

Transistor/Diode Phase Shift Ladders

Thanks again to Jurgen Haible for publishing his excellent work. Much additional research could not be carried on without his generosity.

It is possible to make a variation on the Moog ladder filter that can be used as a phase shifter. The Aries Model 329 Phase Shifter ([Schematic 275K](#)), Tau Systems Model 1190 "The Pipe" ([schematic and manual in pdf 516K](#)) (Thanks to James D. White for pdf) and ARP Quadra phase shifter ([Schematic 100K](#)) use this ladder design.

The Aries unit is a 10 stage phaser (5 notches, 20 transistors?). The Tau Systems unit is said to be 20 stages (10 notches, 40 transistors?) but has a lot of popcorn noise. I seem to have lost the Tau schematic, but the Aries unit is much quieter and has more features. From memory, the current drive sections are identical, but the Tau unit adds an LFO on the PCB. The Quadra phaser has 14 stages (7 notches, 28 transistors). There is a practical limit to the total number of stages caused by the intrinsic voltage drop of the transistor/diode. Assuming 600mv for each diode, there is probably a practical limit of about 40 stages (20 notches) using +/-15 volt supply. It is possible noise could become a problem as the number of stages increases.

The only published information I can find on the actual ladder topology is contained in Jurgen Haible's phase shifter design located at:

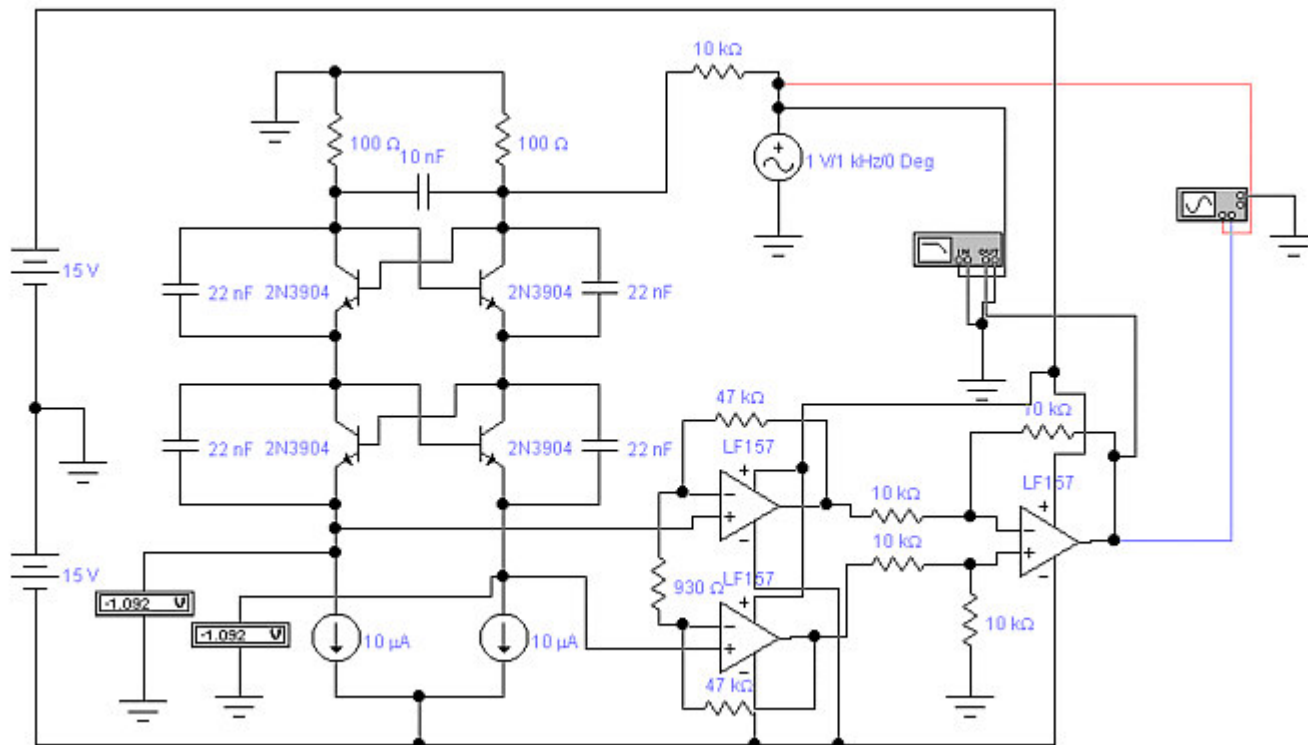
http://www.oldcrows.net/~jhaible/tonline_stuff/hj_qph_2.gif

As an experiment, I tried simulating a couple of sections from Jurgens design in Electronics Workbench, a SPICE program variant. This is a second set of simulations with gain set to unity. Thanks to Don Tillman for pointing out the capacitor value error in the first set. I thought Jurgen would be amused and the diode only topology is rather interesting. Opening the collectors increases the attenuation of the ladder. Connecting the collectors to the base make no difference under simulation.

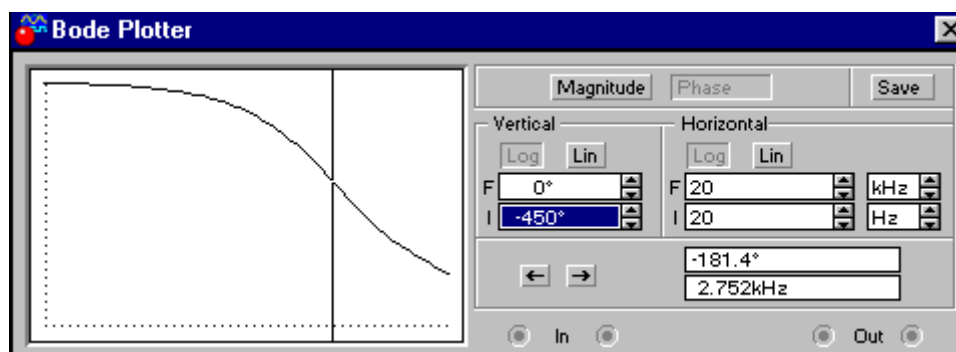
The results seem to confirm differences in ladders built from transistors and those from diodes only. Presumably, this would apply to lowpass topologies also.

Comments are welcomed at griechter@asapnet.net

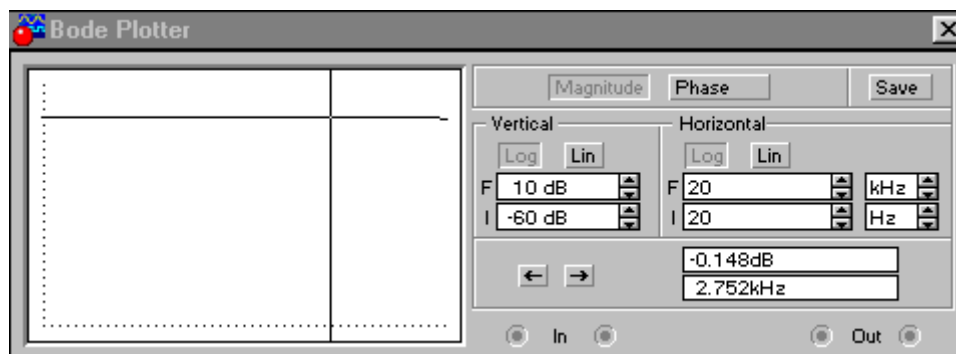
Phase and frequency plots from design simulation most similar to Jurgen's original ladder, All plots are 20Hz to 20Khz



Schematic of simulation

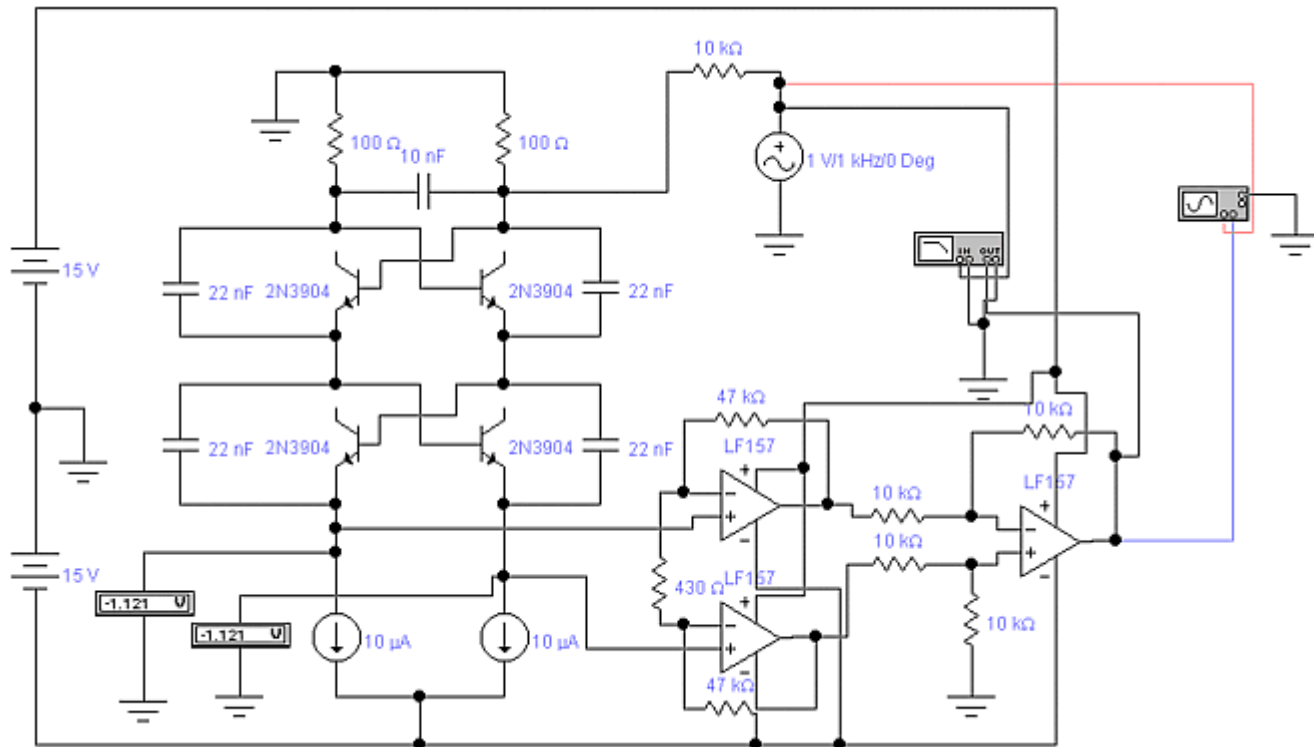


Phase Response

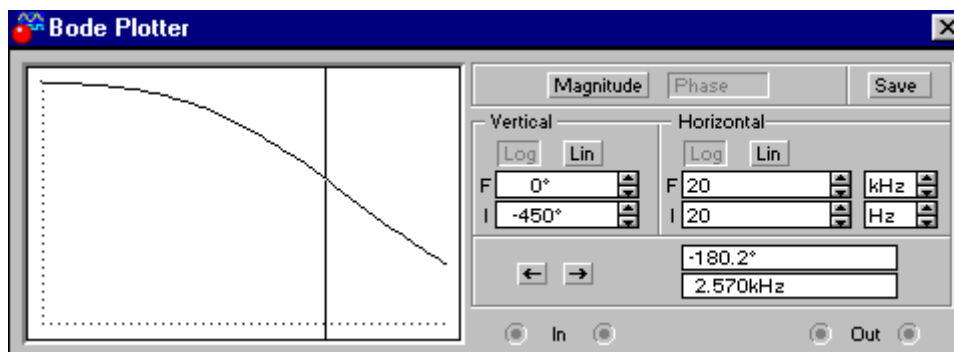


Frequency Response

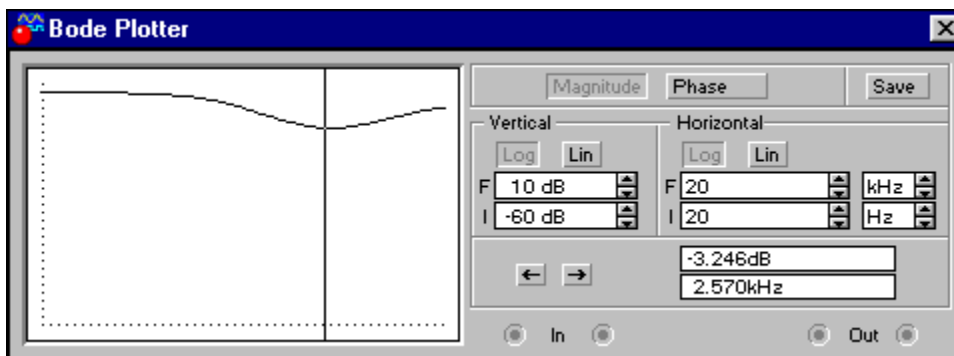
Phase and frequency plots from design simulation with collectors disconnected, All plots are 20Hz to 20Khz



Schematic of simulation

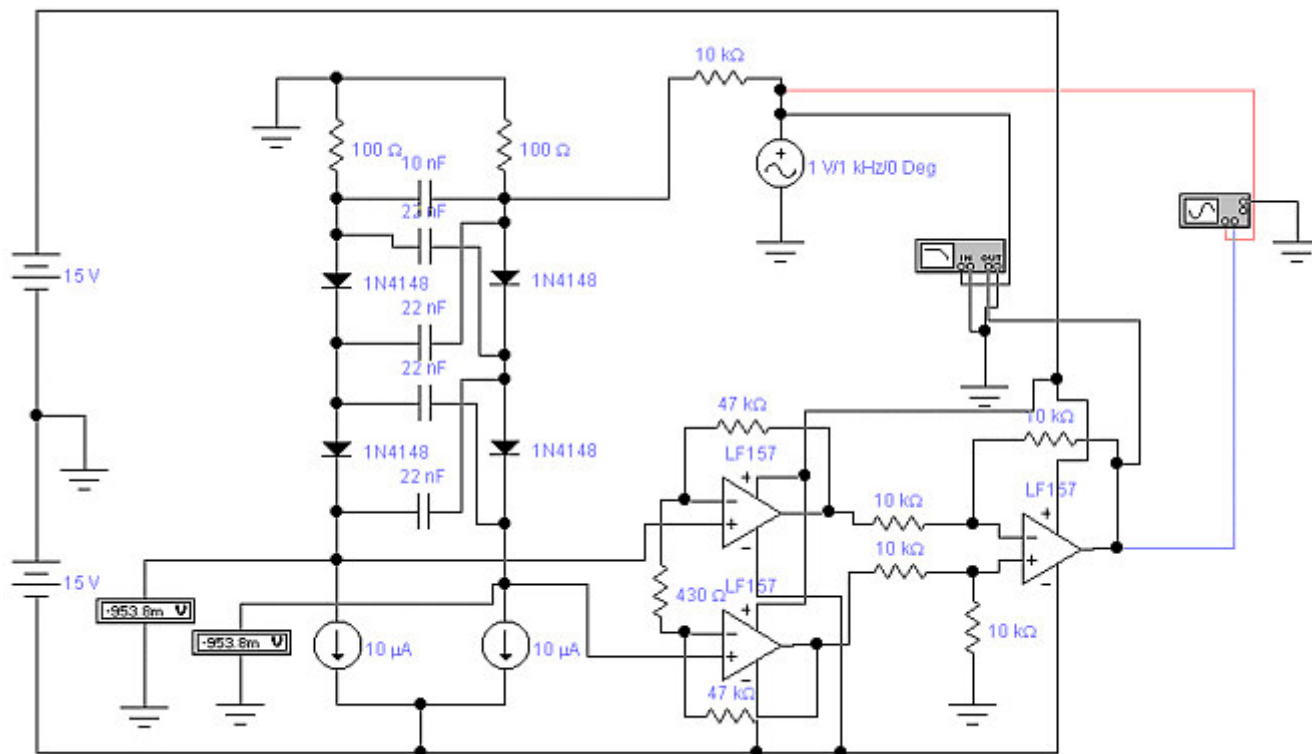


Phase Response

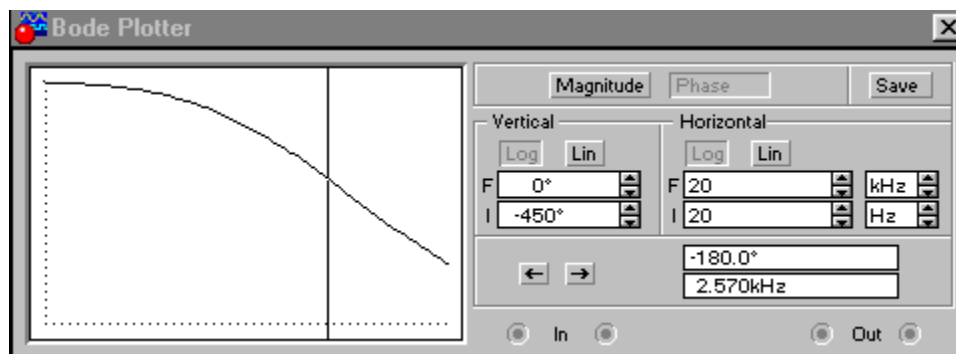


Frequency Response

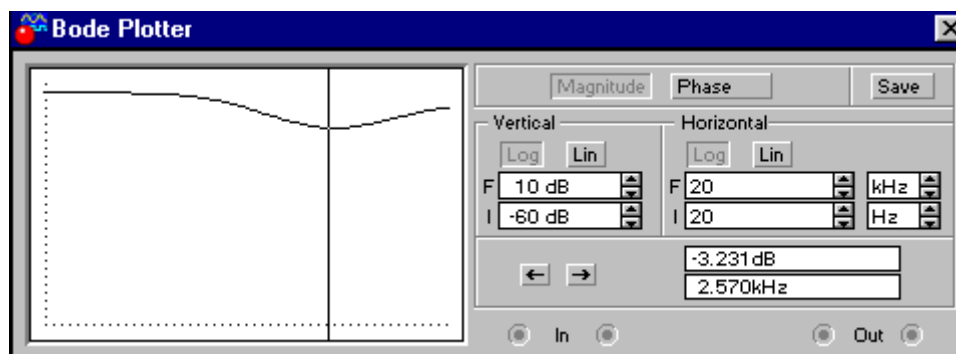
Phase and frequency plots, schematic rearranged to show diode only topology equivalent to open collector, All plots are 20Hz to 20Khz



Schematic of simulation

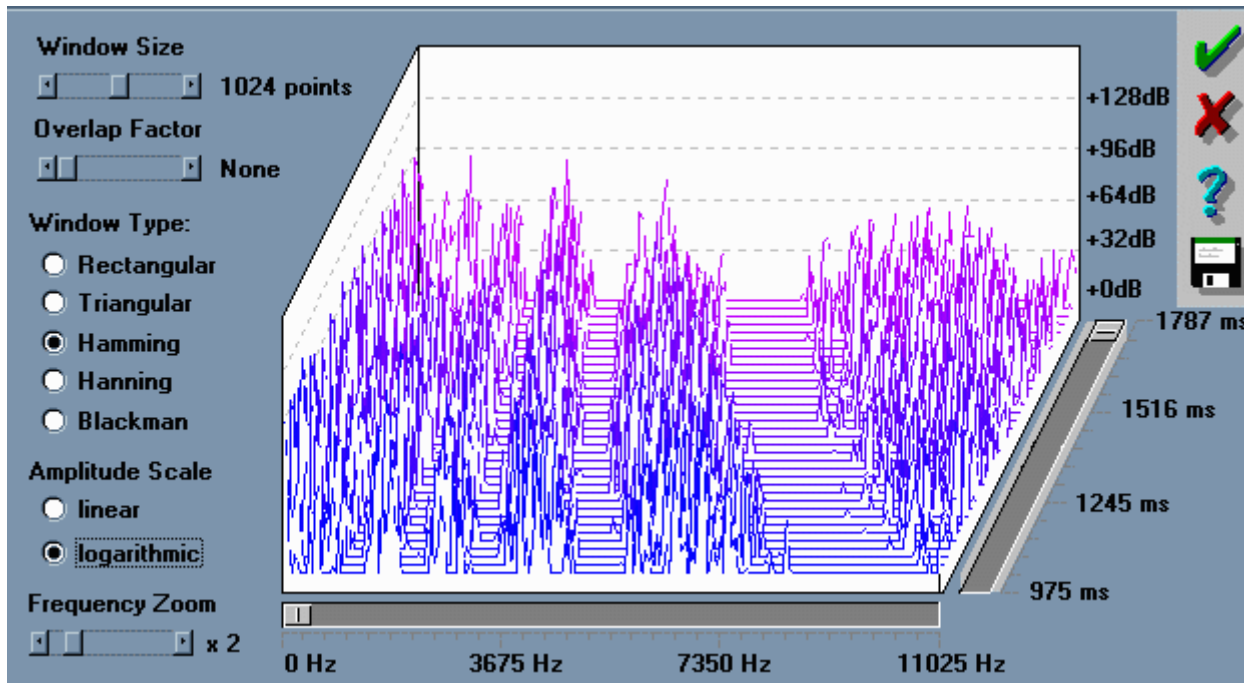


Phase Response

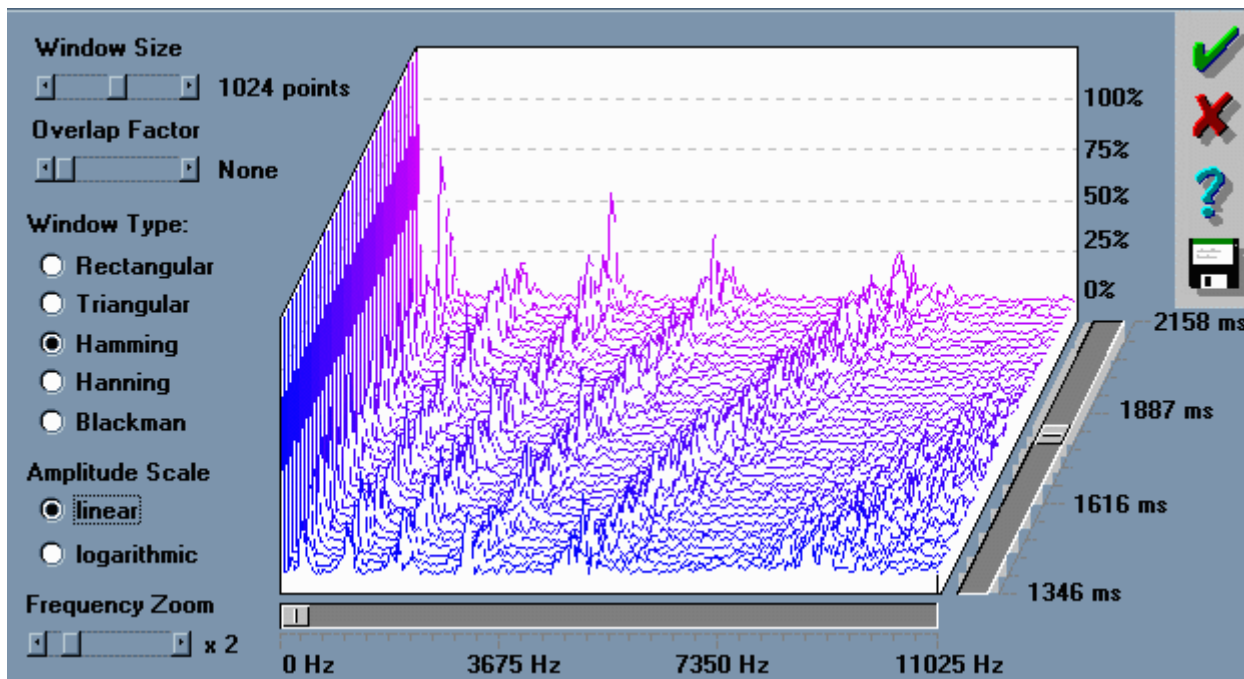


Frequency Response

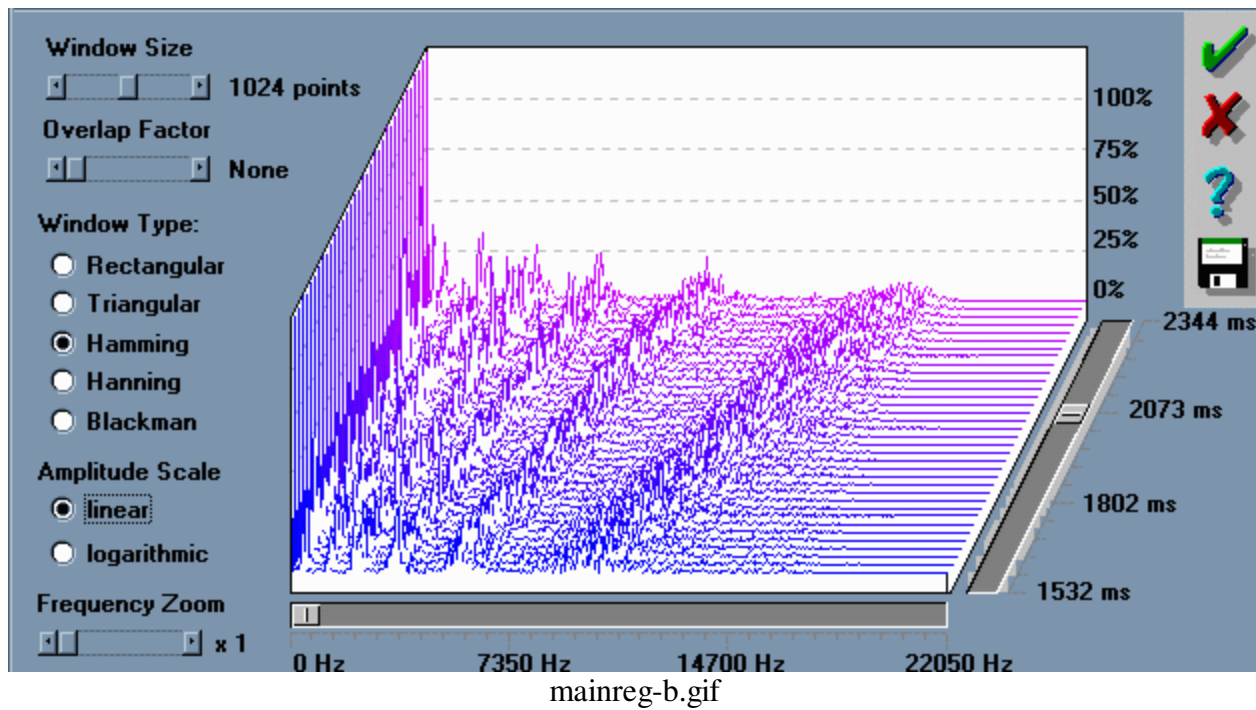
Thanks to Mike I. for the Arp Quadra Phaser schematic and these spectral plots of the Quadra phaser frequency response



auxnores.gif



mainreg-a.gif



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