

A “Simple” Expansion?

The development of the Shure DFR22 processor

By Bob Rieder and Erik Vaveris

This Designer Notebook was submitted by Shure. Live Sound makes every effort to eliminate any use of marketing inspired hyperbole.

The reason for creating the Shure DFR22 audio processor is actually quite simple: users wanted two channels in one digital signal-processing (DSP) package.

With a single-channel product like DFR11EQ already in the catalog, such an order would seem easy to fill, right? Well - yes, no, and sort of. In order to build a two-input by two-output audio processor that would meet market expectation, we hit the road and the phones, talking to numerous DFR11EQ users, delving into the gory details of audio processor performance and features. This roadmap then guided development of the DFR22.

Research showed the most-requested capability to be new options for our DFR (Digital Feedback Reducer) circuitry, including more filters, stereo capabilities and the ability to have filters automatically disappear after a specified

amount of time. Improvements to audio quality were next on the list, along with DFR functions that could be used without connecting to a computer.

This would be housed within a platform providing both XLR and Phoenix connectors as well as an audio processor working through a drag-and-drop PC software interface.

Reliability also rated high on the “most wanted” poster, particularly meeting the needs of those on the road. Of course, reliability also is paramount for those looking at permanent install applications. Once the concept was finalized, we went through an extensive beta testing phase that included both installers and touring personnel.

STOPPING PESKY SQUEALS

The most significant aspect of the DFR22 Audio Processor is its feedback reducer, which is powered by Shure’s



The new DFR22, with a front panel providing audio metering, controls, indicators for feedback reducers a preset selector, and an RS-232 port for remote control via laptop PC.

Designer Notebook

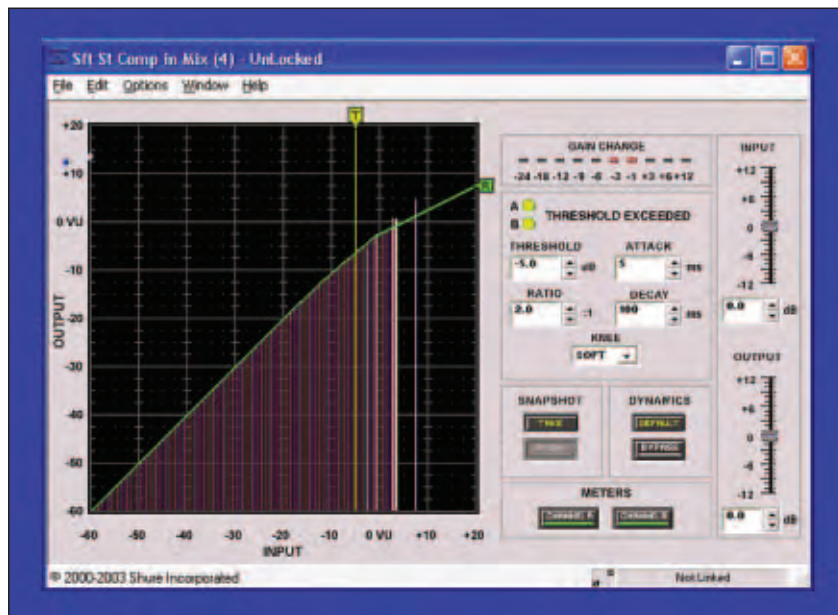
patented DFR algorithm. The goal of any feedback reduction design, naturally, is to stop those pesky squeals and other anomalies before they get into the system.

Further, the goal is to insure that audio quality remains uncolored despite this process, and also to keep “false triggers” on non-feedback signals to a minimum.

With this in mind, we were able to improve the detection speed of the DFR in this new stereo version. Each channel has a discrete detector that scans for feedback frequencies. Because each detector scans independently, on average a stereo DFR will find a feedback frequency 25 percent faster than its single-channel predecessor.

In addition, while one channel of the new DFR deploys a filter to both channels, the other detector is still active. This enables a stereo DFR to detect and remove feedback occurring simultaneously at multiple frequencies with greater speed. In the DFR22, single-channel and stereo DFR processing modules can also be added wherever needed along the signal path.

Another new option built into the DFR22 is the ability to set a timer to automatically remove designated feedback filters. After “ringing out” a sound system to set fixed filters at the most troublesome frequencies, users can engage a new “Auto Clear” mode and set a value for the timer.



Screen 2: Compression provides audio metering within the transfer curve graph.

Once enabled, Auto Clear will remove any additional feedback filters that are deployed after a user-specified amount of time. With a microphone in hand and loudspeakers in the vicinity (especially floor wedges), a performer can often display rather incredible creativity in finding new ways to create feedback.

As a result, customers asked for an Auto Clear mode so that they could leave the DFR unlocked to catch any unexpected feedback that may arise

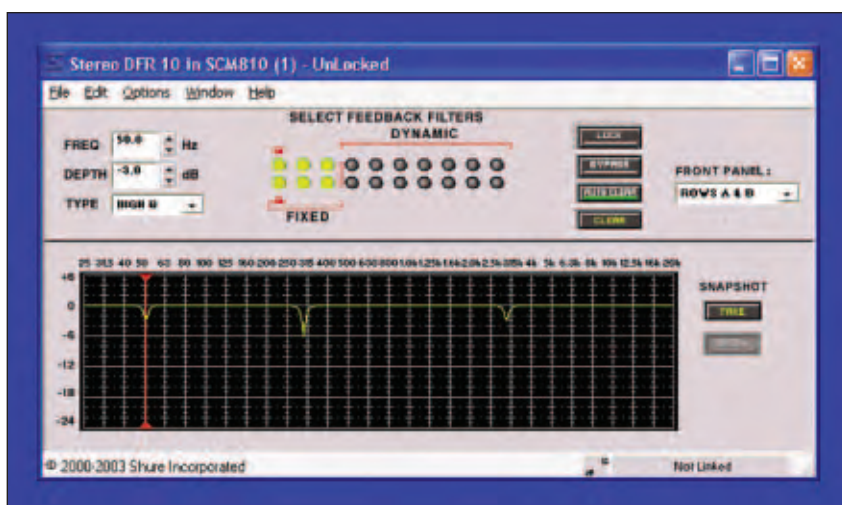
while not having to worry about those filters becoming a permanent part of the sound system tuning.

One of the last items on the DFR wish list was the option of adding up to 16 filters on each channel, as opposed to the 10 available in the DFR11EQ. In combination with Auto Clear mode, the additional filters provide more peace of mind - a microphone can be placed in front of a loudspeaker, with the DFR controlling all feedback frequencies.

MEETING REQUIREMENTS

Customers also requested a high-input clipping level for compatibility with modern mixing consoles. At the same time, it didn't take an incredible amount of intuition to know that this needed to be achieved without a correspondingly high noise floor.

Through some careful design, we achieved a true +24 dBu input clip level with >110 dB of dynamic range A-weighted. We added two software selectable analog pads on the outputs as well, to meet the requirements of different power amplifiers. When the DFR22 is connected between a mixer and a power amplifier, the use of either the 12 dB or 18 dB analog pad helps align the output levels of the unit with the input level of power



Screen 1: The capability to insert shallow, narrow notch filters to improve a system's gain before feedback.

Designer Notebook

amplifiers and maintains an optimized gain structure with a low noise level.

Our market research also emphasized that the DFR22 must meet high durability standards for use on the road and in the most critical installations. Therefore it is manufactured and thoroughly tested to ensure consistent operation and longevity at temperature extremes and in high humidity environments. Other facets in this regard include intense drop testing, vibration testing, and sequential shipping testing.

Even trickier for digital products, the DFR22 has been engineered to pass EMC (electro-magnetic compliance) testing. All digital products emit frequencies related to the clock on the circuit board. If not properly contained, these frequencies can cause interference with other devices such as wireless systems.

Without resorting to inconvenient external ground screws for the Phoenix connectors, we applied our collective experience in RF design and adhered to good grounding practices in order to exceed the strict requirements for a Class B digital device, as specified in Part 15 of the FCC rules.

Although laptop PCs are standard in the sound contracting industry and are becoming more common in the live sound world, we looked at making DFR22 operable both with and without a PC.

The device's front panel includes controls that can be used to configure the functions of its feedback reducer.

Other controls can be used to set the DFR to work as two traditional single channel processors, or in the new stereo mode. Access to the "auto clear" function is offered as well, as is the ability to adjust the time interval for clearing filters. LED displays indicate when each filter is active, along with clear, bypass, and lock buttons.

GETTING CONNECTED

Connecting a PC running the DFR22's Windows software application provides access to full functionality of the device. Although we wrote the software for the latest generation of computers running Windows XP or Windows 2000, the DFR22 software has very modest system requirements. A computer running Windows 98 with a 166 MHz Pentium processor is more than adequate. Windows 95 wasn't included in the "official" battery of compatibility tests, but we know of several users who are successfully controlling the DFR22 within that platform.

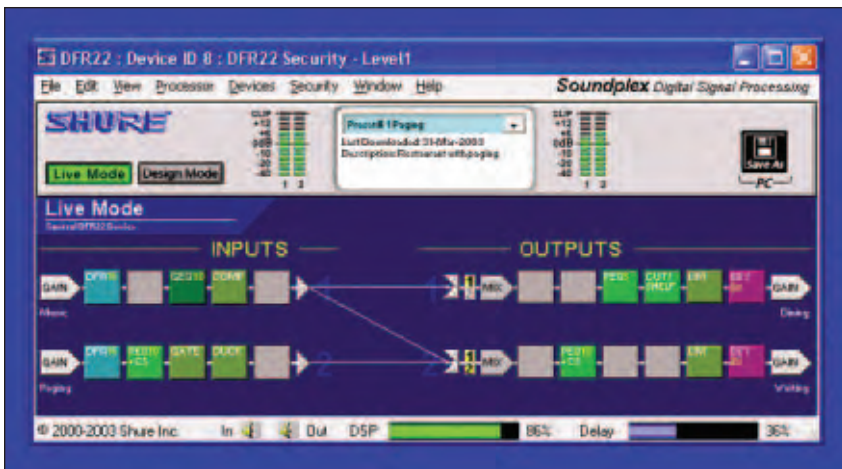
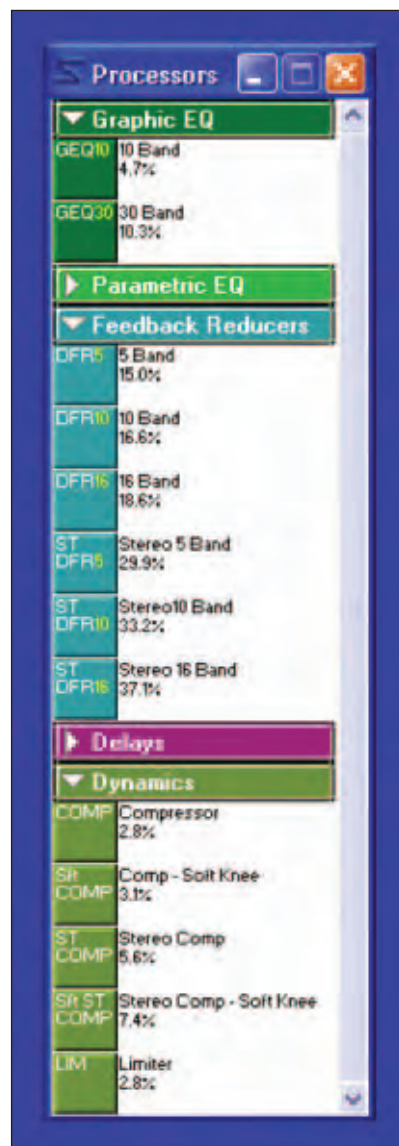
In order to accommodate all of the configurations requested by users, the easy-to-use interface from the larger P4800 processor was adapted to this smaller configuration. (It provides access to a built-in two-by-two matrix mixer and allows users to drag-and-drop processing blocks anywhere along the signal path that they choose.)

Among the processing blocks found onboard are graphic and parametric equalizers (which can be linked for stereo control), 5-, 10-, and

16-band single channel and stereo DFRs, single channel and stereo compressors and limiters, automatic gain control, a ducker, delay, two-way crossover, and subwoofer control. This enables the unit to be used as a main mix processor, a monitor mix processor, and as a channel insert processor.

In addition, it allows for highly customized configurations, such as a restaurant system with background music and paging or a mono church system with separate music and speech mixes and a two-way speaker.

The unit's DSP chip was chosen from the latest generation of floating



Blocks from the processor toolbox can be dragged and dropped in any order onto available slots in the signal flow diagram.

point processors. But note that an audio processor's DSP power is tied not only to its circuitry components but also to the efficiency of its programming. Even with all of the processing blocks in the configuration shown in the illustration on the previous page, the DFR22 is only using 86 percent of its total DSP capacity.

With capabilities such as this, the device is obviously much more than just a feedback reducer, and becomes quite suitable for use as a complete main mix processor, monitor processor, or channel insert processor.

A DB9 connector on the front panel allows the linking of a PC via RS-232. The choice to stick with RS-232, rather than go with a more modern protocol like USB or Ethernet, was a difficult one to make. Although many requested USB, it has a distance limit of about 15 feet.

Exploring the issue further, we found that this isn't suitable for the majority of users. There is high demand to be able to move laptops about freely, particularly to be able to be able to make real-time adjustments while sitting in the coverage field of the sound system.

NETWORK SETTINGS

While we also fielded many requests for Ethernet connectivity (which accommodates plenty of distance), this protocol requires users to reconfigure the network settings of their PCs. It also would have added excessive costs to the product and increased setup complexity.

Conversely, RS-232 is truly plug-and-play, requiring no driver installation or complex setup. The RS-232 specification only guarantees connection up to about 50 feet, but many DFR11EQ users have told us they successfully connect from as far away as 150 feet. So we decided to stick with good ol' RS-232.

For users with newer laptops (which are likely to not have a built-in serial port), we made certain that the DFR22 works cohesively with most USB serial adapters. (The Shure website includes a list of inexpensive, approved adapters.)

Several features were added to the DFR22 to meet the needs of both live

sound and permanent installations. For example, in addition to having both Phoenix and XLR connectors, the device is outfitted with programmable control pin inputs for setting up remote controls, and has facilities on its rear panel suitable for AMX or Crestron RS-232 control.

Back when it all began, customers told us they simply wanted another channel in the DFR11EQ. But when

we looked into it, they really wanted a lot more. Sometimes the "simple" things turn out just the opposite, but in the end, the product needs to be conceived and executed to meet current and future needs. Otherwise, what's the point?

Bob Rieder is category director of audio processing products for Shure, while Erik Vaveris is an audio processing product specialist for the company.



TCS

New 3-way systems

tCSaudio.com
800.854.2235
by Carvin