

Portable Impedance Meter System Type 9737

Portable Impedance Meter System Type 9737 represents state-of-the-art normal incidence impedance measurements for the aerospace industry. Increasingly stringent aerospace environmental regulations are demanding improvements in liner attenuation, which is driving ever improved impedances in installed acoustic liners. As a result, fully bonded panels must now be assessed for their true effective acoustic behaviour in their final condition. These measurements are superseding the traditional geometric and DC flow methods.

Type 9737 is a lightweight, compact, robust and user-friendly system, suitable for both research and production quality control impedance measurements up to 150 dB SPL. It allows immediate extraction of key acoustic parameters, such as impedance spectra vs overall SPL, and acoustic resistance vs acoustic velocity.



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Uses and Features

Uses

- Research and quality control impedance measurements
- Measurement of the acoustic properties of engine nacelle liners and aircraft interiors
- Measurement of:
 - Acoustic absorption coefficient
 - Acoustic reflection coefficient
 - Normalised impedance and admittance
 - Acoustic resistance as a function of acoustic velocity
 - Acoustic velocity as a function of frequency
- Measurements on complex or composite materials
- Measurements on orientation-sensitive materials

Measurement Features

- Turnkey system for ease of operation during calibration, measurement and data export
- Measure at overall SPLs (OASPLs) up to 150 dB
- Measurement parameters and routines include:
 - Option to loop on increasing overall SPL or pure tone SPL
 - Acoustic pressure and acoustic velocity spectra at sample surface
- Measurements viewable in real time for ease of monitoring
- Measurement with broadband, pure-tone, or user-defined source
- Calculation of non-linear resistance variation with acoustic velocity
- In-tube sample holder for flanged tube correction routine

- Automated pass/fail impedance quality control routine, for use by non-acoustic specialists (includes automated Microsoft® Word report with pass/fail result, and interactive impedance plot)
- Automated acoustic centre routine for microphone distance calibration with varying flanges

System Features

- Based on two-microphone transfer function test method, allowing fast data measurement
- Employs LAN-XI data acquisition and PULSE™ LabShop analysis system, providing high speed and accuracy
 - Lightweight and compact
 - Sound source activation switch and status indicator integrated in handle
 - Integrated sensors measure temperature, pressure and relative humidity
 - Two handles for ease of use
 - 29 mm inner diameter tube sized for optimum performance between 500 Hz and 6400 Hz
 - Carrying case (one case for complete system)
 - Can be combined with optional wider tubes for measurements down to 50 Hz, that is, Impedance Tube Kit Type 4206 (50 Hz – 6.4 kHz) or Type 4206-A (100 Hz – 3.2 kHz)
 - Flat flange designed for optimised sealing: flange removable for replacement with custom-built curved flanges, for maximised sealing to contoured panels
 - Pass/fail status light on tube handle and on laptop display for automated QC tests

Fig. 1
The Impedance Meter System
(PC not included)



Fig. 2
Type 9737 being used
on an acoustic panel
sample



Fig. 3
Meter handle controls



Portable Impedance Meter System Type 9737 is a lightweight, compact, robust and user-friendly system suitable for both research and production quality control impedance measurements at up to 150 dB SPL.

The system allows immediate extraction of key acoustic parameters, which are then directly exportable to Microsoft Excel® and/or Word. The system components are shown in Fig. 1.

Type 9737 can be used for in situ measurement of the quality assurance non-linear acoustic properties of acoustic panels, including the acoustic effective open area (acoustic POAeff) for single-layer perforated panels, and the acoustic R105, NLF characteristics for single-layer linear and multiple-degree-of-freedom panels, see Fig. 2.

The system is based on the two-microphone transfer function test method, which means that measurements take only a fraction of the time required by traditional, standing-wave ratio systems.

Using two fixed microphones, the test system makes simultaneous measurements at all frequencies of interest.

Start/stop of the loudspeaker and software can easily be managed from the meter handle controls, see Fig. 3.

Impedance Meter Software

Impedance Meter Program for LAN-XI WT-9888 has dedicated routines for measuring key quality control parameters such as impedance spectra versus OASPL, and acoustic resistance versus acoustic velocity. For the latter, WT-9888 can track the variation in panel resonance frequency with pure tone SPL and measure (pure tone or broadband) the non-linear acoustic slope. The measurement versus velocity characteristic can be used for calculation of the acoustic effective open area (acoustic POAeff) for single-layer perforated panels, and the acoustic R105, NLF characteristics for single-layer linear and multiple-degree-of-freedom panels. WT-9888 works in conjunction with PULSE LabShop and Portable Impedance Measurement Tube WA-1599.

The meter program also contains all the functionality of the standard material testing software, PULSE Acoustic Material Testing in a Tube Type 7758, which is a complete and fully integrated system for making acoustic measurements on small material samples in the 50 Hz to 6.4 kHz frequency range, when using the optional Impedance Tube Kit (50 Hz – 6.4 kHz) Type 4206 or Impedance Tube Kit (100 Hz – 3.2 kHz) Type 4206-A (see the separate Product Data, [BP 1039](#)).

Impedance Meter Hardware

Fig. 4
LAN-XI-based front
end:
Type 3160-A-042 (left)
and Power Amplifier
WB-3592 (right – in a
double casing)



The Impedance Meter system consists of LAN-XI Generator Module Type 3160-A-042 and Power Amplifier WB-3592.

The module provides both the input channels and a generator for the impedance meter sound source. It also functions as the interface for environmental signals coming from the meter handle to the module.

The Power Amplifier is conveniently housed in a double LAN-XI casing, and provides amplification of the generator signal.

Sample Holder

The Portable Impedance Meter is supplied with a screw-on Sample Holder WA-1706, that allows samples to be cut to fit exactly into the 29 mm tube. The Sample Holder is ideal for testing non-locally reacting materials (for example, foams, slotted core, etc.). Use of the Sample Holder also allows calculation of a correction between in-tube impedance tests and flanged tube tests.

Carrying Case

Fig. 5
Type 9737 carrying
case



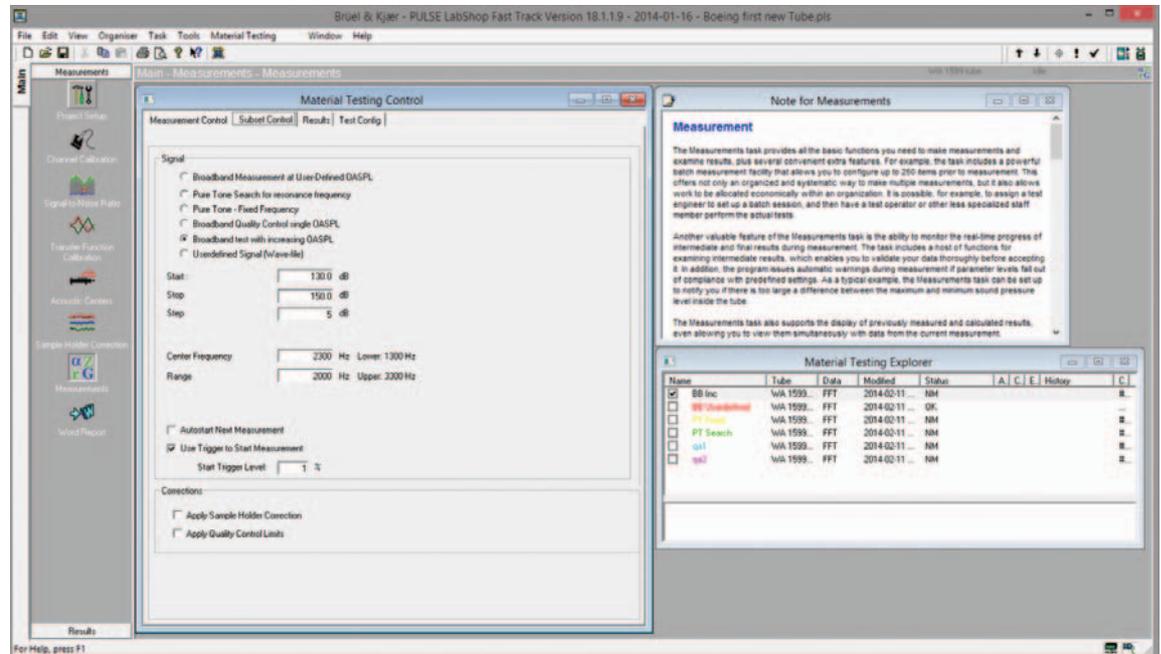
Carrying Case WE-0214-W-005 holds all the elements of the system, see Fig. 5.

The case also has room for the optional Pistonphone Type 4228 and Sound Calibrator Type 4231.

Impedance Meter Program for LAN-XI WT-9888 features an effective, task-oriented user interface that transforms even the most complex test situations into straightforward, intuitive processes, see Fig. 6.

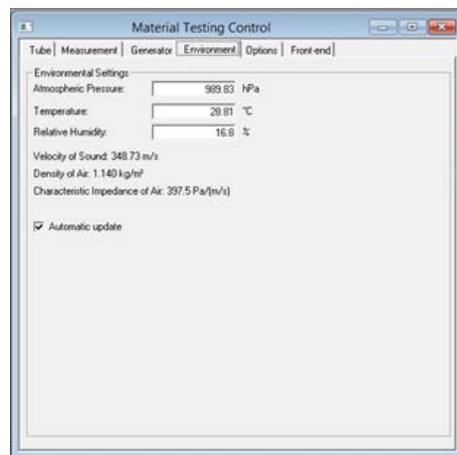
Within the program, each test session is defined as a 'project' that contains all relevant settings and a set of tasks corresponding to the actual stages of the test. Tasks are listed in the display as icons that open predefined screen layouts with task-dedicated control windows and displays.

Fig. 6
The Impedance Meter Program's task-oriented user interface provides step-by-step guidance through all stages of the measurement process



The advantage of this task-oriented approach to session management is that, once a project is defined, the actual test process is a simple matter of working your way down the task list. As you click your way through the tasks, the program opens the appropriate screen layouts, leading you through all stages of the test in a simple and logical way.

Fig. 7
Measurement control interface – environmental data



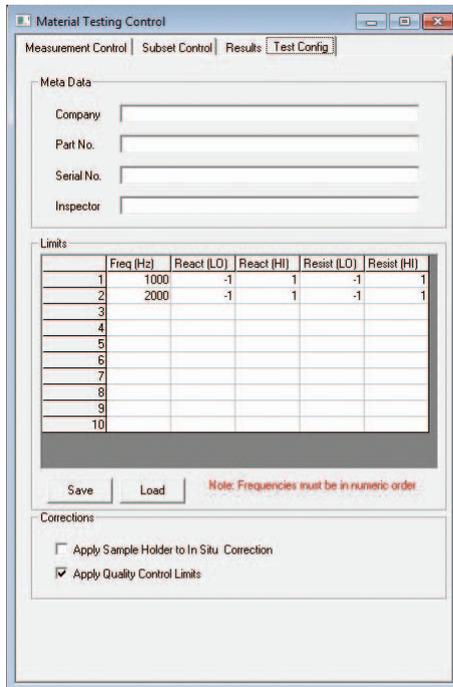
Measurement Control Interface

There are options for testing the non-linear panel response with increasing pure tone and broadband SPL, see Fig. 6.

Measurement start can be controlled to allow one-man operation by allowing the measurement to be automatically triggered, and by choosing that the next measurement will automatically start after completing the last.

Environmental data (pressure, temperature and humidity) can be measured directly from the impedance tube or input manually, see Fig. 7.

Fig. 8
Test configuration interface

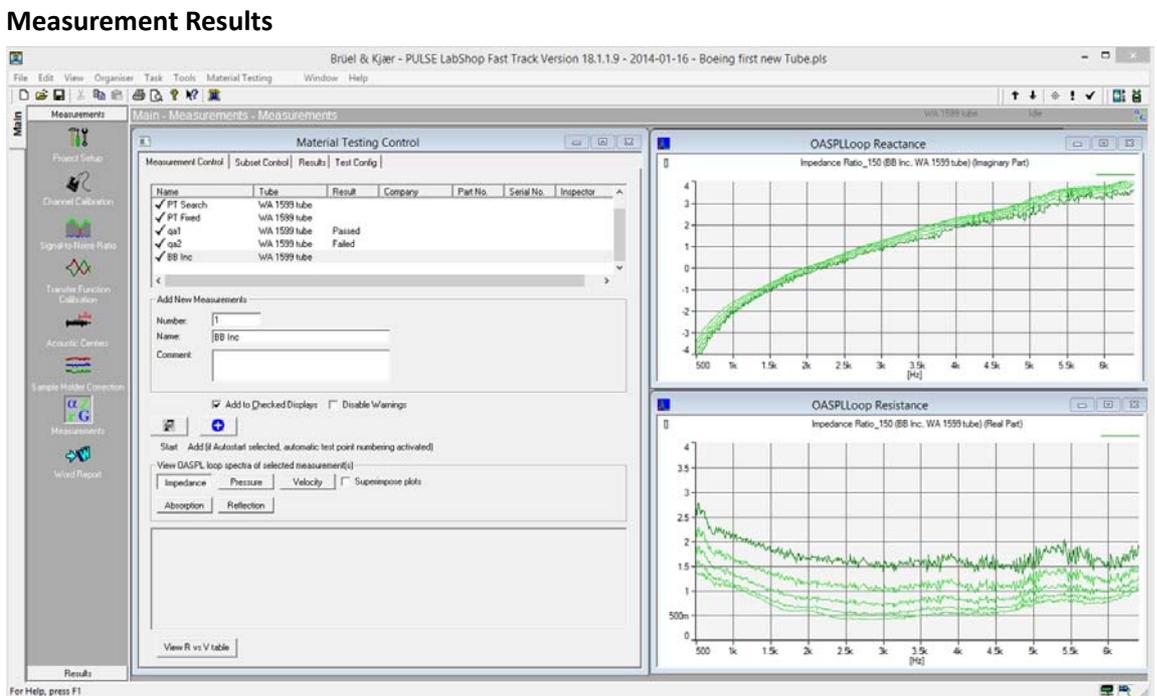


Test Configuration Interface

The test configuration interface allows you to enter test specific metadata, such as the operator and item under test, together with the tolerance limits (dB) for QC checking, see Fig. 8.

Handle and on-screen indicators show you the pass/fail result in real time, while data can be exported directly into a Word-based QC report, with interactive impedance curves for acoustic evaluation.

Fig. 9
Measurement results



The measurement results page shows the impedance variation with increasing broadband OASPL, see Fig. 9.

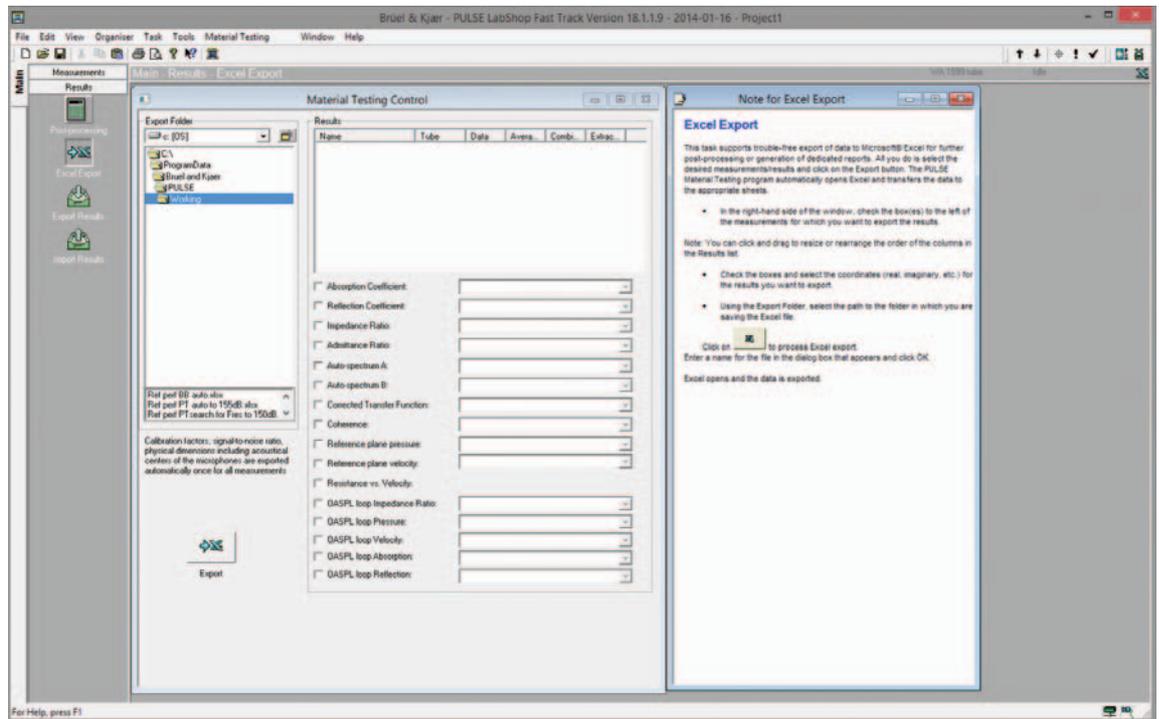
Fig. 10
Measurement results with R versus V table

Target Spl (dB)	Fr (Hz)	Level fs (dB)	V (cm/s)	R (rho*c)	X (rho*c)
0.0	0.000	0.0	0.000	430.707m	0.000
120.0	0.000	120.3	3.713	429.978m	0.000
125.0	0.000	125.5	6.775	429.376m	0.000
130.0	0.000	130.5	11.988	438.410m	0.000
135.0	0.000	134.9	19.758	469.265m	0.000
0.0	0.000	0.0	20.000	470.747m	0.000
140.0	0.000	140.5	36.169	569.922m	0.000
0.0	0.000	0.0	105.000	992.100m	0.000
0.0	0.000	0.0	200.000	1.575	0.000

NLF: 3.345

You can choose to display a table of the acoustic resistance (R) versus velocity (V) measurements, which also shows the resonance frequency, facing sheet SPL, and the panel reactance, see Fig. 10.

Fig. 11
Export measurement results to Excel®



The Portable Impedance Meter allows you to not only make fast acoustic measurements, in situ, at high SPLs, but it also offers immediate export of the data to Microsoft Excel® or Word, see Fig. 11.

The PULSE Impedance Meter Program is delivered with predefined projects for handling typical material testing situations. These provide a convenient starting point for creating user-defined projects.

Compliance with Standards

  	<p>The CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EU directives.</p> <p>RCM mark indicates compliance with applicable ACMA technical standards – that is, for EMC and EME in Australia.</p> <p>WEEE mark indicates compliance with the EU WEEE Directive.</p>
Safety	EN/IEC 61010–1:2010: Safety requirements for electrical equipment for measurement, control and laboratory use.
EMC Emission	<p>EN/IEC 61000–6–4: Generic standards – Emission standard for industrial environments.</p> <p>EN/IEC 61326–1: Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General Requirements.</p> <p>FCC Rules, Part 15: Complies with the limits for a Class A digital device.</p>
EMC Immunity	<p>EN/IEC 61000–6–1: Generic standards – Immunity for residential, commercial and light industrial environments.</p> <p>EN/IEC 61000–6–2: Generic standards – Immunity for industrial environments.</p> <p>EN 61326–1: Electrical equipment for measurement, control and laboratory use – EMC requirements.</p> <p>Note: The above is only guaranteed using accessories listed in this document.</p>
Temperature	<p>IEC 60068–2–1: Environmental testing - Part 2-1: Tests - Test A: Cold.</p> <p>IEC 60068–2–2: Environmental testing - Part 2-2: Tests - Test B: Dry heat.</p> <p>Storage Temperature: –20 to +60 °C (–4 to +140 °F).</p>
Humidity	IEC 60068–2–78: Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state.
Mechanical	<p>Non-operating:</p> <p>IEC 60068–2–6: Vibration: 0.15 mm, 20 m/s², 10 – 500 Hz</p>

Specifications – Portable Impedance Tube WA-1599-W-070

FREQUENCY RANGE

Tube: 500 Hz to 6.4 kHz

ZERO ABSORPTION

(calculated in 1/3-octave bands)

50 Hz to 4 kHz: <4%

5 kHz to 6.3 kHz: <10%

¼" CONDENSER MICROPHONE CARTRIDGE TYPE 4187

To optimise the measurement accuracy of the microphone, it has a non-removable protection grid that forms an airtight front cavity. This gives a coupling between the tube and the microphones that is well-defined with respect to phase

Open-circuit Sensitivity (250 Hz): 4 mV/Pa (– 48 ±3 dB re 1 V/Pa)

Capacitance (250 Hz): 6.4 pF, typical

Frequency Response Characteristic (Flush-mounted) ±1 dB: 1 Hz to 8 kHz

Polarization Voltage: 200 V

PREAMPLIFIER

Type 2670-W-012

ENVIRONMENTAL SENSORS

Integrated sensors measure temperature pressure and relative humidity

LOUDSPEAKER

Max. RMS Power: 50 W at 20 °C (68 °F)

Impedance: 8 Ω

Diameter: 35 mm (1.38")

OPERATION

Sound source activation and status indicator integrated in handle

DIMENSIONS

Tube Inner Diameter: 29 mm (1.14")

Tube Length: 208.2 mm (8.2")

ASSEMBLED DIMENSIONS (EXCL. CABLE)

356.5 × 184 × 150 mm (14 × 7.2 × 5.9")

WEIGHT (WITHOUT ACCESSORIES)

4.2 kg (9 lb 4 oz)

Specifications – Impedance Meter Program WT-9888

WT-9888 is a software application for use with LAN-XI data acquisition hardware

System Requirements

- LAN-XI hardware with one generator output channel (full generator functionality)
- PULSE Acoustic Material Testing in a Tube Type 7758
- Microsoft® Windows® 10 Pro or Enterprise (x64) with either Current Branch (CB) or Current Branch for Business (CBB) servicing model
- Microsoft® Office 2016 (x32 or x64) or Office 2019 (x32 or x64)
- Microsoft® SQL Server® 2017 or SQL Server® 2019

Minimum Licence Requirements:

- BK Connect® Data Viewer Type 8400
- BK Connect Hardware Setup Type 8401
- BK Connect Data Processing Type 8403

Application Projects

WT-9888 includes a number of predefined application projects for material testing

Measurement

Measurements are based on the two-microphone transfer function method as described in the ISO 10534-2 and ASTM 1050-12 standards.

A group or batch of measurements can be made in a project and measurements from previous projects can be imported into the current project

- Measurement with broadband, pure-tone, or user-defined source
- Automated pass/fail impedance quality control routine for use by non-acoustic specialists
- Impedance spectra for broadband OASPLs up to 150 dB
- Perform automated tracking of resonance frequency variation with pure tone SPL for non-linear materials
- Option for non-linear resistance versus velocity characteristic (pure tone or broadband up to 150 dB OASPL)

MEASUREMENT TUBES

WT-9888 supports Portable Impedance Measurement Tube WA-1599, all tube setups included in Impedance Measurement Tubes Types 4206 and 4206-A and up to three user-defined tube setups in a single project

FFT ANALYSIS

Measurements in WT-9888 are based on FFT analysis

Parameters:

- Baseband and Zoom: 50 – 6400 lines
- Frequency Span: 1.56 Hz – 25.6 kHz (tube dependent)
- Centre Frequency Resolution: 1 mHz
- Averaging Mode: Linear, Exponential and Peak hold
- Number of Averages: 1 – 100000

SIGNAL GENERATION

Waveforms: Sine, Random and Pseudo-random

Level: Fixed, Level automation

POST-PROCESSING

Post-processing can be performed on the following results:

- Absorption coefficient
- Reflection coefficient
- Normalised impedance
- Normalised admittance
- Individual measurements can be post-processed as follows:
 - Averaging of multiple individual results
 - Automated procedure for calculation of the distance from the sample to the acoustic centre of microphones
 - Calculation of the pressure at the sample facing sheet
 - Combining measurements from two different tubes
 - Combining measurements from multiple measurements to create resistance versus test level analysis at selected frequency
 - Combining measurements from multiple measurements to create resistance versus test level analysis at selected frequency at surface of test object
 - Extraction of 1/n-octave centre frequency information
 - Acoustic pressure and acoustic velocity spectra at sample surface
 - Calculation of non-linear resistance variation with acoustic velocity (for broadband, pure-tone or user-defined source)
 - In-tube sample holder for flanged tube correction routine

RESULTS

WT-9888 offers a large number of task-dependent intermediate and final result types

Channel Calibration:

- Sound pressure level at each microphone position

Signal-to-noise Ratio:

- Signal-to-noise Ratio (SNR) at each microphone position

Sound Pressure Level at each Microphone Position:

- With generator off (background noise)
- With generator on

Transfer Function Calibration:

- Calibrator factor
- Coherence
- Transfer function H1, H2 and H3
- Sound pressure level at each microphone position and at facing sheet

Measurements:

- Absorption coefficient
- Acoustic resistance as a function of acoustic velocity (pure-tone or broadband)
- Acoustic velocity as a function of frequency

- Coherence
- Corrected transfer function
- Normalised impedance ratio
- Normalised admittance ratio
- Reflection coefficient
- Resistance vs test level at selected frequency at surface of test object
- Sound pressure level at each microphone position
- Transfer function

REPORTING

- Integrated reporting with Microsoft® Word
- Automated export of data to Microsoft® Excel®

Ordering Information

A typical Portable Impedance Meter System Type 9737 comprises the following:

- WT-9888: Impedance Meter Program for LAN-XI
- Type 7758-N: PULSE Acoustic Material Testing Program (node-locked licence)
- Type 8400-N: BK Connect Data Viewer (node-locked licence)
- Type 8401-N: BK Connect Hardware Setup (node-locked licence)
- Type 8403-N: BK Connect Data Processing (node-locked licence)

Portable Impedance Meter System – Hardware Bundles		
	9737-A	9737-B
1 × Type 3160-A-042 : LAN-XI Generator, 4/2-ch. Input/Output Module, 51.2 kHz (Mic, CCLD, V)	✓	
1 × UA-2104-031 : LAN-XI Front Panel, Sound Intensity, 3 ch. circular-1B 7-pins (F) and sub-D 9-pins (F), 1 ch. BNC out	✓	
1 × WA-1599-W-070 : Portable Impedance Tube (500 Hz – 6.4 kHz, max. 150 dB SPL) including: • 1 × Power Cable, 10 m (32.8 ft) • 2 × Microphone Type 4187 (with Type 2670-W-012) • 5 × WS-4929-W-002: Flat Flange (for curved surface) • 1 × WB-3592: Power Amplifier • 1 × AO-0087-D-002: BNC Cable, 0.2 m (0.66 ft) (cable between Type 3160-A and WB-3592 input) • 1 × WE-0214-W-005: Carrying Case* for Type 9737 system (including wheels and extendable handle)	✓	✓
1 × WP-4808 : Hard-wall Calibration Sample (150 × 150 × 10 mm [5.91 × 5.91 × 0.39"]) Aluminium	✓	✓
1 × WP-1706 : Sample Holder	✓	✓
1 × Type 4231 : Sound Calibrator, Class 1 and LS, 94 and 114 dB, 1 kHz	✓	
1 × DP-0775 : Adapter for calibration of ¼" microphones (for Type 4231)	✓	

* **Dimensions (Ext.):** 625 × 500 × 297 mm (24.5 × 19.5 × 11.7")
Total Weight: Full Case: 21.25 kg (46.8 lb)

RELATED PRODUCTS

Type 4228	Pistonphone
Type 4231	Sound Calibrator
DP-0775	Adapter for ¼" Microphones (for Type 4231)
Type 4206	Impedance Tube Kit (50 Hz – 6.4 kHz)
Type 4206-A	Impedance Tube Kit (100 Hz – 3.2 kHz)
WP-4808	Hard-wall Calibration Sample (150 × 150 × 10 mm [5.91 × 5.91 × 0.39"]) Aluminium
WA-1706	Sample Holder
Type 2670-W-012	Short Preamplifier Type 2670 with 10 m (32.8 ft) cable
Type 4187	¼" Microphone
WC-0015	Microphone Fixing Knob

SOFTWARE MAINTENANCE AND SUPPORT AGREEMENTS

M1-7758-N	Agreement for Type 7758-N
M1-8400-N	Agreement for Type 8400-N
M1-8401-N	Agreement for Type 8401-N
M1-8403-N	Agreement for Type 8403-N
M1-9888	Agreement for WT-9888

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