



SPORTS/PERFORMANCE VENUES AND VERTICAL ARRAYS

The array configurations discussed below are ideally suited for Basketball Arenas, Gymnasiums, and large multi purpose rooms. Outdoor venues such as large stadiums, race tracks, baseball stadiums, soccer fields, and open air, or shed style performing arts venues all require both long throw and down fill, or short throw sound reinforcement systems. Typical arrays and a higher performance array are discussed and examples are shown that utilize ONE SYSTEMS unique direct weather high performance sound reinforcement systems.

Medium to large format sports and performance venues often require both medium to long throw acoustic systems as well as short throw, or “down fill” systems. Many professional loudspeaker manufacturers, including ONE SYSTEMS™ offer down fill brackets or other rigging systems to allow a low acoustic Q, or short throw, loudspeaker system to be suspended under a much higher Q, or long throw array. The advantage is the ability to suspend both long throw and down fill devices from a single set of suspension points. Figure 1 represents this type of solution from ONE SYSTEMS. The resultant array is a vertical geometry that consists of a 212IM medium to long throw enclosure that features ONE SYSTEMS ET 60x40 high frequency horn. The 212IM utilizes a 2 element vertical configuration of 12 inch (305mm) direct radiator drivers in increase the vertical coverage angle and extend the rated directivity pattern in the vertical plane to below 500Hz. The ONE SYSTEMS down fill bracket, the DF-IM is used to mate the 212IM with a 112IM for down fill/short throw coverage requirements. In this configuration, the 112IM uses the ET 105x60 high frequency horn to provide wide horizontal directivity in the down fill coverage area. It is a good practice to invert the down fill enclosure in order to allow all low frequency elements to be in close physical proximity. This also insures that the two high frequency horns, the 60x40 and 105x60 in this example, are many wave lengths apart.



FIGURE 1
212IM and 112IM with DF-IM Down Fill Bracket

This is a common configuration and the design is intended to provide both long throw and short throw coverage. Ideally, the system could be driven from two amplifier channels and the respective channel gains adjusted for even SPL coverage and a smooth transition between the short throw and long throw portions of the specified coverage area.

Vertical arrays of either horns or direct radiator loudspeakers are employed to narrow the vertical coverage pattern. However, when the wavelengths become comparable to or shorter than the center to center spacing of the array elements (the 12 inch loudspeakers in this case) the on-axis included angle coverage patterns become extremely narrow. As an example, the included angle of a 2x12 inch direct radiator array, as used in the 212IM, is approximately 40 degrees at 1000Hz. The implication is that using the 2x12 array any

higher than 1000Hz will produce a vertical included angle of less than 40 degrees, and compromise the front to back audience coverage in the frequency band where the 2x12 array is used above 1100Hz. Obviously, it is critical that the crossover frequency be limited to 1100Hz or below for systems such as the 212IM (or any other 2x12 loudspeaker system!)

It is common practice to view the down fill enclosure as a separate radiating element, simply providing coverage to the near audience positions. However, when the down fill loudspeaker is added to the 2x112 enclosure in a vertical array the woofer element in the down fill enclosure becomes part of the vertical array. This effect occurs when the wavelengths are comparable to or long compared to the device spacing. The implication is that from approximately 1500Hz and below, the down fill enclosure and the long throw enclosure are, in fact, one integrated three element vertical array. The best practice, as noted in the first paragraph of this paper, is to invert the lower enclosure in order to physically separate the high frequency radiating elements by many wavelengths at the crossover frequency. This spacing will prevent lobing effects generated by the two high frequency horns due to destructive interference.

Figure 2 shows the two enclosures, the 212IM and 112IM in a typical long throw/down fill configuration. The 112IM has been mounted, using the DF-IM, in an “upside down” arrangement as discussed. Using a conventional wiring configuration, one channel of an amplifier would drive the 212IM and a second channel would drive the 112IM. Both enclosures would be used in a passive, full range mode. This standard approach allows the down fill enclosure, the 112IM to be “amplitude shaded”, or turned down to match the SPL requirements of the down fill zone. This is a common approach and is found in almost all down fill/long throw system designs. Although this approach is common, it suffers from exactly the effects outlined above. Between approximately 800Hz and the down fill crossover point all three low frequency elements are working in parallel. This produces a three element vertical array and, as is the case with the typical 12 inch (305mm)diameter low frequency elements, the wavelengths become shorter than the device spacing. (Figure 2 represents the 112IM at a 30 degree down tilt angle. The DF-IM allows down tilts, in five degree increments from 0 degrees from vertical to 45 degrees.)

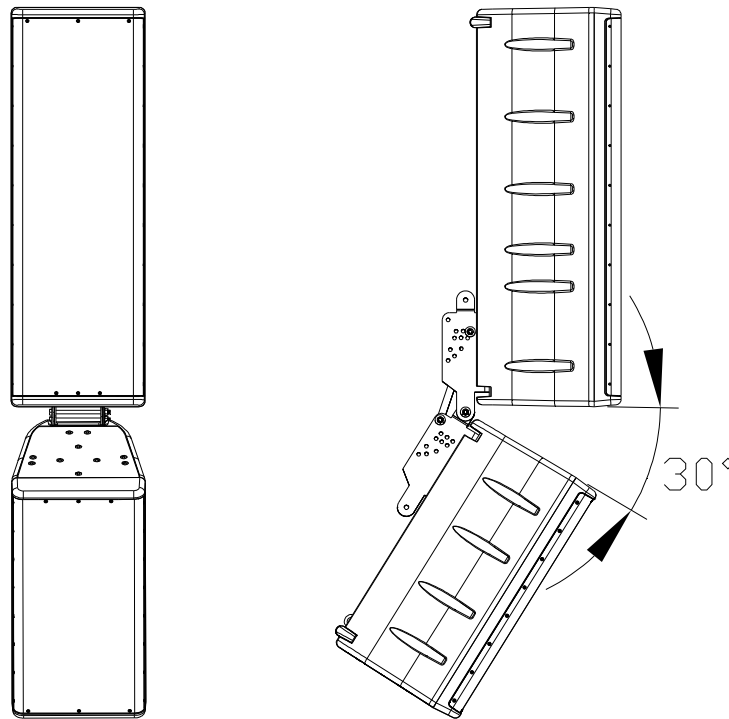


FIGURE 2
Front and Side View of 212IM and 112IM in Down Fill Configuration

The result of this “standard” down fill configuration is an undesirable vertical polar pattern. The vertical included angle at 1000Hz is now only 25 degrees! Above 1100Hz, and up to the down fill crossover frequency, the vertical pattern undergoes a variety of lobing changes. At 1250Hz the pattern presents 15 degree wide lobes that vary in amplitude by 8dB. Within a coverage angle of approximately 40 degrees there is an on axis peak and two wide -8dB dips. Using a conventional -6dB included angle to establish the rated coverage angle will result in a 20 degree rating. All of this can be a bit confusing but the good news, if there can be any, is that the bandwidth of this extreme vertical coverage narrowing is between 2/3 of an octave to 1 octave.

Fortunately, there is another method that can both take advantage of the good aspects of a three element 12 inch vertical array and eliminate the negative aspects discussed above. The physical configuration is identical to that shown in both figures 1 and 2. The specific angle necessary for the down fill enclosure, the 112IM, relative to the long throw enclosure, the 212IM, is of course a function of the array height and venue acoustic coverage requirements. In this new configuration, the ONE SYSTEMS SystemSupervisor™ is used to achieve the necessary frequency and amplitude shading.

An ideal configuration would maximize the system performance while minimizing the system complexity. The long throw enclosure, the 212IM is wired in a full range, passive, configuration just like the simple array referenced above. The down fill enclosure, however, is configured in a bi amp mode with some unique presets. The high frequency horn in the down fill enclosures, the ET 105x60 is in bi amp mode and the high pass filter, the crossover frequency, is set to 1122Hz, just as the passive filter is configured in the long throw enclosure. The 12 inch loudspeaker, however is set to function as a part of the overall array comprised of the two 12 inch speakers in the long throw enclosure and the single 12 inch speaker in the down fill enclosure.

The down fill high frequency horn has a rated coverage pattern of 105 degrees by 60 degrees. The horn is rotatable but in the array shown the horn is oriented to yield a horizontal pattern of 105 degrees. The vertical included angle is then 60 degrees. Because the included angle of the high frequency horn is 60 degrees, it is desirable to maintain this vertical angle for the low frequency/mid bass frequency band as well. (The included vertical angle of the long throw high frequency horn is 40 degrees, so maintaining a 60 degree vertical angle for the entire array represents a good compromise between the low throw section and the down fill section)

To maintain the desired vertical included angle the low pass filter in the SystemSupervisor is set to limit the bandwidth of the 12 inch loudspeaker in the 112IM to below 400Hz. The interesting aspect of this configuration is that the 12 inch loudspeaker in the 112IM is only playing from its low frequency limit to 400Hz, yet the high frequency horn in the 112IM down fill is playing from 1122Hz and above. At first glance, it would seem unusual that there is a 700Hz gap between the 12 inch woofer and the ET 105x60 high frequency horn.

This unusual condition is the result of the three element 12 inch loudspeaker array and the fact that although they are in different enclosures (the 212IM and the 112IM) they behave as a single acoustic element. The common mistake is that the two loudspeaker systems are treated as two separate acoustic elements when in fact all three 12 inch loudspeakers form a single acoustic element, independent of the fact that one of the 12 inch loudspeakers is in a different enclosure.

The next issue to address is that when the lower enclosure is tilted back to provide aiming for the ET 105x60 high frequency horn, the 12 inch loudspeaker moves back as well. This change in physical position acts to “steer” the entire 3 element array down. This occurs because as the 112IM is rotated back to provide the tilting angle necessary for the

high frequency down tilt the 12 inch speaker rotates off the vertical plane of the main three element array. This introduces a small signal delay and acts to introduce a mid bass down tilt. This can either be accepted or can be corrected by adding delay to the 212IM enclosure. This delay brings the entire three element array back into “alignment” and steers the mid bass lobe back to the desired aiming angle of the entire system. The table below (Table 1) indicates the signal delay versus down tilt angle of the 112IM and associated down tilt of the mid bass polar lobe.

Down Tilt Angle	Signal Delay	Mid Bass Polar Lobe Tilt
20 Degrees	0.2mSec	5 Degrees Down
30 Degrees	0.3mSec	10 Degrees Down
45 Degrees	0.5mSec	15 Degrees Down

TABLE 1

The reason to be concerned about this effect is that it is important for the main mid bass array to exhibit the same basic aiming angle as the main system. As the audience gets closer to the front of the listening space the polar response acts as the reciprocal of the audience distance and tends to provide some degree of constant SPL versus distance in the array.

Now the down fill high frequency horn, the ET 105x60, is simply amplitude shaded (attenuated) to provide the required down fill sound pressure levels based on the array height and down tilt angle.

The diagram below (Figure 3) shows typical SystemSupervisor routings that will provide the proper aiming and signal delay correction for the over all system.

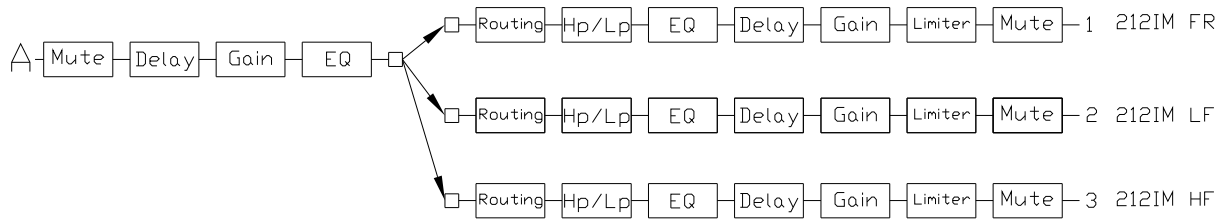


Figure 3

The block diagram above shows the 212IM being run in Full Range mode and only the post router delay is used to provide the necessary signal delay to bring the three element 12 inch array lobe back to the geometric axis of the entire system. This allows for any overall system aiming to be accomplished simply by tilting the entire array (long throw and down fill) to achieve the necessary long throw coverage. The down fill array may then be set separately to achieve the required down fill coverage. (It should also be noted that the entire system uses a high pass filter to achieve sub sonic protection. This is achieved in the high pass filter of output channel 1, the 212IM channel, as well as high pass filter in output 2, the LF section of the down fill, or 112IM channel.)

Output 2 is used to provide the frequency shading for the 112I M and output 3 is used to provide both crossover functions and the amplitude shading required to set the down fill HF level. This level is set in the post router gain function of channel 3.

The input A (1) section mute, delay, gain, and EQ are used for over all system control or for system delay if the 212IM and 112IM are in a zone that requires system delay. The over all array gain may also be set from this input section.

NOTE: The post router gain is set at the 112IM active filter preset level found in the ONE SYSTEMS web site. Post router EQ functions are also set. IN THIS APPLICATION THE EQ SHOULD NOT BE ADJUSTED IN THE POST ROUTER SETTINGS OF CHANNEL 3. HOWEVER, THE GAIN FOR THE DOWN FILL HF DRIVER IS SET HERE.....THE INSTALLER SHOULD SET THIS GAIN TO OPTIMIZE THE DOWN FILL HF LEVEL TO THE REQUIRED VALUE!

ONE SYSTEMS

SystemSupervisor Presets

212IM and 112IM with DF-IM

NOTE: Use input "A". Output routing for outputs 1, 2, and 3 is Input 1 (input A).

212IM

Input A (1) Output 1

Full Range

Gain 0dB
Polarity Norm

Eq1 Type PEQ
Level 0dB
Frequency 917Hz
Bandwidth 0.562 Oct

Eq2 Type PEQ
Level 0dB
Frequency 64.3Hz
Bandwidth 0.353 Oct

Eq3 Type	PEQ
Level	0dB
Frequency	1542Hz
Bandwidth	0.223 Oct

Delay

Pre Crossover	0mSec
Post Crossover	See Table 1 Above (set per 112IM down tilt angle)

Crossover

LPF	
Frequency	OFF
Type	24dB L-R*
HPF	
Frequency	40.5 Hz 24dB Butterworth

Dynamics

Threshold	+4dBu
Comp Ratio	2:1
Attack	10.0mSec

Release 200mSec

112IM 105 x 60 (Down Fill Mode)

Input A (1)	Output 2	Output 3
	LF	HF
Gain	0dB	-10.0dB
Polarity	Norm	Norm

NOTE: the HF level should be set for the desired down fill SPL requirements. The -10dB level referenced above may be adjusted up or down based on venue requirements.

Eq1 Type	PEQ	PEQ
Level	-4.5dB	-3.0dB
Frequency	917Hz	5993Hz
Bandwidth	0.562 Oct	0.375 Oct

Eq2 Type	PEQ	PEQ
Level	+3.0dB	+8.5dB
Frequency	64.3Hz	15.5kHz
Bandwidth	0.353 Oct	0.375 Oct

Eq3 Type	PEQ	PEQ
Level	-2.0dB	-4.0dB
Frequency	1542Hz	2911Hz

Bandwidth	0.223 Oct	0.281 Oct
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Delay

Pre Crossover	0mSec	0mSec
Post Crossover	0mSec	0mSec

Crossover

LPF		
Frequency	400Hz	OFF
Type	24dB L-R*	
HPF		
Frequency	40.5Hz	1122HZ
Type	Butterworth	24dB L-R

Dynamics

Threshold	+4dBu	+2dBu
Comp Ratio	2:1	3:1
Attack	10mSec	2mSec
Release	200mSec	125mSec

NOTE: L-R = Linkwitz-Riley



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