

Agilent Technologies E8362B, E8363B and E8364B Option H85

User's and Service Guide Supplement

Use this manual with the following documents:

PNA Series Microwave Network Analyzer (E8362B, E8363B and E8364B) Service Guide
Part Number E8364-90026

PNA Series Network Analyzer On-line Help System

Application Note 1408-12



Agilent Technologies

Manufacturing Part Number: E8364-90027

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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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General Overview

Introduction

This document describes the differences between the Agilent E8362B, E8363B and E8364B with Option H85 and the standard E8362B, E8363B and E8364B PNA Series Network Analyzer.

Information can be viewed or printed regarding the PNA Series Network Analyzer Data sheets, white papers, or manuals by visiting our web site at <http://www.agilent.com/find/pna>.

Description

The Agilent E8362B, E8363B and E8364B Option H85 is a modified version of the standard E8362B, E8363B and E8364B PNA Series Network Analyzer. Option H85 is designed to permit insertion of high power amplifiers and other signal conditioning equipment to allow high power network 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. Refer to [Figure 3](#), [Figure 4](#), and [Figure 5](#) depending on the type of high power configuration. The Option H85 is similar to the Option UNL with one exception; the modification supplies source attenuators *without* bias tees.

NOTE The Bias Tee's are removed from the Option H85 to allow high power operation. Specifications for the Agilent E8362B, E8363B and E8364B Option H85, when configured in Bypass Configuration, are the same as those of an E8362B, E8363B and E8364B PNA Series Network Analyzer with Options 014, 016, 080, 081 and UNL.

The instrument is shipped from the factory with jumper cables installed on the front panel in what is referred to as the “Bypass Configuration.” Refer to [Figure 2 on page 7](#). This configuration will allow the instrument to operate as a standard E8362B, E8363B and E8364B PNA Series Network Analyzer with Options 014, 016, 080, 081 and UNL.

Additional options are available for the Agilent E8362B, E8363B and E8364B Option H85. The Agilent E8362B, E8363B and E8364B Option H85 bundles Options 014, 016, 080 and 081 and are part of the H85.

Operation

The Agilent Option H85 can be configured differently for many applications. Included in this manual insert are four typical configurations:

- [Figure 2, “Bypass Configuration and Major Assemblies.”](#)
- [Figure 3, “High Power One-way Input/Output.”](#)
- [Figure 4, “High Power DUT One-way to Output.”](#)
- [Figure 5, “High Power Two-way Configuration.”](#)

NOTE The internal firmware of the PNA has not been modified for this option. The power levels indicated on the Agilent E8362B, E8363B and E8364B Option H85 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 E8362B, E8363B and E8364B Option H85. External components are not supplied with this option.

When using the Agilent E8362B, E8363B and E8364B Option H85 in the high power configuration, the 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 1 on page 4](#).

CAUTION The A and B maximum attenuator setting is 35 dB. The PNA Option 016, Receiver Step Attenuators, reduces the power to the A and B receivers. 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 –12 dBm. Refer to [Table 1 on page 4](#).

Refer to [Table 2 on page 16](#) for information regarding the PNA frequency Band-Crossing with high power devices with ALC and [Table 3 on page 17](#) for Watts to dBm Reference Table.

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 [Figure 1](#).

Accordingly, the following power level values are given:

Table 1 Power Levels

Test Setup	Power Level
Max Recommended RF Level at A/B/R1/R2 Receivers	- 12 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	+43 dBm @ 10 MHz to 40 GHz
Max Level to Port 1, 2 Test Ports	+40 dBm @ 40 GHz to 50 GHz
Max Level to Port 1, 2 CPLR THRU	+43 dBm @ 10 MHz to 40 GHz
Max Level to Port 1, 2 CPLR THRU	+40 dBm @ 40 GHz to 50 GHz

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

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.

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.

Specifications

Specifications for Option H85 are the same as those of the Standard Microwave E836xB PNA Series with Option UNL. The Option H85 is a modified version of Option UNL. This modification eliminates the bias tees from the Port 1 and Port 2 Source paths. The Option H85 basic arrangement is configured with PNA Options 014, 016, 022, 080, and 081.

Specifications can be viewed or printed from the PNA Series Data Sheet (a condensed version of the specifications). Visit our web site at <http://www.agilent.com/find/pna>, select your analyzer model (E836xB) and click on the link to the data sheet.

The high power or large signal capability specifications for the Option H85 are not tested at the factory, in the field, or at service centers.

Figure 1 Maximum Power Levels

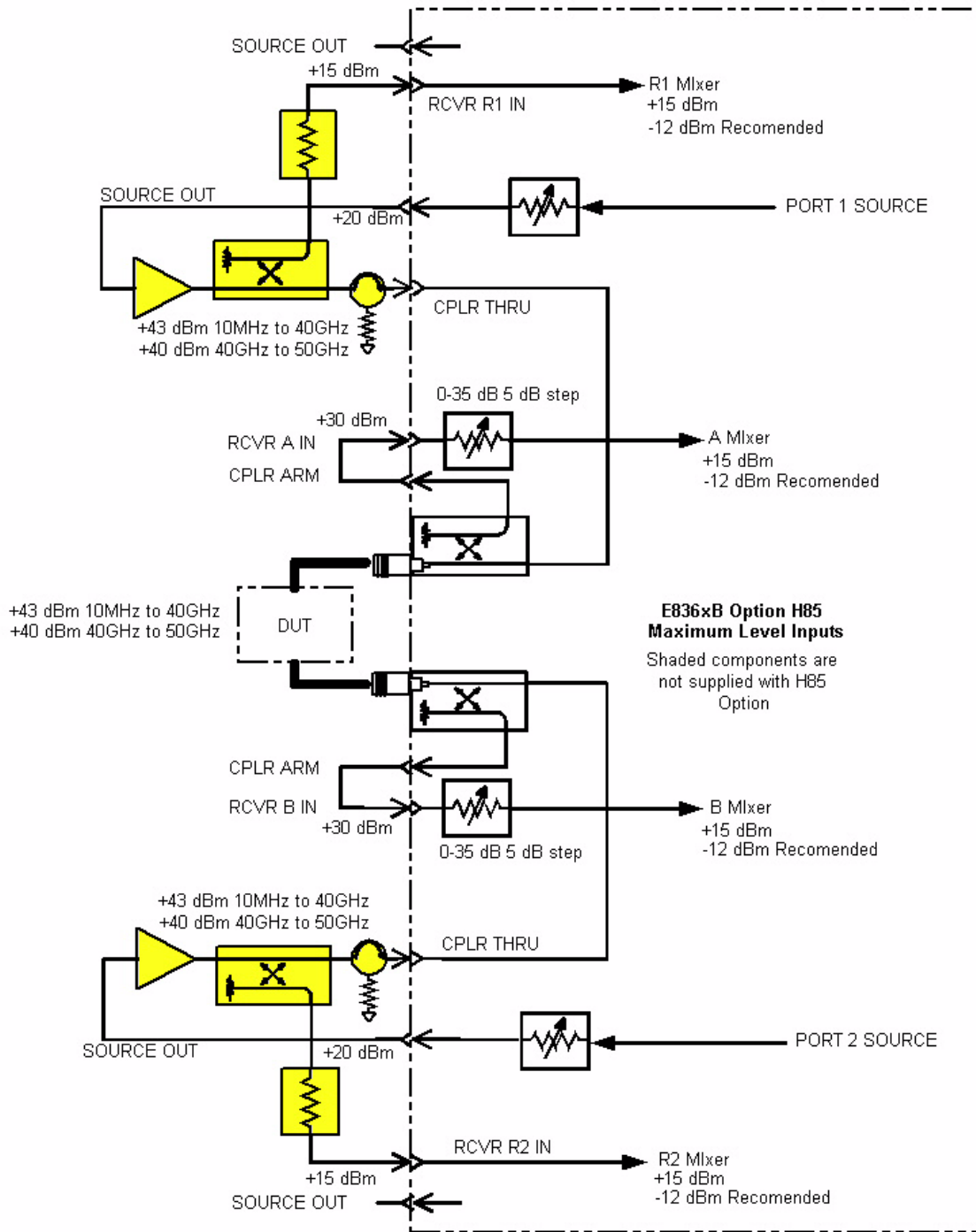
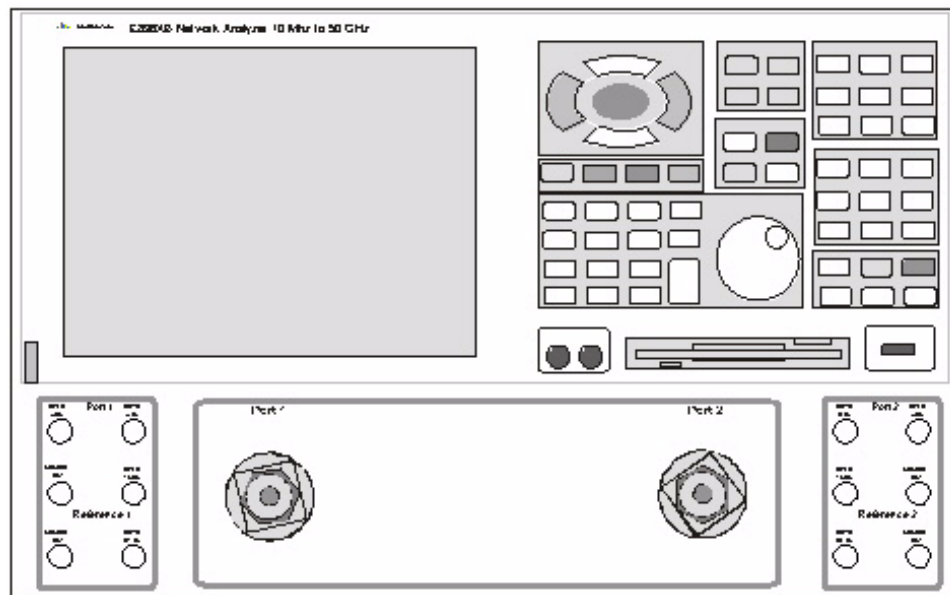


Figure 2 Bypass Configuration and Major Assemblies



In the following diagrams a high power isolator or attenuator *must* be inserted at the Port 1 or Port 2 front panel jumper (CPLR THRU and SOURCE OUT ports) to protect the internal solid state transfer switch (30 dB isolation recommended), or if reverse isolation of the amplifier is less than 30 dB. Maximum power into the SOURCE OUT is 20 dBm. Optimum power level to all receivers is -12 dBm.

- Insert attenuators (A, B, R1 and R2 ports) to reduce power to receivers accordingly.
- Set the initial instrument state to -65 dBm test port power level to reduce the risk of damage when powering on the unit.
- The recommended sweep mode is [STEP].
- Frequency Offset mode must be **On** and the R1 reference channel should be set to **External**.

Figure 3 High Power One-way Input/Output

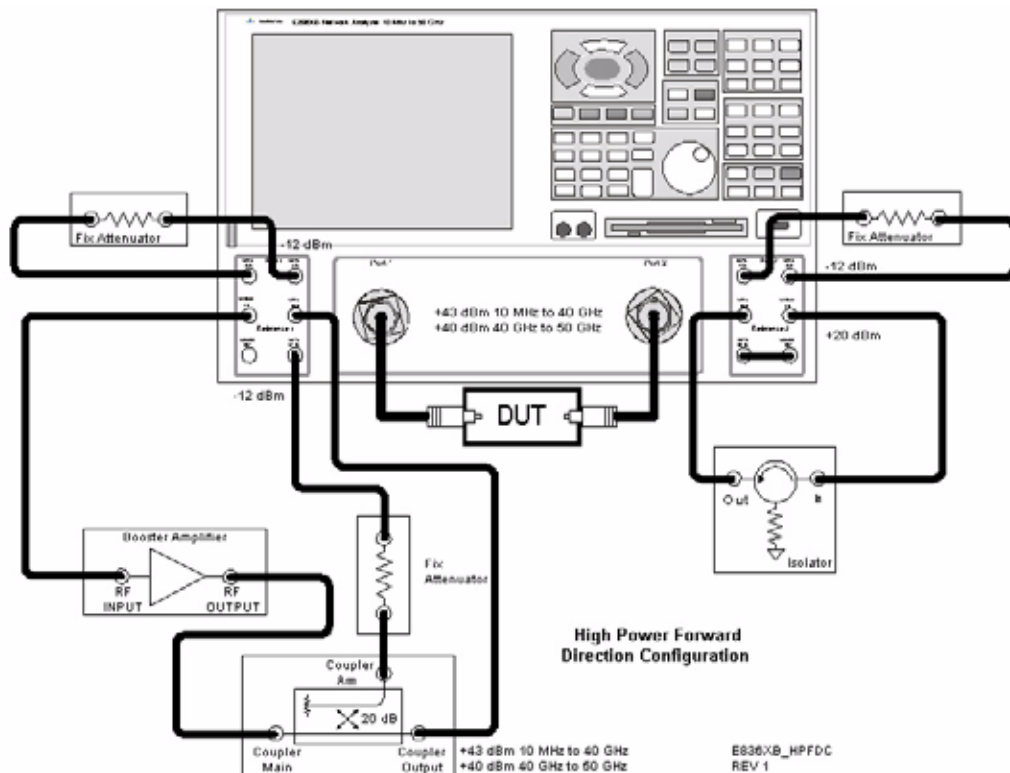


Figure 4 High Power DUT One-way to Output

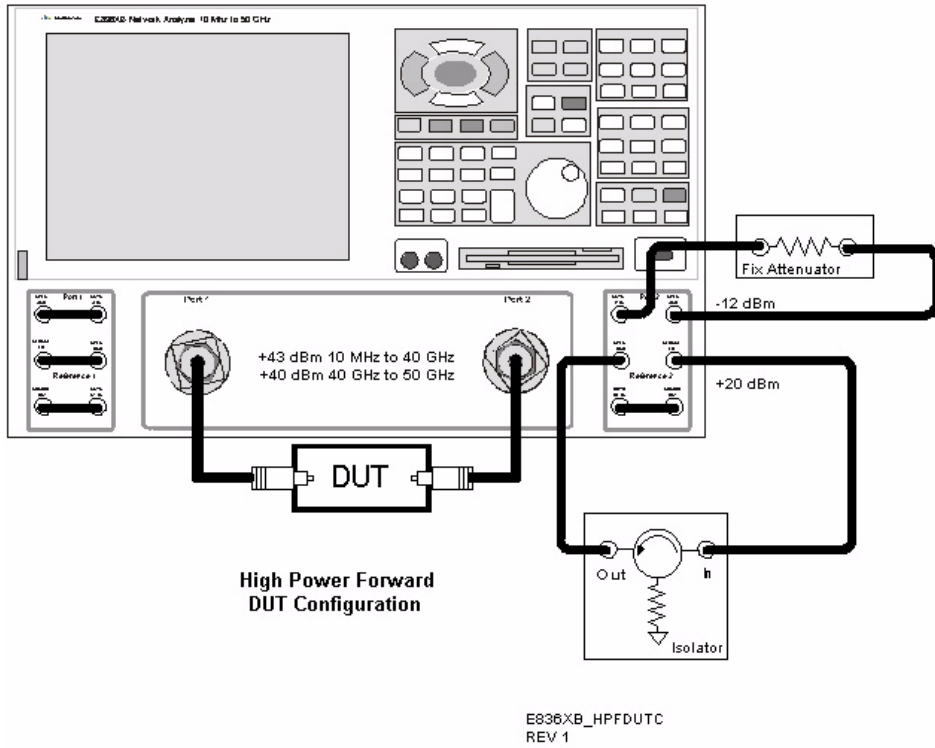
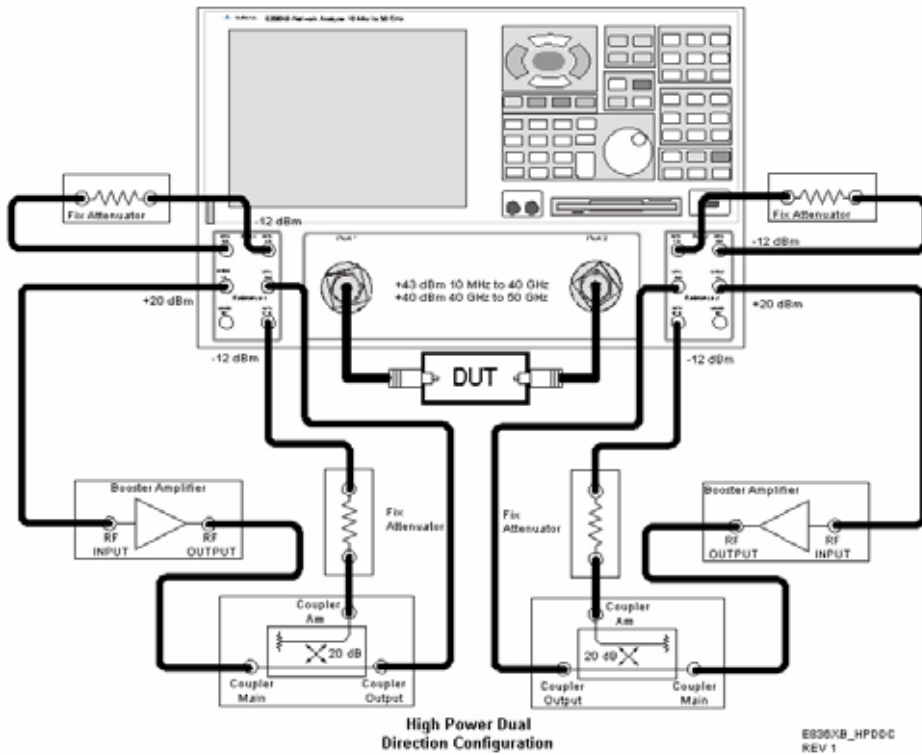


Figure 5 High Power Two-way Configuration



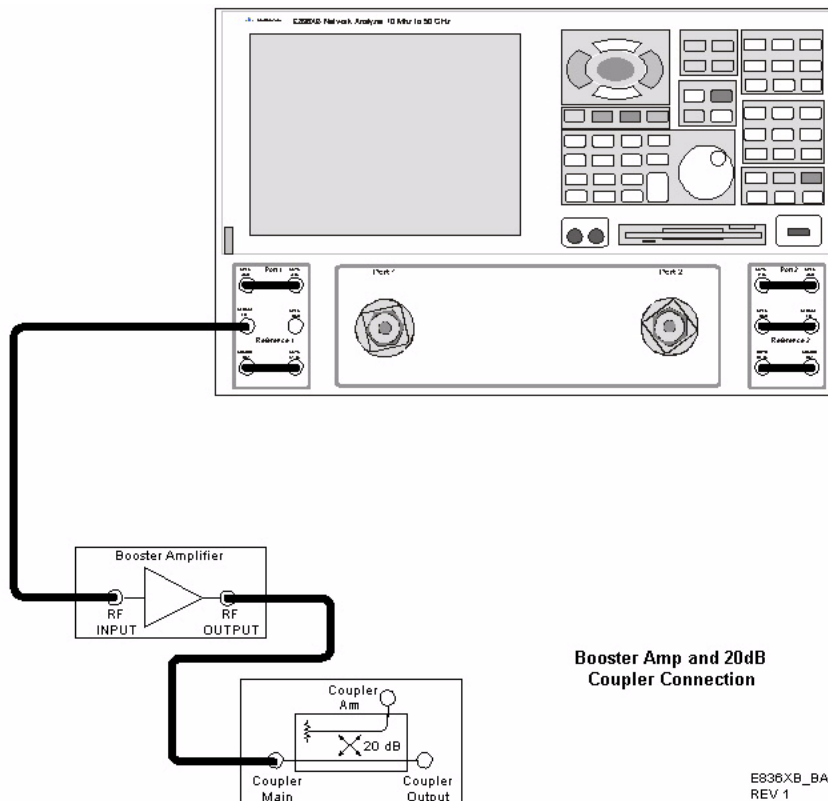
Making High Power Measurements With Option H85

This section describes how to set up the analyzer to perform high power measurements. Analyzers equipped with the Option 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 standard analyzer.

Initial Setup

1. If the analyzer is in the bypass mode configuration remove the jumper between SOURCE OUT and CPLR THRU connector on the front panel for Port 1. This can also be done for Port 2 if high power measurements are necessary for the reverse parameters of a device under test (DUT). Two booster amplifiers and two 20 dB couplers are required for both forward and reverse measurements. Refer to [Figure 1, "Maximum Power Levels."](#)
2. Connect the booster amplifier RF INPUT connector to the Port 1 SOURCE OUT connector on the front panel of the analyzer.
3. Connect a 20 dB coupler (that operates within the frequency range of interest) to the booster amplifier RF OUTPUT connector.

Figure 6 Booster Amplifier and 20 dB Coupler Connection Setup



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.

4. 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:

5. 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**.
6. 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** enter **[-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.
7. Turn on the booster amplifier.

NOTE Depending on the power used, additional attenuation may have to be added between the coupler and the power meter.

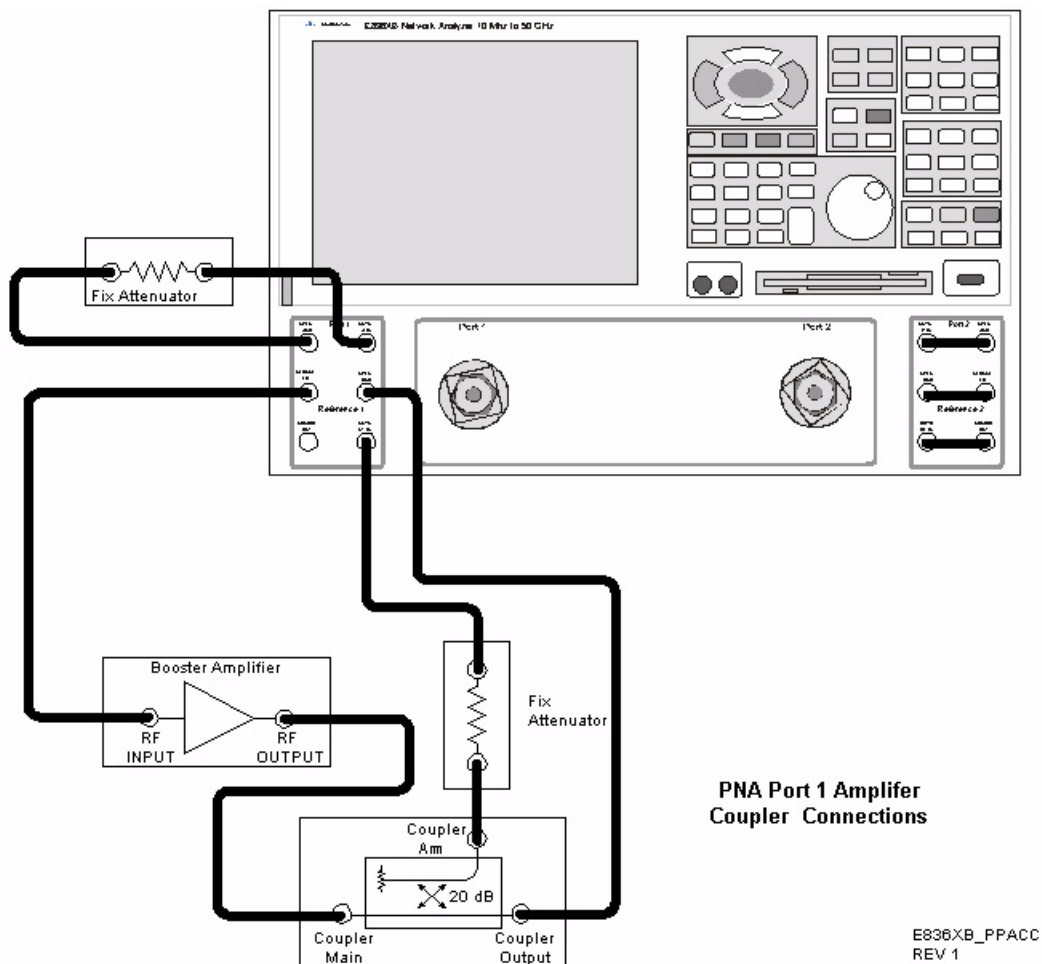
8. Using a power meter and sensor measure the output power from the coupled arm and the open port of the coupler.
9. Verify the gain of the booster amplifier(s). For example; if the analyzer output power level was set to -20 dBm and the output power measured from the open end of the coupler was -5 dBm, the gain of the booster amplifier would be $+15$ dB.
10. Verify that the power measured in the previous steps is within the acceptable limits (less than -12 dBm for the coupled arm, less than $+43$ dBm for the open port). The maximum power level between 40 GHz and 50 GHz is $+40$ dBm.
11. Estimate the maximum power level that will be needed to force the DUT into compression. Determine if the maximum output power from the coupled arm of the coupler will be higher than the acceptable limit. If so, add the appropriate amount of attenuation that will keep the coupler arm output power below -12 dBm.

Making High Power Measurements With Option H85

Additional Setup

12. Turn off the booster amplifier.
13. Connect the open port of the 20 dB coupler to the CPLR THRU connector on the front panel for Port 1. This can also be done on Port 2 if reverse parameters high power measurements are required.
14. Disconnect the REFERENCE SOURCE OUT and RCVR R1 IN jumper on the front panel. Connect the coupled arm of the 20 dB coupler (along with any added attenuation) to the RCVR R1 IN. The same instructions apply to Port 2 with one exception; disconnect the jumper to RCVR R2 IN if high power measurements are required for the reverse parameters.
15. 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]**.

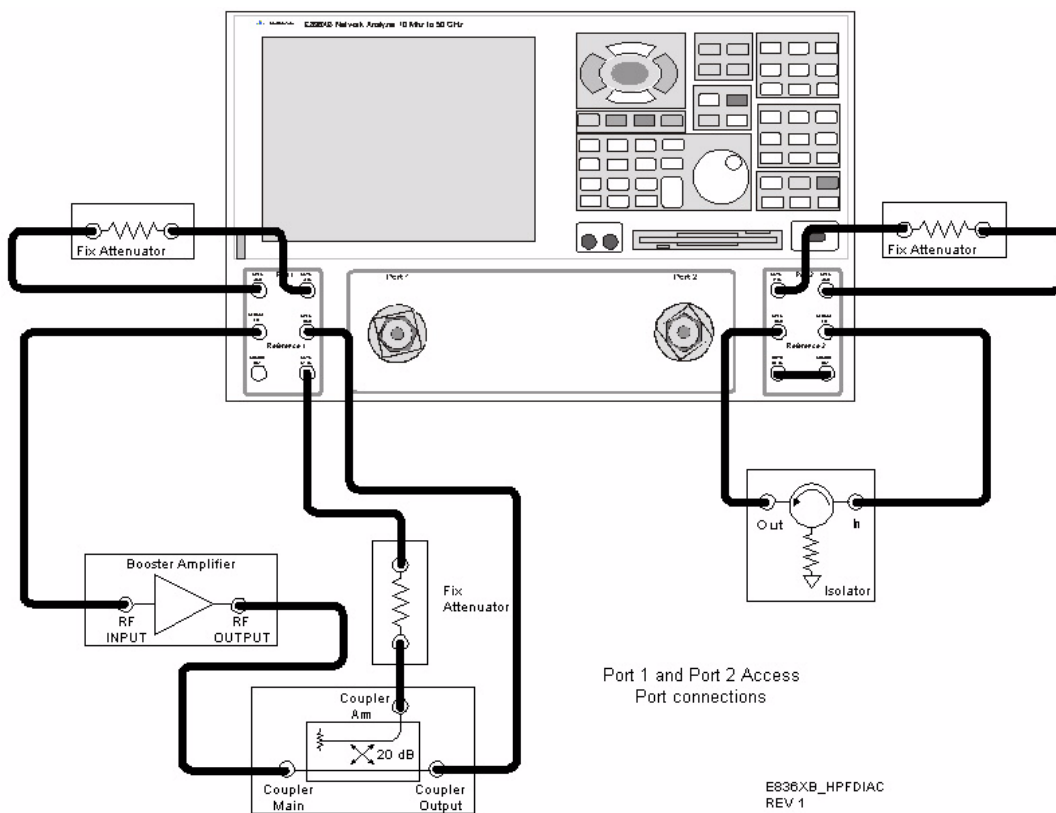
Figure 7 PNA Port 1 Amplifier, Coupler, Attenuator Connections



Selecting Power Ranges and Attenuator Settings

16. 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 output power not to exceed 0 dBm. This can be done by setting Attenuator Control to 10 dB by pressing **Power**, under **Attenuator Control** uncheck **Auto** and enter **[10]** into the entry area.
17. 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 THRU and SOURCE OUT for Port 2. Refer [Figure 8](#).

Figure 8 Isolators and Attenuator Connections



Making High Power Measurements With Option H85

18. 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 -12 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 -12 dBm.

19. 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, see [Figure 8](#).

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

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

$$\text{Receiver Attenuator B} = 20\text{dBm} - 13\text{dBm} - (-12\text{dBm}) \quad \text{Attenuator B} = 20\text{dBm}$$

20. Turn on the booster amplifier.

CAUTION From this point forward, *do not* press Preset unless you have turned off the booster amplifier(s), or you 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. This increase in power may result in damage to the DUT or analyzer.

21. Press **[Menu/Dialog]** to activate the R1 Input Path then tab to **Channel**. In the pull down menu select **Test Set**. A window for the R1 Input Path will be displayed. Select the **External R1 Loop**.

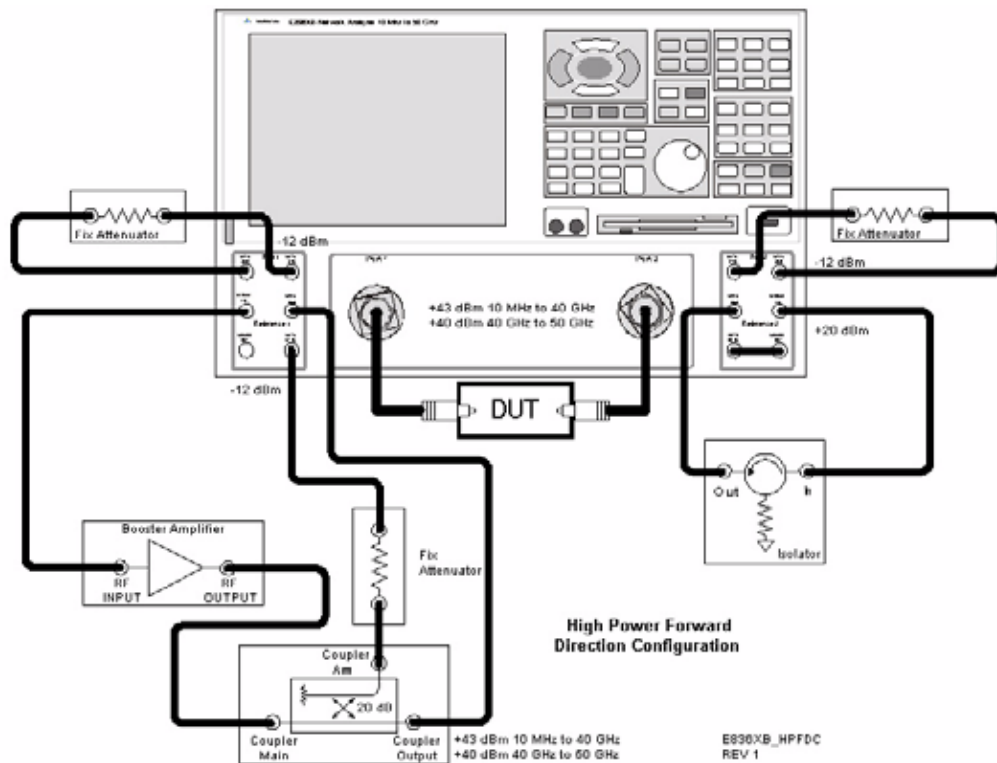
22. Measure the output power from the Test Port 1 using a power meter and verify that it is as you would expect.

If you are measuring a highly reflective device, high power isolators should be inserted between the 20 dB coupler and CPLR THRU front panel ports.

Final Setup and Response Calibration

23. Verify that all of the power and attenuator settings are correct, and set the following measurement. Press **[Menu/Dialog]** then tab to **Trace**. In the pull down menu select **Measure** then **S21**.
24. Connect the test port cables of the analyzer to form a thru configuration.
25. Press **[Menu/Dialog]** then tab to **Calibration**. In the pull down menu select **Calibration Wizard** then **Unguided Calibration Use Mechanical Standards**. Select **THRU Response**. Follow analyzers window prompts to finish calibration.
26. Make the connection as shown in [Figure 9](#). Turn on the DUT and measure the **S21** gain of the amplifier under test to confirm the proper operation of the measurement test setup.

Figure 9 Forward High Power Measurement Configuration



27. Continue with any other high power measurements.

Making High Power Measurements With Option H85

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 coupler arm of the 20 dB coupler.

This procedure can be repeated to setup the reverse high power configuration.

CAUTION The microwave PNA has over 20 frequency bands. During band-crossings, the firmware turns off the RF power level. If you are testing a high-gain device with an ALC when the PNA switches bands, the power shuts down and the DUT ALC attempts to increase the gain. Microseconds later the PNA power returns. However, in this short time frame the DUT or the VNA may be damaged. The band-crossings are listed in [Table 2](#).

Table 2 Frequency Band-Crossing

Band	Frequency (GHz)	Band	Frequency (GHz)
E8362/63/64B:			
0	0 to 0.045	14	15.2 to 16.0
1	0.045 to 0.748	15	16.0 to 20.0
2	0.748 to 1.5	E8363/64B:	
3	1.5 to 3.0	16	20.0 to 22.8
4	3.0 to 3.8	17	22.8 to 25.6
5	4.0 to 4.5	18	25.6 to 30.0
6	4.5 to 4.8	19	30.0 to 32.0
7	4.8 to 6.0	20	32.0 to 36.0
8	6.0 to 6.4	21	36.0 to 38.4
9	6.4 to 7.6	22	38.4 to 40
10	7.6 to 10.0	E8364B:	
11	10.0 to 12.0	23	40.0 to 45.6
12	12.0 to 12.8	24	45.6 to 48.0
13	12.8 to 15.2	25	48.0 to 50.0

Table 3 Watts to dBm Reference Table

Linear (watts)	Log (dBm)
0.001	+0
0.01	+10
0.1	+20
1	+30
2	+33
4	+36
10	+40
20	+43
40	+46
50	+47
100	+50
200	+53

Service Information

Servicing information can be found in the Agilent Technologies PNA Series Microwave Network Analyzers E8362B, E8363B, E8364B Service Guide (E8364-90026). This guide can be found using the our web site at <http://www.agilent.com/find/pna>. Select the link Manuals & Guides and type E8364-90026 in the search field.

In the Replaceable Parts Listing section of the service guide, look up "Parts Included with Options 014, 080, 081 and Parts Included with Options UNL, 014, 016, 080, 081. Both chapters show the parts added and deleted, and the part assembly placement.

The Agilent Technologies PNA Series Microwave Network Analyzers E8362BH85, E8363BH85, and E8364BH85 will display Options 014, 016, 080, 081 and UNL. The Option H85 deletes bias tees from the Option UNL. Service software is available for servicing the E8362BH85, E8363BH85 and E8364BH85 at local service centers.

Follow the Service Guide instructions for all repair, replacement procedures, tests and adjustments.

Replaceable Parts

NOTE Special options are built to order, so long lead times may be encountered when ordering replacement parts.

Reference Designator	PNA	Description	Agilent Part Number
		<i>Add:</i>	
W63 ¹	E8362B	RF Cable: Port 1 CPLR THRU to A25 test port 1 coupler	E8362-20018
W63 ¹	E8363B/ E8364B	RF Cable: Port 1 CPLR THRU to A25 test port 1 coupler	E8364-20073
W64 ²	E8362B	RF Cable: Port 2 CPLR THRU to A26 test port 1 coupler	E8362-20019
W64 ²	E8363B/ E8364B	RF Cable: Port 2 CPLR THRU to A26 test port 1 coupler	E8364-20074
	All	User's and Service Guide Supplement	E8364-90027
		<i>Delete:</i>	
A38/A39	E8362B	Bias tee with cable	5086-7239
A38/A39	E8363B/ E8364B	Bias tee with cable	5086-7239
W55	All	RF Cable: A38 bias tee to A25 test port 1 coupler	E8364-20167
W56	All	RF Cable: A39 bias tee to A26 test port 1 coupler	E8364-20168
W83	E8363B/ E8364B	RF Cable: Port 1 CPLR THRU to A38 bias tee	E8362-20012
W83	E8362B	RF Cable: Port 1 CPLR THRU to A38 bias tee	E8364-20039
W84	E8363B/ E8364B	RF Cable: Port 2 CPLR THRU to A39 bias tee	E8362-20013
W84	E8363B/ E8364B	RF Cable: Port 2 CPLR THRU to A39 bias tee	E8364-20040

1. W63 replaces W55, A38 and W83.
2. W64 replaces W56, A39 and W84.

Safety and Regulatory Information

Introduction

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.

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. See [“Contacting Agilent” on page 24](#). 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.

Warnings

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

Warnings applicable to this instrument are:

WARNING If this instrument is not used as specified, the protection provided by the equipment could be impaired. This instrument must be used in a normal condition (in which all means for protection are intact) only.

WARNING For continued protection against fire hazard replace line fuse only with same type and rating:

- United States—F 3A/250V, Part Number 2110-0780
- Europe—F 3.15A/250V, Part Number 2110-0655

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 instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited.

WARNING The power cord is connected to internal capacitors that may retain dangerous electrical charges for 5 seconds after disconnecting the plug from its power supply.

WARNING These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

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 1010 and 664 respectively.

WARNING No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

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

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.
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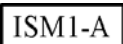



Cautions applicable to this instrument are:

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 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.

Contacting Agilent

By internet, phone, or fax, get assistance with all your test and measurement needs.

This information supersedes all prior contact information.			
Online assistance: www.agilent.com/find/assist			
Americas			
Brazil (tel) (+55) 11 3351 7012 (fax) (+55) 11 3351 7024	Canada (tel) +1 877 894 4414 (alt) +1 303 662 3369 (fax) +1 800 746 4866	Mexico (tel) 1800 254 2440 Ext 2703 (alt) from USA 18008374039 (fax) 1 800 254 422	United States (tel) 800 829 4444 (alt) (+1) 303 662 3998 (fax) 800 829 4433
Asia Pacific and Japan			
Australia (tel) 1 800 225 574 (fax) 1 800 681 776 (fax) 1 800 225 539	China (tel) 800 810 0189 (fax) 800 820 2816	Hong Kong (tel) 800 933 229 (fax) 800 900 701	India (tel) 1600 112 626 (alt) +65 6275 0800 (fax) 1600 113 040
Japan (Bench) (tel) 0120 421 345 (alt) (+81) 426 56 7832 (fax) 0120 01 2144	Japan (On-Site) (tel) 0120 421 345 (alt) (+81) 426 56 7832 (fax) 0120 012 114	Malaysia (tel) 1800 880 399 (fax) 1800 801 054	New Zealand (tel) +64 4 939 0635 (alt) 0800 738 378 (fax) +64 4 972 5364
Singapore (tel) 1 800 275 0880 (fax) (+65) 6755 1214	South Korea (tel) 080 778 0011 (fax) 080 778 0013	Taiwan (tel) 0800 047 669 (fax) 0800 047 667 (fax) +886 3492 0779	Thailand (tel) +66 2 267 5913 (tel) 1 800 2758 5822 (fax) 1 800 653 336
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France (tel) 0825 010 700* (fax) 0825 010 701*	Germany (tel) 01805 24 6333* (fax) 01805 24 6336*	Ireland (tel) (+353) 1 890 924 204 (fax) 1 890 924 024	Israel (tel) (+972) 3 9288 504 (alt) (+972) 3 9288 544 (fax) (+972) 3 9288 520
Italy (tel) (+39) (0)2 9260 8484 (fax) (+39) (0)2 9544 1175	Luxemburg (tel) (+32) (0)2 404 9340 (fax) (+32) (0)2 404 9395	Netherlands (tel) (+31) (0)20 547 2111 (fax) (+31) (0)20 547 2190	Russia (tel) (+7) 095 797 3963 (alt) (+7) 095 797 3900 (fax) (+7) 095 797 3901
Spain (tel) (+34) 91 631 3300 (fax) (+34) 91 631 3301	Sweden (tel) 0200 88 22 55* (alt) (+46) (0)8 5064 8686 (fax) 020 120 2266*	Switzerland (French) (tel) 0800 80 5353 opt. 2* (fax) (0) 22 567 5313	Switzerland (German) (tel) 0800 80 5353 opt. 1* (fax) 0 44 272 7373
Switzerland (Italian) (tel) 0800 80 5353 opt. 3* (fax) (0) 22 567 5314	United Kingdom (tel) (+44) (0)7004 666666 (fax) (+44) (0)7004 444555		
(tel) = primary telephone number; (alt) = alternate telephone number; (fax) = FAX number; * = in country number 8/10/05			