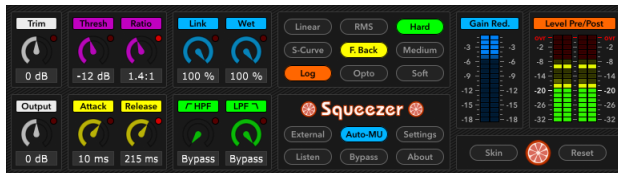


# Squeezer

Flexible general-purpose audio compressor  
with a touch of citrus



*Last edited on 2nd April 2020*



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# 1 About Squeezer

*I wrote this compressor<sup>1</sup> to learn all I could about audio compression. It took me several months to gather all the specs and papers I needed and convert them into code.*

Squeezer is different from all the compressors I know: its knobs are stepped to fine-tuned *preset* values, but can be changed to *continuous* values by clicking a small red light located next to them. This allows you to find nice settings fast while not preventing to optimise these settings.

Squeezer also adapts easily to many tastes and use cases:

- feed-forward & feed-back design
- linear, S-curve & logarithmic reaction
- optical & FET detectors
- peak & RMS sensing
- hard, medium & soft knee
- flexible side-chain & parallel compression

---

<sup>1</sup>In this manual, I will use *compression* synonymous with *downward compression*. There are other ways to reduce dynamic range, but in audio, downward compression is used almost exclusively.

Squeezer has given me a deep insight into compression. But above that, it has quickly become my go-to generic compressor!

## 2 What is compression?

### 2.1 The Tale of the Barkeeper

Once upon a time there was a bar. Customers enjoyed their drinks and music played in the background. After a while, the barkeeper noticed that his drinks sold best when the music had a certain loudness. Unfortunately, almost every record they played had a different loudness.

So he bought a loudness meter and wrote a set of instructions for the DJ:

- 80 dB SPL**     set mixer's output gain to 0 dB
- 85 dB SPL**     set mixer's output gain to -5 dB
- 90 dB SPL**     set mixer's output gain to -10 dB
- 95 dB SPL**     set mixer's output gain to -15 dB

This worked quite well and he could finally afford to buy a shiny new bar counter. Upon which the DJ gave notice (he had always dreamt of getting a *stereo* mixer, so the new counter didn't go down too well with him).

After an initial shock, the barkeeper was quite content. The DJ really *had* been lousy. But how to keep the high number of drinks?

Being an entrepreneur, the barkeeper took his challenge and connected the mixer's output to a simple amplifier. The amplifier's input gain was regulated by a level sensor which in turn was connected to the amplifier's output – a classic negative feed-back loop.

Although the new device exactly followed the DJ's instructions (and didn't smell as bad), customers complained about its bad sound. The barkeeper had invented a *wave shaping* device – gain changes were applied instantly which *distorted* its output signal.

Fortunately, the barkeeper remembered a very important thing: the DJ had often been drunk and taken his time to apply gain changes. So the barkeeper improved his device by smoothing the level sensor's output.

He could have become very rich. But he didn't realise the magnitude of his invention and continued being a happy barkeeper. Which is not the worst thing, when you come to think of it.

To this day, however, sound engineers fall silent in awe when they hear his name – the name of the barkeeper who **invented the compressor**.



## 2.2 How does a compressor work?

*Compressors are inherently complex sound processors. Their technology is quite simple – complexity arises from the dynamic interaction of their controls. While this is definitely a downside when you try to understand compression, it is also what allows you to use compression creatively!*

A compressor is a device for reducing the dynamic range<sup>1</sup> of audio material. In its most basic form, it consists of four modules:

<b>Level detector</b>	measures level of audio at input and sends it to gain computer
<b>Gain computer</b>	calculates difference between input level and desired output level and sends resulting gain reduction to smoothing filter
<b>Smoothing filter</b>	smoothly adjusts <i>current</i> gain reduction in direction of <i>calculated</i> gain reduction and sends result to gain stage; the “speed” of smoothing can often be adjusted ( <i>time constants</i> )
<b>Gain stage</b>	attenuates audio input by current gain reduction

The first three modules are also called *side-chain*. That’s because they form a sideline of processing that will only be *utilised for*, but not *heard in* the compressor’s output.

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<sup>1</sup> difference between loudest and quietest signal

## 2.3 Level detector

As its name implies, a level detector senses the level of an audio signal. It can either detect the input wave form directly (peak sensing) or an estimate of its loudness (average sensing, usually with a RMS<sup>2</sup> filter).

*Peak sensing* allows a compressor to quickly react to sudden changes in level, whereas *average sensing* detects changes over longer periods of time.

There are also two ways of connecting level detectors: vintage compressors sense the gain stage's *output* level (feedback design), leading to a very distinct “bouncing” sound. Modern compressors sense the compressor's *input* signal (feed-forward design) which results in a more natural sound.

## 2.4 Gain computer

The level detector's signal is sent to a gain computer<sup>3</sup> which determines the output level the signal should have. It then calculates a corresponding gain reduction (“attenuate the current input signal by 3.14 dB”). This **gain reduction changes constantly** over time.

---

<sup>2</sup>root mean mean square

<sup>3</sup>in the sense of *calculator* – some gain computers are entirely built from analogue circuitry!

The most common gain computer design is a *threshold* control. It sets a level below which all input passes unchanged. Levels exceeding the threshold are attenuated by a *compression ratio*, set through a second control. Higher ratios effect more compression than lower ratios.<sup>4</sup>

Need an example? A threshold of  $-20$  dB FS yields a gain reduction of 0 dB (no compression) for all levels below  $-20$  dB FS. A signal of  $-18$  dB FS will produce a gain reduction of 1 dB for a compression ratio of 2:1<sup>5</sup> and 0.5 dB for a ratio of 4:1.

There may be a third control called *knee width*. It defines a transition zone around the threshold. In this zone, the compression ratio gradually changes from 1:1 (no compression) to the selected ratio (full compression). Thus, quiet signals receive less compression than loud signals and the compressor sounds “smoother”.

## 2.5 Smoothing filter

*This was the easy part, but from now on explanations usually fail. I'll try my best and continue anyway...*

If you stopped here and let the gain computer control the gain stage directly, you'd have a wave shaping<sup>6</sup> device. By reacting immediately, the compressor would relentlessly

---

<sup>4</sup>a compression ratio of 1:1 effectively bypasses the compressor

<sup>5</sup>a ratio of 2:1 means that 2 dB on the input yields 1 dB at the output

<sup>6</sup>*wave shaping* is a fancy way of saying *distortion*

change the shape of *single wave forms*. Don't get me wrong: this already *is* compression and I occasionally *do* like the sound – but it's not something you want to have on every track, let alone a full song.

*Listen for yourself! Load a drum track into your DAW, add the Squeezer plug-in, unlock attack and release time<sup>7</sup> and set them to their lowest value. Make sure the compressor uses peak sensing<sup>8</sup> and a high compression ratio. Now lower the threshold until you can clearly hear the wave shaping. Keep the DAW open for now.*

To change *sounds* instead of *single wave forms*, the *current* gain reduction has to be slowed down and smoothly adjusted in the direction of the *calculated* gain reduction.

One possibility is using averaging level detectors,<sup>9</sup> employing photo cells is another.<sup>10</sup> Both solutions effectively slow down the compressor's response time, but somewhat crudely.

*Play the drum track and engage the “RMS” button – the distortion vanishes. Disengage the “RMS” button and enable the “Opto” button instead – the distortion vanishes, but the track sounds slightly different. You can now close the DAW.*

---

<sup>7</sup>click on the red lights next to the knobs so they light up

<sup>8</sup>“RMS” button is not engaged

<sup>9</sup>this is *not* the reason why compressors have averaging level detectors; they let compressors react to changes in *loudness*

<sup>10</sup>photo cells react to level changes in complex time-dependant ways

## 2.5.1 Attack and release time

With a little experimentation, it becomes clear that compressors sound best when gain reduction is increased quickly, but released much more slowly.<sup>11</sup> Also, a single “speed” of smoothing could not accommodate the many different types of sound we encounter. So it makes sense to split response time into (at least) two controls:

*Attack* is the length of time it takes to apply roughly<sup>12</sup> two-thirds of an *upward* change in gain reduction.

*Release* is the length of time it takes to apply roughly two-thirds of an *downward* change in gain reduction.<sup>13</sup>

With this in mind, here are the important facts that almost every explanation gets wrong:<sup>14</sup>

- compression starts **the very moment the detected level passes threshold**
- compression continues **even after the detected level falls below threshold**, at least for a short while
- compression occurs **whenever *current* and *calculated* gain reduction differ**; this means **all of the time the detected level is above threshold** and slightly after

---

<sup>11</sup>incidentally, that is *exactly* how vintage photo cells react to changes

<sup>12</sup>every manufacturer defines attack and release times differently

<sup>13</sup>these definitions were shamelessly paraphrased from [Demolishing the Myths of Compression](#) by Gregory Scott, one of the few articles on compression actually worth reading

<sup>14</sup>for simplicity, I will elide the effects of knee width

The last list item may need some explanation. Imagine a signal above threshold<sup>15</sup>.

Whenever the signal's slope is rising, *current* gain reduction will fall below *calculated* gain reduction and will be smoothed using the attack time. Even when the slope starts to drop, *current* gain reduction may still be below *calculated* gain reduction and will be affected by the attack time.

If the slope keeps falling, *current* gain reduction will eventually rise above *calculated* gain reduction and will be smoothed according to the release time. This continues until *current* gain reduction starts to drop again and falls below *calculated* gain reduction, when the attack time will once again take over.

In other words: with any real-world audio signal, compressors enter an ever-changing dynamic state as soon as the input signal passes threshold. And this is what makes them so hard to explain.

The good news is that you can use compressors without fully understanding their dynamic state. I still regard the above necessary knowledge, however, because it will let you *disregard* the countless erroneous explanations out there.<sup>16</sup> In my opinion, the erroneous explanations make it almost *impossible* to understand compression!

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<sup>15</sup>with a compression ratio above 1:1 and below 1:∞

<sup>16</sup>which were the reason for developing Squeezer in the first place

## 3 Installation

In order to use the pre-compiled binaries, simply extract the Squeezer files from the downloaded archive. For the plug-ins, you'll then have to move the extracted files to your respective plug-in folder.

Squeezer requires a processor which supports the SSE2 instruction set. On Windows, you might also have to install the [Visual C++ Redistributable for Visual Studio 2017](#).

Should the stand-alone version ever fail to start, you can reset its settings by deleting the file `squeezer_stereo.ini` or `squeezer_mono.ini`. These files are located in `~/.config` (GNU/Linux) or `%appdata%\config\` (Windows).

## 4 Controls

*Sorry, I have yet to find the time to finish this manual.*



## 5 Final words

I want to express my gratitude to the **Audio Engineering Society** and to the **Rane Corporation** for their wonderful E-Libraries. This includes everybody who wrote the fine papers and notes, especially Dimitrios Giannoulis *et al.*<sup>1</sup> and Rick Jeffs *et al.*<sup>2</sup>

I must also thank the **beta testers** and **users of Squeezer** for sending kind words, suggestions and bug reports. Finally, I want to thank the **open source community** for making all of this possible.

Although coding Squeezer has been a lot of fun, it has also been a lot of work. So if you like Squeezer, why not send me a short email and tell me so? Write a few words about yourself, send suggestions for future updates or volunteer to create a nice skin. I also really enjoy listening to music that you have produced using my software ...

Here is my email address (please remove “-nosspam”):

---

<sup>1</sup>**Giannoulis, Dimitrios; Massberg, Michael; Reiss, Joshua D.** Digital Dynamic Range Compressor Design – A Tutorial and Analysis. *JAES Volume 60 Issue 6 pp. 399-408; June 2012.*

<sup>2</sup>**Rick Jeffs; Scott Holden; Dennis Bohn.** Dynamics Processors – Technology & Application Tips. *Rane Corporation; Rane Note 155; 2005.*

## *Final words*

---

"Martin Zuther" <code-nospam@mzuther.de>

Thanks for using free software. I hope you'll enjoy it!

# A Build Squeezer

## A.1 Dependencies

### A.1.1 premake

Importance: required

Version: 5.0.0 (alpha13)

License: BSD

Homepage: [premake.github.io](https://premake.github.io)

### Installation

Place the binary somewhere in your PATH. Depending on your platform, you should run premake using the scripts `Builds/run_premake.sh` or `Builds/run_premake.bat`.

To change the premake file using the provided Jinja templates, you'll also have to install the necessary dependencies.

## **A.1.2 JUCE library**

Importance: required

Version: 5.3.2

License: ISC and GPL v3 (among others)

Homepage: [www.juce.com](http://www.juce.com)

### **Installation**

Extract the archive into the directory `libraries/juce`.

If you want to build the LV2 plug-in, please extract the archive `distrho_lv2-xxxxxxxx.tar.gz` into the same directory.

## **A.1.3 Virtual Studio Technology SDK**

Importance: optional

Version: 2.4 / 3.6.8

License: proprietary / GPL v3

Homepage: [www.steinberg.net](http://www.steinberg.net)

### **Installation**

Just extract the archive into the directory `libraries/vst`.

## **A.1.4 Python**

Importance: optional

Version: 3.5 (or higher)

License: Python Software Foundation License

Homepage: [www.python.org](http://www.python.org)

You'll only need Python if you want to change the premake file (see [section A.1.1](#)) using Jinja templates.

### **Installation (Windows)**

You can download an installer from the website.

## **A.1.5 Jinja**

Importance: optional

Version: 2.8 (or higher)

License: BSD

Homepage: [jinja.pocoo.org](http://jinja.pocoo.org)

You'll only need Jinja if you want to change the premake file using templates (see [section A.1.1](#)).

## **A.1.6 Artistic Style**

Importance: optional

Version: 2.05.1

License: LGPL v3

Homepage: [astyle.sourceforge.net](http://astyle.sourceforge.net)

This application formats the code so it looks more beautiful and consistent. Thus, you only have to install it if you plan to help me with coding Squeezer.

### **Installation**

Place the binary somewhere in your PATH. Depending on your platform, you should run `astyle` using the scripts `Source/format_code.sh` or `Source/format_code.bat`.

## A.2 GNU/Linux

### A.2.1 Environment

To build Squeezer yourself, I recommend setting up a chroot environment. This is fast and easy to do on Debian-based systems and might save you a **lot** of trouble. At the time of writing, I'm using Linux Mint 19, but the procedure should be similar on your distribution of choice.

Start by installing the necessary packages:

32 and 64 bit

```
sudo apt-get install debootstrap schroot
```

Then install the chroot base system by executing the following statements:

32 bit

```
sudo debootstrap --variant=buildd \  
  --arch i386 bionic \  
  /srv/chroot/bionic_i386 \  
  http://archive.ubuntu.com/ubuntu
```

64 bit

```
sudo debootstrap --variant=buildd \  
  --arch amd64 bionic \  
  /srv/chroot/bionic_amd64 \  
  http://archive.ubuntu.com/ubuntu
```

Running `debootstrap` will take some time. Meanwhile, add the following lines to `/etc/schroot/schroot.conf` (make sure you remove all preceding white space so that each line begins in the first column):

```
32 and 64 bit
[bionic-i386]
description=Ubuntu bionic (i386)
directory=/srv/chroot/bionic_i386
profile=default
personality=linux32
type=directory
users=username

[bionic-amd64]
description=Ubuntu bionic (amd64)
directory=/srv/chroot/bionic_amd64
profile=default
personality=linux
type=directory
users=username
```

Please make the necessary changes to `username`. If you experience problems, you can try to change `bionic` to a release name such as `wheezy`.

When `debootstrap` is done, log in as superuser:

```
32 bit
sudo schroot -c bionic-i386
```



64 bit

```
sudo schroot -c bionic-amd64
```

You'll have to change the file `/etc/apt/sources.list` first (ignore the line break, it should be a single line):

32 and 64 bit

```
deb http://archive.ubuntu.com/ubuntu bionic  
main restricted universe
```

Now install a few packages – `less` and `vim` are optional, but might come in handy:

32 and 64 bit

```
apt-get update  
apt-get -y install bash-completion clang \  
    libasound2-dev libjack-jackd2-dev \  
    mesa-common-dev xorg-dev less vim  
apt-get clean
```

If you like bash completion, you might also want to open the file `/etc/bash.bashrc` and unquote these lines:

32 and 64 bit

```
# enable bash completion in interactive shells  
if [...]  
    [a couple of lines...]  
fi
```

Finally, log out and log in as normal user:

32 bit

```
schroot -c bionic-i386
```

64 bit

```
schroot -c bionic-amd64
```

In this chroot shell, install the dependencies ([section A.1](#)). Congratulations – you are now ready to build Squeezer!

## A.2.2 Build

After preparing the dependencies, start your chroot environment

32 bit

```
schroot -c bionic-i386
```

64 bit

```
schroot -c bionic-amd64
```

change into the directory `build` and execute

32 and 64 bit

```
./run_premake.sh  
make config=CFG TARGET
```

where `CFG` is one of `debug_x32`, `debug_x64`, `release_x32` and `release_x64`, and `TARGET` is the version you want to compile, such as `linux_standalone_stereo`.

In case you run into problems, you can try to switch compilers by opening the file `run_premake.sh` and using the premake options `--cc=clang` or `--cc=gcc`.

The compiled binaries will end up in the directory `bin`.

## A.3 Microsoft Windows

### A.3.1 Build

After preparing the dependencies, change into the directory `build` and execute

32 and 64 bit

```
./run_premake.bat
```

Then change into the directory `Builds/windows/vs20xx`, open the project file with the corresponding version of Visual C++ and build the project.

The compiled binaries will end up in the directory `bin`.

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