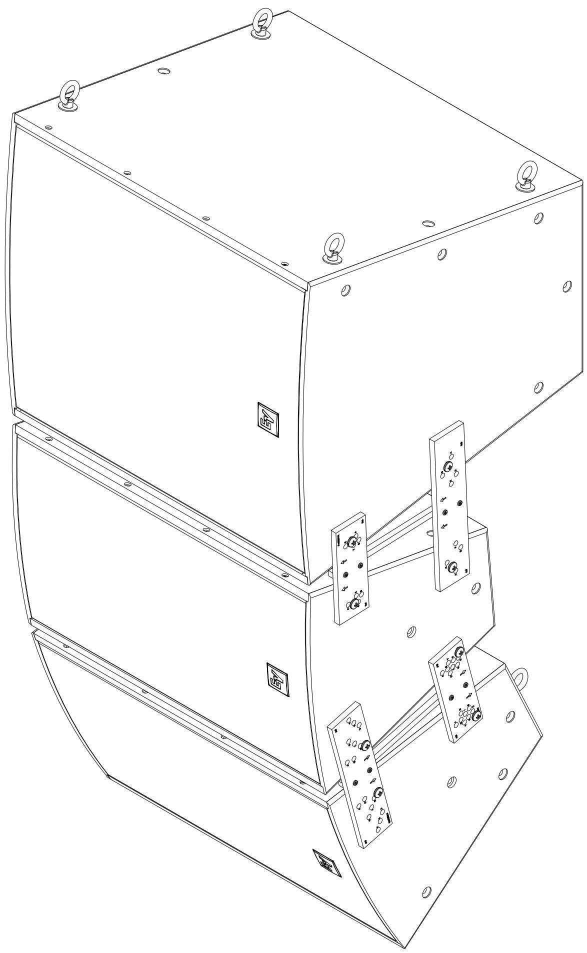
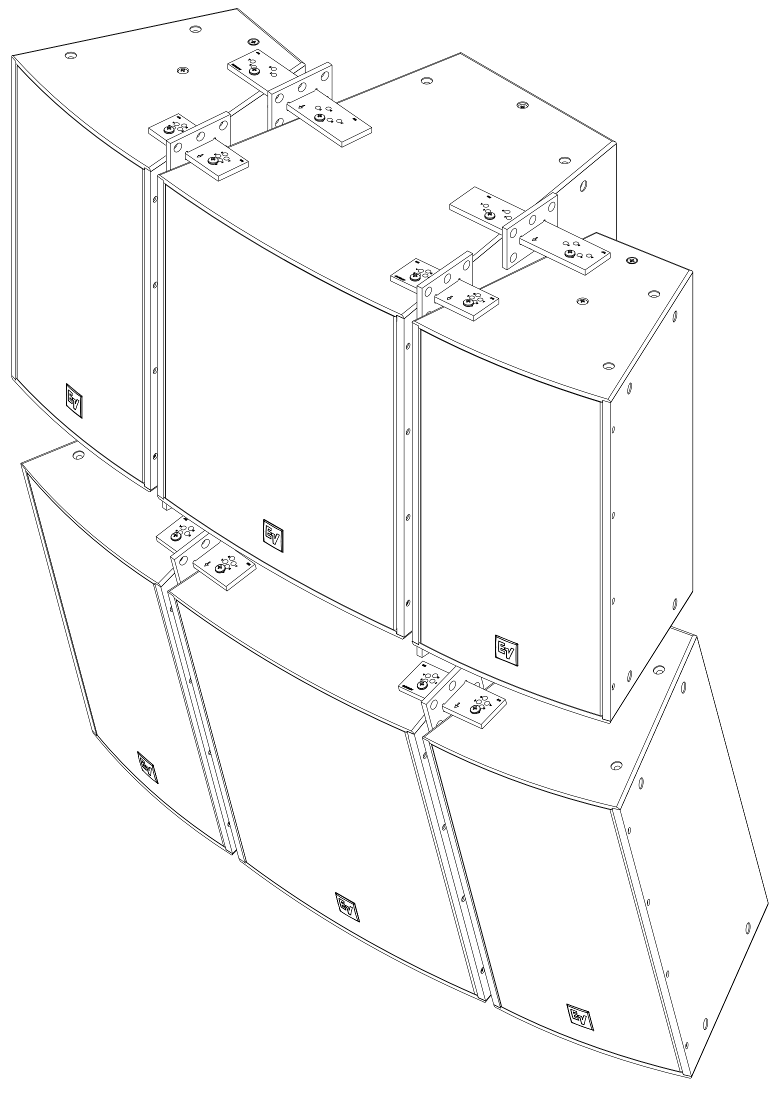
EVF/EVH
User Manual





EVF-1121S
EVF-1151S
EVF-1181S
EVF-2121S
EVF-2151D
EVF-1122S (All Patterns)
EVF-1122D (All Patterns)
EVF-1152S (All Patterns)
EVF-1152D (All Patterns)
EVH-1152S (All Patterns)
EVH-1152D (All Patterns)

Live For Sound
www.electrovoice.com

EVF/EVH

Table of Contents

Table of Contents (cont.)

Rigging-Safety Warning

This document details general rigging practices appropriate to the entertainment industry, as they would apply to the rigging of Electro-Voice EVF and EVH loudspeaker systems. It is intended to familiarize the reader with standard rigging hardware and techniques for suspending EVF and EVH loudspeaker systems overhead. Only persons with the knowledge of proper hardware and safe rigging techniques should attempt to suspend any sound systems overhead. Prior to suspending any Electro-Voice EVF and EVH loudspeaker systems overhead, it is essential that the user be familiar with the strength ratings, rigging techniques and special safety considerations outlined in this manual. The rigging techniques and practices recommended in this manual are, of necessity, in general terms to accommodate the many variations in loudspeaker clusters and rigging configurations. **As such, the user is expressly responsible for the safety of all specific EVF and EVH loudspeaker cluster designs and rigging configurations as implemented in practice.**

All the general rigging material contained in this manual is based on the best available engineering information concerning materials and practices, as commonly recognized in the United States, and is believed to be accurate at the time of original printing. As such, the information may not be directly applicable in other countries. Furthermore, the regulations and requirements governing rigging hardware and practices may be superseded by local regulations. It is the responsibility of the user to ensure that any Electro-Voice loudspeaker system is suspended overhead in accordance with all current federal, state and local regulations.

All specific material concerning the strength ratings, rigging techniques and safety considerations for the EVF and EVH loudspeaker systems is based on the best available engineering information concerning the use and limitations of the products. Electro-Voice continually engages in testing, research and development of its loudspeaker products. As a result, the specifications are subject to change without notice. It is the responsibility of the user to ensure that any Electro-Voice loudspeaker system is suspended overhead in accordance with the strength ratings, rigging techniques and safety considerations given in this document and any manual update notices. All non-Electro-Voice associated hardware items necessary to rig a complete EVF and EVH loudspeaker cluster (chain hoists, building or tower supports and miscellaneous mechanical components) are the responsibility of others.

Electro-Voice
June 2010

1.0 Introduction

The Electro-Voice **EVF** series is a group of compact two-way front-loaded full-range systems, available with 12- or 15-inch woofers, augmented by low-frequency and subwoofer systems. EVF full-range systems are available in two versions. The "S" versions employ 400-watt SMX low-frequency transducers and the ND2B medium-format, 1.4-inch exit/2-inch diaphragm compression driver. The "D" versions employ 500-watt DVX-A low-frequency transducers and the DH7N large-format, 1.4-inch exit/3-inch diaphragm compression driver. Both compression drivers have neodymium magnetic structures. In general, the premium components in the "D" versions provide lower distortion and reduced power compression.

The **EVH** series is a group of larger two-way horn-loaded full-range systems. Both the "S" and "D" EVH versions use SMX low-frequency transducers. The "D" versions substitute the DH7N large-format compression driver for the ND2B medium-format driver.

All full-range systems utilize high-order crossover networks that seamlessly integrate the low-frequency transducers with the high-frequency compression drivers, providing very low distortion and excellent frequency response.

The EVF/EVH systems have many threaded rigging points that can be used with the supplied eyebolt kits or optional suspension kits to easily create a number of horizontal or vertical cluster configurations. All enclosures in their normal orientations (long axis vertical) share the same height, just over 30 inches (762 mm), promoting attractive clusters. Six coverage patterns, all rotatable, are available in each family, as shown in Table 1a. The EVF-1121S and EVF-1151S low-frequency systems have integral low-pass filters that allow paralleling them with up to two full-range systems, offering a cost-effective way to augment the low-frequency output of EVF full-range systems.

Horn Pattern:	40° x 30°	60° x 40°	60° x 60°	90° x 40°	90° x 60°	90° x 90°	120° x 60°
EVF 12-inch		▪	▪	▪	▪	▪	▪
EVF 15-inch	▪	▪	▪	▪	▪	▪	
EVH	▪	▪	▪	▪	▪	▪	

Table 1a:
Coverage patterns available in the EVF and EVH series (all rotatable)

The model number scheme denotes the number of woofers, the diameter of the woofers, the number of band passes in the system, the woofer series used and, following a forward slash, the coverage pattern. An example is the EVF-1122S/96, which has a single SMX series 12-inch woofer in a two-way configuration and a 90° x 60° pattern. Another example is the EVF-1181S subwoofer, which has a single EVS-18S 18-inch woofer in a "one way" configuration and without a specific coverage pattern (essentially omnidirectional in the very-low-frequency range in which it is usually operated).

1.0 Introduction (cont.)

Model Name (As Shown)	EVF-1122S/96 (example)							
Model Name (Separated)	EVF	-	1	12	2	S	/	96
Description	Loudspeaker Family/Series (EVF Series)		Number of Woofers (1 Woofer)	Woofer Diameter (12-inch)	Number of Band Passes (Two-Way)	Woofer Series Used (SMX Series)		Coverage Pattern (90° x 60°)

Table 1b:

Model number scheme, showing the meaning of each individual model number

Typical EVF and EVH systems are shown in Figure 1, with key dimensions, suspension points, weights and centers-of-gravity. Engineering data sheets for each model, containing full specifications and dimensional drawings, are shipped with each loudspeaker and are downloadable from the Electro-Voice Web site (www.electrovoice.com).

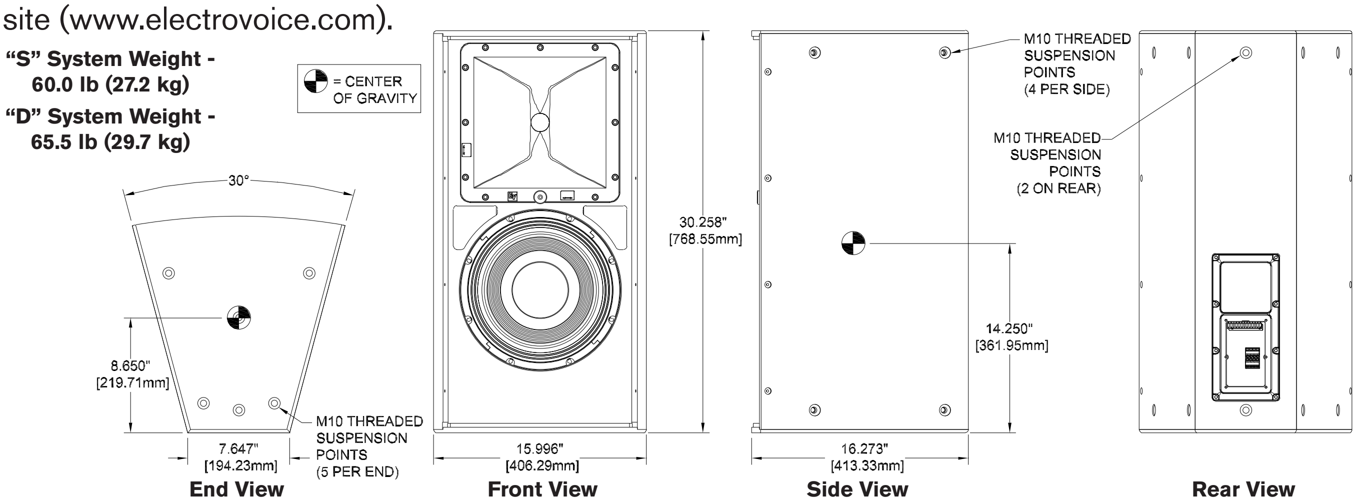


Figure 1a:

Key dimensions, suspension points, weight, and center-of-gravity for EVF-1122 (all coverage patterns)

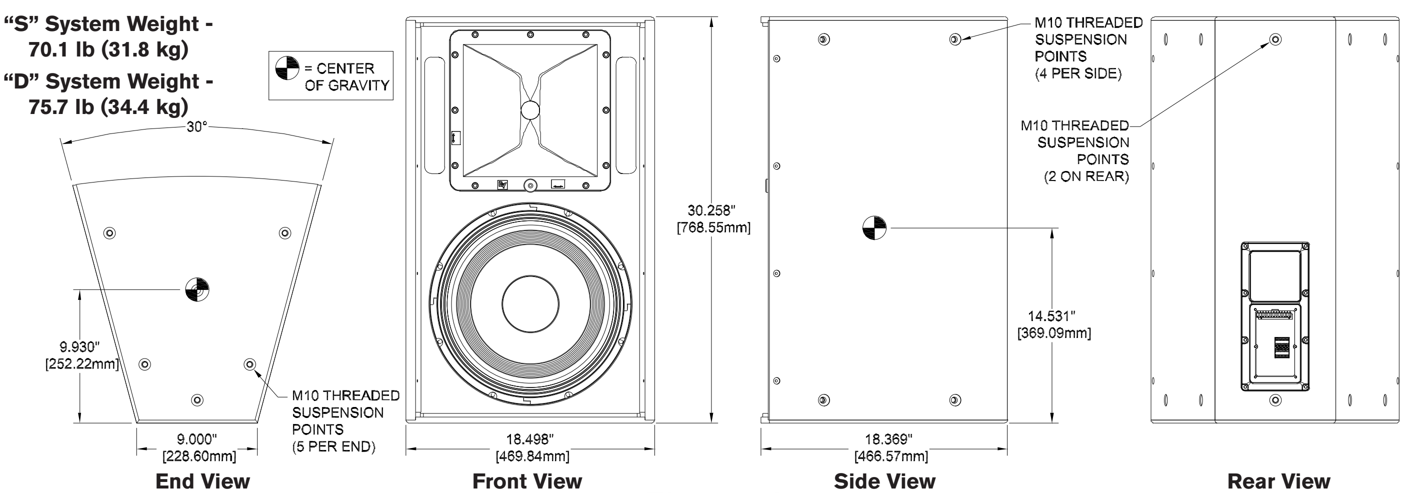


Figure 1b:

Key dimensions, suspension points, weight, and center-of-gravity for EVF-1152 (all coverage patterns)

1.0 Introduction (cont.)

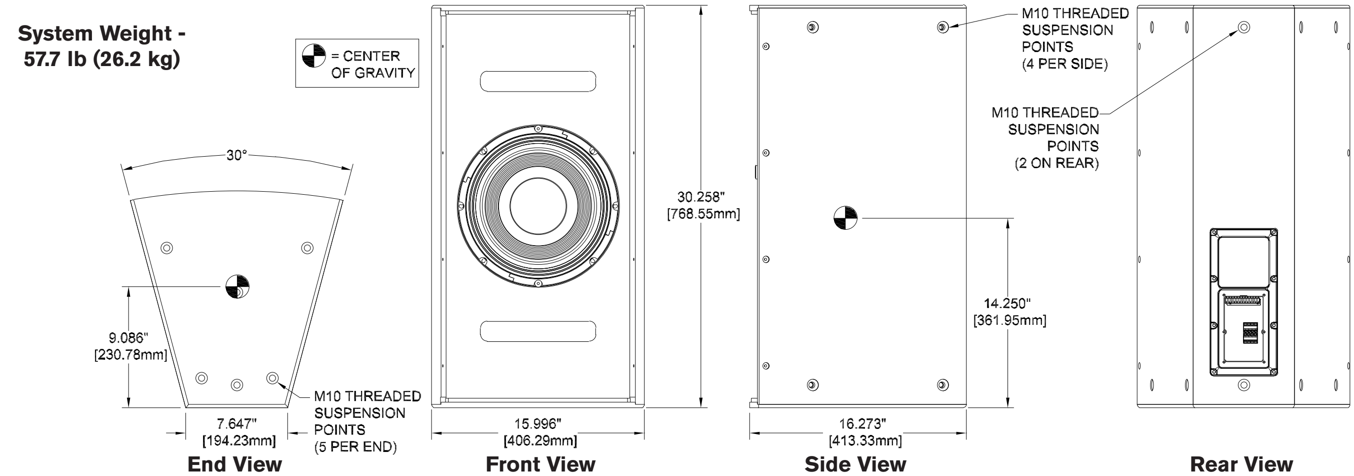


Figure 1c:

Key dimensions, suspension points, weight, and center-of-gravity for EVF-1121S

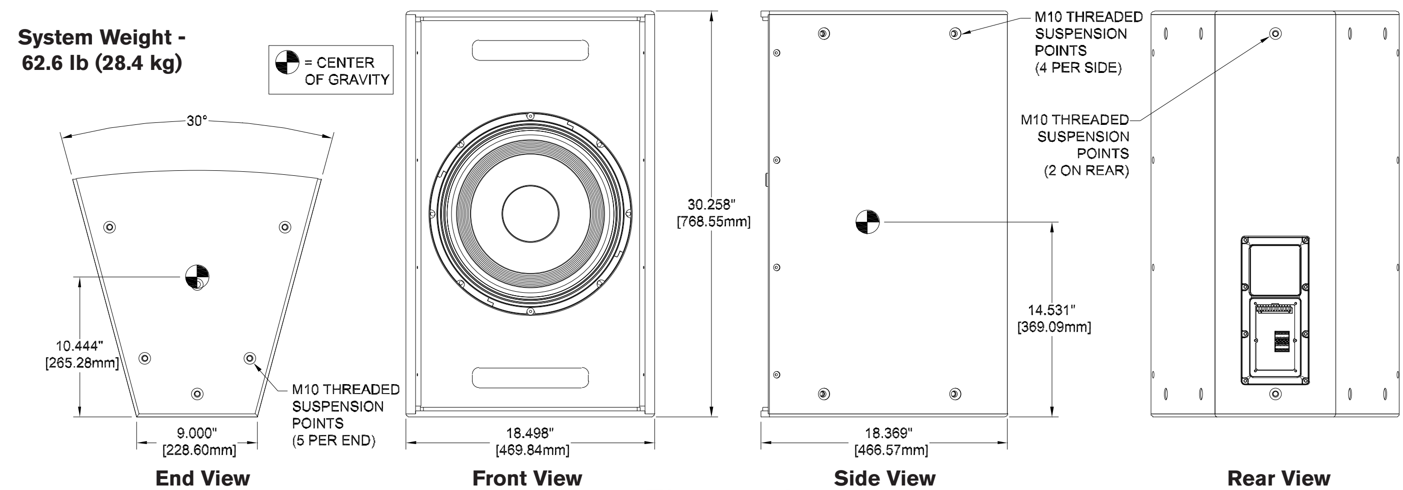


Figure 1d:

Key dimensions, suspension points, weight, and center-of-gravity for EVF-1151S

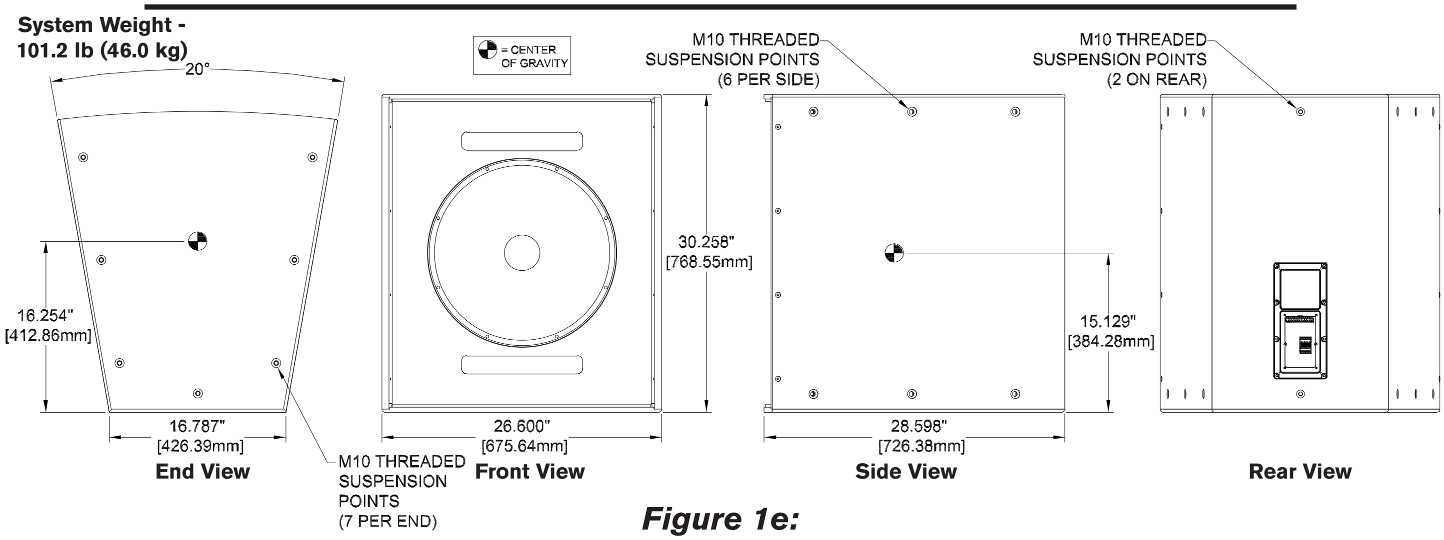


Figure 1e:

Key dimensions, suspension points, weight, and center-of-gravity for EVF-1181S

1.0 Introduction (cont.)

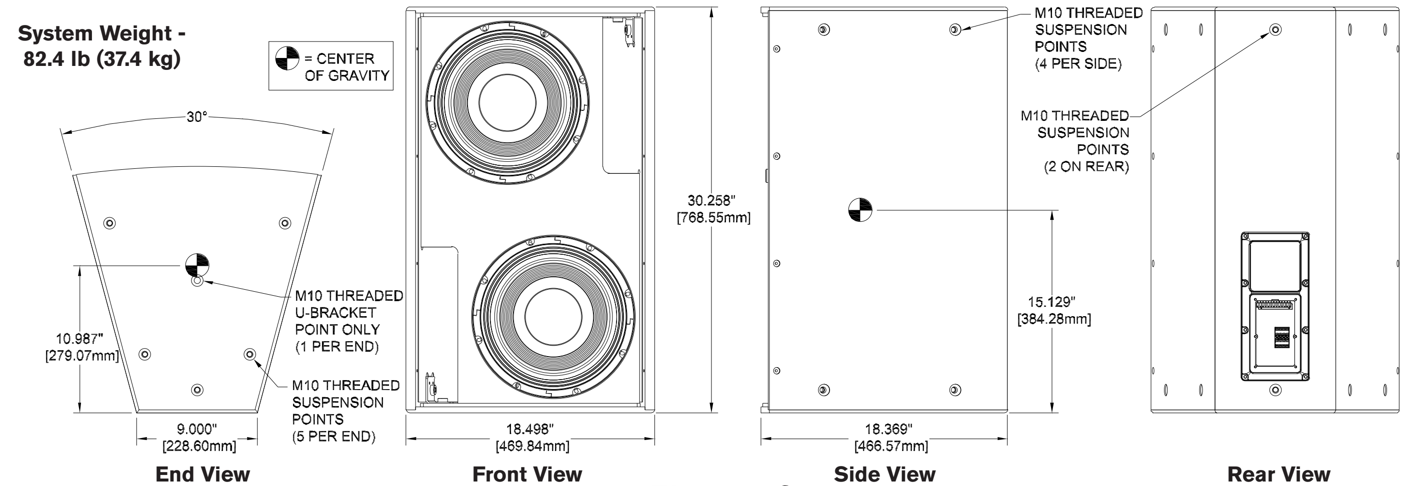


Figure 1f:

Key dimensions, suspension points, weight, and center-of-gravity for EVF-2121S

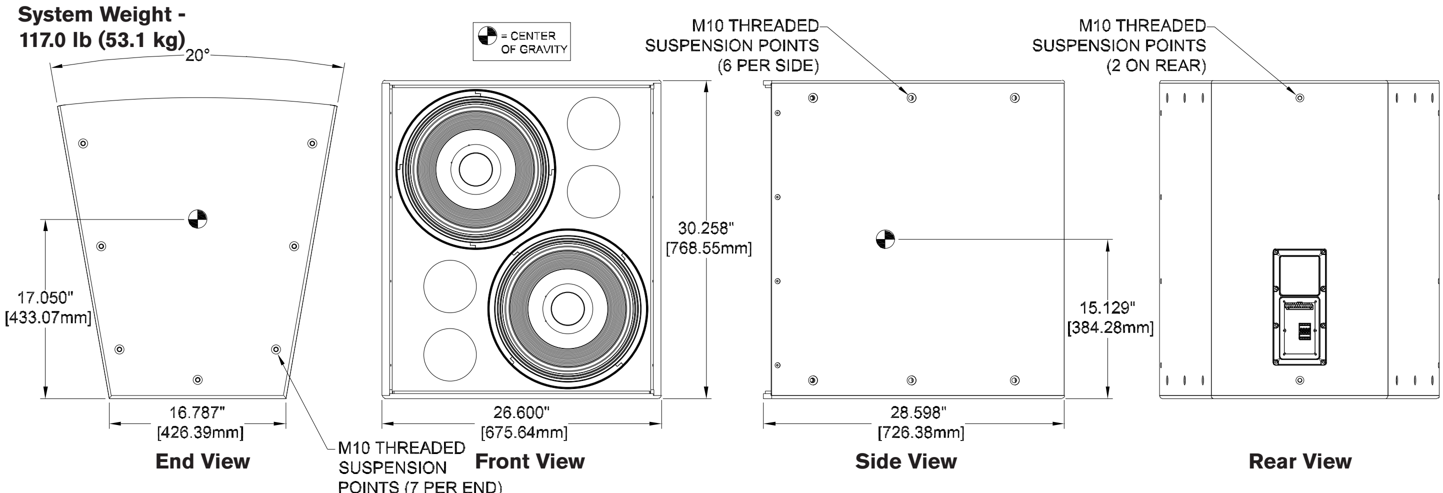


Figure 1g:

Key dimensions, suspension points, weight, and center-of-gravity for EVF-2151D

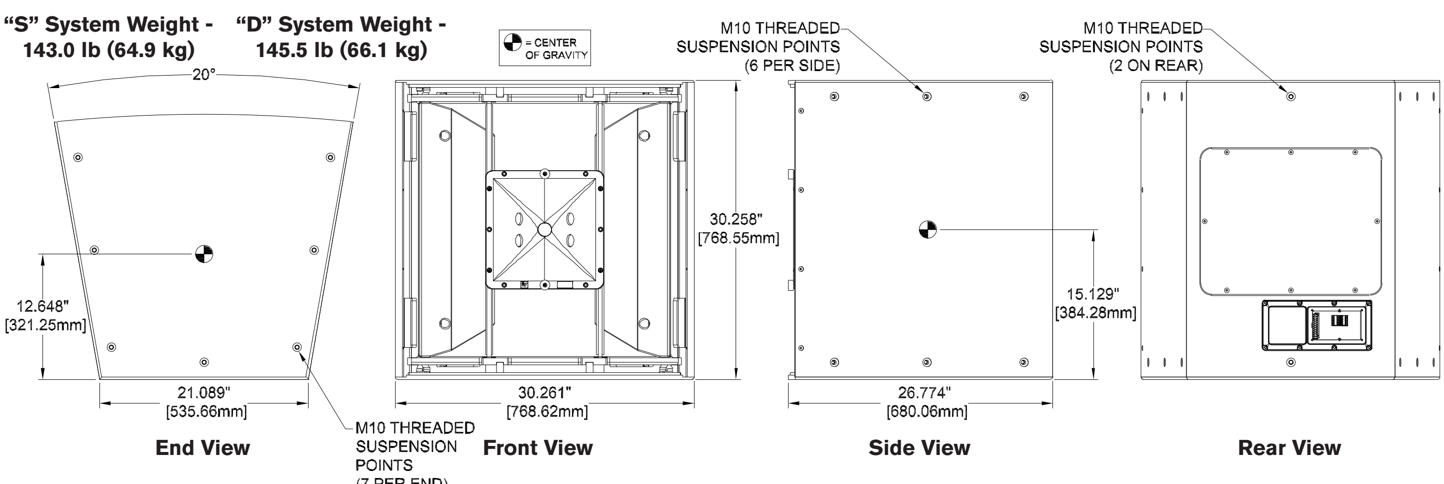
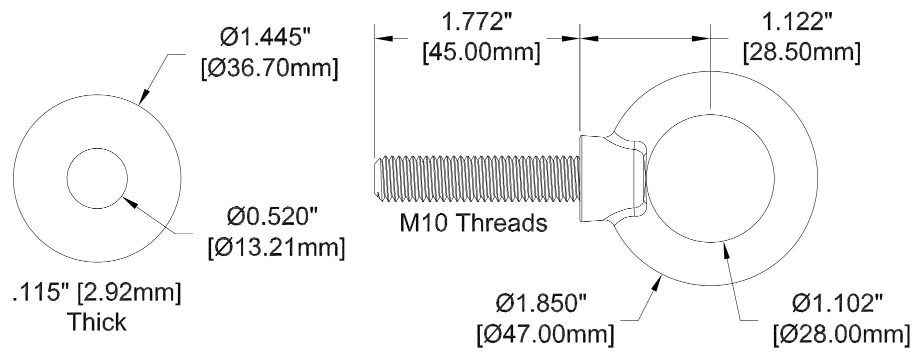


Figure 1h:

Key dimensions, suspension points, weight, and center-of-gravity for EVH-1152 (all coverage patterns)

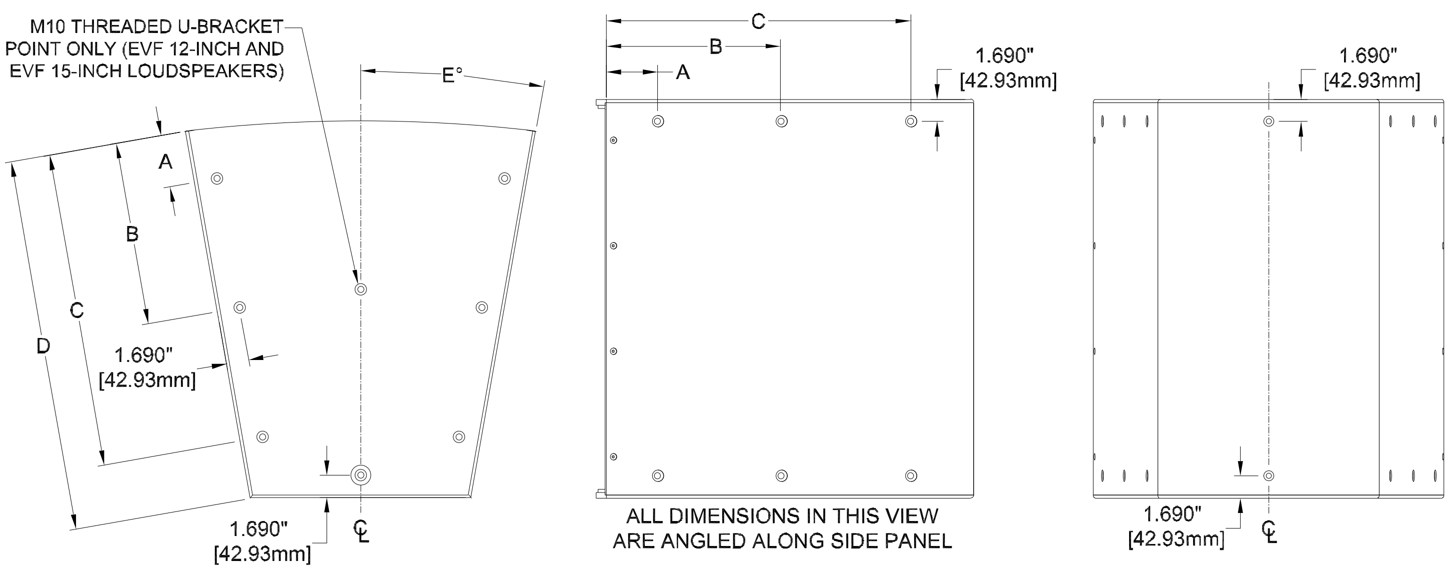
1.0 Introduction (cont.)



Washer (x4) **Eyebolt (x4)**

Figure 1g:

Key dimensions for washers and eyebolts included with each loudspeaker



End View **Side View** **Rear View**

Figure 1h:

Key suspension point dimensions for EVF or EVH loudspeakers as indicated in table below

Dimension:	A	B	C	D	E°
EVF 12-inch	4.176” [106.07mm]	14.301” [363.24mm]	N/A	16.129” [409.67mm]	15°
EVF 15-inch	4.176” [106.07mm]	14.301” [363.24mm]	N/A	18.353” [466.16mm]	15°
EVF Subs	3.957” [100.50mm]	13.889” [352.77mm]	23.857” [605.97mm]	28.255” [717.68mm]	10°
EVH	3.957” [100.50mm]	13.889” [352.77mm]	23.857” [605.97mm]	26.409” [670.79mm]	10°

Table 2:

Key suspension point dimensions as shown in figure above

1.0 Introduction (cont.)

1.1 Finishes and Colors Available

The standard EVF/EVH indoor versions are finished in tough EVCoat. In addition, all models are available in two levels of weather resistance, indicated by letters following the coverage-pattern numbers. The FG versions, e.g., EVF-1152S/64-FGB, are designed for full weather exposure and feature a fiberglass-finished enclosure, stainless-steel hydrophobic grille and the CDG dual-gland-nut input-panel cover. The PI versions, e.g., EVF-1152S/64-PIW, are rated for indirect outdoor exposure only in protected areas, such as under a roof overhang, and feature a stainless-steel hydrophobic grille and CDG dual-gland-nut input-panel cover on an enclosure finished in standard EVCoat. External fasteners on all systems are stainless steel.

All EVF and EVH systems are available in black or white. Black is indicated by BLK or B at the very end of the complete model number and white is indicated by WHT or W at the very end of the complete model number, e.g., EVF-1152/94-BLK and EVF-1152S/94-PIW.

1.2 EVF Front-Loaded Series

Note that engineering data sheets with complete specifications are packed with each system and downloadable at www.electrovoice.com.

EVF-1122S/64, EVF-1122S/66, EVF-1122S/94, EVF-1122S/96, EVF-1122S/99, EVF-1122S/126, EVF-1122D/64, EVF-1122D/66, EVF-1122D/94, EVF-1122D/96, EVF-1122D/99, EVF-1122D/126: two-way 12-inch full-range systems with six different rotatable waveguides ranging from 60° x 40° to 120° by 60°, as detailed in Table 1.

EVF-1152S/43, EVF-1152S/64, EVF-1152S/66, EVF-1152S/94, EVF-1152S/96, EVF-1152S/99, EVF-1152D/43, EVF-1152D/64, EVF-1152D/66, EVF-1152D/94, EVF-1152D/96, EVF-1152D/99: two-way 15-inch full-range systems with six different rotatable waveguides ranging from 40° x 30° to 90° by 90°, as detailed in Table 1.

EVF-1121S: 12-inch low-frequency system.
EVF-1151S: 15-inch low-frequency system.
EVF-1181S: 18-inch subwoofer system.
EVF-2121S: Dual 12-inch low-frequency system.
EVF-2151D: Dual 15-inch subwoofer system.

1.3 EVH Horn-Loaded Series

Note that engineering data sheets with complete specifications are packed with each system and downloadable at www.electrovoice.com.

EVH-1152S/43, EVH-1152S/64, EVH-1152S/66, EVH-1152S/94, EVH-1152S/96, EVH-1152S/99, EVH-1152D/43, EVH-1152D/64, EVH-1152D/66, EVH-1152D/94, EVH-1152D/96, EVH-1152D/99: two-way 15-inch full-range systems with six different rotatable high-frequency waveguides ranging from 40° x 30° to 90° x 90° and mid-frequency waveguide contours, as detailed in Table 1.

1.0 Introduction (cont.)

1.4 Accessories for EVF and EVH Systems

Note that some accessories are supplied with certain system versions, as noted.

CDG: optional dual-gland-nut input-panel cover to protect the input connections from water. Note that this cover is supplied with the weather-resistant versions.

CSG: optional single-gland-nut input-panel cover to protect the input connections from water.

CDNL4: optional input-panel cover equipped with dual Neutrik Speakon® NL4M connectors, providing a quick-disconnect alternative to the standard Phoenix screw-terminal input connectors.

HRK and VRK: a series of horizontal (HRK) and vertical (VRK) rigging kits that accommodate a number of horizontal and vertical system aiming angles. See section 5.0 EVF and EVH Rigging System for details.

TK-150: optional 70.7/100-volt transformer kit mounts on the inside of the EVF and EVH input panels, offering 37.5, 75 and 150 watts at 70.7 volts and 75 and 150 watts at 100 volts. Installation instructions come with the TK-150.

EVF-UB: optional U-bracket kit for mounting single EVF full-range and low-frequency (not subwoofer) systems to a wall or ceiling. Installation instructions come with the EVF-UB.

EVI-M10K: optional eyebolt kit, consisting of four M10 shoulder eyebolts and four fender washers, used when additional eyebolts are needed to suspend loudspeakers. See section 6.3 for details. One EVI-M10K eyebolt kit is supplied with each loudspeaker system.

EVI-AC: optional access card which allows diagnostic access to the transducers and protection circuitry inside the enclosure. Use of this accessory does not require any disassembly or disconnections beyond removal of the plug-in switch card.

2.0 Tool List

Listed below are the tools required to prepare EVF and EVH systems for installation:

1. 3/16-inch flat-blade screwdriver (for attaching signal wires to input-panel connectors).
2. Phillips #2 screwdriver (for grille removal to rotate waveguides, removal of high-frequency waveguides for rotation, and removal of input panel to install the optional TK-150 70.7/100-volt transformer).
3. 4-mm Allen (hex) wrench (for removal and reorientation of the EVH hard foam mid-frequency waveguide contours to rotate the mid-frequency coverage pattern).
4. 6-mm Allen (hex) wrench (for working with all rigging points).

3.0 Designing an EVF/EVH Cluster

3.1 General Aiming and Placement Guidelines

Loudspeakers should be "pointed at the people" and away from reflective room surfaces. Since people are excellent absorbers of sound and room surfaces are often not, this practice insures not only that the audience will receive the high frequencies necessary for good voice intelligibility and musical clarity but also that the reflective surfaces do not energize the room with intelligibility-robbing reverberation.

Loudspeakers for sound reinforcement are usually located high above a stage or platform and aimed down and out into the audience. This minimizes the difference between the longest throws to the rear of a venue and the shortest throws to the front rows, promoting coverage uniformity. Note that the typical portable loudspeaker on a short, 6-foot stand cannot duplicate such uniformity since the distant seats are so much farther away than the front rows. The direct sound from a loudspeaker drops 6 dB every time the distance from it doubles, according to the formula:

$$\text{Level loss (dB)} = 20\log_{10}(\text{closest distance/farthest distance}).$$

See comments on the audibility of different dB differences in section 3.4 Coverage-Uniformity Target.

3.2 Choosing between the EVF Full-Range and the EVH Full-Range Systems

When the reverberation time of a room (formally called T60 and the time it takes sound, once the source has stopped, to decay by 60 dB) exceeds 2-2.5 seconds at mid frequencies, the horn-loaded EVH series should be used. The EVH's low-frequency horn mouth is large enough to control the rated coverage pattern down to 500 Hz, which promotes clarity by keeping more sound off of reflective surfaces than can the smaller, 12-inch-square horns and direct-radiating woofers of the EVF series. This concept is explored in more detail below.

3.21 Directivity Break Frequency Defined

Below a certain frequency, the mouth size of a waveguide is no longer large enough to maintain the nominal coverage angle and the coverage angle gets wider and wider as frequency is decreased. The frequency at which this occurs is called the "directivity break frequency" (f_b) and is inversely proportional to the size of the waveguide mouth and the nominal coverage angle of the waveguide. The directivity break frequency can be approximated by the following formula:

$$f_b \text{ (Hz)} = 1{,}000{,}000/[\text{angle (degrees) x dimension (inches)}].$$

3.0 Designing an EVF/EVH Cluster (cont.)

3.3 More on Coverage Patterns, Multiple Coverage Patterns, the Need for Clusters of Loudspeakers and How Far a Single Cluster Can "Reach" into a Venue

The coverage patterns or angles mentioned previously are defined where loudspeaker output is 6 dB down from maximum, usually on-axis level. In order to help cover only the absorptive audience with sound, given different trim heights and the wide variety of venue shapes, the EVF and EVH series are offered in the many coverage patterns listed in Table 1 (above). Even with this wide choice, it is relatively unlikely that a single loudspeaker will cover the audience uniformly. Therefore, two or more loudspeakers are often assembled into clusters and aimed in different directions in order to reach the entire audience.

3.31 Basic Clustering Guidelines

The aiming angles of systems in a cluster are related not only to room geometry but also to the particular coverage patterns selected. A rough design can be based on the plan and elevation views of a room, representing the loudspeakers by the angles of their horizontal and vertical coverage patterns, e.g., 60° x 40°. A wide or "short throw" coverage pattern, such as 120° x 60°, is good for aiming down into the front rows of a rectangular venue to reach all of the seats left to right. Narrower patterns, such as 60° x 40° and 40° x 30°, are appropriate as "long throw" devices that send sound to the rear of the audience without also "blasting out" the front rows.

Sophisticated software is also available, which allows the designer to build a room model and place and aim loudspeakers within it, assessing the uniformity of coverage. An example is EASE 4.2 (Enhanced Acoustic Simulator for Engineers), developed by Acoustic Design Ahnert (www.ada-acousticdesign.de). EASE is available from the Bosch Communications Systems/Electro-Voice technical support group; specific contact information can be found at www.electrovoice.com. EASE loudspeaker data for EVF and EVH systems may be downloaded at www.electrovoice.com.

A common practice is to widen the horizontal coverage of a single loudspeaker by placing two systems side by side and aiming them in such a way that their horizontal patterns do not overlap. Individually, each system will be 6 dB down at the overlap point. Together at the overlap point, they will sum coherently to the 0-dB on-axis level. A specific example is two 60° horizontal systems clustered together with their axes placed 60° apart.

If these two systems are "underlapped," with, say, their axes 75° apart, the overall coverage angle will be wider but the level near the array axis will drop. If the two systems are overlapped to any great degree, e.g., their axes only 45° apart, the overall coverage angle will be reduced and the interference discussed in section 3.5 Multiple-Source Interference in Clusters will be worsened.

The degree to which long-throw devices can extend the region of uniform coverage is limited. A single loudspeaker will typically "reach" to the rear a distance that is about twice that of the distance to the closest front row. See Figure 2.

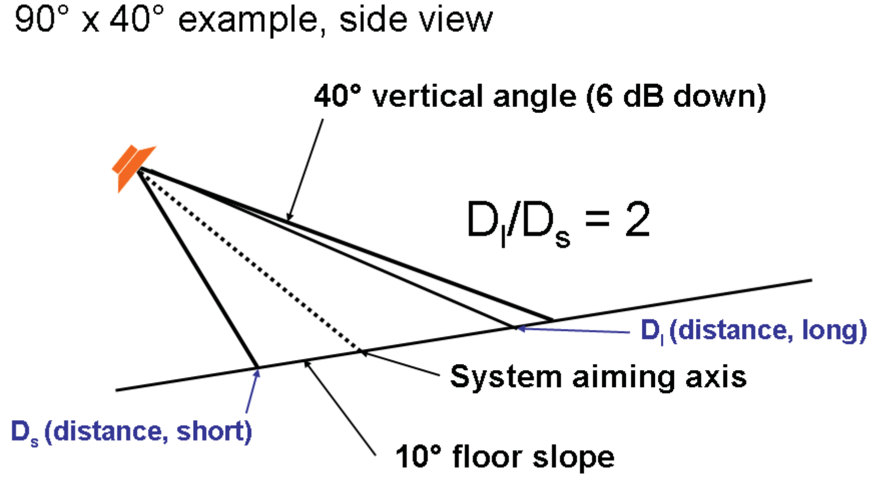


Figure 2:
Typical "reach" of a single loudspeaker into a venue (D_l) in order to maintain the desired ±3 dB coverage is about two times the distance to the closest seats (D_S)

Adding a long-throw device will typically extend this reach to about three times the closest distance. See Figure 3.

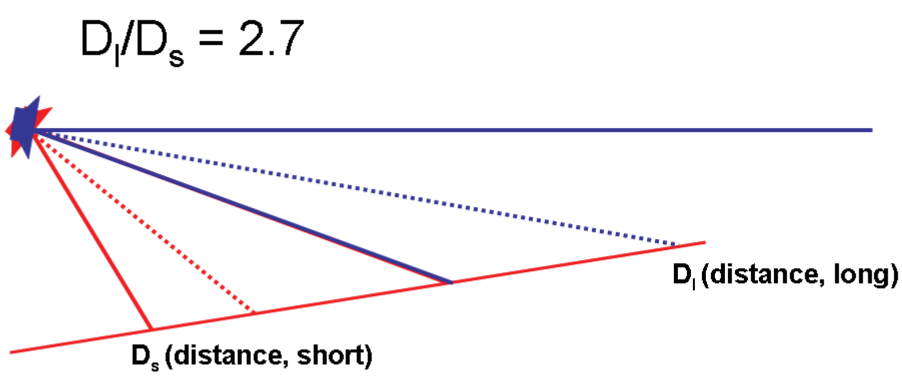


Figure 3:
Adding a long-throw device extends the reach to about three times the distance to the closest seat

For reaches beyond this, loudspeakers can be suspended over the audience, with their signal delayed with respect to the front or source loudspeakers so that the sound image will appear to come from the front of the room. The details of these design tips are beyond the scope of this manual and should be left to experienced design personnel.

3.4 Coverage-Uniformity Target

A good uniformity target is ±3 dB throughout the audience area, particularly in the 2,000- and 4,000-Hz octave bands, the bands most important for intelligibility. Such coverage should also be achieved in the 8,000-Hz band, important for "sparkle." As a reference, a 1-dB level difference is nearly imperceptible, a 3-dB difference is noticeable but not a large change, a 6-dB change is clearly noticeable and a 10-dB change is twice or half as loud. The ±3-dB uniformity target is related to these perceptual differences.

3.0 Designing an EVF/EVH Cluster (cont.)

3.5 Multiple-Source Interference in Clusters

Whenever two or more sources serve a single venue, some seats will receive strong signals from multiple sources. Consider two EVF-1122S/64 60° x 40° systems clustered side by side with their axes 60° apart to form a 120° x 40° cluster. If these systems maintained their rated coverage patterns into the low-frequency range, there would be essentially no interference. But the 12-inch-square waveguides used in the EVF series will begin to “balloon out” at about 2 kHz and below, an effect discussed in Section 3.21 Directivity Break Frequency Defined, above.

On the axis of the cluster, the output of both systems sums perfectly, since the listener is equidistant from each system and the output of both reaches the listener at the same time. This is the axis-of-cluster line shown in Figure 4. If the listener moves to the left (as viewed in the figure), the left loudspeaker will be closer and the sound will arrive sooner. At some angle and at some frequency, the time difference will be equivalent to reversing the polarity of one signal, causing a complete cancellation of cluster output at that frequency.

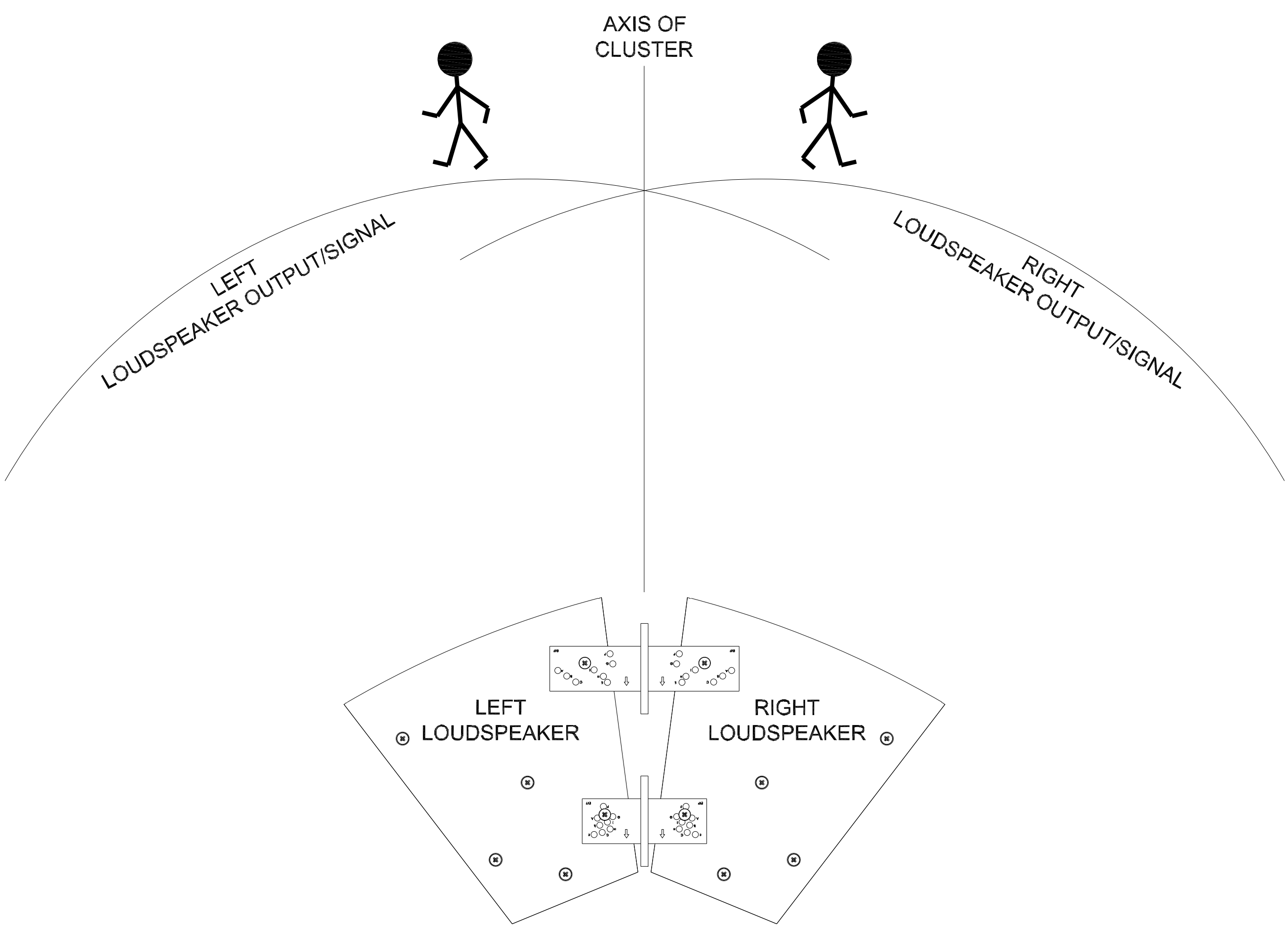


Figure 4:

The two loudspeaker sources sum perfectly only on the axis of the cluster (as shown); to the left and right of this axis, distance differences produce arrival-time differences that cause cancellation of some frequencies (see text for more details)

This effect is shown in the frequency-response of Figure 5. Given the dimensions of the typical compact loudspeaker systems and when they are clustered in close proximity to one another, the first several interference nulls occur right in the middle of the vocal range. A frequency response with these ever-more-closely spaced nulls is known as a “comb filter” response, after the visual appearance of the response.

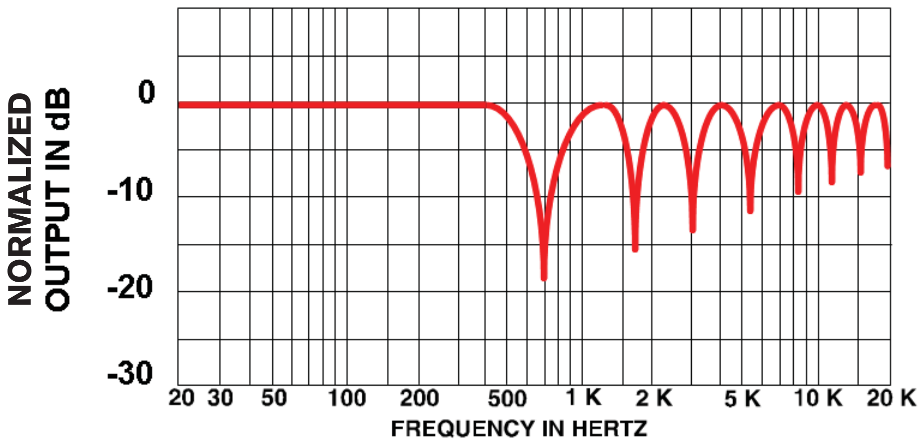


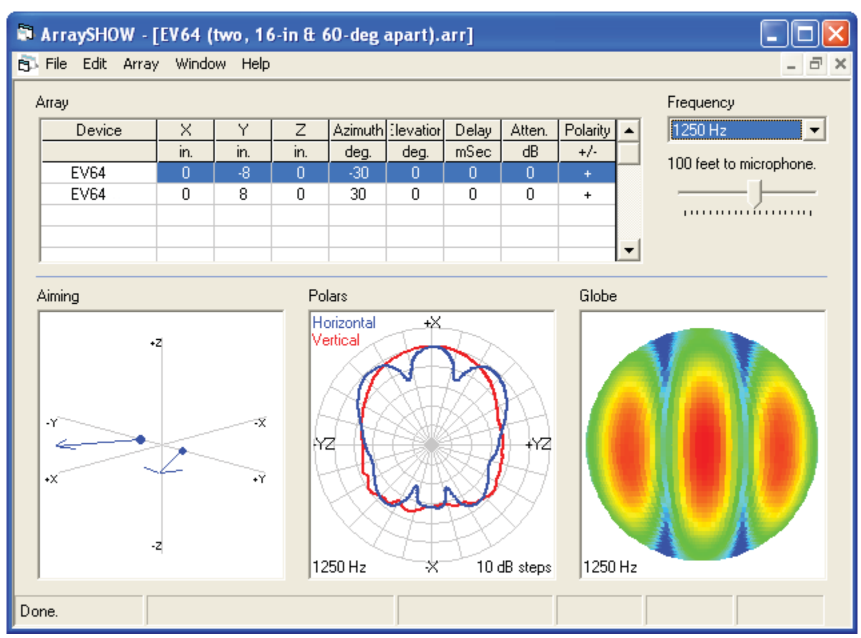
Figure 5:

Typical response off the array axis of the two loudspeakers shown in Figure 4, showing cancellations due to arrival-time differences

If one of the null frequencies is chosen and the horizontal polar response is measured, the result is shaped like the blue polar response in the center lower graph of Figure 6. In this view, the cluster axis points up (+X). Full output is achieved on this axis, since both signals arrive at the same time. But there are off-axis problems. While the overall coverage of the cluster is about 120° (6 dB down), two deep nulls occur at about 20° on either side of the cluster axis.

Figure 6:

Horizontal polar response (blue center plot) of two closely clustered 60° x 40° loudspeakers aimed 60° apart, showing the off-axis nulls at 1,250 Hz caused by multiple-source interference (see text for more details)



3.0 Designing an EVF/EVH Cluster (cont.)

At higher frequencies, the interference patterns become more densely packed, which essentially eliminates their audibility. Figure 7 shows this effect at 8,000 Hz.

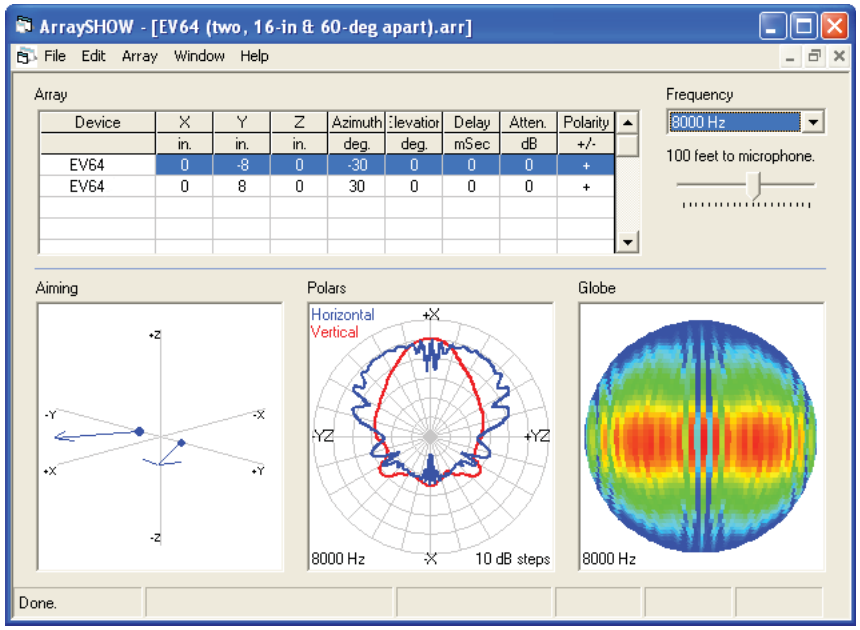


Figure 7:
Horizontal polar response (blue center plot) of two closely clustered 60° x 40° loudspeakers aimed 60° apart, showing multiple, densely packed off-axis nulls at 8,000 Hz caused by multiple-source interference (see text for more details)

3.51 Reducing Multiple-Source Interference

Multiple-source interference cannot be eliminated but it can be substantially reduced. Systems which have radiating devices large enough to hold their rated coverage angles down to relatively low frequencies, such as the horn-loaded EVH series that hold their coverage angles down to 500 Hz, will exhibit less interference in clusters. Also, doubling the distance between the two systems of Figure 8 produces multiple interference nulls which are more densely packed than those of Figure 6, reducing the audibility of the interference.

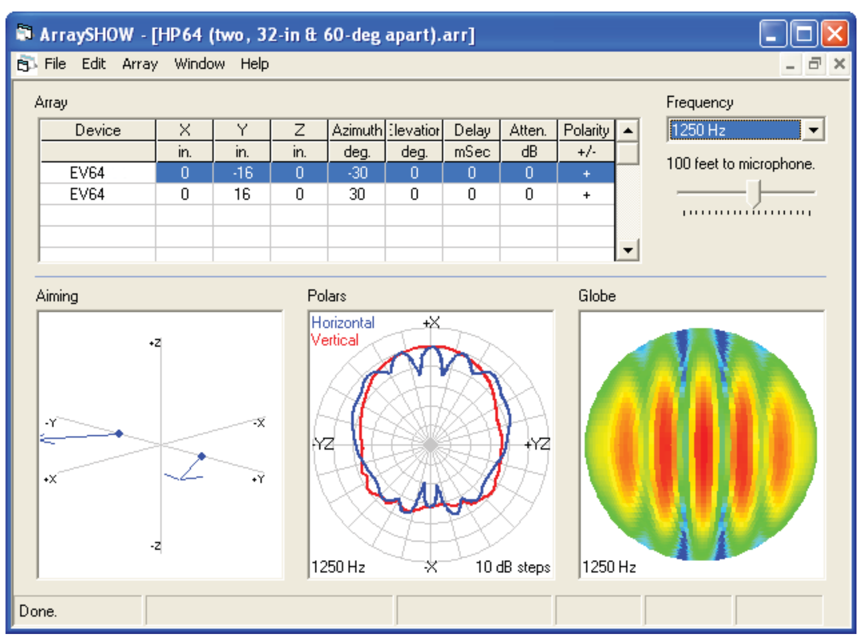


Figure 8:
Horizontal polar response (blue center plot) of two 60° x 40° loudspeakers aimed 60° apart but with double the distance between grille centers compared to Figures 6 and 7, showing the more densely packed 1,250-Hz off-axis nulls caused by multiple-source interference (see text for more details)

One clustering technique that accomplishes this separation without putting a physical space between two full-range systems is putting a low-frequency or subwoofer system between two full-range systems. Such a cluster is shown in Figure 9, assembled with the optional HRK rigging kits.

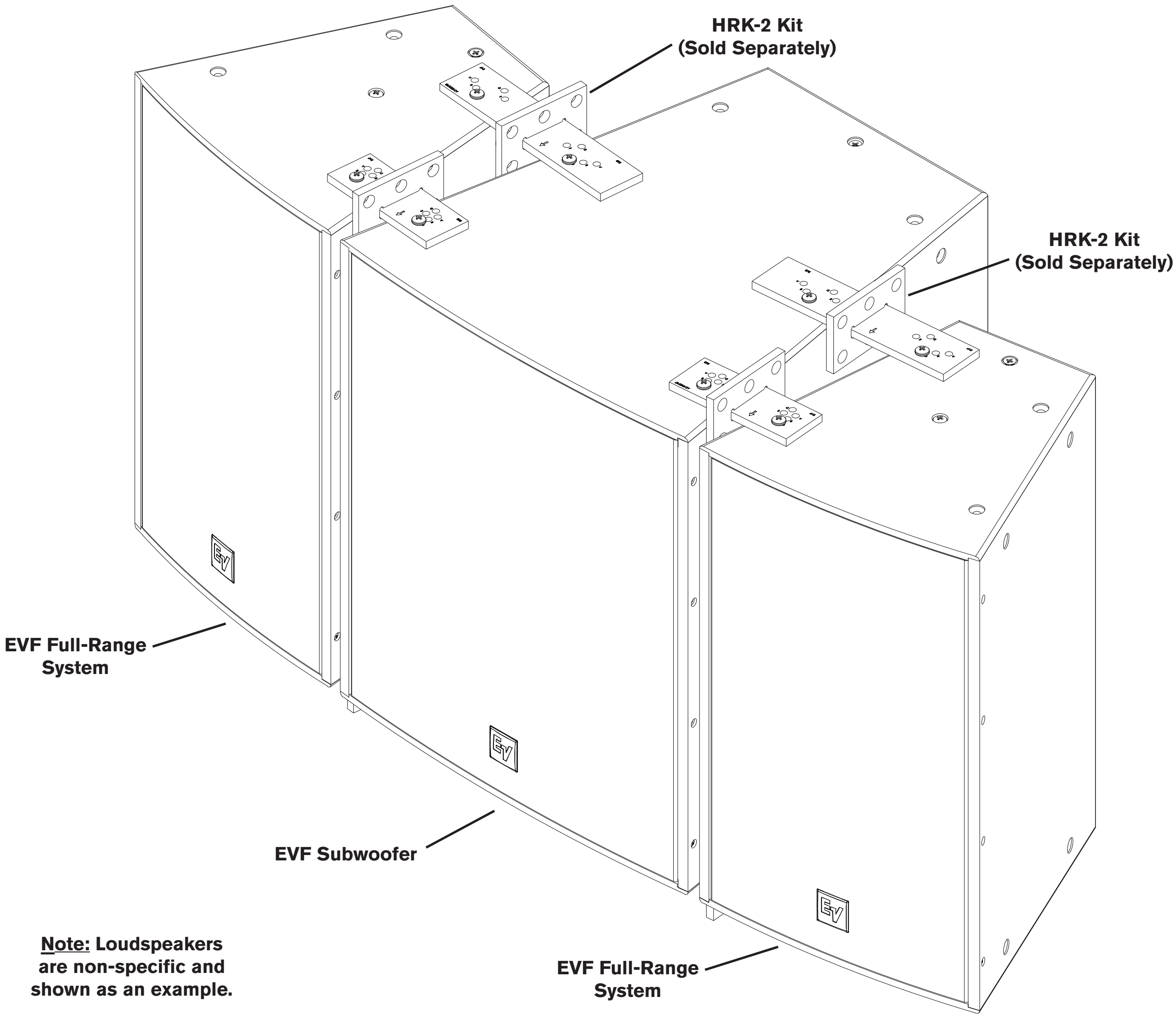


Figure 9:

A way of separating two full-range loudspeakers to reduce the audibility of multiple-source interference by separating them with a subwoofer (see text for more details)

3.0 Designing an EVF/EVH Cluster (cont.)

Finally, another way to reduce interference is to apply signal delay of up to 8 milliseconds to one of the two systems. This requires a separate DSP (digital signal processor) drive to the delayed system. Figure 10 shows the dramatic smoothing achieved at 1,250 Hz. Note that the systems are still close together as in Figure 6.

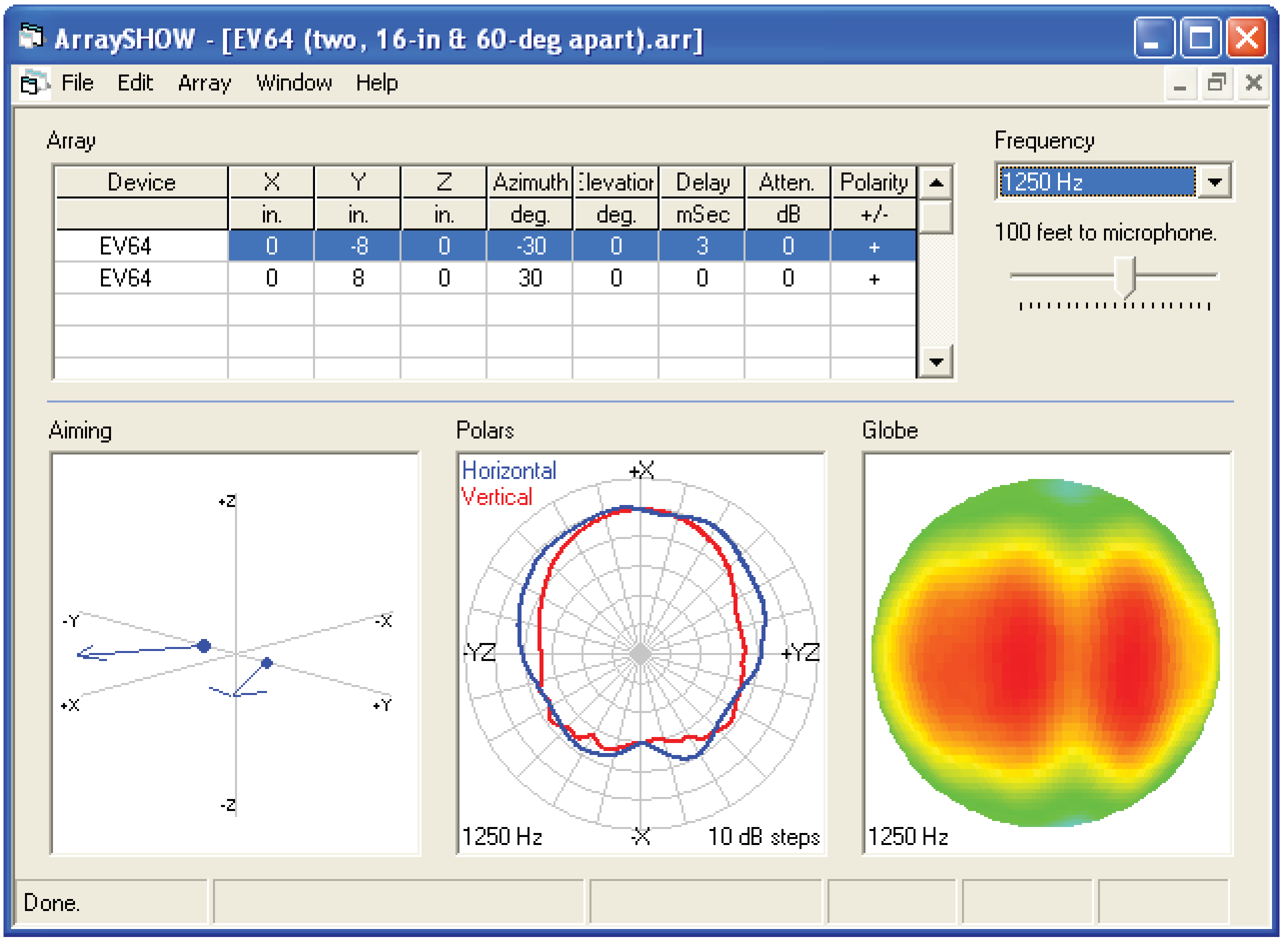


Figure 10:

Horizontal polar response (blue center plot) of two closely clustered 60° x 40° loudspeakers aimed 60° apart, showing the smoothing of multiple-source interference caused by a 3-ms delay to one loudspeaker

In clusters with more than two systems, adjacent boxes are usually delayed. While the effect can be predicted with appropriate software (such as EASE 4.2), the actual delays are typically established in the field during system setup and commissioning, by ear and measurements.

4.0 Preparing EVF and EVH Systems for Installation

4.1 Recommended Preflight Procedures

For any installed sound system, certain checks made at the installer's place of business can prevent expensive on-site delays. A short-list follows, and sets the stage for proper cluster performance:

1. Unpack all loudspeakers in the shop.
2. Check for proper model numbers.
3. Check the overall condition of the loudspeakers.
4. Check for continuity at the loudspeaker inputs.

It is a good idea, once on site and the loudspeakers are connected, to check again for continuity at the power-amplifier end.

4.2 Passive/Biamp Crossover Configuration

All two-way EVF and EVH systems are shipped in the passive crossover mode. In the center of the input panel is an external switch card that can change this configuration. See Figure 11. (Note that EVH input panels, when the systems are in their normal, slanted-sides-vertical orientation, have their long axes rotated 90° with respect to the EVF view of Figure 11.)

Figure 11:
EVF/EVH input panel as supplied, with the passive/biamp switch card in its full-range passive position (left position in picture as oriented)

4.0 Preparing EVF and EVH Systems for Installation (cont.)

To configure for biamp operation, remove the switch card by drawing it toward you using the central finger hole. (The switch can also be removed with the end of a flat-blade screwdriver, by placing the blade end in the switch hole and using the adjacent edge of the input panel as a fulcrum. To facilitate this operation, there is a small recess in the edge of the input panel adjacent to the hole in switch card.) Reinsert the switch card in its biamp-operation position (right position in the picture of Figure 11).

4.3 Rotation of High-Frequency Waveguides (EVF systems)

All high-frequency waveguides have their horizontal and vertical patterns molded in for easy identification of orientation and are rotatable according to the following procedure:

1. With a #2 Phillips screwdriver, remove the four screws on each side of the enclosure and pop the grille out.
2. With a #2 Phillips screwdriver, remove the 12 screws holding the compression-driver/ waveguide assembly.
3. Rotate the assembly 90° and reinstall.
4. Reinstall the grille.

4.4 Rotation of High-Frequency Waveguides and Mid-Frequency Waveguide Contours (EVH systems)

1. With a #2 Phillips screwdriver, remove the four screws on each side of the enclosure and pop the grille out.
2. With a #2 Phillips screwdriver, remove the four screws holding the compression-driver/HF waveguide assembly.
3. Use a 6-mm Allen (hex) wrench to remove the two rails that hold the HF waveguide assembly.
4. Use a 4-mm Allen (hex) wrench to remove the four screws holding the hard foam mid-frequency waveguide contours in place on the left and right sides of the enclosure. Figure 12 shows a contour in the process of being removed.
5. Rotate and reinstall the contours in the top and bottom of the enclosure.
6. Reinstall the two rails that hold the HF waveguide assembly.
7. Rotate and reinstall the compression-driver/HF waveguide assembly.
8. Reinstall the grille.

Figure 12:
An EVH hard foam waveguide contour being removed for reorientation

4.5 Digital Signal Processing

4.51 Full-Range Systems in Passive Mode

For full-range systems in the passive mode, the internal crossover/equalizer network sends low frequencies to the woofer and high frequencies to the compression-driver/waveguide combination. In addition, the network tailors the frequency response and levels of each individual driver so that the overall frequency response of the loudspeaker is essentially flat over its design operating range.

Once a cluster of EVF and/or EVH systems is installed in a venue, a digital signal processor (DSP) will typically be used to adjust the in-room frequency response, based on the specifics of the situation. In addition, the DSP should be used to provide the high-pass filters recommended to protect EVF and EVH systems against overdrive at frequencies below their operating range. Failure to do so could damage the low-frequency drivers if fed high-level signals below the system's operating range. Table 3 shows the recommend high-pass filter frequencies for infrasonic protection of EVF and EVH systems. Different high-pass filter frequencies are recommended for some fiberglass versions based on changes in operation range due to the effects of having a sealed enclosure.

Model(s)	Recommended High-Pass Frequency (minimum)
EVF-1122/XX	65 Hz
EVF-1152/XX	45 Hz (55 Hz for Fiberglass Versions)
EVF-1121S	50 Hz (55 Hz for Fiberglass Versions)
EVF-1151S	35 Hz (45 Hz for Fiberglass Versions)
EVF-1181S	33 Hz
EVF-2121S	45 Hz
EVF-2151D	35 Hz
EVH-1152/XX	60 Hz

Table 3:
Recommended high-pass frequencies for infrasonic protection of EVF and EVH systems

4.0 Preparing EVF and EVH Systems for Installation (cont.)

4.52 Using the EVF-1121S and EVF-1151S Low-Frequency Systems in Full-Range Clusters that Operate on a Single Power-Amplifier Channel

The EVF-1121S and EVF-1151S low-frequency systems have integral passive low-pass filters that roll off frequencies above 100 Hz at the rate of 12 dB per octave. This means that these systems can be used to augment the low-frequency output of the EVF-1122/XX and EVF-1152/XX full-range systems without the use of an external digital signal processor (DSP) for crossover from the low-frequency to the full-range systems. As many as two full-range systems can be paralleled with an EVF low-frequency system on a single power-amplifier channel capable of driving a 2.1-ohm minimum impedance.

This simplified, cost-effective configuration is most appropriate for applications that require only moderate or moderately high acoustic output. This is because the full-range systems cannot have the full infrasonic protection provided by the high-pass filters specified in Table 3. However, useful overall cluster protection will be provided by employing the high-pass frequency recommended for the particular EVF low-frequency system used.

Note that the EVF-1181S, EVF-2121S, and EVF-2151D do not incorporate a low-pass filter.

4.53 DSP (Digital Signal Processor) Loudspeaker Presets for Biamp Operation

In the biamp mode, the crossover and equalization must be achieved external to the loudspeaker. This is typically done with a digital signal processor (DSP) that has crossover and equalization filters that are adjusted by the manufacturer to provide the essentially flat frequency response mentioned above. The factory presets for the EVF and EVH loudspeakers have been determined for Electro-Voice processors and are available for download at www.electrovoice.com. Presets for other popular processors often can be provided by the Bosch Communications Systems/Electro-Voice technical support group; specific contact information can be found at www.electrovoice.com.

By providing a single loudspeaker system with uniform frequency response, the loudspeaker presets are a good starting point for equalizing a cluster of systems during setup and commissioning. Final equalization of a cluster should be accomplished with additional equalization made in front of the DSP device, not by modifying the preset crossover and equalization parameters in the low- and high-frequency outputs of the DSP. The later is likely to produce undesirable frequency-response and directivity changes in the crossover region.

5.0 EVF and EVH Rigging System

5.1 Introduction

5.11 The Flying EV-Innovation (EV-I) Loudspeaker System

All EVH and EVF loudspeaker systems incorporate heavy-duty M10-1.5 threaded attachment points on each enclosure. These attachment points work in conjunction with (1) the M10 eyebolts included with each loudspeaker or (2) the optional VRK and HRK rigging kits. The rigging kits allow the user to rig multiple systems together in horizontal and vertical configurations. The horizontal and vertical rigging kits are an open-ended design, meaning that any system in the EVF and EVH families can rig to any other. The vertical and horizontal rigging plates give the user ultimate flexibility for splay angles from 0° to 45° degrees in 5° increments (0° to 20° for EVF to EVF subwoofer). This system was designed to allow the end user to construct a loudspeaker cluster to fit nearly any application. Figure 13 and Table 4 show the possible connections using the three VRK and HRK rigging kits to connect any EVF or EVH loudspeaker.

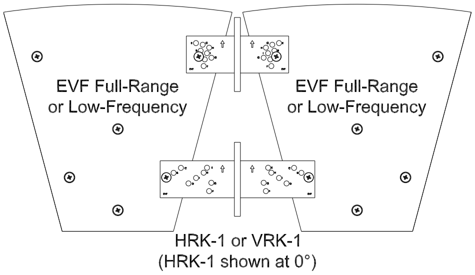


Figure 13a:
VRK-1 or HRK-1 connection

Model	Orientation	Color	Function
VRK-1B/ VRK-1W	Vertical Cluster	Black/ White	EVF full-range and low-frequency systems
HRK-1B/ HRK-1W	Horizontal Cluster	Black/ White	EVF full-range and low-frequency systems

Table 4a:
VRK-1 or HRK-1 connection

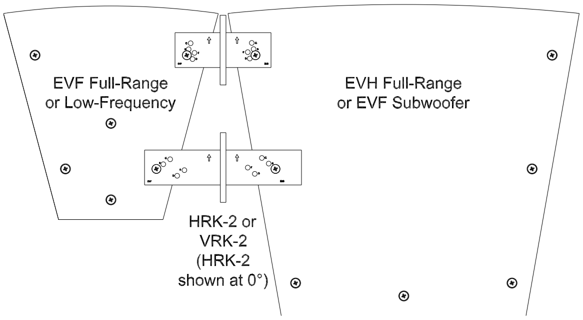


Figure 13b:
VRK-2 or HRK-2 connection

Model	Orientation	Color	Function
VRK-2B/ VRK-2W	Vertical Cluster	Black/ White	EVF full-range or low-frequency systems to EVF subwoofer or EVH full-range
HRK-2B/ HRK-2W	Horizontal Cluster	Black/ White	EVF full-range or low-frequency systems to EVF subwoofer or EVH full-range
Plates may need to be flipped depending on which side is being connected, due to asymmetry of the plates.			

Table 4b:
VRK-2 or HRK-2 connection

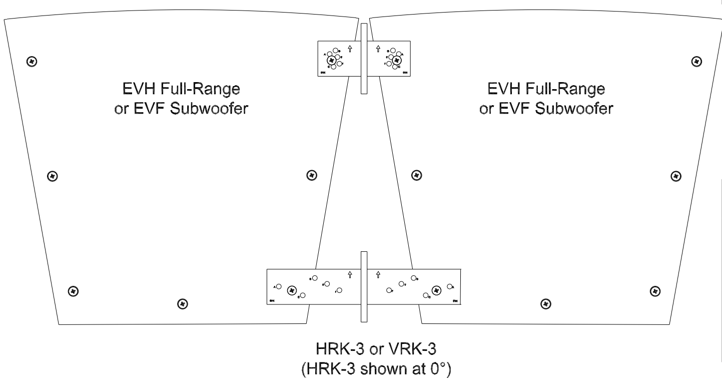


Figure 13c:
VRK-3 or HRK-3 connection

Model	Orientation	Color	Function
VRK-3B/ VRK-3W	Vertical Cluster	Black/ White	EVF subwoofer and EVH full-range
HRK-3B/ HRK-3W	Horizontal Cluster	Black/ White	EVF subwoofer and EVH full-range

Table 4c:
VRK-3 or HRK-3 connection

5.0 EVF and EVH Rigging System (cont.)

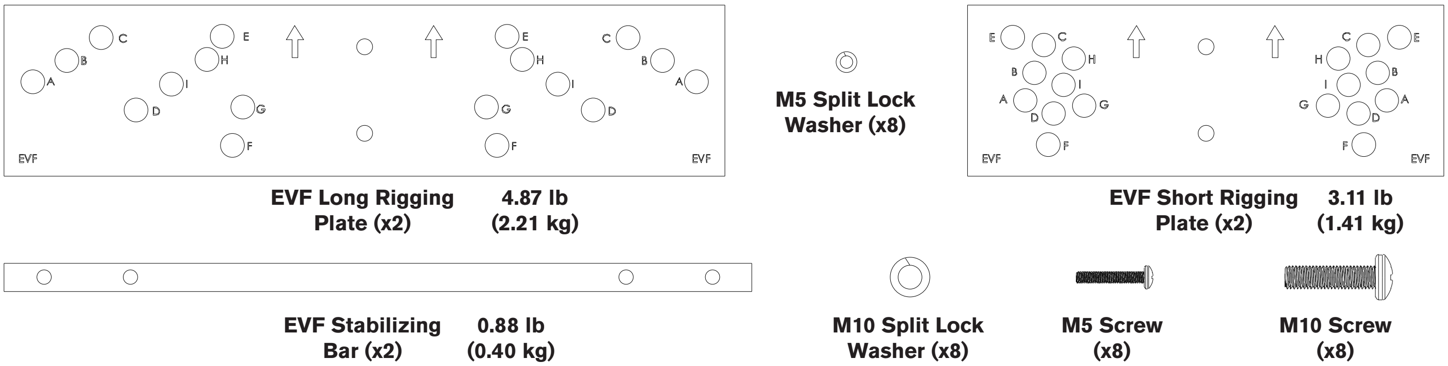


Figure 14a:
VRK-1 rigging kit with parts identified

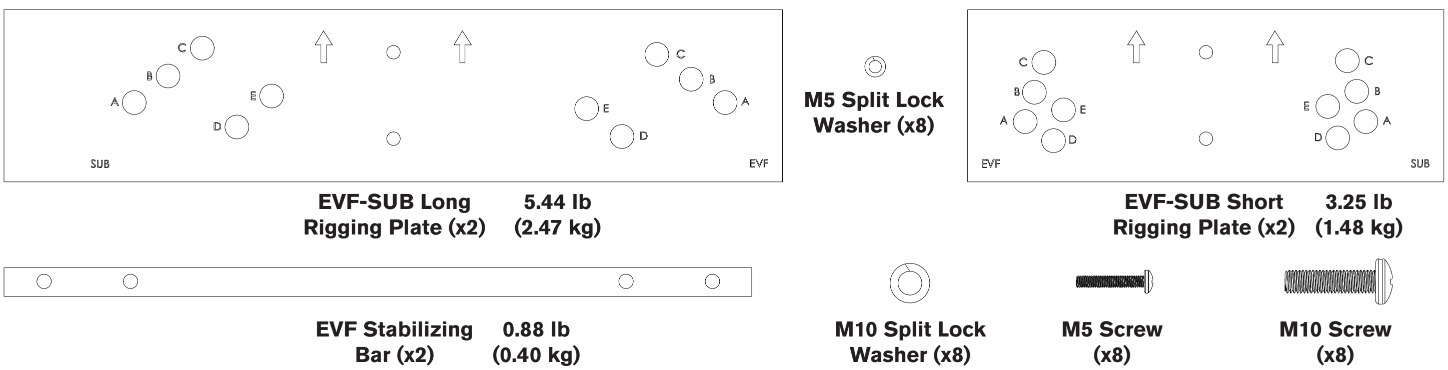


Figure 14b:
VRK-2 rigging kit with parts identified

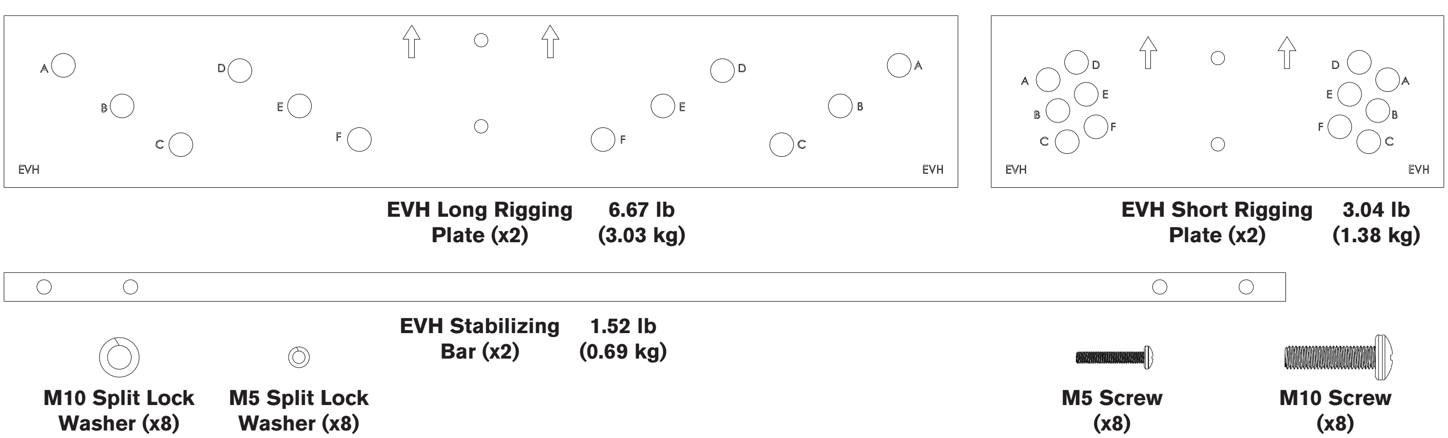


Figure 14c:
VRK-3 rigging kit with parts identified

5.0 EVF and EVH Rigging System (cont.)

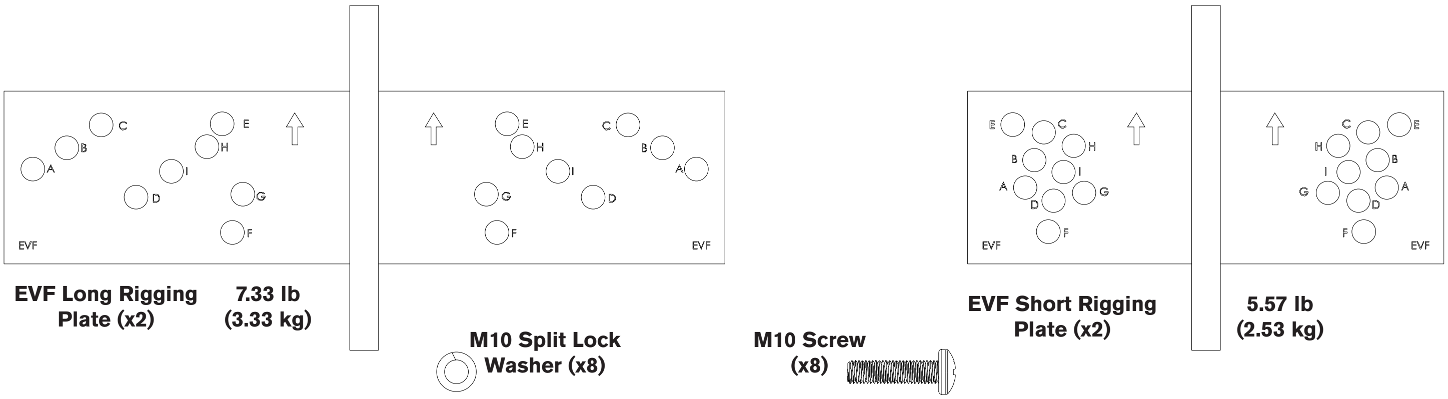


Figure 15a:
HRK-1 rigging kit with parts identified

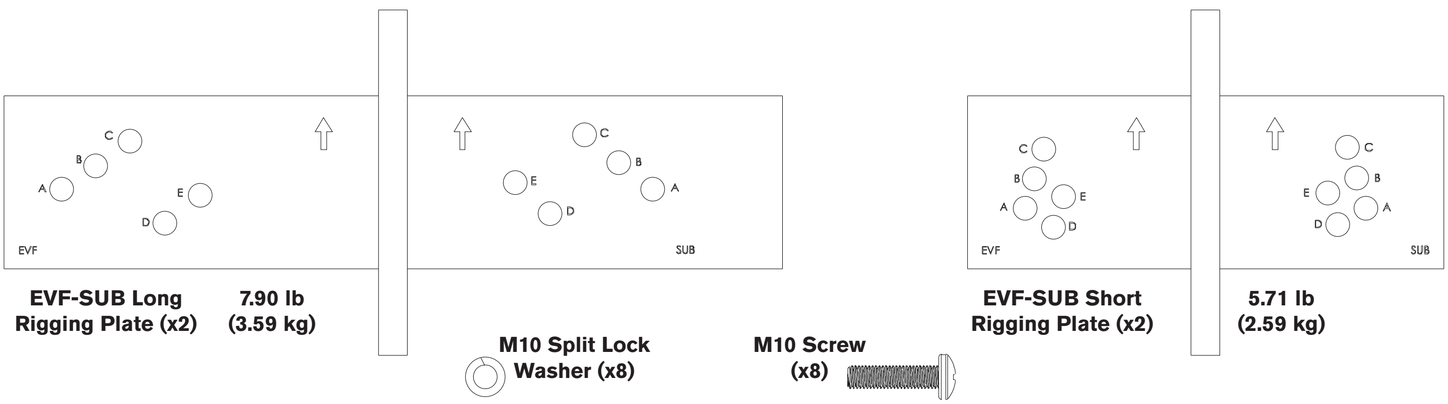


Figure 15b:
HRK-2 rigging kit with parts identified

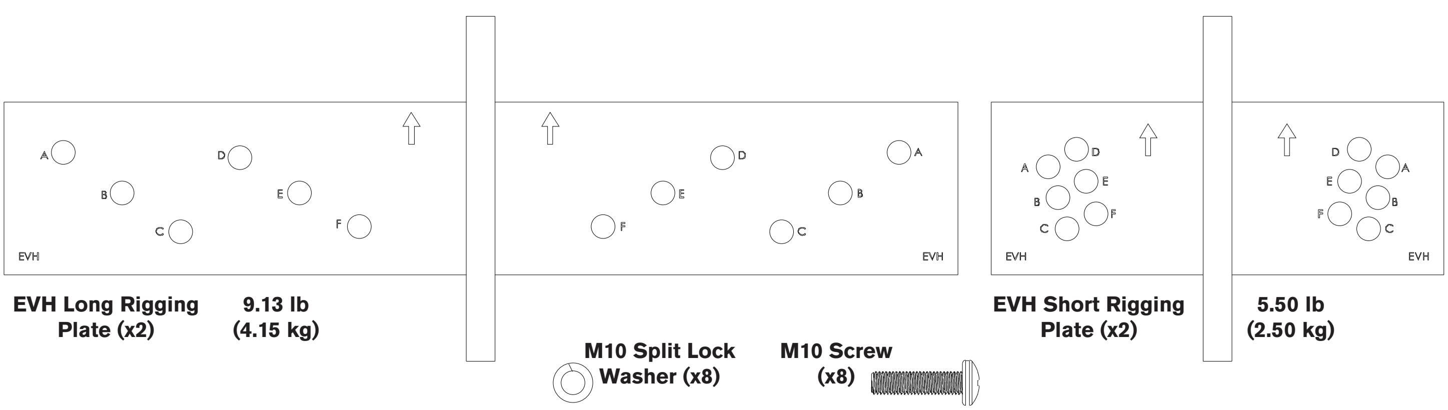


Figure 15c:
HRK-3 rigging kit with parts identified

5.0 EVF and EVH Rigging System (cont.)

5.12 Important Details that Apply to the VRK and HRK Rigging Kits

Both the VRK and HRK kits include all necessary mounting hardware (as shown in Figures 14 and 15). Additionally, the VRK kits include a set of low-profile stabilizer bars to both simplify alignment of the enclosures during the rigging process and keep the front edges of the systems neatly aligned. Additional hardware is included in the VRK kits to mount these stabilizer bars. The stabilizer bars mount to the insides of the vertical rigging plates for a clean appearance. Stabilizer bars can be seen in Figure 14 and, installed, in Figure 21.

The HRK horizontal rigging kits have a tie plate that is welded to the center of the rigging plate. This tie plate is for suspending the top systems in a cluster and for suspending lower systems below (with user-supplied hardware). It has six holes that fit a standard 5/8-inch shackle (user supplied). Tie plates can be seen in Figure 15 and, installed, in Figure 22.

Both the VRK and the HRK rigging plates use arrow designators and a series of letters by each of the mounting holes to ensure that the desired angle is achieved. Refer to Tables 5, 6, and 7 for a description of the appropriate arrow direction and letter.

All rigging plates except the EVF-to-EVF-subwoofer rigging plates are symmetrical, meaning that the mounting-hole layouts are the same from the left to the right sides of the rigging plate. The EVF-to-EVF-subwoofer rigging plates are asymmetrical, meaning that one side is for subwoofers, labeled “Sub,” and the other side is for EVF’s, labeled “EVF.” This rigging plate must be flipped over depending on which side the subwoofer is on. This asymmetry is shown in Figure 15b.

All user-supplied hardware must be overhead load-rated (using applicable safety factors) for the specific cluster. See section 6.0 for additional details on load limits and safety factors.

5.2 EV-I Rigging Primer

The following sections describe the clustering of EVF and EVH systems using one of the following three approaches:

1. EVI-M10K eyebolt kits supplied with each system (used in conjunction with other user-supplied hardware).
2. Optional VRK vertical rigging kits, in conjunction with the supplied eyebolt kits and user-supplied hardware.
3. Optional HRK horizontal rigging kits, in conjunction with the supplied eyebolt kits and user-supplied hardware.

In all cases, note that the weight of the cluster can be substantial and the building structure must be capable of supporting the weight. (System weights are given in Figure 1.)

The optional VRK and HRK rigging kits are the most convenient way to assemble EVF and EVH clusters, offering a great deal of flexibility in box aiming angles. Using the supplied eyebolt kits with additional user-supplied hardware is more difficult, but does allow the most flexibility, since not only can box aiming angles be determined but also the boxes can be rotated about their aiming axes, which can improve coverage uniformity in certain venue shapes (EASE 4.2 allows this option).

5.0 EVF and EVH Rigging System (cont.)

5.21 Anatomy of an EVF or EVH Flying System Using M10 Eyebolts

5.211 Eyebolt Application Warnings

NO EYEBOLT SHOULD BE MOUNTED IN THE SIDES OF ANY EVF OR EVH ENCLOSURE IN ORDER TO SUSPEND A SYSTEM OR CLUSTER FROM THE TOP.

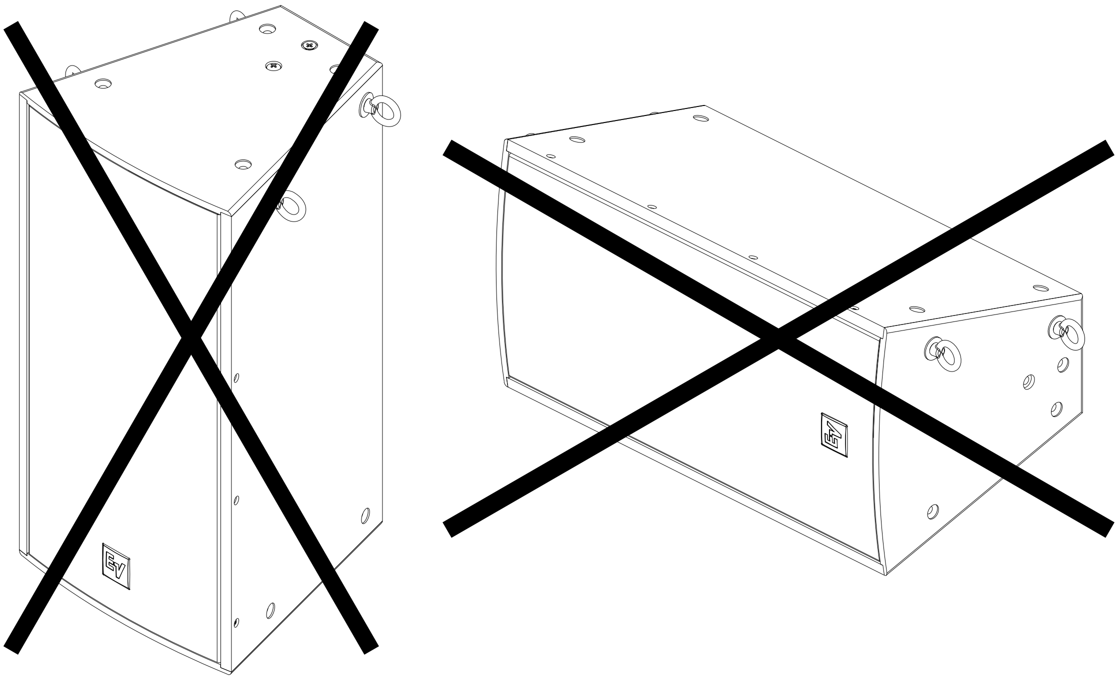


Figure 16:
Eyebolts installed __incorrectly__ in the sides of an enclosure in order to suspend it from above

EYEBOLTS MUST BE FULLY SEATED AND ORIENTED IN THE PLANE OF PULL AS SHOWN IN FIGURE 17. ALWAYS USE WASHERS TO DISTRIBUTE SUSPENSION LOADS. REFER TO SECTION 6.3 FOR SPECIFIC EYEBOLT WEIGHT AND ANGLE RESTRICTIONS.

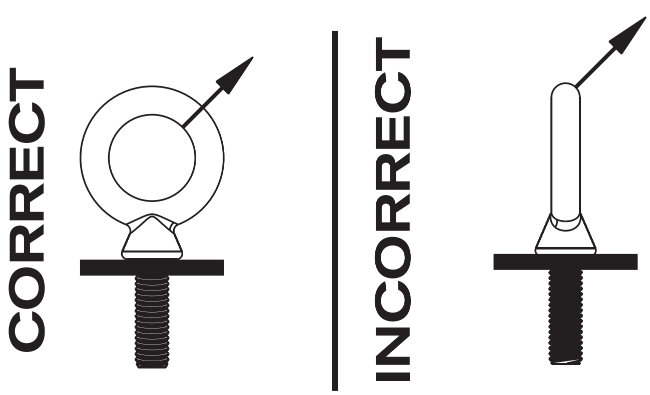


Figure 17:
Illustration showing the use of washers with fully seated eyebolts, with correct orientation in the plane of pull

5.0 EVF and EVH Rigging System (cont.)

5.212 Eyebolt Installation

Installation instructions follow:

1. Remove the M10 flat-head bolts from the enclosure (see Figure 18a).
2. Screw the lifting eyebolt with fender washer into the threaded attachment point until the fender washer has contacted the enclosure (see Figure 18b).
3. Continue to finger tighten the eyebolt until the correct alignment position is obtained, a maximum of one complete turn.
4. All hardware supplied by the user must be rated for overhead lifting to suspend the loudspeaker system.
5. Never install the eyebolt without the factory-supplied washer.

Eyebolts must be fully seated and oriented in the plane of pull (see section 5.211 Eyebolt Application Warnings, Figure 17). Always use the factory-supplied fender washer to distribute the load on the enclosure. Over tightening the eyebolt with a wrench, screwdriver, etc., can result in a system failure and possible injury.

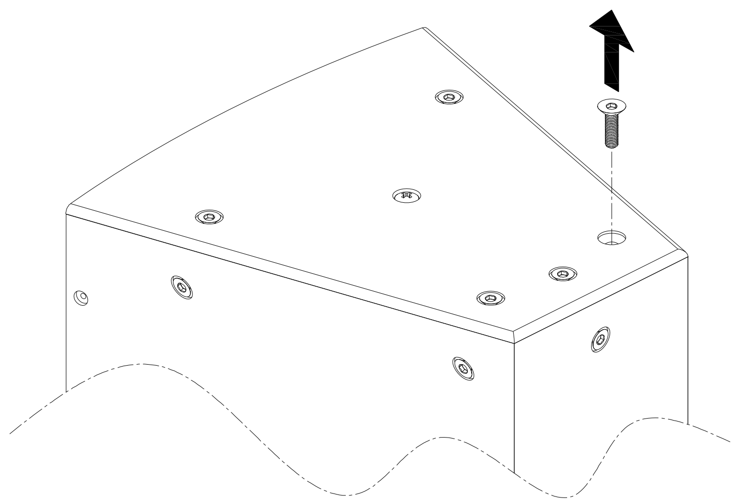


Figure 18a:
Removal of the flat-head bolts from the enclosure

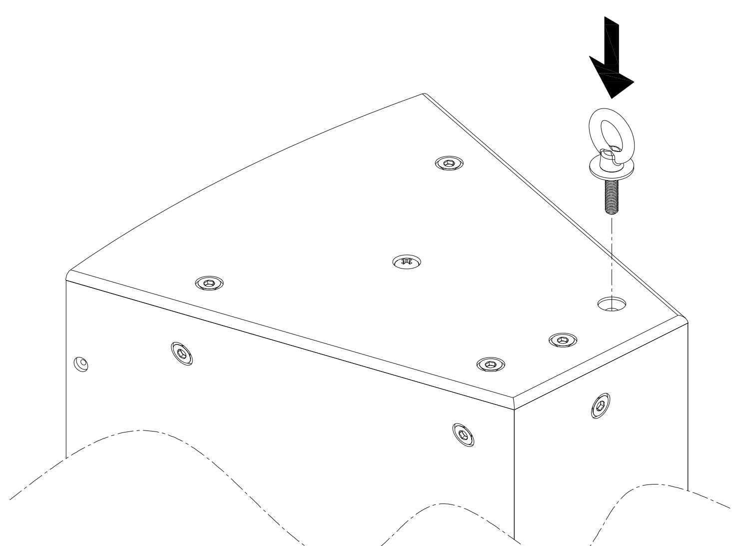


Figure 18b:
Installation of eyebolts and washers to the enclosure

5.213 All-Eyebolt Clusters

A basic two-cabinet flying system is shown in Figures 19 and 20, illustrating the components necessary to make a typical two-system horizontal or vertical cluster using M10 eyebolts. Secure cabinets to the building structure with user-supplied hardware. All user-supplied hardware, shackles, wire rope, bolt connectors, etc., must be rated for overhead lifting. Refer to section 1 for suspension point locations.

A second enclosure may be suspended from the first by using the same M10 rigging points on the second enclosure. Connection between the two enclosures through the M10 eyebolts requires hardware supplied by the end user. All user-supplied hardware must be rated for overhead lifting. The angle between the two enclosures as well as the angle between the first enclosure and the structure can be controlled by the length of the user-supplied hardware. If the desired angle cannot be achieved by varying the length of this hardware, then pull-back points can be used. It is recommended that both the top and the second box use a pull back. The pull back can be achieved with the use of additional M10 eyebolts at the back of the enclosures. The hardware used to achieve the pull back is supplied by the end user.

A MAXIMUM OF TWO ENCLOSURES IS ALLOWED WITH ALL-EYEBOLT CLUSTERS.
A MINIMUM OF TWO EYEBOLTS ARE REQUIRED FOR SUSPENSION OF ALL-EYEBOLT CLUSTERS.

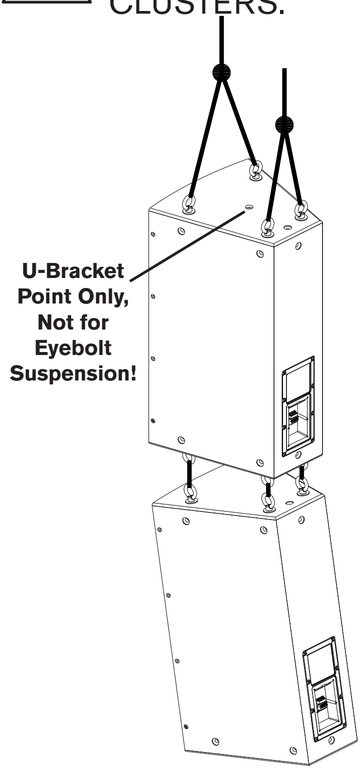


Figure 19a:
A two-system vertical cluster using the eyebolt kit supplied with each system plus user-supplied hardware (not shown), using a moderate trim angle

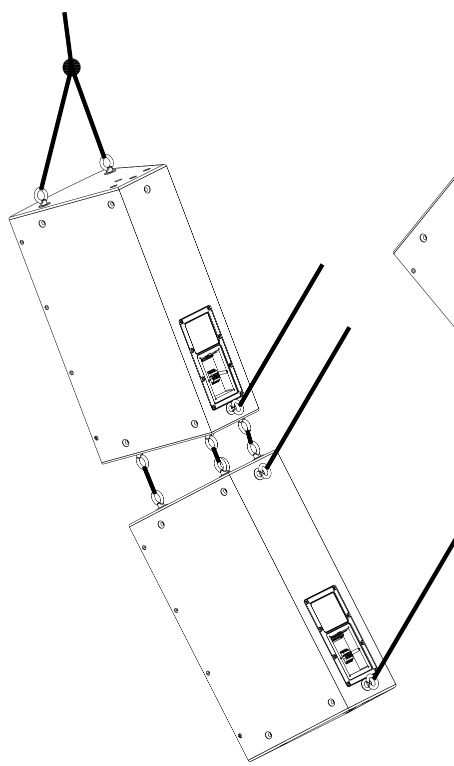


Figure 19b:
A two-system vertical cluster using the eyebolt kit supplied with each system plus user-supplied hardware (not shown), using a more extreme trim angle

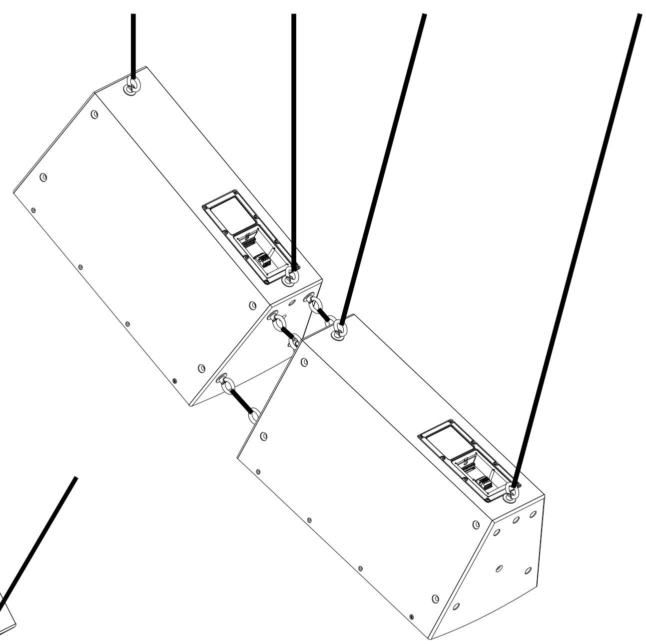


Figure 19c:
A two-system vertical cluster using the eyebolt kit supplied with each system plus user-supplied hardware (not shown), using an extreme trim angle

5.0 EVF and EVH Rigging System (cont.)

A horizontal two-cabinet eyebolt hang, shown in Figure 20, is similar to a vertical hang (shown in Figure 19), but with the cabinets rotated and other surfaces used for mounting eyebolts.

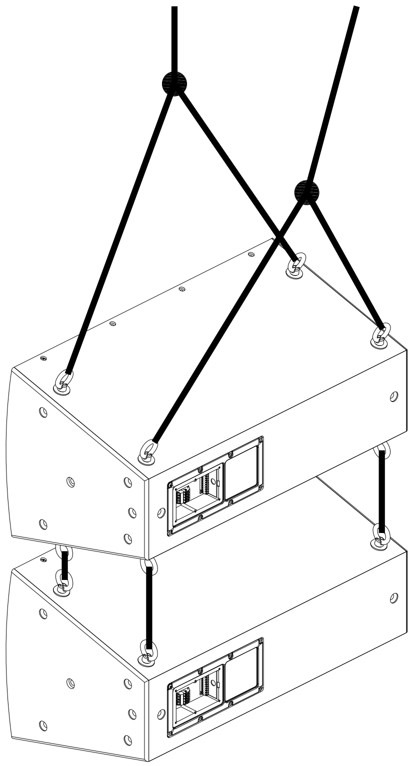


Figure 20a:
A two-system horizontal cluster using the eyebolt kit supplied with each system plus user-supplied hardware (not shown), using a moderate trim angle

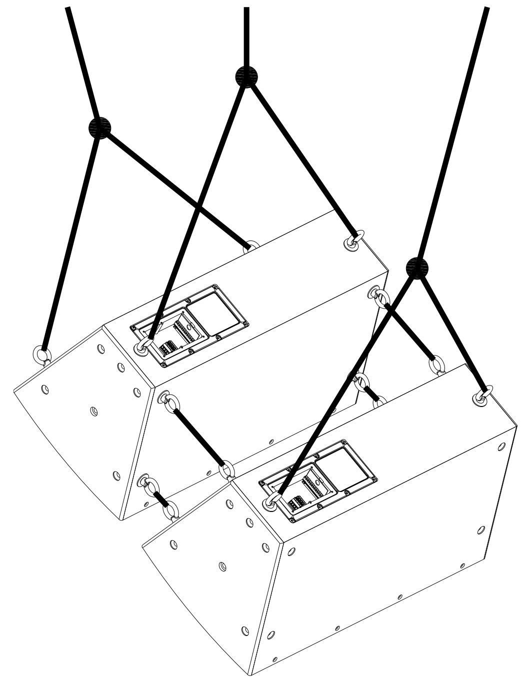


Figure 20b:
A two-system horizontal cluster using the eyebolt kit supplied with each system plus user-supplied hardware (not shown), using a more extreme trim angle

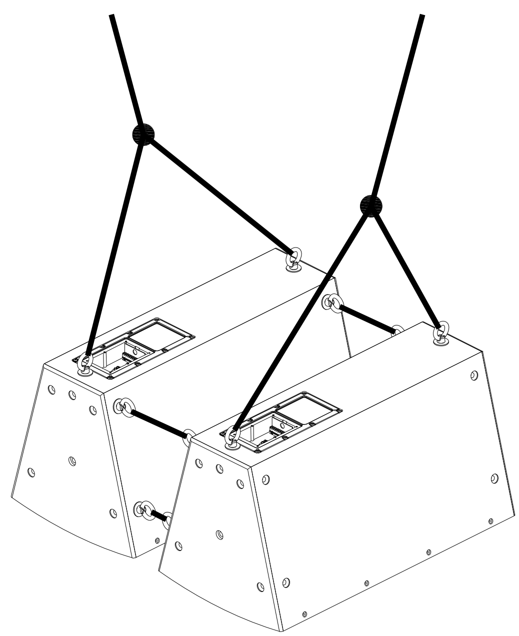


Figure 20c:
A two-system horizontal cluster using the eyebolt kit supplied with each system plus user-supplied hardware (not shown), using an extreme trim angle

5.0 EVF and EVH Rigging System (cont.)

5.22 VRK Kits and Vertically Rigged Clusters

A basic three-enclosure vertical hang is shown in Figure 21. The following components are necessary to construct this cluster:

1. One VRK-1 vertical rigging kit for EVF to EVF.
2. One VRK-2 vertical rigging kit for EVF to EVF subwoofer.
3. Four M10 eyebolts from the supplied EVI-M10K eyebolt kit (to suspend the top cabinet).

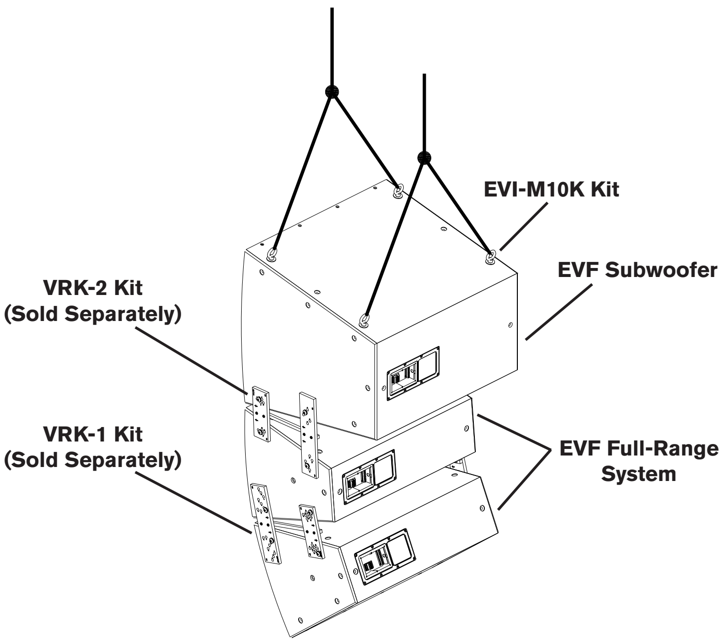


Figure 21a:
Basic three-enclosure vertical hang of an EVF subwoofer on top and two EVF full-range systems below, using one each VRK-1 and VRK-2 kits (optional accessories) and four eyebolts (supplied with systems), using a moderate trim angle

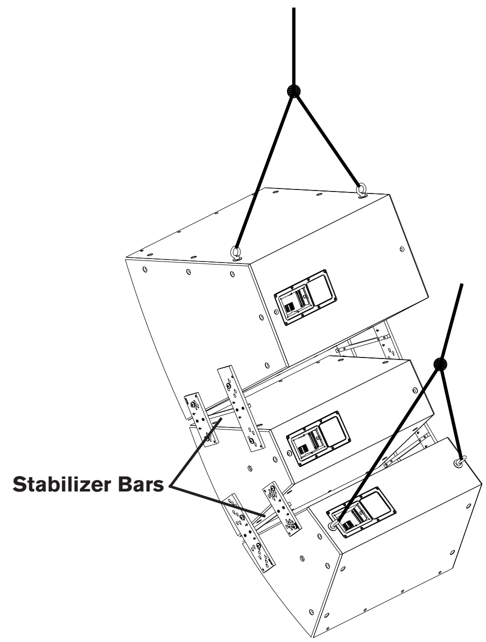


Figure 21b:
Basic three-enclosure vertical hang of an EVF subwoofer on top and two EVF full-range systems below, using one each VRK-1 and VRK-2 kits (optional accessories) and four eyebolts (supplied with systems), using a more extreme trim angle

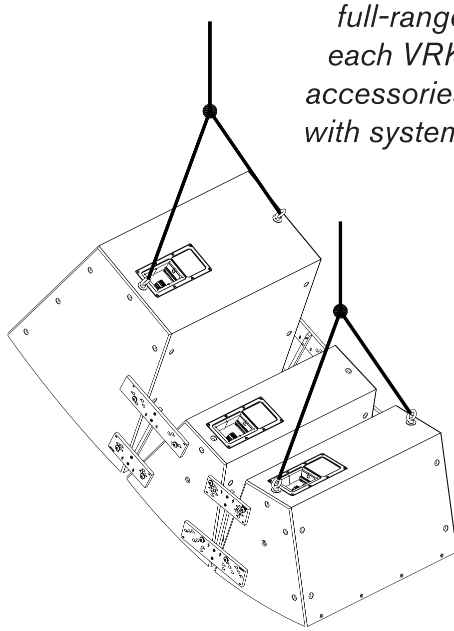


Figure 21c:
Basic three-enclosure vertical hang of an EVF subwoofer on top and two EVF full-range systems below, using one each VRK-1 and VRK-2 kits (optional accessories) and four eyebolts (supplied with systems), using an extreme trim angle

5.0 EVF and EVH Rigging System (cont.)

5.23 HRK Kits and Horizontally Rigged Clusters

The main difference between the HRK and the VRK rigging kits is the addition of a tie plate in the center of the rigging plate. Tie plates are identified in Figure 22.

MAIN SUSPENSION LINES AND PULL BACKS MUST BE TIED TO THE TIE PLATES.

Enclosures may be suspended below using the HRK rigging kits. Connection between the enclosures through the tie plates within the HRK kits requires hardware supplied by the end user. All user-supplied hardware must be rated for overhead lifting. The angle between the two enclosures as well as the angle between the first enclosure and the structure can be controlled by the length of the user-supplied hardware. If the desired angle cannot be achieved by varying the length of this hardware, then pull-back points can be used. It is recommended that both the top and the second box use a pull back. A pull back can be achieved through the use of attachment to the tie plates. Stabilization can be achieved through the use of M10 eyebolts at the back of the enclosures. The hardware used to achieve the pull back is supplied by the end user.

A basic two-over-two cluster is shown in Figure 22.

NOTE THAT THE HRK KITS ARE DESIGNED TO MAKE WEIGHT-SYMMETRICAL CLUSTERS, I.E., THOSE WHOSE LEFT-TO-RIGHT CENTER OF GRAVITY IS IN THE CENTER OF THE CLUSTER.

The following components are needed to achieve this cluster:

1. Two HRK-1 horizontal rigging kits for EVF to EVF.
2. User-supplied hardware to link the upper cluster to the lower cluster.

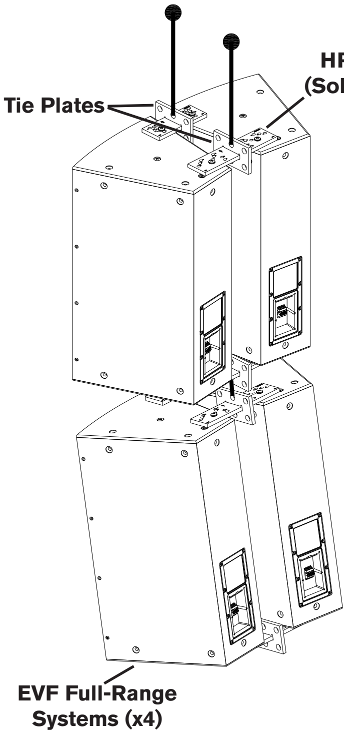


Figure 22a:
A four-enclosure horizontal hang of two EVF full-range systems above and two EVF full-range systems below, connected by two HRK-1 kits (optional accessories) and user-supplied hardware to link both clusters, using a moderate trim angle

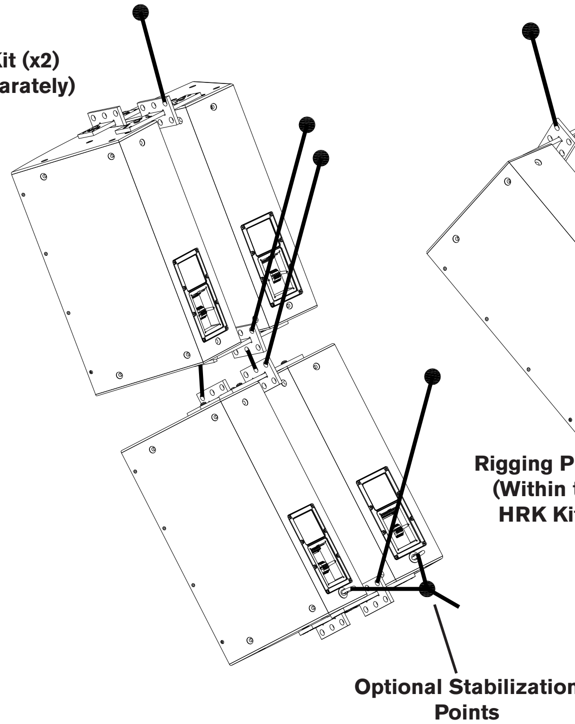


Figure 22b:
A four-enclosure horizontal hang of two EVF full-range systems above and two EVF full-range systems below, connected by two HRK-1 kits (optional accessories) and user-supplied hardware to link both clusters, using a more extreme trim angle

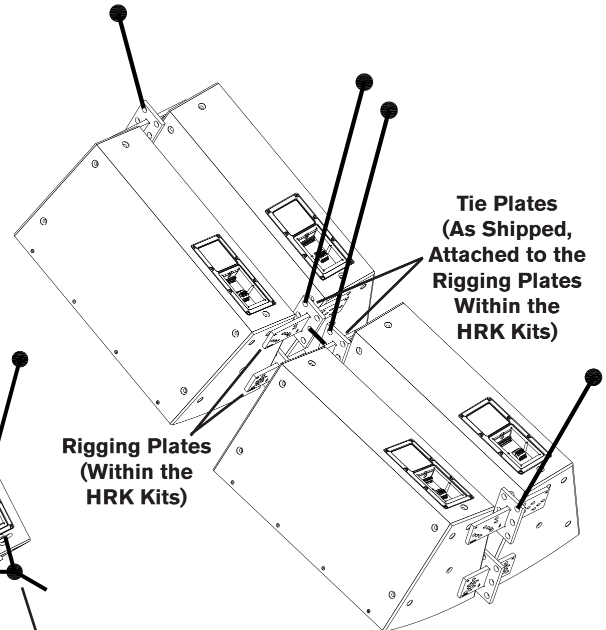


Figure 22c:
A four-enclosure horizontal hang of two EVF full-range systems above and two EVF full-range systems below, connected by two HRK-1 kits (optional accessories) and user-supplied hardware to link both clusters, using an extreme trim angle

A basic three-over-three cluster is shown in Figure 23.

⚠ MAIN SUSPENSION LINES AND PULL BACKS MUST BE TIED TO THE TIE PLATES.

⚠ NOTE THAT THE HRK KITS ARE DESIGNED TO MAKE WEIGHT-SYMMETRICAL CLUSTERS, I.E., THOSE WHOSE LEFT-TO-RIGHT CENTER OF GRAVITY IS IN THE CENTER OF THE CLUSTER.

The following components are needed to achieve this cluster:

1. Four HRK-2 horizontal rigging kits for EVF to EVF subwoofer/EVH.
2. User-supplied hardware to link the upper cluster to the lower cluster.

5.0 EVF and EVH Rigging System (cont.)

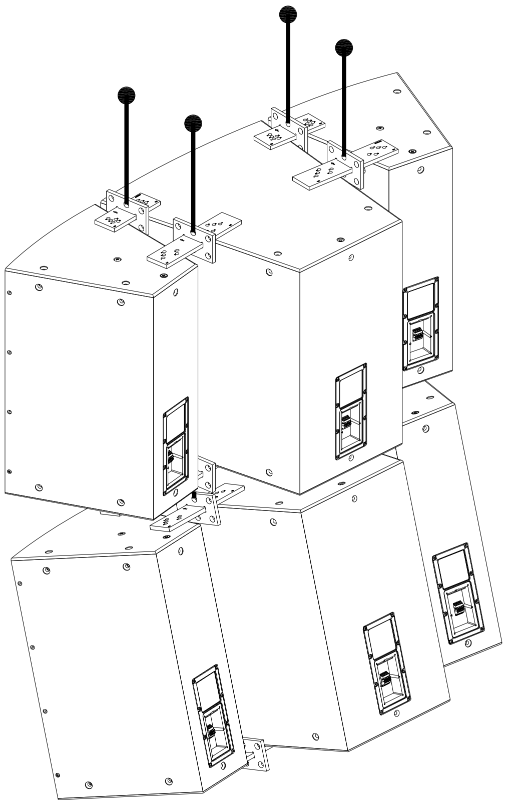


Figure 23a:
A six-enclosure horizontal hang of three systems above and three systems below, connected by four HRK-2 kits (optional accessories) and user-supplied hardware to link both clusters, using a moderate trim angle

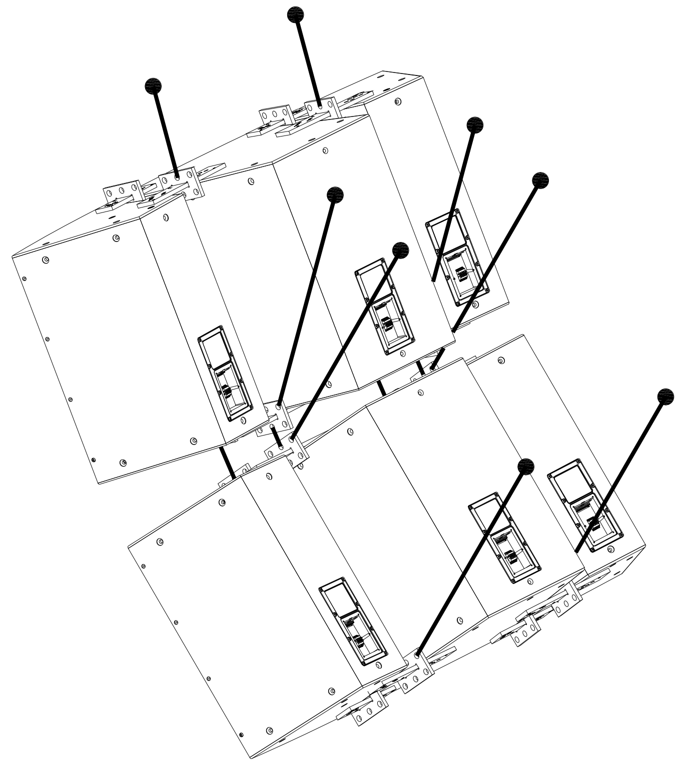


Figure 23b:
A six-enclosure horizontal hang of three systems above and three systems below, connected by four HRK-2 kits (optional accessories) and user-supplied hardware to link both clusters, using a more extreme trim angle

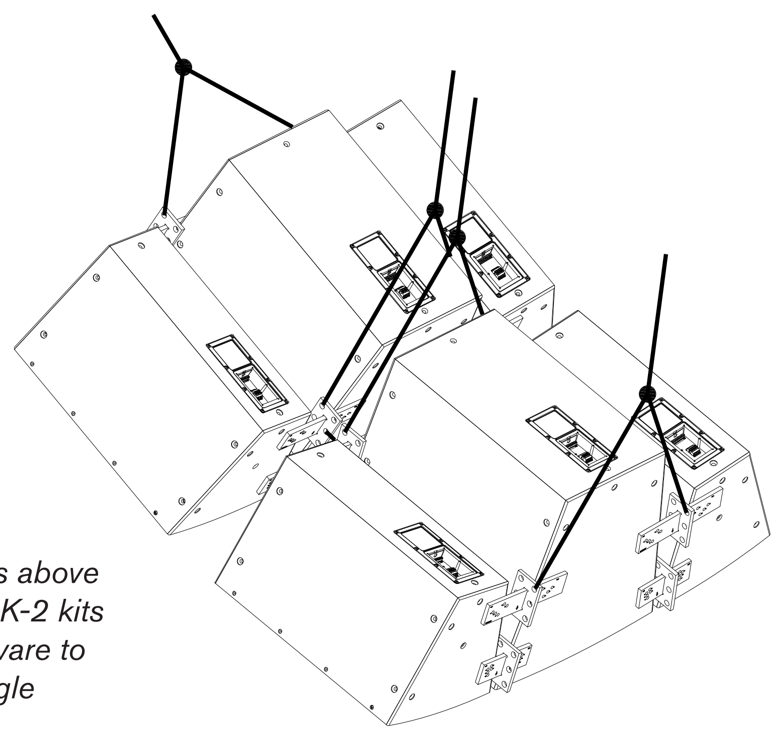


Figure 23c:
A six-enclosure horizontal hang of three systems above and three systems below, connected by four HRK-2 kits (optional accessories) and user-supplied hardware to link both clusters, using an extreme trim angle

5.0 EVF and EVH Rigging System (cont.)

5.24 Assembly Instructions for VRK and HRK kits

Both the VRK and HRK rigging kits share the same mounting hole positions and letter designations. Tables 5, 6, and 7 apply to both the VRK and HRK kits. The only difference between the kits is the HRK rigging plates have an integral tie plate and the VRK kits use a stabilizing bar.

1. Refer to Tables 5, 6, or 7 to determine which lettered hole position to use. Follow the directions in these tables for arrow direction and positioning on the cabinet. Note that "Front" will always refer to the front of the enclosure (i.e., the grille).
2. HRK kits skip to step 3. For VRK kits, preassemble them using the supplied hardware by attaching the stabilizer bar to both the large and small rigging plates. Attach the stabilizer bars to the back side of the plates, using a #2 Phillips screwdriver, the eight M5 pan-head machine screws and M5 split-lock washers supplied with the hardware kit. You are now ready to attach the VRK kits to the loudspeakers.
3. Referring to Tables 5, 6 or 7 (depending on which systems are being connected), find which rigging-plate letter will give you the desired angle. Also pay attention to the arrow direction as listed in the table.
4. With a 6-mm Allen (hex) wrench, remove the M10 flathead bolts that were installed by the factory. Remove only those bolts that are going to be replaced by rigging hardware, in order to remain safe and avoid audible enclosure leaks.
5. Using the appropriately lettered rigging-plate holes, attach the VRK or HRK kits to the enclosure sides using the eight supplied M10 button-head bolts and split-lock washers. Use a 6-mm Allen (hex) wrench.
6. Install any M10 eyebolts that are needed for suspension, pull back, or stabilization at this time.
7. Ensure that all M10 bolt points in the enclosure have an M10 flathead bolt, an M10 eyebolt or an M10 button-head bolt where the rigging plates attach. Do not hang any cluster with missing M10 bolts!
8. Check all M10 and M5 fasteners and eyebolts to ensure they are tight.
9. You are now ready to hoist the cluster and make the final attachments to the building structure.

5.0 EVF and EVH Rigging System (cont.)

Table 5:
For clustering EVF full-range and low-frequency (not subwoofer) systems using VRK-1 or HRK-1 rigging kits

Letter	Rigging-Plate Position	Arrow Direction (both rigging plates)	Angle	Hole-to-Hole Dim. (Short Bar/Long Bar)
A	Short in front	Toward grille	0°	6.276” [159.41mm] 11.518” [292.56mm]
B	Short in front	Toward grille	5°	5.958” [151.33mm] 10.338” [262.59mm]
C	Short in front	Toward grille	10°	5.630” [143.00mm] 9.144” [232.26mm]
D	Short in front	Toward grille	15°	5.292” [134.42mm] 7.934” [201.52mm]
E	Long in front	Toward input panel	20°	6.710” [170.43mm] 4.946” [125.63mm]
F	Long in front	Toward input panel	25°	5.476” [139.09mm] 4.592” [116.64mm]
G	Long in front	Toward input panel	30°	4.230” [107.44mm] 4.228” [107.39mm]
H	Long in front	Toward input panel	35°	4.592” [116.64mm] 5.472” [138.99mm]
I	Long in front	Toward input panel	40°	4.946” [125.63mm] 6.708” [170.38mm]
D	Long in front	Toward input panel	45°	5.292” [134.42mm] 7.934” [201.52mm]

Table 6:
For clustering EVF full-range and low-frequency systems to EVF subwoofers and EVH using VRK-2 or HRK-2 rigging kits

Letter	Rigging-Plate Position	Arrow Direction (both rigging plates)	Angle	Hole-to-Hole Dim. (Short Bar/Long Bar)
A	Short in front	Toward grille	0°	5.913” [150.19mm] 10.258” [260.55mm]
B	Short in front	Toward grille	5°	5.595” [142.11mm] 9.080” [230.63mm]
C	Short in front	Toward grille	10°	5.268” [133.81mm] 7.889” [200.38mm]
D	Short in front	Toward grille	15°	4.932” [125.27mm] 6.685” [169.80mm]
E	Short in front	Toward grille	20°	4.588” [116.54mm] 5.468” [138.89mm]

Table 7:
For clustering EVF subwoofers and EVH systems using VRK-3 or HRK-3 rigging kits

Letter	Rigging-Plate Position	Arrow Direction (both rigging plates)	Angle	Hole-to-Hole Dim. (Short Bar/Long Bar)
A	Short in front	Toward grille	N/A	Not Used
B	Short in front	Toward grille	0°	5.554” [141.07mm] 12.466” [316.64mm]
C	Short in front	Toward grille	5°	5.234” [107.44mm] 10.430” [264.92mm]
D	Short in front	Toward grille	10°	4.908” [124.66mm] 8.376” [212.75mm]
E	Short in front	Toward grille	15°	4.572” [116.13mm] 6.308” [160.22mm]
F	Short in front	Toward grille	20°	4.230” [107.44mm] 4.230” [107.44mm]
A	Long in front	Toward input panel	45°	5.892” [149.66mm] 14.506” [368.45mm]
B	Long in front	Toward input panel	40°	5.554” [141.07mm] 12.466” [316.64mm]
C	Long in front	Toward input panel	35°	5.234” [107.44mm] 10.430” [264.92mm]
D	Long in front	Toward input panel	30°	4.908” [124.66mm] 8.376” [212.75mm]
E	Long in front	Toward input panel	25°	4.572” [116.13mm] 6.308” [160.22mm]
F	Long in front	Toward input panel	20°	4.230” [107.44mm] 4.230” [107.44mm]

6.0 Rigging-Strength Ratings and Safety Factors

6.1 Working Load Limit and Safety-Factor Definitions

The structural ratings for all of the EVF and EVH rigging components and complete loudspeaker systems are based on test results in which parts were stressed to failure. Manufacturers typically present the structural-strength ratings of mechanical components or systems as either the Working Load Limit (WLL) or the ultimate-break strength. Electro-Voice chooses to present the structural-load ratings of the EVF and EVH loudspeaker systems as the WLL. The WLL rating represents the maximum load that should ever be applied to a mechanical component or system.

⚠ THE USER SHOULD NEVER APPLY A LOAD THAT EXCEEDS THE WLL OF ANY OF THE RIGGING COMPONENTS OR COMPLETE LOUDSPEAKER SYSTEMS DESCRIBED IN THIS MANUAL.

The WLL for the EVF and EVH rigging components and complete loudspeaker systems described in this manual are based on a minimum 8:1 safety factor. The safety factor is defined as the ratio of the ultimate-break strength divided by the WLL, where the ultimate-break strength represents the force at which a part will structurally fail. For example, if a part has a WLL of 1,000 lb (454 kg), it would not structurally fail until a force of at least 8,000 lb (3,629 kg) was applied, based on an 8:1 safety factor. However, the user should never apply a load to that part that exceeds 1,000 lb (454 kg). The safety factor provides a margin of safety above the WLL to accommodate normal dynamic loading and normal wear.

CAUTIONS for Working Load Limits and Safety Factors

The WLL defined by the manufacturer of any rigging component should never be exceeded. Electro-Voice bases the WLL of its EVF and EVH products on a minimum of an 8:1 safety factor. Other manufacturers of rigging components may base their WLL on safety factors other than 8:1. For example, 5:1 safety factors are fairly common among rigging manufacturers because many regulatory agencies call for a minimum safety factor of 5:1.

When an EVF and EVH loudspeaker system is installed where local regulations only require a safety factor of 5:1, Electro-Voice insists that the WLL of the EVF and EVH rigging never be exceeded and that an 8:1 safety factor be maintained for the EVF and EVH loudspeakers.

The user is cautioned that some local regulations may require safety factors higher than 8:1. In that circumstance, Electro-Voice insists that the user maintain the higher safety factor as required by the local regulations throughout the entire EVF and EVH installation. It is the responsibility of the user to make sure that any EVF and EVH installation meets all applicable local, state or federal safety regulations.

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.2 Structural Rating Overview

Designing a safe structural cluster is usually a very complex process best left to experienced professionals. Since the EVH and EVF rigging options allow the user to configure a wide variety of clusters, the following guidelines have been broken into three sections: eyebolts, vertical rigging and horizontal rigging. Each section will give the end user guidelines for maximum weight and height of clusters. At the end of each section, typical clusters will be recommended. The following is a short synopsis of the considerations involved.

There are three independent strength ratings that, together with listed maximums, give a complete description of the overall structural capabilities of the loudspeaker cluster.

1. The strength of each M10-1.5 threaded attachment point in each of the individual enclosures. This is the strength of the M10 corner bracket and the enclosure.
2. The strength of the rigging plates included in the VRK and HRK rigging kits described in section 5.0 EVF and EVH Rigging System.
3. The strength of the M10-1.5 eyebolts.

Using the three strength ratings listed above, maximum cluster heights and weights will be recommended so that the cluster maintains an 8:1 safety factor.

In any cluster, the forces acting on each loudspeaker (on each individual rigging point and on the enclosure) and the forces acting on each point of the rigging accessory (M10-1.5 eyebolts, rigging plates and tie plates) will vary with each cluster configuration. Determining those forces throughout a cluster requires complex mathematical calculations. Electro-Voice engineers have therefore defined a set of simplified structural-rating guidelines for both vertical and horizontal clusters that eliminates the need for complex calculations. The interaction of complex forces throughout EVF and EVH clusters was analyzed using a combination of destructive testing and computer modeling to develop this set of conservative guidelines, presented below, to enable a rigger to immediately determine on site whether or not a cluster is safe without having to make weight-distribution calculations.

6.3 All-Eyebolt Structural Ratings

The guidelines for simplified all-eyebolt structural ratings cover the following information:

1. Maximum number of enclosures.
2. Maximum weight of the cluster.
3. WLL for eyebolts.
4. Suspension-line angles.
5. Left-to-right all-eyebolt cluster angles.

⚠ THE MAXIMUM LOAD, MAXIMUM NUMBER OF ENCLOSURES AND MINIMUM NUMBER OF SUSPENSION LINES FOR ALL-EYEBOLT CLUSTERS ARE LISTED IN TABLE 8.

LIMITS FOR ALL-EYEBOLT CLUSTERS ONLY		
Maximum Working Load Limit	**Maximum Number of Enclosures**	**Minimum No. of Suspension Lines**
291 lb (132 kg)	Two, either vertical or horizontal	Two (for any all-eyebolt cluster)

Table 8:
Maximum load, maxiumum number of enclosures and minimum number of suspension lines for all-eybolt clusters

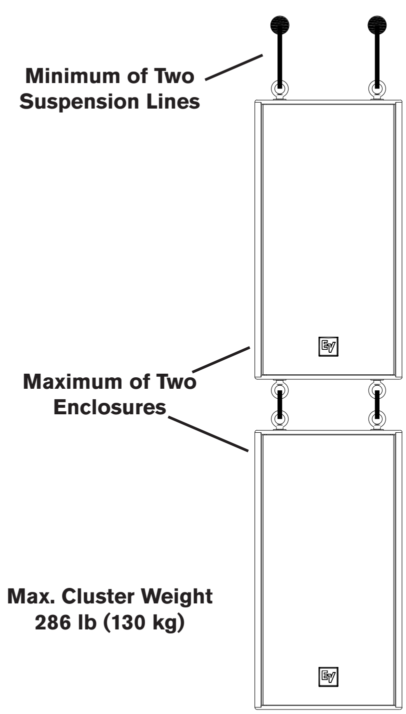


Figure 24a:
Limitations for vertical all-eyebolt clusters

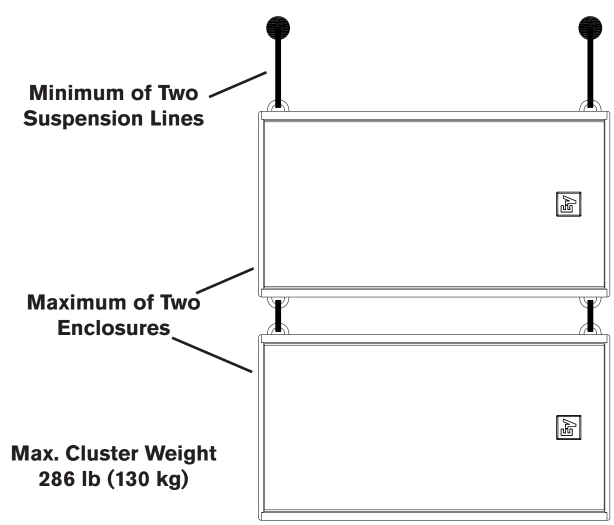


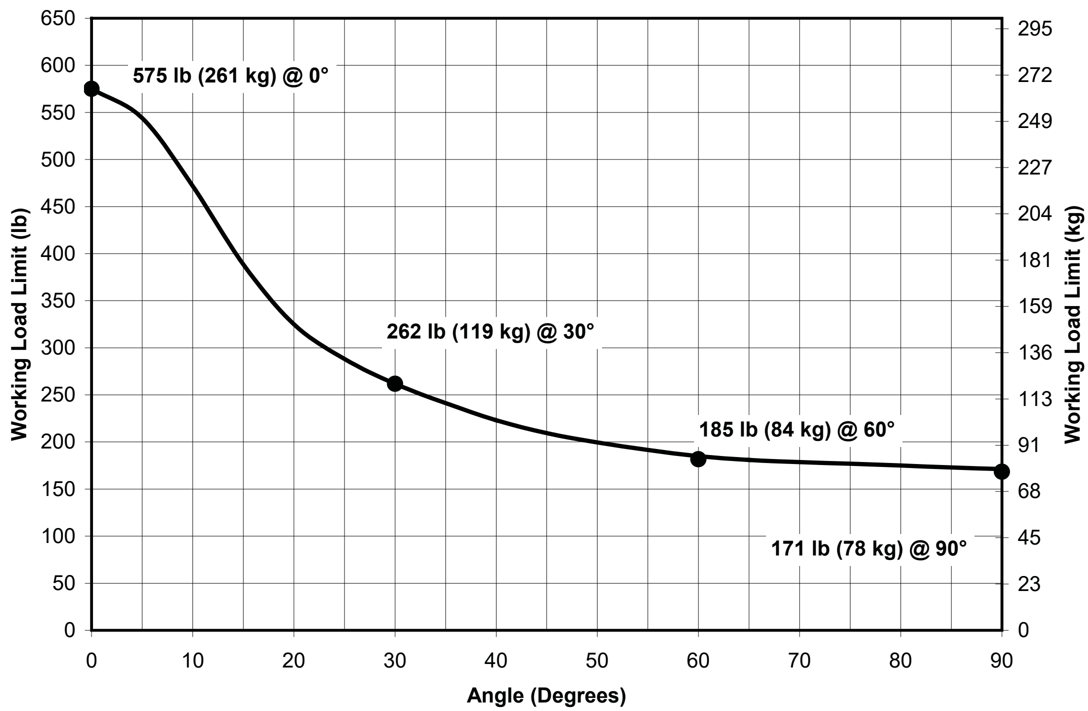
Figure 25b:
Limitations for horizontal all-eyebolt clusters

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.31 Working Load Limits for Eyebolts

Eyebolts can be used to suspend individual loudspeakers and certain types of clusters. Eyebolts attach to the EVF and EVH enclosures through the integral M10-1.5 attachment points. Section 5.21 Anatomy of an EVF or EVH Flying System Using M10 Eyebolts should be reviewed at this time for more information on eyebolt alignment and positioning on the enclosure. Table 9 shows the WLL per eyebolt with respect to the angle of the applied load. Figure 25 shows the suspension-point angles that are referenced in the table. It is a good idea to stay within 30° of the maximum WLL of the eyebolt (straight up position) for main suspension lines.

Table 9:
WLL for M10 eyebolts in the EVI-M10K eyebolt kit



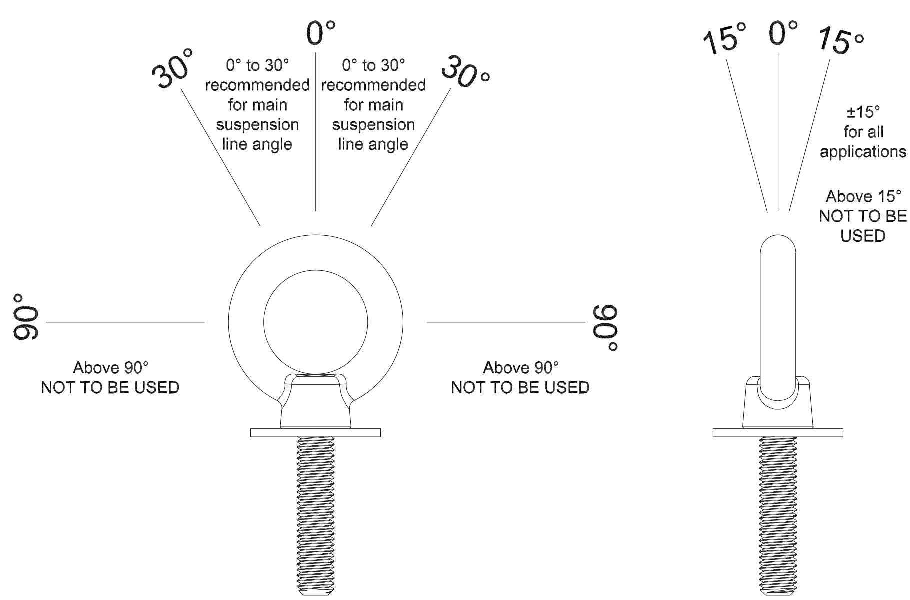


Figure 25:
Suspension line angle limits for individual eyebolts, both in plane of pull (left) and against plane of pull (right)

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.32 Suspension-Line Angles

Refer to Table 9 and Figure 25 for specific eyebolt angle and weight limitiations when using all-eyebolt clusters. These limits are not to be exceeded under any circumstances. If a higher safety factor than 8:1 is required, the angle limitations for each eyebolt may actually decrease to a number less than what is shown in Figure 25.

Always make sure that the suspension line is in the plane of the eyebolt, as shown in Figure 17. Readjust the eyebolt during the installation if necessary to maintain this alignment.

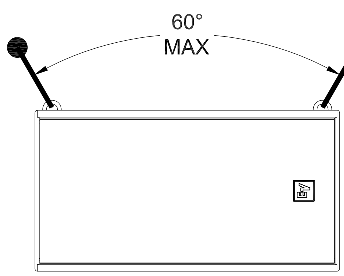


Figure 26a:
All-eyebolt suspension-line angle limit, independent suspension lines

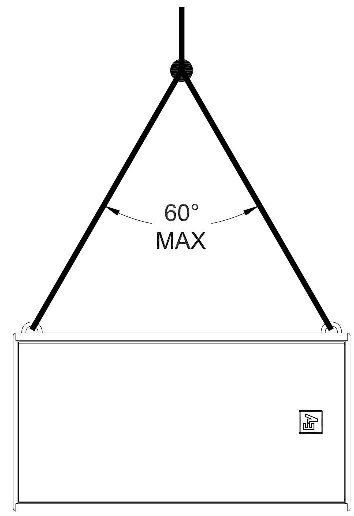


Figure 26b:
All-eyebolt suspension-line angle limit, bridled suspension lines

6.33 Left-to-Right All-Eyebolt Cluster Angles

The suspended all-eyebolt cluster must be perpendicular (plumb) to within ±5° as shown in Figure 27.

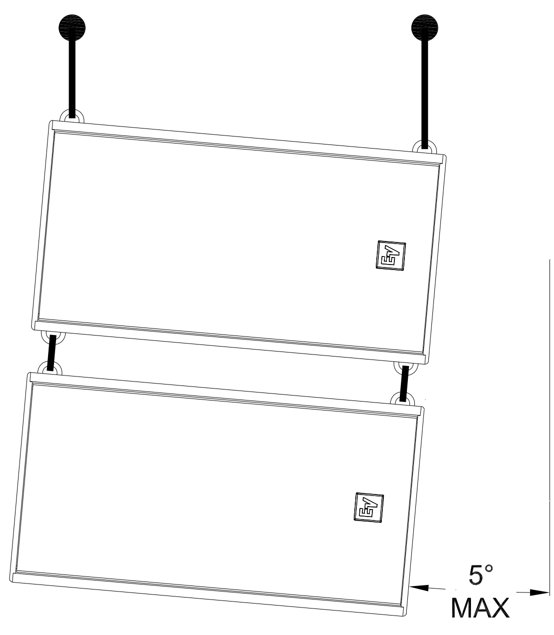


Figure 27:
Left-to-right angle limits for an all-eyebolt cluster (angle shown exaggerated for illustration purposes)

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.4 VRK Rigging Structural Ratings for Vertical Clusters

The guidelines for simplified vertical structural ratings cover the following information:

1. Maximum length of the cluster.
2. Maximum weight of the cluster.
3. WLL for eyebolts.
4. Trim angle.
5. Tie points for eyebolts.
6. Left-to-right vertical cluster angles.

The majority of vertical clusters will be suspended using a combination of VRK vertical rigging kits and factory-supplied eyebolts. For a vertical cluster, select the eyebolt position that results in the highest eyebolt strength as shown in Table 12. Different eyebolt positions are shown in Figure 28.

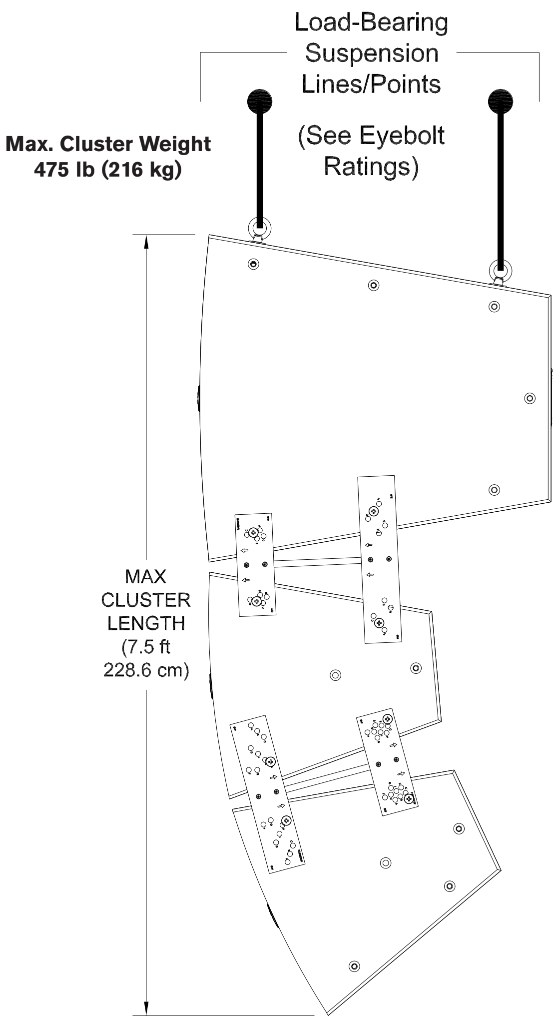


Figure 28a:
Load-bearing suspension points used for positive or moderate negative trim angles

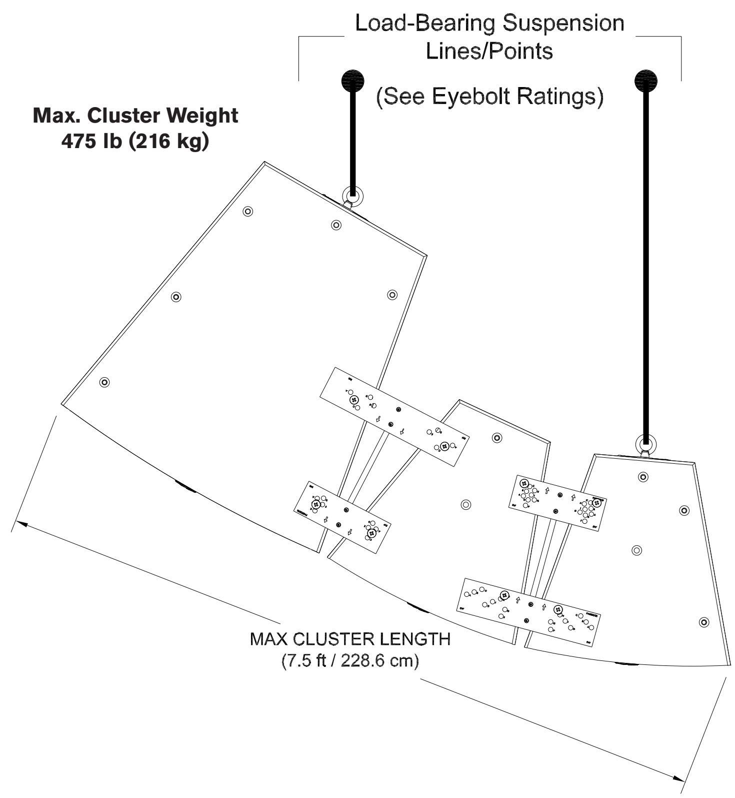


Figure 28b:
Load-bearing suspension points used for more extreme negative trim angles

THE MAXIMUM LOAD, MAXIMUM LENGTH AND EYEBOLT ANGLE RESTRICTIONS FOR VERTICAL CLUSTERS ARE LISTED IN TABLE 10.

LIMITS FOR VERTICAL CLUSTERS ONLY		
Maximum Working Load Limit	**Maximum Length**	**Eyebolt Angle Restrictions**
482 lb (219 kg)	7.5 ft (228.6 cm) (as shown in Figure 27)	When using eyebolts, refer to Table 12 and Figure 29 for angle restrictions.

Table 10:
Maximum load, maximum length and eyebolt angle restrictions for vertical clusters

Table 11 gives a brief guide to the cluster combinations possible within the WLL of the EVF and EVH enclosures.

LIMITS FOR VERTICAL CLUSTERS ONLY			
Clustered Enclosures	**Maximum Number of Enclosures**	**Minimum No. of Suspension Lines**	**Eyebolt Angle Restrictions**
EVH-1152/XX full-range and/or EVF subwoofer	3	4 (2 per side)	See Table 12 and Figure 29
EVF-1122/XX and/or EVF 12” low-frequency	5	4 (2 per side)	See Table 12 and Figure 29
EVF-1152/XX and/or EVF 15” low-frequency	4	4 (2 per side)	See Table 12 and Figure 29
One EVF subwoofer and four EVF-1122/XX	5	4 (2 per side)	See Table 12 and Figure 29
Two EVF subwoofer and two EVF-1122/XX	4	4 (2 per side)	See Table 12 and Figure 29
One EVF subwoofer and three EVF-1152/XX	4	4 (2 per side)	See Table 12 and Figure 29
Two EVF subwoofer and two EVF-1152/XX	4	4 (2 per side)	See Table 12 and Figure 29

Table 11:
Possible vertical cluster combinations within the WLL of each enclosure

For clusters with trim angles between +20° and –10°, or where a rear pull back will not be used, the four eyebolt attachment points on the top surface of the vertical cluster should be used.

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.41 Working Load Limits for Eyebolts used with VRK Vertical Rigging Kits

Eyebolts are the most convenient way to suspend vertical clusters. Eyebolts attach to the EVF and EVH enclosures through the integral M10-1.5 attachment points. Section 5.21 Anatomy of an EVF or EVH Flying System Using M10 Eyebolts should be reviewed at this time for more information on eyebolt alignment and positioning on the enclosure. Table 12 shows the WLL per eyebolt with respect to the angle of the applied load. Figure 29 shows the suspension-point angles that are referenced in the table. It is a good idea to stay within 30° of the maximum WLL of the eyebolt (straight up position) for main suspension lines.

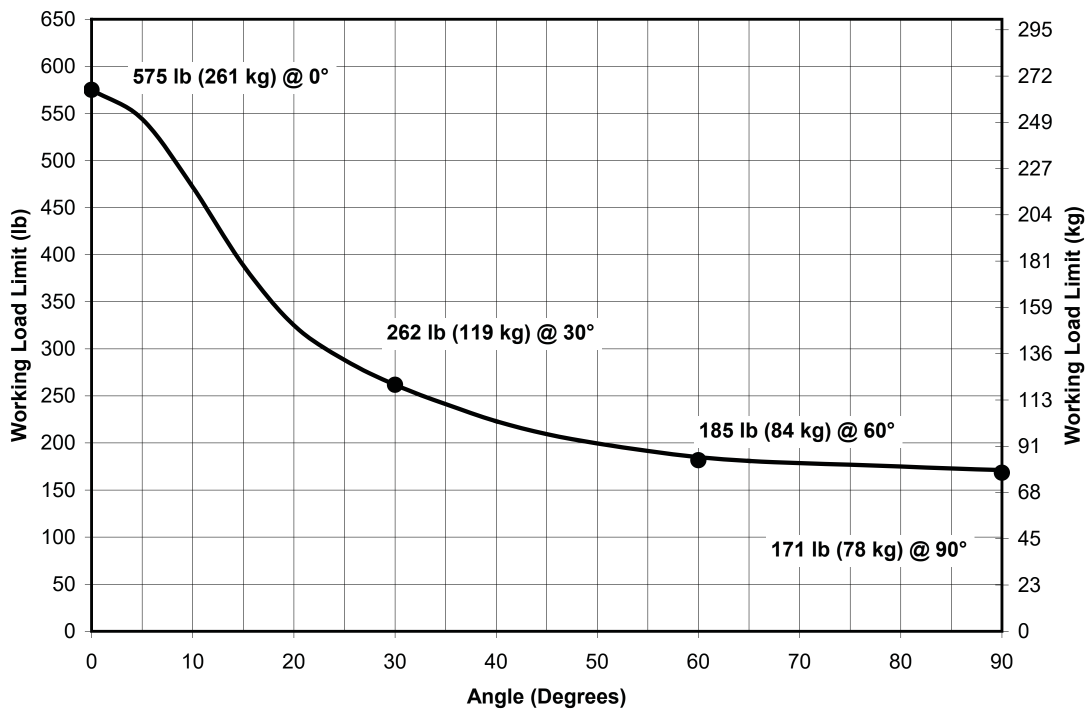


Table 12:
WLL for M10 eyebolts in the EVI-M10K eyebolt kit

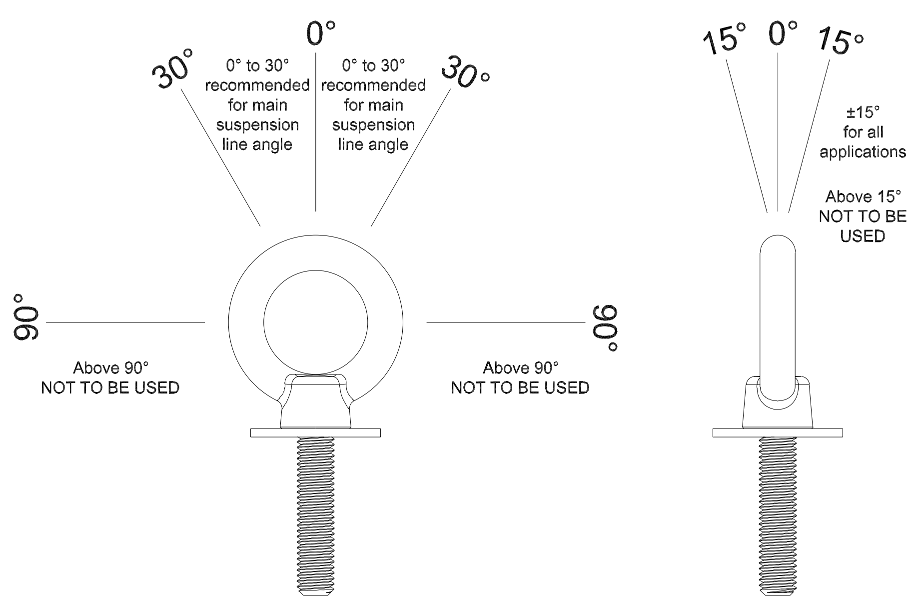


Figure 29:
Suspension line angle limits for individual eyebolts, both in plane of pull (left) and against plane of pull (right)

6.42 Left-to-Right Vertical Cluster Angles

The suspended vertical cluster must be perpendicular (plumb) to within ±5° as shown in Figure 30.

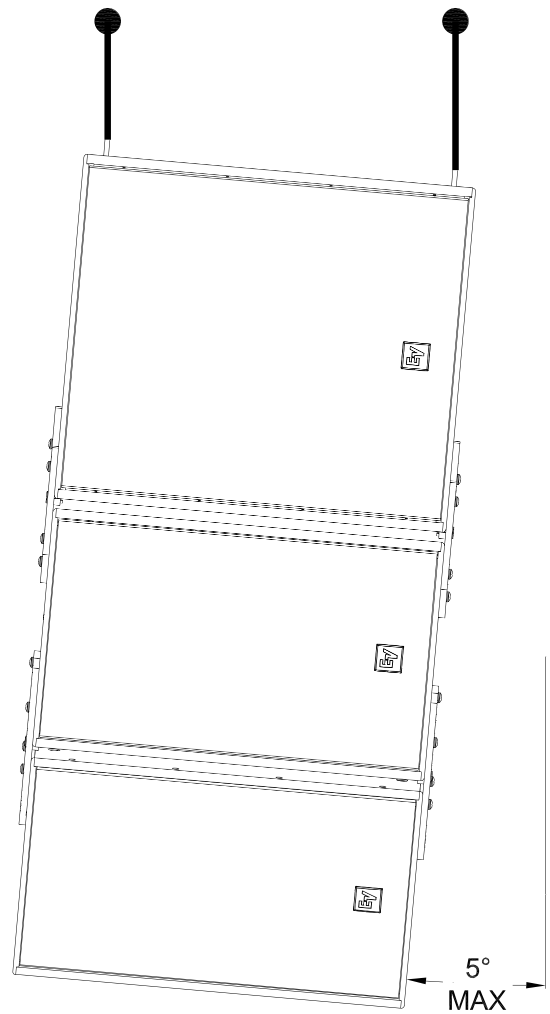


Figure 30:
Left-to-right angle limits for a vertical cluster (angle shown exaggerated for illustration purposes)

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.5 HRK Rigging Structural Ratings for Horizontal Clusters

The guidelines for simplified horizontal structural ratings cover the following information:

1. Maximum height of the cluster.
2. Maximum weight of the cluster.
3. Cluster combinations, per weight and height.
4. Using tie plates for suspension.
5. Suspension-line angles for HRK rigging.
6. Symmetry of cluster.
7. Inner connection points.
8. Left-to-right horizontal cluster angles.

Using the HRK horizontal rigging kits, any combination of EVF and EVH enclosures can be assembled in a cluster as long as the WLL, angles, and height limits are observed. For horizontal clusters, left-to-right symmetry must also be observed to keep even loads across suspension lines.

⚠ SUSPEND HORIZONTAL CLUSTERS USING TIE PLATES ONLY, NO EYEBOLTS.

LIMITS FOR HORIZONTAL CLUSTERS ONLY

Maximum Working Load Limit	Maximum Height
Three-over-Three = 980 lb (445 kg) Two-over-Two = 634 lb (288 kg)	Max. Two Enclosures High or 5.25 ft (160.1 cm)

Table 13:
Maximum load and maximum height for horizontal clusters

Table 14 gives a brief guide to the cluster combinations possible within the WLL of the EVF and EVH enclosures.

LIMITS FOR HORIZONTAL CLUSTERS ONLY

Clustered Enclosures	Maximum Number of Enclosures	Minimum No. of Suspension Lines	Tie Plate Angle Restrictions
Three enclosures over three enclosures	6	4 (2 per side)	See Figure 32
Two enclosures over two enclosures	4	2	See Figure 32
Three enclosures across	3	4 (2 per side)	See Figure 32
Two enclosures across	2	2	See Figure 32

Table 14:
Possible horizontal cluster combinations within the WLL of each enclosure

6.51 Using Tie Plates as Main Load-Bearing Suspension

Horizontal clusters are attached to the structure with the tie plates located on the rigging plates of the HRK kits. The tie plates have six holes that will accept a 5/8-inch shackle or similar connector. All main suspension lines that carry the cluster's load should be tied to these tie plates. Both the front and rear tie plates on the top boxes must be connected to the building structure when the cluster is installed using a moderate trim angle as shown in Figure 31.

For purposes of stabilization, especially with the two-over-two cluster, additional stabilization points can be helpful. These stabilization points can be used as eyebolts on the enclosures at the rear of the cluster. Figure 31 shows typical stabilization points.

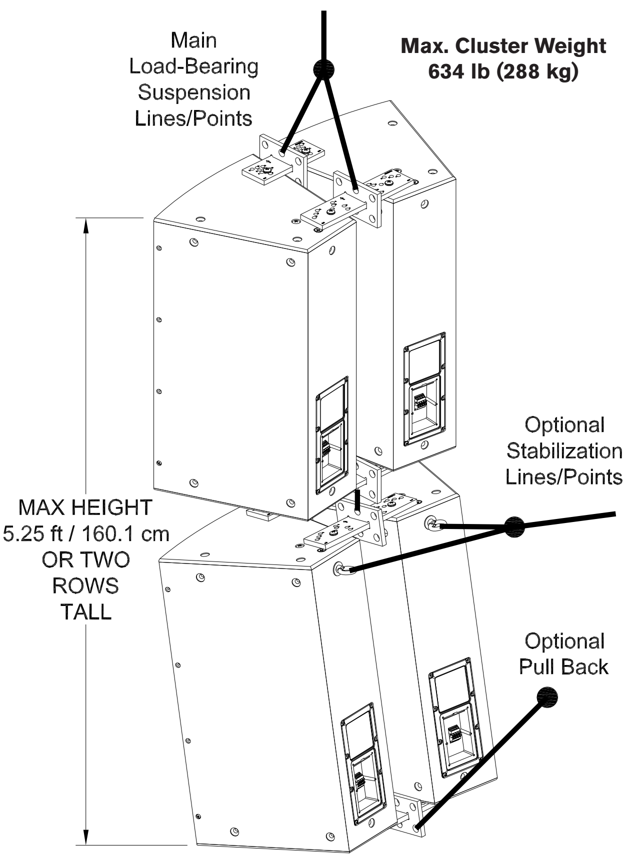


Figure 31a:
Use of tie plates in the suspension of a two-over-two cluster using HRK rigging kits

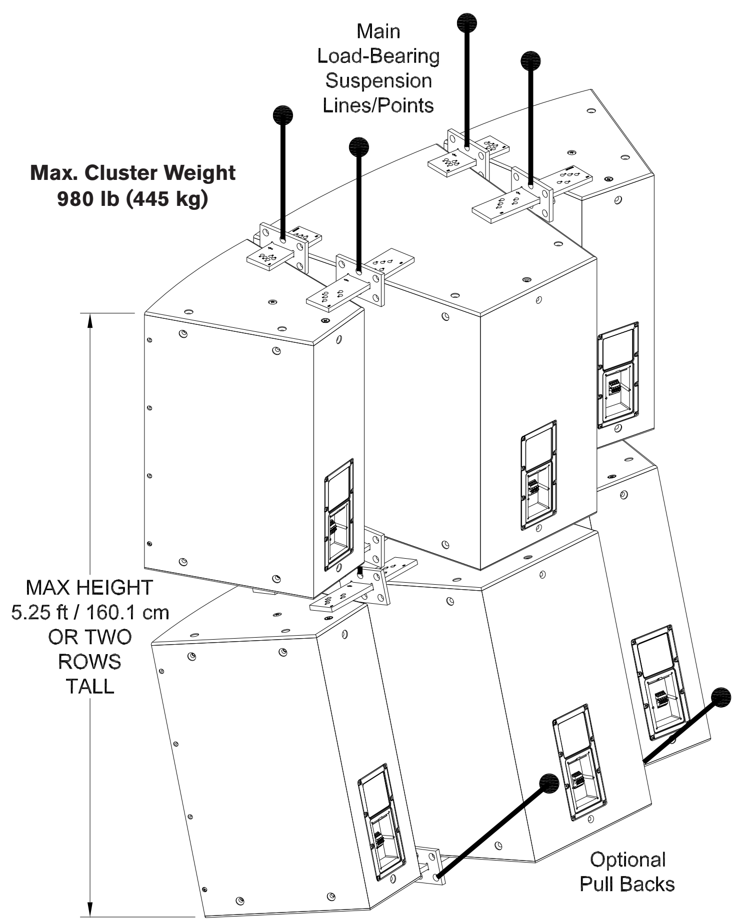


Figure 31b:
Use of tie plates in the suspension of a three-over-three cluster using HRK rigging kits

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.52 Suspension-Line Angles for HRK Kits

Suspension-line angles are restricted to 30° off the axis of the tie plate's center line. Figure 32 shows the angle limitations recommended for horizontal clusters when using HRK kits.

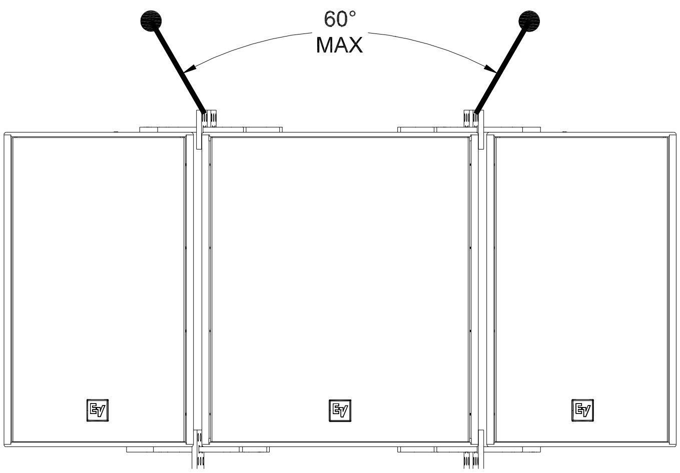


Figure 32a:
Horizontal cluster suspension-line limit, left-to-right, independent suspension lines

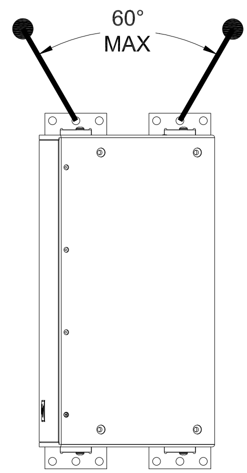


Figure 32b:
Horizontal cluster suspension-line limit, front-to-back, independent suspension lines

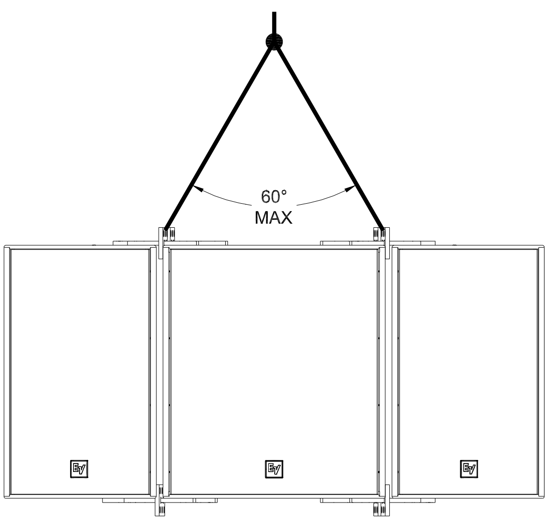


Figure 32c:
Horizontal cluster suspension-line limit, left-to-right, bridled suspension lines

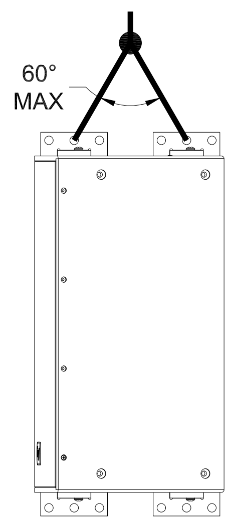


Figure 32d:
Horizontal cluster suspension-line limit, front-to-back, bridled suspension lines

6.53 Symmetry for Horizontal Clusters using HRK Kits

The cluster's center of gravity is centered under the two suspension points in a two-over-two cluster (see Figure 33a) or between the suspension points in a three-over-three cluster (see Figure 33b).

Both the cluster's weight and center of gravity must be symmetrical about the cluster's center line. For individual enclosure weights and centers of gravity, refer to section 1.

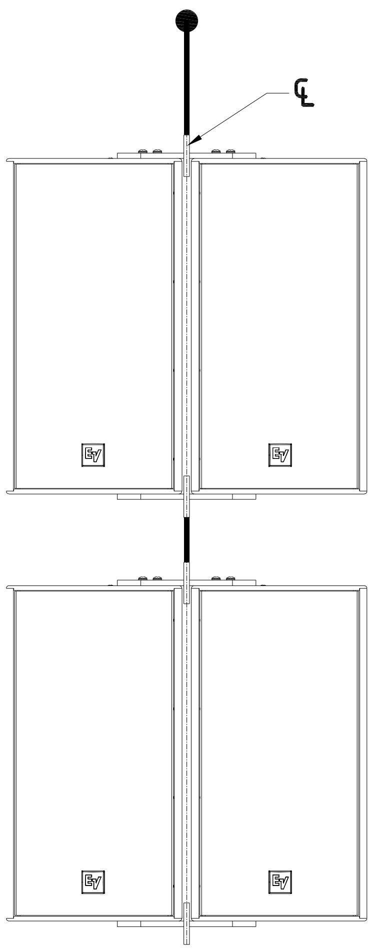


Figure 33a:
Suspension of a symmetrical two-over-two horizontal cluster using HRK horizontal rigging kits

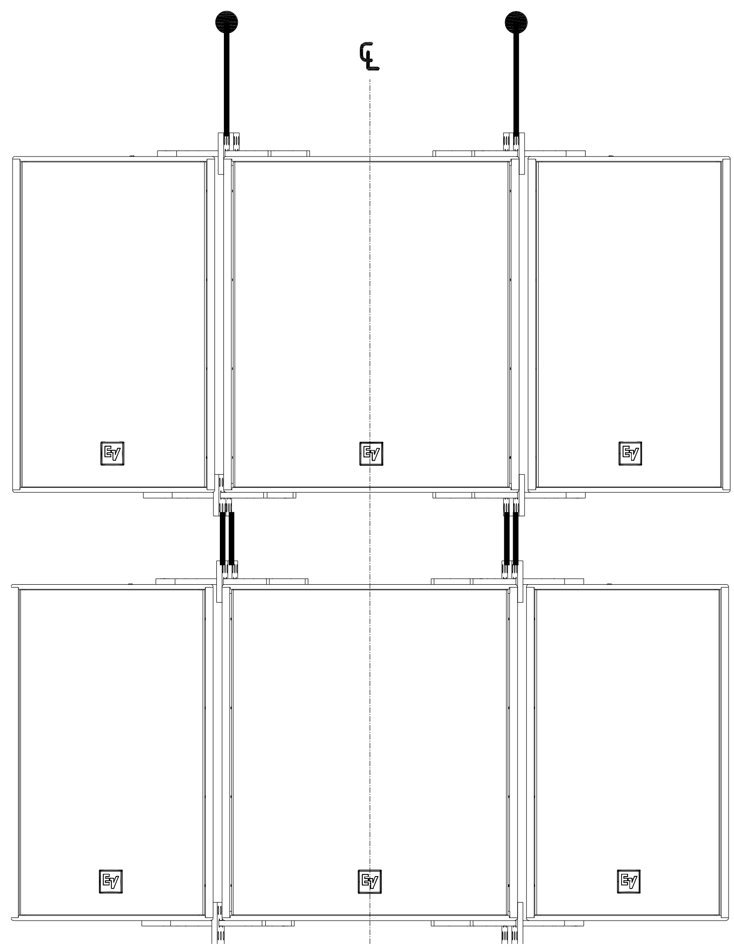


Figure 33b:
Suspension of a symmetrical three-over-three horizontal cluster using HRK horizontal rigging kits

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.54 Inner Connection Points

For connection between the clusters (from bottom of top enclosure to the top of the bottom enclosure), both the front and rear rigging plates must be connected (see Figure 34). The maximum box-to-box angle is 45°.

WHEN RIGGING BOX-TO-BOX, BOTH FRONT AND REAR TIE PLATES MUST BE CONNECTED.

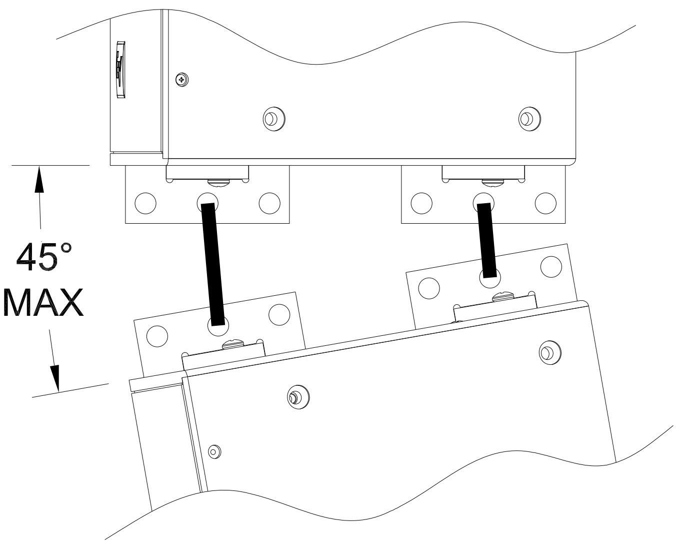


Figure 34:
Box-to-Box internal connection points of a horizontal cluster using HRK horizontal rigging kits

6.55 Left-to-Right Horizontal Cluster Angles

The suspended horizontal cluster must be perpendicular (plumb) to within ±5° as shown in Figure 35.

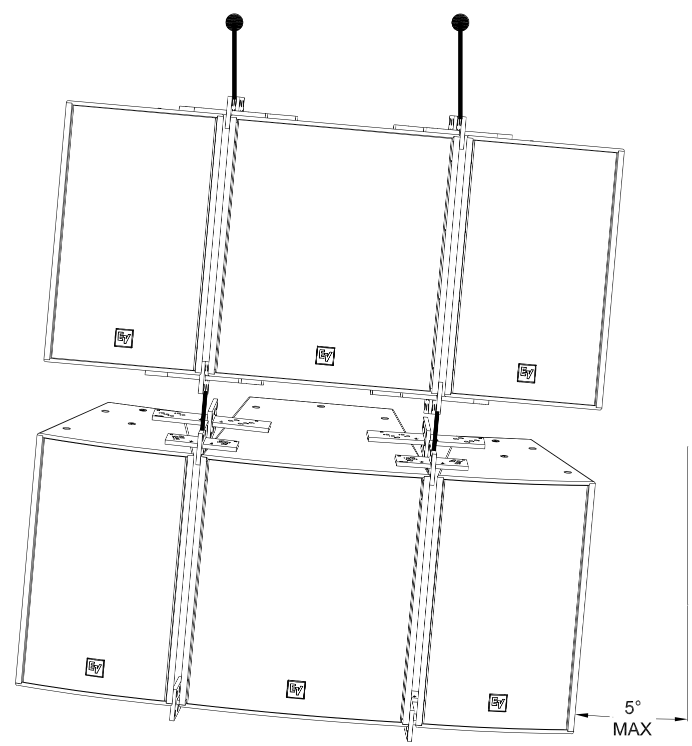


Figure 35:
Left-to-right angle limits for a horizontal cluster (angle shown exaggerated for illustration purposes)

6.0 Rigging-Strength Ratings and Safety Factors (cont.)

6.6 Ratings for Outdoor Applications with Wind Loading

Special considerations must be made for outdoor venues where wind conditions could become a concern. High wind gusts can push the loudspeakers in a way that the suspension lines' direction of force can become misaligned with the plane of the eyebolt. Larger clusters pose more of a concern because more surface area exists for the wind to act upon. Counteracting these effects requires the use of additional suspension lines and/or stabilization lines to reduce the potential overloading of the existing suspension lines.

⚠ IT IS THE RESPONSIBILITY OF THE USER TO ENSURE THAT ALL CLUSTERS ARE SUSPENDED SAFELY UNDER ALL CONDITIONS. IT IS RECOMMENDED TO CONSULT A STRUCTURAL ENGINEER WHEN WINDS ARE ANTICIPATED.

It is recommended that all loudspeakers and rigging components are inspected after high wind conditions have occurred.

6.7 Electro-Voice Structural-Analysis Procedures

Electro-Voice maintains a structural pull-test facility in Burnsville, Minnesota, USA, which includes load cells with digital-electronic display and recording. The load cells are calibrated annually by an independent laboratory to a standard traceable to the United States National Bureau of Standards. This pull-test facility is capable of pulling to destruction both individual rigging components and complete loudspeaker systems.

Electro-Voice utilizes state-of-the-art computer modeling programs for structural analysis throughout the development of loudspeaker systems. The computer modeling enables the complex forces in the rigging components and enclosures to be analyzed for loudspeakers assembled into arrays and clusters in both static and dynamic conditions.

Structural testing and computer modeling were used throughout the engineering development of all EVF and EVH individual rigging components and complete loudspeaker systems described in this manual. Testing and modeling involving both anticipated use and anticipated misuse were performed as part of the analysis. Engineering prototypes were stressed to failure and designs were revised based on those test results. Production systems and components were stressed to failure for verification of the final designs.

7.0 Rigging Inspections and Precautions

Electro-Voice EVF and EVH Loudspeaker Systems: Prior to each use, inspect the enclosures for any cracks, deformations or missing or damaged components that could reduce enclosure strength. Inspect the rigging plates, tie plates and stabilizer bars between enclosures for cracks, corrosion or other deformations that could reduce their strength and integrity. Check to be sure there are no missing screws and that all M5 connector bolts and M10 rigging bolts are securely tightened. Hardware that is bent or showing signs of more than cosmetic surface corrosion should be replaced immediately.

Lifting Hoists: Prior to each use, inspect the lifting hoist(s) and associated hardware (including motors, if applicable) for any cracks, deformation, broken welds, corrosion or missing or damaged components that could reduce the hoist strength. Replace any damaged hoists. Never exceed the limitations or maximum recommended load specified by the hoist manufacturer. Always follow manufacturers' recommendations for operation, inspection and certification. Always raise and lower the load slowly and evenly, avoiding any rapid changes in speed or shifting loads that could result in a sudden jolt to the suspended system or the structure from which it is suspended.

Building, Tower or Scaffold Supports: Prior to each use, the strength and load-bearing capabilities of the building, tower or scaffold structural supports should be evaluated and certified by a professional engineer as being adequate for supporting the intended rigging system (including the loudspeakers, grids, chain hoists and all associated hardware). Prior to each use, inspect the building, tower or scaffold structural supports for any cracks, deformation, broken welds, corrosion or missing or damaged components that could reduce the structural strength. Damaged structural supports should be replaced or repaired and recertified by a professional engineer. Never exceed the limitations or maximum recommended load for the supports.

Miscellaneous Mechanical Components: Prior to each use, inspect all mechanical components (chain, wire ropes, slings, shackles, hooks, fittings, ratchet straps, etc.) for any cracks, deformation, broken welds, slipping crimps, fraying, abrasion, knots, corrosion, chemical damage, loose screws or missing or damaged components that could reduce the maximum strength specified by the component manufacturer. Replace any damaged mechanical components immediately. Never exceed the limitations or maximum recommended load for the mechanical components.

8.0 Installation Instructions TK-150

Tools Required:

1. #2 Phillips screwdriver
2. 3/16 in (5 mm) flat blade screwdriver

High Pass Filter Requirements:

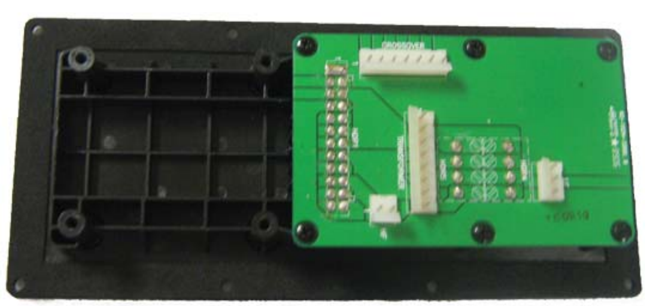
The TK-150 is designed to be used with a 50 Hz Butterworth 24 dB/octave active high-pass filter inserted in the signal chain at the input to the driving amplifier. This filter protects the amplifier from damage caused by transformer saturation at low frequencies and allows any number of transformers to be driven on the same line, up to the rated power of the amplifier. The TK-150 is capable of delivering up to 300 Watts to the loudspeaker using the following configuration. Connect a 100 V drive line to the tap labeled, DO NOT USE (150 W at 70.7 V). Insert a Butterworth 24 dB/octave active high-pass filter tuned to 66 Hz or higher in the signal chain at the input to the driving amplifier. Due to the band limited spectrum of the EN54-24 simulated program signal (89 Hz - 11.2 kHz) the EN54-24 rated power handling is certified up to 400 Watts at the100 V drive line.

⚠ **Caution!**
Failure to use the proper high-pass filter may result in damage to the amplifier.

Instructions:

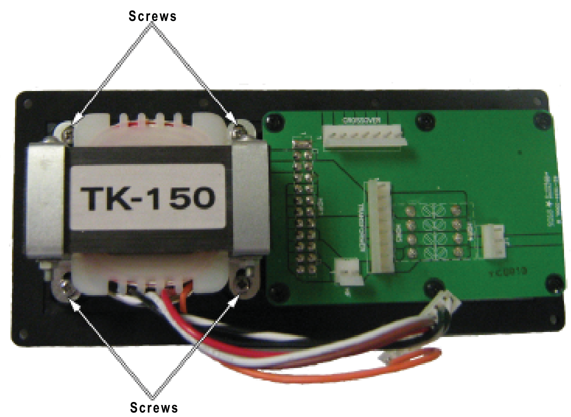
To **install the TK-150**, do the following:

1. Remove the input panel by removing the eight (8) screws securing it.
   Make note of the original orientation prior to removing the input panel.
2. Unplug the crossover wiring harness from the 7-pin header.
3. Place the input panel horizontally face down with the green circuit board on the right.



4. Place the transformer in the pocket on the left.
   The lead wires from the transformer should be pointed toward you.

5. Secure the transformer mounting ears to the four (4) input panel bosses with the four (4) #10 screws provided. *Carefully tighten the screws evenly in an X-cross pattern to avoid warping the plastic input panel.*



6. Unplug the 8-position jumper connector located at right angle to the 7-pin crossover header.Plug in the 8-position wiring harness connector from the transformer to the 8-pin header in place of the jumper. *Notice the direction of the connector.*
7. Reconnect the 7-position connector from the crossover to the 7-pin header.

8.0 Installation Instructions TK-150 (cont.)

8. Reinstall the input panel in the same orientation it was in before removal.
Do not install backwards.

9. Apply the new label (supplied) over the input connectors.

Notice!
This product ships with two (2) input panel labels:
• One (1) label is for standard use.
• One (1) label is for EN54-24 Voice Alarm systems. Apply the *TK-150 EN54 Rated* label when TK-150 is used in an EN54-24 system.

10. Confirm the switch card is set for *FULL RANGE PASSIVE* operation.

Notice!
Bi-Amp operation is not possible with a TK-150 installed.

11. Connect the (-) input line to the COM input terminal and the (+) input line to the terminal corresponding to the desired wattage in either the 70.7 V or 100 V column.

Notice!
Each group of four (4) terminals is electrically connected in parallel to the group of four (4) terminals directly across from it. The wattages charted in these two (2) columns represent the wattage available from each of the three (3) transformer taps at the designated voltage.

Caution!
This transformer is intended to affect only the loudspeaker in which it is installed. When daisy chaining additional systems, connect the wires to the next system only to those terminals directly opposite the input wires. Improper connection may result in damage to the transformer, successive loudspeakers, the driving amplifier or any combination thereof.

Notice!
Tighten all unused connector screws to prevent rattles.

8.1 Transformer Ratings

	70 V	**100 V**	**Z nom**
Transformer: Standard 50 Hz BW24 High-pass	37.5 W	75 W	130 Ω
	75 W	150 W	65 Ω
	150 W	Do Not Use	33 Ω
Transformer: 89 Hz High-pass per EN54-24 Spectrum	**70 V**	**100 V**	**Z nom**
	50 W	100 W	100 Ω
	100 W	200 W	50 Ω
	200 W	400 W	25 Ω

8.2 Approvals and Certifications

CE
1438

Bosch Security Systems Inc.
12000 Portland Ave South, Burnsville, MN 55337, USA

1438-CPR-0283

EN 54-24:2008
Voice alarm loudspeakers
for fire detection and fire alarm systems for buildings

Loudspeakers type: EVF-1122S/64, EVF-1122S/66, EVF-1122S/94
EVF-1122S/96, EVF-1122S/99, EVF-1122S/126
(BLK, WHT, PIB, PIW)

DoP: REG000104002

EN54-24 type B certification 1438-CPR-0283 **(Only available in select regions)**

CE
1438

Bosch Security Systems Inc.
12000 Portland Ave South, Burnsville, MN 55337, USA

1438-CPR-0299

EN 54-24:2008
Voice alarm loudspeakers
for fire detection and fire alarm systems for buildings

Loudspeakers type: EVH-1152D/43, EVH-1152D/64, EVH-1152D/66,
EVH-1152D/94, EVH-1152D/96, EVH-1152D/99
(BLK, WHT, PIB, PIW)

DoP: REG000666000

EN54-24 type B certification 1438-CPR-0299 **(Only available in select regions)**

9.0 References

9.1 Rigging (printed)

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[10] Newberry, W.G., Handbook for Riggers, Newberry Investments Company, Calgary, Alberta, Canada (1989).

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[2] R.C. Hibbeler, Mechanics of Materials, Pearson Prentice Hall, Upper Saddle River, NJ, USA (2005)

[3] J.L. Meriam & L.G. Kraige, Engineering Mechanics, Volume One - Statics, John Wiley & Sons, Inc., New York, NY, USA (1992).

[4] J.L. Meriam & L.G. Kraige, Engineering Mechanics, Volume Two - Dynamics, John Wiley & Sons, Inc., New York, NY, USA (1992).

[5] J.E. Shigley & C.R. Mischke, Mechanical Engineering Design, McGraw-Hill Book Company, New York, NY, USA (1989).

9.3 Rigging (Web sites)

[1] http://www.rigging.net

[2] http://www.cmworks.com/

[3] http://catalog.thecrosbygroup.com/maininterface.htm

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Burnsville MN 55337
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