Brüel & Kjær application notes

# Software Package WW 9041 for Noise Measurements on Business Machines according to ECMA 74


Brüel & Kjær

BO 0128–11

# Software Package WW 9041 for Noise Measurements on Business Machines according to ECMA 74

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## 1. Introduction

Software Package WW 9041 allows noise measurements on business machines according to ECMA 74, Measurement of Airborne Noise Emitted by Computers and Business Equipment. It includes programs for determination of sound power and for measurement of sound pressure at the operator and bystander positions. The programs are written in BASIC 4.0, and can operate in an HP 200/300 series computer. They are stored on a 5¼ or 3½ inch disc. The programs also make use of a data disc for storage and retrieval of results.

The programs can be used for semi-automatic or automatic measurements. For semi-automatic measurements, the following instruments are required:

1. The Digital Frequency Analyzer Type 2131, or the Sound Intensity Analyzing System Type 3360
2. Modifications WH 0490/WI 1624 to the Type 2131 or Type 3360
3. A Microphone and Preamplifier, (e.g. Type 4165 with Type 2639)

For automatic measurements, the following instruments are required:

1. The Digital Frequency Analyzer Type 2131, or the Sound Intensity Analyzing System Type 3360
2. Modifications WH 0490/WI 1624 to the Type 2131 or Type 3360
3. 1 to 4 Multiplexers Type 2811
4. 1 to 32 Microphones and Preamplifiers, (e.g. Type 4165 with Type 2639).

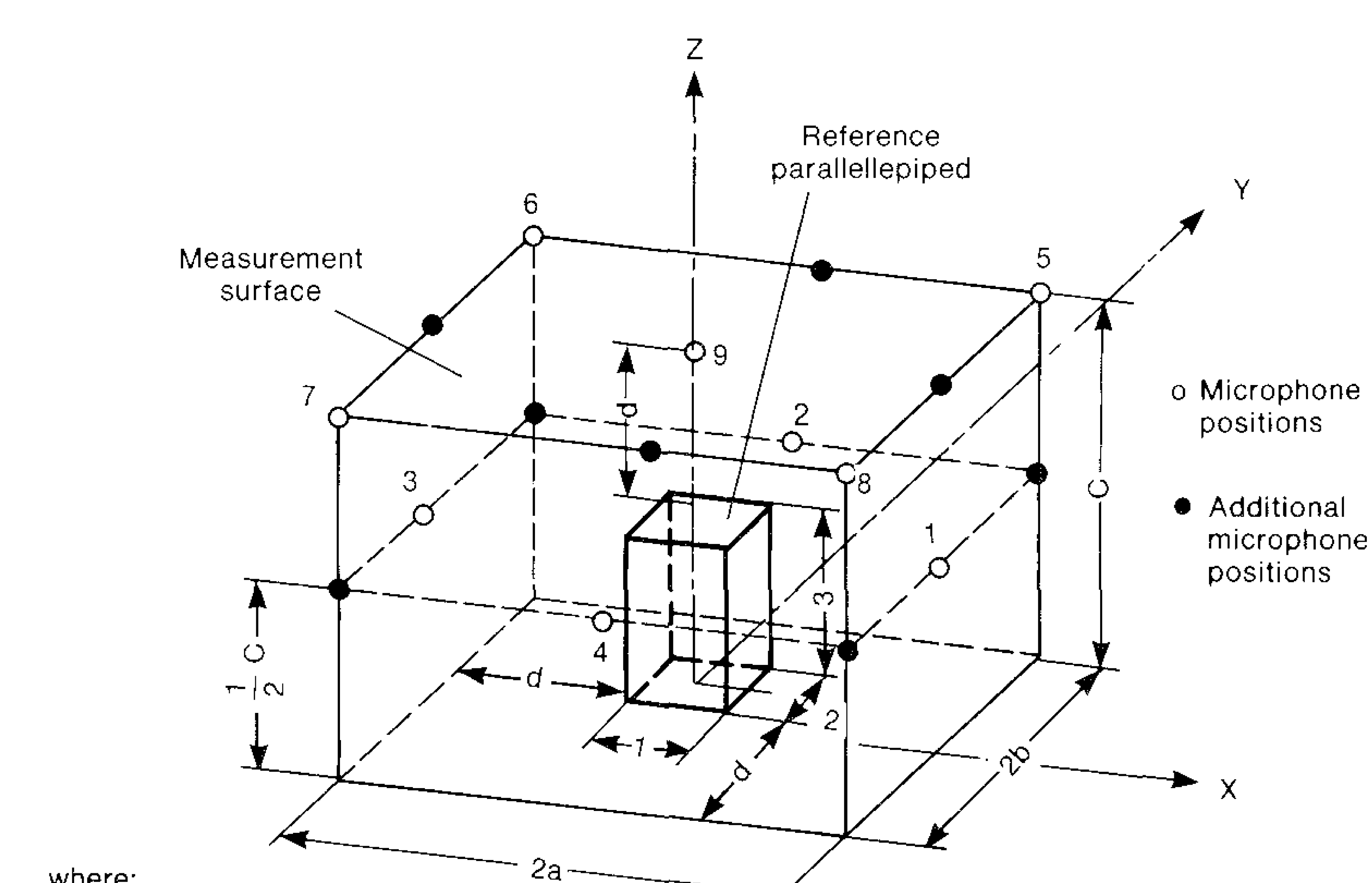
Since the determination of sound power follows ISO 3744, (ANSI equivalent, ANSI S1.34), a Reference Sound Source Type 4204 might also be required for measurement of the room correction factor K.

The sound power determination is according to ECMA 74 and ISO 3744, from sound pressure measurements in an essentially free field over a reflecting plane. The sound pressure levels are determined according to ECMA 74 and ISO 6081. The test for impulsive noise uses the modifications WH 0490/WI 1624 to the 2131 or 3360, and follows ECMA 74, as does the pure tone determination, which uses the 1/12 octave mode of the 2131 or 3360. All measurements are according to the September 1981 draft of ECMA 74, except the pure tone determination, which follows the September 1982 amendment.

The programs can also be operated with an unmodified 2131 or 3360. All of the measurements described above can be carried out, except the impulsive noise test.

## 2. Sound Power Determination

The sound power levels are determined from ⅓ octave sound pressure measurements at a number of microphone positions on a measurement surface in an essentially free field over a reflecting plane. Two measurement surfaces are allowed, namely the par-




where:

$\overline{L_{pm}}$ = The band pressure level averaged over the measurement surface

$L_{pi}$ = The band pressure level resulting from the i-th measurement

N = The total number of measurements

$$\overline{L_{pm}} = 10 \log \left[ \frac{1}{N} \sum_{i=1}^{N} 10^{0.1 L_{pi}} \right]$$

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*Fig. 1. Microphone positions for the parallelepiped, or "shoe-box"*

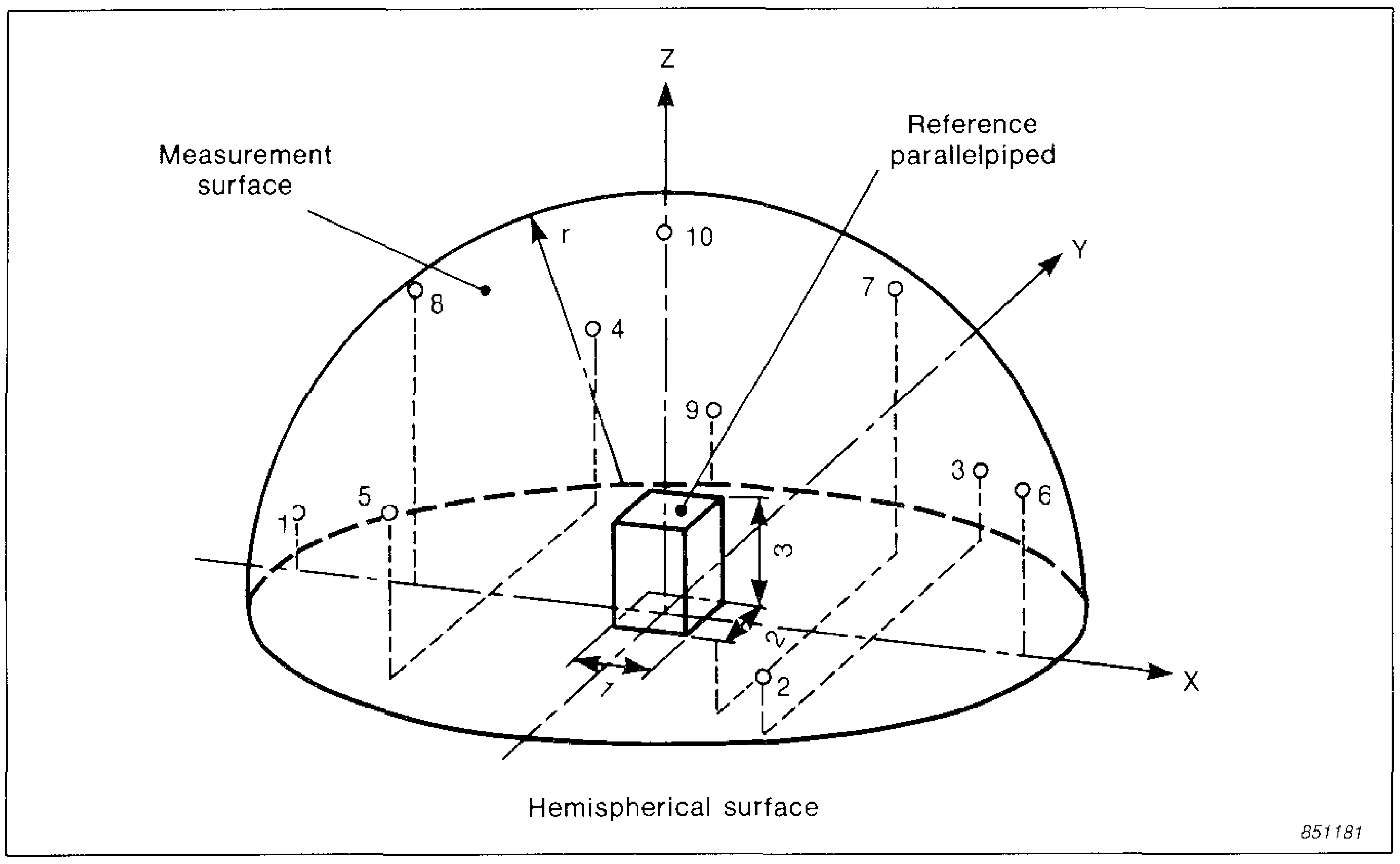


*Fig. 2. Microphone positions for the hemisphere*

allelepiped, or "shoe-box", and the hemisphere, shown in Figs.1 and 2 respectively. Of these two surfaces, ECMA 74 states that the parallelepiped is preferred, and that the hemisphere can only be used for measurements on small noise sources.

The measurements can be performed in a semi-automatic or automatic mode. The semi-automatic mode is intended for use with systems using only one microphone. A pause is introduced between each sound pressure measurement to enable the microphone to be moved to the next microphone position. The automatic mode is for use with multiplexed microphone systems, whereby the program automatically scans around all microphone positions. The scan can either be continuous, or a pause can be introduced between each sound pressure measurement at each microphone position, should it be necessary to make adjustments to the device under test. For instance, for printers printing onto single sheets of paper, it will be necessary to insert a new sheet of paper for each sound pressure measurement at each microphone position.

Up to 32 microphone positions can be scanned, either semi-automatically or automatically, with a linear averaging time of up to 128 seconds at each microphone position. When an averaging time of 128 seconds is insufficient, it may be extended by repeating the measurement at each microphone position, with up to 10 repetitions being possible. In addition, up to 10 complete scans can be carried out around the selected microphone positions. All of the measured spectra are stored on the data disc for later retrieval.

In addition to the source scan, a background noise scan is required. In both semi-automatic and automatic measurements, the background noise at each microphone position is measured as a separate scan prior to the source scan.

The background noise scan is stored on the program disc, and provided the number of microphone positions remains unchanged, it can be used for multiple measurements of sound power. If the number of microphone positions is changed, however, (or the background noise conditions change), a new background noise scan must be made. The averaging time used for the background noise scan and the source scan is independently selectable.

| Difference in dB between sound pressure level measured with equipment operating and background noise alone | Correction in dB to be subtracted from sound pressure level measured with equipment operating to obtain sound pressure level due to equipment alone |
|---|---|
| < 6 | *measurement invalid* |
| 6 | 1,0 |
| 7 | 1,0 |
| 8 | 1,0 |
| 9 | 0,5 |
| 10 | 0,5 |
| > 10 | 0,0 |

T00846GB0

*Table 1. Corrections for background noise according to ECMA 74, Clause 6.7.3.*

The sound pressure spectrum at each microphone position, averaged over the number of scans performed and corrected for background noise according to ECMA 74, (see Table 1), can be displayed on the screen of the computer or printed out on its graphics printer. The measured background noise spectrum for each microphone position can also be displayed or printed. The average sound pressure level, $L_{pm}$, (corrected for background noise), is calculated for each 1/3 octave band across all microphone positions, and can be displayed or printed, as can the average background noise level.

The software includes the possibility of entering the environmental or room correction factor, K, (ECMA 74, clause 6.8, and ISO 3744, annex A). This factor describes the amount of noise measured in dB due to unwanted reflections. The correction factor can be entered manually for each 1/3 octave and the A-weighted channel, or can be measured using the Reference Sound Source Type 4204, which is placed in the test environment in the same position as the source under test, and with the same microphone positions. The correction factors are stored on the program disc, and hence provided that the test environment and microphone positions remain unchanged, they need only be entered or measured once. The maximum range allowed for the room correction factors is 0 to 2 dB.

The surface sound pressure level $L_{pf}$ is the average sound pressure level, corrected for the amount of noise due to unwanted reflections:

$$L_{pf} = L_{pm} - K$$

The sound power level is calculated from the surface sound pressure level according to the equation:

$$L_W = L_{pf} + 10 \log_{10}\left(\frac{S}{1\,m^2}\right)$$

where S is the surface area of the measurement surface in $m^2$. Both the surface sound pressure level and the sound power level can be displayed on the computer's display screen or printed on its graphics printer, as can the room correction factor K.

The display and printout of measured and calculated spectra can be made both in numeric and in graphic form. The A-weighted and 1/3 octave or 1/1 octave levels, (calculated from the 1/3 octave data), are shown. Corrections for background noise or unwanted reflections, (room corrections), are indicated, as are underrange in the measurements or invalid data due to too high background noise or room correction factors. Examples of printouts are given in Section 7.

The data can also be displayed and printed out without the background noise correction. This allows sound power to be calculated even when the required background noise conditions have not been met. However, the calculated values will be too high, and cannot be quoted as being measured according to ECMA 74. A warning is given on the display or printout when the background noise correction has not been made.

# 3. Sound Pressure Measurements at the Operator and Bystander Positions

The operator position for noise measurements on business machines according to ECMA 74 is defined as in Fig.3. The microphone should be oriented such that it has a flat response to sound incident on it from the device under test at an angle of 30° below the horizontal. Where the device under test is not usually operator attended, the noise measurements are made at the bystander position(s). A number of bystander positions can be defined e.g. at the front, sides, and back of the equipment under test. It is left to the manufacturer to decide how many positions are relevant. The bystander positions are defined similarly to the operator position, except that they are now 1 m from the device under test. The sound pressure measurements required at the operator and/or bystander positions are the mean A-weighted sound pressure level, $\overline{L_p}A$, and where impulsive noise and/or pure tones are audible, an impulsive noise test and/or a pure tone determination.

The scanning of the microphone positions for sound pressure measurements and the data storage is performed as described in Section 2. The sound pressure spectrum at each microphone position, averaged over the number of scans performed and corrected for background noise can be displayed and printed, as can the A-weighted sound pressure level, $L_pA$. The average sound pressure spectrum, (corrected for background noise), over all the microphone positions is calculated and can be displayed and printed. Also, the measured background noise at each microphone position and the average background noise over all microphones can be displayed and printed.

If the 2131 or 3360 is fitted with the modifications WH 0490/WI 1624, the impulsive noise test according to ECMA 74 is performed at the same time as the sound pressure measurement. The A-weighted impulse rectified sound pressure level, $L_pAI$, averaged on a mean-square basis, is measured. If the difference between $L_pAI$ and $L_pA$ is equal to a greater than 3 dB, the noise is considered to be impulsive, and this is indicated on the display and print-out.

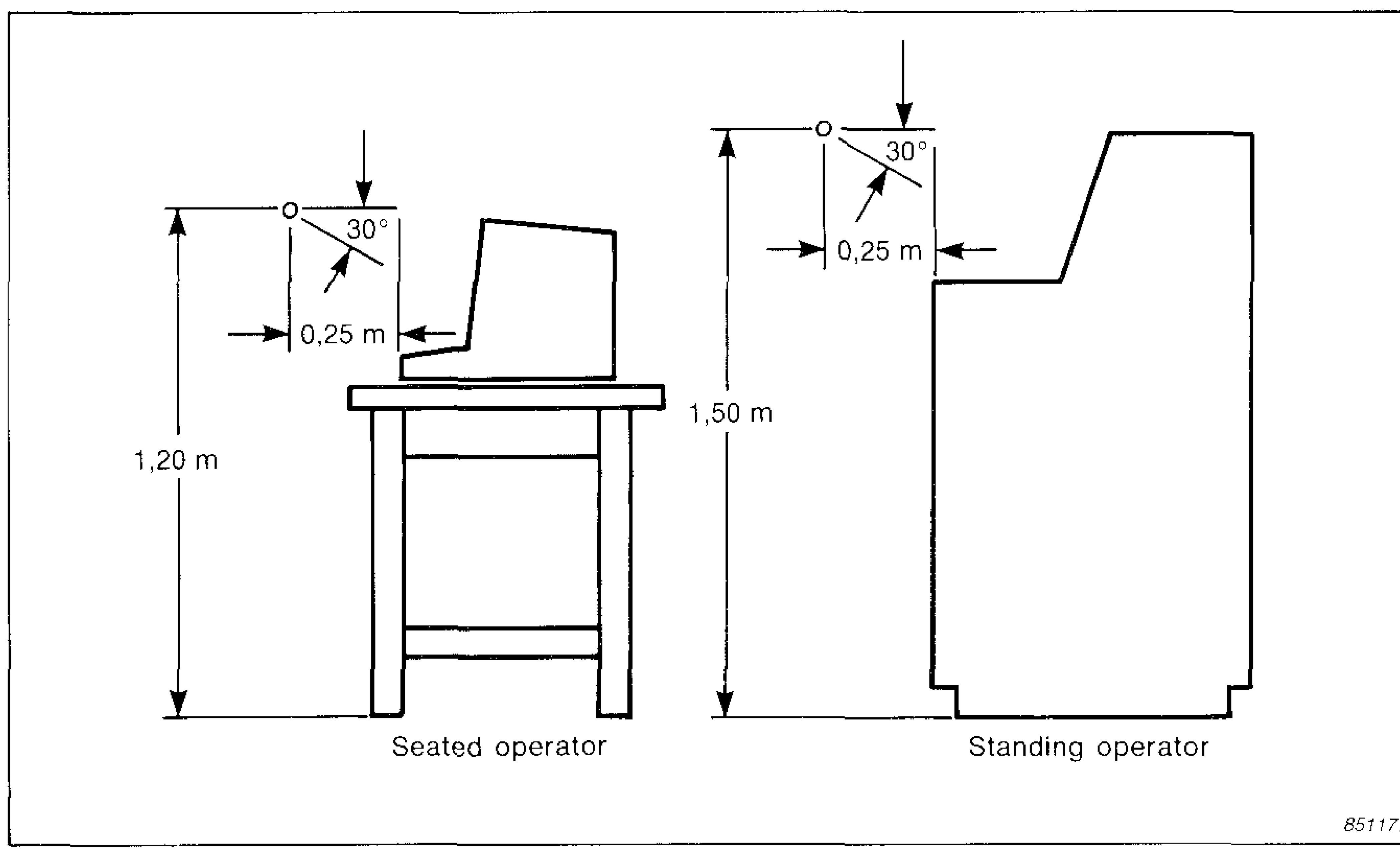


*Fig. 3. Examples of the operator position for a seated and standing operator*

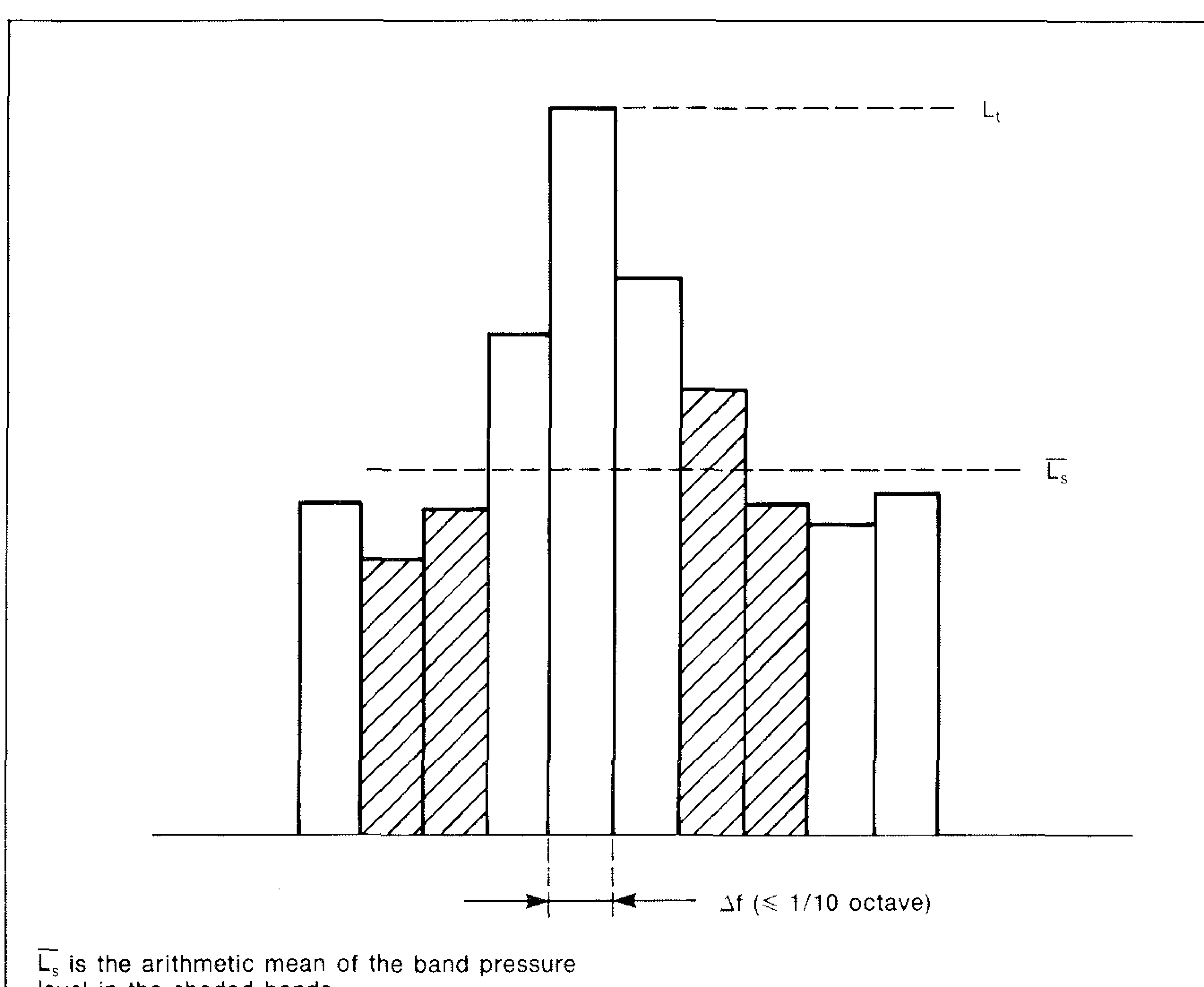


*Fig. 4. Determination of $L_t - \overline{L_s}$ in the pure tone determination*

The pure tone determination is performed according to the amendment to ECMA 74, September 1982. It uses the 1/12 octave mode of the 2131 or 3360, which requires a four pass analysis. Hence, the number of scans is limited to 1, and no background noise scan is made. The difference $L_t - \overline{L_s}$ is determined as shown in Fig.4, and a pure tone is detected when:

$$L_t - \overline{L_s} \geq 10 - 10 \log_{10} \left(\frac{\Delta f}{f_c}\right) \text{dB}$$

where $\Delta f$ is the bandwidth of the analyzing filter, (1/12 octave), and $f_c$ is the Fletcher critical bandwidth. Frequencies where a pure tone has been detected are indicated on the display or print-out of the 1/12 octave spectrum and where the analyzer has been modified as described in the previous paragraph, the impulsive noise test is also performed.

Examples of printouts for all of the above measurements are given in Section 7.

# 4. Set-up of Instruments

The instruments should be set up as shown in Figs.5, 6 or 7. Fig.6 shows 10 microphone channels, which is the minimum required when the hemisphere is used. Where the parallelepiped is used, the minimum number of microphone channels is 9. However, in both cases, additional microphone channels could be required for the operator and/or bystander positions. The microphone channels to be used for the measurements in an automatic scan are selected using the SELECT-INHIBIT switches on the Multiplexer(s) Type 2811. Note, however, that Channel No. 1 on the main multiplexer must always be connected. As mentioned earlier, up to 4 multiplexers and 32 microphone channels can be controlled.

The modification WH 0490/WI 1624 to the 2131 or 3360 are required to perform the impulsive noise test. Where these modifications are included, both WH 0490 channels should be set to A weighting, with a "Fast" time weighting in the first channel and an "impulse" time weighting in the second.

For detailed instructions on the instrument set-up and running the programs, refer to the Instruction Manual for WW 9041.

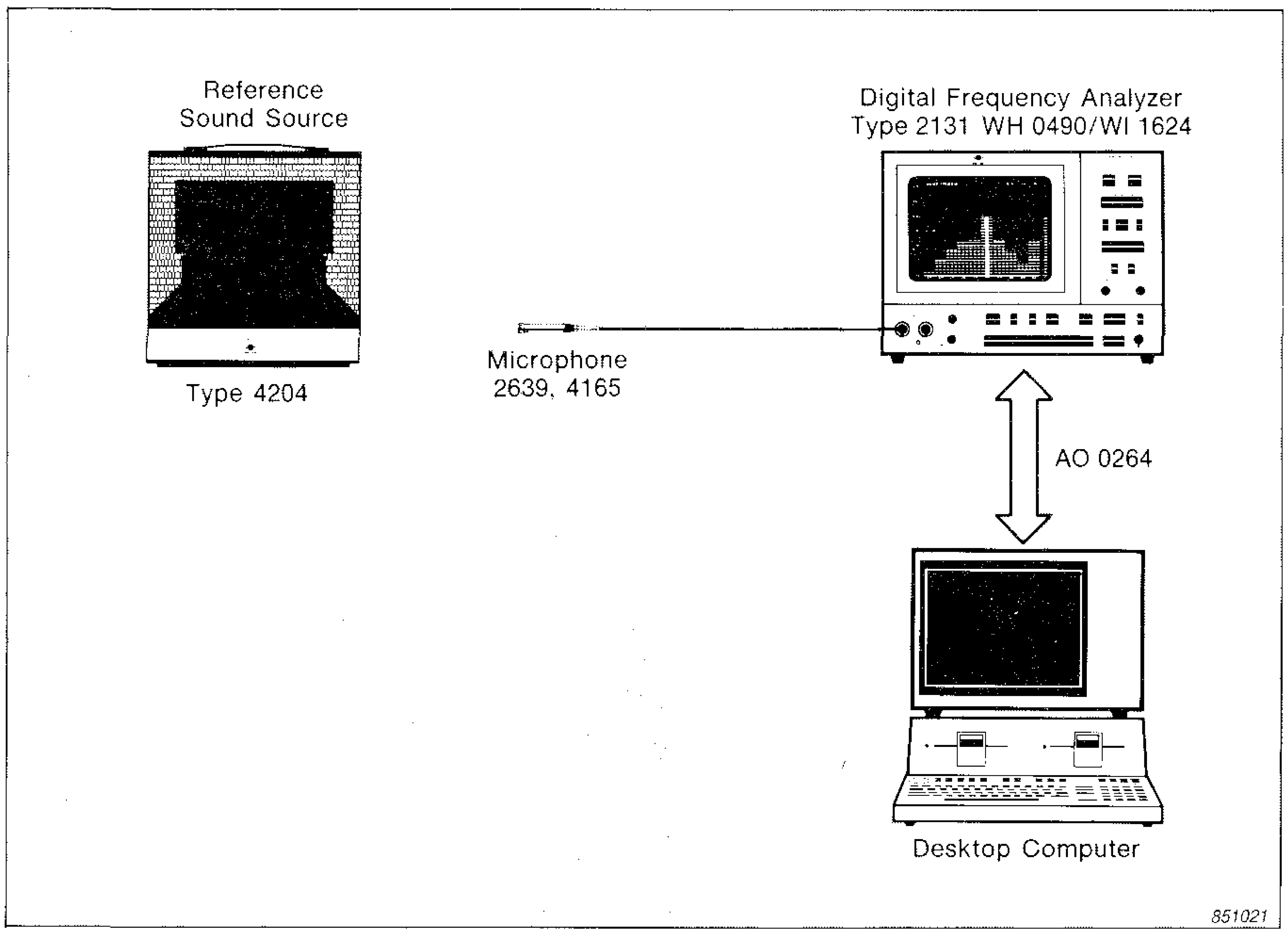


*Fig. 5. Set-up of instruments for semi-automatic measurements*

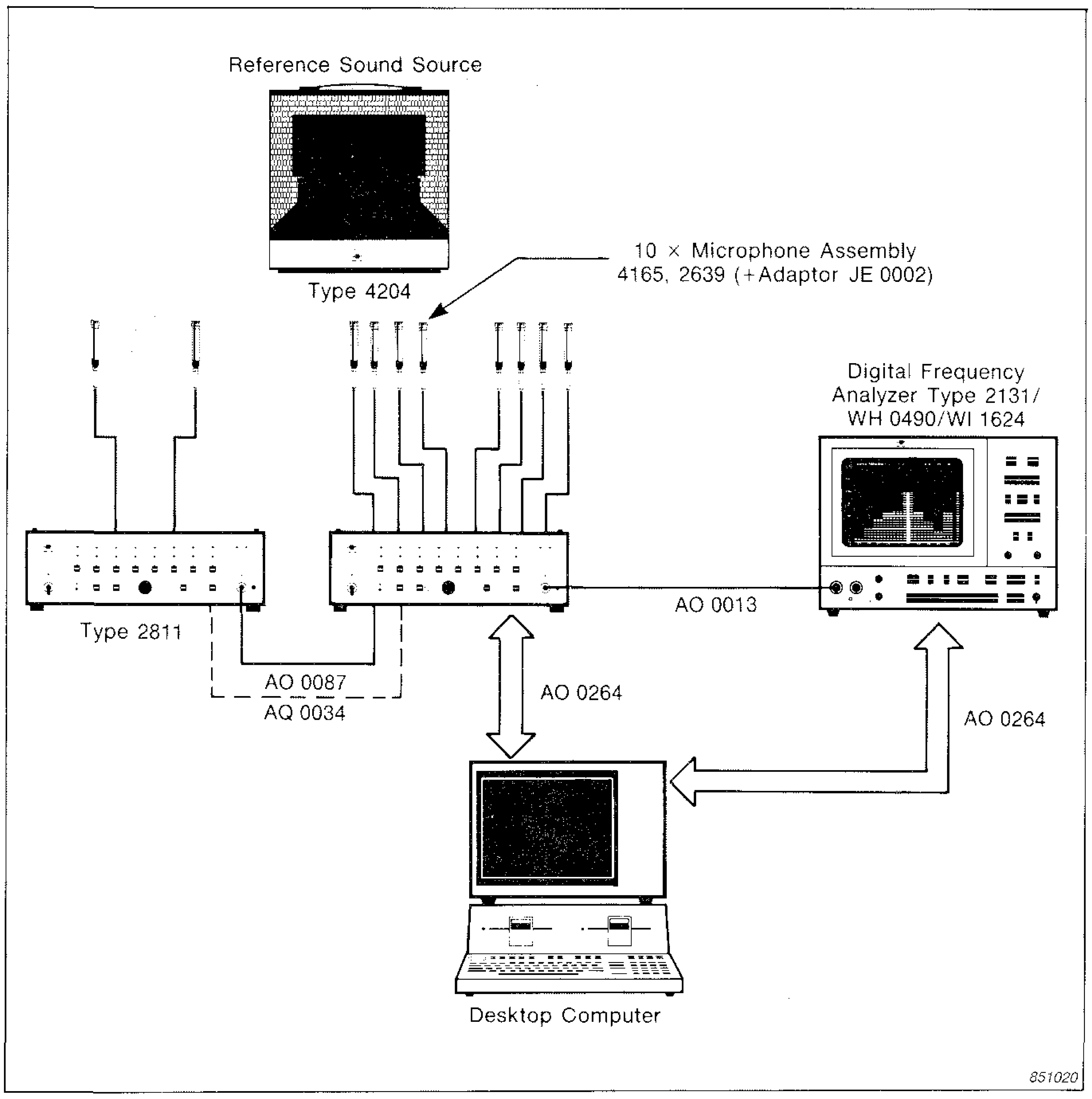


*Fig. 6. Set-up of instruments for automatic measurements*

# 5. Available Options

WW 9041/WW 1475 – programs on a 5¼ inch disc for an HP 9826 or 9836 computer
WW 9041/WH 1476 – programs on a 3½ inch disc for an HP 9816/9817 or a series 300 computer.

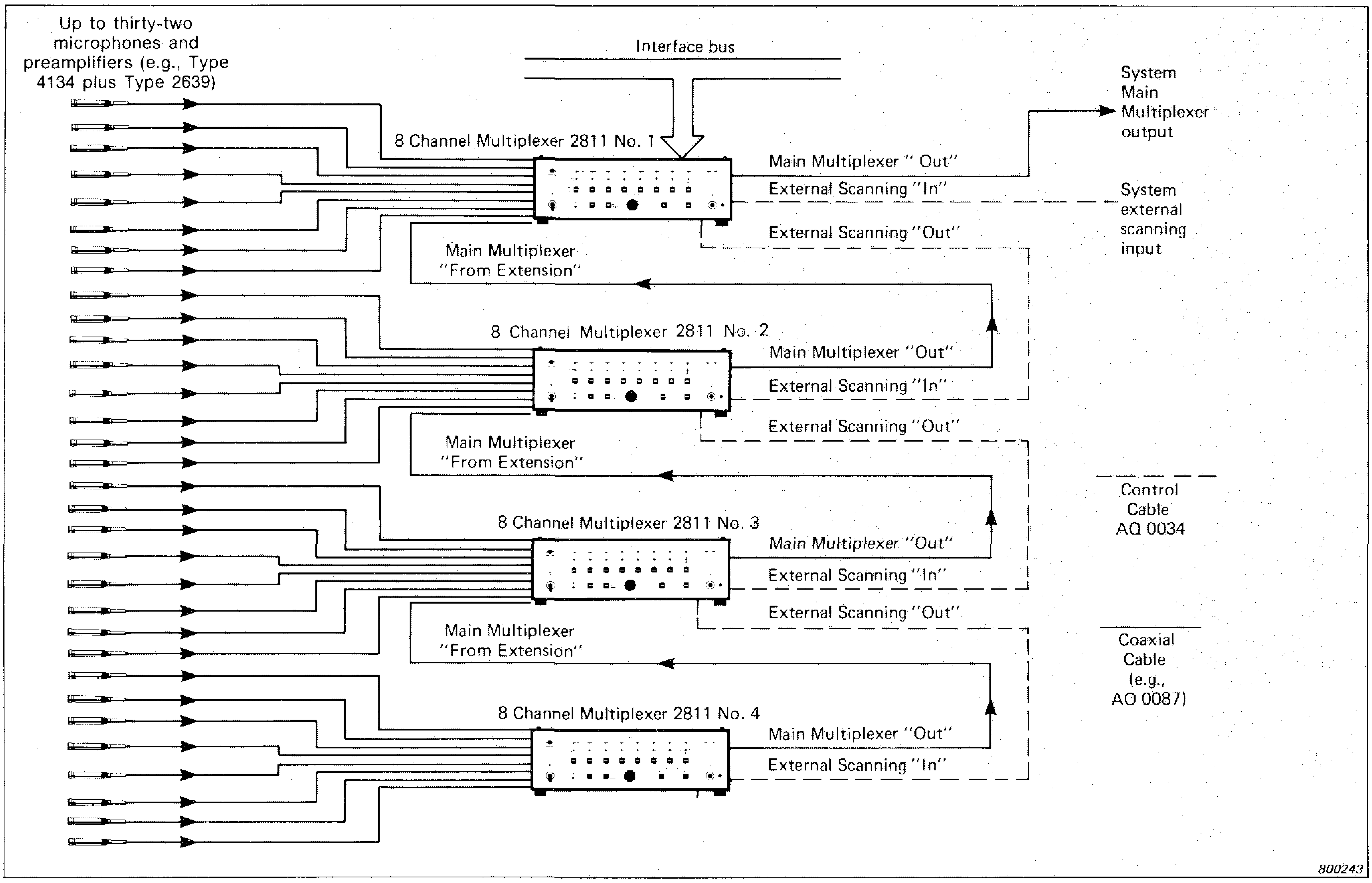


*Fig. 7. Use of more than one multiplexer in the set-up*

# 6. Example of a Complete System for measurement according to ECMA 74

| | |
|---|---|
| 1 × 2131/WH 0490/WI 1624 | Digital Frequency Analyzer with options WH 0490 and WI 1624 |
| 2 × 2811 | 8 Channel Multiplexer |
| 9 × 2639 | Microphone Preamplifier |
| 9 × 4165 | Condenser Microphone |
| 1 × 4204 | Reference Sound Source |
| 1 × AO 0133 | BNC to BNC Cable (0,6 m) |
| 1 × AO 0127 | BNC to B & K Cable (1,2 m) |
| 1 × AQ 0034 | Control Cable |
| 1 × AO 0194 | IEC – IEC Interface Cable (2 m) |
| 1 × AO 0264 | IEC – IEEE Interface Cable (2 m) |
| 1 × HP 98580 A, opt. 008 | Series 300 Computer with 1 Mbyte and Basic 4.0 (includes 98546 A Display Compatibility interface) |
| 1 × HP 9122 D | Double-sided $3^1/_2$ inch Dual Disc Drive |
| 1 × HP 2225 A | Graphics Printer |
| 1 × WW 9041/WH 1476 | Software Package on $3^1/_2$ inch discs |

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*Table 2.*

# 7. Examples of Printouts

SOUND POWER MEASUREMENT

OPERATOR: E.M.

DATE: 1/2 1985 ID/MEAS.NO: 1

MACH.TYPE: LINE PRINTER OP.MODE: NORMAL

MODEL NO.: 7506A SERIAL NO.: 723567

COMMENTS:

TEMP.: 19 C PRESS.: 98.6 kPA R.H.: 45 %

NUMBER OF POS.: 9 NUMBER OF SCANS: 1

AVERAGING TIME: 16 s TOTAL AREA: 12.00 m^2

LOWEST FREQ.: 100 Hz HIGHEST FREQ.: 10000 Hz

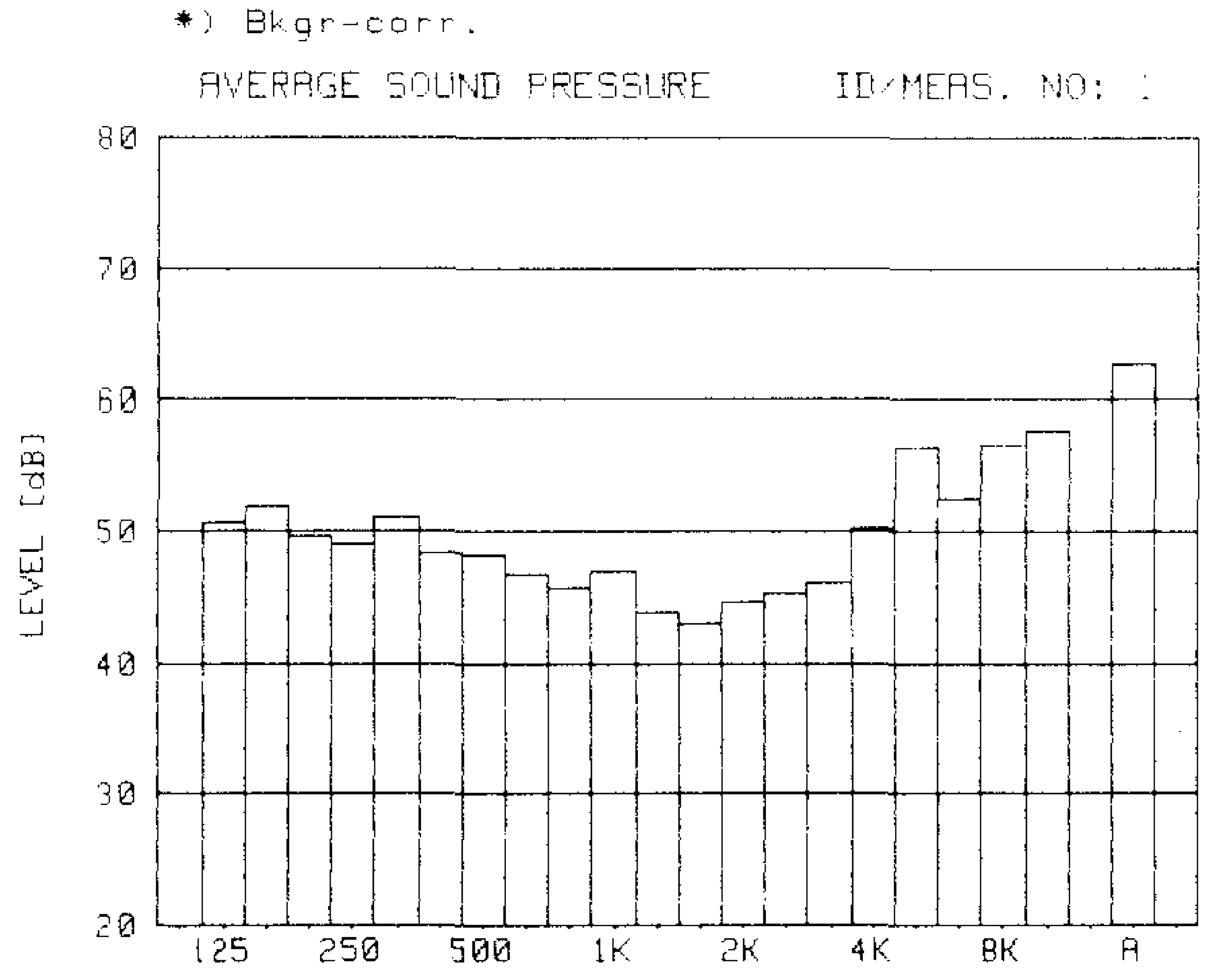
A-WEIGHTED SOUND PRESSURE

| POS | LpA |
|---|---|
| 1 | 62.8 dB |
| 2 | 62.8 dB |
| 3 | 63.5 dB |
| 4 | 64.0 dB |
| 5 | 61.9 dB |
| 6 | 62.1 dB |
| 7 | 63.7 dB |
| 8 | 61.1 dB |
| 9 | 62.3 dB |

AVERAGE SOUND PRESSURE ID/MEAS.NO: 1

| FREQ. | LEVEL |
|---|---|
| 100 Hz | **** |
| 125 Hz | 50.6 dB * |
| 160 Hz | 52.0 dB * |
| 200 Hz | 49.7 dB * |
| 250 Hz | 49.0 dB |
| 315 Hz | 51.0 dB * |
| 400 Hz | 48.4 dB |
| 500 Hz | 48.2 dB |
| 630 Hz | 46.8 dB |
| 800 Hz | 45.6 dB |
| 1000 Hz | 46.9 dB |
| 1250 Hz | 43.9 dB |
| 1600 Hz | 43.1 dB |
| 2000 Hz | 44.6 dB |
| 2500 Hz | 45.3 dB |
| 3150 Hz | 46.1 dB |
| 4000 Hz | 50.2 dB |
| 5000 Hz | 56.4 dB |
| 6300 Hz | 52.5 dB |
| 8000 Hz | 56.6 dB |
| 10000 Hz | 57.5 dB |
| A-wht. | 62.8 dB |

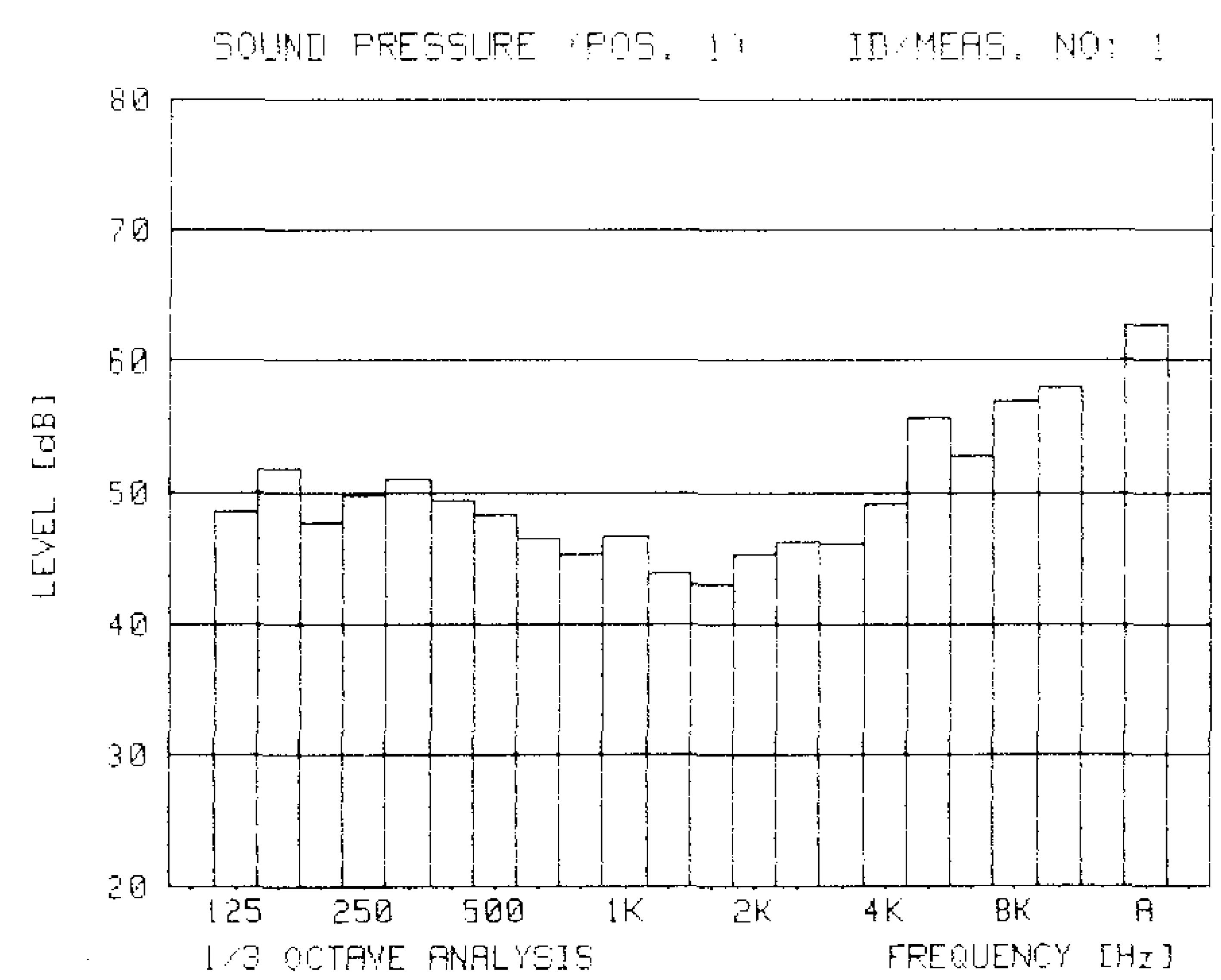
*) Bkgr-corr.




SOUND PRESSURE (POS. 1) ID/MEAS.NO: 1

| FREQ. | LEVEL |
|---|---|
| 100 Hz | **** |
| 125 Hz | 48.5 dB * |
| 160 Hz | 51.9 dB * |
| 200 Hz | 47.7 dB * |
| 250 Hz | 49.8 dB |
| 315 Hz | 51.0 dB * |
| 400 Hz | 49.4 dB |
| 500 Hz | 48.4 dB |
| 630 Hz | 46.6 dB |
| 800 Hz | 45.2 dB |
| 1000 Hz | 46.7 dB |
| 1250 Hz | 43.8 dB |
| 1600 Hz | 43.1 dB |
| 2000 Hz | 45.2 dB |
| 2500 Hz | 46.3 dB |
| 3150 Hz | 46.1 dB |
| 4000 Hz | 49.2 dB |
| 5000 Hz | 55.8 dB |
| 6300 Hz | 53.0 dB |
| 8000 Hz | 57.1 dB |
| 10000 Hz | 58.0 dB |
| A-wht. | 62.8 dB |

*) Bkgr-corr.




ROOM CORRECTION FACTORS

| FREQ. | LEVEL |
|---|---|
| 100 Hz | 1.7 dB |
| 125 Hz | 1.8 dB |
| 160 Hz | 1.6 dB |
| 200 Hz | 1.4 dB |
| 250 Hz | 1.2 dB |
| 315 Hz | 1.0 dB |
| 400 Hz | .9 dB |
| 500 Hz | .8 dB |
| 630 Hz | .5 dB |
| 800 Hz | .8 dB |
| 1000 Hz | .7 dB |
| 1250 Hz | .6 dB |
| 1600 Hz | .6 dB |
| 2000 Hz | .5 dB |
| 2500 Hz | .3 dB |
| 3150 Hz | .1 dB |
| 4000 Hz | 0.0 dB |
| 5000 Hz | 0.0 dB |
| 6300 Hz | .7 dB |
| 8000 Hz | .4 dB |
| 10000 Hz | .6 dB |
| A-wht. | .5 dB |

SURFACE SOUND PRESSURE ID/MEAS.NO: 1

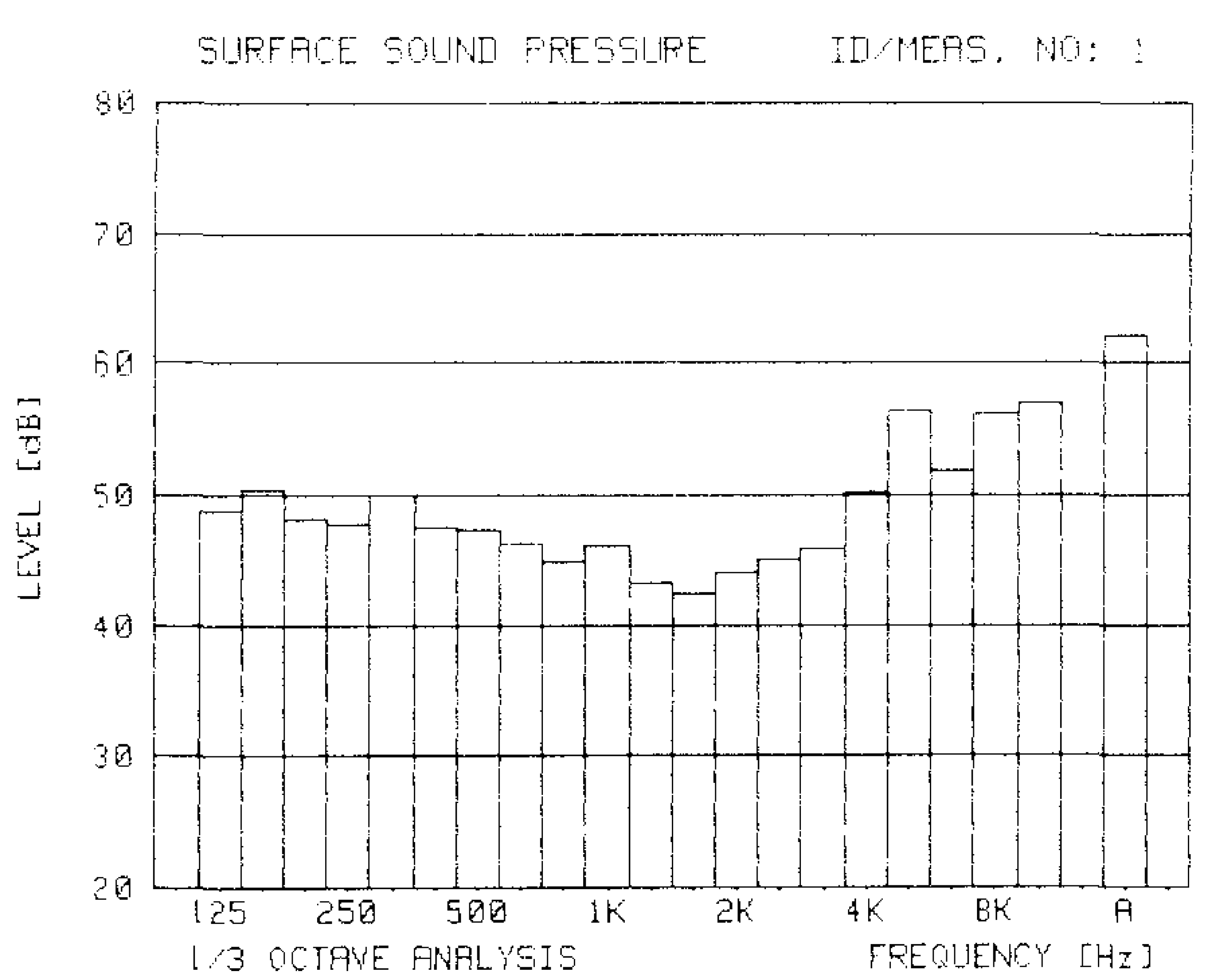
| FREQ. | LEVEL |
|---|---|
| 100 Hz | **** |
| 125 Hz # | 48.8 dB * |
| 160 Hz # | 50.4 dB * |
| 200 Hz # | 48.3 dB * |
| 250 Hz # | 47.8 dB |
| 315 Hz # | 50.0 dB * |
| 400 Hz # | 47.5 dB |
| 500 Hz # | 47.4 dB |
| 630 Hz # | 46.3 dB |
| 800 Hz # | 44.8 dB |
| 1000 Hz # | 46.2 dB |
| 1250 Hz # | 43.3 dB |
| 1600 Hz # | 42.5 dB |
| 2000 Hz # | 44.1 dB |
| 2500 Hz # | 45.0 dB |
| 3150 Hz # | 46.0 dB |
| 4000 Hz | 50.2 dB |
| 5000 Hz | 56.4 dB |
| 6300 Hz # | 51.8 dB |
| 8000 Hz # | 56.2 dB |
| 10000 Hz # | 56.9 dB |
| A-wht. # | 62.3 dB |

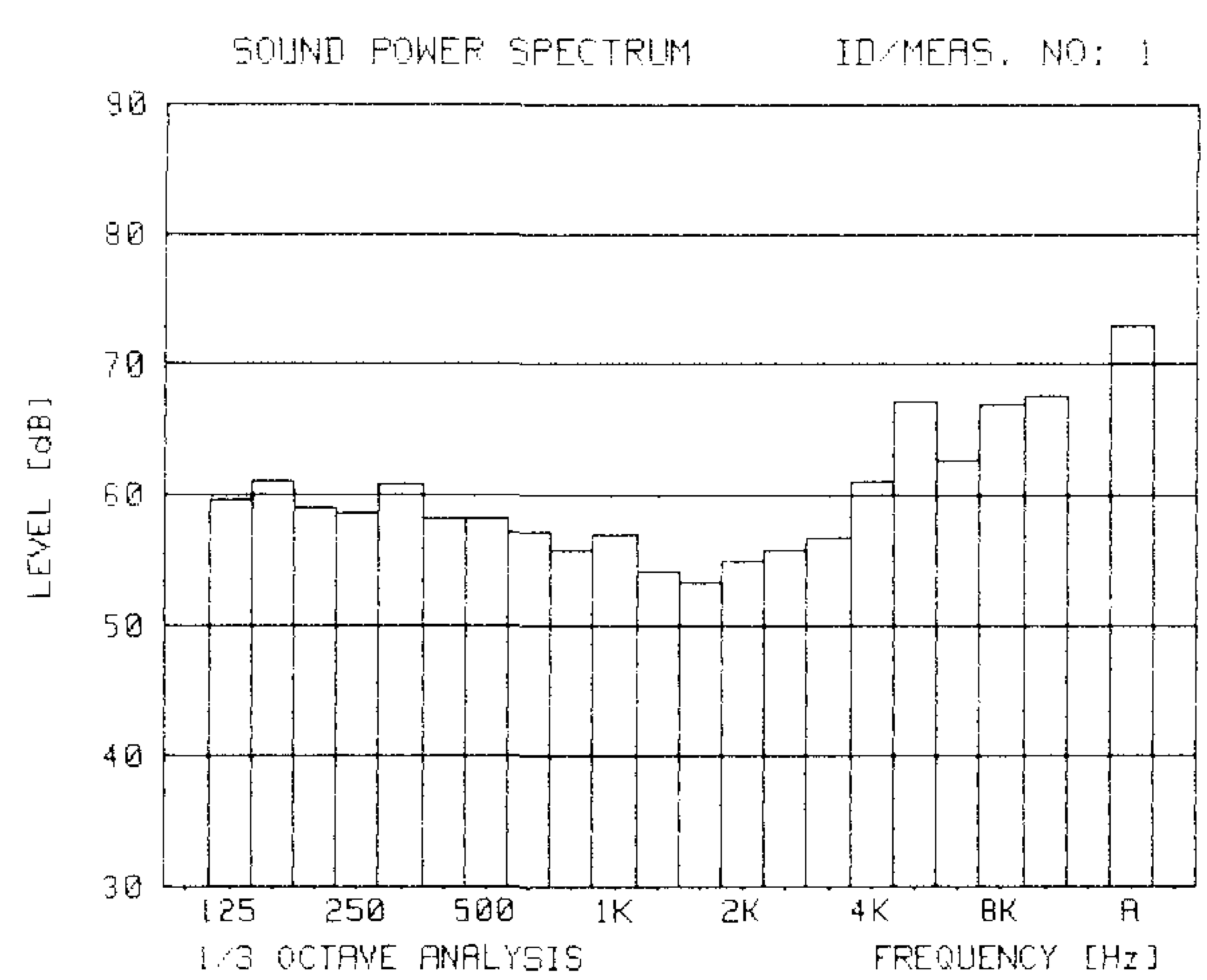
*) Bkgr-corr.
#) Room-corr.

SOUND POWER SPECTRUM ID/MEAS.NO: 1

| FREQ. | LEVEL |
|---|---|
| 100 Hz | **** |
| 125 Hz # | 59.6 dB * |
| 160 Hz # | 61.1 dB * |
| 200 Hz # | 59.0 dB * |
| 250 Hz # | 58.6 dB |
| 315 Hz # | 60.8 dB * |
| 400 Hz # | 58.3 dB |
| 500 Hz # | 58.2 dB |
| 630 Hz # | 57.1 dB |
| 800 Hz # | 55.6 dB |
| 1000 Hz # | 56.9 dB |
| 1250 Hz # | 54.1 dB |
| 1600 Hz # | 53.2 dB |
| 2000 Hz # | 54.9 dB |
| 2500 Hz # | 55.8 dB |
| 3150 Hz # | 56.7 dB |
| 4000 Hz | 61.0 dB |
| 5000 Hz | 67.2 dB |
| 6300 Hz # | 62.6 dB |
| 8000 Hz # | 67.0 dB |
| 10000 Hz # | 67.7 dB |
| A-wht. # | 73.0 dB |

*) Bkgr-corr.
#) Room-corr.



| |
|---|
| SOUND PRESSURE MEASUREMENT |
| OPERATOR: E.M. |
| DATE: 1/2 1985     ID/MEAS.NO: 1 |
| MACH.TYPE: LINE PRINTER     OP.MODE: NORMAL |
| MODEL NO.: 7506A     SERIAL NO.: 723567 |
| COMMENTS: BYSTANDER POSITIONS |
| TEMP.: 19 C     PRESS.: 98.6 kPA     R.H.: 45 % |
| NUMBER OF POS.: 4     NUMBER OF SCANS: 1 |
| AVERAGING TIME: 16 s |
| LOWEST FREQ.: 100 Hz     HIGHEST FREQ.: 10000 Hz |

A-WEIGHTED SOUND PRESSURE LEVELS

| POS | LpA | LpAI |
|---|---|---|
| 1 # | 63.2 dB | 66.4 dB |
| 2 | 62.2 dB | 64.9 dB |
| 3 # | 63.8 dB | 67.2 dB |
| 4 | 62.8 dB | 65.6 dB |

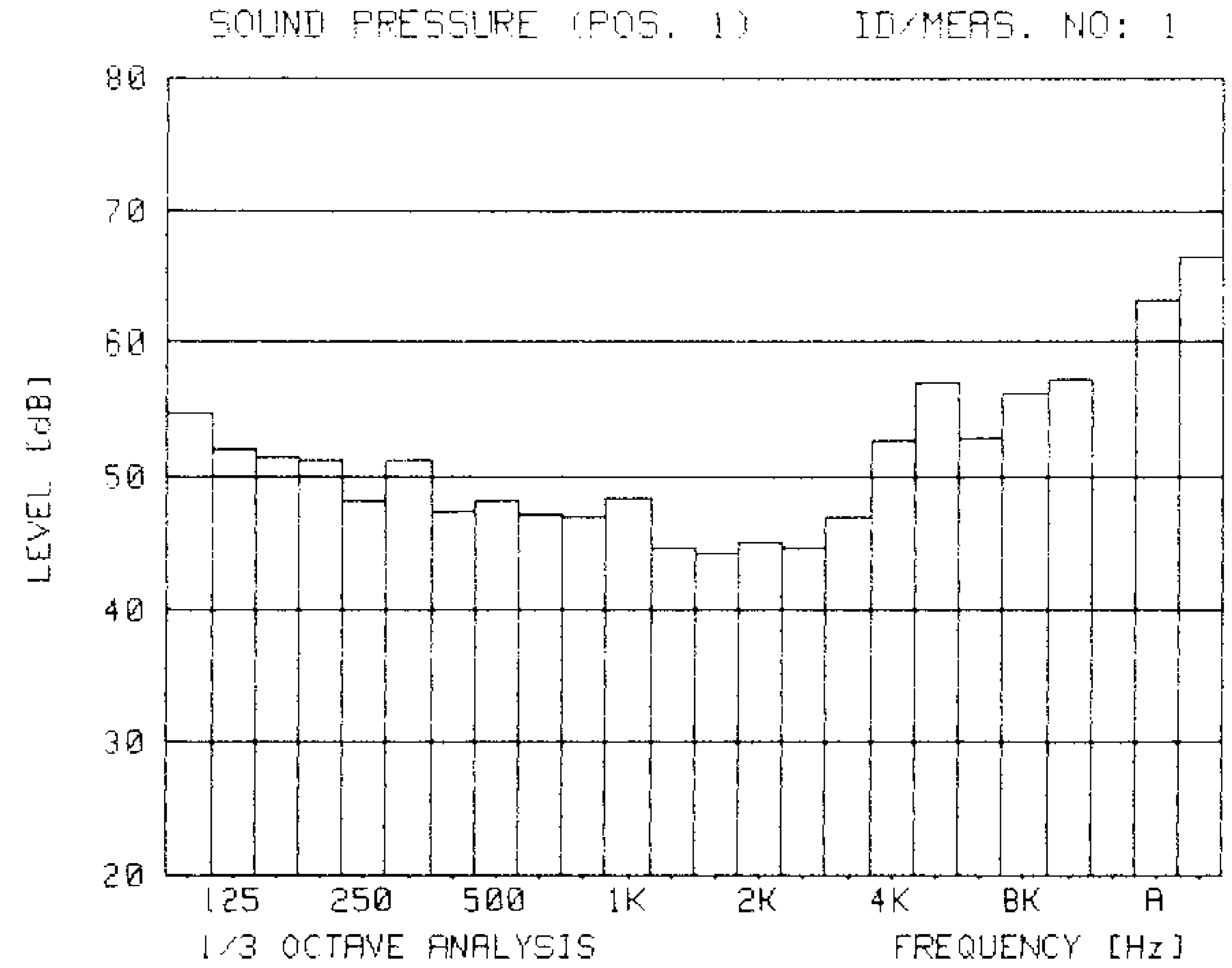
#) IMPULSIVE

SOUND PRESSURE (POS. 1)     ID/MEAS.NO: 1

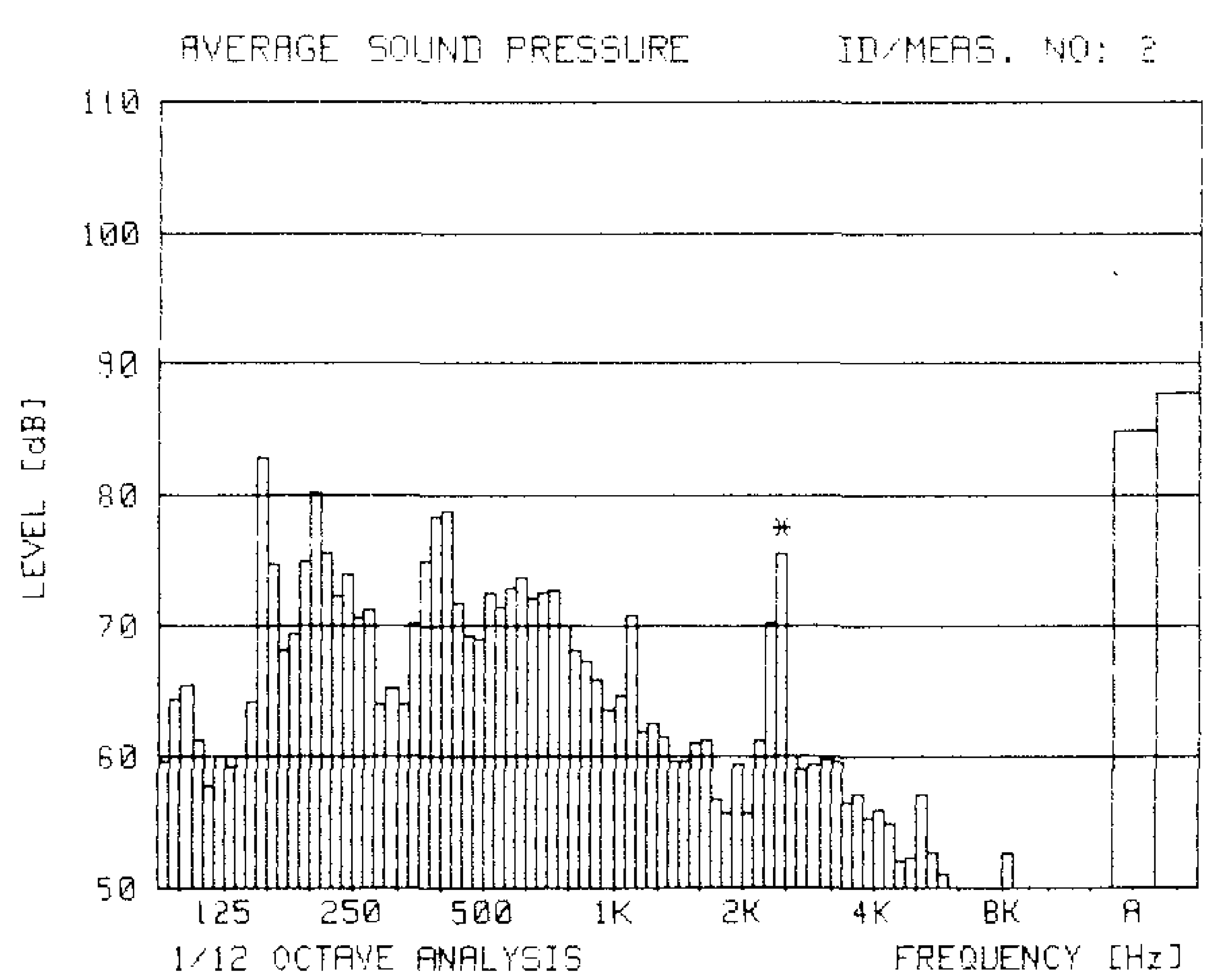
| FREQ. | LEVEL |
|---|---|
| 100 Hz | 54.8 dB * |
| 125 Hz | 52.1 dB * |
| 160 Hz | 51.4 dB * |
| 200 Hz | 51.2 dB |
| 250 Hz | 48.2 dB |
| 315 Hz | 51.2 dB |
| 400 Hz | 47.4 dB |
| 500 Hz | 48.2 dB |
| 630 Hz | 47.2 dB |
| 800 Hz | 46.9 dB |
| 1000 Hz | 48.3 dB |
| 1250 Hz | 44.6 dB |
| 1600 Hz | 44.3 dB |
| 2000 Hz | 45.0 dB |
| 2500 Hz | 44.7 dB |
| 3150 Hz | 46.9 dB |
| 4000 Hz | 52.6 dB |
| 5000 Hz | 57.0 dB |
| 6300 Hz | 53.0 dB |
| 8000 Hz | 56.2 dB |
| 10000 Hz | 57.3 dB |
| LpA | 63.2 dB |
| LpAI # | 66.4 dB |

#) IMPULSIVE
*) Bkgr-corr.

SOUND PRESSURE (POS. 1)     ID/MEAS. NO: 1



| |
|---|
| PURE TONE MEASUREMENT |
| OPERATOR: E.M. |
| DATE: 1/2 1985      ID/MEAS.NO: 2 |
| MACH.TYPE:      OP.MODE: |
| MODEL NO.:      SERIAL NO.: |
| COMMENTS: |
| TEMP.:      PRESS.:      R.H.: |
| NUMBER OF POS.: 4      NUMBER OF SCANS: 1 |
| AVERAGING TIME: 8 s |
| LOWEST FREQ.: 100 Hz      HIGHEST FREQ.: 10000 Hz |




1/12 OCT. AVERAGE SOUND PRESSURE      ID/MEAS.NO: 2

| FREQ. | LEVEL | FREQ. | LEVEL |
|---|---|---|---|
| 92 Hz | 59.7 dB | 1029 Hz | 64.5 dB |
| 97 Hz | 64.4 dB | 1090 Hz | 70.8 dB |
| 103 Hz | 65.4 dB | 1155 Hz | 61.9 dB |
| 109 Hz | 61.3 dB | 1223 Hz | 62.6 dB |
| 115 Hz | 57.9 dB | 1296 Hz | 61.5 dB |
| 122 Hz | 60.0 dB | 1372 Hz | 59.7 dB |
| 130 Hz | 59.2 dB | 1454 Hz | 59.6 dB |
| 137 Hz | 60.1 dB | 1540 Hz | 61.2 dB |
| 145 Hz | 64.1 dB | 1631 Hz | 61.4 dB |
| 154 Hz | 82.8 dB | 1728 Hz | 56.7 dB |
| 163 Hz | 74.6 dB | 1830 Hz | 55.8 dB |
| 173 Hz | 68.0 dB | 1939 Hz | 59.5 dB |
| 183 Hz | 69.4 dB | 2054 Hz | 55.8 dB |
| 194 Hz | 74.9 dB | 2175 Hz | 61.3 dB |
| 205 Hz | 80.3 dB | 2304 Hz | 70.2 dB |
| 218 Hz | 75.5 dB | 2441 Hz * | 75.4 dB |
| 230 Hz | 72.2 dB | 2585 Hz | 60.1 dB |
| 244 Hz | 73.8 dB | 2738 Hz | 59.1 dB |
| 259 Hz | 70.5 dB | 2901 Hz | 59.4 dB |
| 274 Hz | 71.1 dB | 3073 Hz | 59.9 dB |
| 290 Hz | 63.9 dB | 3255 Hz | 59.7 dB |
| 307 Hz | 65.3 dB | 3447 Hz | 56.6 dB |
| 325 Hz | 64.0 dB | 3652 Hz | 57.1 dB |
| 345 Hz | 70.1 dB | 3868 Hz | 55.4 dB |
| 365 Hz | 74.9 dB | 4097 Hz | 55.9 dB |
| 387 Hz | 78.3 dB | 4340 Hz | 54.9 dB |
| 410 Hz | 78.8 dB | 4597 Hz | 52.1 dB |
| 434 Hz | 71.5 dB | 4870 Hz | 52.3 dB |
| 460 Hz | 69.1 dB | 5158 Hz | 57.1 dB |
| 487 Hz | 68.9 dB | 5464 Hz | 52.7 dB |
| 516 Hz | 72.5 dB | 5788 Hz | 51.0 dB |
| 546 Hz | 71.4 dB | 6131 Hz | 50.0 dB |
| 579 Hz | 72.8 dB | 6494 Hz | <<<< |
| 613 Hz | 73.7 dB | 6879 Hz | <<<< |
| 649 Hz | 72.1 dB | 7286 Hz | <<<< |
| 688 Hz | 72.5 dB | 7718 Hz | <<<< |
| 729 Hz | 72.6 dB | 8175 Hz | 52.6 dB |
| 772 Hz | 70.0 dB | 8660 Hz | 50.0 dB |
| 818 Hz | 68.1 dB | 9173 Hz | <<<< |
| 866 Hz | 67.2 dB | 9716 Hz | <<<< |
| 917 Hz | 65.8 dB | 10292 Hz | <<<< |
| 972 Hz | 63.5 dB | 10902 Hz | <<<< |

| | |
|---|---|
| LpA | 85.0 dB |
| LpAI | 87.8 dB |

*) PURE TONES

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