Controlling Feedback

Audio **Feedback** or the '**Larsen**' Effect (*Danish Scientist Søren Larsen*) occurs when the sound from a Loudspeaker (whether main L-R Speakers, or Floor Monitors) is picked up by a microphone. This sound that the microphone hears gets sent back through the Sound System to the Loudspeaker again, and the microphone hears it again. With each loop the volume increases. Finally, it becomes a continuous loop (positive feedback) and sounds like it is squealing.

If you listen to a feedback squeal it starts quietly, and then as it feeds itself it rises to full volume. The point of full volume is called "unity" gain or a gain of '1'. At this point the volume out equals the volume in and according to the *Barkhausen Stability Criterion* a stable oscillation will now exist. Basically, what that means is that the squeal will sustain itself, and sing forever, if you don't remove the cause.

If a microphone cannot hear a loudspeaker then we call it an *open-loop*. Once a microphone can pick up a loudspeaker then we have a *closed-loop*.

The actual frequency of the squeal depends on a few variables... the distance between the microphone and the loudspeaker, the air temperature (*hotter means more ringing expected*), the reflectiveness of the room *etc.*

Microphones usually squeal in the mid to high frequencies, however the rumbling of a large wooden stage or the rumblings of a reflective venue can generate low frequencies which can stimulate low-frequency feedback.

Some Pick-ups on acoustic instruments (many are just tiny microphones) can start a feedback loop with a floor monitor if it gets too loud.

THE MICROPHONE AND THE LOUDSPEAKER

Positioning
Only use *angled* Floor monitors.
Only use directional microphones that don't hear at their rear (cardioid) to minimise picking up the floor monitor.
Always keep the microphone close to its sound source. Position Lapel Microphones close to the chin of a person.
Avoid aiming speaker cabinets directly at reflective surfaces such as walls. The reflections will bounce over to the microphones.

Directivity
Loudspeakers and Microphones are both directional. Keep Front-of-House loudspeaker cabinets further forward (i.e. closer to the congregation) and the microphones behind the Loudspeaker line, facing backward.
If you are having trouble with feedback, even with a cardioid microphone, you would improve things with hyper-cardioid or super-cardioids.
For desperate venues you can even purchase woofers with a cardioid characteristic (more directional).

When you hear a feedback squeal… quickly look at the stage…
- Has a microphone on a stand just been turned around by someone on the stage so that it is pointing towards a Loudspeaker somewhere?
- Has a Singer, who is holding a microphone, relaxed and dropped their arm, pointing their microphone at a floor monitor?
- Is a Singer holding a microphone in such a way that their hand is covering part of the wire grill? This turns a cardioid microphone into an omni-directional microphone and it will cause squealing.

Be aware… when things start to squeal, some performers immediately place their hands over the wire grill to try and stop the feedback. This will make the microphone completely omni-directional and guarantees it will squeal.

Microphone Sensitivity
If the Gain knob on a microphone channel is too high, the microphone will be over-sensitive, and it will pick up the Front-of-House speakers or Floor Monitors unnecessarily. On a mixer the Gain dial for a microphone should be between 9 o'clock and 12 o'clock. A microphone that has a Gain turned around to 3 o'clock (¾ of it's turn), will normally be a feedback risk. In order for a microphone channel Gain to be only turned up to the minimum necessary, be sure that the Channel fader and the L-R master Faders are always high up (*the more you have the Faders down, the more you need to turn up the Gains*).
Lapel (Lavaliere) omni-directional microphones are always candidates for squealing. Check if it has a sensitivity screw inside the transmitter pack (turn it down).

Volume
The task is to keep the Floor Monitors as quiet as the performers are happy to work with. Unnecessarily loud Floor Monitors increase the risk of Feedback squeal as well as creating extra noise on stage which adds to, and confuse, the Front-of-House mix.

If they just can't hear the floor monitor (eg. the drummer) put it on a chair in front of them.

Turn off any microphones not in use (mute). Don't have open microphones picking up things unnecessarily. The more microphones that are open, the higher the risk of squeal.

Separation or Isolation Panels can be placed to minimise particularly loud floor monitors, and they help immensely in reducing spillage between microphones.

if, after you have tried everything, you're still getting a lot of feedback, consider other *monitoring* methods:

**In-Ear monitors** (IEM's) or even **Headphones** (for musicians).

Spot Monitors- small monitors attached directly to the microphone stand, such as Mackie SRM150, or The Flea.

LOUDSPEAKER EQUALISATION

If you have a potentially squealy channel(s) and you can never raise the channel volume far or you set off the squeal, then you need to Ring Out (or Bleed) (or Dial Out) the Loudspeakers. We do this before the Sound Check (it's not the most pleasant exercise and best done when no one else is around.

We normally use a 31 band Graphic Equalizer because it is most precise, and least invasive on the overall sound. It is inserted between the Mixer and the Power Amplifier of the Loudspeaker. The Graphic Equalizer is used like a 'notch' filter. Try not to filter excessively to minimise the loss of sound quality.
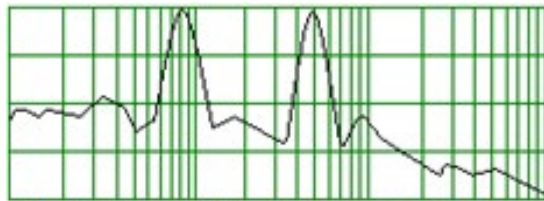
Music with several Squeal Frequencies that force the general volume to remain low.

The Squeal Frequencies are identified and lowered.
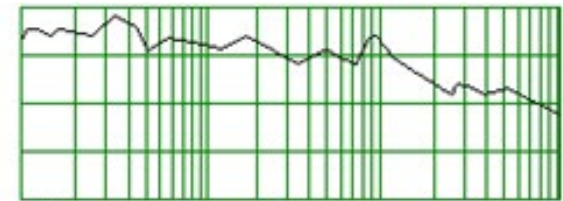
The general volume can be increased noticeably before any further risk of feedback.

By lowering the frequency(s) that are causing the feedback, you can make it much harder for the Sound System to squeal. This allows you to raise your channel faders up to further, with confidence.

The simplest method of "ringing out" Loudspeakers (FOH or Floor Monitors):

Insert a Graphic Equaliser in the Front-of-House monitor or Floor monitor line.
Connect a microphone to a Channel, and send (assign) the channel out to the loudspeaker.
Make sure that the channel EQ is flat (not filtering).
Point the microphone at the Loudspeaker and slowly raise the Gain until it squeals.
Monitors typically feedback in the 1.2, 3.5-5kHz range on the high end, and around 630Hz on the mid-low end, but you never know exactly where until you start "bleeding it".

To find the squeal frequency, pull down (slightly) each Graphic Equaliser fader one at a time. If it doesn't stop the squeal, return Eq fader to zero and try the next one. When you find squeal frequency(s) then slide their faders down just enough to cut the squeal. No more.
If you like, try turning up the Gain further, to see if any other frequencies appear. When you find it difficult to start anything squealing, you know your Sound System is stable.
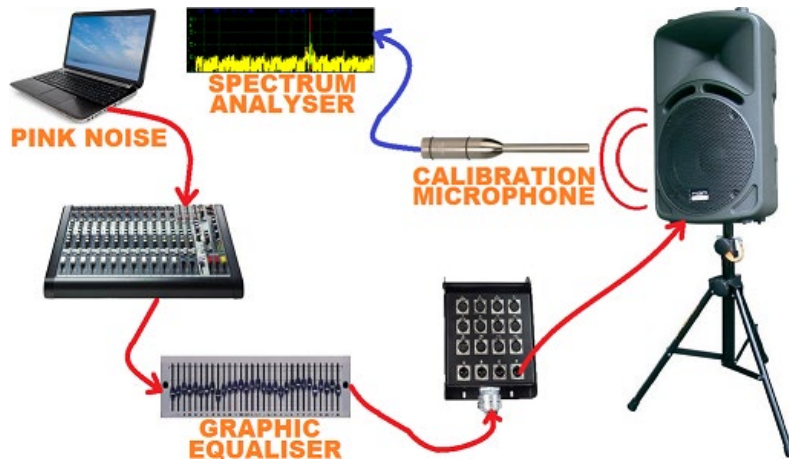
"Ringing out" using Pink Noise (FOH or Floor Monitors):

Insert a Graphic Equaliser in the Front-of-House monitor or Floor monitor line.
Connect a Pink Noise source (from a Laptop or Spectrum Analyser) to a Channel and send (assign) the channel out to that monitor. Make sure that the channel EQ is flat (not filtering).
Connect a calibration microphone to a Spectrum Analyser and point the microphone at the Loudspeaker.
When you play Pink noise (it just means all the frequencies are played at once) out through your Sound System, you would expect to see a smooth line (the way it was when it was sent). The result will never be smooth, and will display all the imperfections of your loudspeaker cabinet, all electronic devices in the line and resonances that the church building added to your sound. By adjusting the Graphic Equaliser, you can "compensate" for the imperfections and get a curve that is more or less smooth, like you sent it.

FEEDBACK ELIMINATORS (Feedback Destroyers) (Automatic Notch Filters)
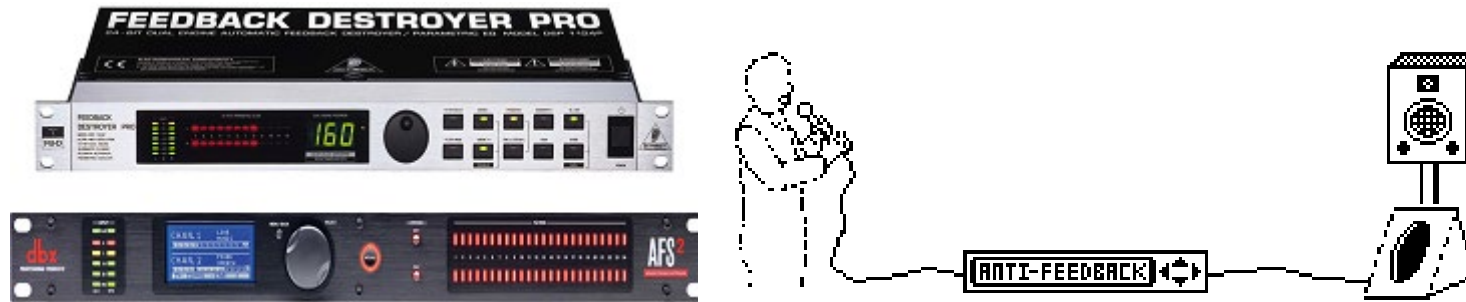
Instead of inserting a Graphic Equaliser, you could insert a Feedback Eliminator Unit. This device is like a computerised Graphic Equaliser that scans the incoming signal for any tall peaks (squeal frequencies) and then automatically lowers them.

Here are two typical examples: **Behringer** Feedback Destroyer Pro and **dbx** AFS224 Feedback Eliminator. They both have:
- two channels (good for stereo output L-R, or 2 separate floor monitors)
- 24 narrow band filters. When the unit finds a squeal frequency, it assigns one of the filters to notch it out. It can kill 24 different frequencies.
- Should an additional squeal frequency occur (more than 24, you're having a bad day) the unit will drop one of the previous frequencies and grab the new one. They are intuitive, and do a great job of juggling, discerning which ones are less dangerous.

Some units offer you the chance of keeping a few of the (24) filters fixed (*for the continuous squeal offenders*) and the remaining filters roaming.

DRIVE RACK LOUDSPEAKER MANAGEMENT

For the Sound Technicians who have a budget, a wonderful "all-inclusive" solution is to insert a stereo **Drive Rack** in the Front-of-House Left/Right line.

A Drive Rack does all the work for you. It includes a Feedback Eliminator, so you shouldn't get any feedback squeals in the Front-of-House loudspeakers. They also contain a Compressor/Limiter to keep the levels smooth and everything audible. A Drive Rack will let you equalise the FOH loudspeakers to compensate for the room (church building) resonances and electronic imperfections in the Sound System and Loudspeaker cones. For this there will be a built-in Graphic Equaliser, Spectrum Analyser, Pink Noise Generator, and you will need to connect a Calibration microphone (not expensive).

OTHER FEEDBACK REDUCTION IDEAS

Use contact microphones and pickups instead of regular microphones.

Use direct injection (D.I. box) instead of microphones for musical instruments.

Use a noise gate (automatically shuts off a signal when it gets below a certain threshold) on potentially squealy microphone lines. This is like automatically turning off any microphones not being used.

It is a good habit to put on the Headphones and go along the **PFL** buttons every so often. You can usually hear potential squealing earlier with Headphones, the guilty channels will have a particularly bright, metallic sound when you PFL them.

OTHER TYPES OF FEEDBACK

Normally feedback squeals are caused by a loudspeaker to microphone loop. However, there are a things to keep in the back of your mind. *For example:*

A feedback squeal can also be caused electronically. If the output from a channel or device is fed back in to its own input you may start an 'electronic' loop, and it sounds the same as a microphone squeal.

A highly reverberated environment will stimulate feedback. Room resonances can make your Sound System start ringing, and subsequently squeal. Because these squeal frequencies will be the same as the room's own resonance frequencies, the room will "sustain" the feedback squeal.

If you have Loudspeaker cabinets sitting flat on a hollow wooden stage, the cabinet vibrations will vibrate the floor. These vibrations arrive at the microphone stands and consequently the microphones pick up the vibrations. This starts a mechanical feedback loop.
When dealing with hollow stages, make sure all cabinets are on wheels, spikes, or rubber pads to minimise the transfer of vibrations which, if nothing else, add low frequency rumble into your microphone channels.

CREDITS

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Text: *Original, by the Author, a Christian Recording Engineer.*
Images: *Designed by the Author. Some photographs were sourced from the Internet, then re-worked.*

Ever since the creation of the world, God's invisible attributes and divine nature have been evident. They are clearly understood through his workmanship, and all the wonderful things that he has made. Therefore, those who fail to believe and trust in him are without excuse, or defence. **Romans 1:20**

All of us have sinned and fallen short of God's glory, but God treats us much better than we deserve.
Because of Christ Jesus, he freely accepts us and sets us free from our sins. God sent Christ to be our sacrifice. Christ offered his life's blood, so that by faith in him we could come to God. **Romans 3:23**

If you declare with your mouth, "Jesus is lord," and believe in your heart that God raised him from the dead, you will be saved. For it is with your heart that you believe and are justified, and it is with your mouth that you profess your faith and are saved. **Romans 10:9**

For the Scripture (*Isaiah 28:16*) says, "Whoever believes in Him will not be disappointed." **Romans 10:11**

These things have been written so that you may believe that Jesus is the Christ, the son of God; and that by believing, and relying on him, you may have new life in his name. **John 20:31**