Errata

Title & Document Type: 5373A Modulation Domain Pulse Analyzer Application Guide

Manual Part Number: 05373-90005

Revision Date: May 1, 1992

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

www.tm.agilent.com

Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

HEWLETT PACKARD

Application Guide

HP 5373A Modulation Domain Pulse Analyzer

APPLICATION GUIDE

HP 5373A
Modulation Domain Pulse Analyzer

MANUAL APPLICABILITY

This manual applies directly to an HP 5373A having the serial number prefix listed below. If this number does not match your instrument, refer to the "Manual Updating Changes" included with this manual.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY THIS MANUAL in the introduction of the HP 5373A Operating Manual.

SERIAL NUMBER
Serial Number Prefix: 3102

Edition 1
E0191

Printed: MAY 1992

MANUAL PART NUMBER 05373-90005

HEWLETT PACKARD

Safety Considerations

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to instructions in Appendix B of the Operating Manual.

SAFETY EARTH GROUND

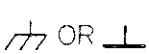
An uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

Safety Symbols

Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

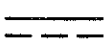
Indicates hazardous voltages.

Indicates earth (ground) terminal.



Indicates terminal is connected to chassis when such connection is not apparent.

Alternating current.



Direct current.

WARNING

THIS DENOTES A HAZARD. IT CALLS ATTENTION TO A PROCEDURE, PRACTICE, OR THE LIKE, WHICH, IF NOT CORRECTLY PERFORMED OR ADHERED TO, COULD RESULT IN PERSONAL INJURY. DO NOT PROCEED BEYOND A *WARNING* SIGN UNTIL THE INDICATED CONDITIONS ARE FULLY UNDERSTOOD AND MET.

CAUTION

This denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a *CAUTION* sign until the indicated conditions are fully understood and met.

Safety Information

WARNING

Any interruption of the protective grounding conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.)

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earthed pole terminal (neutral) of the power source.

Instructions for adjustments while covers are removed and for servicing are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform such adjustments or servicing unless qualified to do so.

For continued protection against fire, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay). Do not use repaired fuses or short circuited fuseholders.

When measuring power line signals, be extremely careful and always use a step-down isolation transformer whose output voltage is compatible with the input measurement capabilities of this product. This product's front and rear panels are typically at earth ground, so NEVER TRY TO MEASURE AC POWER LINE SIGNALS WITHOUT AN ISOLATION TRANSFORMER.

Table of Contents

Chapter 1
Meet The HP 5373A Modulation Domain Pulse Analyzer

What is the HP 5373A? 1-1
The Measurement Features 1-1
The Analysis Features 1-2
How To Use This Guide 1-2

Chapter 2
Using The HP 5373A

Chapter Overview 2-1
A Look at the Front Panel 2-1
Switching on the Analyzer 2-2
HP 5373A Quick Reference Guide 2-5
Measurement Function Menus 2-11
How to Change Menu Parameters 2-15
Softkey Operation 2-18
Menu Selection Keys 2-19
Measurement Setup Menus 2-19
Instrument Management Menus 2-19
Operating Information Menu 2-20
Making a Simple Frequency Measurement 2-20
Reviewing Measurement Results 2-23
Numeric Results 2-23
Other Numeric Result Screens 2-24
Customizing Your Measurements 2-26
Change the Arming Mode 2-27
Change the Interval 2-30
Pre-Trigger 2-32

Chapter 3
Simple Pulsed Radar

Chapter Overview 3-1
Simple Pulsed-Radar Summary 3-1
Basic Pulse Envelope Characteristics and Terminology 3-2
General Test Set-up/Measurement Considerations 3-4
Pulse Envelope Measurements 3-4
Front-panel Procedure 3-5
Remote Operation 3-8
Carrier Frequency/period Measurements 3-9
Front-panel Procedure 3-10
FMOP Assessment 3-12
Remote Operation 3-16

Chapter 4
Coherent Pulse-Doppler Radar

Chapter Overview 4-1
Coherent Pulse Doppler Radar Summary 4-1
Coherent Pulse-to-Pulse Phase Measurement 4-2
Front-panel Procedure 4-2
Staggered PRI Measurement 4-5
Front-panel Procedure 4-5

Chapter 5
Linear-Chirp Radar

Chapter Overview 5-1
Linear-Chirp Radar Summary 5-1
Carrier Frequency- Profile Measurement 5-2
Front-panel procedure 5-2
Frequency Deviation Measurement 5-4
Front-panel procedure 5-4

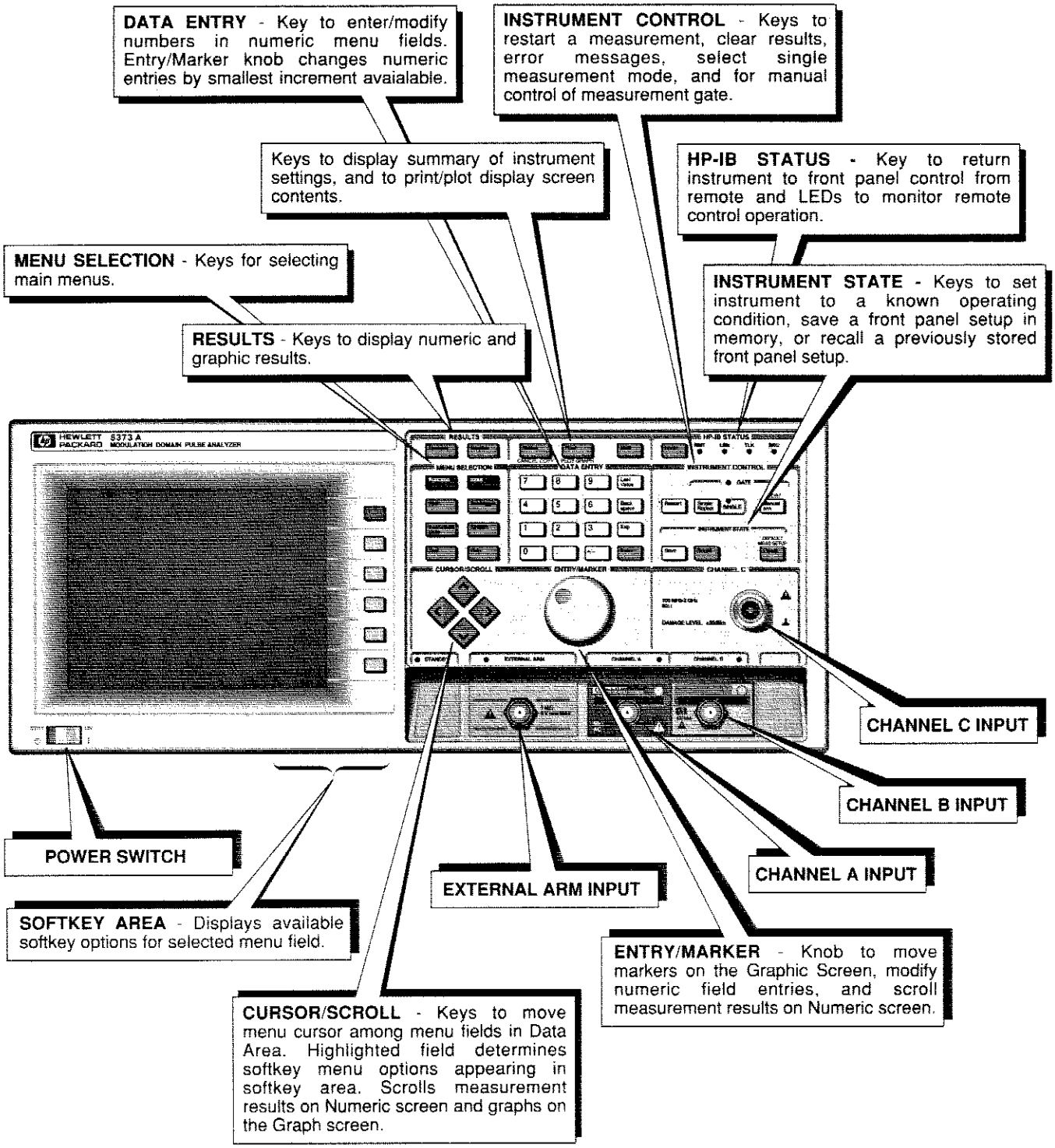
Chapter 6
Phase-Coded Radar

Chapter Overview 6-1
Phase-Coded Radar Summary 6-1
Phase-Code Demodulation 6-2
Front-panel procedure 6-2
Phase-Transition Timing 6-4
Phase Accuracy 6-6

Chapter 7
Frequency Agile Radar

Chapter Overview 7-1
Frequency Agile Radar Summary 7-1
Frequency Sequence 7-2
Front-panel Procedure 7-2
Frequency Distribution 7-4
Front-panel Procedure 7-4
Frequency Transition (VCO) 7-5
Front-panel Procedure 7-5
Transient Overshoot 7-6
Settling Time 7-7

HP 5373A
Front Panel Features



1

Meet The HP 5373A Modulation Domain Pulse Analyzer

WHAT IS THE HP 5373A?

The Hewlett-Packard 5373A Modulation Domain Pulse Analyzer provides flexibility and high performance for Pulsed or CW frequency, phase, and time interval measurements. It has full HP-IB programmability and a powerful feature set for a wide range of applications.

THE MEASUREMENT FEATURES

The HP 5373A key features include:

- Pulse or CW Carrier Frequency up to 500 MHz (2 GHz with optional input channel)
- Pulse Repetition Interval (PRI) or Frequency (PRF)
- Pulse Width and Pulse Offtime
- Pulse Duty Cycle
- Pulse Envelope Power
- Amplitude Modulation
- Frequency, Phase, and Time Deviation
- Continuous measurements up to a 13.3 Million per/second
- Measurement arming by signal edge, time, or events
- Measurement averaging for greater resolution
- Pre-trigger for frequency and time interval measurements
- Selectable hysteresis for measurements on noisy signals
- –4.0 to +4.0 second time interval range
- Histogram measurements via hardware for rapid acquisition and analysis of very large data samples
- Input Pod Selection: 50Ω Envelope Detector, 10 kΩ active probe, 50Ω, and 1 MΩ active pods

THE ANALYSIS FEATURES

The HP 5373A has a powerful set of analysis features. It provides:

- Time Variation graph of measurements: frequency vs. time, time-interval vs. time, phase vs. time, and envelope parameters vs. time
- Histogram graph
- Event Timing graph
- Limit testing
- Statistics: mean, minimum, maximum, standard deviation, variance, rms, Allan variance, root Allan variance
- Modulation values (peak-to-peak deviation, center frequency, modulation rate)

HOW TO USE THIS GUIDE

Follow these three simple steps to use this guide for your pulse measurement applications:

- Read the first chapter for a product overview.
- Read the second chapter for basic front-panel operating instructions.
- Read each successive chapter for information about increasingly complex pulse measurement procedures. Example HP-IB programs are also included for the pulse-envelope measurements and pulsed or CW carrier frequency measurements.

2

Using The HP 5373A

CHAPTER OVERVIEW

This chapter briefly explains the menu structure, provides basic measurement definitions, and shows you how to start using the HP 5373A Modulation Domain Pulse Analyzer (Analyzer) to make measurements. The items covered in this chapter are:

- Front-panel layout pg. 2-1
- Power-up pg. 2-2
- Quick Reference Guide pg. 2-5
- Measurement function menus pg. 2-11
- How to change menu parameters pg. 2-15
- Menu Selection Keys pg. 2-19
- Making a simple frequency measurement pg. 2-20
- Reviewing measurement results pg. 2-23
- Customizing your measurements pg. 2-26

A LOOK AT THE FRONT PANEL

This brief tour of the front panel in *Figure 2-1* looks at the groups of keys used most often in operating the Analyzer. A detailed explanation of each front-panel feature can be found in "Front Panel/Rear Panel," chapter 6 of the Operating Manual. A summary of the front-panel features appears on the inside front cover of this manual.

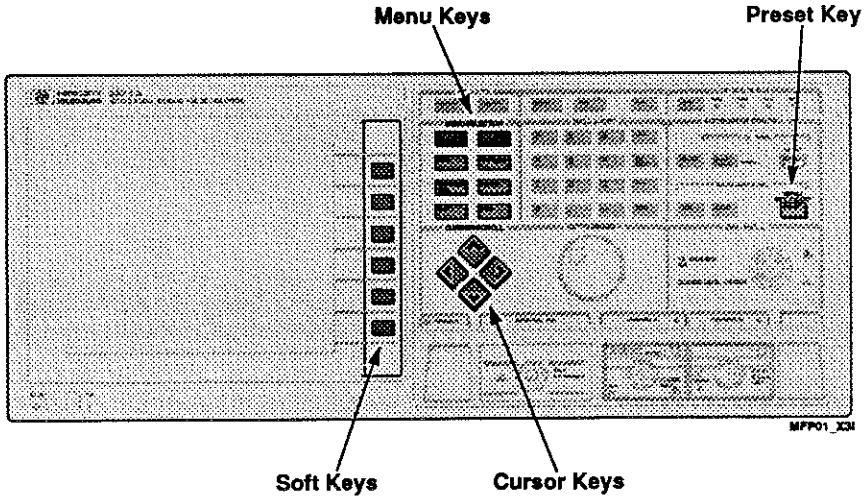


Figure 2-1. Selected Front-Panel Keys

SWITCHING ON THE ANALYZER

This procedure assumes the Analyzer is already plugged into the correct ac power source. (If not, refer to the Installation instructions in "Appendix B" of the Operating Manual and then return to this point.)

1. Set the power switch to ON.

   The Analyzer executes some internal tests to verify basic functionality. During this time the display shows, **PERFORMING SELF TEST...**

   The display warm-up and instrument self-test normally take 10-15 seconds. Refer to "Test Menu," chapter 13 of Operating Manual, for a listing of the power-up tests. When testing is completed, the first Function menu is displayed, and the Analyzer is ready to use.

NOTE

Battery Backup Feature — The Analyzer can save measurement setups in memory. This information is saved by battery power when the instrument is set to Standby or is disconnected from a power source. The battery can preserve stored setups for up to six months with power disconnected.

At the completion of the power-up procedure, the last measurement setup before the power was interrupted is recalled and the measurement is restarted. The measurement and display memories are cleared, so no past data is preserved.

2. Connect your input signal and press the green **Preset** key.

   This sets the Analyzer to its default operating condition. The first Function menu is displayed and should look identical to the one shown in *Figure* 2-2. The Analyzer will attempt to make measurements using the preset default function of PRF/Frequency.

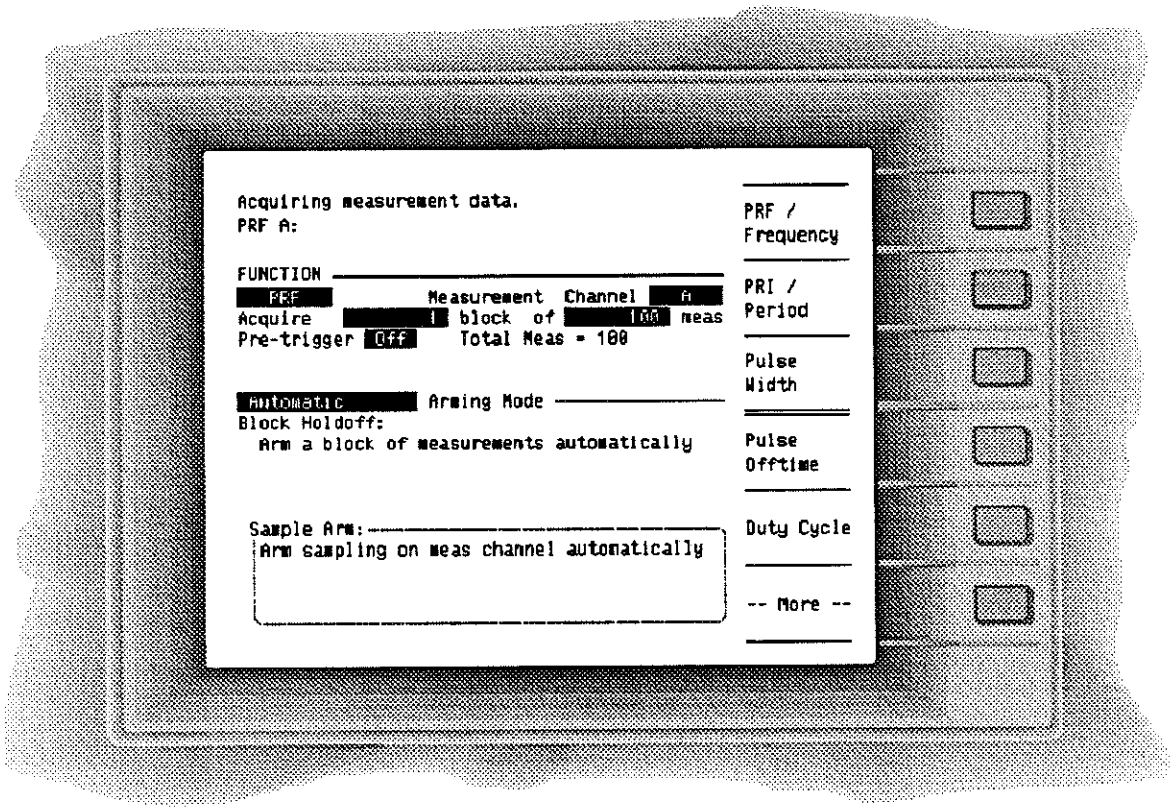


Figure 2-2. Preset Function Menu

NOTE

Pressing the **Preset** *key at any time brings you back to the default instrument state . Use the* **Preset** *key to quickly reset the Analyzer parameters to their default settings. If you should ever press the* **Preset** *key by mistake, your last instrument setup can be retrieved by pressing the* **Recall** *key and* **0** *on the DATA ENTRY keypad. The instrument setup at the time Preset is selected is saved in storage register* **0**. *Automatic storage of the current instrument setup also occurs for the Default Measurement Setup feature.*

The Default Measurement Setup (selected by **Shift** *key and then* **Preset** *key) automatically configures the HP 5373A to make measurements and display the results for the current measurement function. For more information on saving and recalling instrument setups, refer to "Instrument State Menu", chapter 11 of the Operating Manual. For a listing of the parameters selected by the Preset function, refer to "Front Panel/Rear Panel", chapter 6 of the Operating Manual.*

HP 5373A QUICK REFERENCE GUIDE

All measurements made from the HP 5373A front panel require you to make some decisions in several areas as part of a general measurement process. Regardless of the particular type of measurement made, you'll probably think about:

- ***Measurement function, sample size, and arming: FUNCTION***
- ***Input signal conditioning and event triggering: INPUT***
- ***Math value inputs and statistics: MATH***
- ***Repetitive or single-shot measurements: SINGLE/REPET - RESTART***
- ***Results output as numeric or graphic displays: GRAPHIC - NUMERIC***

These areas directly correspond to seven front-panel keys. You'll be using these keys much of the time when setting up and making front-panel measurements.

The key sequence on the next five pages shows a very general relationship between the HP 5373A measurement process and associated front-panel keys. The choices available from the Function key for arming modes and measurement functions are all listed on the "HP 5373A Function and Arming Summary", located on the inside back cover of this manual.

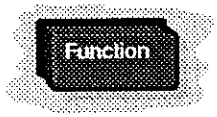
Depending upon the nature of the signal you want to look at, and the complexity of the measurement you're making, one or more of these keys and associated variables may need to be changed. (Some functions will limit these choices.)

Step through these keys/variables making changes where needed by:

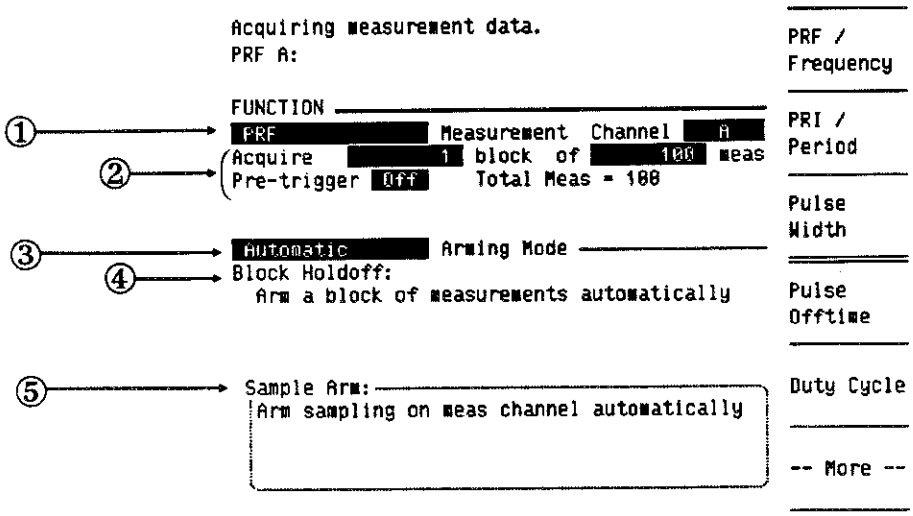
1. Using the six softkeys located at the right side of the screen.
2. Pressing the Cursor/Scroll keys to move around inside each screen.
3. Using the data entry keypad or Entry/Marker knob to change current or default settings.

If you get unexpected results (or none at all) consider these possibilities:

1. Is your input signal active at the front-panel input (LED flashing)?
2. Are the input signal coupling/attenuation/channel A,B,C choices correct?
3. Are the event triggering settings causing event counts?
4. Is the active arming mode appropriate for your signal?
5. Are the sample size parameters of "m" blocks of "n" measurements sufficient (or too many) to display your signal in a meaningful way?



: Select measurement function, channel, sample size, and arming.



① Choose the *Measurement* function for channel **A**, **B**, or **C**. (**More** key calls more function choices.)

② Acquire **m** blocks of **n** measurements (with Pre-triggering **On** or **Off**).

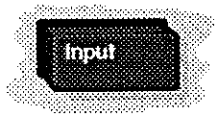
③ Select *Arming Mode* within the **Holdoff, Sample, Hld/Samp,** or **Default [Auto]** arm categories.

④ Set *Block Holdoff:* This condition is met prior to each block of measurements. (For example, with **Edge/Interval** arming, the specified edge must be detected before a block begins.)

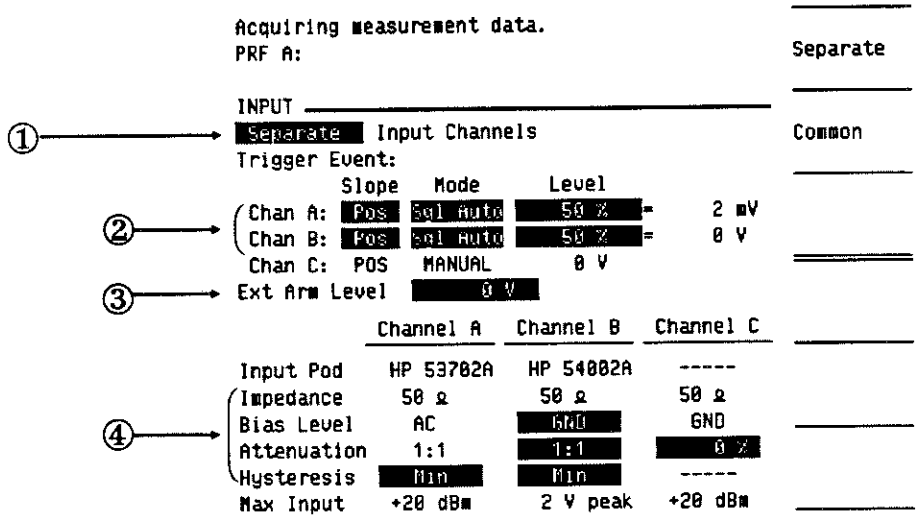
The specified edge may be either a **Pos** or **Neg** edge on front-panel inputs **A**, **B**, or **Ext Arm**.

⑤ Set *Sample Arm:* This condition is met prior to each measurement. (For example, with **Edge/Interval** arming, a measurement is made after each elapsed interval.)

Figure 2-3. Quick Reference Guide



: Getting your input signal to generate samples.



① Set **Separate** or **Common** Input Channels.

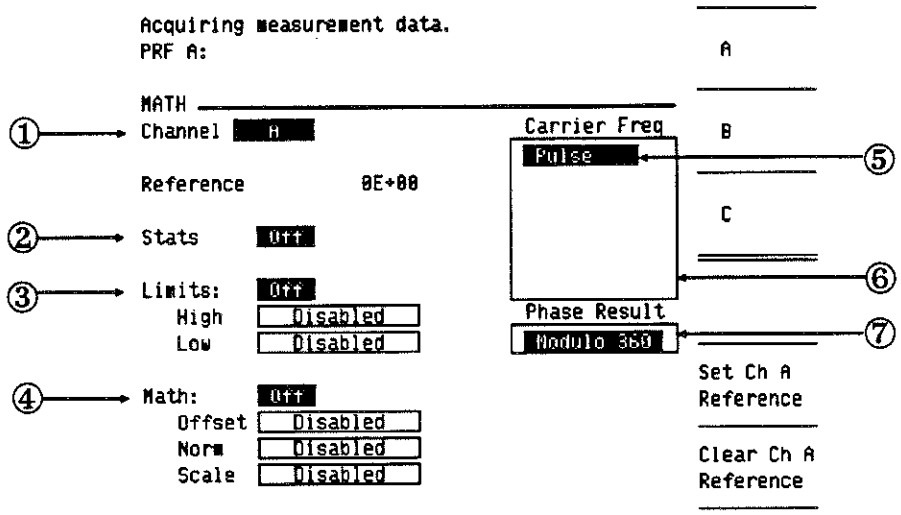
② Set Trigger Event: *Slope, Mode,* or *Level* for channels **A** or **B**.

③ Set *External Arm level* select **0 V, TTL Preset [1.4 V], ECL Preset [–1.3 V].**

④ Set *Impedance, Bias Level, Attenuation,* or *Hysteresis* settings. Channel A is always set as shown with the HP 53702A input pod installed.

Figure 2-3. Quick Reference Guide (Continued)

: Set up math operation, enter variables, and enable statistics.



① Select channel **A**, **B**, or **C** prior to setting up items 2 through 7 below.

② Set *Statistics:* either **On** or **Off**.

③ Set *Limits:* **On** or **Off** for *High* or *Low*.

④ Set *Math:* **On** or **Off** for *Offset, Norm,* or *Scale.*

⑤ Set *Carrier Frequency* computed as **Pulse, CW, Manual,** or **Linear.**

⑥ Enter *Carrier Freq* value as **Freq, Slope,** or **Start** when **Manual** or **Linear** are active.

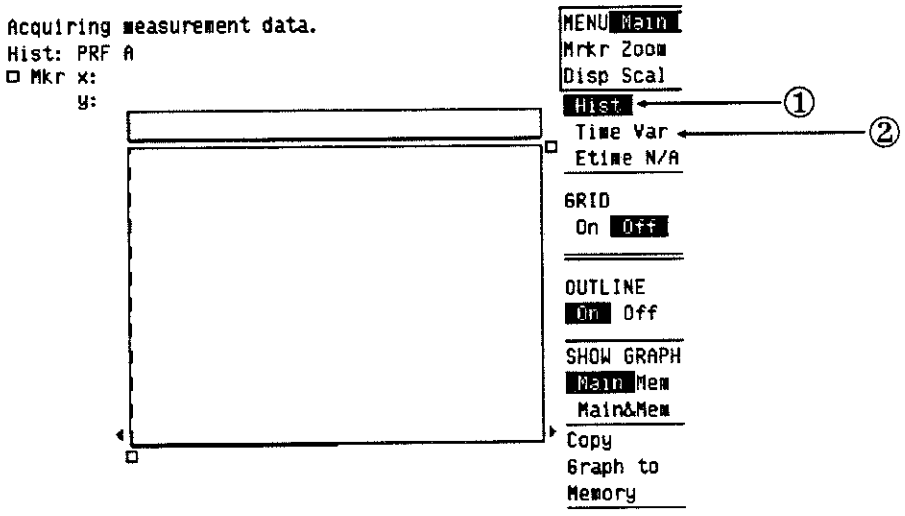
⑦ Set *Phase Result* as **MOD 360** or **Cumulative.**

Figure 2-3. Quick Reference Guide (Continued)

Single/ Repet : Select measurement execution as Single or Repetitive.

Restart : Make another single-shot measurement when the analyzer is set to Single.

Graphic : Display graphic results.

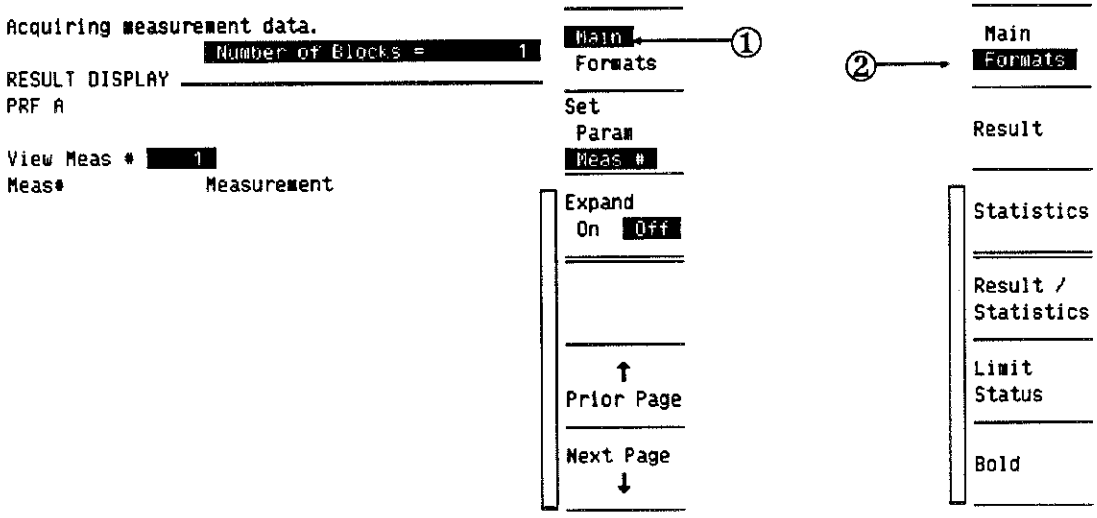


① **Histogram:** Get simple statistics

② **Time Variation:** Function vs. Time

Figure 2-3. Quick Reference Guide (Continued)

: Display numeric results.



① Measurement Data: Examine individual results

② Statistics: Examine summary values

NOTE: You must enable Statistics via the Math menu before summary values can be displayed.

Figure 2-3. Quick Reference Guide (Continued)

MEASUREMENT FUNCTION MENUS

Four measurement function menus provide you with fast access to twenty different types of easy-to-use measurements. Each menu contains five measurement function softkeys and a bottom key labeled **More**. The softkeys are lined up vertically along the right side of the display bezel.

Pressing the **More** key causes the next menu to appear. When the last menu appears, pressing the **More** key causes the first measurement menu to reappear.

The following pulse envelope measurement functions require use of either the included HP 53702A Envelope Detector Pod in channel A or an external detector set up to output a video signal into an HP 54002A input pod in channel A:

- Pulse Repetition Frequency (PRF)
- Pulse Repetition Interval (PRI)
- Pulse Width
- Pulse Offtime
- Duty Cycle
- Envelope Power
- Amplitude Modulation

When an external detector is used for channel A, envelope parameters are reported as Frequency or Period results. (Use of channel B for envelope parameters with either the HP 53702A or an external detector is not supported.)

NOTE

The Envelope Power measurement can also be made on channel B, but is derived as a function of signal peak-to-peak voltage measurement rather than detected envelope amplitude. (Refer to chapter 3 for details of envelope power measurements.)

Whenever you select a measurement function, it will appear on the screen under the upper left-hand label FUNCTION_____. Each function also displays its own set of measurement parameters that you can change to suit your measurement needs.

NOTE

The following figures and text introduce you to the function menus. The next section of this chapter then explains how to use both the front-panel measurement function softkeys and menu selection hardkeys to make these changes.

The menu screens are shown in *Figures 2-2, 2-4, 2-5,* and *2-6.* Each measurement function softkey can enable one (or two) measurement functions. The actual measurement function can vary depending on which input pod and associated channel is currently active. For example:

- If the **PRI/Period** function is active and a CW signal is present at either selected input channel B (HP 54002A pod) or C, the displayed measurement function and result is Period. With input channel A (HP 53702A pod), the displayed function is PRI.

  – or –

- If the **PRF/Frequency** function is active and a pulsed RF or IF signal is present at selected input channel A (HP 53702A pod), the displayed measurement function and result is Pulse Repetition Frequency (PRF). With input channel B (HP 54002A pod), the displayed function is Frequency.

In addition, the following restrictions apply to the input channels:

- Channel A is supported for use with pulse envelope measurements when the HP 53702A Envelope Detector Pod is present.
- Channel B is supported for non-envelope signal measurements such as Frequency (pulsed or CW), Period, Time Interval, and is the recommended channel for Phase Deviation measurements. (An exception to this is Envelope Power. Refer to chapter 3 for more information.)
- Channel C is supported only for pulsed or CW Frequency and Period.

NOTE

More details of measurement functions and the input channels associated with them are described in the Operating Manual.

Detailed descriptions of pulse envelope terminology and characteristics can be found at the beginning of the next chapter.

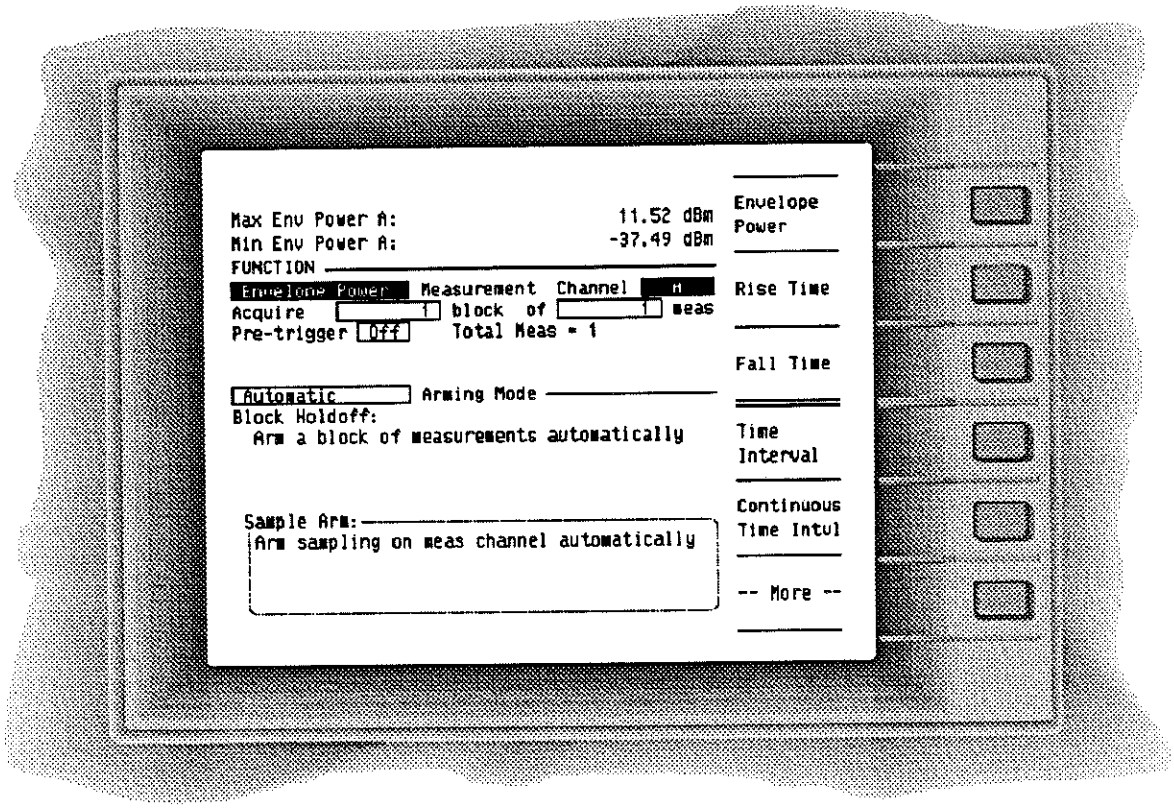


Figure 2-4. Measurement Menu 2

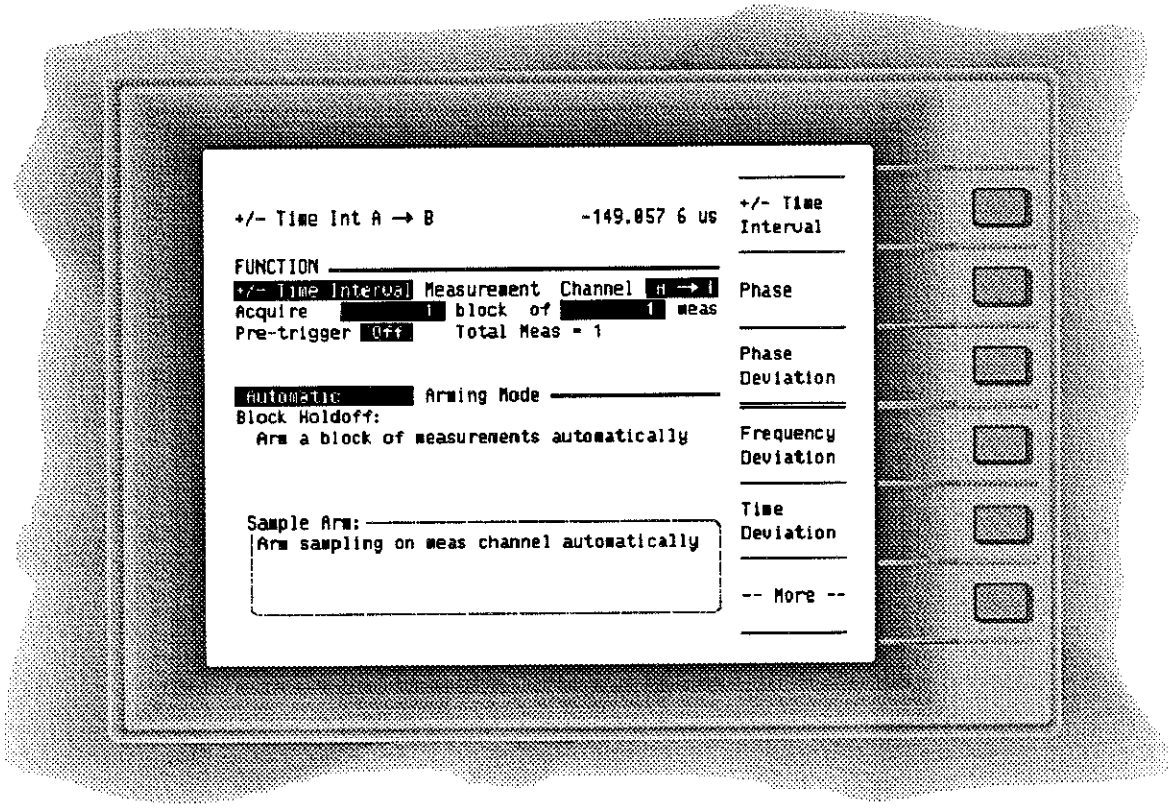


Figure 2-5. Measurement Menu 3

NOTE

For all measurement menus, pressing the **More** *softkey calls the next measurement menu or returns the first menu.*

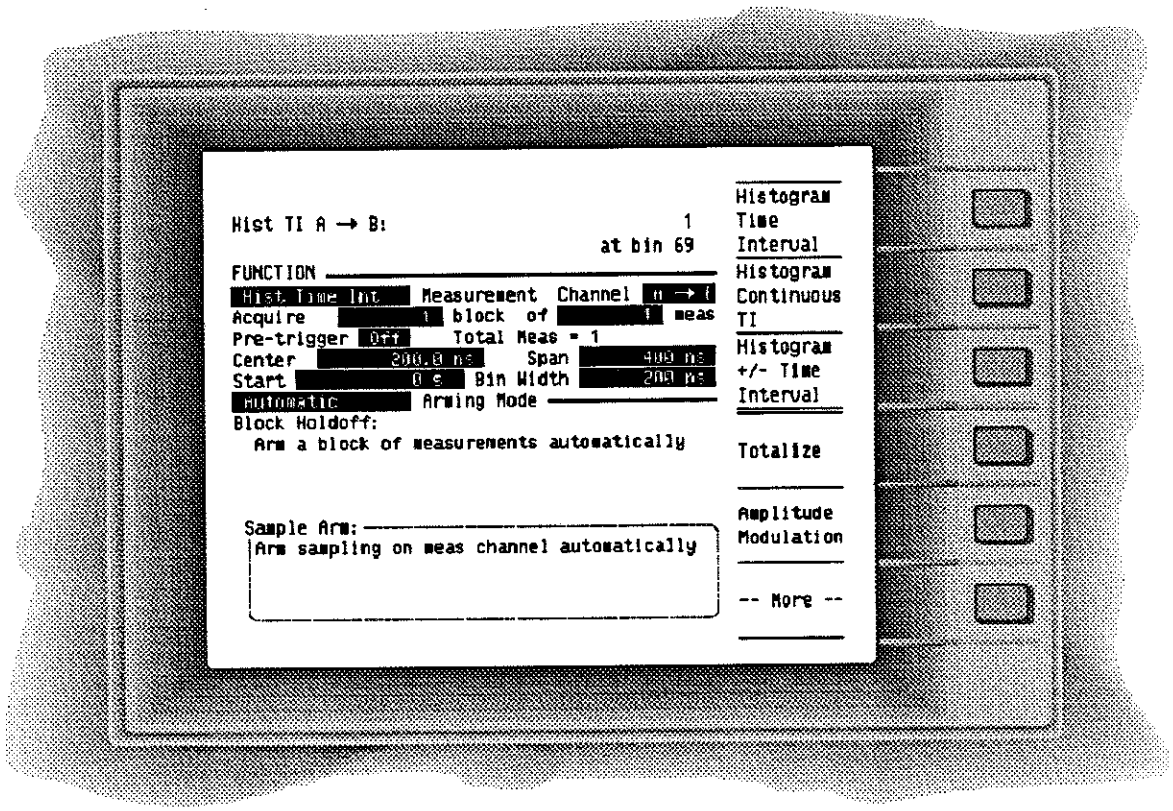


Figure 2-6. Measurement Menu 4

HOW TO CHANGE MENU PARAMETERS

Menu parameters specify how the Analyzer operates. These parameters are inside the inverse video (shown as black-on-white) rectangles on the menu screens. These rectangles are called "fields" and are referenced by the words preceding or following them on the screen.

For example, in *Figure 2-7*, the Channel field is set for a measurement on the signal at Channel A, the Sample Arm intervals field is set to 1 ms.

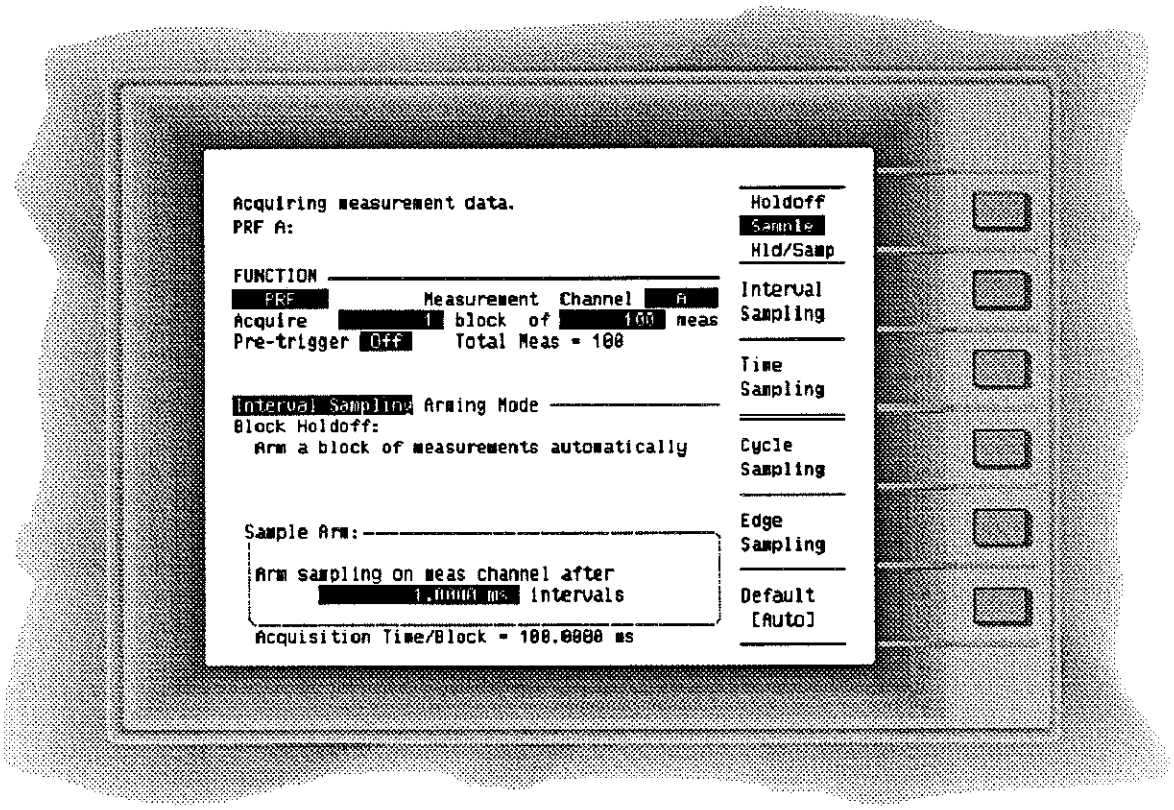


Figure 2-7. Menu Screen 1

There are three steps to change a menu parameter, as shown in *Figure 2-8*:

1. Select a menu with the Menu Selection hardkeys (callout 1 in *Figure 2-8*).

2. Use the Cursor/Scroll keys to move the menu cursor to the field you want to modify (callout 2 in *Figure 2-8*).

3. Use the softkeys to select the desired option from the list at the right-hand edge of the display (callout 3 in *Figure 2-8*).

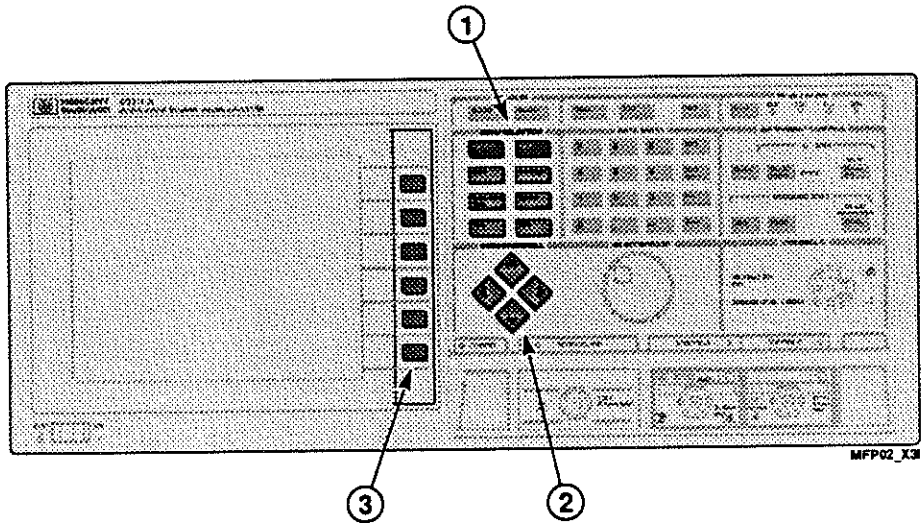


Figure 2-8. Three Steps to Change a Menu Parameter

Softkey Operation

Where a softkey presents more than one option (Frequency, measurement channel parameter), the active option is shown in inverse video. Pressing the softkey causes the next option to become active. The inverse video always highlights the current selection. Where all options for a field do not fit on one "page" of softkeys, a **More** softkey appears to allow access to additional choices.

Figure 2-9 shows a pictorial description of softkey functions from the Graphics screen. The detailed softkey options shown here are described in, "Graphic Results", chapter 16 of Operating Manual.

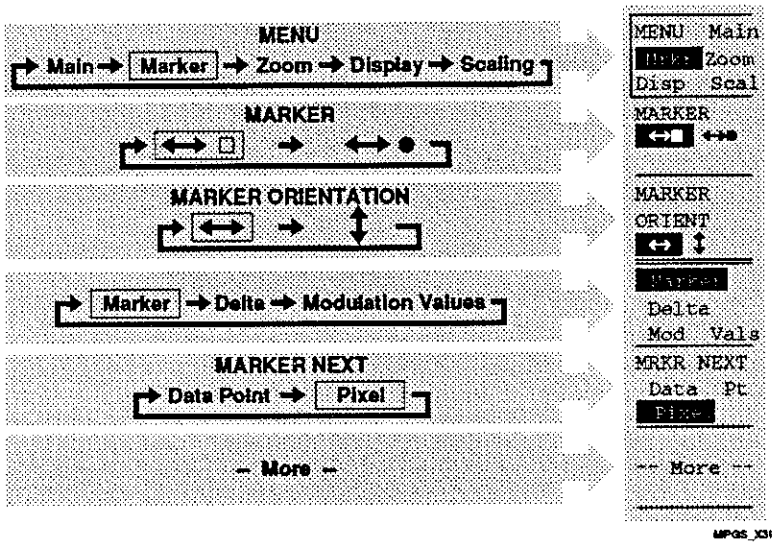


Figure 2-9. Graphic Softkey Description (see text)

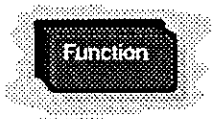
MENU SELECTION KEYS

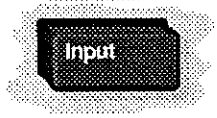
The Menu Selection keys give you access to the main functions of the Analyzer. The menus can be divided into three groups:

- Measurement setup (Function, Input, Math, Pre-trigger)
- Instrument management (Instrument state, System, Test, Status)
- Operating information (Help)

The menu keys are discussed briefly here. If you want more information on any of the menus, consult the Operating Manual. Select each of the menus on the front panel as you read the following menu descriptions.

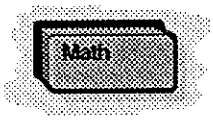
Measurement Setup Menus





There are four menus (front-panel keys) for setting up a measurement:

- **Function** selects the measurement type, the size of the data set, and sets up arming conditions.
- **Input** sets the conditions under which the Analyzer will trigger on the input signal. A trigger event occurs when the input signal satisfies two conditions defined on this menu. One condition is the slope of the input signal, the other is a specific voltage of the input signal. The Analyzer will trigger on a positive (rising) or negative (falling) slope of the signal. The voltage at which the instrument will trigger can be specified as a voltage level or a percentage of peak-to-peak voltage.



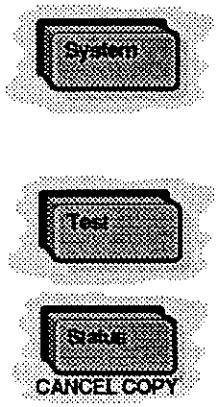
- **Math** selects post-measurement processing features such as statistics, math processing features such as offset or scale, limit testing values, and a specified carrier frequency for measurements such as frequency deviation.

- **Pre-trigger** captures measurement data occurring prior to a specified time interval or external event. Data occurring before and/or after this event can be measured and analyzed.

Instrument Management Menus

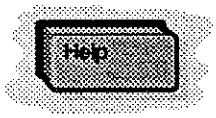
These menus provide control of features separate from measurement setup.

- **Instrument State** lets you view saved instrument setup conditions and protect storage registers from accidental over-writing.



- **System** contains:
  - HP-IB mode and address selection
  - Status of instrument options
  - Measurement data width selection
  - System clock
- **Test** provides control of operational checks and diagnostic tests for the use of a trained service technician.
- **Status** gives a summary of the current instrument settings. The summary includes the settings of the:
  - Function menu
  - Input menu
  - Math menu
  - Pre-trigger menu

Operating Information Menu



Help provides operating information on the following topics:

- Function menu
- Input menu
- Math menu
- Pre-trigger menu
- Results
- User interface
- Graphs
- HP-IB
- Test menu

MAKING A SIMPLE FREQUENCY MEASUREMENT

You can use the frequency standard output signal from the rear panel to get started making measurements. Using this procedure you can make some measurements and review the results.

1. Connect the Frequency Standard output from the rear panel to the channel B Input as shown in *Figure 2-10.*
2. Press the **Preset** key to return the Analyzer to the default state.
3. Press the Cursor-control **right** key to enter the measurement channel parameter field.
4. Press the **More** softkey to move to the next page of the measurement channel parameter field.
5. Press the **B** channel selection at the top of the softkey menu choices.

6. Press the Cursor/Scroll **left** key to return to the measurement field.

7. Notice that the LED above the Channel B Input Pod starts flashing. It indicates that there is a signal at Channel B triggering the input circuitry. Use the LEDs near the input pods as your first indication of the presence of an input signal to the Analyzer.

NOTE

If you connect a signal to channel A, B, or External Arm, and the input LED does not start flashing, first check the Trigger Event settings on the input menu. The trigger level may be set incorrectly for your signal. Then check your signal source to ensure that its output meets the input requirements of the Analyzer (+/- 2V limit with a HP54002A input pod and the 1:1 attenuation setting).

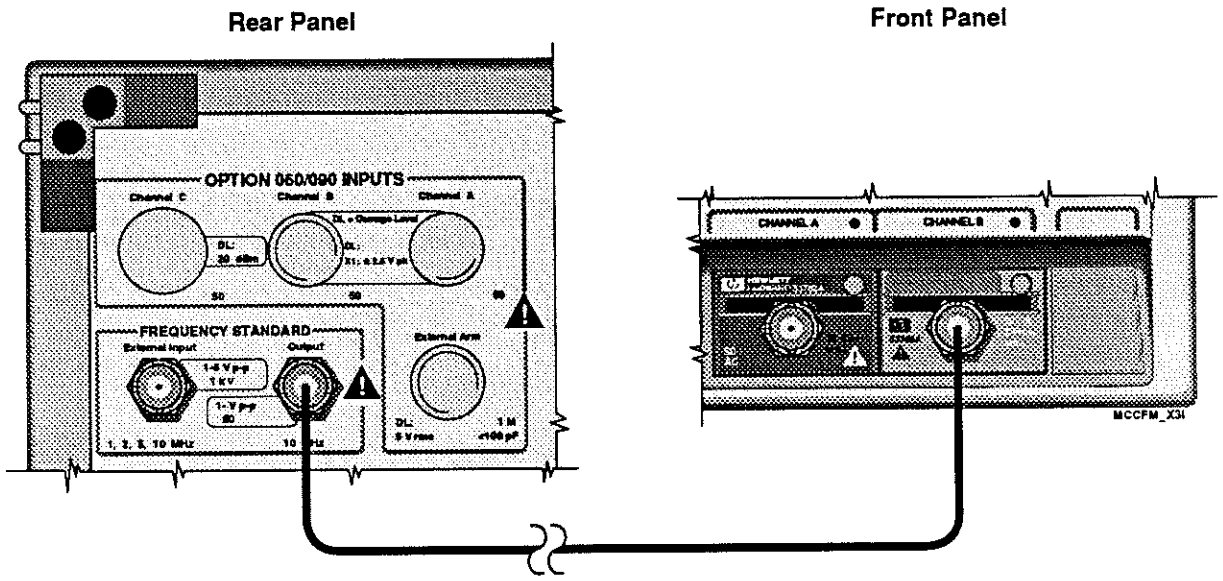
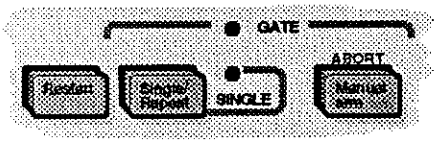


Figure 2-10. Cable Connection for Simple Frequency Measurement



8. Notice also the Gate LED located near the right-hand side of the Analyzer under the words, INSTRUMENT CONTROL. The LED is illuminated whenever data is being acquired by the Analyzer. For this setup selected by the Preset key, a measurement sequence consists of 100 measurements, as shown on the Function menu. Use the Gate LED to monitor the acquisition of data.

The Analyzer is currently making 100 measurements at a time. As you can see on the Function menu, the text reads, "Acquire 1 block of 100 meas." A block is one or more measurement(s) collected in a group.

The Function menu only has space to show you one result. It is found near the top of the display. This result is always the first measurement of each block. You can see the other 99 results by using the measurement review features of the Analyzer.

REVIEWING MEASUREMENT RESULTS

The entire list of results can be shown on the Numeric screen. Use the following procedure to display individual measurement results via the Numeric display.

Numeric Results

1. Access the 100 measurement results by pressing the **Numeric** key.
   - The first twelve results are displayed as shown in *Figure 2-11*.

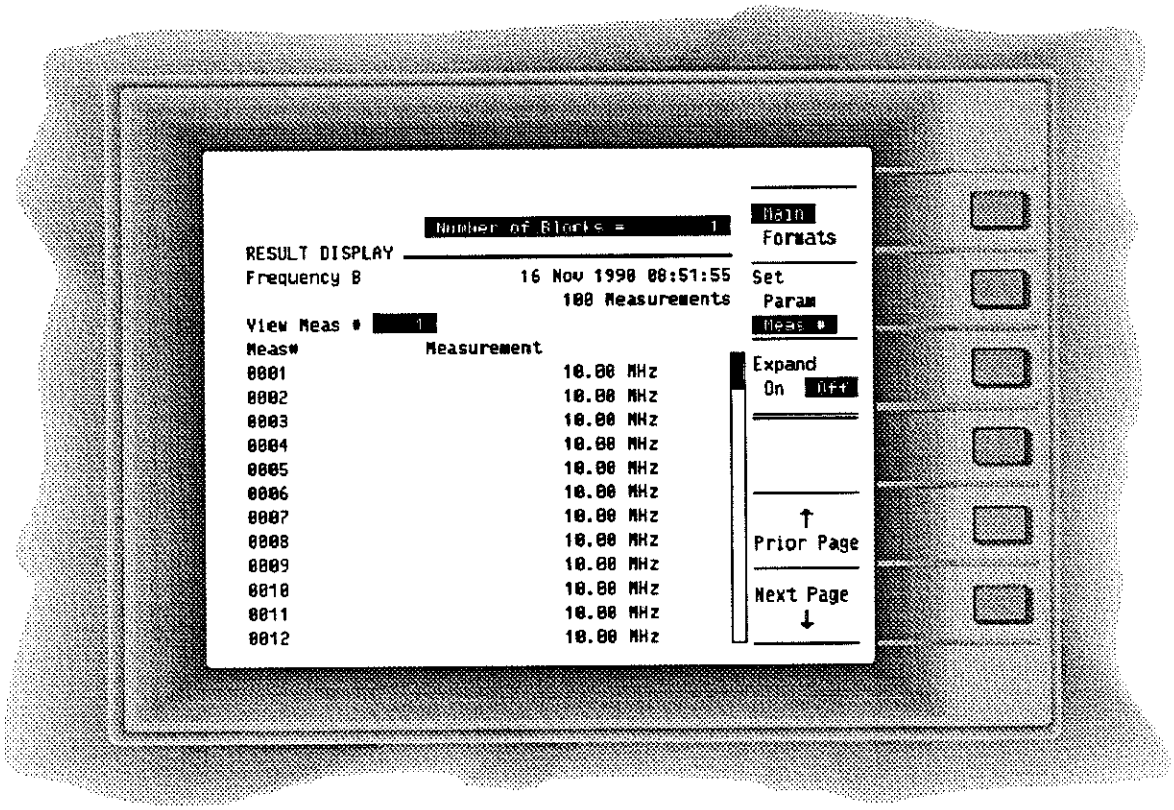
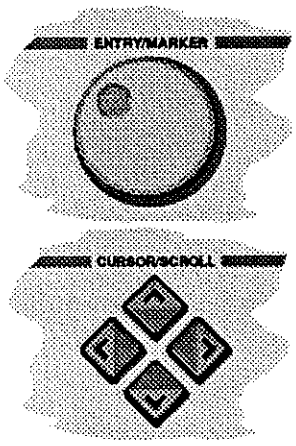


Figure 2-11. Numeric Results

2. Press the top softkey to select **Main**.

3. Press the **Next Page** softkey to see additional results. Press this softkey and the one above it. You can move forwards and backwards through your measurement results. Notice the bar indicator to the left of the softkey labels as you press the **Prior/Next** softkeys. It shows you the relative position of where you are in the list of results and the portion of the results currently displayed. The first measurement is at the top; the last is at the bottom.



Here are two additional ways the data results can be scrolled:

- Entry/Marker knob

- or -

- ◆ and ◆ Cursor/Scroll keys

Before using the knob to scroll the results, make sure the **Set Param/Meas #** softkey function is set to **Meas #**. A specific measurement result can be displayed by entering the number at the numeric keypad and pressing the **Enter** key to complete the entry.

Notice the **Number of Blocks** = field near the top of the display. This feature allows you to alter numeric entries normally found on other menu screens. This feature is demonstrated later in this chapter.

Other Numeric Result Screens

There are additional screens for reviewing numeric results. The following steps display them.

1. Press the top softkey to select **Formats**.
   - The softkey labels show the options for the result displays. (See *Figure 2-12.*)
2. Press the **Statistics** softkey.
   - The message on the screen indicates that the statistics function is turned off. This feature is enabled on the Math menu. The next two steps demonstrate how to enable Statistics.
3. Press the **Math** key.
4. Make sure the Channel B **Stats** field is highlighted. If not, press the Cursor-control **down** key to highlight Stats by selecting the **B** softkey option, and then press the **On** softkey.
   - The statistics feature is enabled for Channel B. See *Figure 2-13.*

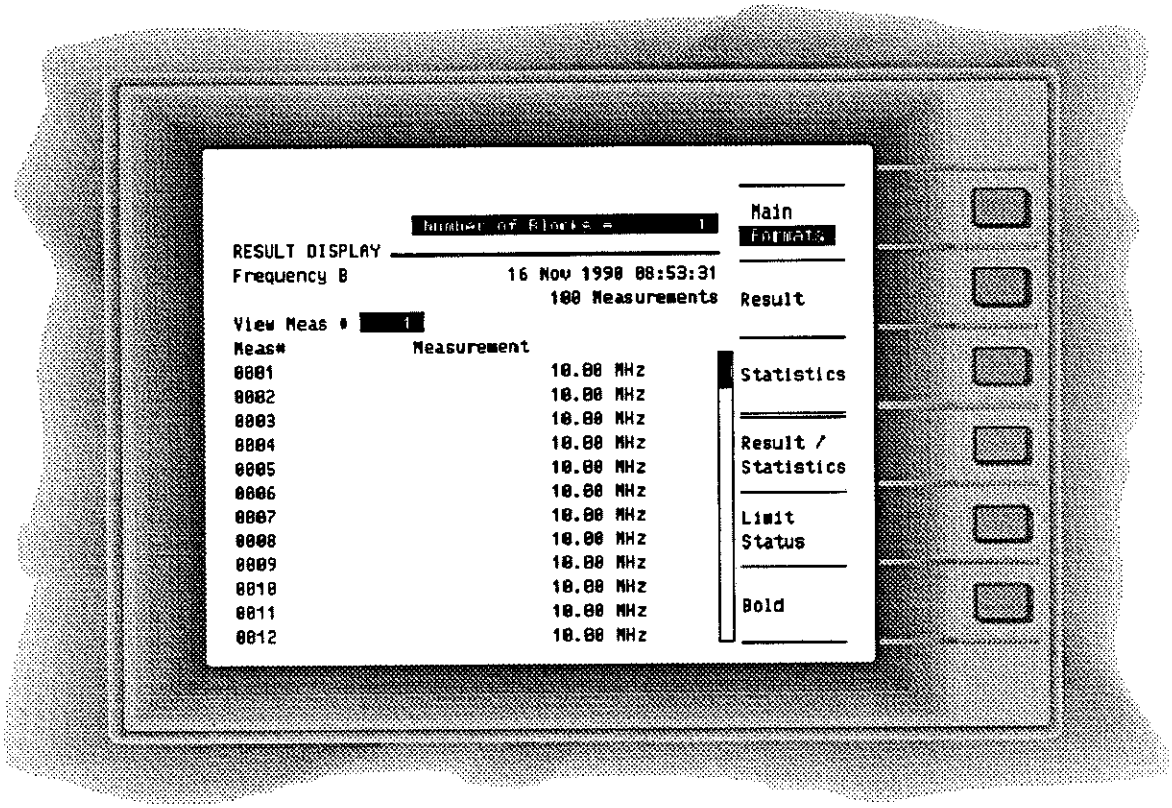


Figure 2-12. Numeric Screen Result Formats

5. Press the **Numeric** key.
   - Eight statistical values are displayed.
6. Press the **Result/Statistics** softkey.
   - You can now see eight measurement results and four statistical values.
7. Press the **Limit Status** softkey.
   - As you can see, Limits are disabled, but also accessible on the Math menu. The Limits feature is not demonstrated here. For more information, refer to "Math Menu," chapter 9 of Operating Manual.
8. Press the **Bold** softkey.
   - One measurement result and two statistical values are displayed in an enlarged size for easy viewing.

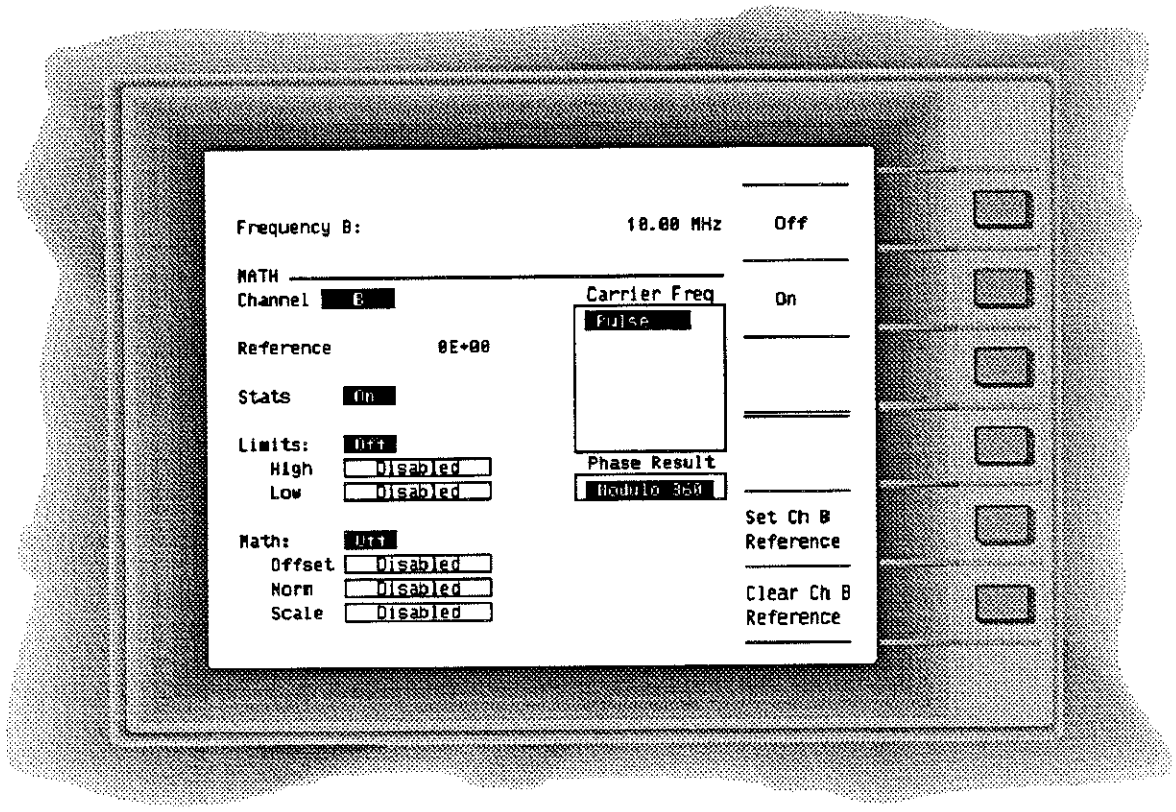


Figure 2-13. Math Menu Showing Statistics On

CUSTOMIZING YOUR MEASUREMENTS

Up to now you have demonstrated features for reviewing data once it's collected. The next series of steps let you modify the measurement function and other instrument parameters to control how the measurements are made. This procedure shows how to change from Frequency to Time Interval measurement:

1. Press the **Function** hardkey and ensure that the **Frequency** function is highlighted (press the Cursor/Scroll **left** key if necessary).

2. Press the **More** softkey.

3. Change the measurement function from Frequency to Time Interval by pressing the **Time Interval** softkey.

NOTE

Time Interval may not be displayed as a softkey option when the menu cursor is at the Measurement field. If not, just press the **More** *softkey until you see Time Interval as a softkey selection. Then press that softkey.*

4. Observe the 100.0 ns result at the upper right-hand portion of the screen.

Change the Arming Mode

One of the most powerful aspects of the Analyzer is its arming capability. With arming, it is possible to specify when and where on an input signal the Analyzer will start and stop a measurement, or a series of consecutive measurements. For now, just be aware that there are four general categories of arming modes, and within each category are individual arming modes that present you with alternatives to select the amount of control you want to impose on your measurement. For detailed arming information, refer to "Arming," chapter 5 of Operating Manual.

The following procedure introduces you to arming through the use of a general-purpose arming mode.

1. Return to the Frequency measurement function by pressing the appropriate measurement function softkeys.
2. Move the menu cursor to the **Arming Mode** field by pressing the Cursor/Scroll **down** key.
   - The next two steps let you change the arming mode from Automatic to Interval Sampling.

NOTE

The Automatic arming mode lets the Analyzer take samples on the measurement signal as quickly as possible. Interval sampling is an arming mode that lets you control the rate at which samples of data are collected (see Figure 2-14)

3. Press the top softkey to select Sample.
4. Press the **Interval Sampling** softkey.
   - An interval of 10 microseconds is the default setting for this arming mode. Use of the Interval Sampling arming mode is similar to setting a gate time on a traditional counter. The Analyzer differs from traditional counters in that these measurement intervals are continuous, or back-to-back.

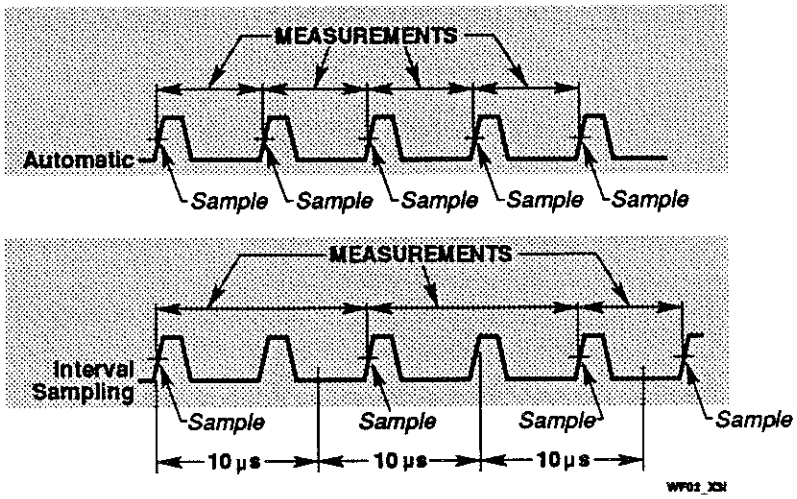


Figure 2-14. Automatic vs. Interval Sampling

5. Check the measurement result at the top of the display and note the increase in measurement resolution over the Automatic arming mode.

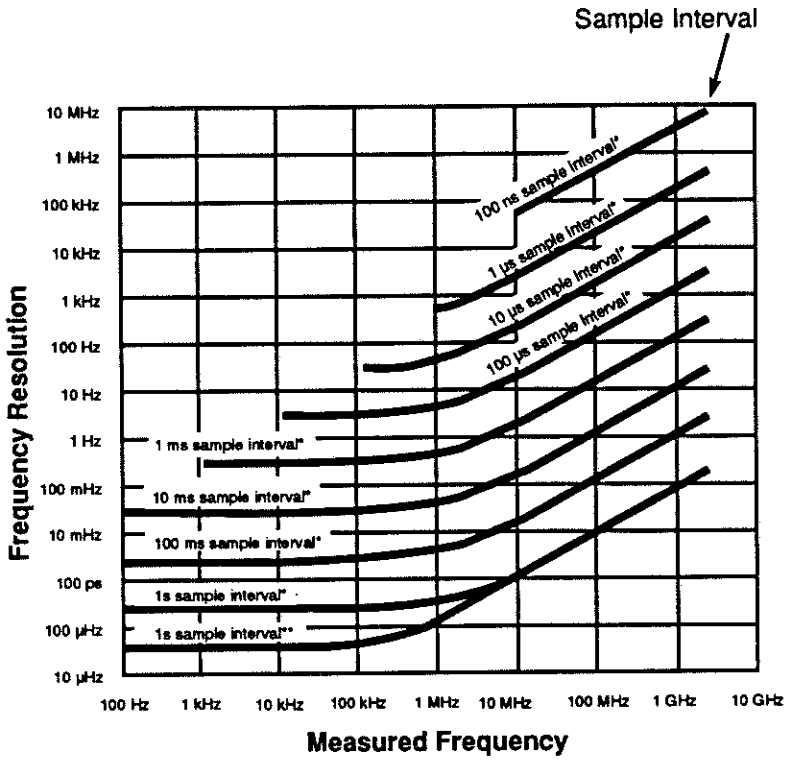
NOTE

Measurement Resolution - The resolution of your measurement results is determined by the input frequency and the interval between samples. The longer the sampling interval, the greater the resolution of results. Figure 2-15 shows the single-shot resolution of the Analyzer as a function of sampling interval and input frequency.

For example, taking samples at 100 us intervals on a 10 MHz input signal will yield a resolution of 10 Hz (10. 000 00 MHz).

6. Switch between **Automatic** (bottom softkey) and **Interval Sampling** while you observe the measurement result. Select **Interval Sampling** before continuing to the next step.

7. Go to the Numeric screen. (If **Statistics** is highlighted, press **Results**.)



Frequency resolution is a functon of measured frequency, sample interval, and input signal noise.

Figure 2-15. Frequency Resolution

8. Press the top softkey to select **Main**.

9. Set the **Expand** feature to **On**.
   - The elapsed time for each measurement is displayed after each measurement result as shown in *Figure 2-16*.

10. To see the gate time for measurements with Automatic arming, return to the Function menu, change the arming mode back to Automatic, and return to the Numeric screen.
    - The gate time for this measurement using Automatic arming is 100 ns. This is the time over which the measurement was made. It is also the period of the 10 MHz signal. The Analyzer is measuring 100 consecutive cycles of the 10 MHz signal.

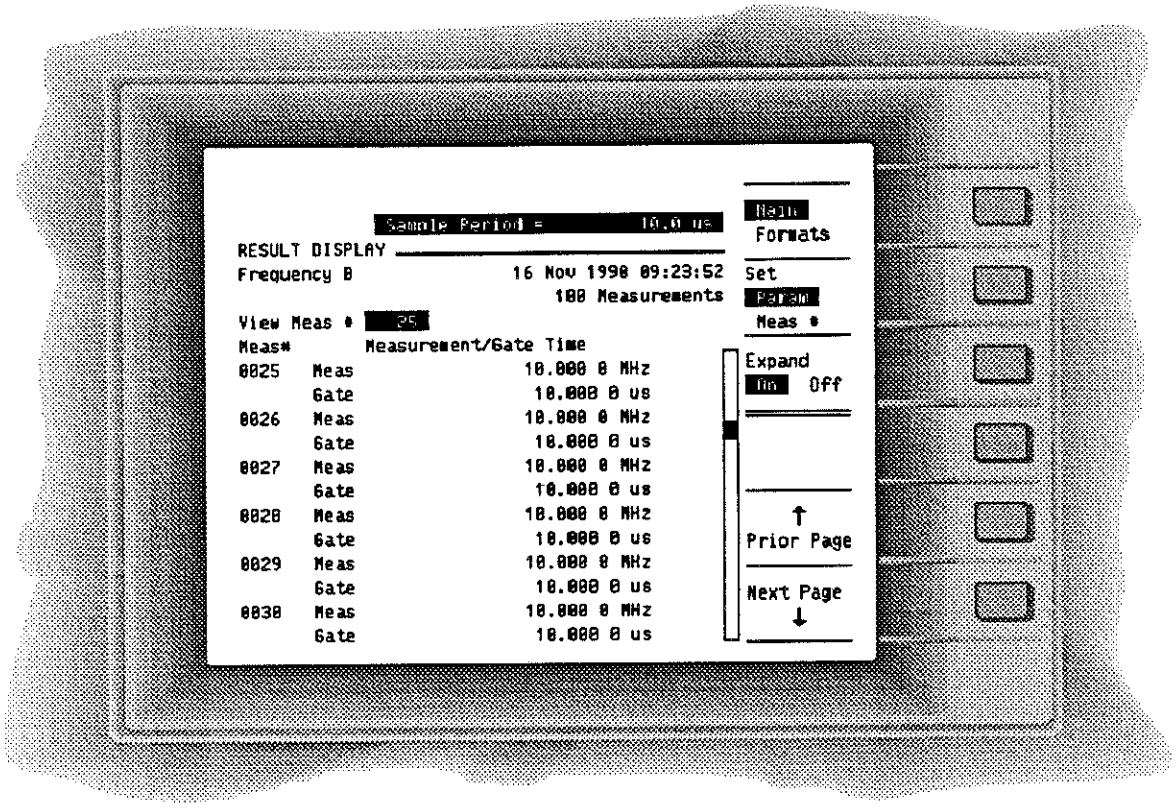


Figure 2-16. Gate Data Display

Change the Interval

Here you will further increase measurement resolution by lengthening the interval over which each measurement will be collected .

1. Go to the Function menu and set the arming mode to **Interval Sampling.**
2. Move the menu cursor to the **intervals** field.
   - The next two steps let you set the interval to 1 millisecond.
3. Press **1** on the DATA ENTRY keypad.
   - Notice the softkey choices now available.
4. Press the **ms** softkey and then go back to the Numeric screen.
   - The gate data now reflects the increased time over which each measurement is collected. Note that the gate time may not be exactly 1 ms.
   - In the next step you will use a field on the Numeric screen to again modify the interval.

5. Press the **Set** softkey to select **Param** (abbreviation of **Parameter**) if not already selected.
   - Now you can enter a new value for the interval at the top of the display.
6. Press **1**, then the **Exp** key, then **6**, then the **+/-** key, and finally the **Enter** key.

A new block of 100 measurements is acquired immediately with a 1 µs sample interval as shown in *Figure 2-17*.

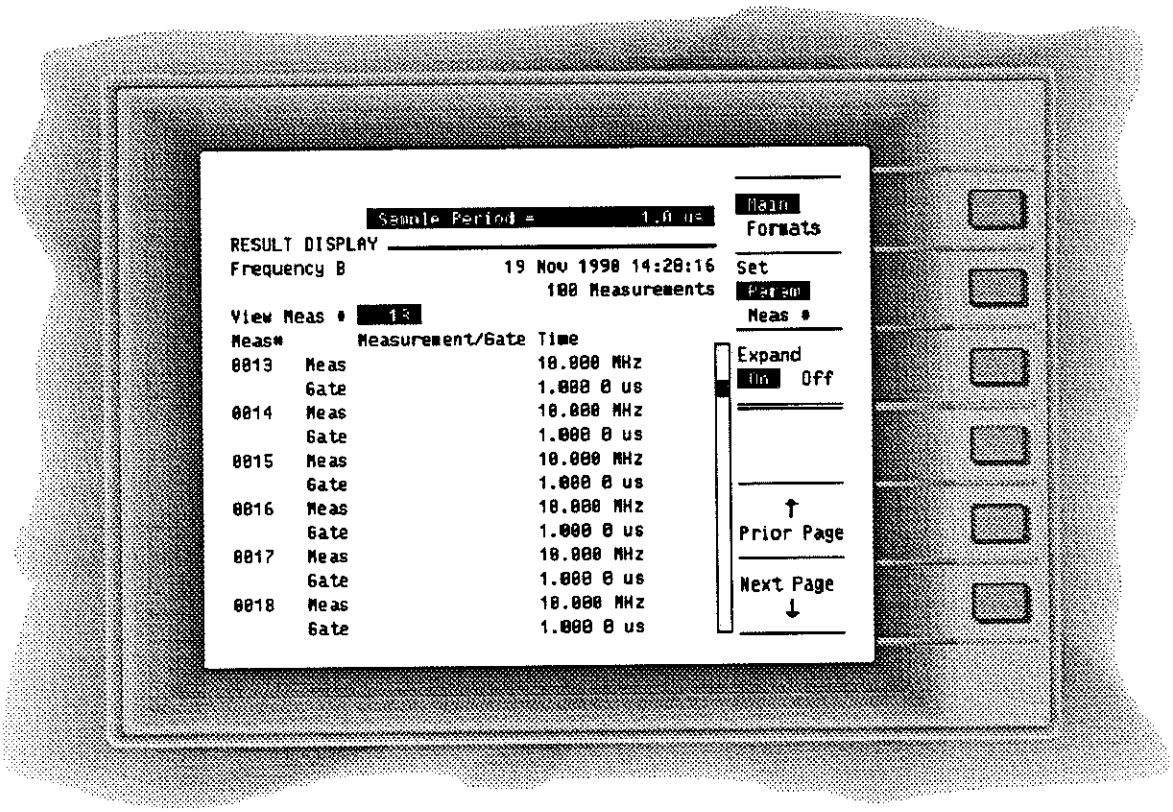


Figure 2-17. Parameter Field on the Numeric Screen

NOTE

You can modify numeric entry fields from the Numeric screen. Here's how: Whatever numeric entry field is selected by the menu cursor on the Function, Input, Math, or Pre-trigger menu is displayed at the top of the Numeric screen. The field will always reflect whichever was the last numeric field from one of these that was displayed.

For example, go to the Input menu and set the menu cursor to a numeric entry field such as Trigger Event Level. Return to the Numeric screen and see that the same field is displayed. The Entry/Marker knob can be used to modify the value in this field.

With this feature you don't have to return to one of the menus if you want to see the effect on measurement results of changing one numeric parameter.

PRE-TRIGGER

This feature allows the Analyzer to capture measurement data that occurs before some event or interval that you specify.

If you want to use the Pre-trigger feature for a measurement, one or more steps may be needed to turn Pre-trigger On and verify the setup on the Pre- trigger menu. Refer to, "Pre-trigger Menu," chapter 10 of Operating Manual for more information.

3

Simple Pulsed Radar

CHAPTER OVERVIEW

This chapter provides measurement procedures for fundamental signal parameters of a simple pulsed-radar system. Front-panel operating steps are covered first, followed by HP-IB program examples for selected measurements. The pulsed-radar signal parameter measurements explained in this chapter are as follows:

- Pulsed Radar Summary pg. 3-1
- Pulse Envelope Terminology pg. 3-2
- Pulse Envelope Measurements pg. 3-4
- Carrier Frequency and Period Measurements pg. 3-9
- FMOP Assessment pg. 3-12

SIMPLE PULSED-RADAR SUMMARY

Most simple pulsed-radar systems are capable of automatic search, single-target tracking, and crude real-beam ground mapping. A typical limitation of this radar is its inability to detect airborne targets in ground clutter. The primary performance parameters for this radar are range accuracy and resolution.

Important measurements are carrier frequency stability, pulse repetition interval (PRI) stability, pulse width, and peak envelope power. Additional parameters of interest could include duty cycle and pulse offtime.

These pulse envelope characteristics and terminology are described next followed by the front-panel measurement procedures and an example HP-IB program.

NOTE

Although the measurement examples apply directly to simple pulsed-radar signals, they can also be used on more complex radars described in subsequent chapters of this manual.

Basic Pulse Envelope Characteristics and Terminology

The HP 5373A can make several kinds of pulse burst measurements that include:

A) Pulse Repetition Frequency (PRF) is the number of pulses per second.

B) Pulse (or CW) Carrier Frequency is measured in Hertz (Carrier period is defined as 1/Carrier, and is measured in time.)

C) Pulse Repetition Interval (PRI) is the time interval between the leading edges of two consecutive pulses and is the reciprocal value of PRF (1/PRF).

D) Pulse Width is the time interval from the leading edge to the trailing edge of a single pulse.

E) Pulse Offtime is the time interval between two adjacent pulses, measured from the trailing edge of the first pulse to the leading edge of the second pulse.

F) Duty Cycle is the Pulse Width divided by PRI, and is expressed in percentage (PW/PRI × 100).

G) Envelope Power is the maximum (peak) detected pulse envelope power derived from the formula shown below. This corresponds to:

(G-1) - Maximum envelope power for the HP 53702A Envelope Detector pod.

(G-2) - Minimum envelope power for the HP 53702A is pulse offtime power.

(G-3) - Maximum envelope power for the HP 54002A 50Ω Input Pod is the maximum positive input signal power.

(G-4) - Minimum envelope power for the HP 54002A is the maximum negative signal power.

$$\text{Power in dBm} = 10 \log \left[\frac{(Ve/\sqrt{2})^2}{50\Omega} / 1\text{mW} \right]$$

Figure 3-1 shows each pulse parameter characteristic corresponding to these definitions. *Table 3-1* lists the measurement function softkeys with a selected channel and actual measurement.

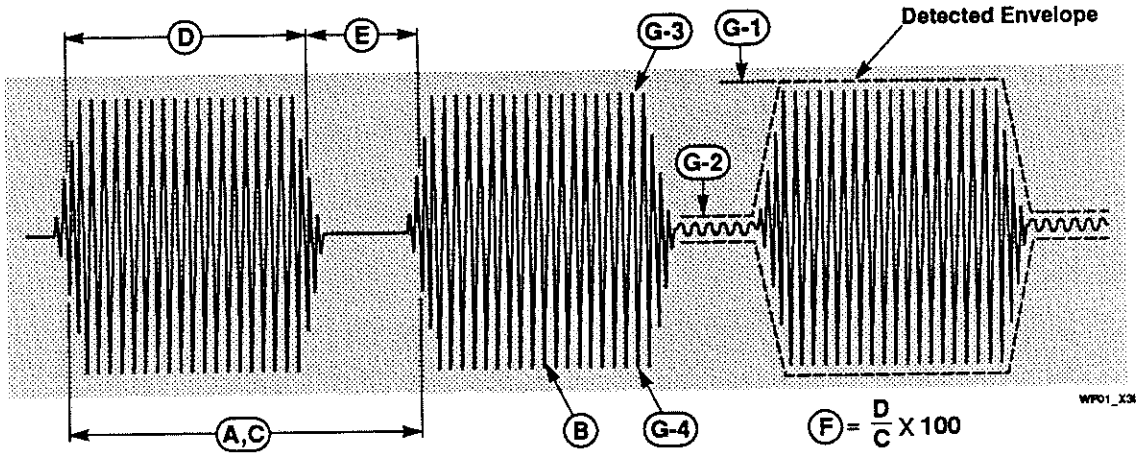


Figure 3-1. Pulse Burst Measurement Parameters

*Table 3-1. Pulse/CW Measurement Functions**

SOFTKEY	CHANNEL	MEASUREMENT FUNCTION
PRF/Frequency	A	Pulse Repetition Frequency (PRF)
	B	Pulse/CW Carrier Frequency
	C	Pulse/CW Carrier Frequency
PRI/Period	A	Pulse Repetition Interval (PRI)
	B	Pulse/CW Carrier Period
	C	Pulse/CW Carrier Period
Pulse Width	A	Pulse Width
Pulse Offtime	A	Pulse Offtime
Duty Cycle	A	Duty Cycle [(PW/PRI) × 100]
Envelope Power	A	Detected Envelope (Vpeak)
	B	ac signal maximum positive power

* The remaining measurement functions and Softkeys are listed in the previous chapter in the "Measurement Function Menus" section. Details of the standard Time Interval, Frequency, Period, and Histogram measurements along with the Arming can be found in chapters 1 through 8 of the Operating Manual.

General Test Set-up/Measurement Considerations

Figure 3-2 shows a general test setup for use with the HP 5373A Modulation Domain Pulse Analyzer. The use of a power splitter is mandatory for test measurement accuracy when an input signal is shared with another test instrument.

Use the following checklist prior to setting up any pulsed-radar measurements:

1. Ensure that all input signals are within the normal operating power and voltage levels for the External Arm, Channel A, Channel B, (or Channel C) front panel inputs. (See Front panel for details - Use external attenuators if necessary.)

2. Ensure that all input signals are within the normal operating frequency ranges for the appropriate front-panel inputs. (Use external mixers/oscillators if needed or obtain measurement signal from radar IF hardware.

PULSE ENVELOPE MEASUREMENTS

Pulse envelope measurements can be made on channel A. Front-panel measurement steps appear first followed by an example HP-IB program that can be used to make the same measurements and report results. This procedure demonstrates the following pulse envelope measurements:

- Pulse Repetition Frequency (PRF)
- Pulse Repetition Interval (PRI)
- Pulse Width
- Pulse Offtime
- Duty Cycle
- Envelope Power
- Rise/Fall Time

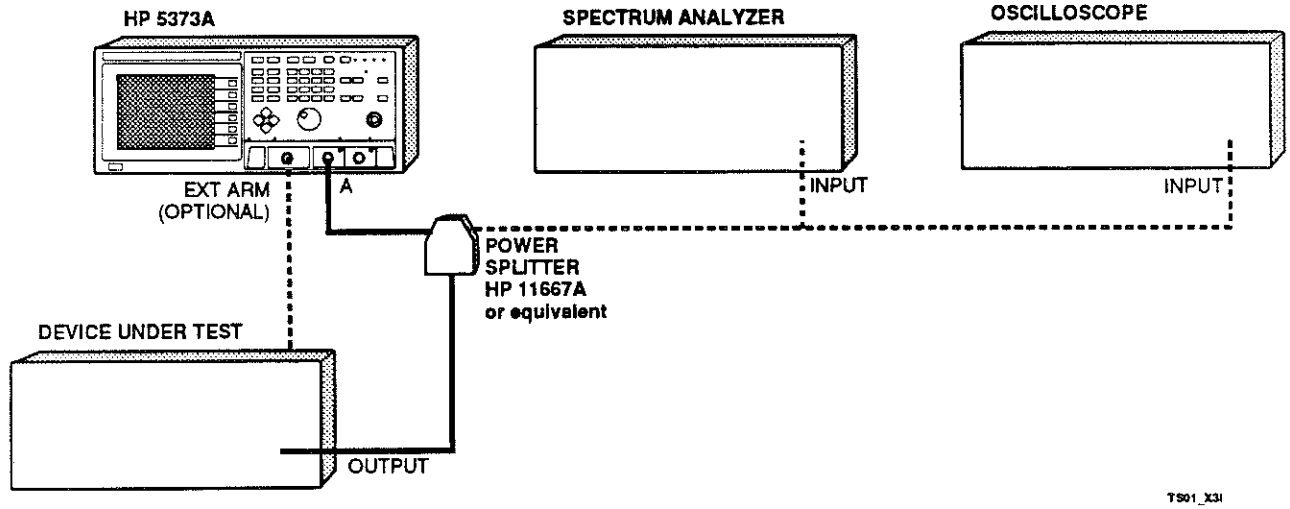


Figure 3-2. General Radar Test Setup

Front-panel Procedure

Use the following procedure to make a PRF measurement on channel A via the front-panel controls. The input signal for this measurements has these approximate characteristics:

- 70 MHz intermediate frequency
- 1 ms PRI
- 10 us pulse width
- 0 dBm peak envelope power

Figure 3-3 shows the first menu display that always appears when the **Preset** key is pressed. *Figure* 3-4 shows the basic statistical results summary that can be displayed for a group of pulse envelope measurements.

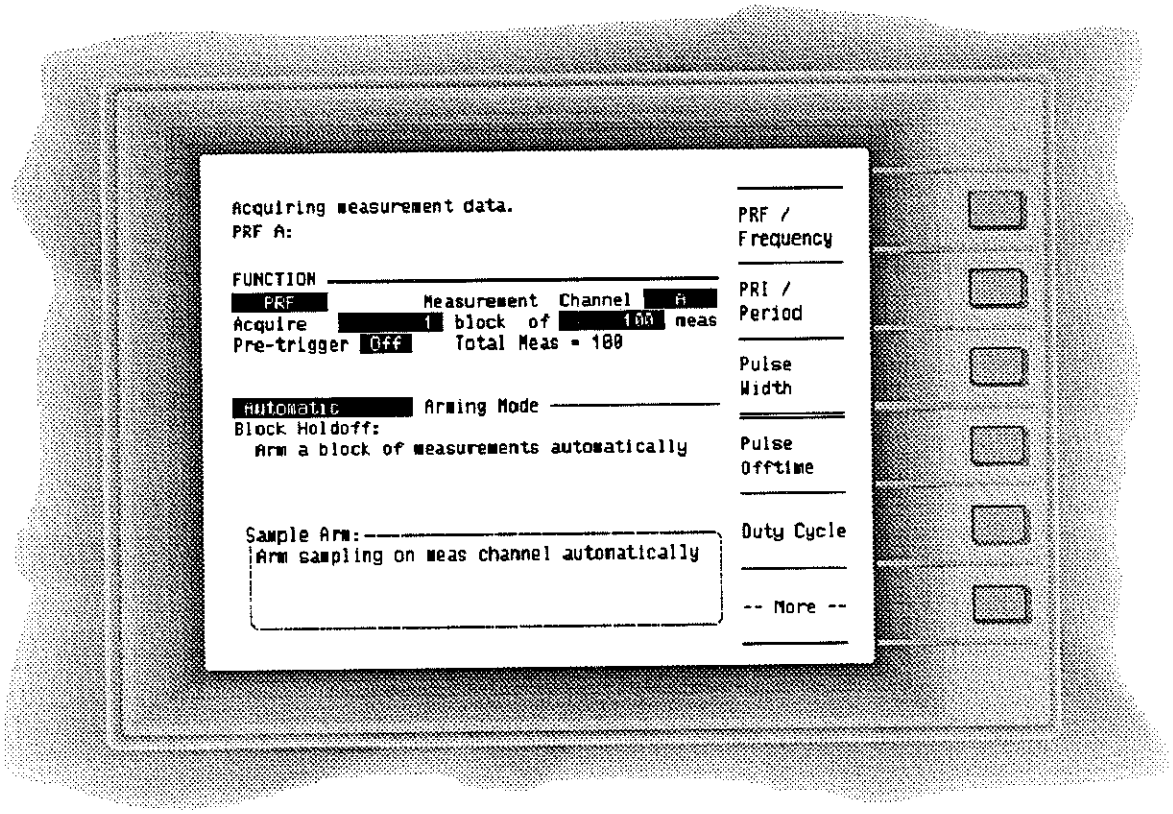


Figure 3-3. *Preset Function Menu*

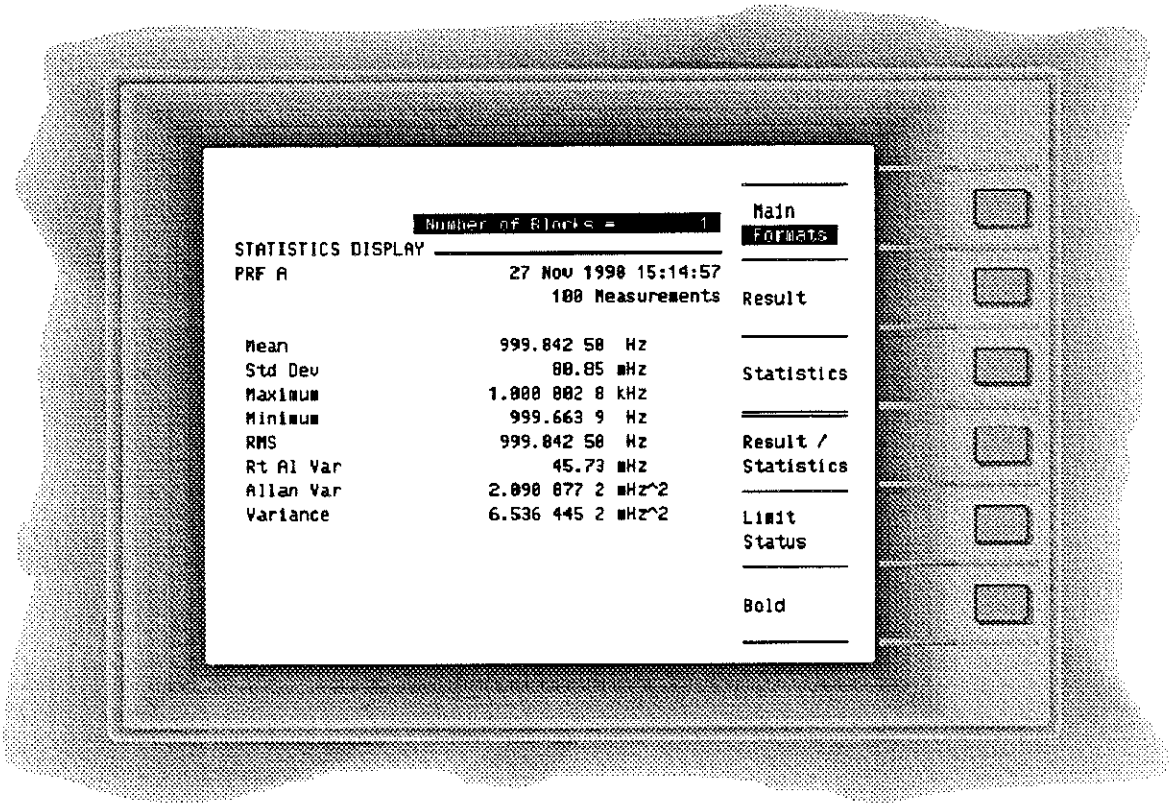


Figure 3-4. Numeric Results Display with Statistics

1. Connect the input signal to the channel A.
2. **Preset** the Analyzer to the default state.
3. Observe the first PRF measurement result in the upper-right hand corner of the screen display. You can view the first measurement result for any of the following envelope measurements in the upper right-hand corner of the same measurement function screen used to call the measurement.

NOTE

You can use the following keystrokes to display statistical results for a group of pulse envelope measurements:

1. *Press the* **Math** *menu selection hardkey to access the statistics function.*
2. *Press the* **On** *Softkey to activate the statistics function for channel A.*
3. *Press the* **Numeric** *Hardkey for preliminary display of the PRF results.*
4. *Press the top Softkey of this menu to highlight the* **formats** *choice.*
5. *Press the* **Statistics** *softkey to display the measurement mean value along with other standard statistical values.*
6. *Press the* **Single/Repet** *Hardkey in the Instrument Control front-panel group to momentarily freeze the data collection process and view the results for one measurement sample.*

If desired, you may display the statistical results for any of these measurements by pressing the **Numeric** *hardkey.*

4. Press the **PRI /Period** Softkey to measure PRI.
5. Press the **Pulse Width** Softkey to measure pulse width.
6. Press the **Pulse Offtime** Softkey to measure pulse offtime.
7. Press the **Duty Cycle** Softkey to measure duty cycle.
8. Press the **Envelope Power** Softkey to measure envelope power. (You can also make this measurement via channel B.)
9. Press the **Rise Time** Softkey to measure rise time.
10. Press the **Fall Time** Softkey to measure fall time.

Remote Operation

The program listed here makes the same measurement described above via remote HP-IB operation with HP BASIC for a Series 200/300 9000 Controller. Use the same input signal connections as the previous measurements.

Ensure that the Analyzer is in the "Talk/Listen" addressing mode by pressing the **System** hardkey and selecting **Talk/Listen** as the active addressing mode. Then, load the program and begin program execution.

```
10    !Envelope Parameter Demonstration Program
20    !For HP 5373A Modulation Domain Pulse Analyzer
30    !************
40    !
50    !Equipment Required:HP 5373A Modulation Domain Pulse Analyzer
60    !
70    !Connection Diagram:Figure 3-2 General Radar Test Setup
80    !
90    !Manual Reference:HP 5373A Modulation Domain Pulse Analyzer
100   !Application Guide
110   !************************************************
120   !This program is intended to produce the same results as the
130   !Envelope Parameter measurement procedures in the HP 5373A Modulation Domain Analyzer
Application Guide
140   !
150   !
160   Analyzer=703
170   !
180   PRINT
190   PRINT "Install an HP 53702A Envelope Detector Pod "
200   PRINT "in the HP 5373A CHANNEL A input position,"
210   PRINT "if one is not already there."
220   PRINT "Press Continue when done"
230   PAUSE
240   PRINT
250   PRINT "Connect the input signal to the CHANNEL A pod."
260   PRINT "Press Continue when done"
270   PAUSE
280   PRINT
290   PRINT "Press the HP 5373A ""System"" key."
300   PRINT "Press Continue when done"
310   PAUSE
320   PRINT
330   PRINT "Select ""Addressing Mode"" = ""Talk/Listen""."
340   PRINT "Press Continue when done"
350   PAUSE
360   PRINT
370   PRINT "Select ""Device Address"" = ""3""."
380   PRINT "Press Continue when done"
390   PAUSE
400   PRINT
410   PRINT "This program will now cause the HP 5373A to display the statistics for a single
block of PRF measurements, ";
420   PRINT "then cause one block of measurements to be taken."
430   PRINT
440   OUTPUT Analyzer;"preset;meas;func,prf;sour a;proc;sour a;statistics on;smode
single;men,num"
450   !
460   OUTPUT Analyzer;"num;display statistics;restart"
470   PRINT "The program will now cause the analyzer to display other pulse parameters."
```

```
480   PRINT "Press Continue to see next measurement."
490   PAUSE
500   PRINT
510   PRINT "PRI measurement"
520   OUTPUT Analyzer;"meas;func pri"
530   PRINT "Press Continue to see next measurement."
540   PAUSE
550   PRINT
560   PRINT "Pulse Width measurement"
570   OUTPUT Analyzer;"func pwidth"
580   PRINT "Press Continue to see next measurement."
590   PAUSE
600   PRINT
610   PRINT "Pulse Offtime measurement"
620   OUTPUT Analyzer;"func offtime"
630   PRINT "Press Continue to see next measurement."
640   PAUSE
650   PRINT
660   PRINT "Duty Cycle measurement"
670   OUTPUT Analyzer;"func duty"
680   PRINT "Press Continue to see next measurement."
690   PAUSE
700   PRINT
710   PRINT "Envelope Power measurement"
720   OUTPUT Analyzer;"func power"
730   PRINT "Press Continue to see next measurement."
740   PAUSE
750   PRINT
760   PRINT "Rise Time measurement"
770   OUTPUT Analyzer;"func rtime"
780   PRINT "Press Continue to see next measurement."
790   PAUSE
800   PRINT
810   PRINT "Fall Time measurement"
820   OUTPUT Analyzer;"func ftime"
830   PRINT "****************************************"
840   BEEP
850   PRINT "END OF PROGRAM"
860   PRINT "Press RUN to restart program."
870   PRINT
880   END
```

CARRIER FREQUENCY/PERIOD MEASUREMENTS

Carrier frequency and period measurements can be made on channel B up to 500 MHz, or channel C between 100 MHz and 2 GHz. Front-panel measurement steps appear first followed by an example HP-IB program that can measure carrier frequency.

A reported frequency that is derived from pulse offtime will be lower than that reported by a measurement occurring entirely within the pulse width. Frequency values that result from pulse offtime are NOT used to compute statistical results for the pulse carrier measurement.

Front-panel Procedure

Use the following procedure to make pulsed/CW carrier frequency/period measurements on channel B or C. The input signal for this measurement has these characteristics:

- 70 MHz carrier frequency
- –15 dBm peak power
- 1 percent duty cycle

Figure 3-5 shows the numeric results display with statistics that can be used to summarize carrier stability and center frequency. *Figure 3-6* shows the pulsed carrier in the modulation domain.

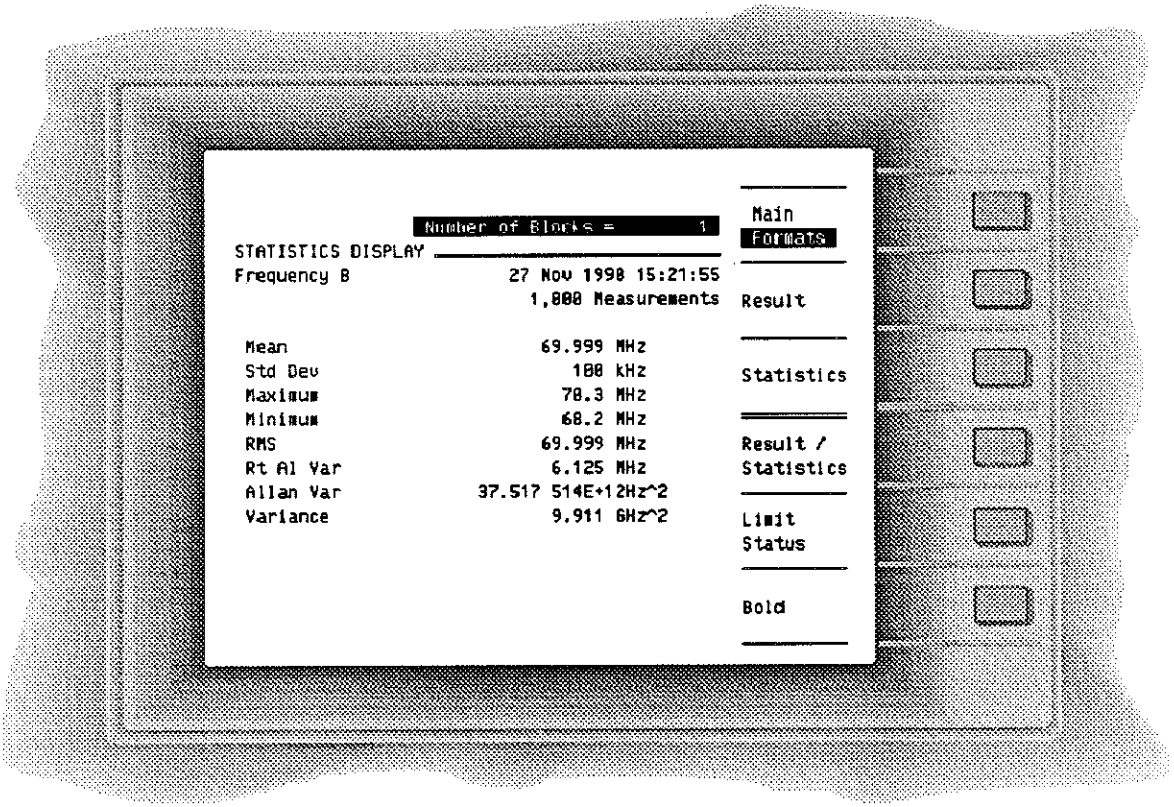


Figure 3-5. Numeric Results with Statistics

1. Press the **Preset** key to return the Analyzer to the default state.

2. Connect the input signal to the channel B pod when the input frequency is 500 MHz or less. (If the input frequency is greater than 500 MHz, connect it to the optional 2 GHz channel C input.)

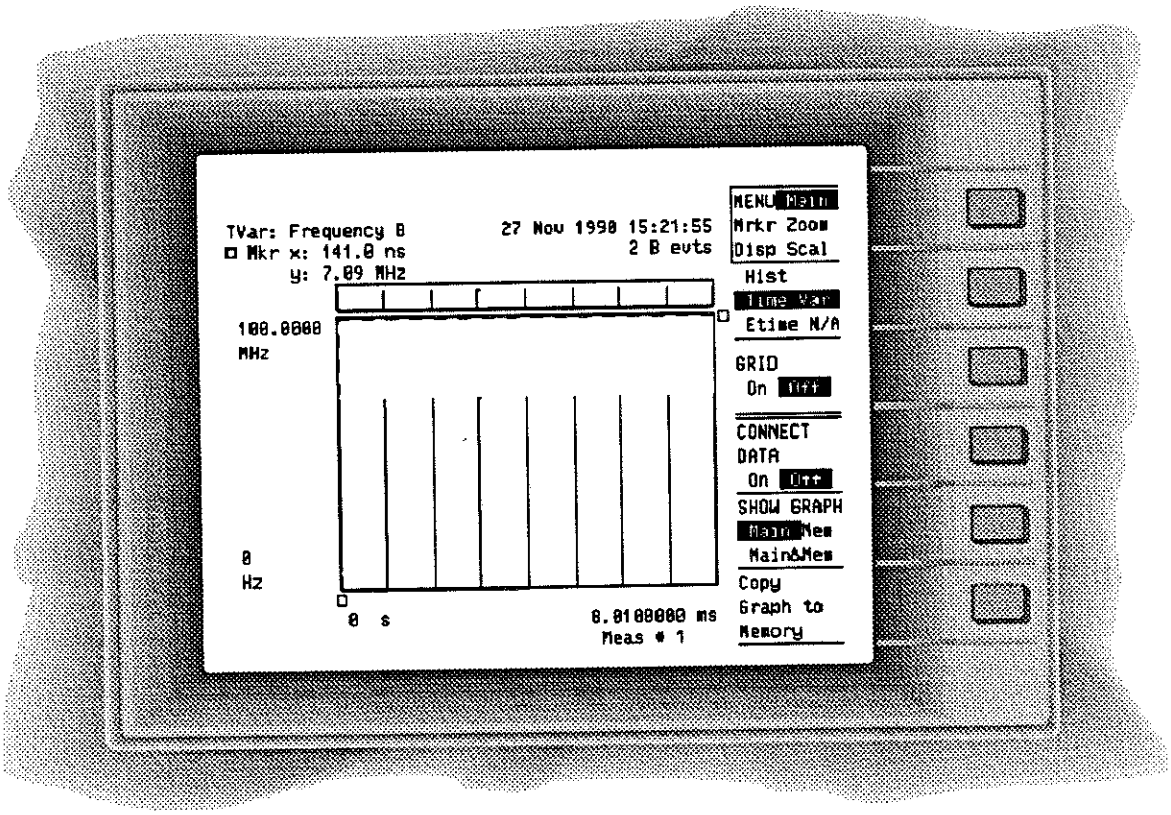


Figure 3-6. Modulation Domain Display (F vs. T)

NOTE

If you want to measure the carrier period, press the **PRI/ Period** *Softkey on the first measurement function menu before completing the next step.*

3. Press the Cursor-control **right** key to enter the measurement channel parameter field.

4. Press the **More** softkey to move to the next page of the measurement channel parameter field.

5. Press the **B** channel softkey to select channel B as the active measurement channel.

6. Press the Cursor-control **left** key to return to the first measurement function menu.

7. Press the **Math** menu selection hardkey to access the statistics function.

8. Press the second softkey from the top to select the channel **B** math functions.

9. Press the Cursor-control **down** key to select the channel B statistics parameter field, then press the **On** Softkey to activate the statistics function for channel B.

10. Press the **Numeric** Hardkey for preliminary display of the carrier frequency results.

11. Press the top Softkey of this menu to highlight the **formats** choice.

12. Press the **Statistics** softkey to display the carrier frequency mean value along with other standard statistical values.

13. Press the **Single/Repet** Hardkey in the Instrument Control front-panel group to momentarily freeze the data collection process and view the results of one sample.

FMOP Assessment

Unwanted Frequency Modulation On Pulse "FMOP" degrades radar performance by creating added spectral sidelobes. These additional sidelobes introduce resolution ambiguities and reduce useful radiated power by subtracting energy from the mainlobe.

You can easily identify variations in pulse carrier frequency by using the following procedure:

NOTE

This procedure shows you how to "expand" displayed data on either axis for not only the Frequency, Phase, and Time-interval versus Time display but also the Histogram display.

The generalized form of this procedure can be used to magnify any displayed parameter for any Modulation Domain measurement made by the Analyzer.

1. Use the previous procedure to make a pulsed carrier frequency measurement.

2. Press the **Graphic** hardkey to view the graphic display.

3. Ensure that the **Main** MENU option is displayed in inverse video as the active choice.

4. Press the second Softkey from the top to move from the **Hist** selection to the **Time Var** graphic display.

5. Press the fourth Softkey from the top to turn ON the **CONNECT DATA** display function.

6. Press the top menu Softkey to move from the **Main** selection to the **Mrkr** display function.

7. Press the **MARKER ORIENT** Softkey to select the vertical arrows.

8. Rotate the **ENTRY/MARKER** knob until the dashed horizontal cursor line lies on top of the pulse carrier. (See *Figure 3-7*)

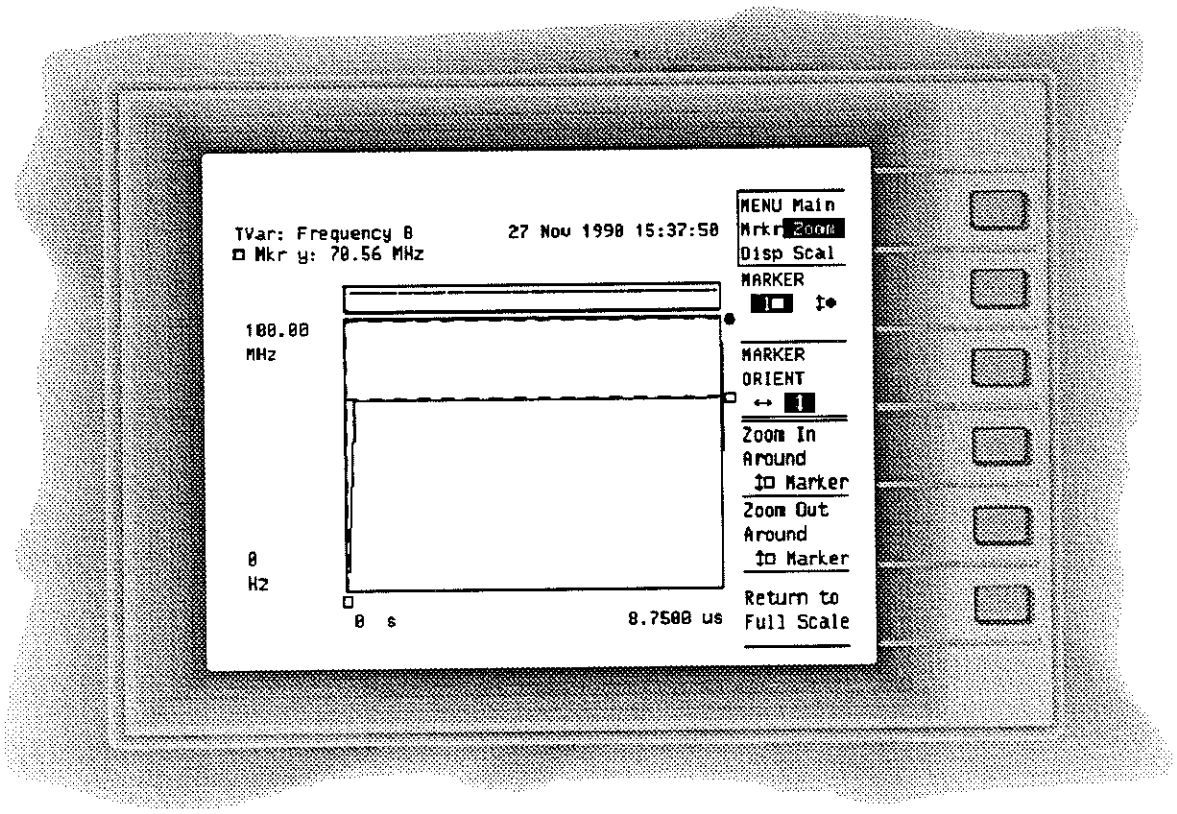


Figure 3-7. Modulation Domain Display (F vs. T)

9. Press the top menu Softkey to move from the Mrkr selection to the **Zoom** display mode.

10. Press the fourth Softkey from the top as needed to Zoom **In** (magnify) the pulse carrier frequency variation over time until the desired result is obtained (See *Figure 3-8.*).

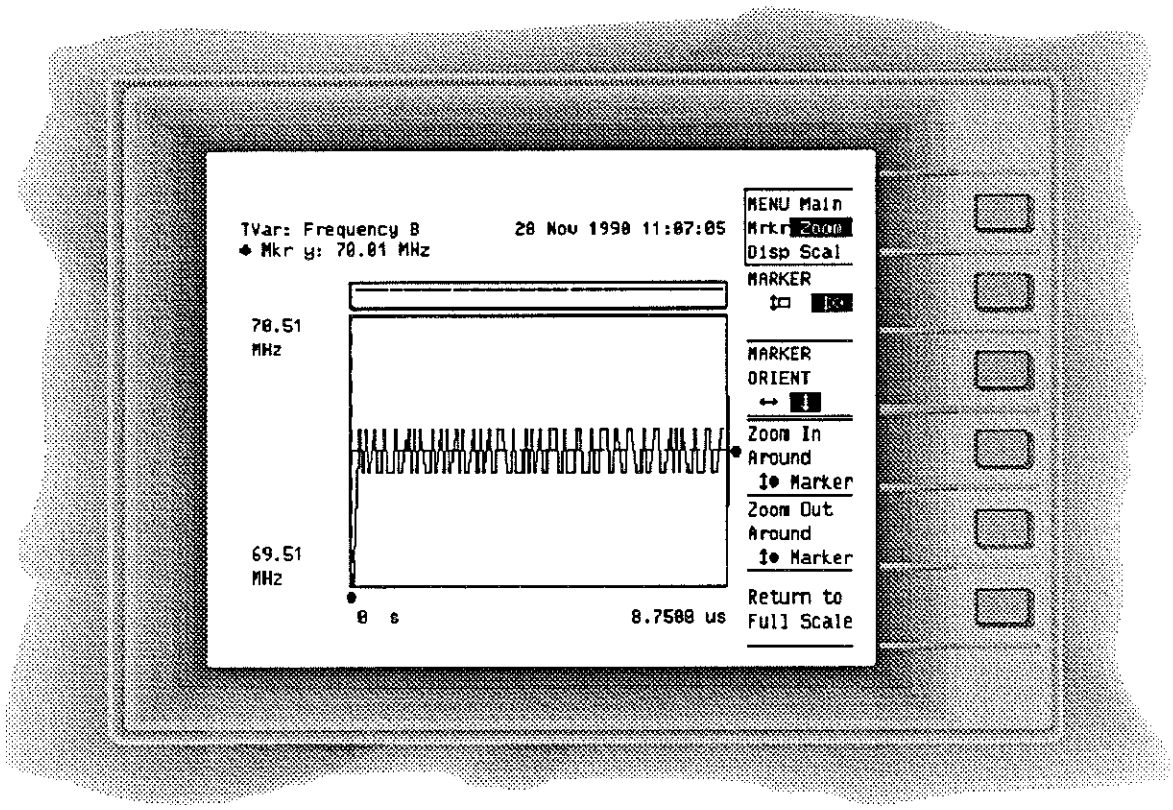


Figure 3-8. Modulation Domain Display (F vs. T)

NOTE

If you want quantitative values for the magnified frequency variation (modulation), follow the next set of front-panel keystrokes:

1. *Press the top menu Softkey to move the* **Zoom** *selection to the* **Mrkr** *display mode.*
2. *Press the* **MARKER ORIENT** *Softkey to select the vertical orientation.*
3. *Press the* **MARKER** *Softkey to select a marker you wish to move first.*
4. *Rotate the* **ENTRY/MARKER** *knob until the dashed horizontal cursor line lies at the lowest peak location of the modulation you want to quantify.*
5. *Press the* **MARKER** *Softkey to select the next marker you wish to move.*
6. *Rotate the* **ENTRY/MARKER** *knob until the dashed horizontal cursor line lies at the highest peak location of the modulation you want to quantify.*
7. *Press the fourth menu Softkey from the top to select the* **Mod Vals** *choice.*
8. *Read the Pk-Pk, Center, and Rate values located in the upper half of the graphic screen display.*
9. *You can use this procedure to measure delta time events by choosing the horizontal marker orientation in step "b".*

11. Press the fifth Softkey to **Zoom Out** or press the bottom SoftKey to return to fullscale presentation.

Remote Operation

The program listed here makes the same measurement described above via remote HP-IB operation with HP BASIC for a Series 200/300 9000 Controller. Use the same input signal connections as the previous measurements.

Ensure that the Analyzer is in the "Talk/Listen" addressing mode by pressing the **System** hardkey and selecting **Talk/Listen** as the active addressing mode. Then, load the program and begin program execution.

```
10    !Carrier Frequency and Period Measurement Demonstration Program
20    !For HP 5373A Modulation Domain Pulse Analyzer
30 !**************
40    !
50 !Equipment Required:HP 5373A Modulation Domain Pulse Analyzer
60 !
70 !Connection Diagram:Figure 3-2 General Radar Test Setup 80 !

90 !Manual Reference:HP 5373A Modulation Domain Pulse Analyzer
100 !Application Guide
110 !********************************* ******************
120 !This program is intended to produce the same results as the
130 !Carrier Frequency/Period Measurement
Procedures in the HP 5373A Modulation Domain Analyzer Application Guide
140 !
150   !
160 DIM Func$[20],Meas_sour$[20],Proc_sour$[20]
170 Analyzer=703
180   !
190 PRINT
200 PRINT "Install an HP 54002A 50-ohm Input Pod "
210 PRINT "in the HP 5373A CHANNEL B input position,"
220 PRINT "if one is not already there."
230 PRINT "Press Continue when done"
240 PAUSE
250 PRINT
260 PRINT "Connect the input signal to the CHANNEL B pod."
270 PRINT
280 PRINT "If the input signal frequency is greater than 500 MHz,"
290 PRINT "and the HP 5373A has an (optional) 2 GHz CHANNEL C,"
300 PRINT "connect it to that input."
310 PRINT "Press Continue when done"
320 PAUSE
330 PRINT
340 PRINT "Press the HP 5373A ""System"" key."
350 PRINT "Press Continue when done"
360  PAUSE
370 PRINT
380 PRINT "Select ""Addressing Mode"" = ""Talk/Listen"". "
390  PRINT "Press Continue when done"
400 PAUSE
410 PRINT
420 PRINT "Select ""Device Address"" = ""3""."
430 PRINT "Press Continue when done"
440 PAUSE
450 PRINT
460 INPUT "Do you want to make a carrier period measurement?",Carr_per_flag$
470 IF UPC$(Carr_per_flag$)="Y" THEN
480 Func$="Period"
490 ELSE
```

```
500 Func$="Frequency"
510 END IF
520 PRINT
530 !
540 INPUT "What HP 5373A Channel are you using for your measurement?",Hp_5373a _ chan$
550 IF UPC$(Hp_5373a_chan$)<"B"> AND UPC$(Hp_5373a_chan$)<"C"> THEN
560 PRINT
570 GOTO 540
580 END IF
590 PRINT "This program will now cause the HP 5373A
to display the statistics for a single block of ";Func$;" measurements, ";
600 PRINT "then cause one block of measurements to be taken."
610 PRINT
620 !
630 Func$="meas;func,"&Func$
640 Meas_sour$="meas;sour,"&Hp_5373a_chan$
650  Proc_sour$="proc;sour,"&Hp_5373a_chan$
660 !
670 Restart: !
680 OUTPUT Analyzer;"preset"
690 OUTPUT Analyzer;"";Func$;""
700 OUTPUT Analyzer;"";Meas_sour$;""
710 OUTPUT Analyzer;"";Proc_sour$;""
720 OUTPUT Analyzer;"proc;statistics on"
730 OUTPUT Analyzer;"smode single"
740 OUTPUT Analyzer;"num;display statistics"
750 OUTPUT Analyzer;"men,num"
760   !
770 PRINT "Press Proceed to take another measurement."
780 PRINT "Press any other key to end."
790 !
800 Wait_for_input: !
810 ON KEY 2 LABEL "Proceed" GOTO Restart
820 ON KBD GOTO End
830 GOTO Wait_for_input
840 !
850 End: !
860 BEEP
870      PRINT ************************* ***************"
880 PRINT "END OF PROGRAM"
890 PRINT "Press RUN to restart program."
900 PRINT
910 END
```

4

Coherent Pulse-Doppler Radar

CHAPTER OVERVIEW

This chapter provides front-panel measurement procedures to assess signal parameters typically found in a coherent pulse-doppler radar system. The signal parameter measurements explained in this chapter are as follows:

- Pulse-to-Pulse Phase pg. 4-2
- Staggered PRI pg. 4-5

COHERENT PULSE DOPPLER RADAR SUMMARY

Coherent pulse-doppler radar adds four performance improvements over the basic capabilities of simple-pulsed radar. These include: relative target velocity and direction, increased ability to distinguish moving targets from ground clutter/stationary objects, improved signal-to-noise ratio, and reduced false alarms.

Important measurements for this radar include pulse-to-pulse phase, and staggered PRI. These measurements are described below.

Refer to the general test setup/measurement considerations subsection in chapter 3 for instrument connections and checklist.

COHERENT PULSE-TO-PULSE PHASE MEASUREMENT

Measurement of pulse-to-pulse phase coherence is necessary not only to optimize performance of a coherent pulse doppler radar system but also to aid in the assessment of threat classification.

Front-panel Procedure

Use the following three-part procedure to make pulse-to-pulse phase measurements on channel B up to 500 MHz. The input signal for this measurement example has these characteristics:

- 50 MHz intermediate frequency
- 13 µs pulse width
- 1 ms pulse PRI
- –15 dBm peak power
- Phase coherent

Figure 4-1 shows how this signal may appear in the time domain while *Figure 4-2* shows its pattern in the modulation domain.

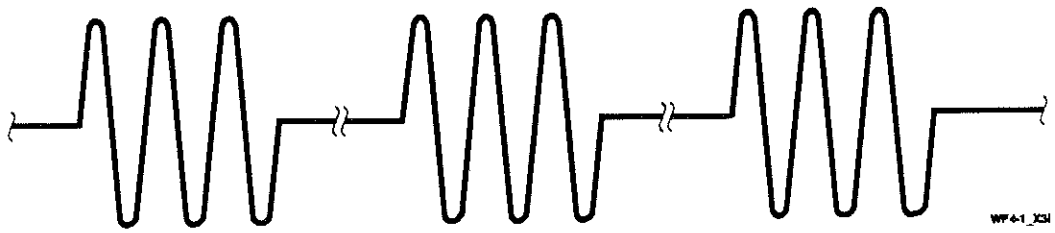


Figure 4-1. Coherent Phase Signal in Time Domain

***PART I** - Set up the input signal conditioning, sampling, arming, and measurement function:*

1. Connect the input signal to the BNC connector of the 50-Ohm input pod located in channel B.
2. Connect an arming signal to the External Arm front-panel BNC connector.
3. **Preset** the Analyzer to the default state, then press the **Single/Repet** key for single-measurement data sampling.
4. Select the **Phase Deviation** measurement function (Menu 3) to measure pulse-to-pulse phase and select channel **B** as the active measurement channel.
5. Ensure that the **Acquire** field is set to 1 block and move to the **block of** field. Enter **100** in this field using the numeric keypad then press the **Enter** key.

6. Move to the **Arming Mode** field and select the **Hld/Samp** choice (top softkey), then select **Edge/Interval**.

7. Select the **Block Holdoff** arming parameters for **Pos** and **Ext Arm**.

8. Move to the **Sample Arm** field, enter **1** on the keypad, and then select **us** by pressing the fourth softkey from the top.

NOTE

You may need to set the External Arm input or Channel B trigger level for the signal you intend to measure:

Press the **Input** *Hardkey, move to the* **Ext Arm Level** *or* **Channel B** *field and make any adjustments necessary.*

PART II - Set up the Math menu and make a measurement:

1. Go to the **Math** menu and select channel B (**B** softkey). Select the **Carrier Freq** parameter field, and press the **Compute Carrier Manual** softkey.

2. Move to the manual frequency data entry field **10.00000E+06** and enter the carrier frequency (50 MHz) of the input signal via the keypad. Terminate with the appropriate softkey data terminator.

3. Move to the **Phase Result** parameter field and press the **Phase Result MOD 360** softkey.

4. Press the **Restart** Hardkey to collect a block of 100 pulse-to-pulse phase measurements.

PART III- Set up the Display menu to view the graphic results.

1. Select the Graphic display (**Graphic** Hardkey) and press the top softkey to select **Scal**

2. Press the bottom **More** softkey twice, then press the **MAN SCALE Y-AXIS** softkey to highlight **on**.

3. Press the **Y MINIMUM** softkey and enter **–250** via the front-panel keypad.

4. Press the **Y MAXIMUM** softkey and enter **250** via the front-panel keypad.

5. Press the top softkey once to return to the graphics **Main** menu, then select the **Time Var** display choice (second softkey from the top).

   (Remember to turn manual scale **off** before you go on to another measurement function.)

6. Observe the graphic display of phase-deviation versus time. Each pulse-phase plot should line up exactly with every other pulse-phase plot in a straight line if a coherent-phase carrier is present (see *Figure 4-2*).

   (If extra events are present between the expected pulses, go to the Input screen and readjust channel B hysteresis for **Max**.)

7. Try changing the Function screen **Sample Arm** interval from 1 µs to 20 µs. This action will cause many more pulse measurements to appear on the display showing an overall phase trend.

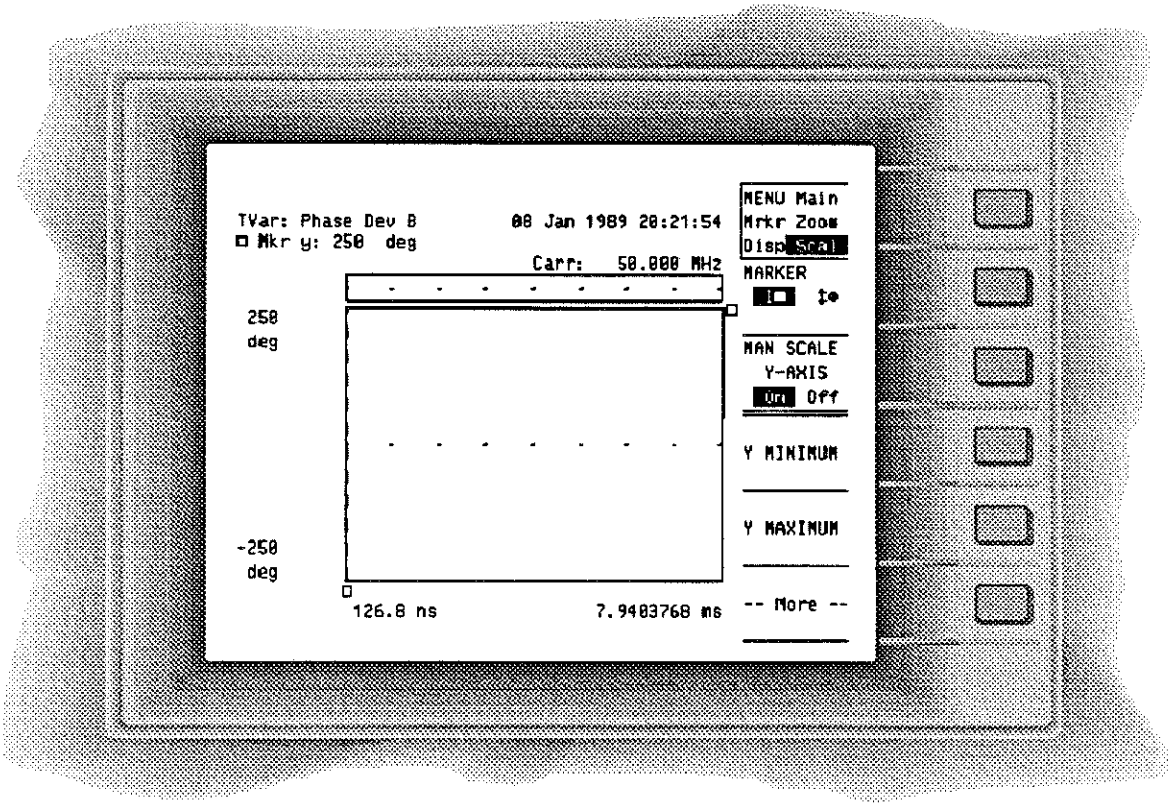


Figure 4-2. Modulation Domain Display

STAGGERED PRI MEASUREMENT

Pulse repetition intervals that are too short can introduce range ambiguities. The variations of a staggered PRI eliminates these ambiguities but requires additional signal processing and very precise PRI time sequencing. This PRI time sequencing can only be as accurate as the measurement techniques used to assess and test the radar-pulse timing.

Front-panel Procedure

Use the following procedure to make staggered-PRI measurements on channel A. The input signal for this measurement example has these characteristics:

- 50 MHz intermediate frequency
- 10 µs pulse width
- 0 dBm peak power
- 920, 730, 444, 333, 222, and 110 µs staggered PRI

Figure 4-3 shows the accumulated PRI values over a period of time via the Histogram display. *Figure 4-4* shows how this signal appears in the Modulation domain.

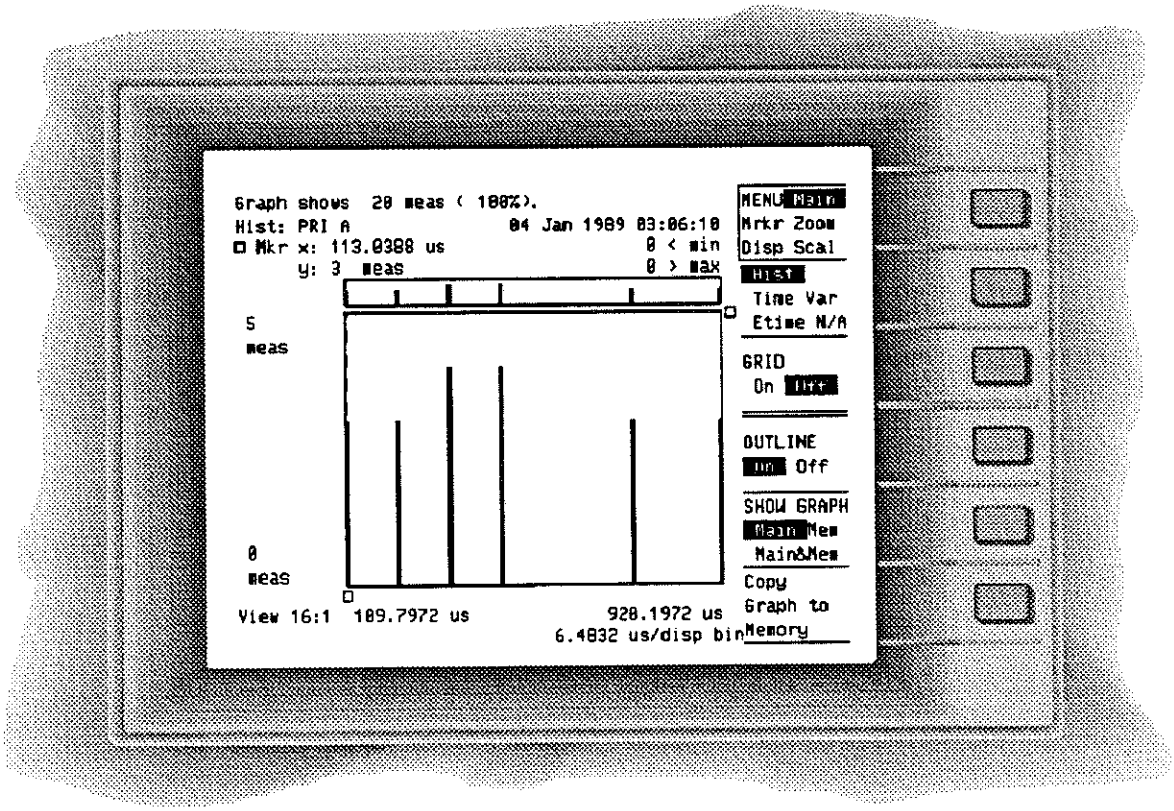


Figure 4-3. Staggered PRI Histogram Display

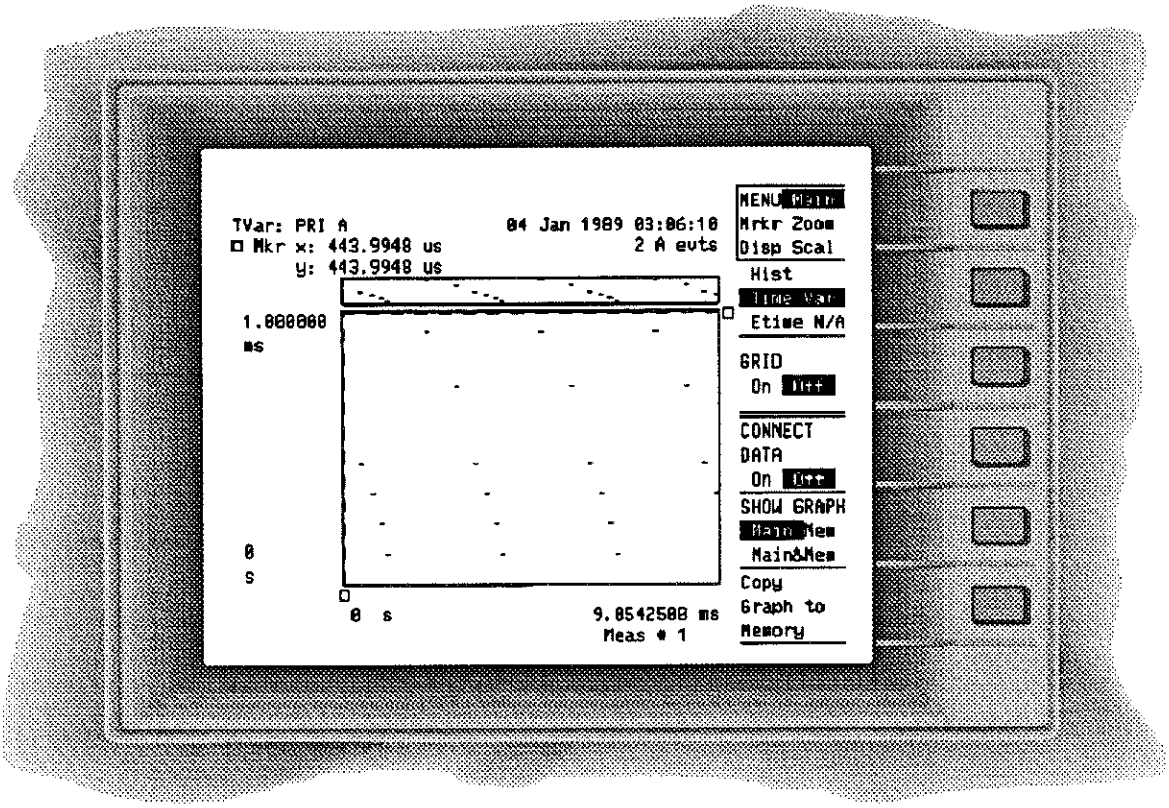


Figure 4-4. Staggered PRI Modulation Domain Display

1. Connect the input signal to the BNC connector of the Envelope Detector pod located in channel A.

2. Connect an arming signal to the External Arm front-panel BNC connector.

3. **Preset** the Analyzer to the default state, then press the **Single/Repet** key for single-measurement data sampling.

4. Select the **PRI /Period** measurement function to measure PRI.

5. Ensure that the **Acquire** field is set to 1 block and move to the **block of** field. Enter **20** in this field using the numeric keypad then press the **Enter** key.

6. Move to the **Arming Mode** field and select **Hld/Samp** (top softkey), then select **Edge/Interval**.

7. Select the **Block Holdoff** arming parameters for **Neg** and **Ext Arm**.

8. Move to the **Sample Arm** field, enter **1** on the keypad, press **Enter**, then select us (μs softkey).

NOTE

You may need to set the External Arm input level appropriately for the signal you intend to measure:

Press the **Input** *Hardkey, move to the* **Ext Arm Level** *field and make any adjustments necessary.*

9. Press the **Restart** Hardkey to collect a block of 20 PRI measurements. Observe the PRI modulation Histogram as shown in *Figure* 4-3.

10. Select the **Graphic** display, select **Main**, then select the **Time Var** display choice (second softkey). Observe the Staggered PRI signal as shown in *Figure* 4-4.

5

Linear-Chirp Radar

CHAPTER OVERVIEW

This chapter provides front-panel measurement procedures to assess signal parameters typically found in a linear-chirp radar system. The signal parameter measurements explained in this chapter are as follows:

- Carrier Frequency Profile pg. 5-2
- Frequency Deviation pg. 5-4

LINEAR-CHIRP RADAR SUMMARY

Linear-chirp radar adds three performance improvements over the basic capabilities of simple-pulsed radar. These include: longer detection range with increased resolution, improved subclutter visibility, and multiple- target acquisition.

Important measurements for this radar include intra-pulse carrier frequency profile (chirp profile), frequency deviation, and phase deviation. Frequency profile and Frequency deviation measurements are described below.

Refer to the general test setup/measurement considerations subsection in chapter 3 for instrument connections and checklist.

CARRIER FREQUENCY-PROFILE MEASUREMENT

Measurement of pulse carrier frequency profile provides a direct view of intra-pulse modulation on a single-pulse basis (multiple measurements can be averaged for more resolution). This allows for the study and comparison of several individual pulses not available with repetitive techniques.

Front-panel procedure

Use the following procedure to make pulse carrier frequency-profile measurements on channel B up to 500 MHz. Channel C can be used for frequencies between 100 MHz and 2 GHz. The input signal for this measurement example has these characteristics:

- 30 - 70 MHz intermediate frequency
- 2 MHz/μs linear chirp modulation
- 20 μs pulse width
- 60 μs PRI
- –15 dBm peak power

Figure 5-1 shows how this signal appears in the modulation domain.

1. Connect the input signal to the BNC connector of the HP 54002A input pod located in channel B.
2. Connect an arming signal to the External Arm front-panel BNC connector.
3. **Preset** the Analyzer to the default state (if necessary), then press the **Single/Repet** key for single-measurement data sampling.
4. Select the **PRF /Frequency** measurement function to measure Intra-pulse chirp modulation and select channel B as the active measurement channel.
5. Ensure that the **Acquire** field is set to 1 block then move to the **block of** field. Enter **160** using the numeric keypad then press **Enter**.
6. Move to the **Arming Mode** field, select **Hld/Samp** (top softkey), then select **Edge/Interval** (second softkey).
7. Select the **Block Holdoff** arming parameters for **Pos** and **Ext Arm**.
8. Move to the **Sample Arm** field, enter **100** on the keypad, then select the **ns** Softkey.

NOTE

You may need to set the External Arm input level and channel B triggering appropriately for the signal you intend to measure:

Press the **Input** *Hardkey, move to the* **Ext Arm Level** *and* **Chan B** *field and make any adjustments necessary.*

9. Press **Restart** to make one Intra-pulse chirp-modulation measurement.

10. Select the **Graphic** display, go to **Main**, then choose the **Time Var** display (second softkey).

Observe *Figure 5-1* for a profile of the pulse frequency modulation (chirp).

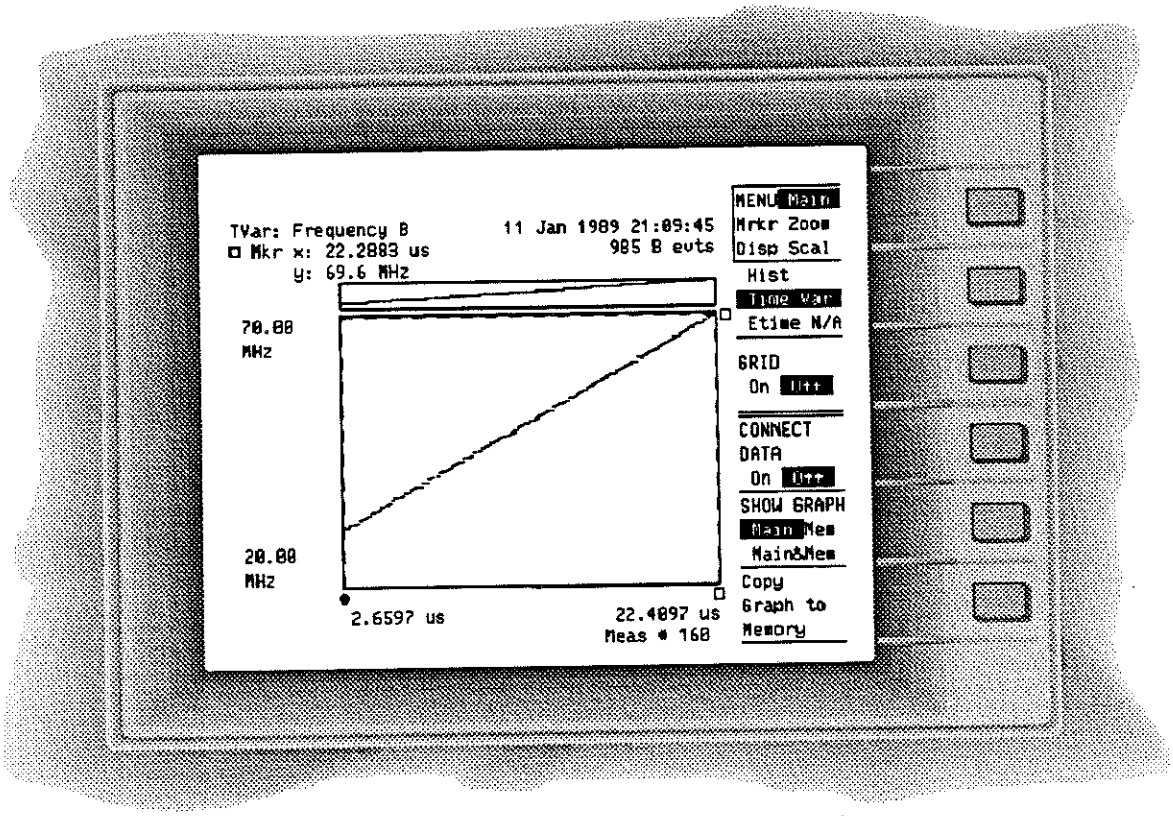


Figure 5-1. Modulation Domain Display

FREQUENCY DEVIATION MEASUREMENT

The measurement of frequency deviation extends the usefulness of single-shot pulse carrier frequency-profiling. This measurement is a curve-fit test providing quantitative data that describes how well the input signal pulse chirp conforms to a desired modulation rate. As with the previous procedure, multiple measurements will increase the resolution of frequency deviation results.

The measurement technique requires you to input the desired modulation rate in the form of a start frequency and slope. The results of this measurement show you how far (in Hertz) the pulse chirp deviates from linearity.

Front-panel procedure

Use the following procedure to make frequency-deviation measurements on channel B up to 500 MHz. The input signal for this measurement example has the same characteristics as used in the previous example.

Figure 5-1 shows how a chirped signal appears in the modulation domain while *Figure 5-2* shows the curve-fit frequency deviation from linearity.

1. Use the Carrier Frequency-Profile procedure to set up the Analyzer for Frequency Deviation measurements (steps 1–9) with these exceptions:

   a. Select the **Frequency Deviation** measurement function.

   b. Set the Function screen **block of** field for **99**.

   c. Set the Function screen **Sample Arm** field for **200** ns.

2. Move to the **Math** menu then select channel **B**. Go to the **Stats** field and press the **On** softkey.

3. Move to the first choice of the **Carrier Freq** parameter field (Cursor/Scroll keys) then select **Compute Carrier Linear** (fourth softkey).

4. Move to the **Slope** parameter field, enter the desired slope in Hz/us (via keypad) and press the softkey corresponding to the required exponent. (For this example **2**, then terminate entry with the **M** softkey.)

5. Move to the **Start** parameter field, enter the desired start frequency and press the softkey corresponding to a required exponent. (For this example **30**, then terminate entry with the **M** softkey.)

NOTE:

The entered start-frequency value should be as close as possible to the actual pulse-start frequency. This helps ensure the best absolute accuracy of the Frequency Deviation measurement.

6. Press **Restart** to collect one Intra-pulse chirp modulation measurement.

NOTE:

You'll need to manually re-scale the display y-axis depending on the modulation rate and start frequency of your signal. A good rule for manually setting the y-axis is to make **Y MINIMUM** *and* **Y MAXIMUM** *equal to (or slightly larger than) the min/max values of your signal's modulation rate (slope in MHz).*

Follow the procedure below to manually scale the Y-axis.

*1. Select the Graphic display (***Graphic** *Hardkey) and press the top softkey to select* **Scal**

2. Press the bottom **More** *softkey twice, then press the* **MAN SCALE Y-AXIS** *softkey to* **on**.

3. Press the **Y MINIMUM** *softkey and enter* **-1.5 MHz** *via the front-panel keypad.*

4. Press the **Y MAXIMUM** *softkey and enter* **1.5 MHz** *via the front-panel keypad.*

5. Press the top softkey once to return to the graphics **Main** *menu.*

(Remember to turn manual scale **off** *before you go on to another measurement function.)*

7. Ensure that **Main** appears as the active choice, then select **Time Var** (second softkey).

8. Observe the display for a curve fit of the frequency modulation (chirp) linearity as shown in *Figure* 5-2.

The displayed slope of the plot provides a good visual indication of the extent of deviation from the expected chirp rate.

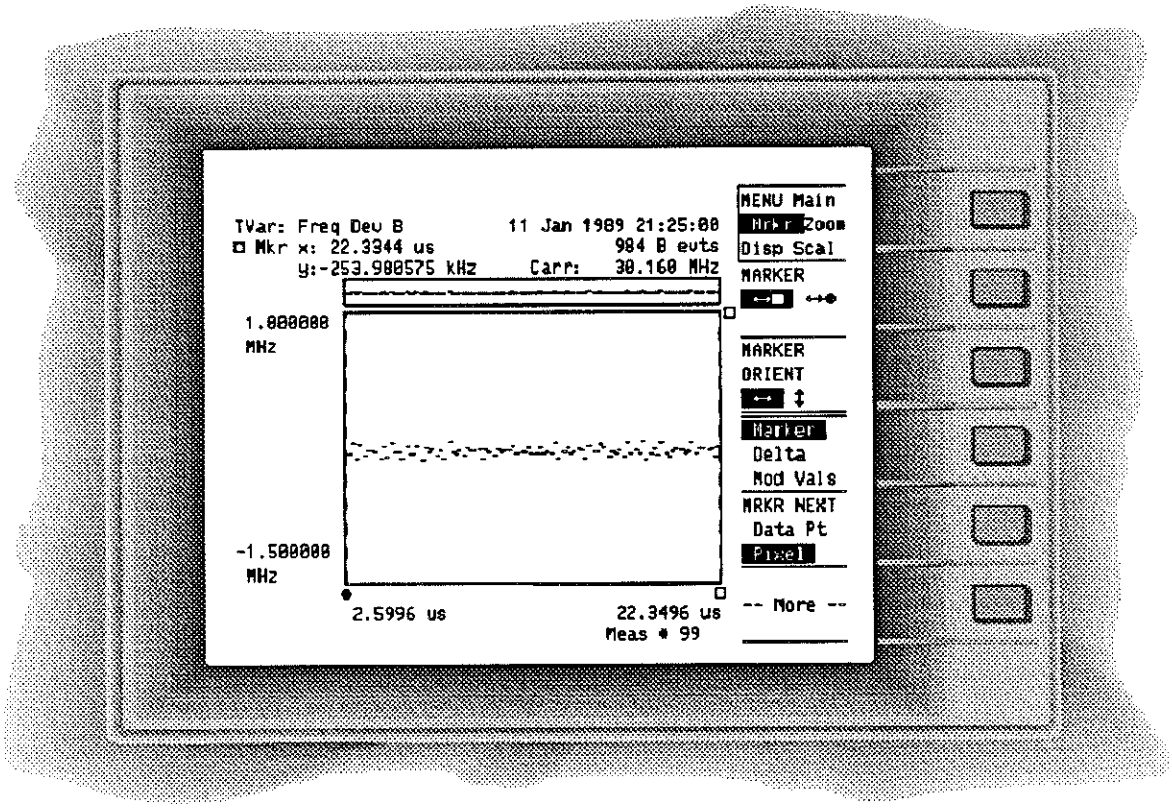


Figure 5-2. Modulation Domain Display

6

Phase-Coded Radar

CHAPTER OVERVIEW

This chapter provides front-panel measurement procedures to assess signal parameters typically found in a phase-coded radar system. The signal parameter measurements explained in this chapter are as follows:

- Demodulated Barker Code pg. 6-2
- Phase Transition Timing pg. 6-4
- Phase Accuracy pg. 6-6

PHASE-CODED RADAR SUMMARY

Phase-coded radar adds three performance improvements (similar to linear chirp) over the basic capabilities of simple pulsed radar. These include: longer detection range with increased resolution, improved subclutter visibility, multiple-target acquisition, and improved range resolution.

Important measurements for this radar include intra-pulse carrier phase-transition timing and phase accuracy. These measurements are described for a 13-bit Barker code sequence as shown in *Figure 6-1*.

Refer to the general test setup/measurement considerations subsection in chapter 3 for instrument connections and checklist.

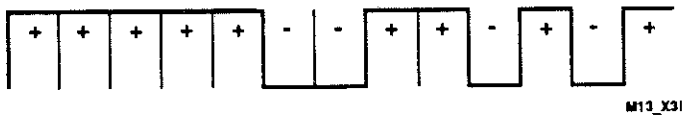


Figure 6-1. 13-bit Barker-Code Signal Sequence

Phase-Code Demodulation

Measurement of pulse carrier phase-transition provides a direct view of intra-pulse modulation on a single-pulse basis. This allows for the study and comparison of individual pulse-to-pulse code transitions not available with repetitive techniques.

Front-panel procedure

Use the following two-part procedure to make pulse carrier phase-transition measurements on channel B up to 500 MHz. The input signal for this measurement example has these characteristics:

- 13-bit Barker sequence
- 70 MHz intermediate frequency
- 13 µs pulse width
- 1 ms PRI
- –15 dBm peak power

Figure 6-2 shows how this signal appears in the modulation domain.

***PART I** - Set up the input signal conditioning, sampling, arming, and measurement function:*

1. Connect the input signal to the BNC connector of the HP 54002A input pod located in channel **B**.
2. Connect an arming signal to the **External Arm** front-panel BNC connector.
3. **Preset** the Analyzer to the default state, then press the **Single/Repet** key for single-measurement data sampling.
4. Select the **Phase Deviation** measurement function to measure intra-pulse phase modulation and select channel B as the active measurement channel.
5. Ensure that the **Acquire** field is set to 1 block then move to the **block of** field and ensure that this field displays 65.
6. Move to the **Arming Mode** field, select the **Hld/Samp** choice, then select **Edge/Interval**.
7. Select the **Block Holdoff** arming parameters **Pos** and Ext **Arm** .
8. Move to the **Sample Arm** field, enter 200 (keypad), then select **ns**.

NOTE

You may need to set the External Arm input or channel B trigger level appropriately for the signal you intend to measure.

Press the **Input** *Hardkey, move to the* **Ext Arm Level** *or* **Chan B:** *field and make any adjustments necessary.*

PART II - Set up the Math/Display menus and make a measurement:

1. Select the **Math** menu, go to the **Channel** field and select **B**.
2. Move to the first choice of the **Carrier Freq** parameter field then select **Compute Carrier Manual** (third softkey).
3. Go to the **Carrier Freq** entry field (cursor/scroll **down** key), enter **70**, and press the **M** softkey.
4. Go to the **Phase Result** parameter field (cursor/scroll **down** key) and press the **Phase Result MOD 360** softkey.
5. Press **Restart** to collect one Intra-pulse phase modulation measurement.
6. Select the **Graphic** display, ensure that **Main** is the active choice, choose **Time Var** (second softkey), then press the **CONNECT DATA** softkey to highlight **On**.
7. Observe the display for phase deviation versus time in modulo 360 format which clearly shows the 13-bit Barker sequence. If desired, use the procedure in chapter 4 to manually scale the display y-axis for ± 250° (page 4-3).

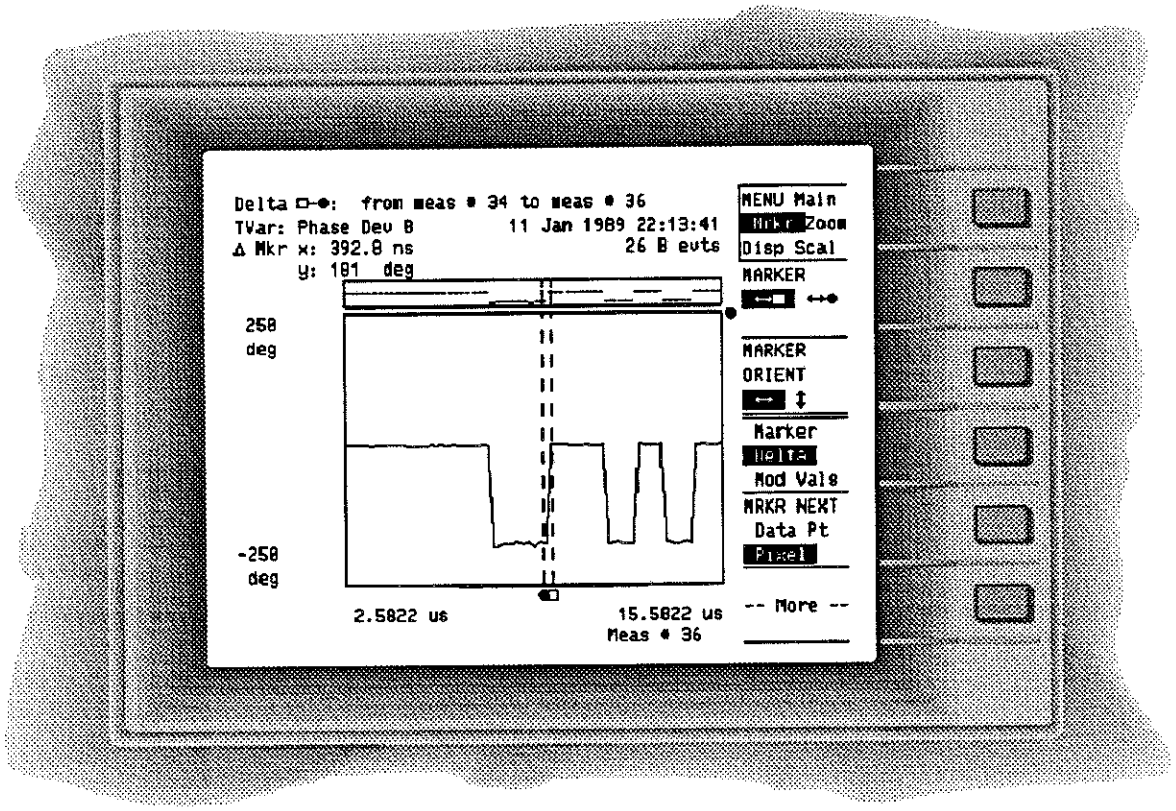


Figure 6-2. Modulation Domain Display

PHASE-TRANSITION TIMING

Once the phase-transition events are captured in the modulation domain, you can place markers on the time axis to measure the exact transition time. Use the following front-panel steps to make high-resolution measurements of phase-transition timing as shown in *Figure 6-3*.

1. Use the previous procedure to capture a phase-coded event sequence.

2. Move from the **Main** Graphics display selection to the **Mrkr** display function (top softkey).

3. Press **MARKER ORIENT** to select the horizontal arrows, then select (**MARKER** softkey) a marker you wish to move first.

4. Rotate the **ENTRY/MARKER** knob until the dashed vertical cursor line lies at the lowest peak location (-181 degrees) of the phase transition you want to quantify.

5. Select the next marker you wish to move (**MARKER** softkey).

6. Rotate the **ENTRY/MARKER** knob until the dashed vertical cursor line lies to the right of the first marker and locate it exactly at the next phase transition (+181 degrees).

7. Select the **Delta** choice (fourth softkey) and read the exact phase transition time value (392.8 ns) located in the upper half of the graphic screen display immediately to the right of **Mkr**.

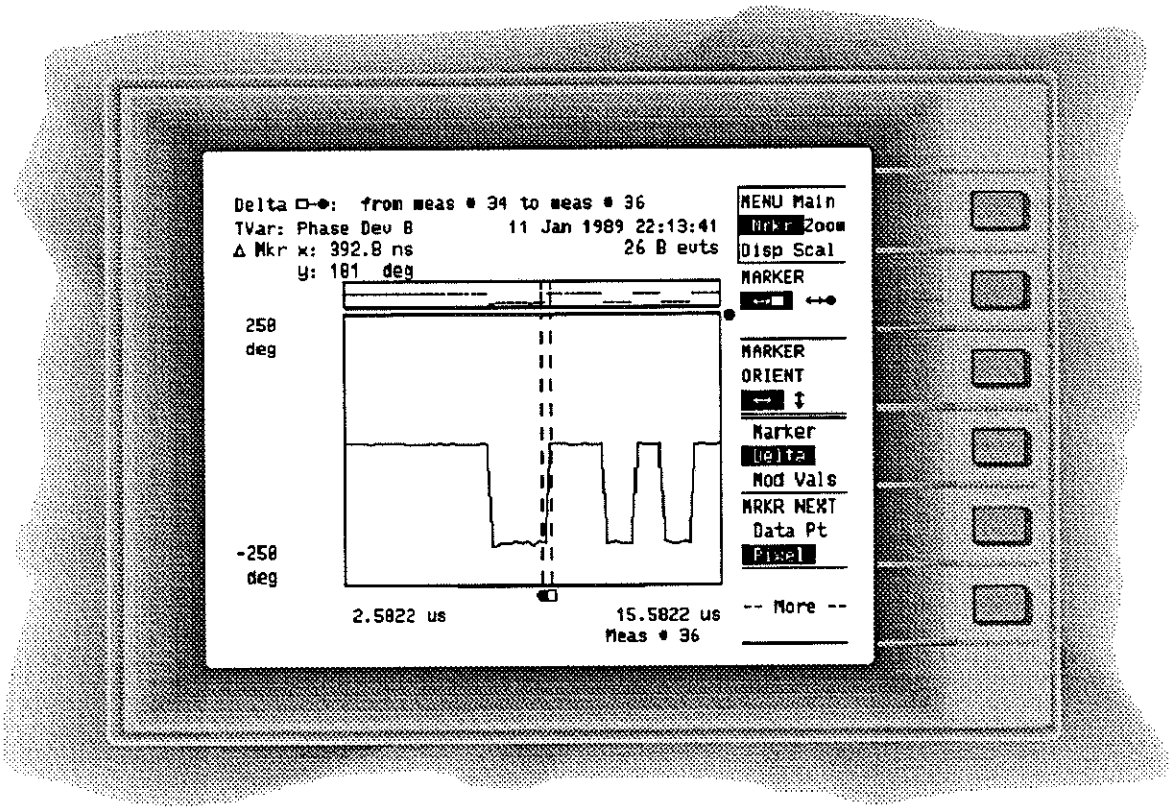


Figure 6-3. Modulation Domain Display

PHASE ACCURACY

You can also **Zoom in** on the phase axis to greatly magnify the measurement of phase deviation (just as you did for phase-transition timing). Use the following front-panel steps to make high-resolution measurements of phase deviation accuracy as shown in *Figure 6-4*.

1. Use the first procedure in this chapter to capture a phase-coded event sequence.

2. Move from the **Main** Graphic display selection to the **Mrkr** display function.

3. Press **MARKER ORIENT** to select the horizontal arrows, then select the marker (**MARKER** softkey) you wish to move first.

4. Rotate the **ENTRY/MARKER** knob until the dashed vertical cursor line lies at the lowest peak location of the phase transition you want to quantify.

5. Select the next marker you want to move (**MARKER** softkey).

6. Rotate the **ENTRY/MARKER** knob until the dashed vertical cursor line lies to the right of the first marker and locate it exactly at the next phase transition.

7. Select the **Mod Vals** choice (fourth softkey).

8. Read the exact peak-to-peak phase-transition value (+186) in degrees at the upper half of the graphic screen display just to the right of **Pk-Pk:**.

   - The median of the peak-to-peak value (-81) is read just underneath to the right of **Center:**.

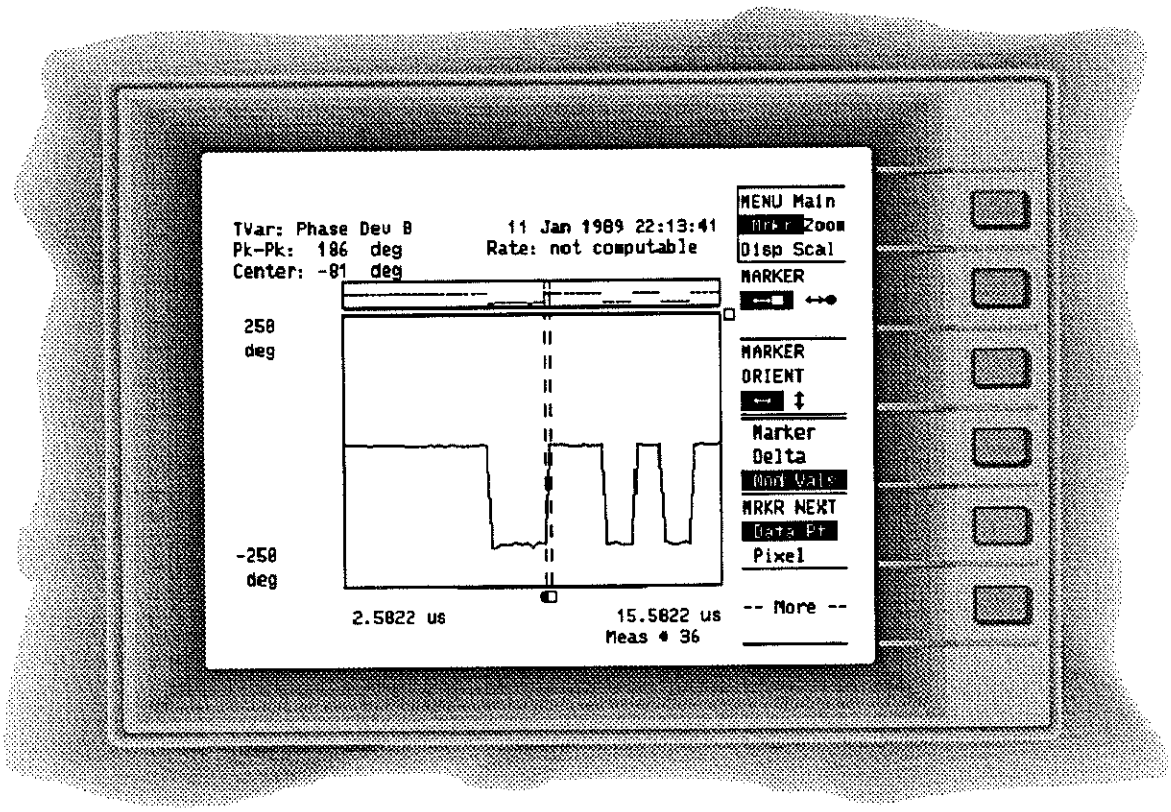


Figure 6-4. Modulation Domain Display

7

Frequency Agile Radar

CHAPTER OVERVIEW

This chapter provides front-panel measurement procedures to assess signal parameters typically found in a frequency agile radar system. The signal parameter measurements explained in this chapter are as follows:

- Frequency Sequence pg. 7-2
- Frequency Distribution pg. 7-4
- Frequency Transition (VCO) pg. 7-5
- Transient Overshoot pg. 7-6
- Settling Time pg. 7-7

FREQUENCY AGILE RADAR SUMMARY

Frequency-agile radar adds four performance improvements over the basic capabilities of simple pulsed radar. These include: resistance to jamming, lower probability of intercept, improved clutter rejection, and imaging capability.

Important measurements for this radar include carrier frequency sequence in time and frequency distribution. These measurements are described below.

Refer to the general test setup/measurement considerations subsection in the third chapter for instrument connections and checklist.

FREQUENCY SEQUENCE

Measurement of pulse carrier frequency sequence provides a direct view of inter-pulse modulation on a frequency vs. time basis. You can directly see the pattern of agile frequency changes and assess settling time necessary to optimize performance of this radar.

Front-panel Procedure

Use the following procedure to make pulse carrier frequency sequence measurements on channel B up to 500 MHz, or on channel C between 100 MHz and 2 GHz. The input signal for this measurement example has these characteristics:

- 94 MHz center frequency
- 60 MHz deviation range
- Pseudo-random frequency hopping
- 50 µs pulse width
- 125 µs PRI
- –15 dBm peak power

Figure 7-1. shows how this signal appears in the modulation domain.

1. Connect the input signal to the BNC connector of the HP 54002A input pod located in channel **B**.
2. Connect an arming signal to the **External Arm** front-panel BNC connector.
3. **Preset** the Analyzer to the default state (if necessary), then press the **Single/Repet** key for single-measurement data sampling.
4. Select the **PRF /Frequency** measurement function softkey to measure the agile frequency modulation and select channel **B** as the active measurement channel.
5. Ensure that the **Acquire** field is set to 1 block and move to the **block of** field. Enter **500** (numeric keypad) then press **Enter** key.
6. Move to the **Arming Mode** field, select the **Hld/Samp** choice (top softkey), then select **Edge/Interval** (second softkey).

7. Select the **Block Holdoff** arming parameters **Pos** and Ext **Arm**.

8. Go to the **Sample Arm** field, enter 1 on the keypad, then select **us** (third softkey).

NOTE

You may need to set the External Arm input appropriately for the signal you intend to measure. Press the **Input** *Hardkey, move to the* **Ext Arm Level** *field and make any adjustments necessary.*

9. Press **Restart** to collect a block of 500 measurements.

10. Move to the **Graphic** display, select **Main** (top softkey), then choose the **Time Var** display choice (second softkey).

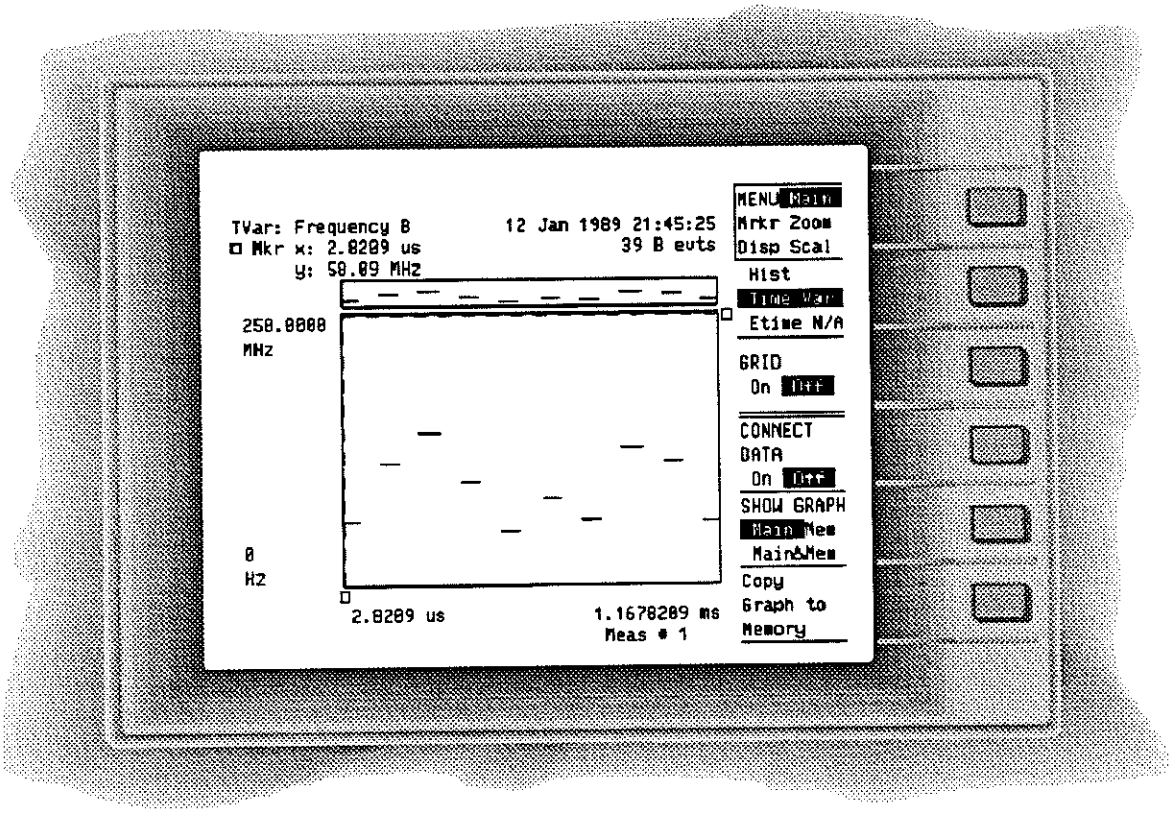


Figure 7-1. Modulation Domain Display

FREQUENCY DISTRIBUTION

Measurement of pulse carrier frequency sequence is enhanced by generating a histogram that displays the statistical distribution of utilized frequencies for the agile frequency input signal. You can directly see the pattern of agile frequency usage and easily assess cumulative distribution characteristics for this type of radar.

Front-panel Procedure

Use the following procedure to make pulse carrier frequency-distribution measurements on channel B up to 500 MHz, or on channel C between 100 MHz and 2 GHz. *Figure 7-3.* shows how the agile signal shown in *Figure 7-2* appears as a frequency distribution (histogram).

1. Use the previous procedure to collect and measure an agile carrier frequency sequence.
2. Go to the **Graphic**, select **Main**, then choose the Hist display choice (second softkey).
3. Use the graphic display markers to examine the frequency distribution represented by the bins. (Refer to the marker analysis keystrokes for phase transition/accuracy measurements that were explained in chapter 6.)

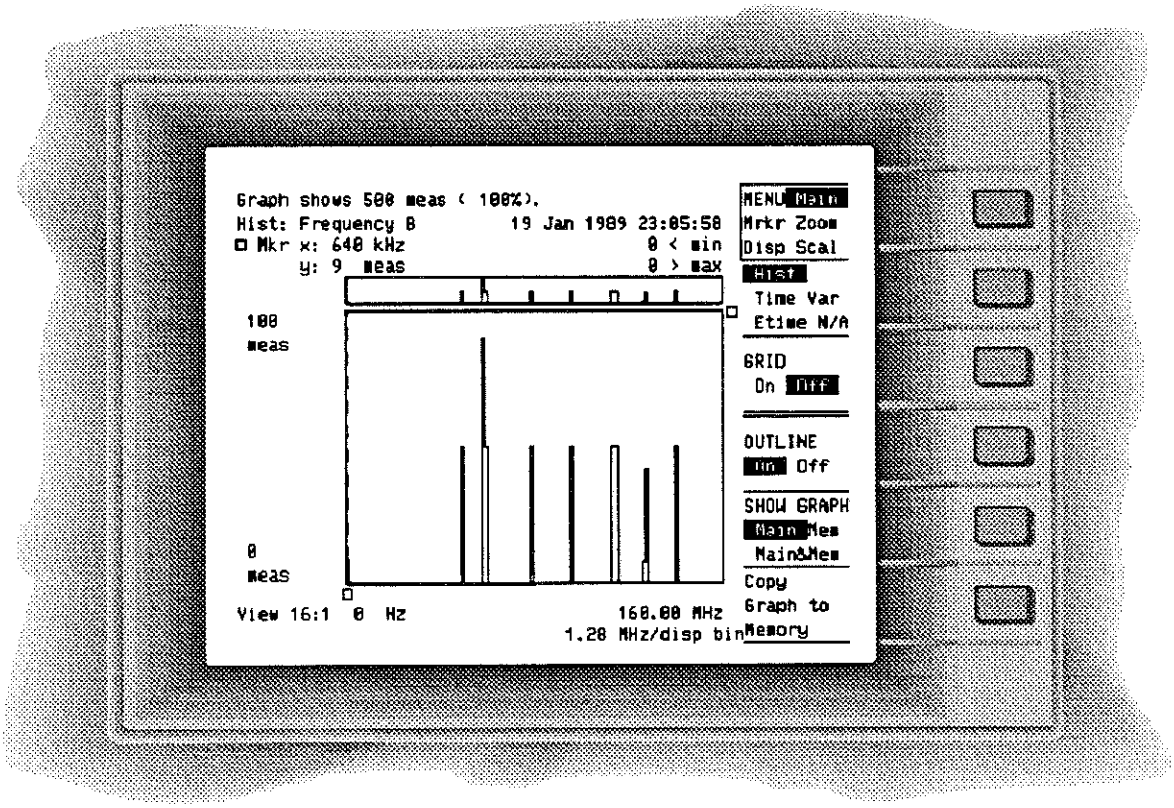


Figure 7-2. Modulation Domain Histogram Display

FREQUENCY TRANSITION (VCO)

The characterization of Voltage Controlled Oscillator (VCO) dynamic performance is easily accomplished with the HP 5373A.

The dynamic frequency transition (also known as Step Response) of a VCO or other agile source can be assessed in two stages. First, the Frequency step can be measured for transient overshoot, then the overall settling time can be assessed.

Front-panel Procedure

Use the following procedure to make VCO frequency transition measurements on channel B up to 500 MHz or on channel C between 100 MHz and 2 GHz. The input signal for this measurement example has these characteristics:

- ~70 MHz Start Frequency
- ~84 MHz Stop Frequency
- 365 µs total transition time
- –15 dBm peak power

Figure 7-3. shows how the VCO frequency transition appears in the modulation domain graphic display with the markers set for measurement of overshoot. *Figure 7-4* shows the entire VCO frequency transition measurement with markers set for settling time.

1. Connect the input signal to the BNC connector of the HP 54002A input pod located in channel B.

2. Connect an arming signal to the External Arm front-panel BNC connector.

3. **Preset** the Analyzer to the default state, then press **Single/Repet** for single-measurement data sampling.

4. Select the **PRF /Frequency** measurement function to measure the frequency profile of a VCO tuning step, then choose channel **B**.

5. Ensure that the **Acquire** field is set to 1 block then move to the **block of** field. Enter **190** (numeric keypad) then press **Enter**.

6. Move to the Arming Mode parameter field (cursor/scroll **down** key), select **Sample** (top softkey), then choose **Interval Sampling** (second softkey).

7. Go to the **Sample Arm** field, enter 5 on the keypad, then select **us** (third softkey).

8. Press **Restart** to collect a block of 190 measurements.

9. Go to the **Graphic** display, select **Main**, choose the **Time Var** display choice (second softkey), then press **CONNECT DATA** to highlight **On**.

10. Observe the graphic display for a profile of VCO tuning response and use the following keystrokes to set graphic markers for tuning overshoot and settling time.

TRANSIENT OVERSHOOT

Perform the following steps to determine the transient overshoot:

1. Use the previous procedure to capture a VCO step-response profile.

2. Move the **Main** Graphic display selection to the **Mrkr** display function (top softkey).

3. Select the horizontal arrows (**MARKER ORIENT** softkey).

4. Select a marker you wish to move first (**MARKER** softkey).

5. Rotate the **ENTRY/MARKER** knob until the dashed vertical cursor line lies at the first settled VCO post-tune output frequency.

6. Select the next marker you wish to move (**MARKER** softkey).

7. Rotate the **ENTRY/MARKER** knob until the dashed vertical cursor line lies on the peak overshoot of the VCO tuning profile.

8. Press the fourth menu softkey from the top to select the **Mod Vals** choice.

9. Read the exact overshoot frequency (1.460 MHz) located in the upper half of the graphic screen display immediately to the right of **Pk-Pk:**. The median of the marker peak-to-peak value is read just underneath to the right of **Center:**.

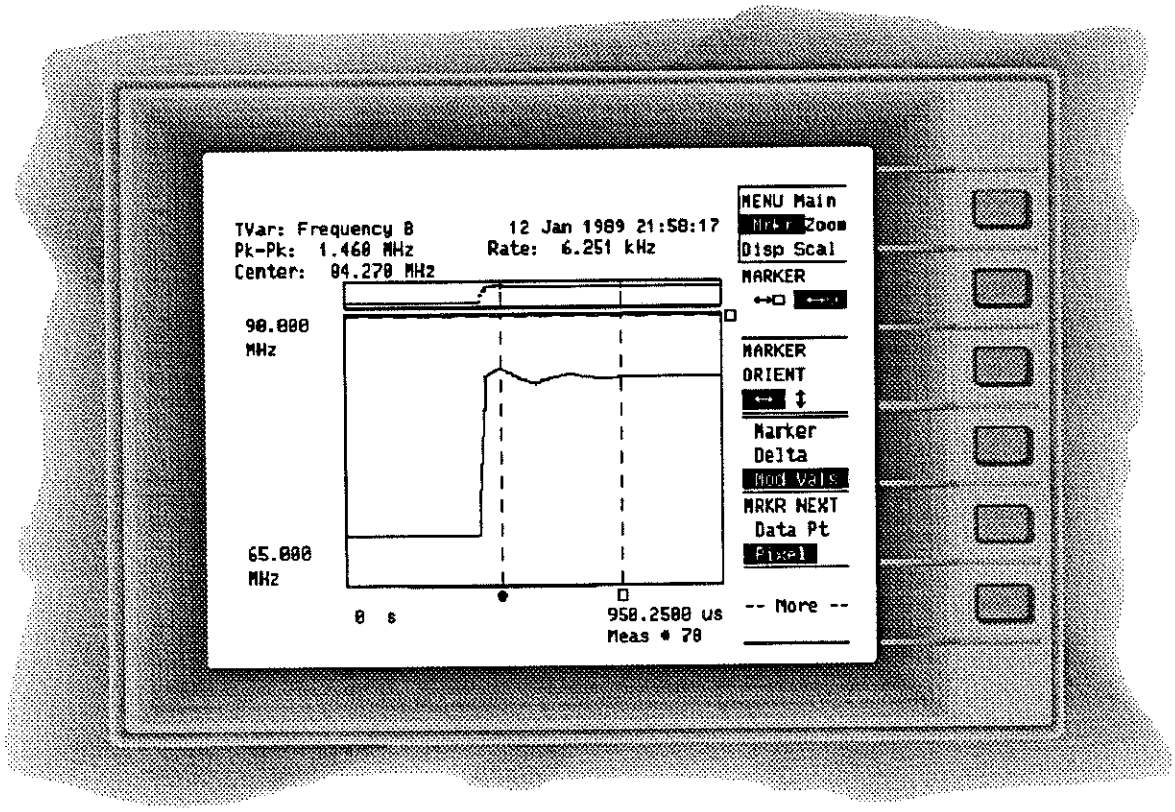


Figure 7-3. Modulation Domain Display

SETTLING TIME

Perform the following steps to determine the settling time:

1. Use the first VCO transition measurement procedure to capture a VCO step response profile.
2. Move from the **Main** Graphic display selection to the **Mrkr** display function (top softkey).
3. Select the horizontal arrows (**MARKER ORIENT** softkey).
4. Select a marker you wish to move first (**MARKER** softkey).
5. Rotate the **ENTRY/MARKER** knob until the dashed vertical cursor line lies at the beginning of the VCO step.
6. Select the next marker you wish to move (**MARKER** softkey).

7. Rotate the **ENTRY/MARKER** knob until the dashed vertical cursor line lies at the new VCO post-tune frequency

8. Select the **Delta** choice (fourth softkey).

9. Read the exact settling-time value (360.0040 us) located in the upper half of the graphic screen display immediately to the right of **Mkr x:**.

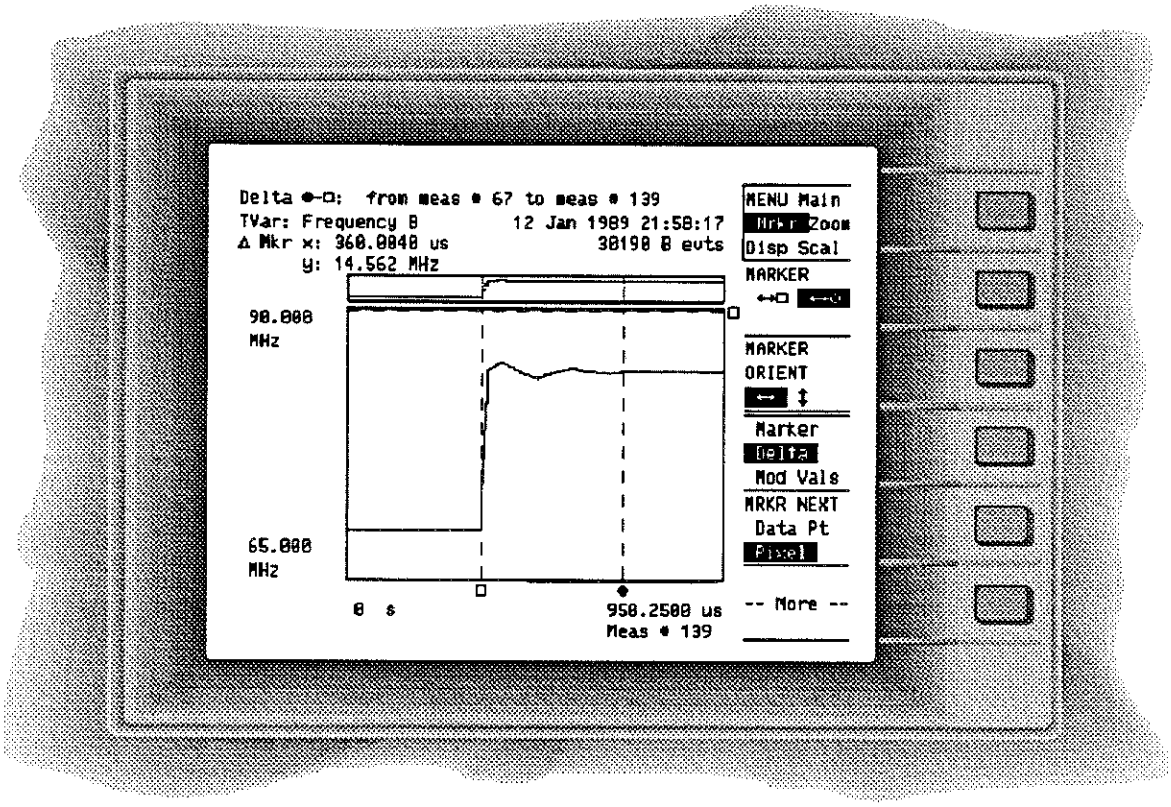


Figure 7-4. Modulation Domain Display

Index

A

Analysis features 1-2
Analyzer
  Front-panel softkeys 2-18
  HELP menus 2-19
  Main function hardkeys 2-19
  Measurement function 2-11
  Menu parameters 2-15
  Power-up 2-2
Arming
  Automatic 2-28
  Interval sampling 2-28
  Mode selection 2-27
  Pre-trigger 2-32

B

Barker-code sequence (13-bit) 6-1
Block sample size 2-22

C

Chirp modulation 5-1
Coherent pulse-to-pulse phase 4-2
Coherent pulse-doppler radar 4-1
Cursor/scroll control keys 2-17

D

Default conditions 2-3
Detected video output 2-11

E

Event pre-triggering 2-32
External attenuators 3-4
External detector 2-11

F

False alarms 4-1
Features 1-1
FMOP assessment 3-12
Frequency agile radar 7-1
Frequency standard output 2-20
Front panel
  Cursor/scroll control keys 2-24
  Entry/marker knob 2-24
  Frequently used keys 2-2
  Function hardkeys 2-19
  Input hardkey 2-19
  Instrument state hardkey 2-19
  Math hardkey 2-19
  Pre-trigger hardkey 2-19
  Softkeys 2-11, 2-18
  Status hardkey 2-20
  System hardkey 2-20
  Test hardkey 2-20
Function menu HELP 2-20

G

Gate
  Controlling, time 2-30
  Data display 2-30
  LED indicator 2-22
General measurement process 2-5
Graphic display HELP 2-20
Ground clutter 4-1

H

HP-IB HELP 2-20

I

Input
  Attenuators 3-4
  Channel A measurements 2-11
  Channel B envelope power measurements 2-11
  Standard 50 Ohm pod 2-11
Input menu HELP 2-20
Instrument
  Default state 2-4
  Front-panel softkeys 2-18
  Management menus 2-19
  Measurement function display 2-11

L

Linear-chirp radar 5-1

M

Making measurements
- Coherent pulse-to-pulse phase 4-2
- Frequency deviation 5-4
- Frequency distribution histogram 7-4
- Frequency profile 5-2
- Pulse carrier-frequency sequence 7-2
- Pulse envelope parameters 3-5
- Pulse/CW frequency/period 3-10
- Simple frequency 2-20
- Staggered PRI 4-5
- VCO frequency transition 7-5

Math menu HELP 2-20
Measurement
- Function menu result display 2-22
- Agile frequency procedure 7-2
- Arming modes 2-27
- Block size 2-22
- Changing menu parameters 2-15
- Coherent pulse-to-pulse phase procedure 4-2
- Cursor/scroll control 2-17
- Customization 2-26
- Data entry/number of blocks 2-24
- Features 1-1
- Frequency deviation procedure 5-4
- Frequency distribution histogram procedure 7-4
- Frequency profile procedure 5-2
- Function menus 2-11
- Gate- time control 2-30
- General process 2-5
- General test setup/considerations 3-4
- Menu function listing 2-12
- Parameter fields 2-15
- Phase transition procedure 6-2
- Pulse burst parameters 3-3
- Pulse envelope parameters procedure 3-4
- Pulse envelope terminology 2-13, 3-2
- Pulse or CW frequency and period procedure 3-9
- Reviewing results 2-23
- Sample -size preset default 2-22
- Setup menus 2-19
- Softkey function control 2-18
- Staggered PRI procedure 4-5
- VCO frequency transition procedure 7-5

Measurement Resolution 2-28
Menu
- Instrument management 2-19
- Measurement functions 2-11
- Measurement setup choices 2-19
- Operating information (HELP) 2-20
- Softkey operation 2-18

Modulation analysis 3-15
Modulation domain
- Agile frequency 7-3
- Barker-code sequence 6-2
- Coherent pulse-to-pulse phase 4-4
- FMOP assessment 3-12
- Frequency deviation 5-6
- Frequency histogram 7-4
- Frequency profile 5-3
- Phase accuracy 6-7
- Phase-transition timing 6-5
- Staggered PRI histogram 4-5
- VCO overshoot frequency 7-7
- VCO settling time 7-8

N

Numeric results 2-23

P

Parameter fields 2-15
Phase deviation measurement 4-2
Phase-accuracy measurement 6-6
Phase-code demodulation 6-2
Phase-coded radar 6-1
Phase-transition timing measurement 6-4
Power-up
- Default condition 2-3
- Self- test 2-2

Pre-trigger menu HELP 2-20
Preset function menu 2-3
Preset key default conditions 2-4
Pulse
- Carrier Frequency 3-2
- Carrier frequency/period measurement procedure 3-9
- Duty cycle 3-2
- Envelope detector pod 2-11
- Envelope measurement procedure 3-4
- Envelope parameter terminology 3-2
- Envelope Parameters 2-11
- Envelope power 3-2
- Offtime 3-2
- Repetition frequency (PRF) 3-2
- Repetition interval (PRI) 3-2

Width 3-2
Pulse/CW Measurement Functions 3-3

Q

Quick Reference Guide 2-5
Function key/menu 2-5, 2-6
Graphic key/menu 2-5, 2-9
Input key/menu 2-5, 2-7
Math key/menu 2-5, 2-8
Numeric key/menu 2-5, 2-10
Restart key 2-5, 2-9
Single/Repet key 2-5, 2-9

R

Radar
Coherent pulse-doppler 4-1
Detection range 5-1, 6-1
Frequency agile 7-1
Linear-chirp 5-1
Phase coded 6-1
Range accuracy 3-1
Resolution 3-1, 5-1, 6-1
Simple, pulsed 3-1
Target velocity/direction, relative 4-1
Test setup 3-4
Remote operation
Pulse envelope measurements 3-8
Pulse/CW carrier frequency/period measurement 3-16
Resolution
Input frequency/sampling interval 2-28
Selecting 2-30
Results HELP 2-20

S

Self-test
Power-up run time 2-2
Simple pulsed radar 3-1
Single-shot resolution 2-28
Statistics softkey 2-24

T

Test menu HELP 2-20
Test setup,general 3-4

U

User interface HELP 2-20
Using
Cursor/scroll control keys 2-17
Front-panel controls 2-1
Front-panel menu parameters 2-15
Front-panel softkeys 2-18
Measurement function menus 2-11
The HP 5373A analyzer 2-1
Using this manual 1-2

V

VCO settling time measurement 7-7
VCO transient overshoot measurement 7-6
Video signal parameters 2-13, 3-2

Z

Zooming in and out 3-14

HP 5373A Function and Arming Summary

ARMING MODE	MEASUREMENT FUNCTION												
	TIME INTERVAL OR HISTOGRAM TI		CONTINUOUS TIME INTERVAL OR HISTOGRAM CTI	± TIME INTERVAL OR HISTOGRAM ± TI		PRF, FREQUENCY, PRI, PERIOD		TOTALIZE		PULSE WIDTH, OFFTIME, RISE TIME, FALL TIME, DUTY CYCLE	PHASE	ENVELOPE POWER, AMPLITUDE MODULATION	PHASE DEVIATION, TIME DEVIATION, FREQUENCY DEVIATION
	A	A → B	A	A	A → B	A	DUAL[1]	A	DUAL[1]	A	A rel B	A	A
	B	B → A	B	B	B → A	B	RATIO[2]	B	RATIO[2]		B rel A	B	B
						C	SUM[3]		SUM[3]				
							DIFF[4]		DIFF[4]				
AUTOMATIC													
AUTOMATIC	C *	C *	C *		C *	C *	C *			C *	C *	N *	C *
HOLDOFF													
EDGE HOLDOFF	C	C	C		C	C					C		C
TIME HOLDOFF	C	C	C			C							
EVENT HOLDOFF	C	C	C			C							
SAMPLING													
INTERVAL SAMPLING	C	C	C		C	C	C	C *	C *		C		C
TIME SAMPLING						N							
CYCLE SAMPLING						C							
EDGE SAMPLING						C	C	C	C				
PARITY SAMPLING					C								
REPET EDGE SAMPLING	C	C	C		C								
REPET EDGE-PARITY SAMPLING					C								
RANDOM SAMPLING	C	C			C								
HOLDOFF/SAMPLING													
EDGE/INTERVAL	C	C	C		C	C	C	C	C		C		C
EDGE/TIME						N							
EDGE/EDGE						C		C	C				
EDGE/CYCLE						C							
EDGE/EVENT				N	N	N							
EDGE/PARITY					C								
EDGE/RANDOM	C	C			C								
TIME/INTERVAL						C		C					
TIME/TIME				N	N	N							
EVENT/INTERVAL						C							
EVENT/EVENT				N *	N	N							
EXTERNALLY GATED						C		C	C				
MANUAL								N	N				

Symbol C or N indicates that a measurement can be made using the corresponding combination of Function, Channel, and Arming selections.

C = Continuous Arming, (Block/Sample Arming)

N = Non-Continuous arming, (Start/Stop Arming), setups are limited to M blocks of 1 measurement.

1. DUAL. Simultaneous Dual-channel, (2 results). Frequency and Period options are: A&B, A&C, B&C. Totalize option is: A&B.
2. RATIO. Frequency and Period ratio options are: A/B, A/C, B/A, B/C, C/A, C/B. Totalize ratio options are: A/B, B/A.
3. SUM. Frequency and Period sum options are: A+B, A+C, B+C. Totalize sum option is: A+B.
4. DIFFERENCE. Frequency and Period difference options are: A–B, A–C, B–A, B–C, C–A, C–B. Totalize difference options are: A–B, B–A.

* = Default Arming

ARMING CATEGORIES

Category	Continuous Arming Modes	Non-Continuous Arming Modes
Automatic	Block Holdoff is Automatic Sample Arm is Automatic	none
Holdoff Modes	Block Holdoff is User-defined Sample Arm is Automatic	none
Sampling Modes	Block Holdoff is Automatic Sample Arm is User-defined	Start Arm is Automatic Stop Arm is User-defined
Holdoff/Sampling Modes	Block Holdoff is User-defined Sample Arm is User-defined	Start Arm is User-defined Stop Arm is User-defined