Software for PULSE™ LabShop

including Types 7700, 7705, 7709, 7764, 7770, 7771, 7773, 7789 and 7797

PULSE is Brüel & Kjær's platform for noise and vibration analysis and builds on 70 years of measurement experience and innovation.

The PULSE hardware/software family is your solid foundation upon which to build a system to suit your present needs, and which can also be extended as your requirements change. This expandability, and the continuing development of new PULSE applications and hardware, ensures the safety of your investment now and in the future.

PULSE's flexibility, combined with industry-specific solutions, has made PULSE Brüel & Kjær's best-selling analyzer platform. The PULSE system is a leader in a wide range of industries including:

- *Automotive*
- *Electroacoustics and telecommunications*
- *Aerospace and defence*
- *Consumer products*

PULSE Software and Literature Overview

The base measurement software for a PULSE system is PULSE FFT & CPB Analysis Type 7700. Separate FFT and CPB licenses are also available as FFT Analysis Type 7770 and CPB Analysis Type 7771. On this base, you can install PULSE application software such as Time Data Recorder Type 7708. Table 1 illustrates the range of application software available for use with PULSE systems.

With a PULSE Software Maintenance and Support Agreement (M1) you can ensure that your PULSE installation is kept updated to the latest security updates from Microsoft® as well as having access to a global network of specialists, with experience from more than 13,000 PULSE systems in a multitude of application and test configurations. Details of the PULSE Software Maintenance and Support Agreement are given in BP 1800.

We strongly recommend that you update your PULSE installation to the latest major release to ensure that the latest security updates from Microsoft® are supported by your installation.

Details on PULSE Reflex™, which brings data acquisition together with a wide range of generic post-processing tools for off-line analysis and processing of time data and spectra, can be found in application-specific Product Data such as PULSE Reflex Core, which contains PULSE LabShop compatible FFT, CPB (1/n-octave) and order analysis (BP 2258) or PULSE Reflex Modal Analysis (BP 2257). See Table 1 for further references to PULSE LabShop or PULSE Reflex Product Data.

Details of the LAN-based hardware available for use with PULSE are given in the LAN-XI Data Acquisition Hardware Product Data (BP 2215).

Brüel & Kjær

Table 1 *Overview of PULSE application software specifying support of FFT & CPB Analysis Type_7700, FFT Analysis Type 7700 and/or CPB Analysis Type 7771 with references to Brüel & Kjær source literature. See also the PULSE Analyzers and Solutions catalogue BF 0209*

	Type/Part Number	FFT and CPB Analysis Type 7700	FFT Analysis Type 7770	CPB Analysis Type 7771	Further Information	Specifications
Platform Enhancements						
PULSE Time Capture	7705	●	●	●	page 9	page 17
PULSE Time Data Recorder	7708	●	●	●	BP 2110	BP 2110
PULSE Viewer	7709	●	●	●	page 9	–
PULSE Reflex Base	8700	●*	●*	●*	BP 2258	BP 2258
PULSE Reflex Basic Post-processing	8702	●*	●*	●*	BP 2258	BP 2258
PULSE Reflex Advanced Processing	8703				BP 2258	BP 2258
PULSE Reflex Standardized CPB Option	8706	●*		●*	BP 2258	BP 2258
LAN-XI Notar†	BZ-7848-A	●	●	●	BP 2215	BP 2215
Acoustic Applications						
PULSE Sound Quality	7698	●	●	●	BP 1589	BP 1589
PULSE Material Testing	7758	●	●		BP 1870	BP 1870
PULSE Acoustic Test Consultant	7761	●	●	●	BP 1908	BP 1908
PULSE Vehicle Pass-by Systems, Ground/Vehicle	7788-G, -V	●			BP 2011	BP 2011
PULSE Indoor Pass-by	7793	●			BP 2015	BP 2015
PULSE Sound Power	7799	●		●	BP 2093	BP 2093
PULSE Sound Power using Sound Intensity	7882	●	●	●	BP 2494	BP 2494
PULSE Sound Power Determination for Earth-moving Machinery	7883	●		●	BP 2521	BP 2521
PULSE Sound Power for Reverberation Rooms	7884	●		●	BP 2519	BP 2519
PULSE Noise Emission Outdoor Machinery, Directive 2000-14	7885	●		●	BP 2539	BP 2539
PULSE Sound Power of Fans	7886	●		●	BP 2549	BP 2549
PULSE Wind Turbine Sound Power Determination	7914	●			BP 2322	BP 2322
PULSE Small Wind Turbine Sound Power Determination	7915	●			BP 2492	BP 2492
PULSE Spherical Beamforming	8606	●	●	●	BP 2144	BN 0690
PULSE Acoustic Holography	8607	●	●	●	BP 2144	BP 2144
PULSE Beamforming	8608	●	●	●	BP 2144	BP 2144
PULSE Reflex SQ Metrics‡	8710				BP 2258	BP 2258
PULSE Reflex Array Analysis	8781				BP 2534	BP 2534
PULSE Sound Quality Zwicker Loudness	BZ-5265	●	●	●	BP 1589	BP 1589
PULSE Sound Quality Order Analysis	BZ-5277	●	●	●	BP 1589	BP 1589
PULSE Pyschoacoustic Test Bench	BZ-5301	●	●	●	BP 1589	BP 1589
Robot Option for ATC	BZ-5370	●	●	●	BP 1908	BP 1908
PULSE Position Detection Option	BZ-5611	●	●	●	BP 1908	BP 1908
PULSE Quasi-stationary Calculations	BZ-5635	●	●	●	BP 2144	BP 2144
PULSE Transient Calculations	BZ-5636	●	●	●	BP 2144	BP 2144
PULSE Conformal Calculations	BZ-5637	●	●	●	BP 2144	BP 2144
PULSE Plug-in Manager	BZ-5652	●	●	●	BP 2144	BP 2144
PULSE SQ Metrics Calculations	BZ-5638	●	●	●	BP 2144	BP 2144
PULSE Refined Beamforming	BZ-5639	●	●	●	BP 2144	BP 2543
PULSE Wideband Holography	BZ-5644	●	●	●	BP 2144	BP 2530
PULSE Proximal Holography	BZ-5693	●	●	●	BP 2144	BP 2538
PULSE Panel Contribution	BZ-5640	●	●	●	BP 2144	BP 2144
PULSE Intensity Component Analysis	BZ-5641	●	●	●	BP 2144	BP 2144
PULSE In situ Absorption	BZ-5642	●	●	●	BP 2144	BP 2144
PULSE Array Acoustics Rail Vehicles Moving Source Beamforming	BZ-5939	●	●	●	BP 2454	BP 2454

	Type/Part Number	FFT and CPB Analysis Type 7700	FFT Analysis Type 7770	CPB Analysis Type 7771	Further Information	Specifications
PULSE Array Acoustics Flyover Moving Source Beamforming	BZ-5940	•	•	•	BP 2537	BV 0064
PULSE Array Acoustics Wind Turbines Moving Source Beamforming	BZ-5941	•	•	•	BP 2493	BP 2493
PULSE Array Acoustics Road Vehicles Moving Source Beamforming	BZ-5943	•	•	•	BP 2453	BP 2453
Electroacoustics						
PULSE Basic Electroacoustics	7797	•	•		page 13	page 17
PULSE Electroacoustics	7907	•	•	•	BP 2085	BP 2085
PULSE Reflex Telephone Test Software	8770	•			BP 2428	–
PULSE Reflex Telephone Test Suite for 3GPP2 C.S5600-0	8772-X01	•			BP 2429	–
PULSE Reflex Telephone Test Suite for 3GPP TS.26.132 (Handset)	8772-X02	•			BP 2522	–
PULSE Reflex Telephone Test Suite for 3GPP TS.26.132 (Hands-free)	8772-X04	•			BP 2522	–
PULSE Reflex Telephone Test Suite for CES-Q003-2	8772-X05	•			BP 2528	–
PULSE Reflex Telephone Test Suite for YD/T-1538 (Handset)	8772-X06	•			BP 2532	–
PULSE Reflex Telephone Test Suite for CMCC	8772-X07	•			BP 2542	–
PULSE Reflex Telephone Test Suite for YD/T-1538 (Hands-free)	8772-X08	•			BP 2532	–
PULSE SSR Analysis – Harmonic Distortion	BZ-5548	•	•		BP 2085	BP 2085
PULSE SSR Analysis – Intermodulation Distortion	BZ-5549	•	•		BP 2085	BP 2085
PULSE SSR Analysis – Difference Frequency Distortion	BZ-5550	•	•		BP 2085	BP 2085
PULSE Directivity and Polar Plot	BZ-5551	•	•		BP 2085	BP 2085
PULSE Sequencer	BZ-5600	•	•		BP 2085	BP 2085
PDM for Electroacoustics	BZ-5601	•	•		BP 2085	BP 2085
PULSE Receiver Test Applications	BZ-5602	•	•		BP 2085	BP 2085
PULSE Loudspeaker Test Applications	BZ-5603	•	•		BP 2085	BP 2085
PULSE Thiele Small Parameter Calculation	BZ-5604	•	•		BP 2085	BP 2085
PULSE TSR Analysis – Harmonic Distortion	BZ-5742	•	•		BP 2085	BP 2085
PULSE Microphone Test Application	BZ-5743	•	•		BP 2085	BP 2085
PULSE Headset Test Application	BZ-5744	•	•		BP 2085	BP 2085
Machine Diagnostics						
PULSE Order Analysis	7702	•	•		BP 1634	BP 1634
PULSE Envelope Analysis	7773	•	•		page 12	page 17
PULSE Two-plane and Multi-plane Balancing Consultants	7790-A/B	•	•		BP 2010	BP 2010
PULSE Vibration Check for Aircraft Engines	7795	•	•		BP 2059	BP 2059
PULSE Vibration Analysis for Aircraft Engines	7906-S 1	•	•		BP 2059	BP 2059
PULSE Reflex Order Analysis	8704	•**	•**		BP 2258	BP 2258
PULSE Reflex Advanced Order Analysis	8705	•††	•††		BP 2258	BP 2258
Orbit and Polar Plots for PULSE	WT-9695	•	•		–	–
Structural Dynamics						
PULSE Structural Dynamic Test Consultants	7753/7765	•	•		BP 1850	BP 1850
PULSE Operational Modal Analysis (OMA)	7760	•	•		BP 1889	BP 1889
Batch Processing Option for OMA Pro	BZ-8527	•	•		BP 1889	BP 1889
PULSE Multiple-Input Multiple-Output Analysis	7764	•	•		page 11	page 17
PULSE Run-up/down ODS Option	BZ-5612	•	•		BP 1850	BP 1850
PULSE Animation Option	BZ-5613	•	•		BP 1850	BP 1850
PULSE Reflex Finite Element Interfaces	8718				BP 2395	BP 2395
PULSE Reflex Geometry	8719				BP 2257	BP 2257
PULSE Reflex Modal Analysis	8720	•‡‡	•‡‡		BP 2257	BP 2257

	Type/Part Number	FFT and CPB Analysis Type 7700	FFT Analysis Type 7770	CPB Analysis Type 7771	Further Information	Specifications
PULSE Reflex Advanced Modal Analysis	8721	●‡‡	●‡‡		BP 2257	BP 2257
PULSE Reflex Correlation Analysis	8722				BP 2395	BP 2395
PULSE Reflex Spectral Analysis	8729-A	***	***		BP 2518	BP 2518
PULSE Reflex Structural Measurements – Hammer and Shaker	8729-B	***	***		BP 2518	BP 2518
PULSE Reflex Structural Measurements – Stepped Sine	8729-C				BP 2518	BP 2518
PULSE Reflex Shock Response Analysis	8730				BP 2339	BP 2339
Vibroacoustics						
PULSE Source Path Contribution	7798	●	●		BP 2086	BP 2086
PULSE DTS Software for NVH Simulator	8601	●	●		BP 2109	BP 2109
Test and Data Management						
PULSE Data Manager	7767	●	●	●	BP 1961	BP 1961
PULSE Time	7789	●	●	●	page 10	page 17
PULSE Automotive Test Manager	7796	●	●	●	BP 2061	BP 2061
PULSE CAN Bus Option	BZ-5610	●	●	●	BP 2150	BP 2150

* PULSE Reflex features are accessible with Like-for-Like functionality
† Analysis using Type 7701 (part of Type 7708) and Type 8702
‡ Part of Like-for-Like with Type 7698
** PULSE Reflex Type 8704 features are accessible with Like-for-Like functionality with Type 7702-N1 to NN licence
†† PULSE Reflex Type 8705 features are accessible with Like-for-Like functionality with Type 7702-N2 to NN licence
‡‡ With Modal Test Consultant Type 7753
*** Types 7700/7770 plus 7753 give Types 8729-A and 8729-B as Like-for-Like

FFT & CPB Analysis Type 7700

Type 7700 is PULSE LabShop's base software for FFT, CPB (Constant Percentage Bandwidth, 1/n-octave) and overall level analysis with simultaneous measurement of exponential, linear, impulse and peak levels. Type 7700 provides general noise and vibration testing using real-time, multichannel analysis as well as general R & D, noise and vibration analysis using several analyzers and multiple frequency spans simultaneously.

With user-definable measurement solutions, all basic requirements, including data acquisition, calibration, measurement, analysis, post-processing and reporting are convenient and manageable.

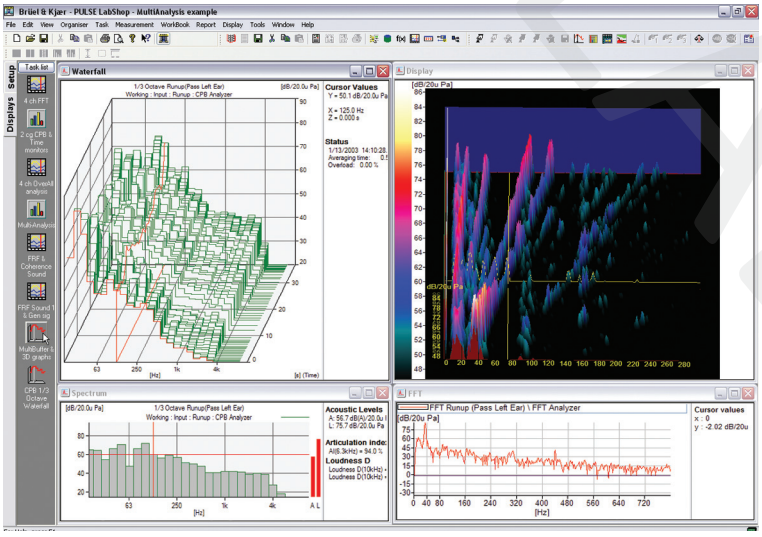


Fig. 1
PULSE software showing task-oriented user interface

Powerful Analysis Capabilities

- Real-time measurements on over 200 channels (recordings and post-analysis on over 300)
- Multi-analysis allows multiple analyses of the same input data, reduces test and reporting time, and ensures consistency of data, for example:
  - Simultaneous FFT and 1/n-octave analysis of the same data
  - Simultaneous analysis using several FFT analyzers with different properties such as frequency span, zoom, etc.
- Real-time signal analysis using the PC's CPU (typical performance, 2.6 GHz i7 Quad Core PC):
  - FFT analysis on 160 channels to 25.6 kHz bandwidth (67% overlap, 800 lines)
  - 1/3-octave analysis on 80 channels to 25.6 kHz bandwidth
- Powerful signal generator, providing a host of sine, random and user-definable waveforms (requires hardware module with generator support, see BP 2215)
- Tonality and prominence ratio calculations according to ECMA 74 and ISO 7779
- Reverberation time calculation

FFT, CPB and Overall Level Analyzers

The FFT analyzer allows real-time, multichannel FFT spectrum analyses whether you want to perform mobility measurements, vibration diagnostics or narrow-band analysis of acoustic signals.

- Supplied in Types 7700/7770

PULSE's CPB analyzer provides real-time standardized digital filter-based analysis using 1/1, 1/3, 1/12 and 1/24 octaves. This 1/n-octave analysis is often preferable to FFT analysis when analysing noise. The real-time CPB analyzer can be used, among other things, for the determination of sound power levels and intensity measurements. CPB filters meet the requirements of IEC 61260–1:2014 Class 1, DIN 45651, ANSI S1.11–1986, ANSI S1.11–2004 and ANSI S1.11–2014.

- Supplied in Types 7700/7771

For characterizing your noise or vibration signals, there is an overall level analyzer, which performs a broadband analysis. When measuring sound, this analyzer is equivalent to a sound level meter and meets selected, relevant requirements of IEC 651, IEC 61672–1:2013 and IEC 60804 for a class 1 instrument.

- Supplied in Types 7700/7770/7771

Selective Intensity

PULSE LabShop FFT and CPB analyzers support the selective intensity function that can be used to determine the internal root causes of the noise sources observed at the surface of an object. Selective intensity provides a direct way to measure whether an external 'hot-spot' is related to a specific internal root cause.

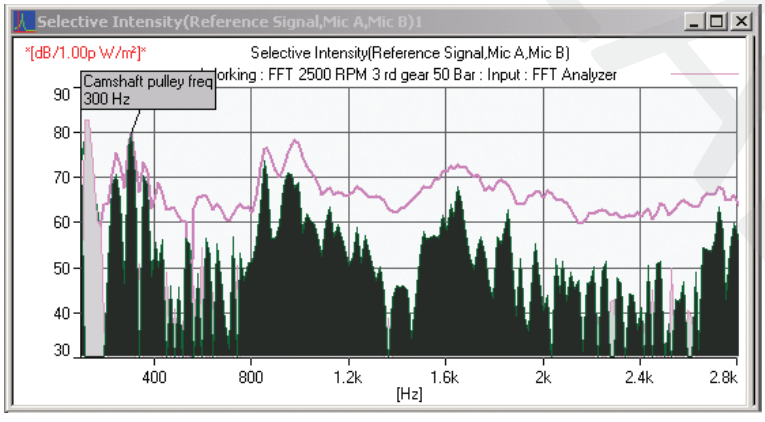


Fig. 2
Selective intensity can be used to rank noise sources, for example in terms of contribution to cabin noise
Pink: Ordinary intensity
Black: Selective intensity
The pulley belt frequency of 300 Hz is fully audible at the driver's position

The selective intensity function calculates that part of the full measured intensity that is coherent with a specific reference signal. If, for instance, the vibration of a specific part is suspected to be the main cause of the noise radiated, you can simply put an accelerometer on that part and use it as the reference for a selective intensity calculation. If the suspicion is correct, the selective intensity will be close to the full intensity observed.

The reference signal may be of any nature: acoustic, vibration, force, electrical, etc., whichever provides the cleanest and least noisy representation of the suspected root cause.

Smart Start

Now it is easier than ever to start and operate PULSE LabShop. With Smart Start, configuration and project setup is performed in just a few steps.

- Quick 3-step start-up for new projects: Select the default New Project template, click Start and start measuring

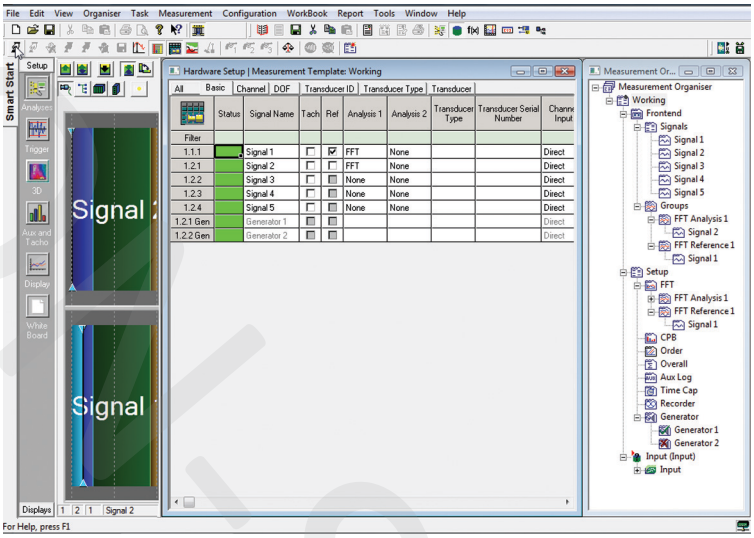


Fig. 3
Smart Start uses the Hardware Setup table to automatically detect current hardware connections – simply click Start to begin measurements

If a more advanced setup is required, the user interface's various organiser windows provide access to all analyses and function properties available:

- Find and connect any front end available on the LAN using the Front-end Setup. Management of front ends and IP addresses are done easily through the LAN
- Easy and automatic update of signal names and functions when loading a PULSE project on a new front end, or when opening time recordings into PULSE projects where signal names do not match

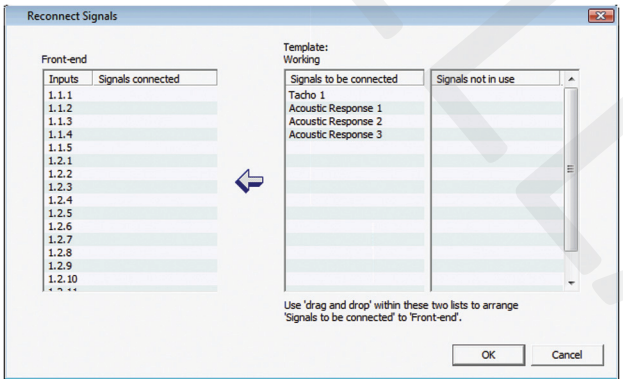


Fig. 4
Reconnect Editor facilitates easy connection of signals to match current hardware setup

Response Equalization

Response Equalization eXtreme (REq-X) allows you, in real-time, to effectively equalize the frequency response of a transducer to a flat response. This applies to both accelerometers and microphones. REq-X is performed by filtering the time signal of a transducer by the inverse of the frequency response. When applicable, the equalization can be performed in both phase and magnitude.

- Expands the high accuracy frequency range for transducers
- Extends the usability of existing transducers
- Use of the same microphone in different sound fields (free field, pressure field and random) and with various accessories can be compensated
- Microphone correction using the frequency response functions found in the Transducer Database
- Increase frequency range for accelerometers by up to 50%
- Automatic detection of the accelerometer frequency response via TEDS

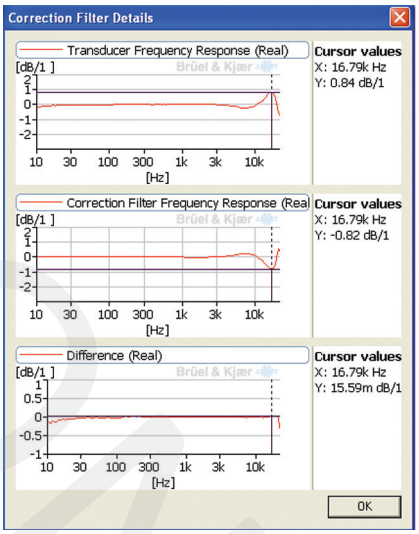


Fig. 5
The upper curve shows a typical microphone frequency response without correction. The middle curve shows the correction filter. The lower curve shows the resulting frequency response after equalization

Data Acquisition Hardware

- Automatic detection of front-end hardware and attached transducers – supports IEEE 1451.4 transducers with TEDS (transducer electronic data sheets)
- Automatic calibration sequencing and registration of calibration history
- Level meter for monitoring of conditioned signals for optimal data quality
- Hardware setup table provides easy management of multiple channels

Easy-to-use Software

- Runs on Microsoft® Windows® 10 (x64), Windows® 8.1 (x64), or Windows® 7 (x64) operating systems
- Task-oriented user interface that guides you through the measurement process step by step. Task views are easy to set up and customize for specific needs. They are the best way to switch easily between multiple display and settings windows
- Advanced graphical display and cursor facilities
- Data export in a variety of formats for use with external applications
- Linked with Microsoft® Word and Excel® allowing fast, automatic report generation and post-processing
- Supports external control and data export (OLE automation and ActiveX® control)
- Built-in VBA (Visual Basic® for Applications) allowing easy customization of PULSE
- A comprehensive library of sample projects and technical literature
- IRIG-B time/data synchronization – ensures timestamp alignment between different types of IRIG-B enabled instrumentation using an encoded analogue channel

Data Transfer and Post-processing

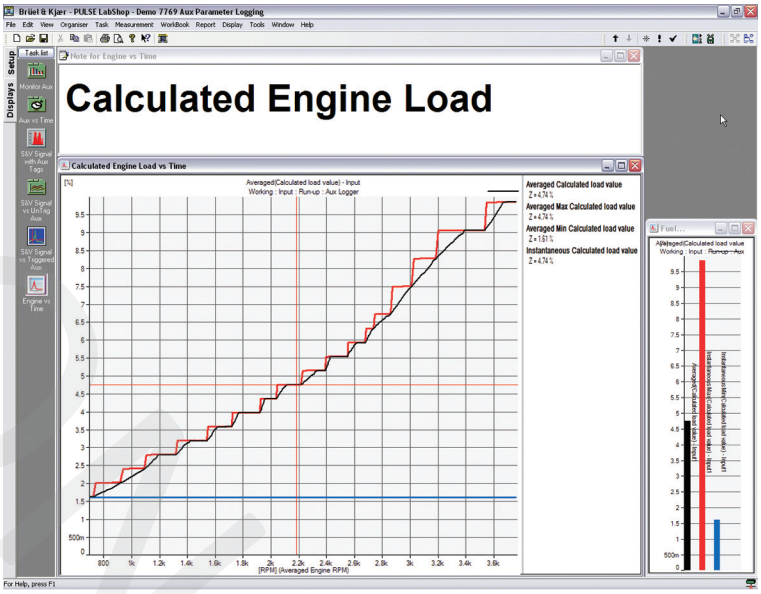
Transfer measurement data from PULSE LabShop to PULSE Reflex, MATLAB®, Excel®, etc., for post-processing and calculations with:

- Fast and flexible viewing, editing and selection of time data for post-processing
- Graphical display of measurement data
- Mathematical calculation procedures for experimental data
- Data comparison from experiment to numerical calculation
- Easy-to-use data transfer, including x-, y- and z-axis DOF annotation, using PULSE LabShop's Function Organiser

Auxiliary Parameter Logging

Measurement of auxiliary, pseudo-DC parameters with 12 channels of low-frequency (10 Hz sampling rate) input channels for IDA^{e} modules and 8 channels of low-frequency (16 Hz sampling rate) input channels for LAN-XI module Type 3056 that can be recorded along with the dynamic channels and used as logging or multi-buffer tags. Up to 100 digital channels can be measured using Generic Auxiliary Digital Interface Type 3099-E (GADI) with sampling rate determined by the GADI driver.

Fig. 6
A typical auxiliary parameter logging display in PULSE



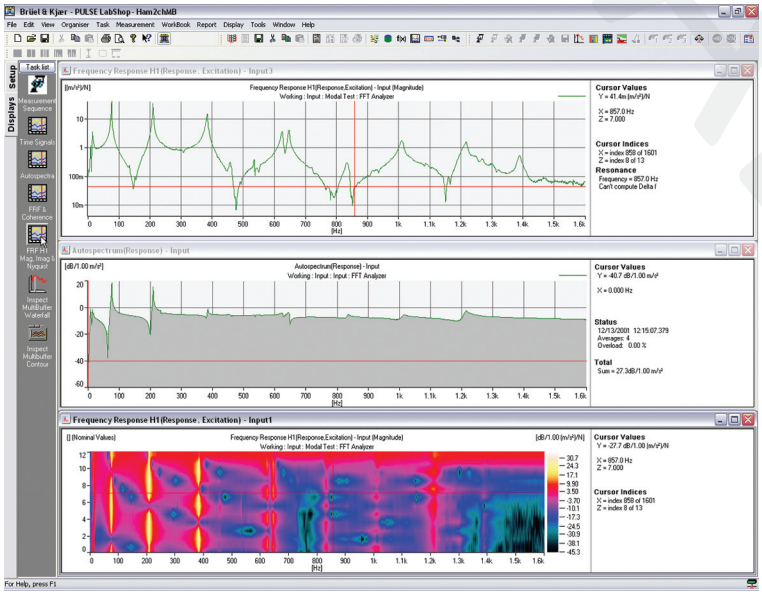
Typical applications include:

- Automotive – intake pressure, thermocouples, throttle position, vehicle acceleration/braking, CAN bus parameters, strain gauges
- Industrial – process parameters (temperature, pressure, control position, etc.)
- Production Line Testing – PLC control parameters, environmental conditions (temperature, barometric pressure)
- Pass-by Testing – environmental parameters

- Auxiliary data like temperature and wind speed are available as time data or as z-axis tags
- Integration of auxiliary parameters with dynamic data such as FFT, order and CPB spectra
- Data is available as instantaneous, instantaneous maximum, instantaneous minimum, linear average, averaged maximum, and averaged minimum
- Individual channels can be logged with multiple average settings (that is, average over 10 s and 24 hours)
- Access to auxiliary channels settings and data through OLE
- Requires cable AO-0738-D010 to connect to LAN-XI module Type 3056, or cables AO-1472 and AO-0594 to connect to IDA^{e} modules
- Requires customized code interface using Generic Auxiliary Digital Interface Type 3099-E

FFT Analysis Type 7770

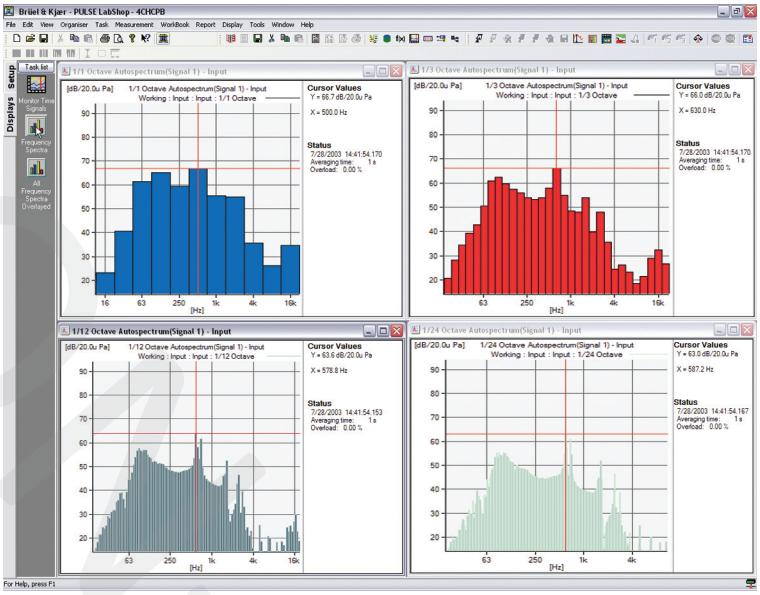
Fig. 7
Autospectrum, frequency response function (FRF) and contour plot of FRF for an impact hammer test



FFT Analysis Type 7770 is intended for users who only require FFT and overall analysis. With the exception of CPB analysis, it includes all the configuration, calibration, measurement, post-processing display and reporting features, including multi-analysis, described above for FFT & CPB Analysis Type 7700.

CPB Analysis Type 7771

Fig. 8
1/1-, 1/3-, 1/12- and 1/24-octave measurements of acoustic response from multiple, simultaneous, CPB analyzers



CPB Analysis Type 7771 is for users who only require 1/n-octave and overall analysis. With the exception of FFT analysis, it includes all the configuration, calibration, measurement, post-processing, display and reporting features, including multi-analysis, described above for FFT & CPB Analysis Type 7700.

PULSE Viewer Type 7709

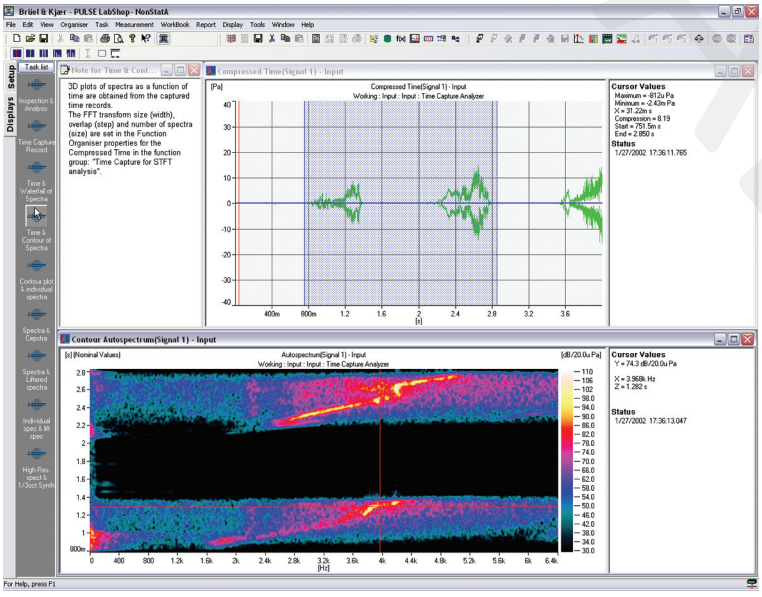
PULSE Viewer Type 7709 provides remote measurement viewing and report generation separate from the PC connected to the PULSE front end:

- Frees up your front end for more measurements and more efficient use
- Import multiple sets of measurement data
- Store data on a network drive for processing at any number of licensed workstations with only a single front end
- Handles data measured using Types 214x, FFT and CPB Analysis Type 7700, Order Analysis Type 7702 and Time Capture Type 7705

Time Capture Type 7705

Time Capture Type 7705 is designed for the capture of long time signals in PC memory and for their subsequent retrieval for post-processing or for data export. If a data recorder is installed, the input can also be played back from disk. Type 7705 allows you to extract any part of the recorded time signal for analysis.

Fig. 9
Using Time Capture and short-time Fourier transform (STFT) to analyse speech signals



Uses

- Capture, retrieval and export of time-data sequences
- Post-processing and time inspection of long time records
- Data export including waveform files (*.wav) at selectable sampling rate

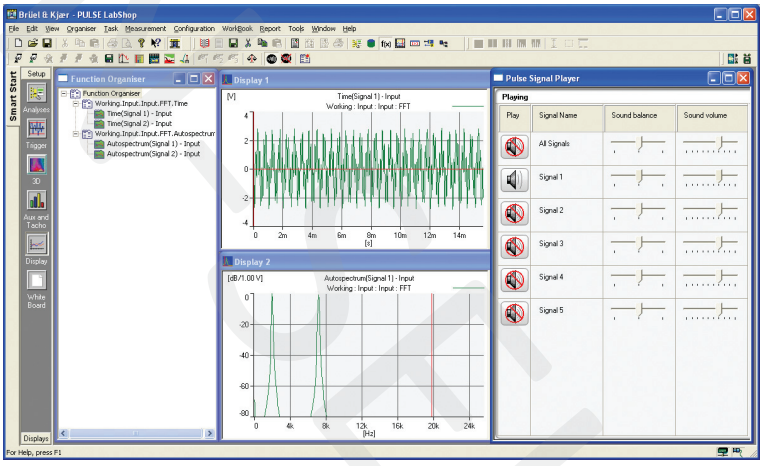
Features

- FFT, STFT and synthesis to other frequency resolutions while listening to time signals
- Pre-processing of input data
- All analysis done as post-processing
- Extraction of any selectable part of a recorded signal

PULSE Signal Player – Part of Types 7700, 7770, 7771

PULSE Signal Player allows you to listen to any of the active analogue channels using the PC's built-in sound card and headphone output.

Fig. 10
PULSE Signal Player



Uses

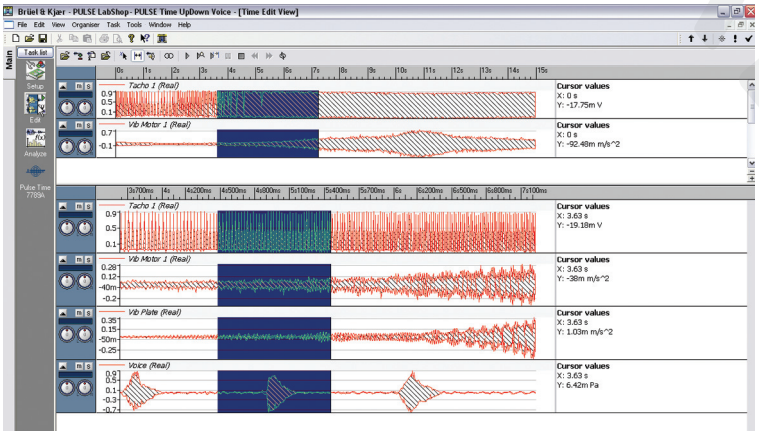
- Enables you to listen to any of the analogue channels during measurement or recording

Features

- Allows you to select between channels during measurement or recording
- Allows you to listen to the channel using the computer's built-in sound card
- Allows you to individually control balance and volume per monitored channel
- Allows you to mix the sound from many (all) channels

PULSE Time Type 7789

Fig. 11
Using PULSE Time to select portions of recorded signals for post-analysis



PULSE Time Type 7789 allows you to listen to time data recordings or to select portions of the recorded signals for post-analysis. Import, edit and inspect the recordings prior to analysis as well as export them. PULSE LabShop lets you analyse an edited recording by opening PULSE Time in a running project.

Uses

- Allows the import, export, inspection and editing of PULSE time data recordings (*.dat, *.pti), Universal File Format (*.uff), Time Data Format (*.tdf), Waveform (*.wav), TEAC (*.hdr), MATLAB (*.mat), Head Acoustics (*.hdf) and Test for I-deas Time (*.ati) files
- Enables you to listen to any part of the time data recording
- Enables you to focus post-analysis on a particular part of a time data recording

Features

- Accesses data from disk, handling very large files without exhausting computer memory
- Allows you to inspect multiple signals, in both overview and edit panes
- Allows you to listen to the full signal, or selected tracks and ranges
- Allows you to select/crop a time range and select individual signals for further analysis with any PULSE measurement project

Multiple-Input Multiple-Output Analysis Type 7764

MIMO Analysis Type 7764 allows multiple-input multiple-output (MIMO) analysis on large, complex and/or symmetrical structures.

Fig. 12
Application of PULSE multiple-input multiple-output (MIMO) analysis using multiple shakers and accelerometers

On large structures such as aircraft, it may not be possible to drive the entire structure from a single excitation point. The solution is to distribute the excitation over the structure using several smaller shakers. This also reduces the risk of non-linear structural behaviour.

Complex structures exhibit local modes that require multiple excitation points in order to extract all of them.

On symmetrical structures, repeated roots are found (that is, multiple modes at the same frequency). The solution here is to decompose the repeated roots using MIMO analysis and polyreference curve-fitting.

In addition, measuring simultaneously multiple output optimizes data consistency.

Uses

- Analysis of large structures requiring high excitation energy
- Analysis of complex structures with local modes
- Analysis of symmetrical structures with repeated roots

Features

- Determination of MIMO Frequency Response Function H_1 and H_v, ordinary coherence and multiple coherence
- Number of inputs limited only by your PC's processing power
- Automatic parameter setup when used with Modal Test Consultant Type 7753

Envelope Analysis Type 7773 is implemented as one of three 'modes' in PULSE LabShop's FFT analyzer (baseband, zoom, envelope). It can be used for diagnostics/investigation of machinery where faults have an amplitude modulating effect on the characteristic frequencies of the machinery.

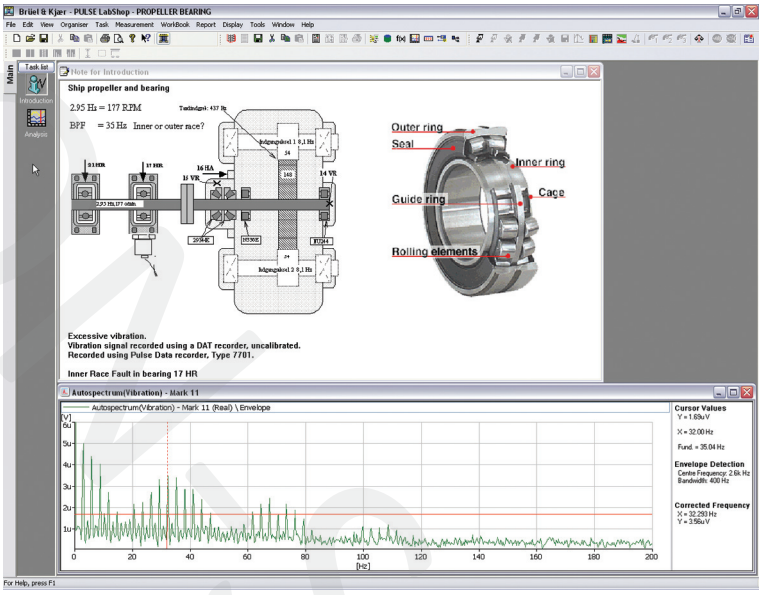


Fig. 13
Application of envelope analysis to detect and identify faults in roller-bearings

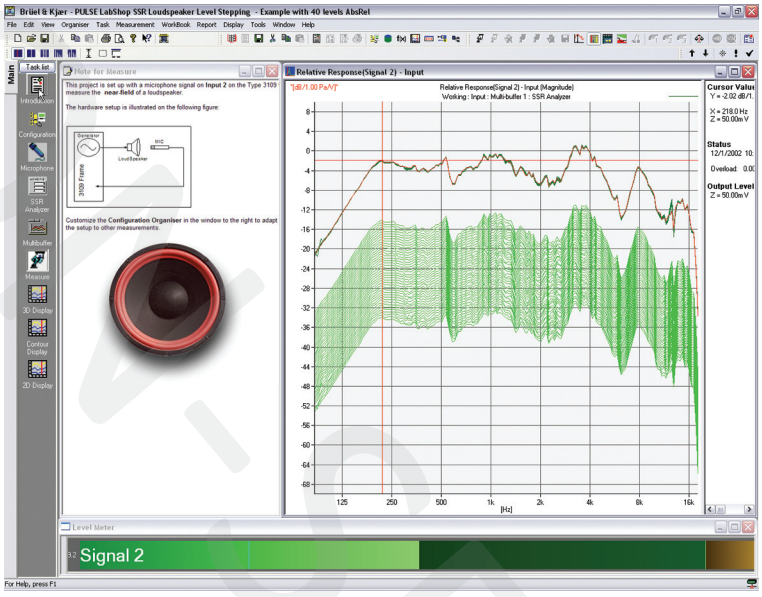
Uses

- Amplitude demodulation, that is, detection of the spectral and temporal representation of the modulating signal
- Spectral (what frequency) and temporal (where in a cycle) identification of the occurrences of impulsive events in rotating machinery
- Common applications:
  - Roller-bearing elements: identification of cracks in inner race, outer race or roller defects
  - Gear boxes: identification of cracked or broken teeth from impulsive modulation of the tooth-meshing frequency
  - Turbine blades: identification of broken or distorted blades from modulation of the blade-passing frequency
  - Induction motors: identification of broken or cracked rotor bars, or bad soldering from modulation of slot harmonics by twice the slip frequency
- Reciprocating machinery: determination of precise point (in time) in the cycle of impulsive events like valve openings/closings or combustion

Basic Electroacoustics Type 7797

PULSE Basic Electroacoustics uses stepped- or swept-sine excitation to measure responses of electroacoustic systems. Reliable and efficient testing is made possible with user-definable measurement and analysis setup – allowing you to characterize electroacoustic equipment using traditional performance specifications such as: frequency response, linearity, directivity, delay, impedance, etc., with a wide range of acoustical and vibration measurements.

Fig. 14
Application of basic electroacoustics on a speaker using level stepping



Uses

- Development and quality control testing of electroacoustic and vibration transducers: loudspeakers, telephones, headphones, microphones, hearing-aids, hydrophones, accelerometers
- Linear and non-linear system analysis
- Acoustical measurements in rooms and vehicles

Features

- Frequency response measurements using the steady state response method
- Excellent noise suppression using the steady state response method
- Fast measurements using the time selective response method

Electronic License Protection System

To accommodate a modern working environment, PULSE LabShop uses a flexible electronic license protection system (Flexnet®). There are two main license models, N and F:

- Node-locked license (N) – license locked to a specific PC's hardware or hardware key
- Floating license (F) – a network server lends out licenses in a larger work environment allowing multiple users to share a single license

PULSE will, as standard, be supplied with a node-locked licence applicable to a single PC. Licenses can be issued/fulfilled directly through a Web interface and hardware keys can be purchased if required.

One of the benefits of this system is that you can combine licenses from different license models. For example, two separate Type 7700 licenses can be combined to give a system with an unlimited number of channels if the combined number of channel licenses is eight or more. In this way, it is possible to 'stack' licenses.

PULSE Software

We strongly recommend that you update your PULSE installation to the latest major release to ensure that the latest security updates from Microsoft® are supported by your installation
The software can be ordered with a license for measurement on a specified number of channels (see Ordering Information). As many signal groups as desired can be created from the measured signals. The license is either node-locked to a PC host ID or hardware key, or floating – locked to a network server

Recommended PC

- Intel® Core™ i7 3 GHz processor, or better
- 32 GB RAM
- 480 GB Solid State Drive (SSD) with 20 GB free space, or better
- DVD-RW drive
- 1 Gbit Ethernet network
- Microsoft® Windows® 10 Pro or Enterprise (x64)
- Microsoft® Office 2016 (x32)
- Adobe® Reader® 11
- Microsoft® SQL Server® 2014 Express (SP1) (included with PULSE)

Hardware Configuration

The software automatically detects the front-end hardware connected and configures the system. If IEEE 1451.4 capable transducers (with standardized TEDS) are being used, these are also detected and attached automatically to the correct channel of the input module

Calibration and System Validation

Calibration can be performed before or after measurement. The program uses automatic calibration sequencing

Measurement Control

AVERAGING
Averaging types available for the measured signals are:
- Linear
- Exponential
- Max. hold
- Min. hold
- +Peak
- −Peak
- Overlaps – fixed values of 0%, 50%, 66.67%, 75% and max. (95%)

TRIGGER TYPES
- Signal
- Manual
- Free-run
- Time
- Generator
- Internal level (CPB and overall level analyzers)

A channel or a trigger delay can be applied

PRE-PROCESSING
Pre A-, B-, C- and D-weighting (IEC 61672–1:2013/IEC 651/IEC 60804 Class 1)

MULTI-ANALYSIS
A number of instruments of the same or different types can be used simultaneously. The instrument types in Type 7700 are:
- FFT analyzer
- CPB analyzer (1/n-octave) (IEC 61260–1: 2014 Class 1, DIN 45651, ANSI S1.11−1986, ANSI S1.11−2004 and ANSI S1.11−2014)
- Overall level analyzer (IEC 61672–1:2013/IEC 651/IEC 60804 Class 1)
- Signal generator
- Order tracking (with Type 7702)
- Time data recording (part of Time Data Recorder Type 7708)

Measurement

ANALYZERS
For the FFT, CPB and Overall Level analyzer specifications see the relevant analyzer specifications at the end of this section

MULTI-BUFFERS
No. of Multi-buffers: 8
Maximum Capacity: 30,000 and dependent on RAM in PC

Display

Maximum Display Cycle Rate: 25 times per second, per display, depending on PC hardware

GRAPH TYPES
Display of functions in a range of graph types including:
- Waterfall
- Waterfall (step)
- Colour contour
- Bar
- Line
- Curve
- Curve (step)
- Overlay
- Overlay (all)
- Multi-value

Superimposed Graphs: A number of functions can be superimposed on the same curve graph

DERIVED DISPLAYS
Harmonic and individual slices can be cut and extracted from contour, waterfall and overlay plots

AXES
X-axis Scale: Linear, logarithmic and CPB
Y-axis Scale: Linear, logarithmic and dB
Z-axis Scale: Linear and logarithmic

COORDINATES
- Real
- Imaginary
- Magnitude
- Phase
- Nyquist

SPECTRAL UNITS
- Root mean square (RMS)
- Power (PWR)
- Power spectral density (PSD)
- Root mean square spectral density (RMSSD)
- Energy spectral density (ESD)
- Peak (Peak)
- Peak-to-Peak (PkPk)

ACOUSTIC POST-WEIGHTING
- A-, B-, C-, D-, L-weighting

jω WEIGHTING
- $1/j\omega^2$, $1/j\omega$, 1, $j\omega$, $j\omega^2$ (single and double integration and differentiation)

Cursors

CURSOR TYPES
Depending on the display type, the following are available:
- Main
- Delta
- Reference
- Harmonic
- Sideband

Alignment: Cursors in different displays can be synchronized to allow the changes to one display to be reflected in other displays showing the same or different functions

CURSOR READINGS
The cursor values that can be read out include:
- Acoustic levels
- Corrected frequency
- Cursor indices and values
- Delta
- Delta/total
- Max. and min. values
- Nearest harmonic
- Nearest sideband
- Reference
- Resonance
- Reverberation
- Slice definition
- Status
- Total

Other cursor readings can be added

TOLERANCE CURVES
With tolerance curves you can define upper or lower tolerances that allow you to evaluate your measurement results. Pass/Fail tolerance check results are visible in the displays and can be sent out to any of the available auxiliary output channels

AUXILIARY PARAMETER LOGGING
Provided by IDA^e LAN modules Type 7533, 7536, 7537/37-A, 7538/38-A, 7539/39-A, 7540/40-A, 3560-B-XXX, and LAN-XI module Type 3056-A-040 for the integration of auxiliary parameters (temperature, wind speed, etc.) with dynamic data
Sampling Rate: 10 Hz each channel for IDA^e front ends, 16 Hz for LAN-XI module Type 3056. With Generic Auxiliary Digital Interface Type 3099-E, the sampling rate is determined by the GADI driver
Detectors: Instantaneous and Linear
Averaging: The following averaging modes are available:
- Average over a period
- Continuous running averaging

Average Over a Period of Time:
- Max. linear averaging time: 86,400 s (24 hr)
- Min. linear averaging time: 0.1 s
- Averaging can be reset by measurement start and/or a user selected trigger

Continuous Running Averaging: Via cyclic buffer
Averaging can be reset by measurement start and/or a user-selected trigger
Measurement Modes:
- Instantaneous
- Instantaneous Maximum
- Instantaneous Minimum
- Averaged
- Averaged Maximum
- Averaged Minimum

All modes can be measured simultaneously. An auxiliary channel can have multiple signals with multiple averaging settings. Only auxiliary signals can be measured using an auxiliary parameter logger
Integration With PULSE Platform:
- Data available as multi-buffer tags
- Auxiliary parameter as a function of time
- Auxiliary channels can be recorded and played back with Time Data Recorder Type 7708 (including LabShop Data Recorder)
- Access to auxiliary channel settings and data through OLE interface
- Connection to hardware: use 37-pin D-sub to Aux I/O cable AO-1472 and 16 BNC Female to 37-pin D-sub AO-0594 for IDA^e modules. Use cable AO-0738-D010 to connect to LAN-XI module Type 3056

Programmable

Visual Basic® for Applications is embedded in PULSE software and also supports OLE Automation/ActiveX® controls, allowing the development of customized control programs. A wide range of functions that are not directly available in PULSE are supported using PULSE Programming Language, written in a text editor and compiled

Export

Export of data to a file in ASCII format or to spreadsheet packages such as Microsoft® Excel® 2003, or later. Also PULSE File Binary, Universal File ASCII/Binary, SDF, WAV (Time Data Recorder Type 7708, Data Recorder Type 7701 or Time Capture Type 7705 license required) and STAR Binary

Reporting

Integrated reporting with Microsoft® Word 2007 (SP2), or later

FFT Analyzer – Types 7700, 7770

A number of variants of the FFT analyzer can be used simultaneously

Measurement

FREQUENCY RANGE
Baseband and Zoom: 50 – 6400 lines
Frequency Span: 1 Hz – 204.8 kHz in 1, 2, 5, … or 2^n (1, 2, 4, 8, …) sequence (depending on hardware)
Centre Frequency Resolution: 1 mHz

TIME WEIGHTING
The following are available:
- Uniform
- Hanning
- Flat-top
- Kaiser-Bessel
- Transient
- Exponential

FREQUENCY WEIGHTING
- A, B, C, D
- $j\omega^2$, $j\omega$, 1, $1/j\omega$, $1/j\omega^2$

Pre-processing

The following pre-processing can be selected for an analyzer:
- Time
- Autospectrum
- Cross-spectrum

Post-processing

The following post-processing functions can be applied to measured data:
- Complex time (Hilbert transform)
- Monitor time
- Fourier spectrum
- Phase-assigned autospectrum (PAS)
- Ratio-based PAS
- Frequency response function (H1, H2, H3)
- 1/Frequency response function (1/H1, 1/H2, 1/H3)
- Coherence
- Signal-to-noise ratio
- Coherent/non-coherent power
- Auto-correlation
- Cross-correlation
- Impulse response (h1, h2, h3)

- Calculated intensity
- Calculated complex intensity
- Calculated mean pressure spectrum
- Calculated velocity spectrum
- p–I index
- Cepstrum
- Liftered spectrum
- CPB (1/n-octave) synthesis
- Orbit

CPB (Real-time 1/n-octave) Analyzer – Types 7700, 7771

A number of variants of the CPB analyzer (Real-time 1/n-octave Digital Filter analyzer) can be used simultaneously. The analyzer uses real-time standardized fractional octave digital filters

Measurement

1/1-OCTAVE FILTERS
14-pole filters with centre frequencies given by $10^{3n/10}$. Meets the requirements of IEC 61260–1:2014 Class 1, DIN 45651, ANSI S1.11–1986, Order 7 Class 1–D, optional range, ANSI S1.11 –2004, 1/1-octave bands, Class 1, Group X/Z, all filters and ANSI S1.11–2014, Class 1
Single Channel: Filters with centre frequencies from:
- 125 mHz to 16 kHz (25.6 kHz modules, $-3 \leq n \leq 14$)
- 125 mHz to 31.5 kHz (51.2 kHz modules, $-3 \leq n \leq 15$)
- 125 mHz to 63 kHz (102.4 kHz modules, $-3 \leq n \leq 16$)
- 125 mHz to 125 kHz (204.8 kHz modules, $-3 \leq n \leq 17$)

1/3-OCTAVE FILTERS
6-pole filters with centre frequencies given by $10^{n/10}$. Meets the requirements of IEC 61260–1:2014 Class 1, DIN 45651, ANSI S1.11–1986, Order 3 Class 1–D, ANSI S1.11 –2004, 1/3-octave bands, Class 1, Group X/Z, all filters and ANSI S1.11–2014, Class 1
Single Channel: Filters with centre frequencies from:
- 100 mHz to 20 kHz (25.6 kHz modules, $-10 \leq n \leq 43$)
- 100 mHz to 40 kHz (51.2 kHz modules, $-10 \leq n \leq 44$)
- 100 mHz to 80 kHz (102.4 kHz modules, $-10 \leq n \leq 45$)
- 100 mHz to 160 kHz (204.8 kHz modules, $-10 \leq n \leq 46$)

Minimum Mean Time Interval between Spectra: 5 ms

1/12-OCTAVE FILTERS
6-pole filters with centre frequencies given by $10^{(n + 0.5)/40}$
Single Channel: Filters with centre frequencies from:
183 mHz to 21.8 kHz ($-30 \leq n \leq 173$)
Minimum Mean Time Interval between Spectra: 5 ms

1/24-OCTAVE FILTERS
6-pole filters with centre frequencies given by $10^{(n + 0.5)/80}$
Single Channel: Filters with centre frequencies from:
90.4 mHz to 11.1 kHz ($-84 \leq n \leq 323$)

Minimum Mean Time Interval between Spectra: 10 ms

DETECTORS
- Linear averaging
- Exponential averaging
- Exponential confidence averaging
- Exponential confidence limit averaging

With exponential confidence, the averaging time is administered so that the estimates for all octaves are within the same confidence level. Exponential confidence limit is the same as exponential confidence, but a minimum averaging time can be set

PROCESSING
The following can be measured:
- Autospectrum
- Cross-spectrum
- Mean pressure spectrum
- Velocity spectrum
- Intensity spectrum
- Complex intensity spectrum

Note: Intensity measurement is for intensity probes with two microphones

MAX./MIN. SPECTRUM HOLD
Max./min. hold of spectrum for exponential averaging mode

Post-processing

The following post-processing can be applied to a CPB measurement:
- Phase-assigned autospectrum
- Frequency response function (H1, H2, H3)
- 1/Frequency response function (1/H1, 1/H2, 1/H3)
- Coherence
- Signal-to-noise ratio
- Coherent/non-coherent power
- Calculated intensity/complex intensity
- p–I index
- Loudness (ISO 532 B)
- Articulation Index (ANSI 53.5–1969)

Overall Level Analyzer – Types 7700, 7770, 7771

A number of variants of the overall level analyzer can be used simultaneously. Any signal can be measured using an overall level analyzer. Complies with the requirements for a Class 1 instrument in IEC 61672–1:2013/IEC 651/IEC 60804

DETECTORS
- Exponential, linear, impulse, peak

AVERAGING
The following averaging modes are available:
- Average over a period
- Continuous running averaging

Average Over a Period of Time:
- Max. linear averaging time: 86,400 s (24 hr)
- Max. exponential averaging time: 1024 s
- Max. peak detection time: 36,000 s (10 hrs.)

Continuous Running Averaging: Via cyclic buffer

FREQUENCY SPAN
Maximum: Determined by maximum analysis bandwidth of hardware used

MEASUREMENT MODES
- Exponential (including fast and slow)
- Exponential + impulse
- Exponential + maximum hold
- Exponential + minimum hold
- Exponential + statistics (L_N percentile level, N = 1, 2, …, 99)
- Linear
- Linear + impulse
- Peak

All modes can be measured simultaneously

ACOUSTIC WEIGHTING
- Linear, A, B, C, D

Signal Generator – Types 7700, 7770, 7771

Provides signals for performing a system analysis. Requires the use of modules with generator outputs. See LAN-XI Data Acquisition Hardware Product Data, BP 2215, for further specifications

WAVEFORMS
- Sine – fixed or swept (burst or continuous)
- Dual sine – fixed, swept or combination
- Random (burst or continuous)
- Pseudo-random
- Periodic Random
- User-defined waveform (import from WAV file)

Specifications – Time Capture Type 7705

Requirements

Type 7700, 7770 or 7771

Recording

Frequency Span: 1 Hz – 204.8 kHz in 1, 2, 5, … or 2^n (1, 2, 4, 8, …) sequence (depending on hardware)

Record Length: 1 ms to 24 hr with indication of equivalent record size in samples

TRIGGER
Start: Any virtual trigger or free-run
Stop: Any virtual trigger or "stop at end"

Specifications – Multiple-Input Multiple-Output Analysis Type 7764

Requirements

Type 7700 or 7770

MIMO Analysis

- Provides calculations of MIMO H_1 and H_v multiple coherence
- Automatic parameter setup when used with PULSE MTC Type 7753

Specifications – Envelope Analysis Type 7773

Requirements

Type 7700 or 7770

Envelope Analysis

Uses FFT analyzer in Envelope Mode
Detection Range: Set by the Centre Frequency and 2 × selected Frequency Span
For other specifications, see FFT Analyzer – Types 7700, 7770

Specifications – PULSE Time Type 7789

Requirements

- Types 7700, 7770 or 7771
- Type 7708 – if data are to be analysed in PULSE LabShop
- PC should be equipped with a sound card that is compatible with Windows® in order to play back signals
- A PC optimized for CPU and hard disk intensive operations is recommended

Data Import/Export

- PULSE Data Recorder (.dat and .pti)*
- Universal File Format (.uff), ASCII and Binary
- Time Data Format (.tdf)
- Waveform file (.wav)
- TEAC (.hdr)
- MATLAB (.mat)
- Head Acoustics (.hdr)
- Test for I-deas Time (.ati)

* Maximum .pti file size is 2 G samples per channel

Specifications – PULSE Basic Electroacoustics Type 7797

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:** LAN_XI module Type 3109 up to 25.6 kHz; LAN_XI module Type 3110 up to 102.4 kHz; LAN_XI module Type 3160 up to 51.2 kHz; IDA^e module 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*

Basic Software

Type 7700-Xy	PULSE FFT & CPB Analysis
Type 7770-Xy	PULSE FFT Analysis
Type 7771-Xy	PULSE CPB Analysis

PULSE VIEWER LICENSE

Type 7709-X	PULSE Viewer

HARDWARE DRIVERS REQUIRED
One of:

Type 3099-A-X	PULSE LAN-XI and IDA^e Multiple Module Front-end Driver
Type 3099-A-X1	PULSE LAN-XI Single Module and IDA^e Systems any size Front-end Driver
Type 3099-A-X2	PULSE LAN-XI Dual Module and IDA^e Systems any size Front-end Driver
Type 3099-D-X	PULSE VXI Multiple Module Front-end Driver

Optional extension to Type 3099-A-X/X1/X2:

Type 3099-E-X	PULSE Generic Auxiliary Digital Interface (GADI)

SERVICES

3560-SI1	Installation and Configuration (at Brüel & Kjær)
M1-ZZZZ-Xy	PULSE Software Maintenance & Support Agreement

See the Software Maintenance and Support Agreement Product Data (BP 1800) for further details of M 1 Agreements

PULSE Applications

PULSE LABSHOP – PLATFORM

Type 7705-X	PULSE Time Capture
Type 7708-X	PULSE Time Data Recorder (incl. Type 7701)
BZ-5231-X	IDA^e Driver for Test for I-deas
BZ-5610-X	PULSE CAN Bus Option
BZ-7848-A	LAN-XI Notar™

PULSE LABSHOP – TEST AND DATA MANAGEMENT

Type 7767-A-X	PULSE Data Manager, single user
Type 7767-B-X	PULSE Data Manager, up to 5 users
Type 7767-C-X	PULSE Data Manager, up to 10 users
Type 7789-X	PULSE Time
Type 7796-X	PULSE Automotive Test Manager

PULSE LABSHOP – ACOUSTIC APPLICATIONS

Type 7698-X	PULSE Sound Quality
Type 7758-X	PULSE Material Testing
Type 7761-X	PULSE Acoustic Test Consultant
Type 7788-G-X	PULSE Vehicle Pass-by Ground System
Type 7788-V-X	PULSE Vehicle Pass-by Vehicle System

* ZZZZ = product type number
X = license model either N for node-locked or F for floating
y = optional channel count, from 1 (single) to 7. No number denotes unlimited channels (channel-independent)

Type 7793-X	PULSE Indoor Pass-by Noise Testing
Type 7799-X	PULSE Sound Power
Type 7882-X	PULSE Sound Power using Sound Intensity
Type 7883-X	PULSE Sound Power Determination for Earth-moving Machinery
Type 7884-X	PULSE Sound Power for Reverberation Rooms
Type 7885-X	PULSE Noise Emission Outdoor Machinery, Directive 2000-14
Type 7886-X	PULSE Sound Power of Fans
Type 7914-X	PULSE Wind Turbine Sound Power Determination
Type 7915-X	PULSE Small Wind Turbine Sound Power Determination
Type 8606-X	PULSE Spherical Beamforming
Type 8607-X	PULSE Acoustic Holography
Type 8608-X	PULSE Beamforming
BZ-5265-X	PULSE Sound Quality Zwicker Loudness
BZ-5277-X	PULSE Sound Quality Order Analysis
BZ-5301-X	PULSE Sound Quality Psychoacoustic Test Bench
BZ-5370-X	Robot Option for ATC
BZ-5611-X	PULSE Position Detection Option for ATC
BZ-5635-X	PULSE Quasi-stationary Calculations
BZ-5636-X	PULSE Transient Calculations
BZ-5637-X	PULSE Conformal Calculations
BZ-5652-X	PULSE Plug-in Manager
BZ-5638-X	PULSE SQ Metrics Calculations
BZ-5639-X	PULSE Refined Beamforming
BZ-5644-X	PULSE Wideband Holography
BZ-5693-X	PULSE Proximal Holography
BZ-5640-X	PULSE Panel Contribution
BZ-5641-X	PULSE Intensity Component Analysis
BZ-5642-X	PULSE In situ Absorption
BZ-5696-X	PULSE Moving Source Option for Beamforming
BZ-5939-X	PULSE Array Acoustics Rail Vehicles Moving Source Beamforming
BZ-5940-X	PULSE Array Acoustics Flyover Moving Source Beamforming
BZ-5941-X	PULSE Array Acoustics Wind Turbines Moving Source Beamforming
BZ-5943-X	PULSE Array Acoustics Road Vehicles Moving Source Beamforming

PULSE LABSHOP – MACHINE DIAGNOSTICS

Type 7702-Xy	PULSE Order Analysis
Type 7773-X	PULSE Envelope Analysis
Type 7790-A-X	PULSE Two-plane Balancing Consultant
Type 7790-B-X	PULSE Multi-plane Balancing Consultant
Type 7795-X	PULSE Vibration Check for Aircraft Engines
Type 7906-S1-X	PULSE Vibration Analysis for Aircraft Engines
WT-9695-X	Orbit and Polar Plots for PULSE

PULSE LABSHOP – STRUCTURAL DYNAMICS

Type 7753-X	PULSE Modal Test Consultant™
Type 7753-A-X	PULSE Modal Test Consultant with FRF Animation
Type 7760-X	PULSE Operational Modal Analysis (OMA)
Type 7764-X	PULSE Multiple-Input Multiple-Output Analysis
Type 7765-X	PULSE Operating Deflection Shapes Test Consultant™
Type 7765-A-X	PULSE Operating Deflection Shapes
Type 7765-B-X	PULSE Run-up/Down Operating Deflection Shapes
BZ-5612-X	PULSE Run-up/down ODS Option
BZ-5613-X	PULSE Animation Option
BZ-8527	Batch Processing Option for OMA Pro

PULSE LABSHOP – ELECTROACOUSTICS

Type 7797-X	PULSE Basic Electroacoustics
Type 7907-X	PULSE Electroacoustics
BZ-5548-X	PULSE SSR Analysis – Harmonic Distortion
BZ-5549-X	PULSE SSR Analysis – Intermodulation Distortion
BZ-5550-X	PULSE SSR Analysis – Difference Frequency Distortion
BZ-5551-X	PULSE Directivity and Polar Plot
BZ-5600-X	PULSE Sequencer
BZ-5601-X	PULSE Data Manager for Electroacoustics
BZ-5602-X	PULSE Receiver Test Applications
BZ-5603-X	PULSE Loudspeaker Test Applications
BZ-5604-X	PULSE Thiele Small Parameter Calculation
BZ-5742-X	PULSE TSR Analysis – Harmonic Distortion
BZ-5743-X	PULSE Microphone Test Application
BZ-5744-X	PULSE Headset Test Application

PULSE LABSHOP – VIBROACOUSTICS

Type 7798-X	PULSE Source Path Contribution
Type 8601-X	PULSE DTS Software for NVH Simulator

PULSE REFLEX – POST-PROCESSING

Type 8700-X	PULSE Reflex Base
Type 8701-X	PULSE Reflex Data Viewer
Type 8702-X	PULSE Reflex Basic Processing
Type 8703-X	PULSE Reflex Advanced Processing
Type 8704-X	PULSE Reflex Order Analysis
Type 8705-X	PULSE Reflex Advanced Order Analysis
Type 8706-X	PULSE Reflex Standardized CPB Option
Type 8710-X	PULSE Sound Quality Metrics
Type 8718-X	PULSE Reflex Finite Element Interfaces
Type 8719-X	PULSE Reflex Geometry
Type 8720-X	PULSE Reflex Modal Analysis
Type 8720-A-X	PULSE Reflex Modal Analysis Pack
Type 8720-B-X	PULSE Reflex Modal Acquisition and Analysis Pack
Type 8721-X	PULSE Reflex Advanced Modal Analysis
Type 8721-A-X	PULSE Reflex Advanced Modal Analysis Pack
Type 8721-B-X	PULSE Reflex Advanced Modal Acquisition and Analysis Pack
Type 8722-X	PULSE Reflex Correlation Analysis
Type 8729-A-X	PULSE Reflex Spectral Analysis
Type 8729-B-X	PULSE Reflex Structural Measurements – Hammer and Shaker
Type 8729-C-X	PULSE Reflex Structural Measurements – Stepped Sine
Type 8730-X	PULSE Reflex Shock Response Analysis
Type 8770-X	PULSE Reflex Telephone Test
Type 8772-X01	PULSE Reflex Telephone Test, Test Suite for 3GPP2 C.5600-2
Type 8772-X02	PULSE Reflex Telephone Test, Test Suite for 3GPP TS.26.132 (Handset)
Type 8772-X04	PULSE Reflex Telephone Test, Test Suite for 3GPP TS.26.132 (Hands-free)
Type 8772-X05	PULSE Reflex Telephone Test, Test Suite for CES-Q003-2
Type 8772-X06	PULSE Reflex Telephone Test, Test Suite for YD/T-1538 (Handset)
Type 8772-X07	PULSE Reflex Telephone Test, Test Suite for CMCC
Type 8772-X08	PULSE Reflex Telephone Test, Test Suite for YD/T-1538 (Hands-free)
Type 8781-X	PULSE Reflex Array Analysis

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