277 Lakeshore Road
Pointe-Claire, Quebec, H9S-4L2, Canada
Tel 514-630-6067 Fax 514-630-7466
E-mail: focusmw@compuserve.com

Product Note 38

SPAR, S-Parameter Measurement Software with Adapter Removal Capability

SPAR software allows to measure S-parameters of active and passive components using any Hewlett-Packard or Wiltron network analyzer and de-embed to DUT reference plane. SPAR allows to calibrate test fixtures using TRL standards (Thru-Delay-Reflect) and has Adapter Removal capability. This allows to measure S-parameters of components with one coaxial and one microstrip terminal, like matching networks of amplifiers.

Description of SPAR

SPAR contains essentially four modules:
1- Main Menu Shell, which allows User selections and access to data
2- Data Acquisition module, which configures and reads the network analyzers
3- TRL Calibration module
4- Data Manipulation and De-Embedding module.

The Main Shell Module (figure 1) allows to enter comments regarding the device to be tested (DUT), select the frequency list to be used (up to 201 frequency points in Fmin-Fmax-Fstep format), and choose the de-embedding status of the measurement (DUT reference plane or VNA reference plane). It also allows to initiate the fixture TRL calibration and decide of the status of the Adapter Removal operations.

The Data Acquisition module includes GPIB drivers for the following network analyzers: Hewlett-Packard 8510 B, C, 8720 A-C, 8753 A-C and 8753 D and Wiltron 360 A, B and 37000 series. The SPAR software assumes the network analyzers to be calibrated at the reference plane at which the test fixture is being connected. This calibration may be coaxial or microstrip. The data received in binary format from the analyzers are then processed internally according to the de-embedding status selected by the User and saved in ASCII format (.S2P format) on the hard-disk.

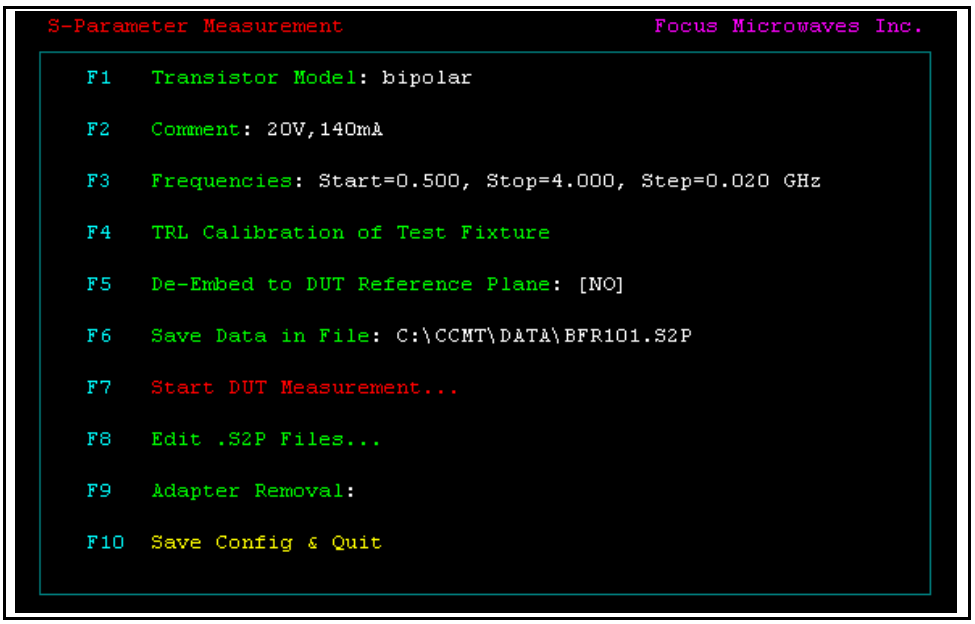
The TRL Calibration module contains the generic TRL algorithm used in all FOCUS' calibration software. This algorithm is very robust and allows wideband calibrations

Product and Company names listed are trademarks of their respective companies and manufacturers.
©Copyright 1997 Focus Microwaves Inc. All rights reserved

with only one DELAY standard required, in addition to a THRU and two REFLECTS. The characteristic impedance of the DELAY can be different than 50 Ω. This is very useful when

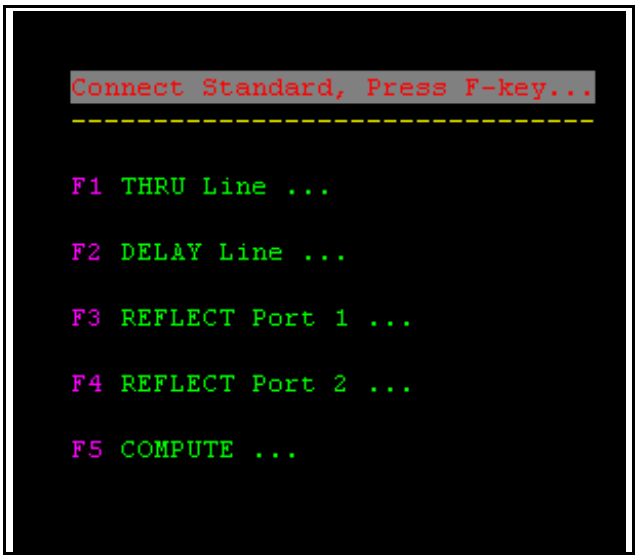
characterizing transforming test fixtures. If the two opposite sections of the test fixture to be calibrated have different characteristic impedances the TRL algorithm still works as long as the DELAY line characteristic impedance is the geometrical average of the impedances of the two sections.

The Data Manipulation and Deembedding module uses the test fixture calibration data to de-embedd to the DUT reference plane. A special feature of this module is **Adapter Removal**. Adapter Removal in the software SPAR consists of replacing one (or both) test fixture blocks (after been calibrated) by the ideal matrix of a THRU line and execute normal de-embedding. In this case the S-parameters of a section included in place of the original test fixture section will be measured accurately, even if this section has a coaxial terminal on one side and a microstrip terminal on the other side.
This feature is very useful for accurate characterization of complex input or output matching networks of amplifier's, oscillators or other component's stages, which cannot be measured otherwise, since it is normally extremely difficult to perform mixed coaxial-microstrip calibrations of a network analyzer using normal calibration standards.



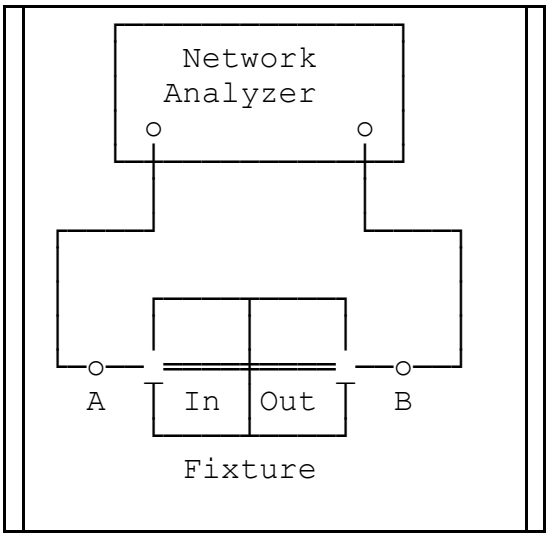
TRL Calibration

SPAR's TRL calibration applies normally to a microstrip test fixture or a wafer probe station, but can also be used for coaxial calibrations. Since it uses an 8 term error model, however, this calibration will not consider the cross-talking terms (isolation).
The menu of TRL calibration is structured as shown in figure 2. It is similar to menus used by network analyzers and it allows to select the TRL standards independently in any sequence in order to minimize manipulations and and also be able to repeat their measurement without being forced to restart from the beginning, before computing the S-parameters of the test fixture.



```
! Test Fixture S-Parameter: Freqs=0.5000 4.5000 Step 0.0200
! Output Section
! Freq    S11               S12               S21               S22
! ------------------------------------------------------------------------
0.500000 0.122163 0.047283 -0.622052 -0.728882 -0.622052 -0.728882 0.007183 -0
0.520000 0.132436 0.050601 -0.691971 -0.665103 -0.691971 -0.665103 -0.015144 -
0.540000 0.128165 0.047278 -0.748048 -0.599292 -0.748048 -0.599292 -0.040432 -
0.560000 0.128791 0.044728 -0.801900 -0.530294 -0.801900 -0.530294 -0.050838 -
0.580000 0.133487 0.043839 -0.847619 -0.452554 -0.847619 -0.452554 -0.067352 -
0.600000 0.139964 0.045424 -0.885945 -0.370590 -0.885945 -0.370590 -0.085935 -
0.620000 0.140132 0.048883 -0.918683 -0.288413 -0.918683 -0.288413 -0.095956 -
0.640000 0.143003 0.048586 -0.938743 -0.202815 -0.938743 -0.202815 -0.108950 -
0.660000 0.146029 0.045664 -0.951864 -0.117140 -0.951864 -0.117140 -0.117225 0
0.680000 0.150011 0.041267 -0.956214 -0.025472 -0.956214 -0.025472 -0.117262 0
0.700000 0.149863 0.047607 -0.956689 0.063641 -0.956689 0.063641 -0.112901 0.0
0.720000 0.154293 0.041361 -0.942594 0.151016 -0.942594 0.151016 -0.107402 0.0
0.740000 0.162768 0.039241 -0.928010 0.236715 -0.928010 0.236715 -0.092757 0.0
0.760000 0.165099 0.036632 -0.899840 0.321818 -0.899840 0.321818 -0.077334 0.1
0.780000 0.167640 0.029598 -0.863463 0.402773 -0.863463 0.402773 -0.060876 0.1
0.800000 0.175227 0.024869 -0.823329 0.477381 -0.823329 0.477381 -0.043815 0.1
0.820000 0.174168 0.020004 -0.773030 0.553065 -0.773030 0.553065 -0.020133 0.1
0.840000 0.181537 0.010767 -0.720424 0.618491 -0.720424 0.618491 0.001048 0.15
```

Adapter Removal



We define, in this context, as Adapter Removal, the capability of the software to de-embedd automatically only part of the test fixture, and be able, this way, to measure S-parameters of another section which is placed in the fixture in place of the original adapter. If the network analyzer is calibrated on refernece plane A-B anhd TRL is performed for the test fixture insereted between A and B (figure...) then any device placed in the centre of the test fixture X can be characterized and its S-parameters measured at X reference plane. The "In" and "Out" blocks can be replaced by other sections to be measured directly. In this case the software will replace the matrix A-X or B-X correspondingly by the ideal Thru-line matrix and perform de-embedding as usual. But then only the non-replaced block will be corrected for and we will