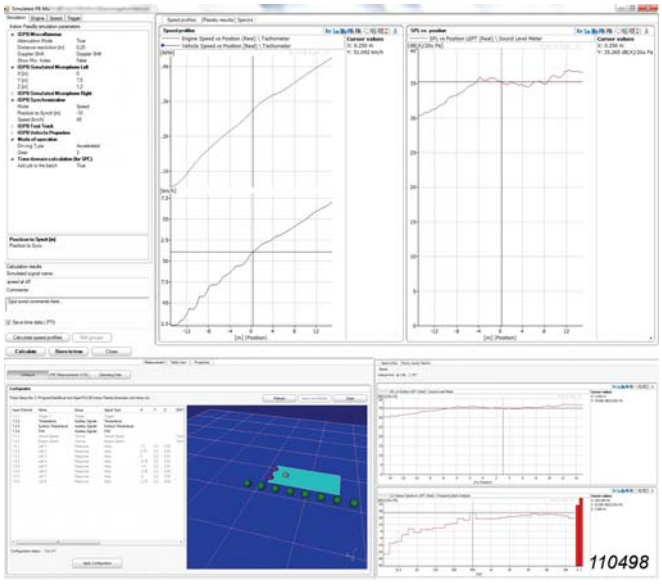
# PULSE™ Indoor Pass-by Noise Testing Type 7793

with Optional Exterior Noise Contribution Analysis

*Pass-by measurements are mandatory for automotive manufacturers for product certification and pass-by measurement procedures and conditions are recommended by international standards. In addition, pass-by measurements can be used as a product development and troubleshooting tool. PULSE Indoor Pass-by provides a tool for simulating field pass-by performance for a vehicle being run on a chassis dynamometer in an anechoic test chamber.*

*Together with the Indoor Pass-by measurement, the Exterior Noise Contribution Analysis option gives further possibilities for identifying the major contributions of exterior noise corresponding to the specific noise sources.*




## Uses and Features

**Uses**

- Combines with PULSE hardware and suitable microphones to simulate pass-by measurements for exterior vehicle noise
- Simple and reliable tool for product development and troubleshooting
- Tyre Noise Correction is also available for combining with Coast Down Test
- Optional Exterior Noise Contribution Analysis of specific noise sources, powertrain, intake/exhaust system, tyres

**Features**

- Task-oriented software
- Simple measurement setup and system calibration
- Simulation of field pass-by measurements according to a range of international standards including ISO 362
- Flexible concept – it is possible to choose your own acoustic centre for both the left and right sides of test vehicles
- Correction function to simulate Doppler effect
- Measurements can be stored in a database and compared with field pass-by results
- Suitable for sound-absorbing rooms and/or limited spaces that prohibit recommended microphone setup
- Constraints caused by standards, facilities, etc., can be introduced to measurements
- Pass-by values automatically calculated upon completion of a measurement
- Dynamic creation of meta-data

## Field Versus Indoor Pass-by

Indoor pass-by noise measurements on chassis dynamometers are also the way to certify a vehicle for exterior noise emission, together with field pass-by, since the ISO announced that Indoor Pass-by is a standard measurement. However, indoor pass-by techniques provide an extremely powerful and repeatable method of troubleshooting exterior vehicle noise in the controlled environment of an anechoic test chamber.

When making a field pass-by measurement, a number of parameters must be taken into consideration, including:

- Background noise and weather conditions
- Ambient air temperature must be between 0°C – 40°C
- Wind speed must be <5 m/s to make a test run valid
- Wind direction, humidity and barometric pressure must all be measured

Conversely, indoor pass-by measurements require none of the above parameters owing to their nature, that is, measurements that take place protected from the elements. As the vehicle is stationary, it also becomes possible to instrument the vehicle to a greater degree in order to ascertain the root causes of the emitted noise.

As with most simulation techniques, some assumptions must be made. In the case of indoor pass-by this relates to the assumption that all noise radiates from a single point (the acoustic centre). Type 7793 allows the definition of multiple acoustic centres (one for each side). Additionally, an outdoor/field pass-by measurement would experience the Doppler effect. To make a better simulation of outdoor measurements, the indoor pass-by system can introduce a correction that simulates the Doppler effect. In order to get an accurate comparison with field and indoor pass-by measurement results, tyre noise should be included with the coast down test.

Data from Brüel & Kjær's family of Field Pass-by solutions can be easily imported and compared with PULSE Indoor Pass-by results.

## PULSE Indoor Pass-by Concept

Instead of making the test vehicle pass two stationary microphones as is standard in a field pass-by measurement, indoor pass-by measurement setups use two rows of microphones placed alongside the test vehicle. The vehicle is run on a chassis dynamometer (dyno) and accelerated in the same way as it would be for a field pass-by measurement. Time histories are measured by the microphones in parallel with vehicle parameters and dyno drum speed. A sophisticated algorithm uses information from the dyno to calculate a vehicle position relative to the microphones as a function of time. This is then used to extract the contributing portions of the time histories that correspond to when the vehicle would have passed the standard microphone positions had the vehicle been moving. A synchronised single time history is created by stitching all of these time history sections together and interpolating across the boundaries of the segments. This synchronised single time record combined with the dyno drum speed profile represents the vehicle noise emitted during a pass-by measurement.

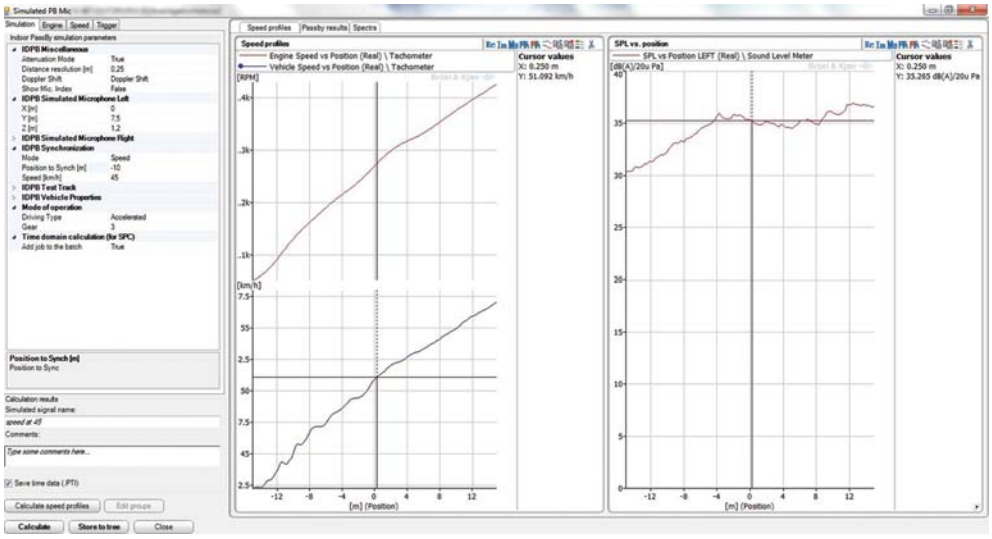
The created time history is then played back through the analysis section of the system, giving the option of applying various types of frequency analysis to the time history.

You can also preview and listen to the simulated time history to determine whether it sounds right using PULSE Time Type 7789.

The system implementation is very flexible. Normally, it is assumed that noise comes from one point (an acoustical centre), independent of frequency, but with PULSE Indoor Pass-by, it is possible to choose your own acoustic centres for both the left and right sides of the vehicle.

This system has been developed to allow microphone positions closer than 7.5 metres from the vehicle centre, while still providing correct results. This is extremely useful for situations where space is limited.

***Fig. 1***
*Setting up a Indoor Pass-by calculation*



## Optional Exterior Noise Contribution Analysis

The approach takes its starting point in PULSE Source Path Contribution (SPC), a technique designed to evaluate contributions from different sources through various paths to a desired receiver location. As such, the dominating source with respect to a given receiver can be highlighted.

Using this option the SPC technique will be exploited so as to model the exterior sound field of a vehicle. The exterior noise can be seen as a sum of contributions from a set of noise components. The noise components represent the true physical noise sources to be modelled by a set of assumed point source positions. For example, each engine face, the intake orifice and the exhaust orifice, can be taken as one source each. Each source then has an associated strength explaining how powerful the given source is.

The first step in the SPC technique is to determine the strength of all the vehicle model sources. This is done indirectly, by measuring the sound field at points close to the vehicle with an array of indicator microphones, during vehicle operation. The link between strengths at source positions and sound pressure at indicator positions is made by a set of acoustic transfer functions, measured with a powerful volume velocity source when the vehicle is not operating. Combining the indicator operating measurements (pass-by run-up data) with the set of transfer functions provides an estimate of the individual source strengths. Additionally, this first step will be the source separation step, which is necessary for obtaining the correct contributions of individual noise components later.

The second step makes use of another set of transfer functions, from all source positions to one, or several, receiver positions. Using the obtained vehicle model from the first step (above) in combination with the second set of transfer functions, provides estimates of the sound field at all the receivers. Here the receivers will be the microphones of the pass-by array. For each receiver we can calculate the contribution from one source position, or make a simple time series summation, in order to express the predicted contribution from a group of sources. This is necessary to get the contribution from a noise component modelled by several point sources, or to get the overall vehicle contribution, that is, the sum over all source positions.

The final simulated pass-by results are obtained using standard synthesis approach, which needs to know which part of the time recordings to use (measured or predicted at the pass-by array) and when to switch between pass-by array microphones. This information is derived from the drum tacho and a fixed condition, like vehicle speed at a certain position relative to the pass-by array.

## Product Description

The workflow of the PULSE Indoor Pass-by system is concentrated into two task groups:

- Setup
- Measurement

## Setup

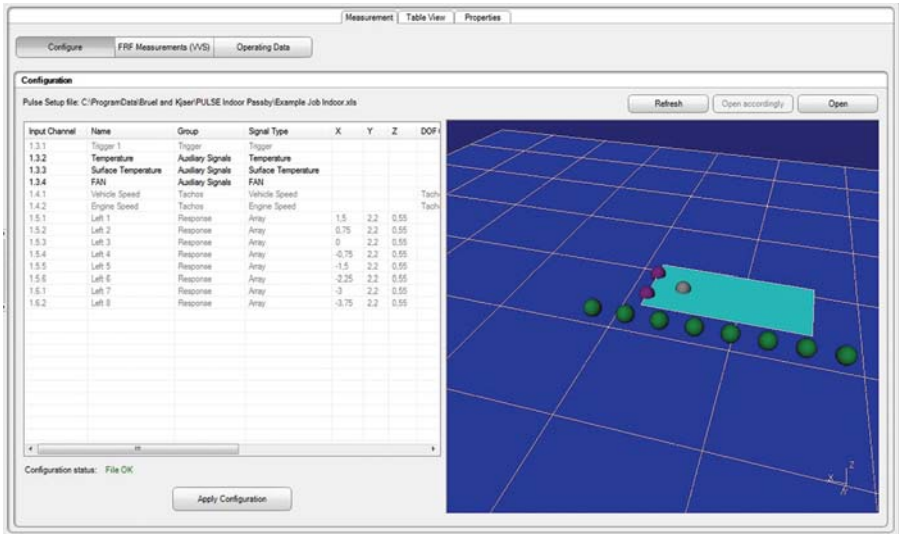



***Fig. 2***
*The Array View and Array Setup windows where your microphone positions are input*

Indoor Pass-by measurements require multiple measurement channels to provide realistic results. This has attendant challenges such as configuring all of the attached microphones and then calibrating them. There is then a need to record the position of each microphone (setting up the geometry). All of these activities, along with the setting up of the measurement template, can be performed by PULSE Acoustic Test Consultant (ATC). For more information on ATC, see its Product Data BP 1908.

Depending on the type of standard you select, different constraints have to be met for the measurement to be valid. You can set up constraints relating to target values of measurement precision using the built-in Validation Tool.

Examples of constraints required by the ISO 362 standard include:

- Defined entry speed
- Allowed deviation from other measurements in dB
- Throttle position

## Measurement

Having configured your setup once, there is no need to do so again, which leaves you free to concentrate on making measurements. Measurements are begun and automatically recorded using the Measurement Control window, or by simply pushing the space bar on your keyboard.

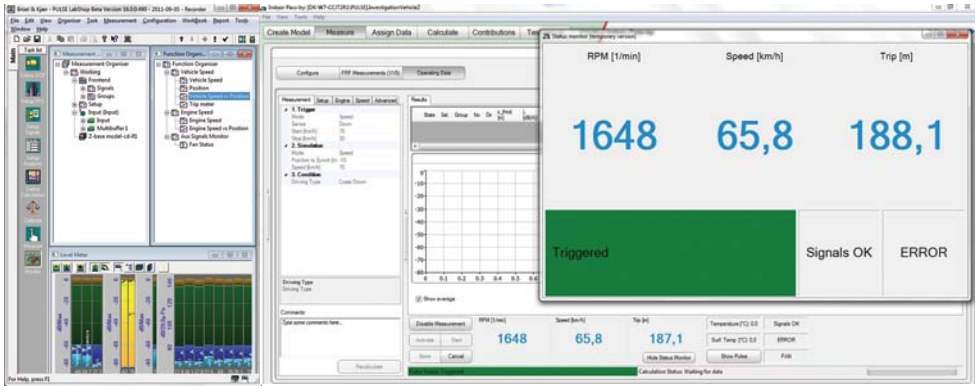
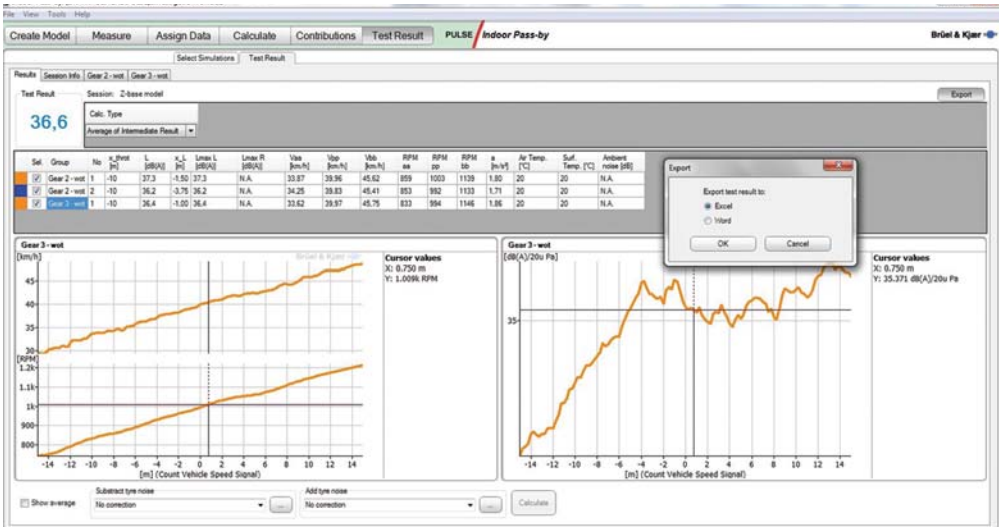



***Fig. 3***
*Measurement overview featuring tools such as the Level Meter, Measurement Control panel, signal displays, and Status Monitor. PULSE Indoor Pass-by displays can be modified according to user preferences*

Measurements can be stored in a database, where you can compare them to previously stored data.

***Fig. 4***
*The measurement result*

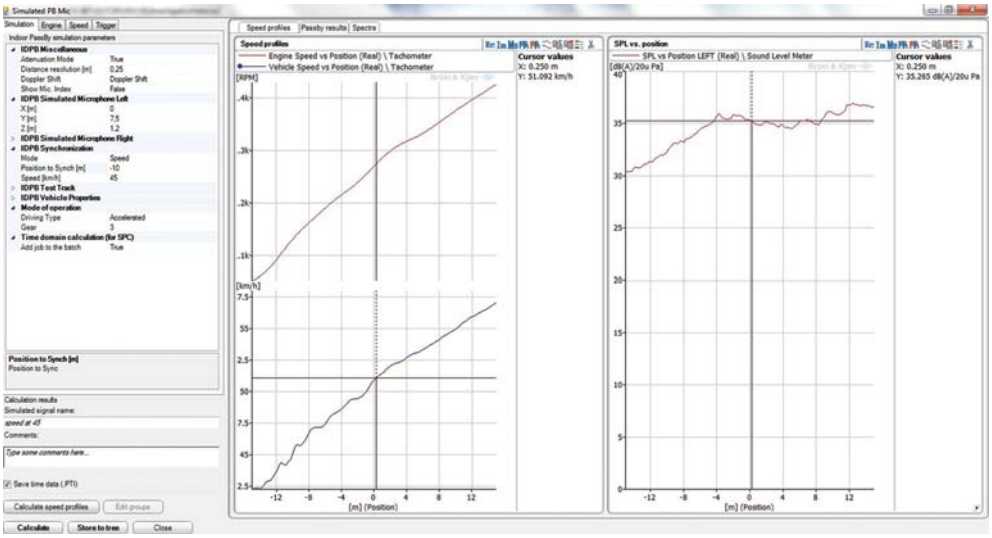



As with the Field Pass-by solutions, Indoor Pass-by has a built-in data management system based around PULSE Data Manager Type 7767. An interface is provided for inputting documentation relating to the test and the vehicle under test. These documenting data are known as meta-data.

Alternatively, click 'Calculate' in the Calculation Setup window to get an immediate result.

## *Compare Data from Different Measurements*

***Fig. 5***
*Two SPL graphs retrieved from the database for comparison*




Any previous measurement can be compared with any other measurement in the database. Since all data are stored in the database, a utility that can dynamically extract data from the database and display them in a graph is provided. This takes the form of a tree structure that allows you to retrieve results based on user-defined filter definitions for the measurement meta-data. A slice selector is also provided that allows you to dynamically view slices from any 3D data set or, conversely, view spectra from any Z-axis position selected on the slice.

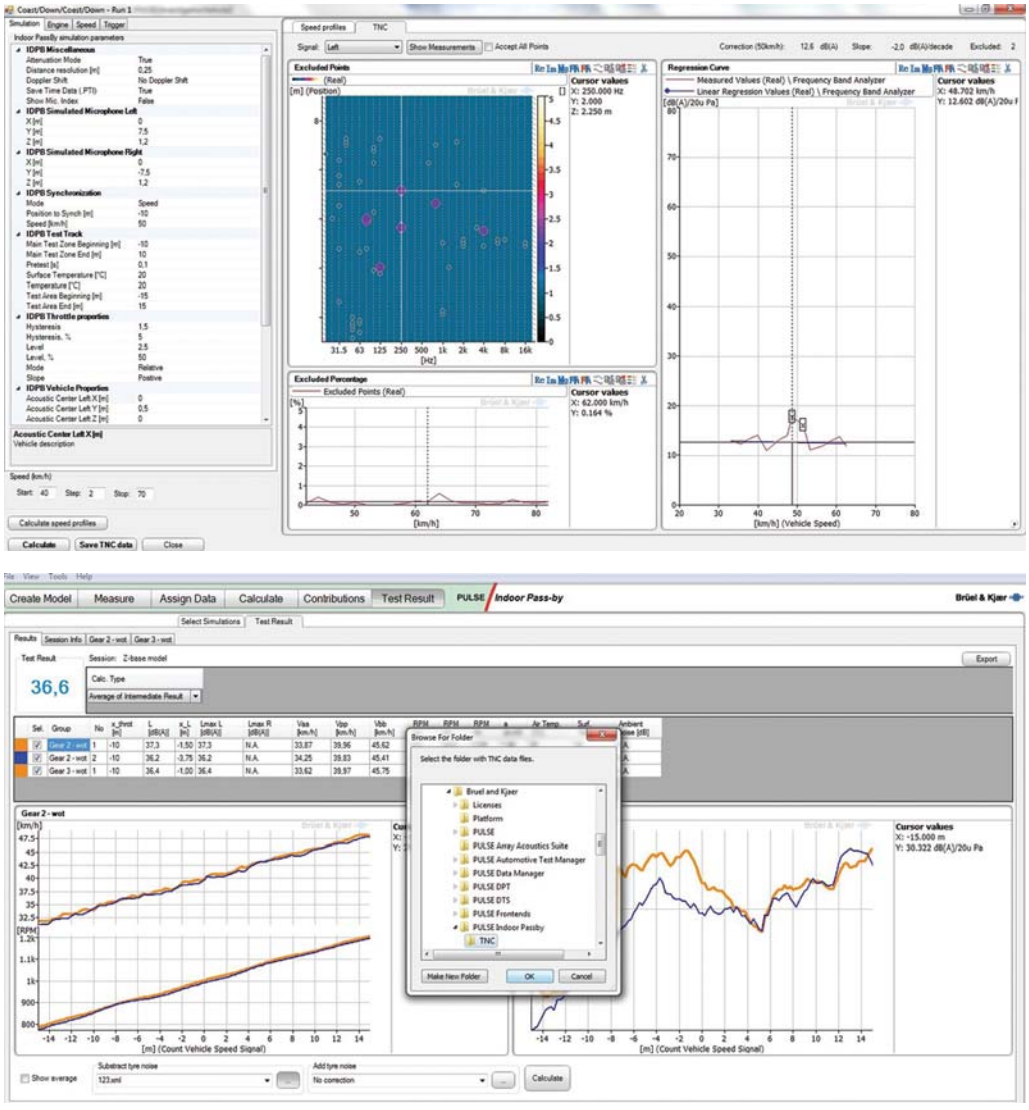
## *Reporting*

Using the built-in data management features, you can select a measurement run and report it in a standard format. The format of the report depends on the reporting template selected. The reporting templates are configurable to fit the customer or company procedures.

*Tyre Noise Correction*

The tyre noise measurement data from the field coast down test (which is saved in the database) is added as a correction to the indoor pass-by noise measurement data, together with the data from the indoor coast down test. See the examples in Fig. 6.

***Fig. 6***
*Tyre noise measurement – example data*




The 1/3-octave band analysis data can also be seen in these corrections.

## Specifications – PULSE Indoor Pass-by Noise Testing Type 7793

**Type 7793 is Indoor Pass-by application software based on the PULSE Multi-analyzer System**

### Recommended PC

- Intel® Core™ i7 3GHz processor, or better
- 16 GB RAM
- 480 GB Solid State Drive (SSD) with 20 GB free space, or better
- DVD-RW drive
- 1 Gbit Ethernet network
- Microsoft® Windows® 8.1 Pro or Enterprise (x64), Windows® 7 Pro, Enterprise or Ultimate (x64)
- Microsoft® Office 2013
- Adobe® Reader® 11.0 (US version available on PULSE installation DVD)
- Microsoft® SQL Server® 2012 Express (SP 2) (included with PULSE)

**REQUIRED SOFTWARE**
PULSE FFT and CPB Analysis Type 7700, PULSE Time Data Recorder Type 7708
To perform the optional Exterior Noise Contribution Analysis, you must have PULSE SPC Viewer Type 7798-A and PULSE Time Domain SPC Type 7798-E

## Ordering Information*

**Type 7793-X** PULSE Indoor Pass-by Noise Testing

**ACCESSORIES**
Type 3099-A-X PULSE LAN-XI Multiple Module Front-end Driver
Type 3099-A-X1 PULSE LAN-XI Single Module Front-end Driver
Type 3099-A-X2 PULSE LAN-XI Dual Module Front-end Driver
Type 3099-D-X PULSE VXI Multiple Module Front-end Driver

**REQUIRED SOFTWARE**
Type 7700-Xy PULSE FFT and CPB Analysis
Type 7708-X PULSE Time Data Recorder

**OPTIONAL SOFTWARE**
Type 7798-A-X PULSE SPC Viewer
Type 7798-E-X PULSE Time Domain SPC
Type 7784-X PULSE Volume Velocity Measurement
Type 7767-A-X PULSE Data Manager, Single-user License
Type 7767-B-X PULSE Data Manager, 5-user License
Type 7767-C-X PULSE Data Manager, 10-user License
Type 7761-X PULSE Acoustic Test Consultant
Type 7789-X PULSE Time

**MAINTENANCE AND SUPPORT AGREEMENTS**
M1-7793-X PULSE Indoor Pass-by Noise Testing Software Maintenance & Support Agreement

### Typical System Configurations

| | | One-sided | Two-sided |
|---|---|---|---|
| | | 18-ch. PULSE System | 30-ch. PULSE System |
| **Type** | **Description** | **Quantity** | |
| Type 3053-B-120 | 12-channel Input Module LAN-XI 25.6 kHz | 1 | 2 |
| Type 3050-A-060 | 4/6-channel Input Module LAN-XI 51.2 kHz | 1 | 1 |
| Type 3660-C | 5-module LAN-XI Front-end Frame | 1 | 1 |
| UA-2116-120 | LAN-XI Front Panel, 12-channel Charge | 1 | 2 |
| UA-2120-060 | LAN-XI Front Panel, 6-ch. Charge with Gain and High-pass Filter Shift | 1 | 1 |
| UA-2203 | Blank Module for LAN-XI Mainframe | 3 | 2 |
| Type 7793 | PULSE Indoor Pass-by Noise Testing | 1 | 1 |
| Type 7700 | PULSE FFT and CPB Analysis | 1 | 1 |
| Type 7708 | PULSE Data Recorder | 1 | 1 |
| Type 3099-A-X | PULSE LAN-XI Multiple Module Front-end Driver | 1 | 1 |
| **Optional** | | | |
| Type 7784 | PULSE Volume Velocity Measurement | 1 | 1 |
| Type 7798-A | PULSE SPC Viewer | 1 | 1 |
| Type 7798-E | PULSE Time Domain SPC | 1 | 1 |
| **Accessories** | | | |
| Type 7767-B | PULSE Data Manager | | |
| Type 7789 | PULSE Time | | |
| Type 4188-A-021 | 1/2-inch Free-field Microphone | | |
| UA-0588 | Microphone Holder for Tripod | | |
| UA-0801 | Lightweight Tripod | | |
| WA-1669-W-001 | Volume Velocity Source | | |
| AO-0426-D-100 | Double-screened Coaxial Cable, BNC to BNC, 10 m (33 ft) | | |

* X = licence 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)

BP 2015 – 18 2015-10



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