

# **Agilent Technologies Z5623A Option H86**

## **User's and Service Guide**

**Use this manual with the following documents:**

PNA Series Network Analyzer On-line Help System

Application Note 1408-12



**Agilent Technologies**

**Manufacturing Part Number: Z5623-90069**

**Printed in USA**

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## Safety Notes

The following safety notes are used throughout this manual. Familiarize yourself with each of the notes and its meaning before operating this instrument. All pertinent safety notes for using this product are located in [Chapter 2, “Safety and Regulatory Information,”](#) on page 70.

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**WARNING**      **Warning denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.**

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**CAUTION**      Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, could result in damage to or destruction of the instrument. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

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## Definitions

- *Specifications* describe the performance of parameters covered by the product warranty (temperature - 0 to 55 °C, unless otherwise noted.)
- *Typical* describes additional product performance information that is not covered by the product warranty. It is performance beyond specification that 80% of the units exhibit with a 95% confidence level over the temperature range 20 to 30 °C. Typical performance does not include measurement uncertainty.
- *Nominal* values indicate expected performance, or describe product performance that is useful in the application of the product, but is not covered by the product warranty.



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## **Z5623A Option H86**

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## Description

The [Agilent Technologies Z5623A Option H86](#) is a 2 to 40 GHz Forward Direction Pulse Test Set. When connected to the E8363B or E8364B PNA Series Network Analyzer with option H08 (Pulse) and H11 (IF access), pulse measurements from 2 GHz to 40 GHz can be made depending on the PNA and Band Pass filter. The Z5623A Option H86 can be configured in many ways. The Bypass configuration allows the user to use the E8363B or E8364B PNA Series Network Analyzer from 10 MHz to 50 GHz depending on the analyzer. This mode bypasses the test sets internal 2 GHz to 40 GHz pin modulator switch. In the pulse mode the user can configure the test set for their application needs to either make straight un-conditioned pulse measurements or permit the insertion of high power amplifiers and other signal conditioning equipment to allow high power measurements at RF levels up to 20 Watts (+43 dBm) from 10 MHz to 40 GHz and 10 Watts (+40 dBm) from 40 GHz to 50 GHz.

Control of the Z5623A Option H86 forward direction pulse test set can be performed either by GPIB or directly. Both methods control the port 1 internal switches and attenuator. Direct control requires the user to connect the port 1 37-pin D-sub connectors located on the rear panel. Both GPIB and direct control cannot be used simultaneously. When used in the direct control mode the test sets front panel LCD indicator may differ from the user setup.

High power configurations require that attenuators and isolators be connected to the test ports and receivers in order to protect the E8363B or E8364B PNA Series Network Analyzer. The Agilent E8363BH85 and E8364BH85 High Power Configurable PNA Series Network Analyzer when ordered with the Option H08 and H11 can be used for high power pulse measurement applications. More information on the setup and configuration of the Agilent E8363BH85 and E8364BH85 PNA Series Network Analyzer can be found in manual p/n E8364-90027 Microwave PNA Series High Power Configurable Test Set Option H85.

The instrument is shipped from the factory with jumper cables installed on the front panel in what is called the Shipped Configuration.

Two filters are also shipped with the Test Set. The filters are used externally. These filters are used to eliminate video feed thru from the PIN switch. The filters are banded. The low frequency highpass filter (Z5623-80027) allows pulse measurements between 2 to 20 GHz. The high frequency band filter (Z5623-80042) allows pulse measurements between 20 and 40 GHz. See Pulse Configurations Setups.

The pulse test set can be used from 400 MHz to 2 GHz but is not specified. No band pass filter is provided. If pulse measurements below 2 GHz are required, the user must provide an appropriate high pass filter for that band.



If any pulse measurements are required using a frequency band that includes frequencies above and below 20 GHz, the user must supply a bandpass filter for that band or make two separate measurements.

Install the instrument so that the ON/OFF switch is readily identifiable and is easily reached by the operator. The ON/OFF switch or the detachable power cord is the instrument disconnecting device; it disconnects the mains circuit from the mains supply before other parts of the instrument. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

## Verifying the Shipment

After the test set has been unpacked, keep the original packaging materials so they can be used if you need to transport the instrument.

Check the items received against [Table 1](#) to make sure you have received everything.

Inspect the test set and all accessories for any signs of damage that may have occurred during shipment. If your test set or any accessories appear to be damaged or missing, refer to [“Contacting Agilent Sales and Service Offices” on page 75](#).

**Table 1**      **Content List**

Agilent Part Number	Description	Qty
0955-0608	μ-Wave Term 40 GHz, 1 Watt	2
1250-2330	3.5 mm M to 2.4 mm M Adapter	1
1250-0774	BNC Short	1
5063-9226	Kit — Front Handles	1
5063-9232	Kit — Rack Mount	1
5063-9805	Cable Assembly 2.4 mm, 6 in.	1
5065-9872	RCVR Jumper	1
5065-9873	Source In Jumper	1
5065-9874	CPLR THRU Jumper	1
E8364-20059	Front Panel Jumper (attached)	3
Power Cord	See <a href="#">Figure 4 on page 8</a>	1
Z5623-10014	Pulse Test Set Control Programs Disk	1
Z5623-20519	Coaxial Cable (2.4 - 3.5 male, 6 in)	1
Z5623-60202	37-Pin D-SUB Jumper	1
Z5623-80027	2-20 GHz (highpass filter)	1
Z5623-80042	20-40 GHz (bandpass filter)	1
Z5623-90069	User's and Service Guide	1

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## General Information

### Environmental:

Operating Temperature Range	0 to 40 °C
Non-Operating Temperature Range	-40 to 70 °C
Operating Humidity Range	Maximum relative humidity 80% for temperatures up to 31 °C decreasing linearly to 50% relative humidity at 40 °C (unless specified otherwise).
Non-Operating Humidity Range	Maximum relative humidity 90% for temperatures up to 65 °C (non condensing).
Operating Altitude	3000 meters (9840 ft)
Non-Operating Altitude	15,240 meters (50,000 ft)
EMC	Meets the conducted and radiated interference and immunity requirements of IEC/EN 61326-1. Meets radiated emission requirements of CISPR Pub 11/1997 Group 1 Class A.
Indoor/Outdoor Use	Indoor Use (unless specified otherwise)  This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2, per IEC 61010-1 Second Edition and 664 respectively.

### Power Requirements:

Frequency	50 to 60 Hz
Voltage	100/115/230/240VAC
Power	40 Watts

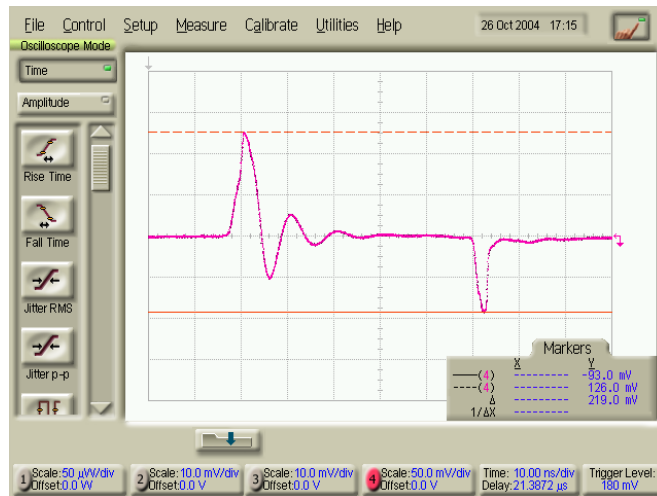
### Weights and Dimensions:

Net Weight	9.1 kg (20 lb)
Dimensions	Height: 9 cm (3.54 in) Width: 42.5 cm (16.7 in) Depth: 50 cm (19.7 in)

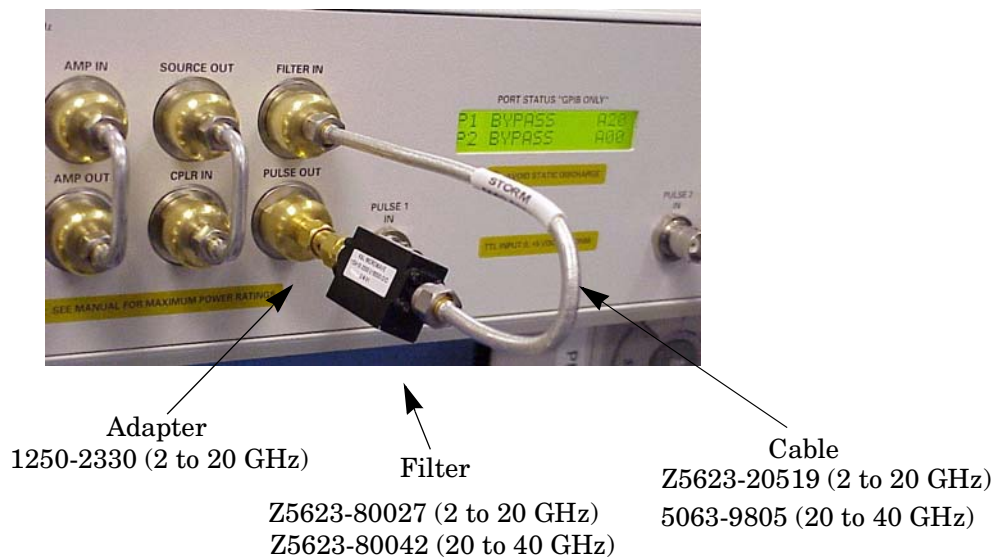
## Video Feed Through

Video leakage refers to the spurious signals present at the RF ports of the switch when it is switched without an RF signal present. These signals arise from the waveforms generated by the switch driver and, in particular, from the leading edge voltage spike required for high speed switching of PIN diodes. When measured into a 50 Ω system, the magnitude of the video leakage can be as much as several volts. The frequency content is concentrated in the band below 250 MHz, although measurable levels can be observed as high as several GHz. The magnitude of the video leakage can be reduced significantly by adding a high pass filter in the RF path Pulse Out to Filter In. The picture below shows the leading and trailing edges of video feed through.

**Figure 1 Video Filter**



**Figure 2 Video Filter and Parts**



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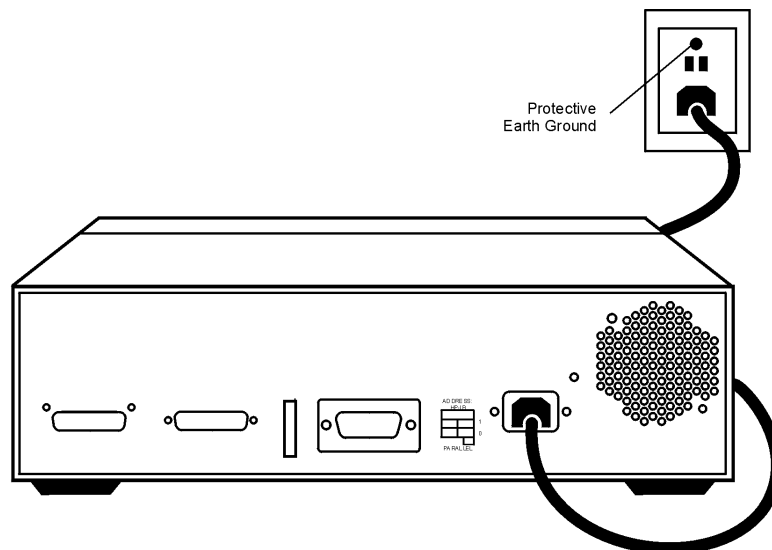
## Electrical Preparations

1. Ensure that the “[Power Requirements:](#)” on page 5 are met.
2. Verify that the power cable is not damaged and that the power source outlet provides a protective earth ground contact. Note that [Figure 3](#) depicts only one type of power source outlet. Refer to [Figure 4](#) to see the different types of power cord plugs that can be used with your test set.

Cables are available in different lengths. For descriptions and part numbers of cables other than those described in [Figure 4](#), Refer to “[Contacting Agilent Sales and Service Offices](#)” on page 75.

3. 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.

**Figure 3** Protective Earth Ground

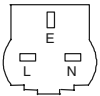

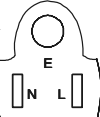
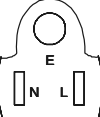
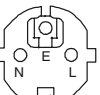
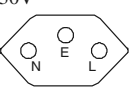

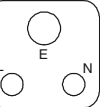



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### WARNING

**This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted into a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption of the protective conductor is prohibited.**

**Figure 4 Power Cables**

Plug Type <sup>a</sup>	Cable Part Number	Plug <sup>b</sup> Description	Length cm (in.)	Cable Color	For Use in Country
250V 	8120-8705	Straight BS 1363A	229 (90)	Mint Gray	Option 900 United Kingdom, Hong Kong, Cyprus, Nigeria, Singapore, Zimbabwe
	8120-8709	90°	229 (90)	Mint Gray	
250V 	8120-1369	Straight AS 3112	210 (79)	Gray	Option 901 Argentina, Australia, New Zealand, Mainland China
	8120-0696	90°	200 (78)	Gray	
125V 	8120-1378	Straight NEMA 5-15P	203 (80)	Jade Gray	Option 903 United States, Canada, Brazil, Colombia, Mexico, Philippines, Saudi Arabia, Taiwan
	8120-1521	90°	203 (80)	Jade Gray	
125V 	8120-4753	Straight NEMA 5-15P	229 (90)	Gray	Option 918 Japan
	8120-4754	90°	229 (90)	Gray	
250V 	8120-1689	Straight CEE 7/VII	200 (78)	Mint Gray	Option 902 Continental Europe, Central African Republic, United Arab Republic
	8120-1692	90°	200 (78)	Mint Gray	
230V 	8120-2104	Straight SEV Type 12	200 (78)	Gray	Option 906 Switzerland
	8120-2296	90°	200 (78)	Gray	
220V 	8120-2956	Straight SR 107-2-D	200 (78)	Gray	Option 912 Denmark
	8120-2957	90°	200 (78)	Gray	
250V 	8120-4211	Straight IEC 83-B1	200 (78)	Mint Gray	Option 917 South Africa, India
	8120-4600	90°	200 (78)	Mint Gray	
250V 	8120-5182	Straight SI 32	200 (78)	Jade Gray	Option 919 Israel
	8120-5181	90°	200 (78)	Jade Gray	

a. E = earth ground, L = line, and N = neutral.

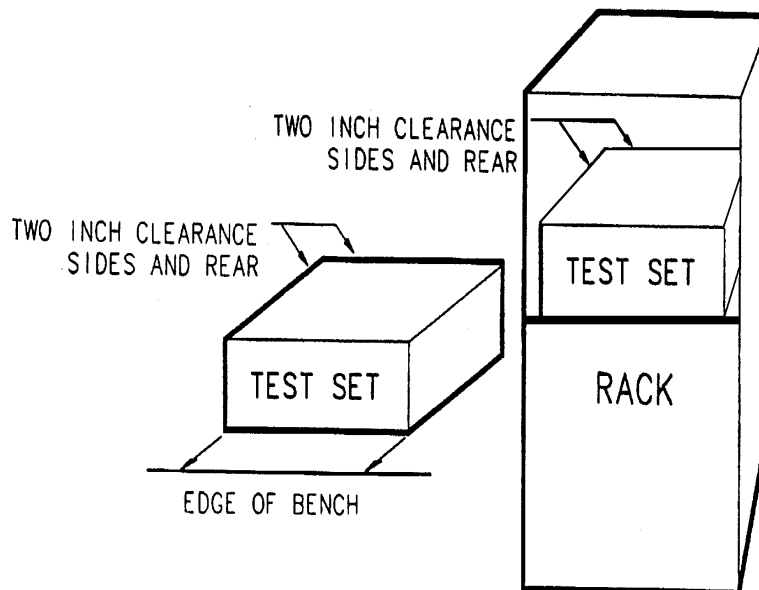
b. Plug identifier numbers describe the plug only. The Agilent Technologies part number is for the complete cable assembly.

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## Environmental Preparations

1. Ensure that the “[Electrical Preparations](#)” on page 7 are met.
2. If you are installing the test set into a cabinet, ensure there are at least two inches of clearance around the sides and back of the test set and the system cabinet. See [Figure 5](#). The convection into and out of the test set must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the test set by 4 °C for every 100 watts dissipated in the cabinet.

**Figure 5** Ventilation Clearance Requirements



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**CAUTION**

If the total power dissipated in the cabinet is greater than 800 watts, forced convection must be used.

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## Electrostatic Discharge Protection

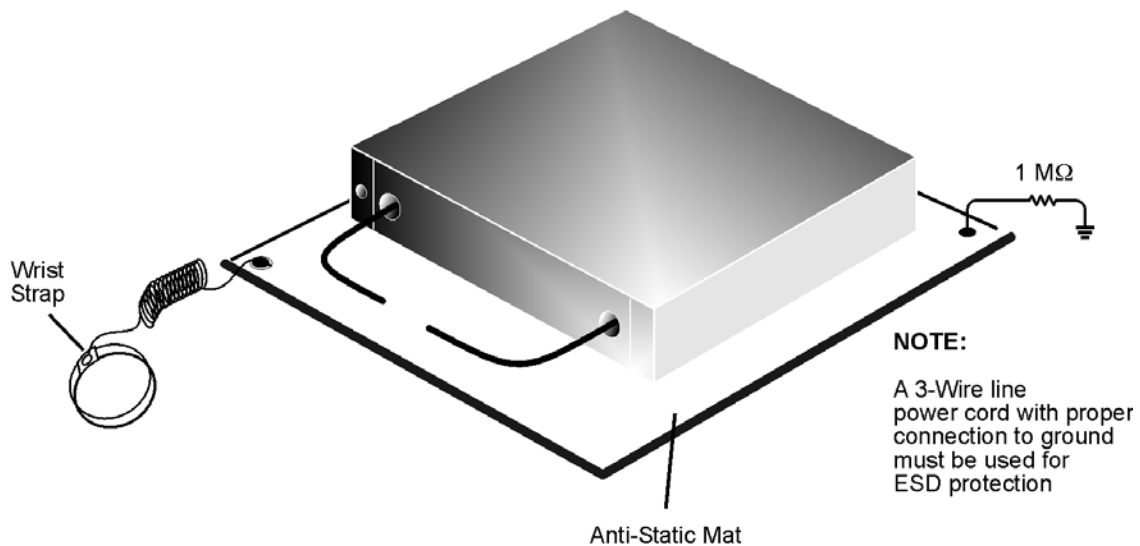
Protection against electrostatic discharge (ESD) is essential while removing or connecting cables or assemblies within the network analyzer.

Static electricity can build up on your body and can easily damage sensitive internal circuit elements when discharged. Static discharges too small to be felt can cause permanent damage. To prevent damage to the instrument:

- *always* wear a grounded wrist strap having a 1 M $\Omega$  resistor in series with it when handling components and assemblies.
- *always* use a grounded, conductive table mat while working on the instrument.
- *always* wear a heel strap when working in an area with a conductive floor. If you are uncertain about the conductivity of your floor, wear a heel strap.

Figure 6 shows a typical ESD protection setup using a grounded mat and wrist strap.

**Figure 6** ESD Protection Setup



esd\_setup



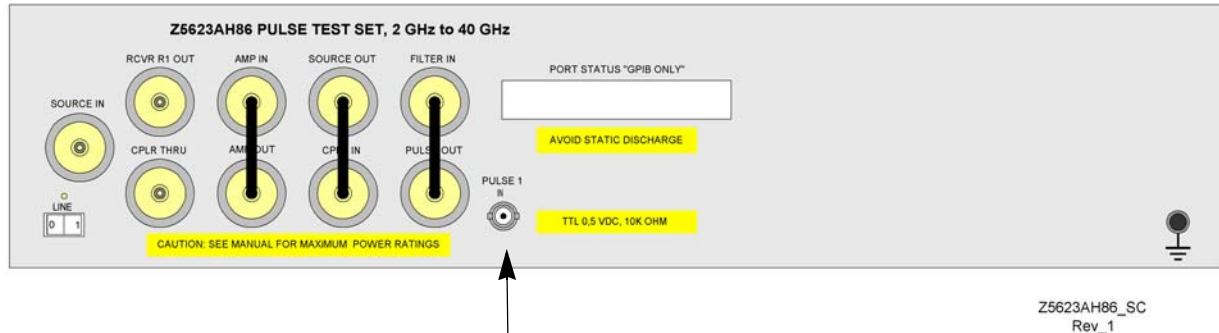
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## Test Set Familiarization

This section familiarizes the user with various front and rear panel features of the test set.

### Front Panel

**Figure 7 Front Panel Features**



BNC Short attached  
for shipment (1250-0774)

### Power On Switch

The Power On switch turns the AC power to the test set on and off. The switch is located at the bottom left corner of the front panel.

The switch disconnects the mains circuits from the mains supply after the EMC filters and before other parts of the instrument.

### Power LED

The power LED is illuminated when the power switch is in the on (1) position.

### RF Connectors

All of the RF connectors are 50  $\Omega$  2.4 mm connectors.

### Pulse Connector

The pulse input connector is a 50  $\Omega$  BNC female connectors.

## Rear Panel

Figure 8 Rear Panel Features



Line Module

### Line Module

The line module contains the power cable receptacle and the line fuse.

### Power Cables

The line power cable is supplied in one of several configurations, depending on the destination of the original shipment.

Each instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument chassis. The type of power cable shipped with each instrument depends on the country of destination. See [Figure 4 on page 8](#) for the part numbers of these power cables.

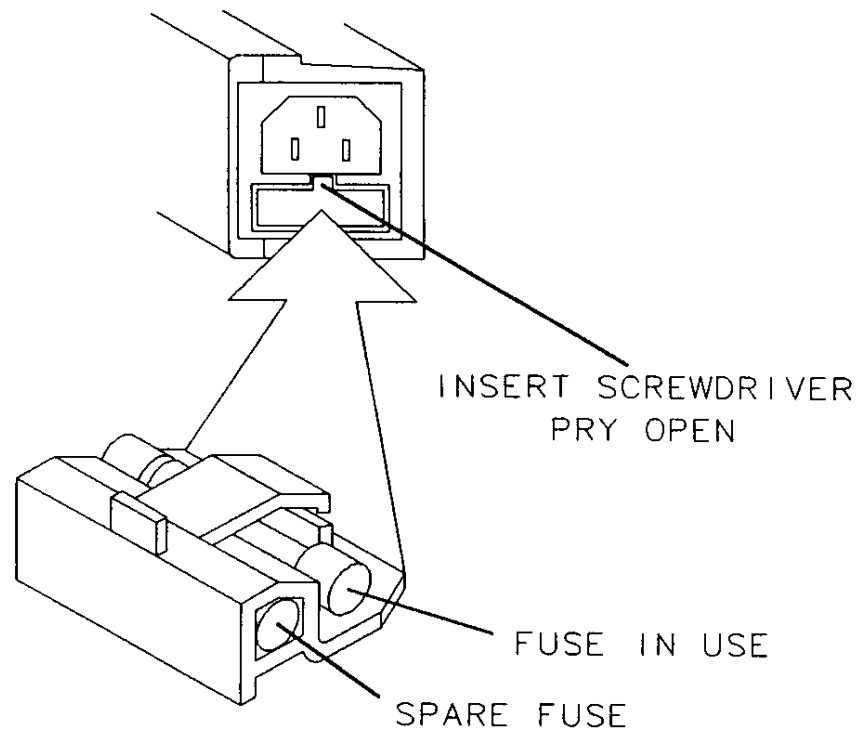
#### WARNING

**This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited.**

### The Line Fuse

The line fuse (F 3 A/250 V, 2110-0780) and a spare reside within the line module. [Figure 9](#) illustrates where the fuses are and how to access them.

**Figure 9** Location of Line Fuses



---

## Operation Overview

The Z5623A Option H86 forward direction pulse test set can be configured differently for many applications. Included in this document are four typical configurations:

- [Figure 11, “Shipped Configuration.”](#)
- [Figure 12, “System Setup Configuration.”](#)
- [Figure 13, “Pulse Configuration.”](#)
- [Figure 14, “High Power Pulse Configuration.”](#)

---

**NOTE** The internal firmware of the PNA has not been modified for this test set option. The power levels indicated on the Agilent E8363B and E8364B may differ depending on the user configuration that is chosen.

Refer to the configuration diagrams for external component connections and/or operating constraints when utilizing the high power capability of the Agilent Z5623AH86 Forward Direction Pulse Test Set. External components are not supplied with this option other than those in the [Content List](#).

When using the Agilent E8363B and E8364B Series Network Analyzer with Z5623AH86 Forward Direction Pulse Test Set in the bypass or the high power configuration, the PNA Frequency Offset mode (Option 080) and External R1 (Option 081) must be activated. This will ensure phase lock and allow R1 and R2 to receive the new reference power levels from the amplifiers. Refer to [Table 2 on page 15](#).

---

**CAUTION** The Z5623AH86 is equipped with reference channel attenuators. These attenuators reduce the RF power to the PNA R1 and R2 receiver ports. The test set attenuators can be set from 0 to 60 dB in 10 dB steps. The recommended power levels to the PNA R1 and R2 receiver ports is -15 dBm. Refer to your PNA specifications to optimize power levels to the receiver ports.

The PNA Option 016, Receiver Step Attenuators, reduces the power to the A and B receivers. The A and B maximum attenuator setting is 35 dB. Power measurements to Test Ports 1 and 2 above +35 dBm will require additional attenuation. Add the appropriate amount of attenuation that will keep the coupler arm output power below -15 dBm. Refer to [Table 2 on page 15](#).

---

**CAUTION** Hot Switching is not allowed with the Z5623AH86 when making high power measurements or damage to the switch will occur. Hot Switching is the condition when the internal switch or switches are set to a position for making high power measurements, and then set to another position without reducing the power. The maximum power that the switches are allowed to switch states is +20 dBm.

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**CAUTION** Prior to powering-up the booster amplifier, it is highly recommended that the user verify the RF power levels seen by the various elements of the test setup. At high power levels a mistake could permanently damage the instrument. Refer to [Table 2](#).

---

**Table 2 Power Levels**

Test Setup	Power Level
<b>Maximum Z5623AH86 RF Power Levels to Access Ports:</b>	
SOURCE IN	+20 dbm
RCVR R1 OUT	+20 dBm
CPLR THRU, CPLR IN	+43 dBm @ 10 MHz to 40 GHz
CPLR THRU, CPLR IN	+40 dBm @ 40 GHz to 50 GHz
AMP IN, AMP OUT, SOURCE OUT	+30 dBm
FILTER IN	+30 dBm (Dependent on Filter)
PULSE OUT	+20 dbm (Dependent on Filter)
AMP 1 IN TERM (J4)	+30 dBm
AMP 1 OUT TERM (J3)	+30 dbm
<b>Maximum PNA RF Power Levels to Access and Test Ports:</b>	
Max Recommended RF Level at A/B/R1/R2 Receivers	-15 dbm
Damage Level at A/B/R1/R2 Receivers	+15 dbm
Max Recommended RF Level at Port 1, 2 Source	+0 dBm
Damage Level to Port 1, 2 SOURCE OUT	+20 dBm
Max Level to Port 1, 2 Test Ports	+20 dBm

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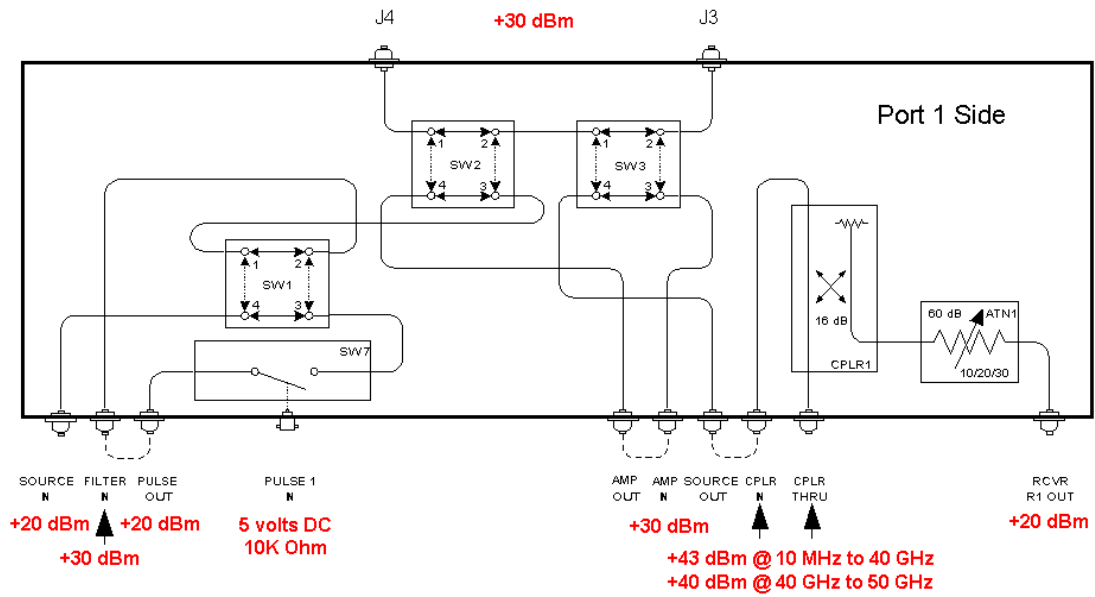
**NOTE** Refer to your PNA specifications to optimize the power levels in the receivers.

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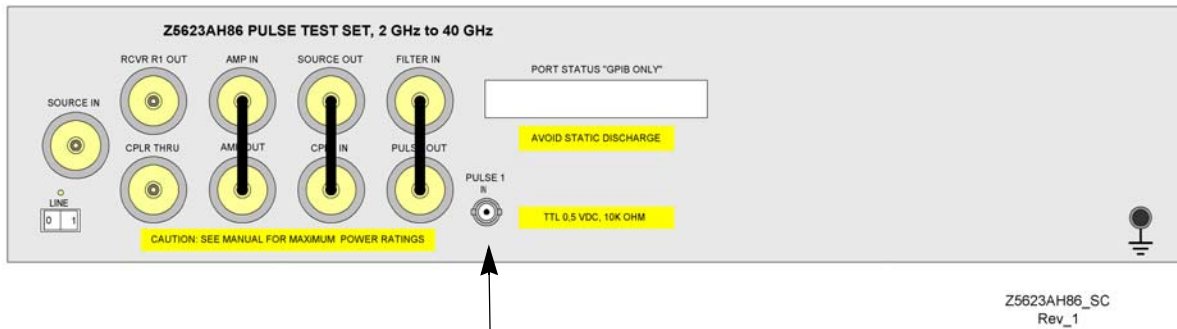
**NOTE** We recommend that you do NOT operate components near damage or maximum levels. The power levels should be kept at less than 3 dB, preferably 6 dB, below damage and maximum levels. Damage and Maximum levels are not necessarily the optimum level.

---

**Figure 10 Maximum Power Levels**



**Figure 11 Shipped Configuration**



BNC Short attached for shipment (1250-0774)

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## System Setup

Figure 12 on page 18 shows the setup configuration of the Z5623A Option H86 forward direction pulse test set and how it should be configured with the PNA and the Pulse Pattern Generators.

1. Connect the following RF Cables:
  - Connect RF Cable (5065-9872) from the Test Set RCVR R1 Out to the PNA RCVR R1 IN.
  - Connect RF Cable (5065-9873) from the Test Set SOURCE IN to the PNA SOURCE OUT.
  - Connect RF Cable (5065-9874) from the Test Set CPLR THRU to the PNA CPLR THRU.

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**NOTE** The test set rear panel connections are not shown in [Figure 12 on page 18](#).

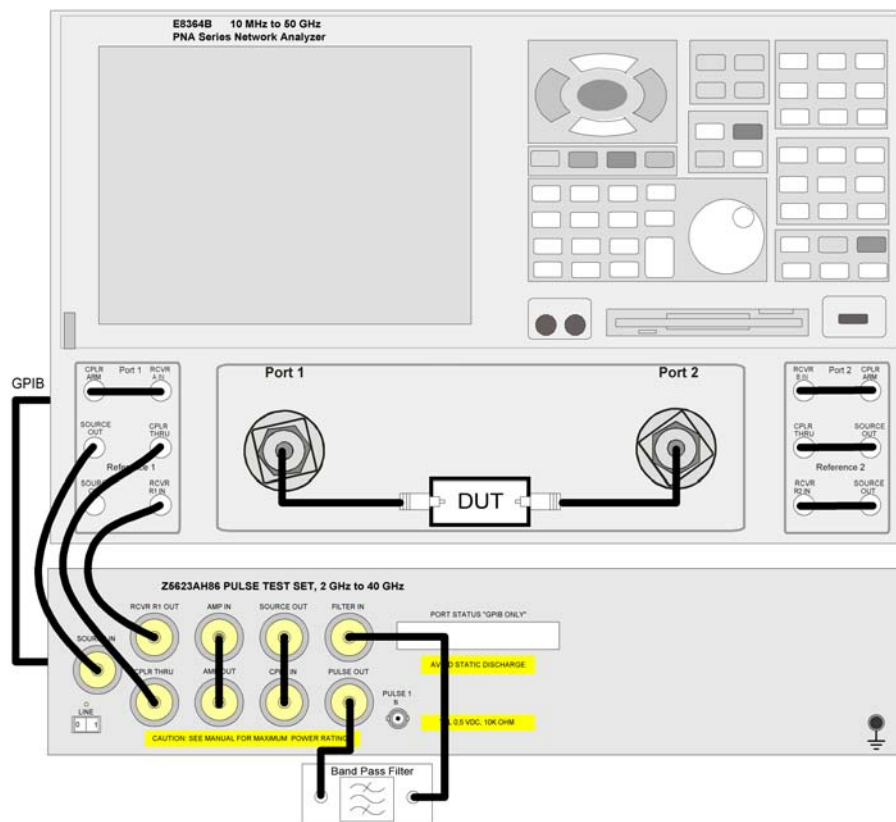
2. Connect the external 50  $\Omega$  loads (0955-0608) on test sets rear panel RF Ports J3 and J4.
3. Connect the test set's 37-Pin D-SUB jumper (Z5623-60202) to port 1 on the rear panel for GPIB and parallel control.
4. Connect a GPIB cable from the PNA, Test Set and Pulse Pattern Generators. (These cables are not supplied).
5. Connect a BNC cable for the 10 MHz Reference between the PNA and the Pulse Pattern Generators. (These cables are not supplied).
6. Connect four BNC cables from each Pulse Pattern Generators Output 1 and 2 to the PNA rear panel IF Inputs. (These cables are not supplied).
7. Connect a BNC cable from the test sets PULSE 1 IN to the Pulse Pattern Generator. (These cables are not supplied).





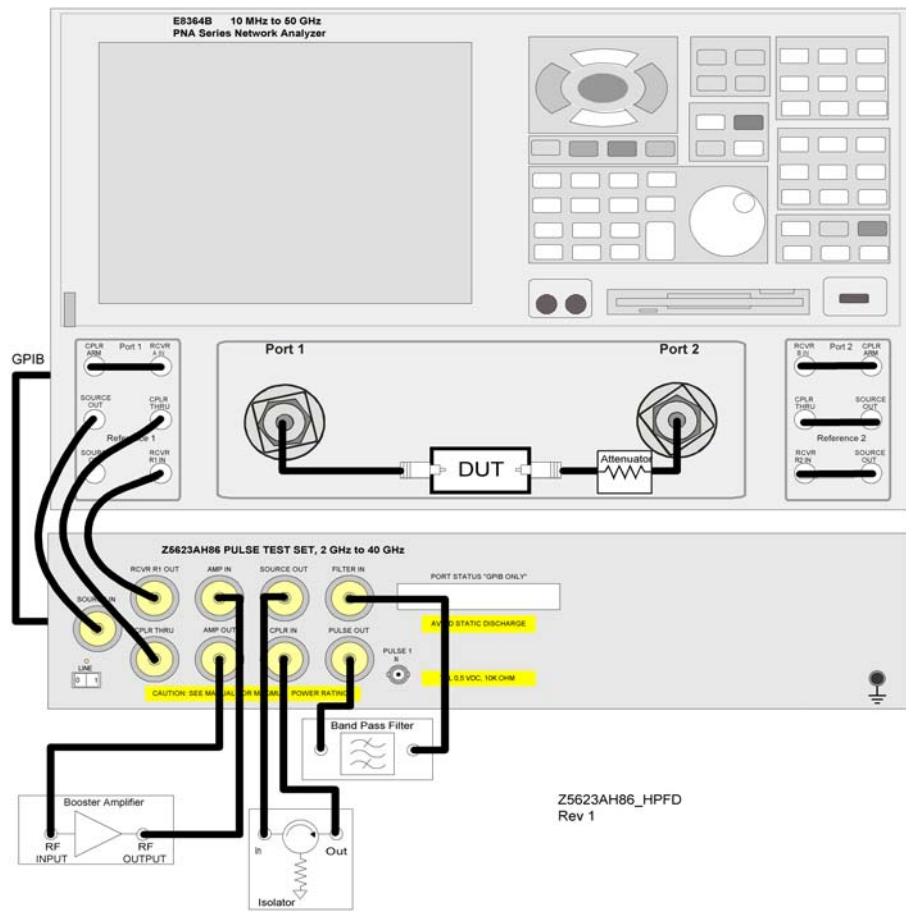
A high power isolator or attenuator *must* be inserted at the Source Out and CPLR IN front panel connectors to protect the internal test set modulator pin-switch and PNA solid state transfer switch (30 dB isolation recommended), or if reverse isolation of the amplifier is less than 30 dB. Maximum power into modulator pin-switch is 20 dBm for both forward and reverse directions. Optimum power level to all PNA receivers is  $-15$  dBm. Insert or set attenuators to the receivers (A, B, R1 and R2 ports) to reduce power to receivers accordingly. Set initial instrument state to  $-65$  dBm test port power level to reduce risk of damage when turning on the unit. Recommended sweep mode is **[STEP]**. Frequency Offset mode must be on and the R1 reference channel should be set to external.

**Figure 13 Pulse Configuration**



Z5623AH86\_PFD  
Rev 1

Figure 14 High Power Pulse Configuration



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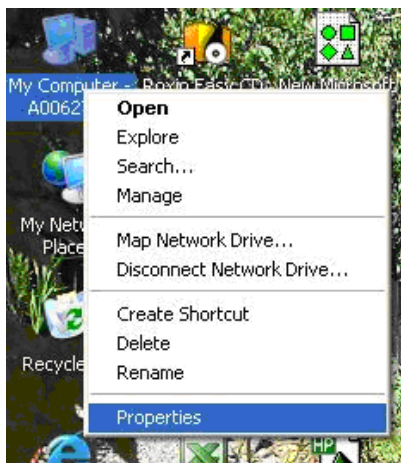
## Pulse Test Set Control Program

### Getting Started

Your Z5623A Pulse Test Set, comes with a Pulse Control Program disk, (Z5623-10014, Disk 1 of 1). This disk is in a DOS high density format and can be inserted directly into the PNA disk drive. Your PNA must have revision 6.0 PNA firmware and XP operating system installed so that the Pulse Test Set Control Program can be installed.

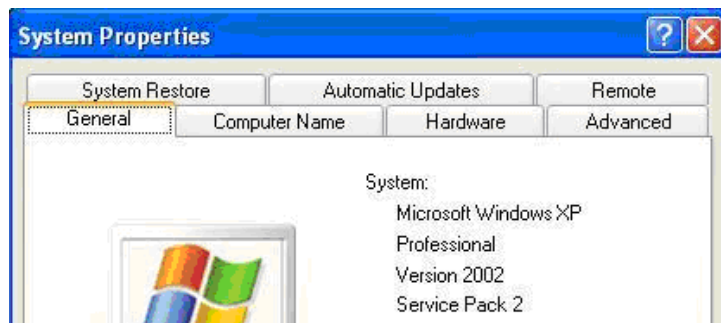
1. You can verify your PNA operating system by navigating to the PNA desktop. Right-click the My Computer icon. A drop-down menu will appear. Refer to [Figure 15](#).

**Figure 15**      **Desk Top Properties**



2. Select **Properties** in the drop-down menu. The System Properties will appear. Refer to [Figure 16](#).

**Figure 16**      **XP OS**



3. If your analyzer does not have the XP OS stop, you will need to upgrade the PNA with the N8990A. This option will install a new CPU and the XP operating system.

## Pulse Control Program Installation

The Pulse Control Program disk has the file to control the Pulse Test Sets. It is found by navigating to the A:\ (floppy drive) after the Control Program diskette has been inserted into the PNA disk drive. Refer to [Figure 17](#).

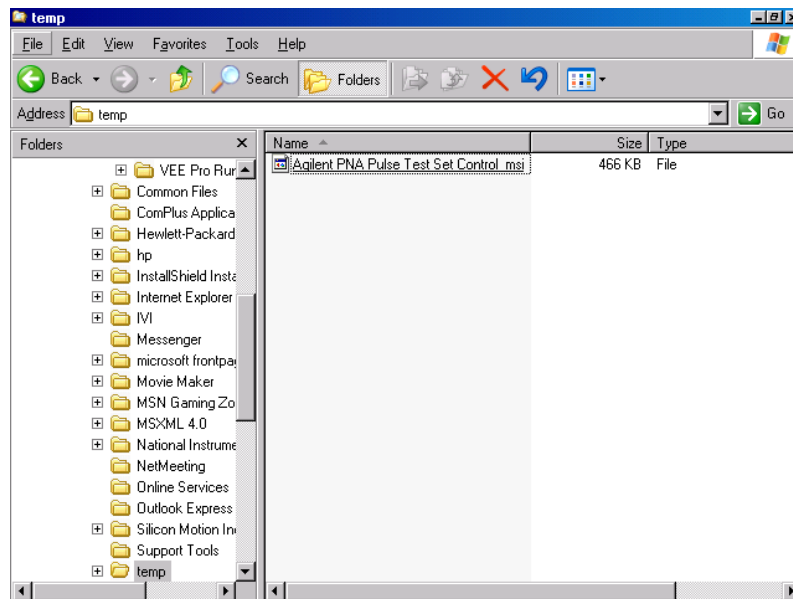
**Figure 17** Disk Program Files



Agilent PNA Pulse Test Set Control\_msi

1. Using Windows Explorer, navigate to the C:/Program Files directory to verify that a “temp” directory exists. If not, create one by right-clicking within the Program Files folder then select **New > Folder** and name it “temp”. Once the **temp** directory is created or located, insert the Pulse Control Program disk into the PNA disk drive. Copy the desired file listed above into the **temp** folder from the A:\(floppy drive) to the C:\Program Files\temp folder. Refer to [Figure 18](#).

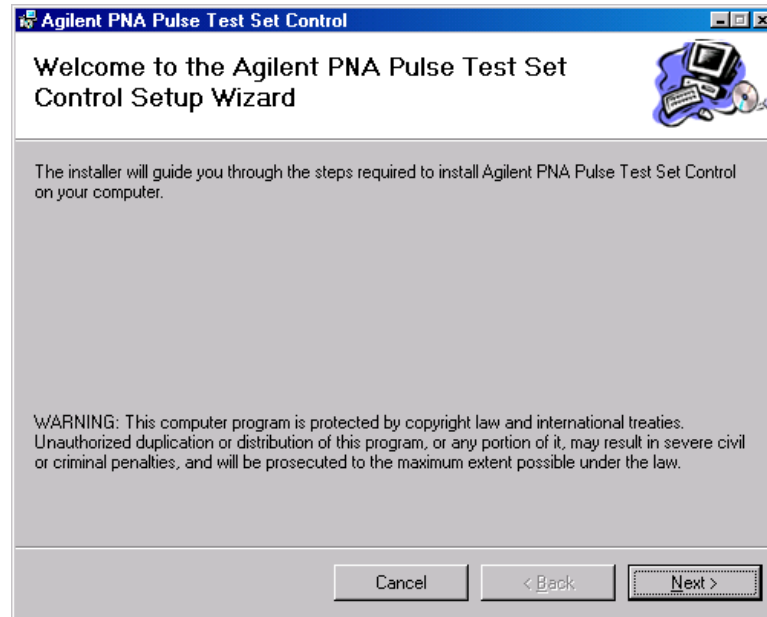
**Figure 18** Temp Folder



2. The file copied into the **temp** directory must be renamed to function. The file has an underscore “\_” between Control\_msi. Replace the underscore with a period “.” Highlight the file name, right click and select rename.

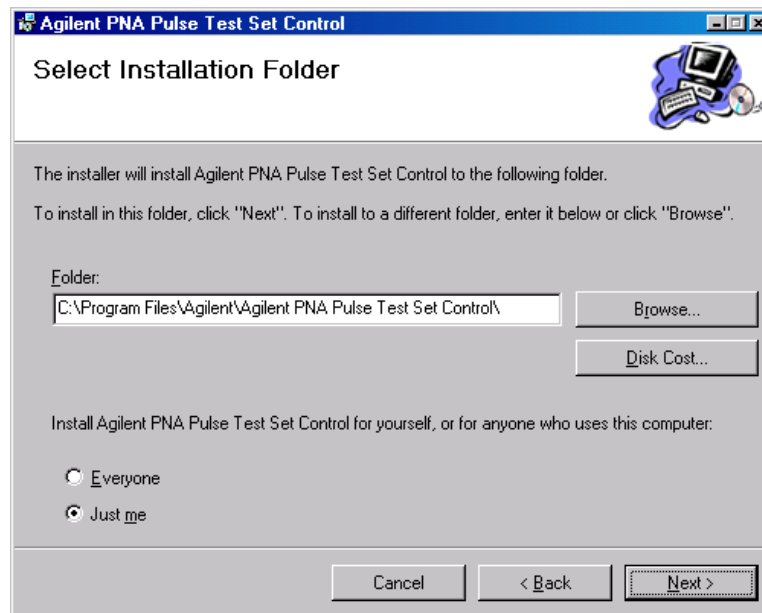
3. Once the file has been renamed, double-click on the file to start the installation. The Setup Wizard will appear in the display.
4. Press **Next**. The Selection Installation folder will appear. Refer to [Figure 19](#).

**Figure 19**      **Installation Start**



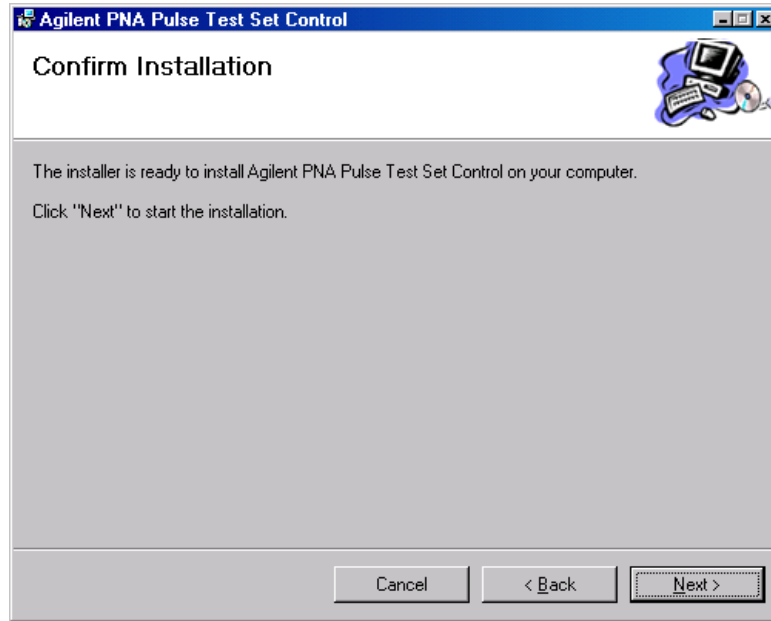
5. Press **Next** for default or to modify where to install the folder. Refer to [Figure 20](#).

**Figure 20**      **Folder Selection**



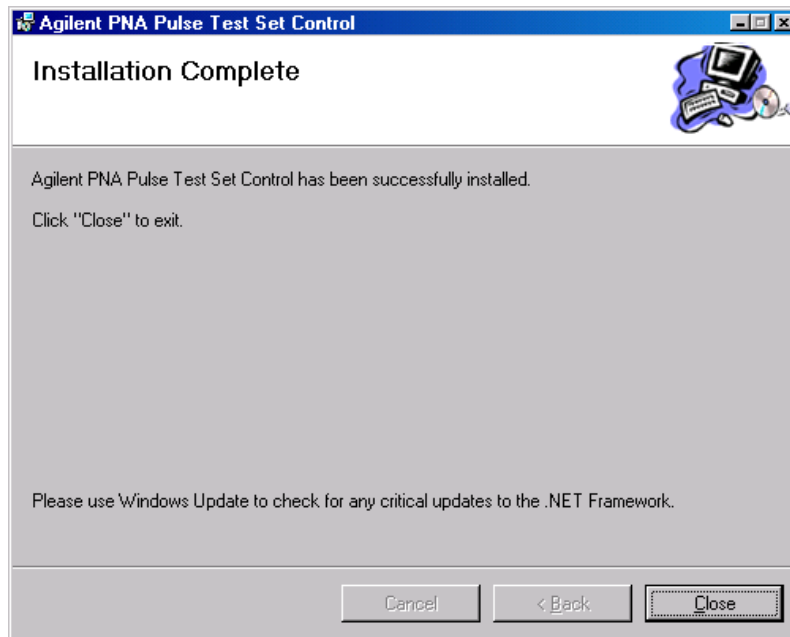
6. Press **Next** to confirm the installation. Refer to [Figure 21](#).

**Figure 21**      **Confirm Installation**



7. Press **Close** to complete the installation. Refer to [Figure 22](#).

**Figure 22**      **Installation Complete**



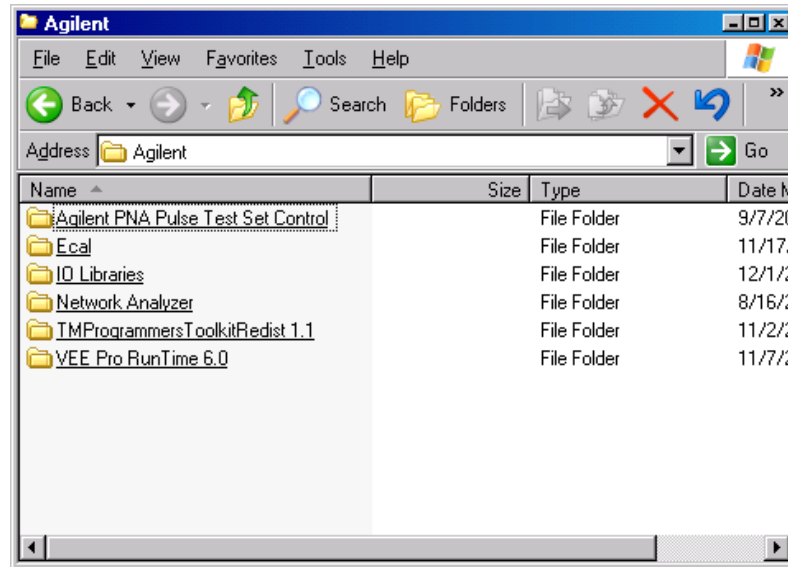
## Accessing the Program

The program installed will be located in its own file folder:

C:\Program Files\Agilent\Agilent PNA Pulse Test Set Control

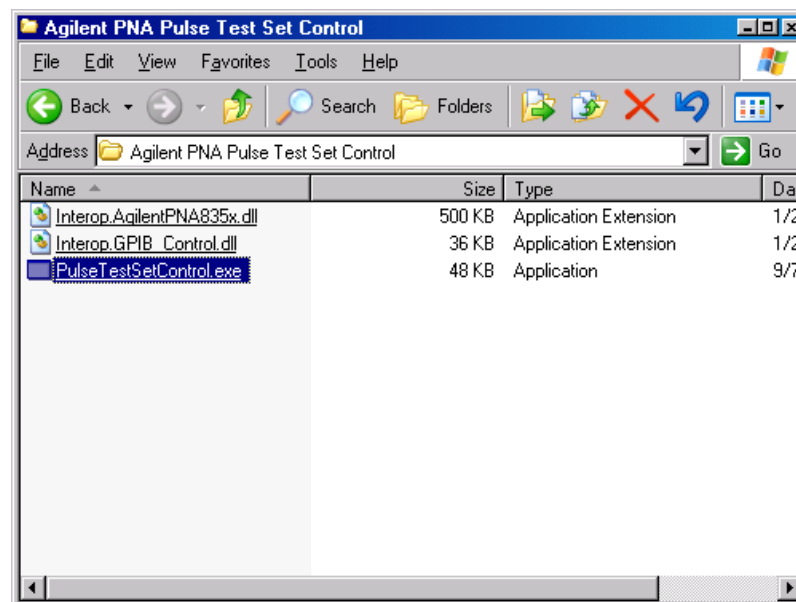
1. Locate the file directory. Refer to [Figure 23](#).
2. Select the **Agilent PNA Pulse Test Set Control** folder. Refer to [Figure 23](#).

**Figure 23** Locate the Folder



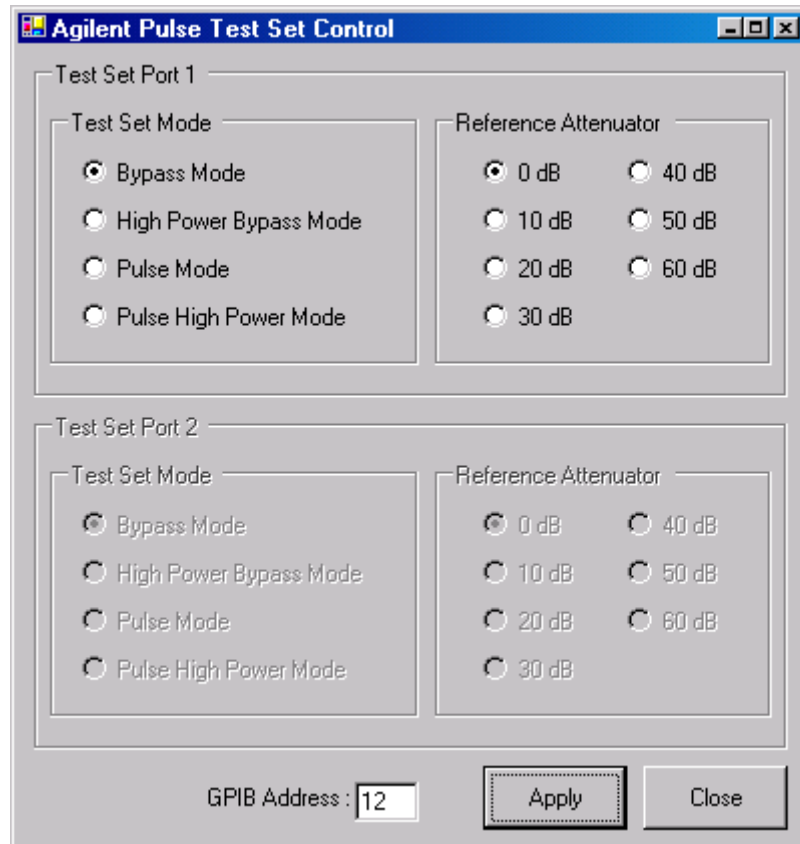
3. Double-click **PulseTestSetControl.exe** file. Refer to [Figure 24](#).

**Figure 24** PulseTestSetControl.exe



Once the file has been executed the Agilent Pulse Test Set Control panel will appear. The control panel shown in [Figure 25](#) is for Option H86 that has the forward direction (Port 1) only and therefore, the Port 2 controls are not selectable. For the dual direction models both port controls will be active.

**Figure 25** Control Panel





## **Control Panel Features**

The control panel is used to set the operation mode of the test set to the user's requirements.

These features are listed in the user manual for the Pulse Test Set.

As outlined in the manual switching between Bypass/Pulse Modes to High Power Modes can damage the test set and PNA if care is not taken.

## **Test Mode of Operation**

- Bypass Mode - PNA in its normal operation
- High Power Mode - Allows the user to insert source amplifiers
- Pulse Mode - Accesses the pin switch modulator
- Pulse High Power Mode - Accesses the pin switch modulator and allows the user to insert amplifiers

## **Reference Attenuator**

- Allows the user to select between 0 to 60 dB in 10 dB steps the amount of attenuation to the reference channel for high power applications.

## **GPIB Address**

- The address of the Pulse Test Set. Default is 712. Only the last two digits are required.

---

## Controlling the Test Set

The Z5623A Option H86 is considered a “slave” instrument. A Controller must be used to control the test set. There are four ways to control the test set:

- The PNA can be used as the controller to talk to the test set over the GPIB.
- A Controller can directly talk to the test set over the GPIB.
- The Parallel port can be used to set the test set.
- Direct control access to the internal switches and attenuators via open collector lines to ground the input lines.

### Commands

As mentioned before, the test set can be controlled in four ways. The first two involve the use of a separate computer. The third way uses the parallel port manually. The fourth control method uses direct access from the port 1 rear panel 37 pin D-Sub connector.

---

**NOTE** The 37 pin D-Sub jumper (Z5623-60202) must be attached to the test sets Port 1 rear panel direct access connectors to allow the GPIB and parallel port commands to work. This connector is not connected to the test set when it is shipped.

---

### Typeface Key Conventions

The following key conventions are used throughout this document.

- **[HARDKEYS]** are labeled front panel keys.
- **SOFTKEYS** are unlabeled key whose function is indicated on the instrument display.

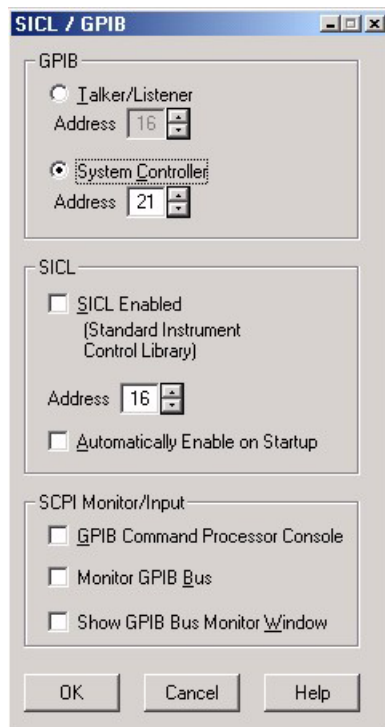
## PNA Control

Write the GPIB commands from the PNA directly to the Z5623A Option H86 test set GPIB port located on the rear panel. The following example assumes that the address of the test set is set to 12. Be sure to use an ending semi-colon.

The PNA must first be setup as the Controller.

1. Select **System > Configure > SICL/GPIB > System Controller**. Under System, select Configure then SICL/GPIB. Once the SICL/GPIB appears in the GPIB section click on System Controller, press OK and close the window.

**Figure 26** SICL/GPIB



2. Launch the **Measurement & Automation** icon located on the PNA desk top.
3. Expand **Devices and Interfaces**.

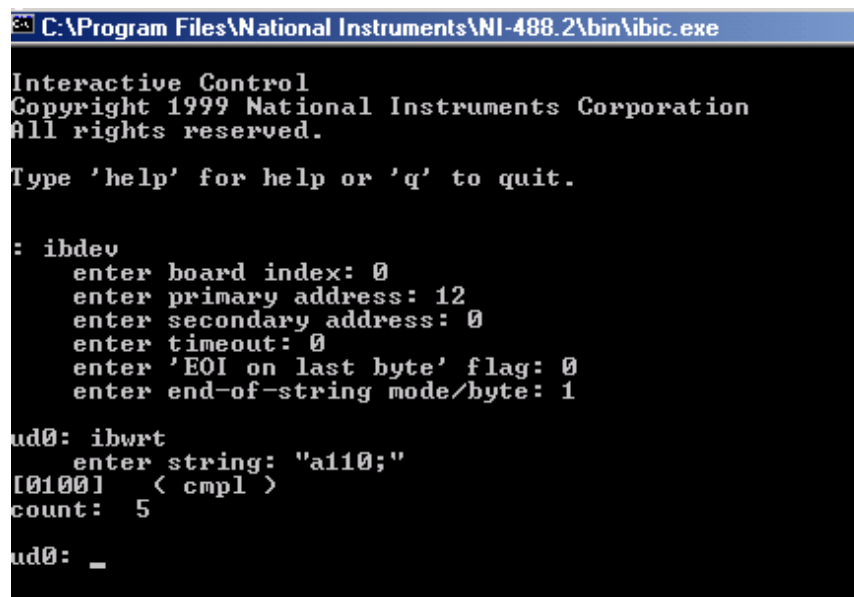
- Right click on  **GPIB0 (AT-GPIB/TNT)** and select **Interactive control**. When the new window appears at the prompt type the following:

: ibdev (This command sets up the PNA GPIB to talk to the Z5623A Option H86 test set)

```
enter board index: 0
enter primary address: 12
enter secondary address: 0
enter timeout: 0
enter 'EOI on last byte' flag: 0
enter end-of-string mode/byte: 1
```

ibwrt: "command\$;" (Command\$ is the string the user would get from the table)

**Figure 27** Interactive Control



```
C:\Program Files\National Instruments\NI-488.2\bin\ibic.exe
Interactive Control
Copyright 1999 National Instruments Corporation
All rights reserved.
Type 'help' for help or 'q' to quit.

: ibdev
  enter board index: 0
  enter primary address: 12
  enter secondary address: 0
  enter timeout: 0
  enter 'EOI on last byte' flag: 0
  enter end-of-string mode/byte: 1

ud0: ibwrt
  enter string: "a110;"
[0100] < cmpl >
count: 5
ud0: _
```

## Addressing Directly

Write GPIB commands from the controller to write commands directly to the Z5623A Option H86 test set GPIB port located on the rear panel. The following RMB example assumes that the address of the test set is set to 712.

### RMB

```
OUTPUT 712;"command$;"
```

To query and read from the Z5623A Option H86 test set, the user needs to send two commands. The first queries the test set for an individual switch count, and the second reads the data as a string. Be sure to use an ending semi-colon. See your manual regarding details for switching the identifier.

```
OUTPUT 712;"sw10?;"!Query test set for switch 10
```

```
ENTER 712;"Count$;" !Read switch 10 Count
```

To query and read from the Z5623A Option H86 test set, the user needs to send two commands. The first queries the test set for an ID, and the second reads the data in as a string. See your manual for details for "ID Identifier read" when queried.

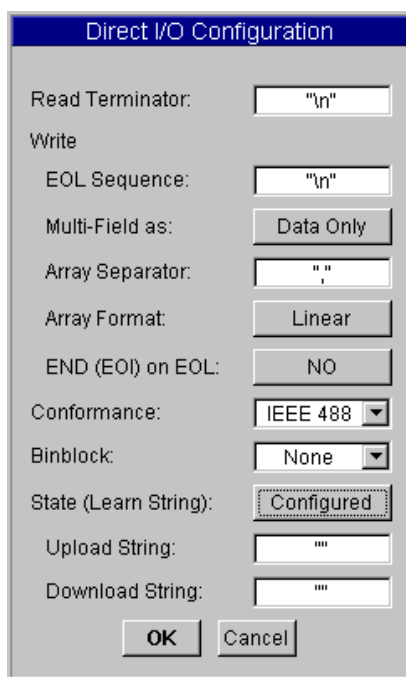
```
OUTPUT 712;"idn?;"!Query test set for ID
```

```
ENTER 712;"Name$;"!Read test set ID
```

### VEE

When using VEE insure the Direct I/O is set as follows. This is also the default Direct I/O settings.

**Figure 28** Direct I/O



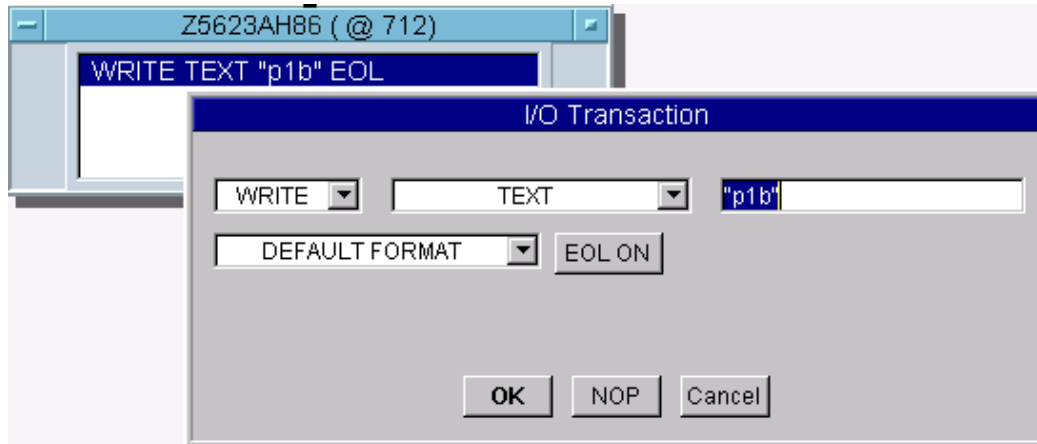
The image shows a dialog box titled "Direct I/O Configuration". It contains several settings for GPIB communication:

- Read Terminator:
- Write:
  - EOL Sequence:
  - Multi-Field as:
  - Array Separator:
  - Array Format:
  - END (EOI) on EOL:
- Conformance:
- Binblock:
- State (Learn String):
- Upload String:
- Download String:

At the bottom are  and .

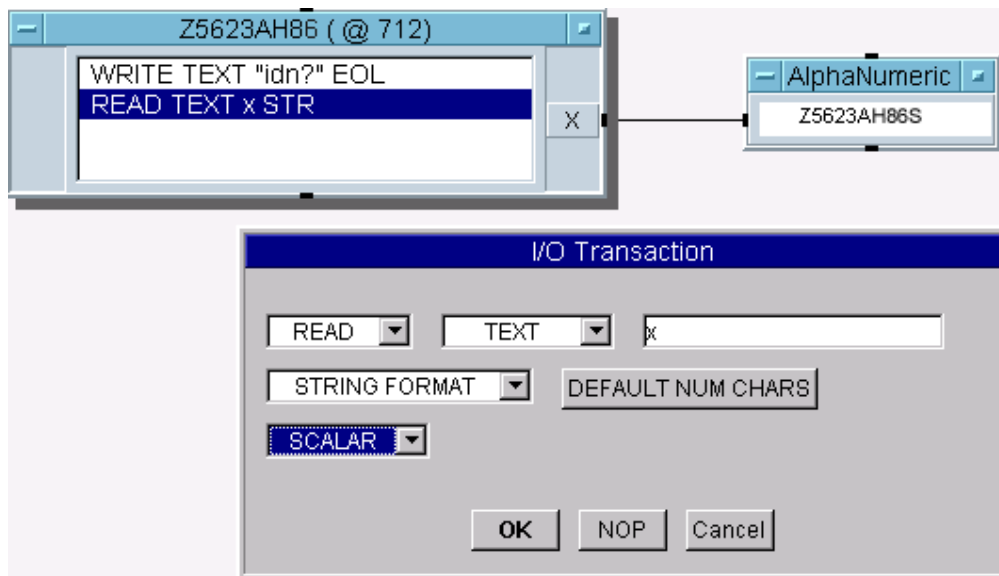
To send commands to the test set configure the I/O Transaction as follows:

**Figure 29 I/O Transaction**



Querying and read from the test set is the same for both switch count and box ID.

**Figure 30 Query/Read**



**Quick Basic**

If you are using Quick Basic or Visual Basic, be sure to disable EOI and EOL before sending commands to the test set. Including the semicolon in program commands will not ensure that these commands are disabled as would be the case in HP Basic/RMB. When using the 82335 GPIB Interface and Visual Basic, use the following commands to disable EOI and EOL, send the necessary data to the test set, and re-enable EOI and EOL.

---

**NOTE** Be sure to re-enable EOI and EOL before sending data to another instrument.

---

**Write Commands**

```
GpibEoi(hGpib;7,0) 'disable EOI
GpibEol(hGpib;7, "",0) 'disable EOL
GpibOutputs(hGpib;712,info$,length%) 'send command to test set.
GpibEol(hGpib;7,chr$(13)+chr$(10),2) 're-enable EOL and set to
chr$(13)+chr$(10)
GpibEoi(hGpib;7,1,) 're-enable EOI where hGpib specifies the handle
returned by GpibOpen
```

**Read Commands**

```
info$ = "sw10?" 'query sw10 for switch count
length% = len(info$) 'length of command
max.len% =10 'max length data form idn? or swxx? function
infi$ = space$(max.len%)
GpibEoi(hGpib;7,0) 'disable EOI
GpibEol(hGpib;7, "",0) 'disable EOL
GpibOutputs(hGpib%,712,info$,length%) 'send query command to tests
set.
GpibEnters(hGpib%,712,infi$,max.len%) 'get data from tests set.
GpibEol(hGpib;7,chr$(13)+chr$(10),2) 're-enable EOL
GpibEoi(hGpib;7,1,) 're-enable EOI
```

## National Instruments VISA

If you are using National Instruments VISA, be sure to set the variables as follows:

`VI_ATTR_SEND_END_ENVI = FALSE` ` This specifies whether to assert END during the transfer of the last byte of the buffer.

`VI_ATTR_TERMCHAR = 0x0A` ` This is the termination character. When the termination character is read and `VI_ATTR_TERMCHAR_EN` is enabled during a read operation, the read operation terminates.

`VI_ATTR_TERMCHAR_EN = VI_TRUE` ` This is a flag that determines whether the read operation should terminate when a termination character is received.

`VI_ATTR_SUPPRESS_END_EN = VI_FALSE` ` This specifies whether to suppress the END bit termination. If this attribute is set to `VI_TRUE`, than the END bit does not terminate read operations. If this attribute is set to `VI_FALSE`, than the END bit terminates read operations.

### Write Commands:

Append all commands with `\n`. For example; `*rst\n`

### Read Commands:

The test set returns data terminated by `\r\n`. For example the query `sw10?\n` returns `00000010\r\n`.

## Parallel Port

The third way is used by the service center or during production to verify the port path connections. This uses the parallel port on the rear panel of the Z5623A Option H86. This method uses an 8722ES Network Analyzers Parallel port to control the test set. The following example assumes that the address of the network analyzer is set to 16. Be sure to use an ending semi-colon.

```
OUTPUT 716;"PARALGPIO"; (Sets the parallel port for GPIO function).
OUTPUT 716;"PARAOUT[D]"; (Programs all GPIO output bits (0 to 256) at once).
```



**Table 3 GPIB and Parallel Commands**

<b>GPIB</b>	<b>Description</b>	<b>LCD Display</b>	<b>Parallel</b>	<b>Decimal</b>
A100	RCVR R1 Attenuator 0 dB	A00	00000000	0
A110	RCVR R1 Attenuator 10 dB	A10	00000001	1
A120	RCVR R1 Attenuator 20 dB	A20	00000010	2
A130	RCVR R1 Attenuator 30 dB	A30	00000011	3
A140	RCVR R1 Attenuator 40 dB	A40	00000100	4
A150	RCVR R1 Attenuator 50 dB	A50	00000101	5
A160	RCVR R1 Attenuator 60 dB	A60	00000110	6
P1B	Port 1 Bypass Mode	P1 Bypass Axx	00001110	14
P1HPB	Port 1 High Power Mode	P1 HP Bypass Axx	00001111	15
P1HPP	Port 1 High Power Pulse Mode	P1 HP Pulse Axx	00010000	16
P1P	Port 1 Pulse Mode	P1 Pulse Axx	00010001	17
*RST	Reset (Port 1 Bypass Mode)	P1 Bypass A00	00010110	22
<b>Display</b>		<b>Description (GPIB)</b>		
IDN?	Z5623AH86S	Read Test Set ID		
	ERR: invalid command	Non GPIB or Parallel Command Sent		

## Direct Control

The fourth method to control the test set uses the port 1, 37 pin D-Sub connector located on the rear panel. When the Z5623A Option H86 is shipped, the jumper (Z5623-60202) is not connected to port 1, 37 pin D-Sub connector. This will allow the user to control the internal switches and attenuators directly from the 37 pin D-Sub connector. Refer to [Table 5 on page 40](#) which shows the pinout and function for port 1.

---

**NOTE** LCD indicator is only valid when the test set is used in control methods; PNA, Controller, and Parallel. Direct control does not change the LCD indicator when either the switches or attenuators are repositioned.

---

## Controlling the Switches

Control of the internal switches directly, is provided from the 37 pin D-Sub connector and can be done in two ways.

- TTL
- Open Collector

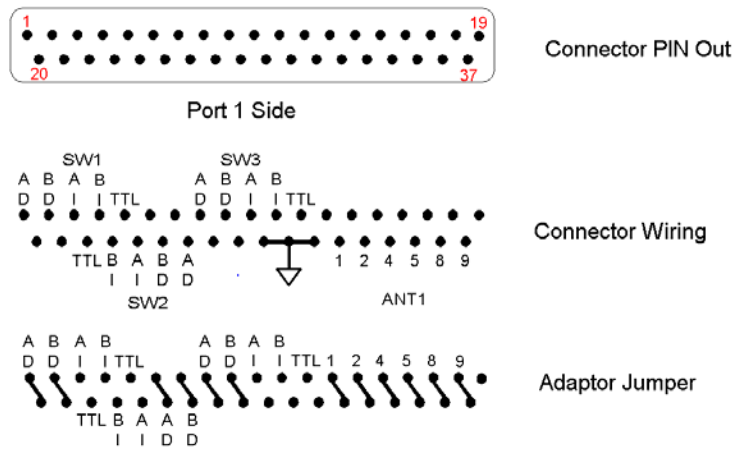
The TTL input allows the user independent switch position control by either a low (0) or high (1). The TTL voltage is 0 or 5 Volts. Refer to [Figure 31 on page 37](#). The 37 Pin D-Sub connector shows the rear panel input/output configuration for Port 1. Pins 5, 12, 22 are the TTL input pins. Pin 5 controls SW1, pin 12 controls SW3 and pin 22 controls SW2.

The Open Collector inputs allows the user to control a switch position by grounding either the A (AD) or B (BD) drive input lines for each switch. Only one of these two input lines can be grounded at any given moment. Recommended is break-before-make when the input line position changes. Refer to [Figure 31](#). The 37 Pin D-Sub connector shows the rear panel input/output configuration for port 1. Pins 1, 2 control SW1, pins 8, 9 control SW3 and pins 25, 26 control SW2.

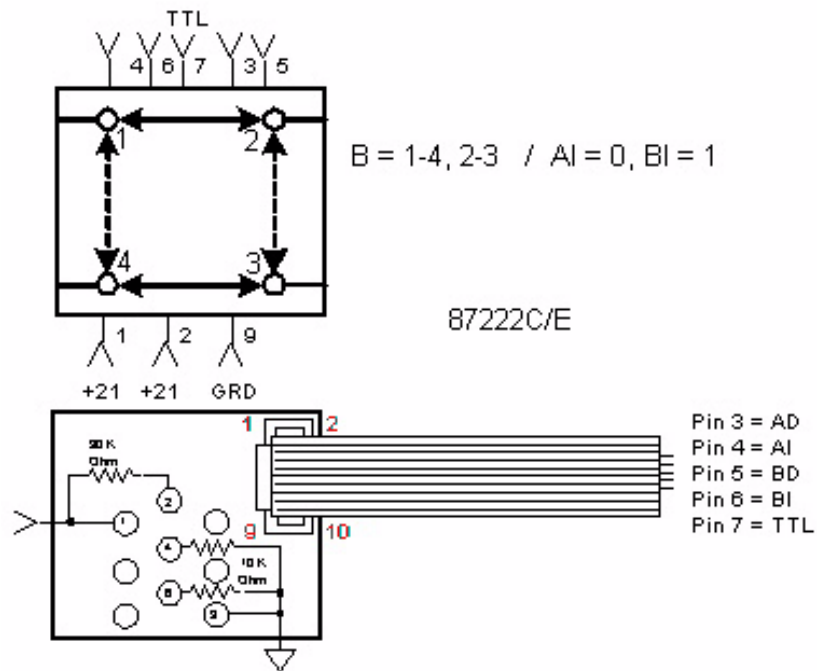
## Switch Indicators

The internal switch positions can be read-only when used in the Direct Control method. A switch position can be read by either a low (0) or high (1) on the A (AI) or B (BI) indicator lines. The voltage is either 0 or 5 Volts depending on the switch position. Low (0) indicates disabled, and high (1) indicates enabled. [Figure 31](#) shows the rear panel input/output configuration for port 1. Pins 3, 4 indicate SW1 position, pins 10, 11 indicate SW3 position, and pins 23, 24 indicate SW2 position. [Figure 32 on page 37](#) shows how each switch is configured.

**Figure 31 37 Pin D-Sub Connector**



**Figure 32 Switch Connection**



## Switch Indicator Function

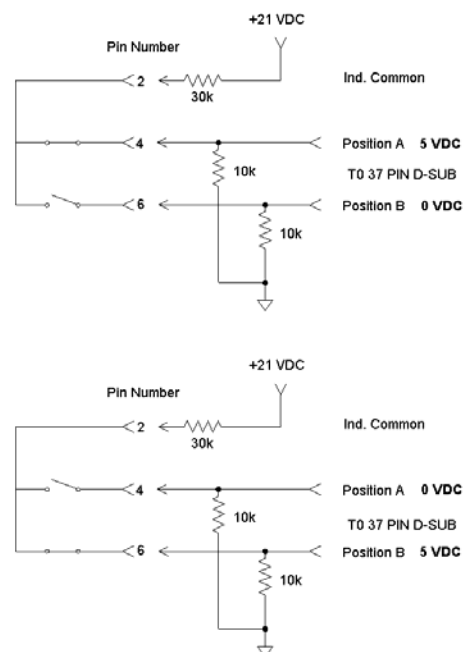
The 87222E is set to the A or B Position. Refer to [Table 6 on page 41](#), Switch Indicator Voltages for Test Set Modes. When the switch is set to the A position the Indicator Common is connected, completing the A Indicator path. The 21 VDC connected to the Indicator Common is connected to ground by two resistors (30 k $\Omega$  and 10 k $\Omega$ ). The Position A and B Indicators have independent 10 k $\Omega$  resistors to ground. The measured voltage from Position A Indicator to ground is approximately 5 Volts and the Position B Indicator will measure 0 Volts. When the switch is set to Position B, the Indicator common is connected. Measuring the voltage from Position B Indicator to ground will measure approximately 5 Volts and the A indicator will measure 0 Volts.

### Example 1 A Indicator Position Connected

- Resistance Indicator Common in a connected path = 40 k $\Omega$
- Resistance between the Indicator Common and Position A when connected = 30 k $\Omega$
- Resistance between Position A and ground = 10 k $\Omega$
- Resistance between the Indicator Common and Position B when connected = OPEN
- Resistance between Position B and ground = 10 k $\Omega$
- $I = V/R = 21 \text{ V}/40 \text{ k}\Omega = 0.525 \text{ mA}$
- Voltage drop across 30 k $\Omega$  resistor:  $V = I \times R = 0.525 \text{ mA} \times 30 \text{ k}\Omega = 15.75 \text{ Volts}$
- Voltage drop across 10 k $\Omega$  resistor:  $V = I \times R = 0.525 \text{ mA} \times 10 \text{ k}\Omega = \text{Position A indicator to ground} = 5.25 \text{ Volts}$

In that the Position B switch to the Indicator Common is open, only the 10 k $\Omega$  resistor ground is connected providing a pull down on the Position B Indicator pin, effectively grounding it.

**Figure 33** Switch Indicator Status



## Controlling the Attenuators

Controlling the attenuators are identical to the Switch Open Collector control method.

Figure 31 on page 37 shows the rear panel input/output configuration for Port 1.

Pins 13-18 control the attenuator. Like the switch open collector lines, brake-before-make operation is used for the attenuator bypass or select setting changes.

---

**CAUTION** Always break-before-make a selection when using the Open Collector control inputs for the switches and attenuators. Failure to do so can damage the internal switches or attenuators.

---

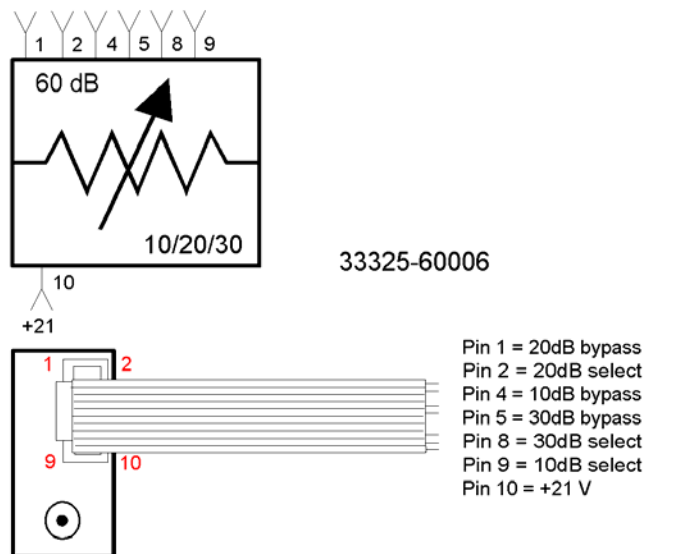
**CAUTION** Make rear panel Direct Control connections while the test set is off. Ensure that all inputs are OFF before making any connection. Turn off the test set before removing the connector jumper. Failure to do so can damage the internal switches or attenuators.

---

**Table 4 Attenuator Connections**

Pin	Description
13	10 dB bypass
14	10 dB select
15	30 dB bypass
16	20 dB bypass
17	20 dB select
18	30 dB select

**Figure 34 Attenuator Connection**



**NOTE** Switches and attenuators supply voltage is supplied internally by the test set. The supply voltage is 21 Vdc.

**NOTE** LCD indicator is only valid when the test set is used in the following control methods; PNA, Controller, Parallel. Direct Control does not change the LCD indicator when the switches or attenuators are repositioned.

**Table 5 Rear Panel Connection for Port 1**

Pin #	Switch	Function	Port 1	Description	Switch Position	Pin Bias Switch Control
1	1&4	AD	SW1	Position A Drive	1 to 2; 3 to 4	1=gnd; 2=OPEN
2	1&4	BD	SW1	Position B Drive	1 to 4; 2 to 3	1=OPEN; 2=gnd
3	1&4	AI	SW1	Position A Indicator	A= 5 volts; B= 0 volts	
4	1&4	BI	SW1	Position A Indicator	A= 0 Volts; B= 0 volts	
5	1&4	TTL	SW1	TTL Drive	A=High; B=Low	A=5 volts; B=gnd
26	2&5	AD	SW2	Position A Drive	1 to 2; 3 to 4	1=gnd; 2=OPEN
25	2&5	BD	SW2	Position B Drive	1 to 4; 2 to 3	1=OPEN; 2=gnd
24	2&5	AI	SW2	Position A Indicator	A= 5 volts; B= 0 volts	
23	2&5	BI	SW2	Position B Indicator	A= 0 volts; B= 5 volts	
22	2&5	TTL	SW2	TTL Drive	A=High; B=Low	A=5 volts; B=gnd
8	3&6	AD	SW3	Position A Drive	1 to 2; 3 to 4	1=gnd; 2=OPEN
9	3&6	BD	SW3	Position B Drive	1 to 4; 2 to 3	1=OPEN; 2=gnd
10	3&6	AI	SW3	Position A Indicator	A= 5 volts; B= 0 volts	
11	3&6	BI	SW3	Position B Indicator	A= 0 volts; B= 5 volts	
12	3&6	TTL	SW3	TTL Drive	A=High; B=Low	A=5 volts; B=gnd
Pin #	Attenuator	Function	Port 1	Description	Attenuator Position	Pin Bias Atten Control
13	1&2	10 OUT	Atten1	10 dB Bypass	0	13=gnd; 14=OPEN
14	1&2	10 IN	Atten1	10 dB Select	10	13=OPEN; 14=gnd
15	1&2	30 OUT	Atten1	30 dB Bypass	0	15=gnd; 18=OPEN
16	1&2	20 OUT	Atten1	20 dB Bypass	0	16=gnd; 17=OPEN
17	1&2	20 IN	Atten1	20 dB Select	20	16=OPEN; 17=gnd
18	1&2	30 IN	Atten1	30 dB Select	30	15=OPEN; 18=gnd

**Table 6**      **Switch Indicator Voltages for Test Set Modes**

VDC	SW1		SW2		SW3	
	AI	BI	AI	BI	AI	BI
0 VDC= Disengaged 5 VDC= Engaged						
Bypass	0	5	0	5	0	5
HP Bypass	0	5	5	0	5	0
Pulse	5	0	0	5	0	5
HP Pulse	5	0	5	0	5	0

---

**NOTE**                      Indicator position voltages are influenced by the user's interface. High impedance, sensor, or TTL input may be used to monitor the indicator position lines.

---

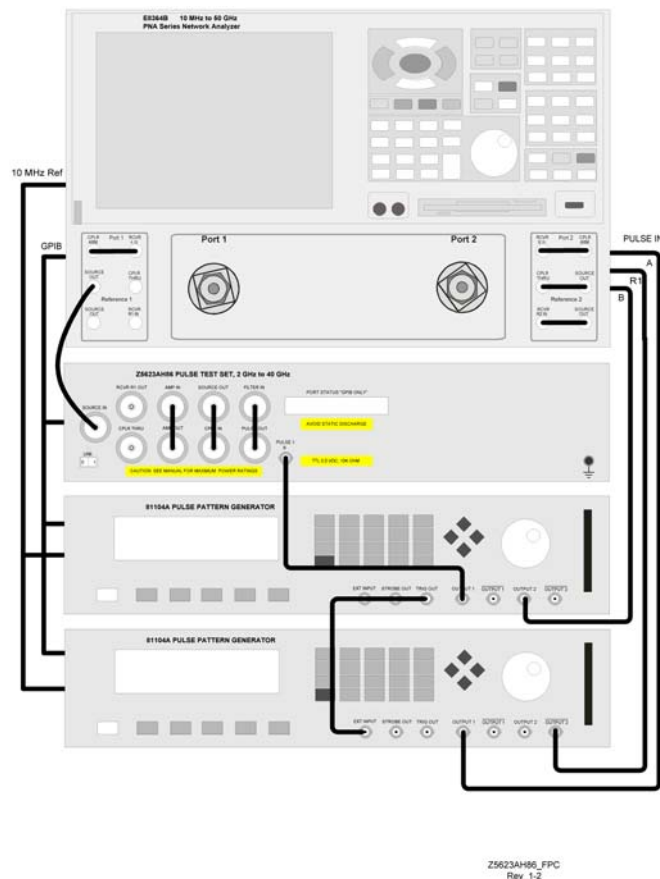
## Making High Power Measurements With Option H86

The Z5623A Option H86 and PNA with Options 014, 016, 080, 081, and UNL or H85 can be configured to measure high power devices. This ability is useful if the required power for the device under test is greater than the analyzer can provide, or if the maximum output power from an amplifier under test exceeds safe input limits for a test set and analyzer. This section describes how to set up the analyzer to perform high power measurements.

### Setup

1. Turn off all of the equipment. Be sure that the jumpers between the PNA and test sets RCVR 1 and CPLR THRU are disconnected at this time. This will protect the PNA from damage.
2. Connect the PNA jumpers for Port 1 SOURCE OUT and RCVR IN connectors.
3. Connect the Z5623A Option H86 to the PNA, refer to [Figure 35, "Setup Configuration."](#) Depending on your application set up, not all pulse pattern generators may be required as shown in this figure.

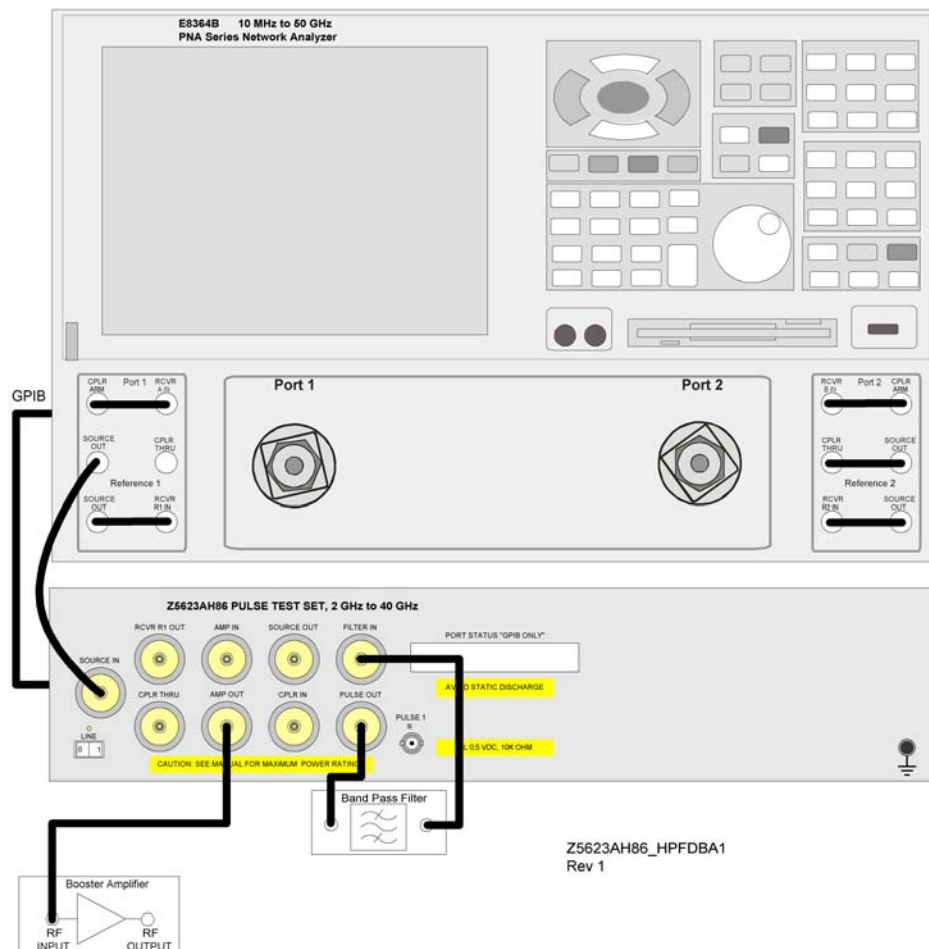
**Figure 35** Setup Configuration





4. If the Z5623A Option H86 is in the Shipped mode configuration (all the jumpers are still on) remove the jumper between AMP OUT and AMP IN connectors on the front panel for Port 1. Refer to [Figure 36, “Connect Booster Amplifier.”](#)
5. Place two terminations on J3 and J4 on the rear panel for AMP 1 and 2.
6. Verify that the Booster Amplifier is turned off at this time.
7. Connect the Booster Amplifier RF INPUT connector to the Port 1 AMP OUT connector on the front panel of the Z5623A Option H86.
8. Remove the jumper on the Z5623A Option H86 between SOURCE OUT and CPLR IN. Place an isolator or attenuator between the SOURCE OUT and CPLR IN on the port 2 side of the PNA.

**Figure 36** Connect Booster Amplifier



---

## Determining Power Levels

Before continuing, save this state and set it up as the **User Preset** key. The User Preset Conditions can be found in the PNA Series Network Analyzer's help menu.

1. Press **[Menu/Dialog]** then tab to **Help**. Select **Network Analyzer Help**. Type in *User Preset*, this will describe how to setup a User Preset. The final state should be saved as the User Preset to avoid an over power condition from the factory preset.

To find the User Preset:

2. Press **[Menu/Dialog]** then tab to **System**. Scroll down to **User Preset**. Click on **User Preset Enable** and press **Save**, then **OK**. This will save the current state as **User Preset**.
3. Turn on the analyzer and decrease the power level to  $-20$  dBm by pressing **[Menu/Dialog]** then tab to **Channel**. In the pull down menu select **Power**. Scroll to **Port Selection** type **[-20]**. Select **Port Power Coupled** to ensure that Ports 1 and 2 power levels are the same. Uncoupled ports should be used when adjusting the S12 power level or when Port 1 has a very low power level in comparison to Port 2.

---

**NOTE** Frequency Offset mode (Option 080) and External R1 (Option 081) must be activated when using the analyzer in a high power configuration. This will ensure phase lock and allow the R1 and R2 to receive the new reference power levels from the amplifiers.

- Press **[Menu/Dialog]** then tab to **Channel**. In the pull down menu select **Frequency Offset** and turn on the **Frequency Offset Mode**. In the Offset Setting set the **Offset** to **[0]**.
  - Press **[Menu/Dialog]** then tab to **Channel**. In the pull down menu select **Test Set**. Select the **External R1 Loop** in the R1 Input Path window.
4. Set the Z5623A Option H86 Test Set so that the external booster amplifier is in the RF path. Refer to [“Controlling the Test Set” on page 28](#) to set the external Booster Amplifier to be engaged in the RF path.
  5. Turn on the booster amplifier.
  6. Measure the output power from the booster amplifier RF Output using a power meter and sensor.

---

**NOTE** Additional attenuation may have to be added between the coupler and the power meter, depending on the power used.

7. Verify the gain of the Booster Amplifier(s). For example, if the analyzer's output power level was set to  $-20$  dBm and the output power measured from the open end of the coupler was  $-5$  dBm, the gain of the booster amplifier would be  $+15$  dB.

8. Verify that the power measured in the previous steps is within the acceptable limits (less than +43 dBm for the AMP IN port). The maximum power level between 40 GHz and 50 GHz is +40 dBm.
9. Turn off the booster amplifier.
10. Estimate the maximum power level that will be needed to force the DUT into compression. Acceptable limits are less than +43 dBm for the AMP IN port. The maximum power level between 40 GHz and 50 GHz is less than +40 dBm.

---

**CAUTION** Do not command the test set to engage *or* disengage the amplifier from the Port 1 RF path while the amplifier is on. This can damage the internal RF switches in the test set.

---

11. Verify that the Booster Amplifier is turned off.
12. Connect the Booster Amplifier RF OUTPUT connector to the Port 1 AMP IN connector on the front panel of the Z5623A Option H86.
13. Turn on the Booster Amplifier.
14. Using a high power meter and sensor, measure the output power from the test sets RCVR R1 port.
15. Turn off the Booster Amplifier.
16. Estimate the maximum power level that will be needed to force the DUT into compression.

---

## Selecting Power Ranges and Attenuator Settings

1. Select a power range that will not exceed the maximum estimated power level, but will force the DUT into compression. For example, if your Booster Amplifier has a gain of +15 dB and the DUT will compress if supplied with +15 dBm, then you would adjust the analyzer's output power not to exceed 0 dBm. This can be done by setting the Attenuator Control to 10 dB by pressing **Power**, under **Attenuator Control**, clear **Auto** command and type **[10]** into the entry area. In the "Port Selection" area, the Port Power Coupled can be checked to ensure that Port 1 and 2 power levels are the same, or unchecked if Port 1 and 2 power level requirements are different.
2. Estimate the maximum amount of gain that could be provided by the DUT and as a result, the maximum amount of power that could be received by Test Port 2 when the DUT is in compression. For example, if a DUT with a maximum gain of +10 dB receives an input of +10 dBm, then the maximum amount of power that could be received by Test Port 2 is +20 dBm. An isolator or attenuator may be required depending on the amount of power at Test Port 2. An isolator is placed between the CPLR IN and SOURCE OUT to protect the test set and the PNA.
3. Calculate the amount of attenuation needed between the analyzer's coupler and receiver so that you do not exceed the optimum receiver power level of -15 dBm. Refer to your PNA specifications to optimize power levels to the receiver ports.

It will be necessary to take the following into consideration:

- Power measured at the test sets RCVR R1 OUT = -2 dBm.
- Estimated compression power = -2 dBm.
- The optimum PNA receiver power level = -15 dBm.

Attenuation Equations:

4. Set the internal Z5623A Option H86 Test Set RCVR R1 step attenuator to the value calculated below (rounding off to the highest 10 dB step). Refer to ["Controlling the Test Set" on page 28](#) to set the Attenuator for RCVR R1 OUT path.

With the previous points in mind, the amount of attenuation can be calculated from the following equations:

$$\text{Attenuator RCVR R1 Setting} = -2\text{dBm} - (-15\text{ dBm}) = 13\text{ dBm}$$

$$\text{RCVR R1 Attenuator Value} = 20$$

5. Turn on the Booster Amplifier.
6. Measure the output power from the test sets RCVR R1 using a high power meter and sensor.
7. Verify that the power measured in the previous step is within the acceptable limits (-12 dbm at the RCVR R1 OUT).

8. Measure the output power from the test sets CPLR THRU port using a high power meter and sensor.
9. Turn off the Booster Amplifier.
10. Verify that the power measured in the previous step is within the acceptable limits (less than +43 dBm at the CPLR THRU port). The maximum power level between 40 GHz and 50 GHz is less than +40 dBm.
11. Calculate the amount of attenuation needed between the analyzer's coupler and receivers so that you do not exceed the optimum receiver power level of -15 dBm.

It will be necessary to take the following into consideration:

- Receiver A will be coupled to the analyzer RF path that could receive power reflections as high as +10 dBm.
  - Receiver B will be coupled to the analyzer RF path that could receive a maximum of +20 dBm from the DUT.
  - Analyzer coupler loss is -13 dB.
  - The optimum receiver power level is -15 dBm.
12. Set the internal step attenuator to the value calculated below (rounding off to the highest 5 dB step). Setting the receiver attenuation will set the internal attenuation. Press **[Menu/Dialog]** then tab to **Channel**. In the pull down menu select **Power**, under **Receiver Attenuation** set Receiver A to **[10]** and Receiver B to **[20]**. Power levels greater than +35 dBm will require additional attenuation between Port 2, access ports CPLR ARM and RCVR B IN.

With the previous points in mind, the amount of attenuation can be calculated from the following equations:

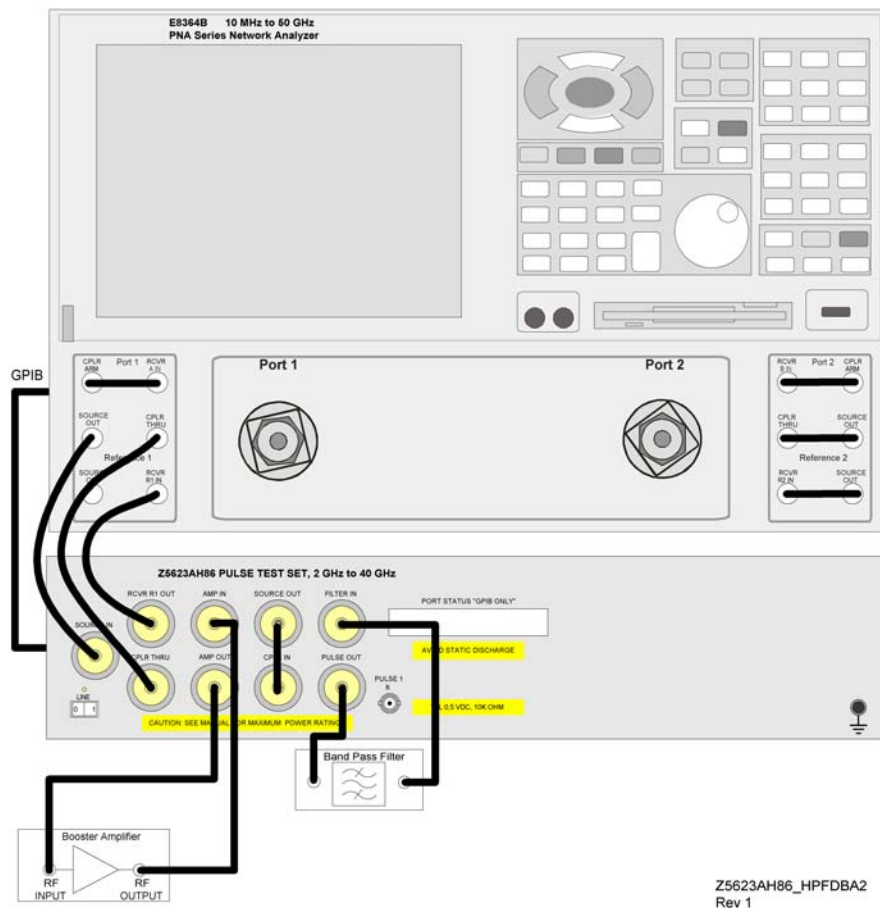
$$\text{Receiver Attenuator A} = 10 \text{ dBm} - 13 \text{ dBm} - (-15 \text{ dBm}) \quad \text{Attenuator A} = 12 \text{ dBm}$$

$$\text{Receiver Attenuator B} = 20 \text{ dBm} - 13 \text{ dBm} - (-15 \text{ dBm}) \quad \text{Attenuator B} = 22 \text{ dBm}$$

## Additional Setup

1. Remove the PNA SOURCE OUT and the RCVR IN jumpers.
2. Insert the jumpers between the PNA and the test set RCVR RI and CPLR THRU ports.
3. Turn on the Booster Amplifier.
4. Measure the output power from test Port 1 using a high power sensor. Verify that the power level is as expected.

**Figure 37** Connect PNA and Test Set Jumpers



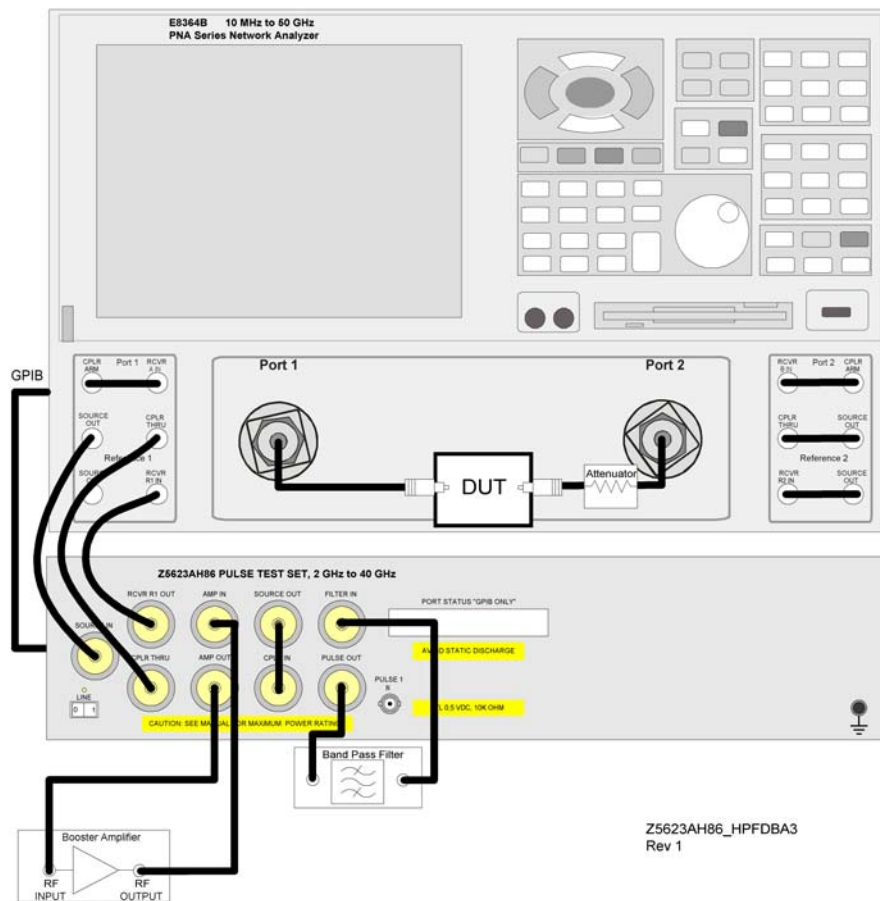
**CAUTION** Do *not* press Preset unless you have turned off the Booster Amplifier(s) or have saved this state and renamed it to User Preset. Pressing Preset will return the analyzer to its default power level and default internal attenuator settings. The increase in power may result in damage to the DUT or analyzer.

**CAUTION** High power isolators should be inserted between the SOURCE OUT and CPLR IN front panel ports on the test set if you are measuring a highly reflective device. The increase in power may result in damage to the analyzer.

## Final Setup and Response Calibration

1. Verify that all of the power and attenuator settings are correct, and set to the following measurement. Press **[Menu/Dialog]** then tab to **Trace**. In the pull down menu select **Measure** then **S21**.
2. Connect the analyzers test port cables to form a thru configuration.
3. Press **[Menu/Dialog]** then tab to **Calibration**. In the pull down menu select **Calibration Wizard** and then **Unguided Calibration Use Mechanical Standards**. Select **THRU Response**. Follow the analyzers window prompts to finish the calibration.
4. Make the connection as shown in [Figure 38](#).

**Figure 38** Connecting the DUT



5. Turn on the DUT and measure the S21 gain of the amplifier under test to confirm the proper operation of the measurement test setup.

6. Continue with any other high power measurements.

---

**NOTE** Ratio measurements, such as gain, will be correctly displayed. However, the displayed absolute power levels on the analyzer will *not* be correct. To correctly interpret power levels and the gain of the booster amplifier, the attenuator setting must be taken into consideration.

---

If no calibration has been performed or if the instrument is in an un-calibrated state, the following must be taken into consideration when interpreting the measured data:

- The value of attenuation added to receiver A and B.
- The R channel reference level supplied from the test set.
- Protection of the internal parts for the test set and PNA.



## Test Set Internal Configurations

The Z5623A Option H86 can be internally configured to allow the user to configure it for different application requirements. In this section we will show the test sets internal configurations.

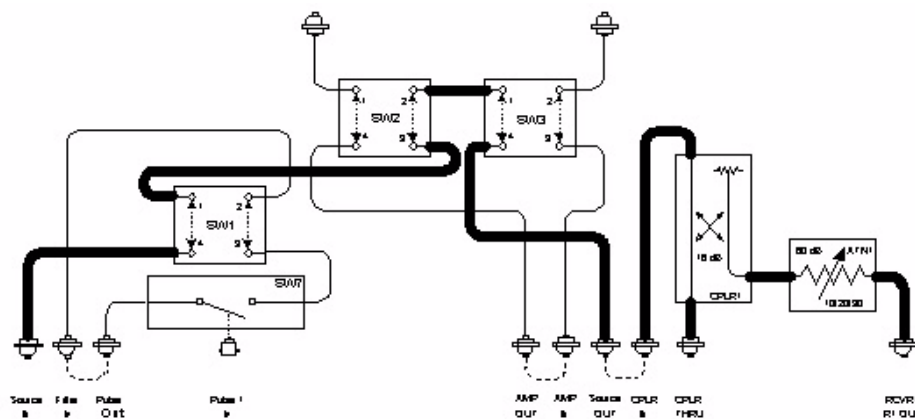
There are five basic mode configurations:

- Bypass
- High Power
- Pulse
- Pulse High Power
- Amplifier Terminate

### Bypass

The bypass mode sets the Test Set's internal switches so that the SOURCE IN port thru path connects directly to the CPLR THRU port. This allows you to use the PNA in a normal operation. The test port and R1 reference power at the PNA will be reduced due to the loss of the test set.

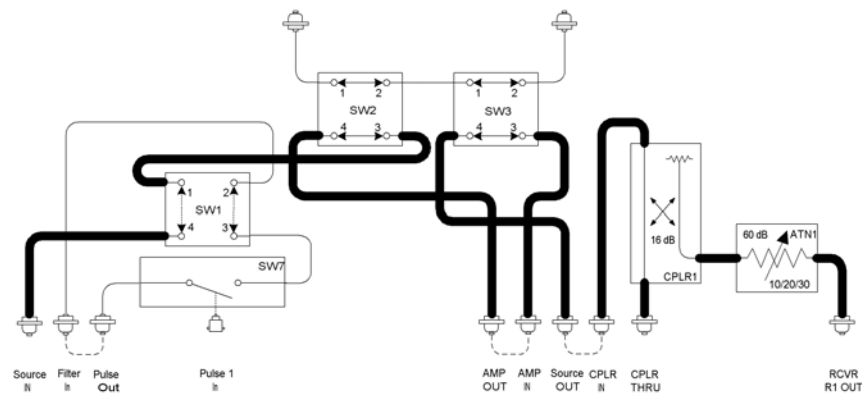
**Figure 39** Bypass



## High Power

The high power mode sets the Test Set's internal switches so that the SOURCE IN port thru path connects to the AMP OUT and AMP IN ports, and then to the CPLR THRU port. This allows the user to insert a Booster Amplifier in the RF path.

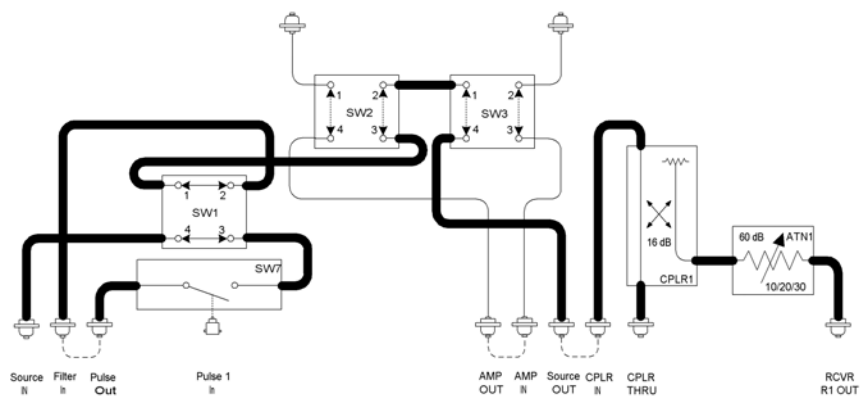
**Figure 40 High Power**



## Pulse

The pulse mode sets the Test Set's internal switches so that the SOURCE IN port thru path connects to the pin switch modulator, directly to the CPLR THRU port. This allows the user to make lower power pulse measurement.

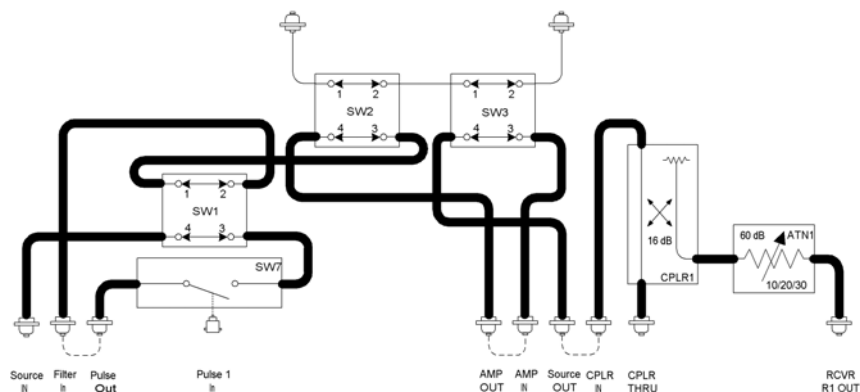
**Figure 41 Pulse**



## Pulse High Power

The pulse high power mode sets the Test Set's internal switches so that the SOURCE IN port thru path connects to the pin switch modulator, then to the AMP OUT and AMP IN ports, and then to the CPLR THRU port. This allows user to insert a booster amplifier in the pulsed RF path.

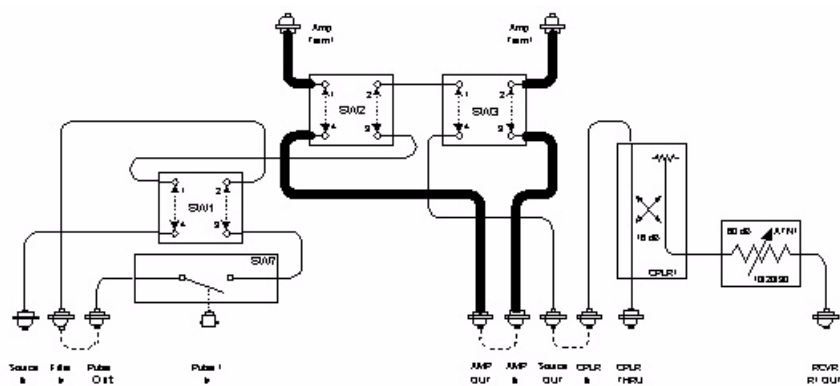
**Figure 42 Pulse High Power**



## Amplifier Terminate

The terminate amplifier is set in the bypass and pulse mode. This sets the Test Set's internal switches so that the AMP IN and AMP OUT RF ports are routed to the rear panel Amp Term 1 ports. Customer furnished terminations can be connected to these ports so that you may customize your power requirements. This allows the user to terminate the Booster Amplifiers input and output.

**Figure 43 Amplifier Termination**



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## Specification

Specifications for the Z5623A Option H86 forward direction pulse test set are nominal.

### Pulsed RF Pin Switch Detectors

Transition Time: 30 nanoseconds; (Typically < 20 nanoseconds)

Rise/Fall Time (10% to 90%): 20 nanoseconds; (Typically < 10 nanoseconds)

Pulse Width (minimum): 100 nanoseconds

Trigger Level (External): 10 k $\Omega$  TTL, "0" ON, "1" OFF, TTL-low-level signal turns RF on.

Maximum Power Input: 20 dBm

On/Off Ratio: 50 dB (> 70 dB, 400 MHz to 2 GHz)

Frequency Range: 2 to 40 GHz

## E8363B/E8364B Option H11

Widest Bandwidth: 10 kHz

Trigger Level (External): TTL

Trigger Width (minimum): 20 nanoseconds

**Table 7 Nominal System Performance**

Item		Unit of Measure			
Nominal system Performance (Not tested at this time)		0.01 to 8 GHz	8 to 20 GHz	20 to 40 GHz	40 to 50 GHz
Maximum Power at Port 1 <sup>a</sup> (nominal)		-25 dBm	-30 dBm	-35 dBm	-40 dBm
Reference Power at Port 1 (nominal)		-38 dBm <sup>b</sup>	-43 dBm	-48 dBm	-53 dBm
Minimum Power at Port 1 <sup>c</sup> (nominal)		-80 dBm	-80 dBm	-80 dBm	-80 dBm
System Dynamic Range <sup>d</sup> (bypass mode)		110 dB	100 dB	90 dB	85 dBm
System Dynamic Range <sup>d</sup> (pulse mode)	Pulse <sup>e</sup>	70 dB <sup>f</sup>	60 dB	50 dB	
	Non-Pulse <sup>e</sup>	80 dB <sup>f</sup>	80 dB	80 dB	

- a. This maximum power measurement assumes that the PNA source attenuator is set to 0 dB and the power level is set to -17 dBm (default power level for the E8363B and E8364B).
- b. Excludes frequencies below 1 GHz due to test sets RCVR Out Coupler. Frequencies below 1 GHz are nominally -3 dB at 500 MHz, -15 dB at 100MHz, and -20 dB at 50MHz from measured performance at 1 GHz.
- c. This minimum power measurement is in bypass mode.
- d. Forward transmission measurements. Limited by compression level and noise floor.
- e. System Dynamic Range “Pulse” indicates the ON/OFF ratio of the pin switch. The Non Pulse indicates when the pin switch is ON and not used in a pulse mode application.
- f. Excludes performance below 2 GHz.

## Test Set Performance Verification

### Equipment Required

- E8363B/E8364B Network Analyzer 10 MHz to 50 GHz or equivalent
- 85056A Calibration kit or equivalent
- 81110A with 81111A Pulse Pattern Generator
- (2) 2.4 mm RF cables (36 inch or equivalent)
- 86110A Infinium DCA Wideband Oscilloscope
- 83484A Two Channel 50 GHz Module

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## Procedure

To test the performance of the Z5623A Option H86 this document assumes that the user is familiar with the necessary equipment. The PNA USB keyboard and mouse will be necessary to enter GPIB commands and to read the trace data. Measurements can be made easier by setting up Markers with search, tracking and search domain user states for each of the frequency bands.

Using the PNA as the controller to issue commands to the Z5623A Option H86 Test Set can be found in [“Controlling the Test Set” on page 28](#).

General S-Parameters are used to characterize the connection paths of the test set. Both reflection and transmission measurements are required. These measurements are made with the E8363B, 2.4 mm cal kit and RF cables. Power Output and Pulse Shape are not measured to re-verify the Z5623A Option H86 test set.

A Full 2-Port Slot Calibration should be performed on the PNA at the ends of the RF cables. The Isolation must not be omitted. The calibration should be performed at the following settings shown in [Table 8](#).

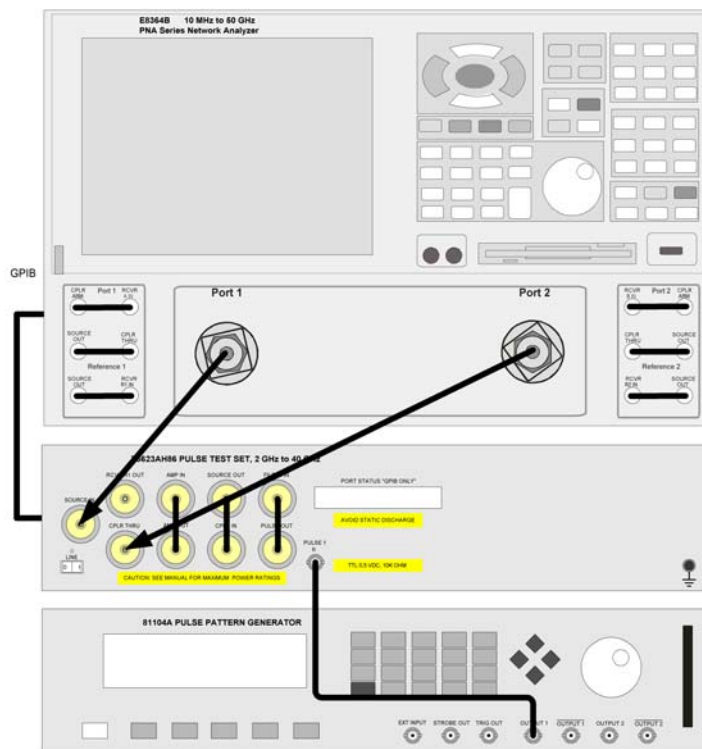
**Table 8**      **Calibration Settings**

Start freq	10 MHz	Stop Freq	50 GHz
Power level	-17 dbm	IF bandwidth	100 Hz
Number of points	401		

## CPLR Thru S-Parameters

1. Connect the RF cables as shown in [Figure 44, “CPLR Thru S-Parameters,”](#) which shows the configuration for Port 1 setup. This measures the Source In to CPLR THRU S-Parameters and On/Off Ratio for Port 1. Connect Port 1 and record the data in [Table 9 on page 65](#).
2. Connect a 50  $\Omega$  load to the RCVR Out Port.
3. Set the Z5623A Option H86 Test Set to the Bypass mode using the PNA as the controller. Measure the S-Parameters for the Source In to CPLR THRU. Record the performance data in [Table 9](#).
4. Verify that the Pulse In is set to 0 Volts on the 81111A and set the impedance on the Output to 1000  $\Omega$
5. Set the Test Set to the High Power mode using the PNA as the controller. Measure the S-Parameter for the Source In to CPLR THRU. Record the data in [Table 9](#).
6. Set the Test Set to the High Power Pulse mode using the PNA as the controller. Measure the S-Parameter for the Source In to CPLR THRU. Record the data in [Table 9](#) for frequencies between 20 to 40 GHz only.
7. Set the Test Set to the Pulse mode using the PNA as the controller. Measure the S-Parameter for the Source In to CPLR THRU. Record the data in [Table 9](#) for frequencies between 20 to 40 GHz only.

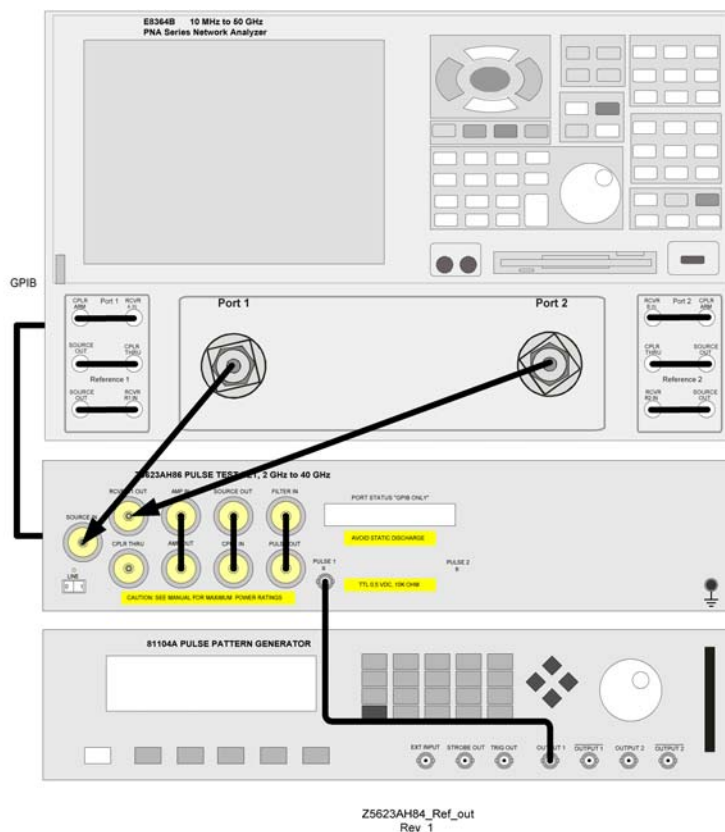
**Figure 44** CPLR Thru S-Parameters



## RCVR Port S-Parameters

1. Connect the RF cables as shown in [Figure 45, “RCVR Port S-Parameters,”](#) which shows the configuration for Port 1 setup. This measures the Source In to REF 1 OUT S-Parameters for the Port 1. Record the data in [Table 10 on page 65.](#)
2. Set the Z5623A Option H86 Test Set to the Bypass mode using the PNA as the controller. Measure the S-Parameters for the Source In to REF OUT. Record the data in [Table 10](#) for frequencies between 2 to 50 GHz only.
3. Connect a 50  $\Omega$  load to the CPLR Thru Port.
4. Verify that the Pulse In is set to 0 Volts on the 81111A and set the impedance on the Output to 1000  $\Omega$

**Figure 45 RCVR Port S-Parameters**

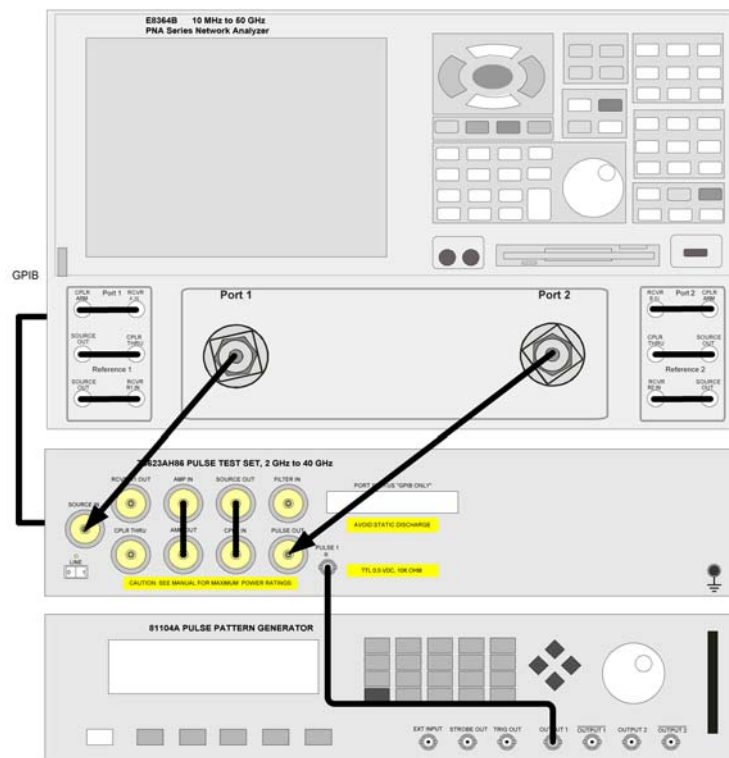




## On/Off Switch Ratio

1. Connect the RF cables as shown in [Figure 46, “On/Off Switch Ratio,”](#) which shows the configuration for Port 1 set up. This measures the Source In to REF 1 OUT S-Parameters and Reference Attenuators for Port 1. Record the data in [Table 11 on page 66.](#)
2. Verify that the Pulse In is set to 0 Volts on the 81111A and set the impedance on the Output to 1000  $\Omega$
3. Set the Z5623A Option H86 Test Set to the Pulse mode using the PNA as the controller. Measure the S-Parameter for the Source In to Pulse Out. Record the data in [Table 11.](#)
4. Set the PNA to measure S21 only. Normalize the S21 response.
5. Set the Pulse In to 5 Volts by changing the 81111A Output to 5 Volts.
6. Measure the On/Off Ratio. Record the data in [Table 11.](#)

**Figure 46 On/Off Switch Ratio**

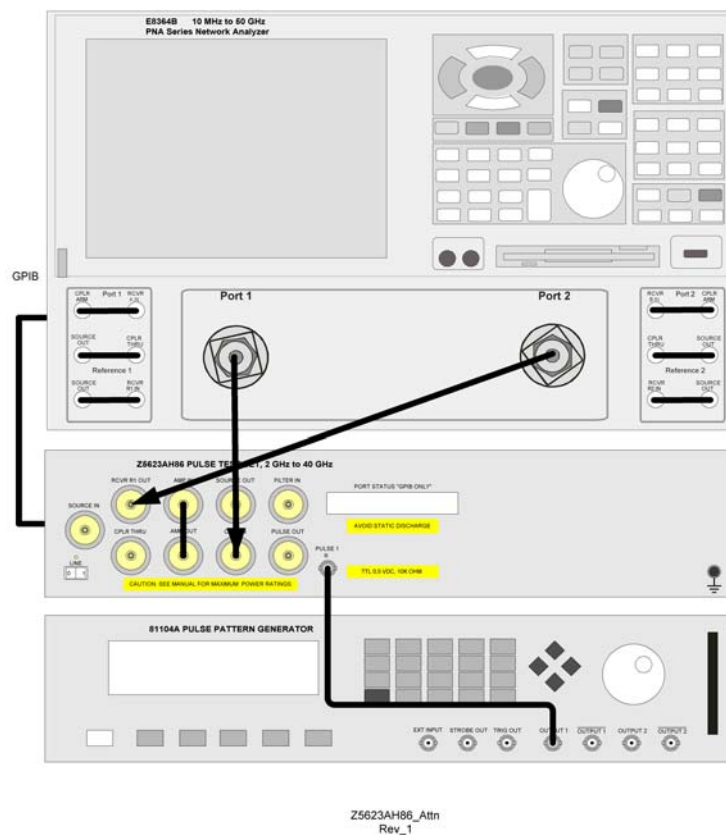


Z5623AH86\_on\_off  
Rev\_1

## Attenuator Settings

1. Connect the RF cables as shown in [Figure 47, “Attenuator Steps.”](#) This configuration measures the CPLR IN to REF 1 OUT Reference Attenuators for Port 1. Record the data in [Table 11 on page 66.](#)
2. Connect a 50  $\Omega$  load to the CPLR Thru Port.
3. Set the PNA to measure S21 only. Normalize the S21 response.
4. Set Marker 1 to 2 GHz. The attenuator setting is measured at 2 GHz only to test the attenuators relative attenuation for each setting. The noise floor of the PNA limits measurements when the test sets attenuator setting is greater than 40 dB. Frequencies above 6 GHz at low power levels make measurements difficult. Frequencies below 1 GHz are also difficult due to the coupler roll off.
5. Set the Z5623A Option H86 Test Set Reference Attenuator in 10 dB steps (10 – 60 dB) and measure the response. Record the data in [Table 11.](#)

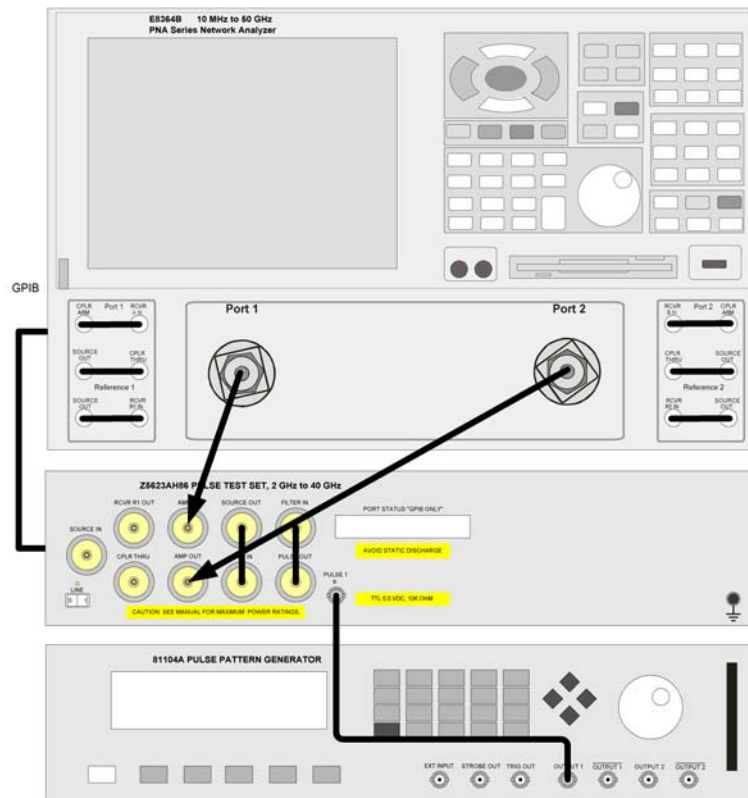
**Figure 47 Attenuator Steps**



## Rear Panel Termination Test

1. Connect the 50  $\Omega$  loads to the rear panel connectors J3, and J4.
2. Set the PNA to measure S11 and S22.
3. Set the Z5623A Option H86 Test Set to the Bypass mode using the PNA as the controller. Measure the S-Parameter to the Amp In and Amp Out for J4 and J3. Record the data in [Table 11 on page 66](#).

**Figure 48 Rear Panel Termination**



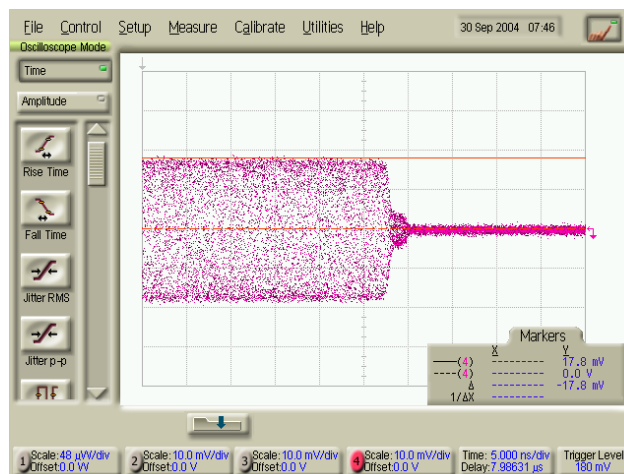
## Rise and Fall Time Test

1. Connect the RF cables shown in [Figure 51 on page 64](#). This configuration measures the rise and fall times of the pin switch modulators in the test set. Record the data in [Table 11 on page 66](#).
2. Set the E8363/64B to **[CW mode] [Frequency] [20 GHz]**.
3. Set the E8363/64B **[Power Level] [-20 dBm]**.
4. Turn the 81110A Output 1 **On**.
5. Set the 81110A **[LEVEL] Normal > High 5 Volts > Low 0 Volts > 50 to 1 kΩ**
6. Set the 81110A **[TRIGGER MODE] to Continuous > Pulse Signal to Output 1 > Pulse Period to Internal Osc.**
7. Set the 81110A **[TIMING] to Freq 100 kHz > Delay 0 ns > Duty Cycle 90% > LeadEdge 2 ns > TrailingEdge = LeadEdge.**
8. Set the 81110A **[PATTERN] to Update Continuous > CH1 to 1.**
9. Set the 86100A for **Channel 1 On > Scale to 10 mv > Time to 2 μs**. Position the pulse to the right edge of display.
10. Expand the **Time** scale to measure the pulse amplitude at 100 ns. You may need to reposition the pulse to keep the rising edge on the display.
11. Measure the amplitude of the Positive pulse side by setting the **solid horizontal marker** to the center of the trace 0 Volts. Set the **dash horizontal marker** to the maximum Positive Pulse amplitude. Measure the delta voltage. The following equation will allow you to calculate the 10% and 90% rise and fall time.

$$10\% \text{ point} = \text{delta (positive pulse)} \times 0.1$$

$$90\% \text{ point} = \text{delta (positive pulse)} \times 0.9$$

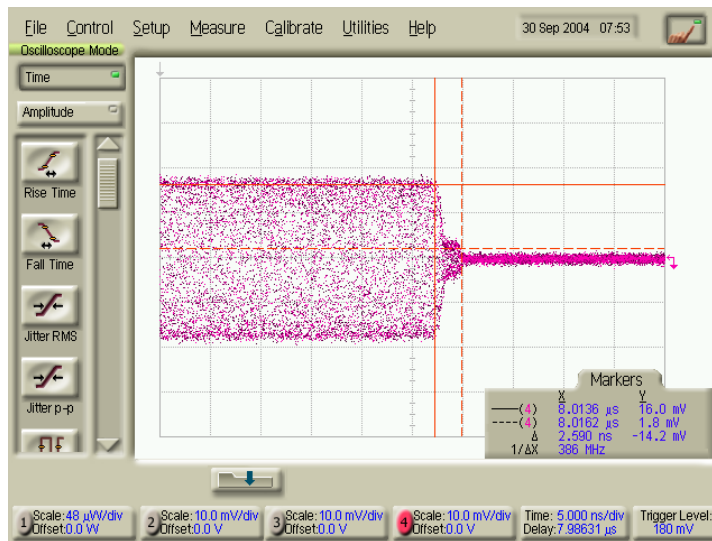
**Figure 49 Delta Voltage**



12. Set the **solid horizontal marker** to the 10% point and the **dash horizontal marker** to the 90% point.

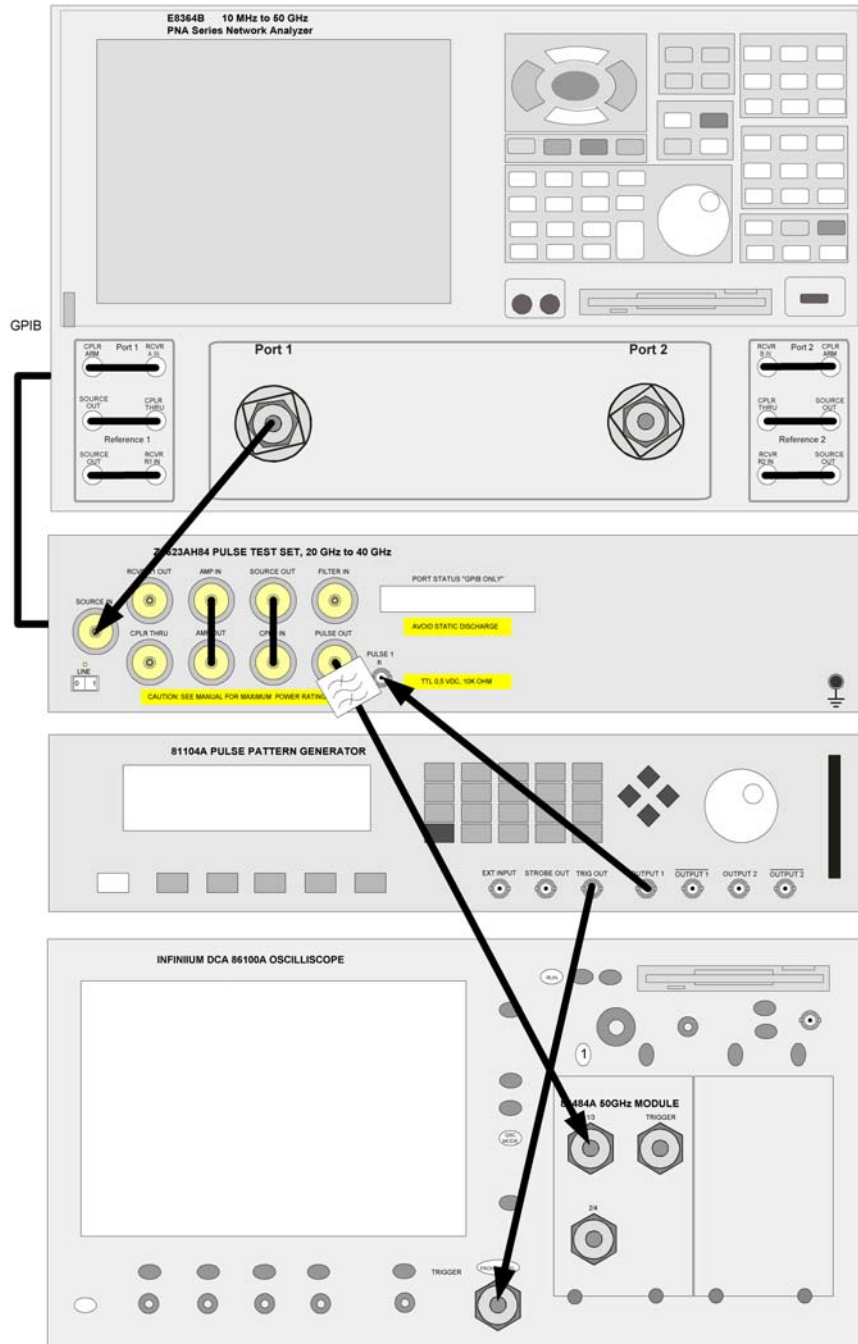
13. Expand the **Time scale** of the oscilloscope for **5 ns**, keeping the pulses rise time in view.
14. Set the **vertical solid marker** to the 10% point and the **vertical dash marker** to 90%, and measure the rise time by reading the delta vertical Marker. Record the rise time in [Table 11](#).
15. Increase the **Time scale** to 100 ns. Position the marker on the pulses fall time to the right on the display and then expand the scale to 5 ns keeping the pulse fall time in view.
16. Set the **vertical solid marker** to the 90% point and the **vertical dash marker** to 10%, measure the fall time by reading the delta vertical marker. Record the fall time in [Table 11](#).

**Figure 50**     **Fall Time**



17. Repeat [step 9](#) through [step 16](#) for 30 GHz and 40 GHz by changing the CW frequency on the E8363/64B and measure the rise and fall times.

**Figure 51 Rise and Fall Time Setup**



**Table 9 Performance Data (Port 1 to CPLR THRU)**

Port/Connection/Mode	0.01 to 8.0 GHz		8.0 to 20.0 GHz		20.0 to 40.0 GHz		40.0 to 50.0 GHz	
	Spec (dB)	Meas	Spec (dB)	Meas	Spec (dB)	Meas	Spec (dB)	Meas
<b>Port 1 SOURCE IN to CPLR THRU<sup>a</sup></b>								
Bypass								
S11, S22	18		10		8		8	
S21, S12	-6		-10		-15		-19	
High Power								
S11, S22	18		10		8		8	
S21, S12	-9		-13		-19		-22	
Pulse								
S11, S22	8		6		6		n/a	n/a
S21, S12	-16		-20		-25		n/a	n/a

a. Pulse path measurement specification starts at 2 GHz.

**Table 10 Performance Data (Port 1 to RCVR R1 OUT)**

Port/Connection/Mode	1 to 8.0 GHz		8.0 to 20.0 GHz		20.0 to 40.0 GHz		40.0 to 50.0 GHz	
	Spec (dB)	Meas	Spec (dB)	Meas	Spec (dB)	Meas	Spec (dB)	Meas
<b>Port 1 SOURCE IN to RCVR R1 OUT<sup>ab</sup></b>								
Bypass								
S11, S22	18		10		8		8	
S21, S12	-24		-26		-29		-31	

a. RCVR OUT measured from 1 to 50 GHz due to internal coupler roll-off below 1 GHz. The roll-off adds -3 dB at 500 MHz, -15 dB at 100 MHz and -20 dB at 50 MHz from the measured response value at 1 GHz.

b. Pulse path measurement specification starts at 2 GHz.

**Table 11 Performance Data (On/Off, Attenuation, Rise and Fall)**

Port/Connection/Mode	2 to 8.0 GHz		8.0 to 20.0 GHz		20.0 to 40.0 GHz		40.0 to 50.0 GHz	
<b>On/Off Switch Ratio Normalized S21 Response</b>	Spec (dB)	Meas	Spec (dB)	Meas	Spec (dB)	Meas	Spec (dB)	Meas
Port 1 side (typically >70 dB, 400 MHz to 2 GHz)	70		60		50		n/a	n/a
<b>Attenuator Setting<sup>a</sup> Normalized S21 Response</b>	Specification ± 3.5 dB				Measured Value			
Port 1 Side								
10	10							
20	20							
30	30							
40	40							
50	50							
60	60							
<b>Rear Panel Match</b>	J4 (AMP IN)		J3 (AMP OUT)					
	Spec (S22 dB)	Meas	Spec (S11 dB)	Meas				
<b>AMP IN/OUT Term Ports</b>	8		8					
<b>Rise and Fall Time</b>	Rise Time Spec (ns)		Meas		Fall Time Spec (ns)		Meas	
Port 1 Side								
< 20 GHz	20				20			
30 GHz	20				20			
40 GHz	20				20			

a. Marker 1 data measured at 2 GHz only with 0 dB attenuation in the RCVR Out path normalized. This is a functional check only.



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## Replaceable Parts

**Table 12      Replaceable Parts List**

Reference Designator	Description	Agilent Part Number
	PWR-SPLY; power-110W; number of Outputs = 4	0950-2252
ATTN1	Attenuator assembly (60 dB 3-Section)	33325-60006
FP/RP RF Conn	Connector assembly (bulkhead)	5062-7243
CPLR1	Coupler (50 GHz)	5068-7658
	Daughter controller board	87050-60324
	Board assy interim	87050-63149
SW1-SW3	50 GHz transfer switch	87222-60015
	Pulse bias board assy	Z5623-63293
	Manual control interface assembly	Z5623-63364
SW7	U-Wave pin diode switch (2 to 40 GHz)	Z5623-80031
	User's and Service Guide (Option H86)	Z5623-90069





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## Safety and Regulatory Information

### Introduction

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

### Connector Care and Cleaning

If alcohol is used to clean the connectors, the power cord to the instrument must be removed. All cleaning should take place in a well ventilated area. Allow adequate time for the fumes to disperse and moist alcohol to evaporate prior to energizing the instrument.

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<b>WARNING</b>	<b>To prevent electrical shock, disconnect the Agilent Technologies model product from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.</b>
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### Before Applying Power

Verify that the product is configured to match the available main power source. 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.

### Shipping Instructions

You must always call the Agilent Technologies Instrument Support Center to initiate service before retuning your instrument to a service office. Refer to [“Contacting Agilent Sales and Service Offices” on page 75](#). Always transport or ship the instrument using the original packaging if possible. If not, comparable packaging must be used. Attach a complete description of the failure symptoms.

### Statement of Compliance

This product has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

### Declaration of Conformity

For a copy of the manufacturer’s Declaration of Conformity for this apparatus, contact your local Agilent Technologies office or sales representative on [page 75](#).

## **Compliance with Canadian EMC Requirements**

This ISM device complies with Canadian ICES-001.  
Cet appareil ISM est conforme a la norme NMB du Canada.

## **Compliance with German Noise Requirements**

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung-3. GSGV Deutschland).

<b>Acoustic Noise Emission/Geraeuschemission</b>	
LpA<70 dB	Lpa<70 dB
Operator Position	am Arbeitsplatz
Normal Operation	normaler Betrieb
per ISO 7779	nach DIN 45635 t. 19

## Warnings

Warnings applicable to this instrument are:

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WARNING	To prevent electrical shock, disconnect the <b>Agilent Technologies Z5623A Option H86</b> from the mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.
WARNING	For continued protection against fire hazard replace line fuse only with same type and rating: <ul style="list-style-type: none"><li>• United States—F 3.0A/250V, Part Number 2110-0780</li><li>• Europe—F 3.15A/250V, Part Number 2110-0655</li></ul> The use of other fuses or material is prohibited.
WARNING	This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the product is likely to make the product dangerous. Intentional interruption is prohibited.
WARNING	These servicing instructions are for use by qualified personnel only.
WARNING	The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.
WARNING	This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 61010-1: 2001.
WARNING	No operator serviceable parts inside. Refer servicing to qualified personnel.
WARNING	If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

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## Cautions

Cautions applicable to this instrument are:

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**CAUTION** Always use the three-prong ac power cord supplied with this instrument. Failure to ensure adequate earth grounding (by not using this cord) can cause instrument damage.

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**CAUTION** This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 61010-1:2001.

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**CAUTION** This instrument has autoranging line voltage input; be sure the supply voltage is within the specified range.













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**CAUTION** Ventilation Requirements: When installing the instrument in a cabinet, the convection into and out of the instrument must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the instrument by 4 °C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, forced convection must be used.

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## 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.
	The laser radiation symbol is marked on products that have a laser output.
	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.
	This symbol indicates the product meets the Australian Standards.
	This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive, 2002/96/EC).
	This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPR 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.



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## Contacting Agilent Sales and Service Offices

Assistance with test and measurement needs, and information on finding a local Agilent office are available on the Internet at:

*<http://www.agilent.com/find/assist>*

You can also purchase accessories or documentation items on the Internet at:

*<http://www.agilent.com/find>*

If you do not have access to the Internet, contact your field engineer.

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### NOTE

In any correspondence or telephone conversation, refer to the product by its model number and full serial number. With this information, the Agilent representative can determine whether your unit is still within its warranty period.

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