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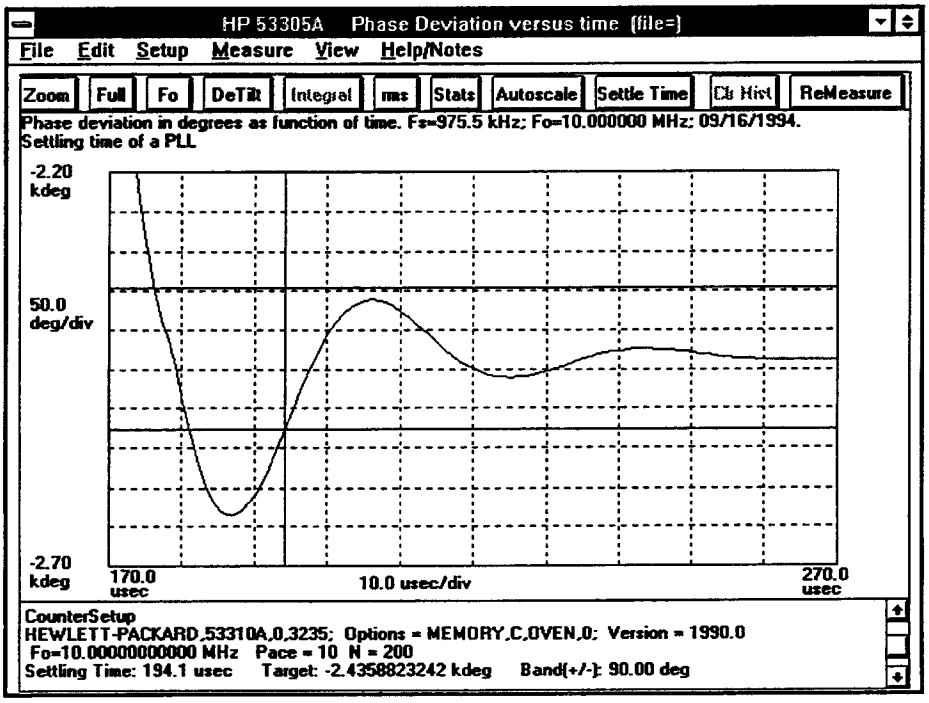
Demonstration Procedure for Measuring Phase with the HP 53310A Modulation Domain Analyzer

HP 53305A
Phase Analyzer Software

HP 53310A Option 305
Modulation Domain Analyzer



Introduction

Welcome to the HP 53305A Phase Analyzer Demonstration Software! This demonstration gives you an opportunity to use the analyzer just as you would in a measurement application. You will recall data files of actual measurements saved to a disk using the HP 53305A Phase Analyzer Software with the HP 53310A Modulation Domain Analyzer (MDA) as the measurement hardware.

This Demonstration Guide shows you how the HP 53305A Phase Analyzer Software and the HP 53310A Modulation Domain Analyzer can be configured to make frequency and phase measurements on various RF components in your communications design. Examples include measuring frequency and phase settling times of VCOs and PLLs, measuring the total integrated noise power over the modulation bandwidth, examining the phase deviation (phase trajectory) of the RF transmission, and looking at phase modulation frequencies and spurs.

It is recommended that you do all the demonstrations described in this guide to see the full set of capabilities the HP 53305A provides. The demonstrations are best done in order, as subsequent demonstrations build on points made earlier. The entire demonstration should take approximately 20 to 30 minutes to complete.

Phase Analyzer Product Description

The HP 53310A Modulation Domain Analyzer's Option 305 Phase Analysis Software adds the power of phase analysis in the Modulation Domain to your HP 53310A MDA. The software is a Microsoft® Windows-based program that runs on an IBM compatible PC. If you already own the HP 53310A MDA, the software is available separately as the HP 53305A. Now you can better understand your design through direct phase analysis by measuring phase settling time, phase noise (phase spectrum, total integrated noise power over the modulation bandwidth), and phase deviation (phase trajectory).

External downconversion and uncalibrated discriminators are a thing of the past. With the software and the HP 53310A MDA Option 031 High Resolution 2.5 GHz Input, you can directly measure the phase detector's RF output at modulation rates up to 500 kHz, saving you time and effort.

Up to 8,000 continuous samples of frequency or phase (up to a 1-MHz sample rate) can be stored and analyzed with the standard memory. Up to 32,000 samples are available with the HP 53310A MDA Option 001 Extended Memory.

The program uses pull-down menus and buttons like many other Windows applications to accomplish tasks. The primary task is to display data gathered by the HP 53310A MDA hardware in a format you have never been able to see with just the HP 53310A MDA alone, such as phase settling time. Measurement results, graphs and data can be easily exported to other Windows applications using the Clipboard or files.

The HP 53305A software offers the following functionality:

- Frequency
- Frequency deviation (deviation from carrier)
- Phase Deviation (phase trajectory)
- Phase Power Spectral Density (total integrated noise in the modulation bandwidth)
- FFT of current display (frequency or phase modulation spectrum)
- Histogram of current display (peak-to-peak and rms modulation)
- Automatic settling time (VCO or PLL)

System Requirements

The minimum PC system requirements to use this demonstration software are:

386-based microprocessor with a 387 math coprocessor.
4 Mbyte RAM.
2 Mbyte free hard disk space.
VGA Display, keyboard and a two-button mouse.
MS-DOS 5.0.
Windows 3.1.
3.5-inch floppy disk drive.

Loading the Demonstration Software

Installation of the demonstration software takes about 5 minutes.

1 Insert the HP 53305A demonstration diskette into the 3.5-inch floppy drive.

2 Start Windows.

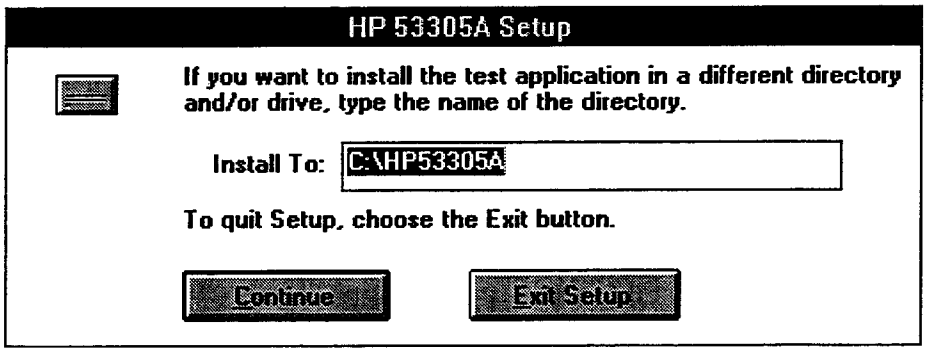
3 Open the Program Manager window and choose Run from the File menu.

4 Type **a:\setup** and then press ENTER or click the **OK** button.

If your 3.5-inch drive is not assigned to a:, then substitute the correct drive assignment in place of a:.

NOTE *The software cannot be installed while another Visual Basic program is open in Windows. If you see an error message to this effect, close all other Visual Basic programs to proceed with the installation.*

Sometime after pressing ENTER, you will see the installation window shown below. This window allows you to modify the directory for the software installation, or to cancel the installation completely. To cancel the installation, click the **Exit Setup** key or press **ALT E**.



To Modify the Directory

The default directory is **c:\hp53305a**. If you want to install the demonstration software files in a different directory, highlight **hp53305a** and type in the preferred directory name. Highlight the **C:** if you wish to modify the drive location as well. Click the **Continue** button to continue the installation.

A new program group "HP Applications" will be created with this installation. The HP 53305A demonstration application and a "readme" file will be placed in this program group.

1 An Interface Options window will appear next. Choose "none" and click the **OK** button.

2 When the installation is complete, click the **OK** button or press ENTER.

The installation procedure will present a registration information reminder which may be ignored with this demonstration software. You are welcome to share this demonstration software with others and copy it freely.

3 Double-click the HP 53305A icon to open the application and begin the demonstration. You will see a message indicating that this is a demonstration version of the HP 53305A software.

Demonstrations With Saved Data

The demonstrations use data that was acquired with the HP 53310A MDA and processed using the HP 53305A software. The acquired data was saved in files in the "demo" directory.

You will be recalling this measurement data from stored files that are installed during the HP 53305A demonstration software installation process described earlier. These demonstrations can be performed without having the HP 53310A Modulation Domain Analyzer hardware present.

Three demonstrations are included to show you the functionality and power of the HP 53305A Phase Analyzer Software.

Demo 1 shows the step response of a VCO (voltage controlled oscillator). This demonstration introduces you to some basic features of the software; for example, saving and recalling data files, zooming and scaling, and making settling time measurements.

Demo 2 shows the phase modulation analysis capabilities using a BPSK signal (binary phase shift keying). This is a common form of intentional phase modulation for digital communication systems, where a carrier is shifted between two phase states (± 180 degrees).

Demo 3 shows how you can export the graphics and the results of the analyses to other Windows programs.

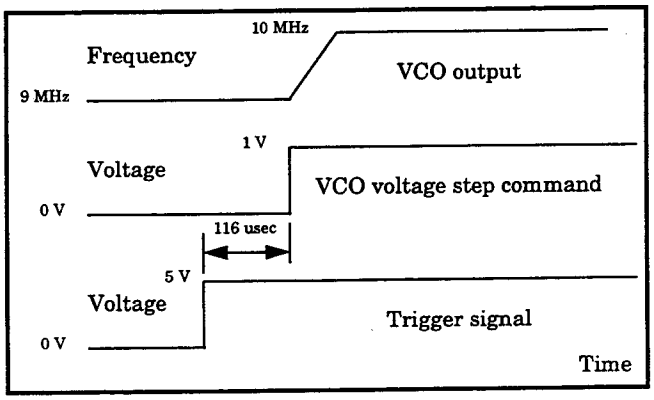
Demo 1: Voltage-Controlled Oscillator (VCO) Step Response and Settling Time

This demonstration shows a VCO whose output is stepped from 9 MHz to 10 MHz. Data was saved to a file, along with the measurement setup which processes the data for frequency and phase measurements. The following will be demonstrated:

- Recalling data files from disk
- Frequency measurements
- Using the cursors
- Zooming and scaling
- Frequency deviation measurements
- Frequency overshoot
- Frequency settling time
- Phase deviation measurements
- Phase settling time

Overview

The VCO under test has a voltage step applied to the input control voltage causing the frequency output to step from 9 MHz to 10 MHz. A trigger signal occurs approximately 116 µsec prior to the voltage step. This trigger signal is connected to the "Ext Arm" input of the HP 53310A. The VCO output signal is connected to input A of the HP 53310A, and is 1 volt pk-pk, centered at 0 volts (no DC offset).



1 Select **File>Load Setup**.

Select the file **vco.stp** in the **c:\hp53305a\demo** directory.

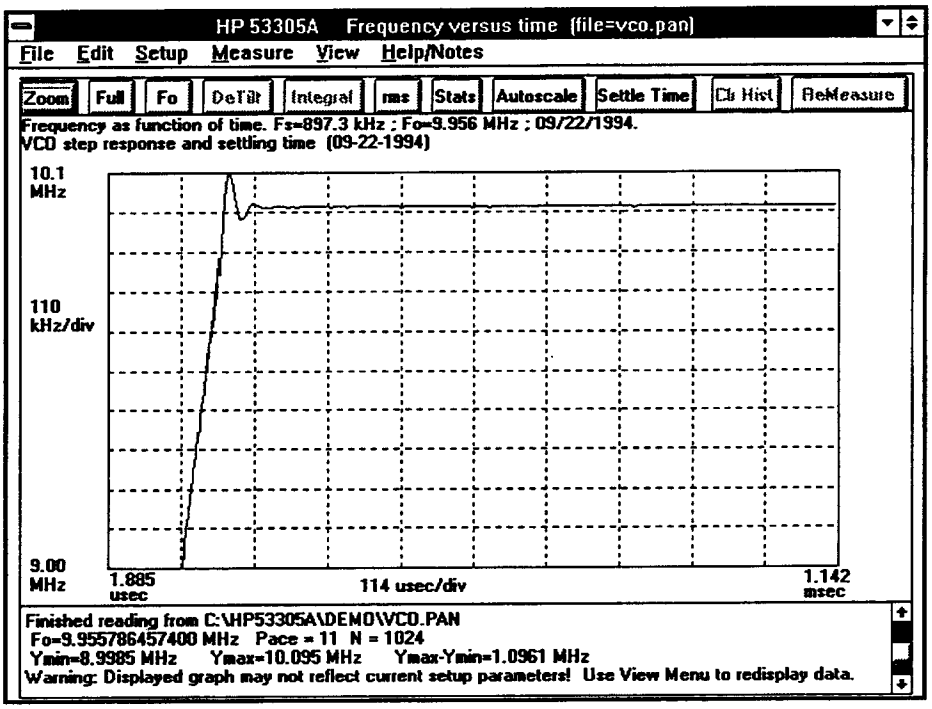
This retrieves the instrument setups used to capture the signal. They will be examined in detail after viewing the Frequency vs. Time display.

2 Select **File>Load Data File**.

Select the file **vco.pan** in the **c:\hp53305a\demo** directory.

This will retrieve the data and display the computed frequency versus time.

Frequency Measurements



This is a display of frequency versus time.

The step response, frequency overshoot, and settling can be seen clearly on this display. They will be examined in more detail later in this procedure.

Cursors

The software lets you easily find the (x,y) coordinates of any point on the display (it doesn't have to be a measurement point.) Position the "crosshair" (+) using the mouse at a point of interest, for example the peak of the VCO step waveform, and click the **left** mouse button. The

bottom entry in the log area (bottom of the display) will show both the x value (time) and the y value (frequency).

Move the cursor to a point at the bottom of the "ringing" of the waveform and click the **right** mouse button. The data log now shows the difference in both x (Dtime) and y (Dfreq) from the previous cursor position (D = delta). The peak-to-peak ringing is about 130 kHz. You can continue positioning the cursor at various points and clicking the right mouse button; each new log entry will be the x,y difference from the previous cursor position.

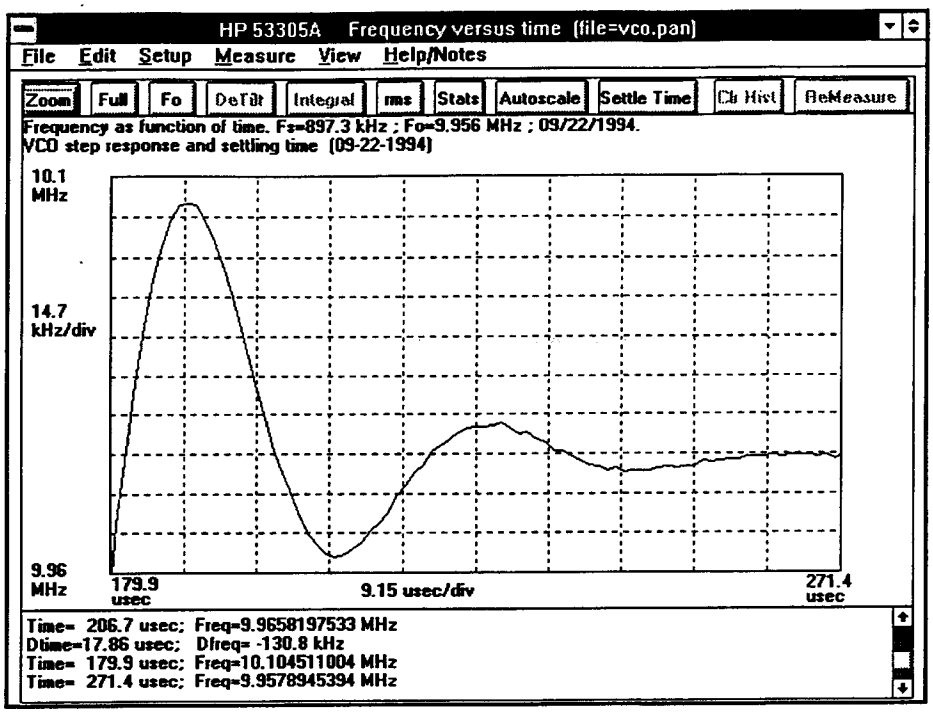
Zooming

Any portion of the data display may be arbitrarily magnified using the zoom feature. You simply define two diagonal corners of a rectangle which will be the new, magnified display.

1 To magnify the peak overshoot and settling of the VCO response, position the cursor just to the left of the overshoot of the waveform and click the left mouse button. You've just defined the upper left hand corner position of the magnified display.

2 Next move the cursor to a point just to the right of the ringing portion of the waveform, and slightly beneath the 10 MHz frequency level. Click the left mouse button again and you have defined the lower right hand corner position of the magnified display.

3 Click the **Zoom** button on the tool bar.



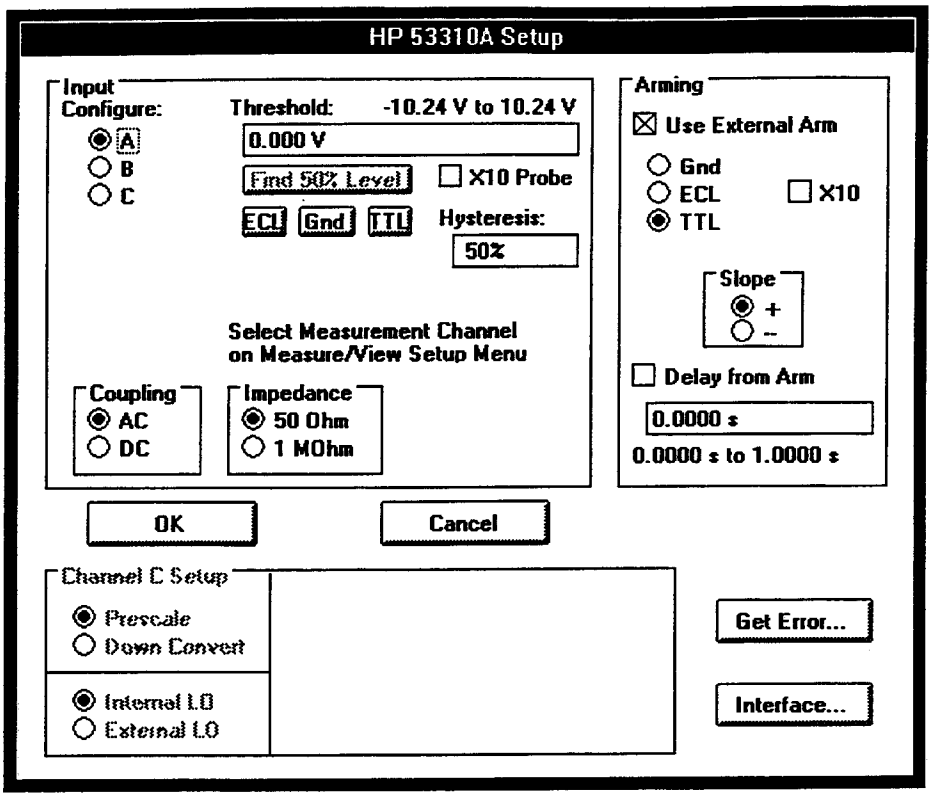
The display "zooms" to the points defined by the previous two cursor positions.

NOTE *Valid cursor positions include any portion of the display where the cursor appears as a crosshair (+). The data area is not confined to the grid portion of the display. You can actually increase the current display range by clicking in positions off of the grid.*

4 To return the scaling to the previous full view, click the **FULL** button.

Setups

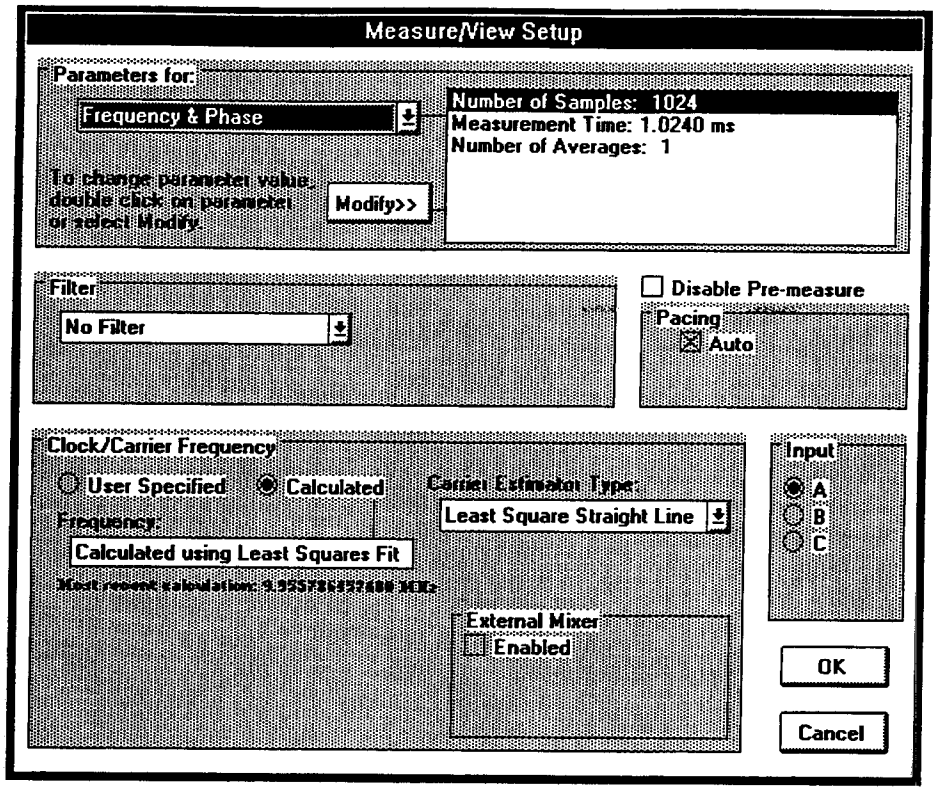
1 Select **Setup>Instrument Setup**.



This is the **Instrument Setup** dialog box for the HP 53310A, configured to measure the VCO signal. The input circuitry for inputs A, B, and C and the Ext Arm input, as well as the delay from Ext Arm are specified on this dialog box. If Option 031 Channel C is not present, the Channel C setup section cannot be accessed.

2 Click **Cancel** to close this dialog box without making changes, and proceed to the next step.

3 Select **Setup>Measure/View Setup.**



The **Measure/View Setup** dialog box lets you set various parameters that apply to the computations performed on the raw timing information from the measurement hardware. You can see the various choices of parameters for Frequency & Phase measurement processing. In this case 1,024 measurement samples will be acquired over a period of 1.024 ms. Note that this implies a sample interval of 1 µsec (1.024 msec/1,024 samples).

The remainder of this dialog box is left with default values for this measurement. No filtering will be applied to the data. The carrier frequency will be calculated automatically from the data using a least-square fit algorithm. For the VCO, the "carrier" frequency is not steady-state or repetitive modulation (it switches from 9 MHz to 10 MHz, with most of the time spent at the final value of 10 MHz). So an "average" carrier value of slightly less than 10 MHz results. The carrier frequency will be used later in the procedure to determine the deviation of the signal from the carrier value. Pacing will be determined automatically, and input A will be used for acquiring data.

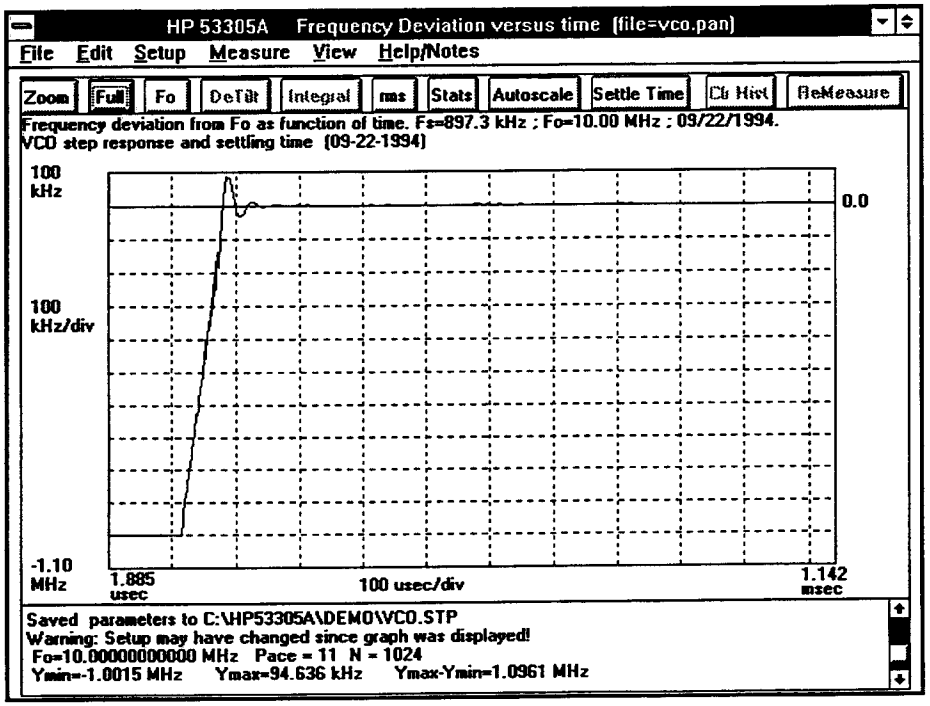
Frequency Deviation Measurements

For this measurement it is advantageous to view frequency in terms of deviation from a carrier. This can make it easier to see the peak-to-peak deviation on a steady-state or modulated carrier. For the VCO, a frequency deviation display shows the ringing and overshoot (the deviation from the final 10 MHz "carrier") at a glance, with more resolution than the frequency display (e.g., you can see kHz deviation directly). You can measure signals directly as frequency deviation. Or, since the VCO data has been recalled from disk, you can view the original frequency data as frequency deviation without taking a new measurement.

1 To change the carrier frequency value to 10 MHz, select "User Specified" in the **Clock/Carrier Frequency** area of the dialog box, enter **10 M** (10 MHz) and press **ENTER**.

2 Click the **OK** button to close the window.

3 Select **View>Frequency Deviation**.



The display will be updated with calculations based on the new carrier of 10 MHz. The carrier shows up in the display as a green line with a value of zero. The absolute value of the carrier is displayed at the bottom of the screen as **Fo**. If it is not displayed, click the **Fo** button. Note that it is much easier to see the overshoot directly from the display, without having to use the cursors.

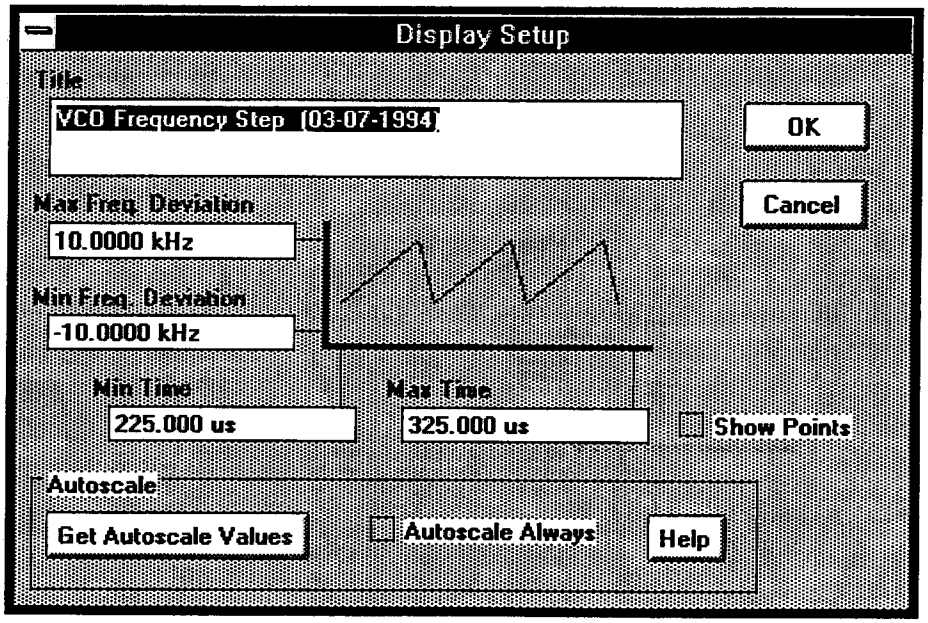
NOTE *The display does not update the new **Fo** value until **View>Frequency Deviation** is executed.*

Autoscale and Scaling

The HP 53305A will normally autoscale to the current data set, placing the minimum value near the bottom of the display, and the maximum value near the top of the display. This is particularly useful when you don't know the exact values of the acquired data.

At other times you may be interested in manually fixing the scale to view a particular portion of the waveform. For example, you may only be interested in the waveform settling characteristics. Suppose that you are only interested in verifying that the VCO output frequency is within ± 10 kHz of 10 MHz, 225 µsec after the Ext Arm signal occurs.

1 To fix the display scale in that region, select **Setup>Display Setup**.



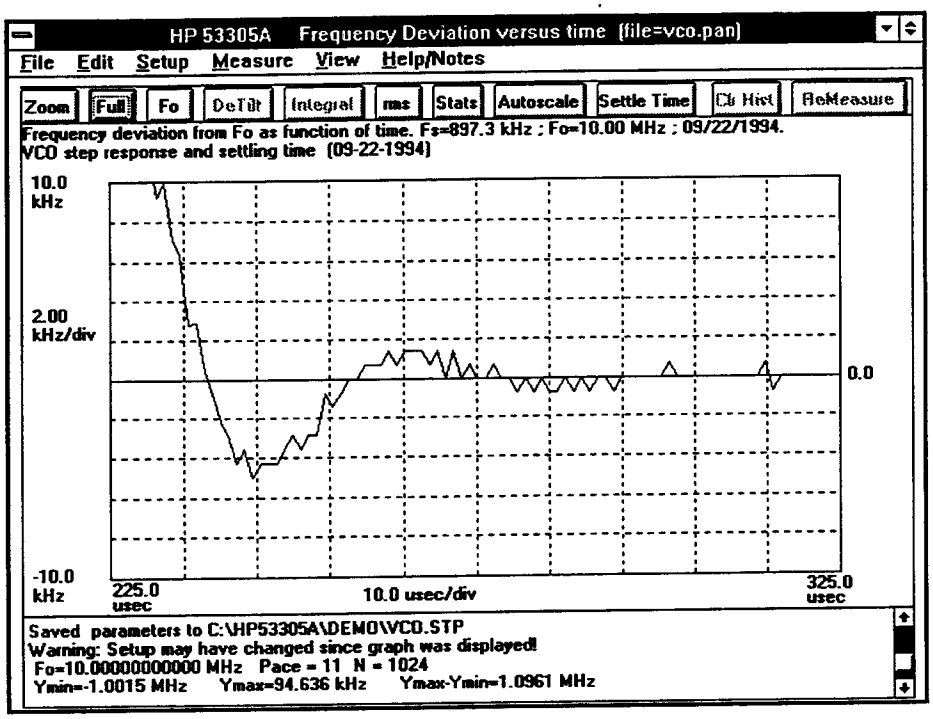
2 Click the **Autoscale Always** box to disable this feature.

3 Enter 10 k into the **Max Frequency Deviation** field and press **ENTER**.

4 Enter –10 k into the **Min Frequency Deviation** field and press **ENTER**.

5 Enter **225 u (for µsec)** and **325 u** into the **Min Time** and **Max Time** fields respectively. Press **ENTER** after each entry.

6 Click **OK** to close this window.



The display scale is now fixed at these values. This VCO fails the ± 10 kHz after 225 µsec specification since the frequency first enters the display window at about 230 µsec.

Automatic Frequency Settling Time

You can also have the HP 53305A software calculate the settling time of the VCO for you automatically, without using the **Setup>Display Setup** dialog box.

1 Return to the original display by clicking on the **Autoscale** button.

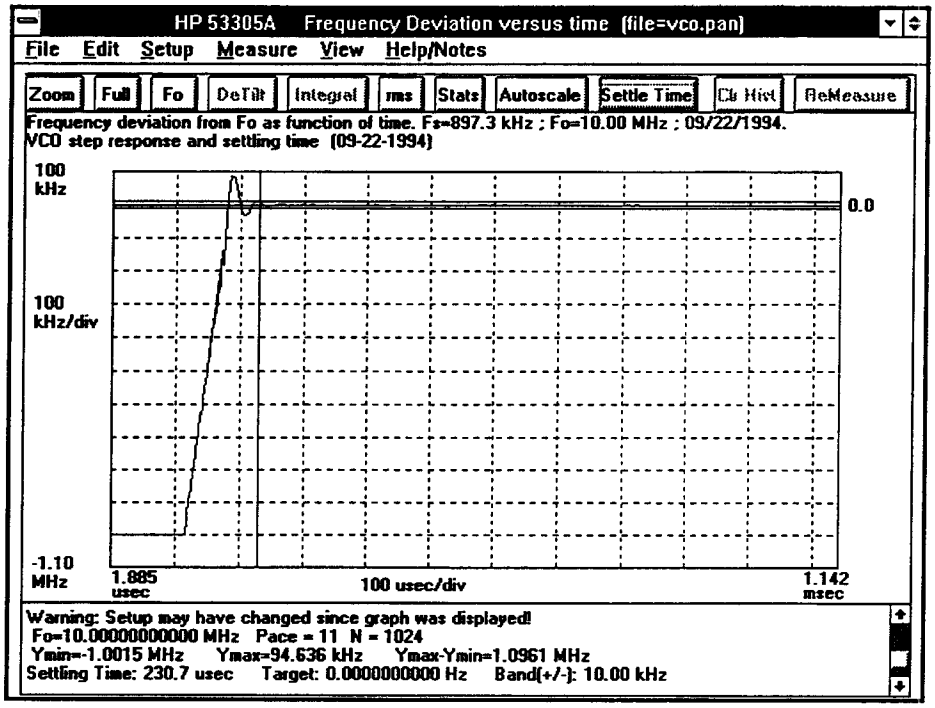
2 To set the settling time parameters, select **Setup>Settling Time Setup.**

3 In the **Frequency Deviation Settling Time Parameters** area, check the "Use final value as target value" box if it is not checked already.

4 Enter **10 k** in the "Allowed deviation from target value" text box and press **ENTER**.

5 Click **OK** to close this window.

6 Click the **Settle Time** button.



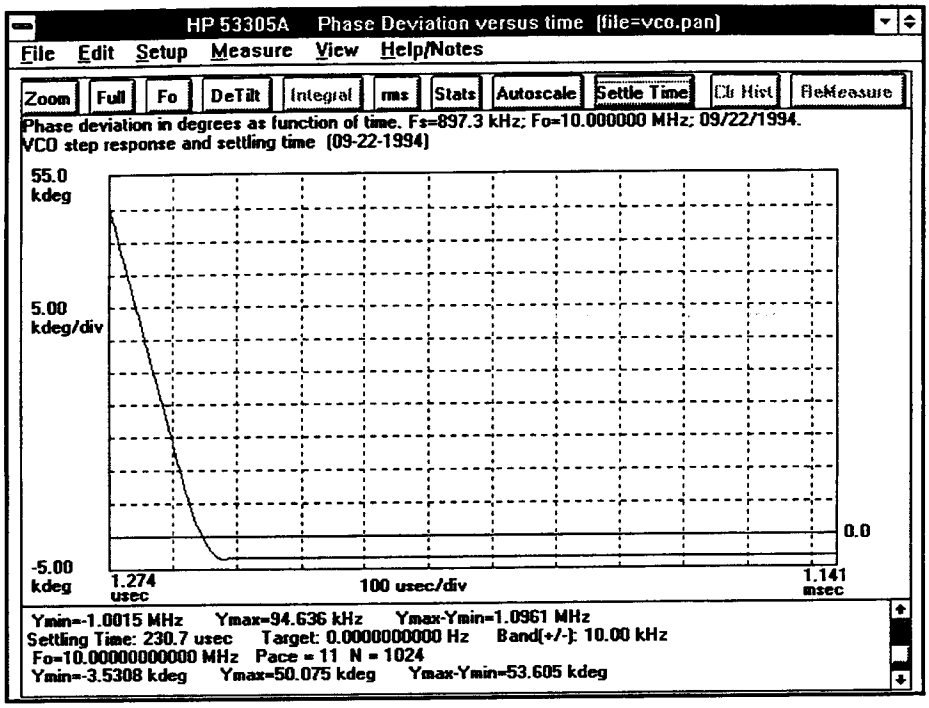
The VCO settling time (230.7 µsec) is calculated for you automatically and displayed in the data display at the bottom of the screen. Horizontal markers show the tolerance band of 10 kHz and vertical markers show the time that the VCO first settles within the tolerance band (the settling time).

You can zoom in on the display to see more detail. Click the Settle Time button after you zoom in to display the markers again.

Phase Deviation Measurements

You can use a similar procedure to examine the phase settling time of PLLs. In this case, we will examine the phase of the VCO as it settles to the final 10 MHz frequency value.

1 Select **View>Phase Deviation.**



The phase deviation display shows the difference between the phase of the measured signal to an unmodulated, perfect carrier of 10 Mhz.

NOTE

The "perfect" carrier is entered into the software in one of 3 ways.

1. *Enter a "user specified" carrier frequency in the **Clock/Carrier Frequency** portion of the **Setup>Measure/View Setup** dialog box as you did earlier in the Frequency Deviation Measurements part of this VCO demonstration.*

2. *Select "calculated" instead of "user specified" and the software will calculate an "average" frequency from the measured data (using the **Carrier Estimator Type** selected).*

3. *Use the **DeTilt** process described in the next demonstration. You may need to use **DeTilt** and **Zoom** several times to fine tune the carrier frequency.*

Since the VCO is switching between 9 MHz and 10 Mhz at the start of the measurement, the phase is at first very far away from the phase of a 10 MHz carrier. But as the VCO settles around 10 MHz, there is very little deviation from the final value. The final value of phase is arbitrary.

If you wish to view the display with phase units other than degrees, select **Setup>Phase Units** and select radians or unit interval. Return the Phase Units to degrees when done.

Automatic Phase Settling Time

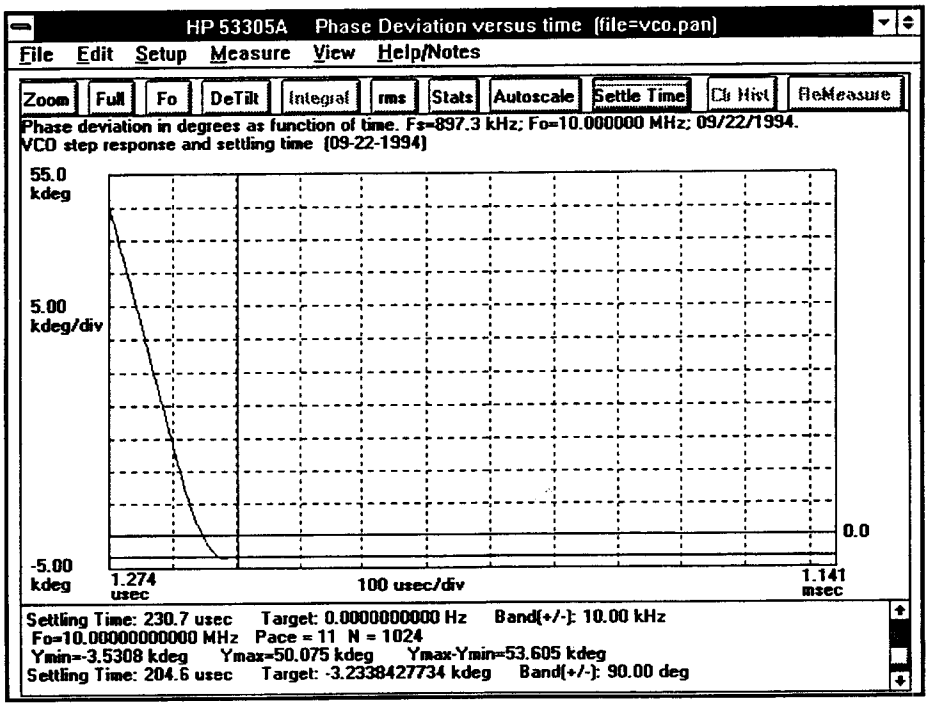
1 To set the settling time parameters, select **Setup>Settling Time Setup.**

2 In the **Phase Deviation Settling Time Parameters** area, check the "Use final value as target value" box if it is not checked already.

3 Enter **90** in the "Allowed deviation from target value" text box and press **ENTER**. The phase units you are currently using will be appended to this value (degrees in this case).

4 Click **OK** to close this window.

5 Click the **Settle Time** button.



The phase settling time (204.6 μsec) is calculated for you automatically and displayed in the data display at the bottom of the screen. Horizontal markers show the tolerance band of 90 degrees and vertical markers show the time that the phase of the VCO first settles within the tolerance band (the settling time).

You can zoom in on the display to see more detail. Click the Settle Time button after you zoom in to display the markers again.

6 Select **File>Load Default Setup** to return the software to the default setup conditions.

This completes Demo 1.

Demo 2: Phase Modulation Analysis (BPSK)

This demonstration shows the phase modulation analysis capabilities of the MDA, using a BPSK signal (binary phase shift keying). This is a common form of intentional phase modulation for digital communication systems, where a carrier is shifted between two phase states (± 180 degrees). A "1" may be represented by one of the phase states, while a "0" is represented by the other.

The HP 53310A is used to gather timing information from the modulated carrier. This information has been processed as deviation in phase from a carrier and stored in a file. The following features will be demonstrated on this waveform:

- Phase Deviation measurements
- De-Tilt feature
- FFT analysis

Overview

The signal is a 100 kHz carrier, phase modulated by a 1 kHz square wave. The input signal has an amplitude of 500 mV p-p, and is centered about 0 volts. The signal is connected to input A of the HP 53310A.

1 Select **File>Load Setup**.

Select the file **bpsk.stp** in the **c:\hp53305a\demo** directory.

This retrieves the instrument setups used to capture the signal. They will be examined in detail before viewing the Phase Deviation vs. Time display.

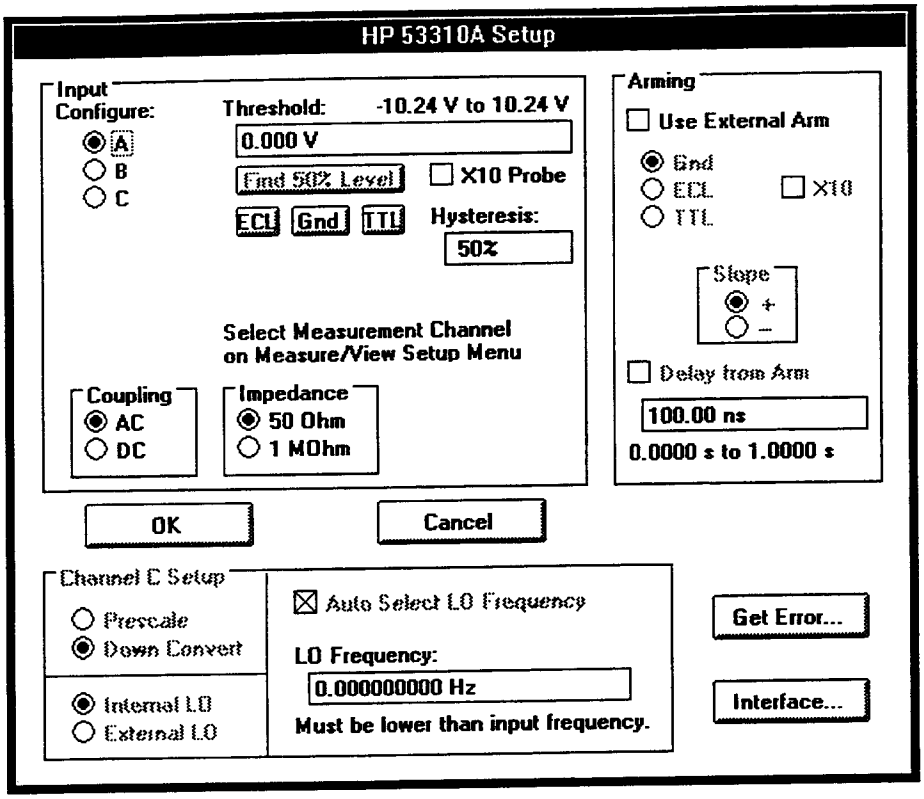
2 Select **File>Load Data File**.

Select the file **bpsk.pan** in the **c:\hp53305a\demo** directory.

This will retrieve the data and display the computed phase deviation versus time.

Setups

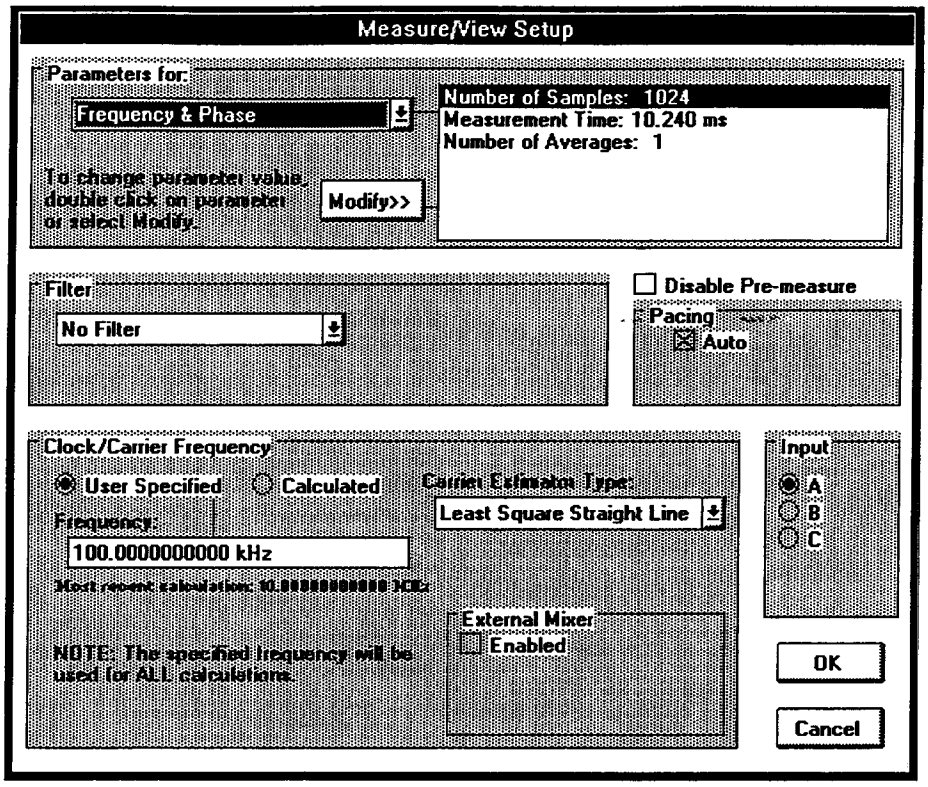
1 Select **Setup>Instrument Setup.**



This is the **HP 53310A Setup** dialog box to configure the instrument to measure the BPSK signal.

2 Click the **Cancel** button to exit this dialog box without making changes.

3 Select **Setup>Measure/View Setup.**

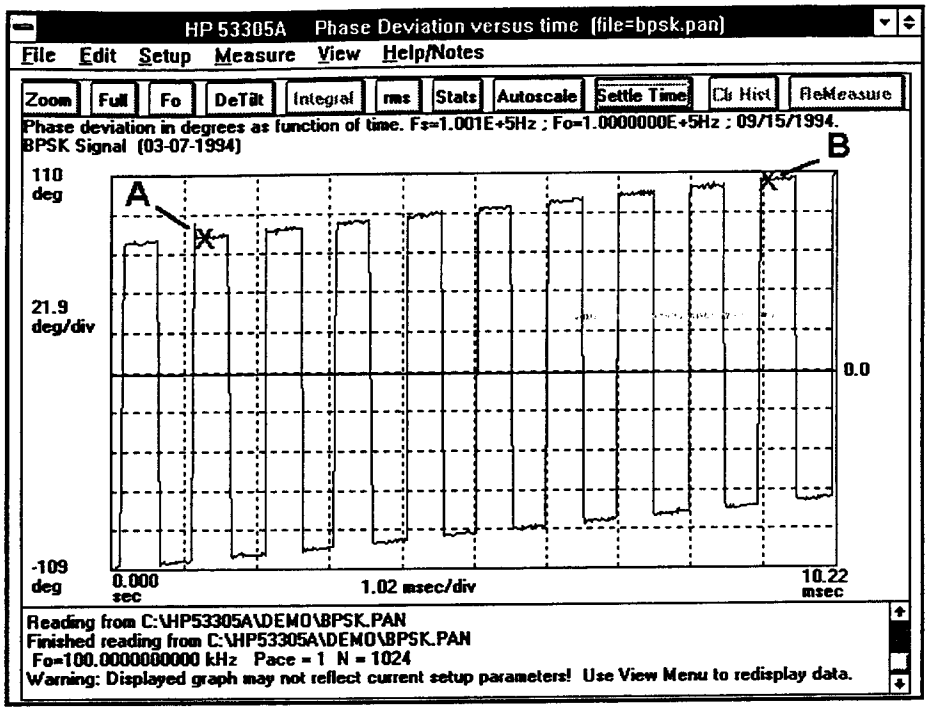


Notice that the measurement time for the Frequency & Phase function is 10.24 msec. This has been done so the display will show a number of cycles of the 1 kHz modulation. The use of automatic pacing will let the MDA determine the appropriate number of cycles of the 100 kHz carrier to skip, so 10 msec of the signal can be captured and analyzed. 10.24 msec/1024 samples implies that a sample will be captured every 10 µsec.

The Carrier Frequency has been entered as a User Specified value of 100.0 kHz. The phase deviation measurements will be computed relative to the constant carrier frequency value of 100 kHz.

4 Click the **Cancel** button to exit this dialog box without making any changes.

Phase Deviation Measurements



This is a display of phase deviation from the constant carrier frequency, Fo = 100 kHz. The square wave modulation can easily be seen. Using the cursor and delta cursor feature (right mouse button), you can easily determine the period of the modulation (about 980 µsec), and the pk-pk values (about 180 degrees).

DeTilt

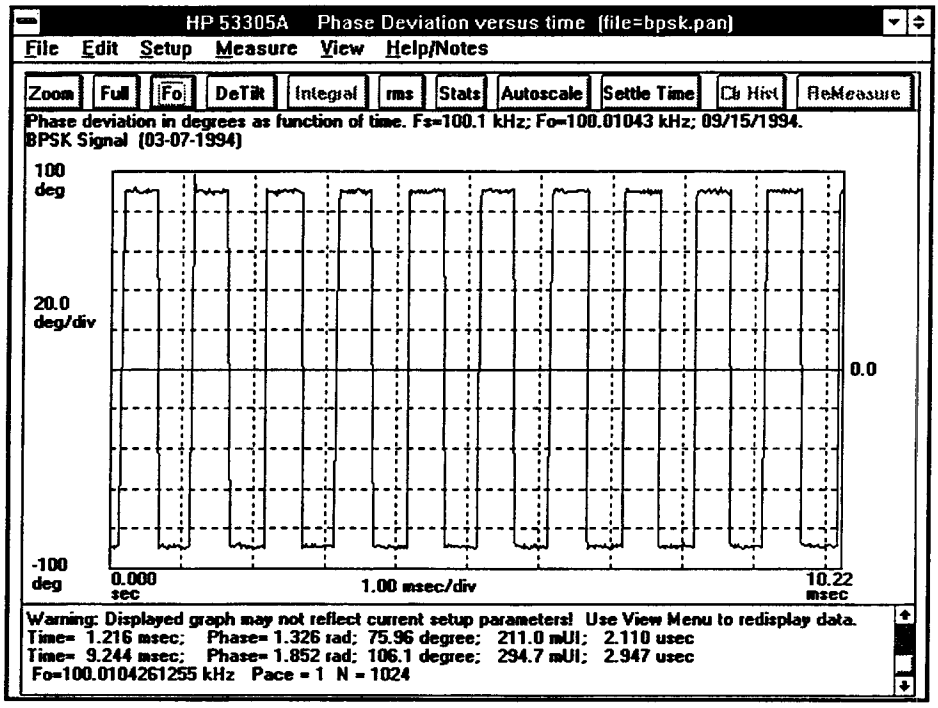
Notice that the display has a "tilt" over time. This is because the actual carrier is not exactly 100.0 kHz as we specified as the carrier frequency on the **Measure/View Setup** dialog box. The **DeTilt** feature provides a convenient way to fine tune this value of Fo to get a "flat" display, and determine the precise value of the actual carrier frequency.

1 Position the cursor on one of the "high" phase states near the left side of the plot (point A on the plot shown above). Click the left mouse button.

2 Re-position the cursor on another "high" phase state near the right side of the plot (point B on the plot shown). Click the left mouse button.

You have now defined two points which *should* be at the same vertical level, but currently are not due to the "tilt" in the waveform.

3 Click the **DeTilt** button. A warning message will appear indicating that the value of Fo will be modified in the DeTilt process. Click **OK** to acknowledge the warning. After a moment of recalculation, the graph will be re-drawn with a slightly modified value of Fo. The tilt should be removed. Click the **Fo** button. Note the new value of Fo (versus 100.0 kHz previously). You can view Fo in the results log at the bottom of the display.



NOTE

The actual carrier frequency is about 10 Hz greater than the initial value specified for Fo. The DeTilt feature lets you quickly correct for minor discrepancies in Fo.

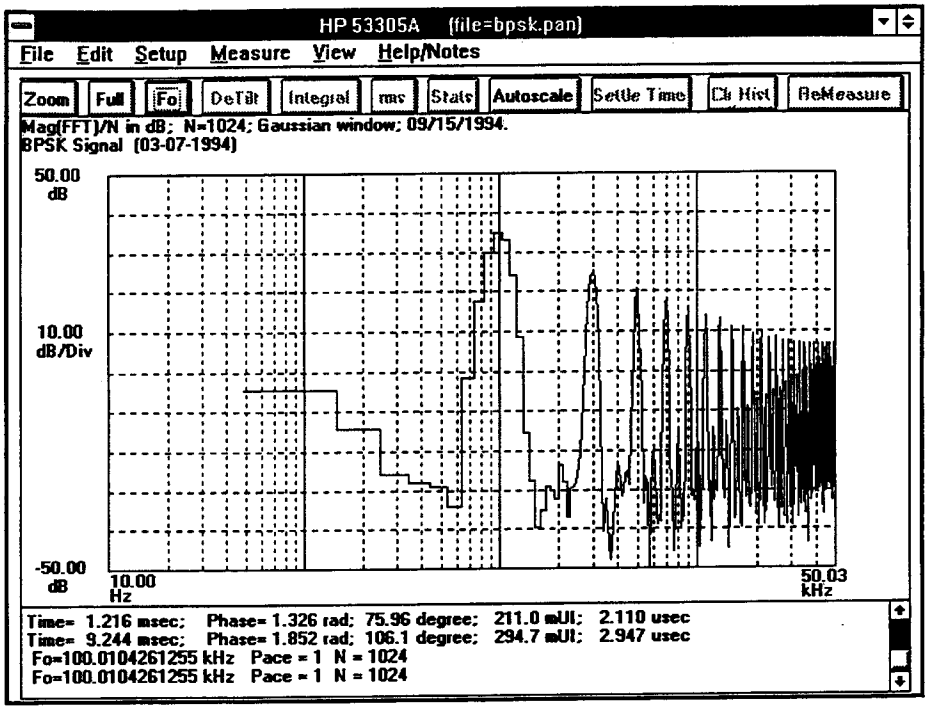
FFT Analysis

In certain applications it may be useful to study the spectrum of the modulating tone, or perhaps the spectrum of undesired jitter. This analysis can be useful to determine the source of unwanted jitter, or phase noise.

The analysis software offers two methods to view jitter spectrum or phase noise. FFT computations can be made on the currently displayed data (vs. time views). Phase power spectral density calculations can also be performed. This differs from the FFT

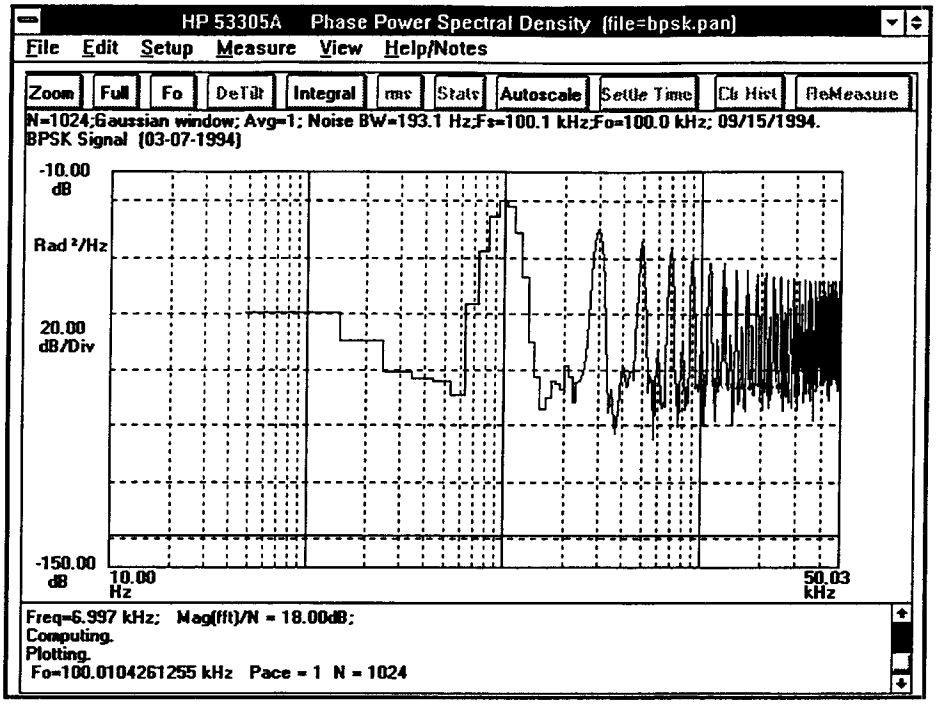
calculations can also be performed. This differs from the FFT calculations in that you may also specify a windowing type and sample frequency for the calculations (**Setup>Measure/View Setup**). The theoretical noise floor of the instrument is displayed in addition to the measurement data.

1 Select **View>FFT of current display**.



Using the cursor and clicking on each peak in the spectrum, the characteristic odd harmonics of the square wave phase modulation can be seen. Note that this is not the same view as a spectrum analyzer would display (spectrum of the modulated carrier), but a direct view of the spectral content of the modulation.

2 Select **View>Phase Power Spectral Density.**



This plot is very similar to the FFT. Note that the top line of the display offers additional information, including the type of window used in the computations, and the noise bandwidth. The solid line across the bottom of the display (first decade up from the bottom) indicates the noise floor of the HP 53310A. It may not be visible on your display. If you wish to see it, you can fix the display scale by using the **Setup>Display Setup** dialog box and entering **–150** as the **Min dB** parameter.

3 Select **File>Load Default Setup** to return the software to the default setup conditions.

This completes Demo 2.

Demo 3: Sharing MDA Graphs and Data

A powerful feature of Microsoft Windows is the ability to share data and graphics between various applications using "cut and paste" or files. The HP 53305A takes advantage of this feature allowing you to easily share MDA data and graphics with other applications such as spreadsheets (Lotus, Excel, etc.), word processors, and other computational packages such as MathCad.

This demonstration will show how easy it is to share the HP 53305A graphics plots and data with a word processor, such as the Windows "Write" application. (In fact, this demonstration guide was written using Microsoft Word for Windows, and illustrated with the HP 53305A graphics using the cut and paste procedure).

Sharing Graphics

1 Select **File>Load Data File**.

Select the file **fm.pan** in the **c:\hp53305a\demo** directory.

You have retrieved a frequency modulated signal. Suppose you want to integrate this data with a report or your lab notebook.

2 Select **Edit>Copy Graph**.

You have now copied the active window in the HP 53305A application to the Windows Clipboard. If you want, you can verify the current contents of the clipboard by opening the Clipboard Viewer application in the Main group of Program Manager.

Pasting Graphics into a Word Processor

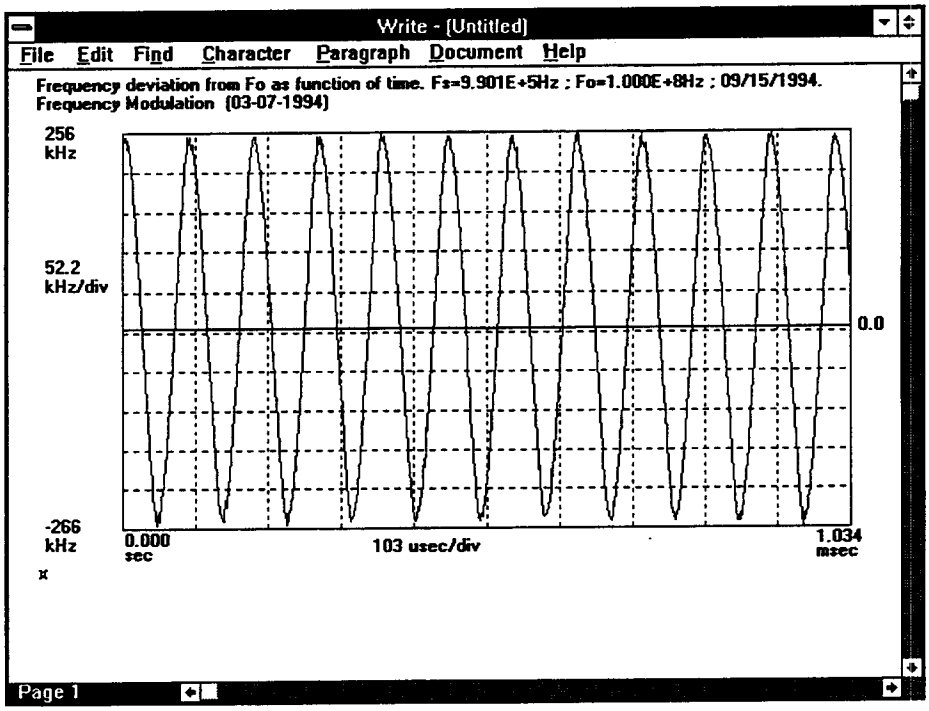
1 Minimize the MDA application by clicking on the **down arrow** in the top right corner of the window.

2 Double-click the **Accessories** icon in the Program Manager display.

3 Double-click the **Write** icon to open this application.

You have now opened the Windows' Write word processor application, and you will see a blank space.

4 Select **Edit>Paste.**



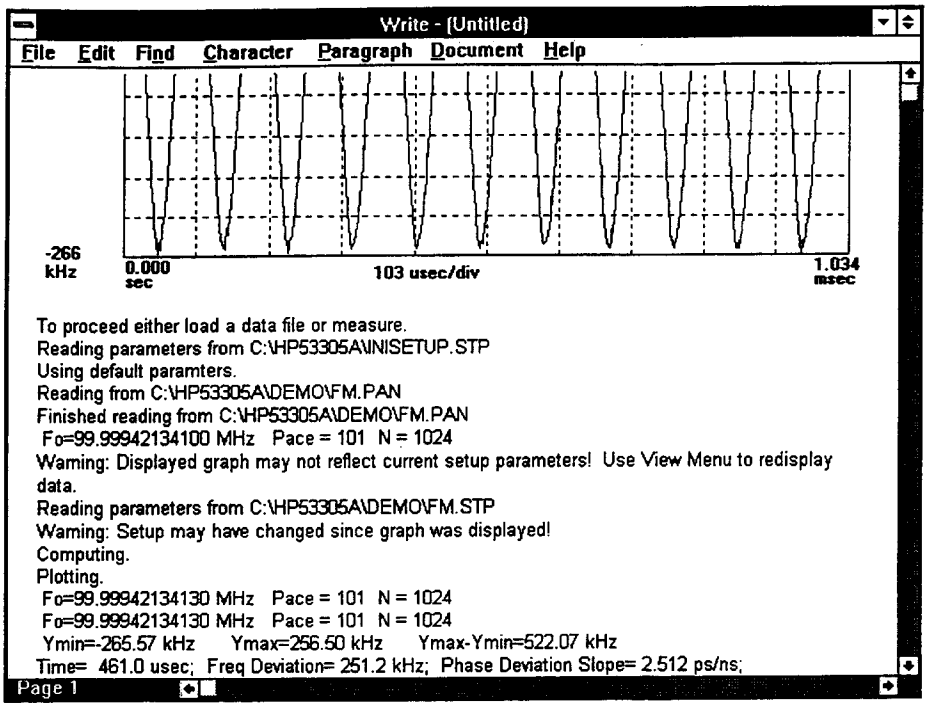
You have just copied the bit mapped graphics from the MDA application to the word processor. No scope cameras, and no printers or plotters to worry about.

Copying and Pasting Log Text

1 Double-click the HP 53305A icon (or select it from the Window pull-down in the Program Manager). Select **Edit>Copy Log as Text**. This will copy the entire contents of the logging area of the MDA display as text to the Windows Clipboard.

2 Bring up the Write application using ALT-TAB, the Window pull-down menu in the Program Manager, or clicking on it in the display.

3 Select **Edit>Paste** in the Write application.



You now have both the graphic results, and the entire log window neatly pasted in your report.

NOTE

You may need to modify the font for the logged data. This is easily done in Write by selecting the text you wish to change and selecting ***Character>Reduce/Enlarge Font.***

Note also that you can directly edit the logging window in the 53305A application by positioning the cursor in the logging window and typing or using basic edit functions from the keyboard. In this way, you can add annotations to the data, or delete undesired information if desired.

You can copy the entire HP 53305A display using the "Print Screen" key found in the upper right hand corner of most keyboards. Print Screen will copy the entire current display to the Windows clipboard. ALT-Print Screen will copy only the active window to the clipboard.

Sharing Data

1 Return to the HP 53305A application.

2 Select **File>Save Data ~~for Export As~~**. file.txt.

3 Open the demo directory **c:\hp53305a\demo**.

4 Type the filename **"temp.txt"** and click the **OK** button.

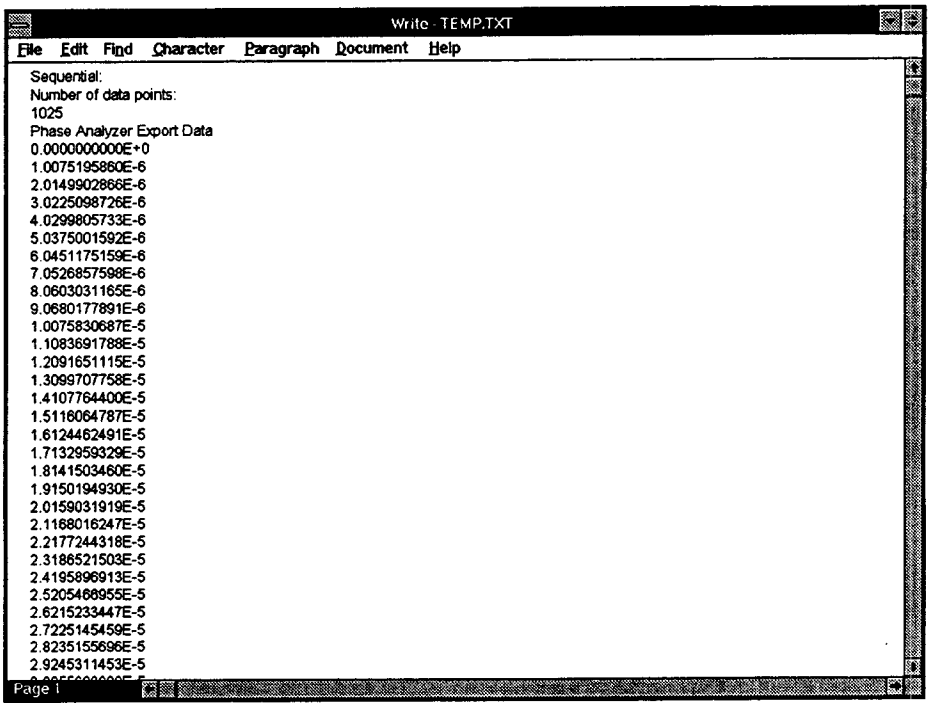
You have saved the FM data as ASCII text.

5 Return to the Windows "Write" application.

6 Select **File>Open** and click **NO** to answer the question "Save current changes?"

7 Open the demo directory **c:\hp53305a\demo**.

8 Enter the filename **"temp.txt"** and click the **OK** button. Click the **No Conversion** button.



You now have a list of the raw data measured by the HP 53305A MDA (the "time stamps" — see the Help file for more information). You could just as easily imported the data into a spread sheet so that you could perform your own custom analysis of the data.

You can also save the data to a file using the **File>Save Data As** command. Instead of the time stamps, the data is stored in the format as currently viewed. For instance, if you are viewing a Frequency Deviation display at the time the data is stored, the data is saved as Frequency Deviation versus Time values. If you are viewing a Phase Power Spectral Density display, the data is saved as Frequency versus Amplitude values.

The HP 53305A makes it easy to share data and graphics with your word processor and other analysis packages. **This completes the demonstrations.**

Conclusion

Congratulations! You have completed the HP 53305A Phase Analyzer demonstration. You have seen the power and flexibility that the HP 53305A along with the HP 53310A MDA offers for frequency and phase measurements.

It's time to take a real test drive! Contact your local HP sales representative to arrange for an on-site demonstration of the HP 53310A Option 305 Modulation Domain Analyzer, or call the Modulation Domain Analyzer Applications Hotline (408) 553-2587, 8AM to 5PM Pacific Time.

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