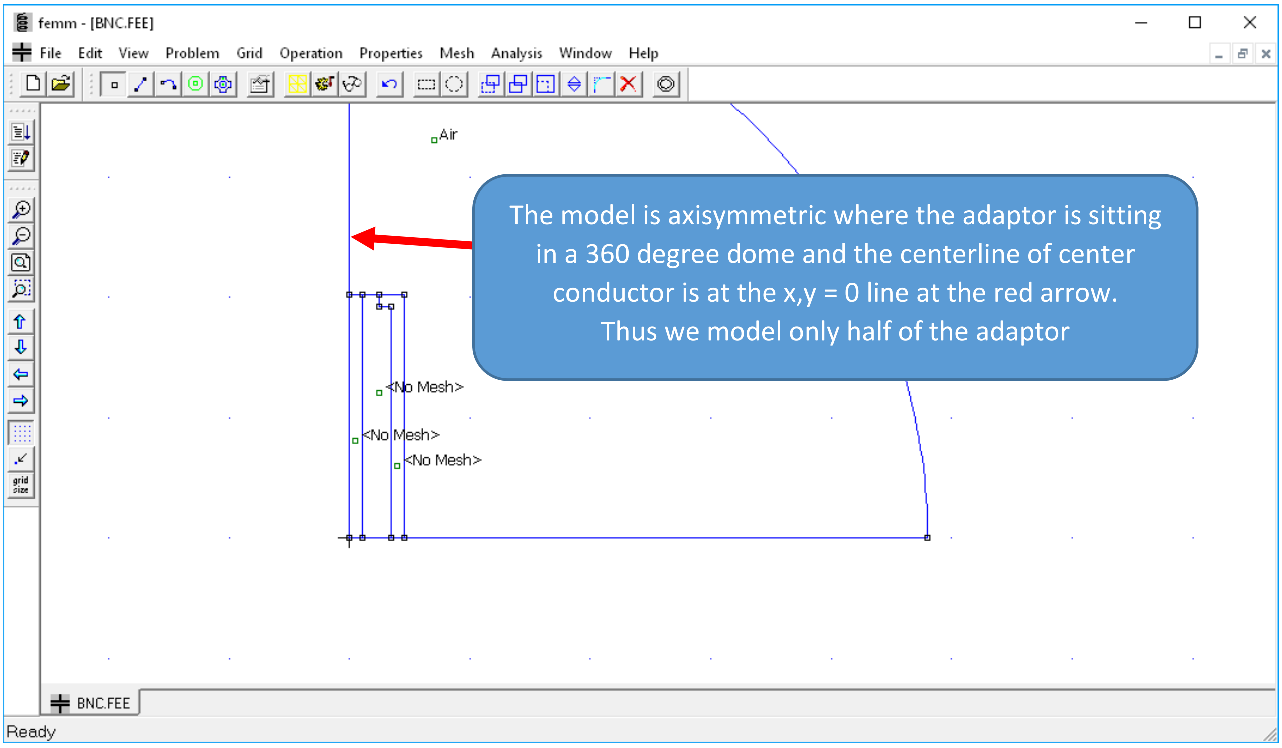
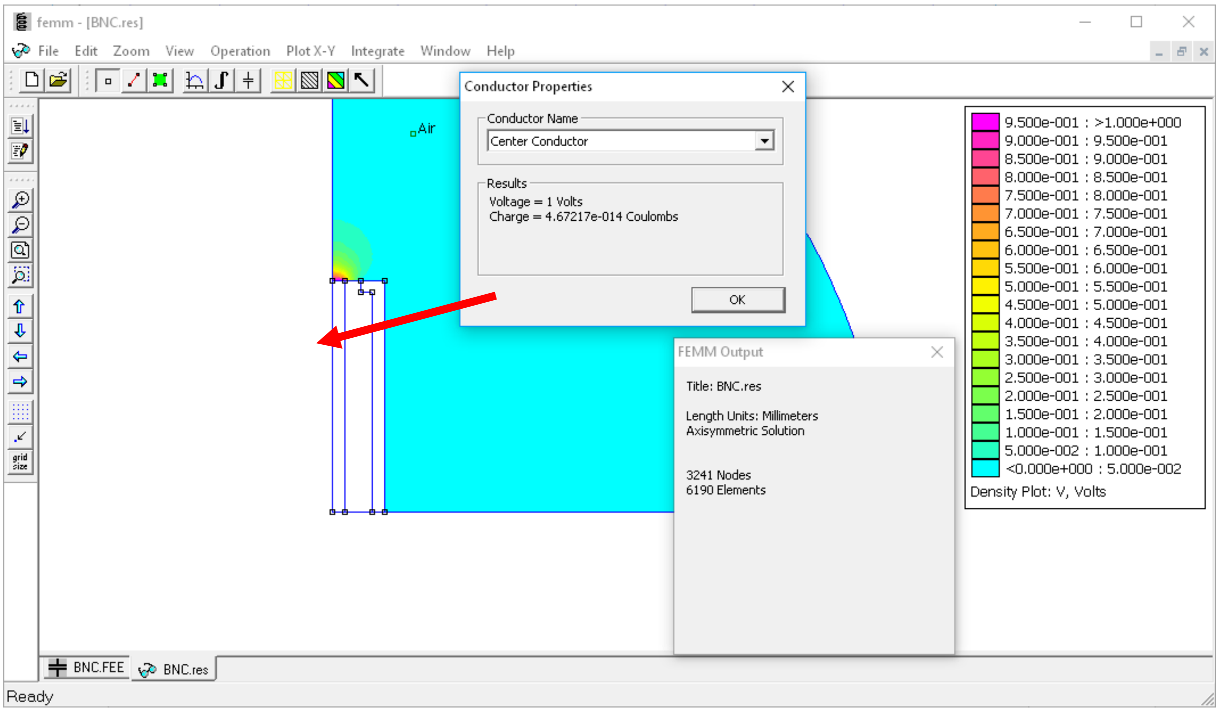
How to design a homemade male BNC calibration kit
Images at the end of the report

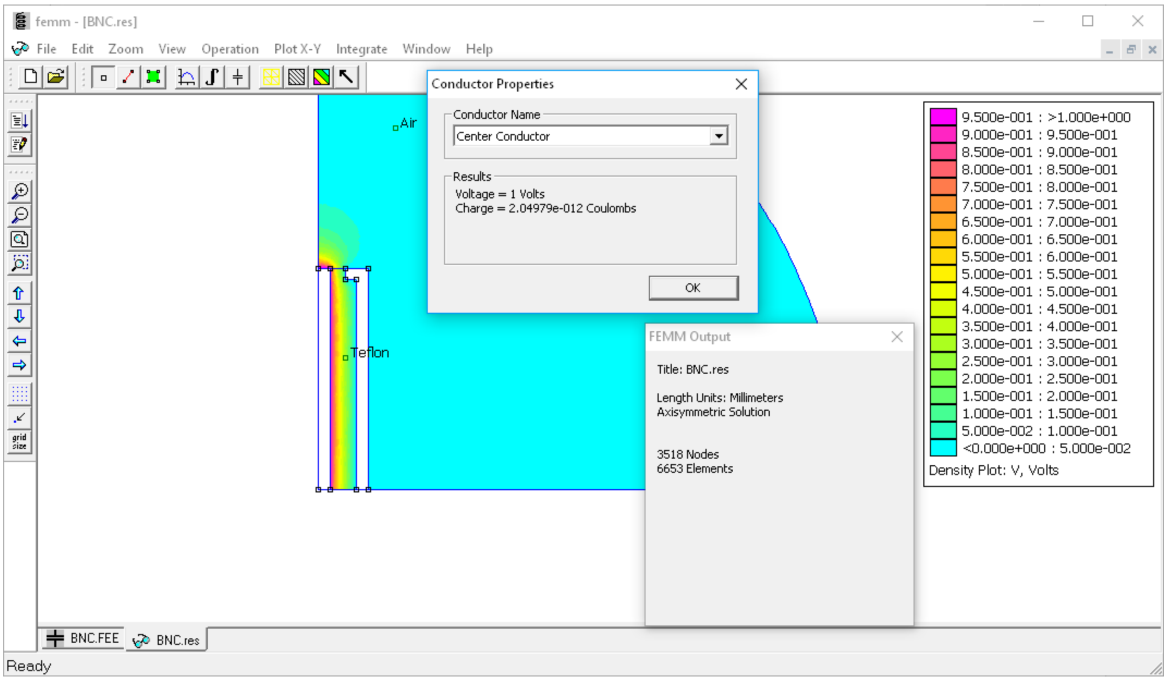
At first, a simulation was performed for the basic BNC male adaptors used for the homemade kit.
The application FEMM was used for finding the delay of the adaptors used, by creating a model in FEMM as shown below. Length is 20.2mm and the inner diameter 7mm diameter of center conductor 2.1mm and the end opening is 5mm in diameter in a depth of 1 mm from the rear of the adaptor. The female counterpart are considered to mate that accurate so the entire structure is filled within the diameter of 7mm with Teflon all the way from reference plane to 19.2mm where the diameter of the PTFE is reduced from 7mm to 5mm.



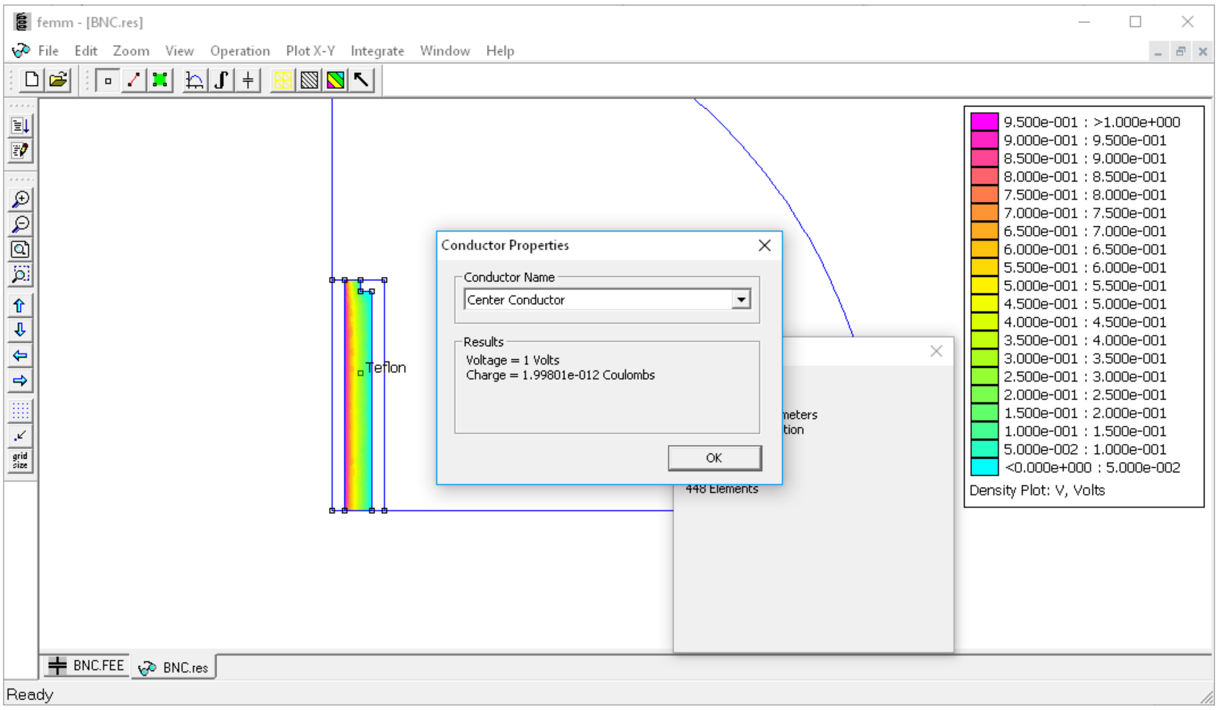
At first we calculate the fringe capacitance at the end of the adaptor to be used for the open and load calibration adaptor which is 4.67217e-14 coulumbs at 1Volt equal to **46.7217fF** which correspond to a one way delay of **2.3361ps** as 1 fF=0.05ps.



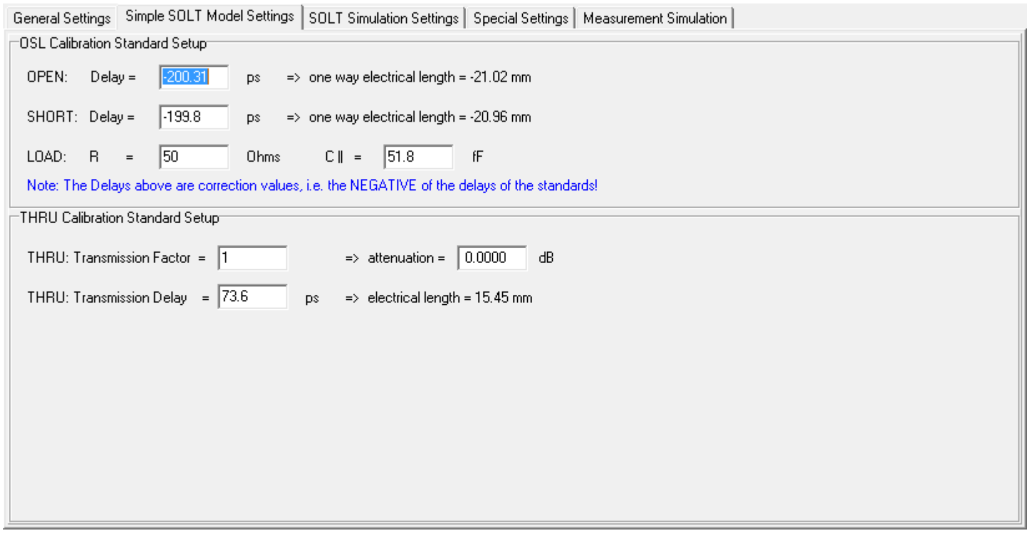
Next is the calculation of the entire Charge, as shown below being 2.04979e-12 Coulombs at 1V equal to 2.04979pF or 102.4895ps, used for the open. For the load we only use the fringe C / delay, as in parallel with the 50 ohm (being two 100ohm SMD resistors), because the structure considered to be 50 ohm, and thus there is no impact from the total delay. This due to the fact there is no reflection to consider except from the fringe C, so actually adding a delay to the load is more correct and will not harm. For the short we use a delay as total delay minus fringe delay which is (102.4895-2.3361)ps =100.1534ps. Remember that any delay caused by a reflection, must in the calibration kit file, be multiplied by two, as it is a two way travel.



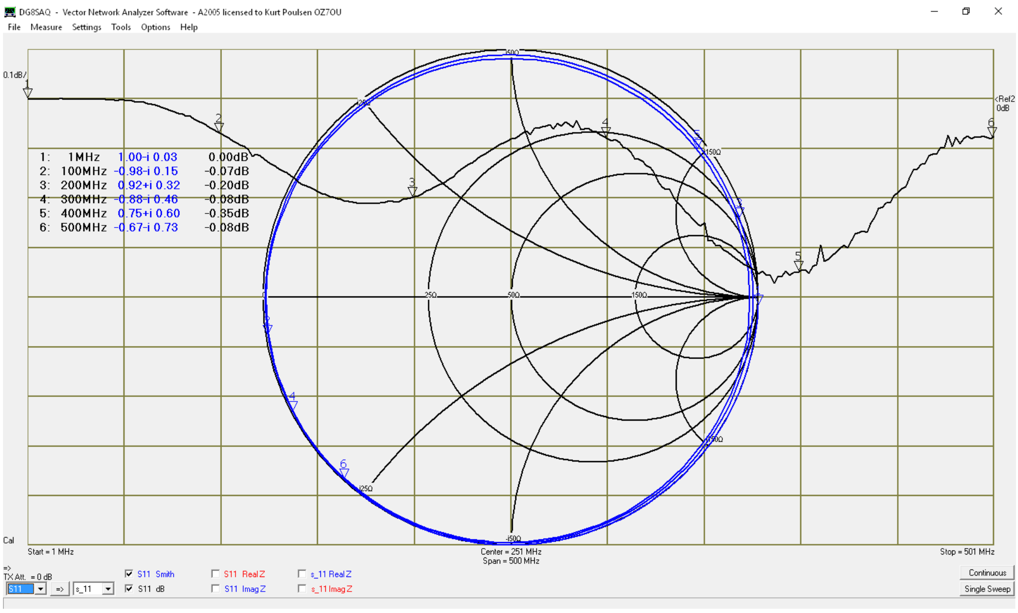
A simulation without fringe C lead to 1.99801pF or 99.9ps for the short delay which is the correct value as subtracting fringe from total delay get a lager value due to improper simulation of the fringe only.



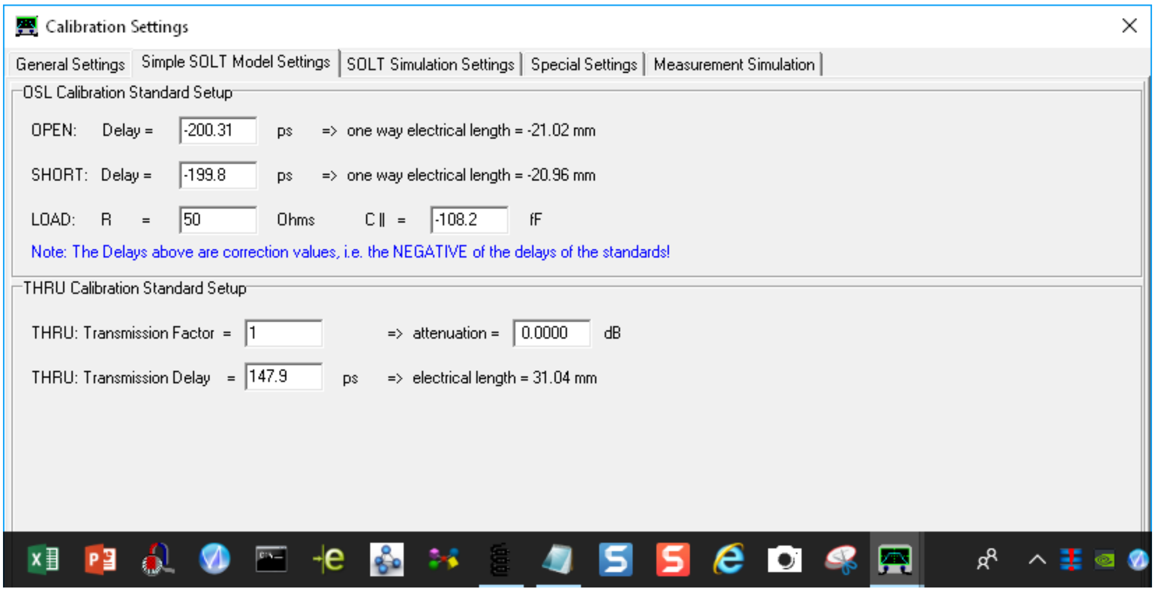
So a simulation without fringe C lead to 1.99801pF or 99.9ps for the short delay and a more accurate calculation of the fringe C is total minus total without fringe C 2.04979pF - 1.99801pF = 51.8fF =2.59ps as opposed to 46.7217fF and 2.3361ps in the above first simulation. As we know the traveling speed in a transmission line with Teflon is 4.7962ps/mm then by multiplying by 20.2mm (the adaptor length) we get 96.8825ps and above simulation said 99.9ps but as the top last 1 mm is with ø5mm there is a justification that the simulation is more correct as that increases the capacitance.



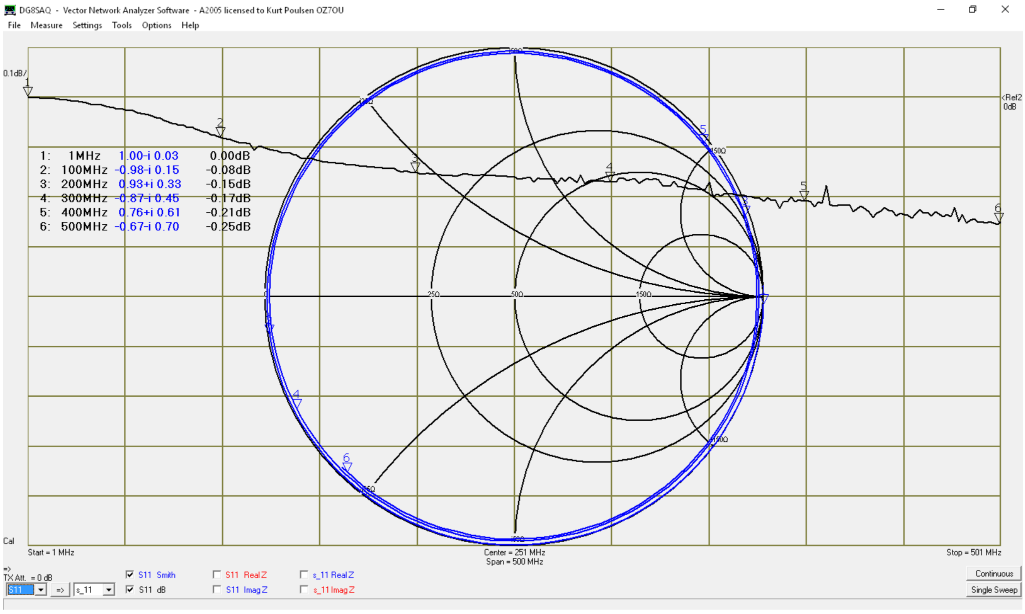
First attempt to calibrate and sweep a semirigid cable or better an professional airline



As seen the trace is not flowing the circumference off the Smithchart which must spiral inwards in a progressive way. The S11 dB trace with 0.1dB/div has oscillations due to that. As the asymmetry is along the vertical centerline is due to a shunt C for the load we trim that value from initial 51.5fF to 108.2fF which provides the perfect sweep.

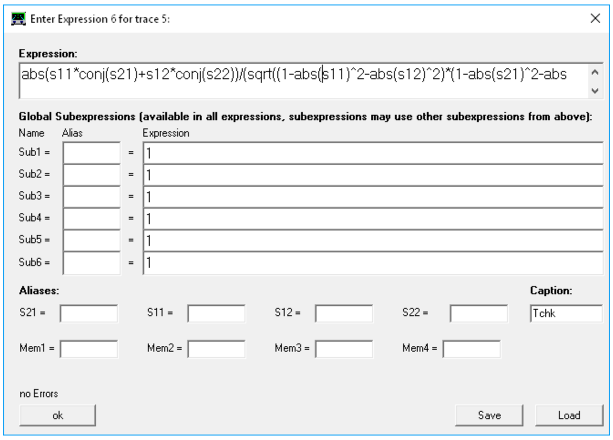


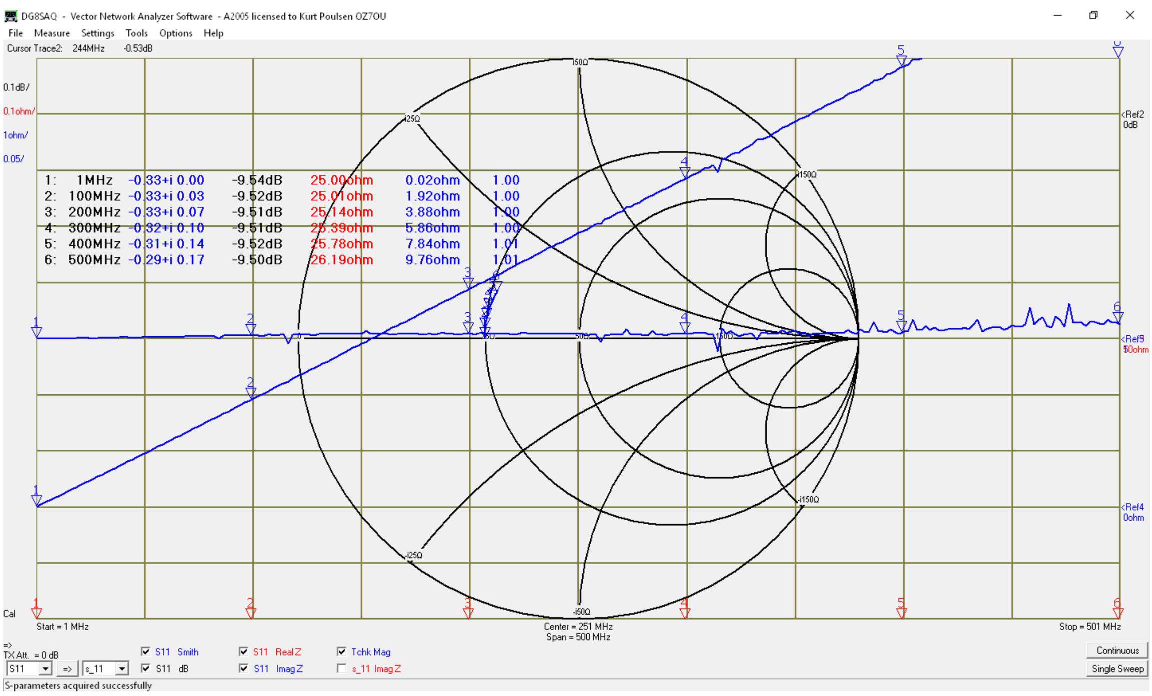
This is how the S11 dB trac shall look like sloping down to a straight line indication the increasing loss in the semirigid cable and for a professional airline to a horizontal line as so to speak no loss in such an airline



A T-Check Test which requires a full 12Term correction. (The Thru adaptor delay had also been adjusted)

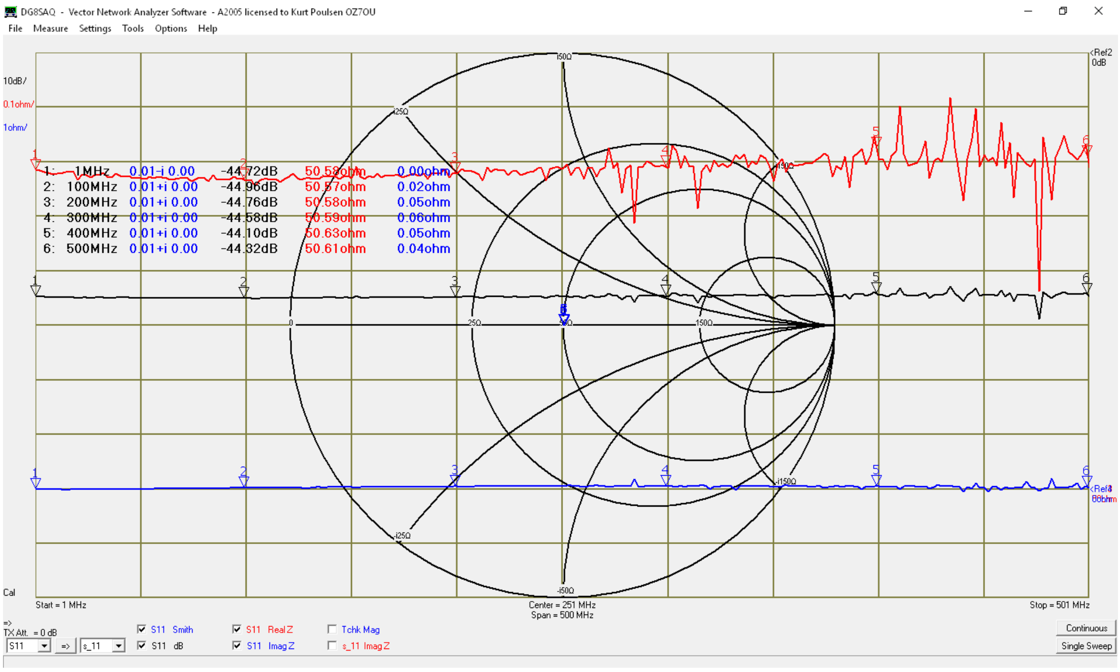
abs(s11*conj(s21)+s12*conj(s22))/(sqrt((1-abs(s11)^2-abs(s12)^2)*(1-abs(s21)^2-abs(s22)^2)))

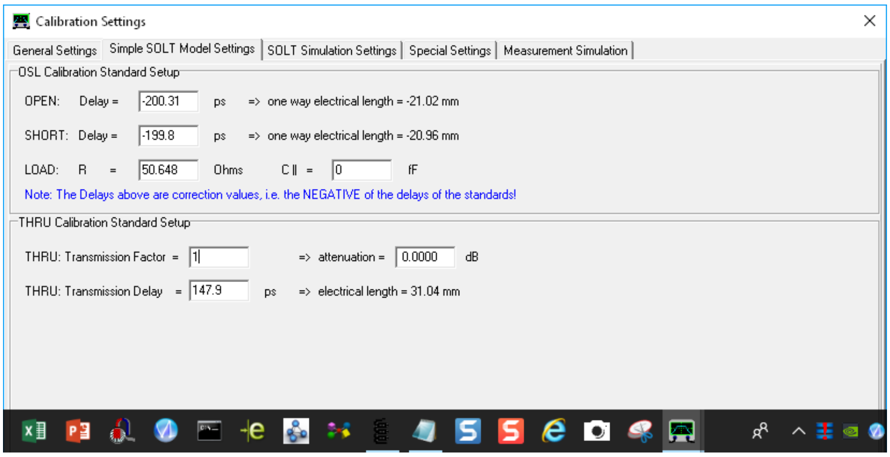




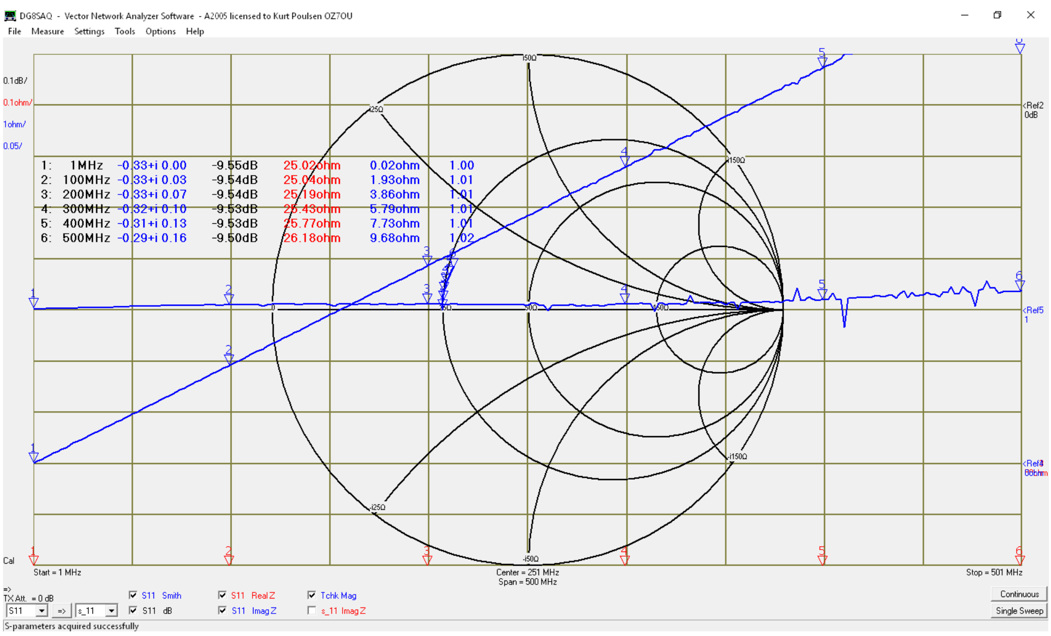
Measurement Huber Suhner BNC50 ohm Load

Measured to 50.648ohm with 4 point tester





T check with Huber Suhner load. The homemade load perform better later the Huber Suhner load found to have a fringe/shunt C of 50fF and thus on level with the homemade load 😊



Same method can be used for creation a female calibration kit and observe that you only need to do the FEM simulation and a final sweep with a semirigid cable (even a good quality BNC test cable may be used) for fintuning the Load fringe C.

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