# On the Development of a new Vocalist Microphone

**Dipl. Ing. Stephan Peus**

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Vocalist microphones are used primarily by vocalists at very close range in "hand-held" situations. These applications dictate the need for robust construction and specific acoustical performance.

With the vocalist microphones KMS 140 and KMS 150, two completely new microphones have been created. Both exhibit outstanding sound characteristics with a high degree of feedback suppression on the stage and, by means of an innovative acoustical filter, are very effectively protected against explosive consonants.

GEORG NEUMANN GMBH · CHARLOTTENSTR. 3 · D-1000 BERLIN 61 · TEL.: 030 / 2 59 93-0 · FAX: 030 / 2 59 93-108 · TLX.: 1 84 595 NEUAK D

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In 1977, GEORG NEUMANN GmbH introduced the KMS 84 vocalist microphone, a further development of the KMS 85 vocalist microphone which had appeared six years previously.

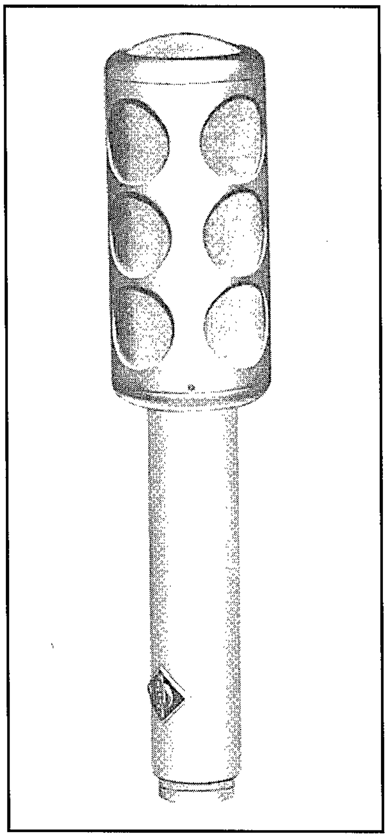

*Fig. 1a: KMS 85*

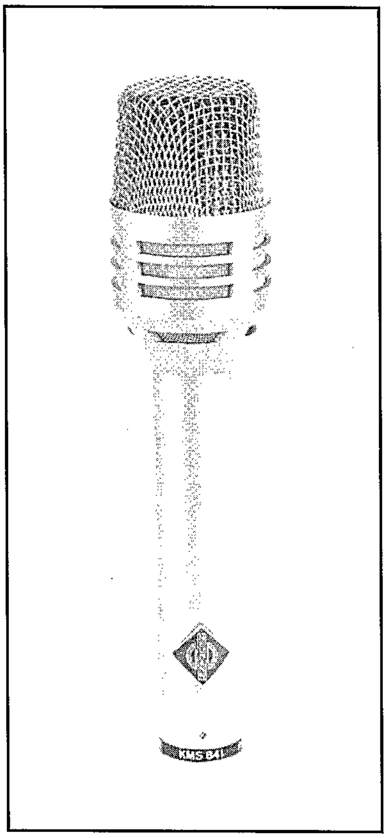

*Fig. 1b: KMS 84*

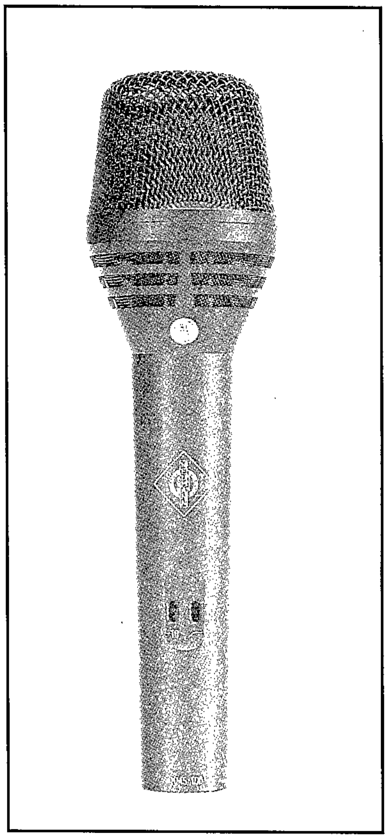

*Fig. 1c: The new KMS 140/150*

The KMS 84 had marked a substantial improvement in low-frequency sensitivity and pop behaviour[1] over the KMS 85. To improve upon the KMS 84, the following characteristics were desirable during the years:

- Effective suppression of handling noise.
- A more rigid microphone housing and protective grille.
- Improved directivity at low frequencies.
- More pronounced sound focussing over the entire frequency range, i.e. improved feedback suppression.
- Improved bass frequency response.

The following is a demonstration of how that improvements have been realized with the new vocalist microphones KMS 140 and KMS 150.

[1] Pop behaviour refers to the sensitivity of the microphone to explosive consonants, such as "P", "T" and "K". At close range, such consonants can easily attain sound pressure levels of 135 dB and more, even at quite normal vocal levels.

## The Suppression of Handling Noises

The output signal of a microphone is proportional to the movement of the diaphragm in relation to the other elements of the microphone capsule[1]. To achieve effective suppression of handling noises - or structure-borne noise in general -, the following criteria are considered:

- The diaphragm should be small.
- The microphone capsule should be mechanically decoupled from the housing.
- The housing should neither generate nor transmit any structure-borne noise.

The mass of the diaphragm of a condenser microphone, (1.5 mg or so) is small and presents no problem in these respects. Therefore, in mechanical noise suppression, condenser microphones are principally superior to dynamic types.

The microphone capsule in many vocalist microphones is suspended elastically in the housing. The KMS 84 used this technique by which the capsule was decoupled from the housing by means of a rubber collar. However, the resultant combination of resilience and mass has two disadvantages:

- The elastic suspension could not be adjusted sufficiently to provide really effective decoupling. The support of the capsule would then be unstable and would impinge on the housing when any sizeable microphone movements occurred.

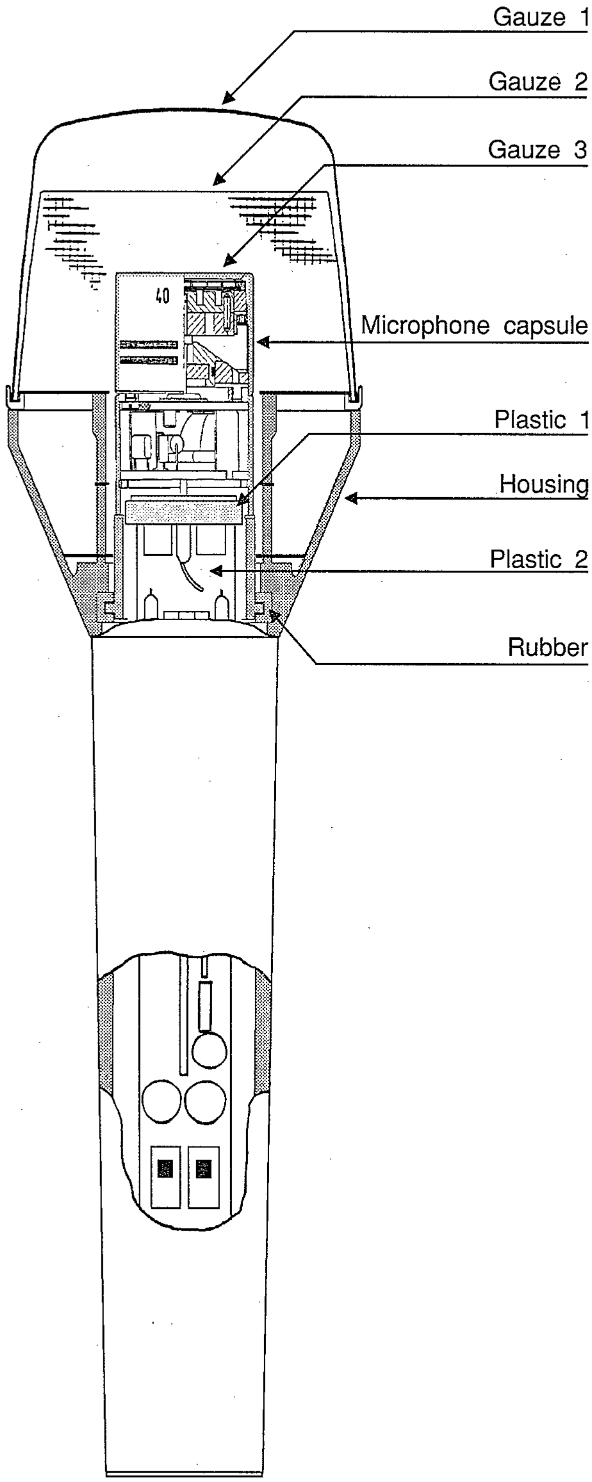


*Fig. 2: View into the KMS 140*

[1] With condenser microphones, the microphone capsule is regarded as the entire acoustic transducer. The associated impedance converter is normally incorporated in the shaft of the microphone.

- Every oscillating system has at least one resonant frequency which, in the capsule suspension described above, would be in the audible range and might be undesirably intrusive with certain stimuli.

Thus, after many attempts at optimization, a **non** elastic capsule suspension was selected. This capsule is decoupled from the microphone housing by a multi-stage filter formed by the "series" and "parallel" arrangement of various materials chosen with consideration of their moduli of elasticity (Fig. 2).

## The Stable Microphone Housing

The microphone housing is constructed from thick-walled brass material of conical shape. This material and shape were chosen to suppress sensitivity to and transmission of structure-borne noise to the maximum extent. Beyond the obviously natural subjective testing of such design principles, we have tried to register the results of our optimization attempts objectively. Here there are two different methods which suggest themselves:

- The first method employed the stimulation of the microphone by mechanical oscillations of defined amplitude and frequency; here a vibration exciter is activated by a sliding sine-wave signal over a range from 20 Hz to 2 kHz. The output level L received of the microphone displays the low-frequency spectrum of interest.

- The second method employed impact excitation of the microphone, i.e. external wide-band excitation, followed by FFT analysis of the microphone output signal.

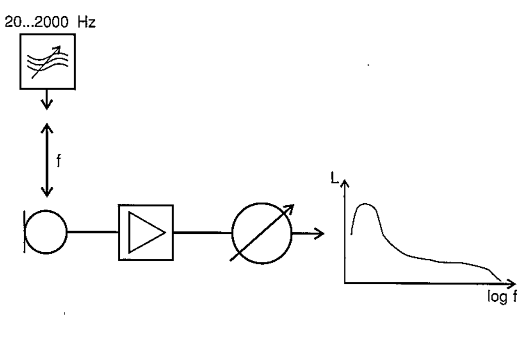


*Fig. 3a: Stimulation with sine-wave signals*

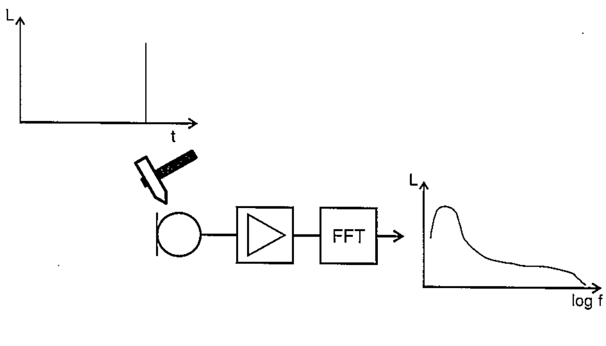


*Fig. 3b: Impact excitation*

In our experience, such impact excitation is more practical than mechanical vibrations at single frequencies. Fig. 4a, 4b and 4c are illustrating the comparative results between the new vocalist microphone, KMS 140, its predecessor and with another make. Notice the high-level resonance at 150 Hz of the microphone in Fig. 4c. This is caused by the inadequate stability of the capsule mounting.

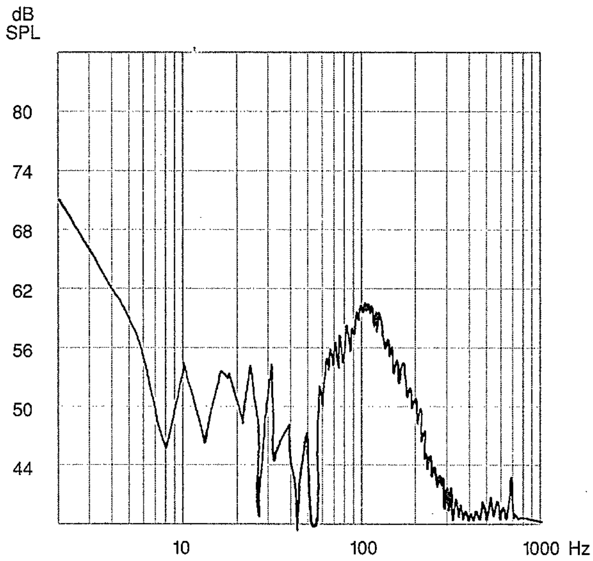


*Fig. 4a: KMS 140*

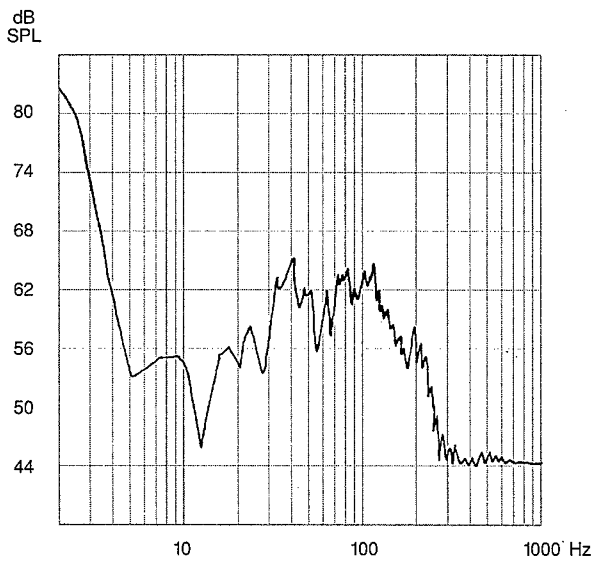


*Fig. 4b: KMS 84*

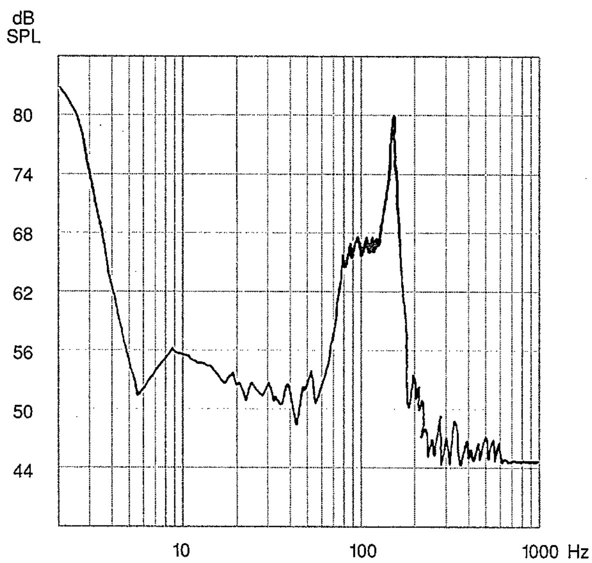


*Fig. 4c: Another make*

*Fig. 4: Output level due to structure born noise - Comparison between KMS 140, KMS 84 and another make*

## The Stable Protective Grille

The microphone grille should be as sound-permeable as possible, but simultaneously it should be sufficiently rugged to protect the microphone if dropped. With the KMS 84 vocalist microphone made until now, stability was achieved by using three brass gauzes of different mesh size and by the shape. This caused to high manufacturing costs and the grille had a high degree of closure at the sides which was contradictory to the requirement of high sound permeability.

In the new vocalist microphones KMS 140 and KMS 150, a grille of single-layer high-grade steel is used which is more stable then the three brass gauzes previously described while being acoustically completely open. Thus the excellent sound characteristics of the microphone capsules and their pronounced directivity are retained - a point to which I shall be returning later.

## Directivity at Low Frequencies

Directivity at low frequencies is not only dependent on the directional characteristic of the built-in microphone capsule but also a direct result of the methods used for pop suppression.

As mentioned earlier, explosive consonants reaching the microphone at close range can cause very high sound pressure levels without the need for loud speaking or singing. Therefore, deliberate measures in the front of the microphone capsule have to be taken to reduce these sound pressure peaks in terms without influencing the sound image.

The typical method used to accomplish this involve embedding or surrounding the capsule of vocalist microphones with foam materials, or lining the grille with felt or something similar. These methods, however, affect negatively the directivity of the microphone, particularly at low frequencies, at which the said materials are intended to oppose the high interference crossover pressures.

The result is that with lower frequencies, a cardioid microphone polar pattern, for example, will become more “omni-directional”. New ways were therefore explored to optimize the pop behavior of a vocalist microphone without such a loss of quality.

To reduce the high sound energy of explosive consonants, a three-stage acoustic filter consisting of three different wire gauzes is used in the new vocalist microphones KMS 140 and KMS 150:
The filter consists of the outside the grille, a middle gauze between the grille and the capsule and a third at the capsule itself.

These three gauzes are optimized concerning to their spacing and mesh size, and provide 10...12 dB better pop suppression than comparable conventional vocalist microphones with a foam windscreen (Fig. 5).

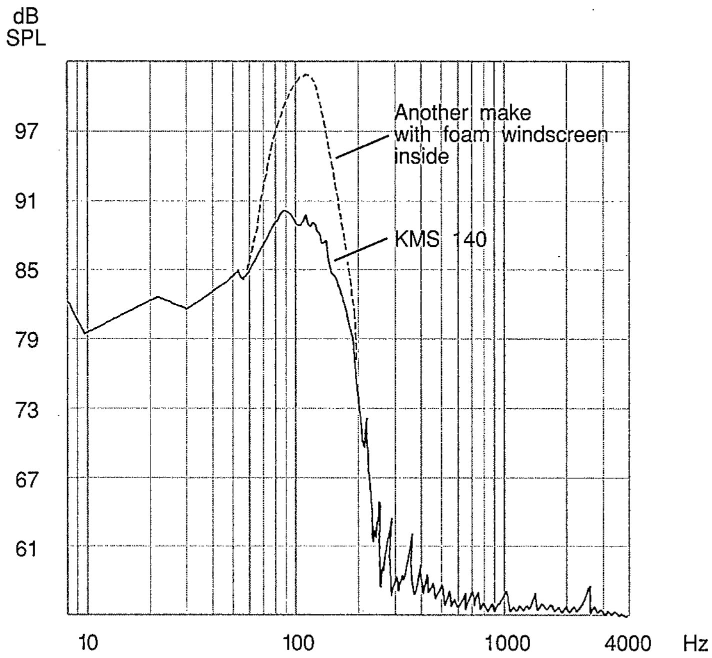


***Fig. 5: Pop sensitivity of the KMS 140 and of another make***

The result is that the wire gauze grille of the new microphones is transparent. Neither foam materials nor any other linings are used in the grille which might affect the inherent characteristics of the built-in microphone capsules. As a non acoustic side-effect, it shows that no materials can be saturated and hold dirt. However, the wire gauze grille can easily be unscrewed, if necessary, washed out and blown through.

The directivity of the new microphones KMS 140 compared to its predecessor KMS 84 can be seen in Fig. 6. The frequency response at sound incidence angles of 0° and 180° is shown in each case.

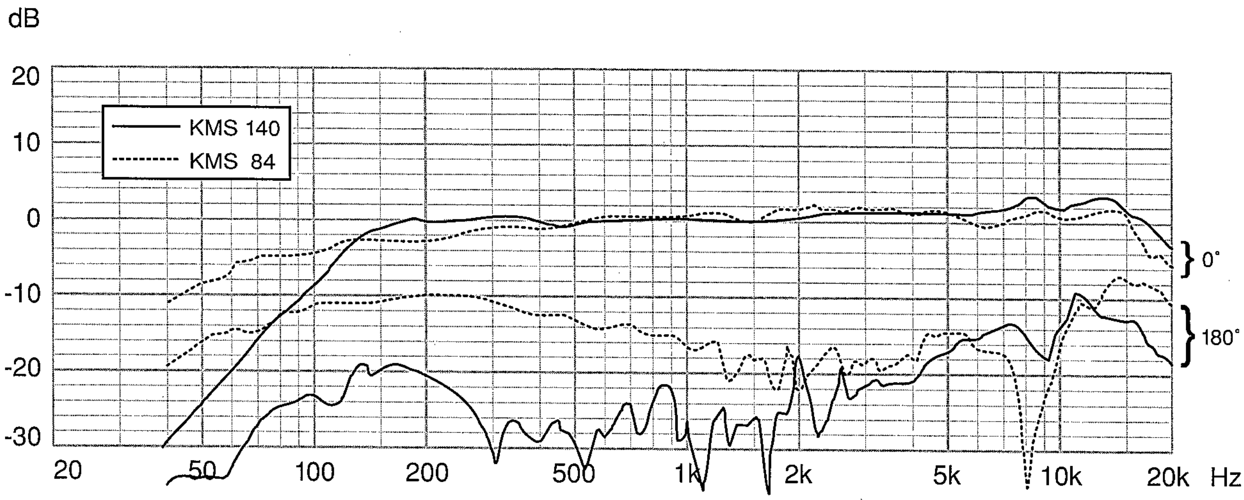


*Fig. 6: Directivity of KMS 140 compared to KMS 84*

## Sound Focussing and Feed Back Suppression

Vocalist microphones are used frequently for live stage performances during which the signal is amplified and heard through loudspeakers. The microphones mostly have a cardioid polar pattern or the somewhat intensified sound focussing characteristic of a super or hypercardioid.

The new NEUMANN vocalist microphone is available in two versions (Figs. 7a and 7b):

- As KMS 140 with frequency-independent cardioid characteristic
- As KMS 150 with frequency-independent hyper-cardioid characteristic.

The "cardioid" has its maximum "rejection" at 180°, i.e. for sounds arriving directly from the rear. The "hypercardioid" is least sensitive to sound arriving from the rear at an angle of about 120°. At the same time a hypercardioid microphone is some 6 dB less sensitive to lateral sound than a cardioid microphone. It accepts, however, sound from the rear - where the zero point of the "cardioid" is - with approximately the same sensitivity as from the side.

The directivity characteristic of the hypercardioid is the one with the lowest acoustic power response. This makes such a microphone particularly suitable for critical live situations, where feedback interaction with the auditorium or stage loudspeakers can occur.

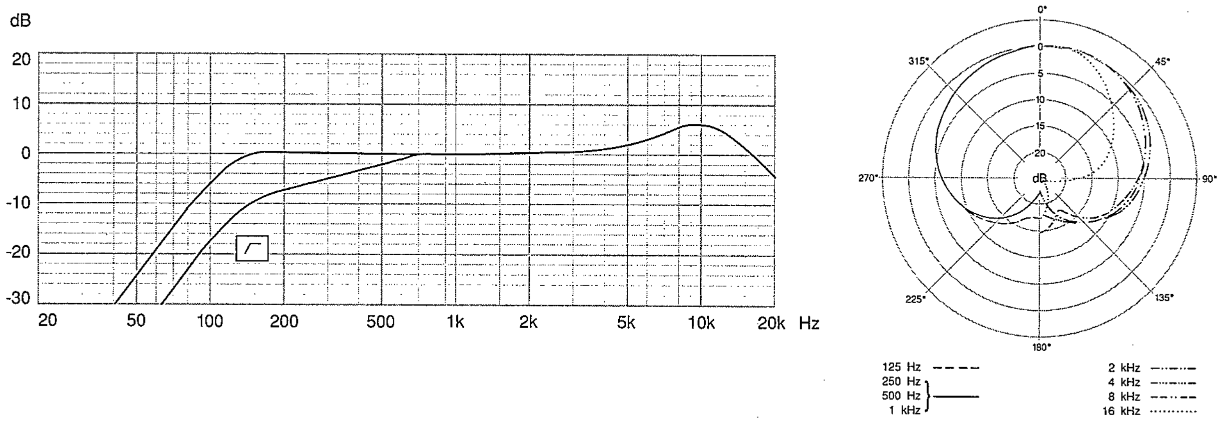


*Fig. 7a: Frequency responses and polar patterns of KMS 140*

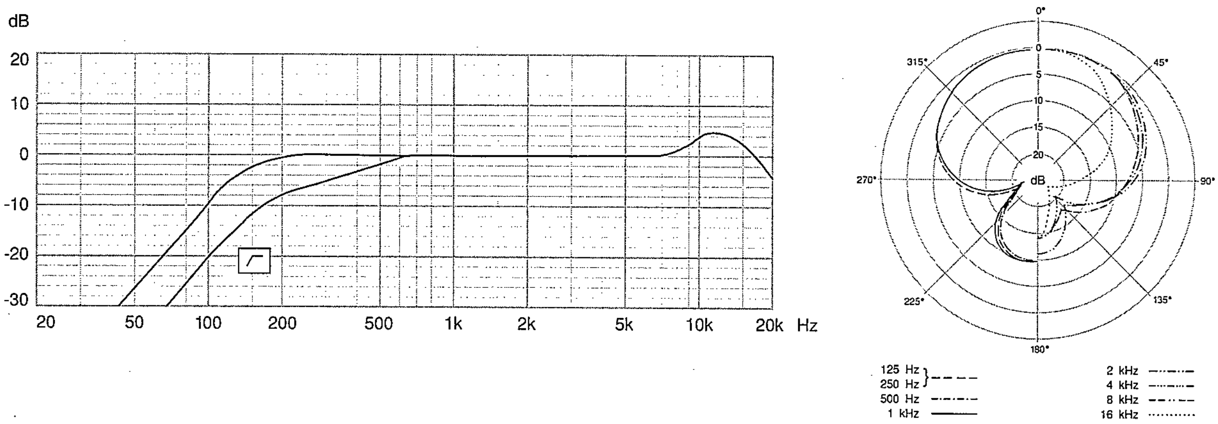


*Fig. 7b: Frequency responses and polar patterns of KMS 150*

## The Frequency Response in the Bass Range

As was seen in the these paragraphs, many requirements imposed on a vocalist microphone come together in the low frequency range:

- Pop suppression, because explosive consonants generate forceful low-frequency energy components.
- Feedback suppression, because loudspeakers reproduce low- frequency signals with little directional orientation, and therefore the microphone has to ensure that this “interference noise” is well screened out.
- Handling noise suppression, because structure-born noise is mainly a low-frequency component.
- The frequency response, which contributes substantially to the sound character of the microphone, especially in the low frequency region.

The vocal character of the performer can be supported, reinforced or even weakened by the microphone. The free-field frequency response of the microphones as represented in standard form in Fig. 7a and 7b is influenced by the particularly image-forming proximity effect.

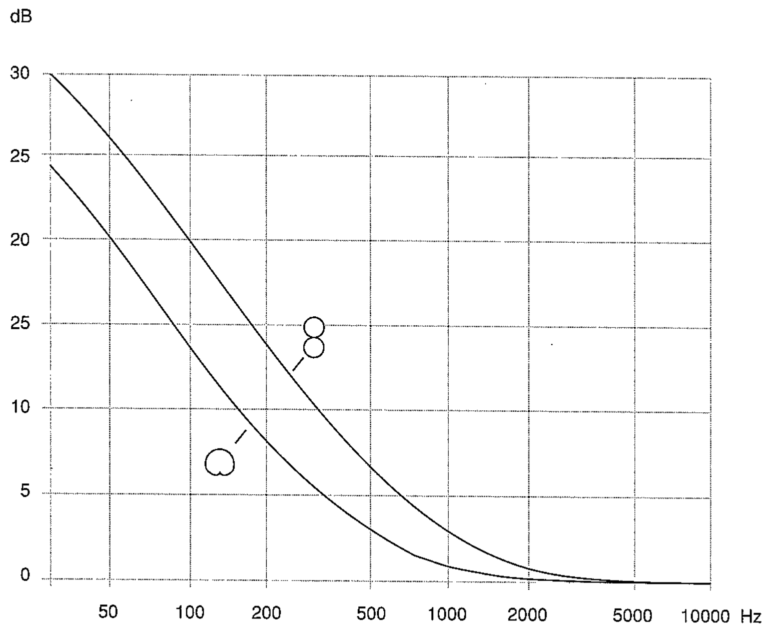


*Fig. 8: Increase of the sensitivity of pressure gradient microphones when close to the speaker ( Distance: 5.4 cm)*

The shorter the distance from which the microphone is addressed, the more the low frequency components are emphasized. Mostly this flatters the voice of the performer. Therefor a balance must be found with "high-end" microphones to exploit this proximity effect without restricting the suitability of the microphone for use on the stage according to the acoustic effects described.

## Summary

A vocalist microphone serves not only for the transmission of a voice; it must also - more than any other kind of microphone - be used judiciously to form a sound image. It must accomplish this while being confronted with a series of specific interference components because of being held in the hand and used at close proximity to the mouth of the performer.

With the new vocalist microphones KMS 140 and KMS 150, two microphones have been created which exhibit outstanding sound characteristics with a high degree of feedback suppression on the stage. By means of an innovative acoustical filter, they are very effectively protected against explosive consonants.