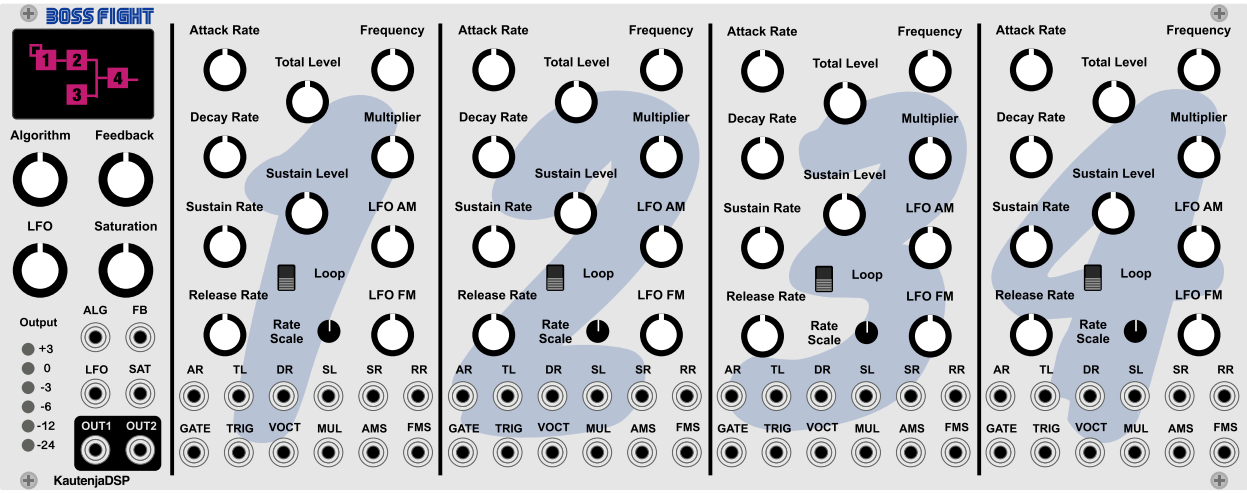
BOSS FIGHT



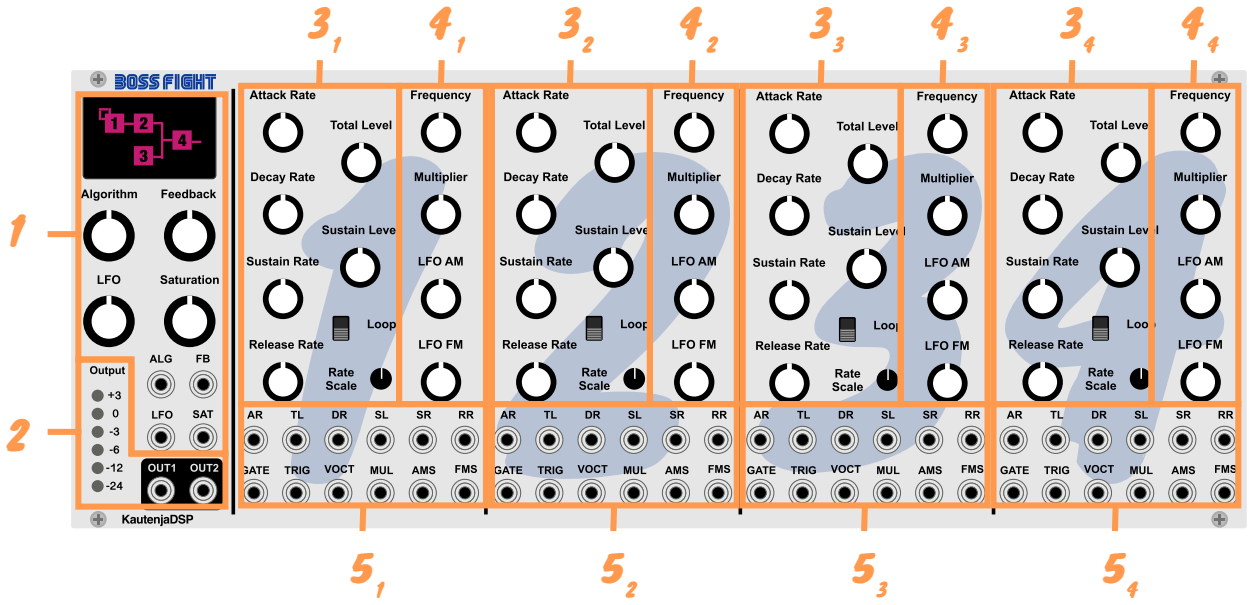
KautenjaDSP

Overview

Boss Fight is an emulation and re-envisioning of the Yamaha YM2612 audio processing unit from the Sega Mega Drive and Sega Genesis. Boss Fight provides the key functionality of the *3rd channel* of Yamaha YM2612, in addition to some hacks, omissions, and re-envisioned features, namely,

- **16-bit Audio:** It's 8 bits better than the previous generation of chips! This is marketing! We're actually lying though – the YM2612 produced a *14-bit* stream, and so does BossFight. You're not getting those 2 bits back; go cry about it.
- **4-Operator FM Synthesis:** Full panel and CV control over the parameters for each of the four operators including envelopes, multipliers, rate scalings, tunings, gates, and LFO modulations.
- **8 FM Algorithms:** 8 different arrangements of the four operators following the original chip implementation.
- **Operator 1 Feedback:** Feedback into operator one for interesting timbres or total wave destruction.
- **Individual Operator Frequencies:** Control the frequency of each operator to produce weird, harsh, and trashed noises.
- **Looping Envelopes:** Transform the one-shot envelope generators of individual operators into looping AD envelopes.
- **Saturation/Aliasing Control:** The YM2612 hard clips the output signal when it gets too loud. This is both a musically useful effect for introducing high-order harmonics, as well as aliasing. Nyquist lied to you, aliasing is your friend. However, if you are not a fan of clipping and aliasing, aliasing control allows you to attenuate the output signal from the chip *before* it passes through the hard clipper to prevent fully saturating the 14-bit PCM stream.
- **VU Meter:** A VU meter tracks how hot the signal from BossFight is getting and makes it easy to visualize how much clipping is occurring.
- **Low-Frequency Oscillator:** A shared low-frequency sine oscillator controls amplitude modulation and frequency modulation of each operator.
- **Mono Output:** The original YM2612 was stereo, but only because it had six channels of synthesis. Boss Fight is a monophonic voice so there is no built-in stereo processing.
- **Semi-Modular Normalization:** Inputs are normalled forward across the operators to reduce the amount of patch cables for setting up simple patches quickly.

Panel Layout



1 Synthesizer Control

The **Algorithm** knob controls the routing between the four operators on the synthesizer. Boss Fight offers eight FM synthesis algorithms that Figure 1 depicts. Table 1 presents some possible use cases for each of the algorithms. When an input is patched to the **ALG** input, algorithms can be selected in increments of $1V$.

Figure 1: An illustration of the FM algorithms on the module.

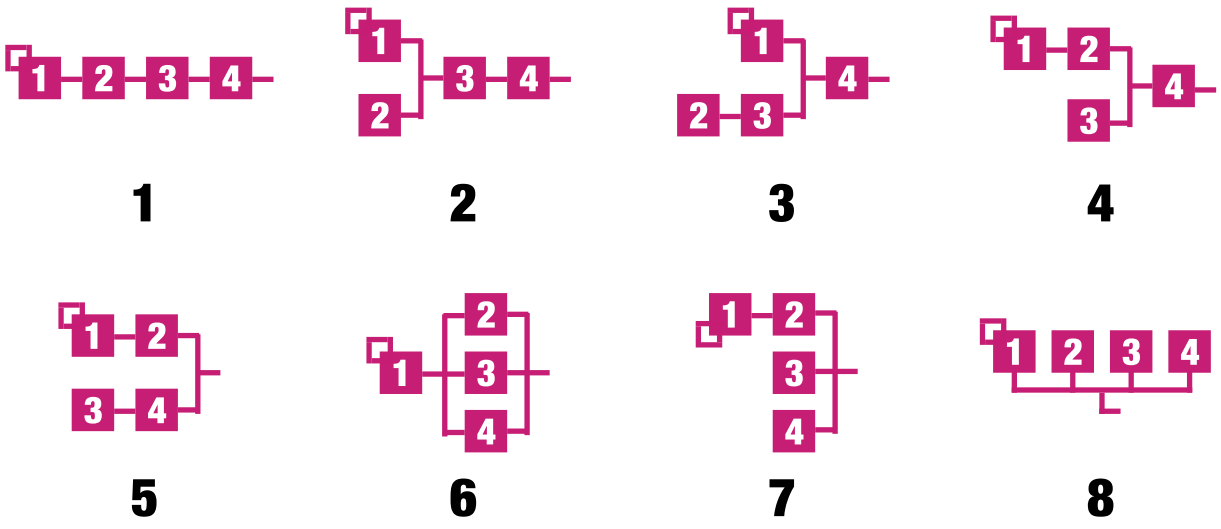


Table 1: Suggested uses for the individual FM algorithms.

Algorithm	Suggested Uses
1	Distortion guitar, “high hat chopper” bass
2	Harp, PSG (programmable sound generator) sound
3	Bass, electric guitar, brass, piano, woods
4	Strings, folk guitar, chimes
5	Flute, bells, chorus, bass drum, snare drum, tom-tom
6	Brass, organ
7	Xylophone, tom-tom, organ, vibraphone, snare drum, base drum
8	Pipe organ

The **Feedback** knob controls the amount of feedback for operator 1 $\in [0, 7]$. When an input is patched to the **FB** input, feedback levels can be selected in increments of $1V$.

The **LFO** knob controls the rate of the internal low frequency oscillator $\in [0, 7]$ with frequency values mapped by Table 2. The LFO is used for both amplitude and frequency modulation of the individual oscillators. When an input is patched to the **LFO** input, LFO frequencies can be selected in increments of $1V$.

Table 2: Frequencies of the low-frequency oscillator.

Knob Position	0	1	2	3	4	5	6	7
Frequency (Hz)	3.98	5.56	6.02	6.37	6.88	9.63	48.1	72.2

The **Saturation** knob controls the amount of internal attenuation of the master signal before passing through the DAC emulator and hard-clipper[1]. This control can be used to remove/control the hard-clipping effect on the master signal. It can also be used to invert the phase of the master signal. When an input is patched to the **SAT** input, saturation levels can be selected in increments of $\approx 5mV$.

2 Output

The dual output provides a buffered copy of the monophonic output from the synthesizer. The VU meter visualizes the level of the output signal from the synthesizer. Clipping begins at $0dB$, and will introduce intentional aliasing.

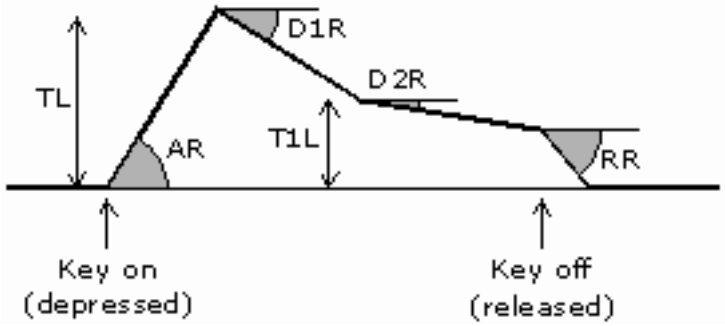
3 Envelope Generator

The envelope generator section provides control over the envelope generator parameters for each of the four operators on the module. Figure 2 depicts the stages in the envelope generator, where

[1] The saturation parameter is not a feature of the Yamaha YM2612, but is added to Boss Fight for creative utilities.

- **Total Level (**`TL`**)** is the highest amplitude of the envelope generator. A change of one unit is about $0.75dB$;
- **Attack Rate (**`AR`**)** is the angle of initial amplitude increase. This can be made very steep if desired. The problem with slow attack rates is that if the notes are short, the release (called `key off`) occurs before the note has reached a reasonable level;
- **Decay Rate (**`D1R`**)** is the angle of initial amplitude decrease from the highest point in the envelope generator;
- **Total Level 1 (**`T1L`**):** The amplitude where the second decay stage starts;
- **Sustain Rate (**`D2R`**)** is the angle of secondary amplitude decrease. This will continue indefinitely unless `key off` occurs; and
- **Release Rate (**`RR`**)** is the final angle of amplitude decrease, after `key off`.

Figure 2: An illustration of the stages in the envelope generator.



The **Rate Scale** parameter additionally controls the amount of key-scaling that occurs for the envelope generator parameters $\in [0, 3]$, i.e., the degree to which envelopes become shorter as frequencies become higher. For example, high pitched notes on a piano fade much more quickly than the low pitched notes.

The **Loop** switch causes the envelope generator to enter a looping LFO mode when pointing up. When pointing down, the envelope generator is triggered by gate signals to the **GATE** port. The envelope generator can be re-triggered (i.e., triggered during a sustained note) using the **TRIG** port.

4 Voice Control

The voice control section provides control over the FM synthesis parameters for each of the four operators on the module, namely,

- **Frequency** is the frequency offset for the operator. For standard FM sounds, all operators should be tuned to harmonically related frequencies. Individual operators with different frequencies is a special mode of the 3rd voice on the Yamaha YM2612 that can produce some weird and bizarre sounds;
- **Multiplier** is an integer multiplier for the frequency of the operator. MUL ranges from 0 to 15, and multiplies the overall frequency, with the exception that 0 results in multiplication by $\frac{1}{2}$;

- **Amplitude Modulation** determines the amount of amplitude modulation applied to the operator by the global LFO $\in [0, 3]$; and
- **Frequency Modulation** determines the amount of frequency modulation applied to the operator by the global LFO $\in [0, 7]$.

5 Input Ports

The top row of ports provides control for the envelope generator parameters that act as offsets from the knobs. Voltage is quantized from $7V$ to the discrete space for the parameter. The **GATE** input goes high at $2V$ and triggers the envelope generator on the operator. Figure 2 illustrates how the envelope generator interprets `key on` and `key off` events in the gate signal. The **TRIG** input goes high at $2V$ and re-triggers the envelope generator on the operator if the gate is high. The **VOCT** port provide exponential control for the oscillator's frequency offset from the base frequency determined by the **Frequency** knob. The **MUL**, **AMS**, and **FMS** inputs provide offset control for the multiply, amplitude modulation sensitivity, and frequency modulation sensitivity parameters. **All operator input ports are normalled from operator 1 through to operator 4.**

Data Sheet

Type	Oscillator / Synth voice
Size	65 HP Eurorack
Depth	NA
Power	NA
$+12V$ draw (mA)	0 mA
$-12V$ draw (mA)	0 mA
$+5V$ draw (mA)	0 mA

References

Various (1992). *Genesis Sound Software Manual*. Sega Corporation.