the respective microphone Product Data

CALCULATION

$\overline{L}_{pf}$	surface time-averaged sound pressure level
L_W	sound power level

Quantities Specific to ISO 3744 and ISO 3746:

$\overline{L'}_{p(B)}$	mean measured time-averaged background noise level over the measurement surface
$\overline{L'}_{p(S)}$	mean measured time-averaged sound pressure level for the noise source under test over the measurement surface
K_1	background noise corrections for the surface sound pressure level
K_2	environmental corrections measured using reference sound source

Quantities Specific to ISO 3745:

K_{1i}	background noise corrections
L_{pi}	sound pressure level corrected for background noise
L'_W	sound power level under alternate meteorological conditions
DI_i	directivity index
Q_i	directivity factor

- A-weighted values are calculated from 1/1-octave or 1/3-octave values as specified in, for example, Annex C of ISO 3745:2012 or from narrow-band values (FFT)

VALIDATION
Criterion for background noise
Requirement evaluation for additional microphone positions

STATISTICS
Mean and standard deviation of any measured or calculated quantity on batch measurements
PULSE Data Manager Type 7767 license required

Free-field with Emission SPL (PULSE Template)

All specifications given for the Free-field method apply plus the following standards

STANDARDS
ISO 11201:1995
ISO 7779:2010 (sound power levels are determined under free-field or essentially free-field conditions only)
ECMA 74 (10th edition, sound power levels are determined under free-field or essentially free-field conditions only)

CALCULATION

L_{pj}	time-averaged sound pressure level corrected for the background noise, A-weighted
$L_{pCpeakj}$	C-weighted peak sound pressure level

IDENTIFICATION OF PROMINENT DISCRETE TONES
Tone-to-Noise Ratio criteria according to ISO 7779:2010 and ECMA 74 (9th edition)
Prominence Ratio method according to ECMA 74 (10th edition)

MEASUREMENT

$L'_{p(B)\,j}$ *	measured time-averaged sound pressure level produced by the background noise, A-weighted
$L'_{p(S)\,j}$	measured time-averaged sound pressure level during operation of the source under test, A-weighted
$L'_{p(S)\,j(\mathrm{FFT})}$	measured time-averaged sound pressure level during operation of the source under testing, in narrow band

* Throughout these specifications subscript *j* means that the quantity is measured or calculated for the *j*th operator or bystander position

Directive 2000/14/EC (PULSE Template)

Provides measurement and calculation procedures for the determination of the sound power of noise sources in accordance with provisions of the EU Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors

SUITABLE TEST ENVIRONMENTS

- Typically outdoor on a reflecting surface of concrete or non-porous asphalt
- In cases where the equipment cannot be operated on such surface, a suitable environment is defined and max environmental correction K_{2A} is given in the Directive 2000/14/EC (or in the noise test codes referenced in the Directive)

MEASUREMENT

$L'_{p(B)\,i}$	time-averaged sound pressure level produced by the background noise
$L'_{p(S)\,ikn}$	time-averaged sound pressure level from the noise source under test for the *k*th operating mode and the *n*th run

- All quantities can be measured in 1/3 octave band for any range with nominal midband frequencies from 50 Hz to 20 kHz or in 1/1-octave band for any range with nominal midband frequencies from 63 Hz to 16 kHz
  If microphone frequency range and available number of beats allow. For information on microphone frequency range, please refer to the respective microphone Product Data.

CALCULATION

$\overline{L'}_{p(B)}$	mean measured time-averaged background noise level over the measurement surface
$\overline{L'}_{p(S)\,kn}$	mean measured time-averaged sound pressure level for the noise source under test over the measurement surface for the *k*th operating mode and the *n*th run
K_1	background noise corrections for the surface sound pressure level
$\bar{L}_{pf\,kn}$	surface time-averaged sound pressure level for the *k*th operating mode and the *n*th run
$\bar{L}_{pf\,k}$	surface time-averaged sound pressure level for the *k*th operating mode*
$\bar{L}_{pf}$	surface time-averaged sound pressure level calculated using the appropriate equation for the specific type of equipment under test† given in the Directive 2000/14/EC (or in the corresponding noise test code)
L_W	sound power level

* Calculated as the arithmetic mean of the two highest values from three or more runs, which do not differ by more than 1 dB according to Annex III Part A of Directive 2000/14/EC

† The equation, which combines the $\bar{L}_{pf\,k}$ test results from *k*, is manually entered in the user interface

- A-weighted values are calculated from 1/1-octave or 1/3-octave values as specified in Annex C of ISO 3745:2012

VALIDATION

Criterion for background noise

Automatic determination of surface time-averaged sound pressure level values from three or more runs, which do not differ by more than 1 dB

STATISTICS

- Mean and standard deviation of sound power level on batch measurements

Reverberation Room (PULSE Template)

Provides measurement and calculation procedures for the determination of the sound power of noise sources using the comparison method as described in the following international standards
The comparison method requires a reference sound source meeting the requirements of ISO 6926 (e.g., Reference Sound Source Type 4204)

STANDARDS

ISO 3741:1999 (Comparison method only)
ISO 3743–1:1994 (Comparison method only)
ISO 3743–2:1994 (Comparison method only)

SUITABLE TEST ENVIRONMENTS

- Reverberation rooms as specified in ISO 3741:1999
- Reverberant fields as specified in ISO 3743–1:1994 or ISO 3743–2:1994

MEASUREMENT

$L'_{p(B)\,ij}$	time-averaged sound pressure level produced by the background noise
$L'_{p(R)\,ij}$	time-averaged sound pressure level from the reference sound source
$L'_{p(S)\,ij}$	time-averaged sound pressure level from the noise source under test

- All quantities are measured in 1/3-octave band for any range with nominal midband frequencies from 50 Hz to 20 kHz or in 1/1-octave band for any range with nominal midband frequencies from 63 Hz to 16 kHz
- A-weighted values calculated from 1/1-octave or 1/3-octave values as specified in Annex C of ISO 3745:2012

CALCULATION

K_1	background noise corrections
$\bar{L}_{p(R)\,j}$	mean corrected time-averaged sound pressure level from the reference sound source over all source positions
$\bar{L}_{p(S)\,j}$	mean corrected time-averaged sound pressure level from the noise source under test over all source positions
N_M	number of necessary microphone positions or separate microphone traverses for each source position
N_S	number of necessary source positions
L_W	sound power level

VALIDATION

Criterion for background noise
Requirement evaluation for additional microphone positions
Requirement evaluation for additional source positions

Washing Machines and Spin Extractors (PULSE Template)

Provides measurement and calculation procedures for the determination of the sound power of noise sources as described in the following international standards

STANDARDS

IEC 60704-2-4 2001 (identical to EN 60704-2-4 2001)
ISO 3744: 2010

SUITABLE TEST ENVIRONMENTS

Essentially free-field over a reflecting plane as specified in ISO 3744:2010

MEASUREMENT

$L'_{p(B)\,i}$	time-averaged sound pressure level produced by the background noise
$L'_{p(S)\,i}$	For washing, A-weighted sound pressure level time-averaged over the total duration of the washing period
	For spinning, the highest A-weighted sound pressure level for an averaging time of 50 seconds determined during the rinsing and spinning period
	Maximum spin speed achieved during noise measurement

- All quantities can be measured in 1/3-octave bands for any range with nominal midband frequencies from 50 Hz to 20 kHz, in 1/1-octave bands for any range with nominal midband frequencies from 63 Hz to 16 kHz or in narrow-band (FFT) for any range with nominal midband frequencies from 50 Hz to 20 kHz

CALCULATION

$L_W wash$	sound power level for the washing period
$L_W spin$	sound power level for the rinsing and spinning period corresponding to the 50 seconds interval with the highest sound pressure level

QUANTITIES SPECIFIC TO ISO 3744

$L'_{p(B)}$	mean measured time-averaged background noise level over the measurement surface
$L'_{E(S)}$	mean measured time-averaged sound pressure level for the noise source under test over the measurement surface
K_1	background noise corrections for the surface sound pressure level
K_2	environmental corrections measured using reference sound source

- A-weighted values are calculated from 1/1-octave or 1/3-octave values as specified in, for example, Annex C of ISO 3745:2012 or from narrow-band values (FFT)

VALIDATION

Criterion for background noise
At least three complete measurements to be made for sound power calculations
Requirement evaluation for additional microphone positions

STATISTICS

Mean and standard deviation of any measured or calculated quantity on batch measurements

Ordering Information

Type 7799–X*	PULSE Sound Power

RECOMMENDED ACCESSORIES

Type 7767-A-X*	PULSE Data Manager, single user
Type 7767-B-X*	PULSE Data Manager, up to five users
Type 7767-C-X*	PULSE Data Manager, up to ten users

FREE-FIELD METHODS

Type 4190-L-001	½″ Free-field Microphone with 2669-L, TEDS
Type 4955	½″ Low-noise Free-field TEDS Microphone
Type 4188-A-021	Prepolarized Free-field ½″ Microphone with 2671-L, TEDS
Type 4950	½″ Prepolarized Free-field Microphone
Type 2671	DeltaTron Microphone Preamplifier
Type 4204	Reference Sound Source
Type 4231	Sound Calibrator
MM-0360	CCLD Laser Tacho probe with retroreflective tape

REVERBERANT-FIELD METHODS

Type 4943-L-001	½″ Diffuse-field Microphone with 2669-L, TEDS
Type 4188-A-021	½″ Prepolarized Free-field Microphone with 2671-L, TEDS
Type 4942-A-021	½″ Prepolarized Diffuse-field Microphone with 2671-L, TEDS
Type 4204	Reference Sound Source
Type 4231	Sound Calibrator

Type 3923	Rotating Microphone Boom
UA-0587	Heavy Duty Tripod for Type 3923
AO-0488-Y-XXX†	Cable, Brüel & Kjær Female to LEMO 1 B Connector
ZQ-0350	LEMO Brüel & Kjær Socket Adaptor

SOUND INTENSITY METHOD

Type 3599	Sound Intensity Probe Kit
Type 4297	Sound Intensity Calibrator
UA-1451	Telescopic Boom Kit

OTHER ACCESSORIES

UA-0801	Lightweight Tripod
UA-1317	½″ Microphone Holder
AO-0087-Y-XXX†	Screened Signal Cable, BNC to BNC Connector
AO-0414-Y-XXX†	7-pin LEMO Microphone Ext. Cable
UA-0459	Windscreen for ½″ Microphone, 65 mm diameter
UA-0237	Windscreen for ½″ Microphone, 90 mm diameter

SERVICE

M1-7799-X*	Annual Software Maintenance and Support Agreement for PULSE Sound Power
M3-7799-X*	Update of M1-7799-X* for PULSE Sound Power

* Where 'X' indicates the license model, either N: node-locked, or F: floating

† Cables are available in different lengths, specified by Y-XXX, where:
Y = D (decimetres) or M (metres)
XXX is the length in the given units
Please specify

BP 2093–15 2013-08

HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
Telephone: +45 7741 2000 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com

Local representatives and service organisations worldwide

Brüel & Kjær