Sound Masking System Design for the Integrator

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In this paper, we will discuss the rule-of-thumb principals required for a commercial sound contractor to successfully design and install a basic sound masking system. This paper is not intended to serve as a complete engineering textbook to cover the subject of sound masking. Lowell Manufacturing recommends that the contractor retain the services of a qualified acoustical consultant if the sound masking system to be designed is more complex than the basic systems described in this paper, especially if the facility will require any structural or acoustical modifications to make it suitable for the successful implementation of an electronic sound masking system. This paper is not intended to provide the engineering level expertise required to design a sound masking system that meets performance requirements that have been specified by an acoustical consultant. The rule-of-thumb design methods described in this paper assume that a building owner has requested a design/build project directly from a commercial sound contractor.

1. THE NEED FOR SPEECH PRIVACY

There are many times when it is important that a conversation that is taking place in one location, not be overheard in another location. Sometimes hearing the voices of others is just annoying or distracting. In other situations, it can be politically or financially damaging, or even illegal, to allow the content of speech to be overheard by others.

Open office designs
The current trend in office space design (that is driven primarily by economic pressures), is to use open-office plans with only partitions to separate the cubicles occupied by office workers. The cubicle design is much more flexible to the changing needs of the office area, and is much less expensive to build. Voices from adjacent cubicles can be a distraction to co-workers and this lack of conversational separation can result in reduced productivity. The ever improving technology that has made office machines and air handling units quieter than in the past, has also contributed to the problem by reducing the typical ambient noise levels in modern offices. Increased speech privacy in an open office area can create a more pleasant work environment and improve office productivity.

Private meeting rooms and private offices
Speech privacy is often essential in the vicinity of rooms where sensitive material is discussed like near a manager's private office, or near conference rooms, corporate board rooms, law offices, human resource offices, or security offices, etc.

HIPAA laws
Government HIPAA privacy regulations that mandate that there is speech privacy when a doctor shares sensitive information with a patient, have resulted in an increased need for speech isolation around doctors' offices and exam rooms.

Court rooms
In courtrooms, speech privacy is required when the attorneys are called up to the judge's bench for a sidebar discussion and they don't want the information discussed to be shared with others in the courtroom including those in the jury box and the spectators in the gallery.

Study rooms
Speech isolation can also be helpful in areas that are intended for quiet study like libraries, study rooms, or testing centers.

2. SOUND MASKING SYSTEMS & SPEECH PRIVACY

How does sound masking work?

Many people mistakenly think that an electronic sound masking system magically gobbles up unwanted sounds. There have been a few products, like those special headphones you can buy for air travel, that actually do cancel out unwanted sounds. Although that can work in a very confined space like the headphone muff that covers your ear, that technology will not work on the scale of an open room. Electronic sound masking systems do not gobble up sound at all. In fact, they do just the opposite. Sound masking systems actually add ambient noise to the area. The sound masking noise used is a specially filtered audio signal that is described by the NC-40 Contour (described in more detail later in this article). Increasing the ambient noise in an area effectively masks the spoken word because it makes it more difficult for speech to be heard and understood.

What does masking noise sound like?

Most people say that masking noise sounds like an air conditioning unit blowing. In fact, office workers have been known to put on sweaters and other extra clothing when a sound masking system is introduced to an office area because they think that the air conditioning unit is constantly running. Although electronic sound masking systems have been called “White Noise Systems” and “Pink Noise Systems,” a sound masking system doesn’t use white or pink noise but instead incorporates a very specific filtered noise (described by the NC-40 Contour) that has been proven scientifically to produce the maximum speech masking effect.

3. DEAL WITH THE ACOUSTICS FIRST

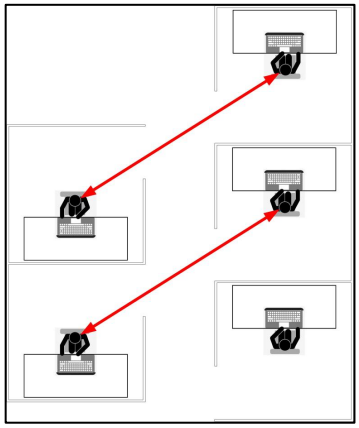
It is universally agreed that office designers should attempt to provide acoustic solutions to areas that require speech privacy before resorting to the use of an electronic sound masking system. Proper choices concerning the location of windows, wall construction and finishes, ceiling materials, floor coverings, partition materials, and lighting fixtures, can improve conversational separation by reducing sound reflections, blocking sound transmission, and absorbing stray sounds.

When a sound contractor is called in to provide a bid for a sound masking system, acoustical mistakes may already have been made by others and correcting those mistakes will probably be costly for the customer. Even though the acoustics may be beyond the control of the sound contractor, a discussion about any problems with the acoustics before the masking system is sold can reduce the possibility that the customer will be unhappy because they had unrealistic expectations about how much an electronic sound masking system can improve the current situation.

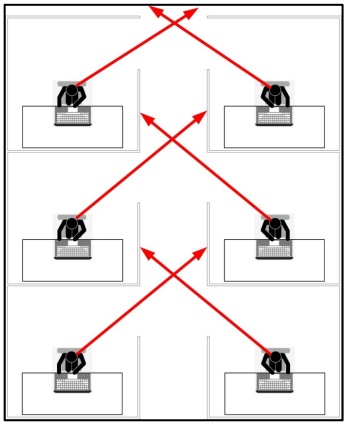
If the acoustical problems in the space are extreme, the contractor would be wise to either note the problem with the acoustics as a disclaimer in the quotation documents, or not provide a bid. We recommend that you never propose a sound masking system installation that has no realistic hope of improving speech privacy and will probably just result in an unhappy customer.

Acoustical problems that reduce speech privacy:

- **Line-of-Sight Transmission**
  In a properly designed open office plan, there should never be a line-of-sight path between two workers if speech privacy is to be achieved. That line-of-sight should be interrupted by any means possible. It is almost impossible for an electronic sound masking system to provide speech privacy when direct line-of-sight transmission of voice exists.



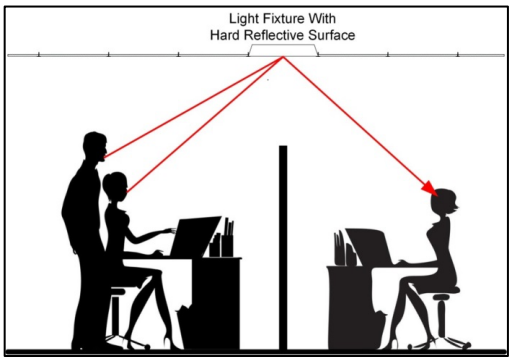
Poor Design (Line-of-sight between office workers)



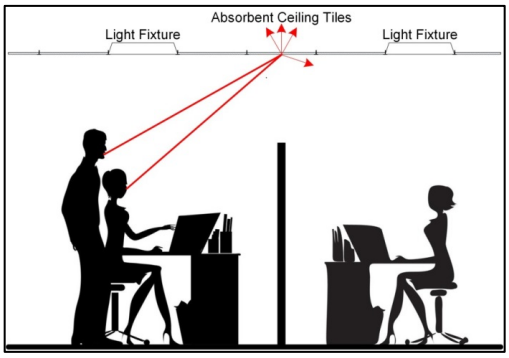
Good Design (No line-of-sight between office workers)

- **Ceiling Reflections**

  In a good open office design, all reflective surfaces are considered. Placement of light fixtures on the ceiling can provide a path for reflected speech that can be as distracting as line-of-sight transmission. Placing absorbent ceiling tiles over cubical walls can reduce voice reflections.

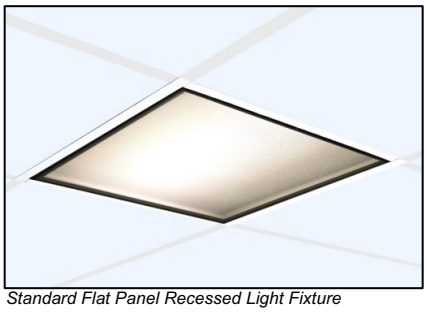


Poor Design (Reflective Path Between Workers)

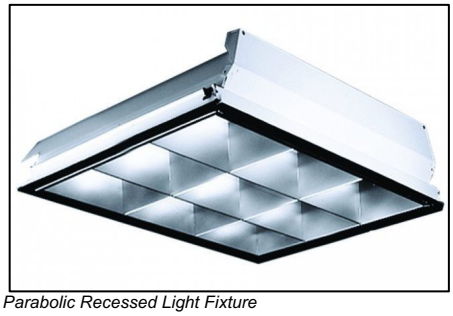


Good Design (No Reflective Path Between Workers)

Parabolic recessed light fixtures can dramatically reduce ceiling reflections, compared to standard flat panel light fixtures, and are highly recommended for use in an open office design.



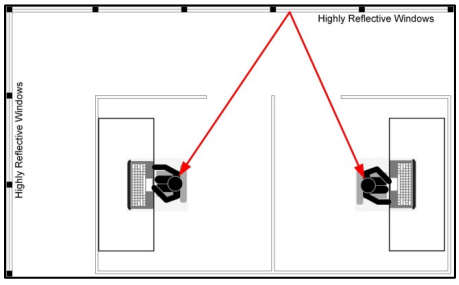
Standard Flat Panel Recessed Light Fixture



Parabolic Recessed Light Fixture

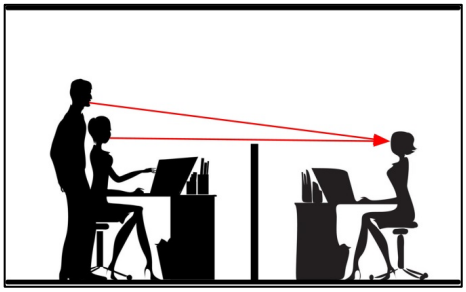
- **Wall, Window, and Floor Reflections**

  Hard reflective windows, glossy walls, and reflective floor materials should be avoided in open office plans when possible. Reflections from these surfaces can be particularly troublesome.

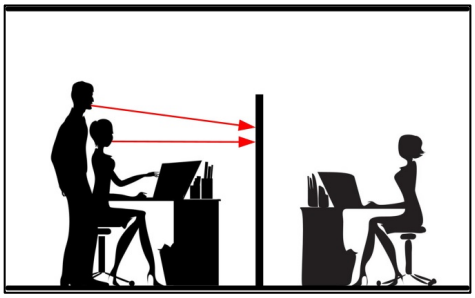


- **Partition Walls**

  Cubical partition walls are available in a wide range of quality and sizes. The height of the partitions and the specifications that describe the absorbency and sound transmission of the partitions are important factors. Low partitions provide no speech blocking as shown below:

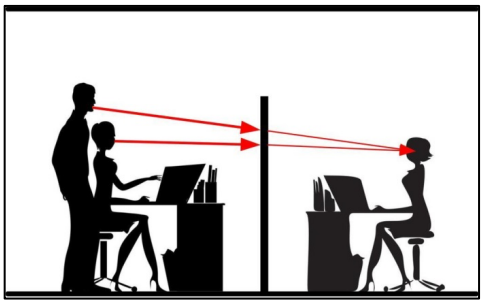


Low Partitions Offer No Speech Privacy

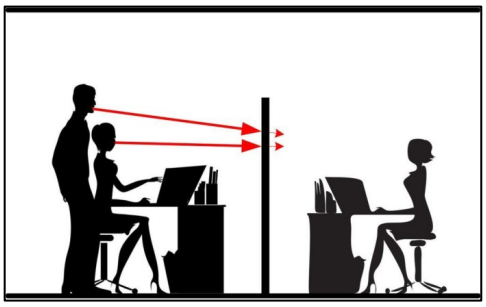


Minimum 66" Partitions Can Block Speech

A low cost partition wall may provide visual privacy but may have very little capability of blocking sound. Quality cubical partition walls are key elements required to provide speech privacy.



Low Cost Partition Passes Speech



Quality Partition Blocks and Absorbs Speech

Summary

In a perfect world, all practical architectural and acoustical improvements should be considered to maximize speech isolation before considering the installation of an electronic sound masking system. Very often the acoustical mistakes have already been made and the owner of the facility is calling in the sound contractor to install a sound masking system to rectify the problems caused by the substandard acoustics.

I often get calls from sound contractors with examples of what their customers are requesting. My favorite call (and I get it often) is when a customer has built a telephone call center where 100 people are talking on the phone all day to clients. There are 3' low partitions between the desks so there is no line of sight separation between the talkers. The floor is hard reflective tile. The ceiling is open structure with a hard slab above that is painted with a nice shiny reflective paint. There are windows ceiling to floor down one whole side of the room. Every surface is reflective and there is no absorptive material anywhere. There is a constant roar in the room from the reflected voices of the call center workers. The owner of the business tells the sound contractor that it is so loud in the room that their employees can't talk on the phone with the distraction of the voices of other nearby workers and the roar of background noise in the room. Here it comes: The owner of the business says, "I want you to install a sound masking system to mask all of this noise and fix the acoustics". It would be wise to walk away from a situation like this. Adding more ambient noise to an acoustical nightmare like this will just make the situation worse.

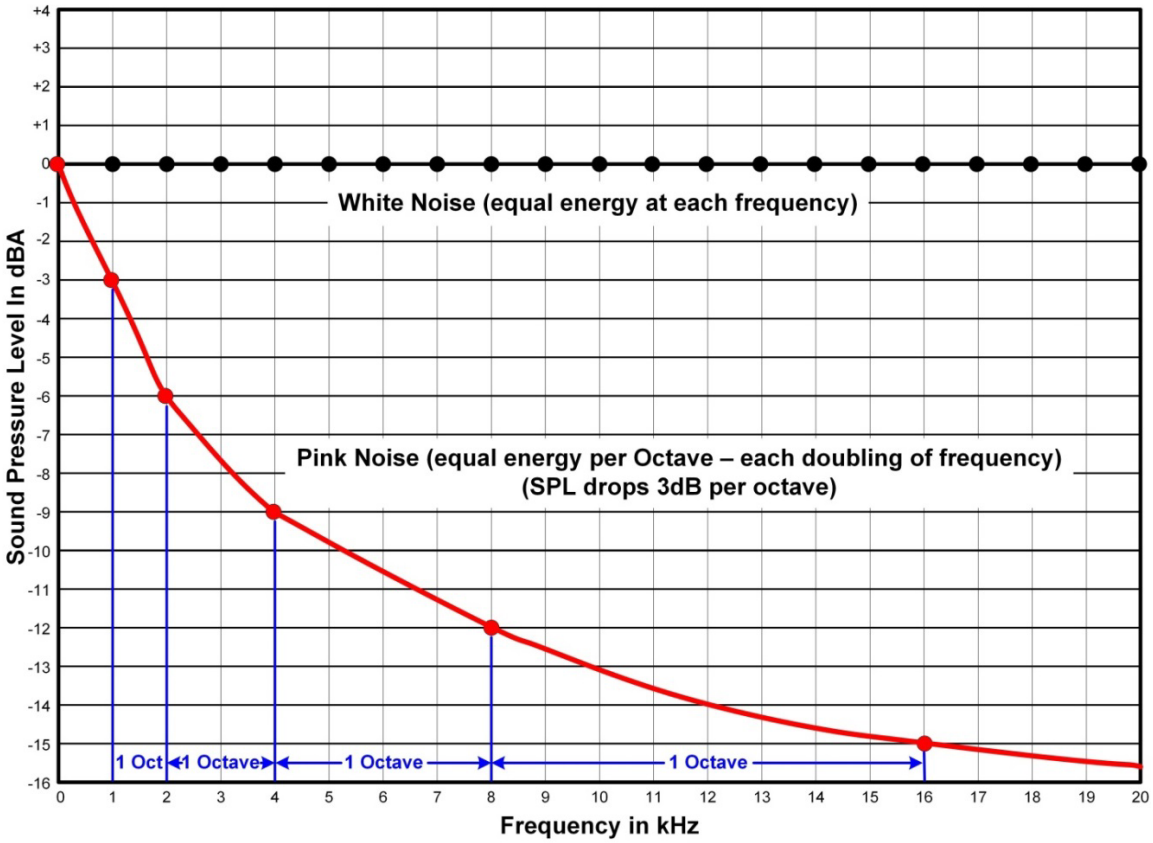
Nobody wins in a situation where a sound masking system gets installed in a room with poor acoustics and where there never was any hope that the system would help to increase speech

privacy. If the acoustics are not suitable for a sound masking system and the customer is not willing to take steps to improve the acoustics, you may just need to bow out and keep the reputation of your company intact. The biggest mistake that some sound contractors make is not spending the time required before the sale to educate their customers so they have realistic expectations and clearly understand what a sound masking system can and cannot do.

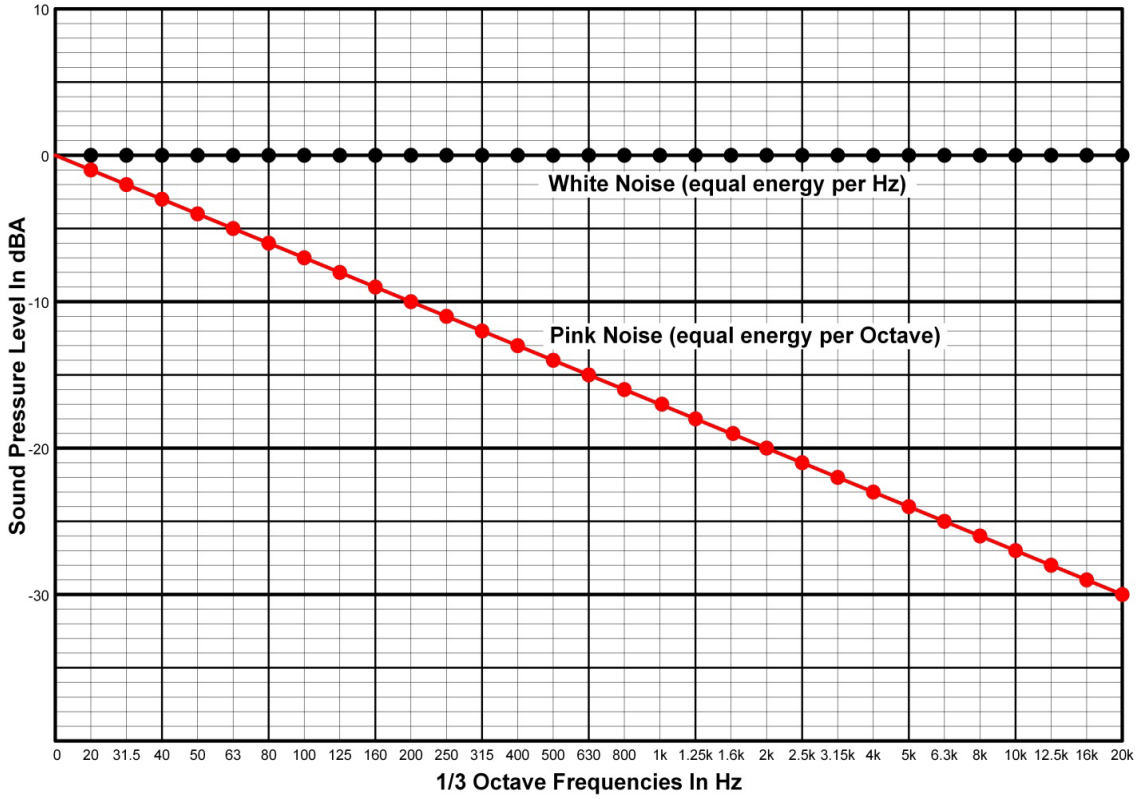
4. FREQUENTLY ASKED QUESTIONS

A. What is Sound Masking Noise?

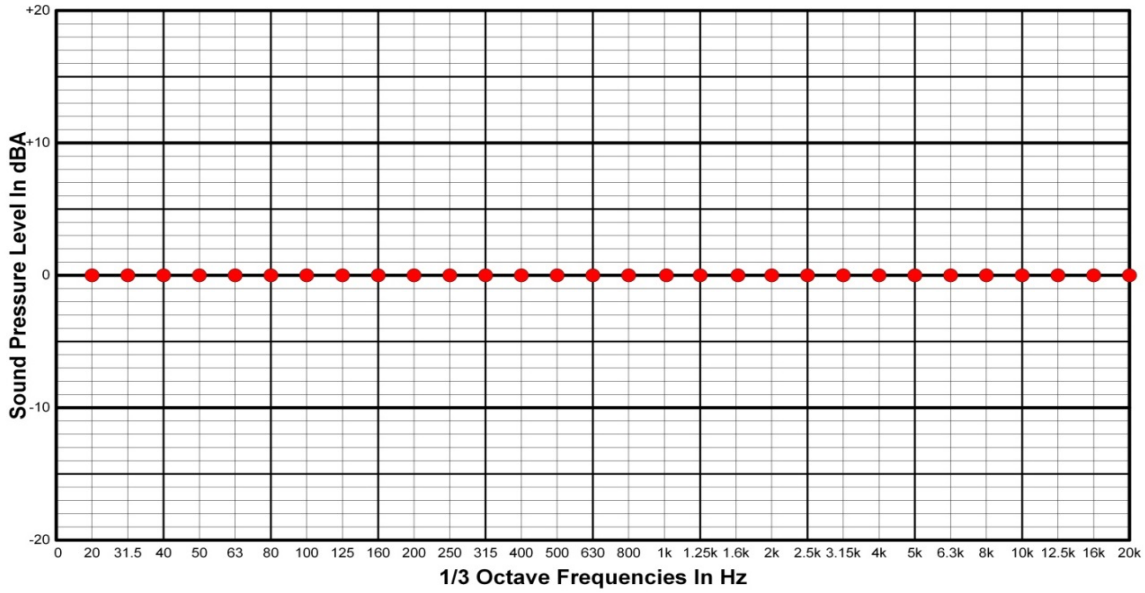
Electronic sound masking systems are often called “White Noise Systems” or “Pink Noise Systems.” Neither term is technically correct. White Noise (for audio use) is defined as “Equal sound energy at each frequency over the usable audio spectrum.” Pink Noise is defined as “Equal sound energy per octave over the usable audio spectrum.” Note that by definition, an octave is a doubling of frequency, so between 20Hz and 40Hz is one octave, between 40Hz and 80Hz is one octave, and so on. That means that compared to White Noise, Pink Noise has much less energy in the higher frequencies than it does at lower frequencies. Since our ears work in a logarithmic manner, Pink Noise sounds flat to the human ear but White Noise sounds overly bright. In other words, because of the logarithmic nature of our human ears, it sounds to us like Pink Noise has as much energy in the low frequencies as there is in the high frequencies (even though that is really not the case). White Noise and Pink Noise on a linear frequency scale are shown below, which shows how much less high frequency energy there is in Pink Noise compared to White Noise.



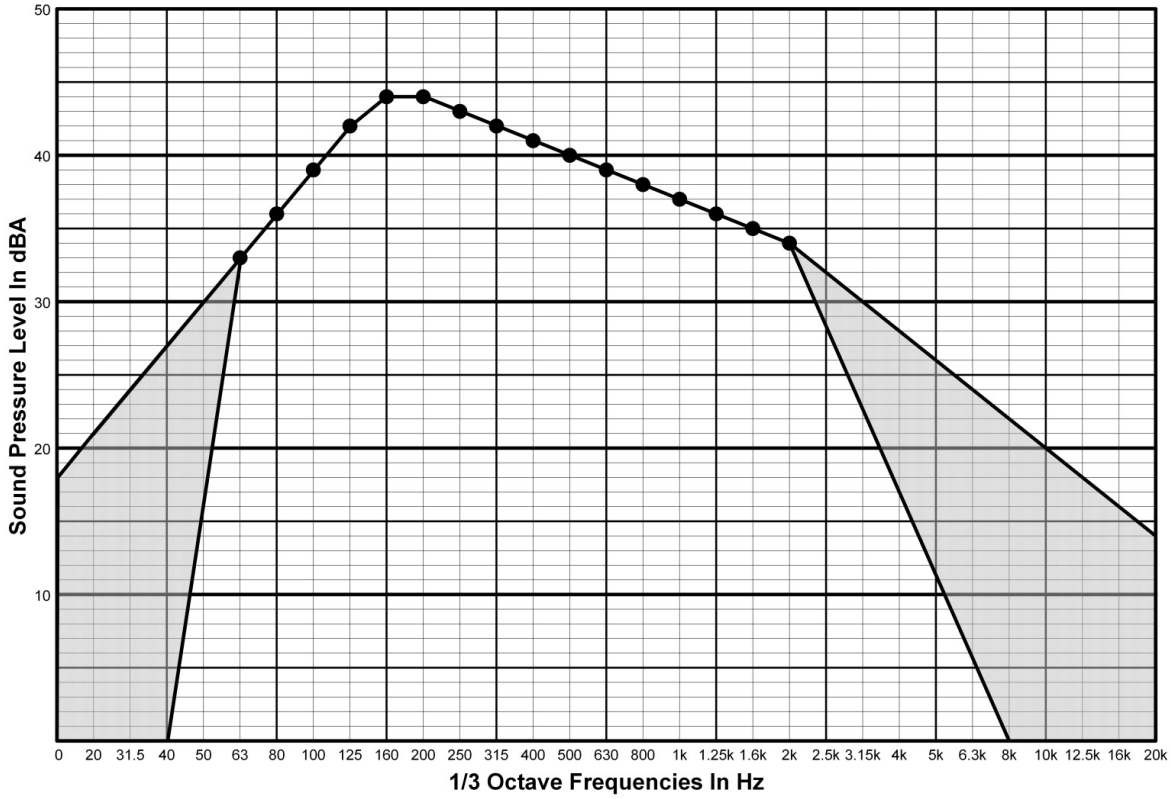
The curve below shows Pink Noise on a logarithmic frequency scale.



Notice that on a logarithmic scale as shown above, Pink Noise appears as a straight line and it clearly shows that in Pink Noise, the sound pressure level is reduced 3dB per octave. Real time audio spectrum analyzers (RTA) are calibrated so that correct Pink Noise response appears as a flat horizontal line (as shown on the RTA display below) to make it easier to set the EQ for flat Pink Noise response. That's why sound contractors say "the sound system's response is flat" if it correctly reproduces the Pink Noise test signal as a flat line on an RTA.



The ideal noise content for optimum speech privacy in a noise masking system is based on the NC-40 noise contour. Compared to the flat horizontal line expected on an RTA for Pink Noise, the response of a sound masking system if properly tuned for the NC-40 contour has considerably less high frequency than Pink Noise. Often sound masking noise generators start with White Noise or Pink Noise, but a 1/3 octave equalizer is typically used to shape the system response and roll off the high frequencies to result in the NC-40 curve for masking. Note that the critical curve is between 63Hz and 2kHz. Below 63Hz and above 2kHz is not as critical as shown in the wider acceptable window on the typical masking RTA display below:



B. What are the major benefits of an electronic sound masking system?

The major benefit of the introduction of an electronic sound masking system is the improved speech privacy that results from the increased ambient noise in the problem area. A second benefit of electronic sound masking can be the reduction of distractions caused by the awareness of noises from outside traffic, keyboards clicking, and nearby conversations. Together, these benefits can help to create a more pleasant working environment and may even improve office productivity.

C. Where is sound masking system electronic equipment typically located?

Some self-amplified masking speakers include a small amplifier inside of each speaker. All masking speakers manufactured by Lowell, however, are designed as passive units (they do not contain amplifiers) so the electronic equipment is typically located in an equipment cabinet or on a shelf in an electrical utility closet.

D. Where are the sound masking speakers installed?

In most cases the sound masking speakers are located above the finished lay-in tile ceiling. In cases where the finished ceiling is very high, masking speakers can be installed direct radiating (recessed in the ceiling facing down). In buildings that have open architecture (open trusses with no finished ceiling) the speakers can be installed exposed.

E. Can background music be used for sound masking?

Background music does raise the ambient noise level in an area and while the music is playing at a consistent level it can result in some speech privacy. Music, however, does not contain the spectral content required to provide the maximum speech privacy. Music also has varying dynamic range as loud and soft passages may be contained in the same song. The most distracting feature of music, for the purposes of speech privacy, are the sometimes long quiet pauses between songs. All of these variations in level make music a poor signal source to provide consistent speech privacy.

F. Is it possible to feed music and paging through an electronic masking system?

There are typically a lot of speakers used in a sound masking system so customers often ask if voice paging and music can be fed through those same masking speakers. Sound masking speakers are typically installed above the finished ceiling firing upward and bouncing off of the slab above to provide the maximum dispersion and overlapping coverage. Music and paging bouncing around above a tile ceiling, and then filtering down through the ceiling tile to the listeners, produces a distant unnatural sound that can't be totally corrected with equalization. Using a masking system for rare pages, like emergency announcements, may be economical and acceptable, but using masking speakers for frequently occurring voice pages and continuous background music produces sound quality that may not be acceptable to your customers. Despite the disadvantages of feeding paging and music through sound masking speakers, the subject will be discussed in this paper because sometimes your customer may feel that a compromise in sound quality is necessary to stay within their budget.

G. What areas are typically covered by sound masking speakers?

Sound masking speakers are typically used in open office areas with low cubicle partitions and in common areas like hallways and reception areas. In many instances, customers would prefer that sound masking not be provided in areas like lunchrooms and storage rooms. Other customers prefer that all of these areas be covered so there is not a perceived jump in ambient noise when an employee goes from these quiet areas to the areas with sound masking. To a certain extent, this is a personal preference issue and should be discussed with the customer. Budget restrictions may make it impossible to provide masking noise in all areas of an office.

H. What areas should not be covered by sound masking speakers?

- Conference Rooms and Private Offices: Sound masking typically should be avoided inside of private offices and conference rooms where people need to hear each other. If masking noise would be introduced in those rooms, people would have to talk louder to be understood which defeats the purpose. Often sound masking is installed just outside of private offices and conference rooms since it is desirable to make it harder for people outside of these rooms to hear what is being said inside them. An exception would be where masking is required between adjacent offices to increase speech privacy between offices.

- Training Rooms and A/V Presentation Rooms: Sound masking noise is typically not used in rooms where people need to clearly hear a presentation like in training rooms and audio/visual presentation rooms.

- Rest Rooms: Even in offices where most of the ceilings are lay-in tile ceilings, the rest room ceilings are typically low drywall ceilings (for security reasons). Typically sound masking speakers are not installed in rest rooms unless a special request is made by the customer.

- Areas used by the Hearing and Sight Impaired: Sound masking systems should also not be installed in environments that are meant to be used by hearing impaired or sight impaired people. A sound masking system's purpose is to raise the ambient noise level so it is harder

to hear the voices of others. This can be very detrimental to a hearing impaired or sight impaired person since their ability to hear the environment around them is critical to them being able to function.

I. Are there cases where sound masking can be switched on and off?

Sound masking systems should normally run 24/7. In a rare case, a manager may want a small sound masking system to be installed with speakers around the wall of his/her office. A wall switch is often installed allowing the manager to turn the masking on only when something very sensitive or top secret is being discussed. When the masking is turned on/off it can be annoying to other workers in the office but if that's what the manager wants, it's hard to argue.

J. Are there cases where sound masking can be automatically turned up and down?

There are two schools of thought when it comes to automatic level controls. Sound masking is needed the most when the office machines are turned off and only a few workers are still around. Traditional textbooks will say that a sound masking system should normally run at the same level 24/7. Others feel that the sound masking noise should be turned down slightly after hours. One argument made for that reduction in level after hours is that a reduction in the amplifier output of only 3dB can reduce the power consumption slightly but that over a year, there can be a noticeable savings on the electric bill. This argument will continue to be debated. At the current time, Lowell Manufacturing comes down on the side of running the sound masking at the same level 24/7 and for that reason, Lowell does not currently offer a sound masking generator with a built-in time clock to adjust the masking noise level.

K. Are there situations where an electronic sound masking system will not help?

A properly installed sound masking system will increase ambient noise — it will not reduce noise. If the goal of the system is to add ambient noise to limit the ability of a person to clearly hear nearby conversations, then a sound masking system can help. However, if a room (like a call center) is already so noisy that people can't talk on the phone, then a sound masking system will not help because it cannot reduce ambient noise.

L. As a contractor, should I beware of processor based sound masking technology?

There are many different levels of technology in sound masking. Choose the technology that your company can install successfully. For instance: Self-amplified IP addressable sound masking speakers are now available that allow adjustment of the level and EQ of each individual speaker from a laptop location. That technology is a favorite of many consultants who can afford to make such intricate time consuming adjustments. Some would question the need for such critical adjustments on a system who's primary goal is to raise the ambient noise level in the space. For a contractor, we would recommend that you steer clear of methods that require such a high level of expertise and a lot of time to equalize and balance each one of the system loudspeakers during the commissioning process.

M. What is the typical power tap to use on 70V sound masking speakers?

Sound masking systems need to be balanced and adjusted. When masking speakers are installed above the finished ceiling, many things can cause variations in the volume of sound masking noise that reaches the listener's ears, such as leaks in the ceiling around light fixtures and open return air grilles. Sometimes there are also dead spots around the edges of the room or where ducts above the ceiling have blocked the masking noise. The 1W tap on a sound masking speaker is typically loud enough for most applications. Tapping the 70V transformer on the 1W tap gives the installers 2 louder taps (2W and 4W) and 2 softer taps (1/2W and 1/4W) that can be used if a particular speaker needs to be made louder or softer so that the noise level at the listening level is even across the entire office area. It is always good practice to tap the sound masking speakers at the center 1W tap when possible to allow for this adjustment.

N. How much headroom is recommended for a sound masking amplifier?

With any 70V sound system amplifier, it is always good design practice to limit the speaker load to 85% of the amplifier's power rating. That designed-in 15% headroom allows for future expansion (adding a few speakers) and also the reduced load will increase the lifetime of the amplifier by allowing it to run cooler. Although headroom is always desirable, be assured that Lowell amplifiers will survive and operate safely when they are fully loaded.

5. SOUND MASKING SYSTEM DESIGN FOR THE INTEGRATOR

A. Tips for the Sales Process:

1. **The first meeting, educate the customer:** Many contractors skip this step and it is a critical mistake. This is your opportunity to find out what the customer knows about sound masking. If their understanding is that a sound masking system is a big “sound sucker” that can rid their office of unwanted noise, this is your chance to set them straight. Taking the time to educate your prospective customer can set you apart from the other bidders, cementing your place in your customer’s mind as the expert that they want to work with. Your first meeting also gives you the chance to form your customer’s expectation of what the installation of the sound masking system can and cannot do. Correcting any misconceptions that the customer has at this point may mean the difference between a happy customer after the system has been installed and a disgruntled customer that refuses to pay their bill. Find out about your competition. Sound masking systems are expensive because of the number of speakers required. The contractor with very little knowledge about sound masking who spaces the speakers way too far apart is likely to be the successful low bidder. Find out what the decision to award the contract is going to be based on. If the decision will be based solely on cost, you may have to make some compromises on the quality of your system design. Find out if you can help the customer evaluate the bids before making a decision. That may be your last chance to discredit your competition if their system design is faulty or substandard.

2. **The site survey:** Tell your customer that you need to meet again after you have completed your site survey. You’d be surprised how many contractors prepare a bid before even lifting a ceiling tile to see what’s up there. If you find out there is a foot of sound batting on top of all of the ceiling tiles, or that the plenum space is 15’ tall and there’s no way you can get through the existing lay-in ceiling to attach your speaker chains to the building structure, you will be very glad you took a good close look before you prepared your bid. Don’t forget to evaluate the building acoustics. When you talk to your customer a second time, that’s the time to plant the seed if there are acoustic challenges that are going to reduce the effectiveness of any sound masking system that you install.

3. **The second meeting, tell the customer your findings:** This is the critical meeting where you’ll prepare the customer to receive your bid. Tell the customer if there are any acoustical issues. Let the customer know if you discovered any irregularities in their building that will dictate which direction you go in with your design (and prepares the customer to expect that other bidders should be going in that direction as well). Find out if the customer has a budget in mind. If their budget is unrealistic, now is the time to educate them. Ask the customer if you can call them with some budget numbers before you complete the final design and prepare the final bid documents. When a customer says they don’t have a budget in mind and you call them with a proposed $20,000 budget price, you’ll be surprised how fast they will say, "Oh I was thinking it would be more like $xxx." That’s information you really need before you lock yourself into a firm written quotation. The pre-design checklist on the following pages will help you to gather all information required to prepare a bid and will eliminate return trips because you forgot to check something.

Sound Masking System Design Checklist

CUSTOMER INFORMATION

Customer Name: _____ Date: _____

Address: _____

Contact Name: _____ Phone: _____

E-mail: _____

SYSTEM INFORMATION

SYSTEM REQUESTED (check one):

☐ Sound Masking Only ☐ Sound Masking & Paging ☐ Sound Masking, Paging, and Music

☐ Other _____

Details: _____

PAGING SOURCE (check one):

☐ Telephone Paging ☐ Paging Microphone ☐ Other _____

Details: _____

MUSIC SOURCE (check one):

☐ Subscription Service (ex. Satellite, describe): _____

☐ AM/FM Tuner ☐ CD Player ☐ Other _____

Details: _____

SPEAKER TYPE REQUESTED:

☐ Above Ceiling ☐ Mounted In Ceiling (direct radiating)

Details _____

COVERAGE AREA:

☐ Open Office ☐ Foyer/Reception ☐ Hallways ☐ Lunch Room ☐ Private Offices

☐ Conference Rooms ☐ Rest Rooms ☐ Storage/File Rooms ☐ Other _____

Details: _____

CONTINUED ON NEXT PAGE...

Lowell™

BUILDING SPECIFICS

CEILING DETAILS:

☐ Tile Ceiling

Tile Details: ☐ 2X2 Tiles ☐ 2X4 Tiles

Tile Type: ☐ Non-Tegular (flat) ☐ Tegular (drops down)

Tile Material: ☐ Soft absorbent ☐ Hard non-sound-passing Thickness _____

Tile Backing: ☐ None ☐ Foil ☐ Sound batting ☐ Insulation

☐ Drywall Ceiling

Location Description: _____

☐ Open Architecture Ceiling

Location Description: _____

☐ Other: _____

Finished Ceiling Height _____ Plenum Height _____

Plenum space used for return air? Y N

ACOUSTIC DETAILS:

☐ Low Partitions ☐ Height ☐ Line-of-sight problems ☐ Reflective Walls ☐ Reflective Windows

☐ Reflective Ceiling Light Issues: _____

☐ Carpet Flooring ☐ Hard Tile Floor ☐ Other _____

Other Acoustic Issues: _____

LOCATION FOR EQUIPMENT:

☐ Closet ☐ Utility Closet ☐ Sufficient AC Power Available for Head End

Other Location: _____

Project Budget: _____ Installation Timeline: _____

Lowell™

C. Speaker Selection:

1. **Above Ceiling Speakers (UL Listed):** The SM810/SM820/SM410 sound masking speakers are listed in the USA for UL1480A General Signaling and UL2043 (suitable for use in a return air plenum space). They are also listed for CSA C22.2 No. 205-M1983 for use in Canada. This line of sound masking speakers covers every application possible for a sound masking speaker that will be located above the finished ceiling in the plenum space and they can also be used in open architecture applications. Each is equipped with a transformer tap selector switch with 70V 1/4W, 1/2W, 1W, 2W, and 4W taps. A comparison of features for each model is given below:

Lowell HEARD EVERYWHERE®

Feature Comparison Chart
SM810A / SM820A / SM410A

Electrical and Acoustical Specifications

Model Number	Model Type	Driver Type	Frequency Response	Sensitivity (70V/1W/1M)	Dispersion (-6dB@2kHz Oct.)	Transformer Taps Switch
SM810A	Black With Hangers	#810 8" Dual Cone	117Hz-6.9kHz ± 7dB	97.1dB	115 Degrees Conical	1/4W @ 70V 1/2W @ 70V 1W @ 70V 2W @ 70V 4W @ 70V "Off" Switch Position Is Also Available
SM810AW	White With Hangers					
SM810A-BR	Black, Factory Installed Rails					
SM820A	Black With Hangers	#8A50 8" Coaxial	60Hz-16.5kHz ± 7dB	90.6dB	100 Degrees Conical	
SM820AW	White With Hangers					
SM820A-BR	Black, Factory Installed Rails					
SM410A	Black With Hangers	#JR410 4" Single Cone	85Hz-12.6kHz ± 7dB	92.1dB	170 Degrees Conical	
SM410AW	White With Hangers					
SM410A-BR	Black, Factory Installed Rails					

GENERAL SIGNALING EQUIPMENT
c UL us
LISTED
4M24
UL1480 A GENERAL SIGNALING
CSA C22.2 NO. 205-M1983, UL2043
SUITABLE FOR USE IN PLENUM SPACES

Mounting Note:
The speaker system must be mounted in accordance with local, state, and federal codes and regulations, and industry standard practices.

- Model No. SM810A: Incorporates Lowell's 810 driver. This 8" dual cone 15W driver with a 10 oz. magnet includes a whizzer cone for high frequency enhancement. Over 90% of the masking speakers sold by Lowell use the classic 810 driver because of its very high sensitivity and wide dispersion. Includes two hangers that can be easily configured so the speaker can be hung aiming up, down, or sideways. Black enclosure.

- Model No. SM810AW: Identical to the SM810A except the enclosure is painted white for exposed open architecture installations.

- Model No. SM810A-BR: Same as SM810A (black enclosure) except that it ships from the factory with two bridge rails attached to the speaker. When the speaker is installed, the rails simply rest on the tile ceiling grid making this a very cost-effective labor-saving installation. In some areas of the country, the rails will need to be attached to the grid using sheet metal screws provided by the installer. In other parts of the country, earthquake restraint cables will be required to attach the speaker to structural support for safety reasons. Refer to the local Authority Having Jurisdiction (AHJ) for any special requirements in your area.

- Model No. SM820A: Incorporates Lowell's 8A50 coaxial 8" 50 watt driver. This is a favorite with consultants who want the maximum low frequency response for sound masking and for systems where music is played through the masking speakers.

- Model No. SM820AW: Same as above except that it's painted white for open architecture installations

- Model No. SM820A-BR: Same as the SM820A (black enclosure) except that it ships with bridge rails mounted to the speaker.

- Model No. SM410A: Features Lowell's JR410 driver. This 4" 15W driver has lower sensitivity but extremely wide dispersion, making it ideal for very low 2' to 3' plenum spaces where maximum dispersion is required.

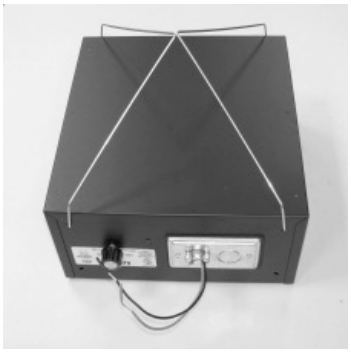
- Model No. SM410AW: Same as SM410A except that it's painted white for open architecture installations.

- Model No. SM410A-BR: Same as SM410A (black enclosure) except it ships with bridged rails mounted to the speaker.

Note: Except for model numbers on labels, the SM810A, SM820A and SM410A look identical. The same is true for the SM810AW, SM820AW and SM410AW; and SM810A-BR, SM820A-BR and SM410A-BR.

SM810A Aiming Up

SM810A Aiming Sideways



SM810A Aiming Down

Relocating Hangers

4' Hanging Chain (included)

SM810A-BR on grid

2. **Above Ceiling Speakers (Entry Level):** Value priced sound masking speaker.

   - Model No. SM805A: Very cost effective sound masking speaker with 8” dual cone 12W driver that includes a 5 oz. magnet and a whizzer cone for high frequency enhancement. It features high sensitivity and wide dispersion which makes it perfect for those price sensitive installations. Hangers on the SM805A only allow it to be installed aiming up. The SM805A masking speakers are listed for UL1480A, CSA C22.2 No. 205-12 for use in Canada, and UL2043 for use in a return air plenum space.



3. **Containerized Ceiling Speakers:** There are times when installing sound masking speakers above the finished ceiling is not possible including when the ceiling tiles are rock hard and won’t pass sound, when sound batting or insulation that won’t pass sound has been placed above the ceiling tiles, or when there is a drywall or plaster ceiling. In these cases it is necessary to either hang the sound masking speaker exposed (which is often not aesthetically acceptable to the customer) or to use direct radiating masking speakers that are recessed in the ceiling. Lowell ES Series labor saving speakers are ideal for this application. For existing drywall, plaster, or lay-in tile ceilings, the ES-4T (4” dual cone driver), ES-52T (5-1/4" coaxial driver), and the ES-62T (6-1/2” coaxial driver) come with all of the hardware that’s required for installation including dog-mounting-ears that make mounting quick and easy.

   - Model No. ES-4T: The ES-4T has extremely wide dispersion that is required for direct radiating sound masking when the finished ceiling is less than 12' from the floor.

   - Model No. ES-52T: The ES-52T has extremely wide dispersion that is required for direct radiating sound masking when the finished ceiling is less than 12' from the floor. It's the better choice when paging and music will also be played through the sound masking speakers.

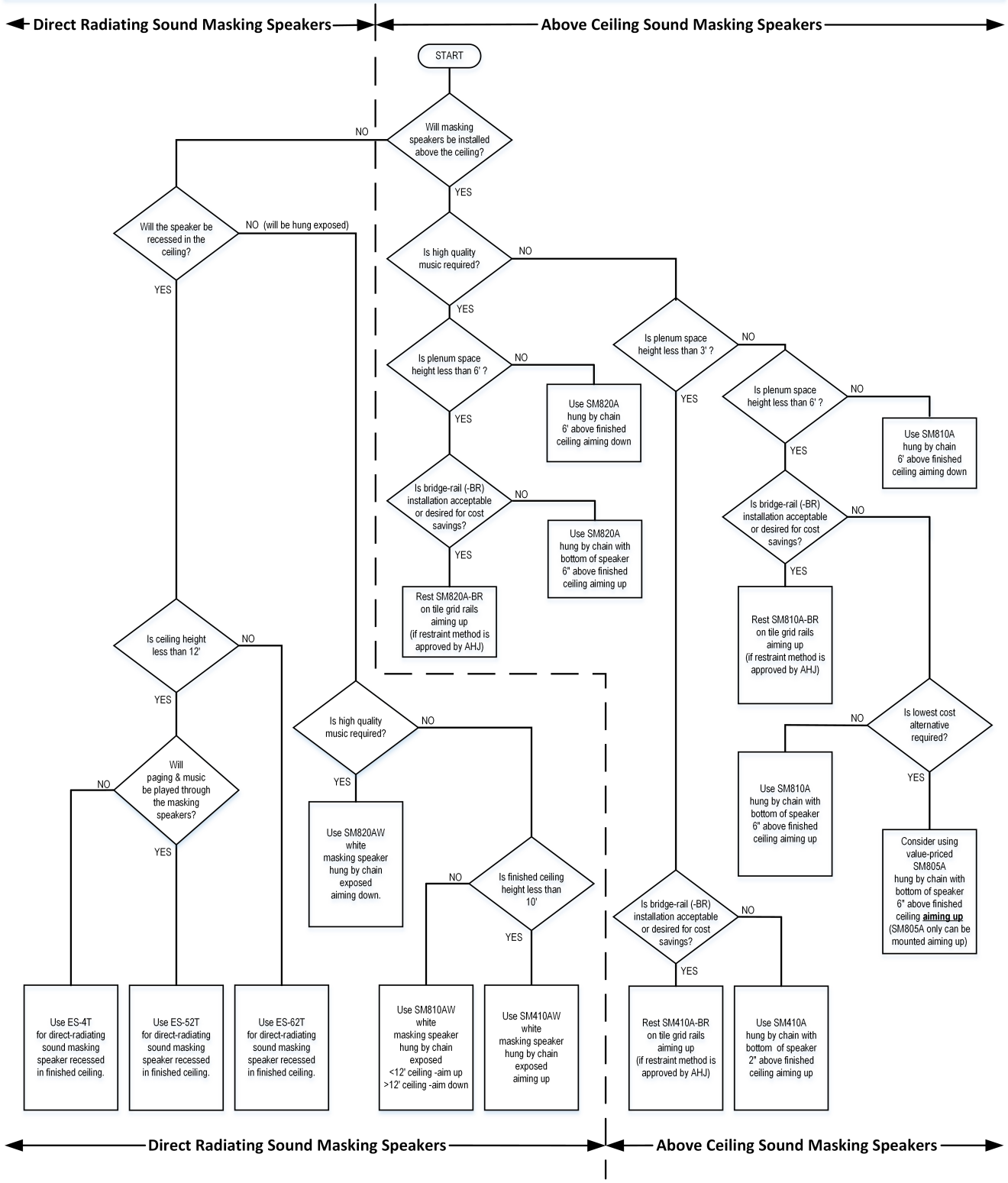
   - Model No. ES-62T: For taller ceilings (over 12'), especially when paging and music will also be played through the masking speakers, the higher powered ES-62T is the best choice.

For new construction where the drywall has not yet been installed, the ES-4-RIB rough-in bridge (shown being installed above) is available to reserve a spot for installation of an ES-4T speaker after the finished drywall ceiling or wall has been installed and painted. The ES-4-RIB can be mounted on 24” centers for ceiling trusses and framing or can be mounted on 16” centers for mounting to wall studs or floor joists. The return lip on the ES-4-RIB provides a guide so drywall installers can use their routers to cut a perfect hole for the installation of the ES-4T. Because the screws used depend upon the requirements of a particular application, the mounting screws are furnished by the installer. The ES-6-RIB is also available to rough-in for the ES-52T and ES-62T. See the ES Series spec sheets and the “LowellDSS” technical paper describing the spacing required at www.lowellmfg.com.

Speaker Selection Summary:

Choosing the Lowell sound masking speaker model that is best for your application can be a challenge, but it is one of the most important steps in your sound masking system design. The handy “Lowell Sound Masking Speaker Selection” flow chart on the following page, and the examples that follow, should help as you make this critical choice.

Lowell Sound Masking Speaker Selection



Follow the “Lowell Sound Masking Speaker Selection” flow chart on the previous page as you consider how the speaker selection was made in the following examples:

Example 1 Application: Standard open office. 9’ lay-in tile ceiling. 5’ tall return air plenum space. UL Listing required for plenum use. AHJ (Authority Having Jurisdiction) has confirmed that resting the speakers on the tile grid will be approved. System is for masking only.

Navigating the flow chart:

Start.
- ♦Masking speakers above ceiling? YES.
- ♦High quality music? NO.
- ♦Plenum space height less than 3’? NO.
- ♦Plenum space height less than 6’? YES.
- ♦Is bridge-rail acceptable? YES.

Speaker selected: Model SM810A-BR aiming up.

Example 2 Application: Standard open office. 9’ lay-in tile ceiling. 12’ tall plenum space. Listing required for plenum use. System is for masking only.

Navigating the flow chart:

Start.
- ♦Masking speakers above ceiling? YES.
- ♦High quality music? NO.
- ♦Plenum space height less than 3’? NO.
- ♦Plenum space height less than 6’? NO.

Speaker selected: Model SM810A hung 6’ above the finished ceiling aiming down.

Example 3 Application: Standard open office. 9’ lay-in tile ceiling. 2.5’ tall return air plenum space. UL Listing required for plenum use. AHJ (authority having jurisdiction) has confirmed that resting the speakers on the tile grid will be approved. System is for masking only.

Navigating the flow chart:

Start.
- ♦Masking speakers above ceiling? YES.
- ♦High quality music? NO.
- ♦Plenum space height less than 3’? YES.
- ♦Is bridge-rail acceptable? YES.

Speaker selected: Model SM410A-BR resting on the grid rails.

Example 4 Application: Standard open office. 9’ lay-in tile ceiling. 12’ tall plenum space. System will be used for above-the-ceiling paging, high quality music, and sound masking.

Navigating the flow chart:

Start.
- ♦Masking speakers above ceiling? YES.
- ♦High quality music? YES.
- ♦Plenum space height less than 6’? NO.

Speaker selected: Model SM820A hung 6’ above the finished ceiling aiming down.

Example 5 Application: Open office with 25’ drywall ceiling. Speakers to be recessed in drywall ceiling. UL Listing is required. System will be used for paging, background music, and sound masking.

Navigating the flow chart:

Start.
- ♦Masking speakers above ceiling? NO.
- ♦Will speakers be recessed in the ceiling? YES.
- ♦Is ceiling height less than 12’ NO.

Speaker selected: Model ES-62T

Example 6 Application: Open office with 11' drywall ceiling. Speakers to be recessed in drywall ceiling. UL Listing is required. System will be used for sound masking only.

Navigating the flow chart:

Start.
- ♦Masking speakers above ceiling? NO.
- ♦Will speakers be recessed in the ceiling? YES.
- ♦Is ceiling height less than 12'? YES.
- ♦Will paging and music be played through the masking speakers? NO.

Speaker selected: Model ES-4T

Example 7 Application: Open truss ceiling. Bottom of truss is at 9-1/2'. System will be used for sound masking only.

Navigating the flow chart:

Start.
- ♦Masking speakers above ceiling? NO.
- ♦Will speakers be recessed in the ceiling? NO.
- ♦Is high quality music required? NO.
- ♦Is finished ceiling height less than 10'? YES.

Speaker selected: Model SM410AW hung by chain exposed aiming up.

Example 8 Application: Standard open office. 9' lay-in tile ceiling. 5' tall return air plenum space. AHJ (Authority Having Jurisdiction) has stated that local codes state that speakers may not rest on the tile grid. System is for masking only.

Navigating the flow chart:

Start.
- ♦Masking speakers above ceiling? YES.
- ♦High quality music? NO.
- ♦Plenum space height less than 3'? NO.
- ♦Plenum space height less than 6'? YES.
- ♦Is bridge-rail acceptable? NO.
- ♦Is lowest cost alternative required? NO.

Speaker selected: Model SM810A hung by chain with bottom of speaker 6" above finished ceiling aiming up.

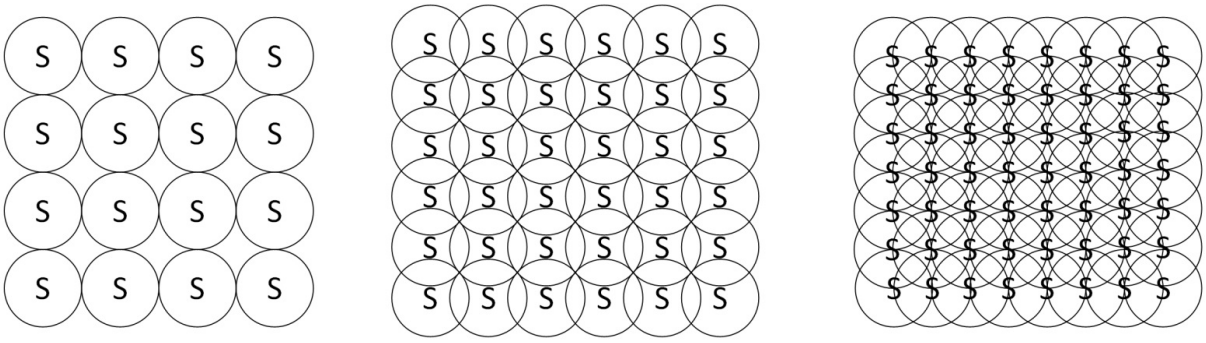
D. Speaker Spacing:

When sound system designers lay out distributed speaker spacing for a paging or music system, they always consider the speaker coverage at the listening height, which is defined as the height of the listener's ears. For office sound systems it is usually assumed that the office workers will be seated at their desks and so the average listening height will be 4' above the finished floor. Most system designers consider that the minimum coverage pattern that is acceptable for a blanket covered distributed speaker system is "Edge-to-Edge Coverage" where the edge of the coverage circles just touch each other.

Take for example a recessed ceiling speaker that has a linear dispersion of 90 degrees at the 2kHz octave (the octave most important for speech articulation). For this example, we will assume the office ceiling height is a standard 9' from the finished floor. The ceiling height is 9', minus the average listening height 4', so the speaker's throw is 5'. With a 90 degree linear dispersion, we can use some basic trigonometry and know that at a throw of 5', we can draw a dispersion circle with a diameter of 10'. The diagram shown below shows that with "Edge-to-Edge Coverage", the coverage circles of the speakers just barely touch. Notice that there is a dead spot between each 4 speakers. For most paging and background music applications, "Edge-to-Edge Coverage" is acceptable.

Once we start talking about higher quality foreground music we want to close those dead spots so it is wise to consider "Minimum Overlap Coverage" as shown below. Note that it takes a lot more speakers to produce "Minimum Overlap Coverage".

For extremely high quality pro sound systems, some designers will use "Edge-to-Center Coverage" where the dispersion circle from one speaker extends to the center of the adjacent speaker as shown below. The sound pressure level will be very uniform throughout the listening height, but notice that "Edge-to-Center Coverage" requires roughly 4 times the number of speakers that are required for "Edge-to-Edge Coverage." It becomes clear why, for cost reasons, "Edge-to-Edge Coverage" is what is used most often for paging and background music systems.



Edge to Edge Coverage | Minimum Overlap Coverage | Edge to Center Coverage

For a sound masking system, it is important to have coverage similar to that of Edge-to-Center Coverage. Under textbook conditions, an occupant of an office space should be able to walk through the office area and not be able to locate where a sound masking speaker is above the ceiling. In other words, the sound masking noise coverage should have sufficient overlap that a solid blanket of sound is heard with no hot spots or dead spots. This overlapping coverage produces the optimum speech privacy. A poorly laid-out sound masking system, where the overlap in speaker coverage is not sufficient, will have hot spots and dead spots so it will be annoying to those in the hot spots and can produce little or no speech privacy for those in the dead spots. In sound masking the old saying is true that you get what you pay for. For a complete discussion of linear dispersion and recessed speaker spacing see the white paper at www.lowellmfg.com

There are formulas and many software programs that describe the recommended speaker spacing for direct radiating paging and music speakers, but the layout of sound masking speakers is not quite as scientific. That's because a sound masking speaker installed in the plenum space typically shoots up, bounces off of an unknown slab or structural ceiling, reflects back toward the tile ceiling, may be diverted by ductwork, lighting fixtures, or sprinkler pipes, and then finally filters through a porous ceiling tile. Just the properties of the ceiling tiles used can dramatically affect how the masking noise is affected as it passes through. There's no way to scientifically predict what the exact coverage will be in such an unpredictable situation, so it has become industry standard to work with some "rule of thumb" spacing guidelines that are based on experience. Note that for sound masking it is always better to error on the side of more overlapped coverage, rather than coverage that might be too thin.

The other issue that affects our rule of thumb spacing recommendations for sound masking speakers is the budget for the project. As I stated before, with sound masking you get what you pay for. More speakers with better overlapping coverage results in a better sound masking system. There are, however, limits to what customers can afford. Sound masking systems are expensive to install due to the number of speakers involved. Some customers have to sacrifice quality to keep their budget in line, so rule of thumb recommendations for sound masking speakers will always be a distance range and not an absolute spacing.

- **Rule-of-Thumb 1:** For a standard 9' office ceiling with a typical 4'-6' plenum space above the finished ceiling, the rule-of-thumb recommended spacing for upward firing sound masking speakers is between 10' centers and 16' centers. With speakers on 10' centers, the blanket of sound masking noise coverage will be seamless with no hot spots or dead spots and the office workers will not be able to locate where a masking speaker is above the ceiling. With speakers on 16' centers, the blanket of sound masking noise coverage will not be seamless and there will be hot spots and dead spots in the coverage. At 16' centers, office workers will probably be able to locate where a masking speaker is above the ceiling. Any spacing between 10' and 16' will be not as good as 10' centers but not as bad as 16' centers. The determination needs to be made based on the dimensions of the room and the customer's available budget.

- **Rule-of-Thumb 2:** The higher the finished ceiling is, the farther the speakers can be spread apart. For a 12' ceiling, consider the range to be 12' to 18' centers. Note that for a higher ceiling, increase the typical transformer tap setting of 1W to 2W to compensate for the longer distance throw.

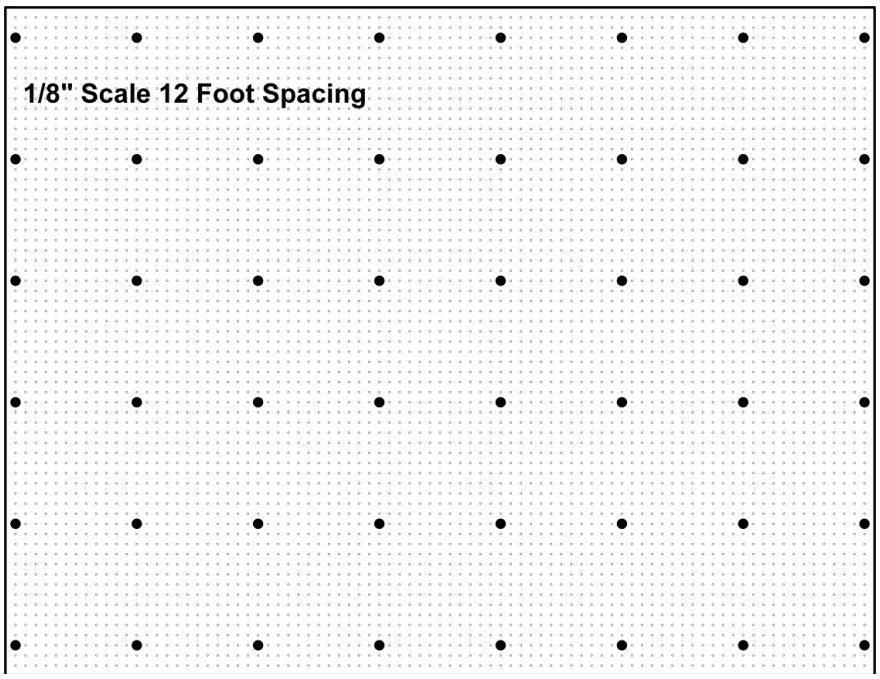
- **Rule-of-Thumb 3:** The shorter the plenum space is, the closer the speakers should be together. This limitation can be overcome by using wider dispersion Model SM410A-BR speakers tapped at 2W.

- **Rule-of-Thumb 4:** It is impractical (because of inverse squared losses) to aim a masking speaker up if the plenum space is taller than 6'. By the time the masking noise travels that far, is reflected by the structural ceiling and travels back down to the tile ceiling, very little sound pressure level will be left. It is better in this case to mount the speaker with the face of the speaker at 6' above the finished ceiling aiming down. When mounted in this fashion, the typical 1W transformer setting is still typically adequate.

An Old Estimator's Trick: Once you have decided what speaker spacing to shoot for on your masking system, the tricky part is how to determine the exact layout. For example: The open office area has a standard 9' lay-in tile ceiling with a 5' plenum space above the ceiling. As a designer, I choose to shoot for 12' spacing (not the Cadillac at 10' spacing but certainly on the quality end of the rule of thumb spacing). So the textbooks would recommend that I place my first speaker in one corner of the room 6' in from the rear wall and 6' in from the side wall. I put a row of speakers that are spaced 12' apart. I move over 12' and put the next row of speakers that are also spaced 12' apart. When I get to the last row, I should have 6' to the other side wall. In reality though, rooms never fit perfectly into

that textbook spacing. What do I do next? Should I move the first row in farther from the side wall or spread the rows farther apart? How can I decide how to make the rows fit?

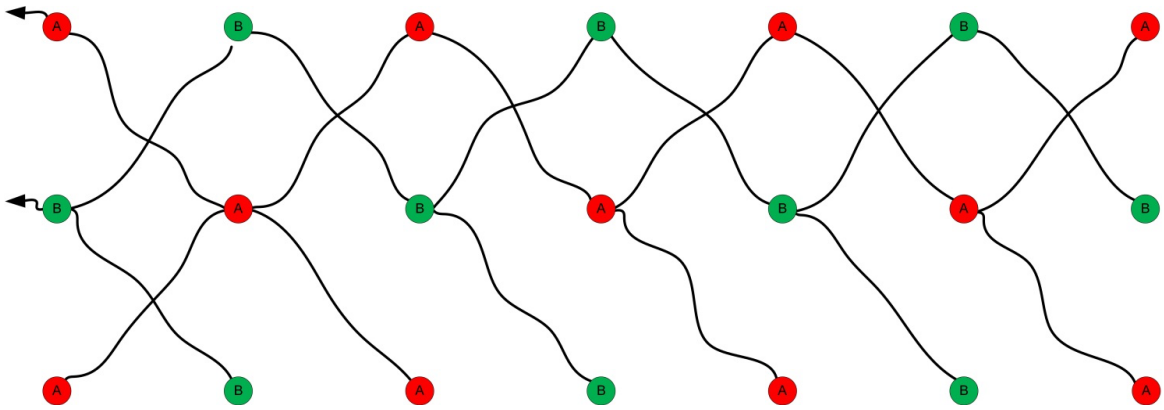
Whether you work on CAD drawings on your computer or on printed drawings, here's an old sound masking estimator's trick that works like a charm. My directions will be for the paper drawing version, but it will work just as well on CAD systems. Faced with a floor plan drawn to a 1/8" scale, take a piece of clear plastic and lay out an 1/8" grid. You younger people may not even know what this is, but there used to be a device called an overhead projector where clear overlays with images printed on them would project the image on a projector screen. Those clear 8-1/2" X 11" transparency films are still made by 3M and they work great for this purpose. If you are going to be a sound masking designer and you will be working on paper drawings, you're going to need to order a box of these films. Once I have my 1/8" grid, I mark out my speakers on 12' centers (which will be twelve 1/8" increments) as shown below. Next I can take a pin and punch a hole in the plastic at each speaker location.



Shown at Reduced Scale

Now I can lay this clear sheet with my speaker spacing on my 1/8" scaled floor plan drawing. If I need to scoot the pattern one direction or the other, I can do that easily. I can even decide if I want to add or drop a row by scooting my pattern. When I've got the pattern where I want it, I take a pencil and mark the drawing through the pin hole at the speaker locations. Then I can go back and make a symbol for the speaker centered at each of those locations. At the contracting firm where I worked, you could always tell who were the sound masking estimators because they had a stack of speaker spacing sheets hanging by their drawing templates. The beauty of this method is that once you've made a template for 12' spacing on 1/8" scale, you'll never have to make that template again. On the next project, if you are faced with a drawing that is 3/16" scale, you just need to whip up a template and keep building your template library. If you make the basic 1/8" or 3/16" grid etc. and print it on the transparency films on a dot matrix printer (don't use a laser printer or it may melt the film), it's easy to make different sheets for different spacing. In no time at all you'll have the standard masking speaker spacing for the most typically used drawing scales. This eliminates having to calculate how far you have to move in from the side wall and back wall and how much is left over on the opposite side. It's simple just to move the template until your spacing is correct and you have equal spacing around the edges.

The Cadillac — Redundant Masking Systems: It's not very often when a customer can afford "the Cadillac" of masking system designs, but this paper would not be complete without mentioning this method. The speaker selection and layout is done just as described above. The difference is that every other speaker is wired to one of two different amplifiers, amplifier A or amplifier B as shown below:



It doesn't take more speakers for a redundant system, but it does take a lot more wire and wiring labor. The concept is really quite simple. The head-end equipment includes two complete systems: Masking Generator A, Equalizer A, and Amplifier A, as well as Masking Generator B, Equalizer B, and Amplifier B. There are two main advantages to redundant systems. When you feed phase-coherent noise through 2 speakers, as you walk through the coverage of the first speaker to the second speaker, you will hear the combing that is caused by phase cancellation. The first advantage is that if two adjacent speakers are feeding from two completely different noise generators, that combing will be eliminated. The second advantage is that if one noise generator, EQ, or amplifier fails, the second system will keep running so the masking level will only be down by 3dB to 6dB. That can be particularly important if paging announcements are fed through the masking system. The pages will be spotty in coverage, but they will still be heard. It's a great concept and a noteworthy design, but in my experience, it's rare that customers can be convinced that the extra cost is justified.

A Reminder About the Sales Process: As stated above, when it comes to sound masking, overlapping coverage is the key to a quality system and you get what you pay for. The question for a contractor in a competitive bid situation is, "How can I provide a quality system with the proper number of speakers for overlapping coverage if my competition proposes half the number of speakers?" Here's a quick reminder of some suggestions I gave in the "Tips for the Sales Process" section earlier in this paper.

- **Step 1:** Most customers have no idea how much a sound masking system is going to cost. The number of speakers required and the labor needed to install those speakers can make the cost steeper than your customer is expecting. It's a big mistake to do a complete design with an exact speaker layout before you run some budget numbers by your customer. For example: A customer tells you that their office space is 200' X 75' (or just tells you it is 15,000 square feet). Don't waste the time doing an exact speaker layout for that area. You're not sure at this point if the customer can afford the deluxe end of the rule of thumb spacing. Assume for this example that after you have completed your site survey, you have decided to propose 12' speaker spacing (which is on the higher quality end of the "rule of thumb" spacing). That means that each speaker is covering an area that is 12' X 12' or 144 square feet. (15,000 square feet divided by 144 square feet = 104.2 speakers) Based on the customer's head-end requirements, calculate a quick budget price for the installation of 105 speakers plus the head equipment. Call your customer and tell them, "It looks like the sound masking system for your facility is going to cost $20,000" (or whatever the

amount is). After a discussion about sound masking systems and speaker spacing, you are very quickly going to find out if your customer is interested in the quality level you have proposed or if you are going to need to space the speakers farther apart to reduce the cost of the system. Now you can spend the time to lay out the exact details of the system design and you won't have to do it twice.

- **Step 2:** Here's another great sales technique: Ask the customer to make sure that the number of speakers in your written bid is comparable to the number of speakers that your competition is proposing. Your customer will either question the credibility of a contractor that submits a bid with a lot fewer speakers, or if your customer is attracted by the lower price and is leaning toward a lower quality proposal from your competition you might get a chance to match your competition's proposed number of speakers. Starting the process with an adequate number of speakers gives you the high ground later if your customer realizes that they asked for the speaker quantity to be cut back too far. It's always nice to be able to say that if they had gone with your original quantity of speakers the quality of the sound masking system would have been better.

Volume Controls: A sound masking system is just another form of a standard 70V sound system, so standard autoformer wall-mount or rack-mount volume controls like those used on paging and music systems can be used. It is important, however, to avoid giving the customer too much control over the sound masking level. Sometimes a small sound masking system gets installed surrounding a local office or conference room and in that case, if the customer requests a wall-mounted volume control so sound masking can be turned off or the volume can be adjusted, that's fine. We strongly recommend that you never put volume controls in an open office area so that all employees have access to them. There are always a few people that will not like the sound masking noise and it will become a constant battle to keep them from fiddling with the masking volume. In general, volume controls should only be used as a device that will be used to balance the system and then will never be touched again. If the managers of the office want access to make adjustments to the sound masking level, put the controls required in a locked equipment cabinet where only those managers have access. Volume control example: If one sound masking amplifier is used to drive masking speakers in an open office area and also a string of masking speakers down a hallway near private offices, it would certainly be acceptable to add a volume control that adjusts just the speakers near the private offices. We recommend that volume control be locked up at the head-end location so that it is only used to balance the system.

Head End Equipment:

- **The Equipment Cabinet:** It is often tempting to place a sound masking generator and amplifier on a shelf in an electrical closet where none of the employees are supposed to go. The door to an electrical closet is rarely sufficient to slow down those office fiddlers that take it on themselves to rebalance the system to their likes. We strongly recommend that the masking equipment be located in an equipment cabinet with a locking front door so that only management can access the equipment. Even with a locked equipment cabinet door, all tuning and adjustment controls like the sliders on the equalizer should be covered with security panels to make it difficult for any of the critical adjustments to be altered. See Lowell Manufacturing's complete line of locking floor and wall-mount equipment cabinets at www.lowellmfg.com.

- **Lowell Noise Generator:**
  1. Model No. SMG-2: This sound masking generator produces an analog pink noise signal that is fed to sound masking amplifiers (ordered separately) in order to produce random low-level background noise to increase ambient noise and aid conversational privacy. The pre-EQ output has a flat spectrum that can be used as an input to equalizers that feed power amplifiers for masking systems that require precise equalization. The post-EQ output is adjusted by bass, mid and treble controls and can be used for less demanding applications that utilize basic spectrum shaping. See the spec sheet for more information.

Lowell Model No. SMG-2 (rear view)

- **Noise Clock Adjustment:** As discussed earlier in this paper, there are two schools of thought when it comes to automatic sound masking noise level controls. Some system designers feel that the sound masking noise should be turned down slightly after hours. Others believe that sound masking is needed most when the office machines have been turned off for the day and only a few workers are still around. Most traditional textbooks state that a sound masking system should run at the same level 24/7 and Lowell Manufacturing agrees with that philosophy. For that reason, Lowell does not offer a sound masking generator with a built-in time clock to adjust the masking noise level.

- **Equalizers:** With the exception of very small sound masking systems with only one to four speakers, it is always important to incorporate a 1/3 octave equalizer in a sound masking system. Sound masking speakers are typically installed above the finished ceiling aiming upward. The masking noise bounces off of the structural ceiling that is above the lay-in tile finished ceiling and then filters down through the ceiling tile to the office area below. The masking sound is colored by the structural ceiling that it bounces off of, by the properties of the ceiling tile that it passes through, and by the acoustical properties of the actual office space. It is important to have a 1/3 octave equalizer available to tune the frequency content of the sound masking noise to the NC40 spectrum that has been determined to optimize the speech privacy effect.

  Using a 1/3 octave equalizer for paging or music fed through a sound masking system: When a sound masking system is used to distribute paging or music, it is not realistic to think that voice or music produced by the sound masking speakers firing up, bouncing off of the slab or structural ceiling, and then filtering through the ceiling tiles to the office acoustical space below, will sound natural. A method of pre-emphasis of the high frequencies is required on the paging feed or music feed before it is mixed with the masking noise. To tune the equalizers for paging or music, the real time analyzer microphone is placed at the listener's ear level. Pink noise is then fed through the sound masking system. The equalizer is adjusted for flat pink noise response at the listening height. If you would stick your head above the finished ceiling, the paging or music would be very bright with too much high frequency, but once that paging or music has filtered down through the ceiling tile it will sound natural at the listener's ear height.

- **Amplifiers:** Lowell offers a line of mixer/amplifiers and power amplifiers that can be used for sound masking systems. The choice of the amplifier will be made depending on the output power requirements (which will be determined by the number of sound masking speakers used and the power tap chosen for each speaker) and the number of inputs required (if paging or music etc. will be added to the sound masking noise). See the specification sheets for Lowell Models MA30, MA60, MA125, MA250, and PA250A at www.lowellmfg.com.

- **System Wiring:** Follow all local and national building codes and National Electric Code regulations regarding the installation of 70 volt sound masking speaker cable, including using cable with a plenum rated jack if the plenum space is used for return air. Other than meeting code requirements, the decision about sound masking speaker cable has to do with line loss. All Lowell sound masking speakers include 70V matching transformers to reduce the line loss. Line loss can also be minimized by keeping the length of the speaker lines as short as possible and using the largest conductor size possible. As with all sound system work, the size of the speaker cable to reduce line loss must be balanced against the cost of the cable. Most masking system designers are willing to accept a 12.5% loss of power in the speaker lines to

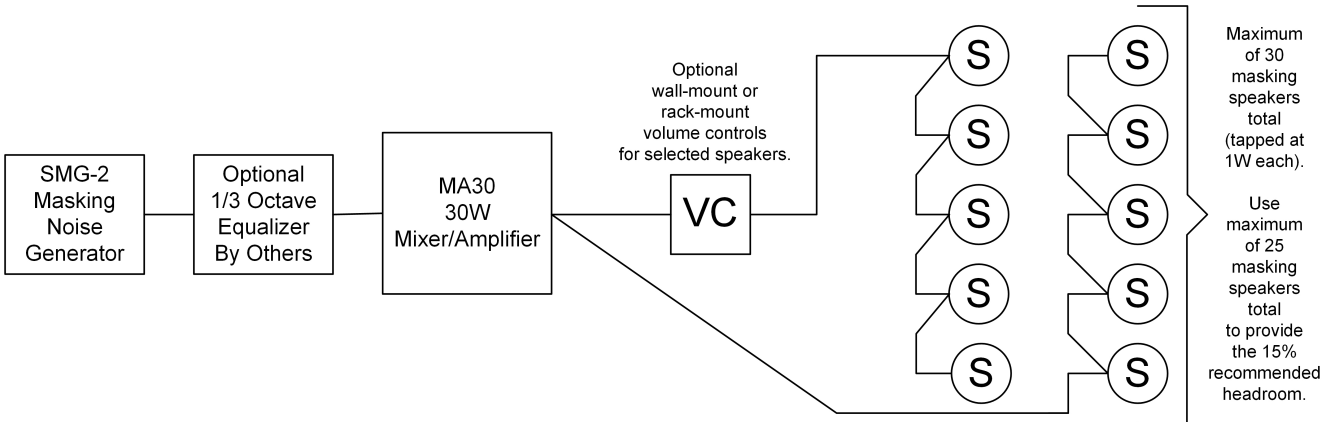
keep the wiring as small as possible. Knowing the load on your speaker line and the distance the total speaker line is running, the chart below will tell you what size speaker cable is required so the loss in the cable is not more than 12.5%. Note that the red area in the chart represents wire sizes and speaker loads where the amperage would violate the national electrical code.

2 WIRE COPPER CABLE LENGTHS FOR SPEAKER LINES AT –0.5dB LOSS IN SPL (12.5% POWER LOSS IN WATTS)

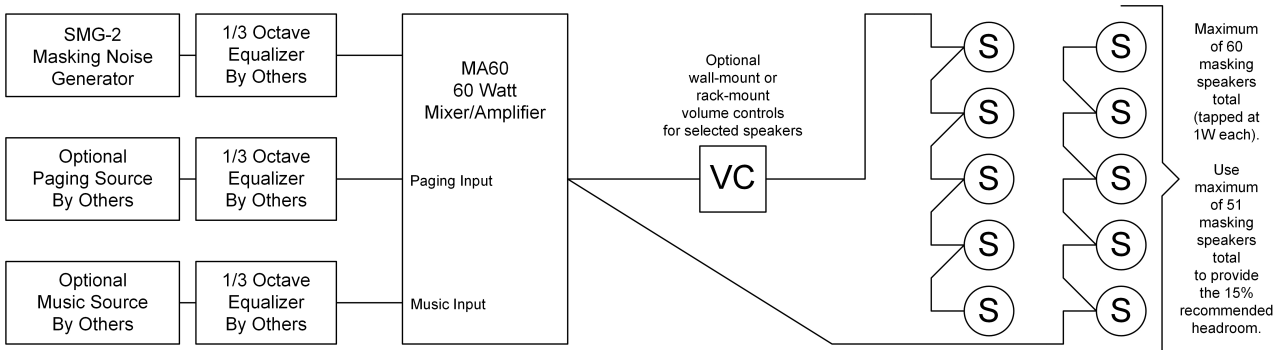
AWG SIZE	LOW IMPEDANCE SPEAKER LINE			70.7V SPEAKER LINE (FOR 25V LINE DIVIDE ALL 70.7V LENGTHS BY 8) NOMINAL POWER IN LOAD								
	4 OHMS	8 OHMS	16 OHMS	7.5W	15W	30W	60W	100W	125W	250W	400W	500W
10	120	240	480	-	-	5,000	2,500	1,500	1,100	550	365	275
12	75	150	300	-	6,200	3,100	1,550	940	750	375	230	185
14	50	95	190	7,600	3,800	1,900	950	600	450	225	140	110
16	30	60	120	4,800	2,400	1,200	600	370	290	145	90	
18	20	40	75	3,000	1,500	750	375	230	180	90		
20	15	25	50	1,920	960	480	240	150	110			
22	10	15	30	1,200	600	300	150	95				
				WIRE LENGTHS IN FEET								

The Masking System Schematic: So we've taken the most important steps: (1) We've selected the proper sound masking speaker for the application. (2) We've determined the appropriate speaker spacing for the application. All that remains is to design the head end schematic for the application. There are endless system design configurations depending on a customer's particular requirements, but the following typical system schematics describe many of the possibilities.

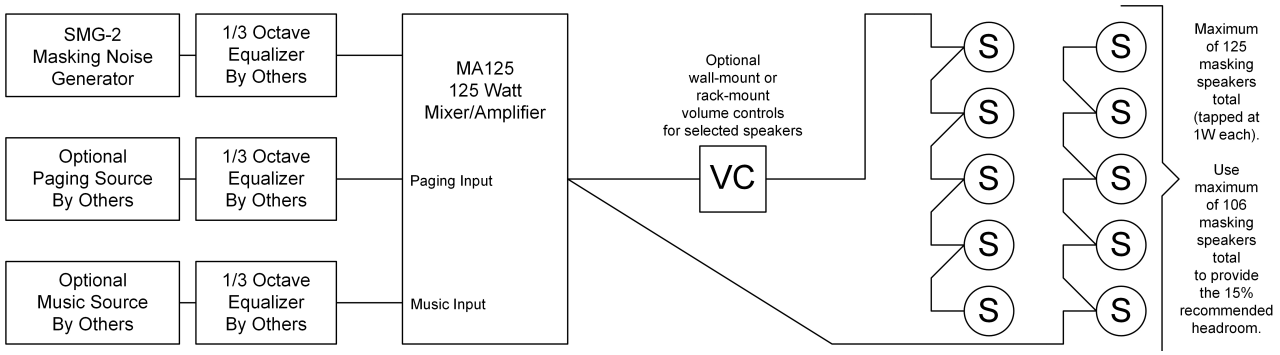
- **Small Sound Masking System (up to 30 speakers):** Application: This small sound masking system is suited for applications that require up to 30 sound masking speakers. *Note: It is always good design practice to allow 15% headroom in the amplifier in case a few speakers need to be tapped higher than 1W to fill dead spots or in case a speaker or two is added in the future.*



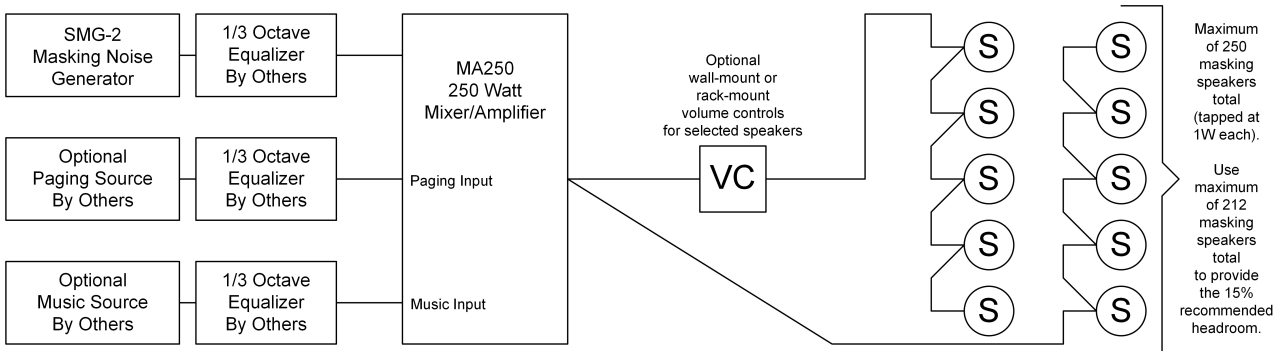
- **Medium Sound Masking System (up to 60 speakers):** Application: This medium sound masking system is suited for applications that require up to 60 sound masking speakers. *Note: It is always good design practice to allow 15% headroom in the amplifier in case a few speakers need to be tapped higher than 1W to fill dead spots or in case speakers are added in the future. The MA60 amplifier inputs make it possible to feed paging or music through the sound masking speakers.*



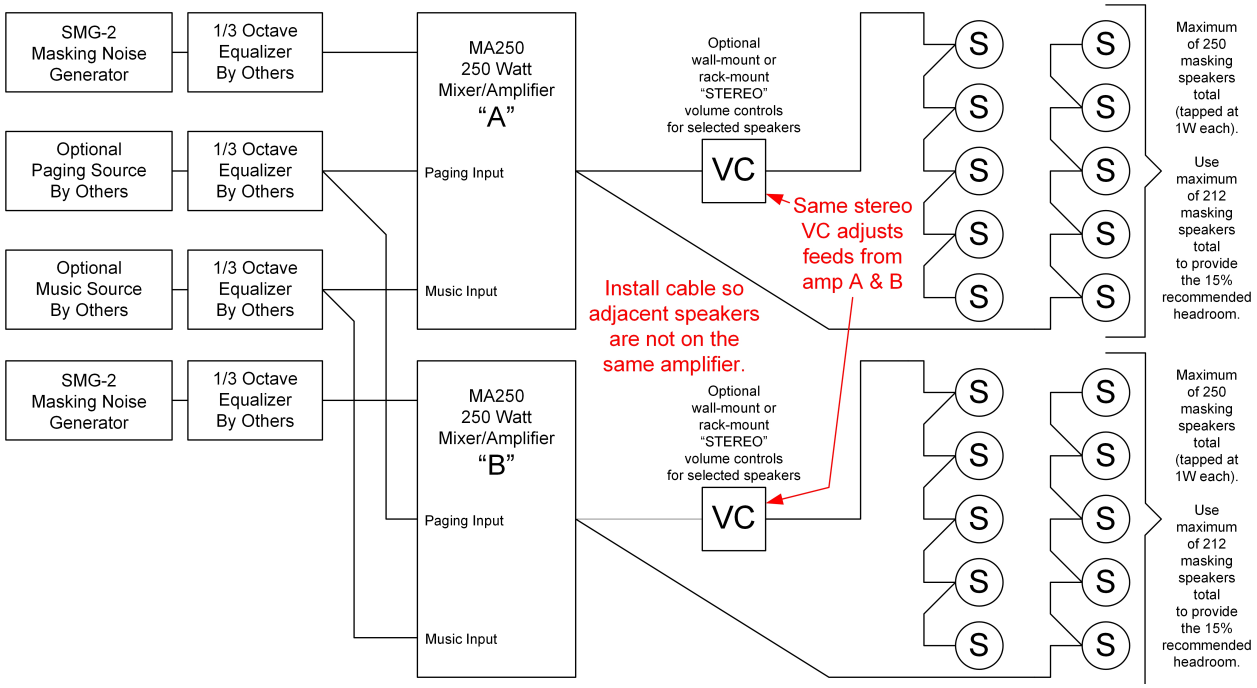
- **Large Sound Masking System (up to 125 speakers):** Application: This large sound masking system is suited for applications that require up to 125 sound masking speakers. *Note: It is always good design practice to allow 15% headroom in the amplifier in case some speakers need to be tapped higher than 1W to fill dead spots or in case speakers are added in the future. The MA125 amplifier inputs make it possible to feed paging or music through the sound masking speakers.*



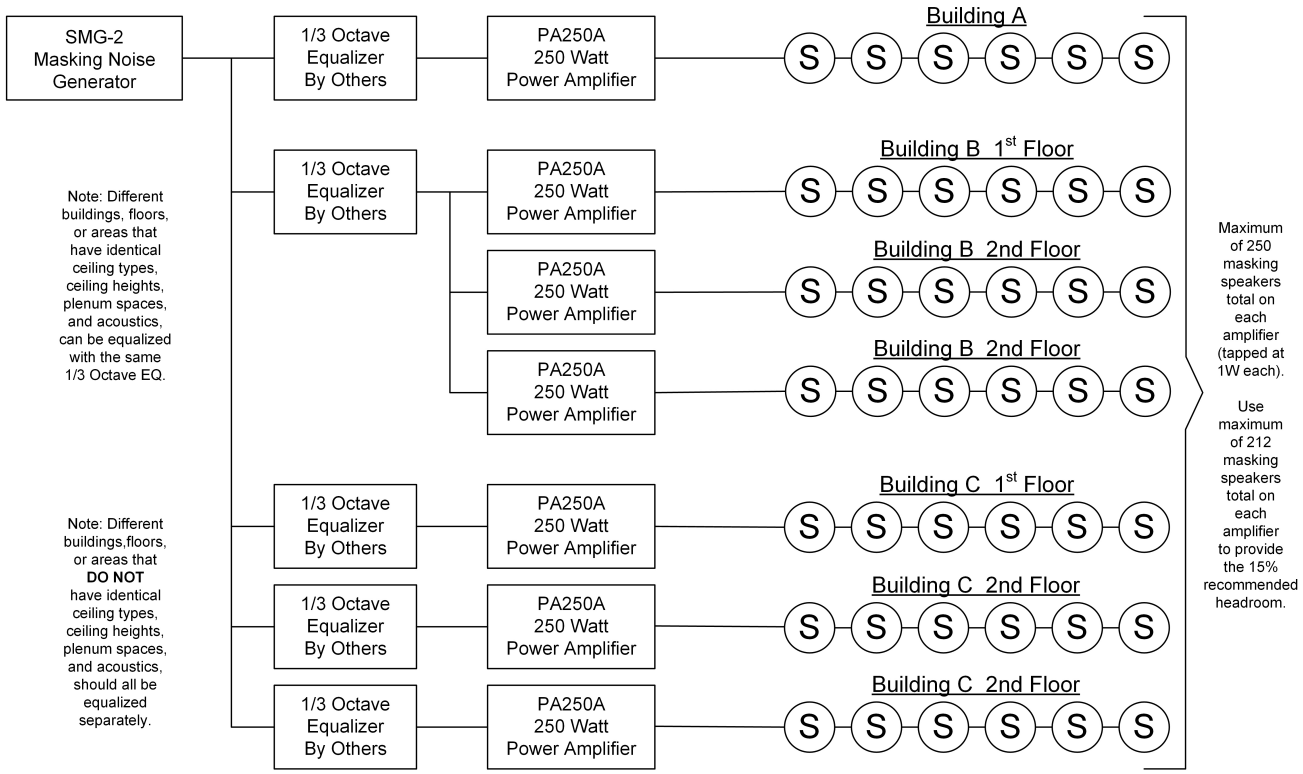
- **Very Large Sound Masking System (up to 250 speakers):** Application: This very large sound masking system is suited for applications that require up to 250 sound masking speakers. *Note: It is always good design practice to allow 15% headroom in the amplifier in case a few speakers need to be tapped higher than 1W to fill dead spots or in speaker are added in the future. The MA250 amplifier inputs make it possible to feed paging or music through the sound masking speakers.*



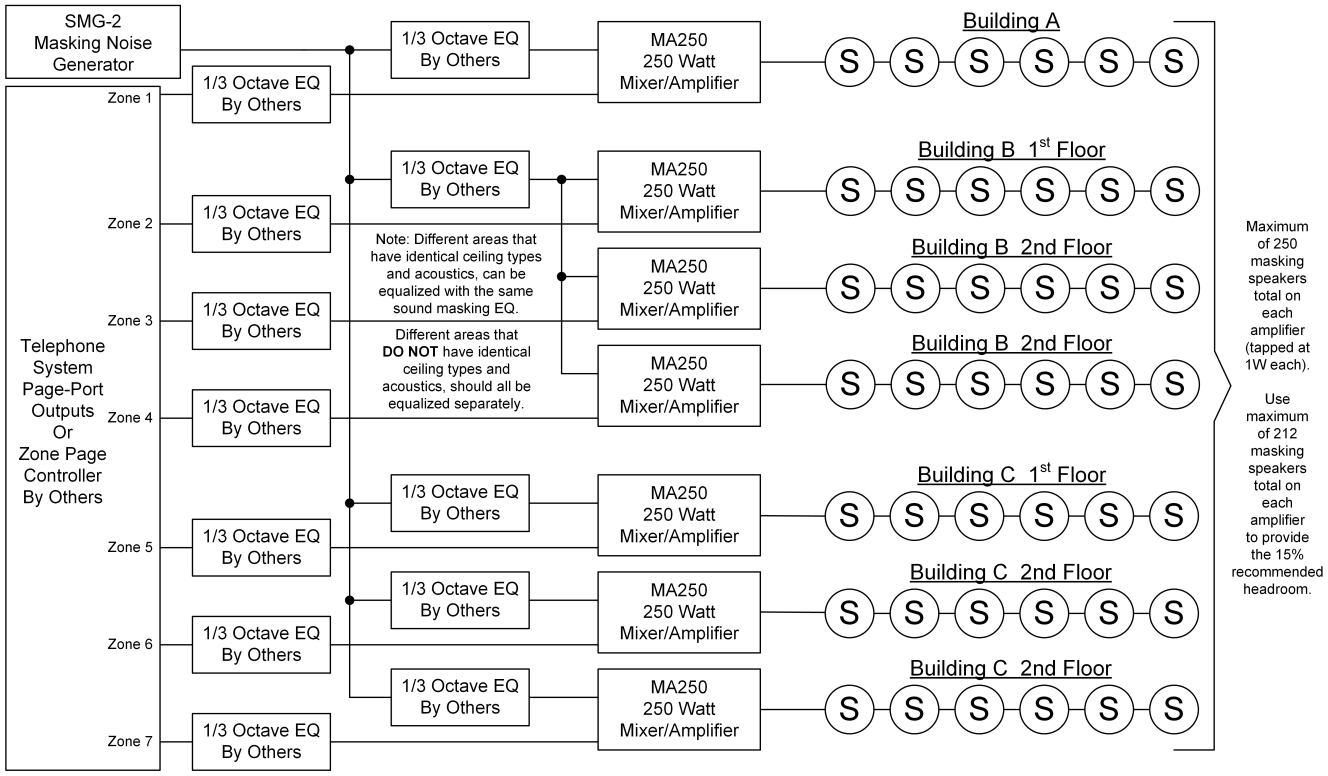
- **Very Large "Redundant" Sound Masking System (up to 500 speakers):** Application: This very large "Redundant" sound masking system is suited for applications that require up to 500 sound masking speakers. *Note: It is always good design practice to allow 15% headroom in the amplifier in case a few speakers need to be tapped higher than 1W to fill dead spots or in case speakers are added in the future.* The MA250 amplifier inputs make it possible to feed paging or music through the sound masking speakers. The "redundant" design includes two complete masking systems: Masking Generator A, Equalizer A, and Amplifier A, as well as Masking Generator B, Equalizer B, and Amplifier B. There are two main advantages to redundant systems. If one noise generator, EQ, or amplifier fails, the second system will keep running so the masking level (or paging and music level) will only be down by 3dB to 6dB.



- **Very Large Zoned Sound-Masking-Only System (unlimited speakers):** Application: This very large zoned sound masking system is suited for applications that require an unlimited number of sound masking speakers. The design shows separate amplifiers and equalizers for different floors or buildings. *Note: It is always good design practice to allow 15% headroom in the amplifier in case some speakers need to be tapped higher than 1W to fill dead spots or in case speakers are added in the future.*



- **Very Large Zoned Sound Masking System with Zoned Paging (unlimited speakers):** Application: This very large zoned sound masking system is suited for applications that require an unlimited number of sound masking speakers. The design shows separate amplifiers and equalizers for different floors or buildings. *Note: It is always good design practice to allow 15% headroom in the amplifier in case some speakers need to be tapped higher than 1W to fill dead spots or in case speakers are added in the future.* The amplifier inputs make it possible to feed zoned paging through the sound masking speakers. All zone paging control must be accomplished with equipment by others. Note that each page zone feed must be equalized separately to provide the pre-emphasis if high frequencies.

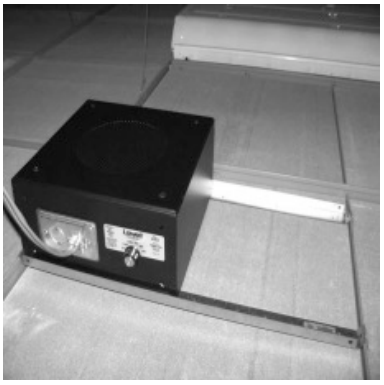


6. SYSTEM INSTALLATION

Wiring: Install the sound masking speaker wiring to meet the national electrical code (NEC) and all national and local building codes. Use plenum rated cable in return air plenum spaces.

Speaker Installation:

- **Grid Mounted Speakers:** Lowell grid-mounted sound masking speakers are easy to install and save labor. In many areas they can simply be placed on the lay-in tile grid with no additional support. But in some parts of the USA, local codes and ordinances will require that one or more earthquake restraint cables be attached from the building structure to each sound masking speaker or the speaker's rails need to be attached to the tile grid with sheet metal screws. Before installation, check with the Authority Having Jurisdiction (AHJ, inspector) for the requirements in your area.



- **Above Ceiling Hanging Masking Speakers:** Lowell hanging sound masking speakers are typically installed above the finished lay-in tile ceiling with the bottom of the speaker roughly 6" above the back of the ceiling tile and with the speaker aiming up as shown. The speakers are shipped with 2 hanger brackets already attached to the masking speakers for shooting up. Two (2) S-hooks and a 4' piece of chain are provided. Lowell hangers can be repositioned so the speaker can aim sideways or down (except Model SM805A which can only aim up).

The S-hook and chain suspend the speaker from one point. Note that the hardware to attach the top S-hook to the slab or building structure is to be furnished by the installer.

For a typical application the sound masking speaker transformer tap switch would be set at 1W. Setting the switch at the middle 1W tap allows the installer to later adjust the switch up 2 positions (6dB louder) or down 2 positions (6dB softer). This volume adjustment capability is important when balancing the system levels (as described in the section on Level Balancing).

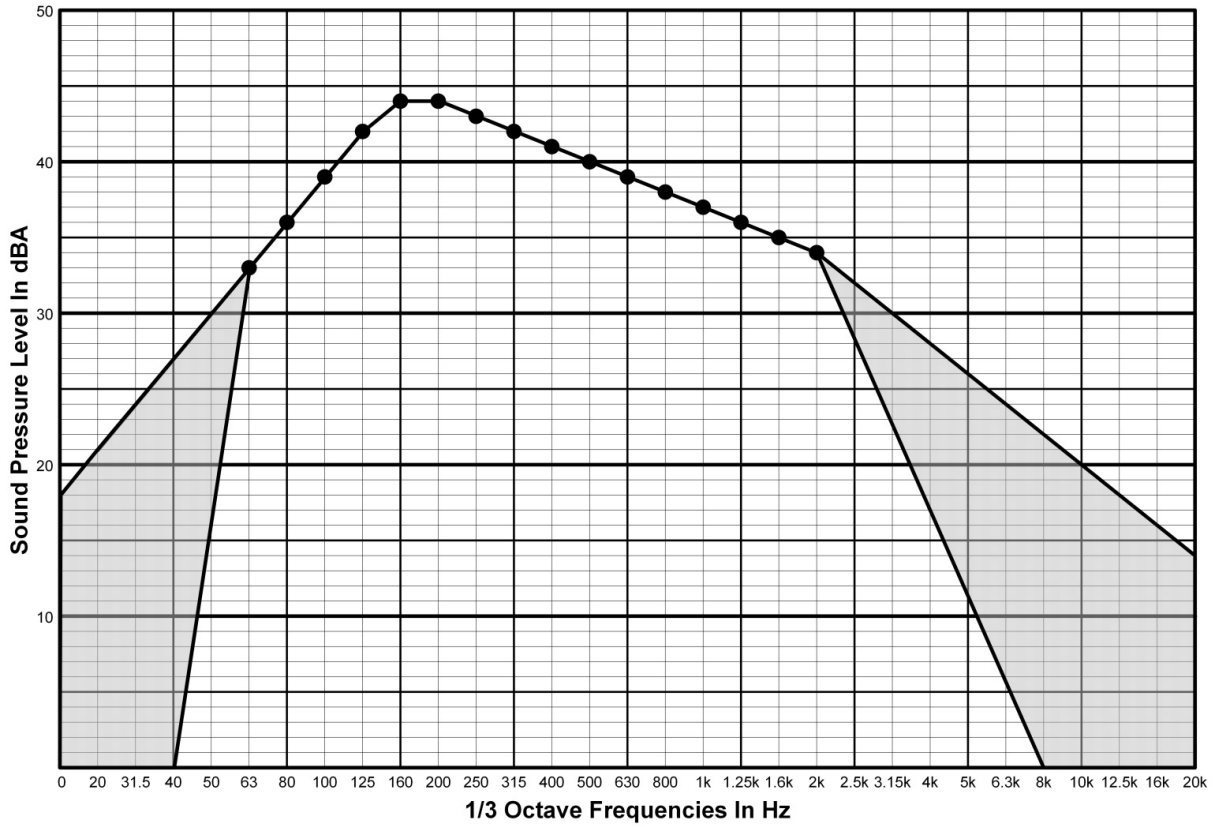
Installing the Head End Equipment: AC power will be required at the head-end location. See the specification sheets at www.lowellmfg.com for the Lowell electronic equipment used in your design for the AC power requirements. Follow all national and local electrical codes when connecting the sound masking electronic equipment to the building's AC power outlet.

As described earlier in this paper, It is always best to place the head-end equipment in a securely locked storage room or electrical closet. Lowell strongly recommends that the masking equipment be located in an equipment cabinet with a locking front door so that only management can access the equipment. Even with a locked equipment cabinet door, all tuning and adjustment controls like the sliders on the equalizer should be covered with security panels to make it difficult for any of the critical adjustments to be altered.

7. COMMISSIONING THE SYSTEM

- **Tuning a Sound Masking System for paging or music using a 1/3 octave equalizer:** Once the system speakers and head-end have been installed and are up and running, make a final check to make sure that all ceiling tiles have been installed and there are no open holes in the finished ceiling. To tune the equalizers for paging or music, place the real time analyzer (RTA) microphone at the listener's ear height in a typical office cubical. Feed pink noise through the sound masking system. Adjust the 1/3 octave graphic equalizer for flat pink noise response at the listening height just like you would for any sound system. If you stick your head above the finished ceiling, the paging or music will be very bright with too much high frequency. By tuning the equalizer with the ceiling tiles in place, you have compensated for the frequency response losses that occur as the paging or music filters down through the ceiling tile. That way it will sound natural at the listener's ear height.

- **Tuning a Sound Masking System using a 1/3 octave equalizer:** The curve below shows the real time analyzer (RTA) display for the ideal sound masking noise curve at the listener's position (this is called the NC40 curve).



Feed pink noise (un-equalized) from the masking noise generator through the system. The real time analyzer (RTA) microphone is placed in a typical cubical at 4' from the finished floor (the average listeners ear position). Turn the masking sound is turned up until the energy at 160Hz is roughly 44 dBA. Adjust the sensitivity of the RTA so the 160 Hz band is reading +4dB. Adjust the 63Hz-2kHz band sliders to achieve the ideal curve shown above.

Desired Results on the RTA Display (NC40 Curve): 63Hz = -7dB, 80Hz = -4dB, 100Hz = -1dB, 125Hz = +2dB, 160Hz = +4dB, 200Hz = +4dB, 250Hz = +3dB, 315Hz = +2dB, 400Hz = +1dB, 500Hz = 0dB, 630Hz = -1dB, 800Hz = -2dB, 1kHz = -3dB, 1.25kHz = -4dB, 1.6kHz = -5dB, 2kHz = -6dB

The masking noise above 2kHz and below 160Hz should be allowed to roll off smoothly and naturally. The acceptable levels above 2kHz and below 160Hz can be anywhere in the shaded area of the graph. The goal is to make the masking noise sound similar to air handling noise. Any adjustments made above 2kHz and below 160Hz should be made in an attempt to make the noise more soothing and more like air handling noise.

- **Level balancing:** Before balancing, check again to make sure that all ceiling tiles are in place and there are no temporary openings in the finished ceiling. Using a sound pressure level (SPL) meter on the A-weighted scale, walk throughout the office area and measure the SPL at the standard listening height (4' from the floor). If you detect areas with lower than average masking noise SPL, turn the transformer tap switches higher on the speakers above that area. If hot spots are detected that have higher than average masking noise SPL (especially in the areas near light fixtures or return air grilles), turn the transformer tap switches lower on the speakers above that area. When you can walk through the office area and the sound masking noise SPL is very uniform, you have completed the balancing step.

- **Final average SPL setting:** In general, the louder the electronic masking system is turned up, the more speech privacy is realized. Consider the trouble you have hearing what another person is saying when a loud shop vacuum is on or when a power saw or other loud machine is running. It can be almost impossible to hear what is being said. In the real world of an open partitioned office there is a limit to just how much speech privacy can be obtained. If the masking noise is turned up too loud, it ceases to sound like a loud air handler and starts to sound like a jet airplane. Complaints from the office staff are sure to follow. There is also a law of diminishing returns that applies to sound masking systems. If the masking noise is turned up past a reasonable level, office workers will start to talk louder and the speech privacy gains that resulted from the use of the masking system will be effectively lost.

  It is advisable to keep the introduction of the masking system a secret from the office workers. Many times if office workers don't know that the noise is artificially produced they will not complain about it and will eventually get used to it. For this reason, masking systems are often installed before building occupancy so that workers experience the system as part of their new environment. In existing spaces, masking systems are usually installed at night so that the office staff is not aware that the system is being installed. In this case, it's a good idea to turn the system on at a reduced level and bring it up to normal level over a period of several days as the office workers get used to the extra ambient sound. Most textbooks agree that the acceptable SPL range for sound masking noise in an otherwise quiet office area is 46dBA to 52dBA. Many contractors will mark that ideal level on the master volume control, and then reduce the level slightly as the employees get used to the system. Often the manager of the office will be willing to turn up the master control slightly every day until the master control reaches the ideal setting that was marked by the contractor.

8. SUMMARY

In this paper, we have reviewed some rule-of-thumb principals that are required for a commercial sound contractor to successfully design, install, tune and balance a basic sound masking system. This paper does not serve as a complete engineering textbook to cover the subject. Many excellent books are available that go much deeper into the subject of sound masking technology. A contractor can successfully design and install a basic sound masking system similar to those described here. Lowell Manufacturing recommends that a contractor retain the services of a qualified acoustical consultant if the sound masking system to be designed is more complex than the basic systems described in this paper.