# DTP2_PROJ_5

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## FM Synthese

# Extra Feature: Ausbau Tone Generator to FM-Synthesizer

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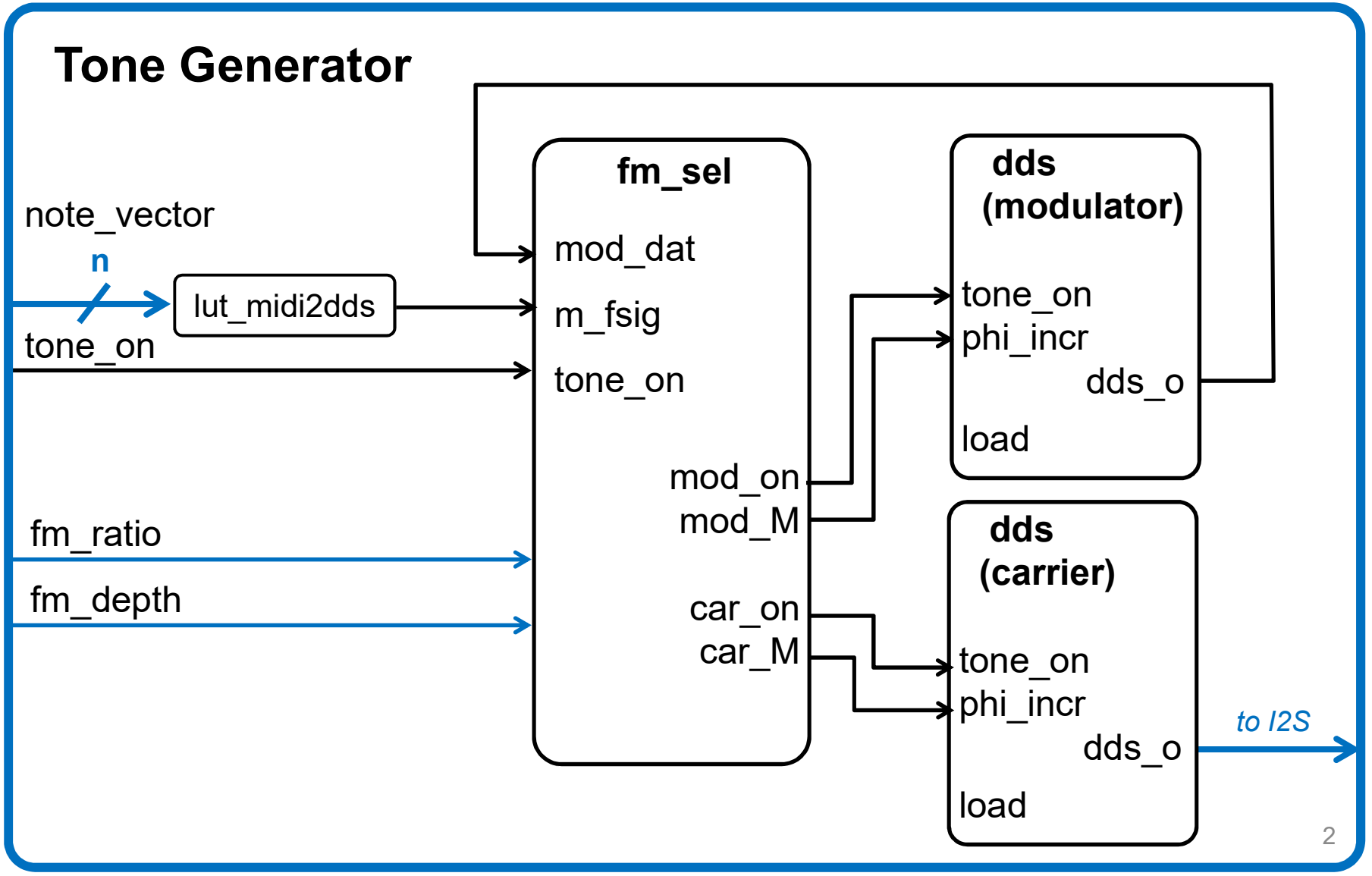

# FM-Synthesizer

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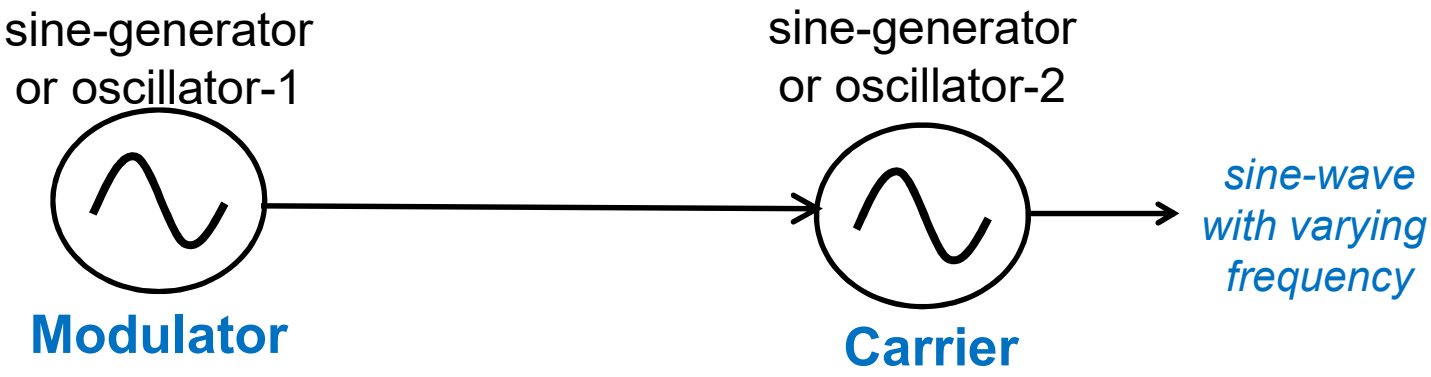
## Basic Idea




*The frequency of the carrier sine-wave varies around a central value (fsig). This frequency variation generates several harmonics and give the sound a characteristic tone colour or timbre («Klangfarbe»).*

*The frequency variation is given by the output of the modulator sine-wave.*

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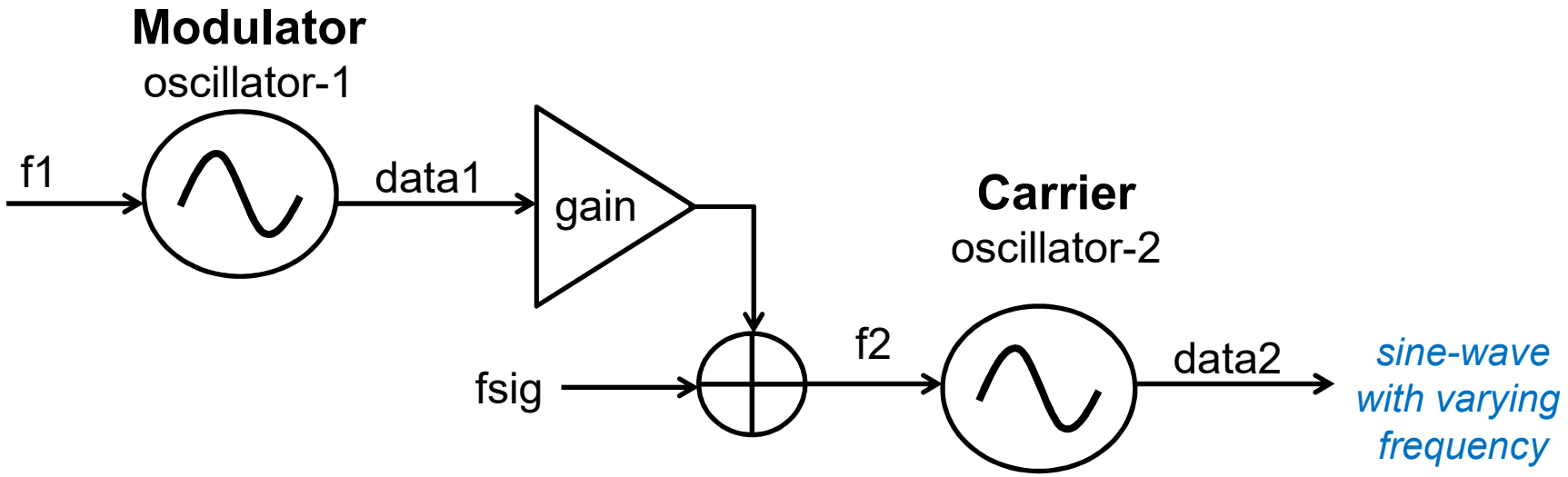
## Parameters




*How are the values of f1 and gain selected? Using the parameters:*

- *Carrier-to-modulator Ratio ( c:m )* => *fsig / f1*
- *Modulation Depth* => *max{data1}.gain / fsig*

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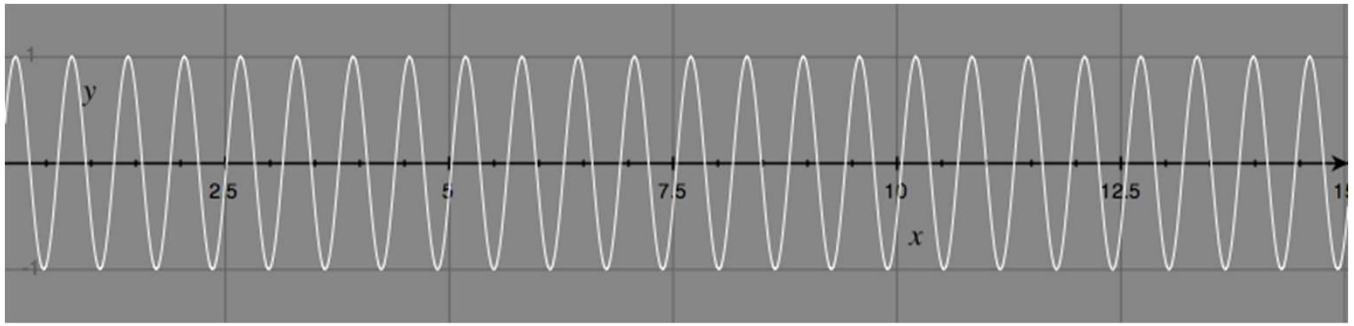
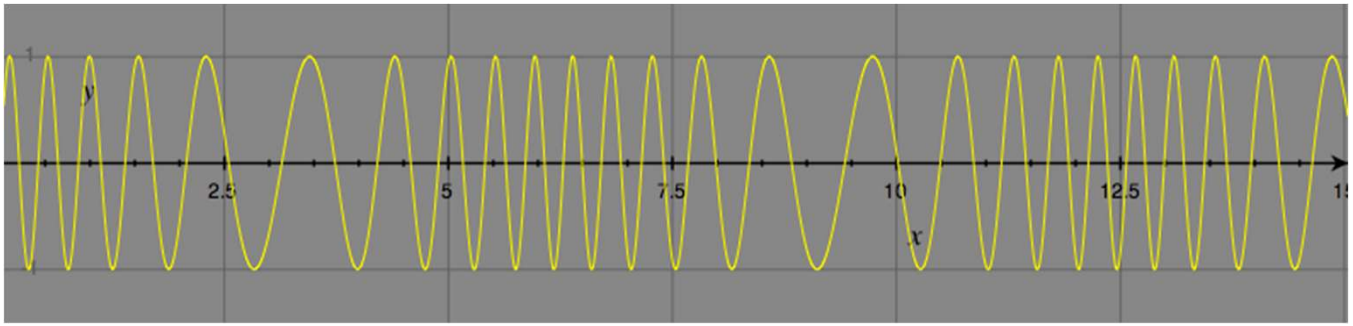
## Illustration

**Carrier**
oscillator-2




**Modulator**
oscillator-1


**Resulting**
Signal



# Example_ carrier to modulator ratio

Use input fm_ratio to select different (c:m) values.

For instance with c:m = 2:1

$$\begin{cases} \dfrac{c}{m} = \dfrac{f_{sig}}{f_1} = 2 \\ \Rightarrow \quad f_1 = \dfrac{f_{sig}}{2} \end{cases}$$

*Tendency*
*( c:m ) < 1 : generates round / full tone colour*
*( c:m ) > 1 : generates shrill / metallic tone colour*

*Some common used values*
*( c:m ) = (1:0) : no modulation, pure carrier*
*( c:m ) = (4:1) ; (2:1) ; (3:2) ; (1:1) ; (2:3) ; (1:2) ; (1:4) ; …*

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## Example_ modulation depth

Use input fm_depth to change the modulation depth,
by selecting the gain value.

*Let us call:*
*A1 : amplitude of modulator sine-wave*
*g : variable gain factor*
*fsig : central frequency of carrier sine-wave*

$$\begin{cases} 0 \le A_1 \cdot g \le f_{sig} \\ \Rightarrow \quad 0 \le \dfrac{A_1 \cdot g}{f_{sig}} \le 1 \end{cases}$$

But our input controlling fsig is phi_incr (or M) which is actually proportional to the phase (2π.fsig.Ts). Therefore it gets a bit tricky to precisely calculate the modulation depth (we miss some theory you will learn in following semesters…).
Order of magnitude: phi_incr_mod about $2^1$ till $2^7$ times smaller than phi_incr_car

**Proposal**: try out some values for gain g and set a range you find effective.
**Tendency**: lower modulation-depth values allows to better notice the difference of tone colour depending on the (c:m) ratio.

# Tutorial Reference (video)

## Simon Cann's Synthesizer Boot Camp #5

(Synthesis Modulation Synthesis – part 1 of 2)
https://www.youtube.com/watch?v=h3yrd2YvkUo

Observation:
The other parts of the Simon Cann's Synthesizer Boot Camp (#1-#4 and #6) present tone-shaping methods which are also very interesting, but they give more work to be implemented in VHDL and the basic Frequency-Modulation Synthesizer of video #5 is rather easy to implement with DDS, and very effective (to cause changes of timbre).

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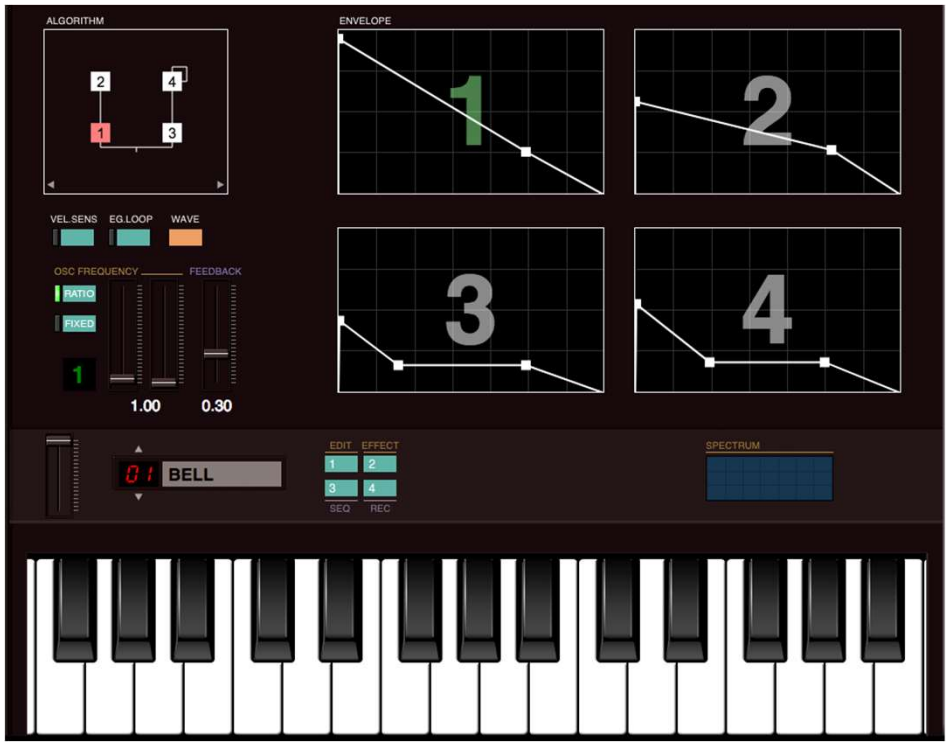
## Online WEB FM-Synthesizer

http://www.taktech.org/takm/WebFMSynth/



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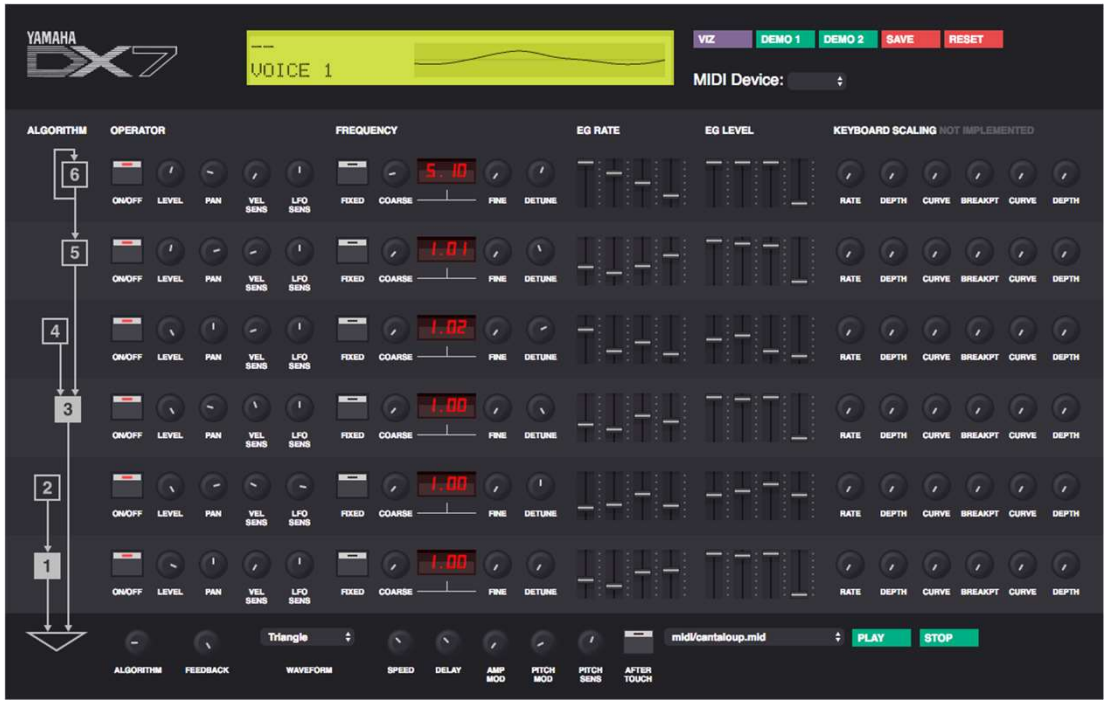
## Online Yamaha DX7 Synthesizer

http://mmontag.github.io/dx7-synth-js/



# Testing FM Synthesis

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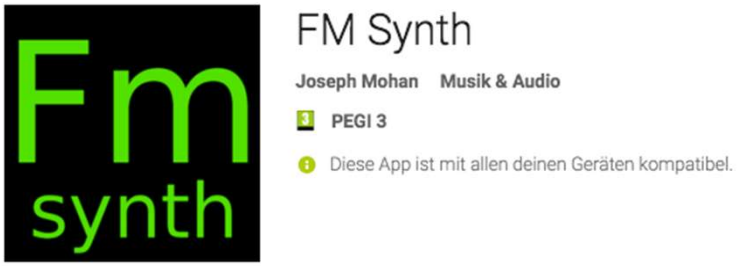
## Android App 1

FM Synth

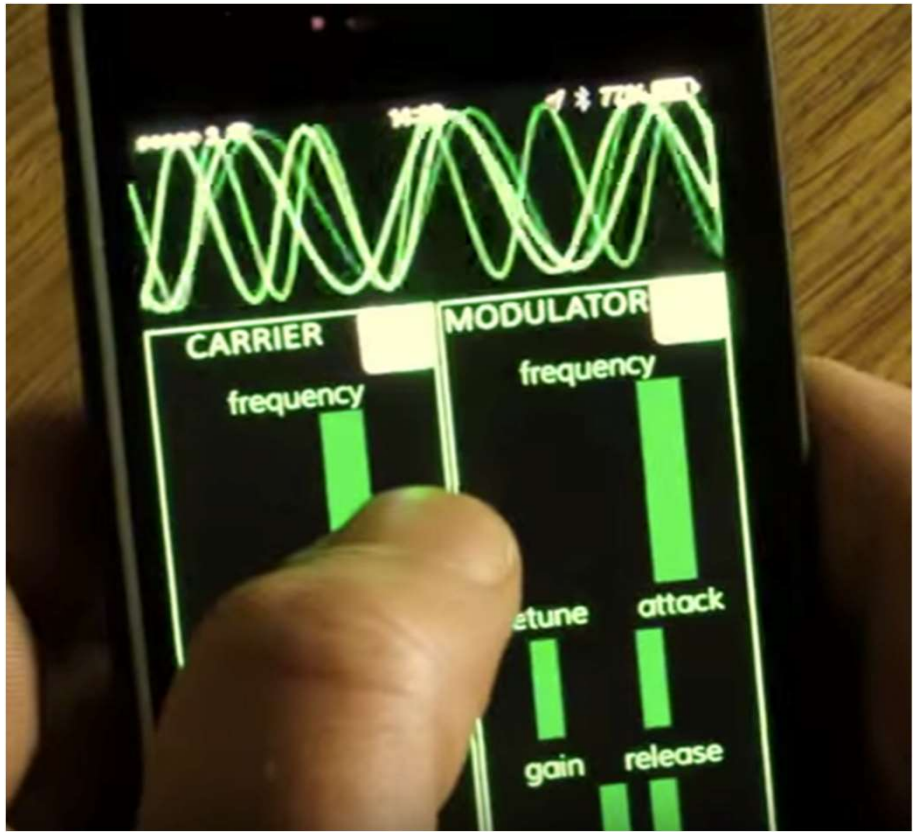



FM Synth

Joseph Mohan  Musik & Audio

PEGI 3

Diese App ist mit allen deinen Geräten kompatibel.




https://play.google.com/store/apps/details?id=com.frequencymodulation.jmohan

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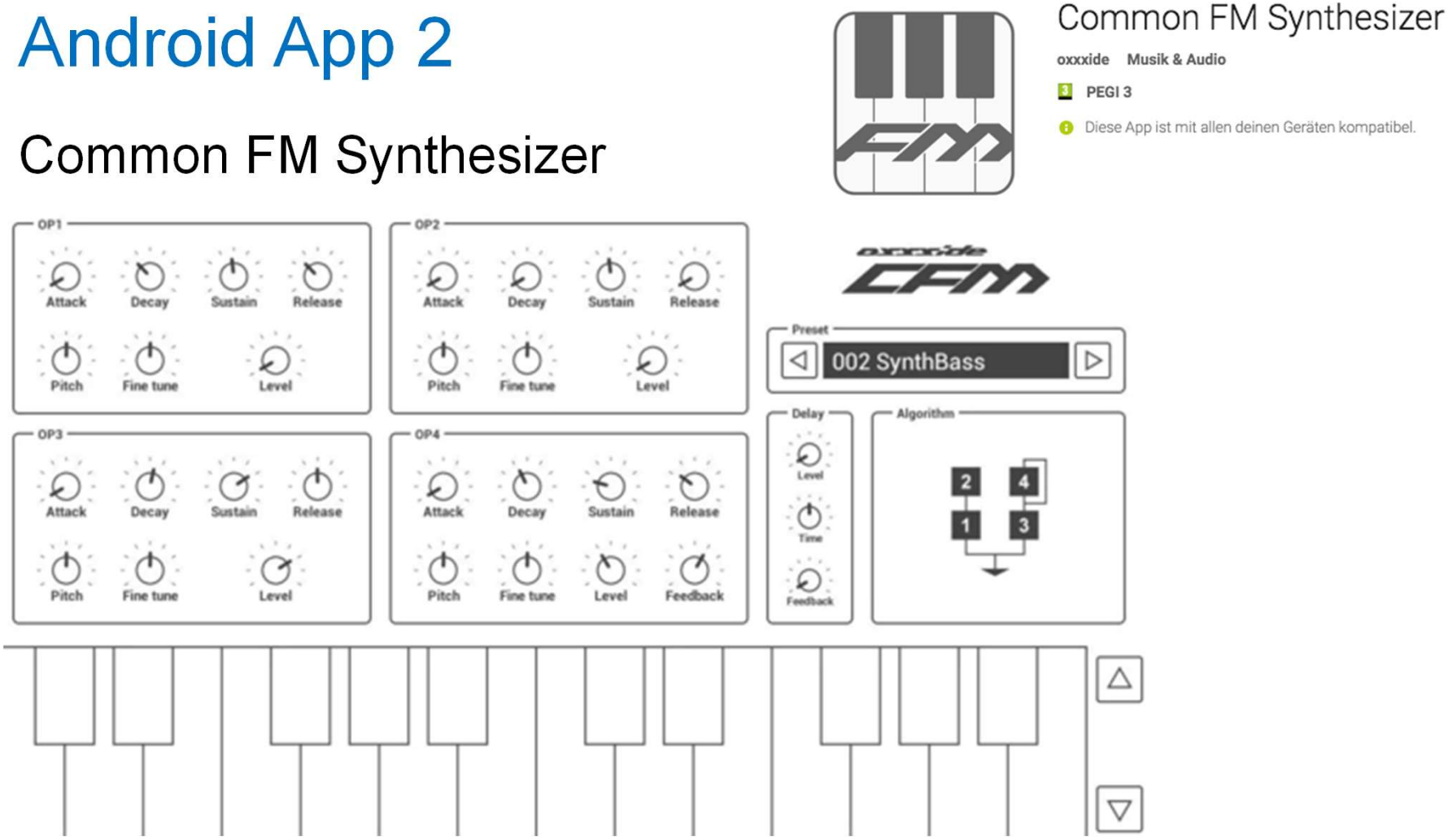
## Android App 2




https://play.google.com/store/apps/details?id=org.oxxxide.fmsynth