The KDM 360° x 180° Central Speaker

The Solution to Many Sound System Problems

The 360° x 180° Central Speaker system will provide the best overall solution for installations in gymnasiums, arenas, large open areas or other similar types of facilities. Examining the basic fundamentals of sound system design will prove KDM's 360° x 180° Central Speakers can vastly alter the equipment required, saving time and money.

Fundamental Sound System Terms

Sound Pressure Level (SPL)
The term "Sound Pressure Level" (or SPL) is a quantitative measurement for the volume or loudness of sound with respect to the characteristics of the human ear. SPL is always expressed in "Decibels" (or dB). 0 dB SPL is the lowest sound level perceivable by the human ear. When sound pressure levels change by 3 dB the difference is barely perceptible to most listeners. 10 dB is considered necessary to perceive when the loudness of sound has doubled (or halved).

To make a speaker system operative, it must be connected to an amplifier, that has adequate power output to drive the speaker to the required SPL The listener must be able to hear, comfortably and clearly, all the information the "Voice and Music" sound system is asked to deliver. For Example: to provide adequate sound pressure level at the location of the spectators watching a sporting event, it is accepted practice that an average level of 90 dB SPL be provided, plus 10 dB of headroom to prevent distortion on peak signals.

Speaker Sensitivity Rating
In order for "electrical" power (the rating given a power amplifier) to be converted to "acoustical" power (the loudness we hear), a speaker must be connected to the power amplifier to perform this conversion. Every speaker performs this conversion at a different efficiency know as the "sensitivity rating". This rating is normally expressed as "SPL" from the speaker with one watt of power delivered to the speaker and measured at a distance of 1 meter on axis (directly in front). Expressed as dB / 1 watt / 1 meter. A speaker specified at 93 dB/w/m sensitivity will provide a SPL of 93 dB when 1 watt of power is applied and the listener is 1 meter directly in front of the speaker.

Power Amplifier Headroom
This term refers to the amount of reserve level capability, (before distortion) that an amplifier has over and above the long-term average level heard as "loudness". 10 dB peaks of a few 1/1000 of a second in duration are common in a PA system. If these peak levels are in any way impeded, the sound will be rough and distorted. To avoid the peak levels from being impeded and the sound becoming rough and distorted, the power amplifier should have plenty of "headroom". The normally acceptable peak to average headroom requirement is 10 dB.

The Physical and Mathematical Laws Governing These Terms

The physical and mathematical rules that govern these measurements relate to the selection of a speaker based upon it's sensitivity and the selection of the amplifier based upon the power requirements to achieve the desired SPL level at the listeners location. They are:

(1) The 3 dB Power Ratio
A 3 dB change, higher or lower, in "SPL" requires double or half the power from the power amplifier.
Example: If an amplifier is delivering 5 watts of average power and a change of + 3 dB SPL is required, the amplifier would have to increase it's average power delivered to 10 watts.

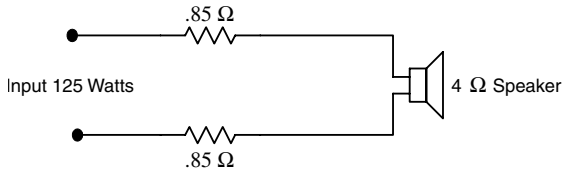
(2) The 6 dB Power Ratio
A 6 dB change in SPL occurs in free space every time the distance between the listener and the speaker is doubled or halved. This would require 4 times the power from the amplifier to compensate and maintain the same SPL.
Example: If the speaker system is moved to a location that is twice the distance from the spectators or audience, a 6 dB SPL reduction in loudness would occur. In order to maintain the original SPL the amplifier would have to increase it's average power delivered to 20 watts.

(3) The Cable Resistance Between the Speaker and The Amplifier and the Impedance of the Speaker
A significant reduction in power delivered to the a speaker can simply occur due to the series resistance of the interconnecting cable, three factors determine the SPL loss with regards to the cable resistance.

- **(a)** Length of Cable.
- **(b)** Thickness (Gauge) of Cable.
- **(c)** Impedance of the Speaker.

Example: If the distance from the amplifier to the speaker is 200 feet and 16 AWG. Cable is used, the total cable resistance would be 1.67 Ohms. (from AWG wire tables 16 gauge cable has 4.18 ohms per 1000 feet, - the round trip cable length is 400 feet). With a speaker impedance of only 4 ohms the series resistance will cause a power ratio loss of 3 dB. In order to maintain the original SPL the amplifier would have to increase it's average power delivered to 10 watts.

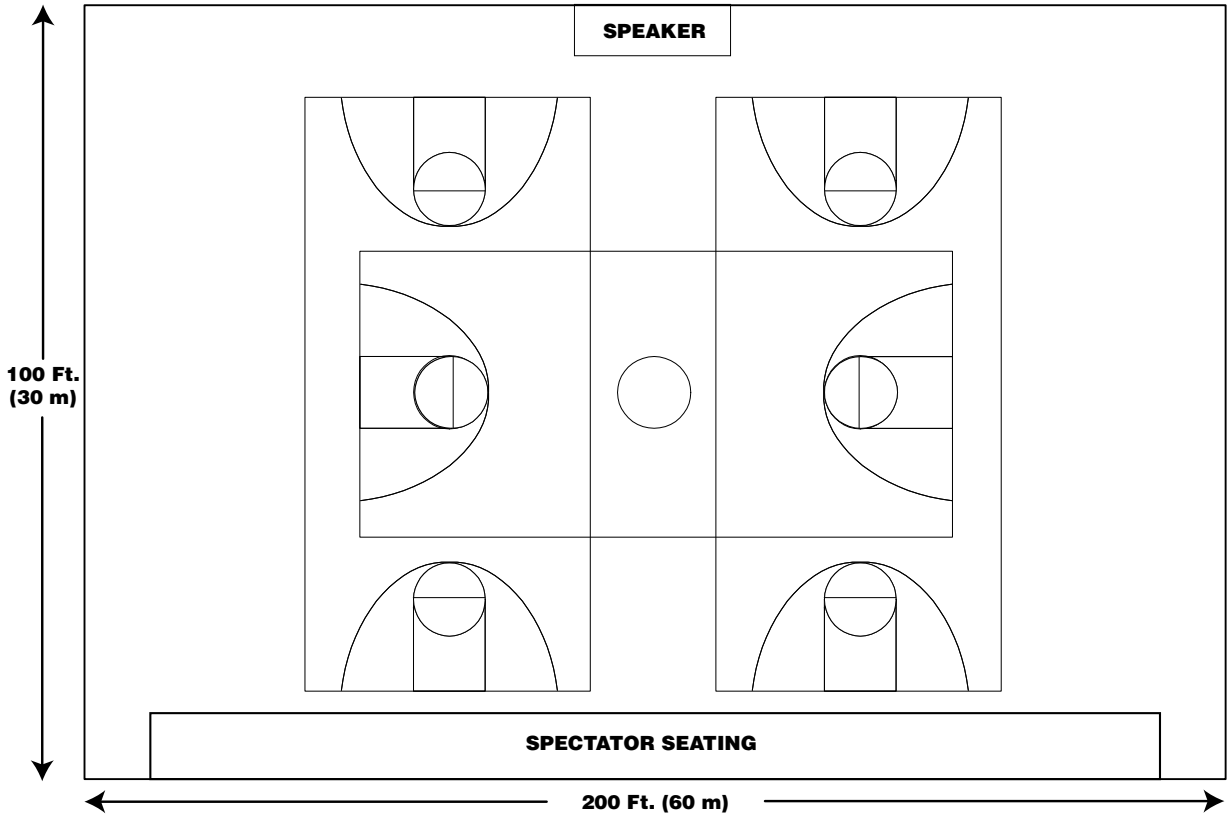
$$\text{Power Loss} = \frac{20 \text{ Log } R_{Speaker}}{R_{speaker} + R_{Cable}} = 20 \log \frac{4}{5.7} = 3 \text{ dB}$$



A 3 dB loss in power represents half the power. (Rule #3). The power to the speakers is 125 / 2 = 62.5 watts.

Sample Sound System Problem:

The customer has complained that the sound system in their school gymnasium is distorted and is not capable of delivering the volume level they desire. This problem was particularly apparent when all the seats where occupied and the home team just scored the game winning goal. The crowd's cheering easily overpowered the SPL output from the sound system.



Installation Details

Speaker is centrally located on the wall opposite the spectator seating with a sensitivity of 97 dB / watt / meter, 150 watt power handling and 4 Ohm impedance. The cable installed has a round trip of 400 ft. and is 16 gauge. Using the rules governing this data will determine the SPL at the spectators from the speaker with full power.

Power at the Speaker

16 gauge cable has a resistance of 4.18 ohms per 1000 ft. and the cable length is = 400 ft. (round trip)
Cable resistance = 4.18 x .4 = 1.7 Ohms. The power reaching the speaker is half the input power, 62.5 watts. A 3 dB loss in power is a 3 dB loss in SPL (Rule #1).

SPL 1 meter From The Speaker With 62.5 Watts Of Power

1 Watt = 97 dB, 2 W = 100 dB, 4 W = 103 dB, 8 W = 106 dB, 16 W = 109 dB, 32 W =112 dB, **64 Watts** = 115 dB
The SPL 1 meter from the speaker with full power applied would be 115 dB.

SPL 30 meters To Spectators

1 meter = 115 dB, 2 meters = 109 dB, 4 meters = 103 dB, 8 meters = 97 dB, 16 meters = 91 dB, **32 meters** = 85 dB.
The SPL 30 meters from the speaker with full power applied would be 85 dB.

To overcome the crowds cheering, it is recommended that a sound system provide at least 100 dB. (90 dB SPL with an amplifier headroom of 10 dB).

Possible Solutions!

Examining the changes that can be made to system, the easiest solution at first glance would be to look at increasing the power of the amplifier.

Increase The Power Amp to Achieve The Required 100 dB (90 dB SPL with 10 dB headroom)
The Losses are: 30 dB loss for distance from the speaker to the bleachers and a 3 dB loss for the resistance of the cable matched to a 4 ohm speaker. 97-30-3=64 dB SPL at the bleachers with 1 watt of power. An additional 36 dB in SPL is required to achieve the accepted level of 100 dB SPL. (90 dB SPL with an amplifier headroom of 10 dB). The power has to be doubled 12 times (36 / 3 = 12 * Rule #1). That equates to a 4096 watt power amplifier! Not only does this exceed the speaker power handling capabilities, it would be a very expensive amplifier.

Move the Speaker Closer to the Spectators
An attempt at utilizing the existing speaker should be considered to try and solve this problem at minimal expense.
(1) The distance between the spectators and the speaker is now half. = +6 dB SPL is saved. (Rule #2)
(2) Replace the existing 16 gauge with 14 gauge cable. = +1.5 dB SPL is saved. (Rule #3a)
(3) Locate the speaker in the center of the room. The cable length is reduced by 50 ft. +.7 dB is saved. (Rule #3b)
A Total of 8.2 dB SPL is recovered. Increasing the SPL at the spectators location from the 85 to 93.2 dB SPL.
A further increase of 7 dB is required to achieve adequate "headroom". A 7 dB increase represents a power ratio of 5:1. The power amplifier would have to capable of delivering 875 watts. The present speaker is only rated at 150 watts. It is pointless to try replacing the cable, the system simply cannot achieve the desired result. The speaker will not be able to handle the need for increased power.

What is required is a more efficient speaker!

The Solution!

Replace the Speaker with KDM's SP820A with a sensitivity of 101 dB SPL.

SP820A

(1) Replacing the speaker (97 dB SPL) with KDM SP820A will increase the sensitivity by 4 dB.
89 dB SPL at spectators.
(2) The distance between the spectators and the speaker is half. + 6 dB SPL (Rule #2)
95 dB SPL at spectators.
(3) The speaker is now 8 Ohms impedance. + 3 dB SPL (Rule #3c)
98 dB at the spectators.
(4) Increasing the power amplifier to 250 watts. +3 dB SPL (Rule #1)
101 dB SPL at the spectators.
(5) The speaker now being in the center of the room reduced the cable length by 50 ft. +.7 dB SPL (Rule #3b)
101.7 dB SPL at the spectators.

SP820A Central Speaker System
25,000 Sq. Ft. (125 x 200 ft.)*

The 100 dB requirement has been met. The amplifier and speaker had to be replaced.

Replace the Speaker with KDM's SP840A with a sensitivity 104 dB SPL.

SP840A

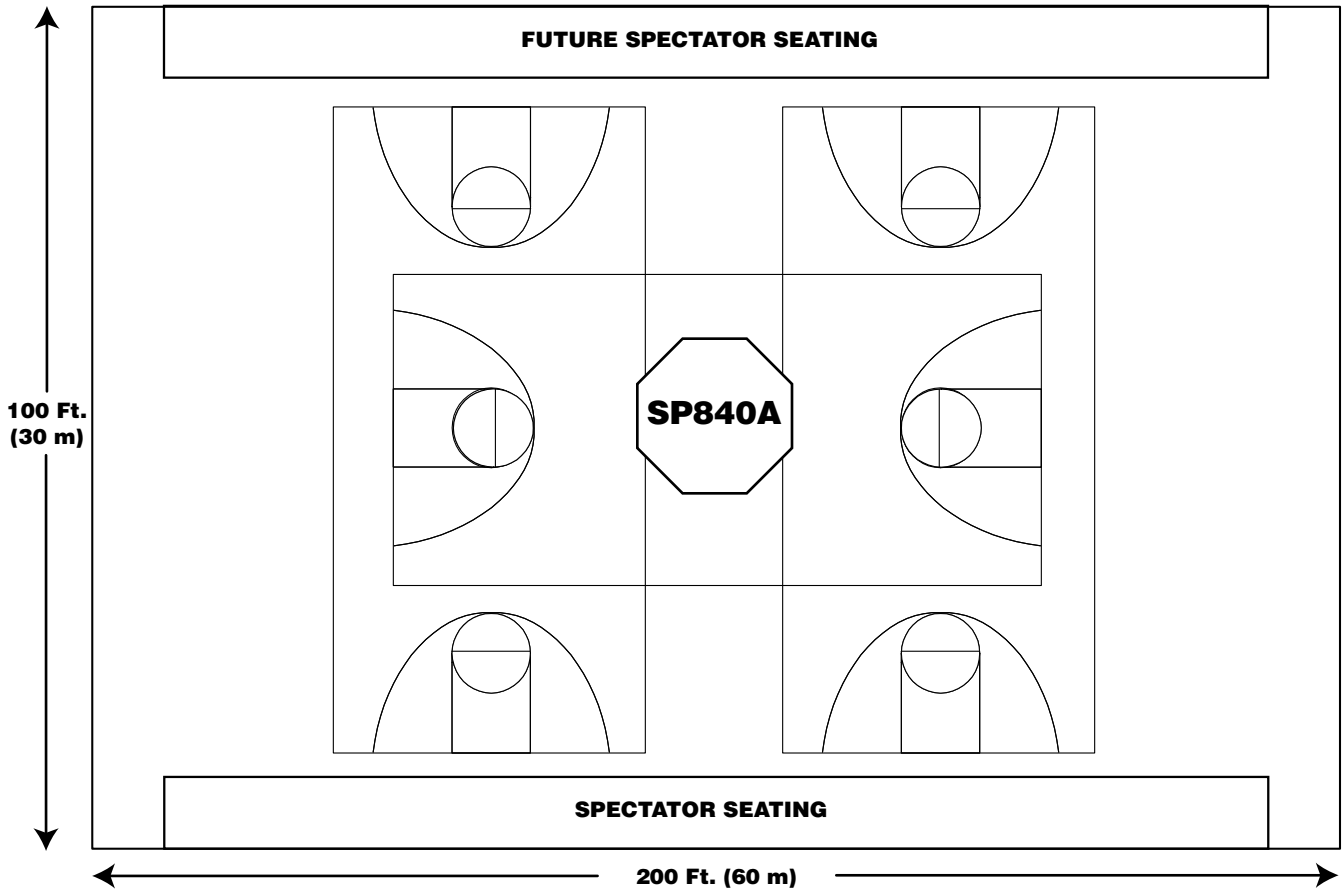
(1) Replacing the speaker (97 dB SPL) with KDM SP840A will increase the sensitivity by 7 dB.
92 dB SPL at spectators.
(2) The distance between the spectators and the speaker is half. + 6 dB SPL (Rule #2)
98 dB SPL at spectators.
(3) The speaker is now 8 Ohms in impedance + 3 dB SPL (Rule #3c)
101 dB at the spectators.
(5) The speaker now being in the center of the room reduced the cable length by 50 ft. +.7 dB SPL (Rule #3b).
101.7 dB SPL at the spectators.
The 100 dB requirement has been met. The speaker was the only replaced component.

SP840A Central Speaker System
35,000 Sq. Ft. (140 x 250 ft.)*

* Coverage areas are approximations only. Contact KDM Electronics Incorporated regarding your specific applications.

We've got You Covered!

Utilizing the SP840A in the gymnasium has some other unique advantages. The unique 360° dispersion pattern provides even coverage throughout the entire gymnasium. Bleachers can now be installed on the other side, increasing spectators and ticket sales to all the events.



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SOUND ABOVE ALL

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