HP 3563A Operating Manual

Control Systems Analyzer

Volume I

HEWLETT PACKARD

HP Part No. 03563-90000
Microfiche No. 03563-90200

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and the calibration facilities of other International Standards Organization Members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.
For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.
HP software and firmware products which are designated by HP for use with a hardware product, when properly installed on the hardware product, are warranted not to fail to execute their programing instructions due to defects in materials and workmanship. If HP receives notice of such defects during their warranty period, HP shall repair or replace software media and firmware which do not execute their programming instructions due to such defects. HP does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.
NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

Warning   Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.


HEWLETT PACKARD

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

⚠️   Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

⚡   Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked.)
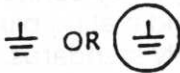
⏚ OR (⏚)   Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

(⏚)   Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

⏚ OR ⊥   Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

∼   Alternating current (power line.)

⎓   Direct current (power line.)

≃   Alternating or direct current (power line.)

Warning   The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.

Caution   The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition 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.

Note   The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Chapter 11: Disc/Plotter/HP-IB Operations

Chapter 12: Special Functions/Preset Conditions

Table of Contents

Table of Contents

Table of Contents

Introduction

This section contains these two chapters:

- Chapter 1: Introduction
- Chapter 2: Measurement Overview

Chapter 1 tells you how to use this manual, where to find additional information, and briefly describes all front-panel hardkeys. It also explains the terms used throughout this manual.

Chapter 2 contains an overview of the measurement setup procedures for the HP 3563A. It also describes how the analyzer's four measurement modes affect the measurement setup procedures. Then, it describes the analyzer's four measurement modes and lists the features available in each.

Note

Chapter 1 contains information necessary to use this manual; chapter 2 contains information necessary to understand how the HP 3563A operates. Other chapters in this manual are easier to understand if you read these chapters first.

Introduction

Please take a few moments to read this introductory chapter. This chapter summarizes the features of the HP 3563A, describes the organization of this manual, and defines the terms used throughout the manual. After you have read this chapter, read chapter 2, "Measurement Overview," to learn some of the fundamentals that you should know before using the HP 3563A.

The HP 3563A offers a variety of features to help you test, analyze, and design analog, digital, and mixed (analog and digital) systems and devices — in both the time and frequency domains. A pair of differential analog-inputs let you measure analog signals from DC to 100 kHz. Or, digital inputs accept TTL-level parallel data up to 16-bits wide with data rates as high as 256 kHz and clock rates up to 10 MHz.

The HP 3563A's source can output many types of analog or digital signals to stimulate your device under test.

How to Use this Manual

This manual consists of two volumes which describe all features in the HP 3563A Control Systems Analyzer (except HP-IB operation; for this information, see the HP 3563A Programming Manual). The information in this manual is divided into chapters — the information that you will use most often is in volume 1. Table 1-1 summarizes the contents of each chapter.

Note

The *HP 3563A Installation Guide* is included in Volume II of this manual. The installation guide shows you how to install the HP 3563A. It also contains specifications, operation verfication tests, and performance tests.

Table 1-1. Manual Summary

VOLUME I	
Sections & Chapters	**Chapter Description**
Introduction	
1 Introduction	Tells you how to use this manual, where to find additional information, and briefly describes all front-panel hardkeys.
2 Measurement Overview	Introduces the measurement setup procedures and explains and compares the four measurement modes.
Measurement Modes	
3 Linear Resolution Mode	Shows you how to perform linear resolution measurements.
4 Log Resolution Mode	Shows you how to perform log resolution measurements.
5 Swept Sine Mode	Shows you how to perform swept sine measurements.
6 Time Capture Mode	Shows you how to perform time capture measurements
Input Setup	
7 Input Setup	Shows you how to set up the inputs for analog, digital, or mixed (analog and digital) systems.
Display Configuration	
8 Display Configuration	Shows you how to configure the display and use the display markers to analyze measured data.

Table 1-1. Manual Summary (cont.)

VOLUME I	
Sections & Chapters	**Chapter Description**
Other Operations	
9 Time Throughput	Shows you how to store input data directly to disc.
10 Auto Sequence Programming	Shows you how to create, run and edit auto-sequence programs.
11 Disc/Plotter/HP-IB Operation	Shows you how to use the HP 3563A as an HP-IB controller to plot the display, access disc drives, and output HP-IB command strings.
12 Special Functions/Preset	Explains the features available under the **SPCL FCTN** and **PRESET** hardkeys (such as self tests, service tests, setting the internal clock or beeper, activating source protection, generating a power-on service request over the HP-IB, or using predefined measurement setups).
Digital & Mixed Measurements	
13 Digital Connections	Shows how to connect the HP 3563A to digital circuits.
14 Digital & Mixed Measurements	Shows how to make digital and mixed measurements with the HP 3563A.
Index	

VOLUME II	
Sections & Chapters	**Chapter Description**
Data Operations	
15 Math & Auto Math	Shows you how to perform manual or automated waveform-math operations on measured data.
16 Curve Fit	Shows you how to generate an H(s) or H(z) model (in pole zero, pole residue, or polynomial format) from measured or synthesized frequency-response data.
17 Synthesis	Shows you how to generate frequency-response curves from an H(s) model, an H(z) model, or the product of both — with or without the effects of zero-order hold.
Appendices	
A Connector/Indicator Descriptions	Explains all connectors and indicators on the front and rear panel.
B Error & Status Messages	Lists and describes all error and status messages.
C Menu Diagrams	Contains the menu diagrams for all hardkeys and softkeys.
Index	

Where to Find Additional Information

Additional information is available for the HP 3563A, as shown below. You received all of this information, except for the *HP 3563A Service Manual*, with your purchase of the HP 3563A. If you need additional copies, contact your local HP Sales and Service Office. HP Sales and Service Office locations are listed in the back of this manual.

- *HP 3563A Installation Guide*
- *HP 3563A Getting Started Guide*
- *HP 3563A Programming Reference*
- *HP 3563A Service Manual* (option 915)
- Help text (see "HELP Hardkey" later in this chapter for details)
- Visual help (see chapters 2 and 12 for details)

The *HP 3563A Installation Guide* contains specifications, installation instructions, and performance tests. The *HP 3563A Getting Started Guide* helps you with your first measurements. It contains an overview of and introduction to the analyzer plus digital details, control system methods and models, and a control system tutorial. The *HP 3563A Programming Reference* tells you how to control the HP 3563A via HP-IB. The *HP 3563A Service Manual* shows you how to maintain, troubleshoot, and repair the HP 3563A. Internal to the HP 3563A are help text and visual help. Press **HELP** to access the HP 3563A's help text— reference information about any hardkey or softkey. Press **SPCL FCTN** VISUAL HELP to access the HP 3563A's visual help — a graphic illustration of the current analyzer configuration.

Applications Information

Additionally, you will find applications information in numerous Hewlett-Packard Application and Product Notes. These are available from your local HP Sales and Service Office. In particular, you might want to read the following notes (the *HP 3563A Getting Started Guide* includes all of these notes):

- AN 243 — The Fundamentals of Signal Analysis
- AN 243-2 — Control System Development Using Dynamic Signal Analyzers
- AN 243-4 — Fundamentals of the z-domain & Mixed Analog/Digital Measurements
- HP 3562A-3 — Curve Fitting in the HP 3562A
- HP 3563A-1 — z-Domain Curve Fitting in the HP 3563A Analyzer
- HP 3563A-2 — Example Microprocessor Interfacing with the HP 3563A
- Designer's Guide to: Linear Control-System Theory (reprint of three separate EDN articles)

Some Terms to Know

The following are terms used throughout this manual that you may not be familiar with:

Hardkeys are all the keys on the front of the analyzer not including the eight softkeys. Hardkeys are grouped by function, as labeled on the analyzer's front panel. Hardkeys always perform the same function.

Softkeys are the eight keys aligned in a vertical column at the right side of the analyzer's screen (see figure 1-2). The function of these keys changes as you press other hardkeys or, in some cases, other softkeys. A softkey's current function is indicated by a video label to the left of the softkey (on the edge of the analyzer's screen). Softkeys perform several functions, as shown in figure 1-1. In some cases, two or more softkeys may be grouped by a left-bracket into a 1-of-N selection. In this case, only one softkey in the group can be active at any time (the active softkey appears highlighted and underlined). In other cases, a softkey may be a toggle softkey — its label contains two or more choices. An example of this is the SLOPE + − softkey. You press this softkey to toggle between a positive or negative slope (the active choice appears highlighted and underlined).

Softkey Menu or Menu refers to the list of video labels next to the softkeys (see figure 1-2).

Menu Diagram shows all softkeys available under a hardkey (for an example, see appendix C which contains menu diagrams for all hardkeys). Default selections are underlined and shown in **bold** type (for example, figure 1-1 shows that **FREE RUN** is the default trigger type).

Note

In this manual, hardkeys and softkeys are printed like this:

Example hardkey: **SELECT TRIG**
Example softkey: FREE RUN

Furthermore, a sequence of key presses is separated by slashes like this:

Example key sequence: **SELECT TRIG**/MORE TYPES/EXT TRIG

```
┌────────┐
│ SELECT │  ┌─⟩    Softkey Menu
│  TRIG  │
└────────┘
```

Data Entry Softkeys ──────────→ TRIG ♪   ☐
                                 LEVEL ꜜ

Toggle Softkeys ──────────────→ ARM   ☐
                                 AU MAN

1 of N Selections ────────────→ FREE   ☐
(bracket marks list)   RUN
                                 ────

                                 CHAN 1   ☐
                                 INPUT

                                 CHAN 2   ☐
                                 INPUT

                                 SOURCE   ☐
                                 TRIG

Displays Another Menu ────────→ MORE →   ☐
                                 TYPES

                                 SLOPE   ☐
                                 + -
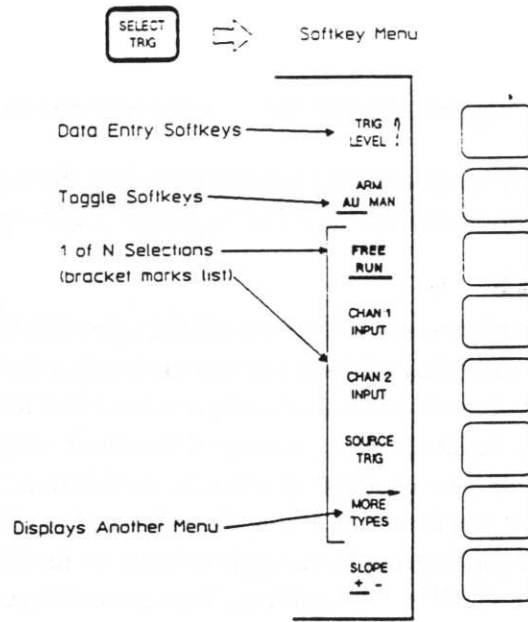
Figure 1-1. Softkey Example: Select Trigger Menu

Front-Panel Tour

The following summaries are an introduction to the basic function of each front-panel key groups or **blocks**. These summaries are presented in the order that the blocks would typically be used to perform a measurement.
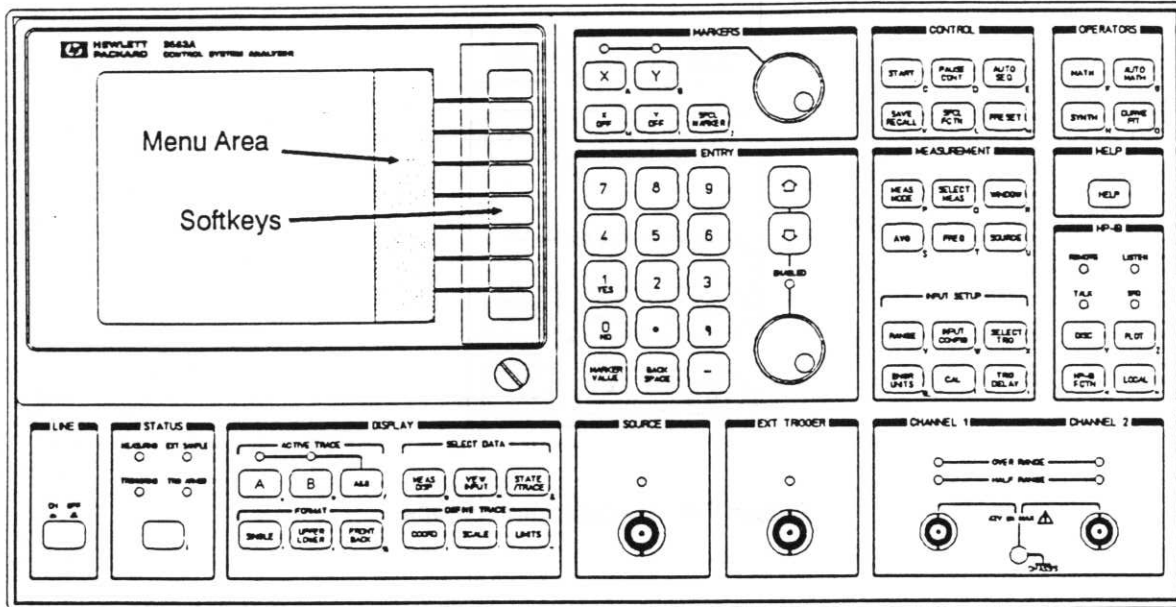
Figure 1-2. HP 3563A Front Panel Connection

Channel 1 and Channel 2 Input Connectors

The maximum input signal level allowed on the input connectors is $\pm 42\ V_{pk}$ relative to chassis ground. Larger voltages could damage the channel input circuitry. The outer conductors of the BNC connectors are **not** connected to chassis ground. This allows the input signal to be floated. They can be individually grounded or floated with selections under the **INPUT CONFIG** hardkey.
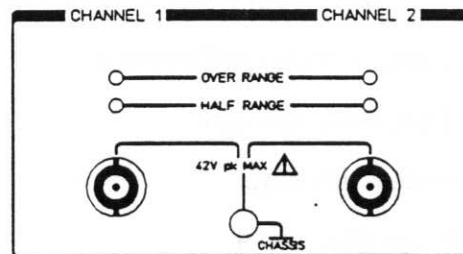
Figure 1-3. Input Connectors

Measurement Block

This group of keys lets you select parameters that determine how the analyzer performs a measurement.
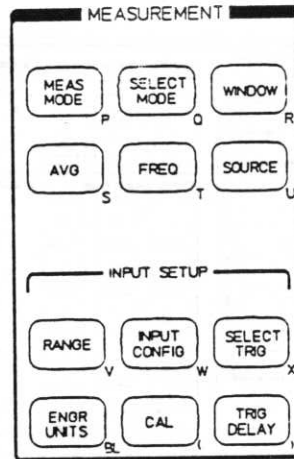
Figure 1-4. Measurement Block

MEAS MODE: selects the measurement mode

SELECT MEAS: selects measurement to be calculated

WINDOW: selects the window used in the FFT analysis

AVG: selects averaging types and number of averages

FREQ: selects the measurement frequency range

SOURCE: used to configure source waveform, amplitude, and offset

RANGE: selects input range configuration (autorange or fixed range)

INPUT CONFIG: selects analog /digital input configuration

SELECT TRIG: selects trigger type, level and slope

ENGR UNITS: selects special engineering units

CAL: controls the analyzer's internal calibration

TRIG DELAY: selects the trigger delay

Display Block

A wide choice of display formats and coordinates enhances the analysis of measurements. Depending on the selected measurement, several functions can be displayed. For example, if the selected measurement is FREQ RESP, the measurement display selections include power spectrum and frequency response.
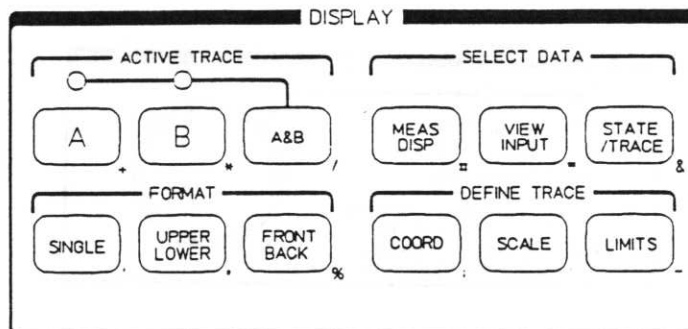
Figure 1-5. Display Block

Active Trace Group: Three hardkeys used to select the active trace. You can have either one or both active. The active trace is used in conjunction with other keys to define/configure the trace data, coordinates, scale, active markers, etc.

Format Group: Three hardkeys used to select the display format. You can have one or both traces displayed. If two are displayed, they can be overlaid with **FRONT BACK** or displayed separately with **UPPER LOWER**.

MEAS DISP: used to select the measurement data to display; depends on selected measurement (configured with **SELECT MEAS**). Other displays are available under VIEW INPUT. See "Measurement Modes and Displays" in chapter 2 for details.

VIEW INPUT: used to display full span, freerun (no trigger), time or spectrum data (independent of the measurement). See "Instantaneous Displays" in chapter 2 for details.

STATE/TRACE: used to toggle the display between showing the traces and displaying a table containing the state (configuration) of the analyzer. This table may be two "pages" if a channel or the source is digital.

COORD: selects coordinates of measurement data display. Measurement data may be complex (in other words, containing both real and imaginary parts). Coordinate selections include magnitude, phase, real, and imaginary for the y-axis; as logarithmic or linear for the x-axis; and Nichols or Nyquist formats for both axes.

SCALE: selects the scaling of the data on the screen.

UNITS: selects the units for both the horizontal and vertical axis. Also adds trace titles.

Markers Block

Markers simplify the analysis of displayed data. Marker functions include single-point and band (delta; Δ) cursor operation. Special markers (such as gain and phase margin, peak search, harmonic, and sideband markers), and slope readouts save time in network and spectrum analysis.
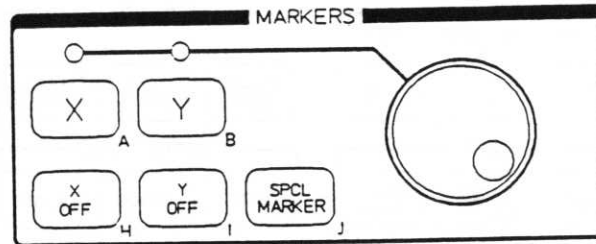
Figure 1-6. Markers Block

X: turns on or activates the horizontal axis marker(s).

X OFF: turns off the horizontal axis marker(s).

Y: turns on or activates the vertical axis marker(s).

Y OFF: turns off the vertical axis marker(s).

SPCL MARKER: selects special marker functions and calculations:
- Harmonic, sideband markers, slope, and move-marker-to-peak
- Gain & phase margins, frequency and damping, power, and average value
- Data editing (for arbitrary source)

Entry Block

You can enter discrete frequencies and levels using the numeric keypad. If a marker is active, the **MARKER VALUE** hardkey can be used to enter the displayed marker amplitude or frequency value for the active parameter. The up/down arrow keys and the knob are used for fast entry or adjustment of numerical parameters. For example, the knob makes it easy to scroll through the available frequency spans for rapid setup of zoom measurements. Manual selection of input range is simplified with the
arrow keys.
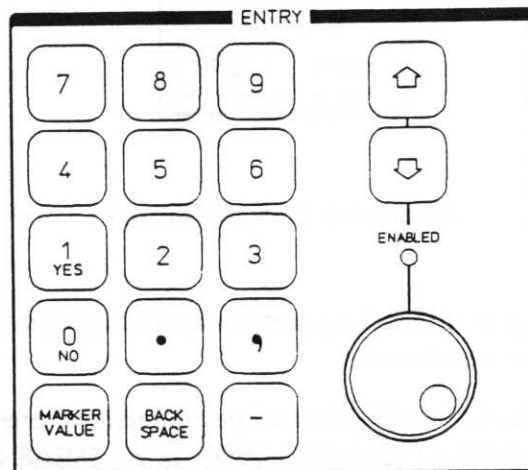
Figure 1-7. Entry Block

Operators Block

These four hardkeys access softkeys that perform advanced analysis of measurement data.
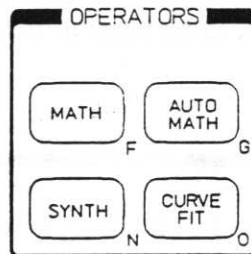
Figure 1-8. Operators Block

MATH: performs waveform math block operations such as algebra, integration, differentiation, forward and inverse Fourier transforms.

AUTO MATH: used to automate math calculations or perform repeated math on measurements as data is collected (See AUTO MATH in the **MEAS DISP** menu).

SYNTH: performs frequency-response trace synthesis from data entered in the synthesis table. Two synthesis tables exist at all times; one for the s domain and another for the z domain.

CURVE FIT: performs curve fitting of measured or recalled frequency-response function data. Two curve-fit tables exist at all times; one for the s domain and another for the z domain.

Control Block

This group of keys helps control the analyzer's operation.
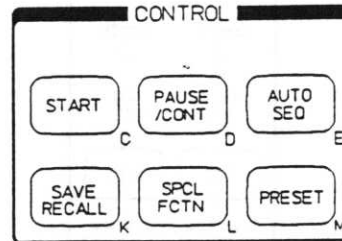
Figure 1-9. Control Block

START: used to start a measurement.

PAUSE/CONT: used to pause or continue a measurement.

AUTO SEQ: used to set up and control auto sequence programs.

SAVE/RECALL: used to save and recall analyzer state or data — there are five non-volatile storage locations for each, numbered 1 through 5. You can also recall the state at last power shutdown.

SPCL FCTNS: accesses a number of the analyzer's miscellaneous features, such as:
- Time and date settings
- Beeper control (on/off)
- Visual help features
- Self-tests and service tests

PRESET: presets the analyzer to the current measurement mode and displays the special preset menu. To perform a complete reset to power-on conditions, press the RESET softkey.

HP-IB Block

These keys allow configuration of the analyzer to provide direct control of external HP-IB plotters and disk drives. for documentation of measurement or analysis results.
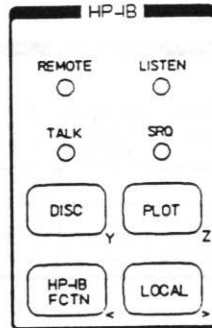
Figure 1-10. HP-IB Block

DISC: selects disk functions

PLOT: selects plotter functions

HP-IB FCTN: used to configure HP-IB (addresses, SRQs, and bus messages)

LOCAL: requests local (front-panel) operation when analyzer is under remote control

Status Block

The operating status of the analyzer is displayed by the LEDs in the Status block. Manually triggered measurements are initiated with the **ARM** key.
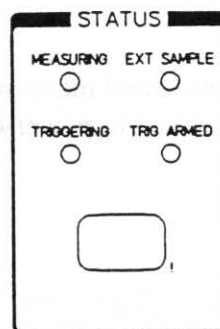
Figure 1-11. Status Block

Help Key

The **HELP** hardkey provides quick, easy to find information shown on the analyzer's display. Press the **HELP** key twice for general information. Press the **HELP** followed by any other key for details about that key.
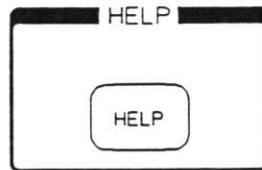
Figure 1-12. Help Block

As an example, press the **HELP** hardkey twice. This displays the help text for the HELP key (see figure 1-13). Note, in the upper right-hand corner of the display, the "Page 1 of 24" callout. This tells you where you are in the help text and how large the help "document" is. To see the next page, press the down-arrow in the Entry Block. To see the previous page, press the up-arrow. To erase the help display, press the **A** or **B** hardkey (this returns the trace display).
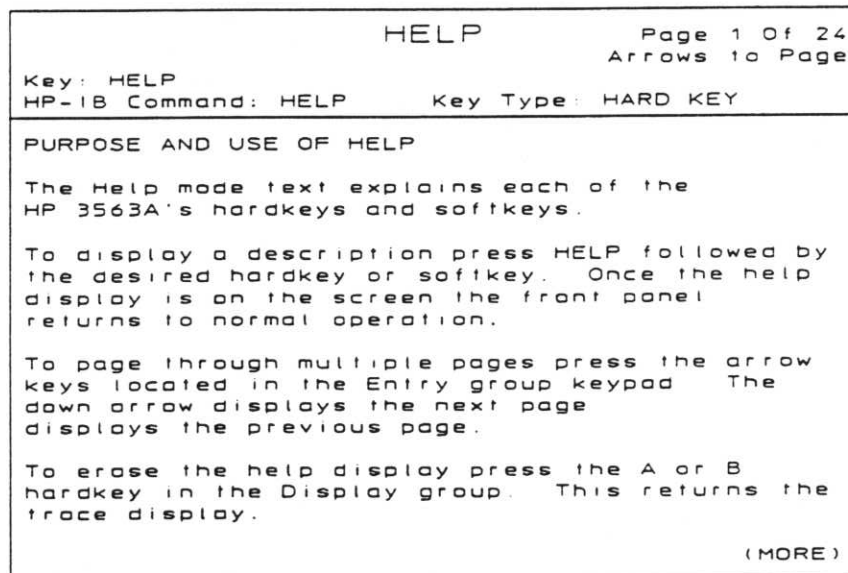
Figure 1-13. Help Text for the HELP Key

Chapter 2

Measurement Overview

Measurement Overview

Purpose Of This Chapter

This chapter provides an overview of the measurement setup procedures for the HP 3563A control systems analyzer. It contains some basic information that you should know — information that will help you choose the best measurement mode for your measurements. You should read this chapter before proceeding with any of the following chapters. The following chapters contain detailed information that may be easier to understand if you read this chapter first.

This chapter begins by explaining the steps necessary to set up the HP 3563A for your measurements. The remainder of the chapter then compares the analyzer's four different measurement modes and discusses why you might select one over another. This comparison includes:

- Descriptions of each measurement mode
- Menus that differ between measurement modes
- How measurements differ between measurement modes, including:
  - the measurements available in each measurement mode
  - the measurement process used by the HP 3563A
  - the measurement displays available in each measurement mode
- Trace coordinates and units available in each measurement mode
- Averaging types and features available in each measurement mode
- Source types available in each measurement mode

Steps to set up a Measurement

With the HP 3563A, all measurements begin by selecting one of the following four
measurement modes:

- Linear Resolution Mode (described in chapter 3)
- Log Resolution Mode (described in chapter 4)
- Swept Sine Mode (described in chapter 5)
- Time Capture Mode (described in chapter 6)

Each measurement mode offers a different measurement technique for your measurements.
The measurement mode that you select determines the steps you should follow to set up your
measurement. In addition, the steps may vary depending on the type of measurement. Specifically,
the steps may vary if the measurement is:

- Analog
- Digital
- Mixed (analog and digital)

See the chapter that discusses the measurement mode you are using for the correct setup
procedures. For example, if you are using the linear resolution mode, see chapter 3 "Linear
Resolution Mode". If you are using the log resolution mode, see chapter 4 "Log Resolution Mode".

Measurement Setup and Visual Help

You may want to use visual help to see configuration changes as you set up the analyzer. There are
several types of visual help available in the HP 3563A. There are flow diagrams and input-channel
configuration diagrams which can be accessed through the **SPCL FCTN** hardkey.

Figures 2-1 and 2-2 show samples of visual help. To display visual help, press **SPCL FCTN** followed
by VISUAL HELP. To redisplay the trace, press the **A** or **B** hardkey. See chapter 12 for further
details.
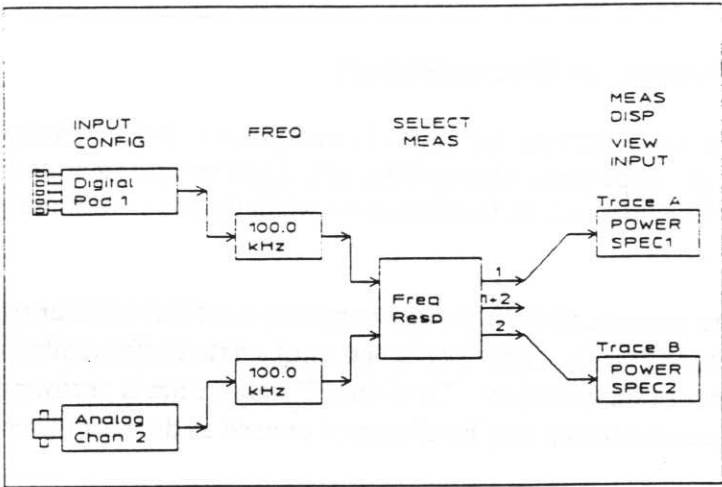
Figure 2-1. Typical Flow Diagram
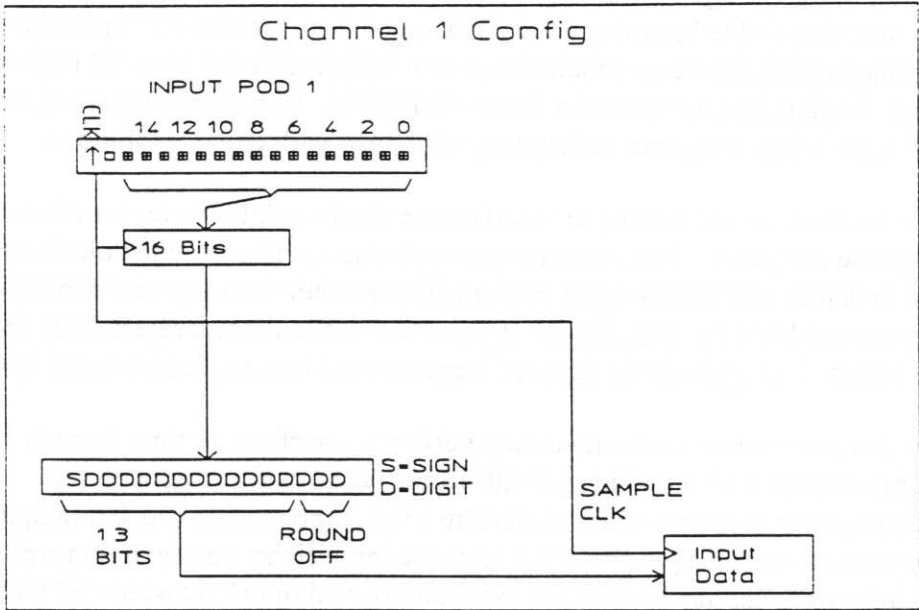
Figure 2-2. Typical Channel-Configuration Diagram

Measurement Modes: A Comparison

The HP 3563A offers four different measurement techniques — called measurement modes (linear resolution, log resolution, swept sine and time capture). Each measurement mode configures the HP 3563A differently. The information in this section will help you determine which measurement mode to use.

Linear Resolution is the measurement technique common to all fast-Fourier transform (FFT) analyzers. Typically, a time domain signal is sampled until a data buffer (called the time record) is filled with a fixed number of time samples. Then the FFT algorithm is performed on the data, creating a frequency spectrum which may be displayed or used as data for other processing.

Log Resolution uses linear resolution data to create proportional-bandwidth, logarithmically-spaced measurements (this is similar to a log swept sine test). Multiple decades of linear resolution data are combined, rather than redistributed, to produce frequency spectrum or power spectrum data with a true log frequency scale. The key contribution of this measurement technique is the combination of fast, high resolution FFT analysis with the proportional resolution of a log sweep measurement. Furthermore, when applied to broadband testing of mechanical or electronic resonances, the log resolution technique provides better resolution at low frequencies and reduced measurement variance at high frequencies (compared to linear resolution). Log resolution can also save significant test time (when compared to log swept-sine tests with equal resolution).

Swept Sine is a measurement technique based on the single-point Fourier transform used in frequency-response analyzers. This measurement technique performs time domain integration of the input data to implement narrow-band tracking filters rather than use very expensive low-frequency narrow-band tracking filters. It provides excellent noise rejection at the cost of measurement speed. It is typically the favored measurement technique for control system analysis.

Time Capture is a measurement technique that performs waveform or time-domain analysis similar to making measurements with a digitizing oscilloscope. Time capture mode in the HP 3563A allows you to capture a block of data up to ten time records (20,480 samples) on one channel, then measure and analyze the block after the input signal has been removed. Time capture is used to record waveforms and to increase the effective real time bandwidth (RTBW) to 100 kHz. See HP Application Note 243 for more information on FFT analysis.

Menus Dependent on Measurement Mode

Most hardkeys, when pressed, display menus next to the softkeys. For example, when you press
MEAS MODE, a menu appears next to the softkeys that allows you to select a measurement mode.
It is important to know that the menus for some hardkeys change as the measurement mode
changes. Appendix C, "Menu Diagrams," shows you the menus that appear for all hardkeys.
You may want to use appendix C as a quick reference since it contains, in one place, all menus
for the analyzer.

If you glance through appendix C, you will notice that the menus for the following hardkeys change
when you change the measurement mode. For a description of these hardkeys, see the chapter that
discusses the measurement mode you are using (such as chapter 3, "Linear Resolution Mode").

- **MEAS MODE**
- **SELECT MEAS**
- **MEAS DISP**
- **AVG**
- **SOURCE** (this menu is the same for Linear Resolution and Time Capture modes)
- **FREQ** (this menu is the same for Linear Resolution and Time Capture modes)
- **VIEW INPUT**

Note

The **WINDOW, SELECT TRIG,** and **TRIG DELAY** hardkeys are *inactive* in Log
Resolution and Swept Sine modes.

Measurement Modes and Measurements

The HP 3563A allows you to make the following measurements:

- Frequency Response
- Power Spectrum
- Auto Correlation
- Cross Correlation
- Histogram

Some measurements are not available in all measurement modes. For example, the histogram measurement can be done only in linear resolution or time capture modes. The next section shows you the measurements that you can do in each measurement mode. Measurements are selected with the **SELECT MEAS** hardkey.

Note

You can also perform Time Throughput measurements with the HP 3563A. However, this measurement is available only in linear resolution and log resolution modes. See chapter 9, "Time Throughput," for details.

The Measurement Process

For all measurements, data may be taken through one or two channels, either of which may be digital or analog, in any combination. Figure 2-3 shows you the measurement process used by the HP 3563A. The process flow does not always include all the blocks shown (for example, swept sine measurements do not use the digital filter, trigger, window, or FFT blocks). Once the data is collected, it may be processed in any number of ways or not at all, as is shown by the display options on the right side of figure 2-3.
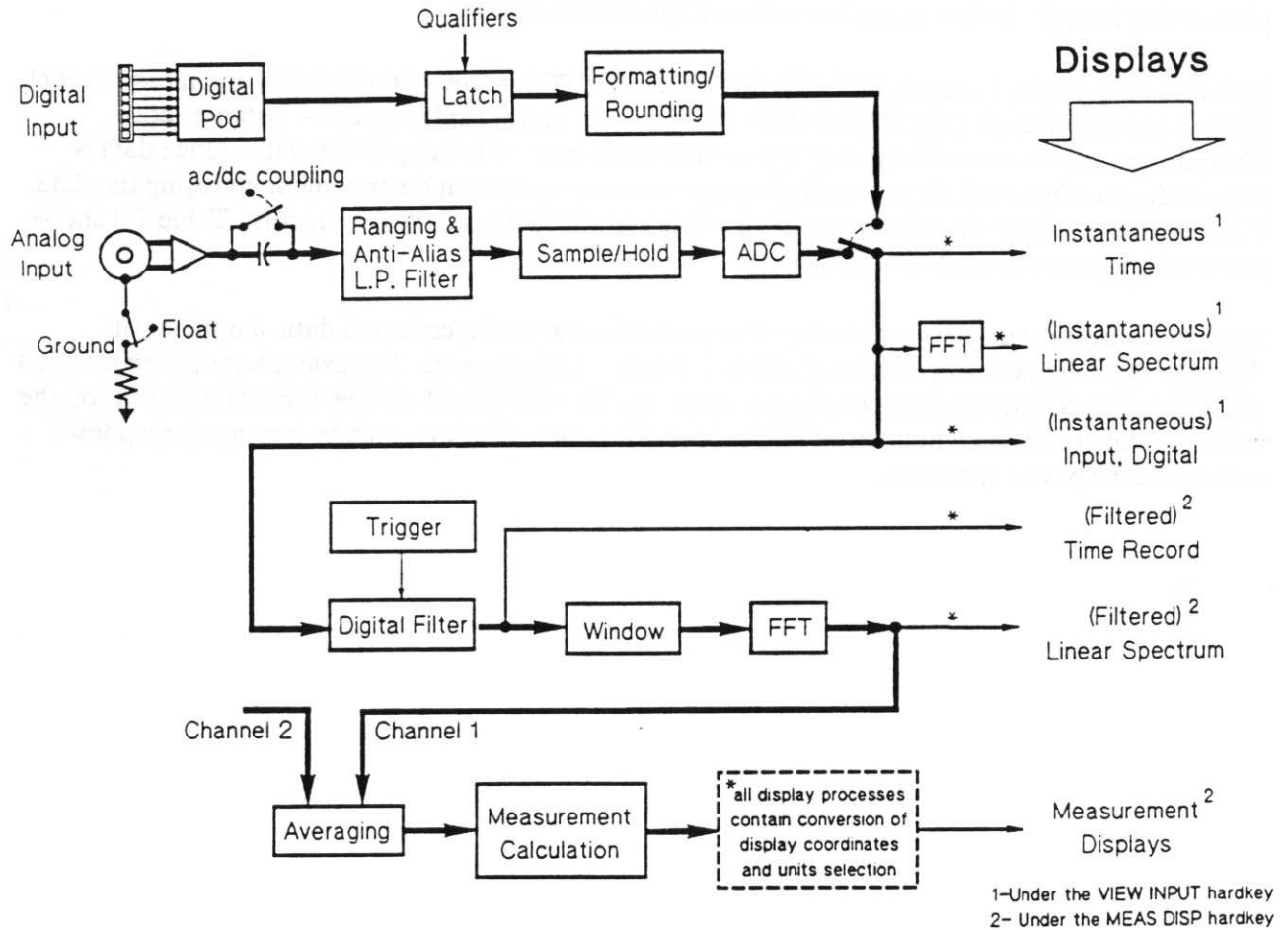
Figure 2-3. Measurement Process Diagram

Measurement Modes and Displays

Notice from figure 2-3 that you may display your measurement data as instantaneous data, filtered-input data, or as a measurement display. Instantaneous displays allow you to see the input signal before it is filtered or measured (see "Instantaneous Displays" later in this section). Filtered-input displays allow you to see the input signal after it has been filtered to the current frequency span (see "Filtered-Input Displays" later in this section). Measurement displays allow you to see the input signal after it has gone through the entire measurement process — which includes performing the calculation necessary to obtain the desired display.

Instantaneous displays are selected with the **VIEW INPUT** hardkey; filtered-input and measurement displays are selected with the **MEAS DISP** hardkey. All three display types — instantaneous, filtered-input, and measurement displays — are simply ways of looking at the data. Once data is collected, you may switch from one display type to another without destroying or changing the data. It is important to note that all display types are not available for all measurements. Table 2-1 shows you when you can use each type of display.

Since measurement displays are derived from calculations on the collected data, a number of different measurement displays are possible from one measurement. For example, suppose that you just completed a frequency-response measurement. The HP 3563A can perform calculations on the collected data to obtain a number of different measurement displays, such as frequency response, coherence, or power spectrum.

Table 2-1. Available Displays

MEASUREMENT (SELECT MEAS Hardkey)	DISPLAY TYPE	MEASUREMENT MODE(MEAS MODE Hardkey)			
		Lin Res	Log Res	Swept Sine	Time Capture
Frequency Response	Measurement Displays				
	- Frequency Response	X	X	X	—
	- Coherence	X	X	X	—
	- Power Spectrum	X †	X	X	—
	- Cross Spectrum	X	X	X	—
	- Impulse Response	X	—	—	—
	- Auto Math	X	X	X	—
	Instantaneous Displays	X	X	X	—
	Filtered-Input Displays	X	—	—	—
Power Spectrum	Measurement Displays				
	- Power Spectrum	X	X	—	X
	- Auto Math	X	X	—	—
	Instantaneous Displays	X	X	—	X
	Filtered-Input Displays	X	—	—	X
Auto Correlation	Measurement Displays				
	- Auto Correlation	X	—	—	X
	- Auto Math	X	—	—	—
	Instantaneous Displays	X	—	—	X
	Filtered-Input Displays	X	—	—	X
Cross Correlation	Measurement Displays				
	- Cross Correlation	X	—	—	—
	- Auto Correlation	X	—	—	—
	- Auto Math	X	—	—	—
	Instantaneous Displays	X	—	—	—
	Filtered-Input Displays	X	—	—	—
Histogram	Measurement Displays				
	- Histogram	X	—	—	X
	- PDF ††	X	—	—	X
	- CDF ‡	X	—	—	X
	- Auto Math	X	—	—	—
	Instantaneous Displays	X	—	—	X
	Filtered-Input Displays	X	—	—	X

† This is the default measurement, measurement display, and measurement mode at power-on or when you press **PRESET** RESET.

†† PDF is the probability-density function (see "The Histogram Measurement" in chapter 3 for details).

‡ CDF is the cumulitive-density function (see "The Histogram Measurement" in chapter 3 for details).

Instantaneous Displays

Instantaneous displays are available in all four measurement modes, as shown in the following table. These *time-domain* displays allow you to see the signal present at the analyzer's input (see figure 2-3). The signal that you see with these displays has not been filtered to the current frequency span (in other words, instantaneous displays are always full span [100 kHz]). Furthermore, the trigger has not been applied to this signal. Therefore, if a signal is present at the analyzer's input, instantaneous displays show that signal even if there is no trigger. In summary, instantaneous displays allow you to:

- See the analog signal present at the input (verify its presence)
- Verify that the input range is set correctly (if the input signal appears clipped, the input range is too low)
- See the status of the data bits on the digital input to help you set up measurements (see "Verifying Digital Connections" in chapter 13)
- See raw capture or throughput data
- Compare an input signal with a measurement display

Instantaneous displays are selected with the **VIEW INPUT** hardkey. For a description of these displays, see chapter 3, "Linear Resolution Mode," or chapter 6, "Time Capture Mode."

Table 2-2. Available Instantaneous Displays

INSTANTANEOUS DISPLAY (VIEW INPUT Hardkey)	MEASUREMENT MODE (MEAS MODE Hardkey)			
	Lin Res	Log Res	Swept Sine	Time Capture
Input Time	X	X	X	X
Input Spectrum	X	X	X	X
Input Digital	X	X	X	X
Time Record	—	—	—	X
Linear Spectrum	—	—	—	X
Time Buffer	—	—	—	X

Filtered-Input Displays

Filtered-input displays are available only in linear resolution and time capture modes, as shown in the following tables. Figure 2-3, "Measurement Process Diagram", shows how these displays are derived. Notice from figure 2-3 that filtered-input displays allow you to see *time-domain* displays (time record displays) or *frequency-domain* displays (linear spectrum displays). Filtered-input time-domain displays show the input signal after the input signal has been triggered and filtered to the current frequency span. Filtered-input frequency-domain displays show the input signal after the input signal has been triggered, filtered to the current frequency span, windowed (windows are selected with the **WINDOW** hardkey), and transformed to the frequency domain. Time record displays provide magnitude information. Linear spectrum displays provide magnitude and phase information.

Table 2-3. Available Filtered-Input Displays: Linear Resolution Mode

MEASUREMENT (SELECT MEAS Hardkey)	FILTERED-INPUT DISPLAY (MEAS DISP Hardkey)
Measurements with Demodulation ON ‡	Time Record Linear Spectrum Demod Polar †
Measurements with demodulation OFF ‡	Time Record Linear Spectrum Orbits †

† This filtered-input display is not available for all analyzer configurations. See "Filtered-Input Displays" in chapter 3 for details.

‡ You can demodulate any linear resolution measurement. See "Demodulated Measurements" in chapter 3 for details (by default, demodulation is OFF).

Table 2-4. Available Filtered-Input Displays: Time Capture Mode

MEASUREMENT (SELECT MEAS Hardkey)	FILTERED-INPUT DISPLAY (MEAS DISP Hardkey)
All time-capture measurements	Time Record Linear Spectrum

Filtered-input displays are useful only for baseband measurements (measurements that have a 0 Hz start frequency). For zoom measurements (measurements that do not have a 0 Hz start frequency), filtered-input displays *heterodyne* the input signal (the resultant signal is a combination of the sum/difference of the input signal and the start or center frequency).

Filtered-input displays can be used with instantaneous displays to check analyzer configuration. For example, you can use an instantaneous display to verify that a signal is present at the analyzer's input. Then, you can use a filtered-input display to verify that the signal is present after it has been triggered. filtered to the current frequency span, and windowed. If you don't see the signal using a filtered-input display (and you do see it using an instantaneous display), check the:

- Trigger type
- Trigger level
- Trigger delay
- Frequency span (if the frequency span is very narrow, it may take several minutes to fill a time record and, consequently, it may take several minutes for a filtered-input display to appear)

Note

If averaging is ON, filtered-input displays do not appear until you press the **START** hardkey.

All filtered-input displays are selected with the **MEAS DISP** hardkeys. For a description of these displays, see chapter 3 (for the linear resolution mode) or chapter 6 (for the time capture mode).

Measurement Modes, Trace Coordinates, and Units

The HP 3563A allows you to specify a number of different coordinates and units to display your measurement data (this display is called a *trace*). The coordinates that you can specify are the same for all four measurement modes; the units are not. When you change coordinates or units, the trace changes, and the new coordinates or units are shown on the trace (in some cases, changing units does not change the trace — see "Trace Units"). Changing coordinates or units does not alter or destroy any measurement data. See chapter 8, "Display Configuration," for complete details, including illustrations.

Trace Coordinates

You select trace coordinates with the **COORD** hardkey. Table 2-5 shows you the available coordinates. For the vertical axis, you can choose between a number of different coordinates. For the horizontal axis, you can choose only linear or logarithmic coordinates. Notice that some selections, such as the Nyquist diagram, set the coordinates for both axes.

Table 2-5. Available Coordinates

Axis	Available Coordinates
Vertical Axis	dB
	dBm (referenced to user-entered impedance)
	Log magnitude (linear magnitude on a log scale)
	Linear magnitude (linear magnitude on a linear scale)
	Phase
	Real portion of complex measurement data
	Imaginary portion of complex measurement data
Horizontal Axis	Logarithmic
	Linear
Both Axes	Nyquist diagram (imaginary versus real)
	Nichols plot (log magnitude versus phase)

Trace Units

You select trace units with the **UNITS** hardkey, as shown in figure 2-4. Table 2-6 shows you the units available for the horizontal and vertical axes. The units for the horizontal axis are used in all four measurement modes. The units that you can select for the horizontal axis depend on your domain: time or frequency. If your trace is time domain. you can choose seconds or revolutions. If your trace is frequency domain, you can choose Hertz. RPM (revolutions per minute), or Orders.

The units for the vertical axis can be set in any of the four measurement modes, but are not used in some modes. For example, you can set the swept units in any measurement mode, but they become effective only when the measurement mode is swept sine. Likewise, you can set the linear-spectrum units in any measurement mode, but they become effective only when the measurement mode is linear resolution or time capture. In the case of power-spectrum units, you can set these units in any measurement mode and the only measurement mode that they are not used in is swept sine.
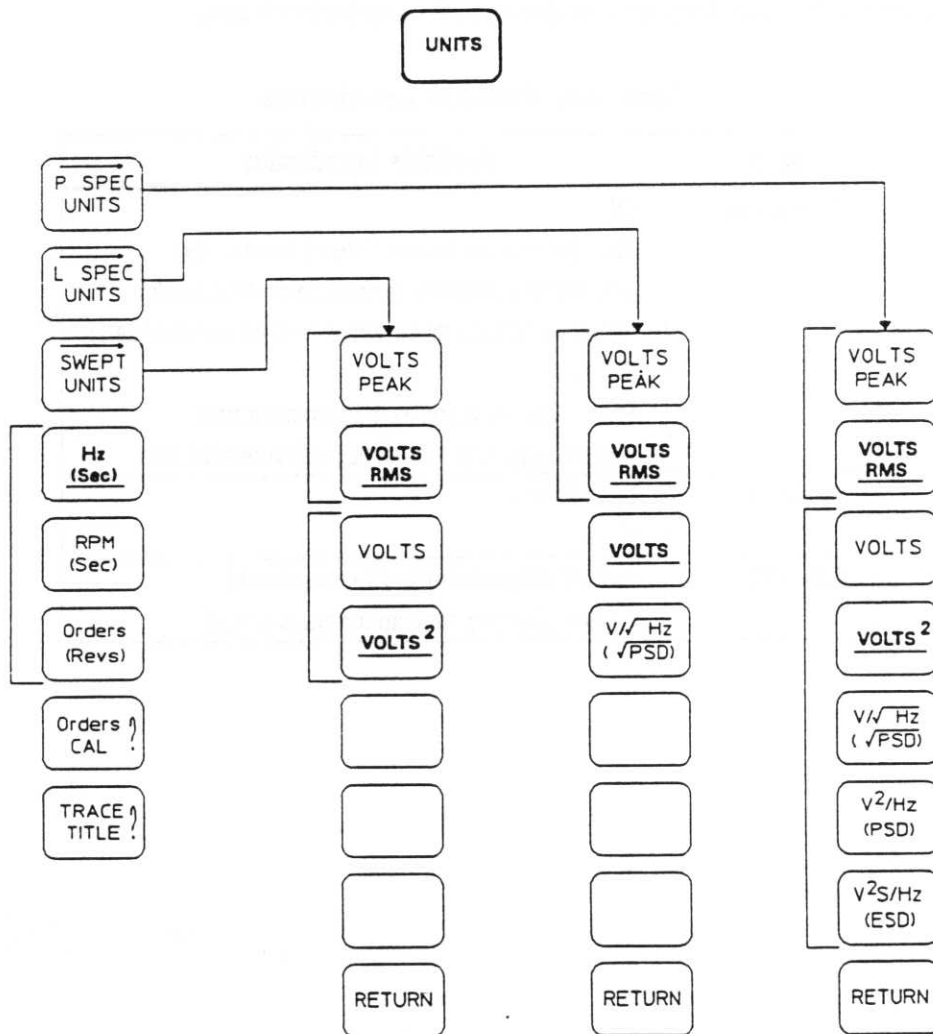
Figure 2-4. UNITS Menu Diagram

Table 2-6. Units for Horizontal and Vertical Axes

Axis	Available Units
Vertical Axis	Power-Spectrum Units Linear-Spectrum Units Swept Units
Horizontal Axis	Hz † RPM (revolutions per minute) † Orders † Seconds ‡ Revolutions ‡

† These units are used only for frequency-domain traces

‡ These units are used only for time-domain traces.

Vertical-Axis Units

The units that you can select for the vertical axis depend on your measurement mode and measurement display, as shown in table 2-7. As mentioned previously, you can set all vertical-axis units at any time. However, they are used only with the measurement mode and measurement display shown in table 2-7. This means that you can set up all vertical-axis units in advance. Then, when you change measurement modes or measurement displays, the analyzer will automatically use the correct units. Table 2-8 shows you the available units for power-spectrum, linear-spectrum, and swept units.

Table 2-7. When Vertical-Axis Units are Used

Measurement Display (MEAS DISP Hardkey)	Measurement Mode (MEAS MODE Hardkey)			
	Lin Res	Log Res	Swept Sine	Time Capture
Power Spectrum	Power-Spectrum Units	Power-Spectrum Units	Swept Units	Power-Spectrum Units
Cross Spectrum	Power-Spectrum Units	Power-Spectrum Units	Swept Units	—
Linear Spectrum	Linear-Spectrum Units	—	—	Linear-Spectrum Units

Table 2-8. Power-Spectrum, Linear-Spectrum, and Swept Units

Type Of Units	Available Units		
	Power-Spectrum	Linear-Spectrum	Swept
Base Unit	V Peak	V Peak	V Peak
	V rms	V rms	V rms
Trace Amplitude	V	—	V
	V^2	V^2	V^2
	$\dfrac{V^2}{Hz}$ †	—	—
	$\dfrac{V}{\sqrt{Hz}}$ ††	$\dfrac{V}{\sqrt{Hz}}$ ††	$\dfrac{V}{\sqrt{Hz}}$ ††
	$\dfrac{V^2 s}{Hz}$ ‡	—	—

† $\dfrac{V^2}{Hz}$ often referred to as the Power Spectral-Density (PSD).

†† $\dfrac{V}{\sqrt{Hz}}$ often referred to as the square root of the Power Spectral-Density ($\sqrt{PSD}$)

‡ $\dfrac{V^2 s}{Hz}$ often referred to as the Energy Spectral-Density (ESD).

Measurement Modes and Averaging

All four measurement modes allow you to average your measurements. With averaging ON, the measurement stops after the analyzer takes the specified number of averages. With averaging OFF, the measurement continues indefinitely, until it is stopped or paused. To turn averaging ON, press **AVG** and select one of the average types shown in the following table; to turn averaging OFF, press **AVG** followed by AVG OFF.

The following table shows the types of averages available in each measurement mode. In some measurement modes, you can select averaging features such as fast averaging. Fast averaging allows you to measure and average as fast as possible without stopping to update the display every time an intermediate average is calculated (in other words, only the final result is displayed). Chapter 3, "Linear Resolution Mode," describes all average features and all average types except those unique to swept sine mode (for these average types, see chapter 5, "Swept Sine Mode").

Table 2-9. Available Average Types and Features

	Measurement Mode			
	Lin Res	Log Res	Swept Sine	Time Capture
Average Type				
Stable (mean)	X	X	—	X
Exponential	X	X	—	X
Peak hold	X	X	—	X
Continuous Peak	X	X	—	X
Auto Integration	—	—	X	—
Fixed Integration	—	—	X	—
Average Features				
Overlap Processing	X	X	—	X
Overload Rejection	X	X	—	—
Fast Averaging	X	X	—	—
Manual Previewing	X	—	—	—
Timed Previewing	X	—	—	—

Measurement Modes and Source Types

All measurement modes allow you to use the HP 3563A's source to stimulate your device-under-test. The following table shows the source types available for each measurement mode. To select a source type, press **SOURCE** followed by the source type. For details, see the chapter that describes the measurement mode you are using (for example, if you are using linear resolution mode, see chapter 3, "Linear Resolution Mode").

Table 2-10. Available Source Types

Source Type	Measurement Mode			
	Lin Res	Log Res	Swept Sine	Time Capture
Random Noise	X	X	—	X
Burst Random	X	—	—	X
Periodic Chirp	X	—	—	X
Burst Chirp	X	—	—	X
Fixed Sine	X	X	—	X
Pulse	X	—	—	X
Step	X	—	—	X
Ramp	X	—	—	X
Arbitrary Waveform	X	—	—	X
Sweep Up	—	—	X	—
Sweep Down	—	—	X	—
Sweep Hold	—	—	X	—
Manual Sweep	—	—	X	—

Introduction

This section contains four chapters:

- Chapter 3: Linear Resolution Mode
- Chapter 4: Log Resolution Mode
- Chapter 5: Swept Sine Mode
- Chapter 6: Time Capture Mode

These chapters describe the analyzer's four measurement modes. Each chapter begins with the steps necessary to set up a measurement (the steps differ for each measurement mode). The steps are then described in detail throughout the remainder of the chapter.

Note

Chapters 3–6 are easier to understand if you read chapter 2 first. Chapter 2 contains an overview and comparison of the four measurement modes.

Furthermore, it is important to know that the steps necessary to set up a measurement differ for each measurement mode. Therefore, it is a good idea to review the chapter that discusses the measurement mode you are using before you make a measurement.

Using The Linear Resolution Mode

Purpose Of This Chapter

This chapter contains a detailed description of the linear resolution mode. The linear resolution mode provides complex spectrum data that is linearly spaced.

As a reminder, the HP 3563A offers four measurement techniques — called measurement modes. You choose the measurement technique you want by selecting one of the following four measurement modes:

- Linear Resolution Mode (described in this chapter)
- Log Resolution Mode (described in chapter 4)
- Swept Sine Mode (described in chapter 5)
- Time Capture Mode (described in chapter 6)

Each measurement mode configures the HP 3563A differently. See chapter 2, "Measurement Overview" for a summary of all four measurement modes. Chapter 2 also compares the four measurement modes and discusses why you might select one over another.

Note   Some menus differ depending on the measurement mode you are in. This chapter shows you only the menus that appear when linear resolution mode is selected. Appendix C, "Menu Diagrams," shows you the menus that appear for all measurement modes. You may want to use appendix C as a quick reference since it contains, in one place, all menus for all hardkeys.

Measurement Setup: Linear Resolution Mode

The steps necessary to set up a measurement are dependent on the measurement mode. The remainder of this chapter details the steps necessary to set up a linear resolution measurement, which are as follows (follow these steps for both analog and digital measurements):

1. Connect the analyzer to your device under test. See chapter 13 for details on digital connections; see chapter 14 for details on planning a digital or mixed (analog and digital) measurement.

2. Preset the analyzer (optional): press **PRESET** or **SAVE RECALL** (see chapter 12 for details).

3. Select linear resolution mode: press **MEAS MODE** followed by LINEAR RES.

4. Configure the inputs: press **INPUT CONFIG**. (See chapter 7 for details).

5. View the input signals (if necessary): press **VIEW INPUT**.

6. Set up the source: press **SOURCE**. If necessary, set up source protection in the **SPCL FCTN** menu.

7. Set the input range: press **RANGE**. (See chapter 7 for details).

8. Select a measurement and measurement display. First, press **SELECT MEAS** to select a measurement and activate one or both channels. Then press **MEAS DISP** to select a measurement display.

9. Set the frequency span: press **FREQ**.

10. Select a window: press **WINDOW**.

11. Set up averaging: press **AVG**.

12. Set up triggering: press **SELECT TRIG**. (See chapter 7 for details).

13. Start the measurement: press **START**.

14. Select other measurement displays (if desired): press **MEAS DISP**.

15. Use the display and marker features (if desired): refer to chapter 8 for details on these features.

Selecting The Linear Resolution Mode

To put the HP 3563A in the linear resolution mode, press **MEAS MODE**. The softkeys that appear depend on which measurement mode is selected. Press LINEAR RES to configure the analyzer to the linear resolution mode. In this measurement mode, you have access to the softkeys in figure 3-1.

Note	The THRUPUT ON OFF and THRUPT SELECT softkeys are not described in this chapter. For a description of these softkeys, see chapter 9, "Time Throughput.."
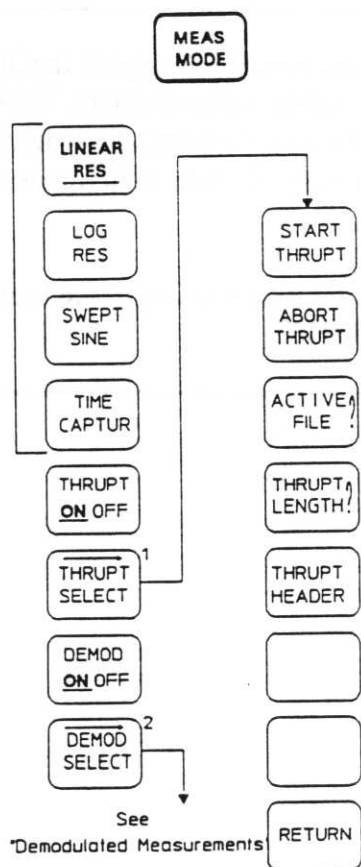
1 Blank if [THRUPT ON **OFF**] is selected (this is the default)
2 Blank if [DEMOD ON **OFF**] is selected (this is the default)

Figure 3-1. MEAS MODE Menu Diagram:
Linear Resolution Mode

Viewing the Input Signals

The **VIEW INPUT** hardkey allows you to look at the input signals before they are filtered to a reduced frequency span, triggered, or measured. These *instantaneous* displays can be viewed at any time, even if the measurement is in progress, waiting for a trigger, or completed. Instantaneous displays can be used to verify the presence of input signals or to compare an input signal with a measurement display. Instantaneous displays are also helpful when manually setting the input range. Chapter 2, "Measurement Overview," explains how these displays are derived and how they differ from filtered-input and measurement displays.

The menu that appears when you press **VIEW INPUT** depends on which measurement mode is selected. In the linear resolution mode, the menu in figure 3-2 appears.

Note	**VIEW INPUT** displays are instantaneous displays of the input signals; the data they show are not necessarily included in a measurement. The window used to compute linear spectra is labeled at the top of the trace. In addition, instantaneous displays always show 801 frequency lines, even when 1024 frequency lines are selected (**WINDOW** 1024 LINES).
	Furthermore, a measurement must be running to see burst source signals or source triggered signals with **VIEW INPUT**.
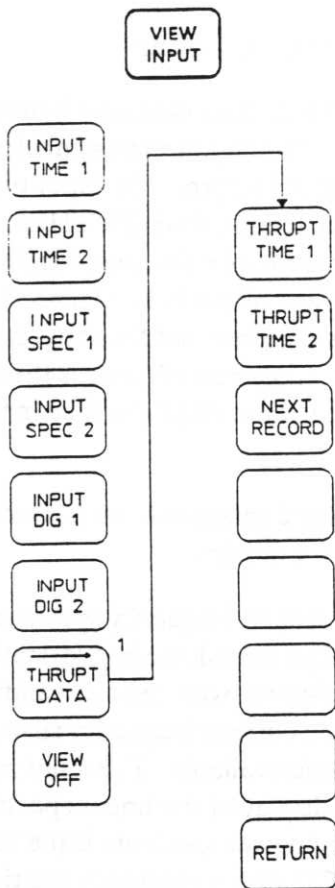
Figure 3-2. VIEW INPUT Menu Diagram:
Linear Resolution Mode

The softkeys in the **VIEW INPUT** menu do the following:

INPUT
TIME1

Displays the time domain data on Channel 1. The view input displays are at full-span based upon the sample frequency, Fs, regardless of the current time record length. The input time displays show an 8 millisecond time length, 2048/256 kHz for internally sampled data. If using an external sample, the time length is 2048/Fs. This is an instantaneous view of the input signals that is helpful when you need to verify a signal's presence, set the input range or set trigger levels. It is not the filtered "time record", nor is there any guarantee that a signal you see in a view input display will be included in the measurement.

INPUT
TIME2

Displays the time domain data on Channel 2. See the description for INPUT TIME1 for details.

INPUT
SPEC1

Displays the full-span frequency spectrum (FFT) of the Channel 1 time domain data. The time domain information has been transformed to the frequency domain with the full-bandwidth FFT of the input signal, regardless of the current frequency span. Free Run triggering is the only trigger mode available. The front panel spectrum is an instantaneous display of the linear spectrum, not a power spectrum. A display of the power spectrum is the result of the Fast Fourier Transform (FFT) plus a conjugate multiply process. All frequency domain coordinates are available. However, due to Free Run triggering, a trigger reference is not available. The uncalibrated message "Uncal" that appears with the INPUT SPEC 1 and 2 displays indicates that these traces have not been corrected by the HP 3563A's calibration routine.

INPUT
SPEC2

Displays the full-span frequency spectrum (FFT) of the Channel 2 time domain data. See INPUT SPEC1 for details.

INPUT
DIG 1

Displays the Channel 1 digital data in digital format (as a 1, a 0, or changing — indicated by the up/down arrow). The number of bits displayed is determined by the number of bits selected and whether the most significant or least significant (upper or lower) bits have been specified in the DATA SIZE menu under the **INPUT CONFIG** hardkey. A filled box is displayed for the most significant bits that overflow OR the least significant bits that round off. This filled box indicates these bits need to be connected. An empty box indicates bits that do not need to be connected (for example, 8 bit data). In SINGLE TRACE format, the qualifier bits on POD Q, the qualifier pod, are displayed. For additional details, see "Verifying Digital Connections" in chapter 13.

INPUT
DIG 2

Displays the Channel 2 digital input in digital format. See the description of INPUT DIG 1 for details.

VIEW
OFF

Disables updating of the view input displays. This does not interrupt the flow of the input signals to the instrument, but merely suspends display updating. VIEW OFF affects only the view input displays.

Setting up the Source: Linear Resolution Mode

The source is used to stimulate the device under test. The HP 3563A offers several types of stimulus signals, all of which can be used in either analog or digital form. When the internal 256 kHz sample clock is used, all source outputs — except pulse, step, ramp, and arbitrary source (user saved 2) — are band-limited to the measurement frequency span (at spans $\geq$ 160 mHz) to maintain constant power with respect to the frequency span selected and to minimize out-of-band excitations. When using the external sample clock at rates less than 256 kHz, the source output may no longer be band-limited (refer to "The Analog and Digital Source Model" in chapter 14 for details).

To set up the source, press **SOURCE**. The softkeys that appear for the linear resolution mode depend on SOURCE AN DIG. If SOURCE AN DIG is toggled to **AN** (analog output) you see one menu; if it is toggled to **DIG** (digital output), you see another (see figure 3-3). Both menus allow you to select any of the following source outputs when the analyzer is in linear resolution mode:

- Random Noise
- Burst Random
- Burst Chirp
- Periodic Chirp
- Fixed Sine
- Pulse
- Step
- Ramp
- User Data (also called arbitrary data; set up with the USER SAVD 2 softkey)
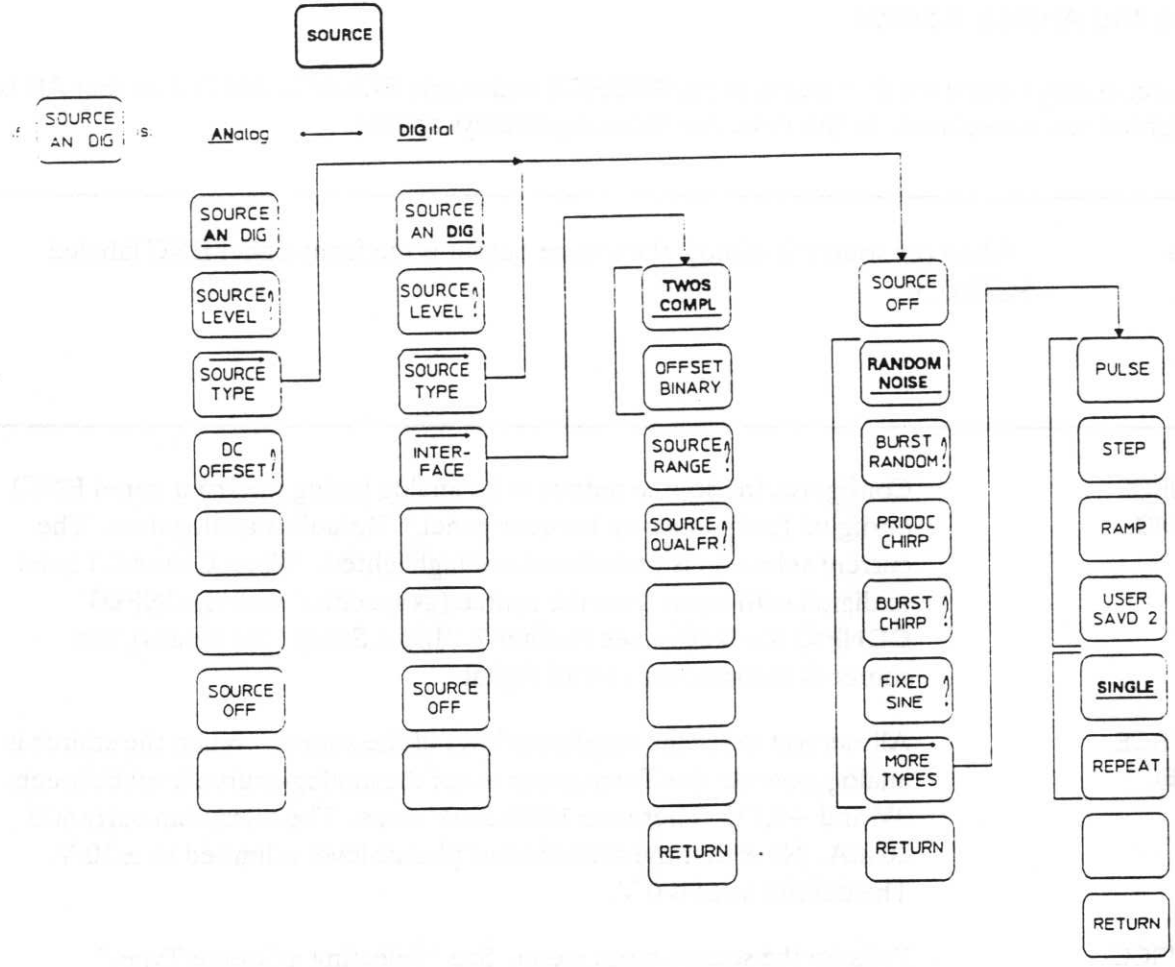
**Figure 3-3. SOURCE Menu Diagram:
Linear Resolution Mode**

Using the Analog Source

To select analog output for the source, press **SOURCE** and toggle SOURCE AN DIG so that **AN** is highlighted and underlined. In this case, the following softkeys appear:

Note   When the source is analog, the source output is the front-panel BNC labeled SOURCE.

SOURCE AN DIG	Configures the source output to be analog (using the front panel BNC) or digital (using pods on the rear panel.) Default is analog data. The current selection is underlined and highlighted. When Channel 1 is set to digital with input from the source (as specified with the **INPUT CONFIG** hardkey — see chapter 7, "Input Setup" for details), the source is automatically set to digital.
SOURCE LEVEL	Allows you to set the amplitude level of the source. When the source is analog, you use the Entry group to set the analog-source level between 0V and +5.1V. There are 1,024 5 mV steps. The maximum current is 20 mA. Note that the combined ac plus dc level is limited to ± 10 V. The default level is 0 V.
SOURCE TYPE	Pulls up the source-types menu. See "Selecting a Source Type."
DC OFFSET	Allows you to add a positive or negative offset to the source output signal. The offset is limited to 10V minus the source level; the combined ac and dc level is limited to ± 10V. The default dc offset is 0 volts.
SOURCE OFF	Turns the source output off. If source protection is on, the source ramps off gradually. See "Source Protection".

Using the Digital Source

To select digital output for the source, press **SOURCE** and toggle SOURCE AN DIG so that **DIG** is highlighted and underlined. In this case, the following softkeys appear:

Note

Chapter 13, "Digital Connections", and chapter 14, "Digital & Mixed Measurements, contain detailed information about the digital source that is beyond the scope of this chapter.

SOURCE
AN **DIG**

Functions the same as when SOURCE AN DIG is set to AN (see "Using the Analog Source").

SOURCE
LEVEL

Allows you to set the amplitude level of the source. When the source is digital, the value of the source level is referenced to the SOURCE RANGE softkey (see "The INTERFACE Menu" for a description of this softkey). The source level cannot exceed the absolute value of the source range. When changing from an analog source to a digital source, the source level is automatically adjusted to be within source range.

As an example, if SOURCE RANGE is 5 V and SOURCE LEVEL is 2.5 V, the maximum output source value is:

$$32767 \times (\text{SOURCE LEVEL} / \text{SOURCE RANGE}) = 16383 \ (0x3FFF)$$

The number 32767 is the largest positive value, if the source output is twos complement.

Systems with low-level signals require finer resolution at the lower end. The digital source has two sizes of steps of attenuation. The source level is incremented by the absolute value of SOURCE RANGE divided by 128 for levels greater than 1/16 of the source range. For source levels below 1/16 of the range, attenuation steps are 1/2048 of the source range.

Note

With 16 bits of data, signal definition decreases as attenuation increases. A signal 1 / 128 of full scale will have 8 bits of sign extension and only 8 bits of data to define the signal waveform.

SOURCE TYPE	Pulls up the source-types menu. See "Selecting a Source Type."
INTER- FACE	Pulls up the interface menu. This menu is used only when the source output is digital (see "The INTERFACE Menu"). It allows you to define Data Format, Range, and Qualifier bits for a digital source type.
SOURCE OFF	Turns the source output off.

The INTERFACE Menu

The INTERFACE softkey pulls up another menu that allows you to tailor the digital source to fit your needs (see figure 3-3). This menu allows you to select the digital source's data format, range, and qualify clock transitions with a pattern of qualifier bits. The softkeys that appear when you press INTERFACE are:

TWOS COMPL	When the source output is digital, this key allows you to set the source data to represent a twos complement number. This is the default setting. See chapter 13 for a description of twos complement numbers.
OFFSET BINARY	When the source output is digital, this key allows you to set the source data to represent an offset binary number. See chapter 13 for a description of offset binary numbers.
SOURCE RANGE	When the source output is digital, this key allows you to specify the full scale range. This relates the source level value (refer to the SOURCE LEVEL softkey described earlier) to the actual digital source scaling. The default value is 5.12 volts. The source range may be any value between 5.12 volts to .128 volts and -0.128 volts to -5.12 volts. Negative values invert the signal.
SOURCE QUALFR	When the source output is digital, this key allows you to choose bits on the qualifier pod to use to qualify the SRC ENABLE (Pod X) output clock. The qualifiers can be used to define the active (low) state of the SOURCE ENABLE output on POD X. There are 8 bits of qualifiers available. Each can have a value of 0, 1, or X (don't care.) This signal can be used in conjunction with a tri-state pod to connect to a microprocessor bus to enable the source output at the desired time.

Selecting a Source Type

As mentioned previously, you can set the source to output analog data (via the SOURCE front-panel BNC) or digital data (via source pods MSB and LSB). The source types that you can select are the same for both types of data. However, the source types that you can select *are not* the same for all four measurement modes. See chapter 2 for a summary of the source types available in each measurement mode.

You choose a source type with the SOURCE TYPE softkey (see figure 3-3). Selection of a source type depends on the nature of the device under test, time versus accuracy trade-offs, and your measurement objectives.

Note

For a general discussion of stimulus signals, leakage and windowing, refer to Hewlett-Packard Application Note 243. Contact your HP Sales Representative to obtain a copy.

The burst source signals are present only when the trigger is armed and the trigger conditions have been met. Source triggering (see chapter 7) is the easiest way to do this. You cannot use **VIEW INPUT** to view triggered source signals.

Source Type Softkeys

The softkeys that you see when you press **SOURCE** / SOURCE TYPE depend on the measurement mode. When the measurement mode is linear resolution and you press **SOURCE** / SOURCE TYPE, the following softkeys appear:

SOURCE
OFF

Turns the source output off. If source protection is on, the source ramps off gradually. See "Source Protection" following this menu.

RANDOM
NOISE

Selects the random noise output; this is the default selection at power-on and after resetting.

BURST
RANDOM

Selects the burst random output and allows you to enter the burst percentage from 1 to 99%. The default is 70%.

PRIODC
CHIRP

Selects the periodic chirp output.

BURST
CHIRP

Selects the burst chirp output and allows you to enter the percentage of the record containing the burst from 1 to 99%. The default is 70%.

FIXED
SINE

Selects the fixed sine output and allows you to enter a frequency, which is dependent on the sample frequency (Fs). If you are using the internal sample frequency of 256 kHz, you can enter a frequency from 64 micro-Hz to 100 kHz; the default is 125 Hz. See "Frequency Spans in the Linear Resolution Mode" for available frequency spans.

MORE
TYPES

Allows you to choose other source types (see figure 3-3).

When the measurement mode is linear resolution and you press **SOURCE** / SOURCE TYPE / MORE TYPES, the following softkeys appear:

PULSE

Sets the source type to be the unit pulse. This source type is not band-limited to the frequency span of the measurement. This source type can be repeated continuously (REPEAT) or only output during data collection of the measurement (SINGLE). If you use REPEAT with this source type, the source output is a series of pulses. SINGLE is usually used with this source type.

STEP

Sets the source type to be a step. This source type is not band-limited to the frequency span of the measurement. This source type can be repeated continuously (REPEAT) or only during data collection of the measurement (SINGLE). If you use REPEAT for this source type, the source output is a dc value. SINGLE is usually used with this source type.

RAMP

Sets the source type to be a ramp. This source type is not band-limited to the frequency span of the measurement. This source type can be repeated continuously (REPEAT) or only during data collection of the measurement (SINGLE). If you use REPEAT with this source type, the source output is a series of ramps. SINGLE is usually used with this source type.

USER
SAVD 2

Allows you to capture and replay a real-world signal. Sets the source type to be arbitrary data from the User Save Data Block 2. This source type can be repeated continuously (REPEAT) or only during data collection of the measurement (SINGLE). See the description that follows for further details.

SINGLE

Sets the source output to occur only during data collection of the measurement for pulse, step, ramp, or user (USER SAVD 2) source types. This is the default selection. You may want to use a pre-trigger delay to look at the initial conditions of the response.

REPEAT

Sets the source type to repeat continuously for pulse, step, ramp, or user (USER SAVD 2) source types. This is useful, for example, if you are using arbitrary data in a user saved data block 2 and have modified an existing continuous source type, such as a chirp.

Source Type Descriptions

The following information describes each source type. Table 3-1 summarizes the source types used for frequency-domain measurements.

Table 3-1. Summary of Source Output Characteristics

	Random Noise	Burst Random	Periodic Chirp	Burst Chirp	Fixed Sine
Need Window?	yes (HANN)	no (UNIFRM)	no (UNIFRM)	no (UNIFRM)	sometimes (FLATTOP, HANN)
Characterizes non-linearities?	no	no	yes	yes	yes
Reduces effects of non-linear distortion?	yes	yes	no	no	no
Signal-to-noise ratio?	fair	fair	high	high	very high
Peak-to-rms ratio?	fair	fair	high	high	very high

Burst chirp supplies a fast sine sweep over the current frequency span that repeats with the same period as the time record. Burst chirp supplies the frequency chirp for the specified percentage of the time record (the default value is 70 %), then no output for the remainder of the record. The burst chirp can characterize nonlinearities because the device under test is excited in exactly the same manner every time record. The nonlinear response and distortion averages to its mean value (it does NOT average to zero.)

As a rule of thumb, set the burst percentage ("ON" time) so the response channel decays to zero by the end of the time record. In this way, the system's response decays to zero between the end of the burst and the end of the time record, and a window is not required. Consequently, leakage and the distortion introduced by windowing are avoided. If the LINES parameter (under the **WINDOW** hardkey — see "Selecting a Window") is set to 1024, the burst chirp frequency range is extended to cover all 1024 lines. If the MIXED RATIO parameter (under the **INPUT CONFIG** hardkey and SAMPLE CLOCK softkey — see chapter 7, "Input Setup") is greater than 1, the burst chirp frequency range is reduced by the mixed ratio factor. If LINES is set to 1024, the periodic chirp frequency range is extended to 1024 lines and then reduced by the mixed ratio factor.

Burst chirp can not be used at spans narrower than 160 mHz (baseband) and 320 mHz (zoom). It is recommended for spans greater than the real time bandwidth (1600 Hz fast averaging).

Use periodic chirp to autorange the analog inputs, then switch to burst chirp. To set the input range, use periodic chirp or autorange up. (Do NOT use autorange UP/DOWN with burst chirp.)

Source triggering should be used with burst chirps. The source output is a signal only when a measurement is in progress and if the source trigger is specified. The source LED will remain on (if the source is analog), but no signal will be produced if the measurement is paused or completed.

Burst random supplies random noise during the specified percentage of the time record and no output for the remainder of the record. Because the burst signal is not on for the entire time record, the leakage problems associated with continuous random noise can be avoided. As a rule of thumb, set the burst percentage ("ON" time) so the response channel decays to zero by the end of the time record. In this way, the system's response decays to zero between the end of the burst and the end of the time record, and a window is not required. Consequently, leakage and the distortion introduced by windowing are avoided. As with random, burst random does not characterize nonlinearities because the effects of distortion are reduced by averaging. Note that the random bursts are gated on and off instantaneously. Furthermore, for burst randoms, the source outputs a signal only when a measurement is in progress and if the source trigger is specified. The source LED remains on (if the source is analog), but no signal will be produced if the measurement is paused or completed. Burst random must be used with source triggering. Use AUTO RNG UP (under the **RANGE** hardkey) and regular random noise to set the input ranges properly.

Fixed sine supplies a constant frequency sine wave at the specified source level. The default value is 125 Hz; the limits are 64 micro-Hz and 100 kHz (this is true only when you use the internal sample frequency of 256 kHz; see "Frequency Spans in the Linear Resolution Mode" for details). If you specify a source level using units set to orders, the order calibration relates Hz to orders (1 Hz = 60 RPM). A fixed sine is used to excite a device under test at a single frequency. If the output is not exactly periodic in the time record, the fixed sine requires a window (usually the flat top — see "Selecting a Window" later in this chapter) to reduce leakage. The fixed sine frequency is dependent on the sample frequency when using external sampling. It will be as accurate as the specified sample frequency.

Periodic chirp supplies a fast sine sweep over a frequency span with a period that equals the time record length. For all-analog or all-digital measurements, or mixed measurements where the mixed-ratio is one, the chirp sweeps over the current measurement span. In a mixed measurement with a mixed ratio > 1 and a measurement span > half the (digital) sample rate, the chirp span is set to minimize overlap in the digital spectrum. This limits the chirp span to be ≤ half the (digital) sample rate. The chrip span is selected based on the measurement span and center frequency, and on the mixed ratio value.

If the LINES parameter (under the **WINDOW** hardkey — see "Selecting a Window") is set to 1024, the periodic chirp frequency range is extended to cover all 1024 lines. If the MIXED RATIO parameter (under the **INPUT CONFIG** hardkey and SAMPLE CLOCK softkey — see chapter 7, "Input Setup") is greater than 1, the periodic chirp frequency range is reduced by the mixed ratio factor. If LINES is set to 1024, the periodic chirp frequency range is extended to 1024 lines and then reduced by the mixed ratio factor. For spans above the real-time-bandwidth, burst chirp is recommended.

Because periodic chirp is periodic in the time record, no windowing is required. The periodic chirp can characterize nonlinearities because the device under test is excited in exactly the same manner every time record, and the nonlinear distortion averages to its mean value (it does not average to zero). The periodic chirp is similar to pseudo-random noise sources, except it has a much higher rms-to-peak ratio. The periodic chirp sets the center frequency to the nearest integer multiple of Δf. Chirps cannot be used at spans narrower than 160 mHz (baseband) and 320 mHz (zoom). For larger spans above the real time bandwidth (1600 Hz fast averaging), burst chirp is recommended.

Pulse sets the source type to be the unit pulse. The pulse starts at the beginning of the measurement data record and ends (goes to zero) one sample later. It is most useful when trying to measure impulse response. This source type is not band limited. For mixed measurements (one channel analog, the other digital), the duration of the pulse is dependent on the mixed ratio. If the mixed ratio is greater than 1, then the duration of the pulse is equal to one digital sample. For example, if mixed ratio is 4, there are 4 analog samples for every digital sample, and the duration of the pulse is equal to one digital sample (or four analog samples).

Ramp sets the source type to be a ramp. The ramp starts at zero at the beginning of the measurement data record and increases linearly to reach the Source Level at the last point of the measurement data record. This source type is not band limited. You may want to use a Pre-trigger delay to look at the initial conditions of the response.

Random noise supplies true random noise at the selected level across the selected frequency span. Random noise is often used to obtain a fast, linear estimate of a system's frequency response at the current operating point. Because it is not periodic in the time record, random noise requires a window (usually the Hanning—see "Selecting a Window" later in this chapter) to reduce leakage. Random noise does not characterize nonlinearities because the device under test is excited differently each time record, so averaging over a number of time records tends to reduce the effects of nonlinear distortion in the measurement. Note that entering a source level in volts peak sets the maximum noise peak that is likely to occur.

Step sets the source type to be a step. The step starts at the beginning of the measurement data record and ends (goes to zero), at the end of the measurement data record. This source type is not band limited. It is useful when trying to measure the step response of a system. You may want to use a Pre-trigger delay to look at the initial conditions of the response.

User Saved 2 sets the source type to be arbitrary data from the User Save Data Block 2. This feature allows you to capture a real-world signal and use the analyzer's source to reproduce it. Or, you can create and reproduce a custom signal. See "Using the Arbitrary Source" for further details.

Note   Source protection is unavailable for this source type. If source protection is on, you cannot select this source type.

Using the Arbitrary Source

There are three steps for using the arbitrary source:

1. Capture (or create) a signal.

2. Save the signal to User Save Data Block 2:

   Press **SAVE RECALL** SAVE DATA # followed by **2.** Then press ENTER

3. Load the source with the data from User Save Data Block 2:

   Press **SOURCE** SOURCE TYPES followed by MORE TYPES. Then press USER SAVD 2.

Arbitrary source data may come from:
- HP-IB
- A measurement time record
- One of the analyzer's other source types
- A waveform created using:
  - Synthesis (see chapter 17)
- A waveform created or modified with these keys:
  - CUSTOM CHIRP
  - DATA EDIT
  - **MATH**

Weighted signals, such as chirp that changes amplitude with increasing frequency, can be constructed by saving a waveform from the source. The waveform can be then be changed with the analyzer's math operations or data edit function.

When creating arbitrary source data, the data must be:
- 2048 points
- Real
- Time domain

If you don't use 2048 points, or if data is complex, or if the data is not in the time domain, zeros are loaded into the source. In this case, the analyzer displays *USER 2 NOT VALID FOR SRC MUST BE BASEBAND TIME* when you enable the arbitrary source. Measurements that begin at 0 Hz contain real data; measurements that do not begin at 0 Hz contain complex data.

The output spectrum of the arbitrary source is dependent on the selected frequency span and sample clock. The time-axis values stored with the trace in USER SAVD 2 do not affect the rate at which the source data is replayed. The USER SAVD 2 data is replayed at a rate that causes all 2048 points to be used within a single measured time record. At maximum span (for any given sample clock frequency) this corresponds to a new output value with each occurence of the sample clock. When the frequency span is decreased (the time record length is increased), each USER SAVD 2 value is repeated a number of times.

The following figure shows what happens when the frequency span is reduced by a factor of two. At the digital source output, each data point is repeated twice. At the analog source output, the repetition is not visible as the output is held between samples. The effect is that of a decreased sample rate. Both the effective sampling interval, Δt, and the time record length are listed in the state table (press **STATE/TRACE**).
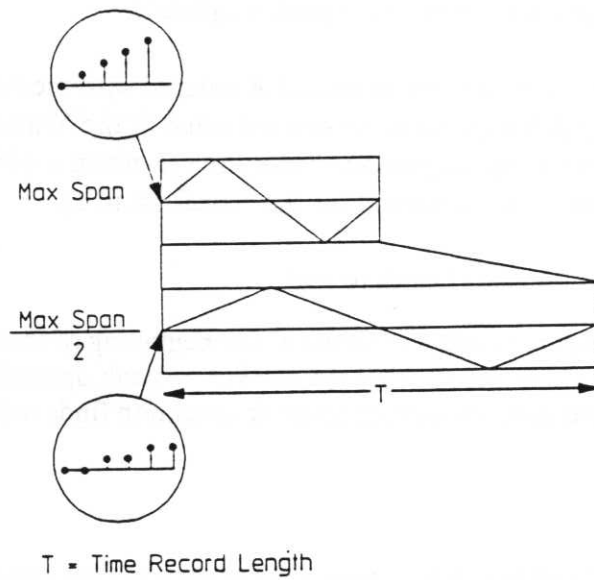
Figure 3-4. Arbitrary Source Data Under Reduced Span

Normalizing A Waveform

Arbitrary source data is scaled relative to ± 1.0 volt for full scale output. This allows you to use the arbitrary source to send a bit pattern or a command to an interface board. However, a saved waveform is clipped upon playback whereever it exceeds ± 1.0 volt.

So that the analyzer's source doesn't clip your captured or created waveform, normalize the waveform before you save it. One way to do this is to activate the trace that contains the waveform. Then press the following keys:

COORD
  MAG (LIN)   Sets the coordinates to linear magnitude.
X   Enables the X marker.
SPCL MARKER
  MRKR -> PEAK   Moves the X marker to the peak magnitude.
MATH
  DIV   Divides the waveform by the value entered with the next key press.
MARKER VALUE   Pressing this key enters the current value of the X marker, which in this case is the peak magnitude. Thus, the waveform is divided by its peak magnitude (which normalizes the waveform to 1).

COORD
  REAL   Returns the coordinates to real.

Notice that the coordinates are set to linear magnitude at the beginning of the key sequence and then returned to real at the end. This ensures that the marker-to-peak operation finds the peak magnitude. If the coordinates are real, the marker-to-peak operation finds only the peak positive amplitude.

Arbitrary source example

The following is an example that shows you how to use the arbitrary source to create an amplitude profile chirp. This example does the following:

1. Sets the frequency span.

2. Generates a *template* time record for trace A and trace B.

3. Uses the following keys to modify the *template* time record:
   - CUSTOM CHIRP
   - DATA EDIT
   - **MATH**

The following key sequence sets the frequency span and generates a *template* time record for trace A and trace B:

PRESET	Resets the analyzer to a known state.
PAUSE/CONT	Pauses the measurement.
FREQ	Press this key to set the frequency span.
50 kHz	Press **50** on the numeric key pad, then press the kHz softkey.
AVG	The next three keys select a single average measurement.
1	
ENTER	
STABLE (MEAN)	Turns on averaging (selects stable averaging).
A & B	Activates both trace A and trace B.
MEAS DISP	
FILTRD INPUT	
TIME REC 1	Displays a *template* time record in trace A and in trace B.
START	Fills the template time record with measurement data.

The following key sequence generates a prototype chirp from 0 to 50 kHz in trace A:

A	Activates trace A.
SPCL MARKER	
MARKER CALC	
CUSTOM CHIRP	
0,50 kHz	Creates a sine chirp signal with a start frequency of 0 Hz; a stop frequency of 50 Khz. Press "0" "," "50" on the numeric keypad. Then press the kHz softkey. At this point the analyzer displays MARKER CALC IN PROGRESS. When finished, the analyzer fills the template time record in trace A with the chirp signal.
SCALE	
Y AUTO SCALE	Auto scales the display to the amplitude of the chirp signal.

The following key sequence uses the analyzer's math operators to build an amplitude profile in trace B. Once built, the amplitude profile will be mulitplied with the chirp in trace A to create an amplitude profile chirp.

B	Activates trace B.
MATH	The following math operations set trace B to unity amplitude.
SUB	
TRACE B	
ADD	
1	
ENTER	
SCALE	
Y AUTO SCALE	Auto scales the display to the amplitude in trace B.

The following key sequence uses the DATA EDIT softkey to generate amplitude ramps in the B trace. For example, you want an amplitude ramp from 0.1 to 1.0 V from 0 to 20 kHz (with an amplitude of 1.0 V from 20 to 50 kHz). The sine frequency of the chirp generated in trace A increases linearly with time. Since the 50 kHz chirp has a record length of 16 mS, then the sine frequency increases at a rate of 50 kHz / 16 mS = 3.125 kHz/mS. Therefore, the chirp will be at 20 kHz at (20 kHz / 3.125 kHz/mS) = 6.4 mS.

B	Activates trace B.
X	Turns on the X marker.
0,6.4 ms	Sets the X marker band between 0 and 6.4 milliseconds.
SPCL MARKER	
MARKER CALC	
DATA EDIT	The DATA EDIT softkey allows you to edit some or all of the waveform
0.1,1 V	displayed in the active trace. This example uses the X marker to select a portion of the waveform (from 0 to 6.4 ms). Entering two numbers after pressing DATA EDIT builds a ramp. The ramp is constructed within the selected portion of the waveform. In this case, the ramp starts at 0.1 volts and ends at 1 volt (see the following figure).
X OFF	Turns off the X marker.

You now have your chirp in trace A and your amplitude profile in trace B, as shown in the following figure.
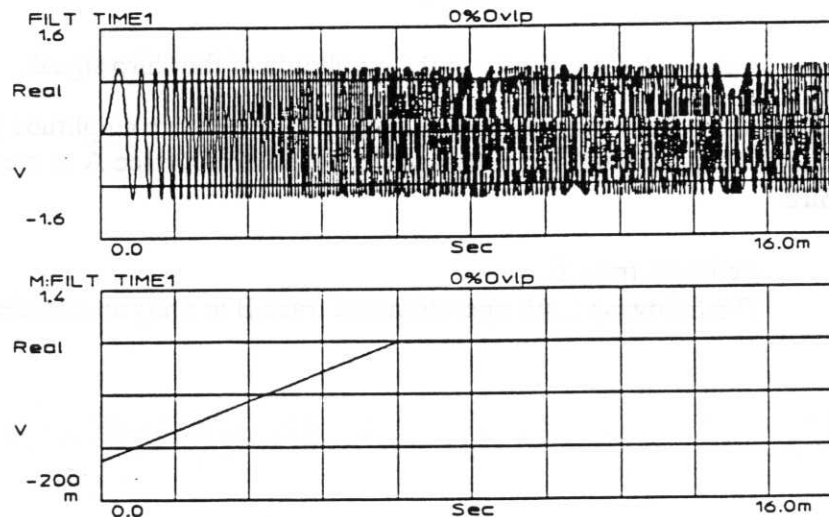
**Figure 3-5. Chirp in Trace A; Amplitude
Profile in Trace B**

The following key sequence multiplies trace A and trace B to obtain an amplitude profile chirp as shown in the following figure:

A   Activates Trace A.

MATH

  MPY   Multiplies the active trace by the next key press.

    TRACE B   In this case, multiplies the active trace (trace A) by trace B. The result is put in the active trace .
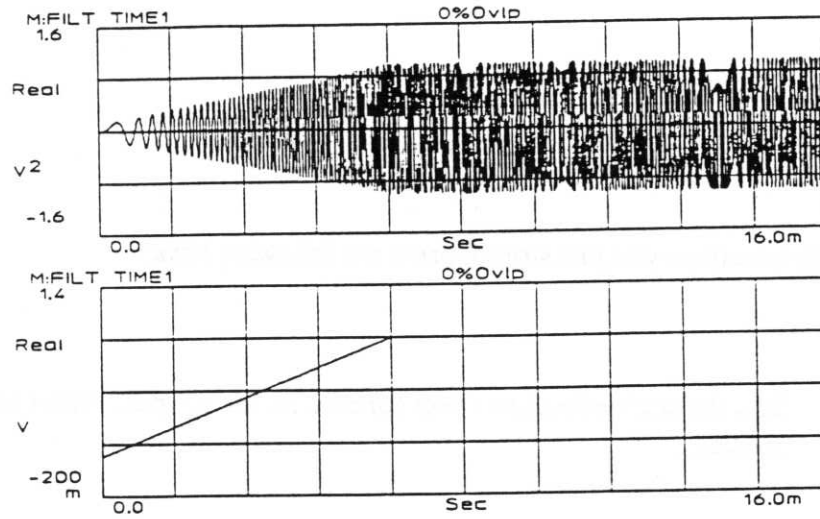
Figure 3-6. **Amplitude Profile Chirp**

The following key sequence saves the amplitude profile chirp in trace A to the User Save
Data Block 2.

Note

As mentioned previously, trace data for the analyzer's arbitrary source must be
normalized (with 1.0 V being the maximum value) before it is saved. This example
produces a trace which is already normalized, so this step is unnecessary.

SAVE RECALL
   SAVE DATA#
  2
    ENTER

To turn on the arbitrary waveform you just stored, press the following keys:

SOURCE
   SOURCE LEVEL
   1 V   Sets the source level to 1 volt (press 1 on the keypad, then press the V
                      softkey).
   SOURCE TYPE
     MORE TYPES
       USER SAVD 2   Selects the User Saved 2 source type (this is the arbitrary source).
       SINGLE   Sets the source to a single output.

To view your new amplitude profile chirp, connect the source to Channel 1 and set up a source triggered measurement by pressing the following keys:

AVG
   AVG OFF   Turns averaging off.

SELECT TRIG
   SOURCE TRIG   Selects source trigger (measurement triggers from source).

WINDOW
   UNIFRM (NONE)   A chirp signal is self windowing (no window needed).

UPPER LOWER   Shows both traces (A and B) on the display simultaneously.

A

MEAS DISP
   POWER SPEC1   Displays the measured spectrum in trace A. At this time there is no data to display — the analyzer collects new data when you press START.

B
   FILTRD INPUT
     TIME REC1   Displays the filtered time-record in trace B (in this case, displays the time domain chirp in trace B). At this time there is no data to display — the analyzer collects new data when you press START.

START   Begins the measurement. At this point, trace A shows the measured spectrum of the amplitude profile chirp; trace B shows the same chirp in the time domain.

Using the Arbitrary Source With a Zoomed Measurement

The output spectrum of the arbitrary source is dependent on the selected frequency span, but not on the center frequency. In other words, *the arbitrary source output is not band translated*. Therefore, in zoomed measurements (measurements that do not start at 0 Hz), it becomes possible to define a source waveform that does not contain energy in the measured portion of the spectrum. This is less likely to occur with the digital source than with the analog source because of the digital signal's replicated spectrum.

At reduced spans or sampling frequencies much less than 256 kHz, the analog source output signal can also contain energy at image frequencies (replications of the fundamental spectrum). These occur because the source output is held between samples, and because the samples are repeated at reduced frequency spans (see figure 3-4). Unlike the digital signal's images, the images in the analog output are attenuated in amplitude. Depending on your requirements, you may be able to use these images to excite your system under test.

Source Protection

Switching source types or changing the output level can potentially damage devices under test. To help you avoid this, the HP 3563A offers source protection. Protection causes the source to ramp from its current level to the desired level, rather than changing instantaneously. When active, ramping occurs whenever the source level is changed or its effective output power can potentially change: if the source is turned on or off or the measurement mode, source output type, frequency span, source level, or dc offset is changed.

If the source is digital, source protect cannot be activated. An analog source cannot be changed to a digital source if source protect is on. Furthermore, source protection is unavailable for these source types:

- Pulse
- Step
- Ramp
- User Data (set with the USER SAVD 2 softkey)

To activate source protection, press the **SPCL FCTN** hardkey followed by the SOURCE PROTCT softkey to display the following softkeys:

PROTCT ON OFF	Activates/deactivates source protection.
RAMP TIME	Allows you to enter the ramp time for the source to turn off or change levels. Ramp time is stored in nonvolatile memory and is not affected by power-down or reset.

The state of PROTCT ON OFF and the value of RAMP TIME are not affected by reset or powerdown. If source protect is active during a calibration, the source is turned off and remains off.

When you change source types with protection activated, you must reenter the source level. This extra step, together with the ramp time, prevents you from supplying an unexpected excitation to a device under test. Note that changing the source level with the Entry knob overrides source protection.

Setting the Input Range

After you set up the source, you should set the input range. The input range is set with the **RANGE** hardkey. You can manually set the range or have the analyzer automatically select the best range. The range options available differ for analog and digital inputs. See chapter 7, "Input Setup," for details.

Selecting a Measurement and Display

The linear resolution mode offers several measurements and displays. This section describes the measurements and displays available for the linear resolution mode.

Selecting a Measurement

The types of measurements that you can select differ depending on which measurement mode is selected. To select measurements in any measurement mode, press **SELECT MEAS**. In linear resolution mode, the menu in figure 3-7 appears.

To choose a measurement, first select the measurement, then select the active channel(s). For example, to take measurement data on Channel 1 and measure a power spectrum, press POWER SPEC, then CH 1 ACTIVE. Keep in mind that for averaged measurements these two selections must be made before the measurement is started. If you want to change either selection, you must restart the measurement. The two dual-channel measurements, FREQ RESP and CROSS CORR, automatically activate both channels when they are selected.
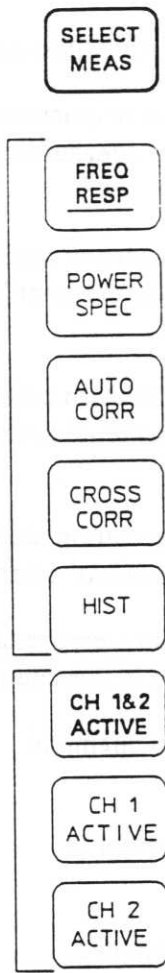
**Figure 3-7. SELECT MEAS Menu Diagram:
Linear Resolution Mode**

The softkeys in the **SELECT MEAS** menu do the following:

FREQ
RESP
Selects the frequency response measurement. (For details, see "The Frequency Response Measurement" later in this chapter).

POWER
SPEC
Selects the power spectrum measurement. (For details, see "The Power Spectrum Measurement" later in this chapter).

AUTO
CORR
Selects the auto correlation measurement. (For details, see "The Auto Correlation Measurement" later in this chapter).

CROSS
CORR
Selects the cross correlation measurement. (For details, see "The Cross Correlation Measurement" later in this chapter).

HIST
Selects the histogram measurement. (For details, see "The Histogram Measurement" later in this chapter).

CH 1&2
ACTIVE
Activates both input channels.

CH 1
ACTIVE
Activates input Channel 1.

CH 2
ACTIVE
Activates input Channel 2.

Note

You can also perform time throughput measurements in the linear resolution mode. Furthermore, you can demodulate any linear resolution measurement. See chapter 9, "Time Throughput" and "Demodulated Measurements" later in this chapter for details.

Selecting a Display

The linear resolution mode offers a number of ways to display your measurement data. You can choose instantaneous displays (press **VIEW INPUT**), filtered-input displays (press **MEAS DISP** followed by FILTRD INPUT), or measurement displays (press **MEAS DISP**). Instantaneous displays allow you to see measurement data before it has been filtered to a reduced frequency span, triggered, or measured. Filtered-input displays allow you to see measurement data after it has been triggered and filtered to the current frequency span. Measurement displays allow you to see measurement data after it has gone through the entire measurement process. Figure 2-3, "Measurement Process Diagram," in chapter 2 shows you how instantaneous, filtered-input, and measurement displays are derived. Chapter 2 also contains an introduction to these displays and shows which ones are available in each measurement mode. All displays — instantaneous, filtered-input, and measurement displays — can be selected before, during or after the measurement.

Since measurement displays are derived from calculations on the collected data, a number of different measurement displays are possible from one measurement. Consequently, the measurement that you select determines the measurement displays available to you. Therefore, first select the measurement (**SELECT MEAS**), then select a measurement display (**MEAS DISP**). Figure 3-8 shows you the menu diagram for the MEAS DISP hardkey when the analyzer is in the linear resolution mode. The softkeys in this menu are described later in this section.

Note   See "Viewing the Input Signals" earlier in this chapter for details about instantaneous displays. See "Filtered-Input Displays" later in this chapter for details about filtered-input displays. See the following sections for details about measurements and measurement displays. Each section begins with a description of one measurement and then describes the measurement displays available for that measurement.

Figure 3-8. MEAS DISP Menu Diagram:
Linear Resolution Mode

The Frequency Response Measurement

The frequency response measurement, often called the "transfer function," is the ratio of a system's output to its input and yields both gain and phase as a function of frequency. (The phase response can be viewed by pressing PHASE in the **COORD** menu.) In the HP 3563A, the signal on Channel 1 is assumed to be the system's input, and the signal on Channel 2 is assumed to be its output. To select the frequency response measurement, press **SELECT MEAS**, followed by the FREQ RESP softkey (see figure 3-7).

To select a measurement display for the frequency response measurement, press **MEAS DISP**. The softkeys that appear are shown in figure 3-8. Notice that a number of different measurement displays are available for this measurement, such as:

FREQ RESP	Displays the frequency response. When default units and coordinates are active, this displays frequency on the X-axis and gain on the Y-axis.
COHER	Displays the coherence of the frequency response. (This softkey does not appear if time averaging is selected—see "Averaging In The Linear Resolution Mode" later in this chapter.)
POWER SPEC1	Displays the power spectrum measured on Channel 1.
POWER SPEC2	Displays the power spectrum measured on Channel 2.
CROSS SPEC	Displays the cross spectrum.
IMPLS RESP	Displays the impulse response.
AUTO MATH	Selects the display calculated with the auto math table; see "Math & Auto Math" in chapter 15. Note that this label might be replaced by a user-defined label.
FILTRD INPUT	Displays the filtered input menu, which provides time record and linear spectrum displays; see "Filtered-Input Displays" later in this chapter.

The Frequency-Response Measurement Display

The frequency response display shows you the frequency response of your measurement. The frequency response is calculated as the ratio of the cross spectrum to the Channel 1 power spectrum as follows:

$$H(f) = \frac{G_{yx}}{G_{xx}}$$

where:

G_{yx} is the cross spectrum (x is Channel 1; y is Channel 2)
G_{xx} is the Channel 1 power spectrum

Figure 3-9 shows the response of a typical filter as characterized with the frequency response display. This example used the default coordinates and units; refer to chapter 8, "Display Configuration," for information on selecting other coordinates or units for the display.
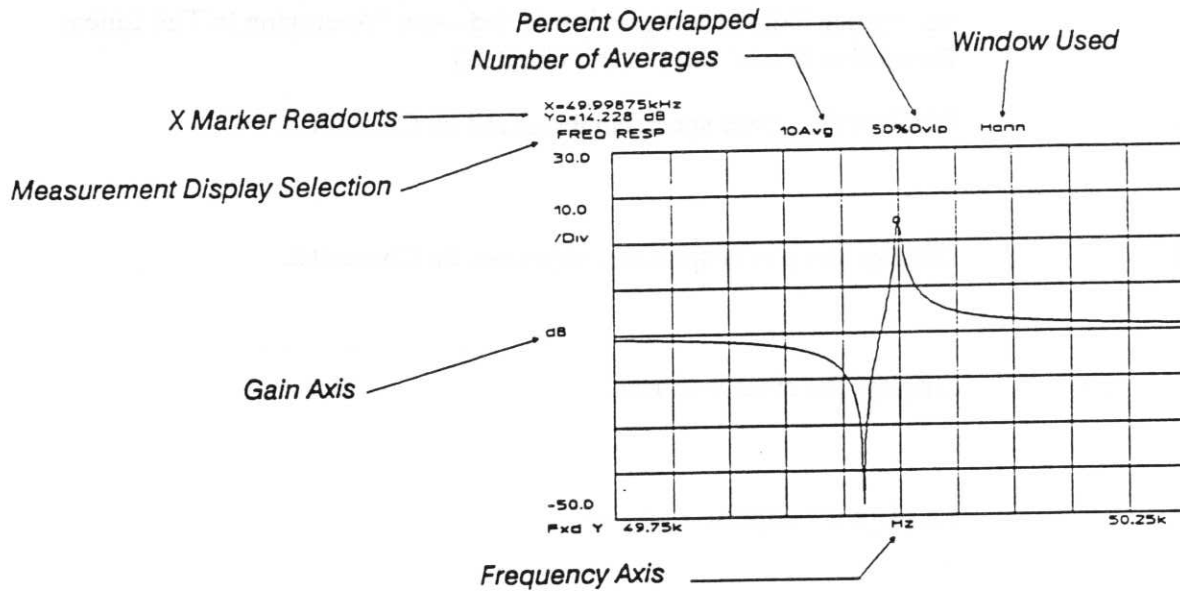
Figure 3-9. The Frequency Response Measurement Display

The Coherence Measurement Display

The coherence measurement display calculates and displays the coherence of the frequency response. Coherence shows the portion of the output power spectrum related to the input spectrum, according to the following formula:

$$\gamma^2 = \frac{G_{yx}G_{yx}*}{G_{xx}G_{yy}}$$

where:

G_{yx} is the cross spectrum
$G_{yx}*$ is the cross spectrum's complex conjugate
G_{xx} is the Channel 1 power spectrum
G_{yy} is the Channel 2 power spectrum

Coherence is an indication of the statistical validity of a frequency response measurement. Coherence is measured on a scale of 0.0 to 1.0, where 1.0 indicates perfect coherence. Coherence values less than unity are caused by poor measurement resolution (in regions with rapid phase change), system nonlinearities, extraneous noise and/or uncorrelated input signals. Because coherence is normalized, it is independent of the shape of the frequency response function.

Note   The coherence function is valid only for averaged measurements.

Figure 3-10 shows the coherence of the frequency response function shown in figure 3-9. The low coherence value at 49.9 kHz is due to the rejection of the input signal at the anti-resonance of the crystal.

X=49.96812kHz
Yo=453.68m
COHERENCE   10Avg   50%Ovlp   Hann

*Coherence Scaled
from 0.0 to 1.0*

1.0

125
m
/Div

Mag

0.0

Fxd Y 49.75k   Hz   50.25k
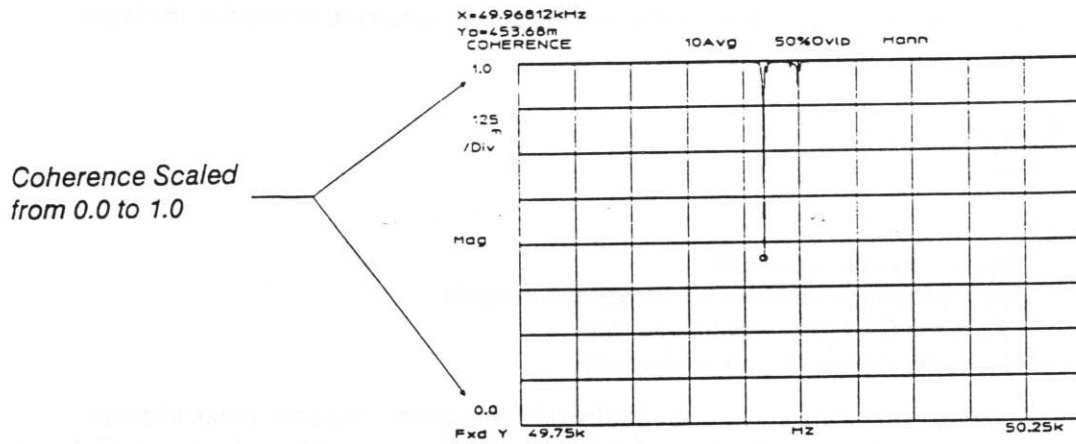
**Figure 3-10. The Coherence
Measurement Display**

The Power-Spectrum Measurement Display

The power spectrum is the FFT of the input signal (in other words, the linear spectrum) multiplied by its complex conjugate. You can display the power spectrum for Channel 1 or Channel 2. For an example of this display, see figure 3-13.

$$G_{xx} = F_x F_x*$$

> where:
> F_x* is the Channel 1 linear spectrum's conjugate
> F_x is the Channel 1 linear spectrum

If you are measuring the frequency response of a system or device, this display is a convenient means of viewing the input and output spectra after taking a frequency response measurement. If you want to measure frequency spectra only, the power spectrum measurement is faster (because cross-channel terms are not calculated). (See "The Power Spectrum Measurement" later in this chapter.) Also, a single-channel measurement has greater maximum real time bandwidth (10 kHz versus 5 kHz).

The Cross-Spectrum Measurement Display

The cross-spectrum measurement display is computed by multiplying the complex conjugate of the linear spectrum on Channel 1 by the linear spectrum on Channel 2 as follows:

$$G_{yx} = F_y F_x*$$

where:
> F_x* is the Channel 1 linear spectrum's complex conjugate
> F_y is the Channel 2 linear spectrum

The cross spectrum shows the amplitude product of the two spectra and the phase difference between them. The imaginary part of the cross spectrum is used in acoustic intensity measurements. Figure 3-11 shows an example of the cross-spectrum measurement display.

x=50kHz
Ya=-33.743 dBVrms
CROSS SPEC   10Avg   50%Ovlp   Hann

Scaled in dB
Referenced to 1V ^{2}rms
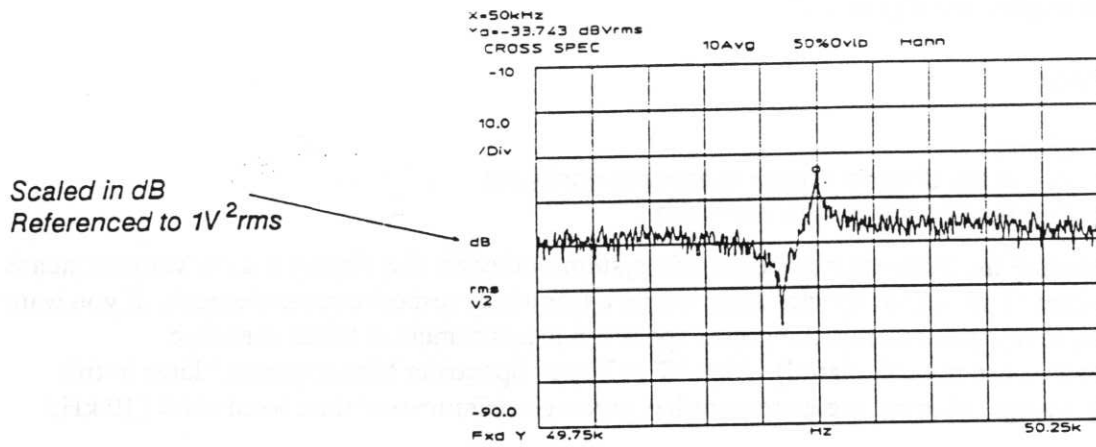
Figure 3-11. The Cross-Spectrum
Measurement Display

The Impulse-Response Measurement Display

The impulse-response measurement display is the inverse FFT of frequency response; it shows response as a function of time as follows:

$$h(t) = FFT^{-1}[H(f)]$$

where:
H(f) is the frequency response

It is useful for studying transient behavior and measuring time delay. Impulse response is valid only for baseband measurements (measurements that start at 0 Hz). The impulse resonse may be measured directly with the PULSE source type. Connect the PULSE signal to Channel 1 (don't forget to use source triggering) and use a filtered-input time display on Channel 2.

Figure 3-12 shows an example of the impulse-response measurement display.

Note

The quality of the impulse-response measurement is a function of the selected frequency span. The frequency span must be chosen so that the pass-band characteristics of H(f) are included in the frequency response measurement.
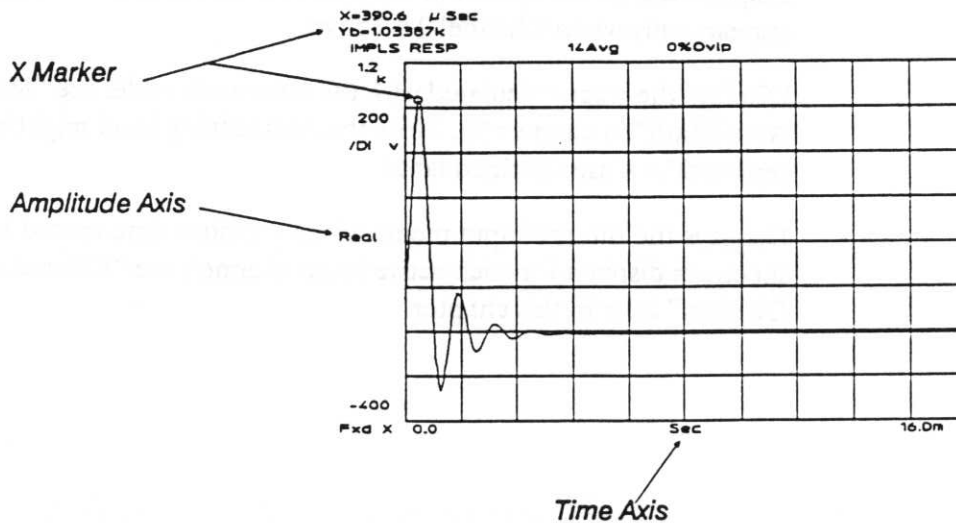
Figure 3-12. The Impulse-Response Measurement Display

The Power Spectrum Measurement

The power spectrum measurement shows the input signal in the frequency domain. It is computed by multiplying the FFT of the signal by its complex conjugate:

$$G_{xx} = F_x F_x*$$

where:
  F_x is the channel's linear spectrum
  F_x* is its complex conjugate

This measurement is provided in addition to the frequency response measurement because the single-channel power spectrum is faster than the dual-channel frequency response measurement. Single-channel measurements also provide greater maximum real-time bandwidth (with fast averaging activated: 10 kHz for single-channel; 5 kHz for dual-channel). The power spectrum provides no phase information.
To select the power spectrum measurement, press **SELECT MEAS**, followed by the POWER SPEC softkey (see figure 3-7).

To select a measurement display for the power spectrum measurement, press **MEAS DISP** (see figure 3-8). Notice that a number of different measurement displays are available for this measurement, such as:

POWER SPEC1	Displays the power spectrum measured on Channel 1. This softkey appears only when Channel 1 is active.
POWER SPEC2	Displays the power spectrum measured on Channel 2. This softkey appears only when Channel 2 is active.
AUTO MATH	Displays the trace calculated with the auto math table; see "Math & Auto Math" in chapter 15. Note that this softkey label might be replaced by a user-defined label.
FILTRD INPUT	Displays the filtered input menu, which provides time record and linear spectrum displays for each active input channel; see "Filtered-Input Displays" later in this chapter.

The Power-Spectrum Measurement Display

The power-spectrum measurement display shows you the power spectrum for the selected channel. Figure 3-13 shows an example of the power spectrum measurement and its measurement display.
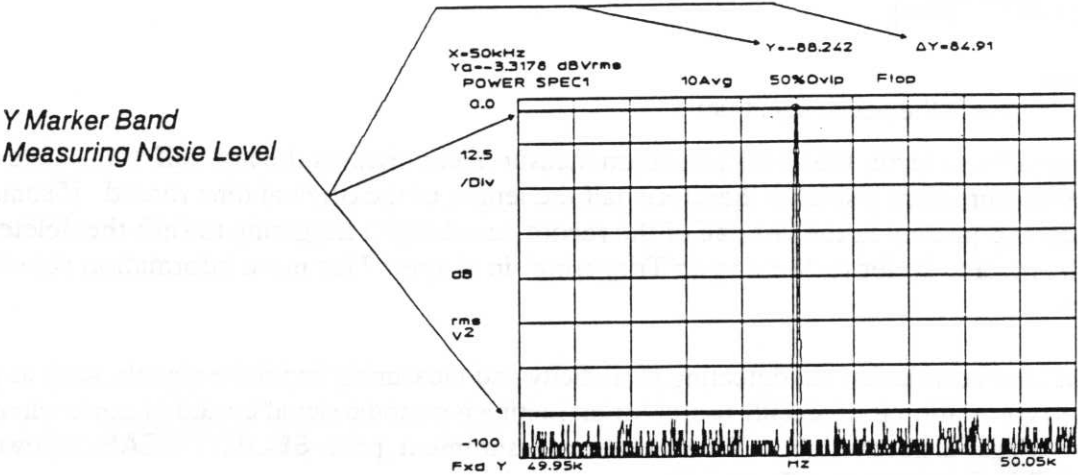
**Figure 3-13. The Power-Spectrum
Measurement Display**

The Auto Correlation Measurement

The auto correlation measurement indicates periodicity in time domain signals. It multiplies the signal by a progressively time-shifted version of itself; this emphasizes periodic parts of the signal and de-emphasizes nonperiodic parts. In the HP 3563A it is computed using the inverse FFT of the power spectrum:

$$R_x(t) = FFT^{-1}[Gxx]$$

where:
    Gxx is the power spectrum

To avoid wrap-around error, the auto correlation measurement discards the last half of the time record. The measurement display is therefore half the length of the original time record. If some signal of interest is present in the last half of the record, use delayed triggering to shift the deleted portion of the record. Refer to "Setting up Triggering" in chapter 7 for more information about trigger delay.

Some uses of auto correlation are detecting periodicity and measuring impulsive signals, such as gear chatter. Auto correlation is especially useful for extracting a periodic signal buried in noise when a synchronized trigger is not available. To select this measurement, press **SELECT MEAS**, followed by the AUTO CORR softkey (see figure 3-7).

To select a measurement display for the auto correlation measurement, press **MEAS DISP** (see figure 3-8). Notice that a number of different measurement displays are available for this measurement, such as:

AUTO CORR1
: Displays the auto correlation of the signal on Channel 1. This softkey appears only when Channel 1 is active.

AUTO CORR2
: Displays the auto correlation of the signal on Channel 2. This softkey appears only when Channel 2 is active.

AUTO MATH
: Displays the trace calculated with the auto math table; see "Math & Auto Math" in chapter 15. Note that this softkey label might be replaced by a user-defined label.

FILTRD INPUT
: Displays the filtered input menu, which provides time record and linear spectrum displays; see "Filtered-Input Displays" later in this chapter.

The Auto-Correlation Measurement Display

Figure 3-14 shows an example of the auto-correlation measurement display. To select this display, press **MEAS DISP**, followed by the AUTO CORR1 or AUTO CORR2 softkeys.
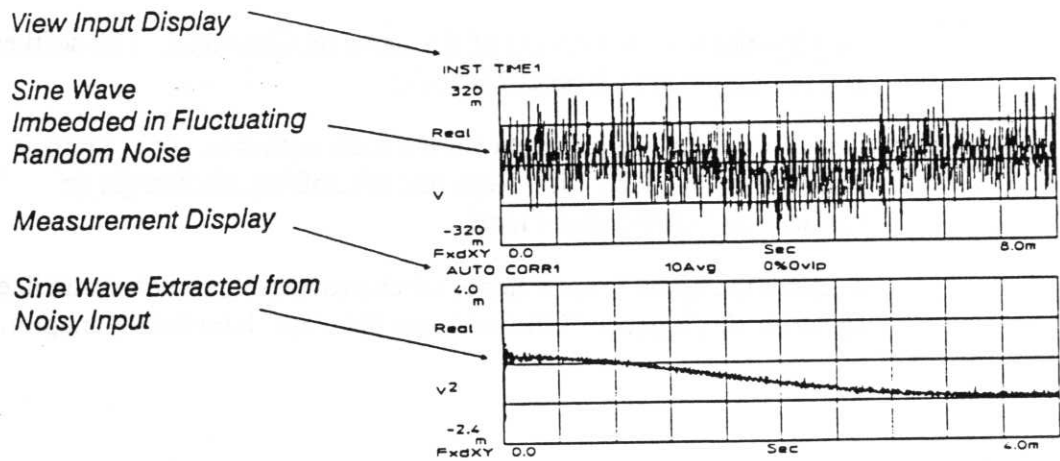
Figure 3-14. The Auto-Correlation Measurement Display

The Cross Correlation Measurement

The cross correlation measurement indicates time domain similarity between the signal on Channel 1 and the signal on Channel 2. It multiplies the Channel 1 signal by a progressively time-shifted version of the Channel 2 signal; this emphasizes similarities between the two while de-emphasizing differences. In the HP HP 3563A it is computed as the inverse FFT of the cross spectrum:

$$R_{xy}(t) = FFT^{-1}[G_{yx}]$$

where:
G_{yx} is the cross spectrum

To avoid wrap-around error, the cross correlation measurement discards the last half of the Channel 2 time record. The measurement display is therefore half the length of the time record. If some signal of interest is present in the last half of the record, use delayed triggering to shift the deleted portion of the record. Refer to "Setting up Triggering" in chapter 7 for more information about trigger delay.

A major application is measuring system time delays since the maximum value of the function occurs at a time delay equal to the time delay in the system under test. To select this measurement, press **SELECT MEAS**, followed by the CROSS CORR softkey (see figure 3-7).

To select a measurement display for the cross correlation measurement, press **MEAS DISP** (see figure 3-8). Notice that a number of different measurement displays are available for this measurement, such as:

CROSS CORR	Displays the cross correlation function.
AUTO CORR 1	Displays the auto correlation function of the signal on Channel 1.
AUTO CORR 2	Displays the auto correlation function of the signal on Channel 2.
AUTO MATH	Displays the trace calculated with the auto math table; refer to "Math & Auto Math" in chapter 15. Note that this softkey label might be replaced by a user-defined label.
FILTRD INPUT	Displays the filtered input menu, which provides time record and linear spectrum displays; see "Filtered-Input Displays" later in this chapter.

The Cross-Correlation Measurement Display

Figure 3-15 shows an example of the cross-correlation measurement display. To select this display, press **MEAS DISP**, followed by the CROSS CORR softkey.

Measurement Display Selection ——→ CROSS CORR   1Avg   0%Ovlp

Time Record Length
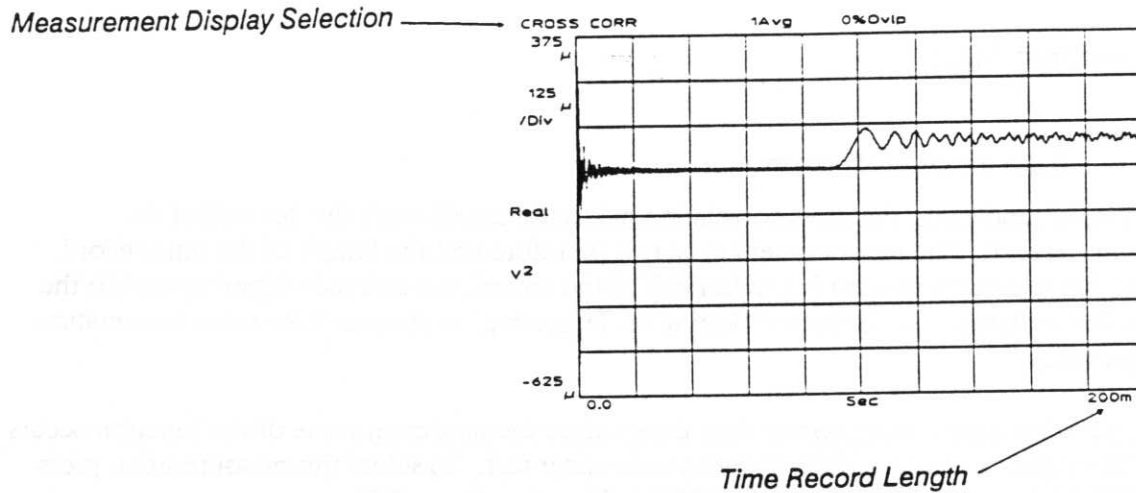
**Figure 3-15. The Cross-Correlation
Measurement Display**

The Auto-Correlation Measurement Displays

If you are interested only in auto correlation, the auto correlation measurement described earlier in this chapter is faster because it is a single-channel measurement (cross-channel terms are not calculated). See figure 3-14 for an example of the auto correlation display. To select an auto-correlation measurement display, press **MEAS DISP**, followed by AUTO CORR1 or AUTO CORR2.

The Histogram Measurement

The histogram measurement shows how the amplitude of the input signal is distributed between its maximum and minimum values versus the number of occurences or measurements. Some of its uses are determining the statistical properties of noise and monitoring the performance of electromechanical positioning systems. Note that the number of averages you may select for a histogram determines how many records are measured; the records are not "averaged". If exponential averaging is selected, the measurement continues indefinitely. Keep in mind that the accuracy of the histogram is dependent on frequency span, record length and number of averages. To select this measurement, press **SELECT MEAS**, followed by the HIST softkey (see figure 3-7).

To select a measurement display for the histogram measurement, press **MEAS DISP** (see figure 3-8). Notice that a number of different measurement displays are available for this measurement, such as:

HIST 1	Displays the histogram of the signal on Channel 1.
HIST 2	Displays the histogram of the signal on Channel 2.
PDF 1	Displays the probability density function of the signal on Channel 1.
PDF 2	Displays the probability density function of the signal on Channel 2.
CDF 1	Displays the cumulative density function of the signal on Channel 1.
CDF 2	Displays the cumulative density function of the signal on Channel 2.
AUTO MATH	Displays the trace calculated with the auto math table; see "Math & Auto Math" in chapter 15. Note that this softkey label might be replaced by a user-defined label.
FILTRD INPUT	Displays the filtered input menu, which provides the time record and linear spectrum displays; see "Filtered-Input Displays" later in this chapter.

Note

The softkeys that actually appear when you press MEAS DISP depend on the active channel selection. For example, if only Channel 1 is active, HIST 2, PDF 2 and CDF 2 do not appear.

Furthermore, although the **WINDOW** hardkey remains active, windows have no effect on histograms.

The Histogram Measurement Display

Figure 3-16 shows an example of the histogram measurement display. To select this display, press
MEAS DISP followed by the HIST1 or HIST 2 softkeys.

Number of Counts
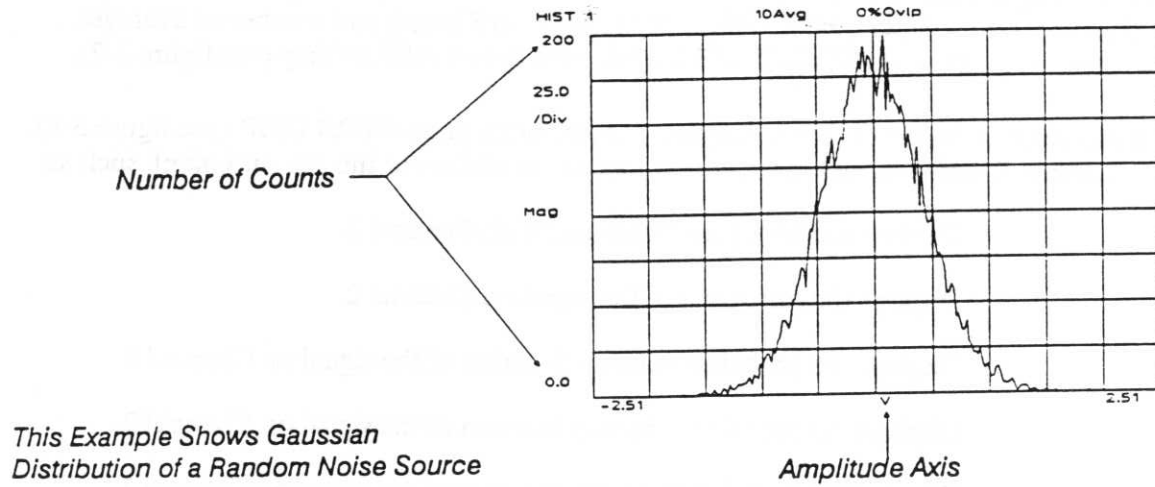
This Example Shows Gaussian
Distribution of a Random Noise Source

Amplitude Axis

Figure 3-16. The Histogram Measurement Display

The Probability-Density-Function (PDF) Measurement Display

The probability density function, computed by normalizing the histogram, is a statistical measure of the probability that a specific level occurred. The PDF is normalized by multiplying the number of averages by 2048 (the number of points in the time record; 1024 for zoom measurements), dividing the histogram by this value, then dividing by the ΔV spacing on the X-axis. The probability of an input signal falling between two points is equal to the integral of the curve between those points (see the following description of the cumulative density function).

Figure 3-17 shows an example of the PDF measurement display. To select this display, press **MEAS DISP**, followed by the PDF1 or PDF2 softkeys.

Similar to Histogram, with # of
Counts Divided by Record Length
and # of Averages
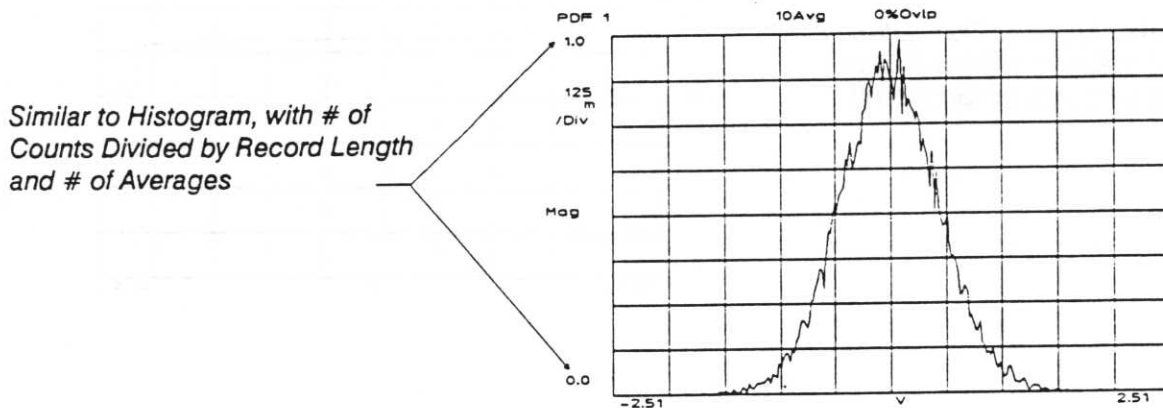
Figure 3-17. The PDF Measurement Display

The Cumulative-Density-Function (CDF) Measurement Display

The cumulative density function, computed by integrating the PDF, shows the probability that a level equal to or less than a specific level occurred. Figure 3-18 shows an example of the CDF measurement display. To select this display, press **MEAS DISP**, followed by the CDF1 or CDF2 softkeys.

X marker Indicates Cumulative
Level of Random Noise Source
(from histogram in figure 3-14)
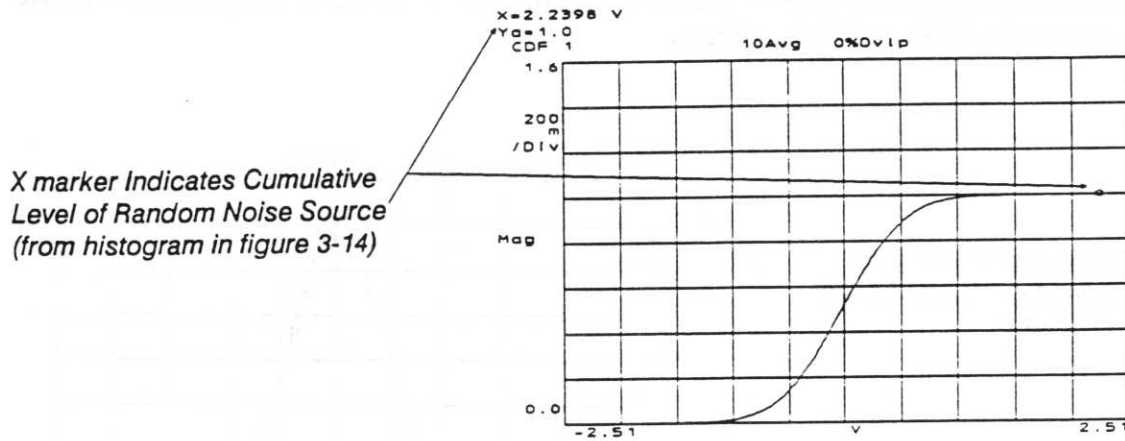
Figure 3-18. The CDF Measurement Display

Frequency Spans in the Linear Resolution Mode

Table 3-1 shows the available spans for the linear resolution mode. Frequency spans in the linear resolution mode are predefined; if a value other than one of these is entered for the span, the analyzer selects the next higher available value. Note that when the span is changed, the new span does not appear on the display until the next measurement is started.

Note

The values in table 3-1 are based on a sample frequency (Fs) of 256 kHz, which is the internal sample frequency of the analyzer. Furthermore, the values are based on 801 frequency lines. The following sections tell you how the values in this table are affected if you change the sample frequency or the number of frequency lines (see "Determining Valid Frequency Spans").

Also notice that some spans are only available with baseband or zoom measurements (baseband measurements start at 0 Hz; zoom measurements do not start at 0 Hz).

Table 3-1. Valid Frequency Spans

Span	Resolution	Record Length	Availablity
10.24 mHz	12.8 μHz	78,123s	baseband
20.48 mHz	25.6 μHz	39,062.5s	zoom
25.6 mHz	32 μHz	31,250s	baseband
51.2 mHz	64 μHz	15,625s	both
64 mHz	60 μHz	12,500s	baseband
102.4 mHz	128 μHz	7,812.5s	zoom
128 mHz	160 μHz	6,250s	both
160 mHz	200 μHz	5,000s	baseband
256 mHz	320 μHz	3,125s	both
320 mHz	400 μHz	2,500s	both
400 mHz	500 μHz	2,000s	baseband
512 mHz	640 μHz	1,562.5s	zoom
640 mHz	800 μHz	1,250s	both
800 mHz	1 mHz	1,000s	both
1.0 Hz	1.25 mHz	800s	baseband
1.28 Hz	1.6 mHz	625s	both
1.6 Hz	2.0 mHz	500s	both
2.0 Hz	2.5 mHz	400s	both
2.5 Hz	3.125 mHz	320s	baseband
2.56 Hz	3.2 mHz	312.5s	zoom
3.2 Hz	4 mHz	250s	both
4.0 Hz	5 mHz	200s	both
5.0 Hz	6.25 mHz	160s	both
6.25 Hz	7.81 mHz	128s	baseband
6.4 Hz	8 mHz	125s	both
8.0 Hz	10 mHz	100s	both
10.0 Hz	12.5 mHz	80s	both
12.5 Hz	15.625 mHz	64s	both
12.8 Hz	16 mHz	62.5s	zoom
15.625 Hz	19.531 mHz	51.2s	baseband
16.0 Hz	20 mHz	50s	both
20.0 Hz	25 mHz	40s	both
25.0 Hz	31.25 mHz	32s	both
31.25 Hz	39.0625 mHz	25.6s	both
32.0Hz	40 mHz	25s	both
39.0625 Hz	48.828 mHz	20.48s	baseband
40.0 Hz	50 mHz	20s	both
50.0 Hz	62.5 mHz	16s	both
62.5 Hz	78.125 mHz	12.8s	both
64.0 Hz	80 mHz	12.5s	zoom
78.125 Hz	97.656 mHz	10.24s	both
80.0 Hz	100 mHz	10s	both
97.65625 Hz	122.0625 mHz	8.192s	baseband
100.0 Hz	125 mHz	8s	both
125.0 Hz	156.25 mHz	6.4s	both
156.25 Hz	195.31 mHz	5.12s	both
160.0 Hz	200 mHz	5s	both
195.3125 Hz	244.14 mHz	4.096s	both

Span	Resolution	Record Length	Availablity
200.0 Hz	250 mHz	4s	both
250.0 Hz	312.5 mHz	3.2s	both
312.5 Hz	390.62 mHz	2.56s	both
320.0 Hz	400 mHz	2.5s	zoom
390.625 Hz	488.28 mHz	2.048s	both
400.0 Hz	500 mHz	2s	both
500.0 Hz	625 mHz	1.6s	both
625.0 Hz	781.25 mHz	1.28s	both
781.25 Hz	976.56 mHz	1.024s	both
800.0 Hz	1 Hz	1s	both
1.0 kHz	1.25 Hz	800 ms	both
1.25 kHz	1.5625 Hz	640 ms	both
1.5625 kHz	1.9531 Hz	512 ms	both
1.6 kHz	2 Hz	500 ms	zoom
2.0 kHz	2.5 Hz	400 ms	both
2.5 kHz	3.125 Hz	320 ms	both
3.125 kHz	3.906 Hz	256 ms	both
4.0 kHz	5 Hz	200 ms	both
5.0 kHz	6.25 Hz	160 ms	both
6.25 kHz	7.8125 Hz	128 ms	both
8.0 kHz	10 Hz	100 ms	zoom
10.0 kHz	12.5 Hz	80 ms	both
12.5 kHz	15.625 Hz	64 ms	both
20.0 kHz	25 Hz	40 ms	both
25.0 kHz	31.25 Hz	32 ms	both
40.0 kHz	50 Hz	20 ms	zoom
50.0 kHz	62.5 Hz	16 ms	both
100.0 kHz	125 Hz	8 ms	baseband

Zoom indicates that this span is available only when the start frequency is not 0 Hz.

Baseband indicates that this span is available only when the start frequency is 0 Hz.

Both indicates that this span is available regardless of the start frequency.

Setting the Frequency Span and Time Record Length

To set the frequency span or time record length, press **FREQ** to display the menu shown in figure 3-19; then select one of the softkeys shown. Notice that there are two possible menus: one when both input channels are analog, another when one channel (or both) is digital.
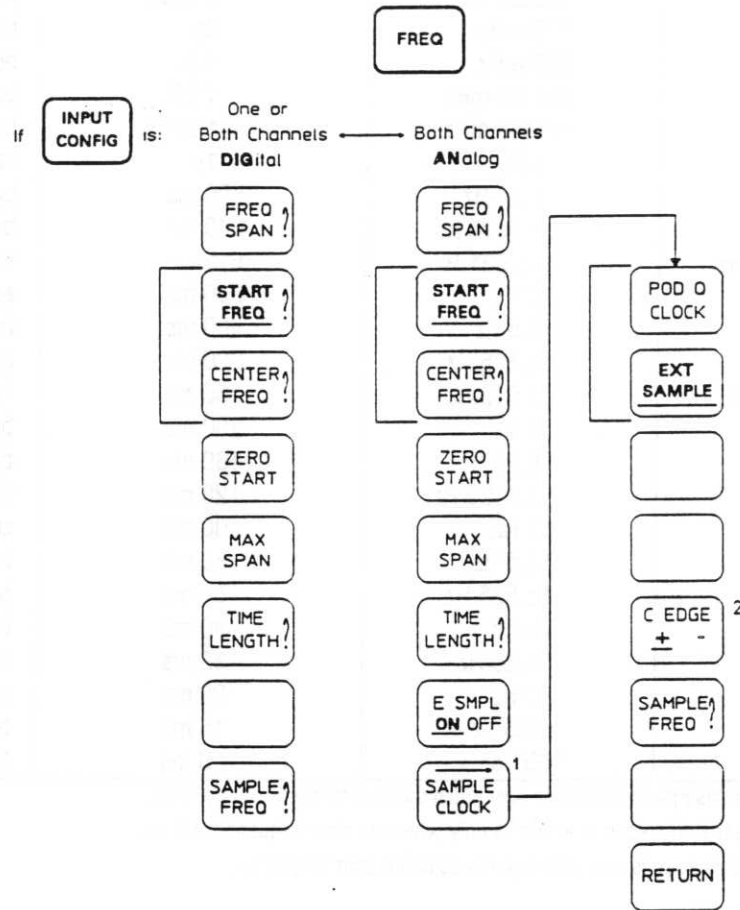
¹ Blank if [E SMPL ON **OFF**] is selected (this is the default)
² Blank if [EXT SAMPLE] is selected

Figure 3-19. FREQ Menu Diagram:
Linear Resolution Mode

The softkeys in the **FREQ** menu do the following (for a description of the softkeys under SAMPLE CLOCK, see the following section, "External Sampling"):

FREQ
SPAN

Sets the frequency span; the span may also be entered immediately after pressing **FREQ**. The frequency span must be entered before the measurement is started. See "Determining Valid Frequency Spans" to determine valid frequency spans when external sampling is used.

START
FREQ

Sets the start frequency, using the Entry group.

CENTER
FREQ

Sets the center frequency, using the Entry group.

ZERO
START

Sets the starting frequency to 0 Hz (dc).

MAX
SPAN

Specifies the maximum frequency span that is displayed for the current sample frequency, Fs. See "Determining Valid Frequency Spans" to determine the maximum frequency span when external sampling is used.

TIME
LENGTH

Sets the time record length, using the Entry group.

SAMPLE
FREQ

This softkey appears only when one or both channels are digital. It allows you to enter the frequency of your external sample clock for digital or mixed (analog & digital) measurements (you must supply an external sample clock for all digital or mixed measurements). SAMPLE FREQ is also located under the **INPUT CONFIG** hardkey (see chapter 7, "Input Setup"). It is duplicated here for your convenience — so that you can set the external sample frequency at the same time you set all other frequency parameters. If both channels are analog, this softkey reads SAMPLE CLOCK. See "External Sampling" later in this section for details.

E SMPL
ON OFF

This softkey appears only when both channels are analog. When toggled to ON, it selects external sampling, activates the EXT SAMPLE indicator in the Status group, and displays the SAMPLE FREQ softkey. See "External Sampling" later in this section for details.

SAMPLE
CLOCK

This softkey appears only when both channels are analog and E SMPL ON OFF is toggled ON. It allows you to set all parameters for the external sample clock for analog measurements. If both channels are *not* analog, this softkey reads SAMPLE FREQ. See "External Sampling" later in this section for details.

Hints for Setting the Frequency Span

The frequency softkeys are easy to use if you treat start/stop and span/center as separate pairs. Specify the frequency by entering start and stop frequencies or by entering center frequency and span. Note that these four softkeys are interrelated; changing one may affect some or all of the others.

As an example, when entering a span other than 100 kHz, you could use FREQ SPAN with either START FREQ or CENTER FREQ. To look for the first five harmonics of a 1 kHz signal, you could enter a span of 5 kHz and a start frequency of 1 kHz. To look for 100 Hz sidebands on a 50 kHz carrier, you could enter a span of 250 Hz and a center frequency of 50 kHz.

To simplify frequency entries, you can press FREQ SPAN, START FREQ, CENTER FREQ or STOP FREQ, then enter the start and stop frequencies separated by a comma. For example, to set up span from 100 Hz to 200 Hz, you can press FREQ SPAN followed by 100, 200 Hz.

For zoom measurements, it is usually easiest to enter the center frequency (CENTER FREQ) first. Then enter the frequency span (FREQ SPAN).

Determining Valid Frequency Spans

In linear resolution mode, the analyzer's frequency span is affected by the following:

- Internal Sampling
    - The number of frequency lines (selected in the **WINDOW** menu)

- External Sampling
    - The number of frequency lines (selected in the **WINDOW** menu)
    - The external sample-frequency

- The MIXED RATIO selection in the **INPUT CONFIG** menu

How The Number of Frequency Lines Affects the Frequency Span

You can configure the analyzer to use 801 or 1024 frequency lines to display frequency-domain data (for details, see "Selecting a Window" later in this chapter). All values in table 3-1 are based on 801 frequency lines. When you select 1024 frequency lines, the analyzer adds an additional 223 lines to extend the maximum baseband frequency from 100 kHz to 128 kHz, as shown in figure 3-20. For zoom measurements, the analyzer adds the additional 223 lines as shown in figure 3-21.
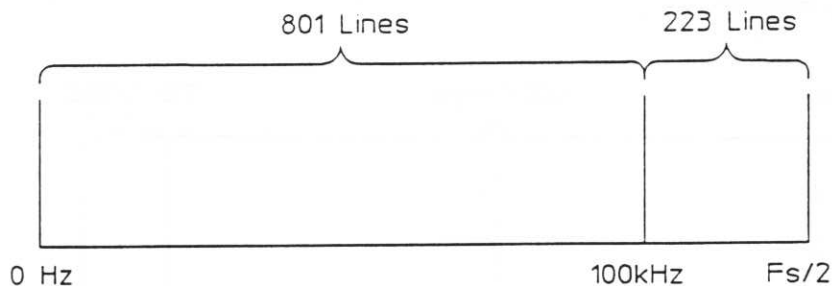
Figure 3-20. 1024 Frequency Lines: Baseband

How Internal Sampling Affects the Frequency Span

For internal sampling, use the values in table 3-1 to determine valid frequency spans. The values in table 3-1 are based on a sample frequency of 256 kHz (the analyzer's internal sample frequency) and a display of 801 frequency-lines. If the start or center frequencies are set to values that would cause some part of the span to exceed the minimum and maximum values in table 3-1, the span is reduced to keep it within the minimum and maximum values. If you select 1024 frequency lines, the values in table 3-1 are still valid, but the maximum displayed frequency span is extended to 128 kHz.

How External Sampling Affects the Frequency Span

For external sampling, you can use the values in table 3-1 to determine valid frequency spans if the external sample-frequency is 256 kHz (the same as the analyzer's internal sample-frequency). If the external sample-frequency is not 256 kHz, you must scale all values in table 3-1 as follows:

$$\text{Span} \times \frac{F_s}{256,000}$$

$$\text{Resolution} \times \frac{F_s}{256,000}$$

$$\text{Record length} \times \frac{256,000}{F_s}$$
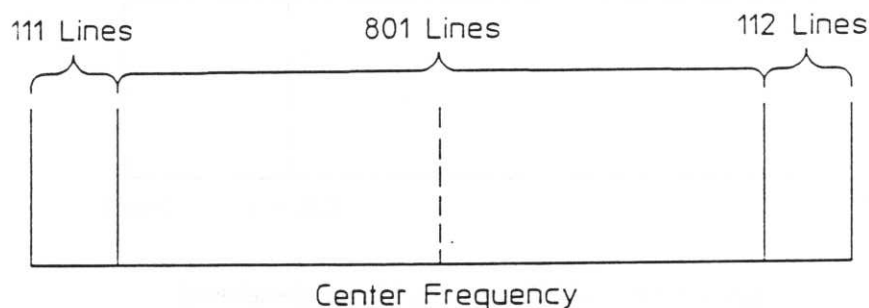
Figure 3-21. 1024 Frequency Lines: Zoom

Furthermore, to determine the maximum frequency span, use the following formulas:

If LINES 801 is selected:

$$\text{Maximum Span} = \frac{F_s}{2.56}$$

If LINES 1024 is selected:

$$\text{Maximum Span} = \frac{F_s}{2.56 \times \left(\frac{800}{1023}\right)} \approx \frac{F_s}{2}$$

If you are making mixed measurements (one channel digital, the other analog), the frequency span is still dependent on the sample frequency — but in a different way. In this case, you must also consider the value of MIXED RATIO as shown in the following formulas (the MIXED RATIO softkey is described in chapter 7, Input Setup). Notice that the following formulas are simply the previous formulas multiplied by the MIXED RATIO.

$$\text{Span} \times \frac{(F_s \times \text{MIXED RATIO})}{256,000}$$

$$\text{Resolution} \times \frac{(F_s \times \text{MIXED RATIO})}{256,000}$$

$$\text{Record length} \times \frac{256,000}{(F_s \times \text{MIXED RATIO})}$$

For mixed measurements, determine the maximum frequency span as follows:

If LINES 801 is selected:

$$\text{Maximum Span} = \frac{(F_s \times \text{MIXED RATIO})}{2.56}$$

If LINES 1024 is selected:

$$\text{Maximum Span} = \frac{(F_s \times \text{MIXED RATIO})}{2.56 \times \left(\frac{800}{1023}\right)} \approx \frac{(F_s \times \text{MIXED RATIO})}{2}$$

Real-Time Bandwidth

The real-time bandwidth (RTBW) is the maximum frequency span you can measure without missing input data. At spans greater than the RTBW, the analyzer's processing time exceeds its data collection time and part of the input signal is ignored while the previous time record is processed. When measuring periodic signals, the RTBW is not important because any data lost in one record is repeated in the next record. However, RTBW is very important when measuring nondeterministic signals. With fast averaging on, the HP 3563A's maximum real time bandwidths in the linear resolution mode are 10 kHz for single-channel measurements and 5 kHz for dual-channel.

To achieve the greatest possible RTBW, you need to limit the number of display calculations required. The less you require of the display, the faster the measurement can run. For example, fast averaging and the single display format provide a greater RTBW than normal display updating and two active traces. One simple way of minimizing display time is to activate fast averaging (in the **AVG** menu) and select the single display format (the **SINGLE** hardkey). The message "Real Time" is displayed in the lower right corner of the trace at the end of the measurement if there were no gaps in the data.

Note   The HP 3563A double-buffers the input signals, so 1- and 2-average measurements are always in real time.

Frequency Span Versus Time Record Length

The HP 3563A allows you to set either the frequency span or the time record length in a measurement. The two are related by this formula:

$$\text{time record length(in seconds)} = \frac{800}{\text{span(in Hz)}} = \frac{1}{\Delta f(\text{in Hz})}$$

For example, a frequency span of 0 to 100 kHz has a time record length of 8 milliseconds (800/100 000). Note that the two are inversely proportional; a narrow span and increased resolution result in a slower measurement. Setting the frequency span automatically sets the time record, and vice versa. Because record length is determined by span, the available time record lengths are also predefined. Refer to table 3-1 for the predefined spans.

Zoom Measurements

Zooming, also known as band selectable analysis (BSA), allows you to concentrate the full measurement power of the HP 3563A on any portion of the 100 kHz frequency span. Say you are characterizing a filter with a resonant frequency of 15.0 kHz. With zoom, you can set the center frequency to 15.0 kHz and then set a very narrow span. A span of 50 Hz would give you a measurement from 14.975 Hz to 15.025 Hz and resolution of 50 Hz/800. Now you can accurately measure and analyze around this point of interest.

To demonstrate the higher resolution zooming provides, press **WINDOW** and select the uniform window by pressing UNIFRM (NONE). This sets the bandwidth equal to Δf. Next, press **STATE TRACE** until the state information is displayed. Set the span to 100 kHz and look under FREQ: BW. You can see that the measurement bandwidth in this span is 125 Hz. Change the span to 50 Hz. The bandwidth is now 62.5 mHz, offering a much more precise characterization of a narrow part of the signal.

External Sampling

The HP 3563A allows you to use its internal sample frequency (256 kHz) or an external sample frequency. The analyzer uses the sample frequency (Fs) to:

- Calibrate the time and frequency axis
- Convert between the s and z domain in synthesis (see chapter 17)
- Determine valid frequency spans (see "Determining Valid Frequency Spans")

External sampling allows you to synchronize the HP 3563A's data acquisition rate to an external signal, such as a tachometer pulse. The signal that you supply for external sampling is called the external sample clock. The external sample clock must be a TTL-level signal.

You use the **FREQ** and **INPUT CONFIG** hardkeys to set up the external sample clock. When both channels are analog, use the **FREQ** hardkey; When one or both channels are digital, use the **INPUT CONFIG** hardkey. This chapter explains how to set up the external sample clock when both channels are analog. See the description of the SAMPLE CLOCK softkey in chapter 7 to set up the external sample clock when one or both channels are digital.

Note   You cannot use external sampling when both channels are analog and the measurement mode is log resolution or swept sine. You can use external sampling in these measurement modes when one or both channels are digital (see chapter 7 for details).

Both Channels Analog

For analog measurements, the external sample clock must be a TTL level signal . You can connect the external sample clock to the EXT SAMPLE IN connector on the analyzer's rear panel. Or, you can connect it to Q-CLK on Pod Q (see chapter 13).

To set up external sampling for analog measurements, press **FREQ** and toggle E SMPL ON OFF to ON. Then press SAMPLE CLOCK, which displays the following menu (as shown in figure 3-19):

POD Q CLOCK	Selects the clock line (Q-CLK) on Pod Q as the Sample Clock. Use C EDGE + − to specify which clock edge to sample on. The Pod Q clock is functionally equivalent to the EXT SAMPLE IN connector located on the rear panel. You can use either connector for your external sample clock. However, you may notice loading problems associated with transmitting a digital signal down a coaxial cable to the EXT SAMPLE IN connector. Therefore, it is recommended that the Pod Q clock be used whenever possible. Signals applied to Pod Q must be TTL level.

EXT SAMPLE	Selects the BNC connector on the back panel (labeled EXT SAMPLE IN) as the Sample Clock. Signals applied to this connector must be TTL level.
C EDGE + −	Selects the active edge for the selected clock. The (+) selects the low-to-high transition, the rising edge. The (−) selects the high-to-low transition, the descending edge.
SAMPLE FREQ	Allows you to enter the frequency of your external sample clock. Enter the value with the Entry group keypad. The value you enter must be ≤ 256 kHz. If the sample frequency is entered in Hertz, it must remain constant. If it is entered in pulses/revolution, it can vary without affecting the accuracy of the measurement. The frequency span defaults to maximum when you enable or disable external sampling (with E SMPL ON OFF), or when you change the sample frequency.

Note

Measurements may not be accurate if the frequency specified with SAMPLE FREQ does not match the frequency of your external sample clock.

The horizontal display units depend on the external sample-frequency units. If the external sample frequency is entered in Hertz, the display shows Hertz. If the external sample frequency is entered in pulses/rev the display shows Orders. Use the Orders (Revs) softkey in the **UNITS** menu to select orders for the horizontal axis.

The HP 3563A's anti-aliasing protection, which is assured at the 256 kHz sample frequency, decreases as you decrease the sample frequency. To avoid aliasing problems, you should use a ratio synthesizer or some other device to keep the sample frequency close to 256 kHz. Or, make sure there are no frequency components in the input greater than half the sample frequency (Fs/2). There is no trigger delay correction for external sample frequencies below 0.6 Hz.

Note

In some cases a lower sample frequency can be used. Refer to "Choosing a Sample Clock" in chapter 14 for details.

Selecting a Window

Windows are time domain functions that reduce the effects of leakage, the smearing of energy across the frequency spectrum. Leakage is caused by signals that are not periodic in the time domain; the FFT assumes all inputs are periodic. For more details about leakage and windowing, obtain a copy of Hewlett-Packard Application Note 243 from your HP Sales Representative.

The HP 3563A offers six windows: Hann, flat top, uniform, force, exponential, and user-defined. To select a window, press **WINDOW** to display the menu in figure 3-22.

Note   Windows are available only in linear resolution and time capture modes.
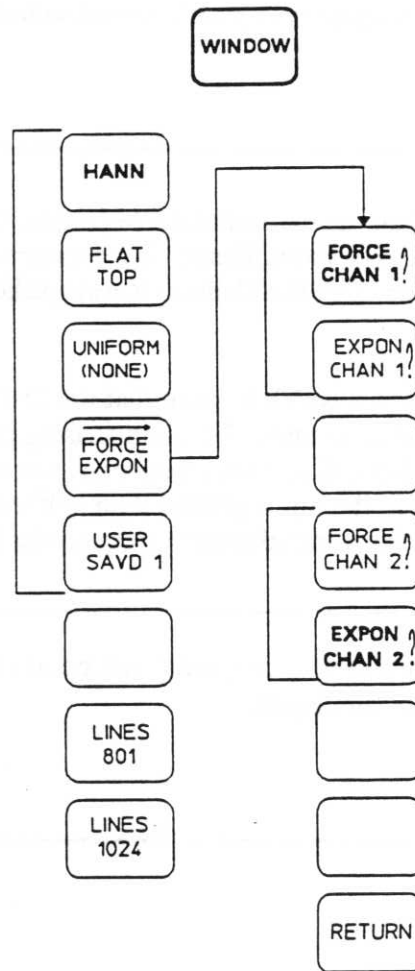
Figure 3-22. The WINDOW Menu Diagram

WINDOW Menu Description

When you press **WINDOW**, the following softkeys appear:

HANN   Selects the Hann window for both channels.

FLAT   Selects the flat top window for both channels.
TOP

UNIFRM   Selects the uniform window for both channels.
(NONE)

FORCE   Displays the FORCE/EXPON menu, which is used to select the force
EXPON   and exponential windows.

USER   Selects the user-defined window (stored in the SAVED 1 memory
SAVD 1   location) for both channels.

LINES   When activated, uses 801 frequency lines to average and display your
801   measurements. For all-digital measurements and for baseband mixed
measurements, 801 frequency lines allow you to view the data with a
frequency span of Fs / 2.56. This parameter is primarily used with
frequency-domain displays (under the **MEAS DISP** hardkey) and
frequency-domain math functions (under the **MATH** hardkey). See the
earlier description of the MAX SPAN softkey in "Frequency Spans in
the Linear Resolution Mode" for additional details.

LINES   When activated, uses 1024 frequency lines to display your
1024   measurements (except for instantaneous displays — these displays
always show 801 frequency lines). This higher number of frequency
lines allows you to view full-span digital data. In addition, you can view
less than full span measurements at half the sampling rate, Fs/2. This
parameter is primarily used with the frequency-domain displays (under
the **MEAS DISP** hardkey) and frequency-domain math functions
(under the **MATH** hardkey).

The span and center frequency selections are determined from the valid
center and span frequencies for LINES 801. See the earlier description
of the MAX SPAN softkey in "Frequency Spans in the Linear
Resolution Mode" for additional details.

The extra frequency lines are displayed at the high end of a baseband
display (see figure 3-20). In Zoom, the display is centered and half of
the extra frequency lines are displayed at the low end and half at the
high end (see figure 3-21). The display shows a dotted line to indicate
where in the extra frequency lines any possible roll-off due to the
anti-aliasing or digital filters are.

The Hann, flat top, uniform, and user-defined windows are applied to both channels. The force and exponential windows may be applied individually.

Pressing FORCE/EXPON displays the following menu:

FORCE   Selects the force window for Channel 1; enter the width using the Entry
CHAN 1   group.

EXPON   Selects the exponential window for Channel 1; enter the decay using the
CHAN 1   Entry group.

FORCE   Selects the force window for Channel 2; enter the width using the Entry
CHAN 2   group.

EXPON   Selects the exponential window for Channel 2; enter the decay using the
CHAN 2   Entry group.

RETURN   Redisplays the **WINDOW** menu.

The Hann Window

The Hann window attenuates the input signal at both ends of the time record, which forces the signal to appear periodic. The disadvantage of the Hann window is some amplitude inaccuracy for sinusoidal signals (up to −1.5 dB), as compared to the flat top window. Its advantage is greater frequency resolution.

1. *Narrow band correction factor = 1.5*
   (area under square of line shape)

2. *Amplitude accuracy uncertainty up to 1.5 dB*

3. *Normalized in frequency domain*
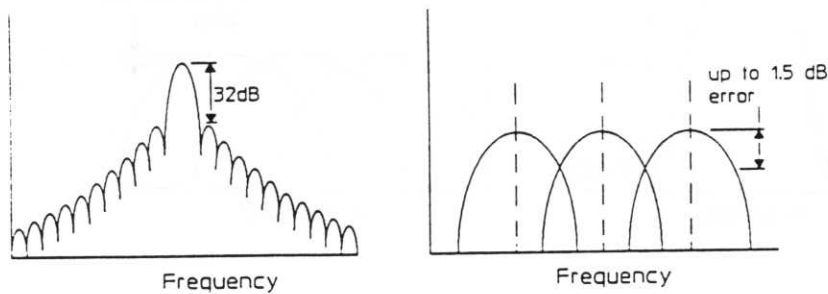
Figure 3-23. The Hann Window

The Flat Top Window

The flat top window compensates for the amplitude inaccuracy of the Hann with its slightly flatter shape, as shown in figure 3-24. The trade-off is the loss of some frequency resolution due to its width.

1. *Narrow band correction factor = 3.82*
   (area under square of line shape)

2. *Amplitude accuracy uncertainty up to 0.01 dB*

3. *Normalized in frequency domain*
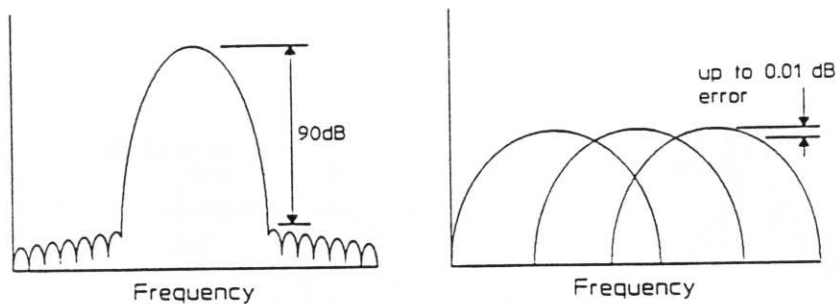
Figure 3-24. The Flat Window

The Uniform Window

The uniform window has a rectangular shape that weights all parts of the time record equally. Because it does not force the signal to appear periodic in the time record, it is normally used only with functions that are self-windowing, such as transients and bursts. The uniform window has amplitude accuracy uncertainty up to 3.9 dB.

The Force Window

The force window passes the first part of the time record and attenuates the last part, as shown in figure 3-25. The width you enter after pressing FORCE CHAN 1 or FORCE CHAN 2 determines how much of the signal is passed and how much is attenuated. Note that the width must be narrower than the time record for the force window to have any effect. The force window is helpful in impact testing because it removes stray oscillations in lightly damped systems.
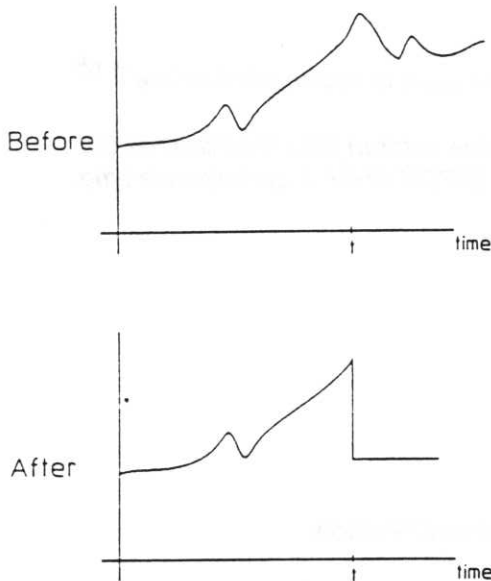
1. t = time entered after pressing FORCE CHAN 1 or FORCE CHAN 2.

2. Portion of window after t is set to average value of remaining data.

Figure 3-25. The Force Window

If you are using delayed trigger and you want to set the force window width using the markers, remember that the time record starts in negative time for pre-triggering. You may have to adjust the window width to allow for this.

The Exponential Window

The exponential window attenuates the input signal at a decaying exponential rate determined by the time constant you entered after pressing EXPON CHAN 1 or EXPON CHAN 2. The general shape of the exponential window is shown in figure 3-26.

1. *Calculation used to create window is* $e^{-t/\tau}$

When τ = *value entered after pressing EXPON CHANN 1 or EXPON CHAN 2 softkeys; t is time.*
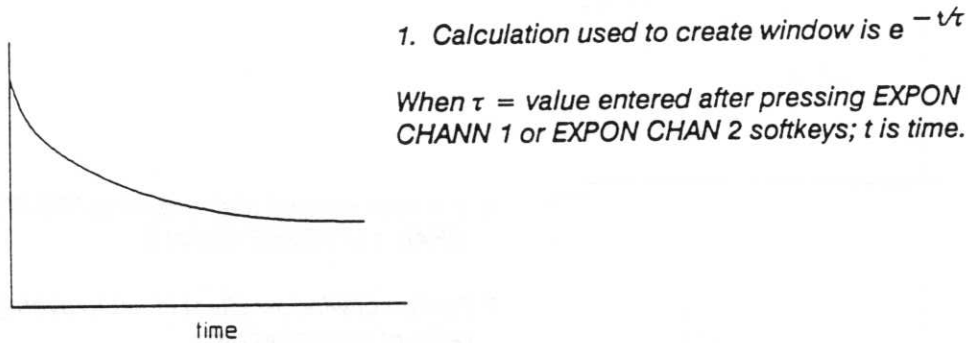
Figure 3-26. The Exponential Window

If you have selected a frequency response measurement with the force window on one channel and the exponential on the other, the channel with the force window selection is multiplied by both the force and the exponential window. Figure 3-27 shows the resulting function.

1. *t determined by force window on Channel 1.*

2. *Delay determined by exponential window on Channel 2.*

3. *The exponential window is still applied to the mean value level after the force window.*
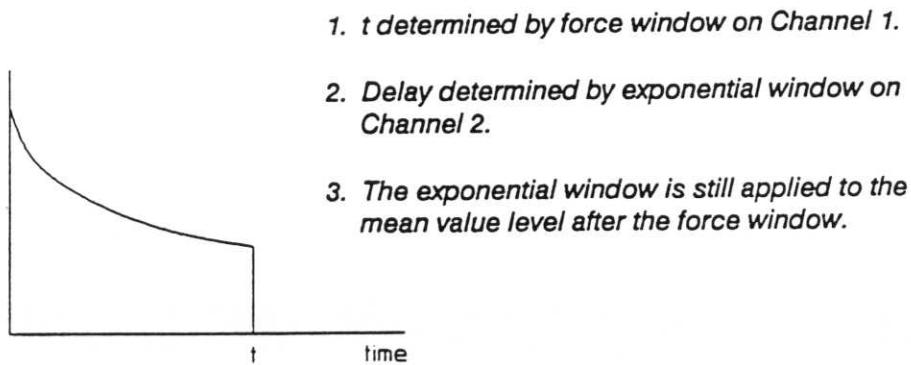
Figure 3-27. The Combined Force and Exponential Windows

The User-defined Window

Selecting USER SAVD 1 forces the HP 3563A to use the time waveform stored in the SAVE DATA #1 data block as the window. This feature allows you to apply your own waveform as a window. There are three ways to store a waveform in the SAVE DATA #1 memory block:

1. Measure a time waveform then store it using the **SAVE RECALL** menu. For information on this technique, refer to "Saving and Recalling States and Traces" in chapter 8.

2. Synthesize a frequency response curve, transform it to the time domain using FFT^{-1}, do any additional math on the time-domain trace, then store it using **SAVE RECALL**. Chapter 17 explains how to synthesize the frequency response, and chapter 15 shows how to use the math functions.

3. Create a waveform on an external controller and transmit it over the HP-IB. For information on this technique, refer to the HP 3563A Programming Manual.

The user window is multiplied by the time record in the time domain. To normalize the window, use the X marker and the DIV math function.

Viewing Windowed Data

The HP 3563A allows you to view the effects of the force and exponential windows on time records. To do this, select either of these windows, select an averaging type then activate previewing (in the **AVG** menu). Next select the TIME REC 1 or 2 display in the FILTRD INPUT menu (under **MEAS DISP**). Press INST WNDOWD to view the windowed data or INST to view the data before the window is applied.

To adjust the exponential window, use INST to display the dotted line representing the window. When it is ready, press TIME REC 1 or 2 again, then press INST WNDOWD to show the effect of the window. Then press **YES** to accept the record. Be careful when making numeric entries while previewing: the **1** and **0** keys represent **YES** and **NO** if the analyzer is not specifically looking for a numeric entry.

Averaging In The Linear Resolution Mode

Averaging improves the measurement and analysis of signals that are purely random or mixed random and periodic. Averaged measurements can yield either higher signal-to-noise ratios or improved statistical accuracy (see "Linear versus Power Spectrum Quantity Averaging" later in this section).

Both stable (often called rms) and exponential averaging are available in the linear resolution mode, as well as the peak hold and peak continuous functions. A comparison of these four functions and descriptions of all the averaging features are provided after the following discussion of the **AVG** menu.

Setting Up Averaging

To set up averaging, press **AVG** to display the menu in figure 3-28.
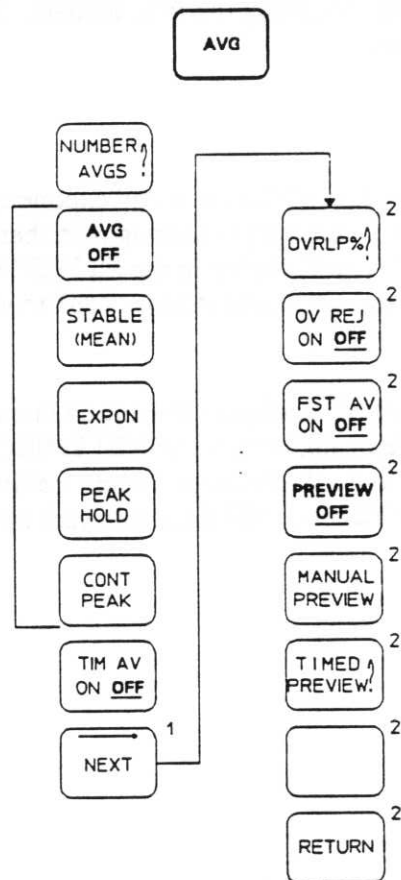
[1] Reads [OV REJ ON **OFF**] if **MEAS MODE** [DEMOD **ON** OFF] is selected
[2] These softkeys are unavailable if **MEAS MODE** [DEMOD **ON** OFF] is selected

Figure 3-28. AVG Menu Diagram:
Linear Resolution Mode

The softkeys you see when you press **AVG** are as follows:

NUMBER AVGS	Allows you to set the number of averages, from 1 to 32767 (using the Entry group). The number of averages can also be entered immediately after **AVG** is pressed. This number is the weighting factor for exponential averaging (the maximum number you can enter is 16384).
AVG OFF	Turns off all averaging functions. If this is pressed while an averaged measurement is in progress, the measurement pauses. See "Measurements with Averaging Off" following this menu.
STABLE (MEAN)	Selects stable averaging.
EXPON	Selects exponential averaging.
PEAK HOLD	Selects the peak hold function.
CONT PEAK	Selects the continuous peak function.
TIM AV ON OFF	When pressed ON, time domain (linear) averaging is selected. When pressed OFF, power spectrum quantity averaging is selected.
NEXT	Displays the next level of the **AVG** menu.

Note

If a non-averaged measurement is in progress, selecting an averaging type (such as STABLE (MEAN)) starts the measurement.

The NEXT softkey pulls up another menu that allows you to modify other averaging parameters, such as the overlap percentage, overload rejection, fast averaging, and previewing. The softkeys in this menu are:

OVLRP%
Allows you to set the overlap percentage from 0 to 90%, using the Entry group. The default is 0%.

OV REJ
ON **OFF**
Selects automatic overload rejection.

FST AV
ON **OFF**
Selects fast averaging.

PRVIEW
OFF
Turns the preview functions off.

MANUAL
PREVIEW
Selects manual previewing.

TIMED
PRVIEW
Selects timed previewing; enter the preview delay in seconds using the Entry group.

Measurements With Averaging Off

When averaging is off (the AVG OFF softkey is active), the analyzer makes continual measurements with one average, erasing the result of each measurement. The overlap processing achieves the greatest possible overlap percentage, regardless of the percentage you may have entered. Overload rejection and previewing are ignored.

Why Four Averaging Functions?

Stable averaging weighs old and new data records equally to yield the arithmetic mean for the number of averages selected. It displays the result of each intermediate average (if fast averaging is off) and stops the measurement after the selected number of averages have been calculated. Stable averaging is calculated with the following formula:

$$A_n = \frac{\Sigma D_n}{n}$$

where:
A_n = cumulative average
D_n = time quantity*
n = number of averages

* quantity is linear spectrum when time averaging is on; power spectrum, cross spectrum or correlation when time averaging is off.

Exponential averaging weights new data more than old to maintain a moving average, rather than the cumulative result provided by stable averaging. It displays the result of each intermediate average (if fast averaging is off). Exponential averaging continues until the measurement is paused. The number of averages is still important with exponential averaging because the weighting of new versus old data is dependent on the number entered with NUMBER AVGS. As the number of averages increases, new records are weighted less exponential averaging selects the next highest power of two (e.g., 2, 4, 8, 16) as the exponential averaging constant. For example, if 25 averages are requested, the measurement uses 32 (2^5). Exponential averaging is calculated with the following formula:

$$A_n = (1 - 2^{-n})A_n + 2^{-n}D_n$$

where:
   A_n = cumulative average
   D_n = time quantity*
   n = number of averages

* quantity is linear spectrum when time averaging is on; power spectrum, cross spectrum or correlation when time averaging is off.

The analyzer uses stable averaging to acquire the first 2^n averages.

The Peak hold function differs from stable and exponential averaging by showing the maximum values that occurred at each of the display lines during the measurement period, rather than the average values. It stops after the selected number of measurements have been made. The peak hold function is applicable only to frequency domain measurements, with time averaging off.

The peak continuous function performs the same operation as peak hold except it continues indefinitely until paused by the user. The peak continuous function is also applicable only to frequency domain measurements, with time averaging off.

Selecting an averaging type depends on your input data and what you need to learn from the measurement. For example, exponential averaging may be selected to track a varying input signal because it weights new data more than old, while the peak continuous function could be used to monitor and record noise peaks or frequency drift.

If **PAUSE/CONT** is pressed while the measurement is in progress, the measurement stops at the completion of the current average. If **PAUSE/CONT** is pressed again, the measurement continues with the next average. If the measurement is restarted rather than continued, it begins with the first average.

Linear Versus Power Spectrum Quantity Averaging

The HP 3563A offers both linear and power spectrum quantity averaging processes for stable and exponential averaging. For linear averaging (TM AVG ON), the averaged quantity is the time record. For power spectrum quantity averaging (TM AVG OFF), the averaged quantity is the power spectrum, frequency response or correlation, depending on the measurement. Table 3-2 summarizes the advantages and disadvantages of the two types.

Table 3-2. Linear Versus Power Spectrum Quantity Averaging

Power Spectrum Quantity	Linear
Statistical spectral estimate (broadband noise)	No statistical spectral estimate (deterministic signals only)
Applicable to both pure random and mixed random/periodic signals	Signal must have periodic component
Does not improve S/N ratio	Improves S/N ratio (random components average to their mean values
Does not require a synchronized trigger	Requires a synchronized trigger in fixed relation to the signal

If you need to extract a small periodic signal (in the time domain) from noise but do not have a synchronous trigger, see "The Auto Correlation Measurement" earlier in this chapter.

Overlap Processing

As the frequency span you select decreases, the corresponding time record length increases. At some point, the time record length and the amount of time the analyzer needs to process each record are equal. If you continue to increase the record length, the FFT processor sits idle after processing the record while it waits for the next record to fill. However, overlap processing allows you to overlap time records and compute the FFT from old and new data.

This offers the advantages of a better statistical estimate with fewer averages, reducing the effects of windowing on statistical variance and providing faster measurements. For a detailed discussion of overlap processing and real time bandwidth, refer to Hewlett-Packard Application Note 243. Copies can be obtained from your HP Sales Representative.

The HP 3563A allows overlap processing from 0 to 90% of the time record. The default at power-on and after reset is 0%. Overlap processing is applicable only to freerun triggering (see "Setting Up Triggering" in chapter 7). To make the selection, press AVG, followed by the NEXT softkey, followed by the OVRLP% softkey, then enter the percentage using the Entry group and the ENTER softkey. For unaveraged measurements, the analyzer measures at maximum possible overlap.

The percentage you enter is the maximum potential overlap. As the time record length is decreased, less and less overlap can be achieved. For example, if you enter an overlap of 50% and a frequency span of 2 kHz (400 ms record length), the analyzer can achieve 50% overlap. However, if you then change the span to 10 kHz (80 ms record length), the analyzer may achieve only 22% overlap. (These are example values only.) Several instrument setup parameters affect potential overlap percentages, including fast averaging and display format. At a given span, the greatest overlap can be achieved with fast averaging on and the single display format. For any particular instrument state, read the top of the display to verify the achieved overlap percentage. In any case, the actual percentage is less than or equal to the selected percentage. Note that the percentage shown applies to the last two records only.

Overlap processing is easy to understand if you relate it to real time bandwidth (RTBW). The RTBW is the frequency span at which the FFT processing time equals the time record length, and all input data are included in the average. However, if you increase the span past the RTBW, the record length becomes shorter than the FFT processing time. Time records are no longer contiguous, and some input data is missed. Therefore, you can overlap records only when measuring below the RTBW, because the time record length must be longer than the FFT processing time to achieve any overlap.

Note

You may want to use time capture (chapter 6) or throughput (chapter 9) to collect contiguous time records. Then, you can make measurements on the collected data at frequency-spans equal to or less than that used to gather the time records.

Overload Rejection

If the magnitude of a signal exceeds the input range (see chapter 7 under "Setting the Input Range"), the time record containing this signal distorts the measurement if it is included in the average. To avoid this, the HP 3563A can automatically reject any time records containing such data. To select overload rejection, press **AVG,** followed by the NEXT softkey, then press the OV REJ ON OFF softkey to ON. The message "Data Rejected" is displayed when a record is rejected. If records are rejected, the analyzer continues to measure and average until it collects the requested number of undistorted records.

Fast Averaging

Fast averaging causes the HP 3563A to measure and average as fast as possible without stopping to update the display every time an intermediate average is calculated. The display is not updated until the specified number of averages have been calculated. The message "Fast Averaging" is displayed in the lower right corner of the screen to advise that fast averaging is in effect. To select fast averaging, press **AVG,** NEXT , and toggle FST AV ON OFF to ON. Fast averaging can be activated and deactivated during a measurement, allowing you to check the measurement's progress. Fast averaging can be used only with stable and peak hold averaging.

Note   Fast averaging must be enabled to ensure maximum real time bandwidths.

Previewing

Previewing gives you the option of approving each time record before it is included in the average. The HP 3563A offers both manual previewing, which pauses indefinitely until you answer with the **YES (1)** or **NO (0)** keys; and timed previewing, which pauses for a specified time then automatically includes each record if you do not reject it. To select previewing, press **AVG,** followed by the NEXT softkey. To select manual previewing, press the MANUAL PRVIEW softkey; to select timed previewing, press the TIMED PRVIEW softkey and enter the number of seconds you wish the instrument to pause while you decide on each record. Note that you must select an averaging type to use previewing (i.e., previewing cannot be used with unaveraged measurements).

```
┌──────┐  ┌──────→┐
│ MEAS │  │ FILTRD│
│ DISP │  │ INPUT │
└──────┘  └───────┘
```

Filtered Input Menu When Both Channels are Active
(Continued from **MEAS DISP** Menu Diagram)
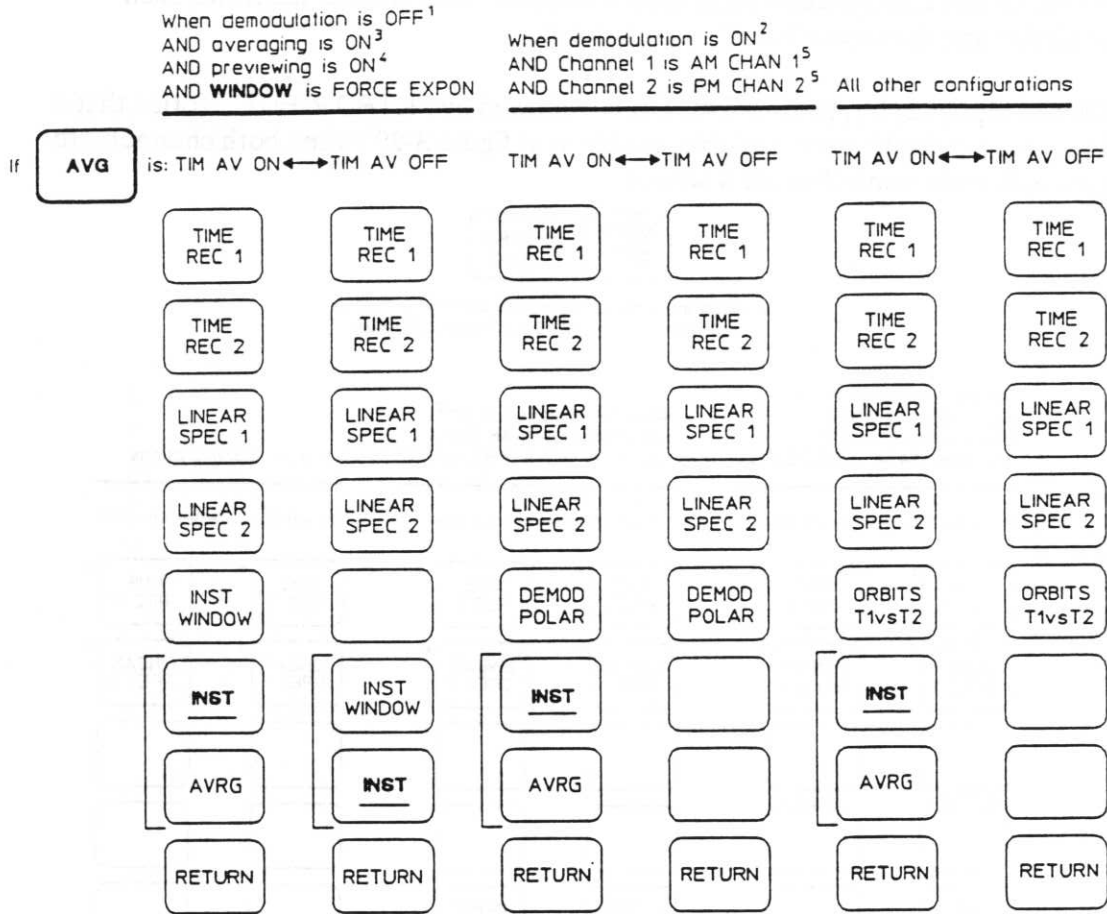
When demodulation is OFF[1]
AND averaging is ON[3]
AND previewing is ON[4]
AND **WINDOW** is FORCE EXPON

When demodulation is ON[2]
AND Channel 1 is AM CHAN 1[5]
AND Channel 2 is PM CHAN 2[5]   All other configurations

If [**AVG**] is: TIM AV ON ←→ TIM AV OFF   TIM AV ON ←→ TIM AV OFF   TIM AV ON ←→ TIM AV OFF

TIME REC 1	TIME REC 1	TIME REC 1	TIME REC 1	TIME REC 1	TIME REC 1
TIME REC 2	TIME REC 2	TIME REC 2	TIME REC 2	TIME REC 2	TIME REC 2
LINEAR SPEC 1	LINEAR SPEC 1	LINEAR SPEC 1	LINEAR SPEC 1	LINEAR SPEC 1	LINEAR SPEC 1
LINEAR SPEC 2	LINEAR SPEC 2	LINEAR SPEC 2	LINEAR SPEC 2	LINEAR SPEC 2	LINEAR SPEC 2
INST WINDOW		DEMOD POLAR	DEMOD POLAR	ORBITS T1vsT2	ORBITS T1vsT2
INST	INST WINDOW	**INST**		**INST**	
AVRG	**INST**	AVRG		AVRG	
RETURN	RETURN	RETURN	RETURN	RETURN	RETURN

[1] Demodulation is OFF when **MEAS MODE** [DEMOD ON **OFF**] is selected.

[2] Demodulation is ON when **MEAS MODE** [DEMOD **ON** OFF] is selected.

[3] Averaging is ON when any average type is selected (in other words, when **AVG** is not [AVG OFF]).

[4] Previewing is ON when **AVG** [NEXT] [MANUAL PRVIEW] or [TIMED PRVIEW] is selected.

[5] Press **MEAS MODE** [DEMOD SELECT] [DEMOD BOTH] to configure both channels for demodulation.

**Figure 3-29. FILTRD INPUT Menu Diagram:
Both Channels Active**

Filtered-Input Displays

Chapter 2, "Measurement Overview," explains how filtered-input displays are derived and how they differ from measurement displays and instantaneous displays. This chapter describes each filtered-input display and shows you how they are selected.

To select a filtered-input display, press **MEAS DISP** ollowed by FILTRD INPUT. Notice that a number of filtered-input displays are available, as shown in figure 3-29 (when both channels are active) or figure 3-30 (when one channel is active).
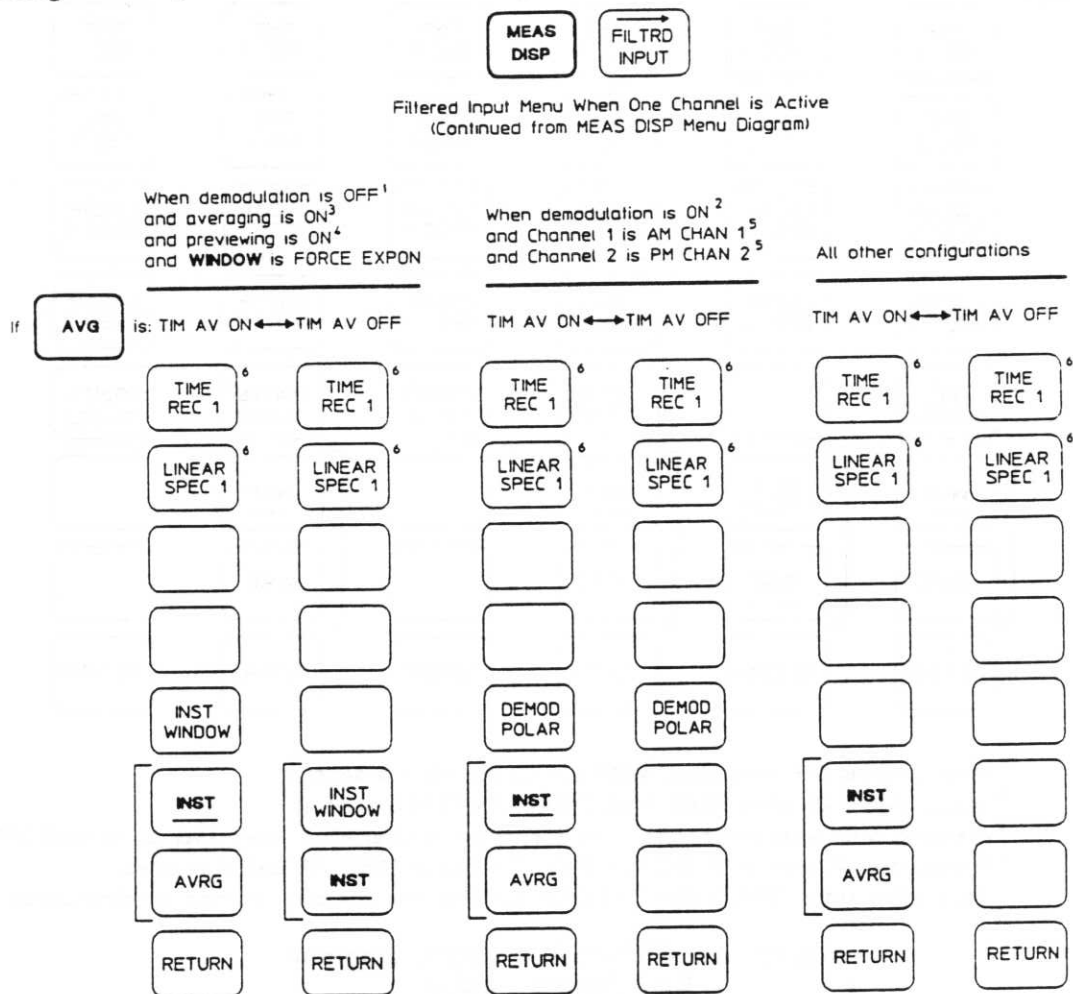
Filtered Input Menu When One Channel is Active
(Continued from MEAS DISP Menu Diagram)

When demodulation is OFF[1]
and averaging is ON[3]
and previewing is ON[4]
and **WINDOW** is FORCE EXPON

When demodulation is ON[2]
and Channel 1 is AM CHAN 1[5]
and Channel 2 is PM CHAN 2[5]

All other configurations

If **AVG** is: TIM AV ON ←→ TIM AV OFF | TIM AV ON ←→ TIM AV OFF | TIM AV ON ←→ TIM AV OFF

TIME REC 1[6] / TIME REC 1[6] | TIME REC 1[6] / TIME REC 1[6] | TIME REC 1[6] / TIME REC 1[6]

LINEAR SPEC 1[6] / LINEAR SPEC 1[6] | LINEAR SPEC 1[6] / LINEAR SPEC 1[6] | LINEAR SPEC 1[6] / LINEAR SPEC 1[6]

INST WINDOW / (blank) | DEMOD POLAR / DEMOD POLAR | (blank)

INST / INST WINDOW | **INST** / (blank) | **INST** / (blank)

AVRG / **INST** | AVRG / (blank) | AVRG / (blank)

RETURN / RETURN | RETURN / RETURN | RETURN / RETURN

[1] Demodulation is OFF when **MEAS MODE** [DEMOD ON **OFF**] is selected.

[2] Demodulation is ON when **MEAS MODE** [DEMOD **ON** OFF] is selected.

[3] Averaging is ON when any average type is selected (in other words, when **AVG** is not [AVG OFF]).

[4] Previewing is ON when **AVG** [NEXT] [MANUAL PRVIEW] or [TIMED PRVIEW] is selected.

[5] Press **MEAS MODE** [DEMOD SELECT] [DEMOD BOTH] to configure both channels for demodulation.

[6] If Channel 1 is active, this key selects a filtered-input display Channel 1.
If Channel 2 is active, it selects a filtered-input display for Channel 2.

**Figure 3-30. FILTRD INPUT Menu Diagram:
One Channel Active**

Choosing a Filtered-Input Display

You choose a filtered input display by selecting one of the softkeys shown in figure 3-29 or figure 3-30. Notice that different softkeys, or different filtered-input displays, are available depending on how you configure the analyzer. For example, the only time the DEMOD POLAR filtered-input display is available is when demodulation is on, Channel 1 is set to AM demodulation, and Channel 2 is set to PM demodulation.

This section describes all the filtered-input displays, except for DEMOD POLAR. See "Demodulated Measurements" later in this chapter for a description of that display. To select a filtered-input display, press **MEAS DISP** FILTRD INPUT. The softkeys that appear do the following:

TIME REC 1	Displays the Channel 1 time record.
TIME REC 2	Displays the Channel 2 time record.
LINEAR SPEC 1	Displays the linear spectrum on the signal on Channel 1. This is the FFT of the time record.
LINEAR SPEC 2	Displays the linear spectrum of the signal on Channel 2. This is the FFT of the time record.
INST	Selects the most recent time record for the filtered input displays.
INST WNDOWD	Shows the effect of exponential windowing on the filtered input displays; see "Selecting a Window" earlier in this chapter.
AVRG	Selects the cumulative average of all time records acquired with the current measurement for the filtered input displays.
ORBITS T1vsT2	Displays the orbits diagram. (This softkey may be replaced with DEMOD POLAR if demodulation is active — in this case, see "Demodulated Measurements" later in this chapter.)
RETURN	Redisplays the previous **MEAS DISP** menu (see figure 3-8).

Note   AVRG, INST, and INST are not available for some analyzer configurations. See
                figures 3-29 and 3-30.

The Time Record Filtered-Input Displays

The "time record" is the amount of time domain data required to perform one FFT. The "time record length" is the length of time required to fill the time record. Figure 3-31 shows an example of the time record filtered-input display. To select one of these displays, press **MEAS DISP**, FILTRD INPUT, and TIME REC 1 or TIME REC 2. For an explanation of the time record length, see "Frequency Spans in the Linear Resolution Mode" earlier in this chapter. Time record filtered-input displays are not calibrated.
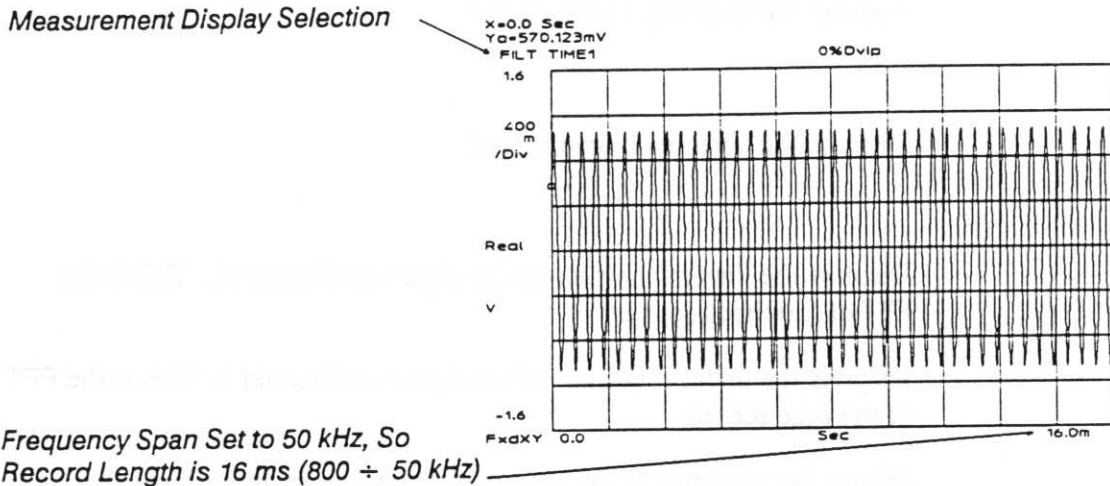
Figure 3-31. The Time Record Filtered-Input Display

The Linear Spectrum Filtered-Input Displays

The linear spectrum filtered-input displays show the input signals after they have been triggered, filtered to the current frequency span, windowed, and transformed to the frequency domain. The linear spectrum is the FFT of the time record. To select a linear spectrum filtered-input display, press **MEAS DISP**, FILTRD INPUT, and LINEAR SPEC 1 or LINEAR SPEC 2. Figure 3-32 shows the linear spectrum of the time record displayed in figure 3-31.

Display Selection

Note -
Units in dBV, not dBV ^{2}

```
X=3kHz
Yd=-1.3891 dBVrms
FILT  LIN  S1                          0%Ovld    Hann
12.5

12.5
/Div


dB

rms
V



-87.5
FxdXY  0                                HZ                50k
```
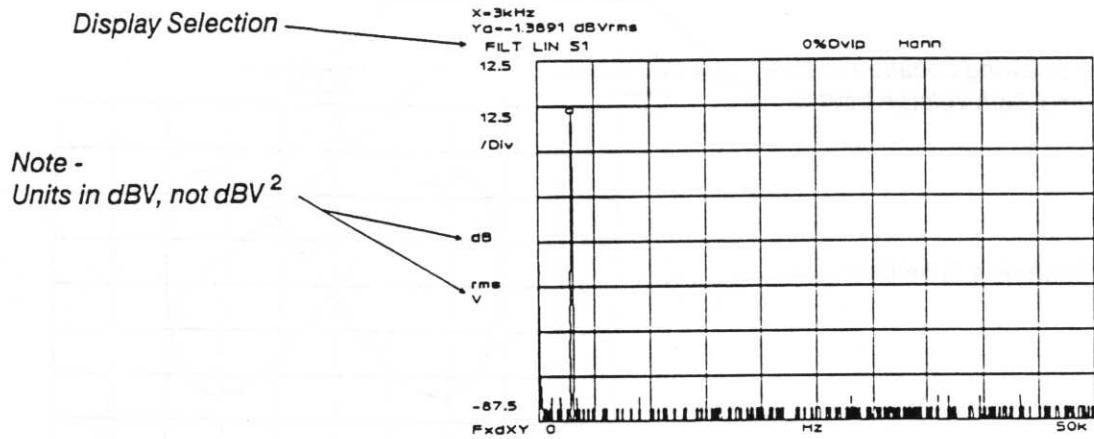
**Figure 3-32. The Linear Spectrum
Filtered-Input Display**

The Orbit Diagram

The orbit diagram, often referred to as a Lissajous pattern, compares the two input time waveforms, Channel 1 versus Channel 2. One of its uses is detecting asymmetries in rotating machinery. The orbit diagram has special scaling characteristics; refer to "Scaling the Display" in chapter 8 for details. To select this display, press **MEAS DISP**, FILTRD INPUT, ORBIT T1vsT2. Figure 3-33 shows an example of the orbit diagram. Note that this display cannot be used with complex time data (when the measurement start frequency is greater than 0 Hz). The **COORD** menu is disabled for the orbit diagram.
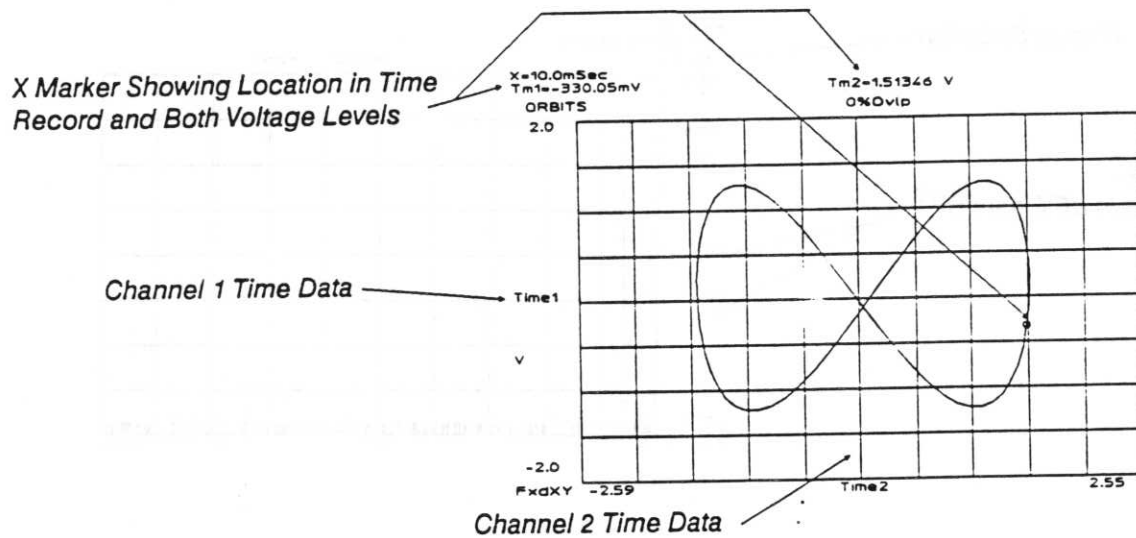
Figure 3-33. The Orbit Diagram

Demodulated Measurements

You can demodulate any linear resolution measurement. This section shows you how to demodulate a measurement and the special displays available for demodulated data. There are several points to consider when using the HP 3563A's demodulation feature:

- Demodulation can be used only in conjunction with the linear resolution mode.

- Demodulation can be performed on zoom measurements only (measurements with non-zero start frequencies). The start frequency can be set to its lowest non-zero value (64 micro-Hz), but not to 0 Hz.

- Because of the number of calculations required, demodulated measurements are not as fast as normal linear resolution measurements.

- Demodulated measurements are not in real time.

- Demodulation collects a 4096-point time record to provide 2048 points in the time domain after demodulation. When these 2048 points are downsampled to the display (to 1024 points), the trace may appear to be shifted slightly.

The Demodulation Softkeys

The softkeys used to set up demodulation are found under the **MEAS MODE** hardkey (see figure 3-1). To access the demodulation softkeys, press **MEAS MODE** and toggle DEMOD ON OFF to ON (this turns on, or activates, demodulation). When you toggle DEMOD ON OFF to ON, the DEMOD SELECT softkey appears. Press DEMOD SELECT to access the demodulation softkeys (see figure 3-34).
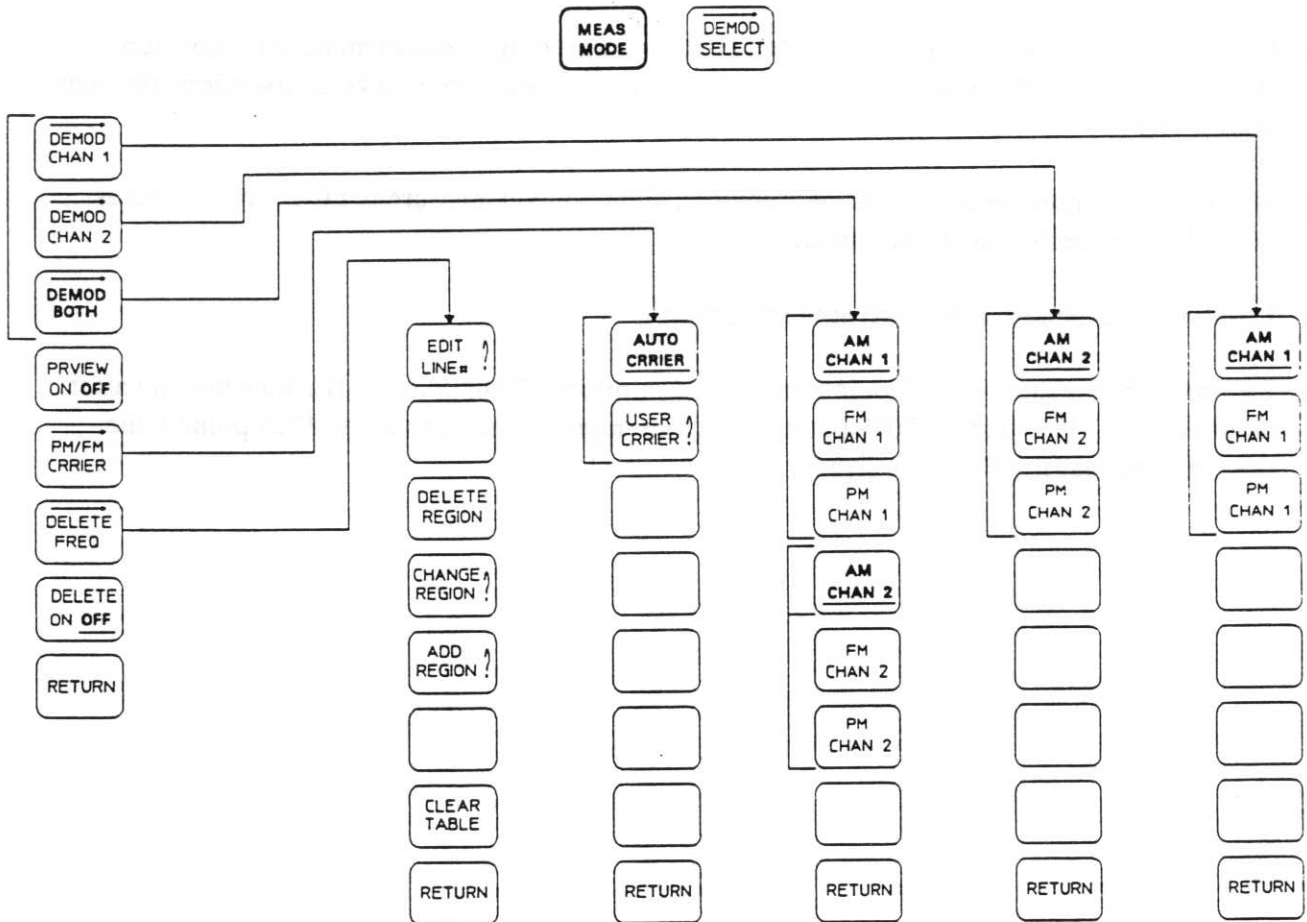
Figure 3-34. The Demodulation Softkeys

When you press DEMOD SELECT, the following softkeys appear:

DEMOD
CHAN 1   Selects Channel 1 for demodulation and displays the demod types
                 menu.

DEMOD
CHAN 2   Selects Channel 2 for demodulation and displays the demod types
                 menu.

DEMOD
BOTH   Selects both channels for demodulation and displays the demod types
                 menu.

PRVIEW
ON OFF   Controls demodulation previewing, which allows you to view modulated
                 records before they are demodulated and measured.

PM/FM
CRRIER   Displays the PM/FM CRRIER menu that allows you to select auto
                 carrier or enter a user carrier.

DELETE
FREQ   Displays the delete frequency table and its menu.

DELETE
ON OFF   Enables or disables the delete frequency table. When this is off, the
                 table is not used, but its contents are preserved.

RETURN   Returns you to the previous menu.

The Demodulation Types Menu

You use DEMOD CHAN 1, DEMOD CHAN 2, and DEMOD BOTH to specify the type of
demodulation for each channel, such as AM (amplitude modulation), FM (frequency modulation),
or PM (phase modulation). For example, to select AM demodulation for Channel 2, press DEMOD
CHAN 2 followed by AM CHAN 2. Or, if you want AM demodulation on Channel 1 and FM
demodulation on Channel 2 , press DEMOD BOTH followed by AM CHAN 1 and FM CHAN 2 (refer
to figure 3-33).

The PM/FM Carrier Menu

Pressing PM/FM CRRIER pulls up the PM/FM Carrier menu. This menu allows you to select auto
carrier or enter a user carrier as follows:

AUTO
CRRIER   Causes the instrument to calculate the carrier frequency based on the
                 input signal; see "Step 4: Select Auto or User Carrier."

USER
CRRIER   Allows you to enter the carrier frequency; see "Step 4: Select Auto or
                 User Carrier."

The Delete Frequency Menu

Pressing DELETE FREQ pulls up the Delete Frequency menu. This menu allows you to edit the delete-frequency table. The delete-frequency table allows you to delete portions of the incoming signal before it is demodulated (see "Step 5: Set Up the Delete Frequency table"). The softkeys in this menu are as follows:

EDIT LINE#	Specifies the line to be edited. Press EDIT LINE#, then enter the number of the line or move the line pointer with the arrows or knob. The edit line is highlighted and indicated by an arrow at the side of the table.
DELETE REGION	Deletes the region identified by the edit line.
CHANGE REGION	Allows you to change the region identified by the edit line. Press CHANGE REGION, then enter the new minimum and maximum separated by a comma (,).
ADD REGION	Allows you to add a region after the edit line. Press ADD REGION, then enter the minimum and maximum frequencies separated by a comma (,).
CLEAR TABLE	Clears the delete frequency table. The message "Push Again to Clear" is displayed to allow you to confirm that the table can be cleared.

Setting up a Demodulation Measurement

There are eight steps for setting up a demodulated measurement.

1. Activate demodulation: press **MEAS MODE** followed by LINEAR RES. Then toggle DEMOD ON OFF to ON.

2. Select the channel(s) to be demodulated: press DEMOD SELECT followed by DEMOD CHAN 1, DEMOD CHAN 2, or DEMOD BOTH.

3. From the menu that appears as a result of the previous step, select AM, FM or PM demodulation for the appropriate channels. Then press RETURN.

4. For FM or PM demodulation, select auto carrier or enter a user carrier frequency: press PM/FM CRRIER and select a carrier. Then press RETURN.

5. Set up the delete frequency table (optional): press DELETE FREQ.

6. Proceed with the linear resolution measurement setup: refer to the beginning of this chapter for details.

7. Use previewing (optional): press **MEAS MODE**, DEMOD SELECT and toggle PRVIEW ON OFF to ON.

8. Use the DEMOD POLAR display, if desired: press **MEAS DISP**, then FILTRD INPUT followed by DEMOD POLAR.

Step 1: Activate Demodulation

To activate demodulation, first press **MEAS MODE** then select the LINEAR RES mode. This displays the DEMOD ON OFF softkey. Press DEMOD ON OFF to ON, then press the DEMOD SELECT softkey to display the first demodulation menu.

If triggering is in free run and averaging is off, a demodulation measurement begins as soon as you press DEMOD ON OFF to ON. If necessary, press the yellow **START** key to restart the measurement after you have finished setting up demodulation.

Step 2: Select the Demodulation Channel(s)

Either or both channels can be selected for demodulation. Press DEMOD SELECT followed by DEMOD CHAN1, DEMOD CHAN 2 or DEMOD BOTH to make the selection. When one of these three is pressed, another menu is displayed to allow you to select the demodulation type(s).

If you plan to use the DEMOD POLAR display, both channels must be set up for demodulation, with AM on Channel 1 and PM on Channel 2.

Step 3: Select Demodulation Type(s)

AM, FM or PM demodulation can be selected independently on either channel. Keep in mind that if demodulation has been selected on a single channel, a baseband measurement is set up on the other channel. When DEMOD CHAN1, DEMOD CHAN 2 or DEMOD BOTH is pressed, the appropriate menu of demodulation types is displayed.

If you plan to use the DEMOD POLAR display, Channel 1 needs to be set up for AM and Channel 2 for PM.

Figures 3-35 through 3-37 show examples of AM, FM and PM demodulation.
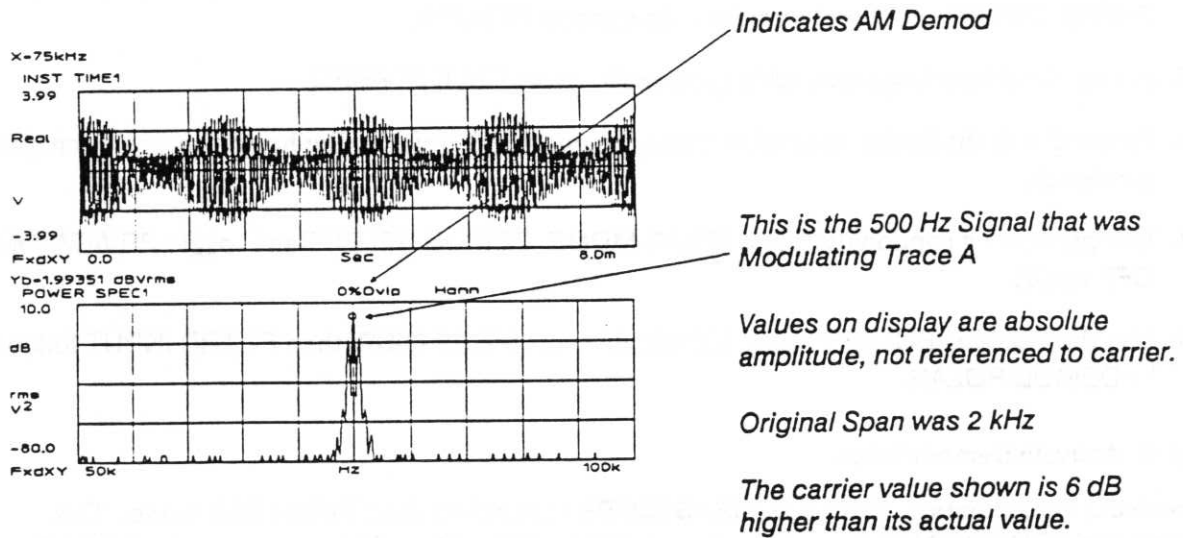
Figure 3-35. AM Demodulation

Note -
This Display is not Calibrated

Indicates FM Demod

The trace and markers are scaled in
"volts" but this should be interpreted
as "Hertz."

Frequency Span set to 10 kHz, so
Demodulated Span is 5 kHz.
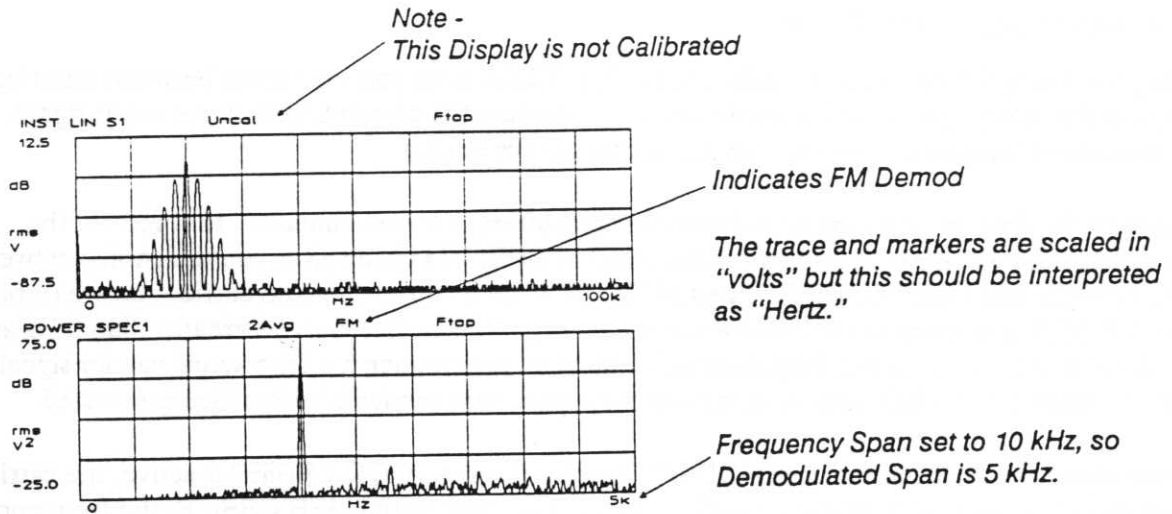
Figure 3-36. FM Demodulation

Indicates PM Demod

The trace and markers are scaled in
"Volts" but this should be interpreted
as "degrees."

Original Frequency Span was 800 Hz
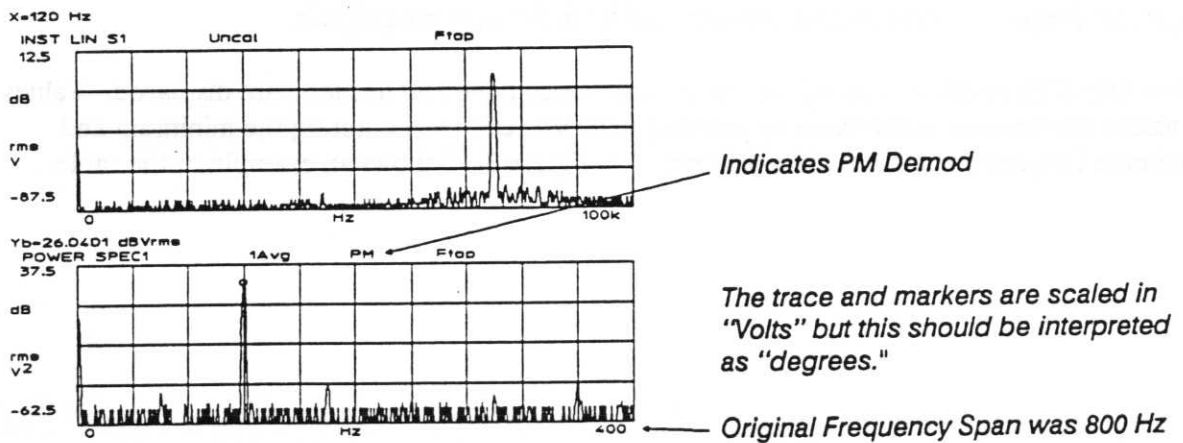
Figure 3-37. PM Demodulation

Step 4: Select Auto or User Carrier

When performing FM or PM demodulation, the HP 3563A gives you the choice between entering a known carrier frequency or letting the instrument calculate the carrier based on the input signal. (AM demodulation does not require any carrier frequency entry.)

Because of the time involved in the auto carrier calculation, it is recommended that you set the carrier frequency whenever it is known. The PM/FM CRRIER softkey gives you the choice between AUTO CRRIER and USER CRRIER. Press AUTO CRRIER to select the auto carrier feature or press USER CRRIER then enter the known carrier frequency. The carrier must be greater than 0 Hz and less than 100 kHz. This carrier frequency value must be the frequency of the actual carrier signal. If the user carrier is not within the current frequency span, auto carrier is automatically selected.

For two-channel demodulation, (DEMOD BOTH active), when AUTO CRRIER is active, the carrier frequency is calculated separately for each channel. However, with USER CRRIER, the frequency you enter is applied to both channels.

The auto carrier values derived during a measurement can be read via HP-IB; refer to chapter 6 in the HP 3563A Programming Manual.

Step 5: Set up the Delete Frequency table (optional)

The delete frequency table allows you to delete portions of the incoming signal before it is demodulated. One use of this is to remove spurious components that might be misinterpreted as modulation sidebands. It also can be used to force the instrument to analyze just selected portions of the signal. The HP 3563A performs linear interpolation across removed areas of the frequency spectrum.

Using the delete frequency table is, of course, optional. If DELETE ON OFF is OFF or the table is empty, no frequency components are removed from the incoming signals.

When DELETE FREQ is pressed, the delete frequency table and its menu are displayed. Values to be added are entered in the table by pressing ADD VALUE, then entering the minimum and maximum frequencies separated by a comma (,). Figure 3-38 shows an example of the table.

```
                    DEMODULATION
                  Deleted Frequency Bands
     Line        Start freq         Stop freq
      1               0  0               3.0  •——————  Deletes from dc to 3 Hz
      2              59.0              61.0  •
      3              75.0k             80.0k  •—————  Deletes from 59 to 61 Hz
      4              90.0k            100.0k  •
      5
      6                                              Deletes from 75 to 80 kHz
      7
      8
      9
     10                                              Deletes form 90 to 100 kHz
     11
     12
     13
     14
     15
     16
     17
     18
     19
     20
```

Figure 3-38. The Delete Frequency Table

Step 6: Proceed with Measurement Set Up

Once demodulation has been set up using the first five steps, you now finish setting up the measurement as you would any other measurement in the linear resolution mode. Note that demodulation must be zoomed (use a non-zero start frequency). Also, the previewing feature (in the **AVG** menu) normally offered in the linear resolution mode is not applicable to demodulation. The special demodulation preview feature, covered next in Step 7, is used instead. When averaging is off and a demod measurement is started, one measurement is taken.

Step 7: Use Previewing (optional)

Demodulation previewing allows you to view each time record before it is demodulated. When PRVIEW ON OFF is ON, the record is displayed along with the message "Accept Data? (Yes/ No)." The analyzer pauses until you press **YES** (the "1" key in the Entry group) to demodulate the record and measure it. If you press **NO** (the "0" key in the Entry group), the record is discarded then the next one is collected and presented for approval. Note that pressing PRVIEW ON OFF while a measurement is in progress pauses the measurement.

Step 8: Use the DEMOD POLAR Display (optional)

The DEMOD POLAR display is a plot of the locus of the tip of the carrier vector as it is being modulated. The normalized carrier vector can be thought of as extending from − 100.0% to 0.0%. The origin of the display, therefore, is at the tip of the at-rest carrier vector. Phase modulation deflects the vector up or down. Amplitude modulation makes the carrier vector shorter or longer. For example, a 90 degree PM with no AM is displayed as a semicircle centered at − 100.0% with radius 100% passing through 0.0% on the right side.
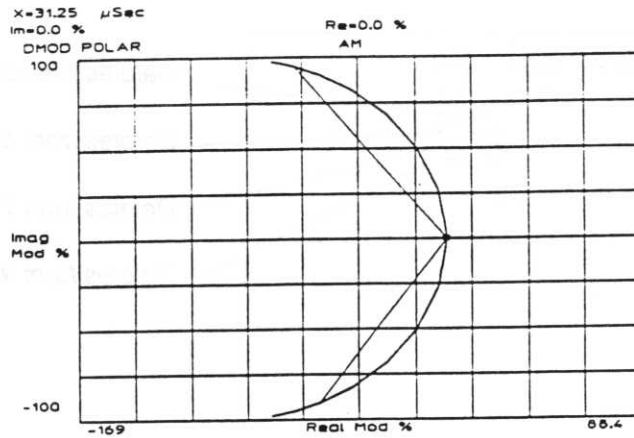
Figure 3-39. The DEMOD POLAR Display

Using The Log Resolution Mode

Purpose Of This Chapter

This chapter contains a detailed description of the log resolution mode. The log resolution mode combines multiple linear resolution measurements to create one proportional-bandwidth, logarithmically spaced measurement.

As a reminder, the HP 3563A offers four measurement techniques — called measurement modes. You choose the measurement technique you want by selecting one of the following four measurement modes:

- Linear Resolution Mode (described in chapter 3)
- Log Resolution Mode (described in this chapter)
- Swept Sine Mode (described in chapter 5)
- Time Capture Mode (described in chapter 6)

Each measurement mode configures the HP 3563A differently. See chapter 2, "Measurement Overview" for a summary of all four measurement modes. Chapter 2 also compares the four measurement modes and discusses why you might select one over another.

Note

Some menus differ depending on the mode you are in. This chapter shows you only the menus that appear when log resolution mode is selected. Appendix C, "Menu Diagrams," shows you the menus that appear for all measurement modes. You may want to use appendix C as a quick reference since it contains, in one place, all menus for all hardkeys.

Measurement Setup: Log Resolution Mode

The steps necessary to set up a measurement in log resolution mode are slightly different than those used for linear resolution mode. For instance, you do not need to select a window (with the **WINDOW** hardkey) in log resolution mode — log resolution mode does not use windows. Furthermore, you do not need to set up triggering — log resolution mode does not use a trigger. The remainder of this chapter details the steps necessary to set up a log resolution measurement, which are as follows (follow these steps for both analog and digital measurements):

1. Connect the analyzer to your device under test. See chapter 13 for details on digital connections; see chapter 14 for details on planning a digital or mixed (analog and digital) measurement.

2. Preset the analyzer (optional): press **PRESET** or **SAVE RECALL** (see chapter 12 for details).

3. Select log resolution mode: press **MEAS MODE** followed by LOG RES.

4. Configure the inputs: press **INPUT CONFIG**. (See chapter 7 for details).

5. View the input signals (if necessary): press **VIEW INPUT**.

6. Set up the source: press **SOURCE**. If necessary, set up source protection in the **SPCL FCTN** menu.

7. Set the input range: press **RANGE**. (See chapter 7 for details).

8. Select a measurement and measurement display. First, press **SELECT MEAS** to select a measurement and activate one or both channels. Then press **MEAS DISP** to select a measurement display.

9. Set the frequency span: press **FREQ**.

10. Set up averaging: press **AVG**.

11. Start the measurement: press **START**.

12. Select other measurement displays (if desired): press **MEAS DISP**.

13. Use the display and marker features (if desired): refer to chapter 8 for details on these features.

In a three-decade measurement, for example, the first decade is measured on one side, and the second and third decades are measured on the other side. (This description applies to a single input channel; it is repeated on the other input channel if both Channel 1 and Channel 2 are active.) It is possible to measure more than one of the higher decades in parallel with the lowest decade because the lowest decade has the longest time record length, and several higher spans (having shorter time records) can be measured in less time than the lowest. Figure 4-2 illustrates this action on a three-decade span from 10 Hz to 10 kHz.
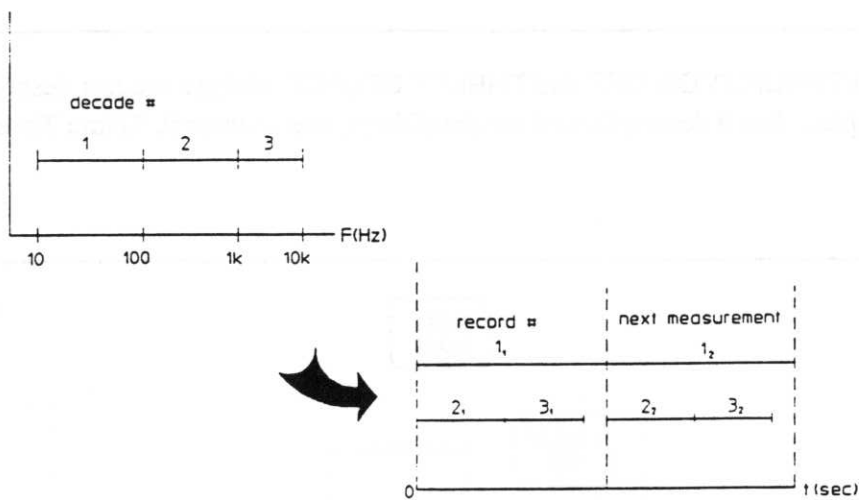
Figure 4-2. Log Resolution Parallel Processing

This parallel processing is important to understand when interpreting overlap processing and real time bandwidth (RTBW) in the log resolution mode. It is obvious from figure 4-2 that overlap processing in the usual sense can be achieved only on one-decade spans. You can still overlap in multidecade measurements, but only the first decade is overlapped.

The same constraint applies to RTBW. In log resolution, only one-decade measurements can be made in real time. Referring to figure 4-2 again, any portion of the input signal above the first decade would be missed in the interval between the end of decade 3_1 and the beginning of decade 2_2. Furthermore, decade 2 is ignored while decade 3 is processed and vice versa.

Overlap processing and RTBW are discussed individually in "Frequency Spans in the Log Resolution Mode" later in this chapter.

Selecting The Log Resolution Mode

To put the HP 3563A in the log resolution mode, press **MEAS MODE**. The softkeys that appear depend on which measurement mode is selected. Press LOG RES to configure the analyzer to the log resolution mode. In this measurement mode, you have access to the softkeys in figure 4-3.

Note

👉

The THRUPUT ON OFF and THRUPT SELECT softkeys are not described in this chapter. For a description of these softkeys, see chapter 9, "Time Throughput."

---
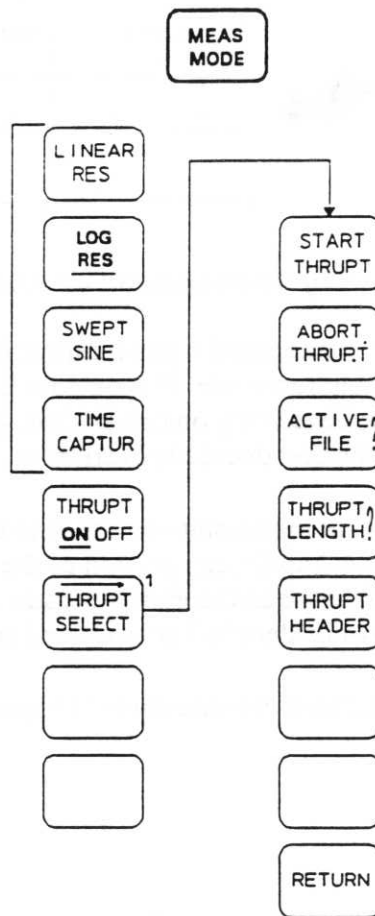
¹Blank if [THRUPT ON **OFF**] is selected (this is the default)

**Figure 4-3. MEAS MODE Menu Diagram:
Log Resolution Mode**

Viewing the Input Signals

The **VIEW INPUT** hardkey allows you to look at the input signals before they are filtered to a reduced frequency span, triggered, or measured. These *instantaneous* displays can be viewed at any time, even if the measurement is in progress or completed. Instantaneous displays can be used to verify the presence of input signals or to compare an input signal with a measurement display. Instantaneous displays are also helpful when manually setting the input range. Chapter 2, "Measurement Overview," explains how these displays are derived and how they differ from filtered-input and measurement displays (remember, filtered-input displays are not available in the log resolution mode).

The softkeys that appear when you press **VIEW INPUT** depend on which measurement mode is selected. For the log resolution and linear resolution modes, the softkeys that appear are identical. For a description of these softkeys, see "Viewing the Input Signals" for the linear resolution mode (in chapter 3).

Setting up the Source: Log Resolution Mode

The source is used to stimulate devices under test. The HP 3563A offers several analog or digital source outputs. To set up the source, press **SOURCE**. The softkeys that appear for the log resolution mode depend on SOURCE AN DIG. If SOURCE AN DIG is toggled to **AN** (analog output) you see one menu; if it is toggled to **DIG** (digital output), you see another (see figure 4-4).

Figure 4-4 shows the softkeys available under **SOURCE** for the log resolution mode. All of these softkeys, except for those under SOURCE TYPES, are identical for all four measurement modes (linear resolution, log resolution, swept sine, and time capture). Notice that the only source types available in the log resolution mode are random noise and fixed sine. These source types are described in chapter 3.

Note

See "Setting up the Source: Linear Resolution Mode" in chapter 3 for further details (such as how to select a source output or how to turn on source protection).
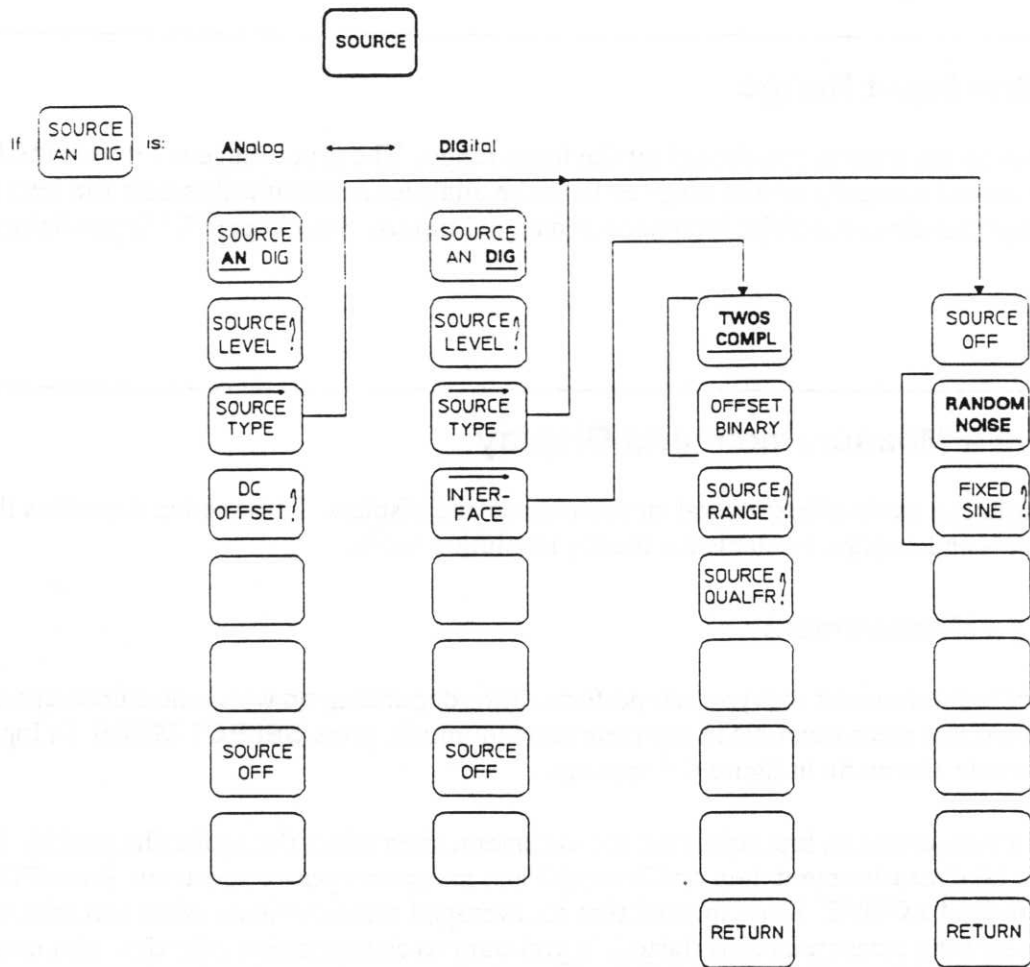
Figure 4-4. SOURCE Menu Diagram:
Log Resolution Mode

Setting the Input Range

After you set up the source, you should set the input range. The input range is set with the **RANGE** hardkey. You can manually set the range or have the analyzer automatically select the best range. The range options available differ for analog and digital inputs. See chapter 7, "Input Setup," for details.

Selecting a Measurement and Display

The log resolution mode offers several measurements and displays. This section describes the measurements and displays available for the log resolution mode.

Selecting a Measurement

The types of measurements that you can perform differ depending on which measurement mode is selected. To select measurements in any measurement mode, press **SELECT MEAS**. In log resolution mode, the menu in figure 4-5 appears.

To choose a measurement, first select the measurement, then select the active channel(s). For example, to take measurement data on Channel 1 and measure a power spectrum, press POWER SPEC, then CH 1 ACTIVE. Keep in mind that for averaged measurements these two selections must be made before the measurement is started. If you want to change either selection, you must restart the measurement. The dual-channel FREQ RESP measurement automatically activates both channels when selected.

```
        ┌─────────┐
        │ SELECT  │
        │  MEAS   │
        └─────────┘


        ┌─────────┐
        │  FREQ   │
        │  RESP   │
        └─────────┘

        ┌─────────┐
        │  POWER  │
        │  SPEC   │
        └─────────┘

        ┌─────────┐
        │         │
        │         │
        └─────────┘

        ┌─────────┐
        │         │
        │         │
        └─────────┘

        ┌─────────┐
        │         │
        │         │
        └─────────┘

        ┌─────────┐
        │  CH 1&2 │
        │ ACTIVE  │
        └─────────┘

        ┌─────────┐
        │  CH 1   │
        │ ACTIVE  │
        └─────────┘

        ┌─────────┐
        │  CH 2   │
        │ ACTIVE  │
        └─────────┘
```

**Figure 4-5. SELECT MEAS Menu Diagram:
Log Resolution Mode**

The softkeys in the **SELECT MEAS** menu do the following:

FREQ
RESP   Selects the frequency response measurement.

POWER   Selects the power spectrum measurement.
SPEC

CH 1&2   Activates both channels.
ACTIVE

CH 1   Activates Channel 1.
ACTIVE

CH 2   Activates Channel 2.
ACTIVE

Note   You can also perform time throughput measurements in the Log Resolution Mode.
                   See chapter 9, "Time Throughput," for details.

Selecting a Display

The log resolution mode offers a number of ways to display your measurement data. You can choose instantaneous displays (press **VIEW INPUT**) or measurement displays (press **MEAS DISP**). Filtered-input displays are not available in log resolution mode. Instantaneous displays allow you to see measurement data before it has been filtered to a reduced frequency span, triggered, or measured. Measurement displays allow you to see measurement data after it has gone through the entire measurement process. Figure 2-3, "Measurement Process Diagram," in chapter 2 shows you how instantaneous and measurement displays are derived. Chapter 2 also contains an introduction to these displays and shows which ones are available in each measurement mode. Both displays — instantaneous and measurement displays — can be selected before, during or after the measurement.

Since measurement displays are derived from calculations on the collected data, a number of different measurement displays are possible from one measurement. Consequently, the measurement that you select determines the measurement displays available to you. Therefore, first select the measurement (**SELECT MEAS**), then select a measurement display (**MEAS DISP**). Figure 4-6 shows you the menu diagram for the MEAS DISP hardkey when the analyzer is in the log resolution mode. The softkeys in this menu are described later in this chapter.

Note

See "Viewing the Input Signals" earlier in this chapter for details about instantaneous displays. See the following sections for details about measurements and measurement displays. Each section begins with a description of one measurement and then describes the measurement displays available for that measurement.

---

¹If Channel 1 is active, this key selects a measurement display for Channel 1.
If Channel 2 is active, it selects a measurement display for Channel 2.

**Figure 4-6. MEAS DISP Menu Diagram:
Log Resolution Mode**

The Frequency Response Measurement

The frequency response measurement, often called the"transfer function," is the ratio of a system's output to its input and provides both magnitude and phase information as a function of frequency. (The phase response can be viewed by pressing PHASE in the **COORD** menu.) In the HP 3563A, the signal on Channel 1 is assumed to be the system's input, and signal on Channel 2 is assumed to be its output. To select the frequency response measurement, press **SELECT MEAS** followed by the FREQ RESP softkey (see figure 4-5).

Note	The following values show the typical accuracy of log resolution frequency response measurements:

Amplitude: ± 0.2 dB

Phase: ± 0.5 degrees

To select a measurement display for the frequency response measurement, press **MEAS DISP** (see figure 4-6). Notice that a number of different measurement displays are available for this measurement, such as:

FREQ
RESP
Displays the frequency response. When default coordinates are active, this displays frequency on the X-axis and gain on the Y-axis.

COHER
Displays the coherence of the frequency response measurement.

POWER
SPEC1
Displays the power spectrum measured on Channel 1.

POWER
SPEC2
Displays the power spectrum measured on Channel 2.

CROSS
SPEC
Displays the cross spectrum.

AUTO
MATH
Displays the trace calculated with the auto math table; see"Math & Auto Math" in chapter 15. Note that this softkey label might be replaced by a user-defined label.

The Frequency Response Measurement Display

The frequency response measurement display shows you the frequency response of your measurement. Frequency response is calculated as the ratio of the cross spectrum to the Channel 1 power spectrum as follows:

$$H(f) = \frac{G_{yx}}{G_{xx}}$$

where:

G_{yx} is the cross spectrum (x is Channel 1; y is Channel 2)
G_{xx} is the Channel 1 power spectrum

Figure 4-7 shows the response of a typical filter as characterized with the frequency response measurement display. This example used the default coordinates and units; refer to chapter 8, "Display Configuration," for information on selecting other coordinates or units for the display.
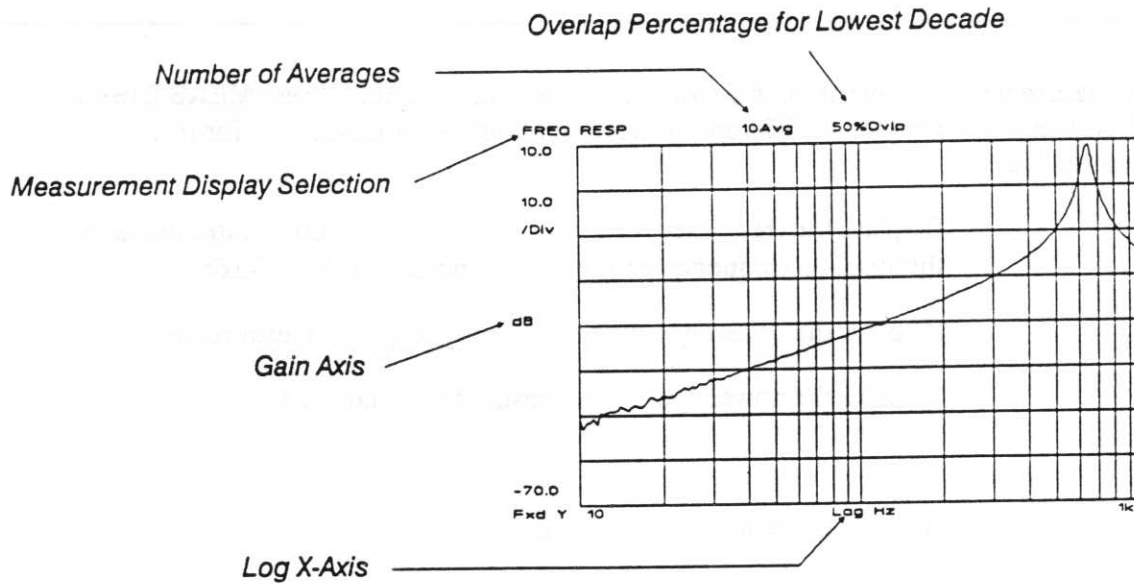
Figure 4-7. The Frequency Response
Measurement Display

The Coherence Measurement Display

The coherence measurement display calculates and displays the coherence of the frequency response. Coherence shows the portion of the output power spectrum related to the input spectrum, according to the following formula:

$$\gamma^2 = \frac{G_{yx}G_{yx}*}{G_{xx}G_{yy}}$$

where:

        G_{yx} is the cross spectrum
        $G_{yx}*$ is the cross spectrum's complex conjugate
        G_{xx} is the Channel 1 power spectrum
        G_{yy} is the Channel 2 power spectrum

Coherence is an indication of the statistical validity of a frequency response measurement. Coherence is measured on a scale of 0.0 to 1.0, where 1.0 indicates perfect coherence. Coherence values less than unity are caused by poor resolution, system nonlinearities, extraneous noise and/or uncorrelated input signals. Because coherence is normalized, it is independent of the shape of the frequency response function.

Note

The coherence function is valid only for averaged measurements.

Figure 4-8 shows the coherence of the frequency response function shown in figure 4-7.

Uncorrelated Noise Injected into
Measurement Showed Up as Poor
Coherence
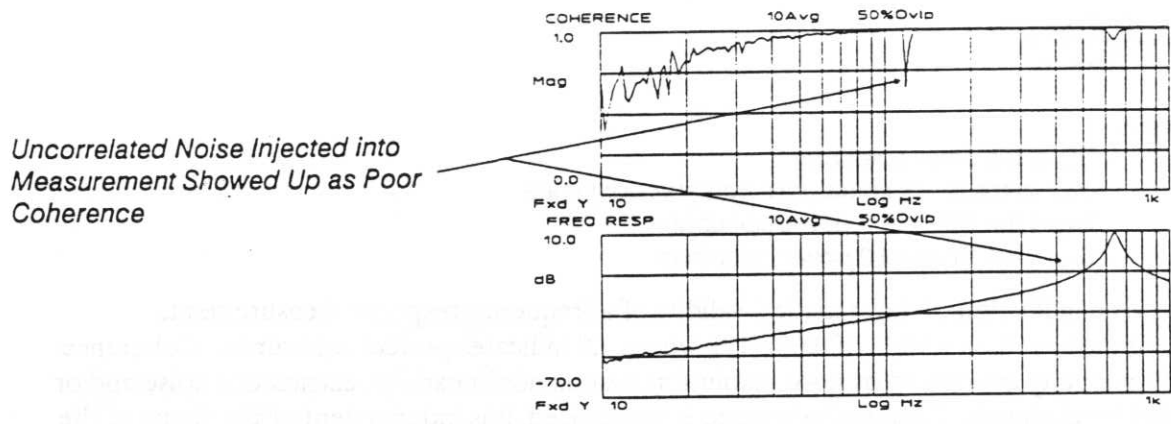
Figure 4-8. The Coherence Measurement Display

The Power-Spectrum Measurement Display

The power spectrum is the FFT of the input signal (in other words, the linear spectrum) multiplied by its complex conjugate. You can display the power spectrum for Channel 1 or Channel 2. For an example of this display, see figure 4-10.

$$G_{xx} = F_x F_x*$$

where:

F_x* is the Channel 1 linear spectrum's conjugate
F_x is the Channel 1 linear spectrum

The power-spectrum measurement display is a convenient means of viewing the spectra after taking a frequency response measurement. If you want only the power spectrum magnitude display, use the power spectrum measurement because it is faster. (See "The Power Spectrum Measurement" later in this chapter.) The single-channel measurement also has greater maximum real time bandwidth. The power spectrum measurement does not, of course, yield the phase information provided by the frequency response measurement.

The Cross-Spectrum Measurement Display

The cross-spectrum measurement display is computed by multiplying the complex conjugate of the linear spectrum on Channel 1 by the linear spectrum on Channel 2 as follows:

$$G_{yx} = F_y F_x*$$

where:

F_x* is the Channel 1 linear spectrum's
complex conjugate
F_y is the Channel 2 linear spectrum

The cross spectrum shows the amplitude product of the two spectra and the phase difference between them. It is often used in acoustic intensity measurements.

Figure 4-9 shows an example of the cross-spectrum measurement display.
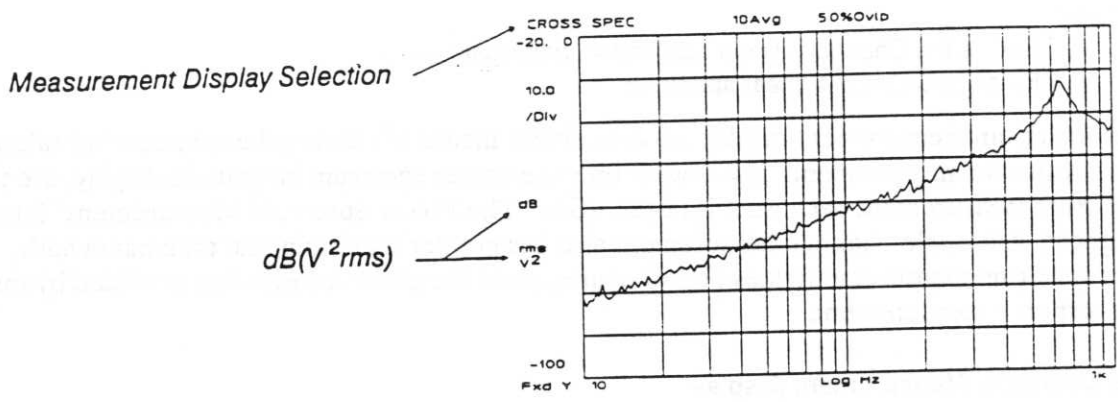
Figure 4-9. The Cross Spectrum
Measurement Display

The Power-Spectrum Measurement

The power spectrum measurement shows the input signal in the frequency domain. It is computed by multiplying the FFT of the signal by its complex conjugate:

$$G_{xx} = F_x F_x*$$

where:
> F_x is the channel's linear spectrum
> F_x* is its complex conjugate

This measurement is provided in addition to the frequency response measurement because the single-channel power spectrum is faster than the dual-channel frequency response measurement. Single-channel measurements also provide greater maximum real-time bandwidth. The power spectrum provides no phase information. To select the power spectrum measurement, press **SELECT MEAS**, followed by the POWER SPEC softkey (see figure 4-5).

Note

Several accuracey values apply to log resolution power spectrum measurements. The initial measurement accuracy is $+0, -0.2$ dB. Added to this are the Hann window used in the next stage of the measurement, which has amplitude errors up to $+0, 451.5$ dB, and the process used to combine linear resolution lines can contribute up to $+0, 451.76$ dB error. Next, the adjustment needed to compensate for the fact that the discrete frequency lines do not always coincide with ideal log bandwidths can contribute up to $+1.72, 452.30$ dB. The maximum overall potential error is $+1.72, 455.76$ dB.

These accuracy values apply only to log resolution power spectrum measurements. This error in the power spectrum measurement occurs because the log resolution mode is optimized for broadband frequency response measurements. The log resolution frequency response measurement has typical amplitude accuracy to ± 0.2 dB and phase accuracy to ± 0.5 degrees. If you need to measure power spectra more accurately, use the linear resolution mode.

To select a measurement display for the power spectrum measurement, press **MEAS DISP** (see figure 4-6). Notice that a number of different measurement displays are available for this measurement, such as:

POWER
SPEC1

Displays the power spectrum measured on Channel 1. This softkey appears if Channel 1 is active.

POWER
SPEC2

Displays the power spectrum measured on Channel 2. This softkey appears if Channel 2 is active.

AUTO
MATH

Displays the trace calculated with the auto math table; see "Math & Auto Math" in chapter 15. Note that this softkey label might be replaced by a user-defined label.

The Power-Spectrum Measurement Display

The power-spectrum measurement display is selected by pressing **MEAS DISP**, followed by the POWER SPEC 1 or POWER SPEC 2 softkeys. Figure 4-10 shows an example of the power-spectrum measurement display.
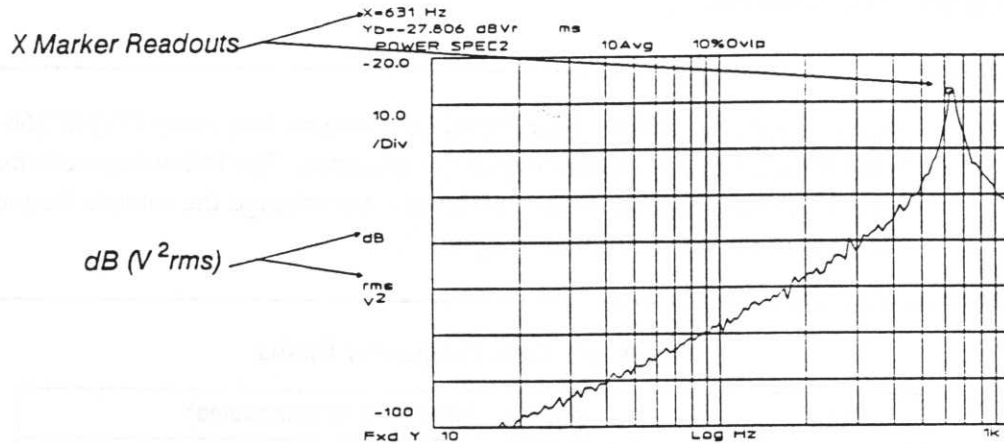
Figure 4-10. The Power Spectrum Measurement Display

Frequency Spans in the Log Resolution Mode

The log resolution mode offers 50 frequency spans. Table 4-1 shows the available spans for the log resolution mode. The width of the frequency span is entered as an integer number of decades from one to five. The span's location in the frequency spectrum is determined by the start and stop frequencies. Note that when the span is changed, the new span does not appear on the display until the next measurement is started.

Note

The values in the table 4-1 are based on a sample frequency (Fs) of 256 kHz, which is the internal sample frequency of the analyzer. The following sections tell you how the values in this table are affected if you change the sample frequency (see "Determining Valid Frequency Spans").

Table 4-1. Valid Frequency Spans

Start Frequencies	Stop Frequencies (for span indicated)				
	1 decade	2 decade	3 decade	4 decade	5 decade
0.1 Hz	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz
0.2 Hz	2 Hz	20 Hz	200 Hz	2 kHz	20 kHz
0.5 Hz	5 Hz	50 Hz	500 Hz	5 kHz	50 kHz
1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz
2 Hz	20 Hz	200 Hz	2 kHz	20 kHz	—
5 Hz	50 Hz	500 Hz	5 kHz	50 Hz	—
10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	—
20 Hz	200 Hz	2 kHz	5 kHZ	—	—
50 Hz	500 Hz	5 kHz	10 kHz	—	—
100 Hz	1 kHz	10 kHz	20 kHz	—	—
200 Hz	2 kHz	20 kHz	50 kHz	—	—
500 Hz	5 kHz	50 kHz	100 kHz	—	—
1 kHz	10 kHz	100 kHz	—	—	—
2 kHz	20 kHz	—	—	—	—
5 kHz	50 kHz	—	—	—	—
10 kHz	100 kHz	—	—	—	—

Setting the Frequency Span

To set the frequency span, press **FREQ** to display the menu in figure 4-11. Then select one of the softkeys shown.
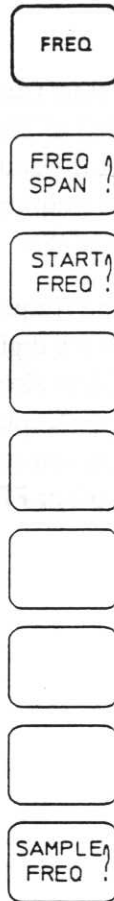
[1] Blank if both channels ANalog

Figure 4-11. FREQ Menu Diagram:
Log Resolution Mode

The softkeys in the **FREQ** menu do the following:

FREQ
SPAN

Allows you to set the frequency span, from one to five decades, using the Entry group. You can also enter the span immediately after pressing **FREQ**.

START
FREQ

Allows you to set the start frequency using the Entry group. If you use a sample frequency (Fs) of 256 kHz (the analyzer's internal sample rate), then you can set the start frequency from 0.1 Hz to 10 kHz. If you use a different sample frequency, then you can set the start frequency from Fs/2,560,000 to Fs/25.6

SAMPLE
FREQ

Allows you to enter the frequency of your external sample clock when one or more channels are digital (this key is blank if both channels are analog). This same key is also located under the **INPUT CONFIG** hardkey (see chapter 7, "Input Setup"). It is duplicated here for your convenience — so that you can set the external-sample frequency at the same time you set all other **FREQ** (frequency) parameters.

Determining Valid Frequency Spans

In log resolution mode, the analyzer's frequency span is affected by the following:

- External Sampling
  - The external sample-frequency
  - The MIXED RATIO selection in the INPUT CONFIG menu

How External Sampling Affects the Frequency Span

For external sampling, you can use the values in table 4-1 to determine valid frequency spans if the external sample-frequency is 256 kHz (the same as the analyzer's internal sample-frequency). If the external sample-frequency is not 256 kHz, you must scale all values in table 3-1 with the following scale factor:

$$\text{Scale Factor} = \frac{Fs}{256,000}$$

Furthermore, to determine the maximum frequency span, use the following formula:

$$\text{Maximum Span} = \frac{Fs}{2.56}$$

If you are making mixed measurements (one channel digital, the other analog), the frequency span is still dependent on the sample frequency — but in a different way. In this case, you must also consider the value of MIXED RATIO as shown in the following formula (the MIXED RATIO softkey is described in chapter 7, Input Setup). Notice that the following formula is simply the previous formula multiplied by the MIXED RATIO.

$$\frac{(Fs \times \text{MIXED RATIO})}{256,000}$$

for mixed measurements, determine the maximum frequency span as follows:

$$\text{Maximun Span} = \frac{(Fs \times \text{MIXED RATIO})}{2.56}$$

Real Time Bandwidth

The real time bandwidth (RTBW) is the maximum frequency span you can measure without missing input data. At spans greater than the RTBW, the instrument's processing time exceeds its data collection time and part of input signal is ignored while the previous time record is processed. When measuring periodic signals, the RTBW is not important because any data lost in one record will be repeated in the next record. However, RTBW is very important when measuring non-deterministic signals. In the log resolution mode, only one-decade measurements can be made in real time.

To achieve the greatest possible RTBW, you need to limit the number of display calculations required. The less you require of the display, the faster the measurement can run. For example, fast averaging and the single display format provide a greater RTBW than normal display updating and two active traces. One simple way of minimizing display time is to activate fast averaging (in the AVG menu) and select the single display format (the SINGLE hardkey). The message "Real Time" is displayed at the end of the measurement if there were no gaps in the data.

Note

The HP 3563A double-buffers the input signals, so 1- and 2-average measurements are always in real time.

Averaging In The Log Resolution Mode

Averaging in the log resolution mode is identical to averaging in the linear resolution mode, with these exceptions:

- In the log resolution mode, overlap processing applies only to the lowest decade in the multiple-decade measurements.

- In the log resolution mode, power-spectrum-function averaging is always used. You cannot select linear averaging (there is no TIM AV ON OFF softkey). See "Linear versus Power Spectrum Quantity Averaging" in chapter 3 for details.

- In the log resolution mode, you cannot preview time records. See "Previewing" in chapter 3 for details.

To select averaging, press the **AVG** hardkey, which allows you to access the softkeys in figure 4-12. For a description of these softkeys, see "Averaging in the Linear Resolution Mode" in chapter 3.

AVG

NUMBER
AVGS

AVG
OFF

OVRLP%

STABLE
(MEAN)

OV REJ
ON OFF

EXPON

FST AV
ON OFF

PEAK
HOLD

CONT
PEAK

NEXT

RETURN
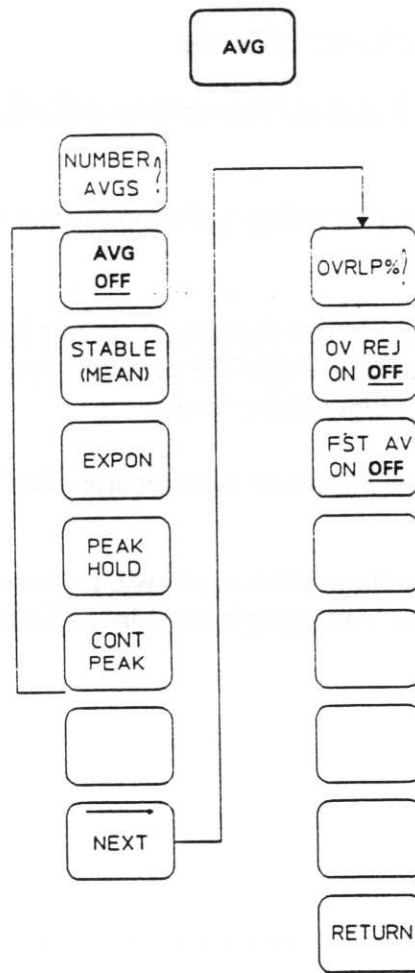
**Figure 4-12. AVG Menu Diagram:
Log Resolution Mode**

Using The Swept Sine Mode

Purpose Of This Chapter

This chapter contains a detailed description of the swept sine mode. The swept sine mode makes frequency-domain measurements at a user-specified set of discrete frequencies.

As a reminder, the HP 3563A offers four measurement techniques — called measurement modes. You choose the measurement technique you want by selecting one of the following four measurement modes:

- Linear Resolution Mode (described in chapter 3)
- Log Resolution Mode (described in chapter 4)
- Swept Sine Mode (described in this chapter)
- Time Capture Mode (described in chapter 6)

Each measurement mode configures the HP 3563A differently. See chapter 2, "Measurement Overview" for a summary of all four measurement modes. Chapter 2 also compares the four measurement modes and discusses why you might select one over another.

Note

Some menus differ depending on the measurement mode you are in. This chapter shows you only the menus that appear when swept sine mode is selected. Appendix C, "Menu Diagrams," shows you the menus that appear for all measurement modes. You may want to use appendix C as a quick reference since it contains, in one place, all menus for all hardkeys.

Measurement Setup: Swept Sine Mode

The steps necessary to set up a measurement in swept-sine mode are slightly different than those used for linear resolution or log resolution modes. For instance, you do not need to select a measurement in swept-sine mode — the frequency response measurement is the only measurement available in this measurement mode. Furthermore, you do not need to select a window (with the **WINDOW** hardkey) or set up triggering (with the **SELECT TRIG** hardkey) — swept sine mode does not use windows or a trigger. The remainder of this chapter details the steps necessary to set up a swept sine measurement, which are as follows (follow these steps for both analog and digital measurements):

1. Connect the analyzer to your device under test. See chapter 13 for details on digital connections; see chapter 14 for details on planning a digital or mixed (analog and digital) measurement.

2. Preset the analyzer (optional): press **PRESET** or **SAVE RECALL** (see chapter 12 for details).

3. Select swept sine mode: press **MEAS MODE** followed by SWEPT SINE.

4. Configure the inputs: press **INPUT CONFIG**. (See chapter 7, "Input Setup," for details).

5. View the input signals (if necessary): press **VIEW INPUT**.

6. Set up the source: press **SOURCE**. If necessary, set up source protection in the **SPCL FCTN** menu.

7. Select auto gain, if necessary: press **MEAS MODE** and toggle A GAIN ON OFF to ON.

8. Set the input range: press **RANGE**. (See "Using the Automatic Swept Sine Features" and chapter 7 for details).

9. Select a measurement display.

10. Select linear or log sweep: press **MEAS MODE** followed by LINEAR SWEEP or LOG SWEEP.

11. Set the frequency span and resolution: press **FREQ**.

12. Set up averaging and integration: press **AVG**.

13. Start the sweep: press **START**.

14. Select other measurement displays (if desired): press **MEAS DISP**.

15. Use the display and marker features (if desired): refer to chapter 8 for details on these features.

Selecting Swept Sine Mode

To put the HP 3563A in the swept sine mode, press **MEAS MODE**. The softkeys that appear under **MEAS MODE** depend on which measurement mode is selected. Press SWEPT SINE to configure the analyzer to the swept sine mode. In this measurement mode, you have access to the softkeys in figure 5-1.
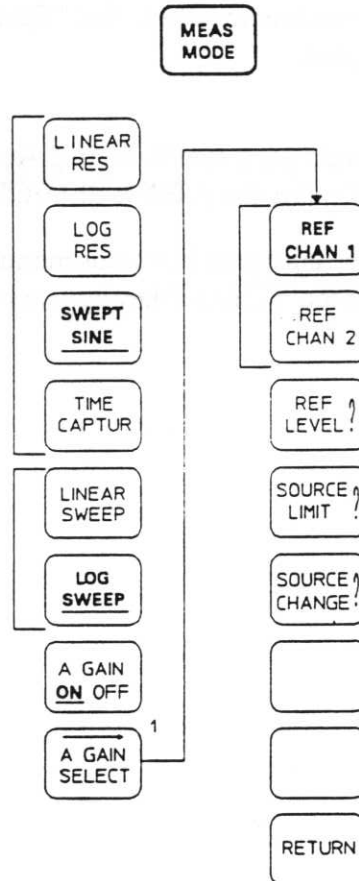
[1] Blank if [A GAIN ON **OFF**] is selected (this is the default)

**Figure 5-1. MEAS MODE Menu Diagram:
Swept Sine Mode**

You press **MEAS MODE** SWEPT SINE to set up the *swept sine receiver*. The swept sine receiver measures the output of the system under test and compares it to the input applied by the source. Use the following softkeys to set up the swept sine receiver:

LINEAR SWEEP	Selects a linear sweep. See "Selecting Linear or Log Sweep" later in this chapter.
LOG SWEEP	Selects a logarithmic sweep. See "Selecting Linear or Log Sweep" later in this chapter.
A GAIN ON OFF	Activates auto gain; see "Selecting Auto Gain" later in this chapter. This also displays the A GAIN SELECT softkey.
A GAIN SELECT	Displays the auto gain functions menu; see "Selecting Auto Gain" later in this chapter. (This softkey appears only when A GAIN ON OFF is ON.)

Viewing The Input Signals

The **VIEW INPUT** hardkey allows you to look at the input signals before they are filtered to a reduced frequency span, triggered, or measured. These *instantaneous* displays can be viewed at any time, even when the measurement is in progress. Instantaneous displays can be used to verify the presence of input signals or to compare an input signal with a measurement display. Instantaneous displays are also helpful when manually setting the input range. Chapter 2, "Measurement Overview," explains how these displays are derived and how they differ from filtered-input and measurement displays (remember, filtered-input displays are not available in the swept sine mode).

The softkeys in figure 5-3, except the one that is blank, are the same for all four measurement modes (linear resolution, log resolution, swept sine, and time capture). For a description of the softkeys in figure 5-3, see "Viewing the Input Signals" in chapter 3 (first, read the following note).

Note

In the swept sine mode, the input spectrum displays use the flat top window, not the window selected under the **WINDOW** hardkey as in other measurement modes. The flat top window is used in the swept sine mode because of its amplitude accuracy. In addition, instantaneous displays always show 801 frequency lines, even when 1024 frequency lines are selected (**WINDOW** 1024 LINES).

VIEW
INPUT

INPUT
TIME 1

INPUT
TIME 2

INPUT
SPEC 1

INPUT
SPEC 2

INPUT
DIG 1

INPUT
DIG 2

VIEW
OFF

**Figure 5-2. VIEW INPUT Menu Diagram:
Swept Sine Mode**

Setting Up The Source: Swept Sine Mode

The HP 3563A offers several analog or digital outputs in the swept sine mode. To set up the source, press **SOURCE**. The softkeys that appear depend on SOURCE AN DIG. If SOURCE AN DIG is toggled to **AN** (analog output) you see one menu; if it is toggled to **DIG** (digital output), you see another (see figure 5-4).

The softkeys available under **SOURCE** control the level and direction of the sweep. Any of the source parameters may be changed while the sweep is in progress. You can change the sweep rate or direction, put the sweep on hold, or use manual sweep without degrading the quality of the measurement. (Changing the source level or dc offset may degrade the measurement, however.)

Figure 5-4 shows the **SOURCE** softkeys for the swept sine mode. All of these softkeys, except for those under SOURCE TYPES, are identical for all four measurement modes (linear resolution, log resolution, swept sine, and time capture). The only softkeys described in this chapter are those specific to swept sine mode — the softkeys under SOURCE TYPES. See "Setting up the Source: Linear Resolution Mode" in chapter 3 for a description of all other **SOURCE** softkeys. Furthermore, see chapter 3 for details on how to select a source output or how to turn on source protection.
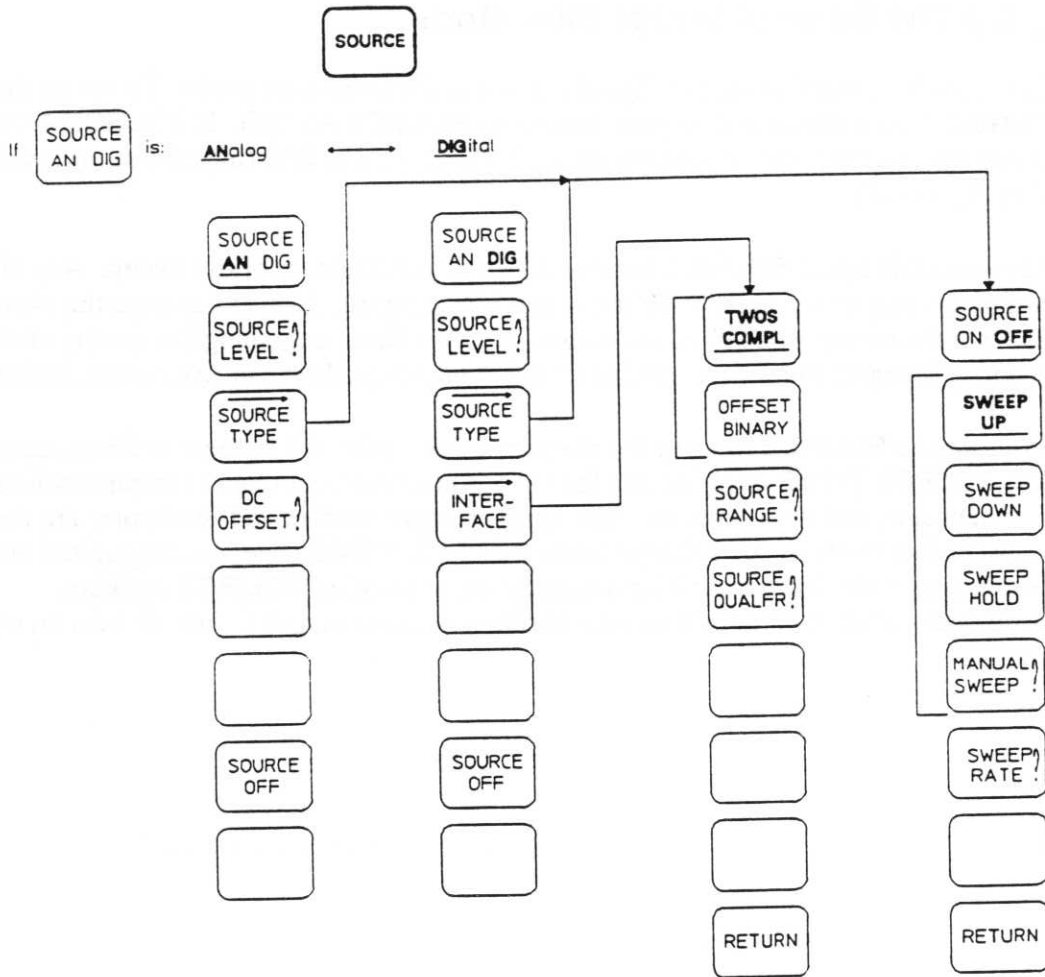
Figure 5-3. SOURCE Menu Diagram:
Swept Sine Mode

SOURCE Types: Swept Sine Mode

The source types in the swept sine mode are unique — they are specific to swept sine measurements. You can set the sweep rate and enable the source to sweep up, sweep down, do a manual sweep, or pause the sweep at any point using these softkeys:

SOURCE ON OFF	Disables the source output. If source protection is on, the source ramps off gradually. See "Source Protection" in chapter 3.
SWEEP UP	Causes the measurement to sweep up in frequency, from the current sweep position to the specified stop frequency. If the sweep is already at the stop frequency, the analyzer measures one point, then stops. This is the default during a swept sine measurement. CAUTION: The new measurement data overwrites the previously measured gain/phase values.
SWEEP DOWN	Causes the measurement to sweep down in frequency, from the current sweep position to the start frequency specified in the **FREQ** menu. If the sweep is already at the start frequency, the analyzer measures one point, then stops. CAUTION: The new measurement data overwrites the previously measured gain/phase values.
SWEEP HOLD	Stops the sweep at the current measurement point. The instrument continues to measure and display the measured value, but the sweep does not continue until SWEEP UP or SWEEP DOWN is pressed. See "Sweep Hold versus Manual Sweep" following this description.
MANUAL SWEEP	Allows you to move the measurement point with the Entry group knob. The instrument then measures at the point you selected. See "Sweep Hold versus Manual Sweep" following this description.
SWEEP RATE	Allows you to set the sweep rate. Sweep rate and resolution are inversely proportional; increasing resolution decreases the sweep rate and increases the sweep time. This softkey is identical to SWEEP RATE in the **FREQ** menu and is duplicated here because this is the menu normally active while the sweep is in progress. Changing the sweep rate also changes the resolution; see "Sweep Rates and Resolution" later in this chapter for more information.

SWEEP HOLD versus MANUAL SWEEP

The sweep hold feature allows you to pause the sweep at any point while continuing to measure the input signals. It measures the signal at the given point. calculates the specified number of averages, then takes a new measurement at the same point. This cycle continues indefinitely. Keep in mind that sweep hold does not accumulate averaged data; each measurement is replaced when the next measurement is completed.

The manual sweep feature allows you to move the sweep point using the arrow keys or the knob in the Entry group. Manual sweep also provides much higher resolution than sweep hold. Contrary to sweep hold, manual sweep does accumulate measurement data in one continuous average. You can also enter a measurement frequency for manual sweep directly using the 0-9 keys on the numeric keypad.

Selecting Auto Gain

Caution

The HP 3563A's auto gain feature is designed to exclude distorted data from the measurement. Because it sweeps past each point before determining whether the source level is appropriate, it may not protect the system under test from damage caused by excessive signal levels. Use extreme caution when exciting systems with potentially high output levels.

The auto gain feature causes the HP 3563A to vary the source level in order to maintain a constant amplitude on one of the input channels. You can select either Channel 1 or Channel 2 as the reference (Channel 1 is the default). In addition, you can specify the reference level for the selected channel.

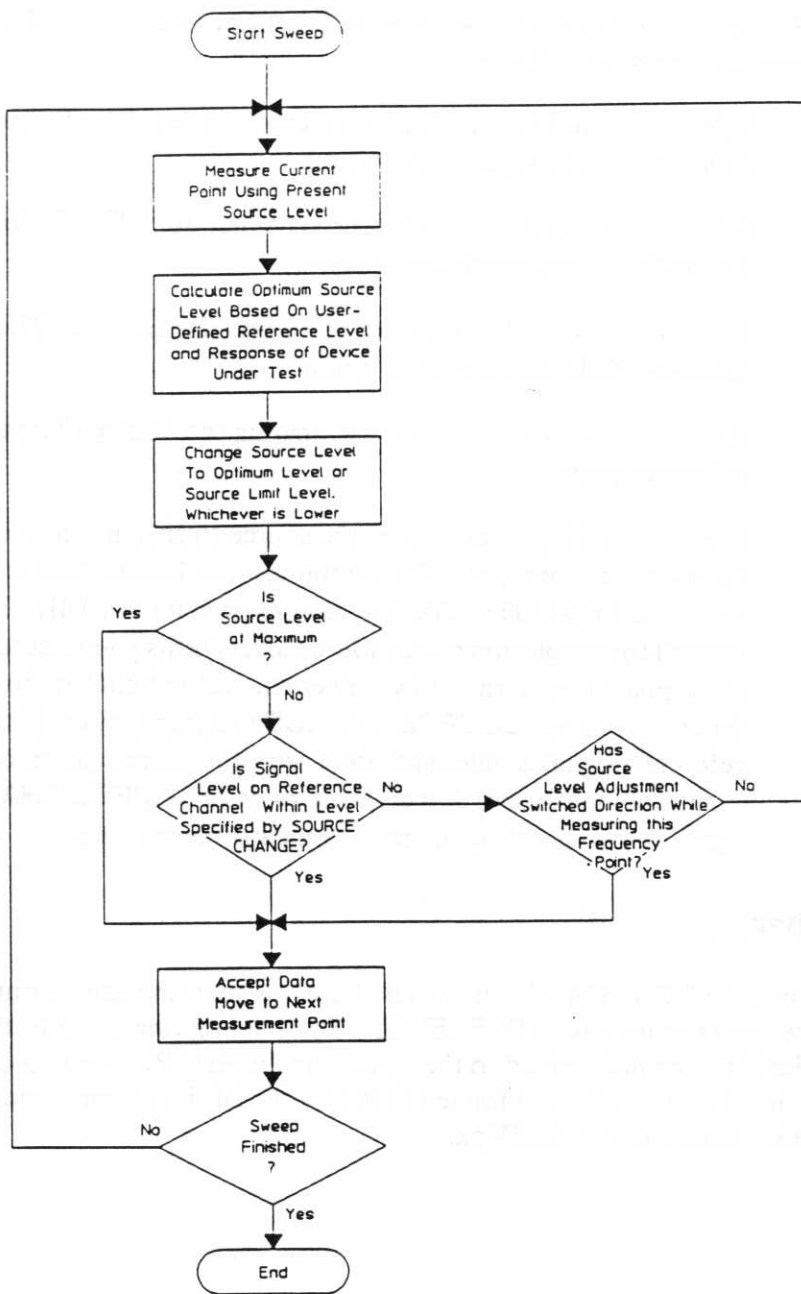Figure 5-2 shows the operation of the auto gain feature.

```
                    ┌─────────────┐
                    │ Start Sweep │
                    └──────┬──────┘
                           │
         ┌─────────────────┤◄──────────────────────────────────┐
         │                 ▼                                    │
         │        ┌─────────────────┐                          │
         │        │ Measure Current │                          │
         │        │ Point Using     │                          │
         │        │ Present Source  │                          │
         │        │ Level           │                          │
         │        └────────┬────────┘                          │
         │                 ▼                                    │
         │        ┌─────────────────────┐                      │
         │        │ Calculate Optimum   │                      │
         │        │ Source Level Based  │                      │
         │        │ On User-Defined     │                      │
         │        │ Reference Level and │                      │
         │        │ Response of Device  │                      │
         │        │ Under Test          │                      │
         │        └────────┬────────────┘                      │
         │                 ▼                                    │
         │        ┌─────────────────────┐                      │
         │        │ Change Source Level │                      │
         │        │ To Optimum Level or │                      │
         │        │ Source Limit Level. │                      │
         │        │ Whichever is Lower  │                      │
         │        └────────┬────────────┘                      │
         │                 ▼                                    │
         │           ╱──────────╲                              │
         │     Yes  ╱ Is Source   ╲                            │
         │  ┌──────◄  Level at      ►                          │
         │  │       ╲ Maximum?     ╱                           │
         │  │        ╲──────┬─────╱                            │
         │  │            No │                                  │
         │  │               ▼                                  │
         │  │       ╱────────────╲          ╱────────────╲     │
         │  │      ╱ Is Signal    ╲   No   ╱ Has Source   ╲ No │
         │  │     ◄ Level on Ref   ►──────► Level Adjust   ►───┤
         │  │      ╲ Channel Within╱       ╲ Switched Dir ╱    │
         │  │       ╲Level Spec by ╱        ╲while Meas   ╱     │
         │  │        ╲SOURCE CHANGE╱         ╲this Freq  ╱      │
         │  │         ╲──────┬────╱           ╲Point?───╱       │
         │  │            Yes │                    │ Yes        │
         │  │                ▼◄───────────────────┘            │
         │  └───────────────►│                                 │
         │                   ▼                                 │
         │          ┌─────────────────┐                       │
         │          │ Accept Data     │                       │
         │          │ Move to Next    │                       │
         │          │ Measurement Pt  │                       │
         │          └────────┬────────┘                       │
         │                   ▼                                │
         │             ╱──────────╲                           │
         │   No       ╱  Sweep     ╲                          │
         └───────────◄   Finished?  ►                         │
                      ╲────────────╱                          
                            │ Yes                             
                            ▼                                 
                     ┌────────────┐                           
                     │    End     │                           
                     └────────────┘                           
```

Figure 5-4. Auto Gain

Press A GAIN ON OFF to ON to display the A GAIN SELECT softkey (see figure 5-1). Pressing A GAIN SELECT displays the following softkeys:

REF
CHAN 1
Selects Channel 1 as the reference channel; see "The Reference Channel" following this description.

REF
CHAN 2
Selects Channel 2 as the reference channel; see "The Reference Channel" following this description.

REF
LEVEL
Sets the reference level for the reference channel; see "The Reference Channel" following this description.

SOURCE
LIMIT
Sets the source limit value; see "Limiting the Source Output" following this description.

SOURCE
CHANGE
Sets the tracking resolution of the source to changes in level measured by the reference input. The default value is 1.0 dB. The minimum value is 0.2 dB (200 mdB). The maximum value is 10 dB. The ability to control the resolution of the source level allows you to accommodate the signal-to-noise ratio of your system. If the signal at the reference input is noisy, set SOURCE CHANGE to a large value. If the measured reference signal is quiet and noise-free, the source can track more accurately so you can decrease the value of SOURCE CHANGE for a tighter control without increasing measurement time.

The Reference Channel

When auto gain is active, the HP 3563A adjusts the level of the swept sine source output to maintain the specified reference level (entered with REF LEVEL). By selecting Channel 1 as the reference, a constant input signal level can be maintained to the system under test. By selecting Channel 2 as the reference, a constant signal level can be maintained at the output of the system under test. The reference level can be set from 5 mV to 31.5Vpk.

Limiting the Source Output

Because auto gain can adjust the source output level to maintain the reference level, it is sometimes necessary to place a limit on the source level. This may be needed to limit input levels (to prevent damage to the system under test) or output levels (to prevent distortion caused by overloading the HP 3563A's inputs). The source can be limited from 5 mV to 5V; the default value is 5 mV. (The source level changes in 5 mV increments.) Source limit applies only to levels automatically set by the auto gain feature, not to levels entered manually by the user.

Note

The source limit does not guarantee any limit on the output of a device under test. Auto gain predicts the future response of the system and attempts to maintain the reference level, but a narrow resonant peak may escape predetection. Take this into consideration when measuring devices with potentially high amplitude responses at resonant frequencies.

Setting the Input Range

After you set up the source, you should set the input range. The input range is set with the **RANGE** hardkey. You can manually set the range or have the analyzer automatically select the best range. The range options available differ for analog and digital inputs. See chapter 7, "Input Setup," for details.

Selecting a Measurement and Display

The swept sine mode offers only one measurement — the frequency response measurement. Because this is the only measurement in this measurement mode, FREQ RESP is the only softkey that appears when you press **SELECT MEAS**.

Selecting a Display

The swept sine mode offers a number of ways to display your measurement data. You can choose instantaneous displays (press **VIEW INPUT**) or measurement displays (press **MEAS DISP**). Filtered-input displays are not available in swept sine mode. Instantaneous displays allow you to see measurement data before it has been filtered to a reduced frequency span, triggered, or measured. Measurement displays allow you to see measurement data after it has gone through the entire measurement process. Figure 2-3, "Measurement Process Diagram," in chapter 2 shows you how instantaneous and filtered-input displays are derived. Chapter 2 also contains an introduction to these displays and shows which ones are available in each measurement mode. Both displays — instantaneous and measurement displays — can be selected before, during or after the measurement.

Since measurement displays are derived from calculations on the collected data, a number of different measurement displays are possible from one measurement. In the swept sine mode, the only measurement available is the frequency response measurement. Figure 5-5 shows you the measurement displays available (under the **MEAS DISP** hardkey) for this measurement when the analyzer is in the swept sine mode. The softkeys in the MEAS DISP menu diagram are described later in this chapter.

Note

See "Viewing the Input Signals" earlier in this chapter for details about instantaneous displays. See the following section for details about the frequency response measurement and the measurement displays available for that measurement.

**Figure 5-5. MEAS DISP Menu Diagram:
Swept Sine Mode**

The Frequency Response Measurement

The frequency response measurement, often called the "transfer function," is the ratio of a system's output to its input and yields both gain and phase as a function of frequency. (The phase response can be viewed by pressing PHASE in the **COORD** menu.) In the HP 3563A, the signal on Channel 1 is assumed to be the system's input, and the signal on Channel 2 is assumed to be its output..

To select a display for the frequency response measurement, press **MEAS DISP**. The softkeys that appear are shown in figure 5-5. Notice that a number of different displays are available for this measurement, such as:

FREQ RESP	The default display when the frequency response measurement is selected; see "The Frequency Response Display" following this description.
COHER	Displays the coherence of the frequency response function; see "The Coherence Display" following this description.
POWER SPEC 1	Displays the power spectrum of the signal on Channel 1; see "The Power Spectrum Displays" following this description.
POWER SPEC 2	Displays the power spectrum of the signal on Channel 2; see "The Power Spectrum Displays" following this description.
CROSS SPEC	Displays the cross spectrum; see "The Cross Spectrum Display" following this description.
AUTO MATH	Displays the trace calculated with the auto math table; please see "Math & Auto Math" in chapter 15. Note that this softkey label might be replaced by a user-defined label.

The Frequency Response Measurement Display

The frequency response measurement display shows you the frequency response of your measurement. The frequency response is calculated as the ratio of the cross spectrum to the Channel 1 power spectrum as follows:

$$H(f) = \frac{G_{yx}}{G_{xx}}$$

where:

G_{yx} is the cross spectrum (x is Channel 1; y is Channel 2)

G_{xx} is the Channel 1 power spectrum

Figure 5-6 shows the response of a typical filter as characterized with the frequency response measurement display. This example used the default coordinates and units; refer to chapter 8, "Display Configuration," for information on selecting other coordinates or units for the display.
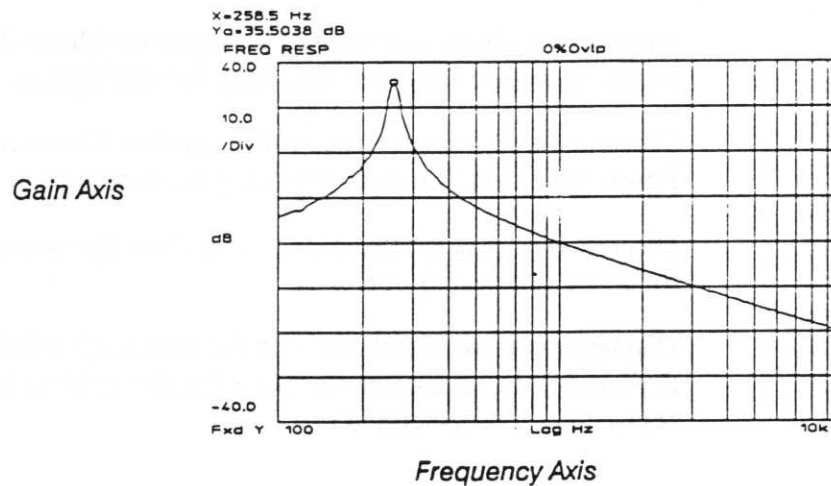
Figure 5-6. The Frequency Response
Measurement Display

The Coherence Measurement Display

The coherence measurement display calculates and displays the coherence of the frequency response. Coherence shows the portion of the output power spectrum related to the input spectrum, according to the following formula:

$$\gamma^2 = \frac{G_{xy}G_{xy}*}{G_{xx}G_{yy}}$$

where:

G_{xy} is the cross spectrum
$G_{xy}*$ is the cross spectrum's complex conjugate
G_{xx} is the Channel 1 power spectrum
G_{yy} is the Channel 2 power spectrum

Coherence is an indication of the statistical validity of a frequency response measurement. Coherence is measured on a scale of 0.0 to 1.0, where 1.0 indicates perfect coherence. Coherence values less than unity are caused by poor resolution, system nonlinearities, extraneous noise and uncorrelated input signals. Because coherence is normalized, it is independent of the shape of the frequency response function.

Note   The coherence function is valid only for averaged measurements.

Figure 5-7 shows the coherence of the frequency response function shown in figure 5-6.

(Scaled past 1.0 to clearly show trace)
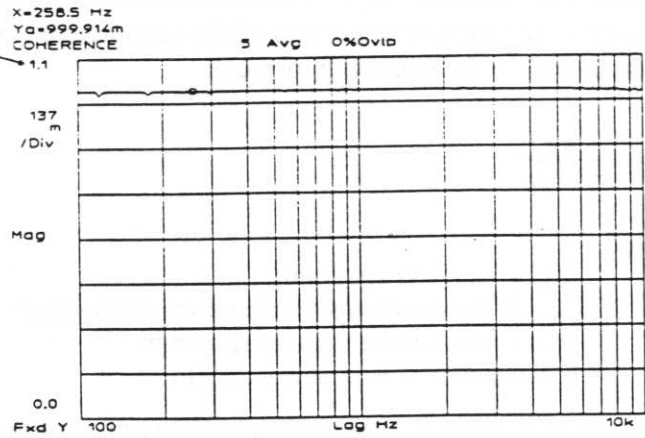
Figure 5-7. The Coherence
Measurement Display

The Power-Spectrum Measurement Display

The power spectrum is the FFT of the input signal (in other words, the linear spectrum) multiplied by its complex conjugate. You can display the power spectrum for Channel 1 or Channel 2.

$$G_{xx} = F_x F_x*$$

where:

F_x* is the Channel 1 linear spectrum's complex conjugate
F_x is the Channel 1 linear spectrum

The power-spectrum measurement display is a convenient means of viewing the spectra after taking a frequency response measurement.. This display shows the power spectrum, defined as the power level of the incoming signal at the measurement frequency for each point measured during the sweep. Figure 5-8 shows the individual power spectra used to calculate the frequency response display in figure 5-6. The upper trace is the power spectrum of the Channel 1 signal, and the lower trace is the power spectrum of the Channel 2 signal.

Power Spectrum of Source Signal
Applied to System Under Test

System's Output Power Spectrum
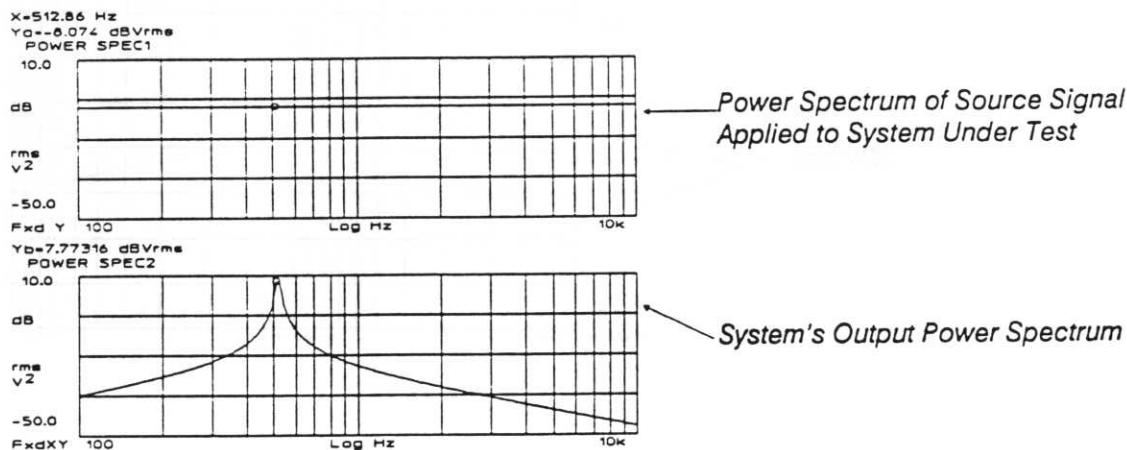
**Figure 5-8. The Power-Spectrum
Measurement Display**

The Cross-Spectrum Measurement Display

The cross-spectrum measurement display is computed by multiplying the complex conjugate of the linear spectrum on Channel 1 by the linear spectrum on Channel 2 as follows:

$$G_{yx} = F_y F_x*$$

where:

F_x* is the Channel 1 linear spectrum's complex conjugate

F_y* is the Channel 2 linear spectrum

The cross spectrum shows propagation velocity as a function of frequency and is often used in acoustic intensity measurements. Figure 5-9 shows an example of the cross-spectrum measurement display.
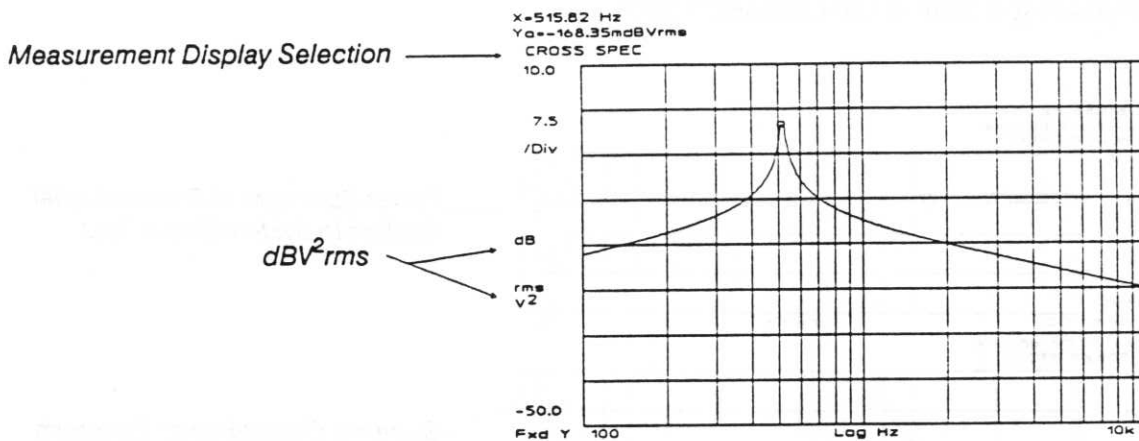
Figure 5-9. The Cross Spectrum
Measurement Display

Selecting Linear or Log Sweep

The choice between LINEAR SWEEP and LOG SWEEP must be made before the measurement is started (any time you press the yellow **START** key the sweep starts again). If a trace is originally measured or synthesized with linear resolution then converted to a log scale using the LOG X coordinates, points in the resultant trace will not be distributed proportionally. To achieve true log distribution, the original trace must have log resolution. The reverse is true for converting log traces to linear scale using the LIN X coordinate. See "Selecting Display Coordinates" in chapter 8 for more information on the LOG X and LIN X coordinates. Note that the sweep rate and resolution values are converted to linear or log values (i.e., Hertz or octaves/decades) when the sweep type is changed.

Frequency Spans In The Swept Sine Mode

The HP 3563A's frequency span in the swept sine mode ranges from 50 mHz to 100 kHz, when a sample frequency of 256 kHz is used (this is the analyzer's internal sample rate). Unlike the other three measurement modes (linear resolution, log resolution, and time capture), there are no preset spans in swept sine. If you use a sample frequency other than 256 kHz, see "Determining Valid Frequency Spans" for details on calculating the maximum stop frequency.

Setting the Frequency Span

To set the frequency span, press **FREQ** to display the menu in figure 5-10; then select one of the softkeys shown.

FREQ

FREQ
SPAN ?

START ?
FREQ ?

CENTER ?
FREQ ?

STOP ?
FREQ ?

SAMPLE ?
FREQ ? [1]

RESLTN ?

RESLTN ?
AU **FIX** ?

SWEEP ?
RATE ?

[1] Blank if both channels ANalog

**Figure 5-10. FREQ Menu Diagram:
Swept Sine Mode**

The softkeys in figure 5-10 do the following:

FREQ SPAN	Sets the frequency span, using the Entry group. The frequency span must be entered before the measurement is started. You can enter the span immediately after pressing **FREQ**. To determine the largest frequency span that can be displayed, see "Determining Valid Frequency Spans".
START FREQ	Sets the start frequency, not less than 50 mHz, using the Entry group. Note that the start frequency cannot be specified higher than the stop frequency.
CENTER FREQ	Sets the center frequency, using the Entry group.
STOP FREQ	Sets the stop frequency, not greater than 100 kHz, using the Entry group. Note that the stop frequency cannot be specified lower than the start frequency.
SAMPLE FREQ	Allows you to enter the frequency of your external sample clock when one or more channels are digital (this key is blank if both channels are analog). This same key is also located under the **INPUT CONFIG** hardkey (see chapter 7, "Input Setup"). It is duplicated here for your convenience — so that you can set the external-sample frequency at the same time you set all other **FREQ** (frequency) parameters.
RESLTN	Used to set the sweep resolution; see "Sweep Rates and Resolution" following this description.
RESLTN AU **FIX**	Selects auto or fixed resolution; see "Sweep Rates and Resolution" following this description.
SWEEP RATE	Used to set the sweep rate. This softkey is duplicated in the **SOURCE** menu so that you can change the sweep rate while the sweep is in progress. See "Sweep Rates and Resolution" following this description.

Hints for Setting the Frequency Span

The frequency softkeys are easy to use if you treat start/stop and span/center as separate pairs. Specify the frequency by entering start and stop frequencies or by entering center frequency and span. Note that these four softkeys are interrelated; changing one may affect some or all of the others.

As an example, when entering a span other than 100 kHz, you could use FREQ SPAN with either START FREQ or CENTER FREQ. To look for the first five harmonics of a 1 kHz signal, you could enter a span of 5 kHz and a start frequency of 1 kHz. To look for 100 Hz sidebands on a 50 kHz carrier, you could enter a span of 250 Hz and a center frequency of 50 kHz.

To simplify frequency entries, you can press FREQ SPAN, START FREQ. CENTER FREQ or STOP FREQ then enter the start and stop frequencies separated by a comma. For example, to set up span from 100 Hz to 200 Hz, you can press FREQ SPAN followed by 100, 200 Hz.

Note   START FREQ is *always less than* STOP FREQ, regardless of the direction of the sweep. If you select SWEEP DOWN (SOURCE TYPE in the **SOURCE** menu), the sweep begins at STOP FREQ and ends at START FREQ.

Determining Valid Frequency Spans

In swept sine mode, there are no preset spans. However, the maximum stop frequency that you can enter for swept sine mode depends on the sample frequency (Fs). The analyzer's internal sample frequency is 256 kHz, which allows a maximum stop frequency of 100 kHz. If you use external sampling, use the following formula to calculate the maximum stop frequency (you must supply an external sample frequency for all digital measurements):

$$\text{Maximum Stop Frequency} = \frac{Fs}{2}$$

Sweep Rates and Resolution

The sweep rate determines the speed at which the measurement sweeps across the given frequency span (set by pressing **FREQ** SWEEP RATE). The resolution defines the distance between measurement points in the frequency domain (set by pressing **FREQ** RESLTN). The rate and the resolution are inversely proportional, resulting in a trade-off between measurement time and resolution. Consequently, fast measurements risk losing data that fall between measurement points. Note that defining resolution in Hz/point or in points/sweep are two ways of accomplishing the same result. For example, a frequency span of 500 Hz with 100 points/sweep yields 5 Hz/point. Table 4-1 shows the resolution settings available for swept sine mode.

Table 4-1. Resolution Settings in Swept Sine Mode (points/sweep)

10	100	4000	10400
16	160	4800	11200
20	200	5600	12000
25	400	6400	12800
32	800	7200	13600
40	1600	8000	14400
50	2400	8800	15200
80	3200	9600	16000

Figure 5-11 shows a low-frequency crystal filter measured with 1 Hz/point resolution and again with 10 Hz/point resolution. Note the differences in the traces and sweep times. The overall sweep time, as indicated in the instrument state display, is equal to the span divided by the sweep rate.
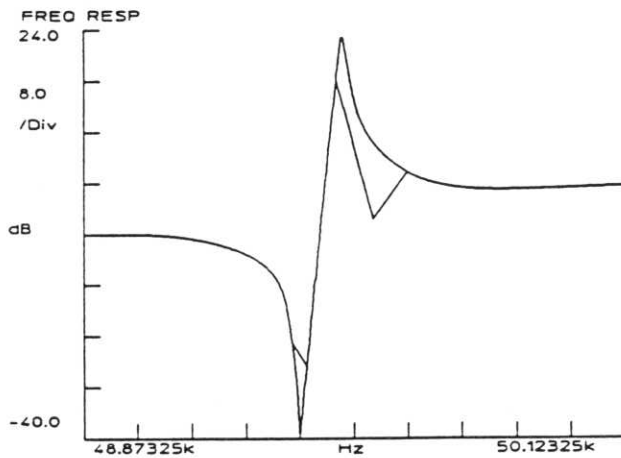
Trace Grid Not Plotted for Clarity.

Better Characterization of Network Due to Increased Resolution.

Poor Characterization Due to Coarse Resolution.

Figure 5-11. Effect of Changing the Resolution

The SWEEP RATE softkey in the **SOURCE** menu is identical to the one in the **FREQ** menu. It is repeated in the **SOURCE** menu because the **SOURCE** menu is generally used while the measurement is in progress, giving you the option of changing the sweep rate (and, indirectly, the resolution) during the sweep.

Auto Resolution

Auto resolution, selected by pressing RESLTN AU FIX to AU, causes the HP 3563A to increase the resolution during rapidly changing portions of the measurement. This reduces the possibility of skipping over a narrow resonance, for example, without slowing the overall measurement with a resolution not required for the entire sweep. Figure 5-12 shows the operation of the auto resolution feature. The minimum resolution is set with the RESLTN softkey.
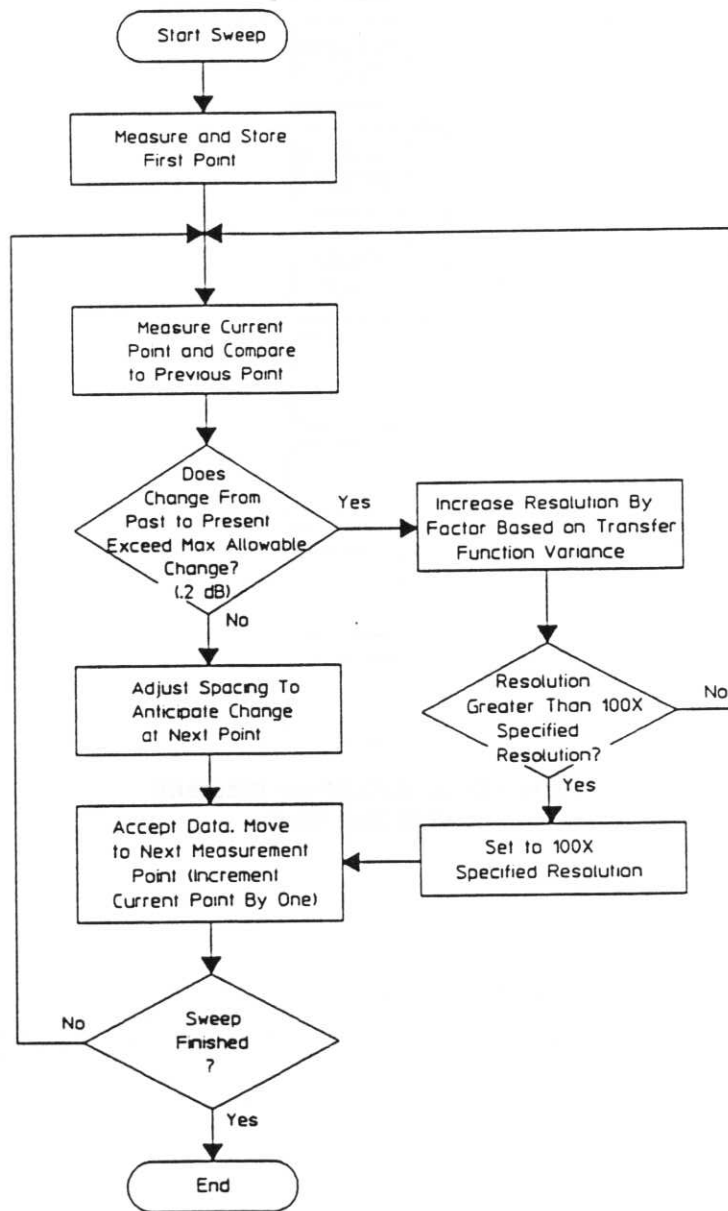
Figure 5-12. Auto Resolution

Averaging And Integration In The Swept Sine Mode

The swept sine mode allows you to control both the integration time and the number of averages per point. Pressing **AVG** displays the menu in figure 5-13.
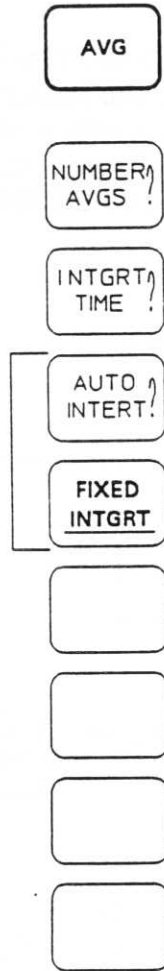
Figure 5-13. AVG Menu Diagram:
Swept Sine Mode

The softkeys in figure 5-13 do the following:

NUMBER AVGS	Sets the number of averages per point, from 1 to 32767. See "Selecting the Number of Averages" following this description.
INTGRT TIME	Sets integration time, from 50 ms to 32,767 s. Default is 50 ms. See "Setting the Integration Time" following this description.
AUTO INTGRT	Activates auto integration and is used to enter a variance threshold. See "Auto Versus Fixed Integration" following this description. This value is saved with the state but is not shown in the display.
FIXED INTGRT	Deactivates auto integration.

Selecting the Number of Averages

Averaging calculates the arithmetic mean of all the measurements made at a given measurement point. For example, if 5 is the selected number of averages, each point in the sweep is measured five times, and the results at each point are averaged (the five results added together then divided by 5).

Averaging helps to decrease the variance in a measurement and enables the HP 3563A to make a good coherence estimate (see "The Coherence Display" later in this chapter). Selecting the number of averages is a trade-off between noise reduction and measurement time: increasing the number of averages increases the overall measurement time.

Note
In order to get a good coherence estimate, a minimum of 5 to 10 averages must be made. If only 1 average (the default number) is made, the coherence is always 1 (perfect coherence); in this case, the coherence value is meaningless.

Auto Versus Fixed Integration

Because it is often difficult to select optimum integration time for an entire sweep (integration increases needed at one point may unnecessarily slow the sweep at other points), the HP 3563A offers auto integration. This feature causes the sweep to adjust integration so that variance is maintained below a user-set threshold. When auto integration is on (AUTO INTGRT is active), integration time can vary between a set minimum of about 300 ms to the maximum time you enter with INTGRT TIME. Figure 5-14 shows the operation of auto integration.

Enter the variance threshold with AUTO INTGRT. Auto integration will continue to integrate at each point until that variance is met or the maximum integration time (value of INTGRT TIME) is reached.

Note that if you are moving the marker around on the trace when auto integration is on, the integration routine may take longer than necessary. Also, if auto integration is active and more than one average is selected, the auto integration routine will be performed for each average.

Setting the Integration Time

Integration time is the amount of time that each point is measured. Because the HP 3563A uses Fourier integration to transform time data to the frequency domain, increasing integration time effectively narrows the bandwidth at each measurement point. The result is greater harmonic rejection and improved signal-to-noise ratios.

Integration time and the period of a given measurement frequency determines the number of cycles of the input signal integrated at that point. For example, an integration time of 100 ms at 50 Hz yields 5 cycles (100 ms times 50 Hz). The integration time at each measurement point is rounded to the closest integral number of cycles equal to or greater than one. Due to settling considerations, if the algorithm detects a significant change in variance between points, it discards the last point, then remeasures it.

Start Sweep

Measure Point Using Minimum Integration Time (Approx. 0.3 Sec)

Is Current Integration Time ≤ 3X Minimum Integration Time ?

No

Yes

Calculate Transfer Function Variance At Given Point

Continue Integrating At current Point

Is Variance Below User Value ?

No

Is Integration Time ≥ User Set Value ?

No

Yes

Yes

Accept Data, Move to Next Measurement Point

Sweep Finished ?

No

Yes

End

Figure 5-14. Auto Integration

Using the Automatic Swept Sine Features

This chapter has discussed three of the automatic swept sine features: auto-gain, auto-integration and auto-resolution. In addition, the HP 3563A's input autoranging feature operates differently in the swept sine mode. Furthermore, swept sine mode allows you to auto-align digital data.

Autoranging in the Swept Sine Mode

The following illustration shows how the analyzer autoranges in the swept sine mode. See "Setting the Input Range" in chapter 7 for details about autoranging.

Note

Autorange works only for analog inputs — you cannot autorange an input that is configured for digital data.
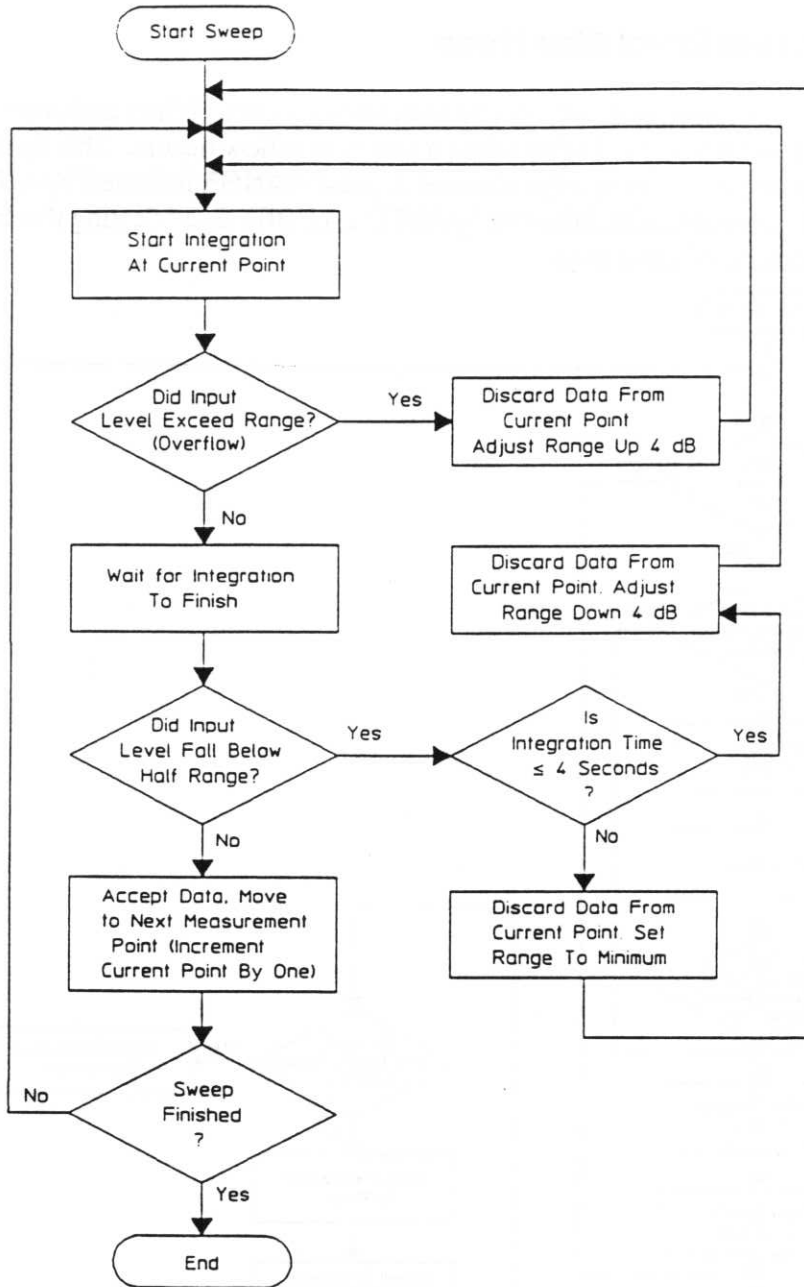
Figure 5-15. Autoranging in the Swept Sine Mode

Auto-alignment in the Swept Sine Mode

For digital data, the swept sine mode allows you to auto-align data. When activated, auto-alignment automatically switches to the upper 13 bits when a digital overflow occurs. This operation is shown in the following illustration. To auto-align channel 1, press **RANGE** followed by AUTO 1 16 BIT; to auto-align channel 2, press **RANGE** followed by AUTO 2 16 BIT. See "Setting the Input Range" in chapter 7 for a description of these keys.
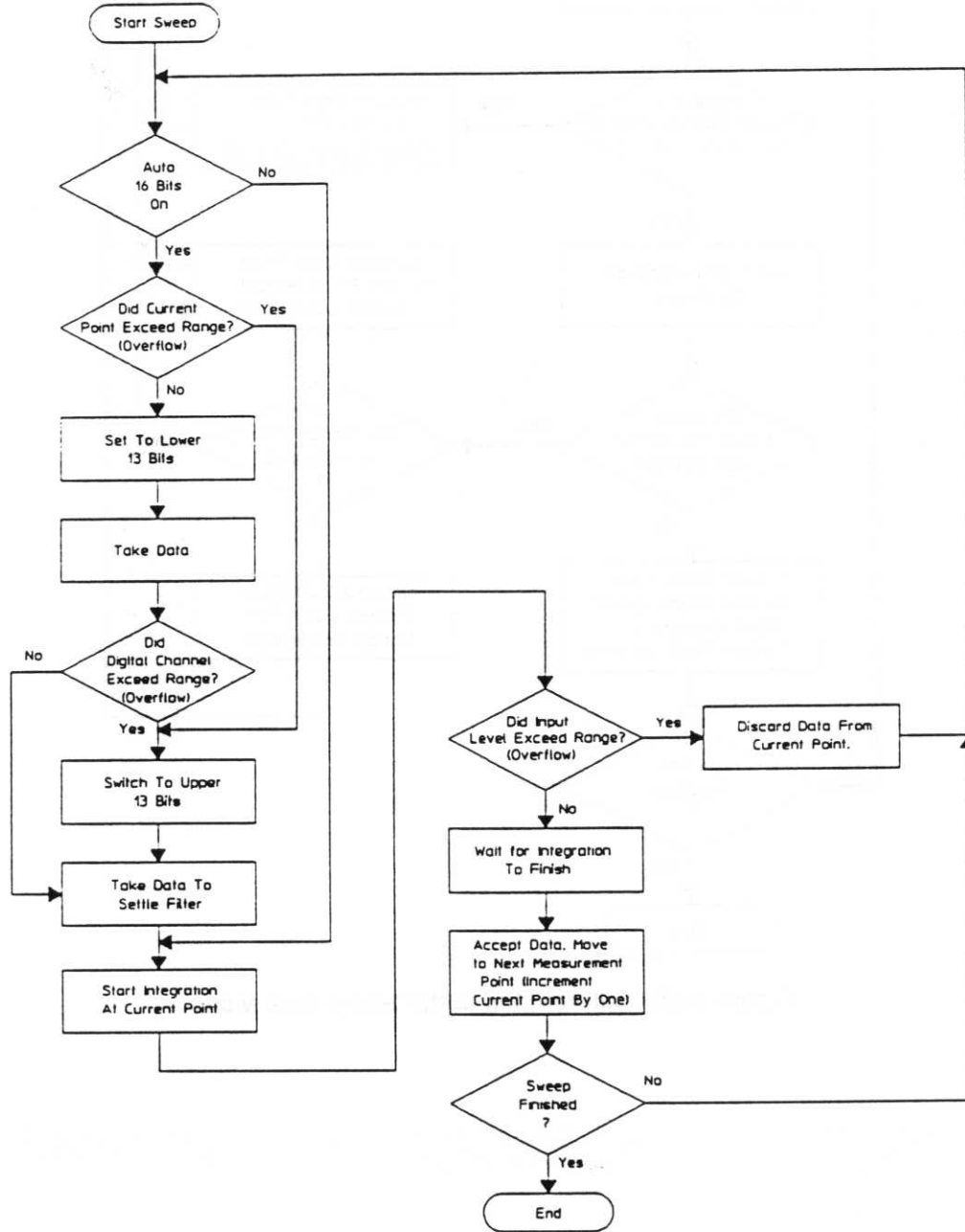
Figure 5-16. Auto-alignment in the Swept Sine Mode

Hierarchy of Operation

These four auto features are arranged in a hierarchy of operation. At each measurement point, the auto features are performed in the order shown in the following table. This assumes, of course, that you have activated all four features. Inactive features are bypassed in the hierarchy.

Analog Channel		Digital Channel	
1.	Autorange	1.	Auto alignment
2.	Integration	2.	Integration
3.	Gain	3.	Gain
4.	Resolution	4.	Resolution

If any of the features cause an adjustment to the instrument, the current measurement point is discarded and the hierarchy starts over. For example, assume the instrument is measuring a given point in the sweep. If the range, integration time and gain are acceptable (do not require adjustment), but the resolution is found to be too coarse, that measurement point is discarded. The resolution is then adjusted, the point is remeasured, and the hierarchy starts over again at autorange. When the measurement passes all four automatic checks, it proceeds to the next point in the sweep.

Using The Time Capture Mode

Purpose Of This Chapter

This chapter contains a detailed description of the time capture mode. The time capture mode lets you capture (store) up to 10 contiguous time records (20,480 samples) and then do measurements on the captured (stored) data that have an effective real time bandwidth of up to 100 kHz. Captured data is stored in the analyzer's internal memory. You can also save captured data to disc (see "Using Capture Blocks as Throughput Files" later in this chapter).

As a reminder, the HP 3563A offers four measurement techniques — called measurement modes. You choose the measurement technique you want by selecting one of the following four measurement modes:

- Linear Resolution Mode (described in chapter 3)
- Log Resolution Mode (described in chapter 4)
- Swept Sine Mode (described in chapter 5)
- Time Capture Mode (described in this chapter)

Each measurement mode configures the HP 3563A differently. See chapter 2, "Measurement Overview" for a summary of all four measurement modes. Chapter 2 also compares the four measurement modes and discusses why you might select one over another.

Note

Some menus differ depending on the measurement mode you are in. This chapter shows you only the menus that appear when time capture mode is selected. Appendix C, "Menu Diagrams," shows you the menus that appear for all measurement modes. You may want to use appendix C as a quick reference since it contains, in one place, all menus for all hardkeys.

Measurement Setup: Time Capture Mode

The steps necessary to set up a measurement in time-capture mode are different than those used for linear resolution or log resolution and swept-sine modes. To perform a time-capture measurement, you first capture the data (to the analyzer's internal memory), then measure the captured data. The remainder of this chapter details the steps necessary to set up a time capture measurement, which are as follows:

Capture the Data

1. Connect the analyzer to your device under test. See chapter 13 for details on digital connections; see chapter 14 for details on planning a digital or mixed (analog and digital) measurement.

2. Preset the analyzer (optional): press **PRESET** (see chapter 12 for a description of the preset options).

3. Select time-capture mode: press **MEAS MODE** followed by TIME CAPTUR.

4. Configure the input: press **INPUT CONFIG**. (See chapter 7 for details).

5. View the input signal (if necessary): press **VIEW INPUT** .

6. Set up the source (if necessary): press **SOURCE**. If necessary, set up source protection in the **SPCL FCTN** menu.

7. Set the input range: press **RANGE**. (See chapter 7, "Input Setup," for details).

8. Select the capture channel: press **SELECT MEAS** followed by CH 1 ACTIVE or CH 2 ACTIVE.

9. Set the capture length: press **MEAS MODE**, CAPTUR SELECT, CAPTUR LENGTH.

10. Set the time length or frequency span: press **FREQ**.

11. Set up triggering: press **SELECT TRIG**. (See chapter 7, "Input Setup," for details).

12. Start the capture: press **MEAS MODE**, CAPTUR SELECT, START CAPTUR.

13. View the captured data: press **VIEW INPUT** (use the capture pointer and TIME BUFFER, TIME RECORD and LINEAR SPEC).

14. View the capture header (if desired): press **MEAS MODE**, CAPTUR SELECT followed by CAPTUR HEADER.

Measure the Captured Data

1. Select a measurement and measurement display. First, press **SELECT MEAS** to select a measurement and activate one channel. Then press **MEAS DISP** to select a measurement display.

2. Select a window: press **WINDOW**.

3. Decrease the frequency span (if necessary): press **FREQ**.

4. Set up averaging: press **AVG**.

5. Set the starting point: press **MEAS MODE** CAPTUR SELECT and use the capture pointer.

6. Start the measurement: press **START**.

Note

When you exit time capture by selecting another measurement mode, the analyzer erases the time capture buffer. Time capture data can be saved in an external disc drive for future analysis.

In addition, changing the analyzer setup during a time capture causes an abort. If a time capture is aborted, a new measurement should be taken or, if the most recent capture data is vital, it may be extracted using the capture pointer.

Curve fit and synthesis cannot be performed in the time capture mode (curve fit and synthesis are described in chapters 16 and 17).

Overview Of Time Capture

Figure 6-1 shows how time capture works in the HP 3563A.

Capturing Data

(This operation initiated by START CAPTUR softkey)

Measuring Captured Data

(This operation initiated by START hardkey)
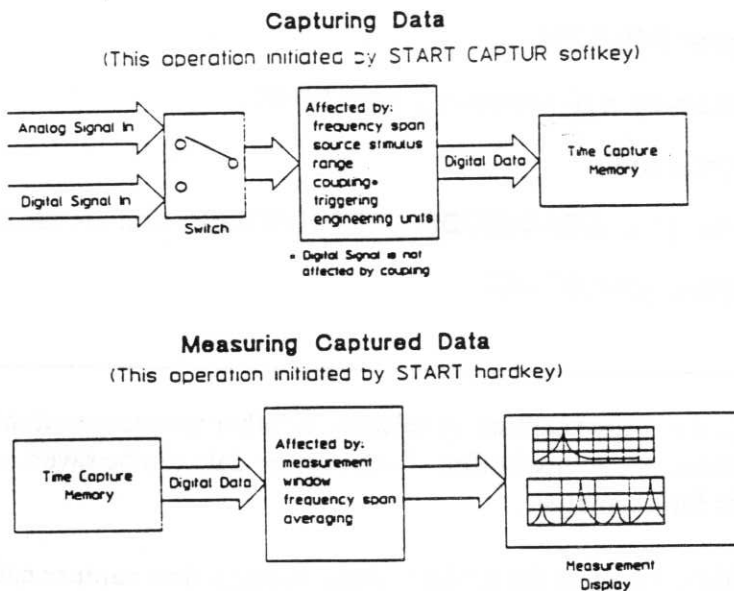
Figure 6-1. Overview of Time Capture

Note	Spectrum traces generated from the same captured data are not identical. To display frequency-domain measurements, the data goes through an FFT (Fast Fourier Transform). The FFT uses dithering, a process which introduces a small amount of randomly generated information to reduce distortion. Because of dithering, no two measurement displays created from captured data appear exactly alike, even if they are derived from the same (stored) data.

Capturing Data

As mentioned previously in "Measurement Setup: Time Capture Mode," a time capture consists of two parts: capturing the data and measuring the captured data. This section tells you how to capture the data. The next section, "Measuring and Analyzing Captured Data," tells you how to measure the captured data.

Setup Step 1: Connect the Analyzer to Your DUT

Determine the best way to connect the analyzer to your device-under-test (DUT). Your DUT may be analog, digital, or mixed (analog and digital). If your DUT is digital or mixed, read chapters 13 and 14 before you continue. Chapter 14 contains information to help you plan a digital or mixed measurement. Chapter 13 shows you how to connect the analyzer to a digital DUT.

Setup Step 2: Preset the Analyzer (Optional)

There are a number of preset options available under the **PRESET** hardkey. You may want to preset the analyzer to a known state before you set up the time capture. See chapter 12 for the preset options available for the time capture mode.

You can also use the **SAVE RECALL** hardkey to preset the analyzer to a known state. Use this hardkey to save your analyzer state to internal, non-volatile memory. You can then recall this state at any time (see chapter 8 for details).

Setup Step 3: Select the Time Capture Mode

To put the HP 3563A in the time capture mode, press **MEAS MODE**. The softkeys that appear under **MEAS MODE** depend on which measurement mode is selected. Press TIME CAPTUR to configure the analyzer to the time capture mode. In this measurement mode, you have access to the softkeys in figure 6-2.

Notice that the CAPTUR SELECT softkey pulls up another menu that allows you to start or abort the time capture or define such things as the capture header. The softkeys under CAPTUR SELECT are described after figure 6-2.

```
                              ┌──────┐
                              │ MEAS │
                              │ MODE │
                              └──────┘

        ┌──────────┐
     ┌──│ L:NEAR   │              ┌──────────┐
     │  │ RES      │         ┌───▶│ START    │
     │  └──────────┘         │    │ CAPTUR   │
     │                       │    └──────────┘
     │  ┌──────────┐         │
     │  │ LOG      │         │    ┌──────────┐
     │  │ RES      │         │    │ ABORT    │
     │  └──────────┘         │    │ CAPTUR   │
     │                       │    └──────────┘
     │  ┌──────────┐         │
     │  │ SWEPT    │         │    ┌──────────┐
     │  │ SINE     │         │    │ CAPTUR?  │
     │  └──────────┘         │    │ POINTR ! │
     │                       │    └──────────┘
     │  ┌──────────┐         │
     │  │ TIME     │         │    ┌──────────┐
     │  │ CAPTUR   │         │    │ POINTR   │
     │  └──────────┘         │    │ INCRMT ! │
     │                       │    └──────────┘
     │  ┌──────────┐         │
     │  │          │         │    ┌──────────┐
     │  └──────────┘         │    │ CAPTUR?  │
     │                       │    │ LENGTH ! │
     │  ┌──────────┐         │    └──────────┘
     └─▶│ CAPTUR   │─────────┘
        │ SELECT   │              ┌──────────┐
        └──────────┘              │ CAPTUR   │
                                  │ HEADER   │
        ┌──────────┐              └──────────┘
        │          │
        └──────────┘

        ┌──────────┐              ┌──────────┐
        │          │              │ RETURN   │
        └──────────┘              └──────────┘
```
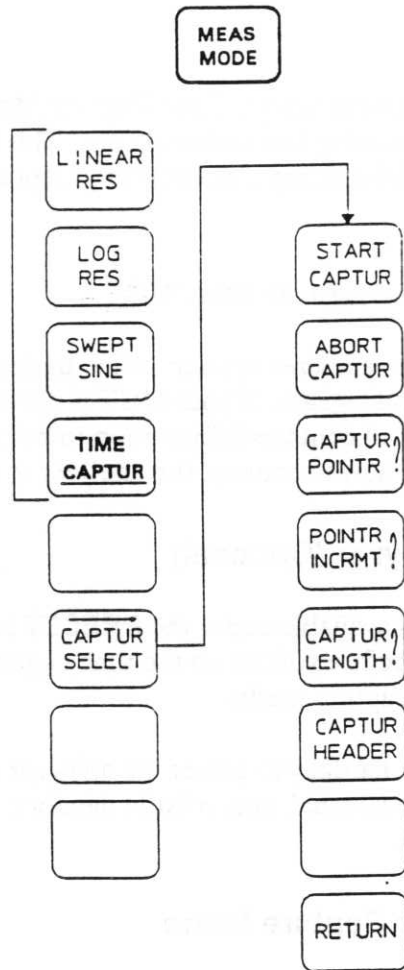
Figure 6-2. MEAS MODE Menu Diagram:
Time Capture Mode

You use the CAPTUR SELECT softkey to control the time capture. The softkeys that appear when you press this key are as follows:

START CAPTUR	Starts the time capture.
ABORT CAPTUR	Aborts time captures in progress. Note that at least one complete record is required for a measurement.
CAPTUR POINTR	Enables the Entry group to move the capture pointer. This is used when measuring and analyzing captured data. The measurement section of this chapter gives instructions for its use.
POINTR INCRMT	Used to enter the knob increment for the capture pointer. This is also covered in the measurement section.
CAPTUR LENGTH	Used to enter the length (up to 10 records) of the capture. See "Setup Step 9: Set the Capture Length."
CAPTUR HEADER	Displays the time capture header, which shows both the current capture setup and a partial instrument state display for the data captured. See figure 6-7, The Time Capture Header, for an example.

Setup Step 4: Configure the Input

After you select the measurement mode, configure the inputs. Analog and digital inputs are configured differently. See chapter 7 for details.

Setup Step 5: View the Input Signal (Optional)

The **VIEW INPUT** hardkey allows you to look at the input signal before it is filtered to a reduced frequency span, triggered, or measured. These *instantaneous* displays can be viewed at any time, even if the measurement is in progress, waiting for a trigger, or completed. Instantaneous displays can be used to verify the presence of input signals or to compare an input signal with a measurement display. Instantaneous displays are also helpful when manually setting the input range. Chapter 2, "Measurement Overview," explains how these displays are derived and how they differ from filtered-input and measurement displays. In time capture mode, **VIEW INPUT** uses the HANN window.

The softkeys that appear when you press **VIEW INPUT** depend on which measurement mode is selected. In the time capture mode, the softkeys in figure 6-3 appear.

Note

VIEW INPUT displays are instantaneous displays of the input signals; the data they show are not necessarily included in a measurement. The window used to compute linear spectra is labeled at the top of the trace. In addition, instantaneous displays always show 801 frequency lines, even when 1024 frequency lines are selected (WINDOW 1024 LINES).

Furthermore, a measurement must be running to see burst source signals or source triggered signals with VIEW INPUT.
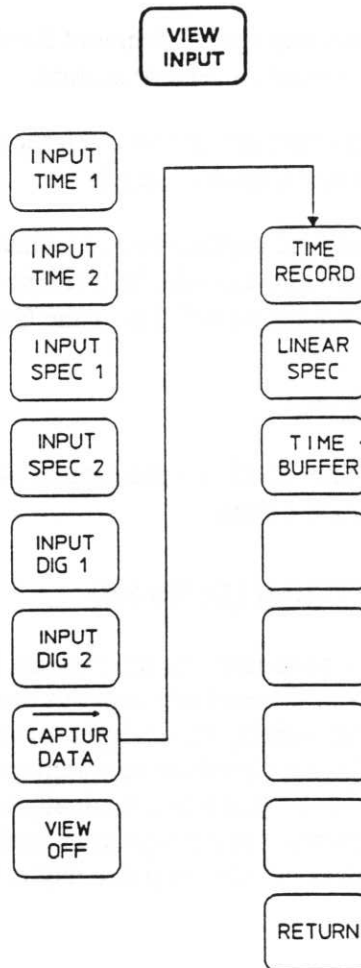
Figure 6-3. VIEW INPUT Menu Diagram:
Time Capture Mode

The softkeys in figure 6-3, except the CAPTUR DATA softkeys, are the same for all four measurement modes (linear resolution, log resolution, swept sine, and time capture). The CAPTUR DATA softkey is used only in time capture mode — it does not appear when one of the other measurement modes is selected. For a description of all other softkeys, see "Viewing the Input Signals" in chapter 3.

The CAPTUR DATA softkey displays the Time Capture Data menu which allows you to control the capture of analog or digital time data. The inputs may be viewed to verify a signal's presence or compare the input signal with the measurement display. The softkeys in this menu do the following:

TIME RECORD	Displays one time record outlined in the time buffer display by the capture pointer. (This softkey is used after the capture and is discussed later in "Setup Step 12: Start the Capture.") The capture pointer and the end of the time record are represented by dashed vertical lines on the time-buffer trace. The length of this record is always one time record (at the capture span). To view this information transformed to the frequency domain, use LINEAR SPEC.
LINEAR SPEC	Displays the linear spectrum of the time record outlined by the capture pointer. (This softkey is used after the capture and is discussed later in "Setup Step 12: Start the Capture.") The linear spectrum display uses the currently-selected window. The capture pointer and the end of the time record is represented by dashed vertical lines on the time-buffer trace. The phase data of record one is the only record referenced to the trigger. The frequency span of the spectrum equals the span at which the capture was made. To view this information in the time domain, use TIME RECORD.
TIME BUFFER	Displays the entire captured time data-block. The length of the block equals the length of the captured data. (This softkey is used after the capture and is discussed later in "Setup Step 12: Start the Capture.")

Setup Step 6: Set up the Source (Optional)

The HP 3563A offers a number of analog or digital source outputs in the time capture mode, including step, pulse, and ramp. To set up the source, press **SOURCE**. The softkeys that appear depend on SOURCE AN DIG. If SOURCE AN DIG is toggled to **AN** (analog output) you see one menu; if it is toggled to **DIG** (digital output), you see another (see figure 6-4).

The **SOURCE** menu shown in figure 6-4 is identical for the time capture and linear resolution modes. The source operates identically in both measurement modes. Therefore, see "Setting up The Source: Linear Resolution Mode" in chapter 3 for details.

**Figure 6-4. SOURCE Menu Diagram:
Time Capture Mode**

Setup Step 7: Set the Input Range

The input range is set with the **RANGE** hardkey. You can manually set the range (best choice for time capture of one-shot events) or have the analyzer automatically select the best range (best choice for time capture of repetitive signals; use AUTO RNG UP). The range options available differ for analog and digital inputs. See chapter 7, "Input Setup," for details.

Setup Step 8: Select the Capture Channel

Either channel can be selected as the capture channel; make the selection with the CH 1 ACTIVE or CH 2 ACTIVE softkey in the **SELECT MEAS** menu.

Setup Step 9: Set the Capture Length

The capture can be up to ten records (20,480 samples) long; the length can be set as time or as a number of points, records, or revolutions. If a value greater than the length of ten records is entered, the analyzer uses the length of ten records. The capture header (see Step 14) shows the time length that was entered in the lower "Setup" section and the length that was actually used in the upper section.

For example, if the frequency span is 100 kHz, the record length is 8 ms (800 ÷ 100 kHz). The length of ten of these records is 80 ms. If a capture length of 90 ms is entered, 80 ms is used; 90 ms is displayed as the capture length in the header "Setup" section. The current record length can be found in the instrument state display or in the capture header under FREQ: REC LGTH.

Setup Step 10: Set the Frequency Span

The frequency span is set before the data block is captured. If you use a baseband frequency span (one that starts at 0 Hz) to capture the data block, you can decrease the frequency span when the data block is retrieved from memory and measured (see "Measurement Step 3: Decrease the Frequency Span (Optional)" for details). If a zoom span (non-zero start frequency) is used, frequency domain measurements can only be performed at the selected frequency span and center frequency.

Setup Step 11: Set up Triggering

Prior to starting the capture, you must set up triggering (using the **SELECT TRIG** hardkey). Pre- or post-trigger delay in time capture mode defines the start of the entire time capture, not of each record. For the time capture mode only, pre-triggering can extend up to 20,479 points (10 records minus one point). The post-trigger limit is fifty records. See chapter 7 for further details.

Setup Step 12: Start the Capture

When the capture is set up and the input signal is ready, press START CAPTUR (see figure 6-2). The entire data block is displayed when the capture is completed; an example is shown in figure 6-5. At frequency spans less than or equal to 2 kHz, the instrument displays the incoming data while the capture is in progress.

Location of Capture Pointer,
Outlining First Time Record

20480 Points (2048 points/record times 10 records) Downsampled to 1601 Points on Display: All data still exist internally

In this Case Record Length was 80 ms; Capture Length 10 Records

X=214.02mSec
Yo=150.116mV
CAP TIM BUF
160 m

40.0 m /Div

Real

V

-160 m

0.0   Sec   800m
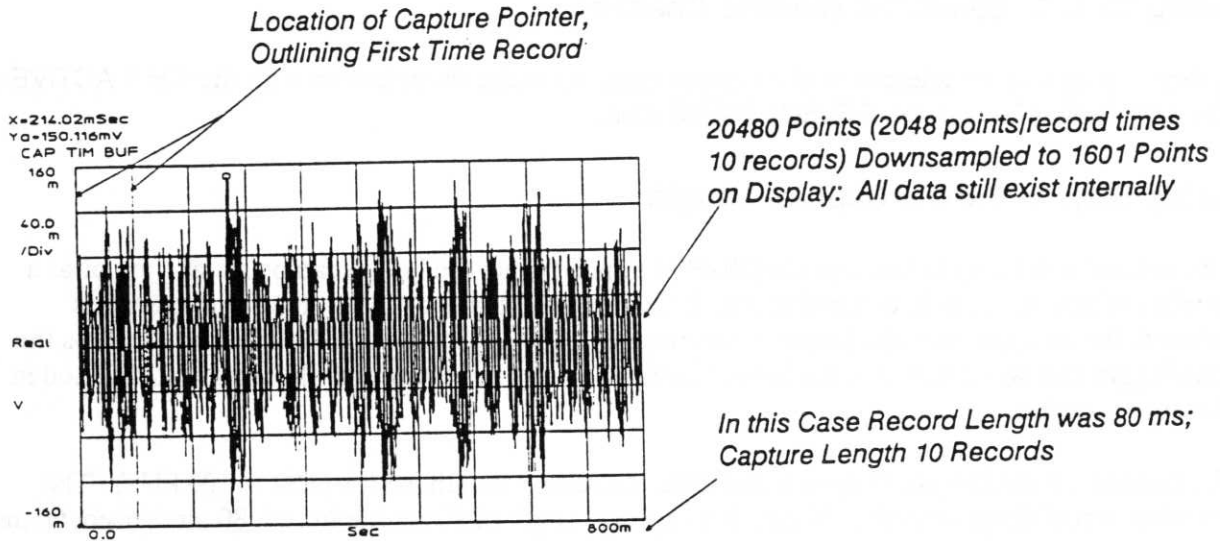
**Figure 6-5. The Time-Capture
Instantaneous Display**

When the capture is finished, the screen shows the entire capture block compressed to one display. The analyzer compresses the display by selecting the points containing the most information. This is the "time buffer" display, and it also can be displayed by pressing TIME BUFFER in the **VIEW INPUT** menu.

Setup Step 13: View the Captured Data

The capture pointer allows you to view data in the capture block after the capture is completed. The pointer outlines one time record in the time buffer display (the display that appears when the capture is finished). The record it outlines can be viewed in the time domain using TIME RECORD and in the frequency domain using LINEAR SPEC. These two softkeys and the TIME BUFFER softkey are in the **VIEW INPUT** menu. Figure 6-6 shows the linear-spectrum instantaneous display of the fourth time record of the TIME BUFFER display in figure 6-5.

Location of Capture Pointer Indicated by Pair of Asterisks and Pair of Dotted Vertical Lines

Uses Currently-Selected Window

Trace B Linear Spectrum of the Time Record Outlined by the Pointers in Trace A
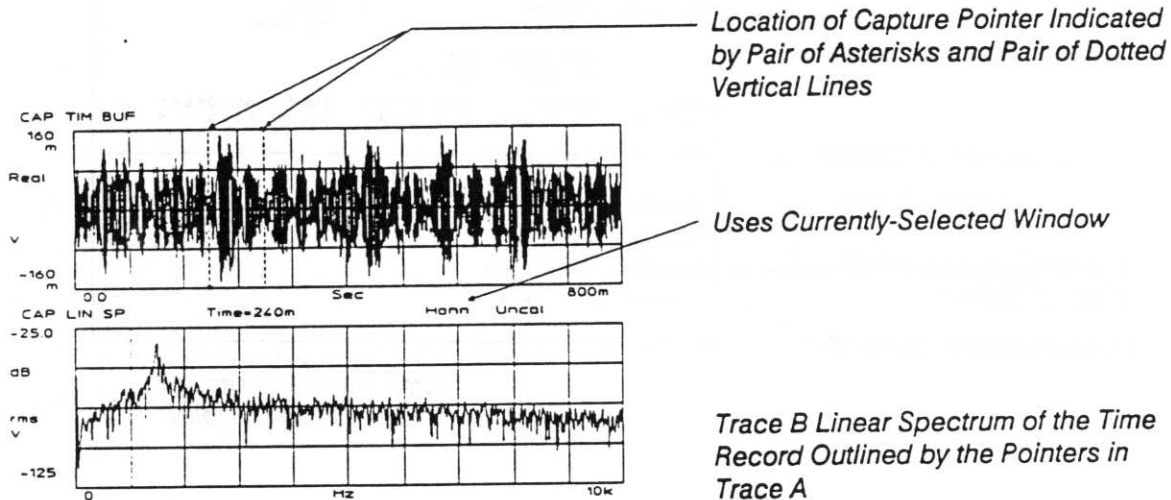
**Figure 6-6. The Linear-Spectrum
Instantaneous Display**

The linear spectrum of the fourth record is displayed by moving the capture pointer to the fourth record in time buffer. Access the capture select menu by pressing **MEAS MODE**, TIME CAPTUR, then CAPTUR SELECT, POINTR INCRMT allows you to set the increment in which the pointer moves through the time buffer. Enter the increment, then press CAPTUR POINTR to allow the Entry group to move the pointer. To move the pointer, rotate the knob, press the up/down arrows, or enter an value using the **0 - 9** keys. The time you enter is the beginning of the time record (i.e., the left side of the capture pointer band). Note that you cannot move the pointer closer than one record to the end of the time buffer.

Setup Step 14: View the Capture Header

The time capture header shows the setup information for the current capture block. To display the header, press CAPTUR HEADER. As shown in figure 6-7, the top of the header displays a subset of the instrument's setup state. The bottom, labeled "Setup," shows the current capture setup.

Total Number of points in
Capture (in this case, 2048
points times 10 records)

Indicate 10-record Capture

Length of Capture

Capture Channel

Current Location of Left
Side of Pointer

Value of POINTR INCRMT

```
            Time  Capture  Header

LENGTH:    800mS      (20480 Pnts)

FREQ:      CENTER              SPAN
           5 kHz               10.0kHz

           REC LGTH   Δt
           80.0mS     39.1μS

INPUT:     RANGE      ENG UNITS    COUPLING DELAY
   CH 1    3.17 Vpk   1.0 V/EU     DC (Flt) 0.0 S

                    Setup

LENGTH:    10.0 Recs

INPUT:     Chan 1

POINTER:   6144 Pnts

INCRMNT:   1.0 Recs
```

Same Information as Input
Section of State Display

Figure 6-7. The Time Capture Header

Measuring and Analyzing Captured Data

As mentioned previously in "Measurement Setup: Time Capture Mode," a time capture consists of two parts: capturing the data and measuring the captured data. This section tells you how to measure the captured data. The previous section, "Capturing Data," explained how to capture the data.

Once a data block has been captured, it can be measured and analyzed in the same manner as a "live" signal. The HP 3563A offers the power spectrum, auto correlation and histogram measurements in the time capture mode. To analyze measured data using the display and marker features, refer to chapter 8, Display Configuration.

Measurement Step 1: Select the Measurement and Display

The time capture mode offers several measurements and displays. This section describes the measurements and displays available for the time capture mode.

Selecting a Measurement

The types of measurements that you can perform differ depending on which measurement mode is selected. To select measurements in any measurement mode, press **SELECT MEAS**. In time capture mode, the menu in figure 6-8 appears. You selected the active channel earlier in "Setup Step 8: Select the Capture Channel". Keep in mind that for averaged measurements the measurement and the active channel must be selected before the measurement is started. If you want to change either selection, you must make a new measurement.

Figure 6-8. SELECT MEAS Menu Diagram:
Time Capture Mode

The softkeys in the **SELECT MEAS** menu do the following:

POWER SPEC   Selects the power spectrum measurement.

AUTO CORR   Selects the auto correlation measurement.

HIST   Selects the histogram measurement.

CH 1 ACTIVE   Activates Channel 1.

CH 2 ACTIVE   Activates Channel 2.

Selecting a Display

There are several ways to display captured data. You can choose instantaneous displays (press **VIEW INPUT** followed by CAPTUR DATA), filtered-input displays (press **MEAS DISP** followed by FILTRD INPUT), or measurement displays (press **MEAS DISP**). Instantaneous displays under the CAPTUR DATA softkey let you see data as it was captured. Filtered-input displays allow you to see measurement data after it has been triggered and filtered to the current frequency span. Measurement displays allow you to see measurement data after it has gone through the entire measurement process. Figure 2-3, "Measurement Process Diagram," in chapter 2 shows you how instantaneous, filtered-input, and measurement displays are derived. Chapter 2 also contains an introduction to these displays and shows which ones are available in each measurement mode. All displays — instantaneous, filtered-input, and measurement displays — can be selected before, during or after the measurement.

Since measurement displays are derived from calculations on the collected data, a number of different measurement displays are possible from one measurement. Consequently, the measurement that you select determines the measurement displays available to you. Therefore, first select the measurement (**SELECT MEAS**), then select a measurement display (**MEAS DISP**). Figure 6-9 shows you the menu diagram for the MEAS DISP hardkey when the analyzer is in the time capture mode.

Note	See "View the Input Signals" earlier in this chapter for details about the instantaneous displays available in the time capture mode. See the following sections for details about the filtered-input displays, measurements and measurement displays available in the time capture mode.
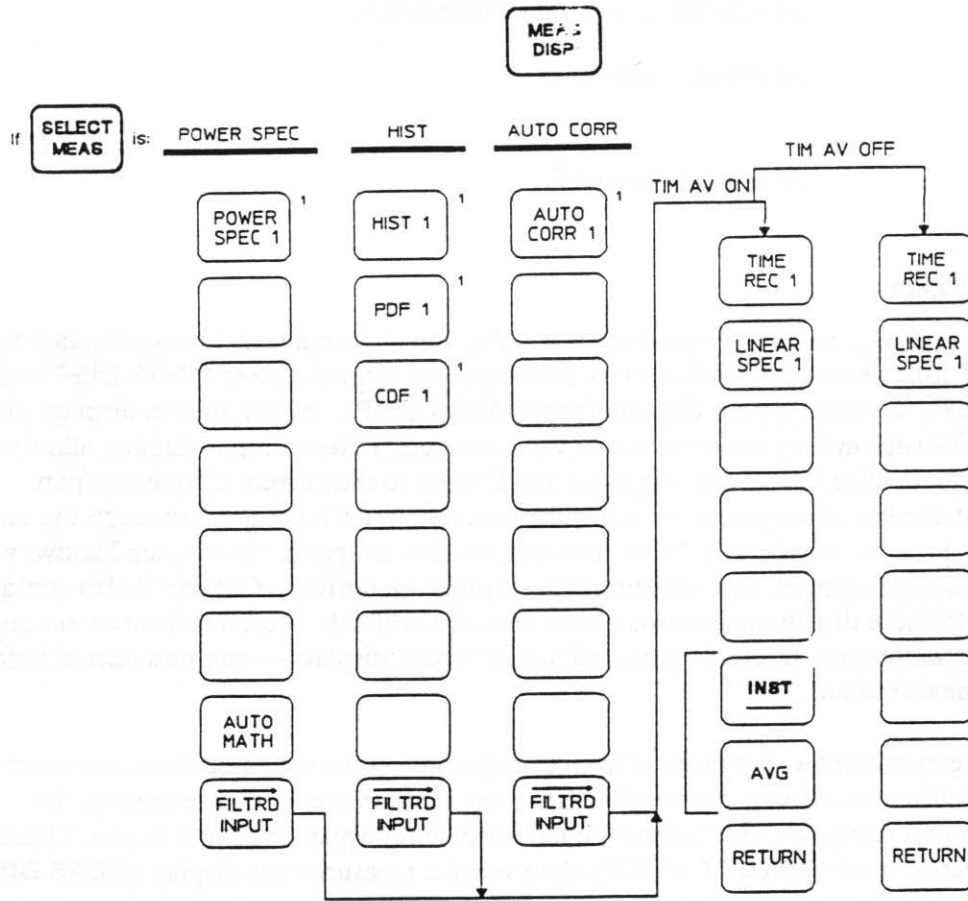
¹If Channel 1 is active, this key selects a measurement display for Channel 1.
If Channel 2 is active, it selects a measurement display for Channel 2.

Figure 6-9. MEAS DISP Menu Diagram:
Time Capture Mode

Filtered-Input Displays

Chapter 2, "Measurement Overview," explains how filtered-input displays are derived and how they differ from measurement displays and instantaneous displays. This chapter describes each filtered-input display and shows you how they are selected.

To select a filtered-input display, press **MEAS DISP** followed by FILTRD INPUT. Notice that a number of filtered-input displays are available (as shown in figure 6-9), which do the following:

TIME REC 1	Displays the Channel 1 time record. (This softkey appears only when Channel 1 is active.)
TIME REC 2	Displays the Channel 2 time record. (This softkey appears only when Channel 2 is active.)
LINEAR SPEC 1	Displays the linear spectrum on the signal on Channel 1; this is the FFT of the time record. (This softkey appears only when Channel 1 is active.)
LINEAR SPEC 2	Displays the linear spectrum of the signal on Channel 2; this is the FFT of the time record. (This softkey appears only when Channel 2 is active.)
INST	Selects only the most recent time record for the filtered input displays. (This softkey does not appear if time averaging is turned off; see "Measurement Step 5: Set up Averaging."
AVRG	Selects the cumulative average of all time records acquired with the current measurement for the filtered input displays. (This softkey does not appear if time averaging is turned off; see "Measurement Step 4: Set up Averaging.")

For further details and examples of each display, see "Filtered-Input Displays" in chapter 3.

Measurement Displays for the Power-Spectrum Measurement

The power spectrum measurement shows the input signal in the frequency domain. It is computed by multiplying the FFT of the signal by its complex conjugate:

$$G_{xx} = F_x F_x*$$

where:
   F_x is the linear spectrum
   F_x* is its complex conjugate

The power spectrum provides no phase information. To select the power spectrum measurement, press **SELECT MEAS**, followed by the POWER SPEC softkey (see figure 6-8).

To select a measurement display for the power spectrum measurement, press **MEAS DISP** (see figure 6-9). Notice that a number of different measurement displays are available for this measurement, such as:

POWER SPEC1	Displays the power spectrum measured on Channel 1. This softkey appears if Channel 1 is active.
POWER SPEC2	Displays the power spectrum measured on Channel 2. This softkey appears if Channel 2 is active.
FILTRD INPUT	Displays the filtered input menu, which provides time record and linear spectrum displays; see "Filtered-Input Displays" later in this chapter.

For an example of the power spectrum measurement, see "The Power Spectrum Measurement" in chapter 3.

Measurement Displays for the Auto-Correlation Measurement

The auto correlation measurement indicates periodicity in time domain signals. It multiplies the signal by a progressively time-shifted version of itself; this emphasizes periodic parts of the signal and de-emphasizes non-periodic parts. In the HP 3563A it is computed using the inverse FFT of the power spectrum:

$$R_x(t) = FFT^{-1}[Gxx]$$

where:
  Gxx is the power spectrum

To avoid wrap-around error, both correlation measurements discard the last half of the time record. The correlation measurement display is therefore half the length of the time record. If some signal of interest
is present in the last half of the record, use delayed triggering to move the deleted portion of the record.

Some uses of auto correlation are detecting periodicity and measuring impulsive signals, such as gear chatter. Auto correlation is especially useful for extracting a periodic signal buried in noise when a synchronized trigger is not available. To select this measurement, press **SELECT MEAS**, followed by the AUTO CORR softkey (see figure 6-8).

To select a measurement display for the auto correlation measurement, press **MEAS DISP** (see figure 6-9). Notice that a number of different measurement displays are available for this measurement, such as:

AUTO CORR1	Displays the auto correlation of the signal on Channel 1. This softkey appears only if Channel 1 is active.
AUTO CORR2	Displays the auto correlation of the signal on Channel 2. This softkey appears only if Channel 2 is active.
FILTRD INPUT	Displays the filtered input menu, which provides time record and linear spectrum displays; see "Filtered-Input Displays" earlier in this section.

For an example, see "The Auto Correlation Measurement" in chapter 3.

Measurement Displays for the Histogram Measurement

The histogram measurement shows how the amplitude of the input signal is distributed between its maximum and minimum values. Some of its uses are determining the statistical properties of noise (such as monitoring the performance of electromechanical positioning systems). Note that the number of averages for a histogram determines how many records are measured; the records are not "averaged." If exponential averaging is selected, the measurement continues until the end of the capture data is reached. Keep in mind that the accuracy of the histogram is dependent on frequency span, record length and number of averages. To select this measurement, press **SELECT MEAS**, followed by the HIST softkey (see figure 6-8).

To select a measurement display for the histogram measurement, press **MEAS DISP** (see figure 6-9). Notice that a number of different measurement displays are available for this measurement, such as:

HIST 1	Displays the histogram of the signal on Channel 1. This softkey appears only if Channel 1 is active.
HIST 2	Displays the histogram of the signal on Channel 2. This softkey appears only if Channel 2 is active.
PDF 1	Displays the probability density function of the signal on Channel 1. This softkey appears only if Channel 1 is active.
PDF 2	Displays the probability density function of the signal on Channel 2. This softkey appears only if Channel 2 is active.
CDF 1	Displays the cumulative density function of the signal on Channel 1. This softkey appears only if Channel 1 is active.
CDF 2	Displays the cumulative density function of the signal on Channel 2. This softkey appears only if Channel 2 is active.
FILTRD INPUT	Displays the filtered input menu, which provides the time record and linear spectrum displays; see "Filtered-Input Displays" earlier in this section.

Note

The softkeys that actually appear when you press **MEAS DISP** depend on the active channel selection. For example, if only Channel 1 is active, HIST 2, PDF 2 and CDF 2 do not appear. Furthermore, although the **WINDOW** hardkey remains active, windows have no affect on histograms.

For examples of these displays, refer to "The Histogram Measurement" in chapter 3.

Measurement Step 2: Select the Window

Windows are time domain functions that reduce the effects of leakage, the smearing of energy across the frequency spectrum. Leakage is caused by signals that are not periodic in the time domain; the FFT assumes all inputs are periodic. For more details about leakage and windowing, see Hewlett-Packard Application Note 243.

The HP 3563A offers six windows: Hanning, flat top, uniform, force, exponential, and user-defined. To select a window, press **WINDOW**. Also under the **WINDOW** hardkey are these two softkeys: LINES 801 and LINES 1024. These softkeys allow you to take a measurement with 801 or 1024 frequency lines, respectively (see "Selecting a Window" in chapter 3 for details).

Note   Windows are available only in linear resolution and time capture modes. For
                  window descriptions and examples, see "Selecting a Window" in chapter 3.

Measurement Step 3: Decrease the Frequency Span (Optional)

When measuring captured data, you can use a frequency span equal to or less than the one you used when you captured the data. You can only use a smaller frequency span if you captured baseband data (the captured data's start frequency is 0 Hz). For example, you can capture at 50 kHz then measure later at 10 kHz. If you zoomed during the capture (non-zero start frequency) you must measure the captured data at the same span as the capture. The analyzer automatically changes the span back to the capture span in these cases, if necessary.

If you measure at a different span than the capture, the HP 3563A's digital filter needs time to resettle to the new span. Because of this, some data distortion can occur in the first record of the measurement (the data in the time buffer are not affected). If this presents a problem, set the capture pointer to some point other than the beginning of the time buffer. "Measurement Step 5: Set the Starting Point" gives further instructions.

The amount of zooming you can perform on the time buffer depends on the number of records you want to average. Remember that as you zoom, the span decreases and the record length increases. Here is an example:

-   You captured 10 records at a 100 kHz span, giving you 80 ms of time data.

-   If you then want to zoom at a 50 kHz span, you will need 16 ms of data for each zoom record (800/50 kHz). Therefore, you could zoom at a 50 kHz span with 5 averages (80 ms total data length divided by 16 ms per record). Overlap processing can be used to increase the number of averages in a measurement; see "Averaging in the Linear Resolution Mode" in chapter 3 for details.

Note

As mentioned, if your captured data is zoomed (the start frequency is not 0 Hz), you must use the same frequency span that you used when you captured the data. If your captured data is baseband (the start frequency is 0 Hz), you can use a frequency span equal to or less than that used when you captured the data. "Frequency Spans in the Linear Resolution Mode" in chapter 3 lists the frequency spans that you can use.

In addition, the frequency spans that you can use are dependent on the sample frequency. For example, changing the sample frequency changes the frequency span. See "Determining Valid Frequency Spans" in chapter 3 for details on how the sample frequency affects the frequency span.

Measurement Step 4: Set up Averaging

Averaging in the time capture mode is identical to averaging in the linear resolution mode, with these exceptions:

- In the time capture mode, overlap processing on unaveraged measurements is different. If AVG OFF is active, there is no overlap processing, regardless of the value of OVRLP%. (In the linear resolution mode, AVG OFF causes maximum overlap.)

- In the time capture mode, selecting the number of averages can also be used to exclude data in the end of the capture buffer. For example, if you want to measure only the first five records in a ten-record buffer, select five averages before starting the measurement. This can be combined with the capture pointer to exclude records from both the beginning and the end of the buffer.

- Several averaging features offered in linear resolution mode are not available in time capture mode (overload rejection, fast averaging and previewing).

To select averaging, press the **AVG** hardkey, which allows you to access the softkeys in figure 6-10. For a description of these softkeys, see "Averaging in the Linear Resolution Mode" in chapter 3.
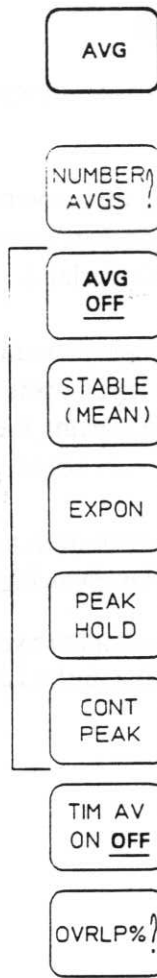
Figure 6-10. AVG Menu Diagram:
Time Capture Mode

Measurement Step 5: Set the Starting Point

After viewing the captured data with the TIME BUFFER display, you may decide that some of the data should be excluded from the measurement. Time capture measurements can be started at any point in the captured data block (from the first point in the block to the first point in the last record, inclusive). The starting point is specified by the current capture pointer position. If the pointer is not active, the measurement starts at the beginning of the first record.

If you are measuring at a different span than the capture, the digital filter's settling time requirements can introduce distortion in the first 1/10 record of the measurement. This affects only measurements that are measured at a different span than the capture. If this presents a problem, set the starting point of the measurement past the first 1/10 of the output record. For example, you could press CAPTUR POINTR, then enter a value equal to 0.1 times the zoom factor, then use the Record softkey.

Measurement Step 6: Start the Measurement

When the HP 3563A is in the time capture mode, pressing **START** causes the analyzer to measure from data stored in the time capture memory. All the measurement input data come from the capture buffer, not from the input channels. Figure 6-1 at the beginning of this chapter summarizes this action. Because individual records are not triggered, phase displays for time capture measurements are not accurate.

Using Capture Blocks As Throughput Files

Captured data blocks can be used as input to a throughput measurement, if they are saved to disc.
To do this, first display the capture block using TIME BUFFER in the **VIEW INPUT** menu. Next,
save this display to disc using SAVE FILE in the **DISC** menu. "Using Capture Blocks as Throughput
Files," the corresponding section in chapter 9, explains how to identify the saved capture data as the
active file for throughput. For more information on using throughput, refer to chapter 9. For more
information on saving and recalling disc files, see chapter 11.

Note

If you capture digital data with the HP 3563A, then store it to disc and analyze it
with the HP 3562A, the HP 3562A scales the amplitude according to the following
ratio:

$(32768/26028.55) = 1.258925$

Scaling is done when the HP 3562A reads the capture file. Thus, the data in the
capture file is not altered.

Input Setup

Purpose Of This Chapter

The purpose of this chapter is to show you how to set up the HP 3563A's inputs, using the six hardkeys in the Input Setup group.

Note   See chapter 13 for details on digital connections and for a description of all digital connectors.

The remainder of this chapter shows you how to:

1. Configure the inputs

2. Set the input range

3. Set up triggering (includes delayed triggering)

4. Calibrate the input channels

5. Use engineering units

Data Path Into the Analyzer

Both input channels in the HP 3563A accept analog or parallel digital data. Use the Channel 1 and Channel 2 BNC connectors on the front panel for analog input data. Use cables and pods attached to the rear panel connectors for digital input data (see figure 7-1).

Figure 7-2 shows the input data path options for both channels. The data path is set with the **INPUT CONFIG** hardkey. Notice in figure 7-2 that one of two menus appears when you press **INPUT CONFIG**. The menu that you see depends on the CHAN AN DIG softkey (one for each channel). If CHAN AN DIG is toggled such that **AN** is highlighted, the menu shows the input configuration options for an analog channel. If CHAN AN DIG is toggled such that **DIG** is highlighted, the menu shows the input configuration options for a digital channel.

As shown in figure 7-2, Channel 1 may receive analog data from the Channel 1 BNC-connector or digital data from Pod 1 or the analyzer's digital source (the connection to the digital source occurs internally). Channel 2 may receive analog data from the Channel 2 BNC-connector or digital data from Pod 1 or Pod 2.

Note that both channels may receive digital data from Pod 1. This selection allows you to use Pod 1 to do a two-channel measurement (such as a frequency response measurement). In this case, you must use qualifiers to associate data with the correct channel. See "Step 5. Set Up the Data Clock and Clock Qualifiers" later in this chapter for details.
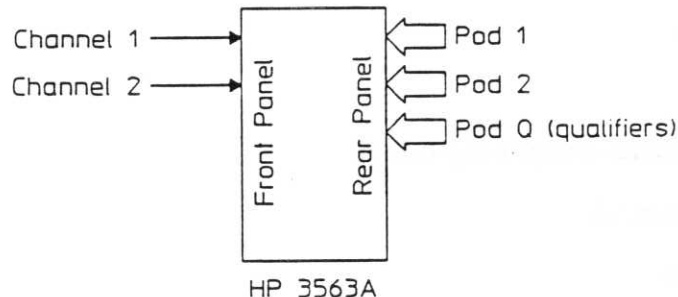
Figure 7-1. Input Connections
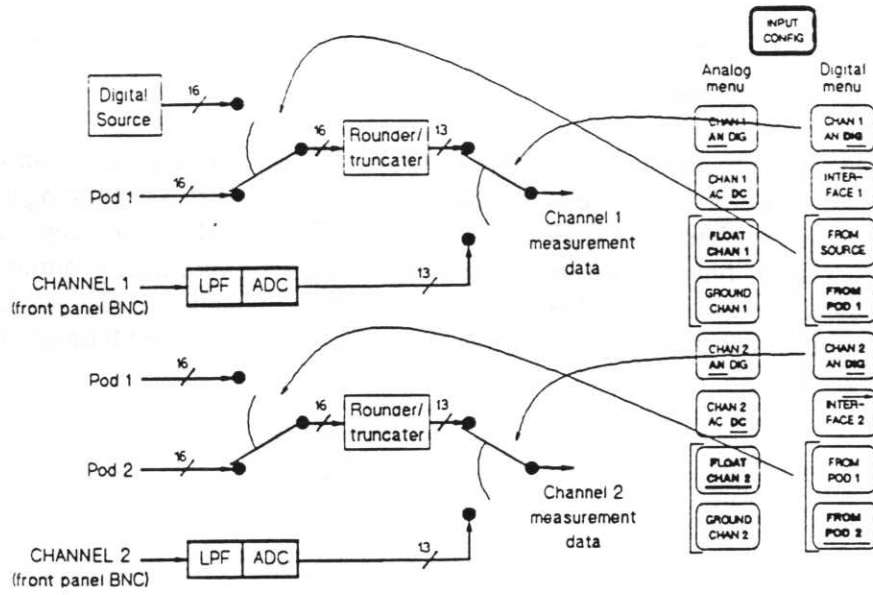
Figure 7-2. Data Paths

Configuring The Inputs

You configure both input channels with the **INPUT CONFIG** hardkey. Figure 7-3 shows the softkeys available when you press this key. Notice that the softkeys differ for analog and digital input channels. If an input channel is analog (the channel's CHAN AN DIG softkey is toggled to AN), you need to configure only two things: ac or dc coupling and floating or grounded inputs. If an input channel is digital (the channel's CHAN AN DIG softkey is toggled to **DIG**), you need to configure several things, such as number format (twos complement or offset binary), data size, data clock, and sample clock.

1 Blank for [INTERFACE 1] if Chan 1 is [FROM SOURCE]
2 If Chan 1 is [FROM SOURCE] then sample clock is [CHAN 2 CLOCK] (no option)
3 Reads [CHAN 2 CLOCK] if [CHAN 2 AN DIG] is selected
4 Blank except when [=BITS 8 16] and [BUS SZ 8 16] is selected
5 Blank if [=BITS 8 16] is selected
6 Blank if [EXT SAMPLE], [CHAN 1 CLOCK], or [CHAN 2 CLOCK] is selected
7 Reads [CHAN 2 CONFIG] for [INTERFACE 2]
8 Blank if chan 1 is [FROM SOURCE] and [CHAN 2 AN DIG] is selected
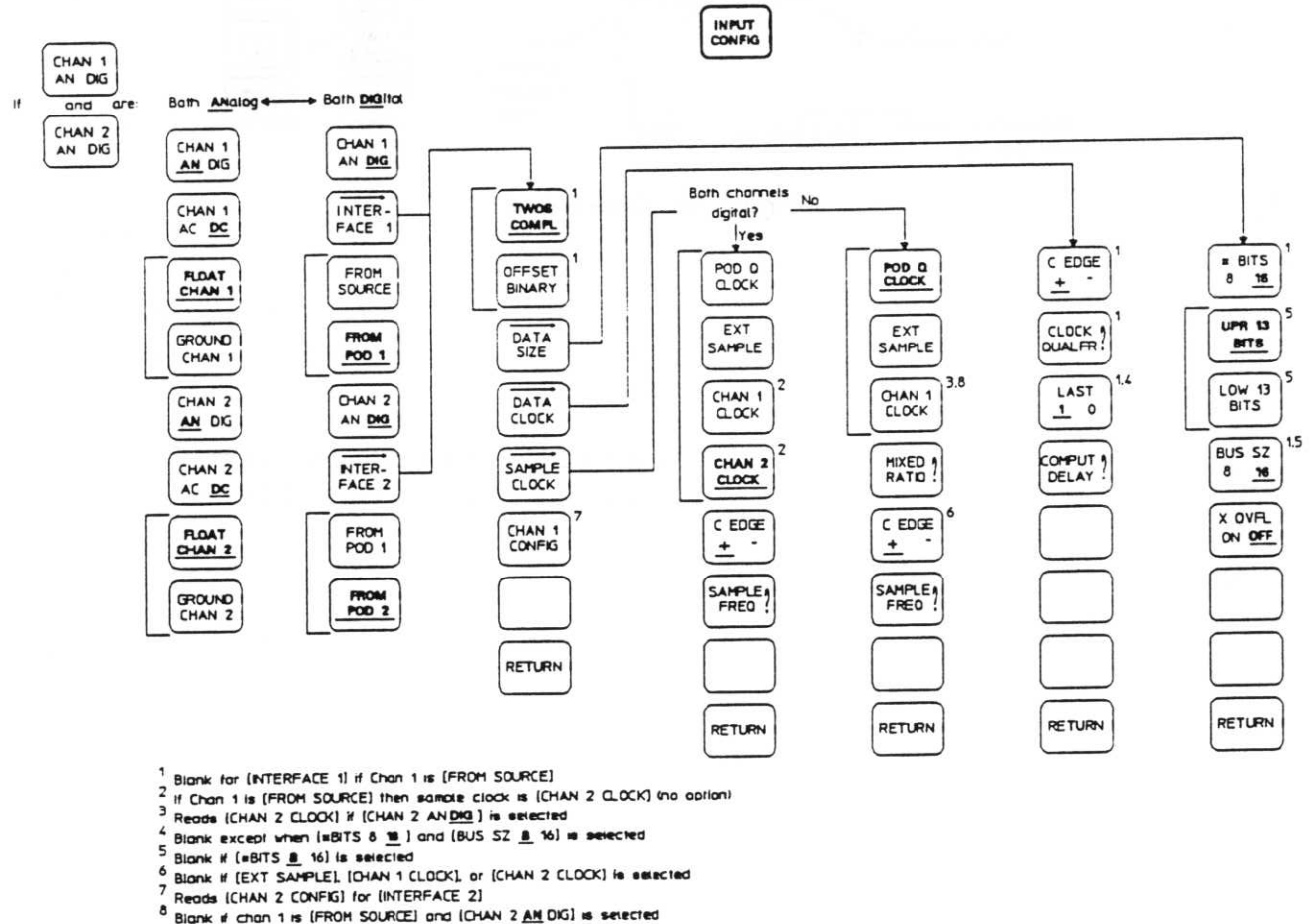
Figure 7-3. INPUT CONFIG Menu Diagram

Configuring an Input Channel for Analog Data

Warning	To assure operator protection, do not exceed ± 42 Vpeak relative to ground or 42 Vpeak between the Channel 1 and 2 BNC connectors.

Caution	When measuring from a low impedance source, do not ground Channel 1 or 2 (by pressing **INPUT CONFIG** GROUND CHAN 1 or GROUND CHAN 2). This could result in damage to the device under test because grounding a channel connects it through 200Ω to chassis ground.

Note	Grounding determines how the Channel 1 or 2 BNC shell is connected to the HP 3563A's internal circuits. The Channel 1 and 2 BNCs are differential and normally float with respect to ground. However, you have the option of floating or grounding the BNCs independently. Grounding connects the BNC's ground reference (the outside shell of the BNC connector) through 200Ω to chassis ground.

To configure an input channel for analog data, press **INPUT CONFIG** and toggle the channel's CHAN AN DIG softkey so that **AN** is highlighted. For analog input channels, you need to select coupling (ac or dc) and grounding (floating or grounded). DC coupling connects the input signal directly to the HP 3563A's input circuits. AC coupling inserts a series capacitor to remove dc signals and drifts associated with dc from the input signals. The 3 dB cutoff frequency for ac coupling is less than 1 Hz.

Softkey Descriptions

Figure 7-3 shows the softkeys for configuring an input channel for analog data. The following paragraphs describe the softkeys in the order that they appear.

CHAN 1
AN DIG

Selects analog (default) or digital data for Channel 1. The other softkeys that you see for Channel 1 depend on the selection of this softkey (see figure 7-3).

CHAN 1
AC DC

Selects ac or dc coupling for Channel 1. The default is dc coupling.

FLOAT
CHAN 1

This softkey and GROUND CHAN 1 determine the internal connection of the Channel 1 BNC shell. This softkey floats (the default) the BNC shell; GROUND CHAN 1 grounds the BNC shell through 200 Ω to chassis ground.

GROUND
CHAN 1

See FLOAT CHAN 1.

CHAN 2
AN DIG

Selects analog (default) or digital data for Channel 2. The other softkeys that you see for Channel 2 depend on the selection of this softkey (see figure 7-3).

CHAN 2
AC DC

Selects ac or dc coupling for Channel 2. The default is dc coupling.

FLOAT
CHAN 2

This softkey and GROUND CHAN 2 determine the internal connection of the Channel 2 BNC shell. This softkey (the default) floats the BNC shell; GROUND CHAN 2 grounds the BNC shell through 200 Ω to chassis ground.

GROUND
CHAN 2

See FLOAT CHAN 2.

Configuring an Input Channel for Digital Data

To configure an input channel for digital data, press **INPUT CONFIG** and toggle the channel's CHAN AN DIG softkey so that **DIG** is highlighted. Several softkeys appear (as shown in figure 7-3) that allow you to set parameters for a digital input channel. You may have already set some of these parameters if you connected the digital pods as described in chapter 13.

Figure 7-4 is a block diagram that shows how the analyzer collects digital and analog data for both input channels. It also shows most of the softkeys used to configure an input channel. The softkeys (shown above the blocks) change the operation of the blocks. For example, the C EDGE + − softkey is shown as a block containing a switch. You toggle this softkey to choose the active clock edge for the CLK signal.
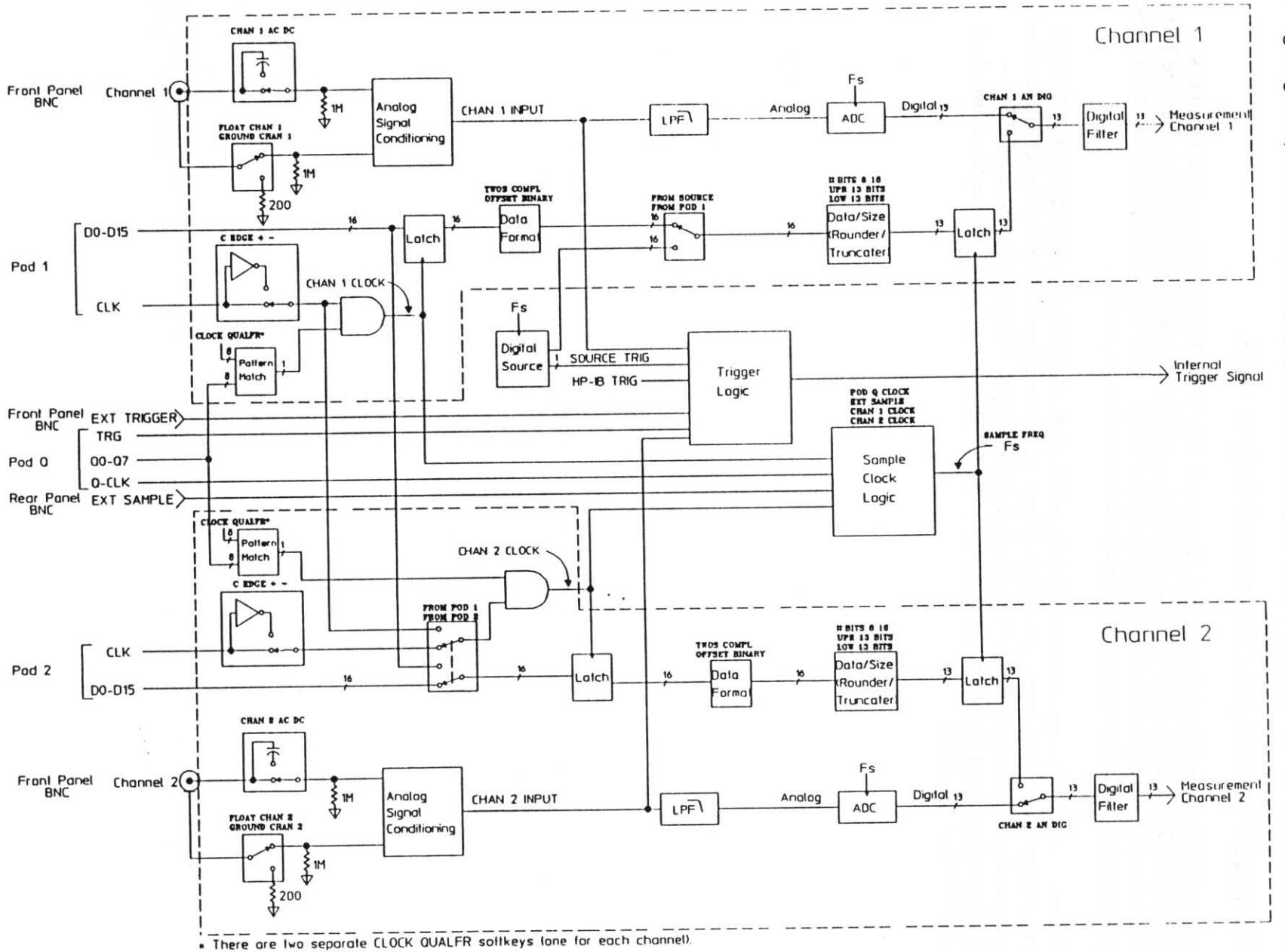
Figure 7-4. Input Block Diagram

* There are two separate CLOCK QUALFR softkeys (one for each channel).

Procedures

Use the menu diagram in figure 7-3, the block diagram in figure 7-4, and the following steps to configure an input channel for digital data. All softkeys used to configure an input channel for digital data are described following the steps.

1. Select the input data path.

2. Display visual help (the channel configuration diagram or state display).

3. Select the data size.

4. Select the data format.

5. Set up the data clock and qualifiers.

6. Select the sample clock.

Note

You must supply a sample clock to measure digital data (you cannot use the analyzer's internal sample clock). If the sample clock is missing or configured improperly, the message MISSED SAMPLE appears in the status line. As you do the following steps, ignore this message; it will disappear when you do step 6.

If you need more information than provided in the following steps, see the softkey descriptions after the steps or see chapters 13 and 14.

Step 1. Select the Input Data Path

Figure 7-4 shows the input data paths available for digital data. For Channel 1, digital data can come from the analyzer's internal source or from Pod 1. For Channel 2, digital data can come from Pod 1 or Pod 2. To select the data path, press the following keys:

Channel 1: **INPUT CONFIG** / CHAN 1 AN **DIG** / FROM SOURCE or FROM POD 1

Channel 2: **INPUT CONFIG** / CHAN 2 AN **DIG** / FROM POD 1 or FROM POD 2

Step 2. Display Visual Help

The HP 3563A offers two types of visual help to assist you while configuring the inputs: a channel configuration diagram or a state display. A channel configuration diagram is a graphical picture of the current input configuration (see figure 7-5). A state display is a table that shows the current input configuration (see figures 7-6 and 7-7). Both types of visual help are updated as you change configurations. Furthermore, when you press a softkey, the analyzer highlights the portion of the diagram or table affected by the softkey.

To display a channel configuration diagram, you can use the **INPUT CONFIG** hardkey or the **SPCL FCTN** hardkey as follows:

Using the **INPUT CONFIG** hardkey, press:

Channel 1: **INPUT CONFIG** / INTERFACE 1 / CHAN 1 CONFIG

Channel 2: **INPUT CONFIG** / INTERFACE 2 / CHAN 2 CONFIG

Using the **SPCL FCTN** hardkey, press:

Channel 1: **SPCL FCTN** / VISUAL HELP / CHAN 1 CONFIG

Channel 2: **SPCL FCTN** / VISUAL HELP / CHAN 2 CONFIG

To see the state display, toggle **STATE / TRACE**. If both channels are analog, the state display consists of one page. If one or both channels are digital, the state display consists of two pages (press the **STATE / TRACE** hardkey again to see the second page). Use the first page to see configuration changes as you make them for an analog channel. Use the second page to see configuration changes as you make them for a digital channel.
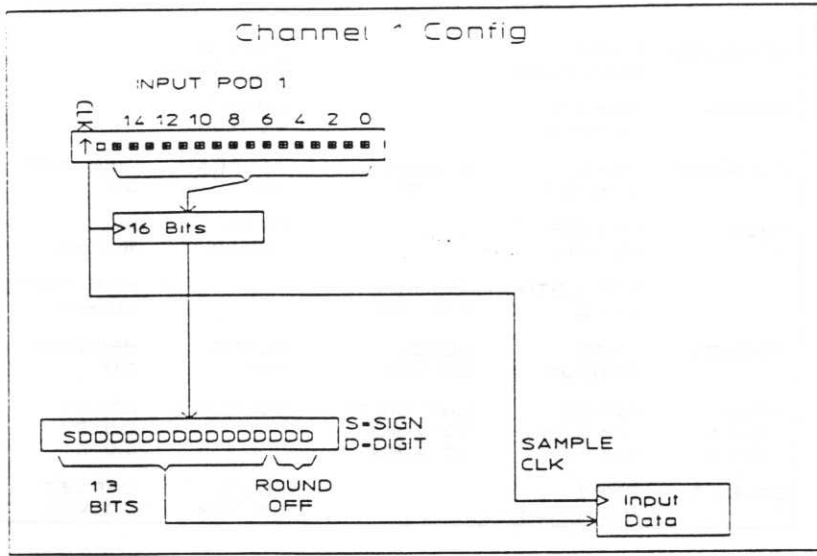
Figure 7-5. Sample Channel Configuration

```
┌─────────────────────────────────────────────────────────────┐
│         Linear Resolution                    Page 1          │
│                                                              │
│  MEASURE:    CHAN 1                   CHAN 2                  │
│              Freq Resp                Freq Resp              │
│                                                              │
│  WINDOW:     CHAN 1                   CHAN 2                  │
│              Hanning                  Hanning                │
│                                                              │
│  AVERAGE:    TYPE        # AVGS       OVERLAP    TIME AVG     │
│              Avg Off       10         0%         Off         │
│                                                              │
│  FREQ:       CENTER                   SPAN       BW          │
│              50 kHz                   100kHz     187 Hz      │
│                                                              │
│              REC LGTH    Δt                      EXT SAMPLE  │
│              8.0mS       3.91 µS                 256kHz      │
│                                                              │
│  TRIGGER:    TYPE        LEVEL        SLOPE      PREVIEW      │
│              Freerun     0.0 Vpk      Pos        Off         │
│                                                              │
│  INPUT:      RANGE       ENG UNITS    COUPLING   DELAY        │
│    CH 1      Src Rng     1.0 V/EU                0.0 S       │
│    CH 2      Src Rng     1.0 V/EU                0.0 S       │
│                                                              │
│  SOURCE:     TYPE                     LEVEL      OFFSET       │
│              Rndm Noise               0.0 Vpk    0.0 Vpk     │
└─────────────────────────────────────────────────────────────┘
```

Figure 7-6. Sample State Display: Page 1

```
┌─────────────────────────────────────────────────────────────┐
│         Digital Setup                        Page 2          │
│                                                              │
│  INPUT:      CHAN 1                   CHAN 2                  │
│              Digital (Pod 1)          Digital (Pod 2)        │
│                                                              │
│  DATA:       FORMAT      # BITS       BUS SZ     ALIGNMENT    │
│    CH 1      Twos Cmp    16           16         Low 13      │
│    CH 2      Twos Cmp    16           16         Low 13      │
│                                                              │
│  CLOCK:      EDGE        QUALIFIER               DELAY        │
│    CH 1      Pos         XXXXXXXX                0.0 S       │
│    CH 2      Pos         XXXXXXXX                0.0 S       │
│                                                              │
│  SAMPLE:                 FREQ                                 │
│    CH 1                  256kHz                               │
│                                                              │
│  ─────────────────────────────────────────────────────────  │
│                                                              │
│  OUTPUT:     Analog                                          │
│                                                              │
│  SOURCE:     TYPE                     LEVEL      OFFSET       │
│              Rndm Noise               0.0 Vpk    0.0 Vpk     │
└─────────────────────────────────────────────────────────────┘
```

Figure 7-7. Sample State Display: Page 2

Step 3. Select the Data Size

The analyzer allows you to read 8-bit or 16-bit digital data from an 8-bit or 16-bit parallel data bus. For 16-bit data, the analyzer uses 13 of the bits and rounds or truncates the other three. If you use the upper 13 bits, the analyzer rounds the lower 3 bits (the 3 least significant bits). If you use the lower 13 bits, the analyzer truncates the upper 3 bits (the 3 most significant bits). For best results, use the lower 13 bits for low-level signals and the upper 13 bits if you are looking at the full range of a device under test.

Note In swept-sine mode, you can configure the analyzer to automatically switch between the upper and lower 13 bits to provide full 16-bit performance. For details, see the description of the AUTO 16 BIT softkey later in "Setting the Input Range."

For an 8-bit bus, you can read 8-bit data as one 8-bit word or 16-bit data as two 8-bit words. In both cases, the analyzer uses only the upper eight data lines (on an input Pod, these lines are D8-D15). **If you are using an 8-bit bus,** review "Data Size Versus Bus Size" in chapter 13 before continuing with these steps.

To select the data size, display the Data Size menu and press the appropriate softkeys. To display the Data Size menu, press the following keys:

Channel 1: **INPUT CONFIG** / INTERFACE 1 / DATA SIZE

Channel 2: **INPUT CONFIG** / INTERFACE 2 / DATA SIZE

Note A good way to learn how the analyzer handles different data sizes is to display the channel configuration diagram (shown in step 2) as you press all softkeys in the Data Size menu.

Step 4. Select the Data Format

The analyzer can read digital data in one of two formats: twos complement or offset binary. Offset-binary is most commonly used with DACs and ADCs. The format of each is as follows (also see table 7-1):

Twos-complement:	sddddddd dddddddd (MSB LSB) where s = sign bit (0 = positive, 1 = negative) d = digits
Offset binary:	sddddddd dddddddd (MSB LSB) where s = sign bit (1 = positive, 0 = negative) d = digits

To select a data format, press the following keys:

Channel 1: **INPUT CONFIG** / INTERFACE 1 / TWOS COMPL or OFFSET BINARY

Channel 2: **INPUT CONFIG** / INTERFACE 2 / TWOS COMPL or OFFSET BINARY

Table 7-1. Data Format Examples

Signed Integer Number	Twos-Complement		Offset Binary	
	(hex)	(octal)	(hex)	(octal)
32767	7FFF	077777	FFFF	177777
1	0001	000001	8001	100001
0	0000	000000	8000	100000
−1	FFFF	177777	7FFF	077777
−32768	8000	100000	0000	000000

Step 5. Set up the Data Clock and Qualifiers

As shown in figure 7-4, each input Pod has a CLK signal. This is the Pod's data clock. You must supply a signal on CLK. The analyzer uses the CLK signal and, if activated, qualifiers to latch digital data into an input channel. You can configure the analyzer to use the rising or falling edge of CLK (using the C EDGE + − softkey).

Caution   The maximum data-clock (CLK) frequency is 10 MHz. The maximum sample-clock frequency is 256 kHz (in other words, the maximum sample rate of the analyzer is 256 kHz). If digital data is latched into an input channel faster than the sample rate, some samples will be lost.

To set up the data clock, display the Data Clock menu and press the appropriate softkeys. To display the Data Clock menu, press the following keys:

Channel 1: **INPUT CONFIG** / INTERFACE 1 / DATA CLOCK

Channel 2: **INPUT CONFIG** / INTERFACE 2 / DATA CLOCK

Qualifiers In some cases, such as clocking data in from a microprocessor bus, you *do not* want to latch data into an input channel at every rising edge of CLK (or the falling edge if C EDGE + − is toggled to −). In situations such as these, you can use one or more of the eight qualifier lines on Pod Q (Q0-Q7) in addition to the CLK signal to determine when digital data is latched into an input channel.

To understand how qualifiers work, examine figure 7-4. There are two signals that latch digital data into the analyzer: Chan 1 Clock for Channel 1; Chan 2 Clock for Channel 2. These signals are called *Channel Clocks*. Channel 1 digital data is latched into the analyzer when Chan 1 Clock is active; Channel 2 digital data is latched into the analyzer when Chan 2 Clock is active. If you use qualifiers, Channel Clock is active when the following **two conditions are met:**

- CLK changes state from low-to-high (or high-to-low if C EDGE + − is −)
- Q0-Q7 on Pod Q match the pattern you enter with the CLOCK QUALFR softkey [this comparison is done by the *Pattern Match* block)

If you don't use qualifiers, Q0-Q7 on Pod Q are ignored. In this case, Channel Clock is active when CLK is active (in other words, the output of *Pattern Match* is held high). Thus, if you don't use qualifiers, digital data is latched into an input channel on the active edge of CLK.

To use qualifiers. connect Pod Q as described in chapter 13. Then press the following keys:

Channel 1: **INPUT CONFIG** / INTERFACE 1 / DATA CLOCK / CLOCK QUALFR

Channel 2: **INPUT CONFIG** / INTERFACE 2 / DATA CLOCK / CLOCK QUALFR

When you press CLOCK QUALFR, the analyzer changes the softkey menu to a menu of editing functions and displays the current definition of CLOCK QUALFR in the lower-left corner of the display. You can enter *ones*, *zeros*, or *don't cares* (the letter "X"). The default is *don't cares* (XXXX XXXX). Enter ones and zeros with the 1 and 0 keys on the numeric keypad. Enter *don't cares* with the DON'T CARE softkey. The knob in the Entry block or the SPACE FORWRD and SPACE BACKWD softkeys move the cursor to allow you to edit any bit. When finished, press the ENTER softkey.

To disable qualifiers, specify *don't cares* for all eight bits of CLOCK QUALFR (this is the default at power-on or reset), in which case the analyzer ignores Q0-Q7 and data from an input Pod is clocked into the analyzer on every transition of CLK.

Configuring Both Channels to Pod 1   In many applications, data comes from one data bus. The HP 3563A allows you to use a single pod (Pod 1) to do a two-channel measurement from a common data bus.

To use Pod 1 to do a two-channel measurement (such as a frequency response measurement), you must use qualifiers to associate data with the correct channel (if you don't use qualifiers, both channels take data at the same time). Figure 7-8 shows you how to do this. Notice that Channel 1 takes data when Q0-Q7 on Pod Q match the pattern of the Channel 1 CLOCK QUALFR softkey. Channel 2 takes data when Q0-Q7 on Pod Q match the pattern of the Channel 2 CLOCK QUALFR softkey. See the previous section for instructions on how to set qualifier patterns.
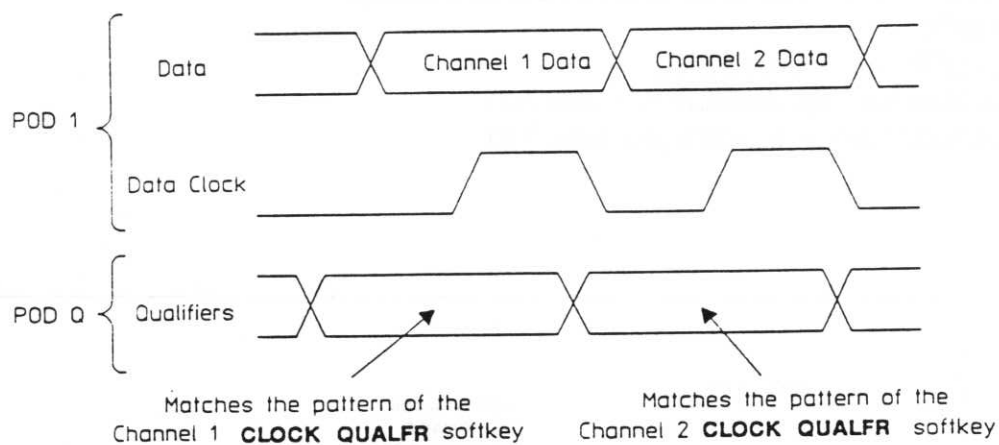
Figure 7-8. Associating Data With the Correct Channel

Note   A good way to learn how the analyzer uses data clocks and qualifiers is to display the channel configuration diagram as you press all softkeys in the Data Clock menu.

Step 6. Select the Sample Clock

The analyzer uses two signals to calculate all timing and phase information: sample clock and trigger. The following paragraphs describe the operation of the sample clock. See "Setting up Triggering" for trigger information.

By default, the analyzer uses its internal sample clock (256 kHz) for analog measurements. For digital measurements, the analyzer does not use its internal sample clock. Instead, you must supply the sample clock.

Figure 7-9 shows the sample clock logic in greater detail than shown in figure 7-4. Notice that the following sample clocks are available (figure 7-4 shows how CHAN 1 CLOCK and CHAN 2 CLOCK are generated):

- Internal (256 kHz; available only when both channels are analog)
- Q-CLK (on Pod Q)
- EXT SAMPLE (BNC on the rear panel)
- CHAN 1 CLOCK (not always available; see table 7-2)
- CHAN 2 CLOCK (not always available; see table 7-2)
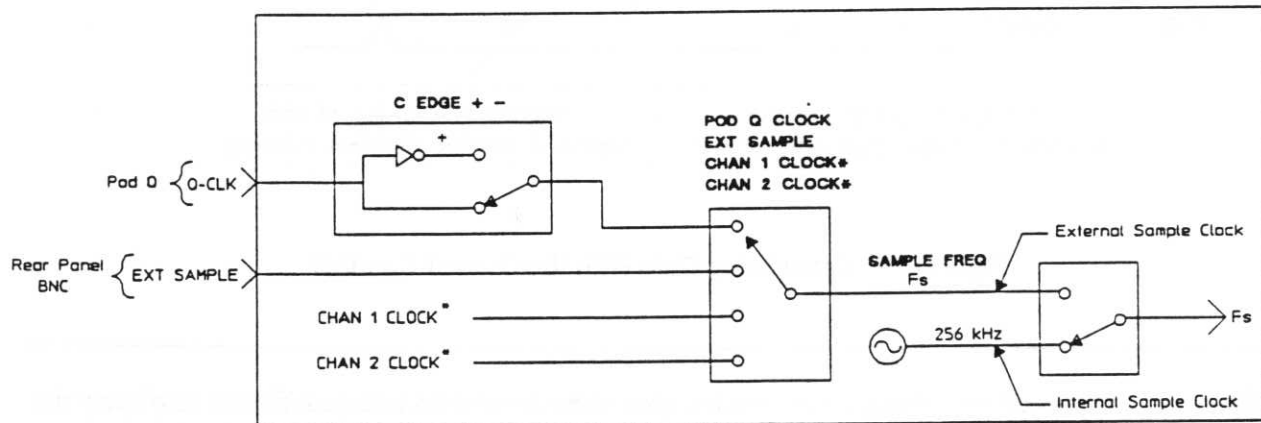
* This selection valid only when Channel is digital.

Figure 7-9. Sample Clock Logic

The sample clock that you can choose when a channel is digital depends on analyzer configuration as shown in table 7-2. Notice that CHAN 1 CLOCK is available only when Channel 1 is digital. However, it is not available if Channel 1 is connected to the internal source. Likewise, CHAN 2 CLOCK is available only when Channel 2 is digital.

Caution

If you choose the wrong sample clock, measurement data may be lost. Make sure you are familiar with the information in "Connecting the Sample Clock" in chapter 13 and "All-Digital Measurements" or "Mixed Measurements" in chapter 14 before you select the sample clock.

Note

In the case where **both channels are connected to Pod 1**, choose CHAN 2 CLOCK if Channel 1 data appears first on the pod; choose CHAN 1 CLOCK if Channel 2 data appears first on the pod. "Connecting the Sample Clock" in chapter 13 shows a timing diagram for this case.

Table 7-2. Available Sample Clocks

	Both Channels Digital		One Channel Digital; One Channel Analog		
	If Channel 1 data is:		If Channel 1 is digital and its data is:		If Channel 2 is digital:
	From Pod 1	From Source	From Pod 1	From Source	
POD Q CLOCK	Yes	Yes	**YES**	**YES**	**YES**
EXT SAMPLE	Yes	Yes	Yes	Yes	Yes
CHAN 1 CLOCK	Yes	No	Yes	No	No
CHAN 2 CLOCK	**YES**	**YES**	No	No	Yes

Note: The default selection is shown in bold type

To select a sample clock when one or both channels are digital, display the sample clock menu and press the appropriate softkeys. You can use the INTERFACE 1 or INTERFACE 2 menus to display the Sample Clock menu — it makes no difference which one you use (both channels use the same sample clock). To display the Sample Clock menu, press the following keys:

INPUT CONFIG / INTERFACE 1 / SAMPLE CLOCK

OR

INPUT CONFIG / INTERFACE 2 / SAMPLE CLOCK

After you select a sample clock, you must also specify its frequency (this properly scales the X-axis display). Press SAMPLE FREQ (in the Sample Clock menu) to enter the frequency of the sample clock. The frequency range of the sample clock is 0.001 Hz to 256 kHz.

Note

A good way to learn how the analyzer uses the sample clock is to display the channel configuration diagram as you press all softkeys in the Sample Clock menu.

Additional information about the sample clock is included in the following chapters:

- Chapter 13 (explains digital connections and timing considerations)

- Chapter 14 (includes advanced information for digital and mixed measurements)

- Chapter 3, "Frequency Spans in the Linear Resolution Mode" (explains how to select a sample clock when both channels are analog)

Softkey Descriptions

Figure 7-3 shows the softkeys for configuring an input channel for digital data. The following paragraphs describe the softkeys in the order that they appear.

CHAN 1
AN **DIG**

Selects analog (default) or digital data for Channel 1. The other softkeys that you see for Channel 1 depend on the selection of this softkey.

INTER-
FACE 1

Displays the Interface menu for Channel 1, which allows you to select the number format (twos complement or offset binary), data size, data clock, and sample clock. This menu has a softkey that lets you see a visual picture of the current configuration for Channel 1. See "The Interface Menu."

FROM
SOURCE

Makes an internal connection to Channel 1 so that it receives digital data directly from the source. In addition, the source type is automatically set to digital (in other words, the SOURCE AN DIG softkey under **SOURCE** is automatically toggled to DIG). FROM SOURCE is inactive for mixed measurements that have a mixed ratio greater than 1 (that is, the analog channel is sampled at a faster rate than the digital channel). In this case, Channel 1 can only receive digital data FROM POD 1, not FROM SOURCE. This prevents an incorrect measurement because the digital clock rate is not multiplied by the ratio value (see "Mixed Measurements" in chapter 14 for details).

When digital data is FROM SOURCE, the digital interface for Channel 1 is automatically configured to match that of the source. Channel 1 reads 16-bit source data and, depending upon the data alignment, ignores the 3 most significant bits or rounds-off the 3 least significant bits.

FROM
POD 1

Connects Channel 1 to receive digital data directly from Pod 1. This is the default selection for Channel 1. Note that you can connect both channels to Pod 1. See "Step 5. Set up the Data Clock and Clock Qualifiers" for details.

CHAN 2
AN **DIG**

Selects analog (default) or digital data for Channel 2. The other softkeys that you see for Channel 2 depend on the selection of this softkey (see figure 7-3).

INTER-
FACE 2

Displays the Interface menu for Channel 2, which allows you to select the number format (twos complement or offset binary), data size, data clock, and sample clock. This menu has a softkey that lets you see a visual picture of the current configuration for Channel 2. See "The Interface Menu."

FROM
POD 1

Connects Channel 2 to receive digital data directly from Pod 1. Note that you can connect both channels to Pod 1. See "Step 5. Set up the Data Clock and Clock Qualifiers" for details.

FROM
POD 2

Connects Channel 2 to receive digital data directly from Pod 2. This is the default selection for Channel 2.

The Interface Menu

The interface menu allows you to set up the digital interface for an input channel. It allows you to select the number format (twos complement or offset binary), data size, data clock, and sample clock. This menu also has a softkey that lets you see a visual picture of the current configuration for a channel.

The interface menu is the same for Channel 1 and 2. To set up the digital interface for Channel 1, press INTERFACE 1; for Channel 2, press INTERFACE 2 (see figure 7-3). The softkeys in this menu do the following:

TWOS COMPL	Sets the input channel to treat data as a twos-complement number. This is the default value. For INTERFACE 1, this softkey is blank if the input data is FROM SOURCE.
OFFSET BINARY	Sets the input channel to treat data as an offset-binary number. For INTERFACE 1, this softkey is blank if the input data is FROM SOURCE.
DATA SIZE	Displays the Data Size menu. This menu allows you to specify the parameters associated with data and bus size, such as number of data bits (8 or 16) and size of the data bus (8 or 16). See "The Data Size Menu" for further details.
DATA CLOCK	Displays the Data Clock menu. This menu allows you to specify the active clock edge and the qualifiers (on Pod Q) necessary to select the data to be associated with the input channel. See "The Data Clock Menu" for further details.
SAMPLE CLOCK	Displays the Sample Clock menu. This menu allows you to set up the sample clock for digital or mixed measurements. See "The Sample Clock Menu" for further details.
CHAN 1 CONFIG	Displays a graphic representation of the current configuration for the Channel 1 input. If you press INTERFACE 1, this softkey reads CHAN 1 CONFIG; if you press INTERFACE 2, it reads CHAN 2 CONFIG (see figure 7-3). CHAN 1 CONFIG and CHAN 2 CONFIG are also available under SPCL FCTN VISUAL HELP.
CHAN 2 CONFIG	Displays a graphic representation of the current configuration for the Channel 2 input. Its operation is identical to CHAN 1 CONFIG.

Note

The preceding paragraphs describe the softkeys for INTERFACE 1. These softkeys operate the same for INTERFACE 2, except as noted.

The Data Size Menu

This menu allows you to specify the parameters associated with data and bus size, such as number of bits (8 or 16) and size of the data bus (8 or 16). The softkeys in this menu do the following:

# BITS 8 16	Sets the number of bits in the digital input data (16-bit data is the default value). For INTERFACE 1, this key is blank if the digital data is FROM SOURCE.
UPR 13 BITS	Selects the upper 13 bits (most significant bits) of the 16 bit data to be used as input. The lower 3 bits (least significant bits) are rounded. This softkey is blank if # BITS 8 16 is set to 8.
LOW 13 BITS	Selects the lower 13 bits of the 16-bit data to be used as input. The upper 3 bits (most significant bits) are ignored. This softkey is blank if # BITS 8 16 is set to 8.
BUS SZ 8 16	Specifies the size of the bus being used. The default selection is 16 bits. If the data size is 16 bits it may be read from a 16-bit bus or an 8-bit bus (see "Data Size Versus Bus Size" in chapter 13 for details). If the data size is 16 bits and the data-bus size is 8 bits, use the LAST 1 0 softkey (in the Data Clock menu) to determine which byte is read last. The BUS SZ 8 16softkey is blank if # BITS 8 16 is set to 8. In addition, this softkey is blank for Channel 1 if the digital data is FROM SOURCE.
X OVFL ON OFF	Enables or disables overflow detection (using the Pod Q overflow signal). The default is OFF. See "Digital Range and Overflow" in chapter 14 for further details.

The Data Clock Menu

The Data Clock menu allows you to specify the active clock edge and the qualifiers (on Pod Q) necessary to select the data to be associated with the input channel. The softkeys in the Data Clock menu do the following:

C EDGE + —	Selects the active edge for the selected data clock. The (+) selects the low-to-high transition, the rising edge. The (−) selects the high-to-low transition, the falling edge. This softkey is blank for Channel 1 if the digital data is FROM SOURCE.
CLOCK QUALFR	Selects Q0-Q7 on Pod Q to qualify the data clock. Each bit can have the value of 0, 1 or X (don't care).
LAST 1 0	Specifies which of two bytes from an 8-bit bus is the last one to be read when using 16-bit data. This is significant only when the selected channel has been specified as the sample clock because it determines when the 16-bit word is complete and the sample taken. When the channel is not the sample clock, the last two bytes sent before the sample clock make up the data point. This softkey appears only when an input channel is configured for 16-bit data from an 8-bit data bus. For further details, see "Data Size Versus Bus Size" in chapter 13.
COMPUT DELAY	Sets a computational delay to correct the time lag associated with the computations in your system from digital filters, microprocessors and the like. The analyzer corrects the specified channel's input data phase using the value you specify. See chapter 14 for details.

The Sample Clock Menu

The Sample Clock menu allows you to select a sample clock. For mixed measurements (one channel analog; the other digital), the sample clock menu includes an additional softkey: MIXED RATIO (see figure 7-3). The following paragraphs describe the operation of all softkeys in the sample clock menu.

Note Chapter 14 contains additional details (not included here) that you should be aware of when making mixed measurements.

POD Q
CLOCK

Selects Q-CLK on Pod Q as the sample clock (use a TTL level signal). You can clock on the rising or falling edge (see C EDGE + − below). This clock is functionally equivalent to the BNC on the rear panel labeled EXT SAMPLE. To reduce loading problems associated with transmitting a digital signal through a coaxial cable, use Pod Q clock instead of EXT SAMPLE.

EXT
SAMPLE

Selects the BNC on the rear panel labeled EXT SAMPLE as the sample clock (use a TTL level signal). It always clocks on the rising edge (+).

CHAN 1
CLOCK

Selects the CHAN 1 CLOCK signal as the sample clock. Figure 7-4 shows how this signal is generated. Basically, CHAN 1 CLOCK is the Pod 1 data clock after it has been qualified (you cannot select CHAN 1 CLOCK if Channel 1 is FROM SOURCE). If the data clock is not qualified (the state of the Channel 1 CLOCK QUALFR is all *don't cares*), the frequency of CHAN 1 CLOCK and the data clock are identical. If qualifiers are used for Channel 1, CHAN 1 CLOCK is qualified — its frequency is dependent on the data clock and the state of the Channel 1 CLOCK QUALFR (see "Step 5. Set up the Data Clock and Clock Qualifiers" for details).

CHAN 2
CLOCK

Selects the CHAN 2 CLOCK signal as the sample clock. Figure 7-4 shows how this signal is generated. Basically, CHAN 2 CLOCK is the Pod 1 or Pod 2 data clock after it has been qualified (digital data for Channel 2 can come from Pod 1 or Pod 2). If the data clock is not qualified (the state of the Channel 2 CLOCK QUALFR is all *don't cares*), the frequency of CHAN 2 CLOCK and the data clock are identical. If qualifiers are used for Channel 2, CHAN 2 CLOCK is qualified — its frequency is dependent on the data clock and the state of the Channel 2 CLOCK QUALFR (see "Step 5. Set up the Data Clock and Clock Qualifiers" for details).

C EDGE
+ −

This softkey appears only when POD Q CLOCK is selected as the sample clock. It selects the active edge for that clock. The (+) selects the low-to-high transition, the rising edge. The (−) selects the high-to-low transition, the falling edge.

SAMPLE
FREQ

Allows you to enter the sample-clock frequency (default is 256 kHz). This is the frequency at which samples from the digital input(s) are read into the input time record(s). This same softkey is also located under the **FREQ** hardkey.

MIXED
RATIO

This softkey appears only when one channel is analog and the other digital. It specifies the ratio between the analog sample rate (Fsa) and the digital sample rate (Fsd). The default value is 1. Measurements using a mixed ratio can avoid aliasing and provide the ability to measure beyond half the digital sampling frequency, Fsd/2. Values must be an integer from 1 to 512. For additional details, see "Mixed Measurements" in chapter 14.

Setting The Input Range

Range operates differently for analog and digital input channels. If an input channel is analog, the range value configures attenuators in the analog input circuitry so that the analog input circuitry is not overdriven. If an input channel is digital, the range value corresponds to the maximum value of digital data. The sections that follow contain additional details for both analog and digital input channels.

To set the input range, press **RANGE** to display the menu in figure 7-10. Notice that the softkeys you see when you press **RANGE** differ for analog and digital channels.
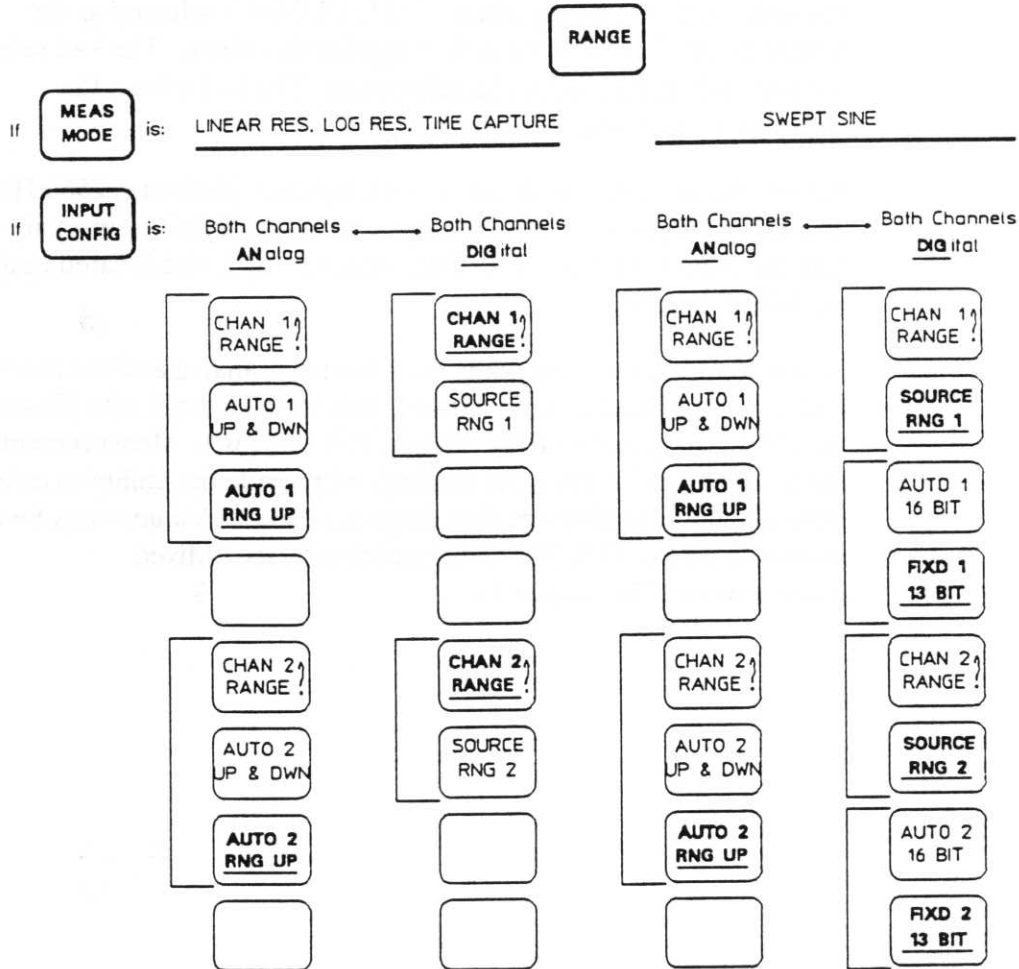
Figure 7-10. RANGE Menu Diagram

Setting the Input Range for an Analog Channel

For an analog input channel, you have a choice between manually setting the input range or letting the analyzer automatically set the range. The auto-range feature sets the range in response to the amplitude level detected at the inputs. It adjusts the range to attempt to keep the input level in the upper half of the input range; this helps to maximize the measurement's dynamic range.

If an analog input signal exceeds the value specified with **RANGE**, an overload occurs. When an overload occurs, the red over-range LED on the front panel illuminates and the data record is flagged with an overload (appears at the upper-right corner of the trace). In the linear resolution and log resolution measurement modes, if averaging is ON and overload rejection is ON (**AVG / NEXT / OV REJ ON OFF** is ON), the data record is excluded from the average.

Note   The input range should be set so that the green, front-panel, half-range LED is lit
                   and the red over-range LED is off. This ensures a maximum signal-to-noise ratio.

If an input channel is analog and you press **RANGE**, the following softkeys appear:

CHAN 1 RANGE	Allows you to set the range for Channel 1, from − 51 dBV (3.99 mVpeak) to + 27 dBV (31.66 Vpeak). The current value is in the bottom left-hand corner of the display and is always rounded to 3 digits. You can set the range for BOTH channels at once by entering the value immediately after pressing **RANGE**. When entering a range in Vrms or dBVrms, the peak-to-rms ratio of a sine wave is always used to convert Vrms to Vpk. Further information is provided later in "Choosing the Best Range."
AUTO 1 UP&DWN	Activates autoranging on Channel 1 and allows it to adjust the range in either direction as signal level changes. Best with continuous signals such as sine waves.
AUTO 1 RNG UP	Activates autoranging on Channel 1 but allows it to increase the range only after starting at the minimum input range. Best with random noise or impulse signals.

CHAN 2 RANGE	Allows you to set the range for Channel 2. See CHAN 1 RANGE for details.
AUTO 2 UP&DWN	Activates autoranging on Channel 2 and allows it to adjust the range in either direction as signal level changes. Best with continuous signals such as sine waves.
AUTO 2 RNG UP	Activates autoranging on Channel 2 but allows it to increase the range only after starting at the minimum input range. Best with random noise or impulse signals.

Note

Changing autorange to AUTO UP&DWN or AUTO RNG UP immediately causes an autorange cycle. You can press the range softkey currently selected for a channel to display the channel's range setting in the lower left-hand corner of the display.

Autoranging an Analog Channel

When autoranging is active, UP & DOWN autoranging occurs whenever the input signal level falls below half range for at least one time record or exceeds full range, with several exceptions. Input range is not changed during averaged measurements, time captures, or time throughputs. Auto ranging activity is indicated by flashing of the OVER RANGE and HALF RANGE LEDs. Up and down autoranging is useful when performing spectrum analysis of continuous signals. Refer to chapter 5 for an explanation of autoranging in the swept sine mode.

Up-only autoranging prevents autoranging from decreasing the range and is helpful for impact, transient, burst, and random noise measurements (for this, use AUTO 1 RNG UP for Channel 1;AUTO 2 RNG UP for Channel 2). When the input signal level drops momentarily (e.g., between hammer impacts), this prevents the analyzer from immediately autoranging down to the ambient noise level. If necessary, you can restart AUTO 1 RNG UP for Channel 1 by momentarily switching to CHAN 1 RANGE, then back to AUTO 1 RNG UP. If necessary, you can do the same for Channel 2.

Choosing the Best Range for an Analog Channel

When entering a range in Vrms or dBVrms, the peak-to-rms ratio of a sine wave is always used to convert Vrms to Vpk. This differs from source level, where the ratio matches the current source type. You can manually set the range (using CHAN 1 RANGE and/or CHAN 2 RANGE) anywhere from − 51 dBV (3.99 mVpeak) to + 27dBV (31.66 Vpeak), where dBV is referenced to 1 Vrms. Note that you can set the range for both channels at once by entering the value immediately after pressing **RANGE.**

Setting the input range is critical for making distortion-free measurements. The input range should be set at such a level that the input signal's peak amplitude is within 50% to 100% of the input range. You can monitor this by ensuring that the green HALF RANGE indicator is on (flashing or steady), but the red OVER RANGE indicator is not. If HALF RANGE is off, the signal-to-noise ratio is less than optimum; if OVER RANGE is on, the measurement will be distorted. The message "OV1" or "OV2" at the top right corner of the trace indicates an overload occurred in the respective channel. Figure 7-11 gives an example of the distortion introduced by an incorrect range setting.
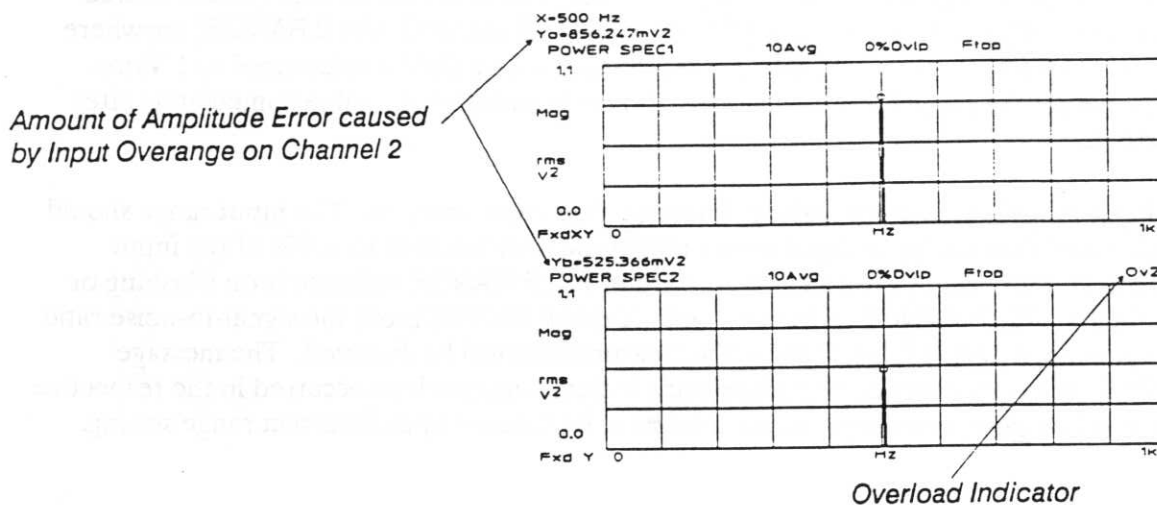
Figure 7-11. The Importance of Correct Input Range

If you are in the linear or log resolution modes, the **AVG** menu offers automatic overload rejection which can reject any time record whose amplitude exceeded the input range; refer to chapter 3 (for linear resolution) or chapter 4 (for log resolution). Also, the **VIEW INPUT** displays can simplify setting the input range by allowing you to view the actual amplitude of the input signals.

Note

When using time throughput, overloads are indicated only during the throughput session — not when data files are being read back from disc during a measurement.

Setting the Input Range for a Digital Channel

For a digital input channel, the range is usually fixed at the value you enter. However, if the measurement mode is swept sine, you can configure the analyzer to automatically set the range. In this case, the analyzer switches between the upper and lower 13 bits of digital data; it attempts to keep the input level in the upper eighth of the input range.

When setting the range for a digital channel, here are some details that you should be aware of:

- Except for the AUTO 16 feature in swept sine mode, autoranging is unavailable for a digital channel — it is automatically turned off.

- A digital-channel overrange condition (an overflow of the lower 13-bits) is indicated by the message DIGITAL OVER RANGE # — where # indicates Channel 1, 2 or 1 and 2. This is different then an analog-channel overrange condition — where the overload is indicated by the red Overrange LED on the front panel. For a digital channel, there can be no overflow condition if the upper 13-bits have been selected because the lower bits are rounded. See "Digital Range and Overflow" in chapter 14 for additional details.

- There is no half-range indicator for a digital channel. In other words, the green Half-Range LED on the front panel is not used by a digital channel — but it is always active. This LED lights anytime an analog signal at the front-panel BNC connector goes beyond half-range. Therefore, if you see this LED light for a channel that is digital, it is because you have an analog signal that is above half-range connected to the front-panel BNC connector.

- When using time throughput, overflows are indicated only during the throughput session, not when data files are being read back from disc during a measurement.

Range Operation for a Digital Channel

For a digital input channel, the range setting defines full range, which corresponds to the maximum possible value of digital data. Full range is determined by the size of the data you specify with the # BITS 8 16 softkey in the DATA SIZE menu. Full range is either 32,767 for 16-bit data or 127 for 8-bit data. The range entry can be any value between −51 dBV (3.99 mV) and +27 dBV (31.68 V_{pk}) where dBV is reference to 1 V_{rms} for a digital channel. The range entry value determines the scale factor used internally to scale the digital input data so that the maximum input amplitude value is displayed as the range amplitude value.

For example, to set the range to 10 volts for Channel 1, press CHAN 1 RANGE. Then enter "1", "0" on the numeric keypad and press the V softkey. In this case, half the full-scale digital value corresponds to 5 volts; one-fourth the full-scale digital value corresponds to 2.5 volts (see the following table).

Table 7-3. Example: Equivalent Digital Values When Range = 10 Volts

Voltage	Digital Value	
	16-Bit Data	8-Bit Data
10 Volts	32,767	127
7.5 Volts	24,576	96
5 Volts	16,383	64
2.5 Volts	8,192	32

Notes

The same range is valid for an analog channel configuration, but the value may be changed to the next integer dBV value. The range entry value displayed in the lower-left corner of the screen is always rounded to 3 digits and is, therefore, an approximation.

The peak-to-rms ratio of a sine wave is *always* used to convert V_{rms} to V_{pk} when entering a range in V_{rms} or dBV_{rms}. This differs from source level, where the ratio matches the selected source type.

RANGE Menu: All Measurement Modes Except Swept Sine

The following softkeys appear when you press **RANGE**, both channels are digital, and the analyzer is in any measurement mode except swept sine. See the following section for similar details when the measurement mode is swept sine.

CHAN 1 RANGE	Allows you to set the range for Channel 1. For a digital channel, the value that you enter corresponds to the maximum positive value for digital data, and the units dBV is referenced to 1Vrms. Otherwise, this softkey operates the same for both analog and digital channels. See the description for CHAN 1 RANGE in "Setting the Input Range for an Analog Channel."
SOURCE RNG 1	Sets the Channel 1 range to be the same as the source range. With an analog source, this predefined value is 5.0 Vpk. With a digital source, this predefined value is 5.12 Vpk. If the source is changed from digital to analog, the source range is turned off and the value is changed to the range of the analog channel.
CHAN 2 RANGE	Allows you to set the range for Channel 2. See the previous description of CHAN 1 RANGE for details.
SOURCE RNG 2	Sets the Channel 2 range to be the same as the source range. See SOURCE RNG 1 for details.

RANGE Menu: Swept Sine Mode

The following softkeys appear when you press **RANGE**, both channels are digital, and the analyzer is in the swept sine mode:

Note Unlike the other measurement modes, swept sine mode includes a feature that automatically switches between the upper and lower 13 bits to provide full 16-bit performance. This feature is called *auto-alignment*. For details, see the description of the AUTO 16 BIT and FIXD 13 BIT softkeys below and see "Using the Automatic Swept Sine Features" in chapter 5.

CHAN 1 RANGE	Operates the same in all measurement modes. See the previous section for details.
SOURCE RNG 1	Operates the same in all measurement modes. See the previous section for details.
AUTO 1 16 BIT	Specifies 16 bit dynamic range for Channel 1. This is useful if you do not know which range is appropriate for your device under test. Each sample is checked for a digital overflow condition to determine if the upper 13 bits or the lower 13 bits should be read. The last sample's selection (UPR 13 BITS or LOW 13 BITS in the INTERFACE 1 / DATA SIZE menu) is saved during a pause or at the end of a measurement. This feature may extend measurement time as compared to FIXD 1 13 BIT.
FIXD 1 13 BIT	Specifies 13 bit dynamic range for Channel 1. The analyzer uses the upper 13 bits or lower 13 bits (as selected by UPR 13 BITS or LOW 13 BITS in the INTERFACE 1 / DATA SIZE menu). If you are uncertain about the range of your data, select AUTO 1 16 BIT (FIXD 1 13 BIT is the default selection).
CHAN 2 RANGE	Operates the same in all measurement modes. See the previous section for details.
SOURCE RNG 2	Operates the same in all measurement modes. See the previous section for details.
AUTO 2 16 BIT	Specifies 16 bit dynamic range for Channel 2. This is useful if you do not know which range is appropriate for your device under test. Each sample is checked for a digital overload condition to determine if the upper 13 bits or the lower 13 bits should be read. The last sample's selection (UPR 13 BITS or LOW 13 BITS in the INTERFACE 2 / DATA SIZE menu) is saved during a pause or at the end of a measurement. This feature may extend measurement time as compared to FIXD 1 13 BIT.
FIXD 2 13 BIT	Specifies 13 bit dynamic range for Channel 2. The analyzer uses the upper 13 bits or lower 13 bits (as selected by UPR 13 BITS or LOW 13 BITS in the INTERFACE 2 / DATA SIZE menu). If you are uncertain about the range of your data, select AUTO 1 16 BIT (FIXD 1 13 BIT is the default selection).

Setting Up Triggering

The HP 3563A's trigger function defines the conditions for acquiring a new time record. To set up triggering, press **SELECT TRIG** to display the menu in figure 7-12.
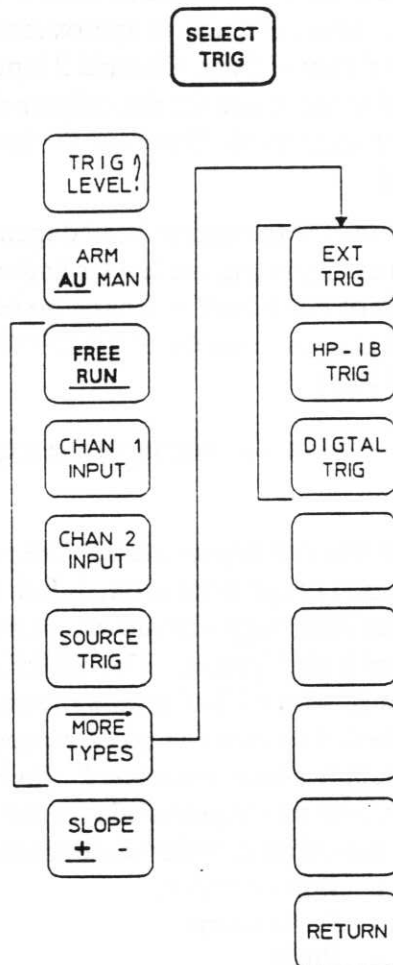
Figure 7-12. SELECT TRIG Menu Diagram

Softkey Descriptions

The softkeys that appear when you press **SELECT TRIG** do the following:

TRIG
LEVEL

Allows you to set the amplitude level at which the trigger is activated. The trigger level is limited to approximately 120% of the current range setting for Channel 1 and Channel 2 input triggering. If a value greater than 120% of the range for the ttrigger channel is entered, the display shows the higher level. However, the level is set to 120% of the input range level.

The resolution of the trigger level depends on the current input range. For external triggering, the level is limited to ± 10V, can be set in increments of 78.125 mV and has a hysteresys of approximately 320 mV. Trigger level is not used for SOURCE TRIG, HP-IB TRIG, DIGTAL TRIG and FREE RUN.

ARM
AU MAN

Selects auto or manual arming of the trigger circuit (default is Auto Arming).

FREE
RUN

Selects the free run trigger mode. The instrument collects the next time record as soon as the current one is full, without waiting for a trigger signal. Free Run triggering always overrides manual arming. The trigger level is also ignored. The TRIGGERING indicator LED (in the Status group) is on while the time record is being filled. The indicator does not flash if the measurement is paused, nor after an averaged measurement has been completed. For best measurement results, do *not* use the free run trigger mode for the following source types (source triggering should be used for these source types):

- Burst Random
- Burst Chirp
- Pulse
- Step
- Ramp

CHAN 1
INPUT

Designates the signal on Channel 1 as the trigger signal. Channel 1 must be analog (if it is digital, the message NO INPUT TRG ON DIG CHAN is displayed). The maximum trigger level you can set is limited to 120% of the input range on Channel 1. Triggering is possible at levels down to 32 dB below 2.5% of the current input range. Burst sources should use source triggering and not input triggering.

CHAN 2
INPUT

Designates the signal on Channel 2 as the trigger signal. Channel 2 must be analog (if it is digital, the message NO INPUT TRG ON DIG CHAN is displayed). The maximum trigger level you can set is limited to 120% of the input range on Channel 2. Triggering is possible at levels down to 32 dB below 2.5% of the current input range. Burst sources should use source triggering and not input triggering.

SOURCE   Designates the source gating signal as the trigger signal. Note that level
TRIG   and slope are not selectable with source triggering. Source triggering is
designed for use with the source burst outputs because it ensures
accurate triggering with these signals:

- Burst Random
- Burst Chirp
- Periodic Chirp
- Pulse
- Step
- Ramp
- User Defined (arbitrary source)

The source gating signal is also available at the rear panel SYNC OUT
connector; see "SYNC OUT (connector)" in appendix A for more
information.

MORE   Displays another menu that allows you to select additional methods of
TYPES   triggering a measurement. See "The MORE TYPES Menu."

SLOPE   Determines whether the measurement triggers on the positive or
+ −   negative transition of the trigger signal through the selected trigger
level. The default trigger is a rising edge (+). Slope is not active with
Free run, Source, Digital, or HP-IB triggering (slope is shown for digital
trigger, but has no effect).

The MORE TYPES Menu

The following trigger types are available when you press **SELECT TRIG** MORE TYPES:

EXT TRIG   Designates the signal at the EXT TRIGGER front panel input as the
trigger signal. This signal is limited to ± 10 Vpeak. This input is always
DC coupled.

HP-IB   Triggers the clock from the HP-IB. Once the HP-IB trigger has been
TRIG   enabled, the analyzer can respond to the HP-IB bus management
command "TRIGGER."

DIGITAL   Specifies the digital trigger, labeled TRG, on the qualifier pod, POD Q.
TRIG   The trigger is a TTL level. Slope is shown for digital trigger, but has no
effect.

Trigger Operation

Figure 7-13 shows the trigger logic in greater detail than shown in figure 7-4. The default trigger type is FREE RUN. You can also choose an analog or digital trigger type as shown in the following table.

Table 7-4. Analog & Digital Trigger Types

Analog Trigger Types	Digital Trigger Types
Channel 1 input (CHAN 1 INPUT)	Internal Source trigger (SOURCE TRIG)
Channel 2 input (CHAN 2 INPUT)	Pod Q TRG signal (DIGTAL TRIG)
Front panel External trigger BNC(EXT TRIG)	HP-IB trigger (HP-IB TRIG)

For analog trigger types, you can specify the trigger level and slope. See "Trigger Conditions" that follows for additional details.
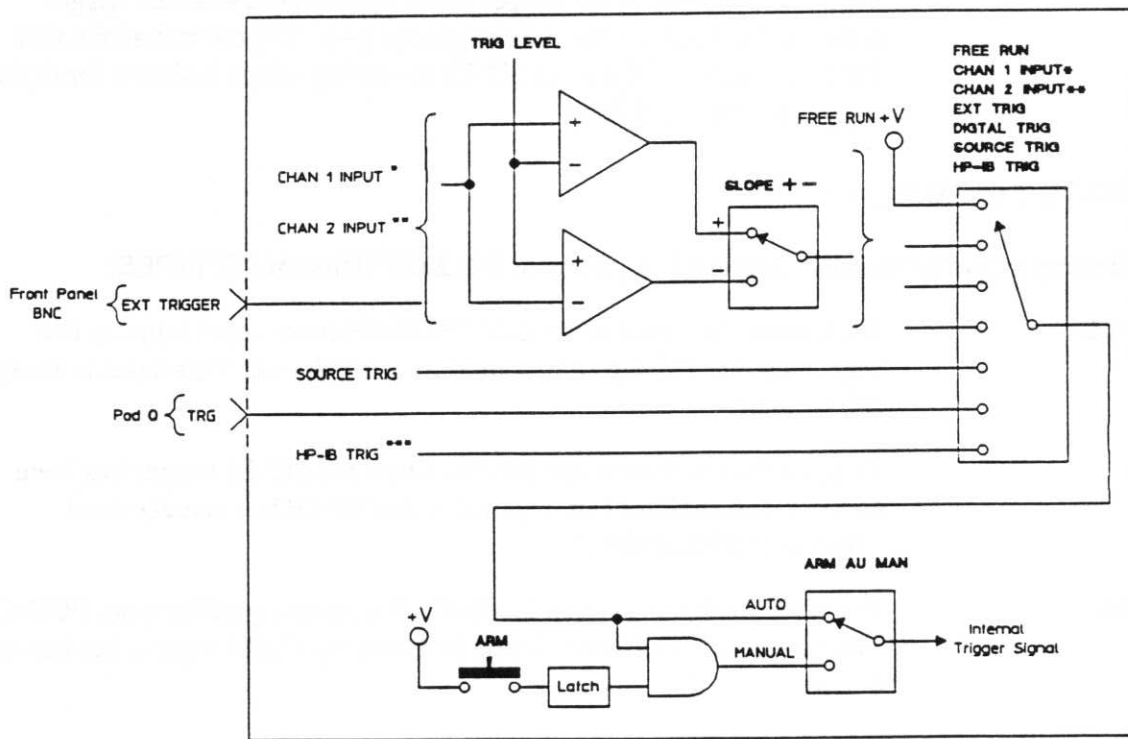
TRIGGER LOGIC

* This selection valid only when Channel 1 is analog.
** This selection valid only when Channel 2 is analog.
*** This signal is generated by the HP-IB Trigger Command.

Figure 7-13. Trigger Logic

Trigger Conditions

The trigger conditions are level and slope, as defined by TRIG LEVEL and SLOPE + −. Whenever the designated analog trigger signal (except source triggering) passes through the specified level on the specified transition, the trigger conditions are met and the measurement triggers. The TRIGGERING indicator LED (in the Status group) may stay on or flash, depending on the type of trigger used (for details, see the TRIGGERING indicator description in appendix A).

Trigger level is limited to 120% of the current range setting for CHAN 1/2 INPUT triggering, to ± 10V for EXT, and is irrelevant for FREE RUN and SOURCE TRIG.

Phase (at time zero) is referenced to the beginning or the center of the time record depending on the window selected, as shown in the following table.

Table 7-5. When Phase is Referenced

Center of Time Record	Beginning of Time Record
Hann	Uniform
Flat Top	Force
User-defined windows	Exponential

Note

External triggering does not operate reliably on signals below 500 mVpeak. With the Channel 1 or 2 inputs, triggering is possible at levels down to 32 dB below 2.5% of the current input range. If the desired external trigger signal is less than 500 mVpeak, it can be applied to either input channel, if the range is set approximately and input channel triggering is used.

Manual Arming Versus Auto Arming

Auto arming automatically resets the trigger after each time record is acquired. Manual arming collects one time record when **ARM** (in the Status group) is pressed and the trigger conditions are satisfied. The instrument does not look for the trigger signal until **ARM** is pressed. The TRIG ARMED indicator light (in the Status group) indicates the trigger has been armed. When one record is acquired, the instrument then waits until **ARM** is pressed again. Free run triggering always overrides manual arming.

Delayed Triggering

The HP 3563A can pre-trigger up to 4095 samples (4094 for zoom) before and post-trigger up to 102,400 samples after the trigger signal actually arrives. Pre-triggering is useful for impact analysis to ensure that you have captured the entire impulse. Post-triggering is helpful when analyzing systems with time delays because the measurement can wait until the desired signal arrives. Delayed triggering is also used when recalling and measuring throughput files from disc (see chapter 9 for more information on time throughput). Note that overload rejection does not reject records used in counting post-trigger delay. Press **TRIG DELAY** to display the following softkeys:

CHAN 1
DELAY   Allows you to set the pre- or post-trigger delay for Channel 1, using the
                    Entry group.

CHAN 2
DELAY   Allows you to set the pre- or post-trigger delay for Channel 2, using the
                    Entry group.

The delay may be specified in microseconds, milliseconds, seconds, minutes, revolutions or records. Enter negative numbers to specify pre-trigger delay. The resolution is 1/2048 of a record (one sample). To find the current time record length for setting delayed triggering, press **STATE TRACE** until the state is displayed and look under **FREQ: REC LGTH**. **Delay is rounded to the nearest** Δt, and the actual delay used can be echoed by pressing CHAN 1/2 DELAY after the measurement. Trigger delays are ignored when the trigger type is free run.

Note   If you change the sign of the trigger delay (with averaging off), disregard the first
                  triggered measurement taken.

Calibrating the HP 3563A

The HP 3563A's calibration routine adjusts the gain and phase accuracy and common-mode rejection of the input channels to comply with the analyzer's specifications. It starts by applying a known signal (internally) to the input channels. Next, it measures this known signal and compares it to the channels' responses. From these, it generates calibration constants that it uses to adjust the input circuitry. During calibration, the analyzer displays "CALIBRATION IN PROGRESS".

If a calibration failure should occur (the failure message will be displayed on the screen), refer servicing to qualified personnel. A list of HP Sales and Support Offices is included at the end of this manual.

You can choose auto cal, which calibrates on a regular schedule, or single cal, which calibrates only when you desire. To make the choice, press **CAL** to display the following softkeys:

AUTO
ON OFF

Selects auto cal; see table 7-6 for the auto cal schedule. This softkey is reset to ON at power-up.

SINGLE
CAL

Pauses any measurement and performs a single calibration. Do a single cal before a measurement if auto cal is off and the measurement must provide calibrated results.

Note

If auto cal is enabled, the analyzer follows the calibration schedule shown in table 7-6, even if both channels are digital. In this case, you can turn auto cal OFF — the analyzer does not use calibration results for digital channels.

Auto Calibration

When auto calibration is selected, the analyzer calibrates according to the schedule in the following table.

Table 7-6. Auto Calibration Schedule

At power-on
8 minutes after power-on or after reset.
1 hour after power-on or after reset.
Every 2 hours thereafter

There are several exceptions to the auto cal schedule. Auto cal does not interrupt averaged measurements, time captures, time throughputs, auto math/auto sequence editing, or sweeps. If source protect is on, calibration turns the source off during the cal, then turns it back on when the cal is finished. Before starting lengthy measurements, turn auto cal off and perform a single cal. Note that the gain and phase are still accurate after two hours unless a significant change in the operating environment (temperature change, etc.) is experienced.

Note   Calibration activates AC coupling and leaves it active.

Calibration at Power-up

The analyzer automatically performs the calibration routine at power-up. You can inhibit the power-up calibration routine using auto-sequence programming (see chapter 10). Simply create an auto-sequence program and label it "AUTOST, CALOFF". The analyzer will then run your auto-sequence program at power-up and skip the calibration routine.

Using Engineering Units

The HP 3563A can calibrate and display measurements using your own engineering units (EU). For example, assume you have an accelerometer calibrated at 10 mV/G. You can tell the HP 3563A to calibrate its measurements at 10 mV/EU and label the display in Gs. Now you can read the display directly and accurately in Gs. You can enter EU values and labels for the two channels independently. Press **ENGR UNITS** to display the following menu:

EU VAL CHAN 1	Selects engineering units for Channel 1. Press EU VAL CHAN 1, then enter your calibration constant.
VOLTS CHAN 1	Selects volts for Channel 1 and disables engineering units.
EU LBL CHAN 1	Used to enter the label for Channel 1 engineering units. See "Entering EU Labels." The label can contain up to five characters. Pressing this displays the alpha menu.
EU VAL CHAN 2	Selects engineering units for Channel 2. Press EU VAL CHAN 2, then enter your calibration constant.
VOLTS CHAN 2	Selects volts for Channel 2 and disables engineering units.
EU LBL CHAN 2	Used to enter the label for Channel 2 engineering units, "See Entering EU Labels." The label can contain up to five characters. Pressing this displays the alpha menu.

Engineering units labels replace "volts" on the trace's vertical scale and EU is used in all applicable units menus. For example, if "METER" is the EU label and you select VOLTS2 as the vertical unit, the display reads $METE^2$ (truncated to four characters) instead of V^2. Two-channel measurements display both EU labels.

EU VAL entries are limited to $\pm 1nV$ to $\pm 1000V$. The dB terminator choice is dB referenced to 1Vrms. The EU terminator softkey that appears in some menus is always linear, even if the trace is displayed on a log scale.

Entering EU Labels

When either EU LBL CHAN 1 or EU LBL CHAN 2 is pressed, the HP 3563A shifts into the alpha mode to allow you to enter an alphanumeric label. In the alpha mode, all front panel keys (except LINE and **HELP**) are converted to their blue labels, and the following menu is displayed:

ENTER	Saves the current alpha entry and exits the alpha mode.
SPACE FORWRD	Moves the cursor one space forward for editing. Use the ARROW keys or the "BL" key to add blanks.
SPACE BACKWD	Moves the cursor one space backward without erasing any characters. To erase, use the **BACK SPACE** key.
INSERT ON OFF	When this is ON, characters are inserted at the cursor position. When it is OFF, new characters are written over existing ones.
DELETE CHAR	Deletes the character at the cursor position.
CLEAR LINE	Clears the alpha entry from the cursor to the end of the line.
CANCEL ALPHA	Clears the current entry and exits the alpha mode.

If engineering units are selected but an EU label is not entered, the default labels EU1 and EU2 are used. Note that EU labels are not displayed on the horizontal axis of orbits diagrams.

Display Configuration

Purpose Of This Chapter

The purpose of this chapter is to show you how to analyze measured data using the HP 3563A's display and marker features. It shows you how to:

1. Select the active trace

2. Format the display

3. Define trace coordinates, units and scale

4. Select the display data — measurement display, input signals or instrument state

5. Use the X, Y and special markers

6. Save and recall states and traces using the HP 3563A's internal memory (storage in external disc memory is discussed in chapter 11)

The HP 3563A Display

Figure 8-1 shows a plot of the HP 3563A's display and explains the various fields on the screen. Some fields depend on display format (single, upper/lower, or front/back).
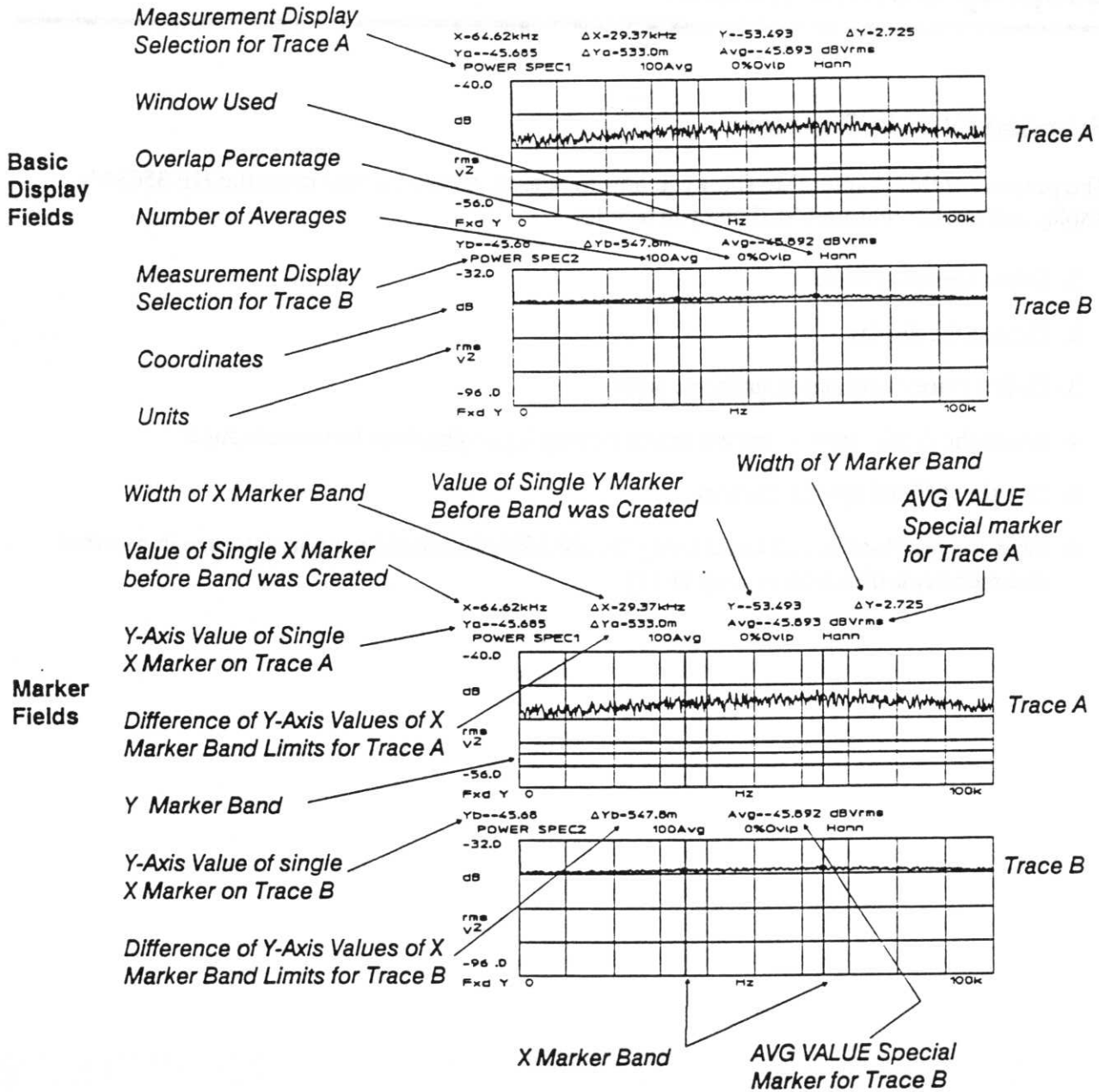
Figure 8-1. The Display

Selecting The Active Trace

The three keys in the Active Trace group select the active trace. Pressing **A** activates trace A and illuminates the indicator above that key. Pressing **B** activates trace B and illuminates the indicator above that key. Pressing **A&B** activates both traces and illuminates both indicators.

Selection of the active trace is important because most display functions, including markers, math, coordinates, scale and Y-axis units, apply only to the active trace(s). In addition to selecting the active trace, these three keys may be used to return a measurement display after a table has been displayed.

Formatting The Display

The three keys in the Display Format group determine the format of the display.

SINGLE shows the active trace in a full 7 cm high display.

UPPER LOWER divides the screen into two 3 cm high displays. Trace A is displayed on the upper grid, and trace B is displayed on the lower grid. The labels for the active trace(s) are highlighted.

FRONT BACK superimposes both traces in a 6.5 cm high display. The display height is reduced slightly to allow room for the extra annotation at the top of the screen. The active trace and its annotation are highlighted.

Defining The Trace

Three keys and their associated menus define the active trace(s). **COORD** selects the trace coordinates, including the choice between linear and logarithmic X-axis, to show different aspects of the measurement data. **SCALE** defines the horizontal and vertical scales. **UNITS** selects the horizontal and vertical units in which the traces are displayed.

Note   For user-defined vertical units, see "Using Engineering Units" in chapter 7.

Combining Coordinates And Units

The HP 3563A was designed to provide maximum flexibility in arranging the display to best fit your measurement needs. As a result, it can provide many combinations of units and coordinates. Some of these combinations yield unconventional results, so you should verify each combination. Refer to the coordinate and units fields on the display when interpreting each trace. Figure 8-1 at the beginning of this chapter shows where these fields are on the display.

Selecting Trace Coordinates

Trace coordinates may be selected before or after the measurement is made. Changing coordinates changes only the displayed trace; it does not alter or destroy any measurement data. Coordinates cannot be selected for the ORBITS T1vsT2 and DEMOD POLAR displays. To select coordinates, press **COORD**. Figure 8-2 shows the menu diagram for this hardkey.

Note	See "Measurement Modes, Trace Coordinates, and Units" in chapter 2 for an overview of trace coordinates and units. Furthermore, chapter 2 shows the vertical axis units available in each measurement mode (some vertical axis units are not available in all measurement modes).
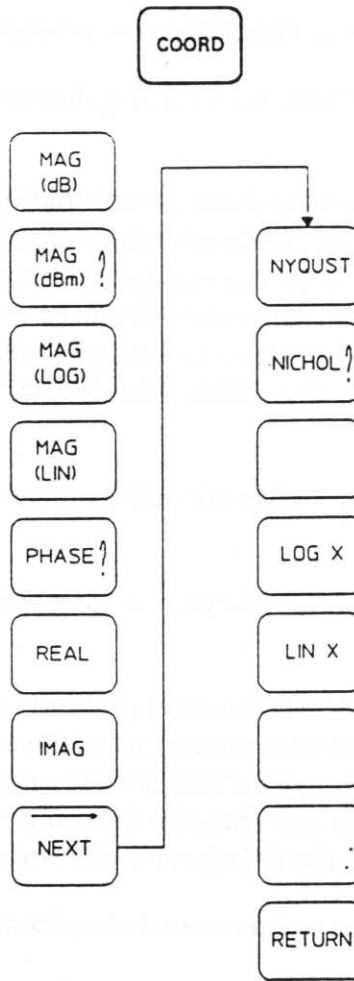
Figure 8-2. COORD Menu Diagram

The softkeys that appear when you press **COORD** do the following:

MAG
(dB)
Defines the vertical axis as magnitude displayed in dB (deciBels).

MAG
(dBm)
Defines the vertical axis as magnitude displayed in dBm (deciBels referenced to 1 milliwatt). After pressing MAG (dBm), you can enter an impedance value that matches the impedance of your input signal. The dBm coordinate must be referenced to a known impedance (traditionally 50Ω), so the analyzer needs to know the impedance of your inputs. The default value is 50Ω. See Note 2 at the end of this menu.

MAG
(LOG)
Defines the vertical axis as linear magnitude on a log scale.

MAG
(LIN)
Defines the vertical axis as linear magnitude on a linear scale.

PHASE
Displays phase coordinates (the vertical axis units are degrees). At power-on or after pressing reset, the center of the vertical axis is set to zero degrees. Other center values may be selected by pressing PHASE, entering the new phase for the center of the display, then pressing DEGREE. The default is 0°. See Note 1 at the end of this menu.

REAL
Displays the real portion of complex measurement data.

IMAG
Displays the imaginary portion of complex measurement data.

NEXT
Selects other options for the trace coordinates (see the following section).

Note 1

The appearance of the phase display depends on the Y-axis scaling; see "Scaling the Display" later in this section. Single-channel phase is referenced to the middle of the time record for the Hann, user-defined, flat top; and the beginning of the record for force, exponential and uniform windows. Phase is not calibrated for time capture and time throughput measurements.

Note 2

MAG (dBm) selects dBm for power spectra and dB for frequency response. If a frequency response is displayed when MAG (dBm) is pressed, dBm is still selected for subsequent power spectra.

The softkeys that appear when you press **COORD** NEXT do the following:

NYQUST — Configures the display as a Nyquist diagram (often referred to as a polar plot). Nyquist shows real values on the X-axis versus imaginary values on the Y-axis. This display is available only with complex data.

NICHOL — Configures the display as a Nichols plot. This display shows phase on the X-axis versus log magnitude on the Y-axis. At power-on and after pressing reset, the center of the X-axis defaults to zero degrees. After pressing NICHOL, you can enter the phase center of the X-axis, from -360 to +360 degrees. This display is available only with complex data.

LOG X — Selects a logarithmic horizontal axis. This softkey is applicable only to frequency domain displays. See the Note at the end of this menu.

LIN X — Selects a linear horizontal axis. See Note at the end of this menu.

Note

If a trace is created with linear resolution, then displayed in log resolution (using LOG X), points in the resultant trace are not equally spaced on the x-axis. The converse is true if a trace is created with log resolution and then displayed in linear resolution (using LIN X).

Selecting Units

The **UNITS** key allows you to select the horizontal and vertical units and enter trace titles. As with coordinates, changing the units does not alter or destroy any measurement data. Figure 8-3 shows the menu diagram for the **UNITS** hardkey.

Note	See "Measurement Modes, Trace Coordinates, and Units" in chapter 2 for an overview of trace coordinates and units. Furthermore, chapter 2 shows the vertical axis units available in each measurement mode (some vertical axis units are not available in all measurement modes).

UNITS

P SPEC UNITS

L SPEC UNITS

SWEPT UNITS

| Hz (Sec) |
| RPM (Sec) |
| Orders (Revs) |
| Orders ? CAL ! |
| TRACE ? TITLE ! |

| VOLTS PEAK |
| VOLTS RMS |
| VOLTS |
| VOLTS² |
| |
| |
| |
| RETURN |

| VOLTS PEAK |
| VOLTS RMS |
| VOLTS |
| V√Hz (√PSD) |
| |
| |
| |
| RETURN |

| VOLTS PEAK |
| VOLTS RMS |
| VOLTS |
| VOLTS² |
| V√Hz (√PSD) |
| V²/Hz (PSD) |
| V²S/Hz (ESD) |
| RETURN |
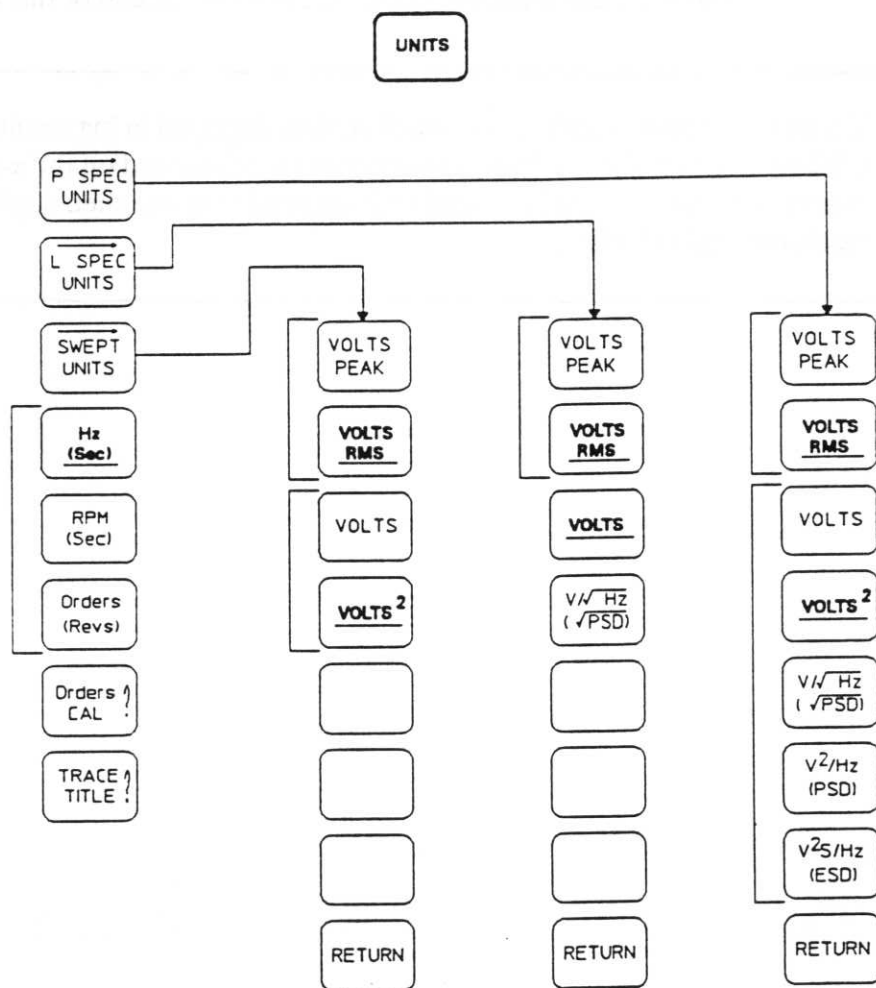
Figure 8-3. UNITS Menu Diagram

The softkeys that appear when you press **UNITS** do the following:

P SPEC UNITS	Displays the power spectrum units menu, which sets the units for power and cross spectrum displays. See "The Power Spectrum Units Menu" later in this chapter.
L SPEC UNITS	Displays the linear spectrum units menu, which set the units for linear spectrum displays. See "The Linear Spectrum Units Menu" later in this chapter.
SWEPT UNITS	Displays the swept units menu, which sets the units for power and cross spectrum displays in the swept sine mode. See "The Swept Units Menu" later in this chapter.
Hz (Sec)	Selects Hertz (or seconds for time domain traces) as the horizontal unit. This softkey does not apply to amplitude domain displays.
RPM (Sec)	Selects RPM (or seconds for time domain traces) as the horizontal unit. This softkey does not apply to amplitude domain displays.
Orders (Revs)	Selects Orders (or revolutions for time domain traces) as the horizontal unit. This is normally used with external sampling; refer to chapters 3, 4 or 6 (depending on the measurement mode) for more information. This softkey does not apply to amplitude domain displays.
Orders CAL	Used to enter Orders calibration in Hz/Ord. The calibration is stored in nonvolatile memory and is not affected by power-on or reset. This display unit does not affect the sampling frequency.
TRACE TITLE	Displays the alpha mode menu and allows you to enter a trace title. See "Trace Title" later in this chapter.

The Power Spectrum Units Menu

Power spectrum units apply to power and cross spectrum displays in the linear resolution, log resolution and time capture modes. After a selection is made, all power and cross spectrum displays in these three modes are in those units. Note that power spectrum units apply only to these displays and do not affect any other displays. To select these units, press **UNITS** followed by P SPEC UNITS (see figure 8-3).

The softkeys that appear when you press P SPEC UNITS do the following:

VOLTS PEAK	Selects volts (peak) as the basic amplitude unit.
VOLTS RMS	Selects volts (rms) as the basic amplitude unit.
VOLTS	Displays the trace in volts.
VOLTS^2	Displays the trace in volts^2.
V/$\sqrt{Hz}$ ($\sqrt{PSD}$)	Displays the trace in volts divided by square root of equivalent filter bandwidth.
V^2/Hz (PSD)	Displays the trace in volts^2 divided by equivalent filter bandwidth (power spectral density).
V^{2}s/Hz (ESD)	Displays the trace in volts^2 times record length divided by equivalent filter bandwidth (energy spectral density).

The Linear Spectrum Units Menu

Linear spectrum units apply to linear spectrum displays. After a selection is made, all linear spectra are displayed in those units. Note that linear spectrum units apply only to these displays and do not affect any other displays. To select these units, press **UNITS** followed by L SPEC UNITS (see figure 8-3).

The softkeys that appear when you press L SPEC UNITS do the following:

VOLTS PEAK	Selects volts (peak) as the basic amplitude unit.
VOLTS RMS	Selects volts (rms) as the basic amplitude unit.
VOLTS^2	Displays the trace in volts^2.
V/$\sqrt{Hz}$ ($\sqrt{PSD}$)	Displays the trace in volts divided by square root of equivalent filter bandwidth.

The Swept Units Menu

Swept units apply to power and cross spectrum displays in the swept sine mode. After a selection is made, all power and cross spectrum displays in the swept sine mode are in those units. Note that swept units apply only to these swept sine displays and do not affect any other displays. To select these units. press **UNITS**, followed by SWEPT UNITS (see figure 8-3).

The softkeys that appear when you press SWEPT UNITS do the following:

VOLTS PEAK	Selects volts (peak) as the basic amplitude unit.
VOLTS RMS	Selects volts (rms) as the basic amplitude unit.
VOLTS	Displays the trace in volts.
VOLTS^2	Displays the trace in volts^2.

Note   MAG (dB) provides a faster display when used with the VOLTS^2 unit, as opposed to the VOLTS unit.

Trace Title

This softkey (see figure 8-3) is used to enter trace titles. Titles can contain up to 20 alphanumeric characters and are plotted along with the display. When TRACE TITLE is pressed, the instrument shifts into the alpha mode, in which all front panel keys (except **LINE** and **HELP**) are converted to the blue labels under them. The **START** key, for example, becomes "C" in the alpha mode. Titles are erased at power-on and after reset.

When you press TRACE TITLE, the following alpha-mode menu appears:

ENTER — Saves the current alpha entry, displays it under the active trace, then exits the alpha mode.

SPACE FORWRD — Moves the cursor one space forward without erasing any characters. Use the ARROW keys or the "BL" key to add blanks.

SPACE BACKWD — Moves the cursor one space backward without erasing any characters. To erase, use **BACK SPACE**.

INSERT ON OFF — When this is ON, characters are inserted at the cursor position. When it is OFF, characters are written over existing characters at the cursor position.

DELETE CHAR — Deletes the character at the cursor position.

CLEAR LINE — Clears the alpha entry from the cursor position to the end of the line.

CANCEL ALPHA — Exits the alpha mode without changing the trace title.

Scaling The Display

The horizontal and vertical axes offer several scaling options. You can explicitly enter minimum and maximum values for either axis, or the HP 3563A can auto scale to obtain the optimum display. In addition, the scale can be set to the current X and Y marker bands. Note that several of the **SCALE** softkeys are duplicated in the **X** and **Y** marker menus for convenience. Press **SCALE** to display the menu in figure 8-4.

```
┌──────────┐
│  SCALE   │
└──────────┘

┌──────────┐
│ X FIXD   │
│ SCALE    │
└──────────┘
┌──────────┐
│ X MRKR   │
│ SCALE    │
└──────────┘
┌──────────┐
│ X AUTO   │
│ SCALE    │
└──────────┘
┌──────────┐
│          │
└──────────┘
┌──────────┐
│ Y FIXD   │
│ SCALE    │
└──────────┘
┌──────────┐
│ Y MRKR   │
│ SCALE    │
└──────────┘
┌──────────┐
│ Y AUTO   │
│ SCALE    │
└──────────┘
┌──────────┐
│ Y DFLT   │
│ SCALE    │
└──────────┘
```
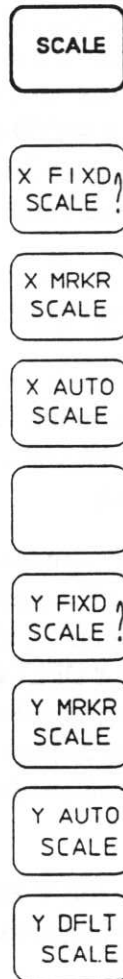
Figure 8-4. SCALE Menu Diagram

The softkeys that appear when you press **SCALE** do the following:

X FIXD SCALE	Used to enter the X-axis scale values. Press X FIXD SCALE then enter the minimum and maximum values separated by a comma (,). A single entry sets the right side of the scale and uses the previous width to determine the left side. You can also press this to fix scales defined by autoscaling.
X MRKR SCALE	Scales the X-axis to the current X marker band. This softkey appears in both the **X** and **SCALE** menus. The X marker must be active. No information is lost when the display is scaled; the original scale can be returned by pressing X AUTO SCALE. See "The X Marker" later in this chapter for information on hold modes (the HOLD X softkeys) and setting up the X marker band.
X AUTO SCALE	Automatically scales the X-axis to display all of the measured data. To fix a scale defined by autoscaling, press X FIXD SCALE.
Y FIXD SCALE	Used to enter the Y-axis scale values. Press Y FIXD SCALE then enter the minimum and maximum values separated by a comma (,). A single entry sets the top of the scale. You can also press this to fix scales defined by autoscaling.
Y MRKR SCALE	Scales the Y-axis to the current Y marker band. This softkey appears in both the **X** and **SCALE** menus. The Y marker must be active. No information is lost when the display is scaled; the original scale can be returned by pressing Y DFLT SCALE (assuming the trace has not changed.) Pressing this softkey with a single Y marker puts the marker level at the top of the display. See "The Y Marker" later in this chapter for information on hold modes (HOLD Y softkeys) and setting up the Y marker band.
Y AUTO SCALE	Automatically scales the Y-axis to obtain the optimum display and activates the autoscaling mode. To fix a scale defined by autoscaling, press Y FIXD SCALE.
Y DFLT SCALE	Selects the Y default scale, which is defined by the current input range, amplitude units and measurement display.

Y-axis Scaling

You can scale the Y-axis in one of two ways: auto or fixed. Vertical auto-scaling (selected with Y AUTO SCALE) checks the active trace every time it is changed or updated to ensure that the vertical scale provides the optimum display. Pressing Y AUTO SCALE scales the trace immediately and leaves the display in auto scaling. Y DFLT SCALE, Y MRKR SCALE and Y FIXD SCALE explicitly define the vertical scale. When one of these three softkeys is pressed, the display stops auto-scaling and stays fixed at the selected values. To determine whether the current scaling is auto or fixed, look at the bottom of the Y-axis on the display; if "Fxd Y" or "Fxd XY" is displayed, the scale is fixed. If not, Y-axis auto-scaling is active.

X-axis Scaling

You can also use auto or fixed scaling to scale the X-axis. However, the X-axis auto scale operates in a different manner than the Y-axis. X AUTO SCALE sets the horizontal scale to match the frequency span (for frequency domain displays), the time record length (for time domain displays), or amplitude range (for amplitude domain displays). X AUTO SCALE also activates auto-scaling and changes the scale whenever the span, record length or amplitude range is changed. X FIXD SCALE and X MRKR SCALE explicitly define the horizontal scale. When either of these is pressed, the display stops auto-scaling and stays fixed at the selected values. To determine whether the display is auto or fixed scaling, look at the bottom of the Y-axis on the display; if "Fxd X" or "Fxd XY" is displayed, the scale is fixed. If not, X-axis auto-scaling is active. To leave auto-scaling in the last scale it defined, press X FIXD SCALE.

Displays With Special Scaling Characteristics

The Nichols, Nyquist, ORBITS T1vsT2, and DEMOD POLAR displays have special scaling characteristics since they are three-dimensional displays. The X and Y scaling softkeys operate on the horizontal and vertical axes, not on the third axis. On the Nichols display, for example, X FIXD SCALE sets phase on the X-axis, not frequency. The third axis is adjusted automatically when either the X- or Y-axis is adjusted. Note also that adjusting the X-axis on Nyquist, orbits, and demod polar automatically adjusts the Y-axis, and vice versa. This is done to maintain the display's aspect ratio.

With the Nyquist, orbits, and demod polar displays, Y DFLT SCALE sets the center of the display to 0,0 and puts all measurement data on the screen and sets the minimum and maximum scales depending on input range. Y AUTO SCALE also puts all data on the screen, but sets the center of the display to the center of the data. For the Nichols display, Y DFLT SCALE sets the Y scale to the MAG (dB) scale and fixes the X scale to its current value. X and Y AUTO SCALE adjust their respective scales for an optimum display.

Selecting Display Data

The Select Data keys provide three choices of display data: measurement displays, view inputs and the state display.

MEAS DISP selects measurement displays. Chapter 2 shows how these displays are derived. The menu displayed with this key depends on the measurement mode selected; refer to chapters 3-6 (depending on the current measurement mode) for more information.

VIEW INPUT lets you display the input signals before they are filtered to the current frequency span, triggered, or measured. Chapter 2 shows now these displays are derived. The view input displays (also called *instantaneous* displays) are useful when you need to verify the presence of an input signal or compare the input signal with the measurement display. The menu displayed with this key also depends on the measurement mode selected; again, refer to chapters 3-6 (depending on the measurement mode selected) for more information.

STATE/TRACE toggles between the instrument state display and the displayed trace. There may be two pages of state information: page one with measurement setup information (Figure 8-5); page two with digital input-channel information (Figure 8-6). Figure 8-5 and shows the state display at power-on or reset.

Page two exists only when one or both channels are digital. When page two exists, the current page number is displayed in the upper-right corner of the display. To see the second page of state information, press **STATE/TRACE** a second time. Press **STATE/TRACE** a third time to redisplay the trace.
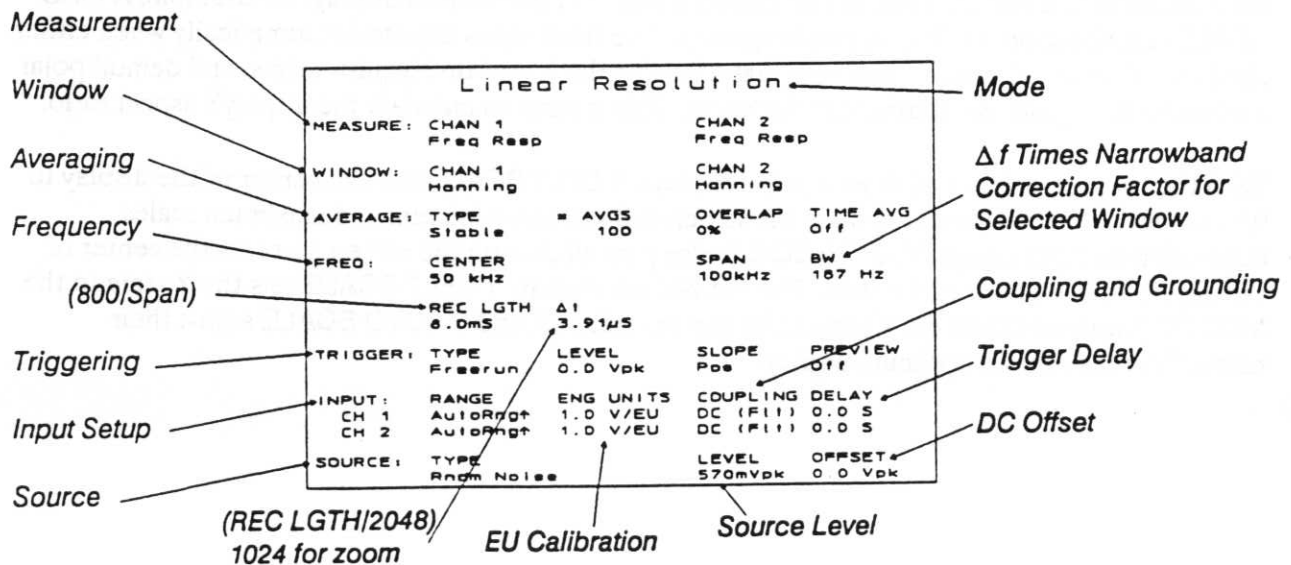
Figure 8-5. Analog State Information

```
                    Digital  Setup                    Page 2

        INPUT:      CHAN 1                  CHAN 2
                    Digital (Pod 1)         Digital (Pod 2)

        DATA:       FORMAT      # BITS      BUS SZ      ALIGNM ENT
         CH 1       Twos Cmp    16          16          Low 13
         CH 2       Offset      16 + Ovfl   16          Upr 1 3

        CLOCK:      EDGE        QUALIFIER               DELAY
         CH 1       Pos         XXXX0101                5.0 μS
         CH 2       Neg         XXXXXXXX                0.0 S

        SAMPLE:                 FREQ
         CH 2                   256kHz


        OUTPUT:     Digital

        SOURCE:     TYPE                    LEVEL
                    Rndm Noise              0.0 Vpk

        DATA:       FORMAT      QUALIFIE R  RANGE
                    Twos Cmp    XXXXXXXX    5.12 Vpk
```

Input Channels

Sample Clock

Source

Indicates computational delay for Channel 1 is 5.0μs

Indicates overflow detector is on

Channel 1 qualifier pattern

Channel 2 qualifier pattern

Shows active clock edge for Channel 1&2 data clocks

Figure 8-6. Digital State Information

Using The Markers

The HP 3563A offers both horizontal (X-axis) and vertical (Y-axis) markers, as well as several special marker functions. The markers can be used to magnify a narrow portion of a trace, identify a band or region, curve fit inside a band, adjust the horizontal and vertical scales, measure relative to fixed reference, or highlight items such as harmonics and sidebands. In addition, the **MARKER VALUE** key in the Entry group works in conjunction with the markers to simplify numeric entries by entering values that are identified on the display.

The knob in the Marker group is assigned to move the marker that is currently active. The active marker is identified by the indicators above the **X** and **Y** keys.

The X marker is tied to the displayed trace data, while the Y marker is tied to screen locations. Because of this, minor rounding discrepancies may occur when the markers are positioned at the same point.

Creating Marker Bands

Bands are created in one of two ways:

1. After pressing **X**, **Y**, **X VALUE** or **Y VALUE**, enter the minimum and maximum values separated by a comma. For example, pressing X VALUE 10,20 kHz sets up an X marker band from 10 to 20 kHz.

2. Activate either marker then use the HOLD X or HOLD Y softkeys to expand the band from the single dot (X) or line (Y).

To erase marker bands and return the single dot or line, refer to the descriptions of HOLD X OFF and HOLD Y OFF in the following sections.

The X Marker

Pressing X in the Marker group activates the X marker. When it is activated, the X marker appears as an intensified circle which is moved across the trace with the Markers knob. Pressing **X** also displays the menu in figure 8-7.
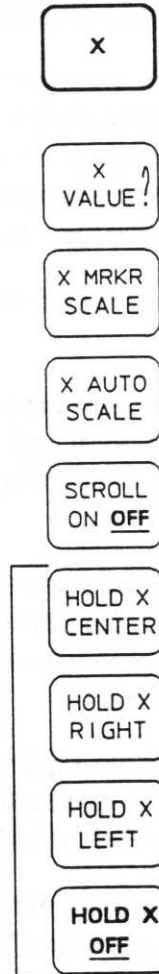
Figure 8-7. X Menu Diagram

The softkeys that appear when you press **X** do the following:

X VALUE	Used to move the X marker to a explicit point on the horizontal axis. The units softkeys displayed after you enter the value are determined by the current horizontal units. To set up a band, enter the minimum and maximum values separated by a comma. You can also enter X values immediately after pressing the **X** key.
X MRKR SCALE	Scales the X-axis to the current X marker band. The X marker must be active. No information is lost when the display is scaled; the original scale can be returned by pressing X AUTO SCALE. Pressing this with a single X marker results in a scaled display centered about the marker position. This softkey appears in both the **X** and **SCALE** menus.
X AUTO SCALE	Scales the X-axis to display all measured data.
SCROLL ON OFF	SCROLL ON allows you to scroll the complete trace through the magnifying "window" of an X marker band. See the HOLD X softkeys and "An Example of Scrolling" later in this chapter. SCROLL OFF is the default.
HOLD X CENTER	Causes the X marker to split and expand symmetrically around its original position as the marker knob in the Entry group is rotated. The two vertical lines outline the band. See "Using the X Marker Bands" later in this chapter.
HOLD X RIGHT	Causes the X marker to split and expand to the left as the marker knob is rotated. The two vertical lines outline the band. See "Using the X Marker Bands" later in this chapter.
HOLD X LEFT	Causes the X marker to split and expand to the right as the marker knob is rotated. The two vertical lines outline the band. See "Using the X Marker Bands" later in this chapter.
HOLD X OFF	To move a band across the display while maintaining its current width, press HOLD X OFF, then move the band with the Marker knob. To erase a band and restore the single X marker, activate one of the HOLD X softkeys, then turn the knob until the band contracts to a single line and press HOLD X OFF. HOLD X OFF is the default X marker.

An Example of Scrolling

Figure 8-8a shows a measurement made at 0 — 100 kHz. A 10 kHz wide X marker band was created using HOLD X CENTER; the band is shown from 45 to 55 kHz in figure 8-8b. Figure 8-8c shows this 10 kHz band magnified using X MRKR SCALE. Finally, SCROLL ON OFF was toggled ON, then the entire 0—100 kHz trace was viewed, 10 kHz at a time, using the knob in the Marker group. Figure 8-8d shows the trace scrolled through 5 to 15 kHz. Note that scrolling follows the time or frequency axis in displays with more than two axes.
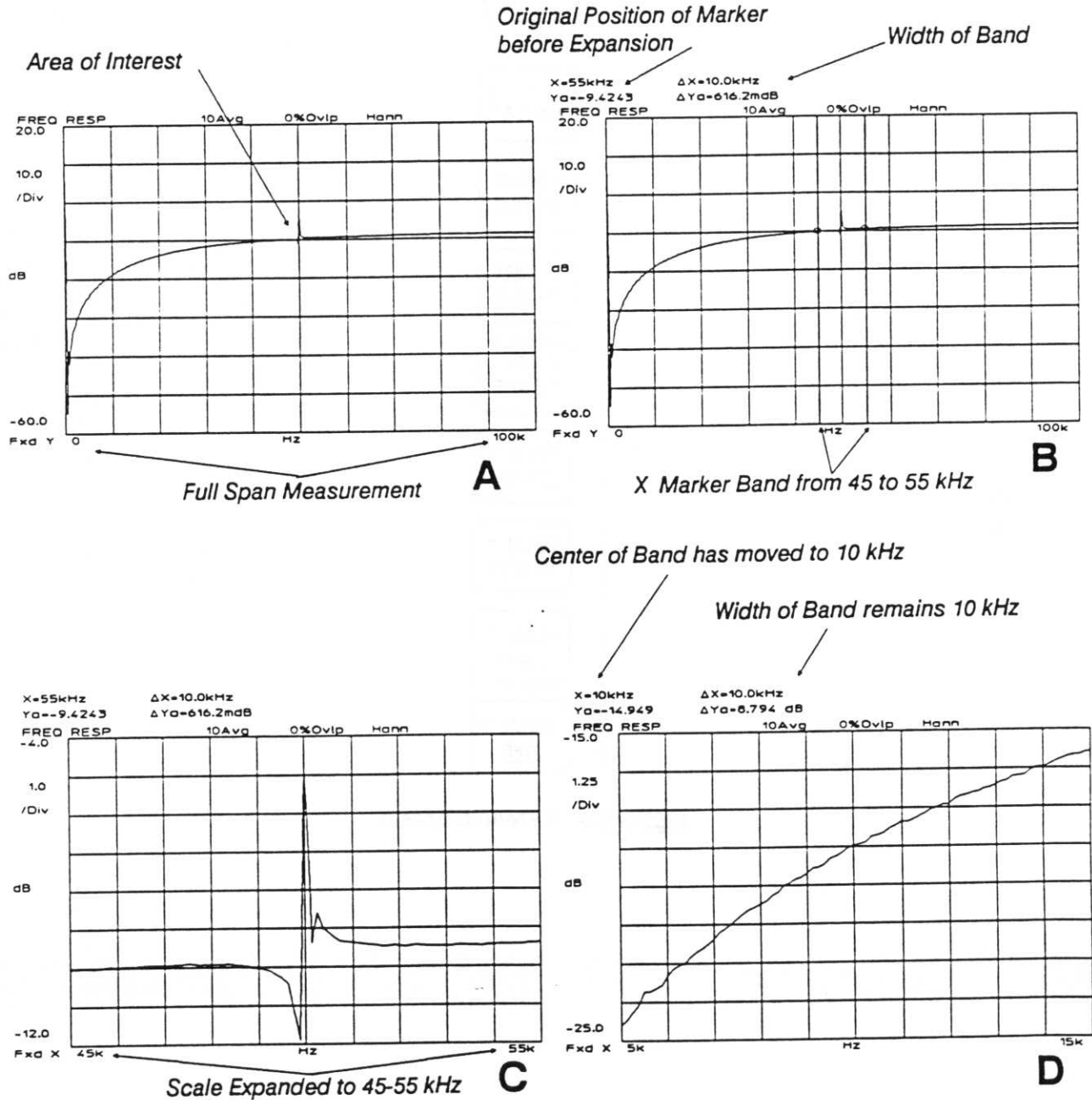
Figure 8-8. Using X Marker Scrolling

The Y Marker

Pressing Y in the Marker group activates the Y marker. When the Y marker is activated, it appears as a single horizontal line which is moved along the vertical axis with the Markers knob. Pressing **Y** also displays the menu in figure 8-9.
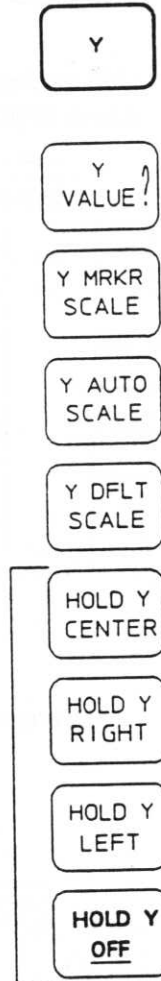
Figure 8-9. Y Menu Diagram

The softkeys that appear when you press **Y** do the following:

Y VALUE	Used to move the Y marker to an explicit point on the vertical axis. The units softkeys displayed after you enter the value are determined by the current amplitude units and coordinates. To set up a band, enter the minimum and maximum values separated by a comma. You can also enter Y values immediately after pressing the Y key.
Y MRKR SCALE	Scales the Y-axis to the current Y marker band. This softkey appears in both the **X** and **SCALE** menus. The Y marker must be active. No information is lost when the display is scaled; the original scale can be returned by pressing Y DFLT SCALE (assuming the trace has not changed.) Pressing this softkey with a single Y marker puts the marker level at the top of the display.
Y AUTO SCALE	Automatically scales the vertical axis to obtain the optimum display.
Y DFLT SCALE	Select the Y default scale, which is determined by the input range setting, measurement display and coordinates.
HOLD Y CENTER	Causes the Y marker to split and expand symmetrically around its original position to form a band as the Marker knob is rotated.
HOLD Y UPPER	Causes the Y marker to split and expand downward to form a band as the Marker knob is rotated.
HOLD Y LOWER	Causes the Y marker to split and expand upward to form a band as the Marker knob is rotated.
HOLD Y OFF	To move a HOLD Y band along the vertical axis while maintaining its current width, press HOLD Y OFF, then move the band with the Marker knob. To erase a band and restore the single Y marker, activate one of the HOLD Y softkeys, then turn the knob until the markers contract to a single line, then press HOLD Y OFF. HOLD Y OFF is the default Y marker.

Relative Marker Measurements

The HOLD X and HOLD Y marker bands are also used to measure points on the display relative to a fixed reference. As an example, here are the steps to measure the amplitude level of a harmonic relative to the fundamental:

1. Activate the Y marker and move it to the peak of the fundamental.

2. Press HOLD Y UPPER to activate the Y marker band.

3. Rotate the Markers knob until the band spreads from the fundamental to the harmonic in question.

4. The absolute amplitude of the fundamental is displayed as "Y =" and the amplitude of the harmonic relative to the fundamental is displayed as "ΔY =." These readouts appear at the top of the screen.

The Special Marker Functions

The special marker functions provided by the HP 3563A are harmonic and sideband markers, a variety of special calculations, and peak search. These functions operate with the X markers in both single and band modes. Press **SPCL MARKER** to use the special markers. Figure 8-10 shows the menu diagram for this key.
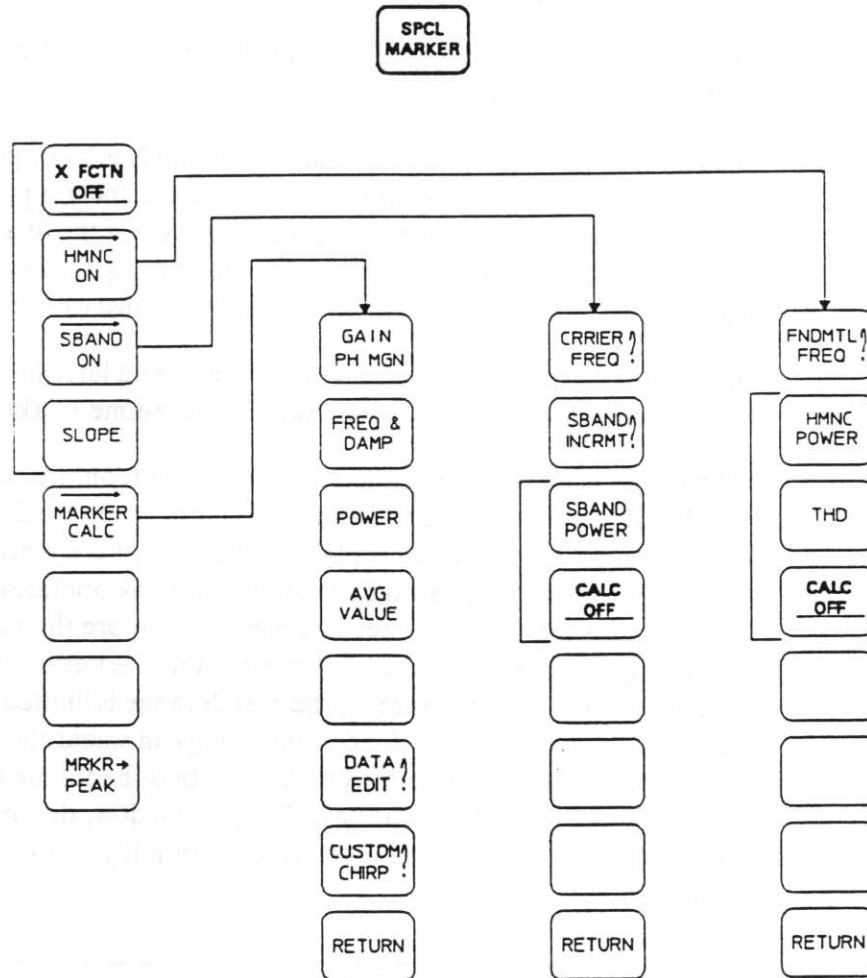
Figure 8-10. SPCL MRKER Menu Diagram

The softkeys that appear when you press **SPCL MARKER** do the following:

X FCTN OFF	Deactivates all special marker functions. Special marker functions are turned off at power-on or after a reset.
HMNC ON	Activates the harmonic marker and displays its menu (described later in "The Harmonic Markers").
SBAND ON	Activates the sideband marker and displays its menu (described later in "The Sideband Markers").
SLOPE	Calculates and displays the slope at the current X marker position. The slope is shown in the measurement area of the display (upper right corner). If an X marker band is active, the slope of the least squares average inside the band is calculated. Slope on log Y-axes is read out as Log Y/x-axis unit. Slope is not available on Nyquist or Nichols displays.
MARKER CALC	Displays the marker calculations menu (described later in "The Marker Calculations Menu") that allows you to do one-time marker calculations.
MRKR → PEAK	Moves the marker to the highest amplitude point on the active trace. If X→MRKR is not on, this function turns it on. The search for the highest amplitude point takes place to the right of the marker. No points are skipped. An automatic marker to peak operation is performed when the X marker is turned on. If more than one point is at the highest amplitude, the marker moves to the leftmost point. If an X marker band is on the screen, the search range is limited to the area between the two markers. Since windowing can smear the dc component when in the frequency-domain base-band, the marker skips the first 5 points if you are using a Flat Top window, the first 2 points if you are using a Hann window, or the first point if you are using any other window.

Note

To pause view-input displays (also called instantaneous displays) for stable marker readouts, press **VIEW INPUT** followed by VIEW OFF.

Note that for computationally-intensive functions (such as slope) the marker annotation jumps across the trace as you rotate the Markers knob, rather than calculating across.

The Harmonic Markers

These markers highlight a fundamental frequency and its first twenty harmonics. To activate the harmonic markers, press **SPCL MARKER** followed by HMNC ON (see figure 8-10).

The harmonic markers are not available for the following:

- Non-Frequency Data (time, histograms)
- Log Sweeps
- Log Resolution Mode Displays
- Nichols and Nyquist displays

The harmonic-marker softkeys do the following:

FNDMTL FREQ	Used to enter the frequency of the fundamental. Press FNDMTL FREQ, then enter the frequency using the Entry group. The range of fundamental frequencies is 0 to 100 kHz. After the fundamental has been entered, markers are displayed at that frequency and its first 20 harmonics. The default value is 5 kHz at power-on and after reset. The fundamental can be set below the current frequency span.
HMNC POWER	Shows the harmonic power in the area outlined by the X marker band. Up to 20 harmonics can be used to calculate harmonic power. If a band is not active, the power in all 20 harmonics is calculated. Press CALC OFF to stop the calculation. See "The X Marker", earlier in this chapter, for information on the X marker bands.
	The harmonic power readout is in volts squared (or volts squared seconds for ESD units). The label on the harmonic power readout depends on the trace units as follows: ■ HEG indicates harmonic energy ■ HSM indicates harmonic sum ■ HPR indicates harmonic power
THD	Calculates the total harmonic distortion (THD) generated by the harmonics identified with the harmonic markers. Only the harmonics inside the display scale are included in the calculation. Press CALC OFF to stop the calculation. THD is displayed in dB for log traces and in % for log magnitude and linear magnitude traces. No more than 20 harmonics are used to calculate harmonic THD.
CALC OFF	Deactivates the HMNC POWER and THD calculations. This does not affect the harmonic markers themselves. This is the default harmonic marker selection.

The Sideband Markers

The sideband markers highlight a carrier frequency and the first 10 sidebands on each side of the carrier. You can specify the carrier frequency and the sideband increment. Press **SPCL MARKER** followed by SBAND ON to activate the sideband markers (see figure 8-10). The sideband-marker softkeys do the following:

CRRIER
FREQ
    Used to enter the carrier frequency. The carrier may be set at any frequency and need not be within the current frequency span. The first marker is placed at the value you enter (The default value at power-on and after reset is 5 kHz). Additional markers, determined by the value of the SBAND INCRMT softkey, are placed at the first ten sidebands.

SBAND
INCRMT
    Used to enter the sideband increment. This value is used to calculate the sideband frequencies based on the carrier frequency. The default value at power-on and after reset is 2.5 kHz.

SBAND
POWER
    Calculates and displays the sideband power contained in the area outlined by the X marker band. The sideband power readout is in volts squared (or volts squared seconds for ESD units). If the band is not active, the power in all 20 sidebands is calculated. Only sidebands on the screen are included. No more than 20 side bands are used to calculate sideband power, 10 per sideband. Press CALC OFF to stop the calculation.

The label on the sideband power readout depends on the trace units as follows:
- SEG indicates sideband energy
- SSM indicates sideband-sum (same as harmonics)
- SPR indicates sideband power

The sideband marker is not available for:
- Non-Frequency Data (time, histograms)
- Log Sweeps
- Log Resolution Mode Displays
- Nichols and Nyquist displays

CALC
OFF
    Deactivates the SBAND POWER calculation. This does not affect the sideband markers themselves. This is the default sideband marker selection.

The Marker Calculation Menu

The marker-calculation softkeys allow you to do one-time marker calculations. Press **SPCL MARKER** followed by MARKER CALC to access these softkeys (see figure 8-10), which do the following:

GAIN &
PH MGN

Calculates and displays the gain and phase margin for the active trace. The gain margin is defined as the magnitude level (in dB) when the phase crosses below – 180 degrees. A value in the range of ± 6dB, indicates the possibility of an unstable system. The phase margin is defined as 180 degrees minus the absolute value of the phase angle (in degrees) when the gain is equal to 0 dB or 1. A value less than ± 10 indicates the possibility of an unstable system. If the gain or phase crossover occurs between measured data points, the actual crossover is linearly interpolated.

The search for zero gain and phase starts at the beginning of the data, regardless of whether it is on the screen, and continues until the first gain and phase crossovers are found. Or, the search starts at the marker if an X marker is on the screen. The search is limited to the area between the two markers if an X marker band is on the screen. The gain and phase margin values found by the search are displayed above the trace and are preceded by "G=" and "P=", respectively. If no margin is found, the message "NONE" is displayed.

FREQ &
DAMP

Calculates and displays the resonant frequency and damping values in the active trace using a 1 degree of freedom curve fitter. The calculation is made inside the X marker band if it is active, or 20 points on both sides of the active single X marker if a band is not active. For accurate values, the marker band (or the 20 points), should cover at least the 3 dB bandwidth. This works only for frequency response displays.

POWER

Calculates and displays the power contained in the current X marker band or in the entire trace if a band is not active. For frequency domain displays that have units, POWER shows energy (if the ESD unit is selected) or power (for all other units). Energy is always expressed as peak, and power is expressed as rms. For all frequency domain displays, the POWER marker compensates for the effect of the window when the units selected are VOLTS or VOLTS^2.

AVG
VALUE

Calculates the average value over the portion of the active trace enclosed by the current X marker band or the entire trace if the X marker is not active.

DATA
EDIT

Specifies a new value for all of or a portion of a trace. When you press DATA EDIT, you are prompted to enter one value, or two values separated by commas. To modify the entire trace, press DATA EDIT and enter two values separated by commas. A ramp is then constructed between the two values. To modify a portion of the trace, use two markers to select the portion you want to modify, press DATA EDIT, and enter two values separated by commas. A ramp is then constructed between the two marker positions using your values. To specify a constant between the markers, enter a single value. To modify a single point on the trace, use a single marker, press DATA EDIT, and enter one value. In this case, only the value at the marker position is modified.

All editing is done in terms of the current trace coordinates. If the current display coordinate is REAL, only the real part of the trace is changed — the imaginary part is not altered. If the current display coordinate is IMAG, the imaginary part of the trace is changed — the real part is not altered. If the current display coordinate is PHASE, the phase of the trace is changed — the magnitude is not altered. If the current display coordinate is MAG (dB), MAG (dBM), MAG (LIN), or MAG (LOG), only the magnitude of the trace is changed — the phase is not altered. For linear trace coordinates, a linear ramp is constructed between the markers; for logarithmic trace coordinates, a log ramp is constructed between the markers.

CUSTOM
CHIRP

Allows you to edit a time record to include a 1V sine or sine chirp signal. A weighting function can emphasize portions of the chirp .

A maximum of two frequency parameters are entered to define the signal. If a single frequency is entered, a sine wave (pure tone) is generated at that frequency relative to the time record length. If a positive value is entered, the sine wave starts at 0 phase. If a negative value is entered, the sine wave starts at 180 degrees. If two frequencies are entered, the first value defines the start frequency, Fstart, and the second value defines the stop frequency, Fstop. Fstop can be less than Fstart. Negative values are valid. If the two frequencies differ in sign, the chirp signal passes through dc, 0 Hz.

You can also "pre-window" the chirp to reduce the effects of leakage. Use the DATA EDIT softkey to create weighting functions which are multiplied together with the custom chirp time record.

The trace is the displayed portion of the time record. Use the band markers (X hardkey menu in the Markers group) to modify a segment of the trace. The entire trace is modified by turning the X marker off (X OFF in the Markers group).

Custom Chirp frequencies are calculated for a specified frequency span and sample frequency, Fs. Changing either of these causes the arbitrary source to operate at a different sampling frequency.

Note

See "Using the Arbitrary Source" in chapter 3 for an example that uses DATA EDIT and CUSTOM CHIRP.

Saving and Recalling States and Traces

The HP 3563A can save up to five instrument states and five data traces in its internal, non-volatile memory. (Refer to chapter 11 for saving states and traces in disc memory.) The current state is stored in non-volatile memory at power-down and may be recalled later.

When you save an instrument state, only the information in the instrument state display is saved. Coordinates, for example, are not saved. A triangle preceding the measurement display name indicates that the trace has been recalled from memory.

When you store a trace, the analyzer stores all information needed to recreate the trace. When you recall a trace, the trace is displayed without changing the configuration of the analyzer. If you want to recall a trace and reconfigure the analyzer as it was when you saved the trace, you must save the state information with the trace. Time buffer and demod preview displays cannot be saved in local memory.

Use the **SAVE RECALL** hardkey to save and recall instrument states and traces. When you press **SAVE RECALL**, the menu in figure 8-11 appears.

Figure 8-11. SAVE RECALL Menu Diagram

The softkeys that appear when you press **SAVE RECALL** do the following:

RECALL PWR DN	Recalls the state the instrument was in when power was last removed. Reapplying power automatically resets the instrument to its default values. This feature allows you to restore the state when power is removed. The power-down state is saved only if it differs from the default power-on state.
RECALL STATE#	Recalls a saved instrument state; press RECALL STATE#, then enter the number (from 1 to 5) under which the state was stored.
SAVE STATE#	Saves the current instrument state to internal, non-volatile RAM; press SAVE STATE#, then enter the number (from 1 to 5) under which you want the state to be saved. Note that any information previously saved under this number will be erased.
RECALL DATA #	Recalls a saved .a trace display; press RECALL DATA #, then enter the number (from 1 to 5) under which the display was saved.
SAVE DATA #	Saves the current data trace display in internal, non-volatile RAM. Press SAVE DATA #, then enter the number (from 1 to 5) under which you want the display to be saved. Note that any information previously saved under this number will be erased.

Note

When you save a trace while the display is in the upper/lower or front/back formats, only the active trace (or Trace A if both are active) is saved.

Introduction

This section contains the following four chapters:

- Chapter 9: Time Throughput
- Chapter 10: Auto Sequence Programming
- Chapter 11: Disc/Plotter/HP-IB Operation
- Chapter 12: Special Functions/Preset

Chapter 9 describes the time throughput feature. It shows you how to store input data directly to disc. It also shows how to measure and analyze throughput data, and how to use capture blocks as throughput files.

Chapter 10 shows how to create, run, and edit auto sequence programs. An auto sequence program consists of sequential key presses. You can loop an auto sequence program and include messages, time pauses, and timed starts.

Chapter 11 shows how to use the HP 3563A as an HP-IB controller to plot the display, access disc drives, and output HP-IB command strings.

Chapter 12 describes the features available under the **SPCL FCTN** and **PRESET** hardkeys. This includes self tests, service tests, setting the internal clock or beeper, activating source protection, generating a power-on service request over the HP-IB, or using predefined analyzer configurations.

Time Throughput

Purpose Of This Chapter

This chapter shows you the details of using the time throughput feature. The HP 3563A's HP-IB system controller capability allows you to store input data directly to disc memory, without using an external controller. Time throughput supports the Hewlett-Packard 91XX, 794X, and 795X series of disc drives. No HP-IB programming knowledge is required to use time throughput.

Note   Time throughput is available only in the linear resolution and log resolution measurement modes.

This chapter is divided into four parts:

- Creating throughput files on disc
- Setting up the throughput session
- Measuring and analyzing throughput data
- Using capture blocks as throughput files

To keep track of where you are while setting up throughput sessions, see the following section, "Throughput Setup Checklist".

Throughput Setup Checklist

The following steps show how to open a throughput file on disc, set up a throughput session, and then analyze the throughput data. The remainder of this chapter describes each step in detail.

Open a Throughput file

1. Set file size: press **DISC**, DISC FCTN, THRUPT SIZE.

2. Open and Name the file: press **DISC**, DISC FCTN, CREATE THRUPT.

Collect Throughput Data

1. Connect the analyzer to your device under test. See chapter 13 for details on digital connections; see chapter 14 for details on planning a digital or mixed (analog and digital) measurement.

2. Preset the analyzer (optional): press **PRESET** (see chapter 12 for a description of the preset options).

3. Activate throughput: press **MEAS MODE** followed by LINEAR RES or LOG RES. Then toggle THRUPT ON OFF to ON.

4. Configure the inputs: press **INPUT CONFIG**. (See chapter 7 for details).

5. View the input signals (if necessary): press **VIEW INPUT** .

6. Set up the source (if necessary): press **SOURCE**. If necessary, set up source protection in the **SPCL FCTN** menu.

7. Set the input range: press **RANGE**. (See chapter 7, "Input Setup," for details).

8. Select the throughput channel(s): press **SELECT MEAS** followed by CH 1&2 ACTIVE, CH1 ACTIVE or CH 2 ACTIVE.

9. Set the session length: press **MEAS MODE**, THRUPT SELECT, THRUPT LENGTH.

10. Set the frequency span: press **FREQ**.

11. Set up triggering: press **SELECT TRIG**. (See chapter 7, "Input Setup," for details).

12. Identify the active file: press **MEAS MODE**, THRUPT SELECT, ACTIVE FILE.

13. Start the session: press START THRUPT (in the THRUPT SELECT menu).

14. View the throughput header, if desired: press THRUPT HEADER (in the THRUPT SELECT menu).

Analyze a Throughput File

1. Identify the active file: press ACTIVE FILE (in the THRUPT SELECT menu).

2. View the active file, if desired: press **VIEW INPUT**, THRUPT TIME 1, and/or THRUPT TIME 2.

3. Set the measurement starting point (if other than the beginning of the file): press **TRIG DELAY.**

4. Set up and start the measurement: refer to chapter 3 (linear resolution mode) or chapter 4 (log resolution mode).

Overview Of Time Throughput

Figure 9-1 shows the interaction between the HP 3563A and the disc drive during time throughput.

Time Throughput to Disc

(This operation initiated by START THRUPT softkey)

Analog Signal In

Digital Signal In

Switch

Affected by:
frequency span
source stimulus
range
coupling•
triggering
engineering units

• Digital Signal is not affected by coupling

Digital Data

Disc Drive

Measuring Throughput Data

(This operation initiated by **START** hardkey)

Disc Drive

Digital Data

Affected by:
measurement
window
frequency span
averaging
trigger delay

Measurement Display

Figure 9-1. Overview of Time Throughput

The remainder of this chapter explains the steps to open files, collect throughput data, and analyze a throughput file.

Throughput Real Time Bandwidths

Real time bandwidth (RTBW) with time throughput is a function of the disc drive being used. Here are nominal RTBWs for several Hewlett-Packard disc drives:

Model	1-Channel	2-Channel
All Command Set/80 drives: (such as 794X & 795X)	10 kHz	5 kHz
Subset/80 drives: 9122D	1.56 kHz	800 Hz
Floppy Winchester 9133D	1.56 kHz 2.5 kHz	800 Hz 1.25 kHz
9121S	500Hz	200Hz
9121D	500Hz	200Hz
9133V	500 Hz	200 Hz
9133XV	500 Hz	200 Hz

Note that these are nominal values and are not guaranteed for a particular setup. The throughput header indicates the number of records that were collected in real time. For example, if "10" is indicated under REAL TIME in the header, the first ten records were real time and gaps appear between records starting with the eleventh record.

A Note About Log Resolution Throughput

Because the log resolution mode measures multidecade spans in parallel (see chapter 4 for details), more records are required when opening a throughput file and collecting throughput data for log resolution throughputs. Here are the required number of real time records for each log resolution span (double these numbers for two-channel throughputs):

Span (in decades)	Number of Records Required
1	1
2	10
3	100
4	1000
5	10000

Because you do not have to measure in the same mode as your throughput, the number of records on disc is the same. For example, if your throughput at a 4-decade span, you need to set a session length of 1000 records.

The number of records required for log resolution throughputs must be taken into consideration twice in this chapter: first when opening the throughput file, then again when setting the session length.

Opening a Throughput File

Time throughput requires a disc drive connected to the HP 3563A and an initialized disc. To connect the disc drive, select drive addresses and unit numbers, and initialize discs, refer to chapter 11.

Once your disc has been initialized, a file must be opened for throughput sessions. This requires two steps:

1. Set the file size

2. Open and Name the file

To perform these two steps, press **DISC** in the HP-IB group. When its menu appears, press the DISC FCTN softkey, which displays the following menu (the only softkeys of concern here are THRUPT SIZE and CREATE THRUPT):

SERVCE FCTNS	Displays the disc service functions menu; see chapter 11.
DISC COPY	Displays the disc copy menu; see chapter 11.
FORMAT	Displays the disc formatting menu; see chapter 11.
PACK DISC	Packs the disc; see chapter 11.
THRUPT SIZE	Used to enter the size of the throughput file. The size is limited to 32,767 records or the space available on your disc. You must specify the size every time you open a file.
CREATE THRUPT	Opens and names the throughput file.
ABORT HP-IB	Aborts HP-IB operations. Press this if the disc drive does not respond properly.
RETURN	Redisplays the **DISC** menu.

Step 1: Set File Size

The size of throughput files is set in units of time, revolutions, or records. File size is limited to 32,767 records or the space available on disc. The current value of THRUPT SIZE determines the size of the file opened when CREATE THRUPT is pressed. To set the size, press **DISC,** followed by the DISC FCTN softkey. When its menu appears, press THRUPT SIZE and enter the size using the 0 - 9 keys and the units softkeys that appear. If you enter a file size that does not represent an integer number of time records, the size is rounded up to the next whole record. For example, if the record length is currently 1.0 seconds and you enter 9.5 seconds with THRUPT SIZE, a file 10 records (i.e. 10.0 seconds) long will be opened.

Note 1

The file size must be equal to or greater than the size of any throughput session that will use the file. If you plan to save two-channel measurements to disc, make the throughput file twice as long. For example, a 10-record, two-channel record throughput session requires a 20-record throughput file. The throughput session is discussed in "Collecting Throughput Data".

Note 2

If you intend to use cross-channel delays (i.e., use different trigger delays on the two channels), you need to make the throughput file at least one record longer than any session that will be using that file.

Step 2: Open and Name the File

When CREATE THRUPT is pressed, the HP 3563A opens a throughput file, shifts into the alpha mode, and allows you to enter the name for the file. When a file is opened, its size is set to the current value of THRUPT SIZE. The default name for the file (explained later in this chapter) is "THRUPUT". If the file name is not critical, opening a file called "THRUPUT" saves you some keystrokes because this is the default active file name. In the alpha mode, front panel keys are converted to their blue labels, and the following menu is displayed:

ENTER	Saves the current alpha entry, exits the alpha mode, and opens the file on disc. The TALK and LISTEN indicators in the HP-IB group alternately flash as data is put in the file.
SPACE FORWRD	Moves the cursor one space forward for editing. Use the ARROW keys (in the ENTRY group) or the "BL" key to add blanks.
SPACE BACKWD	Moves the cursor one space backward without erasing any characters. To erase, use **BACK SPACE**.
INSERT ON OFF	When this is pressed ON, characters are inserted at the cursor position. When it is OFF, new characters are written over existing ones.
DELETE CHAR	Deletes the character at the cursor position.
CLEAR LINE	Clears the entry from the cursor to the end of the line. This does not exit the alpha mode.
CANCEL ALPHA	Clears the current entry and exits the alpha mode. The file cannot be opened until a valid name is entered.

Collecting Throughput Data

After you open a throughput file, you are ready to collect throughput data. The collection of throughput data is referred to as the throughput session. To collect throughput data, perform the following steps.

Caution   In step 12, you will identify the active file. If you identify a throughput file that you used previously (it contains throughput data), the data in that file will be overwritten.

---

1. Connect the analyzer to your device under test.

2. Preset the analyzer (optional).

3. Activate time throughput.

4. Configure the inputs.

5. View the input signals (optional).

6. Set up the source (if necessary).

7. Set the input range.

8. Select the throughput channel(s).

9. Set the session length.

10. Set the frequency span.

11. Set up triggering.

12. Identify the active file.

13. Start the throughput session.

14. View the throughput header (optional).

Step 1: Connect the Analyzer to Your DUT

Determine the best way to connect the analyzer to your device-under-test (DUT). Your DUT may be analog, digital, or mixed (analog and digital). If your DUT is digital or mixed, read chapters 13 and 14 before you continue. Chapter 14 contains information to help you plan a digital or mixed measurement. Chapter 13 shows you how to connect the analyzer to a digital DUT.

Step 2: Preset the Analyzer (Optional)

There are a number of preset options available under the **PRESET** hardkey. You may want to preset the analyzer to a known state before you set up the time capture. See chapter 12 for the preset options available for the time capture mode.

You can also use the **SAVE RECALL** hardkey to preset the analyzer to a known state. Use this hardkey to save your analyzer state to internal, non-volatile memory. You can then recall this state at any time (see chapter 8 for details).

Step 3: Activate Time Throughput

To activate time throughput, press **MEAS MODE**. Then select LINEAR RES or LOG RES — time throughput is applicable only to the linear and log resolution modes. When one of these modes is selected, the THRUPT ON OFF softkey is displayed. Pressing this softkey ON activates time throughput and displays the THRUPT SELECT softkey (as shown in figure 9-2).

The softkeys that appear when you press THRUPT SELECT do the following:

START THRUPT	Starts the throughput session.
ABORT THRUPT	Aborts the current throughput session. All data up to the last complete record are preserved when a session is aborted. The throughput header shows the actual number of records saved on disc.
ACTIVE FILE	Used to identify the active throughput file; see "Step 12; Identify the Active File."
THRUPT LENGTH	Used to enter the length of the next throughput session. The length is limited only by the length of the active file on the disc. See "Step 9: Set the Session Length."
THRUPT HEADER	Displays the throughput header; see "Step 14: View the Throughput Header."
RETURN	Redisplays the **MEAS MODE** menu.

Caution

When throughputting to CS/80 disc drives, spared areas on the disc are skipped over (without losing real time), but the record count continues to increment as these areas are skipped. Consequently, you should make your file a few records longer than your session to allow room for spared blocks. When throughputting to CS/80 drives, spared areas are not skipped, so real time data could be lost. In this case, it is recommended that you use only unspared, high-quality media for long throughputs.
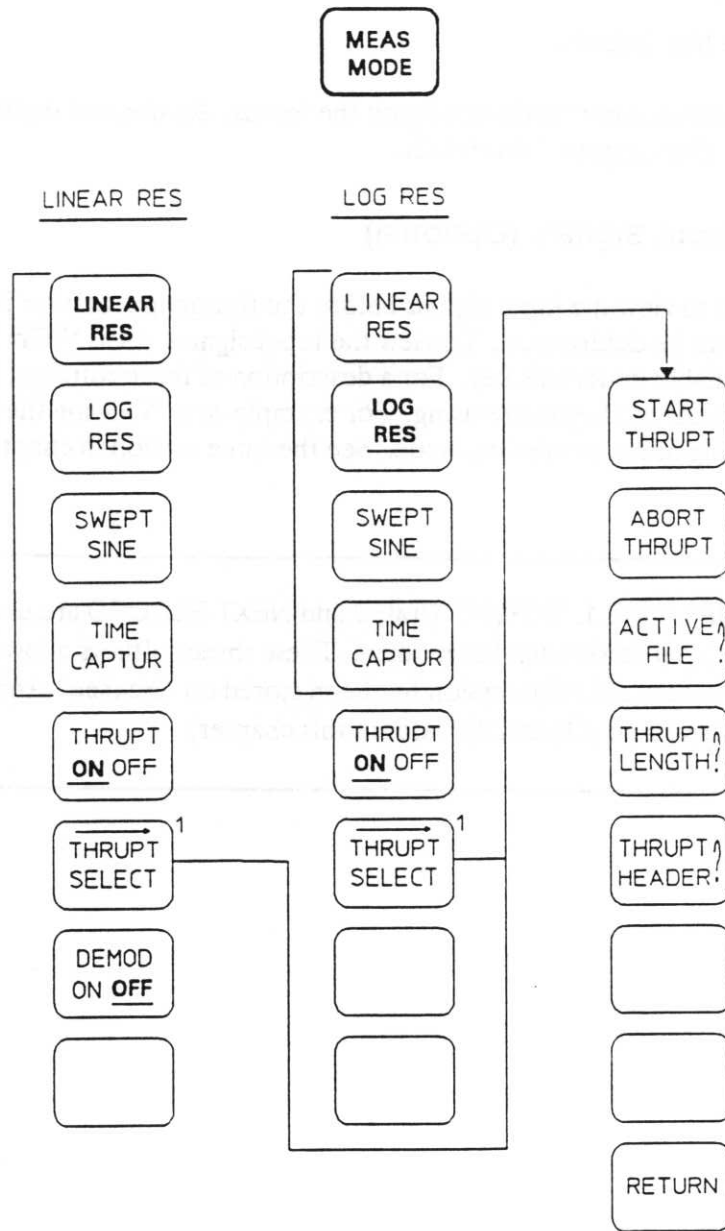
Figure 9-2. MEASMODE Menu Diagram: Time throughput

Step 4: Configure the Inputs

After you select the measurement mode, configure the inputs. Analog and digital inputs are configured differently. See chapter 7 for details.

Step 5: View the Input Signals (Optional)

It is generally desirable to view the input signals before the throughput session is started so that the optimum input setup can be determined. To view the input signals, press **VIEW INPUT**. Figure 9-2 shows the softkeys available under this key. For a description of these softkeys, see the chapter that discusses the measurement mode you are using. For example, see "Viewing the Input Signals" in chapter 3 if you are using linear resolution mode. See the same section in chapter 4 if you are using log resolution mode.

Note   THRUPT TIME 1, THRUPT TIME 2 and NEXT RECORD are used after the
              throughput session has been taken. These three softkeys allow you to view the time
              domain data after the session has been stored on disc (see "Analysis Step 2: View
              the Active File (Optional)" later in this chapter).

VIEW
INPUT

If   MEAS
     MODE   is: LINEAR RES. LOG RES

INPUT TIME 1	
INPUT TIME 2	THRUPT TIME 1
INPUT SPEC 1	THRUPT TIME 2
INPUT SPEC 2	NEXT RECORD
INPUT DIG 1	
INPUT DIG 2	
THRUPT DATA ¹	
VIEW OFF	
	RETURN
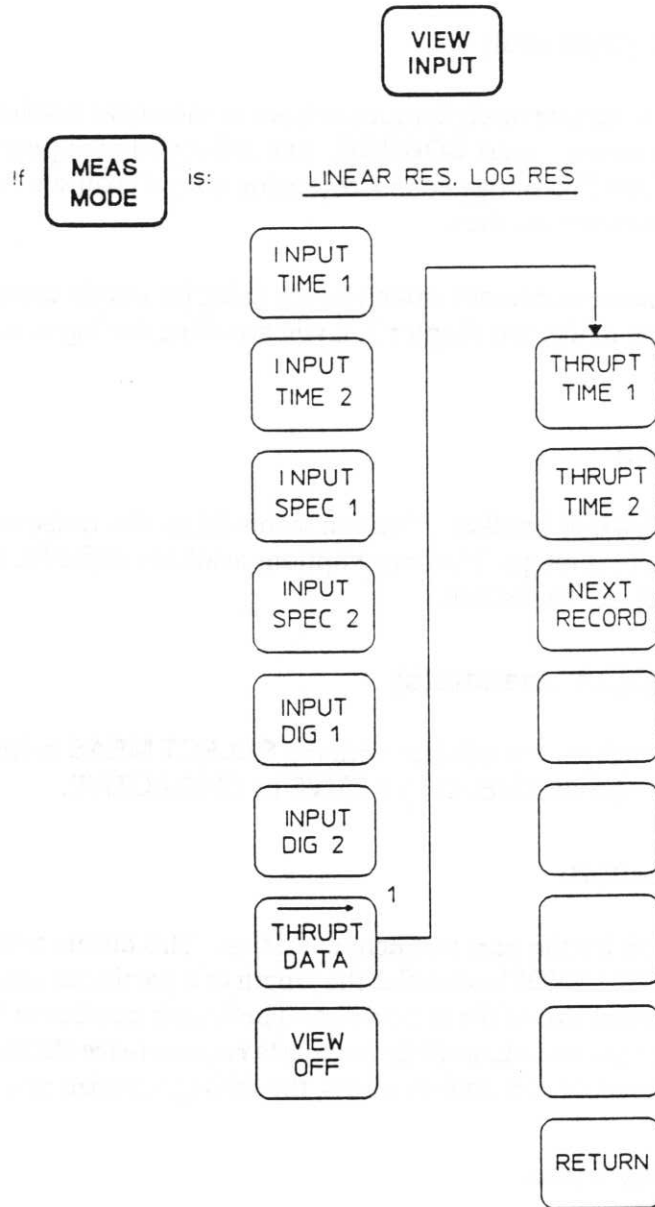
¹ Blank if **MEAS MODE** [THRUPT ON **OFF**] is selected.

**Figure 9-3. VIEW INPUT Menu Diagram:
Linear Res & Log Res**

Step 6: Set up the Source (Optional)

The HP 3563A offers a number of analog or digital source types in the linear resolution and log resolution modes. To set up the source, press **SOURCE**. The softkeys that appear depend on SOURCE AN DIG. If SOURCE AN DIG is toggled to **AN** (analog output) you see one menu; if it is toggled to **DIG** (digital output), you see another.

See the chapter that discusses the measurement mode you are using for details about the source. If you are using the linear resolution mode, see chapter 3; if you are using the log resolution mode, see chapter 4.

Step 7: Set the Input Range

The input range is set with the **RANGE** hardkey. You can manually set the range or have the analyzer automatically select the best range. The range options available differ for analog and digital inputs. See chapter 7, "Input Setup," for details.

Step 8: Select the Throughput Channel(s)

The channels to be used for throughput are selected with the **SELECT MEAS** menu. Press **SELECT MEAS**, then press CH 1&2 ACTIVE, CH 1 ACTIVE or CH 2 ACTIVE.

Step 9: Set the Session Length

THRUPT LENGTH sets the length for the next throughput session. This differs from THRUPT SIZE in the DISC menu in that THRUPT LENGTH specifies the length of a particular session, while THRUPT SIZE is the actual reserved size of the file on disc. The length may be set in time, number of revolutions, or records. **Note that two-channel throughputs require twice the session length.** For example, to throughput five records on both channels, the throughput size must be 10 records.

Step 10: Set the Frequency Span

The frequency span is set before the data is throughput to disc. If you use a baseband frequency span (one that starts at 0 Hz) to throughput data, you can decrease the frequency span when the data is retrieved from memory and measured (see "Analysis Step 4: Set up the Measurement" for details).

Step 11: Set up Triggering

Prior to starting the throughput, you must set up triggering (using the **SELECT TRIG** hardkey). Triggering on throughputs determines the start of the entire session, not of each record. You can set differential delay between the two channels up to 50 records. Overload rejection is ignored in throughput. Overloaded data will not be indicated when throughput data is recalled from disc.

Step 12: Identify the Active File

Once a file has been opened on disc using THRUPT SIZE and CREATE THRUPT in the **DISC** menu, it may be identified as the active file. The active file receives the data when the throughput session is started. The default active file name is "THRUPUT," so if you have a disc file with this name, the active file is already identified for you. When ACTIVE FILE is pressed, the HP 3563A shifts into the alpha mode and displays the alpha menu. This is the same menu described earlier in this chapter under "Step 2: Open and Name the File." The only difference is that pressing ENTER in this case identifies the active file, rather than creating a file on disc.

Step 13: Start the Throughput Session

When the first six steps have been completed, the session can be started by pressing START THRUPT. If a problem is encountered, such as the disc not being connected, press ABORT THRUPT to abort the session and return to normal operation. When finished, the throughput session is saved under the active file name and can be recalled at any time for measurement and analysis.

Step 14: View the Throughput Header (Optional)

The throughput header shows the instrument state and session information for the current throughput session. To display the header, press THRUPT HEADER after the session is complete. Figure 9-3 shows an example header.

Figure 9-4. The Time Throughput Header

Analyzing Throughput Files

Throughput files may be recalled from disc at any time for measurement and analysis. Because throughput must be used in conjunction with the linear or log resolution mode, files are measured and analyzed in one of these two modes. (Data throughput in log resolution then measured in linear resolution will not be calibrated correctly.) To analyze measured data using the display and marker features, refer to chapter 8, "Display Configuration." There are four steps to measure data from a throughput file:

1. Identify the active file

2. View the active file (optional)

3. Set the measurement starting point

4. Set up the measurement

Analysis Step 1: Identify the Active File

When the disc file was being filled with a throughput session, identifying the active file specified which disc file was to receive the data. When the file is to be recalled from disc and measured, identifying the active file specifies which disc file is the source of the data. Identify the file using the procedure outlined in "Step 12: Identify the Active File." Again, the default file name for the active file is "THRUPUT," so if your file has that name, the active file is already identified for you.

Analysis Step 2: View the Active File (Optional)

You can view the time domain data in the throughput file after the session has been stored on disc and before it has been measured. One of the uses of viewing the data before the measurement is made is to determine the appropriate starting point for the measurement. Use **VIEW INPUT** and THRUPT TIME 1, THRUPT TIME 2, and NEXT RECORD to view the time domain data.

Note   THRUPT TIME 1 and THRUPT TIME 2 use the time set with **TRIG DELAY**. For details, see the following step.

Analysis Step 3: Set the Starting Point

When a throughput file is recalled from disc to be measured, you can set the starting point of the measurement using delayed triggering. (For example, if you do not want the first record in the throughput file included in the measurement, set a trigger delay of one record. The measurement would then start at the second record in the file.) The measurement starts at the beginning of the file if you do not set a different starting point. This value of trigger delay is relative to the original trigger point in the data acquired during the throughput session.

This use of delayed triggering is completely separate from any triggering done during the through-put session; the only function of delay here is to set the starting point of the measurement. To set the starting point, press **TRIG DELAY,** then use CHAN 1 DELAY or CHAN 2 DELAY. Note that this is the only time triggering is applicable to the log resolution mode. You must select one of the trigger types to use delay; delay is ignored in free run (except in log resolution).

If you measure the file on a different span than it was throughput, the digital filter in the HP 3563A needs to resettle to the new span. This resettling can introduce a transient into the beginning of the measurement. In this case, it is generally recommended that the beginning of the file be excluded from the measurement to allow time for the filter to settle. The maximum that needs to be excluded is 1/10 of an output record. You can either use pre-triggering during the session to collect 1/10 record (times the zoom factor you will be using) more than you need, or set the measurement starting point at 1/10 record when recalling the file from disc.

Analysis Step 4: Set up the Measurement

When you are ready to measure a stored throughput file, go to chapter 3 (for the linear resolution mode) or chapter 4 (for the log resolution mode) and select the measurement you wish to perform on the throughput data. At this point, you also need to select windowing, averaging and a new frequency span, if desired. Note that you cannot re-zoom (use a different non-zero start frequency) during the throughput measurement if you had zoomed during the throughput session. For example, if the span during the throughput session was 0 to 10 kHz, you could zoom at 5 to 6 kHz for the measurement. However, if you had zoomed during the session from 10 to 20 kHz, you must retain the start frequency and span for the measurement. If you are using delayed triggering to set the measurement starting point and you changed the frequency span, you should set the trigger delay after changing the span because the delay (if entered in records) is converted to seconds upon entry.

Overlap processing with averaging off operates differently when throughput is active. If averaging is off (AVG OFF active), no overlap processing is achieved, regardless of the value of OVRLP%.

Note

If you throughput digital data with the HP 3563A and analyze it with the HP 3562A, the HP 3562A scales the amplitude according to the following ratio:

$$(32768/26028.55) = 1.258925$$

Scaling is done when the HP 3562A reads the throughput file. Thus, the data in the throughput file is not altered.

Note

If you are processing throughput data at a frequency span other than the span at which the data were acquired, the measurement is terminated if it encounters a gap in the data coming from disc (resulting from a loss of real time during the session).

When the setup is ready, press the yellow **START** key. The TALK and LISTEN indicators in the HP-IB group alternately flash to show that the file is being recalled from disc.

Using Capture Blocks As Throughput Files

Capture blocks that have been stored on disc previously can be used as input to a throughput measurement. Identify the stored capture block as the active file (see "Analysis Step 1: Identify the Active File"), then proceed as with a normal throughput measurement. Chapter 6 shows you how to save captured blocks to disc.

Auto Sequence Programming

Purpose Of This Chapter

The purpose of this chapter is to show you how to create, run and edit auto sequence programs. The auto sequence feature allows you to program up to 99 commands in a table that is stored in the HP 3563A's internal nonvolatile memory. Up to five auto sequences, each containing up to 99 commands, can be stored. (Additional tables can be saved in disc memory; see chapter 11 for instructions.) Several example auto sequences are presented at the end of this chapter to show the convenience and versatility of the auto sequence feature.

Depending on the commands used, a table may fill with fewer than 99 lines. (The limit is 99 lines or 1200 key strokes.) Messages and softkeys several menu levels deep require more space than key or simple softkey commands. The message "xxx keys left" is displayed at the top of the table to let you know how many key strokes you have left.

If an auto sequence initiates an indefinitely-long process, it does not wait for that process to finish, but continues after one time record. For example, if you start a measurement with 10 exponential averages, the auto sequence continues after the first record is measured. Similarly, processes initiated by an auto sequence are allowed to finish before the auto sequence continues, if the auto sequence is not paused. For example, if an auto sequence is paused while a measurement is doing 200 averages and then continued a short time after, the measurement continues to run while the auto sequence proceeds beginning with the next command. The auto sequence may finish before the measurement has completed its 200 averages.

There are several hardkeys and softkeys in the HP 3563A that change other softkey menus. For example, if you want to select the histogram measurement, you must first select the linear resolution mode. **MEAS MODE, SELECT MEAS**, TIM AVG ON OFF, and DEMOD ON OFF are examples of such key strokes. If you want to use selections that depend on these hardkeys/softkeys, make sure that you first make the necessary selections with **MEAS MODE, SELECT MEAS**, TIM AV ON OFF, or DEMOD ON OFF. For entries that toggle (AUTO ON OFF, for example), press the softkey, enter a 0 (OFF) or a 1 (ON), then press the Enter softkey.

The AUTO SEQ Hardkey

The **AUTO SEQ** hardkey allows you to create, modify, start, pause, and continue individual auto sequences. The softkeys available under this key are shown in figure 10-1 and described throughout the rest of this chapter.

¹ These softkey names may be redefined with [LABEL ASEQ]
² Requires a 1-digit data entry to get the next menu
³ This softkey has the same effect as pressing [EDIT] followed by [END EDIT]
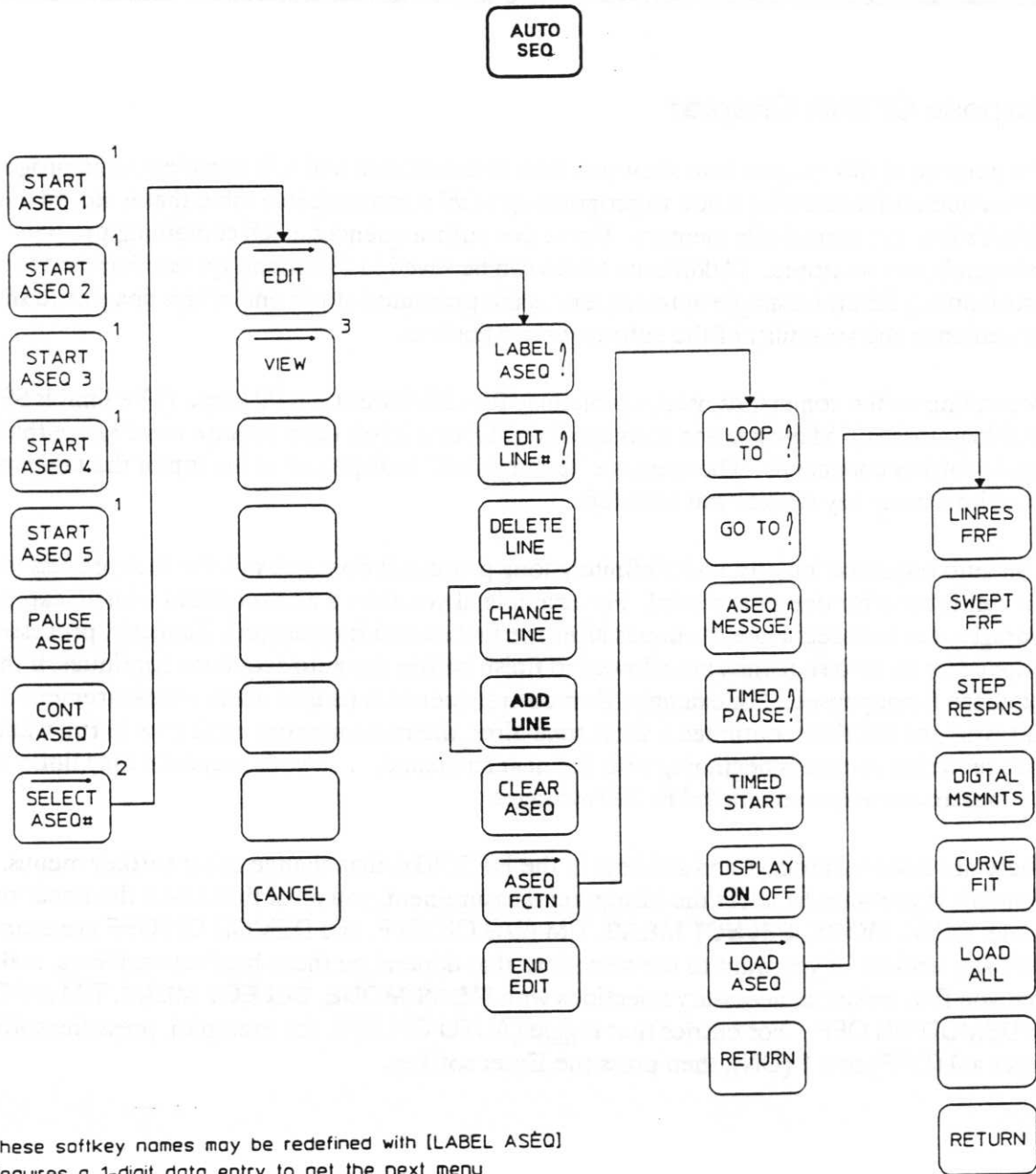
Figure 10-1. AUTO SEQ Menu Diagram

Creating and Editing Auto Sequences

The SELECT ASEQ # softkey allows you to create, view or edit an autosequence program. If you have a measurement running, press PAUSE/CONT before you press SELECT ASEQ #. Then, press SELECT ASEQ # and enter the number of your autosequence program (from 1 to 5). Note that if a label has replaced the START ASEQ 1—5 softkey, the auto sequence is still selected by its number from 1 to 5.

At this point, you can view, create or edit the program. To view the program, press VIEW. To create or edit the program, press EDIT.

Note

You cannot create a throughput file within an auto sequence program (a throughput file is created with this key sequence: **DISC** / DISC FCTN / CREATE THRUPT). However, you can view the contents of a previously created throughput file.

When creating or editing, commands (or lines) are entered in the table in the same manner as they are executed directly: hardkey, softkey(s), then units softkeys, if necessary. For example, to program an input range of 5 volts for Channel 1, the command is entered as **RANGE**: CHAN 1 RANGE: 5V. To program the B trace to activate, the command is entered as just **B**. The HP 3563A enters each line in the table as soon as you enter a complete command.

The EDIT Menu

The following softkeys allow you to create or edit an autosequence program:

LABEL ASEQ	Used to add labels; see "Labeling Auto Sequences".
EDIT LINE #	Used to select the line to be edited. The edit line can be changed if CHANGE LINE is active, or a new line can be added after the edit line if ADD LINE is active. The current line is highlighted and indicated by an arrow.
DELETE LINE	Deletes the edit line, as selected with EDIT LINE#.
CHANGE LINE	Allows the edit line (as selected with EDIT LINE#) to be changed. Once CHANGE LINE is pressed, it remains active until ADD LINE is pressed or the edit is ended.
ADD LINE	Allows a line to be added after the edit line (as selected by EDIT LINE#). Once ADD LINE is pressed, it remains active until CHANGE LINE is pressed. To add a line before the current line #1, move the line pointer to line #0 (above line #1), then enter the new line.
CLEAR ASEQ	Clears the auto sequence table. The message "Push Again to Clear" is displayed to allow you to confirm that the auto sequence is to be cleared.
ASEQ FCTN	Press this softkey to access additional editing functions. See "The ASEQ FCTN Menu" for details.
END EDIT	Saves the changes made in the current editing session, exits the editing mode and redisplays the **AUTO SEQ** menu.

The ASEQ FCTN Menu

The following softkeys provide other editing functions for autosequence programs:

LOOP TO	Used to program loops into auto sequences. Two numbers are required: the number of the first line in the loop and the number of times you want the loop to repeat. Press LOOP TO then enter the line number and loop count separated by a comma. Loops are limited to three levels deep. If only 1 number is entered, then an infinite loop is created (same as GO TO)
GO TO	Causes the program to jump to the indicated line and continue from there. Press GO TO then enter the number of the destination line.
ASEQ MESSGE	Used to program a message into an auto sequence. See "Programming Messages" later in this chapter.
TIMED PAUSE	Used to enter timed pauses. When the program encounters a timed pause, it pauses for the specified time, then continues. Press TIMED PAUSE and enter the desired time, from 0 to (3276) seconds (54.6 minutes). Values entered outside the range are treated as 3276 or 0 seconds, whichever is closest.
TIMED START	Used to enter delayed starting times. The start time is tied to the non-real time clock. See TIME H,M,S in the **SPCL FCTN** menu to view or set the clock. If a starting time is entered, the auto sequence begins when the clock reaches that time. Start times must be between 00,00,00 and 23,59,59. To turn off timed start, set the hour to 24.
DSPLAY ON OFF	When this is pressed ON, all trace displays generated by the auto sequence are displayed. When it is pressed OFF, only the final display is shown; any intermediate results are not displayed.
LOAD ASEQ	Used to create an autosequence program from a sample program; see "Preset Auto Sequences".

Note

To program audible beeps into an auto sequence, press **SPCL FCTN**, followed by BEEPER ON OFF, then type in 1 and press ENTER.

Using Preset Auto Sequences

There are five preset auto-sequence programs available in the HP 3563A. You can load (preset) one or all five autosequence programs with the preset programs. Use the LOAD ASEQ softkey to preset a single autosequence program. Use the LOAD ALL softkey to preset all five autosequence programs (see "LOAD ALL"). The preset auto-sequence programs available are:

1. LINRES FRF (frequency response in linear resolution mode)

2. SWEPT FRF (log frequency response in swept sine mode)

3. STEP RESPNS (step response in linear resolution mode)

4. DIGTAL MSMNTS (digital measurements)

5. CURVE FIT (fitting sample data with a curve)

LINRES FRF

The LINRES FRF softkey programs an autosequence with measurement and display parameters for a frequency response measurement in linear resolution mode. This autosequence program:

- Specifies the linear resolution mode
- Specifies the frequency response measurement
- Specifies all display parameters; phase appears in the top display and magnitude appears in the lower display
- Sets pauses to allow operator entry of frequency parameters
- Takes the measurement
- Calculates the Open Loop measurements from Closed Loop results (using the MATH selection of T/1-T)
- Calculates gain and phase margins with special markers

SWEPT FRF

The SWEPT FRF softkey programs an autosequence with measurement and display parameters for a frequency response measurement in swept sine mode. This autosequence program:

- Specifies the swept sine mode
- Specifies the frequency response measurement
- Specifies all display parameters; phase appears in the top display and magnitude appears in the lower display
- Sets pauses to allow operator entry of frequency parameters
- Takes the measurement
- Calculates the Open Loop measurements from Closed Loop results (using the MATH selection of T/1-T)
- Calculates gain and phase margins with special markers

STEP RESPNS

The STEP RESPNS softkey programs an autosequence with measurement and display parameters for a step response measurement in linear resolution mode. This autosequence program:

- Specifies the linear resolution mode
- Specifies a step response measurement
- Specifies a power spectrum measurement on Channel 1
- Sets the Channel 1 trigger
- Establishes real coordinates
- Sets pauses to allow operator entry of frequency and trigger parameters
- Specifies use of the Uniform window
- Takes the measurement
- Specifies all display parameters for the first time record measurement:
  - Single trace
  - X marker on hold left (to mark off a band on the horizontal axis)
  - Normalize the trace.

DIGTAL MSMNTS

The DIGTAL MSMNTS softkey programs an autosequence for a digital measurement using the digital input and internal digital source. The arbitrary digital source is also utilized.

CURVE FIT

The CURVE FIT softkey programs an autosequence to fit a curve using sample data. The data may be synthesized or measured from the internal source.

LOAD ALL

The LOAD ALL softkey programs all five autosequence softkeys with the following *preset* autosequence-programs:

- ASEQ 1: LINRES FRF — Frequency Response (Linear Resolution)
- ASEQ 2: SWEPT FRF — Log Frequency Response (Swept Sine)
- ASEQ 3: STEP RESPNS — Step Response (Linear Resolution)
- ASEQ 4: DIGTAL MSMNTS — Digital
- ASEQ 5: CURVE FIT

Note

You are asked to press LOAD ALL twice to confirm loading the autosequence softkeys with the sample programs.

Programming Messages

You can program messages into any auto sequence program by pressing ASEQ MESSGE. Messages are limited to 24 characters and appear in the message field in the lower-right corner of the display. When ASEQ MESSGE is pressed, the instrument shifts to the alpha mode; see "Labeling Auto Sequences" for instructions on using the alpha menu.

You can display up to a maximum of 3 lines for each message. Use two apostrophes (") for the first line. Use two quotation marks ("") for the second line. Use the special characters shown in the following table for the last line. Only one character size can be specified for each message.

Auto sequence programming can be used to write HP-IB commands to the bus. See "Outputting Command Strings" in chapter 11.

Special Characters

You can format a message by inserting special characters at the beginning of the message (first 2 characters; see the following table).

Special Characters

>	Makes the message bright
+	Clears screen Justifies message in the center Uses a small character size (maximum of 33 characters/line)
**	Clears screen Justifies message in the center Uses a medium character size (maximum of 24 characters/line)
//	Clears screen Justifies message in the center Uses a large character size (maximum of 19 characters/line)

Auto Sequences With More Than 99 Lines

There are three techniques available if you need more than 99 lines to solve a measurement problem. First, if some steps are repetitive, you can create loops in individual auto sequences to effectively yield more than 99 lines. Second, you can command an auto sequence to start others, giving you up to 495 lines in five auto sequences. Third, you can recall auto sequences from disc memory and run them under auto sequence control, giving you a nearly unlimited number of command lines.

The LOOP TO command is explained in "The Auto Sequence Functions Menu," and using auto sequences with discs is explained in "Saving Auto Sequences in Disc Memory."

Running Auto Sequences

Auto sequences are started by pressing one of the START ASEQ softkeys. For example, to start the auto sequence stored in table #1, press START ASEQ1.

Note	START ASEQ is replaced by a label if one was programmed in the auto sequence. See "Labeling Auto Sequences" later in this chapter.

Commands in an auto sequence are executed sequentially. In most cases, the auto sequence waits until each command has been completely executed before continuing. However, with infinite processes, such as exponential averaging, execution continues after one measurement is made. On the other hand, if you have **START** in the auto sequence, and the analyzer is set up for a 100-average measurement, the auto sequence will idle after executing **START** until all 100 averages are taken. In the swept sine mode, auto sequences idle after starting sweeps.

Pausing/Continuing Auto Sequences

The PAUSE ASEQ softkey pauses a running auto sequence. This softkey applies only when "AUTO SEQUENCE RUNNING" is displayed. A paused auto sequence can be continued by pressing CONT ASEQ (it continues with next line).

The CONT ASEQ softkey continues a paused auto sequence. "Auto Sequence Finished" is displayed if the auto sequence is already finished when CONT ASEQ is pressed.

Labeling Auto Sequences

An auto sequence label serves two functions: it is displayed at the top of the table so that the auto sequence can be easily identified, and it replaces the appropriate START ASEQ # softkey label so that the function of the table is shown in the **AUTO SEQ** menu. Note that clearing the auto sequence also erases the label. Labels are limited to two lines, six characters per line; separate the first and second lines with a comma.

When LABEL ASEQ is pressed, the HP 3563A shifts into the alpha mode, in which the keys (except LINE and HELP) are converted to their blue labels. LABEL ASEQ also displays the following menu to allow you to enter the label:

ENTER	Saves the current alpha entry and exits the alpha mode.
SPACE FORWRD	Moves the cursor one space forward to edit an entry. Use the ARROW keys and the "BL" key to add blanks.
SPACE BACKWD	Moves the cursor one space backward without erasing any characters. To erase, use **BACK SPACE**.
INSERT ON OFF	When this is pressed ON, characters are inserted at the cursor position. When it is pressed OFF, characters are written over existing ones.
DELETE CHAR	Deletes the character at the cursor position.
CLEAR LINE	Clears the alpha entry from the cursor position to the end of the line.
CANCEL ALPHA	Clears the current entry and exits the alpha mode.

Auto sequence labels are not stored in calling auto sequences. For example, if ASEQ 1 has the command "START ASEQ 2" and you change the label of ASEQ 2 to "TEST A," the next time you edit ASEQ 1, the "START ASEQ 2" will be changed to "TEST A."

The Autostart Auto Sequence

You can program one of the five auto sequences to start when power is turned on. In the editing menu, use the LABEL ASEQ softkey and enter "AUTOST" as the first six characters of auto sequence label. Normally, the HP 3563A starts the measurement when power is applied. AUTOST, however, inhibits this, so you need to program the **START** key into AUTOST if you want it to start a measurement at power-on. If the second line of the autostart auto sequence is "CALOFF", then the power-on calibration will be inhibited. If more than one auto start sequence exists, only the first one is executed. To interrupt an autostart sequence at power-on, continually press softkey #6 (even though it has no label) immediately after power-on.

Saving Auto Sequences In Disc Memory

Auto sequences can be stored in disc memory both for archival purposes and to provide more command lines. Chapter 11 gives instructions for connecting a disc drive and using one in general, but several aspects of auto sequences require noting here.

First, recalled auto sequences do not have to be stored in the auto sequence table in which they were created. For example, if you created an ASEQ 1 and saved it on disc as file "TEST," you can recall it into ASEQ 5 by using **DISC**: RECALL FILE: TEST,5. (This would erase the original contents of ASEQ 5, of course.) The number (1—5) after the file name and the comma indicates the table in which you want the recalled auto sequence to be stored.

Second, an auto sequence can be recalled from disc by another auto sequence and stored into one of the five tables. Recalled tables are then started with the appropriate START ASEQ command. For example, you could use **DISC**: RECALL FILE: TEST and AUTO SEQ: TEST as commands to recall and start an auto sequence saved on disc.

Third, labels are not tracked, only auto sequence numbers. For example, if ASEQ 1 has the command "START ASEQ 2" and you save ASEQ 2 on disc and later recall it into ASEQ 3, the command in ASEQ 1 will no longer be valid. (It will go ahead and start ASEQ 2, but the auto sequence you want is now in ASEQ 3.)

Example Auto Sequences

This section provides examples that demonstrate the power and flexibility of the HP 3563A's auto sequence feature. All were plotted directly from the display.

Sets Up a Frequency Response Measurement for Network Analysis

```
            Auto  Sequence    1 1195 Keys Left
Display ON    Label:   NETWRK           19 Lines
 1   MEAS MODE: LINEAR RES
 2   SELECT MEAS:   FREQ RESP
 3   WINDOW: HANN
 4   AVG: STABLE (MEAN)
 5   AVG: NUMBER AVGS 25
 6   FREQ (SPAN): START FREQ 40 kHz
 7   FREQ (SPAN): FREQ SPAN 2 kHz
 8   SOURCE: RANDOM NOISE
 9   SOURCE: SOURCE LEVEL 1 Vrms
10   ASFN: ASEQ MESSGE MEASUREMENT SET UP
11   ASEQ FCTNS: TIMED PAUSE 2 Sec
12   RANGE: AUTO 1 RNG UP
13   RANGE: AUTO 2 RNG UP
14   INPUT CONFIG: CHAN1 AC DC (1/0) 1
15   INPUT CONFIG: CHAN2 AC DC (1/0) 1
16   SELECT TRIG EXT
17   SELECT TRIG: TRIG LEVEL 25 mV
18   ASEQ FCTNS: ASEQ MESSGE INPUT SET UP
19   START
```

Figure 10-2

Sets Up Several Plotting Parameters to Generate Consistent Plots

```
            Auto  Sequence  2 1097 Keys Left
Display ON    Label: REPORT P           6 Lines
 1   PLOT:  SELECT DATA: SOLID GRIDS
 2   PLOT:  SELECT PENS: GRID PEN 1
 3   PLOT:  SELECT PENS: TRACE A PEN 2
 4   PLOT:  SELECT PENS: ANNOT A PEN 2
 5   PLOT:  SELECT PENS: TRACE B PEN 3
 6   PLOT:  SELECT PENS: ANNOT B PEN 3
```

Figure 10-3

Displays "HELLO B.L.B" on the Screen. Refer to Chapter 5 in the HP 3563A Programming Manual for Information on the Commands Used Here.

```
            Auto  Sequence  3 1097 Keys Left
Display ON    Label: DISP M            1 Line
 1   ASFN: ASEQ MESSAGE //HELLO B.L.B
```

Figure 10-4

Sets Up a Continuous, Exponentially Averaged Measurement for Adjusting Filters.

```
            Auto  Sequence  4 1138 Keys Left
Display ON    Label: FILTER           18 Lines
 1   MEAS MODE: LINEAR RES
 2   SELECT MEAS: FREQ RESP
 3   WINDOW: UNIFRM (NONE)
 4   AVG: AVG OFF
 5   FREQ (SPAN): FREQ SPAN 2.5 kHz
 6   FREQ (SPAN): ZERO START
 7   SOURCE: PRIODC CHIRP
 8   SOURCE: SOURCE LEVEL .5 V
 9   RANGE: AUTO 1 RNG UP
10   RANGE: AUTO 2 RNG UP
11   SELECT TRIG: SOURCE TRIG
12   A
13   SINGLE
14   MEAS DISP: FREQ RESP
15   SCALE: Y FIXD SCALE 30 dB
16   START
17   X 440 Hz
18   Y: Y VALUE 10 dB
```

Figure 10-5

Disc/Plotter/HP-IB Operations

Purpose Of This Chapter

The purpose of this chapter is to show you how to use the HP 3563A as an HP-IB controller to plot the display, access disc memories, and output HP-IB command strings. The topics covered are:

- Using the **HP-IB FCTN** menu
  - Selecting system controller or addressable-only
  - Viewing and setting HP-IB addresses
  - Sending user service requests
- Plotting the display
  - Connecting and addressing the plotter
  - Setting the plot parameters
- Using disc memories
  - Connecting and addressing the disc drive
  - Saving and recalling displays
  - Using the disc functions menu
  - Formatting discs
  - Copying disc files
  - Using the disc service functions
- Outputting HP-IB command strings

The HP-IB Function Menu

The **HP-IB FCTN** hardkey (Figure 11-1) allows you to identify the HP 3563A as the HP-IB system controller, view and set addresses, send user service requests and output HP-IB command strings. For programming the HP 3563A as an addressable-only device on the bus, refer to the HP 3563A Programming Manual.
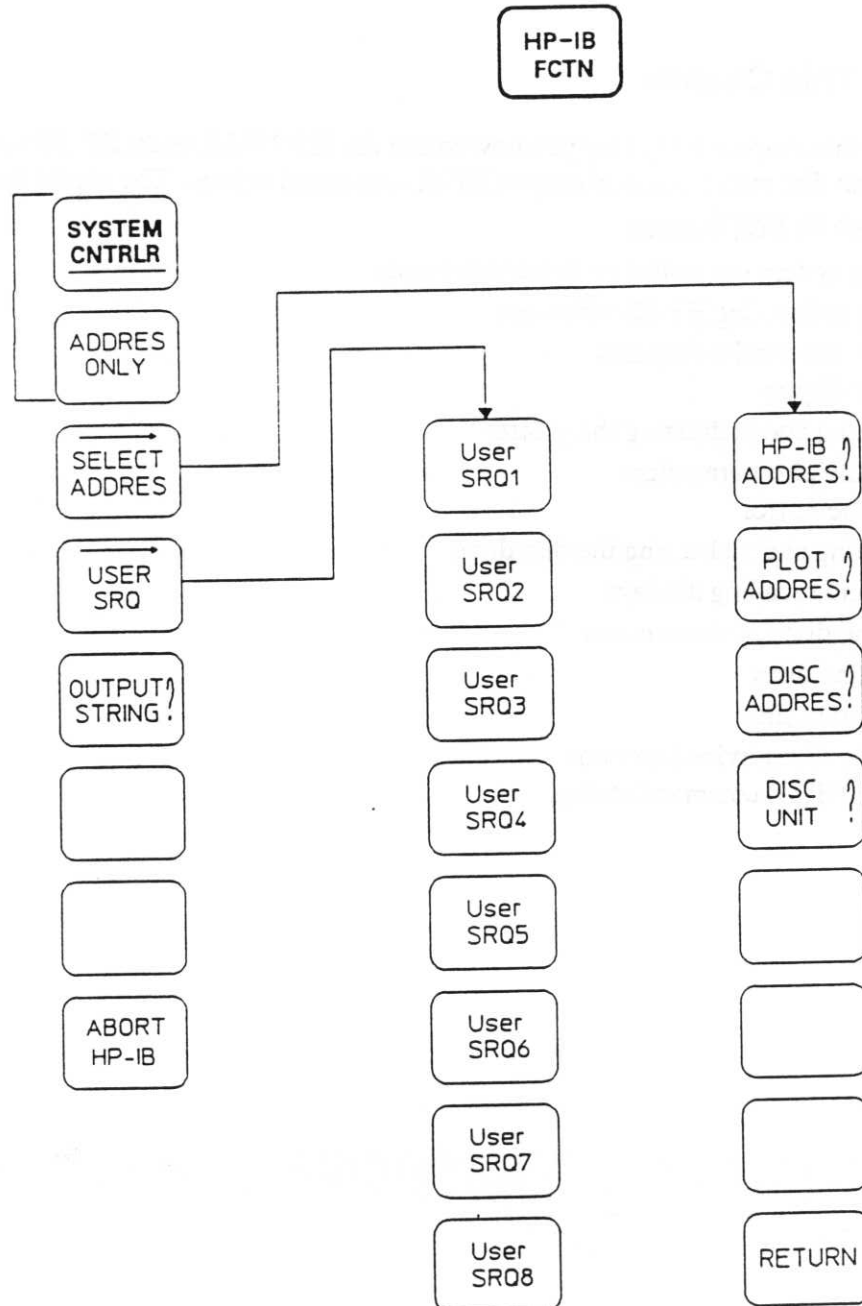
Figure 11-1. HP-IB FCTN Menu Diagram

The softkeys that appear when you press **HP-IB FCTN** do the following:

SYSTEM CNTRLR	Identifies the HP 3563A as the system controller. This is necessary for plotting, accessing discs and outputting command strings.
ADDRES ONLY	Identifies the HP 3563A as an addressable-only bus device. This is necessary for programming the instrument over the HP-IB with an external controller.
SELECT ADDRES	Displays the select address menu, which is used to set the HP 3563A's address and enter the addresses of plotters and disc drives. See "The SELECT ADDRES Menu".
USER SRQ	Displays the user service request menu, which allows you to send eight unique service requests to an external controller. See "The USER SRQ Menu".
OUTPUT STRING	Allows you to output command strings to the HP-IB. See "Outputting Command Strings" later in this chapter.
ABORT HP-IB	Aborts HP-IB operations.

The SELECT ADDRES Menu

The SELECT ADDRES softkey allows you to set the HP 3563A's address and enter the addresses of plotters and disc drives. The softkeys that appear when you press this softkey do the following:

HP-IB ADDRES	Used to view and set the HP-IB address of the HP 3563A, from 0 to 31. The value you enter is saved in non-volatile RAM.
PLOT ADDRES	Used to enter the plotter's address, from 0 to 31. The HP 3563A needs to know the plotter's address to communicate with it. The value you enter is saved in non-volatile RAM.
DISC ADDRES	Used to enter the disc drive's address, from 0 to 7. The HP 3563A needs to know the drive's address to communicate with it. The value you enter is saved in non-volatile RAM.
DISC UNIT	Used to enter the unit number on multiple-unit disc drives, from 0 to 15. This does not actually set it on the drive, but the HP 3563A needs to know the drive unit number to access the desired disc. The value you enter is saved in non-volatile RAM.

The USER SRQ Menu

The softkeys that appear when you press USER SRQ allow you to send eight unique service requests to an external controller on the HP-IB. For information on customizing the softkey's labels and handling the SRQs, refer to the HP 3563A Programming Manual.

The analyzer can also be set to send an SRQ at power-on. To do this, press **SPCL FCTN** PwrSRQ ON OFF. When PwrSRQ ON OFF is on, the analyzer outputs an SRQ to the HP-IB when power is switched on. The state of this softkey is saved in non-volatile memory and is not affected by power-on or reset. See the HP 3563A Programming Manual for instructions on handling the SRQ.

Plotting the Display

The HP 3563A offers direct digital control of HP-IB compatible plotters equipped with Hewlett-Packard Graphics Language (HP-GL). Traces, tables and instrument states may be plotted. HP-IB or HP-GL programming knowledge is not required to use the plotter.

| Note | The HP 3563A must be identified as the system controller (if an external controller is not on the bus) in order to plot. Press **HP-IB FCTN**, followed by SYSTEM CNTRLR. If you are using a controller and a plotter on the bus simultaneously, refer to the HP 3563A Programming Manual to pass control between the controller and the HP 3563A. |

Connecting and Addressing the Plotter

To connect a plotter to the HP 3563A, refer to figure 11-2. A standard HP-IB cable is required; the following cables are available from Hewlett-Packard:

Part Number	Length
10833A	1 m (3.3ft)
10833B	2 m (6.6ft)
10833C	4 m (13.2ft)
10833D	0.5 m (1.6ft)

| Caution | The HP 3563A has metric threaded HP-IB cable mounting studs, as opposed to English threads. Metric-threaded HP 10833A/B/C/D cables must be used. Metric fasteners are colored black, while English fasteners are colored silver. DO NOT attempt to connect black and silver fasteners, or damage to cable and instrument will result. |
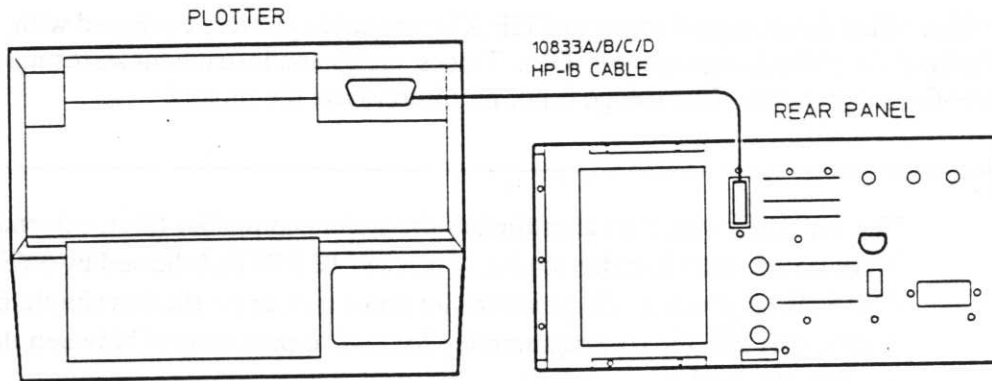
Figure 11-2. Connecting a Plotter to the HP 3563A

To address the plotter, the HP 3563A needs to know the plotter's HP-IB address. Refer to your plotter's manual to set and read its address. To enter the corresponding address into the HP 3563A, press **HP-IB FCTN** in the HP-IB group. When its menu is displayed, press SELECT ADDRES followed by PLOT ADDRES, then enter the plotter's current address. The address is stored in non-volatile memory (it need not be reentered if the instrument is turned off). Note that some plotters do not recognize an address change until their power is turned off then on again.

Setting the Plot Parameters

The HP 3563A offers control of every aspect of plotting. However, plotting can be a very simple operation by using the preset parameters. To set the parameters and start plotting, press **PLOT** to access the softkeys in figure 11-3. These softkeys are described on the following pages.
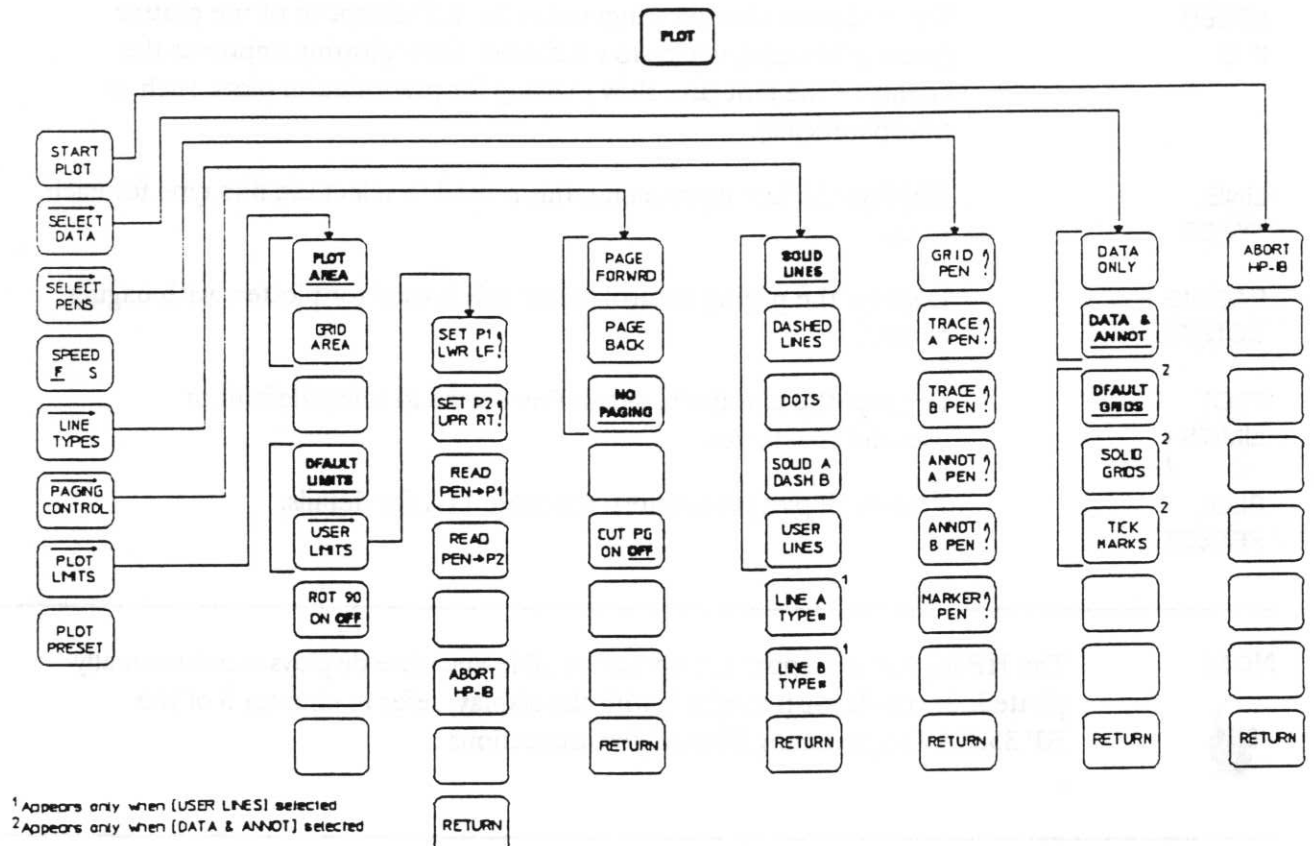
Figure 11-3. PLOT Menu Diagram

The softkeys that appear when you press **PLOT** do the following:

START PLOT	Initiates plotting of the current display using the current plot parameters and displays the ABORT HP-IB command to abort plotting, if necessary.
SELECT DATA	Displays the select data menu; this determines the combination of data, annotation and grid for plotting.
SELECT PENS	Displays the select pens menu; this determines the pen numbers for plotting the various parts of the display.
SPEED F S	Selects fast or slow piotting; fast is the default speed of the plotter (usually 36 cm/s), while slow is 5 cm/s. Slow plotting improves the quality of the plot (use slow plotting for presentation plots, such as transparencies).
LINE TYPES	Displays the line types menu; this is used to select the line type for each trace.
PAGING CONTRL	Displays the paging control menu; this is used for plotters with paging control.
PLOT LIMITS	Displays the plot limits menu; this is used to select default or user-defined limits.
PLOT PRESET	Presets all plot parameters; see table 11-1 for details.

Note   The HP logo in the upper left corner of table and state displays is not normally plotted. If you do wish to plot it with the display, refer to chapter 6 of the HP 3563A Programming Manual for instructions

.

Plot Preset

Table 11-1 shows the plot preset parameters. These are the conditions immediately after PLOT PRESET is pressed. These conditions also apply immediately after power-on and after RESET in the preset menu is pressed. However, pressing only the green **PRESET** key or one of the special presets does not affect the plot setup.

Table 11-1. The Plot Preset Parameters

Parameter	Preset Condition
SELECT DATA	DATA & ANNOT active DFAULT GRIDS active
SELECT PENS	Pen #1 for grid, Trace A and its annotation
	Pen #2 for marker, Trace B and its annotation
SPEED F S	Fast
LINE TYPES	SOLID LINES is active
PAGING CONTRL	NO PAGING is active
	CUT PAGE ON OFF is OFF
PLOT LIMITS	PLOT AREA is active DFAULT LIMITS is active ROT 90 ON OFF is OFF

The Select Data Menu

To select the combination of data, annotation and grid to be plotted, press SELECT DATA to display the following softkeys:

DATA
ONLY
    Selects only the data trace(s) for plotting (does not plot grids).

DATA &
ANNOT
    Selects the data traces and all the alphanumeric annotation for plotting; also displays the three grid control softkeys shown below.

DFAULT
GRIDS
    Plots the grids exactly as they appear on the screen. If the display includes many dashed grid lines, you may want to plot with SOLID GRIDS instead.

SOLID
GRIDS
    Plots the grids with solid lines, regardless of how they appear on the screen. This increases the life of the plotter pens when dashed grid lines are displayed.

TICK
MARKS
    Plots tick marks on the grid axes in place of the horizontal and vertical grid lines.

The Select Pens Menu

To select the pen number for plotting the various parts of the display, press SELECT PENS to display the following softkeys:

GRID PEN	Used to enter the pen number for plotting the grid and the capture pointer.
TRACE A PEN	Used to enter the pen number for plotting trace A.
TRACE B PEN	Used to enter the pen number for plotting trace B.
ANNOT A PEN	Used to enter the pen number for plotting the annotation for trace A.
ANNOT B PEN	Used to enter the pen number for plotting the annotation for trace B.
MARKER PEN	Used to enter the pen number for plotting the markers.

The pen numbers can range from 0 to the maximum number of pens in the plotter. Refer to your plotter's manual for its response to invalid pen numbers. If you enter 0 for a pen number, the HP 3563A instructs the plotter to put the pen away. This is useful to selectively avoid plotting parts of the display.

The Line Types Menu

To select one of the preset line types or to define one of your own, press LINE TYPES to display the following softkeys:

SOLID LINES	Selects solid lines for both traces.
DASHED LINES	Selects dashed lines for both traces.
DOTS	Selects dotted lines for both traces.
SOLID A DASH B	Selects a solid line for Trace A and a dashed line for Trace B.
USER LINES	Displays the line type number softkeys below, which allow you to define custom line types, and activates user lines.
LINE A TYPE #	Used to enter a line type number and length for Trace A; see "User Lines." This softkey appears only after USER LINES is pressed.
LINE B TYPE #	Used to enter a line type number and length for Trace B; see "User Lines." This softkey appears only after USER LINES is pressed.

User Lines

The user lines are defined by two variables: the pattern number and pattern type. Refer to your plotter's programming manual for more information. (This feature uses the HP-GL command "LT" to enter the user line numbers.) You can use just the standard line numbers 1 through 8, if desired, without using the second parameter. The second parameter is always optional. In the HP 3563A, solid lines are assigned the line type number —32768.

The Paging Control Menu

To control paging features on plotters so equipped, press PAGING CONTRL to display the following softkeys:

PAGE
FORWRD
Enables the page forward feature. Pages are forwarded after the plots are finished.

PAGE
BACK
Enables the page back feature. Pages are backed up after the plots are finished.

NO
PAGING
Disables the paging features.

CUT PG
ON **OFF**
Controls the page cutting feature. Pages are cut after the plot is finished.

These commands are not sent to plotters without paging capabilities. Refer to your plotter's manual for information on its paging features.

The Plot Limits Menu

You can set the plotter's limits directly from the HP 3563A. Press PLOT LIMITS to display the following softkeys:

PLOT
AREA
Causes the entire screen, including annotation, to be plotted within the plot limits.

GRID
AREA
Causes the plot grid to line up with the plot limits. Useful for printed graph paper.

DFAULT
LIMITS
Selects the P1 and P2 values defined by the plotter.

USER
LIMITS
Selects the P1 and P2 values defined by the HP 3563A, and displays the user limits menu and allows you to set the plotter's P1 and P2 coordinates directly from the HP 3563A. See "The User Limits Menu" following this menu.

ROT 90
ON **OFF**
Rotates the plot 90 degrees. This puts P1 in the upper left corner and P2 in the lower right corner. Note that if your plotter also has a rotate feature, it does not have to be active if ROT 90 is ON. This reverses the aspect ratio to 3.7:4.9(X:Y).

Once you select USER LIMITS and redefine the P1 and P2 positions, these new locations become the plotter's default values. This sets the DFAULT LIMITS equal to USER LIMITS.

The User Limits Menu

The HP 3563A allows you to define the P1 and P2 locations from the instrument. When USER LIMITS is active, the plotter uses the analyzer's definitions of P1 and P2, not its own. You can also read the current P1 and P2 locations as defined on the plotter. Press USER LIMITS to display the following menu:

SET P1 LWR LF	Used to specify the location of P1, normally the lower left corner of the plot. When USER LIMITS is active, the plotter uses the analyzer's definition of the P1 and P2 (described below) location, not its own. The P1 location is entered as an X,Y coordinate pair separated by a comma (as is the P2 location). Refer to the plotter's HP-GL instructions for further details. Note that defining P1 as the upper left corner and P2 as the lower right corner produces a mirror image of the display. This can be useful for making overhead transparencies.
SET P2 UPR RT	Used to specify the location of P2, normally the upper right corner of the plot. See SET P1 LWR LF for details.
READ PEN→P1	Reads the current location of the plotter's pen into the HP 3563A's P1.
READ PEN→P2	Reads the current location of the plotter's pen into the HP 3563A's P2.
ABORT HP-IB	Aborts HP-IB operations. Use this if the plotter fails to respond to one of the READ PEN softkeys.

P1 is the lower left corner of the plot, and P2 is the upper right corner. The screen's aspect ratio is 4.9:3.7 (X:Y). HP-GL assigns the origin to the lower left corner of the plotter's usable area. The values entered for P1 and P2 are an X-Y coordinate pair separated by a comma. For example, entering a P1 location of 250,100 sets the lower left corner 250 units to the right and 100 units above the corner. Refer to your plotter's programming manual for more information.

Using Disc Memories

The HP 3563A allows you to store an unlimited number of displays (tables, traces, and states) to disc memory without using an external controller. The instrument supports the Hewlett-Packard 794X, 795X, and 91XX series disc drives. This ability to directly control a disc is also used with time throughput; refer to chapter 9 for using throughput.

This section shows you how to:

1. Connect and address the disc drive

2. Save and recall displays

3. Use the disc functions menu

4. Format discs

5. Copy disc files

6. Use the disc service functions

Any Hewlett-Packard 1/4-inch tape drives using the Command Set/80 disc control language can be used for any applicable operations. Because of their slower speed, tapes are used primarily for disc backup. The HP 3563A accesses only volume 0 of multivolume discs.

Connecting and Addressing the Disc Drive

Note

The HP 3563A must be identified as the system controller (if an external controller is not on the bus) in order to use a disc memory. Press HP-IB FCTN, followed by SYSTEM CNTRLR (the HP-IB FCTN menu is shown in figure 11-1). If you are using a controller and a disc drive on the bus simultaneously, refer to the HP 3563A Programming Manual information on passing control.

To connect a disc drive to the HP 3563A, refer to figure 11-4. A standard HP-IB cable is required; the following cables are available from Hewlett-Packard:

Part Number	Length
10833A	1 m (3.3ft)
10833B	2 m (6.6ft)
10833D	0.5 m (1.6ft)
10833C	4 m(13.2ft)

Caution

The HP 3563A has metric threaded HP-IB cable mounting studs, as opposed to English threads. Metric-threaded HP 10833A/B/C/D cables must be used. Metric fasteners are colored black, while English fasteners are colored silver. DO NOT attempt to connect black and silver fasteners, or damage to cable and instrument will result.
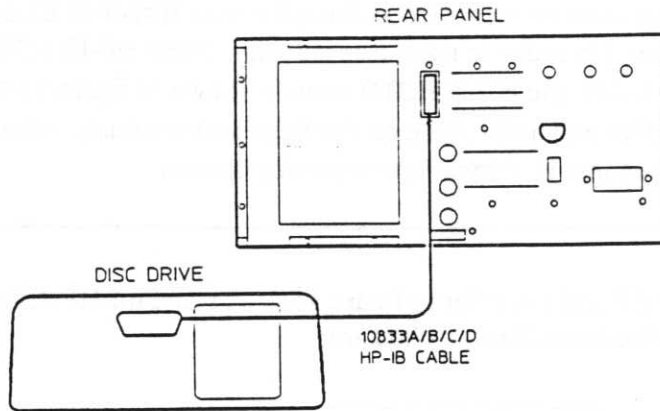
Figure 11-4. Connecting a Disc Memory to the HP 3563A

To address the disc drive, the HP 3563A needs to know the disc's HP-IB address (and the current disc unit number for multiple-drive memories). Refer to your disc's manual to set and read its address. To enter the address into the HP 3563A, press **HP-IB FCTN** in the HP-IB group. When its menu is displayed, press SELECT ADDRES, then DISC ADDRES and enter the disc's current address. The address is stored in nonvolatile memory and is not affected by power-on or reset.

If the disc drive has more than one unit, you must also specify the unit. Press SELECT ADDRES, DISC UNIT, then enter the unit number. If the disc has only one unit, set the unit number to zero. As with the address, the unit number is saved in nonvolatile memory.

Note   Discs must be initialized before data can be stored on them. Refer to "Formatting Discs" later in this chapter.

Saving and Recalling Displays

Data traces, instrument state displays, fault logs, curve fit tables, delete frequency tables and synthesis tables can be saved on disc memory. In addition, auto sequence, auto math, synthesis, curve fit and delete frequency tables are fully operational when recalled. The **DISC** hardkey allows you to access the disc softkeys (see figure 11-5).
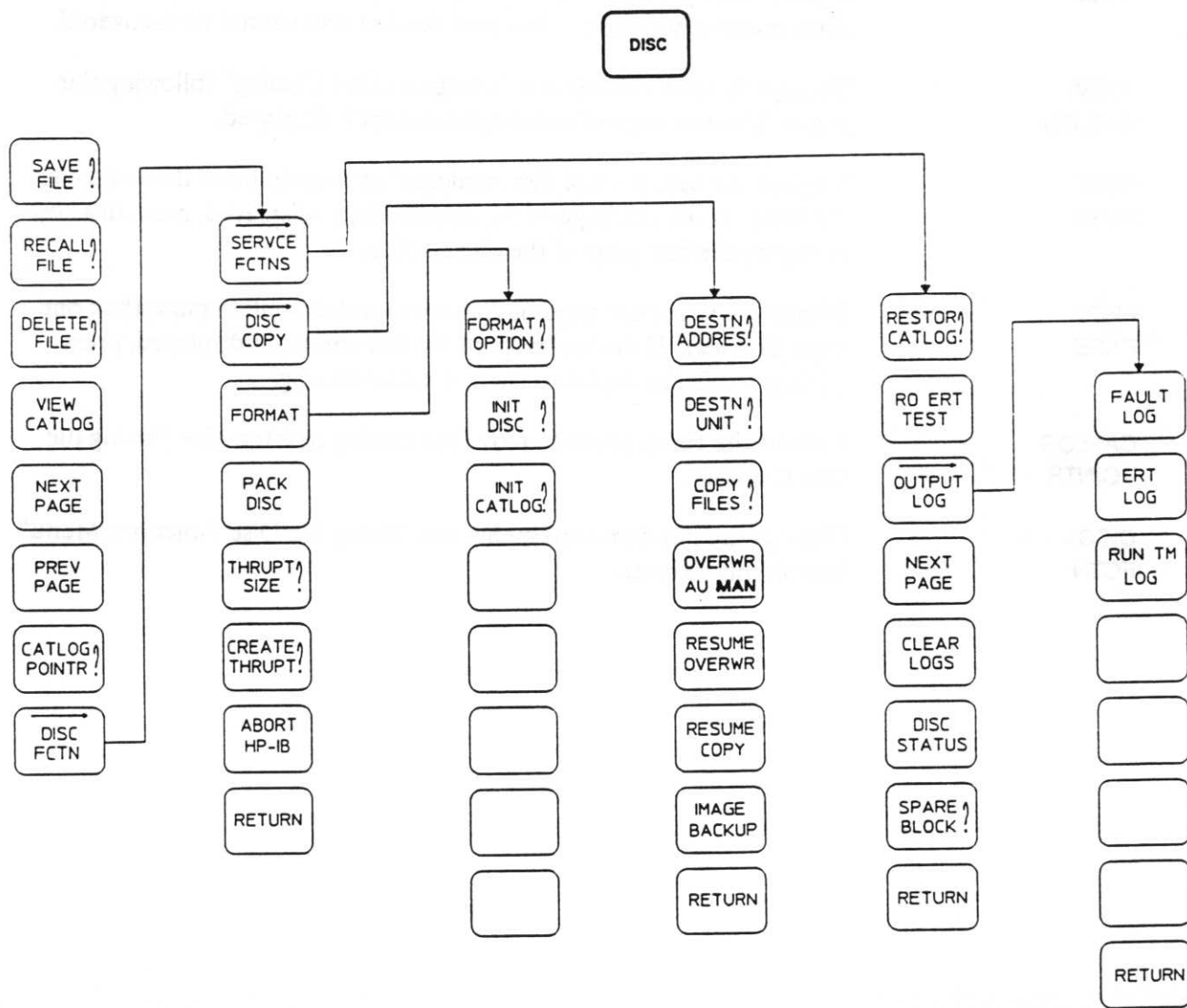
Figure 11-5. DISC Menu Diagram

When you press **DISC**, the following softkeys appear:

SAVE FILE	Used to save the current display on disc. There are three ways to save files; see "Saving Files on Disc".
RECALL FILE	Used to recall an existing file from the disc to the display. There are three ways to recall files; see "Recalling Files from Disc".
DELETE FILE	Used to delete a file from the disc. Enter the name of the file to be deleted, then press ENTER. You can also use AT POINTR; refer to the alpha menu description. Note that deleted files cannot be recovered.
VIEW CATLOG	Displays the disc catalog; see "Using the Disc Catalog" following this menu. The last page of multipage catalogs is displayed.
NEXT PAGE	Displays the next page of disc catalogs that contain more than one page (20 files). If the last page of the disc catalog is displayed, press this key to display the first page of the disc catalog.
PREV PAGE	Displays the previous page of disc catalogs that contain more than one page (20 files). If the first page of the disc catalog is displayed, press this key to display the last page of the disc catalog.
CATLOG POINTR	Enables the Entry group to move the catalog pointer. See "Using the Disc Catalog".
DISC FCTN	Displays the disc functions menu; see "Using the Disc Functions Menu" later in this chapter.

Saving Files on Disc

There are three ways to specify the name for a file you are saving to disc:

1. Enter a file name (up to 8 key strokes) using the alpha menu that is displayed then press ENTER.

2. Enter a file name then press OVER WRITE in the alpha menu. If a file under this name already exists on the disc, OVER WRITE deletes the original file and replaces it with the new file. This differs from pressing ENTER as in #1 above, which will not let you write over an existing file.

3. Press ENTER immediately after pressing SAVE FILE. This uses the last file name you stored on disc since power-up, increments any number at the end of its name by one, then stores the current display under the incremented file name. If the last file name does not contain a number, a 1 is appended to the new file name. If no files have been saved since power-up, the new file is simply named "1." To give you an idea of the space required to save files on disc, here are some example file sizes:

File Type	Size (in 256-byte sectors)
Time record trace	33
Frequency response trace	28
Power spectrum trace	15
Setup state	3
Auto sequence table	2 or 6*
Auto math table	2 or 6*
Synthesis table	4
Curve fit table	4
Time capture file	164
Throughput file (1 record)	20
Throughput file (10 records)	164
Throughput file (50 records)	804

*Note: The file size for this file type is 2 256-byte sectors if it contains features common to both the HP 3562A and the HP 3563A. The file size is 6 256-byte sectors if it does not. It is best to assume 6 256-byte sectors to ensure sufficient file size.

Note   A double-sided 3.5" microfloppy disc can hold about 80 frequency response traces.

To save files not currently on the display. use " NAME, XXX" where XXX is the proper code from
table 11-2.

Table 11-2. Codes for Saving Files Not on Display

To Save:	Use this Code:
Active Trace	DA
Data in trace A	DAA
Data in trace B	DAB
Instrument state	SE
Auto sequences	A1,A2,A3,A4 or A5
Auto Math	AM
Fault Log	FL
Capture buffer	CS
Test Log	TL
Demod delete frequency table	DM
s-domain synthesis table	ST
z-domain synthesis table	ZT

Note

Notice that there are no codes in table 11-2 for curve-fit tables. The reason for this
is that you must always display curve-fit tables before you save them. When you
save a curve-fit table, do not attach a suffix (NAME,XXX) to the file name. The
table domain (s or z) is automatically attached to the file type.

Recalling Files from Disc

There are three ways to recall files from disc:

1. After pressing RECALL FILE, enter a file name using the alpha menu that is displayed.

2. Display the disc catalog, move the pointer to the file you want to recall, press RECALL FILE, then press AT POINTR in the alpha menu.

3. After pressing RECALL FILE, press ENTER in the alpha menu. This recalls the next file from disc of the same file type as the last file you recalled since power-on. For example, if the catalog showed:

(Name)	(type)
TEST1	State
TEST2	State
FRESP	Synth
TEST3	State

and the last file you recalled since power-on was TEST2, pressing RECALL FILE followed by ENTER would recall TEST3.

Note that auto sequences can be recalled into tables other than the one in which they were created by appending a comma and the desired table number to the file name when recalling.

Note   If you save an HP 3563A setup state and recall that state on an HP 3562A, the HP 3562A ignores state information unique to the HP 3563A.

Using the Disc Catalog

When VIEW CATALOG is pressed, the disc's file catalog is displayed. The catalog shows the number of files on the disc, along with name, type, and size. The amount of disc space deleted and the number of entries available are shown at the top of the table. The upper left corner indicates the name of the disc, as entered when the disc is initialized (see "Using the Disc Functions Menu").

The catalog pointer makes entering file names much faster. The pointer highlights a file in the catalog and can be moved through the display with the Entry group. Press CATLOG POINTR to enable the Entry group, move the pointer to a file you wish to recall or delete, then press RECALL FILE or DELETE FILE. When the catalog is displayed, AT POINTR is displayed in the alpha menu. Press AT POINTR, and the file highlighted with the pointer will be recalled or deleted. This saves you the trouble of manually entering each file name with the alpha mode.

The Alpha Mode

When SAVE FILE, RECALL FILE or DELETE FILE is pressed, the HP 3563A shifts into the alpha mode to allow you to enter the file name. In the alpha mode, all front panel hard keys (except **LINE** and **HELP**) are converted to the blue labels under them, and the following softkeys are displayed:

ENTER
Saves, recalls or deletes the file, then exits the alpha mode. A status message is displayed for saving, recalling and deleting.

SPACE
FORWRD
Moves the cursor one space forward for editing. Use the ARROW keys and the blue "BL" key to add blanks.

SPACE
BACKWD
Moves the cursor one space backward without erasing any characters. To erase, use BACK SPACE or DELETE CHAR.

INSERT
ON OFF
When this is pressed ON, characters are inserted at the current cursor position. When pressed OFF, characters are written over existing ones.

DELETE
CHAR
Deletes the character at the cursor position.

CLEAR
LINE
Clears the alpha characters from the cursor position to the end of the line.

OVER
WRITE
Deletes the original file and replaces it with the new file. Appears only when SAVE FILE pressed.

AT
POINTR
Uses the name highlighted on the disc catalog display, appears when DELETE FILE or RECALL FILE is pressed.

CANCEL
ALPHA
Aborts the current entry and exits the alpha mode.

The number of files stored is limited only by space on the disc. Note that when ENTER is pressed and the file is saved, recalled or deleted, the instrument exits the alpha mode, and the keys return to normal operation.

Using the Disc Functions Menu

The disc functions menu allows you to pack discs, abort HP-IB operations, and create throughput files. It also gives you access to the service functions, copying and formatting menus. Press **DISC** DISC FCTN to display the following softkeys (Figure 11-5 shows the menu diagram for the **DISC** hardkey):

SERVCE FCTNS	Displays the disc service functions menu, which allows you to perform media and hardware tests and spare blocks in media. See "Sparing Blocks" later in this chapter.
DISC COPY	Displays the disc copying menu, which allows you to COPY copy files and perform backups. See "Copying Disc Files" later in this chapter.
FORMAT	Displays the formatting menu, which allows you to initialize catalogs, format media and select format options for HP Subset/80 discs. See "Formatting Discs" later in this chapter.
PACK DISC	Packs the disc by removing any space remaining when files have been deleted. Before packing, look at the top of the catalog to see how much space has been deleted. This is the amount of space that packing will recover.
THRUPT SIZE	Used to specify the size of throughput files; refer to chapter 9 for instructions.
CREATE THRUPT	Creates time throughput files; refer to chapter 9 for instructions.
ABORT HP-IB	Aborts disc operations. Use this when the bus fails to respond or when you wish to gracefully terminate a bus operation before it is finished.

Packing discs requires several minutes because the entire contents of the disc must be read then rewritten. "PACK DISC IN PROGRESS" and "% Done" are displayed while the pack is in progress. Disc packing can be gracefully aborted by pressing ABORT HP-IB.

Formatting Discs

Caution	The first step the analyzer takes when formatting discs is to erase any existing data. When formatting discs with multiple software volumes, the HP 3563A re-initializes the entire disc into a single volume.

The HP 3563A allows you to format discs to two levels: INIT CATALOG writes a catalog on the media, and INIT DISC formats and writes a catalog on the media. In addition, FORMAT OPTION allows you to enter a format option number for Hewlett-Packard Subset/80 discs. Press **DISC** then DISC FCTN, followed by FORMAT to display the following softkeys (Figure 11-5 shows the menu diagram for the **DISC** hardkey):

FORMAT OPTION	Allows you to enter a formatting option, from 0 to 239, for Subset/80 discs. This is ignored by all other disc command sets.
INIT DISC	Initializes media by writing a catalog and formatting the media. On tapes, INIT DISC performs an automatic certification test and stores the results in the ERT log.
INIT CATLOG	Initializes media by writing a catalog. This does not format the media and is primarily used to initialize pre-formatted tapes. This is also a fast, easy way to erase discs.

Refer to your Subset/80 disc drive's manual for more information on the formatting options. The HP 3563A can use only the 256-byte sector size. For example, the HP 9122D disc drive must use format options 0 (its default), 1 or 4 to work with the HP 3563A. Not all drives default to 256 bytes/sector, so refer to your drive's manual if there is any question about its default format.

After you press INIT DISC or INIT CATLOG, the instrument shifts into the alpha mode to allow you to enter the name for the disc. After typing in the name, you can type a comma followed by a number from 1 to 32 767 to specify the maximum number of files you will be storing on this disc. The number you enter is rounded up to the nearest 8n (8, 16, 24, etc). For example, on a disc to be used solely for time throughput, you could initialize it as "THRU,5." This initializes the disc and allows you to store up to five large files. The reason for specifying the number of files is that it reserves only the minimum necessary space for the catalog and allows you maximum space for files. If you choose not to specify the number of files, 6% of the disc is automatically reserved for the catalog and the rest is reserved for files.

Both INIT DISC and INIT CATLOG erase any files existing on media. If you are not sure whether a tape or disc has been initialized, press VIEW CATALOG in the **DISC** menu. If "Unformatted Disc" is displayed, you need to initialize the media with INIT DISC. If "Not a Valid Catalog" is displayed, you need to initialize the catalog with INIT CATLOG.

Copying Disc Files

The DISC COPY menu allows you to copy any number of files, from one to the entire disc contents. It also provides image backup to quickly copy data images from discs and tapes, sector-by-sector. Press DISC, then DISC FCTN followed by DISC COPY to display the following softkeys (Figure 11-5 shows the menu diagram for the **DISC** hardkey):

DESTN ADDRES	Used to enter the HP-IB address of the destination disc drive, from 0 to 7. See "Identifying the Copy Destination" following this menu.
DESTN UNIT	Used to enter the unit number of the destination disc, from 0 to 15. See "Identifying the Copy Destination" following this menu.
COPY FILES	Used to enter name(s) of the file(s) to be copied. See "Selecting Files To Be Copied" following this menu.
OVERWR AU **MAN**	Selects auto or manual overwrite. Auto overwrites any duplicate files without stopping; manual pauses each time it encounters duplicates. See "Selecting Files To Be Copied" following this menu.
RESUME OVERWR	Instructs the file copier to write over the duplicate file, erasing the destination file. See "Selecting Files To Be Copied." This can also be used to resume over writing on a second disc if the first one fills before copying is finished and to resume after HP-IB aborts.
RESUME COPY	Instructs the file copier not to write over the destination file and skip the file in question when duplicates are encountered. See "Selecting Files To Be Copied." This can also be used to resume copying on a second disc if the first one fills before copying is finished and to resume after HP-IB aborts.
IMAGE BACKUP	Performs a backup of the source to the destination. Refer to "Image Backup" following this menu. **DO NOT PRESS THIS UNTIL YOU HAVE READ "IMAGE BACKUP" FOLLOWING THIS MENU.**

Identifying the Copy Destination

The destination disc is identified with DESTN ADDRES and DESTN UNIT. An error message is displayed if the destination address and unit match those of the source when a copy or backup is attempted. The source address and unit are identified with the SELECT ADDRES menu under the **HP-IB FCTN** key.

Selecting Files To Be Copied

You have four choices for selecting the files you wish to copy: enter a single name, use the catalog pointer and AT POINTR, enter the starting and ending of a group of file names, or copy all the files from the source disc.

1. To copy a single file, press COPY FILES then enter the file name using the alpha menu and the blue labels on the front panel. Copying starts when you press the ENTER softkey.

2. Move the catalog pointer to the desired file, press COPY FILES, then press AT POINTR in the alpha menu.

3. To copy a contiguous group of files, first display the disc catalog by pressing VIEW CATALOG in the **DISC** menu. Then press DISC FCTN followed by DISC COPY and COPY FILES. Enter the starting and ending file names separated by a comma. When you press the ENTER softkey, all the files from the starting to the ending in the catalog are copied. Files are stored on the destination disc in the same order they appear on the source disc. If the ending file is not found, all files after the starting file are copied. To copy from the beginning of the catalog to a specific file, enter:

    < ,filename

4. To copy from a specific file to the end of the catalog, enter:

    filename, >

5. To copy all the files from the source to the destination, press COPY FILES followed immediately by the ENTER softkey.

If the file copier encounters a file on the destination with the same name as the a file in the source, it takes one of two actions depending on the state of OVERWR AU MAN. If this is set to AU (auto overwrite), the destination file is written over by the source file and erased. **NO COPY OF THE ORIGINAL DESTINATION FILE IS PRESERVED.**

However, if OVERWR AU MAN is set to MAN, the file copier stops and informs you each time it encounters a duplicate file name. You then have the options of ignoring the warning and writing over the destination file or skipping the file in question and proceeding to the next source file. Press RESUME OVERWR to write over the destination file or RESUME COPY to skip the file.

RESUME COPY or RESUME OVERWR can also be used to resume copying on a second disc if the first destination disc fills before all files are copied. If "Disc Full" or "Catalog Full" is displayed, replace the disc in the destination drive then press RESUME COPY or RESUME OVERWR to finish copying.

If a copy is aborted before finished, the destination disc retains all files copied up to, but not including, the one being transferred. ABORT HP-IB during copying does not affect the source disc.

Image Backup

Note　　　　The first action IMAGE BACKUP takes is to completely erase the destination disc or tape. Do not perform an image backup to a tape or disc that contains valuable data.

Image backups are used to save entire discs for security and archival purposes. This feature allows you to quickly copy the entire contents of a disc; it is much faster than using the COPY FILES command. Backup creates an exact data image of the source disc on the destination disc. You cannot perform a partial backup on one disc then resume on a second disc. IMAGE BACKUP does not allow you to start a backup if the destination is too small.

Using the Disc Service Functions

The disc service functions are intended for disc service technicians as well as advanced HP 3563A operators who need to spare blocks on disc or tape. The run time error log and the hardware fault logs are offered, as well as the read-only error rate test. Press **DISC** then DISC FCTN followed by SERVCE FCTNS to display the following menu (Figure 11-5 shows the menu diagram for the **DISC** hardkey):

RESTOR CATLOG	Restores the catalog if power was lost during a data transfer or the catalog was somehow erased. See "Restoring Catalogs" following this menu.
RO ERT TEST	Clears the ERT log and starts the read-only error rate test (ERT). See "The Error Rate Test" following this menu.
OUTPUT LOG	Displays the output log menu, which gives you access to the run time, ERT or fault logs.
NEXT PAGE	Displays the next page of the log displayed last. Page numbering in logs is separate for each head in multihead discs, so keep pressing NEXT PAGE until "LAST PAGE" is displayed in the log.
CLEAR LOGS	Clears the run time, ERT and fault logs. You should read and appropriately act on any information in the logs before clearing them.
DISC STATUS	Retrieves the disc status display, which shows the last disc access error that occurred since power-up. See "Disc Status" following this menu.
SPARE BLOCK	Allows you to spare blocks that have been confirmed bad. Blocks are identified either with a 1-vector address or a 3-vector cylinder,head,sector address. Refer to "Sparing Blocks" later in this chapter before attempting to spare blocks.
RETURN	Redisplays the DISC FCTN menu.

When OUTPUT LOG in the SERVCE FCTNS menu is pressed, the following menu is displayed:

FAULT LOG	Displays the hardware fault log. Refer to "The Fault Log" later in this chapter.
ERT LOG	Displays the ERT Log. Refer to "The Error Rate Test" following this menu.
RUN TM LOG	Displays the run time log. Refer to "The Run Time Log" later in this chapter.

Disc Status

The disc status display shows the last disc data access error since power-up. An example is shown in figure 11-6.
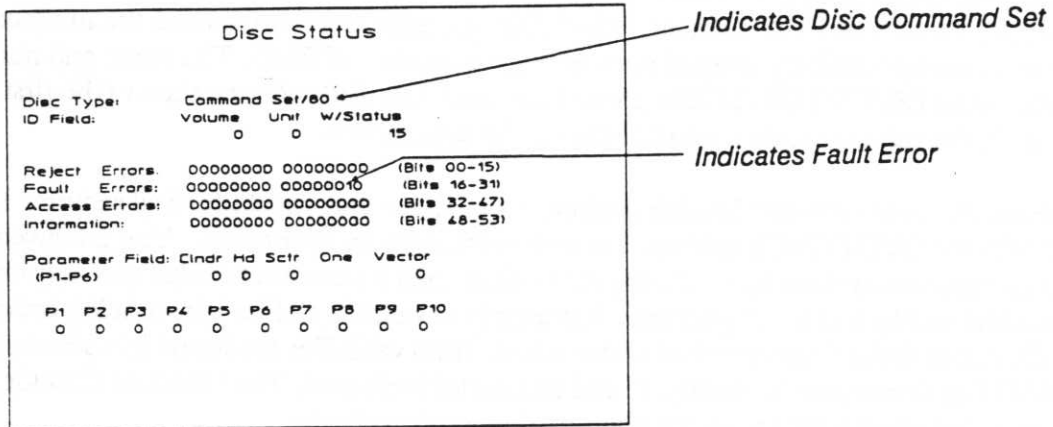
Figure 11-6. The Disc Status Display

Restoring Catalogs

Catalogs can be restored if power was lost during a data transfer or if the catalog appears corrupted. If RESTOR CATLOG finds a catalog sector that it determines to be bad. it clears that catalog sector. For this reason. be certain that a catalog definitely needs restoring before you press RESTOR CATLOG.

The next step after pressing RESTOR CATLOG is to use the alpha mode to enter a name for the restored catalog. As with INIT DISC and INIT CATLOG, you may add a comma and the number of files for the disc (for restoration you **must** use the original number of files). The name and number of files entered after RESTOR CATLOG is pressed are used only if the volume sector (the first sector) is bad. If the volume sector is good, these entries are ignored.

If you terminate this entry with the ENTER softkey, the analyzer only checks for bad sectors. If you terminate it with the OVER WRITE softkey, it actually performs the restoration. You are given this choice because restoration starts by validating the catalog, then it searches for files that may exist in data sectors addressed by bad catalog sectors. It attempts to validate all files in ascending order, and if it finds a file out of order it assumes that sector is bad. If no valid files are found in a sector, the message "BAD Cat Sector nnn" is displayed, and that sector is cleared. The "Restore Catalog" display at the end of restoration shows the number of bad sectors found.

Restoration is fast if all files can be located in the order indicated in the catalog. If some sectors are determined bad and need to be spared, restoration can take a long time. It can, however, be gracefully aborted by pressing ABORT HP-IB and started again.

The Error Rate Test – Discs

This test checks for data reading errors. The error rate test (ERT) is read-only, so it does not destroy data on the disc. Because the disc drive's error correction circuitry is disabled while the ERT is running, the ERT records all errors—both correctable and uncorrectable. This differs from the run time log, which shows only uncorrectable errors.

The ERT starts by performing a full-volume error test, noting bad sectors in the ERT log. Next, it reads the ERT log to check each bad sector individually. Each bad sector is checked 20 times to see if errors occur consistently. The ERT then reads the run time log to individually check sectors that historically produced errors. These are checked 20 times also. The final ERT log can be retrieved from disc when the ERT is finished; it shows the number of times each error occurred.

Figure 11-7 shows an example of the disc ERT log. Note that pressing RO ERT TEST to start the ERT erases the ERT log.
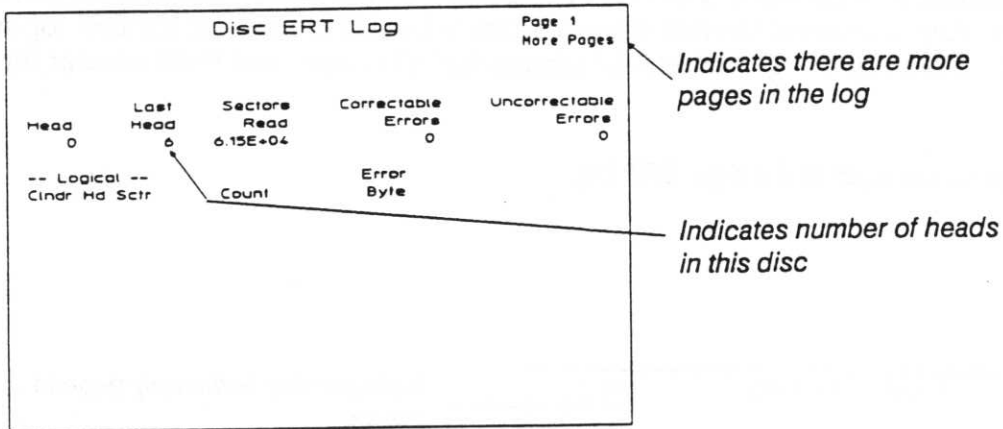
Figure 11-7. The Disc ERT Log

The ERT is used in conjunction with the run time log to help you locate and spare bad blocks on media. Refer to "Sparing Blocks" later in this chapter for instructions.

The Error Rate Test—Tapes

The ERT is run differently for tapes. First, it does not disable error correction circuitry, so only uncorrectable errors are shown. Second, it does all the interpreting for you, so any sector that shows up in the ERT log on a tape needs to be spared. Any errors it encounters are tested three times to see if they are transient or permanent. The ERT then ignores transient errors and tries to correct permanent errors. Any permanent errors it cannot correct or locate are shown in the ERT log and need to be spared. Note that the ERT takes 8-10 minutes for 150-ft tapes and 35-40 minutes for 600-ft tapes.

Figure 11-8 shows an example of the tape ERT log.
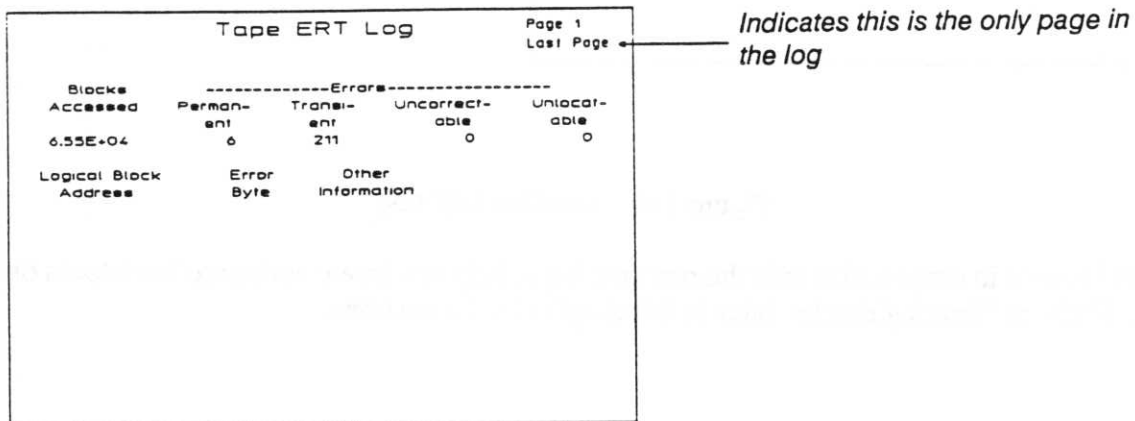
Figure 11-8. The Tape ERT Log

Any errors displayed in the uncorrectable or unlocatable columns need to be spared. If 150-ft tapes have more than 128 errors, they need to be backed up and replaced. If 600-ft tapes have more than 250 errors, they need to be backed up and replaced.

The Run Time Log

This log records data errors that occur during normal operation. Because the error correction circuitry is enabled during normal operation, the run time log does not show correctable errors. Other than that, it records and shows the same information as the ERT log. Figure 11-9 shows an example.

Figure 11-9. The Run Time Log

You should first read the run time log to see if the ERT needs to be run. It also can be used in conjunction with the ERT and its log to help you locate and spare bad blocks on media. Refer to the next section, "Sparing Blocks," for instructions.

Sparing Blocks

You can use the run time and ERT logs to locate bad blocks on media. Once located, these blocks can be spared using SPARE BLOCK. This allows you to continue using the media while avoiding bad areas. There are four steps to sparing blocks:

1. View the run time log (press **DISC**, DISC FCTN, SERVCE FCTNS, OUTPUT LOG then RUN TM LOG). If there are no errors in this log, there are probably no data access problems. If there are errors recorded in this log, proceed with Step 2.

2. Run the error rate test (press **DISC**, DISC FCTN, SERVCE FCTNS then RO ERT TEST). NOTE: pressing RO ERT TEST erases the ERT log—view the ERT log first to avoid erasing valuable test data. The ERT first checks all sectors by reading their data and checking for errors. Any bad sectors are noted in the log. For discs, the ERT then reads the log to check each bad sector individually. Each bad sector is checked 20 times to see if errors occur consistently. The ERT then reads the run time log to check those bad sectors 20 times also. When the ERT is finished, proceed to Step 3.

3. Any disc sector that produced a repeatable error is probably bad. View the run time and ERT logs to see if any address appears more than once. Those that do should be spared; proceed to Step 4. Errors that occur only once are probably random and could not be remedied by block sparing. A large number of bad sectors could indicate other trouble.

For tapes, every block in the uncorrectable and unlocatable columns in the ERT log is confirmed bad and needs to be spared.

1. To spare a block, press SPARE BLOCK then enter the block's address. This will either be the 1-vector address or the 3-vector cylinder, head,sector address; use the address shown in log. In 3-vector addresses, enter all three vectors at once, separated by commas.

2. To verify sparing, you can run the ERT again. In any case, you should clear all three logs after sparing all bad blocks and see if any errors accumulate when you put the disc or tape back into operation.

The Fault Log

The fault log shows disc hardware errors that have accumulated since the log was last cleared. Figure 11-10 shows an example.

Figure 11-10. The Disc Fault Log

Note

This fault log is designed for the disc service technician who is familiar with its contents. It is not intended for use by HP 3563A operators.

Quick Reference Tables

ERROR REPORTING FIELDS[1]

IDENTIFICATION FIELD	REJECT ERRORS FIELD	FAULT ERRORS FIELD[2]
<VVVUUUU> <SS SS SS SS>	0 7 8 15 <0 0 2 0 0 5 6 7> <8 9 10 0 12 0 0 0>	16 23 24 31 <0 17 0 19 0 0 22 0> <24 0 26 27 28 0 30 31>

VVV = Volume number UUUU = Unit number SSSSSSSS = Value of the lowest numbered unit with status pending (all ones if no units have status pending).	2 = CHANNEL PARITY ERROR A channel command was received without odd parity, 5 = ILLEGAL OPCODE An unrecognizable opcode was received. 6 = MODULE ADDRESSING An illegal volume or unit number was specified for this device 7 = ADDRESS SOUNDS The target address has exceeded the bounds for this device. 8 = PARAMETER BOUNDS A parameter (other than unit, volume, or target address) is not allowed for this device. 9 = ILLEGAL PARAMETER A parameter field was the wrong length for the opcode preceding it. 10 = MESSAGE SEQUENCE The message sequence has been violated. (Error suppressed if any reject or fault errors have occurred prior to sequence error.) 12 = MESSAGE LENGTH The total length of the execution message differs from the current default value.	17 = CROSS-UNIT[3] An error has occurred during a Copy Data operation 19 = CONTROLLER FAULT A hardware fault occurred in the controller. 22 = UNIT FAULT A hardware fault has occurred in the unit addressed. 24 = DIAGNOSTIC RESULT[3] The hardware failed the diagnostic indicated in the parameter field. 26-28 = RELEASE REQUIRED This command cannot be executed until after release is granted to the device. Device requires release for indicated reason: 26 = OPERATOR REQUEST Release required for operator request (e g., load/unload, restore). 27 = DIAGNOSTIC REQUEST Release required for diagnostics initiated from control panel (e.g., HIO, self test). 28 = INTERNAL MAINTENANCE Release required for internal maintenance (e.g., head alignment error log). 30 = POWER FAIL The power to the unit failed, a diagnostic destroyed configuration, or a pack was loaded. Device should be reconfigured. 31 = RETRANSMIT The preceding transaction should be retried.

Notes:
1. Error bit positions correspond to bit positions in Set Status Mask command. A "1" indicates presence of an error. Unused bit positions must be zeroes.
2. All Fault Errors are unmaskable.
3. Error uses parameter field.

4. • Parameter field configuration is dependent on reported errors.
   • Highest priority is given to lowest numbered errors.
   • Masked errors relinquish their priority.

Request Status Summary (continued)

ERROR REPORTING FIELDS[1]

ACCESS ERRORS FIELD	INFORMATION ERRORS FIELD	PARAMETER FIELD[4]
32 39 < 32 33 34 35 36 37 0 0 > 40 47 < 40 41 0 43 44 0 0 0 >	48 55 < 48 49 50 51 52 0 0 55> 56 63 < 0 57 58 59 0 61 0 0 >	<P1 > ————— <P10 >
32 – ILLEGAL PARALLEL OPERATION The requested operation cannot be executed in parallel with some other operation(s) currently in progress. **33 – UNINITIALIZED MEDIA** The host attempted to access unformatted media, or unusable media has been Loaded. **34 – NO SPARES AVAILABLE** Spare Block cannot be executed due to lack of spare media. **35 – NOT READY** The selected unit is not ready for access at this time (e.g., heads or media not yet fully loaded). **36 – WRITE PROTECT** The selected volume is write protected. **37 – NO DATA FOUND** A block accessed during a read has not been written. **40 – UNRECOVERABLE DATA OVERFLOW** The previous transaction generated more than 1 unrecoverable data error. The entire transfer should be considered in error. **41 – UNRECOVERABLE DATA[3]** Unrecoverable data at indicated block(s). **43 – END OF FILE** End of file encountered on file structured device. **44 – END OF VOLUME** The host attempted to access across a volume boundary.	**48 - 50 REQUEST RELEASE[3]** Device requests release for indicated reason: **48 – OPERATOR REQUEST[3]** Release requested for operator request (e.g., load/unload, restore) **49 – DIAGNOSTIC REQUEST[3]** Release request initiated from diagnostic control panel (e.g., HIO, self test). **50 – INTERNAL MAINTENANCE[3]** Release requested for internal maintenance (e.g., head alignment, error log). **51 – MEDIA WEAR** Only one spare track (disc) or one spare block (tape) remaining. **52 – LATENCY INDUCED** A latency was induced during the transfer due to slow transfer rate or seek retry. **55 – AUTO SPARING INVOKED** A defective block has been automatically spared by the device. **57 – RECOVERABLE DATA OVERFLOW** The previous transaction generated more than 1 recoverable data error. **58 – MARGINAL DATA[3]** Data was recovered, but with difficulty **59 – RECOVERABLE DATA[3]** A latency was introduced in order to correct a data error. **61 – MAINTENANCE TRACK OVERFLOW** Error and fault log area is full. Error Bit No 41 Unrecoverable Data: P1 through P6 indicate address of bad block.	No Errors P1 through P6 indicate new Target Address. The address format which is used anytime P1 through P6 contain address information, is defined by the Set Return Addressing command. No Errors P7 through P10 contain run-time drive error codes (DERRORS), except after a Spare Block command. The errors are arranged chronologically. P7 contains the most recent of the four errors recorded, P10 contains the oldest of the four recorded. Note: Error codes 40H and CBH are always followed by a single byte containing fault latch information. After a Spare Block command P1 through P6 contain the beginning address of the reformatted area (Disc operation only.) After Spare Block command, P7 through P10 indicate the length - in blocks - of the reformatted area. The length is a four-byte, unsigned binary number. (Disc operation only.) Error Bit No 17 Cross-unit: P1 through P6 contain the encoded values of each unit which has experienced an error. A byte of all ones indicates no additional units. Error Bit No 24 Diagnostic Results: P1 through P6 contain the following information: P1 – most suspect component P2 – next most suspect component P3 – test error (TERROR) associated with P1 P4 – test error (TERROR) associated with P2 P5- P6- not used P7- P10 contain DERROR information (format described above). Error Bit No 48-No 50 Request Release; P1 through P6 contain the encoded values of each unit requesting release. A byte of all ones indicates no additional units. Error Bit No 58 Marginal Data: P1 through P6 indicate address of the marginal block. Error Bit No 59 Recoverable Data: P1 through P6 indicate address of recoverable block

Outputting Command Strings

The HP 3563A can output HP-IB command strings up to 25 key strokes long (excluding the address). Press OUTPUT STRING, enter the address of the destination device followed by a comma, then enter the command string. For example, the command:

OUTPUT STRING 5, PA1000,1000

sends the HP-GL command "PA1000,1000 " (Plot Absolute to location 1000,1000) to a plotter at address 5. For secondary addresses, use 3- or 4-digit addresses. The last two digits in 3- and 4-digit addresses are treated as the secondary address.

The HP 3563A can send HP-IB commands to itself. Use — — as the address, instead of a standard HP-IB address from 0 to 31. This sends each command back through the analyzer's HP-IB command translator. You can use all the commands except those involving data transfer. All parameter entry commands can be used, however. For example, the command

OUTPUT STRING — — DBAC1

clears and activates display buffer #1.

OUTPUT STRING is especially useful when programmed in auto sequences. Refer to chapter 10 for information on creating and using auto sequences. Refer to the HP 3563A Programming Manual for information on the analyzer's HP-IB commands.

Special Functions/Preset Conditions

Purpose of This Chapter

This chapter describes the features available with the **SPCL FCTN** and **PRESET** hardkeys. The **SPCL FCTN** hardkey allows you to:

- Initiate self tests
- Initiate service tests
- Set the analyzer's internal clock
- Enable or disable the analzyer's beeper
- Set up source protections
- Configure the analyzer to send an SRQ over the HP-IB on power-on
- View block diagrams useful while configuring the analyzer
- Enable/disable softkey annotation for parameter entry or submenus (see the description of the MENU ON OFF and NMBR ? ON OFF softkeys)

The **PRESET** hardkey presets the analyzer. When pressed it does two things: presets the analyzer for the current measurement mode and displays a softkey menu. The softkey menu lets you reset the analyzer to its power-on state or select predefined measurement mode setups. Specifically, you can select predefined setups for these measurements:

- Frequency-response
- Power-spectrum
- Time capture
- Time throughput

The SPCL FCTN Hardkey

The **SPCL FCTN** hardkey provides access to the HP 3563A's special features — features such as self tests, service tests, the internal non-real time clock, the internal beeper, source protection, and power-on service requests. Figure 12-1 shows the menu diagram for the **SPCL FCTN** hardkey.
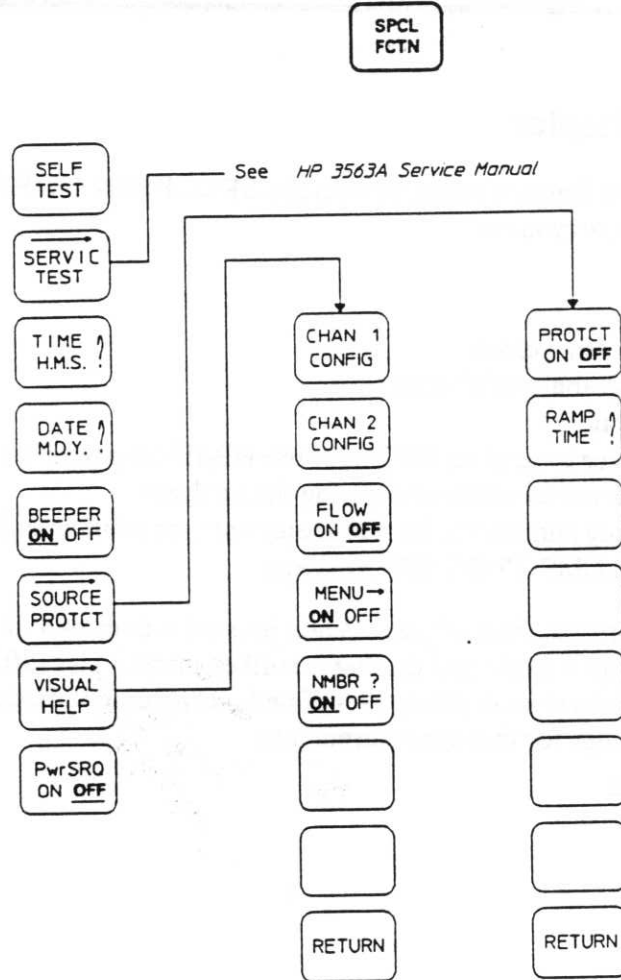
Figure 12-1. SPCL FCTN Menu Diagram

Softkey Descriptions

The softkeys that appear when you press **SPCL FCTN** do the following:

SELF
TEST

Determines if the HP 3563A is operating correctly. To initiate the self tests, reset the analyzer, press **SPCL FCTN**, then press this softkey twice. All measurement data and display setup information is erased during the self test cycle. The self test takes about 1 minute to complete. During the test, Diagnostic In Progress appears on the display in the message area. This test finishes by calibrating the input channels. The self test does not erase any data stored in non-volatile memory (for example, the synthesis table). If the message "SELF TEST PASSES" is displayed, your analyzer is operating properly. If any other message is displayed indicating a failure, refer servicing to qualified personnel. HP Sales and Service Offices are listed in the back of this manual.

SERVIC
TEST

Accesses the servicing diagnostics softkeys; refer to the HP 3563A Service Manual for instructions on their use. These softkeys are intended for use by qualified service technicians only; **none of the softkeys accessed through** SERVIC TEST are intended for use by HP 3563A operators.

TIME
H, M, S

Enters the time for analyzer's clock. The time is saved in non-volatile memory and is not erased at power-down or after the analyzer is reset. Enter the time as hh,mm,ss. The hours reset after 23; the minutes and seconds reset after 59. The time and date of the clock are used in the disc catalog and to provide timed starts for autosequences.

DATE
M, D, Y

Enters the date for the analyzer's clock. The date is stored in non-volatile memory and is not affected by power-down or reset. Enter the date as mm,dd,yy. Leap years and month length are automatically accounted for. The time and date of the clock are used in the disc catalog and to provide timed starts for autosequences.

BEEPER
ON OFF

Controls the internal beeper. The default is ON at power-up and after reset.

SOURCE
PROTCT

Displays the source protection menu, which allows you to activate source protection and set its ramp time (see "Source Protection"). Source protection helps avoid damage to devices under test by shutting the source off when the measurement mode, frequency span or source type is changed. It also ramps the source to new levels, rather than changing the level abruptly. For example, you can set a ramp time of 10 seconds which allows you to monitor the device under test as you turn the source on. Changing the source level or dc offset with the Entry group knob or arrow keys, bypasses the source protection delay. The source protection setting is stored in non-volatile memory and is not affected by PRESET or turning off the power. Source protection is not available for the following types of sources:

- PULSE
- RAMP
- STEP
- Arbitrary (USER SAVD 2)

VISUAL
HELP

Displays the Visual Help softkeys (See "Visual Help"). These softkeys provide block diagrams useful in setting up the analyzer.

Pwr SRQ
ON OFF

When in the ON position, outputs a service request, SRQ, to the HP-IB when power is switched on. The default value is OFF. The state of this softkey is saved in nonvolatile memory and is not affected by power-down or reset. For instructions on handling the SRQ, refer to the HP 3563A Programming Reference.

Source Protection

The SOURCE PROTCT softkey allows you to activate source protection and set its ramp time, as follows:

PROTCT ON OFF	Controls source protection. If ON, the source level and the dc offset return to 0V when the measurement mode, the source output type or any frequency parameter is changed. For example, if source protection is on, changing the source type from random noise to fixed sine will cause the source level and the dc offset to return to 0V. The setting is stored in non-volatile memory. Source protection remains on after RESET or a power cycle. You can specify the rate at which the level changes with the RAMP TIME softkey. The ramp time rate is used when the source changed from the present level to a new level. Units can be in seconds or minutes. Source protection is not available for some source types (see the previous description of the SOURCE PROTCT softkey).
RAMP TIME	Specifies the ramp time for source protection. This is the time the source takes to change levels, either from the present level to zero or from the present level to another level, when source protection is on. Units can be in seconds or minutes. In the swept sine mode, ramp time is a volts/second slope, not absolute time.

Visual Help

The VISUAL HELP softkey allows you to view block diagrams useful in setting up the analyzer. A variety of visual helps are available, as follows:

CHAN 1
CONFIG

Selects a block diagram display of the channel configuration for Channel 1. This block diagram illustrates the source of the data, analog or digital, the source of the sample clock and, if Channel 1 is configured for digital data, the pin connections, clock polarity, data qualifier pattern, clock source, and data format. The block diagram reflects the current state of the channel configuration. See chapter 2 for a sample block diagram. This softkey is also available when channel 1 is digital and you press **INPUT CONFIG** INTERFACE 1 (see chapter 7).

CHAN 2
CONFIG

Selects a block diagram display of the channel configuration for Channel 2. See the description for CHAN 1 CONFIG for details. This softkey is also available when channel 2 is digital and you press **INPUT CONFIG** INTERFACE 2 (see chapter 7).

FLOW
ON OFF

Illustrates the data path from input to display (called the flow diagram). The following hardkeys affect this measurement flow:
- INPUT CONFIG
- SELECT MEAS
- FREQ
- MEAS DISP
- VIEW INPUT
- A
- B
- A&B

These hardkeys do not generate trace displays when the FLOW softkey is ON. (ON is highlighted and underscored). To turn off the FLOW feature, toggle FLOW ON OFF to OFF or press the **STATE/TRACE** hardkey. See chapter 2 for a sample flow diagram.

MENU
ON OFF

Controls an arrow which indicates a lower level menu. If ON, an arrow appears above softkeys to indicate additional selections will be displayed if the softkey is pressed. The default is ON.

NMBR ?
ON OFF

Controls a question mark which appears next to softkeys to indicate data entry of either numeric or alphanumeric values. If ON, a question mark appears next to softkeys that require numeric or alphanumeric entries. The default is ON.

The PRESET Hardkey

The **PRESET** hardkey presets the analyzer. When pressed it does two things: presets the analyzer for the current measurement mode and displays a softkey menu. The softkey menu lets you reset the analyzer to its power-on state or select predefined measurement mode setups. Specifically, you can select predefined setups for these measurements:

- Frequency-response
- Power-spectrum
- Time capture
- Time throughput

When you press **PRESET**, the softkeys in figure 12-2 appear.

Note	You can also use the **SAVE RECALL** hardkey to set the analyzer to a known state. Use this hardkey to save your analyzer state to internal, non-volatile memory. You can then recall this state at any time (see chapter 8 for details).

PRESET

F RESP
LINRES

F RESP
LOGRES

F RESP
SWEPT

P SPEC
LINRES

TIME
CAPTUR

TIME
THRUPT

RESET

Figure 12-2. PRESET Menu Diagram

Softkey Descriptions

The following paragraphs describe the **PRESET** softkeys:

F RESP
LINRES

Presets the instrument to the frequency response measurement in the linear resolution mode. Figure 12-3 shows the instrument state display.

```
                    Linear  Resolution

 MEASURE:  CHAN  1                    CHAN  2
           Freq Resp                  Freq Resp

 WINDOW:   CHAN  1                    CHAN  2
           Hanning                    Hanning

 AVERAGE   TYPE        # AVGS    OVERLAP    TIME AVG
           Avg Off        10    0%         Off

 FREQ:     CENTER                 SPAN      BW
           50 kHz                 100kHz    187 Hz

           REC LGTH    Δt
           8.0mS       3.91μS

 TRIGGER:  TYPE        LEVEL      SLOPE     PREVIEW
           Freerun     0.0 Vpk    Pos       Off

 INPUT:    RANGE       ENG UNITS  COUPLING  DELAY
   CH  1   AutoRng↑    1.0 V/EU   DC (Flt)  0.0 S
   CH  2   AutoRng↑    1.0 V/EU   DC (Flt)  0.0 S

 SOURCE:   TYPE                   LEVEL     OFFSET
           Rndm Noise             0.0 Vpk   0.0 Vpk
```

**Figure 12-3. Frequency Response
(linear resolution) Preset**

F RESP
LOGRES

Presets the instrument to the frequency response measurement in the log resolution mode. Figure 12-4 shows the instrument state display.

```
                    Log  Resolution

 MEASURE:  CHAN  1                   CHAN  2
           Freq Resp                 Freq Resp


 AVERAGE.  TYPE        # AVGS    OVERLAP   OVFL REJ
           Avg Off        10    0%        Off


 FREQ:     START       STOP       SPAN     RESOLUTION
           100 Hz      100kHz     3 Dec    240 Pts


           REC LGTH
           800mS


 INPUT:    RANGE       ENG UNITS  COUPLING
   CH  1   AutoRng↑    1.0 V/EU   DC (Flt)
   CH  2   AutoRng↑    1.0 V/EU   DC (Flt)


 SOURCE:   TYPE                   LEVEL     OFFSET
           Rndm Noise             0.0 Vpk   0.0 Vpk
```

**Figure 12-4. Frequency Response
(log resolution) Preset**

F RESP
SWEPT

Presets the instrument to the frequency response measurement in the swept sine mode. Figure 12-5 shows the instrument state display.

```
                    Swept  Sine

AVERAGE:  INTGRT TIME          # AVGS
          50.0mS                  1


FREQ:
   START  100 Hz               SPAN    3.0 Dec
   STOP   100 kHz              RESLTN  66.7 Pt/Dc


SWEEP:    TYPE        DIR       EST TIME  EST RATE
          Log         Up        2.05 Min  27.3 S/Dc


AU GAIN:  Off



INPUT:    RANGE       ENG UNITS  COUPLING
   CH 1   AutoRngt    1.0 V/EU   DC (Flt)
   CH 2   AutoRngt    1.0 V/EU   DC (Flt)


SOURCE:   TYPE                   LEVEL     OFFSET
          Off                    0.0 Vpk   0.0 Vpk
```

**Figure 12-5. Frequency Response
(swept sine) Preset**

P SPEC
LINRES

Presets the instrument to the power spectrum measurement in the linear resolution mode. Both channels are active and the flat top window is selected. Figure 12-6 shows the instrument state display.

```
              Linear  Resolution

MEASURE:  CHAN 1                CHAN 2
          Power Spec            Power Spec

WINDOW:   CHAN 1                CHAN 2
          Flat Top              Flat Top

AVERAGE:  TYPE        # AVGS    OVERLAP   TIME AVG
          Avg Off         10    0%        Off

FREQ:     CENTER                SPAN      BW
          50 kHz                100kHz    477 Hz

          REC LGTH    Δt
          8.0mS       3.91μS

TRIGGER:  TYPE        LEVEL     SLOPE     PREVIEW
          Freerun     0.0 Vpk   Pos       Off

INPUT:    RANGE       ENG UNITS  COUPLING DELAY
   CH 1   AutoRngt    1.0 V/EU   DC (Flt) 0.0 S
   CH 2   AutoRngt    1.0 V/EU   DC (Flt) 0.0 S

SOURCE:   TYPE                   LEVEL     OFFSET
          Rndm Noise             0.0 Vpk   0.0 Vpk
```

**Figure 12-6. Power Spectrum
(linear resolution) Preset**

TIME
CAPTUR

Presets the instrument to the time capture mode and sets up a
10-record capture on Channel 1, from 0 to 5 kHz. Figure 12-7 shows
the instrument state display.

```
              Time  Capture

MEASURE    CHAN 1                  CHAN 2
           Power Spec              Off

WINDOW:    CHAN 1                  CHAN 2
           Flat Top                Flat Top

AVERAGE    TYPE        # AVGS      OVERLAP    TIME AVG
           Avg Off        10       0%         Off

FREQ:      CENTER                  SPAN       BW
           2.5 kHz                 5.0kHz     23.9 Hz

           REC LGTH    Δt
           160mS       78.1μS

TRIGGER:   TYPE        LEVEL       SLOPE
           Freerun     0.0 Vpk     Pos

INPUT:     RANGE       ENG UNITS   COUPLING DELAY
   CH 1    AutoRng↑    1.0 V/EU    DC (Flt) 0.0 S
   CH 2    AutoRng↑    1.0 V/EU    DC (Flt) 0.0 S

SOURCE:    TYPE                    LEVEL      OFFSET
           Rndm Noise              0.0 Vpk    0.0 Vpk
```

Figure 12-7. Time Capture Preset

TIME
THRUPT

Presets the instrument to the linear resolution mode and activates time
throughput. The power spectrum measurement is selected and both
channels are active. Figure 12-8 shows the instrument state.

```
              Linear  Resolution

MEASURE:   CHAN 1                  CHAN 2
           Freq Resp               Freq Resp

WINDOW:    CHAN 1                  CHAN 2
           Hanning                 Hanning

AVERAGE:   TYPE        # AVGS      OVERLAP    TIME AVG
           Avg Off        10       0%         Off

FREQ:      CENTER                  SPAN       BW
           50 kHz                  100kHz     187 Hz

           REC LGTH    Δt
           8.0mS       3.91μS

TRIGGER:   TYPE        LEVEL       SLOPE      PREVIEW
           Freerun     0.0 Vpk     Pos        Off

INPUT:     RANGE       ENG UNITS   COUPLING DELAY
   CH 1    AutoRng↑    1.0 V/EU    DC (Flt) 0.0 S
   CH 2    AutoRng↑    1.0 V/EU    DC (Flt) 0.0 S

SOURCE:    TYPE                    LEVEL      OFFSET
           Rndm Noise              0.0 Vpk    0.0 Vpk
```

Figure 12-8. Time Throughput Preset

RESET   Resets the instrument to its power-on default conditions. Figure 12-9
                         shows the reset instrument state display and additional default
                         conditions. RESET also clears the analyzer's HP-IB command buffer
                         and stops any running auto sequence.

```
┌─────────────────────────────────────────────────────────────┐
│                L i n e a r   R e s o l u t i o n              │
│                                                               │
│  MEASURE:  CHAN 1                  CHAN 2                      │
│            Freq Resp               Freq Resp                  │
│                                                               │
│  WINDOW:   CHAN 1                  CHAN 2                      │
│            Hanning                 Hanning                    │
│                                                               │
│  AVERAGE:  TYPE      # AVGS      OVERLAP    TIME AVG           │
│            Avg Off      10       0%         Off               │
│                                                               │
│  FREQ:     CENTER                  SPAN      BW               │
│            50 kHz                  100kHz    187 Hz           │
│                                                               │
│            REC LGTH   Δt                                      │
│            8.0mS      3.91μS                                  │
│                                                               │
│  TRIGGER:  TYPE       LEVEL     SLOPE      PREVIEW            │
│            Freerun    0.0 Vpk   Pos        Off               │
│                                                               │
│  INPUT:    RANGE      ENG UNITS  COUPLING  DELAY             │
│    CH 1    AutoRng↑   1.0 V/EU   DC (Flt)  0.0 S             │
│    CH 2    AutoRng↑   1.0 V/EU   DC (Flt)  0.0 S             │
│                                                               │
│  SOURCE:   TYPE                  LEVEL     OFFSET            │
│            Rndm Noise            0.0 Vpk   0.0 Vpk           │
└─────────────────────────────────────────────────────────────┘
```

Figure 12-9. RESET Default Conditions

Introduction

This section contains two chapters to help you make digital and mixed (one channel digital; the other analog) measurements:

- Chapter 13: Digital Connections
- Chapter 14: Digital & Mixed Measurements

Chapter 13 describes all the digital connectors on the analyzer's rear panel. It contains the information you need to connect the analyzer to your digital device-under-test.

Chapter 14 combines information from several other chapters to present a concise overview plus in-depth analysis of digital and mixed measurements. You may want to read this chapter before doing your first digital measurement.

Digital Connections

Purpose Of This Chapter

This chapter is a collection of information about digital connections. Making connections is the first of three steps required to make measurements.

1. Make connections (this chapter)
2. Set up the inputs (chapter 7)
3. Make the measurement (chapter 14)

Introduction

Digital connections are ribbon cables which connect rear-panel connectors to the system under test. Figure 13-1 shows general signal I/O for everything except HP-IB. Most of the signals at the rear panel are digital. Figure 13-2 shows the connector layout of the rear panel.
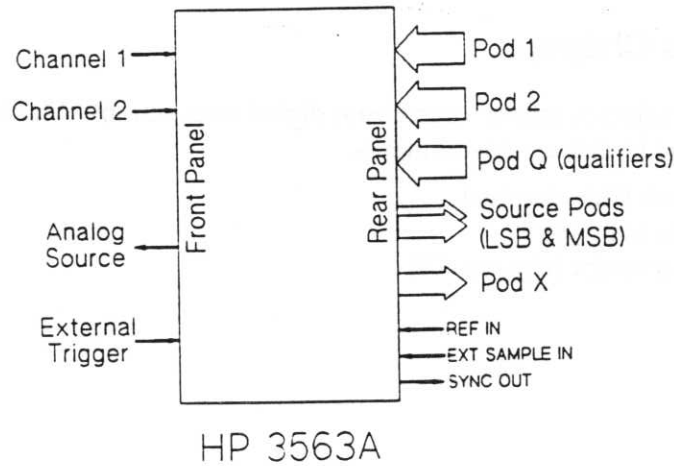
Figure 13-1. HP 3563A I/O (HP-IB not shown)
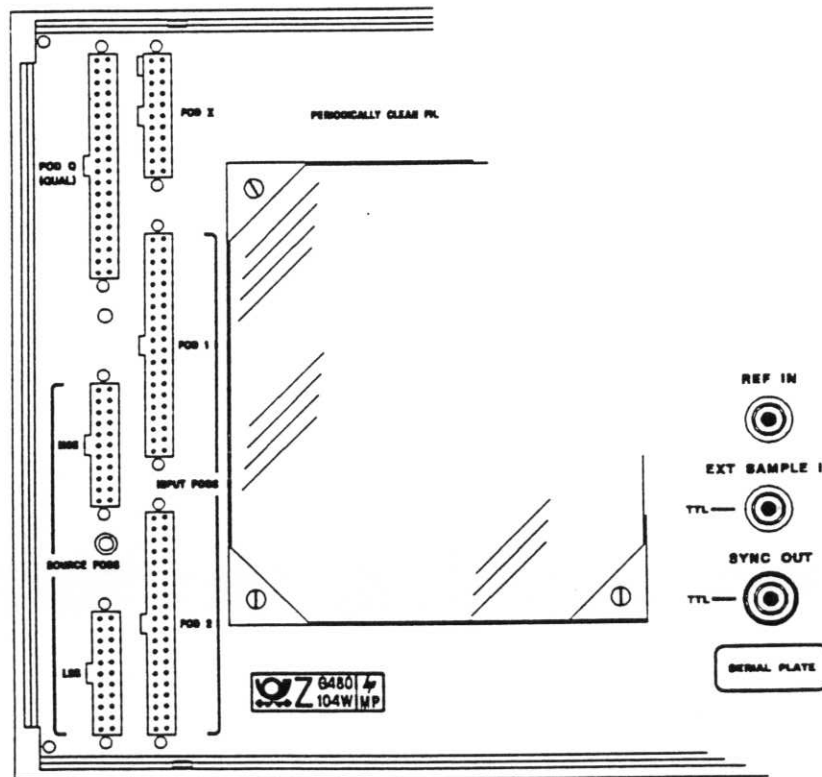
Figure 13-2. Rear-Panel Connectors

Digital Overview: The Hardware

Moving digital data in or out of the analyzer requires physical connections and clock signals unique to digital data. The data pods are identical to those used in logic analyzers and pattern generators. The clock signals and qualifiers indicate when data is valid and latch it into the analyzer. The input and output cables are used to move TTL-level, parallel data.

There are two kinds of digital cables and pods; input and output. Throughout this manual, the cable and pod that plugs into the Pod 1 rear-panel connector are referred to as "Pod 1." Likewise, Pod 2, Pod X, source pods LSB and MSB, and Pod Q refer to both the cable and the labeled pods.

Input Cables

There are three identical input cables and input pods supplied with the HP 3563A. During installation these are labeled as Pods 1, 2, and Q. See figure 13-3. The input cables should be connected to the device under test with either the pod tips or the optional termination-adapter pod. See figure 13-9. These contain signal-conditioning circuitry. The input pods are:

- **Pod 1**: 16-bit data lines and a data clock
- **Pod 2**: 16-bit data lines and a data clock
- **Pod Q**: 8 qualifier lines, a sample clock, a trigger signal and an external overflow signal
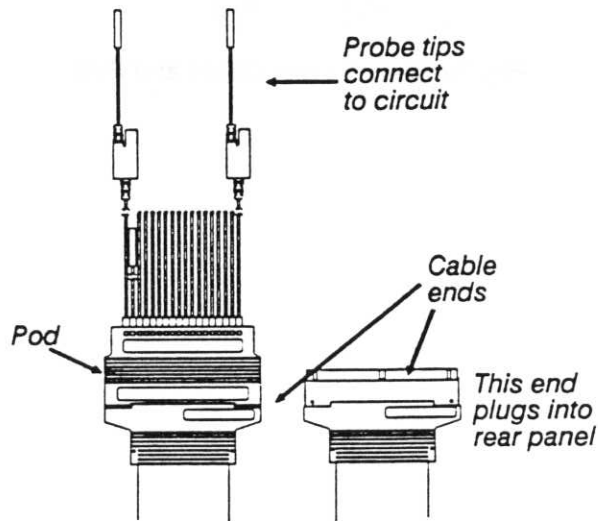
Figure 13-3. Input Cable and Pod

Output Cables

There are three identical output cables and output pods supplied with the HP 3563A. During installation these are labeled as LSB, MSB, and Pod X (See figure 13-4). The output cable impedance is 50Ω and does not require the use of pod tips. The output pods are:

- **Source MSB** an 8-bit pod used to output the most-significant byte of digital source data
- **Source LSB:** an 8-bit pod used to output the least-significant byte of digital source data
- **Pod X:** Miscellaneous output signals. See "Pod X" on page 13-18.
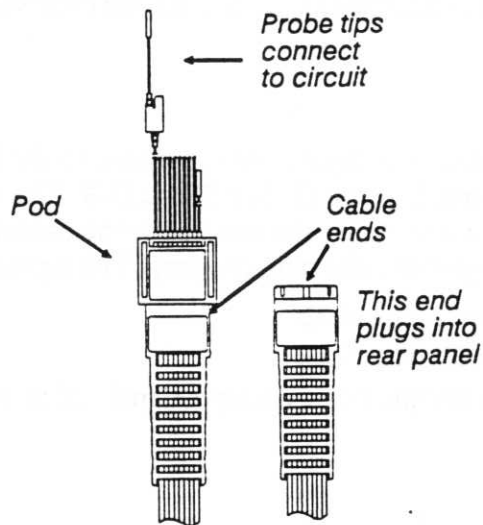
Figure 13-4. Output Cable and Pod

Input Probe System

The digital probe system consists of probes, pods, probe cables, and grabbers. The input probe leads contain an RC network consisting of a 90.9 kΩ resistor in parallel with an 8 pF capacitor. The input cables are shielded resistive transmission line. Each cable, probe, and pod assembly is (collectively) 4.5 feet long and contains 16 data channels, one clock channel, and a pod ground. See the *Installation Guide* for labeling instructions.

Caution   The probe grounds are chassis (earth) grounds, not "floating" grounds.

✋

Each input probe is a 12-inch twisted-pair cable connected to the cable at the pod. One end of the probe contains an input RC network and a lead to connect to the target system. The other end of the probe has a two-pin connector that plugs into the pod.

You can connect the probe directly to test pins on your target system or to grabbers. Grabbers are spring-loaded connecting hooks designed to fit on adjacent IC pins. See figure 13-5. If you want to connect to test pins without using the grabbers, the pins must be 0.63 mm (0.025 in.) square or round pins with a diameter between 0.66 mm (0.026 in.) and 0.84 mm (0.33 in.). Most IC test clips work.

Probes can be grounded either through a common pod ground or with a ground connection that exists on each of the probe ends. To reduce noise and aid clocking of high-speed signals, use probe grounds close to the signal source; clock grounding is the most critical. See figure 13-5. There are two ways to connect the digital input signal lines to the target system: with the input probes defined here or with the termination adapter pod shown in figure 13-9. Both of these methods provide the RC signal-conditioning network required by the analyzer inputs (90.9 kΩ in parallel with 8 pf). To disconnect a probe from the pod assembly, insert the tip of a ball-point pen in the latch opening while gently pulling the probe out of the probe housing.
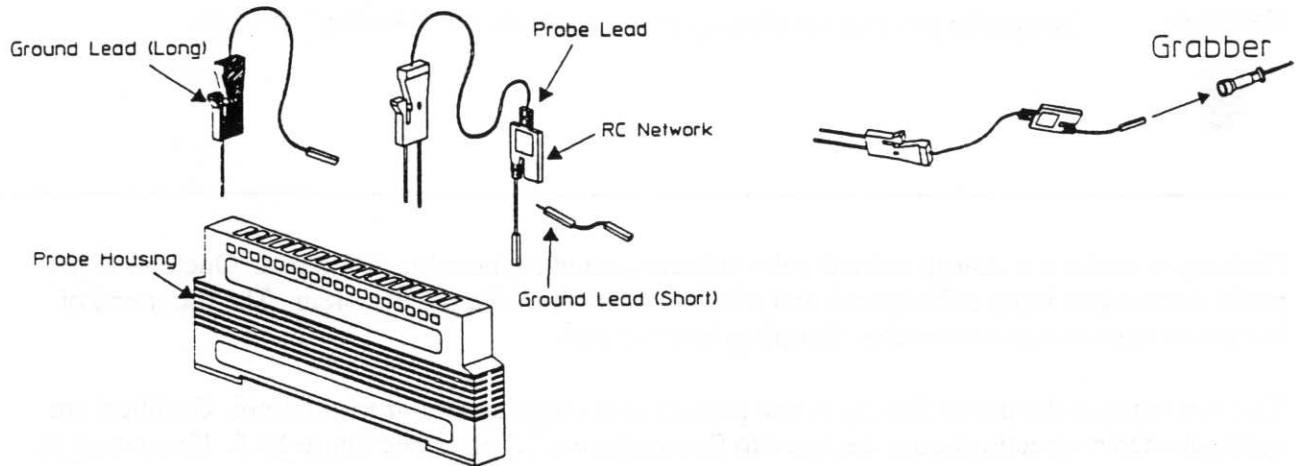
Figure 13-5. Digital Input Pod Assembly

Output Probe System

The output cable is an 8-wire coaxial ribbon cable. The output pod (also referred to as a probe adapter) holds 10 probes, two of which are circuit ground. The pod with the probes installed, is called a pod assembly. See figure 13-6. All signal probes are gray with a violet probe tip. The pod grounds are black and do not have colored probe tips. See the *Installation Guide* for labeling instructions. The colored probe tip at the end of each probe has a gray lead to connect the output signal to your target system. These is also a detachable signal ground for each probe to help maintain signal fidelity. If you have trouble with the pod grounds, try using these signal grounds.

There are several ways to connect to your target system.
1. The probe lead will connect directly to an IC clip or round pins with a diameter between 0.66 mm (0.026 in.) and 0.84 mm (0.033 in.).
2. You may also clip directly onto your circuit using the optional grabbers with the probes. To connect a grabber to a probe, push the probe lead onto the pin in the head of the grabber.
3. If you have a pin-strip header or square-pin connector on your board, you can remove the probe adapter from the output cable and plug the cable directly onto the connector. The connector must have pin spacing of 2.54 mm (0.1 in.), pin size of 0.63 mm (0.025 in.), and pin height of at least 5.97 mm (0.235 in.). A polarized connector equivalent to 3M® part number 3592-500X or 3592-600X is suggested. A non-polarized pin-strip header also works, provided it meets the spacing and pin-size requirements given here.
4. A tri-state pod may be installed between the cable end and the source pod as shown in figure 13-8.

To disconnect a probe from the pod assembly, insert the tip of a ball-point pen in the latch opening while gently pulling the probe out of the probe housing as shown in figure 13-6. Notice that one corner of the insertion piece is beveled so that it goes into the probe adapter only one way.

To reinstall a probe lead, line the beveled corner up with the corresponding hole in the probe housing and push the metal prongs of the lead into the probe housing until the lead snaps into place. When the lead is properly installed, you should not be able to pull it out.
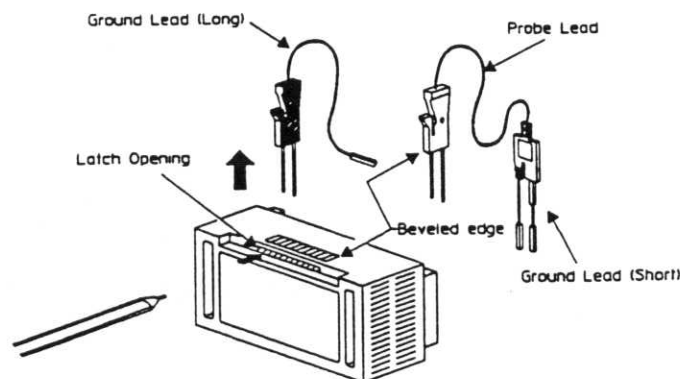
Figure 13-6. Digital Output Pod Assembly

Digital Accessories Provided

Table 13-1. Digital Accessories Provided

Accessory Description	HP Part number	Quantity
Cable/Pouch kit (includes all of following)	03563-84402	1
Input cable; 40-pin woven	01650-61607	3
Input pod assembly (includes following 4 items)	03563-61605	3
Probe housing	01650-45203	1
Probe lead set	01650-82101	1
Pod ground lead (long)	01650-82102	1
Probe ground lead (short)	01650-82103	1
Output cable: 8-wire coaxial	03563-61604	3
Output pod assembly	16520-62102	3
Grabber clip set (20 each)	5959-0288	4
Labels	03563-34302	1
Pouch	1540-1199	1

Optional Digital Accessories

- HP 10346A 8-channel TTL tri-state buffer (for output cables)
- HP 10348A 8-channel CMOS tri-state buffer (for output cables)
- HP 01650-63201 termination adapter pod (for input cables); see figure 13-9. A 40-to-20-pin adapter containing the same signal conditioning circuits as are in the standard input pod. The 20-pin connector is a 2×10 position, 4-wall, low-profile header connector, 3M® Series 3592.
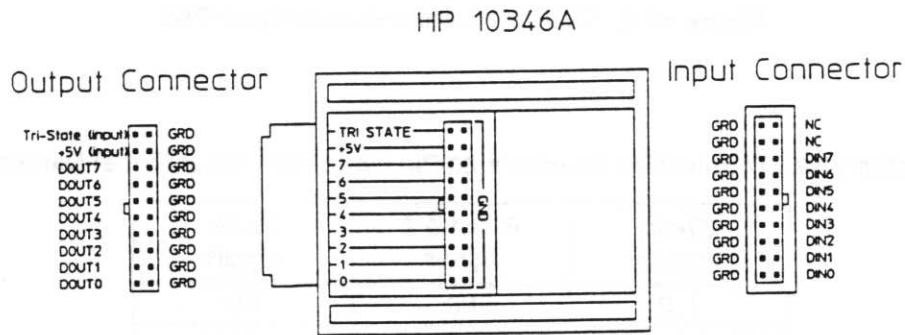
Figure 13-7. Optional TTL Tri-State Buffer Pod
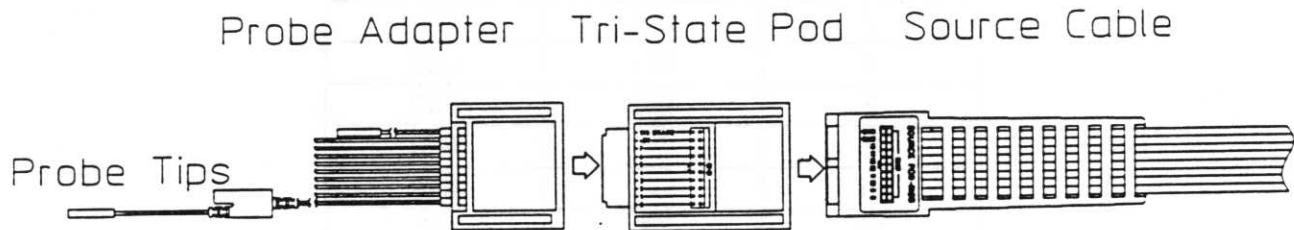
Figure 13-8. Tri-State Buffer Installation

NC = no connection
R = 90.9 kOhm
C = 8 pF

40-pin	20-pin
NC	1, 2
1, 2	NC
3	3
5	NC
7	4
9	5
11	6
13	7
15	8
17	9
19	10

40-pin	20-pin
21	11
23	12
25	13
27	14
29	15
31	16
33	17
35	18
37	19
4, 6, ... 38	20
39, 40	NC
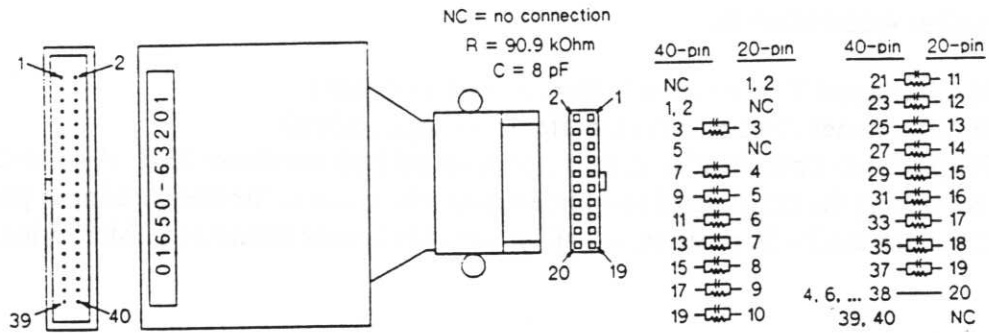
Figure 13-9. Optional Termination-Adapter Pod

Table 13-2. Termination Adapter's 20-Pin Connector Input Signal Names

20-pin connector	Pods 1 & 2 signals	Pod Q signals
1, 2	NC	NC
3	CLK	CLK
4	D15	TRG
5	D14	OVF
6	D13	GND
7	D12	GND
8	D11	GND
9	D10	GND
10	D9	GND
11	D8	GND
12	D7	Q7
13	D6	Q6
14	D5	Q5
15	D4	Q4
16	D3	Q3
17	D2	Q2
18	D1	Q1
19	D0	Q0
20	GND	GND

Connecting the Input Pods

Signals on Pods 1 and 2

Data is brought into the analyzer through input pods 1 and 2. Each pod has 16 data lines (D0–D15) and a data clock (CLK) which must be used to clock in data on that pod. Pod 1 can bring in data for Channel 1 or Channel 2 or both (useful for taking data for both channels from a common bus). Pod 2 can only bring in Channel 2 data. Thirteen of the sixteen data bits are used as measurement data by the analyzer. The other 3 are either rounded in or truncated, depending on whether you select the upper-13 or lower-13 bits.[1] See the discussion and note on page 14-8 concerning digital range and overflow for more information on truncation and rounding.

Other options include transferring 8-bit data or 16-bit data on an 8-bit bus and data format of either two's-complement or offset binary. See figures 13-11 and 13-20 for information on data timing versus the sample and data clocks.
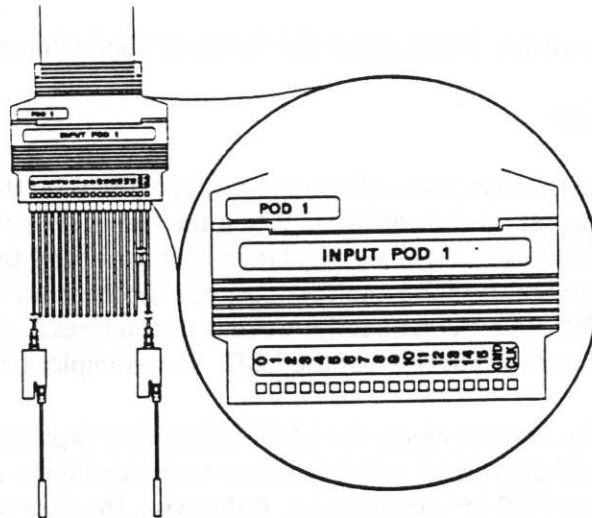
Figure 13-10. Pod 1

---

[1]   In the swept-sine measurement mode, the analyzer can be configured to automatically switch between the upper and lower 13 bits to provide full 16-bit performance with the AUTO 16 BIT softkey in the RANGE menu. In other measurement modes the lower 13 bits should only be used for low-level signals.

Timing Considerations

t$_{su1}$ Data set-up time relative to data clock; 20 ns

t$_{h1}$ Data hold time relative to data clock; 5 ns

t$_{su2}$ Qualifier set-up time relative to data clock; 60 ns

t$_{h2}$ Qualifier hold time relative to data clock; 5 ns
(15 ns when moving 16-bit data on an 8-bit bus)
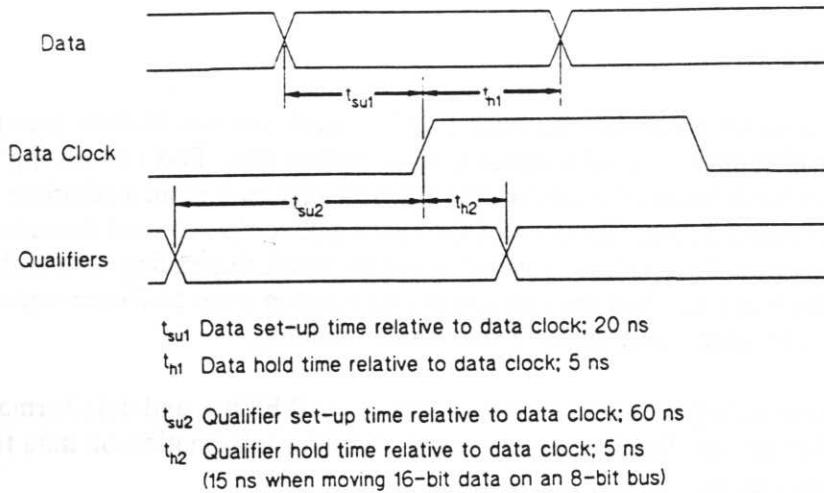
Figure 13-11. Setup and Hold Times for Digital Inputs

Data Size versus Bus Size

The number of data bits doesn't always match the number of data lines on the bus. Use the following configuration table to set up the analyzer. When the (input) bus size is 8 bits and the data size is 16 bits, the analyzer multiplexes the incoming data and reconstructs the data internally. In this case, Q0 is used to differentiate between the qualifier patterns for the most-significant byte (MSB) and least-significant byte (LSB). The clock qualifier word is the "address" of the MSB. The same word, with Q0 complemented, is the "address" of the LSB. See examples on pages 13-13 and 13-22.

When a channel is providing the sample clock, the LAST 1/0 softkey (appears in the DATA CLOCK menu when bus size is 8 bits and data size is 16 bits) is used to designate the end of a two-byte transfer by specifying the state of Q0 for the last byte. Otherwise, the data word is composed of the last two bytes clocked into that channel before the sample clock. These two settings (values of Q0 and Last) allow the two bytes to be read in either order as well as allowing either state of Q0 to indicate MSB. See the following examples and figures 13-22 and 13-23.

Notes

The MSB and LSB can be read from the analyzer in a variety of ways, but there must be only one signal differentiating them; this signal must be used for Q0.

The qualifiers Q1 – Q7 must be the same when reading MSB as for LSB. In these examples, that requires that the addresses must be consecutive. Not all consecutive pairs work; 5 and 6 are consecutive but more than one bit changes.

Table 13-4. Configuration Steps Concerning Data Size versus Bus Size

Bus Size	Data Size (# Bits)	
	8	16
8	Connect the 8 data lines to the 8 upper-most pod lines, D8-D15.	1. Connect the 8 data lines to the 8 upper-most pod lines, D8-D15. 2. Connect Q0 on the qualifier pod to a signal to indicate which byte (MSB or LSB) should be clocked in first. 3. Set the qualifier pattern to match the state of Q0 for the MSB in DATA CLOCK/CLOCK QUALFR?. Q0 differentiates the qualifier patterns for MSB and LSB. 4. If that channel is providing the sample clock, use the LAST 1/0 key to select which byte is clocked in last. This refers to the state of Q0 when the last byte is present. It may help to turn on the visual display of the digital interface. 5. Select the upper or lower 13 bits.
16	Connect the 8 data lines to the 8 upper-most pod lines	Connect all 16 lines to the pod; then select either the upper or lower 13 bits to be processed.

Figure 13-12 shows a configuration that may be used to move 16-bit data on an 8-bit bus. Notice that the qualifiers are used to identify each byte, with MSB read in first, when Q0 = 0, and LSB read in last, when Q0 = 1. See also the examples on page 13-22.
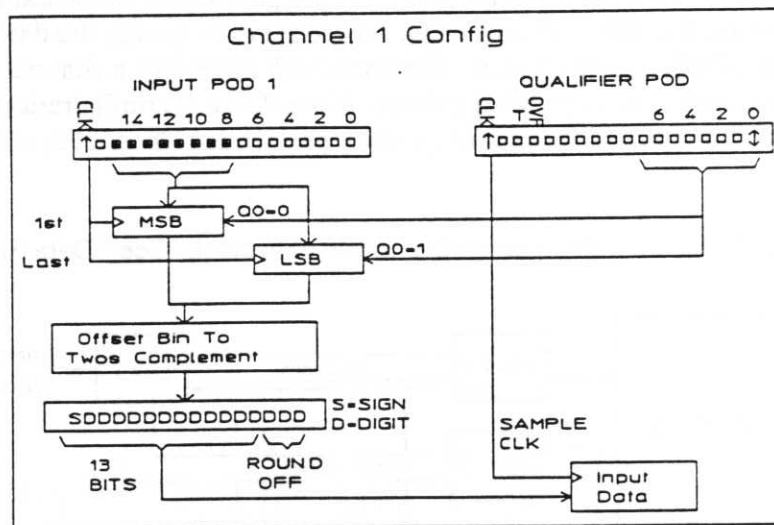
Figure 13-12. Moving 16-Bit Data on an 8-Bit Bus

Connecting the Qualifier Pod

Clock Qualifiers

In some applications, data isn't valid at every transition of the data clock signal. In such cases, you can use the eight qualifier lines on Pod Q (Q0–Q7) to qualify data clocked into the analyzer. The analyzer monitors the state of the qualifier lines Q0–Q7, comparing them to states you specify. When the selected clock edge occurs and the qualifier signal states match the user-specified qualifier pattern, data is latched into the Ch 1/2 data latches shown in figure 13-19. The qualifier pattern is defined with the CLOCK QUALFR? data-entry softkey as described in chapter 7.

Note The clock on Pod Q cannot be qualified.

The data rate of the qualified data clock (channel clock) must not exceed 256 kHz. The data clock, itself, may run much faster.

Example

In figure 13-13 a microprocessor generates a digital signal which is written to a DAC (digital-to-analog converter) connected to the microprocessor bus. The data is transferred using a write pulse (WR) in conjunction with an address. To read the same data with the HP 3563A, the WR signal is connected to the CLK input on Pod 1. This signal serves as the data clock. The address lines are connected to Q0– Q7 on Pod Q. These serve to qualify the data clock. The qualified data clock is called a *channel clock*. The data clock generates a channel clock when the qualifier signal states match a user-specified pattern. Note that this configuration offers access to another channel of data by specifying another qualifier pattern for Channel 2; without connecting Pod 2.

See figure 13-11 for setup and hold times relative to the data clock. See "Data Size" on page 13-12 for more detail.
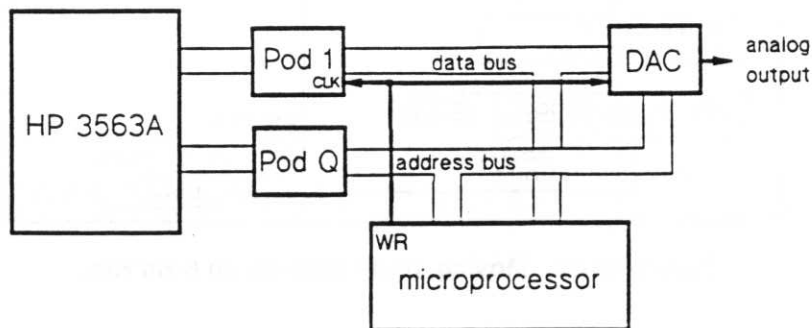
Figure 13-13. Example of Qualifier Selection

Pod Q Signal Descriptions

Pod Q connects qualifier signals Q0 through Q7 to the analyzer. Other signals on this pod are:

TRIG   Digital trigger; another form of external trigger. This signal is TTL, active on the rising edge. The front-panel signal, EXT TRIGGER, is qualified by slope and level.

Q-CLK   The Pod-Q clock; when one channel is analog and the other is digital (in a mixed measurement) this is the default sample clock selection. Unlike the Pod 1 and Pod 2 clocks, it cannot be qualified and, therefore, must be ≤ 256 kHz.

OVF   Overflow; an input signal from the circuit under test. A high TTL level indicates an overflow condition. If an overflow condition occurs while averaging and overflow rejection is on (in the DATA SIZE menu, X OVFL is a softkey that is either ON or OFF), the data record is not used in the average calculation. Also, when this signal becomes active, the status message DIGITAL OVER RANGE appears with the numbers 1, 2, or 1&2, depending on which channels have overflow detection on.

Note   The OVF signal is not latched in the HP 3563A. This line is read after the time record is filled and must be active at that time to be detected. To ensure detection, the signal should be active for a period of time which exceeds the time record length defined for the measurement.

Timing Considerations

See figure 13-11 on page 13-12.
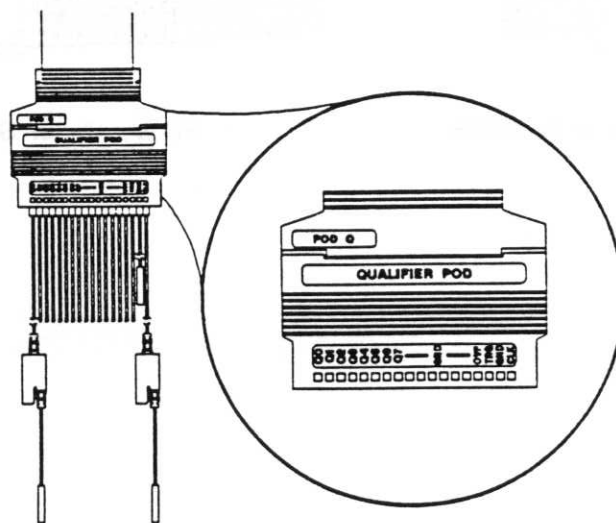
Figure 13-14. Pod Q

Connecting the Source Pods

Signals on Pods LSB and MSB

Sixteen bits of source data are available on two 8-bit pods — source MSB and source LSB. The upper 8 bits appear on the source MSB pod; the lower 8 bits (where bit 0 is the least significant bit) appear on the source LSB pod. These are TTL-level signals with 50 Ω output impedance.

Source data is valid at every occurrence of the sample clock. See figure 13-17. Source data is updated at the effective sample rate of $1/\Delta t$ where Δt appears in the state display. Source data becomes valid approximately 150 ns after the transition sample clock period (+ transition of Ext. Sample, or the selected transition of the channel clock or the Pod Q-Clk). An output signal on Pod X (SRC-CLK) indicates valid source data. This signal may be used to clock new source data into a register on the system under test. See also the SRC-CLK description under Pod X.
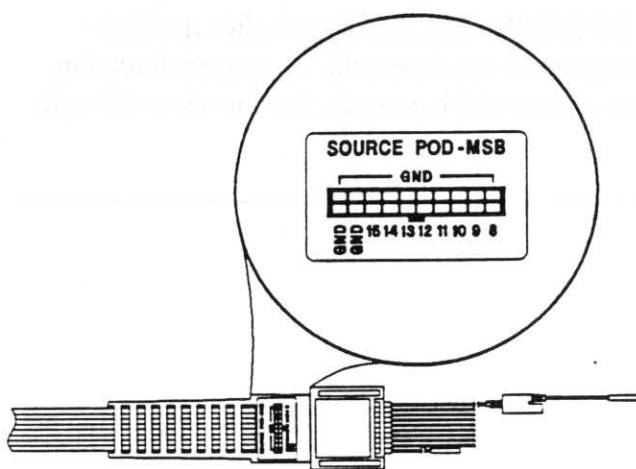
Figure 13-15. Source Pod MSB
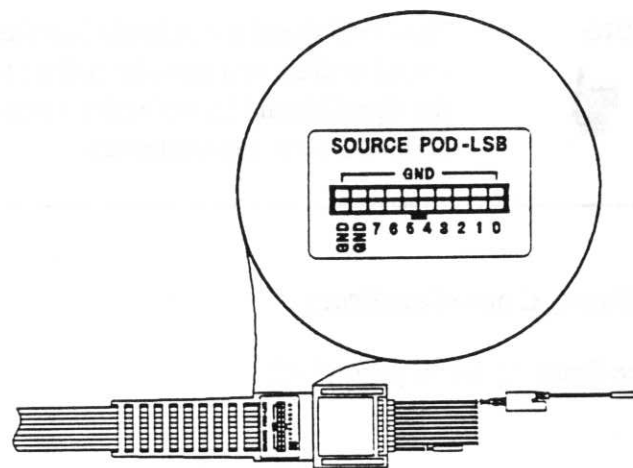
Figure 13-16. Source Pod LSB

Timing Considerations

* 3500ns is the minimum at a 256 kHz sample rate.
Interval increases with decreasing sample rate.
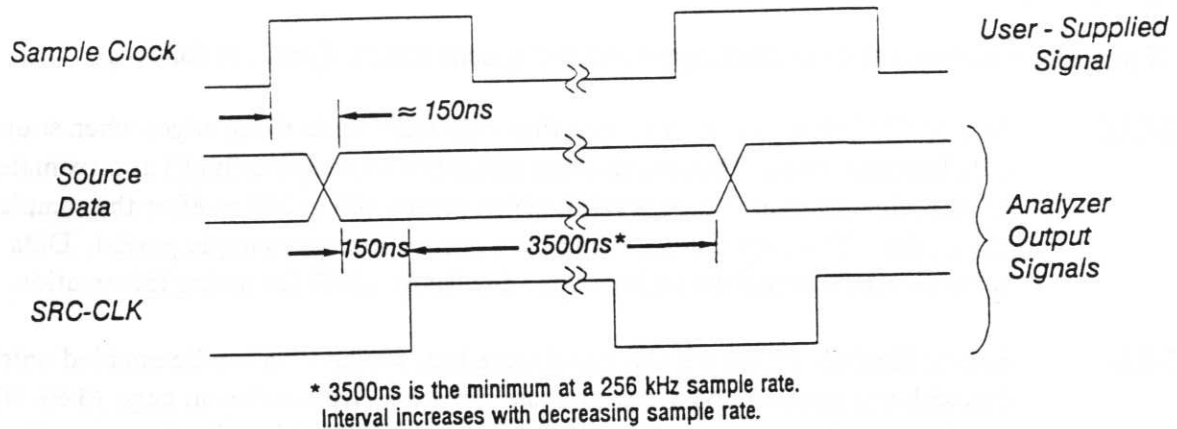
Figure 13-17. Source Timing Diagram

Clocking the Source

The digital source updates are triggered by the sample clock. The source clock which appears on Pod X as SRC-CLK is a "data-valid" signal that may be used to latch data into a circuit outside the analyzer. See figure 13-17. Source data becomes valid approximately 150 ns after the transition of the sample clock and is valid for the entire sample period.

"Qualifying" the Digital Source

The digital source data can be enabled and disabled with a tri-state pod accessory (see Accessories on page 13-9) and the SRC-EN signal on Pod X. The SRC-EN signal is an active-low signal that occurs whenever the qualifier signals connected to Pod Q match the source qualifier pattern. The qualifiers do not directly affect the operation of the source; only the state of the SRC-EN signal. The source data changes with every occurrence of the sample clock, regardless of the state of the qualifier signals.

To use the source qualifiers, connect the SRC-EN signal from Pod X to the TRI-STATE enable on each tri-state pod. (See figure 13-7 on page 13-9 for detail on the tri-state pod.) Then enter the qualifier pattern under the **SOURCE/INTERFACE/SOURCE QUALFR?**softkey (configuration details are discussed in chapter 7). When the qualifier signals match the qualifier pattern, SRC-EN goes low and the output on each tri-state pod becomes active.

You must provide +5V, ground, and a tri-state enable signal to each tri-state pod. The SRC-EN signal on Pod X can be used to enable the tri-state pod(s). If the SRC-EN signal is not used, the enable signal must come from another source such as the system under test.

Connecting Pod X

Pod X provides a buffered sample clock signal and two special source signals, as follows:

SRC-CLK   Source Clock is an analyzer output that indicates (on its rising edge) when source data becomes valid. The source clock signal becomes active (high) approximately 150 ns after the source data is valid, which occurs 100 to 200 ns after the sample clock edge. The source clock rising edge occurs once per sample period. Data remains valid beyond the falling edge. See figure 13-17 for timing information.

SRC-EN   Source Enable. If you are using a tri-state bus, source data can be enabled onto the bus with the tri-state pod accessory (see Optional Accessories on page 13-9). This pod has built-in tri-state buffers. It requires you to provide +5 volts, ground, and an active-low enable signal. If the system being tested does not have a convenient enable signal, SRC-EN may be generated with qualifiers. SRC-EN should be connected to the tri-state pod enable. Qualifier signals should be connected to Pod Q and configured with the Source/Data Interface softkeys. When the qualified condition is satisfied, SRC-EN goes low and turns on the tri-state pod signals.

SMP-OUT   Sample-Clock Output is a buffered version of the Sample Clock signal.

Note   The SMP-OUT rate changes to 256 kHz during calibration or when external sampling is not enabled.
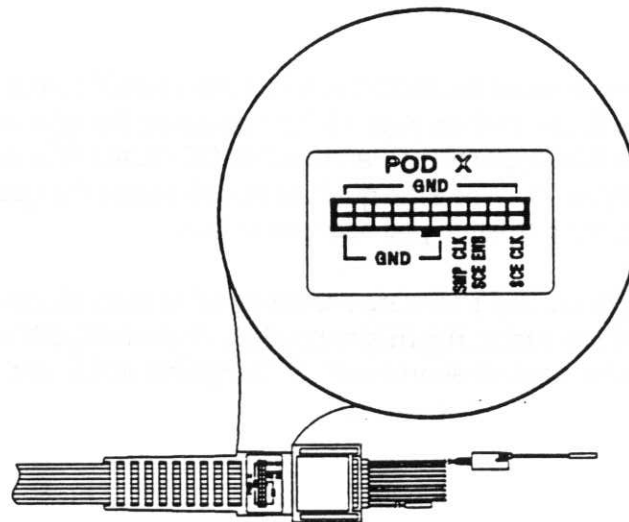
Figure 13-18. Pod X

Connecting the Sample Clock

The analyzer clocks data from both channels into internal memory with the *sample clock*. See figure 13-19. The sample clock is chosen from among the various clock signal inputs. The sample clock can be either Pod Q Clock, External Sample, Channel 1 clock, or Channel 2 clock. The frequency range of the sample clock is 0.001 Hz to 256 kHz. If the signal selected for the sample clock is not present or occurs at a rate that is slower than the qualified data clocks, the message "MISSED SAMPLE Check External Clock" appears in the lower-right corner of the display.

(Does not illustrate use of 16-bit data on an 8-bit bus.)
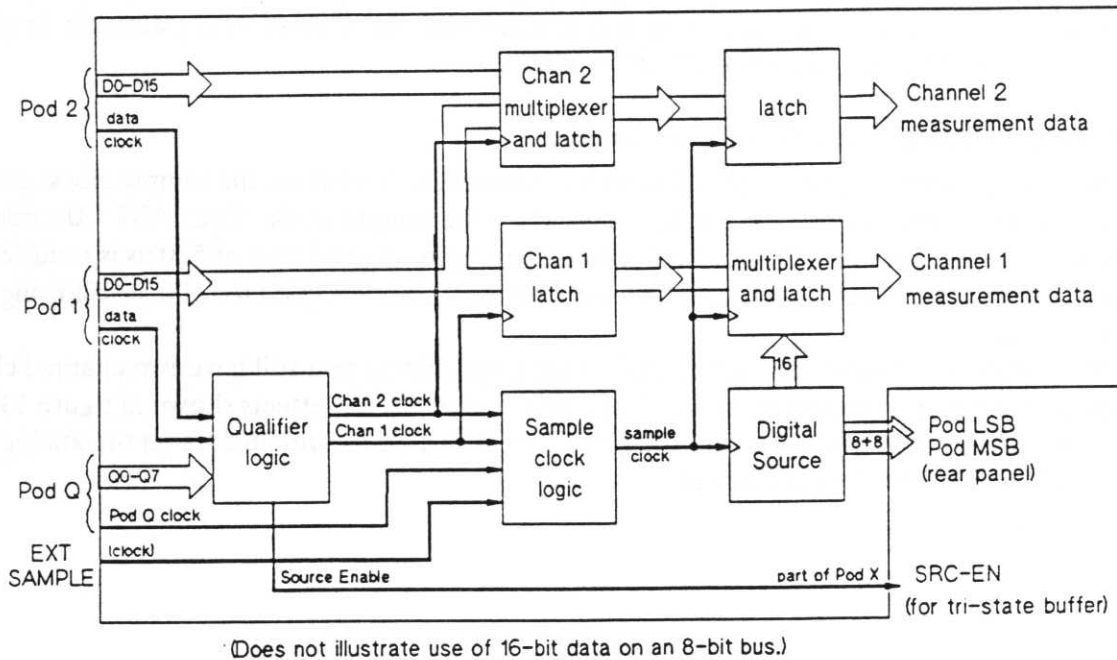
Figure 13-19. Clock Signals in the Block Diagram

Note

No measurement activity occurs when there is no sample clock. If you start a measurement and nothing seems to happen, look for the MISSED SAMPLE message in the lower-right corner of the display.

Timing Considerations

The sample clock is the main system clock — all other timing (and phase) relationships are referenced to it. See figure 13-19. There can be only one sample clock selected for the analyzer. When there are two clocks in a system (implying that data occurs at different times within a sample period), the sample clock is usually set to be the signal that clocked in data last. However, a channel clock can occur up to 250 ns after the active edge of the sample clock and still have its data point associated with the sample clock edge. See figure 13-20. If the channel clock occurs after t_2 but before t_1, the data on that pod may be associated with either sample edge (the relationship is not defined and the measurement data could be corrupt). Data occurring after t_1 is associated with the next sample. In mixed measurements, analog data is sampled at the user-defined transition, or active clock edge. See the following discussion on clock polarity.

Configurations requiring special timing consideration:

- When moving 16-bit data on an 8-bit bus with a channel clock used for the sample clock, the data clock edge used to move the last byte is used for the sample clock. The LAST 1 0 softkey is used to define the state of Q0 associated with the last byte. A minimum of 500 ns is required between bytes transferred on one pod. New digital data is not sampled for 500 ns following a sample clock.
- When moving two channels of data on Pod 1 (using qualifiers), you still have two channel clocks to select from when choosing a sample clock. The choice has the effects shown in figure 13-21.
- When making a mixed measurement, the sample clock is used to sample data on the analog channel at or after the digital channel.

t_1 Minimum interval after Sample Clock before the
next Channel Clock transition should occur: 700 ns

t_2 Maximum time after Sample Clock that the
Channel Clock can occur and still associate
pod data with that rising edge: 250 ns
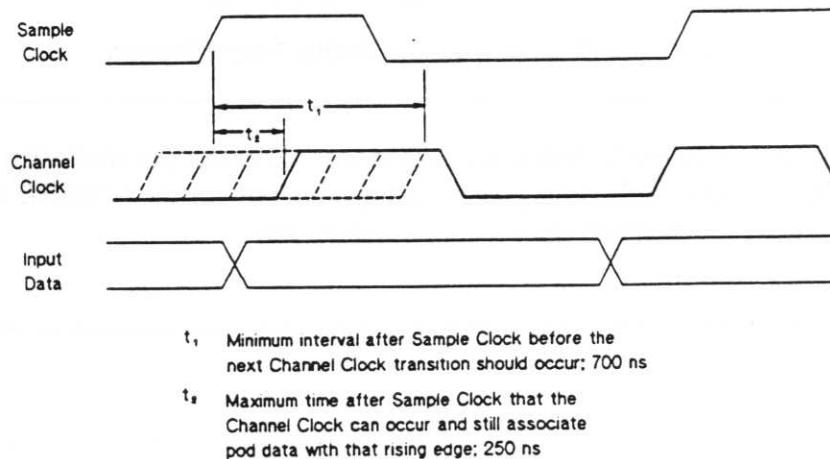
Figure 13-20. Channel and Sample Clock Timing Diagram
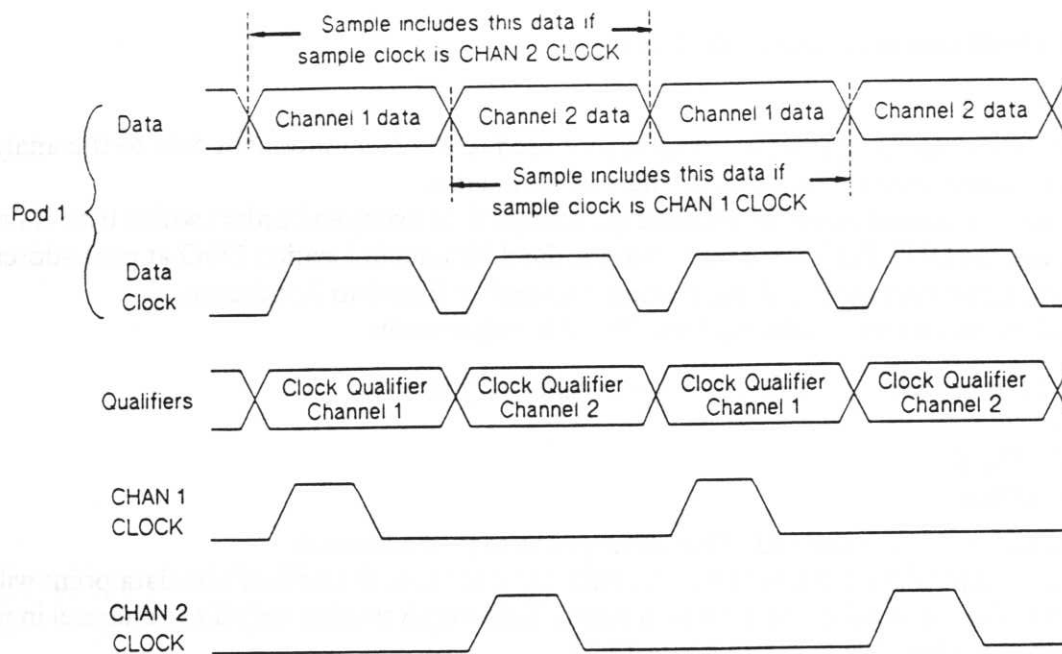
Figure 13-21. Selecting Channel Clocks for Sample Clock

Clock Polarity

You may define the active transition on most of the system clocks. The positive selection (+) makes the low-to-high transition active and the negative selection (−) makes the high-to-low transition active. Data clock polarity is selected in the DATA CLOCK menu. The polarity of the sample clock is determined by the selection of sample clock:

- If the sample clock is the Pod Q clock, the polarity is selected in the sample clock menu.
- If the sample clock is one of the two channel clocks, the polarity is determined by the configuration of the corresponding data clock.
- If the sample clock is the external sample signal (a BNC connector on the rear panel) the polarity is not selectable; its active transition is always low-to-high.

Example: An 8-bit processor using 16-bit data

Assumptions:

- Output statements in a processor program are used to send measurement data to the analyzer.
- Each 16-bit data transfer requires two output statements.
- There are four combinations of qualifier pattern (odd or even) and order (which byte is first).
- The statement OUT FOOn means to output the 8-bit data in location FOO at port address n.
- There are three port address lines, making n a number from 0 to 7, inclusive.
- Q0– Q2 are connected to address lines A0– A2, respectively.

Example 1: Output MSB first with an even port address (Q0 = 0)
Program:
```
OUT  MSB,6
OUT  LSB,7
```

1. Set qualifier word to xxxxx110. This corresponds to port address 6.
2. Make sure that LAST 1/0 is set to 1. If LAST 1/0 is set to 0, the LSB of one data point will be matched with the MSB of the next data point. This step is needed only if the channel in use is supplying the sample clock. See figure 13-22.
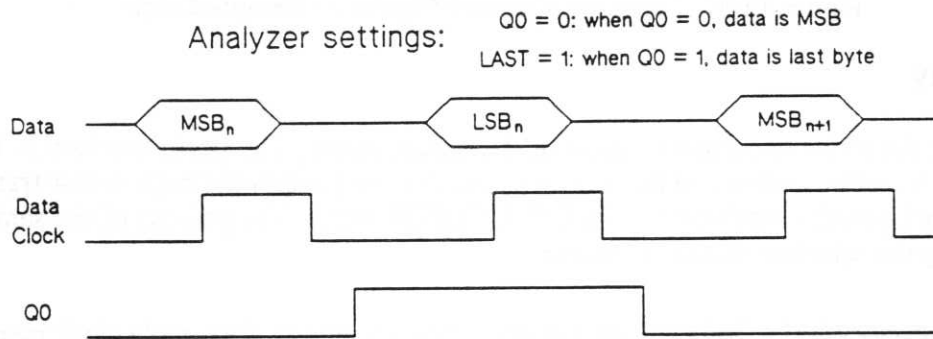
Figure 13-22. Example: Transfer MSB First

Example 2: Output LSB first with an even port address (Q0 = 0)

Program:

```
OUTPUT LSB,7
OUTPUT MSB,6
```

The setup is the same as the first example, but set LAST 1/0 to 0. See figure 13-23.

Analyzer settings:
Q0 = 0: when Q0 = 0, data is MSB
LAST = 0: when Q0 = 0, data is last byte

Data — LSB$_n$ — MSB$_n$ — LSB$_{n+1}$

Data Clock

Q0
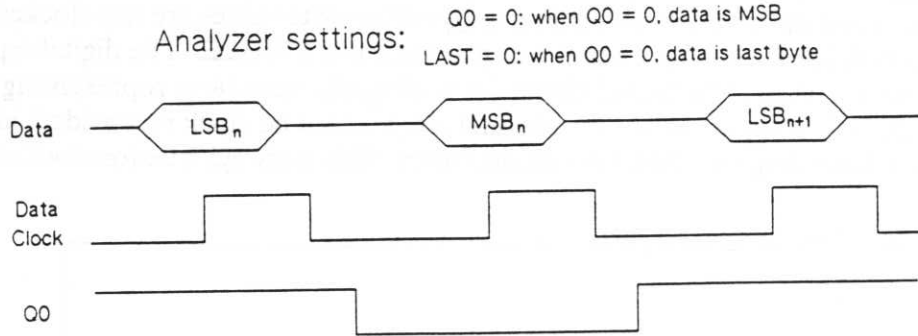
Figure 13-23. Example: Transfer LSB First

Verifying Digital Connections

Under the **VIEW INPUT** hardkey are the two softkeys INPUT DIG 1 and INPUT DIG 2. These allow you to view the digital input as shown in figure 13-24. The channel data displayed is what resides in memory after going through several stages of latching and conversion. Figure 13-24 shows the bit values for Channel 1 and the signal levels for Pod Q (qualifier state values are not clocked in). The qualifier information is displayed only when the display format is **SINGLE**. The digital input display contains no information when the selected channel is analog; all the squares representing a value are empty, indicating there is no data. When the channel is digital but no clock is provided, all the squares contain a + indicating that data can't be displayed. This is always true for clock signals.
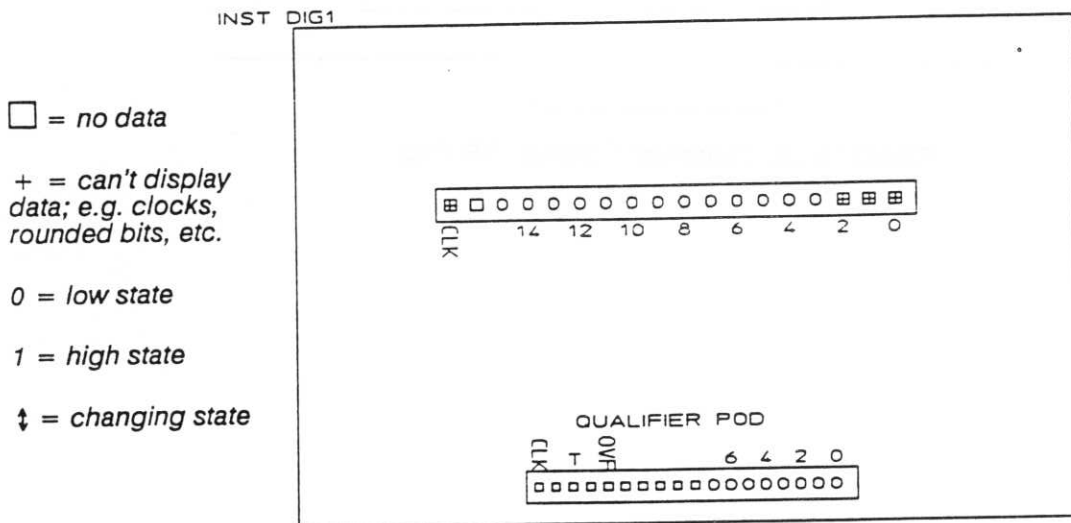
Figure 13-24. Viewing a Digital Input

The basic approach to verify digital connections is to toggle individual connections and check to see that the appropriate display bit toggles (changes between a 1 and a 0). This approach is complicated by the fact that the information displayed is what appears at the Input Data block in figure 13-25, *not* what appears on the cable inputs. Between those two points several things can change the data:

- Reconstruction of 16-bit data from an 8-bit bus
- Conversion of offset-binary to two's-complement format
- Rounding or truncation

These three things won't always affect the data; it depends on the configuration. Reconstruction and conversion are selected for special configurations. Since the data is always converted to 13-bit words, either rounding (for upper-13) or truncation (for lower-13) is always selected.
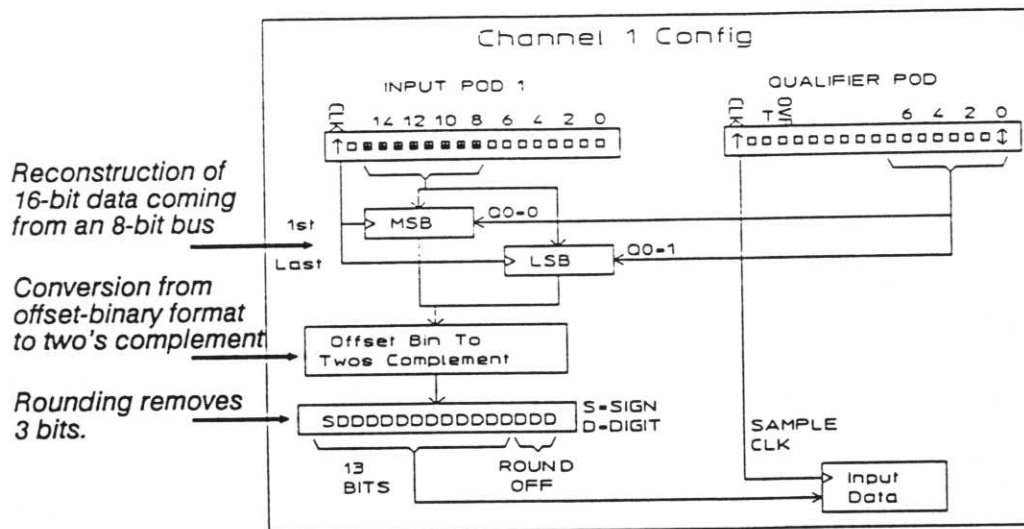
Figure 13-25. A Complicated Configuration

The general approach used to verify digital connections is:

1. Provide a sample clock
2. Toggle the state of the signal present at each of the connections one at a time and verify that the corresponding bit on the display toggles as expected

The best way to verify digital connections depends on the bus size selected. The steps for each of the two possible cases are:

16-bit bus:

1. Choose 2's complement number format
2. Choose lower-13 bits (under DATA SIZE softkey)
3. Verify connections D0 through D12
4. Choose upper-13 bits (under DATA SIZE softkey)
5. Verify connections D13, D14, and D15

8-bit bus:

1. Choose 2's complement number format
2. Select 8-bit data size
3. Verify connections D8 through D15

If you are going to move 16-bit data on an 8-bit bus, you should verify connections as described for the 8-bit bus and then test the reconstruction of data to be sure the bytes aren't being switched and that each LSB is paired with the correct MSB.

Digital and Mixed Measurements

Purpose Of This Chapter

This chapter is a collection of information about making digital and mixed measurements. Mixed measurements are two-channel measurements taken with one analog channel and one digital channel.

This chapter is also the third in the following sequence:

1. Make the connections (chapter 13)
2. Set up the input(s) (chapter 7)
3. Make the measurement (this chapter)

For more specific information on making digital connections and setting up the inputs, refer to chapters 13 and 7, respectively.

Introduction

The HP 3563A measures continuous-time (analog) signals by first filtering the signal to limit energy above 100 kHz, then sampling the signal at the 256 kHz, and storing it in memory. The data samples (collectively called a *time record*) are stored in memory. Figure 14-1 shows the overall measurement process. Note the differences between the analog and digital paths. For more detail on the digital paths, see figure 13-19.

Digital and mixed measurements require more planning than analog measurements. They are not necessarily more difficult, only more susceptible to minor mistakes in the setup. For example, in an analog measurement you may make a fairly good measurement, even if circuit loading by the measuring device is neglected. In a digital measurement, a small setup error such as a failure to select the proper edge of a data clock could result in poor if not completely erroneous results. Planning a measurement is the best way to ensure a valid measurement.
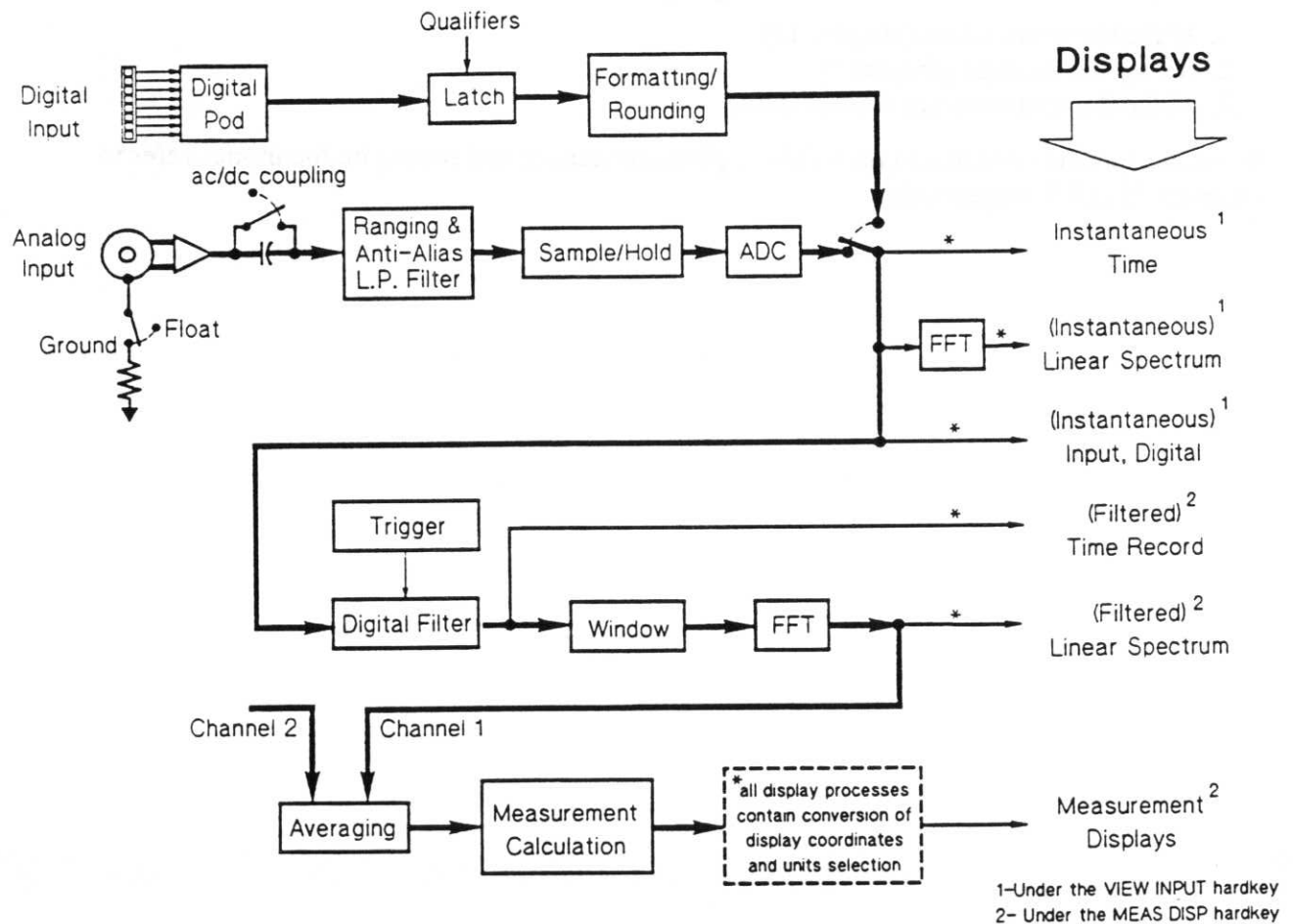
Figure 14-1. Measurement Process Diagram

All-Digital Measurements

Planning the Measurement

Digital measurements are performed the same as for analog measurements except that there is no anti-alias filtering and the physical connections are through digital signal analyzer pods instead of coaxial wire and BNC connectors. Some features must be interpreted differently when the channel is digital, like view input, input range, and overflow. Also, digital measurements require more consideration of sample frequencies and data clocks.

The six following steps outline the planning process for a typical digital measurement on a microprocessor-based system:

1. **Use a signal flow diagram to select measurement points.** The input data pod(s) are usually connected to a shared data bus. Thus, the measurement points are determined by the selection of the clocks and qualifiers which identify the data; not necessarily by the physical connection point. Measurement points are not limited to existing I/O ports. Additional measurement points can be created by modifying the microprocessor software to write data to (or read data from) non-existent ports. This technique allows multiple test points to be placed inside the software algorithm.

   Figure 14-2 shows an example of a signal flow diagram. In this example there are three test points. Only two of the test points, TP1 and TP3, correspond to actual I/O devices. Physically, all three test points are on same microprocessor data bus. Because the test points share a common bus, only one data pod needs to be connected to capture one or two channels-worth of data. The data is identified using the data clock and qualifiers. Using qualifiers, test points can be selected without changing the physical connections.
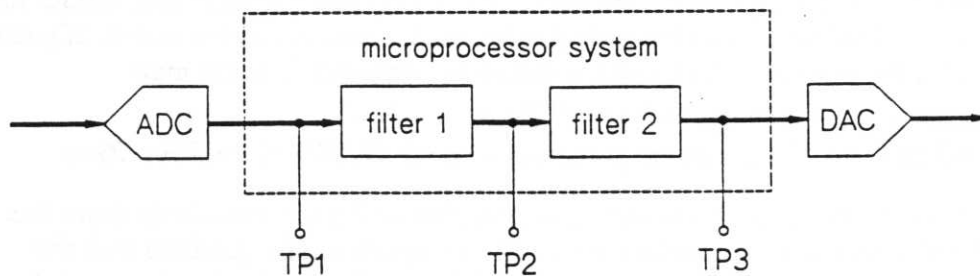
Figure 14-2. Signal Flow Diagram

2. **Determine method of connecting the source.** There are two methods that can be used to inject a digital signal into a circuit under test. In the first method, an existing input device, like an A/D converter, can be disabled and the source data substituted for the disabled device's output. In the second method, the microprocessor software is modified to read the source data from a previously unused port address instead of the port address for the original input device.

3. **Develop a timing diagram** of the circuit under test. These diagrams are essential for determining which signals to use as clocks in the measurement process. Later they are used to determine the computational delay value.

4. **Select data clock and qualifiers.** (See "Selecting Data Clocks and Qualifiers")

5. **Choose a sample clock.** (See "Choosing a Sample Clock")

6. **Determine how the physical connections will be made.** For a one-time measurement, you should probably use grabbers. When cable connectors are built into the circuit under test, repeated testing is easier and the possibility of making incorrect connections is reduced.

Selecting Data Clocks, Channel Clocks, and Qualifiers

There are three types of clocks used in digital and mixed measurements: data clocks, channel clocks, and a sample clock. Each input pod has (Pod 1 and Pod 2) has a data clock. The analyzer uses the data clock and, if activated, qualifiers to generate a channel clock. There is one channel clock for each input channel: CHAN 1 CLOCK for Channel 1 and CHAN 2 CLOCK for Channel 2. CHAN 1 CLOCK latches digital data into Channel 1 measurement channel and CHAN 2 CLOCK latches digital data into Channel 2 measurement channel. The sample clock is the main clock and is usually chosen from one of the channel clocks in an all-digital measurement. Further information on the sample clock exists in a later discussion under "Choosing a Sample Clock."

To understand the operation of data clocks, channel clocks, and qualifiers, examine figure 14-3. This illustration shows how the analyzer uses the data clock (CLK) and qualifiers to generate the channel clock. Digital data is latched into an input channel when its channel clock is active. If you use qualifiers, the channel clock is active when the following two conditions are met:

- CLK goes low-to-high (or high-to-low if C EDGE + − is −)
- Q0–Q7 on Pod Q match the pattern you enter with the CLOCK QUALFR softkey

For microprocessor-based systems, the most common choices for the data clock(s) are the microprocessor read/write or data strobe signals. These signals can be qualified with the microprocessor address lines to generate the channel clocks. Obviously, the choice of clock signals and qualifiers is going to be heavily dependent on the architecture of the system under test.
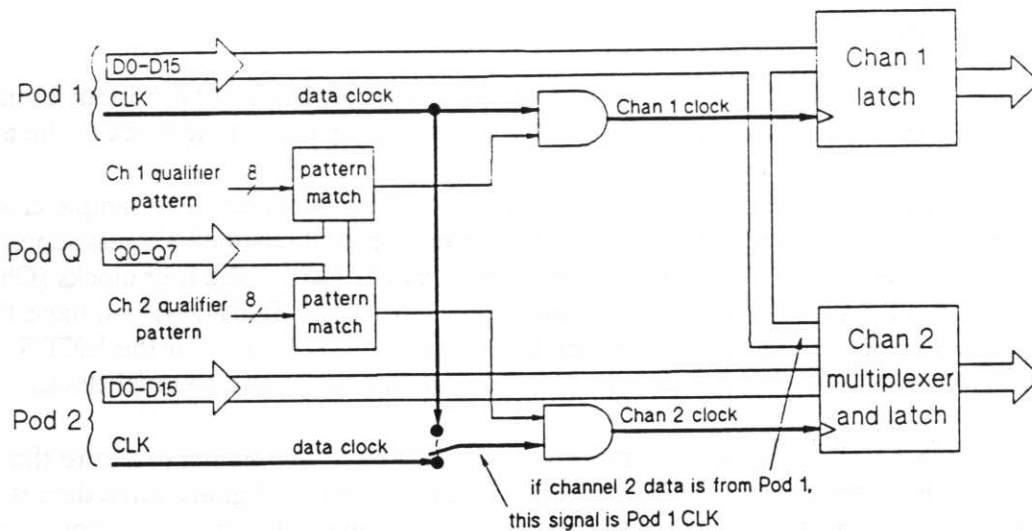
**Figure 14-3. Block Diagram Showing Logic Used to
Qualify the Data Clocks**

Example: Suppose data is latched into a D/A converter using a combination of a chip-select signal (CS) and a write signal (WR). To latch the same data into the analyzer, the WR signal is connected as the data clock and the CS signal connected to one of the qualifier inputs. With the appropriate qualifier pattern, the combination of the data clock (WR) and the qualifiers (CS) generates a channel clock to latch the data.

Although qualifiers aren't always necessary, their use can add a great deal of flexibility to the test setup. Whenever possible, the qualifier signals should be chosen so that switching from one measurement point to another can be accomplished by simply changing the analyzer's qualifier pattern(s). One way to do this is to connect each of the eight qualifier lines to a different chip-select signal. Perhaps a better way is to connect at least some of the qualifier lines to the address bus. The latter method has the advantage of not being limited to eight pre-defined measurements points.

The qualifiers can also be used with the digital source. A source-enable signal (SRC-EN) is available as an output on Pod X. This signal goes low whenever the qualifier lines match the source qualifier pattern. Connecting the SRC-EN line to the TRI-STATE signal on optional tri-state buffer pods allows the source data to be enabled and disabled (via the tri-state buffers) at the appropriate times.

Note

Using the source qualifier feature does not inhibit data from the digital source. The source data updates regardless of the state of the SRC-EN signal. If the qualifier pattern doesn't occur every time the source output is updated, data from the digital source is not available at the tri-state outputs.

Qualifier Q0 *must* be used for 16-bit data on an 8-bit bus. Refer to chapter 13 for more information regarding this configuration.

Choosing a Sample Clock

The HP 3563A has an internal 256 kHz sample clock which is used whenever both input channels are analog. When one or both channels are digital, you must supply the sample clock to the analyzer.

For all-digital measurements, the channel clocks latch data into the analyzer. The sample clock moves the latched data from the input latches into both measurement channels simultaneously and starts the source-update process. There is only one sample clock. One of the four clocks (Ch 1^1, Ch 2^1, Pod Q, and EXT SAMPLE) is chosen as the sample clock. See figure 13-19 on page 13-19. Although the sample clock can be supplied via the CLK input on Pod Q clock or the EXT SAMPLE clock, for all-digital measurements, it is usually selected from one of the two channel clocks.

When choosing a sample clock, the main consideration should be source timing to assure that the correct sample pair is taken (see figure 13-21 on page 13-21). Since the digital source data is updated with every occurrence of the sample clock, the clock edge must occur early enough to ensure that the source data is valid when it is read by the circuit under test. See the timing diagram in figure 13-17. For measurements involving 16-bit data on an 8-bit bus, the sample clock edge must occur after both bytes of the 16-bit word have been latched into the analyzer (for both channels).

Note

If the analog source is going to be used, then the chosen sample clock should be as stable (free from jitter) as is practical.

Measured phase is also a consideration in choosing the sample clock. The phase relationship between channels is determined by the timing relation between the channel clocks and the sample clock. Recall that the sample clock simultaneously moves data from both input latches into the measurement channel. This "re-clocking" of the input eliminates any partial-sample delays present between channel clocks.

Example: Consider a microprocessor running a digital filter program. It reads an input sample, then calculates and writes the next output sample. See the timing diagram in figure 14-4. In this example Channel 1 data is from the microprocessor input, Channel 2 data is its output, and the Channel 2 clock has been selected as the sample clock. The delay in the Channel 1 data occurs because the data latched with the Channel 1 clock is not moved into the measurement channel until the next sample clock occurs. See figure 13-19 on page 13-19. This is a partial-sample delay introduced in the Channel 1 data. This delay exactly cancels the microprocessor computational delay (delay between the channel clocks).

---

1   If configured to be digital

If the delay value is known, you may wish to include the phase effects of the microprocessor computational time in a transfer function measurement. Enter the delay value with the COMPUT DELAY? softkey (in the **INPUT CONFIG**/INTERFACE 1/DATA CLOCK menu). Entering a negative delay value for Channel 1 negates the positive delay introduced by the measurement.
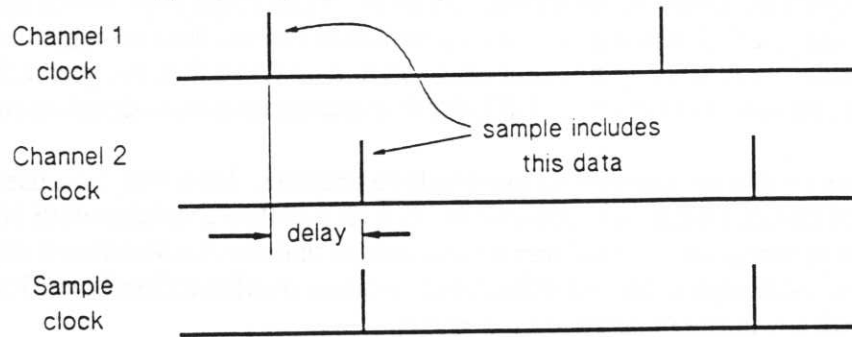
Figure 14-4. Last Channel Clock is Sample Clock

If Channel 1 is chosen as the sample clock, the Channel 2 data would be delayed until the next sample clock, as shown in figure 14-5. Notice that this delay, plus the partial sample delay due to the microprocessor, adds up to a full sample delay. *If no computational delay values are entered, we would see a phase difference corresponding to a single sample delay between this transfer function measurement and the same measurement made with Channel 2 chosen as the sample clock.*

The COMPUT DELAY? softkey can be used to correct for delays introduced in the measurement process. Usually the value entered for a channel's computational delay is the negative of the delay from the corresponding channel data clock to the next sample clock.
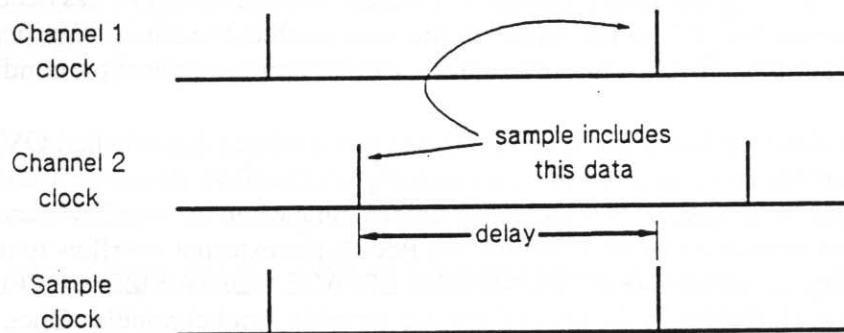
Figure 14-5. First Channel Clock is Sample Clock

Digital Range and Overflow

Overload versus over*flow*: In an analog measurement the input range value is used to configure attenuators in the front end so that the analog input circuitry is not overdriven. An overload occurs whenever the input signal exceeds the value specified by the input range key. When an overload occurs, the red over-range LED on the front panel illuminates and the data is flagged as having been taken during an over*load* condition. (The input range should be set so that the green. front-panel. half-range LED is lit and the red over-range LED is off to ensure maximum signal-to-noise ratio.)

For digital measurements it is not possible to overload the analyzer. However, because the analyzer uses a maximum word size of 13-bits, it is possible to have an overflow condition with 16-bit input data. The difference between an overload and an overflow is that overloaded data is clipped at the maximum signal level. Although there are differences between overloaded and overflowed data, they are treated identically in the measurement process.

The HP 3563A uses 13-bit data in all measurement calculations. To convert 16-bit data into 13-bit words, the data is either rounded or truncated, depending on whether the upper-13 or lower-13 bits are chosen. If the *upper* 13 bits are chosen, the 3 least-significant bits are rounded into the upper 13 bits. If the *lower* 13 bits are selected, the 3 most-significant bits are truncated (not used as data).

The upper-13 bit mode should be used with large signals. For low-level signals, using the lower 13 bits increases the measurement sensitivity. It also improves the signal-to-noise ratio by decreasing the level of quantization distortion. Selecting the lower 13 bits is similar to selecting a more-sensitive input range on an analog input channel. When the lower 13 bits are selected, an overflow condition can occur. So, before the 3 most-significant bits are truncated, the 16-bit data is checked to see if it can be represented by 13-bits. If it can't, then an overflow has occurred and the data is flagged as overloaded. When the upper-13 bits are selected, the 3 least-significant bits are rounded into the upper bits. In this case, the analyzer cannot create an overflow condition.

To signal a data overflow condition in the system under test, an input signal called OVF is provided on Pod Q. This input can be used to set the overload flag on data from either or both digital input channels. The system under test is responsible for determining when an overflow occurs. When the signal is available and connected to the OVF line on Pod Q, the external overflow feature should be turned on with the key sequence **INPUT CONFIG/INTERFACE 1/DATA SIZE/X OVFL ON OFF**. Overflow should be set individually for each of the two possible input channels. Once the digital data has been flagged as overflowed, it is treated the same as overloaded analog data and can be used by features such as overload rejection (**AVG/NEXT/OV REJ ON OFF**).

Note   The range LED's on the front panel apply only to the analog channels.

The OVF signal is not latched by the HP 3563A. To ensure detection, the signal should active longer than the time record length defined for the measurement.

Making an All-Digital Measurement

Except for clock selection, digital input and source setup, and overflow detection, there are few differences between an all-analog and all-digital measurements. One feature that is unique to digital measurements is the 1024-line display mode in the **WINDOW** menu. By default the analyzer displays 801 of 1024 lines of resolution. The remaining lines are not displayed because they contain data that is distorted beyond the calibrator's ability to meet specifications and because it may be contaminated by aliasing. In a full-span all-digital measurement, aliasing and distortion are not factors and the data is valid up to $F_s/2$ – one bin. For reduced spans (analog or digital), the data is once again suspect and should be ignored. Markers appear as necessary to indicate suspect data. See figure 14-6

Dashed line marks the suspect data.
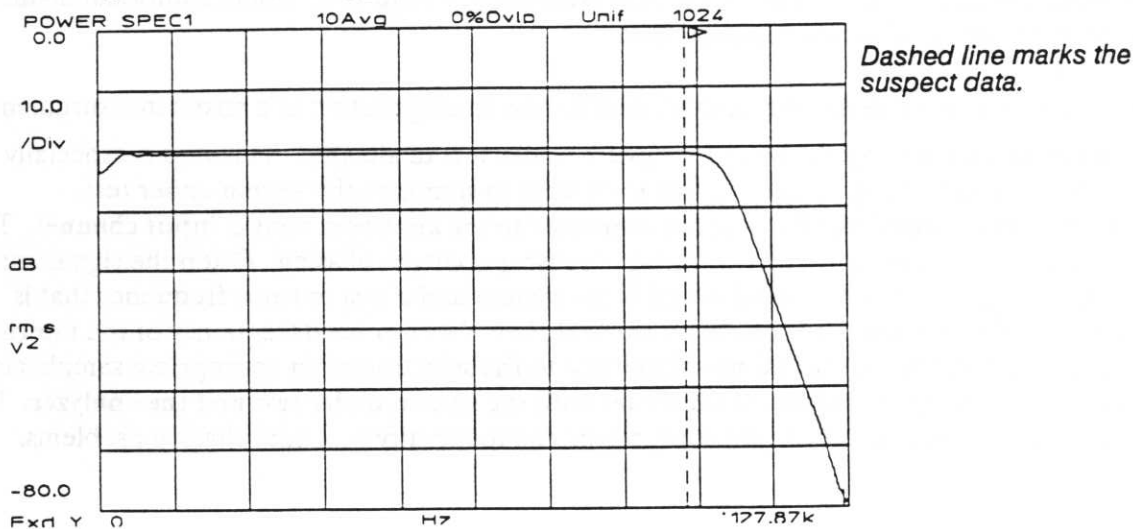
Figure 14-6. 1024-Line Feature

Mixed Measurements

A mixed analog/digital measurement is a measurement configuration that has one analog channel and one digital channel. The source can be either analog or digital.

Planning the Measurement

The steps discussed previously for planning an all-digital measurement apply to the digital portion of a mixed measurement. See "Planning the Measurement" on page 14-2. Some additional planning is necessary to ensure an alias-free measurement.

The following steps outline the planning process for the analog portion of a mixed measurement:

1. **Understand the susceptibility of the system under test to aliasing.** This step is especially important if the analog source is going to be used to stimulate the system under test.
2. **Estimate the bandwidth of the signal connected to the analyzers analog input channel.** This step is necessary to determine the analyzer's susceptibility to aliasing. Often the signal applied to the analyzer's input will bandlimited by the system under test to some frequency that is considerably less than the 156kHz; where 156kHz is the stop-band frequency of the internal anti-alias filter. This information is important to the selection of an appropriate sample clock.
3. **Build a measurement model that includes both the system under test and the analyzer.** Use this model to determine the system equations and to identify potential aliasing problems.

The Mixed-Measurement Model

For mixed measurements, it's usually necessary to model the analyzer as a sampled system in order to design a measurement and interpret the results. In an all-analog measurement, this "modelling" was unnecessary because the internal input anti-alias and source reconstruction filters were completely effective at the 256 kHz internal sample clock rate. Although simple models described here are not intended to accurately represent actual signal paths and data operations, they do provide some insight into the effects and interactions of the various clocks and filters.

The Analog Input Model

The analog input is modeled a sampler preceded by an analog anti-alias filter as shown in figure 14-7. The sampler operates at the sample clock rate, which is the digital rate times the value of the mixed ratio. The low pass anti-alias filter begins to roll-off at 100 kHz and is down at least 80 dB by 156 kHz. The model shows that corrections, which compensate for the effects of the anti-alias filter, are applied after the sampling process. The corrections are applied with the assumption that the input signal is bandlimited to one-half the sample clock rate (not necessarily 256kHz). If this assumption is violated, then the corrections will be in error and the filter will affect the measured results over the portion of the spectrum that is aliased.
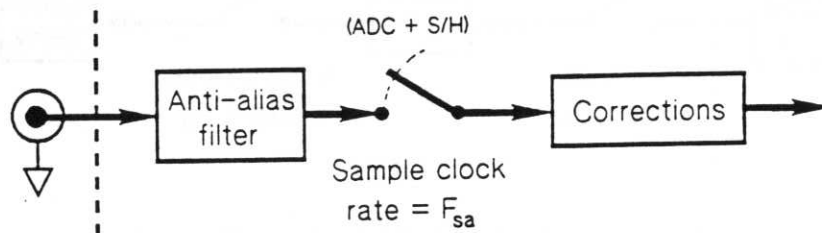
Figure 14-7. Model of an Analog Input Channel

The effects of the input anti-alias filter should be considered whenever the input signal is not bandlimited to one-half the sample clock rate. For example, a rectangular pulse (which is not band limited) is delayed as it passes through the filter. This changes the timing relationship between the pulse and the sample clock. If the pulse width is less than one sample period, then the pulse may or may not be sampled.

The Digital Input Model

The digital input can be modeled as a sampled system with two delay elements and two samplers as shown in figure 14-8. The left delay block models the time delay between the data clock (data latched into the analyzer) and the next sample clock. See the timing diagram in figure 17-2. The right delay block is used to model the delay (or advance) introduced when a value is entered using the COMPUT DELAY? softkey. A positive value introduces a linear phase ramp with a negative slope in the specified channel's linear spectrum data. See figures 14-4 and 14-5 on page 14-7.

Note   The computational delay affects the input spectrum, not the time data.
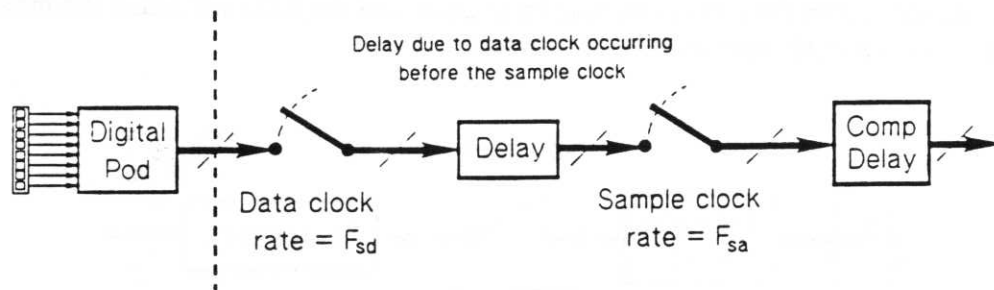
Figure 14-8. Model of a Digital Input Channel

The left sampler is operating at the data clock rate, the right at the sample clock rate. When the sample clock is faster than the data clock (mixed ratio > 1), then the right sampler samples either the digital input value (both switches closed within one sample clock period) or a zero (left switch open longer than one sample clock period). This condition is referred to elsewhere as "zero-fill."

The Analog and Digital Source Model

The analog source is modeled as a zero-order hold (ZOH) followed by an analog reconstruction filter. As shown in figure 17-7, the source is updated at the sample clock rate. The reconstruction filter is designed to produce a flat, image-free source response when the sample clock is operating at a 256 kHz rate. At lower sampling rates, the filter is less effective at maintaining a flat response, and may pass image frequencies present at the output of the ZOH.
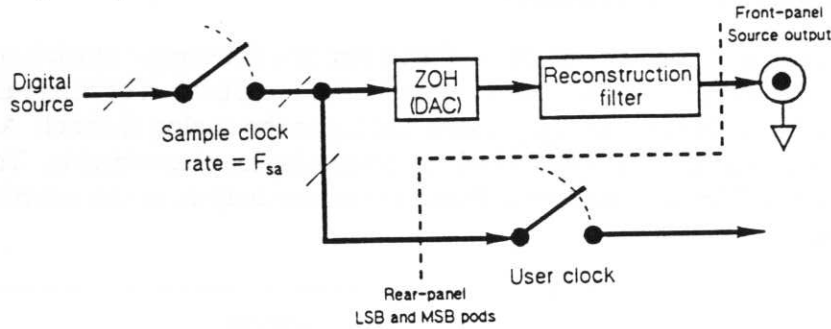
Figure 14-9. Model of the Digital and Analog Sources

The digital source is also updated at the sample clock rate, but is re-sampled at the user clock rate by the system under test. The user clock is usually operating at the data clock rate. When the sample clock is faster than the user clock, then the system under test is sub-sampling the source data (using every n'th value). This creates the potential for aliasing. Note that the user clock does not have to occur at the same time as the sample clock (as implied by the model). See figure 13-17 on page 13-17 for source timing information.

Note

Although the source model shows both analog and digital sources, only one of the source outputs can be active at a time.

Why Models Are Important

Consider the example measurement shown in figure 14-10. The measurement model helps answer the following questions:

1. Does the analog input channel, CH1, have sufficient alias protection?
2. What are the characteristics of the source spectrum?
3. Does the system under test suffer from aliasing?

When the analog input channel is connected directly to the source and the sample clock is operating at less than 256kHz, then some aliasing occurs. In this example, the combination of the source reconstruction and input anti-alias filters does not prevent aliasing in the analog channel. As is discussed later in the section on choosing a sample clock, some aliasing may be tolerable. To reduce the effects of aliasing, additional filtering could be added at the source output, or the sample clock frequency could be increased.
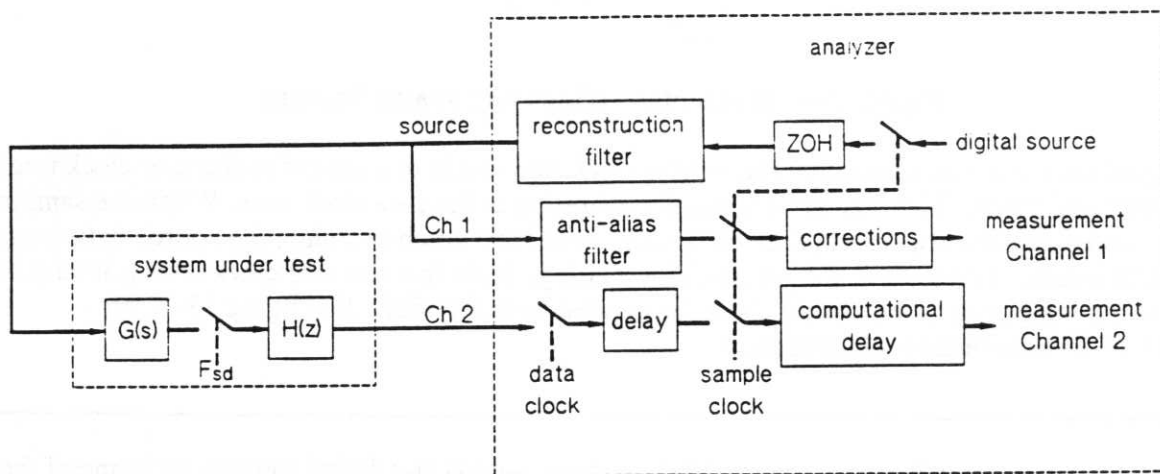
Figure 14-10. Model of Analyzer & Test System

The measurement model also shows the potential for aliasing in the system under test. For sample frequencies less than 256kHz, spurious signals (image frequencies) may be present at the source output. No matter what source type is selected (sine, chirp, etc.), it's usually not safe to assume that the analog source output is bandlimited. This places the burden of alias protection on the system filter $G(s)$.

Selecting Data Clocks and Qualifiers

The techniques for selecting data clocks and qualifiers differs little from those described previously for all-digital measurements.

Choosing a Sample Clock

The sample clock plays a very important role in mixed measurements. It controls when the analog channel is sampled, when the digital data is sampled (moved into the measurement channel), and when the source is updated. It also determines the maximum span and the amount of alias protection provided to the analog channel. In addition, it affects the characteristics of the source.

Unlike a purely digital measurement, the sample clock in a mixed measurement can run at a different rate than the data clock. This rate, which must be an integer multiple of the data clock rate, allows for measurements with spans greater than half the data clock rate and also improves the alias protection for the analog inputs. In many cases, using a faster sample clock can eliminate the need for external anti-alias filters.

One of the most important parameters of the sample clock is the frequency, F_{sa}. Determining the minimum sample clock frequency requires two pieces of information:

1. the highest frequency to be measured (F_{top}) and
2. the highest frequency for which energy exists at the analog input (F_{stop}).

If F_{stop} is unknown, a value of 156 kHz can be used. This is the stopband frequency for the input channel's anti-alias filter. Using F_{top} and F_{stop}, the minimum sample frequency can be calculated as:

$$F_{sa} = F_{stop} + F_{top}$$

Note

F_{top} is the highest frequency to be measured; not the highest frequency that can be measured. It's up to the user to avoid using data with frequency components above F_{top}. If possible, reduce the measurement span and adjust the center frequency to cover the frequencies of interest. This improves the frequency resolution and reduces the chance of viewing corrupt data.

Figure 14-11 illustrates how the formula works. The input spectrum contains energy up to the frequency, F_{stop}. When the input signal is sampled, the negative image of the spectrum is replicated at the sample frequency, F_{sa}. Aliasing occurs only where the spectrum and its image overlap. As shown, this leaves the portion of the input spectrum between 0 Hz and F_{top} unaffected by aliasing. So, while aliasing does occur, it doesn't affect the frequencies of interest.
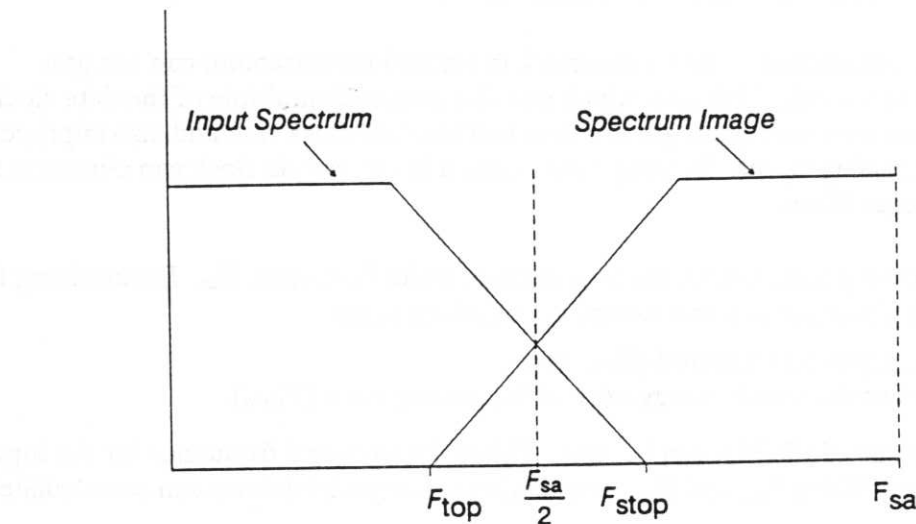
$$F_{top} = F_{sa} - F_{stop}$$

$$F_{sa} = F_{top} + F_{stop}$$

Figure 14-11. Calculating F$_{sa}$

Example

This example explains how to measure the sin(x)/x response of a digital-to-analog converter (DAC) operating at 44 kHz. Assume that the highest frequency to be measured is chosen to be 47 kHz.
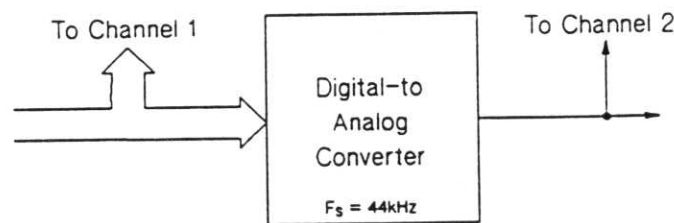
Device Under Test

Figure 14-12. DAC Frequency Response Measurement

Channel 1 is in digital mode and is connected to the DAC input. Channel 2 is in analog mode and is connected directly to the output of the DAC. There is no low pass filter on the DAC output so the output of the DAC is not band-limited. This example, therefore, specifies 156 kHz for F_{stop} and 47 kHz for F_{top}.

Use the formula, $F_{sa} = F_{stop} + F_{top}$, to determine the minimum analog sampling frequency.

$$F_{sa} = 156 \text{ kHz} + 47 \text{ kHz} = 203 \text{ kHz}$$

The analog-to-digital ratio (mixed ratio) is: $\dfrac{F_{sa}}{F_{sd}} = \dfrac{203 \text{ kHz}}{44 \text{ kHz}} = 4.61$
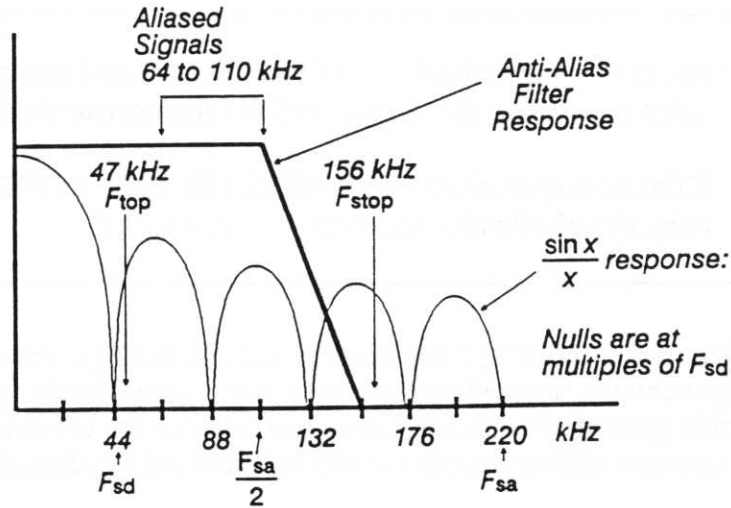
Figure 14-13. Digital-to-Analog Converter Response

The mixed ratio must be an integer; 4.61 rounds up to 5. (Always round up.) Then:

1. Set the sample frequency, F_{sd}, to 44 kHz.
2. Connect a 44 kHz clock to the Channel 1 Input Pod Clock input.
3. Set MIXED RATIO to 5.
4. Connect a 220 kHz clock (F_{sd} × Mixed Ratio which is 44 kHz × 5) to either the EXT SAMP or the POD Q CLOCK input.

$\dfrac{F_{sa}}{2}$ is 110 kHz (220/2). Anything in the frequency span between 110 kHz and 156 kHz will alias into the span between 64 kHz and 110 kHz. Energy above 156 kHz is removed by the HP 3563A's anti-alias filters and does not produce aliasing.

In the example, the maximum analyzer span is 85.94 kHz in 801-line mode.

$$\text{MAX FREQ SPAN} = \frac{801}{1024} \times \frac{F_{sa}}{2}$$

equivalent to: $\dfrac{F_{sd}}{2.56} \times \text{Mixed Ratio} = \dfrac{44 \text{ kHz}}{2.56} \times 5 = 85.94 \text{ kHz}.$

To avoid using the data above 64 kHz, and to improve frequency resolution, the center frequency and span should be set so the 801 lines of resolution are concentrated between 0 Hz to 64 kHz. The analyzer's frequency spans are based on F_{sa}. As the mixed ratio increases, the maximum displayed span increases. As the analyzer's span increases, the resolution for the digital spectrum, 0 to $F_{sd}/2$, decreases.

Note

Avoid very large mixed-ratio values. As a general rule, the best signal-to-noise ratios occur when the sample clock is running near the digital rate.

If the math operations COMPRESS, EXPAND, or EXTRACT are used with mixed ratio, the mixed ratio value must be a power of 2.

Another consideration in choosing a sample clock is *clock stability*. The sample clock determines when the analog channel is sampled, so the sample clock signal should be as stable as possible. Avoid using signals generated by microprocessor instructions for the sample clock. These signals may have large amounts of jitter introduced by interrupts and pipeline effects.

If the digital source is to be used, the timing of the sample clock to source data should be considered. Refer to the all-digital section on sample clock selection.

Index

Index