Manual for understanding SIEG® waveform

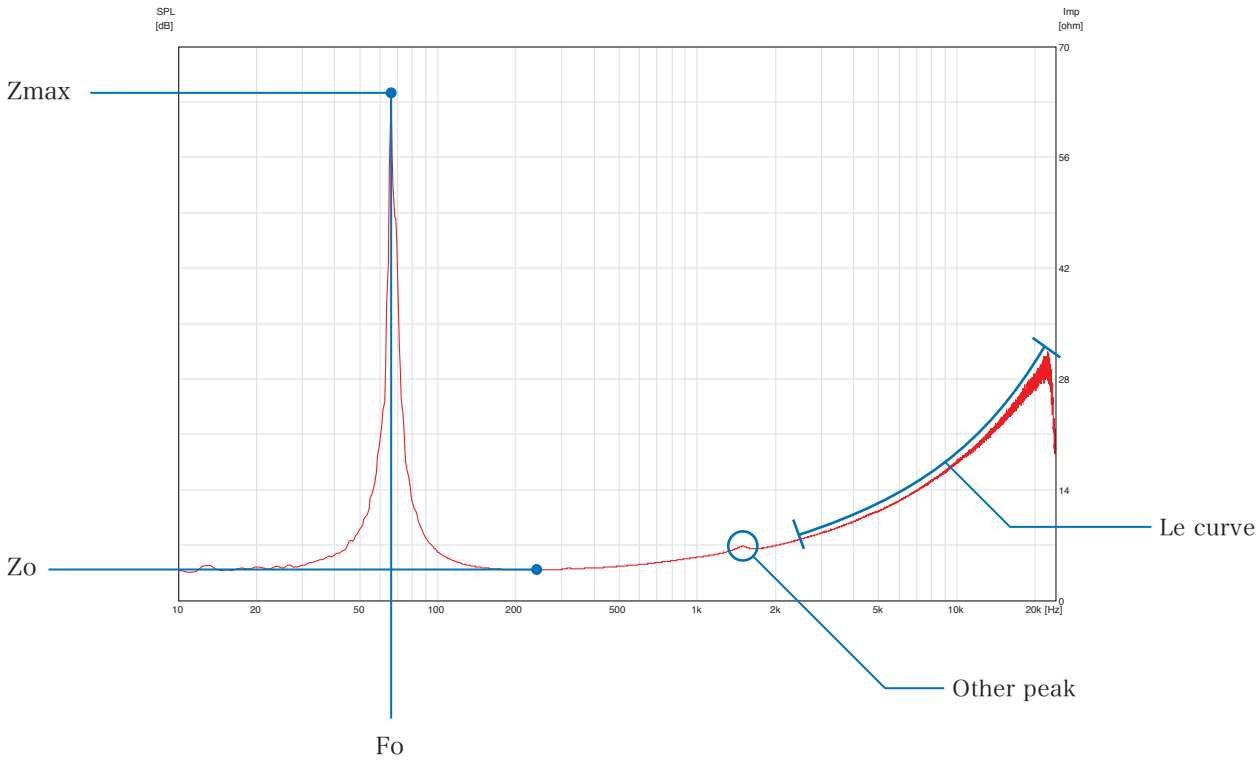
Impedance characteristic (frequency characteristic)

1. Impedance

●Impedance characteristic (impedance frequency characteristic) is a measure of opposition to electric current propagation of a speaker. The graph shows the changes of the impedance in the frequencies. Generally, the graph plots the frequency (Hz) along an x-axis and the speaker impedance (Ω) up a y-axis.

●There are 2 impedance measurements; the fundamental characteristic of the speaker and the characteristic after the installation (in an enclosure or a vehicle).

●A resonance peak occurs when resistance arose by the back electromotive force caused by the speaker's resonance. General cone speaker characteristic shows a large peak in the low frequency band, flat characteristic in the middle frequency band, and high impedance value in the high frequency band. Other small peaks on the graph suggest the resonance caused by its fundamental characteristic of the speaker or by the installation.



Fo

In the fundamental frequency characteristic of the cone speaker, the largest peak which occurs in low frequency is called the lowest frequency characteristic F0 (Hz), and it is the minimum reproduction capacity of the speaker. The smaller the frequency becomes than F0, the lower the sound. In dome speaker characteristic, gentle lower peak would occur.

Zmax(Ω)

The peak of the impedance of F0 is called Zmax (Ω). Speakers with larger Zmax have better control of driving and damping.

It is possible to confirm speaker's capacity and reproduction frequency band by the measurements of F0 and Zmax.

Zo

In higher reproduction frequency band than F0 (on the flat part in higher frequency band than F0), the smallest value of the impedance is called Nominal impedance (Ω). When actual measurement value is way smaller than the value on catalog, it puts more loads to amplifier.

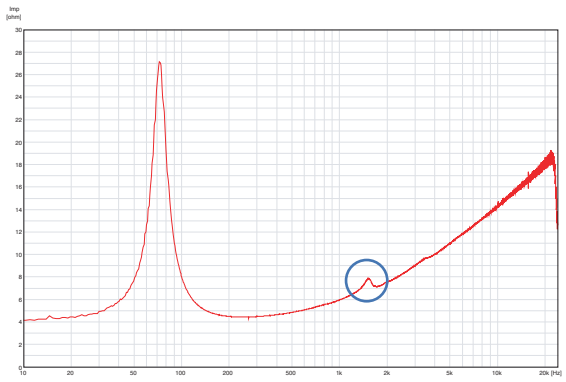
Le curve

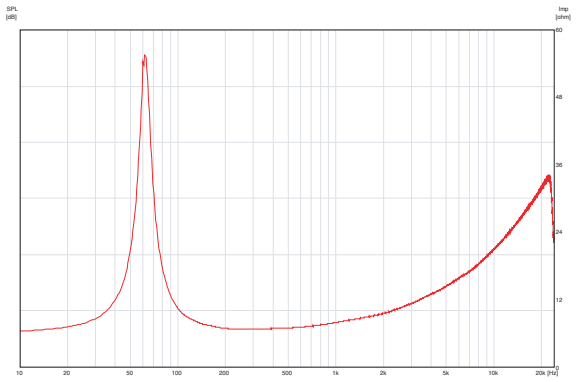
In high frequency band, the impedance becomes large along with the frequency by voice coil's reactance. The larger the impedance is, the lower the electric current flow. Therefore, the volume of the sound is low.

Other peak

General cone speaker has the frequency band where the volume of the sound becomes low by the interference of the cone and the surround in middle frequency band. There will be a little peak on the impedance characteristic in this band. Also, there may be a little peak in the resonant high frequency band.

*Those little peaks cannot be seen in BEWITH speakers which employ the off-centered P.P.C. cone.

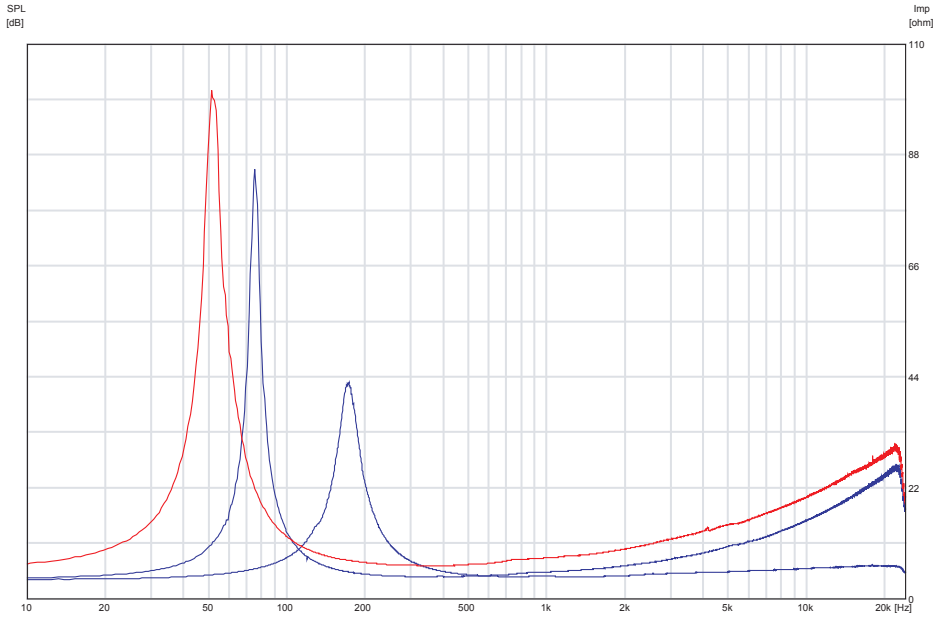




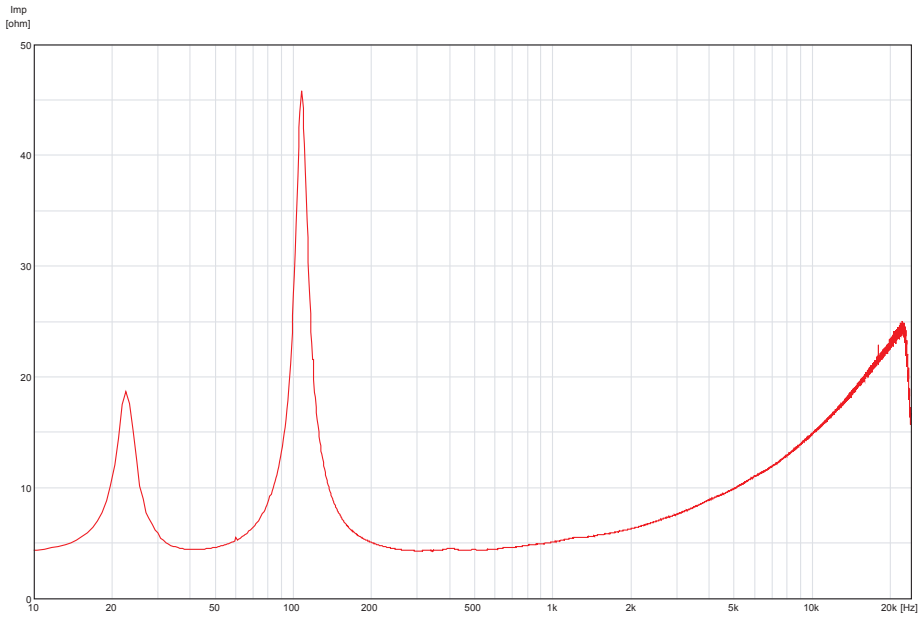
2. How to read the impedance curve and its application.

2-1. Example of impedance curves

- BEWITH ConfidenceII Surise

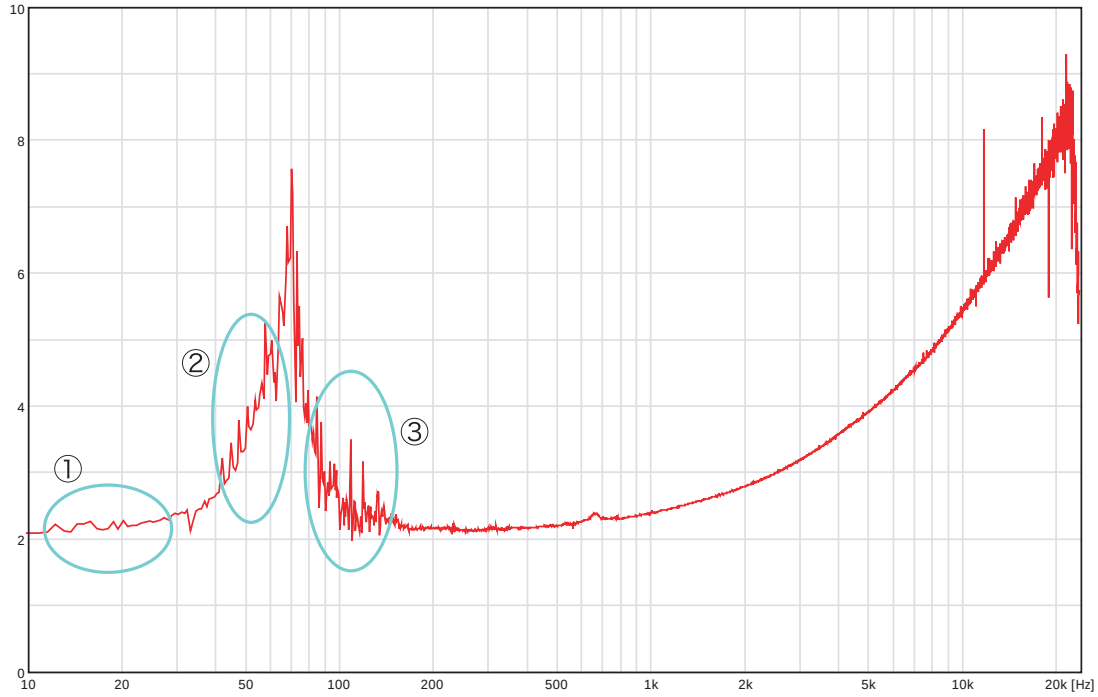


- The impedance curve with using bass-reflex enclosure.



2-2. Diagnosis and solution of the impedance curve

■ Door deadening and installation of the baffle board



①Distortion of the impedance curve caused by the resonance of outer door.

→ Suppress and control the vibration of the outer door caused by the direct back pressure of the speaker. It is effective to apply sound absorption material.

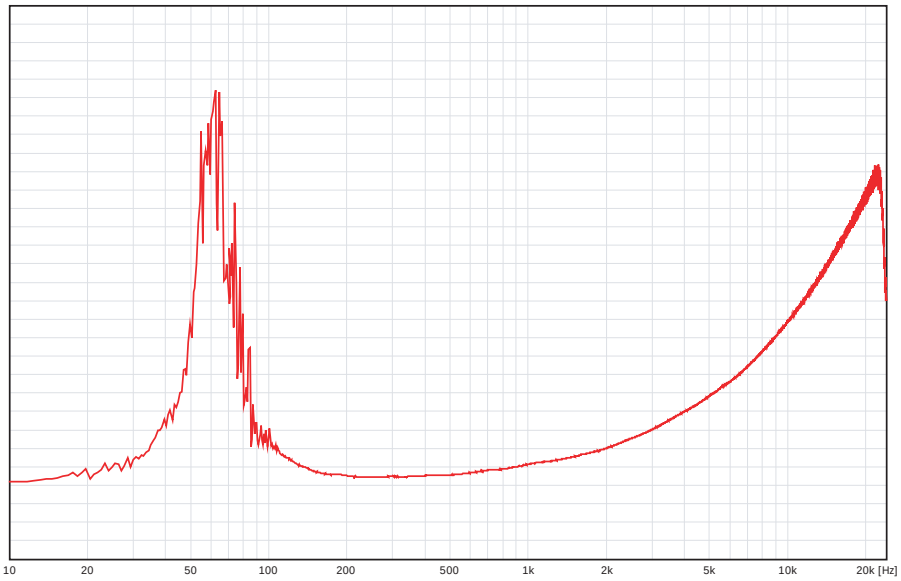
②Distortion of the impedance curve caused by the resonance of the door trim.

→ Suppress and control the vibration of the door trim, behind the door pocket, and around the speakers. It is effective to apply urethane or felt sheets between the door trim and steel frame.

③Distortion of the impedance curve caused by muffling the sound in the back of the speaker

→ Trim off the corner of the back of the baffle board to release the back pressure smoothly. Loose installation of the baffle board may also cause the distortion.

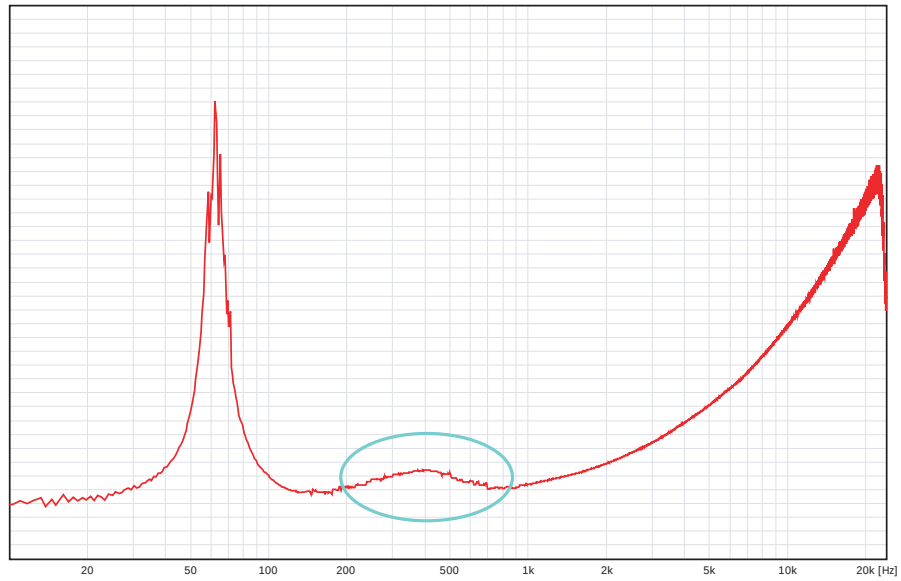
■ Example of the characteristic with using sealed enclosure ①



→ The rigidity of the enclosure is not enough.

→ Reconsider the material, structure, and reinforcement of the enclosure.

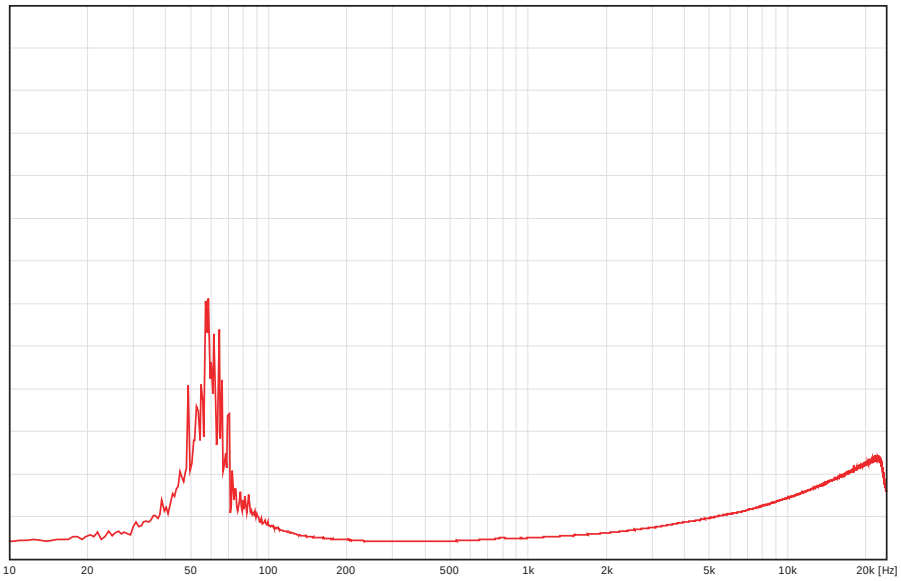
■ Example of the characteristic with using sealed enclosure ②



→ Shape of the enclosure is inappropriate. Standing wave occurs when the shape of the enclosure is too long horizontally or vertically.

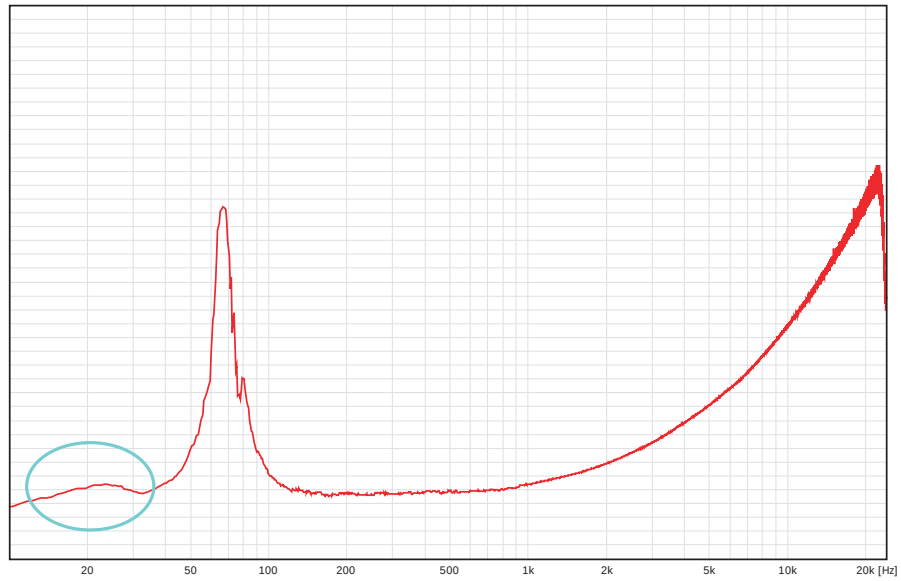
→ Reconsider the shape of the enclosure.

■ Example of the characteristic with using sealed enclosure ③



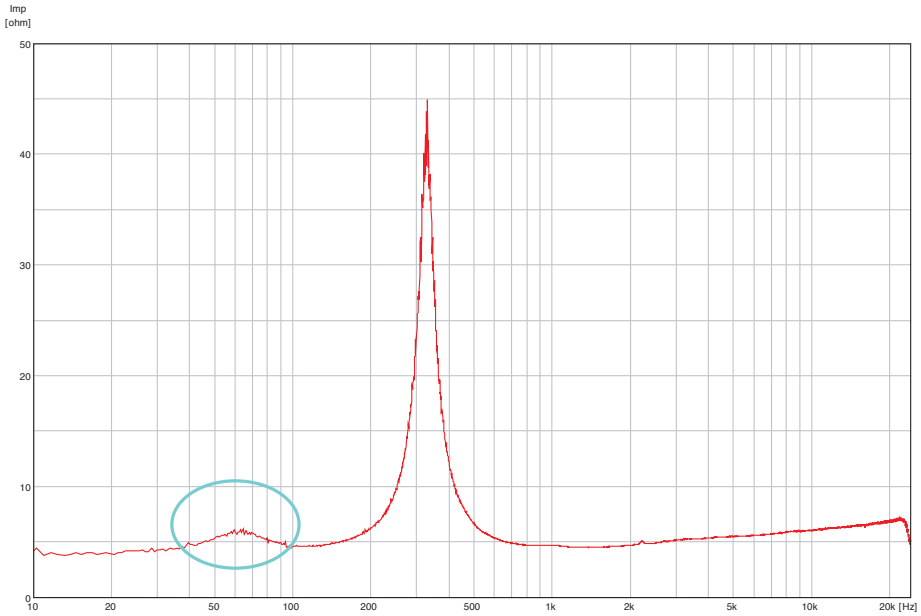
→ Less rigidity and inappropriate shape of the enclosure.
The impedance curve like this occurs when the enclosure is too deep and tapered.

■ Example of the characteristic with using sealed enclosure ④



→ Air leakage occurs from the gap of the enclosure.
→ Seal the enclosure and reinforce the installation of the speaker.

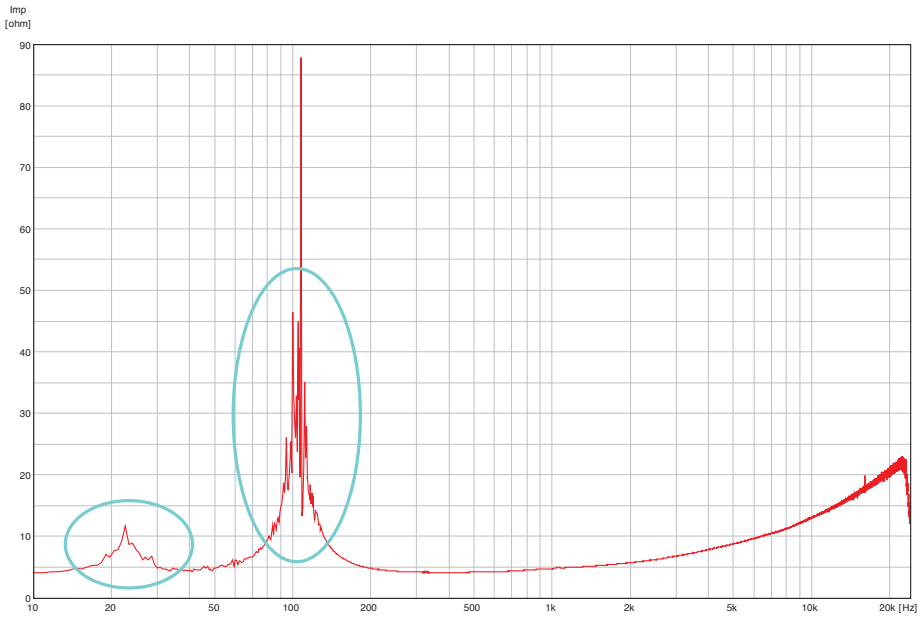
■ Example of the characteristic with using bass-reflex enclosure ①



→ The rigidity of the enclosure is not enough. The port doesn't fulfill the role because the speaker is not able to perform enough either.

→ Reconsider the material, structure, and reinforcement of the enclosure.

■ Example of the characteristic with using bass-reflex enclosure ②



→ The port is installed loose and the flared processing is not enough.

→ Fix the port tight and make enough flare on the port.

3. Fo

3-1. Xover points for TW, MW, and SW

Inputting too much low frequency sound to TW may cause damage to speaker. It is necessary to carefully determine the Xover point for TW, especially when connecting processors or channel dividers. An appropriate frequency can be determined by measuring tweeter's F0. Tweeter's hi-pass Xover frequency should be more than twice the F0.

With BEWITH speakers

- F0 of TW : about 200 to 300 Hz (with enclosure)
- Recommended Xover point : more than 800 Hz

Recommended Xover point for TW is more than a double of F0.

- F0 of MW : about 70 Hz
- Recommended Xover point : 40 or 63 Hz

Recommended Xover point (high pass) for MW is 10 to 20 Hz lower than F0.

- F0 of SW : about 50 Hz
- Recommended Xover point : 10 to 20 Hz

Recommended Xover point (high pass) for SW is 10 to 20 Hz.

3-2. Relation between F0 and the enclosure capacity

Speaker *	Capacities (ℓ)	Fo	Duct length (cm)	The inside diameter of the duct (mm)	Duct Fo	X-over frequency (Hz)	
						High pass	Low pass
C-130II A-130II	2.5	120Hz	22	25mmϕ	30Hz	50·63Hz	MW high pass (800Hz)
	3.0	110Hz	23		26Hz	40·50Hz	
	3.5	106Hz	24		24Hz	40·50Hz	
	4.0	100Hz	24		22Hz	40·50Hz	

Speaker *	Capacities (ℓ)	Fo	Duct length (cm)	The inside diameter of the duct (mm)	Duct Fo	X-over frequency (Hz)	
						High pass	Low pass
C-180II A-180	20	70Hz	22	40mmϕ	20Hz		MW high pass
	25	65Hz	23		19Hz		
	30	60Hz	23		17Hz		

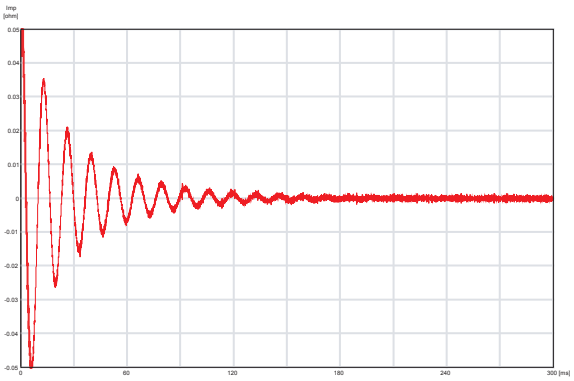
Impedance characteristic (Time waveform)

1. Definition of Time waveform

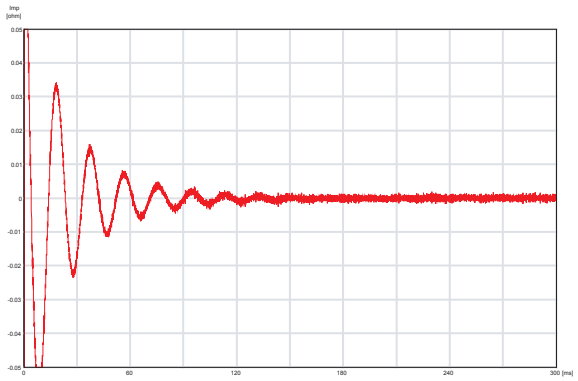
Time domain (time waveform) of the speaker impedance plots time along an x-axis and impedance up a y-axis, and displays response speed. Up and down movement of the waveform shows cone movement from start until the end. You can compare fundamental characteristic of the speaker and the characteristic of the installed speaker, and also confirm the condition of the enclosure and door.

Response speed of the speaker and the condition after the installation can be confirmed.

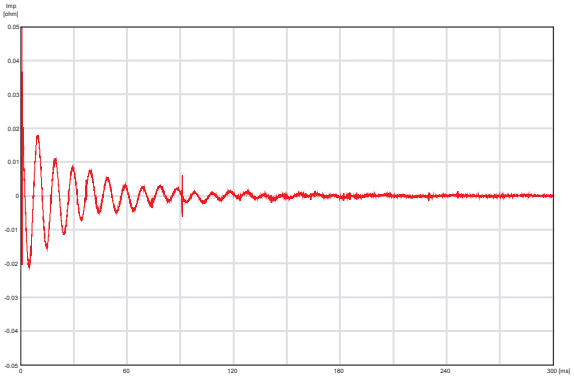
■ C-130II Sunrise (fundamental characteristic)



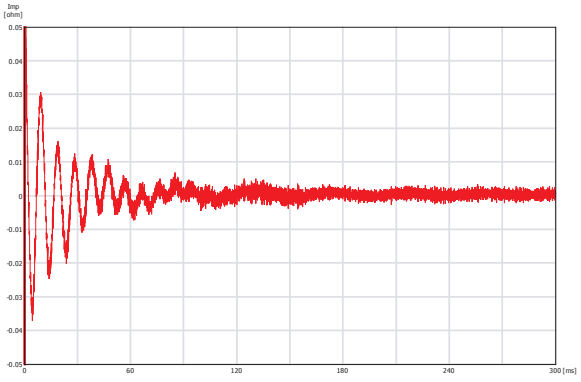
■ C-180II Sunrise (fundamental characteristic)



■ Installed in an enclosure



■ Example of inappropriate installation



There are many kind of speakers designed di?erently. Some speakers are designed to respond excessively, some speakers are designed to rather keep the balance of the cone and the magnetic circuit than obtain better time characteristic. Though the time waveform displays tiny vibration, it is very important for reproducing small signal.

Car audio debase after the installation as time goes by. It could be from any causes like a ba?e board becomes old and car itself becomes rusty. According to the result of this measurement, you can confirm whether there is any problems on the system or not, and take measures to it. It is useful for sales promotion because taking measures leads to re-installation of the system or sales of new products.

FFT（Fast Fourier Transform）

1. FFT

●FFT analysis displays sound pressure level (dB) in every frequency. For test signal, use pink noise that has equal energy in all octaves, or steady sound of certain frequency band.

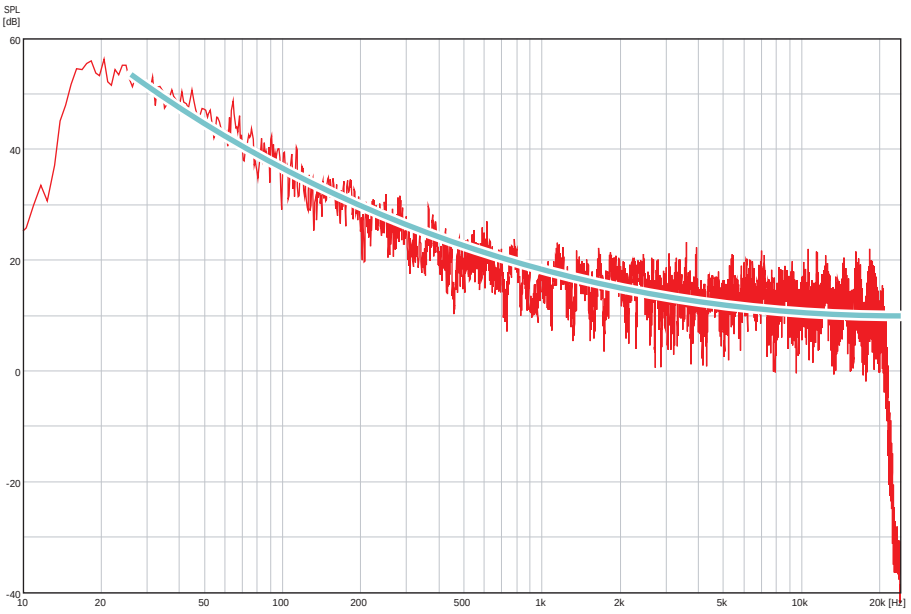
●Measure characteristic of vehicle when adjusting the sound finally after the installation. Confirm peaks and dips which occur in a certain frequency, find out the cause of them, and take measures. Finally, use equalizer to correct and adjust each frequency band.

Necessary adjustment points can be confirmed from the peaks and dips.

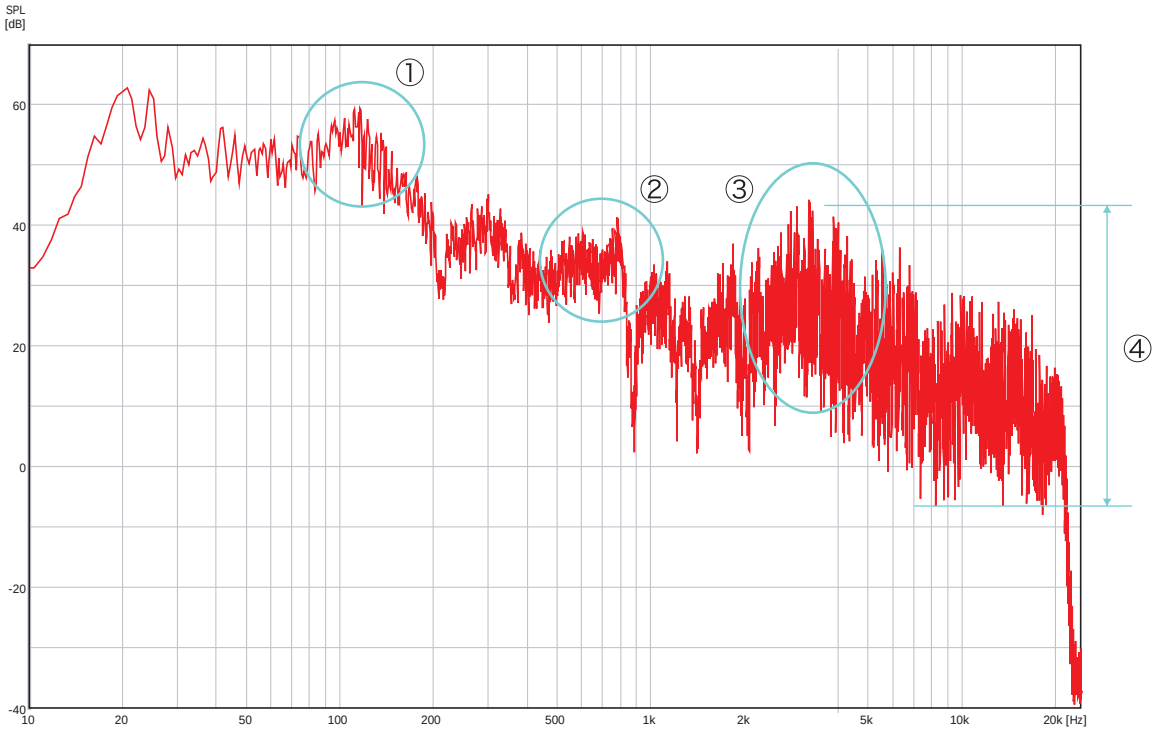
2. How to read FFT waveform and its application

2-1. Ideal FFT waveform

Sound pressure of the pink noise for the adjustment falls off at 3dB per octave, and it falls off 30dB in 10 octaves between 20 Hz to 20 kHz. In short, the line connected from 20 Hz to 20 kHz at -30dB becomes flat mechanically. Because, however, human ear has the characteristic that is easy to hear the middle range, the line of -30db which arches a little is the flat line for human ear.



2-2. FFT waveform of the general vehicle



①This peak occurs peculiarly inside the sealed vehicle. It shifts to the lower frequency band with large-size vehicle, and shifts to the higher frequency band with small-size vehicle. Because this peak influences the whole band, tuning begins with controlling it.

②This peak is caused by the shape of the vehicle. It shifts to the higher frequency band with small-size vehicle.

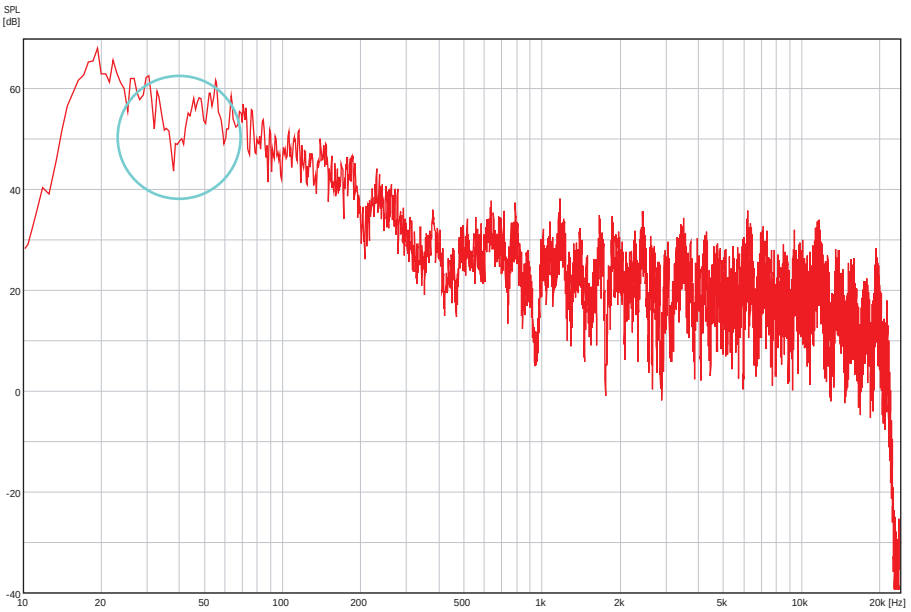
③This peak is caused by sound reflection from the dashboard, windshield, and windows. Control it to suppress unpleasant sound.

④Precise tuning from the low frequency band is effective to the resonance of the high frequency band. The condition of the entire air inside the vehicle is smooth when the resonance width is narrow.

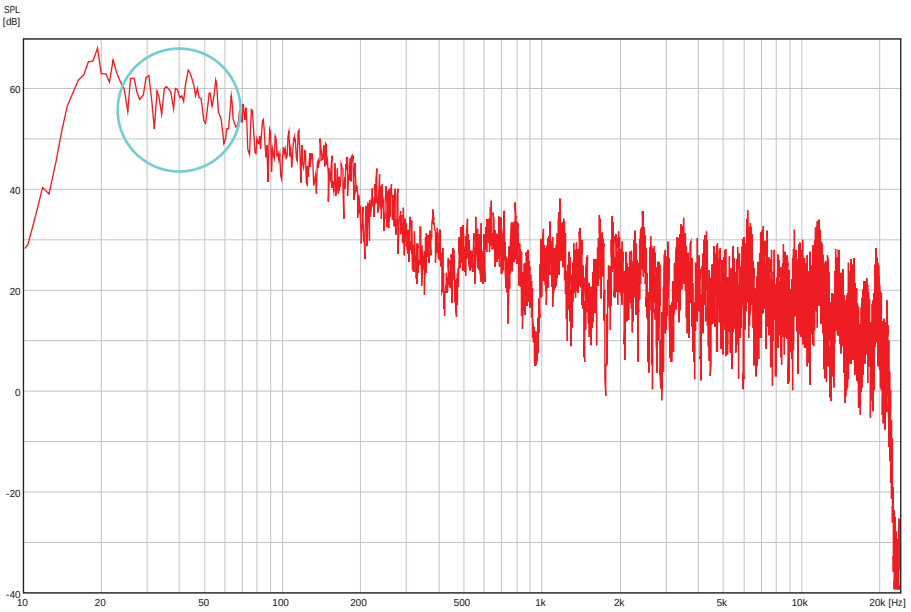
2-3. Confirming phase of the SW by FFT waveform

Confirm the phase of SW before equalizer adjustment. When a dip occurs around the Xover point (40 Hz) as shown in the graph, reverse the phase of the SW by 180°. If the dip becomes larger than before the phase is reversed, reverse the phase back again.

* When changing Xover slope of the SW, the phase is also changed. It is necessary to check the phase every time you change the slope.



It achieves the smooth line by adjusting the phase to control the dip.



Transmission frequency characteristic

1. Transmission frequency characteristic

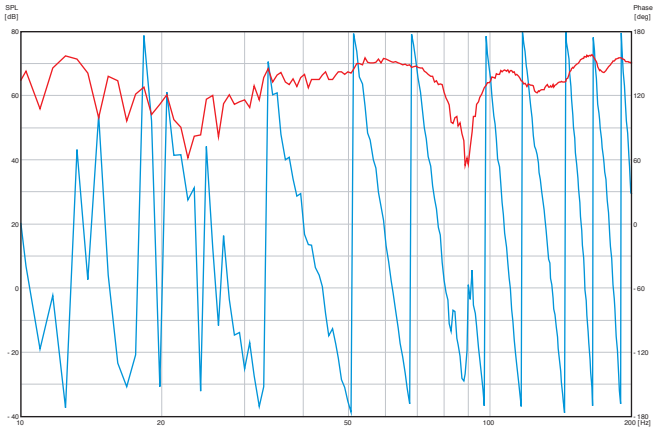
Transmission frequency characteristic is the characteristic of the sound pressure level inside the vehicle. Graph plots the frequency along an x-axis and the sound pressure up a y-axis. It also measures the phase characteristic simultaneously. SIEG generates the pink noise and then the car audio system which consists of amplifiers and speakers reproduces it. And SIEG analyzes the sound pressure level and phase of the sound reached to the measuring point in every frequency. Even though the frequency and amplitude of the sound is the same, the sound is not the same when there are phase lags. When distance from the sound source to microphone becomes long, the slope of the phase characteristic becomes steep. The distance from the sound source obtained from the measurement result can be displayed in the column of the time alignment on SIEG.

This measurement provides you the data such as the electric characteristic of each equipments and wirings, individual difference of the speaker, and all the acoustic characteristics in the vehicle. It may not be able to measure when connecting processors including Mirror Station. In this case, take out the processor from the audio system and measure.

To understand the electrical phase lag of each equipment and the phase distortion caused by the installation angle of the speakers, reproduce each speaker separately and measure them at the front. Inappropriate installation angle of the speakers causes distortion on the phase characteristic.

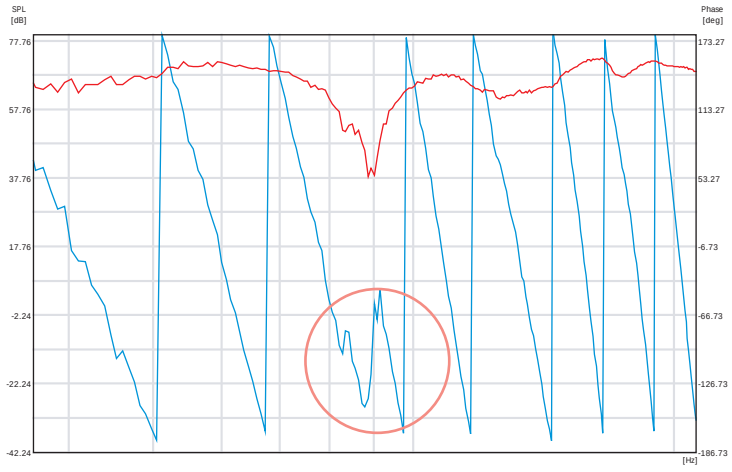
In any case, consider a course of the sound which radiated from the speakers, and install to make good use of the speakers' directivity and response. And it prevents unnecessary sound interference caused by diffraction and reflection. Because BEWITH speakers can control the
directivity, it is easy to install by the image of the radiation of the sound.

The phase measurement is useful for
confirming the phase and time alignment.

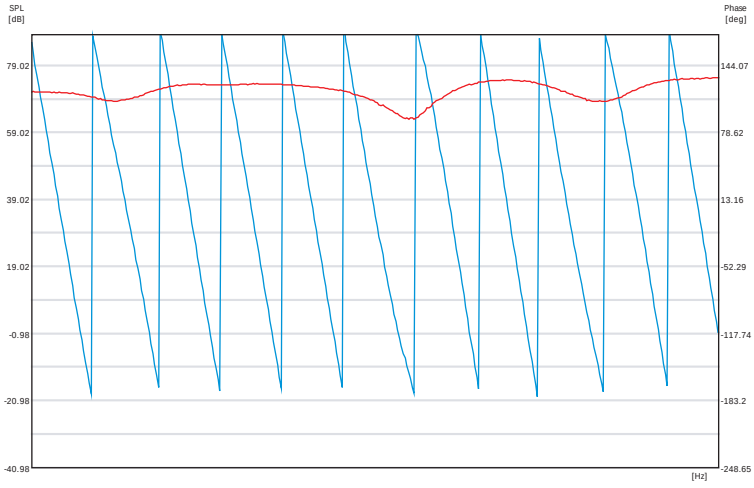


1. Measurement example of TW (C-50)

The distance from each speaker can be measured by measuring the arrival time from the sound source to the microphone. Measuring the difference of the distance between the main speaker (the closest speaker to an ear) and other speakers is useful for time alignment adjustment.



→ The phase is twisted by diffraction caused by the inappropriate installation angle of speaker. The graph also shows that the twisted phase influences the frequencycharacteristic.

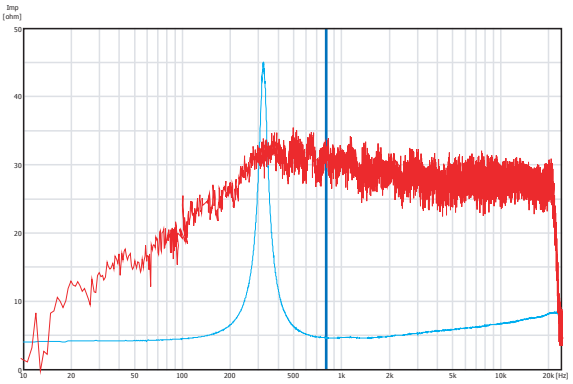


→ The phase is corrected by reconsidering the installation angle of the speaker. It also adjusts the frequency characteristic.

The distance from each speaker can be measured by measuring the arrival time from the sound source to the microphone. Measuring the difference of the distance between the main speaker (the closest speaker to an ear) and other speakers is useful for time alignment adjustment.

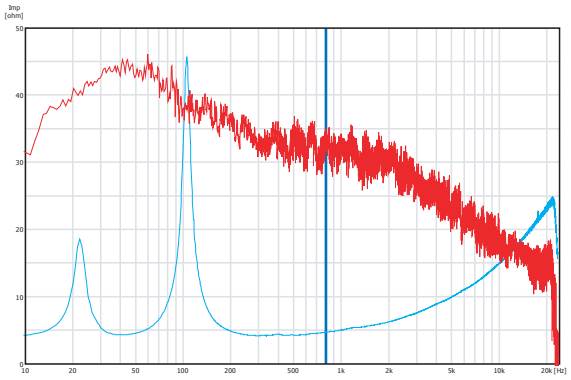
2. BEWITH Speaker (AccurateII)

- A-50II tweeter (installed in G-50 enclosure)



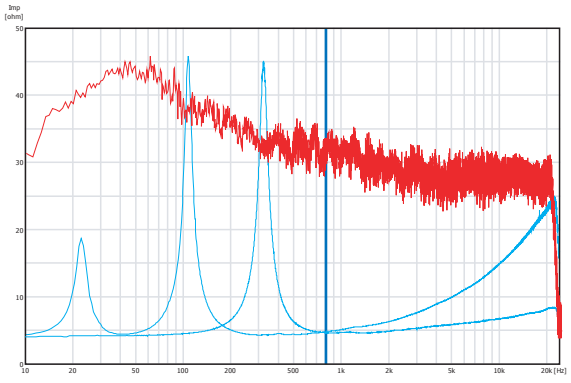
High F0 shows high potential of this tweeter. It has wide frequency range and stable reproduction up to 20kHz.

- A-130II mid-range woofer (installed in a 3.2 liter bass reflex (ported) enclosure)



It reproduces lower frequency range by being installed in the enclosure. Its impedance at the cross point is 4Ω and stable. It can be connected to the tweeter's cross point smoothly.

- A-50II + A-130II + A-NW 2-way system

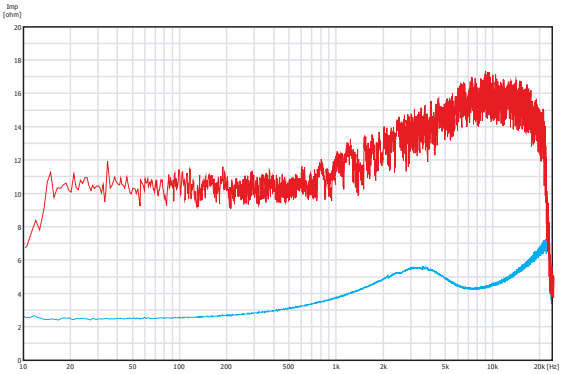


The impedance in the frequency range is always 4Ω and smooth frequency response is achieved in wide range.

Speaker unit analysis and usage by impedance measurement

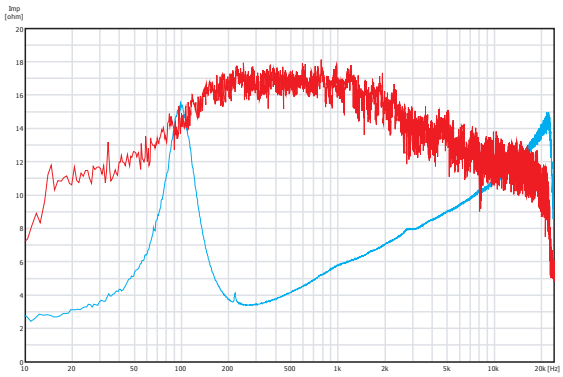
1. General speaker

- General dome tweeter



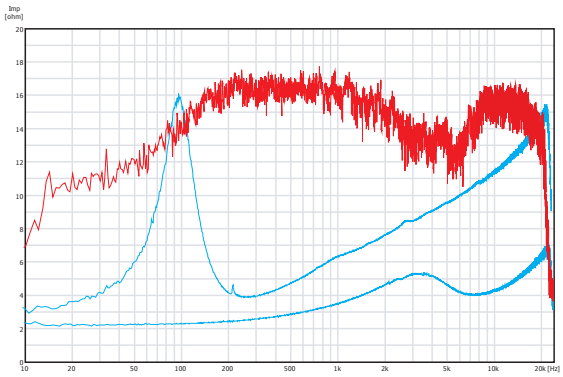
F0 (the lowest resonance frequency) of the dome tweeter with an internal magnet becomes gentle due to lower magnetic force. F0 of the speaker unit shown on the left is 3.5kHz., so that the cross point is determined to be over 7kHz.

- General 16cm cone mid-range woofer



F0 of the 16cm mid-range woofer would be in between 50 to 120Hz.Impedance of the speaker unit shown on the left is 4Ω and it rises toward higher frequency.Therefore the frequency range declines in the higher frequency.

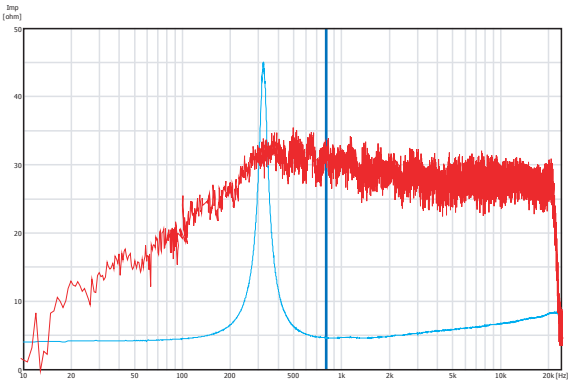
- General 16(13) cm 2-way speaker system



The impedances of tweeter and mid-range woofer at cross point are very different and the connection between those two speakers is not appropriate.Adding 5 to 10cm squawker to the 2-way system and making a 3-way system is common way to solve this matter.

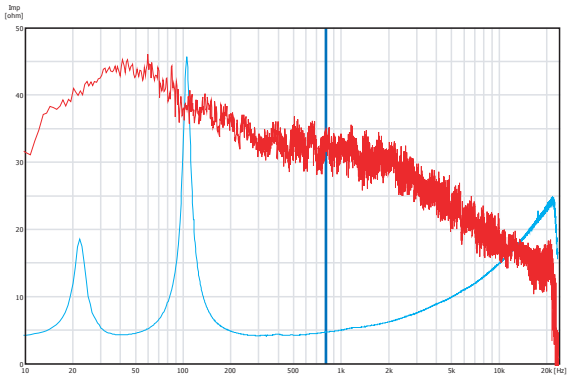
2. BEWITH Speaker (AccurateII)

- A-50II tweeter (installed in G-50 enclosure)



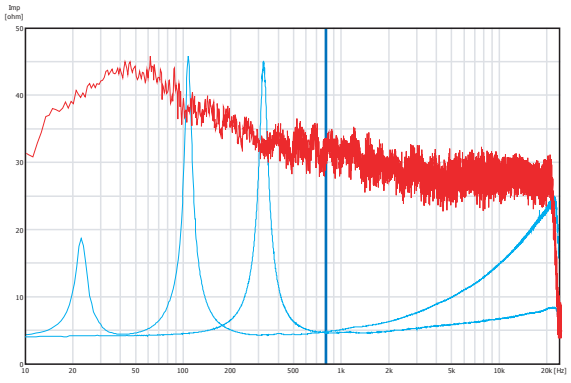
High F0 shows high potential of this tweeter. It has wide frequency range and stable reproduction up to 20kHz.

- A-130II mid-range woofer (installed in a 3.2 liter bass reflex (ported) enclosure)



It reproduces lower frequency range by being installed in the enclosure. Its impedance at the cross point is 4Ω and stable. It can be connected to the tweeter's cross point smoothly.

- A-50II + A-130II + A-NW 2-way system



The impedance in the frequency range is always 4Ω and smooth frequency response is achieved in wide range.