LOUDSPEAKER
Selection Guide

GAI-TRONICS®

CERTIFIED QUALITY MANAGEMENT SYSTEM ISO 9001:2008

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Introduction

GAI-TRONICS designs loudspeakers especially for the reproduction and broadcast of voice communications. These loudspeakers are used typically in industrial and commercial locations. GAI-TRONICS' loudspeakers provide extremely high intelligibility and efficiency in the speech frequency range. In addition, our constant directivity loudspeakers provide tightly controlled coverage patterns, making them excellent for use in noisy and highly reverberant areas. However, to maximize sound system performance, you must follow specific guidelines for selection and placement of loudspeakers.

Intelligible voice broadcasts impact directly on safety and productivity. An effective broadcast system creates a secure work environment where individuals can perform daily tasks with greater efficiency.

1. Identify Objective

It is important to determine the basic objectives of a sound system before selecting any type of speaker. This determination includes identifying critical areas and/or individuals (such as workstations/production line operators) who need to hear the broadcast instructions.

The next consideration is the size and general acoustics of the space. Reverberation is a major consideration with large rooms because these structures typically contain highly reflective surfaces, i.e. concrete floors, cinderblock walls, and exposed metal roofs. Under these conditions, the best design is a large central cluster of horns, with appropriate coverage patterns, aimed to minimized reverberation. In any acoustic environment, intelligibility increases when the sound is perceived as coming from a single point. Due to overhead handling cranes or large banks of machinery or shelving, this type of installation is not always possible and these situations require a wider system of distribution and careful placement to ensure that loudspeaker coverage patterns do not overlap.

Speakers should be placed six feet above head level, and should rarely be positioned to face each other unless they are more than 50 feet apart. When facing each other serious degradation of frequency response can occur, resulting in unintelligible speech broadcasts.

2. Analyze the Environment

The next step prior to speaker selection is to analyze the environment. First, determine whether any areas have hazardous ratings. GAI-TRONICS has a line of loudspeakers approved for hazardous areas. Next, identify sound pressure levels in decibels for critical and surrounding areas. An effective solution is to have GAI-TRONICS perform a noise survey of your facility using state-of-the-art equipment to determine sound pressure levels.

The following figure **(Figure 1)** illustrates dB levels for particular noises as a reference.

Decibels	dB
Jet engine 100 ft. (30m)	140
Threshold of pain	130
Rock Concert	120
Subway train	90
Speech 3 ft. (1m)	70
	60
Business office	50
Soft whisper 5 ft. (1.5m)	30
Empty movie theater	20

FIGURE 1

General Rules of Sound Pressure Levels

Increased input power will increase the dB level of a loudspeaker. Doubling the power will result in an increase of 3dB. The converse is also true. A minimum 3dB increase is required to detect any change in volume. To perceive a doubling of loudness, an increase of 10dB is required.

Doubling the distance to a measuring point decreases SPL by 6dB. **Figure 2** assists in calculating the changes in SPL at various distances from the source. Note that there is a zero change in dB SPL at 4 feet because the SPL rating is measured at 4 feet on axis with the loudspeaker.

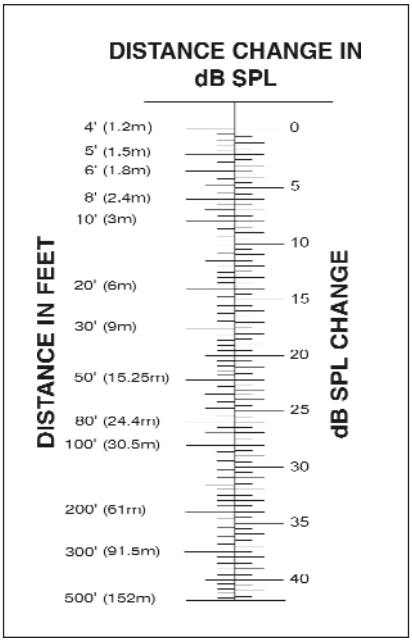

FIGURE 2. A decibel is a unit of sound, expressed as a ratio of relative sound pressure to a reference sound pressure. Decibels, when referring to loudspeakers, are a reference quantity of Sound Pressure Level (SPL).

3. Speaker Placement

To ensure proper paging performance, set the paging speakers at a level 6 to 10 dB louder than the sound in the surrounding area. Most types of industrial noise tend to mask frequencies within the speech range, so it is vital that the paging speakers operate at a higher level.

To achieve the 6 to 10 dB ratio, it is critical that the loudspeaker be placed as closely as possible to the noise source. Loudspeaker position is important for two reasons:

- As you move away from a sound source, the sound pressure level will drop (attenuate) roughly 6 dB each time you double your distance from the source. Therefore, if the loudspeaker and the noise source are very close together, both loudspeaker output and noise will attenuate at the same rate.
- If a speaker is too far from the main noise source, people near the noise will be unable to hear the broadcast over the ambient noise.

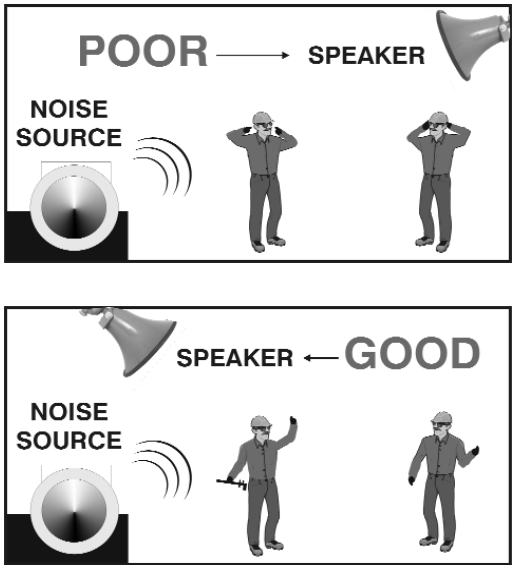

FIGURE 3

4. Speaker Selection

The three types of loudspeakers available are wide-angle horns, narrow-angle horns and cone speakers.

Wide-angle Horns
(Coverage angles greater than 90° nom.) work best for indoor or outdoor coverage of large spaces. Use caution in indoor areas because wider coverage angles expose the sound field to large reflective areas—adding to reverberation and detracting from speech intelligibility.

Narrow-angle Horns
(Coverage angles less than or equal to 90° nom.) work best for outdoor long distance coverage over a narrow angle, or for indoor reverberant environments where there may be obstructions. Excellent for hallways.

Cone Speakers
Work best for ceiling or wall mounting where ceiling heights are less than 20 feet. Cone speakers usually have frequency ranges extending beyond those of horn-loaded drivers, but with lower power output and less rugged construction.

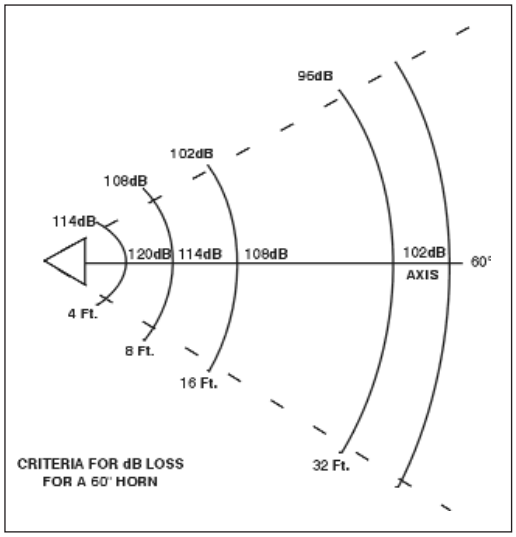

FIGURE 4
Criteria for dB Loss

Loudspeaker choice is typically based on two factors: efficiency and coverage angle. Efficiency is the amount of input power vs. output power, and is usually expressed as dB output at 1 meter distance with a one watt electrical input. High efficiency signifies a high acoustic output (dB) with low distortion. The coverage angle is defined as the angle between the points where the response SPL drops by 6 dB **(Figure 4)**, and where voice broadcasts can be understood at all frequencies within the normal speaking range, 500 to 4,000 Hz.

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Speaker Selection...continued from page 3

Loudspeaker VS. Horns and Drivers

Both wide-angle and narrow-angle loudspeakers are available with integral or separate drivers. Loudspeakers requiring separate drivers are generally referred to as horns. A driver converts the electrical source signal to a sound pressure signal and passes it on to a horn, which amplifies and projects this signal. Separate horns and drivers generally provide the greatest flexibility, and GAI-TRONICS provides a variety of horns to suit any area.

Driver Types

There are two basic types of integral or separate drivers available.

The first type has a variable impedance, with a transformer for tapping the required power. This type is typically used in a central amplifier or a GAI-TRONICS Centra Page system. The transformer on this type of driver allows many speakers to be powered from a single amplifier.

The second type of drivers has a nominal impedance of 8 or 16 ohms. These are typically used in distributed amplifier (Page/Party®) systems. Without a transformer, only a small number of loudspeakers, placed closely to the amplifier can be powered by distributed amplifiers.

5. Determine Speaker Quantity

Generally, in distributed amplifier systems, we suggest one 8 or 16 ohm speaker per amplifier in noisy environments (above 85 dB). Where noise levels may be slightly lower, two 16 ohm speakers can be used for each amplifier. For SmartSeries® amplifiers, only one speaker per amplifier is recommended. Finally, in quiet areas, such as control rooms or office environments, up to four 8 ohm cone-type speakers can be used per amplifier. Note that when a single amplifier is linked to two or more speakers, the total power output remains constant and must be divided among the speakers. Please reference General Rules of Sound Pressure Levels for the impact on the decibel level.

Central amplifier systems can use any number of speakers, provided that the summation of their power requirements (level speakers are tapped) does not exceed the power available from the central amplifier.

Wire Size	Central Amplifier Systems	Distributed Amplifier Systems
#18 AWG	6,250 feet (1,903m)	Cable distance should be as short as possible to reduce power loss. GAI-TRONICS recommends that the cable distance between a speaker and its associated amplifier not exceed 30 feet (9.14 meters).
#16 AWG	9,900 feet (3,017m)	
#14 AWG	15,800 feet(4,816m)	

FIGURE 5. This chart (Figure 5) illustrates the wire size and the distance speakers with integral drivers or horns with separate drivers...can be placed from either a central amplifier or distributed amplifier.

Summary

Selecting the horn that best matches the application and the placement of that horn is important to the performance of an effective communications sound system. GAI-TRONICS offers a full range of products and services to help maximize the performance of your system.

GAI-TRONICS®

USA Toll Free: 1 (800) 492-1212 Tel: (610) 777-1374 Fax: (610) 796-5954 www.gai-tronics.com
UK Tel: +44 (0)1283 500500 Fax: +44 (0)1283 500400 www.gai-tronics.co.uk
Italy Tel: +39 02 48601460 Fax: +39 02 93663110 www.gai-tronics.com
Asia Tel: +(65) 6282 2242 (Press 4 for GAI-TRONICS) www.gai-tronics.com
Australia Tel: 011-61-28-851-5000 Fax: 011-61-29-899-2490 www.austdac.com.au

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