

RIGGERMEISTER

SOUND SYSTEM RIGGING

INTRODUCTION

Rigging loudspeakers must be approached with a great deal of caution. Rigging is a very important and serious part of implementing high quality sound reinforcement systems in both portable sound system applications and permanent sound system installations. Accidents can be avoided if the rigging professional understands the mechanism behind the rigging of loudspeakers, and employs safe rigging practices for every event or installation that will require the flying of loudspeakers.

LOUDSPEAKER ENCLOSURES

Loudspeaker enclosures can be reduced into two classifications; flyable, and not flyable. When rigging loudspeakers it is MANDATORY that flyable loudspeaker enclosures be used. This may sound obvious, however in many instances loudspeaker rigging accidents have been caused by suspending non-flyable loudspeakers from their handles, or by suspending a non-flyable loudspeaker with lag bolts, etc... In any case, a non-flyable loudspeaker enclosure cannot be safely suspended.

Many loudspeaker manufacturers offer loudspeaker enclosures that are fly ready. A multitude of rigging hardware has been employed with great success by various manufacturers. In all cases, the manufacturer should offer a certification that the loudspeaker enclosure is capable of being suspended, and what load limitations apply to the loudspeaker enclosure. Rigging operational guidelines should also be available from the manufacturer. Without this information, and a complete understanding of this information, the loudspeaker should not be suspended.

It is simple to determine a fly ready loudspeaker if it is built by a manufacturer who has designed and certified the use of the loudspeaker for overhead suspension. However, rigging a non-flyable loudspeaker enclosure, or a proprietary loudspeaker is a little more complicated.

There are a multitude of manufacturers offering loudspeaker enclosures that are not flyable, and the situation often requires these loudspeaker enclosures to be suspended. Safe suspension of the loudspeaker enclosures is possible if the enclosure is braced properly and safe rigging practices are implemented by the rigging professional. Many of these loudspeaker manufacturers have worked in conjunction with ATM Fly-Ware to develop



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internal brace kits which can be installed into the loudspeaker enclosure in order to safely accommodate the loading caused by suspension of the enclosure. (See **Enclosure Bracing** section)

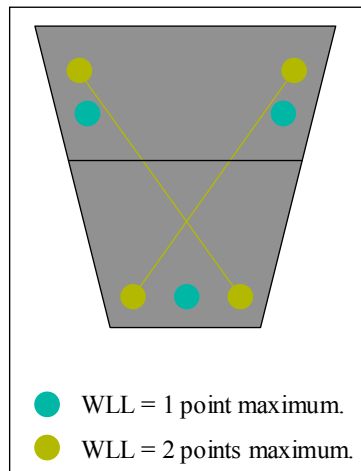
Proprietary loudspeaker enclosures must be designed, constructed, and then tested to insure their safety in rigging applications. This process can be costly and time intensive. Prior to rigging any proprietary loudspeaker enclosure, one must consider the following;

- Is the enclosure constructed for vertical and horizontal loading?
- Is the enclosure internally braced sufficiently?
- Has the loudspeaker enclosure been officially tested?

Know the loudspeaker enclosure being suspended. Make certain that it is capable of flying, and make certain that it can withstand at least five times the loads being applied to it. If there is any reluctance or discrepancy whatsoever - **DO NOT FLY THE LOUD-SPEAKER.**

LOAD RATING LOUDSPEAKER ENCLOSURES

Loudspeaker rigging hardware can be load rated in several different ways. However, in ATM Fly-Ware's opinion, the rigging hardware should always employ a minimum of a 5:1 design factor. If the enclosure is the failure mode, then a 10:1 design factor should be applied. (See **Design Considerations** section) An enclosure with one, two or three suspension points should be rated such that a single suspension point will support the entire load. An enclosure with four suspension points can be rated such that two of the suspension points will encounter distributed loading under normal conditions, thereby doubling the working load limit.



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Another important part of load rating loudspeaker rigging hardware is the certification process for overhead lifting applications. Many components classified as cargo control hardware, chain, aircraft hardware, and various other hardware components do not carry load ratings for overhead lifting. In fact, many of the aforementioned components are specifically designated for non-overhead lifting applications only. Below are a sampling of the clauses manufacturers of commonly found loudspeaker enclosure component hardware publish within their product literature;

- It is the owner's and user's responsibility to determine suitability of a product for any particular use.
- No straps are to be used for lifting purposes.
- Not recommended for overhead lifting.

This issue can be resolved by individually testing the component and certifying its use in overhead lifting applications. Be aware, however, that this process will void any claim made against the manufacturer of the component should any type of failure or damage take place. If this method of certifying the loudspeaker enclosure for overhead lifting is employed, be certain to document everything well, and to retain copies of the testing results indefinitely. The responsibility for the safety of the loudspeaker enclosure is in the hands of the loudspeaker builder, not the hardware manufacturer.

Another issue to be aware of when examining load ratings of loudspeaker enclosures is the origin of the load rating itself. Load ratings can be found as a result of the ultimate strength load of the component, or as a result of the yield strength load of the component. (*See **Design Considerations** section*) Either of the two load rating measurement methods can be used by hardware manufacturers, and each of the two methods has its advantages. What is important to the rigging professional is to know which method is being used by the hardware manufacturer, and what limitations may exist due to the measurement method.

LOUDSPEAKER ENCLOSURE CONSTRUCTION

Loudspeaker enclosures are constructed in many different ways; it is not possible to list all the methods of joinery and material types in the space available for this topic. However, there are a few popular conventions used throughout the professional loudspeaker enclosure manufacturing industry which represent the majority of professional loudspeaker enclosure constructions. Contact the loudspeaker manufacturer or



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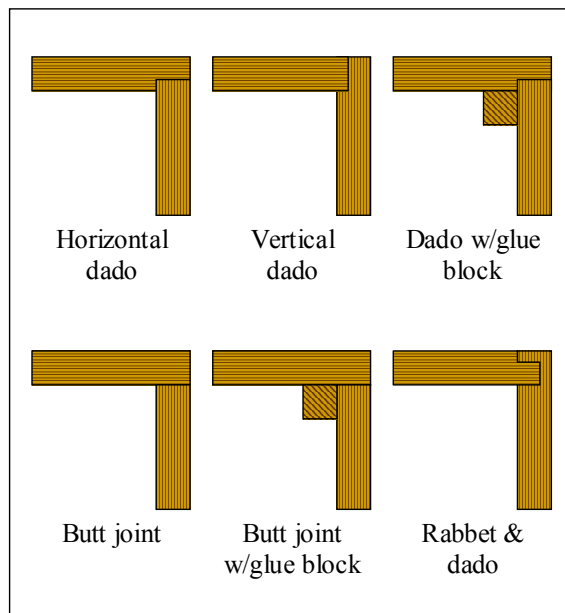
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ATM Fly-Ware should additional information be necessary for enclosure types not listed.

Enclosure materials used in the professional loudspeaker manufacturing industry include; Multi-Ply Finland Birch, Multi-Ply Maple (a.k.a. Apple-Ply), Domestic birch, ACX, MDF (Medium Density Fiber Board), Chip Board, and Particle Board. The type of material used is usually the result of the intended use for the loudspeaker. For example, many flyable touring grade loudspeaker enclosures are constructed from Multi-Ply Maple or Multi-Ply Birch. Many of the flyable installation grade loudspeaker enclosures are constructed from Domestic Birch and ACX. And many of the non-flyable contractor grade and musical instrument grade loudspeaker enclosures are constructed from MDF, Chip Board, and Particle Board.

Joinery methods will vary with the loudspeaker manufacturer, and with the intended use of the loudspeaker. Below are the most common forms of enclosure joinery;



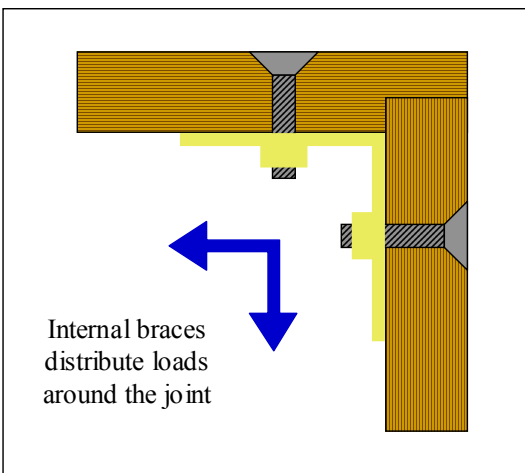
Various types of fasteners are used to hold the seams of the joints together while glue sets the joint. Some manufacturers will not use fasteners at all, and hold the joint tight with clamping presses. Either way, there is no considerable gain in strength.

In order to strengthen the joint of the enclosure, a brace of some kind must be employed. Both internal and external bracing systems are effective, however internal bracing is the most common, and will therefore be examined more closely. The theory behind both internal and external brace systems is the same.

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Internal brace hardware is usually found around the edges of the loudspeaker enclosure. The installation of the brace helps to distribute much of the force from the top and/or bottom of the enclosure to the sides of the enclosure. This load distribution is achieved by using fasteners to bond the enclosure to the installed internal brace;



There are many types of internal brace hardware installed by loudspeaker manufacturers, and there are many styles of internal brace hardware available from ATM Fly-Ware. Different lengths and construction parameters dictate the strength added to the enclosure by the internal brace. ATM Fly-Ware has researched the load strength of a series of internal brace hardware in various enclosure types;



Various Internal Braces and hardware available from ATM Fly-Ware



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Internal Brace Working Load Guidelines

Working Load Guidelines include a 5:1 design factor and an additional ATM Fly-Ware imposed 2:1 fatigue factor due to materials weathering.

INTERNAL BRACE	MATERIAL	WORKING LOAD GUIDELINE
.....		
Enclosures with 1/4" rabbet & dado construction - seams glued 100% - stapled, Four corners braced;		
2X8-IB-3/8"	3/4" Multi-Ply Birch	1314 lb / 596 kg
OSRIB1	3/4" Multi-Ply Birch	1145 lb / 519 kg
2X8-IB-3/8"	3/4" Multi-Ply Maple	788 lb / 357 kg
OSRIB1	3/4" Multi-Ply Maple	754 lb / 342 kg
OSRIB1	3/4" ACX	715 lb / 324 kg
2X2-IB-3/8"	3/4" Multi-Ply Birch	600 lb / 272 kg
2X2-IB-3/8"	3/4" Multi-Ply Maple	548 lb / 248 kg
2X2-IB-3/8"	3/4" ACX	483 lb / 219 kg
2X2-IB-3/8"	3/4" Particle Board	212 lb / 96 kg
Enclosures with 3/4" X 1/4" dado construction - seams glued 100% - stapled, Four corners braced;		
2X8-IB-3/8"	3/4" Multi-Ply Birch	1035 lb / 469 kg
OSRIB1	3/4" Multi-Ply Birch	880 lb / 399 kg
2X8-IB-3/8"	3/4" Multi-Ply Maple	680 lb / 308 kg
2X8-IB-3/8"	3/4" ACX	670 lb / 303 kg
2X8-IB-1/4"	3/4" Multi-Ply Birch	620 lb / 281 kg
2X2-IB-3/8"	3/4" Multi-Ply Birch	600 lb / 272 kg
OSRIB1	3/4" Multi-Ply Maple	580 lb / 263 kg
OSRIB1	3/4" ACX	550 lb / 249 kg
2X2-IB-3/8"	3/4" Multi-Ply Maple	460 lb / 208 kg
2X2-IB-3/8"	3/4" ACX	450 lb / 204 kg
2X8-IB-1/4"	3/4" Multi-Ply Maple	410 lb / 185 kg
2X8-IB-1/4"	3/4" ACX	400 lb / 181 kg
2X2-IB-1/4"	3/4" Multi-Ply Birch	360 lb / 163 kg
2X2-IB-1/4"	3/4" Multi-Ply Maple	276 lb / 125 kg
2X2-IB-1/4"	3/4" ACX	270 lb / 122 kg
2X2-IB-3/8"	3/4" Particle Board	250 lb / 113 kg
2X2-IB-1/4"	3/4" Particle Board	150 lb / 68 kg
Enclosures with butt joint construction - seams glued 100% - stapled, Four corners braced;		
2X2-IB-3/8"	3/4" ACX	348 lb / 157 lb
2X2-IB-3/8"	3/4" Particle Board	160 lb / 72 kg

Note: The above listed results are for comparison only. No structural rating or performance of product is guaranteed whatsoever. ATM Fly-Ware recommends that every enclosure design be tested on an individual case basis. Seek assistance from a qualified professional prior to suspending any enclosure.

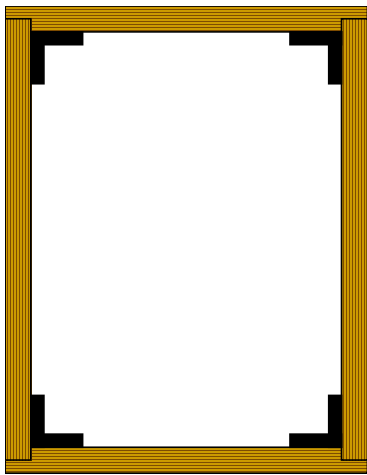


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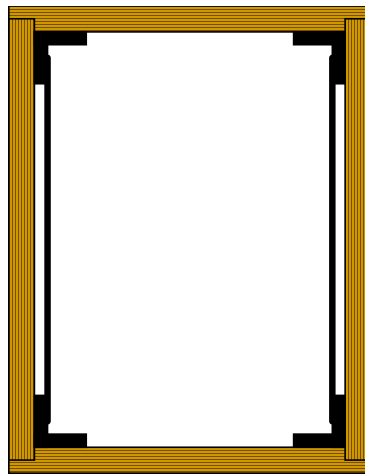
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SOUND SYSTEM RIGGING

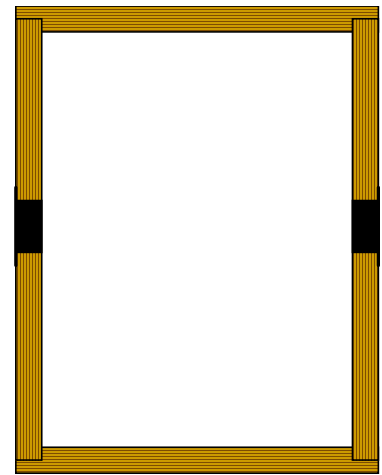
A stronger method of bracing loudspeaker enclosures is by means of through-enclosure bracing hardware. With this design type, the top and bottom internal braces are joined by means of an intermediary hardware component. When installed properly, the enclosure's construction is somewhat irrelevant as the through-enclosure bracing hardware carries most of the load. Again, various methods can be applied here. Threaded rod and flat strapping are the most common means of through-enclosure bracing hardware.



Four corner brace system



Four corner brace system W/
through-enclosure strapping



Pivotal brace system

The above mentioned methods of loudspeaker enclosure bracing are designed to accommodate top and/or bottom surface suspension points, or side surface suspension points located near the top and bottom of the enclosure.

Another method of bracing a loudspeaker enclosure is to locate the suspension point in the side of the enclosure near the center of gravity. The pivotal method is perhaps the strongest method of loudspeaker enclosure suspension as most of the load on the enclosure is shear force. Additionally, the hardware necessary to accommodate this type of suspension method may be large and will not allow wavefront coherent arrayability.

Side mounting methods may cause inhibiting factors when constructing loudspeaker arrays. (*See Array Theory section*)

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ENCLOSURE HARDWARE

The external hardware on loudspeaker enclosures is just as diverse as the internal hardware. There are several common types of hardware components being utilized by professional loudspeaker manufacturers. The more common hardware components have been found in the aircraft cargo control industry. Yet, today the professional loudspeaker manufacturers are moving toward loudspeaker specific hardware systems in order to avoid liability and availability concerns involved with the aircraft cargo control hardware.

Some of the more common aircraft cargo control hardware;



Ring/Stud Pan Fitting



Ring Pan Fitting



Stud Pan Fitting

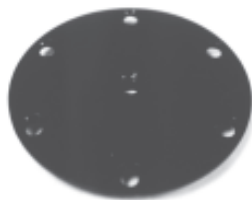


L-Type Track

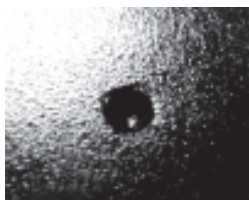


Round Anchor Plate

Some of the more common loudspeaker specific hardware;



Nut Plate



Threaded Hole OSRIB1 & OSRV1-3/8"



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With most of these hardware types, the hardware is attached to the internal bracing hardware using high grade fasteners. Various methods are employed by loudspeaker manufacturers, therefore it is mandatory to periodically check the fastener tightness in order to be certain the enclosure rigging hardware is secure and safe to use. With some of the hardware types, such as the threaded hole and the OSRIB1, ancillary fasteners are not necessary since the hardware component also serves as the internal brace.

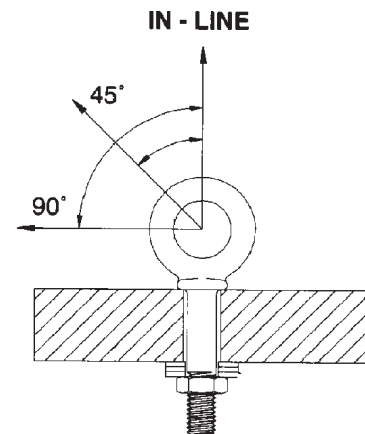
Rigging hardware must be used properly to be safe and effective. The improper use of rigging hardware is the primary cause of rigging accidents throughout the world. Most of the time, a basic knowledge of what types of hardware, and how to use the hardware would prevent rigging incidents from occurring.

The primary cause of rigging hardware failure is improper loading. It can be surprising when one considers how much negative effect there is on a rigging hardware component when it is not loaded according to the manufacturer's recommendations.

Below is the load rating chart for a forged shoulder eyebolt, take note of the adjustment factor for the component as the load is directed away from an in-line load.

Crosby Group General Catalog March 1992

Direction of Pull	Adjusted Working Load
45 degrees	30% of rated working load
90 degrees	25% of rated working load

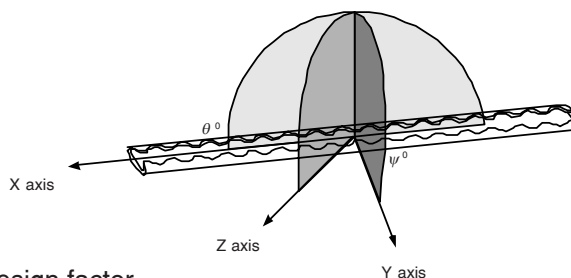


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ATM Fly-Ware ATM-TRACK

ANGLE FROM CENTERLINE OF TRACK θ°	VERTICAL ANGLE OF PULL ψ°	WORKING LOAD LIMIT	
		AF-DSSF	AF-DSF
0°	0°	1500Lb/680Kg	1000Lb/454Kg
0°	30°	1250Lb/567Kg	1500Lb/680Kg
0°	60°	950Lb/431Kg	900Lb/408Kg
0°	90°	550Lb/249Kg	800Lb/363Kg
90°	0°	1050Lb/476Kg	400Lb/181Kg
90°	30°	1250Lb/567Kg	400Lb/181Kg
90°	60°	1150Lb/522Kg	550Lb/249Kg



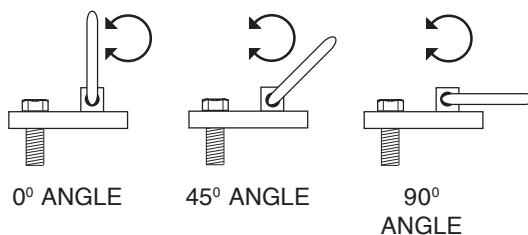
Working load limits shown represent a 5:1 design factor.

ATM Fly-Ware OSR Series Offset Swivel Ring Fittings

	0° ANGLE	45° ANGLE	90° ANGLE
OSRV1-1/4"	350 Lb 159 Kg	350 Lb 159 Kg	350 Lb 159 Kg
OSRV1-3/8"	800 Lb 363 Kg	750 Lb 340 Kg	650 Lb 293 Kg
OSRV2-3/8"	800 Lb 363 Kg	750 Lb 340 Kg	650 Lb 293 Kg
OSRV2-1/2"	1250 Lb 567 Kg	1000 Lb 453 Kg	1000 Lb 453 Kg



ATM Fly-Ware OSRV1-3/8"



Working load limits specified are for rigid surface installations. Results with soft surface installation results will vary according to material. A general rule for soft surface installations is to multiply the corresponding working load limit by 75%: the result will be an approximation of working load strength.

All fasteners must be a minimum of grade 8. Use threadlocking compound for all installations. Follow installation instructions completely.

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ENCLOSURE HARDWARE

Aircraft Fitting style hardware is available from ATM Fly-Ware with rating for overhead suspension. The fittings in the AF Series product line address the product liability concerns associated with the cargo control hardware shown previously.

Some of the more common AF Series hardware;



AF-RSPF

WLL = 440 lbs / 198 kg



AF-RPF

WLL = 465 lbs / 210 kg



AF-SPF

WLL = 440 lbs / 198 kg



AF-12JF

WLL = 440 lbs / 198 kg



AF-12JF-1"

WLL = 440 lbs / 198 kg

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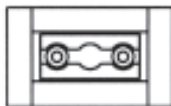
AF-HDTrack
WLL = 605 lbs / 274 kg



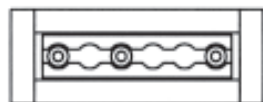
AF-DSF
WLL = 605 lb / 274 kg



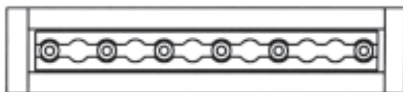
AF-DSSF
WLL = 605 lb / 274 kg



AF-HD3
WLL = 605 lb / 274 kg



AF-HD3
WLL = 605 lb / 274 kg



AF-HD3
WLL = 605 lb / 274 kg

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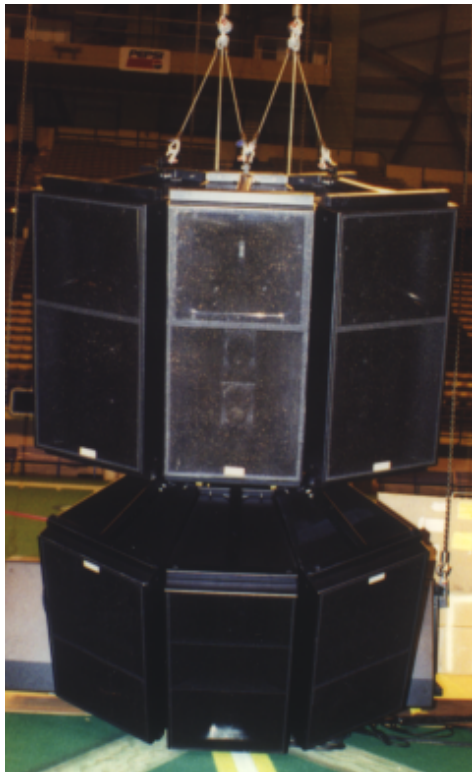
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ARRAY THEORY

Some feel loudspeaker array theory is a somewhat controversial subject. As with any controversial subject, the arguments lie in the measures and balances of the data available. ATM Fly-Ware has invested a great deal of resources toward "loudspeaker array technology" in order to provide quality rigging products to the sound reinforcement industries.

ATM Fly-Ware has researched many of the differences in array construction types and has concluded that horizontally configured arrays (a.k.a. planer arrays) are preferable to vertically configured arrays in the following ways;

- ◆ Loudspeaker wavefront alignment, array comb filtering minimization
- ◆ Array distortion control
- ◆ Directional control of quality audio program in most venues
- ◆ More compact arrays - more true to point source array technology



The photo to the left shows a horizontally configured array (planer array). Each row of the array is locked into place in the horizontal plane - hence the terms horizontally configured array and planer array. Each row can then be tilted as a unit, rather than each individual loudspeaker being tilted as a single entity. (*See vertically configured arrays*)

Horizontally configured arrays show increased averaged intelligibility for most venues due to a reduction in comb filtering and the controlled horizontal organization of combined sound source distortion effects.

Photo: EAW MH660 loudspeakers flown with ATM Fly-Ware AMFS Series Modular Loudspeaker Flying Hardware.



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ARRAY DEFINITIONS

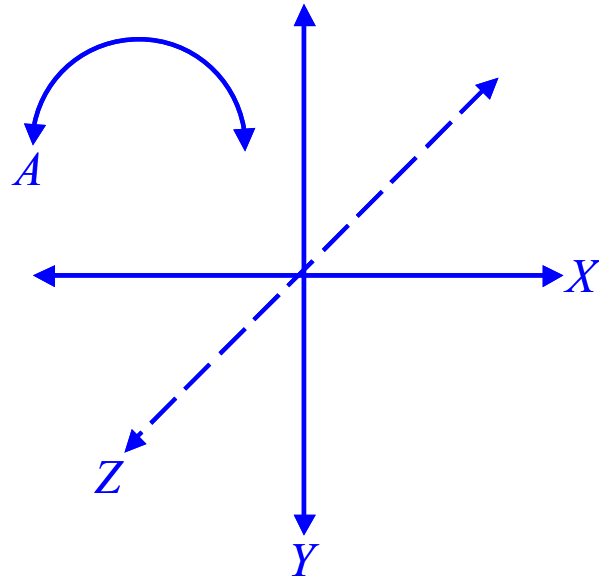
✓ Axial definitions:

X = Horizontal Plane

Y = Vertical Plane

Z = Proximal Plane

A = Rotational Plane

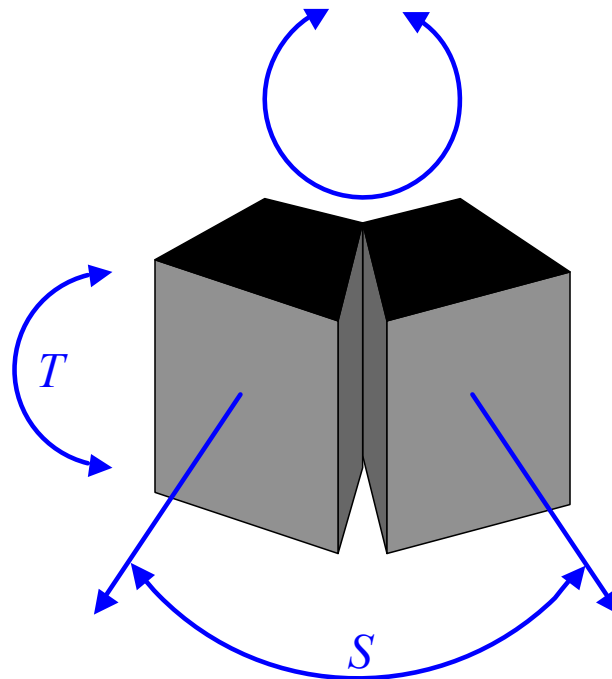


✓ Angular definitions:

S = Splay Angle

T = Tilt Angle

R = Rotational Angle



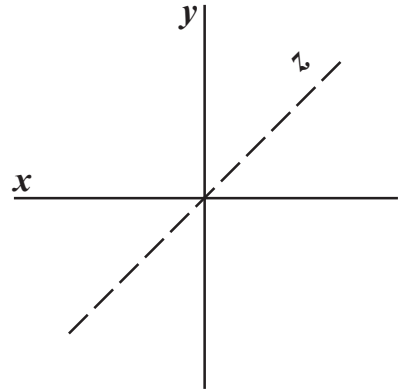
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Horizontally configured loudspeaker arrays will inherently maintain acoustic wavefront coherency along the horizontal plane since the loudspeaker enclosures are fixed along the z-axis.

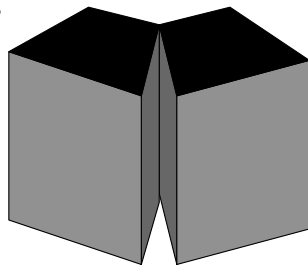
As long as the loudspeaker enclosures maintain proper acoustic wavefront alignment, the array will minimize comb filtering and distortion effects caused by misaligned acoustic wavefronts.

ATM Fly-Ware AMFS Series Loudspeaker Flying Hardware also enables the loudspeaker array to be configured so that the vertical acoustic wavefronts between rows can be aligned as well.

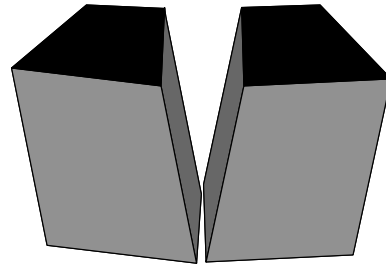


Horizontally configured arrays are not without distortion: the interaction between rows of loudspeakers will cause comb filtering. However, in most venues, distortion and filtering effects in the horizontal plane will not be as damaging to average sound system intelligibility since the seating areas effected will number fewer in the horizontal plane than in the vertical plane. Horizontally configured arrays can be configured so that in many venues the unwanted horizontal coverage can be directed toward areas without seating, such as a balcony face or aisle way.

Since horizontally configured loudspeaker arrays are constructed in the horizontal plane (x-axis) first, and the vertical plane (y-axis) secondarily, the space the entire array occupies is less than that of a similarly fashioned vertically configured array. This is clear when one considers the cubic space occupied by a loudspeaker, and then configures multiples in suspended in space. Since two objects cannot occupy the same space at the same time;



Horizontally configured array



Vertically configured array

Both arrays show rectangular loudspeakers at a 20° splay with 20° downward tilt.



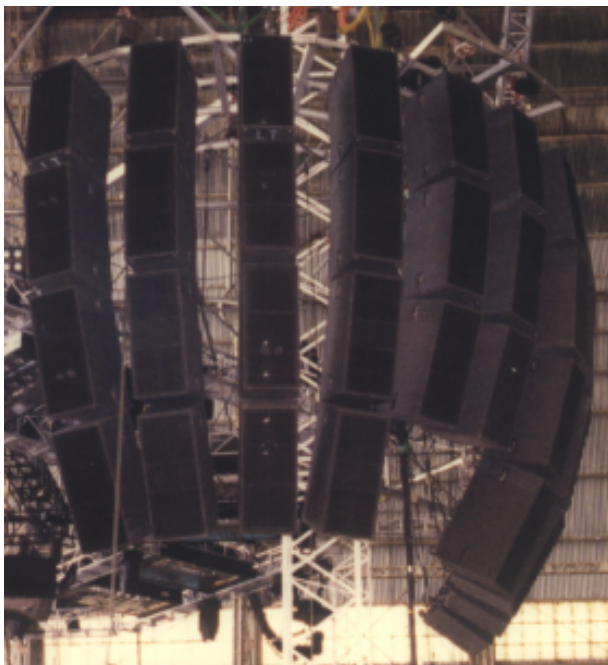
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ATM Fly-Ware research into the differences between horizontally configured arrays (planer arrays) and vertically configured arrays shows that vertically configured arrays are preferable to horizontally configured arrays in the following ways;

- ◆ Independent loudspeaker directional alignment
- ◆ Easy adjustment to loudspeakers after being suspended (depending on rigging system)
- ◆ Can be easily implemented with trapezoidal and rectangular enclosures



The photo to the left shows a vertically configured array. Each column of the array is independent from the next, and therefore can be pivoted independently. Each loudspeaker can be tilted as a single entity.

Photo: Electrotec LAB-Q loudspeakers flown from an ATM Fly-Ware custom grid truss system.

Vertically configured loudspeaker arrays allow independent horizontal adjustment for each column of loudspeakers. However, this adjustment capability limits the amount of acoustic wavefront alignment possible with a vertically configured array. The loudspeaker columns must also be spaced apart from one another in order to avoid any tilted loudspeakers from attempting to occupy the same space.

Tilt adjustments can be made after the loudspeaker array is suspended with most vertical array rigging systems. The acoustic wavefront alignment in the vertical plane can also be adjusted, depending on the rigging system employed.

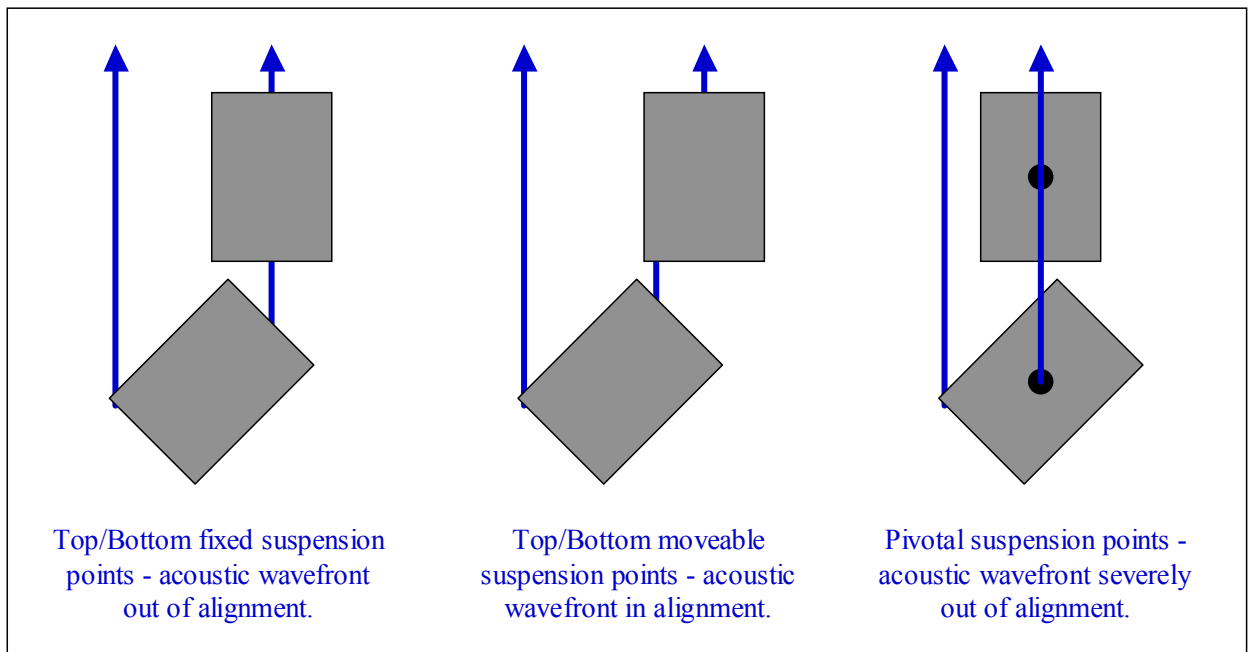
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While there may be variations of designs, there are a few basic rules regarding the rigging hardware used with horizontally and vertically configured loudspeaker suspension systems.

Horizontally configured loudspeaker systems must utilize the top and bottom surfaces of the loudspeaker enclosure to suspend the enclosure weight since the sides of the enclosures are not accessible. The load can be substantial when numerous loudspeakers are put together, so there is usually some sort of through-enclosure bracing system installed in conjunction with the enclosure rigging hardware. Systems such as the ATM Fly-Ware AMFS Series Loudspeaker Flying Hardware help to safely distribute the load evenly over the loudspeaker enclosure hardware.

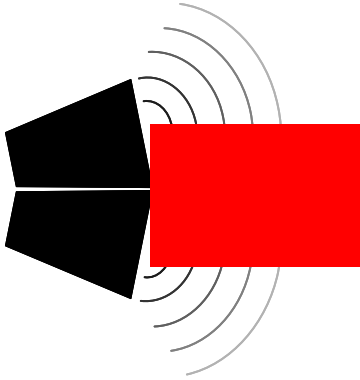
Vertically configured loudspeaker systems can utilize either the top and bottom surfaces or the side surfaces of the loudspeaker enclosure to suspend the enclosure weight. As with the horizontally configured system, if the top and bottom surfaces are utilized, the loudspeaker enclosure will be loaded with the weight of any successive loudspeakers suspended from it. However, if the side surfaces are utilized in conjunction with through-enclosure bracing hardware, the loudspeaker will only be loaded with its own weight. A suspension point located near the center of gravity alleviates the need for through-enclosure bracing altogether.



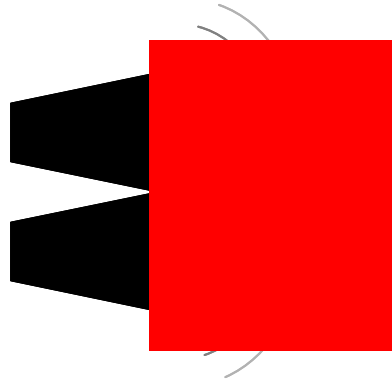
RIGGERMEISTER

SOUND SYSTEM RIGGING

Acoustic wavefront alignment is very important if the intelligibility of the sound system is to be maintained. If the acoustic wavefronts are not aligned, wavefront distortion will occur since sound waves are propagating pressure waves.



Acoustic wavefront in alignment



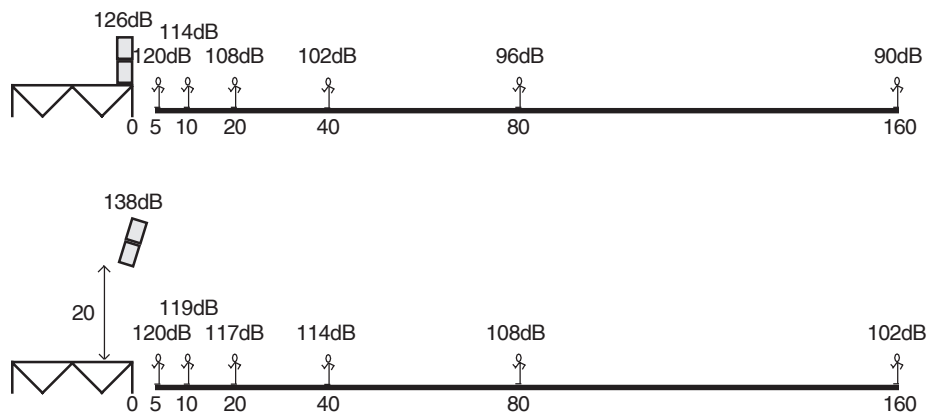
Acoustic wavefront not aligned

The aligned array benefits from the combined pressure waves since the pressure waves are arriving at the same time and are in relative phase. The non aligned array is subject to unwanted acoustic wavefront distortion since the pressure waves come without synchronicity which results in varying arrival times and out of phase interaction.

The same effects are present in the vertical plane, however they are less noticeable by the listening audience.

INVERSE SQUARE LAW

Each time the distance from a sound source is doubled, the sound pressure level is decreased by 6dB.



RIGGERMEISTER

INDIVIDUAL ENCLOSURES

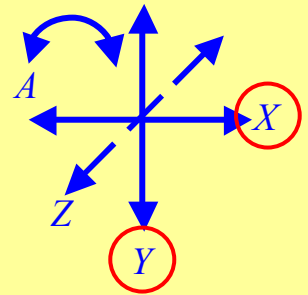
When suspending individual enclosures, the center of gravity must be kept below the suspension device or the load may shift or flip upside down. A vertically loaded enclosure will maintain the greatest working load limit. Redundant primary suspension points are also recommended.

YOKE SYSTEMS

A yoke will allow pan and tilt adjustment, as well as orientation of the loudspeaker in the vertical or horizontal depending on the yoke design.

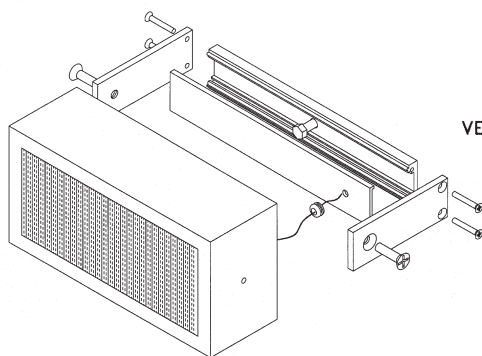


Adjustable:

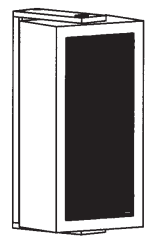
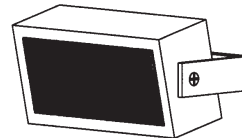


U-BRACKET YOKE SYSTEMS

A U-bracket yoke will allow pan or tilt adjustment depending upon how it is mounted, as well as orientation of the loudspeaker in the vertical or horizontal depending on the yoke design.



VERTICAL ORIENTATION
SPEAKER PAN



VERTICAL ORIENTATION
SPEAKER PAN



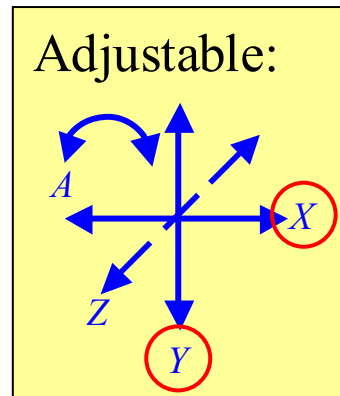
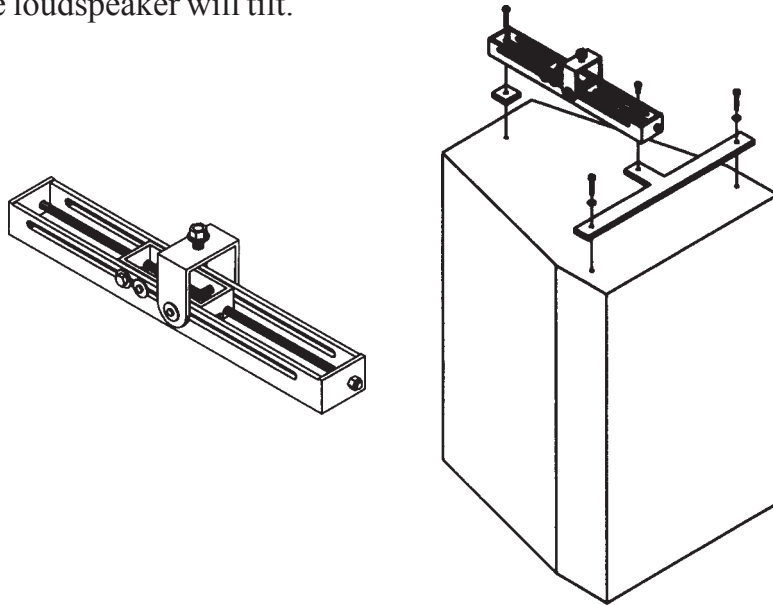
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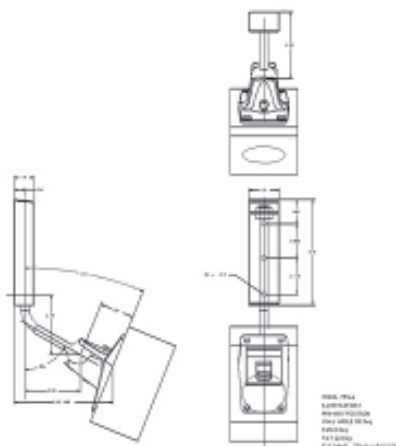
INDIVIDUAL ENCLOSURES

ADJUSTABLE TILT BRACKET SYSTEM

The ATM Fly-Ware ATB Series adjustable tilt bracket manipulates the center of gravity of the loudspeaker by a shaft-driven moveable truck, as the truck moves backward the loudspeaker will tilt.



WALL MOUNTS



OmniMount
OmniMount
Phoenix, Arizona

Multi-Mount
Allen Products Co.
Signal Hill, California



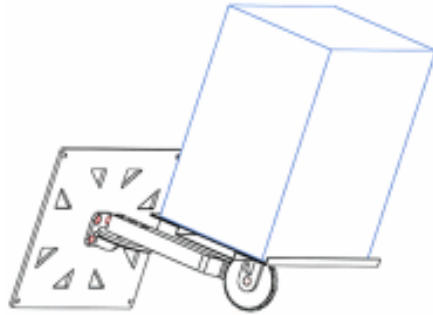
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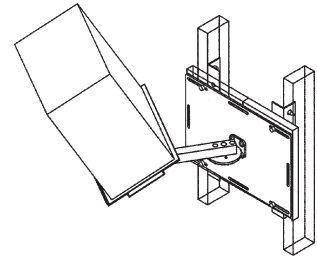
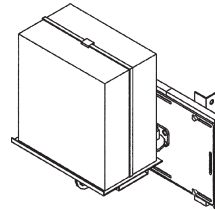
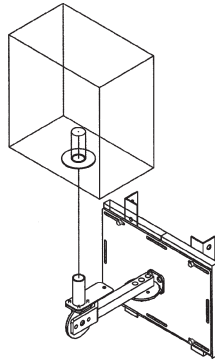
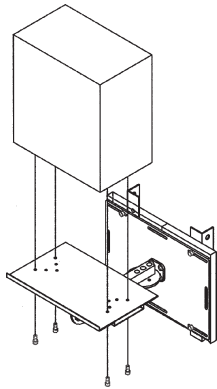
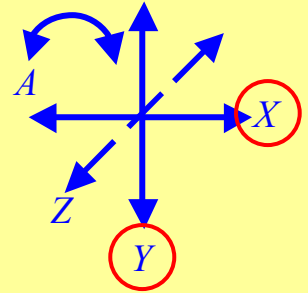
INDIVIDUAL ENCLOSURES

ATM MOUNT-WARE

The ATM Mount-Ware adjustable wall mounts allow pan and tilt adjustment as well as compliance with global overhead suspension standards.

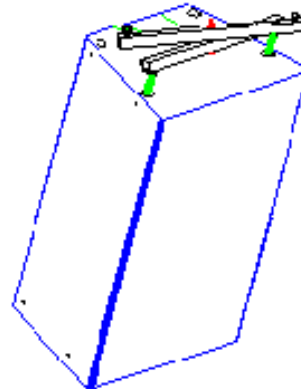
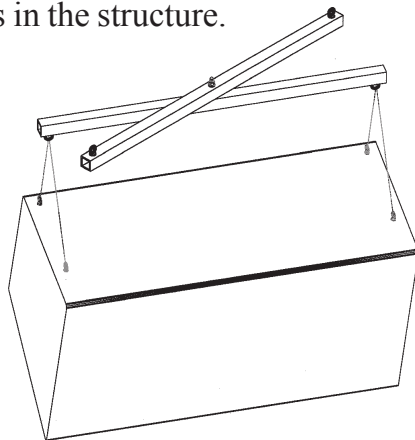


Adjustable:



SWIVEL BEAMS

Swivel beams allow adjustable pan and tilt with suspension from two attachment points in the structure.



Alternate manufacturer prevented the inclusion of their swivel beam in this educational reference guide.

ATM Fly-Ware SB Series



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Page E-21

RIGGERMEISTER

LOUDSPEAKER ARRAYS

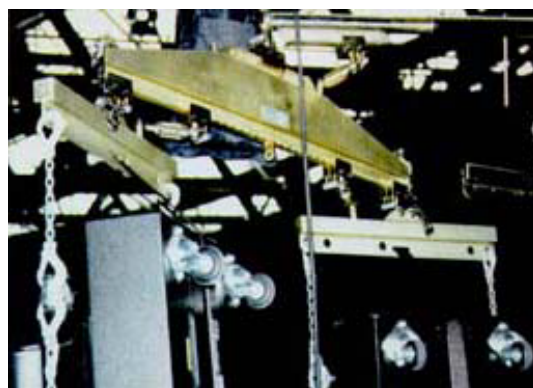
GRID TRUSS SYSTEMS

Grid truss suspension systems come in a variety of sizes, shapes, and materials. Usually grid truss systems are proprietary designs manufactured by sound rental companies or sound system installation contractors.



The photo to the left shows a grid truss which will accommodate four columns of loudspeakers. This grid truss also allows each of the columns to be independently swivelled on axis.

Photo: Electrotec Productions



The photo above will accommodate two columns of loudspeakers with independent swivel, tilt and gap.

Photo: M.A.N. Flying Systems

M.A.N. Flying Systems, Essex, UK

MODULAR GRID TRUSS SYSTEMS

Modular grid truss systems are similar to grid truss systems with the added flexibility of truss sections. These truss sections can be in column multiples of one, two, or three loudspeaker columns wide. By providing modularity to the grid truss, splay angles and enclosure numbers can be varied easily.

Some modular grid truss systems are constructed to provide a coherent acoustic wavefront in the horizontal plane as long as the loudspeakers are not tilted. Tilting the loudspeakers causes misalignment between the loudspeaker enclosures due to the inherent nature of flexibly suspending the loudspeaker enclosures from the modular grid truss.



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LOUDSPEAKER ARRAYS

The photo to the right shows one of the ATM Fly-Ware AMFS-3X4 Series Modular Grid Truss Loudspeaker Flying Hardware Systems.



Photo: EAW KF850 loudspeakers flown with ATM Fly-Ware Modular Loudspeaker Flying Hardware.

The ATM Fly-Ware AMFS-3X4 Series Loudspeaker Flying Hardware allows the user to add as many loudspeaker columns as desired. Each of the modular truss sections connects to the adjacent truss section with the use of a connecting bar which slides inside the tubular truss body. The connecting bar is secured into the truss bodies with grade 8 bolt fasteners.



The photo to the left shows two sections of the ATM Fly-Ware AMFS-KF850-T modular grid truss system. There is an AMFS-3X4-30 connecting bar between the two modular grid trusses giving a 30° total splay between adjacent on axis responses.

Many different splay angles and loudspeaker spacing can be achieved by changing out the connecting bar. The AMFS-3X4 Series is designed to accommodate a 5 loudspeaker load from any one suspension point, this load rating includes a 5:1 design factor.



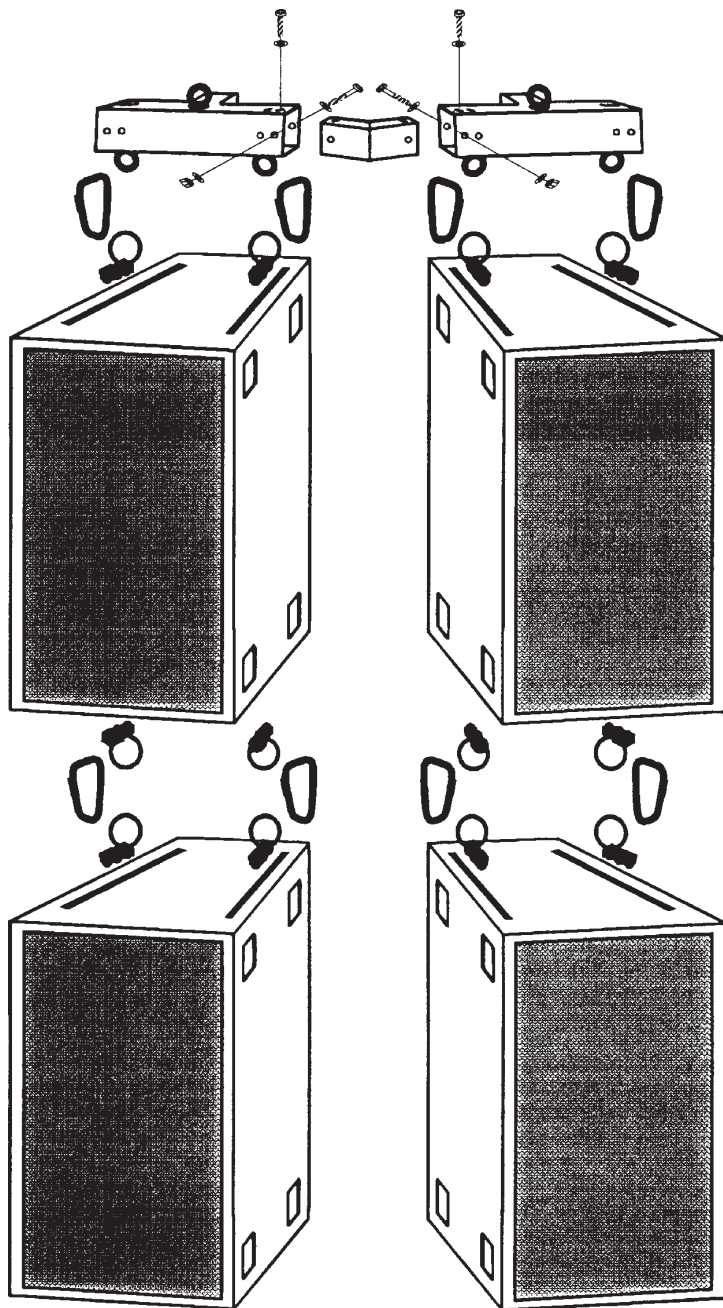
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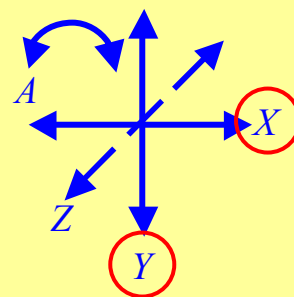
LOUDSPEAKER ARRAYS

AMFS-3X4 SERIES

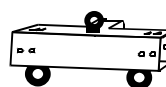
Exploded View



Adjustable:



LEGEND



AMFS-3X4 Series
Truss Module



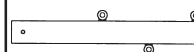
AMFS-3X4 Series
Connecting Bars



AF-DSF



OPSCARABINER

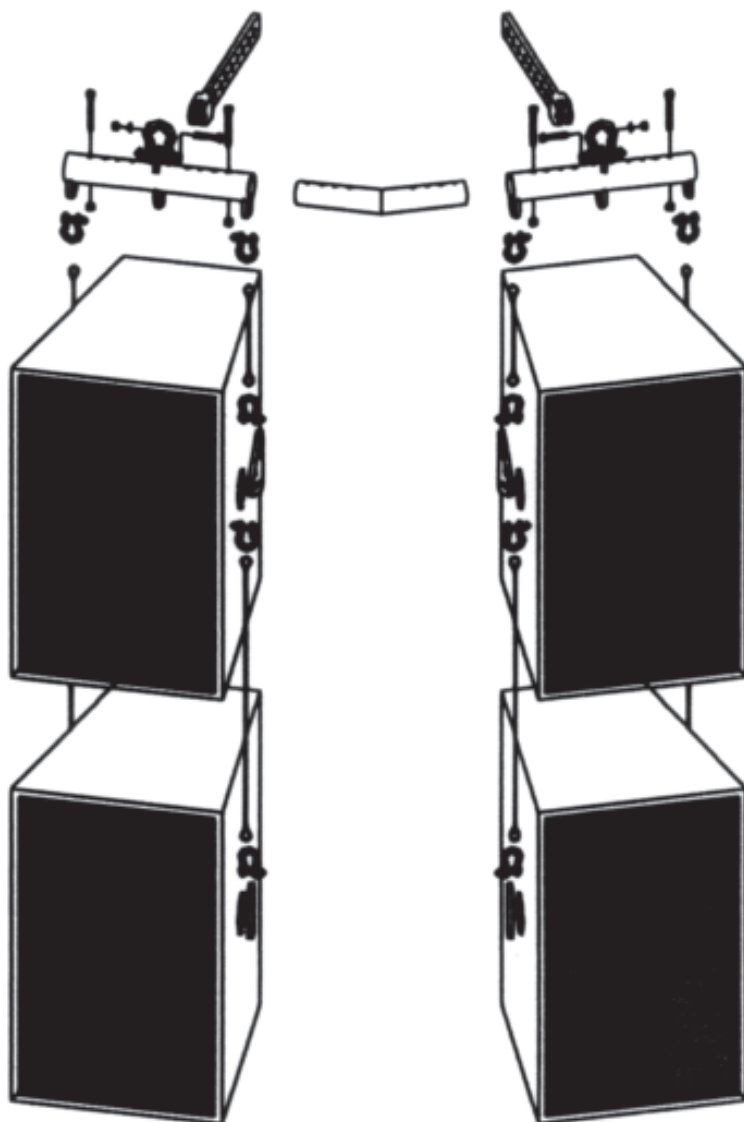


AMFS-3X4 Series
Pull Strap Bar

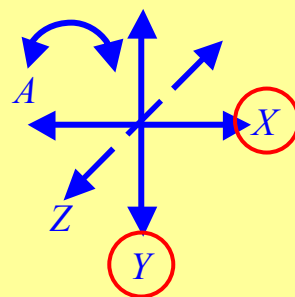
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LOUDSPEAKER ARRAYS

AMRS-3R SERIES
Exploded View



Adjustable:



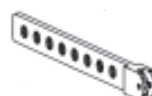
LEGEND



AMRS Series
Truss Module



AMRS Series
Connecting Bar



AMRS Series
Pull Strap Bar



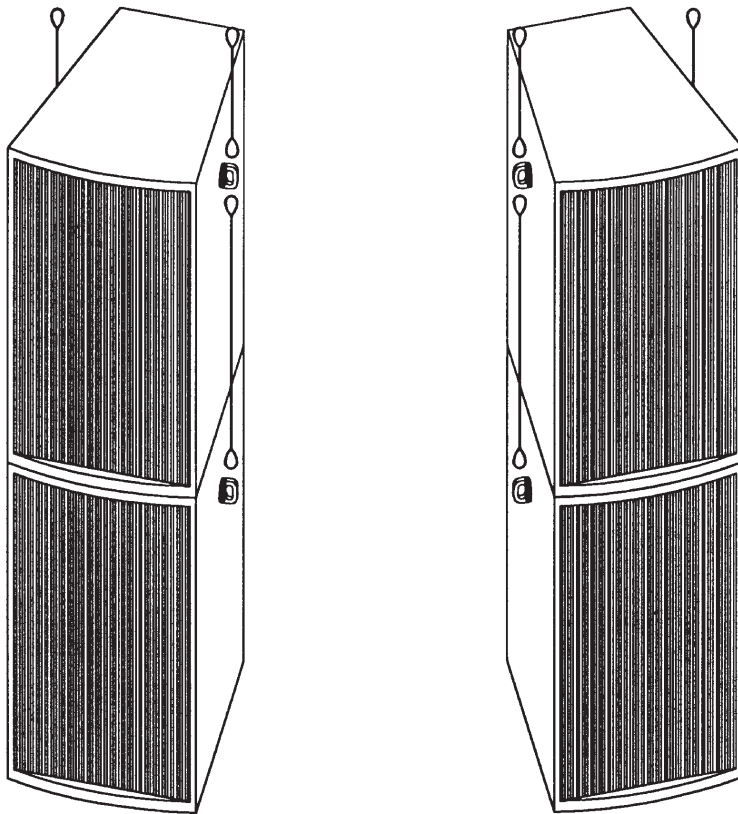
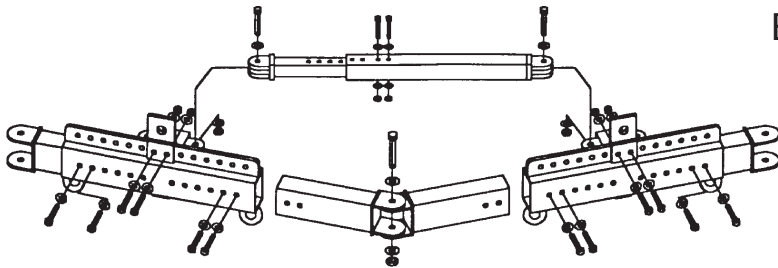
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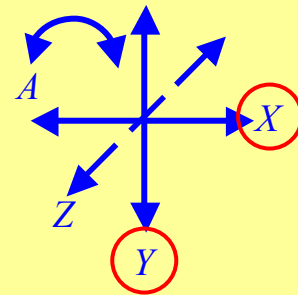
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LOUDSPEAKER ARRAYS

MEGS-3X4 SERIES Exploded View



Adjustable:



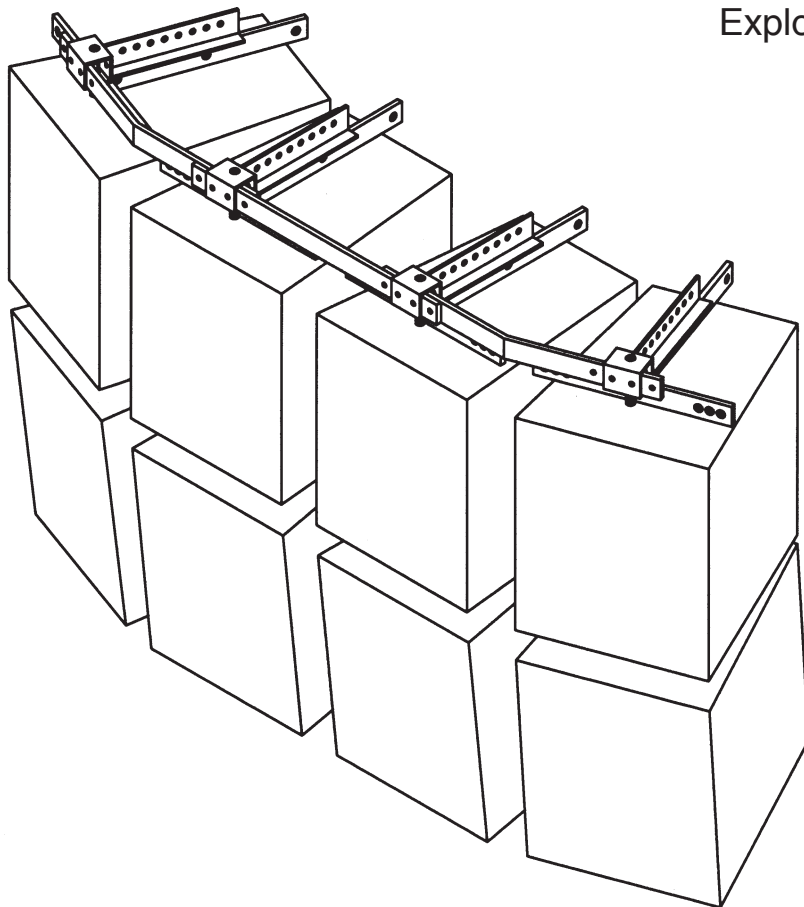
LEGEND



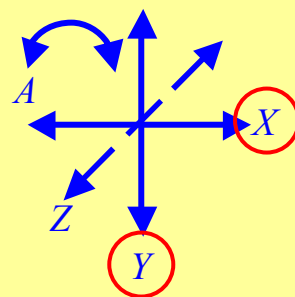
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LOUDSPEAKER ARRAYS

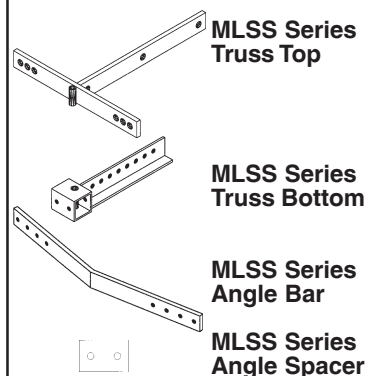
MLSS SERIES
Exploded View



Adjustable:



LEGEND

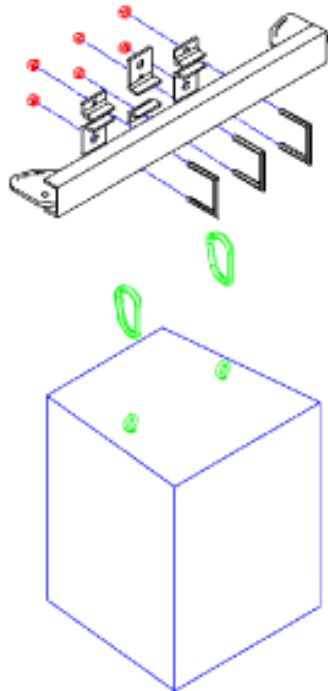


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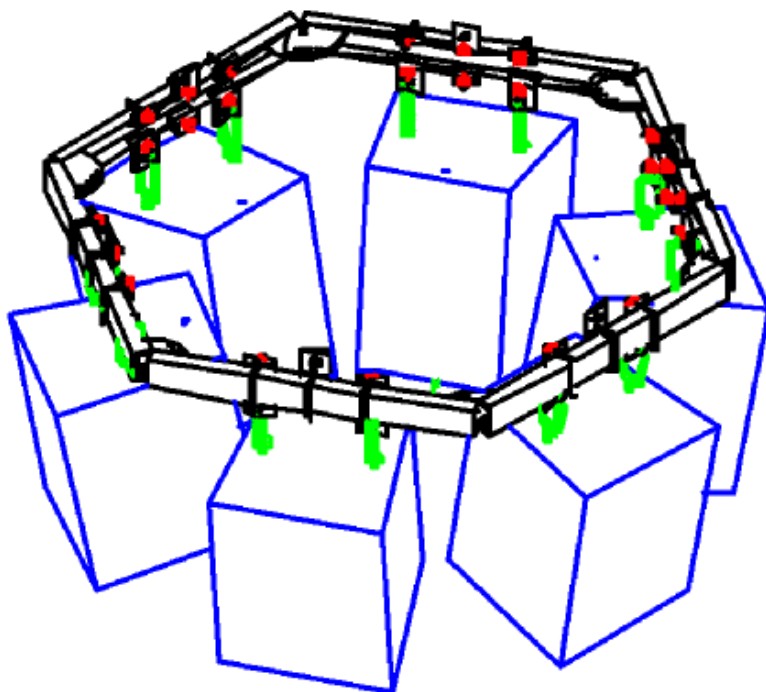
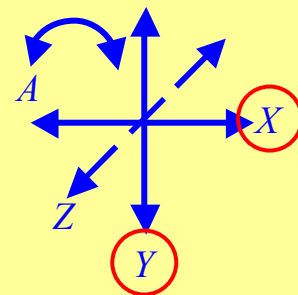
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LOUDSPEAKER ARRAYS



MLDS SERIES
Exploded View

Adjustable:



LEGEND



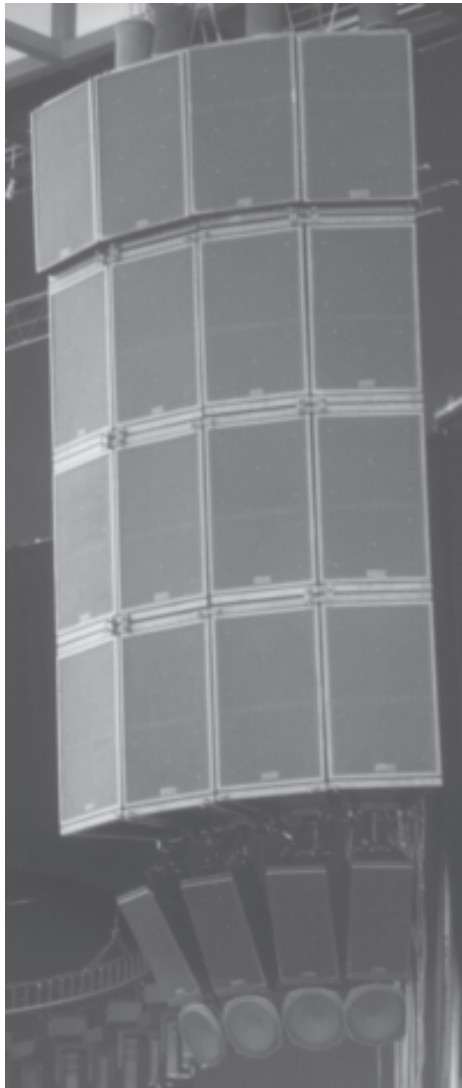
MLDS Series
Truss Module

RIGGERMEISTER

LOUDSPEAKER ARRAYS

MODULAR RIGGING HARDWARE SYSTEMS

Modular rigging hardware systems are horizontally configured systems designed to expand and decrease in size with the requirements of the loudspeaker system. A modular rigging hardware system will usually allow a high degree of flexibility when considering splay and tilt angles, all the while maintaining a coherent acoustic wavefront in both the horizontal and vertical axis.



The photo to the left shows a large loudspeaker array constructed with the ATM Fly-Ware AMFS-2X2 Series Modular Loudspeaker Flying Hardware system. Notice that the ATM Fly-Ware system is a "direct suspension" system, meaning the suspension cables attach directly to the modular loudspeaker truss hardware without first going to a grid truss or load beam.

The AMFS-2X2 Series is designed to accommodate a 2 loudspeaker load from any one suspension point. Notice that in the photo the top two rows are suspended from one set of cables from the chain motors above, and the lower two rows are suspended from a different set of cables from the same chain motors.

The three top rows of loudspeaker are not tilted, however the bottom row of loudspeakers is tilted 10° downward. Additionally, the first and third row of loudspeakers are inverted.

Photo: ProMix



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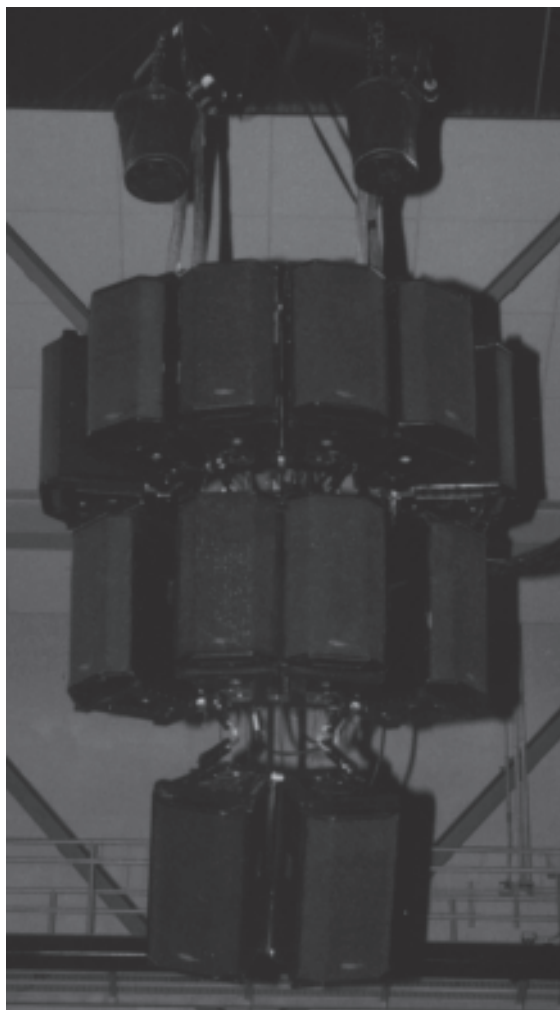
LOUDSPEAKER ARRAYS

The photo to the right shows a loudspeaker array constructed with the ATM Fly-Ware AMFS-1X2 Series Modular Loudspeaker Flying Hardware system. As with the AMFS-2X2 Series, the AMFS-1X2 Series is also a direct suspension system.

The AMFS-1X2 Series Modular Loudspeaker Flying Hardware system is designed to accommodate a 4 loudspeaker load from any one suspension point. Notice that the twelve loudspeaker array is suspended from two chain motors with simple bridles to four suspension points.

One of the many advantages of the ATM Fly-Ware Modular Loudspeaker Flying Hardware system is that loudspeakers can be attached to one another in any configuration or attitude since the modular trusses are fastened to the top and the bottom of the loudspeaker.

Photo: Apogee Sound AE-5 loudspeakers flown with ATM Fly-Ware Modular Loudspeaker Flying Hardware.



Modular rigging hardware systems are inherently rigid in the horizontal plane: meaning loudspeakers adjacent to one another are locked together with some kind of intermediary device. The ATM Fly-Ware Modular Loudspeaker Flying Hardware systems utilize components called connecting bars which can be interchanged for varying splay angles. ATM Fly-Ware also manufactures a variable splay connecting bar for applications which require an independent arch array.

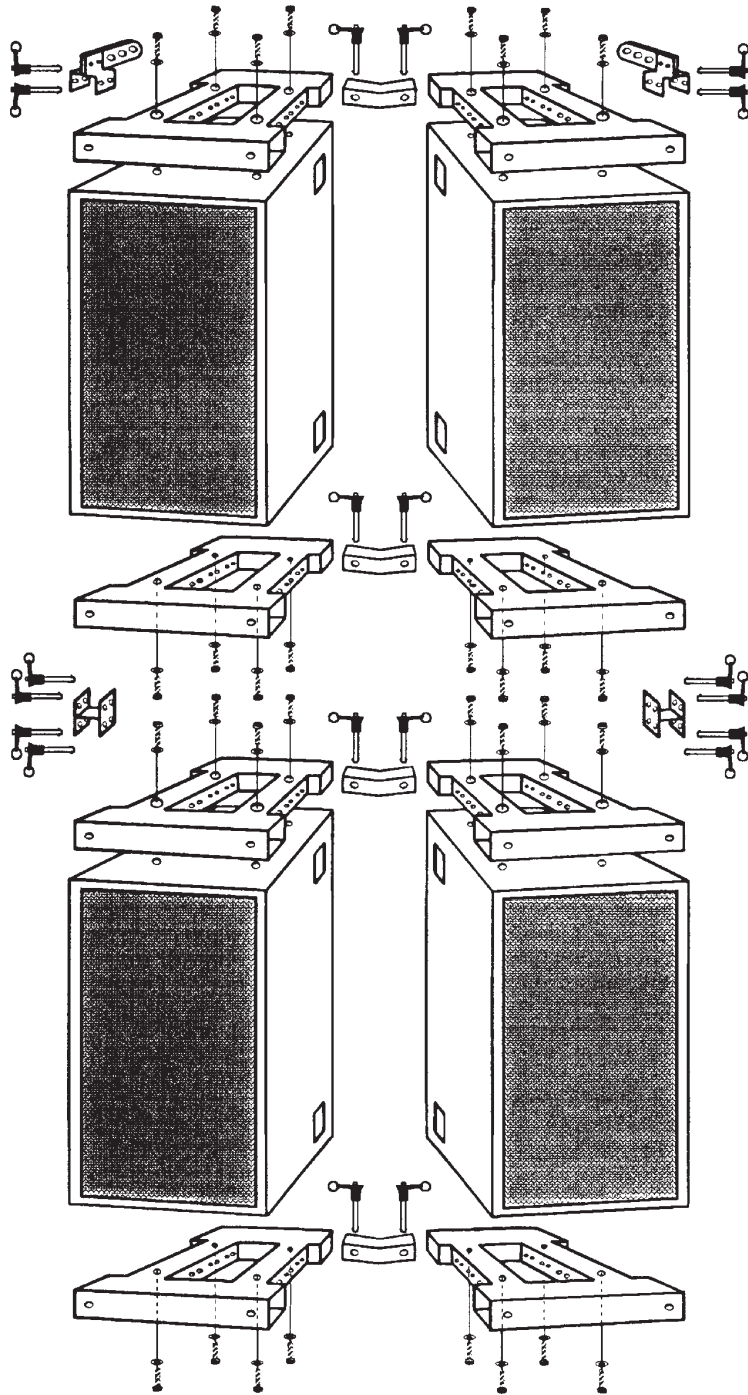
Modular rigging hardware systems enable sound system designers and consultants to confidently specify loudspeaker arrays which will perform to their expectations since the rigging and positioning of the loudspeaker will be fixed to the specifications.



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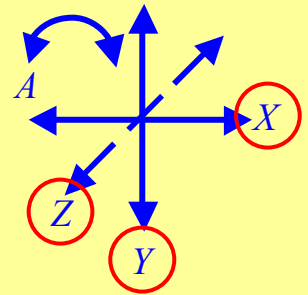
RIGGERMEISTER

LOUDSPEAKER ARRAYS








AMFS-2X2 SERIES
Exploded View

Adjustable:



LEGEND

-  **AMFS-2X2-SME**
Shackle Mount Extended
-  **AMFS-2X2 Series**
Connecting Bar
-  **AMFS-2X2-SB**
Stacking Bracket
-  **2.5" QRP**
Quick Release Pin
-  **Truss Attachment Hardware**

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Page E-31

RIGGERMEISTER

LOUDSPEAKER ARRAYS

AMTS SERIES

TRACK BASED LOUDSPEAKER FLYING HARDWARE SYSTEM

The AMTS Series track based modular loudspeaker flying hardware system has the capacity to either be arranged as a suspended track style system or a rigid horizontally arranged modular system. Additionally, both formats can be used within the same loudspeaker cluster in order to optimize set-up time and loudspeaker array acoustical characteristics. Advantages are clear when one considers the speed with which a track style suspension system can be constructed, and the coherent acoustic wavefront properties of a rigidly configured modular loudspeaker flying hardware system.

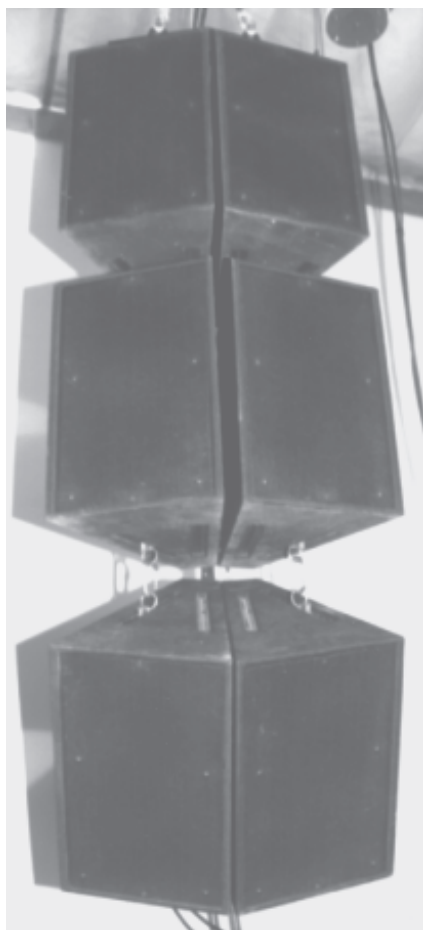
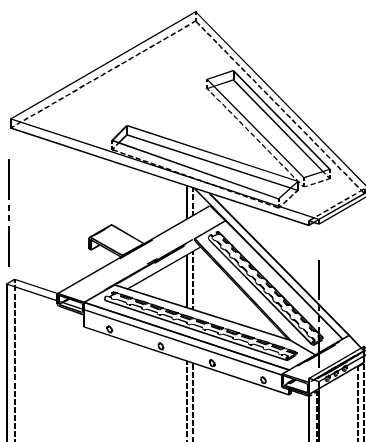
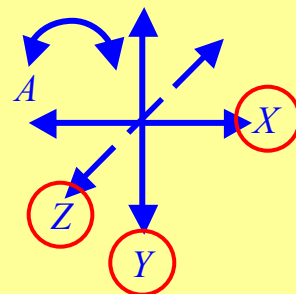


Photo: Westcoast Sound loudspeakers flown with the ATM Fly-Ware AMTS Series Track Based Loudspeaker Flying Hardware System.

The AMTS Series track based modular loudspeaker flying hardware system combines the features of a track system with those of a modular hardware system by implementing an internal brace assembly designed specifically for this use. The internal brace is built into the loudspeaker enclosure with access to the track on top and bottom of the enclosure. Additionally, connecting bar holes are accessible at the rear of the enclosure and pin holes are present in the back of the enclosure. With careful design, the enclosure remains air tight.



Adjustable:



The AMTS Series can be flown without a modular grid truss if the loudspeakers are arrayed using connecting bars (as with the AMFS-1X2 Series and AMFS-2X2 Series). If the loudspeaker cluster is configured as a track style array a modular grid truss is required (as with the AMFS-3X4 Series). In the photo a grid truss is used to hang the top two rows in a track configuration while the bottom row is tilted down using only two suspension points and connecting bars between the enclosures.



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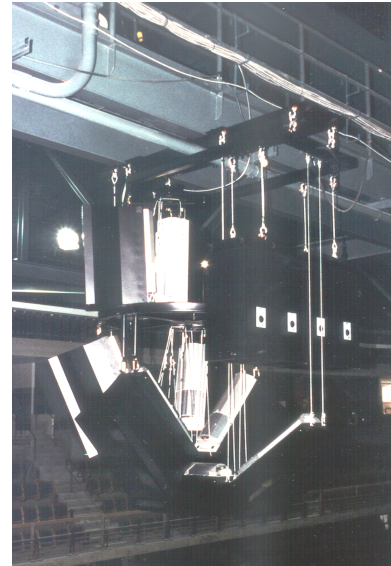
LOUDSPEAKER ARRAYS

LOUDSPEAKER GRIDS

Loudspeaker grid systems allow the suspension of numerous loudspeakers below a structural grid support. Depending on the grid design, adjustability can be found in pan, tilt, gap and convergence.



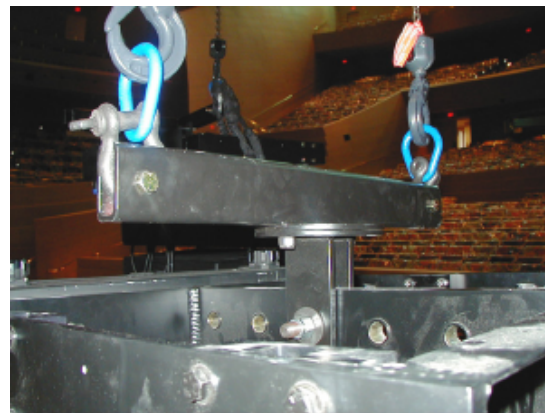
ATMFly-Ware AMGS Series



ATMFly-Ware Custom



M.A.N. Flying Systems Custom
M.A.N. Flying Systems, Essex, UK



ATMFly-Ware Custom



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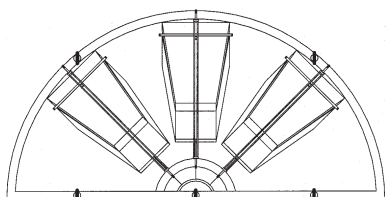
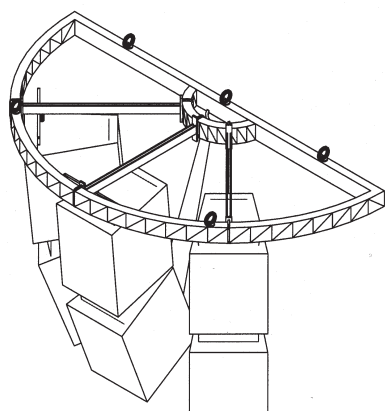
RIGGERMEISTER

LOUDSPEAKER ARRAYS

AFGS SERIES

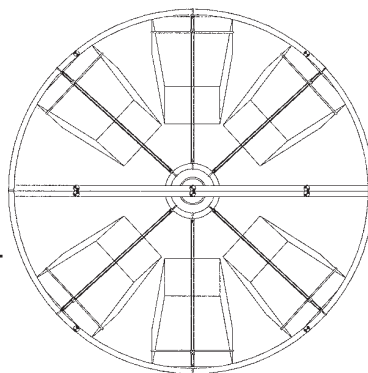
MODULAR LOUDSPEAKER GRID FLYING HARDWARE SYSTEM

The AFGS Series is comprised components which act together to provide the end user with a safe and efficient permanent support grid which is rated for overhead suspension. Several grid sizes are available to suit a multitude of permanent installation variables and loudspeaker enclosure designs.

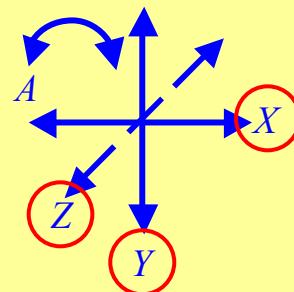


The AFGS Series modular loudspeaker grid flying hardware system is designed to accommodate loudspeaker enclosure horizontal aiming angles from 0° to 180° and vertical tilt angles as radical as necessary to meet cluster specifications. The grid framework is designed as a complete $1/2$ circle, so loudspeaker acoustic wavefront alignment can be maintained. If necessary, two grids can be attached together to form a completely circular array.

The modularity of the AFGS Series modular loudspeaker grid flying hardware system enables the user to attach a number of loudspeakers as may be necessary for the design. This is achieved by providing a structural grid framework into which few or several spokes can be inserted. The spokes then act as the attachment point for loudspeaker suspension beams which are available in several widths. Since everything is designed to be modular, the installer is able to assemble the grid in the configuration that will work best for the application; even if the loudspeaker types change within the loudspeaker cluster. The AFGS Series will also satisfy many applications in which non-enclosed horns and various rectangular enclosures need to be suspended.



Adjustable:

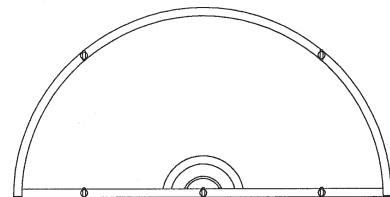


RIGGERMEISTER

LOUDSPEAKER ARRAYS

AFGS SERIES MODULAR LOUDSPEAKER GRID FLYING HARDWARE SYSTEM

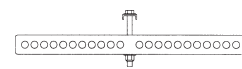
The AFGS Series modular loudspeaker grid rigging hardware system is made up of three (3) interacting components. The primary component of the AFGS Series is the Suspension Grid which serves as the primary suspension system for the loudspeaker cluster as well as providing the fixing points for other flying system attachments. The Suspension Grid is constructed from structural steel in a 1/2 circle configuration with five primary suspension eyes located on the top of the Suspension Grid. The Suspension Grid is made up of an inner and outer circular arc that has the capability of holding Spokes in between.



AFGS Series Grid Truss



AFGS Series Spoke



AFGS Series Loudspeaker Suspension Arm

The Suspension Grid Spokes can be placed and fixed at any positions on the Suspension Grid. The Spokes all converge to a central point at the center/rear of the suspension Grid, and fan out to the forward arc of the Suspension Grid. The Spokes are bolted into position with high tensile fasteners. Several Spokes can be affixed to one Suspension Grid, thereby providing accommodation for several loudspeaker enclosure aiming angles.

The Spokes provide a front to back rail which serves as the attachment base for a Loudspeaker Suspension Bar. The Loudspeaker Suspension Bar clamps onto the under-side of the Suspension Grid Spoke and provides an evenly spaced span which will allow the attachment of a wire rope wrap which in turn suspends the loudspeaker enclosure. Additionally, the Loudspeaker Suspension Bar will pivot $\pm 180^\circ$ in the horizontal direction. Since the Loudspeaker Suspension Bar is clamped onto the spoke, the position of the Loudspeaker Suspension Bar can be adjusted forward or backward along the axis of the Spoke. This allows the suspended loudspeakers to be moved close together to form a tight loudspeaker array. There are several Loudspeaker Suspension Bar widths that will serve various loudspeaker enclosure dimensions.

Loudspeaker enclosures are suspended from the Loudspeaker Suspension Bar with standard wire rope and wire rope clamps. Loudspeaker enclosure tilt is achieved by pulling the rear of the loudspeaker back to the central axis of the Suspension Grid and wrapping around a pull-back ring located there. Since there is only one pull back ring, all of the loudspeakers will array into a nicely arched cluster.



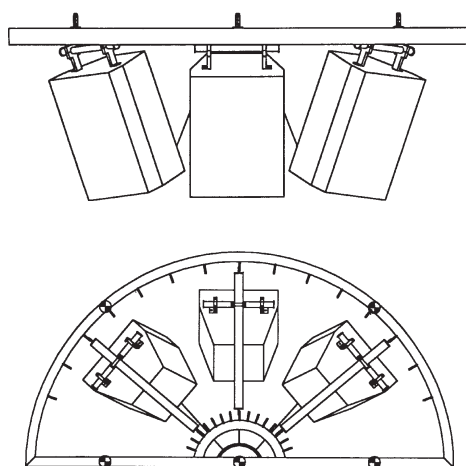
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LOUDSPEAKER ARRAYS

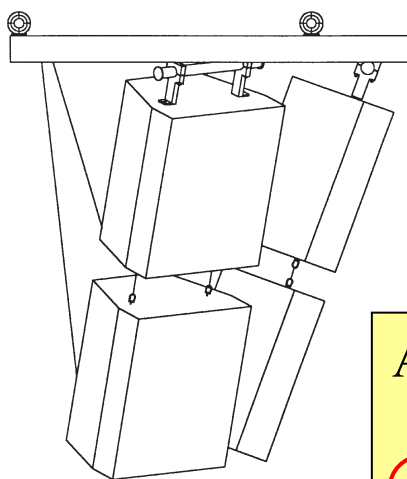
AMGS PIVOTAL SERIES MODULAR LOUDSPEAKER GRID FLYING HARDWARE SYSTEM

The AMGS Pivotal Series is comprised components which act together to provide the end user with a safe and efficient permanent support grid which is rated for overhead suspension. Several grid sizes are available to suit a multitude of permanent installation variables and loudspeaker enclosure designs.

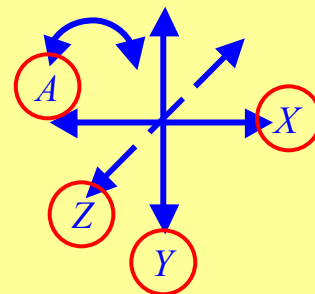


The modularity of the AMGS Pivotal Series modular loudspeaker grid flying hardware system enables the user to attach a number of loudspeakers as may be necessary for the design. This is achieved by providing a structural grid framework into which few or several spokes can be inserted. The spokes then act as the attachment point for loudspeaker suspension beams which are available in several widths. Since everything is designed to be modular, the installer is able to assemble the grid in the configuration that will work best for the application; even if the loudspeaker types change within the loudspeaker cluster.

The AMGS Pivotal Series modular loudspeaker grid flying hardware system is designed to accommodate loudspeaker enclosure horizontal aiming angles from 0° to 180° in 5° increments and vertical tilt angles. Additionally, the AMGS Pivotal Series allows the rotation of the loudspeaker for highly demanding installations. The grid framework is designed as a complete $1/2$ circle, so loudspeaker acoustic wavefront alignment can be maintained. If necessary, two grids can be attached together to form a completely circular array.



Adjustable:



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LOUDSPEAKER ARRAYS

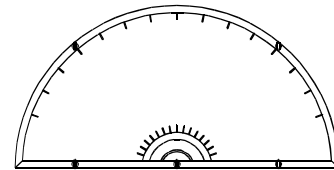
AMGS SERIES MODULAR LOUDSPEAKER GRID FLYING HARDWARE SYSTEM

The AMGS Pivotal Series modular loudspeaker grid rigging hardware system is made up of four (4) interacting components. The primary component of the AMGS Pivotal Series is the Suspension Grid which serves as the primary suspension system for the loudspeaker cluster as well as providing the fixing points for other flying system attachments. The Suspension Grid is constructed from structural steel in a 1/2 circle configuration with five primary suspension eyes located on the top of the Suspension Grid. The Suspension Grid is made up of an inner and outer circular arc that has the capability of holding Spokes in between.

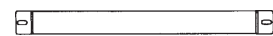
The Suspension Grid Spokes can be placed at any of the various attachment positions located in 10^0 increments on the Suspension Grid. The Spokes all converge to a central point at the center/rear of the suspension Grid, and fan out to the forward arc of the Suspension Grid. The Spokes are bolted into position with high tensile fasteners. Several Spokes can be affixed to one Suspension Grid, thereby providing accommodation for several loudspeaker enclosure aiming angles.

The Spokes provide a front to back rail which serves as the attachment base for a Loudspeaker Suspension Bar. The Loudspeaker Suspension Bar clamps onto the under-side of the Suspension Grid Spoke and provides an evenly spaced span which will allow the attachment of Loudspeaker Suspension Arm Bracket which in turn suspends the loudspeaker enclosure. Since the Loudspeaker Suspension Bar is clamped onto the spoke, the position of the Loudspeaker Suspension Bar can be adjusted forward or backward along the axis of the Spoke as well as rotated around the central axis of the spoke. This allows the suspended loudspeakers to be moved close together to form a tight loudspeaker array while locking the loudspeaker in a rotated position. There are several Loudspeaker Suspension Bar widths that will serve various loudspeaker enclosure dimensions.

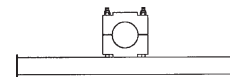
Loudspeaker enclosures are suspended from the Loudspeaker Suspension Arm Bracket with bolt fasteners. Loudspeaker enclosure tilt is achieved by pulling the rear of the loudspeaker back to the central axis of the Suspension Grid and wrapping around a pull-back ring located there. Since there is only one pull back ring, all of the loudspeakers will array into a nicely arched cluster.



AMGS Series Grid Truss



AMGS Pivotal Series Spoke



AMGS Pivotal Series Loudspeaker Suspension Arm



AMGS Pivotal Series Loudspeaker Arm Bracket



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