PCB's - Do They Affect Guitar Tone More Than PTP Wiring?

In a recent article published in Guitar and Bass (January 2011 Vol 22 No 04), it was suggested that parallel tracks on PCBs (Printed Circuit Boards) contribute signal degradation caused by fairly high amounts of inter-track capacitance. It was duly supported by nice photos and even an oscilloscope picture of how the tracks contribute to the PCB's 'lofi' solution to manufacturing amplifiers at very attractive cost reduction and with consistantly predictable performance.

I was very surprised by the article's findings and was driven, the very same day that the mag landed on my front door mat, to create the tests myself. This was not an exploration I felt I needed to do in the past. Since if it were true, then most of our modern equipment simply would not work with any degree of accuracy. I took the view that it was yet another attempt to put a few more nails in the coffin of modern reliable manufacturing techniques. As an older guy myself, having worked with guitar amps and military electronics since 1967, you'd usually expect someone like me to agree with it! But I can't... I love moving forward and I'm absolutely excited by Solid State electronics and all the wonderful benefits it can bring to music in general.

Further, I was even more surprised by the fact that this was a 'consumer' magazine intended for non-technical musicians and my first thought was... 'Do they really need to be worried by all this stuff', as interesting as it may be. My experience over the years is that musicians only misunderstand what is being said and resultantly all PCBs will now be automatically crap by default! Now that this article has been published, it will be almost impossible to reverse musician's opinions... after all, a respected magazine published it, so it MUST BE TRUE!

Sadly, the author did not state any values for the main component used to carry out the test... a resistor, which was to represent the highish output impedance of a typical valve that drives signals along the wires and/or PCB tracks to the next group of components in the amplification chain. By this, I presume that the driving valve would be an ECC83 or similar. So to be careful, I selected two values of resistor and repeated the tests twice, with the alternate values. The values were 47k and a 220k resistor.

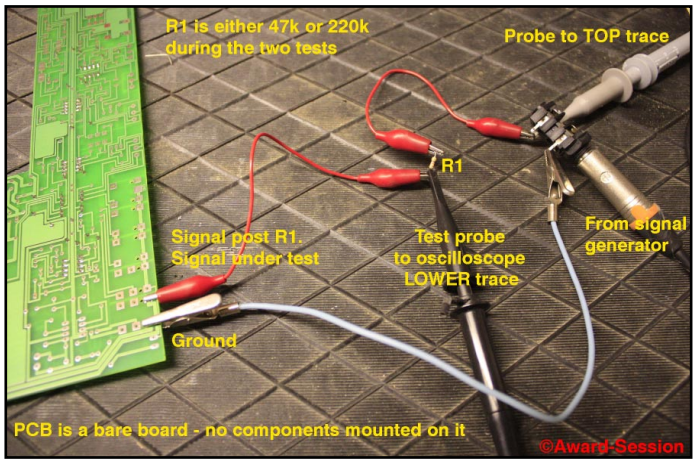
Now, I know that the output impedance of a new ECC83 is about 38k ohms. This means that the valve would be hard put to drive any load much lower than this without imparting volume and tonal detriment to the signal. Ideally, any load would best have an impedance of 100k ohms or more.

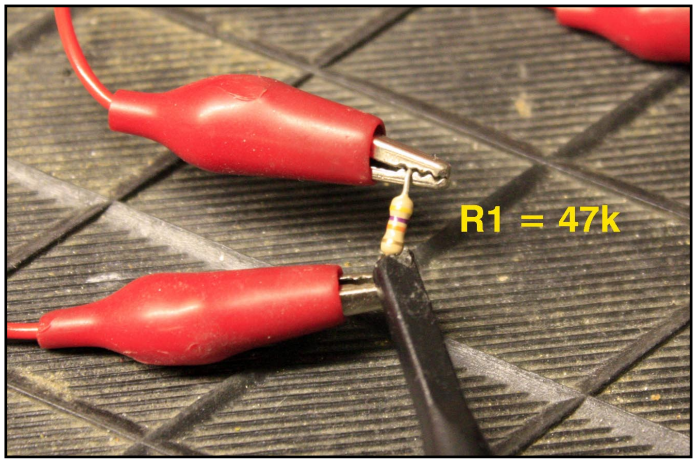
In the first test, I used the 47k series resistor (R1) which is about 20% higher than the output impedance of an ECC83, so it should show results appreciably worse than the valve's 38k! Even so, my findings did not agree with the magazine article.

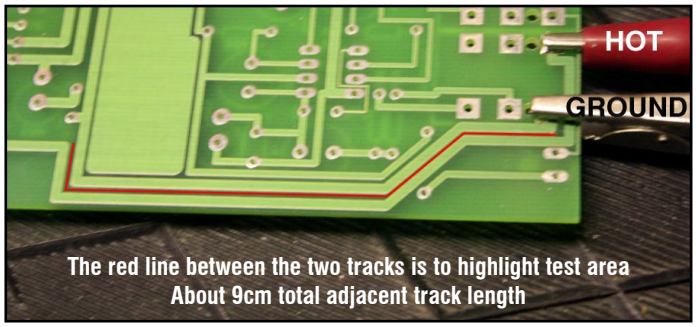
For what it's worth, I don't think that this method of testing such claims is at all reliable using very simple workshop test equipment. Never-the-less, I have recreated the tests in a similar fashion and have not found any reason to doubt the very high standards that PCBs bring to the electronics world.

In fact, my own tests seem to show that any negative results were caused by the test equipment itself. General oscilloscope inputs are at best 1M ohm input impedance... and that's before you attach a test probe. And using a test probe on X1 will always corrupt the signal's image on the 'scope's screen when the probe is attached to a high source impedance signal of this

The circuitry to test the theory







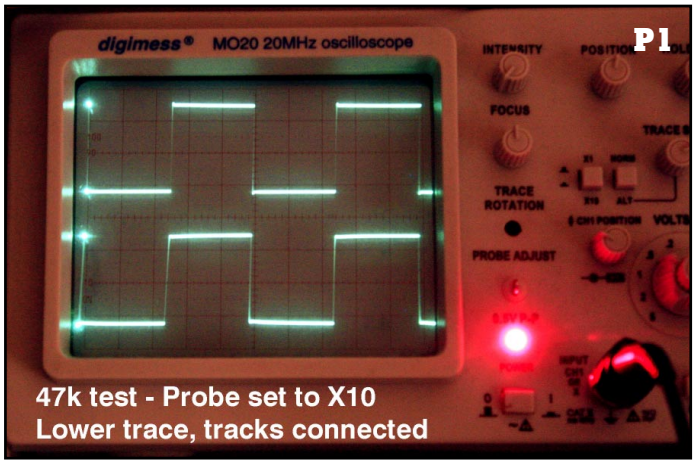
nature. In order to carry out any meaningful test on this kind of topic, technicians need the help of some very expensive and sophisticated Techtronix oscilloscopes with input impedances of 50-100M ohms plus; and suitable test probes that can match that performance too.

Many old hand wired valve amps employ the use of 'looms' to trail the wiring around the chassis in neat order. HiWatt being a 'pretty' example. But those wires tightly bundled together can cause all kinds of 'hairy' performance due to capacitive coupling between signal carrying wires at higher sound volumes. So I can't really say this PTP method is any better. With PCBs, every amp will perform roughly the same! Customers don't want 'hit or miss.'

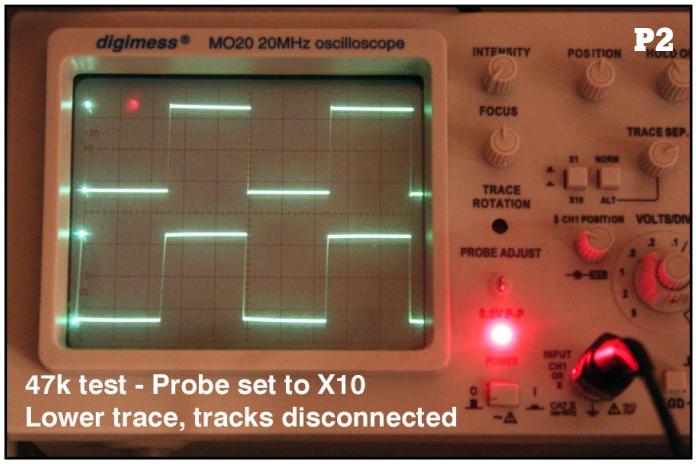
This, to my mind, is just one great big 'Red Herring' and I will not be advising any musicians to tear out their amp's PCBs and replacing them with highly expensive hand wiring at any time soon. Stuff nostalgia, I say!

Cont'd

PCB Tracks Capacitive Loading - My Test Results

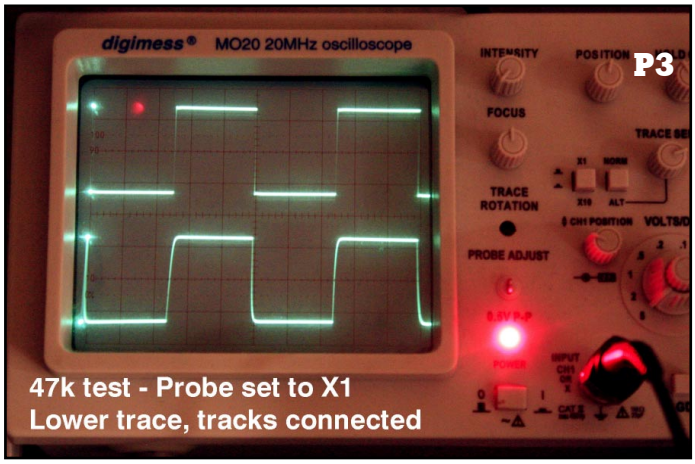


P1 & P2 - Here in the first two tests using a series resistor of 47k (R1) it is important to note that the oscilloscope probe can be set to X1 or X10, where actually, the X10 setting divides the signal amplitude by 10. Also, the impedance of the test probe is greatly increased, so the loading on the signal is proportionately reduced.

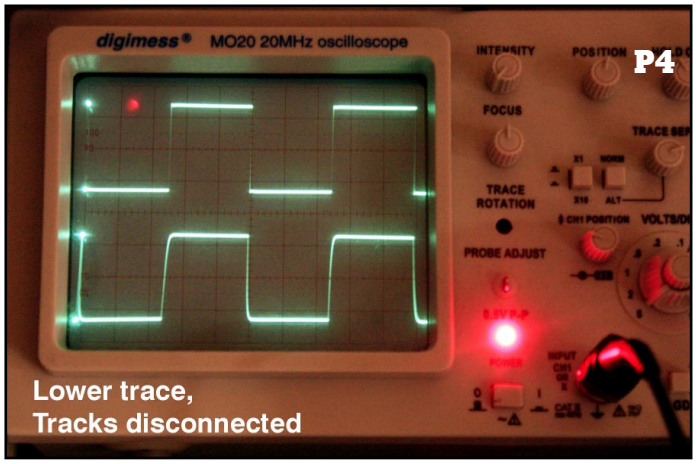


It can be seen in the two oscilloscope photos above, that there is practically no loading of the signals by the probes set to X10. And there is virtually no difference when the the tracks are connected or not.

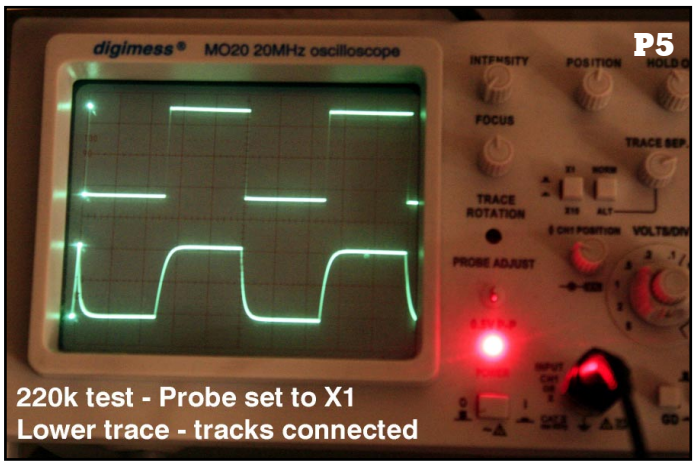
The frequency used for all tests was 1kHz, as the mag article.



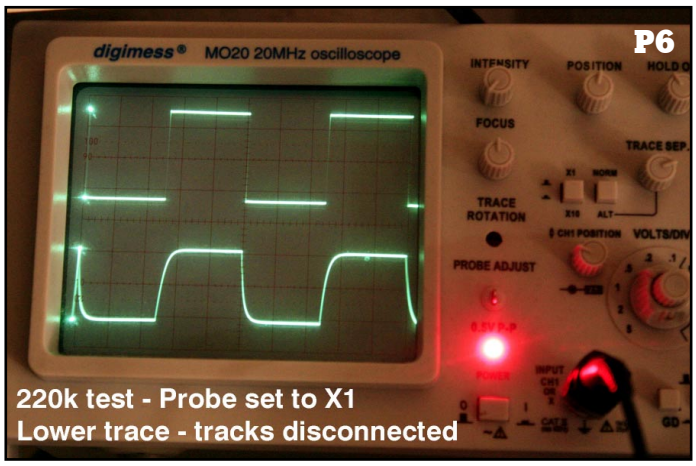
P3 & P4 - In this set of oscilloscope photos, the 'scope probe is set to X1. Most technicians who deal with high source impedance audio signals know that using a 'scope probe set to X1 will give a false trace on the 'scope.



Again, although the signal is affected by the lower impedance of the 'scope probe, there is no visible difference when either the tracks are connected or not to the test circuit.



P5 & P6 - In this set of results, R1 has been raised in value to 220k ohms - a much higher impedance. Therefore, the 'scope probe will have really dramatic influence on the traces displayed. But the images are false due to the probe loading once again.



Conclusion: Throughout these tests, the actual loading put on the signals by the PCB tracks themselves, are probably no worse than equal to the loadings caused by PTP wiring, where wires run in close proximity to each other.