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Application Note 23

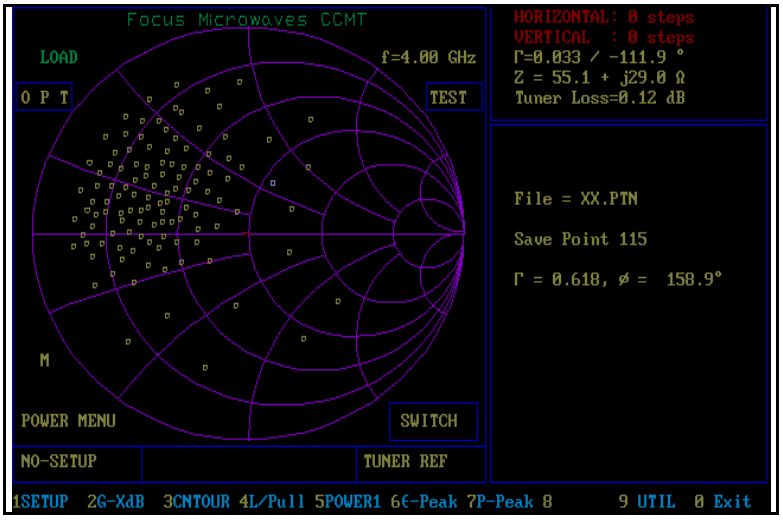
Selective Load Pull using Pattern and Section Tuning

The CCMT load pull measurement software allows selective load pulling of transistors in any area of the Smith Chart. This is possible either by defining an impedance pattern point by point using the mouse or a rectangular zone on the Smith Chart to be included or excluded from the measurement area. As a result the measurement speed is increased and uncontrollable oscillations avoided. The low pass nature of Focus tuners also eliminates parasitic low frequency oscillations which can be destructive for the devices. A "sample and measure" feature allows to commute between load impedances following a "minimum VSWR" path and avoids crossing through instability regions.

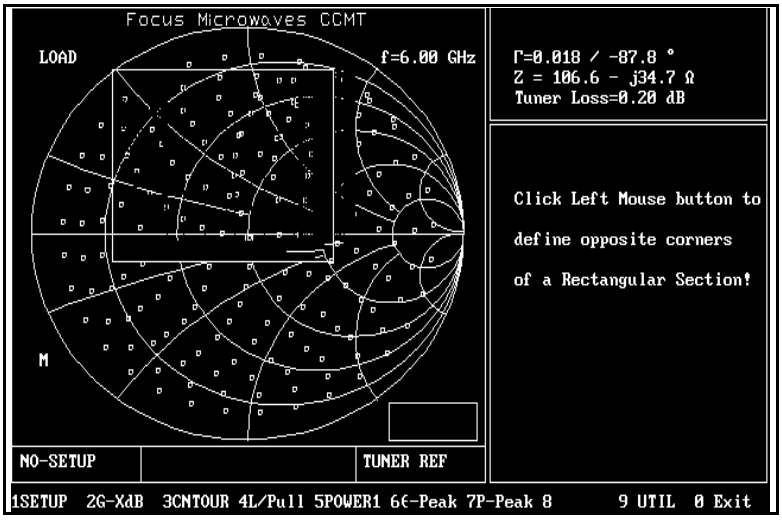
Introduction

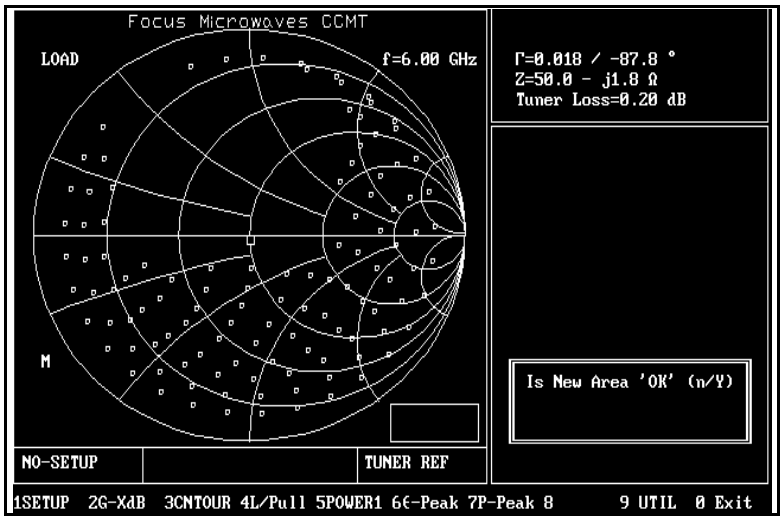
Load Pull measurements on high power transistors requires a lot of precaution in order to avoid uncontrollable oscillations and other parasitic effects that may falsify the measured data or even destroy the devices. If testing is made manually, careful inspection of the instruments may help to avoid these phenomena. Manual load pull however is not sufficient, because of inadequate setup corrections and large amount of time required to perform the tests.
Automated load pull systems tune to a number of impedances automatically and measure power, gain, efficiency, intermod etc. with the capability of graphical presentation of the results lateron. During the measurement many things can happen. The transistors may oscillate. This will falsify the data or destroy the devices. Or, DC bias may drop to very low values and the system will display an non-meaningfully high efficiency. Also, if the tuners have non-negligible reflection at frequencies below the lowest operation frequency, this may create, due to the high internal gain of the devices, additional parasitic oscillations, which are often destructive. Reflections caused by the tuners at high frequencies, on the other hand, is not so disturbing, since the gain of the devices at high frequencies is in general lower.
Focus tuners use low pass transmission airlines and metallic probes, thus eliminating the latter cause of problems. CCMT software includes features that allow to load pull in selected zones of the Smith Chart only without causing parasitic oscillations. These features are the subject of the present note.

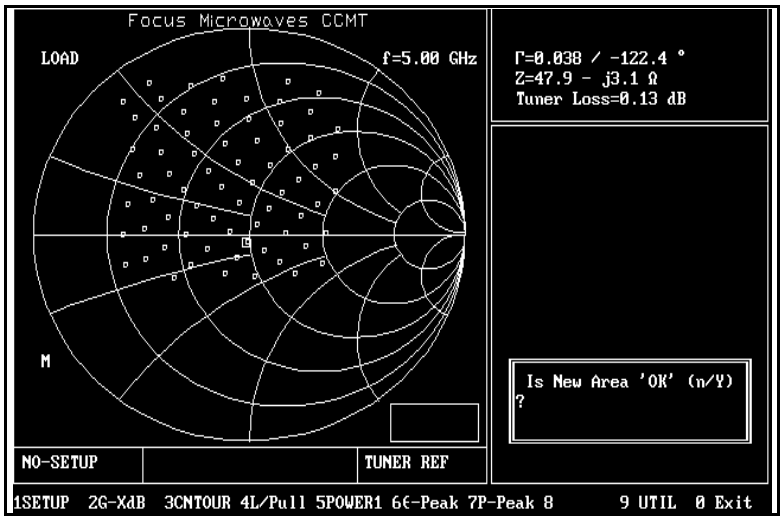
A **Pattern** is an arbitrary selection of impedance points on the Smith Chart, which can be used for automatic load pull. Pattern points are defined using mouse clicking and their impedance values (not tuner positions) are saved in a pattern file on disk (figure 1). Patterns can be recalled and re-used at any other frequency and they always generate the same impedances, independent of frequency. Any point within the tuning range of the tuners can be included in a pattern. CCMT software permits to include not only tuner calibration points but also any interpolated point between them. The same impedance pattern can be used both at load and source side of the DUT, and this independently whether it has been generated on the other side of the DUT. Pattern impedances are referred to DUT reference plane. A pattern can include up to 181 impedance points. A pattern permits a high resolution user defined measurement analysis in any load zone of interest for the transistor.



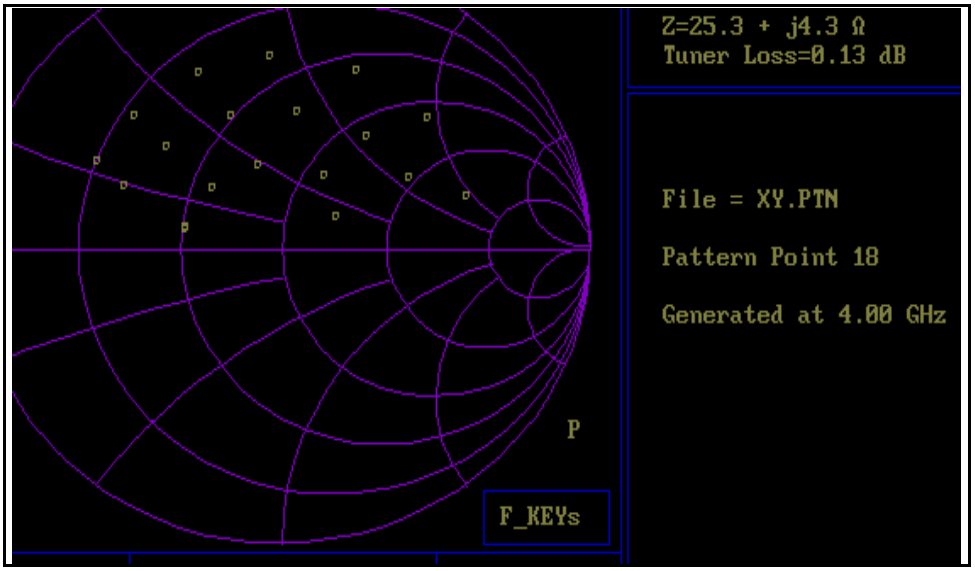
A **Section** is a rectangular zone of the Smith Chart that includes only tuner calibration points.
A section can be defined by mouse clicking on its opposite corners. The impedance points inside the zone can either be included or excluded from the measurement (figures 2,3,4). This permits to concentrate in a test area or to eliminate problematic impedance zones from the test.
A section is automatically saved in an internal configuration file and can be loaded, modified and used at any point of time. CCMT accepts different sections for input and output tuner. When switching between input and output the corresponding section is activated. If a new section is defined it replaces the old one.



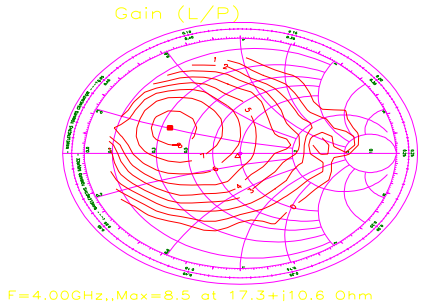




A **Minimum VSWR Path** is a route the tuner follows between measurement impedances in order to generate very low reflection factor at all frequencies and any point during movement. This can easily be done using CCMT tuners, since they present very low VSWR when the RF probes are pulled out of the airline. The special "minimum VSWR" routine moves the probe in and out of the airline between measurement points. This way each reflection point is tuned directly from the centre of the Smith Chart and it returns there immediately after the measurement, before changing the phase of Γ (figure 5). The "minimum VSWR" routine can be activated for normal load pull as well as section measurements. The disadvantage of this routine is that it takes longer to execute, since the RF probe has to be moved in and out of the airline between each measurement. The time required for this test is about 4 seconds more per point.



Measurement Data



A major advantage of using Pattern operation (figure 1) is that we can concentrate in a particular area of interest and collect a large number of data n this area. The contours in figure 6 have been generated using the pattern shown in figure 1, which has been placed near the expected optimum load impedance of the transistor. The fact that much less points are included in the remote areas of the Smith Chart may generate flawy contours in these areas but these are not important for the transistor evaluation.

References

[1] "Load Pull Measurements on Very Low Impedance Transistors", Appl. Note 6, Focus Microwaves, November 1993.

[2] "Measurement Routines of MTS and CCMT: A Comparison", Product Note 8, Focus Microwaves, February 1994.

[3] "High Resolution Tuners Eliminate Load Pull Performance Errors", Appl. Note 15, Focus Microwaves, January 1995.