

## 1. Introduction

Electro-Voice has recently launched a program that we refer to as FIR-Drive. FIR-Drive is a combination of DSP and other Electro-Voice technologies that come together to create a sophisticated loudspeaker correction and protection system. Electro-Voice DSP, loudspeaker, and application engineers have been working together on this new technology for many years now, and have been constantly improving the technology with firmware, software and speaker preset updates. The technology is modular and modules can be added to the package for further functionality. FIR-Drive has allowed Electro-Voice engineers to improve and correct loudspeakers in ways unimaginable only a few years ago.

The technology requires both software and hardware components to work at its maximum potential and it is proprietary to Electro-Voice. Electro-Voice has a number of loudspeaker management controllers that support the implementation at a variety of price points. Different styles of processors are available to meet the needs of any company or application.

### 1.1 Components needed

To process a sound system with FIR-Drive, three components are required:

- FIR-Drive speaker presets for your sound system (i.e. XLC System)
- FIR-Drive based DSP processor (i.e. TG series amplifiers with RCM26 modules)
- IRIS-Net control software to control and setup the processors

## 2. Supported DSP processors

Electro-Voice offers three DSP solutions that can fully support and process FIR-Drive Presets:

- TG-Series Amplifiers via RCM26 or RCM28 DSP modules
- DX46 – 2 input, 6 output loudspeaker management processor
- N8000 modular DSP unit via DSP2 extension module

The FIR-Presets supplied by Electro-Voice are compatible with all mention DSP's and they are interchangeable eliminating the need of having processor specific presets. The 3 processor options offer a different solution for different type of applications.



The TG series offers a distributed DSP model where the speaker presets are processed in each one of the amplifiers giving the system extreme flexibility and redundancy since no one component can potentially interrupt audio from the entire system. The model is highly recommended for Live Sound and touring application and also for high-end installs.

The DX46 solutions offers a centralized DSP where all speaker presets are processed in one or two DSP units which then feed non DSP amplifiers such as the CP4000s. This configuration is fairly inexpensive and very easy to use.

The NetMax N8000 solution offers a similar solution as with the DX46 but in a more flexible and easily expandable way. The N8000 option is typically recommended for fixed install applications and to be used with CPS series amplifiers. The N8000 can also be used for high-end touring applications where extensive control and digital audio (like Dante) is needed.

### 3. DSP components under the FIR-Drive umbrella

As mention before FIR-Drive is the container that houses of a number of underlying DSP technologies.

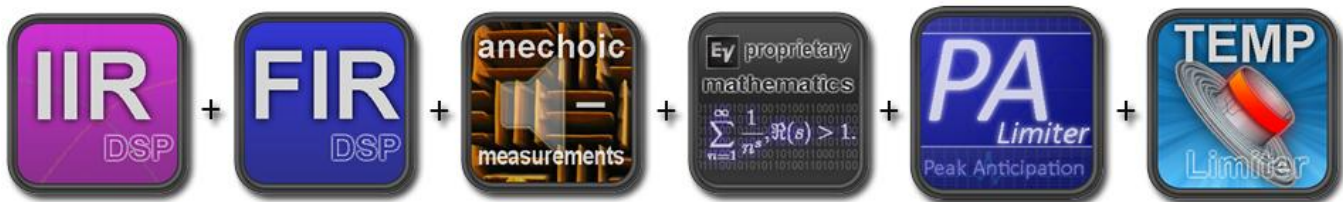


Figure 1: FIR-Drive DSP modules

The above picture (Figure 1) shows the current modules included in FIR-Drive. Each one of these modules has a distinct and important role that we will investigate in greater detail later in this document. Some of the above components are actual DSP elements and some are important features which are necessary to assist creating parameters for the different components.

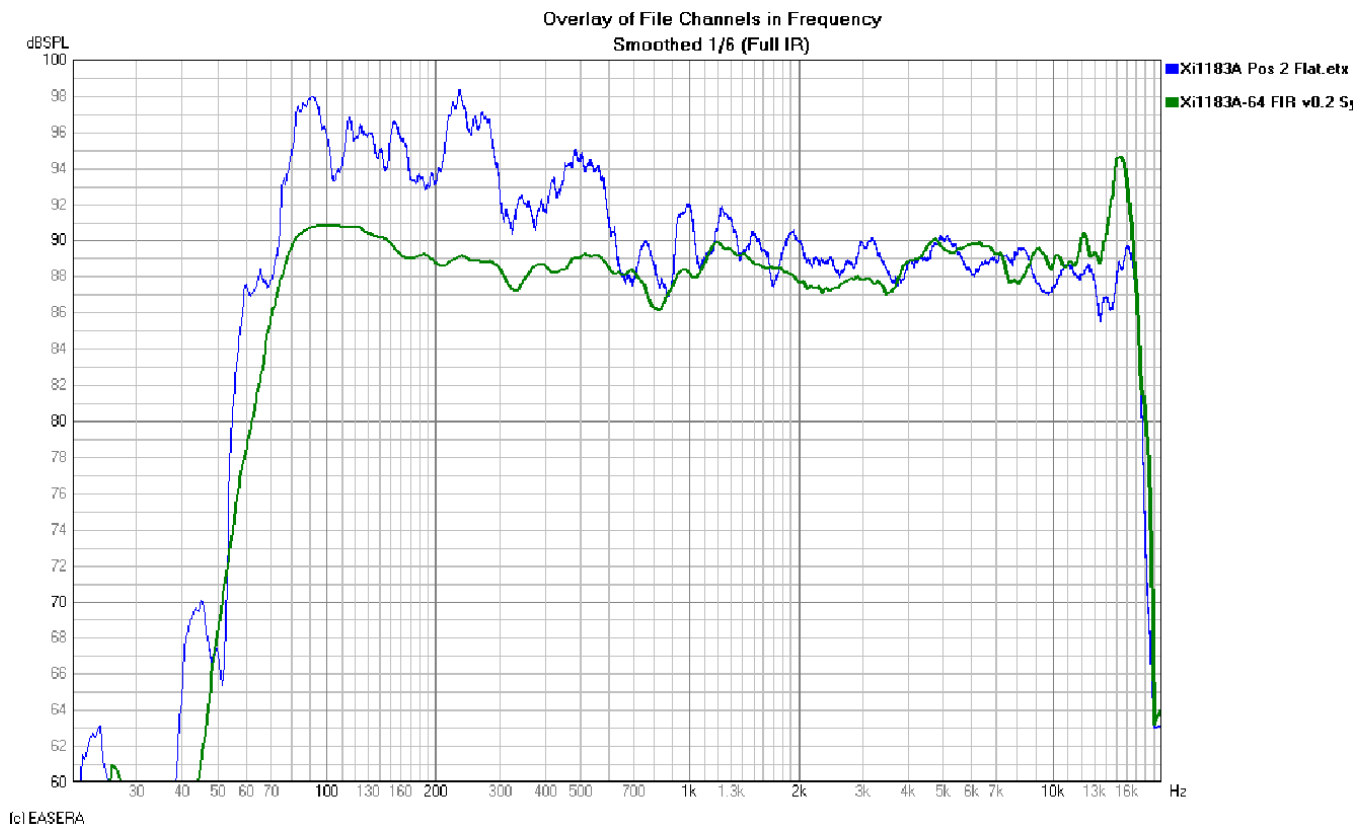
For example, it is important that FIR-Drive presets are created in an anechoic environment. When correcting for speaker components it is crucial that the measurements taken are not contaminated with room anomalies. A room response will affect the frequency response of the loudspeaker, forcing the engineer to correct for unnecessary anomalies. When measuring components the ideal situation is that the frequency response collected includes nothing but what’s projected of that component. The only way to repeatedly produce such results is with the use of an anechoic chamber. Thankfully Electro-Voice owns one of the biggest anechoic chambers in the industry. The chamber is used for all EV testing and among other things for the creation of FIR-Drive speaker presets. The chamber can accurately collect data down to 50Hz (full-space anechoic), and is large enough to take measurements up to 20 feet away from the loudspeaker.

The picture below shows the anechoic chamber at the Electro-Voice headquarters in Burnsville, MN. The cabinet shown in the picture is the XLC-127DVX at the 10' position. Measurements were taken for the creation of the XLC FIR-Drive preset.



Figure 2: Electro-Voice anechoic chamber

The frequency response chart below shows an Xi-1183A cabinet measured in the chamber and in a performance space room. In both cases the speaker is driven by the same speaker preset and amplification. The only difference is the room. The picture illustrates how many incorrect changes would have to be made had we not measured using the anechoic chamber.



(c) EASERA

Figure 3: Xi-1183A measured in the chamber and in a performance space

## 4. FIR-Drive sections

FIR-Drive modules are divided in two categories. Some modules are responsible for component correction (what makes a speaker sound good) and the component protection (what prevents the speaker from blowing up).



First we will analyze the functionality of the protection systems and then we will move to the correction components.

### 4.1. Electro-Voice FIR-Drive protection package

Loudspeaker components face potentially fatal situations every time they are used. They have to deal with extreme signals that force them to accelerate at incredible rates, potentially threatening their mechanical and thermal systems. They are driven by high voltage amplifiers with abundant amounts of current capabilities. With more demanding speaker presets, larger amplifiers and abusive shows, the protection system enclosed is more important now than ever before. The traditional limiter sections in legacy DSP's are simply not intelligent enough to consistency protect a sound system from any given situation.

With amplifiers being as powerful as they are (TG7!), more than one protection system needs to be deployed to protect the components from different type of failure occurring for different reasons. The protection system should also be intelligent enough to prevent damage to the system from user error and external events that can accidentally happen. There are two types of issues that can happen to a component. The first one is mechanical damages that tend to happen from voltage peaks. Mechanical damages typically cause issues to the suspension system of a component like the spider, surround or cone. The limiter responsible for protecting against mechanical damages is what's known as the Peak Limiter which is the most commonly used limiter in DSP's. The other type of damage is thermal, typically damaging the Voice-Coil of the component. Thermal damages are caused by excess heat building at the voice coil and are much harder to protect against. Peak Limiters in these cases would not be able to prevent the damage.

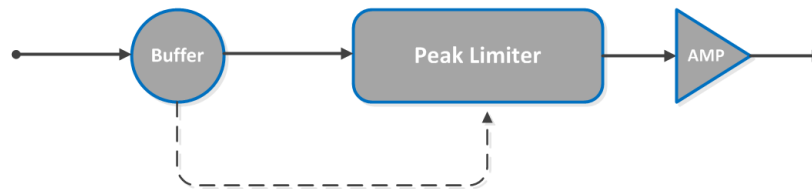
Electro-Voice includes two types of limiters in its FIR-Drive to protect for both Mechanical and Thermal damages, making the system close to indestructible.

## 4.1.1 Peak Anticipation (PA) Limiter

The Peak Anticipation (PA) Limiter was designed to control and prevent excursion related failures (mechanical).

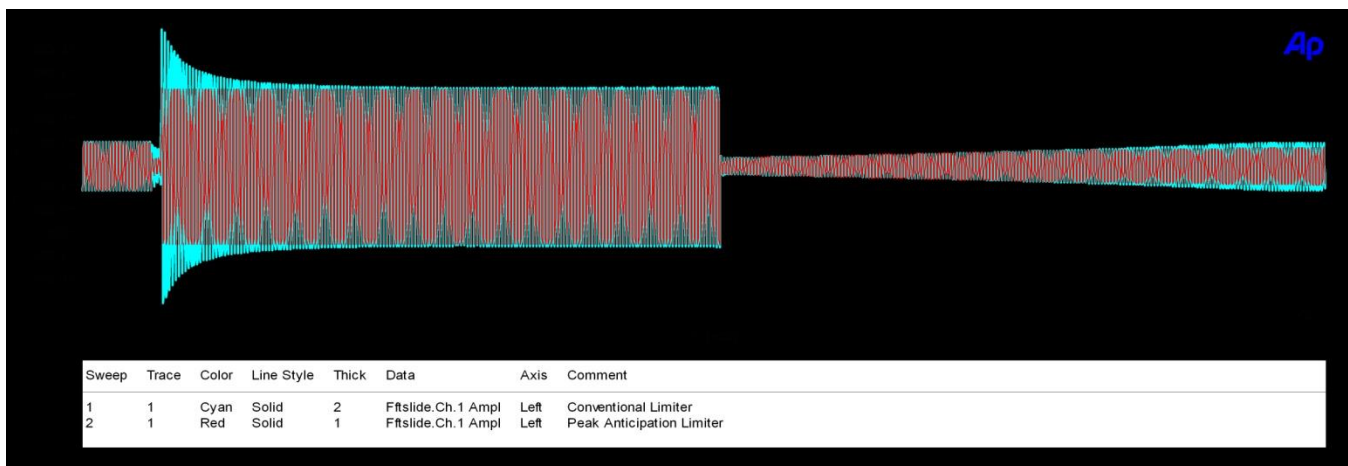
Limiters in general are time-variant and non-linear. Their behavior, which depends on input signal, often causes audible “pumping” effects and distortion. During development of the PA limiter, the goals were to improve protection and make its behavior more transparent sounding, so even when a system is driven hard, it stays linear sounding.

To improve protection, a look-ahead system was developed. A buffer which is located 15 samples before the actual limiter is monitoring the incoming signal and informing the limiter of threatening peaks in advance. By the time a peak reaches the input of the limiter, the reduction value is already in place to eliminate the peak from going through.



Typical limiters do not take advantage of this technique. As a result, they suffer from over shoot issues where the first part of a peak gets through before the limiter reacts.

The image below shows a comparison between the PA limiter and another industry leading limiter. As can be seen the PA limiter (in red) reacts in time to eliminate the incoming peak where the other limiter (in green) allows the first part of the peak to go through and reach the loudspeakers.



A lot of work was also done to fine-tune the behavior of the PA limiter to eliminate distortion as much as possible.

