Instruction Manual

CCP Intensity Probe for LMS Type 50AI-L

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SOUND & VIBRATION

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CCP Intensity Probe for LMS
Type 50AI-L

Revision 6 June 2014

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1 Introduction

1.1 Description

The Intensity Probe Type 50AI-L (Fig. 1.1) is a two-microphone CCP intensity probe with USB remote control for LMS Analyzers. It has a pair of G.R.A.S. phase-matched ½″ microphones Type 40GI, a set of matched ¼″ microphone preamplifiers Type 26CB, solid spacers, remote control handle and connection cable. The probe is adjustable, durable and fully complies with the following requirements:

- IEC 61043, Electroacoustics - Instruments for the Measurement of Sound Intensity - Measurements with Pairs of Pressure Sensing Microphones, 1993 for Class-1 Intensity probes.

Fig. 1.1 The CCP Inensity Probe Type 50AI-L

1.2 Main Features

The CCP Intensity Probe Type 50AI-L is a simple-to-use and reliable probe designed with the following features:

- Complete Sound Intensity Probe for noise source location and sound power measurements
- Easy connection to LMS analysers with IEPE inputs and USB connector
- Complete ready-to-use kit delivered in a carrying case
- Easy to calibrate.

1.3 Special Features

Figure 1.2 shows the main external features of Type 50AI-L.

Type 50AI-L has built-in remote-control functions for direct connection to, and control of, sound-intensity measuring systems from LMS.

Fig. 1.2 Close-up view of Type 50AI-L

2 Delivered Components

The main components of the Intensity Probe Type 50AI-L are:

- Sound Intensity Microphone Pair Type 40GK (see section 2.1)
- Microphone Preamplifiers Type 26CB-Set (see section 2.2)
- Four solid spacers of various lengths and a spacer cup (see section 2.3)
- Remote-control handle with USB interface and four push-buttons for controlling the LMS Sound Intensity Analyzer.

As shown in Fig. 2.1, Type 50AI-L is delivered in a carrying case complete with microphones, preamplifiers, and standard accessories.

Fig. 2.1 The components delivered with the Type 50AI-L. See also Fig. 2.2.

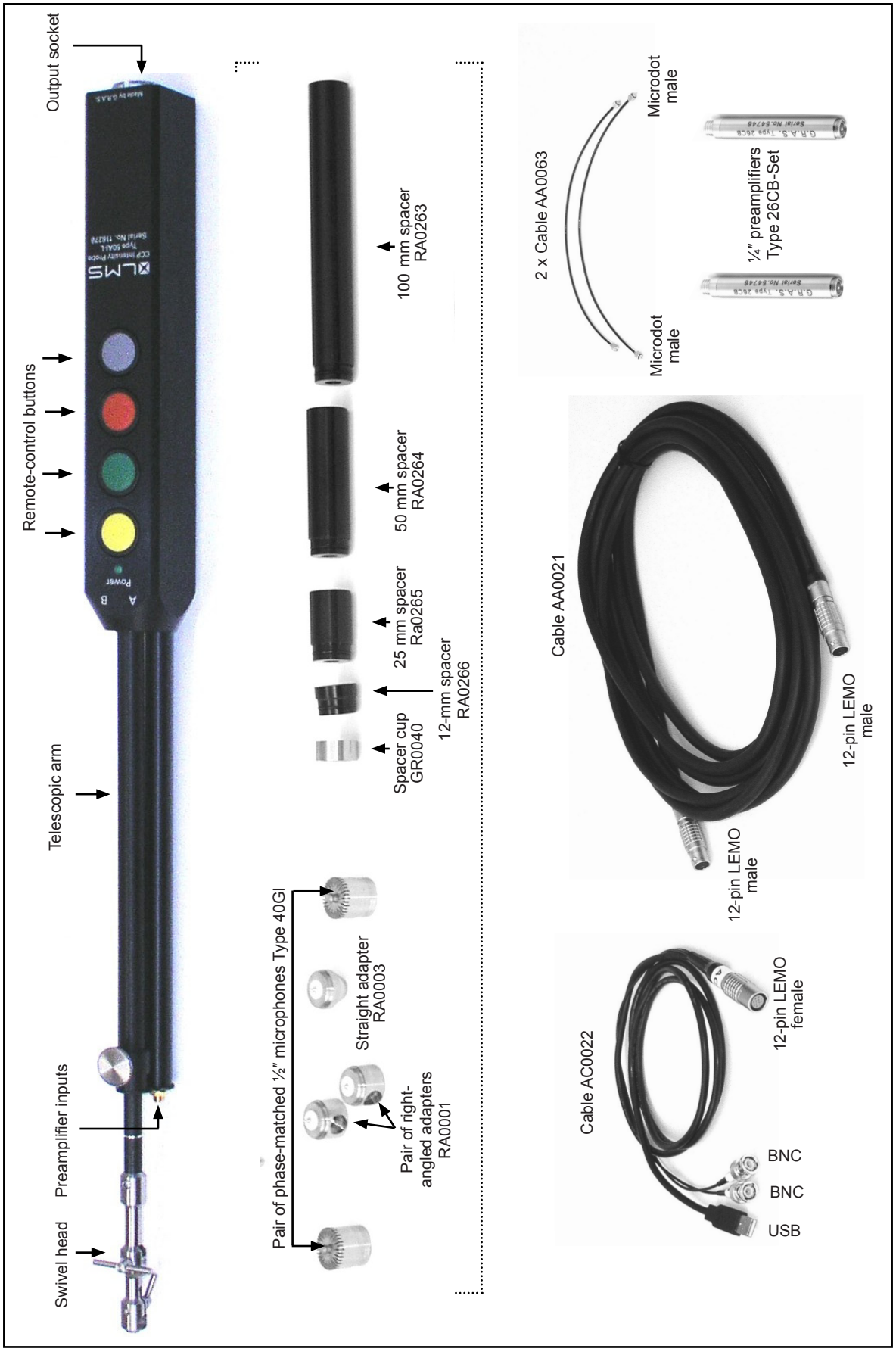

Fig. 2.2 Showing the complete range of components delivered apart from the wind screen

2.1 Microphones

The microphones (Fig. 2.3) are ½″ prepolarized free-field condenser microphones with high sensitivity and a uniquely-designed pressure equalisation system that ensures extremely well-defined phase characteristics. The microphones and preamplifiers are mounted onto the end of the telescopic arm of the Probe handle. To cover the full frequency range from 30 Hz to 10 kHz, the Type 50AI-L is delivered with four solid interchangeable spacers for spacing the microphones at 12 mm, 25 mm, 50 mm, and 100 mm.

Fig. 2.3 Showing similar pairs of phase-matched ½" microphone cartridges:
Above: Type 40GK which includes spacers and three adapters for ¼" preamplifiers as supplied with the Type 50AI-L
Below: Type 40GI (cartridges only)

2.2 Preamplifiers

The small ¼″ diameter and 40 mm long CCP microphone preamplifiers (Fig. 2.4) are housed in robust, stainless steel casings which enable novel probe designs that reduce disturbances to the sound field otherwise brought about by the effects of shadows and diffraction. Symmetry of design enables reliable calibrations as described in the proposed standard (ISO/DIS 9614-2) for sound power measurements using sound intensity measurements.

Fig. 2.4 ¼" Preamplifiers Type 26CB-Set supplied with Type 50AI-L

2.3 Spacers

To cover the wide frequency range (30 Hz - 10 kHz), Type 50AI-L is delivered with four solid spacers of various lengths and a spacer cup (Fig. 2.5).

To select the most appropriate spacer for the actual measurements, refer to Fig. 2.6.

Fig. 2.5 Showing the various spacers and the spacer cup supplied with the Type 50AI-L

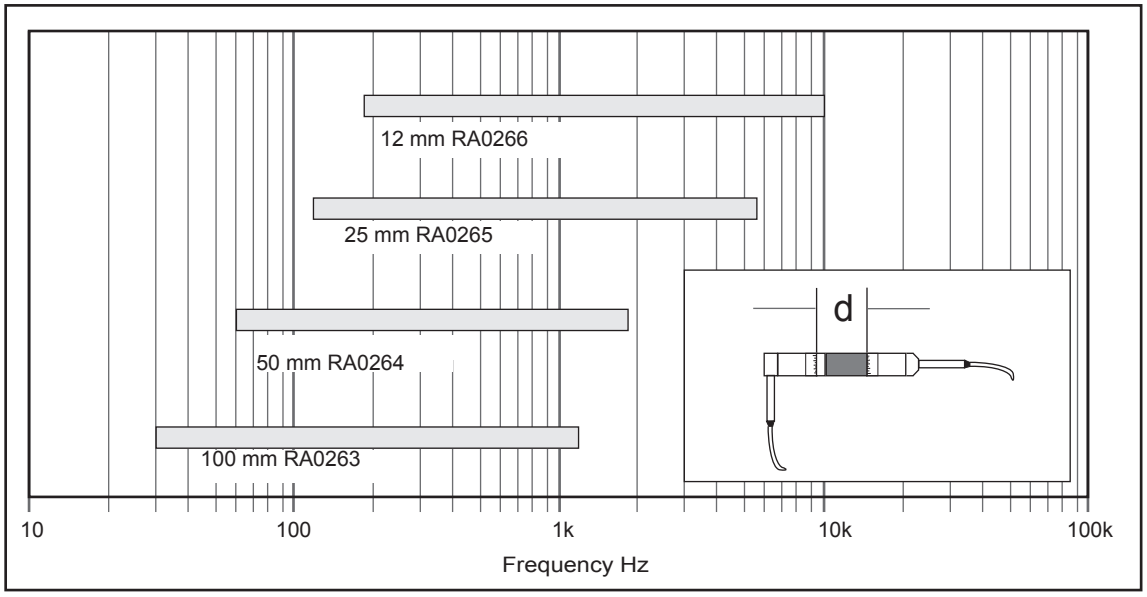

Fig. 2.6 Frequency ranges covered by the various spacer lengths.

3. Handling and Assembling the Probe

3.1 The Microphones

The Microphones Type 40GI (Fig. 1.3) are a pair of special free-field microphones with extremely well-controlled phase characteristics. They are delivered as a matched pair each with individual calibration data as well as data on differences between their phase responses.

These microphones have a unique pressure equalisation system which ensures a well defined lower-limiting frequency and an extremely low sensitivity to sound pressures at the pressure equalisation channels. Therefore, they can be calibrated in single-port phase calibrators such as the G.R.A.S. Intensity Calibrator Type 51AB.

3.2 Probe Design

The design of the Intensity Probe minimises acoustic reflections and the influence of diffraction. This has been achieved by removing any physical, reflective components from the sound path at 0° incidence. Since sound waves at 0° incidence are the main contributors to the total sound intensity level, it is important that disturbances in this direction be minimised.

The thin preamplifier cables (diameter of 2.5 mm) will have no influence on the sound field since they constitute a highly irregular surface with negligible reflections. The effects of acoustic diffraction and reflection from the physical parts of the Intensity Probe are below 0.15 dB.

Microphones are supplied as pairs (Type 40GI) or as sets (Type 40GK) which include spacers and three preamplifier adapters (two right-angled and one straight).

The distances between microphones and preamplifiers have been kept to a minimum in order to avoid problems with any stray capacitance and sensitivity to vibration. While amplitude characteristics are little influenced, the phase characteristics of an Intensity Probe can be critically affected by even very small vibrations in the conductors carrying the raw signals from the microphones. Therefore, the ¼″ preamplifiers are mounted in rigid contact with the ½″ microphones via short adapters (right-angled and/or straight). This also eliminates problems with non-matching capacitances between microphones and preamplifiers, which could give rise to phase problems.

3.3 Physical Strength

From a physical point of view, an Intensity Probe should be robust and easy to assemble and dismantle. Typically, there are two points in an Intensity Probe which can be identified as critical for physical strength and are the most likely to suffer damage and are the most difficult to repair. These points are the threads on microphones and preamplifiers as well as on the microphones' protection grids. The connections between microphones and preamplifiers are very delicate and carry both microphone signals and microphone polarisation voltages. Therefore, the preamplifier threads of the Type 50AI-L are supported by stainless steel ½″ to ¼″ adapters. There is also a protective guard within the ¼″ housing of each preamplifier. In addition, the microphones' protection grids are made of stainless steel to withstand rough physical treatment since a buckled or damaged protection grid will almost invariably damage a microphone's diaphragm beyond repair.

3.4 Assembling the Probe

The Intensity Probe can be assembled in either a straight setup or a symmetrical setup:

- The straight setup (Fig. 3.1), is for intensity measurements close to surfaces and general source location measurements.
- The symmetrical configuration (Fig. 3.2), is ideal for sound power measurements, for example according to international standard ISO 9614-2 “Acoustics - Determination of sound power levels of noise sources using sound intensity” where a rotation test is required.

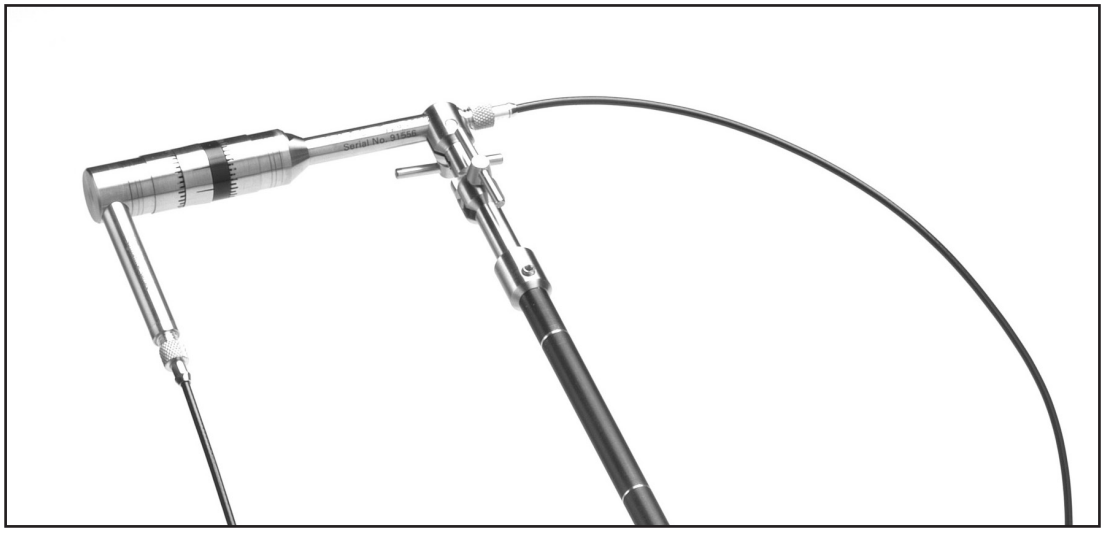

Fig. 3.1 Straight setup using the 25-mm spacer

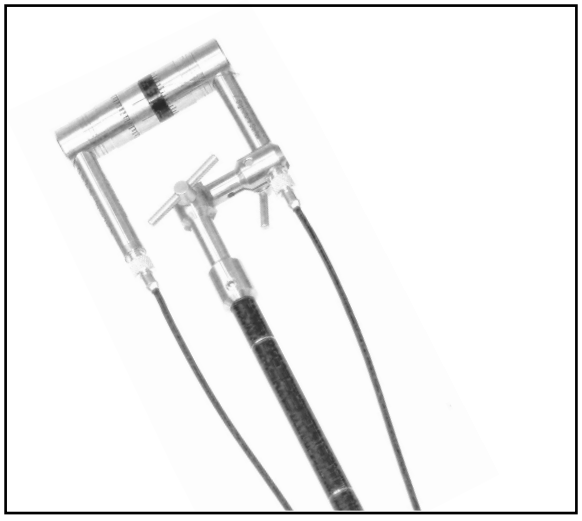

Fig. 3.2 Symmetrical setup using the 12-mm spacer

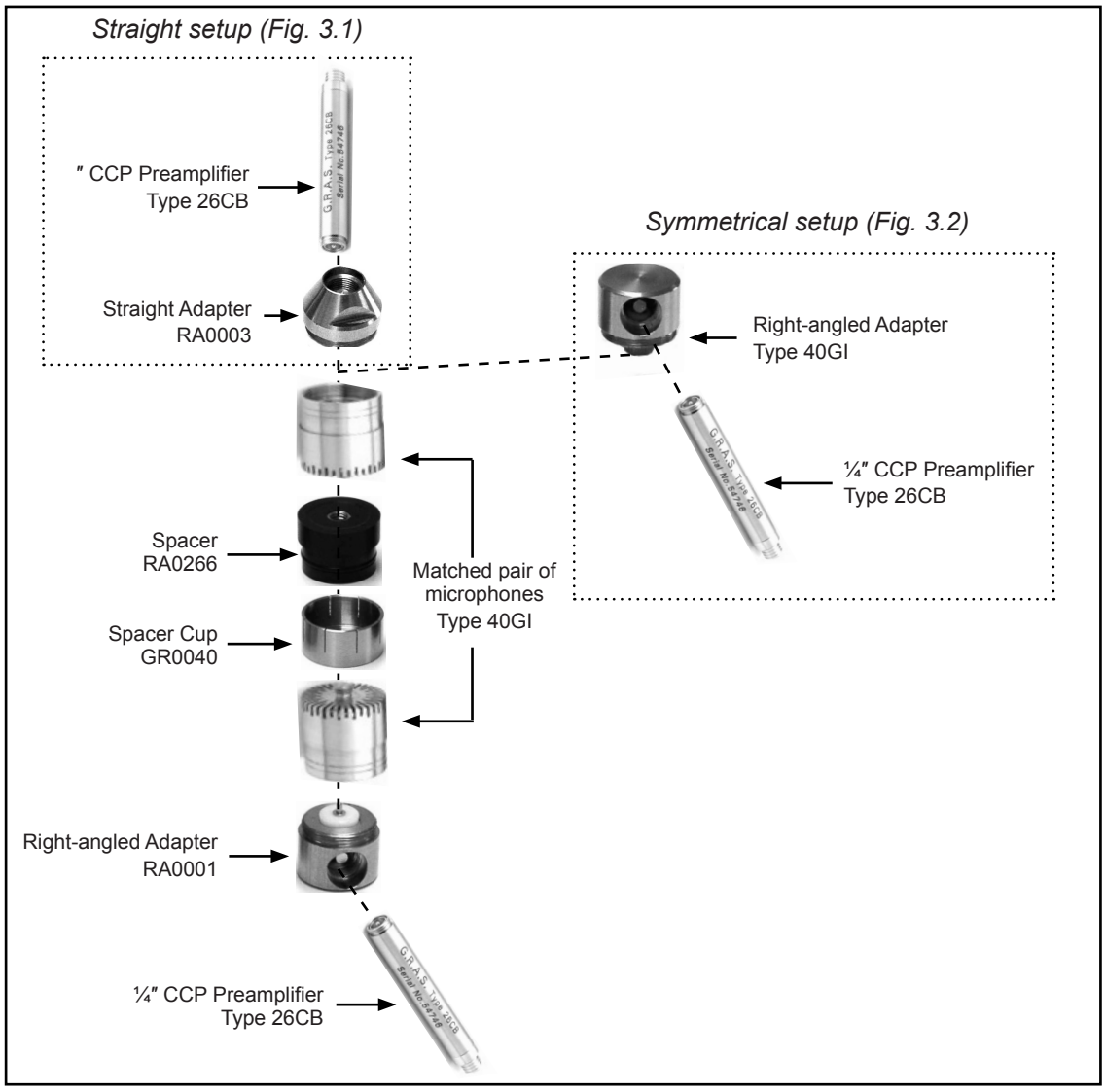

Fig. 3.3 Exploded view of probe assembly for both straight and symmetrical setup

Assemble as follows:

1. Mount either of the microphones onto a Right-angled Adapter RA0001 and the other microphone onto either the other Right-angled Adapter RA0001 (symmetrical configuration) or the Straight Adapter RA0003 (straight configuration).
2. Unscrew the black protection caps from the two CCP Preamplifiers Type 26CB.
3. Mount the microphone-adapter assemblies onto the preamplifiers.
4. Screw the Spacer Cup GR0040 onto the protection grid of one of the microphones.
5. Among the four spacers supplied, select the most appropriate one for the frequence range you wish to measure. Refer to Fig. 2.6 to read off frequency ranges for the spacers. In many cases, the 25-mm spacer RA0265 will be appropriate and will cover the frequency range from 100 Hz to 6.3 kHz*.
6. Screw the spacer onto the protection grid of the other microphone.

** According to the investigations of Jacobsen, Keith, and Krishnappa, diffraction effects at the intensity probe compensate for the insufficiencies of the finite difference approximation. The frequency range of intensity measurements may therefore be extended to frequencies up to 10kHz using ½" probes with a 12-mm spacer.*

7. Now assemble the probe head by pressing the free end of the spacer (mounted on the one microphone) into the spacer cup mounted on the other microphone:

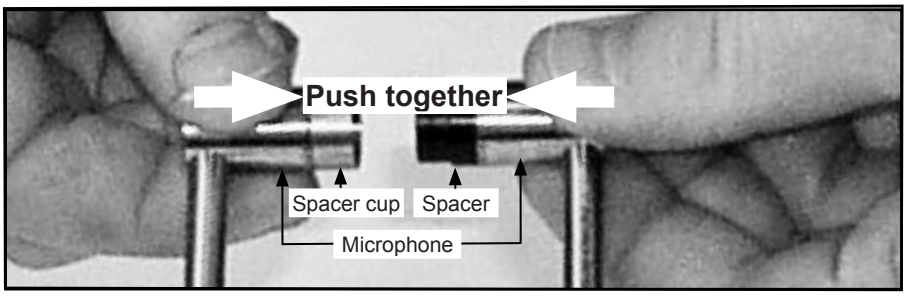

Fig. 3.4 Assembling the probe head (shown for the symmetrical setup)

8. Mount the probe head by sliding either of the preamplifiers into the clamp (which can be locked at angles of 0°, 45°, 90°, 135° and 180°) at the top of the telescopic arm, and tighten the finger screw (see the examples in Figs. 3.1 and 3.2).

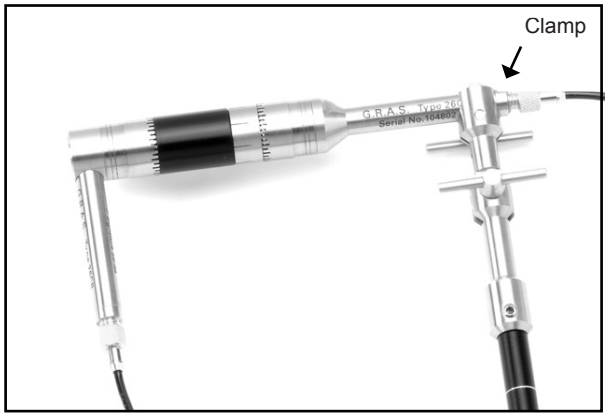

Fig. 3.5 Probe head mounted on the probe (straight setup)

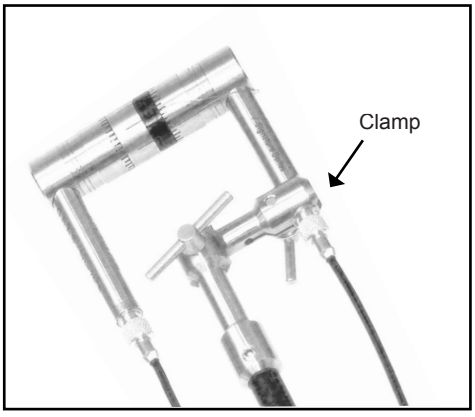

Fig. 3.6 Probe head mounted on the probe (symmetrical setup)

9. Connect the Cable AA0063 to the preamplifiers (Fig. 3.7).

10. Mount the cables into the cable guides of the probe handle (Fig. 3.7).

Fig. 3.7 Example of completely assembled Probe Type 50AI-L (symmetrical setup with 25-mm spacer)

3.5 Using the Windscreen

The Sound Intensity Probe Type 50AI-L includes an elliptical windscreen (AI0001) which can be used whenever making outdoor measurements or when making indoor measurements in the presence of bulk air movements. Use it only when measurements are influenced by wind. It gives good protection at wind speeds greater than 0.5 m/s and can reduce pressure fluctuations caused by turbulence by as much as 20 dB with this technique of intensity measurements.

3.6 Changing the Spacer (to cover a different frequency range)

1. Dismantle the probe head by pulling the spacer out of the spacer cup (Fig. 3.8)
2. Unscrew the spacer and replace it with the one covering the desired frequency range (see Section 2.3 Spacers).

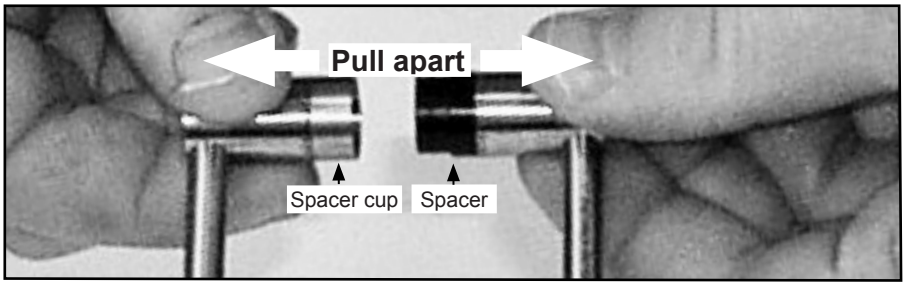

Fig. 3.8 Changing the spacer

4 Calibration

4.1 Checking the Sensitivity and P-I Index using a Pistonphone

4.1.1 Checking the Sensitivity

Check the sensitivity of the microphones using a Pistonphone Type 42AP (recommended) or Type 42AA. Refer to the manual supplied with the pistonphone for instructions on using the pistonphone.

4.1.2 Checking the P-I Index (Pressure Intensity)

Check the P-I index using Two-port Calibration Coupler RA0024 and a pistonphone, either Type 42AP (recommended) or Type 42AA. Refer to the manual supplied with the pistonphone for instructions on using the pistonphone.

1. Dismount the standard ½″ coupler (Fig. 4.1).

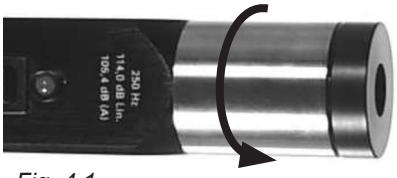

Fig. 4.1

2. Mount the Two-port Calibration Coupler RA0024, and insert the two microphones into its ports (Fig. 4.2). *The two microphones will be subjected to the same pressure level.*

Fig. 4.2

You will have to add the two-port correction factor for the RA0024 to the calibration value given for the pistonphone. The sound pressure level L_{2P} obtained in the two-port adapter is then:

$L_{2P} = L_P + L_C$ *L_P: normal pistonphone level corrected for the barometric pressure*
L_C: two-port correction factor (nominal 8.0 dB)

If the pistonphone is used an ambient temperature different from that ambient static pressure (1013 hPa), the sound pressure level must be corrected accordingly.

Two-port correction factor (nominal):	8.0 dB
Nominal Frequency	250 Hz

4.2 Checking the Probe's P-I Index using an Intensity Calibrator

The P-I (Pressure Intensity) index of the sound intensity microphone pair and preamplifiers can be checked using the Intensity Calibrator Type 51AB - proceed as follows:

1. Mount the intensity microphones on their preamplifiers.
2. Connect the preamplifier outputs to the sound-intensity analyzer[1].
3. Insert the microphones into the holes at the ends of the Intensity Calibrator, making sure to push then all the way in.
4. Set the intensity analyzer to measure intensity corresponding to a 25 mm microphone spacing.
5. Apply a signal[1] to the BNC input of the Intensity Calibrator (signal must not exceed 1 V RMS).
6. Set the analyzer to mean pressure mode, and measure the result in decibels re. 20 µPa.
7. Set the analyzer to intensity mode and measure the result in decibels re. 10^{-12} W/m^2.

The P-I index of the intensity probe is then the difference, in decibels, of these two results. For frequencies above 300 Hz, this should be at least 29 dB.

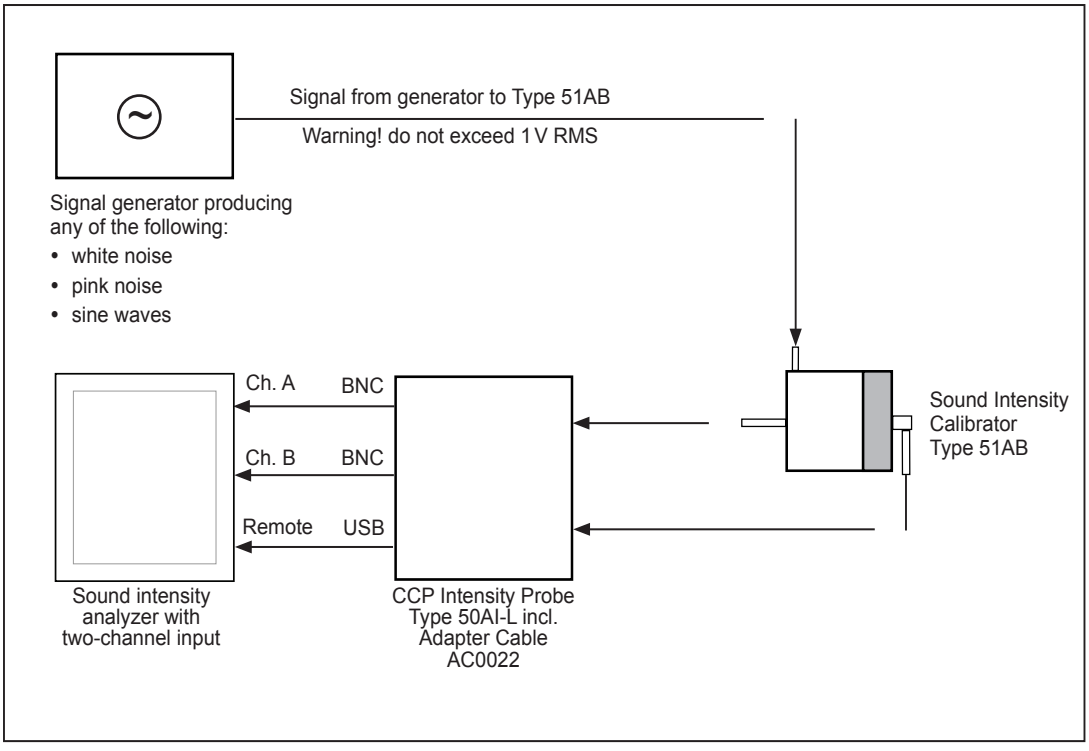

Fig. 4.3 Setup with signal generator and sound intensity analyzer

[1] *White-noise, pink-noise or a sine wave.*

[2] *Via a preamplifier power module (e.g. the GRAS 2-channel Power Module Type 12AQ) if the sound-intensity analyzer does not provide power for preampliers.*

5 Application Setup

5.1 Typical Application Setup

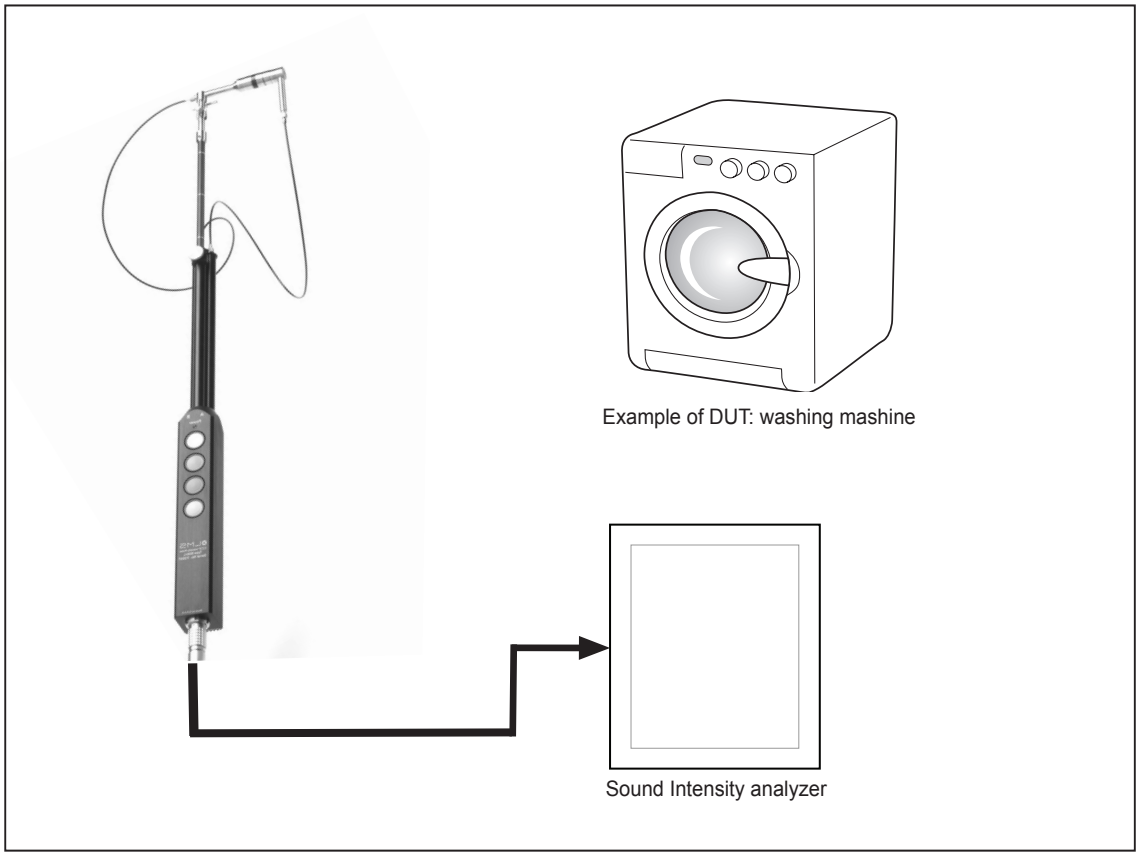

Fig. 5.1 Example of application setup: measuring the sound intensity of a washing mashine

5.2 Using the Probe

A and B refer to the two probe channels:

Channel A is reserved for the leading microphone, i.e. the microphone first struck by the acoustic wavefront. The wavefront travelling from microphone A to microphone B should be interpreted as a positive component of the sound intensity.

Sound-intensity Axis

Fig. 5.2 illustrates the origin and direction of positive sound-intensity vectors. Positive direction is always from microphone A to microphone B.

The origin of the sound-intensity axis is always located in the geometric centre of the probe microphone pair.

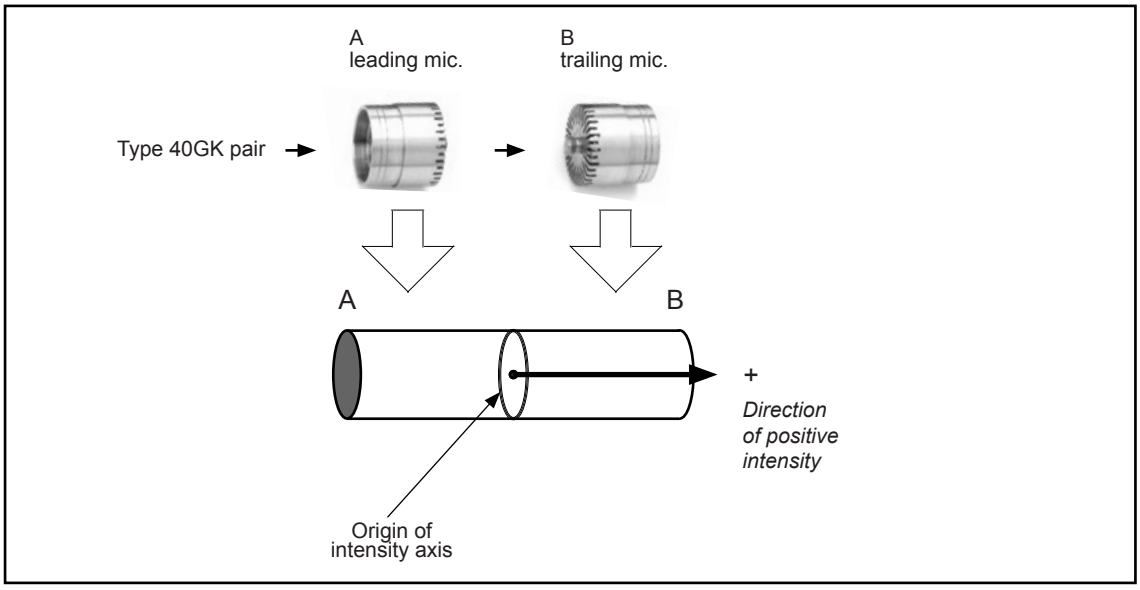

Fig. 5.2 Showing the microphones 'A' and 'B' which correspond with channels A and B respectively. 'A' is the leading microphone and is struck first by a sound wave

6 Specifications

Sound-intensity microphone pair Type 40GK:
½″ free-field

Preamplifiers Type 26CB-Set: Phase-matched

Frequency response and phase matching:
IEC 61043 Class 1

Weight:
0.4 kg (0.9 lbs)

Frequency range:
with 100-mm spacer . . . . . 30 Hz - 1 KHz
with 50-mm spacer . . . . . 80 Hz - 1.5 KHz
with 25-mm spacer . . . . . 120 Hz - 5 KHz
with 12-mm spacer . . . . . 200 Hz - 10 KHz

See also Product Data for Type 40GK and Type 26CB.

7 What to Order

7.1 Accessories Included

Accessories Included

Microphoneset.....Type40GK
comprising:

½″ Free-field Sound Intensity Microphone set . . . . . .Type 40GI
Spacer, 100 mm RA0263
Spacer, 50 mm. RA0264
Spacer, 25 mm RA0265
Spacer, 12 mm RA0266
Straight adapter RA0003
Angled adapter RA0001

¼″ CCP Preamplifier set . . . . . Type 26CB

12-pin LEMO Extension Cable, 5 m (male-male) AA0021

Adapter, 12-pin LEMO (fem.) to 2 x BNC + USB Type A (male) AC0022

2 x Cable microdot, 30 cm (male-male) AA0063

Probe handle AI0046

Windscreen AI0001

Optional Accessories

Microphone Adapter (microdot-microdot (female) AE0046

For Calibration:

Intensity Calibrator . . . . . .Type 51AB

Pistonphone with built-in barometer and thermometer (recommended) . . . . . Type 42AP

Pistonphone . . . . . .Type 42AA

Two-port Calibration Coupler (for Pistonphones Type 42AP or 42AA) RA0024

Manufactured to conform with:

CE marking directive: 93/68/EEC

WEEE directive: 2002/96/EC

RoHS directive: 2002/95/EC

G.R.A.S. Sound & Vibration continually strives to improve the quality of our products for our customers; therefore, the specifications and accessories are subject to change.