C M Y

DESIGNS AND IDEAS, INC.

R G B

See the Future…

or

What you can expect to learn.

See the Future…

or

What you can expect to learn.

- The three main categories of audio signal types

See the Future…

or

What you can expect to learn.

- The three main categories of audio signal types.
- What is a decibel and why do we care?

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- The three main categories of audio signal types.
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- Audio flow through a mixing console

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- Equalizer basics

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- The three main categories of audio signal types.
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- Signal to Noise Ratio and Gain Structure

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- Equalizer basics
- Signal to Noise Ratio and Gain Structure.
- Polar plots

See the Future…

or

What you can expect to learn.

- The three main categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics
- Signal to Noise Ratio and Gain Structure.
- Polar plots
- Understanding Feedback

The Signals we Know and Love

The Signals we Know and Love

- Mic level
- Line level
- Speaker level

The Signals we Know and Love

- **Mic level** approx -60 dBu to -40 dBu
  - **Small and delicate**
  - **Shielded cable**
  - **Can use tiny cable**
- **Line level**
- **Speaker level**

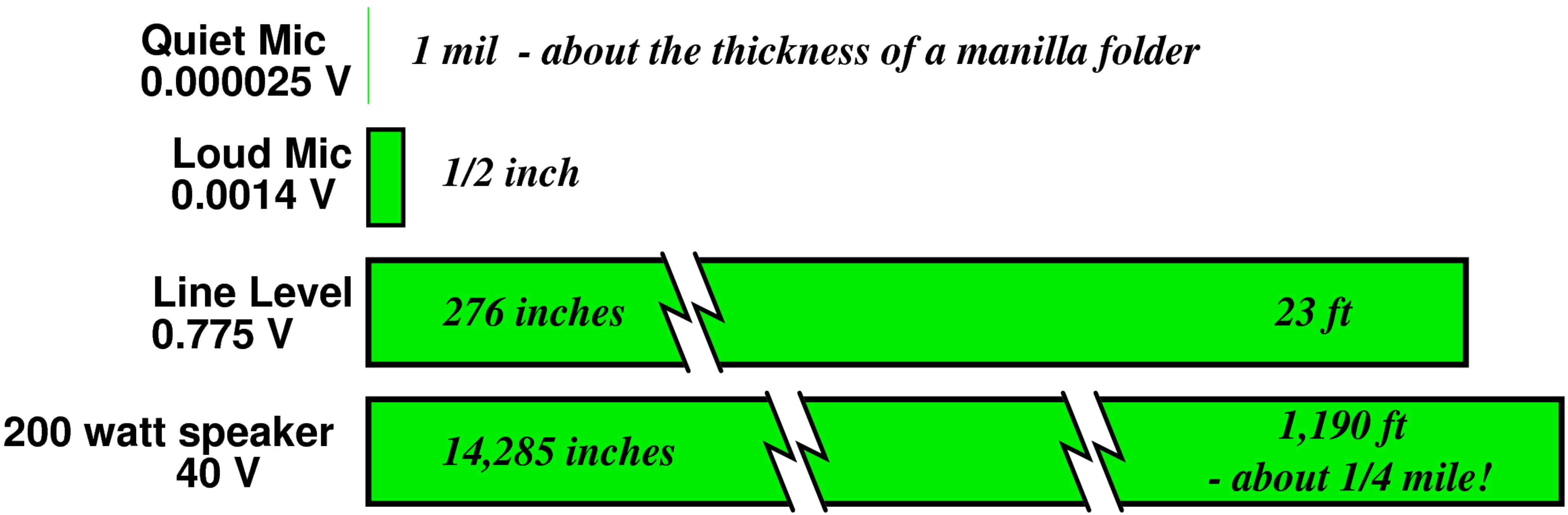
The Signals we Know and Love

- **Mic level** approx -60 dBu to -40 dBu
- **Line level** approx -8 dBu to +4 dBu
  - **Fairly sturdy**
  - **Shielded cable a very good idea**
  - **Can still use small cable**
- **Speaker level**

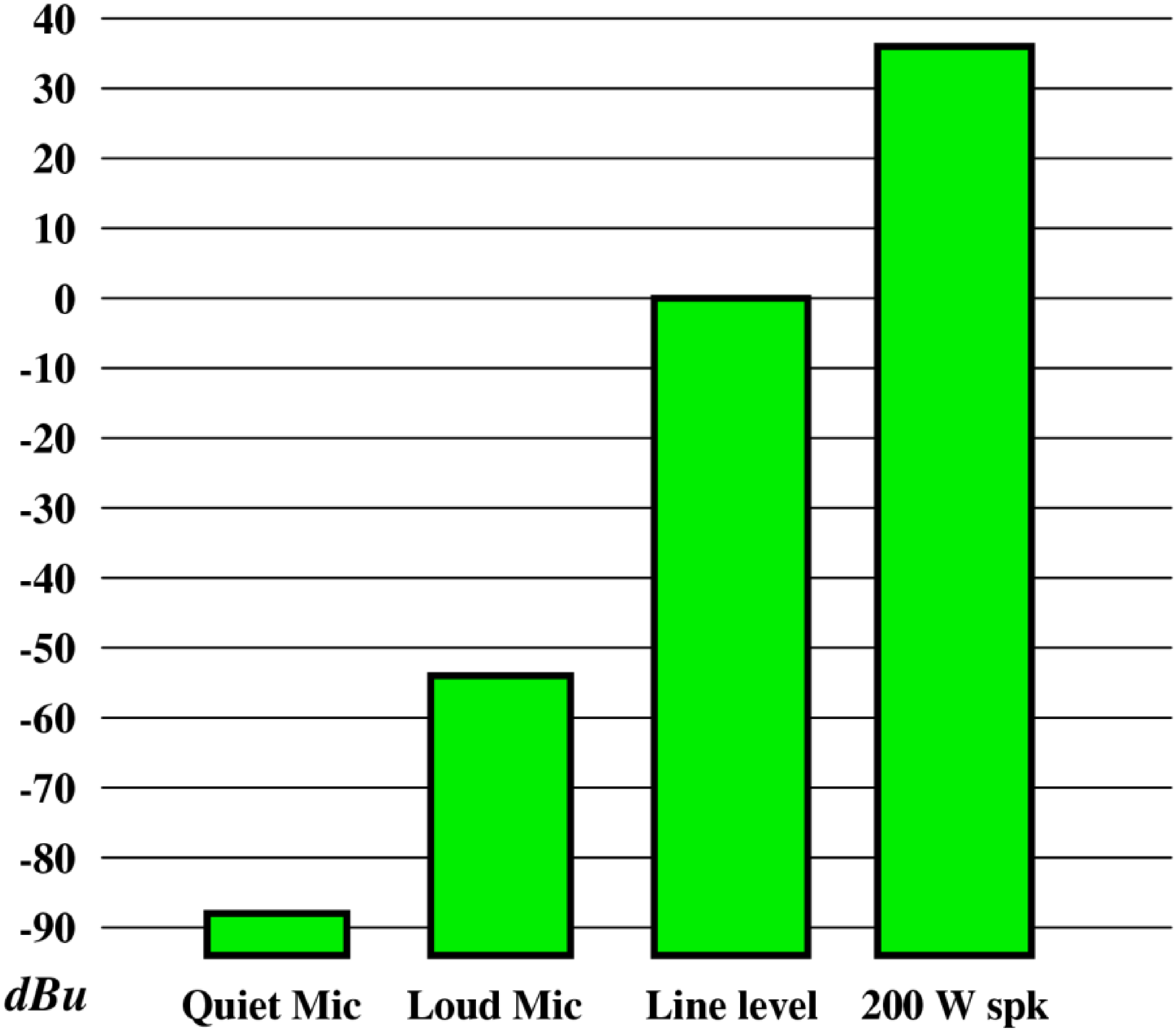
The Signals we Know and Love

- **Mic level** approx -60 dBu to -40 dBu
- **Line level** approx -8 dBu to +4 dBu
- **Speaker level** approx +10 dBu to +40 dBu
  - **Large and robust, somewhat of a bully**
  - **Cable twisted, no need for shield**
  - **Large cable a good idea**

Voltage Range of Audio Signals



Range of Audio Signals



What is a decibel?

What is a decibel?

A decibel is one tenth of a bel (B). Devised by engineers of the Bell Telephone Laboratory to quantify the reduction in audio level over a 1 mile (approximately 1.6 km) length of standard telephone cable, the bel was originally called the transmission unit or TU, but was renamed in 1923 or 1924 in honor of the Bell System's founder and telecommunications pioneer Alexander Graham Bell. In many situations, however, the bel proved inconveniently large, so the decibel has become more common.

From Wikipedia

What is a decibel?

- A ratio or comparison
- It is useless without a reference!

What is a decibel?

- **A ratio or comparison**
- **It is useless without a reference!**

“Nice mixer, how much did it cost?”

"Twice as much”

What is a decibel?

- **A ratio or comparison**
- **It is useless without a reference!**

"Nice mixer, how much did it cost?"

"Twice as much"

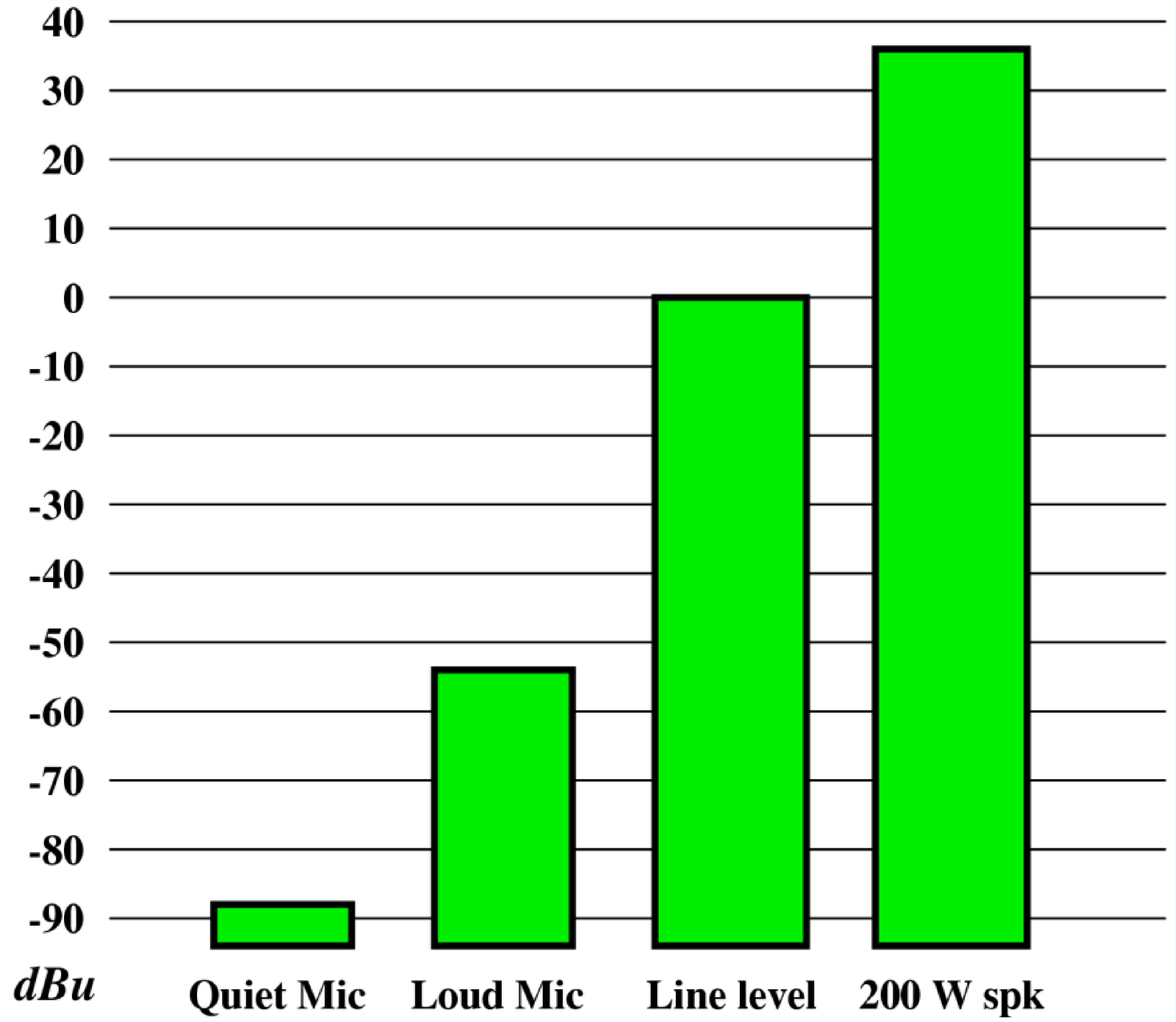
????!!!!????

Two times more… ***than what?***

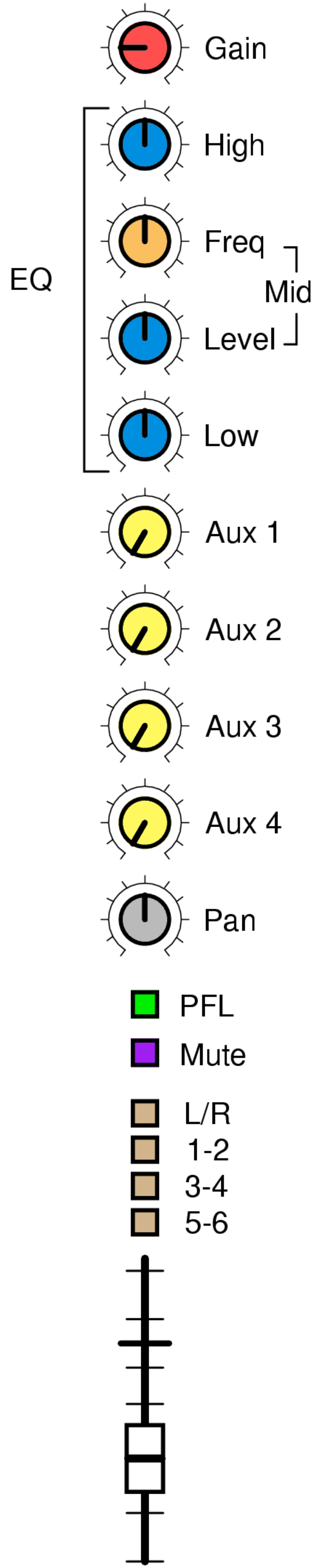
What is a decibel?

- A ratio or comparison
- It is useless without a reference!
  - There are standard references
  - For prices, we use dollars.
  - For sound we use:
    - dBu
    - dBm
    - dB V
    - dB SPL
    - dB FS

Range of Audio Signals



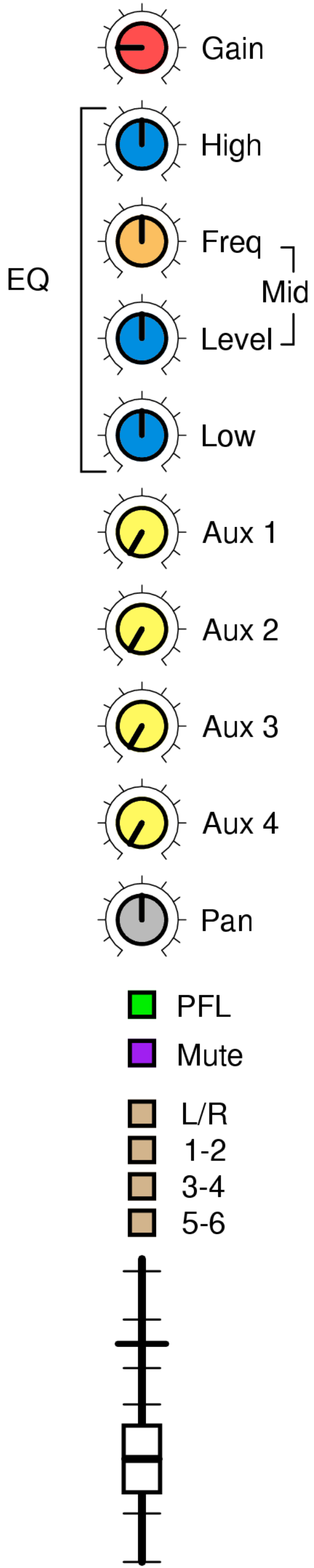
One channel of an <u>imaginary</u> mixing console.

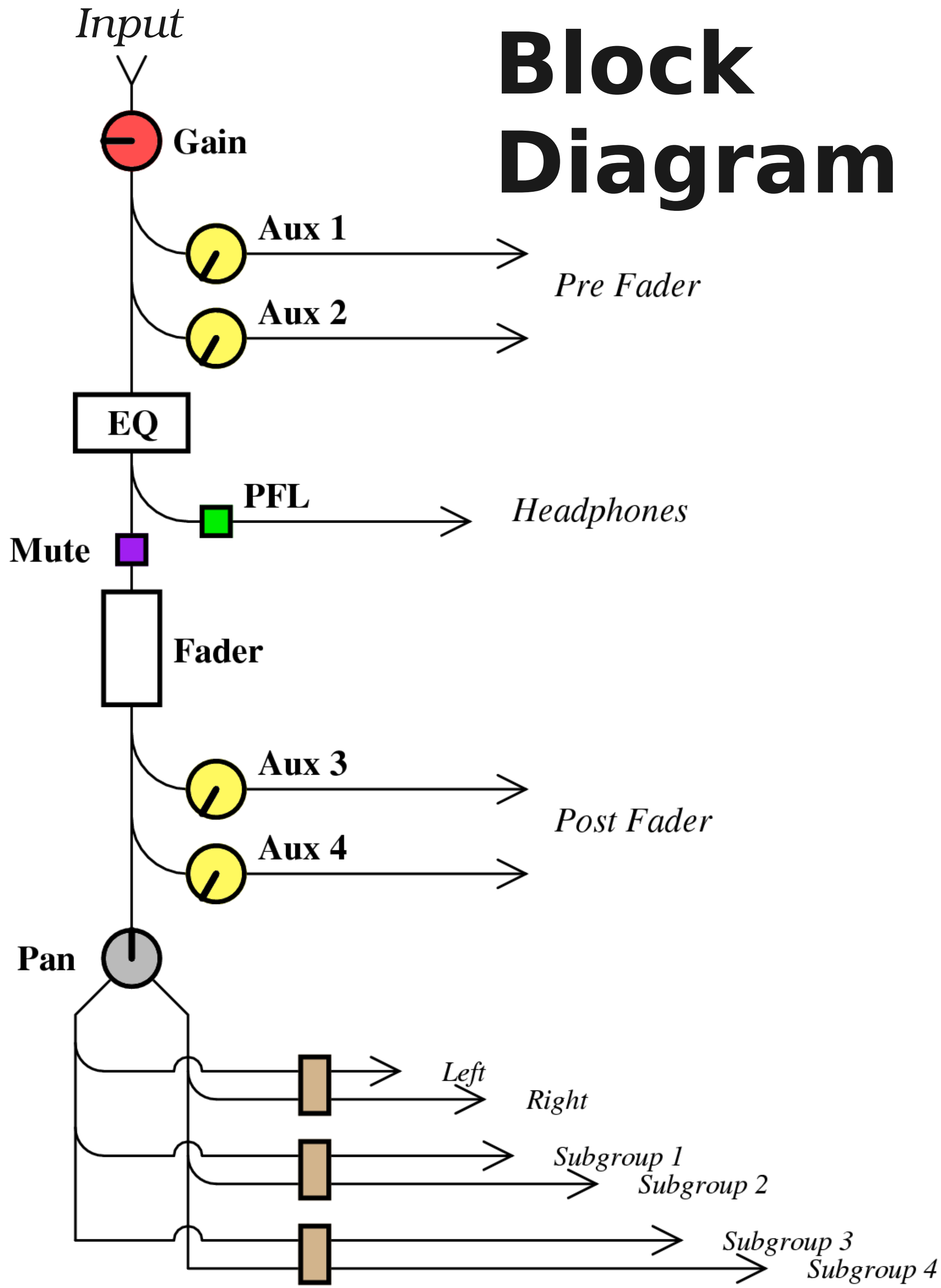


One channel of an average mixing console.

This is not any particular mixer. It is one that my fertile imagination invented. Any resemblance to a real mixer is purely coincidental.

Block Diagram





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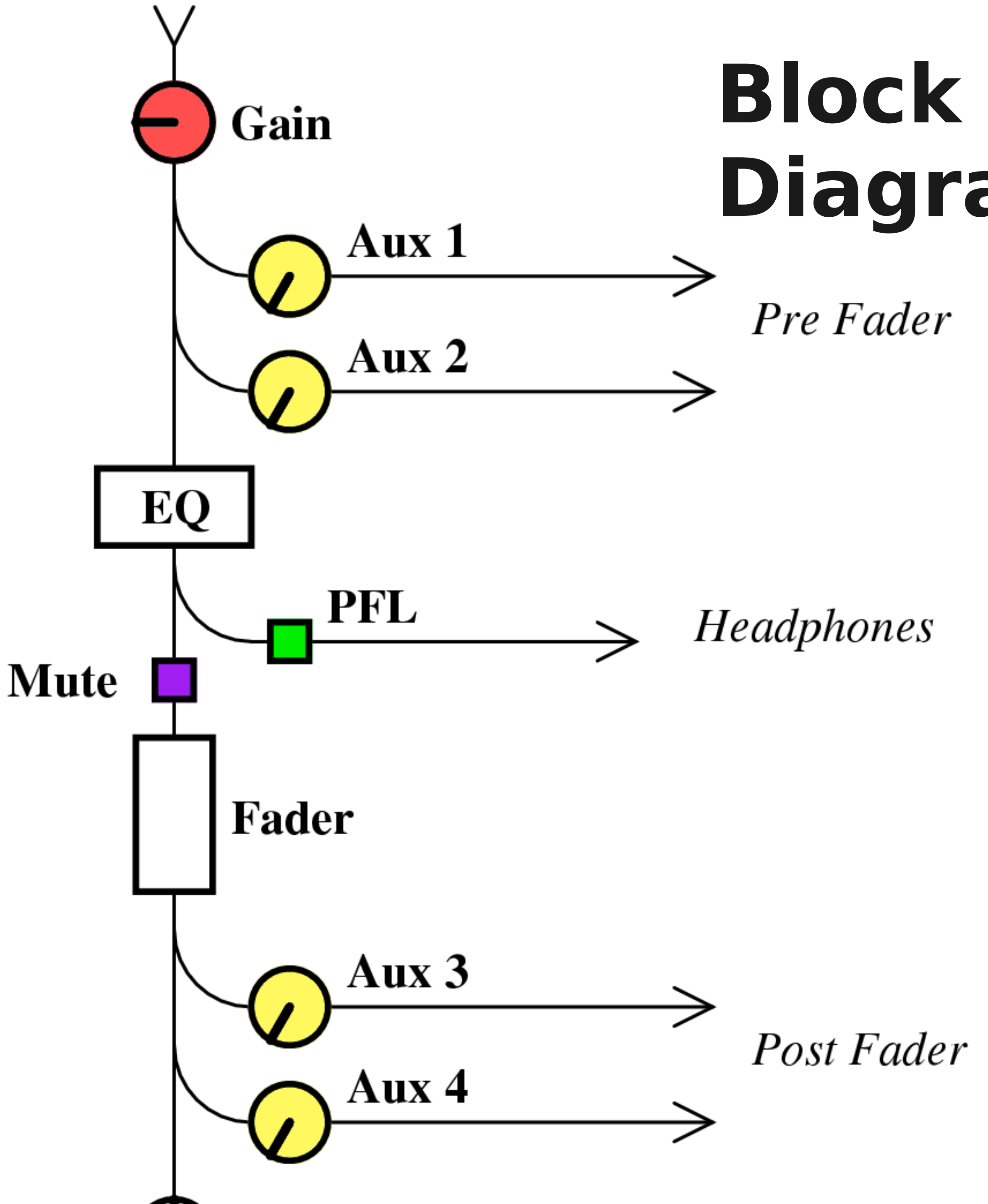
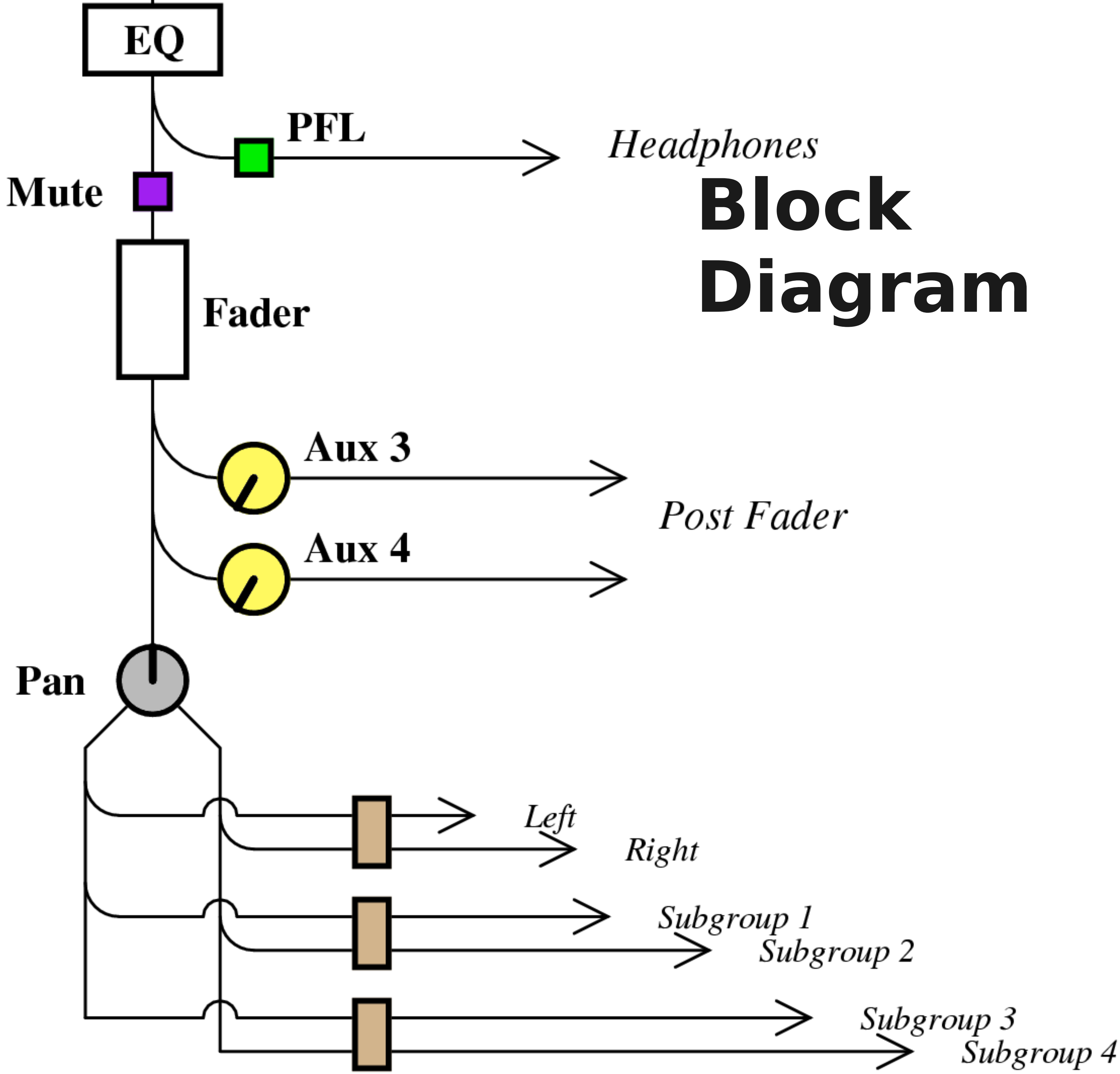
Block Diagram



Block Diagram



Equalizer

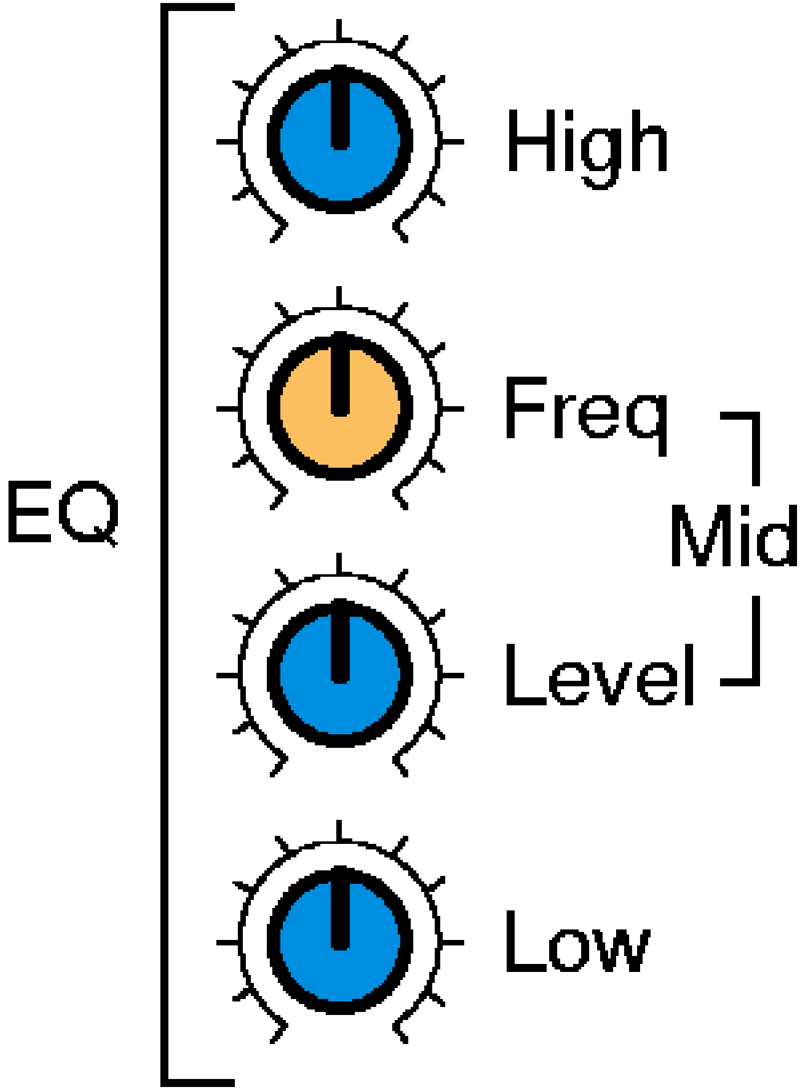
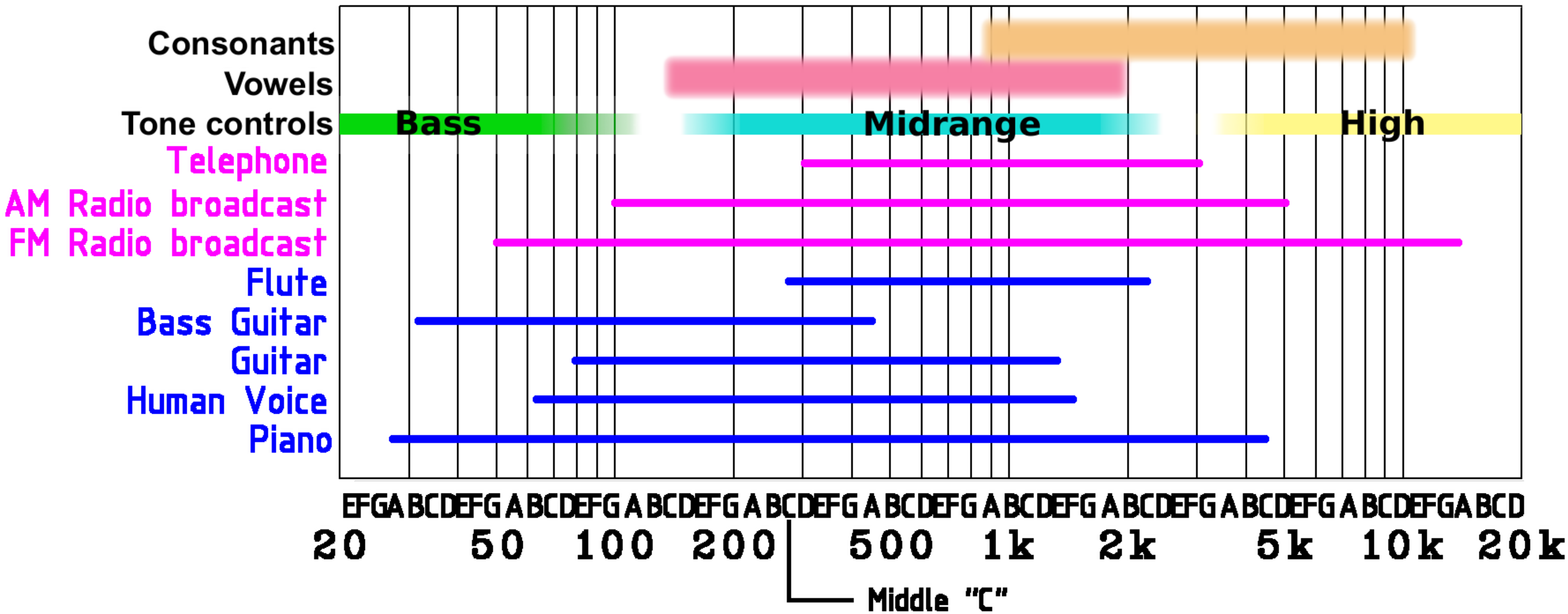
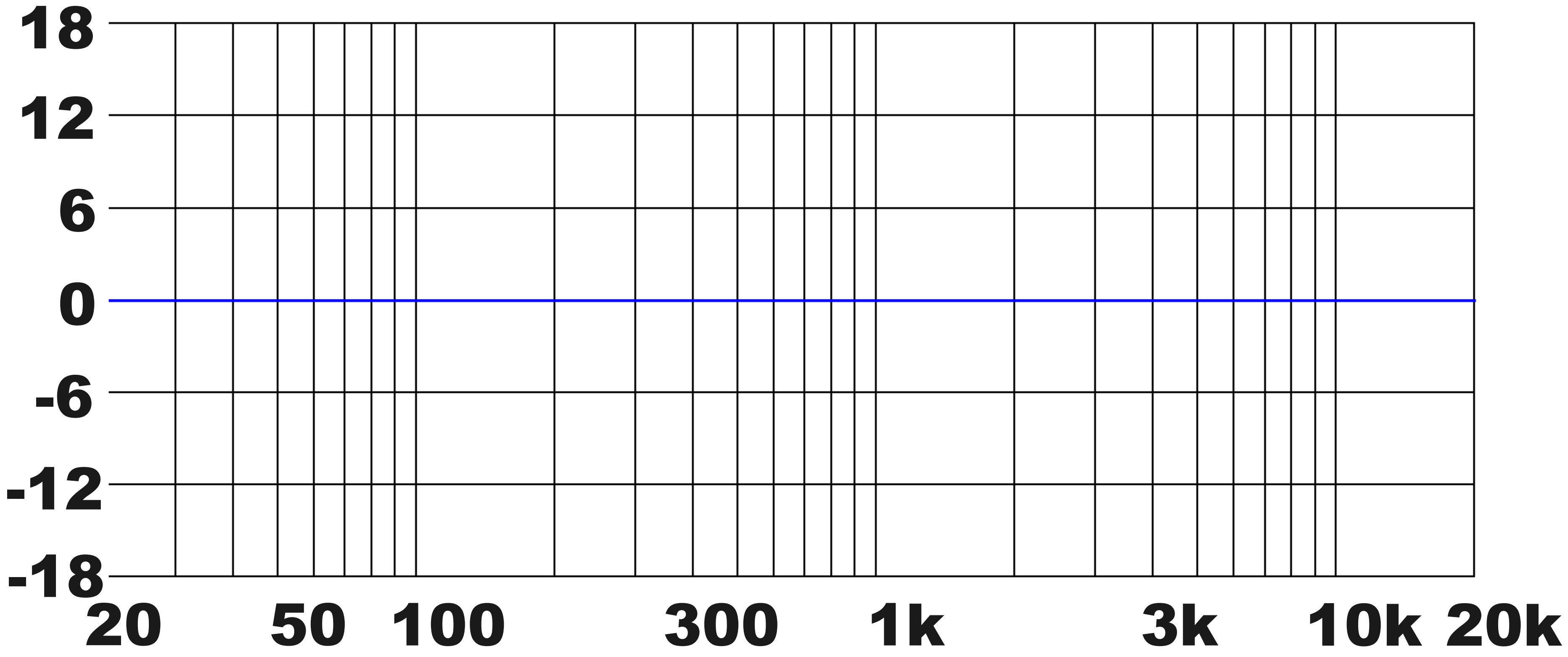


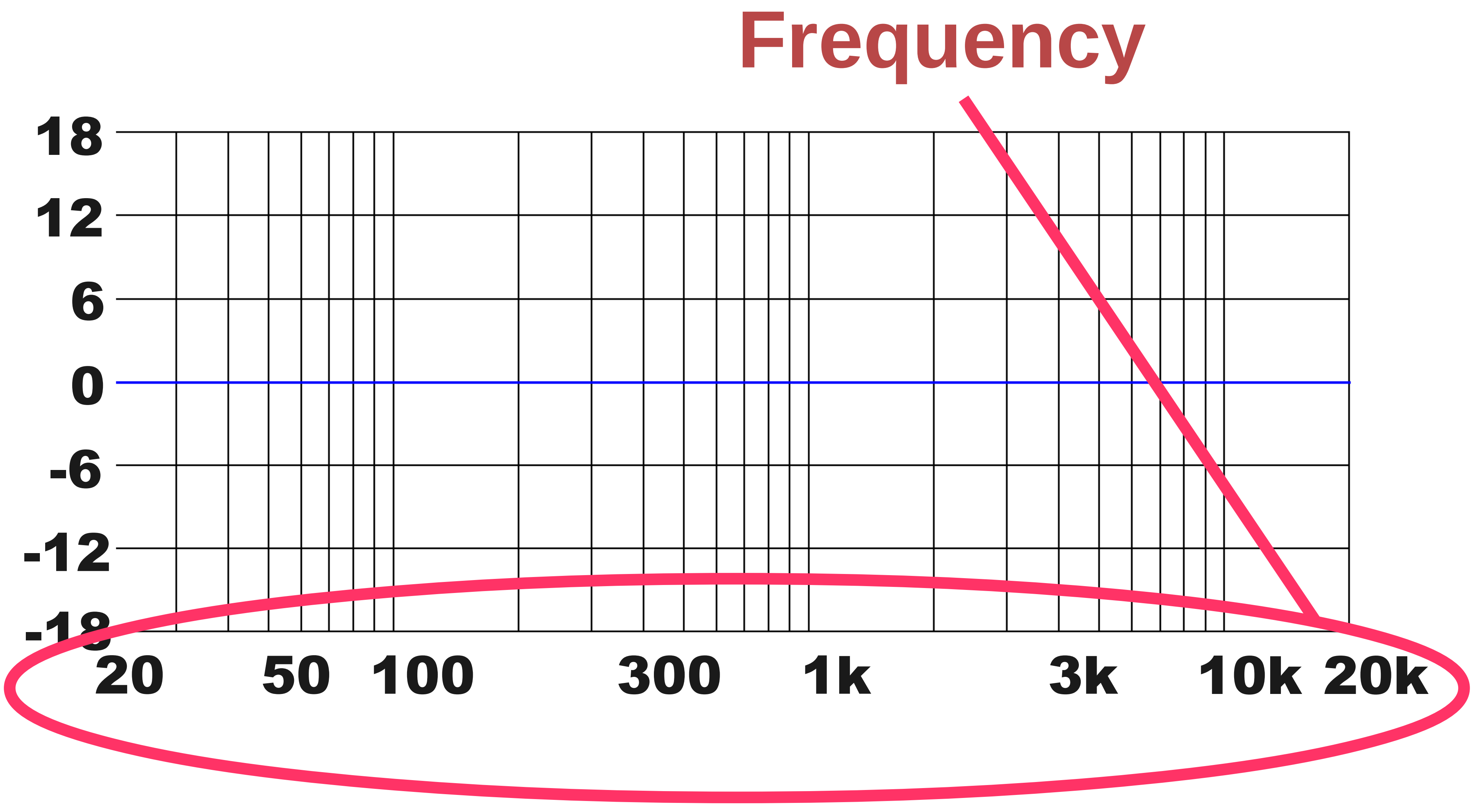
Chart of Common frequency ranges



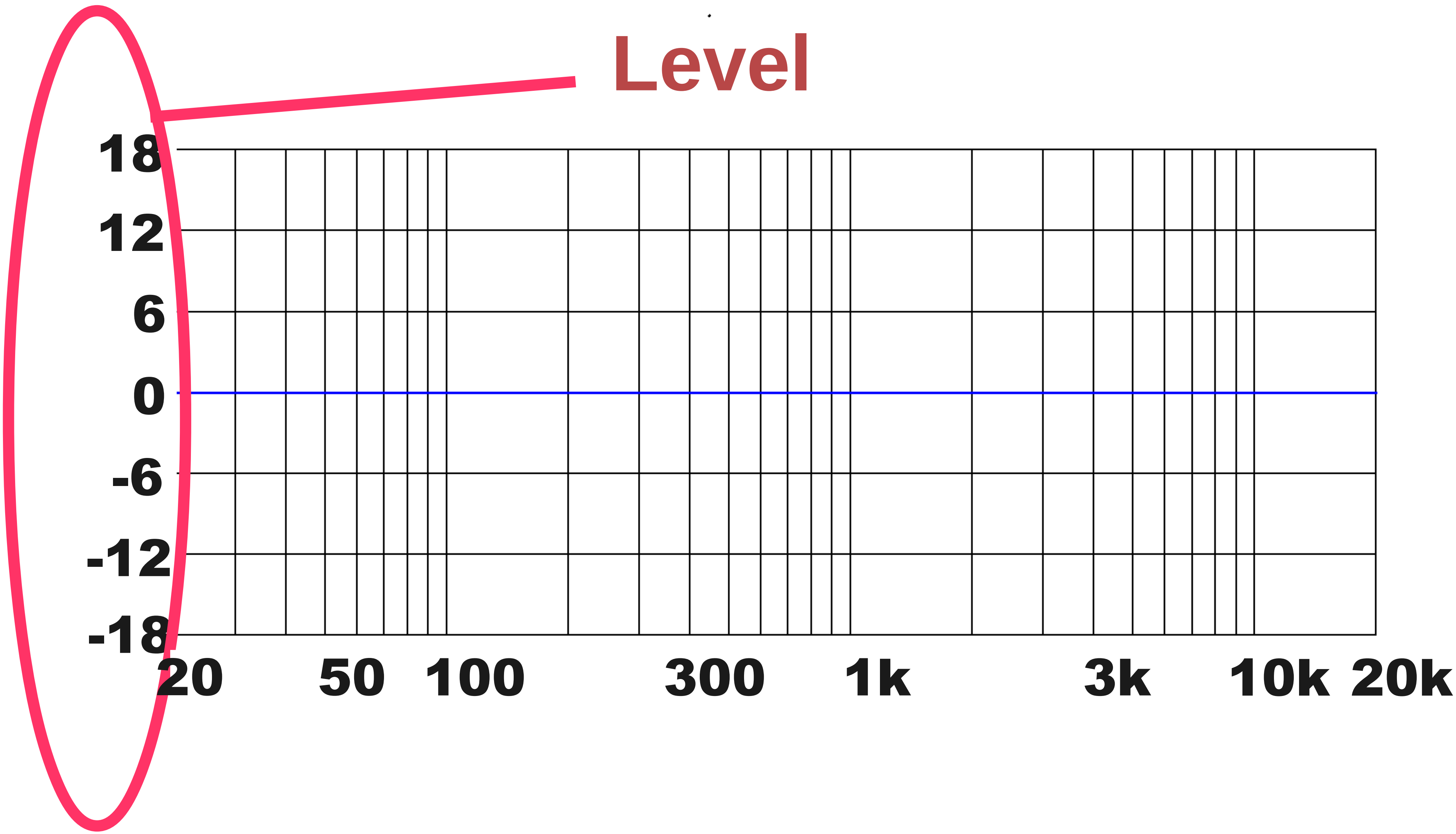
Frequency Response Chart



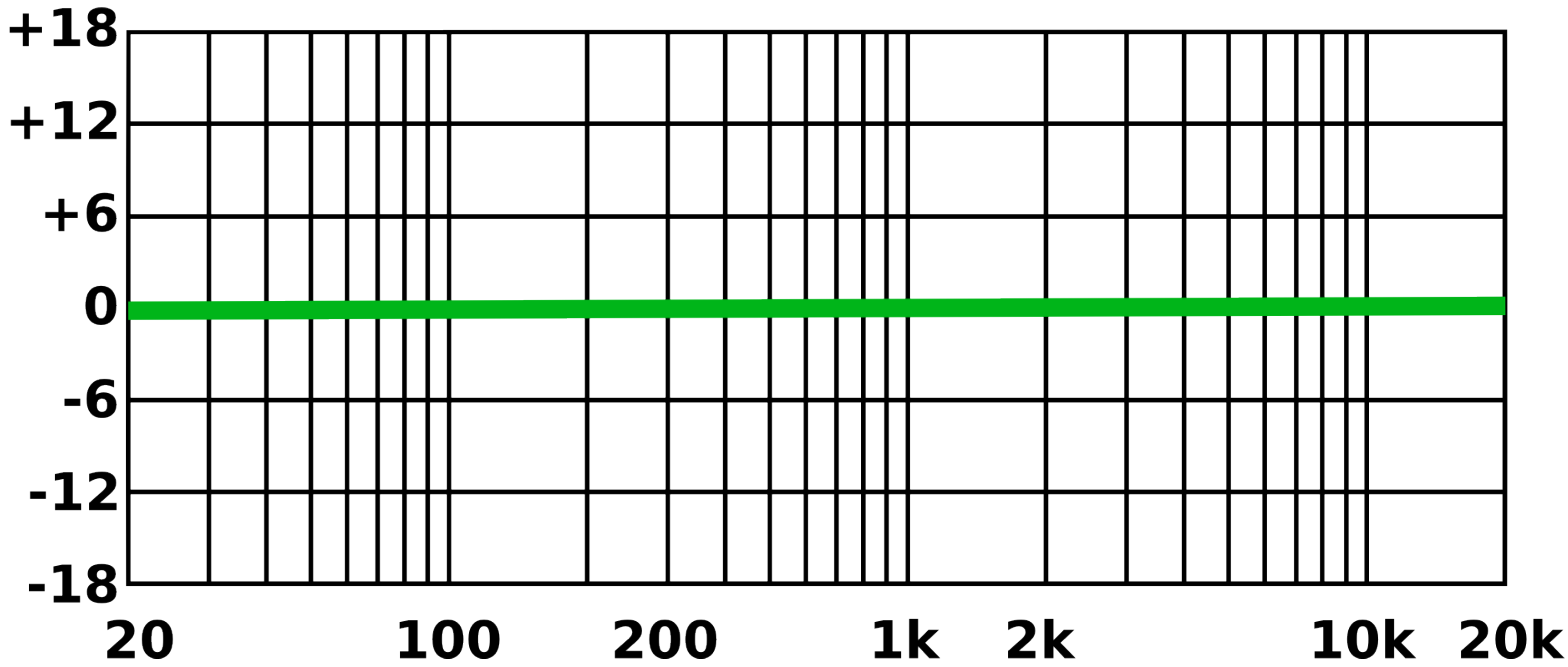
Frequency Response Chart



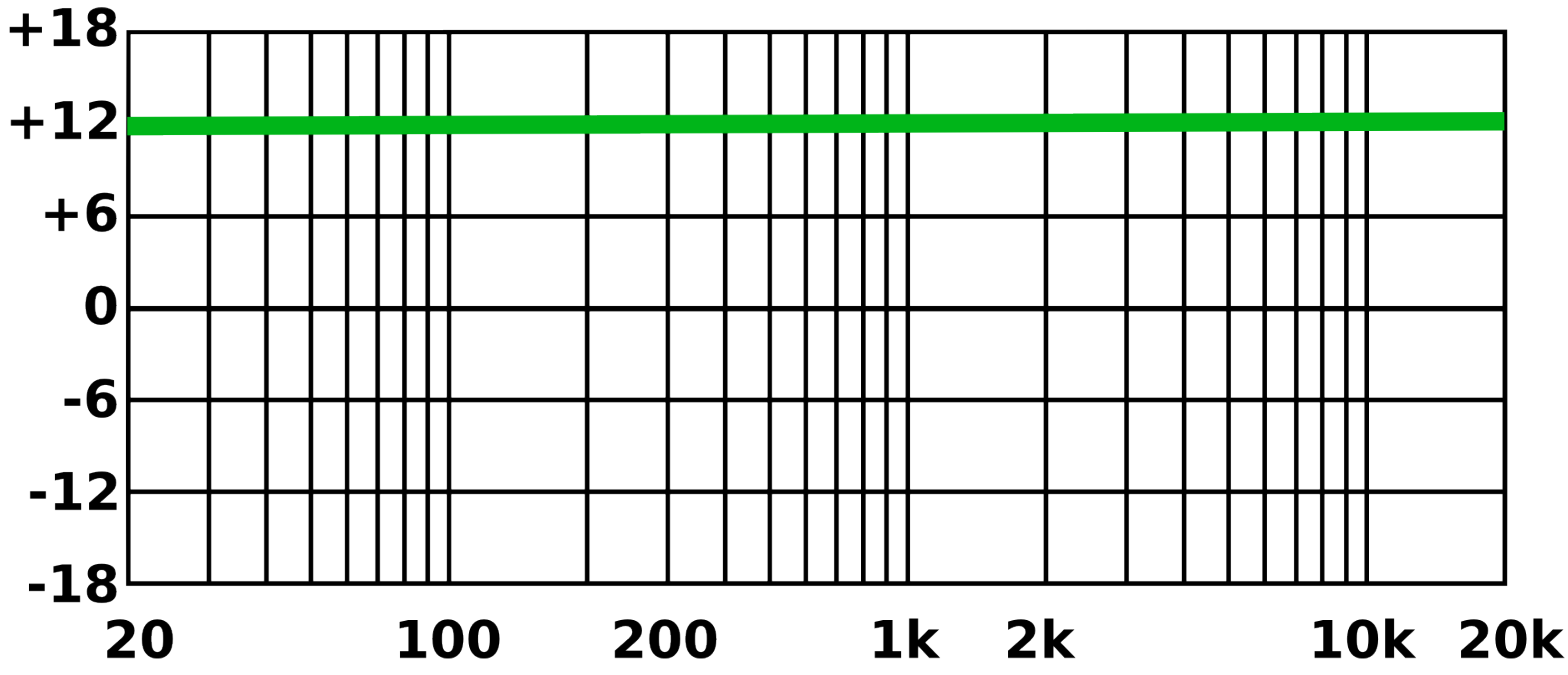
Frequency Response Chart



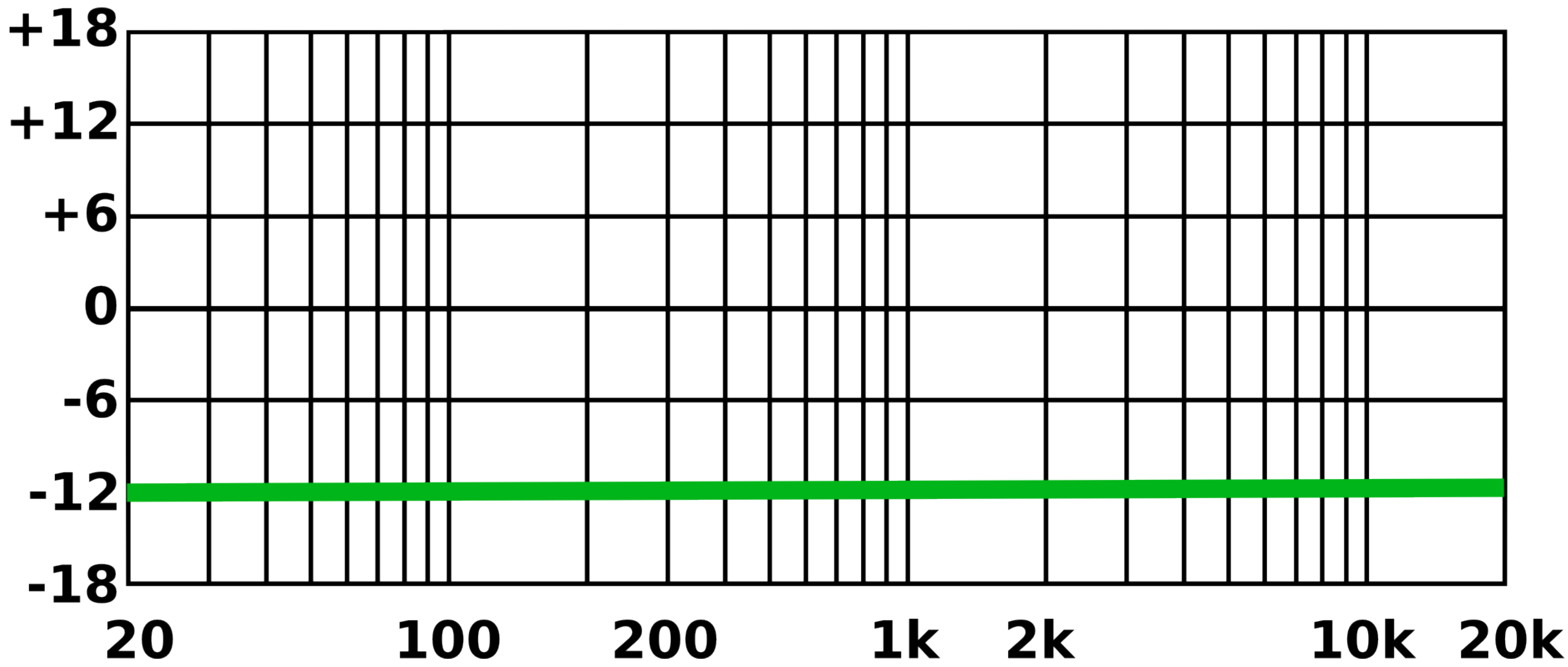
Level, or volume, control

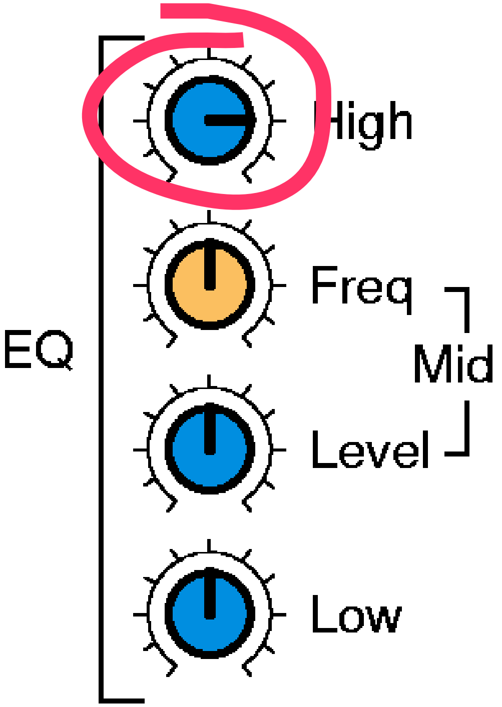


Level, or volume, control



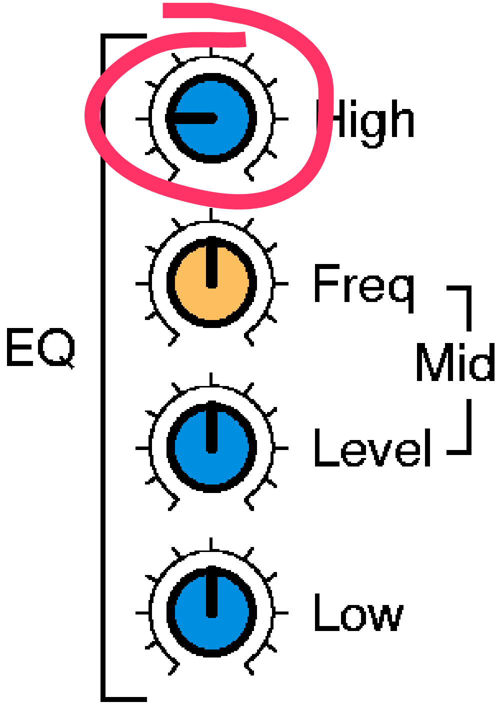
Level, or volume, control





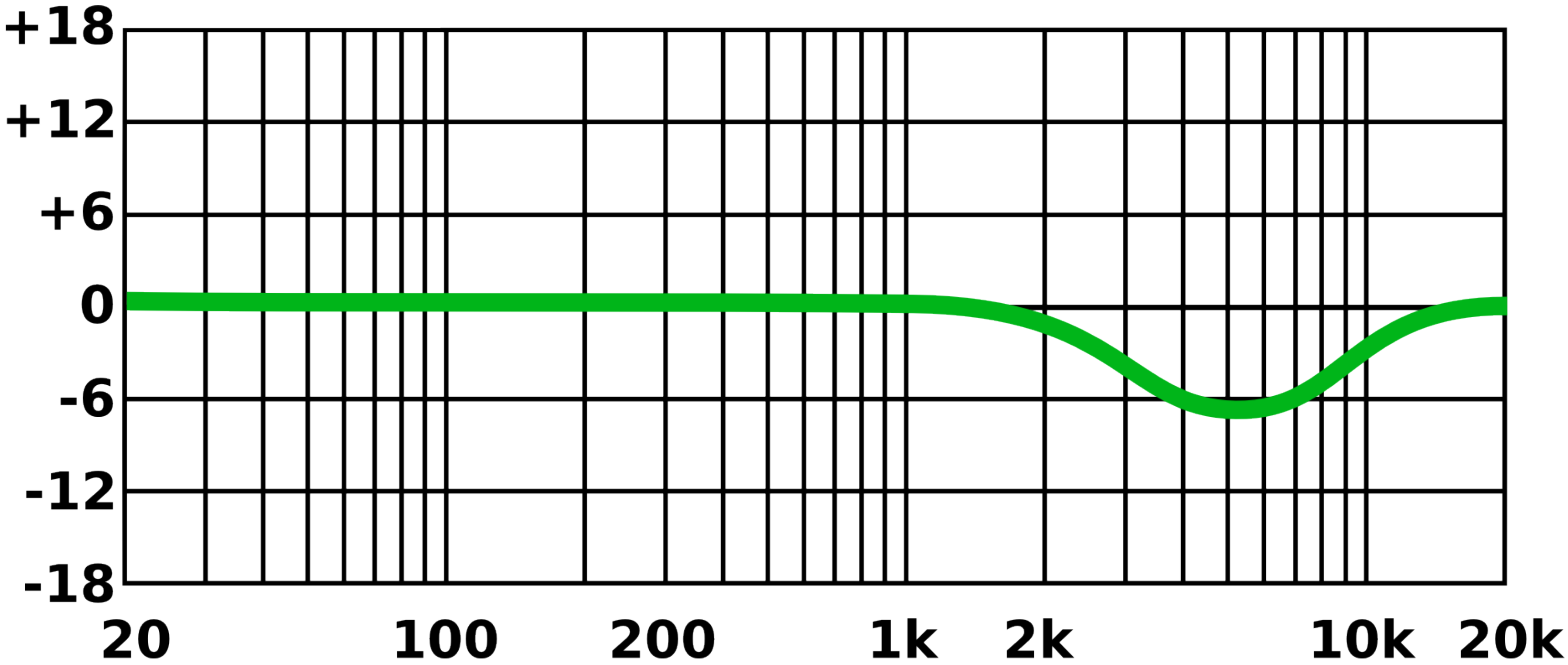
High boost

- How much



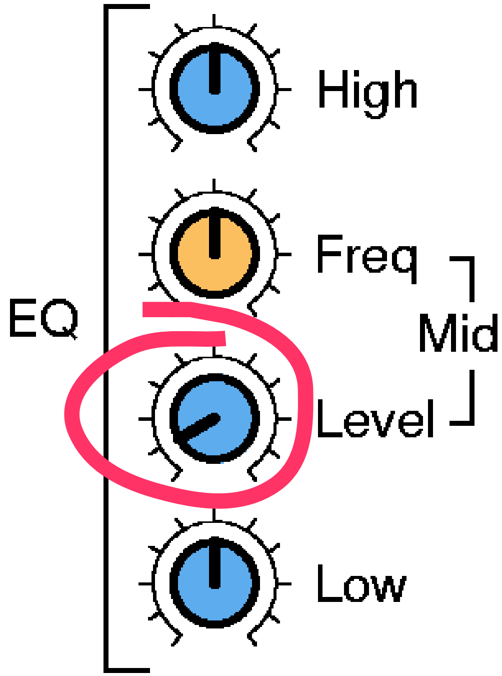
High cut

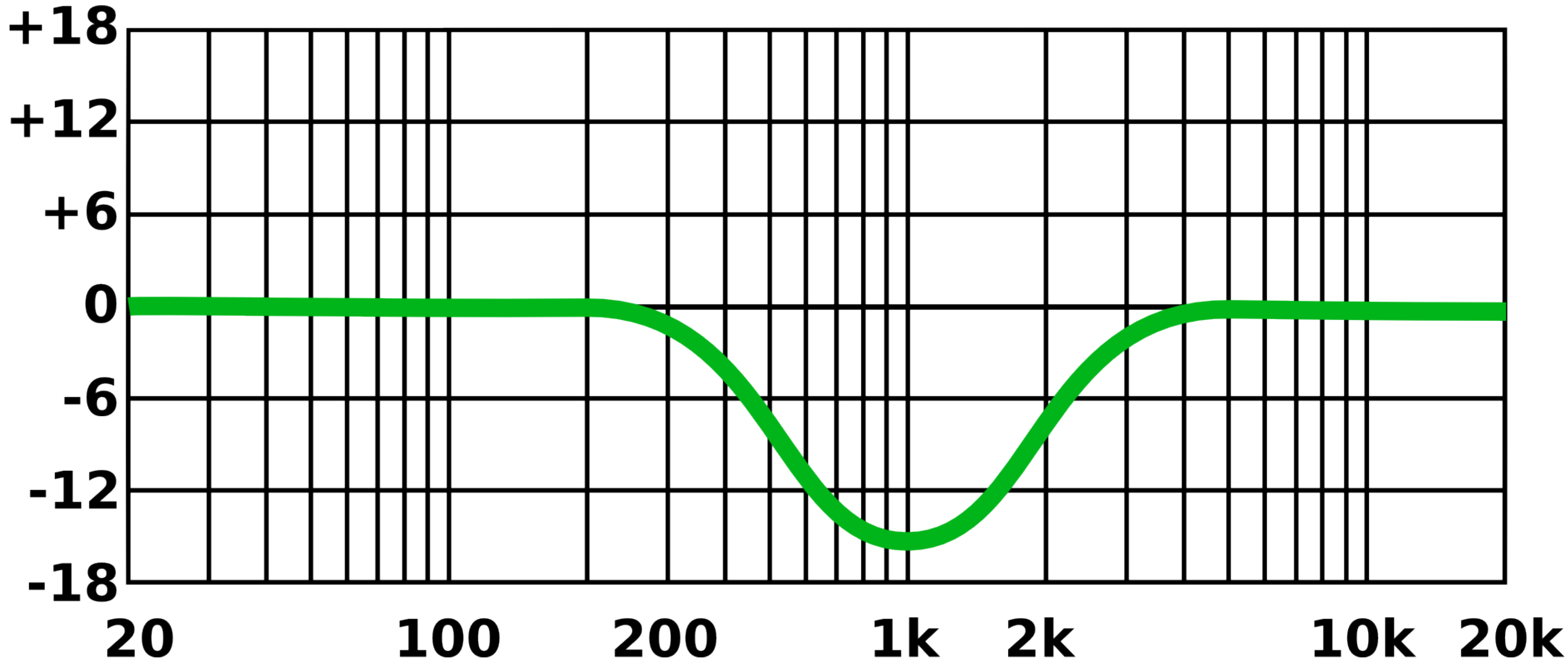
- How much

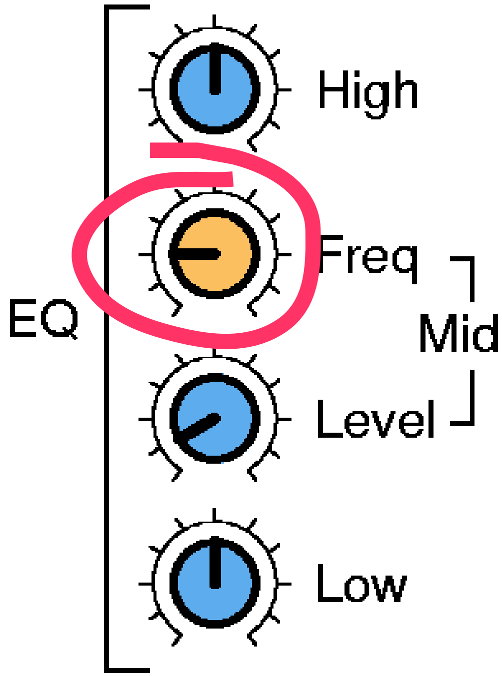


Mid cut

• How much

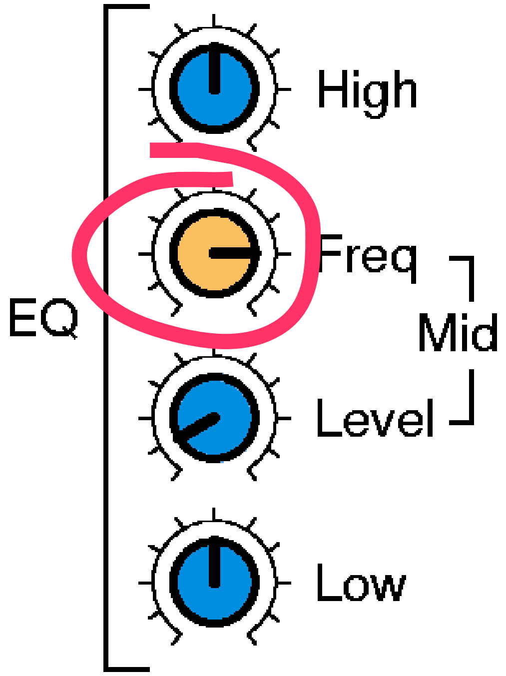






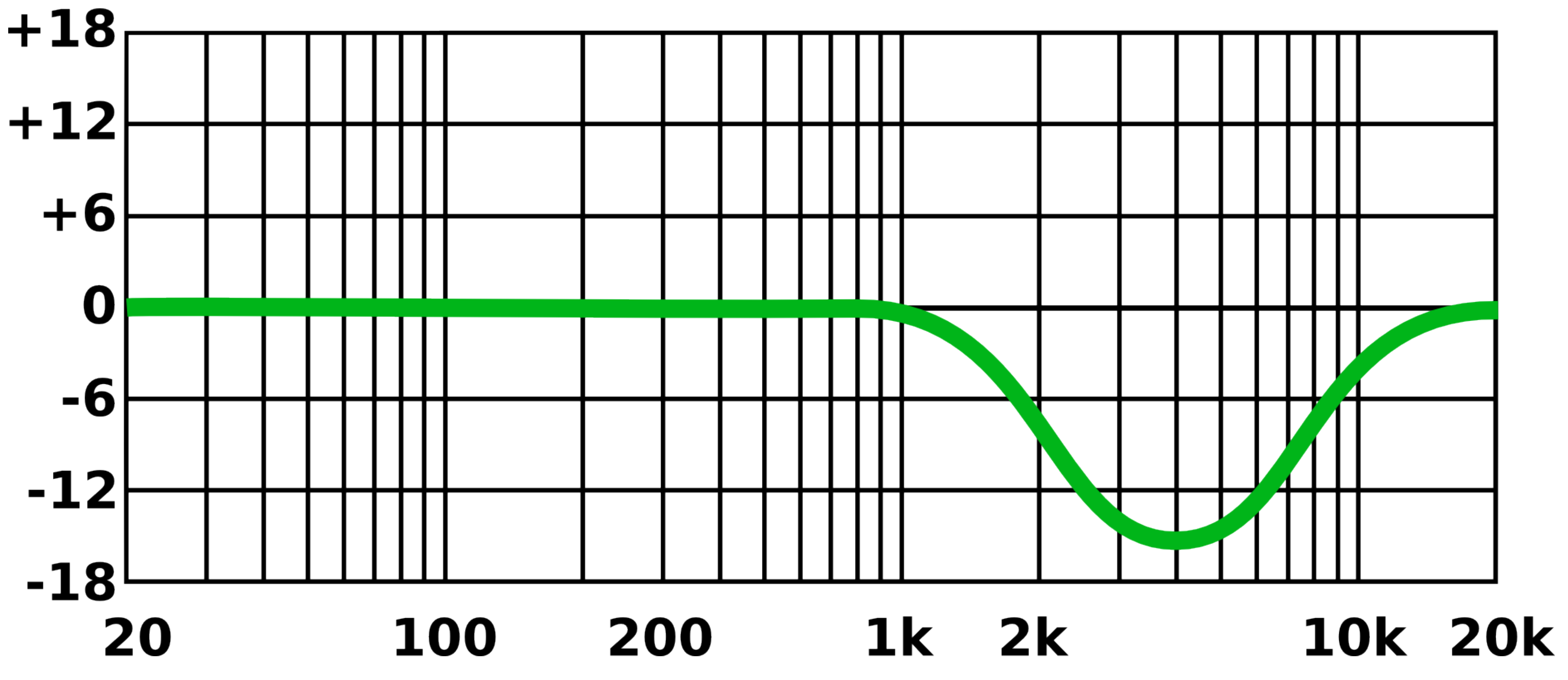
Mid-cut Low

- How much
- Where



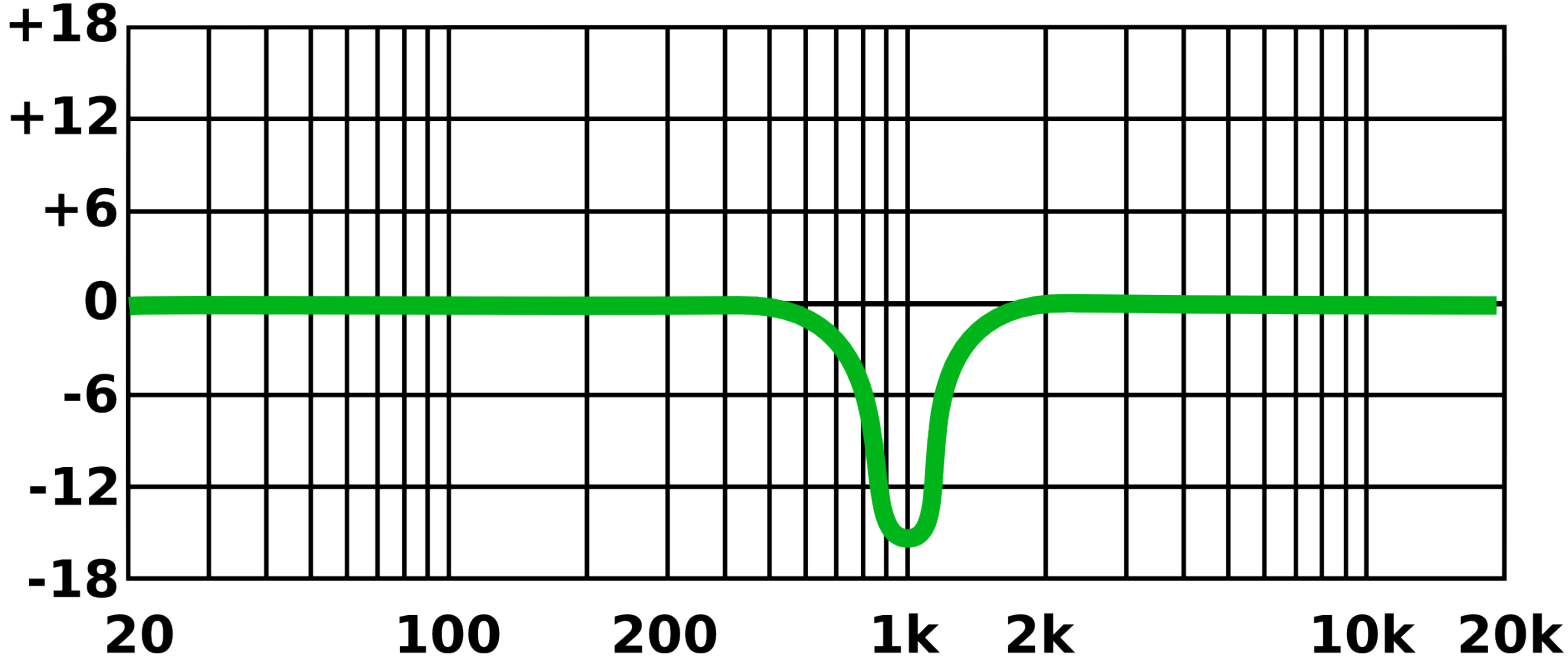
Mid-cut High

- How much
- Where



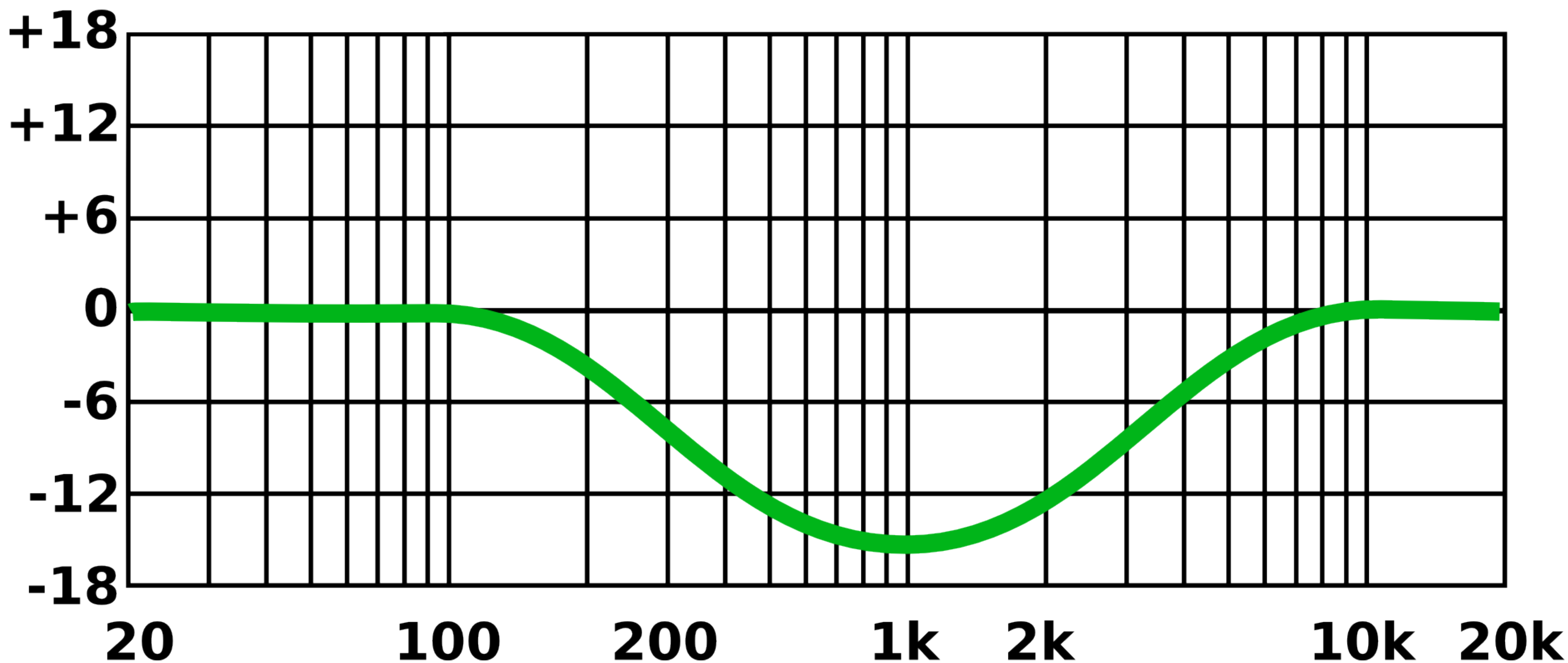
Parametric Equalizer

- How much
- Where
- How wide



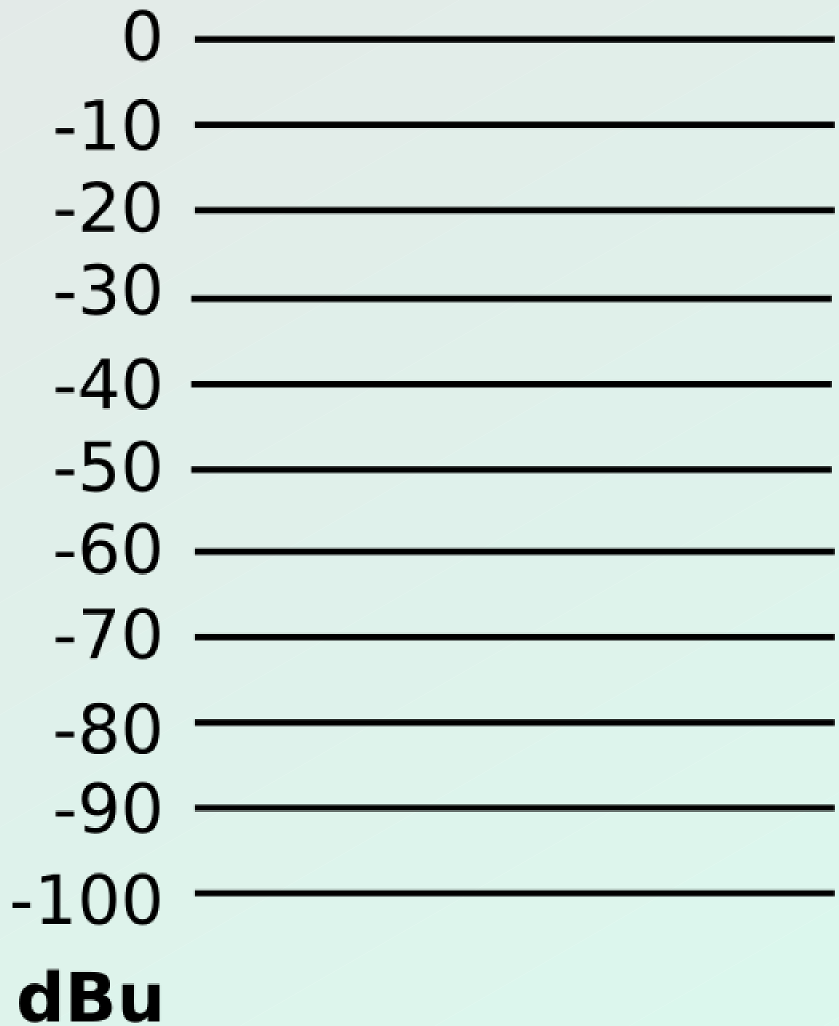
Parametric Equalizer

- How much
- Where
- How wide

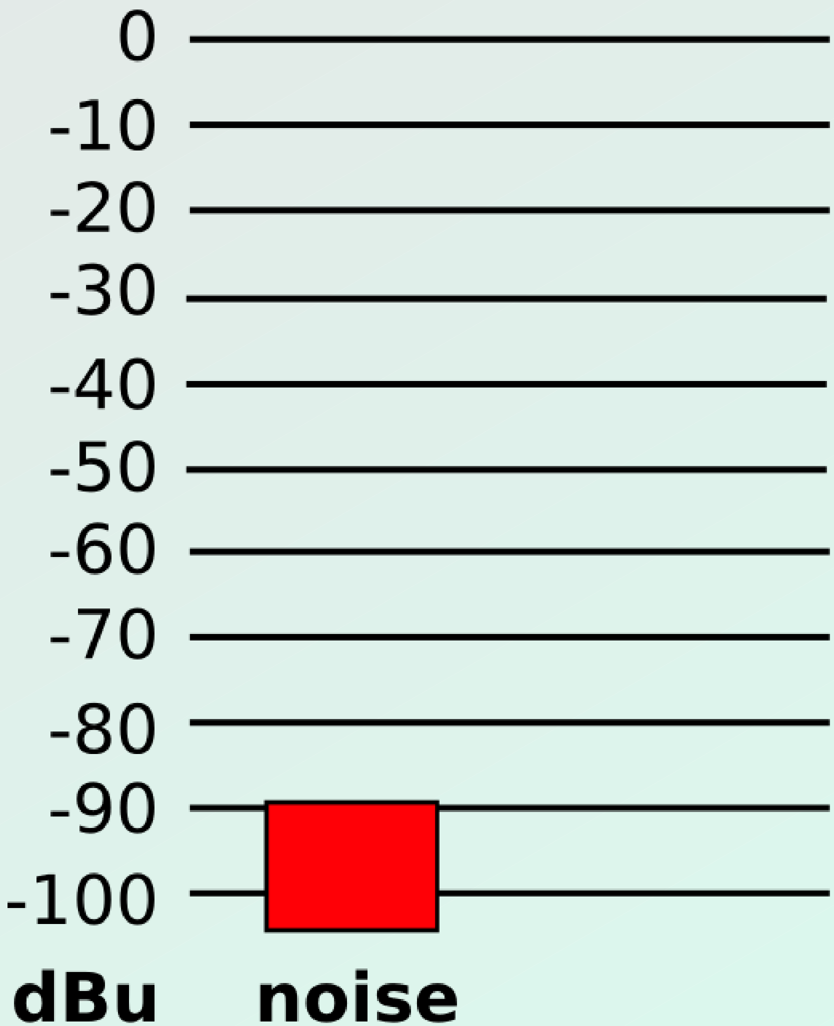


Signal to Noise Ratio

Signal to Noise Ratio



Signal to Noise Ratio



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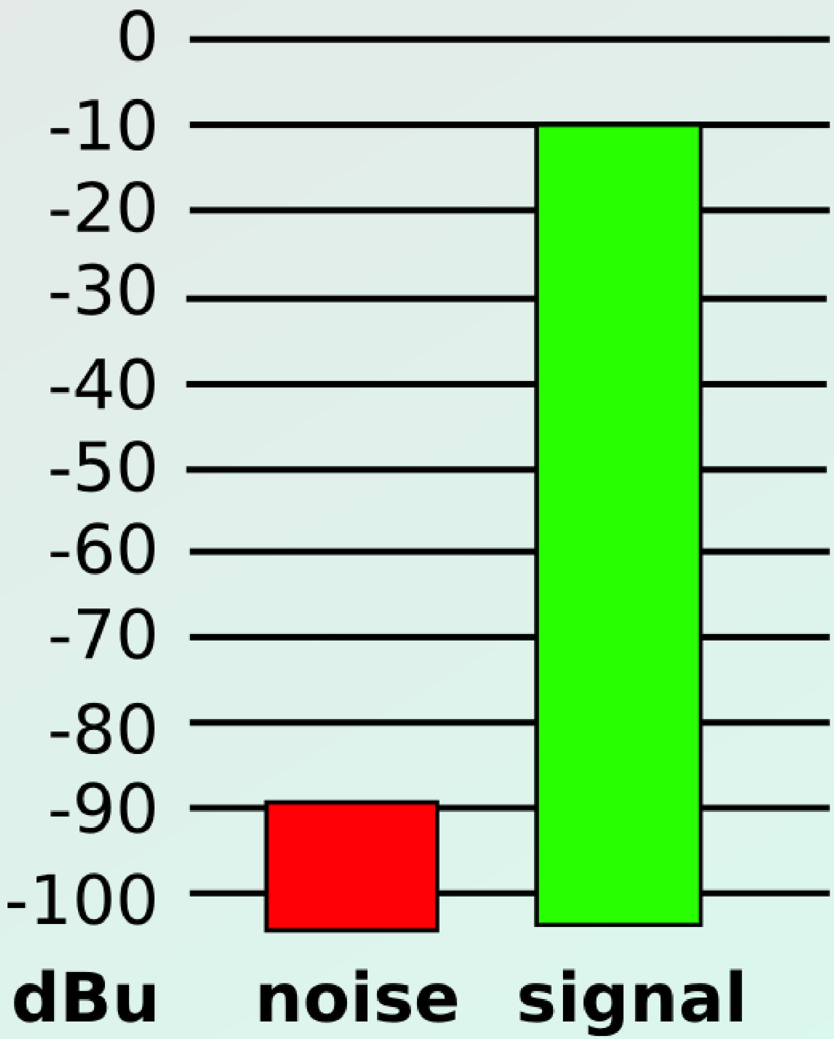

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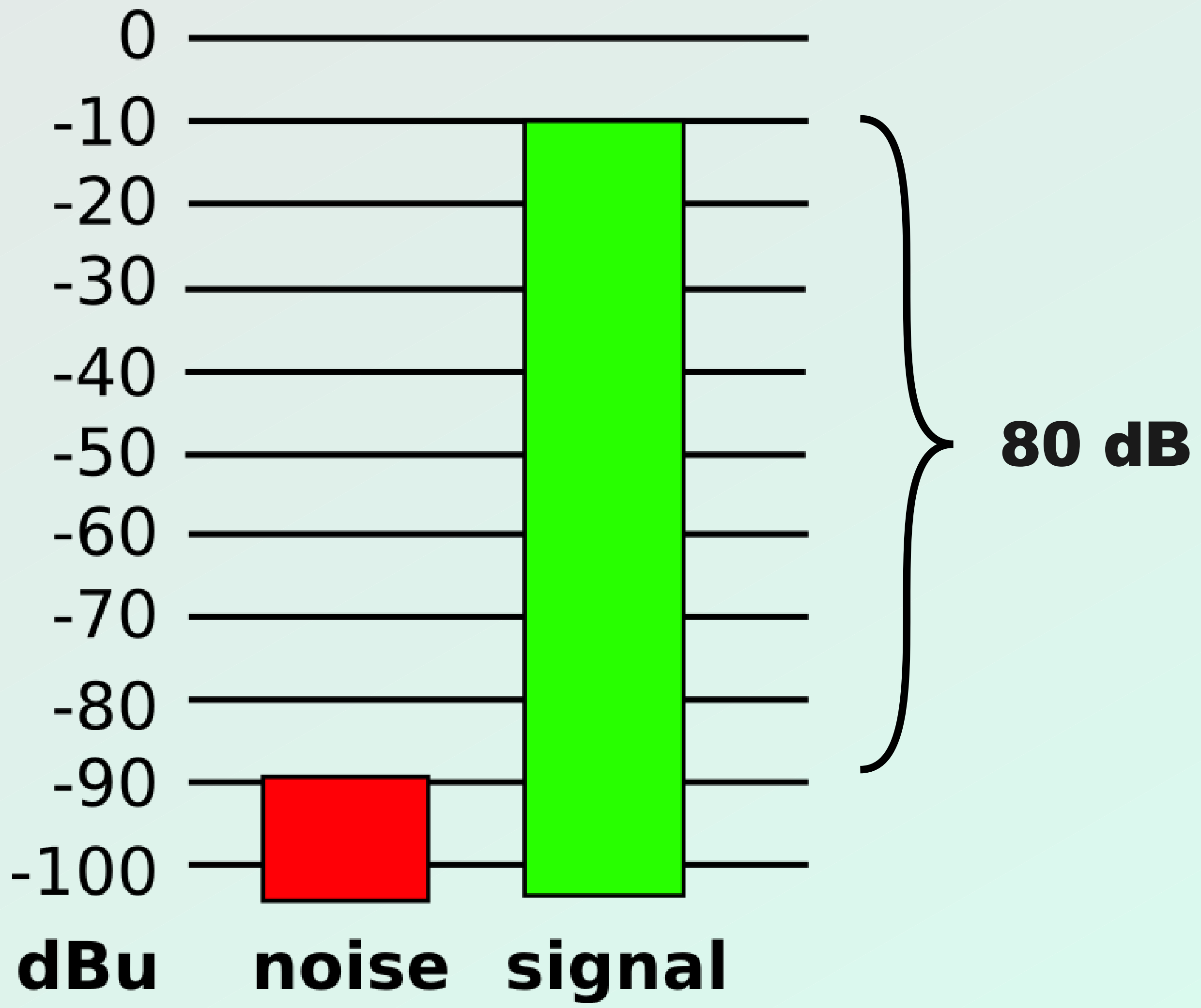
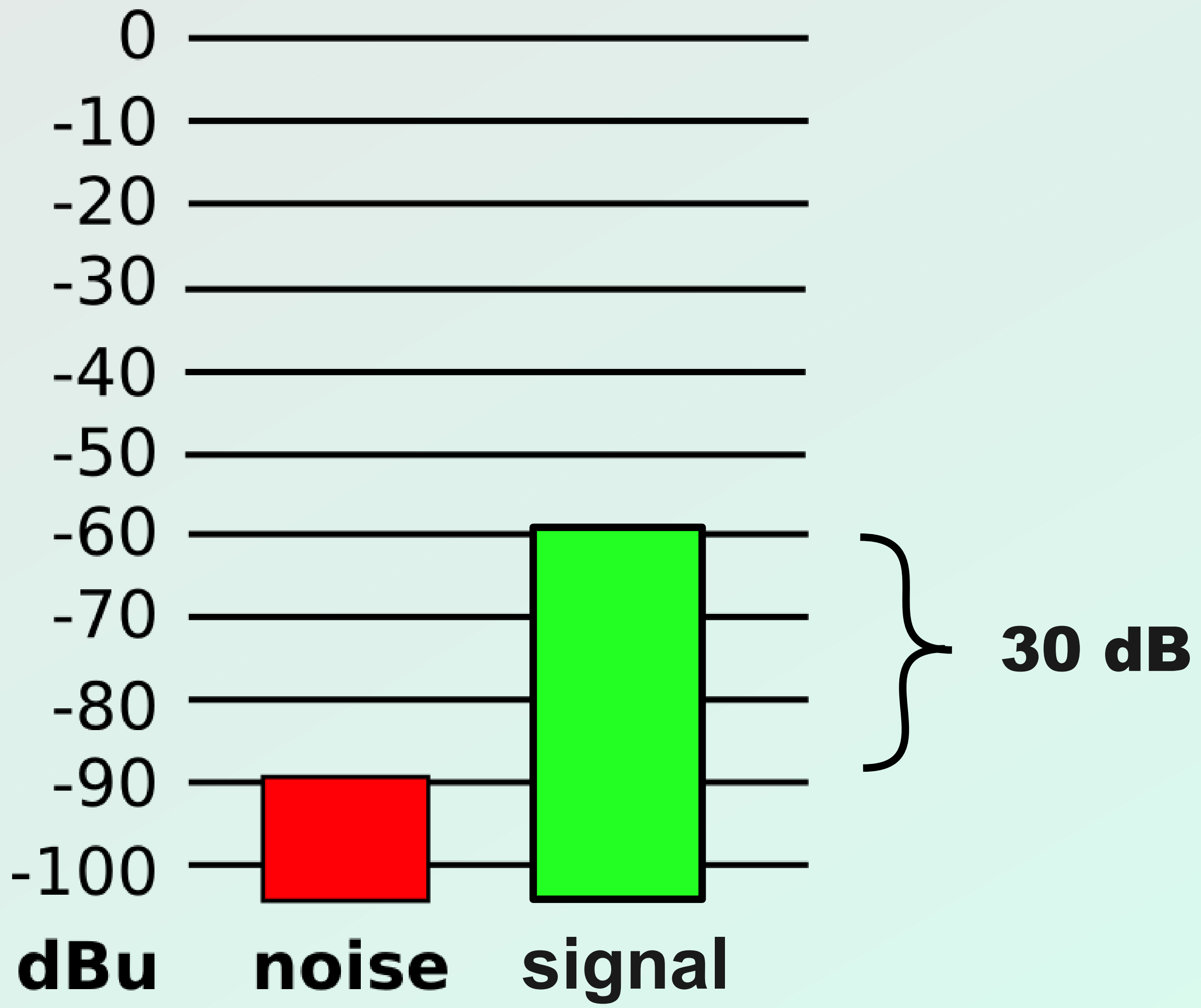
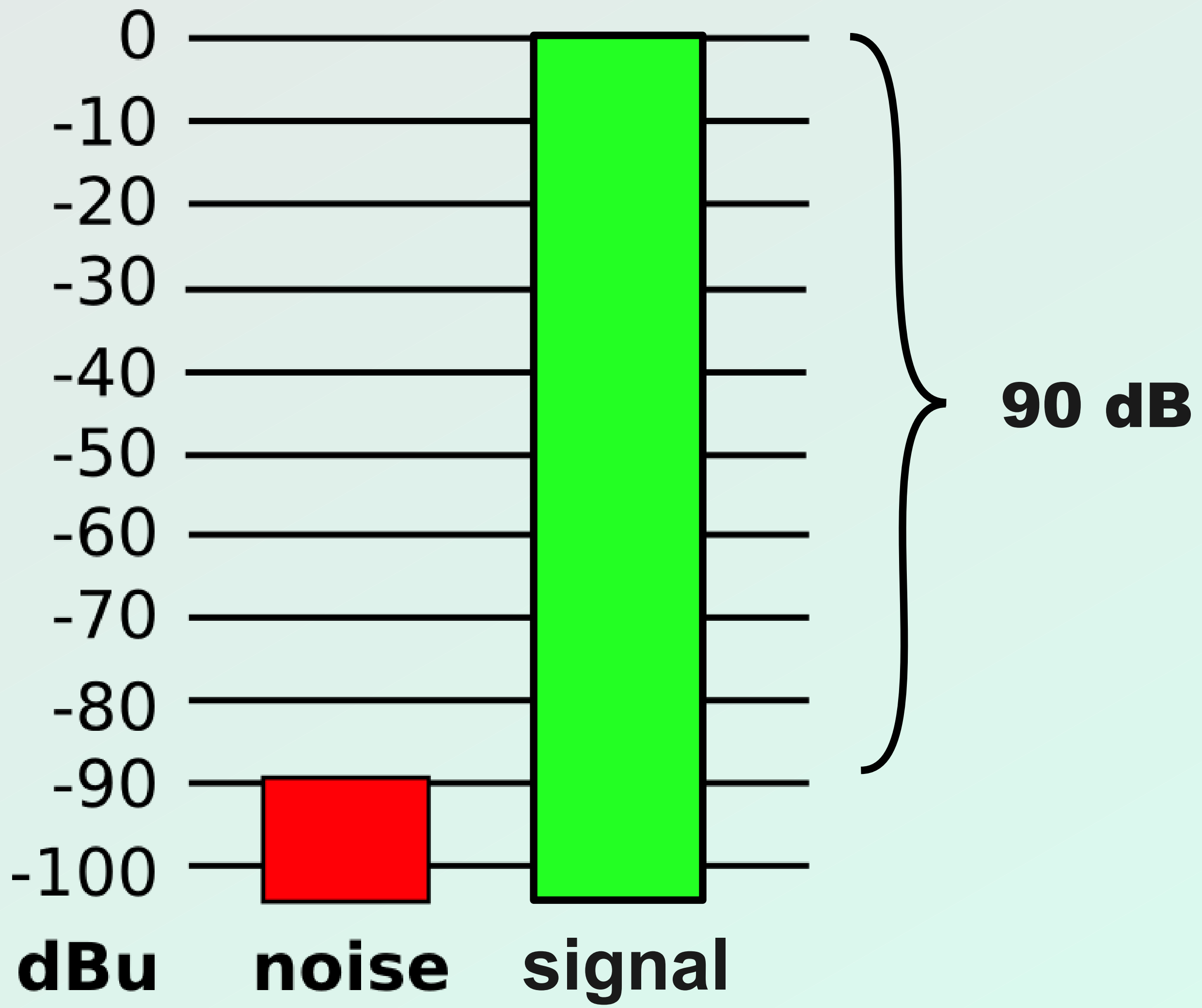


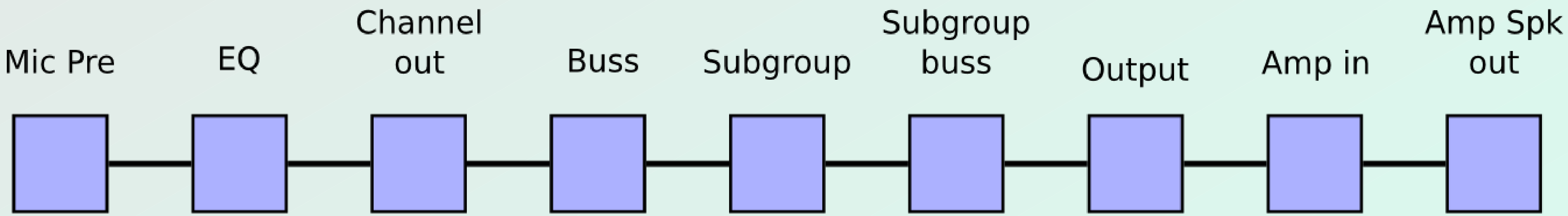
Signal to Noise Ratio



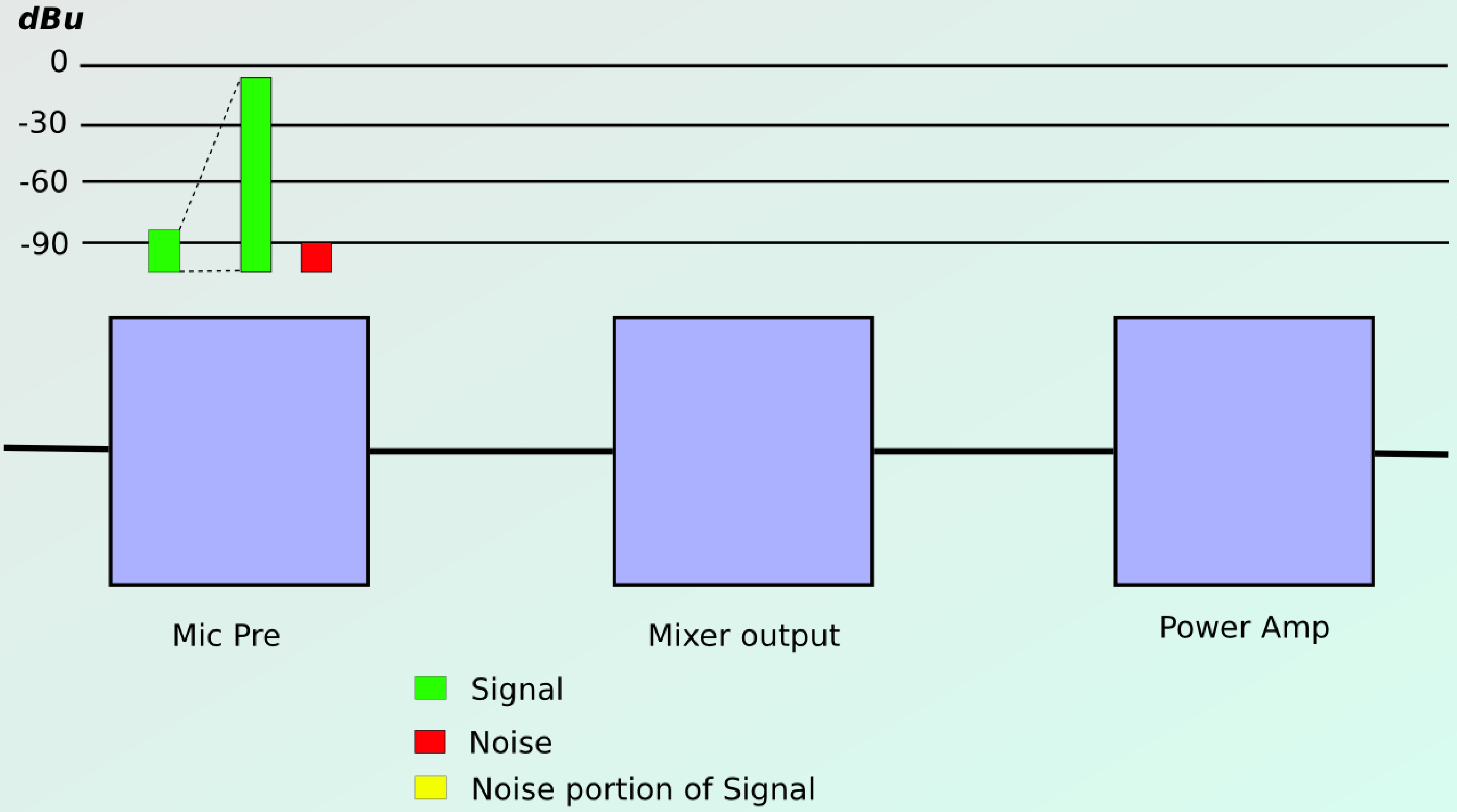
Signal to Noise Ratio



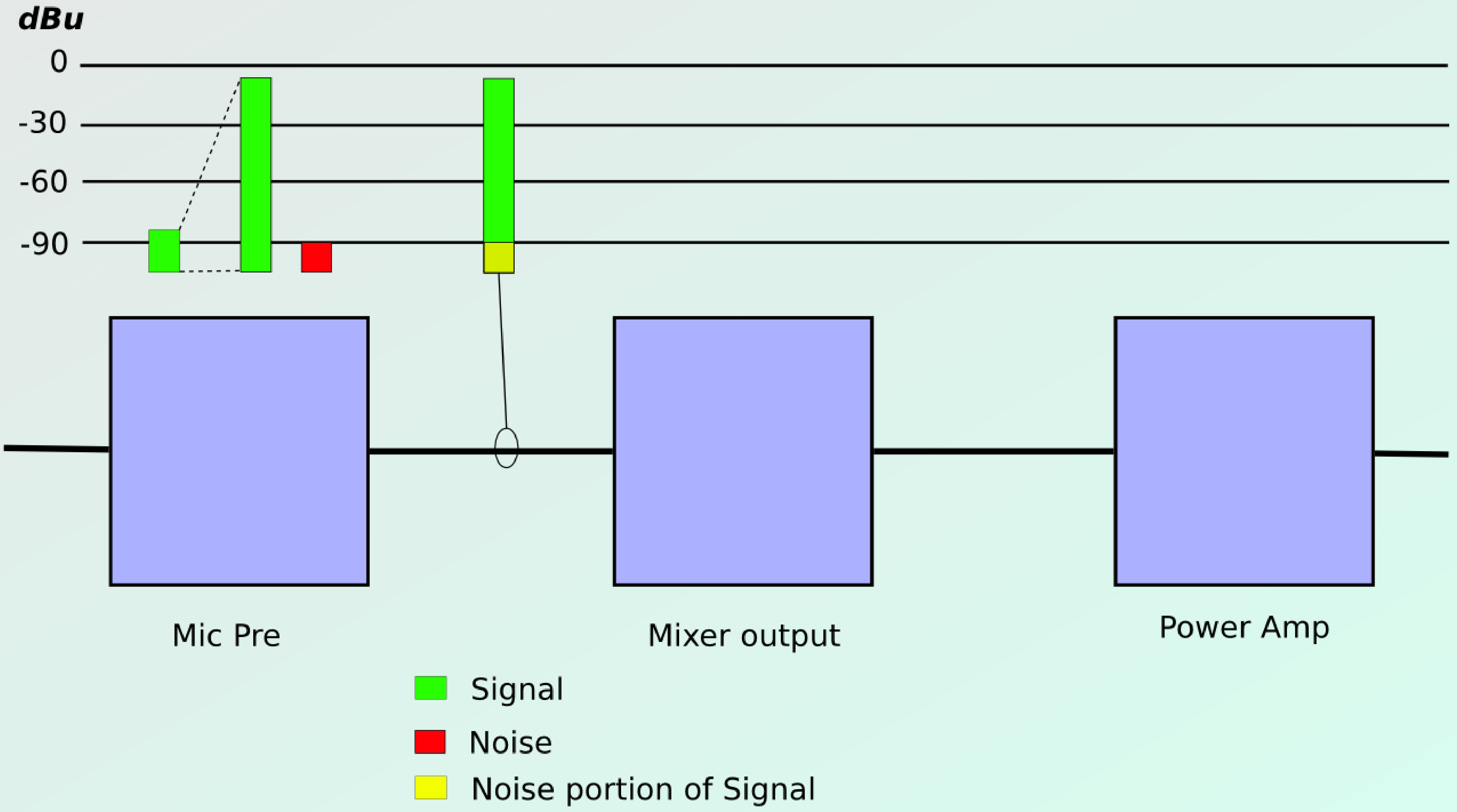
Signal Flow


Mic Pre
EQ
Channel out
Buss
Subgroup
Subgroup buss
Output
Amp in
Amp Spk out

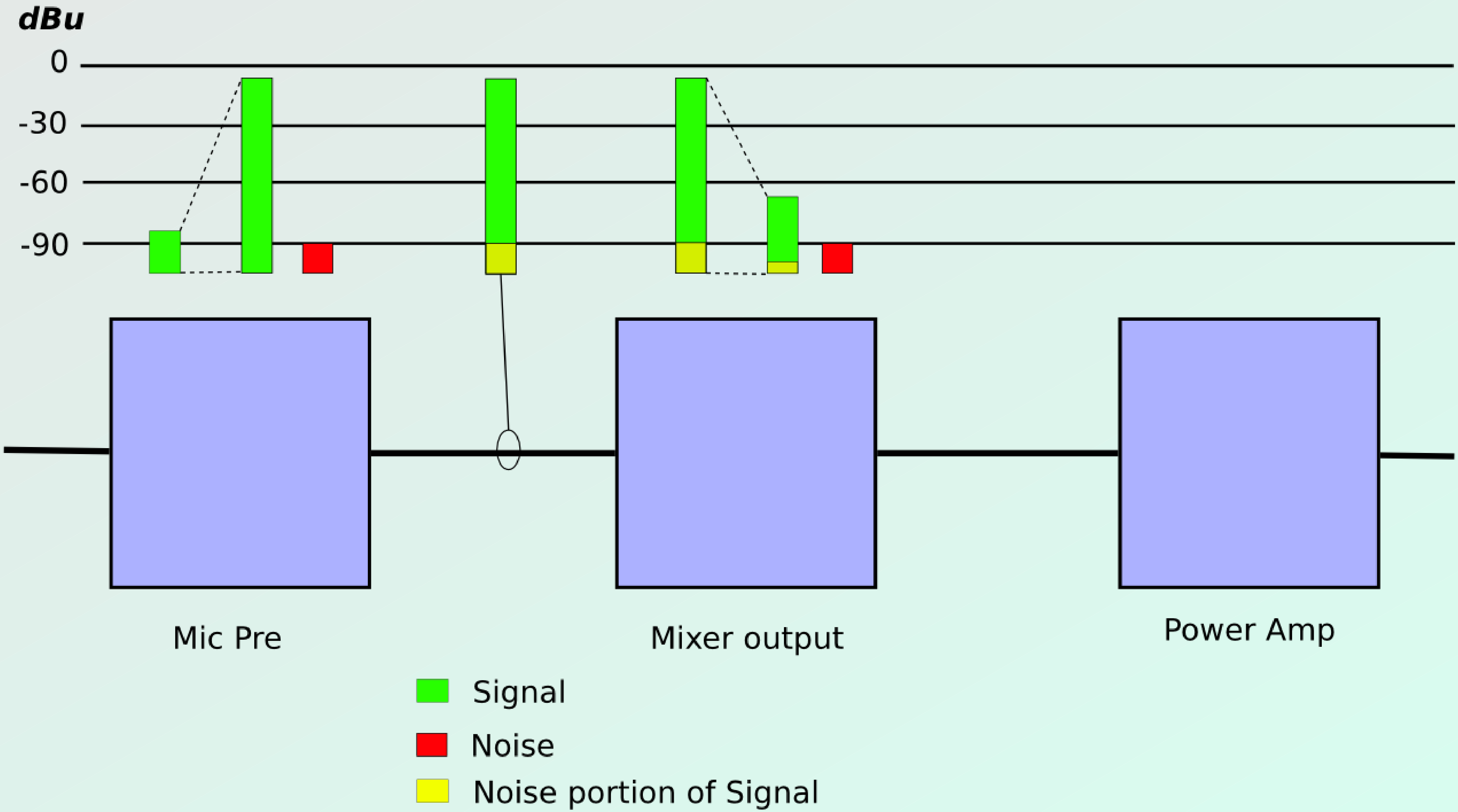
Gain Structure



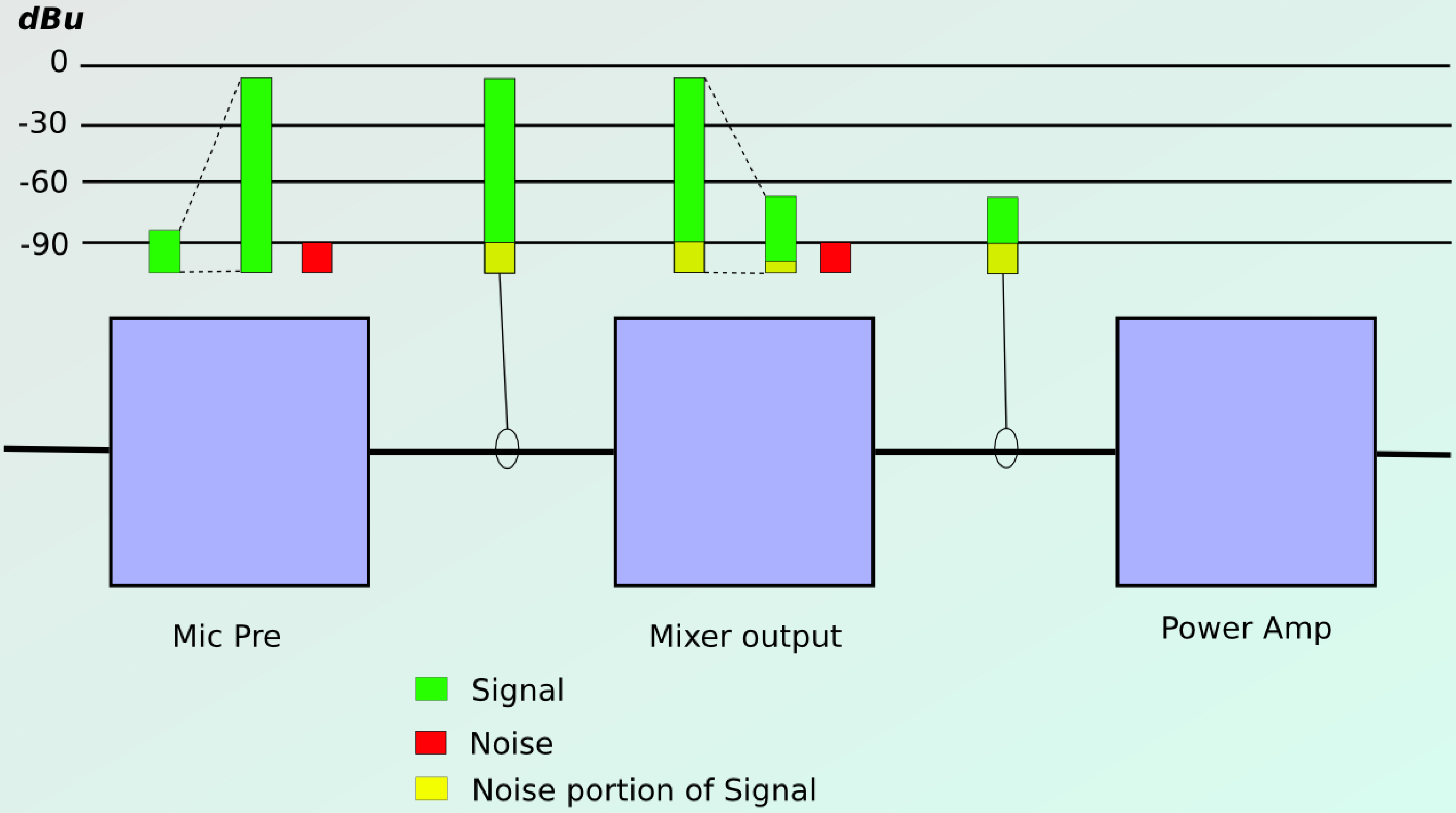
Gain Structure



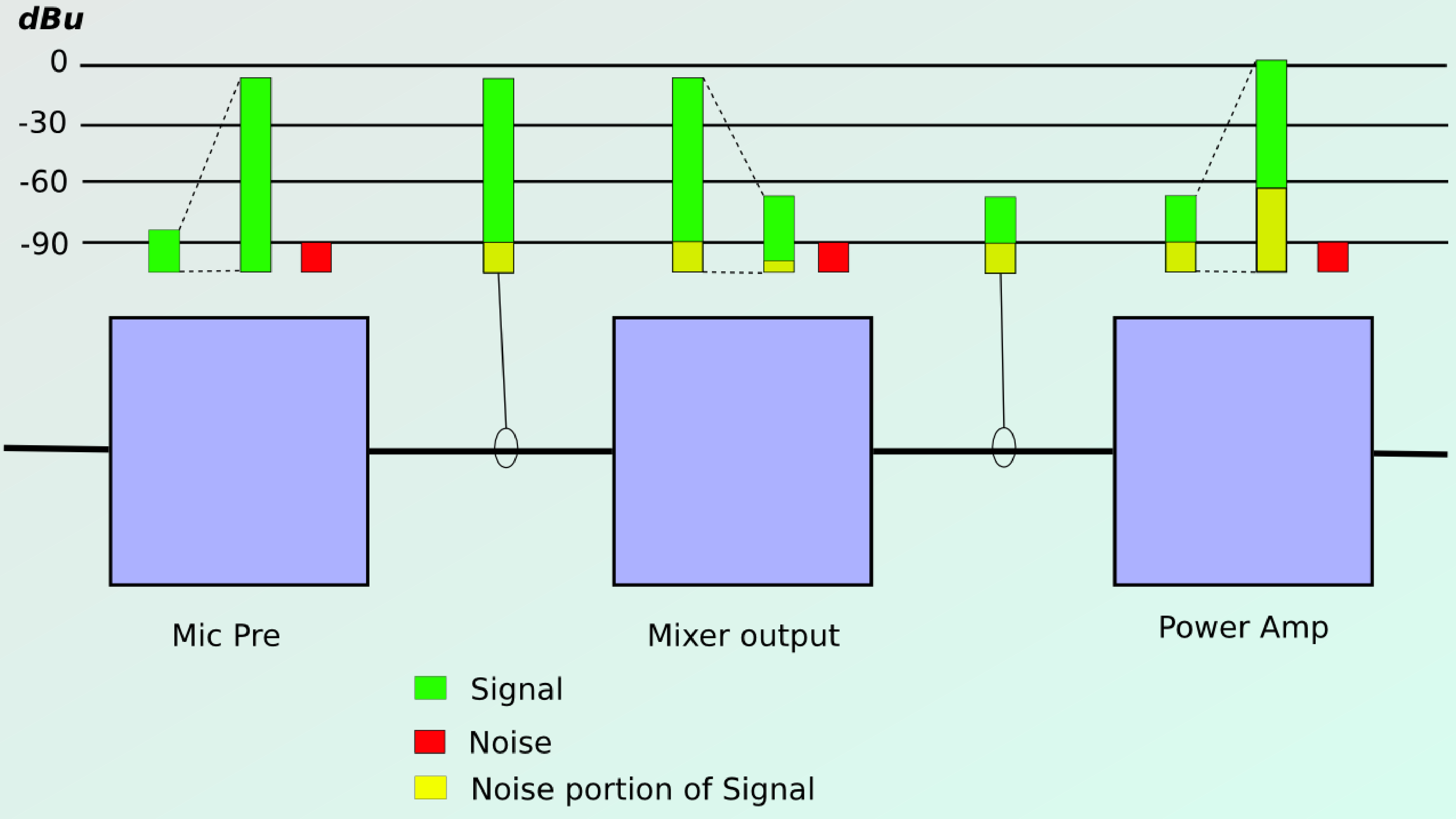
Gain Structure



Gain Structure



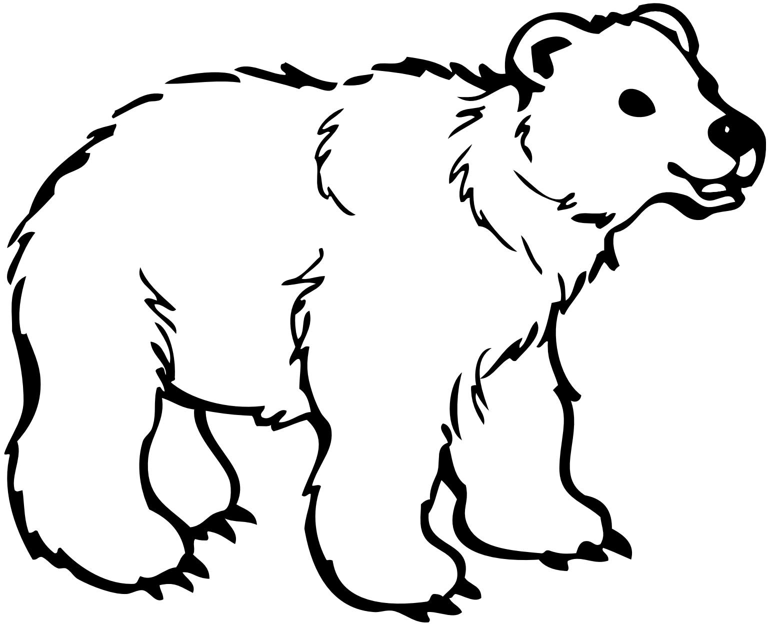
Gain Structure



Polar Plots

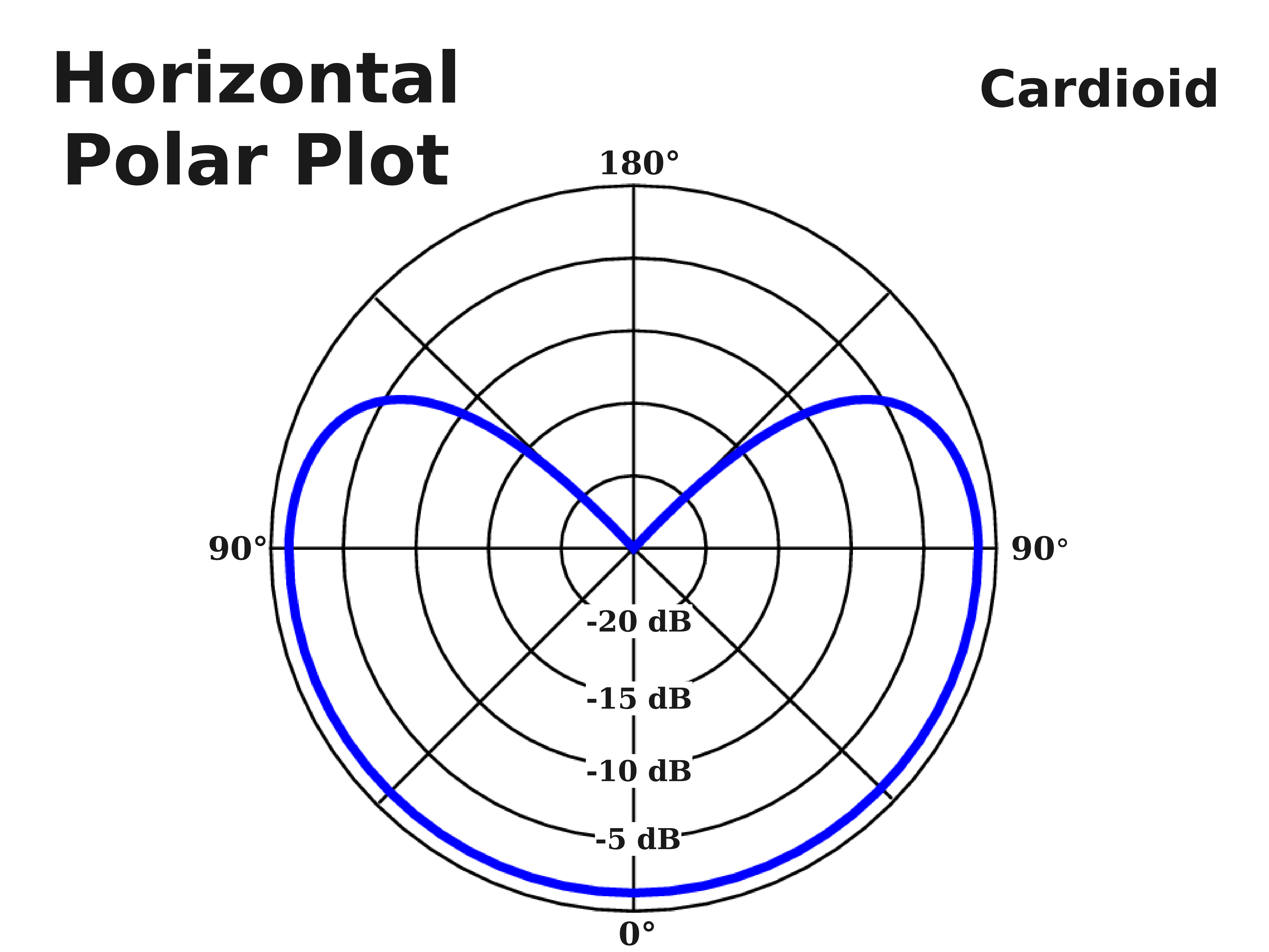
Polar Plots

- **It is not:**
  - **B-rate movie about the North Pole**
  - **Anything to do with polar bears**



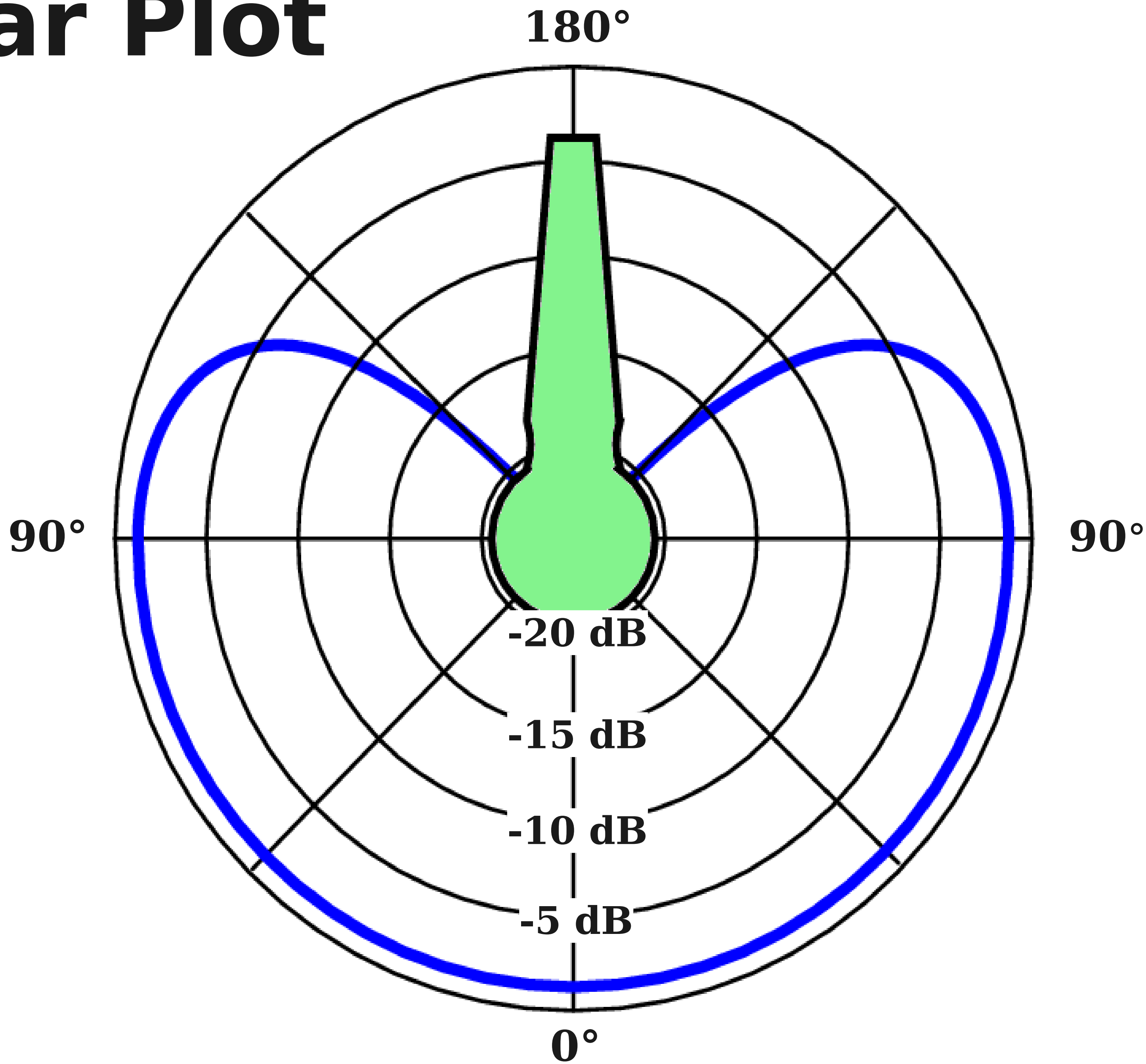
Polar Plots

- It is not:
  - B-rate movie about the North Pole
  - Anything to do with polar bears
- It is a way to chart signal levels as they relate to physical space.


Horizontal
Polar Plot
Cardioid
180°
90°
90°
-20 dB
-15 dB
-10 dB
-5 dB
0°

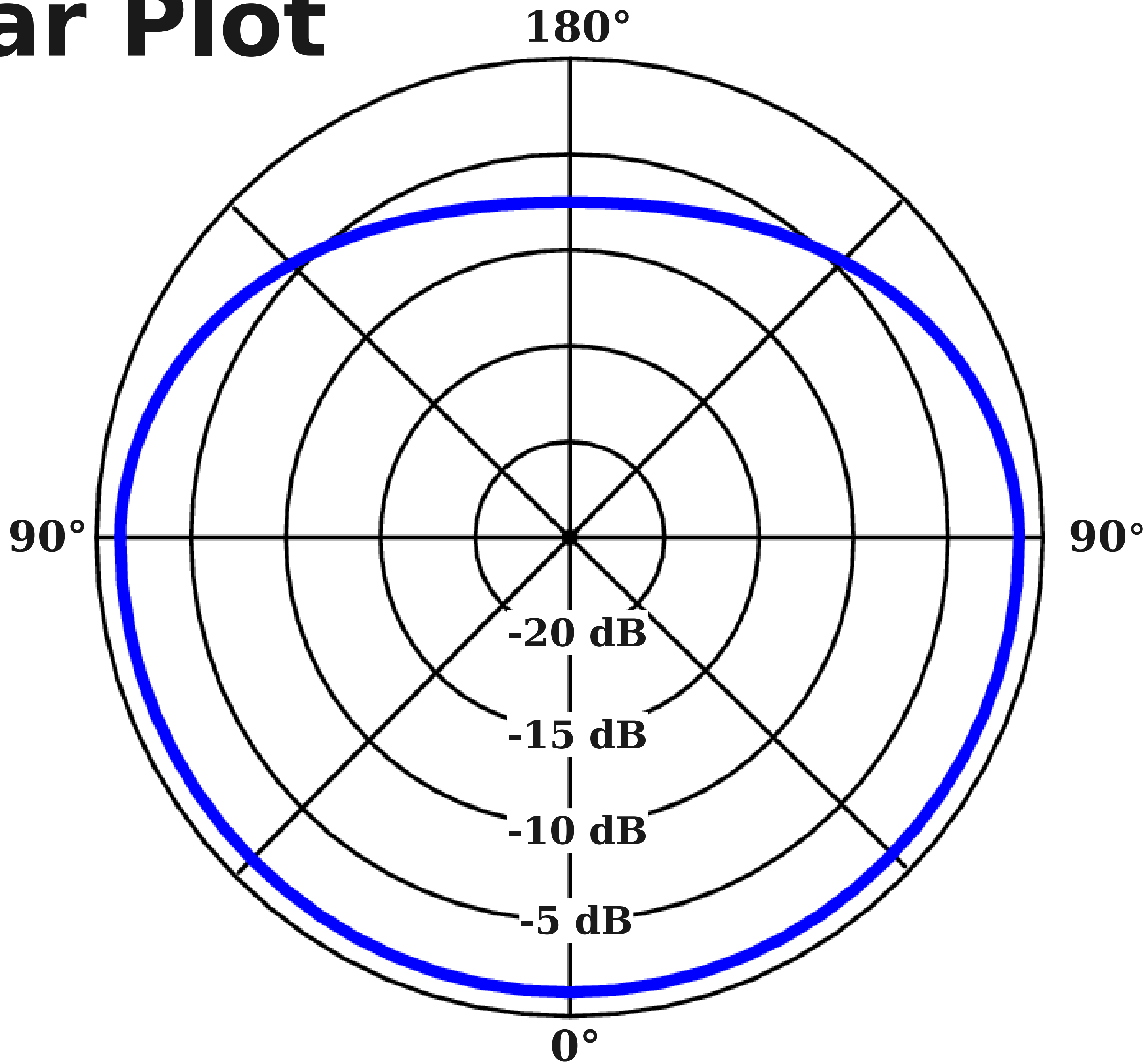
Horizontal Polar Plot

Cardiod

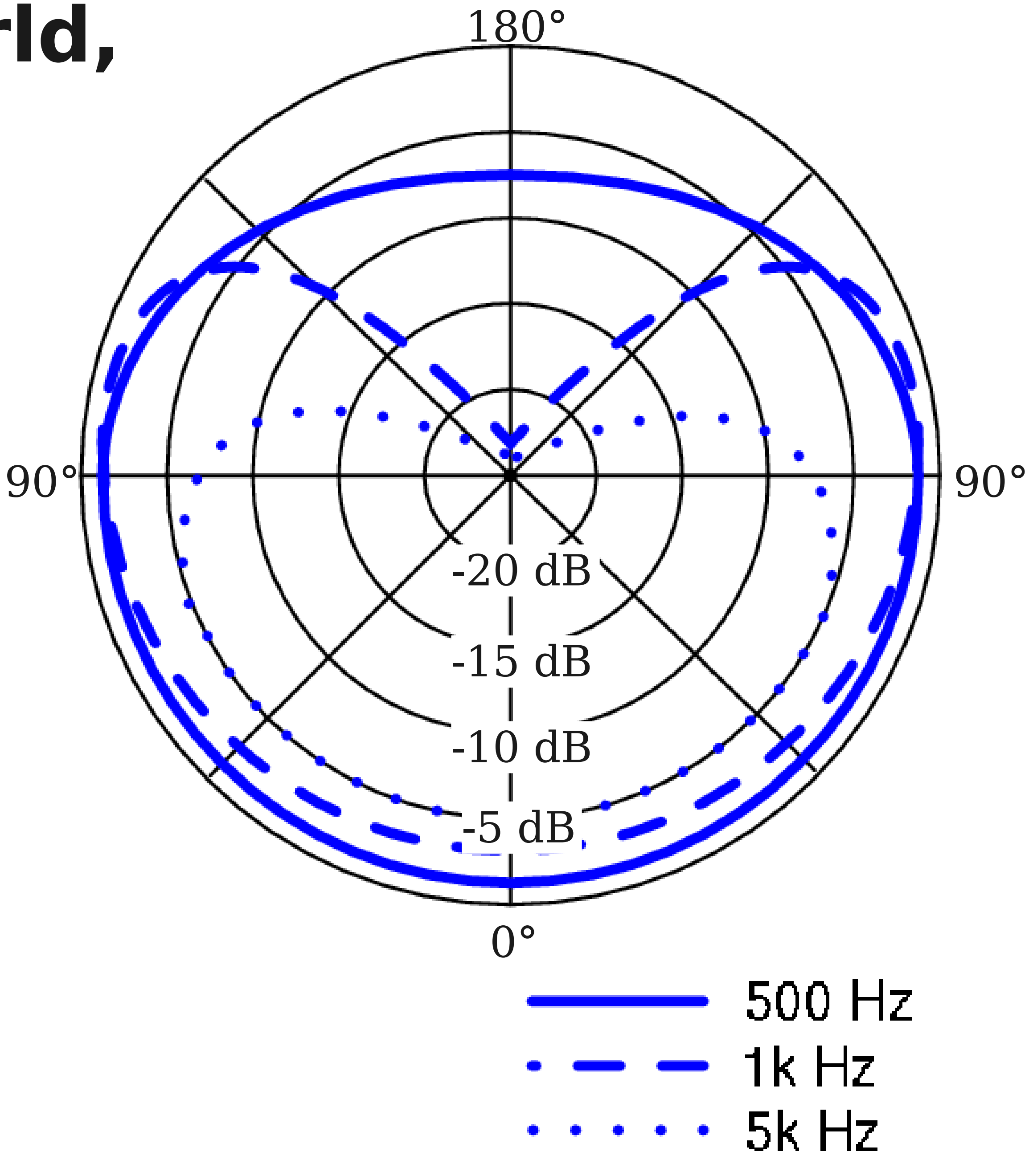


Horizontal Polar Plot

Omni-directional



In the real world, the pattern changes with frequency!



What is "Feedback"?

What is “Feedback”?

- **What does it sound like?**
- **What is it <u>not</u>.**
- **What causes it?**

What is "Feedback"?

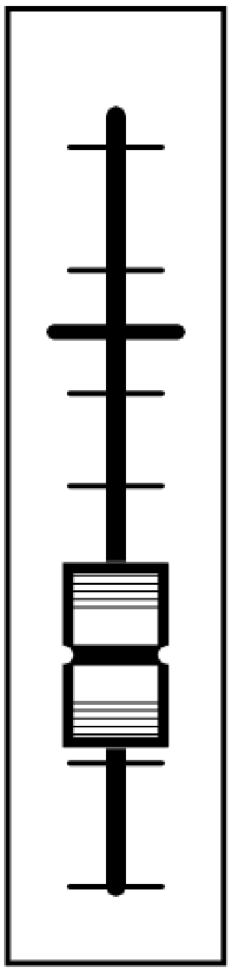
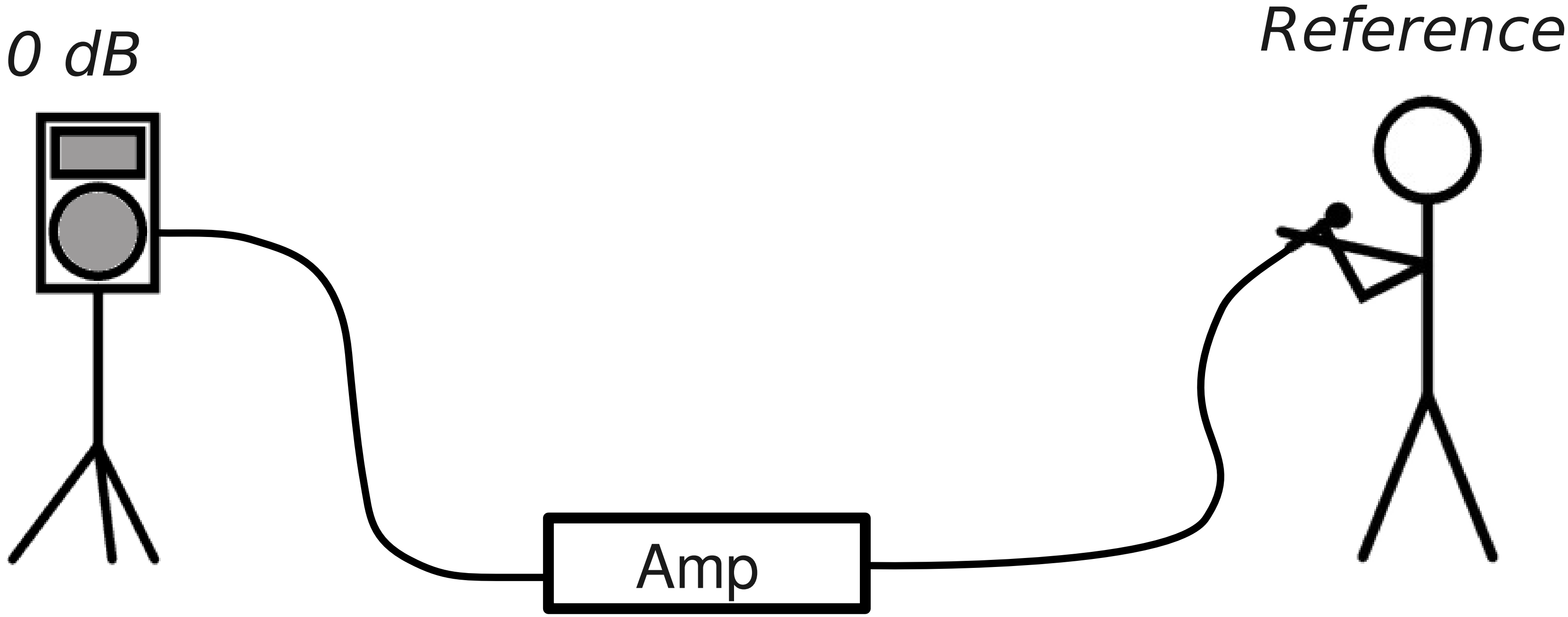
- **What does it sound like?**
  - **Usually a single tone - or two...**
  - **Often high-pitched**
- **What is it <u>not</u>.**
- **What causes it?**

What is "Feedback"?

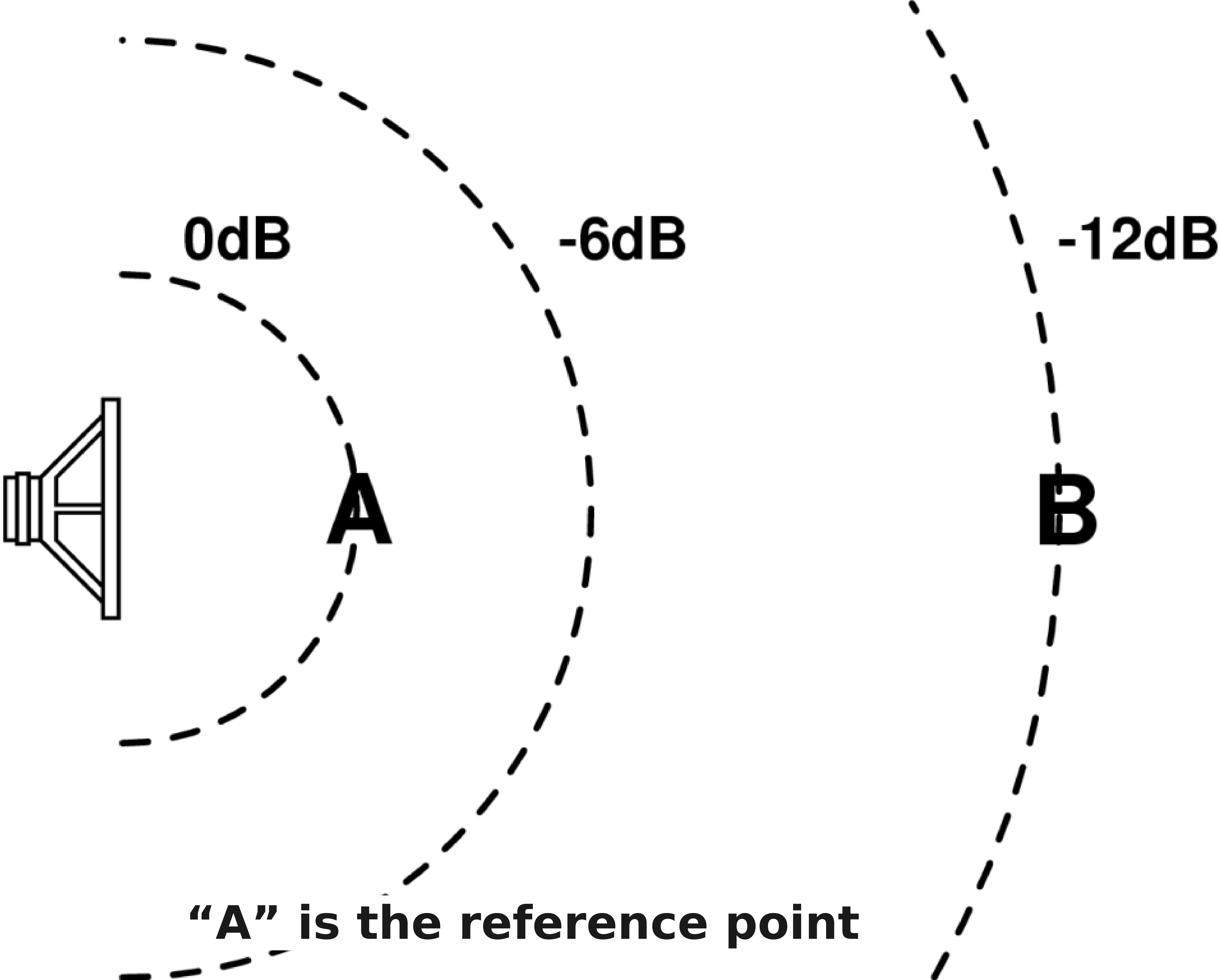
- **What does it sound like?**
- **What is it <u>not</u>.**
  - **Crackles**
  - **Pops**
  - **Static**
  - **Other noises**
- **What causes it?**

What is "Feedback"?

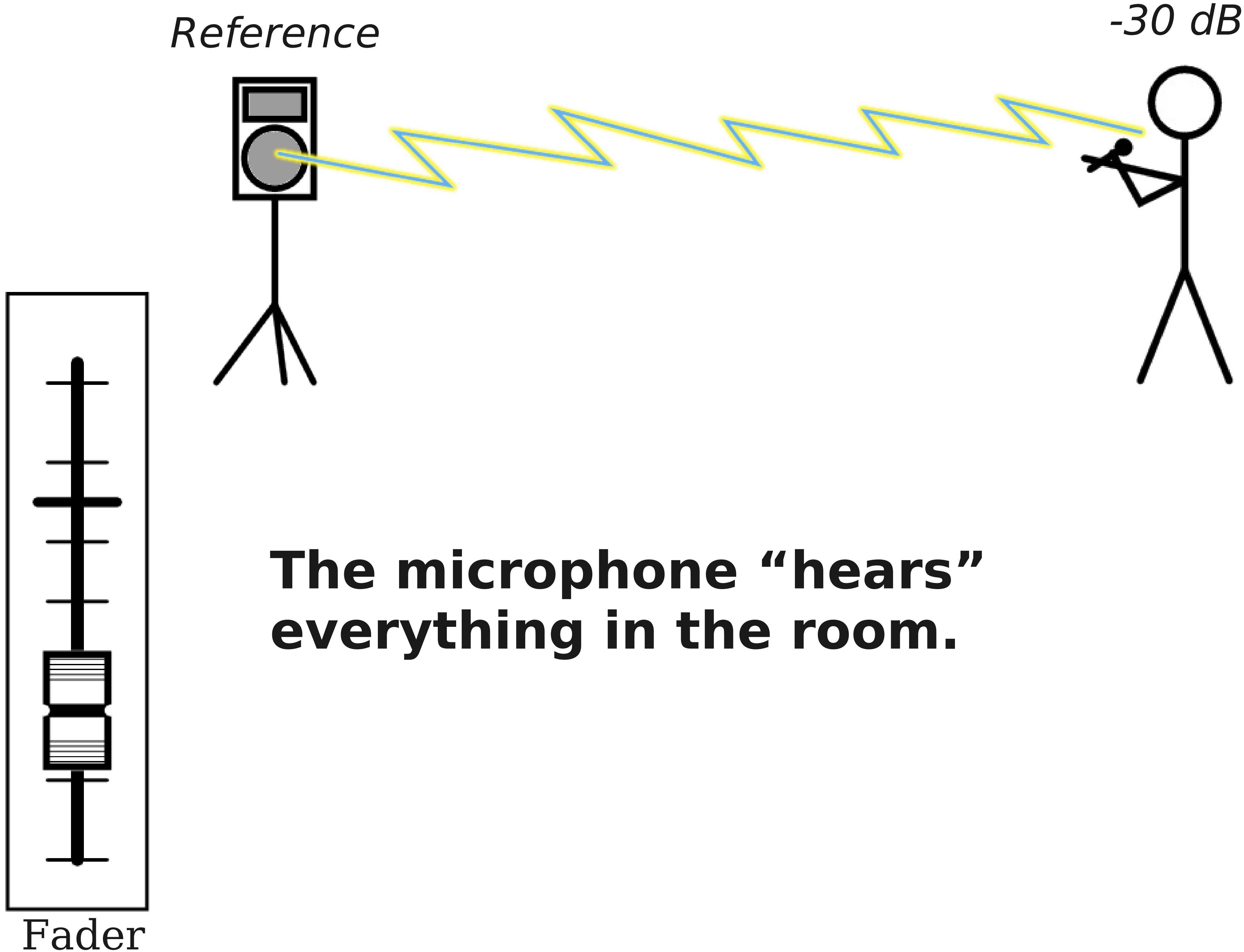
- **What does it sound like?**
- **What is it <u>not</u>.**
- **What causes it?**
  - **More electronic gain than acoustic loss**

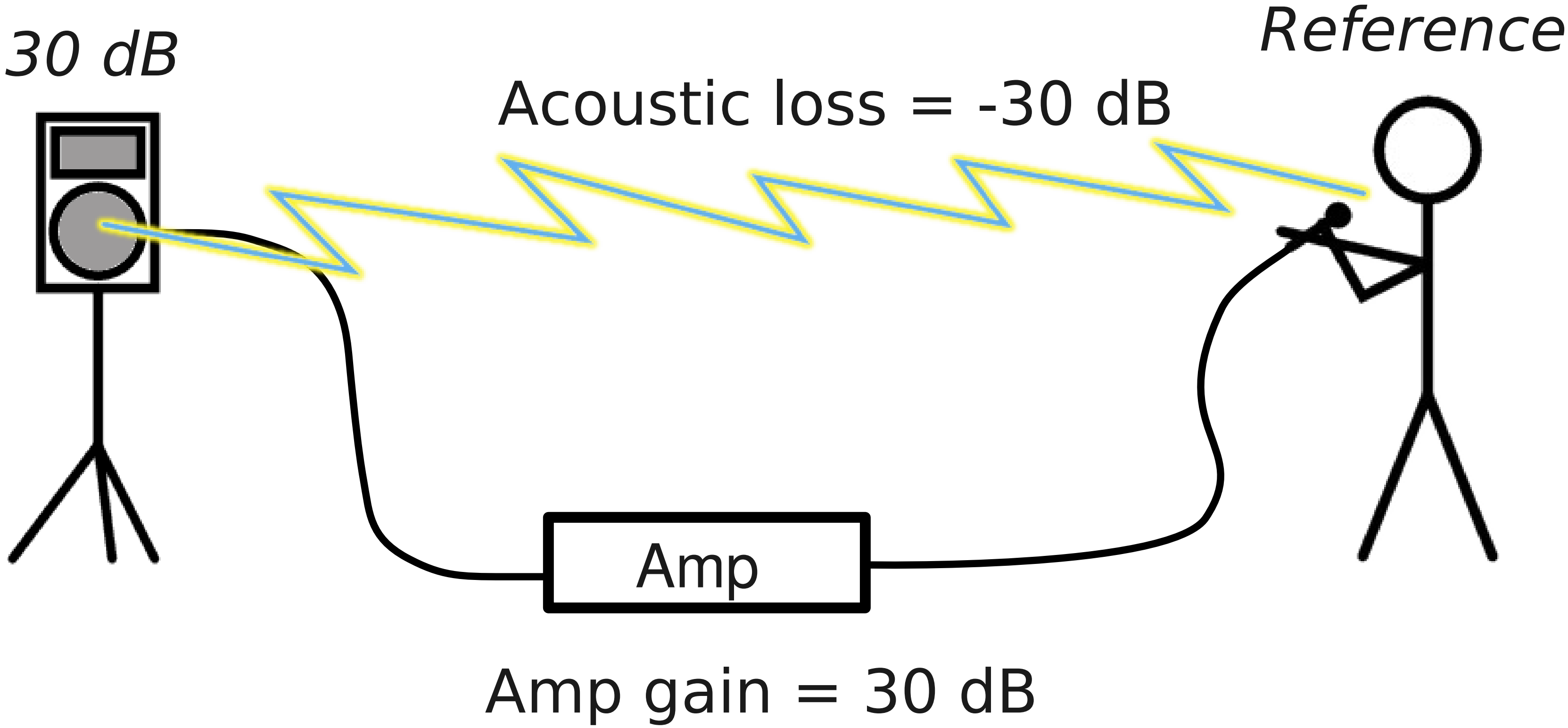



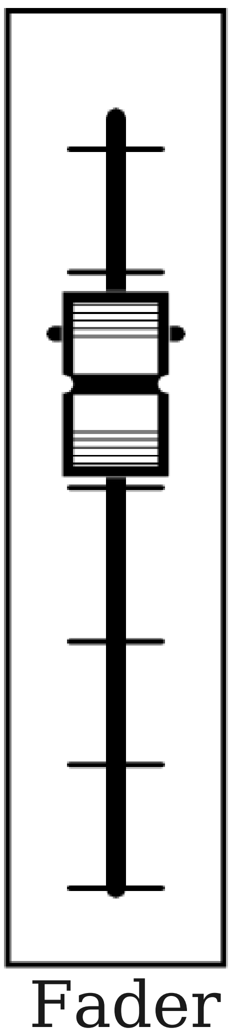
The amplifier completely "makes up for" all the losses from the voice to the loudspeaker. That is, the volume (dB SPL) from the loudspeaker is exactly the same as the voice.



“A” is the reference point

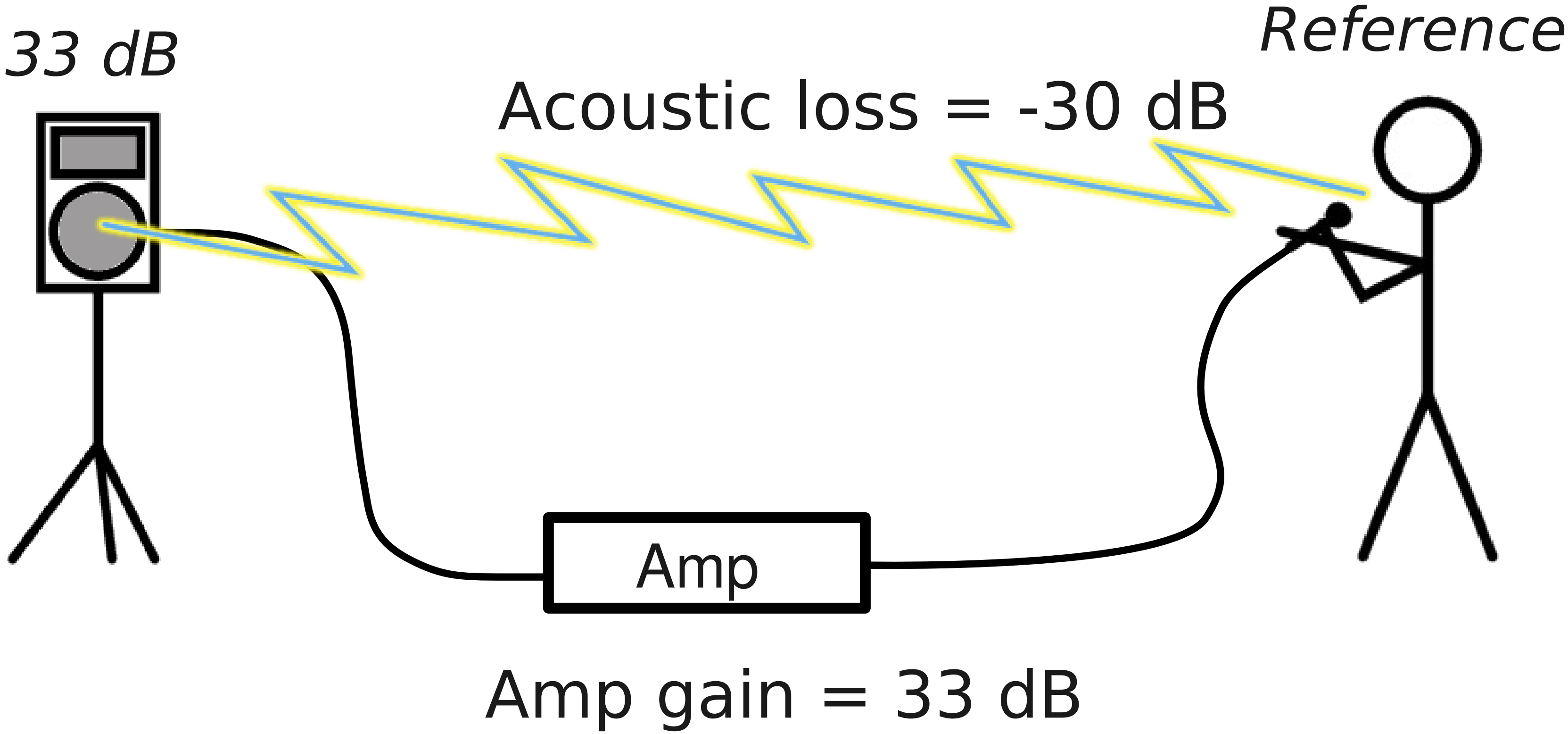

Reference
-30 dB
The microphone “hears” everything in the room.
Fader

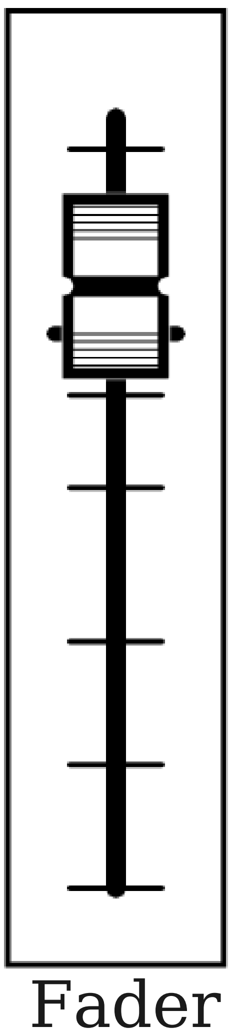




Balance point!

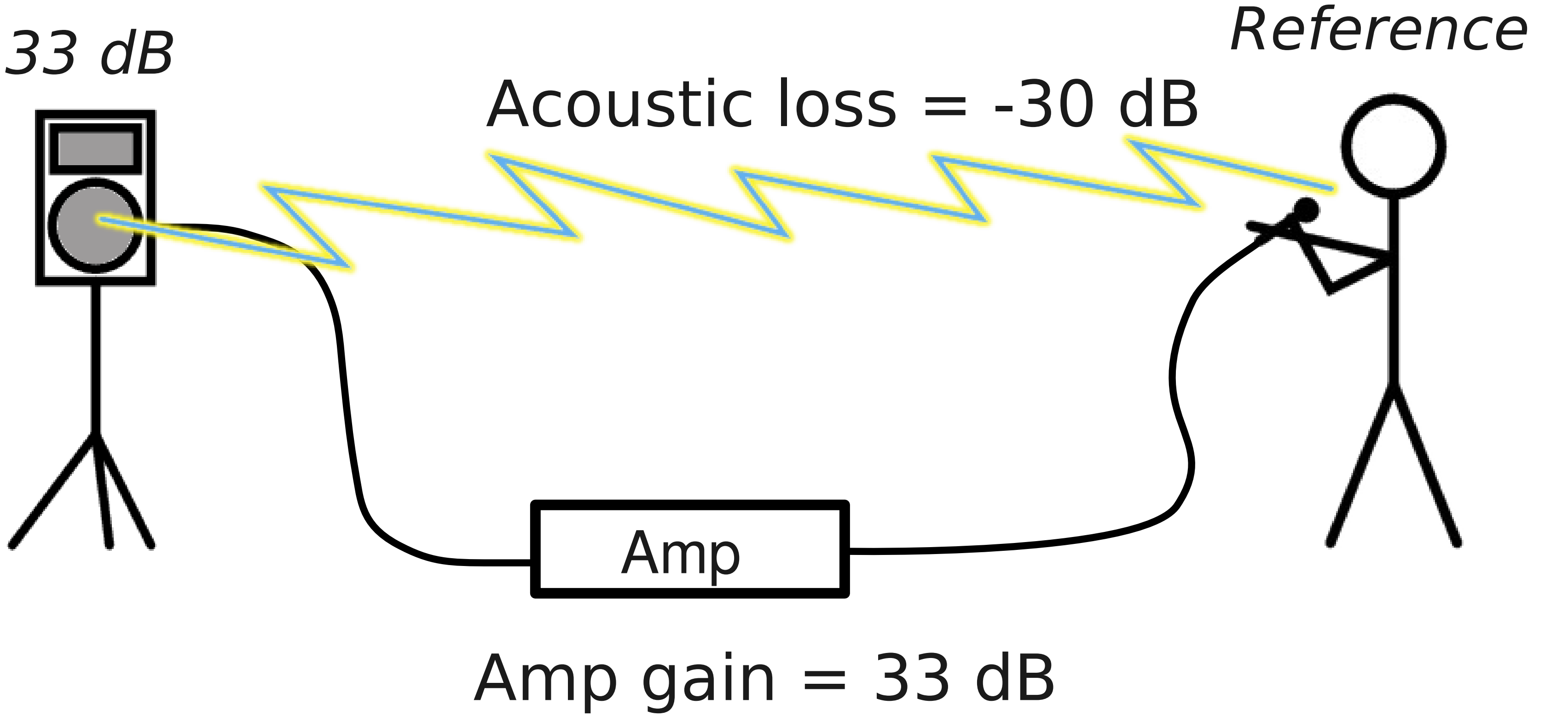
Amp gain = acoustic loss





Feedback!!!!!

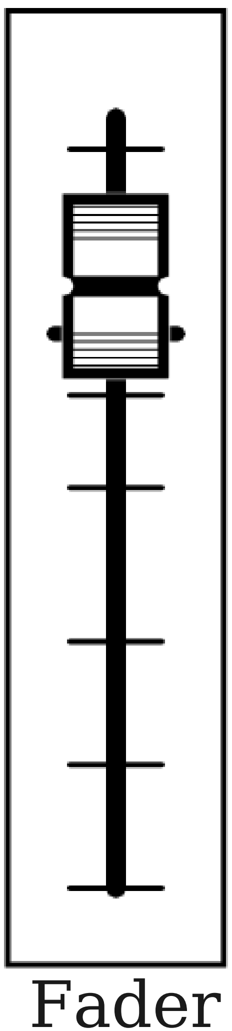
Amp gain is greater that speaker-to-mic loss. The sound keeps getting louder!



Feedback!!!!!

Amp gain is greater that speaker-to-mic loss. The sound keeps getting louder!

So, what can we do about it?



So what can we do about it??

So what can we do about it??

- Increase the acoustic loss.
- Decrease the electronic gain.

So what can we do about it??

- Increase the acoustic loss.
  - Move the mic and loudspeaker farther apart.
  - Change the angle of the loudspeaker.
  - Change the angle of the microphone.
- Decrease the electronic gain.

So what can we do about it??

- **Increase the acoustic loss.**
  - **Move the mic and loudspeaker farther apart.**
    - **Remember that sound get weaker the further it has to travel.**
  - **Change the angle of the loudspeaker.**
  - **Change the angle of the microphone.**
- **Decrease the electronic gain.**

So what can we do about it??

- Increase the acoustic loss.
  - Move the mic and loudspeaker farther apart.
  - Change the angle of the loudspeaker.
    - Speakers are rarely omni-directional. Get the mic to a spot that the loudspeaker doesn't cover well.
  - Change the angle of the microphone.
- Decrease the electronic gain.

So what can we do about it??

- Increase the acoustic loss.
  - Move the mic and loudspeaker farther apart.
  - Change the angle of the loudspeaker.
  - Change the angle of the microphone.
    - Use the mic's polar plot to “point” the weak pickup area toward the loudspeaker.
- Decrease the electronic gain.

So what can we do about it??

- Increase the acoustic loss.
- Decrease the electronic gain.
  - Change the frequency response of the system.
  - Turn down the fader.

So what can we do about it??

- **Increase the acoustic loss.**
- **Decrease the electronic gain.**
  - **Change the frequency response of the system.**
    - **Adjust an equalizer to turn down the frequency to which the mic/speaker/room system is most responsive.**
  - **Turn down the fader.**

So what can we do about it??

- Increase the acoustic loss.
- Decrease the electronic gain.
  - Change the frequency response of the system.
    - Adjust an equalizer to turn down the frequency to which the mic/speaker/room system is most responsive.
    - It <u>will</u> affect the desirable sound too!
  - Turn down the fader.

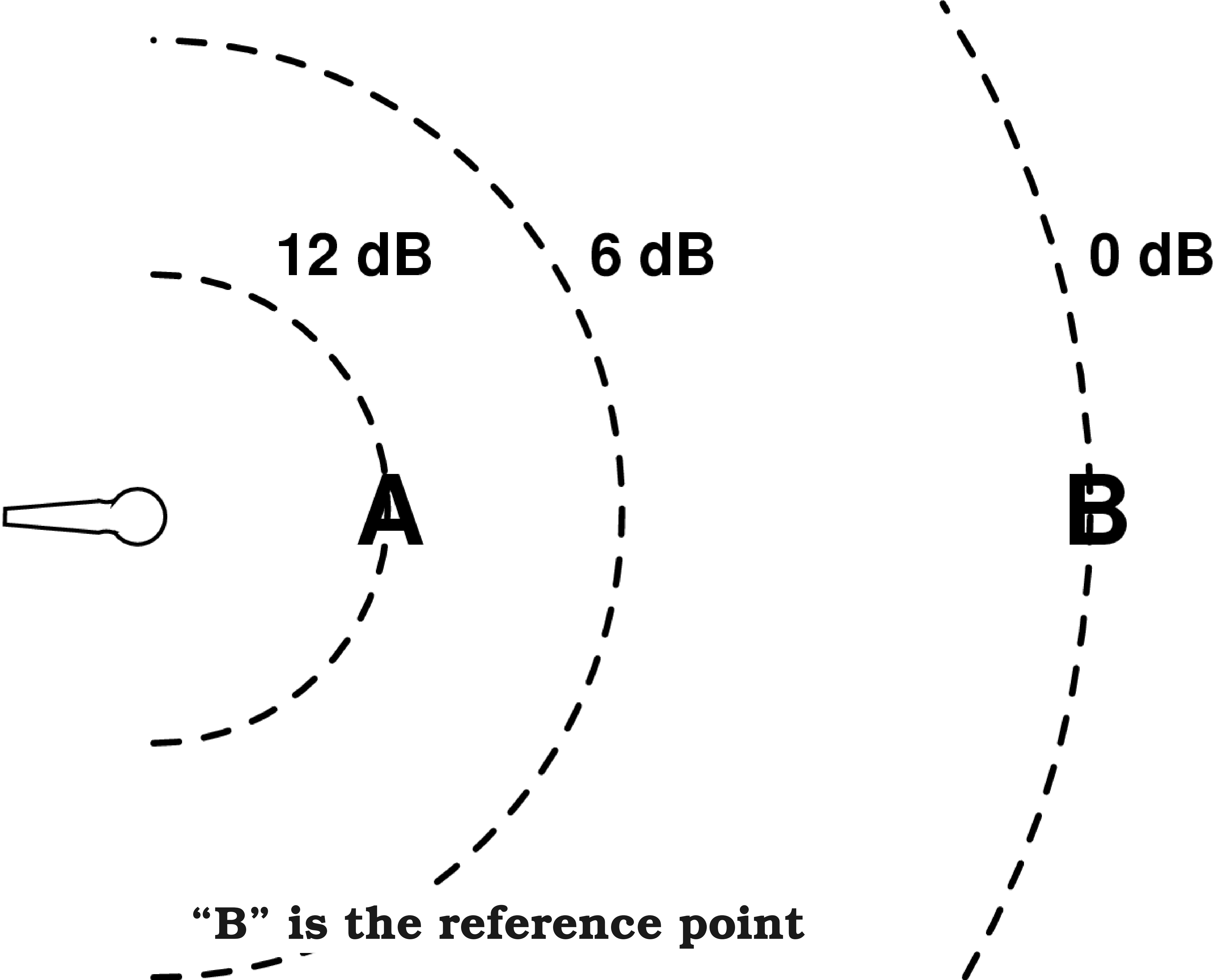
So what can we do about it??

- Increase the acoustic loss.
- Decrease the electronic gain.
  - Change the frequency response of the system.
  - Turn down the fader.

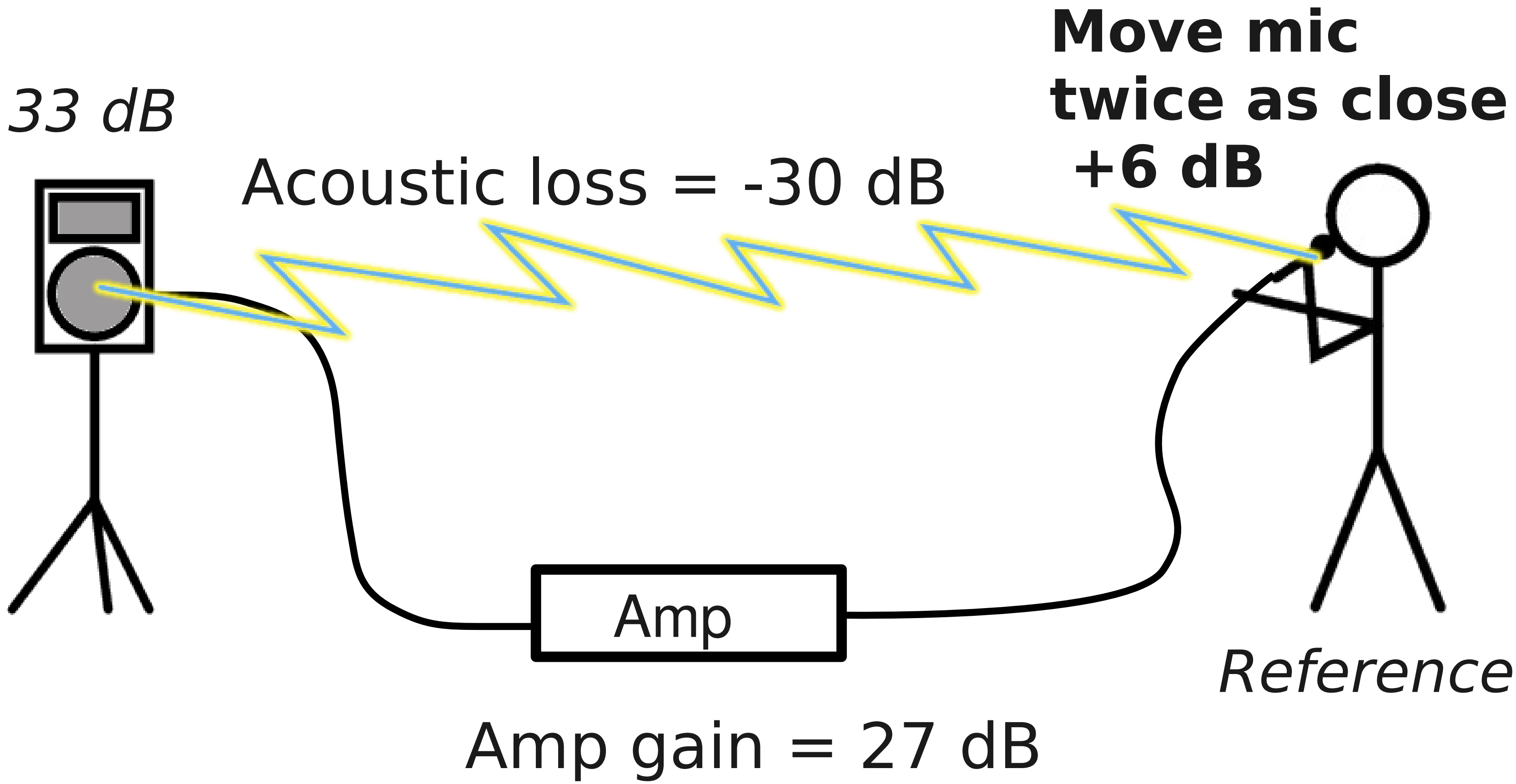
So what can we do about it??

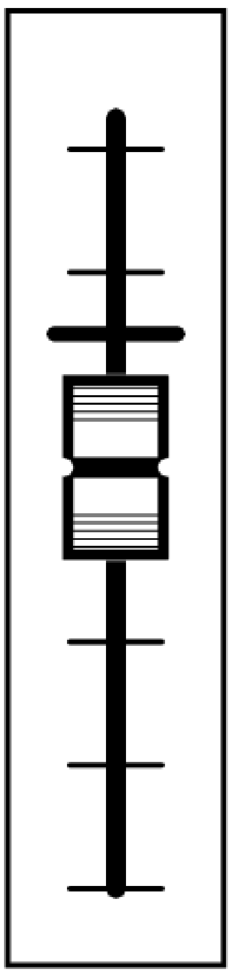
- Increase the acoustic loss.
- Decrease the electronic gain.
  - Change the frequency response of the system.
  - Turn down the fader.

But now we can't hear because it is too quiet!



“B” is the reference point





Turn down the amp 6 dB

The sound in the room is the same volume, but there is less amp gain needed because the source sound is louder.

So no more feedback!

Instant Replay

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

Instant Replay

- The three categories of audio signal types.
  - Mic, Line and Speaker level
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
  - A convenient way to manage a large range of signal ratios.
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
  - Don't be afraid of your owner's manual.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
  - Practices - just not during the service.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
  - Apply the gain early in the chain.
- Polar plots.
- Understanding Feedback.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
  - A picture of the sound in 3D space.
- Understanding Feedback.

Instant Replay

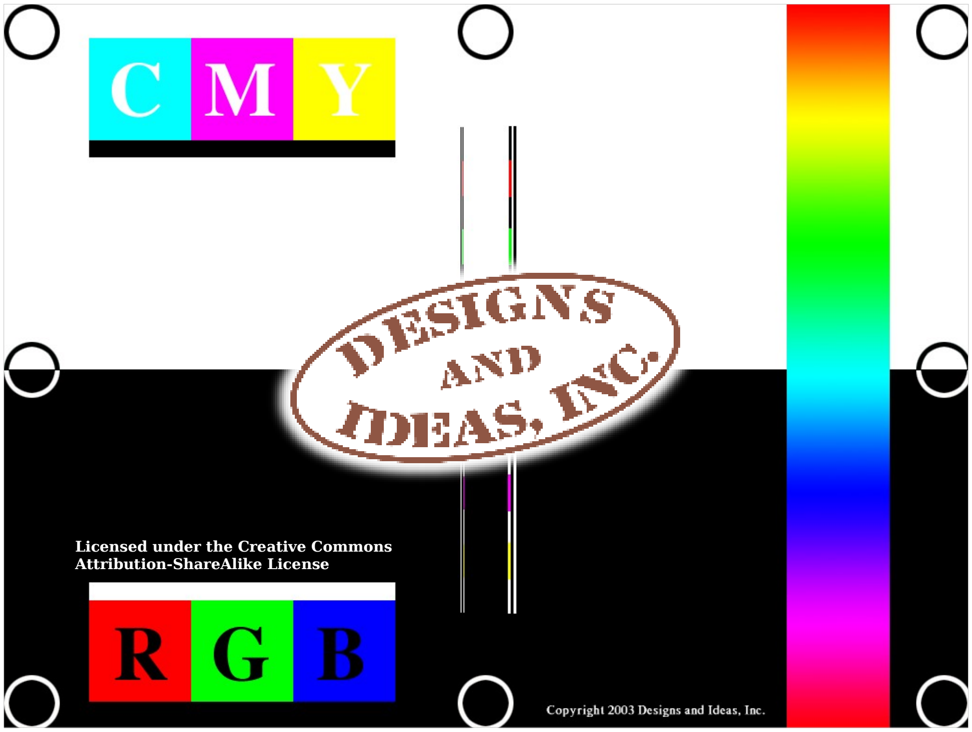
- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.
  - Move the mic closer.

C M Y

It's all over - it's safe to wake up!

R G B

Black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Welcome

See the Future…

or

What you can expect to learn.

The topics that will be discussed.

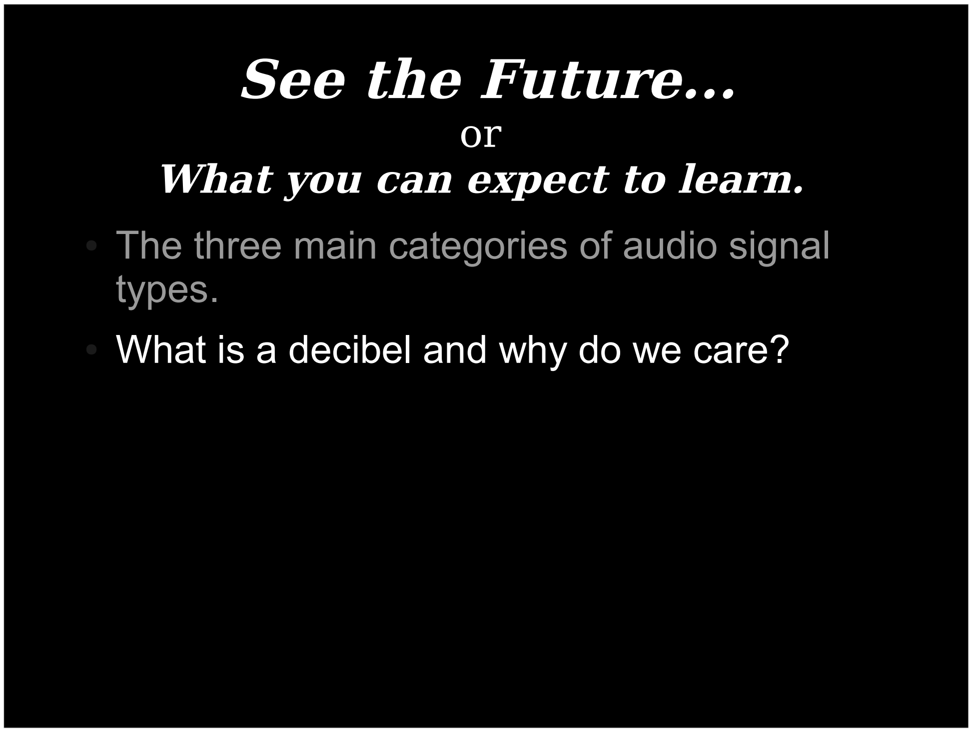
See the Future...

or

What you can expect to learn.

- The three main categories of audio signal types

In pro audio, we can divide the signals into three groups. We'll look at how they differ and how they should each be treated.



The term "decibel' shows up often. We'll look into what it is, what it means, and how to use it.

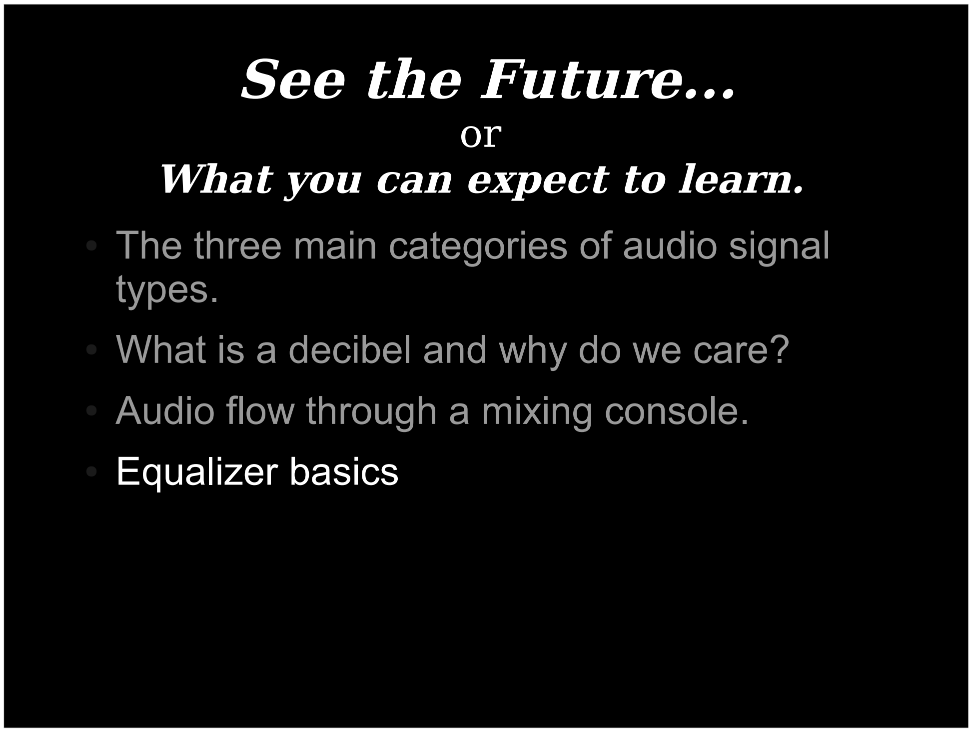
See the Future…

or

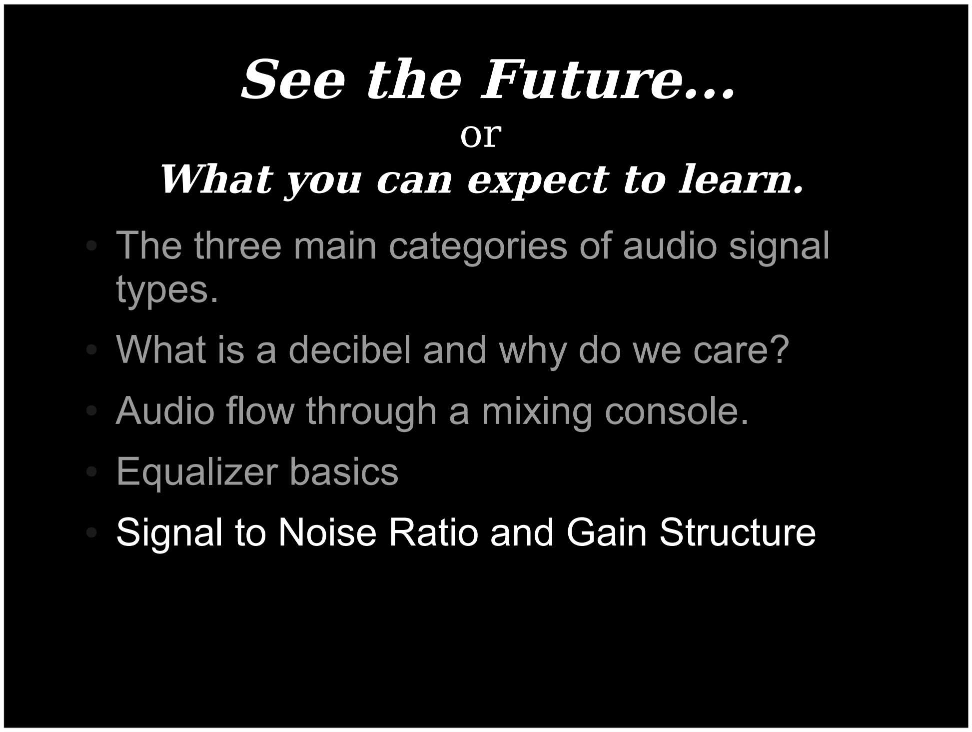
What you can expect to learn.

- The three main categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console

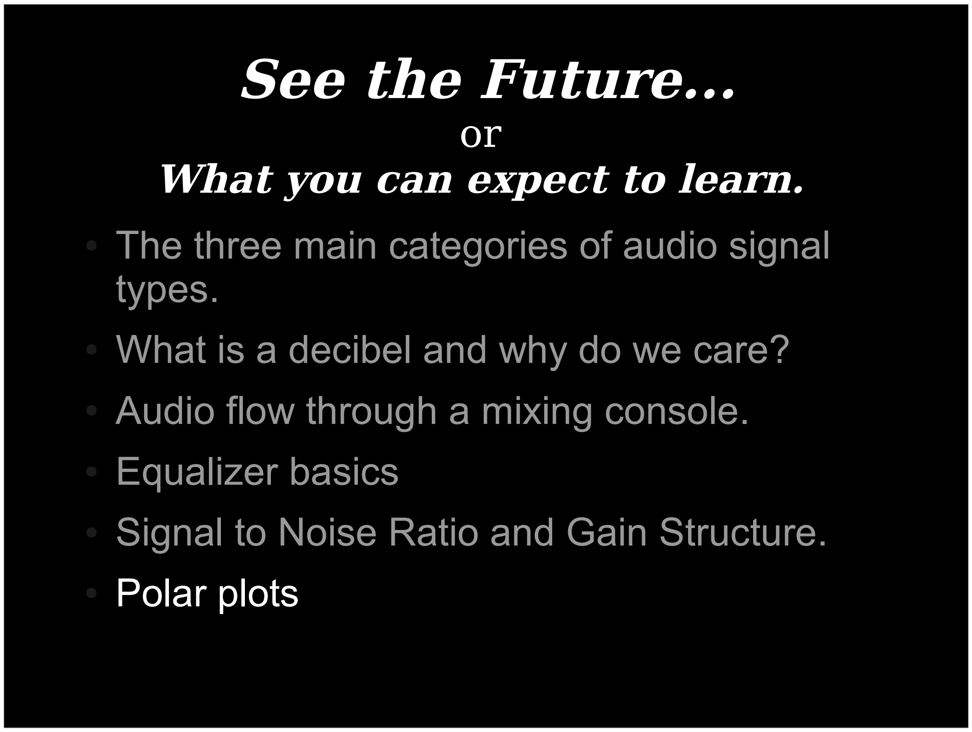
Every mixer is different, but this is a quick walk-through of what happens to a signal as it passes through a mixer.



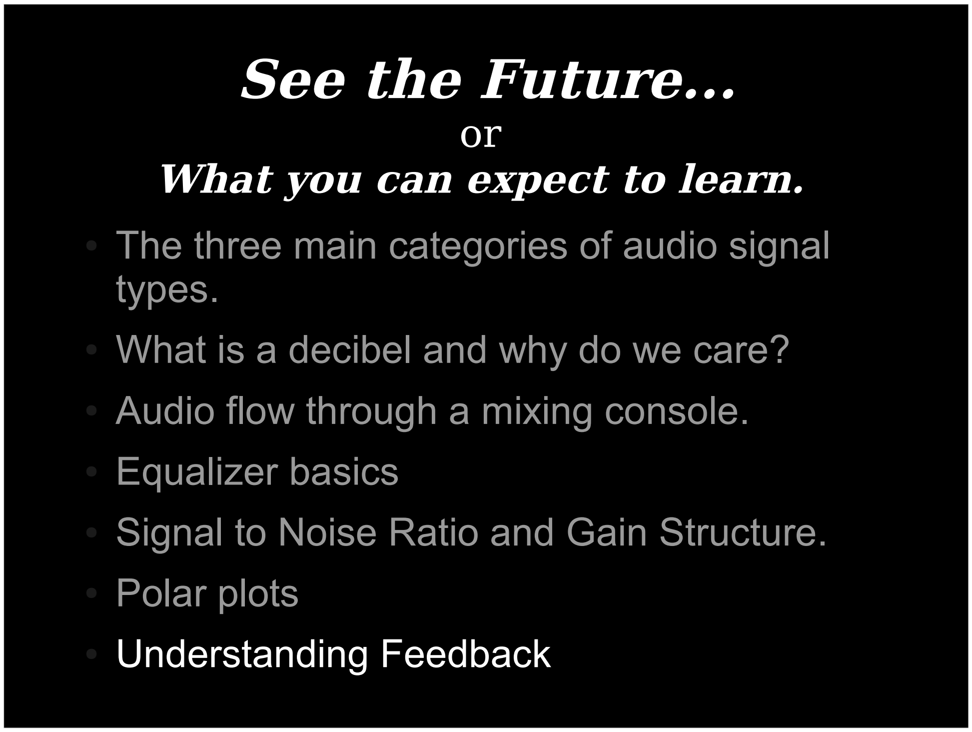
An equalizer can't fix every problem. So we'll dig into what it does and how it can be helpful.



In even simple systems, there are a lot of level controls. We'll get into the theory why it's good to turn it up early and down late.



How to read a polar plot graph and how that information can help a sound system operator.



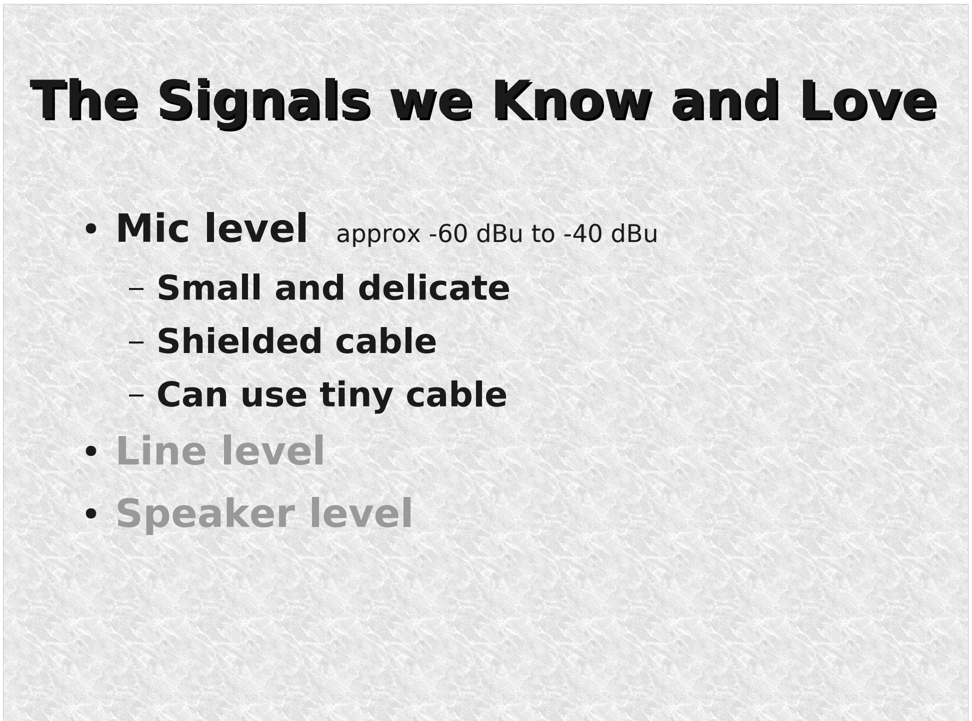
That ever troublesome feedback. We will walk through what it is, how it's caused, and what to do about it.

The Signals we Know and Love

The three signals...

Audio signals can be grouped into three main categories. The main difference between them is the voltage, or level.

How we handle the signals and the cables we use does vary.



"Mic level" is the type of signal a microphone outputs.

Mic level has the least voltage. It is the most susceptible to interference. A cable that is built both with a shield and as a twisted pair cable is preferred because both features aid in avoiding interference.

The current is also low, and so small wires work just fine.

Line level is the level used to interconnect most equipment.

It is has a much higher voltage than mic level, but it is not immune to interference. Shielded twisted pair cable is still a good idea, but not as necessary as with mic level.

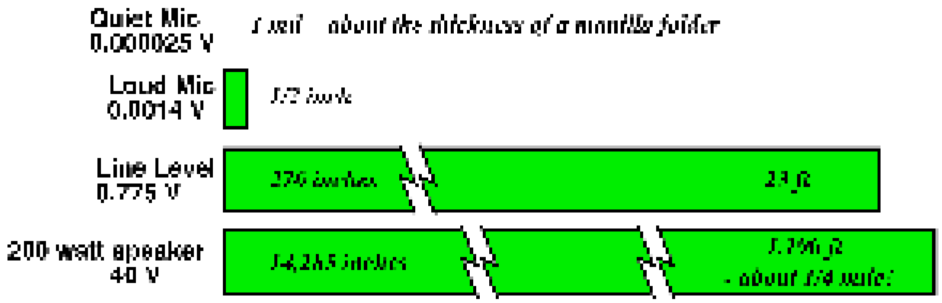
The current is low enough so that small wires are still usable.

"Speaker level" is the signal used to drive speakers.

Speaker level voltage is high enough that there is no need to protect it. Actually, it is high enough that mic level cables need to be protected **from** it! Twisted pair cable helps contain the magnetic field so it is less likely to cause interference.

Large cable is often necessary due to the higher current.

Voltage Range of Audio Signals

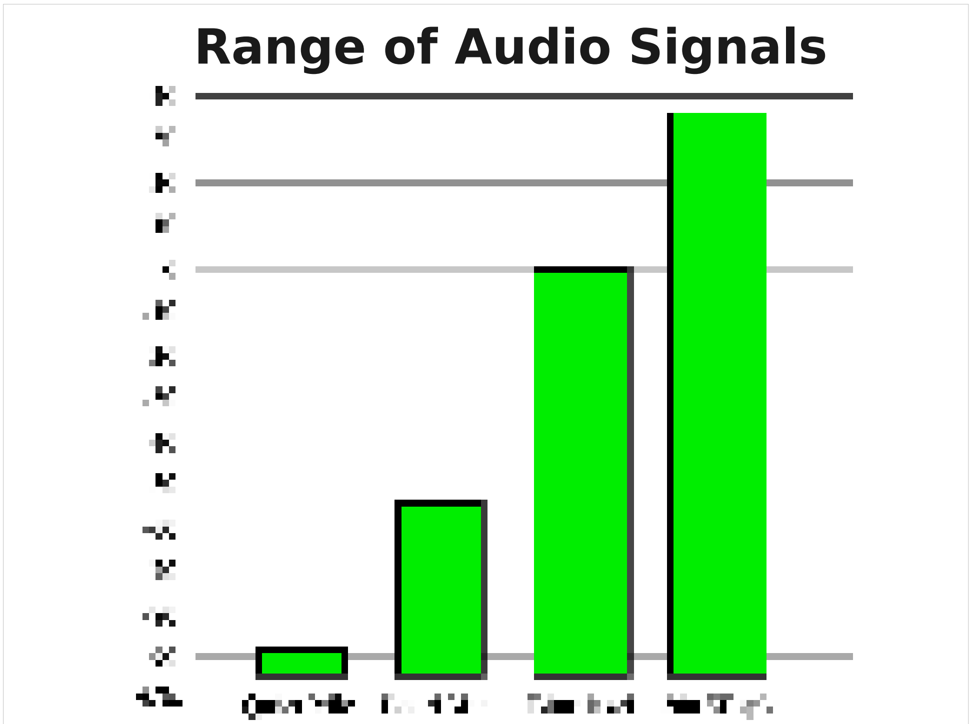


This is a graph to compare the voltages of the signals. It doesn't works so well.

If the scale is such we can see the difference between a quite and loud mic - the other two are off the chart!

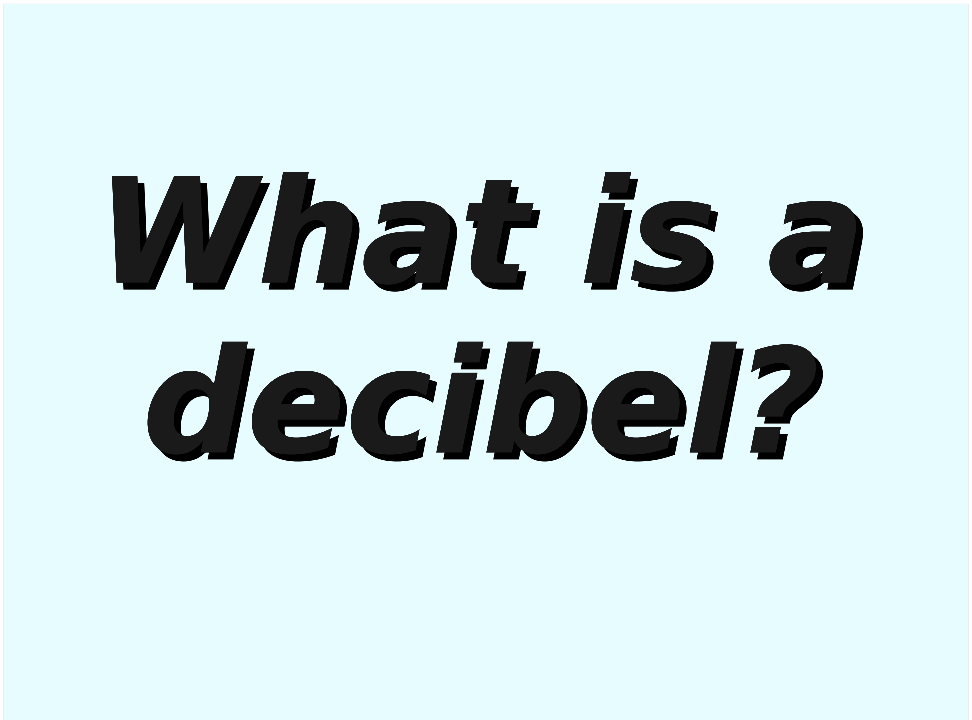
Adjust it so the speaker level fits - and the other three are so small they look the same.

So....



Lets display it with a logarithmic scale.
This one is labeled in decibels.

Labeled in _what_?



Decibel header.

What is a decibel?

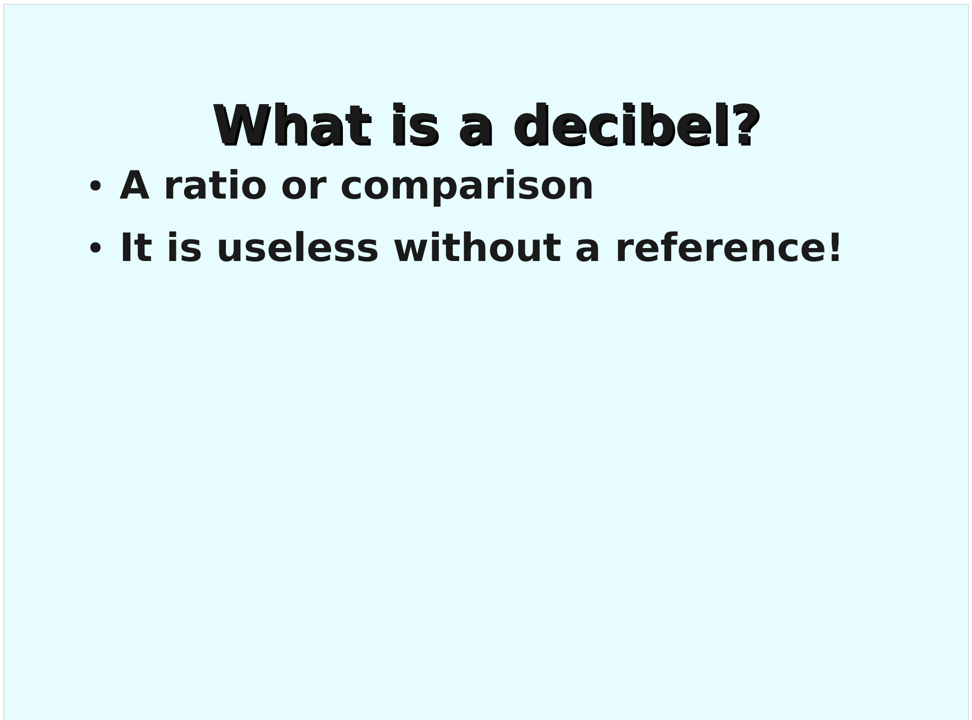
A decibel is one tenth of a bel (B). Devised by engineers of the Bell Telephone Laboratory to quantify the reduction in audio level over a 1 mile (approximately 1.6 km) length of standard telephone cable, the bel was originally called the transmission unit or TU, but was renamed in 1923 or 1924 in honor of the Bell System's founder and telecommunications pioneer Alexander Graham Bell. In many situations, however, the bel proved inconveniently large, so the decibel has become more common.

From Wikipedia

Wikipedia's definition.

Since much of the pro sound came from the telephone field, it should be no surprise that some of the references would to.

But few modern audio folk have any idea how much signal is lost on an telephone line. And with cell phones and VOIP - who cares!



A decibel is logarithmic ratio of either the voltage (pressure) or the power.

Because it is a ratio, it requires there to be two factors.

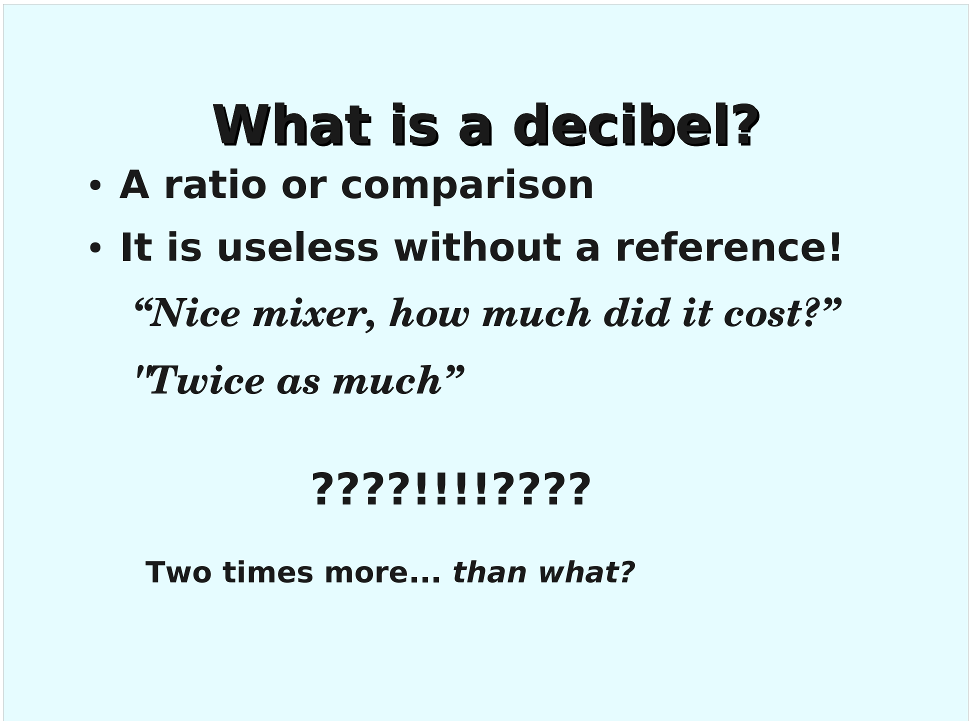
What is a decibel?

- **A ratio or comparison**
- **It is useless without a reference!**

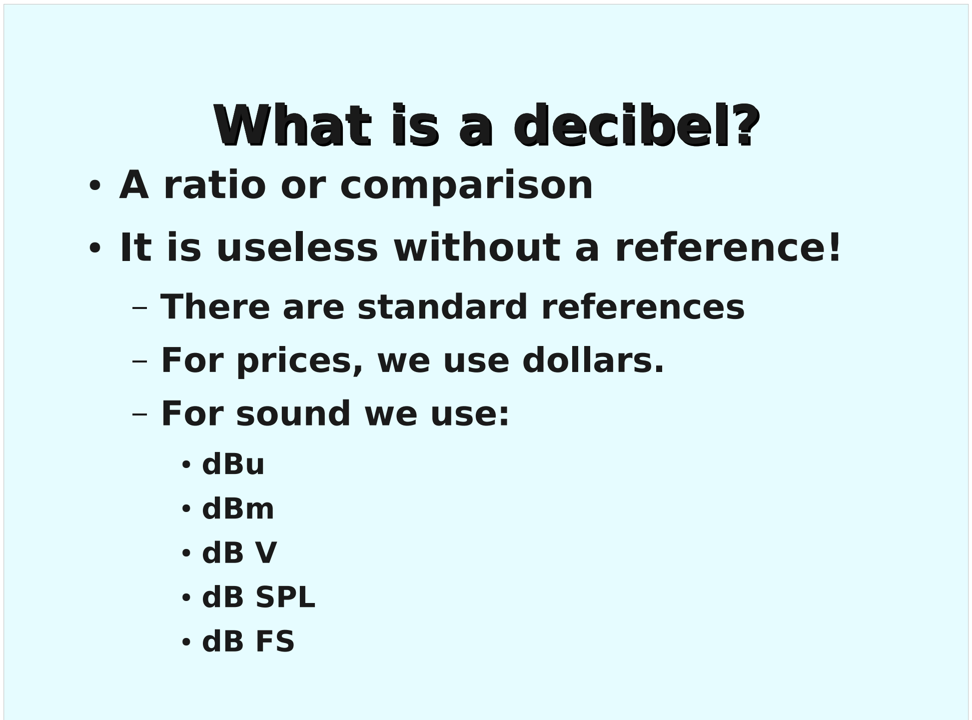
"Nice mixer, how much did it cost?"

"Twice as much"

The concept of a "compare" value shows up in normal life too.



Did it cost twice as much as the last one?
Two times more than a car?
Two times more than a candy bar?



There are standard references. These append a letter or two after the “dB” to indicate which one.

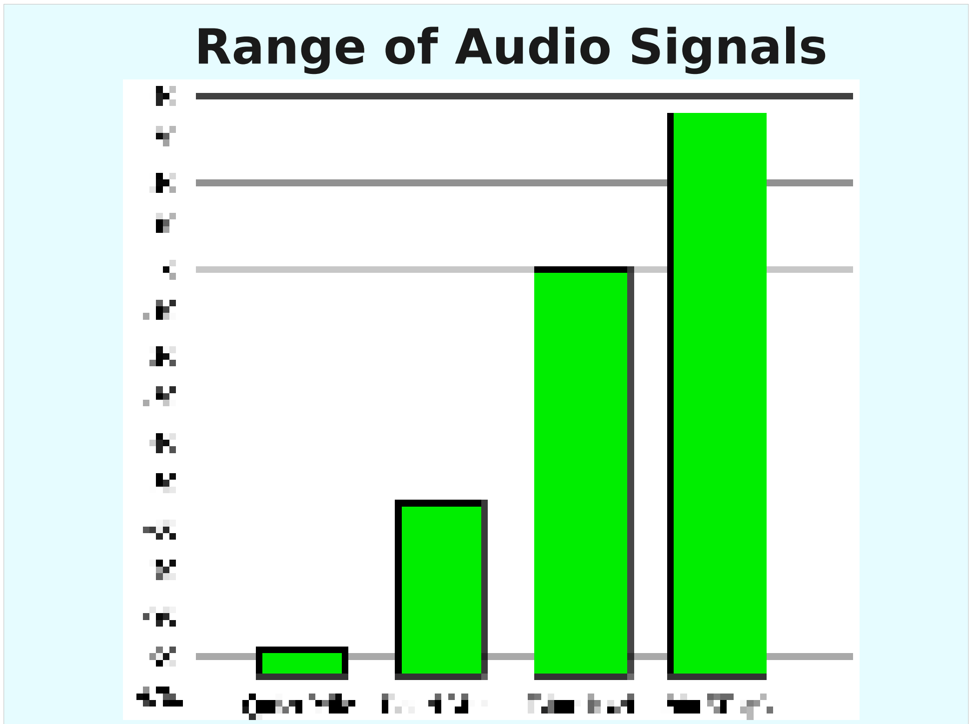
dBu - decibel unloaded. The most common in pro sound. Reference is 0.775 V RMS

dBm - **power** value, so impedance matters. Reference is 1 mW

dB V - reference is 1 V RMS

dB SPL - sound pressure level. Reference is 20 µPa (rms)

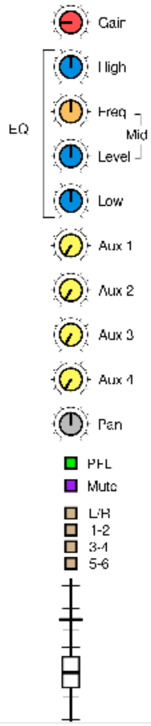
dB FS - Common in digital. Reference is maximum value that can be expressed



Here's that logarithmic chart again. Note that it is in dBu

One channel of an <u>imaginary</u> mixing console.

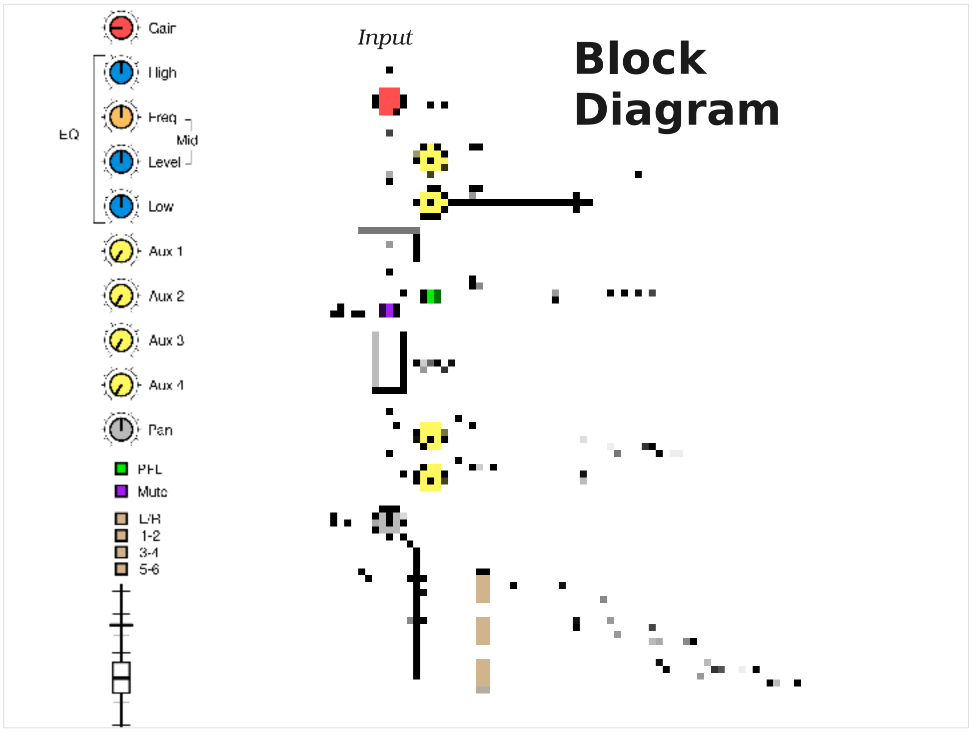
This is an imaginary mixer. It is almost certainly **not** the same as yours.



One channel of an average mixing console.

This is not any particular mixer. It is one that my fertile imagination invented. Any resemblance to a real mixer is purely coincidental.

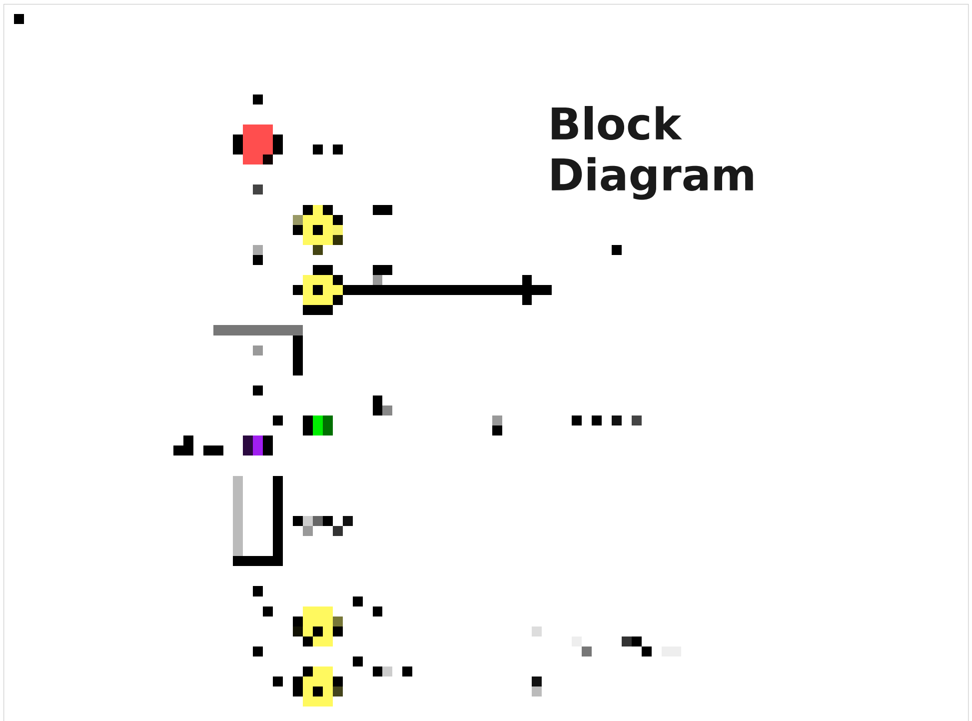
Here is a graphic representation of one channel. See any parts you recognize? Trim/Gain/Attn knob at the top, Fader at the bottom, and a bunch of other stuff in between.



Here I have a graphic of how the signal moves through the mixer channel (called a block diagram) shown next to the graphic of the physical channel.

In the block diagram, the signal flows from top to bottom and left to right

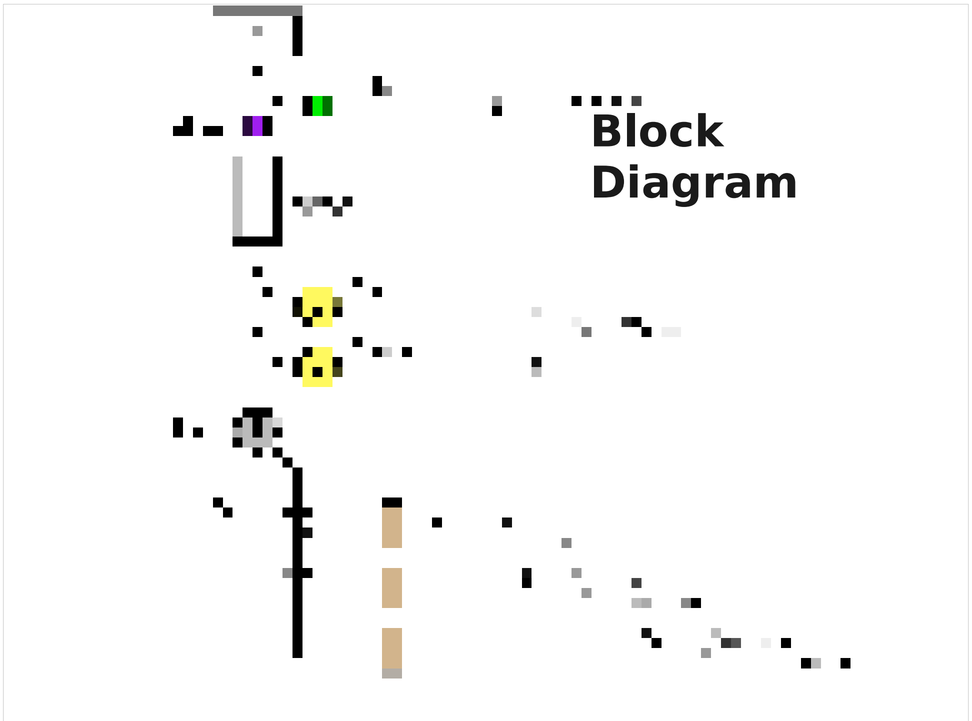
The first thing to note is the signal does **NOT** flow through in the same order as the physical layout!



Taking a closer look at the first part.

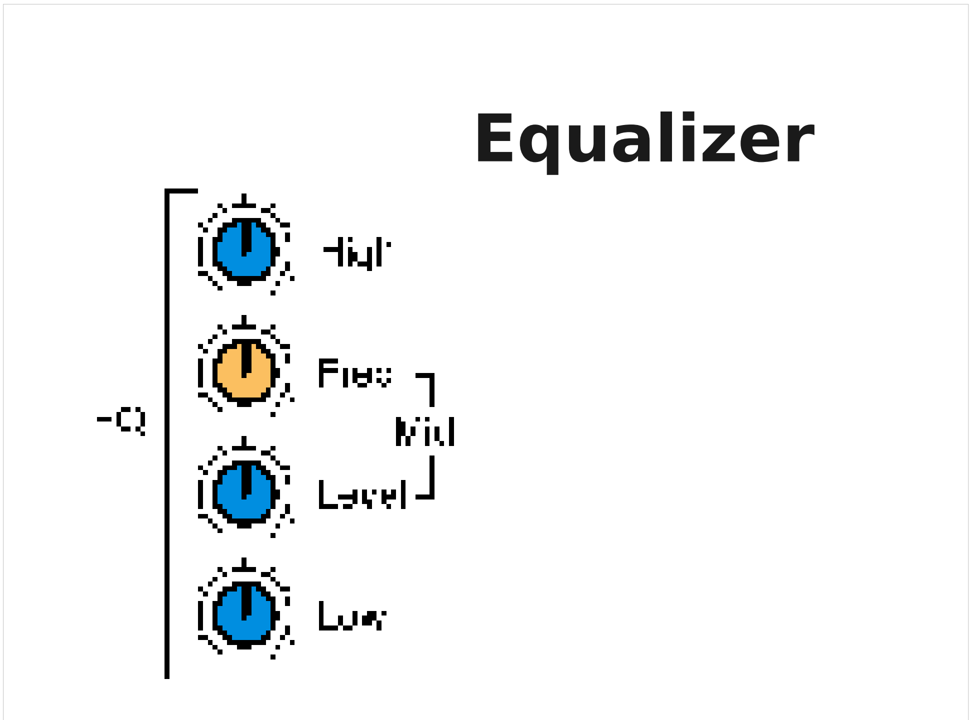
The first thing the signal encounters is the “gain” knob. The job of this is to compensate for the different levels of incoming signals. Once past the gain block, there should be NO DIFFERENCE BETWEEN A LOUD AND A QUIET SIGNAL!

See that the “Aux” knobs don't effect the main signal flow? Adjusting the EQ will **not** effect Aux1? PFL (solo) is before the mute button?



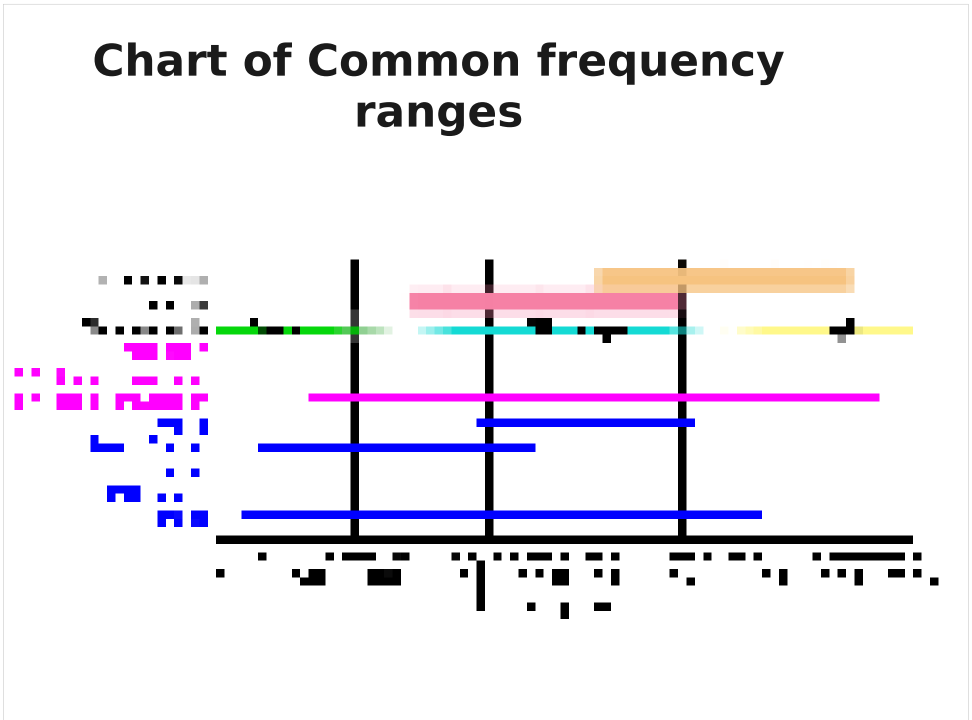
See that moving the fader affects Aux4? That the fader is not the last thing in the chain?

In most live sound situation, the “pan” knob becomes a three position switch - all the way left, centered, all the way right. This is how the signal is routed to the pairs of subgroups.



The equalizer need not be scary. It is just another tool.

But to explain what it is and how to use it, first lets look at what “frequency” means.

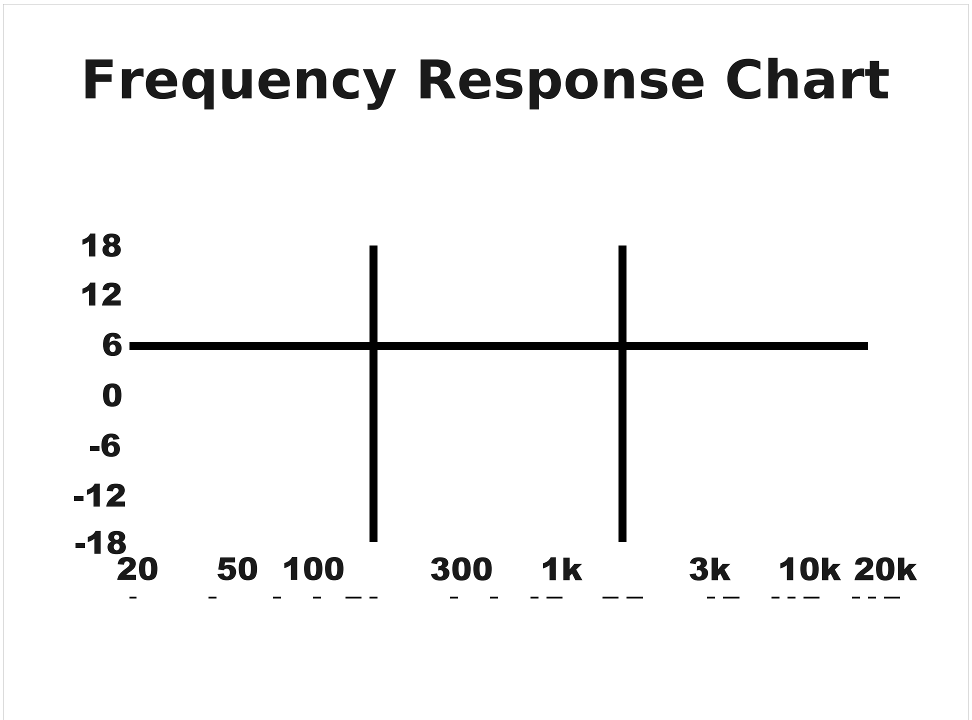


The bar on the chart for each of the musical instruments shows the **fundamental** only. The fundamental is what we think of as the note it's playing. But what makes a flute sound different than a trumpet is the quantity and strength of the harmonics. The harmonics are multiples of the fundamental and can continue up off the right side of this chart.

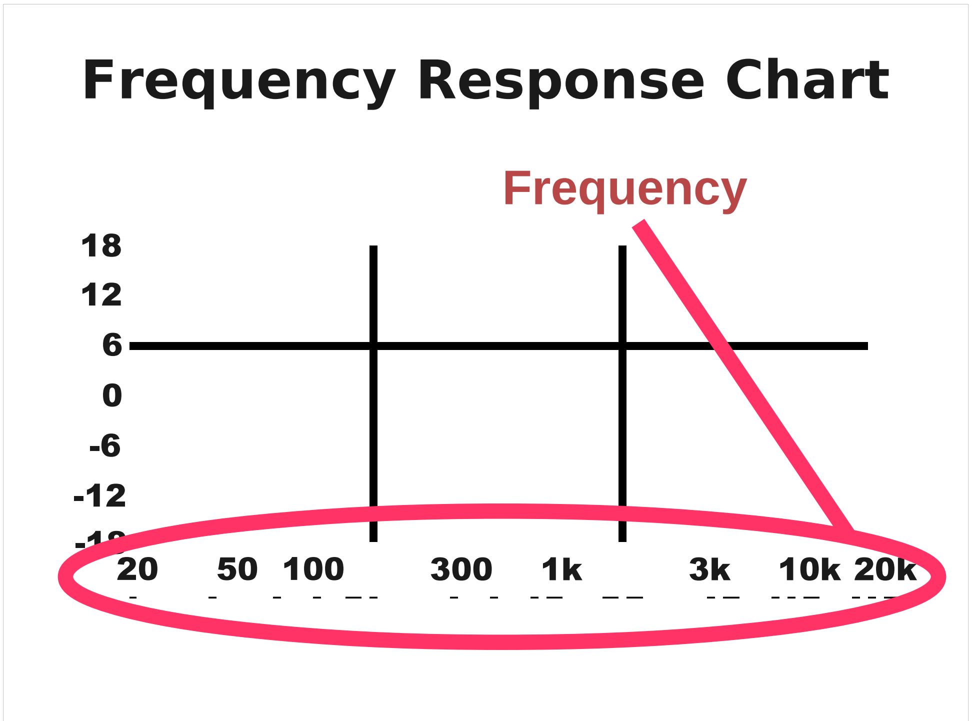
To help you get a grasp of the various frequencies, the chart has some “handles”.

Watch for situations where it's loud enough, but not intelligible. Or it's missing the body and roundness of the vowels.

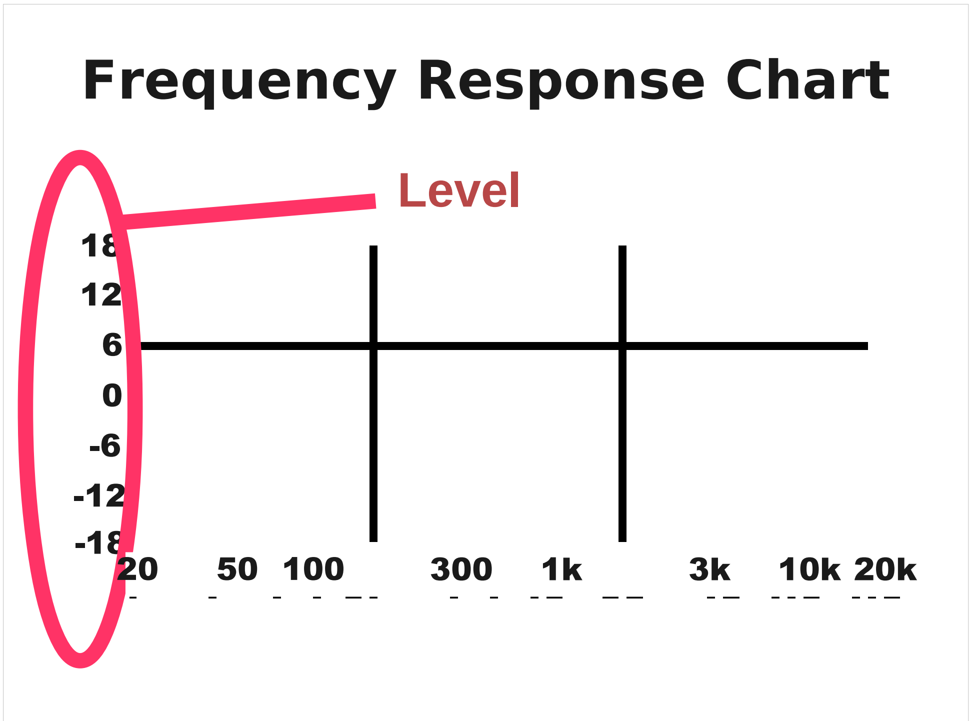
Also shown are common limited range systems. The sound of AM radio and telephone can help you figure out what needs adjusting.



This is a blank frequency response chant. I'll be using this framework to show what an equalizer does.

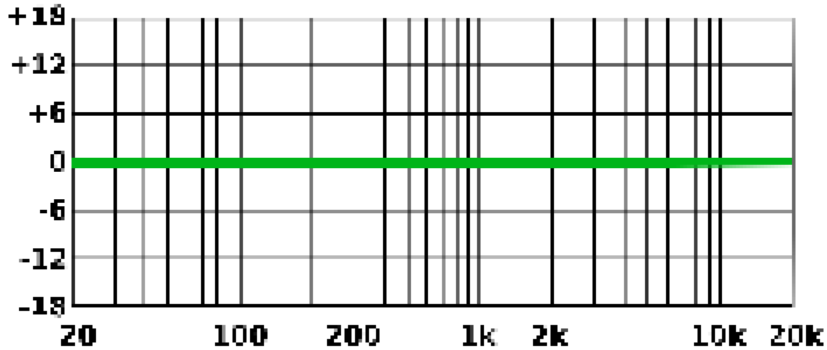


Across the bottom of the chart is the range of frequencies - just like on the last chart with the instruments.



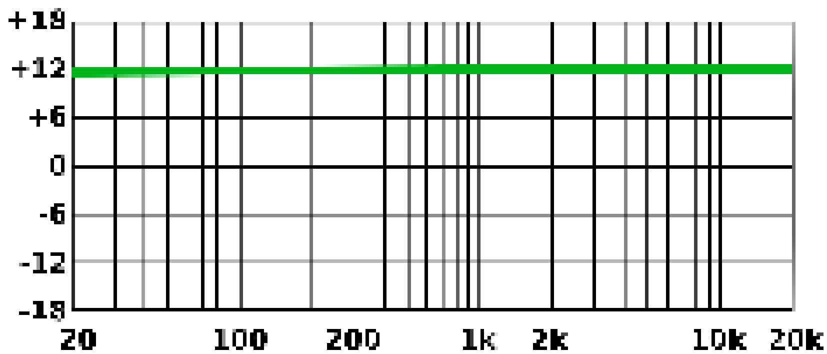
On the left is a scale of decibels. Since we only care about the change, we don't need or care about any of the standard levels.

Level, or volume, control



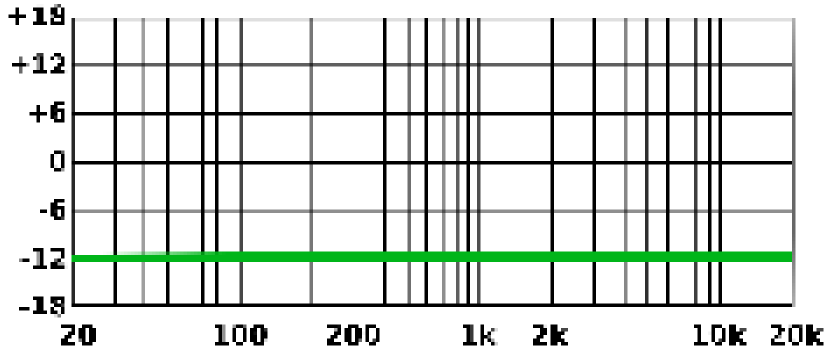
Affects all frequencies equally

Level, or volume, control

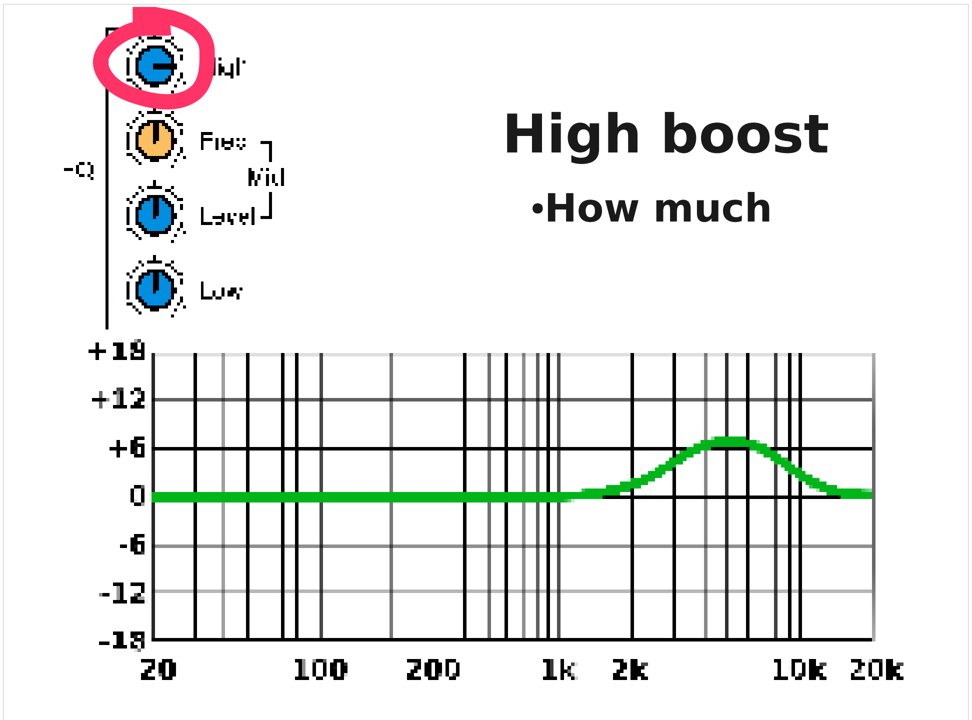


Increasing...

Level, or volume, control



…. or decreasing.

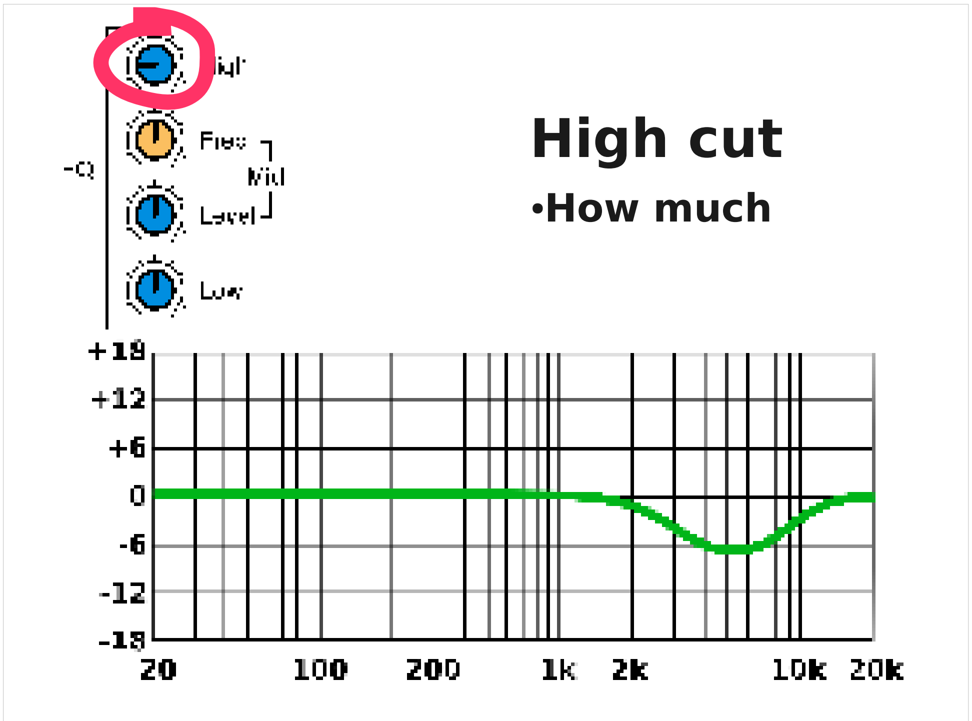


An equalizer could be described as a "frequency specific volume control".

Here, the "high" knob is turned up which turns up only some the high frequencies.

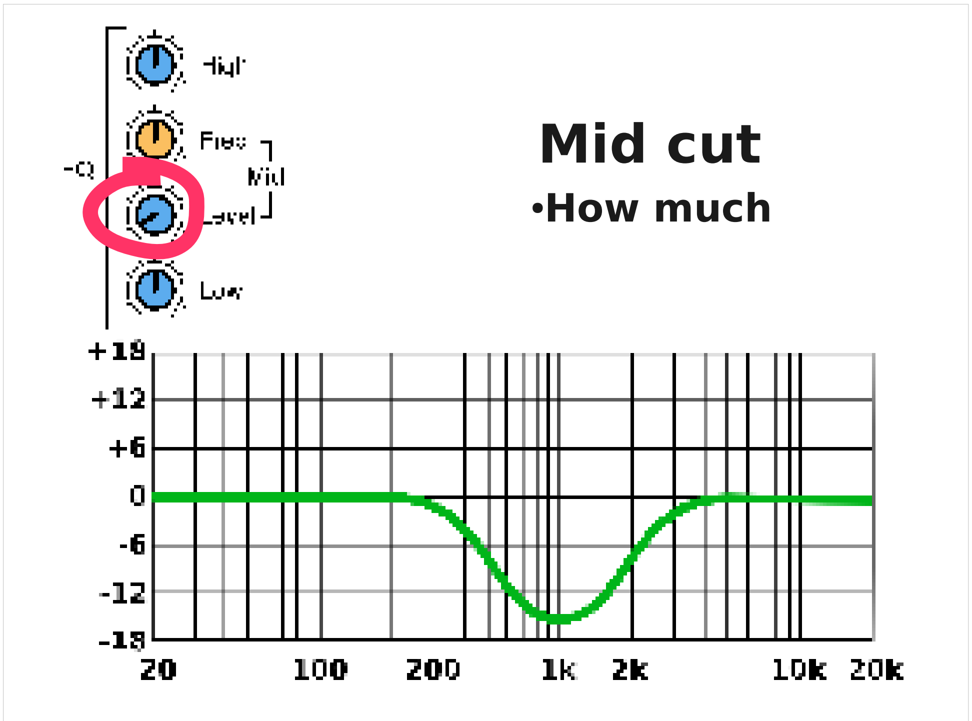
Note that more than one frequency is changed, and that it is really a region and the effect tapers off on both sides.

On this mixer, the "Low" works the same way, but for the low frequencies.

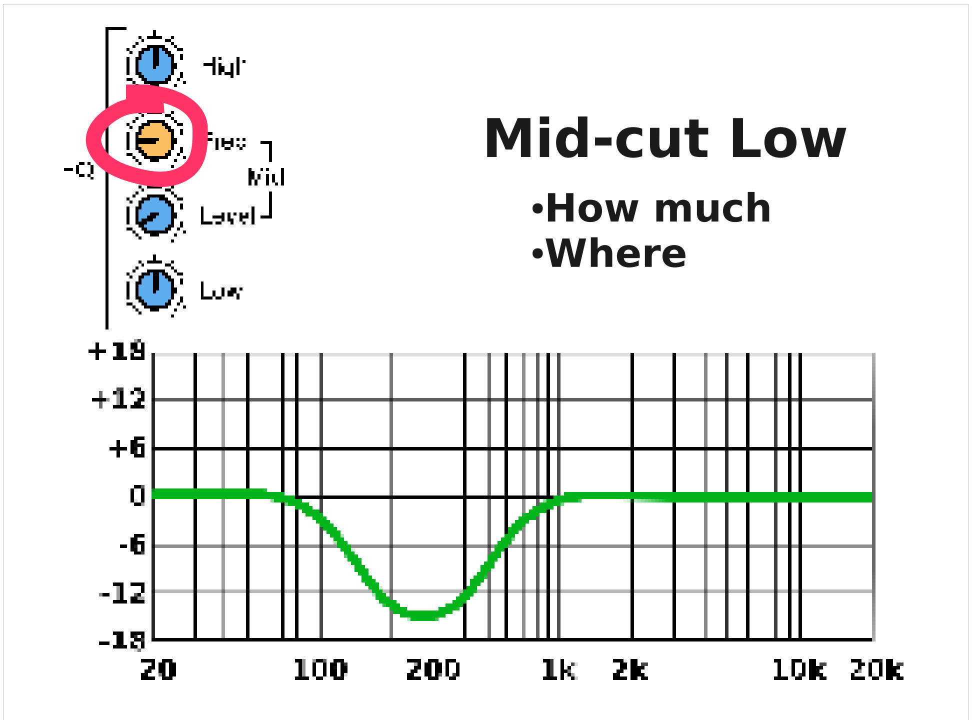


And now it's turned down. We get to choose how much it's changed.

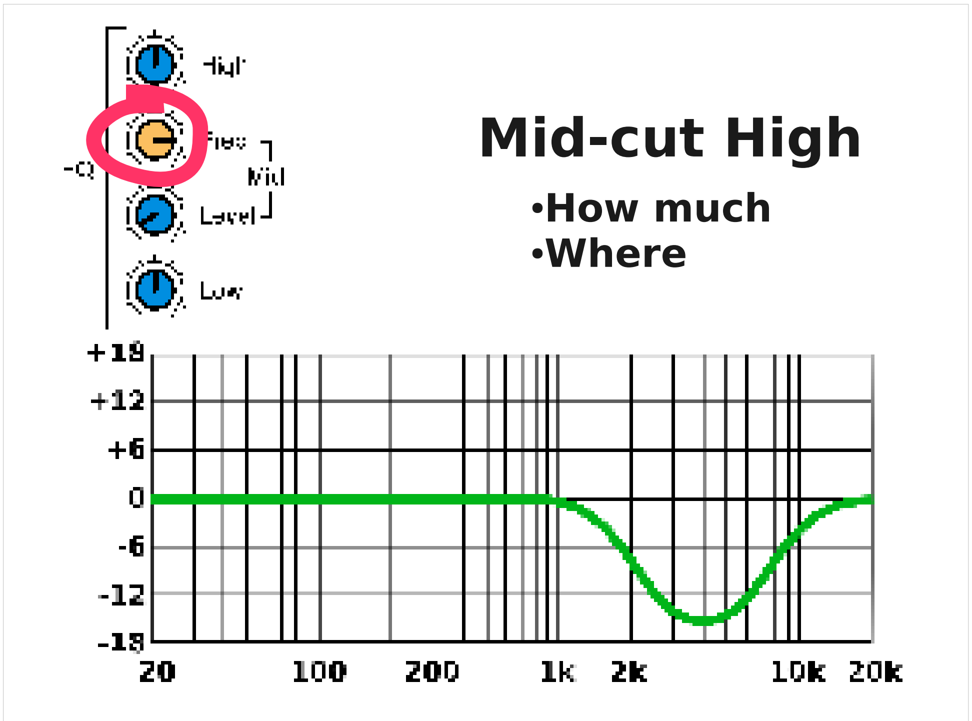
But the choice of which frequency it's centered on has been determined by the engineer who designed the mixer. Hopefully he correctly guessed the frequency where you would need it!



The “mid”, or middle, has two knobs. This style is called a “semi-parametric”. One knob adjusts “level” just like we already saw.



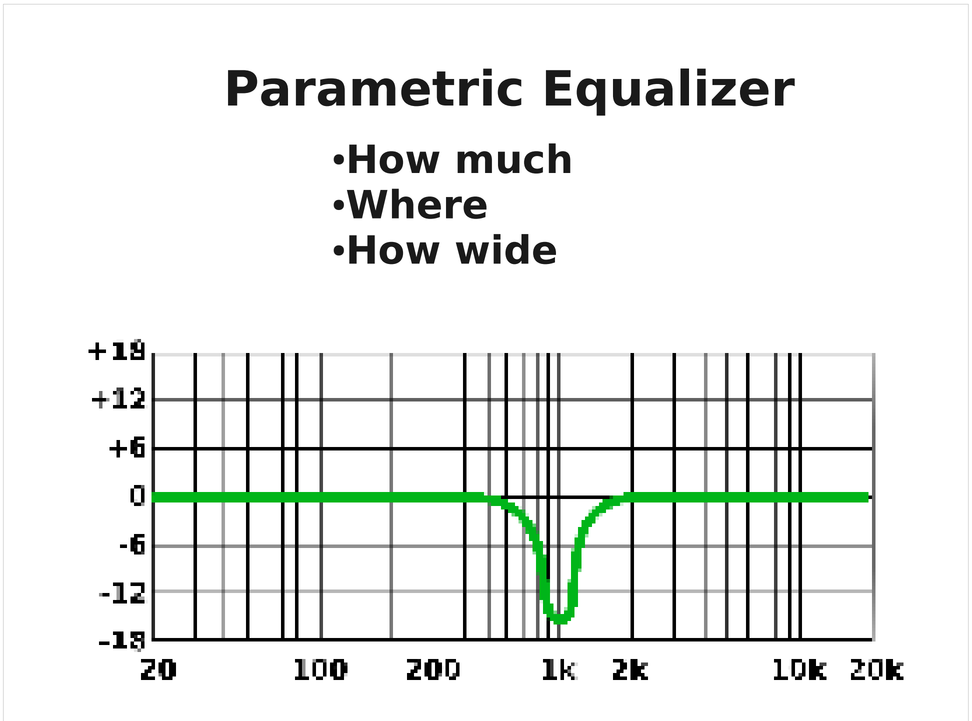
But the other one lets **us** choose the frequency. So we can shift the effected range from low....



... to high.

The design engineer chose the range, but we can position it where we actually need it.

Realize that with the “mid level” knob set to “zero”, turning the “freq” knob will have no effect on the sound.

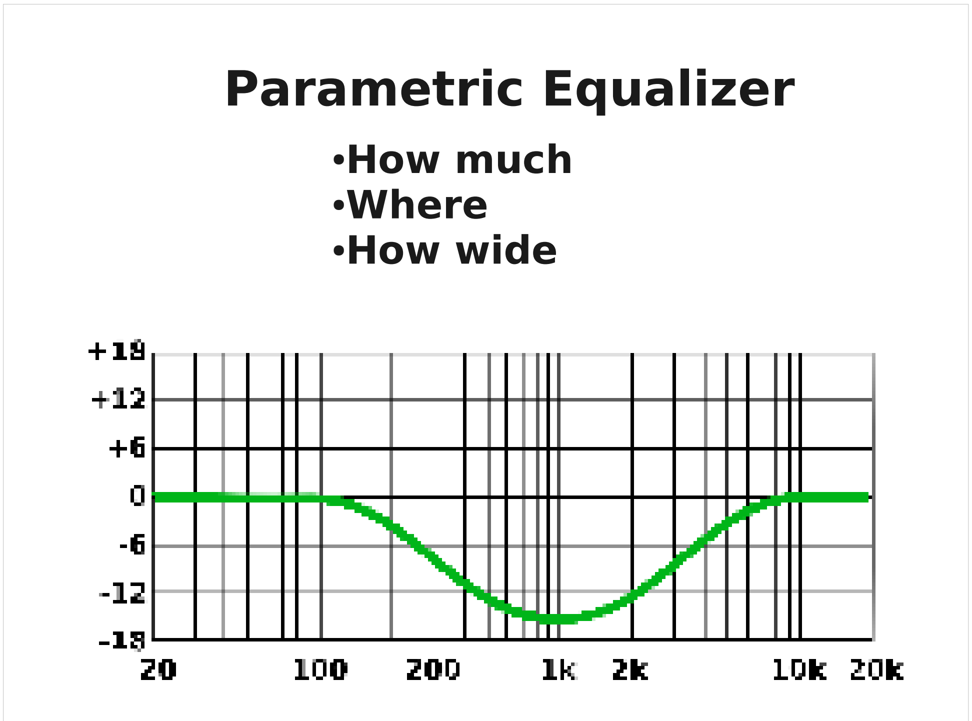


Very few analog mixers have have full parametric equalizers. I'm showing it so you are aware it exists and because it shows up on many digital mixers.

Like the semi-parametric, we can choose the level and the frequency.

But now we also get to adjust the width of the effect.

Narrow....

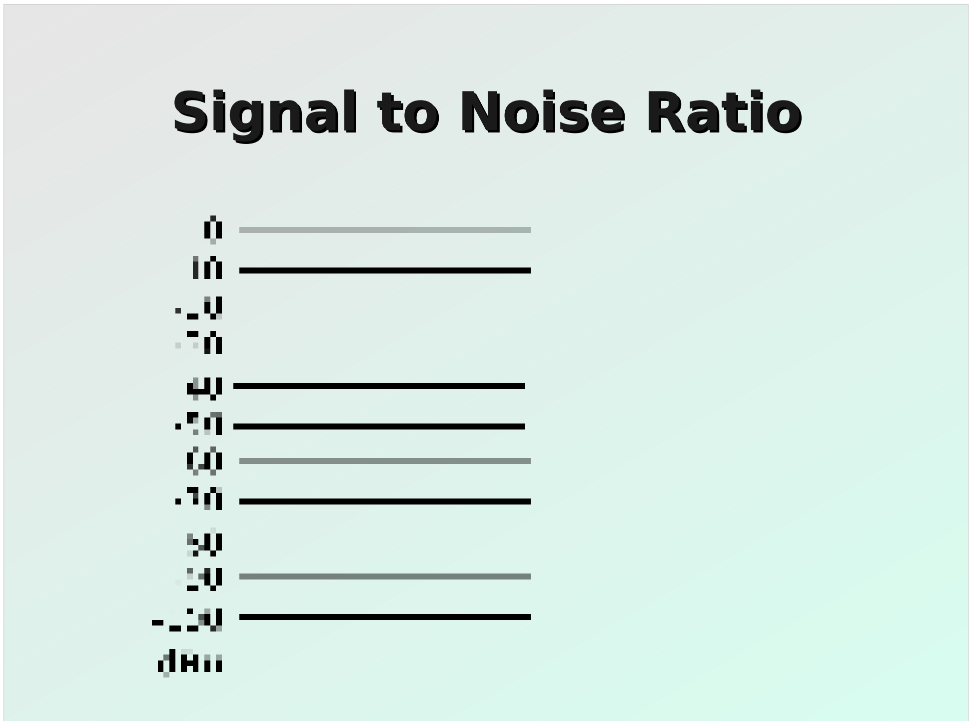


…or wide.

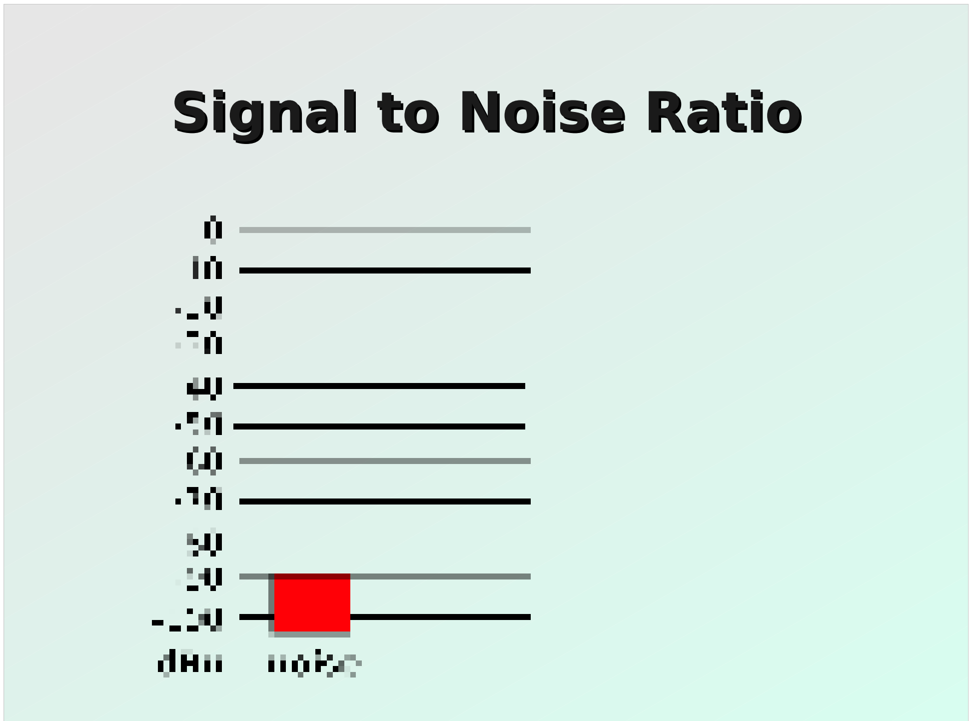
These three controls make it a very powerful tool.

Signal to Noise Ratio

The ratio of the difference between the noise level and the signal level, expressed in decibels.

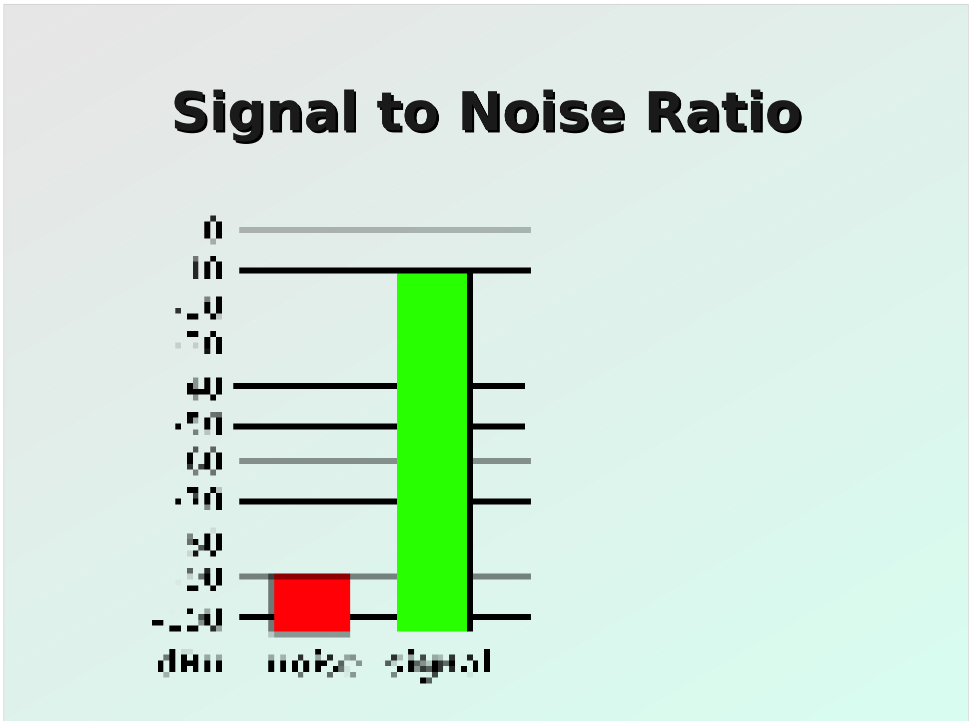


Since it's expressed in decibels, let's start with the same chart we used earlier.

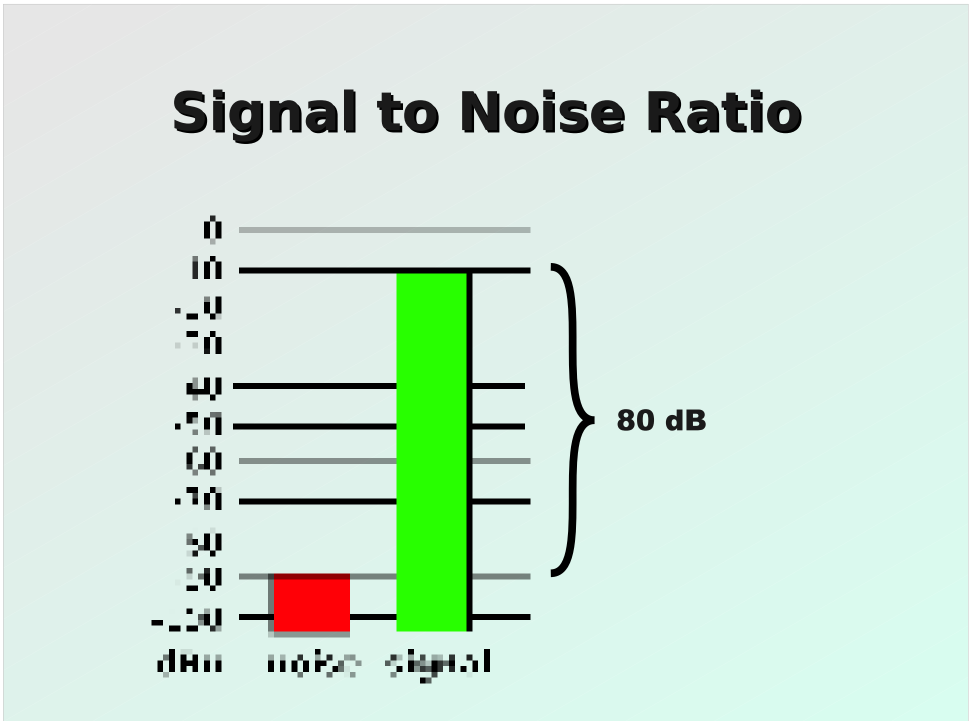


All electronics generate noise. This noise is heard as “ssssssss”.

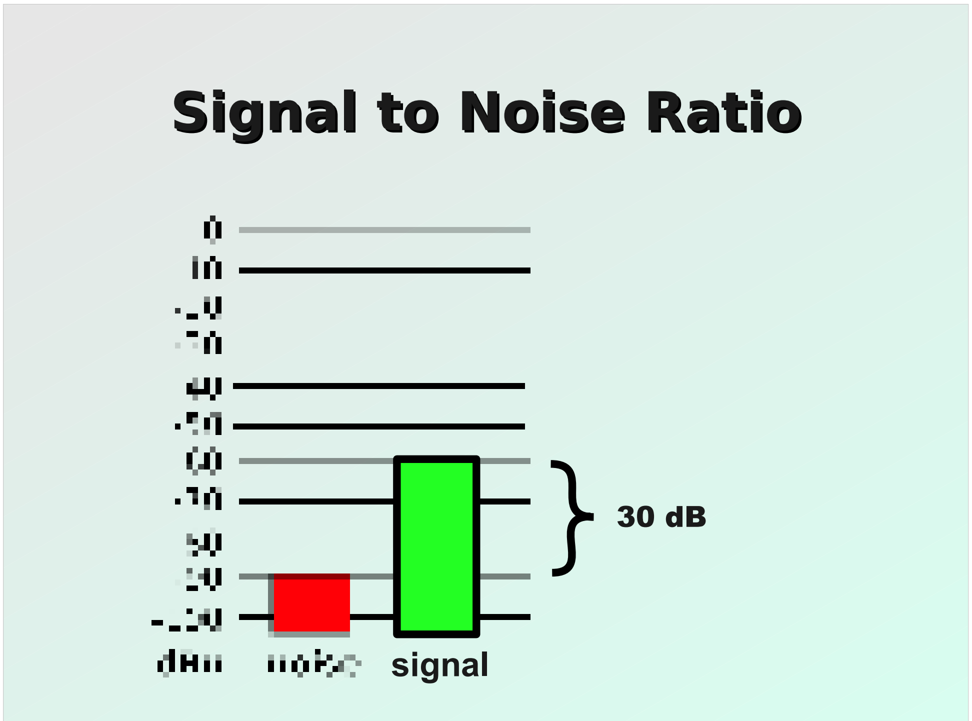
In this example, with no signal present, the meter shows a “signal” of -90 dBu - which is all noise.



Now there is a real signal - a steady tone. The meter shows a level of -10 dBu.

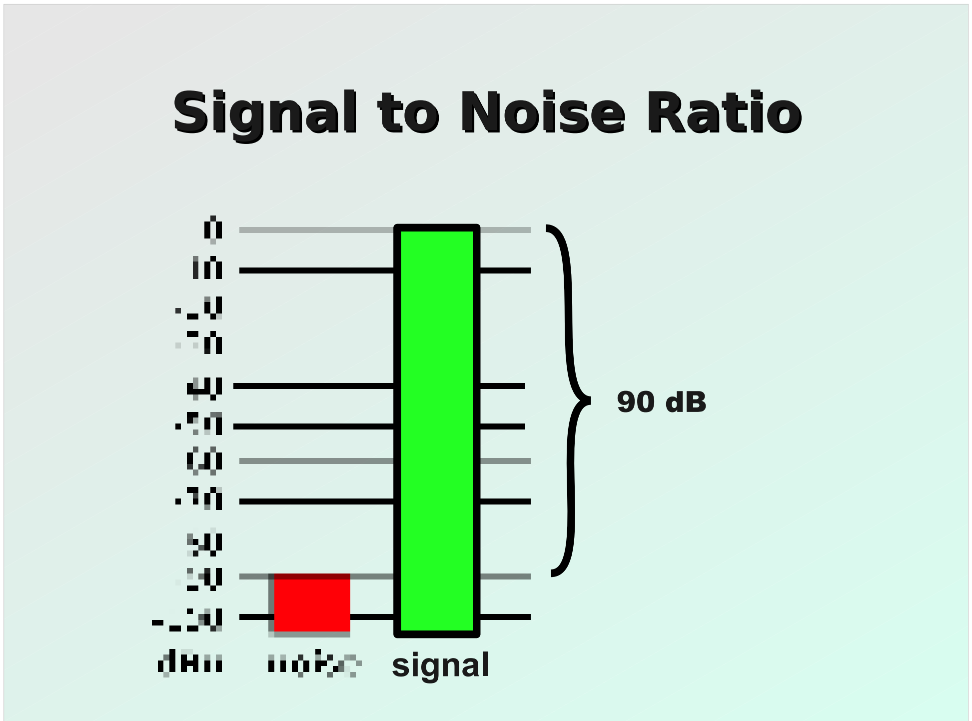


The difference between the -90 dBu noise and the -10 dBu signal is 80 dB (no “u” because it is a ratio).



What if the signal was only -60 dBu?

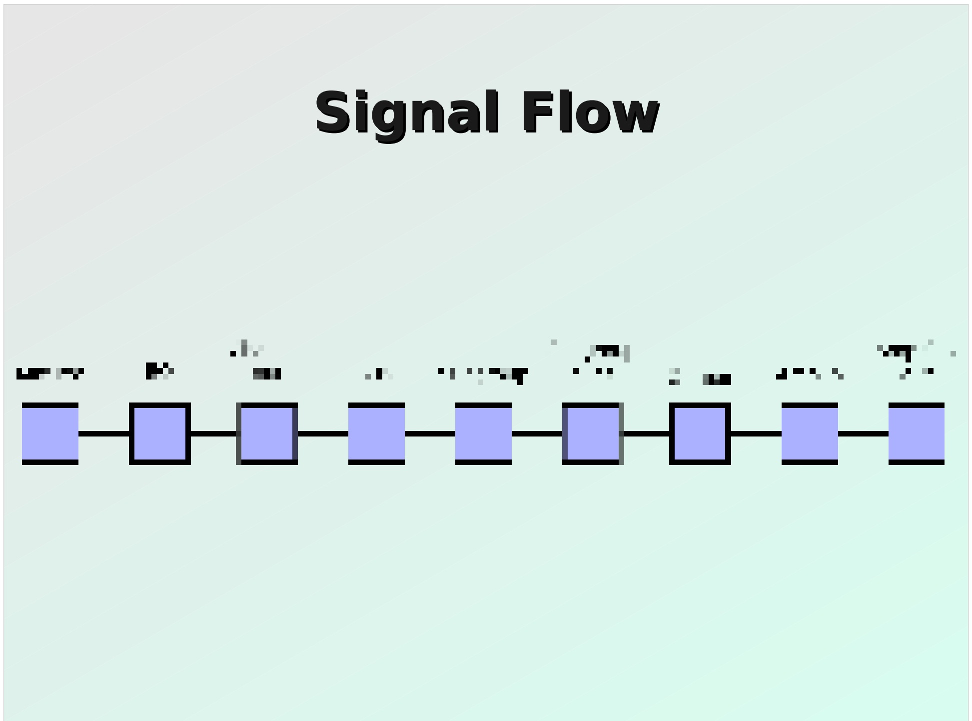
The noise level is the same at -90 dBu, so the signal to noise is now 30 dB.



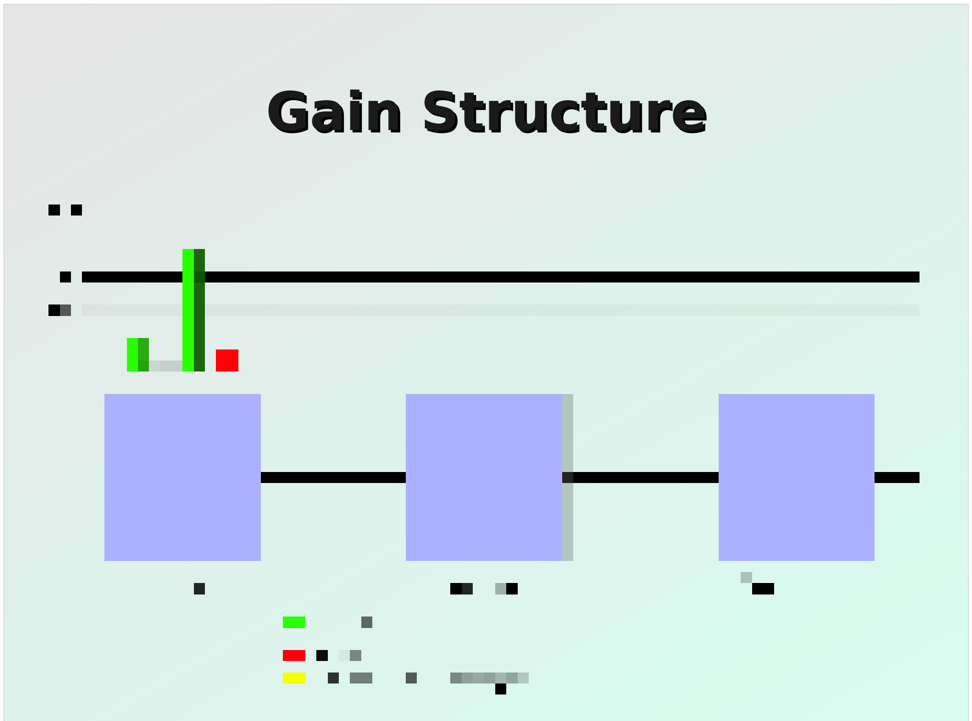
With a signal level of 0 dBu, the ratio is 90 dB.

Since we usually are mixing music or speech and not steady tones, the signal to noise ratio (SN) varies continuously with the signal level.

Therefore, the specification is usually "maximum signal to noise" which compares the maximum possible without distortion to the noise with no signal at all.

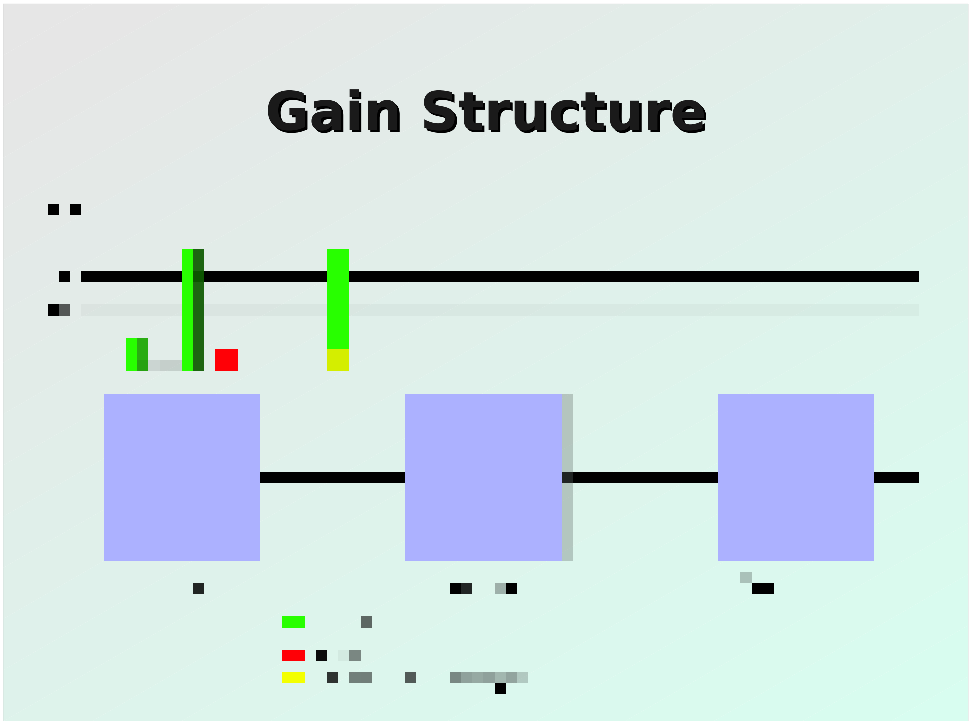


While our equipment list may only include a mixer and an amplifier between the mic and the speaker, in the mixer are many individual sub sections the engineers refer to as “stages”. Each of this is it's own amplifier and so has it's own signal to noise ratio.

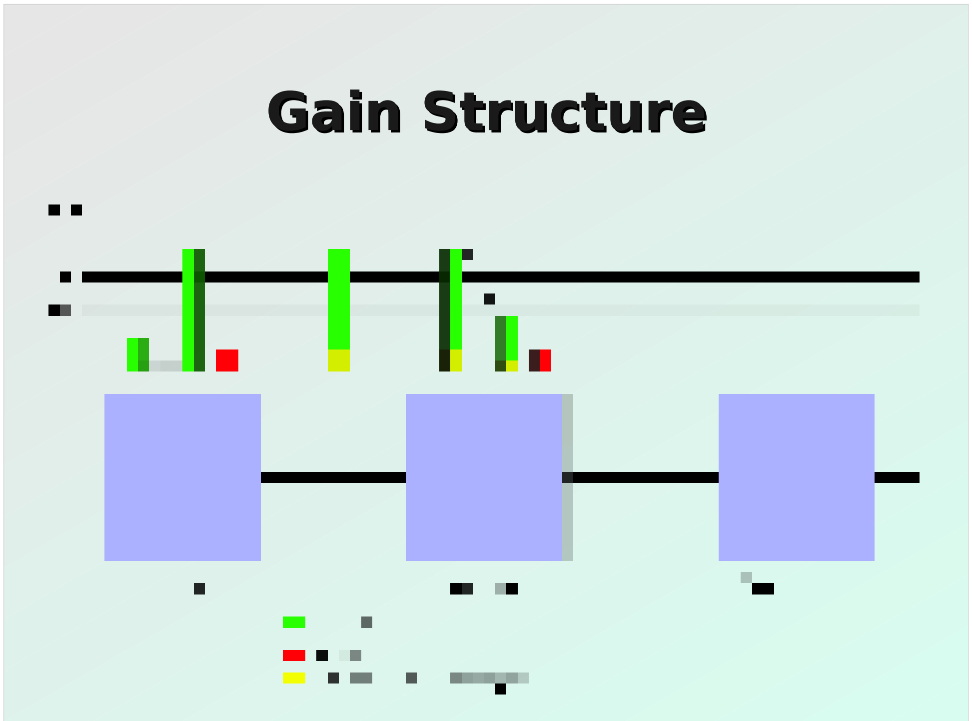


To simplify the explanation, here is a simplified diagram.

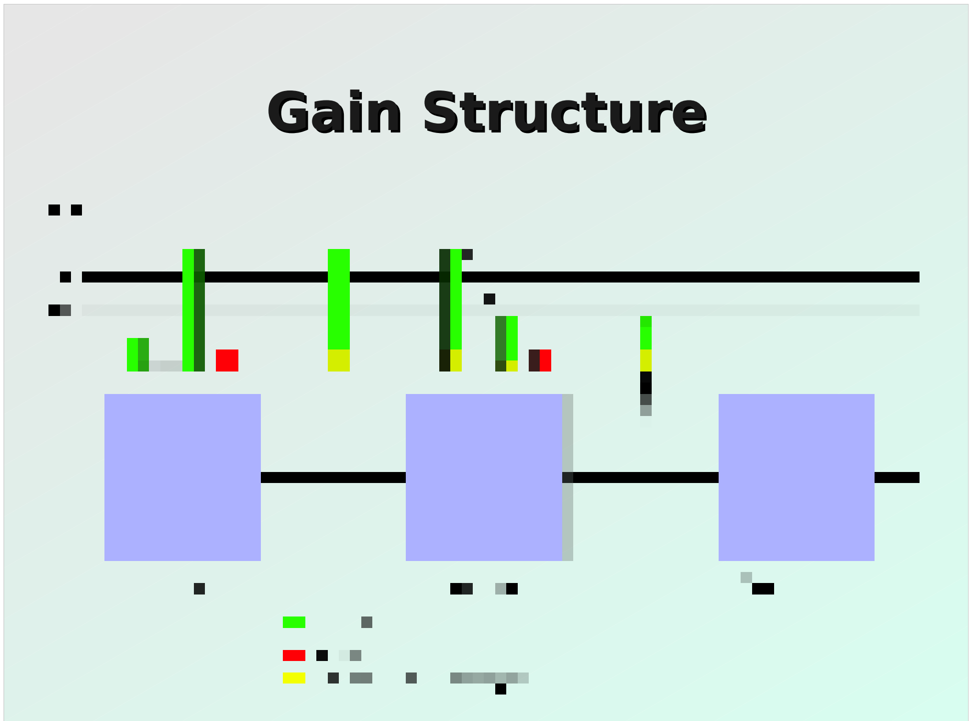
The mic preamp amplifies the incoming mic signal. It adds to this it's own noise.



Realize that once it leaves a stage, the noise is no longer a separate part - it is no an permanent part of the signal!

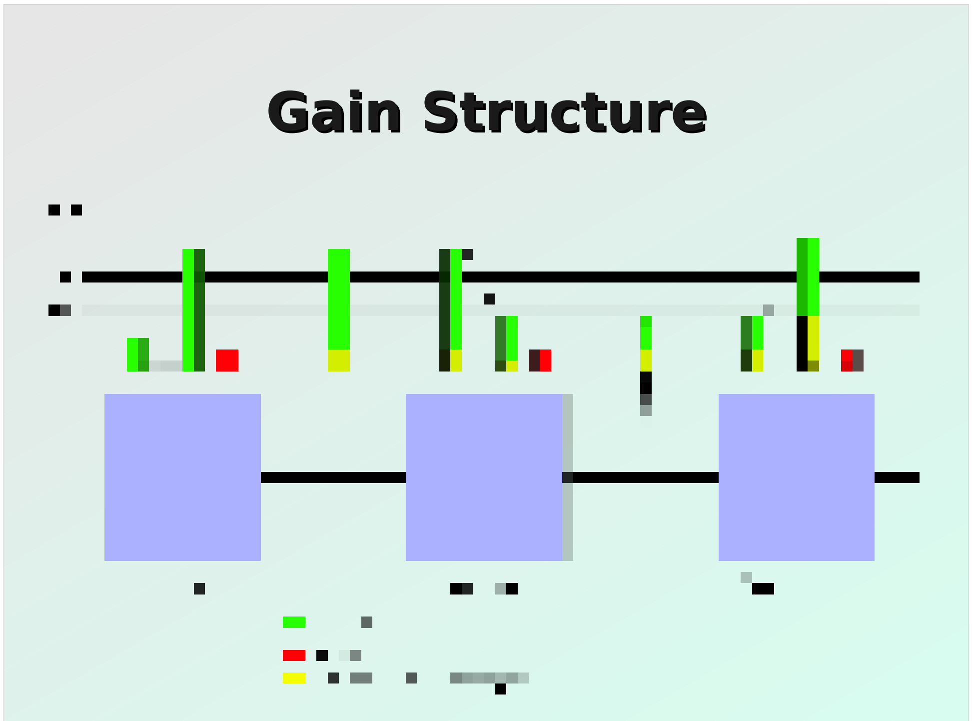


In this second stage, the signal is actually being turned down. But the noise component is still there…



So now the noise is a much larger percentage of the signal passing on to the next stage.

And there is no way to again separate the signal and the noise.



In the power amp, the signal is again amplified. But the noise level of the incoming signal is already much more than the inherent noise of the power amp.

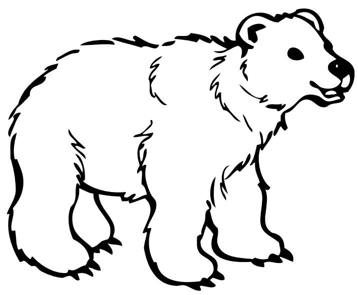
Therefore, the rule of thumb is - turn it up as much as possible as early as possible in the chain. If it is too loud, turn it down as late as possible in the chain.

Polar Plots

Polar Plots are about....

Polar Plots

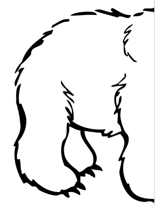
- It is not:
  - B-rate movie about the North Pole
  - Anything to do with polar bears



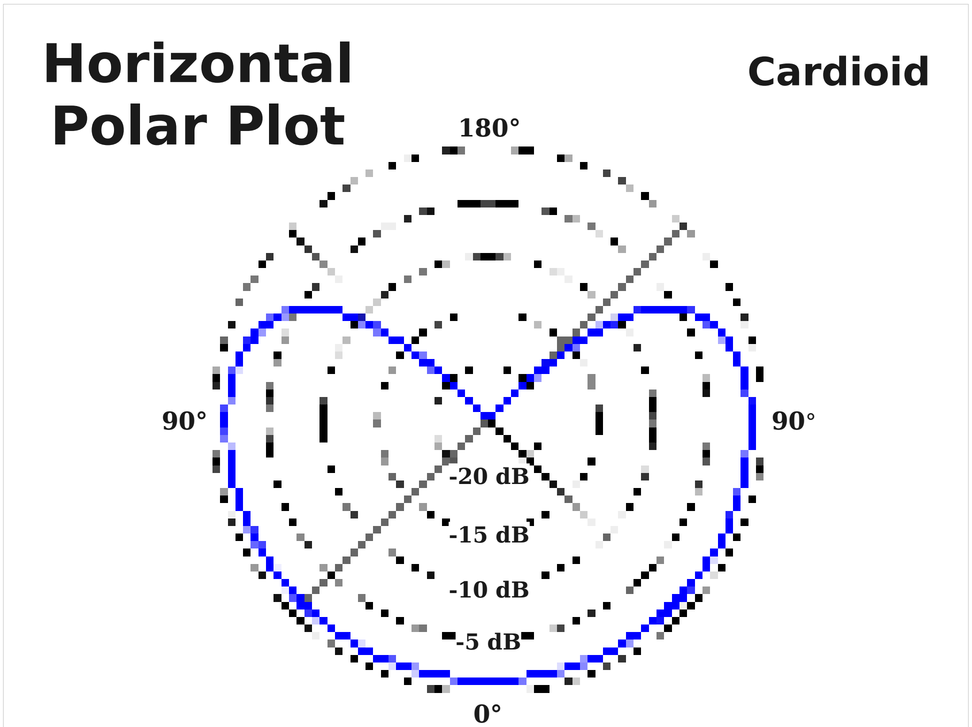
What it's not.

Polar Plots

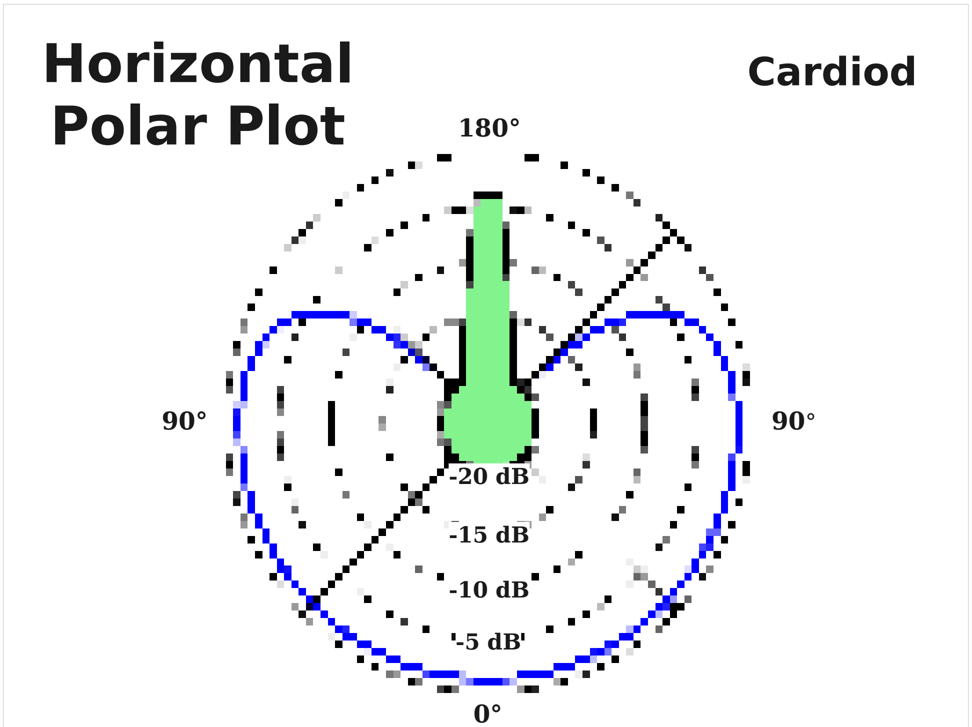
- It is not:
  - B-rate movie about the North Pole
  - Anything to do with polar bears
- It is a way to chart signal levels as they relate to physical space.



Since we can't see sound, sometimes it's helpful to represent it graphically.

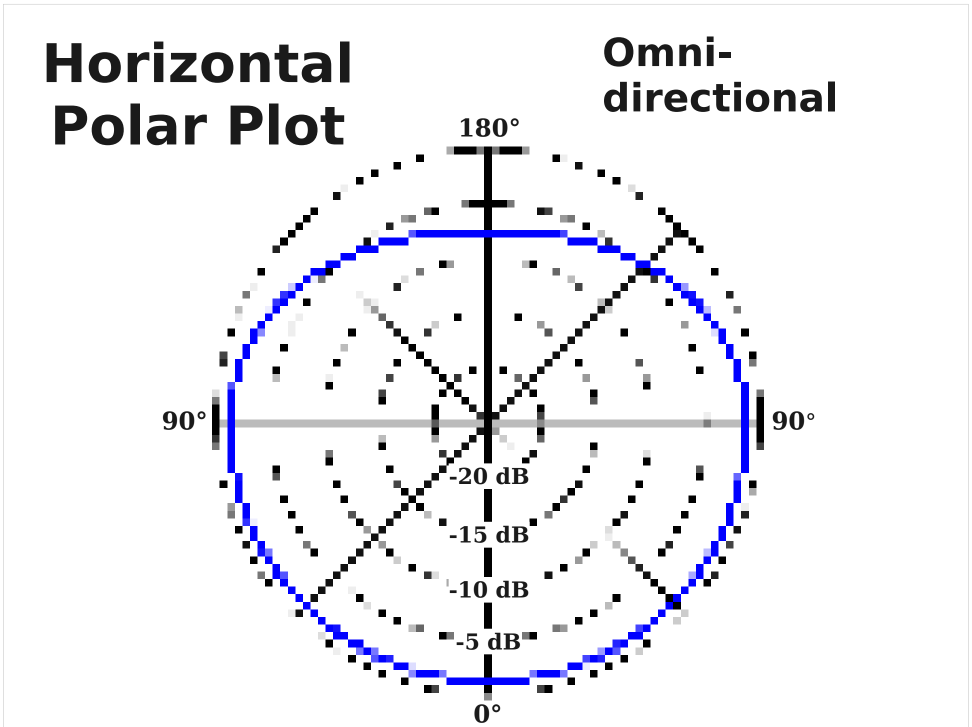


The blue line represents the signal level measured at the various angles.

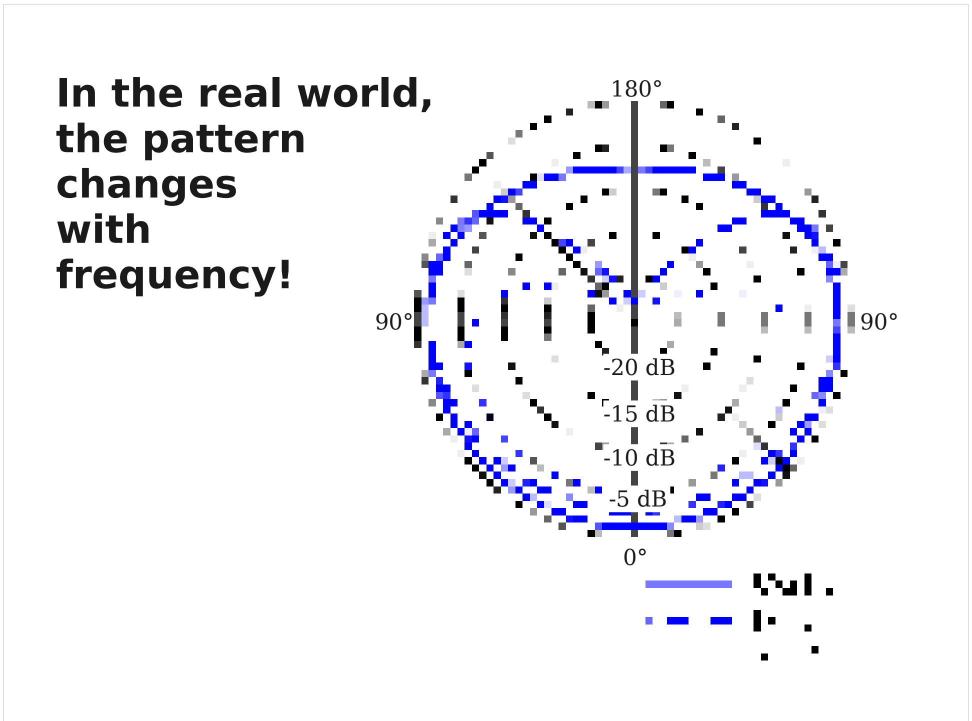


This is how the microphone would be if it were visible.

The pattern is heart, or “cardiod” shaped.



An “omni-directional” should be equally sensitive in all directions - but it's not. Just more so than the more directional mics.



Then in the real world, the pattern changes with frequency. Omni at low frequency, then more directional at higher frequencies.

There is not a “best” pattern, rather the polar plot lets you learn about the characteristics of each mic so you can make the best use of each tool.

Feedback!

Now that we have laid a foundation of terms and principles, we can explain feedback.

What is "Feedback"?

- **What does it sound like?**
- **What is it <u>not</u>.**
- **What causes it?**

Feedback!

What is “Feedback”?

- **What does it sound like?**
  - **Usually a single tone - or two...**
  - **Often high-pitched**
- **What is it <u>not</u>.**
- **What causes it?**

It's hard to describe a sound with words.

What is "Feedback"?

- **What does it sound like?**
- **What is it <u>not</u>.**
  - **Crackles**
  - **Pops**
  - **Static**
  - **Other noises**
- **What causes it?**

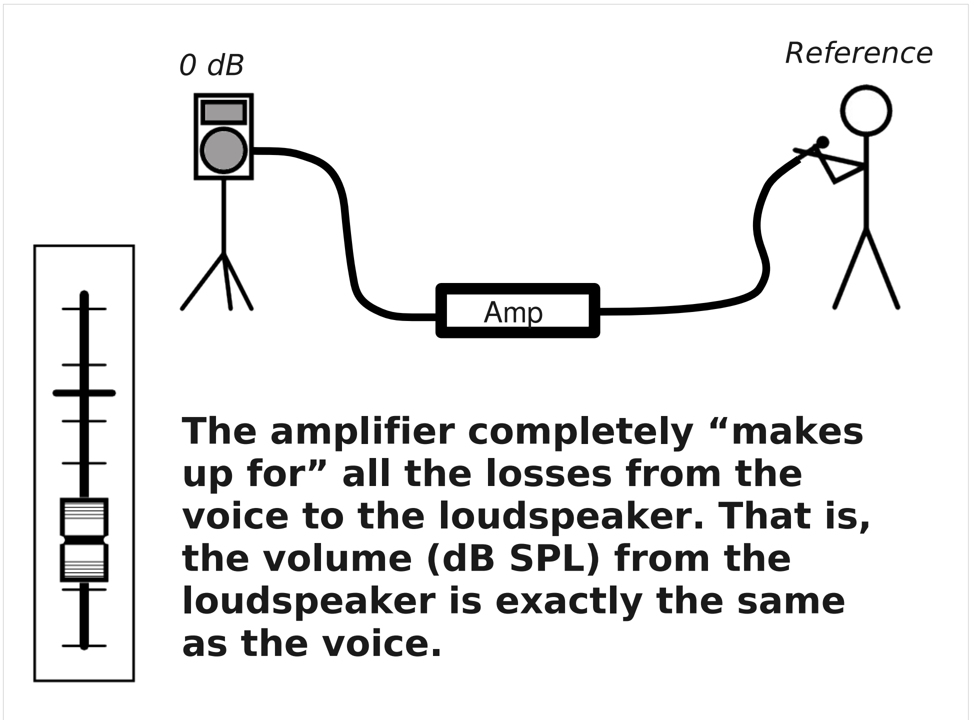
I often hear the term "feedback" to describe any undesirable noise in a sound system. While those sounds may be problems that need to be fixed, feedback has a clear definition.

What is "Feedback"?

- **What does it sound like?**
- **What is it <u>not</u>.**
- **What causes it?**
  - **More electronic gain than acoustic loss**

When the gain of the entire electronic signal chain is greater than the acoustic loss from the speaker to the mic, the system will feedback.

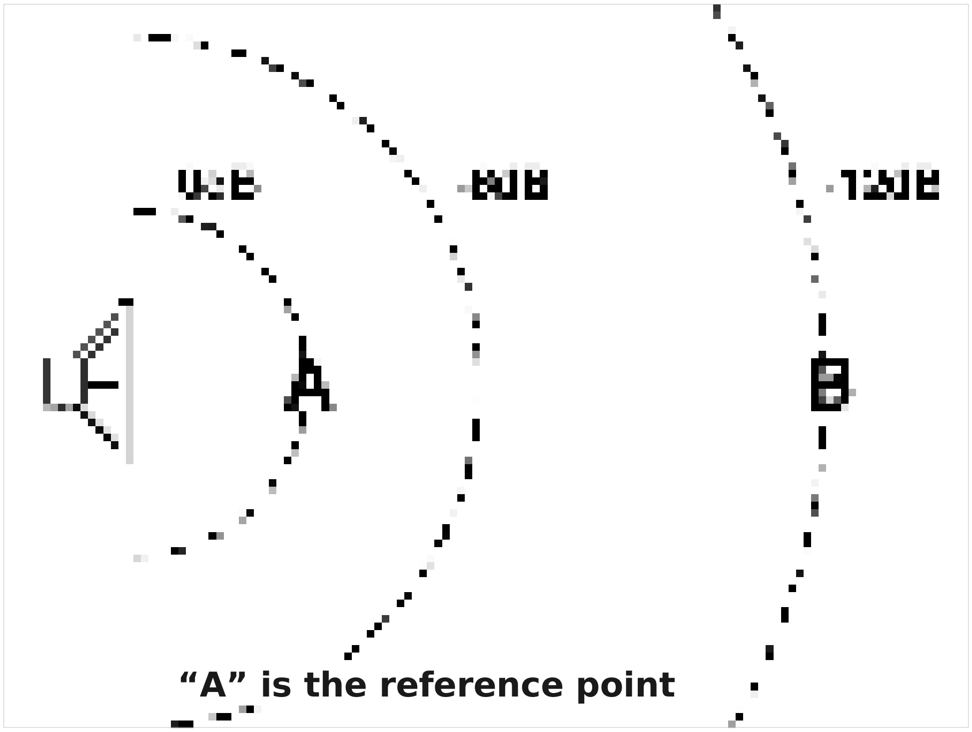
Electronic gain? Acoustic loss?



Here is the reference point. The talent is talking into the mic. The entire electronic amplifier chain is represented by the box labeled “amp”. The gain is represented by the fader on the left edge. It's set so the acoustic output of the speaker is exactly the same as the acoustic output of the talent.

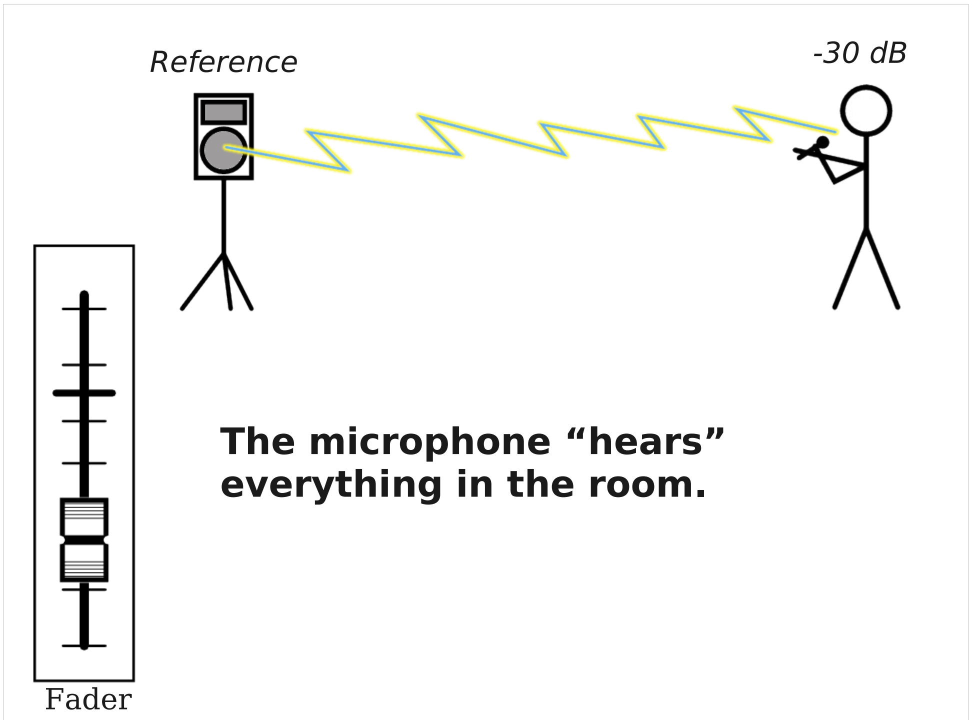
While this setting establishes our reference, it is not very useful because it's not any louder than just the talent talking.

Never the less, this is the “electronic gain” part of the equation.



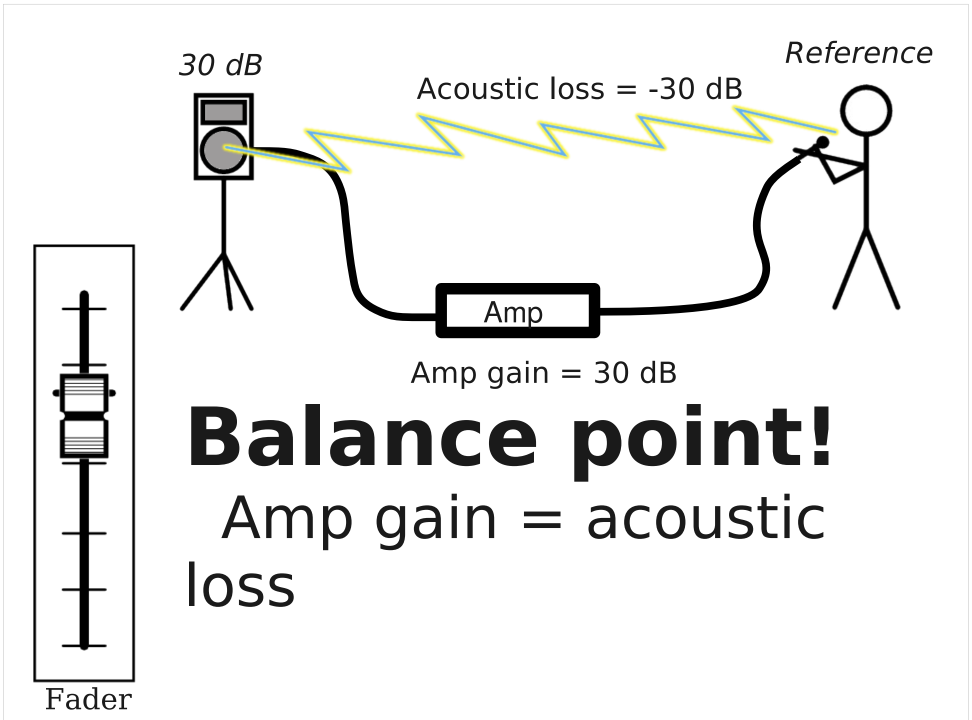
The acoustic loss is a result of the sound level decreasing over distance.

In an space without any wall reflections, the Sound Pressure Level will decrease by 6 dB every time the distance is doubled.



Be aware that the microphone is always "hearing" everything, but because the loss over distance, the level is much less at the mic.

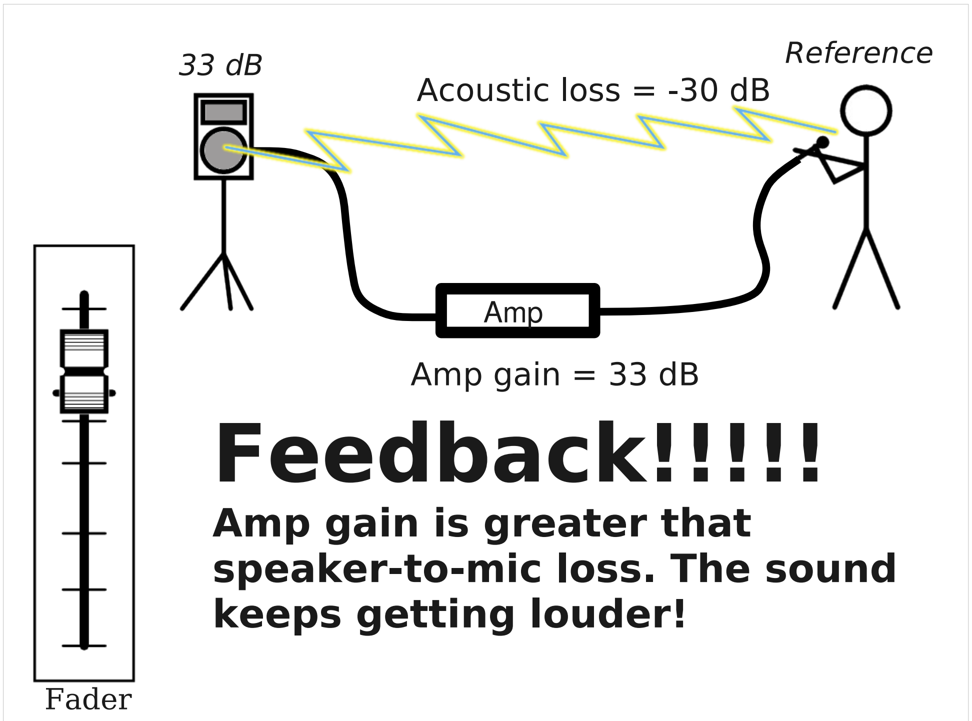
In this example, the loss from the speaker to the mic is 30 dB.



Now lets turn it up.
The fader is moved up, adding 30 dB gain.

This is exactly the same as the acoustic loss - so we will start to hear “ringing” as it just begins to feedback.

The talent talks. The sound enters the mic, is amplified 30 dB, comes out the speaker, looses 30 dB, is picked up by the mic, is amplified 30, looses 30 dB, is amplified 30 dB, etc.

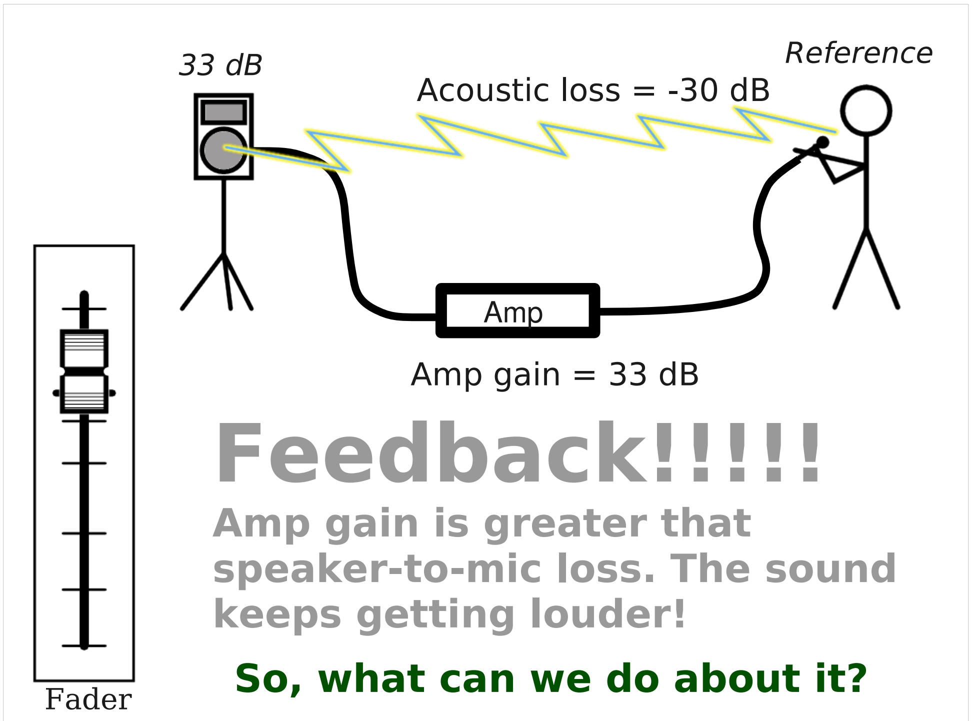


But someone in the back said “I can't hear!”, so we turn it up just a bit more.

Now the amp chain adds 33 dB, but the acoustic path still only loses 30 dB. + 33 dB, -30 dB, +33 dB, -30 dB.

Every trip “around”, the net gain is 3 dB, so the howl/squeal keeps getting louder and louder.

This is feedback!



You have probably all experience it - but now what can we do about it?

So what can we do about it??

With the problem defined, let's discuss solutions.

So what can we do about it??

- **Increase the acoustic loss.**
- **Decrease the electronic gain.**

Because feedback is caused by the relationship between the electronic gain and the acoustic loss, we can make adjustments in either place to fix it.

So what can we do about it??

- **Increase the acoustic loss.**
  - **Move the mic and loudspeaker farther apart.**
  - **Change the angle of the loudspeaker.**
  - **Change the angle of the microphone.**
- **Decrease the electronic gain.**

Starting with the acoustic portion…

So what can we do about it??

- **Increase the acoustic loss.**
  - **Move the mic and loudspeaker farther apart.**
    - **Remember that sound get weaker the further it has to travel.**
  - **Change the angle of the loudspeaker.**
  - **Change the angle of the microphone.**
- **Decrease the electronic gain.**

If we move the mic further away from the speaker, the greater distance will result in a greater loss.

This can be hard to do with permanently installed speakers.

So what can we do about it??

- Increase the acoustic loss.
  - Move the mic and loudspeaker farther apart.
  - Change the angle of the loudspeaker.
    - Speakers are rarely omni-directional. Get the mic to a spot that the loudspeaker doesn't cover well.
  - Change the angle of the microphone.
- Decrease the electronic gain.

Nearly all speakers are directional. Study the polar plots to figure out how to best position it so there is more loss in the direction of the microphone.

This can be very hard to do with permanently installed speakers.

So what can we do about it??

- **Increase the acoustic loss.**
  - **Move the mic and loudspeaker farther apart.**
  - **Change the angle of the loudspeaker.**
  - **Change the angle of the microphone.**
    - **Use the mic's polar plot to "point" the weak pickup area toward the loudspeaker.**
- **Decrease the electronic gain.**

Make note of the polar plots of the mic. Maybe there's a way to position the mic to cause a bit more acoustic loss.

A good idea, but rather hard to do with a lapel mic.

So what can we do about it??

- **Increase the acoustic loss.**
- **Decrease the electronic gain.**
  - **Change the frequency response of the system.**
  - **Turn down the fader.**

Now on to the what can be changed on the electronic side.

So what can we do about it??

- Increase the acoustic loss.
- Decrease the electronic gain.
  - Change the frequency response of the system.
    - Adjust an equalizer to turn down the frequency to which the mic/speaker/room system is most responsive.
  - Turn down the fader.

Because microphones and speakers are essentially never have a totally flat frequency response, systems will tend to feedback first at frequencies where there is a peak in either the mic, speaker, or both.

An equalizer can be used to turn down this “hot” frequency. .

So what can we do about it??

- Increase the acoustic loss.
- Decrease the electronic gain.
  - Change the frequency response of the system.
    - Adjust an equalizer to turn down the frequency to which the mic/speaker/room system is most responsive.
    - It <u>will</u> affect the desirable sound too!
  - Turn down the fader.

But as a system is adjusted to be more "feedback safe", it is almost never the same adjustment needed to make it sound better.

Thus we have a compromise between "sounds good" and "feedback safe".

So what can we do about it??

- Increase the acoustic loss.
- Decrease the electronic gain.
  - Change the frequency response of the system.
  - Turn down the fader.

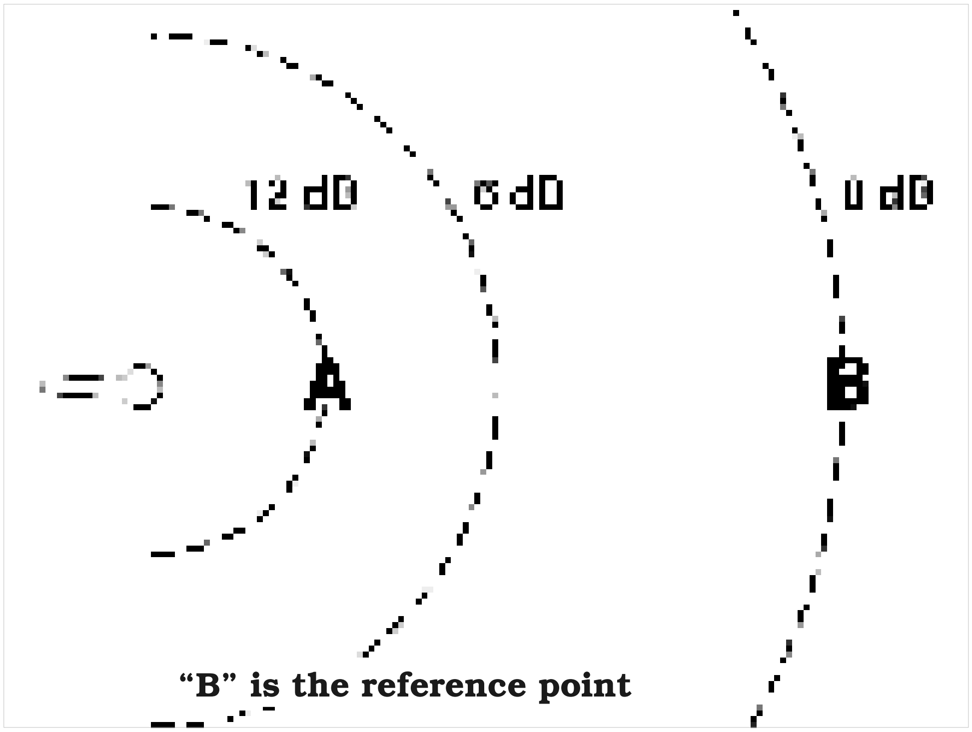
Another way to decrease the electronic gain is to - turn it down.

So what can we do about it??

- **Increase the acoustic loss.**
- **Decrease the electronic gain.**
  - **Change the frequency response of the system.**
  - **Turn down the fader.**

But now we can't hear because it is too quiet!

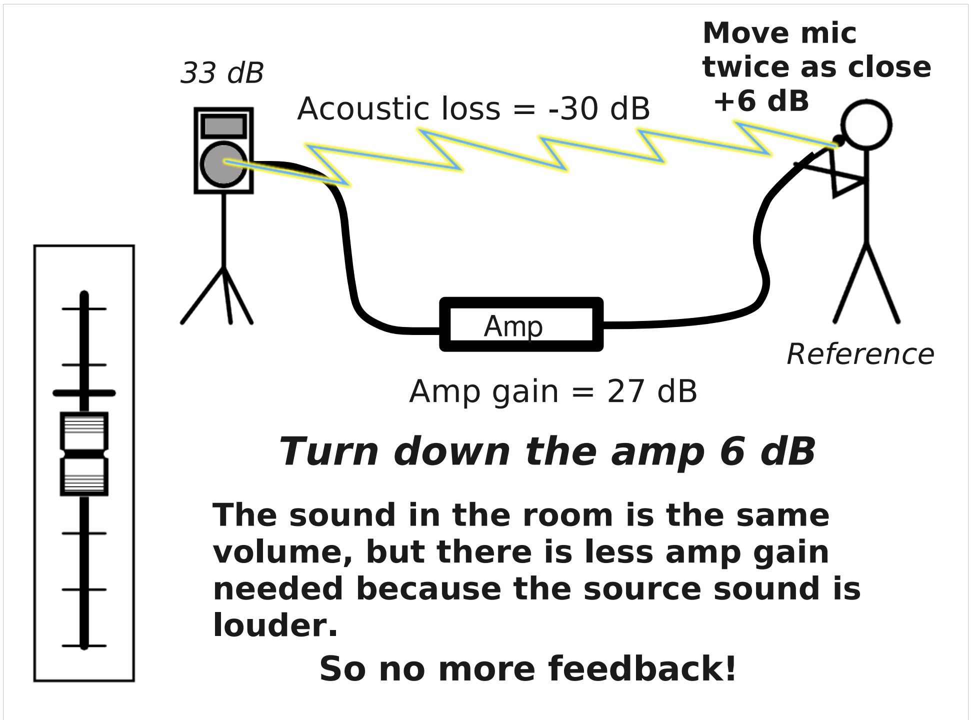
While this works, it has the side effect of making it quieter.



"B" is the reference point

We saw how the Sound Pressure Level from a speaker decreases and distance increases.

The same principle applies to microphones. As we move the mic closer to the sound source, the level increases.



I convinced the talent to hold the mic twice as close. This means we get a "free" 6 dB for the electronic gain side. The amp can be turned down by 6 dB and the output at the speaker is the same as before the mic moved closer.

The speaker-to-mic distance didn't really change, so there is still 30 dB loss there, and with the amp chain set to 27 dB gain, there is zero feedback - but it's just as loud in the room.

When it's practical, this is the best method to prevent feedback.

Instant Replay

Say it all, all over again. - The Replay

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

A review of what we covered.

Instant Replay

- The three categories of audio signal types.
  - Mic, Line and Speaker level
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

The signals in wires are divided into three groups based on level.

Mic - from a microphone - delicate
Line - general purpose - be careful
Speaker - for speakers - the bully

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
  - A convenient way to manage a large range of signal ratios.
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

A decibel is a way to describe the vast range of signal levels we deal with in a way it's possible for our brains to manage.

Remember it is a ratio, comparing two signals or a signal and a standard.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
  - Don't be afraid of your owner's manual.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

The block diagram in the mixer's manual can be quite helpful for figuring out the signal flow in *your* mixer.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
  - Practices - just not during the service.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.

Equalizers can be powerful tools to shape the sound. It's hard to describe sounds, so try it out. Practice. Play. Explore. But not during the service...

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
  - Apply the gain early in the chain.
- Polar plots.
- Understanding Feedback.

Understand that every device adds some noise, so keep the signal as close as practical to “max” for as much of the signal chain as possible.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
  - A picture of the sound in 3D space.
- Understanding Feedback.

Use the polar plots of mics and speakers to understand how they interface to the space around them.

Instant Replay

- The three categories of audio signal types.
- What is a decibel and why do we care?
- Audio flow through a mixing console.
- Equalizer basics.
- Signal to Noise Ratio and Gain Structure.
- Polar plots.
- Understanding Feedback.
  - Move the mic closer.

The best way to fix feedback is to get the mic closer to the talent.

When this isn't possible, use your understanding of the other influences to shift the balance of acoustic loss and electronic gain.


C M Y
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it's safe to wake up!
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R G B

The End