Version 2

Positive Feedback™

The Advantages of FBX Feedback Exterminators®

• Automatic feedback control • More wireless mic mobility
• Louder & clearer sound systems

Feedback and the FBX: the whole story

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Real-life examples of the FBX in use

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"No one's ever taking the POWER-Q off me. It's welded into the (Spice) rack!"

– *Mike Dolling*

The entire FBX product line

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SABINE®
ADAPTIVE AUDIO

The Story of Feedback

By Doran Oster, President

Ever since Lee DeForest invented the first vacuum tube, engineers have walked the tightrope between feedback and system gain. The purpose of this guide is to give you the tools to get all the gain you need without the agony of feedback. We'll start with a common-sense discussion of the techniques sound engineers now use to control feedback to get the most gain and clarity out of their sound systems.

Our imaginary work bench

Imagine a mic and speakers set up in a tiny shower room. Clap your hands. The sound reverberates back and forth between the tile walls and floor. Just a touch of the volume fader fills the room with screeching feedback.

Now move our sound system out to an open grassy field. Clap your hands. There is no echo. The speakers are well away from the microphone and there are no reflections, so now we can really crank up the system without a bit of feedback.

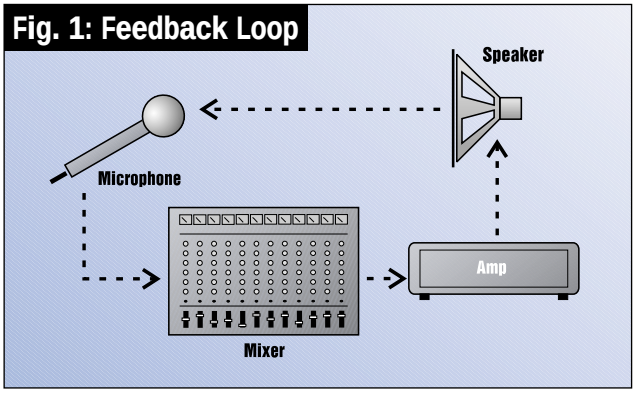
Most sound systems have characteristics that fall between these two examples, but examining the extreme cases makes it easier to understand the more common in-between situations.

What is acoustic feedback?

Feedback is the loud ringing sound that occurs when the sound leaving a speaker is picked up by a microphone and reamplified again and again. (See Fig. 1.) The cycle repeats until the feedback reaches the system's maximum loudness or until someone turns down the volume. Virtually every sound system that has a microphone and a speaker in the same room is susceptible to feedback.

Which frequencies feed back? All acoustic systems have distinct resonant frequencies. Regardless of where you thump a guitar's top, it always responds with the same tone. This is the natural resonant frequency of the guitar. It is the frequency where all of the instrument's components vibrate naturally as a unit. In sound systems, these resonant points are the frequencies where feedback occurs.

Fig. 1: Feedback Loop



Each of the system's components, including and especially the room itself, has its own set of resonant frequencies. Each component adds together to produce the total system's resonant frequencies. It is almost impossible to predict which frequencies will feed back without first "thumping" the system, but you only have to turn up the amp for them to rudely reveal themselves.

The frequency that feeds back first is the one that requires the least amount of energy to excite the resonance. If you remove the first feedback frequency, the next feedback frequency will be the one that requires the second least amount of energy, and so on.

Controlling feedback

In order for feedback to occur, the amplifier has to be turned up enough so that sound from the speaker reenters the microphone louder than the original sound. In our imaginary experiment, feedback easily occurred in the shower room because the sound leaving the speakers did not dissipate very much before reentering the microphone. But when we move the speakers away in the open field, the sound energy dissipates as it radiates away from the speakers. If there are no surfaces to reflect the sound back to the mic, the sound quickly loses energy, dropping to one quarter the

energy every time the distance from the speakers is doubled. By the time the sound finally reaches the microphone, the sound energy is weaker than the original sound, so there is no feedback. From this example we deduce the Prime Directive of Feedback Control:

Keep the sound emanating from the speakers away from the microphones as much as possible.

Here are the most common tricks of the trade for controlling feedback:

• **Stand close to the microphone.** Speak loudly and clearly so that you do not have to amplify the sound too much.

• **Each open microphone has a chance to feed back.** Mute or turn down the gain of any microphone that is not in use. Noise gates can be helpful for this.

• **Mount the microphones in fixed positions.** Moving the microphone around on the stage increases the chances that the microphone and the speaker will form new resonant paths.

• **Use cardioid or hyper-cardioid microphones, and point the mics away from the speakers.** They pick up much less sound from the back side of the mic, which protects against monitor feedback. Be careful not to put your hand on or too close to the microphone's screen, since this can cover the ports that enable the heart-shaped (hence cardioid) rejection pattern.

• **Place the speakers in front of the microphones** so there is not a direct path back to the microphone.

• **Aim the speakers so the sound does not reflect directly off a wall back into the mic.** You can estimate the speaker's dispersion pattern (the area that is directly "sprayed" with sound) for the mids and high frequencies by imagining rays of light radiating out of the speaker's horns. If you can see the center part of the horn, you are probably in the dispersion pattern. Lower frequency sounds tend to radiate out in all directions from all sides of the speakers.

• **Make the surfaces of the room as sound absorbent as possible** to reduce sound reflections. Use acoustical absorbing tiles in the ceiling, put down carpeting, and hang curtains.

In the real world of most performance spaces, you cannot always follow these anti-feedback techniques. Lead singers insist on pointing the monitors directly at the mic. Worship leaders insist on the mobility of a wireless microphone, and night club owners will not likely carpet the dance floor and hang velvet curtains. Even after you've tried all these tricks, you may still not have enough gain and clarity to satisfy the audience. Do the best you can, and then go on to the next level of feedback control: equalization.

Equalization

Equalizers (EQs) are sets of filters, or volume controls, for different parts of the audio spectrum.

Since the earliest days, sound engineers have used equalizers for two distinctly different purposes: 1) To improve the tone quality and balance of the sound, and 2) To control feedback for extra gain and microphone mobility. Some types of EQs are best at shaping the tone and other types are better at controlling feedback.

It may seem paradoxical to add filters to a sound system in order to increase the gain. But if you can use extremely narrow filters to turn down the frequencies that are feeding back, you will be able to increase the gain of all the other frequencies for a total net gain. There are essentially three categories of equalizers: graphic, parametric and adaptive parametric.

Graphic EQ

Graphic EQs are basically a set of volume controls for individual sections of the audio spectrum. The earliest music equalizers were the bass and treble tone knobs. As technology advanced, these filters were narrowed to give more precise control. Today, the industry standard is called a 1/3-octave graphic equalizer, which has 31 individual volume controls spaced 3 per octave.

There is a common misconception in the industry about 1/3-octave EQs that is important to this discussion. Many industry veterans incorrectly presume that 1/3-octave EQs use 1/3-octave wide filters. If this were the case, the EQ filters would not be wide enough to create smooth curves. Instead, they would produce a notched frequency response that would make the EQ useless for shaping the sound and useless for controlling feedback frequencies between the sliders. Actually, most manufacturers use 3/4 to 1-octave wide overlapping filters placed on 1/3-octave center points. These wider filters provide the necessary smooth frequency response. (See Fig. 2.) **It's important to understand that the term "1/3-octave" refers to the spacing of the sliders, not the filter width.**

Graphic EQs are excellent for shaping the sound, and they are fairly simple to use. However, using one-octave wide EQ filters to control feed-

back invariably causes an unnecessary decrease in the gain and fidelity of the program. It's easy to see that if feedback occurs somewhere between the sliders, you will have to pull one of those EQ sliders down pretty far to eliminate feedback. That pulls out plenty of your program, too. On the other hand, you'll get considerably more net gain and much better sound quality if you use wide graphic EQ filters for tone control and insist on narrow filters for feedback control. (See Fig. 3.) That's where parametric EQs come in.

Parametric EQ

In the quest for perfect sound, engineers developed very narrow tuned filters for controlling feedback points in auditoriums. In the early days of sound reinforcement, these filters were custom made to a specific frequency and width for a specific application. Now there are a number of commercially available parametric filter sets that allow engineers to dial in the width, center frequency and depth of the filter.

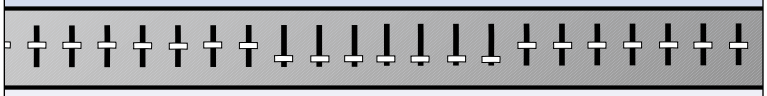
The problem with parametrics is that they're expensive, they require a good deal of expertise and auxiliary equipment to tune properly, they require constant retuning whenever the room acoustics change, and they are far too slow and cumbersome for catching feedback that occurs during the program.

Adaptive Parametric: The FBX Solution

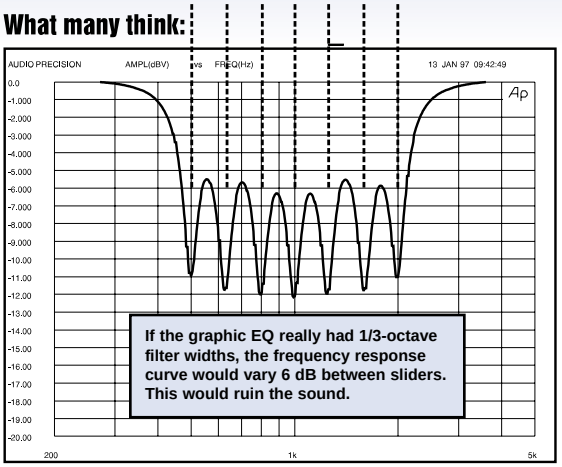
The Sabine FBX Feedback Exterminator® is the next step in the evolution of feedback control. The FBX is essentially a self-tuning parametric EQ. It constantly monitors the program, searching for tones that have the overtone signature of feedback. Once feedback occurs, the FBX automatically places a very narrow, constant-width filter directly on the feedback frequency and lowers it just deep enough to eliminate the ringing sound.

Fig. 2: Graphic EQ

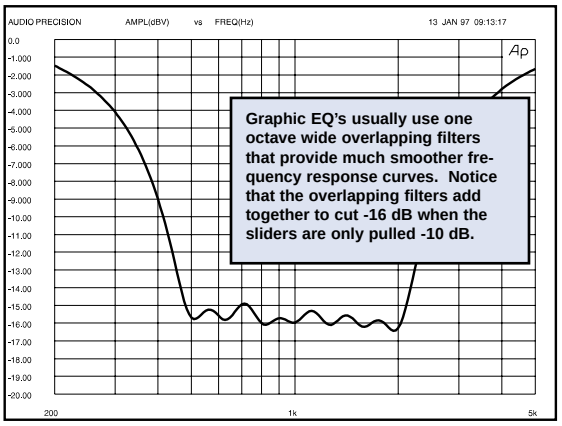
Typical Graphic EQ:
-10 dB cut at 500, 630, 1K, 1.25K, 1.6K & 2K Hz



What many think:



What really happens:



The FBX out performs other EQs five ways:

1. The FBX finds and eliminates feedback automatically before and during the program.

2. The FBX's narrow filters eliminate feedback without losing the fidelity of the sound.

3. The FBX is fastest. It typically finds and eliminates feedback in less than one second.

4. The FBX gives the most gain. Use wide-filter graphic EQs for controlling the shape of the sound and narrow FBX filters for controlling feedback, and you'll typically achieve a 6 to 9 dB increase in gain compared with using the EQ alone.

5. Increase wireless mic mobility.

What about that 6 to 9 dB increase in gain? Gain increase from equalization really depends on the characteristics of the sound system and the room. Returning to our imaginary system in the shower room, the sound bounces off the hard tile surfaces and reflects back into the microphone with only a slight touch of the volume slider. If you filter the first feedback point, you can only increase the volume fader a touch more before the second feedback occurs at a new frequency. Even if you filter six different resonance points, you may only achieve 1 or 2 decibels of net gain because there are so many low-energy resonant paths.

When we set our system in a large open field and the speakers are far away from the microphone, we really have to crank it up before we hear the first feedback. We would need an enormous system to drive six feedback points. In this system, damping six feedback points could easily deliver well over 15 dB net gain!

How much gain do you achieve with the six FBX filters? Six resonance points worth - whatever that happens to be in your unique system. You can maximize your gain by following our anti-feedback directives and by learning more about how the FBX filters work best for your situation.

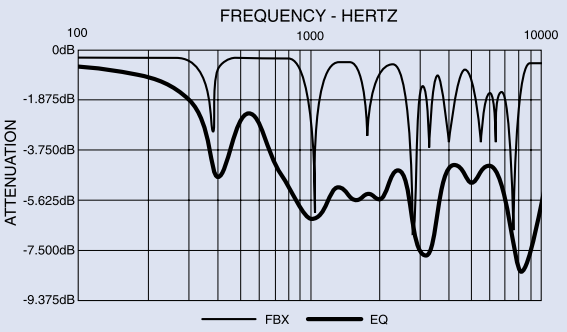
Microphone Mobility

Mobile karaoke and wireless microphones present a special feedback challenge. It does little good to set a number of filters for a mounted microphone if you plan to carry the mic around the stage to different locations. Each position on the stage has its own unique set of resonant frequencies, so the filters that control feedback in one location will probably not provide much help in other locations.

You are faced with a balancing act. If you insert too many filters in the system, you will hear a degradation of the sound quality. If you set too few filters, you will not have enough mobility or gain.

move. These filters provide the initial maximum gain before feedback and are set automatically during setup. Dynamic filters can release and move to new feedback frequencies and are for adaptive feedback control during the performance. You can change the number of fixed vs. dynamic filters using

Fig. 3: FBX vs. 1/3-Octave Graphic EQ



A PA System was set up using a microphone, mixer, FBX, power amp and two speakers. The system's gain was raised until the FBX removed nine feedback points. Next the FBX was replaced with a graphic EQ. The EQ was adjusted while the system gain was raised to the same level achieved with the FBX. The frequency response curves of each device were then plotted.

In this case, it is usually best to walk around the stage area until you find an area where feedback is a particular problem. Then place one or two feedback control filters to take care of that location and repeat the process in the next few areas. FBX filters add less gain to mobile systems than to fixed microphone systems, but they add a significant increase in the usable area while preserving the natural clear sounds.

Feedback Control During the Program

One of the most powerful features of the FBX is that it can eliminate feedback during the program. FBX filters come in two types: fixed and dynamic. Both filters are placed the same way: Feedback is detected, and the filter is placed just deep enough to eliminate it. The difference comes after the filter is placed. Fixed filters remain on the initially detected feedback tone - they do not

front panel controls.

Hearing is Believing

To hear the difference for yourself, insert an FBX in your sound system and bypass it. Mount the mics on stands to fix their positions. Remove as much feedback as possible using your normal method with just the graphic EQ. Next, lower the volume, bypass the graphic EQ, and activate the FBX. Now slowly raise the gain of the system until at least six FBX filters have kicked in.

Next, turn down the mics and play your favorite CD through the system. Alternately listen to the system with just the FBX and then just the graphic EQ. You will hear the FBX provides much clearer, brighter and louder sound.

If you do not have immediate access to an FBX, run this experiment with a graphic EQ alone. You will be amazed to hear what it does to your sound.

SEE THE GLOSSARY ON THE NEXT PAGE (p. 5) FOR DETAILED EXPLANATIONS OF SOME OF THE TERMS USED HERE.

GLOSSARY: Definitions of "tech" terms

What is Gain?

Gain is a measure of the change in power (or loudness) in a sound system. For example, turning up the amp causes an increase in gain, while moving away from the speakers causes a decrease in gain. By convention, gain is expressed in decibels.

ClipGuard™ Adaptive Clip Level Control

Sabine's ClipGuard™ makes FBX feedback control faster and easier to use, and it adds about 10 dB to the effective dynamic range. Until ClipGuard, engineers manually set the input and output level controls to a compromise setting that causes unnecessary noise during quiet programs and risks clipping overload during high level programs. Now ClipGuard constantly readjusts the FBX's electronics to match the continually changing program levels.

Another feature of ClipGuard is TURBO mode that cuts the time of the pre-program setup to just a few seconds. ClipGuard is currently a standard feature in Sabine's FBX-1020P & 2020P Feedback Exterminators, POWER-Q ADF-4000, GRAPHI-Q, DQX-206 parametric EQ/delay and the REAL-Q_2 Real-Time Adaptive Equalizer.

Noise Gate/ Comb Filters

As we mentioned earlier, every microphone creates a potential source of feedback, so it is advantageous to turn off microphones that are not currently being used. Noise gates do this automatically by continuously monitoring the program's loudness. If the loudness falls below a threshold set by the user, the noise gate automatically turns off the microphone. Once the loudness exceeds the threshold, the microphone channel automatically turns back on.

Noise gates are useful for a number of important sound applications besides feedback control. For example, if a person or instrument is picked up by two microphones placed in different locations, the combined mic signals will interfere with each other, causing a type of distortion called comb filters. Comb filters add gain at certain frequencies and thus increase the chance of feedback. At the same time, they cut the gain at other frequencies, causing the program to sound thin and over-equalized. Gating the unused microphones eliminates this source of comb filtering.

Noise gates are often employed in CD players to eliminate noise between songs. They are similarly used in sound systems to mute the hiss of noisy electronic components during quiet periods.

Most Sabine FBX Feedback Exterminators feature user-progammable noise gates.

What are Decibels?

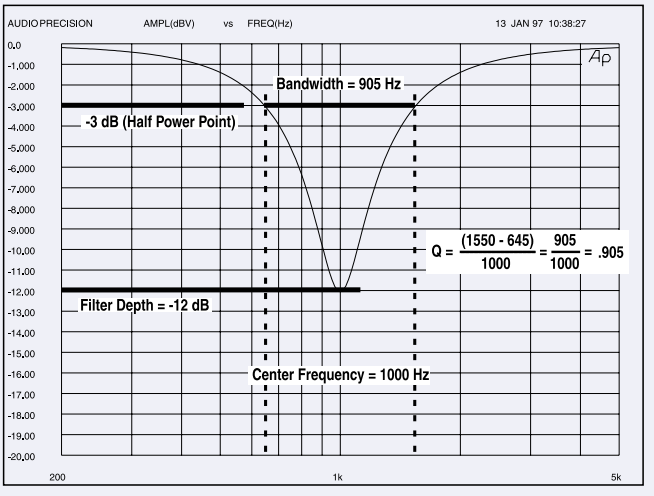
We have the ability to hear an amazing range of loudness. People placed in an absolutely quiet anechoic chamber eventu-

Fig. 4: Loudness in Decibels

Sound Source	Sound Pressure Level in dB
Jet Engine	160
Threshold of pain	132
Riveter	120
Noisy Office	80
Conversational Speech	60
Quiet Residence	40
Recording Studio	30
Leaves Rustling	10
Hearing Threshold	0

Fig. 5: Typical Frequency Response

1K EQ slider pulled down 12 dB



ally perceive the sound of air molecules hitting their eardrums. On the other hand, people working near jet engines hear sounds a billion times more powerful. Engineers have developed a convention that economizes the calculations of such an enormous range of values. This convention describes these changes in terms of decibels (abbreviated dB) named in honor of Alexander Graham Bell.

Many non-technical people find the different uses of the term decibels confusing because it seems to have so many different meanings. For example, decibels are commonly used to describe the loudness of a sound, the change in loudness (or gain) from one time to another, for changes in signal voltage, and a number of other technical measurements involving the power ratio of large numbers. While we gladly leave these calculations to the engineers, it is helpful to realize that a change of 1 dB is equivalent to a 27 percent change in power. With this in mind, we realize that turning up the system gain by 3 dB increases the power approximately 100% (27% x 3). In other words, turning up the amp from 400 Watts to 800 Watts adds about 3 dB to the system gain.

Wow! Does doubling the power from 400 Watts to 800 Watts make it sound twice as loud? No! A three decibel change sounds only slightly louder. In general, you have to increase the power about 10 times (or 10dB) to make the sound seem twice as loud.

When engineers describe the loudness of a sound in terms of decibels, they are comparing the sound pressure level of a particular sound compared to an international standard. Fig. 4 gives several common reference points.

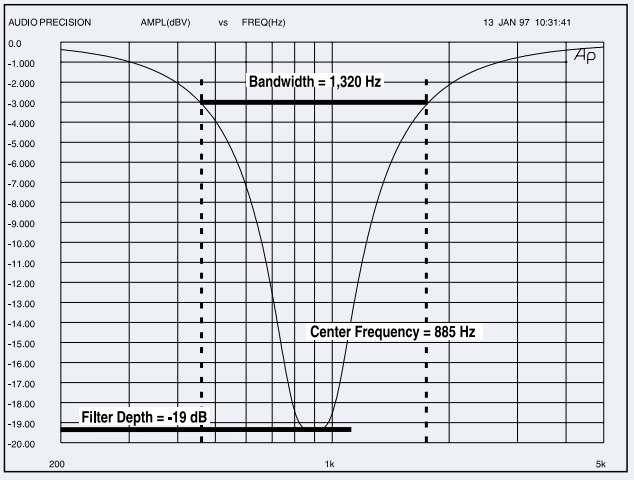
Frequency Response Curves

A frequency response curve is a graph that shows the gain of a component or a group of components at different frequencies. Fig. 5 shows the frequency response of a typical equalizer with the 1,000 Hz slider pulled down 12 dB. The frequency response curve shows that the biggest cut in power, called the center frequency is at 1,000 Hz, that the filter removes half of the power (-3dB) between 645 Hz and 1550 Hz, the Q of the filter is 1550-645 Hz/1000 Hz (.905), and the maximum depth is -12 dB.

Fig. 6 shows the frequency response of two adjacent sliders pulled down 12 dB. Notice that the center frequency of the two sliders is at 885 Hz. The combined filter width is 1.49 octave and the two filters add together to give a maximum depth of -19.3 dB.

Fig. 6: Typical Frequency Response

Two overlapping EQ sliders pulled down 12 dB



Constant-Q Filters

It is common to describe a filter's quality factor, or "Q," as the center frequency of the filter divided by the filter width (in Hertz) measured at the -3dB point. Filters that have the same Q, or width, at the -3dB point regardless of the filter's cut or boost are called constant Q filters. Filters that get wider as the filter gets deeper are called proportional Q filters.

There seems to be a new development in the audio industry. The definition of constant Q is blurring. Many equalizer manufacturers claim their equalizers have constant Q filters, when in fact they get substantially wider as they get deeper. The only way to know for sure if the filters are truly constant Q is to inspect their frequency response curves. (See Figs. 7 & 8.)

Net Gain Before Feedback

Many people measure their increase in gain by the amount they push up the mixer's calibrated slider. But if adding gain

Fig. 7: Typical Constant Q Filter

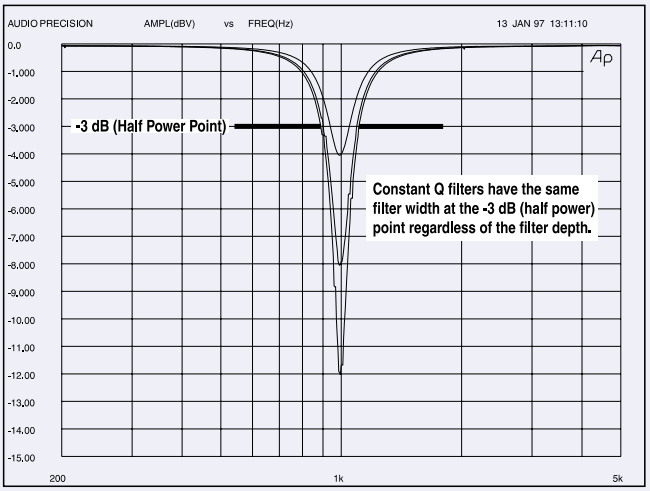


Fig. 8: Typical Proportional Q Filter

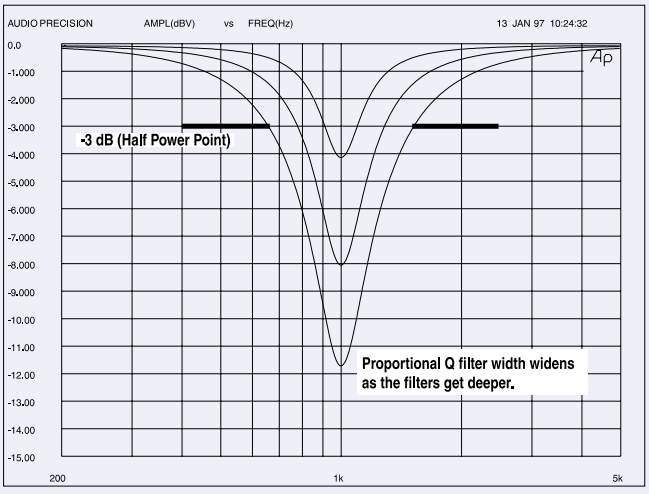
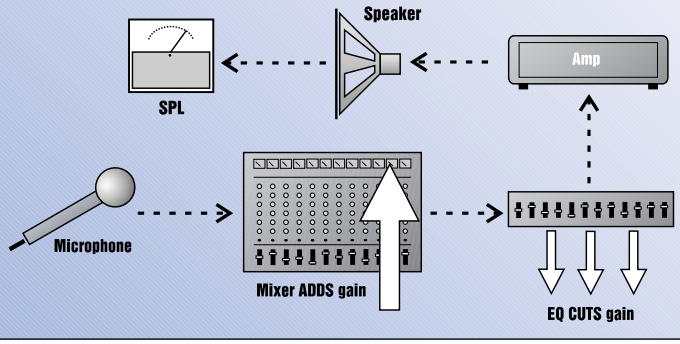


Fig. 9: Net Gain = Mixer minus EQ



causes feedback, you will have to cut the gain of the feedback frequency at the EQ in order to add gain at the mixer. A more accurate concept could be called NET gain. It is the amount of gain you achieve pushing up the mixer slider, minus the gain you lose lowering the EQ sliders. NET gain is the gain you realize in front of the speakers as measured by a sound pressure level meter. That is the gain that matters. (See Fig. 9.)

The Frequency Spectrum

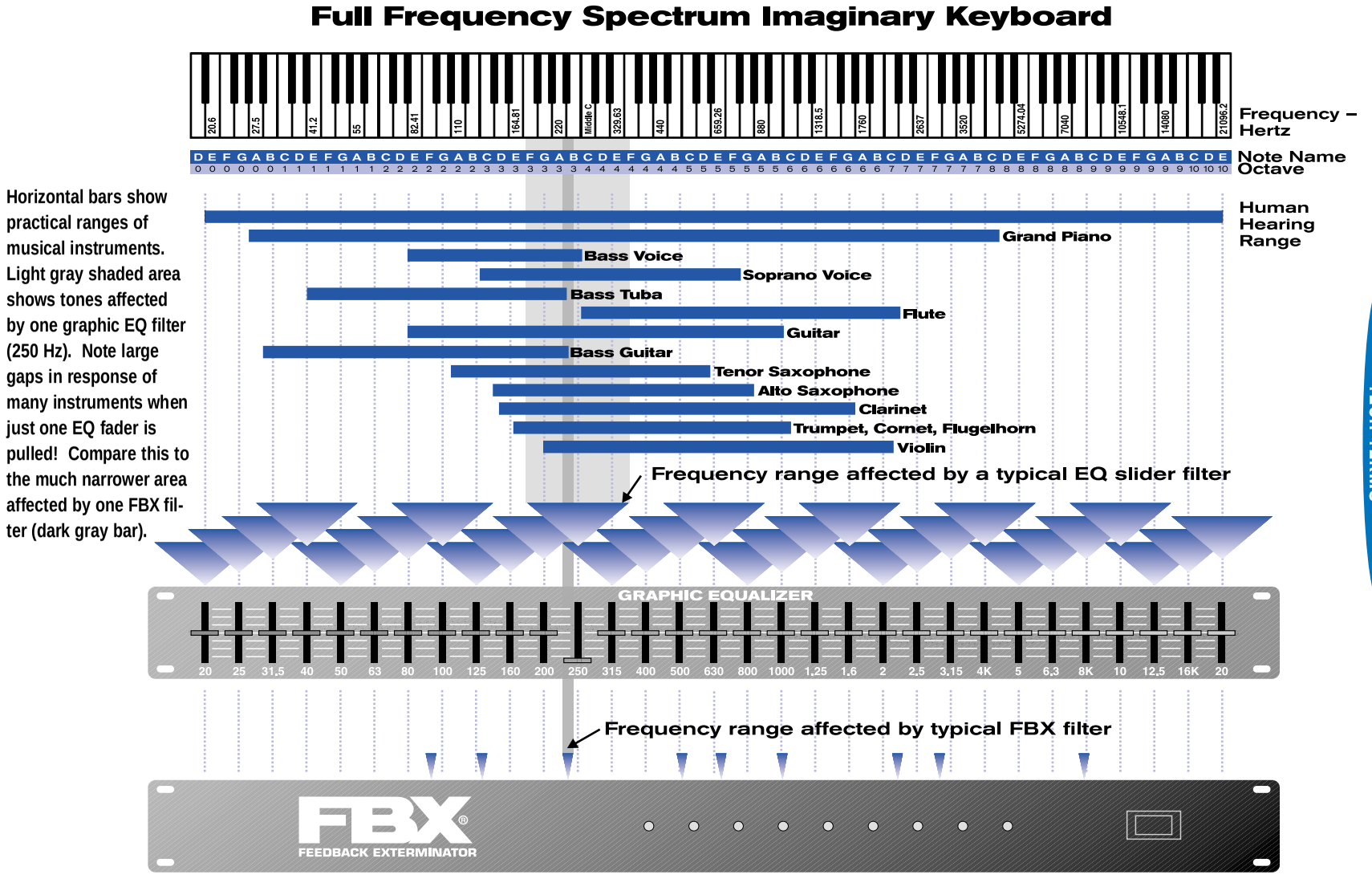
People with excellent hearing can hear frequencies between 20 and 20,000 vibrations per second or Hertz. Fig. 10 shows an imaginary 120 key keyboard that would be big enough to play all the notes that we can hear. The lowest key would play a 20 Hz “E” and the highest key would play a 19,912 Hz “D#.” Notice that doubling the frequency raises the pitch one octave. We hear the same one-octave musical interval between 40 and 80 Hz as we do between 10,000 and 20,000 Hertz.

A graphic equalizer is superimposed that shows which sliders affect the notes of several instruments. For example, the chart shows that the 250 Hz slider affects most of the bottom 1/3 of a guitar’s range.

The typical FBX filter below the EQ shows the relatively smaller size and effect on sound of FBX filters and illustrates why they cause less tonal change and gain loss.

The nine FBX filters are not preset on any particular frequencies like EQ filters. They are placed precisely where feedback occurs.

Fig. 10: The Frequency Spectrum

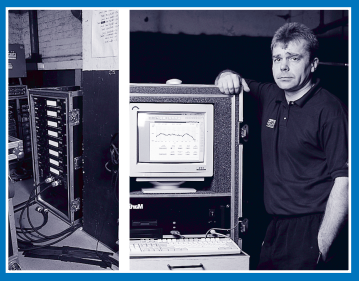


TECH TERMS

POWER-Q

Sixteen channels of monitors:

Chris Trimby & TFI Friday



Chris Trimby

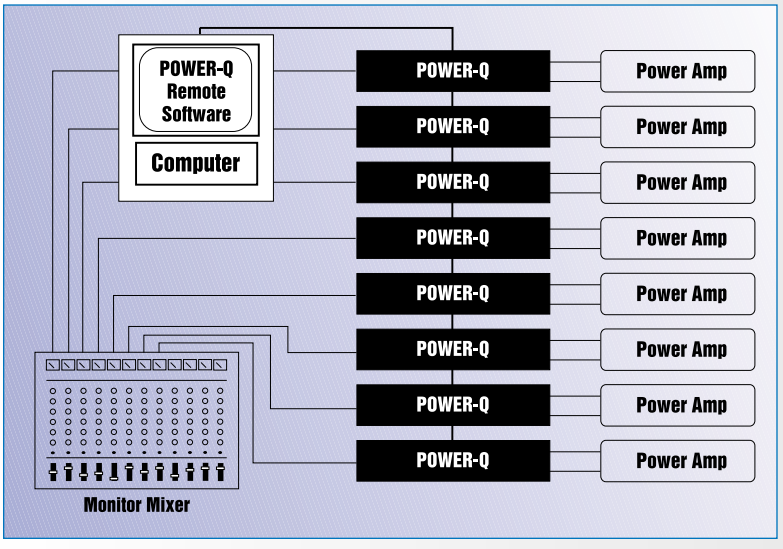
Every Friday evening at 6:00 all of Britain celebrates the start of the weekend with the hit television show "TFI Friday." Hosted by star Chris Evans, TFI Friday features an informal "big bar" setting as a backdrop for entertaining conversation between host and guests, plus the occasional musical act. Adding to the normal mayhem and stress of a weekly television production is the fact that the show is broadcast **live** to millions of devoted fans. Then consider that Chris and his guests like to wander around the set during the course of their conversations – with their lavalier microphones amplified to quite loud levels for monitoring purposes. Finally, throw in not just one, but three sound stages for live music, and you might think a sound engineer in charge of such a setup would long wistfully for a carefree career as a professional mine sweeper or some other less stressful occupation.

Not so Chris Trimby, monitor engineer extraordinaire, in charge of 16 monitor mixes for TFI Friday. Chris, whose London rental company ENTEC supplies all the sound requirements for the show, has made his demanding job far less stressful by harnessing a total of eight Sabine POWER-Qs (plus 2 in rotational duty), all controlled from a central computer station.

"The POWER-Q contains every possible bit of information you could ever need to detect problems and then put them right in a fraction of the time it would have taken using traditional methods," states Chris. "Set-up time for the POWER-Qs is remarkably fast. Via the PC, all the machines copy to each other, so once one is programmed, they can all be preset. By the time the show airs on Friday, I can virtually put my feet up! I get an extra 9 dB of gain before feedback! It's a real joy to mix."

Chris uses all the features of the POWER-Q, but especially finds the EQ and powerful FBX notch filters useful in preventing any surprises during the show's live broadcast. He also uses the unit's delay, compression, limiting, and Real Time Analyzer and curve display. Chris finds the potential uses of the POWER-Q almost limitless. "I am discovering new ways to manipulate the system all the time," claims Chris. He describes the POWER-Q's flexibility as an absolute essential in live television, where the limits are always tested and new problems are a constant challenge. "Sabine's POWER-Q is the perfect tool for the job."

Thanks to Kiera Leeming of Fuzion, Sabine's UK distributor, for her assistance in compiling this information.



POWER-Q
FBX-1020Plus

Using the FBX in churches:

Daytona Beach Assembly Hall of the Jehovah's Witnesses

William Heien
Assembly Hall Manager

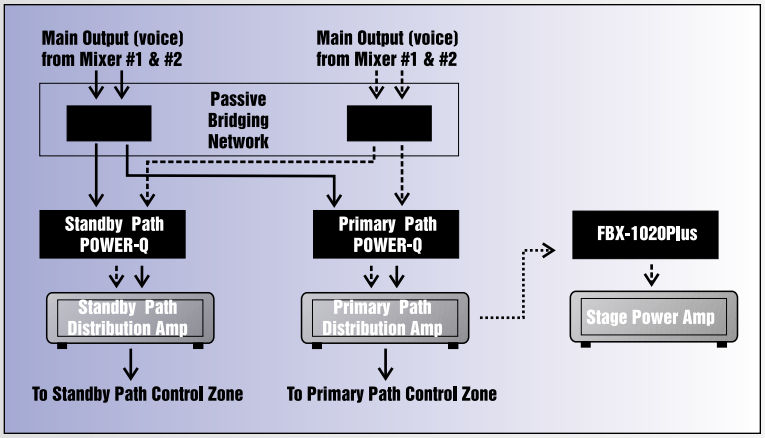
Sabine's adaptive audio products provide a gentle but powerful application of technology to solving acoustical challenges presented by both historic houses of worship, and brand new, modern facilities. That's why you'll find the name "Sabine" in use all over the world, in places of worship of all shapes, sizes, and denominations – from the huge scale of the Vatican in Rome (GRAPHI-Qs and FBXs) and the Grand Mosque in Mecca (a rack full of FBX-1020Pluses), to small churches and modest ministries.

Somewhere in between the largest and smallest house of worship is the 2,200-seat Assembly Hall of the Jehovah's Witnesses in Daytona, Florida. Here Sabine's POWER-Q provides feedback-free sound and worry-free operation, perfectly suited for quiet contemplation or festive celebration.

Contractor Larry Kommers of Sight & Sound in Laurens, SC calls the POWER-Q a "powerful and essential" piece in the Assembly Hall's sound system. "We chose the POWER-Q because we knew we could use the equalizer, the FBX Feedback Exterminator®, the compressor/limiter and the real-time analyzer – without a bunch of boxes all having to be converted back and forth from digital to analog. It makes for a much cleaner installation," asserts Kommers.
The Assembly Hall installation makes good use of the POWER-Q many functions. "We are using parametric EQ, graphic EQ, the FBX and the compressor," states Kommers. "And of course we used the auto-EQ function to set it up. We also use the display screen on the POWER-Q to monitor what's going on in the audio signal," he continues.

The POWER-Q's ease of operation also helps assure against system failure. Kommers installed two completely identical, redundant systems into the main auditorium. "Now these systems have to be dead equal to each other," states Kommers. pointing to the POWER-Q precision as another reason to buy one. "With the POWER-Q, we can very easily get the exact same equalization, exact same compression, and the exact same configuration for the sound on each of them. During the program we can hit the switch to go from standby and the audience will never hear the switch – never detect that it is now going through different equipment."

The POWER-Q is not the only Sabine equipment installed within the Assembly Hall. Kommers used a Sabine FBX-1020 Feedback Exterminator® for the stage monitors – making sure that "the people on the stage could hear what the audience was hearing – without causing any feedback."



Since the Assembly Hall opened its doors in January, 1999, the sound system has received nothing but praise. "We are delighted with the sound," says William Heien, manager of the Daytona Beach Assembly Hall of Jehovah's Witnesses. Kommers has had requests from other similar facilities – one in New York State, one in Pittsburgh and another one in Florida – to look over their systems and give advice. Not surprisingly, "we are going to recommend using Sabine," asserts Kommers.

GRAPHI-Q
GRQ-3102

GRAPHI-Q on Board

GRQ Saves Ferry from Structural Overhaul

Ib Sigismund

The quest for bigger and better almost put the Danish ferryboat *Christian IV* in for structural overhaul – that is, until Sabine's GRAPHI-Q was called in to solve the problem.

The nightclub on the *Christian IV* offers such a powerful sound system that the bass frequencies enjoyed by its patrons were disturbing the sleep of passengers three decks away. The club's metal stage, and an array of subwoofers placed underneath it, combined to act as a huge resonant chamber, and the thud of bass drums and other low frequencies were being transmitted to distant decks through the hull of the ship.

Musik Huset Hjorring (MHH), the installation contractor, proposed a solution that would require difficult and expensive modifications to the stage construction. Fortunately, prior to their undertaking such costly action, they called Ib Sigismund of Ascon, the Danish distributor of Sabine pro audio products. Ascon had already provided MHH with 2 Sabine GRAPHI-Qs (GRQ-3102 units) for the installation. MHH was initially attracted to the GRAPHI-Q because of its powerful combination of features (2-channel compressor, delay, graphic equalizer, parametric equalizer, and of course Sabine's industry-leading Feedback Exterminator®), superb specifications, and reasonable cost. But what clinched the purchase was the fact that the GRAPHI-Q is truly tamper proof. After too many unpleasant past experiences where glass protection panels failed to keep the gremlins away from the controls, MHH wanted a product with true tamper lock out.

The GRAPHI-Q delivered all this … and one more very important benefit: a simple solution to the bass propagation problem. While monitoring the GRAPHI-Q software over the course of an evening's entertainment, Sigismund noticed that certain low frequencies resonated so extremely that they actually caused FBX filters to set – all clustered between 50-60 Hz. After a little experimentation, Sigismund determined that a very narrow and very deep parametric filter around 55 Hz both solved the resonance problem, and left the sound system quality intact even for fanatical bass loving DJs. With the exceptional versatility of the GRAPHI-Q, he literally saved the client thousands of dollars in unnecessary construction costs with an amazingly simple solution.

This same GRAPHI-Q versatility allows the the ship's club to successfully host a variety of applications, from techno raves to business meetings requiring only vocal microphones at a low volume. The GRAPHI-Q's separate compressor and limiter adjustments allow MHH to, first, boost sound levels for low-volume uses of the sound system, and, second, to protect speakers from overload when the DJs crank it up. The FBX section of the GRAPHI-Q protects against feedback when microphones are operated by unsophisticated users, or when the system gain is set to high levels. The programmable and recallable graphic and parametric EQ settings of the GRAPHI-Q enable selection of different EQ curves for different applications. And, finally, the digital delay of the GRAPHI-Q enables time alignment of the multiple speaker clusters needed for even sound distribution throughout the expanse of the large club.

So club goers enjoy great sound, and weary passengers enjoy sound sleep, and Ascon and MHH sleep well at night with the knowledge of a job well done, all thanks to the exceptional power of the GRAPHI-Q.

REAL-Q2
POWER-Q
FBX-2020Plus

FBX & REAL-Q2 in theme parks:

Busch Gardens

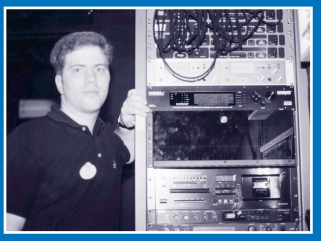
A world class theme park is designed to provide an exciting escape from everyday life. Hard at work behind the scenes is a team of clever engineers, designers, and technicians, working as invisibly as possible to blur the boundaries between reality and fantasy.

The fantasy world of a theme park is far more compelling when the equipment that helps create it is both transparent in its operation, and absolutely reliable. At Busch Gardens in Tampa, Florida, that means that audio designer Brian Rudolph is specifying Sabine products in every theater and live sound venue throughout the park. Brian is using a full palette of Sabine products, including POWER-Qs, REAL-Q2s, SDA-102 delays, FBX-1020Plus and FBX-2020Plus units.

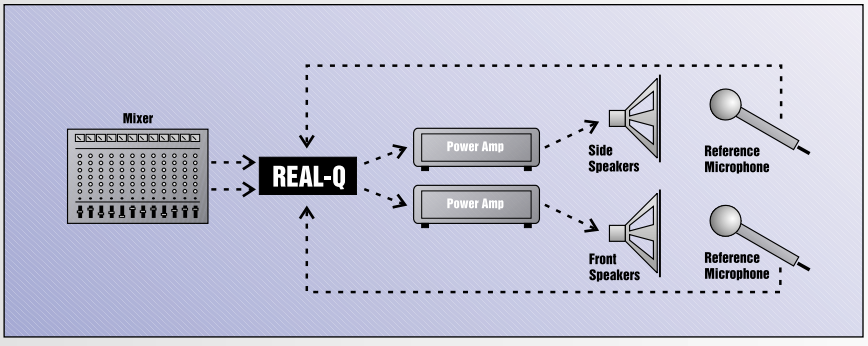
"Sabine products have saved my tail many times," Rudolph claims. As an example, he describes the audio challenges presented by the park's Dragon's Tail Children's Theater in the Land of the Dragons, where loudspeakers are located two feet above the actors' heads. "Every area of the stage was a feedback nightmare. We tried conventional EQ's with no luck, but had instant results when we added FBX. Sabine turned a sound engineer's nightmare into a sleeper."

At the Marrakech Theater (part of Busch Gardens' Morocco exhibit), Rudolph has been using a REAL-Q2 to automatically adjust system response – an area subject to drastic changes from both climate fluctuations and audience size. Brian observes, "It's run flawlessly since we installed it, through all kinds of conditions, and all sizes of audiences, producing consistent quality audio. In this kind of situation, you can't expect to install a standard graphic EQ, set it and leave. Buy you CAN do that with the REAL-Q2."

From the FestHaus (Sabine POWER-Qs used for EQ, delay, and feedback control) to the Bird Show (SDA-102s used for speaker alignment), Busch Gardens now sports one of the world's densest concentration of Sabine products. Not surprising, since Rudolph claims, "Sabine makes great stuff, and it's made my job easier and lot more fun. It's so reliable it's even survived a lightning hit. It took 5 minutes to reset it, and it's still running perfectly."



Brian Rudolph



FBX-SOLO SM-820

The acoustic setup:

J.D.Crowe & The New South

J.D.Crowe & The New South

Amplified acoustic music always presents an inherently contradictory situation. On the one hand, acoustic musicians strive for the intimacy and presence of a living room performance. On the other hand, as audience size grows beyond the dimensions of the living room, the musicians require amplification in order to be heard. The challenge for the sound engineer is to project sound to a larger audience as free as possible from coloration, and to preserve the natural balance of the instruments and voices in a musical ensemble.

One popular method of achieving the right sound and balance that is particularly popular with bluegrass musicians is the "one microphone" technique, where all the musicians cluster in a semi-circle around a single microphone, and adjust their positioning and volume to essentially mix themselves.

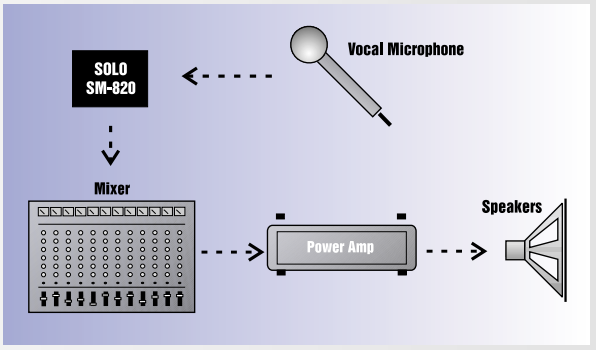
J.D. Crowe and the New South, one of the most successful and long-running bluegrass bands now working, employ a slight variation of the one microphone technique, using a single mic for their three vocalists. According to group member Phil Leadbetter, the single microphone allows for a better vocal blend, but the band prefers to mic their instruments individually.

For the vocals, the group uses an omni-directional, large diaphragm, high output condenser microphone. With this carefully honed setup, they are able to achieve an excellent live sound…with one major drawback.

Leadbetter explains, "We play everywhere from big festivals to small indoor clubs. Because the vocal mic gain has to be cranked up to get us the right sound, we're constantly battling feedback. The mic was almost impossible to use in some situations…until we got a Sabine SM-820 to kill feedback."

Setup for the Sabine microphone-level FBX unit is simple: insert the unit between the mic and the mixer. Output levels can be set to match either mic or line level inputs on the mixer channel, and the sound quality of the 20-bit SM-820 is extremely transparent.

"We used to spend a half hour or more EQing the mic to sound right and not squeal. It was always a compromise. Now with the Sabine we can set up in a couple of minutes, and the sound is great, loud and free from feedback no matter how difficult the acoustics. We're real pleased with the Feedback Exterminator. You can't hear it working…which means it's working perfectly."



POWER-Q

House Sound on the Road:

Mike Dolling & The Spice Girls

One of the hottest acts in the music business recently is the Spice Girls. With two mega-platinum albums behind them, the band has been touring the world and selling out huge stadium venues to hordes of devoted fans. Of course, given the size of the venues, the success of the band, and the budget for the sound system, you can expect to see nothing but the best equipment in the racks back at the front-of-house mixing position.

Out of all this gear, Mike Dolling, from England's top notch hire company Wigwam, and FOH engineer for the Spice Girls, has a favorite box. It's far from the most expensive piece in the rack, but, in fact, dollar for dollar offers one of the best buys in sound technology.

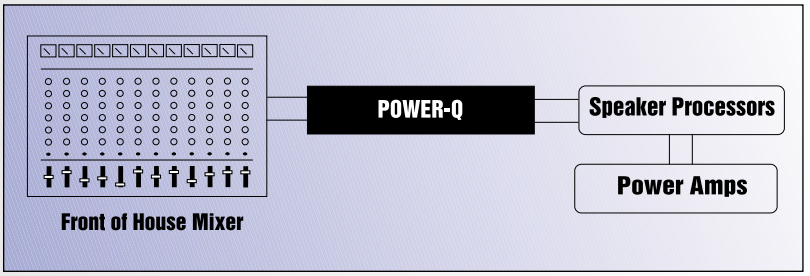
To say Mike Dolling loves his Sabine POWER-Q is putting it mildly. "No one's ever taking the POWER-Q off me. It's welded into the rack!" he declares. Mike is impressed by the multiple functions of the POWER-Q, the speed with which he can set up his system, and its transparency. "I can literally EQ the system with the POWER-Q in something like a minute. It's amazingly quick. The FBX filters are so transparent that we don't lose anything from the sound but the feedback itself. As I get into using the delay, compression, gating, limiting, and expansion, this thing will replace almost everything in the rack – which will improve signal to noise ratio and cut the amount of stuff in the chain."

The Spice Girls recently completely sold out a 40-city US tour, with POWER-Qs used for both FOH and monitor mixes.

Mike Dolling continues to use POWER-Qs in all his live sound gigs. Most recently he has toured with the English phenomenon "Boyzone," who also sport a multiple-vocalist lineup that benefits from the POWER-Q's transparent operation.

Thanks to Mike Dolling, Graham Blake, Dean Davoile of Fuzion, and Pro Sound News European edition for information contributing to this story.

Mike Dolling



True Mobility™ Wireless Mic Systems: The Perfect Combination!

Sabine is proud to present the first wireless microphone system with all the built-in processing you need on every microphone. Introducing Sabine **True Mobility Wireless Systems**.

Sabine Wireless Systems are superior to conventional systems because Sabine's include the two most comprehensive features found in any wireless system: **True Mobility** and **Targeted Input Processing**.

We call our system True Mobility because it provides the freedom you should expect from a wireless system. With a conventional wireless system, your range of movement is limited by the potential for feedback in acoustical "hot spots". Some areas are so feedback prone you cannot go near them. Other areas allow only minimal gain before feedback occurs.

Sabine's True Mobility system includes our patented, industry-standard FBX Feedback Exterminator®. The FBX automatically kills feedback in setup and during the show, giving you a greatly increased area of feedback-free movement. Your mic finally will sound loud and clear, and you'll get the mobility you were hoping for when you chose a wireless system.

Sabine's True Mobility doesn't stop with automatic feedback control. Conventional wireless systems require the added cost of outboard processors to maximize performance. Sabine offers a different approach: on-board processing at no extra cost, all dedicated to one microphone. We call this Targeted Input Processing.

With Targeted Input Processing, no mic gets more processing than it needs, and every mic gets precise, targeted control perfectly suited to provide maximum performance. Until now you had to settle for controlling your mics using compromise settings on outboard gear. Targeted Input Processing gives you specific control over every microphone – it's the ultimate way to control your sound.

Each True Mobility Wireless Receiver comes with the all-digital Targeted Input Processing you need for maximum performance, yet Sabine's system costs no more than other far less powerful UHF or VHF systems.

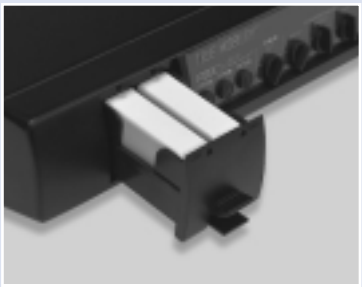
Targeted Input Processing:

- **Patented FBX Feedback Exterminator®**
  The industry standard in automatic feedback control. The FBX includes our fast Turbo Setup Mode.
- **Auto De-Esser**
  Sabine's new automatic de-essing algorithm senses, tracks, and removes sibilance without affecting the rest of your program.
- **Compressor/Limiter**
  Our famous digital compressor offers the gain management you need to compensate for all types of performers and speakers, from those who are shy around microphones, to the boldest worship leader.

Sabine Wireless Systems come in two models, with many accessories to complete your system packages. The UHF system is a state of the art PLL synthesized system with 30 channels, True Diversity, dual-squelch circuitry, excellent noise rejection and superior dynamic range. Choose a hand-held, lavalier, or headset microphone.

Our VHF system includes a 16-channel PLL synthesized, True Diversity receiver with your choice of hand-held, lavalier, or headset microphones. Both UHF and VHF systems offer optional front or rear mount antennas, extension antennas, and antenna divider systems.

Visit your dealer today and get a Sabine True Mobility Wireless System with Targeted Input Processing – your new choice for the best in trouble-free wireless systems.



Built-In Dual NiMH Battery Charger!

The only wireless systems that pays for itself! No more wasting batteries – always a fresh, long-lasting NiMH battery ready for your microphone or transmitter.

True Mobility systems give you what no other wireless offers:

- Increased mobility with no feedback
- Increased gain and clarity
- Increased intelligibility without sibilance
- Virtually unlimited battery life
- An adaptive system that compensates for all kinds of performers and conditions – from concerts and theaters to boardrooms and churches.
- All for no more money than you are currently spending for high-quality wireless systems.

SW-30R True Mobility UHF Receiver

UHF: 30 channels - or - VHF: 16 channels

- ◆ True diversity
- ◆ PLL synthesized
- ◆ Dual-squelch circuitry
- ◆ 10 Simultaneous channels (UHF)

SWM-3000 UHF Systems

SW-30R	30-Ch Receiver with Battery Charger / NiMH rechargeable battery
SW-30H	Condenser PLL Hand Held Microphone
SW-30T	PLL Belt Pack Transmitter

SWM-1600 VHF System

SW-16R	16-Ch Receiver with Battery Charger / NiMH rechargeable battery
SW-16H	Condenser PLL Hand Held Microphone
SW-16T	PLL Belt Pack Transmitter

Microphones

SWT-42L	Unidirectional Condenser Lavalier Microphone
SWT-25H	Unidirectional Condenser Headset Microphone
SWT-30G	Guitar Interface (Plug and Cable)

Batteries

SWB-BAT	Rechargeable 9-volt NiMH Battery

Antennas

SWA-100	Rear to Front Antenna Converter Kit
SWA-4V	VHF 4-Channel Antenna Divider System
SWA-VEXT	VHF Extension Antenna
SWA-4U	UHF4-Channel Antenna Divider System
SWA-UEXT	UHF Extension Antenna
SWA-UB	UHF Extension Antenna Booster

Mic & Transmitter Accessories

SWC-200	Condenser Microphone Capsule Module
SWC-CLIP	SW-series Hand held Microphone Holder
SWC-TRI	Desktop microphone tripod
SWC-101	Protective pouch for Belt Pack Transmitter
SWC-4P	4-pin Connector

POWER-Q ADF-4000

POWER-Q Multi-Function Processor

Nine professional audio products in one low-cost package. The choice of professionals world-wide. 24-bit digital resolution, ClipGuard™ adaptive clip level control, automatic room equalizing, and 12 independent digital filters per channel, switchable to FBX-feedback control or parametrics; also has dual 31-band equalizer, full-featured RTA, compressor/limiter, digital delay, noise gate, and 99 memories. Options include remote control software, digital I/O, and blank front panel version.

REAL-Q2

REAL-Q2 Real-Time Adaptive Equalizer

Automatically analyzes and equalizes your sound space during program even if you're not there, and automatically compensates for changes in the frequency response curve caused by the audience or changes in temperature or humidity. Provides full-featured RTA and noise generator, digital graphic EQ, compressor/limiter, noise gate/expander, graphic display of the room's response curve, remote control, and storage for up to 99 different response curves.

GRAPHI-Q GRQ-3100

GRAPHI-Q EQ, FBX, Compressor, Delay

All digital processing with an analog feel. Graphic EQ with high & low cut filters, patented FBX filters, compressor and delay controlled with "hands-on" front panel. GRQ Remote software gives control over parametric filters, limiter, and allows saving presets (68), linking units, channels, and functions independently. SIngle channel and dual channel units available with and without front panel controls.

FBX-1020 & 2020Plus

FBX-1020 & 2020Plus Feedback Exterminators

The single channel FBX-1020Plus and dual channel FBX-2020Plus provide 20-bit digital resolution, 12 feedback filters per channel, ClipGuard™ adaptive clip level control with TURBO set-up mode, selectable noise gate, lockable fixed filters and switchable filter widths.

FBX-SOLO

FBX-SOLO Feedback Exterminator, models SL-820 & SM-820

Eight-filter unit automatically eliminates feedback, providing more gain and increased clarity. 20-bit digital in a small package. SL-820 has 1/4" in/out connectors and in/out level switches; for use with acoustic/electric guitars, mixer insert points. SM-820, with selectable phantom power, has XLR in/out connectors; for use with balanced mics. Both have selectable noise gates.

FILTERS
Twelve independent digital notch filters per channel which can be controlled automatically or parametrically from 20 Hz to 20 KHz

DIGITAL DELAY
1.3 to 83.2 msec. per channel in 20 microsecond steps
Programmable in milliseconds, feet or meters.

NOISE GATE/EXPANDER
Attack time: 1 to 99 msec. in 1 msec. steps
Threshold: -20 to -90 dBu in 0.5 dB steps

REAL-TIME ANALYZER
31 band, 20 Hz — 20 KHz on ISO center frequencies
Peak-Hold, Fast/Slow display
A, B, C or Flat weighting

GRAPHIC EQUALIZER
31 digital filters on ISO center frequencies, width from .5 to 1 octave in .01 octave increments, +12 dB boost or - 15dB cut
Independent display and control of channels A & B, or LINK

COMPRESSOR/LIMITER
Threshold: +32 dBu to -30 dBu in 0.5 dB steps
Ratio: 1:1 through infinity

INPUT/OUTPUT
Input impedance: Balanced > 10K Ohms, PIN 2 high
Output impedance: Balanced 10 Ohms nominal, PIN 2 high
Input/Output maximum signal levels: Balanced +26 dBV peak
Output load: 600 Ohms balanced
Bypass: true power-off bypass
Headroom: +22 dB peak @ 4 dBV nominal input
I/O connectors: XLR-3

PERFORMANCE
Spectral variation 10 Hz to 20 KHz, +/- 0.2 dB @ +22 dBV
SNR: > 105 dB typical (with ClipGuard)
THD: < 0.01% @ 22 dBV at 1 KHz
Dynamic range: > 110 dB (with ClipGuard)

POWER SUPPLY
50/60 Hz available in 100 V, 120 V or 230 V; 25 W

GRAPHIC EQUALIZERS
31 digital filters on ISO center frequencies, width selectable from .5 to 1 oct. in .01 oct. increments, + or - 15dB boost & cut, 20Hz to 20KHz
Simultaneous display and control of REAL & Adaptive EQs
Simultaneous display of RTA and REAL EQ

REAL-TIME ANALYZER
31-band, 1/3 octave digital analyzer, 20Hz to 20KHz
Peak-Hold, and Fast/Slow display
A, C or Flat weighting
60, 30 or 15dB full scale displays with adjustable position
Pink & white noise generators

COMPRESSOR/LIMITER
Threshold: +26 dBV to 0 dBV in 0.5 dB steps
Ratio: 1:1 through infinity

INPUT/OUTPUT
Input Impedance: Balanced >10K Ohms nominal, Pin 2 high
Output Impedance: Balanced 10 Ohms nominal, Pin 2 high
Input/Output max. signal level: Balanced +29 dBV peak
Bypass: True power-off bypass
Output Drive: +28dBV peak into 600 Ohm load
Headroom: +25dB peak at 4dBV nominal input
I/O Connectors: XLR-3

PERFORMANCE
Frequency Response: +/-0.20dB, 20Hz to 20KHz
SNR: >105dB typical (with ClipGuard)
THD: <0.02% @ 22dBV at 1KHz
Dynamic Range: >110dB (with ClipGuard)

POWER SUPPLY: 100, 120, 230 VAC, 50/60Hz, 25 W

GRAPHIC EQUALIZER
31 digital filters on ISO center frequencies, width from .5 to 1 octave in .01 octave increments, +/- 6 or 12 dB boost or cut

FBX/PARAMETRIC FILTERS
Twelve independent digital notch filters per channel which can be controlled automatically or parametrically from 20 Hz to 20 KHz with 1Hz resolution

COMPRESSOR/LIMITER
Front Panel controls for Ratio, threshold, Gain; software controls for Attack, Release, Knee, Limit threshold

DIGITAL DELAY
1.38 to 999.9 msec. per channel in 20 microsecond steps
Programmable in milliseconds, feet or meters.

INPUT/OUTPUT
Input impedance: Balanced > 10K Ohms, PIN 2 high
Output impedance: Balanced 10 Ohms nominal, PIN 2 high
Input/Output max. signal levels: Balanced +26 dBV peak
Headroom: +22 dB peak @ 4 dBV nominal input
I/O connectors: XLR-3

PERFORMANCE
Freq. response: 20 Hz to 20 KHz, +0.0, -0.3 dB @ +22 dBV
SNR: > 105 dB typical (with ClipGuard)
THD: < 0.01% @ +22 dBV at 1 KHz
Dynamic range: > 110 dB (with ClipGuard)

POWER SUPPLY
100, 120, 230 VAC, 50/60Hz, 18 W

INPUT/OUTPUT
Input/Output Maximum Signal Levels: Balanced +27dBV peak, unbalanced +21 dBV peak
Output Drive: Unit will perform as specified driving a load >600 Ohms
Input Impedance: Balanced or unbalanced >10K Ohms, PIN 2 high
Output Impedance: Balanced or unbalanced 10 Ohms nominal, PIN 2 high
Bypass: True power off bypass
Headroom: +23dB peak @ 4dBV nominal input, balanced
I/O Connectors: XLR-3 and 1/4" TRS

PERFORMANCE
Spectral Variation: < .25 dB, 20Hz to 20 KHz
SNR: >100 dB, typical, "A" weighted
THD: <0.02% @ 23 dBV sine wave at 1 KHz
Dynamic Range: >110 dB with ClipGuard™ automatic clip level control active

POWER INPUT
Factory configured to either 115 VAC or 230 VAC. 50/60 Hz, 12 Watt input.

INPUT/OUTPUT - SL-820 ONLY
I/O Connectors: 1/4" TRS; tip=input, ring=output, sleeve=ground
Input Impedance: Unbalanced >1 meg Ohm
Output Impedance: Unbalanced 10 Ohms nominal; Maximum load 2K Ohms
Maximum Input/Output Level at lowest gain: +20 dBV
Gain Range (with line out selected): 0 to +35 dB (high in), +30 to +65 dB (low in)
Input to Output Gain @ unity setting: +/- 0.5 dBV
Bypass: Digital

INPUT/OUTPUT - SM-820 ONLY
I/O Connectors: XLR-3 PIN 2 high Balanced
Input Impedance: 1K Ohm nominal
Output Impedance: Unbal. 10 Ohms nominal; Max. load 2K Ohms
Maximum Input/Output Level at lowest gain: -10 dBV
Gain Range: -15 to +20dB (at high output)
Input to Output Gain @ unity setting: +/- 0.5 dBV
Bypass: Digital
EIN: -105dBm @ 150 Ohms, 20Hz-17KHz or better
Phantom Power: 48V switch selectable

PERFORMANCE
Frequency Response: < +0.75dB, 20Hz to 17,000Hz
Signal to Noise Ratio: >87dB typical
Total Harmonic Distortion: <0.02% @ 1KHz @ any gain setting
Dynamic Range: >92dB

POWER SUPPLY
8-20VDC @ 400 mA

You're in good company when you use Sabine FBX Products

SPORTS ARENAS:
Jacksonville Jaguars Stadium
Lambeau Stadium, Green Bay
Shea Stadium
Orlando Arena
Gateway Arena
Citrus Bowl
Rose Bowl
Tampa Sundome
National Bowling Stadium
Olympics 1998 (Nagano)
Olympics 2000 (Sydney)
Redskins Stadium
Baltimore Ravens Stadium

GOVERNMENT:
NASA
U.S. District Court
The Pentagon
Australian Federal Parliament
United Nations Headquarters
Navy's Sea Lift Vessels
Police Headquarters, NY
MARTA System, Atlanta
R.A.I. Congress Centre
U.S. Federal Courthouses
Church House, Westminster
Tien An Men Square 50th Anniversary of the PRC
Government Hall (Honduras)
Congress Innsbruck
Pennsylvania State Supreme Court
Saskatchewan Legislature

CHURCHES:
The Vatican
Crystal Cathedral
St. Mary's Cathedral
Grand Mosque (Mecca)
Grand Mosque (Oman)
Baylake United Methodist Church
Golden Era A/V Facility
Daytona Beach Assembly Hall of the Jehovah's Witnesses

EDUCATION:
Ohio University
University of New Orleans
University of Michigan
Iowa State Education System
The Rotunda (U. Va.)
Northwestern College
University of North Carolina
Full Sail Center for Recording Arts
Bangkok University
University of Florida

MUSEUMS:
Smithsonian Institution
Museum of Flight
Mingei International Folk Art Museum
American Museum of Natural History
Arizona Science Center

THEATERS/ ENTERTAINMENT:
United Artists Theaters
Lone Star Amphitheater
Late Show With David Letterman
Alanis Morissette
Craig Chaquico
Oprah Winfrey Show
Grand Ole Opry
L.A. Shakespeare Festival
Tavern on the Green
Ricky Van Shelton Band
Up With People
Vienna State Opera
Willie Nelson
Waylon Jennings
Howard Page (Bee Gees FOH Engineer)
Steve Miller Band
Hollywood Casino
Cairo Opera House
Disneyland's Tomorrowland
Jeff Carson Band
Fox Studios

HOTELS:
Hyatt Regency San Francisco
Debbie Reynolds Hotel
The Sands Hotel
Luxor Hotel
Marco Island Marriott
Westin Bonaventure Hotel
Crown Plaza Hotel

BROADCAST:
TNN
ABC Studios
CBS Studios
NBC Studios L.A.
Austrian Federal Broadcast
City TV, Toronto
WDUZ Radio
WRKO Radio
Korean Broadcast System

CONVENTION CENTERS:
Jacob Javitz Convention Center
Meadowlands Exposition Center
Metro Portland Convention Center

CORPORATE SOUND:
Walt Disney Company
Hewlett Packard
American Stock Exchange
Sea World
Universal Studios
Microsoft
Boeing Test Labs
Wendy's Restaurants
Busch Gardens
Dave & Buster's Restaurants
Quantum Research
Don Cesar Beach Resort

SOUND COMPANIES:
Sounds Great Enterprises
Wigwam-U.K. (Spice Girls)
Sound Services
Showco
Rock 'n' Road Audio
Wavelength Hire Co.
Sound Planning

...And thousands more!

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