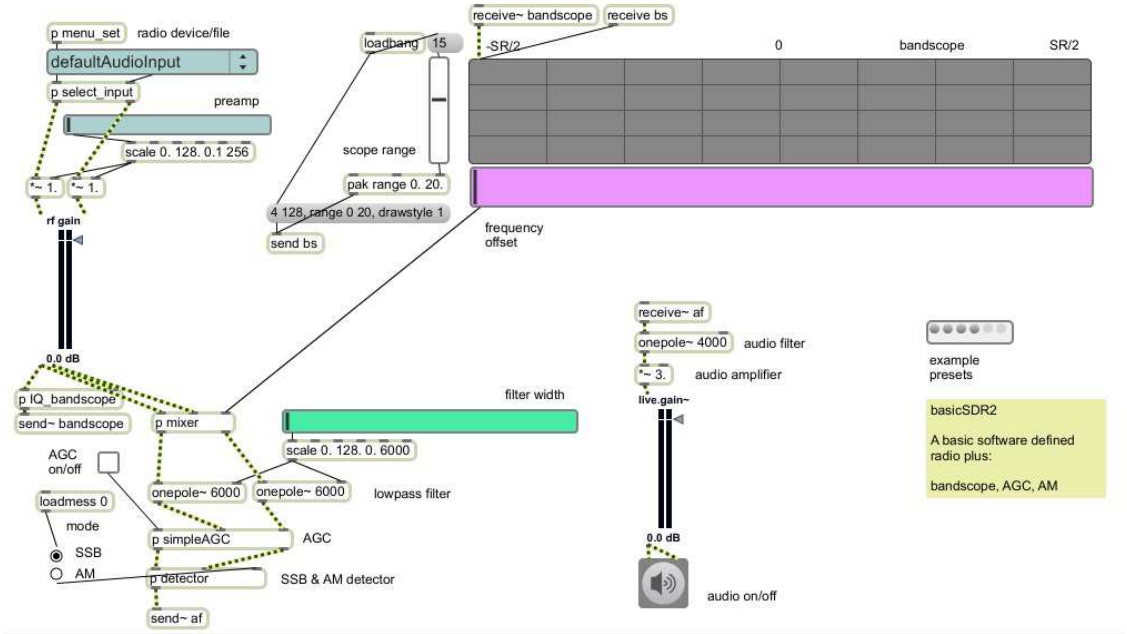
Software Defined Radio in Max/MSP

Tutorial 2 – Preamp, Bandscope, AGC, and AM

November 17th, 2011

For hardware setup information please refer the first tutorial in this series.

Open the patch: **basicSDR2.maxpat**



Probably the first thing you'll notice is this patch 'looks' like a classic software defined radio. The horizontal bandscope sets SDR receivers apart from their analog ancestors. The bandscope lets you see the whole band.

Click the speaker icon [ezdac~] to start the audio. Then click on the first tiny example preset button to hear an AM broadcast station. Reduce the filter width and tune the frequency slider to the signal that's visible on the right side of the bandscope. Q: Why is another station playing the same song? A: Because it's the same station. The signal on the right is an image that appears equidistant and opposite of the actual signal. It's caused by improper balance between I and Q signals in the hardware front end.

Click the second preset to hear a 'Numbers' station similar to the one in Wilco's "Yankee Hotel Foxtrot". Try adjusting the scope range slowly up and down. Toggle the AGC. And finally, try changing the mode from SSB to AM. It should sound like someone speaking with a mouthful of food. SSB signals sound that way because they lack the carrier and one sideband of an AM signal.

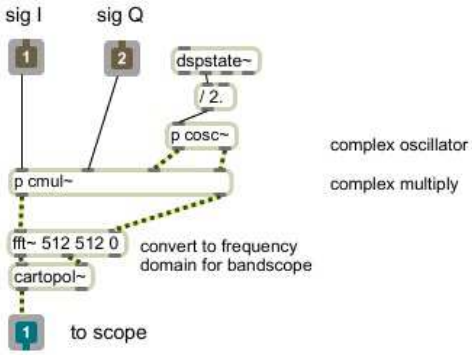
The third preset is an annoying digital signal. Click on the fourth preset and toggle the AGC again while the signal is present. How does AGC affect loud signals?

Preamp

At the beginning of the signal path you'll find a [slider~] labeled 'preamp'. The preamp boosts or attenuates incoming signals to a reasonable level.

Bandscope

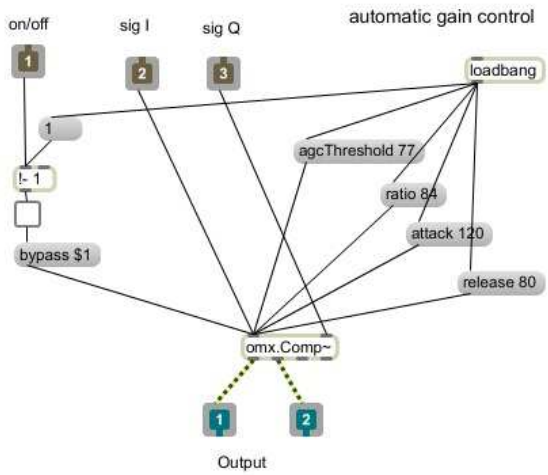
The bandscope uses [fft~] to display signals in the frequency domain. Look inside [IQ_bandscope].



Note the similarity to the mixer patch. In an audio Fourier transform frequencies above SR/2 fold back and mirror the actual frequencies. With IQ signals, negative frequencies represent half the bandwidth. After the Fourier transform, signal amplitude is calculated by [cartopol~] and sent on to [scope~]

AGC

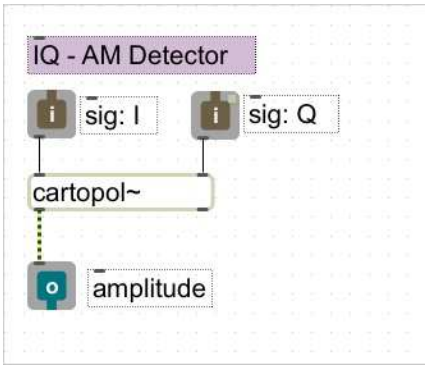
Automatic Gain Control (AGC) is equivalent to audio compression with makeup gain. Like classic Red Hot Chili Peppers CD's, the volume remains the same; quiet signals get louder – loud signals get quieter. Look inside the [simpleAGC] subpatch.



It's just a wrapper for [omx.Comp~]. Without AGC, listening to radio is a painful experience. But it can be difficult to find the right AGC settings. High end radios allow infinite adjustment. AGC usually occurs after filtering so it doesn't get triggered by strong signals in the passband.

AM Detector

A detector extracts information, like music or speech, from a carrier signal. [cartopol~] calculates the amplitude of an IQ signal. Most AM detectors also include a high pass filter to remove the carrier and a low pass filter to remove high frequency artifacts of detection.



What's Next?

In the next tutorial, look for an FM detector and a bunch of filters. Please send comments and questions to radio@zerokidz.com