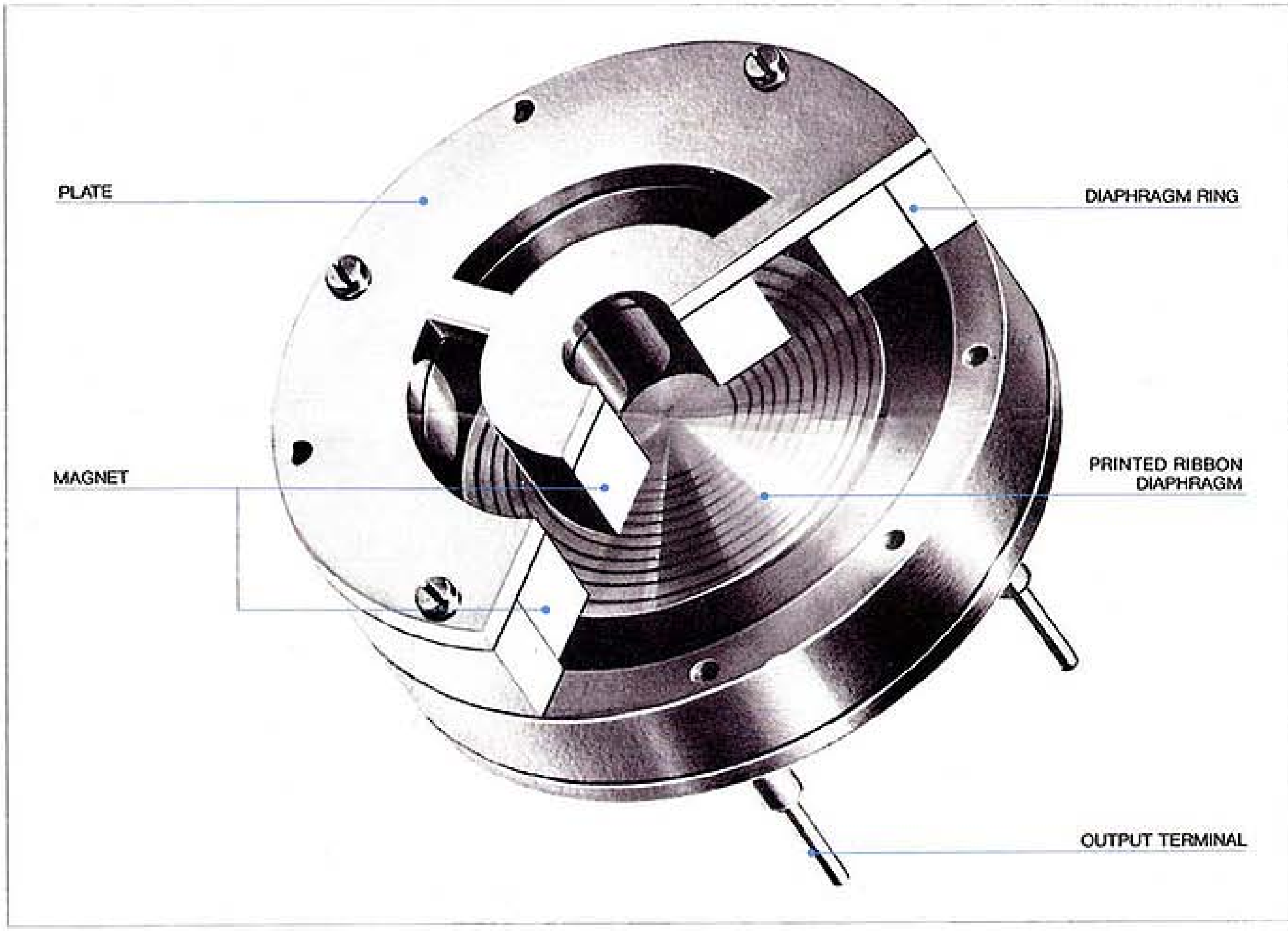
New Printed Ribbon with Completely Re-thought Core.



CONSTRUCTION OF PRINTED RIBBON MICROPHONES

The advent of multitrack recording with the resultant 'close-micing' techniques have placed a great deal of importance on the ability of a microphone to withstand very high sound pressure levels with low distortion and continued reliability. The 'printed-ribbon' microphone, the result of years of research, is the first microphone to operate in such high sound pressure level fields with extremely low distortion while remaining rugged and easy to service.

Because the principle of operation is dynamic, as opposed to electrostatic, the printed-ribbon microphone requires no power supply and is therefore more versatile and easier to use.

In all applications, the printed-ribbon microphone offers the same high performance and accuracy traditionally expected from a regular ribbon-type microphone, without the characteristic fragility.

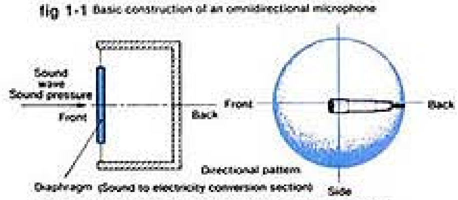
Fostex has made available, for the first time, to the professional sound engineer, a microphone which combines the finest sonic attributes of ribbon and condenser microphones with the durability and cost benefits of dynamic microphones.

MICROPHONE DIRECTIONAL CHARACTERISTICS

OMNIDIRECTIONAL (PRESSURE MICROPHONE)

A microphone transducer which exposes only the front side of the diaphragm to the sound field reacts equally to sound pressure fluctuations arriving from any direction. Pressure transducers thus have an omni-directional characteristic, as shown in fig. 1-1.

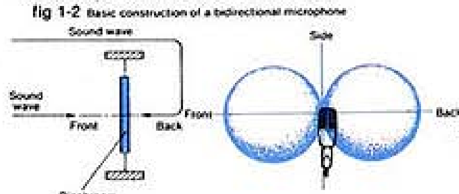
fig 1-1 Basic construction of an omnidirectional microphone



BI-DIRECTIONAL (PRESSURE GRADIENT MICROPHONE)

A pressure gradient transducer allows sound pressure information to reach both the front and the back diaphragm surfaces and the transducer reacts to the instantaneous sound pressure difference occurring between the two surfaces of the diaphragm. Sound waves reaching the diaphragm from only the front or the back are reproduced, while those arriving at both sides simultaneously are rejected. This occurs when sounds arrive at 90° to the diaphragm, as illustrated in fig. 1-2.

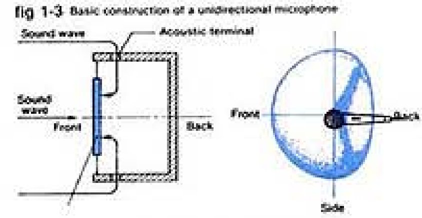
fig 1-2 Basic construction of a bidirectional microphone



UNIDIRECTIONAL

A unidirectional, or cardioid, pickup pattern results when delayed sound waves are allowed to reach the back-side of the diaphragm of a pressure gradient transducer, as shown in fig. 1-3.

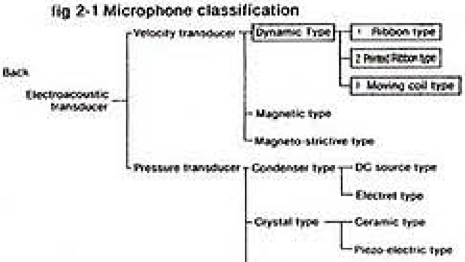
fig 1-3 Basic construction of a unidirectional microphone



MICROPHONE CLASSIFICATIONS

A microphone is a transducer, or a device for converting sound energy into electrical energy. Microphones may be classified into several types, as outlined in fig. 2-1. The most common type is the 'dynamic', or moving-coil type. The internal construction of dynamic microphones has been limited in the past to the 1) traditional ribbon type and the 3) moving coil type, as shown in fig. 2-1. The printed-ribbon microphone can be said to be an entirely new approach, combining the advantages of both the former types.

fig 2-1 Microphone classification



The Printed Ribbon Microphone—Designed to Be Tough.

MOVING COIL MICROPHONES

An example of the moving-coil element is shown in fig. 2-2. The diaphragm is normally formed of a plastic film, 9-35 μm thick, with a wound coil attached.
The coil is placed into a magnetic field and as the diaphragm vibrates due to sound pressure changes, the coil is moved through the magnetic field, inducing a voltage across the coil.
This microphone type is generally used because of its durable construction. However, it is difficult to construct the element so that the acoustical impedance at the front and at the rear of the diaphragm are equal, making it almost impossible to obtain a bi-directional pickup pattern with flat frequency response. This problem is illustrated in the equivalent circuit in fig. 2-3. Because of these difficulties, most moving-coil microphones are of the unidirectional or omnidirectional varieties.

fig 2-2 Basic construction of the transducer section of a moving coil microphone

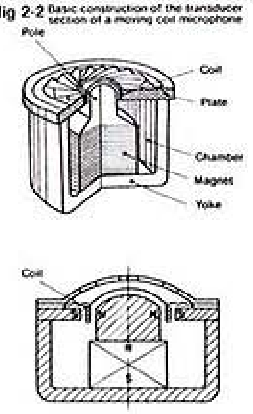
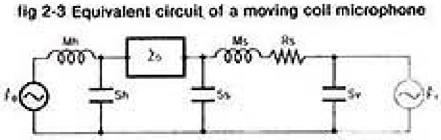


fig 2-3 Equivalent circuit of a moving coil microphone



RIBBON MICROPHONES

The traditional construction of the ribbon microphone is shown in fig. 2-4.
The diaphragm is belt-shaped, made of aluminum-foil 1-5 μm thick. 1. 5-4 μm wide and 20-50 μm long. It is corrugated to allow uniform vibration over a broad frequency range. The diaphragm itself is the conductor, which is located in the magnetic field; when sound waves excite this diaphragm, moving it through the magnetic field, a voltage is developed across it.
The magnetic gap of the pole piece is comparatively wide, 10-20 μm wider than the ribbon itself. As a very large permanent magnet is required to obtain the necessary flux density in this gap, the overall microphone size becomes large and heavy.
The equivalent circuit of a ribbon microphone is shown in fig. 2-5. Because of the symmetrical construction of the ribbon and magnet pole pieces, the acoustical impedance is the same at the front and at the rear of the diaphragm, resulting in a very uniform bi-directional pickup pattern.
If a sealed labyrinth were attached to the rear of the diaphragm an omnidirectional pickup pattern could be obtained. If an acoustic port (small opening) were introduced into this labyrinth, to allow a velocity component, the pattern changes to a unidirectional one.
Extremely smooth response and accurate sound quality are the outstanding features of the ribbon-type microphone, but it is extraordinarily sensitive to damage: the ribbon will stretch out-of-shape if exposed to wind currents and hence, cannot be used outdoors, or moved quickly. The ribbon is a very fragile element and must be handled very carefully.

fig 2-4 Basic construction of the transducer section of a ribbon microphone

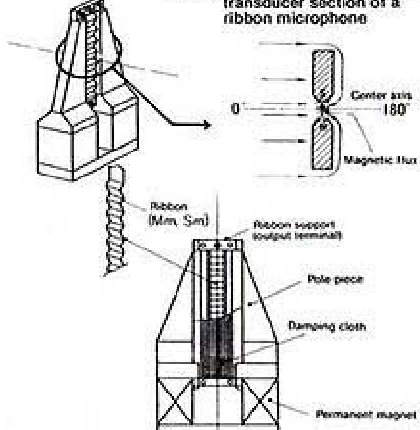
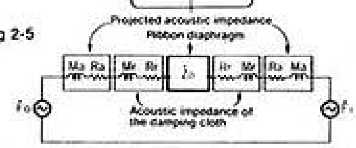


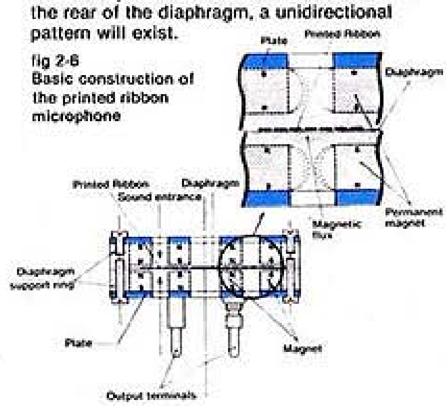
fig 2-5



PRINTED RIBBON MICROPHONES

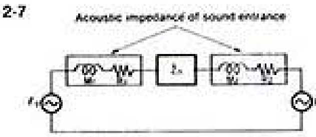
As shown in fig. 2-6, the basic construction of the printed-ribbon microphone consists of a diaphragm sandwiched between two set of concentric ring magnets. The magnetic flux from the two ring magnets, flows from N to S poles in the direction of the radial axis.
The diaphragm is constructed of a plastic film, 4-6 μm in thickness. The aluminum spiral ribbon coil is deposited onto the surface of the diaphragm, producing a single piece diaphragm/coil assembly.
The sound waves arrive at the diaphragm through openings between the inner and outer ring magnets, as well as through the centre hole of the inner magnet. When excited by the sound waves, the diaphragm/coil assembly moves through the magnetic field, and a voltage is induced across the coil winding. The acoustic impedance of this type of transducer is almost identical to the traditional ribbon style, in that the front and rear geometry are symmetrical. Additionally, the diaphragm is symmetrical about the main axis; therefore a figure-8 polar pattern may be obtained in all planes of the diaphragm axis.
The equivalent circuit is shown in fig. 2-7.
As with the traditional ribbon design, if the rear portion of the diaphragm is contained by a sealed labyrinth, to prevent sound waves arriving from the back, an omnidirectional pattern is obtained. If a small opening is made in this labyrinth to introduce sound waves to the rear of the diaphragm, a unidirectional pattern will exist.

fig 2-6
Basic construction of the printed ribbon microphone



While the operation resembles a traditional ribbon microphone, the fact that the ribbon element is permanently bonded to a very stable plastic film base, supported from all sides, the reliability and durability is very high, even higher that typical moving-coil microphones.

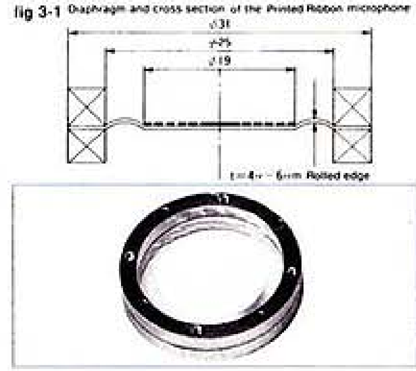
fig 2-7



CONSTRUCTION OF PRINTED RIBBON MICROPHONES

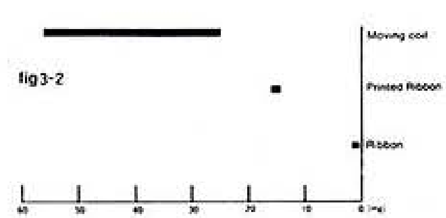
DIAPHRAGM

fig 3-1 Diaphragm and cross section of the Printed Ribbon microphone



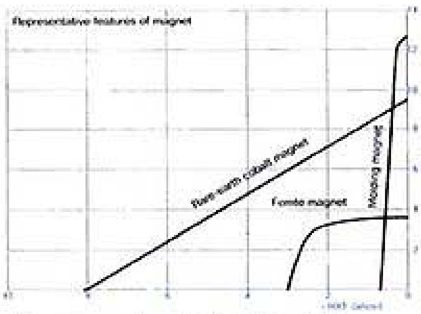
As the bi-directional dynamic type employs inertia damping, a uniform response can be obtained above the resonance of the system. Therefore the low frequency limit is determined by the resonant frequency of the system.
This resonant frequency, in turn, is determined by the diaphragm mass, the mass element applied to the front, the back, and through the edge stiffness. In professional usage, this resonant frequency is generally 50-100Hz.
In order to obtain a low frequency resonance, the edge must be very thin; a rolled edge, shown in fig. 3-1, is used to establish a resonance near 80Hz and also allows uniform movement of the centre of the printed coil.
Although the mass of the diaphragm is greater than that of a traditional ribbon-type, it is far lighter than a moving-coil type, exhibiting superior sensitivity and excellent transient response. The precision etching of the printed-coil also contributes to the flat frequency response and reliability of the system.

fig3-2



MAGNETIC SYSTEM

In order to produce a stable, high-density flux field between the symetrically opposed magnets, a magnetic material of intense flux energy and high retentivity are required. From the standpoint of directional characteristics, a small diameter diaphragm is desirable.
In consideration of these requirements, rare earth cobalt magnets are employed.
In a magnetic circuit where the like poles are placed opposing each other, the lines of flux are bent in a horizontal plane, as shown in fig. 3-3. This increases the flux density in the area where the printed-coil is placed. When optimizing the gap and magnet dimensions



it is necessary to understand the relationship between the flux density and the flux distribution. Through extensive testing and experimentation, it has been determined that uniform flux distribution cannot be obtained if the gap width is small, and the flux density is reduced if the gap is large; hence, the gap width must be selected in conjunction with the proper form of diaphragm. Fig. 3-4 illustrates the relationships of flux distribution and gap width. Fig. 3-5 shows the basic dimensions of the magnetic circuit, as derived through experimentation.

fig 3-3 Gap width and magnetic flux

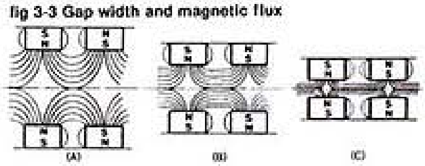


fig 3-4 Gap width and flux distribution

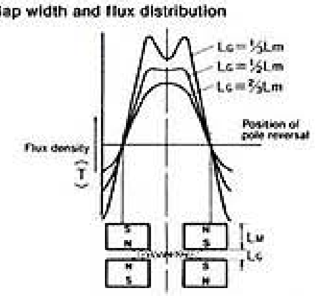
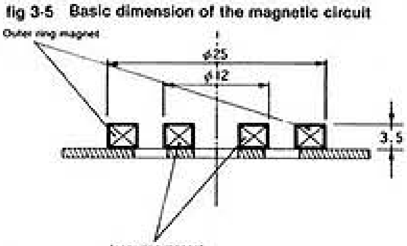


fig 3-5 Basic dimension of the magnetic circuit

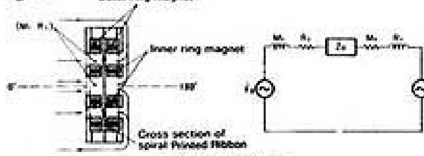


DIRECTIONAL CHARACTERISTICS

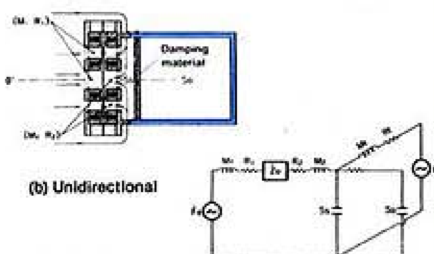
Basic construction of the various directional patterns are shown in figs 1-1 to 1-3. The equivalent printed ribbon implementations are shown in fig. 4-1. As can be seen from these schematics, the basic element is bi-directional; if a sealed cavity is placed behind the element, it becomes omnidirectional; if a sound entrance hole is provided in the cavity, a unidirectional pattern results. The damping material R_s is an acoustic resistance material for adjusting the resonant frequency Q of the diaphragm system.

Microphones of various directional patterns, for many applications may be made easily; not only unidirectional and bi-directional, but M-S stereo, noise-cancelling or 'near-field' type, super directional and pickup microphones may be produced.

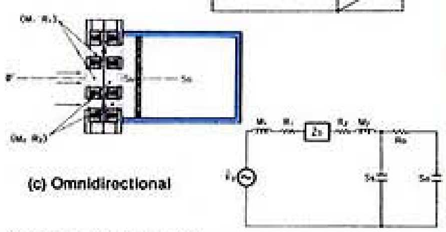
fig 4-1



(a) Bidirectional



(b) Unidirectional



(c) Omnidirectional

APPLICATION NOTES

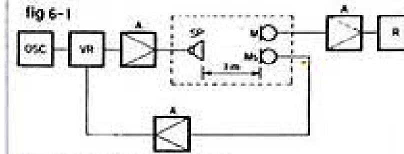
1. To achieve full performance of the printed-ribbon microphone, the cable used must be of low capacitance and low internal resistance.
   *The recommended values for each model are listed in the technical data sheet.
2. If terminated in a very low impedance, not only will the low frequency response deteriorate, but the specified sensitivity cannot be obtained. (This is due to the fact that the specification is an 'open-circuit' voltage.)
   *Optimum termination impedance is specified for each model.
3. The output polarity of the microphone is positive, at the plus terminal, for a positive sound pressure at the front of the microphone. Extreme care is necessary when a number of bidirectional microphones are used together, as the front and rear sound pickups are 180° out-of-phase.
4. Although the microphone is rugged and built in a shock resistant fashion, it should be handled with the care appropriate to any valuable instrument.
5. If stored for long periods, the microphone should be kept in a location with a humidity of less than 90% and a temperature of less than 55°C.

MEASUREMENT CONDITIONS

1. SENSITIVITY & FREQUENCY RESPONSE

The sensitivity specification is the open circuit voltage produced by the microphone while located in a sound field of constant pressure of a continuously changing frequency, using the measurement circuit of fig. 6-1 and a calibrated microphone, Bruel & Kjaer type 4133.
Sensitivity is expressed referred to 1kHz under the above conditions using the open circuit voltage per 0.1/Pa.
Anechoic chamber specifications are: 15dB (A) with an inverse square characteristic of 63Hz—20kHz ± 1dB.

fig 6-1



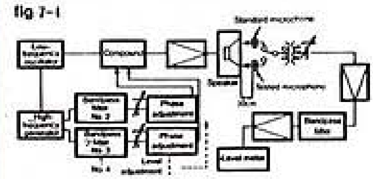
2. FREQUENCY RANGE

This is specified as the frequencies where the lower and upper limits are 10dB below the 1kHz reference level, tested under the conditions outlined in item #1. For special application microphones, the specification is quoted with respect to the environment of the final application.

3. DISTORTION MEASUREMENT

The second harmonic distortion at 400Hz is obtained by the Distortion Cancelling Method[1]. This method is based on the characteristic of fundamental and odd harmonic cancellation of an inverted signal applied to a non-linear system resulting in even harmonic remains. This is shown in fig. 7-1.

fig 7-1



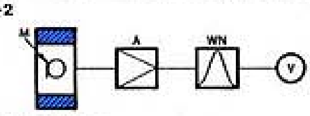
4. MAXIMUM INPUT SOUND PRESSURE LEVEL

The input sound pressure level that produces 3% distortion as measured in item #3, is the maximum specified input sound pressure level.

5. INDUCTION NOISE

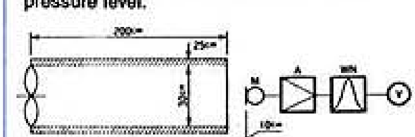
Using the measuring circuit of fig. 7-2, the microphone under test is placed in a parallel magnetic field of a magnetic field generator installed in an anechoic chamber and the induced voltage from the microphone is measured with an 'A-weighted' curve. In this measurement, induction noise is expressed as an equivalent sound pressure level by converting for every 10^{7} (T) the maximum value obtained while rotating the microphone in the centre of the magnetic field.

fig 7-2



6. WIND NOISE

The microphone under test is placed in the opening of a wind tunnel, installed in an anechoic chamber, and the voltage generated by a wind speed of 2m/s is measured with an 'a-weighted' network and the reading is expressed as an equivalent sound pressure level.



Note: equivalent sound pressure level of noise.

The equivalent sound pressure level of noise is the average sound pressure level applied to the diaphragm that will produce an output voltage equal to the noise voltage appearing at the terminals of the microphone and is obtained by the following equation:

$$N = Eu - A + 74$$

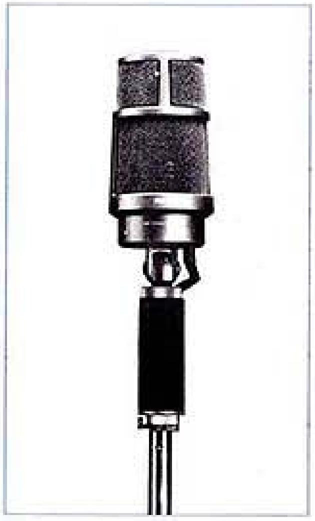
Where: N: Equivalent sound pressure of noise (dB)
Eu: The noise voltage appearing at the output of the microphone measured with 'A-weighting' and expressed in dB (0dB = 1V).
A: Nominal sensitivity (dB).

Extensive Research Produced an Extra-Stable Form.

M11RP

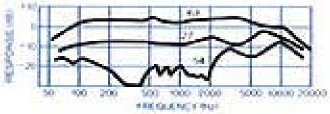
- Professional unidirectional type designed for announcing and speech.
- Wide range of application in broadcasting, recording studios and auditoriums.
- The soft and delicate sound quality is a characteristic of the printed ribbon microphone.
- The double suspension method prevents pickup of mechanical noise.
- Sound quality switchable in 3 steps (0, 1, 2).
- Also suitable for percussion and oriental instruments.

SPECIFICATIONS
•Impedance: 600 ohms •Sensitivity: −51dB, 2.8mV/Pa (0dB = 1V/Pa)
•Frequency response: 40 – 18,000Hz
•Dimensions: 67 × 63 × 179mm (W, D, H) •Weight: 580g



M22RP

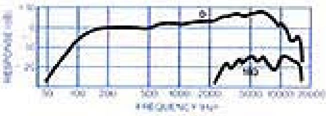
- The only one in the world of the dynamic type M-8 system stereo microphone.
- Most suitable for outdoor stereo sound pickup for television and radio as it needs no power supply.
- Provided with a hand holding grip for outdoor sound pickup. Also has a wind screen.
- The double suspension method prevents pickup of mechanical noise.
- Most suitable for sports broadcasting, pickup of outdoor natural sounds and auditorium on-the-air monitoring.



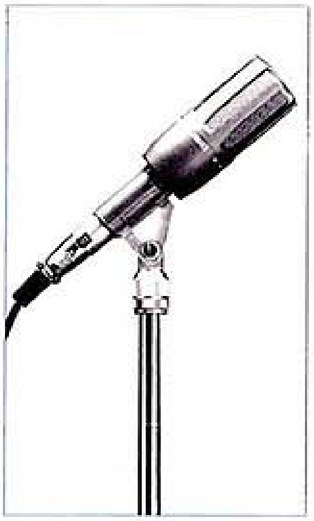
SPECIFICATIONS
•Impedance: 600 ohms •Sensitivity: −51dB, 2.8mV/Pa (0dB = 1V/Pa)
•Frequency response: 40 ~ 13,000Hz
•Dimensions: ø70 × 245mm
•Weight: 730g
(Developed by assistance from NHK Technical Laboratory)

M55RP

- Professional unidirectional type developed solely for vocal use.
- Possesses both the sound quality resembling the ribbon type and the durability of a moving coil type.
- Reliability is high and adaptable to announcing use.
- Can be mounted on a goose neck.

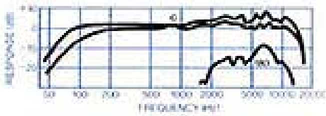


SPECIFICATIONS
•Impedance 250 ohms •Sensitivity: −57dB, 1.4mV/Pa (0dB = 1V/Pa)
•Frequency response: 70 ~ 18,000Hz
•Dimensions: ø50 × 167mm
•Weight: 250g



M77RP

- Professional unidirectional type for pickup of bass and bass drums.
- A straightforward sound attained by lowering resonance of the diaphragm and thus response extended to the lower region.
- The proper equalizer matching the musical instrument can be selected by a 3-step switch.
- Also suitable for strings such as a guitar.



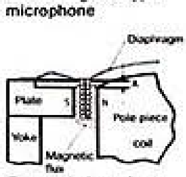
SPECIFICATIONS
•Impedance: 250 ohms •Sensitivity: −[illegible]dB, 1.0mV/Pa (0dB = 1V/Pa)
•Frequency response: 40 ~ 18,000Hz
•Switch: 3 step sound selecting
•Dimensions: ø45 × 172mm
•Weight: 360g

OUTSTANDING FEATURES OF PRINTED RIBBON TRANSDUCER

1. Non-linear distortion during extremely high sound pressure levels where the diaphragm excursion is very large is kept at a minimum because the coil is in a uniform magnetic field.
2. Because very strong magnets are located on both sides of the diaphragm, the diaphragm is protected from minute iron particles floating in the air; this microphone is extremely suitable for outdoor use.
3. Reliability is high and maintenance is simple as the microphone requires neither batteries, nor an external power supply.
4. Due to the extremely small mass of the diaphragm, sensitivity and performance similar to traditional ribbon microphones is achieved while remaining durable.
5. Extremely good bi-directional pickup pattern is possible due to the symmetrical physical construction of the microphone element.

fig 5-1

Enlarged view of gap in the moving coil type microphone



Enlarged view of gap

Enlarged view of gap in the printed ribbon type microphone