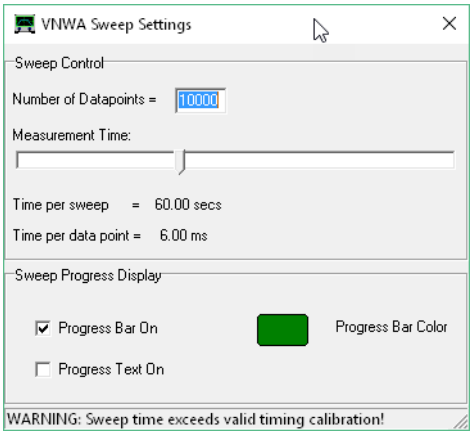
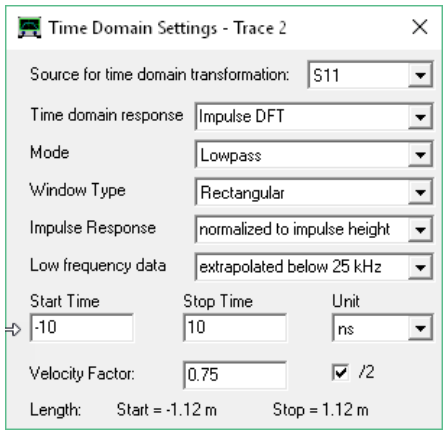
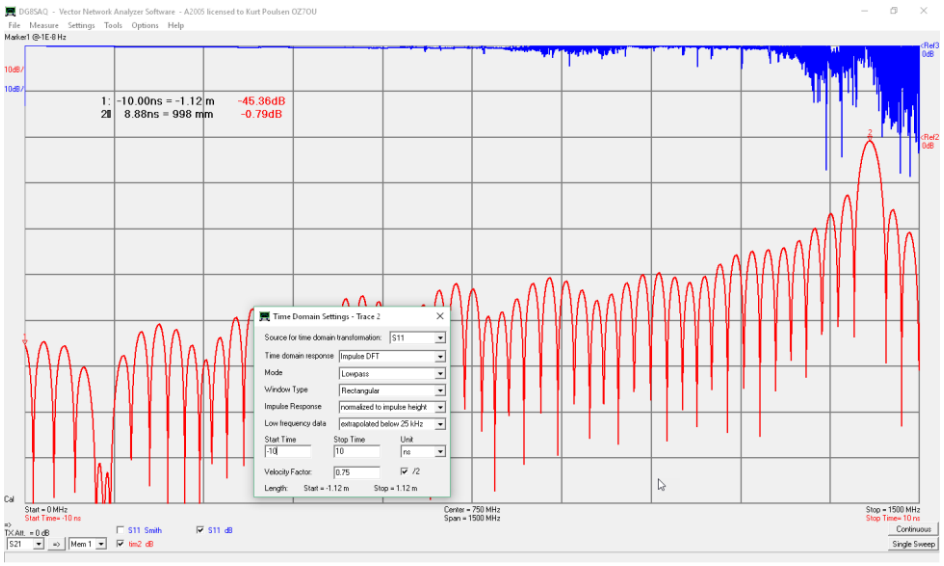
How to measure with the VNWA in time domain on a cable

I have a professional cable of length 1 meter specified up to 26.5GHz fitted with 3.5mm connectors (compatible with the SMA connector). It velocity factor specified to 75 + - 2% and with total length between the reference planes specified to be 100cm + - 2mm. The end to end length is measured to be 100.1 cm. The reference plane is 2.5mm recessed for the 3.5mm male connector so the actual length between reference planes are 95.1cm or 951mm.
For the 3.5mm connectors the velocity factor as being air thus close to 100% and the "air length" judged to be 16mm. So the equivalent length with velocity factor 75% will be 12mm and that implies if we consider the entire cable with velocity factor 75 % we must subtract 2 x 4mm from the length between reference planes equal to 943mm. However measuring the cable as open there is a fringe capacitance of the male 3.5mm connector of 4.5ps equal to a delay of 2 x 4.5 /0.3 = 30mm length. Then all together, the length measured with the VNWA should be 973mm based on VF 0.75.
Please note there is uncertainties about the 3.5mm connectors, which is not entirely with VF 100% and the estimated length not fully accurate.
Let us see if that is true: Note the difference between distance measurement with Impulse DFT and Impedance measurements with Step DFT:

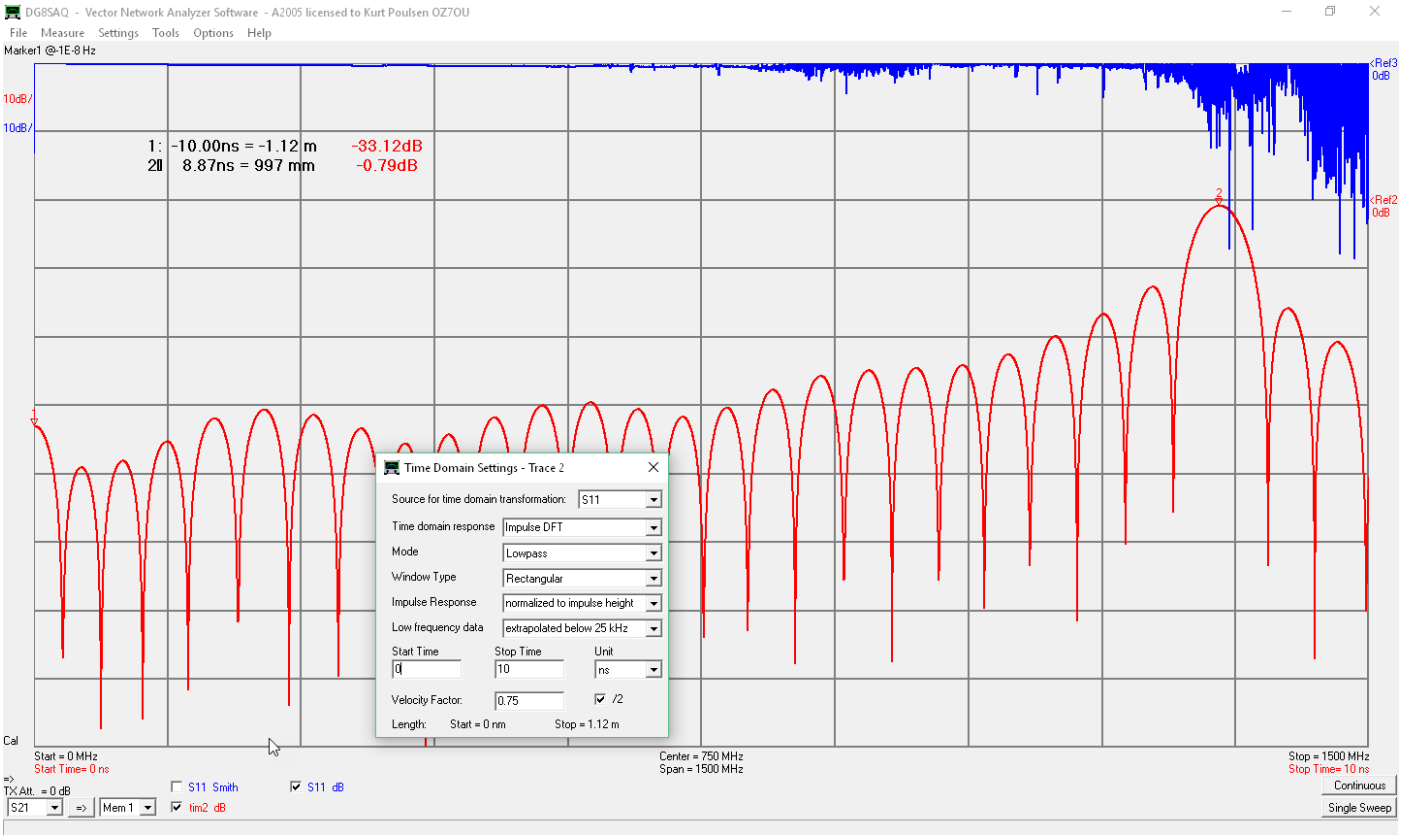
Setting of the VNWA:
First of all we must select a frequency span from 0 to 1500MHz as the resolution is inverse proportional to the frequency span. The number of points determines the maximum length of cable to be measured without folded and false reflection is generated. Number of point of 2000 correspond to a maximum length of 150 meter.
In below example the number of point are 10000, far in excess for a 1 meter long cable, but still measures correct the length to 993mm. Select a 10dB per division S11 dB trace with e.g. 0dB as reference at 10 division, to see the reflection is 100%
Select a tim trace (trace 2 then tim2) and set it for Impulse DFT and set VF=according to cable tested and Start/Stop time according to cable length measure (displayed at the button) .
Result for a maximum time marker selected 998mm



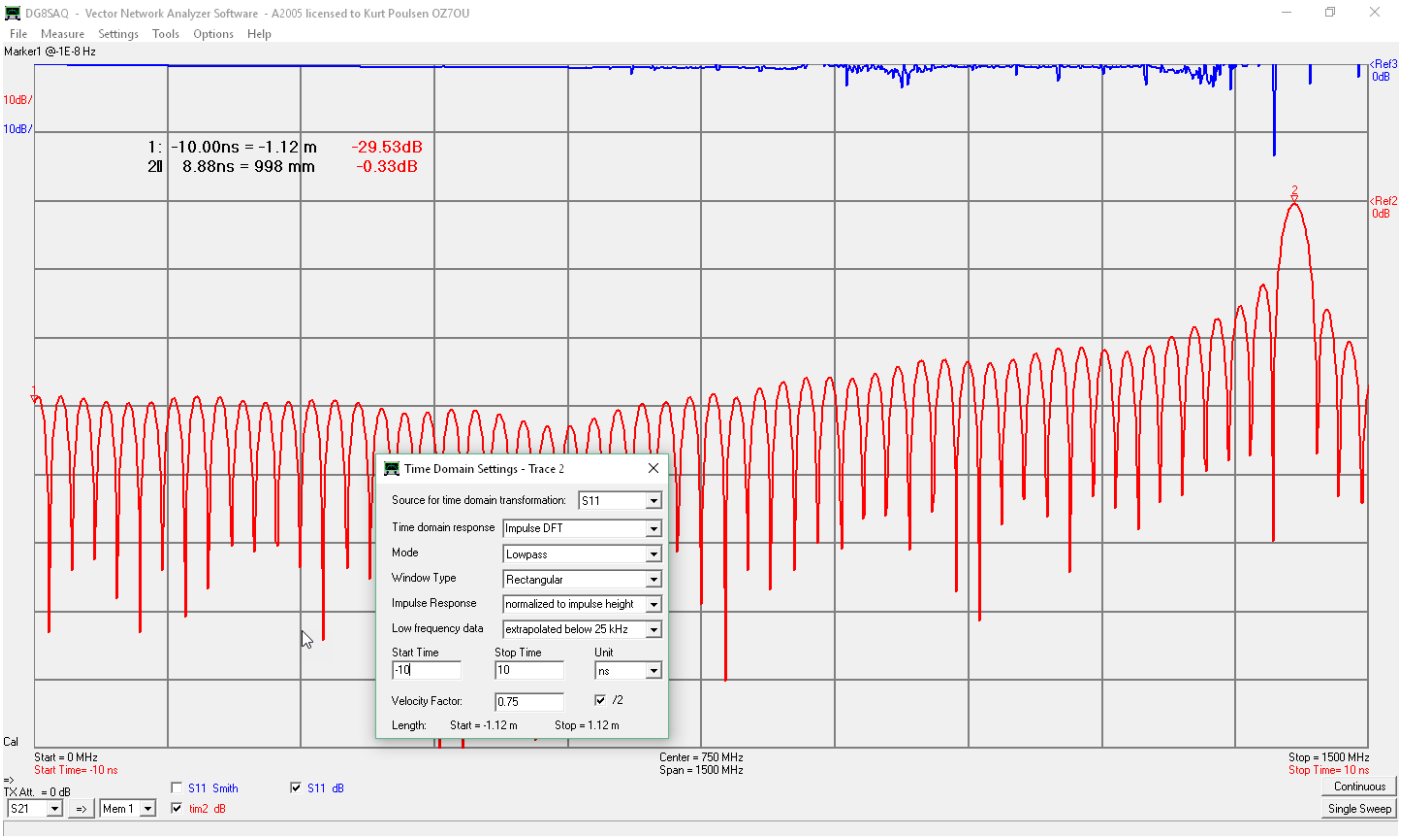




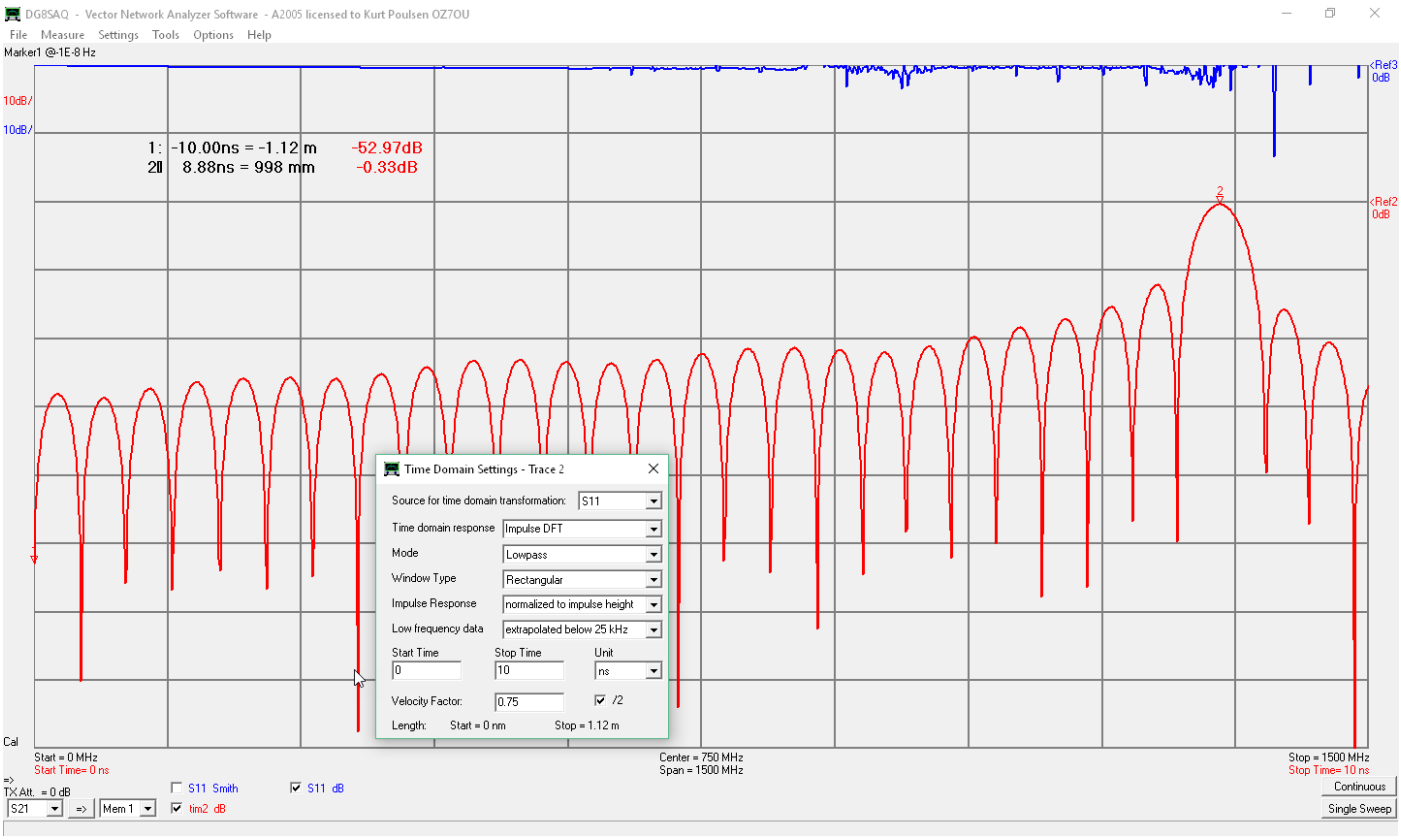
By reducing the start time to 0 we get a result of 997mm length. However optimum resolution is obtained by symmetric start and stop time around zero.



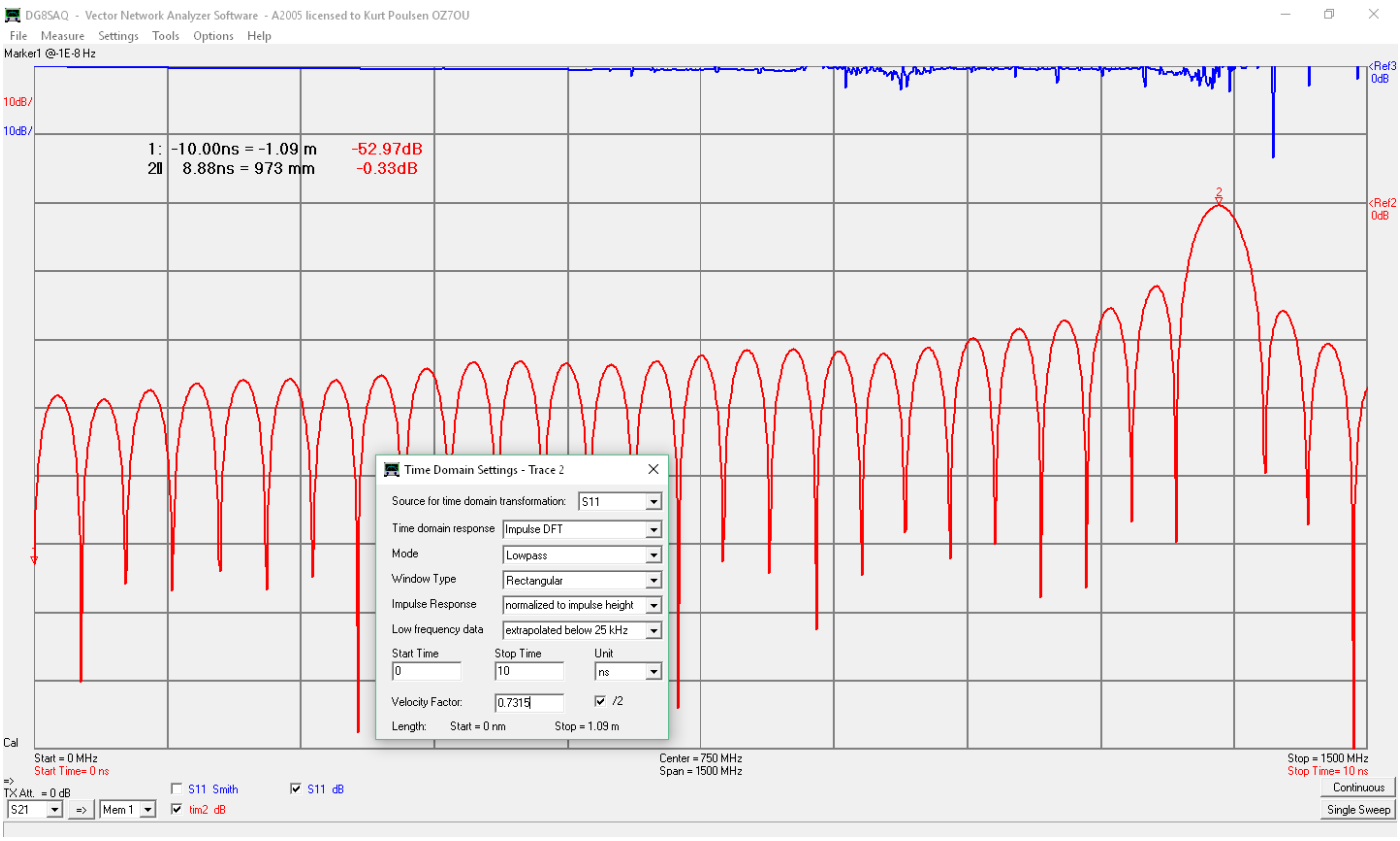
By reducing the number of point to 1000 and 30 ms per point (***renewed calibration***) we get same result



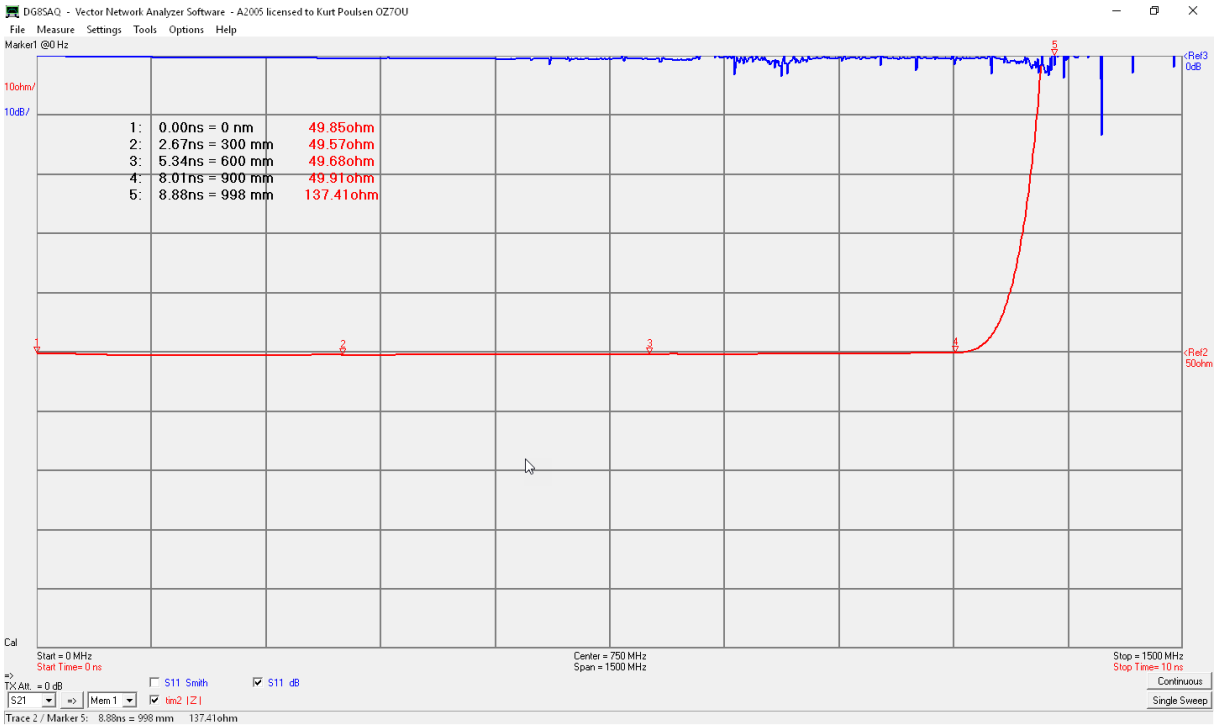
If we change start time to 0 ns no change in length determination.



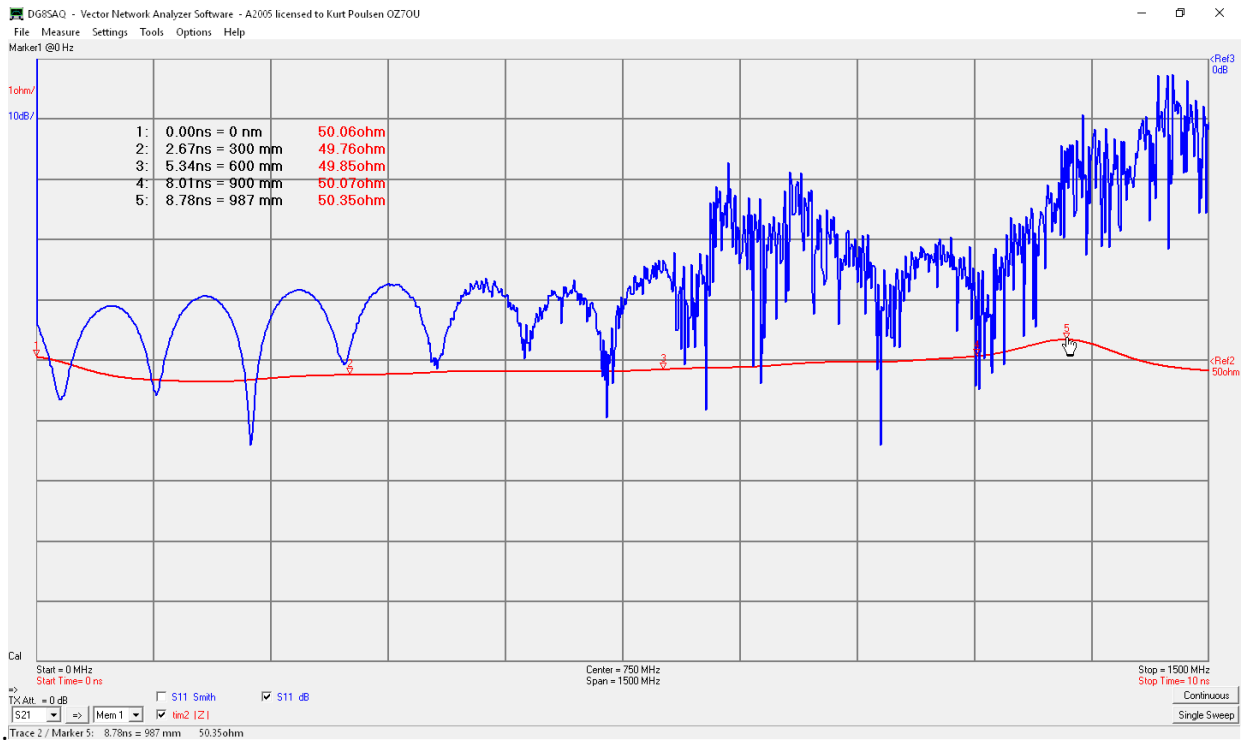
If we change the VF to match the calculated length of 973 mm we get following VF=73.15% and the specification for the cable said 75 + -2% so within spec.



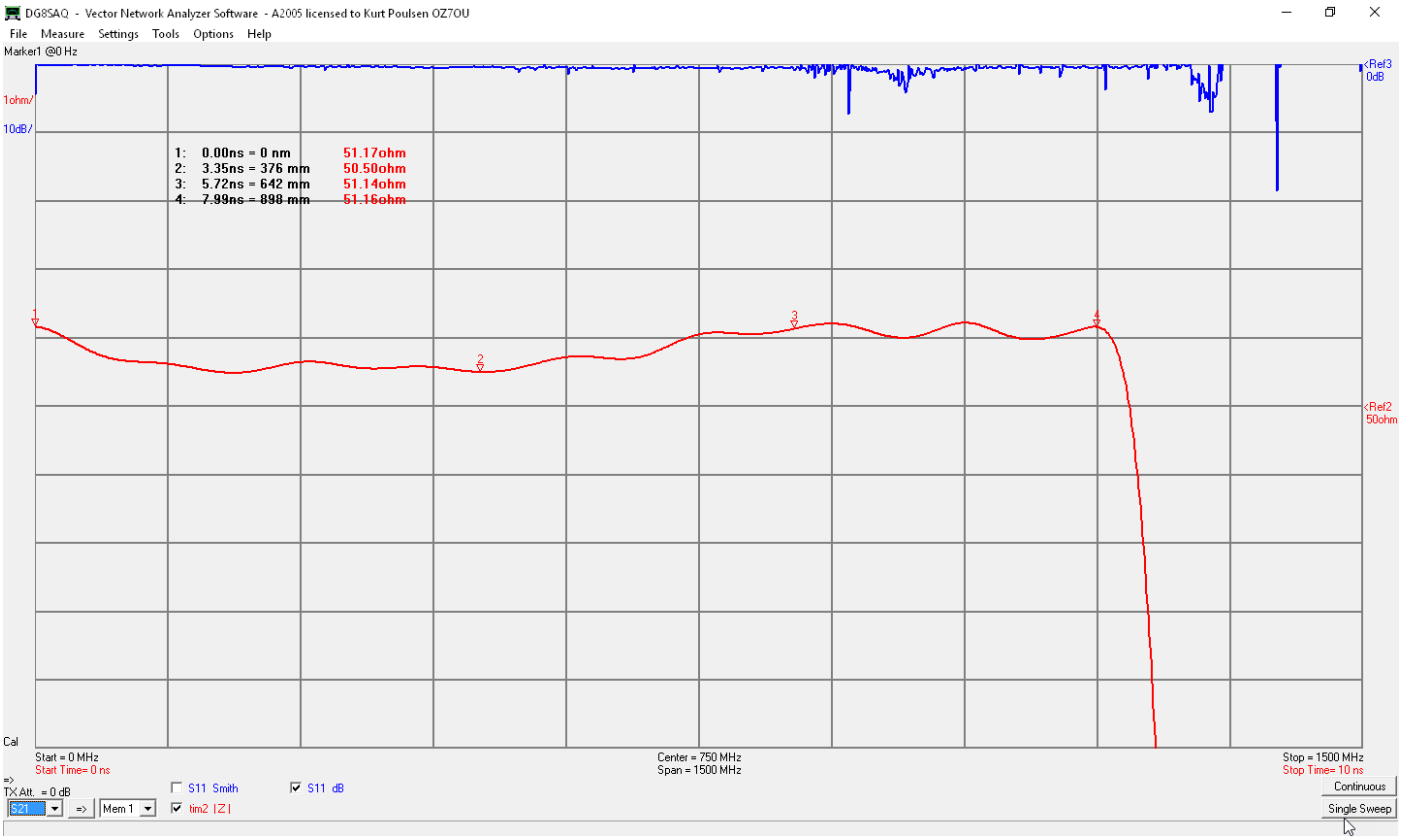
The cable impedance was specified as 50 + - 2 ohm and for testing the cable impedance me must change tim2 to |Z| and chose Step DFT and Windows type to Blackman as seen below. It is still the open cable we measure and Z0 well within specs.



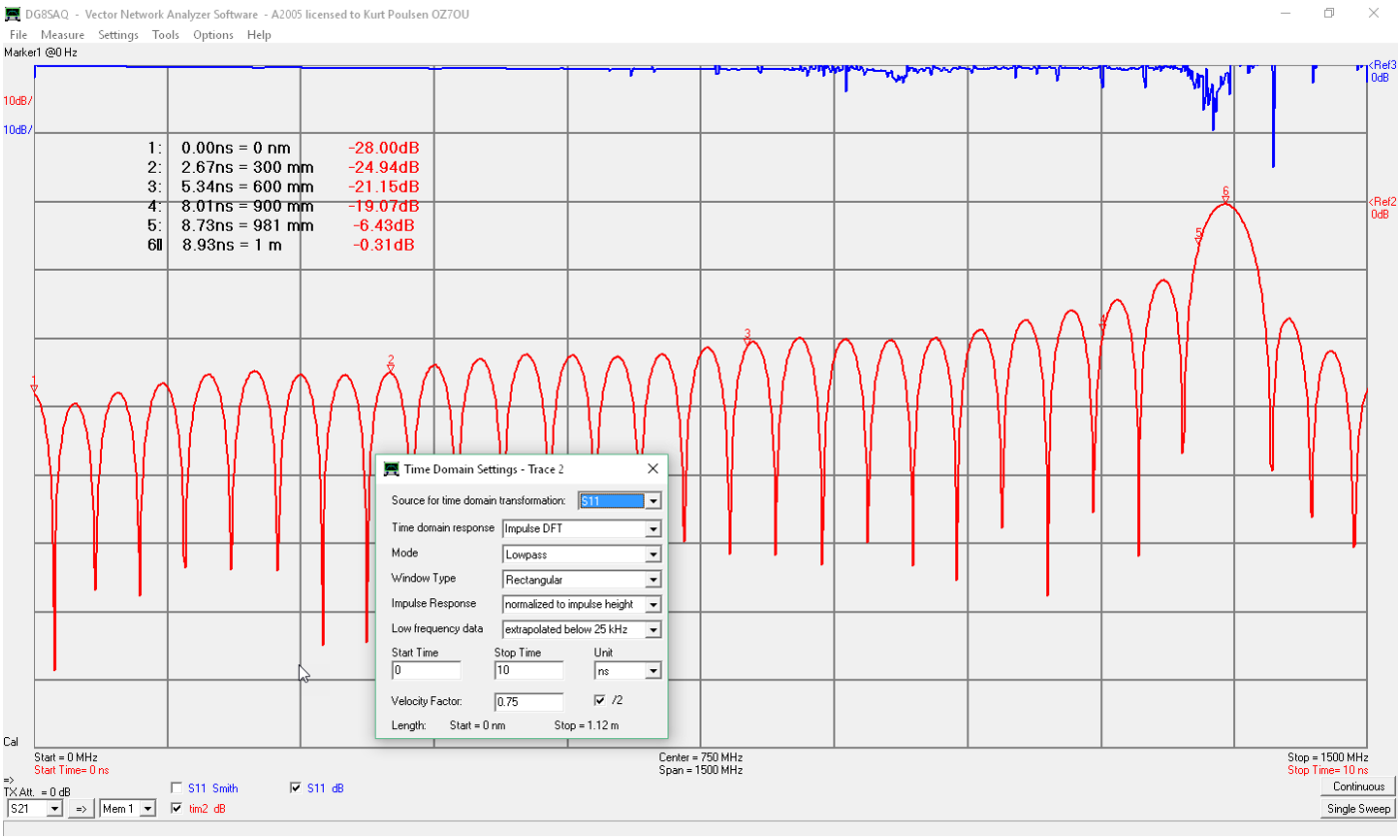
Termination of the cable with a 49.9 ohm Rosenberger female load gives below result
Marker 5 moved to the peak response exactly where the 49.9 ohm load is sitting at 998mm as it should be at 951mm which is the distance between the calibration planes of the two 3.5mm connectors. That we do not measure 49.9 ohm but 50.35 ohm is caused by impedance transformation thru the cable when Z0 is not 100% 50 ohm. This distance difference can be used to calculate the cable VF incl. the two 3.5mm connects as 751/998X75=71.47%. (Later we will see by terminating with a short we find VF=71.55%.)



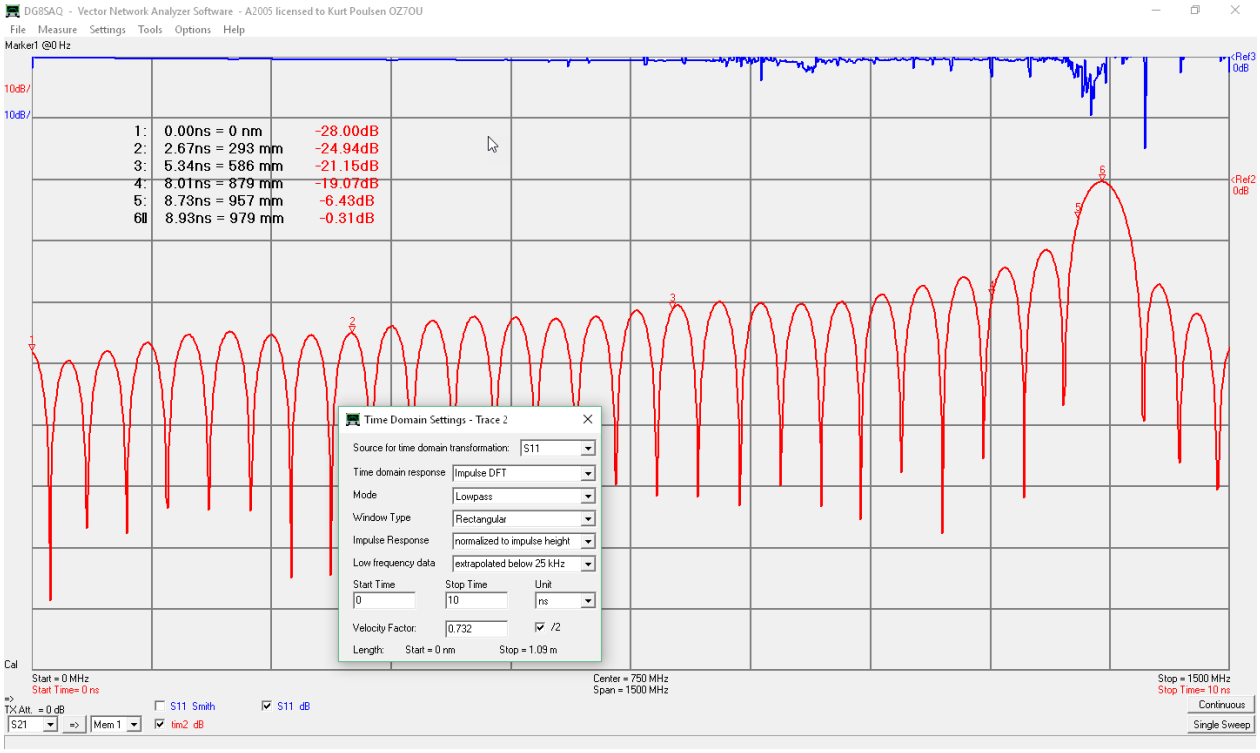
Termination of the cable with a Rosenberger female short provides below result. As seen, the length is not easy to determine so we must go back to Impulse DFT
The electrical length of the short added is 5.65mm for a VF of 69.5% equal to 6.1mm for a VF of 75% so the calculated total length is 973+6.1mm equal to 979.1mm



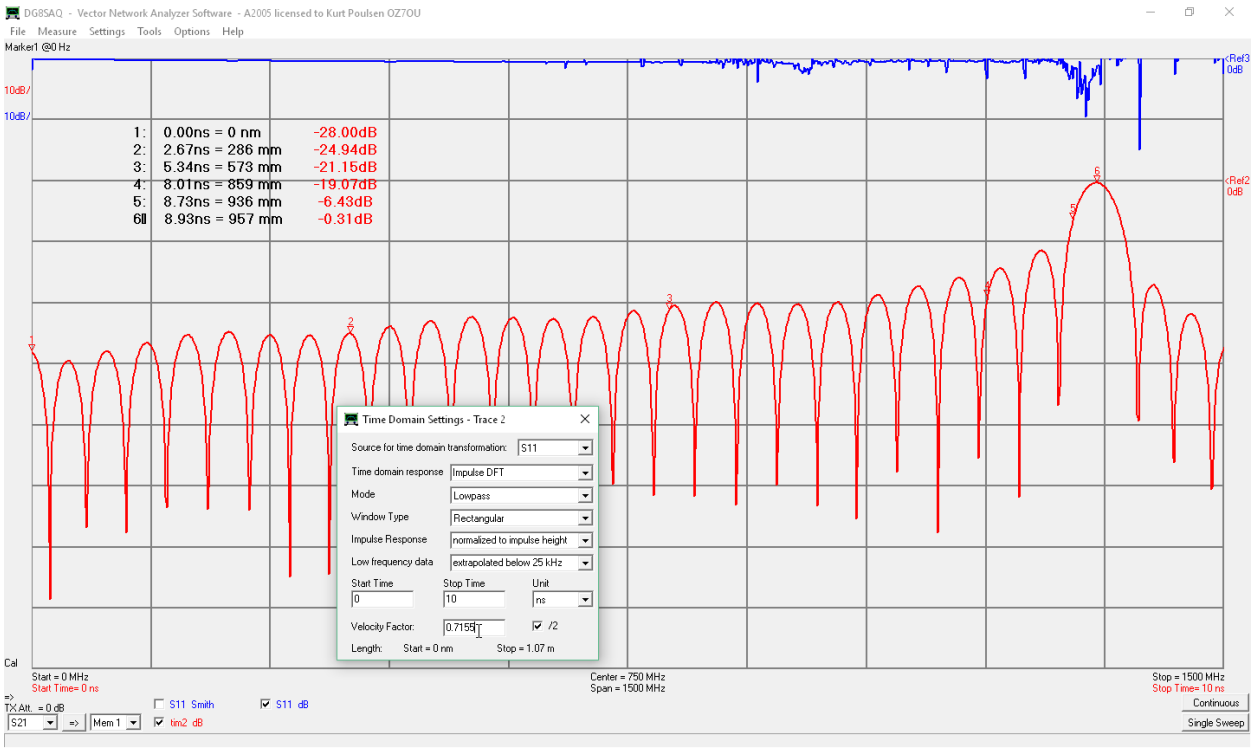
Measuring the distance to the short with VF 75% shown below (1 meter)



By tuning the VF to match the calculated length incl. short we trim such that the max marker 6 fits in length. VF found to be 73.2%



Physical length 951mm between calibration reference planes of the two 3.5mm connector plus short equivalent length of 6.1mm = 957.1mm provides a VF of 71.55% for the entire cable incl. the two 3.5mm connectors.



That was the basic method for cable measurements using the VNWA time domain function.
As seen the connectors plays an important role when the physical length of a cable has to me measured using the VNWA in time domain condition. However if only the electrical length is of interest then we just set the VF to 100% or 1.00 and measure. Then we do not have to be concerned about VF in the cable or the connectors at all.
For further details please study the VNWA help file

4/8/2016 Kurt Poulsen