RA0357 Random-Incidence Corrector for 146AE

By Morten Wille

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For traditional ½" free field microphones it is possible to alter the response of the microphone such that accurate measurements in random-incidence sound fields are possible. This is done by adding a random-incidence corrector e.g. the GRAS RA0122. Due to the different mechanical dimensions and free field response of the 146AE with the dust and water proof blue grid, a new version of the random-incidence corrector has been developed. This report describes the basics of random incidence versus free field, the measurements and the conclusions of the development process.

Free field response

A few definitions: The mechanical response of the microphone, S{mechanical}, is measured with an electrostatic actuator. This response is considered equal to the response of the microphone in a pressure field. When exposing the microphone to a free field, the diffraction of the microphone, S{diffraction}, will influence the measured response. For free field measurements the diffraction is also called the "free field correction". The measured response will be the sum of the mechanical response and the diffraction, this is denoted S. The microphone is designed in such a way that the sum of the diffraction and the mechanical response of the microphone will result in a flat frequency response at 0-degree incidence. By designing the microphone in this fashion, the measured response will equal the sound pressure before the microphone was introduced in the sound field.

Figure 1 shows the mechanical response, diffraction and the resulting flat frequency response of the microphone in free field. This correction is only valid for 0-degree incidence as the diffraction changes with the incidence angle. Corrections are provided for other incidence angles.

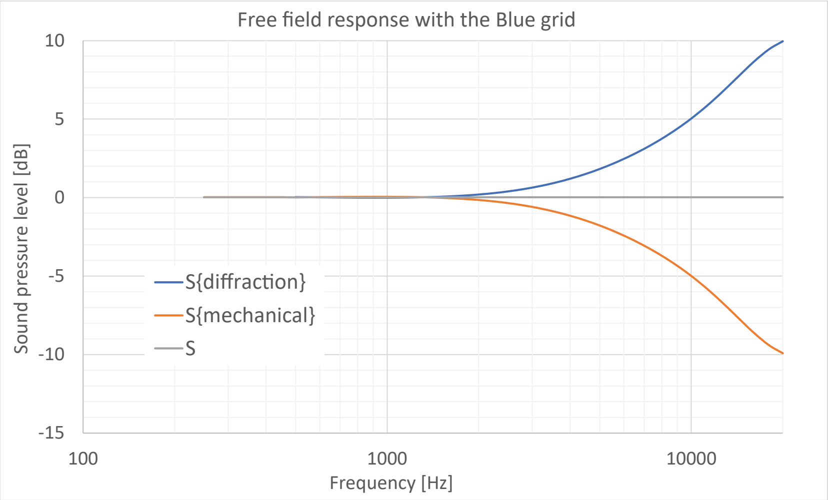

Figure 1
Free field response of 146AE with the Blue Grid

Random incidence response

When measuring in a random incidence sound field the response will be a sum of sound coming from all incidence angles. This means that the 0-degree free field diffraction is no longer valid.

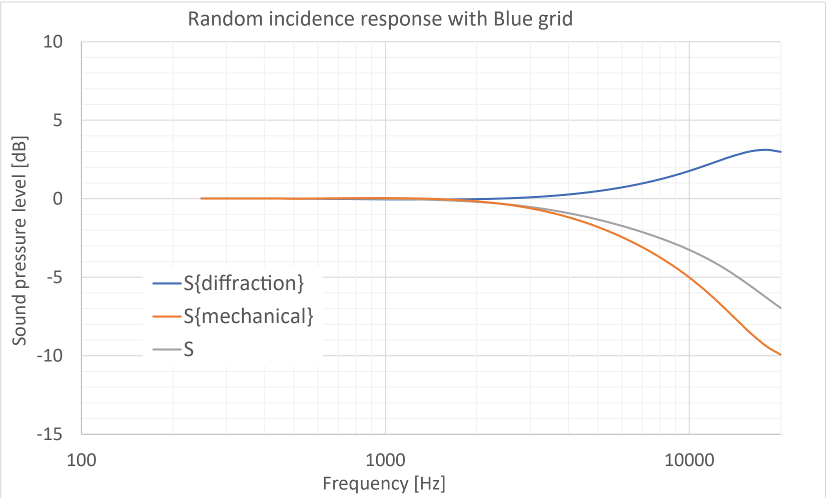

Figure 2
Random incidence response with Blue grid.

Figure 2 shows the resulting response when the microphone is used in a random incidence field with the blue grid. It is clear from the graph that the resulting response, S, is not flat and the microphone will underestimate the true sound pressure at frequencies above 2-3 kHz.

In order to correct for this change in response a Random Incidence Corrector can be used to change the response of the microphone in a random sound field.

Measurements

The random incidence response has been measured using the procedure described in the IEC standard 61183 "Random Incidence Microphone", Annex A.

Based on the known free field response of the microphone at 0 degrees[1] the free field response at other angles was measured relative to 0 degrees. The free field response was measured at 10-degree intervals from 0 to 350 degrees in a setup shown in Figure 3. A ½" microphone was used as a transmitter. The receiving microphone was held in place while the transmitting microphone was rotated. This setup minimizes the influence of the turntable and microphone holders. The receiving microphone is suspended in thin wires while the bulkier arm holding the transmitting microphone rotates. This way the reflections from the turntable are constant regardless of the incidence angle. Since the measurement is relative to the known 0-degree incidence response, the constant reflections of the stand can be disregarded.

Figure 4 shows the measurement setup in the anechoic chamber at GRAS. In the picture there is a positioning rod in front of the receiving microphone. This is only used to ensure correct placement of the microphone in the center of the rotation and is removed during measurements.

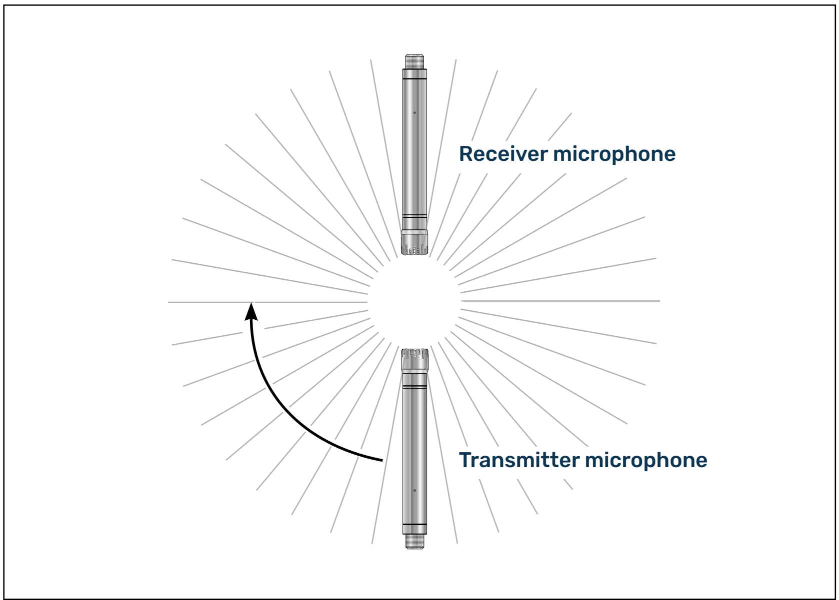

Figure 3
Measurement setup for the random incidence correction.

From the measurement the random incidence response can be calculated using the calculations described in the standard.

[1] As measured by the Danish National Metrology Institute

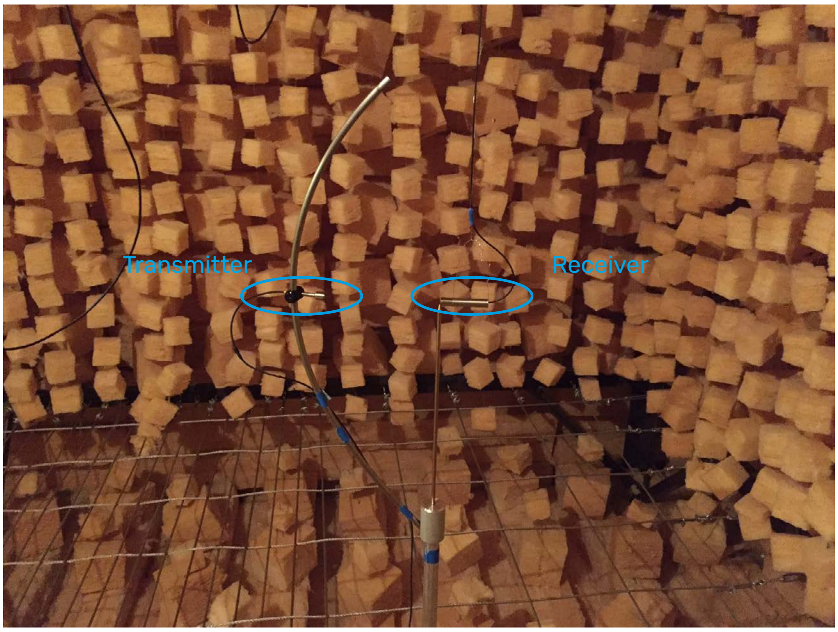

Figure 4
Measurement setup in the anechoic chamber. The rod in front of the receiving microphone is used for placement and removed during the measurement.

Table 1 contains the weights used for the calculation of the random incidence correction.

Table 1
Weights used for calculation of the random incidence correction.

Incidence angle, φ [degrees]				Weight, K(φ)
0	180	-	-	0,00095
10	170	190	350	0,00378
20	160	200	340	0,00745
30	150	210	330	0,01089
40	140	220	320	0,01401
50	130	230	310	0,01669
60	120	240	300	0,01887
70	110	250	290	0,02047
80	100	260	280	0,02146
90	270	-	-	0,02179

Since the microphone has rotational symmetry the measurement only has to be carried out in one plane and the random incidence response is calculated using formula A.4[2]:

$$\gamma = \left(2 \cdot \sum_{\phi=0}^{\phi=350} K(\phi) \cdot 10^{-0,1[L_{rd} - L(\phi)]} \right)^{-1}$$

[2] IEC 61183 Annex A

Where L_{rd} is the sound pressure measured at the reference angle (0 degree), L(ϕ) is the sound pressure measured at the incidence angle φ and K(φ) can be found in Table 1. The random incidence sensitivity is found by using A.6[3]:

$$G_{RI} = G_{FF} - 10 \cdot log_{10}(\gamma)$$

Where GRI is the random incidence response and GFF is the free field response at 0 degrees.

Result

By placing the RA0357 on the Blue grid, the random incidence response of the microphone is altered to enable measurements in random incidence sound fields up to 10 kHz. Figure 5 shows the frequency response of the 146AE with the random incidence corrector.

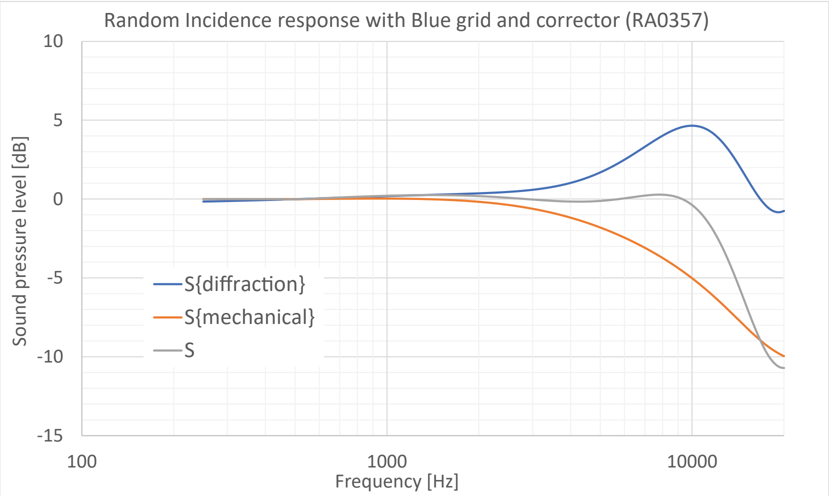

Figure 5
Measurement setup for the random incidence correction.

Figure 6 shows the 146AE with the RA0357 mounted on the grid.

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The 146AE with the RA0357 mounted on the grid.

[3] IEC 61183 Annex A