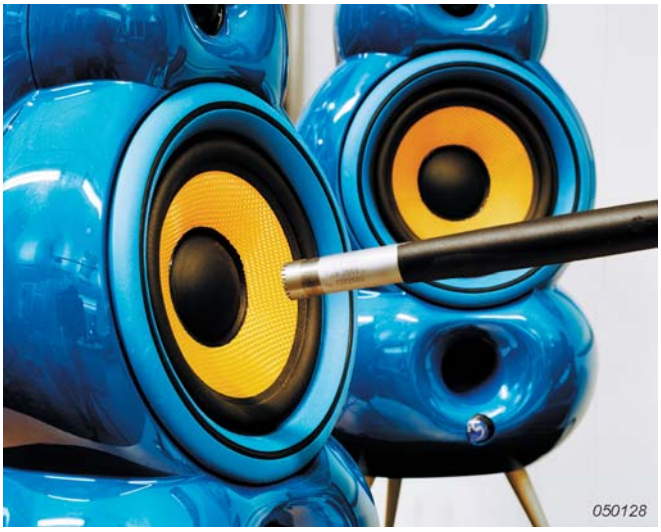
PRODUCT DATA

PULSE Electroacoustics Type 7907-S1
PULSE Basic Electroacoustics Type 7797

PULSE™ Electroacoustics provides a versatile platform for the evaluation of electroacoustic transducers. This includes a wide range of advanced analysis capabilities required by any audio engineer working within the field of research and development of acoustical designs.

With PULSE Electroacoustics, various important features of an electroacoustic transducer can be determined. These features include output response, frequency response, harmonic distortion, intermodulation distortion, difference frequency distortion, directivity, loudness rating, etc.

Combining PULSE Electroacoustics with one of the high-quality PULSE hardware front ends reveals the ideal audio analyzer platform. Furthermore, this platform can be expanded by adding software packages to support vibration analysis, sound quality evaluation, data management, and advanced time data recording and analysis.



Uses and Features

Uses

- Advanced research and development of electroacoustic transducers
- Pre-qualification of electroacoustic transducers
- Benchmarking of electroacoustic transducers
- Sample testing and quality assurance of electroacoustic transducers
- Linear and non-linear system analysis

Features

- Output response, frequency response, directional response and distortion measurement using PULSE Steady State Response (SSR) or Time Selective Response (TSR) analysis
- Tolerance checking applying absolute, floating or aligned masks to live measurements
- Calibration of input and output signals
- Intelligent transducer correction – compensation for amplitude response of microphones and ear simulators as well as speakers and mouth simulators
- Determination of Thiele Small parameters based on simple impedance, added volume, added mass or non-contact laser method
- Sequencer allowing predefined PULSE projects to be executed automatically
- Dedicated database for storing and retrieving measurement data from PULSE, Audio Analyzer Type 2012 and other common audio analyzers
- Calculator for statistical calculations, simple arithmetic and more advanced data transformations
- Advanced display facilities such as 3D display, contour display, polar plot, etc.
- Predefined projects supporting typical electroacoustic measurements
- Loudness Rating Calculation according to ITU-T and IEEE recommendations
- Fully documented OLE2 interface for customized automation using Visual Basic® for Applications
- Easy reporting using Microsoft® Word or Excel®
- Extensive on-line help

Brüel & Kjær

What is Electroacoustics?

Electroacoustics is about measuring the characteristics of devices that either transform sound to electrical voltage or electrical voltage to sound. Or to put it simply, if a device includes a speaker or a microphone, its electroacoustic performance needs to be tested.

The following devices are all examples of electroacoustic transducers used in our everyday life:

- Loudspeaker units like bases and tweeters used in loudspeaker systems
- Loudspeaker systems for professional audio in concert halls or studios
- Consumer loudspeaker systems used in home audio systems or cars
- Receivers used for mobile phones, PDAs or other hand-held devices
- Microphones like Brüel & Kjær high-precision measuring microphones or consumer microphones in mobile phones or computers
- Hearing aids, both in-the-ear and behind-the-ear hearing aids
- Headsets used in call-centres, receptions or offices
- Telephones, both mobile and corded phones
- Audiometers like those used in hearing clinics or diagnostic audiometers used by hospitals and universities
- Alarm systems, for example, fire alarms or fog horns

Before explaining about different electroacoustic measurements, let us first answer the question “Why make measurements at all?” The alternative to measurements, which are objective, is subjective evaluation, and subjective evaluation has some drawbacks. During product design and development, many evaluations will have to be performed, which requires time. Also, the result of the evaluation is highly dependent on the skill and experience of the person performing the evaluation. This makes reproducibility very uncertain. Furthermore, sometimes it is impossible to conduct the evaluation due to the nature of human hearing.

Characteristics of Electroacoustic Devices

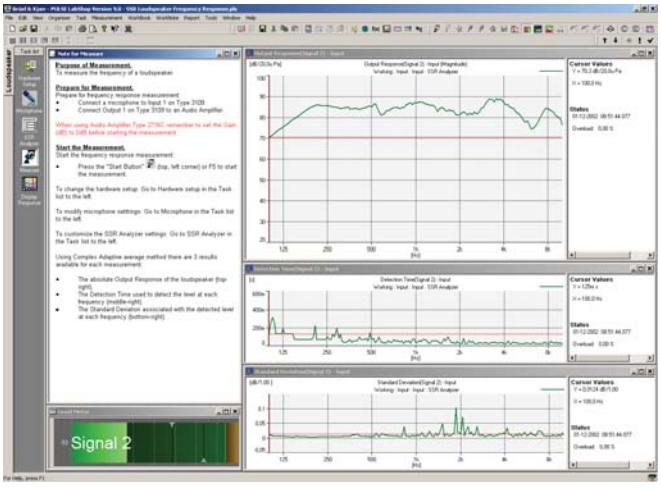


Fig. 1
With PULSE SSR or TSR analyzers, the frequency response and harmonic distortion can be easily measured for an electroacoustic transducer. In this case a loudspeaker has been measured using a measuring microphone

A number of specific parameters can be used to characterize an electroacoustic device. The most commonly used parameters to characterize the static performance of an electroacoustic device are: output response, frequency response, harmonic distortion, intermodulation distortion, difference frequency distortion and directivity. In a similar way, the dynamic behaviour of an electroacoustic device can be described by attack and decay time, switching time and attenuation, etc.

PULSE Basic Electroacoustics Type 7797 software is combined with dedicated PULSE hardware for electroacoustic measurements. With PULSE Basic Electroacoustics Type 7797, basic frequency response measurements can be performed using the SSR or TSR analyzer.

For more information please refer to Ordering Information on page 10.

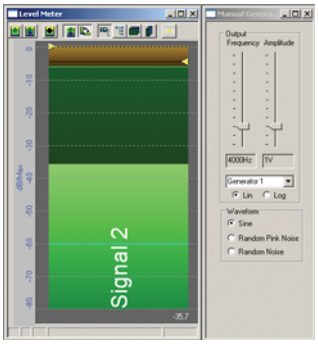


Fig. 2
The level meter and manual generator can be used for determining the required frequency band and excitation level prior to performing the actual measurement

Common to all the audio analyzers are:

- Multiple input channels allow for measurements on different types of input such as different microphone and/or electrical inputs. Preamplifier input, direct input and CCLD input are supported
- Support of CPB, FFT, SSR and TSR. SSR and TSR analysis include frequency response and level-stepped frequency response measurements
- Automated compensation for the frequency response of the source used when testing. Speaker equalization when testing microphones
- Multiple real-time analysis, combining different types of analysis on one or multiple inputs
- Level meter that will measure the level of one or more inputs
- Transducer database holding the sensitivity of specific transducers, including Brüel & Kjær transducers
- Automated procedure for calibration and verification of the nominal sensitivity of Brüel & Kjær transducers
- Separate DC input for monitoring environmental parameters such as temperature, pressure, etc.
- Loudness rating calculation according to ITU-T and IEEE
- Absolute, floating and aligned tolerance checks
- PULSE Data Manager for Electroacoustic Applications (see page 5) – a database where all types of measurement data and other relevant information relating to the measurement can be stored and later retrieved. This ensures easy management of measurement data and analysis results

More features can be enabled by the addition of one or more software options described in the following section.

PULSE Electroacoustics Type 7907 supports a more comprehensive set of electroacoustic measurements. Measurements such as frequency response, harmonic distortion, intermodulation distortion, difference frequency distortion as well as directional response can be determined.

Fig. 3

With measurement control for directivity measurements the angles at which the measurements are performed can easily be set up. Furthermore the measurement can be started, stopped and paused

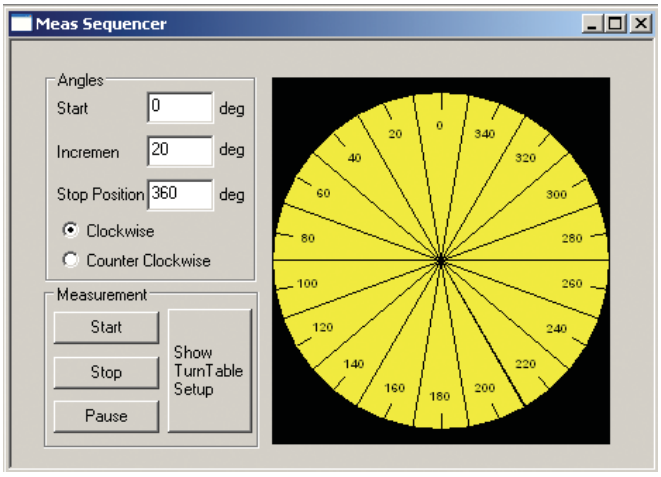
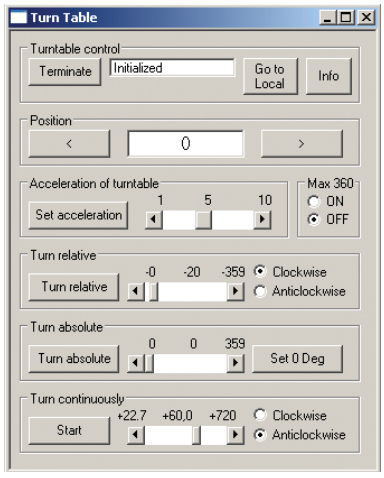


Fig. 4

The turntable control is a powerful tool that allows the turntable to be controlled directly from the PC using an intuitive graphical user interface



PULSE Basic Electroacoustics Type 7797

This software enables measurements of basic output response and frequency response using the PULSE SSR analyzer. The SSR analyzer is unique in that a required accuracy for the measurement can be set by the user prior to starting the measurement. The SSR analyzer will then produce a measurement with the requested accuracy as long as this is possible within the time limits specified by the user. Another feature of the SSR analyzer is that it allows for accurate measurements even in a noisy environment. By default the SSR analyzer measures the frequency response as one analyzer input divided by the generator output; however, PULSE also supports frequency response measured between two different inputs. Frequency step range, frequency step size, step direction up/down, user-defined step frequencies as well as level step can be set up by the user. This software is a prerequisite for any of the software options BZ-5548, BZ-5549 and BZ-5550. Type 7797 also enables simulated free-field measurements of basic output response and frequency response using the TSR analyzer. The TSR method measures a time selective frequency response using a swept sine technique. The main advantage of this technique is its ability to reject noise and reflections. The TSR method allows evaluation of loudspeakers in a normal reverberant environment, thus avoiding the use of an expensive anechoic chamber.

PULSE SSR Analysis Harmonic Distortion BZ-5548

This software enables measurements of harmonic distortion using the SSR analyzer. Up to sixty harmonic distortion products can be measured in parallel during a single frequency scan.

PULSE SSR Analysis Intermodulation Distortion BZ-5549

This software enables measurements of intermodulation distortion using the SSR analyzer. Up to 10 intermodulation distortion products can be measured in parallel during a single frequency scan. The level ratio for the two frequencies can be set by the user.

PULSE SSR Analysis Difference Frequency Distortion BZ-5550

This software enables measurements of difference frequency distortion using the SSR analyzer. Up to 10 difference frequency distortion products can be measured in parallel during a single frequency scan. The level ratio between the two frequencies can be set by the user.

PULSE Directivity and Polar Plot BZ-5551

This software controls Brüel & Kjær's Turntable System Type 9640 and displays the directional response produced by the SSR or TSR analyzer. The software also supports manual measurements at different angles.

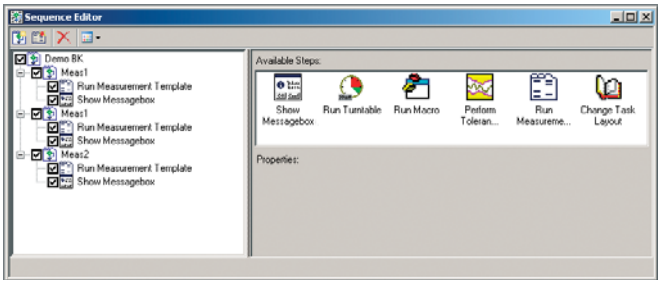


Fig. 5
Create and edit a sequence by dragging and dropping specific PULSE operations into the sequence. After construction, the sequence can be executed to perform the included PULSE operations

PULSE Sequencer BZ-5600

This software will automate measurement tasks that can be performed in PULSE using manual operations. PULSE Sequencer is based on PULSE concepts such as measurement templates, task layouts, macros, etc. With this software, very complex and time-consuming measurement tasks can be automated using the edit and execute sequence controls of the PULSE Sequencer. The software should be considered a non-programmer's alternative to the very extensive Visual Basic for Applications programming environment that is also supported by PULSE.

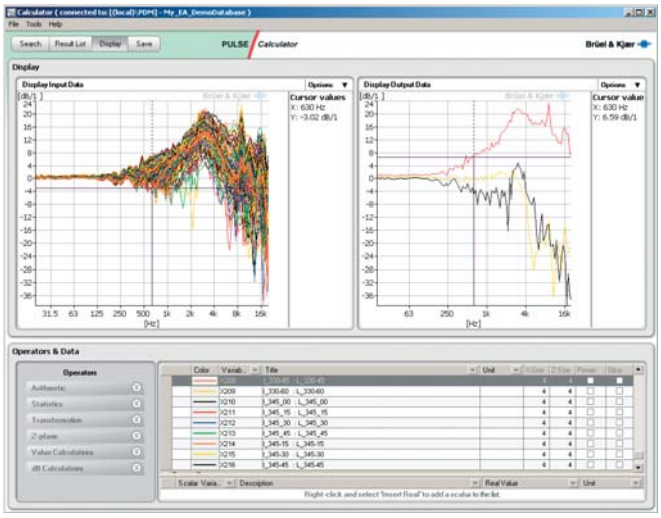


Fig. 6
PULSE Data Manager is a very powerful tool used to compare measurements. Data produced by Audio Analyzer Type 2012 as well as PC-based audio analyzers are easily compared in the same display. Reports, simple calculations and statistical analysis are supported by this software

PULSE Data Manager for Electroacoustic Applications BZ-5601

This software allows measurement data to be stored and retrieved from a database. Data produced by the PULSE SSR analyzer, Brüel & Kjær's Audio Analyzer Type 2012 or any PC-based audio analyzer can easily be stored in the database. A vast number of calculations and comparisons can be performed on data retrieved from the database, regardless of where the data originate. Furthermore, it is easy to create measurement reports with this software.

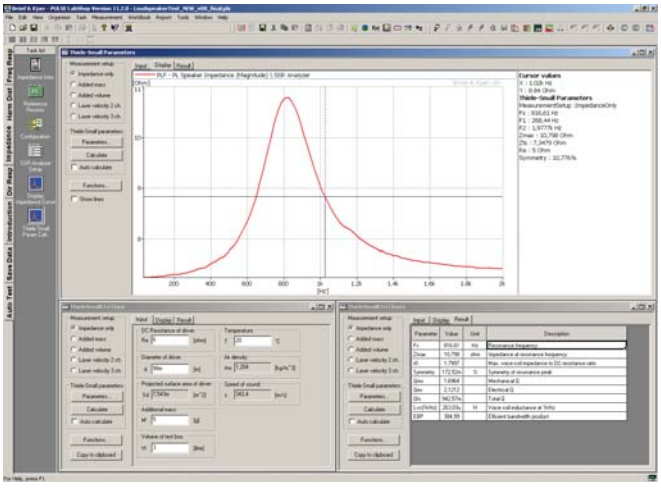


Fig. 7
Thiele Small Parameter display. With PULSE Thiele Small Parameter Calculation, all relevant speaker parameters are automatically calculated

PULSE Thiele Small Parameters Calculation BZ-5604

This software calculates relevant Thiele Small parameters based on the measured impedance of a loudspeaker or a receiver. Measurements based on the simple impedance, added volume, added mass and laser method are all supported.

PULSE TSR Analysis – Harmonic Distortion BZ-5742

This software enables measurements of harmonic distortion using the TSR analyzer. Harmonic distortion products can be measured in parallel during a single frequency sweep.

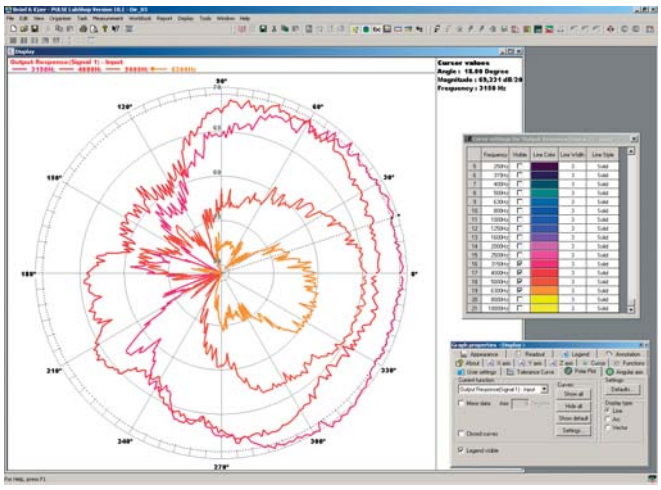


Fig. 8
Polar plot display in PULSE. Polar plots are commonly used to display the directivity of certain electroacoustic devices such as loudspeakers and microphones

All PULSE audio analyzers can display measurement results as various types of functions in both the frequency and time domains. In the frequency domain, functions like magnitude, phase, and real part or imaginary parts can be displayed. The different functions can be displayed as curves, bars, overlays, contour plots, polar plots, etc., or as 3D waterfall displays. The flexibility in setting the scaling of the x-, y- and z-axes makes it possible to view and document the measurement results in various display formats and layouts.

When the measurement results are displayed, they can be read using a simple x-y cursor, or a special calculated cursor value can be determined, for example, the power in a certain frequency range, total power, or loudness rating according to ITU-T and IEEE specifications.

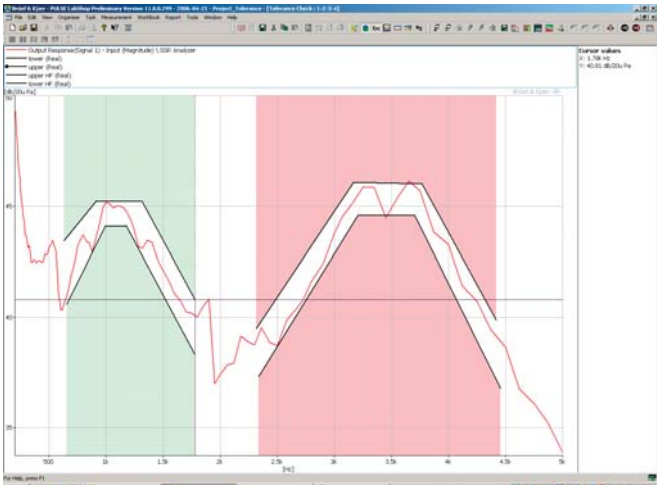


Fig. 9
For verification using certain performance target criteria the SSR analyzer can be used together with any of the tolerance checks available in PULSE. In this case an absolute tolerance check is performed

PULSE audio analyzers also support post-processing of measurement results. Data can be post-processed in real-time using PULSE language or Microsoft Excel, and a dynamic link to the measurement data adds to the flexibility of post-processing. Special types of post-processing such as tolerance checking can be performed live on the measurement, resulting in the display of a clear pass-fail verdict, and an event that can be used to trigger a specific handling.

Measurements can be fully documented using Microsoft Word with user-defined report templates, and the complete measurement, including the actual analysis, display, post-processing, etc., can be stored as a PULSE project. Such projects can later be reloaded into a PULSE audio analyzer and the measurement repeated.

Many typical electroacoustic measurements are available as PULSE projects and form an integral part of the PULSE audio analyzer. If more specialized measurement tasks are required, this can be accomplished using the the task bar or, when full automation of the measurement process is required, by using PULSE Sequencer. For highly specialized measurement tasks, Visual Basic for Applications can be applied. The figures below show different system configurations used for typical electroacoustic applications.

Fig. 10
Loudspeaker testing using measuring microphone

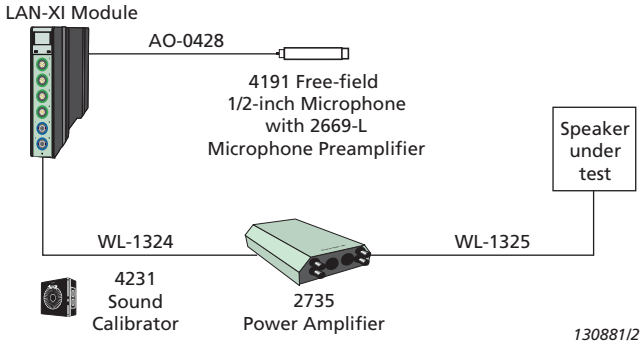


Fig. 11
Receiver testing using ear simulator

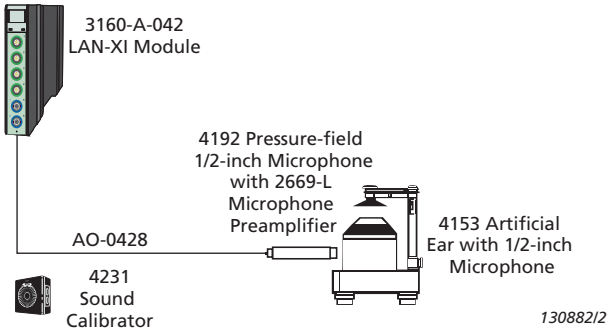


Fig. 12
Microphone testing using mouth simulator

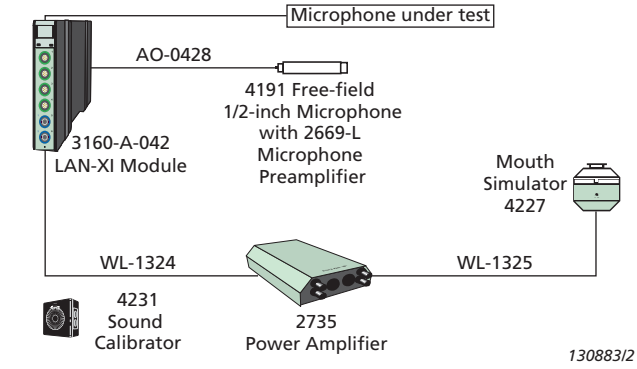


Fig. 13
Telephone testing using test head

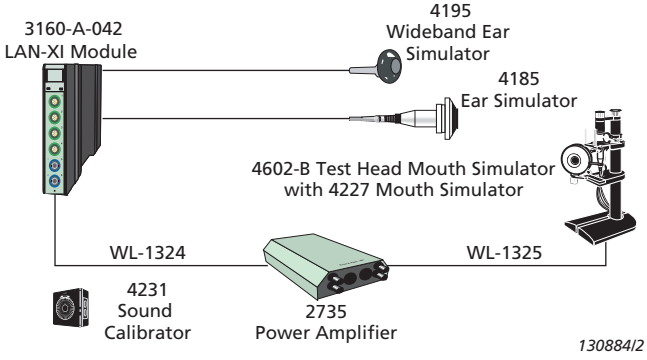


Fig. 14
Telephone testing using head and torso simulator (HATS)

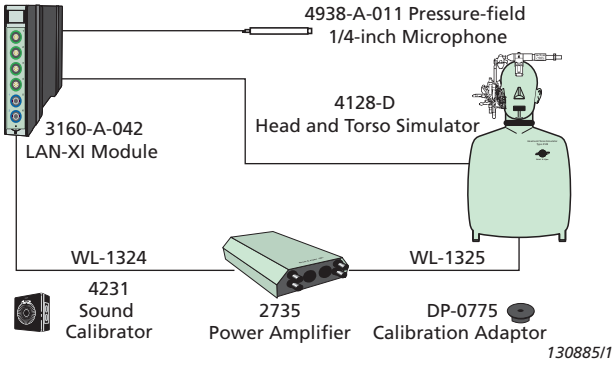


Fig. 15
Hearing aid testing using ear simulator and anechoic test box

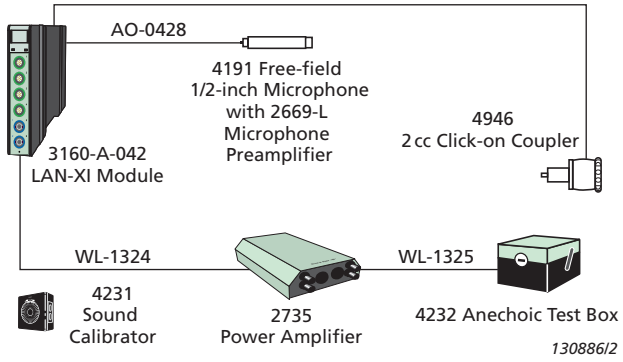


Fig. 16

Audiometer testing using ear simulator and artificial mastoid

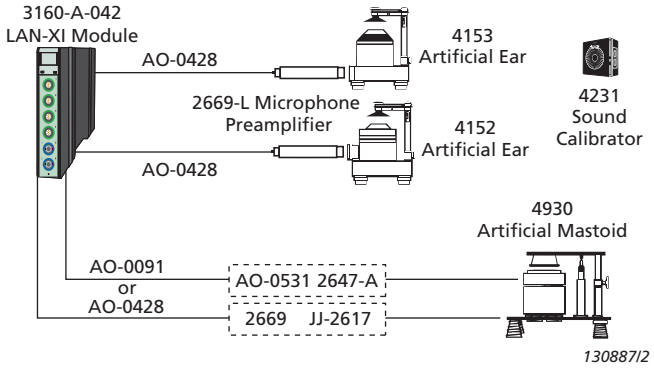


Fig. 17

Headphone and headset testing using HATS

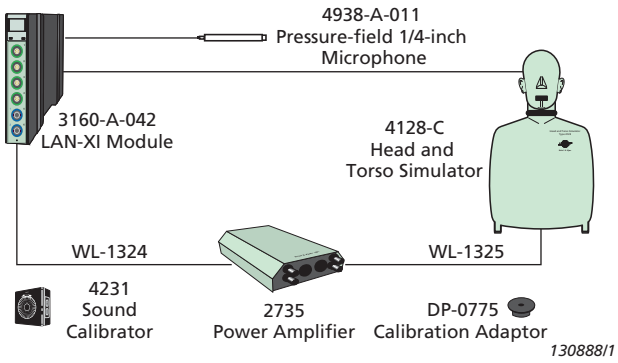


Fig. 18

Example directivity measurement set-up using turntable system

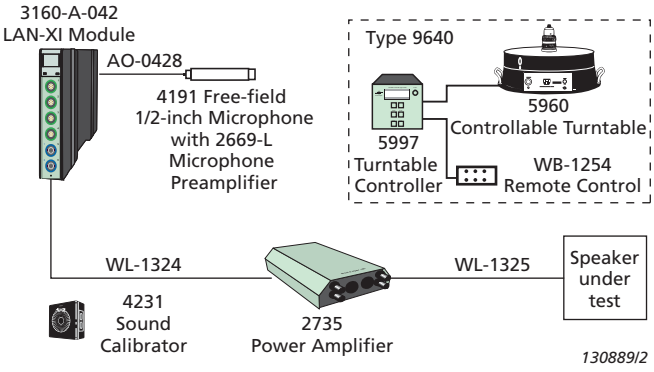
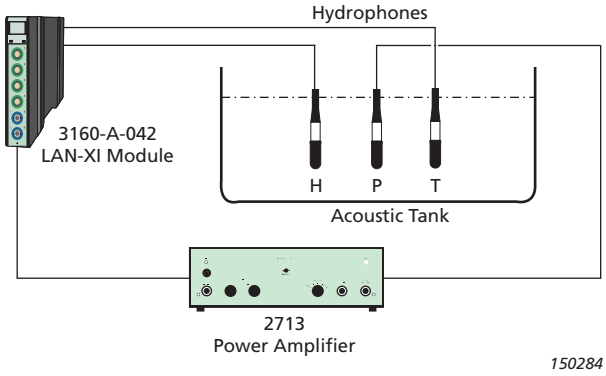


Fig. 19

Hydrophone calibration using PULSE TSR



To support typical electroacoustics measurements and to accommodate the specific requirements of different applications, we have developed dedicated application software packages that are based on PULSE Basic Electroacoustics. The dedicated applications are described below.

PULSE Receiver Test Application BZ-5602

This software supports measurements on receivers using an instrumentation setup similar in principle to that shown in Fig. 11. This application automates measurements of frequency response, harmonic distortion and calculation of Thiele Small parameters using the simple impedance method. BZ-5602 requires Type 7797, BZ-5548, BZ-5600, BZ-5601 and BZ-5604 for full software functionality. Concerning the hardware required for this application, please refer to Ordering Information on page 10.

PULSE Loudspeaker Test Application BZ-5603

This software supports measurements on loudspeakers using an instrumentation setup similar in principle to that shown in Fig. 10 and Fig. 18. This application automates measurements of frequency response, harmonic distortion, directional response and calculation of Thiele Small parameters using the simple impedance method, added volume, added mass or laser method. BZ-5603 requires Type 7797, BZ-5548, BZ-5551, BZ-5600, BZ-5601 and BZ-5604 for full software functionality. Concerning the hardware required for this application, please refer to Ordering Information on page 10.

PULSE Microphone Test Application BZ-5743

This software supports measurements on microphones using an instrumentation setup similar in principle to that shown in Fig. 12 and Fig. 18. This application automates measurements of frequency response, harmonic distortion and directional response. BZ-5743 requires Type 7797, BZ-5548, BZ-5551, BZ-5600 and BZ-5601 for full software functionality. Concerning the hardware required for this application, please refer to Ordering Information on page 10.

PULSE Headset Test Application BZ-5744

This software supports measurements on headsets using an instrumentation setup similar in principle to that shown in Fig. 17.

This application automates measurements of frequency response and harmonic distortion. BZ-5744 requires Type 7797, BZ-5548, BZ-5600 and BZ-5601 for full software functionality. Concerning the hardware required for this application, please refer to Ordering Information on page 10.

Hydrophone Calibration (Using Type 7797)

PULSE TSR is a convenient and quick method for hydrophone calibration – both receiving and projecting responses can be measured. Fig. 19 shows the setup for calibration of the receiving frequency response of an unknown hydrophone (designated 'T') with respect to a reference Type 8104 hydrophone (designated 'H'). The 'projector', a Type 8104 hydrophone (designated 'P'), is connected to the output from Power Amplifier Type 2713. The lowest usable frequency depends on the size of the acoustic tank.

For frequency ranges up to 50 kHz, Type 3160-A-042 can be used; for frequency ranges up to 200 kHz, Type 3161-A-011 can be used. Please note that two Type 3161-A-011 modules are required for the application shown in Fig. 19.

Beyond Electroacoustic Applications

The PULSE audio analyzer family is much more than a platform for electroacoustic measurements. Built on the solid foundation of a very versatile platform, PULSE will allow the PULSE audio analyzer to expand into other related applications areas for acoustics and vibration. Some of the most relevant of these applications are:

- PULSE Sound Quality – a very powerful tool for the evaluation of acoustic performance using methods based on psychoacoustic models
- PULSE Time Data Recorder – record measurements in real-time and, afterwards, use a real-time analyzer such as FFT or CPB
- PULSE Time – a time file manager to visually inspect, listen to, analyse or export any part of a recorded measurement in many data formats such as UFF, WAV, TDF, HDR, MAT, HDF and custom
- PULSE Noise Source Identification – a technique that can perform mapping of sound pressure, sound intensity and other sound field parameters. This technique can be used for detecting leakage in mobile phones, hearing aids or other devices containing an electroacoustic component in a small enclosure

PULSE Electroacoustics Bundles

PULSE Electroacoustics bundles support:

- SSR analysis – for frequency response
- TSR analysis – for frequency response
- FFT analysis
- CPB analysis
- Overall level analyzer
- Auxiliary parameter logging

For more information regarding the features listed above please see System Data BU 0229, containing the specifications for PULSE Software, as well as Product Data BP 2215, containing the specifications for LAN-XI Data Acquisition Hardware.

Additionally, PULSE Electroacoustics bundles support:

- SLR, RLR, STMR, LSTR Calculation according to ITU-T Rec. P.79
- TOLR, ROLR, SOLR Calculation according to IEEE 661
- Absolute, Floating and Aligned Tolerance Checking
- Manual generator for easy control of signal type, level and frequency

PULSE Electroacoustics bundles can be upgraded to support:

- Thiele Small parameter calculation using simple impedance, added volume, added mass or laser method
- Sequencer based on PULSE concepts such as measurement templates, task layout, etc., for automation of measurement procedures
- Directional response measurements and polar plots
- Distortion measurements

Requirements

Type 7700, 7770 or 7771

Steady State Response Analysis

RESPONSE
Relative response (transfer function) or absolute response (response signal only) can be measured

FREQUENCY SWEEP
A frequency sweep is set up by defining a start and a stop frequency and a number of steps that can be distributed on a logarithmic or linear scale or at user-defined frequencies

- **Frequency Span:** Type 3109 up to 25.6 kHz; Type 3110 up to 102.4 kHz; Type 3160 up to 51.2 kHz; Type 3560-B up to 25.6 kHz
- **User Defined:** Frequency sweep inserted by the user, as desired
- **Direction:** Up, Down
- **Log:** 1/3-, 1/6-, 1/12-, 1/24-, 1/48- and 1/96-octave steps
- **Log ISO:** Series R10, R20, R40 and R80
- **Log CPB:** 1/3-, 1/6-, 1/12-, 1/24-, 1/48- and 1/96-octave steps according to CPB frequencies
- **Lin:** 1 to 1600 steps

LEVEL SWEEP
A level sweep is set up by defining the excitation frequency, the output level range to be swept and the step size
Output Level: Range and step size for an Output Level sweep can be selected from 0.1 dB to 80 dB

DETECTOR
For optimal estimation of the frequency response, the Steady State Response Detector or Adaptive Scan Algorithm are used. The detector requires that a detector averaging method, a detector accuracy, a detector delay as well as a detector max. time are defined

- **Detector Averaging:** Complex Adaptive, Power Adaptive, Complex Linear and Power Linear averaging can be selected. When Adaptive averaging is selected, the response is estimated to a user-defined accuracy in the minimum possible time. When Linear averaging is selected, all data within a specified period of time are averaged. Complex indicates that phase information is included in the response, whereas Power indicates no phase information
- **Detector Accuracy:** 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.08, 0.1, 0.15, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8, 1.0, 1.5, 2, 3 and 6 dB. The value specifies the required accuracy of the measurement (67% confidence level) when Complex Adaptive or Power Adaptive is selected
- **Detector Delay:** 0 ms, 10 ms, 20 ms, 50 ms, 100 ms, …, 10 s. The value specifies the delay before the detector is activated for each excitation frequency
- **Detector Max. Time:** 0 ms, 100 ms, 200 ms, 400 ms, 800 ms, 1.6 s, 3.2 s, 6.4 s, 12.5 s, …, 13 ks. For complex averaging, the value specifies the maximum measuring time after the detector algorithm has been activated. For linear averaging, the value specifies the averaging time

Time Selective Response Analysis

RESPONSE
Relative response (transfer function) or absolute response (response signal only) can be measured

FREQUENCY SWEEP
Fundamental: Start and Stop Frequency can be selected from 1 Hz to 25 kHz/50 kHz/100 kHz
Minimum Frequency Range: 39 Hz
Harmonic Distortion: Up to 20th order harmonic distortion can be selected. For the nth order harmonic distortion Start and Stop Frequency can be selected from 20 Hz to (40/n) kHz

TIME WINDOW
50 / (N × F), 100 / (N × F), 200 / (N × F), 400 / (N × F) and 800 / (N × F)
N = harmonic, F = frequency range

DELAY
0.0 s to 100.0 s (max 5 decimals, rounded off to nearest 10 µs value)

SWEEP TIME
0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512 s

AVERAGES
1 to 4096

PAUSE:
0.0 s to 100.0 s

CONDITIONING TONE
0.0 s to 10.0 s (max. 3 decimals, rounded off to nearest 10 ms value)

Ordering Information

In this section, the electroacoustics software packages are listed only using their node-locked license type numbers. However, all the electroacoustics software packages are also available as floating licenses (replace N by F)

PULSE ELECTROACOUSTICS TYPE 7907-S1
This software includes the following PULSE Electroacoustics software:

- Type 7797-N*: PULSE Basic Electroacoustics
- BZ-5548-N: PULSE SSR Analysis – Harmonic Distortion
- BZ-5549-N: PULSE SSR Analysis – Intermodulation Distortion
- BZ-5550-N: PULSE SSR Analysis – Difference Frequency Distortion
- BZ-5551-N: PULSE Directivity and Polar Plot
- BZ-5600-N: PULSE Sequencer
- BZ-5601-N: PULSE Data Manager for Electroacoustic Applications
- BZ-5602-N: PULSE Receiver Test Application
- BZ-5603-N: PULSE Loudspeaker Test Application
- BZ-5604-N: PULSE Thiele Small Parameter calculation
- BZ-5742-N: PULSE TSR Analysis – Harmonic Distortion
- BZ-5743-N: PULSE Microphone Test Application
- M1-7797-N: Annual Software Maintenance and Support Agreement for PULSE Basic Electroacoustics
- M1-5548-N: Annual Software Maintenance and Support Agreement for PULSE SSR Analysis – Harmonic Distortion
- M1-5549-N: Annual Software Maintenance and Support Agreement for PULSE SSR Analysis – Intermodulation Distortion
- M1-5550-N: Annual Software Maintenance and Support Agreement for PULSE SSR Analysis – Difference Frequency Distortion
- M1-5551-N: Annual Software Maintenance and Support Agreement for PULSE Directivity and Polar Plot
- M1-5600-N: Software Maintenance and Support Agreement for PULSE Sequencer
- M1-5602-N: Software Maintenance and Support Agreement for PULSE Receiver Test Application
- M1-5603-N: Software Maintenance and Support Agreement for PULSE Loudspeaker Test Application

* Requires PULSE FFT & CPB Analysis Type 7700, PULSE FFT Analysis Type 7770 or PULSE CPB Analysis Type 7771

- M1-5604-N: Software Maintenance and Support Agreement for PULSE Thiele Small Parameter calculation
- M1-5742-N: Software Maintenance and Support Agreement for PULSE TSR Analysis – Harmonic Distortion
- M1-5743-N: Software Maintenance and Support Agreement for PULSE Microphone Test Application

PULSE ELECTROACOUSTICS SOFTWARE OPTIONS

Type 7797-N*	PULSE Basic Electroacoustics
BZ-5548-N†	PULSE SSR Analysis – Harmonic Distortion
BZ-5549-N†	PULSE SSR Analysis – Intermodulation Distortion
BZ-5550-N†	PULSE SSR Analysis – Difference Frequency Distortion
BZ-5551-N†	PULSE Directivity and Polar Plot
BZ-5600-N	PULSE Sequencer
BZ-5601-N	PULSE Data Manager for Electroacoustics
BZ-5602-N	PULSE Receiver Test Application
BZ-5603-N	PULSE Loudspeaker Test Application
BZ-5604-N	PULSE Thiele Small Parameter calculation
BZ-5742-N	PULSE TSR Analysis – Harmonic Distortion
BZ-5743-N	PULSE Microphone Test Application
M1-7797-N	Annual Software Maintenance and Support Agreement for PULSE Basic Electroacoustics
M1-5548-N	Annual Software Maintenance and Support Agreement for PULSE SSR Analysis – Harmonic Distortion
M1-5549-N	Annual Software Maintenance and Support Agreement for PULSE SSR Analysis – Intermodulation Distortion
M1-5550-N	Annual Software Maintenance and Support Agreement for PULSE SSR Analysis – Difference Frequency Distortion
M1-5551-N	Annual Software Maintenance and Support Agreement for PULSE Directivity and Polar Plot
M1-5600-N	Software Maintenance and Support Agreement for PULSE Sequencer
M1-5602-N	Software Maintenance and Support Agreement for PULSE Receiver Test Application
M1-5603-N	Software Maintenance and Support Agreement for PULSE Loudspeaker Test Application
M1-5604-N	Software Maintenance and Support Agreement for PULSE Thiele Small Parameter calculation
M1-5742-N	Software Maintenance and Support Agreement for PULSE TSR Analysis – Harmonic Distortion
M1-5743-N	Software Maintenance and Support Agreement for PULSE Microphone Test Application

Optional PULSE Electroacoustics Hardware Configurations

LOUDSPEAKER TESTING USING MEASURING MICROPHONE

Type 2735	Audio Amplifier
Type 4191-L-001	Free-field ½″ Microphone with Type 2669-L Microphone Preamplifier
Type 4231	Sound Calibrator
AO-0428	Preamplifier Cable
WL-1324	XLR to BNC Cable, 3 m (10 ft)
WL-1325	Speakon to Banana Cable, 5 m (16.4 ft)

Recommended configuration: LAN-XI Generator, Input/Output Module Type 3160-A-042; PULSE SSR Analysis – Harmonic Distortion BZ-5548-N; PULSE SSR Analysis – Intermodulation Distortion BZ-5549-N; PULSE Directivity and Polar Plot BZ-5551-N; PULSE TSR Analysis – Harmonic Distortion BZ-5742-N; Turntable System Type 9640

RECEIVER TESTING USING EAR SIMULATOR

Type 2669-L	Microphone Preamplifier
Type 4153	Artificial Ear with ½″ Microphone (IEC−318)
Type 4192	Pressure-field ½″ Microphone
Type 4231	Sound Calibrator
AO-0428	Preamplifier Cable

Recommended configuration: LAN-XI Generator, Input/Output Module Type 3160-A-042; PULSE SSR Analysis – Harmonic Distortion BZ-5548-N

MICROPHONE TESTING USING MOUTH SIMULATOR

Type 2735	Audio Amplifier
Type 4191-L-001	Free-field ½″ Microphone with Type 2669-L Microphone Preamplifier
Type 4227	Mouth Simulator
Type 4231	Sound Calibrator
AO-0428	Preamplifier Cable
WL-1324	XLR to BNC Cable, 3 m (10 ft)
WL-1325	Speakon to Banana Cable, 5 m (16.4 ft)

Recommended configuration: LAN-XI Generator, Input/Output Module Type 3160-A-042; PULSE SSR Analysis – Harmonic Distortion BZ-5548-N; PULSE Directivity and Polar Plot BZ-5551-N; PULSE TSR Analysis – Harmonic Distortion BZ-5742-N; Turntable System Type 9640

TELEPHONE TESTING USING TEST HEAD

Type 2735	Audio Amplifier
Type 4185	Ear Simulator
Type 4191	Free-field ½″ Microphone‡
Type 4195	Wideband Ear Simulator
Type 4227	Mouth Simulator
Type 4231	Sound Calibrator
Type 4602-B	Test Head
WL-1324	XLR to BNC Cable, 3 m (10 ft)
WL-1325	Speakon to Banana Cable, 5 m (16.4 ft)

Recommended configuration: LAN-XI Generator, Input/Output Module Type 3160-A-042; PULSE SSR Analysis – Harmonic Distortion BZ-5548-N

For information on a complete turnkey solution for measurements on mobile phones, please see Product Data sheet for Voice Testing for Mobile Phones Type 6712 (BP 1683)

TELEPHONE TESTING USING HATS

Type 2735	Audio Amplifier
Type 4128-D	Head and Torso Simulator
Type 4938-A-011	¼″ Microphone
Type 4231	Sound Calibrator
DP-0775	Calibration Adaptor
WL-1324	XLR to BNC Cable, 3 m (10 ft)
WL-1325	Speakon to Banana Cable, 5 m (16.4 ft)

Recommended configuration: LAN-XI Generator, Input/Output Module Type 3160-A-042; PULSE SSR Analysis – Harmonic Distortion BZ-5548-N

For information on a complete turnkey solution for measurements on mobile phones, please see Product Data sheet for Voice Testing for Mobile Phones Type 6712 (BP 1683)

* Requires Type 7770, Type 7771 or Type 7700

† Requires PULSE Basic Electroacoustics Type 7797

‡ Required when using Type 4195

HEARING AID TESTING USING EAR SIMULATOR AND ANECHOIC TEST BOX

Type 2735	Audio Amplifier
Type 4191-L-001	Free-field ½″ Microphone with Type 2669-L Microphone Preamplifier
Type 4231	Sound Calibrator
Type 4232	Anechoic Test Box
Type 4946	2 cc coupler
AO-0428	Preamplifier Cable
WL-1324	XLR to BNC Cable, 3 m (10 ft)
WL-1325	Speakon to Banana Cable, 5 m (16.4 ft)

Recommended configuration: LAN-XI Generator, Input/Output Module Type 3160-A-042; PULSE SSR Analysis – Harmonic Distortion BZ-5548-N; PULSE SSR Analysis – Intermodulation Distortion BZ-5549-N; PULSE Directivity and Polar Plot BZ-5551-N; Turntable System Type 9640

AUDIOMETER TESTING USING EAR SIMULATOR AND ARTIFICIAL MASTOID

Type 2647-A	Charge Amplifier*
Type 2669-L	Microphone Preamplifier
Type 4152	Artificial Ear with 1″ Microphone (IEC, ANSI, NBS)
Type 4153	Artificial Ear with ½″ Microphone (IEC–318)
Type 4231	Sound Calibrator
Type 4930	Artificial Mastoid
AO-0091	Lemo to BNC Cable
AO-0531	BNC to Microdot Cable
AO-0428	Preamplifier Cable
JJ-2617	Input Adaptor ½″ Microphone to Microdot†

Recommended configuration: LAN-XI Generator, Input/Output Module Type 3160-A-042

* When using charge conditioning

HEADPHONE AND HEADSET TESTING USING HATS

Type 2735	Audio Amplifier
Type 4938-A-011	¼″ Microphone
Type 4128-C	Head and Torso Simulator
Type 4231	Sound Calibrator
DP-0775	Calibration Adaptor
WL-1324	XLR to BNC Cable, 3 m (10 ft)
WL-1325	Speakon to Banana Cable, 5 m (16.4 ft)

Recommended configuration: LAN-XI Generator, Input/Output Module Type 3160-A-042; PULSE SSR Analysis – Harmonic Distortion BZ-5548-N

DIRECTIVITY MEASUREMENTS USING TURNTABLE SYSTEM

Type 9640	Turntable System
WQ-1270	IEEE–488 Interface Card, PCI-GPIB†
WQ-1290	IEEE–488 Interface Card, PCMCIA‡

† For desktop PC
‡ For laptop PC

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