Agilent N5501A/N5502A Phase Noise Downconverter

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Notices

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Agilent Technologies, Inc.
1400 Fountaingrove Pkwy
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Contents

1
General Information

Overview

The Agilent N5501A and N5502A microwave downconverters are part of the Agilent E5505A Phase Noise Measurement System. The downconverters translate microwave signals to RF frequencies with minimal phase and AM noise contribution. State-of-the-art phase noise performance gives the user the capability to lower the microwave noise floor of the phase noise measurement system. The N5501A accepts signals between 5 MHz and 6.6 GHz at levels between +5 dBm and +15 dBm. The N5502A accepts signals between 5 MHz and 18 GHz at levels between +5 dBm (+5 dBm minimum <12 GHz and +10 dBm < 18 GHz) and +15 dBm. Both are half-rack width System II units.

Figure 1 N5501A/N5502A microwave downconverter

Front-Panel Interfaces

This section describes the function of the front-panel interfaces on the N5501A and the N5502A downconverters. The interfaces appear in alphabetical order. The front panel of the N5501A and the N5502A units are identical, except for the model number and maximum input frequency. Therefore, the descriptions apply to both models unless otherwise indicated. Figure 2 represents the front panel of both models.

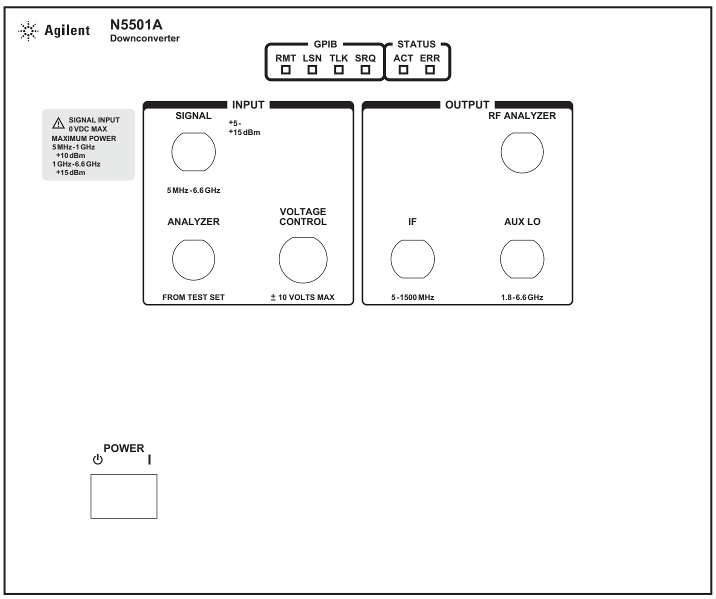

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Figure 2 N5501A/N5502A front panel

NOTE Some interfaces on the front panel are not used for phase noise measurements, as their descriptions indicate. Their primary function is for factory testing and troubleshooting.

ACT (STATUS)

This LED is not used for phase noise measurements.

ANALYZER: FROM TEST SET (INPUT)

This connector is not used for phase noise measurements.

AUX LO (OUTPUT)

The signal at this connector on the downconverter is a low-noise signal source with control over the output power.

When the downconverter is in source mode, this connector is the output.

Characteristics

	N5501A	N5502A
Frequency	5 MHz to 6.6 GHz	5 MHz to 18 GHz

ERR (STATUS)

The error message LED illuminates when a communication error occurs and indicates that an error message is available.

IF (OUTPUT)

The signal at this connector is the downconverter's output.

Limits

- Nominal output level: 0 to +5 dBm (input signal ≥ –30 dBm)
- Maximum output level: +15 dBm
- Frequency: 5 to 1500 MHz

NOTE The IF amplifiers frequency response starts rolling off above 1200 MHz. It is best to use an IF frequency below 1 GHz.

LSN (GPIB)

The listen LED illuminates when the system addresses the instrument to listen.

POWER

This switch puts the instrument in active operation or standby mode. It is a standby switch and not a LINE switch. The detachable power cord is the instrument's disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument or system.

RF ANALYZER (OUTPUT)

This connector is not used for phase noise measurements.

RMT (GPIB)

The remote indicator LED shows when the unit is enabled for GPIB control (lit).

SIGNAL (INPUT)

This connector accepts the input signal.

Limits

Specification	N5501A	N5502A
Frequency	5 MHz to 6.6 GHz	5 MHz to 18 GHz
Maximum signal level	+15 dBm	+15 dBm

SRQ (GPIB)

The service request LED illuminates when the instrument requests service.

TLK (GPIB)

The talk indicator LED illuminates when the system addresses the instrument to talk.

Rear-Panel Interfaces

This section describes the function of the rear-panel connectors in alphabetical order. The rear panel of the N5501A and the N5502A downconverters are identical, therefore the descriptions apply to both models unless otherwise indicated. Figure 3 represents the rear panel of both models.

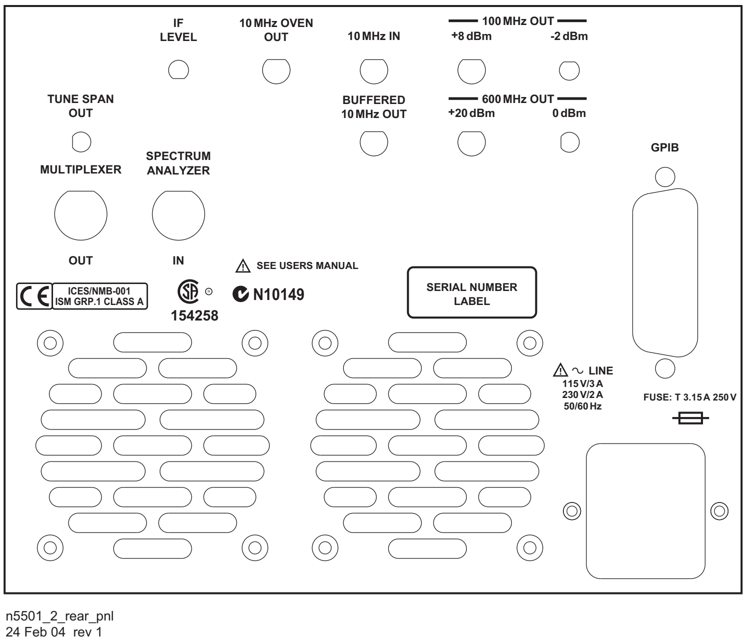

Figure 3 N5501A/N5502A rear panel

10 MHz IN

This connector accepts a 10 MHz reference signal for the unit's phase lock loops. It is normally jumpered to the 10 MHz OVEN OUT connector.

Limits and characteristics

- Level range: +7 to +13 dBm
- Input impedance: 50 Ω

Operating considerations

Noise and other impurities on a signal applied to this input will show up on the output. The amount of noise and impurities passed through depends on the tuning sensitivity.

10 MHz OVEN OUT

The signal at this connector is the output of the 10 MHz ovenized crystal reference oscillator. It is normally jumpered to the 10 MHz IN connector.

Characteristics

- Typical output power: +13 dBm
- Output impedance: 50 Ω

Operating considerations

External tuning: Tune this signal by applying a voltage to the VOLTAGE CONTROL connector.

100 MHz OUT: -2 dBm

The signal at this connector is an output of the 100 MHz reference oscillator.

Characteristics

- Output impedance: 50 Ω
- Typical output power: –2 dBm

Operating considerations

External tuning: Tune this signal by applying a voltage to the VOLTAGE CONTROL connector.

100 MHz OUT: +8 dBm

The signal at this connector is an output of the 100 MHz oscillator.

Characteristics

- Output impedance: 50 Ω
- Typical output power: +8 dBm

Operating considerations

External tuning: Tune this signal by applying a voltage to the VOLTAGE CONTROL connector.

600 MHz OUT: 0 dBm

The signal at this connector is an output of the 600 MHz Output oscillator.

Characteristics

- Output impedance: 50 Ω
- Typical output power: 0 dBm

Operating considerations

External tuning: Tune this frequency by applying a voltage to the VOLTAGE CONTROL connector.

600 MHz OUT: +20 dBm

The signal at this connector is an output of the 600 MHz oscillator.

Characteristics

- Output impedance: 50 Ω
- Typical output power: +20 dBm

Operating considerations

External tuning: Tune this signal by applying a voltage to the VOLTAGE CONTROL connector.

Buffered 10 MHz Out

The signal at this connector is the signal at the rear-panel 10 MHz IN connector after it has been buffered by an amplifier.

Characteristics

- Output impedance: 50 Ω
- Typical output power: +7 dBm

GPIB

GPIB communication between the downconverter and the system occurs through this connection.

IF LEVEL

This output connector is not used for phase noise measurements.

Power Connector (~ LINE)

This is the connection for the AC power cord. The detachable power cord is the instrument's disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument or system. For information on power requirements, see "Power Requirements" on page 29.

MULTIPLEXER: OUT

This connector is not used for phase noise measurements.

TUNE SPAN OUT

This connector is not used for phase noise measurements.

VOLTAGE CONTROL IN

This connector accepts an external tuning voltage from the phase noise test set for the 10, 100, or 600 MHz oscillators.

CAUTION Connect this input *only* to the Agilent N5500A or 70420A Phase Noise Test Set. The connector provides no overvoltage protection.

Limits

- Maximum voltage: ±10 Volts
- Maximum frequency shift (10 MHz): ±0.25 ppm
- Maximum frequency shift (100 MHz): ±5 ppm
- Maximum frequency shift (600 MHz): ±100 ppm

Characteristics

- Input impedance: 100 k Ω

NOTE Several connectors on the rear panel are not used for phase noise measurements, as their descriptions indicate. Their primary function is for factory testing and troubleshooting.

2
Technical Data

Specifications

This section contains environmental, mechanical, and RF specifications, and power requirements for the N5501A and N5502A downconverters. It also specifications for LO resolution and the downconverter noise floor. The specifications apply over the operating conditions unless otherwise noted.

Table 1 Environmental and mechanical specifications

Altitude	Up to 2,000 meters (6,500 ft)
Operating temperature range	+0 °C to +45 °C (32 °F to 113 °F)
Warm-up time	20 minutes
Maximum relative humidity	80% for temperatures up to 31 °C, decreasing linearly to 50% relative humidity at 40 °C.
Height	177.2 mm (7 in)
Width	212.5 mm (8.4 in)
Depth	574.3 mm (22.6 in)
Weight	~ 20 lbs (9 kg)

Table 2 RF specifications

Frequency Range:	
• **N5501A/70421A**	1 to 6.6 GHz
• **N5502A/70422A**	1 to 18 GHz (18 to 20 GHz typical overrange)
Input Power:	
• **N5501A**	• +15 dBm max • +5 dBm min
• **N5502A**	• +15 dBm max • +5 dBm min to 12 GHz • +10 dBm min to 18 GHz
Noise Figure	15 dB (typical)
IF Output Frequency	5 MHz to 1.2 GHz
IF Output Power	0 to +5 dBm (typical)
IF Gain	0 to 45 dB (5 dB steps)
Mixing Spurious:	
• **<6 GHz (<+50 dBm at mixer)**	< –50 dBc
• **>6 GHz**	< 70 dBc

NOTE The N5501A and N5502A downconverters have low susceptibility to RFI and mechanical vibration. However, care must be exercised in making measurements in high RFI or mechanical vibration environments as spurious signals may be induced in the unit.

LO resolution

Table 3 contains the LO resolution for the N5501A downconverter. Table 4 on page 19 contains the LO resolution for the N5502A.

Table 3 N5501A LO Resolution: 600 MHz (1.8 GHz to 6.0 GHz)

Carrier Frequency Range (GHz) in Which a Mixing Spur Occurs <100 MHz from Carrier	Typical Spurious Level (dBc)
1.566 – 1.634, 1.166 – 1.234	–10
1.060 – 1.200, 1.274 – 1.303, 1.325 – 1.375, 1.420 – 1.460, 1.775 – 1.825	–20
1.013 – 1.043, 1.250 – 1.043, 1.900 – 1.940, 2.225 – 2.275	–30
1.112 – 1.138, 1.483 – 1.517, 1.983 – 2.017, 2.380 – 2.420 2.483 – 2.517, 2.975 – 3.025, 3.583 – 3.617	–40
2.556 – 2.586, 2.983 – 3.017, 3.071 – 3.101, 2.860 - 2.900	–50
4.785 - 4.815, 4.183 - 4.217, 3.580 - 3.620, 1.487 - 1.513 4.099 - 4.129, 3.483 - 3.517, 2.042 - 2.072, 2.087 - 2.113	–60

Table 4 N5502A LO Resolution: 600 MHz (1.8 GHz to 18.0 GHz)

Carrier Frequency Range (GHz) in Which a Mixing Spur Occurs <100 MHz from Carrier	Typical Spurious Level (dBc)
1.566 – 1.634, 1.166 – 1.234	–10
1.060 – 1.200, 1.274 – 1.303, 1.325 – 1.375, 1.420 – 1.460, 1.775 – 1.825	–20
1.013 – 1.043, 1.250 – 1.043, 1.900 – 1.940, 2.225 – 2.275	–30
1.112 – 1.138, 1.483 – 1.517, 1.983 – 2.017, 2.380 – 2.420, 2.483 – 2.517, 2.975 – 3.025, 3.583 – 3.617	–40
2.556 – 2.586, 2.983 – 3.017, 3.071 – 3.101, 2.860 - 2.900	–50
4.785 - 4.815, 4.183 - 4.217, 3.580 - 3.620, 1.487 - 1.513, 4.099 - 4.129, 3.483 - 3.517, 2.042 - 2.072, 2.087 - 2.113	–60

Noise floor

Table 5 contains the noise floor specifications for the N5501A. Table 6 contains those for the N5502A.

Table 5 N5501A noise floor specifications (all oscillators locked)

Input Frequency		Offset from Carrier (Hz)									Spurious (dBc)	
		1	10	100	1k	10k	100k	1M	10M	100M	<1k	>1k
1 to 3.0 GHz	Typical	–50	–80	–97	–125	–137	–143	–145	–145	–145	–60	–75
	Spec.	–45	–75	–92	–120	–132	–138	–140	–140	–140	–50	–65
3.0 to 6.6 GHz	Typical	–44	–74	–91	–119	–131	–143	–145	–145	–145	–50	–80
	Spec.	–39	–69	–86	–114	–126	–138	–140	–140	–140	–44	–70

Table 6 N5502A noise floor specifications (all oscillators locked)

Input Frequency		Offset from Carrier (Hz)									Spurious (dBc)	
		1	10	100	1k	10k	100k	1M	10M	100M	<1k	>1k
1.0 to 3.0 GHz	Typical	–50	–80	–97	–125	–137	–143	–145	–145	–145	–60	–75
	Spec.	–45	–75	–92	–120	–132	–138	–140	–140	–140	–50	–65
3.0 to 6.0 GHz	Typical	–44	–74	–91	–119	–131	–143	–145	–145	–145	–50	–80
	Spec.	–39	–69	–86	–114	–126	–138	–140	–140	–140	–44	–70
6.0 to 12.0 GHz	Typical	–38	–68	–85	–113	–125	–140	–140	–140	–140	–50	–80
	Spec.	–33	–63	–80	–108	–120	–135	–135	–135	–135	–40	–70
12.0 to 18.0 GHz	Typical	–34	–64	–81	–109	–121	–131	–131	–131	–131	–47	–70
	Spec.	–29	–59	–76	–104	–116	–126	–126	–126	–126	–37	–60

Power Requirements

This section contains the power requirements and characteristics for the N5501A/N5502A downconverter.

Table 7 N5501A/N5502A power supply requirements

Nominal Voltage	115	230
Nominal Frequency	60 Hz	50 Hz
Power	3 A, max	2 A, max

Power line module

The power module in the N5501A and N5502A units has the following characteristics:

- 200 W
- 85 to 264 VAC continuous-range operation
- 47 to 63 Hz
- Internal fuse: 5 A, 250 V

Fuse

The instrument's AC line cable has a replaceable fuse with the following characteristics:

- 3.15 A, 250 V, time delayed
- Agilent part number: 2110-1124

3
Preventive Maintenance

Using, Inspecting, and Cleaning RF Connectors

Taking proper care of cables and connectors protects your system's ability to make accurate measurements. One of the main sources of measurement inaccuracy can be caused by improperly made connections or by dirty or damaged connectors.

The condition of system connectors affects measurement accuracy and repeatability. Worn, out-of-tolerance, or dirty connectors degrade these measurement performance characteristics.

Repeatability

If you make two identical measurements with your system, the differences should be so small that they will not affect the value of the measurement. Repeatability (the amount of similarity from one measurement to another of the same type) can be affected by:

- Dirty or damaged connectors
- Connections that have been made without using proper torque techniques (this applies primarily when connectors in the system have been disconnected, then reconnected).

CAUTION

Static-Sensitive Devices
This system contains instruments and devices that are static-sensitive. Always take proper electrostatic precautions before touching the center conductor of any connector, or the center conductor of any cable that is connected to any system instrument. Handle instruments and devices only when wearing a grounded wrist or foot strap. When handling devices on a work bench, make sure you are working on an anti-static worksurface.

RF cable and connector care

Connectors are the most critical link in a precision measurement system. These devices are manufactured to extremely precise tolerances and must be used and maintained with care to protect the measurement accuracy and repeatability of your system.

To extend the life of your cables or connectors:

- Avoid repeated bending of cables—a single sharp bend can ruin a cable instantly.
- Avoid repeated connection and disconnection of cable connectors.

- Inspect the connectors before connection; look for dirt, nicks, and other signs of damage or wear. A bad connector can ruin the good connector instantly.
- Clean dirty connectors. Dirt and foreign matter can cause poor electrical connections and may damage the connector.
- Minimize the number of times you bend cables.
- Never bend a cable at a sharp angle.
- Do not bend cables near the connectors.
- If any of the cables will be flexed repeatedly, buy a back-up cable. This will allow immediate replacement and will minimize system down time.

Before connecting the cables to any device:

- Check all connectors for wear or dirt.
- When making the connection, torque the connector to the proper value.

Proper connector torque

- Provides more accurate measurements
- Keeps moisture out of the connectors
- Eliminates radio frequency interference (RFI) from affecting your measurements

The torque required depends on the type of connector. Refer to Table 8. Do not overtighten the connector.

Never exceed the recommended torque when attaching cables.

Table 8 Proper Connector Torque

Connector	Torque cm-kg	Torque N-cm	Torque in-lbs	Wrench P/N
Type-N	52	508	45	hand tighten
3.5 mm	9.2	90	8	8720-1765
SMA	5.7	56	5	8710-1582

Connector wear and damage

Look for metal particles from the connector threads and other signs of wear (such as discoloration or roughness). Visible wear can affect measurement accuracy and repeatability. Discard or repair any device with a damaged connector. A bad connector can ruin a good connector on the first mating. A magnifying glass or jeweler’s loupe is useful during inspection.

SMA connector precautions

Use caution when mating SMA connectors to any precision 3.5 mm RF connector. SMA connectors are not precision devices and are often out of mechanical tolerances, even when new. *An out-of-tolerance SMA connector can ruin a 3.5 mm connector on the first mating*. If in doubt, gauge the SMA connector before connecting it. The SMA center conductor must *never* extend beyond the mating plane.

Cleaning procedure

1 Blow particulate matter from connectors using an environmentally-safe aerosol such as Aero-Duster. (This product is recommended by the United States Environmental Protection Agency and contains tetrafluoroethane. You can order this aerosol from Agilent (see Table 9).)
2 Use alcohol and a lint-free cloth to wipe connector surfaces. Wet a small swab with a small quantity of alcohol and clean the connector with the swab.
3 Allow the alcohol to evaporate off of the connector before making connections.

CAUTION *Do not allow excessive alcohol to run into the connector.* Excessive alcohol entering the connector collects in pockets in the connector's internal parts. The liquid will cause random changes in the connector's electrical performance. If excessive alcohol gets into a connector, lay it aside to allow the alcohol to evaporate. This may take up to three days. If you attach that connector to another device it can take much longer for trapped alcohol to evaporate.

Table 9 Cleaning Supplies Available from Agilent

Product	Part Number
Aero-Duster	8500-6460
Isopropyl alcohol	8500-5344
Lint-Free cloths	9310-0039
Small polyurethane swabs	9301-1243

WARNING **Cleaning connectors with alcohol should only be performed with the instruments' mains power cord disconnected, in a well ventilated area. Connector cleaning should be accomplished with the minimum amount of alcohol. Prior to connector reuse, be sure that all alcohol used has dried, and that the area is free of fumes.**

WARNING **If flammable cleaning materials are used, the material should not be stored, or left open in the area of the equipment. Adequate ventilation should be assured to prevent the combustion of fumes, or vapors.**

General Procedures and Techniques

This section introduces you to the various cable and connector types used in the system. Read this section before attempting to remove or install an instrument! Each connector type may have unique considerations.

Always use care when working with system cables and instruments.

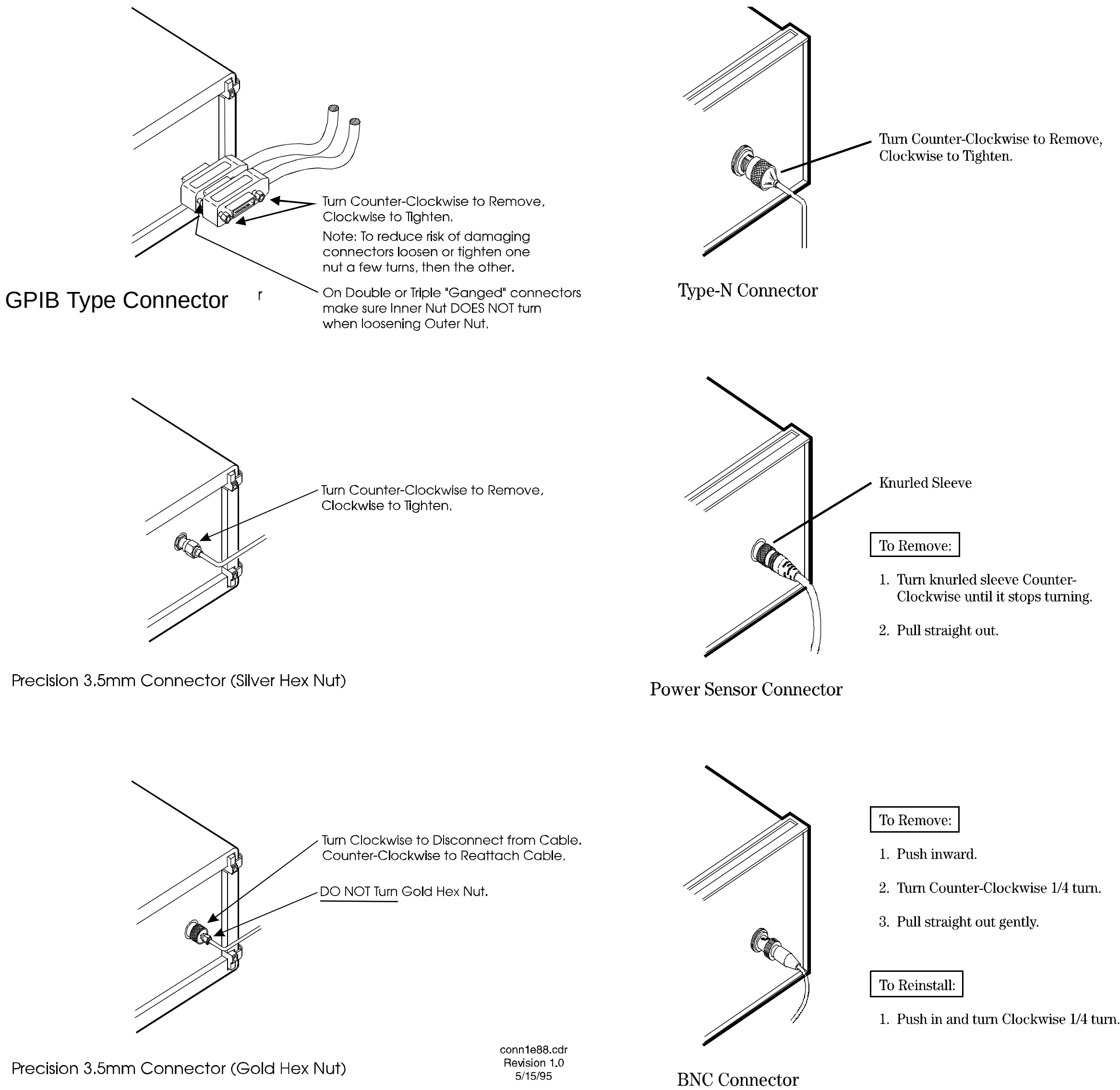

Figure 4 GPIB, 3.5 mm, Type-N, power sensor, and BNC connectors

Connector removal

GPIB connectors

These are removed by two captured screw, one on each end of the connector; these usually can be turned by hand. Use a flathead screwdriver if necessary.

GPIB connectors often are stacked two or three deep. When you are removing multiple GPIB connectors, disconnect each connector one at a time. It is a good practice to connect them back together even if you have not yet replaced the instrument; this avoids confusion, especially if more than one instrument has been removed.

When putting GPIB connectors back on, you must again detach them from one another and put them on one at a time.

Precision 3.5 mm connectors

These are precision connectors. Always use care when connecting or disconnecting this type of connector. When reconnecting, make sure you align the male connector properly. Carefully join the connectors, being careful not to cross-thread them.

Loosen precision 3.5 mm connectors on flexible cables by turning the connector nut counter-clockwise with a 5/16 inch wrench. Always reconnect using an 8 inch-lb torque wrench (Agilent part number 8720-1765). Semirigid cables are metal tubes, custom-formed for this system from semirigid coax cable stock.

3.5 mm connectors with a gold hex nut

The semirigid cables that go to the RF outputs of some devices have a gold connector nut. These do not turn. Instead, the RF connector on the instrument has a cylindrical connector body that turns. To disconnect this type of connector, turn the connector body on the instrument clockwise. This action pushes the cable’s connector out of the instrument connector.

To reconnect, align the cable with the connector on the instrument. Turn the connector body counterclockwise. You may have to move the cable slightly until alignment is correct for the connectors to mate. When the two connectors are properly aligned, turning the instrument’s connector body will pull in the semirigid cable’s connector. Tighten firmly by hand.

3.5 mm connectors with a silver hex nut

All other semirigid cable connectors use a silver-colored nut that *can* be turned. To remove this type of connector, turn the silver nut counter-clockwise with a 5/16 inch wrench.

When reconnecting this type of cable:

- Carefully insert the male connector center pin into the female connector. (Make sure the cable is aligned with the instrument connector properly before joining them.)
- Turn the silver nut clockwise by hand until it is snug, then tighten with an 8 inch-lb torque wrench (part number 8720-1765).

Bent semirigid cables

Semirigid cables are not intended to be bent outside of the factory. An accidental bend that is slight or gradual may be straightened carefully by hand. Semirigid cables that are crimped will affect system performance and must be replaced. Do not attempt to straighten a crimped semirigid cable.

Instrument Removal

To remove an instrument from the system, use one of the following procedures.

Required tools

- #2 Phillips screwdriver
- #2 POZIDRIV screwdriver

Half-Rack-Width instrument

To remove a half-width instrument from a system rack

1 Power off the system.	• For details, see the system installation guide.
2 Remove the selected instrument's power cord from the power strip in the rack.	
3 The instrument is attached to the half-rack width instrument beside it; remove that instrument's power cord from the power strip also.	• The instruments are secured together by lock links at the front and rear. The lock links at the rear attach with screws. The lock links at the front hook together.
4 Remove the power cord and other cables from the front and rear of both instruments.	• Note the location of cables for re-installation.
5 Remove the four corner screws on the front of the rack panel that secures the instruments in place.	• The screws are located near the corners of the face of the instrument. • Use a #2 Phillips screwdriver.
6 Slide both instruments, as a single unit, out from the front of the rack and set them on a secure, flat surface.	
7 Detach the lock links that secure the rear of the instruments together by removing their screws.	• Use a #2 POZIDRIV screwdriver. • See Figure 5 on page 32.
8 Carefully and at the same time, push one instrument forward and pull the other back to unhook the lock links that secure the front of the instruments to each other.	
9 Store the "partner" instrument and lock links while the selected instrument is out of the rack.	• Only install the instruments as a pair; individual installation is not secure.

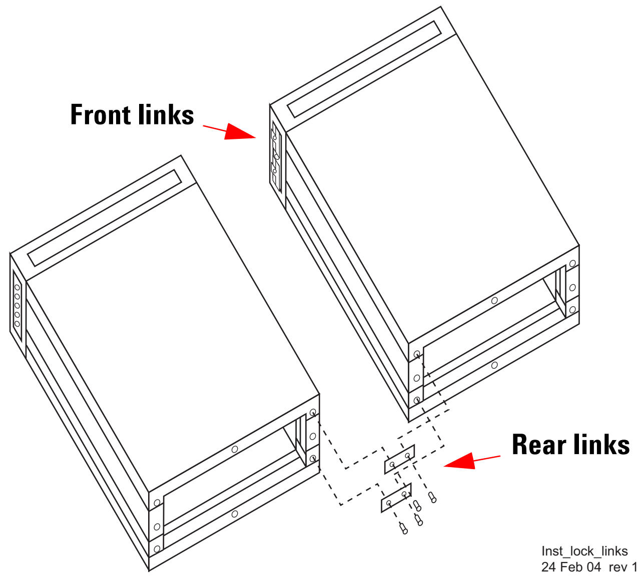

Figure 5 Instrument lock links, front and rear

Benchtop instrument

To remove an instrument from a benchtop system

1 Power off each instrument in the system.	• For details, see the system installation guide or system user's guide.
2 Unplug the selected instrument's power cord from the AC power supply.	
3 Remove the power cord and other cables from the front and rear of the instrument.	• Note the location of cables for re-installation.

Instrument Installation

To install or re-install an instrument in a system, use one of the following procedures.

Required tools

- #2 Phillips screwdriver
- #2 POZIDRIV screwdriver

Half-Rack-Width instrument

To install the instrument in a rack

Step	Note
1 Make sure the system is powered off.	• For details, see the system installation guide or system user's guide.
2 Re-attach the lock link that secures the front of the returned instrument to it's partner half-rack-width instrument.	• Use a #2 POZIDRIV screwdriver. • See Figure 5 on page 32.
3 Re-attach the lock link that secures the rear of the instruments together.	• Use a #2 POZIDRIV screwdriver.
4 Insert the attached instruments in the same slot from which you removed them, sliding them along the support rails until they meet the rack-mount ears.	• The rack-mount ears stop the instruments at the correct depth.
5 Replace the rack panel in front of the instruments and secure the four corner screws.	• The screws are located near the corners of the face of the instrument. • Use a #2 Phillips screwdriver.
6 Confirm that the instrument is turned off.	
7 Connect the appropriate cables to the instruments (front and rear), including the power cords.	
8 Power on the system.	• For details, see the system installation guide or system user's guide.

Benchtop instrument

To install an instrument in a benchtop system

1 Make sure the system is powered off.	• For details, see For details, see the system installation guide or system user's guide.
2 Connect all cables to the instrument (front and rear), including the power cord.	
3 Connect the power cord to the AC power source.	
4 Power on the system.	• For details, see the system installation guide or system user's guide.
5 Set the instrument GPIB address, if necessary.	• For instructions, see the system installation guide or system user's guide.