

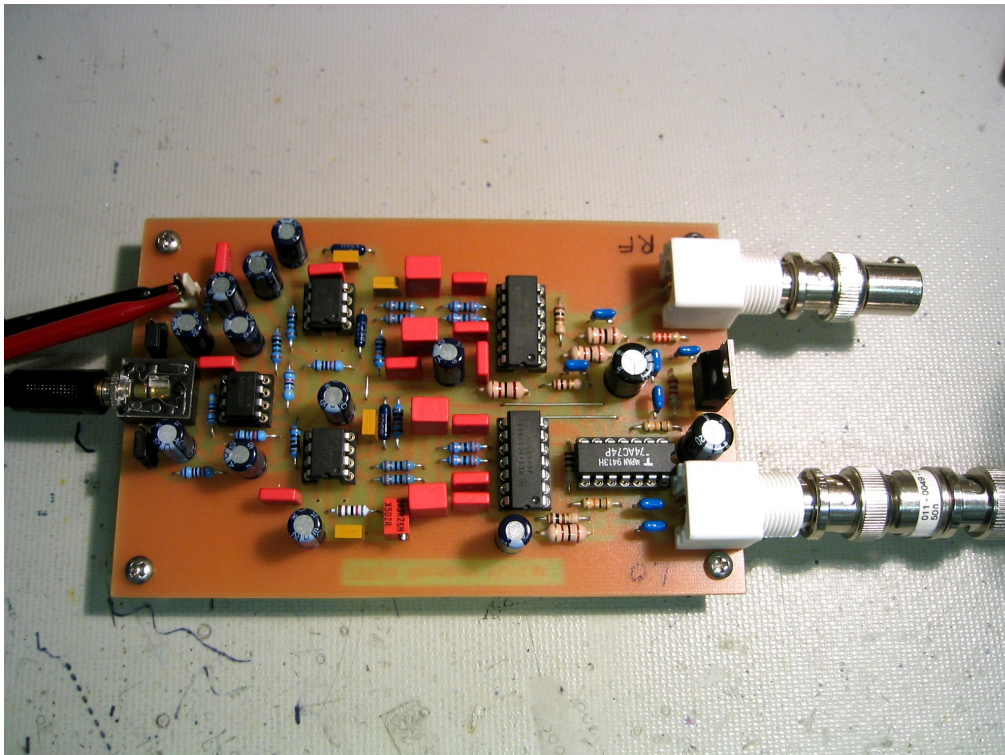
DR2A S/H HF SDR Receiver Additional Measurements

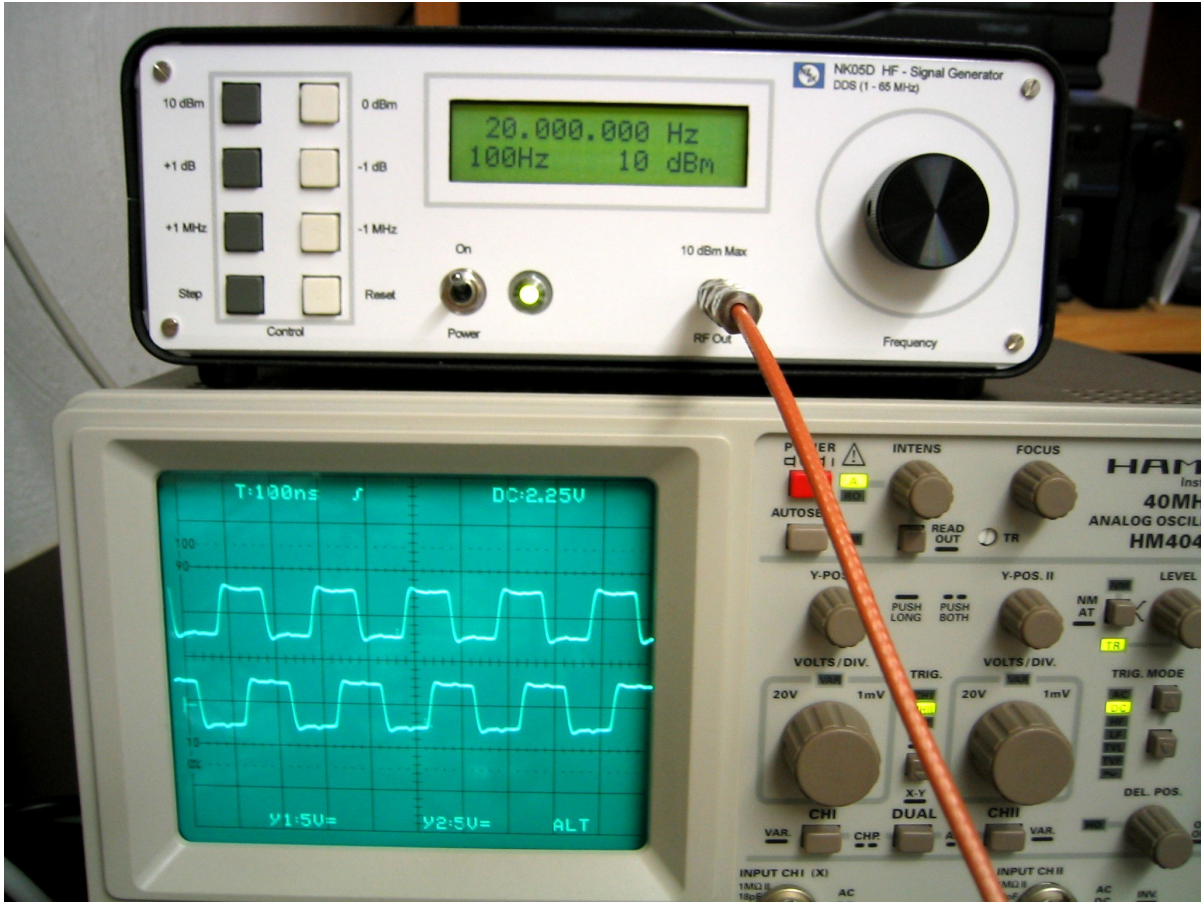
Dipl. Ing Tasić Siniša-Tasa YU1LM/QRP & Norbert Kohns DG1KPN

I received a lot messages about my SDR designs from HAM and non HAM SDR fans all over the world. Some messages, except performances comments and error detection, was very interesting for me like message which I received from Norbert DK1KPN. We exchange few messages and this article is results of this conversation and Norbert's wish to measure some DR2A performances which I didn't make. I want to thank you Norbert to his big effort and very nice measuring diagrams.

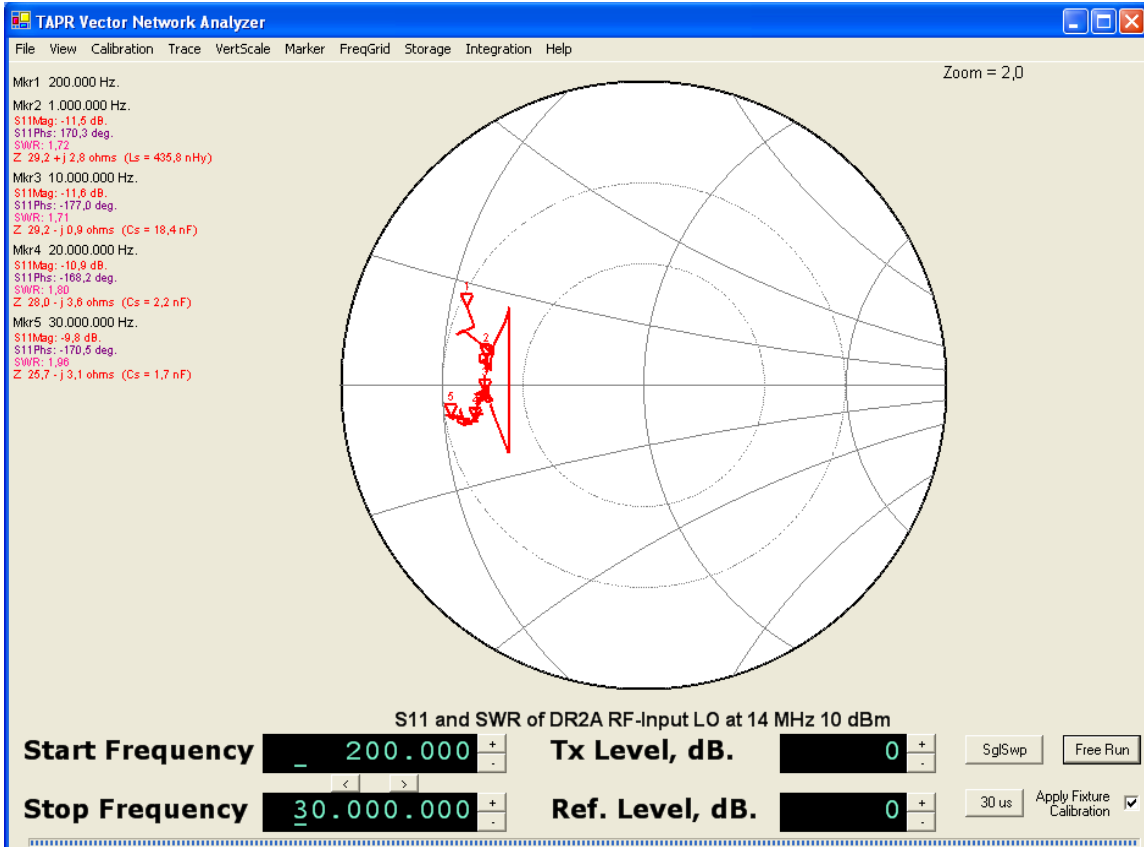
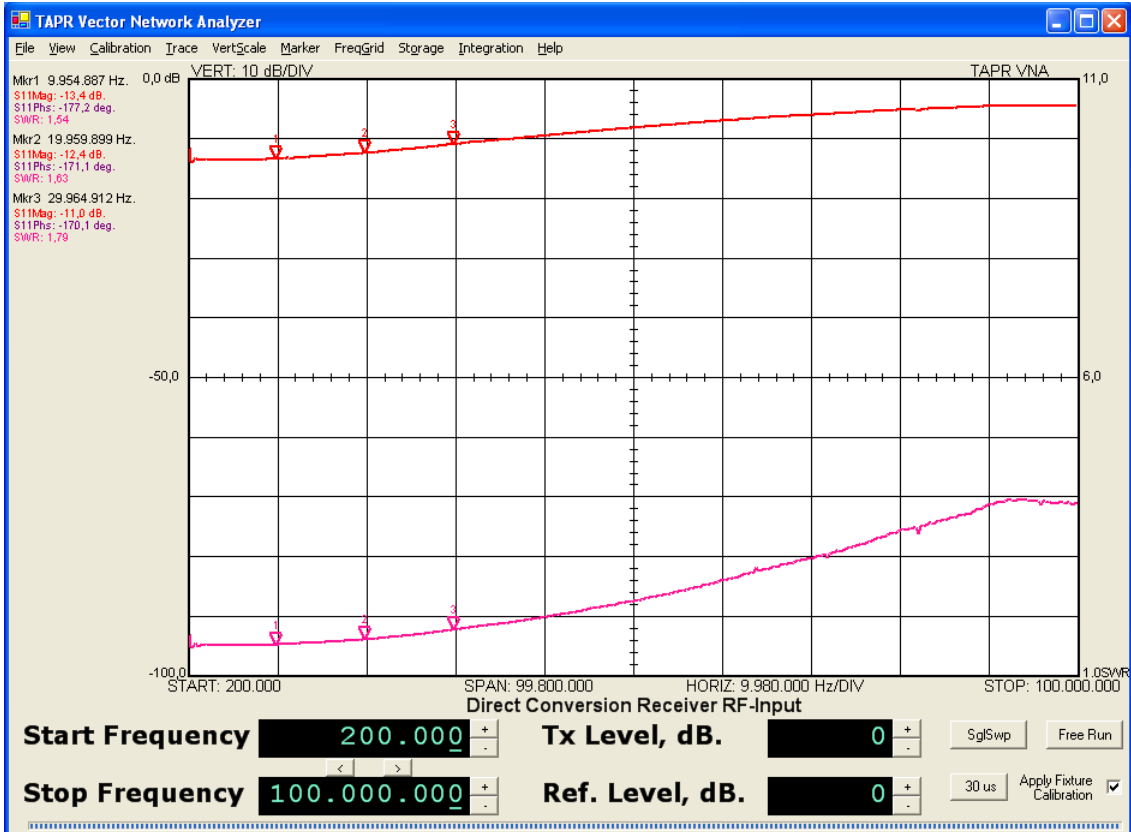
I meantime I made some limited quantity of DR2A PCBs and I assembled few DR2A samples with new PCB also .I made measurements on them to see how receiver performances are spreading. Now for SDR PC processing I used better 24 bit SB USB sound card Audigy NX. The biggest performances improvement was in MDS. MDS (minimal detectable signal) was between -109 to -111 dBm . There is no change in the IIP3 which was around +33 to +35 dBm and result it is component built in related. DR2A have the biggest IIP3 and SFDR (spurious free dynamic range) from all my SDR designs. I measure 1 dB compression point also. 1 dB compression point was between -1dBm to +1 dBm (S9 +68 dB !!!) at the lower AF gain position and for +5 V Vcc power supply for 74 HC4066 IC. Limitation wasn't S/H detector but OP AMP output swing 8 V peak-peak before it is going to the clipping. S/H detector limitation is around +15-+17 dBm !!! If we are using +6 V power supply for the 74HC4066 IC than we have 2 dB 1 dB compression point improvement and OP AMP output swing is now 10V peak-peak. Higher power supply also increase F max for 74AC74 IC LO S/H driver to min 140 MHz min. +6V Power supply decrease ON resistance in 74HC4066 switches and overall improvement in SFRD is about 1-2 dB. In the high AF position 1 dB compression point was between -26 to -28 dBm. Changing input OP AMP OP027 with lowest noise "state of the art" OP AMP AD797 didn't give MDS improvements as I expected. Reading some articles about this problem I realized that it is necessary to obtain this benefit that the first OP AMP must have min +50 dB or more. This is not possible because overall SFDR have to be ruined or it is necessary to have input AGC attenuator and control for it.

Now down they are Norbert's measuring diagrams and some my comments on them. First it is picture of Norbert DR2A realization and second how LO I/Q signal driving S/H detector looks like.

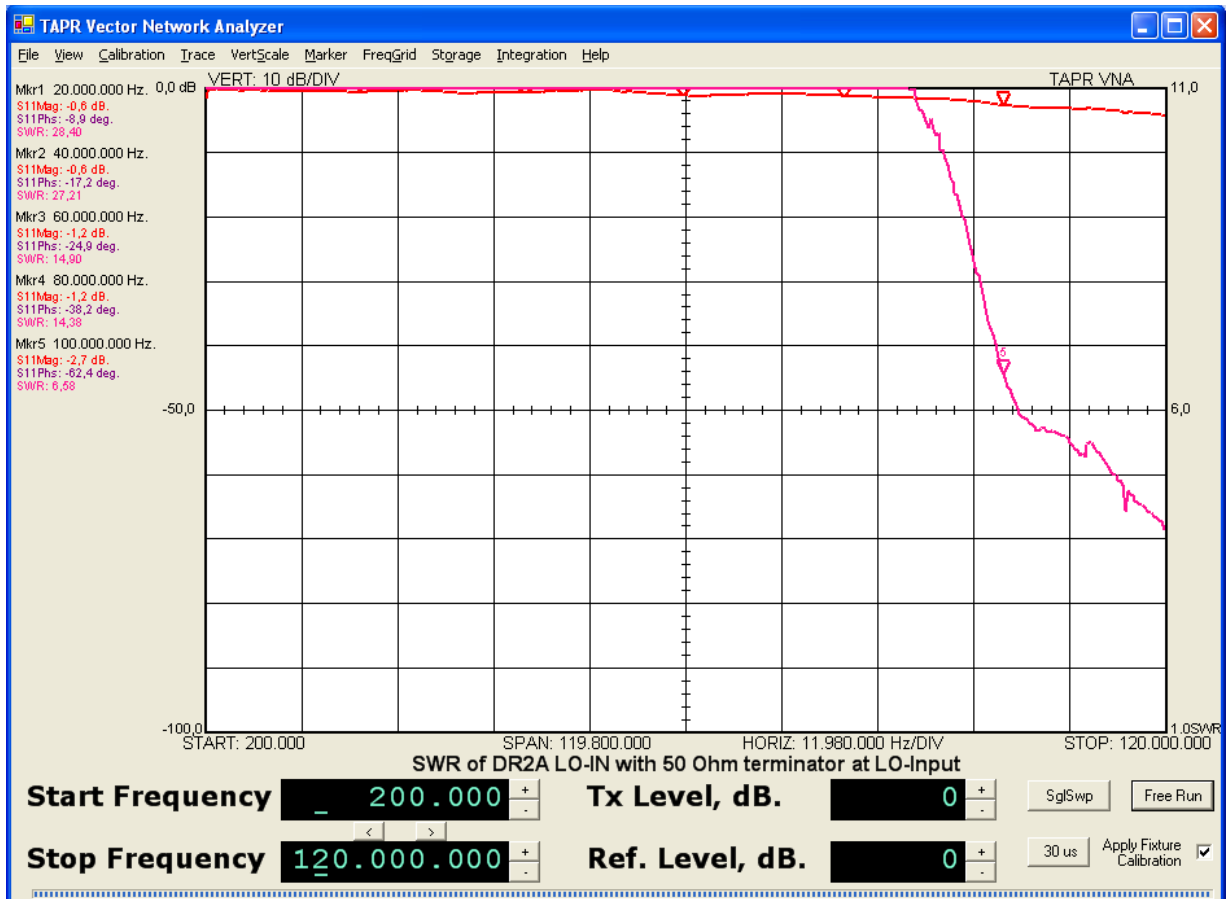




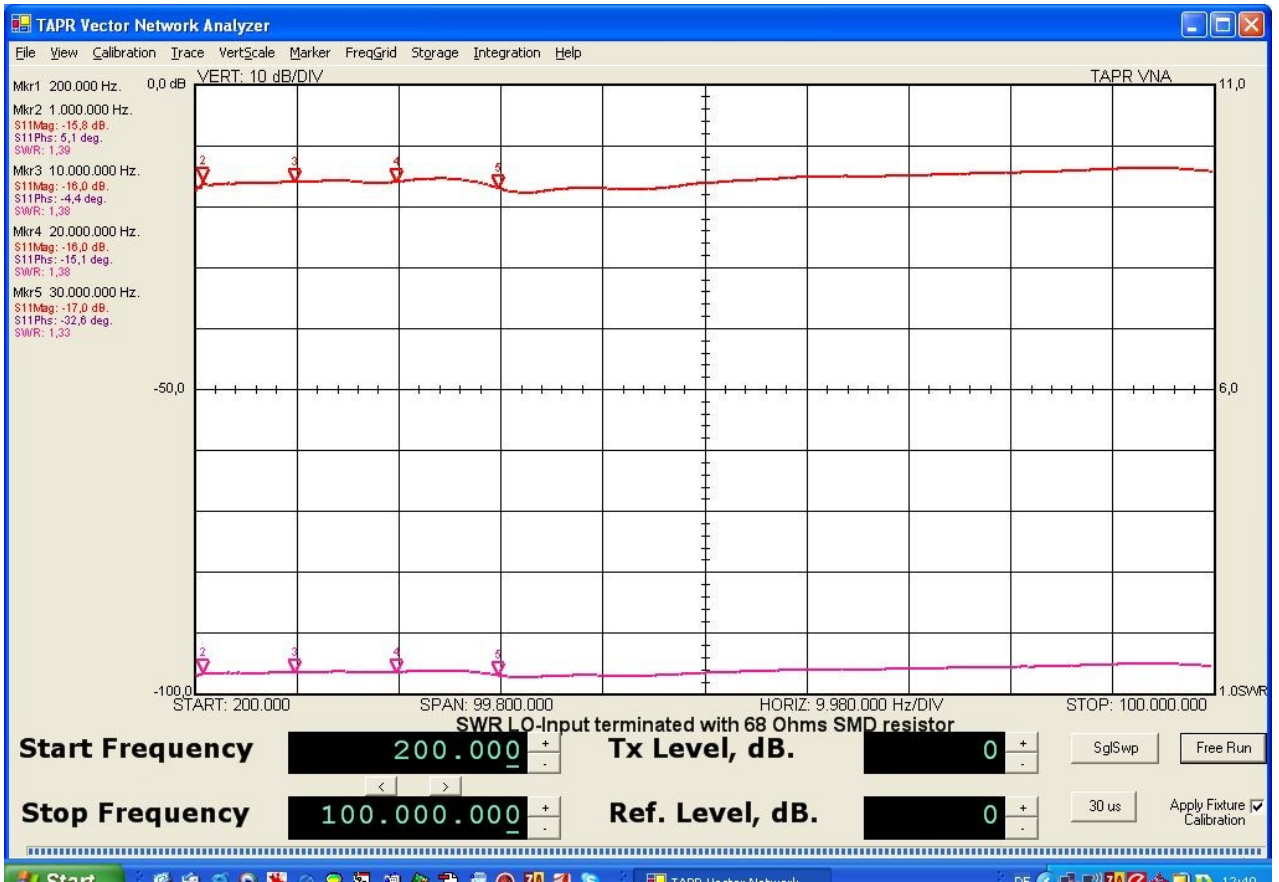
I didn't measure input VSWR for the DR2A receiver. According to the mine calculation it has to be around $S_{11} = -15$ db. Measured result is very close to this value at lower frequencies and I am satisfied with relative good prediction. As I explained in previously published articles this results are very sensitive to the IC manufacturer because this 74HC 4.... series are not last and modern technology products.



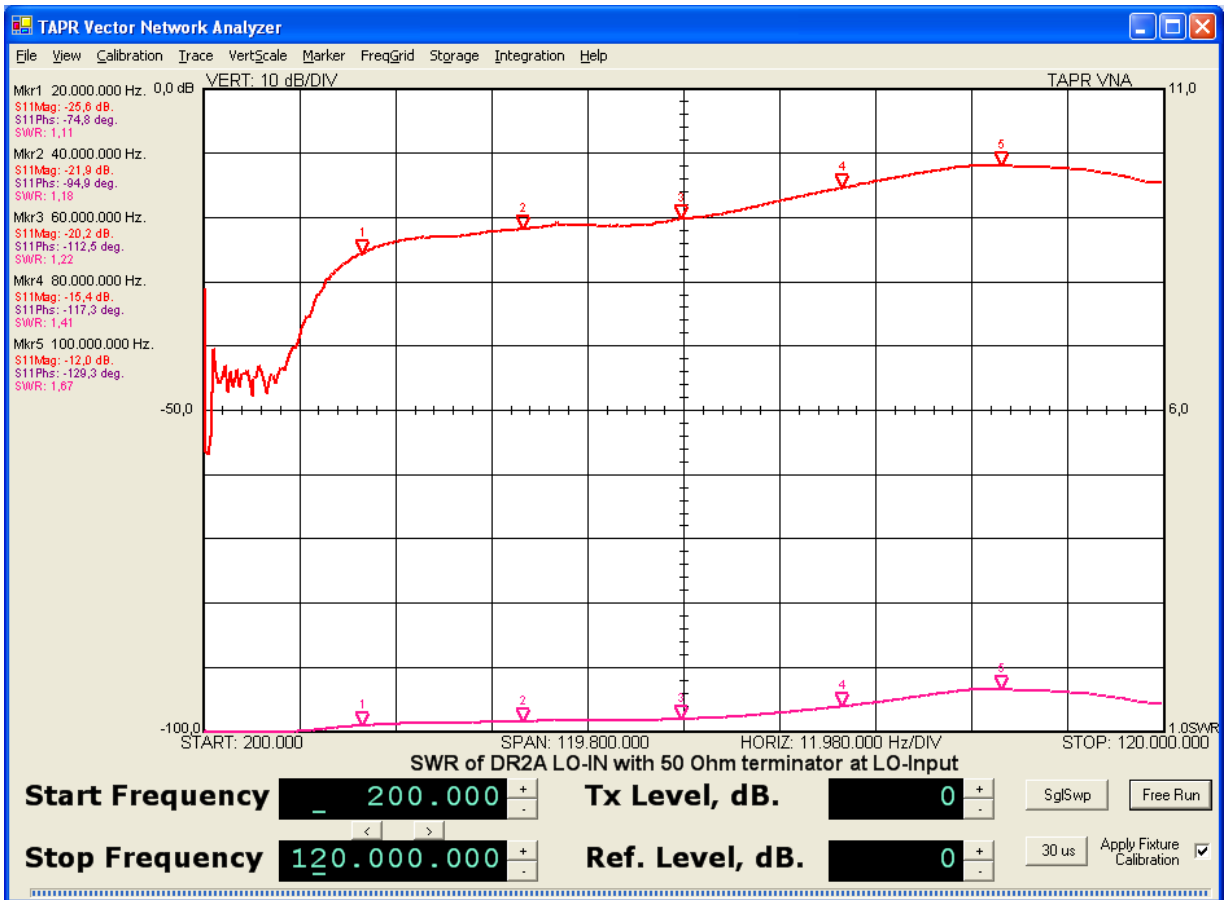
S11= -11 dB at the 29 MHz are not very good result from mine point of view but I have admit that this result is comparable with some HAM professional products. This results will not degrade input band pass filter if it is build-in at the input. Quite different situation is with LO termination. It isn't necessary that we have LO terminated because LO need only enough voltage drive (1.5-2 V peak-peak). Input impedance of LO port is around 4.7 K. Measured diagram gave good agreement



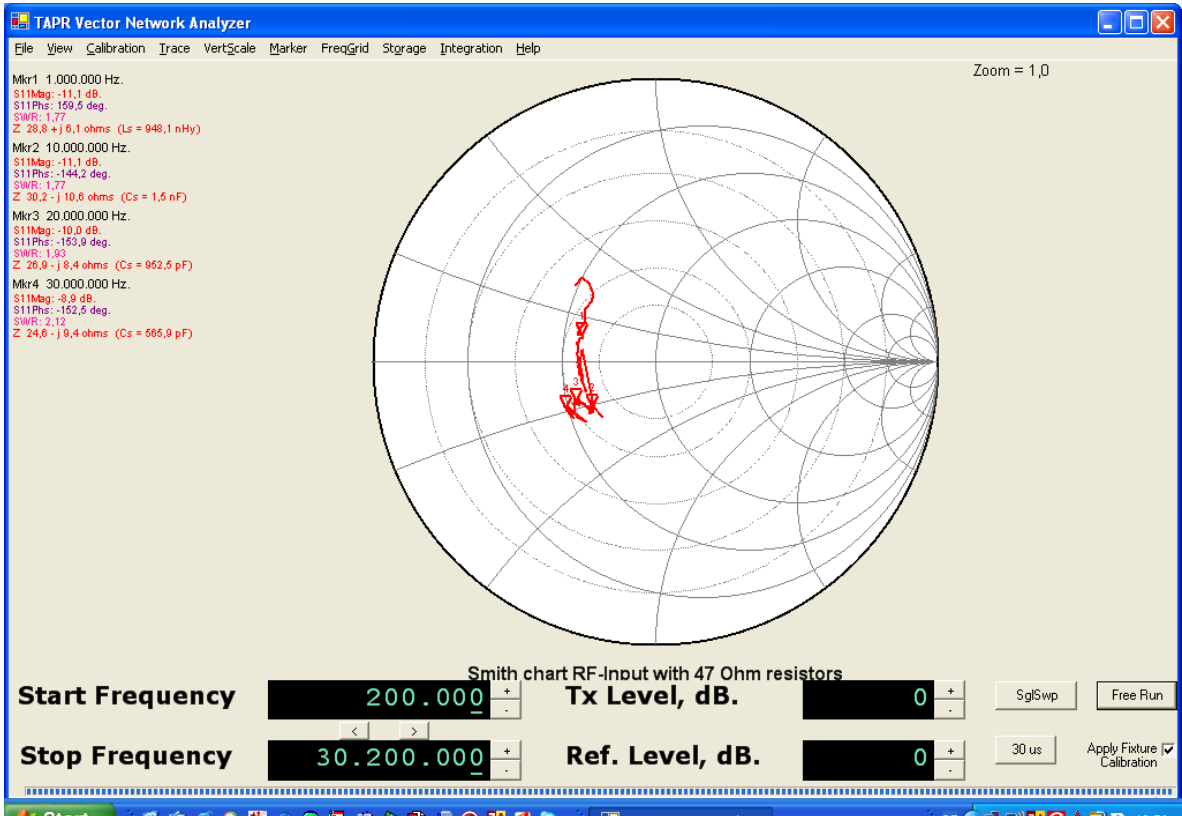
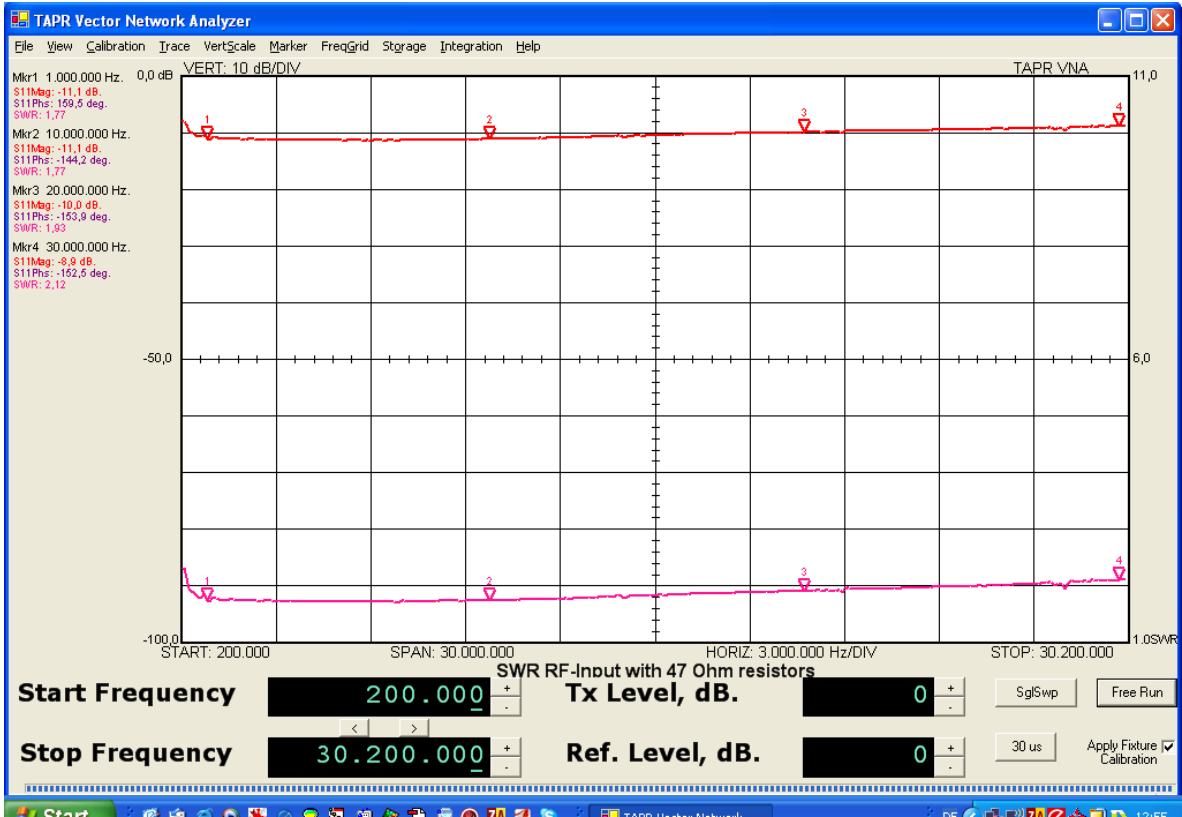
In schematics I gave solution with additional R =68 Ohms at input but this is not integral part of published PCB. Solution is possible as “piglet” from back PCB side.



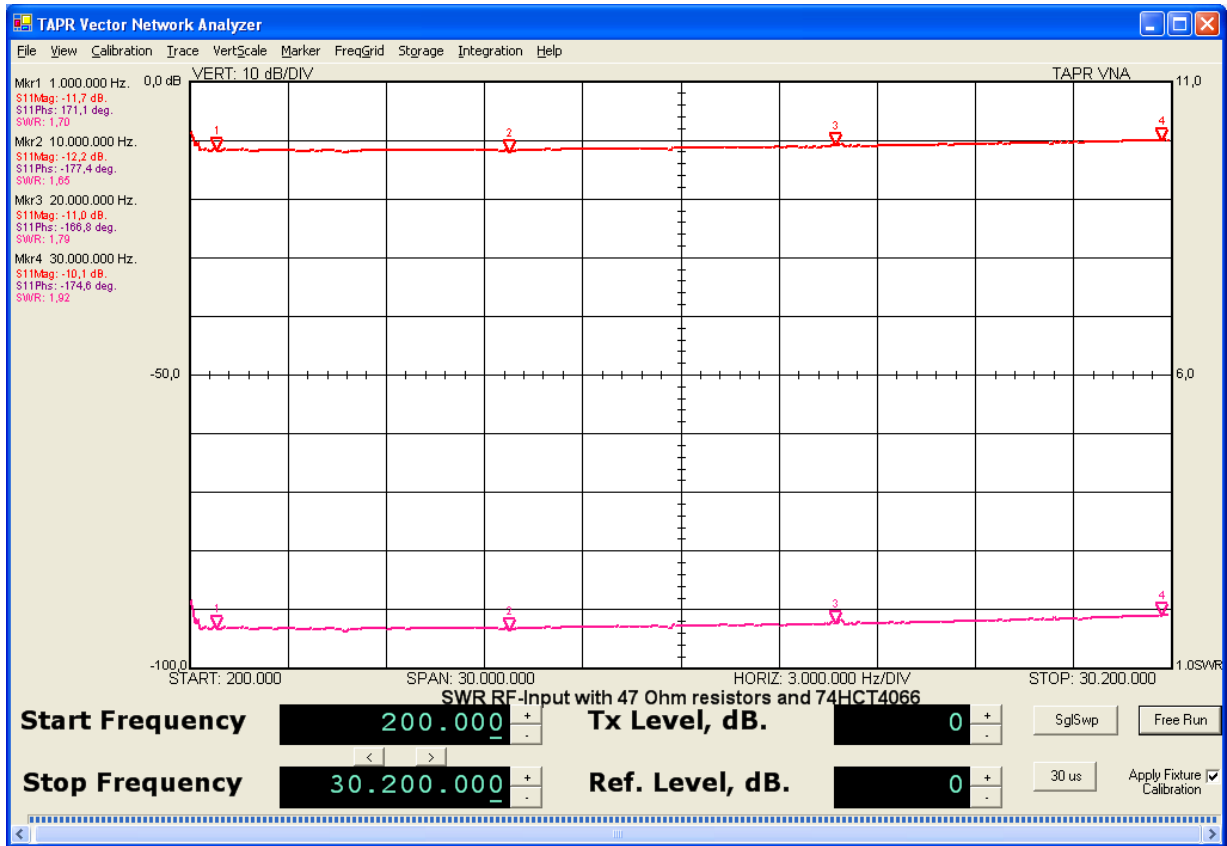
LO termination with 50 Ohms at DR2A LO input.

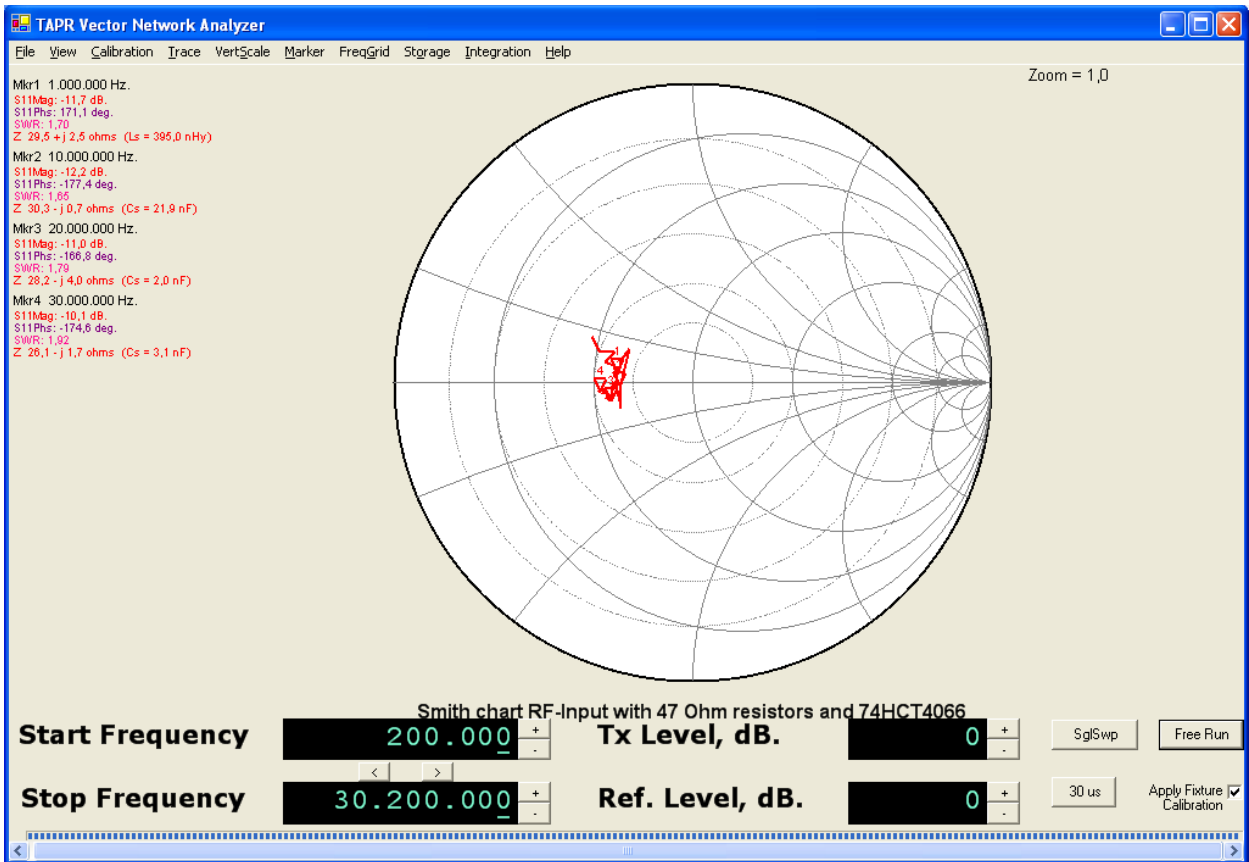


I tried to improve S11 of DR2A receiver and I suggested Norbert to change resistors 33 Ohms in S/H detector to 47 Ohms. Results are down and improvements are not evident except that we have better out of band termination.

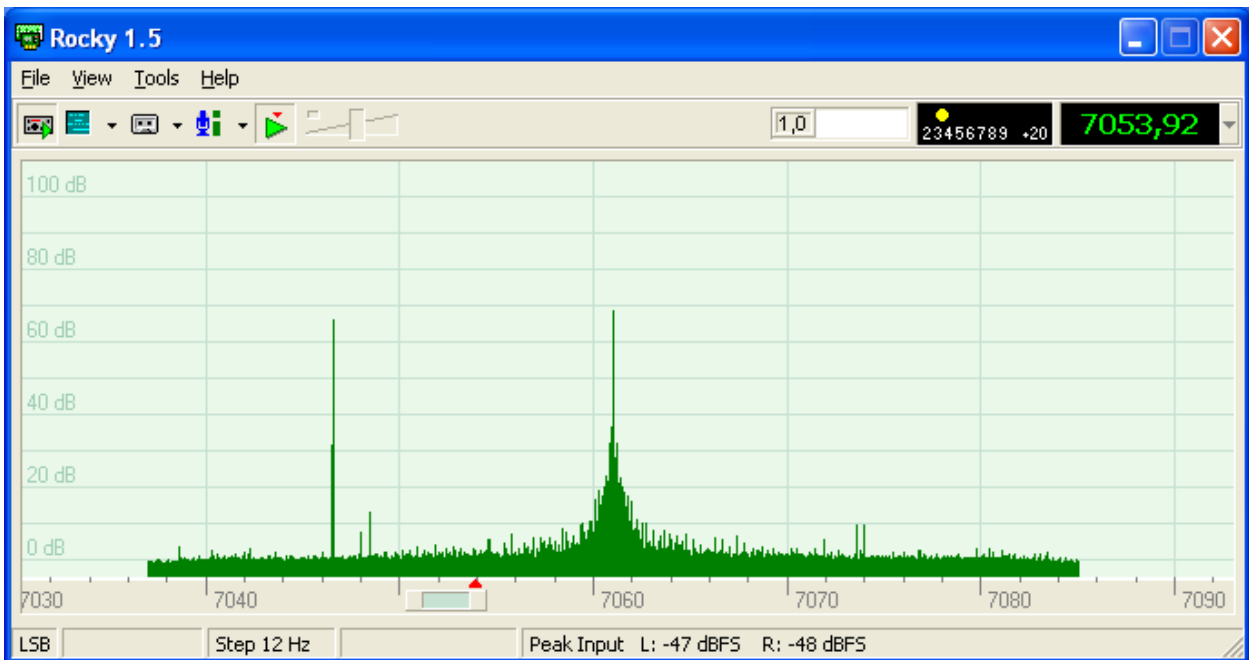


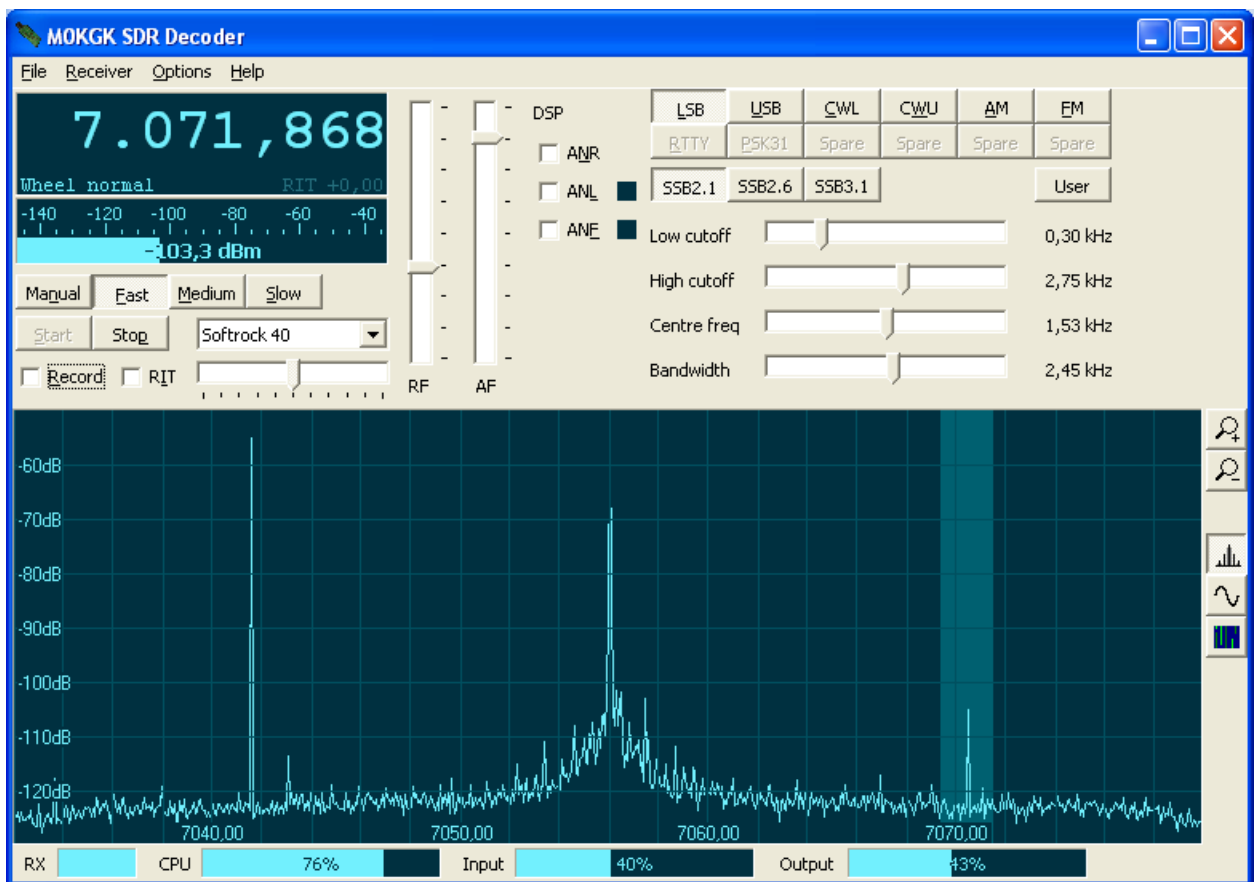
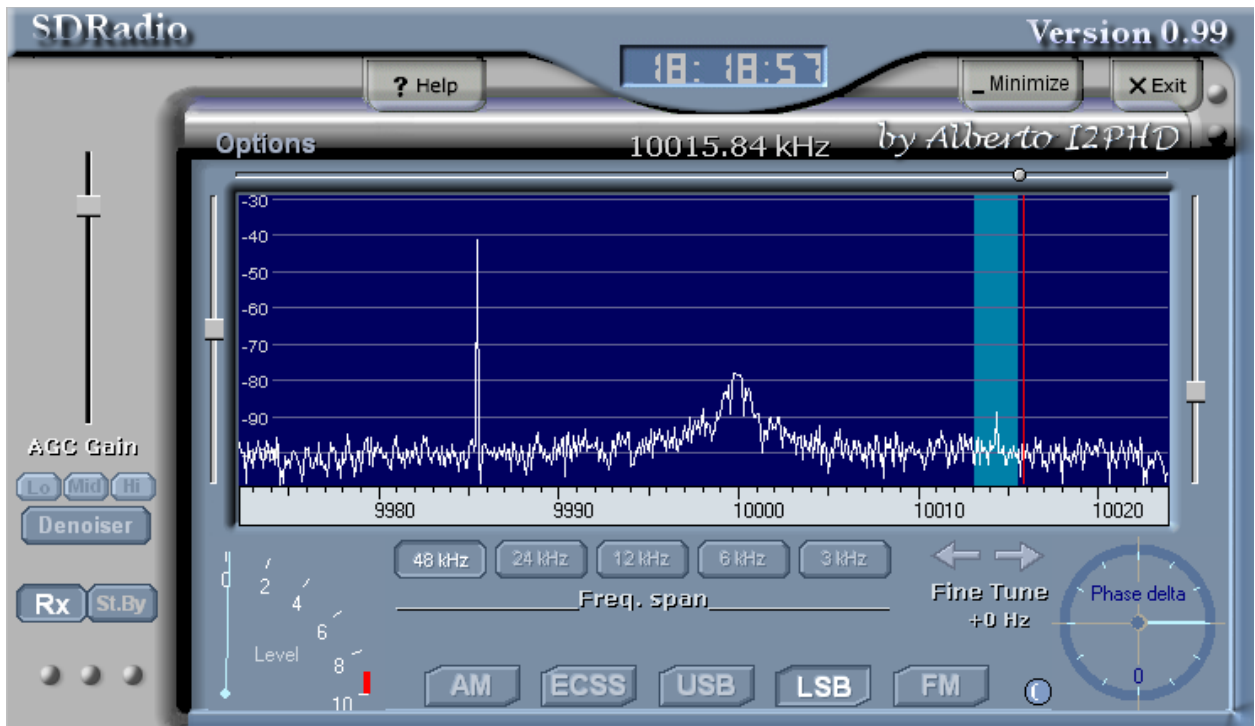
Norbert had change IC in S/H detector 74AC4066 with a 74HCT4066 and results are better



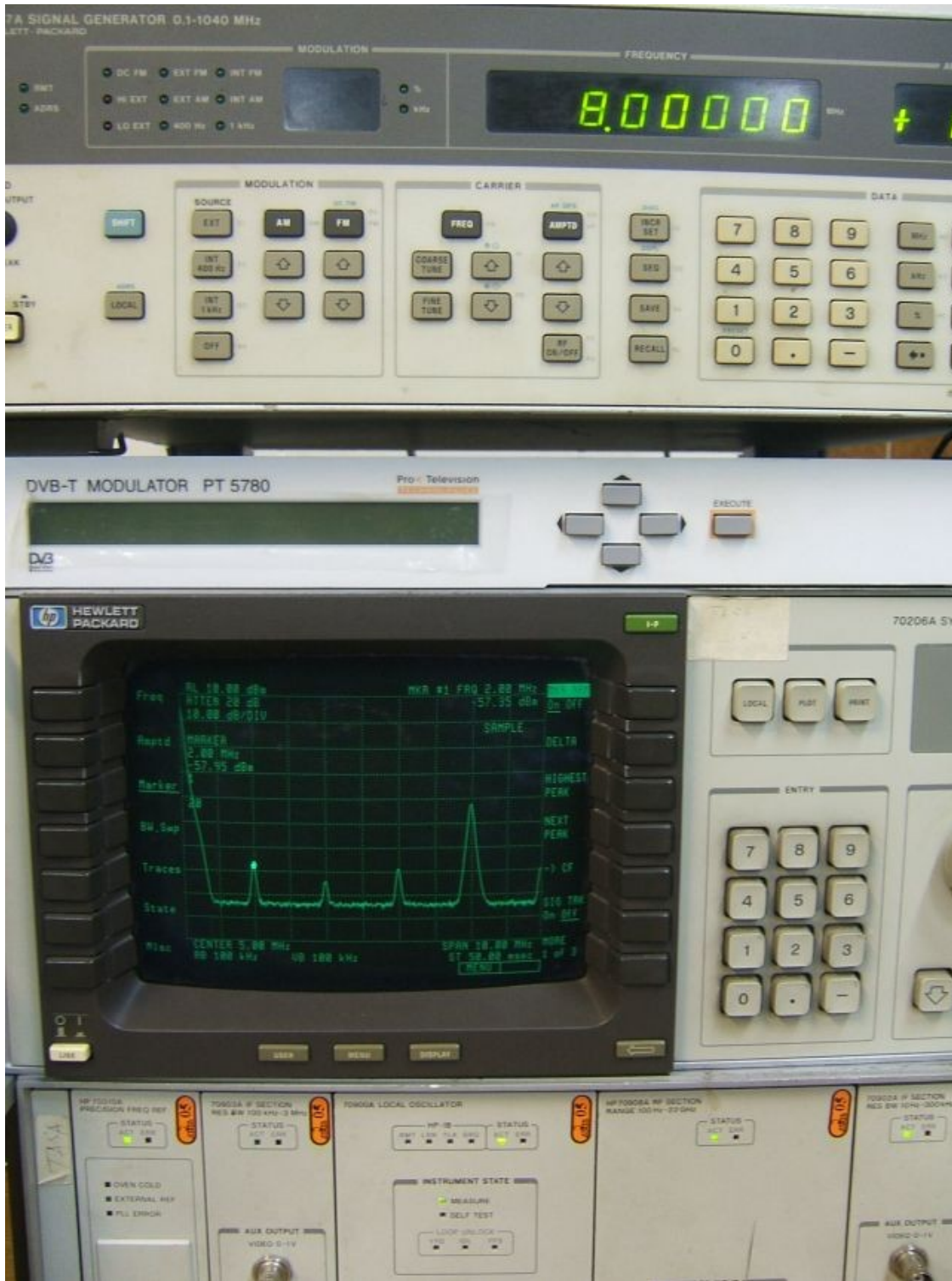


Norbert made image measurements in few programs also, see screens shots down :

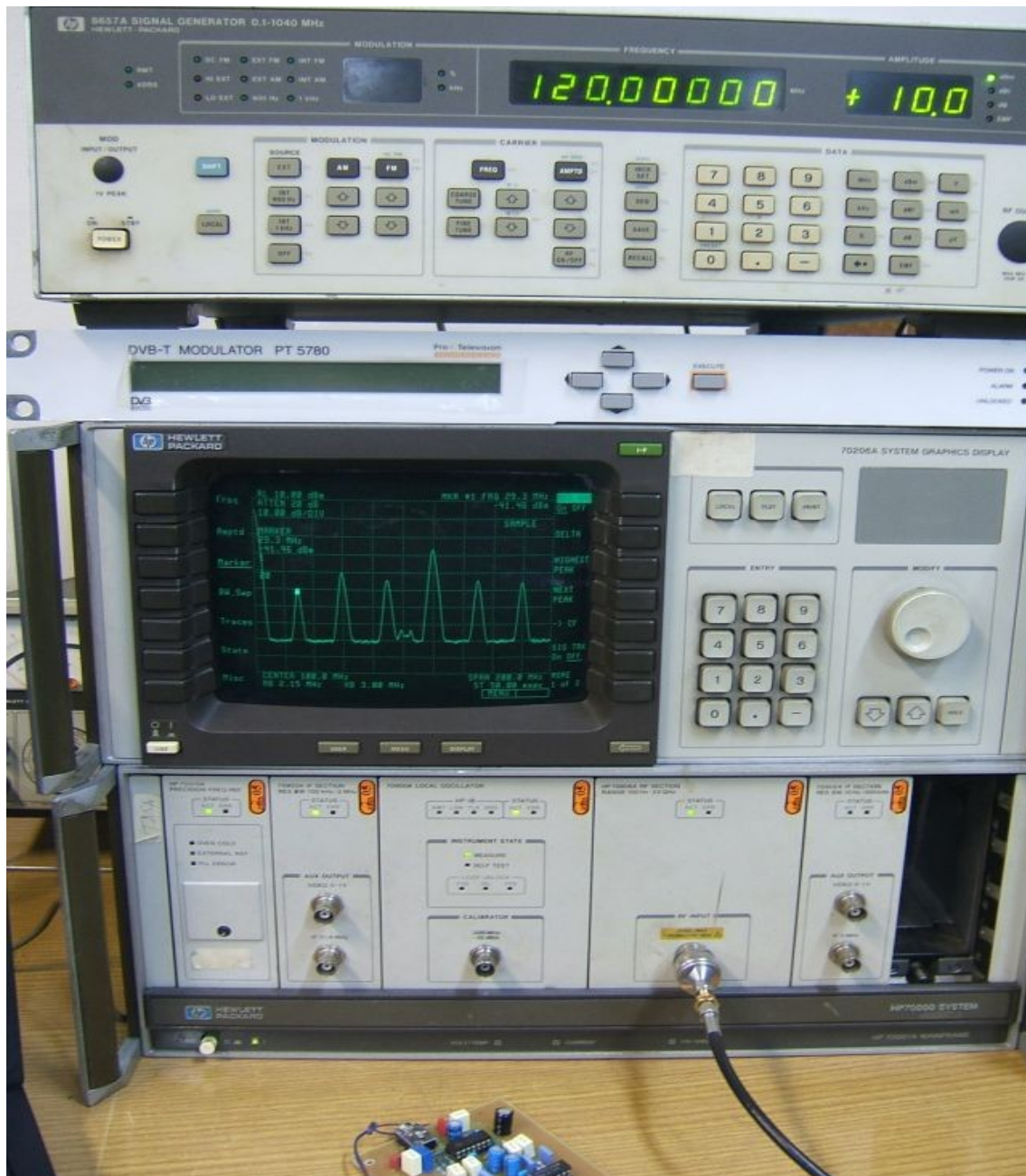




The main discussion between us was about LO isolation and LO leakage at DR2A RX input. It is hard to define LO power because it is not terminated (square LO power measured at 50 Ohms are between +15 dBm to +17 dBm). Because of that I bring you absolute level measured on AS spectrum analyzer screen. Pictures are for the DT2A transmitter but pictures for DR2A are very similar few dB up or down. Here we can see 50/50 % duty ratio advantage over multiplexer 1/4 widely used in other SDR designs. Top level at AS are +10 dBm. This kind of receiver because of that has small or neglected sensitivity to the harmonic receiving.



At first picture RX tuned at 2 MHz you can see that is LO leakage at level -58 dBm or assuming that is LO level +10 dBm LO rejection is 68 dB!!! Similar results are for 2 (lower than receiving frequency as results of perfect 50/50 % duty ratio miss of even harmonics), 3 harmonic and only LO fundamental (4 time the receiving frequency) is passing by out with higher level -33dBm absolutely. Situation at higher frequencies isn't good as it is at 2 MHz but it is still very good if we have at mind that is single side PCB RX realization



At receiving frequency 30 MHz LO leakage is at level -42 dBm absolutely level. It is LO suppression of 52 dB!!! Other harmonics have now higher levels because of finite slew rate and turn ON/OFF times for switches inside IC 74HC4066. LO fundamental (4 time the receiving frequency) is now rejected only 28 dB or absolutely level is -18 dBm.

VY 73/72 GL in SDR homebrew Tasa YU1LM/QRP