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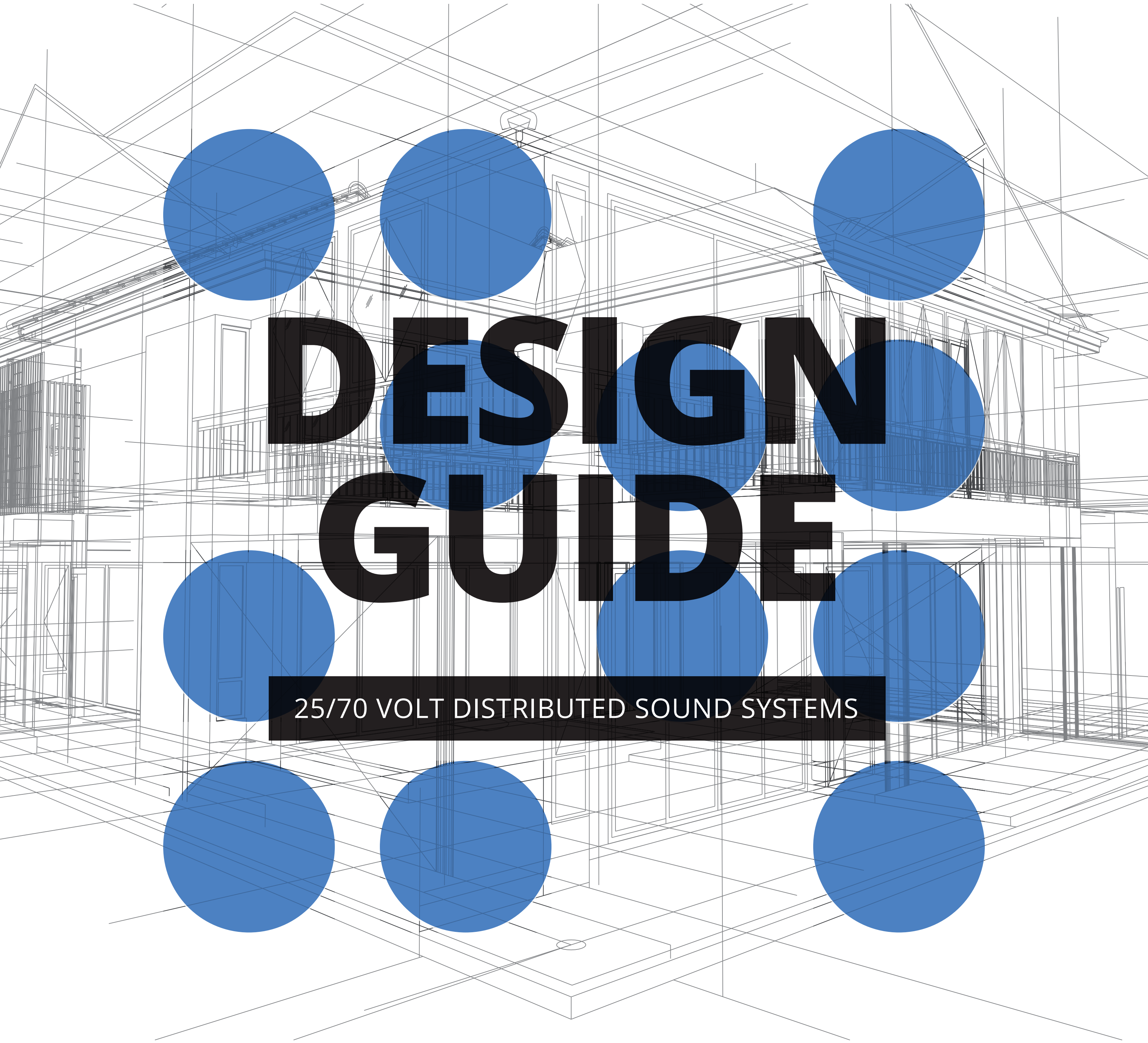

DESIGN GUIDE

25/70 VOLT DISTRIBUTED SOUND SYSTEMS

MADE IN CHICAGO

DISTRIBUTED SOUND SYSTEM Applications Guide

This guide will cover the basic design of a two-wire, 25V(Volt) or 70.7V(Volt) System. The function of the sound system is the transmission of program material such as music, voice, signal tones from a central location, then transmitted via two wires to multiple loudspeakers with individual local control of the audio output of each device. *Distributed 25V/ 70V systems are used whenever one needs to control the individual volume of more than two loudspeakers with the same program material.* **The term "70.7V" is technically correct, although, throughout the industry, they are often referred to as 70V systems.**

25V/70V systems are the most widely accepted solution for distributed audio in fixed patterns of traffic with hard-wired zones because of their simplicity of design, execution and troubleshooting ease. You can control the sound level at each individual loudspeaker as well as overall level at the "head end". Additionally, system design is straight-forward, no special skills are needed for installation or connection and components are widely available.

APPLICATION PARAMETERS- Loudspeakers are aimed at the listener and installed 18'-0 or less above the floor plane in ambient sound fields that are 85 dB-SPL or less. This sound pressure is typical of busy city traffic noise. If listeners are wearing hearing protection, such as in a manufacturing operation, the solution may require paging horns placed closer to the listener- or other communication systems.

25V/70V systems are identical in their design and similar in operation. Most Quam products are available with transformers the "universal type" with both 25V and 70V taps on the same transformer as noted on the product sheet. The application differences are these:

25V systems generally are considered low voltage systems and most times, do not require the wiring to be in conduit. **CHECK LOCAL CODES!** 25V systems require amplifiers with 25V outputs and transformers with 25V taps. 25V systems are most often found in school applications.

70V systems generally are considered low voltage systems however, in many, not all cases; the wiring is required to be in some form of conduit. **CHECK LOCAL CODES!** 70V systems require amplifiers with 70V outputs and transformers with 70V taps.

The most common device used for 25V/70V sound systems is an assembly of a "common" 8-Ohm loudspeaker and a multi-tap transformer. The impedance of the loudspeaker can be any value although 8-ohm is most common; most audio step-down transformers are designed for a nominal 8-Ohm load on the secondary (down) side.

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The advantage of the 70V solution, compared to a 25V system, is higher voltage- and lower amperage, systems can be designed with longer distances from the power amplifier to the final loudspeaker.

Example: A 300’ (90M) distance with a 100W (Max) load to a number of 70V loudspeakers can easily be sent over 18 gauge (1.0mm) wire. A 25V solution with the same load and wire gauge should only be designed to 25% of the distance- or 75’ (23M).

DESIGN FUNDAMENTALS:

Rule #1 Loudspeaker propagation patterns are conical.
Avoid placing loudspeakers so that the pattern radiates onto a reflecting surface, such as a wall or partition. This causes unwanted reflections and creates “muddy” sound.

Rule #2 The ear should “see” the loudspeaker.
When placing loudspeakers, insure that there is an unobstructed visual path from the listener’s ear to the loudspeaker.

Rule #3 Place the devices as close as practical to the listener-
The further the device is from the listener, the more it has “excited” the space and the less energy there is at the ear to deliver the message.

Rule #4 A closer sound is a louder sound.
Even if the sound source “should” be louder than ambient noise, the boisterous fellow in the next cubicle could prevent you from hearing the page. Keep this in mind when placing loudspeakers near local noise sources such as air movers, printers or groups of people around the water cooler.

Rule #5 Install all devices at the same height off the floor-
Different arrival times from multiple loudspeakers destroy intelligibility.

Rule #6 Coverage, not power, increases intelligibility-
All things considered, a 3 x 3 pattern of loudspeakers in a square space will provide smoother coverage, greater intelligibility and greater customer satisfaction than a 2 x 2 pattern- even with higher output.

Rule #7 Consider the environment, the traffic and the message when increasing spacing of loudspeaker devices.

Rule #8 No matter what the math says- Do not space distributed devices more than forty feet apart- or greater than fifty feet to the listener.

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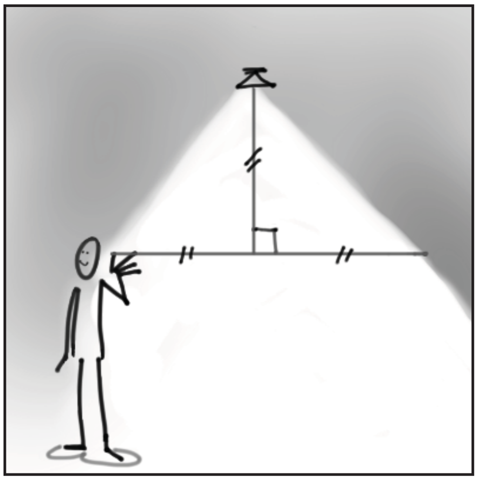
Now, assuming that the space is quieter than 85-dB-SPL, and the install height is less than 18’-0 from the floor- and we have something to attach the loudspeakers to, let’s design the system…

DETERMINING COVERAGE

A loudspeaker’s coverage is easy to calculate.



Center-to-center distance for ceiling/ overhead mount speakers is:

Two times the distance from the listener’s ear to the install height of the loudspeaker.

Example 1- Assume a corridor 20’ wide with a loud-speaker install height of 10’, mounted perpendicular to the floor plane (pointed at the floor); assume pe-destrian traffic in the corridor, program material is 90% paging, 10% background music.

Industry Best Practices uses an “ear height” of 5’-0 for calculations involving paging. Therefore, in this example, the coverage of the loudspeaker will have a diameter of 10’-0. There is only 5’-0 of “out of zone coverage” along the walls on either side; pedestrian traffic is generally down the center of the corridor. Installing loudspeakers 10’-0 apart will have the edges of the loudspeaker coverage “touching” giving very smooth coverage down the corridor.

If this was a hospital, airport, train station or similar environment, you would have excellent intelligibility of critical pages. You have enough power per square foot available to raise the sound level if there was an emergency. When people are not familiar with their surroundings and need to understand paging messages, calculate the coverage “edge-to-edge”.

Example 2- Retail environment- Assume an open space 80’-0 square, an install height of 16’, mounted perpendicular to the floor plane (pointed at the floor); assume retail pedestrian traffic; program material is 90% background music, 10% paging.

Using the process from the first example: **Distance from the device to the ear plane is 11’-0. Therefore direct sound coverage of the loudspeaker is a 22’-0 diameter circle of 380 SF coverage.** Our 80’-0 length/width divided by 22 is 3.63, round down to 3. Because the space is square, the answer is nine devices on 26’-0 centers. Background music would be seamless, with no “hot or dead” spots; the occasional page would only need to be done once. This is a good solution for your customer; it is unlikely that you will have a call-back.

One might be tempted to reduce the number of loudspeakers to 4 devices on 40’-0 centers. This in-creases the number of “hot and dead” spots and require you to raise the sound level of the system so that voice pages were understood. This design bends Rules 6 and 7, Violates Rule 8.

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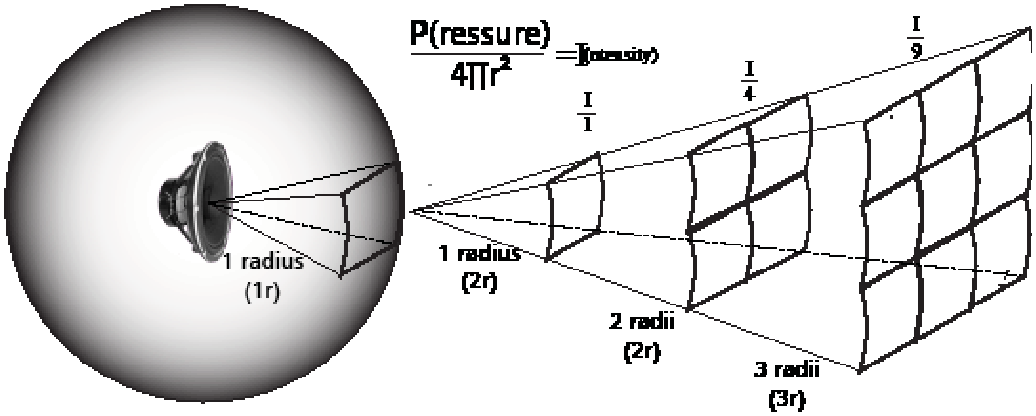
DETERMINING POWER TO EACH LOUDSPEAKER

BACKGROUND: When sound radiates from a point into a space, it observes the Inverse Square Law. Simply put, the further you are from the source, the lower the sound pressure level at the measuring point. Every time you double the distance from the test measurement point, (typically 1-meter) the Sound Pressure Level will decrease by 6 dB-SPL. The diagram below shows how the energy is dissipated over a larger and larger area. The energy twice as far from the source (2r) is spread over four times the area, hence one-fourth intensity.



The other side of this equation is that you would have to increase the power to the loudspeaker by 6dB- or four times the power to "even up". Remember that the loudspeaker taps are in 3dB increments either twice-or half the power of the adjacent tap.

Loudspeaker manufacturers usually specify a reference Sound Pressure Level (dB-SPL) given at 1 meter (3.28') on axis; a QUAM C10X will measure 95 dB-SPL/1M. Assume 1W input to the QUAM C10X, measured at 3.28', at 6.5' from the loudspeaker you will measure 89 dB-SPL and at 13'-0 from the loudspeaker, you would measure 83 dB-SPL.

Let's backtrack to our two examples on coverage. (Page 3) **Example 1 (The Corridor)** will have losses on axis of a little less than 5 dB-SPL, and a little more than 6 dB-SPL at the edges of the coverage- virtually the same. **Example 2 (The Retail Environment)** will have on axis losses of about 9 dB-SPL on axis and about -12 dB-SPL at the edges of the coverage- this is a just noticeable difference.

If we were to to design the Retail Space using 40' centers between devices, we would have losses of -20 dB-SPL at the edges of coverage- most listeners will find this difference unacceptable. Raising the audio power to the loudspeaker will not change these losses due to distance; they are the same at every power level. Now that we understand losses and coverage, how much power do we need at each loudspeaker?

Best practices in the industry recommend that the sound system be able to cleanly deliver the program material at least+6 dB-SPL to as much as +20 dB-SPL over the ambient noise level. Before you start your system design, you need to know the typical noise level at the site, use of a survey-type SPL meter will insure that your solution won't have to re-designed.

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REPRESENTATIVE BACKGROUND SOUND PRESSURE LEVELS:

> **Typical business office interior- 60 dB-SPL,**
> **Normal conversation at 4’- 65-dB-SPL,**
> **Vacuum cleaner at 10 feet- 70dB-SPL**
> **Manufacturing operation requiring hearing protection- 85 dB-SPL (or more)**

Remember Rule #4- A closer sound is a louder sound. Any unexpected higher noise level nearer to the listener will require higher output from the loudspeaker to be intelligible. If there is an area where people gather, such as a cash register area, the sound pressure levels will be higher.

Where +6dB-SPL design headroom might be appropriate-
Low ambient noise levels (55 dB-SPL) that do not change, occupants are familiar with their surroundings, background music, occasional, non-critical announcements, recognized and familiar signal tones.

Where +12dB-SPL design headroom might be appropriate- Moderate ambient noise levels that change, many occupants are familiar with their surroundings, foreground music, frequent non-critical announcements

Where +20dB-SPL design headroom might be appropriate- Ambient noise levels that change greatly due to vehicle noise or high occupancy traffic, occupants are not familiar with their surroundings, frequent critical announcements, need for mass notification

Now that we have figured losses from the loudspeaker to the ear, here follows the process to get the desired sound level at the listener’s ears...

Remember, there are two level controls in this system; **the master volume at the “head end”** and locally at the loudspeaker with the **tap selection on the transformer.** It is common practice to set the “head end” at less than half power output, thereby allowing another 3-4 dB-SPL increase if conditions warrant. When we compute the level of the “local tap”, it should be the sound level needed for the everyday needs of the project.

There are five taps available on most transformers; QUAM units are no exception. The wattage taps generally start from the highest output, with each tap being -3 dB down, or half-power, from the one above. Two examples: 10W, 5W, 2.5W, 1.25W, 0.63W and 5W, 2.5W, 1.25W, 0.63W and 0.32W.

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Why five taps? Start in the middle and you have two taps to make the sound louder, and two taps to reduce the volume.

Remember: A 3 dB-SPL change in sound pressure to an average listener is a just noticeable difference; a 6 dB-SPL change is a noticeable difference. It is good practice to start at the middle tap in virtually every case.

Let's calculate sound pressure needed for an office space with non-critical paging and background music. As the paging is the critical component; we'll design for that- the music levels are always lower, and less critical.

Office space: 80' x 80', ear height 5'-0, ceiling height 12'-0 the speakers are installed in the ceiling facing down.
Per our previous examples, the distance from the loudspeaker to the ear-plane is 7'-0, therefore the direct field coverage is a circle 14'-0 in diameter. 80' (length/ or width) /14'= 5.71, round down to 5. 80/5 = Loudspeakers would be on 16'-0 centers in the length and width.

Assume the following: 65 dB-SPL ambient level, +9 dB-SPL design headroom required (We have split the difference between 6 dB and 12 dB headroom, to insure that we can do emergency paging) That means that the desired average sound pressure level of the voice pages should be around 74 dB.

If we chose the QUAM SYSTEM 12 ceiling tile replacement loudspeaker, and use the 1.25W (middle tap), with our distance losses included, we will measure about 86 dB directly below the loudspeaker and 85 dB at the edge of the coverage. One might say that we're 'too loud, over 10 dB more than we need"- you're right! The remedy is to turn the head-end down; and retain these benefits:

1/ You can always turn the master volume up-or down for all loudspeakers if required.

2/ The head-end amplifier will have plenty of reserve "headroom"

3/ You still have the ability to raise or lower the volume of the individual loudspeaker

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DETERMINING TOTAL SYSTEM POWER REQUIREMENTS

Assuming you have 60 loudspeakers on the project and they all have 1.25W taps (the middle tap), quick math would say the load is 75W. Best practices recommend taking this 75W and divide by 0.6 (60%), that would make the desired power amplifier size 125W. Here are the reasons for this answer:

1/ As the job is commissioned, you will probably be increasing power to some speakers; you need reserve power

2/ There will be line losses through the wire leads and the transformers; not all of the of the audio power will get to the loudspeakers. In order to compensate for these line losses, You will need to increase the volume at the head end; you will need reserve power.

3/ You will have reserve power for a few additional loudspeakers in the future, if required

4/ Your design will always have sufficient headroom regardless of the program material.

5/ Audio power amplifiers are incrementally less expensive as the wattage increases; the labor for installation remains the same. Do it once, do it right.

YOU'RE JUST ABOUT FINISHED!

You've done the following:

Determined how many loudspeakers you'll need
Determined the power needed to each loudspeaker
Determined the amplifier size required for the project

Now, what's left is the choice of the loudspeaker solution- there two basic solution sets available for downward firing applications:

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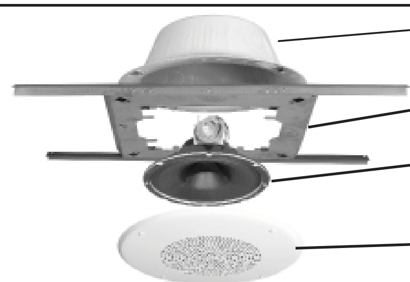
COMPONENT SOLUTIONS- Back can/ Tile bridge/ Loudspeaker assembly/ Baffle

When to consider use:

- **Matching old work**, particularly the look of the loudspeaker baffle
- **Mixed ceiling construction-** when you want the same baffle look throughout
- **Staggered construction schedules**-or- Multiple t**rade jurisdictions**

FOR EXAMPLE: *Electricians might make the electrical connection to the back can, other trades install the loudspeakers*



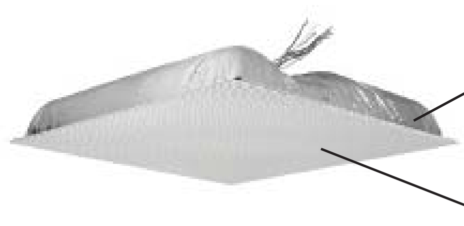
NOTE: All of these component solutions require hand labor to cut the opening in the ceiling or tile- and- some assembly of the components.

Consider: QUAM Solution 1 (As shown above), **Solution 2** -With baffle mounted volume control
Contractor Pair Packs. Two of everything you need in one convenient box!
QUAM System 21, the baffle and loudspeaker with back can, for hard ceilings up to 3" thick

LAY-IN SOLUTIONS- Ready-to-install in 24" wide ceiling-tile grids

When to consider use:

- 24" **wide ceiling-tile grids for either 24" or 48" long ceiling tiles** –and-
Vertical clearance of 8" (about a hand-span) above the grid
- Replacement/ upgrade of loudspeakers existing in a drop-tile ceiling
(Remove the existing tile and loudspeaker assembly; replace with a lay-in loudspeaker)



Consider: QUAM System 12 (As shown above), 24" x 24"; eight other versions available.
Also available in half-size as **System 5**, 12" x 24"; five versions available

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WIRING GUIDELINES

Now that you have all of the detail work done, it's time to climb the ladder and make all this preparation pay off. A very important link in the system is the wire itself- so don't skimp here! As noted much earlier: The advantage of the 70V solution is that because of higher voltage- and lower amperage, systems can be designed with longer distances from the power amplifier to the final loudspeaker. There are many wire gauge guides available and much of the selection process will be based on your core business and previous (satisfactory) completed projects.

Keep these facts in mind:

- Any length of wire induces some form of loss; the smaller the gauge of the wire, the less power actually gets to the speakers.
- Any gauge larger than 20 gauge- such as 18 or 16 gauge, etc. will give you the freedom to design with less line loss.
- The lower the voltage; the higher the current.. For the same wire gauge, you can design a 70V system that is **8 times longe**r than a 25V system with the same loss factor.

TERMINATION GUIDELINES

Every shop, installation crew project has its own way of executing the connection process, but here's an often overlooked finesse point- terminating unused transformer taps. It's good practice to individually insulate each unused wire- even if the insulation is intact.

WATCH THOSE COLORS! QUAM and many other manufacturers have "universal" transformers that can be used for either 25V or 70V projects. Make sure that the installation crew knows the system design!

WIRE COLOR	25V	70V
BROWN	**5W**	Do NOT use
RED	**2.5W**	Do NOT use
ORANGE	**1.25W**	Do NOT use
VIOLET	Not Used	**0.32W**
GRAY	Not Used	**0.62W**
BLUE	Not Used	**1.25W**
WHITE	**0.32W**	**2.5W**
GREEN	**0.63W**	**5W**
BLACK	**Always connected**	

The above chart is only for the QUAM Model TBLU transformer; please refer to the instructions for the device that you are using.

This Design Guide has covered the basics of a sound system design; we're sure that your design is different. **Questions? We have the solutions! Call:1-800-633-3669**