The Spectral Analyser: Theory and Usage

This professional and unique 30 band analyser is based on the *Audio Analyser* of RME's ADI-96 PRO. After a long time of development we succeeded in transforming its extensive DSP routines into native software code - at a sensational low CPU load and with even highly extended capabilities.

As opposed to nearly all current PC-based solutions no FFT (Fast Fourier Transform) is used. Although this method requires only little calculation (CPU) power, it offers no useable translation of sound into vision. The 'bands' of a FFT have a constant frequency distance, which results in the higher area in numerous bands, in the lower frequencies in very few bands. Some manufacturers try to work around this problem, but even then a sine will show an un-symmetrical display, and an insufficient separation between bands.

RME's Spectral Analyser performes a true bandpass filter calculation, as usual in all professional devices (hardware). The frequency distance between the filters is not linear, but scaled according to human hearing. The highly optimized software allows to run a 30 band analyser with 50 dB range, sharp filters and 100 LEDs per band, without driving the computer to its limits.

Thanks to its complete digital operation the Spectral Analyser offers features previously unavailable from analog analysers. These features include freely adjustable rise and release times, a display configurable in many ways, different filters and special display modes. Tanks to the high calculation accuracy of modern CPUs, the Analyser will show levels precisely down to a jaw dropping -140 dBFS.

Notes on Operation
The most important application using a Spectral Analyser is the visualisation of frequencies and levels found in music or speech. What you see is what your hear! The Analyser shows levels and frequencies even at the edge of the human ear's abilities. The visual display helps to train your ears, and avoids serious mistakes when mixing to the master tape. Usual studio monitors won't let you hear frequencies below 100 Hz. Simply look on the Analyser to see what's going on in the underground!

Reading the display is not easy for novices, because of the huge amount of information that it shows. But after some training you'll agree that this tool is a precious help in every day work.

Analysis of Music
Rise and release time are the most important parameters when trying to achieve a display similar to what you hear. At a very fast rise time setting, the Analyser will show even shortest peaks down to one sample. But these are only audible when present in several bands and lasting for more than a millisecond. That's why a 7 ms rise time results in a much better display behaviour. The release time should be set to three different values. A very fast display (1 s) is recommended for example when trying to see the bass which else hides behind the bass drum. At 2 s the display will be more easier to read and is more friendly to your eyes. Some special applications (like averaging the sound impression or noise measurements) require values around 10 to 20 seconds.

Usually music comes along in stereo. Due to phase cancellations, especially when analyzing signals in SIP mode (Solo in Place), the display does not match the perceived sound. This problem is solved with the mode *Max. L/R,* which displays the highest level of right and left channel, no matter what their phase relationship is.

Special Display Modes
The *Spectral Analyser* offers two different envelope modes. Let's look at this example: You want to study the frequency distribution of a bass drum sample.

Method 1: Route the bass drum sample to the analyser and store the display's contents by hitting *Freeze* in the right moment. Much more convenient is

Method 2: Use *Instant Hold* to activate the envelope mode. Play the bass drum sample one time. Thanks to the infinite release time the analyser's result won't vanish from the screen.

Method 3 is mainly used with music. At active *Instant Hold* and display mode *Peak Hold* the music is shown as usual, but the peak display above the bars won't be reset. When playing back a 3 minute pop

song, an envelope of all frequencies and levels which occured in that time is shown.

Sound Measurements
The combination Equalizer/Analyser is used to correct the misalignment of speakers and room. A test signal (pink noise) is send from the speakers into a special measurement microphone placed at the engineer's prefered listening position. Due to the high peaks in noise signals, the Rise time should be set to maximum (4999 ms), Release should be set to 5 s. In *Point* mode a very precise display of the overall frequency response is achieved. The external Equalizer is now used to correct this curve to a straight horizontal line.

Special Applications
At the highest display range (50 dB) and lowest *Top Level* setting the Analyser displays all signals down to -140 dBFS. This allows to examine the hum and noise present in the studio's environment. Disturbing frequencies can be classified and removed more exactly.

In *Left minus Right* mode only the stereo signals within a complete mix are shown. This gives some interesting information on the mixing technique.

Modern (virtual) Music Productions
...often suffer from missing bandwidth limitation and bad programming of PlugIns and (especially) virtual synthesizers. The oversampling mode of e.g. the 4-Bar Level Meter helps to detect hi-frequency components caused by clipping. Of course, the Analyser is a good way to check for overdoses of hi-frequency components as well. Additionally the Biquad filters provide a very useful low-pass filter mode in the lowest band, showing all frequencies down to 0 Hz (DC). Most virtual synthesizers generate inaudible infrawaves, overloading any cutting machine. It's impossible to generate long play records (LPs), as favoured today in dance and electronic music, from such source material. The BiQuad Analyser clearly shows such problematic material. Frequencies below 30 Hz should be removed as good as possible in such a case.

Notes on analysis using noise signals
A FFT shows white noise as horizontal line. This is in most cases also true when examining the noise floor of analog devices, provided those devices do not suffer from hum or other noise signals.

A display based on bandpass filters will show white noise with rising amplitude to higher frequencies, to be more precisely with 3 dB per octave. This has to be taken into account when analysing noise floors of analog devices using the Spectral Analyser.

A linear display requires a noise signal with attenuation of 3 dB/oct to higher frequencies. This signal is called Pink Noise.

But even with such a signal the Rise Time should be set to the highest value, about 5 s. A Release Time set to the same value will cause a display of the average signal, which is well suited for such measurements.