



Live Sound 101

Goal: By end of class students should know how to hook up a basic PA system as well as understand the fundamental principles of live sound.

Schedule:

1st 25 Minutes: Definitions, equipment and what is needed.

2nd 20 minutes: DEMO TIME (set up a basic PA with students)



- **What is Live Sound?**

- Sound Reinforcement: the general term for a sound system designed to amplify the voice and /or music to improve its intelligibility to an audience.
- Live sound can be as simple as a two piece band playing at a coffee shop to an epic show at an amphitheater seating 20,000.
- There are several things that are required to make up a sound reinforcement system. There are also some basic words and principals you need to understand before we can plug things in.
- We will try to make the process of the boring learning as painless and quick as possible. But you know. No guarantees! The definitions for you to reference will be handed out as a separate packet.



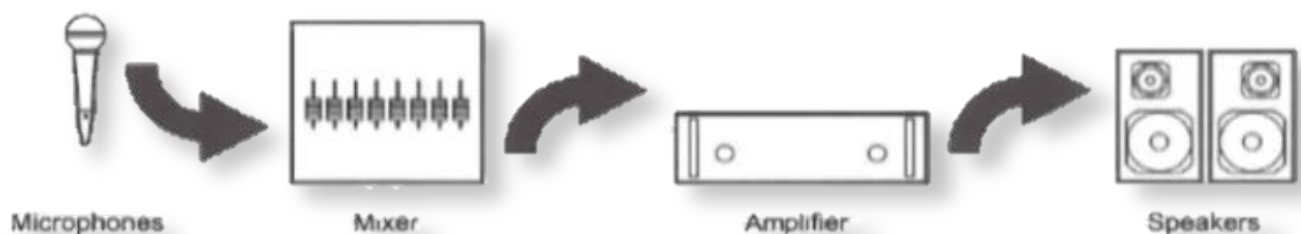


- **What do I need?**

- Well it kind of depends on your particular application, but more likely than not you need some sort of variation of a PA.

- **What the heck is a PA?**

- A Public Address or sound system.
- A PA consists of electronic devices that allow one to project a message, music or artistically enhance sound to the public by using these main components.
 - A sound source
 - Amplifier
 - Mixer
 - Speakers
- Every component that makes up a PA can change the way the system overall sounds.
 - Using microphones that were designed for the purpose you are using them for.
 - Using boards with built in tools to help you make your show sound better (effects, equalizers, compressors)
 - Using high quality speakers and amplifiers to reproduce the sounds the band is making as best possible.
- Who Uses a PA?
 - Everyone that needs to be heard. DJ's use a form of a PA, rock bands need a PA, politicians need a PA, sports announcers need a PA. EVERYONE NEEDS A PA. Including you.





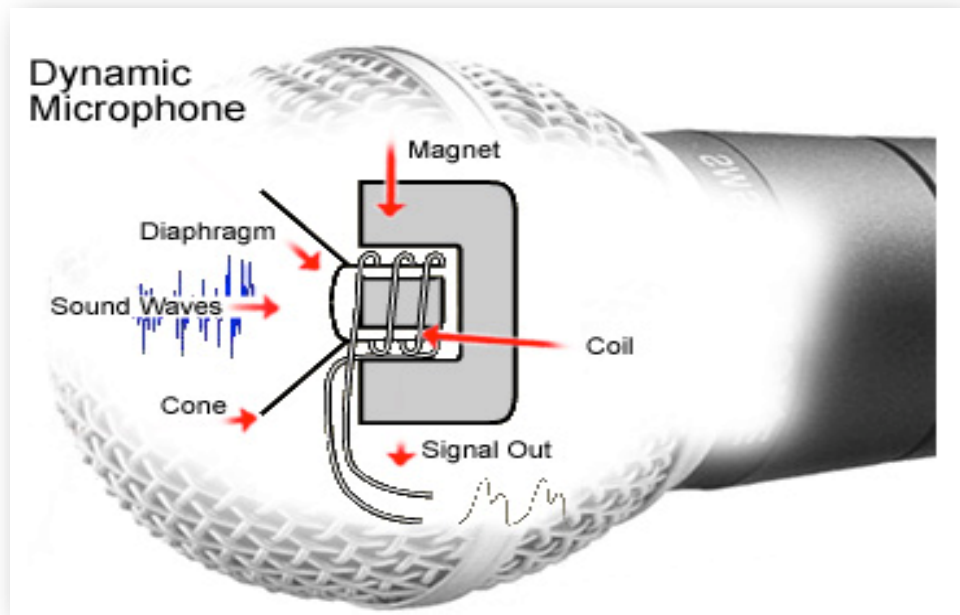
- The size of your PA really depends on what you need from it.
 - If you are a solo singer songwriter you could probably get away with a fairly basic setup. Maybe a single microphone, a compact analog mixer and a powered speaker.



- If you are a platinum record artist on an arena tour you might need several line arrays, 2 or 3 digital mixing consoles, several thousands of dollars in amplifiers and a full staff of people to run all of that equipment.
- **What makes up a PA?**
 - **Microphones**
 - An electroacoustic device that delivers an electrical signal when actuated by a sound. A microphone consists of an acoustic system that supplies mechanical (acoustic) energy to a transducer, which converts the energy into electrical energy.
 - More or less what is happening is acoustic sound waves come into the microphone, push the diaphragm of the microphone back and forth and it converts that acoustic energy into electrical energy.



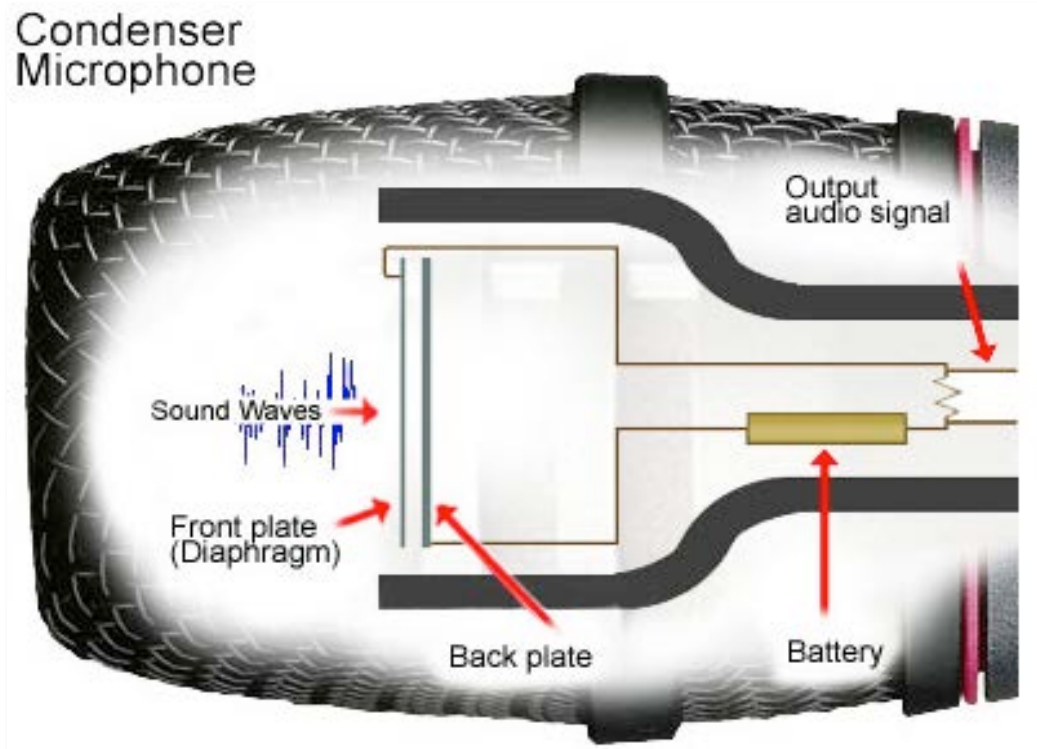
- We could spend an entire day talking about different microphones and reasons they are different, due to the nature of this class we will just quickly cover the different types.
 - **Dynamic Microphone**
 - Consists of a diaphragm with a coil of wire attached to it such that sound pressure moving the diaphragm causes the coil to move in a magnetic field supplied by the permanent magnet. Motion of the coil causes an electric current to be induced in it, and this is the signal output of the microphone. It is similar to a dynamic loudspeaker operating in reverse.
 - Great for close proximity applications. The mass of the diaphragm and voice coil are fairly large. The energy in an acoustic signal takes time for the diaphragm to respond to a signal. As a result, we have a rugged and less-transparent sound which are great characteristics for lead vocals, amplified instruments. You might throw a dynamic microphone in front of your GVT guitar amp, or you could set up your dynamic microphone in your kick drum.



- **Condenser Microphone**

- One of the earliest types of microphone to be invented.
- Very simple mechanical system with almost no moving parts compared to other microphone types. It is simply a thin stretched diaphragm held very close to a metal disc called a back plate. This arrangement is an electrical capacitor, and it is given an electric charge by an external voltage source or a permanently charged electret material. When sound acts on the diaphragm, the pressure variations cause it to move slightly in response to the sound waveform. This causes the capacitance to vary in like manner and because the charge is fixed, the voltage on the back plate will vary according to the laws governing the capacitor. This voltage variation is the signal output of the microphone. The condenser microphone has extremely high output impedance and must be placed very near a Preamplifier to avoid loss of the signal.

Condenser
Microphone





- Because of the voltage needed on the back plate for the microphone to work the microphone requires what is called phantom power.
- Phantom power is simply 48V supplied to the microphone from the mixer with a switch. It is called phantom power because it GENERALLY has no effect on microphones that do not need it.
- There are as many different models and types of microphones as there are genres of music.
- You have microphones built for one purpose and microphones built to be as versatile as possible. I would say due to budget restraints most beginning and small sound systems are probably going to have a lot more of the versatile mics as opposed to the specialty mics.
- **Cables**
 - To get that electric signal from the microphone to the mixer and then to our speakers we need some cables!
 - Cables come in a variety of forms ranging from pro quality shielded and balanced cable, to consumer level RCA cables.
 - We'll try to touch on the most common ones in this class.



- **XLR (Microphone Cable, professional balanced audio cable)**



- In its three-conductor form (XLR-3) a common audio connector, widely used in balanced professional audio applications.
- Pin 1 in the XLR plug is always connected to the shield. The reason is that the connectors are so designed that pin 1 makes contact first ensuring that the ground connection is made before the signal connection. This greatly reduces the transient thumps and pops that can occur when a circuit is patched with the power turned on. IEC standards now specify that pin 2 is wired to the “high” or plus (+) of a balanced pair, and pin 3 to the “low” or minus (-) wire.
- XLR cables are most commonly used for transporting signal between microphones and mixers, and between mixers and speakers. Being that the cables are balanced they prevent things like radio frequencies from interfering with the signals.



▪ **TRS (Tip Ring Sleeve, professional balanced audio cable)**

- A type of phone plug found on patch cords used for balanced audio signals. It makes three separate contacts. On the balanced line, the tip is the “hot” or “signal +” the ring is the “low” or “signal -” side. The sleeve is connected to the shield of the cord; the tip and



ring are connected to the twisted pair of wires enclosed within the shield.

- Abbreviation for Tip, Ring, and Sleeve, this is referring to the three different conductors on the cable. When a TRS is on the end of a mono cable it is a balanced professional quality cable with a sleeve attached to the shield within the cord.
- TRS type connectors are also seen on stereo Y cables and headphone cables with tip and ring going to right and left sides of the headphones and the sleeve acting as the “low” or “signal –“.
- Because XLR and TRS cables both have the same amount of conductors one can be used on each side. For example, if you have XLR outputs on your mixer but your speaker only takes ¼” connectors you could use an XLR-TRS cable. \



▪ **TS (Tip Sleeve, unbalanced cable)**

- Abbreviation for Tip Sleeve, this is referring to the two different conductors, these are unbalanced cables often used between instruments and amplifiers.
- If used for long lengths they can begin to pick up radio frequencies and noise pollution.



- Cables going between power amps and passive speakers usually use a TS connector, but the cable itself is usually a smaller gauge (meaning basically the cable itself is larger in diameter.)



▪ **Speakon Cable**

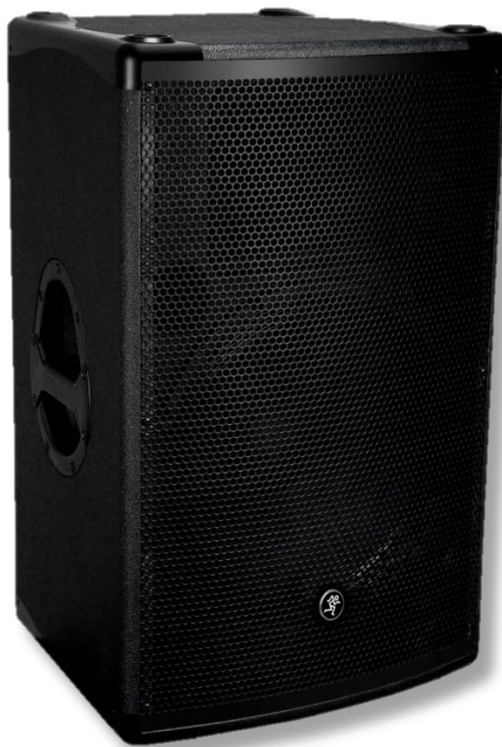
- A trademark for a high-power audio connector from the Neutrik company used for loudspeakers. The previous lack of a good solution has led to wide industry acceptance.
- Speakons can have several contact options, allowing for easy biamping for example and have a locking collar.
- They are used for connecting amplifiers to speakers similar to the TS speaker cable mentioned above, but have the additional security of locking into a speaker.



- **Consumer Audio cables (RCA, 1/8" Stereo cable)**
 - These are generally used between consumer audio products.
 - RCA are the most common type of audio connector, connector designed by RCA many years ago. The same jack is used for most consumer composite video and S/PDIF connections.
 - They have the advantage of small size, however lack in the durability department.
 - With time the outer ground connection can lose its springiness and thereafter make poor contact resulting in a ground loop.
 - These are unbalanced cables, having just a 2 connectors.
 - You will find RCA cables often used between most DJ equipment.
 - 1/8" stereo cable is also an unbalanced cable. Just like some variations of the TRS cable above it's used in a Y style by sending one signal to the left side and one signal to the right side. This is most commonly the output of iPhones and iPods and consumer products with a headphone jack.
 - Another common cable in live sound is 1/8" stereo cable to RCA, live sound consoles like our 402VLZ4 have RCA jacks, making it possible for you to have your iPhone play through the mixer.
- **Speakers!**
 - Well, we have our way of picking up sound (microphone, and our way of getting it around (Cables). We need some way to be heard now though!



- A Loudspeaker is the Transducer that converts electrical energy into acoustic energy. The first such transducers were earphones and the first such unit to make enough sound to be heard in a room was naturally enough, called the loudspeaker.
- The most common type of loudspeaker in use today is called the dynamic loudspeaker. The dynamic loudspeaker is a moving-coil device. The motion of the cone is caused by the force created by an audio signal current in the coil, which reacts with a stationary magnetic field provided by a permanent magnet.
- Different Types of loudspeakers
 - There are many different types and brands of speakers. We'll stay pretty basic for this class.



- **Passive loudspeaker**
 - A device is called passive if it contains no amplification circuitry and a signal suffers a loss in power or level in passing through it.



- Passive speakers require amplification to be heard or to even push the speaker.
- Back in the day, passive speakers were the only option, however it is becoming more and more common to use powered speakers as they are significantly more convenient.



- **Active loudspeakers**

- A device that requires a power source, such as from the AC line or a battery. Generally contains amplifying components such as transistors.
- In an active loudspeaker the amplifier is built INTO the speaker box, this allows the user to not have to carry a speaker and an amplifier when using the equipment.
- As amplifiers have become more efficient and powered speakers have begun to sound more professional, powered loudspeakers are becoming more common at bigger events.
- When they first started out the SRM450 was the most commonly seen powered loudspeaker, now they go as big as EAW's ANYA system a powered line array setup.



- **Amplifiers**

- A device for increasing the amplitude of the voltage, current, impedance or power of a signal. An amplifier is an Active device and strictly speaking should always increase the power of a signal (some amplifiers such as certain distribution amplifiers may only reduce the impedance level of the signal for the purpose of driving long lines.)
- The amount of amplification that an amplifier provides is called its gain, the gain is a ratio of its input signal level to its output signal level and is simply a multiplier or a pure number.
- Amplifiers take our line level signal from our mixing consoles and amplify the signal to power our passive speakers.
- Amplifiers are also present in our mixing boards. They are pre-amplifiers that bring microphone level signals up to line levels. We'll get more into that when we talk about mixing boards.
- There are some mixers like the Mackie PPM mixers that have power amps built into the outputs and make things a little more hassle free.

- **A Note on Signal Strength**

- Each source will have different signal strength. The output of a microphone or instrument will be very quiet in comparison to line level signals.
- We use pre-amplifiers to get microphone and instrument level signals up to line level signals. The amount of gain you will need is dependent on your source.
- We use power amps to bring our line level signal up to a level that can push a passive speaker.



○ Mixer

- Alright, saving the best and most complicated for last. The mixer, is the heart of any live sound setup, it's how you maintain control of all of your different inputs and outputs, and let's be honest...it looks pretty cool too.



- There's a lot going here, but I promise it's easier than you think.
- Let's take a look at each section and figure out what each section does.
- Then we'll figure out how to hook everything up, and how signal flow really works.
- Then we'll do it as a class and in no time all of you will be able to set up a PA like a PRO!



- This is our input section. This is where we actually plug our microphones and instruments into the board.



- This is where we set the initial Pre-Amplification for the instrument or microphone with our **Gain Trim Knob**, like we had talked about in the amplifier section.
- This section also includes a **LOW-CUT switch**. What this switch does is cut all of the frequencies below 75Hz; this is good for things that don't really contain many of those frequencies, like a female vocalist or a ukulele. We wouldn't want to push this button down for something like a kick drum or a bass guitar.



- This next section is our **AUX SEND** section. This is where we can control sending things out of the board. These are found on every channel of the board.



- This allows us to send our channels out of the board, there are 2 separate busses for us to send our signals.
- On an individual channel when you turn up the **AUX 1** knob for example, it will start to come out of **THIS** output.



- What this allows us to do is route individual and specific channels special places. For example, let's say we have a lead singer of a band and he has a powered stage monitor being fed from aux send 1. This vocalist is rather picky; he wants to **ONLY** hear his voice out of his monitor. So what we



would do is go over to the vocalist's microphone channel and turn up that channel's Aux 1 send.

- Aux sends can be also used for sending to recording devices, effects and really anything that takes audio input!
- The next section we're going to look at in the mixer is the **EQ** section
- This section lets you fine tune and change the overall sound of the input of that particular channel.



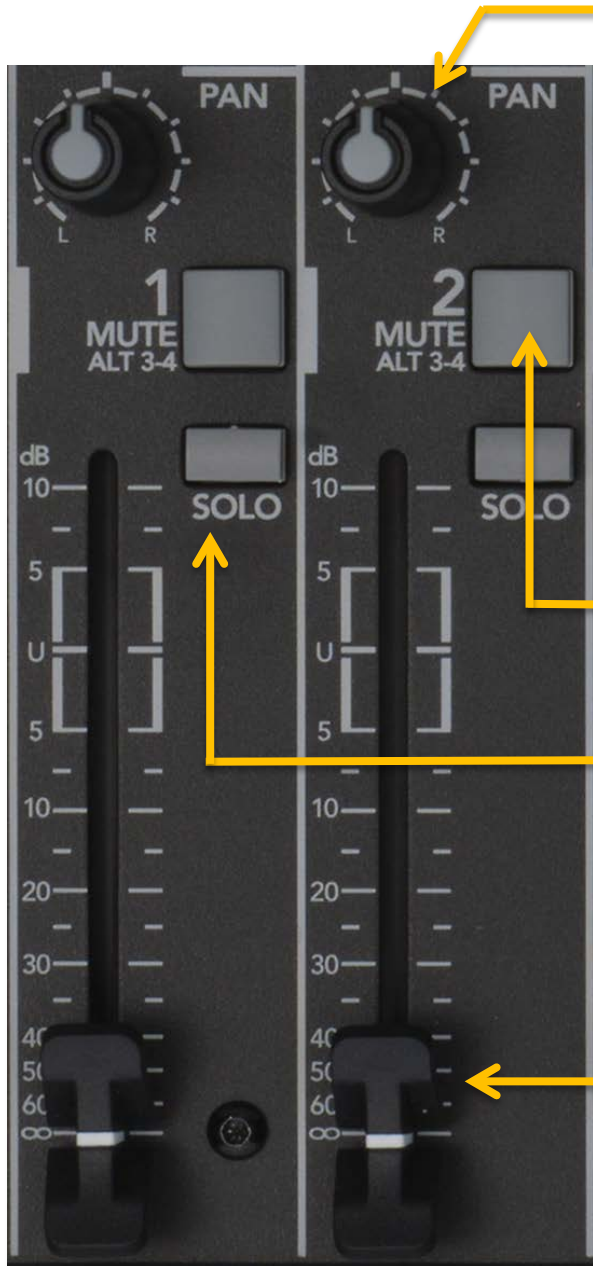
- Let's say for example, your picky vocalist from earlier has some weird kind of boomy-ness/boxy-ness coming out of his voice, he's hitting too many lows and it doesn't sound pretty. What we could do is start to slowly turn down the **80Hz** knob on his channel until things start sounding cleaner.
- Every channel will have a chunk of these EQ's for you to play around with, not every channel will need to have something changed but they can truly help make everything fit together a little bit, and a properly used EQ can be a fantastic tool.



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- This next chunk of the channel is the last step before going to our Main L/R outputs.



The **PAN** knob controls where the mono channel will appear in the stereo image of the main L/R Bus.

So let's say you are running a stereo setup with this mixer, you have a speaker on the left output set up on the left side of the crowd and vice versa. If you were turn the **PAN** knob all the way to the L it would only be heard on the left side, if you turned it to the R it would only be on the right, and if left dead center the channel will remain the same exact volume in both sides.

The **Mute Switch** on this section of the board kills the channel from coming out of the Main LR bus.

The **SOLO** on this board allows you to listen to individual channels, separately from your main mix. This is the best way to go about setting initial gain level for each channel. The solo on this board can be switched between either Pre-Fader or Post Fader in the master section of the board.

Finally the channel **FADER** allows you to control the overall volume of that individual channel and how much of that channel is coming into the main mix. This is what you use to adjust the volume of a channel after you have

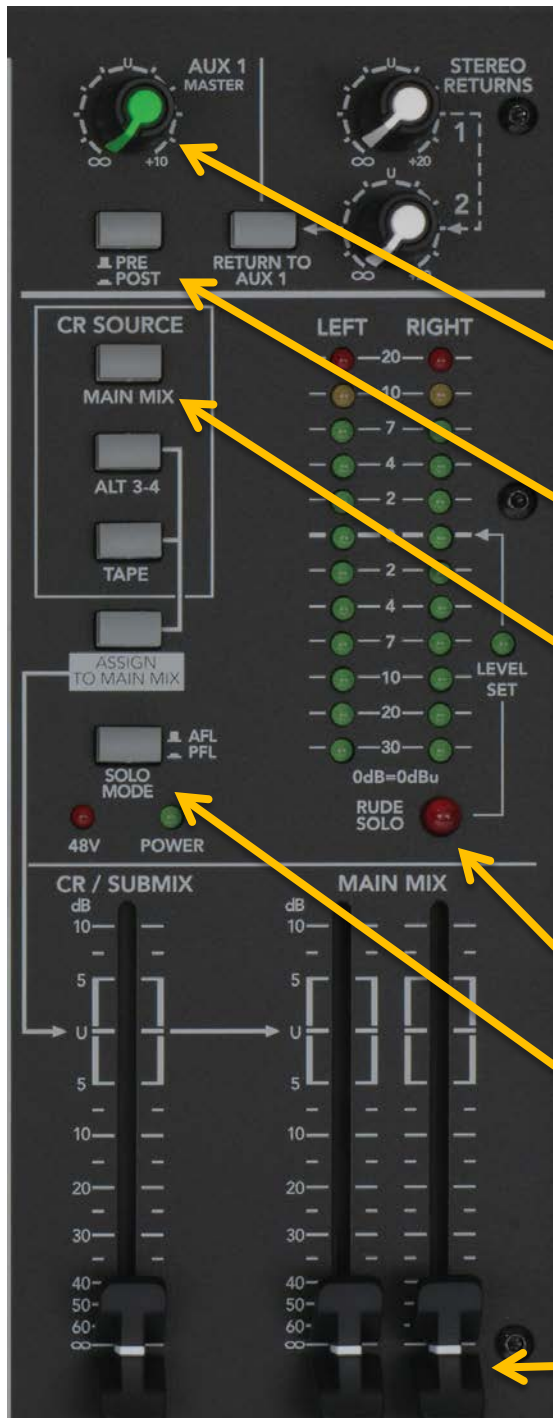
set initial pre-amp gain. Each of your channels will have faders, including your main mix.



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- The next section we're going to look at is the master section. This is where we make our overall volume changes and board settings.



The **STEREO RETURNS** knob controls how much of the stereo return input you are sending to the main mix. For example, if we had our second AUX send feeding an effect we could have the effect coming back into the mix with our stereo return. We could also just use the stereo returns for bringing in more audio sources like CD players etc.

The **AUX 1 MASTER** controls the overall volume of the Aux 1 mix. The other Aux bus volumes are determined by individual channel sends.

The **Pre-Post** AUX 1 switch controls if the channels you are sending out of the Aux are being sent before the EQ or after the EQ.

The **CR SOURCE** allows you to pick what is showing up in your **meters** and what is coming out of the CR outputs.

The **CR/SUBMIX** allows you to control the volume of **ALT-3-4** or **TAPE** which you can assign to come out of your **MAIN MIX**

The **RUDE SOLO** light is a kind way to let you know you still have something selected on **SOLO**.

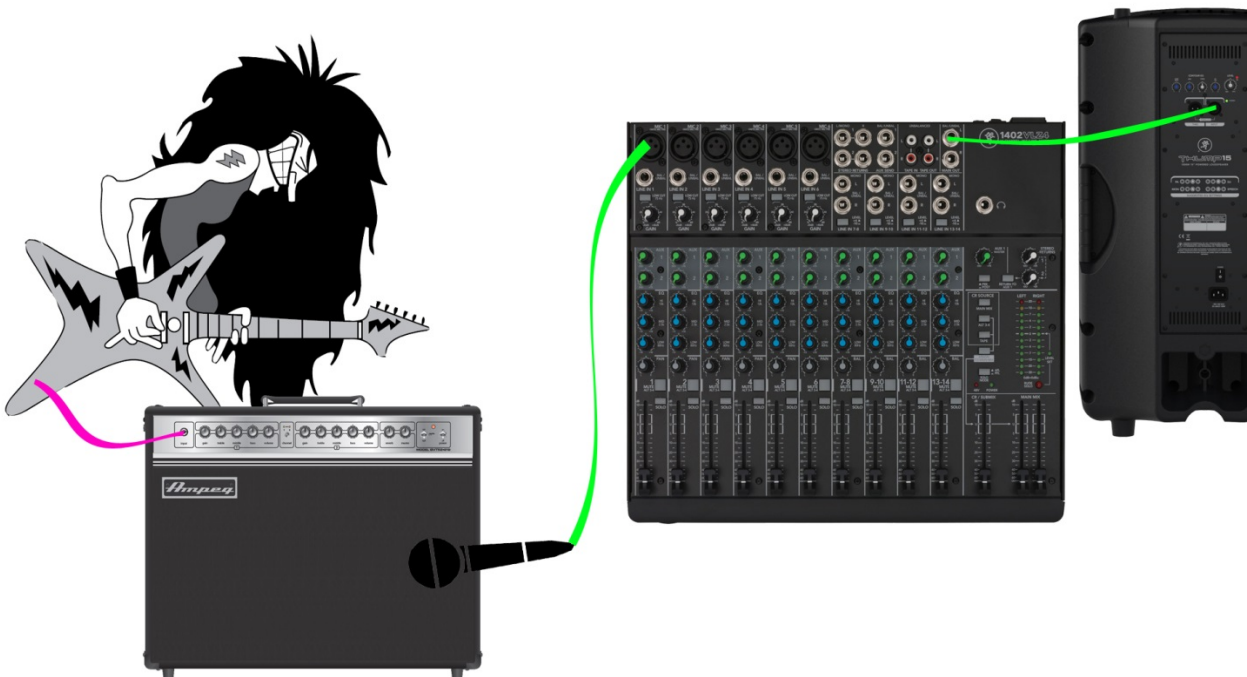
The **SOLO MODE** allows you to change if the solo is Pre-Fader or Post-Fader. If we are setting the initial gain stage it's a good idea to have this set in PFL (Pre-Fader Level)

The **MAIN MIX FADERS** control the overall level of your main mix



▪ SIGNAL FLOW

- What we need to understand now is how audio actually goes in and out all of these different things to make up the sound reinforcement we need in a live sound setup.
- Signal flow is more or less the path our audio signal makes throughout our system.
- Understanding how to trace where your signal is going throughout your system makes it so you can solve almost any problem that comes up by being able to trace where the signal is broken.



- Solo Guitar Player
 - Our guitar player is SHREDDING into his ampeg guitar amp, he uses a 1/4" TS guitar cable to get from his guitar to the amp.
 - We have a nameless generic microphone off axis picking up his sweet riffs, we are using an XLR to connect the mic to our mixer. We use the gain trim to bring the microphone signal up, we use the EQ to make the guitar sound even better, we use the fader to send the channel to our MAIN MIX. We take a 1/4" to XLR cable and plug that into our THUMP which plays the music for everyone to hear.



DEMO TIME!

- What better way to FULLY understand how all this works than actually plugging everything in and making it work!
- We're going to need:
 - 1 Microphone
 - 2 XLR Cables
 - 1 1402VLZ4 Mixer
 - 1 THUMP 15
 - 1 1/8" stereo to TS cable.
 - (The Pictures below are included to show anyone the process that could not make it to the class. We used a 1402VLZ3 and a DLM speaker instead of the list of supplies above. The process stays the same regardless.)





- The first step is to plug in all your hardware.
- Plug your power cables into outlets. Try keeping anything that makes sound on the same circuit to avoid accidental noise. Don't power on your gear yet.
- Take an XLR from your microphone and plug it into your channel one on your 1402VLZ4 mixer.





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- Take an XLR from your Main Output and plug it into your THUMP'S input. (For our pictures we used a TRS cable)
- Make sure your 1402VLZ4 Mixer has its MAIN MIX FADERS all the way down.
- Turn up your THUMPS volume to the Line Level mark.
- Now you can power on your mixer THEN you can power on your THUMP.
- Amplifiers are always last on, first off.



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- Make Sure that the 1402's SOLO MODE is set to PFL.



- Hit the SOLO on channel 1





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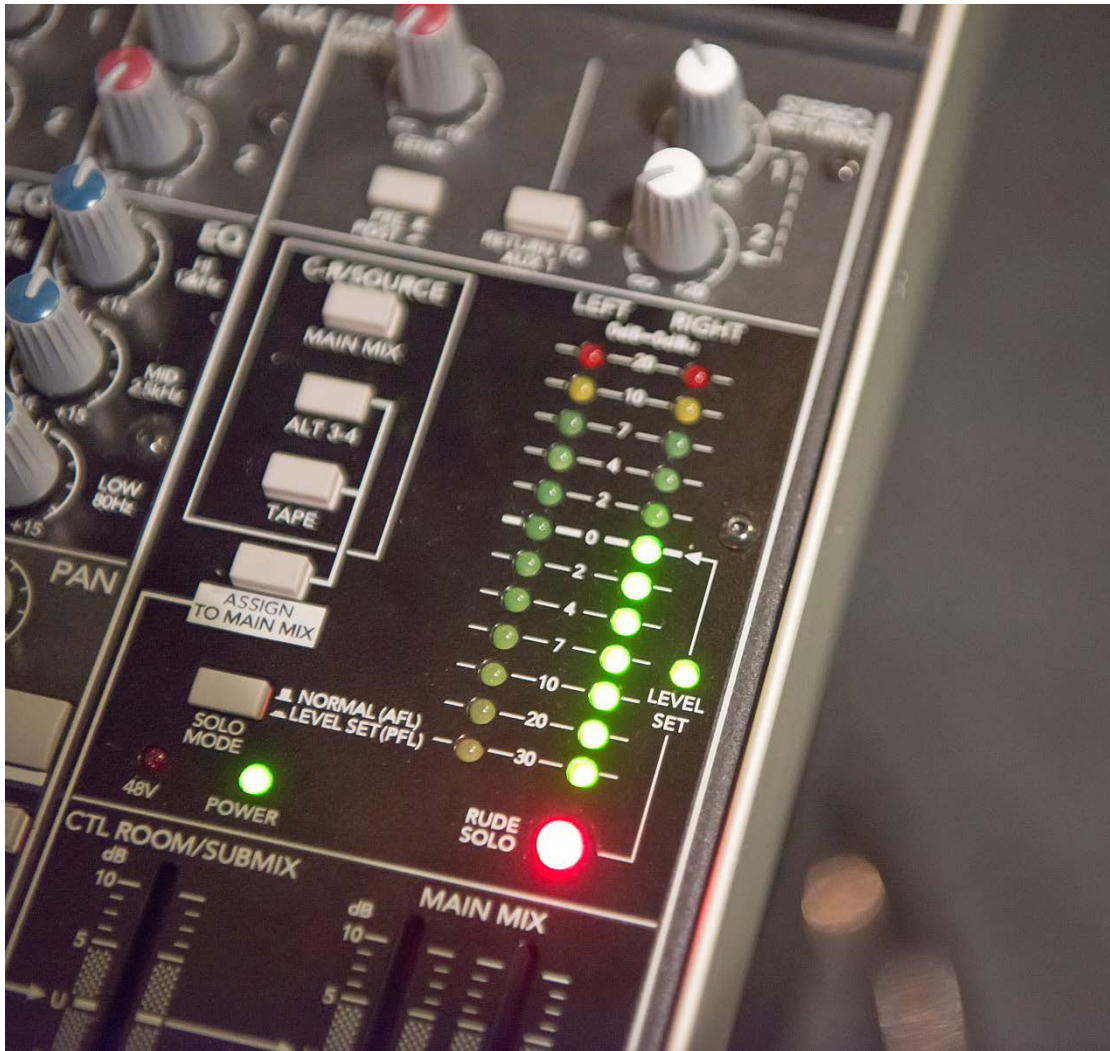


- Talk into the microphone while turning up the Gain Trim.



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- Watch the meters on the right side of the board. We want the microphone to be bouncing around the 0 mark. This means you have brought the microphone level signal up to a line level signal.
- After you've done that take the microphone out of Solo mode.

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- Turn up channel 1's fader.



- While talking into the microphone turn up the MAIN MIX until your THUMP starts to make sound.



- You have just set up your first PA! Yay!



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