Tech Talk
With Bob Dolph

Breaking the Sound Barrier

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BOB'S TIPS

- Make sure that any parallel and/or serial speaker combinations equal the specified output impedance of the power source.
- Estimate the number of speakers need for your system. Take the total wattage count and multiply it by a factor of 1.5.
- Make sure if you are servicein or adding to an existing system to check whether it is 25V, 70V, or even 100V.
- Don't over-tap your speakers with hihger wattage settings. I twill place an overall burden on your system and aplifier.

Practically every commercial and residential customer at one time or another will need to have audio-related equipment installed or serviced. It will either be with home entertainment, paging or emergency evacuation systems for schools and hospitals. This audio system may be accompanying other systems such as CCTV, fire and access control.

A dB Is a dB Is a dB?

Yes, but in different flavors. Previously, we discussed that the term decibel (dB) is not a fixed quantity but is always a *power* ratio and is not a unit of measure by itself. Here we will be dealing with dBm (m is milliwatt). A good fundamental understanding of these strange terms and technologies will take us a long way in working with audio systems.

This all ties back to our old friend Ohm's Law, where W=E2/R or E^2IZ. Therefore, dB=10 log (W1/W2) or dBm=10 log ($E_1^2/0.001R_1$). If you would like to get more into dBs and other audio circuit calculations, I suggest a good audio systems reference book *(see Diagram 1)*.

Low-Impedance Should Be Familiar

Many security technicians are already familiar with a basic alarm siren circuit or a simple audio configuration in which you have an 8-ohm speaker connected to an alarm panel or amplifier output. The output of these devices is 8-16 ohms. Make sure that any parallel and/or serial speaker combinations equal the specified output impedance of the power source. If you are connecting a few speakers and only going a short distance, this combination typically works fine.

What will happen if the speakers we are trying to drive are a considerable distance away and include more than just a few speakers? Now we are faced with some other factors, such as the overall load on the amplifier, including the resistance of the connecting wires, and the low voltage of the transmission circuit. This is referred to as a *low-impedance circuit.*

Let's say we had an 8-ohm speaker that is connected 100 feet away from an 8-ohm amplifier output. If we are using 20-gauge (1 ohm/100 feet) wire, there is total of 10 ohms load to the panel. If the source voltage is 4V, then the circuit is drawing 400mA. The line voltage drop is .8V, while the speaker drop is 3.2V; therefore, the line will consume roughly .32W, or 20 percent of the total power. If we add speakers and more wire distance between them our power resources would be depleted even faster. We could increase the wire size, but, on a larger system, the system cost would go up.

Diagram 1: 70.7V Loudspeaker Cable Lengths Gauges for 1.5dB Power Loss

Wire Gauge (AWG) >		20	18	16	14
Max Current (A) >		7.5	10	13	15
Max Power (W) >		530	700	920	1,060
Load Power	**Load Ohms**	**Maximum Distance in Feet**			
150	33.3	309	490	786	1231
100	50	464	736	1,178	1,848
50	100	929	1,473	2,356	3,696
25	200	1,857	2,945	4,713	7,392

Source: Audio System Design and Installation, Philip Giddings, (Howard W. Sams ISBN 0-672-22672-3)

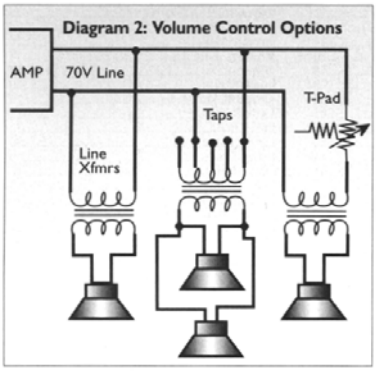
These are the maximum cable runs for a 70V system per gauge of wire and load power.

Design a Constant Voltage System

The *constant voltage system* was designed to help us deal with larger audio system configurations. Many years ago, utility companies decided that the most practical way to transfer electrical power to our homes was a network of transformers that would increase the transmission voltage, reduce the current and allow for small gauge power lines. The same strategy is used for the 100/70/25V constant voltage audio system.

One of the most popular is the 70V (actually 70.7V). Audio signals are sent through a high impedance line of typically 500 ohms. This circuit also has an impedance of around 500 ohms. A small

transformer couples each speaker with multiple impedance or voltage taps, providing different wattage outputs to the speaker *(see Diagram 2)*. The multiple taps allow for the selection of different loudness levels.



On the left is a standard fixed-value transformer. In the center is the popular multiple tap transformer configuration that allows for individual volume settings while the right configuration is a variable T-Pad for individual, manual volume adjustment.

How big an amplifier would you need for the area being covered? First, estimate the number of speakers needed for your system. Take the total wattage count and multiply it by a factor of 1.5. A system of 20 speakers at 5W each would need at least a 150W amplifier.

Tip: Check with the customer for future needs before ordering the amplifier.

Select, Install Appropriate Cable

Selecting the proper cable size is important in a 70V system. If the wire gauge is too large you will have added copper expense. If you select a wire gauge that is too small, much of the system power will be lost in the line and not get to the speakers.

Look at the table samples in Diagram 2. Notice the considerably long distances you can get with 18-gauge AWG and larger cable while maintaining relatively low cable losses of 1dB. For further information, a good book is "Audio System Design and Installation" by Philip Giddings (Howard W. Sams ISBN 0-672-22672-3).

In larger systems, you may find yourself using a combination of the 70V lines for the long runs and sub-distributing to some smaller low-impedance networks. There are also ways to help equalize the overall system's load by having one leg of your system go to the end of the system first and then back to the amplifier. Again, a good reference manual is highly recommended for these additional configurations.

Because you are running a 70V line in ceilings, make sure you are aware of your local electrical codes. These systems may need to be plenum-rated and possibly run in conduit. When considering electrical codes, an alternative is the installation of a 25V system rather than 70V. The cable distances will be shorter due to the lower voltage. These smaller, 25V systems are commonly found in paging systems in schools and hospitals.

Tip: Make sure if you service or add to an existing system to check whether it is 25V, 70V, or even 100V. One hundred-volt systems are typically found in very large audio systems and in Europe. Cable runs of several miles are possible with a 100V system.

Place Speakers for Optimal Usage

On the acoustics side of the system, the placement of the speakers is very important. Speakers should be placed in the ceiling, pointing down as much as possible. Speakers should be positioned equidistant to each other and their placement is vital. Use this rule-of-thumb formula:

Number of speakers = area/(A x [ceiling height-listening height])^2

A= 2 Edge to edge speaker placement

A= 4 Overlapping speaker placement

A = 8 Paging system only

Listening height is 4-5 feet.

Remember you can adjust speaker loudness by using higher wattage taps or pots, L-pads, T-pads *(see Diagram 2)*. Minimize the use of these as much as possible.

Measure and consider background noise. Radio Shack makes a good cost-effective sound pressure level (SPL) dB meter. Some SPL guidelines:

+5dB — Economy background music only

+10dB — Good paging intelligibility and music quality

+15-20dB — Best dynamic range.

Don't over-tap your speakers with high-watt settings. It will place a burden on your system and amplifier.

Check with speaker manufacturers for their specified dB level per tap per distance values.

Final Thoughts and Comments:

Start with a small office or store system if you have never done this before. Work closely with your manufacturers and distributors.

Some manufacturers have proprietary systems that use features such as sub-25V and digital, Cat 5-type transmission.

Identify whether you are working with balanced or nonbalanced lines. The shield is part of the circuit in the latter. Balanced lines are good at canceling out noise.

Be careful when grounding long cable shields. They can cause ground loops, which produce a hum. Typically, 70V-system cabling does not need shielding except for noisy RFI/EMI areas.

If you are installing an audio recording system for CCTV-type surveillance, beware of federal and state statutes. Reference U.S. Code Title 18; Part 1: Chapter 119: Section 2510—2512. Manufacturers may provide signs for public posting. Be careful, recording someone without informing them is a felony. Check with your lawyer first.