Magnetic Sounder
Reflow type
Non-washable type
Washable type
Magnetic Buzzer
Electric Sound type (Washable)
Vibrating Hammer type (Non-washable)
Dynamic Speaker (Non-washable)
Technical data

Various Types of Magnetic Sounder Buzzers

Acoustic components generally referred to as buzzers can be classified as ① magnetic sounders, ② electric sound type buzzers, ③ vibrating hammer type buzzers, ④ piezoelectric buzzers, and ⑤ piezoelectric sounders. Star Micronics produces ①, ②, and ③ in our product line. A sounder issues sound by inputting specific electric signals from outside. Therefore, it is necessary to provide an oscillating circuit when utilizing a sounder. A buzzer (electric sound type buzzers, vibrating hammer type buzzers), meanwhile, incorporates a sounder and an oscillating circuit within, so it produces sound only when direct current is applied to it.

Structure and Operating Principle of Magnetic Sounders

The structure of a magnetic sounder is shown in Fig. 1. The operating principle of a magnetic sounder is herein described, based on this figure. The magnetic flux from a magnet produces a bias magnetic field at the tip of the iron core, drawing a diaphragm toward itself by a suitable force. If electric signals (for example, rectangular-shaped voltage with a frequency of 3.2 KHz and 1.5 Vo-p) coming intermittently at a fixed frequency from an external oscillating circuit are input, an electric current will intermittently flow through the coil, generating an intermittent magnetic field at the tip of the iron core.

The magnetic field drives the diaphragm up and down, generating the sound pressure corresponding to the amplitude of the diaphragm. This sound pressure is further multiplied by the resonance effect of the resonator installed on the case. Each product is designed and adjusted based on resonance frequency (fo) and resonance frequency (fv), so that excellent performance is obtained at the standard frequency. Accordingly, the functional composition of a magnetic sounder can be divided into the magnetic circuit unit, and the resonance unit. (Fig. 1)

Characteristics

■Measuring Circuit

We at Star Micronics input electric signals of a specific frequency to a magnetic sounder, using the measuring circuit shown in Fig. 2, to measure the characteristics of the sounder.
Please use this information in measuring your sounders and arranging driving circuits. (Fig. 2)

■Frequency Characteristics

A magnetic sounder emits sound based on the frequency of the electric signals input, and it is the frequency characteristics that determine what degree of sound is caused in relation to input frequency. Frequency characteristics are generally shown as a graph that indicates results of measurement at the sound pressure level (SPL) 10 cm in front of the magnetic sounder, while changing the frequency of input signals from 500 Hz to 10 KHz at the rated voltage. They are referred to as sound pressure level frequency characteristics.

In this catalog. the representative value of the frequency characteristics for each product is shown for reference. Use these values for product selection to match the purpose and input conditions for use, while nothing their difference. Frequency characteristics shown in the catalog are those at a time when rectangular waves (Vo-p) are input. When input is in the form of rectangular waves (Vp-p), sine waves, etc., frequency characteristics will be different. Attention should be paid to this point.

■Reverse Connection

There is polarity in magnetic sounder input. Even if a reverse-polarity connection is made, sound is produced, but it is not certain that sound pressure specifications will be satisfied. In the case of a reverse connection, the operating direction of the magnetic field will change (attraction ⇔ repulsion), and resonance frequency (fo) will after, so it is possible that sound pressure at the standard frequency will decline or deviation will become larger.

■Frequency characteristics caused by voltage changes

There may be cases in which a magnetic sounder is used at voltages other than the rated voltage. Note that frequency characteristics stated in the catalog are those at the time of the rated voltage. Frequency characteristics during input at voltage other than the rated voltage changes as shown in Fig. 3. As input voltage becomes lower, resonance frequency (fo) of the magnetic sounder rises; as input voltage becomes higher, fo reduces. Because resonance frequency (fv) of the resonator does not change in relation to voltage, the frequency band becomes narrow when voltage is low, while the band widens to the low frequency side when voltage is high. If voltage is too low, fo may rise above the standard frequency, causing a substantial reduction of sound pressure. (Fig. 3)

■Average consumption current

The average consumption current (mA), as set forth in the catalog, is described in the form of MAX.OO. This means that, if the rated voltage is applied without limiting electric current, the average current value will not surpass OOmA. Be careful, as it is not meant that electric current exceeding OOmA must not be applied to the product.
In reality, maximum current 2 to 3 times higher than the average current is required as peak current. Therefore, a driving current that can supply sufficient current should be provided. If the peak current is restricted, there can be a case in which sound pressure will not be output as specified.
(Example) In the case of QMB-111PN, whose average current is MAX. 10mA, prepare a driving circuit that can supply the peak current of at least 30mA.

Fig. 1 Construction view of QMX series

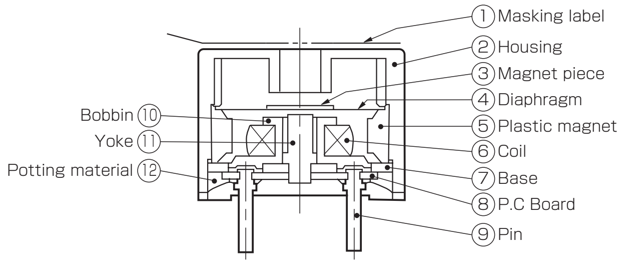


Fig. 2 Measuring Circuit
Our standard circuit for measurement is as shown below:
(V_{CE}=0.15 volts or lower)

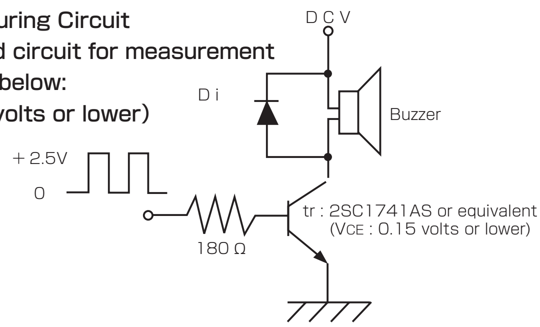
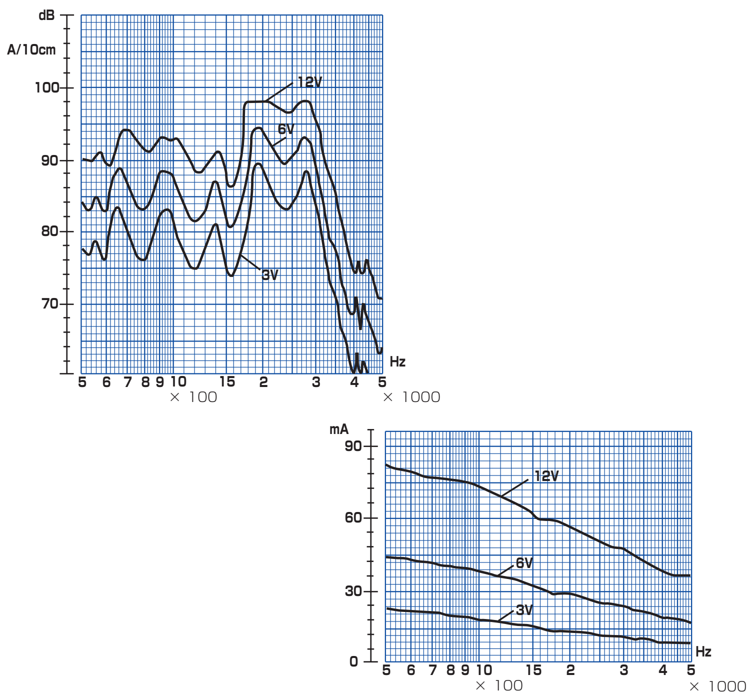


Fig. 3



Resonance Effect of Helmholtz

Sounders are usually built into equipment and used in that state. At that time, users may have various needs, such as "raising sound pressure" or "widening the frequency band." By installing a resonator on the case in which the sounder is contained, etc., it is possible to make sound characteristics closer to these requirements. On this occasion, the "resonance effect of Helmholtz," which can be used for reference purposes, is hereby introduced. To improve the characteristics,, it is possible to widen the frequency band or to raise the sound pressure of the standard frequency or desired frequency by setting the resonance frequency (fv) of the external resonator for the sounder use at a level slightly higher than double the standard frequency, a desired frequency close to it, or the consonance frequency (fo) of the sounder. The resonance effect formula of Helmholtz shown in Fig. 4 represents a theoretical formula that demonstrates the relationship between fv of the external resonator and the size of the resonator. Because the effect of the resonator incorporated in the sounder is not included, it is necessary to take the acoustic combination with the resonator of the sounder in actual setting. The usual method is to incorporate the sounder in the real body of the external resonator and adjust its sound emission hole, etc.,while considering the value, calculated through the formula, and to seek optimization. (Fig. 4)

〈Example of Execution (Experiment)〉

The degree of improvement in the characteristics attained through the addition of a resonator to the outside of the sounder is explained, using the results of an experiment employing the sounder QMB-105P. The standard frequency of this product is 2,048 Hz, while sound pressure specification for the product as a signal unit is min 70 dB (typical 77 dB) in terms of sound pressure at 10 cm. (Fig. 5) Because this sounder has only a small space in front of the diaphragm, it does not have resonance frequency (fv). Therefore, it was considered that, even if it is incorporated, little effect will arise on the external resonator, because its space capacity is small. Dimensional conditions for the external resonator, shall be in accordance with Fig. 6. (Fig. 5 and Fig. 6)

1. Expansion of the band

In order to widen the frequency band to be used to 2,048 Hz - 2,700 Hz, it is considered to set fv for the external resonator in Fig. 6 at around 2,700 Hz.
The theoretical diameter of the sound release hole, obtained by solving the relational expression in Fig. 4, is: D=1.7mm. If the value is slightly reduced to D=1.5mm, for subsequent fine adjustment, the theoretical fv based on the relational expression becomes 2,460 Hz. The fv value resulting from real measurement arises at 1,700 Hz because of the effect of the signal-unit characteristics of the sounder.
The actual measurement value will be equal to the characteristics shown in Fig. 7. Thus, compared with the signal unit case, the frequency band will be expanded. (Fig. 7)

2. Paising the sound pressure

To increase the sound pressure of the standard frequency of 2,048 Hz above that of the single unit, fv for the external resonator in Fig. 6 is assumed to be set at 4,100 Hz, which is twice the standard frequency. If D=3.3 is assumed, the theoretical fv based on the relational expression 4,270 Hz. The fv value resulting from real measurement, however, will generate at around 4,000 Hz due to the single-unit effect, etc., of the sounder.

The real measurement value proves to be as shown in Fig. 8, and it is clear that the sound pressure level at 2,048 Hz is higher than for the single unit. In this case, however, the sound is audibly high-pitched, because the second harmonic portion will increase.
Based on the aforementioned experimental example, the resonance effect of Helmholtz and its significance are believed to be understood.
Points of attention in setting an external resonator are as follows. ① if the sounder has a resonator of its own, there is a possibility that the theoretical value of the relational expression in Fig. 4 and the real measurement value will be substantially different, as the resonator or the sounder and the external resonator combine acoustically. In this case, it is necessary to adjust the actual equipment of the external resonator, attaining optimization.
② To ensure the resonance effect of the resonator, it is necessary to reduce the sound resistance of the sound emission hole. If the sound emission hole of the external resonator is reduced too much, however, it is possible that no satisfactory outcome will be produced, even if the same frequency is set.

If sufficient resonance space cannot be secured for the external resonator, open a sound issuance hole, a size at least equal or larger than the sound emission hole, of the sounder on the equipment case, to ensure satisfactory characteristics for the single unit of the sounder, then operate the equipment.

Fig. 4

$$fv=\frac{CD}{4}\sqrt{\frac{1}{\pi V(L+0.75D)}}$$

Where
fv : resonant frequency of resonator [Hz]
V : volume of resonance chamber [mm^3]
D : diameter of sound emission hole [mm]
L : depth of sound emission hole [mm]
C : speed of sound = approx. 344000 [mm/sec]

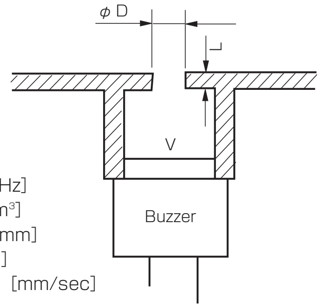


Fig. 5 Frequency response without additional resonator

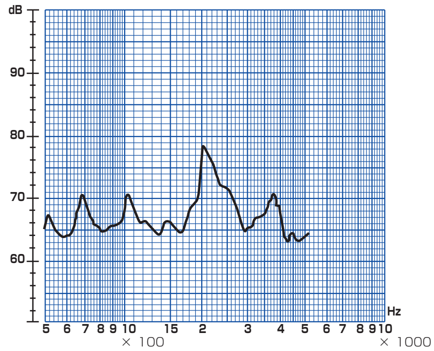


Fig. 6 Geometrical conditions

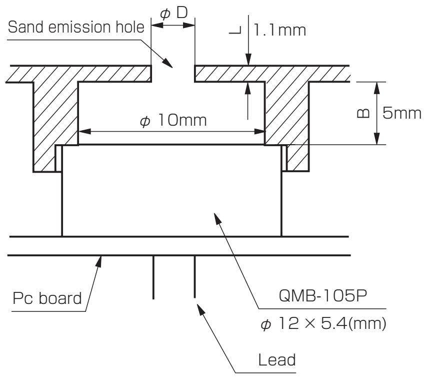


Fig. 7 Frequency response with resonator (Design Ⅰ)

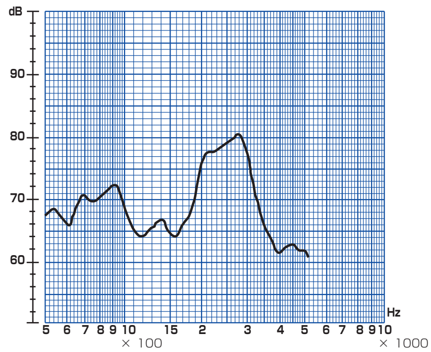
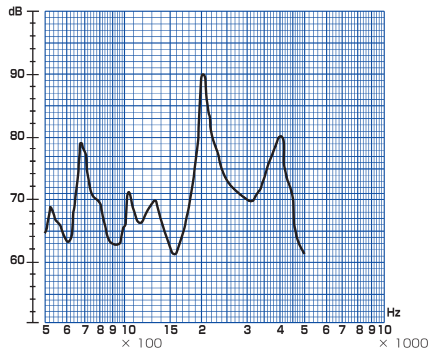


Fig. 8 Frequency response with resonator (Design Ⅱ)



MAGNETIC BUZZER (SELF-CONTAINED DRIVE CIRCUIT)

■ELECTRIC SOUND TYPE BUZZER

Fig. 1 Cut -away view of type TMB

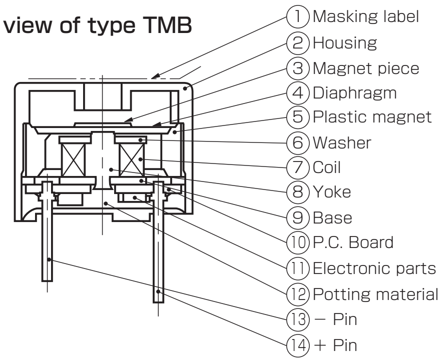
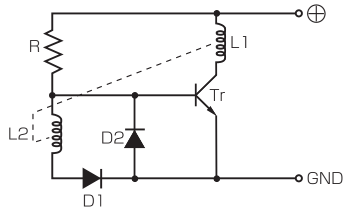


Fig. 2 Circuit diagram of type TMB



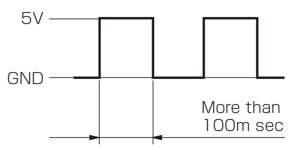
OPERATION PRINCIPLES AND CONSTRUCTION

■ELECTRIC SOUND TYPE BUZZER

These types of electro magnetic buzzers (as pictured in Fig. 1) contain coils which are would in such a manner to produce L1 for driving, and L2 for feedback purposes (as shown in Fig. 2). When current flows through coil L1 and the diaphragm begins to vibrate, coil L2 detects its vibration, providing feedback to the base of the transistor so that the oscillation becomes synchronized with the vibration of the diaphragm.

■RESPONSE TIME

Fig. 3 Response time



CHARACTERISTICS

■RESPONSE TIME

The buzzer will take a certain time to produce a sound at its fundamental frequency with its built-in driver. The time required to generate a sound after application of a rated voltage in the respective specifications as a response time. In case it is intended to use the buzzer for producing a pulsed sound output, it must be designed with special attention on the response time. It is recommended to apply the voltage at least for a time twice as much as the response time specified.(Fig. 3)

〈Example〉
For an intermittent operating of the buzzer TMB whose response time is specified as 50 ms, it is recommended to apply the voltage for at least 100 ms.

■Mean Current Consumption

Excessive restriction in the current fed to Miniature audio transducers and Low-pitched buzzers will adversely affect the oscillation and may result in no sound generation. It is therefore required to design the circuit to supply the current sufficient for the peak current needed to generate a sound, two of three times as much as the averagedly consumed current (See Page 4.)

Fig. 4 EX.1 : Fulcron of diaphragm is unstable

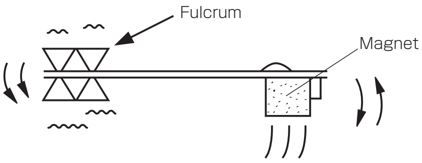


Fig. 5 EX.2 : Fulcron of diaphragm is unstable

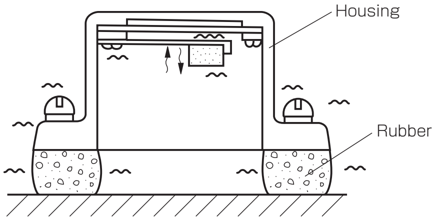
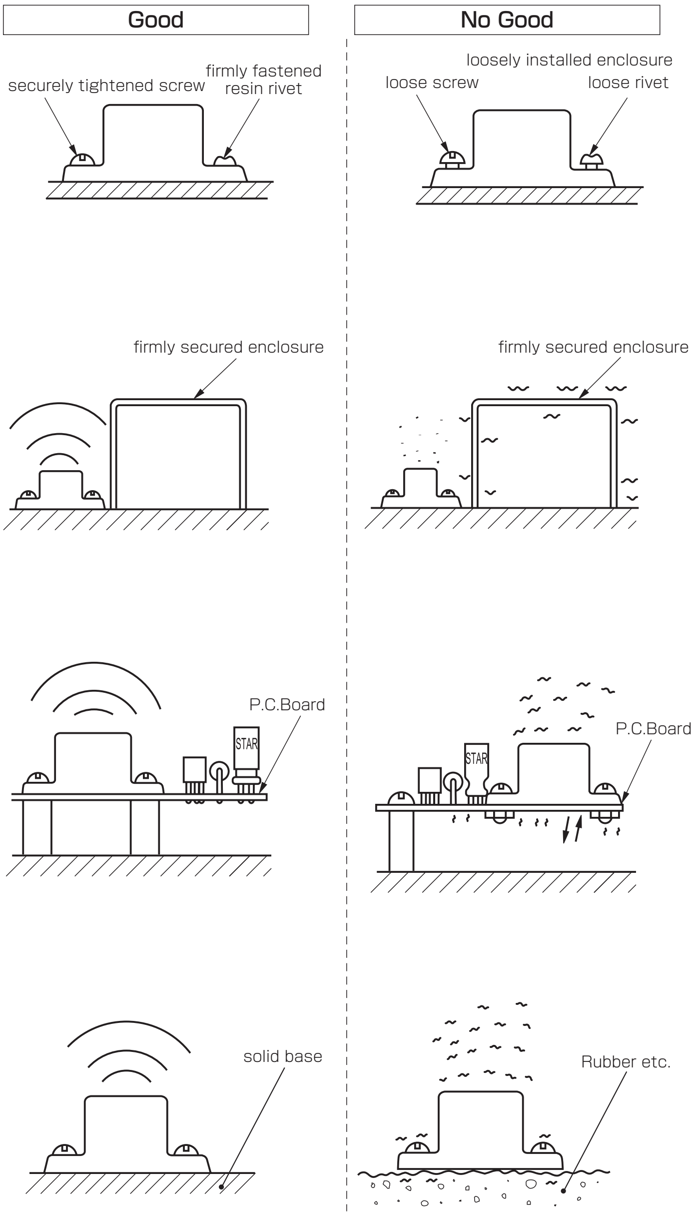


Fig. 6 SUGGESTED INSTALLATION



Buzzer Attachment

Synchronization of a circuit-embedded-type buzzer starts when initial oscillations of the diaphragm (a cantilever diaphragm in the case of an electronic buzzer) are returned to the oscillation circuit by the coil L2. If initial oscillations are disturbed or absorbed, therefore, return will not be sufficiently implemented, so stable synchronization will not be realized; this will be the cause of little sound or non-issuance of sound.
The disturbing or absorption of initial oscillations is liable to occur when the supporting point of the diaphragm easily vibrates, absorbing the oscillation of the tip of the diaphragm, as shown in Figure 9. If this is translated to the buzzer attachment state, it is tantamount to the condition in which initial oscillations of a diaphragm, when it is fitted to a soft object, such as rubber, are absorbed by the rubber. Accordingly, attention should be paid to the following points in attaching a buzzer:

(1)Fix the buzzer firmly.

(2)Make sure that the object to which the buzzer is fitted is hard to oscillate.

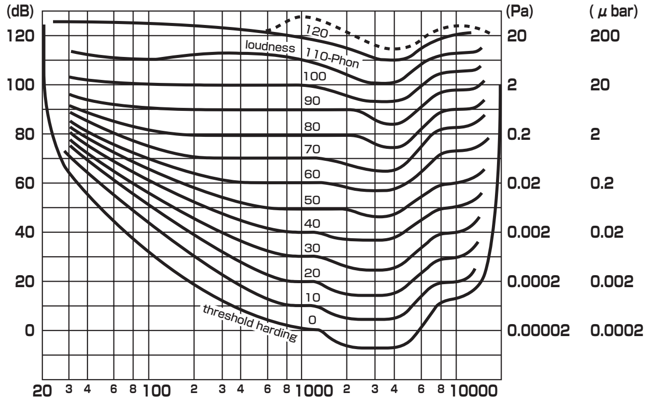
(3)Make sure that, near the buzzer, there is no object that can be oscillated easily.

Even if the aforementioned three requirements are satisfied, it does not guarantee there will be no problems. Namely, initial oscillations of the buzzer are absorbed, and synchronization becomes unstable, if the object to which the buzzer is fixed or items around the buzzer have the same resonance frequency as the diaphragm of the buzzer (resonant conditions), or if these conditions are caused by the fitting method. This situation can be rectified by eliminating resonant conditions through changing the fitting or other conditions. Fig. 11 demonstrates examples of good and bad fitting conditions. (Fig. 4, Fig. 5, and Fig. 6)

■Power Source Ripples

If ripples occur on voltage applied to the buzzer, oscillation of the oscillation circuit unit or the frequency of return will be disturbed. This, in turn, will make synchronization with the resonance frequency and synchronized ringing itself unstable, causing the reduction or non-issuance of sound. As for the size of ripples, effects will appear beginning at around 50 mV.
Although, in some cases, the problem can be solved by linking the capacitor with the buzzer in series and smoothing out ripples, it is necessary to make sure that the circuit can provide stable voltage.

SOUND PRESSURE & TONE



Loudness contour

dB AND PHON

1. Sound pressure level is referred to as Sound Output and rated in dB (decibel). DB is defined as the sound pressure level in logarithmic ratio to a sound pressure on the basis of the minimal sound pressure (20μPa) whose 1 KHz sound that a person in good condition can hear out. The sound pressure level is calculated as shown below in measuring an unspecified sound pressure P (μPa).

Sound pressure level (dB) = 20 log (P/0.0002)

2. The term phon is a unit which describes loudness level as is the case of the decibel. Generally, even the sound level being equal, it is hard for us to hear out the sound clearly due to frequencies. "Loudness contour" is a statistically calculated collection comprising sounds of the same loudness with every frequency based on the 1 KHz sound.
   The phon is formed through corrections of the sound pressure levels, basing the contour.

   For measurement of the sound pressure, the sound level meter possessing the A weighting is employed, which shows relatively corrected values in accordance with the loudness contour. This way the term dB is considered to be phon in specifications.

■SOUND PRESSURE AND DISTANCE

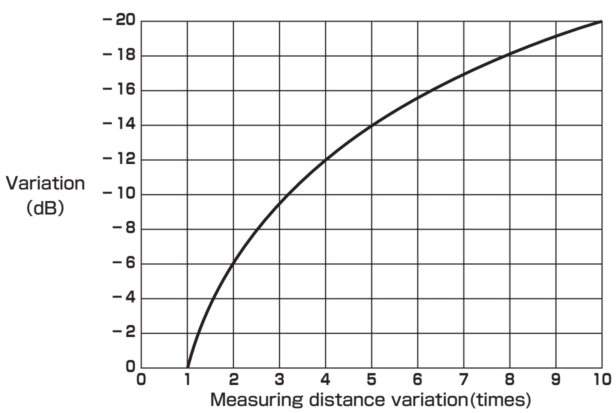
As there are differences in the measuring distances when manufacturers make the measurement of sound pressure, the following formula is recommended for calculation on occasions when a buzzer itself is tested or compared with a planned finished product.
However, as for as the calculated is concerned, it is a theoretical one and therefore subject to change, depending upon circumstances and conditions.

The formula is :

B=A+20 log(La/Lb)	A : sound pressure value at distance La B : sound pressure value at distance Lb

The table below is to shape up relations between the measuring distance variation and the sound pressure variation for reference.

Measuring distance variation	2 times	3 times	4 times	5 times	6 times	7 times	8 times	9 times	10 times
Sound presure variation (db)	−6.02	−9.54	−12.04	−13.98	−15.56	−16.90	−18.06	−19.08	−20.00



〈Example〉 10cm : 80dB → 30cm : 80−9.54=70.46(dB)

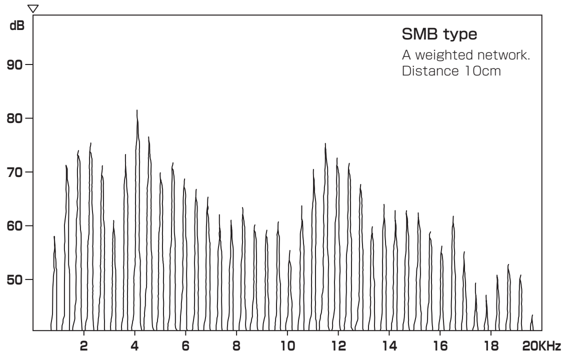
TONE

The tone output, generated by buzzers, is essential in product design. A recommended way of selecting a desired tone is by listening to the different tones produced by the different buzzer. Additionally, FFT analysis is usuable for visual tone selection method. The sound is not an oscillation of a single frequency, but as a collected body of individual frequencies. The analysis is to diagnose the ratio of constituent frequencies. The following is a sample analysis of our typical buzzer.

① Low pitched buzzer (e.g. SMB type)

As observed in Fig. 1, all frequency elements are evenly included within the audio frequency range in which we can hear out, ranging from approx.20 Hz, and the "beep" sound is produced. As an advantage this tone is easily heard out by the aged and persons having difficulty in hearing (they are said to be weak in listening to high frequencies), and also can be followed without being affected under noisy surroundings. Therefore, the tone is more suitable for alarm, no to mention, the continuous sound can be more effective in emergency situations. Since electro magnetic transducers and piezoelectric transducers catch attention with a single sound at the start, however, in the long run, reduce warning effects after lengthy sounding tend to be converted into intermittent sound producing products.

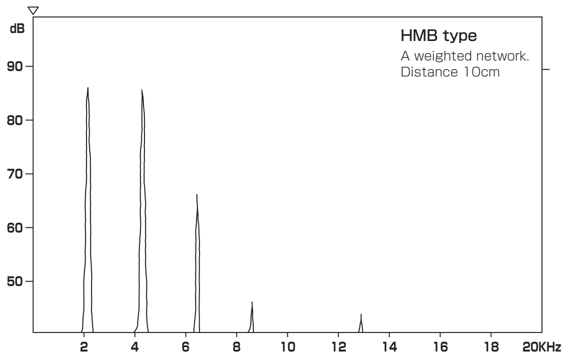
Fig. 1 SMB type FFT analysis



② Transducer with drive circuit (e.g. HMB type)

Transducer with drive circuit (e.g. HMB type) & without drive circuit Fig. 2 shows how the peep sound is composed of a collected body of the fundamental frequency and its integer fold frequencies. This sound composed of integer fold frequencies is generally refereed to as a single sound which has a clearer tone than the low pitched buzzers have.

Fig. 2 HMB type FFT analysis



③ Piezoelectric transducer

The transducer produces the peep sound closer to the pure sound, which is composed of almost the fundamental frequency. Compared with the transducer, it is likely to sound relatively less mellow.(Fig. 3)

Fig. 3 Piezo type FFT analysis