THEATER SOUND SYSTEM BASICS
How to get excellent sound in your play or musical
by Bruce Bartlett (c) 2020

Quality microphones are only one factor in getting great sound in your productions. The rest of the equipment is important, too. Here's a step-by-step procedure on how to choose and set up the mics, mixer/amplifier, and speakers to make the actors' voices easy to understand.

A sound system to amplify actors has five main pieces of equipment:

- microphones
- a mixer
- a power amplifier
- loudspeakers
- cables

Microphones pick up the actors' voices. Floor mics sit on the stage floor near the front edge. Our floor-mic model is the **Stage Floor Mic-EC.**

Mic cables carry the signal from the mics to the mixer. The type of mic cables you need are called "2-conductor shielded mic cables" with a male XLR connector on one end and a female XLR connector on the other end. They typically come in 15 or 20 foot lengths, and you can connect several of them together to reach from the stage to your mixer.

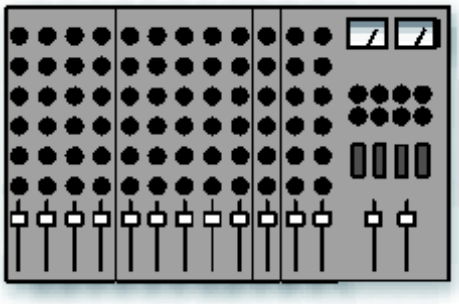

Mic cable

Rather than running several mic cables from the stage to the mixer, you might prefer to use a **Mic Snake** (next page). It's a metal box with several mic connectors in it, wired to a long, thick cable (maybe 50 or 100 feet long). At the end of the cable are several XLR connectors which plug into your

mixer. Using a snake is easier and neater than using many separate mic cables. You still may need some 20-foot mic cables to reach from the stage to the snake box.

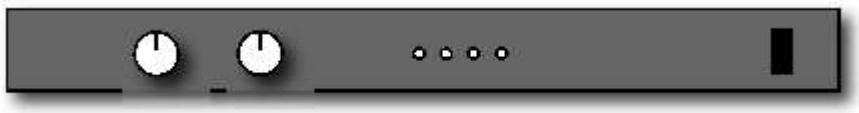
Mic snake

A **mixer** amplifies the mic signals and lets you control their volume and tone (bass, midrange and treble). It also mixes in music and sound effects from an mp3 player or computer. The mixer combines the signals of all the mics and your music player into one signal at the mixer output.

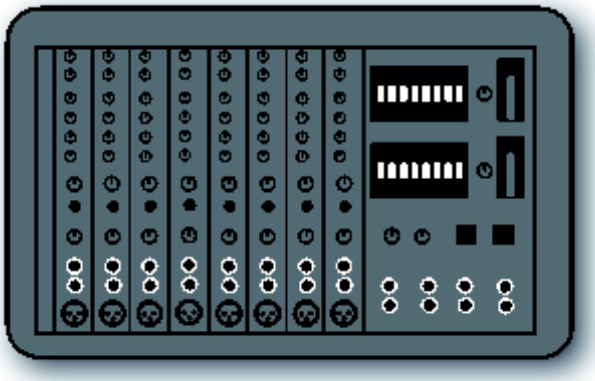


Mixer

A **power amplifier** makes the signal louder. It further amplifies the mixer signal up to a stronger level that can drive loudspeakers. Note: A **powered mixer** combines a mixer and power amp in a common chassis.



Power amplifier



Powered mixer

If your sound system has a separate mixer and power amplifier, you need a **cable between the mixer and power amplifier.** On one end of this cable is a connector that mates with your mixer output connector. The cable connector might be an XLR connector, phone plug or RCA plug. On the other end of the cable is a similar connector that mates with your power amplifier input connector. You won't need

this cable with a powered mixer.

Cable with phone plugs

Cable with XLR connectors

Cable with RCA plugs

Loudspeakers play the amplified actors' voices to the audience. A typical P.A. speaker has an 8" to 15" woofer cone and a horn-shaped tweeter, as shown below.

A typical portable PA loudspeaker

In some sound systems, the power amplifier is built into a loudspeaker. That's called a **powered speaker** or **active speaker**. Using an audio cable, you connect the mixer output to the powered speaker input.

The best type of speaker to use in a gymnasium might be a column speaker or line array speaker (shown below). It focuses sound on the audience rather than radiating it around the room. That prevents a muddy sound and makes speech easier to understand. Two of those on speaker stands can work well to provide clear sound, even in a gym.

The Bogen SCW35 is an example of a column speaker. It has six vertically-arrayed 6" speakers in a single cabinet.

A column speaker

Speaker cables go between the power amplifier and the speakers. Speaker cable comes in a few forms. The simplest is zip cord or lamp cord, which is the kind of wire connected to a lamp. It's two strands of wire coated in rubber or plastic. Another type of speaker cable has the two wires encased in a rubber or plastic cylinder.

Speaker cable made of zip cord or lamp cord

On either end of the speaker cable is a connector that mates with your amplifier on one end and your speakers on the other end. Typical connectors are 1/4" phone plugs, banana plugs, and Speakon™ connectors (below).

Speaker cable with phone plugs

Speaker cable with banana plugs

Speaker cable with Speakon™ connectors

Shown below are various connectors used on speaker cables:

Banana plug: 

Phone plug: 

Speakon™ connector on back of power amplifier:

Speakon™ connector on cable:

A **speaker stand** is a collapsible stand that mounts a loudspeaker 6 to 14 feet high off the floor. That way, the speakers don't blast the nearest listeners, and the sound clears the heads of the audience and isn't blocked by them. Some people omit the speaker stand. They hang the speakers on the side walls instead.

Speaker stand holding up a loudspeaker

Setup procedure

1. Choose a microphone. Our **Stage Floor Mic-EC** has a rugged steel housing and a 6-foot permanent cable for extra ruggedness.

Stage Floor Mic-EC

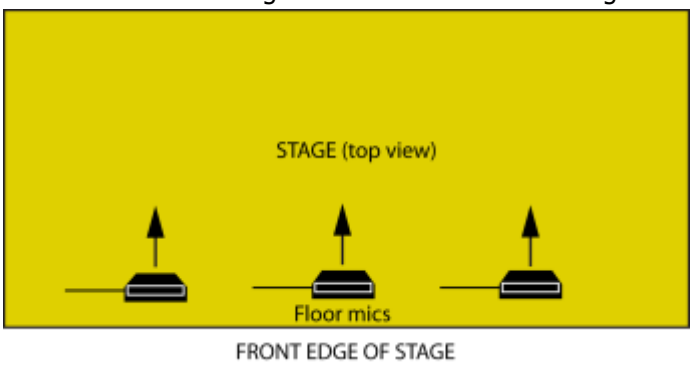
2. Decide how many stage-floor mics you need:

20 ft stage: 1 mic center stage.
24-30 ft stage: 2 mics 12 to 15 feet apart.
35-40 ft stage: 3 mics 15 feet apart.
45-50 ft stage: 3 mics 17 feet apart.

If you can have all the talking actors near center stage, you need only one floor microphone in the center

of the stage near the footlights.

3. Put the mics on stage with each mic cable exiting to the left, about 1 foot in from the stage edge.



Connect each microphone to a long mic cable -- long enough to reach from the stage to your mixer. Your school or church might already have mic cables. You can connect several cables end-to-end to make a long cable run. Or you can use a **mic snake**, which is a metal box with several mic connectors and a long, thick cable going to the mixer.

4. Plug the mic cables into a mixer that has **phantom power** (which is power that a mixer sends to a microphone on its mic cable.) If your mixer lacks phantom power, purchase a **phantom power supply** -- one per microphone. It is available online or in music stores for about $20 to $40. Plug each mic into a phantom power supply input. Using a mic cable, connect the output of each phantom power supply into your mixer mic inputs.

Two phantom power supplies

5. Figure out how long a speaker cable you will need. If the speaker is 50 feet from the mixer/amplifier, you need at least 50 feet of speaker cable. If you have two speakers, you need twice as much speaker cable.

6. Using those speaker cables, connect the power amplifier outputs to the loudspeakers, which are mounted on stands or hung on the wall.

System layout

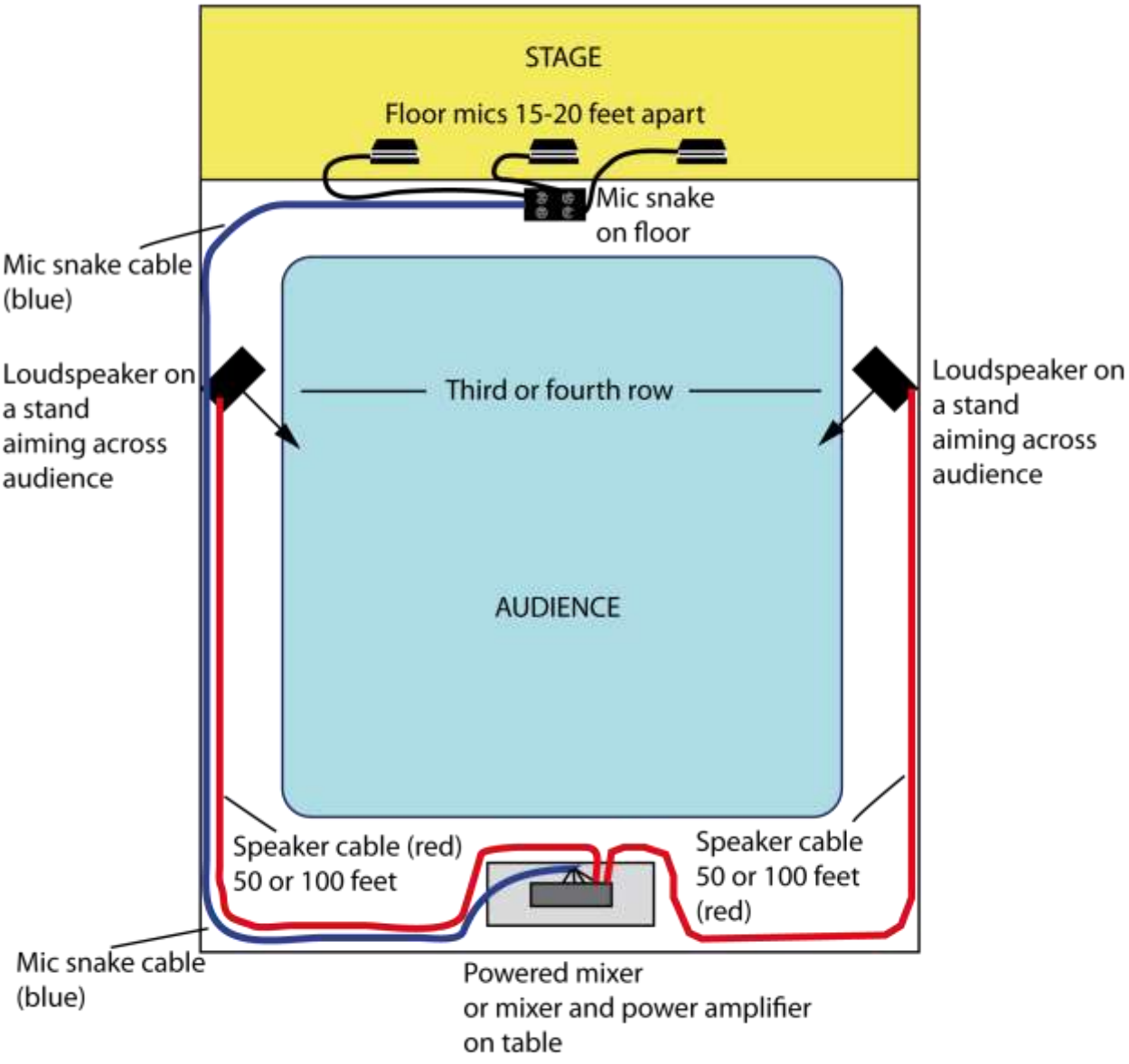
Show on the next two pages are two theater sound systems. In **System 1**, the powered mixer is behind the audience. The advantage is that the sound person can hear what the audience is hearing. In **System 2,** the powered mixer is near the stage. The advantage is that all the cables can be shorter. If you use System 2, have someone in the audience listen to make sure the sound is okay.

The speakers must be closer to the audience than to the mics. For example, if the speakers are 10 feet

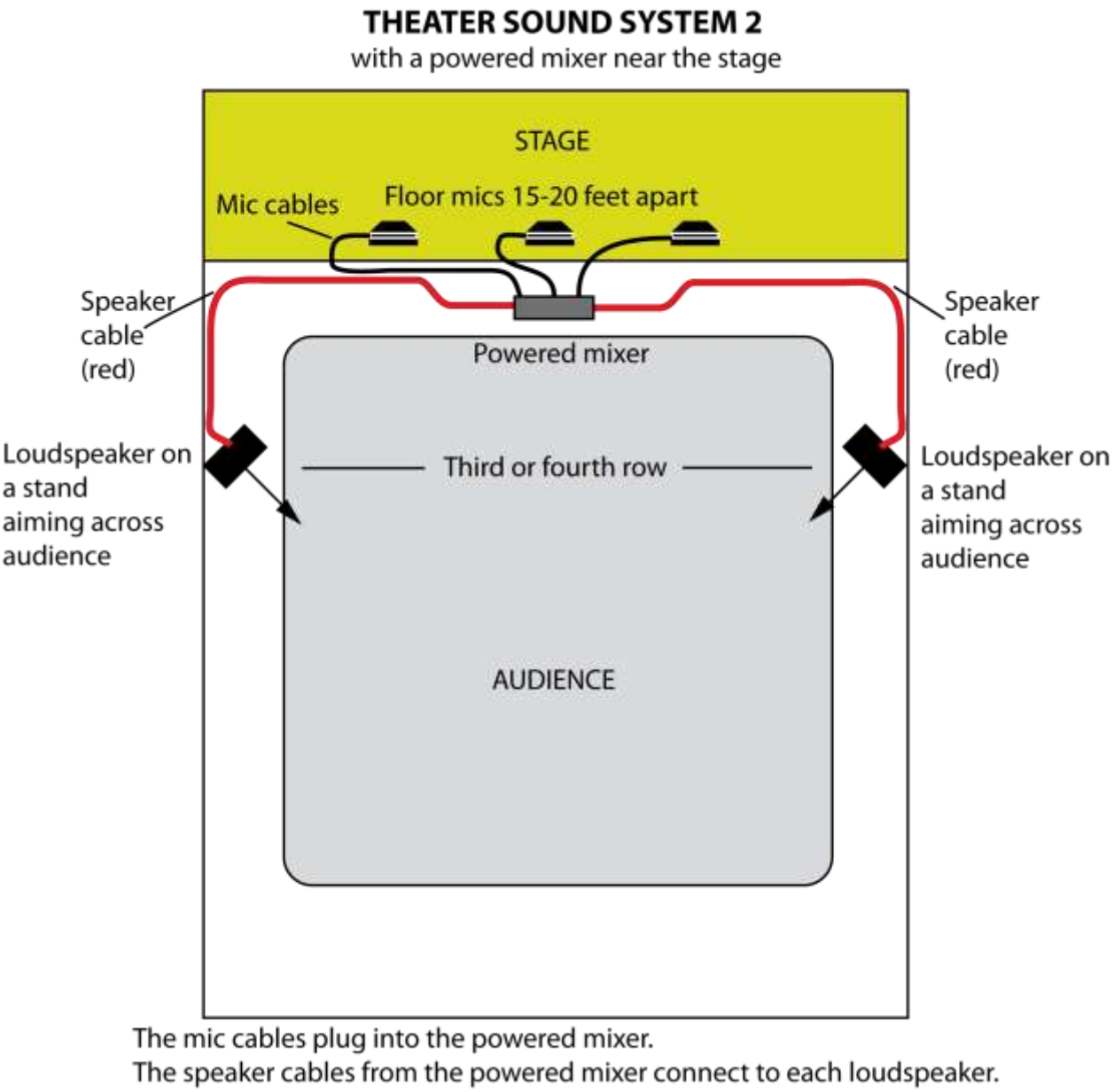
from the microphones, but 20 feet from the audience, the sound system will not work well -- you'll get a lot of feedback when you turn up the mics loud enough to hear them.

THEATER SOUND SYSTEM 1

with a powered mixer behind the audience



Connectors from mic snake plug into powered mixer.
Speaker cables from powered mixer connect to each loudspeaker.



Using the mixer

1. Start with all the equipment turned off. If you have a separate power amplifier and mixer, set the power amplifier's volume controls halfway up.

2. Using a strip of masking tape, labels the faders according to the mic or sound-effects player that each fader affects.

3. Turn down all the mixer faders (sliding volume controls).

4. On the mixer, set all the **EQ** or **equalization** knobs and **pan** knobs to "flat" (straight up, or 12 o'clock). Turn down all the **AUX** knobs (full counterclockwise).

5. Each mic channel in the mixer might have ASSIGN buttons. If so, assign all the mics to Group 1. Assign the Group 1 output to the main mix and turn up the Group 1 fader to "0" (about 3/4 up).

6. Turn on the mixer.

7. On the mixer, turn on phantom power if necessary. There should be a button on the mixer labeled "Phantom", "P48", or "48V". Then turn on the power amplifier.

8. On the mixer, turn up the master faders to "0" (about 3/4 up).

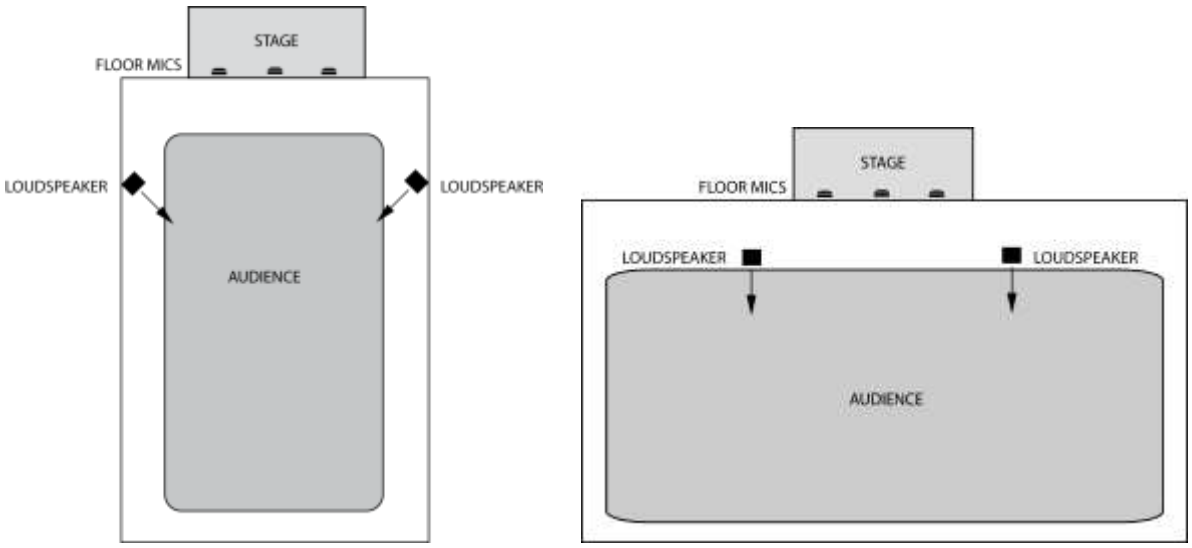
9. Have someone talk loudly on stage about 10 feet in front of a microphone. On the mixer, turn up the **GAIN** knob for that mic until that mic's **CLIP** or **OVERLOAD** light flashes, then turn down the knob just until the flashing light stays out. Repeat for each microphone. This procedure prevents noise and distortion.

10. Slowly turn up the fader for the microphone nearest the actor speaking. The sound over the P.A. system should get louder. If you turn up the volume enough, you'll hear feedback (a squealing tone). Turn down the fader to the point where feedback stops, and don't exceed that point during a show. Mark that point with a grease pencil. If the sound is too quiet in general, turn up the volume controls on the power amp, but watch out for feedback.

How to get louder, clearer sound with floor mics:

1. VERY IMPORTANT: Place the loudspeakers close to the audience and far from the microphones. Your existing speaker placement might work fine. But if you have trouble with feedback, I recommend that you buy, borrow or rent two portable PA speakers and speaker cables. You might want to use a separate powered mixer as well.

Start with just two speakers and place them near (or mounted on) the side walls, even with the third row from the front, as shown below left. That's an effective placement for reducing feedback. If the sound is too quiet at the back of the theater, add two more speakers farther back. The drawing on the right shows a suggested speaker placement in a wide auditorium.



Loudspeakers near the stage tend to cause feedback. Then why are many auditoriums designed with the loudspeakers installed there? Those sound systems were designed for close-miked performances, in which feedback is not a problem. However, distant miking with floor mics or hanging mics requires a different speaker placement to minimize feedback.

I'd recommend a 2-way loudspeaker that combines a 10" to 15" woofer and a horn tweeter. The tweeter ideally has a coverage angle close to 90 degrees horizontal and 40 degrees vertical, but other angles can work. A column speaker or line-array speaker works well too.

Loudspeaker examples: Electro-Voice ZX1, JBL PRX412M, Carvin PM10, Peavey PVx 12. **Speaker stand examples:** Pyle Pro PSTND2, On-Stage Stands SS7761B, Ultimate Support TS-80B.

2. Have a sound person turn the mic faders up or down on the mixer to follow the action on stage. Ideally only one mic is on at a time. The more mics that are turned up, the more feedback.

3. Place the mics as close to the actors as possible without getting in their way.

4. Ask the actors to talk loudly toward the audience. Tell them when you can't hear them. The microphones need something to pick up.

5. If your mixer allows, switch in a 100 Hz highpass filter (lowcut filter) on each mic channel. Use 200 Hz for children.

6. If you can't hear sibilance ("s" sounds) clearly, turn up the high-frequency EQ a little at 10 kHz, but watch out for feedback. Maybe turn up 5 kHz a little for clarity.

7. Do not use compression. It softens loud sounds, and you might need that extra volume.

8. Optional but very helpful: Use a 1/3-octave graphic equalizer between the mixing console and the power amplifier, or plugged into the mic channel's insert jacks. Turn down frequencies that feed back just to the point where ringing stops. Example: Nady GEQ 131**.**

9. If the stage is carpeted, put each mic on an 18-inch-square panel of masonite or other hard material, 1/8" thick or less. That prevents muffled sound.

10. Do not put each mic on a foam pad - that does not reduce footstep noise, and it reduces clarity of speech. Rubber-soled shoes and carpets reduce footstep noise.

Our FAQ page has lots of useful tips:
http://www.bartlettaudio.com/pages/faq-stage-floor-mics

If you want to know more about audio systems, equipment and techniques, check out our free audio articles at http://bartlettaudio.com/pages/learn-more-about-audio