# Noise Gate

VCarrara

## Definition

Effects that need high amplification on output, like, for instance, Compressor, Sustain, Overdrive and Distortion, among others, produce as well high noises. Normally this noise are unheard because the instrument volume over exceed it. When the instrument is silent, however, the noise becomes audible and also cumbersome. That's when a Noise Gate can help.

The Noise Gate (NG) monitors the audio level, and when it detects that the level falls behind a threshold, it mutes the output. No sound is audible since, unless the instrument starts to play again.

## Noise Gate Model

A Noise Gate needs a level detector and, for that, it was chosen the level detector of the Compressor[1] model, which is reproduced here.

Given the input at sampled time $n$, $x(n)$, the best approach to compute the input level $y_L(n)$ is achieved with the level detector in the linear domain, and since the threshold for the input can be neglected, the input level is computed by

$$x_L(n) = |x(n)|$$

Next step consists in smoothing the input level. Good results in both compression quality and fast algorithm were obtained with the decoupled smooth peak detector[1] which responds quickly when the input level rises, but decreases slowly when the input level fades:

$$y_1(n) = \max\left\{x_L(n), \alpha_R\, y_1(n-1) + (1-\alpha_R)\, x_L(n)\right\}$$

So the smoothed output level becomes

$$y_L(n) = \alpha_A\, y_L(n-1) + (1-\alpha_A)\, y_1(n)$$

where $\alpha_A$ and $\alpha_R$ are the low-pass filter attack and release parameters, respectively, obtained from

$$\alpha_A = e^{-\frac{1}{\tau_A f_s}}$$

and

$$\alpha_R = e^{-\frac{1}{\tau_R f_s}}$$

in which $\tau_A$ is the attack time, $\tau_R$ is the release time and $f_s$ is the sampler frequency.

Let $T_{ng}$ be the Noise Gate threshold and $g_{ng}$ the output gain. Then the NG function is given by

$$y_G(n) = \begin{cases} 0, & \text{if } y_L(n) < T_{ng} \\ 1, & \text{if } y_L(n) \geq T_{ng} \end{cases}$$

and noiseless output is computed by

$$y(n) = g_{ng}\ y_G(n)\ x(n)\,.$$

Figure 1 presents the output function $y_G$ of the Noise Gate as function of the input level $y_L$ for a threshold parameter of 0.1.

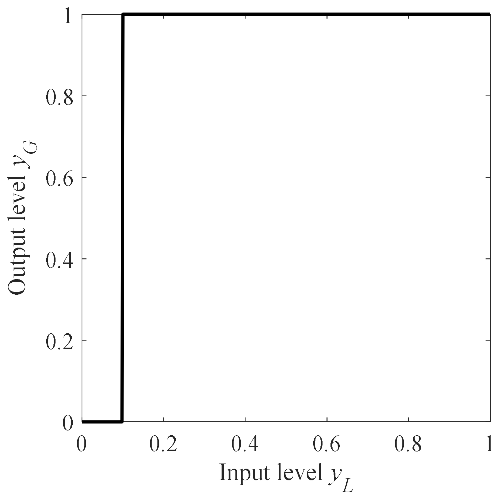


*Fig. 1 – Output level of the Noise Gate for threshold equal to 0.1.*

It can be noted that the GSP main loop has its own level detector, which is used by the Low Frequency Function Generator (refers to specific documentation). So, NG computations could be simplified case it recovers $y_L$ from the GSP level detector, but, for that, both should share the same attack and release times, which could compromise the necessary independence between effect modules.

The adjustable parameters of the Noise Gate are, therefore: the threshold $T_{ng}$, the attack and release times (or number of samples) $\tau_A$ and $\tau_R$, and the output gain $g_{ng}$.

# References


[1] Giannoulis, D.; Massberg, M.; Reiss, J. Digital Dynamic Range Compressor Design – A Tutorial and Analysis. Journal Audio Engineering Society, Vol. 60, No. 6, June 2012.