Terminating the RF part of the quad circuit for back-compatibility

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In his comment [1], Bill says that the current on the 1MΩ resistor is about 25 mA and may be problematic as an additional source of noise (See Figure 1 for the circuit). Indeed the current goes above 20 mA initially and then goes down (Figure 2).

Figure 3 shows the original circuit. I simulated this circuit to see the current through the 20 kΩ resistor and the voltage accross the 250 pF quad plate. The values were chosen to give 5 μs time constant. Figure 4 shows that the current through the 20 kΩ resistor maximizes to 1.3A and disappears in 20 μs. It seems approximately the same with the "QUAD BRANCH" of Figure 2, which is obtained from the circuit in Figure 1.

The major problem with the current on the 1 MΩ resistor is the long time constant. It can be shortened by using a small capacitor in series when the RF amplifier is not being used (Figure 5 shows the updated circuit with 10 MΩ resistor and a 1pF capacitor in series). As shown in Figure 6, the current on the termination becomes two orders of magnitude smaller than the current on the quad branch, with a similar width.

Another concern was about the rise time of the voltage on the quad. Figure 7 zooms in the rising time of the quad voltage of the original design and the design shown in Figure 5. They seem quite the same.

Conclusion

In several email exchanges, Bill and Hogan mentioned some concerns about terminating the RF part of the updated circuit with a 1 MΩ resistor. Indeed the current and voltage are not so small, although comparable to the original design. Still, we can make the effect of the termination much smaller by increasing the resistor from 1 MΩ to 10 MΩ and introducing a 1pF capacitor in series to that.

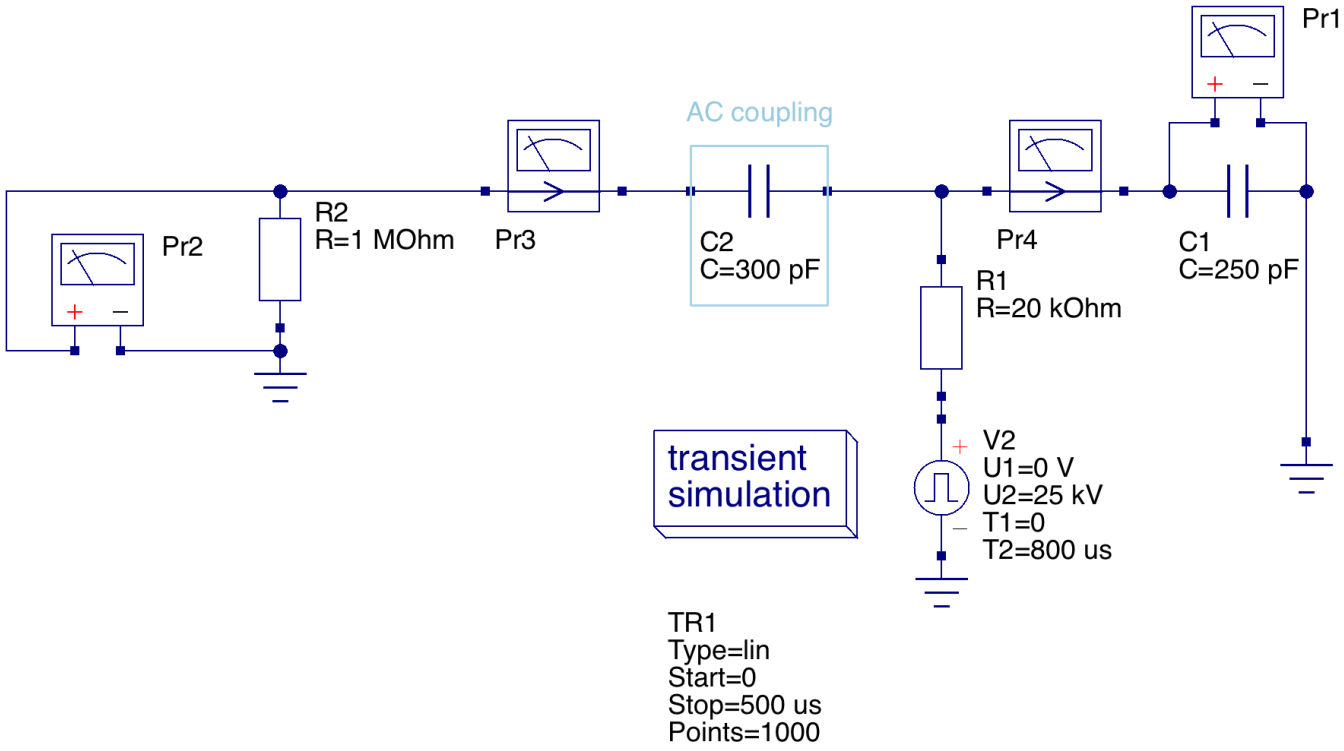


Figure 1: Circuit with the termination (when the RF is not connected).

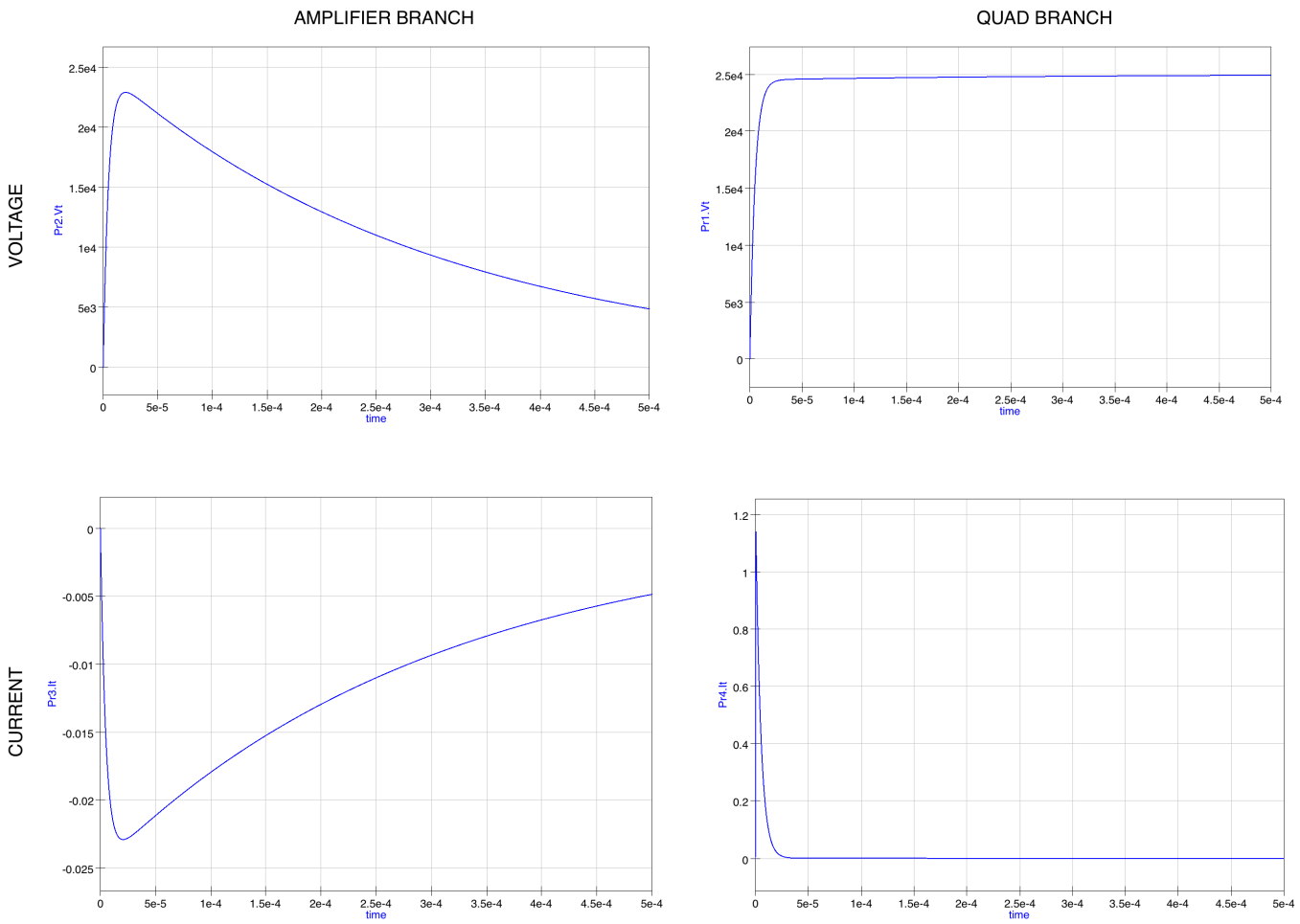


Figure 2: Current and voltage corresponding to Figure 1. Left branch implies AC coupling capacitor and the termination, while the right branch corresponds to the quad side. The left branch has smaller current with a longer time constant. The right branch has bigger current, but lasts shorter. The current on the right branch does not seem to be affected too much by the termination (compare with Figure 4).

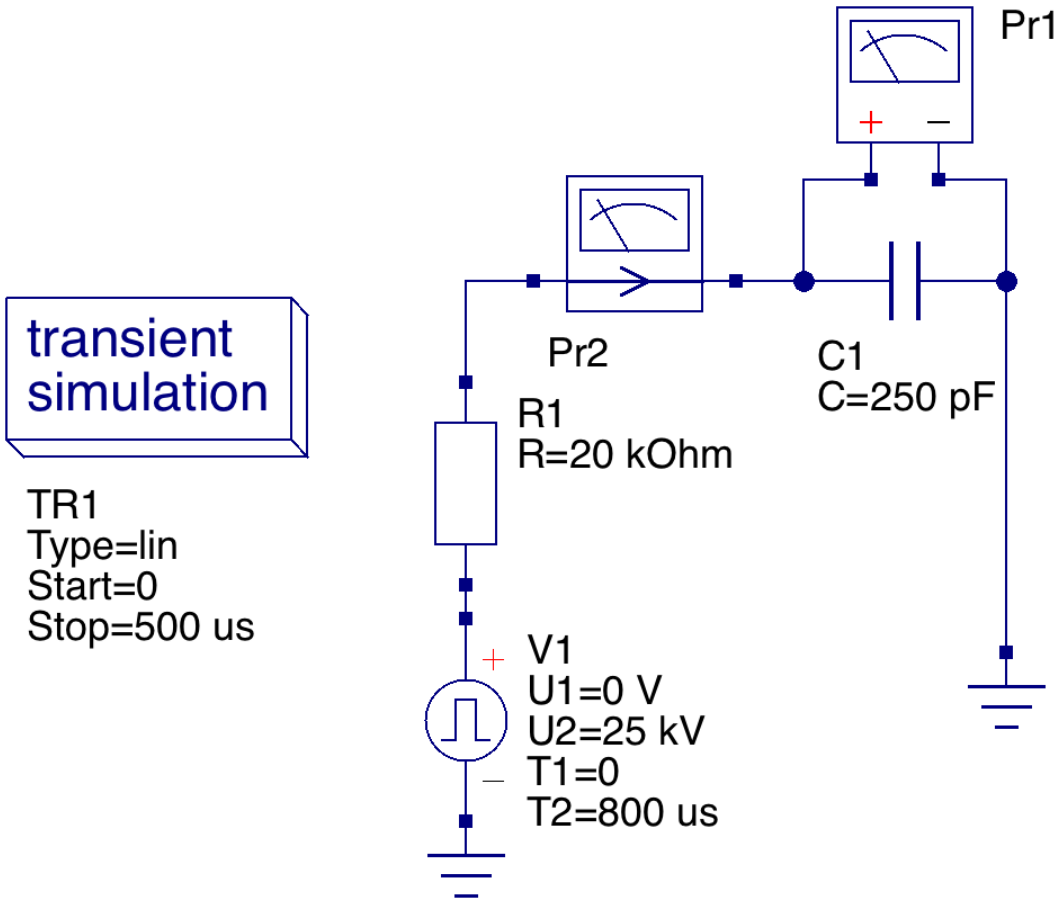


Figure 3: Original circuit without the RF part

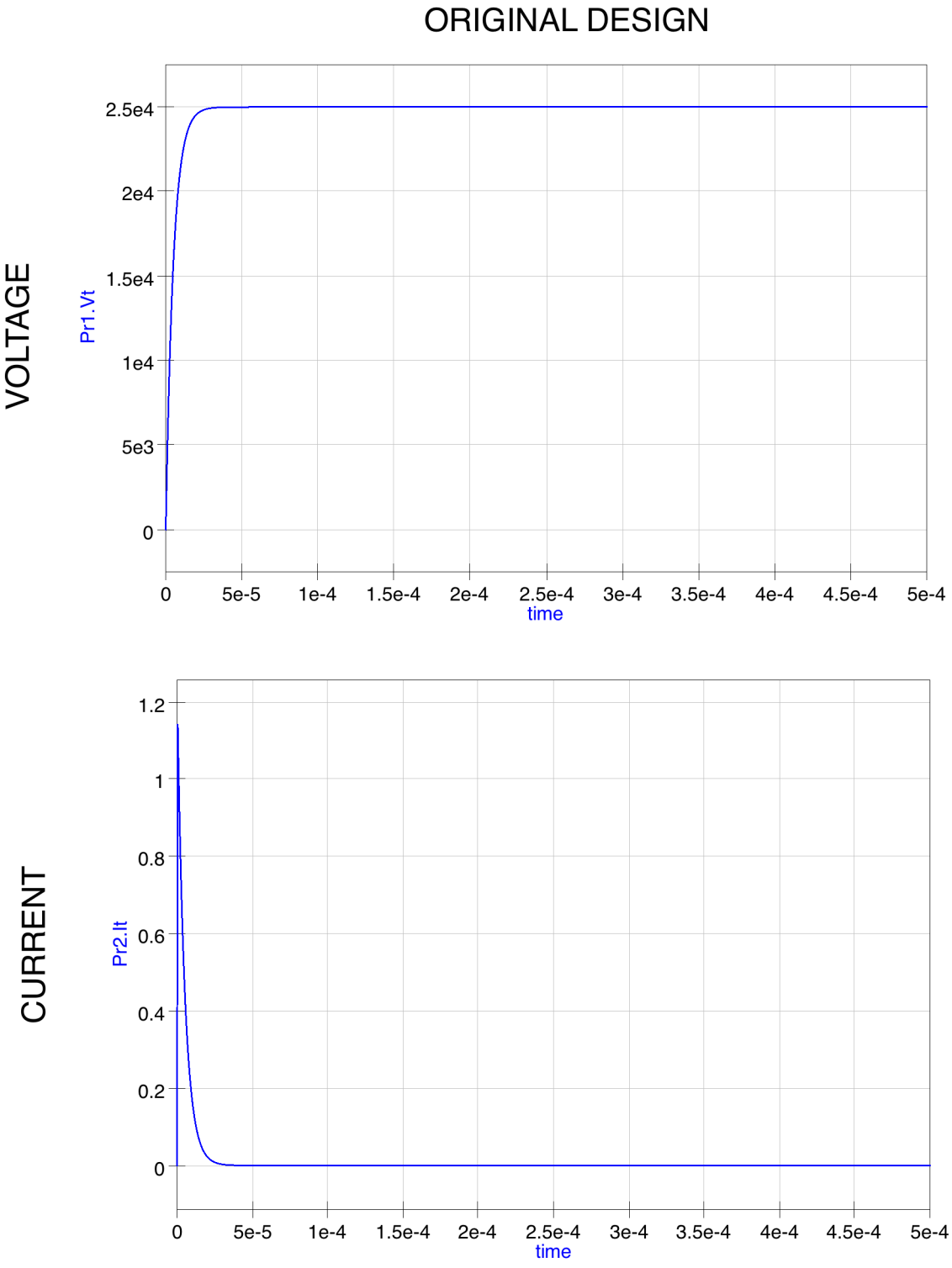


Figure 4: Voltage and current corresponding to Figure 3.

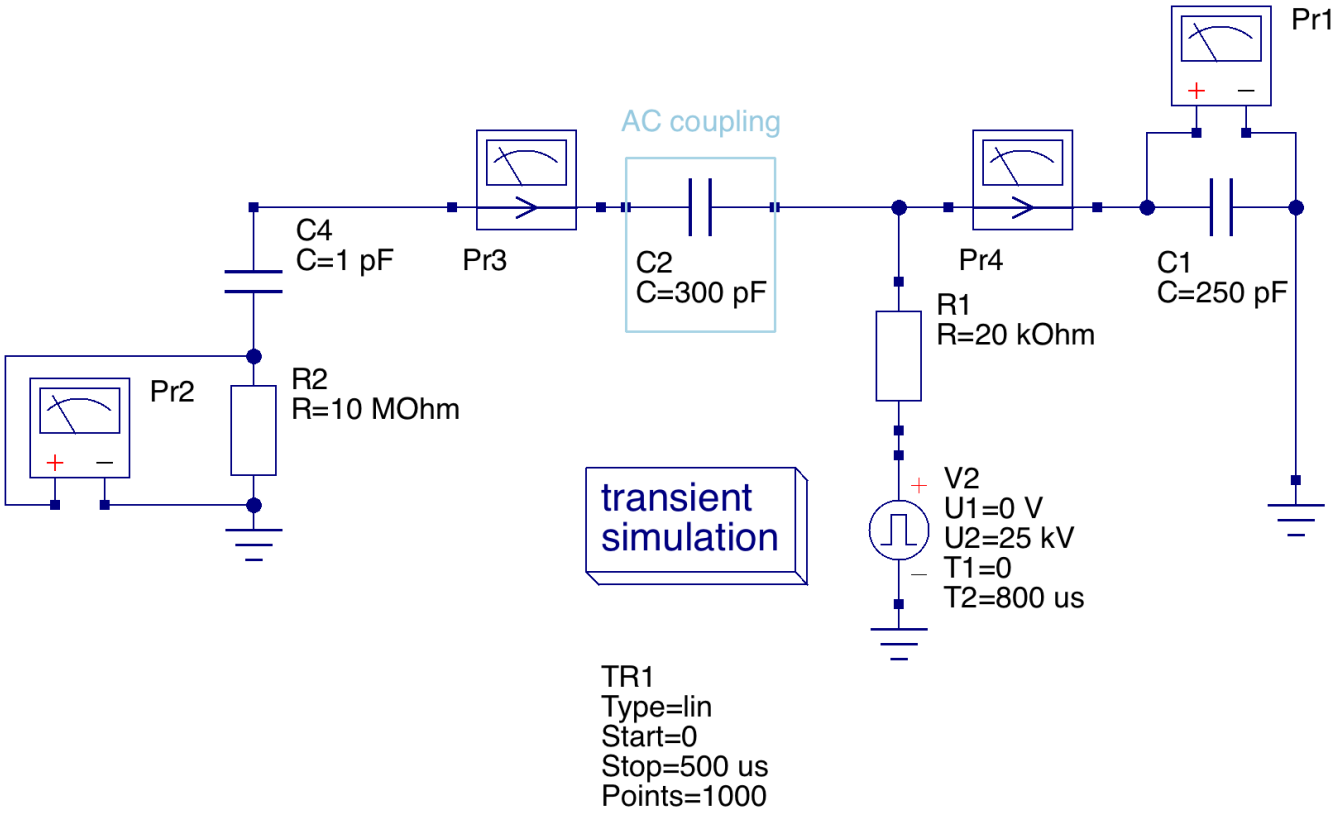


Figure 5: Using a 1 pF capacitor in series decreases the time constant of the current across the 10 MΩ resistor.

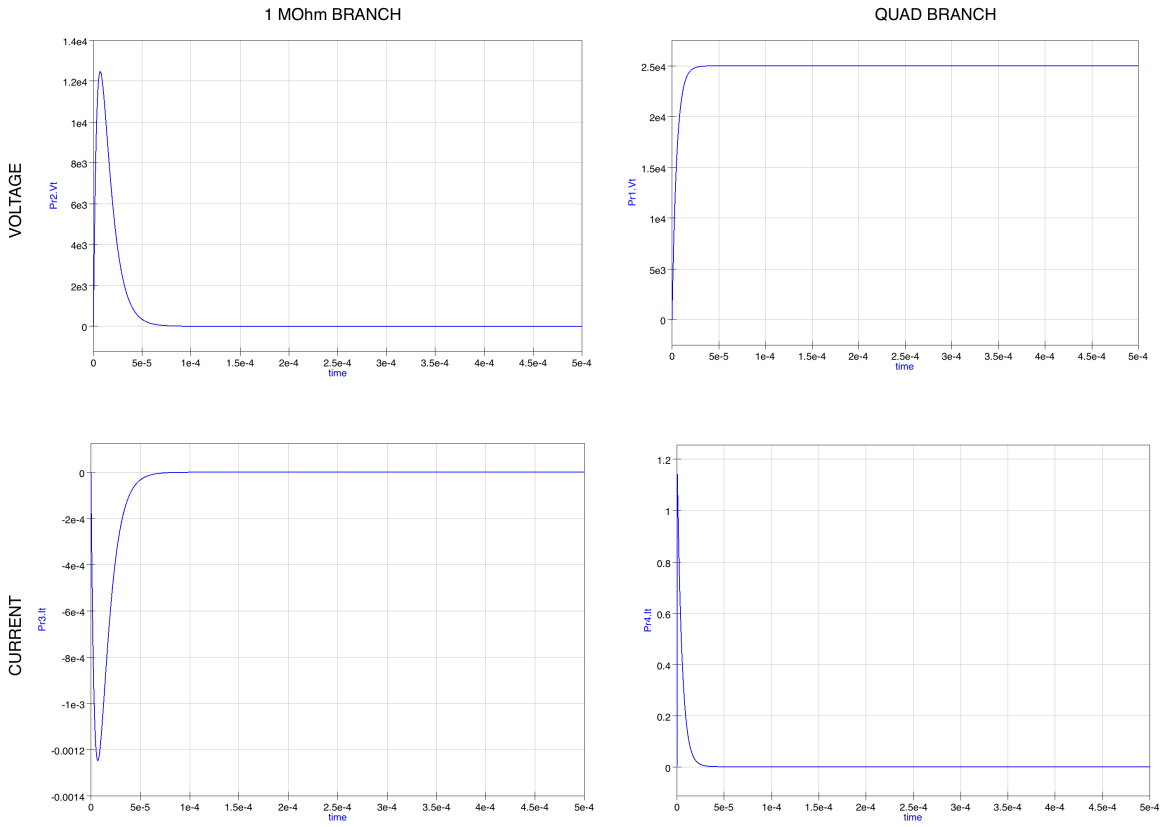


Figure 6: The voltage and current on the quad plate and the 10 MΩ resistor. The current is now a few orders of magnitude smaller compared to the quad branch.

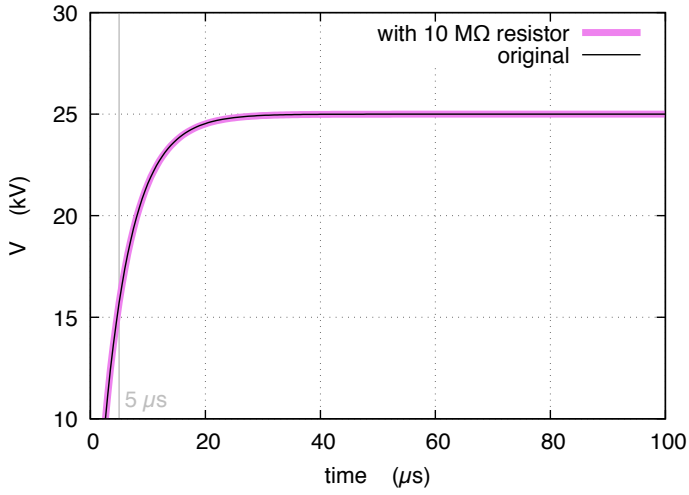


Figure 7: The rise time on the quad voltage is visually identical to that of the design with 10 MΩ, 1 pF termination.

References

[1] W. Morse, *Comments on Selcuk's design*, September 14,2017