Limiter

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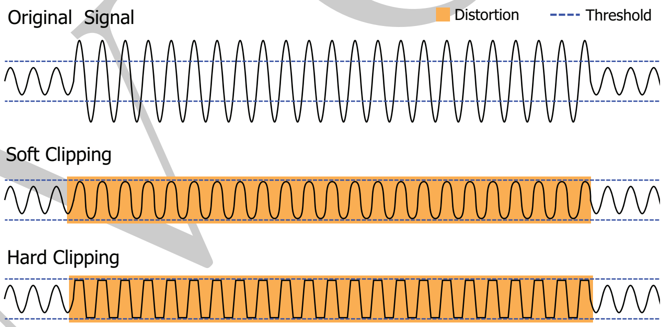
The limiter is used to control the highest peaks in the signal, but to otherwise change the dynamics of the signal as little as possible. Limiting can refer to a range of treatments designed to limit the maximum level of a signal. Treatments in order of decreasing severity range from clipping, in which a signal is passed through normally but sheared off when it would normally exceed a certain threshold; soft clipping which squashes peaks instead of shearing them; a hard limiter, a type of variable-gain audio level compression, in which the gain of an amplifier is changed very quickly to prevent the signal from going over a certain amplitude or a soft limiter which reduces maximum output through gain compression, soft limiter is introduced in this documentation.



This is achieved by employing a characteristic curve with an infinite ratio $R = \infty$ above a limiter threshold LT(Capital letters represent the logarithmic domain) , i.e.,

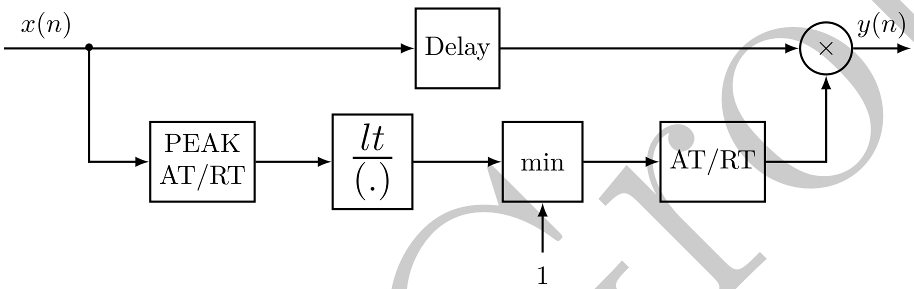
$$G = \begin{cases} 0\text{ dB} & \text{if } X < LT \\ LT - X & \text{else.} \end{cases}$$

Thus, the output level $Y = X + G$ should never exceed the threshold LT. By lowering the peaks, the overall signal can be boosted. Beside limiting single instrument signals, limiting is also often performed on the final mix of a multi-channel application.

A limiter makes use of peak level measurement and should react very quickly when the input signal exceeds the limiter threshold, slowly when belows correspondingly. Typical parameters for a limiter are $t_{AT} = 0.02...10$ ms and $t_{RT} = 1...5000$ ms, for both the peak measurement and the smoothing filter. Actually, t_{AT} is far greater than t_{RT}, an actual implementation may perform the gain computation in linear values by

$$g(n) = \min\left(1, \frac{lt}{x_{\mathrm{PEAK}}(n)}\right),$$

and block diagram.



where $lt = 10^{\frac{LT}{20}}$ is the threshold on the linear scale. This approach is also used in following **Matlab** code, a very simple limiter implementation with the same filter coefficients in the level detector and the smoothing filter.

```
function y = limiter(audio, para)
% para: threshold of limiter in linear scale (lt)
at = 0.3; % Attack time
rt = 0.01; % Release time
delay = 5;

audiopeak = 0; % intialization
g = 1; % gain
buffer = zeros(1,delay);

for n = 1:length(audio)
    a = abs(audio(n));
    if a > audiopeak
        coeff = at;
    else
        coeff = rt;
    end
    audiopeak = (1-coeff) * audiopeak + coeff * a; % Level ...
        detector (A full-wave rectifier in combination with an ...
        AR-averager)
    f = min(1, para / audiopeak); %Static curve
    if f < g
        coeff = at;
    else
        coeff = rt;
    end
    g = (1-coeff) * g + coeff * f; % Smoothing filter
    y(n) = g * buffer(end);
    buffer = [audio(n) buffer(1:end-1)];
end
```

Limiters are common as a safety device in live sound and broadcast applications to prevent sudden volume peaks from occurring. Limiters are also used as protective features in some components of sound reinforcement systems (e.g., powered mixing boards and power amplifiers) and in some bass amplifiers, to prevent unwanted distortion or loudspeaker damage.