HEWLETT PACKARD

User's Guide

HP 53310A Option 031 Modulation Domain Analyzer

A better way to measure for digital RF communications system designers

The HP 53310A Modulation Domain Analyzer's Option 031 provides the following automatic measurements:

- Synthesizer settling time.
- Frequency Shift Keyed (FSK) center frequency.
- FSK peak deviation.

Option 031 also includes:

- An internal downconverter for higher resolution measurements.
- Increased sampling rate for fast data rate systems.

In this book

This user's guide is organized into four parts:

- Chapter 1 demonstrates how to use the Option 031 digital RF analysis features.
- Chapter 2 describes the Option 031 downconverter and some details about using an external LO.
- Chapter 3 explains the Option 031 advisory messages that appear on the display.
- Chapter 4 provides the programming commands to help automate the Option 031 measurement sequences.

Refer to other HP 53310A documentation for important additional information:

- *Quick Start Guide* A step-by-step approach for first-time users of the HP 53310A.
- *Operating Reference Manual* The details of operating the HP 53310A.
- *Programming Reference Manual* The details of programming the HP 53310A.
- *Programming Quick Reference* A summary of programming commands.
- *Service Manual* The performance tests, retrofitting instructions, and troubleshooting help.

Specifications*

Both warranted specifications and operating characteristics of the HP 53310A are discussed in this section. To distinguish warranted specifications from operating characteristics, *specifications are highlighted throughout in italics.*

Input Conditions

Range: *200 MHz to 2.5 GHz*
Sensitivity:
–13 dBm 50 MHz to 200 MHz
–17 dBm 200 MHz to 2 GHz
–12 dBm 2 GHz to 2.5 GHz
Maximum Input Level:
+20 dBm
Damage Level:*+23 dBm*
Impedance: 50 Ω
Coupling: ac
Pulse Width: 50 µs to CW

External Local Oscillator Input

Level: +6dBm (±1dB)
Impedance: 50 Ω
Frequency Range: 150 MHz to 2.5 GHz

Maximum Measurement Rate

Fast Histogram: 1.5 MHz
Other Modes: 1 MHz
Fast Sampling: 8 MHz (repetitive)

RF Envelope Trigger

Level: Adjustable in 100 steps (e.g., –25 dBm to 0 dBm @1 GHz)

Output: 0 to 0.4 volt into 50 Ω or TTL level into high impedance

** Consult the HP 53310A Technical Data Sheet (pub# 5091-2596EUS) for further product information and specifications.*

Resolution

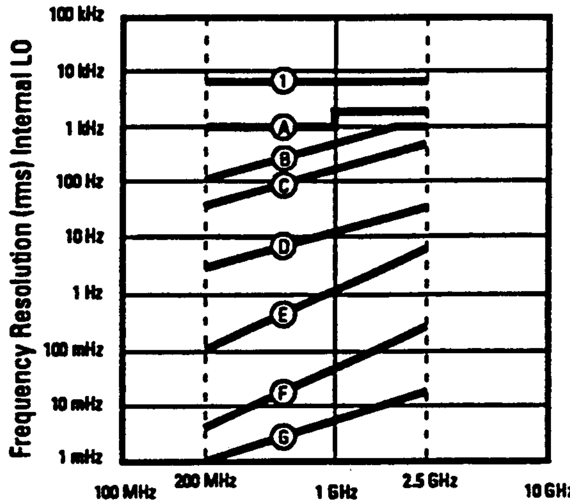
Maximum available measurement resolution or display resolution, whichever is greater.

Maximum Available Measurement Resolution (Auto Sampling): *see graph A*

Display Resolution:
vs Time or Histogram of vs Time
Window Off: Display Span/256
Window On: Display Span/224
Fast Histogram:
Display Span/450

Accuracy: ± *[Resolution + (Frequency × Reference Error*)]*

Maximum Available Frequency Resolution



Measured Frequency
(0 dBm sinewave, 100μV rms noise)

	Timebase Setting Interval @ center: Auto	Interval @ Center Setting (Interval @ Center: Manual	Frequency Resolution (Ext. LO)†
1		125 ns††	7 kHz
A	≤ 20 μs/Div	1 μs	1 kHz
B	200 μs/Div	10 μs	20 Hz
C	2 ms/Div	100 μs	5 Hz
D	20 ms/Div	1 ms	2 Hz
E	200 ms/Div	10 ms	50 mHz
F		100 ms	5 mHz
G		0.5 s	2 mHz

† Typical resolution over the 200 MHz to 2.5 GHz range using an HP 8663A Synthesizer as an external LO.
†† Fast Sampling mode

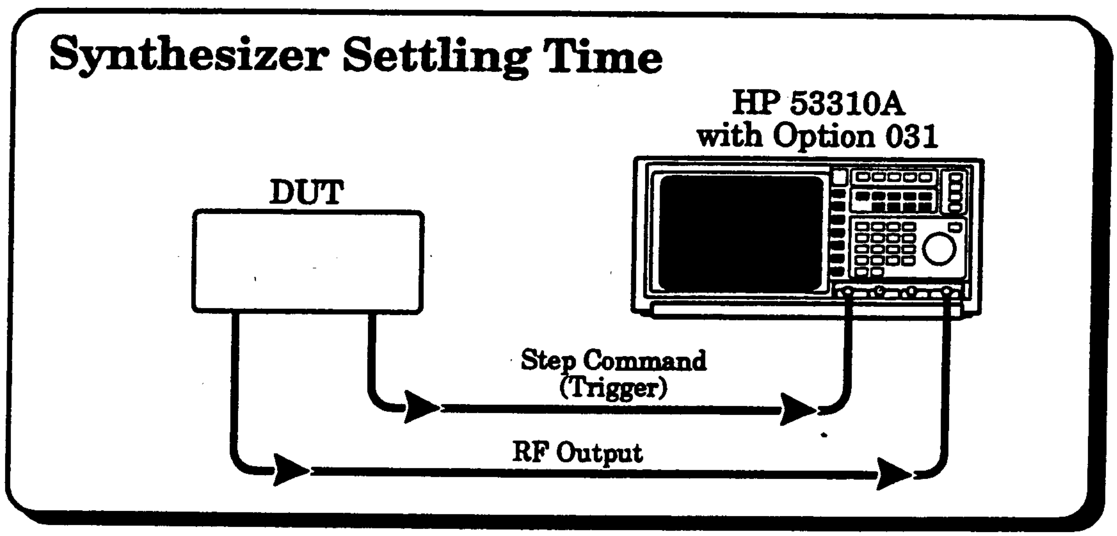
Graph A

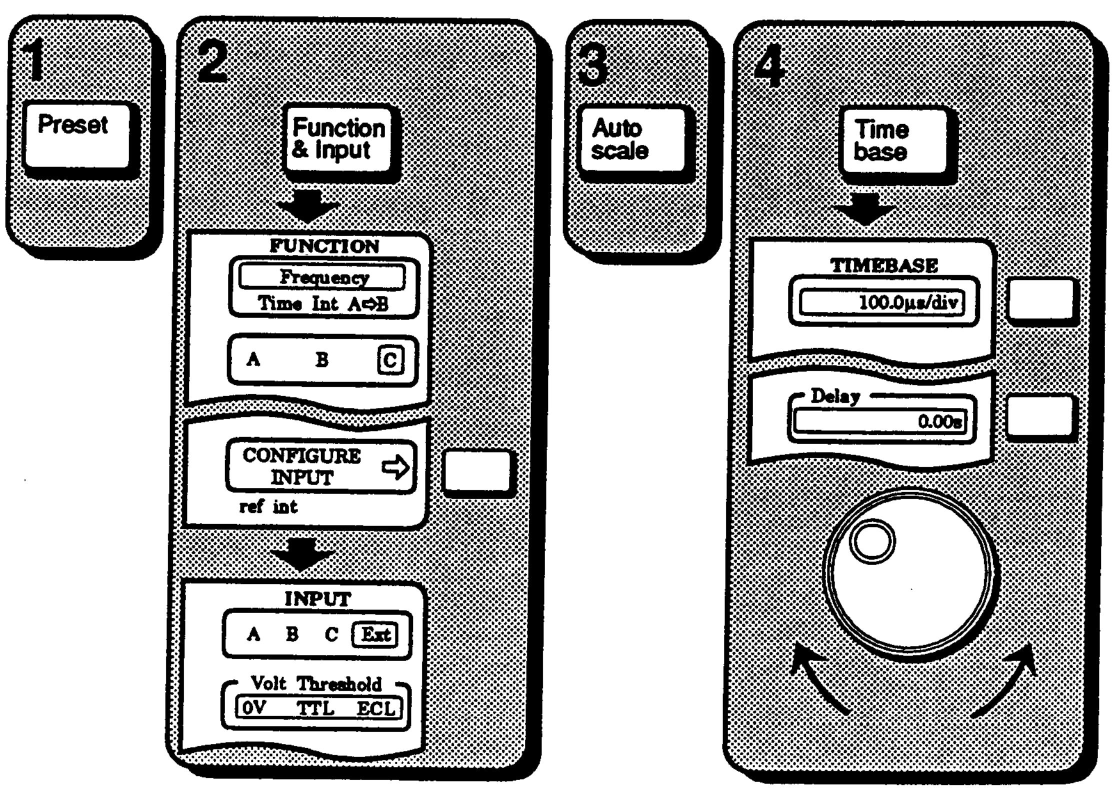
Maximum available frequency resolution for Option 031 Channel C. Larger timebase setting and averaging will reduce the effects of random noise and improve resolution. Please refer to graph 2 of the HP 53310A Technical Data Sheet for resolution over the 50 MHz - 200 MHz band.

Settling Time Quick Reference

Use this visual guide as a quick reference for how to make this measurement. Chapter 1 describes each step in detail.

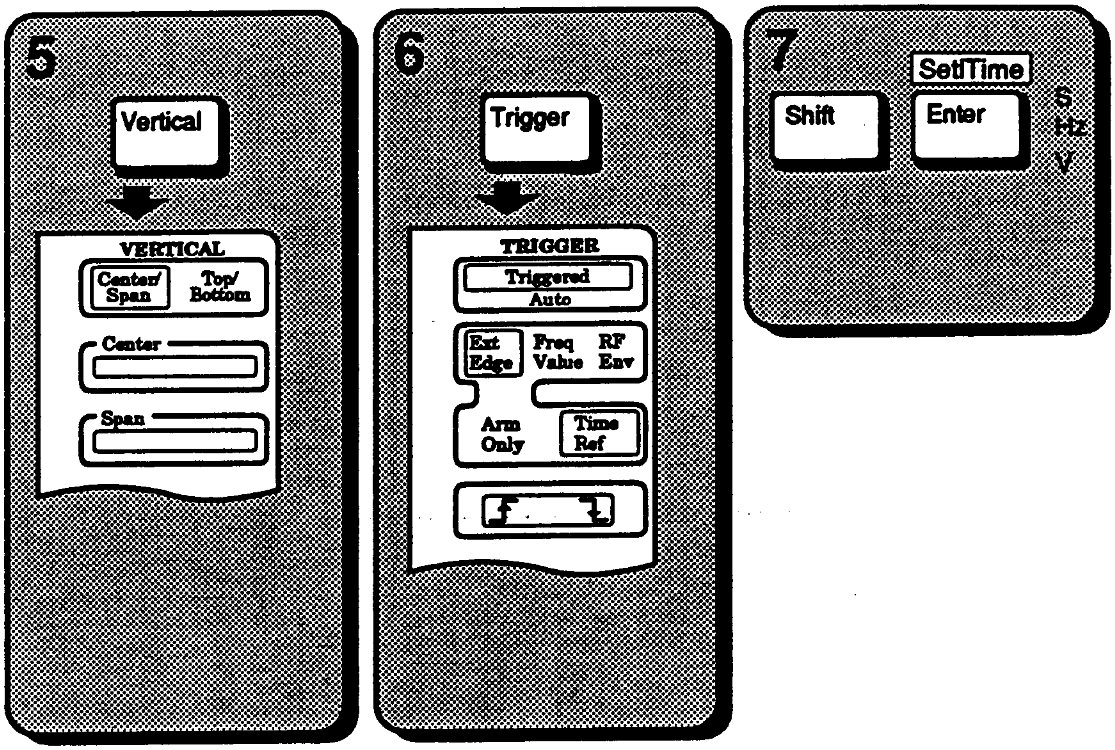
Instructions: Follow the numbered steps to make a settling time measurement. Text in this column indicates where you need to provide input. It is referenced to a step by number.



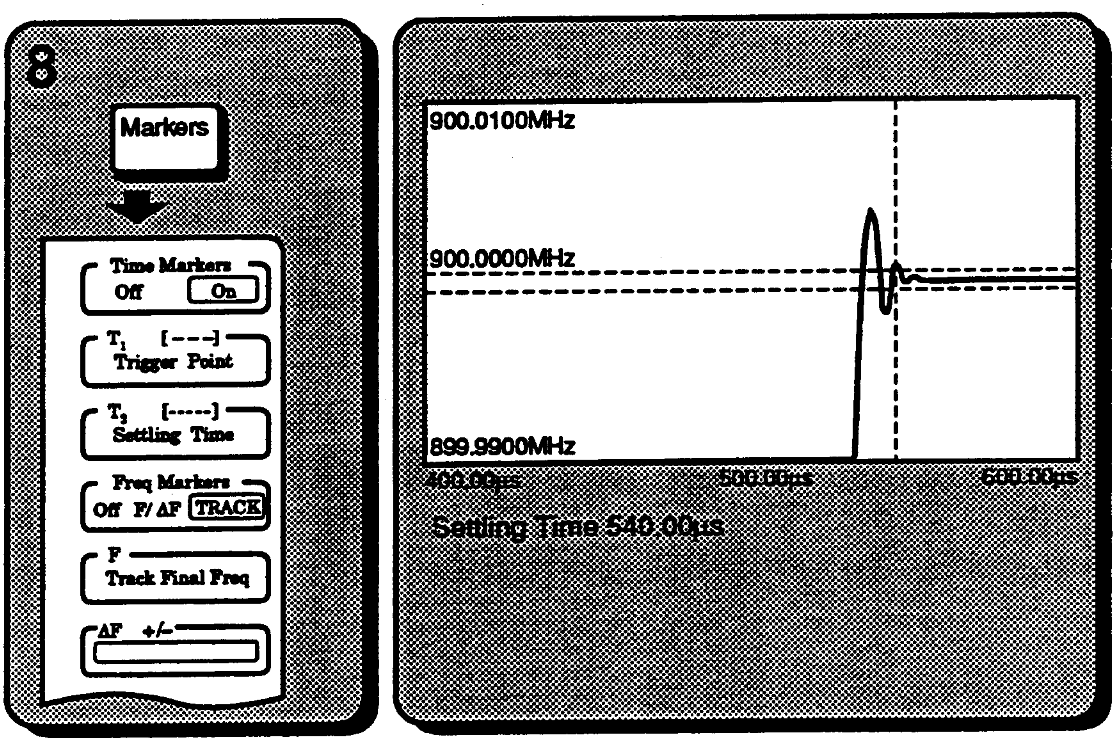


4 Adjust the time/div and Delay values as needed.

5 Enter the Center and Span values appropriate for your measurement.



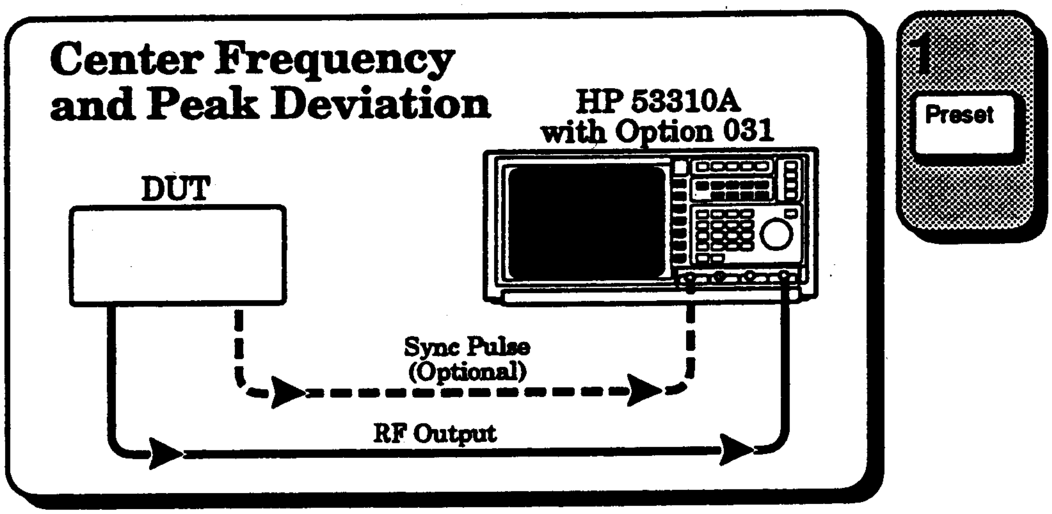
8 Enter the ΔF value appropriate for your measurement.

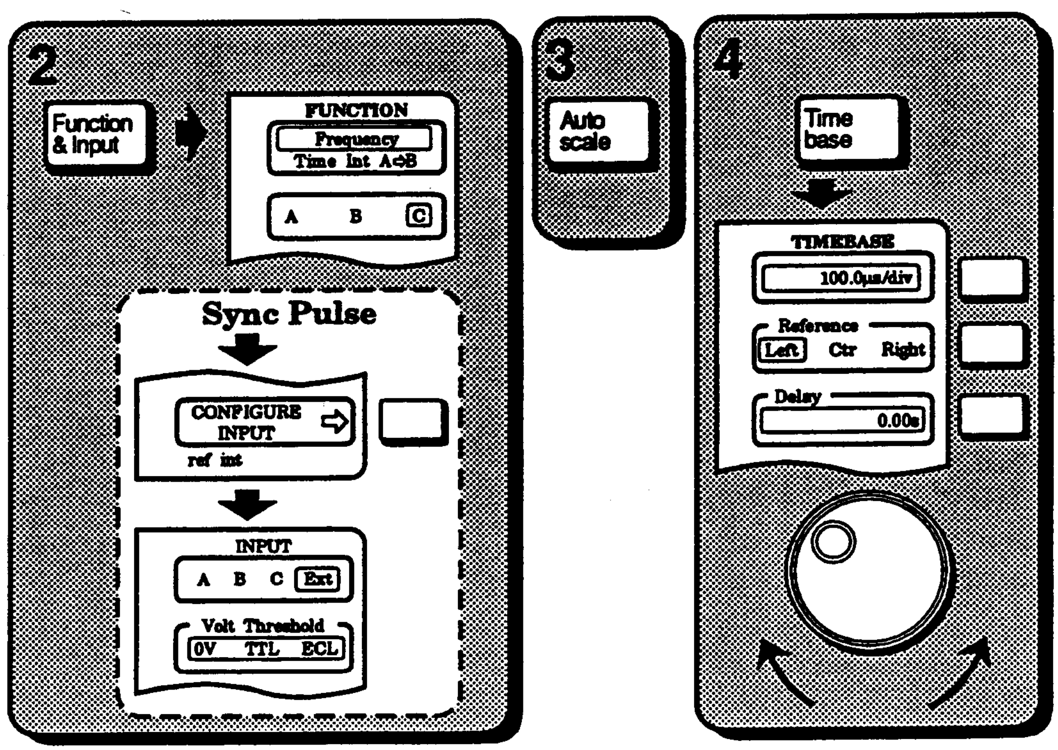


Center Frequency and Peak Deviation Quick Reference

Use this visual guide as a quick reference for how to make this measurement. Chapter 1 describes each step in detail.

Instructions: Follow the numbered steps to make a center frequency and peak deviation measurement. Text in this column indicates where you need to provide input. It is referenced to a step by number.

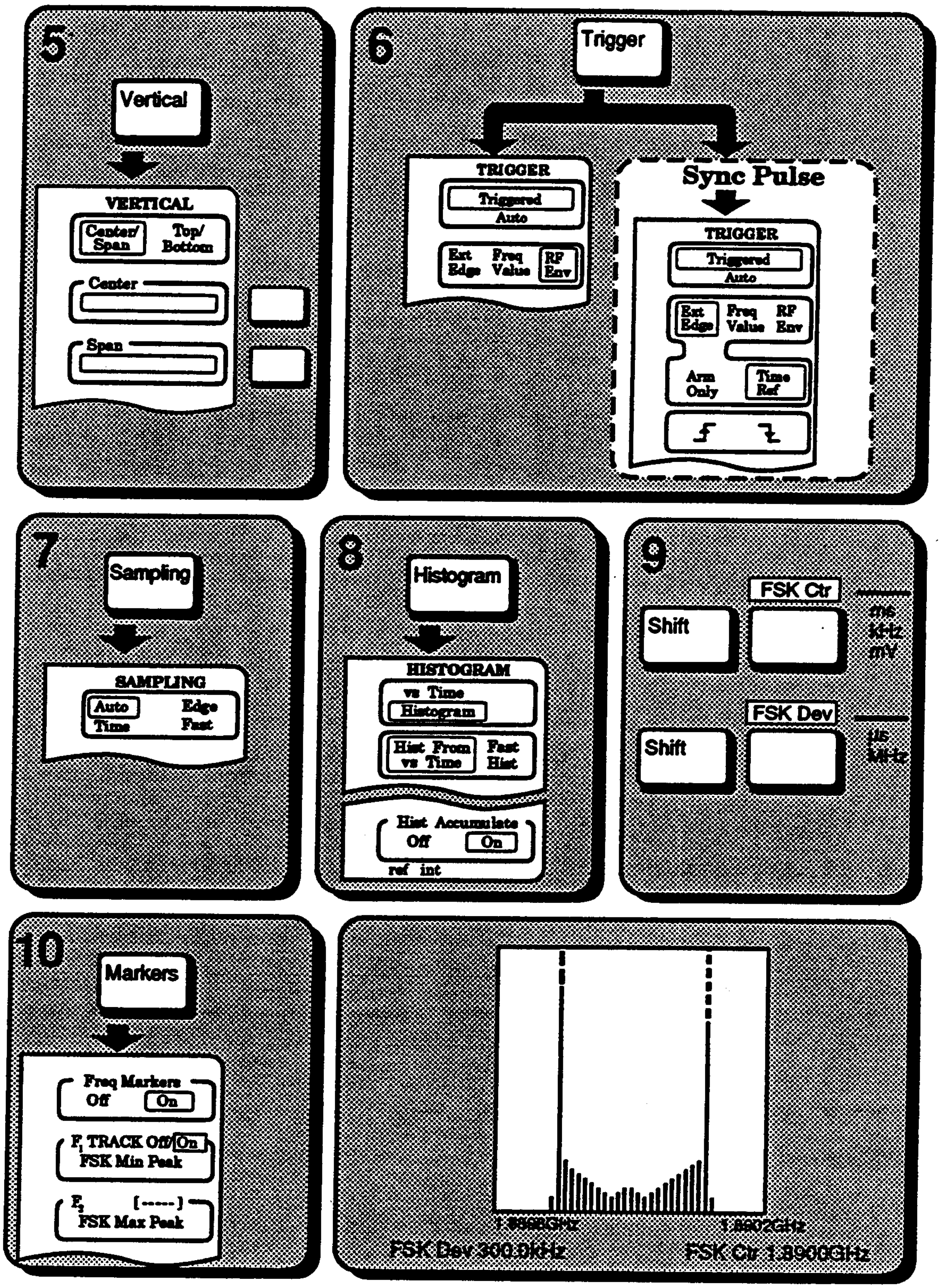




4 Adjust the time/div and Delay values as needed.

5 Enter the Center and Span values appropriate for your measurement.

7 For fast data rate systems, such as DECT, use Fast Sampling.



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Introduction

1 Using Digital RF Communications Analysis

2 Using the Downconverter

3 Messages

4 Programming Information

1

Using Digital RF Communications Analysis

In this chapter

Option 031 adds digital RF analysis features to help a designer of digital RF communication systems. These features include measuring synthesizer settling time, and characterizing center frequency and peak deviation of radio systems such as CT-2, CT-3, GSM, and DECT.

This chapter presents step-by-step procedures for the option 031 measurements. The procedures include CT-2, DECT, and GSM signals as examples.

The following measurements are described in this chapter:

- Synthesizer settling time
- Transmitter turn on/off frequency transients
- Center frequency and peak deviation
- Eye diagram of FSK modulation on RF carrier

To measure synthesizer settling time

Radio manufacturers use synthesizer settling time as a way to evaluate how the performance of a synthesizer compares to internal design needs. The HP 53310A Option 031 measures settling time by displaying the changing frequency of the synthesizer and the time it takes to reach a settled frequency. The following procedure shows how to make this measurement. Information is also included about making averaged measurements on a synthesizer that is being repetitively stepped.

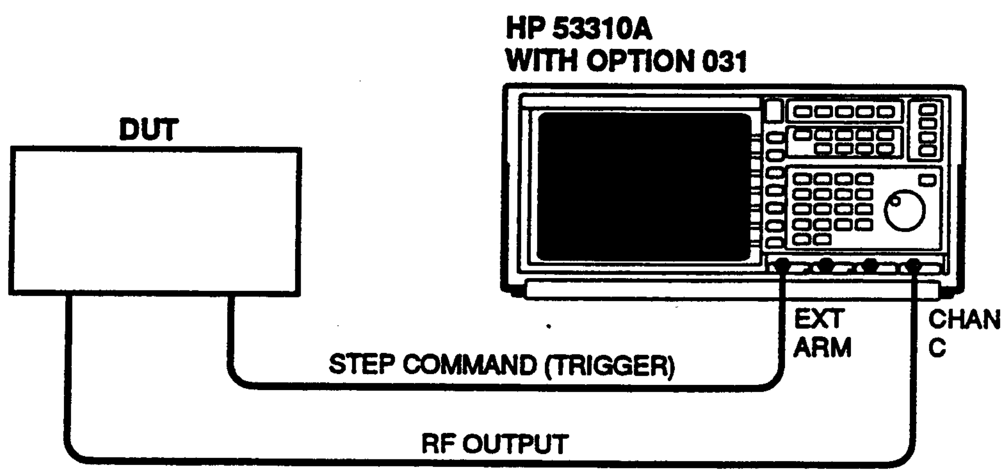
Note

An abbreviated version of this measurement procedure is in the introduction. Use it as a guide after you become familiar with this procedure.

Overview and equipment setup

A settling time measurement consists of a frequency measurement with a time record. Typically the synthesizer step command is used to specify the start of the measurement. The equipment setup is shown below.

This is a typical setup for a settling time measurement. The step command is connected to the Ext Arm input. The measurement determines the time from the occurrence of the step command to when the synthesizer settles.



Settling time measurement

The following steps demonstrate how to measure settling time using a DECT signal as an example.

Preset the HP 53310A.

1 **Press the Preset key.**

Select the channel and input settings.

1 **Select the C channel.**

The Frequency measurement function is selected by Preset.

2 **Press the CONFIGURE INPUT softkey.**

3 **Select the Ext input.**

This is where you set the voltage level at which the step command signal triggers a measurement.

4 **Select the Volt Threshold setting appropriate for your Ext Arm input signal.**

You are setting the voltage threshold for your step command signal. The HP 53310A will sense a signal that passes through the voltage level selected: 0 volts, 1.5 volts (TTL), or −1.3 volts (ECL). A signal transition from low to high or from high to low can be detected and will mark the start of the synthesizer switching time.

Note

The rising or falling edge of the step command signal is selected on the Trigger menu. This is described under "Set the trigger controls" later in this section.

5 **If you are using a 10:1 probe at the Ext Arm input, select the HP 53310A's 10:1 probe setting.**

Autoscale the HP 53310A.

If you have a single-shot measurement situation, skip over this step.

1 Press the **Autoscale** key.

The autoscale feature will usually "find" repetitive signals. This is an easy way to have the instrument adjust itself to display your signal.

Set the timebase controls.

1 **Press the Timebase key.**

2 **Press the top softkey to select the time/div field.**

3 **Enter a value that is approximately one tenth the amount of time over which you want to measure.**

The measurement time should exceed the expected settling time to ensure that the HP 53310A can properly measure it.

> **Hint:** If your synthesizer settles in 500 μs, set the time/div so your signal will be measured for double or triple that length of time. To measure for 1.5 ms, enter a time/div value of 150 μs.
>
> Use this example as a guide. You can readjust this value for subsequent measurements as needed.

4 **Set Reference to Left.**

This moves the 0.0s x-axis reference point to the left edge of the display. If you want to modify the time range on the display, select the Delay feature and adjust the knob to show the time range of interest.

Set the vertical controls.

1 **Press the Vertical key.**

2 **Enter the expected settled frequency as the Center value.**

3 **Enter a Span value.**

The span value is the frequency range that will be shown on the vertical axis of the HP 53310A display. A wide span (larger value) will show the entire synthesizer step. A narrow span (smaller value) will display the settling transient with greater resolution.

> **Hint:** Enter a Span value that is approximately thirty times the tolerance band of the settled result. For example, if you want to measure the time it takes the synthesizer to settle to ± 10 kHz, set the span to 300 kHz. This should provide a reasonable resolution for your measurement.
>
> Use this example as a guide. You can readjust this value for subsequent measurements as needed.

Set the trigger controls.

1 **Press the Trigger key.**

2 **Select Triggered.**

3 **Select Ext Edge.**

4 **Select Time Ref.**

The settling time result will be referenced to the occurrence of the step command at the Ext Arm input.

Note

No pre-trigger data is available when using the time reference trigger. You may need to readjust the timebase delay feature to center your data display after selecting Ext Edge trigger.

5 **Select the rising or falling edge as appropriate for your step command signal.**

Measuring Repetitively

If all the steps have been followed and the synthesizer is being repetitively stepped, the HP 53310A is displaying each sweep of data as it is acquired.

Averaging Multiple Acquisitions

The HP 53310A can average the results from multiple measurements of a synthesizer that is being repetitively stepped. This may be useful when you want to average out the short-term measurement-to-measurement variations and increase resolution.

1 Press the Display key.

2 Select Repetitive.

3 Set Averaging to On.

The HP 53310A will accumulate multiple acquisitions and provide a running average of synthesizer steps, all referenced to the step command edge.

Measuring Single-Shot

1 Press the Stop/Single key once or twice until you see the word "stopped" at the top of the display.

2 Press the Stop/Single key once to start a new acquisition.

The HP 53310A is now waiting for the step command signal.

3 Send the step command signal.

4 The HP 53310A captures and displays the synthesizer settling response.

Enable the settling time feature.

1 **Press the blue Shift key and then the Setl Time key.**

This enables the settling time feature. The measured settling time will not be displayed until you set the markers in the next step.

Set the markers.

1 **Press the Markers key.**

2 **Set Time Markers to On.**

3 **Set Freq Markers to F/ΔF.**

4 Enter the settled frequency for the synthesizer as the F value.

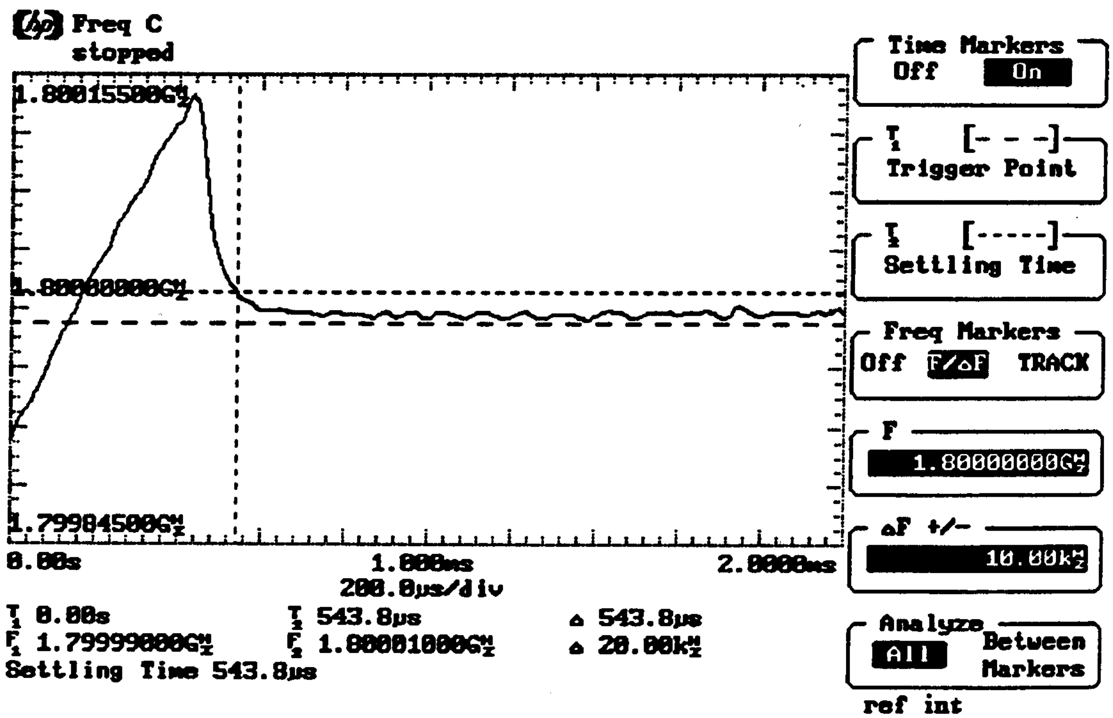
If the settled frequency is drifting, or the final value is not known, the instrument can track this value for you. Go to "Track the settled frequency" later in this section.

5 Enter the plus and minus frequency range for the synthesizer settling as the ΔF +/- value.

6 Read the settling time at the lower left of the display.

The settling time is the time from the step command to when the synthesizer settled within the tolerance band. One of the vertical time markers will indicate the settling point. See the example display below.

The time the synthesizer takes to settle within the tolerance band is displayed at the lower left.



> **Hint:** Once a single measurement has been acquired and the HP 53310A is stopped, you can change the ΔF value and see the settling time for different tolerance band values.

Track the settled frequency.

When you want the HP 53310A to follow a drifting frequency, or to find the settled frequency for you, use the tracking feature.

1 **Perform the preceding tasks in this measurement procedure up to the point where you are asked to enter the settled frequency in the previous task "Set the markers".**

The waveform of the settled frequency must be on the display before you can use the tracking feature.

2 **Set Freq Markers to TRACK.**

3 **Enter the plus and minus range for the synthesizer settling as the ΔF +/- value.**

The settled frequency will now be tracked, as long as the frequency stays on the display. If you do not know the settled frequency, this feature will find it for you.

Note

The tracking feature actually follows the last measured value at the right edge of the display. If the waveform drops off before the edge, use Delay on the Timebase menu to position the settled frequency at the edge of the display, or use the time markers (set the Analyze softkey feature to Between Markers) to limit the area of analysis.

Synthesizer Pulling

Another consideration is the secondary effect on the synthesizer of the power ramp-up of the amplifier as the transmitter is turned on. In most radio transmissions, the power does not come on until the synthesizer has settled. As the TDMA burst is turned on, the amplifier power ramp can cause a temporary shift in the synthesizer's frequency. Leakage signals from the RF antenna can also be radiated back into the circuit causing a pulling effect. The HP 53310A can show you how far from the settled frequency the synthesizer is pulled and how long it takes to relock.

To check for synthesizer pulling:

1. **Use the same setup as for synthesizer settling time.**

2. **Create the condition of power ramp-up in the radio.**

3. **Monitor the synthesizer response at the point the power comes on.**

4. **Use the Delay feature on the Timebase menu to look beyond the point where the synthesizer originally settles.**

Once you find the area of interest, you may want to change the time/div setting on the Timebase menu to take a better look at the synthesizer behavior.

Enhance resolution of settling time measurements

If the resolution of your settling time measurement using averaging and the internal local oscillator (LO) is not sufficient, enhanced resolution can be obtained by using a high performance external LO. Refer to chapter 2 for instructions. Typical resolution using an HP 8663A Signal Generator as an external LO is listed in the specifications.

To measure transmitter turn on/off frequency transients

Various international test standards specify that the transmitter turn-on/off behavior be measured. The HP 53310A Option 031 measures the transient frequency response of a transmitter at turn-on or turn-off by measuring the frequency of the transmitter output signal as the power ramps up or down.

The transmitter response is typically referenced to a point on the power ramp, such as −30 dBc. The HP 53310A can be triggered two ways to make this measurement:

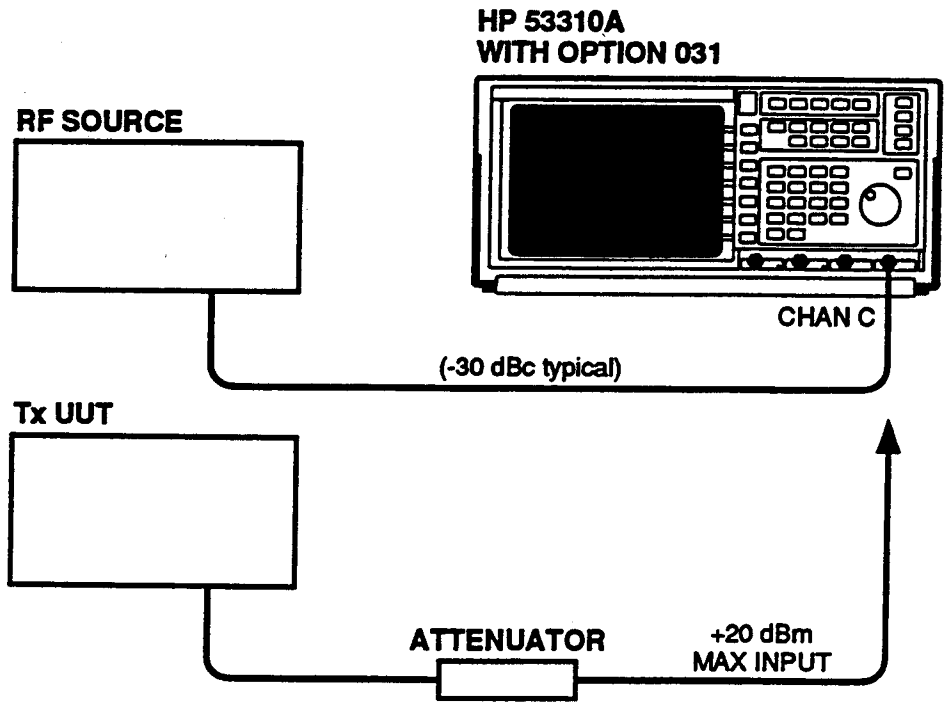
- trigger on an external signal that is synchronized to the −30 dBc power level.
- adjust the RF envelope trigger level to trigger at the −30 dBc power level.

This procedure demonstrates how to use the RF envelope trigger to make this measurement.

Overview and equipment setup

The setup for a transient frequency measurement consists of first setting the HP 53310A RF Envelope trigger level at the proper power level and then measuring the transients referenced to the time when this power level occurs. This adjustment requires an RF source that can simulate the attenuated output power level of the transmitter specified for the test. The equipment setup is shown below.

An RF source is used to help adjust the HP 53310A to make this measurement. Use an attenuator to limit power to the Channel C input to less than +20 dBm.



Transient turn on/off measurement

The following steps demonstrate how to measure transient frequency behavior of a transmitter at turn-on and turn-off.

There are four parts to measuring the turn-on and turn-off transients of a transmitter with the HP 53310A:

Part One: Measure the output power of the transmitter.

Part Two: Adjust an RF source to −30 dBc (typical).

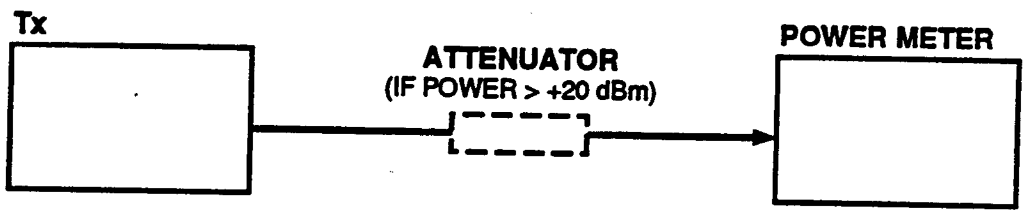
Part Three: Adjust the HP 53310A's RF Envelope trigger level to −30 dBc (typical) using the RF source.

Part Four: Measure the transmitter transients.

Part One: Measure the output power of the transmitter.

The maximum power level that the HP 53310A can accept on the C channel without damage is +23 dBm. Use this procedure to establish the attenuation that will be needed between the transmitter and the HP 53310A if your transmitter's output power is greater than +20 dBm.

Use an attenuator if the output power of the transmitter exceeds +20 dBm.



1 **Determine the nominal output power of the transmitter under test.**

Use a power meter or similar instrument to measure the transmitter power.

2 **If the power is greater than +20 dBm, use an attenuator at the output of the transmitter to limit its output power.**

This protects the front-end circuitry of the HP 53310A from damage by power levels exceeding +23 dBm.

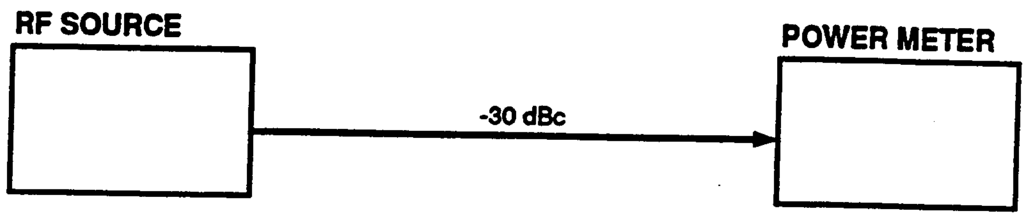
Part Two: Adjust the RF source to -30 dBc (typical).

This section helps you determine the power level at which the HP 53310A RF Envelope trigger level should be set for the test.

The test specification used as an example here, specifies that the transient measurements be triggered at a power level 30 dB below the transmitter's nominal power level. For example, if the nominal power level of the transmitter is +15 dBm, the power level test point is −15 dBm.

Any attenuation required (see preceding section) must be factored in when setting the trigger level of the HP 53310A. For example, if 6 dB of attenuation is needed so the HP 53310A can safely accept the transmitter nominal power output level, this attenuation must be added in when calibrating the HP 53310A trigger level.

This step calibrates the RF source for setting the trigger level of the HP 53310A.



1 **If the nominal output power level is less than +20 dBm, set the RF source to output a level 30 dB below the nominal level and go to the next section.**

2 **If attenuation is required (+20 dBm maximum level allowed at the channel C input), review the example below and set the RF source to the appropriate level using the power meter.**

Example An example of how to determine the power level of the RF source is as follows:

Transmitter's nominal power level = +30 dBm

Transmitter power level at test trigger point = 0 dBm (30 dB below the nominal power level)

If 15 dB of attenuation is inserted to reduce the power level to the HP 53310A to a maximum of +15 dBm:

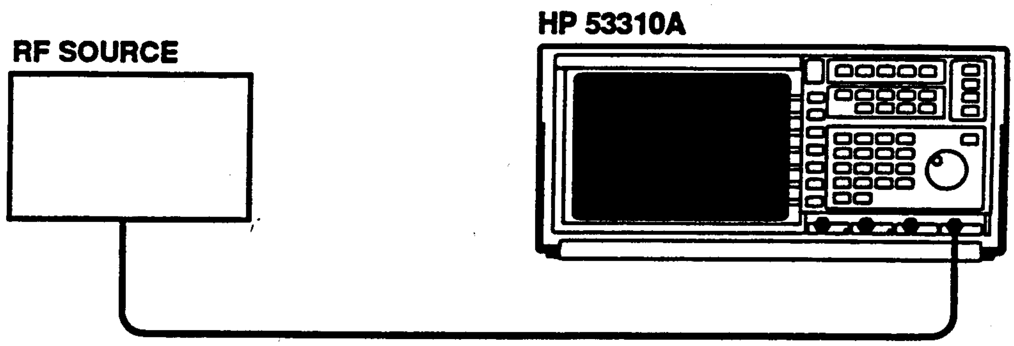
Power level at HP 53310A for the adjustment = −15 dBm (+15 dBm − 30 dB)

For this example, the RF source should be set to −15 dBm.

Part Three: Adjust the HP 53310A RF Envelope trigger level.

Adjust the RF Envelope trigger level using the known reference. This is done so the HP 53310A will detect the transmitter signal and trigger the start of the measurement at the correct power level (−30 dBc in this example).

Adjust the HP 53310A to trigger at the proper transmitter power level.



1 **Set the RF source to output a power level 30 dB below the nominal power level of the transmitter (as determined in the previous section) and at the same frequency as the transmitter.**

Note

If you are using an attenuator on the output of the transmitter, add this attenuation to calculated test level of the transmitter. For example, If the nominal transmitter output power level is +20 dBm and you added 6 dB of attenuation to protect the input of the HP 53310A, the trigger level needs to be set at a power level of −16 dBm (+20 dBm −6 dB −30 dB).

2 **Connect the RF source to the HP 53310A Channel C.**

Setting the RF source to add FM to the output signal will make the signal easier to see in the following steps.

3 **Press the Preset key on the HP 53310A.**

4 **Select the C channel on the Function menu.**

5 **Press the Autoscale key on the HP 53310A.**

The HP 53310A automatically measures and displays the input signal. The green LED trigger light at the C channel input should be flashing.

Note

If Autoscale cannot find the signal, you may have to increase the power level used for this measurement and begin again at Part One.

6 **Press the CONFIGURE INPUT softkey.**

7 **Select the C input.**

The envelope trigger level will be adjusted so the HP 53310A will detect the transmitter signal at the proper level.

8 **Rotate the knob slowly clockwise until the green LED at the C channel stops flashing.**

The trigger level is now adjusted above the input signal. The next step will make a fine adjustment so the signal will be detected again.

9 **Press the Fine key near the knob.**

This step increases the resolution of the trigger level setting by 10 times.

10 **Rotate the knob slowly counterclockwise just until the green LED starts flashing again.**

11 **As a final adjustment check, rotate the knob clockwise until the green LED stops flashing; then rotate the knob counterclockwise just until the LED starts flashing again.**

You have set the envelope trigger level of the C channel to detect a signal at the power level of the RF source. The HP 53310A is now adjusted for the correct power level to test the transmitter.

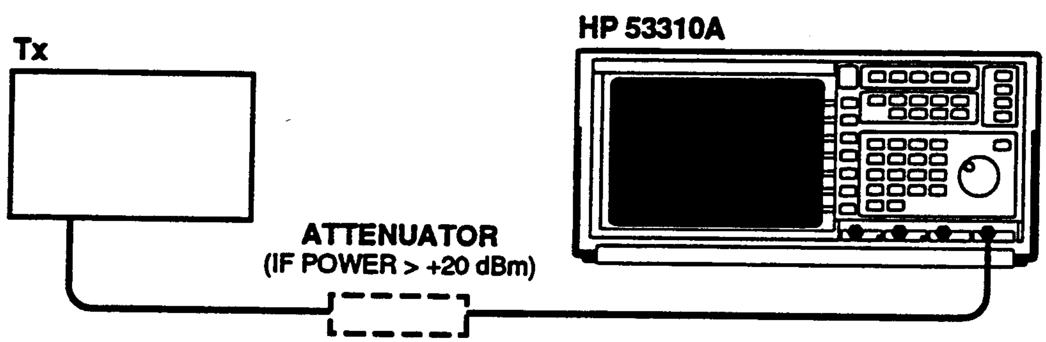
Note

Using Autoscale will reset this trigger level to a default value. If you inadvertently press the Autoscale key, you can recall the previous setup by pressing the Save/Recall key, the Recall Setup softkey, and then the 0 key.

Part Four: Measure the transmitter transient frequency

At this point, the HP 53310A is set to make a frequency measurement on the C channel and the input has been adjusted to the testing level for the transmitter under test.

Remember to protect the input of the HP 53310A, if necessary.



Connect the transmitter.

1 **Connect the transmitter under test to the C channel.**

Ensure that any required attenuation is inserted between the transmitter and the HP 53310A. See the procedure "Measure the output power of the transmitter" at the beginning of this procedure for more on attenuation.

Set the timebase controls.

1 **Press the Timebase key.**

2 **Press the top softkey to select the time/div field.**

3 **Set the value to 10 ms/div, or to a value more appropriate for your test.**

A time/div value of 10 ms/div will display 100 ms of data (there are ten divisions across the display left to right).

4 **Set the Reference to Left.**

Set the vertical controls.

1 **Press the Vertical key.**

2 **Set the Center value to the center frequency, if not already done.**

3 **Enter a span value that is twice the channel spacing for your radio system.**

Now the top and bottom of the display will be one channel spacing away from the channel under test at the center of the display.

Set the trigger controls.

1 **Press the Trigger key.**

2 **Select Triggered.**

3 **Select RF Env.**

4 **Select rising or falling edge as appropriate for your measurement.**

Use the rising edge for turn-on transient and the falling edge for the turn-off transient.

Note When measuring the turn-off transient, set the timebase reference to center or right so you can view the response as the transmitter powers down.

Make the measurement.

1. **Turn on the transmitter.**

If you have a radio that does not use the Time-Division Multiple Access (TDMA) or Time Division Duplex (TDD) systems, you will need to make the RF output ramp up. This can be done by "keying" the transmitter using the Push-to-Talk button.

Automatically measure the settling time of the transient.

Enable the settling time feature.

1 **Press the blue Shift key and then the Setl Time key.**

This selects the settling time feature. Your settling time result is not displayed until you set the markers in the next step.

Set the markers.

1 **Press the Markers key.**

2 **Set Time Markers to On.**

3 **Set Freq Markers to F/ΔF.**

4 **Enter the settled frequency for the synthesizer as the F value.**

5 **Enter the plus and minus range for the tolerance band as the ΔF +/- value.**

If the settled frequency is on the display, you can use the tracking feature instead of entering a frequency value. Select TRACK and the instrument will automatically find this value for you.

The settling time displayed at the lower-left corner of the display is the length of time between the instant when the input signal went through the set power level and when the frequency settled within the tolerance band. One of the vertical markers is positioned at the settling point.

Measure a single transient

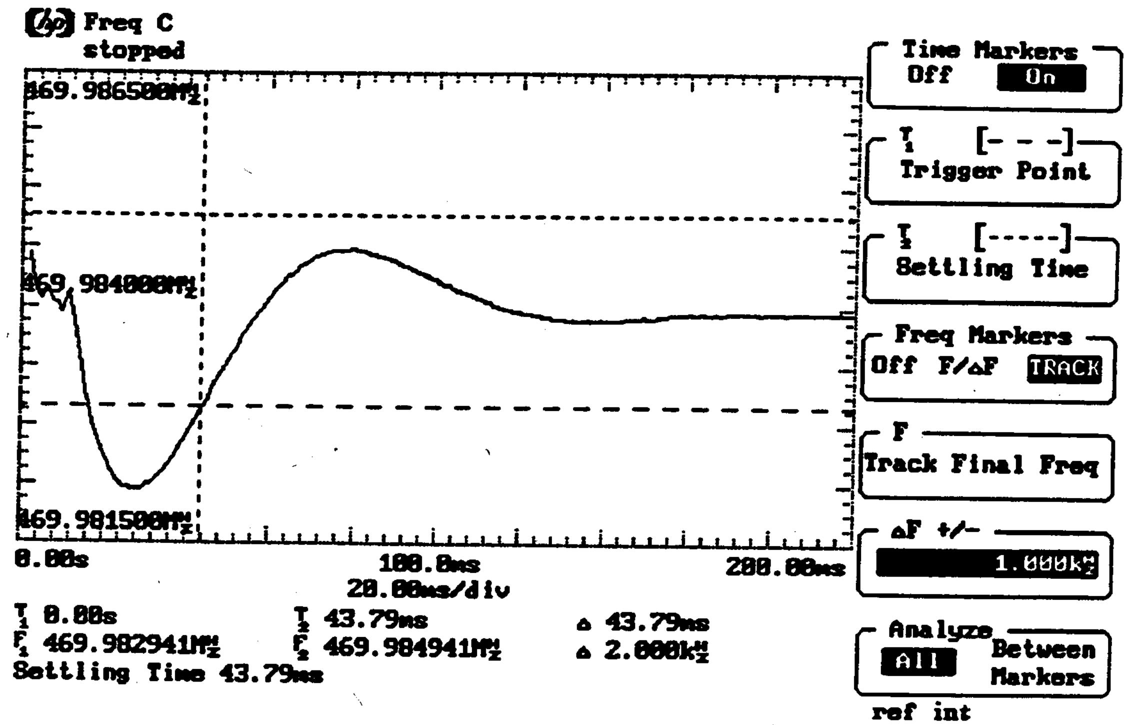
1 **Press the Stop/Single key.**

This stops the HP 53310A.

2 **Press the Stop/Single key again.**

3 Apply the RF pulse burst.

The HP 53310A will measure the transient and display the results. The results will be similar to the waveform shown here.



Results

Compare the results from the HP 53310A display with the requirements over the specified times. The test specifications require that the turn-on transient settles to within a specified frequency range within certain time periods. For example, a radio transmitter may need to settle within a one channel spacing 5 ms after the RF output power is switched on. Between 5 ms and 25 ms, the transmitter may have to settle within a 1/2 channel spacing, and thereafter maintain a 1/8 channel spacing.

To measure center frequency and peak deviation

The HP 53310A Option 031 automatically calculates center frequency and peak frequency deviation from histogram plots based on thousands of data measurements.

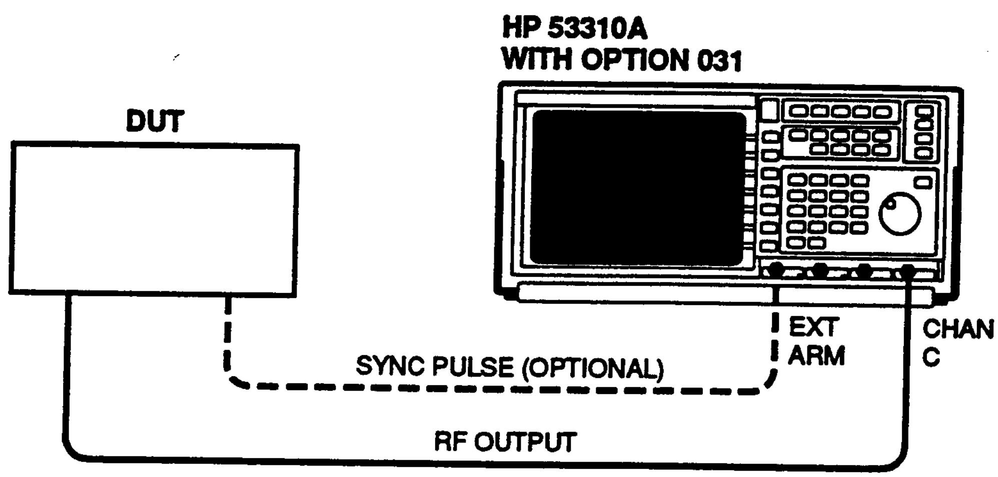
Radio systems, such as CT-2 and DECT, require that radios meet a specification for center frequency and peak deviation in order to guarantee error-free operation.

Note An abbreviated version of this measurement procedure is in the introduction. Use it as a guide after you become familiar with this procedure.

Overview and equipment setup

The CT-2 radio should be configured to output a TDMA burst. This procedure has you first measure the data and display it as frequency vs. time in order to ensure that you are acquiring the appropriate data. The histogram then shows the distribution of many measurements and the built-in analysis determines the center frequency and peak deviation from the histogram. The start of the measurement can be triggered by a sync pulse or the RF burst envelope. The equipment setup is shown below.

This setup shows the sync pulse as optional. The RF Envelope trigger setting can be used for bursted signals.



Center frequency and peak deviation measurement

The following steps demonstrate how to measure center frequency and peak deviation using a CT-2 radio signal as an example.

Preset the HP 53310A.

1 **Press the Preset key.**

Select the channel and input settings.

1 **Select the C channel.**

The Frequency measurement function is already selected by Preset.

2 **Press the CONFIGURE INPUT softkey.**

3 **If you are using a sync trigger, select the Ext input.**

4 **For your Ext Arm input signal, select the appropriate Volt Threshold setting.**

You are setting the voltage threshold for your sync trigger. The HP 53310A will sense a signal that passes through the voltage level selected: 0 volts, 1.5 volts (TTL), or −1.3 volts (ECL). A signal transition from low to high or high to low can be detected and will mark the start of the measurement.

Note — The rising or falling edge of the sync trigger signal is selected on the Trigger menu. This is described under "Set the trigger controls" below.

5 **If you are using a 10:1 probe at the Ext Arm input, select the 10:1 probe setting.**

Autoscale the HP 53310A.

If you have a single-shot measurement situation, skip over this step.

1 Press the **Autoscale** key.

The autoscale feature will usually "find" repetitive signals. This is an easy way to have the instrument adjust itself to display your signal.

Set the timebase controls.

1 **Press the Timebase key.**

2 **Press the top softkey to select the time/div field.**

3 **Use the knob to adjust the amount of data captured, or enter a value appropriate for your measurement.**

> **Hint:** For a CT-2 system, try 5 µs/div to 20 µs/div.

You can use the Delay feature to position the data of interest on the display. The frequency vs. time display shows the FSK modulation on the RF carrier.

Collecting more data

Use the Panorama feature to acquire multiple screens of data. The extended measurement memory option (Option 001) captures up to 80 screens of data. The standard memory configuration provides up to 20 screens of data.

When the Panorama feature is enabled, a second display area appears above the main display. This reduced display shows the entire acquisition and uses vertical indicators to highlight the portion of the data visible in the main display.

For example, the panorama display can show an entire time slot of information. The main display can be used to show greater detail (use the Window Timebase feature) and can be positioned anywhere in the panorama by adjustment of the Window Position feature. Analysis results are based on the panorama display data. The "Histogram From vs Time" mode also includes all the panorama data.

4 **Set Reference to Left.**

This moves the 0.00s time to the left edge of the display.

Set the vertical controls.

1 **Press the Vertical key.**

2 **Adjust the Center and Span values as needed.**

Try to adjust the center and span values so the data covers most of the display. This provides results with better resolution than those produced for a larger span.

Set the trigger controls.

1 **Press the Trigger key.**

2 **Select Triggered.**

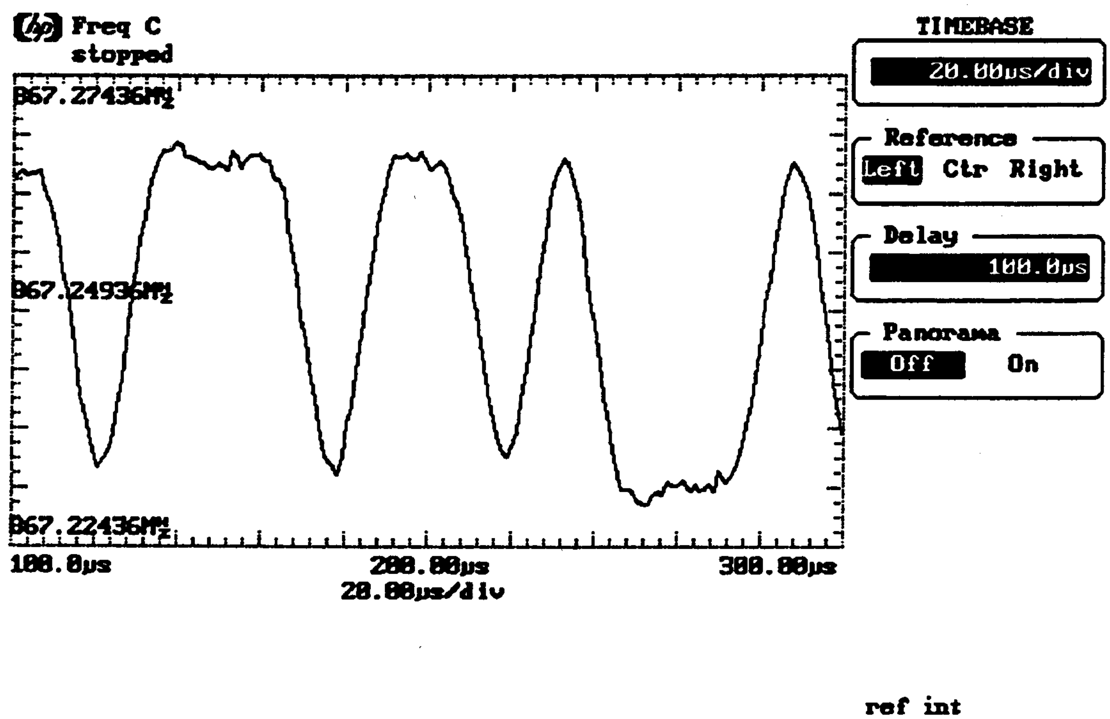
3 **If you are using a sync trigger, select Ext Edge, Time Ref, and the slope appropriate for your sync trigger signal.**

4 **If you want to trigger on the TDMA burst, select RF Env and the rising edge.**

vs Time view of data

At this point, you should see a waveform of the data similar to the one shown below. This is a view of frequency vs. time.

The HP 53310A directly shows the FSK modulation on the signal. Note that the timebase delay is set to 100 µs to delay into the data.



Select the fast histogram mode.

1 **Press the Histogram key.**

2 **Select Histogram.**

3 **Select Fast Hist.**

4 **Enter 1000 as the # of Measurements, if not already set.**

5 **Set Hist Accumulate to On.**

Note

The selection of *Hist From vs Time* will cause approximately 250 measurements per acquisition when not using Panorama (on the Timebase menu). With *Fast Hist,* much larger numbers can be specified, and data is acquired more quickly, because the data is not first acquired in the vs. Time mode.

Enable the center frequency and peak deviation features.

1 **Press the blue Shift key and then the FSK Ctr key.**

2 **Press the blue Shift key and then the FSK Dev key.**

Set the markers.

1 **Press the Markers key.**

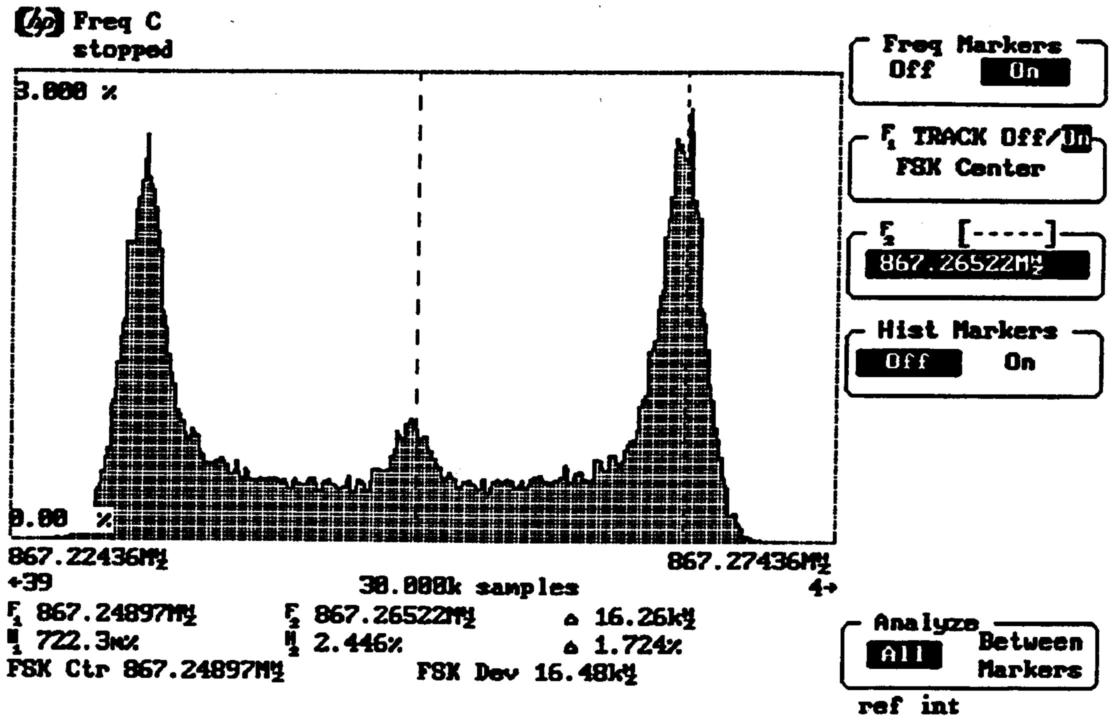
2 **Set Freq Markers to On.**

3 **Set Track to On.**

The markers automatically go to the minimum and maximum peaks. These are the points used to calculate the center frequency and the peak deviation. Center frequency is defined as the midpoint between the deviation peaks.

4 To have a marker show the location of center frequency, enable the FSK Ctr feature again.

The data was collected using the Fast Histogram mode. One of the markers is showing the position of the FSK center frequency. The other marker is at the maximum peak deviation.



Measuring Fast Data Rate Systems

The example in this section uses a CT-2 radio signal. The modulation data rate, or bit rate, for this system is 72 kbits/s. This is well under the default 1 MHz sampling rate of the HP 53310A. If you are measuring a faster data rate system, such as DECT with a 1.152 Mbits/s rate, a 1 MHz sampling rate is no longer adequate. The sample rate needs to be at least 2.304 MHz in order to characterize the modulation on the signal. A faster sampling rate is needed.

For measuring fast data rate systems, use the sampling mode called "Fast". It provides an effective sampling rate up to 8 MHz. Use Fast sampling for any radio system with a bit rate over 300 kbits/s.

Follow these steps to use Fast sampling:

1 **Press the Sampling key.**

2 **Select Fast sampling.**

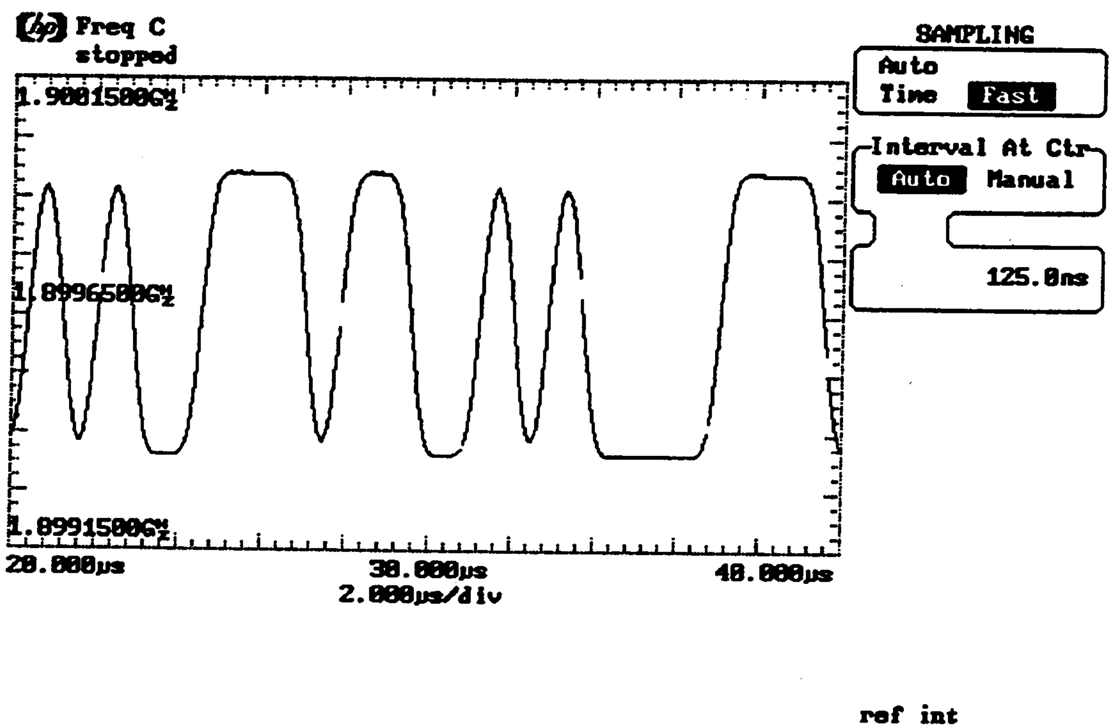
Turn the page for more about Fast sampling.

Fast Sampling

When set to Fast sampling, the HP 53310A makes consecutive acquisitions of 16 measurement samples until enough data is collected to fill the display. This can be up to 225 measurements across the vs. Time display representing 14 separate acquisitions. Each of these acquisitions requires a trigger. For example, if 225 measurements were needed and the trigger condition was an edge at the External Arm input, 14 trigger edges, along with the signal being measured, would be needed before enough measurement data would be acquired and displayed. This sampling scheme produces an effective sampling rate of up to 8 MHz.

In the display below, the gaps in the waveform identify the individual acquisitions.

A DECT signal was acquired using the Fast sampling mode. Connect Data is on showing the individual groups of samples.



Operating Characteristics

Fast sampling increases the effective sampling rate up to 8 MHz. But when using Fast sampling there are certain behaviors you need to understand.

- Because of how Fast sampling operates, it is recommended that you do not use Fast sampling to search for an unknown signal. Use Auto sampling to first find and display the signal, then switch to Fast sampling.
- Use the triggered mode (see Trigger menu) when using Fast sampling. This provides a reference for the multiple acquisitions collected as part of the Fast sampling mode.
- When Connect Data is on (see Display menu), you can see which samples are grouped together in each sampling group separated by a gap.
- The Fast sampling mode is not able to show pre-trigger data.

To check transmitter performance using an eye diagram

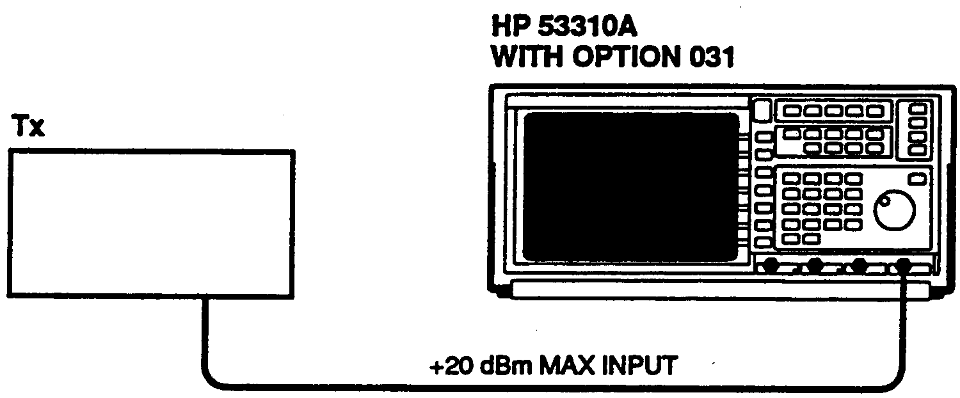
Eye diagrams are often used to characterize baseband modulating signals. The diagram gives a quick qualitative view of the modulation.

The HP 53310A Option 031 produces an RF eye diagram by repetitively measuring the modulated data stream on the RF carrier, and overlaying multiple acquisitions using the infinite persistence feature. The measurement is made at the transmitter's output on random data streams and the resulting eye pattern provides a qualitative view of transmitter performance.

Overview and equipment setup

Set the equipment so the radio is transmitting data. Connect the RF output to the HP 53310A (+20 dBm max input).

Note: Limit the RF power to the Channel C input to less than +20 dBm.



Eye diagram measurement

The following steps demonstrate how to produce an eye diagram using a GSM radio signal.

Preset the HP 53310A.

1 **Press the Preset key.**

Select the channel and input settings..

1 **Select the C channel.**

The Frequency measurement function is already selected by Preset.

Autoscale the HP 53310A.

1 **Press the Autoscale key.**

The autoscale feature will usually "find" repetitive signals. This is an easy way to have the instrument adjust itself to display your signal.

Should autoscale fail to properly display the modulated RF carrier, adjust the time/div on the Timebase menu, the Center value and the Span value on the Vertical menu until the modulation on the carrier is displayed.

Set the trigger controls.

1 **Press the Trigger key.**

2 **Select Triggered.**

3 **If you are using a trigger, such as a data clock, select Ext Edge, Time Ref, and the slope.**

4 **If you can trigger on the TDMA burst, select RF Env and the rising edge.**

Set the timebase controls.

1 **Press the Timebase key.**

2 **Set the Reference to Left.**

3 **Press the top softkey to select the time/div field.**

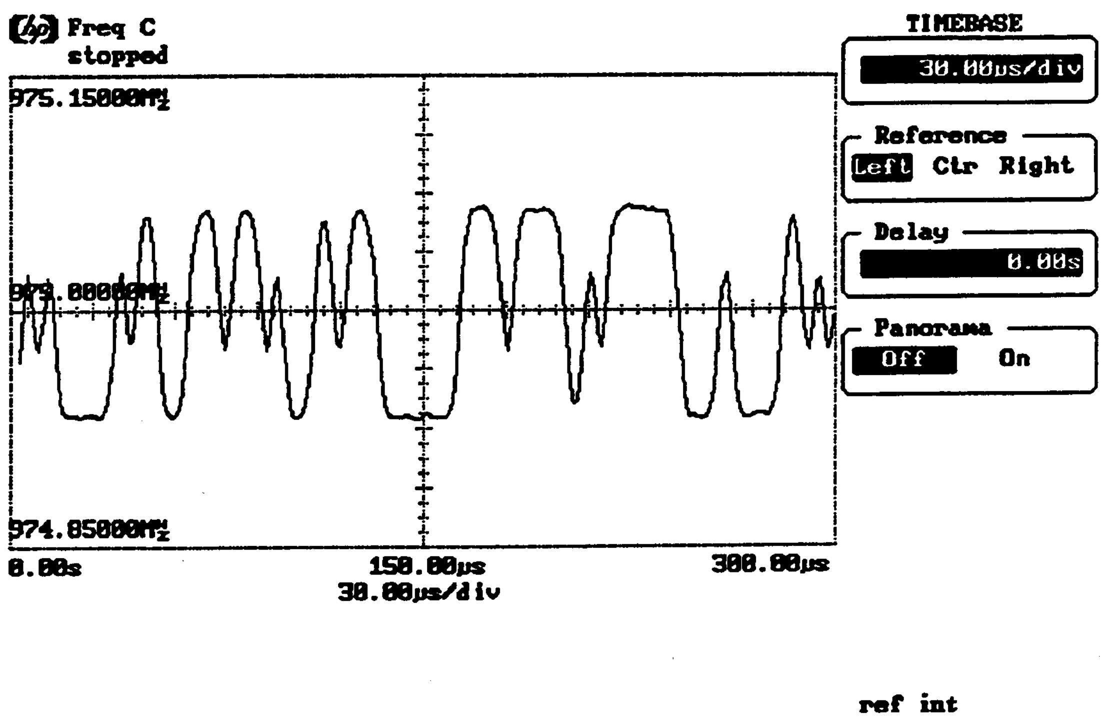
4 **Use the knob to adjust the amount of data captured, or enter a value appropriate for your measurement.**

Set the vertical controls.

1. **Press the Vertical key.**
2. **Adjust the Span value, if necessary, so the data covers at least half of the display.**

   At this point, you should see a waveform of your data similar to the one shown below.

This is the first step in producing an eye diagram.



Measuring Fast Data Rate Systems

This example uses a GSM radio signal. The modulation data rate, or bit rate, for this system is 270.833 kbits/s. This data rate can be adequately measured using the default 1 MHz sampling rate of the HP 53310A.

For measuring fast data rate systems, use the sampling mode called "Fast". It provides an effective sampling rate up to 8 MHz. Use Fast sampling for any radio system with a bit rate over 300 kbits/s.

Overlay many acquisitions.

1 **Press the Display key.**

2 **Set Persistence to Infinite.**

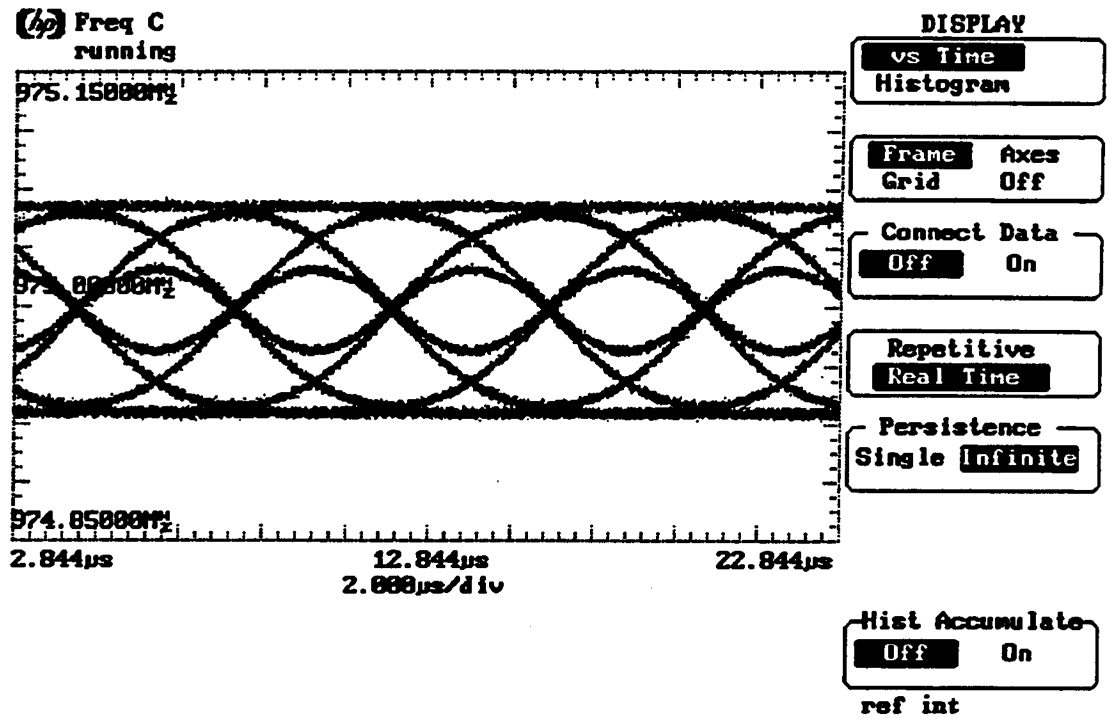
Adjust the timebase controls.

1 **Press the Timebase key.**

2 **Adjust the time/div value until the familiar eye diagram pattern appears.**

For this GSM example, the time/div value was decreased (from 30 μs to 2 μs) to produce the display shown on the next page.

RF eye diagram of a GSM radio signal.



Results

The eye diagram gives you a quick, qualitative view of modulation. Eye closure in the horizontal (time) direction is often due to timing jitter. Eye closure in the vertical (frequency) direction is often due to Inter Symbol Interference (ISI) or filtering problems. Use the markers to measure the amount of jitter or ISI.

2

Using the Downconverter

In this chapter

The HP 53310A with option 031 has an internal downconverter for making high resolution measurements on channel C. It is a fundamental-frequency downconverter. This means the input signal and a local oscillator (LO) are mixed together to produce an intermediate frequency (IF). This is the downconverted signal and is equal to the RF input frequency minus the LO. The downconverted signal is then measured by the HP 53310A. This chapter describes how to use the downconverter with both the internal LO, or an external LO that you provide.

Prescaled or downconverted measurements

The HP 53310A is able to measure frequencies on channel C from 50 MHz to 2.5 GHz without downconversion. This is accomplished with a divide-by-64 prescaler that divides down the input frequency so the HP 53310A can count it. The measured frequency is then multiplied by 64 and displayed as a measurement result. Option 031 adds the ability to make higher resolution frequency measurements using an internal downconverter that measures the frequency range 200 MHz to 2.5 GHz.

Do I use the prescaler or the downconverter?

In most cases, you do not need to think about it. When using the internal LO, the HP 53310A will switch automatically between prescaled or downconverted measurements for channel C as necessary for the current instrument settings.

In general, prescaled measurements satisfy most situations where you are measuring wide changes of frequency in the MHz range. Downconversion is more appropriate for making stability measurements or those measurements where you are trying to characterize a narrow frequency change in the kHz range.

When in doubt, use Auto Select

Auto Select is the default operating condition. On the LO menu (press Utility key, then LO MENU), there is a softkey option for selecting between Auto Select and Prescale Only. If you are using the internal LO, Auto Select will automatically configure the HP 53310A to select the most appropriate method, prescale or downconvert, for your measurement based on the settings of center frequency, timebase, and vertical span (on the Vertical menu or in the LO menu). For frequencies below approximately 200 MHz, prescale is always used.

If you are using an external LO, you can still use Auto Select but you will need to enter the LO frequency on the LO menu for each new frequency measurement. An LO frequency will be suggested for you based upon the center frequency and the frequency span settings.

Hint: The HP 53310A displays at the top of the screen whether it is making a prescaled or downconverted measurement whenever the LO menu is selected.

Downconverter

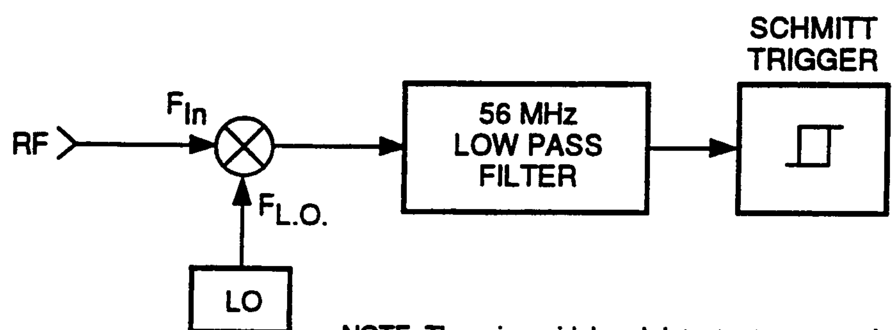
The most common reason for downconversion is to bring the input signal into range of the instrument being used to measure the signal. But there are other reasons to downconvert.

Downconversion also improves the resolution of frequency measurements. More specifically, the resolution improves by the ratio of the RF (the original frequency) to the IF (the downconverted frequency). In addition, the phase is preserved for the signal being downconverted.

A block diagram is included here for your information. This diagram is intended to give you a view of the major elements of the internal fundamental-frequency downconverter.

Block Diagram of Downconverter

The downconverter consists of a mixer, low pass filter and a Schmitt trigger.



NOTE: There is a sideband detector to ensure that F_{In} is greater than $F_{L.O.}$ to 2.5 GHz.

Using the internal LO

Downconversion using the internal LO is automatically selected when Auto Select is enabled on the LO menu and certain instrument settings such as a small vertical span and time/div indicate a need for high resolution frequency results.

The internal LO is intended to make your life easier. Use it whenever you can. You may want to switch to an external LO if you find the performance of the internal LO limits your measurement performance. This will be exhibited by noise on your measurements at very narrow spans and short time/div values.

Hint: When you suspect that you are running up against the noise of the internal LO, substitute an external LO and see if the performance improves. For a comparison of internal to external LO resolution, refer to the specifications in the introduction. The procedure for using an external LO is described in the next section.

To use the internal LO for downconversion.

1. **Connect the jumper cable at the rear panel between the LO In and LO Out connectors.**

2. **Switch on the HP 53310A.**

3. **Press the Preset key.**

4. **Select channel C on the Function menu.**

5. **Connect your RF input signal and press Autoscale.**

   For downconversion, the center frequency must be between 200 MHz and 2.5 GHz, the vertical span needs to be 20 MHz or less, and the timebase setting must be 400 μs or less. These values can be adjusted in the Vertical and Timebase menus.

6. **Refer to chapter 1 for measurement examples.**

Using an external LO

If you need resolution beyond what the internal LO can provide, use a high-performance external LO. For a comparison of internal to external LO resolution, refer to the specifications in the introduction.

To use an external LO for downconversion.

1. **Connect your external LO at the rear-panel LO In connector.**
2. **Set the output power of the external LO to +6 dBm ±1 dB.**
3. **Switch on the HP 53310A.**
4. **Press the Preset key.**
5. **Select channel C on the Function menu.**
6. **Connect your RF input signal.**
7. **Press the Utility key and then the LO Menu softkey.**
8. **Select Ext LO.**
9. **Set the Vertical Center and Vertical Span values.**
10. **Set the external LO frequency based on the suggested value.**

    This value appears on the display when downconversion is compatible with vertical settings. For best results, follow this suggestion.

11. **Enter the frequency of your LO.**

    Enter this value on the LO menu as the LO Frequency.

12. **Refer to chapter 1 for measurement examples.**

To disable downconversion

In those situations when you do not want the HP 53310A to use downconversion, you can force the instrument to only make prescaled measurements.

1. **Select channel C on the Function menu.**

2. **Press the Utility key and then the LO Menu softkey.**

3. **Select Prescale Only.**