Vector Network Analyzer
Coax Cal using TRL on Ref. Plane A-B

Port 1

Port 2

Insert TRL Standards here

Resonators

Tuner 2 (fo)

PHT (2fo) and Tuner(fo)

A

B

Fixture or Probe Station

ConA.S2P

ConB.S2P

ConC.S2P

1.1.

The steps to follow for system and "in-situ" tuner calibration are as follows:

a) <u>Preparation and Setup Calibrations</u>

1. Calibrate VNA on coaxial reference plane A-B (Strongly recommended: TRL);
2. Initialize Tuner 1, Tuner 2 and PHT section;
3. Remove the resonator of the PHT section of the Combo tuner;
4. Do TRL Calibration of the complete setup, using TRL standards in the test fixture (or wafer probe station); This function is available in WinNoise →CALIBRATION→COMPONENT→TRL(MEAS);
5. Save the result in two files: **ConA.S2P** and **ConB.S2P**;
6. Measure S-parameters from A to B (having inserted a THRU-Line in the Fixture), to produce a file as **ConC.S2P**;

b) <u>Tuner Calibrations</u>

7. Calibrate Tuner 2 with option "de-embedding" using ConB.S2P as <u>output</u> file;
8. Calibrate Tuner 1 with option "de-embedding" using ConC.S2P as <u>input</u> file; In the "more" option, **de-select "Combo" and "2fo", "3fo"**

Calibration Group number should be given, for example 8. Then the software will calibrate the fundamental tuner section only and a calibration file will be produced as T18xxxxx.CAL (xxxxx = fo in MHz).

9. Insert the resonator in the PHT section of the Combo tuner.
10. Calibrate the Combo tuner again with option "de-embedding" using ConA.S2P as input file;
    At this time, go to "more" options, **select "Combo" and "2fo".** Also select a Calibration Group number different than the previous one in order to avoid over-writing the cal files you generated in step 8. For example, use group number 9.

    The software will calibrate the harmonic section first (H19yyyyy.CAL, yyyyy = 2fo in MHz), then the fundamental section (T19xxxxx.CAL, xxxxx = fo in MHz).

    Finally when loading the tuner calibration files in the WinPower "Load Setup" menu option, select Group 8 for CCMT (T18xxxxx.CAL, fundamental) and Group 9 (H19yyyyy.CAL) for PHT (harmonic tuner).
    The number selection 8 and 9 are arbitrary, as long as you use different ones. It is best to erase the fundamental tuner calibration files with group number 9 (T19xxxxx.CAL) because they are wrong!! in this case and may lead to confusion later.

SUMMARY on how to Calibrate an Output Combo Tuner "in-situ"

1. Calibrate Fundamental (CCMT) section + De-embed the whole Setup (ConC.S2P) as Input, save as T1Mxxxxx.CAL (xxxxx=fo/MHz)
2. Calibrate Harmonic (Combo) section + De-embed only the opposite side of the Setup (ConA.S2P) as Input, save as H1Nyyyyy.CAL (yyyyy=2fo/MHz)
3. Load in Setup as: CCMT → Cal Group 'M';   PHT → Cal Group 'N';

For calibrating a Combo tuner at the input you reverse the order:

1. Replace all tuner numbers 1 with 2 and
2. Replace ConA.S2P as Input with ConB.S2P as Output in the all Calibration with De-embedding dialogues.

After the calibration is done, calibration points will be shrunk on the Smith Chart and shifted a bit off the center, comparing with the calibration points done by using standard calibration.
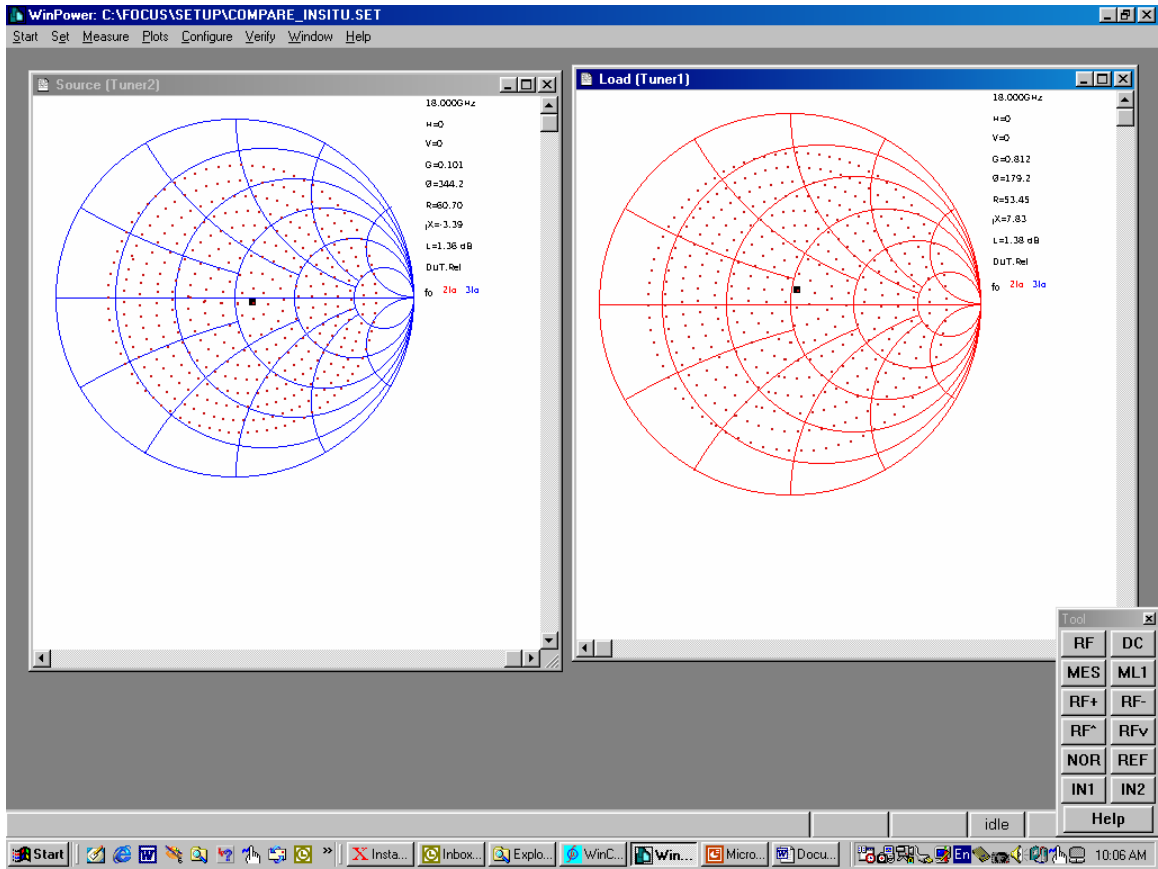It is normal, because the losses are bigger for IN-SITU, especially on higher gamma. For example, for the load tuner calibrated in a standard way and low gamma (S_{11}=0.05) the loss is around 0.6dB, for the IN-SITU calibrated load tuner and similar gamma the loss is around 1.38 dB.

If the gamma is very high (S_{11}=0.92) for the standard calibrated load tuner loss is around 4.8dB, for the IN-SITU calibrated tuner loss is around 10dB. For the same position of the tuner's slug, in which standard calibrated tuner easily obtains reflection of 0.92, IN-SITU calibrated tuner obtains around 0.75 reflection(S_{11}), because of the much higher losses. The same things happen with the source tuner calibrated IN-SITU versus the source tuner calibrated standard. The only difference is, here the S_{22} parameters differ for the same position of the tuners' slugs, especially on higher gamma, because of higher losses. Everything described can be seen from the pictures below.

Picture 1.2. shows calibration points of the load and source tuner calibrated using standard method (just tuners).
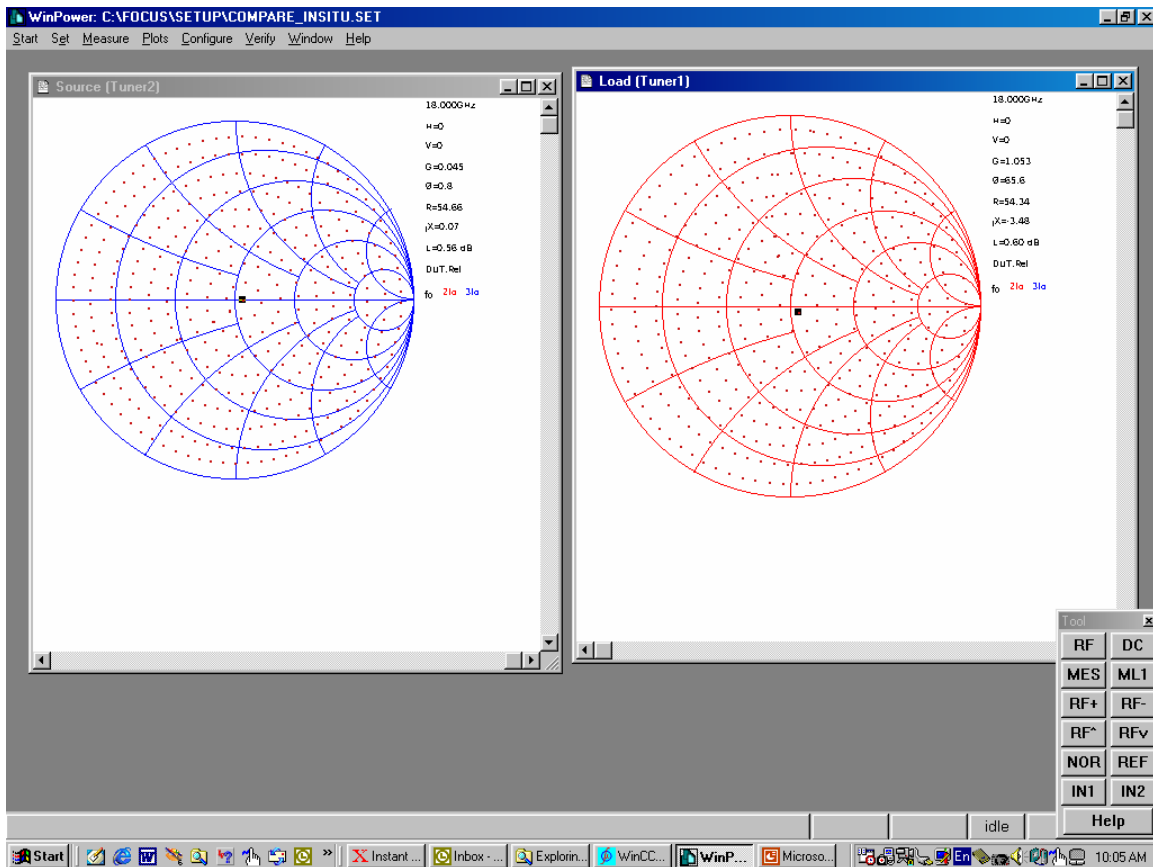
1.2.

Pic. 1.3. shows calibration points of the source and load tuner calibrated IN-SITU(i.e. tuners, cables to DUT and output connections).

1.3.