Technical Notes Volume I, Number 19

Sub-Bass Systems Using Triple Chamber Bandpass™ (TCB) Technology:

1. Introduction:

Most users of JBL products have a basic knowledge of how a simple ported low-frequency system works. The details are shown in Figures 1A and 1B. When the low-frequency driver is operated in the region of box tuning, the amplitude of cone motion is reduced, and air velocity in the port increases. What is happening is simply that the "air spring" in the box is in resonance with the "air mass" in the port. The overall output of the system is the sum of port radiation and cone radiation, and the precise adjustment of driver to box volume and tuning frequency establishes what is known as an *alignment*.

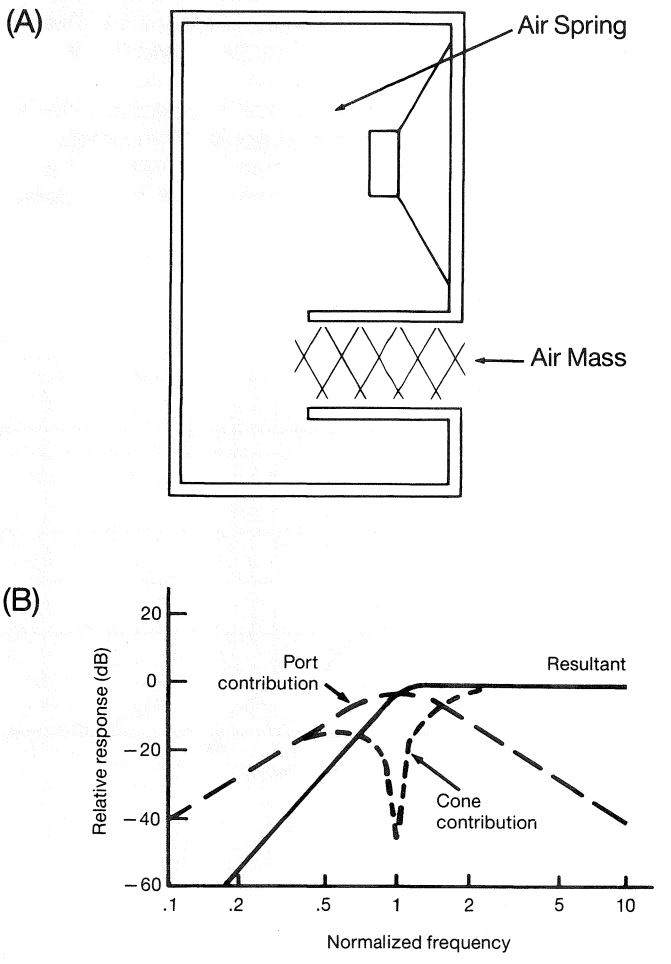
Since the tuning is normally set in the 30 to 50 Hz region, the excursion requirements of the transducer are considerably reduced, and substantial output at the port tuning frequency can be realized with very low distortion. However, at higher frequencies, the contribution from the port is minimal and the output is essentially from the cone.

The TCB design makes use of two tunings. One of these is at the low frequency limit of the intended bandpass range, and the other is at the high frequency limit. There are, thus, two frequency ranges over which enclosure tunings help to reduce distortion by minimizing cone motion. All acoustical output from the system is by way of its port openings, which act effectively as acoustic low-pass filters and further reduce distortion. Dual transducers are used in a "push-push" arrangement which reduces mechanical stresses and minimizes third harmonic distortion through cancellation of nonlinearities.

Because of the complexity of coupled system design, JBL engineers have developed a computer program which optimizes the performance of each TCB design, producing the required volume and tunings needed for a given transducer type and bandpass requirement.

Figure 1. Operation of the basic ported system. Enclosure with driver is shown at A; port and cone output sum to produce extended bass response with reduced distortion in the region of port tuning, as shown at B.

Figure 1

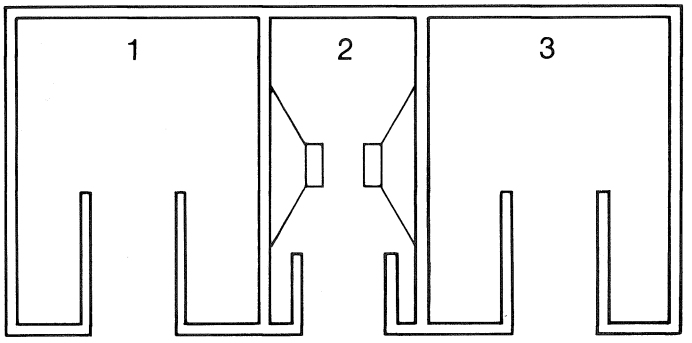


2. Details of the TCB system:

Figure 2 shows a section view of the basic TCB enclosure. Chambers 1 and 3 are identical and are tuned to the lower bandpass frequency, f_1. Since the transducers are wired so that their motions are in push-push the net output of the two low frequency ports is in phase.

Chamber 2 is tuned to the upper bandpass frequency, f_2, and the push-push motion of the transducers produces high air velocity at the single port.

Figure 2



At both extremes of the bandpass of the system, cone motion is minimized, as shown in Figure 3A. The total output is the sum of all port outputs, and this is shown in Figure 3B. Steep rolloffs are apparent above and below the upper and lower cutoff frequencies, due to polarity relationships at the port outputs. With careful adjustment of all driver and enclosure parameters, it is possible to tailor very smooth response over the targeted bandpass range.

Figure 3 (A)

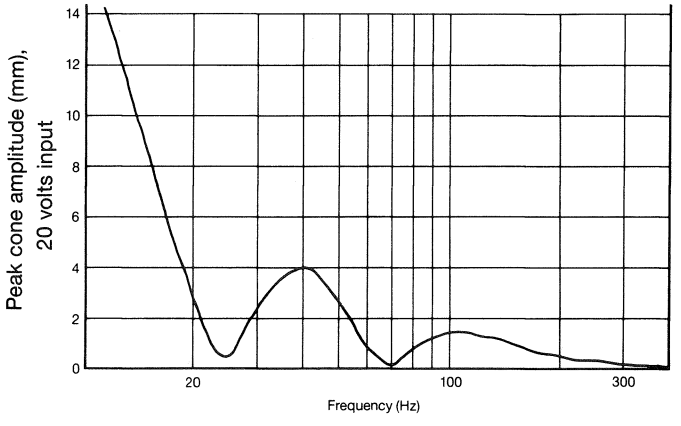
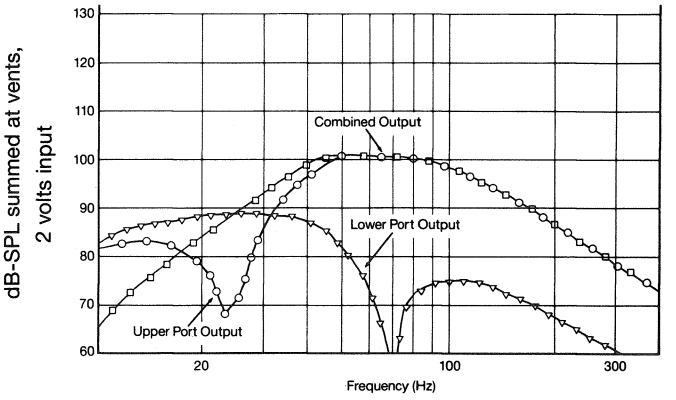


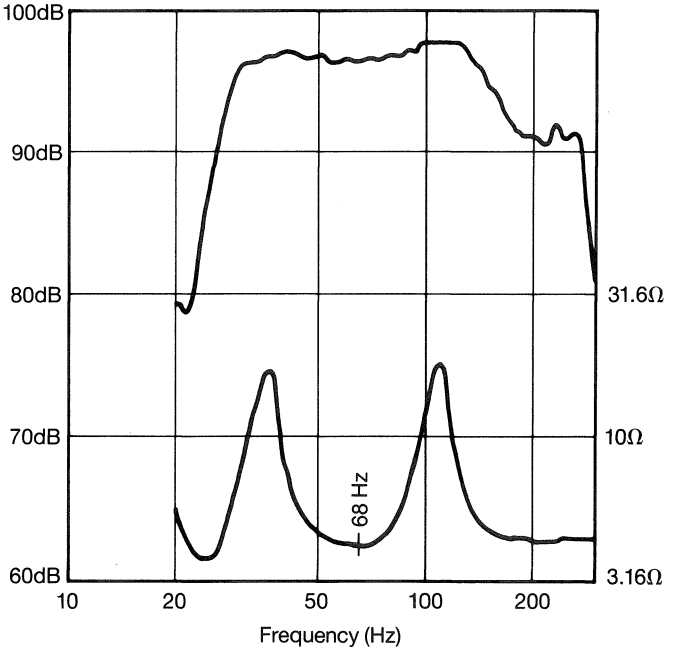
Figure 3 (B)



Typical measured bandpass output and electrical impedance of the dual 460 mm (18 inch) TCB system is shown in Figure 4. Note that the impedance minimums take place at the upper and lower tuning frequencies of the system.

Figure 4

Dual 460 mm (18 inch) TCB
2 volts input
measured at 1 meter,
2π loading



3. Advantages of TCB technology:

A. High acoustical output capability:

Since cone excursion is minimized over a large part of the operating frequency range of the system, very high sound pressure levels can be attained. The use of two transducers in the system provides twice the input power handling capability of a single transducer system.

B. Low distortion:

Three effects contribute to the very low distortion performance of the system: minimized cone motion, acoustical lowpass filtering through the port openings, and push-push operation of the two transducers. Generous port dimensions virtually eliminate air turbulence, even at the highest operating levels.

C. Smooth Response:

The proper choice of driver and transducer parameters produces a near ideal bandpass characteristic with steep slopes in the stop-band regions. Colorations normally associated with the upper end response of transducers used in single-tuned systems are effectively eliminated through the acoustical filtering action of the ports.

D. High performance in a compact size:

The TCB system optimizes output capability and extended low-frequency response for the size of the system. No other arrangement of two drivers in a single system of the same size will produce more output over the same frequency range. The largest of these systems operates well down in the frequency range of 20 to 25 Hz, making it ideal for subwoofer application in motion picture theaters. The efficiencies of these systems remain about the same as the midband efficiency of the drivers which are used in them; however, the TCB design exhibits this efficiency at much lower frequencies than do normal ported systems.

4. JBL TCB Subwoofer Models:

In addition to the large TCB systems, there are two smaller TCB models which complement various models in the Control Series. The SB-1 is a small TCB system which is designed to complement the Control 1 and Control 1 Plus by providing an added bandpass from 50 to 200 Hz. The SB-5 is designed to complement the Control 5 or two pairs of Control 1's or Control 1 Plus's, by adding a complementary bandpass from 45 to 175 Hz. The low frequency extension provided by these TCB units enhances greatly the use of the Control 1 and Control 5 in near-field monitoring and music synthesis applications.

5. Placement of TCB Subwoofers

The same rules apply to TCB systems that apply to other subwoofer systems. The frequency response curves shown in this Technical Note were all made in half space, that is, with the system flush mounted in a large ground plane facing upward. This is a standard mounting condition for measurements, and it corresponds to many field applications where the subwoofers are positioned next to a single large reflecting surface. System response will be flattest when this mounting condition is met. If the subwoofers are flown, there will be relatively less low-frequency output. If the subwoofers are placed at the intersection of a wall and the floor, there will be relatively greater low-frequency output. As with standard ported subwoofer systems, use in multiples will result in increased low-frequency output, due to mutual coupling between the units.

6. Polarity of TCB Subwoofers

Because of the triple chamber design of these new subwoofers, the phase response varies in a complex way. JBL recommends that the TCB's be sharply low-pass filtered so that the overlap between them and the adjacent low-frequency systems is minimized. Some users may wish to use the TCB subwoofers with standard subwoofers. In this case it is important to pick the polarity of the TCB's which best complements the other subwoofers. This correct poling of the systems can be done by ear, or with instrumentation, and in many cases the best response will be when the TCB's are connected in opposite polarity relative to the standard low-frequency systems.

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