

## Calibration Definitions

### Calibrations in a Load Pull System

The term "Calibration" or "Calibration File" is used throughout the L/P system with different meanings:

**Network Analyzer (VNA) Calibration:** Using a set of coaxial or waveguide standards and VNA internal software we determine the Calibration Coefficients, that allow us to make measurements at reference planes other than the VNA internal ports. The best, most accurate and efficient, calibration technique with regard to Load Pull and programmable tuner operation we found to be Thru-Reflect-Line (TRL).

A VNA calibration file contains all error terms for all calibration frequencies (up to several hundred frequency points)

A VNA calibration should be repeated frequently; depending on the VNA model several times a week, or even every day.

**Tuner Calibration:** This is in reality a "tuner characterization" procedure, in which the tuner two-port S-parameters are measured using a, previously calibrated, VNA at a certain number of mechanical positions (states) for one given frequency  $f_0$  (and possibly its harmonics  $2f_0$  and  $3f_0$ ). The tuner calibration files are saved on hard disk and contain a table with S-parameters as a function of motor (or tuner probe) positions, one file per frequency. Best results are obtained when the VNA is calibrated using TRL.

The tuners should be recalibrated only once every few months and only if they have been dis- and re-connected frequently.

**Setup Calibration:** This is a characterization of all component two-ports included in the load pull setup; it is done using a VNA. All 4 S-parameters of each component are measured and saved in .S2P type ASCII files on hard disk.

Setup calibrations can be used for unlimited time.

**Test Fixture Calibration:** This procedure uses, in general, a custom-made TRL method to characterize the two halves of the test fixture. FOCUS' own TRL algorithm, which is part of the basic software package, uses simple standards (Open (Short) - Thru - Line) and allows full test fixture characterization, not assuming symmetrical fixtures and allowing for quarter lambda transformers and bias networks to be included on the fixture. Test fixture calibrations are saved on hard disk as .S2P ASCII files and can be used indefinitely.

Wafer Probe Calibration: The wafer probes and the cables connecting them to the tuners are treated by FOCUS' calibration software the same way as an ordinary test fixture (see above).

In-situ Tuner Calibration: This is a technique that allows us to characterize both fundamental and a single harmonic tuner at  $f_0$ ,  $2f_0$  and  $3f_0$ , without removing them from the setup . In order to do so we must calibrate the VNA at the input and output port reference plane of the setup and then "de-embed" to the tuner reference plane. This option is standard with the basic FOCUS software. However Isolators can not be part of the calibrating section of the setup.