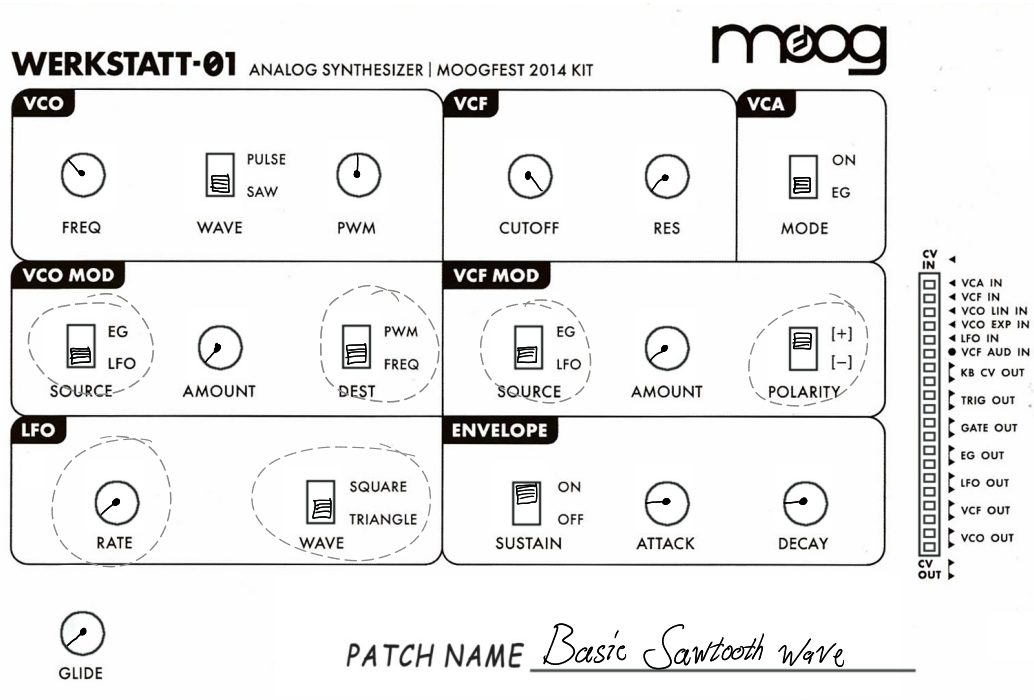


Instead of problems, this week's discussion has "Patches". A patch is a suggested setting for the synthesizer's controls to achieve a certain sound. Each patch also has some questions, which will help you understand what's going on.

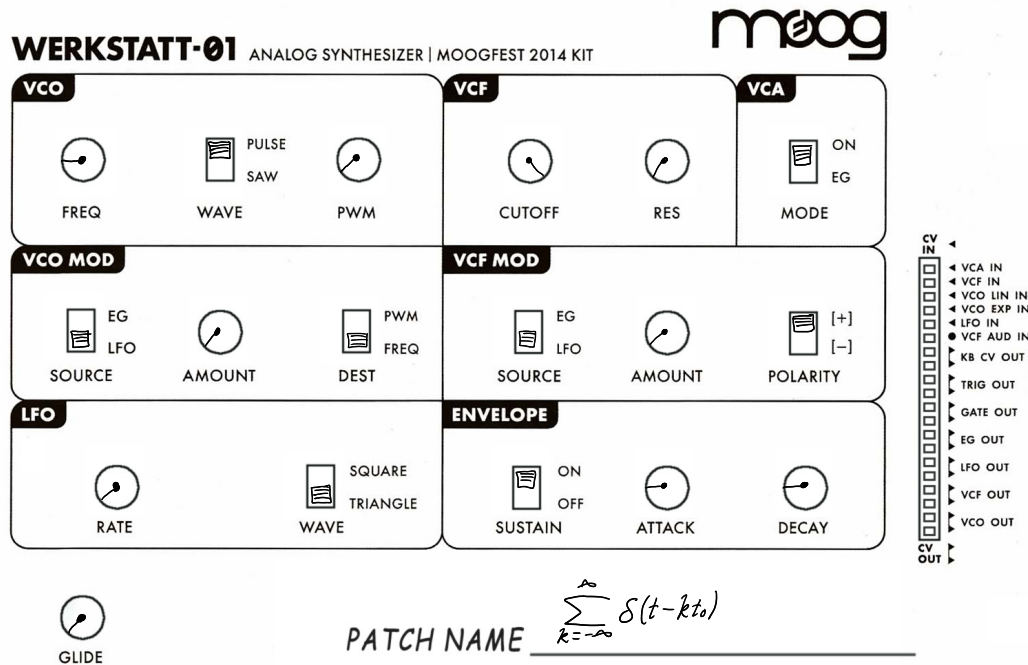
### Patch 1: Basic Sawtooth Wave.

This patch produces a basic sawtooth wave, with no filtering, envelope shaping, or modulation by control voltages. It's a great place to start exploring, and if you can't figure out how to get back to "just a normal sound", you can set it back to this patch.



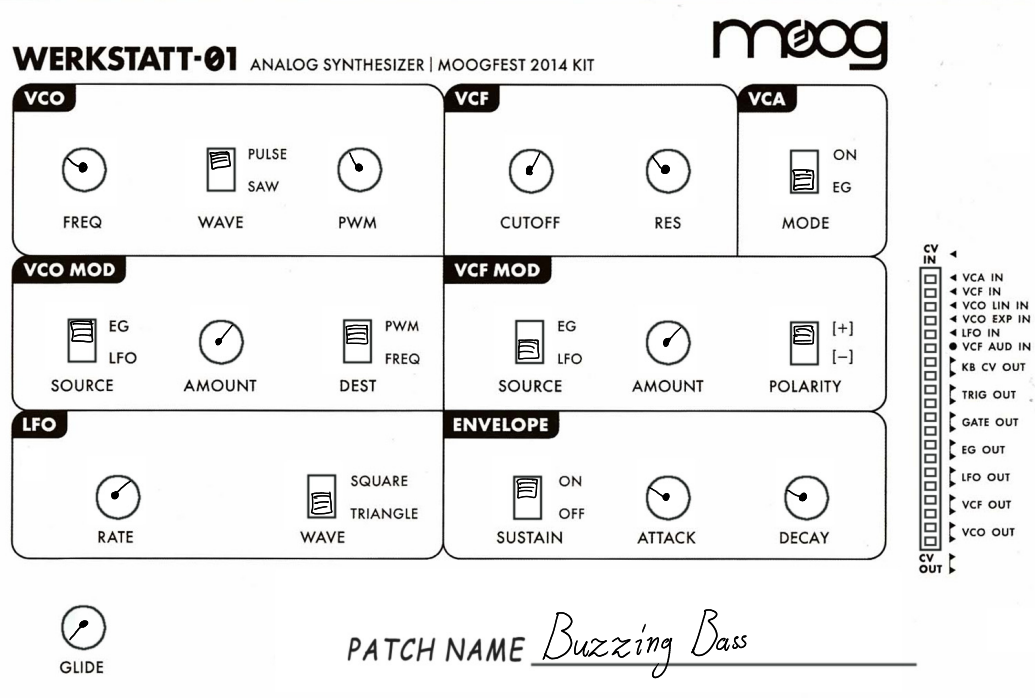
1. A few of the controls are circled with dashed lines. Changing these controls will not change the sound of this patch, which you should check. **Why don't they change anything?**
2. All of the other settings are important to get an unfiltered, unmodulated sawtooth wave. **Why are these controls important to the sound?**
3. Suppose that we wanted to add a "vibrato" effect to the sawtooth wave— this is a slight wobbling in the pitch of the note. **Which circled settings become important? Which setting controls the "depth" of the vibrato? Which controls the "speed"?**

**Patch 2: Impulse Train.** This patch makes a mildly unpleasant buzzing sound. However, that buzzing is the sound of a familiar friend: the impulse function! The signal coming out of the audio jack is a finite-energy approximation of the signal  $x(t) = \sum_{k=-\infty}^{\infty} \delta(t - kt_0)$ , that is a train of delta functions all spaced  $t_0$  apart.



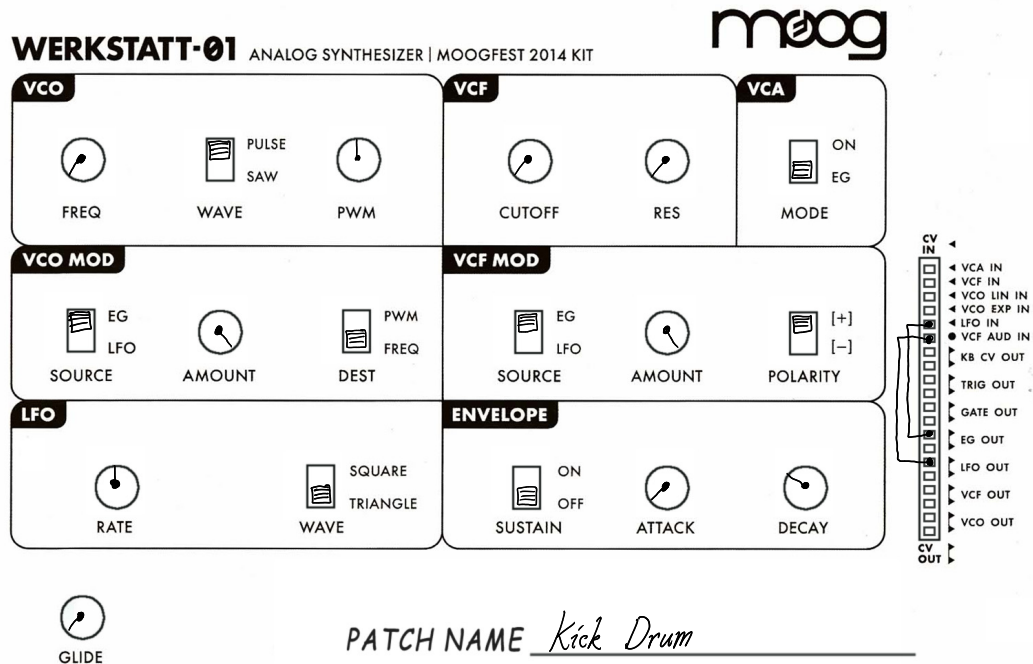
1. Once again, not all of the controls will affect the sound of this patch. Try changing all of the control settings, and circle the ones that don't affect the sound. Why don't those ones have an effect?
2. The settings for this patch is quite similar to the "basic sawtooth" patch, despite the fact that they produce very different waveforms and spectra. Starting from the "basic sawtooth" patch, what changes would you need to make to get to this patch?
3. Connect the audio output of the Werkstatt to an oscilloscope, and look at the audio waveform and its FFT. This signal has a special relationship to its Fourier transform. What is it? *hint: In the homework, you proved that the Gaussian signal enjoys a similar relationship.*

**Patch 3: Buzzing Bass.** A characteristic sound of a lot of electronic music produced in the last couple of years is a deep, metallic-sounding bass with that pulsates with a gently undulating “wub”. This patch produces such a bass sound, where the “wub factor” is different for each note.



1. This patch uses all six of the Werkstatt's modules, but the LFO is the most critical for giving this patch the “wub factor”. **Where is the LFO's control voltage being sent, and what is it doing there?**
2. The effects that a harmonic (that is, a Fourier series component) has on the sound of a signal depends strongly on whether it is an *even* or *odd* harmonic. Use an oscilloscope to check the harmonic content of this patch at a few different notes. **Mostly odd, mostly even, or an even-ish mix of both? What effect does this have on the sound?**
3. This patch can be a starting point for you to find a bass sound that's a bit more “your style”. Experiment with it: change some of the settings, and maybe add some new module connections with the patch headers! If you find a sound you really like, there are blank patch sheets where you can record it for posterity.

**Patch 4: Kick Drum.** It's easy to get the notion that a synthesizer has to produce sounds that mimic pianos, flutes, voices, or other instruments with sustained, nearly periodic waveforms. However, it can also create short sounds with lots of dynamics. For example, this patch creates a deep, resounding drum beat.



1. Watch the LED on the LFO panel when you press a key. **What happens, and why does it happen?**
2. This patch has *two* connections in the patch header, which is pretty advanced. **Describe how each one alters the way the modules are interconnected. How does removing the patches affect the sound?**
3. It's important to have a variety of drum sounds at your disposal. Who ever heard of a drum kit with only one drum? This patch can be a starting point for you to find new percussion sounds. Experiment with it: change the settings, move the patch headers around, and add new ones. You can go for "real drum verisimilitude" if you want, or you can go for a really weird electronic sound– it's your adventure now! If you find one you like, there are some blank patch sheet where you can jot it down.

By the way, you can use the patch headers to connect multiple Werkstatts together. I wonder what that would sound like?