Agilent 81250 ParBERT Measurement Software

Spectral Jitter Measurement User Guide

Agilent Technologies

Important Notice

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Contents

Introduction

The Spectral Jitter measurement allows you to analyze the jitter inherent in the output signals of a device under test (DUT) with several output ports and terminals. The measurement can be used for investigating the behavior of the DUT.

Already existing methods let you measure the total jitter and separate between random and deterministic jitter. The ParBERT Measurement Software provides the DUT Output Timing / Jitter measurement for this purpose.

Spectral jitter analysis

The Spectral Jitter measurement provides a method for investigating the spectrum of the jitter, that means, its power distribution over frequency.

Deterministic jitter can be caused by repetitive data patterns. It can also be caused by internal or external periodic effects.

The Spectral Jitter measurement detects even small periodic components that may be hidden in a high level of random noise. It informs you about the frequencies of such components and measures their contribution to the total jitter.

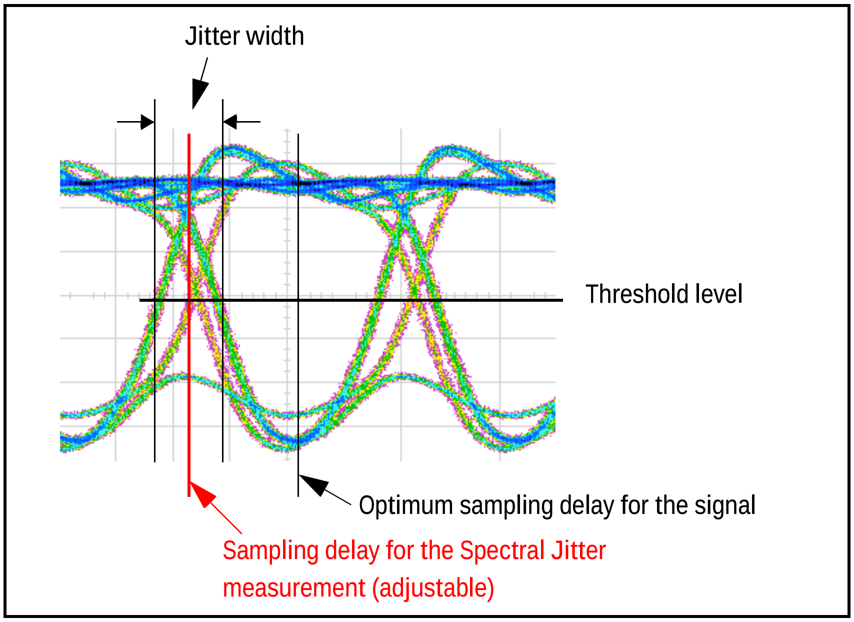
This helps to identify jitter sources and to reduce or eliminate their influence.

What happens

The Spectral Jitter measurement performs a capture and compare operation in the jitter region.

Pseudo random data and automatic analyzer sampling phase adjustment should be used.

Automatic analyzer sampling phase adjustment determines the optimum sampling delay. By default, the sampling point for the measurement is set to an offset of –0.5 analyzer clock periods or unit intervals (UI) from the optimum sampling delay, as illustrated in the following figure. This offset can be fine-tuned.



Capture and compare means that a certain amount of incoming data is captured and also compared with expected data in real time. The number of captured data points is adjustable.

While the measurement is running, correct and incorrect data is captured. The resulting records contain the captured data and the corresponding error information.

These records are automatically processed. The error information is subject to a fast Fourier transform (FFT). FFT reveals the spectral components and their power. Several window algorithms are provided to reduce the influence of leakage.

Measurement results The Spectral Jitter measurement provides:

- A graphical view of power vs. frequency. This makes it easy to identify prominent spectral jitter components. You can adjust the horizontal and vertical axes according to your needs.
- You can switch between linear and logarithmic scales.
- Graphical markers and the zoom function assist you when you are analyzing the graph visually.
- The numerical results include bit error rate, total power, and noise power. They provide also frequency and power information about the dominant peaks in the spectrum.

- Absolute and relative power values are available. Relative values can be normalized to the total jitter power or the power of a selected tone (frequency bin).
- Pass/fail limits can be set for the bit error rate, total power and noise power, and the allowed jitter power in user-defined frequency regions.

About this manual

This document provides the following information:

- For a quick start, read the sample session given in *"Example of a Spectral Jitter Measurement" on page 9*.
- *"Basics of the Spectral Jitter Measurement" on page 33* provides detailed information on the prerequisites and the parameters shown on the result screens.
- *"Setting the Properties of a Spectral Jitter Measurement" on page 51* shows how to specify the input parameters and the graphical display of the measurement.

NOTE

It is assumed that you are familiar with the general characteristics and features of the *Agilent 81250 Measurement Software*. The general capabilities and operating principles are documented in the *Agilent 81250 ParBERT Measurements Framework User Guide*.

It is also assumed that you are familiar with the general characteristics of the fast Fourier transform.

Literature

The following documents provide additional information:

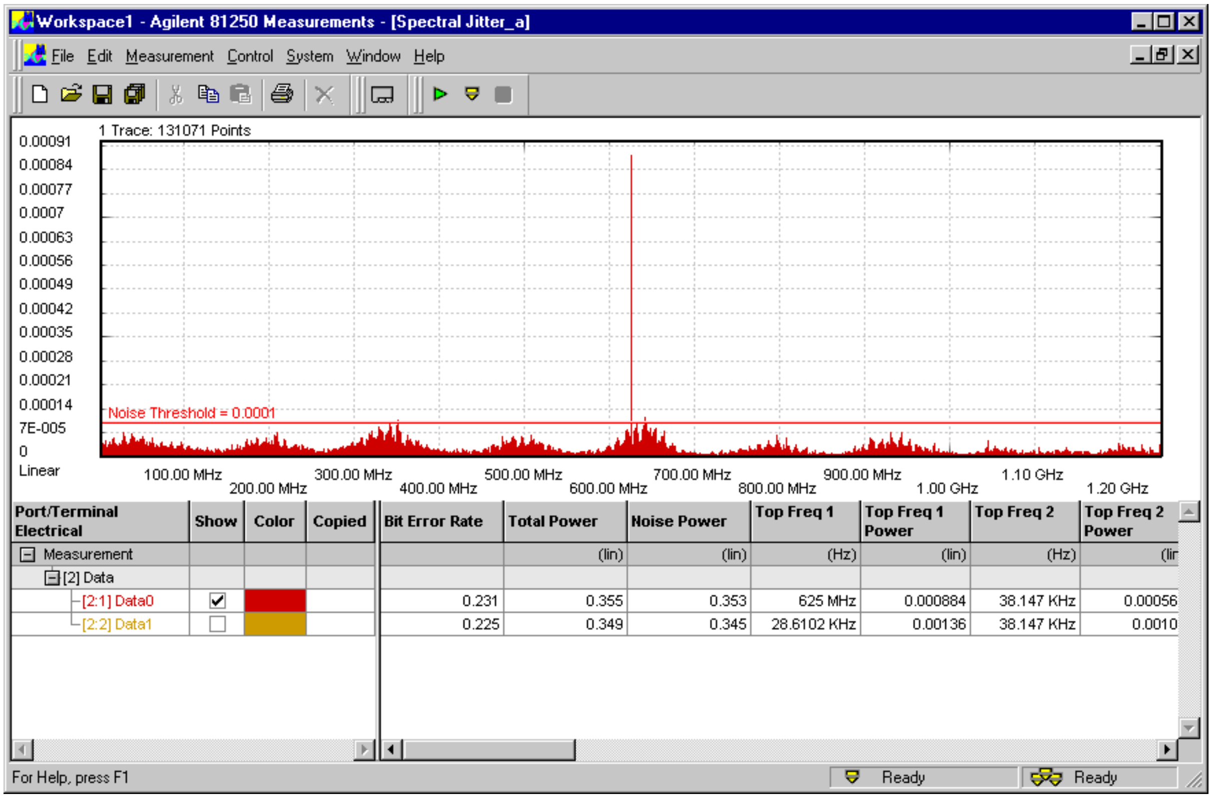
Frederic J. Harris, "On the use of Windows in Harmonic Analysis with the Discrete Fourier Transform", Proceedings of the IEEE, Vol. 66, January 1978

"The Fundamentals of Signal Analysis", Agilent Application Note 243, Publ. No. 5952-8898E

"Fibre Channel – Methodologies for Jitter Specifications", National Committee for Information Technology Standardization (NCITS), T11.2/Project 1230/Rev. 10, June 1999

Yi Cai, Bernd Laquai, Kent Luchman, "Jitter Testing for Gigabit Serial Communication Transceivers", IEEE Design and Test of Computers, Jan-Feb 2002

The following illustration shows the result window of a Spectral Jitter measurement:



The graph refers to the terminal “Data0”. Linear scales are used. A prominent jitter component was found at 625 MHz. It has a power amplitude of 0.000884. Its contribution to the total jitter power of 0.355 is rather small.

Example of a Spectral Jitter Measurement

This chapter shows you how to set up and perform a Spectral Jitter measurement:

1. Use the *Agilent 81250 User Software* for connecting the device under test with the system.

   See *"Setting Up and Connecting the DUT" on page 11*.

2. Prepare a bit error measurement with the *Agilent 81250 User Software*.

   See *"Preparing the Measurement" on page 12*.

3. Use the *Agilent 81250 Measurement Software* for creating a workspace and measurement and run the measurement.

   See *"Executing a Spectral Jitter Measurement" on page 16*.

4. Adapt the display to your needs.

   See *"Improving the Spectral Jitter Display" on page 20*.

5. Change the measurement properties and see the results.

   See *"Changing Spectral Jitter Properties" on page 25*.

6. Compare the results of two or more measurements.

   See *"Comparing Spectral Jitter Measurement Results" on page 29*.

Hardware requirements

For this example, we have used the following ParBERT hardware components:

- One E4805B clock module
- Two E4861A 2.7 GHz data generator/analyzer modules
- Two E4862A generator frontends
- Two E4863A analyzer frontends

NOTE The Spectral Jitter measurement is a very sensitive tool.

Besides the DUT and the measurement parameters, the results are influenced by

- the hardware components that are used
- the data rate
- the data pattern used for the test
- the positioning of the optimum analyzer sampling point

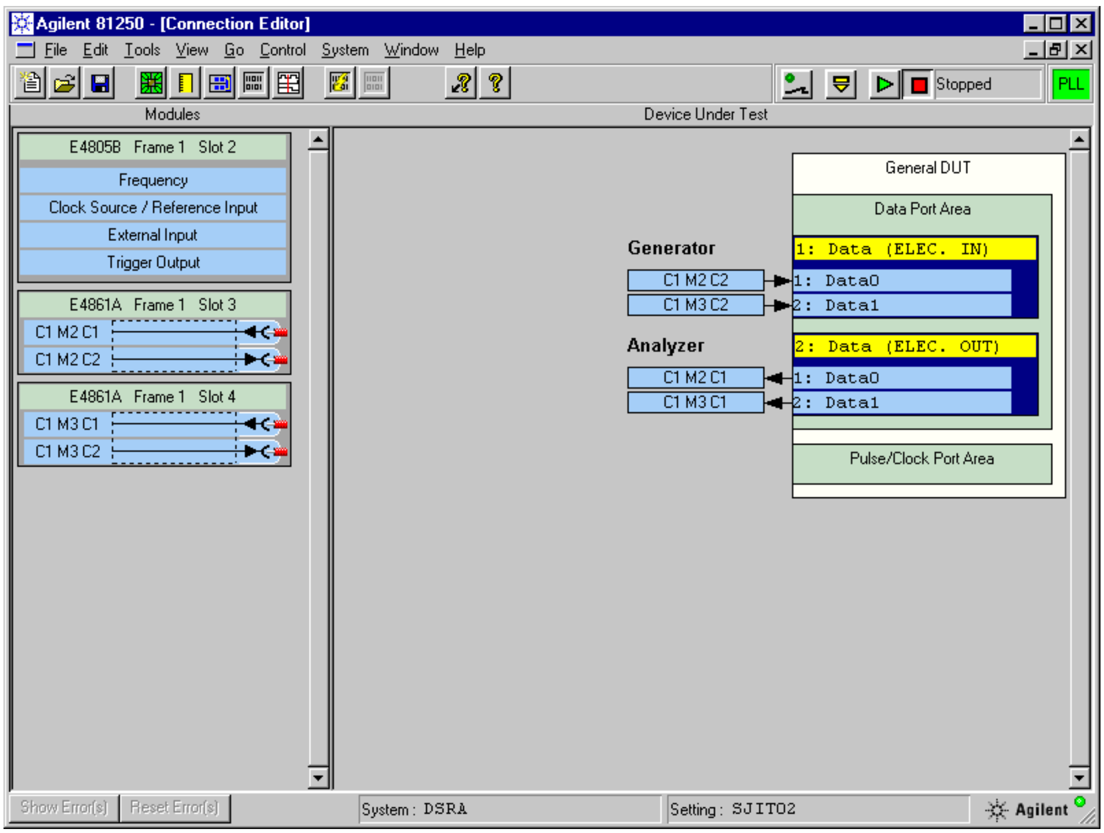
These factors may lead to different results when you reproduce this example with your equipment.

Setting Up and Connecting the DUT

Use the *Agilent 81250 User Software* to create a model of the hardware. For a detailed description of the *Agilent 81250 User Software*, refer to the *Agilent 81250 ParBERT System User Guide*.

1 Create a DUT input port and a DUT output port.

2 Connect the generators to the DUT input port and the analyzers to the DUT output port.

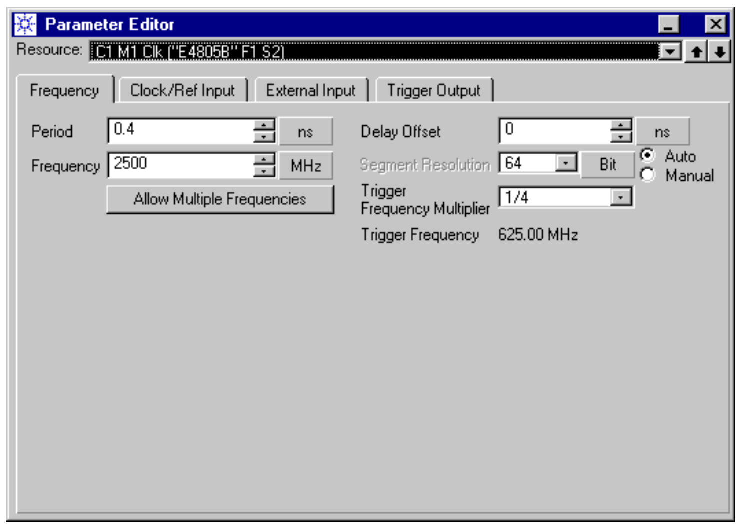


3 Using two shielded SMA cables, connect the analyzers physically with the generators. The cable connections will be our device under test.

Preparing the Measurement

Use the *Agilent 81250 User Software* to prepare a bit error rate test:

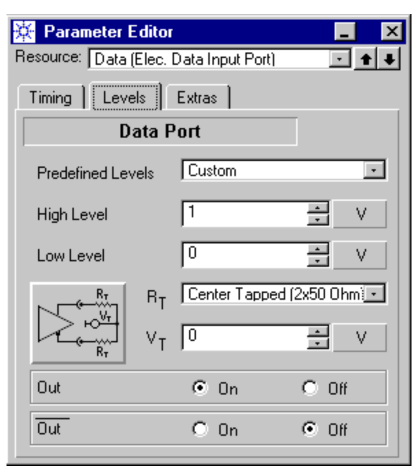
1 Adjust the clock frequency, if desired.



We use a clock rate of 2,500 MHz in this example. This corresponds to a clock period of 0.4 ns.

2 In the Connection Editor, double-click the DUT input port. This opens the Parameter Editor.

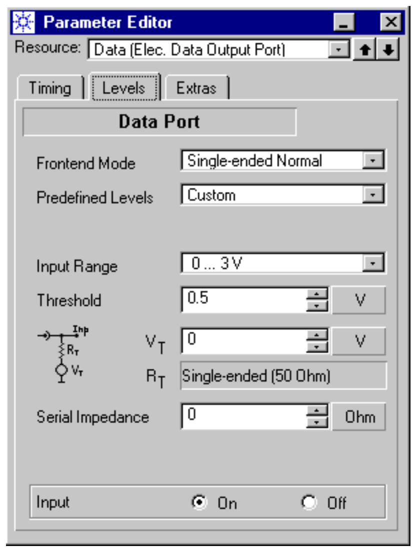
Do not change the *Timing*. On the *Levels* page, set the high and low voltage *Levels* of the generator frontends and switch the frontends on.



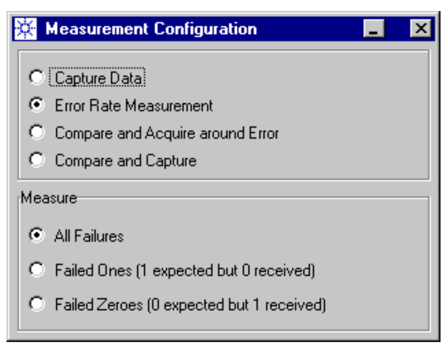
We use a zero-to-one voltage swing in this example.

3 In the Connection Editor, double-click the DUT output port. This opens the Parameter Editor for that port.

Do not change the *Timing*. On the *Levels* page, set the *Frontend Mode* of the analyzers to *Single-ended Normal*. Set the *Level Range* and *Threshold* so that they fit to the generators. Switch the *Input* on.

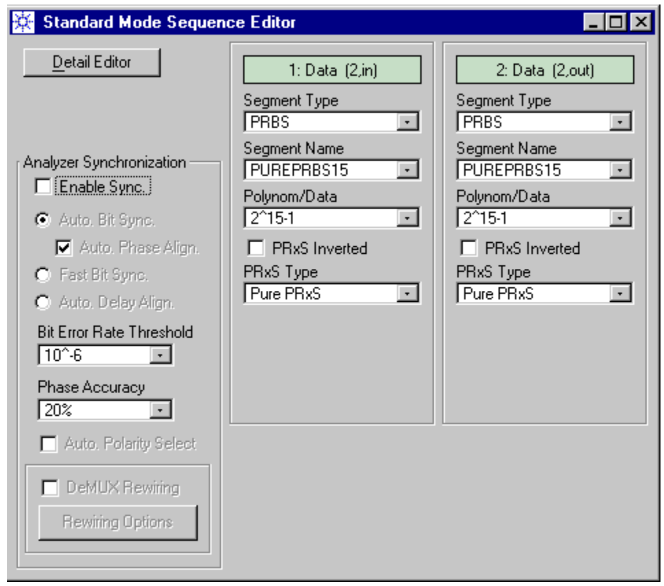


4 Ensure that the measurement mode is set to BER. This is the default.

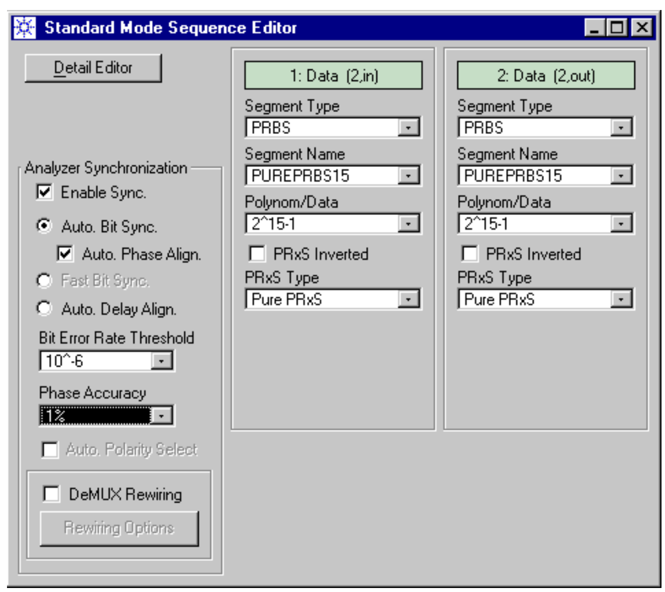


5 Create the test sequence with the *Standard Mode Sequence Editor*.

We use the same PRBS segment for both ports.



6 Enable *Automatic Bit Synchronization* with *Automatic Phase Alignment*. Set the *Phase Accuracy* to 1 %.

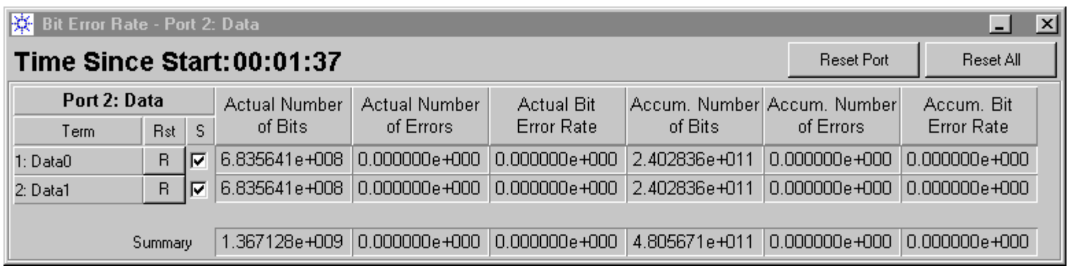


Automatic Bit Synchronization with *Automatic Phase Alignment* ensures that the analyzers will position their sampling point automatically at the optimum, no matter what the total signal delay is.

You could also use *Automatic Delay Alignment*, but this generally requires that you specify a suitable analyzer start delay with the Parameter Editor.

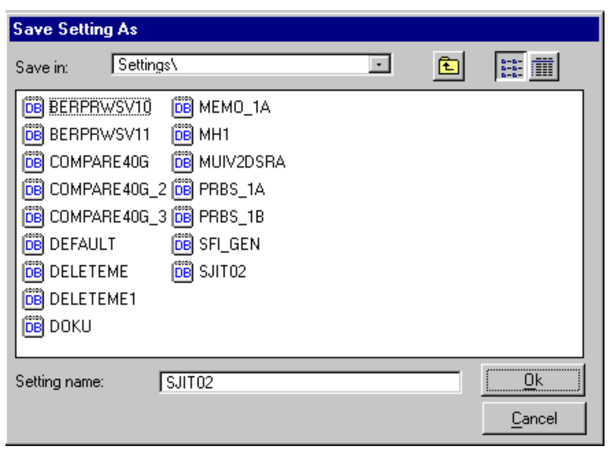
NOTE It is important that you set the *Phase Accuracy* to maximum precision. The Spectral Jitter measurement derives its sampling point from that point in time (by default –0.5 periods, but adjustable).

7 Make a quick test to ensure that everything has been set up correctly. Open the Bit Error Rate display and then click the Run button.



The BER has to be zero.

8 From the *File* menu, use *Save Setting As* to save the setting.



We use the name *SJIT02* in this example.

Once you have saved the setting, you may terminate the *Agilent 81250 User Software*, if you wish to do so.

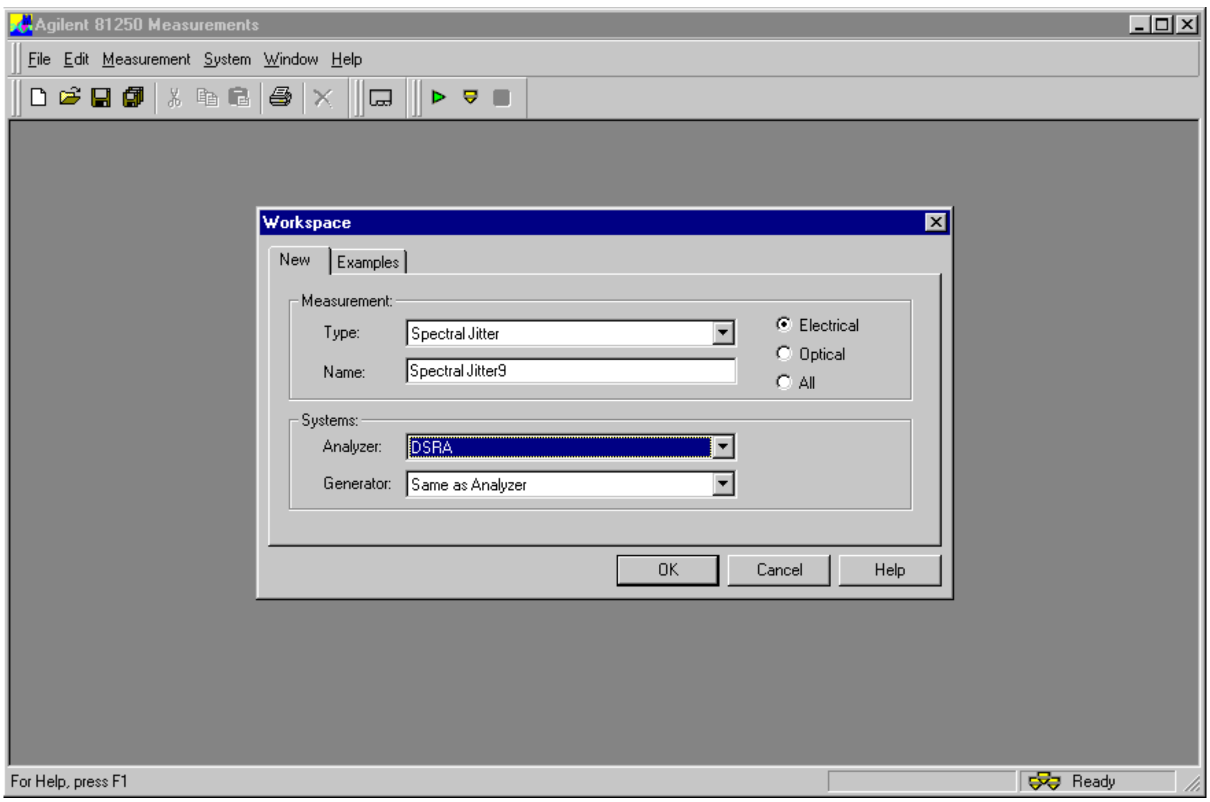
Executing a Spectral Jitter Measurement

Use the *Agilent 81250 Measurement Software* to set up and perform the Spectral Jitter measurement:

1 Start the *Agilent 81250 Measurement Software.*

  If you have kept the defaults, the *New* page of the *Workspace* dialog appears.

2 Select the measurement type *Spectral Jitter*. The measurement is automatically named. If desired, assign your own name. Select the *Analyzer System* from the drop-down list.

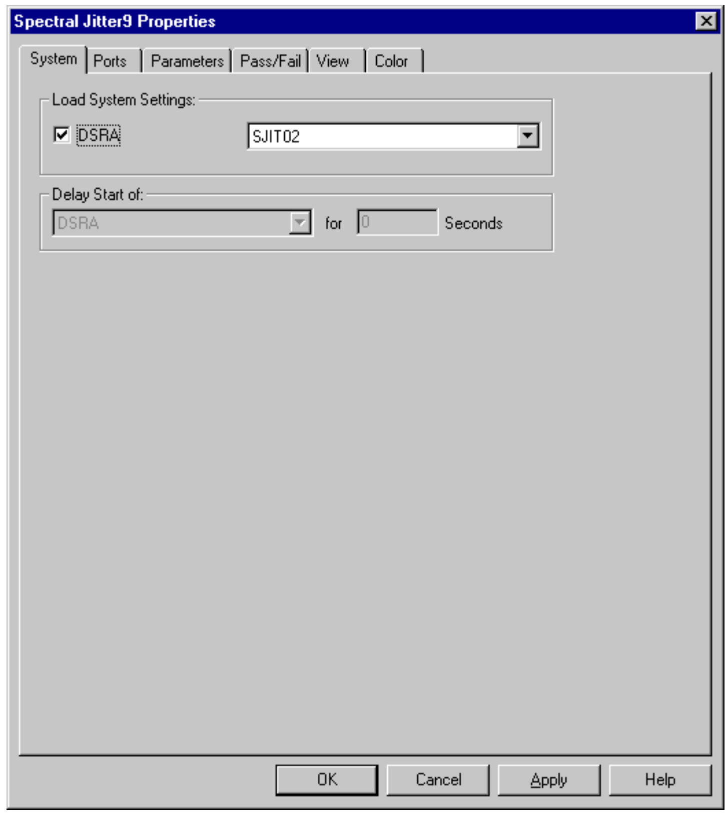


  We use only one system in this example (DSRA). In case of two systems, you would also select the generator system.

3 Click *OK*. This creates a new measurement and opens the measurement*'s Properties* dialog.

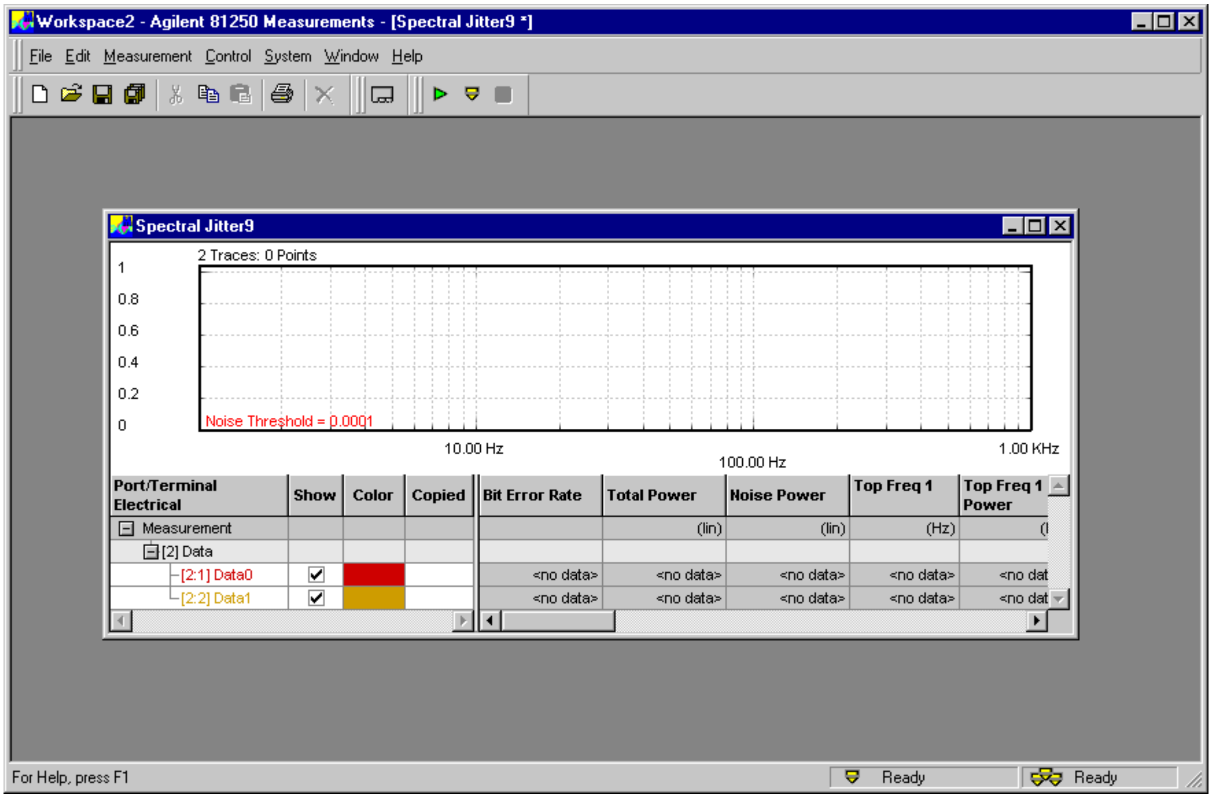
  The *System* page shows the chosen system(s).

4 Enable the checkbox by the side of the system's name. If no setting is loaded on the system(s) or not the setting you need, choose a suitable setting from the drop-down list.



We have chosen the previously created setting SJIT02.

5 Click *OK*. This terminates the *Properties* dialog. Now you can see how the measurement appears.



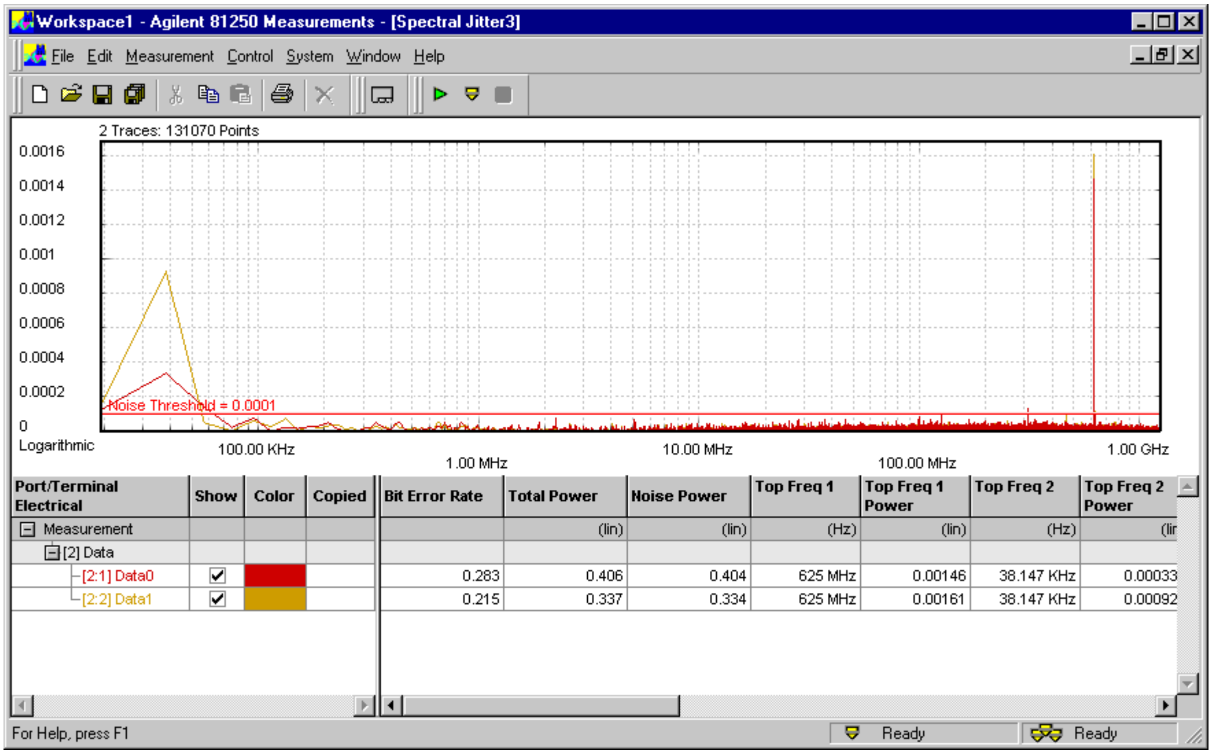
We have closed the Workspace browser in this example.

6 Maximize the measurement window.

7 In the tool bar, click the Run button to execute the measurement.

The status bar at the bottom shows the progress: *Starting*, *Synchronizing*, *Running*, *Ready*.

Finally, the measurement window shows the results.



A total of 131,070 data points is displayed.

By default, the traces of all terminals are displayed. The frequency scale is logarithmic, the power scale is linear.

You can hide a trace by clearing the terminal's checkbox in the *Show* column. You can also change the trace colors by means of the *Color* boxes.

Numerical values are also displayed for each terminal. The values include *Bit Error Rate*, *Total Power*, *Noise power*, and one to 16 frequency/power pairs (default are four). The latter are sorted according to descending power contents. These results will be discussed in *"Spectral Jitter Measurement Numerical Results" on page 48*.

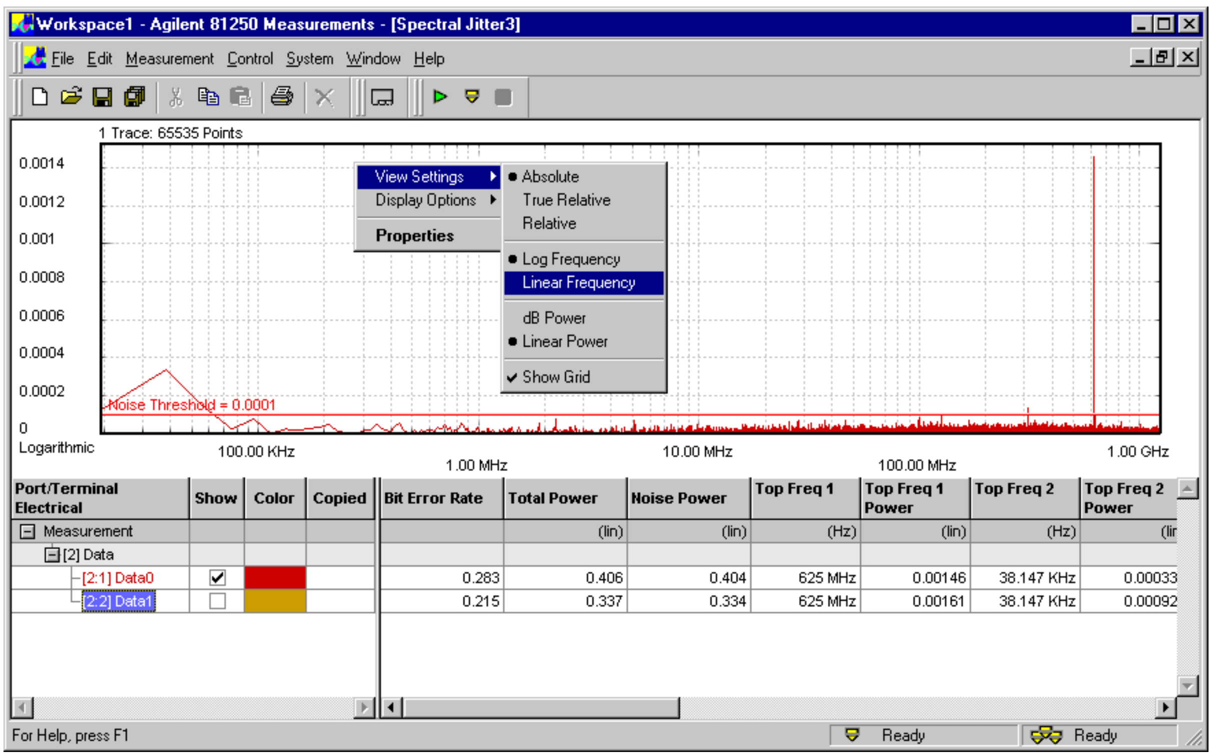
Improving the Spectral Jitter Display

You may wish to see more details and to investigate the graph. This can be done from the *View* page of the *Properties* dialog or directly from the context menu of the graph. The latter method is very convenient and demonstrated here.

1 Right-click the graphical area of the measurement window. This opens the context menu.

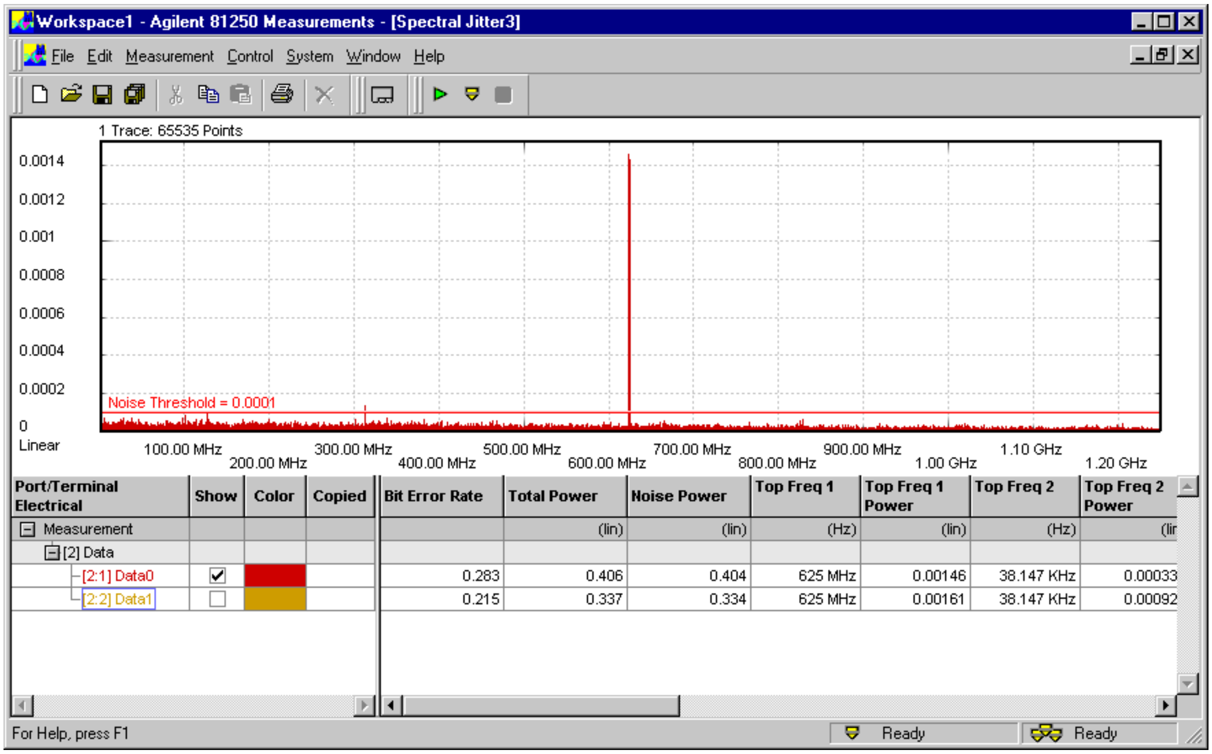
You may prefer a linear frequency scale.

2 Choose *View Settings* and *Linear Frequency*.



NOTE The *View Settings* menu provides quick access to many functions that can be accessed as well from the *View* page of the *Properties* dialog. See also *"How to Specify the View" on page 65*.

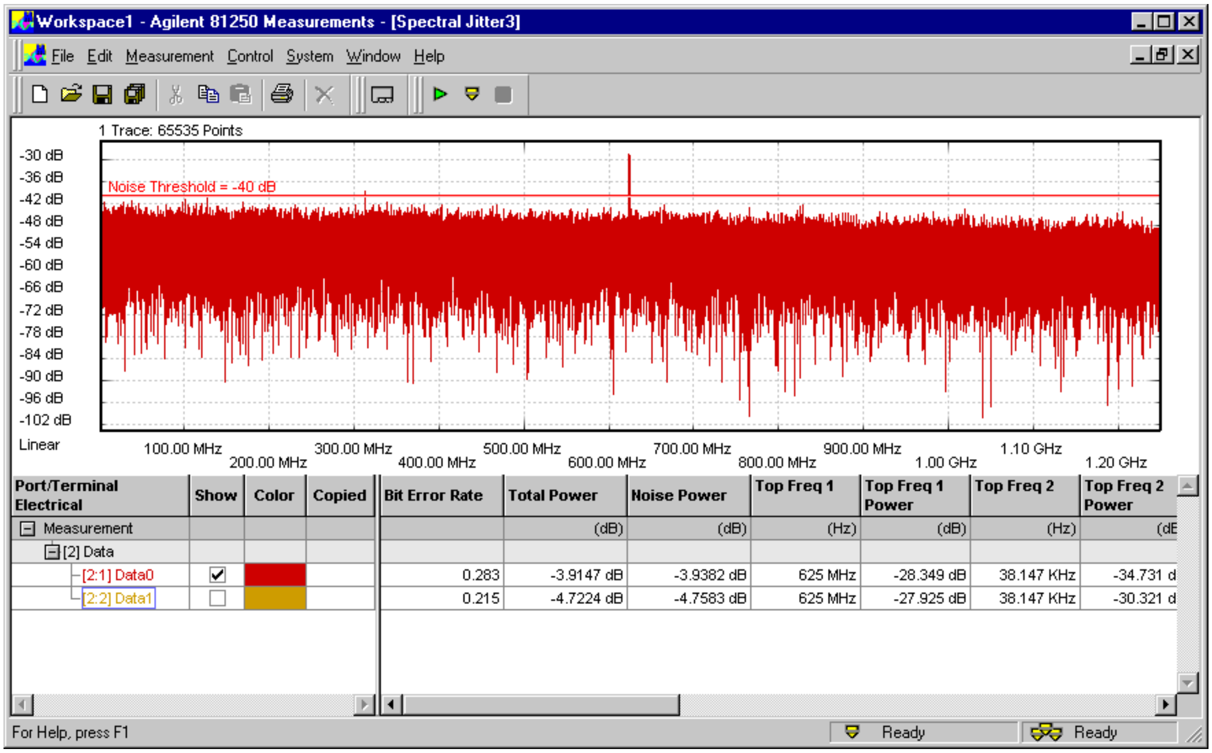
A logarithmic frequency scale gives you an expanded view of the lower frequency parts of the spectrum. In linear mode, the low-frequency components become invisible, as shown in the figure below.



Actually, you see one peak at 625 MHz and not much more. The reason is the linear power scale. A logarithmic power scale has the advantage that you can investigate several decades of the power spectrum in one window.

3 Open the context menu once more and select *dB Power*.

This shows you the power spectrum between –30 dB and –100 dB.



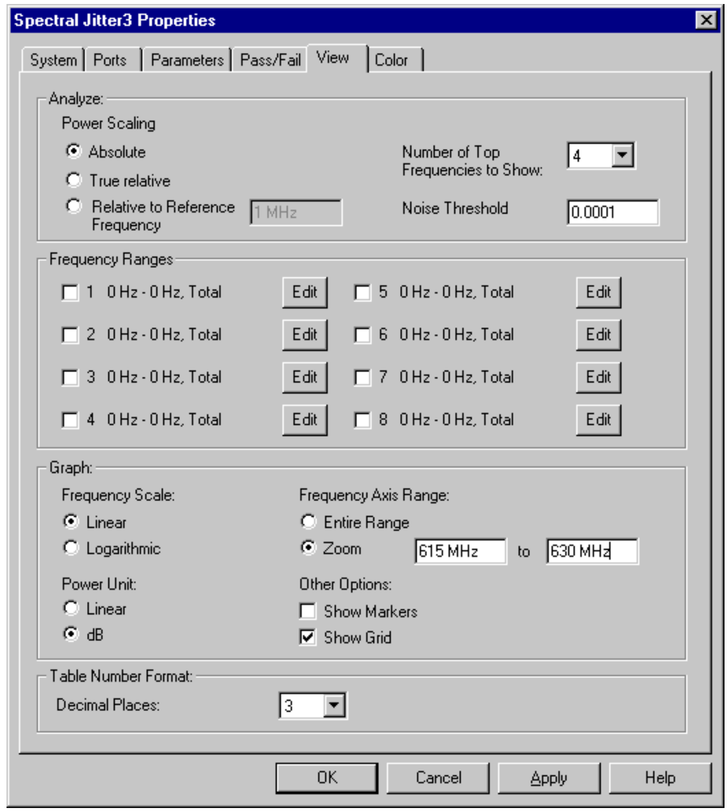
You can see that in this example the random noise is fairly uniform.

Note that the numerical display has also changed to dB units.

You may also wish to zoom into a certain frequency range:

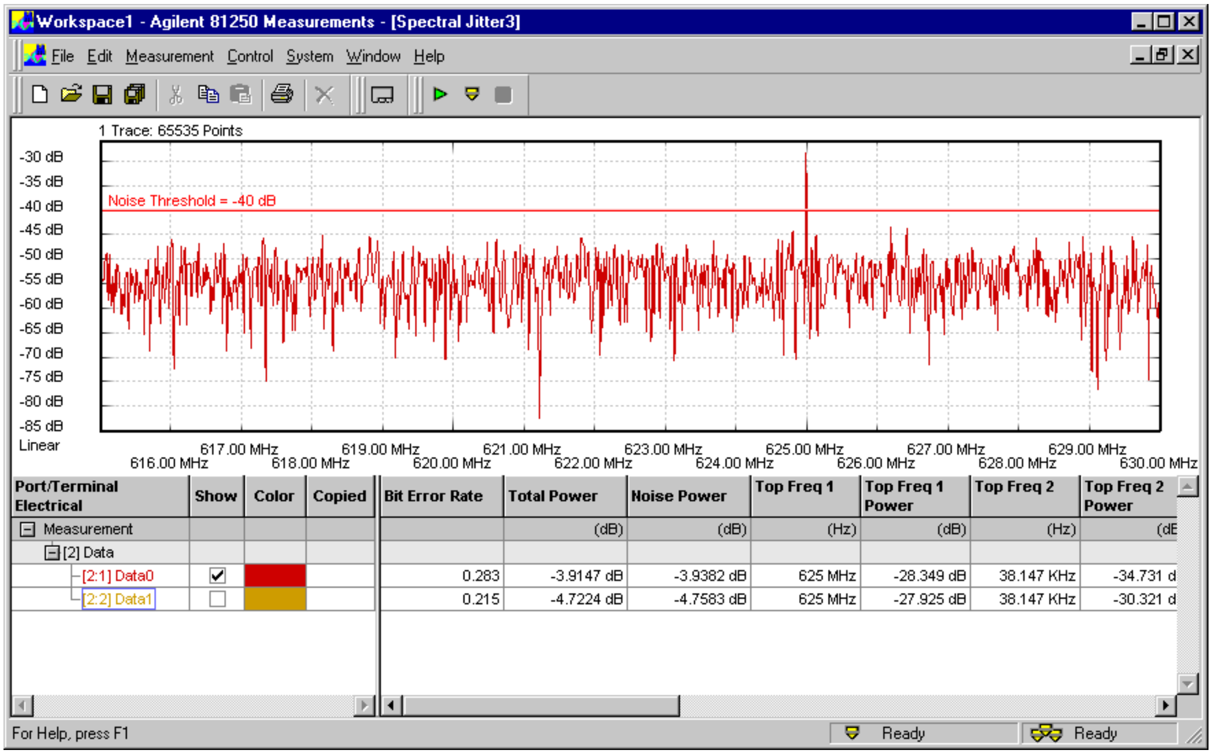
4 Open the context menu and select *Properties*.

5 Open the *View* page. In the *Graph* section, enable *Zoom* and enter the desired frequency range.



6 Click *OK*.

The measurement window shows the expanded view.



You can see that this jitter component really concentrates on one frequency – 625 MHz.

TIP You can also use markers for analyzing the graph or open a zoom window for viewing the details. All this is described in *"Spectral Jitter Measurement Graphical Results" on page 44*.

When you move the *Noise Threshold* bar with the mouse, you will see that the calculated *Noise Power* values change. This is explained in *"Spectral Jitter Measurement Numerical Results" on page 48*.

NOTE We have not captured many points during this measurement, but it was finished in reasonable time. We used the defaults.

The headline of the graph tells us the number of data points included in the display: 65,535 for each of the terminals.

Actually, we have traded measurement precision against test time.

But we can repeat the measurement using custom conditions.

Changing Spectral Jitter Properties

So far, we have set the focus on speed. Capturing more data points increases the measurement duration but yields a better frequency resolution.

1 Open the context menu of the result window (press the right-hand mouse button) and choose *Properties*.

2 Click the *Parameters* tab.

NOTE On this page, you can change the measurement parameters at any time. To view the updated results, you have to repeat the measurement.

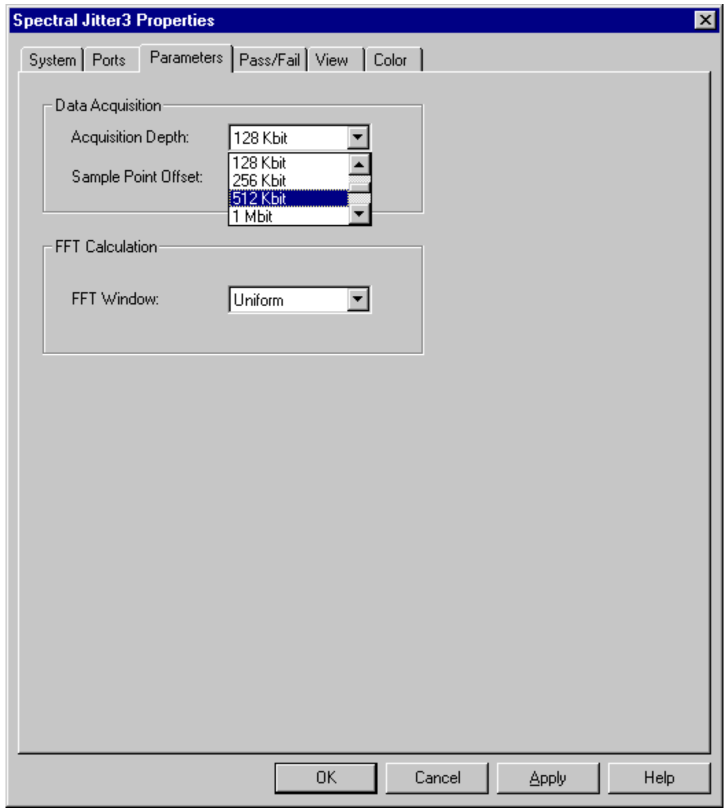
By default, the *Acquisition Depth* is set to 128 Kbit. Considering our data rate of 2,500 MHz, this yields a frequency resolution of 2,500,000 / 131,072 = 19.073 kHz.

From that data record, the FFT calculates 64K pairs of frequency/power values. Considering our data rate of 2,500 MHz, the last pair of values has a frequency of 1,250 MHz.

A finer resolution may help you to analyze low frequency jitter components more precisely.

3 Increase the *Acquisition Depth* to 512 Kbit.

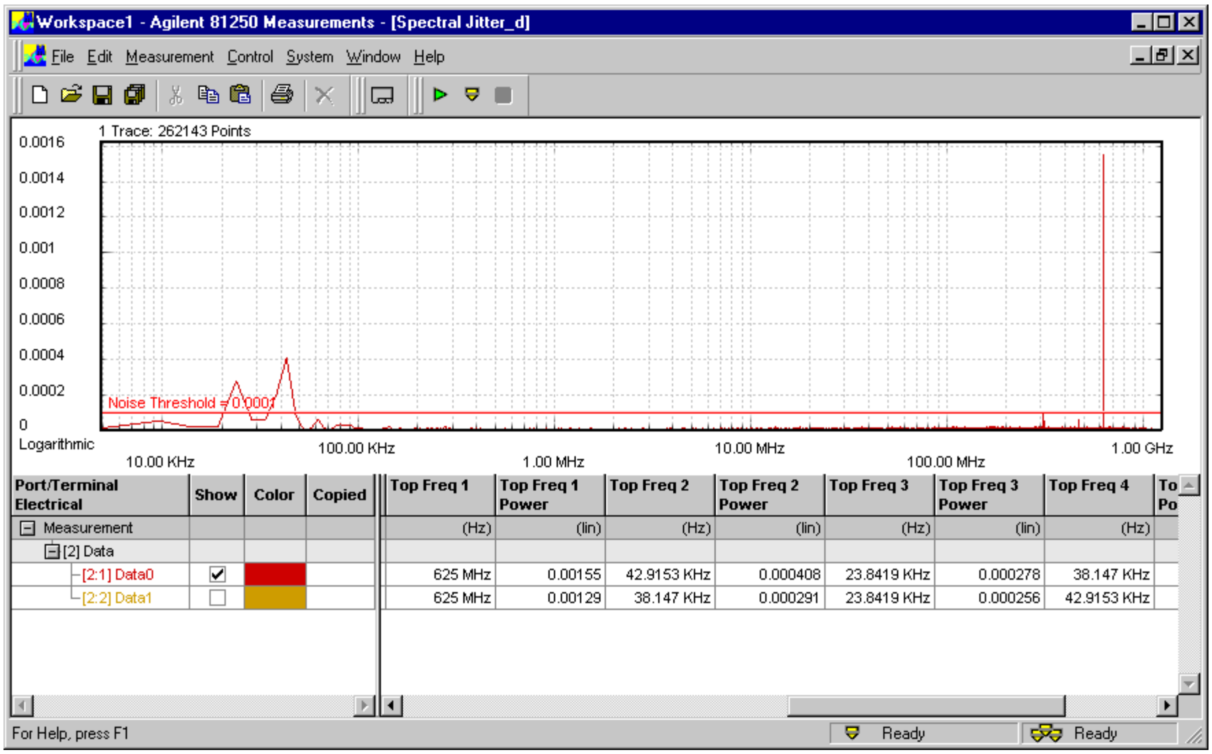
FFT requires that the data record to be processed has a length that is a power of two, such as 2^{17}, 2^{18}, 2^{19}, 2^{20}, and so on. Suitable numbers can be chosen from the list.



4 Click *OK* to terminate the *Properties* dialog.

5 Click the Run button to repeat the measurement.

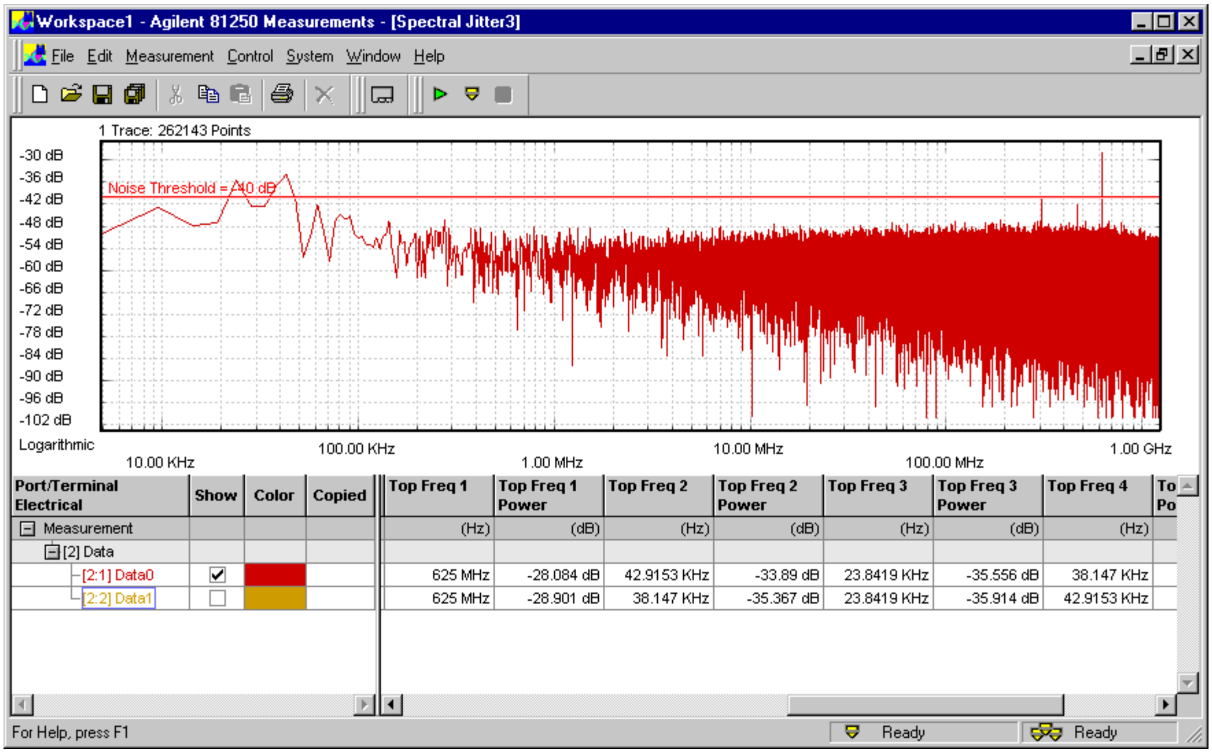
This measurement takes considerably more time than the previous one.



Thanks to the better resolution, you can see that the low frequency jitter component of the terminal “Data0” is actually composed of two frequencies.

You will also find that the noise amplitudes are much lower than in the previous measurement. This is due to the fact that the total noise is now clustered into many more frequency bins.

When random noise amplitudes are so much smaller than prominent peaks, it is always a good idea to choose a logarithmic power scale. This looks now as shown in the following figure.



In this view, you can clearly identify the few prominent peaks and see the noise distribution.

TIP There are two more parameters that can be changed: *Sample Point Offset* and *FFT Window*. These parameters are explained in *"How to Specify the Measurement Parameters" on page 56*.

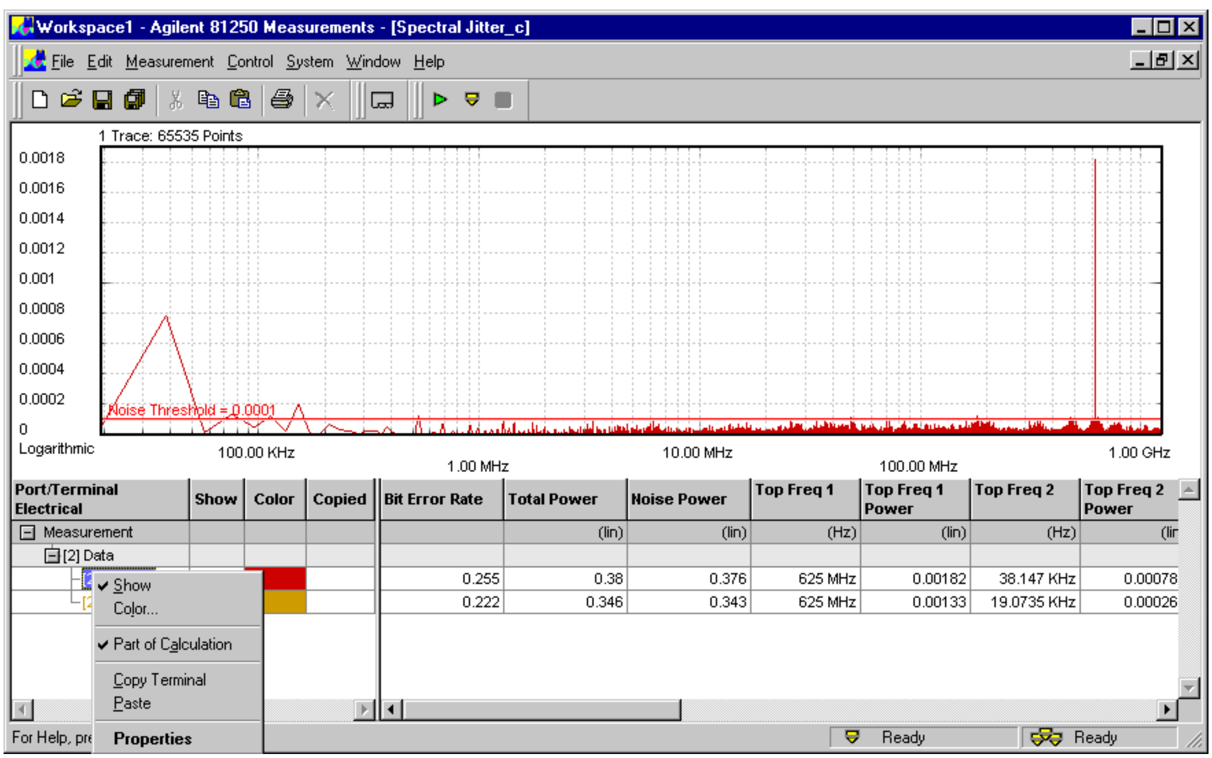
Comparing Spectral Jitter Measurement Results

If you intend to repeat a measurement, you may wish to preserve the current results for easy comparison. This can be done by copying the results of

- the whole measurement,
- a port with all of its terminals,
- a single terminal.

1 In the lower left-hand corner of the measurement window, right-click the measurement, port, or terminal.

This opens the corresponding context menu.



We have chosen the terminal “Data0” in this example.

NOTE This context menu allows you also to disable or enable the display of calculated results.

2 Choose *Copy Terminal*.

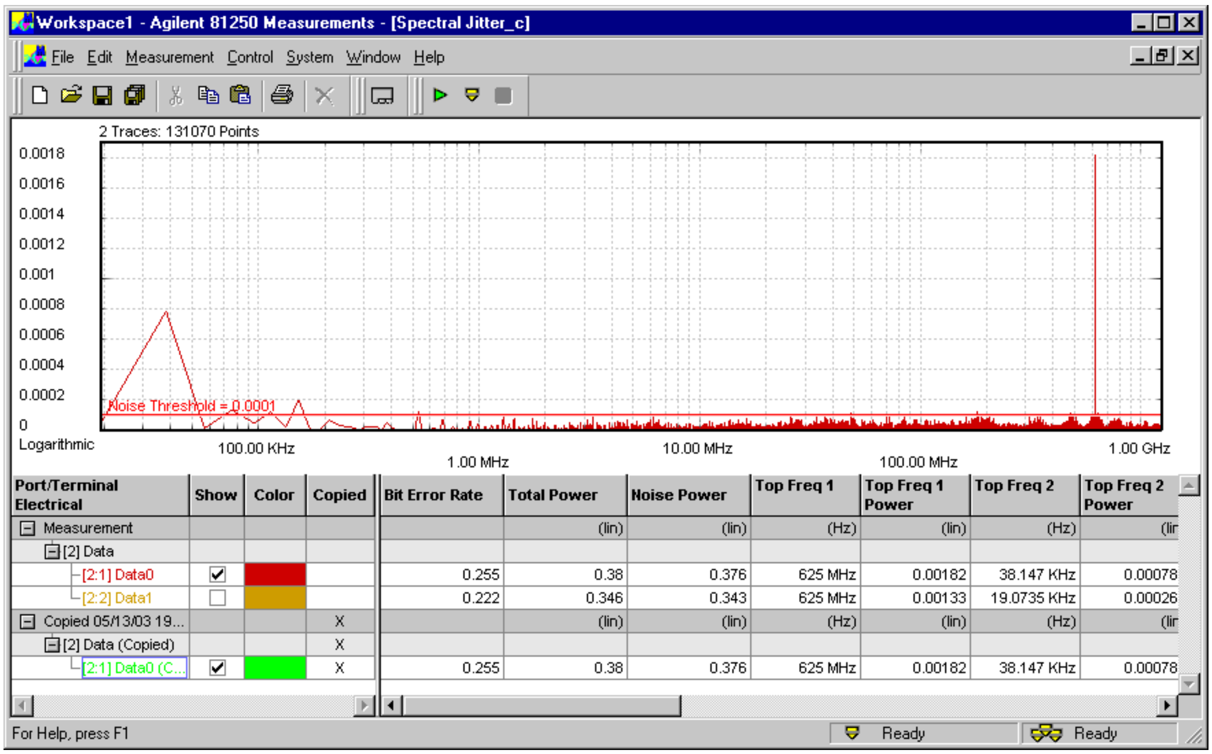
This copies the results of the terminal to the clipboard.

3 Open the context menu once more and choose *Paste*.

This adds a copy of the chosen measurement, port, or terminal results.

4 Click the *Color* field of the copy and select a different color.

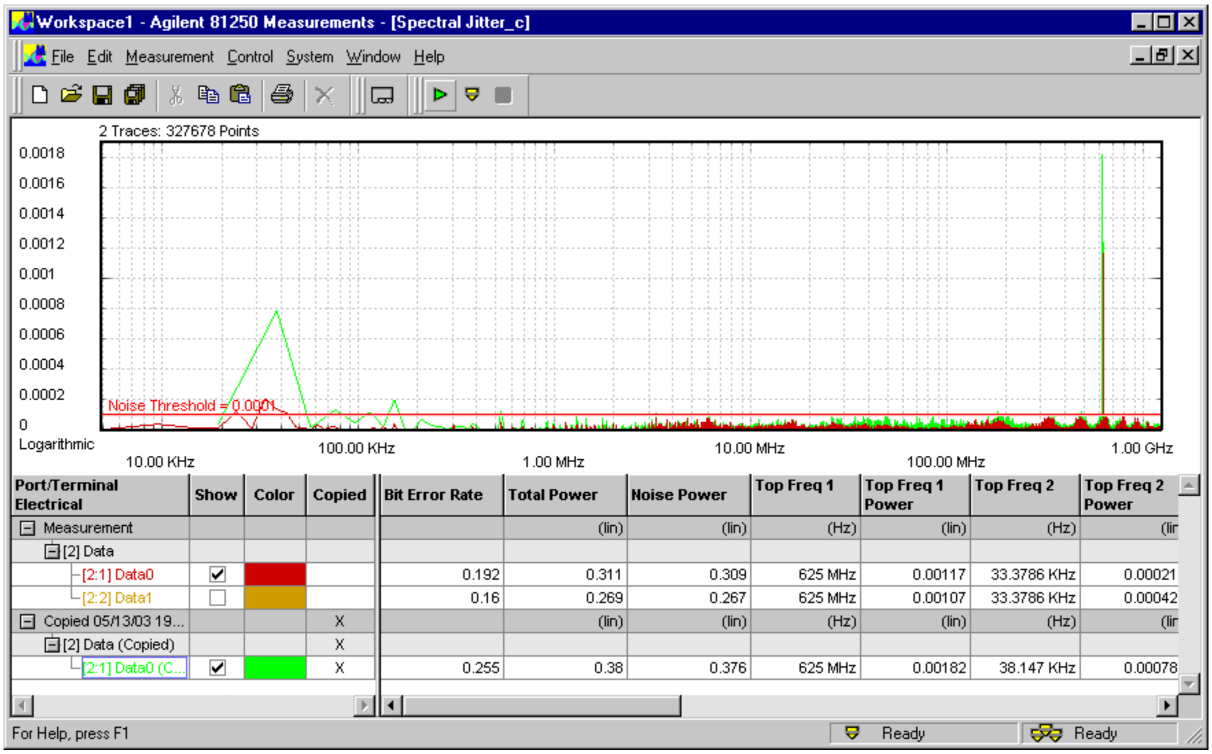
The result looks as shown below:



Because the original and the copy are identical, you see only one trace.

5 Change the *Parameters*, if you wish to do so, and repeat the measurement.

You can now directly compare the graphical and numerical results.



For the new measurement, we have increased the *Acquisition Depth*.

You can see how this affects the results.

Basics of the Spectral Jitter Measurement

In this section, you find the following information:

- For the preconditions that have to be met to run the measurement, refer to *“Prerequisites for Spectral Jitter Measurements” on page 33*.
- For general information see *“How the Spectral Jitter Measurement Works” on page 34*
- For the explanation of the measurement results, refer to *“Spectral Jitter Measurement Results” on page 43*.

Prerequisites for Spectral Jitter Measurements

In order to perform Spectral Jitter measurements, the following prerequisites have to be met in addition to the global ones (see *Prerequisites* in the *Framework User Guide*):

- All analyzed ports have to use the same frequency.
- The test sequence must contain an endless loop.
- The analyzers have to be synchronized to the incoming data stream
  - either manually (specify a start delay that positions the sampling point precisely in the middle of the eye opening)

    or, preferred
  - by automatic analyzer sampling point adjustment (Automatic Bit Synchronization or Automatic Delay Alignment).

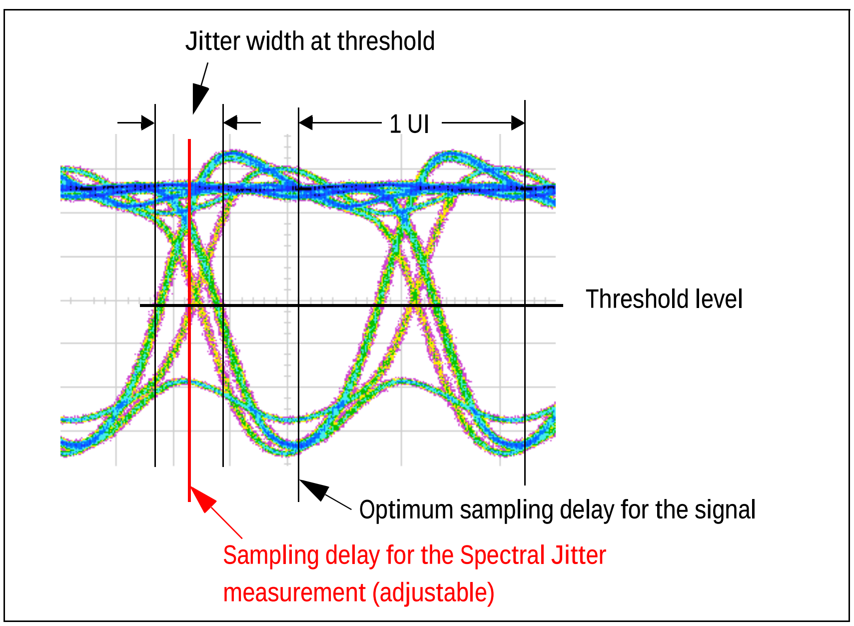
- If automatic analyzer sampling point adjustment is used, a *Phase Accuracy* of 1% should be specified. In addition, the phase delay verniers of the analyzers have to be in zero position.

NOTE It is important that the initial sampling point is in optimum position (which means, in the middle of the eye opening), because the Spectral Jitter measurement derives its sampling moment from that point.

How the Spectral Jitter Measurement Works

The Spectral Jitter measurement performs a capture and compare operation in the jitter region. The number of compared and captured bits is adjustable.

By default, the analyzer sampling point is set to an offset of –0.5 analyzer clock periods or unit intervals (UI) from the optimum sampling delay.

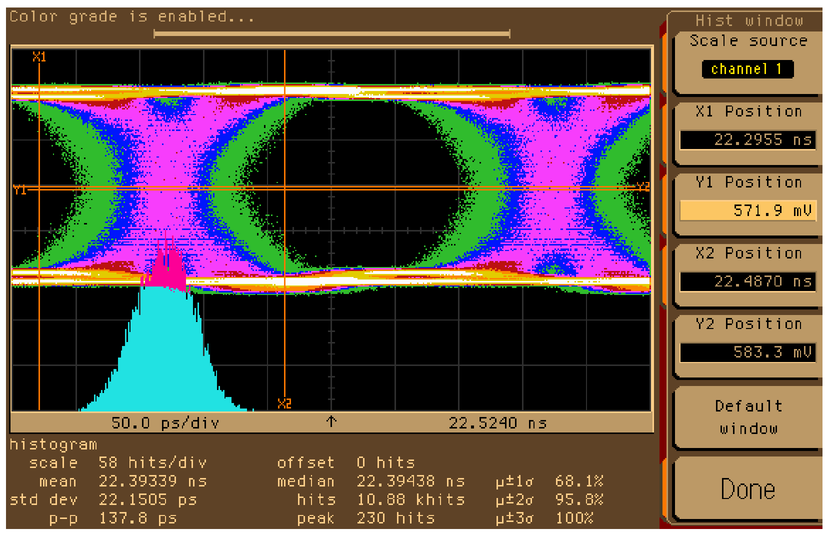


While the measurement is running, correct and incorrect data is captured. The resulting records contain the captured data and the corresponding error information.

Jitter Distribution Over Time

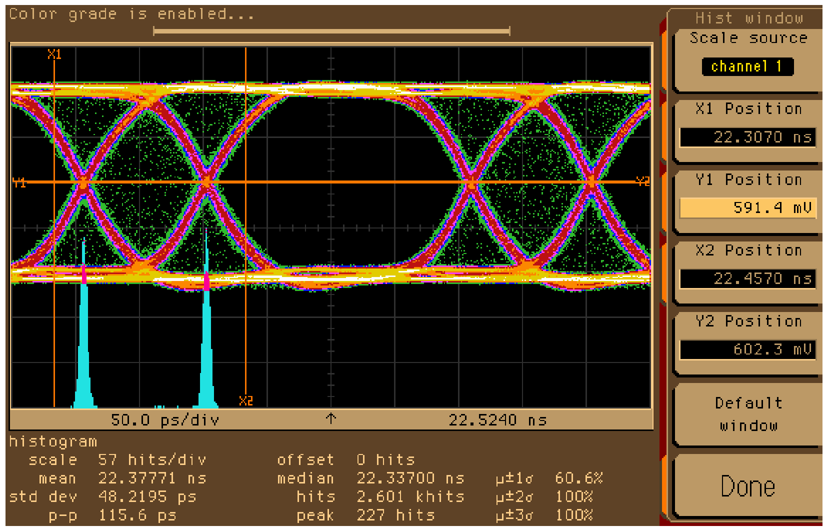
Jitter has a more or less characteristic distribution over time.

The histogram of pure random jitter shows its Gaussian distribution, as illustrated in the following figure:

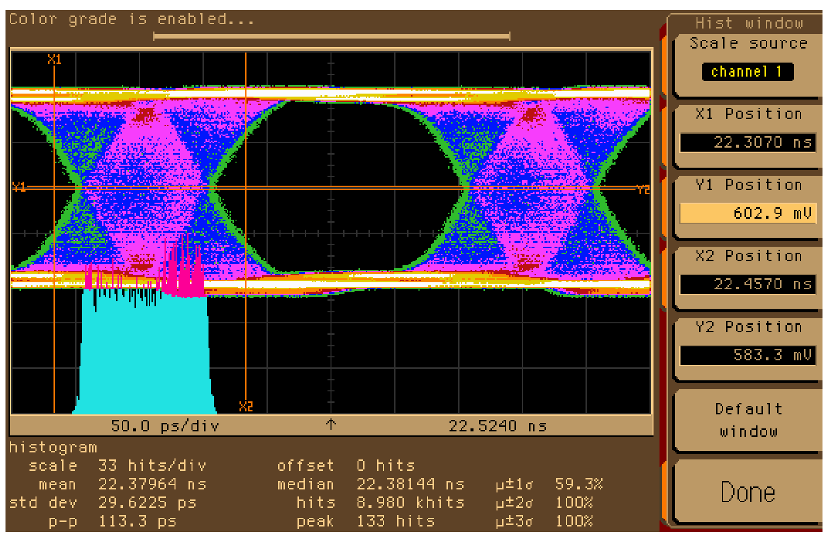


Deterministic jitter periodically adds and subtracts a delay to/from the received signal.

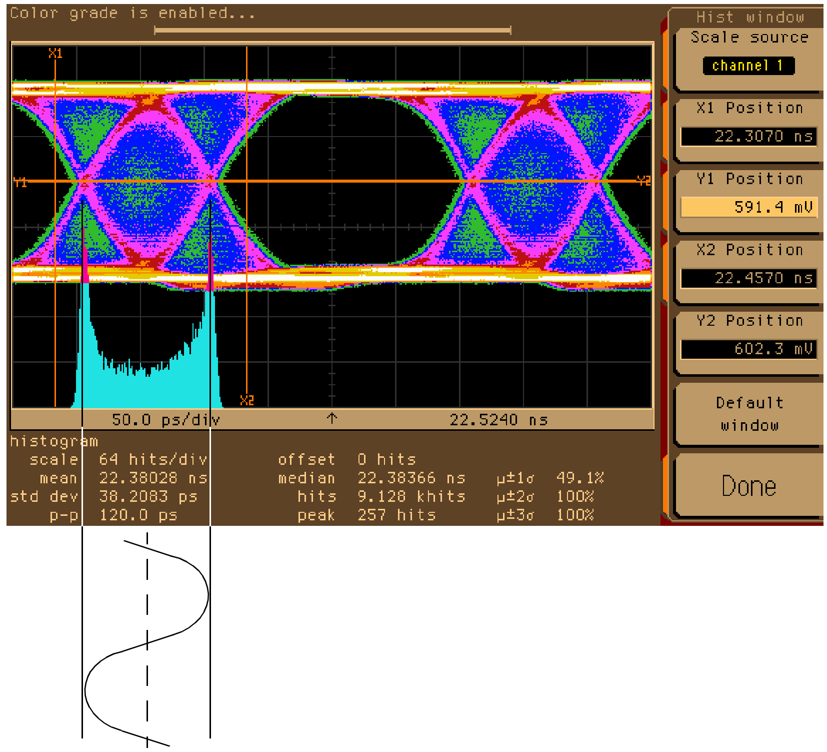
Jitter caused by a square wave or on/off signal has produced the following histogram:



Jitter caused by a triangle signal shows an even distribution:



Last, not least, the histogram of jitter modulated by a sinusoid exhibits two significant peaks:



The jitter histogram of a real world signal shows most often a mixture of these characteristic distributions.

Periodic Jitter and Bit Error Information

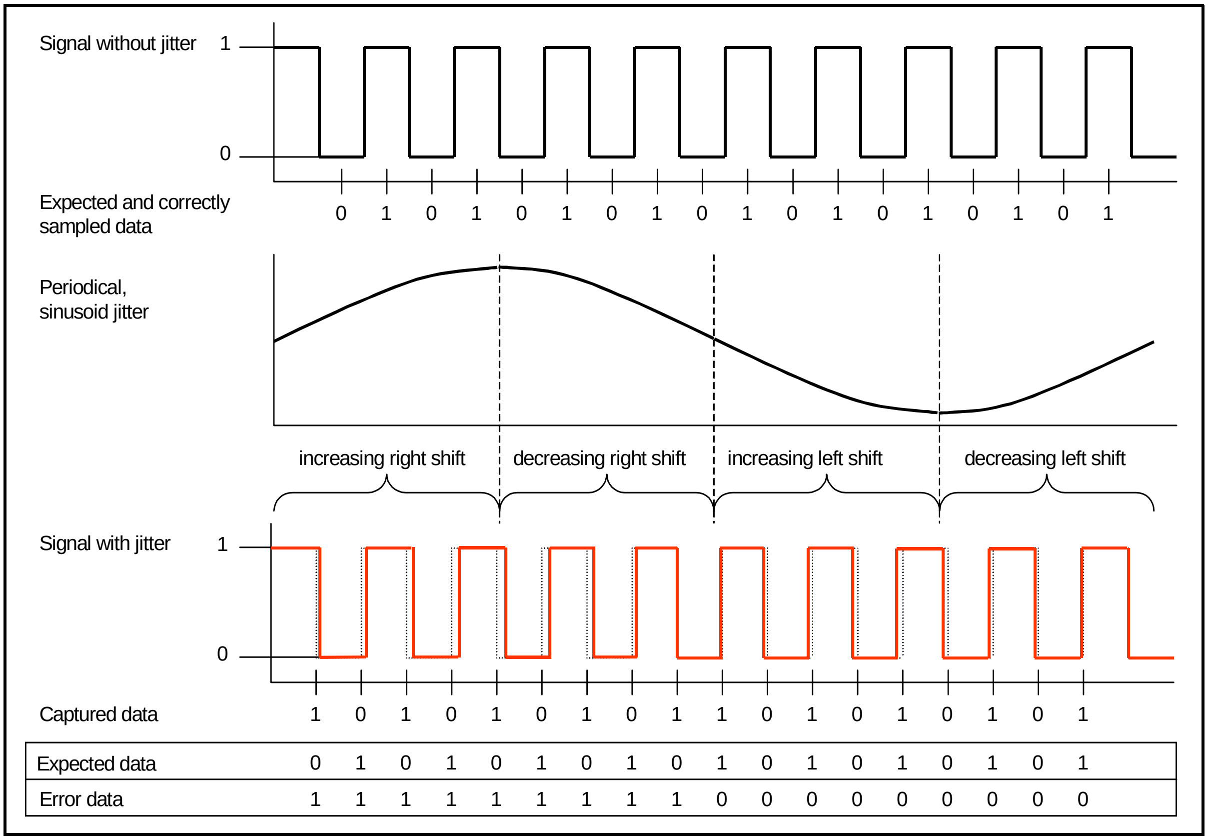
When the incoming signal is sampled at the transition point, periodic jitter manifests itself in the bit error record. An example may be helpful to understand the phenomenon.

Let us assume we expect and correctly receive a simple 0, 1, 0, 1, 0, ... pulse signal. If we would sample this signal one clock period earlier (–1 UI), we would see a bit error rate (BER) of 1.0. This is the maximum BER for this pattern.

Let us also assume, this signal is overlaid by a periodic jitter source with sinusoidal characteristics.

Now we sample the incoming signal at the transition point (–0.5 UI from the optimum sampling point).

The result is illustrated in the figure below.



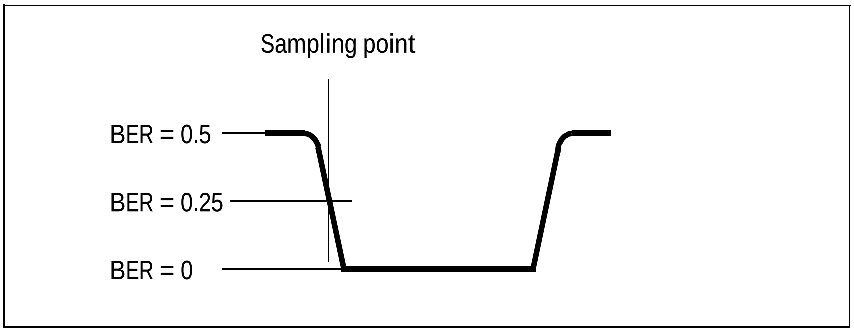
The jitter source moves the received signal to the right and to the left, but the sampling point is fixed (dotted lines show the undisturbed signal). Because we are sampling at the transition point, we get errors when the signal is shifted to the right and no errors when the signal is shifted to the left.

The error signal shows a very characteristic and reproducible pattern. The resulting BER for this kind of signal is 0.5. Other jitter frequencies yield different but also characteristic error patterns and also a BER which is half the maximum BER.

The maximum BER and hence the actual BER are pattern-dependent.

Considering the BER bathtub curve, the sampling point is in the middle of the descending line.

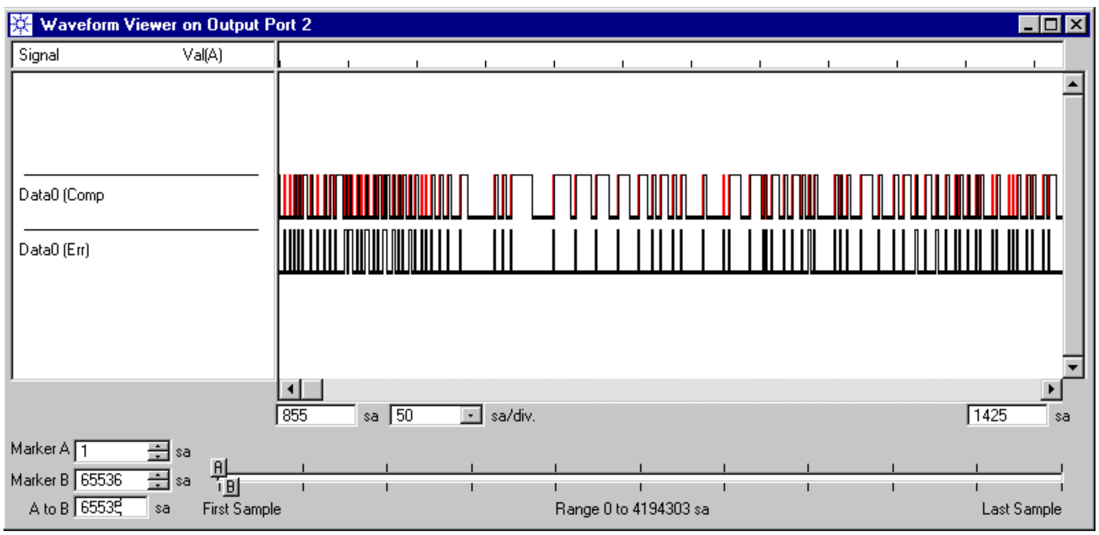
If random data is used, the average bit error rate at the left-hand side of the jitter region is 0.5.



The bit error rate at the right-hand side of the jitter region is 0. We therefore expect a bit error rate around 0.25.

NOTE The Spectral Jitter measurement should only be used in conjunction with data that has an equal distribution of ones and zeros over time. Otherwise, the results are hard to predict and may be not reproducible.

Captured and error data can be visualized with the ParBERT User Software. The following figure shows an example of the Waveform Viewer.



This signal was captured in the jitter region. You can see that the errors are not evenly distributed. The error trace contains patterns that carry spectral information about the jitter.

Signal Processing

If the error signal is obtained as explained above, an analysis in the frequency domain reveals the absense or presence of deterministic jitter. Dominant frequency components become visible and their contribution to the total jitter can be measured.

The modified error signal is subject to a fast Fourier transform (FFT).

FFT requires that the data record to be processed has a length that is a power of two (2^n, such as 2^{17}, 2^{18}, 2^{19}, 2^{20}, and so on).

From that data record, the FFT calculates pairs of frequency/power values. The number of pairs is half the number of samples. If you have chosen a record length of 2^{17} (which means 131,072 bits or 128 Kbit), the result contains 65,536 pairs. The maximum frequency bin is half the data rate used for the test.

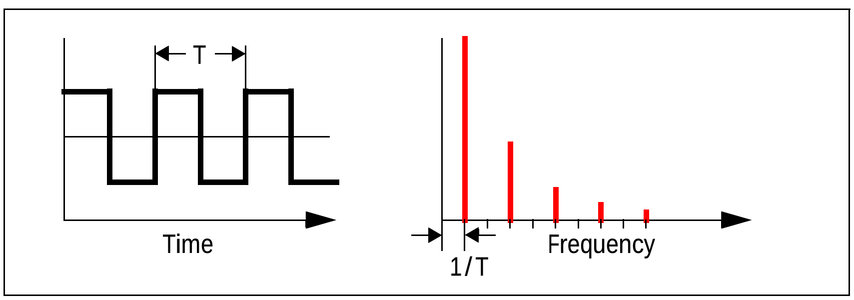
The results are displayed in the Spectral Jitter measurement graphical and numerical result window.

About FFT

For general information about the Fourier transformation and the special characteristics of the fast Fourier transform, please refer to the standard literature. For details, see also the documents cited under *"Literature" on page 7*.

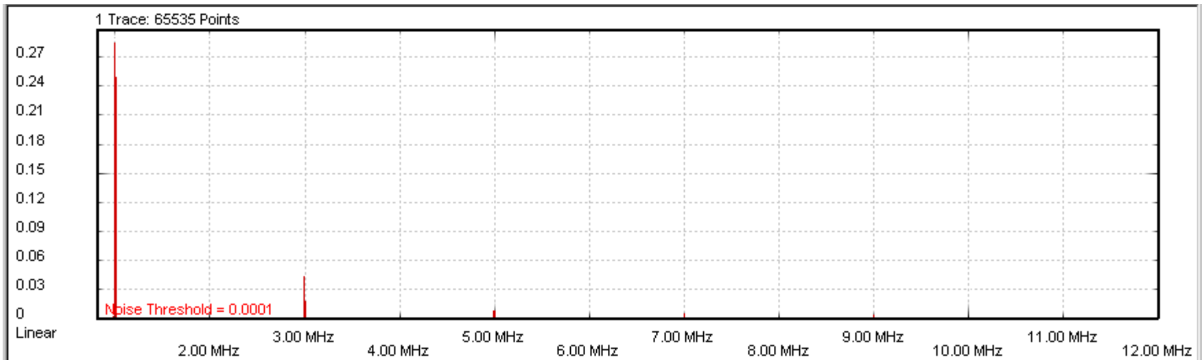
FFT results

The error record contains a bipolar, rectangular signal. If such a signal is periodic, you can expect a spectrum as illustrated below.

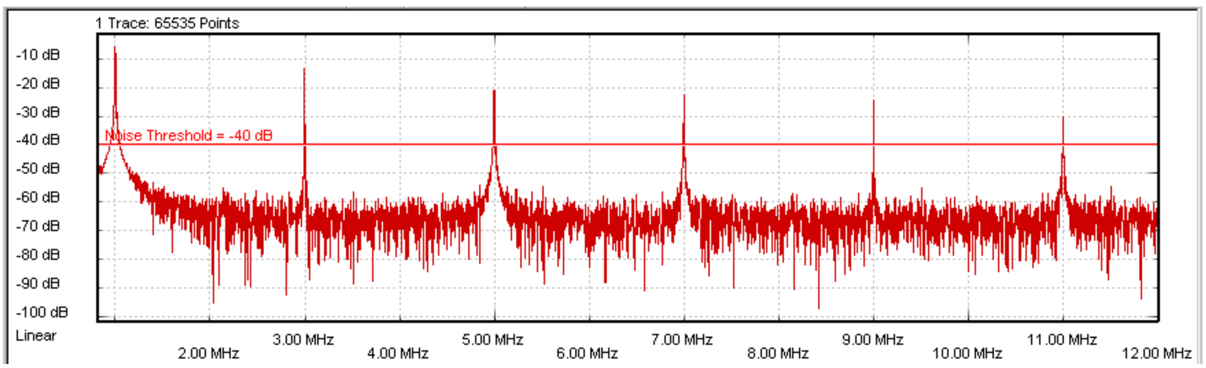


The fundamental frequency and its harmonics appear.

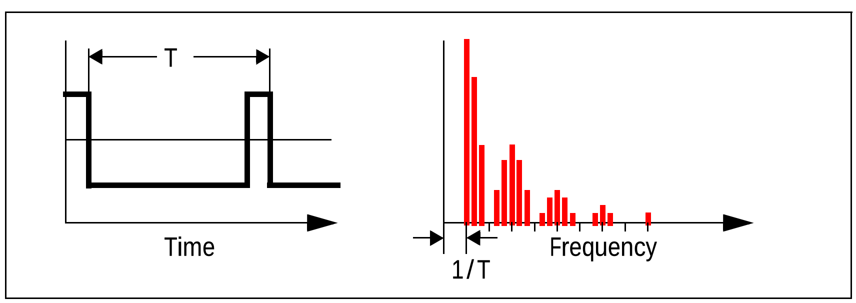
Such spectra have been measured with the Spectral Jitter measurement.



A logarithmic power scale shows the details:



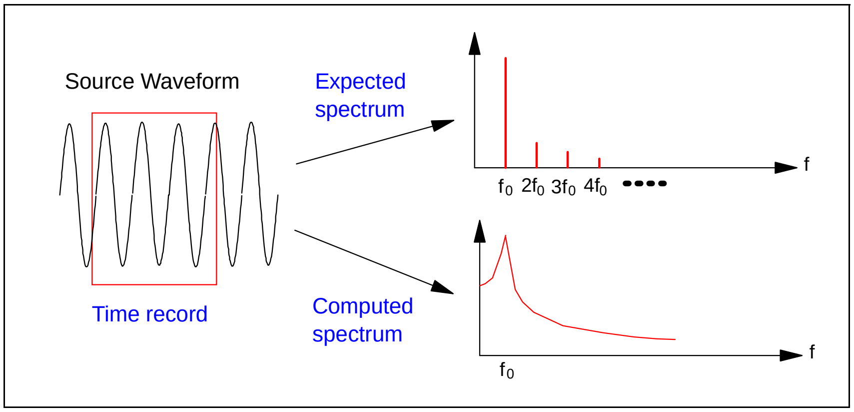
When the repetition period of the characteristic pattern in the error record increases, you will also find the typical sine-x-over-x decay of the spectral power.



Leakage and windowing

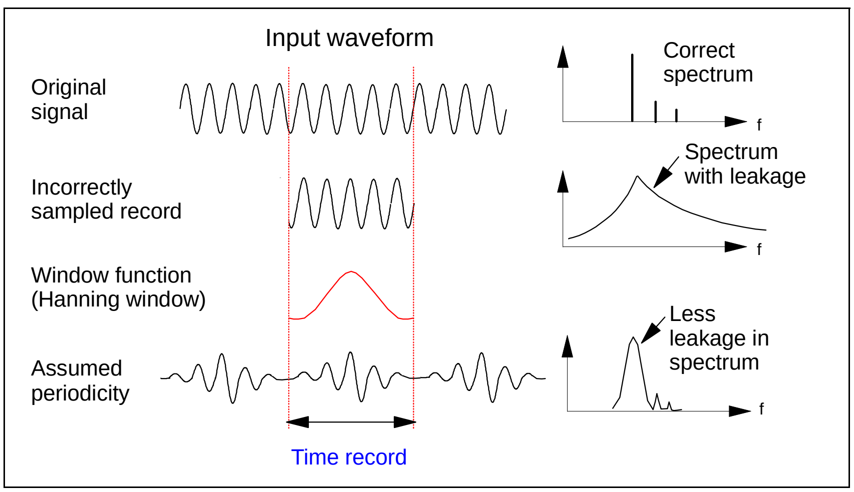
FFT assumes that the time record contains a representative section of an endless periodic signal. It assumes that time records can be seamlessly concatenated. If this is not the case, a phenomenon called leakage occurs.

Leakage makes it impossible to detect minor adjacent spectral components. The following two figures refer refer to a slightly disturbed sine wave.



When you perform a Spectral Jitter measurement, it is likely that some degree of leakage occurs. The measurement therefore provides a choice of FFT windows that allow you to detect leakage and to reduce its impact.

An FFT window is a filter that sets the beginning and end of the time record smoothly to zero. Such records can be seamlessly concatenated.



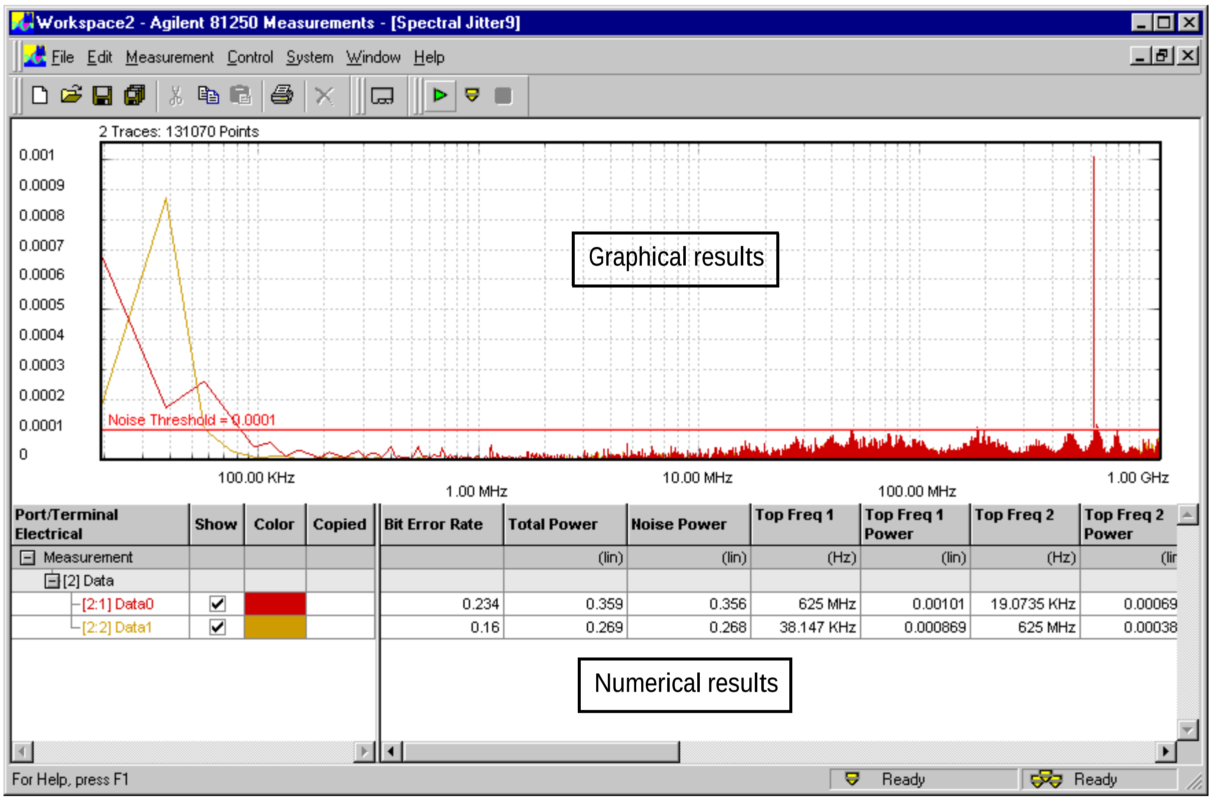
When you are using a window, please note:

- No window removes leakage completely.
- Every window reduces the spectral power.
- Results obtained from different devices can only be compared if the same window is used.

For details see *"How to Specify the FFT Calculation" on page 59*.

Spectral Jitter Measurement Results

The Spectral Jitter measurement software performs a measurement and returns the results graphically and numerically.



The following sections explain these results.

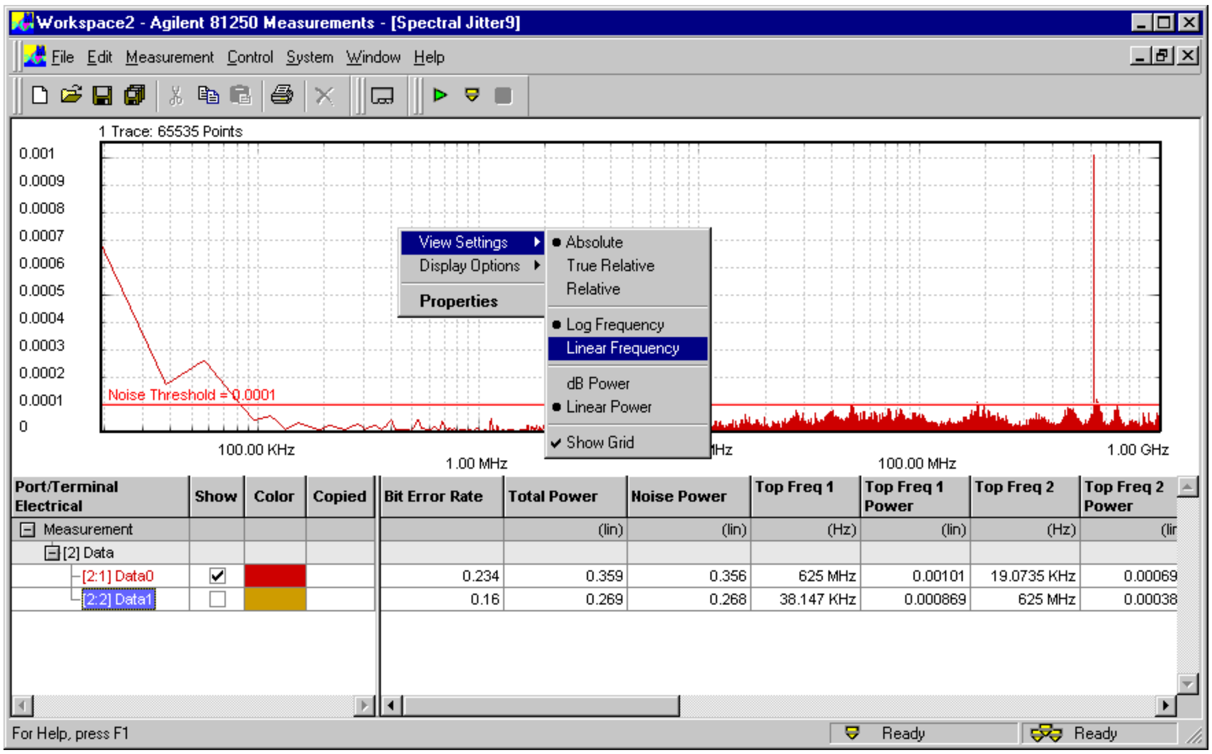
NOTE Under certain circumstances, the numerical results for a terminal are not available. This is indicated in the numerical results table below the measurement graph.

- *<no data>* indicates that no data could be captured. This can happen if the sampling threshold was incorrect or the automatic analyzer delay adjustment failed.

  It can also happen if the computer does not have enough memory.

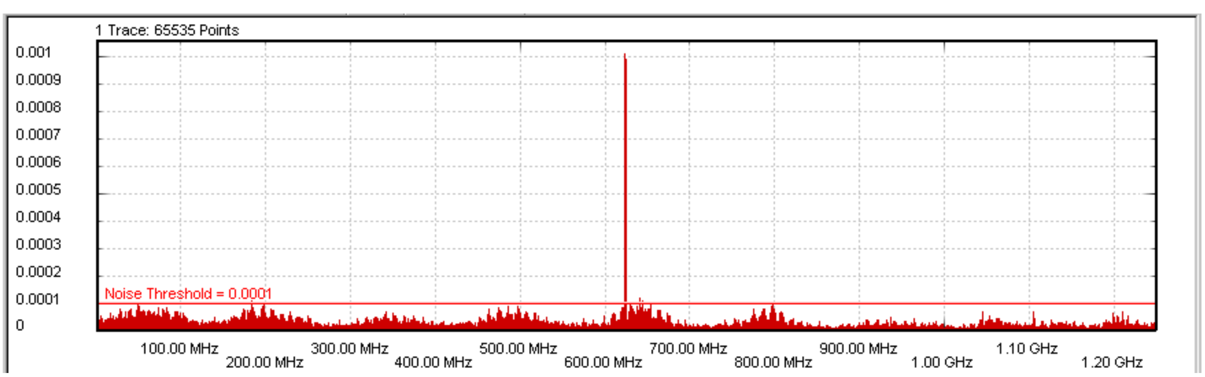
Spectral Jitter Measurement Graphical Results

The graph has a context menu that allows you to change *View Settings* and *Display Options*. The context menu can be accessed by clicking the right mouse button. Its options are also accessible from the *View* page of the *Properties* dialog.



Frequency scale

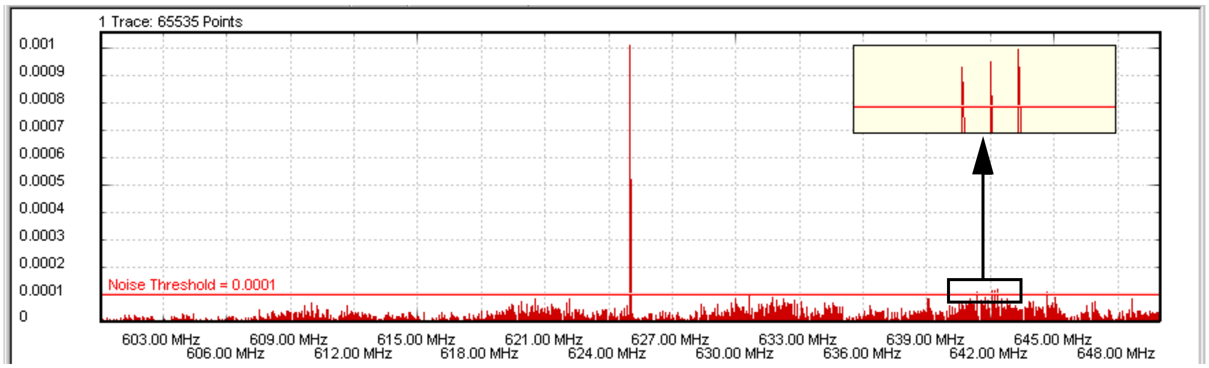
A logarithmic frequency scale, as shown in the figure above, allows you to identify low frequency jitter components. A linear scale, as shown in the following figure, hides these peaks.



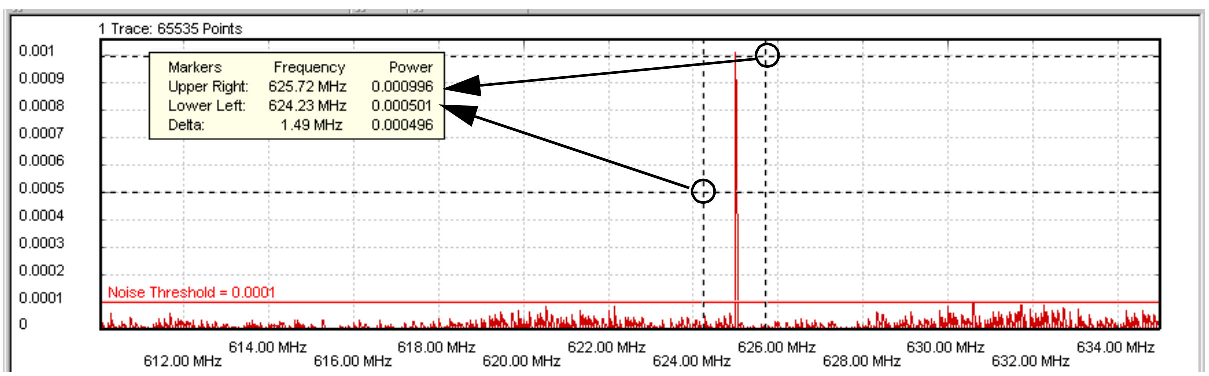
On the other hand, a linear scale may show you frequency-dependent jitter variations more clearly.

Frequency scale zoom A zoom function is available that provides an expanded view of a certain frequency range. This range can be set on the *View* page of the *Properties* dialog (see *“How to Change the Graph” on page 70*).

Zoom window The zoom window that can be opened from the context menu makes it possible to study the details of the graph.



Markers Markers can be used for analyzing the graph. They are formed by two vertical and two horizontal dotted lines that can be moved with the mouse.



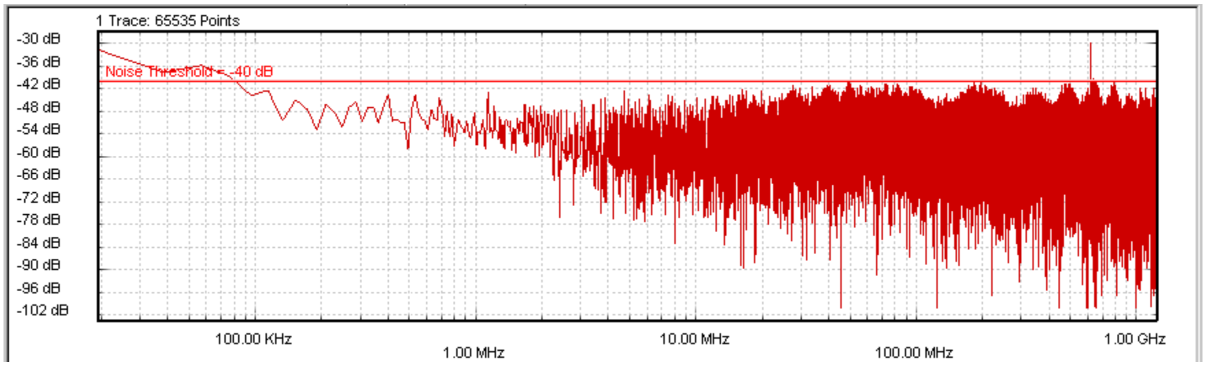
The marker readout informs you about the positions of the upper right-hand and lower left-hand intersections and their deltas.

Power scale

The linear power scale is well suited for identifying large peaks in the spectrum.

From the context menu, you can change the power scale from linear to dB. The dB scale is a logarithmic scale (see also *"How to Change the Graph" on page 70*). The dB scale allows you to examine the whole power range.

The following figure shows an example of a double logarithmic display.



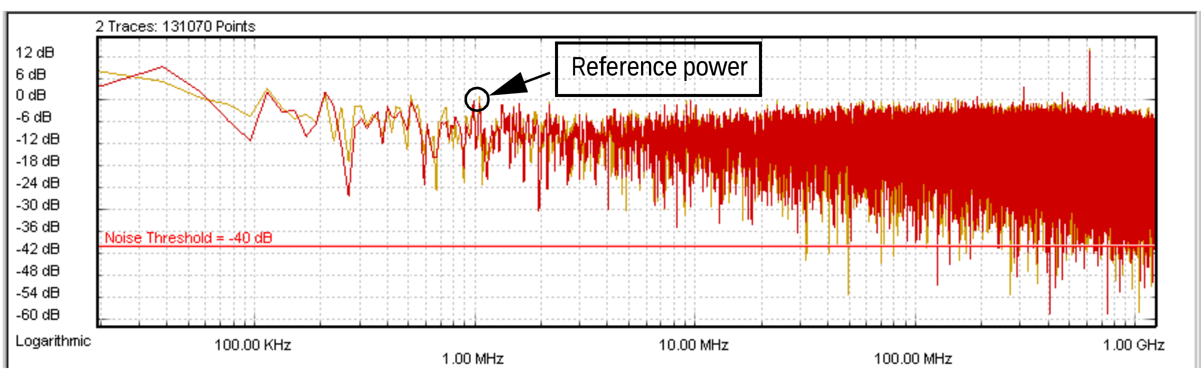
When you switch from linear power display to dB, the numerical values change as well.

Absolute vs. relative values

The figure above shows the absolute power scale and values as calculated by the FFT. You can also calculate relative values.

Relative values can be normalized to either the total power (*True Relative*) or to the power of a selectable frequency bin (*Relative*).

The following figure shows an example where the scale and the power values have been normalized to the power measured at 1 MHz.



When you set the power values to relative, this changes not only the graphical scale but also the calculated results. You can thus calibrate the power values to any reference.

For details see *"How to Set Analyze Parameters" on page 66.*

Noise Threshold The *Noise Threshold* can be moved with the mouse. It can also be set on the *View* page of the *Properties* dialog.

This threshold is used to separate between total power and noise power. All components below the *Noise Threshold* are considered noise. When the threshold is changed, the calculated *Noise Power* values change.

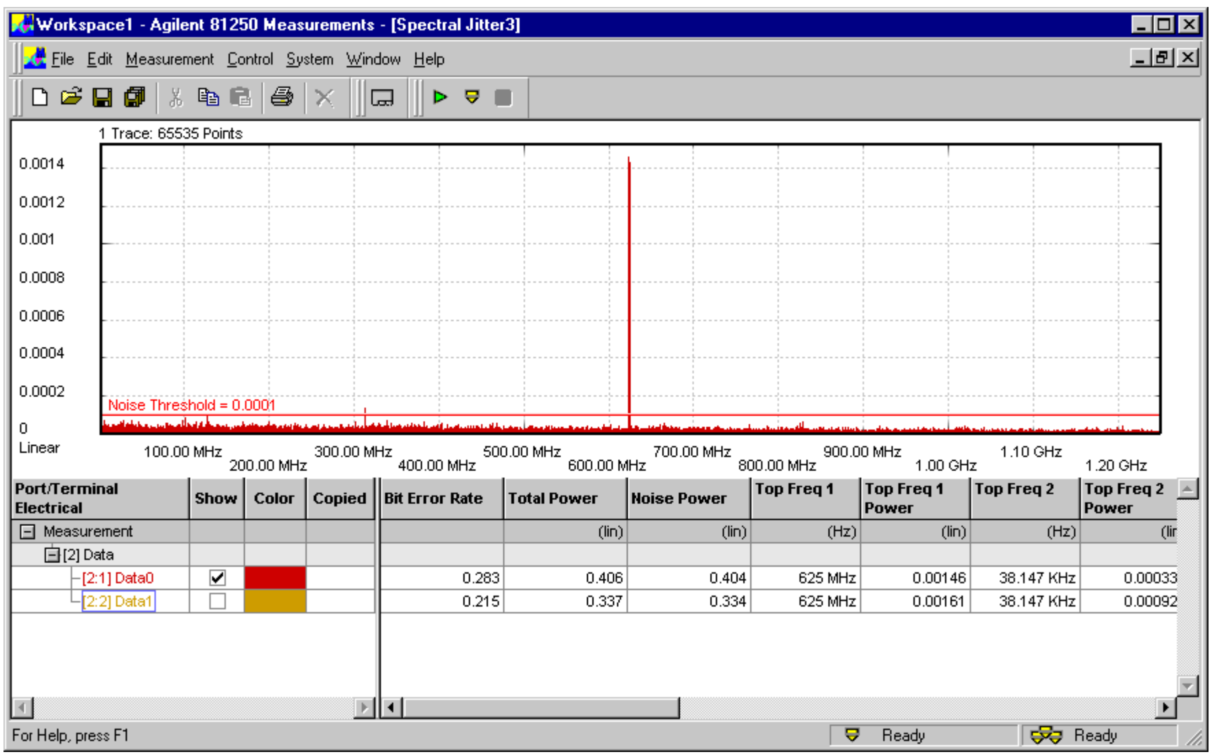
Colors You can customize the graphical display by changing its colors. For details see *“How to Change the Colors of the Graph” on page 73*.

Spectral Jitter Measurement Numerical Results

The numerical results are:

Parameter	pass / fail
Bit Error Rate	min / max
Total Power	max
Noise Power	max
Frequency Range Power	max
Up to 16 pairs of frequency / power values	

The results are displayed below the graph and only calculated for terminals, not for ports.



Bit Error Rate When random data is used, the bit error rate should be around 0.25.

If it is much higher or lower, this indicates that the sampling point of the measurement is not in the middle of the jitter region. For details see also *"How the Spectral Jitter Measurement Works" on page 34*.

Total Power

The *Total Power* is calculated as the total of all spectral power values except any DC component.

Power in dB is calculated as 10 log (power ratio). This yields

Power Ratio	dB
100	+20
10	+10
2	+3
1	0
1/2	–3
1/10	–10
1/100	–20
1/1000	–30

If you have chosen a normalized view (*Relative* or *True Relative*), all power values refer to the selected basis. This can be either the total power (*True Relative*) or the power of a selectable frequency bin (*Relative*).

Noise Power

The *Noise Power* is calculated as the total of all spectral power values except DC that remain under the *Noise Threshold*.

Frequency Range Power

This is the power measured in a certain frequency range.

On the *View* page of the *Properties* dialog, you can define and enable/disable up to eight frequency ranges. When you define a frequency range, you also specify how the Frequency Range Power is determined.

The *Frequency Range Power* is either the total of all power values above the *Noise Threshold* within the range or the highest power value found in the range.

For details see *"How to Define Frequency Ranges" on page 68*.

Top Frequency n / Top Frequency n Power

These columns identify up to 16 power peaks. They show the frequency and the contribution of these peaks to the total power.

The list is sorted descending according to the measured power values.

Setting the Properties of a Spectral Jitter Measurement

Before you can run a new Spectral Jitter measurement, you have to set the required parameters on the measurement's *Properties* pages.

When you create a new measurement, the *Properties* dialog is automatically displayed.

To change the parameters of an existing measurement, choose *Measurement – Properties* from the menu bar. Or click the right mouse button and choose *Properties* from the context menu.

NOTE If you change the measurement settings after the measurement has been run, please note:

- Changes on the *View* and *Pass/Fail* pages have only an impact on the display of the results. There is no need to repeat the measurement.
- Changes on the *System*, *Ports*, and *Parameters* pages only take effect when you repeat the measurement. To remind you that the present results have not been obtained with the modified settings and that you should repeat the measurement, the result display shows a yellow bar.

Numbers can be entered in decimal notation (**`10000000`**, **`0.0003`**, for example) and scientific/engineering notation (**`1e9`**, **`1.7e-3`**, for example).

Frequencies can be entered as value and unit (**`5200 kHz`**, **`7.88 MHz`**, for example).

Power values can be entered in decimal notation (**`0.0001`**, for example) or in dB (**`–40 dB`**).

For detailed instructions see

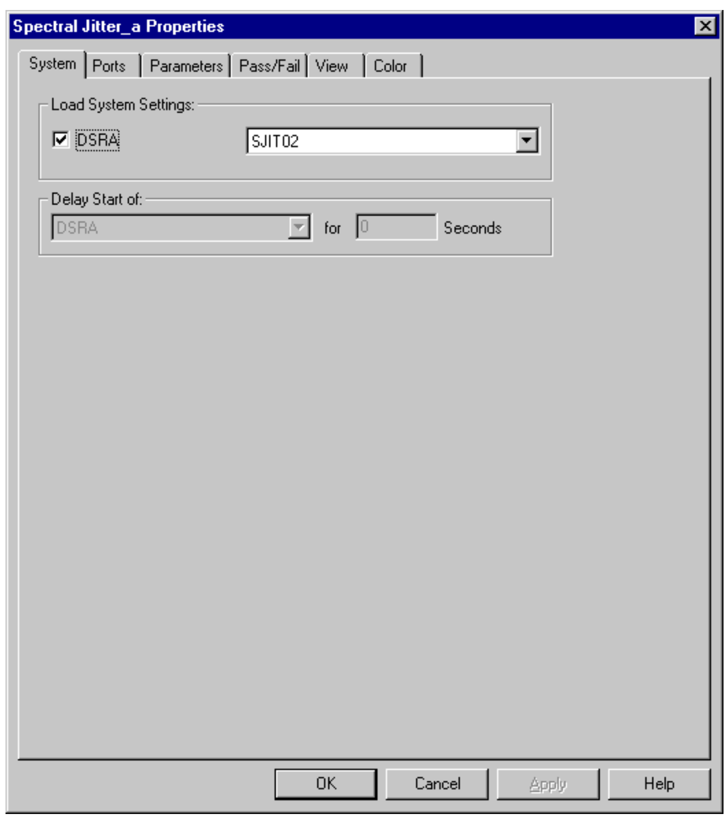
- *"How to Set Up the System to be Used" on page 52*
- *"How to Select the Ports to be Measured" on page 55*
- *"How to Specify the Measurement Parameters" on page 56*

- *"How to Set Pass/Fail Criteria" on page 61*
- *"How to Specify the View" on page 65*
- *"How to Change the Colors of the Graph" on page 73*

How to Set Up the System to be Used

The *System* page of the *Properties* dialog appears automatically if you have set up a new measurement. The *System* page shows one or two systems, depending on your selection when creating the measurement.

The *Agilent 81250 Measurement Software* uses the information on this page to address the system and to obtain all necessary setup parameters like ports, terminals, frequencies, test sequence, segments (data patterns), and so on.



For a saved measurement, the *System* page shows the setting that has been used when performing the measurement, as illustrated in the previous figure.

For a new measurement, the systems chosen for the *Workspace* are displayed.

1 Click the checkbox belonging to the system.

   This connects you to the system and activates the setting name field.

   If the *Agilent 81250 User Software* is active for that system, then the name of the current setting is displayed, and it will be used by default. An empty field indicates that the current setting has not been saved (ParBERT label “Untitled”).

   If the *Agilent 81250 User Software* is not active for that system, then you have to load a setting.

   In any case, if you need a special setting, you can load it.

2 Choose a suitable setting from the drop-down list.

   When you choose a new system setting, it will be downloaded to the firmware. You have to confirm this action before it will actually be performed.

NOTE For one system, only one setting can be loaded at one time. The *Agilent 81250 User Software* and the *Agilent 81250 Measurement Software* therefore always refer to the same setting.

If the *Agilent 81250 User Software* is active, the *Agilent 81250 Measurement Software* proposes the current setting, even if it has not been saved and has hence no name (untitled setting).

If the *Agilent 81250 User Software* is active and you load a different setting from the *Agilent 81250 Measurement Software*, the *Agilent 81250 User Software* will be updated, and vice versa.

If you change the current setting with the *Agilent 81250 User Software* (for example by changing data rates, adding or deleting ports or terminals, changing connections, or changing the test sequence), then the *Agilent 81250 Measurement Software* will detect such changes when you attempt to run the measurement.

TIP If you have changed the current setting with the *Agilent 81250 User Software* and wish to keep your modifications, save the setting with the *Agilent 81250 User Software* before loading a different one. The *Agilent 81250 Measurement Software* does not save settings.

3 In case of two systems, you can specify a start delay for one of the systems.

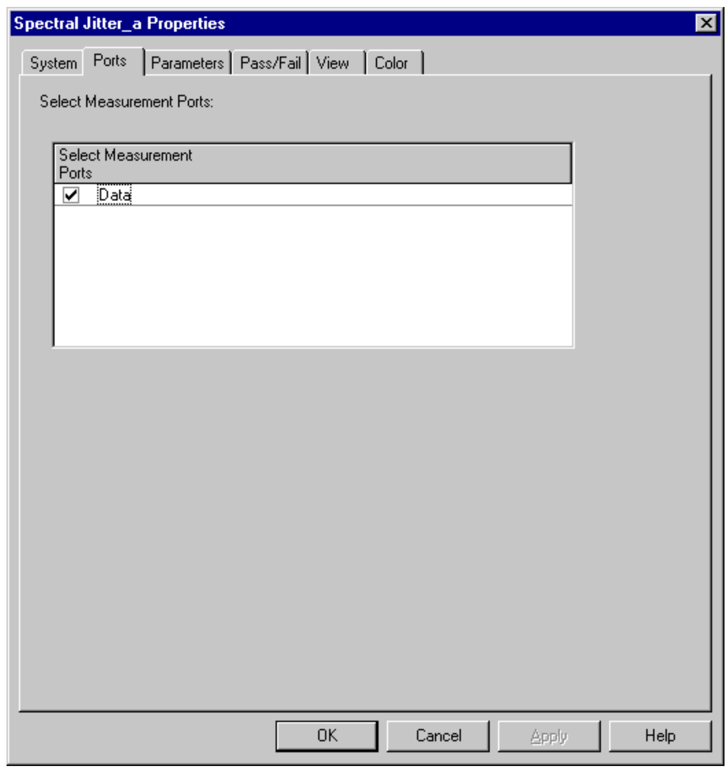
This may be useful, for instance, to allow a PLL or clock recovery circuit in the DUT to lock onto the incoming data stream.

4 Click *Apply* to accept the modifications without leaving the *Properties* dialog. Or click *OK* to accept the modifications and close the *Properties* dialog.

How to Select the Ports to be Measured

After you have specified the measurement system and the related system setting, you may wish to exclude one or several DUT output ports from the measurement.

1 In the *Properties* dialog, select the *Ports* tab.



The *Ports* page lists all the output ports of the device under test, as defined in the loaded setting. In case of two systems, this is the setting loaded on the analyzing system. By default, all these ports are enabled and will be measured.

NOTE This display is not automatically updated if you change the loaded setting by means of the *Agilent 81250 User Software*.

2 Disable the ports that shall not be measured.

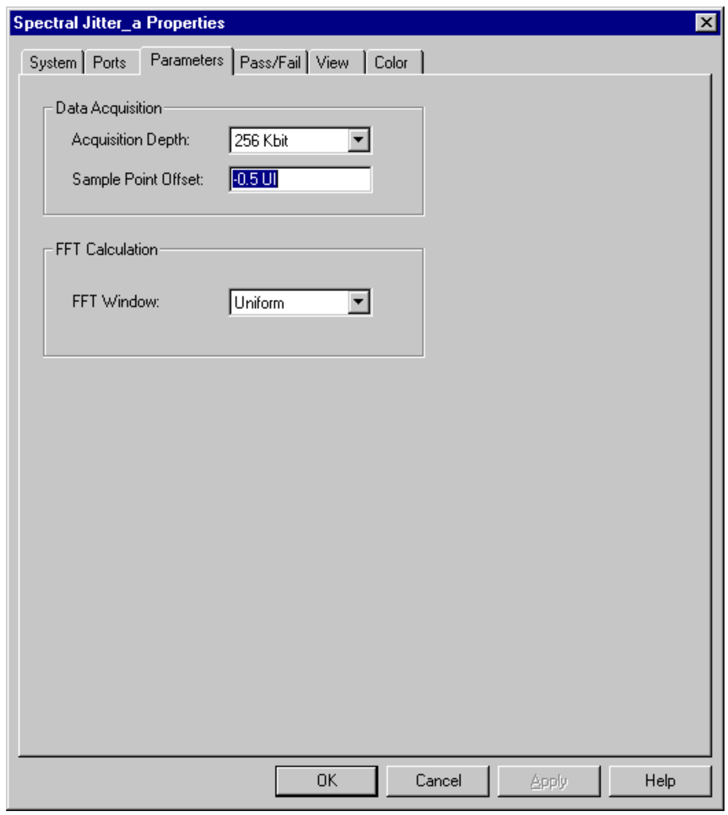
3 Click *Apply* to accept the modifications without leaving the *Properties* dialog. Or click *OK* to accept the modifications and close the *Properties* dialog.

How to Specify the Measurement Parameters

The *Parameters* page of the *Properties* dialog allows you to specify the parameters of the Spectral Jitter measurement.

NOTE If you modify the settings on this page, you have to repeat the measurement to update the results.

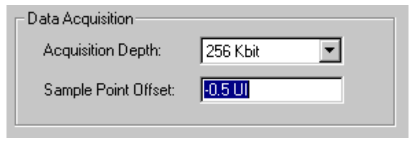
1 In the *Properties* dialog, click the *Parameters* tab.



The parameters refer to *Data Acquisition* and *FFT Calculation*.

How to Specify Data Acquisition Parameters

In the upper section of the *Parameters* page, you can control the number of compared and acquired bits and the position of the sampling point.



For basic information see also *"How the Spectral Jitter Measurement Works" on page 34*.

1 Change the *Acquisition Depth*, if desired.

Suitable numbers can be chosen from the drop-down list. The default is 128 Kbit (131,072) bits.

The *Acquisition Depth* determines the length of the time record used for the FFT.

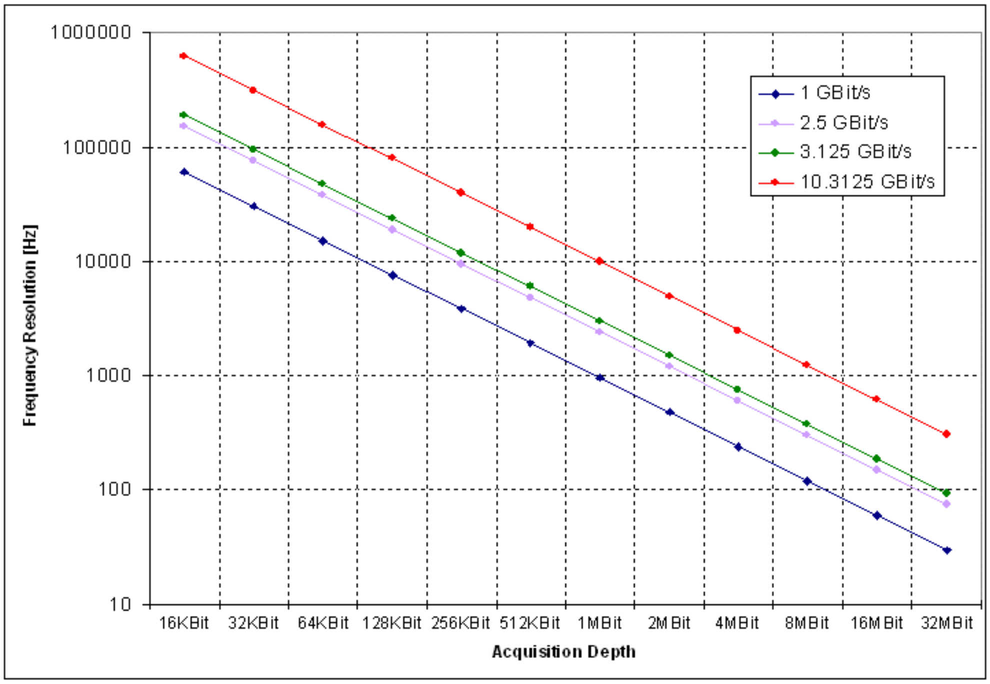
A smaller number reduces the duration of the Spectral Jitter measurement and its precision. A larger number increases the measurement duration but also the frequency resolution of the measured spectral components.

The frequency resolution of the measurement is

```
data rate / Acquisition Depth
```

For example: If you have a data rate of 2.5 GHz and an *Acquisition Depth* of 128 Kbit, the frequency resolution is 19.0735 kHz.

The relations are illustrated in the following figure:



NOTE A high *Acquisition Depth* requires a high degree of computational effort and hence time.

You should therefore not specify an *Acquisition Depth* of 8 Mbit and more unless you have a really fast computer with plenty of RAM.

2 If desired, change the *Sample Point Offset*.

By default, the sampling point for the measurement is positioned 0.5 clock periods or UI ahead of the present analyzer sampling point.

If automatic analyzer sampling delay adjustment is used (with highest accuracy), this corresponds to the transition point of the incoming signal.

If you have set the analyzer sampling delay manually, this is the time offset from that point.

This option allows you to fine-tune the sampling point. The unit is UI (unit intervals). This makes the setting independent of the present clock frequency.

3 Click *Apply* to accept the modifications without leaving the *Properties* dialog. Or click *OK* to accept the modifications and close the *Properties* dialog.

How to Specify the FFT Calculation

In the lower section of the *Parameters* page, you can choose an FFT window.

For an introduction to FFT windows see *"Leakage and windowing" on page 41*.

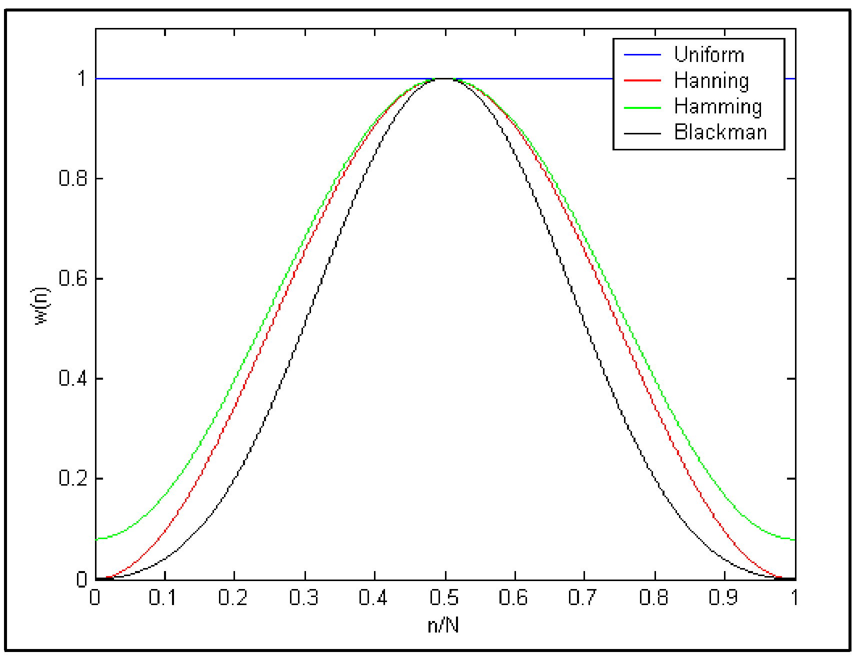
1 Choose the desired window from the list.

The following windows are provided:

- Uniform
- Hanning (sometimes also called Hann)
- Hamming
- Blackman

The "uniform" window is no window at all. This setting supplies the original error record to the FFT.

The other windows have the shapes illustrated in the figure below:



You can see from the figure that the Blackman window is the strongest filter.

The windows are based on the following formulas:

Uniform	$w(n) = 1.0$
Hanning	$w(n) = 0.5 \cdot \left(1 - \cos\left(\frac{2\pi n}{N}\right)\right)$
Hamming	$w(n) = 0.54 - 0.46 \cdot \cos\left(\frac{2\pi n}{N}\right)$
Blackman	$w(n) = 0.42 - 0.5 \cdot \cos\left(\frac{2\pi n}{N}\right) + 0.08 \cdot \cos\left(\frac{4\pi n}{N}\right)$

NOTE In case of leakage, FFT windows improve the spectral resolution.

FFT windows generally reduce the measured spectral power.

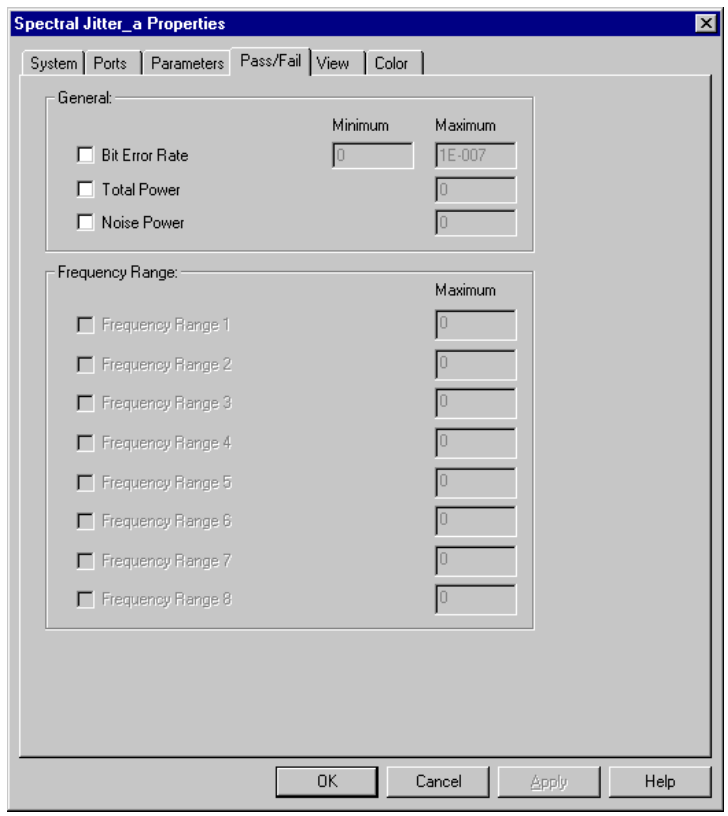
2 Click *Apply* to accept the modifications without leaving the *Properties* dialog. Or click *OK* to accept the modifications and close the *Properties* dialog.

How to Set Pass/Fail Criteria

The *Pass/Fail* page of the *Properties* dialog allows you to specify the criteria which determine whether the DUT has passed or failed the test.

You can change the pass/fail criteria without rerunning the measurement. The software compares the results with the limits after the measurement has finished.

1 In the *Properties* dialog, click the *Pass/Fail* tab.



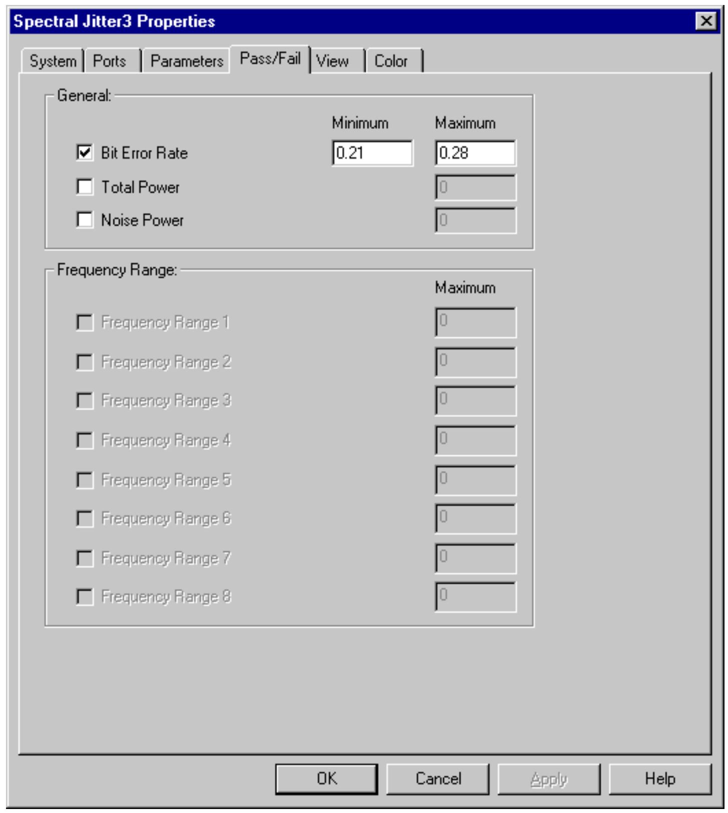
You can set pass/fail limits for general parameters and for frequency ranges.

NOTE Only frequency ranges that have been defined and enabled can take part in the pass/fail evaluation. When you define a frequency range, you specify also how the power value of that range is calculated (see *"How to Define Frequency Ranges" on page 68*).

2 To enable the limits of a parameter, click the corresponding checkbox.

3 Enter the limits as required.

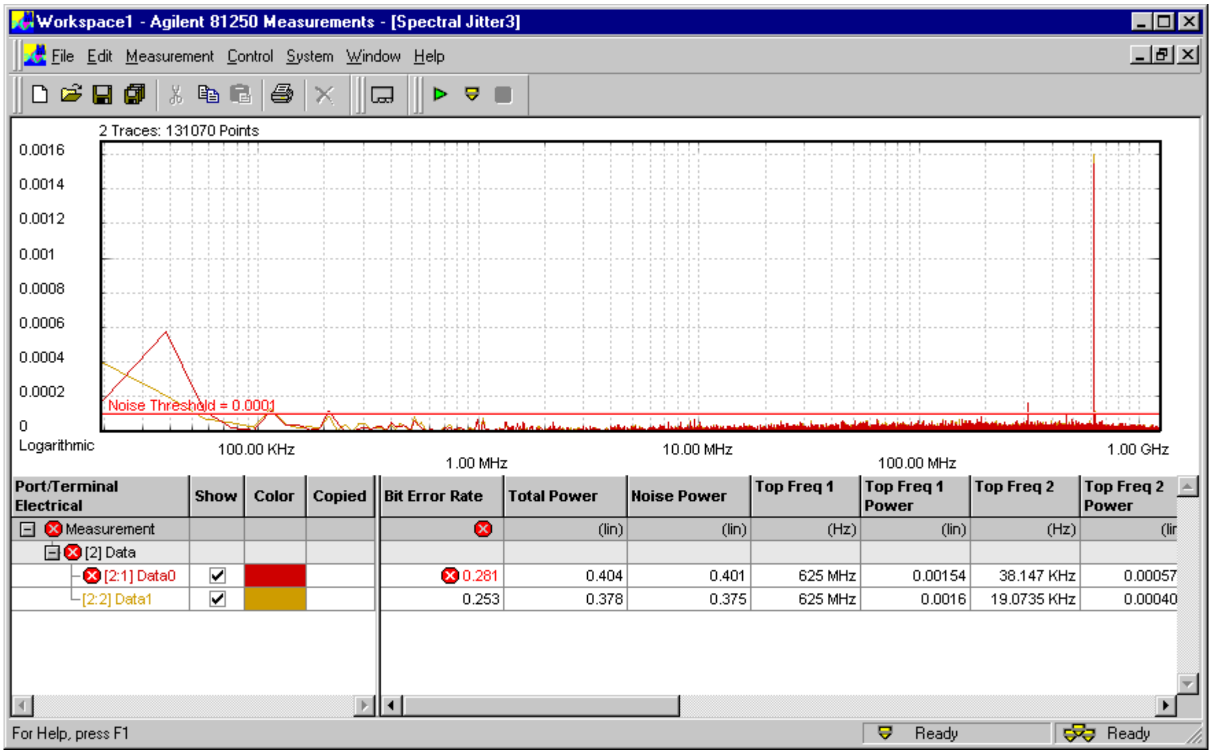
For the bit error rate you can specify a minimum and a maximum limit:



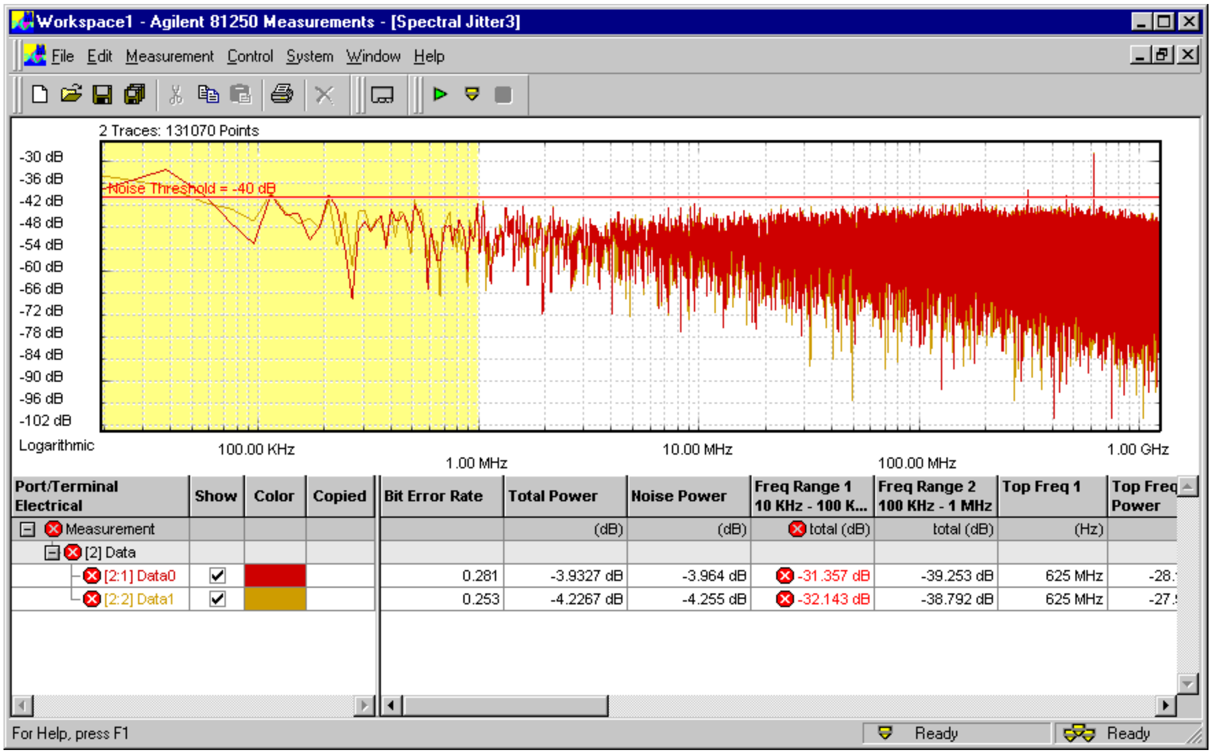
For all other parameters, only maximum limits are accepted.

4 Click *Apply* to accept the modifications without leaving the *Properties* dialog. Or click *OK* to accept the modifications and close the *Properties* dialog.

In the following figure, you can see how an intolerable Bit Error Rate is flagged.



For the next picture, we have defined and enabled two frequency ranges. The power of each range is calculated as the total of all values within the range. We have set the maximum limits to –36 dB.

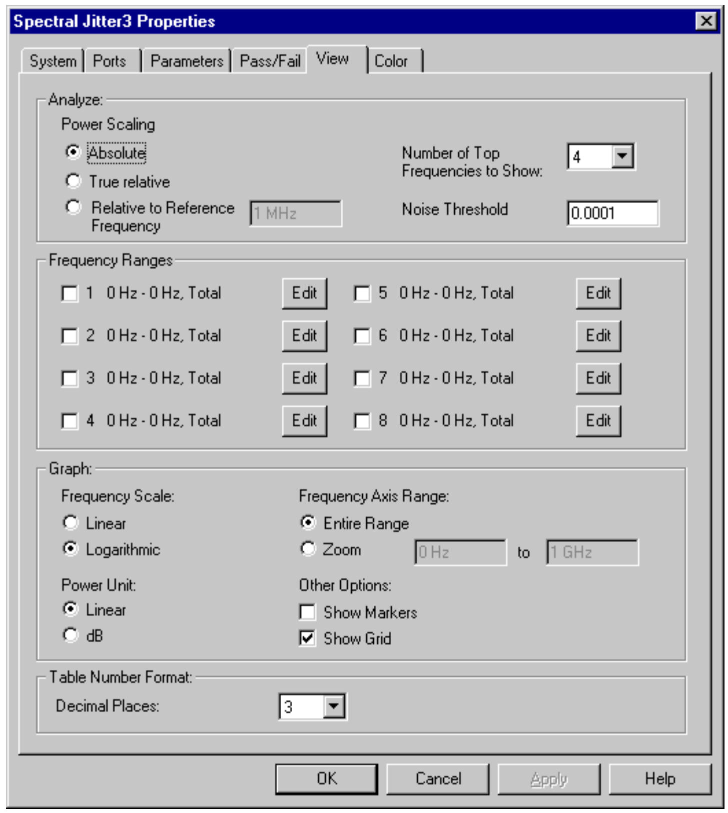


You can see how the frequency ranges are highlighted. Their settings and results are displayed in the numerical section. The total spectral power of Frequency Range 1 exceeds the maximum.

How to Specify the View

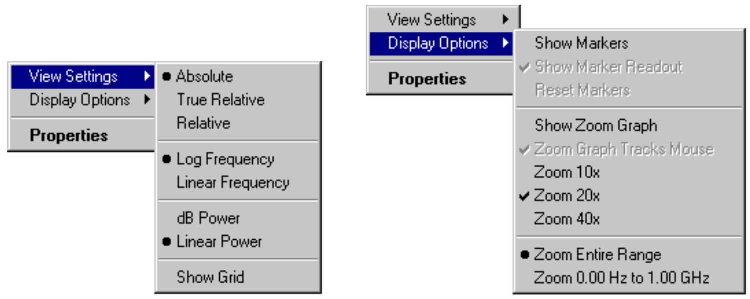
The *View* tab of the *Properties* dialog allows you to modify the display of the measurement results.

1 In the *Properties* dialog, click the *View* tab.



Changes on this page take effect as soon as you click *Apply* or terminate the *Properties* dialog. There is no need to rerun the measurement.

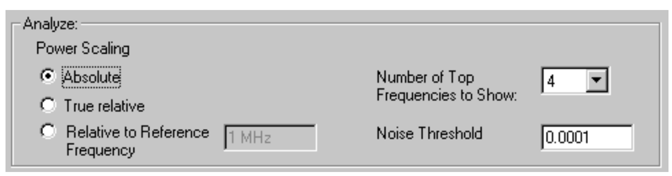
Most of the options can also be chosen from the context menu of the graphical result display:



The *View* page has the sections *Analyze*, *Frequency Ranges*, *Graph*, and *Table Number Format*.

How to Set Analyze Parameters

These parameters refer to the display of the numerical measurement results.



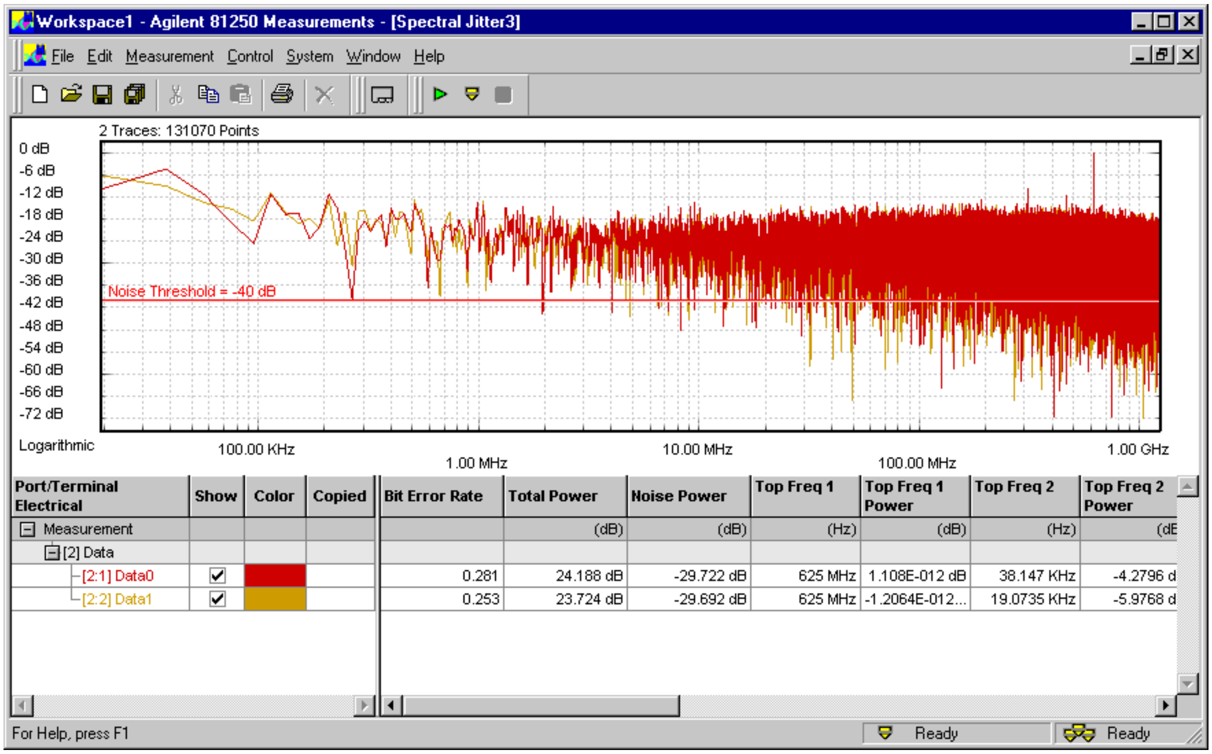
1 Choose the *Power Scaling* you wish to use for the power values.

– *Absolute* shows the values as calculated by the FFT.

– *True relative* shows the values in relation to the *Total Power*.

– *Relative to Reference Frequency* shows the values in relation to the power of one of the frequency bins.

In the following figure we have set the reference frequency to 625 MHz.



The peak at that frequency forms now the 0 dB level. This influences both the graphical and the numerical display.

2 If desired, change the *Number of Top Frequencies to Show.*

This determines the number frequency/power pairs in the numerical section. Up to 16 pairs can be calculated and displayed.

3 Change the *Noise Threshold*, if desired.

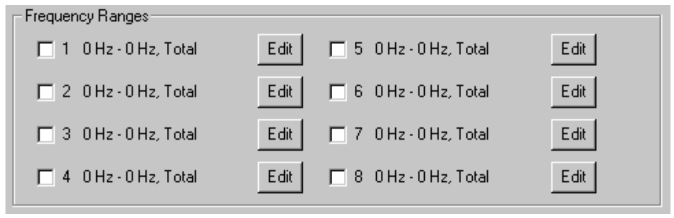
The *Noise Threshold* is used by the calculation for separating between *Total Power* and *Noise Power.*

You can move the *Noise Threshold* also in the graphical display with the mouse.

How to Define Frequency Ranges

Frequency ranges allow you to analyze parts of the spectrum. You can define up to eight frequency ranges.

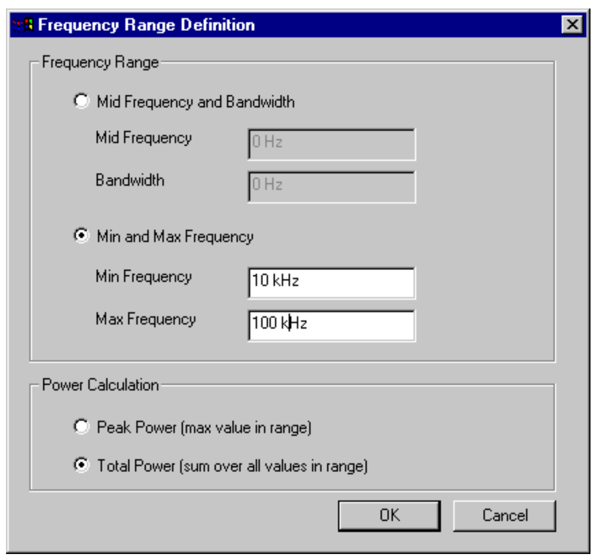
Frequency ranges can also be combined with pass/fail limits.



1 Click the Edit button of a frequency range.

2 Specify its borders.

You can enter minimum and maximum frequency or the middle frequency and the bandwidth.



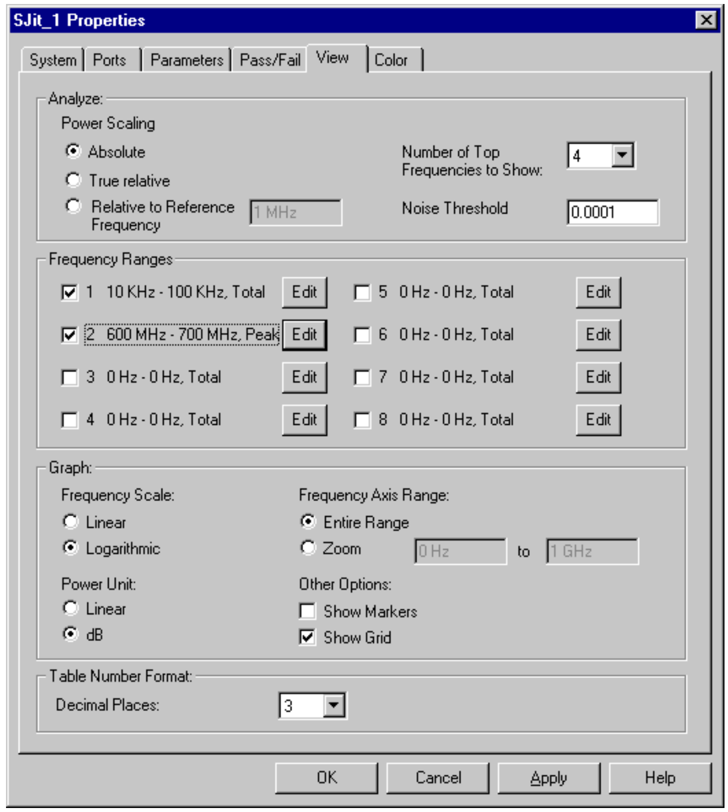
3 Decide on the *Power Calculation*.

You can display either the total of all power values above the *Noise Threshold* within the range or just the power of the highest peak.

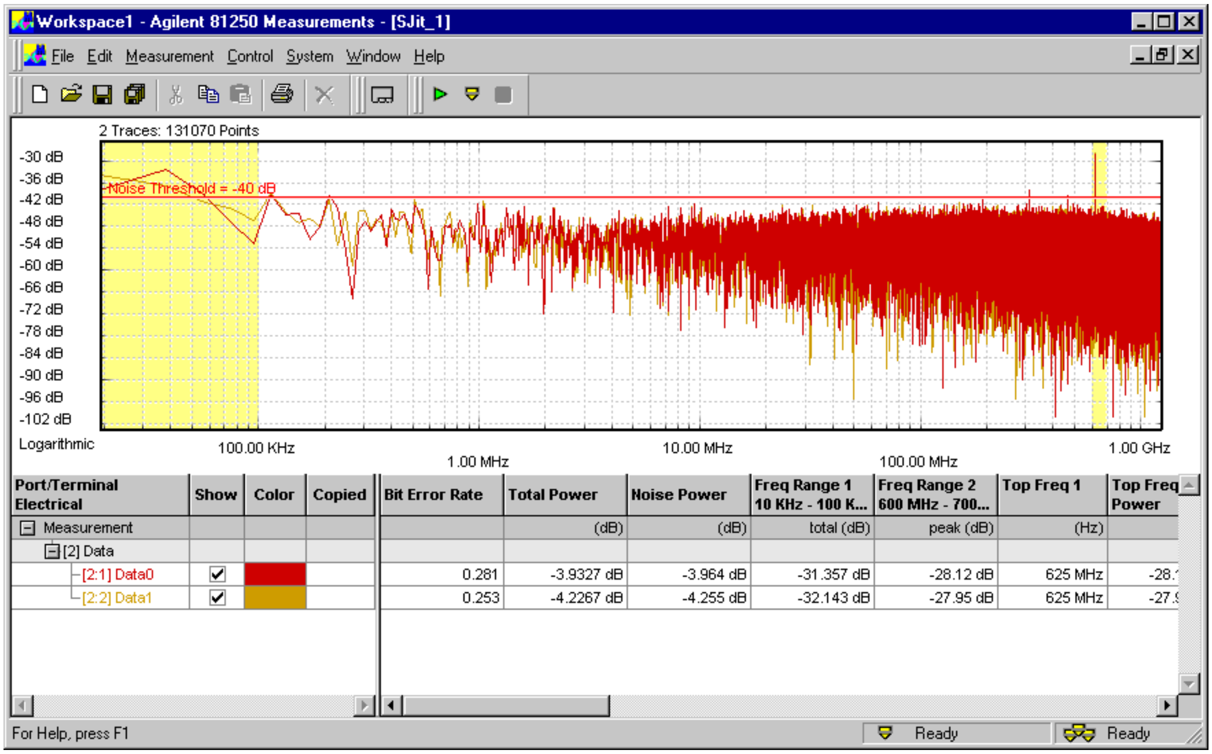
4 Click *OK*.

Your settings are displayed on the *View* page.

5 To enable the frequency ranges, click the corresponding checkboxes.



The measurement window shows enabled frequency ranges, as illustrated in the following figure:

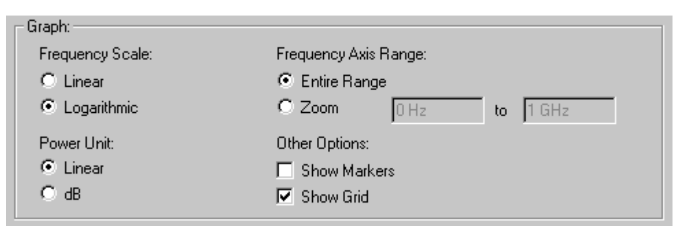


In the graph, the enabled frequency ranges are highlighted by background color. You can change that color (see *"How to Change the Colors of the Graph" on page 73*).

The numerical section shows for each frequency range the measured power values. These values are obtained as specified in the frequency range definition.

How to Change the Graph

All these options can also be enabled from the context menu of the graph (see also *"Spectral Jitter Measurement Graphical Results" on page 44*). Only the frequency *Zoom* range cannot be specified elsewhere.



1 Choose between linear and logarithmic *Frequency Scale*.

In case of a broadband signal, a logarithmic scale shows more low-frequency details. A linear scale, on the other hand, makes it easier to identify fundamental and harmonic frequency components.

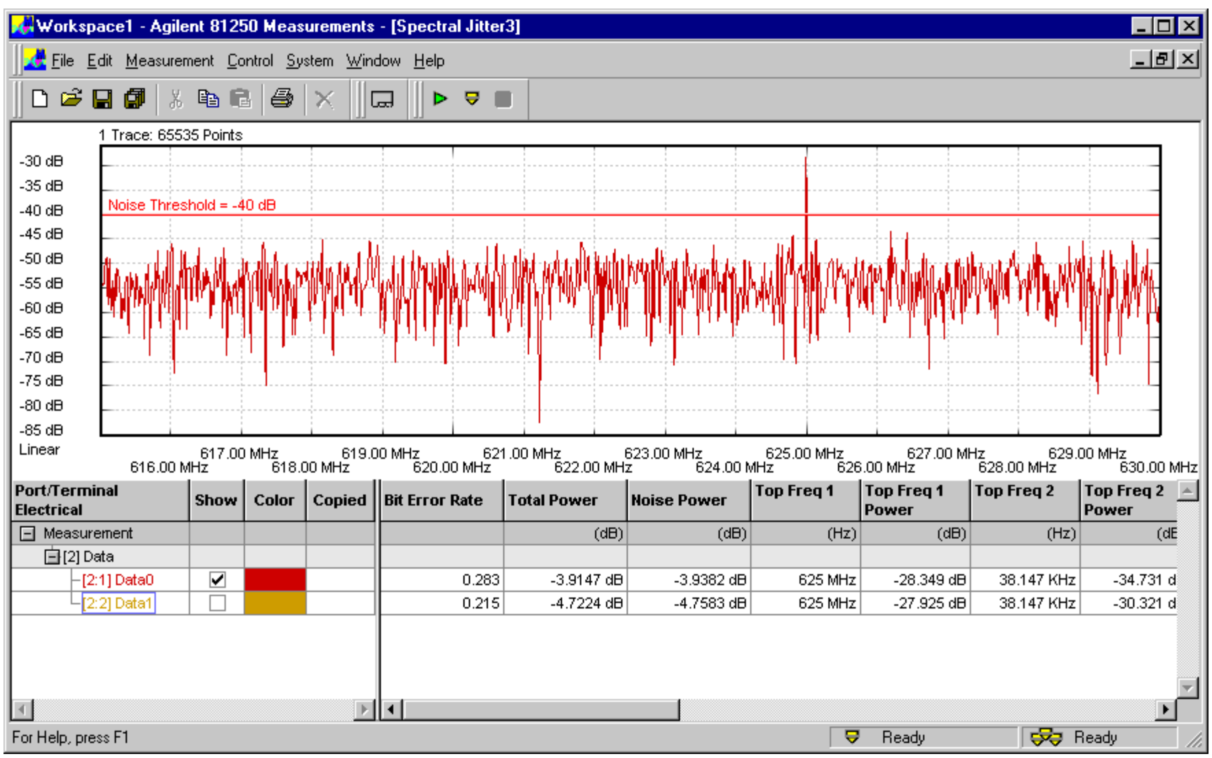
2 Choose between linear and logarithmic (dB) *Power Scale*.

A linear power scale makes it easy to detect prominent spectral components. A logarithmic scale, on the other hand, makes it possible to investigate unobtrusive details.

3 Decide on the *Frequency Axis Range*.

The *Entire Range* comprises the whole spectrum. This covers one half of the data rate or test frequency.

You can define and enable a *Zoom* range. When this is done, the measurement graph shows an expanded view, as illustrated in the figure below:

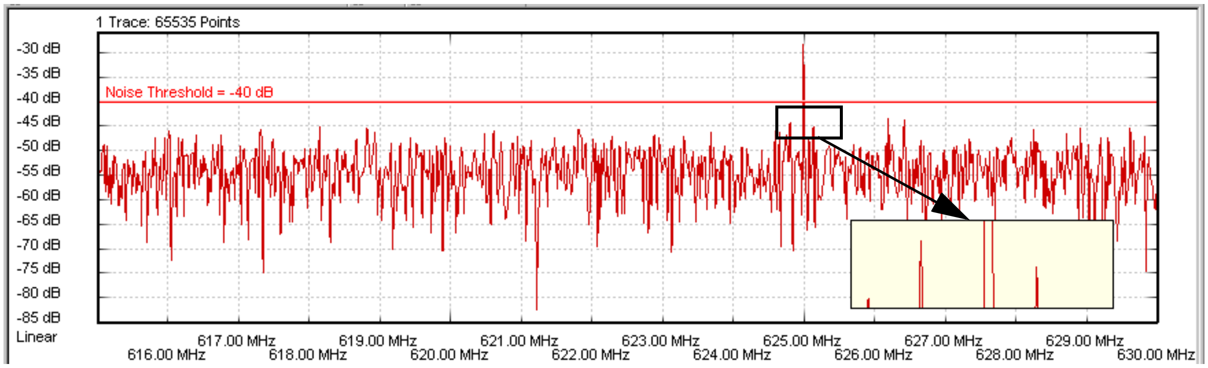


Here, we have defined and enabled a *Zoom* range between 615 MHz and 630 MHz. A linear *Frequency Scale* is used.

When the zoom function is disabled and you enable it from the context menu, the graph shows the specified range.

Note that the zoom function has no impact on the numerical values.

From the context window, you can additionally enable the *Zoom Graph*.



The *Zoom Graph* makes it possible to investigate the peaks and valleys in detail.

How to Change the Table Number Format

You may wish to see numerical results with more or less precision.

By default, the number of decimals is 3.

1 Change the number of *Decimals Places*, if desired.

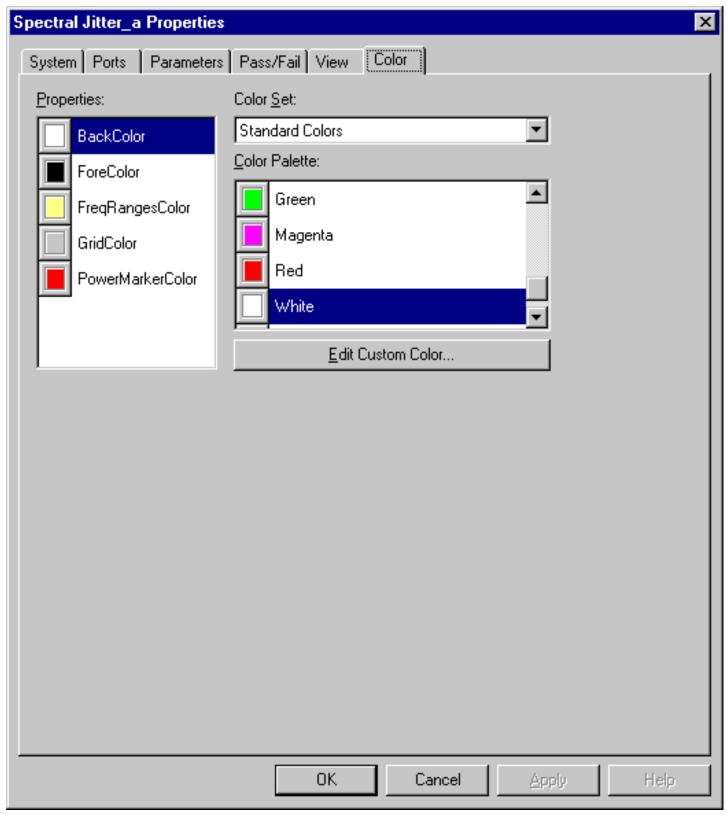
   This does not change the calculated values, only the display.

2 Click *Apply* to accept the modifications without leaving the *Properties* dialog. Or click *OK* to accept the modifications and close the *Properties* dialog.

How to Change the Colors of the Graph

This page of the *Properties* dialog enables you to customize the colors of the graphical display.

1 Click the *Colors* tab.



You can change:

– The background color of the graph (default is white)

– The foreground color of the scales and frame of the graph (default is black)

– The color of the *Frequency Ranges* (default is yellow)

– The color of the *Grid* (default is gray)

– The color of the *Noise Threshold* (default is red)

2 If you have made any changes, click *Apply*.

This updates the measurement window, and you can immediately check the result.

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