Cabinet simulators

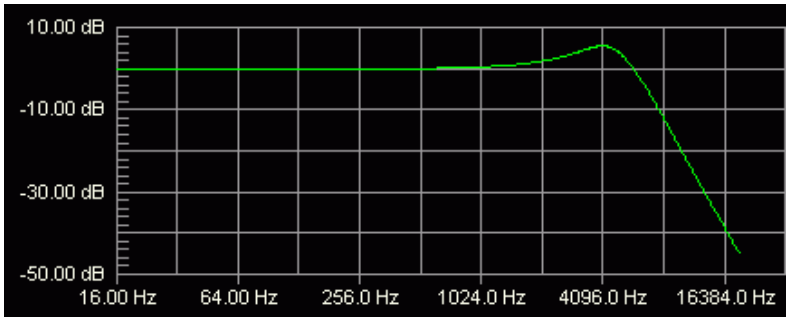
Credits:
the article, originally in polish language was translated by **Teemu Kyttälä**, the author of Solid-state Guitar Amplifiers book and **Markus**.
Thank You guys! P.Z.

Note: information in this article is provided for historical reference. The author currently uses DSP approach in cabinet simulation, which he strongly believes to be a superior solution in comparison to analog circuitry.

Cabsims - Cabinet Simulator (or Speaker Emulator) circuits are very useful not only at home studio, during guitar recording, night practicing using headphones, but also on the stage as an additional signal output, which can be plugged directly into the mixer's input. Cabinet simulator's job is to emulate the frequency response of a guitar amplifier's speaker cabinet, which is the last and one of the most important elements of guitar sound creation (with the exception of microphone and the listener's perception of sound).

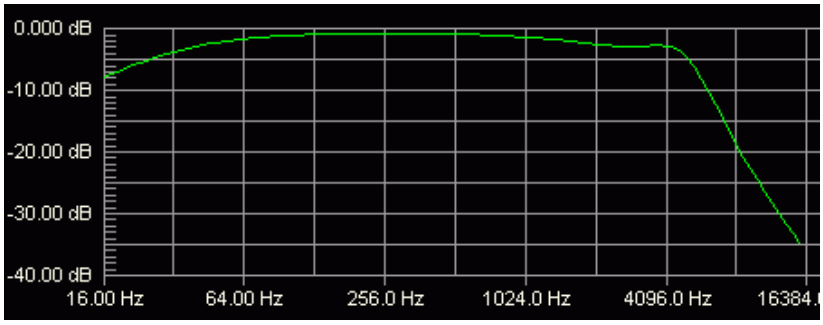
As an electronic circuit a Cabsim is a set of active or passive filters that create a desired frequency response. In its simplest form it's a typical low pass filter with roll off at about 4-5kHz, since this is the usual bandwidth limit of a guitar speaker (-3dB roll off).

Such a simple solution was implemented in **TRIAMP** amp by **H&K**. The schematic is available here and the frequency response is shown below:

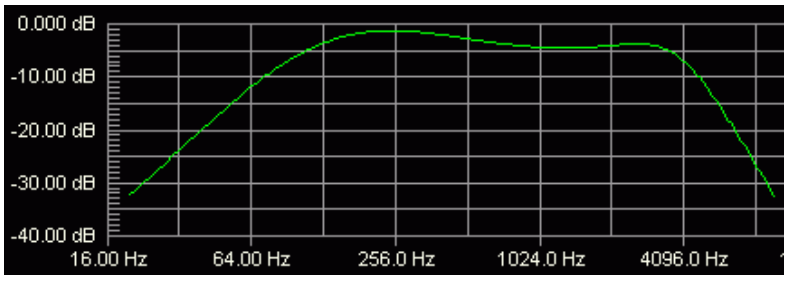


As one can see from the schematic, the cabinet simulator is composed of two low pass filters connected in series.

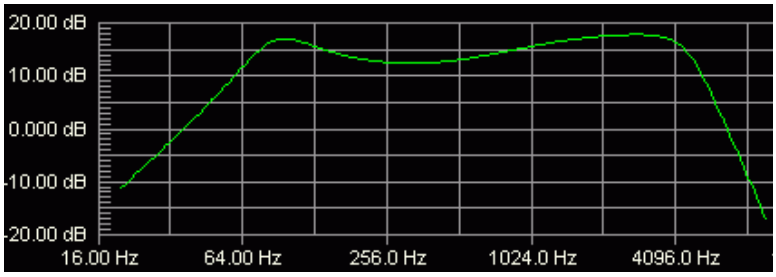
Similar idea (but based on LC elements) can be found in Record Out device in **Triaxis** preamp by **MesaBoogie**.



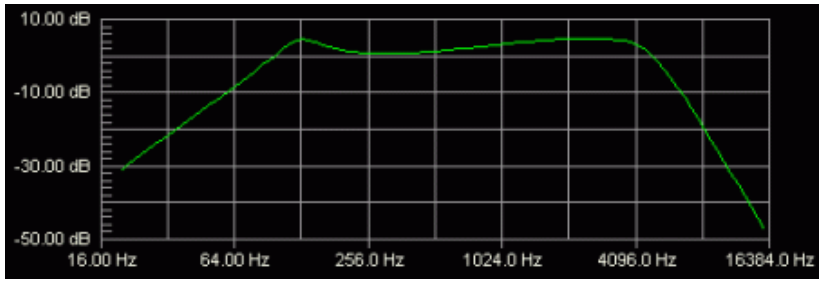
One step further; if we examine the frequency response of a guitar cabinet, we will notice another important feature - low frequency roll off starting usually at 100-200 Hz. This is achieved by using a high pass filter. Many amps contain various devices based on these two filters. Few examples - again by **H&K** - are cabinet simulators available in discontinued preamp series: **Cream Machine**, **Crunch Master**, **Metal Master** - schematic and frequency response:



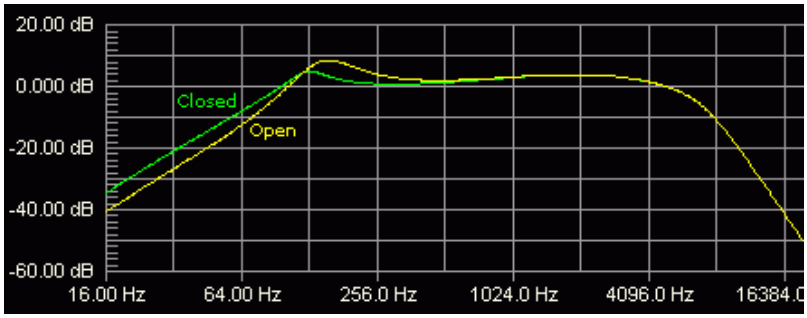
Similar cabinet simulators are utilized in Marshall amps - they have an additional frequency boost close to speaker's resonant frequency.
Cabsim utilized in **JTM** series - schematic and the frequency response:

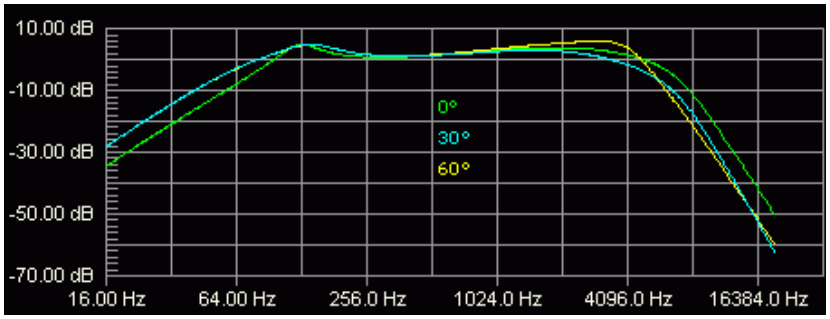


Cabsim used in **JMP-1** preamp - schematic and its frequency response:



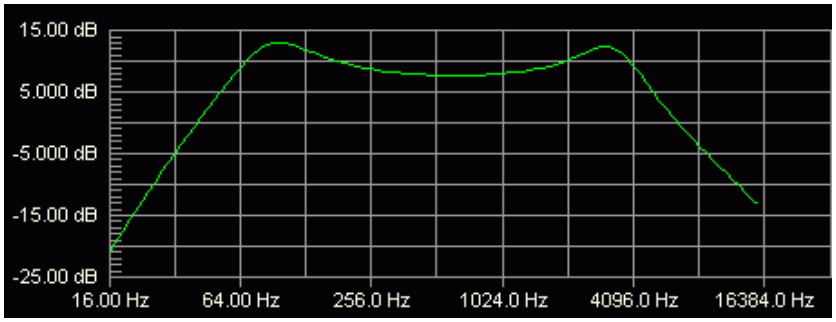
Its older brother, more complex, with a possibility of advanced sound tweaking, used in **SE100** Speaker Emulation System - schematic and its frequency response:



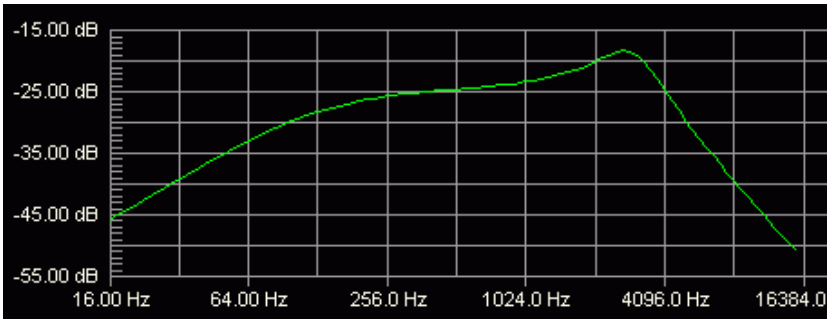


Here's a sound sample (1.1MB) of the Marshall SE100 with all its settings used.

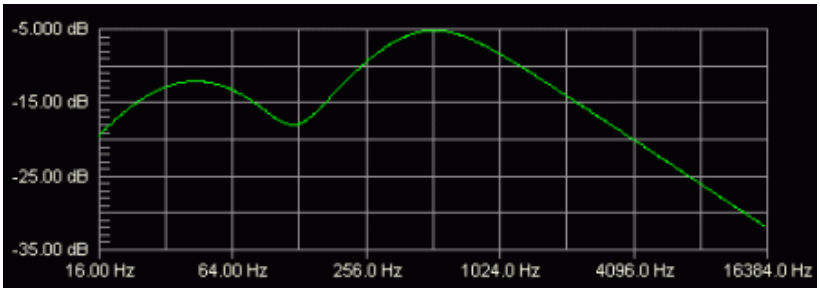
The **LANEY TF-200** amp has a **VIBE** switch (schematic), which turns on a filter that has a frequency response shown below:



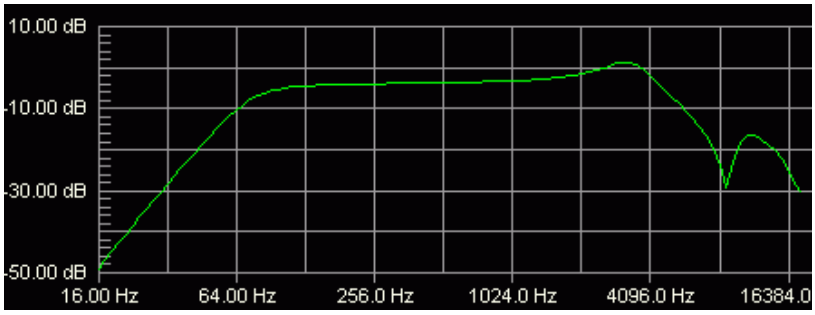
The next preamp by Mesa Boogie - **V-Twin** - has a simple filter, which can deliver purring blues tones. As usual for Mesa, the filter is based on inductance. Its schematic, sound sample, and frequency response:

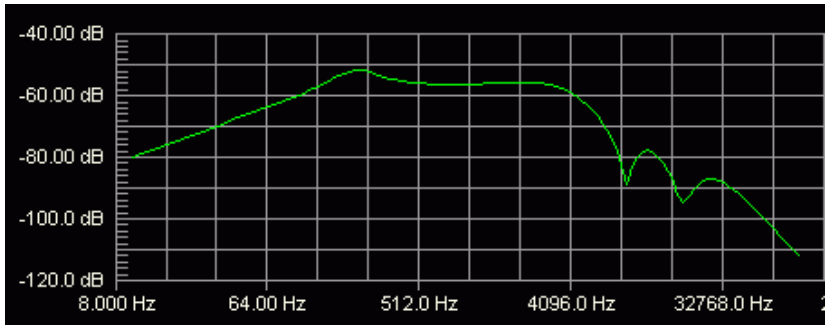


A very simple solution based on two multi-feedback filters and with an unconventional frequency response, was used in the Screamer50 amp by **ENGL**. Signal is collected after the output transformer. However, it is worth to mention that the solution does not sound perfect.
The device schematic and the frequency response:



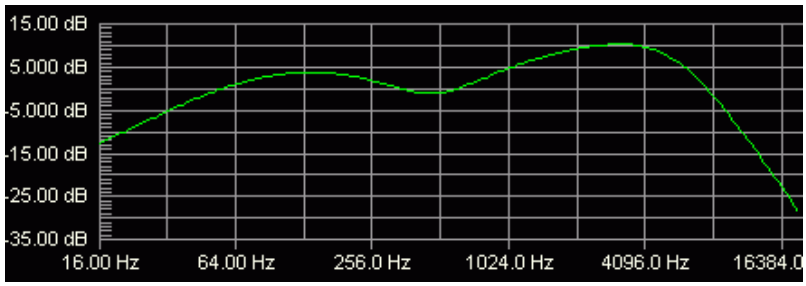
Back to **H&K**. There are several interesting cabinet simulators based on RLC filters. Let's take a look at two devices: **Red Box** and **Tubeman II** preamp. RedBox is a completely passive device (schematic), which can be plugged between the amp and the speaker. It can be also used with line level signals. After extraction of a cabsim schematic out of Tubeman II we can see that both devices are almost identical. Tubeman's initial stage contains an additional second-order high-pass filter (schematic). And here are the frequency responses of Tubeman and RedBox:



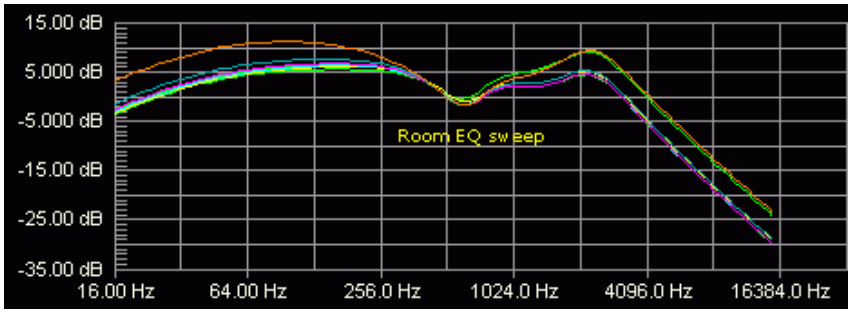


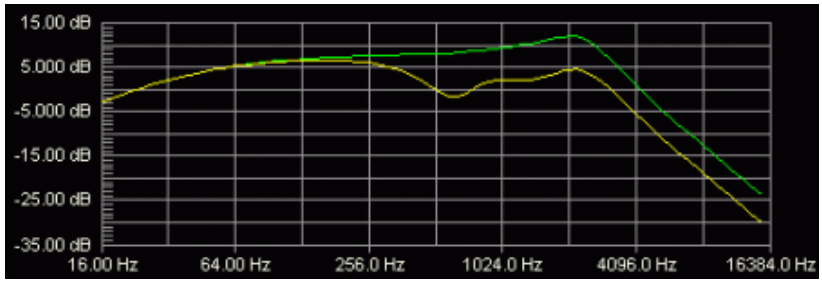
However, speaker cabinet's frequency response does not consist only of high and low frequency reduction and speaker's resonant frequency boost. In between we will find lots of "peaks" and "notches", which are results of many factors like: speaker type, speaker enclosure mechanics, or - very importantly - the cabinet surrounding. The actual frequency

characteristic of a speaker-microphone arrangement is highly irregular and scattered. It is caused by surfaces surrounding the enclosure creating echoes of sound waves. There are simulators that try to implement this frequency response irregularity. **Boss TM3** cabsim is a faint attempt of such an implementation. Its schematic and frequency response:

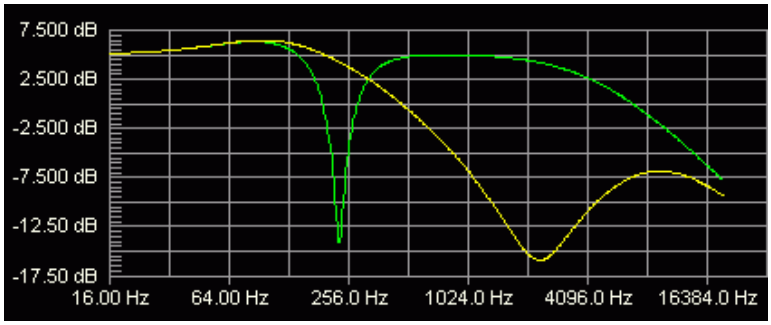


MP2 preamp by ADA has a possibility to to switch on or off additional Notch filters. The schematic available in the Internet can be hardly read, but our colleague RRysiek managed to draw the cabsim part. His schematic and modifications suggested by him can be found here. Below there is a frequency response:

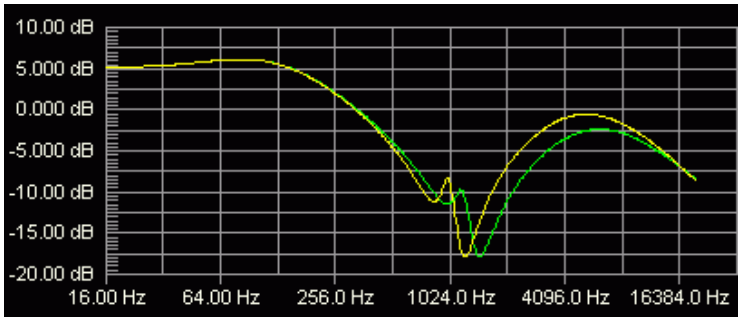




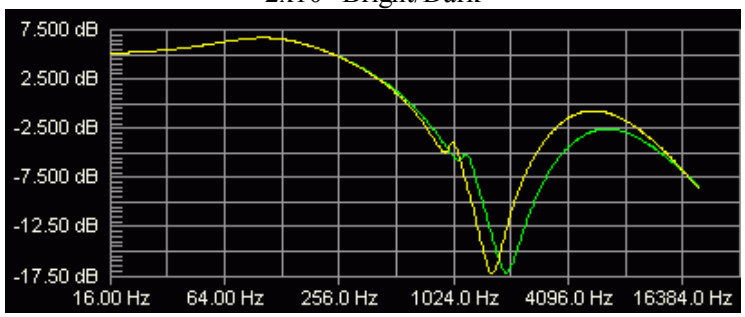
Another quite interesting circuit that provides vast modification possibilities is the **Varicab** module used in **ADA** amps. Electronically (schematic) it's a set of gyrators + two additional low and high pass filters. According to the manufacturer, the circuit offers simulation of all the common guitar cabinet types: 1x12", 2x12", 2x10", 4x12". Let's take a look at the frequency response diagrams:



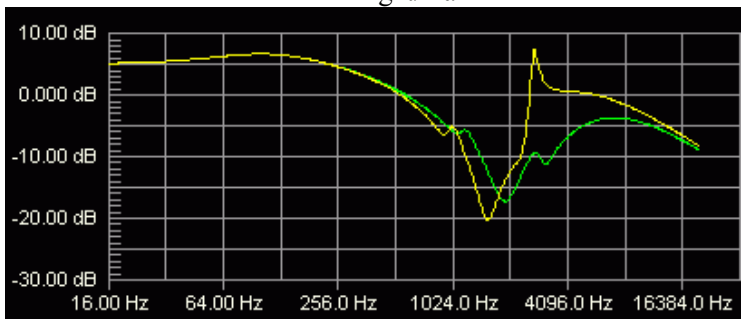
1x12" Bright/Dark



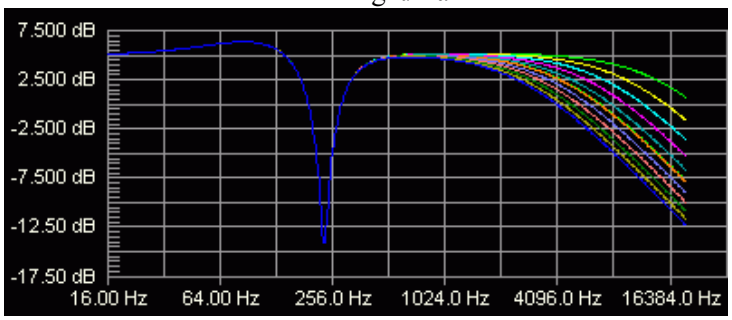
2x10" Bright/Dark



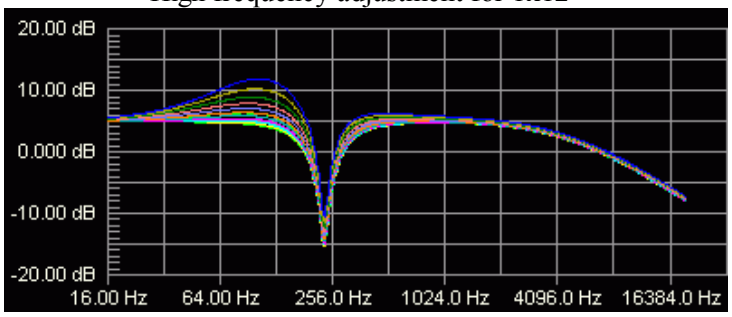
2x12" Bright/Dark



4x12" Bright/Dark



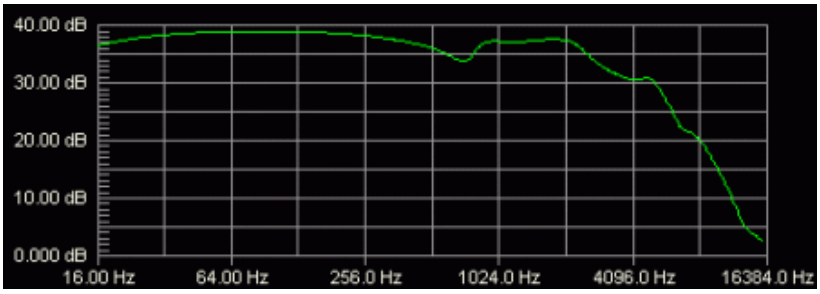
High frequency adjustment for 1x12"



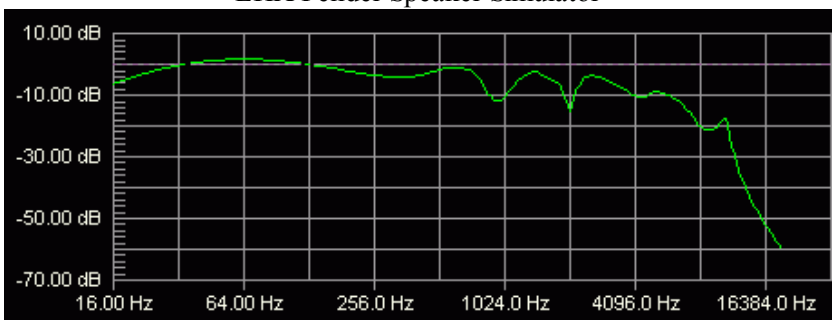
Thump adjustment for 1x12"

And finally two "cherries on the cake" - the most complex circuits that most accurately simulate the speaker enclosure's frequency response. These are devices designed by guys from LHX2 Web site. Please visit their Web site for details. The circuits simulate the sounds of two main brands: Fender and Marshall. Shown are the frequency responses of these

simulators. Slightly modified Fender Cabsim circuit can be heard in sound sample of C-Monster effect (external cabsim). Again, electronically the cabsims are constructed of various multi-feedback filters.
I personally tested only the "Fender" version and without changes it sounded too dark. It's no wonder, it was designed to work together with the preceding circuit that simulated the preamp. After few changes in high pass filters it sounded much better (in my opinion :-)).



LHX Fender Speaker Simulator



LHX Marshall Speaker Simulator

That's all for now folks, although it's not the end. If some new interesting circuits appear, I will check them thoroughly and the report will be extended.

... and the speaker simulation saga continues.
A nice people at runoffgroove.com came up with their own design, a 4x10' speaker simulator called Condor. Check out the whole article on their site.

ADA Ampulator - the schematic is available thanks to the ADA Depot site.

I decided to examine my Korg Pandora PX4D, which delivers some quite good speaker simulations. Here are the frequency plots of the CAB section made with Tombstone software:

- 1x8TWD
- 2x10BLK
- 4x10TWD
- 1x12TWD
- 1x12VOX
- 2x12BLK
- 2x12VOX
- 4x12VOX
- 4x12CLS
- 4x12MDN
- 4x12VIN
- LA4x10 Bass
- MDN4x10 Bass
- MTL4x10 Bass
- CLS8x10 Bass
- UK4x12 Bass

- STU1x15 Bass
- JAZ1x15 Bass
- AC2x15 Bass
- US2x15 Bass
- UK4x15 Bass
- LA1x18 Bass
- COMBI Bass

NEWS:

22.03.2011 NEW
- Bass Engine - new DIY project coming soon

09.01.2011
- BitCrusher III on bass - new video

07.12.2010
- Roboduck III - new version
- Spacetime Modulator - new custom pedal

15.11.2010
- Wolfshade Chorus - new custom pedal

17.09.2010
- Den Agnostiske Fuzz - new custom pedal

11.08.2010
- reVOLVER desktop version - demo video

07.08.2010
- Night Train Overdrive DIY - demo video

08.07.2010
- SE33 Speaker Emulator - new DIY project
- Scream Machine - new DIY project