



The natural sounds of life have an extremely wide dynamic range...

...from the rustle of a falling leaf to the roar of a jet engine on take off.

The human ear has an automatic gain control which enables it to accommodate all of these sounds from the threshold of hearing to close to the threshold of pain, a dynamic range of approximately 120 decibels.

Even the most modern audio equipment is incapable of handling the full range that the ear can cope with. Analogue tape without noise reduction can manage almost 70 decibels dynamic range between its noise floor and the 3% distortion point. 16 bit digital audio equipment can achieve over 90 dB. Still almost 30 dB less than the ear's range.

Even if a 120 dB dynamic range were possible in audio equipment, would it be desirable - and useful? A listener in a domestic setting enjoying the exhilarating effects of a 96 dB Sound Pressure Level will almost certainly be causing his neighbour a significant amount of annoyance, if not distress! At the other end of the dynamic scale, a typical ambient noise level of at least 40 dB SPL precludes the use of very quiet levels in recorded or broadcast sound media.

Almost always, it is necessary to compress the dynamic range of natural sounds to fit them into a window suitable both for the equipment and for comfortable listening. Although the dynamic range of the programme material must fit into a 30 to 40 dB window, there is another factor in the equation - noise. All the sound that we want to listen to, whether natural or electronically processed, are accompanied by a certain amount of unwanted background noise - tape hiss, or the rustle of musicians turning the pages of the score in the studio.

Even if, in the final programme, the noise level is below the ambient noise of the listening area, it may still be heard and is therefore undesirable.

The Compressor/Limiter and the Expander are valuable tools for the control of dynamic range and reduction of noise. Compression reduces the dynamic range of any instrument or programme source. Expansion has the effect of subjectively reducing or eliminating background noise.

Compression and Expansion have their artistic uses too. The sounds of instruments and voices can be altered. A mix of instruments can be compressed to give a 'tighter' dynamic effect. Or a previously over-compressed recording can have life put back into it by the subtle uses of expansion.

The Compressor/Limiter/Expander offers in a compact unit virtually complete control over dynamic range, for corrective and for artistic purposes.

Use of Compression

One of the principal uses of compression is the control of level in vocals. Many singers train for years to achieve the degree of breath control necessary for an even tone and expressive performance. Other vocalists rely on an instinctive voice production technique, which may need help in the studio to maintain a consistent level, and result in a vocal track which sits correctly in the mix.

The unprocessed signal has a large dynamic range between the highest and lowest levels. Applying compression reduces the highest levels, reducing the dynamic range. Because the peak level of the signal is now lower, make-up gain is added to restore the original peak level. The result is a much more controlled and usable sound.

Interface with the Console

The Compressor/Limiter/Expander is optimised for use at line level, therefore to process the signal from a microphone, the input has to be taken from the console - preferably from the channel insert point send. The output then comes back to the channel insert return. By connecting at this position in the signal chain, its operation is unaffected by the use of any of the console controls, except Input Gain.

An alternative is connection to the group insert point of the console. This connection has two uses: The input from the microphone may be compressed post-EQ, which offers an alternative sound quality which may be desirable in some cases. Alternatively, several instruments may be compressed together in the mix to achieve a 'harder' sound.

Setting the Controls

Threshold sets the level above which compression takes place. Signals below the threshold will remain unaltered. Turning the control clockwise lowers the threshold level and allows more of the signal to be compressed.

Ratio is the 'strength' of compression above the threshold level. The higher the ratio, the greater the effect.

At a compression ratio of 2:1, the effect is mild and suitable for the subtle compression of vocals or of a complete mix. At 12:1, compression is becoming stronger and more noticeable. Ratios between 3:1 and 15:1 are suitable for the 'Compressor' sound, used as an effect in its own right. Higher ratios are used for the control of extremely peaky signals.

The point where the slope of the compressor curve changes is known as the Knee. With a soft Knee, signals which only just exceed the threshold level are compressed at a low ratio, the ratio increasing the higher the signal level. Attack sets the time the Compressor takes to respond once the threshold has been exceeded. Attack may be set so that the initial transient of the instrument passes through unaltered, or set to a faster value so that the very start of the sound is compressed. Particularly the drum sounds, careful adjustment of attack time can make the sound more 'punchy' and 'driving'. Release time plays a very important role in compression. During periods of high signal level, gain is reduced. When the signal level falls below the threshold, the gain will increase at a rate determined by the Release control. If the release time is short, the gain will rise quickly. A long release time will mean that the gain will stay at its reduced level, only recovering gradually.

The setting of the correct release time is a compromise. If the release time is too short, background noise can cause effects often known as 'breathing' and 'pumping'. If the release time is too long, the signal will not be compressed, but simply reduced in level. For effective compression, the release time must be set to as short a value as possible before modulation of the background noise becomes too noticeable. The gain reduction bargraph meter will show how much actual compression is going on. If it stays steady, there is little active compression, just a steady-state reduction in level. The faster the bargraph moves up and down, the harder the

Compressor is working.

For a natural unnoticeable compression, attack and release times may be set to Auto. The signal characteristics are continuously monitored for optimum values.

Expansion

Expansion may be used to increase the dynamic range of a signal. Of a performance lacking life and vigour, or of a previously over compressed recording.

Alternatively, expansion can be used to reduce noise, either subtly and undetectably, or with the harder action of a noise gate.

The unprocessed signal has a fairly narrow dynamic range between the highest and lowest levels. Expansion makes the lower levels lower still, increasing the dynamic range. Used as an expander, the unit may be connected in the signal chain in exactly the same manner as when used as a compressor.

Setting the Controls

Threshold sets the level below which expansion takes place. Signals above the threshold will remain unaltered. Turning the control anticlockwise raises the threshold level and allows more of the signal to be expanded. A low threshold would be used to reduce noise, a higher threshold to increase the dynamic range of a signal.

Ratio is the 'strength' of expansion below the threshold level. The higher the ratio, the greater the effect. At an expansion ratio of 2:1, the effect is mild and suitable for subtle noise reduction or dynamic range enhancement. At higher ratios the effect becomes harder and more like a noise gate. The LED bargraph indicates the amount of gain reduction taking place.

Attack sets the time the Expander takes to respond once the signal has passed below the threshold. This can be done automatically, the circuitry continuously analysing the signal to determine optimum attack time.

Release determines the time taken for the gain to return to normal after the signal comes back above the threshold level. For hard gating, this may be set to a short value. Longer release times are suitable for dynamic range enhancement or subtle noise reduction.

Gain is the output level control for the entire channel, Compressor, Expander and Limiter. The output level LED bargraph meter indicates output level when the channel is switched in circuit. When the channel is bypassed, the meter indicates INPUT level.

Limiting

The Limiter acts as a last check on signal level. If the level goes over the threshold, fast acting, high ratio compression is applied to bring it back within bounds.

If absolute control over peak levels is required, a Peak Clipper may be switched in, acting in effect as a compressor with a ratio of infinity:1 and instantaneous attack time.

Threshold sets the level above which limiting takes place.

Compression, Expansion and Limiting together

The act of compressing a signal inevitably causes an increase in noise level. Compression reduces peak levels; gain make up restores the overall level, and in the process increases the level of any background noise that

the signal contains.

Almost always, when compression is used, the Expander section will be used also, to clean up the signal. The Limiter/Clipper will control any unwanted peaks.

The result is three-stage dynamic control over gain with three different threshold levels.

In the mid-range of levels, the signal is unaltered. Above the compression threshold, in this example, gain is reduced by a ratio of 2:1. Above the limiting threshold it is reduced by 25:1. At levels below the Expander threshold, gain is reduced by 2:1. Complete control over signal dynamics is possible.

Applications Using the Side Chain Inputs

Each channel has two Side Chain inputs, one for the Compressor and one for the Expander.

In normal use, the amount of compression or expansion is related to the dynamics of the input signal. The Side Chain allows the signal passing through the unit to be controlled by the dynamics of another separate signal.

Connection to the Side Chain input is made via the rear panel jack sockets.

De-Essing

De-essing is an important compression technique using the Side Chain. Many singers have high level sibilants - 'sss' sounds - which detract from their performance. Equalising the signal will reduce the sibilants, but also make the overall vocal sound dull. The sibilants can be selectively removed by compressing only when there is an excessive level of high frequencies. Here is one way to do it.

The microphone channel is routed to a group with the Compressor patched into the group insert points. The microphone channel is also paralleled into another channel via the line input. The signal in the second channel is equalised so that high frequencies in the sibilant range are boosted. This channel is fed via an auxiliary output to the Compressor Side Chain input.

Now, the Compressor will react whenever there is a sibilant, reducing the gain for the duration of the sibilant and cleaning up the vocal sound. This technique can also be used to compensate for a 'boomy' bass, or other situations where a band of frequencies is occasionally obtrusive.

This technique uses the Side Chain input of the Expander section. If speech is to be mixed with music from a stereo source, it is best if the music is dropped in level during the speech, and raised during pauses. This can be done automatically by passing the music through the Expander section and patching the microphone into the side chain.

Since stereo music is to be controlled by an input into the Side Chain of just one channel, the Stereo link button must be pressed. To prevent the music input to Channel B affecting the degree of expansion, an open circuit jack plug must be inserted in the Side Chain input of Channel B to break away the jack socket's switch connection.

The Compressor/Limiter/Expander offers a unique combination of dynamic gain control processors. Engineers will find it a powerful tool in recording, broadcast and post-production studios, and in sound reinforcement systems.