Agilent Technologies 85108L Pulsed-RF Network Analyzer System

System Manual

Serial Numbers

This manual applies directly to instruments with serial prefix number 3110A or above.

Firmware

This manual applies directly to all 8510 instruments that have been upgraded to the 8510C, with operating firmware revision 6.50 or higher.

Agilent Technologies

Manufacturing Part Number: 85108-90036

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Safety and Regulatory Information

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. This product has been designed and tested in accordance with international standards.

WARNING **The WARNING notice denotes a hazard. It calls attention to a procedure, practice, or the like, that, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.**

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

Instrument Markings

When you see this symbol on your instrument, you should refer to the instrument's instruction manual for important information.

This symbol indicates hazardous voltages.

N279

The C-tick is a registered trademark of the Australian Spectrum Management Agency.

This symbol indicates that the instrument requires alternating current (ac) input.

The CE mark is a registered trademark of the European Community. If it is accompanied by a year, it indicates the year the design was proven.

The CSA mark is a registered trademark of the Canadian Standards Association.

1SM1-A This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).

This symbol indicates that the power line switch is ON.

This symbol indicates that the power line switch is OFF or in STANDBY position.

Safety Earth Ground

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and secured against any unintended operation.

Before Applying Power

Verify that the product is configured to match the available main power source as described in the input power configuration instructions in this manual. If this product is to be powered by autotransformer, make sure the common terminal is connected to the neutral (grounded) side of the ac power supply.

Contacting Agilent

Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact Agilent by internet, phone, or fax to get assistance with all your test and measurement needs.

Online assistance: www.agilent.com/find/assist			
United States *(tel)* 1 800 452 4844	**Latin America** *(tel)* (305) 269 7500 *(fax)* (305) 269 7599	**Canada** *(tel)* 1 877 894 4414 *(fax)* (905) 282-6495	**Europe** *(tel)* (+31) 20 547 2323 *(fax)* (+31) 20 547 2390
New Zealand *(tel)* 0 800 738 378 *(fax)* (+64) 4 495 8950	**Japan** *(tel)* (+81) 426 56 7832 *(fax)* (+81) 426 56 7840	**Australia** *(tel)* 1 800 629 485 *(fax)* (+61) 3 9210 5947	**Singapore** *(tel)* 1 800 375 8100 *(fax)* (65) 836 0252
Malaysia *(tel)* 1 800 828 848 *(fax)* 1 800 801 664	**Philippines** *(tel)* (632) 8426802 *(tel) (PLDT subscriber only):* 1 800 16510170 *(fax)* (632) 8426809 *(fax) (PLDT subscriber only):* 1 800 16510288	**Thailand** *(tel) outside Bangkok:* (088) 226 008 *(tel) within Bangkok:* (662) 661 3999 *(fax)* (66) 1 661 3714	**Hong Kong** *(tel)* 800 930 871 *(fax)* (852) 2506 9233
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Typeface Conventions

Italics

- Used to emphasize important information:
  Use this software *only* with the Agilent Technologies xxxxxX system.
- Used for the title of a publication:
  Refer to the *Agilent Technologies xxxxxX System-Level User's Guide*.
- Used to indicate a variable:
  Type `LOAD BIN` *filename*.

`Instrument Display`

- Used to show on-screen prompts and messages that you will see on the display of an instrument:
  The Agilent Technologies xxxxxX will display the message **`CAL1 SAVED.`**

Keycap

- Used for labeled keys on the front panel of an instrument or on a computer keyboard:
  Press **Return**.

[Softkey]

- Used for simulated keys that appear on an instrument display:
  Press **[Prior Menu]**.

User Entry

- Used to indicate text that you will enter using the computer keyboard; text shown in this typeface must be typed *exactly* as printed:
  Type LOAD PARMFILE
- Used for examples of programming code:
  #endif//ifndef NO_CLASS

Path name

- Used for a subdirectory name or file path:
  Edit the file *usr/local/bin/sample.txt*

Computer Display

- Used to show messages, prompts, and window labels that appear on a computer monitor:
  The **Edit Parameters** window will appear on the screen.
- Used for menus, lists, dialog boxes, and button boxes on a computer monitor from which you make selections using the mouse or keyboard:
  Double-click **EXIT** to quit the program.

Contents

Contents

1 System and Documentation Overview

Manual Overview

Use this manual for installation, operation, calibration, performance verification, and troubleshooting of the pulsed-RF network analyzer system. Consult the manuals of the individual instruments and accessories in the system when necessary for reference.

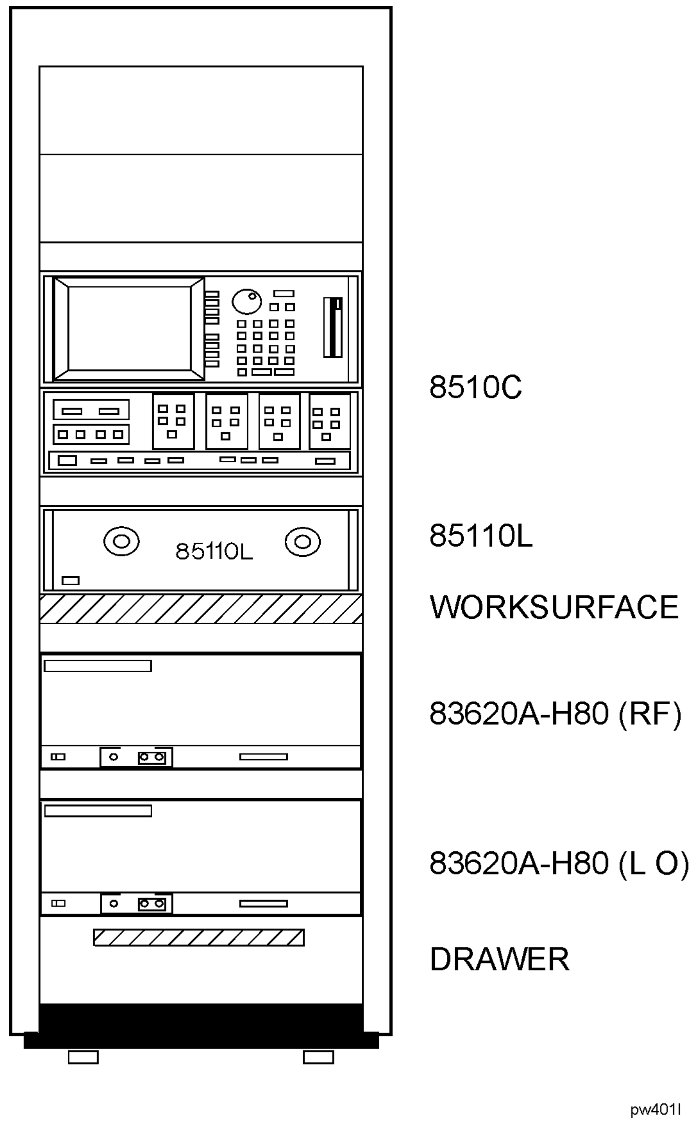
The 85108 system, shown in Figure 1-1, is a factory integrated pulsed-RF system which includes the following components.

- 8510C Option 008 network analyzer
- 83620B-H80 Options 001, 003, 004, and 008 synthesized sweeper
- 83620B-H80 Options 003, 004, and 008, 0.01 to 2.0 GHz synthesized sweeper
- 85110L 0.045 to 2.0 GHz S-parameter test set
- System cabinet (all system instruments are installed in the cabinet at the factory)

Where to Find Information

Chapter 1, “System and Documentation Overview”	Includes an overview of the pulsed-RF network analyzer system and its supporting documentation.
Chapter 2, “System Installation”	Includes information regarding site requirements prior to installation, and cabling/configuration diagrams.
Chapter 3, “Operation”	Includes several system operational tests, and instructions for using the pulsed-RF network analyzer system to make measurements.
Chapter 4, “Specifications and Performance Verification”	Includes instructions for obtaining the specifications of your pulsed-RF network analyzer system and procedures for running a performance verification of your system.
Chapter 5, “Adjustments”	Includes adjustments related to the pulsed-RF portion of the system. For other adjustments, refer to the service manual of the individual instrument in question.
Chapter 6, “System Service and Troubleshooting”	Includes information for troubleshooting the pulsed-RF portion of the system to the board level, and troubleshooting the rest of the system to the instrument level. System cabling diagrams are also included. When the faulty instrument is identified, refer to its manual for further troubleshooting information.
Chapter 7, “Replaceable Parts”	Includes replaceable parts that pertain to the pulsed-RF portion of the system only. Refer to the replaceable parts section of the individual instrument for a complete listing of replaceable parts.
Appendix A, “Glossary of Pulsed-RF System Terms”	Includes a glossary of pulsed-RF system terms.
Appendix B , “Hardware and Instrument States”	Contains information on GPIB addresses, power levels, and hardware and instrument states.
Appendix C, “Loading the System Configuration Disk”	Details a procedure for loading the 85108L system configuration disk.
Appendix D, “Avoiding the Effects of Spurs”	Contains information on avoiding the effects of spurs.

Figure 1-1 Typical 85108L Pulsed-RF Network Analyzer System



System Overview

The pulsed-RF network analyzer system allows you to measure and display the relative magnitude and phase shift of the component under test as a function of time with an equivalent bandwidth of 1.5 MHz. You can evaluate dynamic pulsed-RF characteristics for pulse widths down to 1 microsecond.

You can also configure a pulsed-RF system using your existing 8510 network analyzer system by adding pulsed-RF capability (Option 008) to your 8510C network analyzer. (Refer to "Upgrade Paths.")

Systems Covered by This Manual

The serial number of your system is printed on a label located in the lower left corner on the front of the system cabinet. The serial number prefix is the first four digits followed by a letter. The contents of this manual apply directly to systems having the same serial number prefix, or higher, as listed on the title page of this manual under the heading "Serial Numbers."

85108 Pulsed-RF System Options

The following options are available with the 85108 system:

- **Option 001.** This test set option adds IF switching capability to allow a total of four test sets to be connected to the 8510 at the same time. The test set in use is selected from the 8510 front panel. The 20 MHz IF signal is transmitted from the selected test set through the Option 001 test set(s) to the network analyzer. IF switching is performed automatically by the Option 001 test set(s), without reconnections. For more information, refer to "Controlling Multiple Test Sets" on page 3-5.
- **Option 010.** This option adds time domain capability to the 8510 network analyzer.

Upgrade Paths

To add pulsed-RF capability to an 8510C network analyzer, order an 85111B upgrade kit.

Operating Precautions

CAUTION Handle only at static-safe workstations. Beware of damage from electrostatic discharge (ESD). The input connections on the test set (test ports or cables or adapters connected to the test ports) are very sensitive to ESD. Use a grounded wrist strap when attaching devices to the input connectors.

CAUTION During the retrace time of the network analyzer, the source power may remain on.

2 System Installation

System Arrival

The pulsed-RF network analyzer system will be rack-mounted, assembled, and with the cabling attached when it arrives from the factory.

Keep the shipping containers in one area to help verify the receipt of all components ordered. Inspect all shipping containers. Keep the carton and packaging material until the entire shipment has been verified for completeness, and the system has been checked mechanically and electrically.

If the shipping container is damaged or the packaging material shows signs of stress, notify the carrier as well as Agilent (see “Contacting Agilent” on page iv). Keep the shipping materials for the carrier's inspection. An Agilent representative will arrange for repair or replacement of damaged equipment without waiting for a claim settlement from the carrier.

Contact Agilent for Installation

When the entire shipment has arrived, contact an Agilent customer service engineer to arrange for installation of your system (if installation is available in your area). The customer engineer will check the shipment for completeness.

Setting Up the System

During the installation, the Agilent customer engineer will do the following:

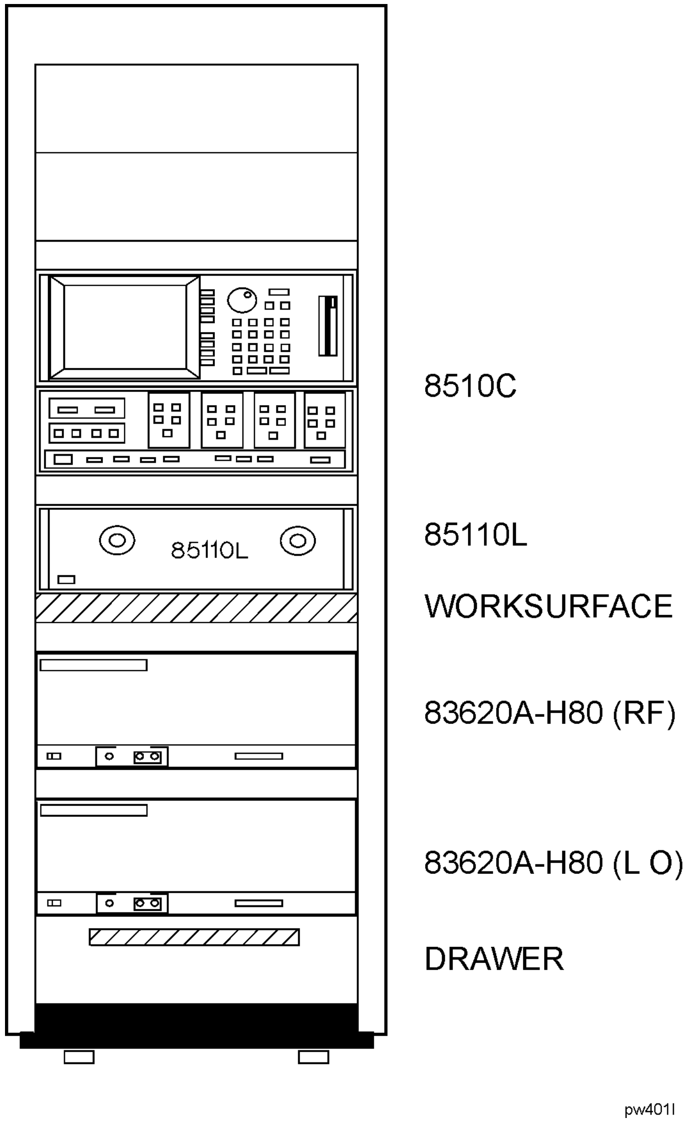
1. Uncrate the system cabinet.
2. Complete the receiving checklist (see Table 2-1).
3. Turn on the system and verify that the GPIB address of each instrument is set properly.
4. Run a performance verification of the system, which includes a measurement calibration.

Table 2-1 System Equipment Checklist

85108L Standard System	
Instrument	**Manual/Software Part Number**
8510C network analyzer (Option 008)	08510-90275
85110L S-parameter test set	85110-90048
83620B-H80 Synthesized Sweeper (RF) (with Options 001, 004, and 008)	83620-90007
83620B-H80 Synthesized Sweeper (LO) (with Options 004 and 008)	
Software	
8510 Specifications and Performance Verification software (Revision A.05.01 or higher)	08510-10033
85108L for use with 8510C.06.5x firmware system configuration disk	85108-10007
85108L for use with 8510C.07.xx or higher firmware system configuration disk	85108-10008
85108 Option 010 (Adds Time Domain)	
85108L Standard System	85108-90036
Miscellaneous Equipment Needed but Not Supplied	
Plotter	
Computer	
Calibration Kits[1]	
Verification Kits[1]	

1. Required for system performance verification. Refer to Chapter 4, “Specifications and Performance Verification,” for more information.

Figure 2-1 85108L Pulsed-RF Network Analyzer System



Site Preparation

Site preparation includes the environmental and electrical requirements necessary for the 85108 system to operate within its specifications. Make sure your site meets these requirements before installing the system.

85108L Environmental Requirements

The environmental requirements of the 85108 system are given below. These characteristics are the same as those for the 8510C network analyzer.

Temperature	+5 °C to 40 °C (+41°F to 104 °F)
Relative Humidity	5% to 95% at +40 °C or less (non-condensing)
Altitude	Up to 4,600 meters (approximately 15,000 feet)

Accuracy-Enhanced Measurement Requirements

Accuracy-enhanced (error corrected) measurements require the ambient temperature of the pulsed-RF network analyzer system to be maintained within ±1 °C of the ambient temperature at measurement calibration. The measurement calibration temperature must be within the operating temperature range of the calibration kit (typically 20 to 26 °C). Refer to the appropriate calibration kit manual for the actual operating temperature of the calibration kit.

Accuracy Enhanced Temperature = Measurement Calibration Temperature ± 1 °C

Power Requirements

Install the required ac power at all necessary locations. Place air conditioning equipment or other motor-operated equipment on a different ac line than that used for the system. Refer to Table 2-2 for a list of the maximum VA power ratings of the Agilent instruments used in the 85108 system.

Three-wire power cables must be used with all instruments. These cables provide the required ground when connected to an appropriate outlet.

System Heating and Cooling

Install air conditioning and heating if required. Air conditioning requirements depend on the amount of heat produced by the instruments. Use the BTU/hour ratings from Table 2-2 to determine the total rating of your system. Each VA rating is multiplied by 3.4 to determine the BTU/hour rating of each instrument.

Table 2-2 Maximum VA Ratings and BTU/hour Ratings of Instruments[1]

Instrument	Maximum VA Rating	VA Subtotal	Maximum BTU/hour	BTU/hour Subtotal
	Standard Equipment			
85101 display/processor	250	________	850	________
85102 IF/detector	210	________	714	________
85110A test set	110	________	323	________
8360 series synthesized source	400	________	1,360	________
8360 series synthesized source	400	________	1,360	________
Totals:				
Standard System	1355VA	________	4607	________
	Accessory Equipment			
HP 9000 Series 300	250	________	850	________
98751A 19 inch CRT	420	________	1,430	________
98752A 19 inch CRT	420	________	1,430	________
98753A 19 inch CRT	420	________	1,430	________
98754A 19 inch CRT	420	________	1,430	________
98785A 16 inch CRT	200	________	680	________
98789A 16 inch CRT	200	________	680	________
Typical hard disk	65	________	222	________
HP Laser Jet II	170 to 800	________	580 to 2,270	________
HP PaintJet	20	________	68	________
HP 7550A Plotter	100	________	340	________
Your Systems Total[2]		________		________

1. Values are based on 120 Vac supplied to each instrument at 60 Hz.
2. To convert the total BTU/hour value to “tons,” divide the total BTU/hour value by 12,000.

System Voltages

All instruments in the 85108 system must be set to the local voltage. All system instruments are set to 120 Vac at the factory, except for Option 230 systems, which are set to 220 Vac.

CAUTION The cabinet fans may be permanently damaged if a 120V system is plugged into a 230V ac power outlet. The cabinet fans are wired for either 120V or 230V, but not both. Therefore, a system wired for 120V operation cannot be switched to 230V operation simply by changing individual instrument voltage selection switches.

Consult the individual instrument manuals to change the voltage selection switches.

Weights and Dimensions

Weight (standard system fully loaded)	**295.5 kg (650 pounds)**
Height	160 cm (63 inches)
Width	60 cm (23.6 inches)
Depth	90 cm (31.4 inches)

Unpacking the System Cabinet

The lifting brackets supplied with the rack are suitable for lifting the rack fully loaded.

CAUTION Do not lift the rack (unpacked) with a fork lift.

Use the following procedure to remove the rack from the shipping base. This procedure can be performed by one person.

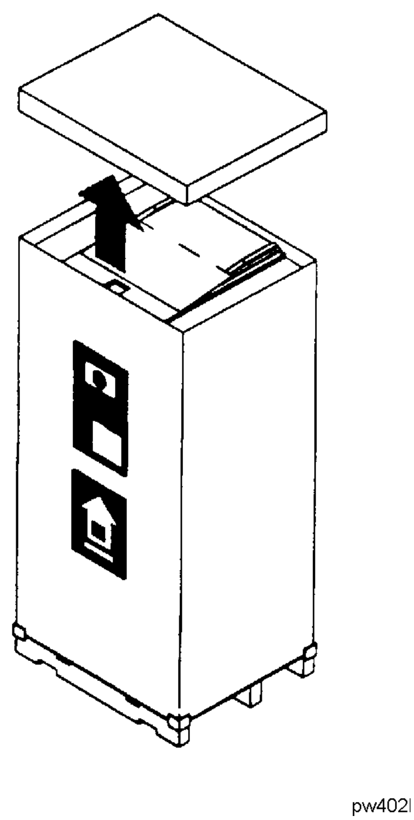
CAUTION Wear protective glasses while cutting the plastic bands around the shipping container. These bands are under tension. When cut, they can spring back and cause serious eye injury.

1. Cut the polystrap bands around the shipping container.

Refer to Figure 2-2.

2. Lift the cardboard top-cap off of the shipping box.
3. Remove the clam shell box from the pallet.

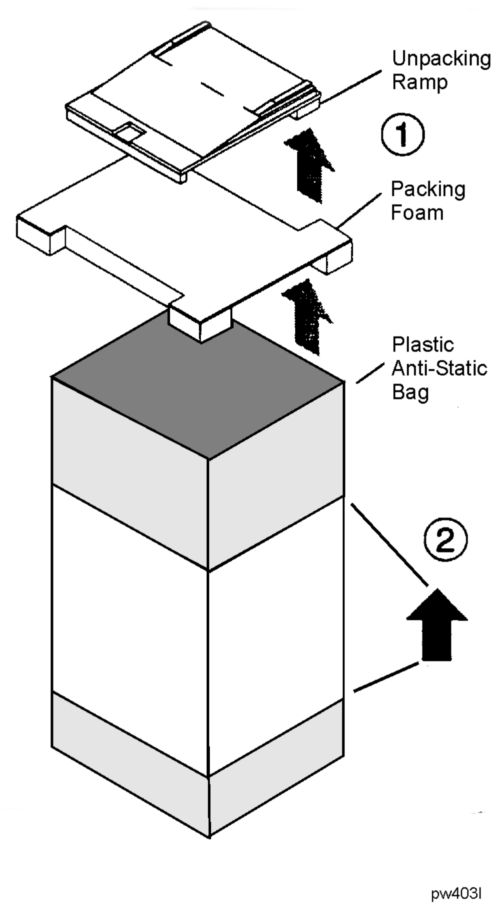
Figure 2-2 Unpacking - Illustration 1



Refer to Figure 2-3.

4. Remove the ramp and packing material ① from the top of the rack.
5. Remove the shrink-wrap ② from around the rack.

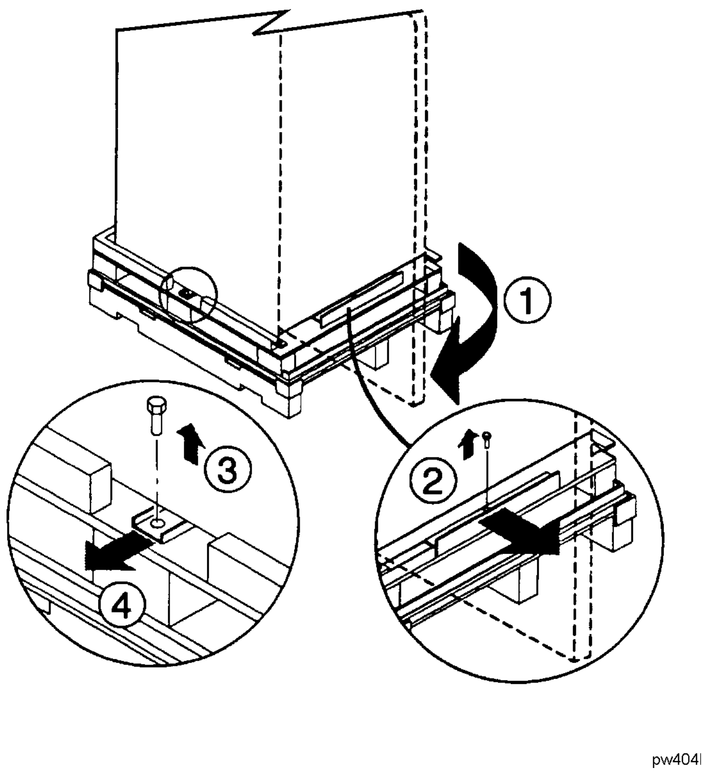
Figure 2-3 Unpacking-Illustration 2



Refer to Figure 2-4.

6. Carefully open the rear door ①. Remove the screw holding the rear door-support ② in place and pull the block out.
7. Remove the two (on each side) shipping clamps from the bottom of the frame. They are bolted to the pallet. Remove the bolt ③ and then remove the clamp ④.

Figure 2-4 Unpacking - Illustration 3



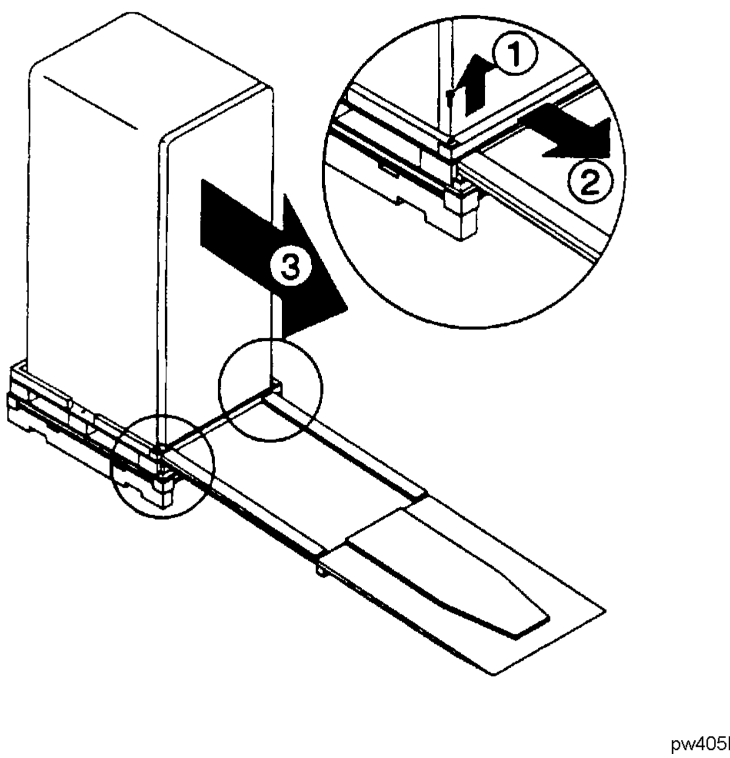
Refer to Figure 2-5.

8. Remove the pallet shipping block ② from the rear of the pallet. Remove the two bolts ①, one on each corner, and pull the block ② out from under the rack.
9. Position the ramp so that the block of wood under the ramp loads into the edge of the pallet with the strip of wood forming a lip. This holds the ramp in place while the rack is moved across the pallet and down the ramp.
10. Raise the rack leveling feet to their highest position.

CAUTION Make sure that the leveling feet on the ramp are raised before you roll the rack down the ramp. If the leveling feet are not raised, they can catch on the ramp and cause the rack to tip over.

11. Carefully roll the rack ③ down the ramp.

Figure 2-5 Unpacking - Illustration 4



System and Benchtop Configuration and Cabling

The configuration of the rack-mounted system with cabling is shown in Figure 2-6. The suggested configuration of the benchtop system with cabling connections is shown in Figure 2-7.

You can configure your own pulsed-RF system using instruments you may already own. The pulsed-RF system consists of the following instruments:

Quantity	Item
1	8510C Option 008 network analyzer
1	85110L S-parameter test set
1	Agilent source (RF)
1	Agilent source (LO)

The RF source must be capable of pulsed operation over the frequency range of 45 MHz to 2 GHz. The LO source must be capable of +10 dB levelled output over the frequency range of 45 MHz to 2 GHz.

Installing a Computer

A computer must be connected to your system to run the performance verification software. The computer must be an HP 9000 series 300 computer with BASIC 5.0 or later and there must be two megabytes of available RAM after BASIC has been loaded. Refer to Chapter 4, “Specifications and Performance Verification,” for more information.

Making Connections

There are two separate buses in this system:

- The GPIB bus
- The 8510 system bus

Both buses use the same type of connector and cable, but the buses are not interchangeable.

The GPIB Bus

The computer retains full control of this bus; no other device can send commands unless the computer relinquishes control. Connect your peripheral equipment to this bus only if you want this equipment to be controlled by the computer.

The 8510 System Bus

The 8510 must be able to send GPIB commands to the other instruments in the system at any time, without waiting for “permission” from the computer. To facilitate this, a special GPIB bus was created called the 8510 System Bus. Connect your peripheral equipment to this bus (via the “8510 Interconnect” connector) only if you want this equipment to be controlled by the 8510.

Figure 2-6 85108 System Cabling Diagram (rack mounted system)

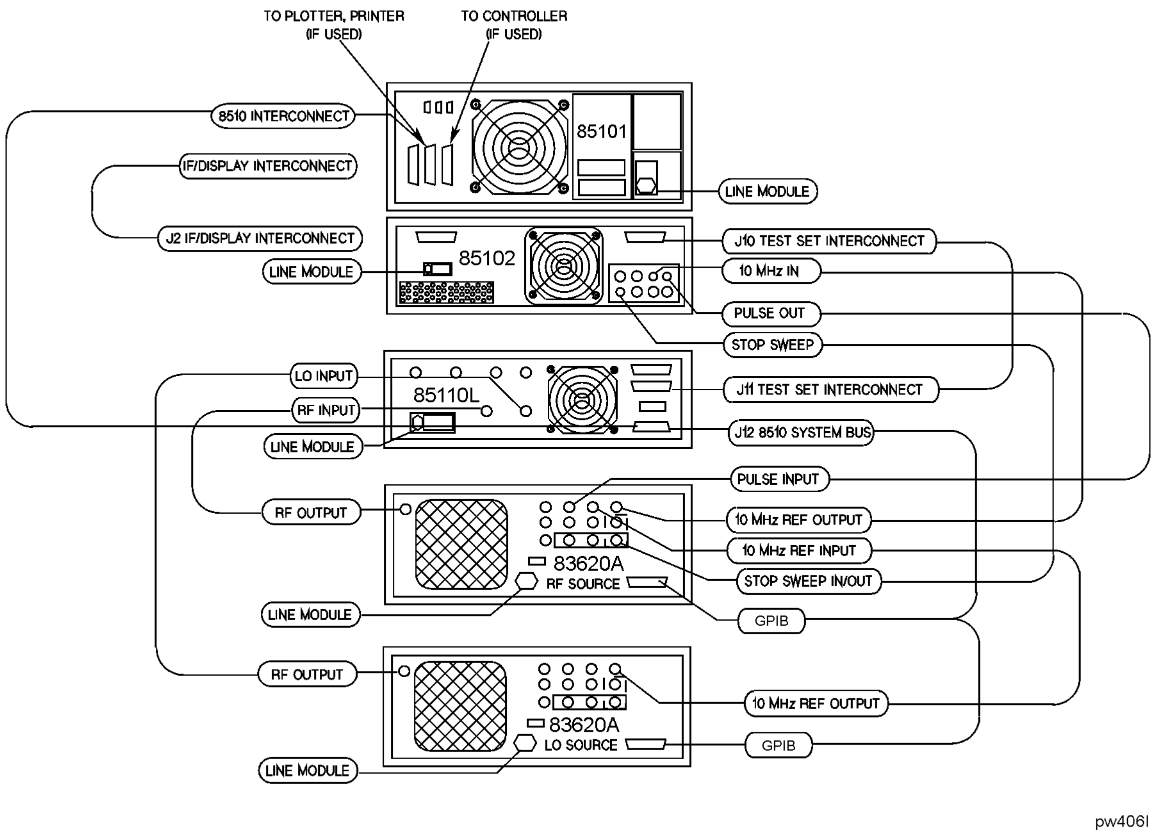
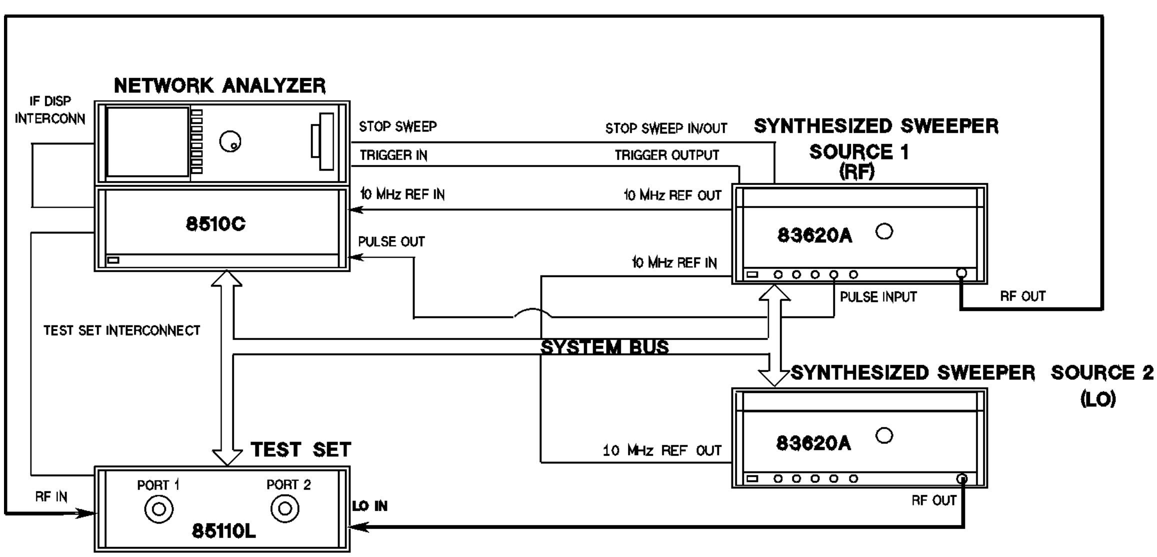


Figure 2-7 85108 System Cabling Diagram (benchtop configuration-without amplifier)



Connecting a Plotter

To connect a plotter to the system, connect one end of the GPIB cable to the plotter (the plotter should have its own GPIB cable). Connect the “free” end of the plotter cable to either the 8510 Interconnect connector (for system bus control) or to the GPIB connector (for GPIB bus control). Refer to “Making Connections” on page 2-12 for more information regarding the busses. Set the plotter GPIB address to 5.

Connect the plotter to an ac power source and turn it on. Refer to the next section, “Accessory ac Power Outlet,” for information about connecting the plotter to an ac power outlet inside the system cabinet.

Accessory ac Power Outlet

All power connections for instruments in the system are located inside the cabinet via a multiple-outlet power strip. On some systems, an extra power outlet is provided on the power strip for accessories. Special “boot” ac power cables are included with your 85108L system for this purpose.

CAUTION Before connecting any equipment to the extra power outlet, refer to Table 2-2, “Maximum VA Ratings and BTU/hour Ratings of Instruments,” on page 2-6 for the maximum VA ratings for this outlet on your system.

85108L Installed in a Different Cabinet

Agilent strongly recommends that the 85108L system cabinet be used with the 85108L pulsed-RF system. Agilent is not obligated to support user-configured pulsed-RF rack systems other than the 85108L rack-mounted system. The customer takes full responsibility for instrument damage incurred due to using racks or system cabinets other than the one supplied with the 85108L system. See “Contacting Agilent” on page iv to order a rack for your system.

System Turn On

Check the fuses of each instrument and verify that they match the local line voltage. Refer to the individual instrument manual to change the fuse or the fuse setting.

Turn On System Power

1. Verify that all cables are connected properly (refer to Figure 2-6 or Figure 2-7).
2. Turn on power to the system rack and to all instruments except the 8510 network analyzer.
3. Once all the instruments are on, turn on the 8510.

Verify GPIB Addresses

Verify that the instrument addresses are set correctly after system power on. On the network analyzer, press: **SYSTEM [HP-IB ADDRESSES].**

Press the softkey that corresponds to each instrument in your system to check each address. Press **[MORE]** to show additional instrument choices.

Compare the addresses on the network analyzer display with the addresses listed in Table 2-3. To change an address, press the softkey corresponding to the desired instrument, then enter the correct address from the keypad: **[n] [n] [x1]**.

Table 2-3 85108 System GPIB Addresses

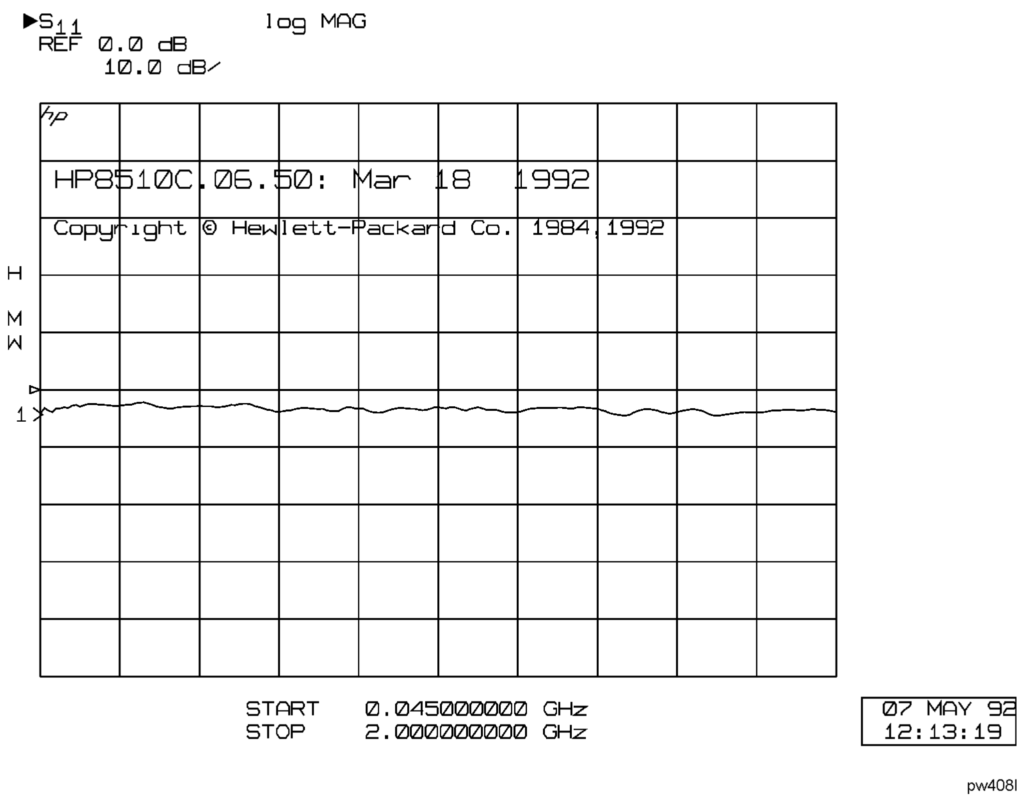
Instrument	GPIB Addresses
8510 network analyzer	16
System bus	17
Source #1 (RF)	19
Source #2 (LO)	18
Test set: 85110	20
RF switch	31

Initial Trace

Once the system is turned on, you should see a trace similar to Figure 2-8 on the network analyzer display. If your display is not similar, load the 85108 system configuration disk using the procedure in Appendix C, "Loading the System Configuration Disk."

If your display is similar to the trace as shown in Figure 2-8, continue with the operator's tests in Chapter 3, "Operation."

Figure 2-8 85108 Initial Trace



Firmware Revision

All properly functioning systems display the firmware revision information illustrated in Figure 2-8 after system turn on.

- 8510C-based systems must have firmware revision 8510C.06.50 or greater.
- 8510B-based systems must have firmware revision 8510B.05.11 or greater. If your 8510B has firmware revision 8510B.06.00 or greater, and you are using an 836xx source, you must upgrade the firmware in each 836xx source you are using (must be March 08, 1991, or higher).

Some 8510 systems may require later firmware revisions than those listed above. Please consult your *8510C On-Site Service Manual* and your Agilent representative for more information on upgrading a network analyzer or source firmware (refer to "Contacting Agilent" on page iv).

3 Operation

System Description

Pulsed-RF stimulus and response measurements may be required in cases where continuous application of a test signal could destroy a device under test, such as when testing occurs prior to packaging, or where a device must be tested using a PRF (pulse repetition frequency) and duty cycle that accurately represents its final application.

The pulsed-RF network analyzer system:

- adds specialized hardware and an optimized firmware feature set to make fully error-corrected S-parameter measurements of pulsed-RF responses.
- combines wideband IF and accurate timing circuits to provide precise synchronization with the pulse, which allows S-parameters to be measured at a precisely known, repeatable time during the pulse.

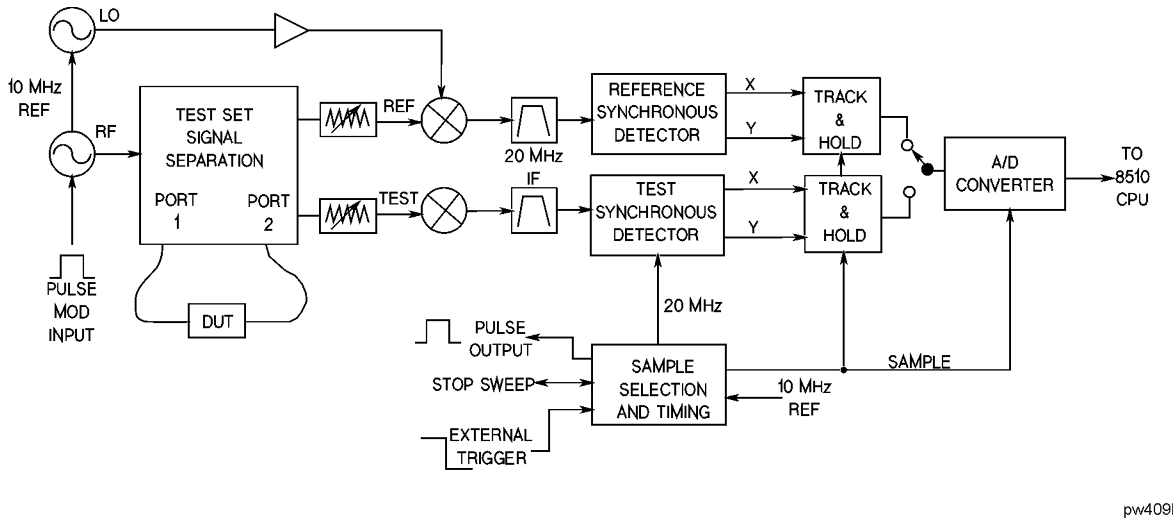
A simplified block diagram of the system is shown in Figure 3-1. One synthesizer provides the test signal stimulus to the RF input of the test set and the other provides the LO signal to the four frequency converters (only two are shown). The LO source is always tuned 20 MHz above the test signal source. Instead of the standard internal phaselock technique, a common 10 MHz frequency reference is used for both of the sources and the internal sample selection and timing logic in the network analyzer. These sources are considered to be coherent, thus generating the correct 20 MHz first IF and the correct clock frequency for the reference and test synchronous detectors. This eliminates the need to use the reference signal for receiver phaselock and allows all reference and test signals to be pulsed, thereby making fully error-corrected 2-port, pulsed-RF S-parameter measurements possible.

One pulse of a user-specified width is measured at each data point and the measurement is synchronized so that it is made at a certain known time in the pulse. The stimulus duty cycle can be predicted for a given instrument state, but the actual pulse repetition period depends on the current domain, cal type, averaging, sweep time, and pulse width selections. For this reason, if your device is sensitive to duty cycle, refer to “Pulsed-RF Timing Information” on page 3-24.

Either the internal logic, the TTL Trigger Input, or the GPIB Group Execute Trigger from an external computer can initiate a measurement cycle. When control of the pulse repetition period and duty cycle is required, the network analyzer can use the trigger input to synchronize with the internal or an external pulse modulator. The 8510 Stop Sweep output can be used as a gating signal to tell when the analyzer is ready for the next measurement. The measurement is made with 100 nanosecond resolution, and about 200 picosecond uncertainty with respect to the internally- or externally-generated measurement trigger.

CAUTION During the retrace time of the network analyzer, the source power may remain on.

Figure 3-1 Simplified Pulsed-RF Network Analyzer Block Diagram



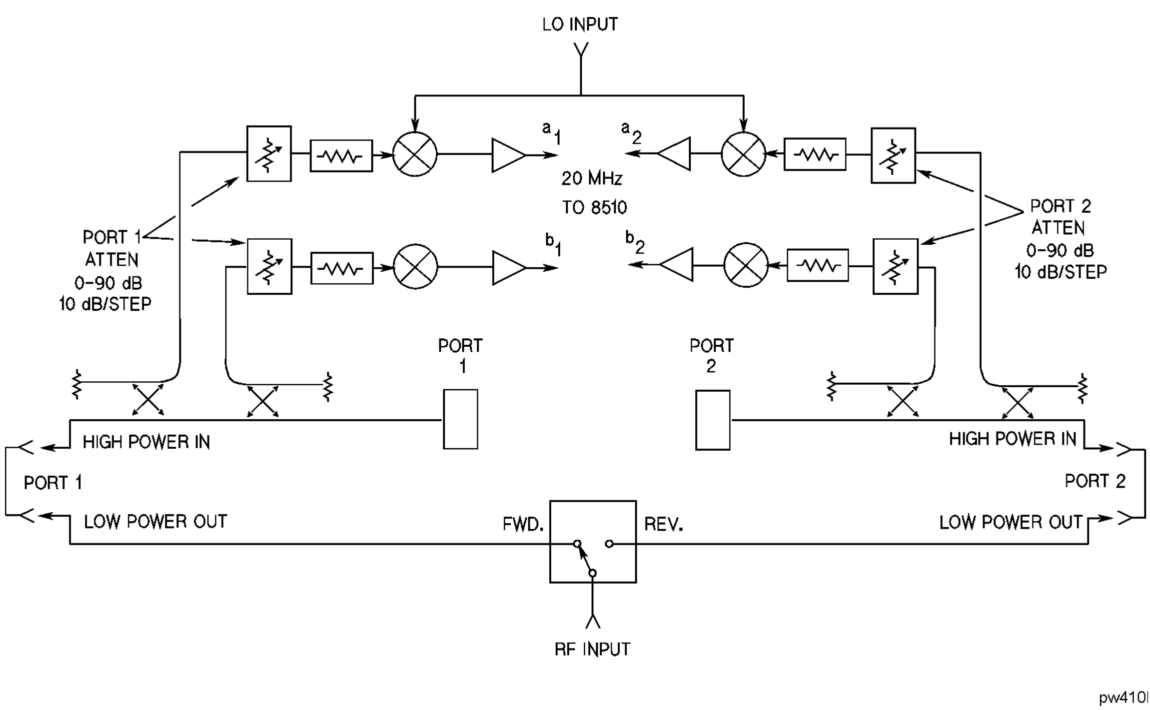
85110L S-Parameter Test Set Operation

Figure 3-2 shows a detailed diagram of the 85110L test set signal separation, signal routing, and frequency conversion. This is a fundamentally mixed test set, providing four 20 MHz outputs to the 8510. Placement of a 0 to 70 dB (10 dB/step) attenuator before each mixer provides control of the signal levels into the mixers while allowing operation at high PORT 1 and PORT 2 signal levels necessary in many pulsed-RF applications.

The test set has rear panel access links to allow integration of additional test and signal conditioning equipment in the low-loss main signal paths to the test ports. If your device exhibits more than about 20 dB of gain, or higher port signal levels are required, refer to "High Power Measurements" on page 3-30.

Agilent harmonic mixing test sets are designed to work with the normal 10 kHz IF and detectors. These include the 8514, 8515, 8516, and 8517 coaxial test sets. This 85110 fundamental mixing test set is designed to work with the wideband IF and detectors. There are applications in which the 85110 can be used with normal IF and detectors. All 85104A-series and 11643-series millimeter test sets can be configured to operate with the wideband IF and perform the pulse measurement functions described here.

Figure 3-2 85110L S-Parameter Test Set Signal Flow



Controlling Multiple Test Sets

Option 001 for the 851x-series and 85110L test sets allows an 8510 to alternately control up to four test sets. While a measurement is proceeding on test set number 1, which is equipped with Option 001, test device hookup can be accomplished on test set number 2, which does not need to be equipped with Option 001, unless another test set is to be connected. When the measurement on test set number 1 is complete, the 8510 can control test set number 2.

Operational Tests

Your system should be installed, turned on, and have the correct machine dump file from the 85108 system configuration disk loaded at this point. If it is, continue with this section. If it is not, return to Chapter 2, “System Installation.”

Operational tests provide you with the assurance that your system is functioning. Operational tests do not indicate if the system is operating within its specifications. Perform these tests after the system is installed for the first time and when any part the system is repaired.

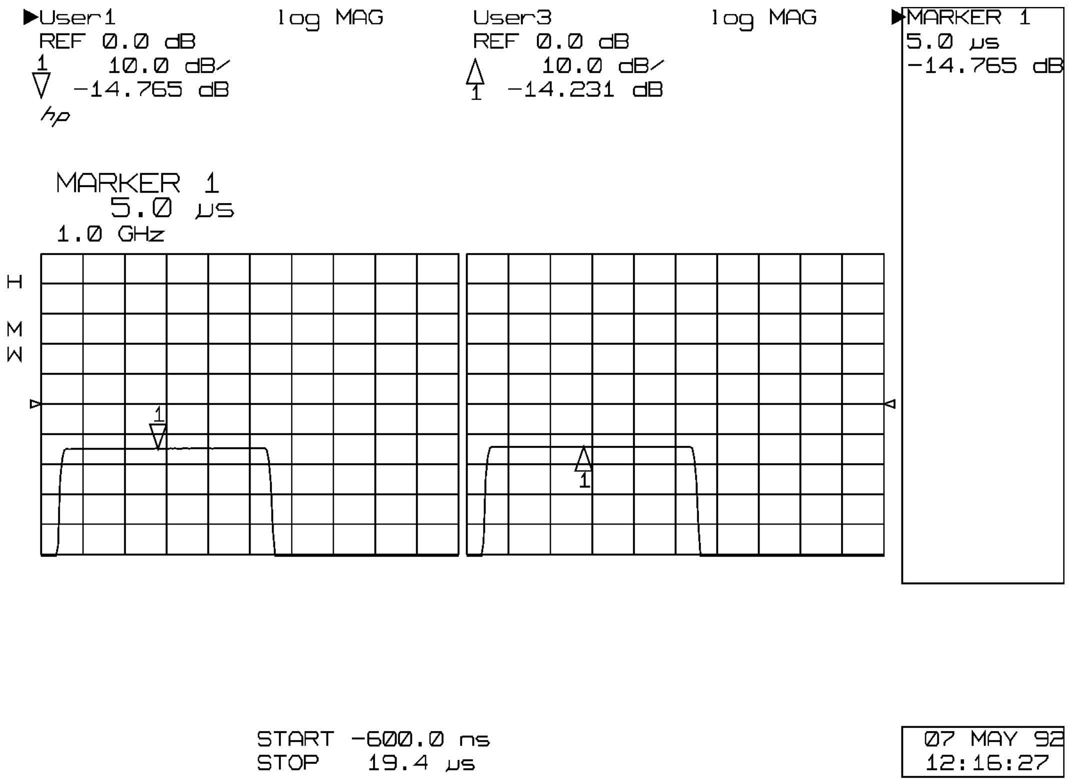
If any of the operational tests fail, refer to “Troubleshooting Strategy” on page 6-2 for more information.

The instrument and hardware states of each operational test are contained on the 85108L System Configuration disk. The configurations for these operator's tests are located in instrument states 1 through 8 of your network analyzer, provided you performed the system installation procedures. If not, refer to Appendix C, “Loading the System Configuration Disk,” to load the machine dump file for the pulsed-RF configuration.

Operational Test Procedure

1. The test ports are both “open” (nothing connected to them) for these tests.
2. Press **RECALL [INSTRUMENT STATE] [1]**. Compare the network analyzer display to Figure 3-3.

Figure 3-3 Instrument State 1



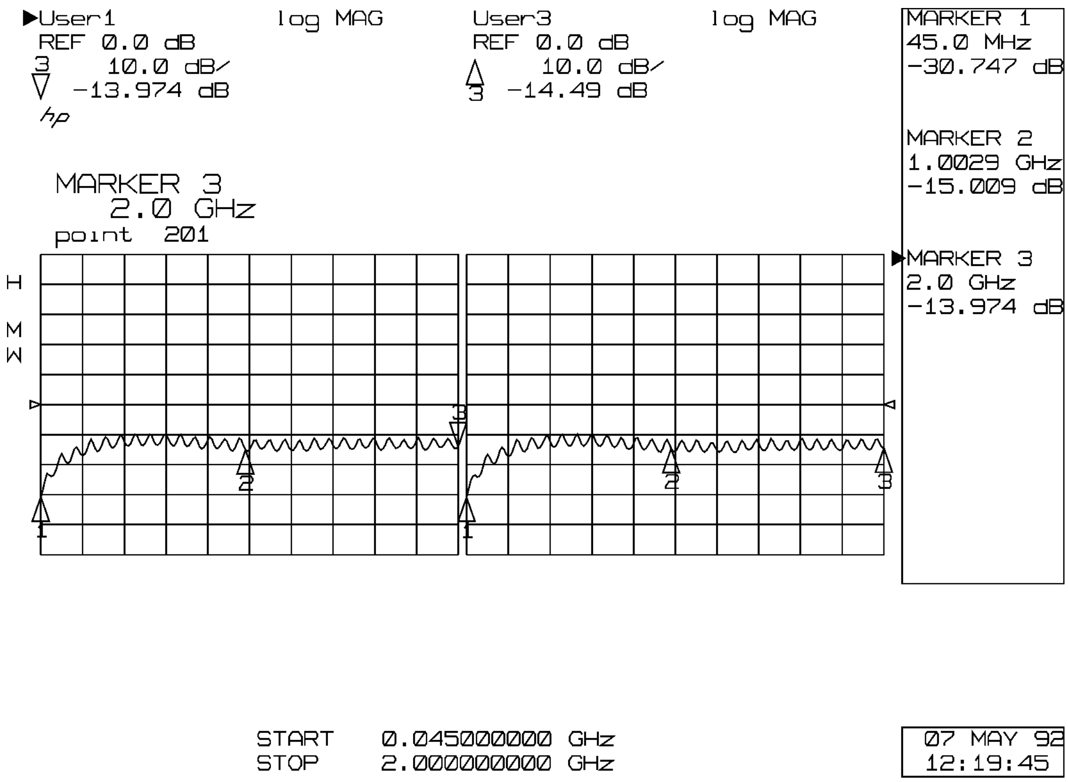
pw411l

Check these items:

- ✓ Domain: Pulse profile
- ✓ Display Mode: Dual channel split
- ✓ Wide BW Detectors: On, indicated by the W to the left of the graticule.
- ✓ Channel 1: log mag, USER 1 a1
- ✓ Channel 2: log mag, USER 3 a2

Repeat step 2 on page 3-5 for the remaining instrument states and compare the results with Figure 3-4 through Figure 3-10 on page 3-13.

Figure 3-4 Instrument State 2



pw412l

Check these items:

✓ Domain: Frequency

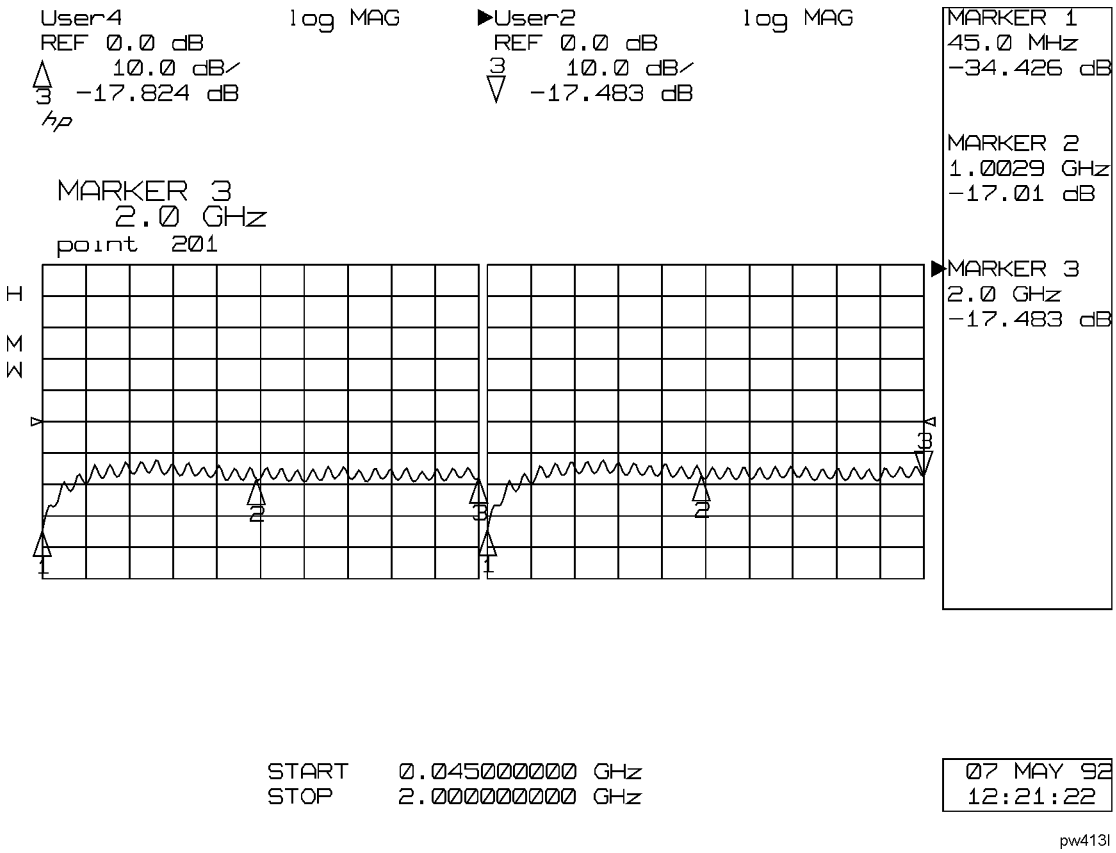
✓ Display Mode: Dual channel split

✓ Wide BW Detectors: On, indicated by the W to the left of the graticule.

✓ Channel 1: log mag, USER 1 a1

✓ Channel 2: log mag, USER 3 a2

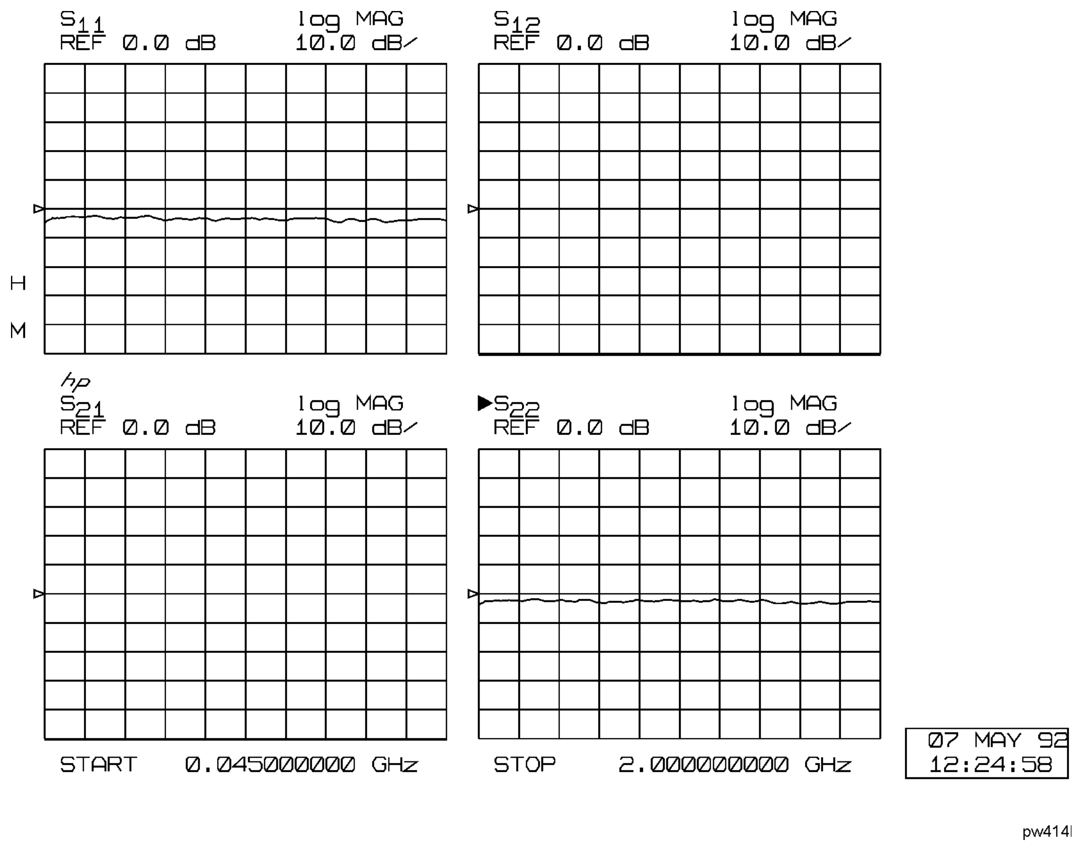
Figure 3-5 Instrument State 3



Check these items:

- ✓ Domain: Frequency
- ✓ Display Mode: Dual channel split
- ✓ Wide BW Detectors: On, indicated by the W to the left of the graticule.
- ✓ Channel 1: log mag, USER 4 b1
- ✓ Channel 2: log mag, USER 2 b2

Figure 3-6 Instrument State 4



Check these items:

✓ Domain: Frequency

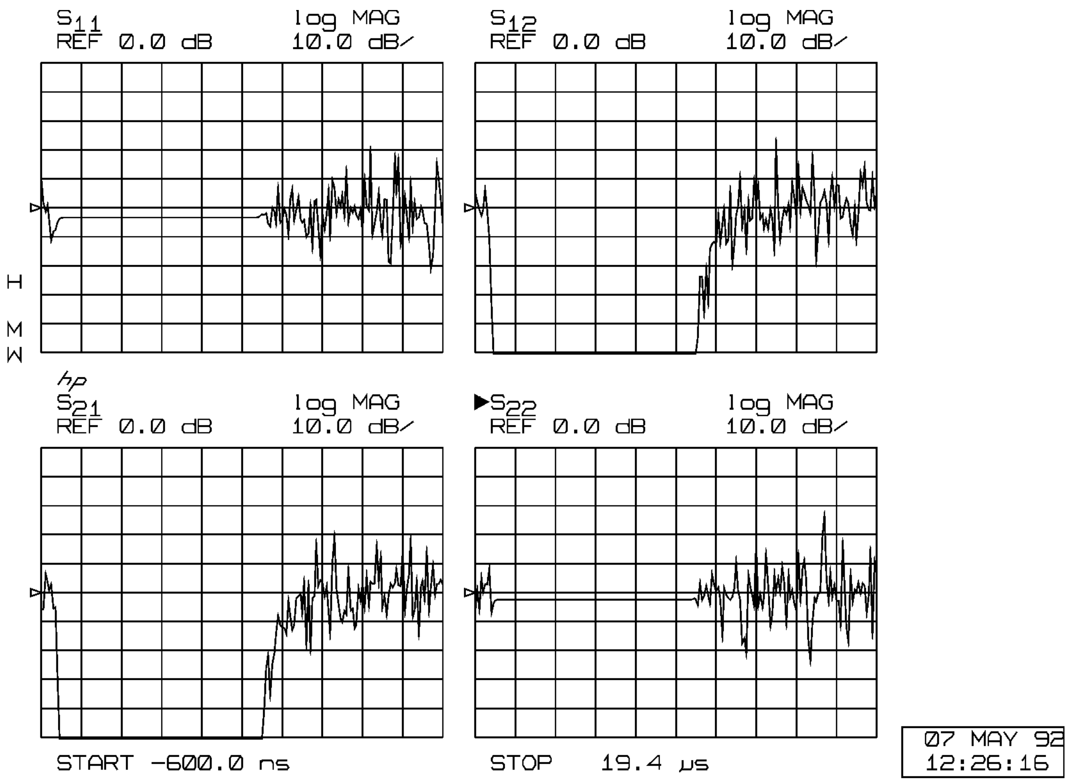
✓ Display Mode: Four parameter split

✓ Normal BW Detectors: On, the W to the left of the graticule should disappear.

✓ Channel 1: log mag, S_{11}, S_{21}, S_{12}, S_{22}

✓ Channel 2: phase, S_{11}, S_{21}, S_{12}, S_{22}

Figure 3-7 Instrument State 5



Check these items:

✓ Domain: Pulse profile

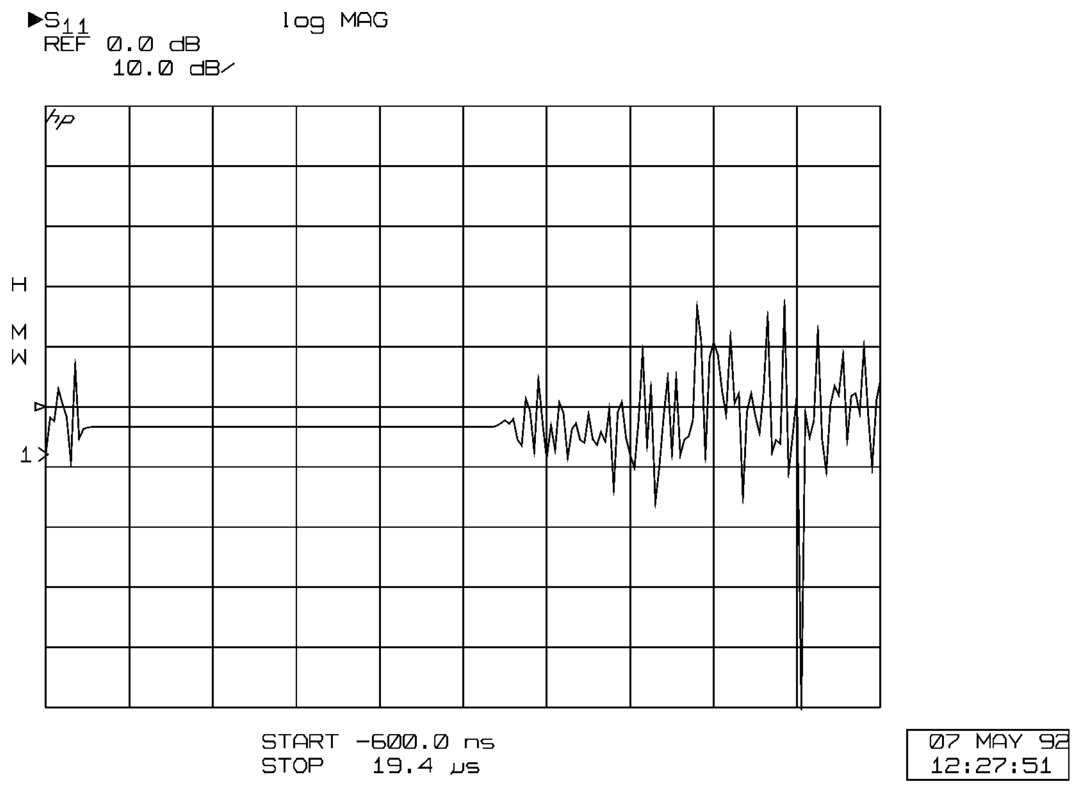
✓ Display Mode: Four parameter split

✓ Wide BW Detectors: On, indicated by the W to the left of the graticule.

✓ Channel 1: log mag, S_{11}, S_{21}, S_{12}, S_{22}

✓ Channel 2: log mag, S_{11}, S_{21}, S_{12}, S_{22}

Figure 3-8 Instrument State 6

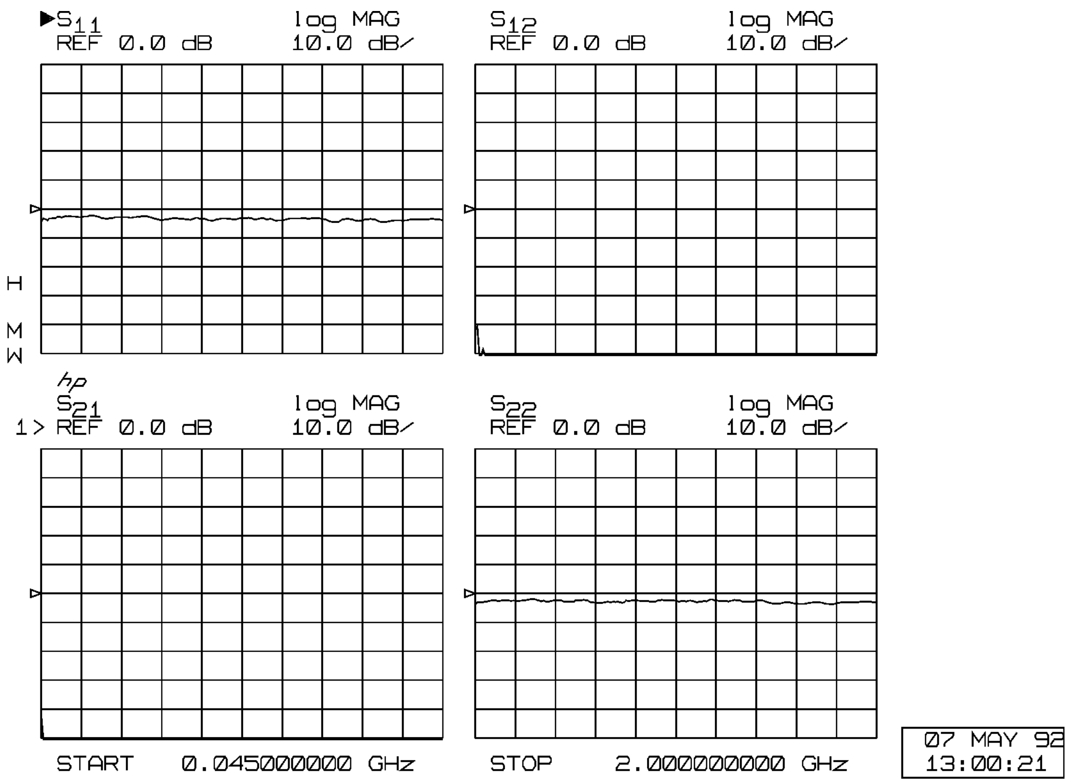


pw416l

Check these items:

- ✓ Domain: Pulse profile
- ✓ Display Mode: Single parameter
- ✓ Wide BW Detectors: On, indicated by the W to the left of the graticule.
- ✓ Channel 1: log mag, S_{11}
- ✓ Channel 2: phase, S_{11}

Figure 3-9 Instrument State 7

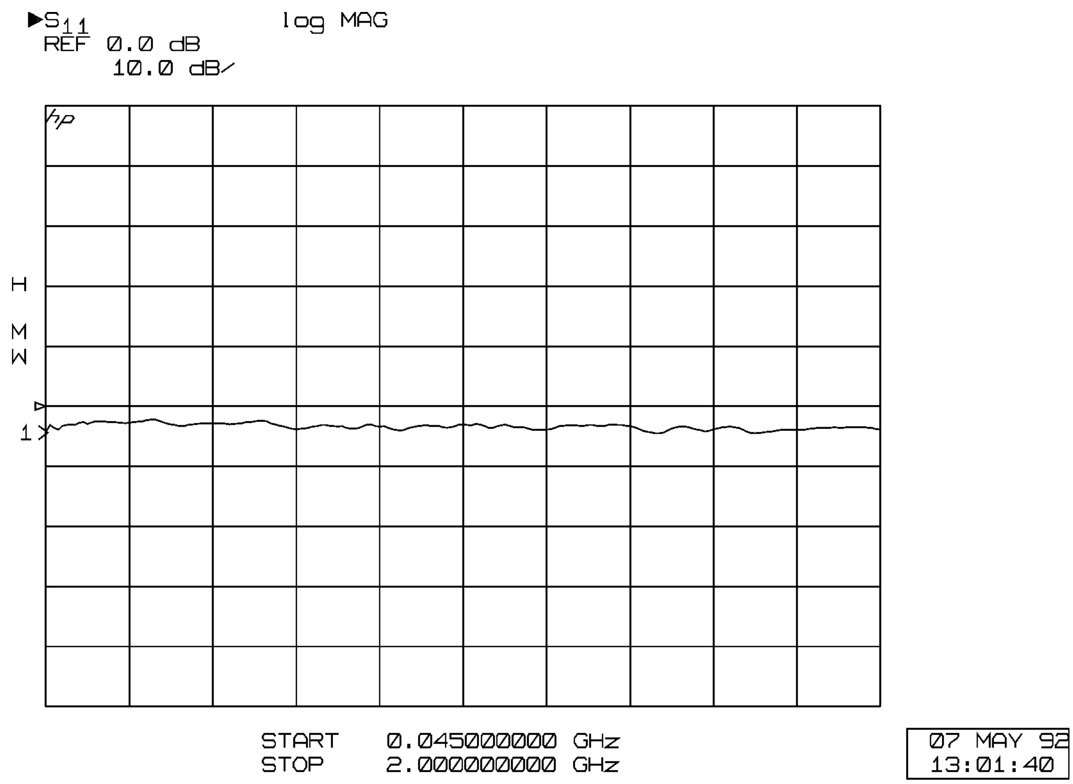


pw417l

Check these items:

- ✓ Domain: Frequency
- ✓ Display Mode: Four parameter split
- ✓ Wide BW Detectors: On, indicated by the W to the left of the graticule.
- ✓ Channel 1: log mag, S_{11}, S_{21}, S_{12}, S_{22}
- ✓ Channel 2: log mag, S_{11}, S_{21}, S_{12}, S_{22}

Figure 3-10 Instrument State 8



pw418l

Check these items:

- ✓ Domain: Frequency
- ✓ Display Mode: Single parameter
- ✓ Wide BW Detectors: On, indicated by the W to the left of the graticule.
- ✓ Channel 1: log mag, S_{11}
- ✓ Channel 2: phase, S_{11}

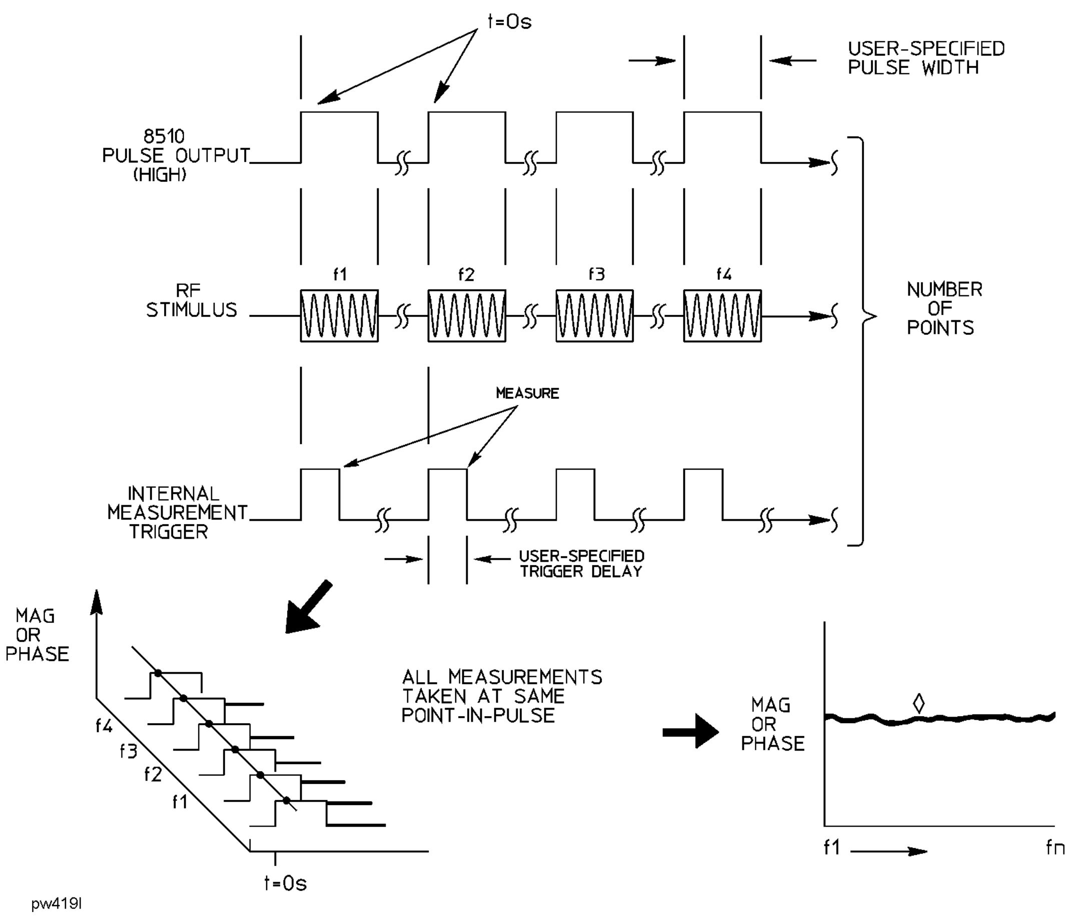
Pulsed-RF Measurements Overview

Two types of measurements are available with the pulse configuration. Each type of measurement is described below.

Pulsed-RF S-Parameters versus Frequency

Making pulsed-RF measurements in the frequency domain is accomplished by synchronizing the measurement process with the pulse so that the measurement is made at a single, user-specified time during the pulse. At each frequency, the sources are tuned, the RF is turned on, then the measurement is made after a certain delay. Figure 3-11 shows an example of this frequency domain (point-in-pulse) measurement using the internal pulse output and the internal measurement trigger. Each data point of the trace represents the response of the device to the pulsed stimulus at the same interval after the pulse is turned on for internal triggering, or after the falling edge of the externally-generated measurement trigger.

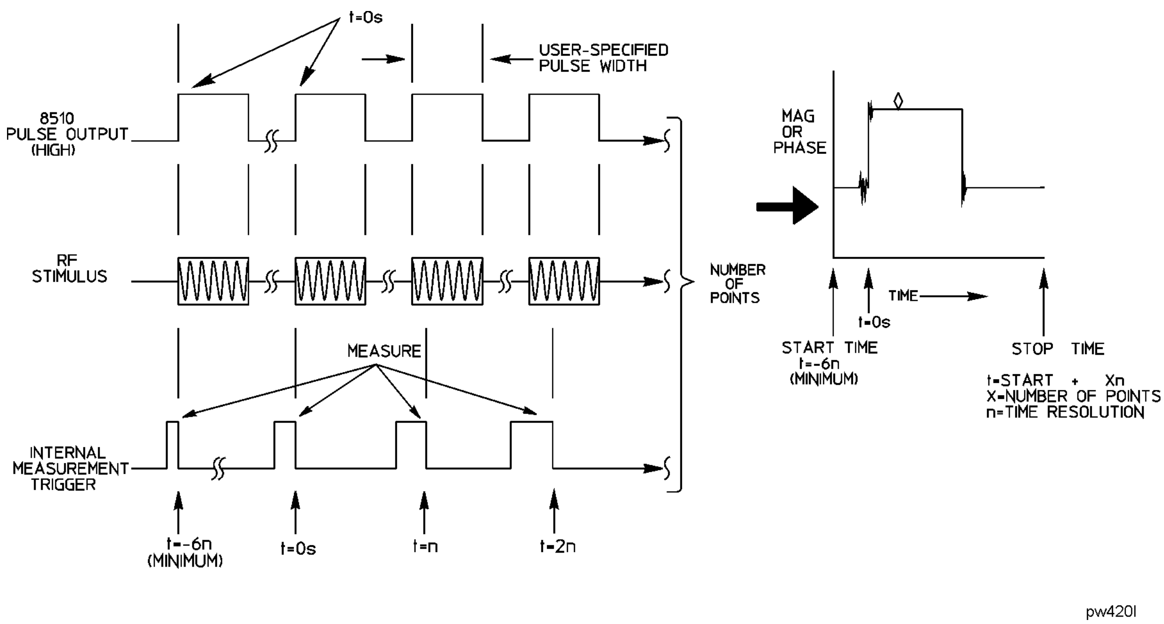
Figure 3-11 Pulsed-RF S-Parameters versus Frequency (Frequency Domain Point-in-Pulse)



Pulse Profile Domain

A repetitive sampling technique is used to make measurements in the pulse profile domain. Measurements are taken at a single frequency as determined by the start frequency setting. Data is reconstructed from samples taken from a series of pulses. This allows display of the S-parameters versus time during the pulse. For each pulse, a single point in the pulse is measured. A profile of the pulse is made by measuring the first pulse at the user-specified Start time, then increasing the measurement trigger delay by a certain time increment for each pulse until the specified number of points is measured. Refer to Figure 3-12 for an example of this process.

Figure 3-12 Pulsed-RF S-Parameters versus Time (Pulse Profile Domain) Measurement Internal Pulse Output and Internal Measurement Trigger



Time zero is the leading edge of the internally-generated pulse output waveform, or the falling edge of the externally-generated measurement trigger waveform. The network analyzer automatically controls the time increment between samples, called the measurement resolution period, using an algorithm that depends on the greater of the user-specified pulse width or stop time. This automatic selection of the measurement resolution period can be seen by changing the number of points and the time span. For narrow pulses and small time spans, the measurement resolution period can be as small as 100 nanoseconds; for wide pulses and large time spans, it can increase to multiples of 10 microseconds. With the internal measurement trigger, the first sample can be taken up to 6 resolution periods prior to time zero. When using external triggering, the external trigger sets time zero and the first sample can be taken three resolution periods after time zero.

A method for making pulse profile measurements at multiple frequencies is described in the next section, “Making Pulsed-RF Measurements.”

Making Pulsed-RF Measurements

Frequency Domain (Point-In-Pulse)

Calibration

Measurement calibration for frequency domain (point-in-pulse) is accomplished in exactly the same way as for the standard 8510 network analyzer.

1. Press **DOMAIN**, then **[FREQUENCY]** to select the frequency domain.
2. If the W annotation is not displayed, select the wideband detector by pressing: **SYSTEM, [MORE], [PULSE CONFIG], [DETECTOR: WIDE BW]**.
3. Select the maximum number of points required for the measurement, then perform the appropriate measurement calibration.

Note that for internal triggering, when you press the key to measure the calibration standard, the 8510 pulse output signal is set to the active state (RF always On) during measurement of the standard. This assures that the calibration is made with respect to the On portion of the pulse independent of the trigger delay.

Note that for external triggering you can control the pulse width and duty cycle during calibration and measurement. You must set the trigger delay to make the measurement at the correct time during the pulse for calibration, then not change it during the measurement.

Measurement

1. **Set Pulse Polarity.** After factory preset, the pulse polarity is set to High for the On period of the pulse appearing at the 8510 rear panel PULSE OUTPUT connector. To set the pulse polarity, press: **SYSTEM, [MORE], [PULSE CONFIG], [PULSE OUT: HIGH]**.
2. **Set Pulse Width.** After factory preset, the pulse width is set to 10 microseconds. To set a different pulse width:

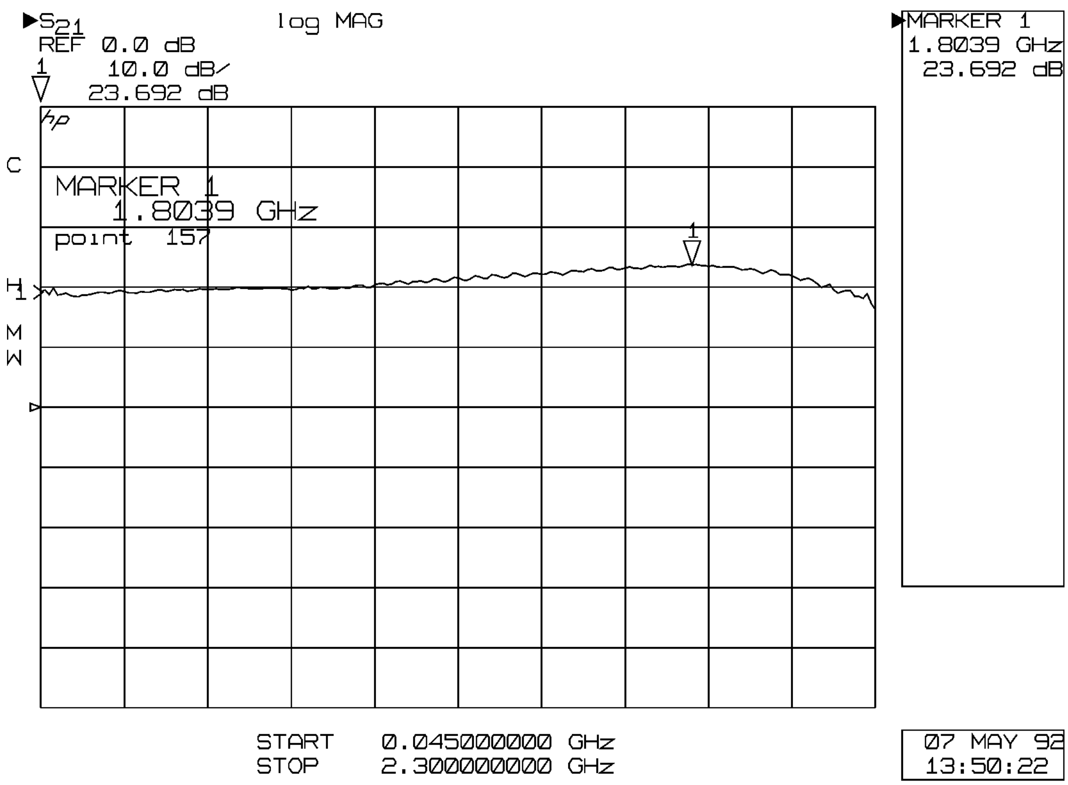
   Press **[PULSE WIDTH]**. Use the knob, step keys, or numeric entry to set the desired pulse width.
3. **Set Duty Cycle Limit.** After factory preset, the duty cycle limit is set to 10. This means that the maximum duty cycle will never be allowed to be greater than 10 percent regardless of the pulse width.

   To set the duty cycle limit, press **[DUTY CYCLE]** on the Pulse Configuration menu. Use the knob, step keys, or numeric entry to set the desired maximum duty cycle limit. Note that the actual duty cycle may be less.
4. **Set Trigger Delay.** After a factory Preset, the trigger delay is set to 5 microseconds. This means that the frequency domain measurement will take place 5 microseconds after time zero. Time equals zero seconds when the 8510 pulse output goes to the active level turning on the pulse modulator. To set the trigger delay, press **STIMULUS MENU, [MORE], [TRIGGER MODE], [TRIGGER DELAY]**. Use the knob, step keys, or numeric entry to set the desired trigger delay.

   Notice that if the trigger delay is set to outside the time interval that the pulse is On, the trace is noisy due to low signal levels.
5. **Connect the Device Under Test.** The trace shows the response of the device to the pulsed-RF stimulus over the current frequency sweep

   Figure 3-13 shows an example of amplifier gain.

Figure 3-13 Amplifier Gain, Frequency (point-in pulse)



pw421l

The dynamic range can be increased using IF averaging, but, given the system noise floor with the wide IF bandwidth, an averaging factor of about 256 averages is the maximum value that should be used for most measurements. Using an averaging factor greater than 256 will not result in any increase in visible dynamic range.

Pulse Profile Domain

Calibration

After selection of the pulse profile frequency, measurement calibration for pulse profile measurements is accomplished in exactly the same way as for the standard 8510. Following are two measurement calibration methods, one for calibration in the Pulse Profile domain, and the second for calibration using the Frequency List feature. Select the best one for your application.

The pulse profile domain calibration procedure is an easy way to familiarize yourself with the pulse profile domain and for general-purpose measurements using response-only correction. Use the frequency list technique when more than one pulse profile frequency and 1-Port or 2-Port correction is required. Given adequate signal levels, accurate timing, and frequency stability, there is no difference in the accuracy of the pulse profile measured data whether the calibration is performed in the pulse profile domain as described in the Pulse Profile Domain procedure or in the frequency domain as described in the Frequency List procedure. The main advantage of calibration in the frequency domain is that you can calibrate at all frequencies in the list while only connecting the standards once.

Measurement Calibration Procedure

Perform measurement calibration in the pulse profile domain as follows:

1. Turn correction off by pressing **CAL**, **[CORRECTION OFF]**.
2. Press **DOMAIN**, then **[FREQUENCY]** to select the frequency domain. Press **STIMULUS MENU**, then **[STEP]** to select the sweep mode.
3. Press **START**, then set the start frequency to the desired pulse profile frequency. This will be the frequency measured when the pulse profile domain is selected.
4. Press **[PULSE PROFILE]** on the Domain menu. Press **MARKER** and notice that the active function readout shows both the time value at the marker position and the current measurement frequency.
5. Select the maximum number of points required for the measurement, then perform the appropriate measurement calibration.

Note that the 8510 pulse output is set to the active state (RF always On) during measurement of the calibration standards. For external triggering, the pulse modulation is operating during the calibration, so the pulse width or time span cannot be changed after calibration.

Repeat this sequence for the next pulse profile frequency. With several cal sets created in this way, you can select each pulse profile frequency in turn by recalling the corresponding cal set.

Frequency Domain Using Frequency List

In the preceding measurement calibration procedure, it is necessary to perform a separate calibration for each pulse profile frequency. This is not a problem for simple response-only calibrations. But, when accuracy considerations require the use of 1-Port or 2-Port calibrations, connecting the necessary sequence of standards repeatedly can be tedious. As an alternative, the frequency list feature allows the standards to be connected once for all pulse profile frequencies.

Perform the calibration as follows:

1. Press **DOMAIN**, then **[FREQUENCY]** to select the frequency domain.
2. If the W annotation is not displayed, the wideband detector must be selected before proceeding.

   Press: **SYSTEM**, **[MORE]**, **[PULSE CONFIG]**, **[DETECTOR: WIDE BW]**.
3. Press **STIMULUS MENU**, **[MORE]**, then **[EDIT LIST]** to display the Edit List menu. Create a segment for each pulse profile frequency to be measured. Each segment is defined such that the start and stop frequencies are identical and the number of points in each segment is the number of points to be displayed in the pulse profile measurement. For example, the following sequence creates a frequency list to measure four pulse profile frequencies of 51 points each.

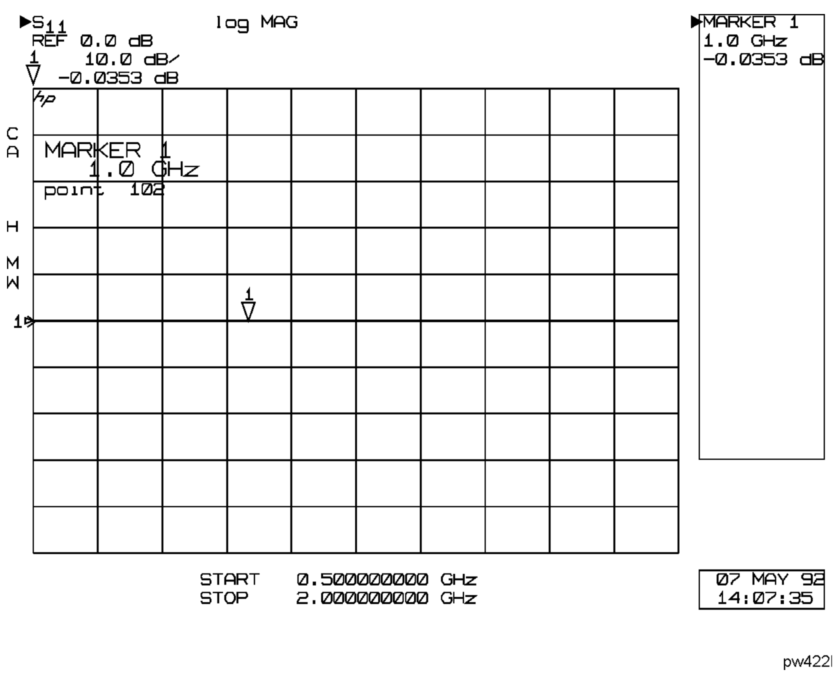
   Press **[ADD]**, **START**, **.5**, **G/n**, **[NUMBER of POINTS]**, **51**, **x1**, **[DONE]**.

   Press **[ADD]**, **START**, **1.0**, **G/n**, **x1**, **[DONE]**. Press **[ADD]**, **START**, **1.5**, **G/n**, **x1**, **[DONE]**.

   Press **[ADD]**, **START**, **2.0**, **G/n**, **x1**, **[DONE]**.
4. Press **[DONE]**, then **[FREQUENCY LIST]**. The frequency list will be measured.

   The display will be similar to Figure 3-14. Proceed with the appropriate measurement calibration.

Figure 3-14 Frequency List Display During Measurement Calibration

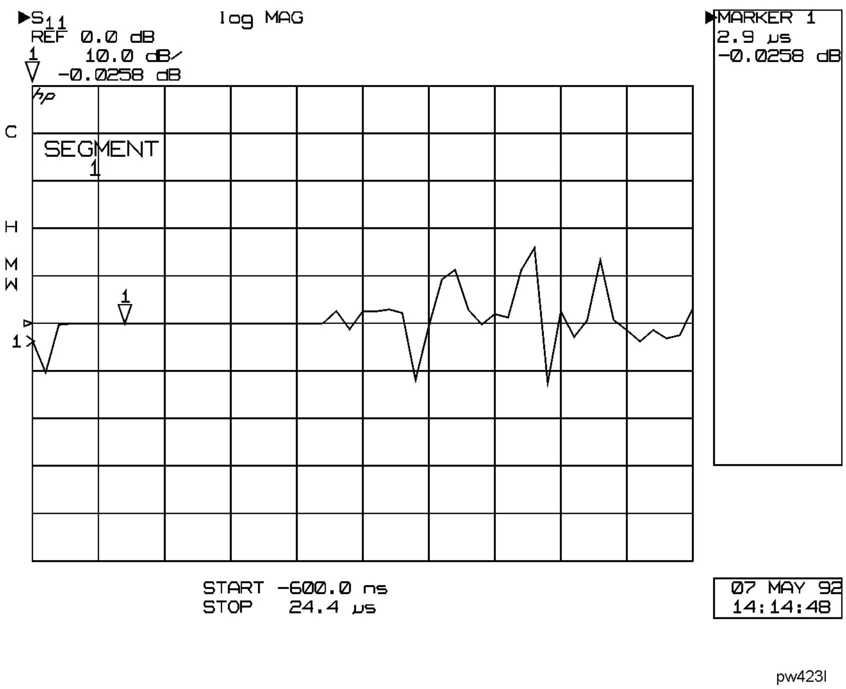


5. Press **DOMAIN**, **[PULSE PROFILE]**.

6. Press: **STIMULUS MENU**, **[FREQUENCY LIST]**, **[SINGLE SEGMENT]**.

The last selected segment will be active as shown in Figure 3-15.

Figure 3-15 Pulse Profile, Frequency List Segment Number 1



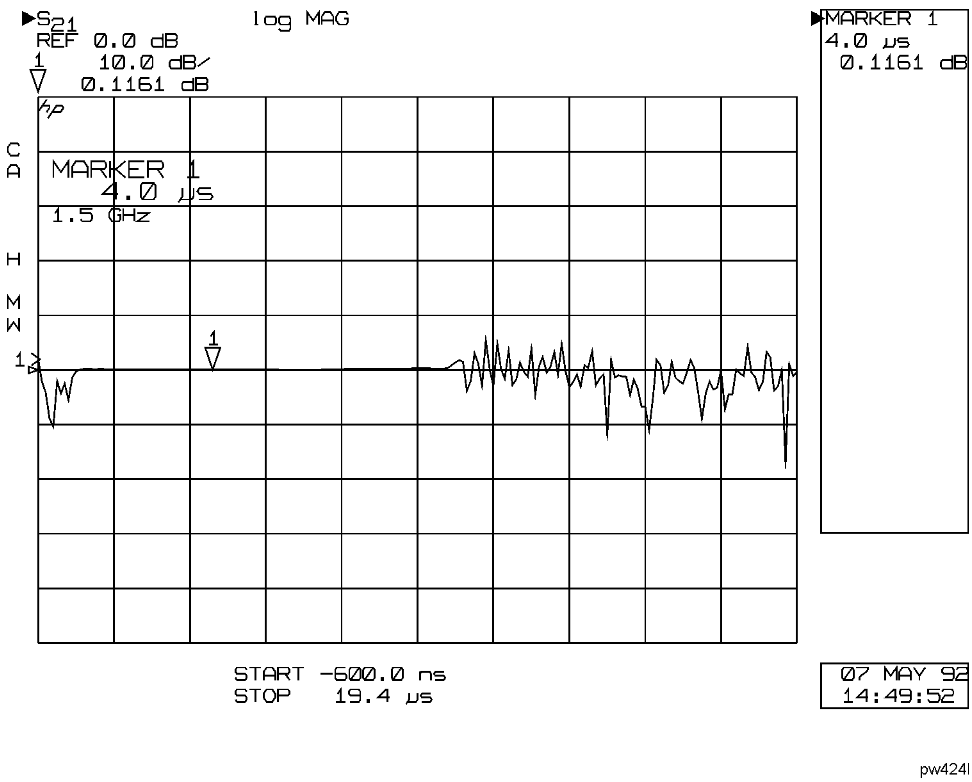
To measure another frequency, select the appropriate active segment.

When either the pulse profile domain or the frequency list calibration procedures is complete, connect the device for measurement. Again, in both of these procedures, note that when you press the key to measure the calibration standard, the 8510 pulse output is set to the active state (RF always On) during measurement of the standard. This ensures that the calibration data at every point is with respect to the On portion of the pulse. If external pulse modulation is used, it is necessary that the RF is On during measurement of the calibration standard.

Measurement

After calibration, first view the response of one of the calibration standards. This example (Figure 3-16) showing S21 of the thru connection is typical: the trace is flat at 0 dB when the pulse is On and noisy around 0 dB when the pulse is Off. The noise during pulse Off will vary depending on the relative signal levels in the reference and test signal paths.

Figure 3-16 Pulse Profile, S21, Thru



1. **Set Pulse Polarity.** After instrument preset, the pulse polarity is set to High for the On period of the pulse appearing at the 8510 rear panel PULSE OUTPUT connector.

   To set the pulse polarity, press:

   SYSTEM, **[MORE]**, **[PULSE CONFIG]**, **[PULSE OUT: HIGH]**.

   For internal pulse modulation and internal triggering, time equals zero seconds is always the point where the pulse transitions to the active level. The internal pulse modulator in the RF source turns the RF pulse On when the analyzer output is positive, so the noisy part of the trace will change location depending on the pulse polarity.

2. **Set Pulse Width.** After instrument preset, the pulse width is set to 10 microseconds. To set a different pulse width press:

   SYSTEM, **[MORE]**, **[PULSE CONFIG]**, **[PULSE WIDTH]**.

   Use the knob, step keys, or numeric entry to set the desired pulse width.

3. **Set Duty Cycle Limit.** After instrument factory preset, the duty cycle limit is set to 10. This means that the maximum duty cycle will never be allowed to be greater than 10 percent regardless of the pulse width.

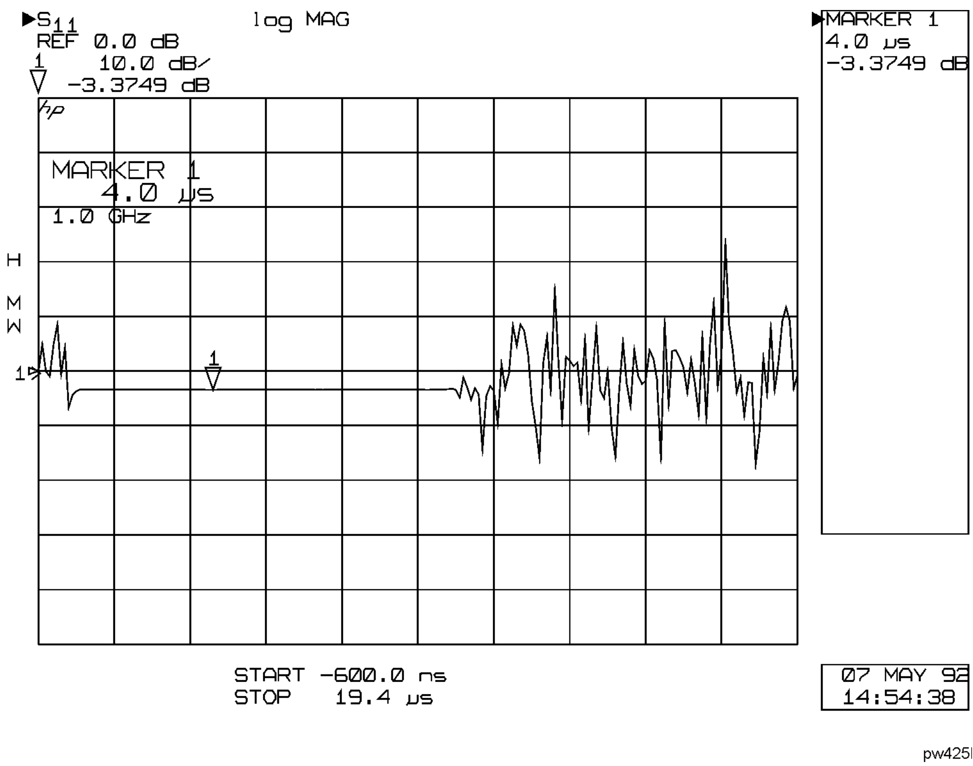
   To set the duty cycle limit, press **[DUTY CYCLE]** on the Pulse Configuration menu. Use the knob, step keys, or numeric entry to set the desired maximum duty cycle limit. Note that the actual duty cycle may be less.

4. **Set Measurement Time Span.** The 8510 automatically chooses the minimum possible time between samples (given the 8510 hardware and firmware capabilities), and thus the measurement resolution period, depending on the larger of the pulse width time or the stop time. This results in a minimum possible span time which depends on the current number of points.

   To view the pulse with minimum sample resolution period and thus the best time resolution, press **STIMULUS STOP**, then repeatedly press the entry STEP Down key until the time value at the bottom of the grid does not change (or enter **STOP**, **0**, **x1**). This also sets the start time to the minimum value. If the pulse is longer than this time span, increase the stop time to view the entire time period of interest.

5. **Set Measurement Resolution Period.** To find the resolution period, press **MARKER**, then move the marker one data point and see the time change in the Active Entry area. If necessary, adjust the resolution period to the value required for your measurement by changing the stop time, pulse width, and number of points.

Figure 3-17 Minimum Time Span, Resolution Period = 100 ns

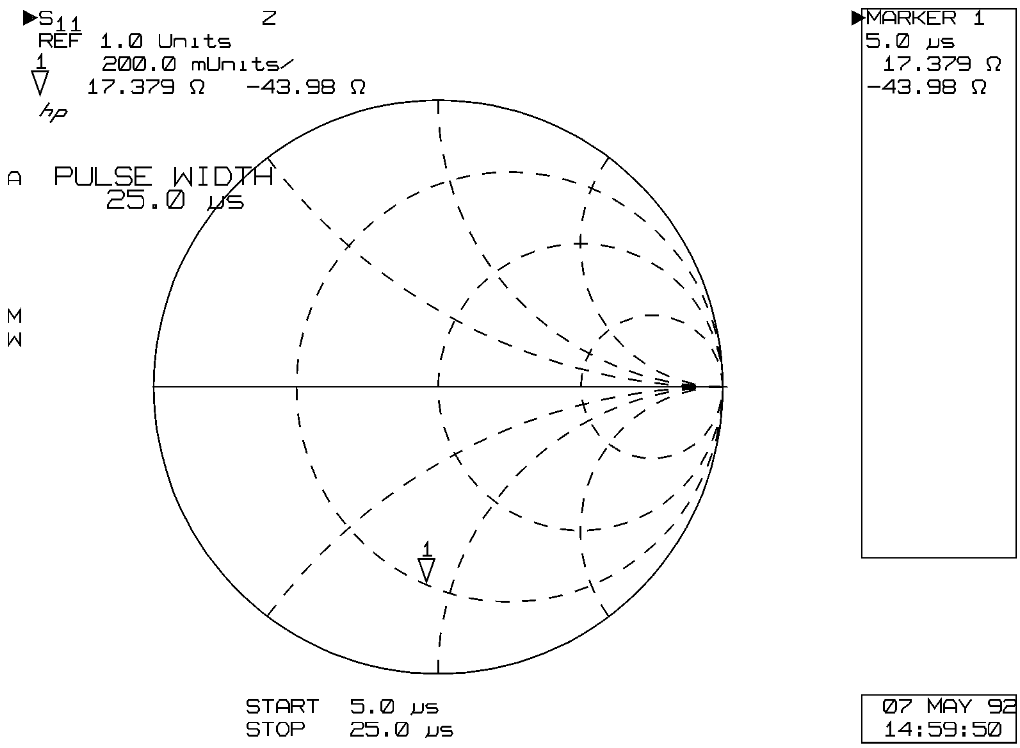


6. **Connect the Device under Test.** With the pulse width set, connect the device under test. The trace will show the response of the device to the pulsed-RF stimulus at the current frequency.

7. To measure another frequency, recall the appropriate cal set (for pulse profile domain calibration) or frequency list segment (for frequency list calibration).

Figure 3-18 shows the S11 response using the Smith chart format. The marker shows the input impedance during the On time of the pulsed-RF stimulus.

Figure 3-18 S11 Smith Chart



pw426l

Switching Between Frequency Domain and Pulse Profile Domain

The domain in which the measurement calibration was performed is not part of the cal set limited instrument state. This means that, for example, a cal set created in the frequency domain could be turned on for a pulse profile domain measurement with no message to the operator. Except for the pulse profile calibration procedure in the frequency domain using Frequency List, a cal set should only be used in the domain in which it was created. To switch between the frequency domain and the pulse profile domain, press:

CAL, **[CORRECTION OFF]**, **DOMAIN**, <select domain>, **CAL**, **[CORRECTION ON]**, **[CAL SET n]**

This sequence makes certain that the cal set applies to the domain in which it was created. Another method is to save a number of instrument states, each with the appropriate domain and cal set, then recall the desired instrument state.

If a cal set created in the pulse profile domain is turned On while in the frequency domain, it is treated as if the calibration were performed using step sweep with the minimum frequency span. The pulse profile domain error coefficients are applied to different frequency points, resulting in trace errors.

Also, if a cal set created in the frequency domain is turned On while in the pulse profile domain, the frequency is set to the start frequency of the frequency domain cal set and the frequency domain error coefficients are applied to each corresponding point in the pulse profile domain. This also results in trace errors.

Pulsed-RF Applications

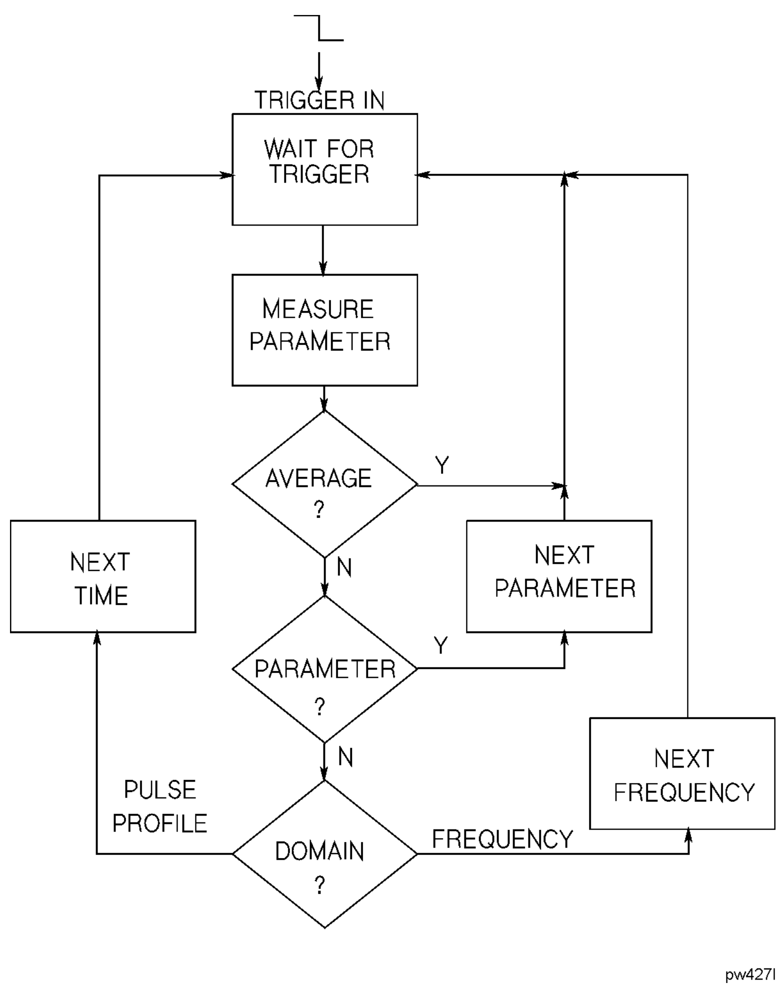
Pulsed-RF Timing Information

If your device is sensitive to Pulse Repetition Period or Duty Cycle, you will need to learn more about how these are affected by the instrument state. The following paragraphs provide information that can be used to predict the internal PRP for different instrument states.

Network Analyzer Measurement Cycle

Figure 3-19 shows the general measurement process flow of the network analyzer measurement cycle. For the frequency domain (point-in-pulse) measurement and the pulse profile domain measurement, the 8510 measurement cycle consists of making the measurement, setting up for the next measurement, then waiting for the next trigger.

Figure 3-19 Network Analyzer Measurement Cycle



Each measurement cycle is initiated by the falling edge of the TTL signal at the rear panel external Trigger Input, or the internal 8510 logic, depending on whether external or internal triggering is selected. At the appropriate time after the trigger, the measurement is made. If averaging is turned On but not completed, the process waits for the next trigger to make the next measurement for that data point. If averaging is complete but another parameter is required (2-Port correction is On), the next parameter is selected and the process waits for the next trigger. When all data for that point is acquired, the process moves to the next point, changing the frequency (if in the frequency domain), or the time (if in the pulse profile domain), then waits for the next trigger.

These times are representative typical measurement cycle times using preset values for the analyzer controls.

Measurement Cycle Times

1 ms	Next Average
4 to 8 ms	Next Parameter (Frequency Domain)
30 to 40 ms	Next Frequency Point (Frequency Domain)
3-4 ms	Next Time Point (Pulse Profile Domain)

Controls that can affect the measurement cycle time are:

Sweep Time	When the analyzer is otherwise ready for the next measurement cycle, it ignores triggering for an interval equal to (Sweep Time (ms)/Number of Points).
Pulse Width	The pulse always remains On for the user-specified time.
Duty Cycle Limit	When the analyzer is otherwise ready for the next measurement cycle, if the Duty Cycle percent maximum limit would be exceeded, the process ignores triggering until the duty cycle limit is satisfied.
Pulse Profile Domain Stop Time	The time value of the current pulse profile data point determines the measurement cycle time when it is greater than the PRP set by the duty cycle limit.
Frequency Domain Trigger Delay	If the Frequency domain Trigger Delay is greater than the duty cycle limit, trigger delay will control the minimum frequency domain measurement cycle time.

The only additional considerations are:

1. Pulse Output is set to the active level during measurement of any calibration standard.
2. It is set to the inactive level during the sweep retrace.
3. It is set to the active level for less than 30 microseconds immediately prior to the beginning of the sweep for the automatic periodic IF calibration sequence.
4. It remains at the inactive level under all conditions when External Triggering is selected.

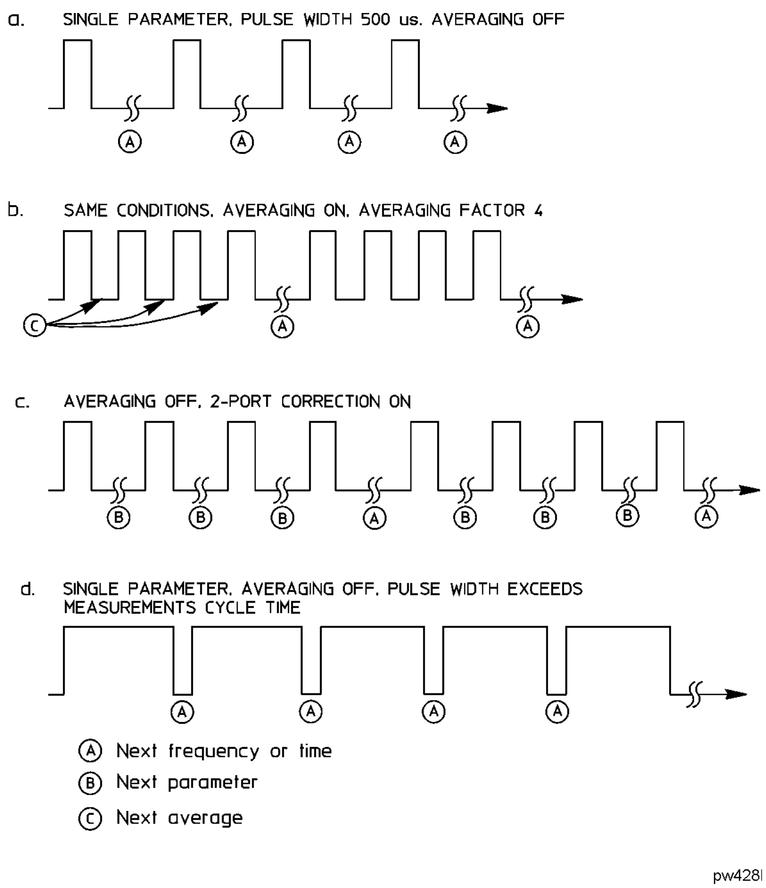
The automatic periodic IF calibration sequence is transparent to the operator except for the less than 30 microsecond pulse output prior to the beginning of a sweep. To the operator, the IF calibration sequence will appear to occur at random times, more frequently just after the 8510 is turned on, then less often as the system temperature stabilizes.

Pulse Repetition Period and Duty Cycle Considerations

From the measurement cycle information, you can see that the pulse repetition period and thus the duty cycle of the pulsed-RF signal applied to the DUT can vary depending on the instrument state. For measurements in which the PRP or duty cycle is not important, set the pulse width and the duty cycle controls to an appropriate value and make the measurement. The specified duty cycle limit will not be exceeded, but the actual duty cycle may be less than expected.

For example, Figure 3-20 shows the pulse output waveform for various conditions. Figure 3-20 part “a” shows the pulse output when the pulse width is 500 microseconds, the duty cycle limit is 50 percent, and averaging is off. Under these conditions the measurement cycle time is about 3 milliseconds per trace data point in the pulse profile domain, or about 30 milliseconds in the frequency domain. Figure 3-20 part “b” shows the same conditions with averaging on and an averaging factor of four. Now four measurements are taken for each data point with the measurement cycle time alternating between 1 millisecond for each of the measurements required for the averaging, and the time to move to the next data point. Figure 3-20 part “c” shows the measurement when 2-Port correction is On. Here, the parameter switching time also affects the overall PRP and duty cycle.

Figure 3-20 Example Internal Pulse Output PRP and Duty Cycle



In Figure 3-20 part “d,” the pulse width is greater than the measurement cycle time, so the duty cycle could approach 100 percent. This is avoided by setting the Duty Cycle function to the maximum value allowed in the measurement. When the combination of the pulse width and the duty cycle limit approaches the measurement cycle time, the pulse off part of the measurement cycle time is increased to satisfy the duty cycle limit.

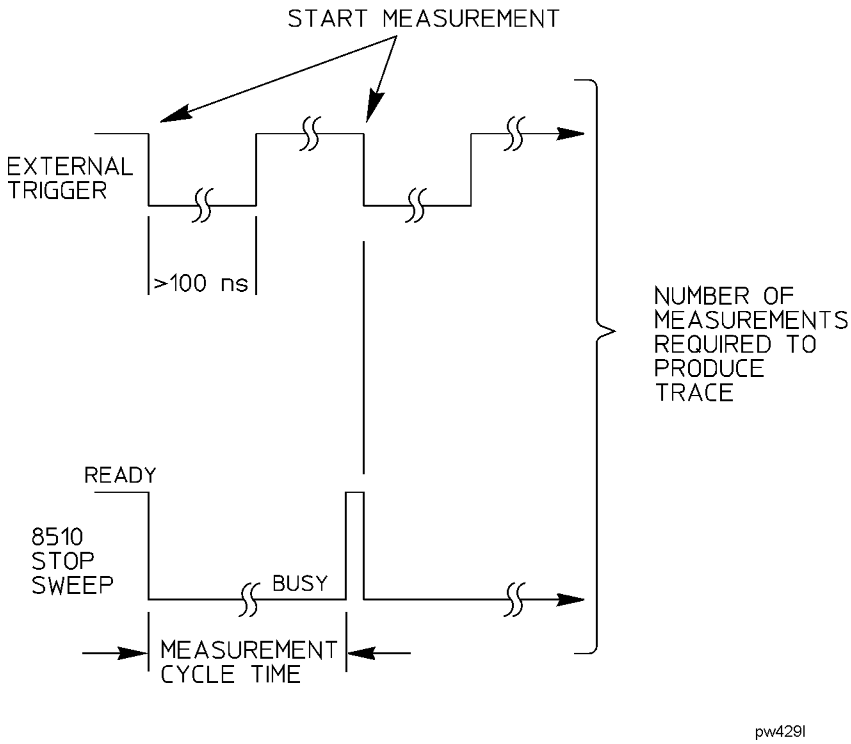
If you are viewing this with an oscilloscope, notice how the measurement cycle time varies according to the pulse profile stop time. If the stop time is greater than the pulse width, the measurement cycle time will extend past the end of the pulse depending on the time value of the data point being measured. Depending on the pulse width, this can result in a lower percent duty cycle toward the end of the time span.

External Trigger and Stop Sweep Signals

Figure 3-21 shows the relationship between the external Trigger Input and the 8510 Stop Sweep output for frequency domain point-in-pulse measurements and for pulse profile domain measurements. For external triggering, Stop Sweep remains Busy (low) until the measurement cycle is complete. This information is important for synchronizing the pulse modulation to the external trigger.

When a TTL pulse train is applied to the 8510 rear panel EXTERNAL TRIGGER INPUT, the trigger should stay low for at least 100 nanoseconds. Excess triggers that occur while stop sweep is busy (low) are ignored. The next external trigger falling edge after stop sweep is ready will initiate the next measurement cycle and retrace is automatic.

Figure 3-21 External Trigger and Stop Sweep Timing Diagram



When internal triggering is selected, the stop sweep output does not operate (always in the ready state). Timing diagrams for the pulse output signal and development of the internal measurement trigger are shown in Figure 3-11 on page 3-14 and Figure 3-12 on page 3-15.

When external triggering is selected, the falling edge of the external trigger input defines time equals zero seconds for each measurement cycle. Stop sweep falls immediately and stays low until the 8510 completes the measurement cycle and is ready to accept the next trigger. The time period that stop sweep remains busy depends upon the next measurement function to be performed. Pulse output is turned Off for external triggering. As for internal triggering, the pulse profile measurement resolution period is set by the larger of pulse width and pulse profile domain stop time.

Using External Pulse Modulation

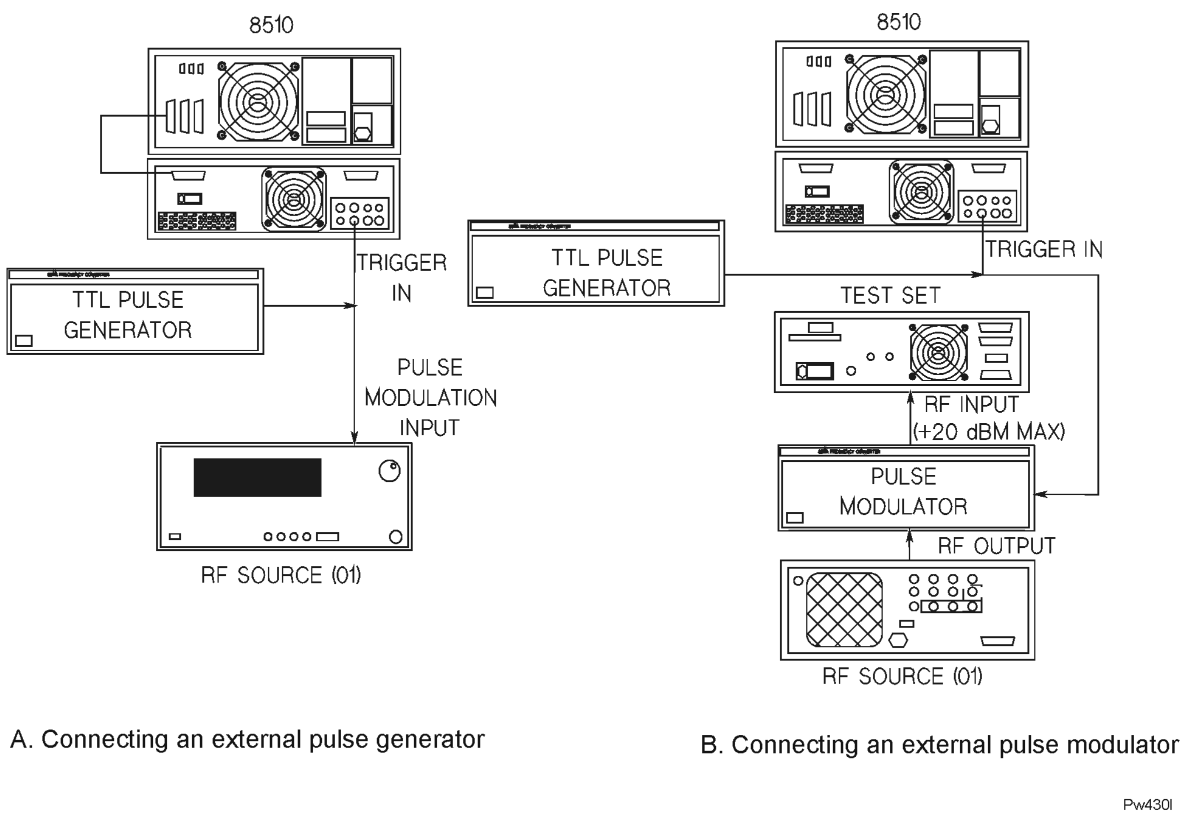
In applications where it is necessary to maintain close control over the PRP and duty cycle of the pulsed-RF stimulus, you can use external equipment to provide the TTL pulse modulation and external trigger signals. When using an external pulse modulation signal, it is necessary to synchronize the network analyzer with the pulse modulation signal so that the measurement is always made at the same time with respect to the stimulus. This synchronization is accomplished using the 8510 external trigger input.

Connect the Pulse Generator

A simple method to control the PRP and duty cycle of the pulsed-RF stimulus is to use an external pulse generator to provide the pulse modulation input to the RF source. Figure 3-22 shows a simple setup. In this example, the same TTL pulse train provides the pulse modulation input to the RF source and to the 8510 rear panel TRIGGER IN connector.

However, in your application it may be desirable to use different synchronized inputs to the network analyzer TRIGGER IN and to the source pulse modulator. If an 8340 source is used, please note that for internal triggering, a BNC short circuit is connected to the TRIGGER IN connector. When the pulse generator is connected to TRIGGER IN, move the BNC short to the SWEEP IN 0 to 10V connector. Otherwise, signals on the sweep in line could affect triggering.

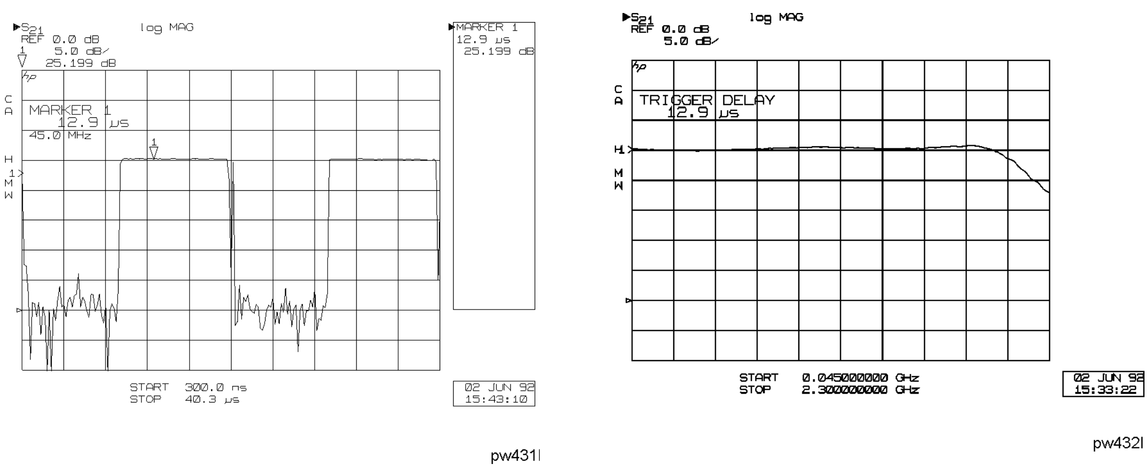
Figure 3-22 External Control of PRP and Duty Cycle



Synchronization is assured because time equals zero seconds for each measurement cycle is defined as the first falling edge of the trigger input after stop sweep is ready (high). Figure 3-22b shows connection of an external pulse modulator instead of the internal modulator in the RF source.

Figure 3-23 shows results using this pulse modulation and triggering method when the pulse modulation input to the RF source is a continuous train of 20 microseconds PRP, 50 percent duty cycle pulses. The same input is applied to TRIGGER IN, and TRIGGERING EXTERNAL is selected.

Figure 3-23 Using External Trigger and External Modulation PRP = 20 microseconds, Duty Cycle = 50%



a. Amplifier Pulse Profile Domain **b. Amplifier Frequency Domain**

Figure 3-23a is the pulse profile domain response. Multiple pulses are visible because the stop time is greater than the stimulus PRP. Notice that for external triggering the minimum start time is about positive 3 measurement resolution periods with respect to the external trigger. Even though the internal pulse output is not used in this particular configuration, the pulse profile measurement resolution period is set by algorithm using the greater of the pulse width and stop time.

Figure 3-23b is the frequency domain response with the trigger delay set to measure during the On time of the pulse. One method used to set the trigger delay to an appropriate value is:

1. Press **DOMAIN**, **[PULSE PROFILE]**, then set appropriate Start and Stop times.
2. Press **MARKER**, then move the marker to the point on the pulse you want the frequency domain measurement to be made.
3. Press **STIMULUS MENU**, **[MORE]**, **[TRIGGER MODE]**, **[TRIGGER DELAY]**.
4. The current value of the Trigger Delay will be displayed. Now press **=MARKER**. The time value at the marker will be assigned to the trigger delay function.
5. Press **DOMAIN**, then **[FREQUENCY]**. The trace shows the response at the time after the TTL Trigger In signal falling edge as set by the trigger delay value.

Control of Pulse Modulation During Calibration

The RF signal must always be On during the time that the calibration standard is being measured. This removes the time element from the calibration. For this reason, either disconnect the RF source pulse modulation input during the calibration procedure or take other step to ensure that the RF is always On during the time that the calibration standard is being measured.

High Power Measurements

Use Figure 3-24 to examine the maximum power ratings and normal signal levels present in the test set. The signal levels are approximate, with signal path loss increasing with frequency. Note the following characteristics:

- Typically, the RF input is about 8 dBm and the loss to the selected test port is about 8 dB.
- With the step attenuators set to zero dB, the loss from the RF input to the a1 or the a2 mixer, and the loss from Port 1 or Port 2 to the b1 or the b2 mixer, are approximately equal at about 26 dB.
- Since each mixer includes a 20 MHz preamplifier to offset its conversion loss, measurement of the User Parameters will show the IF level to be about 24 dB less than the RF input and 16 dB less than the signal level at the test port, with 0 dB test port attenuation.
- For specified performance, the maximum IF signal level as measured by the user parameters is –10 dBm. Higher signal levels cause errors due to compression, and lower signal levels produce greater uncertainty due to noise.

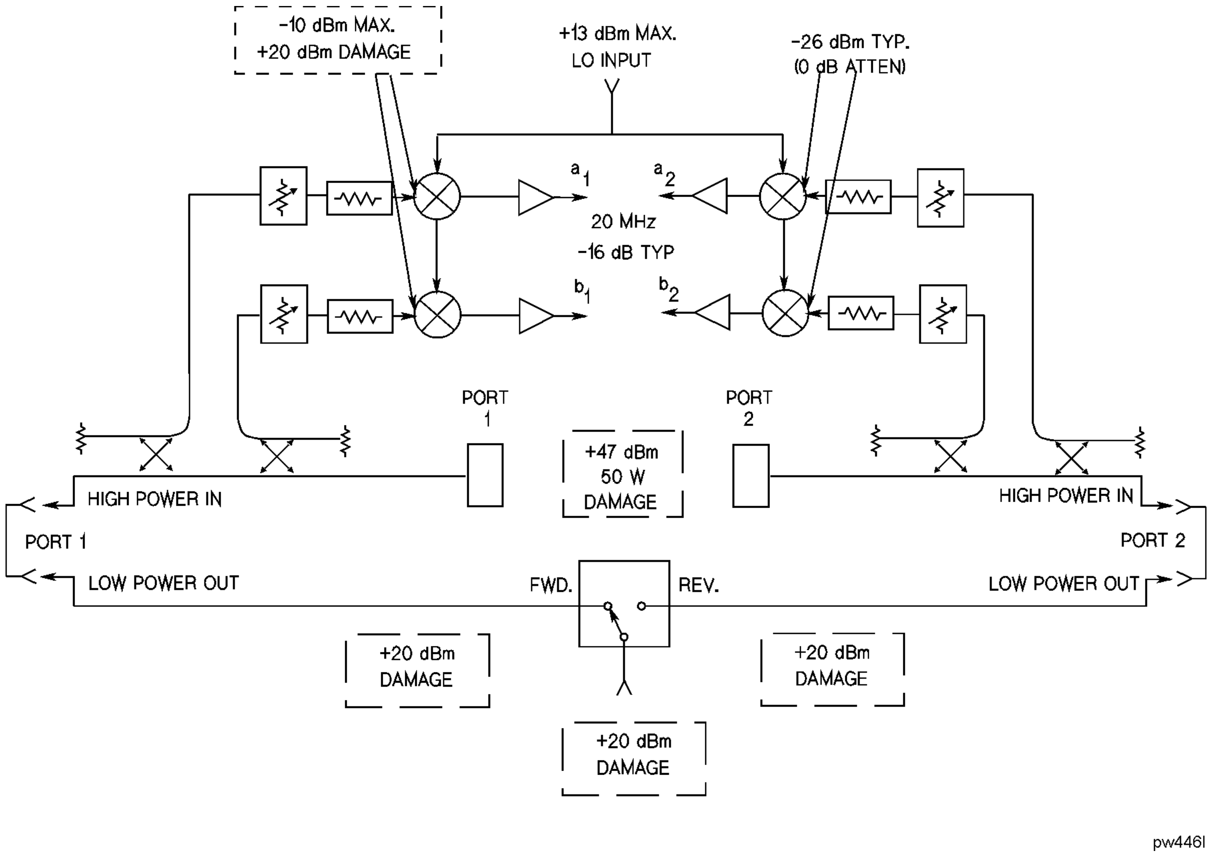
CAUTION Components in the test set will be damaged at certain signal levels. To avoid damage, observe the following operating precautions:

1. Use the PORT 1 and PORT 2 attenuators (Stimulus Power menu) to protect the mixer input — the mixer damage level is +20 dBm (0.1 watt, CW).

2. Install appropriate components in the rear panel extension links to protect the test set Forward/Reverse switch — the damage level is +20 dBm applied at any input or output. This means that if the device output is greater than +20 dBm, the switch can be damaged by +20 dBm present at either LOW POWER OUT connector.

3. If the device output is greater than +47 dBm, use appropriate components to protect the test set ports (and the Forward/Reverse switch) — the damage level is +47 dBm (50 watts) applied at PORT 1 or PORT 2.

Figure 3-24 Test Set Maximum Signal Levels



Connecting External Signal Conditioning

The test set rear panel links labeled PORT 1 and PORT 2 can be used to install external equipment in the Port 1 and Port 2 signal paths. The connectors labeled LOW POWER OUT each connect to an output of the forward/reverse switch. The connectors labeled HIGH POWER IN connect to the front panel measurement PORT 1 or PORT 2.

Note the damage levels indicated on the diagram. The maximum power rating of the forward/reverse switch is +20 dBm applied at the RF input, or applied to the forward/reverse poles via either LOW POWER OUT connector. The maximum signal level applied at either HIGH POWER IN connector, or to either of the front panel PORT 1 and PORT 2 connectors is +47 dBm.

Example High Power Measurements

To set signal levels in the test set, estimate the input and output power levels of the device under test. When the test set is configured to handle these levels, connect the operating device and verify the power estimates by measuring the user parameters. If the estimates were inaccurate, change the test set configuration so that power levels at all points in the system are within limits. When this is accomplished, remove the device, perform a measurement calibration, then install the device and measure its S-parameters.

Examples of two high power measurements follow. These examples should be used as a guide for considerations that are special to your test setup.

Measurement Example 1:

Figure 3-25 shows the setup for measurement of an amplifier having about 30 dB of gain. Using the standard RF source power setting of +8 dBm, the signal level at Port 1 is about +0 dBm, the level at the b2 mixer is about +4 dBm, and the signal level at the reverse pole of the forward/reverse switch is about +30 dBm.

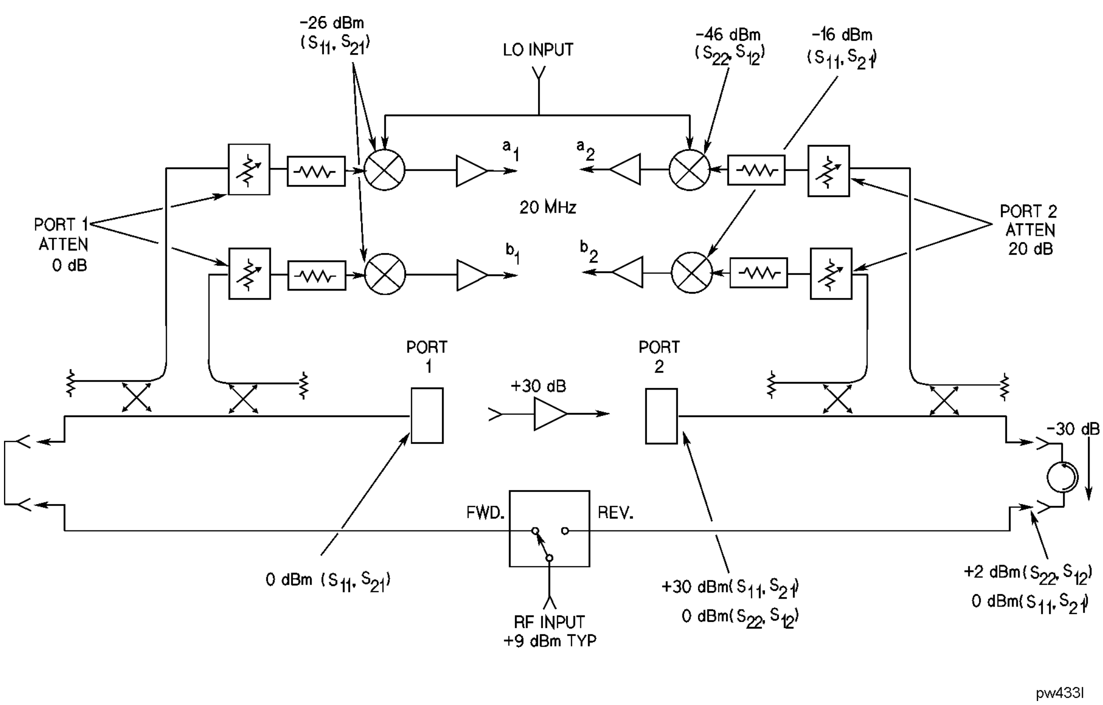
In order to avoid damage:

- The ATTENUATOR PORT: 2 step attenuator must be set to at least 20 dB to protect the b2 mixer.
- An attenuator or isolator must be added in the rear panel PORT 2 links to reduce the signal level at the reverse pole of the switch to below +20 dBm.
- If any “IF OVERLOAD” message or O annotation is displayed on the network analyzer when you are operating in the normal BW, nonpulsed-RF mode, the RF power level must be lowered until the message no longer appears.

An isolator, providing about 30 dB of isolation between Port 2 and the switch, is the best choice because it can preserve the dynamic range for reverse measurements. Better performance for the reverse measurements will be obtained because the isolator will minimize the insertion loss from the reverse pole of the switch to Port 2, and to a2.

NOTE The network analyzer cannot sense IF Overload conditions in the pulsed-RF, wide BW mode of operation. Always check the user 1 through user 4 levels to be sure they are below –10 dB indicated on the display.

Figure 3-25 Measuring a 30 dB Gain Amplifier



Measurement Example 2:

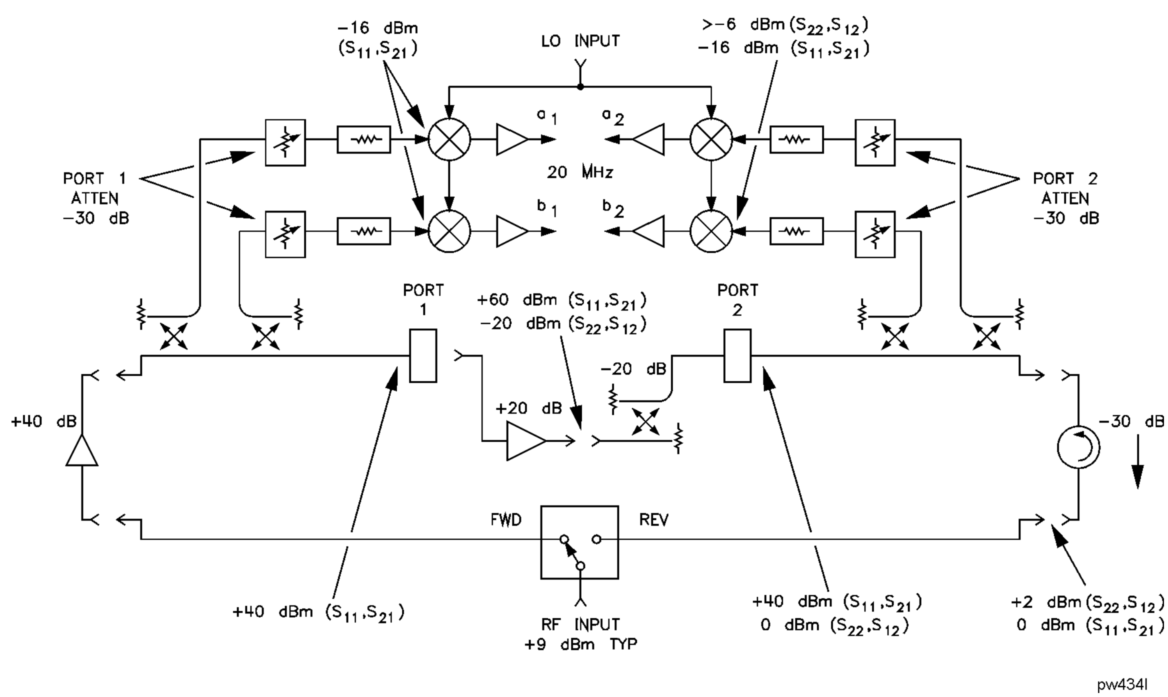
Figure 3-26 shows the setup for measurement of an amplifier with about 20 dB of gain that needs an input level of about 40 dBm. A 40 dB gain amplifier is installed in the rear panel PORT 1 links to boost the signal level to the desired value without exceeding +47 dBm (50 watts). The signal level at the test port is about +60 dBm, making the signal levels at the a1 mixer and the b1 mixer over +30 dBm.

In order to avoid damage:

- The ATTENUATOR PORT: 1 attenuator must be set to 30 dB in order to reduce the a1 and b1 signal levels to below –10 dBm.
- On the transmission return side, the amplifier output is about 60 dBm, making it necessary to add 20 dB of loss between it and Port 2 in order to reduce the signal level incident at Port 2 to less than +47 dBm.
- The ATTENUATOR PORT: 2 step attenuator must be set to 30 dB in order to protect the b2 mixer.
- The reverse pole of the forward/reverse switch must be protected by installing an attenuator or isolator in the rear panel PORT 2 links to reduce the signal level at the reverse pole of the switch to below +20 dBm.

The coupler is used in the transmission return signal path because it provides the necessary loss and is likely to provide a more stable signal path than a high power attenuator that would otherwise be required. A high power termination is required to terminate the through arm of the coupler.

Figure 3-26 Measuring an Amplifier with High Input Levels



Using the Port 1 and Port 2 Attenuators

Use the Port 1 and Port 2 step attenuators to adjust the signal level into the mixers and thus protect the mixers from excessively high signal levels. Note that the attenuators do not change the Port 1 or Port 2 signal levels.

Controlling the Attenuators

Set the step attenuators as follows:

Press **STIMULUS MENU [POWER MENU] [ATTENUATOR PORT: 1]** or **[ATTENUATOR PORT: 2]**.

Use the knob, STEP keys, or numeric entry to set the attenuator from 0 dB to 70 dB in 10 dB steps. Familiarize yourself with operation of the step attenuators by measuring the user parameters

Measure User Parameters and Set Attenuators. In order to maintain specified performance, the IF signal levels are less than –10 dBm as measured by the user parameters. Connect an appropriate device at Port 1 or Port 2 for each measurement, turn on a measurement marker, then measure the user parameters in order to verify the IF signal levels as follows:

1. Press **PARAMETER MENU**, then **[USER 1 a1]** and observe the IF signal level in the LOG MAG format.
2. Press **[USER 4 b1]** and observe the IF signal level. If either a1 or b1 is greater than –10 dBm at any point in the trace, increase the ATTENUATOR PORT: 1 value.
3. Press **[USER 3 a2]**.
4. Press **[REDEFINE PARAMETER] [DRIVE] [DRIVE: PORT 2] [REDEFINE DONE]**. Observe the IF signal level
5. Press **[USER 2 b2]** and observe the IF signal level. This shows the level with the signal applied to Port 1. If either a2 or b2 is greater than –10 dBm at any point in the trace, increase the ATTENUATOR PORT: 2 value.

   In some applications it may be necessary to measure the signal at b2 with the signal applied to Port 2. For this measurement:

   a. Press **[USER 2 b2]**.
   b. Press **[REDEFINE PARAMETER] [DRIVE] [DRIVE: PORT 2] [REDEFINE DONE]**. Observe the IF signal level.

Before you perform a calibration, measure these user parameters with the calibration standards connected, then with the device under test connected and operating.

Generally, set the attenuators to obtain the maximum possible mixer input signal level (less than –10 dBm) with the device connected and operating. This will provide the best signal-to-noise ratio for the measurement. Then remove the device and perform measurement calibration. For best accuracy, do not change either attenuator between calibration and measurement.

Changing the Signal Path After Calibration

If any attenuator or other external equipment is changed after calibration, the measurement results cannot be specified except by your own estimation of the error contribution of the change. For example, when the port attenuation is changed with correction On, the message `CAUTION: CORRECTION MAY BE INVALID` is displayed. The operator must judge whether the error is tolerable in the particular application and how to compensate for the change.

The only reason to change the internal attenuators or external equipment between calibration and measurement is to maximize the levels under both conditions, thus minimizing uncertainty due to noise. Many factors will enter into the decision of whether it is more accurate to calibrate at a low signal level without changing the setup, or change the setup to optimize levels for both calibration and measurement. Changing the Port 1 or the Port 2 attenuator does not seriously change the test set mismatch, directivity, or isolation characteristics, but will change the frequency response magnitude and phase. This difference in the frequency response between calibration and measurement can be normalized using the 8510 trace memories.

The following three procedures can help minimize the errors due to changing the signal levels between calibration and measurements.

Set the Attenuators

If the Port 1 or Port 2 attenuators are changed, the following procedure can minimize the errors.

1. Connect a short or a thru and set the Port 1 and Port 2 attenuators for best IF signal levels during calibration.
2. Perform appropriate measurement calibration.
3. With an appropriate standard connected, set the Port 1 and Port 2 attenuators to the setting required for operating the test device.

If you view the response of a short circuit, notice that changing the Port 1 attenuators has negligible effect on the S11 marker reading, and that changing Port 2 attenuators has negligible effect on the S22 marker reading. This is due to the way that the attenuators are paired. Both the reference and the test signal are changed an approximately equal amount.

However, when viewing S21 or S12, changing the Port 1 or Port 2 attenuators offsets the marker reading by the difference in the Port 1 and Port 2 values.

Store Trace Memories

The main frequency response effects of changing the attenuators can be compensated for by using the 8510 trace memories and trace mathematics as follows:

1. Connect the thru used for calibration. Set the port attenuators to the value used for measurement of the device. Recheck the user parameter levels to be sure they are below –10 dBm.
2. Press **DISPLAY**, then **DATA -->MEMORY** to store the S21 trace in default trace memory 2. This trace is the frequency response difference of the S21 signal path between calibration and measurement.
3. Press **S12 DISPLAY, DATA --> MEMORY** to store the S12 trace in trace memory 3. This trace is the frequency response difference of the S12 signal path between calibration and measurement.

Now that these traces are stored, they can be used to normalize the corrected data.

View the Normalized Parameters

Use these traces to normalize the corrected data to the new levels after the attenuation is changed. This example uses normalization only for S21 and S12. To view the corrected parameters:

1. Press **DISPLAY, DISPLAY: DATA**.
2. Press **S11** and view the S11 measurement.
3. Press **S22** and view the S22 measurement.
4. Press **S21** and view the S21 measurement. If the thru is connected, the transmission coefficient should be $1\angle 0°$.
5. Press **S12 SELECT DEFAULTS, DEFAULT to MEMORY:2**

   View the S12 measurement. If the thru is connected, the transmission coefficient should be $1\angle 0°$.

Normalization is turned off for the S11 and S22 measurements, then the appropriate memory is selected and normalization is turned on to view S21 and S12.

Since these are accurate, repeatable attenuators, this sequence may be effective in your application. If it is necessary to change other parts of the test setup, especially components connected to the test ports or connected between the rear panel links, this procedure may require additional steps to adequately compensate for the changes.

Selecting the Appropriate Measurement Calibration

Selecting appropriate measurement calibration signal levels available for calibration and for measurement may also influence the decision of which error model to use for the measurement.

If appropriate signal levels can be achieved for all parameters during calibration and measurement, the 8510 2-Port accuracy enhancement error model, either the 8510 Full 2-Port or TRL 2-Port, provides best accuracy by providing best characterization and removal of the systematic errors in the test setup. If the device is noninsertable, the 8510 adapter removal calibration procedure can be implemented using the Full 2-Port and/or the TRL 2-Port calibration.

However, there are applications in which the 2-Port error model cannot be used. There are others in which better results are produced using other calibration techniques described later. These are the reasons that 2-Port correction cannot be used effectively:

- Very low signal levels of the S22 and S12 measurement will probably reduce the accuracy of the S11 and S21 measurements.

  Using 2-Port correction, the values of all four parameters are used to find the corrected value for the displayed parameter. If, for example, the reverse parameters are not representative of their actual values due to insufficient signal levels, then their contribution to the accuracy enhancement algorithm will cause errors. This leads to noisy, nonrepeatable data for the other parameters, even if their measured data is representative.

- Equipment external to the test set must be switched depending on the parameter being measured.

  There is no means of automatically switching equipment external to the test set depending on the S-parameter being measured.

  Using 2-Port correction, all four S-parameters are automatically selected in sequence, and there is no signal available to indicate which parameter is being measured. If dynamic range considerations make it necessary to change the test set configuration for measurement of different parameters, the automatic switching used in the 2-Port error model cannot be used.

- Test set configuration changes error terms other than frequency response between calibration and measurement.

  If changes to the test set between calibration and measurement significantly change the directivity, isolation, source or load match, or frequency response error coefficients measured during the calibration, then the corrected data will be in error. If only the frequency response characteristics of the test set change, compensation can be provided using the display memory features of the 8510. (See "Changing the Signal Path After Calibration" on page 3-35.)

In all of these situations the best choice will be to use a separate error model for each parameter. For example, use the Response or the Response & Isolation calibration for the S21 and S12 parameters, and 1-Port calibrations for the S11 and S22 parameters. Combining error models like this allows setup, calibration, and measurement for each parameter to be accomplished independently. After separate calibration for each parameter, the forward/reverse switch in the test set will respond to front panel parameter selections, and the cal set for the selected parameter will be recalled.

General Calibration and Measurement Sequence

- Specify the device's input/output requirements.
- Configure the test set for these levels, plus a guardband.
- Connect the operating device and verify levels.
- Adjust levels for the best dynamic range.
- Perform a measurement calibration.
- Measure operating device S-parameters.

General Calibration and Measurement Sequence Using Display Math

- Specify the device input/output requirements.
- Configure the test set for these levels, plus a guardband.
- Connect the operating device and verify levels.
- Configure the setup for best dynamic range.
- Connect the standards and verify levels.
- Change the setup for best dynamic range during calibration.
- Perform a measurement calibration. (Before saving the cal set, configure the setup for the operating device.)
- Connect the appropriate standards and store the reference traces.
- Connect the operating device.
- Use normalization to view the device parameters.

4 Specifications and Performance Verification

Overview

After installation of the system is complete and the operator's tests have been successfully completed, a performance verification is necessary to assure that the system is operating within its expected measurement uncertainties. A performance verification (in either pulsed-RF mode or nonpulsed-RF mode, but not both) is included with the purchase of an 85108 System.

The verification procedure for the pulsed-RF system is summarized here. Refer to the Performance Verification and Specifications section of the *8510C On-Site Service Manual* (Agilent part number 08510-90282) for an in-depth explanation of the procedure.

NOTE Performance of the Agilent 85108L system is not specified at RF frequencies of exactly 60 MHz, 80 MHz, and 100 MHz. This is due to excess noise caused by spurious responses occurring at harmonics of the 85110L 20 MHz IF frequency.

Of these frequencies, 100 MHz is the only frequency measured during the performance verification process. The performance verification procedure will indicate FAIL for the 100 MHz S21 and S12 measurements of both the 20 dB attenuator and the 50 dB attenuator. This failure is expected. Therefore, the 85108L system is considered to have PASSED the performance verification procedure if the only failed points are the 100 MHz measurements of the attenuator's S21 and S12 parameters.

Refer to Appendix D, "Avoiding the Effects of Spurs," for more information. Also, refer to multiple source settings in Appendix B , "Hardware and Instrument States," for correct source 2 offset frequency settings.

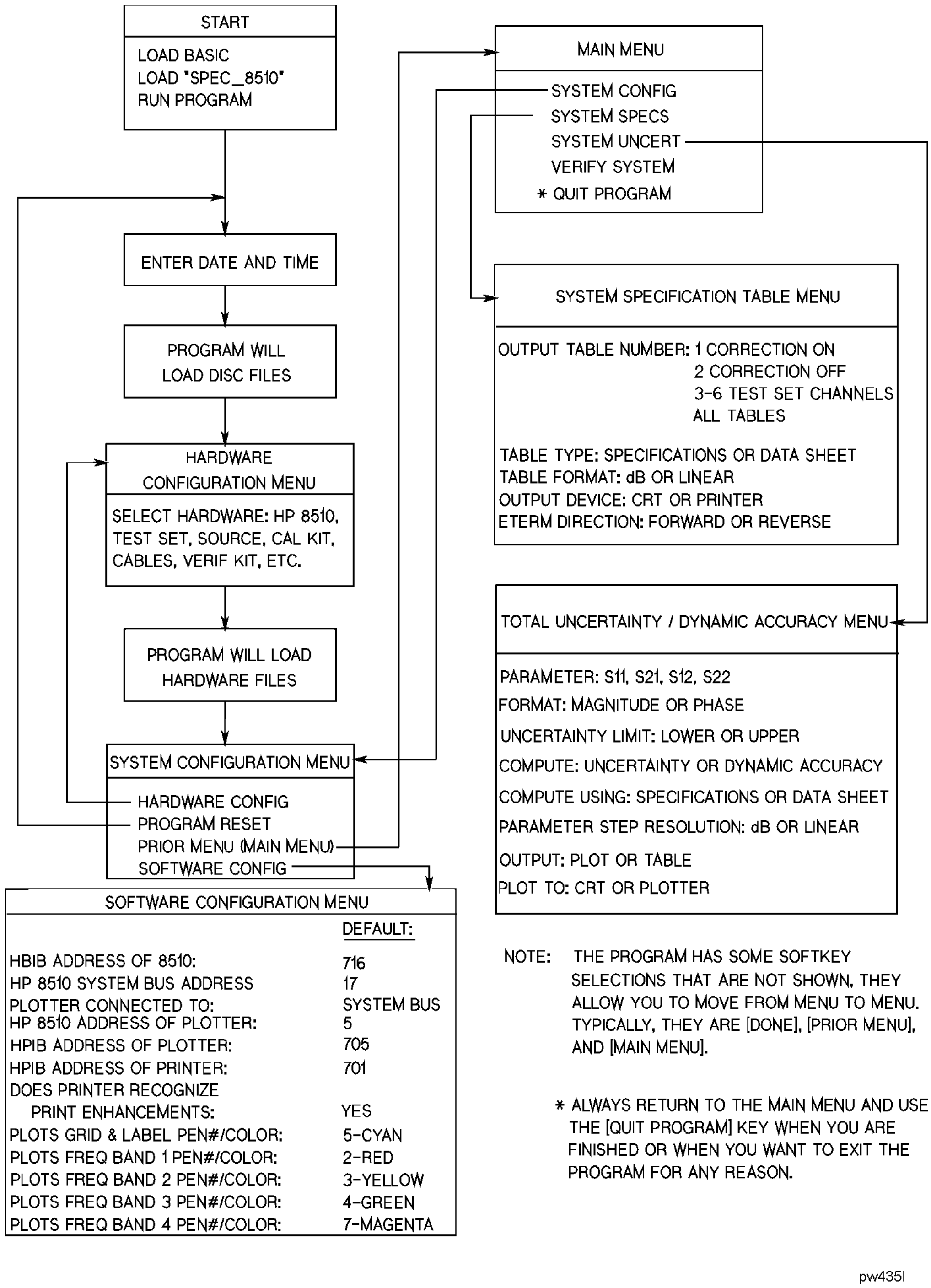
This procedure documents the verification with the system in pulsed-RF mode (wide BW detectors). Any changes to the setup for a nonpulsed-RF verification (normal BW detectors) are noted as they occur.

Performance verification of your pulsed-RF system consists of:

1. Connecting the computer and warming up the system.
2. Loading BASIC and BIN files.
3. Loading and running the performance verification software.
4. Performance testing in 7 mm:
   a. Setting the configuration.
   b. Performing a measurement calibration.
   c. Measuring the verification standards.

Figure 4-1 is a simplified flow diagram of the 8510 Specification and Performance Verification software program. The flow diagram shows the main menus and paths of the program.

Figure 4-1 Specifications and Performance Verification Flow Diagram



Required Equipment

The following items are required to verify the performance of your pulsed-RF system. For PC requirements, please refer to your 8510C service manual.

Item	Part/Model Number
Computer	HP 9000 series 200 or 300[a,b]
7 mm Calibration Kit	85050B/C/D
7 mm Verification Kit	85051B
7 mm cables (required for Full 2-port cal)	11857D
8510 Specification and Performance Verification software	08510-10033 rev. A.05.01 or higher
Basic 5.0 or higher (includes Language extensions and drivers)	order by name

a. With the addition of either the 82300C Measurement Coprocessor or the 82324A High Performance Measurement Coprocessor, the specifications and verification software can be run on an HP Vectra personal computer or AT-compatible computer.
b. The computer must have 4 megabytes of available memory (after HP BASIC has been loaded) for the performance verification program to run.

Verifying Non-Standard Systems

To verify systems that contain instruments additional to the standard system (network analyzer, two sources and the 85110L test set), disconnect all additional instruments from the system, configure the system as a pulsed-RF system (see Figure 2-1 on page 2-4), and then continue with this procedure.

Your verification may not be valid if any of your system instruments are equipped with a “special” option (usually denoted by an “H”, “E”, or “S”, on the serial number label). Refer to your special system documentation for additional information regarding performance verification.

Recommended Performance Verification Cycle

The recommended performance verification cycle for the 85108L system is once a year, initially, and after the system is repaired. You can vary the cycle time of once a year depending on the results of your performance verification. Additionally, an operation verification (frequency tests) is required every year (or after repair) on all 8360 series and 8340 series sources. Refer to the *8510C On-Site Service Manual* for the procedure.

Generating System Specifications

Specifications for the pulsed-RF system are generated using the 8510 Specification and Performance Verification Software, which is supplied with your system. To generate specifications for your system, continue with the performance verification procedure and, at the designated time, select **[SYSTEM SPECS]**.

Table 4-1, “General Characteristics,” on page 4-10 lists the general characteristics of the 85108L pulsed-RF system. General characteristics are typical, non-warranted values.

Performance Verification Procedure

Connect the computer and allow the system to warm up.

1. Connect the computer GPIB to the network analyzer GPIB. Connect a 3.5" floppy disk drive to the computer GPIB and set the disk drive GPIB address to 0.
2. Turn-on procedure:
   a. Turn on the instruments in the pulsed-RF system (network analyzer last). The system requires approximately one hour to stabilize at its operating temperature. Perform the next two steps (load BASIC and BIN files, and run the performance verification software) while the system is stabilizing.
   b. Set the network analyzer to use USER PRESET by pressing **SYSTEM [HP-IB CONFIGURE] [HP-IB USES USER PRESET]**. USER PRESET should be underlined.

Load BASIC and BIN Files

The performance verification program will run on most HP 9000 series 200 and 300 computers, except for a 9826 because of its limited CRT display.

3. BASIC loading procedure:
   a. While the computer is OFF, insert the HP BASIC language system disk in the default drive (typically 0). Then turn the computer ON.
   b. When BASIC is loaded, the drive LED will go off and a prompt will appear on the computer display: BASIC Ready. Remove the disk.
   c. Insert the Language Extensions disk in the drive and—one at a time—load the following files. For example:

      Type: LOAD BIN “ERR”

      Language Extension files: ERR, CLOCK, GRAPH, MAT, IO

      Then press CONTINUE on the computer keyboard. When the file is loaded the drive LED will go OFF. After loading all the Extensions, remove the disk. Insert the Drivers disk and load the following files in the same manner as you loaded the Extension files.

      Driver files: HPIB, (DISC and CS80 for stand alone drives)

   After loading all the drivers, remove the disk.

Run the Specifications and Performance Verification Software

4. Insert the 8510 Specification and Performance Verification software disk into the default drive or the drive you specify as the MSI (mass storage is). Type the load command and the filename as shown below, then press **RETURN** or **ENTER**. Be sure to type the filename exactly as shown.

   Type: load “SPECS_8510” **RETURN/ENTER**

   Type: run **RETURN/ENTER**

The program's title banner information and a **[RESUME]** softkey should be displayed on the computer.

```
8510 Specification and Performance Verification Software
```

Press the **[RESUME]** softkey.

5. The program will load several more files. When it has finished loading the files, a menu will appear on the computer display to allow you to set the time and date.

   Press the computer Y key and the program will continue, or press the computer N key for NO and set the date and time. When your entries are complete, press **RETURN/ENTER**.

6. The program will display the HARDWARE CONFIGURATION menu. This menu allows you to select the type of system equipment you will be using during the calibration and performance verification.

The following example shows the equipment used in a typical pulsed-RF system:

Network analyzer	8510C 008 - Wide BW Detectors[a]
Test set	85110L - 7 mm S-parameter (45 MHz to 2.0 GHz)
Source	83620B - Synthesizer (10 MHz to 2.0 GHz)
Calibration kit	85050B - 7 mm standard
Calibration technique	SL - sliding load cal
Test port cable	11857D - pair of short cables (7.0 mm to 7.0 mm)
Verification kit	85051A/B - 7.0 mm

a. Select "8510 Color Model" if you want to perform a nonpulsed-RF, normal BW system verification.

7. Select the equipment above according to the system you are going to verify. The active selection is denoted by a highlighted field on the CRT/LCD. Use the NEXT and PREVIOUS keys to change the selection in the highlighted area, if required. Use the Tab key to move to the next highlighted field.

   Make all the selections necessary until the hardware configuration is correct for your system.

NOTE Select 83620B for the 83620B Option H80 synthesizer.

8. Press the softkey labeled DONE and the program will load the files from the disk. The program will remember the last system configuration you select and, when you run it again (without turning the computer Off), the same configuration will appear on the display. You can reset the configuration by using the PROGRAM RESET softkey, found in the SYSTEM CONFIGURATION menu. The main menu will now appear on the computer display.

Here is a brief explanation of the main menu choices:

SYSTEM CONFIG	Select this menu if you want to return to the Hardware Configuration menu or if you want to use the software configuration menu to set the addresses of your 8510 or your printer/plotter, or select plotter trace pens/colors. This menu will also allow you to reset the program - all menu choices will be returned to the program's default state and the program will begin again from the time and date setting
QUIT PROGRAM	Always use this selection when you are finished using this program.
VERIFY SYSTEM	Select this menu when you want to verify system performance. Do not choose this selection until the Hardware and Software Configuration menus have been set.
SYSTEM UNCERT	Select this menu when you want to see the calculated uncertainty limits for each type of S-parameter measurement. Do not press this selection now.
SYSTEM SPECS	Select this menu to see the Specifications menu.

9. At this point, be sure you have the following items ready to use:
   - **Calibration kit and its disk.** The model number of the calibration kit must match the one you select in the Hardware Configuration menu.
   - **Verification kit and its disk.** The model number of the verification kit must match the one you select in the Hardware Configuration menu.
10. Be sure the computer is connected to the 8510.
11. Press **[VERIFY SYSTEM]**. If the program acknowledges the system over the GPIB, it will display the System Performance Verification Menu on the computer.
12. Press **[SERIAL NUMBERS]**. Enter the serial numbers and the National Institute of Standards and Technology (NIST) numbers only if you want them to appear on the printout of your performance test results for each verification device. The serial numbers of the instruments are usually located on the rear panels. NIST test numbers are on the Certificate of Calibration that accompanies your verification kit.

    When you are finished with this menu, press **[DONE]**.
13. You should now be back in the System Performance Verification Menu. Press **[SYSTEM CAL]**. The configuration information will be displayed; make sure it agrees with the system you are going to verify. If it does, press **[RESUME]** to continue. If it does not, press **PRIOR MENU** to return to the Hardware Configuration Menu and correct it.

Measurement Calibration

14. Connect the test port cables as directed by the software.
15. Load the 85108 system configuration disk.

NOTE The configuration disk files are not compatible with the 8510B network analyzer. Instead, set the hardware and instrument states manually as shown in Appendix B , "Hardware and Instrument States," and then save in instrument state register number 8 by pressing **INSTRUMENT STATE SAVE [USER PRESET * 8]**.

Insert the disk into the disk drive on the network analyzer. Press **DISC [LOAD] [MORE] [MACHINE DUMP]**. Use the RPG knob on the network analyzer to select file: MD_PULS. Press **[LOAD FILE]**. The network analyzer will load the file into the eight instrument state registers and one hardware state register. Set the hardware state and recall instrument state register eight.

16. Load the Cal Kit Disk as follows:
    a. Insert the standards definition disk and press **TAPE/DISC, [LOAD], [CAL KIT [1-2]**.
    b. Then press **[CAL KIT*1**]. Move the knob to the desired file (to match the calibration kit you are using) and press **LOAD FILE**.
    c. After the disk is loaded, remove it from the disk drive.
17. Press **CAL** to verify that the proper files were loaded. The 8510 softkey field should display the type of calibration and the revision number of the cal kit disk
18. Press **[RESUME]**.
19. The verification program initializes the system and can change some instrument states if the network analyzer was not set to use USER PRESET as instructed in step 2. For pulsed-RF system verification, these values must be reset to their initial values. The prompt `Initializing System Prior to Calibration` will be displayed on the network analyzer display. To check these values, press the following keys after the verification program has initialized the system.

NOTE Your verification will be invalid if you fail to set these states.

Power Levels

Source 1

Place the network analyzer in the normal BW, nonpulsed-RF mode by pressing:

SYSTEM [MORE] [PULSE CONFIG] DETECTOR: [NORMAL BW]

On the network analyzer, press

STIMULUS MENU [POWER MENU] [POWER SOURCE 1] [+8dBm]

If an "`IF OVERLOAD`" error message appears on the display, decrease the power level in 0.5 dB increments until an "`IF OVERLOAD`" error message no longer appears on the network analyzer.

Source 2

On the network analyzer, press **STIMULUS MENU [POWER MENU] [POWER SOURCE 2] [+10 dBm]**.

On the network analyzer, press **STIMULUS MENU [POWER MENU] [POWER SOURCE 2] [SLOPE SRC2] [ON] [2.5 dB/GHz].**

Detectors

On the network analyzer, press:

STIMULUS MENU [POWER MENU] [POWER SLOPE] [SLOPE SRC2] [ON] [2.5 dB/GHz]

On the network analyzer, press:

SYSTEM [MORE] [PULSE CONFIG] [DETECTOR:WIDE BW]

A W should appear to the left of the graticule for wide BW mode.

NOTE Select **[DETECTOR:NORMAL BW]** for nonpulsed-RF verification.

Frequency Offset

On the network analyzer, press:

SYSTEM [MORE] [EDIT MULT. SRC] [DEFINE: SOURCE 2] [OFFSET FREQUENCY] [20.000017 MHz] [x1]

Press **[DONE] [MULT. SRC: ON/SAVE]**. Leave the receiver frequency set to 20.000000 MHz.

These selections will be recalled automatically during verification.

20. Press **[RESUME]**. The program will set up the 8510 and put it into LOCAL operation so you can calibrate the system using its front panel keys.
21. Perform the calibration. The system must be warmed up for one hour before you continue. You need a Full 2-port calibration for S-parameter test sets such as the 85110.
22. On the 8510, press **CAL**. Then select the Cal Kit type by pressing the appropriate softkey on the network analyzer display.
23. Select **[Full 2-PORT]**.
24. A series of softkey selections will appear on the display: **[REFLECT'N], [TRANSMISSION],** and **[ISOLATION]**. When you press one of these keys, another set of softkeys appears. Connect each device as directed; the 8510 will underline each device label when the measurement is complete. After all of the devices are measured (for S11 and S22), press **[DONE]**.
25. Press the appropriate **DONE** softkey when the last measurement is complete. Then store the calibration in a Cal Set Register (1 through 8) by pressing the accompanying softkey. If an asterisk (*) appears alongside one of the cal set registers, it means that a calibration is already stored there. If all of the registers are full, go ahead and press a key and respond to the prompts. You will delete the contents of that register and store your calibration there.

When the calibration is complete, press the program **[RESUME]** key and the program will reset the 8510 to REMOTE operation and return you to the System Performance Verification Menu.

Measure the Verification Standards

26. Press **[SELECT STANDARD]**. The program will display the Verification Kit Device Selection Menu. This menu is a form that allows you to select the standard you want to measure, enter its serial number, change the averaging factor for measurement, select the Cal Set register, and enter any comments.

    A complete verification requires that you measure all devices in the kit. However, you must select the devices, one at a time, from the Verify Standard menu.
27. When the form is complete, press **[DONE]**. Insert the Verification Kit data disk into the network analyzer disk drive and press **[RESUME]**. The program will read the disk and compare device serial numbers. If the numbers do not match, you can change them by responding to the program prompts.

28. When you are ready to measure the verification device, press **[MEASURE DATA]** and respond to the prompts on the computer display. The program will initialize the system and give instructions for making the proper connections. Measure all of the devices in your kit.

Press **[PRINT ALL]** and the program will print a complete results sheet for the measurement of the device. If the device fails at any frequency, the letter F will appear in the column. A pass/fail notice will appear at the bottom of the sheet.

NOTE The uncertainty limits are wider (larger) when operating in the pulsed-RF, wide BW mode than when operating in the nonpulsed-RF, normal BW mode. This is due to the wider bandwidth of the IF.

29. This completes the pulsed-RF system performance verification.

General Characteristics

Table 4-1 lists the general characteristics of the 85108L pulsed-RF system. General characteristics are typical, non-warranted values and are included for user information.

Table 4-1 General Characteristics

Rise Time	10% to 90% of the test and reference channel detectors: 300 nanoseconds.
Setting Time	The time required for a ratioed, high-leveled measurement to reach within 0.1 dB of its final value when the system is in pulse profile mode.
Equivalent Measurement Bandwidth	The effective post-detection bandwidth of the test and reference detectors in the 8510.
Trigger Level	TTL
Trigger Width	The minimum pulse width to be applied to the rear panel input of the 8510 for the 8510 to make a measurement. (External trigger mode: 100 nanoseconds)
Minimum Time Delay	The minimum time span of the x-axis of the 8510 display in pulse profile mode: 5 nanoseconds.
Maximum Time Delay	The maximum time span of the x-axis of the 8510 display in pulse profile mode: 40 milliseconds.

5 Adjustments

Overview

This section contains the procedures for adjusting the pulse detector boards (A3 and A4) in the 85102 IF detector. These boards must be adjusted for minimum circularity error when they are replaced, swapped with each other, or when the 85102 IF detector is upgraded to include pulsed-RF capability (using the 8511B upgrade kit).

Equipment Required

The following equipment is required (in addition to the system instruments) to perform the pulse detector adjustments.

Item	**Agilent Part/Model Number**
RF source (CW sinewave, 20.1 MHz, –10 to –15 dBm	3324A, 3325, 8340/41B, 8360 series[1]
Test cable (required for the adjustment procedure, included in the 85111A/B upgrade kits	85111A-60001
Adapters[2]	
Type-N (m) to BNC (f)	1250-0780
SMA (m) to BNC (m)	1250-1787
BNC (f) to BNC (f)	1250-0080
Type-N (m) to BNC (f)	1250-0077

1. Only those that will provide 20.1 MHz.
2. Some combination of these adapters may be required to use the test cable with your source in the adjustment procedure.

A3/A4 Detector Adjustment

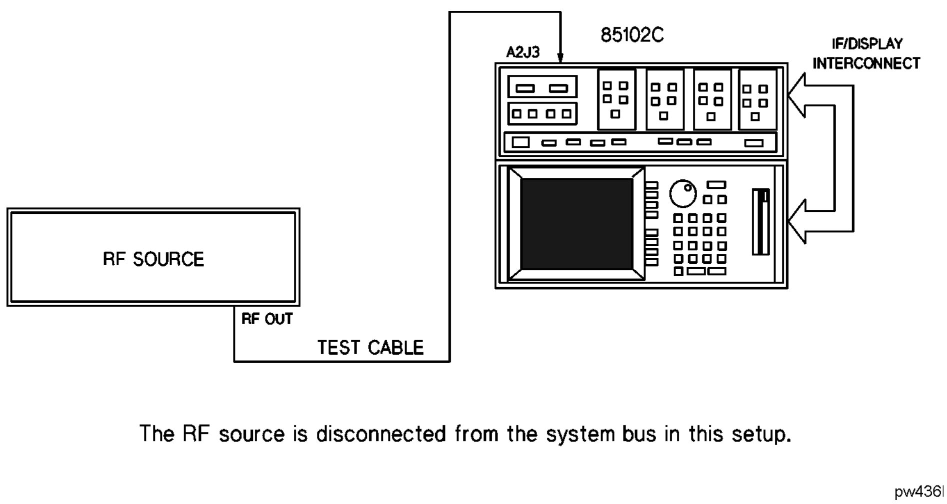
The A3 and A4 pulse detector boards in the 85102 IF detector must be adjusted after installation for minimum circularity error. Follow the procedure below to make this adjustment.

Configure your system as show in Figure 5-1. This is the standard pulsed-RF system configuration except that a connection is made from the RF source to the A2 assembly, and the RF source is disconnected from the system bus.

NOTE For benchtop configurations, notice that the 85102 IF detector is placed on top of the 85101 display/processor for the adjustment procedure.

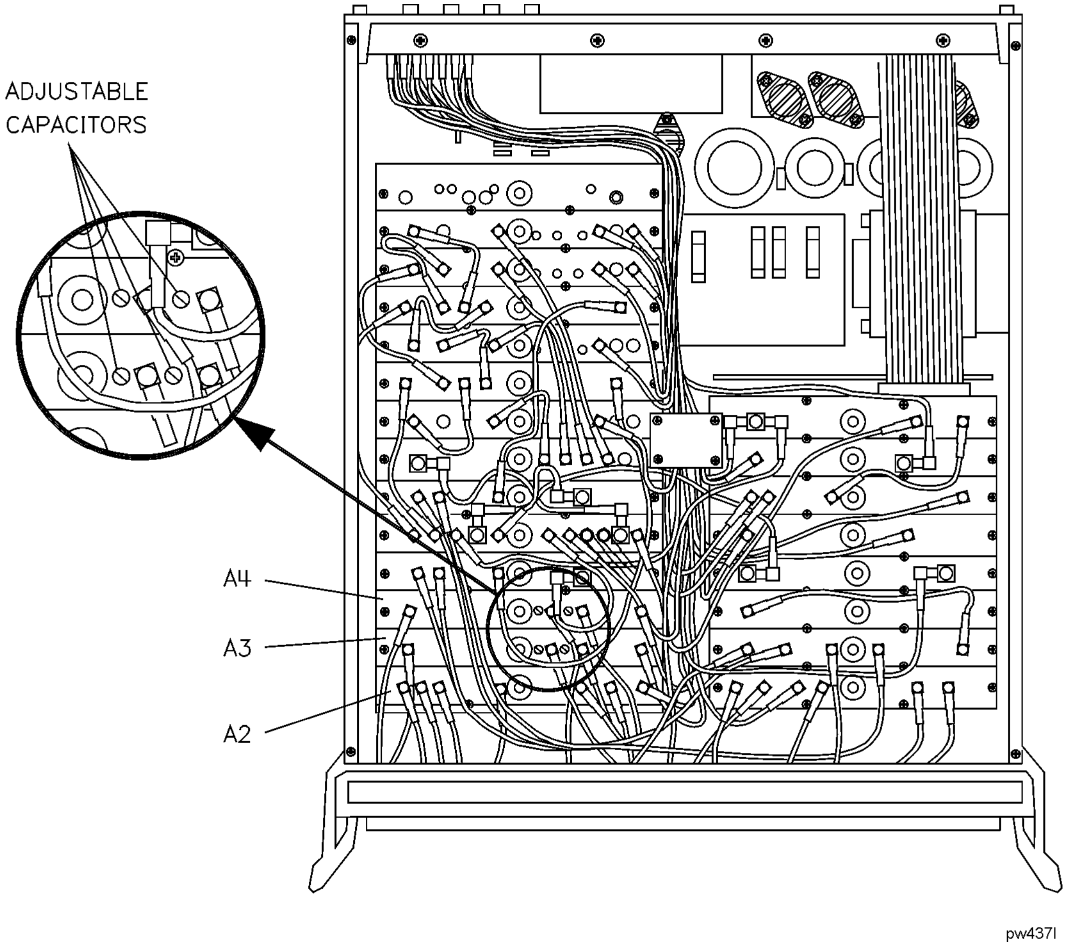
Use the test cable and the SMA to SMB adapter to make the connection from the source output to the A2 board in the 85102B.

Figure 5-1 Adjustment Procedure Setup



NOTE All of the pulsed-RF system instruments can remain connected in the system during the adjustment procedure as long as they are powered OFF during the adjustment procedure. Only the instruments used in Figure 5-1 should be powered ON for the adjustment procedure.

Figure 5-2 A2 IF MUX Board Connections



1. For racked systems, remove the rack mounting screws from the front of the 85102B. Slide the instrument forward slightly to give you access to the A2, A3, and A4 boards (refer to Figure 5-2).

NOTE For benchtop configurations, the 85102 is placed on top of the 85101 display/processor for easy access to the pulsed-RF boards.

2. Turn all the instruments off and move the top cover of the 85102B back to allow access to the A2, A3, and A4 boards only. (Keeping the 85102 partially covered maintains the operating temperature as close as possible to operating temperature with the cover fully on.)
3. Turn on all instruments in the adjustment setup and allow the equipment to warm up for at least one hour.
4. On the 8510, press **DOMAIN [PULSE PROFILE]**. Ignore the `SYSTEM BUS ADDRESS ERROR` on the network analyzer display.
5. Set the source for a power level between –10 and –15 dBm, and a CW frequency of 20.1 MHz.
6. Use the test cable to connect the RF source output to A2J3 (disconnect the cable that is currently to A2J3).

7. On the 8510, press:

   PARAMETER MENU [USER 2 b2]

   RESPONSE REF VALUE [MARKER]

   RESPONSE SCALE [.] [0] [2] [X1]

   SYSTEM [RESET IF CORRECTION]

   STIMULUS MENU [NUM PTS] [101]

8. Adjust the two variable ceramic capacitors, located on the A3 Pulse Detector board near J2 and J3, for minimum ripple (refer to Figure 5-2). Press **[RESET IF CORRECTION]**. See Figure 5-3 and Figure 5-4 for typical network analyzer display traces. Re-center the trace by changing the Reference Value if necessary.

NOTE Noise can sometimes make this adjustment appear temporarily out of specification. Ignore non-repeatable spikes.

9. Move the test cable to J5 on the A2 IF MUX board (refer to Figure 5-2) and replace the original cable on J3. Repeat this procedure from step 6 substituting **[USER 3 a2]** for **[USER 2 b2]**. Adjust the capacitors on the A4 Pulse Detector board instead of the board. The ripple should be <0.06 dB peak-to-peak after **[RESET IF CORRECTION]**.

10. When the A3 and A4 boards have been adjusted, turn the instrument OFF, remove the test cable and replace the original cable on J5. Replace the top cover on the IF/detector. Reconnect the system bus cables to the sources. Reconfigure the network analyzer with the display/processor on top of the IF/detector.

This completes the adjustment procedure. Continue with “Operational Tests” on page 3-5.

Figure 5-3 Misadjusted Pulse Detector Display Trace

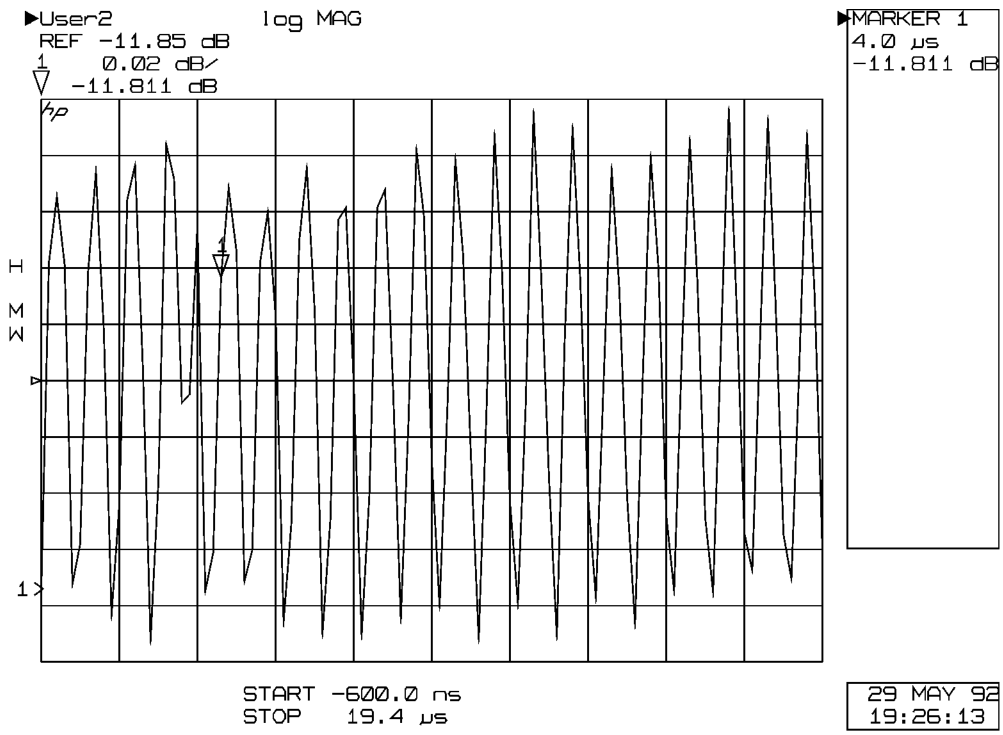
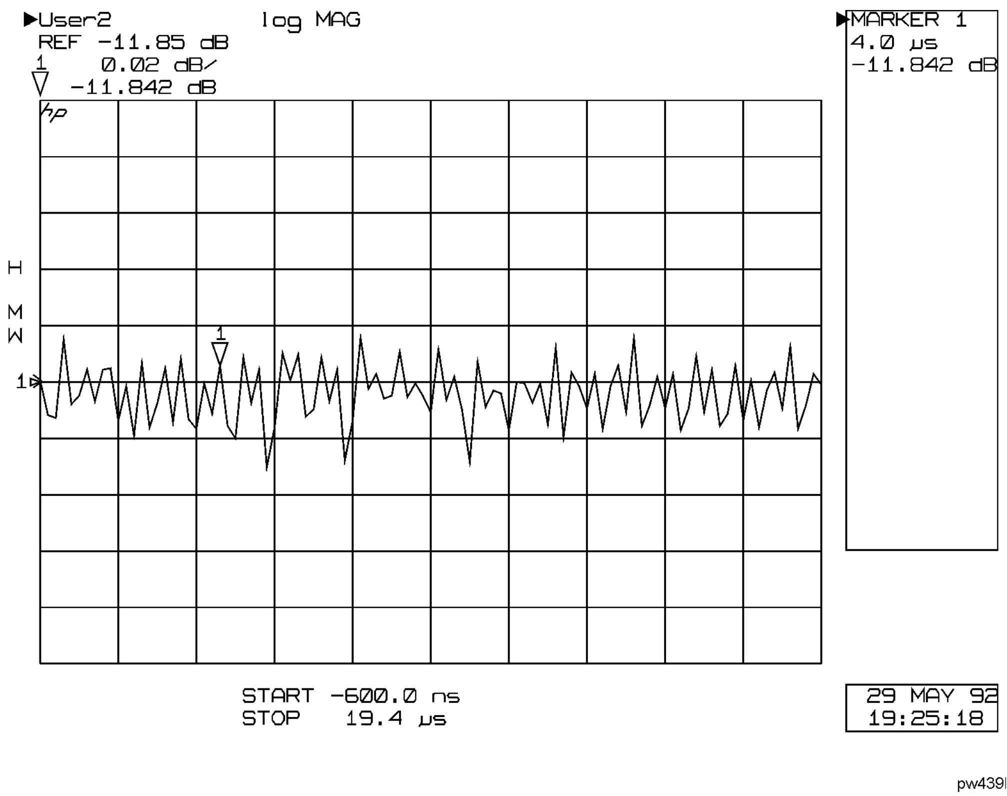


Figure 5-4 Adjusted Pulse Detector Display Trace



6 System Service and Troubleshooting

Overview

This section provides troubleshooting information for the racked, factory-configured pulsed-RF network analyzer system, which may also be useful for similar user-configured systems. It provides board/assembly level information for the features that are unique to wide BW, pulsed-RF operation and the 85102 Option 008. For operation in the normal BW, nonpulsed-RF mode, refer to the *8510C On-Site Service Manual* for board/assembly level service information.

For additional troubleshooting assistance:

- a block diagram of the system and a block diagram of the IF detector, including the pulsed-RF portion, are included at the end of this section.
- contact an Agilent customer engineer who can provide service support for your pulsed-RF network analyzer system. See "Contacting Agilent" on page iv.

Documentation Required

Additional information and troubleshooting procedures are contained in the following manuals:

- *8510C On-Site Service Manual* (part number 08510-90282)
- *85110L Operating and Service Manual* (part number 85110-90048)
- *8360 Series Troubleshooting Manual*

Troubleshooting Strategy

1. Note the symptoms of the failure

Write down the failure now while it is still fresh in your mind.

- What are the symptoms?
- Is the failure constant or intermittent?
- Does the failure always occur under a fixed set of conditions?

2. Check the system setup

The system setup check verifies that the system cabling, firmware revisions, GPIB addresses, and operating languages are correct.

Perform this procedure with the instruments turned off.

1. Use the cabling diagrams on page 2-13 as you verify the system connection for correct location and tightness.
2. Use Table 6-1 as you verify the system settings.

Table 6-1 System Setup Check Table

Check:		Should be:	Additional information:
Rear panel settings	Line voltage	Set to local line voltage	See rear panels of each instrument
	Fuse size	Appropriate for the line voltage	See rear panels of each instrument
Operating system firmware revision	8510C	C.06.50 or higher	See the label on the operating system disk
	85102B (if used)	B.05.11 or higher	See the label on the operating system disk
	8360 series	08 Mar.91 or later	See 8360 series source check
8510 system bus address	RF source in 8360	LANG = 001 ADDRESS = 10010 (binary)	See 8360 series system bus
	LO source is 8360	LANG = 001 ADDRESS = 10010 (binary)	See 8340/41 source check
	RF source if 8340B or 8341B	19 (decimal) address check	See 8340/41 source
	LO source if 8340B or 8341B	18 (decimal) address check	See 8340/41 source
Controller GPIB bus address	3.5 inch drive	700 (decimal)	See your disk drive manual for GPIB address switch location
	8510	716 (decimal)	Checked after power up

8360 Series Source Check
Software, Revision, Language, and GPIB Address

When an 8360 series source is used with an 8510 based network analyzer system, it must be set to the "analyzer" language.

The language and GPIB address of the 8360 series sources can be set using either of two methods: rear panel switches, and front panel keys. The procedure given below sets the GPIB address to 19 (the address of RF source 1).

Rear Panel Switch Method

1. Turn on the source.
2. On the network analyzer, press:

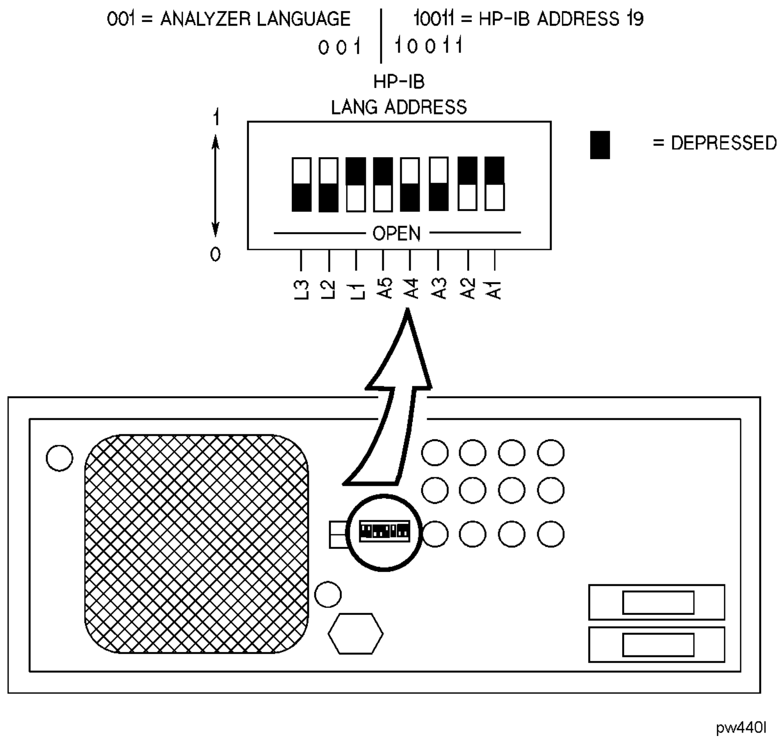
SYSTEM MENU	
[GPIB MENU]	
[ANALYZER]	(an * will appear indicating the selection.)
[ADRS MENU]	(top line of display shows the language and software revision: LANG: ANALYZER, ADRS=nn, REV dd mm yy
[8360 ADRS]	(top line of display shows: HP-IB ADDRESS:nn SELECTED)
Entry 1 9 ENTER	(top line of display shows: HP-IB ADDRESS:19 SELECTED)

3. Turn the source off.

Front Panel Keys Method

Set the rear panel switches on the source as shown in Figure 6-1.

Figure 6-1 8360 Series Source Rear Panel Switches



8340/41 Source GPIB Address Check

These sources are set by front panel keys. The procedure sets the source GPIB address to 19 (the address of RF source 1).

Procedure

1. Turn on the source.
2. Press **SHIFT LOCAL 1 9 HZ.**
3. Turn the source off.

3. Use error messages and internal diagnostics

The network analyzer has built-in self-tests that run automatically at power up. They can locate many problems in the system. If there is a failure of any of the self-tests, a message appears on the display.

During normal operation, the network analyzer continually monitors its operation. When a failure or abnormal operation is detected, a “running error” message is sent to the display.

The following procedure takes advantage of the network analyzer’s built-in self-tests and monitoring to help locate a failure.

This procedure assumes that the proper instrument states and hardware states have been loaded from the configuration disk into the network analyzer. If not, refer to Appendix C, “Loading the System Configuration Disk,” for instructions to load the proper machine dump configuration file.

1. Start with the line power OFF to all instruments.
2. Switch the line power ON to the instruments in the following order:
    - Microwave amplifier (if used)
    - Sources
    - Test set
    - 85102
    - 85101
3. As you turn on each instrument, watch the front-panel indicators for performance as shown in Table 6-2. If an instrument does not power up properly, refer to the service manual for that instrument for troubleshooting information.
4. If the 85101 does not complete the power on sequence, refer to “Network Analyzer Startup Problems” on page 6-10.
5. If a “running error” message appears on the network analyzer display after the power on sequence is completed, not the error and then press the **ENTRY OFF** key. If the error message repeats, refer to “Running Error Messages Specific to Pulsed-RF Systems” on page 6-8.

Table 6-2 Instrument Power On Sequence

Instrument Being Powered On	At Initial Power On	After Self-Test Is Complete (Approximately 5 Seconds)	After 85101C Is Powered On*
8360 series			
line power	ON	ON	ON
Instr check	ON	OFF	OFF
GPIB status			
R	ON	OFF	ON
S	ON	OFF	BLINKING
85110L			
line power	ON	ON	ON
a1	ON	ON	ON
a2	ON	OFF	OFF
85102			
line power	ON	OFF	ON
Channel 1	ON	ON	ON
Channel 2	ON	ON	OFF

* 85101C follows this power on sequence:

a.RLTS8421 LEDs all ON, then OFF
b.Same LEDs light to indicate the number of the self-test being run
c.Display shows: TESTING
d.Display shows: LOADING OPERATING SYSTEM
e.Disk drive is briefly active
f.Display shows: RECALLING INSTRUMENT STATE
g.Display shows: graticule and trace

Running Error Messages Specific to Pulsed-RF Systems

The following running error messages are specific to pulsed-RF systems. If your system shows a different running error message than is listed here, refer to the *8510C On-Site Service Manual* for an explanation.

Error Message	Probable Cause of Failure	Troubleshooting
PULSE CAL FAILURE ON TEST/REFERENCE CHANNEL(S)[1]	• 85102 A2 multiplexer board • 85102 A3 and A4 test and reference channel detector boards • 85102 A16 sample and hold board	
PULSE CAL FAILURE ON BOTH CHANNELS	• 85102 A6 clock board • 85102 A2 multiplexer board • 85102 A16 sample and hold board	Remove W52 from A2J4 and check the output at A2J4 with an oscilloscope. The output should be about 0.6 peak-to-peak into the 1 MOhm input impedance of the oscilloscope. If the output is missing or much lower than typical, replace the A8 Clock board.
UNABLE TO LOCK TO EXT 10 MHZ REF[2] This error message indicates the 10 MHz external input to the 85106 A6 clock assembly is more than +500 Hz off frequency. The level should be > 0 dBm. If the external input is off frequency or is less than 0 dBm, the A6 assembly sets the LIFSRQ low, alerting the CPU to the unlocked condition.	• A6 clock assembly erroneously set LIFSRQ low • A6 clock LIFSRQ signal is pulled low along the way to the 85101 A5 CPU • +5 V input to the 85102 A6 clock is intermittent	• Run the 85102 Service Program tests in the “run all” mode. • Check the 10 MHz input signal frequency and amplitude that you are applying to the rear panel of the 85102. • Refer to your source troubleshooting manual for the 10 MHz RF output level.

1. This error message reports a failure detected in the pulsed-RF circuitry.
2. This message is not applicable unless you are locking to an external source such as in a multiple source network analyzer system.

4. Use specific procedures for certain symptomatic failures

If the symptoms of the failure are only present when the system is operating in the wide BW, pulsed-RF mode, the following procedures may help determine the failure. If the symptoms are present in both wide BW pulsed-RF and normal BW nonpulsed-RF operation, refer to the troubleshooting section of the *8510C On-Site Service Manual* for troubleshooting information.

Power loss, power holes, and frequency related problems	Use the “Unratioed Power Levels Check” in the *8510C Operating and Service Manual*.
Calibration and verification problems	Failure to pass verification of the 40 or 50 dB attenuators while passing the 20 dB attenuator, airline and stepped impedance standard may be caused by incorrect setting of the offset frequency for source 2 in the multiple source setup. The correct offset frequency is 20.000017 MHz.
Software/firmware problems	If your hardware appears to be working properly but the system is not working the way you expect it to, reload the operating system software. If this does not correct the problem, you may have encountered a software “bug”. Determine the exact key sequence and/or setup that causes the failure and then contact Agilent for assistance.

Network Analyzer Startup Problems

If the 85101C does not complete the power on sequence, turn its power off for 10 seconds and then turn the power on. Note at what point in the power on sequence the procedure stops.

Power on sequence:

a.RLTS8421 LEDs all ON, then OFF

b.Same LEDs light to indicate the number of the self-test being run

c.Display shows: `TESTING`

d.Display shows: `LOADING OPERATING SYSTEM`

e.Disk drive is briefly active

f.Display shows: `RECALLING INSTRUMENT STATE`

g.Display shows: graticule and trace

If one or more self-tests fail, the network analyzer will show an “`INTERNAL SELF TESTS HAVE REPORTED A FAILURE`” message. Refer to the “Self-Test Failure” section of the *8510C On-Site Service Manual*.

If the hang-up failure occurs anywhere in steps a, b, or c of the sequence, check the power supplies (refer to the troubleshooting section of the *8510C On-Site Service Manual* for a procedure). If the power supplies are working properly, remove all instruments from the network analyzer system bus and GPIB bus, and power on the network analyzer. If the network analyzer then completes the power on sequence and display a graticule (disregarding any running error messages), one of the other instruments or a GPIB cable is defective. If the network analyzer still does not complete its power on sequence, refer to “Contacting Agilent” on page iv for service support.

Reloading the Operating System

If the failure occurs during steps d through g, the failure may be in the loaded operating system. Try loading the operating system from disk using the following procedure:

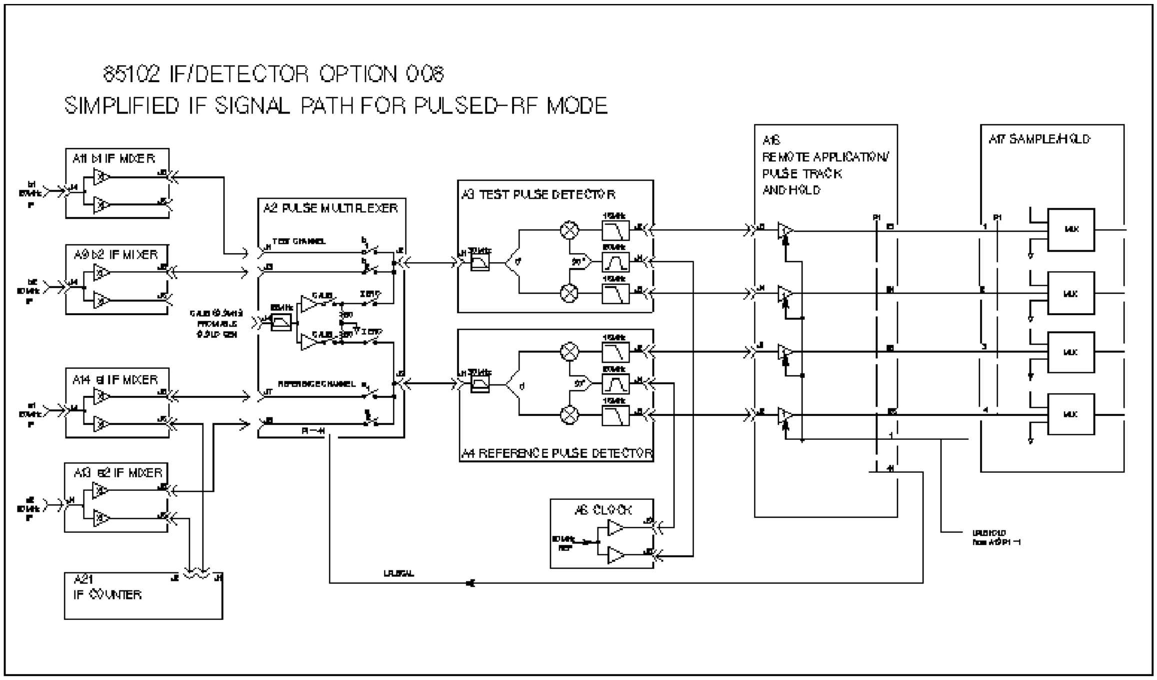
1. Turn on the 85101C while holding down a key in the entry key area of the 85101. This will force a self-test failure and bring up the error message display.
2. Press **=MARKER** to bring up the self-test menu.
3. Insert the operating system disk into the drive.
4. Press **1 9 =MARKER** and a disk directory will be shown.
5. Select the operating system file using the RPG knob, and then press LOAD FILE to load the operating system from disk.

Pulsed-RF IF Signal Path Description

Refer to Figure 6-2, “85102 Pulsed-RF Signal Path,” as you read the following description.

IF Mixer Boards (A9, A11, A13, A14)	The pulsed-RF IF path separates from the normal IF path on the IF mixer boards. On each IF mixer board the pulsed-RF IF signal flows through a buffer amplifier to the output connect J5.
A2 Pulse IF MUX Board	The pulsed-RF IF signals travel through coaxial cables to the input of the A2 Pulse IF MUX board. Firmware controlled switches select either b1 or b2 test IF signals for output at J2, and either a1 or a2 reference IF signal for output at J6. An additional function of the A2 purse IF MUX board allows connection of a 19.9 MHz calibration signal into the test and reference IF signal paths during IF calibration.
Pulse Detector Boards	The test IF signal continues from A2J2 to A3J1 of the A3 Pulse detector board. The reference IF signal continues from A2J6 to A4J1 of the A4 Pulse detector board. The detectors on the A3 and A4 boards generate X and Y vector signals from the test and reference IF signals. A 20 MHz reference signal for the detectors is supplied by the A6 clock board. The X output is at J2 and the Y output at J3 on each board.
A16 Remote Application / Pulse Track and Hold Board	The X and Y test signals enter A16 at J3 and J4 respectively. The X and Y reference signals enter at J1 and J2 respectively. The signals are fed into track and hold circuits. The outputs of the T/H circuits are sent on to the A17 Sample/Hold board multiplexer circuits. At the multiplexer circuits the signal paths converge to be the same as the normal BW, nonpulsed-RF paths

Figure 6-2 85102 Pulsed-RF Signal Path

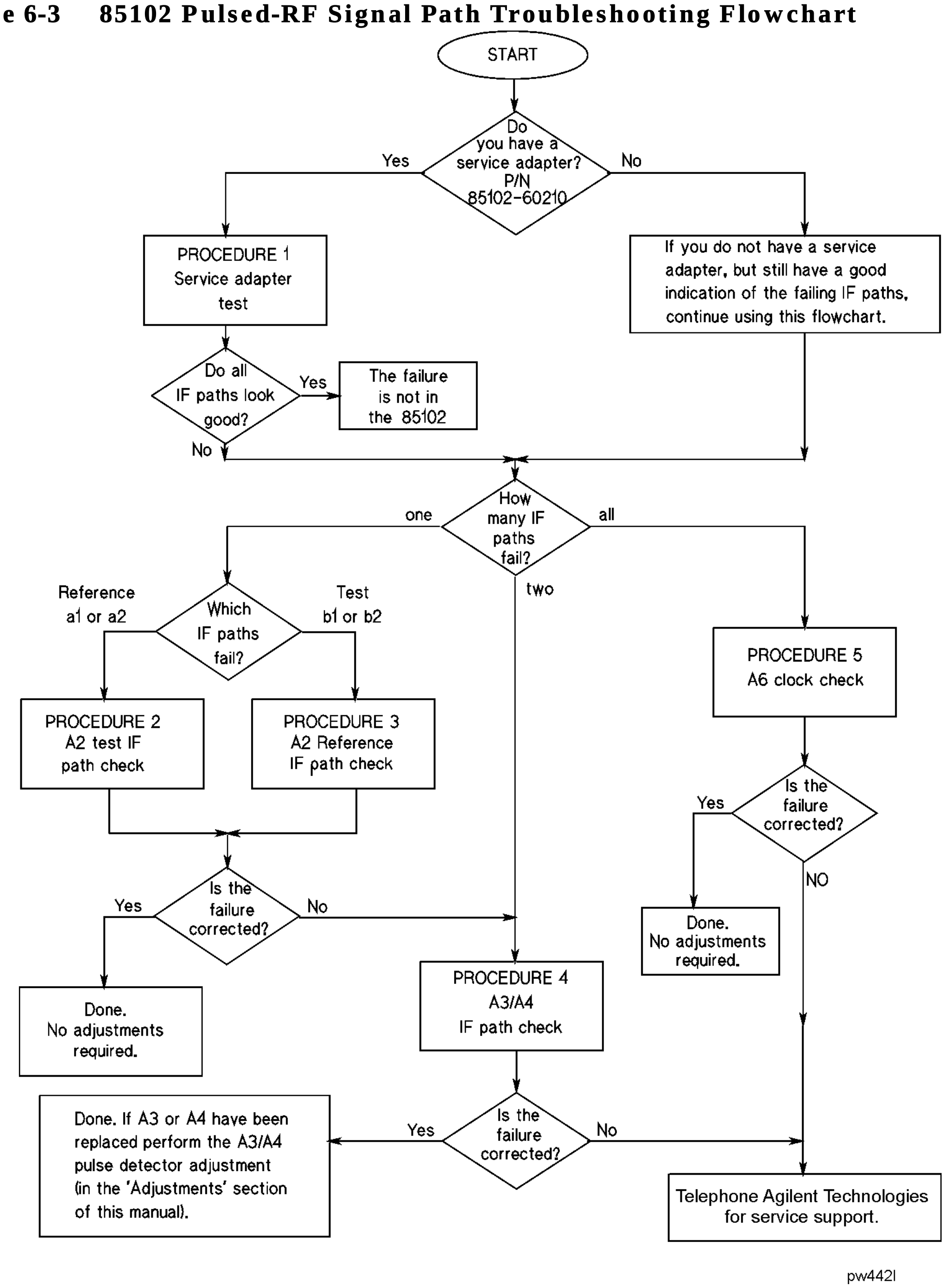


pw441l

85108 IF/Detector Option 008 Pulsed-RF IF Path Troubleshooting Flowchart

Use this troubleshooting flowchart when the problem has been isolated to the IF/detector. If the problem is present during both normal BW and wide BW modes of operation, do not use this flowchart; refer to the troubleshooting section of the *8510C On-Site Service Manual*. This flowchart addresses only the boards and cable unique to pulsed-RF operation. Each procedure is detailed on the following pages.

Figure 6-3 85102 Pulsed-RF Signal Path Troubleshooting Flowchart



Procedure 1. Service Test Adapter

If one or more user channels appear faulty, the problem could be with the source, test set, or the 85102 IF/detector. The service adapter is a source/test set emulator. It provides the same 20 MHz signal to the 85102 as the test set and source thus indicating whether or not the problem is in the 85102 IF/detector.

Equipment

- Service adapter (85102-60210)
- BNC cable

Service Adapter Procedure

1. Connect the 85102 service adapter to the 85102 rear panel 20 MHZ OUT connector and the J2 IF-DISPLAY INTERCONNECT connector.
2. Press **RECALL [MORE] [FACTORY PRESET] MARKER STIMULUS MENU [STEP]**.
3. Press **PARAMETER MENU** and look at the unratioed power of each user channel (User1 through User4). The traces should be flat lines, and all four channels should look similar.

Conclusions

If all of the channels look good (with the service adapter), and all looked bad in the unratioed power test, the 85101 and 85102 are working. The problem is likely source related. Refer to your source troubleshooting manual for further information.

- If all four User channels look bad (with the service adapter), suspect the 20MHz signal from the A6 clock board assembly in the 85102.
- Single channel problems suggest the IF mixer board corresponding to the User function (channel a1, b1, a2, or b2) is faulty. Refer to Figure 6-5, “85102B IF-Detector Block Diagram (1 of 2).”.
- Multiply channel problems indicate the problem is most likely in the 85102 circuitry after the IF Mixer boards.

Procedure 2: A2 Pulse IF MUX Test IF Path Check

Use this check only if the b1 or the b2 pulsed-RF IF signal path looks bad.

NOTE In the following two procedures, always return any moved cables to their original connections before proceeding to the next step.

If the connections/setup correct the problem, carry out the instructions in the conclusion column. If the problem isn't corrected, proceed to the next step.

b1 IF Signal Path Check

Step	Connections/Setup	Conclusion (if the problem is corrected)
1	Move W55 cable on A11J5 to A11J6	replace A11 IF Mixer board
2	Move W46 cable on A2J7 to A2J1	replace W55 (A11J5 to A2J1)
3	If b2 IF signal is okay	replace A2 pulse IF MUX board
4	Return to the pulsed-RF troubleshooting flowchart	

b2 IF Signal Path Check

Step	Connections/Setup	Conclusion (if the problem is corrected)
1	Move W53 cable on A9J5 to A9J6	replace A9 IF Mixer board
2	Move W46 cable on A2J5 to A2J3	replace W53 (A9J5 to A2J3)
3	If b1 IF signal is okay	replace A2 pulse IF MUX board
4	Return to the pulsed-RF troubleshooting flowchart	

Procedure 3: A2 Pulse IF MUX Test IF Path Check

Use this check only if the a1 or the a2 pulsed-RF IF signal path looks bad.

If the connections/setup correct the problem, carry out the instructions in the conclusion column. If the problem isn't corrected, proceed to the next step.

NOTE Always return any moved cables to their original connections before proceeding to the next step.

a1 IF Signal Path Check

Step	Connections/Setup	Conclusion (if the problem is corrected)
1	Move W45 cable on A14J5 to A14J6	replace IF Mixer board
2	Move W46 cable on A2J5 to A2J7. Redefine a2 to: DRIVE: PORT1	replace W45 (A14J5 to A14J7)
3	Redefine a2 to: DRIVE: PORT2. If a2 IF signal is okay	replace A2 pulse IF MUX board
4	Return to the pulsed-RF troubleshooting flowchart	

a2 IF Signal Path Check

Step	Connections/Setup	Conclusion (if the problem is corrected)
1	Move W46 cable on A13J5 to A13J6	replace A13 IF Mixer board
2	Move W45 cable on A2J7 to A2J5. Redefine a2 to: DRIVE: PORT2	replace W46 (A13J5 to A2J5)
3	Redefine a21to: DRIVE: PORT1 If a1 IF signal is okay	replace A2 pulse IF MUX board
4	Return to the pulsed-RF troubleshooting flowchart	

Procedure 4: A3 / A4 Pulse Detector IF Path Check

Use this check if:

- Either both reference (a1 & a2) or both (b1 & b2) pulsed-RF IF signal paths look bad.
- Less than three IF paths are bad.

If the connections/setup correct the problem, carry out the instructions in the conclusion column. If the problem isn't corrected, proceed to the next step.

NOTE Always return any moved cables to their original connections before proceeding to the next step.

Step	Connections/Setup	Conclusion (if the problem is corrected)
1	Swap cables W50 & W51.	If the problem was in the ref. (a1 & a2), replace W50. If the problem was in the test (b1 & b2) path, replace W51.
2	Move W51 on A2J2 to A2J6. Move W50 on A2J6 to A2J2. Move W54 on A16J1 to A16J3. Move W47 on A16J3 to A16J1. Move W43 on A16J2 to A16J4. Move W48 on A16J4 to A16J2.	Go to Step 3.
3	**NOTE** Do this step only if the problem was corrected in step 2. Swap cables W47 & W54. Swap cables W48 & W43.	If the problem was in the ref. (a1 & a2) path, determine which cable is bad (W43 or W54) and replace it. If the problem was in the test (b1 & b2) path, determine which cable is bad (W47 or W48) and replace it.
4	Swap cables W5 & W49.	If the problem was in the ref (a1 & a2) path, replace W5. If the problem was in the test (b1 & b2) path, replace W49.
5	Put in a known good A16 board.	Replace A16.
6	Put in a known good A17 board.	Replace A17.
7	Return to the troubleshooting flowchart.	

Procedure 5: A6 Clock 20 MHz Output Check

1. Disconnect the cable W5 or W54 at A6J9 or J8 and connect an oscilloscope to A6J8 or J9.

   The output should typically be about 1.8 volts peak to peak into the 1 MOhm oscilloscope input impedance. The output voltage drops to about 1.2 volts peak-to-peak when connected to the pulse detector via W5 or W54.

   A6J7 connects to the 20 MHz output on the rear panel and provides the same signal level.

2. If the signal is missing or greatly differs between J8, J9, and J7, replace the A6 Clock board.

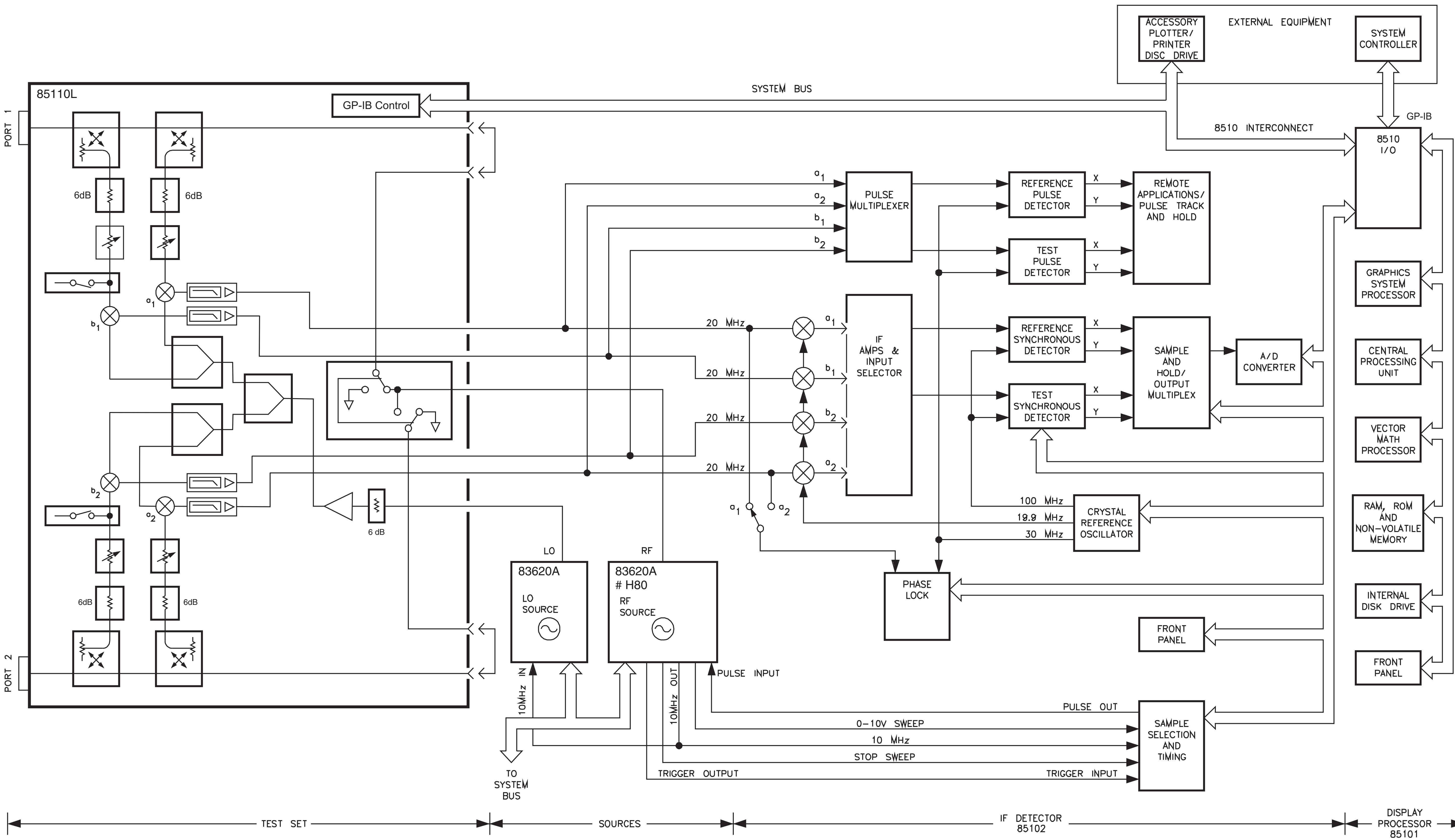
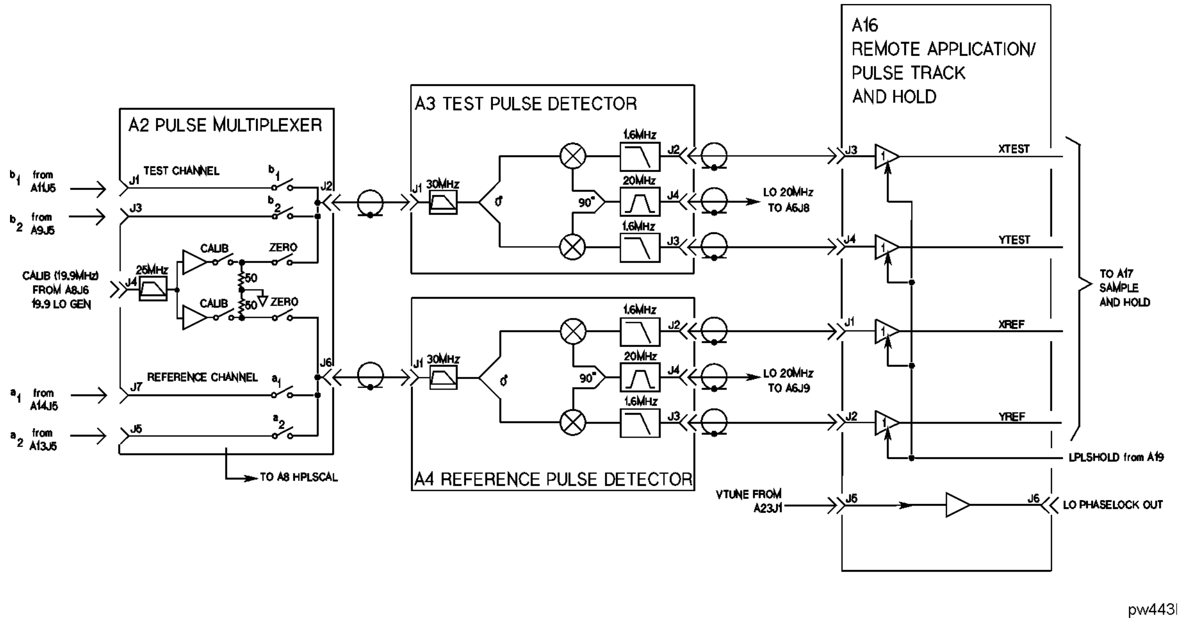


Figure 6-4. 85108L Block Diagram

pw447l

Figure 6-5 85102B IF-Detector Block Diagram

Figure 6-6 IF Detector with Pulse Option Block Diagram (2 of 2)

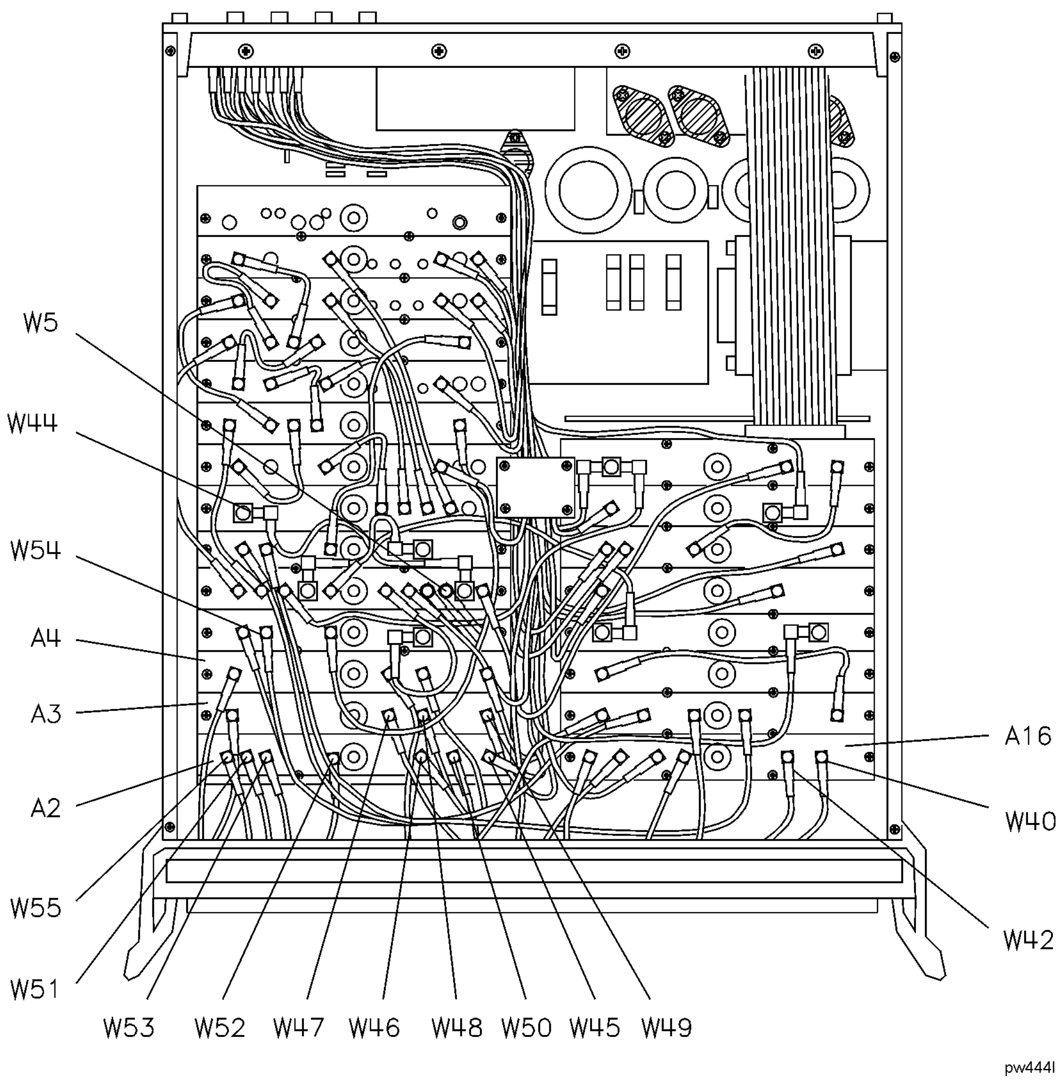


7 Replaceable Parts

Ordering Information

This section contains information for ordering replaceable parts that are unique to the pulsed-RF portion of the 85108 system. Refer to the individual instrument manuals for a complete replacement parts listing. See "Contacting Agilent" on page iv for ordering information.

Figure 7-1 85108L Replaceable Parts



Ref Desig	Quantity	Description	Agilent Part Number
Board Assemblies			
A2	1	Board Assembly, Pulse MUX	85102-60002
A3, A4	2	Board Assembly, Pulse Det	85102-60003
A16	1	Board Assembly, Remote App	85102-60016
Cable Assemblies			
W5	1	Cable Assembly, A6J9 to A4J4	85102-60135
W40	1	Cable Assembly, A16J6 to RPJ9	85102-60249
W42	1	Cable Assembly, A16J5 to A23J1	85102-60248
W43	1	Cable Assembly, A4J3 to A16J2	85102-60173
W44	1	Cable Assembly, A6J10 to A8J1	85102-60174
W45	1	Cable Assembly, A14J5 to A2J7	85102-60175
W46	1	Cable Assembly, A13J5 to A2J5	85102-60176
W47	1	Cable Assembly, A3J2 to A16J3	85102-60177
W48	1	Cable Assembly, A3J3 to A16J4	85102-60178
W49	1	Cable Assembly, A6J8 to A3J4	85102-60179
W50	1	Cable Assembly, A2J6 to A4J1	85102-60180
W51	1	Cable Assembly, A2J2 to A3J1	85102-60181
W52	1	Cable Assembly, A8J6 to A2J4	85102-60182
W53	1	Cable Assembly, A9J5 to A2J3	85102-60173
W54	1	Cable Assembly, A4J2 to A16J1	85102-60172
W55	1	Cable Assembly, A11J5 to A2J1	85102-60170
Documentation (not pictured)			
	1	85108 System Manual	85108-90036
	1	8510 Manual Set	08510-90275
	1	8360 Series Manual Set	83624-90007
	1	85110 Test Set Manual	85110-90048
Touch-Up Paint			
		Dove gray - use on the frame around the front panel and painted portions of front handles.	6010-1146
	1	French gray - use on covers.	6010-1147

Ref Desig	Quantity	Description	Agilent Part Number
	1	Parchment gray - use on the rack mount flanges, rack support shelves, and front panel	6010-1148
System Rack Parts			
	1	System cabinet assembly	85106-60002
	1	Filler panel - right	85043-00028
	1	Filler panel - left	85043-00029
	1	Work surface assembly	85043-00030
	2	Support rail	85043-00031
	1	Blank panel 1.75 in	85043-00046
	2	Blank panel 5.25 in	85043-00048
	1	Ground stud	85043-20001
	1	Shoulder screw	85043-20002
	1	Clip - table lock	85043-20003
	1	Mat kit -antistatic	85043-80013
	2	Fan grill	85043-00019
	2	Plug - painted	85043-00022
	2	Air filter PF30 PPI	85043-00026
Miscellaneous			
1	6	GPIB cable	8120-3445
2	1	Test set interface cable	08510-60106
3	1	BNC cables	8120-1838
	2	BNC cable, 48 inch	8120-1840
4	1	Semi-rigid RF cable	85108-20028
5	1	Semi-rigid RF cable	85108-20029
6	2	Adapter, N(m) to SMA(f)	1250-1894
7	3	Rack mount kit	5062-4071
8	1	8510 Operating and Service Firmware	85101-80116
9	1	85108 System Configuration Disk	85108-10003
10	1	8510 Performance Verification Software	08510-10033

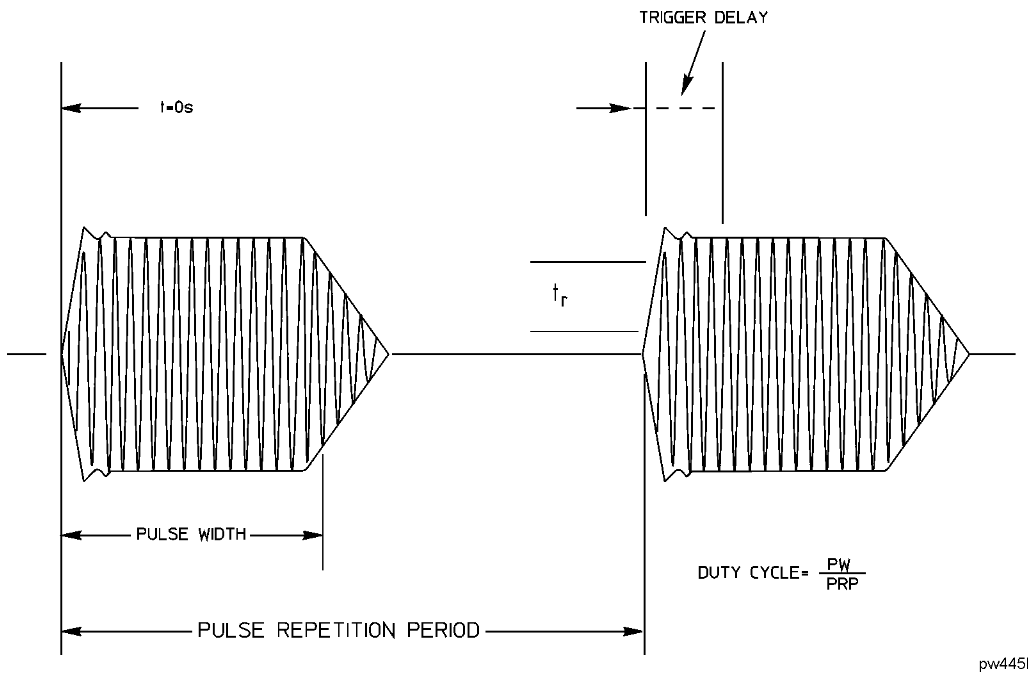
A Glossary of Pulsed-RF System Terms

This appendix includes a list of terms and their definitions used in Chapter 3, "Operation." Figure A-1, "Pulse Terms and Definitions," relates these terms to a typical envelope of the pulsed-RF waveform output by the RF signal source.

Term	Definition
Duty Cycle	The ratio of the time that the pulse is ON to the total pulse repetition period. If the pulse ON and OFF times are equal, the duty cycle is 50 percent. For internal operation, the maximum duty cycle percent limit can be specified, but the actual duty cycle may be less, depending on the user-specified pulse width and the time it take for the analyzer to set up for the next measurement.
Pulse Profile Measurement Resolution Period	The time between adjacent pulse profile domain data points. The minimum is 100 nanoseconds. This is set by an algorithm depending on the pulse profile stop time, pulse width, and number of time points.
Pulse Repetition Frequency, PRF	PRF = 1 / PRP
Pulse Repetition Period, PRP	The time from the 50 percent point on the rising edge of one pulse to the 50 percent point on the rising edge of the next pulse. For internal triggering operation, the system PRP depends on the instrument state. Typically there is one pulse per measurement. The pulse is turned ON for a user-specified time and the measurement is made at some user-specified time relative to the start of the pulse. The time until the next pulse consists first, if necessary, the time waiting to satisfy the user-specified pulse width and duty cycle limit. In the frequency domain, when the analyzer is tuned to the next frequency, the maximum PRP is about 30 milliseconds. In the pulse profile domain, the frequency does not change, making the maximum PRP about 3 milliseconds. With averaging, the PRP can be about 1 millisecond during part of the measurement. Other factors which affect the system PRP are calibration type, pulse width, duty cycle, and pulse profile domain stop time. If the PRP is controlled externally, the analyzer's external trigger input is used to synchronize the analyzer with the pulse.
Pulse Width	The ON time from the 50 percent point on the rising edge to the 50 percent point on the falling edge. The internally-generated pulse width can be set from less than 100 nanoseconds to 40.88 milliseconds.
Rise / Fall Time	tr = pulse rise time, the time it takes for the pulse to rise from the 10 percent ON condition to the 90 percent ON condition. tf = pulse fall time, the time it takes for the pulse to fall from the 90 percent ON condition to the ten percent ON condition. The normal IF responds to rise / fall times of about 75 microseconds; the wideband IF responds to rise / fall times of about 300 nanoseconds.

Term	Definition
Trigger Delay	The time after pulse ON that the measurement is actually made. In the frequency domain, the trigger delay can be set from – 6 resolution periods (internal) or +3 resolution periods (external and up to 40.88 milliseconds. In the pulse profile domain the trigger delay is automatic depending on the display time span, pulse width, and number of points.

Figure A-1 Pulse Terms and Definitions



B Hardware and Instrument States

This appendix contains information on:

- GPIB addresses of the pulsed-RF system instruments (Table B-1).
- Hardware states specific to the pulsed-RF system (Table B-2).
- Instrument states specific to the pulsed-RF system (Table B-3).
- Multiple source setup for the pulsed-RF system (Table B-4).
- Procedures for examining your network analyzer setup (Table B-5).

Table B-1 GPIB Address Specific to Pulse-RF Systems

8510 System Bus	System Bus Addresses	
	During Pulsed-RF Operation	**During 2nd Test Set Operation**
Test set	20	21
RF switch	31	28[a]
Address of 8510	16	
System bus	17	
Source #1 (RF)	19	
Source #2 (LO)	18	
Plotter	5	
Printer	1	
Disk	0	
Pass-thru	31	

a. If you have Option 001 in your test set and a second test set connected, the RF switch address can be left a 28 for both pulsed-RF operation and second test set operation.

Table B-2 Hardware States Specific to the Pulsed-RF System

System Parameter	During Pulsed-RF Operation	During Operation of 2nd Test Set
System phaselock	None	Internal
Multiple source	On / Save	Off
Leveling source #1	Internal	Internal
Leveling source #2	Internal	N/A
Sweep mode	STEP or FRQ LIST	Any

Table B-3 Instrument States Specific to the Pulsed-RF System

System Parameter	Pulsed-RF	CW
Power source #1	+8 dBm[a]	10 dBm
Power slope src 1	OFF	OFF
Power source #2	10 dBm[b]	N/A
Power slope src 2	2.5 dB / GHz	N/A
Pulse config detector	wide BW[c]	normal BW

a. Set source 1 power to the highest level possible without IF overload. Power must be set in the "normal BW" mode, then changed to the "wide BW" mode, if desired.
b. Set source #2 power to –10 dBm if an 8349B amplifier is used to amplify the LO signal.
c. Set to normal BW for nonpulsed-RF operation.

Table B-4 Multiple Source Settings for the Pulsed-RF System

Define	Settings
Source 1	Mult. Numer. = 1 Mult. Denom. = 1 Offset Frequency = 0.000000000 GHz
Source 2	Mult. Numer. = 1 Mult. Denom. = 1 Offset Frequency = 0.020000017 GHz
Receiver	Constant frequency = 0.020000000 GHz

Examining Your Pulse Hardware and Instrument State

Use the following key sequence to examine the hardware and instrument states residing in your network analyzer. These are the settings for the pulsed-RF configuration file on the 85108L system configuration disk (refer to Appendix C, “Loading the System Configuration Disk”).

Table B-5 Network Analyzer Settings

To Check Analyzer Settings	Press These Keys on the Network Analyzer
GPIB Addresses	**SYSTEM [HP-IB ADDRESS]** Press the softkey of each instrument in your system. Refer to Table B-1 for the correct GPIB address settings of the instruments in your system.
Multiple Source	**SYSTEM [MORE] [EDIT MULT. SRC.]** **[DEFINE SOURCE 1]** **[MULTIPLIER NUMER.]** should be 1. **[MULTIPLIER DENOM.]** should be 1. **[OFFSET FREQUENCY]** should be 0. **[DONE]** **[DEFINE SOURCE 2]** **[MULTIPLIER NUMER.]** should be 1. **[MULTIPLIER DENOM.]** should be 1. **[OFFSET FREQUENCY]** should be 20.000017 MHz. **[DONE]** **[DEFINE RECEIVER]** **[CONSTANT FREQUENCY]** should be 20 MHz. Press **[DONE] [MULT.SRC: ON /SAVE]**. (An **M** annotation should appear to the left of the graticule.)
Power Source	**STIMULUS MENU [POWER MENU]** **[POWER SOURCE1]** should be +8 dBm.[a] **[POWER SOURCE 2]** should be +10 dBm.
Sweep Mode	**STIMULUS MENU [STEP]** **SYSTEM [MORE] [PULSE CONFIG] [DETECTOR: WIDE BW]**[b] (A W annotation should appear to the left of the graticule.) **[PULSE OUT: HIGH]** **SYSTEM [MORE] [SYSTEM PHASELOCK] [NONE]** **SYSTEM [MORE] [POWER LEVELING]** **[SOURCE1: INTERNAL]** **[SOURCE2: INTERNAL]**

a. Set source 1 power to the highest level possible without IF overload. Power must be set in the “normal BW” mode, then changed to the “wide BW” mode, if desired.
b. Set to normal BW for nonpulsed-RF operation.

C Loading the System Configuration Disk

The 85108L system configuration disk contains files for pulsed-RF configuration and two nonpulsed-RF configurations. Refer to Table C-1 for 8510C firmware revision C.06.5x, or Table C-2 for 8510C firmware revision C.07.xx to select the appropriate file for your system.

Table C-1 85108L System Configuration Disk Files - 8510C Firmware Revision C.06.5x[1] to C.06.99 (p/n 85108-10007)

File Name	Description of Configuration	
	Source(s)	**Detectors and mode**
MD_PULS	Multiple	Wide BW pulsed-RF mode
MD_NPULS	Multiple	Normal BW nonpulsed-RF mode
MD_SINGSRC[2]	Single	Normal BW nonpulsed-RF mode

1. x denotes any digit as acceptable.
2. This configuration requires a single source, and a test set that provides an LO signal such as the 8514, 8515, 8516, or 8517. Refer to Chapter 9, “System Installation,” in the *8510C On-Site Service Manual* (p/n 08510-90282) for a configuration diagram.

Table C-2 85108L System Configuration Disk Files - 8510C Firmware Revision C.07.xx[1] or higher (p/n 85108-10008)

File Name	Description of Configuration	
	Source(s)	**Detectors and mode**
MD_LOWPLS	Multiple	Wide BW pulsed-RF mode
MD_LOWNPLS	Multiple	Normal BW nonpulsed-RF mode
MD_SINGSRC[2]	Single	Normal BW nonpulsed-RF mode

1. x denotes any digit as acceptable.
2. This configuration requires a single source, and a test set that provides an LO signal, such as the 8514, 8515, 8516, or 8517.

Procedure

1. Insert the 85108L System Configuration disk into the disk drive of the network analyzer. On the network analyzer, press **TAPE/DISC [LOAD] [MORE] [MACHINE DUMP]**. Use the knob to select the appropriate file, and press **[LOAD FILE]**.
2. Remove the disk when it has finished loading. Instrument State 8 (the power-up state) of the loaded file will be recalled automatically.

D Avoiding the Effects of Spurs

Spurious Responses

There are measurement frequencies at which combinations of LO and RF frequencies will potentially produce measurement results that are not desirable. This is due to the spurious responses (harmonics) created by the LO and RF mixing process. This information is presented so that, if the user requires measurements at those frequencies, the LO and RF frequencies can be adjusted to eliminate the spurious response that can cause measurement errors.

Spurious responses occur at harmonics of the 20 MHz 85110L IF frequency (n ∗ 20 MHz). The effect of the spurious response is an increase in noise content at multiples of 20 MHz, specifically at 60 MHz, 80 MHz, and 100 MHz. These effects can raise the noise floor to about –60 dBm at 100 MHz, less at higher multiples of 20 MHz. When making S_{21} and S_{12} measurements on high loss devices, these spurious responses may impact the accuracy of the measurements. *To eliminate these effects, move the measurement frequency up or down by at least 100 kHz*.

Of these frequencies, 100 MHz is the only frequency measured during the performance verification process. The excess noise will cause the performance verification program to indicate failure for both the 20 and 50 dB attenuator's S_{21} and S_{12} measurements at 100 MHz (the first point). This failure is expected, so the 85108L system is considered to have PASSED the performance verification procedure if the only failed points are the 100 MHz measurements of the attenuator's S_{21} and S_{12} parameters.

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