

User's Guide

HP 8711 RF Network Analyzer

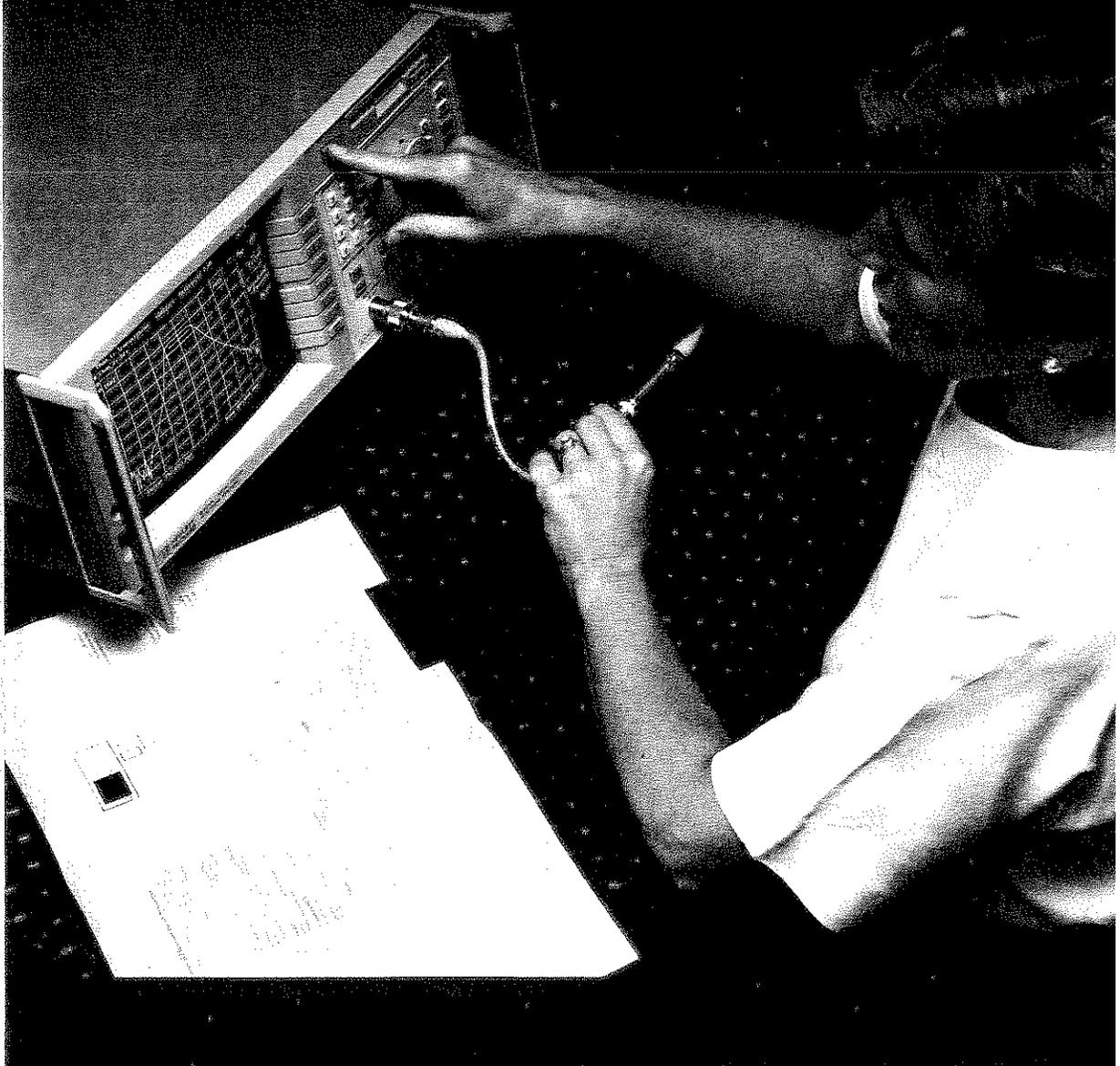
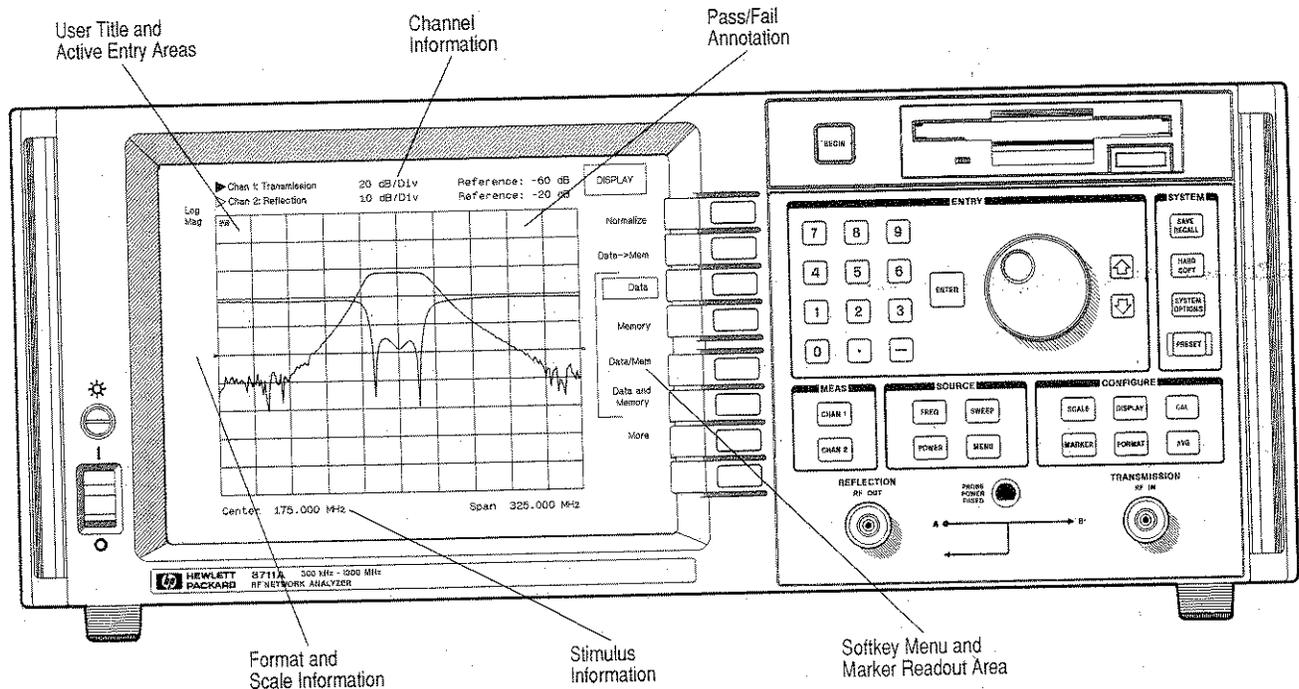


Table of Contents

Getting Acquainted	2
General Measurement Sequence	4
Measuring Transmission	5
Measuring Reflection	10
Maximizing Throughput	11
Instrument Automation	13

Getting Acquainted

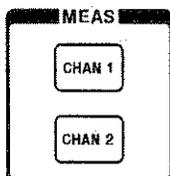
The HP 8711 is an easy-to-use fully integrated RF component test system. It includes a 1 Hz resolution synthesized source, a 90 dB dynamic range receiver and a built-in test set. Features are grouped by functional block and displayed on the instrument CRT. This user's guide familiarizes new users with the HP 8711 network analyzer by describing a variety of measurements on the demonstration filter supplied with the HP 8711.





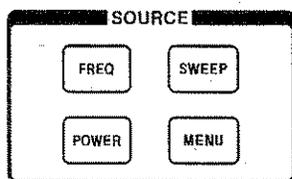
Begin

The BEGIN key allows quick and easy selection of basic measurement parameters for a specific class of devices (e.g., filters, amplifiers, or mixers). For example, when making a transmission measurement, selecting FILTER as your device type puts the analyzer into narrowband detection mode, maximizing measurement dynamic range. In comparison, selecting MIXER as your device type puts the analyzer into broadband detection mode, enabling frequency translated measurements.



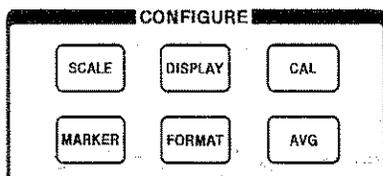
Measure

The measure keys select the measurements for each channel. The HP 8711's measurement capabilities include transmission, reflection, absolute power, and conversion loss.



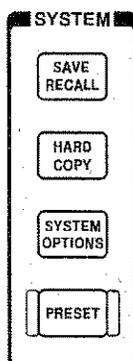
Source

The source keys select the desired source output signal to the device under test, for example, selecting source frequency range or output power. The source keys also control sweep time, number of points, and sweep triggering.



Configure

The configure keys control receiver and display parameters. These parameters include receiver bandwidth and averaging, display scaling and format, marker and marker search functions, and instrument calibration.



System

The system keys control system level functions. These include instrument preset, save/recall, and hardcopy output. HP-IB parameters and IBASIC (Option 1C2) are also controlled with these system keys.

HP 8711 major preset conditions:

Frequency range	0.3 to 1300 MHz
Power level	0 dBm
Measurement	
Channel 1	Transmission
Channel 2	Off
Format	Log Magnitude
Number of points	201
Sweep time	100 ms
Scale	10 dB/div
Reference	0 dB

General Measurement Sequence

The HP 8711's user interface allows measurement flexibility while maintaining overall ease of use. Typical measurements can be set up and made with a few front panel selections. This section describes a general approach to making component measurements with the HP 8711.

The following sequence is used throughout this user's guide to demonstrate the HP 8711 in various measurement configurations and modes of operation.

Preset

Return the instrument to a known state. The HP 8711 major preset conditions are shown to the left.

Begin

Set measurement and format parameters, including source stimulus values.

Connect DUT

Connect the device under test (DUT).

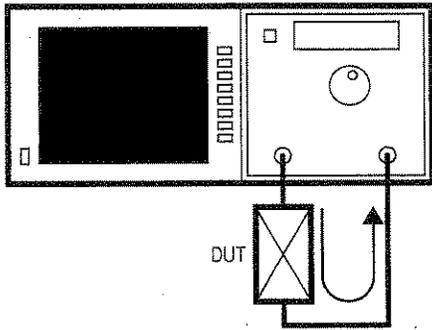
Scale

Scale measurement data as desired.

Calibration

The HP 8711's built-in calibration corrects for systematic loss, leakage and mismatch errors that degrade measurement accuracy. This correction is automatically applied to measurements made on the HP 8711 until a user calibration is performed.

For measurement of devices that cannot be connected directly to the network analyzer's Type N test ports, (e.g., remote location, or different connector type) the HP 8711 provides user calibration capability that can be used to remove systematic errors from the measurement of a DUT.



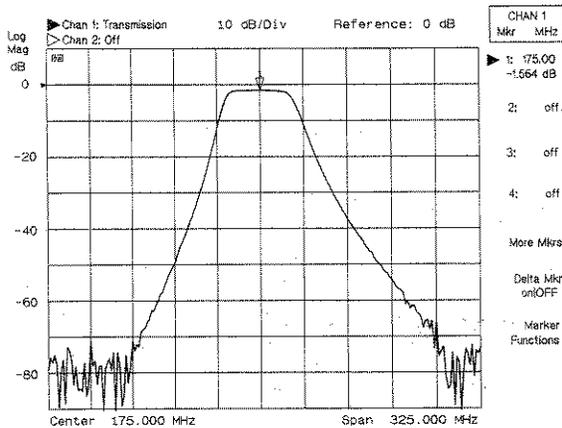
Measuring Transmission

This section describes common transmission measurement procedures. These measurements include insertion loss, 3 dB bandwidth, out-of-band rejection and absolute output power.

Insertion Loss

Insertion loss or gain is the logarithmic ratio of transmitted-to-incident voltage through a device under test. An insertion loss of [infinity] dB corresponds to no transmission, while an insertion loss of 0 dB corresponds to complete transmission, (no loss).

Preset [PRESET]
 Begin [BEGIN]
 [Filter]
 [Transmissn]
 [FREQ]
 [Center] [175] [MHz]
 [Span] [325] [MHz]



Connect the DUT
 Scale [SCALE]
 [Reference Position]
 [9] [ENTER]
 [Reference Level]
 [0] [ENTER]
 [Scale/Div]
 [10] [ENTER]

The figure to the left shows the insertion loss of a bandpass filter under test. A marker can be used to quickly and easily read out the filter's minimum insertion loss.

[MARKER]
 [1:]
 [Marker Search]
 [Mkr→Max]

The marker amplitude and frequency (-1.54 dB at 175 MHz) are shown on the right side of the CRT. Once this measurement has been completed, turn off all markers.

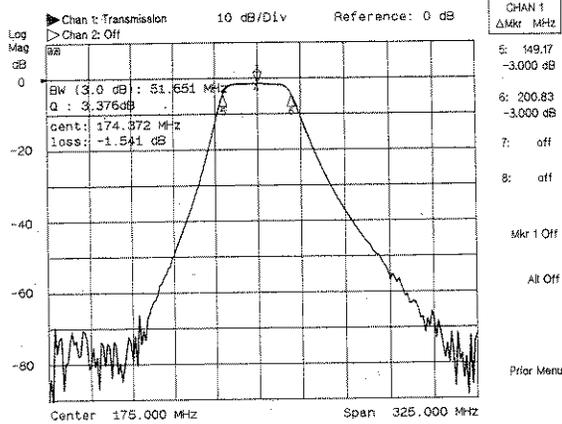
[MARKER]
 [All Off]

3 dB Bandwidth

The HP 8711 can automatically calculate the bandwidth of a DUT between two points of equal insertion loss. In this example, the 3 dB bandwidth of a filter is calculated and displayed relative to the filter's point of minimum insertion loss.

Activate the marker bandwidth function.

[MARKER]
 [Marker Search]
 [Bandwidth]
 [-3] [ENTER]



The figure to the left shows the 3 dB bandwidth of the bandpass filter under test. To have the HP 8711 calculate and display the bandwidth between two other points of equal insertion loss, simply select another insertion loss value.

For example, selecting

[-60] [ENTER]

calculates and displays the filter's 60 dB bandwidth. Once this measurement has been completed, turn off all markers.

[MARKER]
 [All Off]

Out-of-band Rejection

Out-of-band rejection is the difference in insertion loss between the pass and stop bands of a DUT. The high dynamic range of the HP 8711 enables it to measure devices with over 90 dB of out-of-band rejection.

[MARKER]

[1:]

[Marker Search]

[Mkr→Max]

Once marker 1 is in position, designate it as the reference marker, and activate marker 2. Marker 2 is used to locate the maximum out-of-band rejection.

[MARKER]

[Marker Functions]

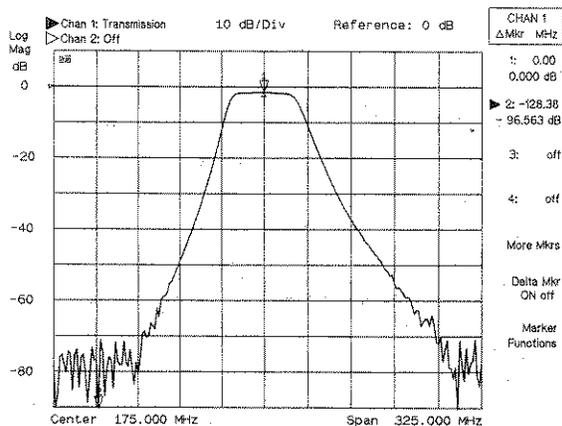
[Delta Mkr On]

[MARKER]

[2:]

[Marker Search]

[Mrk→Min]



The figure to the left shows the maximum out-of-band rejection for the bandpass filter under test. Once this measurement has been completed, turn off all markers.

[MARKER]

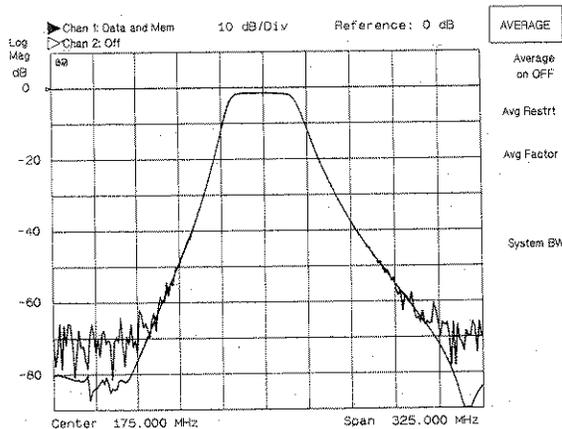
[All Off]

Maximizing Dynamic Range

Dynamic range is the difference between a receiver's maximum input level and its noise floor at a specified system bandwidth. This difference determines the maximum range between signals that can be measured by a network analyzer. For example, the HP 8711 is specified to measure filter out-of-band rejection (the difference in output signal level between the pass and stop bands of a filter) of over 90 dB.

To maximize dynamic range the following guidelines should be followed.

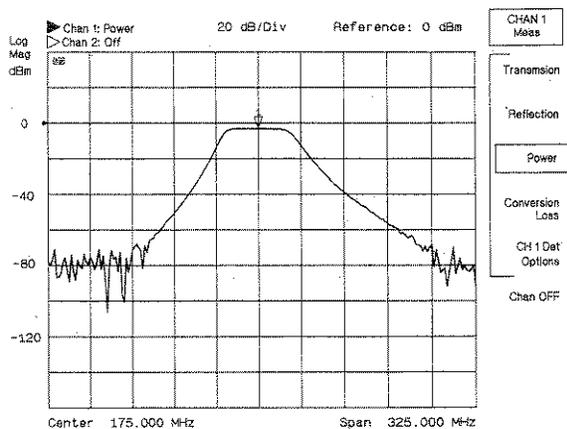
1. Increase source output power. For passive devices, source output power can be increased to the receiver's maximum input level. For the HP 8711 this level is +6 dBm.
2. Reduce the system bandwidth to minimize the amount of noise entering the system's receiver. Reducing system bandwidth requires longer sweep times and therefore reduces overall measurement speed. Sweep time is automatically increased as system bandwidth is reduced.
3. Average successive traces to remove the effect of low-level random noise from the measurement of the DUT. Averaging requires a user-specified number of successive sweeps (default is 16). Averaging also reduces overall measurement speed.



The two traces on the plot to the left compare the same transmission measurement made using two different measurement conditions. The first (upper trace), made using preset source and receiver conditions, has 80 dB of dynamic range and takes 100 ms/sweep. The second (lower trace) is made with a +10 dBm source output power, the minimum system bandwidth and an averaging factor of 64. It has 92 dB of dynamic range and takes 1.6 s/sweep.

Absolute Output Power

In addition to the relative transmission measurements (output/input) already described, the HP 8711 can measure the absolute output power of a DUT. For example, the absolute output power of an amplifier under test.



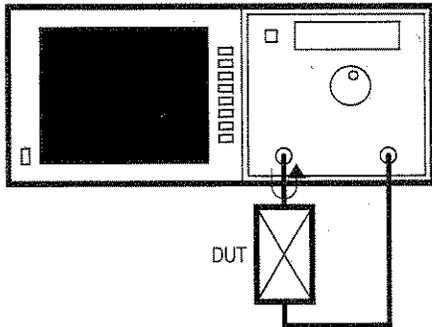
[PRESET]
 [BEGIN]
 [Filter]
 [Transmissn]
 [FREQ]
 [Center][175][MHz]
 [Span][325][MHz]
 [CHAN 1]
 [Power]
 [SCALE]
 [Autoscale]

The figure to the left shows the absolute output power of the bandpass filter under test. Use a marker to quickly and easily locate the maximum power (dBm) at the output of the DUT.

[MARKER]
 [1:]
 [Marker Search]
 [Mrk→Max]

Once this measurement has been completed, turn off all markers.

[MARKER]
 [All Off]



Measuring Reflection

This section describes common reflection measurement procedures. These measurements include return loss and standing wave ratio (SWR).

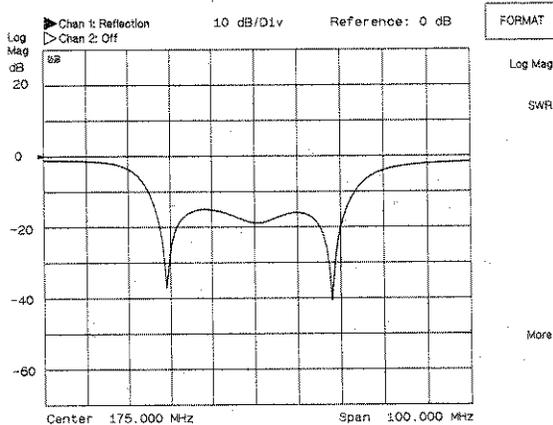
Return Loss

Return loss is the logarithmic ratio of reflected-to-incident voltage for a device under test. Return loss can be derived from the linear reflection coefficient (Γ) using the following equation:

$$\text{Return loss} = -20 \log |\Gamma|.$$

A return loss of [infinity] dB corresponds to no reflection, while a return loss of 0 dB corresponds to a complete reflection.

- Preset [PRESET]
- Begin [BEGIN]
- [Filter]
- [Reflection]
- [FREQ]
- [Center] [175] [MHz]
- [Span] [100] [MHz]
- Connect the DUT
- Scale [SCALE]
- [Autoscale]



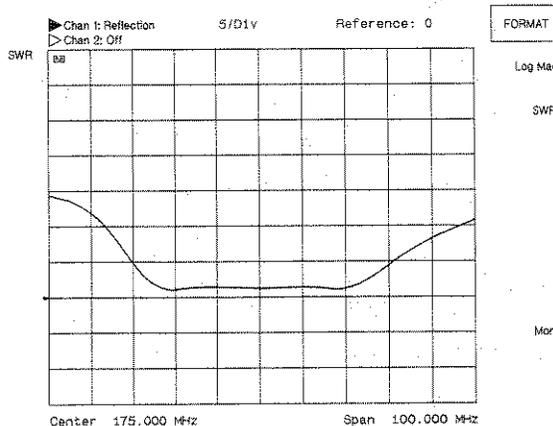
The figure to the left shows the return loss of the bandpass filter under test.

SWR

Standing wave ratio (SWR) is the ratio of maximum to minimum standing wave voltage. SWR can be derived from the linear reflection coefficient (Γ) using the following equation:

$$\text{SWR} = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

An SWR of 1 corresponds to no reflection, while an SWR of (infinity) corresponds to a complete reflection.



The figure to the left shows the SWR of the bandpass filter under test.

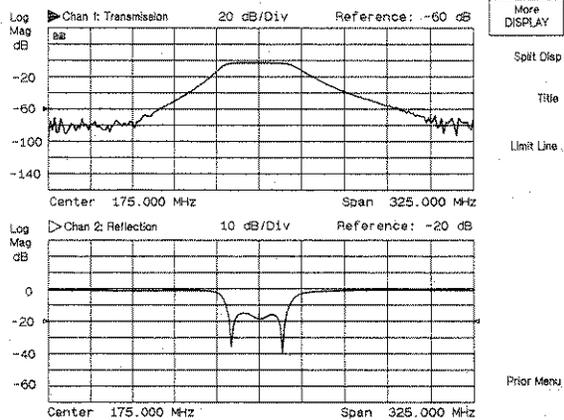
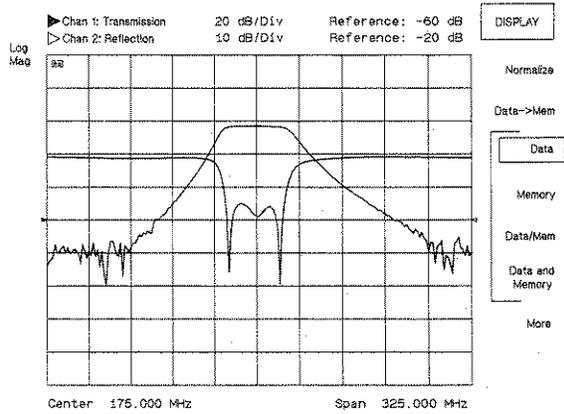
- [FORMAT]
- [SWR]
- [SCALE]
- [Autoscale]

Maximizing Throughput

This section describes features and capabilities of the HP 8711 that can be used to maximize measurement throughput. These features include multiple trace display, limit testing, hardcopy output, internal save/recall, and the internal 3.5 in. disk drive.

Multiple Trace Display

To speed the tuning and testing of devices, the HP 8711 provides the capability to display multiple device parameters simultaneously on the instrument CRT. An example of the simultaneous measurement of transmission and reflection is shown to the left.



- Preset [PRESET]
- Channel 1 [CHAN 1]
- Begin [BEGIN]
- [Filter]
- [Transmission]
- [FREQ]
- [Center] [175] [MHz]
- [Span] [325] [MHz]
- Connect the DUT
- Scale [SCALE]
- [Autoscale]
- Channel 2 [CHAN 2]
- [Reflection]
- [SCALE]
- [Autoscale]
- [DISPLAY]
- [More Display]
- [Split Disp]
- [Split]

The figures to the left show both the overlay and split display formats of the simultaneous transmission and reflection characteristics of the band-pass filter under test.



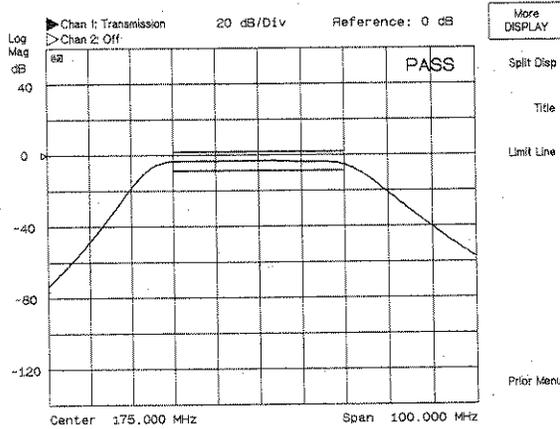
Limit Testing

The HP 8711 enables quick and easy testing of devices by comparing measured data to user-defined test limits, and displaying the results on the instrument's CRT.

Preset [PRESET]
 Begin [BEGIN]
 [Filter]
 [Transmission]
 [FREQ]
 [Center] [175] [MHz]
 [Span] [100] [MHz]

Connect the DUT
 Scale [SCALE]
 [Autoscale]

Enter Limit Lines [DISPLAY]
 [Limit Line]
 [Add Limit]
 [Add Max Line]
 [Begin Frequency]
 [155] [MHz]
 [End Frequency]
 [195] [MHz]
 [Begin Limit]
 [0] [ENTER]
 End Limit
 [0] [ENTER]
 [Prior Menu]
 [Add Min Line]
 [Begin Frequency]
 [155] [MHz]
 [End Frequency]
 [195] [MHz]
 [Begin Limit]
 [-5] [ENTER]
 [End Limit]
 [-5] [ENTER]
 [Prior Menu]
 [Prior Menu]
 [Limit Test On]



The figure to the left shows an example of a limit test performed on the passband of the bandpass filter under test.

File Name	Size	Type	Last Change	
Filter_Test	2304	BDAT	06/10/91	08:42:32
Amplifier_Test	2304	BDAT	06/12/91	10:12:12
Cable_Test	2816	BDAT	06/16/91	04:30:40
Mixer_Test	3684	BDAT	06/22/91	06:08:00
Plot_Control	512	BDAT	07/02/91	08:10:24
AUTOST	2816	BDAT	07/07/91	09:17:44

IBASIC

Run

Continue

Edit

Key Record
on OFF

Save/Rec
Program

IBASIC
Display

Save/Recall

For the quick and easy storage of instrument states and measurement set ups the HP 8711 provides nine internal save/recall registers. The example keystroke procedure below saves the present instrument state, presets the instrument and then recalls the previously saved state from internal memory. This capability can dramatically reduce overall DUT test times by recalling preconfigured instrument states.

[SAVE RECALL]
[Save]
[PRESET]
[SAVE RECALL]

Select Desired File to Recall

[Recall]

The figure to the left shows the HP 8711's internal save/recall directory.

Internal Disk Drive

For the storage of more than nine instrument states (internal capacity), or archiving device calibration and test data, the HP 8711 provides an internal 3.5 in. floppy disk drive. The internal disk drive capability includes file management functions and IBASIC control. IBASIC is discussed in the next section of this guide.

Instrument Automation

In addition to its ability to perform automated measurements under the control of an external controller (PC or HP 9000 Series 300), the HP 8711 can automate measurements using its optional HP Instrument BASIC (IBASIC) capability.

IBASIC

IBASIC is a complete system controller resident in the HP 8711 RF Network Analyzer. IBASIC can be used for a wide variety of applications, from simple keystroke recording and execution, to remote control of HP-IB peripherals such as sources, printers and power meters. Programs can be saved and recalled in both LIF and DOS formatted file systems.

Keystroke Recording

The simplest method of IBASIC programming is keystroke recording. It requires minimal preparation and no programming experience. Simply enable recording, make your measurement, then disable recording. The result is an IBASIC program stored in the HP 8711's program buffer, ready to be edited, run or saved from the HP 8711's IBASIC softkey menu. In the following pages you will save, recall and execute the IBASIC program that you are about to enter.

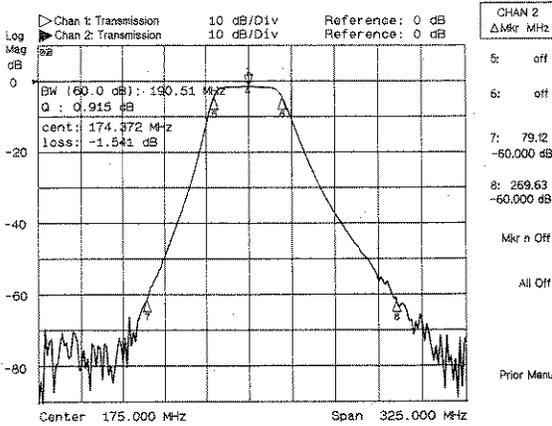
Enable keystroke recording

[SYSTEM OPTIONS]
[IBASIC]
[Key Record ON off]

Connect the DUT.

Make measurement

[PRESET]
[BEGIN]
[Filter]
[Transmissn]
[FREQ]
[Stop] [350] [MHz]
[MENU]
[Trigger]
[Single]
[MARKER]
[Marker Search]
[Bandwidth]
[-3] [ENTER]
[CHAN 2]
[Transmissn]
[MENU]
[Trigger]
[Single]
[SCALE]
[Autoscale]
[MARKER]
[Marker Search]
[Bandwidth]
[-60] [ENTER]
[MENU]
[Trigger]
[Continuous]



The figure to the left contains the result of the filter bandwidth measurements just performed. The filter's shape factor can be calculated by dividing the filter's 60 dB bandwidth (channel 2) by the filter's 3 dB bandwidth (channel 1). In this example $(190.5 \text{ MHz}) / (51.7 \text{ MHz}) = 3.68:1$.

Disable keystroke recording

- [SYSTEM OPTIONS]
- [IBASIC]
- [Key Record on OFF]

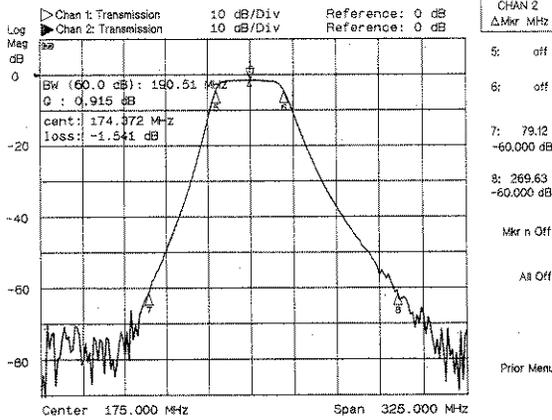
Saving and Retrieving

The HP 8711's internal 3.5 in. floppy disk drive allows fast and easy transfer of data, instrument states and IBASIC programs. To save a program, insert a formatted (DOS or LIF) floppy disk into the HP 8711's internal disk drive and perform the following keystroke sequence.

- [SAVE RECALL]
- [Programs]
- [Save AUTOST]

You will use this as an example autostart program in the next section.





AUTOST

IBASIC's built-in autostart capability enables the HP 8711 to automatically search for, load and execute a program labeled AUTOST. The AUTOST program may be used for applications varying from configuring a specific measurement to creating a series of guided measurements with user graphics.

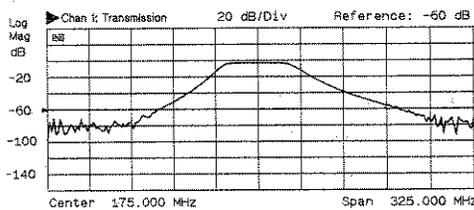
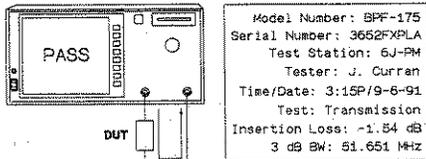
To demonstrate this feature, insert the floppy disk used to store the AUTOST program created in the previous section.

Turn off the HP 8711.

Turn on the HP 8711.

During power-up, the HP 8711 searches for, loads and executes the program labeled AUTOST.

The figure to the left contains the result of the filter measurement configured and saved earlier as AUTOST. This completes the User's Guide tutorial. For more information about using the HP 8711 refer to the HP 8711 Operating and Programming Manual.



- IBASIC
- Run
- Continue
- Edit
- Key Record on OFF
- Save/Plot Program
- IBASIC Display

Hardcopy Output

To record device data in a hardcopy format, the HP 8711 provides direct printer and plotter control of HP-IB and RS-232 devices. IBASIC, an internal real-time clock, and hardcopy editing functions help you quickly and easily create customized outputs. The figure to the left shows an example of a customized output plot.

For more information, call your local HP sales office listed in your telephone directory.

Data Subject to Change
 Copyright © 1991
 Hewlett-Packard Company
 Printed in U.S.A. 6/92
 5091-1660E