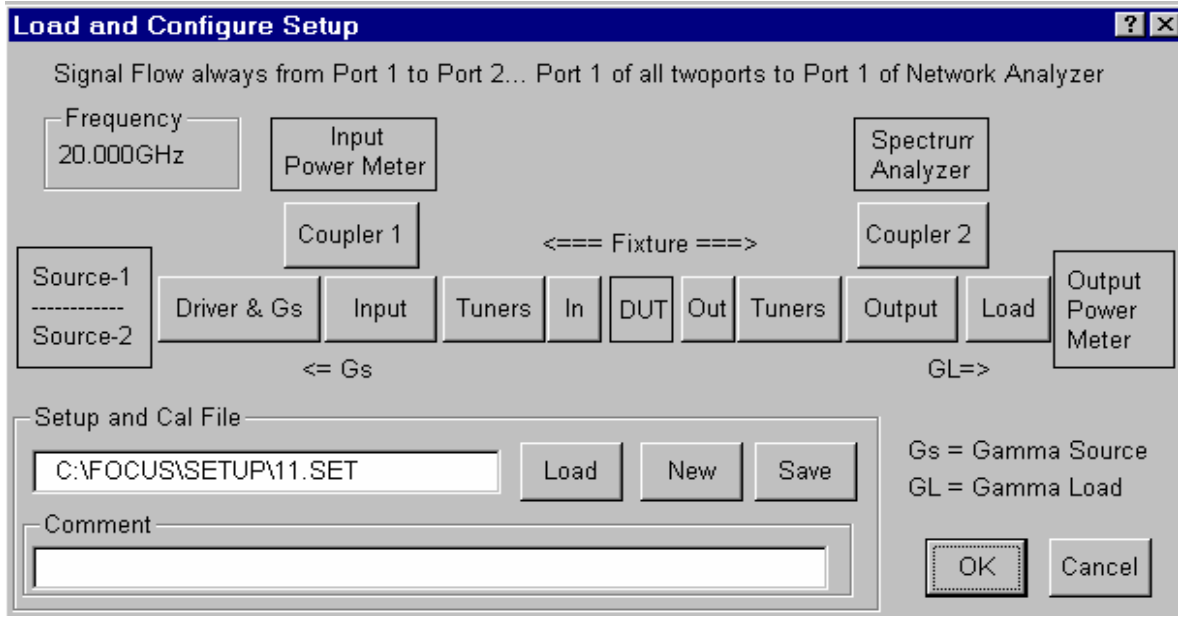
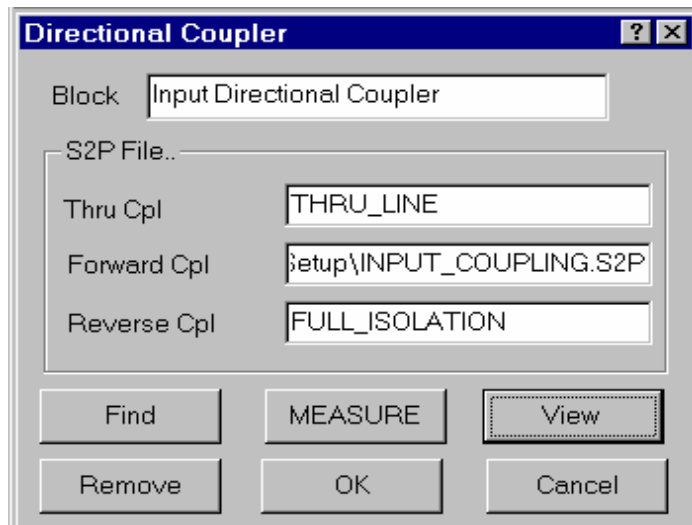


Load Pull Operation Procedure:

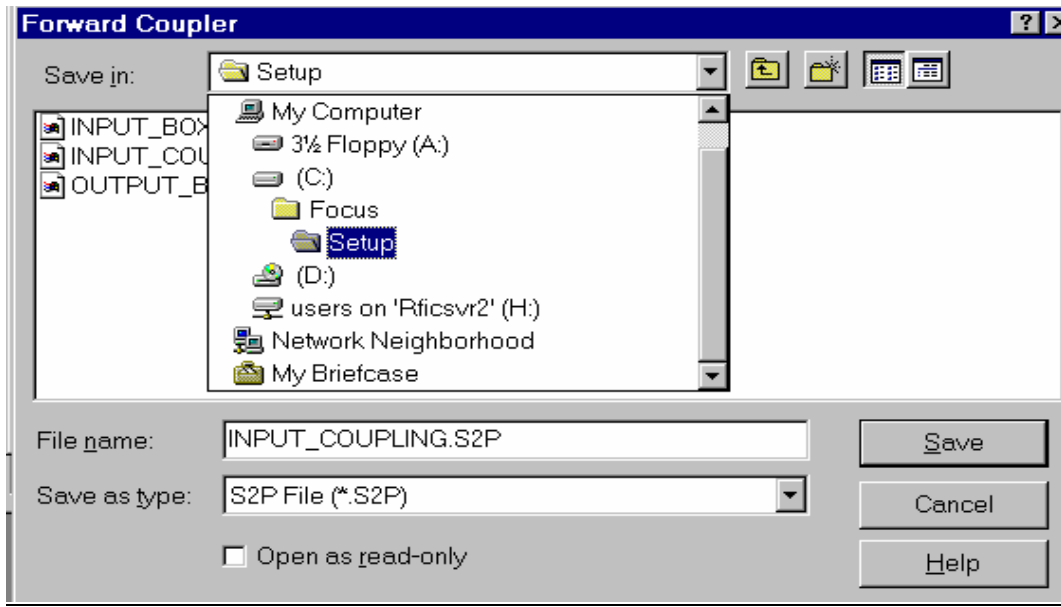
1. Calibrate Network Analyzer using a FOCUS TRL calibration kit.
2. To calibrate a tuner from **WinCCMT** → **Calibrate** → **Tuner Cal.**
 - a. Select **CCMT Cal.** The Tuner Calibration dialog box of WinNoise will appear.
 - b. Select a tuner to be calibrated in the Tuner (S/N) box.
 - c. Select number of points of calibration in the Resolution (points/frequency) box.
 - d. Select s-parameters to be calibrated in the Save Format box.
 - e. Select Standard or De-embed (for In-situ calibration) in the De-Embedding Option box.
 - f. The maximum Gamma shall be set to 0.90 in Max. Gamma box. For the CCMTs the maximum value will typically lie between 0.92-0.95.
 - g. Enter the frequencies (GHz) in the F1 F2 F2... box. Select Mode for the frequency operation List or Sweep.
 - h. Enter the file name (with .TCF extension) under which the calibration data is to be stored in File box.
//You don't need to input name which is for Noise measurement, nothing to do with Winpower.
 - i. Click the **More** button. Advanced Tuner Selection dialog box will appear.
 - j. For the power measurements ensure that the **Auto Export** box is checked in the CCMT Calibration Export section.
//Select calibrate group
 - k. Click on the **Start** button and another Tuner Calibration dialog box will appear.
//Select register if using the HP analyzer
 - l. Click on the **Measure** button to begin the calibration of the selected tuner.
 - m. When calibration is completed, this whole process is repeated for other tuners in the setup.
3. To calibrate the setup components from **WinCCMT** → **Calibrate** → **Setup.**
//Tuner calibration also can be achieved by this menu
 - a. The Load and Configure Setup dialog box of WinPower will appear.



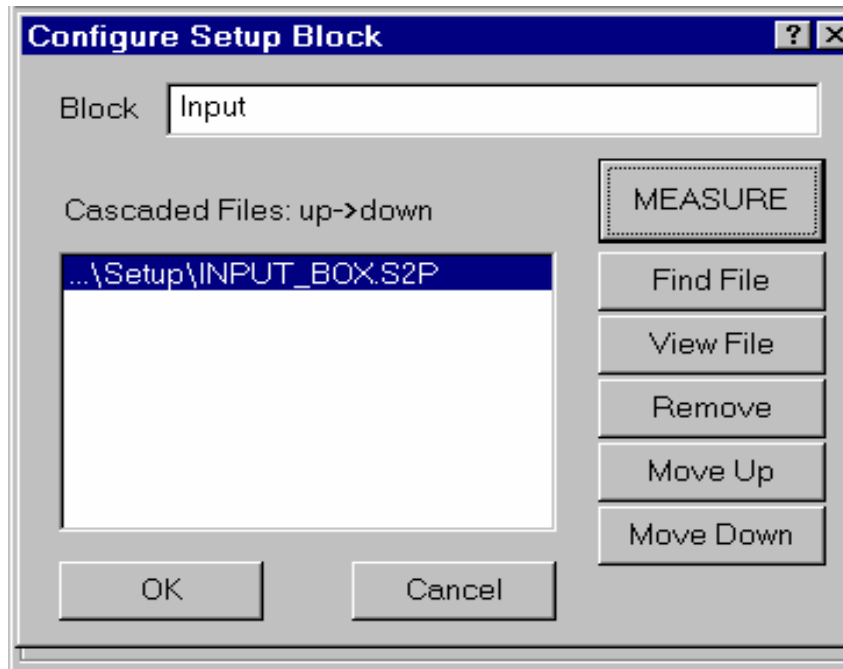
- b. Click on the **Coupler 1** button, the Directional Coupler dialog box will appear. If an isolator is used in conjunction with the coupler, the **Thru Cpl** and **Reverse Cpl** boxes of the S2P File section doesn't need to be considered. The **Forward Cpl** box can be left at the default option of "Full Coupling".



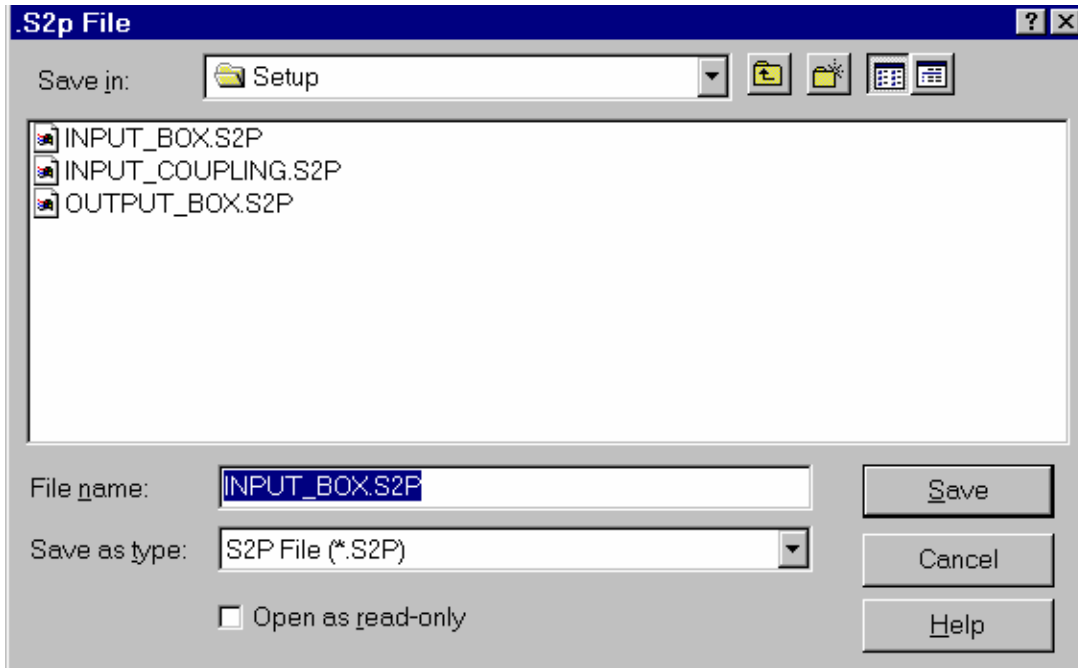
- c. Connect the network analyzer to the input and coupling ports of the coupler.
- d. Click on **Measure** button to calibrate. A dialog box will appear.



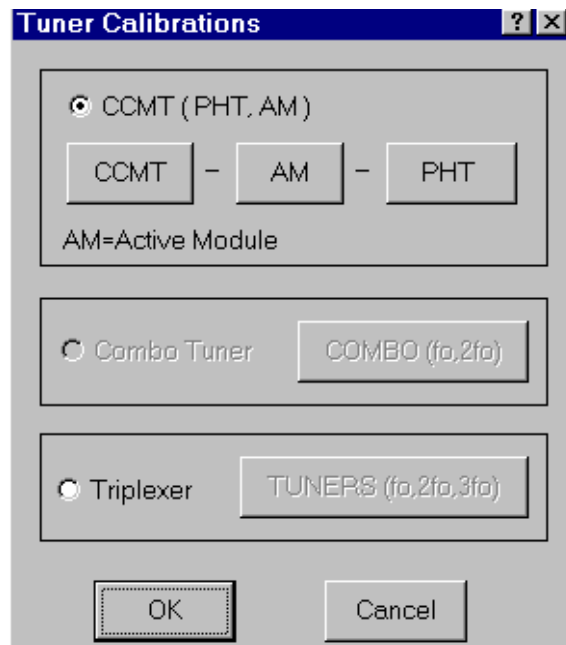
- e. Enter a file name for the input coupler s-parameters. Save the file with .S2P extension to C:/ Focus/ Setup folder.
- f. Click on the **Save** button.
- g. Connect the input components to the network analyzer and click on the **Input** button in the Load and Configure Setup dialog box. The Configure Setup Block dialog box will appear.



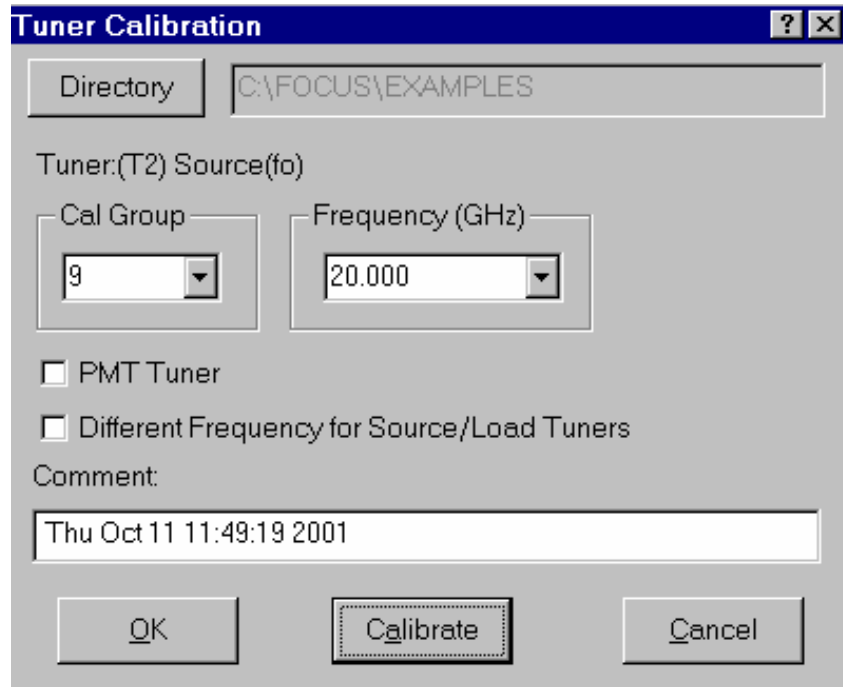
- h. Click on the **Measure** button to calibrate. A dialog box will appear.



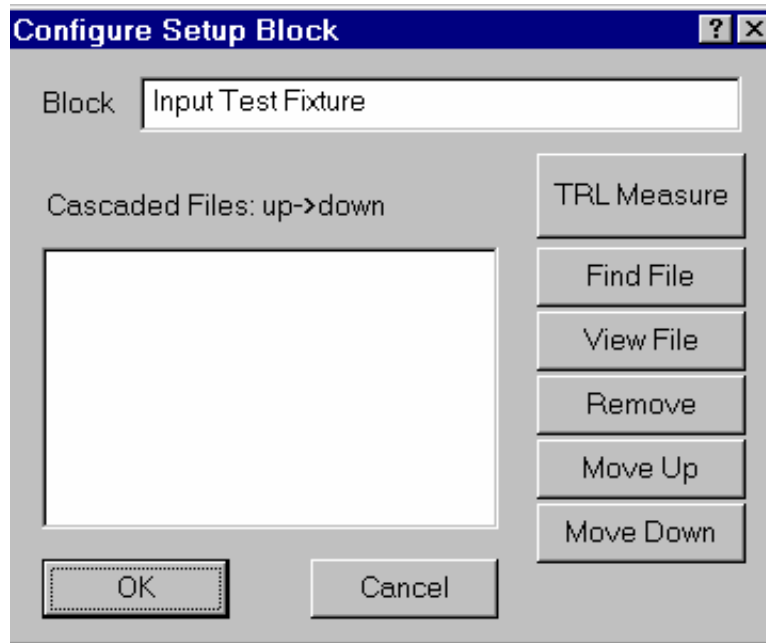
- i. Enter a file name for the input network s-parameters. Save the file with .S2P extension to C:/ Focus/ Setup folder.
- j. Click on the **Save** button.
- k. Click on the **Tuners** (input) button in the Load and Configure Setup dialog box. The Tuner Calibration dialog box will appear.



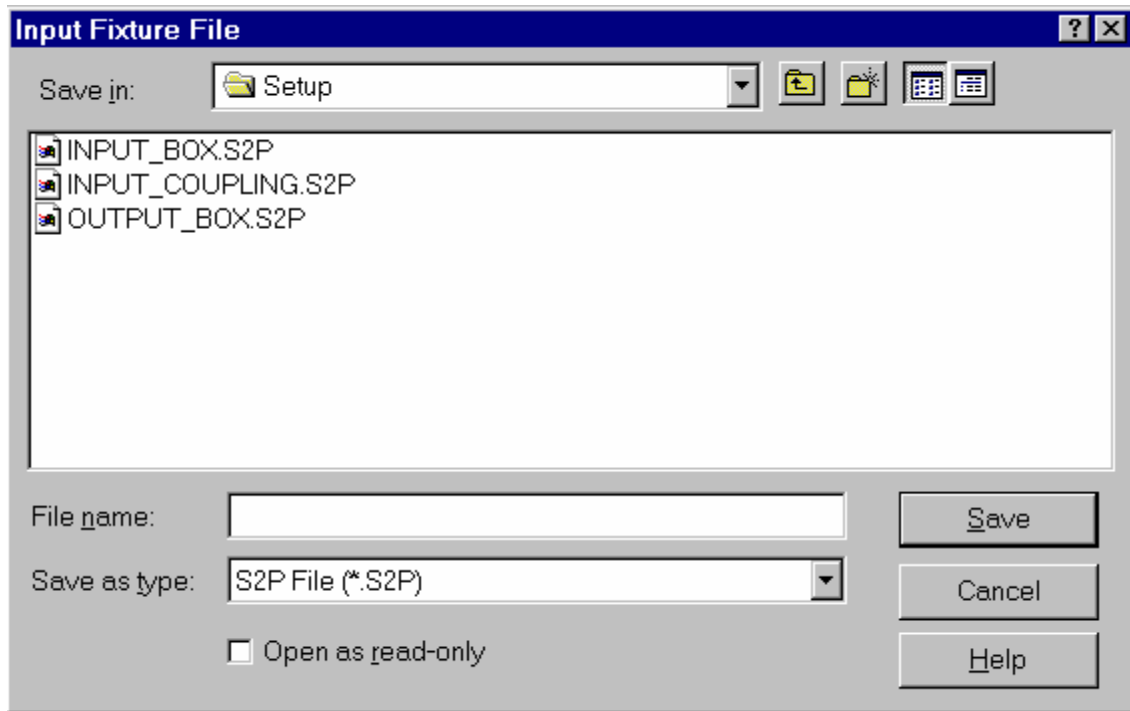
- l. Click on the **CCMT** button. Another Tuner Calibration dialog box will appear. If tuner hasn't been calibrated, connect the tuner to network analyzer and click the **Calibrate** button.



- m. Click on the **IN** button in the Load and Configure Setup dialog box for the test fixture calibration. The Configure Setup Block dialog box will appear.



- n. Click on the **TRL Measure** button. Enter a name for the file for Input test fixture s-parameters. Click on the **Save** button.



o.

Now your setup is ready.

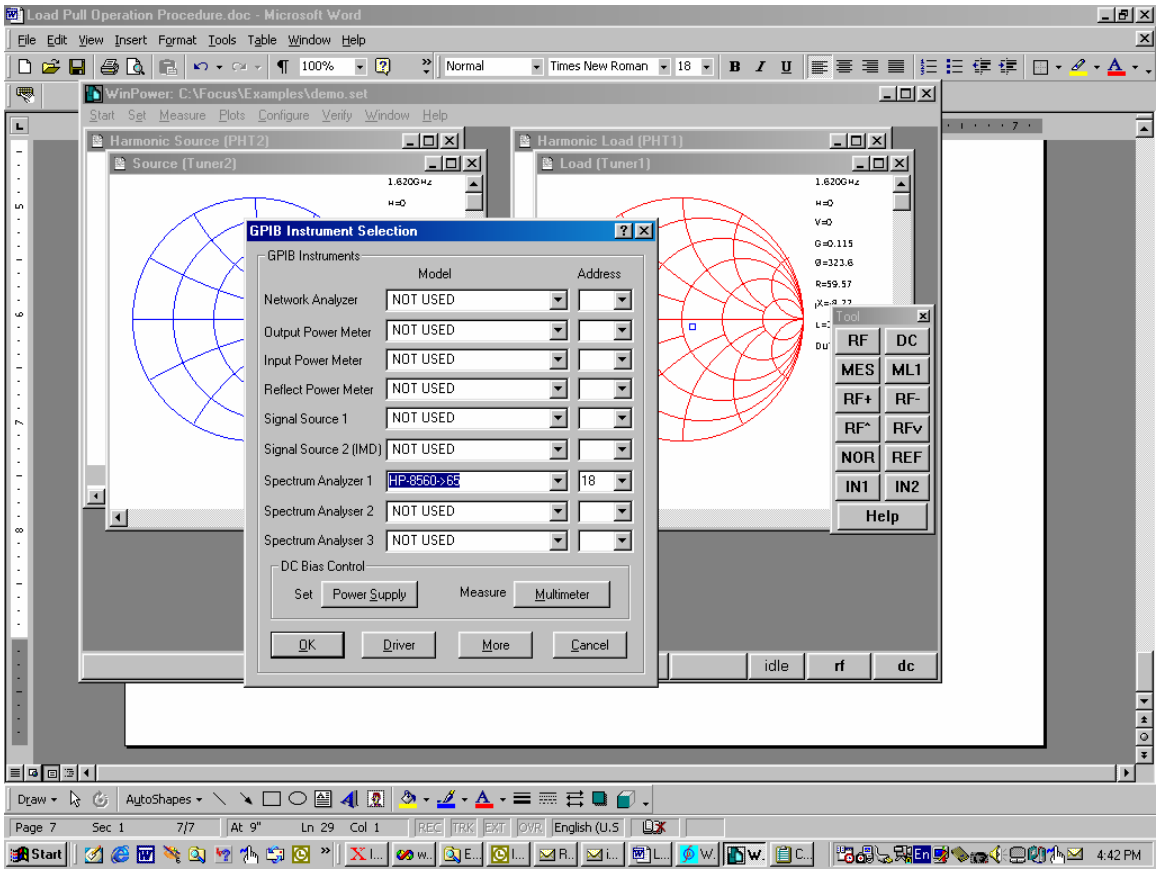
- 1) Bias your device properly. Don't forget select transistor type and reverse the cable for the input if your are testing FET.
- 2) Make a I-V curve to find the good bias point
- 3) Make a IV curve with RF signal, this will be the real situation where the transistor will work in. Be sure Pin at DUT reference plane is close to the real application. (refer to step 5)

Play with it in “design window” you will find best combination of several RF parameters

- 4) Select Bias again
- 5) Do power sweep in order to set the proper signal level at input of the device
- 6) Make a peak search of source tuner, looking for optimum transducer gain to match input of the device
- 7) Make a peak search of Load tuner, looking for optimum output power(or Gain)
- 8) Repeat 4), 5) one more time (“fine search” will also help for accuracy)
- 9) Do power sweep again to set proper source level
- 10) Select parameter before any measurement
- 11) Make a loadpull or other measurement
- 12) Display contour after loadpull
- 13) Process data in the Design window
- 14) You may make a source pull then.

Regarding ACPR and IMD

a)configure GPIB instrument of your spectrum analyzer



b)
Configure the spectrum analyzer parameters

Load Pull Operation Procedure.doc - Microsoft Word

File Edit View Insert Format Tools Table Window Help

Normal Times New Roman 18 B I U

WinPower: C:\FocusVExamples\demo.set

Start Set Measure Plots Configure Verify Window Help

Harmonic Source (PHT2) Harmonic Load (PHT1)

Source (Tuner2) Load (Tuner1)

Spectrum Analysis ACP Parameters

Create Setup IMD Parameters

Directories Harmonic Power

GPiB Instruments Oscillation Det.

Options / Limits 12.47

Config? 3.69

15 dB DuT,rel

1.6200 MHz

H=0

V=0

G=0.115

Q=323.6

R=59.57

$\rho_X=0.77$

Tool

RF DC

MES ML1

RF+ RF-

RF* RFv

NOR REF

IN1 IN2

Help

idle rf dc

Draw AutoShapes

Page 8 Sec 1 8/8 At 6" Ln 4 Col 1 REC TRK EXT OVR English (U.S) 4:43 PM

Load Pull Operation Procedure.doc - Microsoft Word

File Edit View Insert Format Tools Table Window Help

Normal Times New Roman 18 B I U

WinPower: C:\FocusVExamples\demo.set

Start Set Measure Plots Configure Verify Window Help

Harmonic Source (PHT2) Harmonic Load (PHT1)

Source (Tuner2) Load (Tuner1)

1.6200 MHz

H=0

V=0

G=0.116

Q=345.4

R=62.47

$\rho_X=3.69$

1.6200 MHz

H=0

V=0

G=0.115

Q=323.6

R=59.57

$\rho_X=0.77$

Tool

RF DC

MES ML1

RF+ RF-

RF* RFv

NOR REF

IN1 IN2

Help

idle rf dc

ACP(R) Parameter Configuration (Custom)

Channel BW (center) 10.000 kHz

Channel Samples 41

SideBand BW 10.000 kHz

SideBand Samples 5

SideBand 1 Offset 800.000 kHz

SideBand 2 Offset 1200.000 kHz

SideBand 3 Offset 0.000 kHz

SideBand 4 Offset 0.000 kHz

Span BW 5.00000 MHz

Sweep Time 0.100 Sec.

Configuration File

ACPPAR.ACP Open Save

Spectrum Analyzer 1

Measurement Mode

Marker CDMA Mode

Signal Type Worst Case

Averaging

Channel VBW AUTO kHz

SideBand VBW AUTO kHz

Resolution BW AUTO kHz

Software Average 1

Instrument Average 1

OK Advanced Cancel

Draw AutoShapes

Page 9 Sec 1 9/9 At 5.5" Ln 2 Col 1 REC TRK EXT OVR English (U.S) 4:44 PM

(i) ACP Parameters

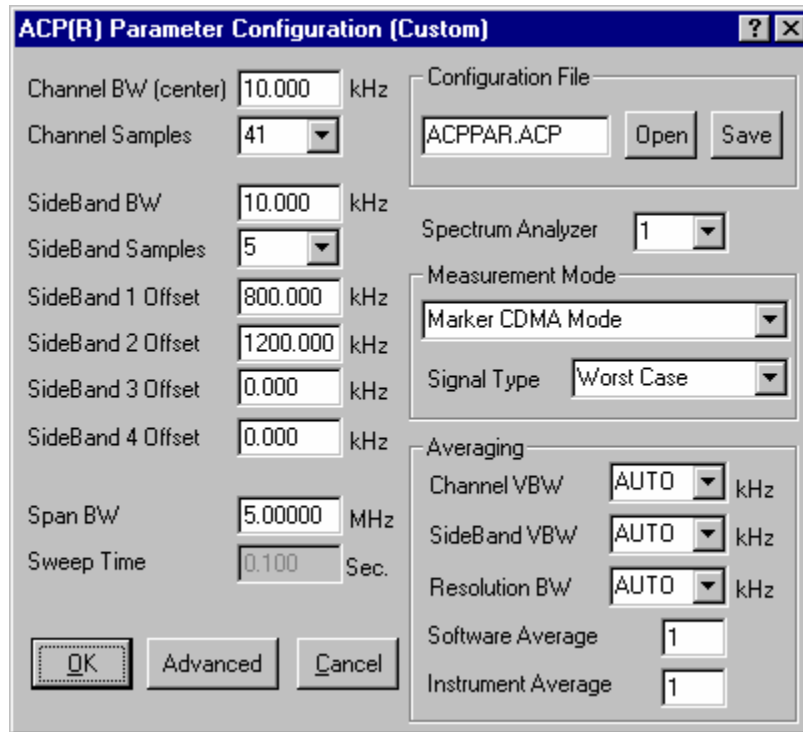


Figure Fout! Geen tekst met opgegeven opmaakprofiel in document..1: ACP(R) Parameter Configuration

This box allows the user to measure the Adjacent Channel Power in a CDMA or a similar type modulated signal. It includes Custom and Built-In options. This configuration dialog is used to make the Adjacent Channel Power Measurement in a "Customized" way: i.e. you determine the accuracy and the resolution of the power measurement inside the CDMA channel. You can also determine if you require the system to make one (or more) "settling sweeps" before it takes the actual measurement. The routine allows also for simultaneous or individual saving of power leakage into each of the sidebands, which are saved in the load-pull file (extension .LPD or .LPC), and processed by the graphics software to individual contour plots.

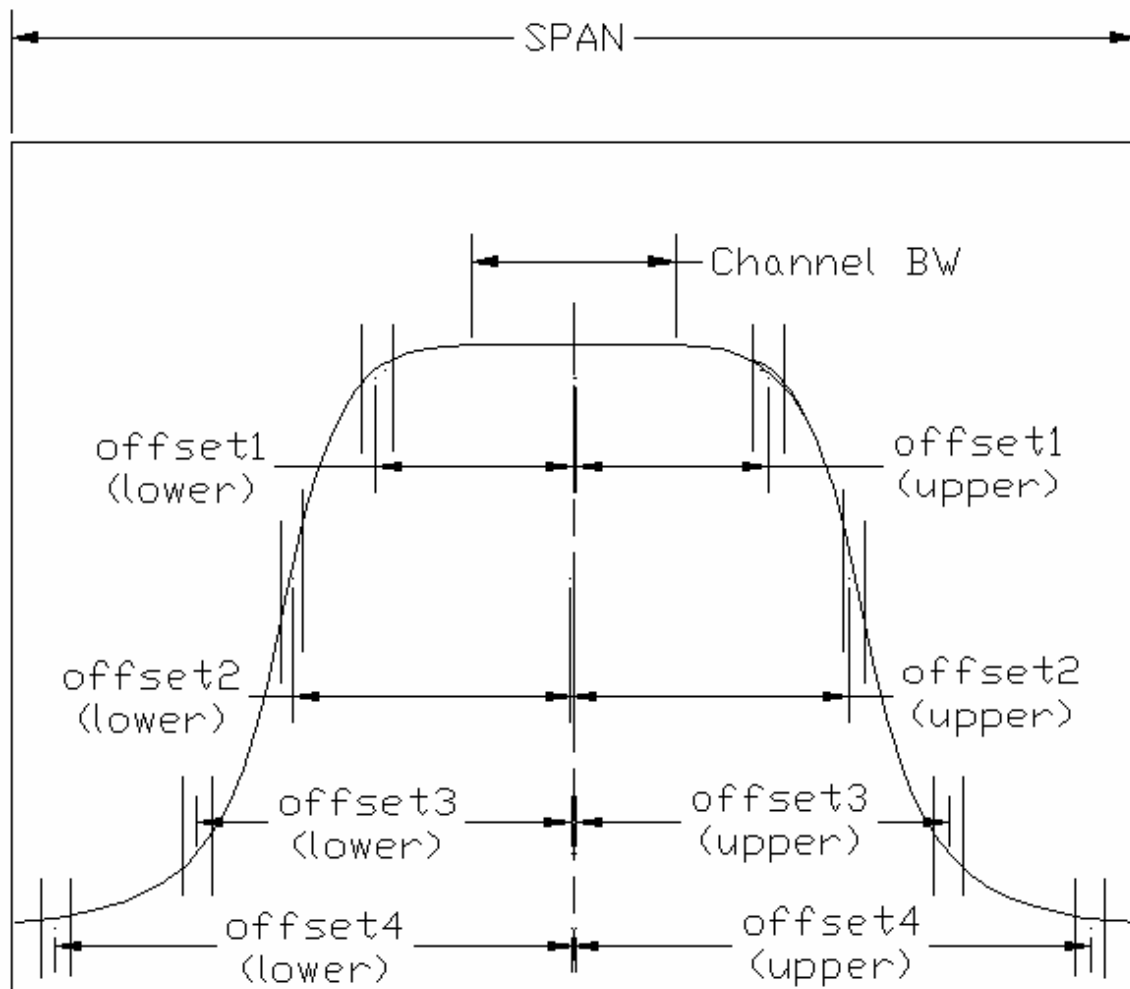


Figure Fout! Geen tekst met opgegeven opmaakprofiel in document..2: ACPR Channel

Figure **Fout! Geen tekst met opgegeven opmaakprofiel in document..2** illustrates a Typical ACPR Channel (in this fig., the RBW is constant for the whole channel)

In this dialog you can enter the exact parameters of your measurement, independently of the frequency of calibration of the tuners and the setup. The frequency and channel information entered here will be saved and used automatically to configure and read your spectrum analyzer.

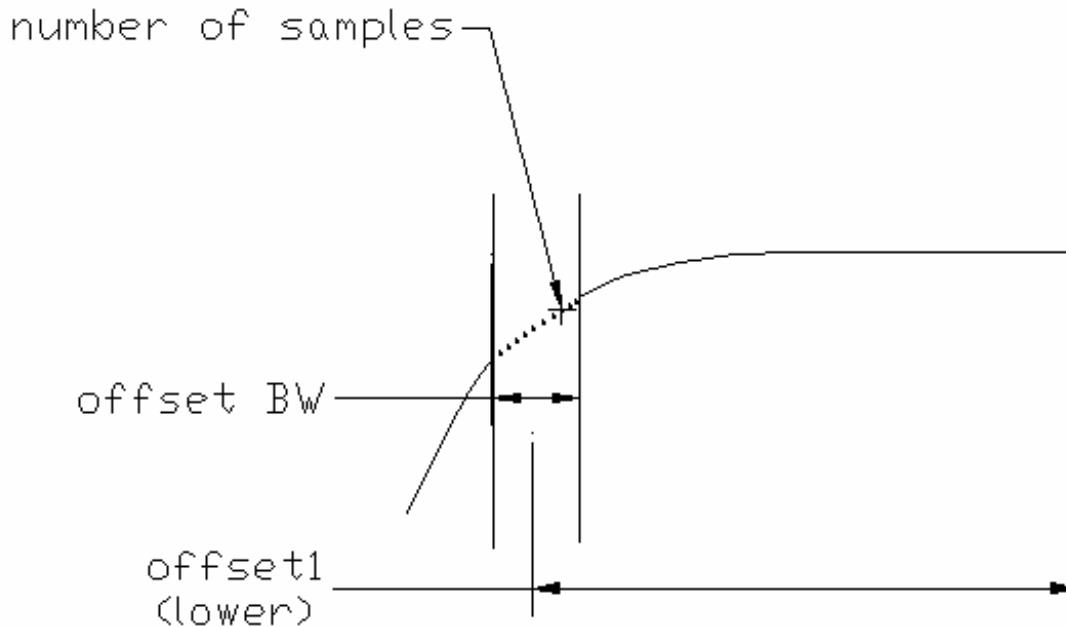


Figure Fout! Geen tekst met opgegeven opmaakprofiel in document..3: Offset Close Look

Figure **Fout! Geen tekst met opgegeven opmaakprofiel in document..3** presents an offset close look. It allows seeing the Band Samples repartition.

Definitions of items in dialog:

The figures above allow you to understand the definitions used in this dialog:

- Channel Bandwidth (center): Defines the distance at which samples are taken in the central channel.
- Channel Samples: How many times we integrate the Marker value inside the main (CDMA) channel. Again number is odd, 1,3,5,7...
- Sideband bandwidth: Defines the distance at which samples are taken in the sidebands.
- Sideband Samples: How many times we integrate the Marker value inside each band. To include the center frequency this number is odd (1,3,5,7...).
- Sideband 1 Offset: Distance of closest sideband to f_0 .
- Sideband 2 Offset: Distance of furthest sideband to f_0 .
- Sideband 3 Offset: Distance of furthest sideband to f_0 .
- Sideband 4 Offset: Distance of furthest sideband to f_0 .
- Span Bandwidth: Defines the channel width.
- Sweep Time: You can define how many times the spectrum must sweep before an actual reading. Depending on your setup/instruments you should determine if such sweeps are necessary. Find out if the value at zero settling sweeps is different from using one or more.

Averaging

- Channel VBW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.
- Sideband VBW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.
- Resolution BW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.
- Software Average: The software routine reads the Instrument several times and builds an average. This is necessary only if the instrument itself does not have averaging, but it slows down the operation. You must experiment with this option to find out if the delay is worth the gain in accuracy.
- Instrument Average: Reads the same sweep more than once internally and averages. Not all instruments have this option, but it is faster than Software averaging. Again, check if this is necessary. All extra operations cost execution time.

Configuration File

Saves on disk the actual ACPR measurement settings. Can be reloaded. The actual configuration will be reloaded at AutoStart. Save the configuration if you want to keep it. The file on the disk won't be modified unless you say so.

Measurement Mode

This mode defines the way the total channel power is measured: Either using Built-In methods (check Spectrum Manual) or using the Peak Reading of the Marker or Integrating the Marker up to the end of the Peak Window or up to the Second Sideband...(see also Product Note 20 of Focus Microwaves).

- Signal Type: Considers either the smallest sideband power (BEST) or the highest (WORST) or the Average of both (AVERAGE)

CDMA specifics

This routine allows an accurate determination of the adjacent channel power ratio to the Signal Power included in the CDMA channel. This power can be determined over the entire (User Defined) bandwidth of the CDMA channel (typically 1.23 or 1.25 MHz). The two sidebands (typically at +/-885 kHz and +/-1.98 MHz off the center frequency) can also be set by the user.

We can also determine the Marker Peak Power (central point power) just by using a small channel bandwidth in the CDMA routine.

Saving Configuration

- You can save an ACPR configuration in a file [.ACP] and reload it. Click **Save** or **Load** to load an existing file.
- The actual configuration is saved in the winpower.ini file and is reloaded automatically when ACP is included in the measurement list.

Advanced

The Advanced button allows the user to set ACP parameters as: Separate Lower and upper Band, Offset, delay and the GPIB address.

You have to use this dialog in order to change the configuration parameters.

(ii) IMD Parameters

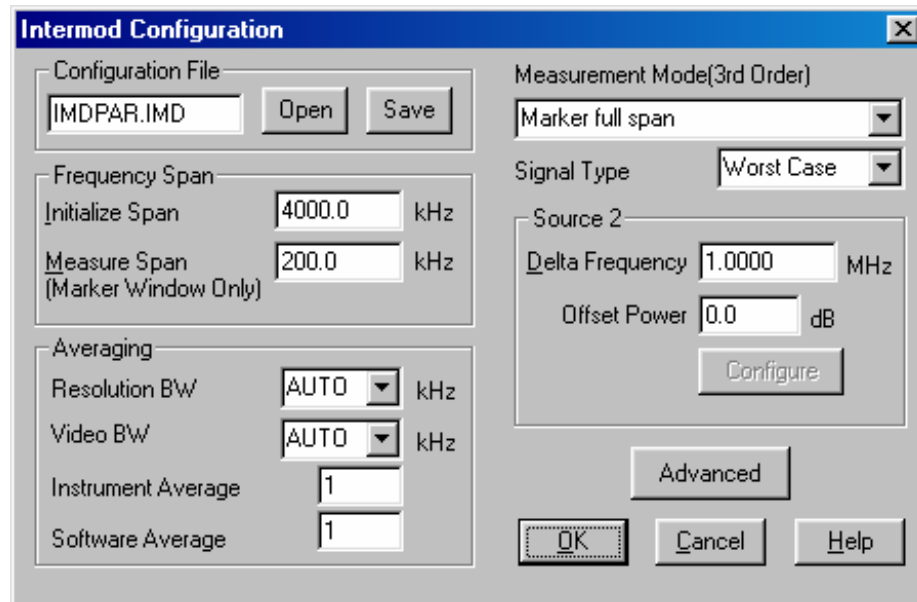


Figure Fout! Geen tekst met opgegeven opmaakprofiel in document..4: **Intermod Configuration**

WinPower can measure high order Intermod, up to four IMD products simultaneously. The type of Intermod product you measure must be selected in the **Parameters** options in the **Measure** menu.

This dialog serves ONLY to Configure the Measurement.

Measurement Mode (3rd Order)

Defines the way the total channel power is measured: Either using Built-In methods (check Spectrum Manual) or using the Peak Reading of the Marker or Integrating the Marker up to the end of the Peak Window or up to the Second Sideband (see also Product Note 20 of Focus Microwaves).

- **Signal Type:** Considers either the smallest sideband power (BEST) or the highest (WORST) or the Average of both (AVERAGE)
- **Configure:** Allows you to set the power of the first source and automatic control of the second source. The exact operation frequency is the one displayed in the "Configure" dialog "minus the Offset" you selected in the Intermod Configuration.

Source Control

When measuring IMD and other parameters at the same time, the two signal sources are controlled as follows:

In case "IMD": both sources ON and Level controlled for Pin.DUT=equal.

In case "Non IMD": Source 2 is OFF and Source 1 is set to Level+3.0dB.

In case "Two Tone Tests" is activated: Both sources are ON as in IMD testing.

Frequency span

- Marker Windows / Marker Full Span: The first method is safe from the point of view that it cannot mix up the Intermod products. The second method is faster.
- You may save the measurement result as "Best", "Average" or "Worst Case".
- Software/Instrument Average: Experiment with these numbers in your particular setup (in relation to the Resolution and Video Bandwidth) to determine the optimum speed at which you obtain reliable and repeatable readings.
- Select the Initialization span around four times the Frequency Difference between signals (it must be large enough to make all the Intermod products to be measured visible on the screen).
- Select the Measurement span around 1/2 the Frequency Difference between signals. This will be used to "window" the analyzer in for the exact measurements. Make sure this window does not include more than one Intermod product. This option is used only if you selected "Marker Windows" in the "Measurement Options".

Assuming the four Intermod products on the screen are A,B,C,D with B,C the main signals and A and D the IMD products, where B=C and A > D, then

1 Best Case: $IMD = 1/2 * (B+C - 2*A)$ [dBc]

2 Average: $IMD = 1/2 * (B+C - A-D)$ [dBc]

3 Worst Case: $IMD = 1/2 * (B+C - 2*D)$ [dBc]

Averaging

- Video BW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.
- Resolution BW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.
- Software Average: The software routine reads the Instrument several times and builds an average. This is necessary only if the instrument itself does not have averaging, but it slows down the operation. You must experiment with this option to find out if the delay is worth the gain in accuracy.
- Instrument Average: Reads the same sweep more than once internally and averages. Not all instruments have this option, but it is faster than Software averaging. Again, check if this is necessary. All extra operations cost execution time.

Configuration File

Saves on disk the actual IMD measurement settings. Can be reloaded. The actually used configuration will be reloaded at AutoStart. Save the configuration if you want to keep it. The file on the disk won't be modified unless you say so.

Advanced

The Advanced button allows the user to set IMD parameters as: Separate Lower and upper Band, Offset and delay.

- If you select [Separate Lower & Upper Sideband] the signal power in each sideband will be saved separately and can be used to generate independent contours.
- [Use Power Meter for Intercept]: Intercept (ICPT) is computed as:
 $ICPT = 0.5 * IMD + Pout [dBm]$
Pout is the TOTAL output power and can be measured (less accurately) with the spectrum analyzer, or, more accurately (but with longer time delay) with the output power meter. Both signal sources are switched ON during this measurement.
- Select the exact frequency of operation by entering the difference [in MHz] from the default frequency. The default frequency is the frequency of calibration of the tuners. A resolution of 1 Hz can be programmed in the system, even though most synthesizers are not going to handle this.
- Set the exact frequency of the second source as a difference to the frequency of the first source.

To compensate for differences in the signal path you can enter the difference in loss (offset power). This will set the signal source 2 at: Psignal.1-Delta.Loss to ensure the same power arrives at the DUT from both sources.

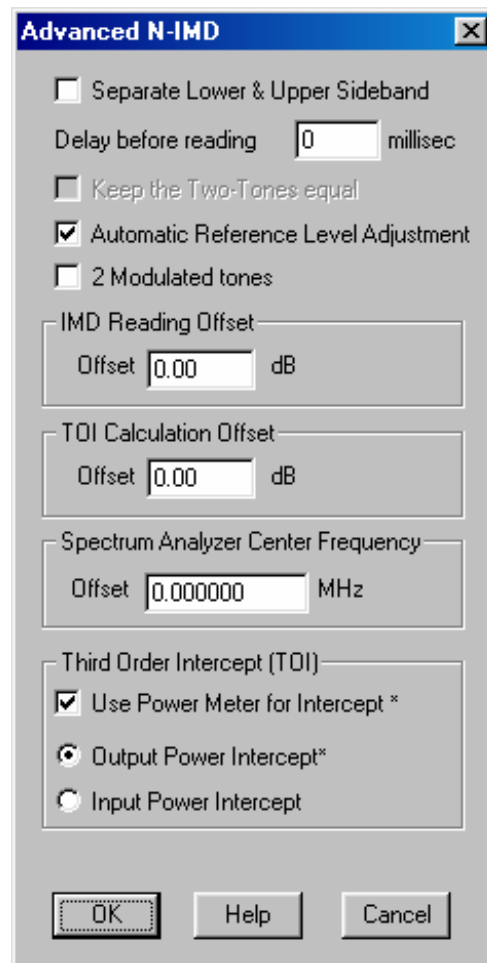


Figure Fout! Geen tekst met

(iii) Harmonic Power

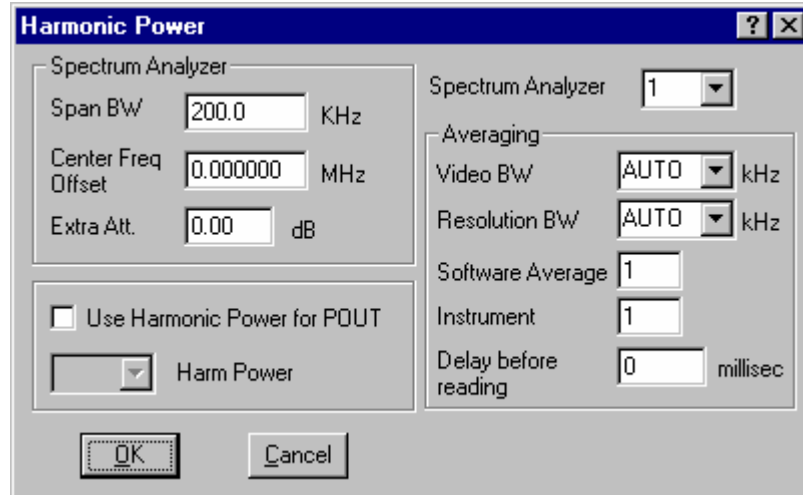


Figure Fout! Geen tekst met opgegeven opmaakprofiel in document..6: Harmonic Power

This option sets the network analyzer parameters that will allow the user to determine the harmonic power. Also, it helps to fix some secondary parameters as: Delay, Resolution and Offset.

Spectrum Analyzer

- Span Bandwidth: Defines the channel width.
- Center Freq. Offset: Enter the Difference [in MHz] to the tuner calibration frequency. Small differences have no effect on the measurement, since the tuner/setup calibrations are wideband quantities (within around 10 MHz).
- Extra Att.: Allows the user to set an additional attenuation value.

We can also use the Harmonic Power for Pout by selecting its option.

Averaging

- Video BW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.
- Resolution BW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.
- Software Average: The software routine reads the Instrument several times and builds an average. This is necessary only if the instrument itself does not have averaging, but it slows down the operation. You must experiment with this option to find out if the delay is worth the gain in accuracy.
- Instrument Average: Reads the same sweep more than once internally and averages. Not all instruments have this option, but it is faster than Software averaging. Again, check if this is necessary. Extra operations create longer execution time.
- Delay before reading: The user can also add a time delay before reading the measurements.

(iv) Oscillation Detection

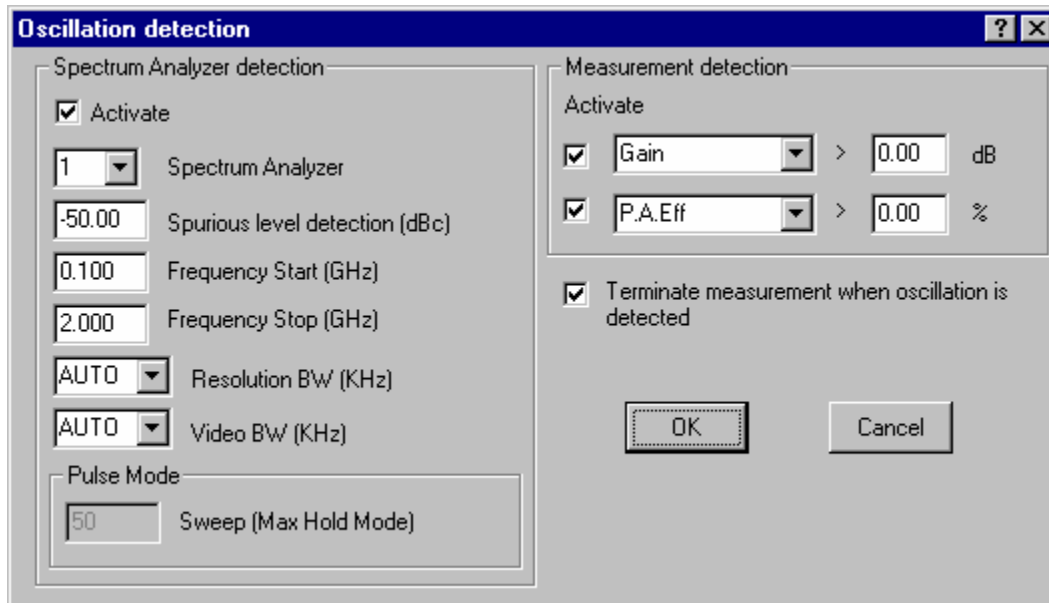


Figure Fout! Geen tekst met opgegeven opmaakprofiel in document..7: **Oscillation Detection**

The user can activate the Spectrum Analyzer detection by selecting the **Activate** option. This option allows the user to modify the Spectrum Analyzer parameters:

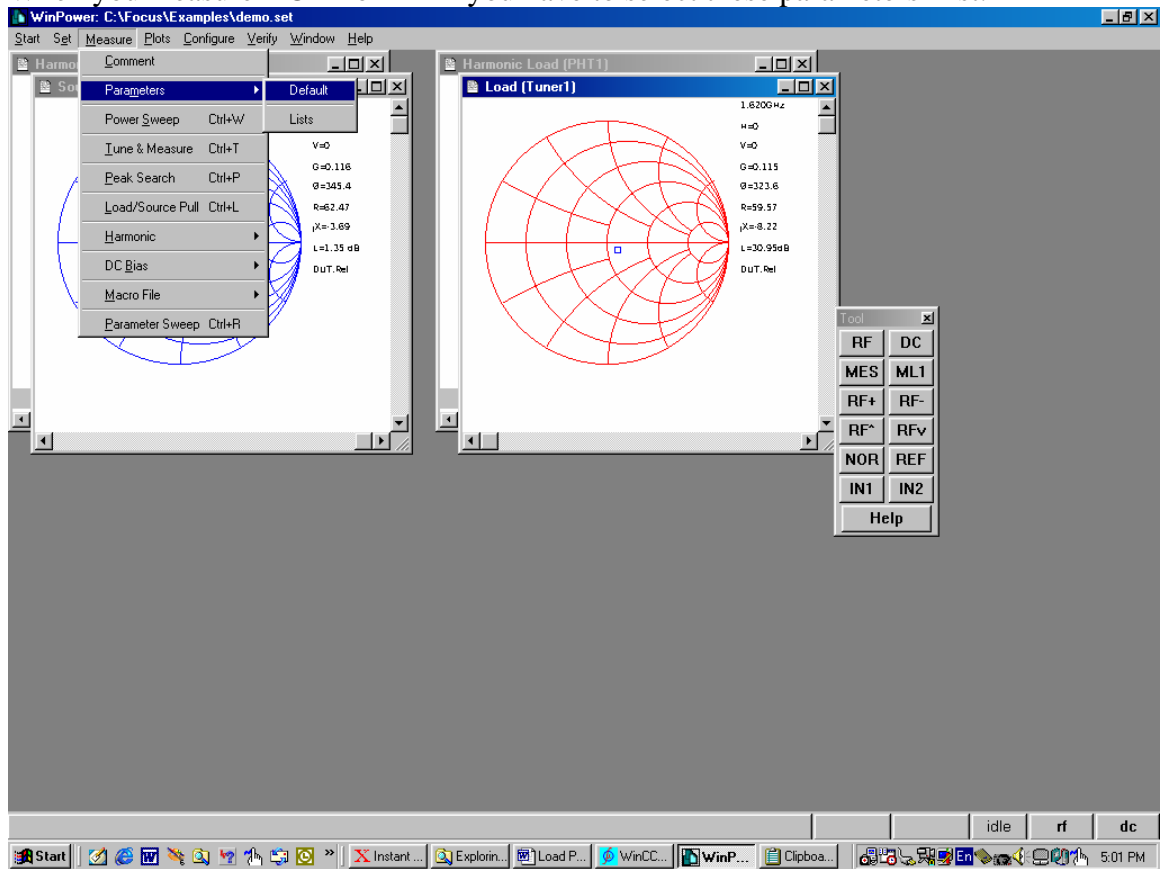
- Spectrum Analyzer:
- Spurious level detection (dBc): Allows the user to select the desired oscillation level.
- Frequency Start (GHz): Allows the user to set the starting frequency in the Spectrum Analyzer display channel.
- Frequency Stop (GHz): Allows the user to set the last frequency shown in the Spectrum Analyzer display channel.
- Resolution BW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.
- Video BW: setting of Spectrum Analyzer for optimum accuracy/speed ratio.

Pulse Mode: Sweep(Max Hold Mode)

Terminate measurement when oscillation is detected:

This last action takes a lot of time. For time saving, the user can use the **Measurement detection** dialog box to measure the oscillation detection. This technique allows the user to set one, two or three parameters (current and/or tension and/or Power) with a limit value. If any of these parameters decreases below its limit value the system will automatically stop.

C) When you measure ACPR or IMD you have to select these parameters first.



D)

