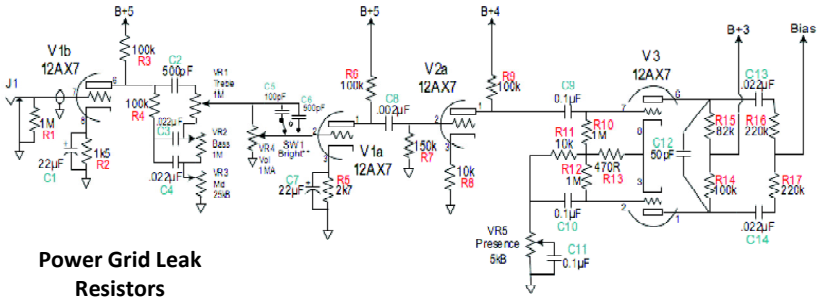
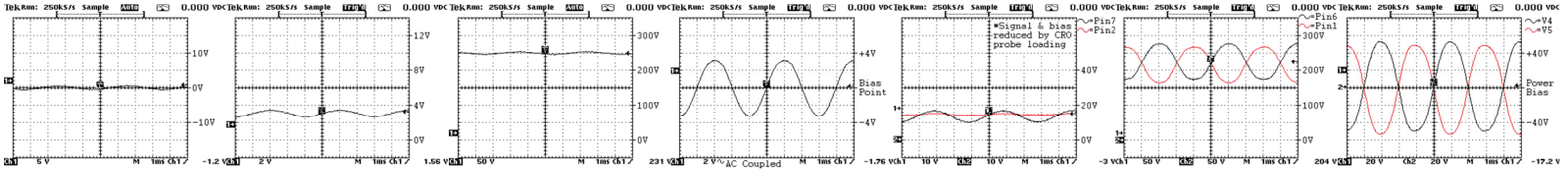
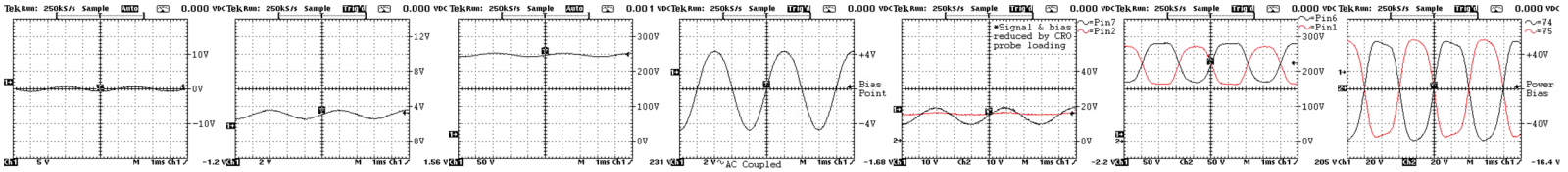
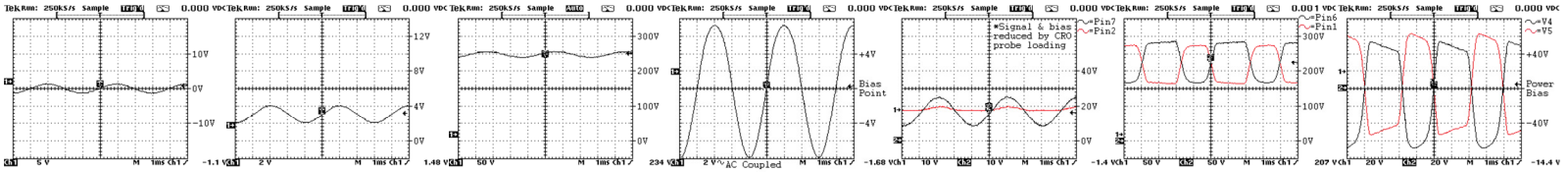
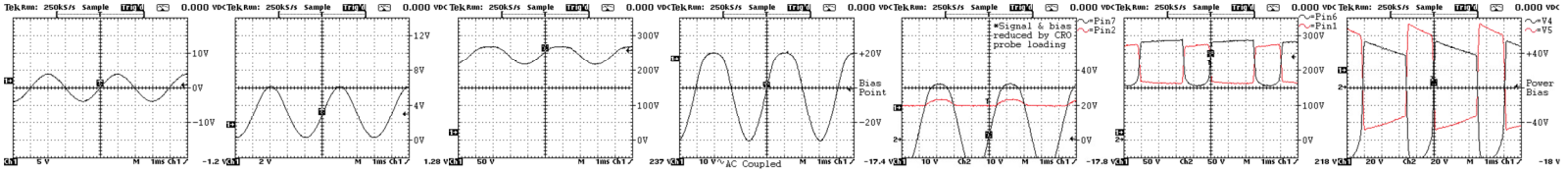
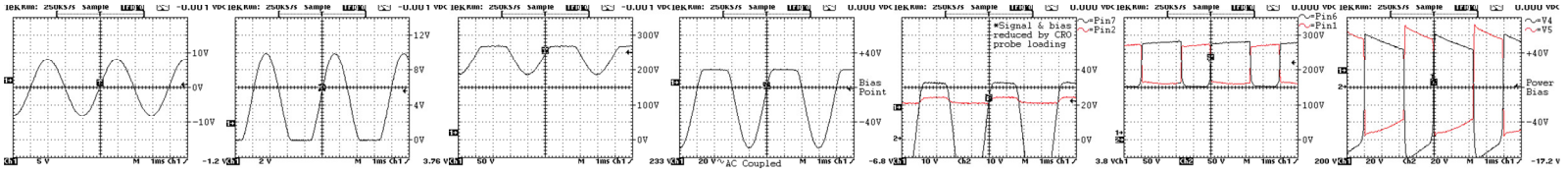
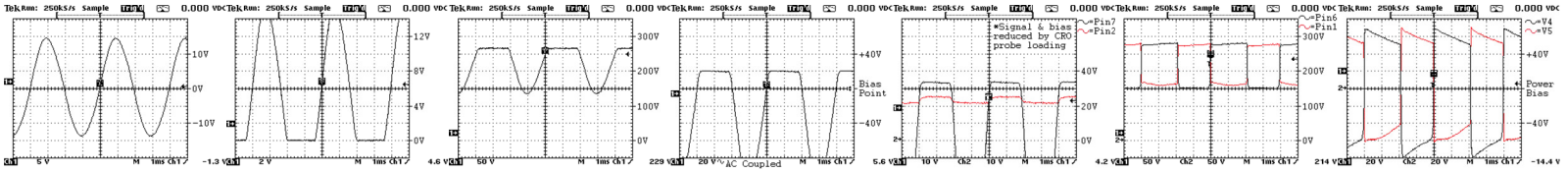
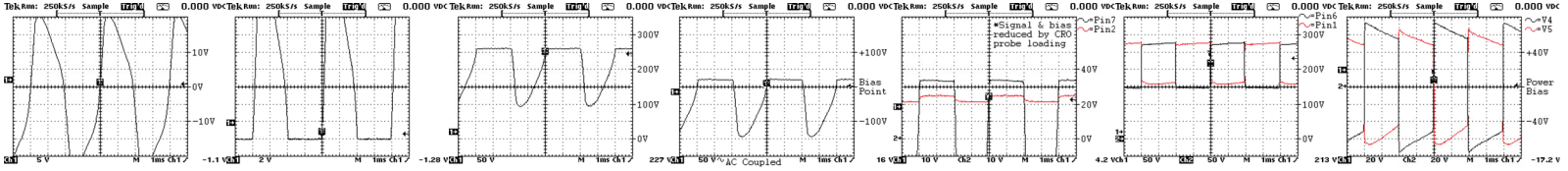
TW Express 3rd Stage & PI Waveforms

Waveforms tested with an Express preamp & PI at standard idle power supply voltages. 6N2P valves were used in place of 12AX7, which give an equivalent response. 1k5 power valve grid resistors were disconnected from PI output and 220k grid leak resistors to show the PI behaviour without power grid clipping. With the power stage connected supply sag will give a corresponding drop of waveform magnitude compared to the shots below. Also power valve grid clipping will load and change the PI output waveform. 250Hz test signal used. Measured with a Tektronix THS720P oscilloscope and captured with the Wintek32 program.



3rd Stage Grid	3rd Stage Cathode	3rd Stage Plate	3rd Stage Plate Zoomed	PI Grids	PI Plates	Power Grid Leak Resistors
						First test signal level has a clean output for both the preamp and PI. This PI output level would be enough to be a have a bit of power grid clipping. The speaker output would be evenly clipped and symmetrical.
						PI input from the 3rd stage is enough on the negative swing to take PI V3b into cutoff shown by the flat positive peaks on the plate pin 6. V3a has a corresponding flat negative peak on the plate pin 1 because of that side's inability to draw grid current from the tail through C10. The speaker output will still be symmetrical but with more clipping.
						Positive side of the signal into the PI is now large enough to cause grid clipping at the PI input. The 3rd stage plate isn't showing much of the effect of this clipping, but you can see the small positive bumps appearing in the PI pin 2 from the PI grid current feeding into the tail and raising the tail voltage. With a small amount of PI grid clipping, coupling cap C9 has charged up a small amount and pushed the signal on PI grid pin 7 down a little. This shift in the centre point of the PI input signal results in the assymetry seen from the PI plates onwards. We are now seeing a difference in height of the power grid leak resistor signals from shifting voltage across both C13 & C14.
						PI grid clipping drawing current is now more evident. The positive bumps on the tail feeding into PI pin 2 are larger and the loading effect of drawing grid current causes smooth clipping the top of the 3rd stage plate signal. But the 3rd stage is not yet in cutoff, shown by the 3rd stage cathode signal not yet reaching down to 0V. Now there is a definite height difference between the two power grid leak resistor signals. Looking at speaker output waveforms posted elsewhere at this point the V4 side is below the power valve clipping threshold and dominated by PI distortion and the V5 side is driven hard into power clipping.
						3rd stage is now driven into cutoff shown by the 3rd stage cathode going down to the 0V line. The 3rd stage plate signal is starting to square up at the top which starts to reverse the assymetry seen on the PI output.
						Driving the 3rd stage further into cutoff, but it's not grid clipping yet as seen by the clean 3rd stage input and no clipping on the bottom part of the 3rd stage plate waveform. But the top of the 3rd stage plate signal has squared up so much here that the PI output is symmetrical again. The symmetry causes the voltage across C13 & C14 to even up again and the power grid leak resistor signals return to being the same amplitude. Both sides are above the power grid clipping threshold again and the speaker output would have the flatter and same amplitude power clipped characteristic both top and bottom.
						The input has got to the point of distorting the previous preamp stages, shown by the distorted 3rd stage grid signal. The 3rd stage plate signal shape is now actually driving the balance back the opposite way to what we see above. The effect is slight but the power grid leak resistor waveforms are very slightly asymmetric in duty cycle and height in the opposite way to before. This level of signal is only really on the peaks of a normal guitar output, and the amp dynamics are slow enough to not show this effect under normal use.