TI-330
Cardioid Subwoofer Array - CSA
(CSA function within the d&b D12 amplifier)

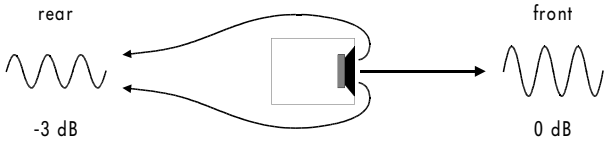
d&b audiotechnik®

1. Introduction

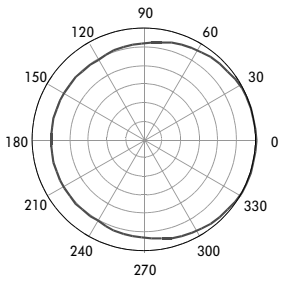
CSA enables the combination of three or a multiple of three subwoofer cabinets to an array providing exceptional directivity at low frequencies. It can be applied to either d&b Q-SUB or B2-SUB cabinets, when driven by d&b D12 amplifiers. The Q-SUB and B2-SUB configurations in the D12 provide a selectable CSA function for these applications.

2. Directivity of subwoofer cabinets

To achieve a usefull directivity a sound source has to have at least the dimensions of the wave length it is radiating. Audio frequencies cover a 20 Hz to 20 kHz band which result in wave lengths from 17 m (56 ft) to 1.7 cm (0.7"). The typical operating range of subwoofer cabinets is 35 Hz to 120 Hz, the corresponding wavelength is 10 m (33 ft) to 3 m (10 ft). Therefore the directivity of a subwoofer or subwoofer array of a given size will depend on the frequency. The rejection to the rear for a single cabinet is very small. For a typical 18" subwoofer it is usually about 3 dB at 70 Hz.



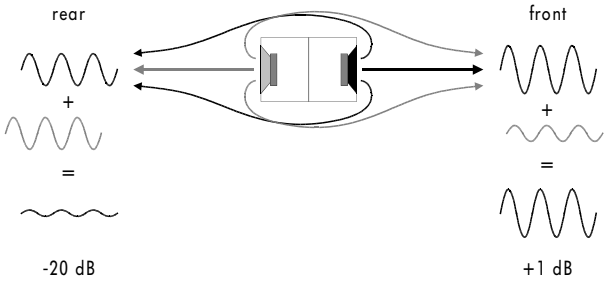
Larger arrays will increase the directivity. A stack of three subwoofers will give about 5 dB rejection, displayed in the polar diagram below.



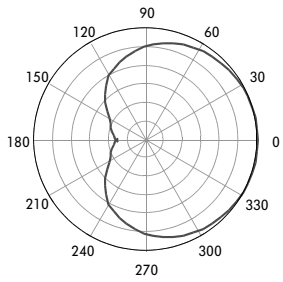
To achieve a useful directivity in both the horizontal and the vertical plane (e.g. to avoid interference by low frequencies behind the system) a very large (wide and high) subwoofer array is required.

3. Cardioid subwoofers

The Cardioid Subwoofer Array is a method of increasing directivity at low frequencies without the need for very large arrays. The principle is the introduction of a second sound source at a defined distance behind the main source which will cancel the sound energy radiated by it to the rear. To work effectively i.e. cancelling the energy at the rear and not at the front, the length of the sound path from the rear source to the front has to be in the magnitude of a quarter of the wavelength to be controlled by the system. To achieve the desired cancellation of the sound phase and level of the rear source, the subwoofers have to be aligned by seperate signal processing and amplification.



The resulting polar diagram shows a cardioid pattern.

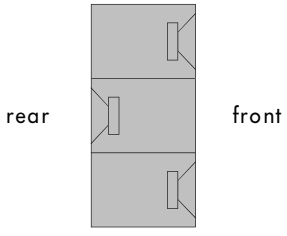


As the wave length varies with frequency and the distance of the sources is constant, this principle will only work for a fraction more than an octave, just enough for the typical bandwidth of a subwoofer. Within this bandwidth there are frequency ranges where a tuning for best cancellation to the rear does not give the maximum possible output to the front. So the overall sensivity to the front of a cardioid arrangement will naturally be lower than with a conventional set up of the same components.

4. Cardioid Subwoofer Array

Common cardioid subwoofer designs employ relatively large cabinets fitted with low drivers and/or ports at the front and rear. d&b has devised a method that uses either Q-SUBs or B2-SUBs in this special set up. This CSA (Cardioid Subwoofer Array) generates an uncompromised cardioid behaviour, which means that there is no need for special cabinets, enabling the use of the systems full efficiency when there are no particular requirements for low frequency directivity.

In its minimum configuration a CSA set up consists of a stack of three subwoofer cabinets. Due to the directivity of the cabinet arrangement only one subwoofer is needed to compensate for the energy of the other two radiating to the front. For reasons of symmetry the cabinet facing to the back should be located in the centre of the column.



The front facing subwoofers can be driven in parallel from one D12 channel, with the rear cabinet being driven by a separate channel with additional filtering (CSA circuit selected on the controller).

The diagrams below show the vertical and horizontal isobar plots of the CSA. It produces a constant directivity with 180° dispersion and a minimum rejection of 15 to 20 dB to the rear.

The phase response to the front of a CSA is almost identical to a standard set up so the crossover settings to the top cabinets will still work in the same way.

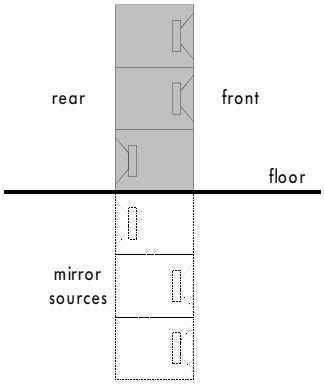
The contribution of the reversed subwoofer cabinet to the front radiated sound is only significant at very low frequencies (approx. +2 dB). So compared to a conventional set up the tonal balance of the CSA will be slightly shifted towards lower frequencies. Depending on the application this may be compensated for by selecting the higher crossover frequency on the subwoofer controllers.

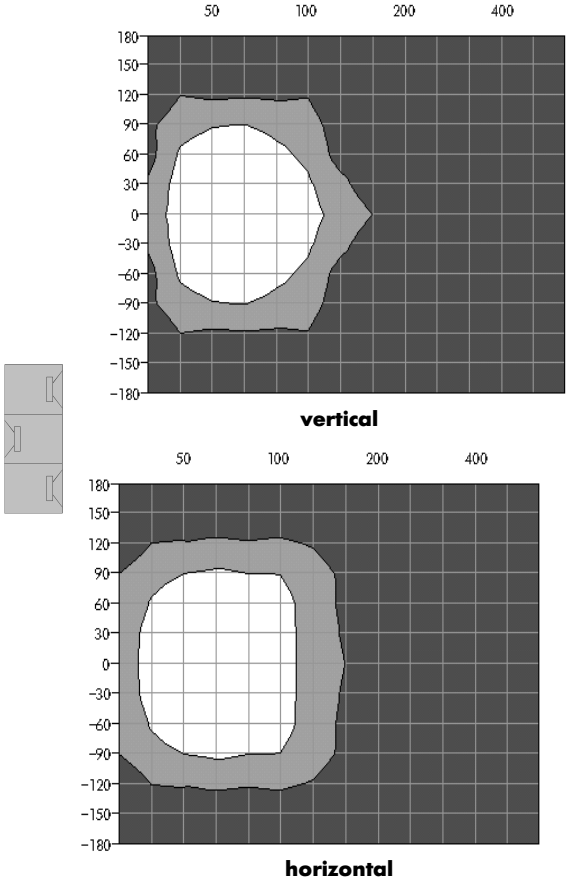
Q-SUB: standard = 130 Hz instead of 100 Hz.
B2-SUB: standard = 100 Hz instead of INFRA (70 Hz).

5. System configuration

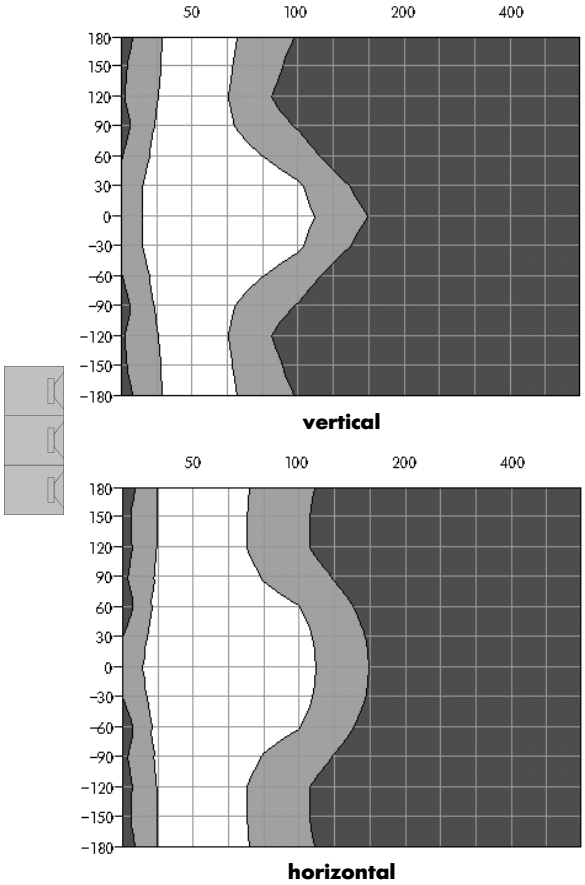
To achieve the best rejection to the rear the mechanical set up of the system has to be very accurate. With Q-SUB systems, use the runners and recesses in the cabinet top and bottom panels to align the cabinets. All amplifiers driving the subwoofers have to be set to the same input gain and fed with the same input signal. Only the D12 channel driving the rear subwoofer has to be set to CSA. All other parameters of the amplifier channels have to be configured identically, including delay and equalisation if used.

If the array is stacked directly on the ground which reflects low frequencies, also with the lowest cabinet rotated symmetry is achieved.





Dispersion characteristics of a CSA of Q-SUBs. Isobars for -6 dB and -12 dB versus frequency (x) and angle (y).



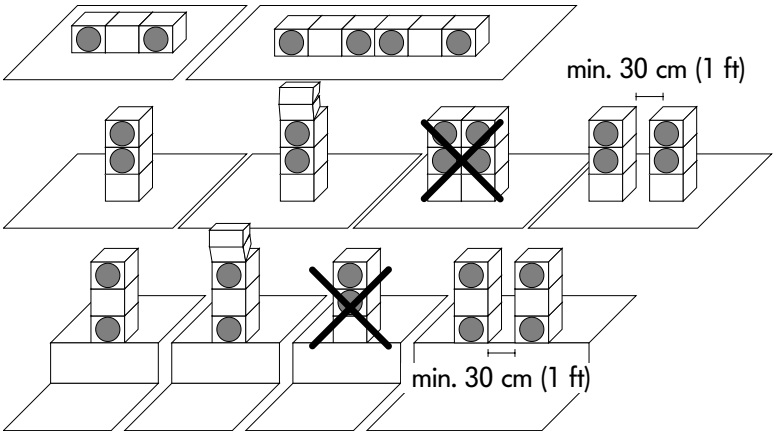
Isobar plots of a conventional 3 high array

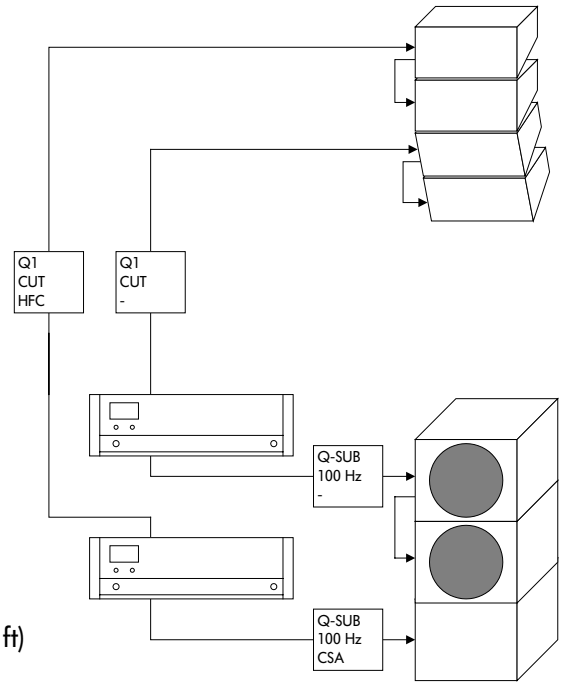
The CSA will also work in other mechanical configurations provided the effective pathlength from rear to front drivers is identical. For example when the subwoofer cabinets are arrayed horizontally on the floor, vertical and horizontal directivity is provided without the need for high sub columns.

Q-SUB configurations

Possible set ups using the CSA function are shown below (front of house view).

When wiring the system please note that front radiating subwoofers may not be daisy chained with reversed subwoofers. All reversed cabinets have to be driven from D12 channels set to Q-SUB and CSA mode, all others should be driven from channels without CSA selected. The gain and crossover settings (standard/100 Hz) have to be identical.





Q1/Q-SUB CSA wiring example

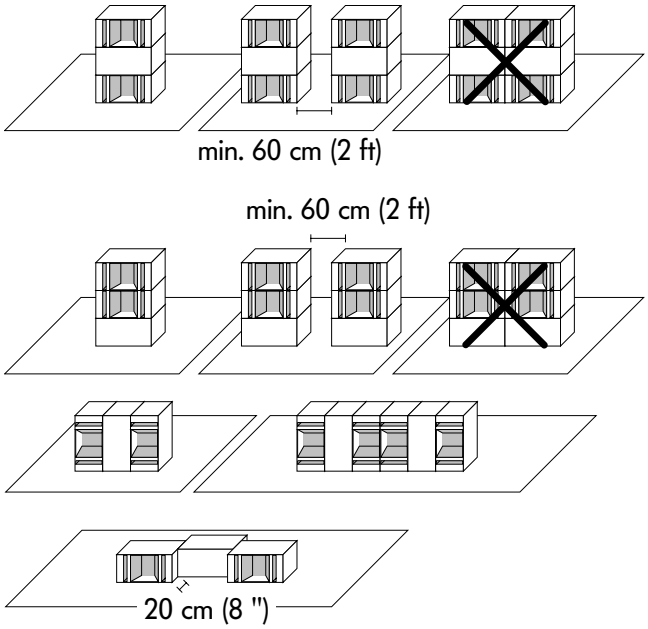
B2-SUB configurations

All reversed cabinets have to be driven from D12 channels set to B2-SUB/INFRA and CSA mode, all others should be driven from channels set to B2-SUB/INFRA configuration without CSA selected.

Please note that when extended bandwidth of a CSA using B2-SUBs is necessary the standard configuration may also be used (i.e. INFRA not selected, e.g. to support a Q1 system without Q-SUBs), raising the crossover frequency from 70 Hz to 100 Hz. The dispersion control above 70 Hz, however, will be less accurate than below.

Mixed configurations

CSA will only work with a single type of subwoofer. Using combinations of B2-SUBs and Q-SUBs within one array will not allow an accurate dispersion control. However, combined systems are possible when the arrays are physically separated, e.g. a CSA of three B2-SUBs on the ground supporting a flown rig of Q1 and Q-SUBs.



d&b audiotechnik

d&b audiotechnik AG, Eugen-Adolff-Str. 134, D-71522 Backnang, Germany, Phone +49-7191-9669-0, Fax +49-7191-95 00 00