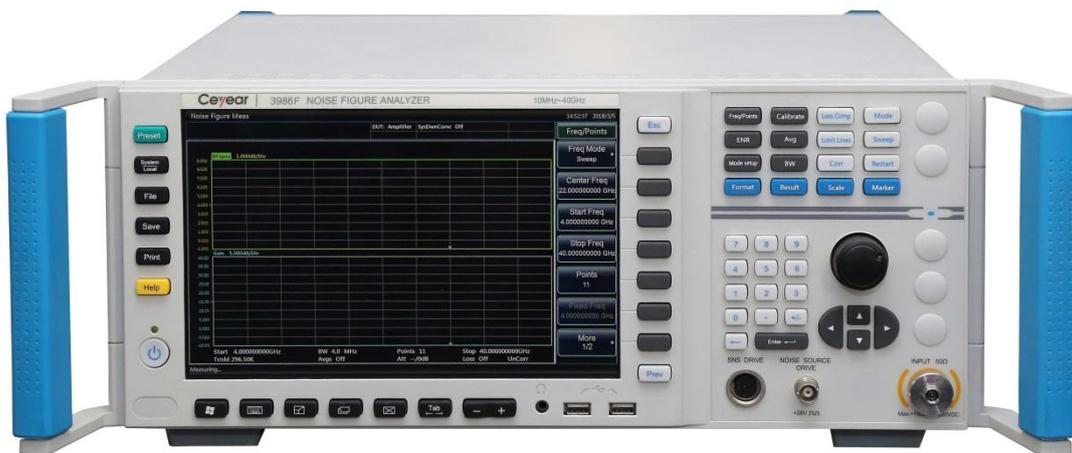




# 3986 Series Noise Figure Analyzer User Manual



**China Electronics Technology Instruments Co. Ltd**



This manual is suitable for the following models of noise figure analyzer:

- 3986A Noise Figure Analyzer (10MHz~4GHz)
- 3986D Noise Figure Analyzer (10MHz~18GHz)
- 3986E Noise Figure Analyzer (10MHz~26.5GHz)
- 3986F Noise Figure Analyzer (10MHz~40GHz)
- 3986H Noise Figure Analyzer (10MHz~50GHz)

Options:

- 3986-H01, 16603/16604 series noise source: used as a noise power standard for noise figure measurements.
- 3986-H02, 711XX series high-performance co-axial adapter: used to connect the noise source to the noise figure analyzer.
- 3986-H03, multi-core cable: used for smart noise source driver interface and noise source connection of noise figure analyzer.
- 3986-H04, BNC(m)-BNC(m): used for connection of normal noise source driver interface and standard noise source for noise figure analyzer
- 3986-H05, aluminum alloy transportation case: high-strength, lightweight aluminum alloy transportation case that comes with handle and wheels for ease of transport.
- 3986-H98, English kit: English display, English manual, English interface, and English operating system.

Version:  
Address:  
Tel:  
Website:  
E-mail:  
Postal code:

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## Foreword

Thank you for choosing the 3986 series noise figure analyzer developed and manufactured by CETI!

We are devoted to providing for you high-quality products and first-class after-sales service with your most concerns and demands in mind. Our consistent aim is providing excellent quality and good service, and this is our sincere commitment for all users.

## Manual No.

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China Electronics Technology Instruments Co., Ltd.

## Manual Authorization

This manual may be subject to change without notice. CETI reserves all the rights to the final explanation for all the information and terminologies referred to in this manual.

The copyright of this manual belongs to China Electronic Instrument Co., Ltd. No entity or individual may modify the contents of this manual without the authorization of the company, and may not copy or distribute this manual for profit. Upon infringement, China Electronic Instrument Co., Ltd. reserves the right to pursue legal responsibilities.

## Product Warranty

The warranty for this product is 18 months from the day of delivery. Instrument manufacturer will repair or replace the damaged parts according to the actual situation in the warranty period. In order to ship the product back to the manufacturer for repairs, the user must pay shipping and handling fees. After maintenance and repair, the manufacturer will ship the product back to the user along with reimbursement of the shipping and handling fees.

## Product Quality Certification

This product is certified to fulfill the standards indicated in this manual from the day of delivery. Calibration measurements have been carried out based on national standards. Related information is available to the user for reference.

## Quality/Environmental Management

The quality and environmental management systems have always been implemented during development, manufacturing and test of this product. China Electronics

Technology Instruments Co., Ltd. is certified by ISO 9001 and ISO 14001 standards.

## Safety Precautions



WARNING indicates a danger. It reminds the user to be cautious of a certain operation process, operation method or the similar. Failure to follow the rules or operate correctly may result in the personal injury. The conditions indicated by WARNING should be fully understood and met before the next operation.

---

## Attention

CAUTION indicates an important information rather than danger. It reminds the user to be cautious of a certain operation process, operation method or the similar. Failure to follow the rules or operate correctly may cause the damage to the instrument or loss of important data. The conditions indicated by CAUTION should be fully understood and met before the next operation.

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**Table of Contents**

## 1 About This Manual

This section introduces the function, structure, and main contents of the user manual for the 3986 series noise figure analyzer and also provides documents associated with the use of the instrument.

- [About this manual.....1](#)
- [Related Documents.....2](#)

### 1.1 About This Manual

This manual introduces the basic function and operational procedures of the 3986 series noise figure analyzer. It describes the safety precautions, how to get started, operation guide, button categories and menu items, remote control, troubleshooting and fault repair, technical standards and testing protocols, etc. to help you quickly familiarize with and understand the operation and main features of the apparatus. To facilitate your familiarity with the instrument, please read this manual carefully before operating the instrument, and then follow the instructions of manual.

The chapters included in this User's Manual are as follows:

- **Overview**

This chapter generally introduces the main performance characteristics, typical application and operational safety precautions of the 3986 series noise figure analyzer, so that the user can know about the main performance characteristics of the instrument and operate the instrument safely in accordance with the instructions.

- **Start Guide**

This chapter describes the preparation for use, instructions for front and rear panels, setting of analyzer reset status, file operations, form processing and instructions for basic measurements of Series 3986 Noise Figure Analyzer, so that the user can have a preliminary knowledge about the instrument and measurement process and become familiar with the operation methods of the 3986 series noise figure analyzer quickly.

- **Operation Guide**

This chapter describes in detail the various measurement modes and operating procedures of the instrument in two parts: basic operation guide and advanced operation guide. The basic operation guide is intended for users who are not familiar with the use of the 3986 series noise figure analyzer. The guide systematically introduces and lists the various settings of the instrument so that users may gain a basic understanding of the noise figure analyzer. The advanced operation guide is intended for users who are already comfortable with the general use of the instrument but not familiar with certain specific functions. This guide introduces several relatively complex testing procedures and operational techniques to help users in carrying out measurements. For example: converter noise figure measurement, system downconverter mode extension measurement, loss compensation and line limits functions, etc.

- **Button categories and menu items**

This chapter introduces the menu structure and items by key function for user's query and reference.

- **Remote Control**

This chapter introduces the remote control methods of the instrument so that the user can rapidly master the method to control the instrument in a remote way. It is further divided into the following four sections: remote control basis, which introduces the concepts related to remote control, software configuration, remote interface, SCPI, etc.; instrument interface configuration methods, which introduces the remote interface connection methods and software configuration methods of the 3986 series microwave power meter; basic programming methods of the VISA interface, which gives a basic programming example in the form of text description plus programming examples so that the user can quickly grasp the programming methods; the I/O function library, which introduces the basic concept of the instrument driver and the basic installation and configuration of the IVI-COM/IVI-C driver.

- **Fault Diagnosis and Repair**

## 1.2 Related Documents

This chapter introduces the working principle of the instrument, troubleshooting steps, common malfunctions and ways to solve and repair the problem.

### ● **Specifications and Test Methods**

This section lists the performance standards and technical parameters of the 3986 series noise figure analyzer, and provides recommended procedures for measurement, so that the users can more thoroughly understand the main performance indicators of the product. The standard working conditions of the 3986 series noise figure analyzer are: atmospheric temperature of  $0^{\circ}\text{C}\sim+40^{\circ}\text{C}$ , pressure of 1 atm. Data collection should be performed at an atmospheric temperature of  $23^{\circ}\text{C}\pm 3^{\circ}\text{C}$ .

### ● **Appendixes**

This chapter list important information related to the 3986 series noise figure analyzer, including: terminology, SCPI lookup table, error information lookup table, etc.

## 1.2 Related Documents

The documents related to the 3986 series noise figure analyzer include:

- Quick Start Guide
- Online support
- User Manual
- Programming Manual

### **Quick Start Guide**

This manual introduces the settings of the 3986 series noise figure analyzer as well as the basic operating methods of measurement with the aim of enabling users to quickly understand the features and basic local and remote control operation of the instrument. Main chapters included in this manual are as follows:

- About This Manual
- Preparation before Use
- Typical Applications
- Getting Help

### **User Manual**

This manual gives a detailed introduction of features and operation methods of the instrument, including information about configuration, measurement, remote control, maintenance, etc. so as to provide users with an all-round understanding of the features of the instrument and aid users in learning the most common measurement procedures. Main chapters included in this manual are as follows:

- About This Manual
- Overview
- Start Guide
- Operation Guide
- Button categories and menu items
- Remote Control
- Fault Diagnosis and Repair
- Specifications and Test Methods
- Appendixes

### **Programming Manual**

This manual describes the basics of remote control programming, basics of SCPI, SCPIs, examples of

## 1.2 Related Documents

programming, and I/O driver library, for the purpose of guiding the user to master the SCPIs and methods of the instrument quickly and comprehensively. Main chapters included in this manual are as follows:

- Remote Control
- SCPI
- Programming Examples
- Error Description
- Appendixes

### **Online support**

Online help is integrated with the product in order to provide quick navigation and enable convenient access by local and remote users. The contents are the same as those in the user manual.

1 About This Manual

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1.2 Related Documents

## 2 Overview

This chapter introduces the main performance characteristics and application scope of the 3986 series noise figure analyzer, as well as the methods for proper operation and precautions for electrical safety.

- [General.....5](#)
- [Safety guide.....5](#)

### 2.1 General

The 3986 series noise figure analyzer can cover a frequency range of 10MHz to 50GHz. It contains a highly sensitive receiver, user-friendly interface, high-definition dual-channel display, an abundance of external connection ports, dual-noise source driver, etc. It is able to measure the noise figure of amplifiers, downconverters and upconverters; supports the measurement of multi-stage converters; and supports extended frequency range measurements. With complete loss compensation function, the loss in the measurement channel can be compensated by means of fixed and/or table form before and/or after the device under test, which would greatly benefit precise measurement of noise figure of automatic test system or microwave chips. The limit lines function provides pass/fail notification to simplify pass/fail assessment. The product can be applied to microwave and millimeter wave amplifiers, mixers, attenuators and other components to measure noise figure and gain, and is suitable for scientific research, production, testing, and technical security evaluation in such fields as radar, communication and navigation.

A mechanical switch is built at the input port of the 3986D/E/F/H series noise figure analyzer to switch the frequency range between 10MHz to 4GHz and 4GHz to 18/26.5/40/50GHz. The mechanical switch has a limited service life. To maximize the reliable life of the switch, please avoid frequencies setting across 4 GHz as much as possible.

### 2.2 Safety guide

Please carefully read and strictly follow the precautions below!

We will spare no effort to ensure that all production processes meet the latest safety standards and provide users with the highest security. Our product and its auxiliary equipment have been designed and tested in accordance with relevant safety standards, and a quality assurance system has been established for product quality monitoring to ensure that the product complies with these standards. To keep the equipment in good condition and ensure safe operation, please observe the precautions in this manual. In case of any doubt, please contact us for consultation.

It is your responsibility to use the product in an appropriate manner. Please carefully read and follow safety instructions prior to use. This product is applicable to measurement in laboratory environments or on the site. Always remember to use this product within its restricted conditions to avoid personal injury or property damage. Any problems caused by failure to use this product properly or as required are to be accounted by yourself, and we will not bear any responsibility therefrom. Therefore, please always follow the safety instructions to prevent any risks of personal injury or property damage. Please keep the product document properly and deliver them to the end user.

- [Safety signs.....6](#)
- [Operation status and position.....7](#)
- [Electrical safety.....8](#)

2.2 Safety guide

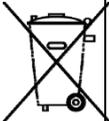
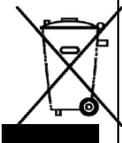
- [Operation precautions](#).....8
- [Maintenance](#).....9
- [Transport](#).....9
- [Waste disposal/environmental protection](#).....10

2.2.1 Safety signs

2.2.1.1 Safety signs on the product

The warning signs on the product are given as follows (see Table 2.1):

Table 2.1 Safety Signs on the Product

Symbol	Meaning	Symbol	Meaning
	CAUTION, which indicates information that requires special attention from the user, or operation information or instructions require attention from the user.		Power ON/OFF
	ATTENTION, which represents handling of heavy equipment.		Readiness Indicator
	DANGER! Risk of electric shock.		Direct current (DC)
	WARNING! Risk of scalding.		Alternating current (AC)
	Protection of conductive terminal		Direct/alternating current (DC/AC)
	Ground		Reinforced insulation protection of instrument
	Grounding terminal		EU mark of battery For detailed description, please refer to Paragraph 1 of <a href="#">“2.2.7 Waste disposal/environmental protection”</a> .
	ATTENTION, care should be taken to handle the electrostatic sensitive device.		EU mark of separate collection of electronic device For detailed description, please refer to Paragraph 2 of <a href="#">“2.2.7 Waste disposal/environmental protection”</a> .

Symbol	Meaning	Symbol	Meaning
	WARNING! Risk of radiation. For detailed description, please refer to Paragraph 5 of " <a href="#">2.2.4 Operation precautions</a> ".		

### 2.2.1.2 Safety signs in the manual

For the purpose of this manual, the following safety warning signs are used to remind the user of operating the instrument safely and paying attention to relevant information,:



DANGER indicates a situation which, if not being avoided, will lead to personal injury or equipment damage.



WARNING indicates a situation which, if not being avoided, will lead to personal injury or equipment damage.



CAUTION indicates a situation which, if not being avoided, will lead to minor or moderate personal injury or equipment damage.



ATTENTION indicates an important information rather than a danger.



NOTE indicates information about the instrument and its operation.

### 2.2.2 Operation status and position

Before instrument operation, please pay attention to the followings:

- 1) Unless otherwise stated, the 3986 series noise figure analyzer must satisfy the following environmental requirements: be placed on a flat surface. The maximum altitude at which the instrument is operated and transported should not be greater than 4,600 m. The actual supply voltage is allowed to vary within  $\pm 10\%$  of the specified voltage, and the supply frequency is allowed to vary within  $\pm 5\%$  of the specified frequency.
- 2) Unless otherwise stated, the instrument not subject to waterproof treatment should not be placed on a watery surface, vehicle, cabinet, table or other unfixed objects that don't meet the load-bearing condition. Please place and fix the instrument reliably on the surface of a solid object (e.g. anti-static workbench).
- 3) Do not place the instrument in an environment that is prone to fogging. For example, if the instrument is moved in an alternate cooling and heating environment, water droplets will be formed on the instrument, causing electric shock and other hazards.
- 4) Do not place the instrument on the surface of a radiating object (e.g. radiator). The ambient temperature in which the instrument works should not exceed the value given in the section regarding description of relevant indicators of the product. Overheating of the product will result in electric shock, fire and other hazards.
- 5) Do not insert anything into the instrument through the openings on the housing or cover the notches or openings on the instrument because they are designed for internal ventilation to prevent the instrument from overheating.

### 2.2.3 Electrical safety

Electrical safety precautions of the instrument:

- 1) Before turning on the instrument, ensure that the supply voltage matches the indicated supply voltage of the apparatus.
- 2) With reference to the power requirements on the instrument's rear panel, a three-core power cord is used to ensure reliable grounding of the power wire during use. Poor floating or grounding may cause damage to the instrument or harm to the user.
- 3) Do not damage the power cord; otherwise leakage will occur, which may damage the instrument and even cause injury to the operator. If an external power cord or terminal board is used, check it before use to ensure the electrical safety.
- 4) If the power outlet is not equipped with ON/OFF switch, the instrument can be directly unplugged for deenergization. For this purpose, it is necessary to ensure that the instrument can be plugged and unplugged conveniently.
- 5) Do not use a damaged power cord. It is necessary to check the integrity and safety of the power cord before connecting it to the instrument, and place it reasonably to avoid the influence due to human factors, e.g. the operator is tripped by an excessively long power cord.
- 6) The outlet should be kept clean and tidy, and the plug and outlet should be contacted properly and firmly.
- 7) The outlet and power cord should not be overloaded; otherwise, fire or electric shock will be caused.
- 8) Unless otherwise permitted, the instrument enclosure should not be opened; otherwise, the internal circuits and components will be exposed, causing unnecessary damage or injury.
- 9) If the instrument needs to be fixed at the test site, a protective ground wire should be installed between the test site and the instrument by a qualified electrician.
- 10) Appropriate overload protection measures should be taken to avoid instrument damage or personal injury caused by overload voltage (in the event of lightning for example).
- 11) Please note that if the instrument catches fire, it may release gases or liquids that are toxic to the human body.

### 2.2.4 Operation precautions

- 1) The instrument operator should have certain professional technical knowledge and certain ability of emergency response.
- 2) Before moving or transporting the instrument, please refer to the relevant instructions in [“2.2.6 Transport”](#).
- 3) If the instrument operator suffers from allergy (e.g. rash, frequent sneezing, red eyes, or breathing difficulty) during operation due to the inevitable use of substances (such as nickel) that may cause personal allergy in the process of production of the instrument, please seek medical advice promptly to find the cause and resolve the symptom.
- 4) Before disassembling the apparatus for waste management, please consult the instructions in the [“2.2.7 Waste disposal/environmental protection”](#).
- 5) As the radio frequency instrument will produce a high level of electromagnetic radiation, a pregnant woman and an operator with a heart pacemaker need special protection.
- 6) To prevent static electricity from causing damage to the instrument, an anti-static table mat, footpad, and wristband should be worn to manage static voltage so that it does not exceed 500 V.

- 7) Use connectors and cables that comply with the specified conditions and check them before carrying out any operations.
- 8) Ensure that the power of the RF input port of the instrument is less than the maximum safe input level of +15dBm to avoid burning the instrument.
- 9) Do not hot-swap components where it is forbidden, such as GPIB or monitor interfaces.
- 10) It is forbidden to remove any connector protectors and matching devices provided by the instrument to avoid causing damage to the connectors or measurement errors.
- 11) Use the power button on the front panel to turn the instrument on or off normally. Do not disconnect the power source abruptly. Doing so may cause the system to function abnormally.
- 12) To ensure the accuracy of the measurement, the instrument must be pre-heated for 30 minutes before running a measurement.
- 13) It is forbidden to delete factory data.
- 14) The instrument adopts an open Windows environment. It is forbidden to modify the configuration of the BIOS. Doing so will cause the instrument to initiate and function abnormally.
- 15) Users may only delete his/her own saved files. It is forbidden to delete system files.
- 16) When transferring files via USB ports or network interface, ensure that they are safe and reliable to avoid infecting the instrument.
- 17) To build a test system using GPIB or a network port, the address of the GPIB and the network port must be configured correctly.
- 18) If the instrument malfunctions, do not disassemble it, but send .it back to the manufacturer for maintenance and repair.

### 2.2.5 Maintenance

- 1) Only authorized technical personnel who have been professionally trained is allowed to open the casing of the instrument. Before performing such operation, it is necessary to disconnect the power cord to prevent instrument instrument or even personal injury.
- 2) The instrument should be repaired, replaced or maintained by a professional electronic engineer designated by the manufacturer. The replaced and maintained part should be subject to safety test to ensure safe use of the product in the future.

### 2.2.6 Transport

- 1) If the instrument is heavy, please move it carefully, and if necessary, use an aid (such as crane) to move the instrument so as to avoid body damage.
- 2) The instrument handle is suitable for personal handling, and it should not be used to fix the instrument on the carrier for transportation. To prevent property damage or personal injury, please transport the equipment based on the safety regulations specified by the manufacturer.
- 3) When operating the equipment on a transport vehicle, the driver must be cautious to ensure the safety of transport. The manufacturer is not responsible for any unforeseen circumstances during the transport process. Therefore, please do not operate the apparatus when it is being transported. In addition, safety measures should be reinforced in order to ensure that the product is transported safely.

2.2.7 Waste management/environmental protection

- 1) Please do not dispose of equipment marked with batteries or rechargeable batteries with unsorted waste. These wastes should be individually collected and disposed of at an appropriate collection point or through the customer service center of the manufacturer.
- 2) Please do not dispose of electronic equipment with unsorted waste. These wastes should be individually collected. The manufacturer has the right and responsibility to aid the end user in managing waste products. If necessary, please contact the customer service center of the manufacturer for the corresponding procedures in order to avoid environmental harm.
- 3) When the product or the internal components are subjected to mechanical or thermal reprocessing, toxic substances may be released (e.g. lead, niobium, nickel, etc.) To avoid causing harm to the user, the equipment must only be disassembled by technical personnel who have received professional training and have the relevant experience in handling the equipment.
- 4) During reprocessing, the product may release toxic material or fuel. Please refer to the operational safety procedures outlined by the manufacturer and use specific measures for processing in order to avoid causing harm to the user.

## 3 Start Guide

This Chapter describes the preparation for use, instructions for front and rear panels, setting of analyzer reset status, file operations, use of form processing and instructions for basic measurements of 3986 Series Noise Figure Analyzer, to enable users get a preliminary knowledge and the measurement process of the noise figure analyzer. The content contained in this chapter is consistent with that in relevant chapters of Quick Start Guide.

- [Preparation for Use](#).....11
- [Instructions for Front and Rear Panels](#).....27
- [Basic Operating Instructions](#).....35

### 3.1 Preparation before Use

- [Preparations before operation](#).....11
- [OS configuration](#).....20
- [Routine maintenance](#).....26

#### 3.1.1 Preparations before operation

This section provides precautions for initial use of Series 3986 Noise Figure Analyzer.

#### **WARNING**

##### **To prevent injuries and analyzer damages:**

To avoid the electric shock, fire and personal injury:

- 1) Please do not disassemble the casing of the instrument.
- 2) Do not attempt to dismantle or modify any part not described in this manual. In case that the user disassemble the analyzer without approval and cause the electromagnetic shielding performance degradation and component damages that affect the reliability within the warranty period, we will not provide free repairs.
- 3) Please read related content in [“2.2 Guidelines for Safe Use”](#) and the safety cautions for operations below carefully and pay attention to related requirements for specific operating environment in technical specifications.

#### **Attention**

##### **Electrostatic protection:**

Pay attention to the ESD protection measures in the workplace to avoid the damage to instrument.

Please see [“2.2 Guidelines for Safe Use”](#) for details.

## Attention

**During instrument operation, please pay attention to the following aspects:**

An improper operating position or measurement setting can damage the instrument or appliances connected to it. Before powering on the instrument, please pay attention to the followings:

- 1) To ensure that the fan blade and radiating hole are unobstructed, keep the instrument at least 15cm away from the wall, and ensure that all ventilation holes of the fan are unobstructed;
- 2) Keep the instrument dry;
- 3) Place the instrument horizontally and reasonably;
- 4) Ensure that the surrounding temperature is in accordance with the requirements in the technical specifications.
- 5) The power of input signal shall not exceed the rating.

## NOTE

**Effect of electromagnetic interference (EMI):**

The electromagnetic interference can affect the measurement results, therefore, it is necessary to:

- 1) select appropriate shielded cables, For example, use RF shielded twisted pair/network connection cable.
- 2) Always use a protective sleeve to cover a cable connection port not used temporarily.
- 3) Refer to the EMC class identified in the technical specifications.

### 3.1.1.1 Unpacking

#### 1) Visual inspection

**Step 1.** Check if the packaging box and shockproof package are broken; if so, keep the outer package and continue to check in accordance with the following steps;

**Step 2.** Unpack and check if the main unit and accessories are broken;

**Step 3.** Check the following items against Table 3.1 carefully;

**Step 4.** If the outer package is broken, the instrument or accessories are damaged or there is any error of the delivery, it is strictly forbidden to switch on the instrument! Please contact our service hotline provided in this manual and we will repair or replace them quickly as appropriate.

#### 2) Model confirmation

The Series 3986 Noise Figure Analyzer will be delivered with the items shown in Table 3.1.

Table 3.1 Packing List of Series 3986

Item	Quantity	Function
<b>Main unit</b>		
3986	1	—
<b>Standard parts</b>		
3-core power cord	1	—
USB mouse	1	—
User Manual	1	—
Programming Manual	1	—

## 3.1 Preparation before Use

Packing list	1	—
<b>Noise source option</b>		
16603	1	—
16604	1	—

**3.1.1.2 Environmental requirements**

Series 3986 Noise Figure Analyzer shall be operated in a place meeting the following environmental requirements:

**1) Operating environment**

The operating environment shall meet the requirements specified in Table 3.2.

Table 3.2 Requirements for Operating Environment of Series 3896

<b>Working temperature</b>	0°C~40°C
<b>Relative humidity</b>	Not controlled at 0°C~10°C 5% - 95% at 10°C~30°C 5% - 75% at 30°C~40°C
<b>Altitude</b>	(0 - 4600) m

**Attention**

The above environmental requirements are only defined for the operating environment of the instrument and are not within the scope of specifications.

**2) Radiation requirements**

In order to ensure that the ambient temperature of the instrument is within the temperature range required for the operating environment, it shall meet the requirements for heat dissipation space of the instrument, as shown in Table 3.3:

Table 3.3 Requirements for Heat Dissipation of Series 3986

<b>Instrument Part</b>	<b>Radiation Distance</b>
Rear part	≥150mm
Left and right parts	≥60mm

**3) ESD protection**

The static electricity is destructive to electronic components and equipment. Generally, we will use two anti-static measures, including combination of conductive table mat and wrist combination as well as combination of conductive floor mat and ankle strap. If these two combinations are used together, a good anti-static protection can be provided. For the safety of users, anti-static components must provided an isolation resistance of at least 1 MΩ to the ground.

Please use the following anti-static measures to reduce damages caused by static electricity:

- 1) Ensure that all instruments are properly grounded to avoid generating static electricity;
- 2) Before connecting the coaxial cable to the instrument, contact its inner and outer conductors with the ground temporarily;
- 3) The staff shall wear anti-static wrist straps or adopt other anti-static measures before contacting joints and core wires or carrying out any assembly operation.

**WARNING****Voltage range:**

The above anti-static measures can't be taken in a place where the voltage exceeds 500 V.

**3.1.1.3 Power on/off****1) Precautions before power-on**

It is necessary to check the following items before powering on the instrument:

**a) Confirmation of power supply parameters**

Series 3986 Noise Figure Analyzer is equipped with a built-in 220VAC power module (using 220VAC power supply) or 110V/220V adaptive AC power module (optional, using 110VAC or 220VAC power supply; the internal AC power module is adaptive to external AC power supply voltage for automatic switching of working modes). Therefore, please check the power supply requirements indicated on the rear panel before using the Noise Figure Analyzer. The requirements for external power supply for the normal operation of the Noise Figure Analyzer are listed in Table 3.4.

Table 3.4 Requirements for Power Supply of Series 3986

Power Supply Parameter	Applicable Scope	
	220V±22V, 50Hz-60Hz	110V±11V, 50Hz-60Hz/400Hz
Voltage, frequency	220V±22V, 50Hz-60Hz	110V±11V, 50Hz-60Hz/400Hz
Power consumption (power-on)	<250W	<250W
Power consumption (standby)	<20W	<20W

**NOTE****To prevent mutual interference of power supplies:**

In order to prevent damages of the instrument hardware due to the mutual interference of several devices via power supplies, especially peak pulses generated by high power equipment, it is recommended to use the 220VAC or 110 VAC regulated power supply.

**b) Confirmation and connection of power cord**

Series 3986 Noise Figure Analyzer is equipped with a port in compliance with the national safety standard for 3-core power cords. Before energizing the Noise Figure Analyzer, it must be confirmed that **the protective ground wire in the power cord has been reliably grounded**; either floating or improper grounding can cause the instrument to be destroyed or injuries to the operator. It is prohibited to use a power cord without a protective ground. When connected to a suitable power socket, the power cord realizes grounding of the instrument enclosure. The power cord should be rated at  $\geq 250\text{V}$  for voltage and  $\geq 6\text{A}$  for current.

## ⚠ WARNING

### Grounding

Poor or incorrect grounding may cause instrument damage and even personal injury. Before energizing the Noise Figure Analyzer, it must be ensured that the power supply is properly grounded.

Please use the power socket with a protective ground. Do not replace the protective ground wire with an external cable, power cord or autotransformer without grounding protection. If an autotransformer must be used, the common port must be connected to the protective ground wire of the power port.

When connecting the instrument to the power cord:

**Step 1.** Check if the power cord is damaged;

**Step 2.** Use the power cord to connect the power port on the rear panel of the instrument to a well-grounded 3-core power socket.

### 2) First power-on

The methods and precautions for instrument power-on/power-off are as follows:

#### a) Connection of power supply

Verify the power supply parameters and the power cord before powering on for the first time; see [“Precautions before power-on”](#) for details.

When connecting the power supply, connect one end of the power cord supplied with the Noise Figure Analyzer in the packaging box or a 3.1-core power cord as required to the power port on the rear panel of the analyzer, as shown in Fig. 3.1; the required voltage parameter is indicated beside the port to remind users to use specified voltage; and then, connect the other end of the power cord to the AC power supply as required.



110V/220VAC adaptive power module      220VAC power module

Fig. 3.1 Power Port on Rear Panel of Series 3986

#### b) Power on/off

##### i Power-on

**Step 1.** Turn on the power switch of the rear panel, as shown in Fig. 3.2, and check if the standby indicator above the power switch of front panel lights up in yellow, which indicate that the instrument is in standby.

3.1 Preparation before Use



Fig. 3.2 Power Switch on Rear Panel of Series 3986

**Step 2.** Do not connect any device to the Noise Figure Analyzer before power-on; turn on the power switch of the front panel, as shown in Fig. 3.3 and the indicator above the power switch of front panel turns to green.



Fig. 3.3 Power Switch on Front Panel of Series 3986

**Step 3.** The user interface of the front panel displays related information of the starting process: briefly display the manufacturer name and logo and then go to the OS menu. There are two options in the menu and users have no need to operate this menu during normal use. the user does not need to operate the menu. After the timer reaches “0”, Windows 7 will start automatically.

**Step 4.** After Windows 7 launches, the system runs the initialization program of the Noise Figure Analyzer automatically and display the main operation interface, in which the analyzer can be operated.

---

**NOTE**

**10MHz time base and warm-up**

During the cold start (started from full shut-down status), Series 3986 Noise Figure Analyzer shall be warmed up for a period of time to enable the analyzer to reach the operating temperature at 10MHz time base. If the analyzer starts from standby mode, it does not require the time base warm-up. When the specifications are tested, the instrument should warm up for 0.5 h (please refer to the relevant instructions for specifications in the specifications for details).

---

---

**Attention**

**System startup:**

The analyzer is equipped with a console based on Windows computer; during the BIOS boot test and Windows loading, no user intervention is needed but the power supply shall not be cut off and no settings in BIOS shall be changed.

---

**ii Power-off**

**Step 1.** Turn off the power switch on the bottom left of front panel. Then the analyzer goes into the shut-down process (software and hardware may need some time to process before power-off)

## 3.1 Preparation before Use

and after several seconds, the analyzer powers off when the indicator above the power switch turns from green to yellow.

**Step 2.** Turn the power switch on the rear panel to OFF position or disconnect the power supply of the analyzer.

## Attention

### Analyzer power-off:

During normal operation, the analyzer shall only be powered off by operating the power switch of the front panel. Do not operate the power switch of the rear panel or disconnect the power supply directly, or otherwise the analyzer cannot go into the power-off status, which may damage the analyzer or cause the current status/measurement data being lost. Please shut down the analyzer properly.

### c) Disconnection of power supply

In abnormal conditions, the analyzer shall be power off to avoid causing personal injuries. At this time, just disconnect the power cord (from the AC power outlet or rear panel power outlet of the instrument). Therefore, a sufficient operating space should be reserved during instrument operation so that the power supply can be disconnected directly when necessary.

#### 3.1.1.4 Correct use of connector

Connectors are often used in various tests by analyzer and when connecting them, the followings shall be noted:

#### 1) Check connectors

It is necessary to wear an anti-static wrist strap when checking the connectors. It is recommended to use a magnifier to check:

- the electroplated surface for wear and deep scratches;
- the thread for deformation;
- the thread and joint surface for metallic particles;
- the inner conductor for bending and breakage;
- the screw for improper rotation.

## CAUTION

### Check the connectors to prevent damaging the analyzer ports:

Any damaged connector may damage the good connector connected to it even for the first time of measuring connection, and to protect the ports of the analyzer, the connector to be used shall be checked before connection.

#### 2) Connection

The connectors should be checked and cleaned before measurement and connection to ensure that they are clean and undamaged. It is necessary to wear an anti-static wrist strap during connection. The correct connection methods and procedures are as follows:

**Step 1.** As shown in Fig. 3.4, align the axis of both devices to be connected to ensure the pins of male connector can concentrically slide into the holes of female connect;

## 3.1 Preparation before Use



Fig. 3.4 Diagram - Connecting Connector

**Step 2.** As shown in Fig. 3.5, move both connectors straight together, so that they can be connected smoothly; rotate the threaded sleeve of connector (rather than the connector itself) until it is tightened; during connection, there can be no relative rotary motion both connectors;

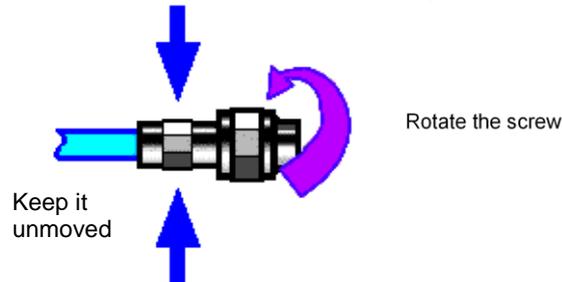


Fig. 3.5 Diagram - Rotating Connector

**Step 3.** As shown in Fig. 3.6, use a torque wrench to tighten the connectors and finish the connection; the torque wrench shall not exceed the starting break point and an auxiliary wrench can be used to prevent the connector rotating.

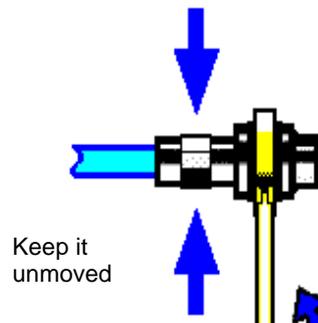


Fig. 3.6 Diagram - Use of Wrench

### 3) Disconnection

- Step 1.** Support the connectors to prevent applying twisting, rocking or bending force to any one of the connectors;
- Step 2.** Use a open-end wrench to prevent the connector body from rotating;
- Step 3.** Use another wrench to loosen the threaded sleeve;
- Step 4.** Rotate the threaded sleeve by hand and finish the disconnection;
- Step 5.** Separate both connectors straight.

### 4) Use of the torque wrench

The torque wrench should be used as indicated in Figure 3.7. Please pay attention to the following points when using the torque wrench:

- Confirm that the torque of the torque wrench is set correctly before use;
- Ensure that the angle between the torque wrench and the other wrench (used to support the connector or cable) is less than 90° before applying a force;
- Hold the end of torque wrench's handle and apply force perpendicular to the handle until reach the break point of torque wrench.

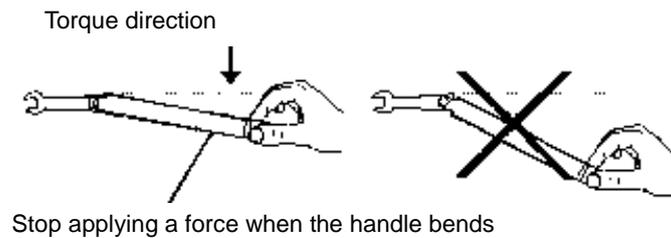


Fig. 3.7 Use of Torque Wrench

### 3.1.1.5 User checks

Series 3986 Noise Figure Analyzer shall be checked, after being powered on for the first time, whether it is working properly for subsequent measurements.

## NOTE

Hard keys on the front panel and soft keys of the menu are described in the following forms:

- 1) Hard key: **【XXX】**, where XXX is the name of the hard key;
- 2) Soft key: **[XXX]**, where XXX is the name of menu soft key or button.

If a soft key entry corresponds to several status, the selected entry will have a blue background to indicate its status is active. e.g.: [Sweep Mode Cont Single] indicates the single sweeping is active.

### 1) Function verification

After power-on and warm-up of Series 3986 Noise Figure Analyzer, connect the analyzer and noise source as shown in Fig. 3.8.

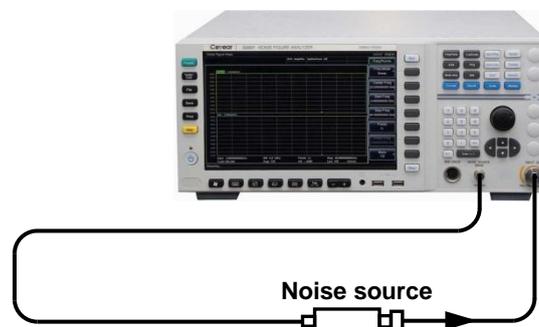


Fig. 3.8 Connection of Noise Figure Analyzer and Noise Source

Set the analyzer as below:

- Step 1.** Load the excess noise ratio (ENR) of the noise source used and set the start frequency of the analyzer at 10MHz and the stop frequency at 4GHz; check if the analyzer display the noise figure measuring traces are normally, and the noise figure measurements shall meet the requirements for noise figure indicators of the analyzer;
- Step 2.** Set the start frequency of the analyzer at 4GHz and the stop frequency at 18/26.5/40/50GHz depends on the models; check if the analyzer display the noise figure measuring traces are normally, and the noise figure measurements shall meet the requirements for noise figure indicators of the analyzer;
- Step 3.** Press **【Calibrate】** key to go to the Calibrate menu; press [Calibrate] twice; then the analyzer can calibrate and the noise figure and gain values displayed after calibration are close to 0dB.

## 3.1 Preparation before Use

## 2) Self-test

Self-test is not necessary every time the instrument is turned on. Self-test is only needed to be done when the analyzer works abnormally.

**Step 1.** Press **【System/Local】** key to go to the system menu;

**Step 2.** Select the [Self-test] from the soft menu to access the self-test interface;

**Step 3.** Select the items to be tested and click [Start] soft menu to start the test, and the test results are shown in the column Result, as shown in Fig. 3.9. Check the test results: all passed indicates the analyzer works normally; any failed item indicates the analyzer work abnormally in the corresponding aspect, please contact our service hotline provided in this manual and we will repair or replace them quickly as appropriate. After the above two steps are successfully completed, the analyzer is ready for operate.

Test Item	ID	Type	Max	Min	Value	Result
Instrument Test	0					
CPU Board	100					
3.3VD Test	101	Quantization	2.97	3.63		
5VD Test	102	Quantization	4.50	5.50		
12VD Test	103	Quantization	10.80	13.20		
5VA Test	104	Quantization	4.50	5.50		
-5VA Test	105	Quantization	-5.50	-4.50		
9VA Test	106	Quantization	8.10	9.90		
15VA Test	107	Quantization	13.50	16.50		
-15VA Test	108	Quantization	-16.50	-13.50		
30VA Test	109	Quantization	27.00	33.00		
YTF Voltage Test	110	Quantization	0.00	32.00		
CPU Temp Test	111	Quantization	-40.00	105.00		
PCH Temp Test	112	Quantization	-40.00	105.00		
Module Temp Test	113	Quantization	-40.00	105.00		
LO Board	200					
Sample Loop Test	201	Process	-2.00	2.00		Detail
YO Loop Test	202	Process	-0.50	0.50		Detail
YO Multi-Loop Test	203	Process	-0.50	0.50		Detail
YTO Temp Test	204	Quantization	-10.00	100.00		

Fig. 3.9 Self Test Screen of Series 3986

### 3.1.2 Configuration of operating system

This section describes the OS of Series 3986 Noise Figure Analyzer and its configuration and maintenance. To ensure the normal operation of software functions, the following instructions for the analyzer's OS below shall be referenced.

#### 3.1.2.1 Description of instrument software

The main unit software of Series 3986 Noise Figure Analyzer is running on Windows 7, which has been installed and configured as per specific demands of the analyzer.

#### 3.1.2.2 Use of Windows 7

The administrator account has the permissions to:

- 1) install third-party software;
- 2) configure network and printer;
- 3) read and write any files on the hard disk;
- 4) add and delete user accounts and passwords;

- 5) reconfigure Windows settings;
- 6) run other applications.

## Attention

### **Third-party software may affect the analyzer's performance:**

Series 3986 Noise Figure Analyzer is equipped with open Windows environment, and installing other third-party software may affect the analyzer's performance. Only software tested by the manufacturer and compatible with the main unit software can be run.

### **3.1.2.3 Windows 7 configuration**

Before delivery, the operating system of Series 3986 Noise Figure Analyzer has been optimized to the best configuration, and any changes in the OS settings may cause a decrease in the performance of the analyzer. Generally, no changes need to be made for Windows OS settings.

## Attention

### **Change of system settings may cause problems:**

In case that any problems in use of the analyzer or system crash due to changes of system settings, users can use the system recovery tool of the analyzer to recover the OS and applications, or contact our service hotline provided in this manual and we will solve the problems as quickly as possible.

In order to facilitate the measurement reporting and system integration, user can change the following items as needed.

### **1) Configuring USB devices**

Series 3986 Noise Figure Analyzer is provided with USB ports on front and rear panels for connecting USB devices directly. If there are not enough USB ports, USB hubs may be used to meet the demands. Following USB devices can be connected to the analyzer:

- Hot-plug USB memory for updating data;
- CD-ROM drive for installing firmware and programs;
- Keyboard and mouse for editing data and operating the analyzer;
- Printer for outputting measurement results.

The Windows 7 operating system supports plug-and-play devices, so it is convenient to install USB devices, and when a device is connected to a USB port, Windows 7 will automatically search for matching device drivers. If no available driver is found, the system will prompt to find the driver directory to complete the installation.

If an USB device is removed from a USB port, Windows 7 system will automatically detect a change in hardware configuration, and the plug of a USB device will not affect the analyzer's working state; the method for connecting USB devices is described below:

#### **a) Connecting memory or CD-ROM drive**

If the memory or CD-ROM drive is installed successfully, Windows 7 system will prompt "The device has been installed successfully and is ready to use" and automatically display the path name and prompt (e.g. "D:").

## 3.1 Preparation before Use

**b) Connecting keyboard**

Windows 7 system will automatically detect the USB keyboard connected to the analyzer and default the input language as Chinese (ZH) - Simplified - US; the keyboard properties can be configured via [Start]→[Control Panel]→[Language and Region]→[Keyboard and Language] menus and buttons.

**c) Connecting mouse**

Windows 7 system will automatically detect the mouse connected to the analyzer; the mouse properties can be configured via [Start]→[Control Panel]→[Mouse] menu and buttons.

**d) Connecting printer**

Use Windows Control Panel to configure printers. Using an external USB mouse and keyboard can make the printer configuration easier. If you need to install a new printer, you only need to install the printer's driver. The printer manufacturer will provide the printer installer. You can also install the driver through the external USB optical drive.

**2) Configuring GPIB**

The user may need to modify the GPIB address when building a system with a noise figure analyzer. The GPIB address of the machine is 8 by default. The method to change the GPIB address is as follows: Press【System/Local】→[Interface Config]→[GPIB Address] and go to the screen shown in Fig. 3.10; you can change the address in “GPIB Addr” box with numeric keys on the front panel.



Fig. 3.10 Change GPIB Address

**3) Configuring network****a) Changing host name**

The host name (computer name) of Series 3986 Noise Figure Analyzer has been preset as “3986-PC” before delivery. To avoid duplication of network names, users can change the host name in case that several Series 3986 analyzer are connected to same network. The host name can be changed as below (see Help document of Microsoft Windows 7):

## 3.1 Preparation before Use

**Step 1.** Press [Start], right click [Computer], and click [Properties]→[Change Settings]→[Change], as shown in 3.11;

**Step 2.** Edit or enter new host name in “Computer Name” box, click [OK] and reboot.

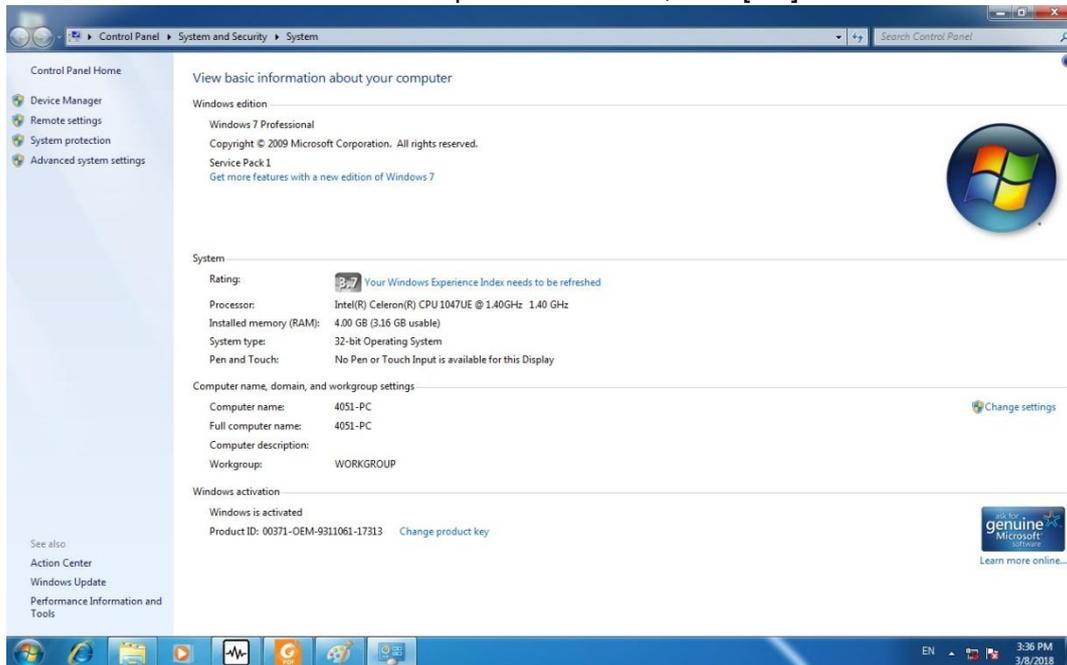


Fig. 3.11 Change Host Name

### b) Configuring IP address, subnet mask and default gateway

Press **【System/Local】** →[Interface Config]→[Internet Config] and the network connection setting page pops up; double click [Local Connection 2]→[Internet Protocol version 4 (TCP/IPv4)]→[Properties], as shown in Fig. 3.12, and there you can change the local IP address, subnet mask and default gateway.

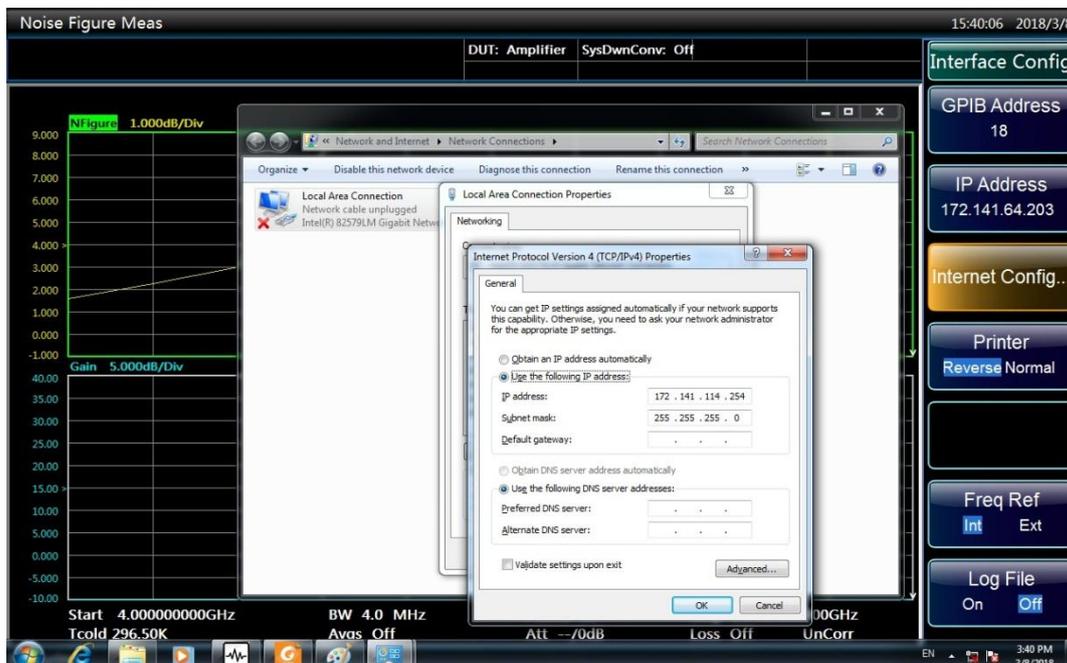


Fig. 3.12 Configuring IP Address, Subnet Mask and Default Gateway

### c) Changing system firewall settings

The firewall is used to prevent unauthorized users from remotely operating the analyzer, so the

### 3.1 Preparation before Use

manufacturer advises to enable the firewall protection. Before delivery, Series 3986 Noise Figure Analyzer has been set to enable firewall protection for port connections related to system and all remote operations.

Only the administrator has the permission to change the firewall settings.

#### 4) Configuring BIOS

Settings have been configured for the analyzer in BIOS.

### Attention

#### The BIOS settings cannot be changed:

Settings have been configured for the analyzer in BIOS and users shall not change any BIOS settings, or otherwise the analyzer may not be started and operated normally.

#### 5) External monitor

An external monitor (or projector) can be connected to the “Display Port” connector on the rear panel of the analyzer as described below:

**Step 1.** Connect the external monitor to the “Display Port” connector on the rear panel of Series 3986 analyzer.

**Step 2.** The analyzer has been set to Automatic Dual-View and other display modes can be selected via the GPU Settings on the bottom right of the system task bar.

**Step 3.** Click [Graph]→[Output to] in GPU Settings to select the device to display:

- “Monitor”: only displaying via external monitor;
- “Built-in display”: only displaying via the analyzer’s LCD screen;
- “Clone display”: displaying via LCD screen and external monitor.

**Step 4.** If necessary, change the screen resolution to be used.

#### 6) Setting date/time

Date/time is displayed on the status bar at the top right of the Series 3986 Noise Figure Analyzer operation interface and the file storage will synchronize the storage time information; users can set the date/time in Windows 7 system.

### 3.1.2.4 Windows 7 system security and maintenance

#### 1) Antivirus software

Installing antivirus software may have some negative effects on the performance of the instrument, and it is strongly advised that users do not to use the instrument as a common computer to browse or transfer documents so as not to get infected with virus.

Before using USB mobile storage devices, a computer with the latest antivirus software should be used to process these mobile devices to kill virus may exist and ensure that they do not become a viral carrier. Once the analyzer’s system platform is infected with virus, the operation of measurement and control programs and the use experience will be affected; in this case, it is recommended to perform system recovery. See “[System maintenance](#)” for the system recovery operations.

## 2) System maintenance

### a) Windows 7 system backup

It is recommended to backup the system regularly; to do this you can use the System Recovery Tool to completely backup the analyzer data and system, see [“3.1.2.5 System backup recovery”](#).

Before using the analyzer for other purposes other than normal use such as long-term Internet connection and installing third-party software, it is recommended to backup the analyzer system to avoid accidental infection of virus and other operations harmful to the system.

The Windows 7 operating system has the same data backup function that can backup all data on the analyzer and create a system disk that can be used to restore Windows in case of serious failure. See help document of Windows 7 for more details. Additionally, third party backup software can be used, but there is a need to ensure that this software does not conflict with the analyzer's system software. It is recommended to backup the system data on external devices such as a network hard drive or USB hard drive.

### b) Windows 7 system recovery

Windows 7 has the system recovery function that can restore the system to the state of a previous moment. However, the built-in system backup recovery function of Window cannot work successfully every time, so it's not recommended to use this backup program.

## 3) Partitions and use of hard disk

The hard disk has three partitions: “C:”, “D:” and “E:”.

Windows 7 OS and the analyzer's applications are installed in Disk C. Third-party software can also be installed in Disk C. Disk C is the only disk for backup and recovery.

Disk D is mainly used for the key response program KeyMap and storage of user data.

Disk E is mainly used to store data, including software data stored by users and system backup of Disk C. Backup data in Disk E can be copied to external storage media so that even the hard drive needs to be replaced, only the backup data will be recovered to the new hard drive.

### 3.1.2.5 System backup recovery

#### 1) Hard drive OS or data recovery

The analyzer's hard drive recovery system can used to fix software errors on Disk C (may be caused by loss of system files or data) or recover the original factory data.

Recovery of original factory data will affect on the following entries:

- User-defined Windows 7 settings, such as newly added user accounts, need to be reset after system recovery;
- Other third-party software installed by users needs to be re-installed after system recovery.

Using the data recovery function to repair hard drive errors may result in the loss of data or files, so the data generated during measurements should be stored in an Disk E; it is recommended to periodically transfer the data to a computer or other storage media through local network connections.

#### 2) How to use the analyzer recovery program

**Step 1.** Check if the analyzer is shut down.

**Step 2.** Plug a standard keyboard into the PS/2 interface on the rear panel.

### 3.1 Preparation before Use

**Step 3.** Switch on the analyzer and after the display of system information, an OS menu with timer appears:

[Windows 7]

[System Recovery Tool]

When the timer counts down to 0, use the Up/down arrows on the standard keyboard to highlight the [System Recovery Tool] and press Enter after selecting it.

**Step 4.** Perform the recovery in the recovery program screen as below:

- 1) Select the first option [GHOST, DISKGEN, PQMAGIC, MHDD, DOS], wait and go to the next operation prompt screen;
- 2) Select the third option [GHOST11.2], wait and go to the GHOST11.2 screen, and press Enter when the dialog box with [OK] button;
- 3) Select [Local]→[Partition]→[From Image]; in the Open Files dialog box, press Tab to activate “File name” box to input “E:\SystemGhost.GHO”;
- 4) In the Select Source Partition and Select File dialog box pops up, press Tab to switch to [OK] and press Enter; in the Select Destination Device dialog box pops up, press Tab to switch to [OK] and press Enter; in the Select Destination Partition dialog box pops up, select the first partition, press Tab to switch to [OK] and press Enter;
- 5) In the Warning and Confirmation dialog box, select [Yes] and press Enter;
- 6) The the system recovery finishes, reboot as prompted.

**Step 5.** After the analyzer reboots, the system will be restored to the status of last backup.

#### 3.1.3 Routine maintenance

This section describes the routine maintenance methods of Series 3986 Noise Figure Analyzer.

##### 3.1.3.1 Cleaning

###### 1) Cleaning of instrument surface

Clean the instrument surface as per the following steps:

**Step 1.** Shut down the analyzer, and disconnect the power cord;

**Step 2.** Wipe the surface gently with dry or slightly wet cloth; it is prohibited to wipe the interior;

**Step 3.** Do not use any chemical detergents such as alcohol, acetone and other detergents can be diluted.

###### 2) Cleaning LCD

---

### Attention

#### Cleaning display

The display screen is coated with a layer of anti-static coating, and therefore detergents with fluoride or acidic or alkalic detergents shall not be used. Do not spray detergent onto the display panel directly, or otherwise it may penetrate into the analyzer and cause damages.

The LCD needs to be cleaned after a period of time. Please operate according to the following steps:

**Step 1.** Shut down the analyzer, and disconnect the power cord;

**Step 2.** Wipe the display panel gently with clean and soft cotton cloth dipped with detergent;

## 3.2 Description of front and rear panels

**Step 3.** Dry the display panel with clean and soft cotton cloth;

**Step 4.** Connect the power cord after the detergent dries thoroughly.

## 3.1.3.2 Input port maintenance

There is an input port (50Ω) on the front panel of Series 3986 Noise Figure Analyzer, which may affect measurement results if damaged or having dust accumulated inside; please maintain the port as described below:

- 1) The conductor in the port shall be kept away from the dust and kept clean.
- 2) In order to prevent electrostatic discharge (ESD), do not directly contact the internal conductor of the port.
- 3) Do not use a damaged port connector.
- 4) Use a hairdryer to clean the port and don't use tools such as sandpaper to grind the port surface.

## Attention

### Port impedance matching:

The input port on the front panel of Series 3986 Noise Figure Analyzer is available to 50Ω connectors. Connecting a connector with unmatched impedance will affect the measurement result.

## 3.2 Description of front and rear panels

This section describes the front and rear panels of Series 3986 Noise Figure Analyzer and their functions.

- [Instructions for front panel.....27](#)
- [Instructions for rear panel.....32](#)

### 3.2.1 Description of front panel

This section describes components of the front panel of Series 3986 Noise Figure Analyzer and their functions, as shown in Fig. 3.13.

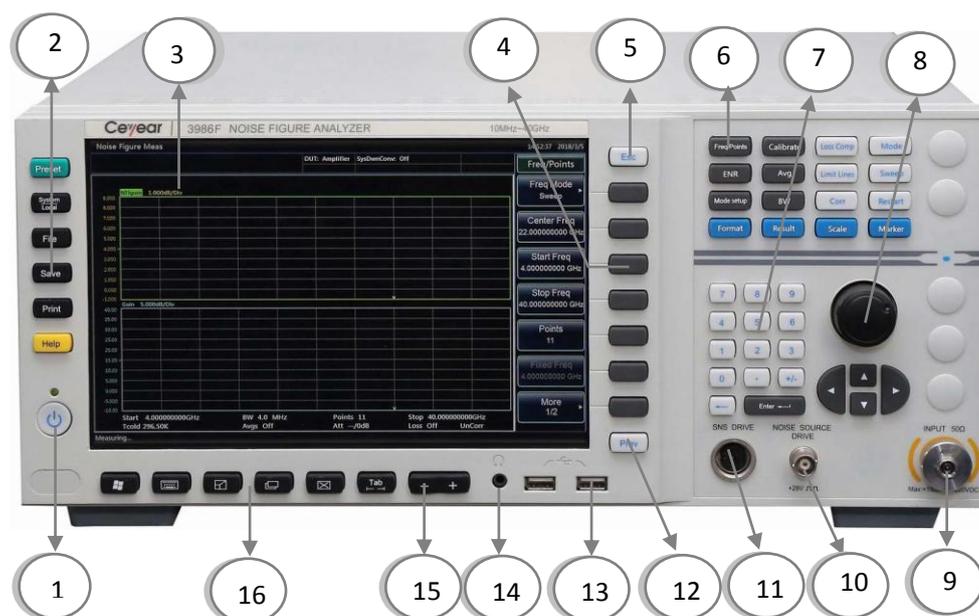


Fig. 3.13 Front Panel of Series 3986 Noise Figure Analyzer

## 3.2 Description of front and rear panels

- |                             |                                    |                    |
|-----------------------------|------------------------------------|--------------------|
| 1. Power button             | 7. Numeric key area                | 13. USB port       |
| 2. System function keys     | 8. Knob and arrow keys             | 14. Headphone jack |
| 3. Display screen           | 9. Input ports                     | 15. Volume key     |
| 4. Soft keys                | 10. Normal noise source drive port | 16. Window key     |
| 5. Cancel key               | 11. Smart noise source drive port  |                    |
| 6. Measurement setting keys | 12. Back key                       |                    |

### 3.2.1.1 Power button

The power button locates at the bottom left of front panel and is used to start and shut down the analyzer.

### 3.2.1.2 System function keys

System function keys are used to set system level functions as shown in Table 3.5.

Table 3.5 Instruction of System Function Keys

Key Name	Functional Description
Preset	Restore the analyzer to the default status.
System/Local	Provide functions related to system settings such as: error list, reset, calibration, self-test, configuration information.
File	Provide functions for storage and calling of files.
Save	Provide the function of saving screen image files.
Print	To customize print output, select and configure printers.
Help	To show online help.

### 3.2.1.3 Display screen

All measurement results are displayed on the screen of front panel. Additionally, the screen also displays status and setting information and enable you to switch between different measurement tasks.

### 3.2.1.4 Soft keys

There are seven dark gray keys not identified, called “soft key”. The corresponding commands of these soft keys are dynamic, and the displayed functions depend on the current selected mode and measurement and are directly related to the recently used keys. Press a soft key and its corresponding function is highlighted. The soft key menu corresponding to **【Frequency/Points】** key is shown in Fig. 3.14.

#### 1) Select soft key

- Press the corresponding soft key on the right directly;
- Use the mouse pointer to click the key on the screen.

#### 2) Navigate in soft key menu

- [More 1/2] indicates that the menu contains multiple soft keys cannot be shown in one page. Press the menu, the next group of soft keys appears;
- The symbol “▶” in a soft key tab indicate that the soft key has a sub-menu. Press the soft key, the sub-menu appears;
- The key **【Prev】** used to go back to the parent menu.

### 3) Soft key operations

When a soft key is pressed, one of the following actions will be performed:

- open a dialog box to input data;
- open or close a function;
- open a sub-menu (only for soft key with the symbol “▶”).



Fig. 3.14 Soft Key Menu

### 4) Soft key status identified with colors

The soft key selected will be highlighted. If a function of the analyzer cannot be used temporarily due to a specific setting, the related soft key will be disabled and the text will be grayed.

#### 3.2.1.5 【Esc】 key

This key is used to exit from any functional operation without changing the current parameters, including: canceling the active function, quitting the numeric operation and exiting from the file dialog box.

#### 3.2.1.6 Measurement setting keys

The measurement setting keys provides most common measurement settings and functions, as shown in Table 3.6. See [“5 Instructions for Key Groups and Menus”](#) for detailed function descriptions.

Table 3.6 Measurement Setting Keys

Key Name	Functional Description
Freq/Points	Press this key to go to setting menus such as Freq Mode, Center Freq, Start Freq, Stop Freq and Points.
Calibrate	Press this key to go to the Calibrate menu. In the Calibrate menu, press the [Calibrate] soft key twice to perform the calibration program. The calibration function is used for the noise figure measurement with second-order correction, which is to deduct the analyzer's noise to get the noise figure and gain of device under test (DUT).
ENR	Press this key to go to the ENR setting and editing menu.
Avg	Press this key to go to the Average setting menu.

## 3.2 Description of front and rear panels

Mode Setup	Press this key to go to the Mode Setup menu, including DUT Setup, Ext OL Config, Uncertainty Calculator and Extend Setup.
BW	To set the measuring bandwidth.
Loss Comp	Press this key to go to the Loss Comp menu.
Mode	Used for analyzer's function extension and defaulted as standalone mode.
Limit Lines	Press this key to go to the Limit Line Setup menu; the limit line is used to mark the boundary of trace.
Sweep	Press this key to go to the Sweep setting menu.
Corr	Press this key to open or close the measurement correction. The default status depends on whether a calibration is performed previously; if calibrated, the default value is Correction On; if not, the default value is Correction Off.
Restart	If this key is pressed during measurement, the current measurement will be stopped and a new measurement started.
Format	Press this key to select the display format of measurement data, including graph, table and tester.
Result	Press this key to go to the Trace setting menu. Measurement and display results includes noise figure, gain, Y-factor, Teffective, PHot and PCold.
Scale	Press this key to specify units and display limit for each active measurement result.
Marker	Press this key to go to corresponding marker setting menu.

## 3.2.1.7 Numeric keys



To input numeric parameters. Including the following keys:

**1) Number pad**

To input numbers in editing dialog box.

**2) Decimal point**

To insert a decimal point "." at the cursor position.

**3) Symbol key**

To change the symbol of numeric parameters. To input a "-" symbol at the cursor position when inputting numeric parameters.

**4) 【←】 key**

To delete the input to the left of cursor.

**5) 【Enter↵】 key**

To confirm the non-dimensional input as a new value.

**3.2.1.8 Knob and arrow keys****1) Knob functions**

- To increase (clockwise) or decrease (counterclockwise) the instrument parameters by specified steps when inputting numbers;
- To move the marker on screen and display trace positions;
- It works similarly to the 【Enter↵】 key when pressed.

**2) 【▲】 and 【▼】 keys**

To increase or decrease instrument parameters in number editing dialog boxes.

**3) 【◀】 and 【▶】 keys**

- To move the cursor in alphanumeric value editing dialog boxes;
- To scroll forward and backward items in the frequency list;
- To move the selection bar horizontally in tables.

**3.2.1.9 INPUT ( 50Ω )**

The measurement & calibration of the analyzer's noise figure and measurement of DUT's noise figure and gain can be performed by connecting the noise source or DUT's output via an adapter or cable to the analyzer's input port.

### Attention

Do not overload the input port and the input signal shall not exceed the maximum allowable value. The RF power level input by the analyzer's RF port shall not exceed +15dBm, and the DC voltage input shall not exceed  $\pm 20\text{VDC}$ . If the above conditions are not met, the front parts of the analyzer's internal receiver will be damaged first.

**3.2.1.10 Noise Source Drive**

+28V pulse voltage is provided for standard noise sources. When there is +28V output, switch on the noise source; when there is no +28V output, switch off the noise source.

**3.2.1.11 SNS Drive**

The smart noise source drive & communication port is provided to load ENR data, monitoring ambient temperature and switching on/off smart noise sources.

## 3.2 Description of front and rear panels

### 3.2.1.12 【Prev】 key

Press the 【Prev】 key to go back to parent menu of the soft menu.

### 3.2.1.13 USB interface

Standard Type A USB2.0 port. To connect USB peripherals such as keyboard, mouse, CD driver and hard drive.

### 3.2.1.14 Headphone jack

To connect headphone

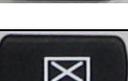
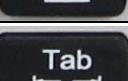
### 3.2.1.15 【- +】 KEY

Volume key to adjust headphone volume.

### 3.2.1.16 Window keys

Icons and function description of window keys are listed in Table 3.7.

Table 3.7 Measurement Setting Keys

Icon	Name	Function description
	Start Menu of Windows system	To display Windows “Start” menu to perform other operations or settings. Once this key is pressed, the measurement control program will lose the focus resulting in the keyboard of front panel unavailable; press this key again to close “Start” menu and enable the measurement control program get the focus again.
	Virtual Keyboard key	To switch between on-screen keyboard display
	Window key	To switch between single and dual window modes
	Activated Trace Switch key	To switch the activation status of trace.
	Close key	To close the measurement program
	Tab key	To switch among different areas of Windows dialog box to activate functions.

## 3.2.2 Description of rear panel

This section describes components of the rear panel of Series 3986 Noise Figure Analyzer and their functions, as shown in Fig. 3.15.

## 3.2 Description of front and rear panels

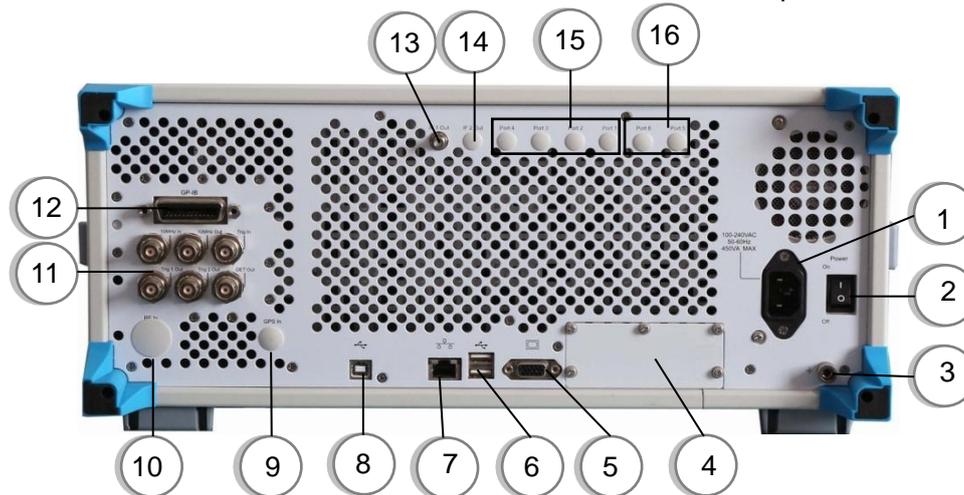


Fig. 3.15 Rear Panel of Series 3986 Noise Figure Analyzer

- |                          |                                 |                       |
|--------------------------|---------------------------------|-----------------------|
| 1. Power input port      | 7. LAN interface                | 13. IF output 1       |
| 2. Power switch          | 8. USB slave port               | 14. IF output 2       |
| 3. Grounding terminal    | 9. Positioning antenna input    | 15. Wideband output   |
| 4. Option module         | 10. Rear panel RF input         | 16. Narrowband output |
| 5. External monitor port | 11. Rear panel BNC input/output |                       |
| 6. USB interface         | 12. GPIB interface              |                       |

**3.2.2.1 Power input port**

Instrument AC power input.

**3.2.2.2 Power switch**

Master power switch of the analyzer.

**3.2.2.3 Ground terminal**

For reliable grounding of the analyzer.

**3.2.2.4 Option module**

Not available for this series.

**3.2.2.5 External monitor port**

VGA port, to connect external VGA monitor.

**3.2.2.6 USB interface**

Standard Type A USB2.0 port. To connect USB peripherals such as keyboard, mouse, CD driver and hard drive.

**3.2.2.7 LAN interface**

RJ45 port and TCP/IP port, 10/100/1000M adaptive, for remote operations.

**3.2.2.8 USB slave port**

Type B USB2.0 port. USB TMC linked to external computer-based equipment controller to control the

### 3.2 Description of front and rear panels analyzer and high-speed data transfer.

#### 3.2.2.9 Positioning antenna input

Not available for this series.

#### 3.2.2.10 Rear panel RF input

Optional port depending on the analyzer's frequency range, used for input connections when building test system.

#### 3.2.2.11 Rear panel BNC input/output

BNC ports on the rear panel and their descriptions are shown in Table 3.8 and Fig. 3.16.

Table 3.8 Measurement Setting Keys

Port name	Port description
10MHz In	BNC female, used for 10MHz reference signal input, amplitude greater than 0dBm required.
10MHz Out	BNC female, used for internal 10MHz reference signal output. Used to lock the frequency of other test equipment to the analyzer's frequency reference.
Trig In	BNC female, used for external trigger signal input of the rear panel, input voltage range [-5V, +5V], not available for this series.
Trig 1 Out	BNC female, TTL level, trigger signal output for synchronizing other test equipment. Output signal types configurable via input/output menu, not available for this series.
Trig 2 Out	BNC female, TTL level, trigger signal output for synchronizing other test equipment. Output signal types configurable via input/output menu, not available for this series.
DET Out	BNC female, used for video detection signal output, not available for this series.

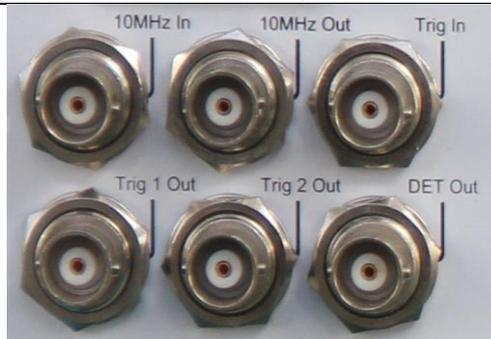


Fig. 3.16 BNC Ports on Rear Panel

#### 3.2.2.12 GPIB interface

Standard IEEE488 port supporting SCPI language, used to remotely control the analyzer.

#### 3.2.2.13 IF output 1

The second IF output for channel test, not available here.

#### 3.2.2.14 IF output 2

The third IF output for channel test, not available here.

**3.2.2.15 Wideband output**

Not supported and not available here.

**3.2.2.16 Narrowband output**

Not supported and not available here.

**3.3 Basic operating instructions**

- Display annotation.....35
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- Perform file operations.....40
- Input ENR.....44
- Set measurement frequencies.....50
- Set bandwidth and average.....53
- Calibrate NFA.....53
- Display measurement result.....56
- Measure fixed frequency.....64

**3.3.1 Display annotation**

The measurement display annotation, shown in Fig. 3.17, is referenced by numbers. Table 3.9 describes each function, followed with detailed information.

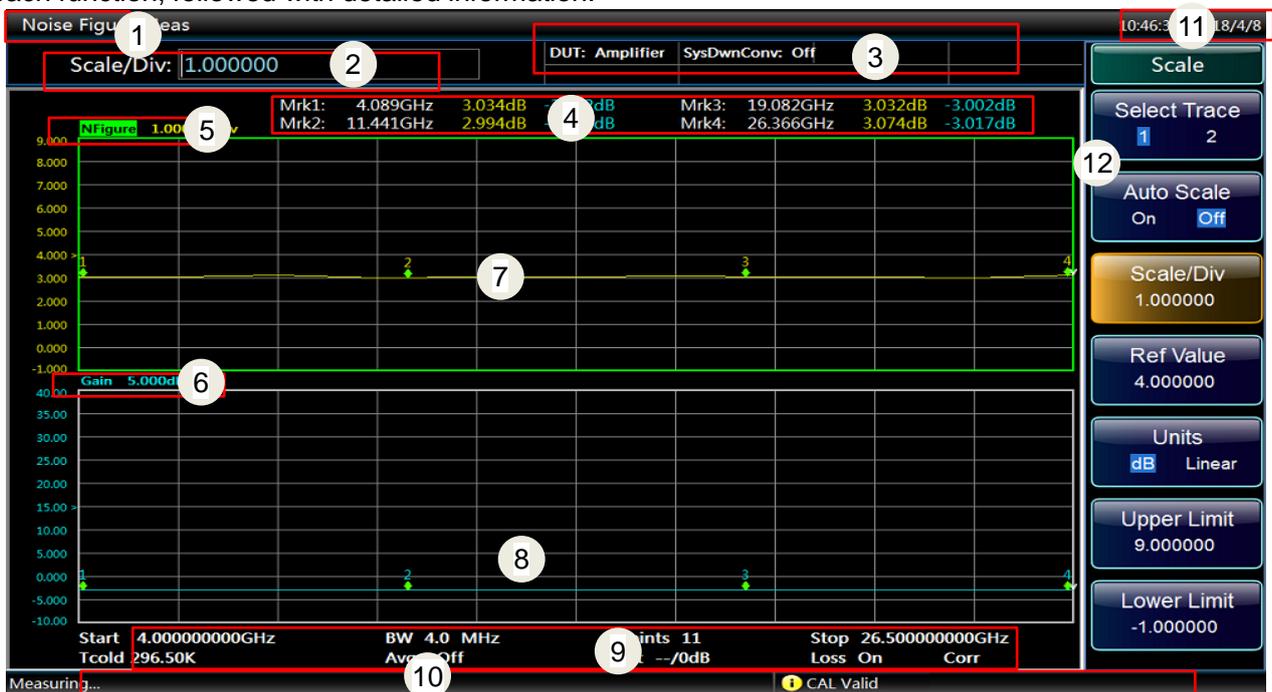


Fig. 3.17 Measurement display of 3986 series NFA

Table 3.9 Display annotation item description

Graphic Number	Function description
1	Title bar, displaying the currently active function

3.3 Basic operating instructions

2	Result input area, for entering measurement setup data
3	Mode setup column, showing the current mode information, such as DUT type, sideband, LO control, LO mode, frequency property and so on
4	Marker display column
5	Upper graph measurement result, controlled by [Result - Trc 1] menu key
6	Lower graph measurement result, controlled by [Result - Trc 2] menu key
7	Result - Trc 1 measurement
8	Result - Trc 2 measurement
9	Measurement setup information display bar; this example displays the start frequency, bandwidth, points, stop frequency, cold temperature, average, attenuation, compensation, correction state, etc.
10	Instrument status bar, displaying the measurement progress, instrument status and error information
11	Time and date display
12	Soft key menu, displaying the menu corresponding to the latest operation.

3.3.1.1 Title bar

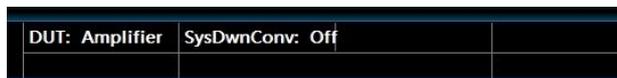
The title bar displays the currently active function.

3.3.1.2 Result input area



It is used to enter result(s) for the currently active function.

3.3.1.3 Mode setup column



This column displays the setup information related to the instrument for viewing, as shown in Table 3.10.

Table 3.10 Description of the Mode Setting Display Area

Information Content	Corresponding setup option	
DUT	Amplifier	SysDwnConv: Off
		SysDwnConv: On
	DownConv	
	UpConvr	
Sideband	LSB	
	USB	
	DSB	
LO mode	Fixed	
	Variable	
Ext LO Ctrl	On	
	Off	
Freq Context	RF-Input or IF-Input	

### 3.3.1.4 Marker displays column

This column displays the trace 1 and trace 2 results on X and Y axes when markers are activated under graph mode.

Mrk1:	4.000GHz	1.547dB	--	Mrk3:	4.000GHz	1.547dB	--
Mrk2:	4.000GHz	1.547dB	--	Mrk4:	4.000GHz	1.547dB	--

### 3.3.1.5 Upper graph measurement result

The upper graph measurement result can be selected through the [Result-Trc 1] menu. The options include noise figure, gain, Y-factor, Teffective, PHot and PCold.

### 3.3.1.6 Lower graph measurement result

The lower graph measurement result can be selected through the [Result-Trc 2] menu. The options include noise figure, gain, Y-factor, Teffective, PHot and PCold.

## Attention

Unable to select the same measurement result for both the upper graph and the lower graph.

### 3.3.1.7 Result-Trc 1 measurement

The trace result related to the upper graph measurement result.

### 3.3.1.8 Result-Trc 2 measurement

The trace result related to the lower graph measurement result.

### 3.3.1.9 Measurement setup information

Start	4.000000000GHz	BW	4.0 MHz	Points	11	Stop	40.000000000GHz
Tcold	296.50K	Avg	Off	Att	--/0dB	Loss	Off
				UnCorr			

The description of each setup information is shown in Table 11.

Table 3.11 Measurement setup information description

Information Content	Meaning
Start	Display the start frequency of sweep measurement.
BW	Measurement bandwidth; this noise figure analyzer has 6 options: 4MHz, 2MHz, 1MHz, 400kHz, 200kHz and 100kHz.
Points	Display the number of measurement frequency points. The number of sweep measurement points ranges from 2 to 401, and the default is 11.
Stop	Display the stop frequency of sweep measurement.
Tcold	Display the ambient temperature during measurement. When being connected to a smart noise source (SNS), the noise figure analyzer can monitor the ambient temperature and update this value.
Avg	The number of averages
Att	Display the value of RF/microwave input attenuation.
Loss	Display the compensation status, On or Off.
UnCorr	Display the measurement correction state, corrected or uncorrected.

### 3.3.1.10 Instrument status bar

The status bar below the graphs displays the instrument status or error messages (if any).

#### 1) Measurement progress



The left of the status bar below the graphs displays the progress of current operation.

#### 2) Calibration state



Display the calibration as valid. If any error or abnormality is detected, error code and information will be displayed.

### 3.3.1.11 Time and date display



The time and date information is displayed at the upper right corner of the screen.

### 3.3.1.12 Soft key menu

Display the menu corresponding to the latest operation.

## 3.3.2 User interaction

Available means for interaction:

- 1) Instrument keypad;
- 2) Knob;
- 3) Arrow keys;
- 4) Soft keys.

All tasks can be accomplished through such user interface. All keys correspond to those operations on an external keyboard (such as arrow keys, Enter key and so on) and comply with the Microsoft standard, except the special keys of the instrument.

#### 3.3.2.1 Next trace key

This key is used to change the active trace for the corresponding settings. When a trace is active, the corresponding window displaying the trace is enabled. Only when the trace is active can each setting be performed.

#### 3.3.2.2 Input data

You can use the following method to input data into the dialog box:

- 1) Use the keys available on the front panel, for example, the keypad, knob or arrow keys;
- 2) Use the soft keys on the virtual keyboard;
- 3) Use an external keyboard connected to the NFA.

Characteristics of Windows dialog box: For certain applications, for example, if you want to install a printer, the Windows defined dialog boxes will be used, and the knob and function keys of the NFA are not applicable.

The keypad is only used to enter numeric data when you input a numeric value to a certain segment.

- 4) Use the keypad to enter a value, or change the current value by rotating the knob or pressing the up/down arrow keys **【▲】** and **【▼】**.

## 3.3 Basic operating instructions

- 5) After each complete numerical entry, you need to press the unit menu keys to add a unit to the input.
- 6) If no unit is needed, press the **【Enter.↵】** key or one unit key to confirm the input. The editing row is highlighted to confirm the input.

### 3.3.3 Set preset and poweron states

The 3986 series NFA has the following preset and poweron states:

**Factory default:** The default configuration originally set by developers at factory, which is also the optimum setting that can satisfy most measurements and cannot be changed by the user.

**User preset state:** The configuration set by the user for specific measurement;

**User power on state:** The initial configuration of the instrument at power on; users can define and save a specific configuration as the power on state. The factory default is set as the power on state of the instrument upon delivery.

**Preset state:** The state that the instrument returns to after users press the **【Preset】** key; users can set either factory default state or the user preset state. If incorrect configuration defined by users leads to NFA failure, users can preset the instrument to the factory state.

#### 3.3.3.1 Save user preset/poweron state

- Step 1.** Complete the NFA result settings as you need.
- Step 2.** Press the **【System/Local】** key.
- Step 3.** Press the [PowerOn/Preset] menu key.
- Step 4.** Press the [Save UserPreset] menu key to save the User Preset state; press the [Save PowerOn] menu key to save the user PowerOn state.

#### 3.3.3.2 Set preset state

- Step 1.** Press the **【System/Local】** key.
- Step 2.** Press the [PowerOn/Preset] menu key.
- Step 3.** Press the [Preset] menu key to set the preset switch. If you want to return the NFA to its factory default, set the preset switch to [Preset Factory User preset]; if you want to return the NFA to the user preset state, set the preset switch to [Preset Factory User].

#### 3.3.3.3 Save factory default as user preset/poweron state

- Step 1.** Press the **【System/Local】** key .
- Step 2.** Press the [PowerOn/Preset] menu key.
- Step 3.** Press the [Preset] menu key, and set the switch to [Preset Factory User].
- Step 4.** Press the [Preset] key to return the NFA to factory default.
- Step 5.** Press the **【System/Local】** key.
- Step 6.** Press the [PowerOn/Preset] menu key.
- Step 7.** Press the [Save UserPreset] menu key to save the factory default as the user defined state upon preset; press the [Save PowerOn] menu key to save the factory default as the user defined state upon power on.

### 3.3.4.1 File types

The types of files can be saved include:

- 1) ENR Files (\*.ENR), including Meas ENR Files and Cal ENR Files
- 2) State Files (\*.STA)
- 3) LimitLine Files(\*.LIM), including LimitLine1/2/3/4 Files
- 4) Freq List Files (\*.LST)
- 5) LossComp Files (\*.LOS), including Before/After LossComp Files
- 6) Trace Files (\*.TRC)

The types of files to be loaded include:

- 1) ENR Files (\*.ENR), including Meas ENR Files and Cal ENR Files
- 2) State Files (\*.STA)
- 3) LimitLine Files(\*.LIM), including LimitLine1/2/3/4 Files
- 4) Freq List Files (\*.LST)
- 5) LossComp Files(\*.LOS), including Before/After LossComp Files

#### Attention

Except trace files, all other files previously stored by the users can be reloaded to the NFA.

### 3.3.4.2 Saving/loading files

The 3986 series NFA provides the file saving/loading function.

#### 1) Saving files

Saving files means to save files (limit lines, ENR tables, traces, frequency lists and loss compensation tables) to the specified directory.

#### NOTE

It is recommended to save limit lines, ENR tables, traces, frequency lists or loss compensation tables to the User (D:) drive.

Use the following steps to save a file:

- Step 1.** Press the **【File】** key to enter the file saving/loading menu.
- Step 2.** Press the [Save...] menu key. "Save as" dialog box appears, as shown in Fig. 3.18.
- Step 3.** Select the drive you want to save the file to, for example, User (D:).
- Step 4.** You can determine the path and file name as you need. For example, save the file to the root directory of drive (D:).
- Step 5.** Select the type of file you want to save from the Save As type dialog box , for example, if you want to save a state file, select the State Files (\*.STA) with mouse.
- Step 6.** Enter the file name to the File name dialog box using the numeric keys of NFA, on-screen keyboard or an external keyboard.
- Step 7.** Click the [Save] button on the dialog box to save the file to the specified directory.

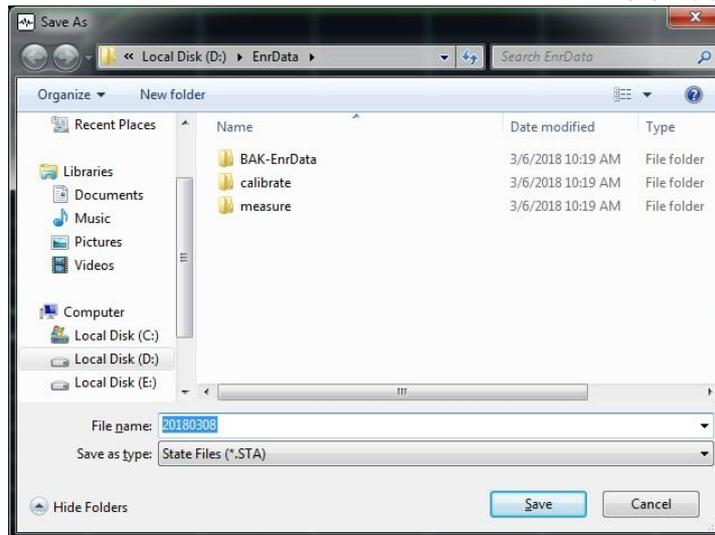


Fig. 3.18 File saving display

## Attention

If you want to use on-screen keyboard to enter the file name, be sure to open the on-screen keyboard before the Windows operation display appears, i.e., before Step 2.

## 2) Loading files

Loading files means to load data files and state files previously stored on the disk back to the NFA measurement program for use.

The types of files can be loaded include:

- ENR Files (\*.ENR), including Meas ENR Files and Cal ENR Files
- State Files (\*.STA)
- LimitLine Files(\*.LIM), including LimitLine1/2/3/4 Files
- Freq List Files (\*.LST)
- LossComp Files(\*.LOS), including Before/After LossComp Files

Use the following steps to load files:

- Step 1.** Press the **【File】** key to enter the file saving/loading menu.
- Step 2.** Press the [Load...] menu key. "Open" dialog box appears, as shown in Fig. 3.19.
- Step 3.** Select the drive you want to save the file to, for example, User (D:).
- Step 4.** Select the path where the file to be loaded is saved, for example, "D:\ENR-Data".
- Step 5.** Select the type of the file in "File name" input box, for example, "Meas ENR Files (\*.ENR)".
- Step 6.** Select the file to be loaded, for example, "346CK01.enr".
- Step 7.** Click the [Open] button on the dialog box to load the specified file from the user drive to the NFA measurement program.

3.3 Basic operating instructions

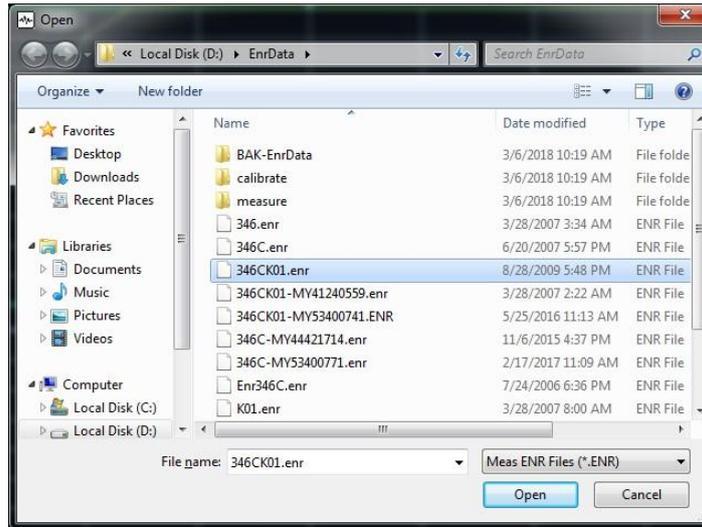


Fig. 3.19 File loading display

3.3.4.3 Printing/saving screenshots

The 3986 series NFA provides screenshots saving (as bmp format) and printing functions.

1) Saving screenshots

Use the following steps to save a screenshot:

**Step 1.** Press the **【Save】** key. "Save as" dialog box appears, as shown in Fig. 3.20.

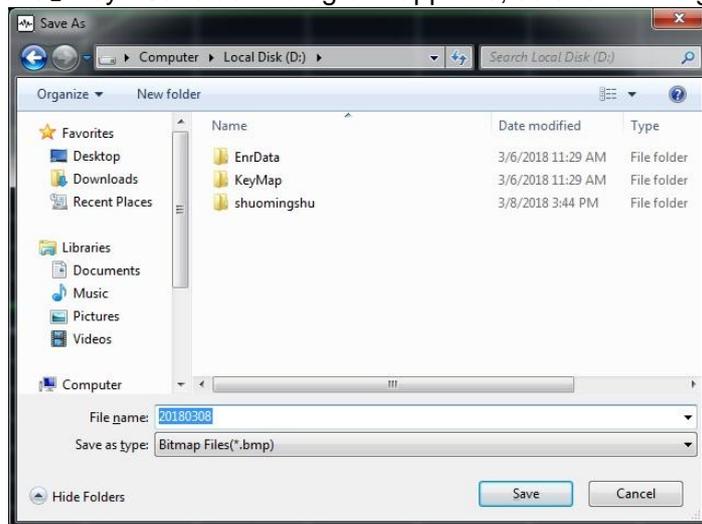


Fig. 3.20 Saving a screenshot

**Step 2.** Select the drive you want to save the file to, for example, User (D:).

**Step 3.** You can determine the file name and path as you need. For example, save the file to the root directory of drive (D:).

**Step 4.** Enter the file name to the File name input box using the numeric keys of NFA or an external keyboard.

**Step 5.** Click the [Save] button on the dialog box to save the file to the specified directory.

2) Printing a screenshot

**NOTE****Install the printer driver as follows:**

Before printing, you need to install the support printer driver to the 3986 series NFA.

**Step 1.** Press the **【Print】** key. "Print" dialog box appears, as shown in Fig. 3.21.

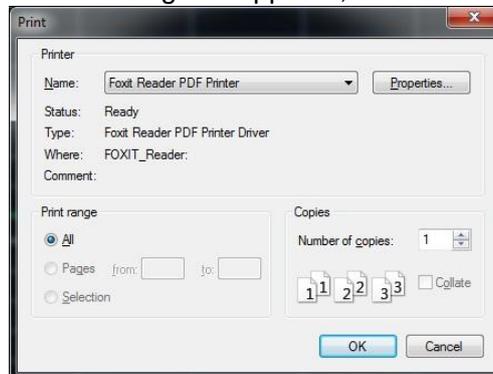


Fig. 3.21 Print dialog box

**Step 2.** Configure the printer. Select the appropriate printer. To customize the configuration, click the Properties button to access the printer properties display, as shown in Fig. 3.22.

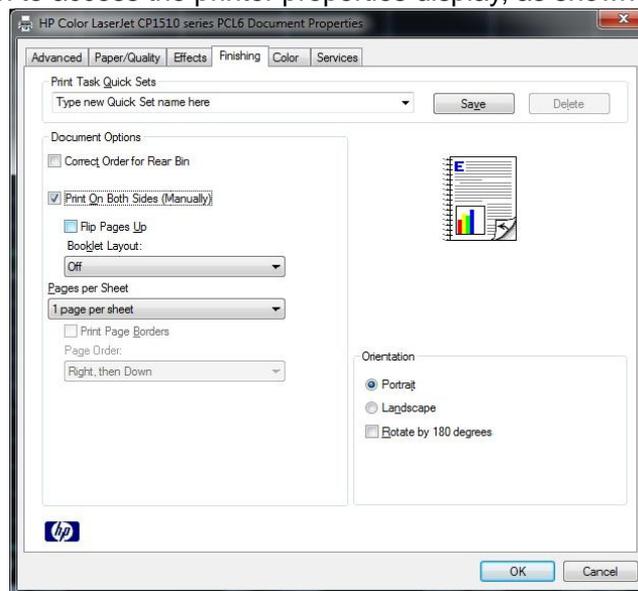


Fig. 3.22 Printer properties display

**Step 3.** Click the **[OK]** button on the dialog box to complete the screenshot printing.

### 3.3.4.4 File directory management

The 3986 series NFA does not provide separate file directory management functions for file browsing, cutting, pasting and deleting operations. Please exit the NFA program and perform the specific operations in the Windows interface.

### 3.3.4.5 Working with tables

The ENR table, frequency list, limit line and loss compensation table use table formats. Table 3.12 outlines how to perform various table editing and processing functions.

Table 3.12 Using tables

Description	Method
Move the active entry in the table	Arrow keys: 【◀】 and 【▶】
Clear all entries in the table	[Clear Table] menu key
Delete a single row	[Delete Row] menu key
Add a new entry	[Add] menu key
Move the active entry up by one row	[Row up] menu key
Move the active entry down by one row	[Row down] menu key
Move the table up by one page	[Page up] menu key
Move the table down by one page	[Page down] menu key
Enter a value	Numeric keypad, 【▲】 and 【▼】 arrow keys, or knob
Finish entering value	Unit menu keys
Connect limit line points	【▲】 and 【▼】 arrow keys, or knob

### 3.3.5 Input ENR

ENR data can be entered into the noise figure analyzer as a table of values or as a single spot value. The table of values is used for sweep measurement. The single spot value is used for single frequency measurements or it is applied across the whole frequency measurement range.

There are two types of noise sources which are compatible with the 3986 series noise figure analyzer. The first type is a normal noise source, for example the 16603 series, normal Keysight 346 series noise source, etc. The ENR data for these normal noise sources can be entered manually either by using the keypad or using the ENR data previously stored on a disk. The other type is a smart noise source (SNS), for example 16604 series and Keysight 4000 series smart noise source, of which the ENR data can be loaded to the analyzer automatically.

#### 3.3.5.1 ENR common table setting

You can use the same ENR table for calibration and measurement when the same noise source is used in calibration and measurement processes, or you can use separate ENR tables for calibration and measurement when different noise sources are used in calibration and measurement processes.

##### 1) Common ENR Table On mode

To use the same ENR table for calibration and measurement, press the 【ENR】 key and the [Common Table] menu key to select [Common Table On Off]; See Fig. 3.23, and this is the default setting.

In this mode, the format of the ENR table file to be loaded and saved is Meas ENR Files(\*.ENR).



Fig. 3.23 Common ENR Table On menu

## 2) Common ENR Table Off mode

To use different ENR tables for calibration and measurement, press the **【ENR】** key and the [Common Table] menu key to set it to [Common Table On Off]; see Fig. 3.24.



Fig. 3.24 Common ENR Table Off menu

In this mode, the Meas ENR Table and Cal ENR Table can be edited, loaded and saved separately for calibration and measurement.

In the [Common Table On Off] mode, the ENR data in the [ENR Table] are those in the Meas ENR Table.

### NOTE

If you use a SNS when [Common Table On Off] is set, you need to set [Auto load ENR On Off] and use [Fill from SNS] menu to fill the Cal ENR Table or Meas ENR Table with SNS ENR data.

### 3.3.5.2 Input ENR manually

Follow the steps below to input ENR manually:

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [ENR Table] menu key. An ENR table appears on the display with the first frequency point highlighted. See Fig. 3.25.



Fig. 3.25 ENR table

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- Step 3.** Press the [Model ID] menu key and enter the noise source model using an external keyboard and numeric keys.
- Step 4.** Press the [Serial] menu key and enter the noise source serial number using an external keyboard and numeric keys.
- Step 5.** Press the [Edit] menu key. The table editing and navigation menu items now appear for frequency point selection.
- Step 6.** Enter the frequency/ENR value in the table using the numeric keys, and finish it using the unit menu keys.

**NOTE**

To facilitate the manual entering of frequency/ENR data pair, if the frequency column is already set in default ENR nominal frequency point order, you only need to press the **【Enter↵】** key to complete the entering of default frequencies in the frequency column.

- Step 7.** After entering the frequency value, the highlight will automatically moves to the ENR value column. Enter the corresponding ENR value using numeric keys, and finish it using [dB], [K], [C] or [F] unit menu keys. The K, C or F entry is converted to dB appearing in the ENR table.
- Step 8.** After entering the ENR value, the highlight automatically moves to the next frequency point in the frequency column for entering the next frequency/ENR pair in the ENR table.
- Step 9.** Repeat Step 6 and Step 7 until all needed frequency and ENR values are entered, as shown in Fig. 3.26. For details on working with the ENR table, refer to [“3.3.4.5 Working with tables”](#).



Fig. 3.26 Typical ENR table with entered data

- Step 10.** Once you have completed entering the ENR data, press the **【File】** key to save the ENR table. For details of saving ENR files, refer to [“3.3.4 Perform file operations”](#).

**NOTE**

The data in the current ENR table still exists after the NFA is preset. You can insert a frequency/ENR pair into the ENR Table entry in any order, as the NFA automatically sorts the frequency list into ascending order. When results are needed at non-cardinal ENR data points, a linearly interpolated value is automatically used at adjacent points.

**3.3.5.3 Load ENR table from a disk**

If the noise source to be used has its ENR data previously stored on a disk, you can load this ENR data into NFA as follows.

- Step 1.** Press the **【File】** key.
- Step 2.** Press the [Load...] menu key.
- Step 3.** Select the file path where the ENR table file has been saved with mouse.
- Step 4.** Select the file type as Meas ENR Files (\*.ENR) with mouse.
- Step 5.** Select the appropriate file name, and press the [Open (O)] button. For more details of loading an ENR file, refer to [“3.3.4.2 Saving/loading files”](#).

**3.3.5.4 Saving an ENR table**

You can save an ENR table to the NFA disk as follows:

- Step 1.** Press the **【File】** key.
- Step 2.** Press the [Save...] menu key. “Save as” dialog box will appear.
- Step 3.** Select a location where you want to save the ENR table.
- Step 4.** Select the file type that you want to save the file in. There are two types, the Meas ENR Files (\*.ENR) and Cal ENR Files (\*.ENR).
- Step 5.** Input the file name using the numeric keys of NFA, on-screen keyboard or an external keyboard.
- Step 6.** Click the [Save] button to save the file. For more details of saving a file, refer to [“3.3.4.2 Saving/Loading files”](#).

**NOTE**

In the [Common Table On Off] mode, the file type, i.e., Meas ENR Files (\*.ENR) or Cal ENR Files (\*.ENR), shall be specified when saving a file. Cal ENR Files (\*.ENR). The saved ENR files can be loaded to corresponding tables according to the files types (Meas ENR Files or Cal ENR Files) selected.

**3.3.5.5 Input fixed ENR value**

During the measurement in spot frequency mode, you can input a fixed ENR value corresponding to the fixed frequency. The fixed ENR value can also be applied across the whole measurement frequency range.

**1) Input fixed ENR value**

- Step 1.** Press the **【ENR】** key.
- Step 2.** Press the [ENR Mode] menu key, and select the [ENR Mode, Table Spot] mode.
- Step 3.** Press the [Spot ENR] menu key.
- Step 4.** Press the [Spot Mode] menu key, and select the [Spot Mode ENR Thot] mode.

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**Step 5.** Press the [Spot ENR], enter an ENR value using numeric keys, and finish it using unit menu keys. The [dB], [K], [C] or [F] unit menu key can be used, the K , C or F entry is automatically converted to appear in the ENR table as dB, and the default value is 15.200dB.

#### 2) Enabling Spot ENR mode

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [ENR Mode] menu key, and select the [ENR Mode, Table Spot] mode.

**Step 3.** Press the [Spot ENR] menu key.

**Step 4.** Press the [Spot Mode] menu key, and select the [Spot Mode ENR Thot] mode. This is the default setting.

#### 3.3.5.6 Input Spot THot

##### 1) Input Spot THot

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [ENR Mode] menu key, and select the [ENR Mode, Table Spot] mode.

**Step 3.** Press the [Spot ENR] menu key.

**Step 4.** Press the [Spot Mode] menu key, and select the [Spot Mode ENR THot] mode.

**Step 5.** Press the [Spot THot] menu key, input Spot THot using the numeric keys, and finish it using the unit menu keys. The [K], [C] or [F] unit menu key can be used, the C or F entry is automatically converted to appear as K, and the default value is 9892.80K.

##### 2) Enabling Spot THot mode

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [ENR Mode] menu key, and select the [ENR Mode, Table Spot] mode.

**Step 3.** Press the [Spot ENR] menu key.

**Step 4.** Press the [Spot Mode] menu key, and set the [Spot Mode ENR THot] mode.

#### 3.3.5.7 Using Smart Noise Source

### NOTE

If there is a SNS connected to the NFA SNS DRIVE port, the 3986 series NFA, by default, selects the SNS as its noise source. If an SNS is not connected, the NFA uses the normal noise source.

##### 1) Selecting the noise source preference

If noise sources are connected to both ports, you need to select a preference either Normal or SNS. The default setting is SNS.

##### 2) Steps for selecting the noise source preference

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [SNS Setup] menu key.

**Step 3.** Press the [Preference] menu key, and select SNS or Normal according to specific conditions.

##### 3) Loading the SNS ENR data to the common table

You can enable the 3986 series NFA to automatically load the ENR data to the common table. To enable

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the automatic loading after connecting a SNS, set the Auto Load ENR to On. If you do not want to automatically load the ENR data to the common table from the SNS, set the Auto Load ENR to Off.

If you have selected [Auto Load ENR On Off], you can use the [Fill from SNS] menu key to load the ENR data from the SNS. This menu key is active only when a SNS is connected.

### WARNING

Do not disconnect the SNS from the NFA port when the ENR data is being transferred, otherwise the data stored in the SNS would be affected.

#### 4) Loading the SNS ENR data to the Meas Table or Cal Table

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [SNS Setup] menu key.

**Step 3.** Press the [Auto Load ENR] menu key, and set it to [Auto Load ENR On Off] mode.

**Step 4.** Press the [Common Table] menu key, and set it to [Common Table On Off] mode.

**Step 5.** Press the [Meas Table] or [Cal Table] menu key.

**Step 6.** Press the [Fill from SNS] menu key, and wait until all data is loaded.

### NOTE

When a SNS is connected and the [Auto Load ENR On Off] is enabled, the common table is set automatically, and the SNS ENR data is loaded to the common table automatically. You can use the [Fill from SNS] menu key to load the SNS ENR data manually. This allows you to select either the Meas Table or the Cal Table as your loading destination.

#### 3.3.5.8 Setting Tcold

During the measurements in different ambient temperature conditions, you can change Tcold. The default value is 296.50K.

There are three methods to change the Tcold. This depends on the type of noise source you are using.

- 1) The first method is to enter a Tcold manually. It is applicable to either type of noise source.
- 2) The second method is applicable when you use a SNS. The NFA loads the Tcold from the SNS and updates it periodically.
- 3) The third method is applicable when you use a SNS and you can set the value to be updated as you need.

##### 1) Changing the User Tcold manually

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [Tcold] menu key.

**Step 3.** Press the [User Tcold] menu key.

**Step 4.** Enter the actual measured temperature value using numeric keys, and finish it using unit menu keys. The [K], [C] or [F] unit menu key can be used. The C or F entry is converted to appear as K.

### NOTE

When using a SNS, the SNS Tcold menu key must be set to [SNS Tcold On Off] for this function to work.

## Attention

The lower limit of the Tcold is 0K, the upper limit is 29,650,000K, and the default value is 296.50K. The K value is always displayed, and the C or F entry is automatically converted to appear as K.

### 2) Setting the SNS Tcold to update automatically

This function is available only when the 3986 series NFA is connected to a SNS.

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [TCold] menu key.

**Step 3.** Press the [SNS Tcold] menu key, and set it to [SNS Tcold On Off]. This is the default setting.

### 3) Loading the Tcold from the SNS manually

This function is available only when the 3986 series NFA is connected to a SNS.

**Step 1.** Press the **【ENR】** key.

**Step 2.** Press the [TCold] menu key.

**Step 3.** Press the [SNS Tcold] menu key, and set it to [SNS Tcold On Off].

**Step 4.** Press the [User Tcold from SNS] menu key. The 3986 series NFA loads the Tcold from the SNS and displays it in the User Tcold menu key.

## NOTE

When using a SNS, the SNS Tcold menu key must be set to [SNS Tcold On **Off**] for this function to work.

### 3.3.6 Set measurement frequencies

Before setting the measurement frequencies, you need to select a frequency mode. The 3986 series NFA provides three frequency modes for selection:

- 1) **Sweep** --the measurement frequencies are obtained from the start and stop frequencies (or equivalent center and span) and the number of measurement points.
- 2) **Fixed** --measure a fixed frequency.
- 3) **List** --the measurement frequencies are obtained from the frequency list entries.

#### 3.3.6.1 Selecting sweeping frequency mode

In sweeping frequency mode, set the start and stop frequencies (or equivalent center and span frequencies) and the number of measurement points. These measurement points are equally spaced over the frequency span. The maximum number of points is 401, and the default number of points is 11.

Make a measurement over a frequency range as follows:

**Step 1.** Press the **【Freq/Points】** key.

**Step 2.** Press the [Freq Mode] and [Sweep] menu keys to set the frequency mode to Sweep. This is the default setting.

**Step 3.** Press the [Start Freq] and [Stop Freq] respectively, enter the frequency values using the numeric keypad, and finish it using unit menu keys.

**Step 4.** Press the [Points] menu key, enter the number of measurement points using numeric keys, and press the **【Enter↵】** key or [OK] menu key to finish the input. You can also use **【▲】** and **【▼】** arrow keys or rotate the knob to change the number of measurement points. One step varies

the number by +/-1.

Step 3 and Step 4 can be substituted by the following:

- Step 5.** Or, press the [Center Freq], [More 1/2] and [Span]. Enter the center frequency and span values using the numeric keypad, and finish it using unit menu keys.
- Step 6.** Press the [More 2/2].
- Step 7.** Press the [Points] menu key.
- Step 8.** Enter the number of measurement points using numeric keys, and press the **【Enter.↵】** key or [OK] menu key to finish the input. You can also use **【▲】** and **【▼】** arrow keys or rotate the knob to change the number of measurement points. One step varies the number by +/-1.

### 3.3.6.2 Selecting fixed frequency mode

The fixed frequency mode is used when you want to make a measurement at a single frequency. Make a measurement at a single frequency as follows:

- Step 1.** Press the **【Freq/Points】** key.
- Step 2.** Press the [Freq Mode] and [Fixed] menu key.
- Step 3.** Press the [Fixed Freq] menu key, and enter the frequency value using numeric keys and unit menu keys.

### 3.3.6.3 Selecting list frequency mode

The list frequency mode is used to make a measurement at frequency points of interest. Set the NFA to the list frequency mode as follows:

- Step 1.** Press the **【Freq/Points】** key.
- Step 2.** Press the [Freq Mode] menu key.
- Step 3.** Press the [List] menu key to set the frequency mode to List.

#### Create a frequency list as follows:

- 1) Specify each frequency point manually.
- 2) Create a frequency list according to the sweep points.

#### 1) Creating a frequency list manually

- Step 1.** Follow the above steps to set the frequency mode to List.
- Step 2.** Press the [More 1/2], and press the [Freq List] menu key. An empty frequency list appears on the display with the first point activated, as shown in Fig. 3.27.
- Step 3.** Enter the frequency value using numeric keys, and finish it using unit menu keys.
- Step 4.** The highlight will move to the next entry of the Edit dialog box automatically. Enter the frequency value using the numeric keys, and finish it using the unit menu keys. You can also use the [Row up], [Row down], [Add] or [Delete Row] menu key to do corresponding editing.
- Step 5.** Repeat Step 4 until your frequency list is completed. The frequency list with data entry is shown in Fig. 3.28.

## NOTE

No matter which order is followed when you enter frequency values the 3986 series NFA continually sorts the values into ascending order.

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Fig.3.27 An empty frequency list

**Step 6.** As you need, use the **【File】** key and [Save...] menu key to save the edited frequency list to the disk of the 3986 series NFA. For details of saving files, refer to [“3.3.4 Perform file operations”](#).

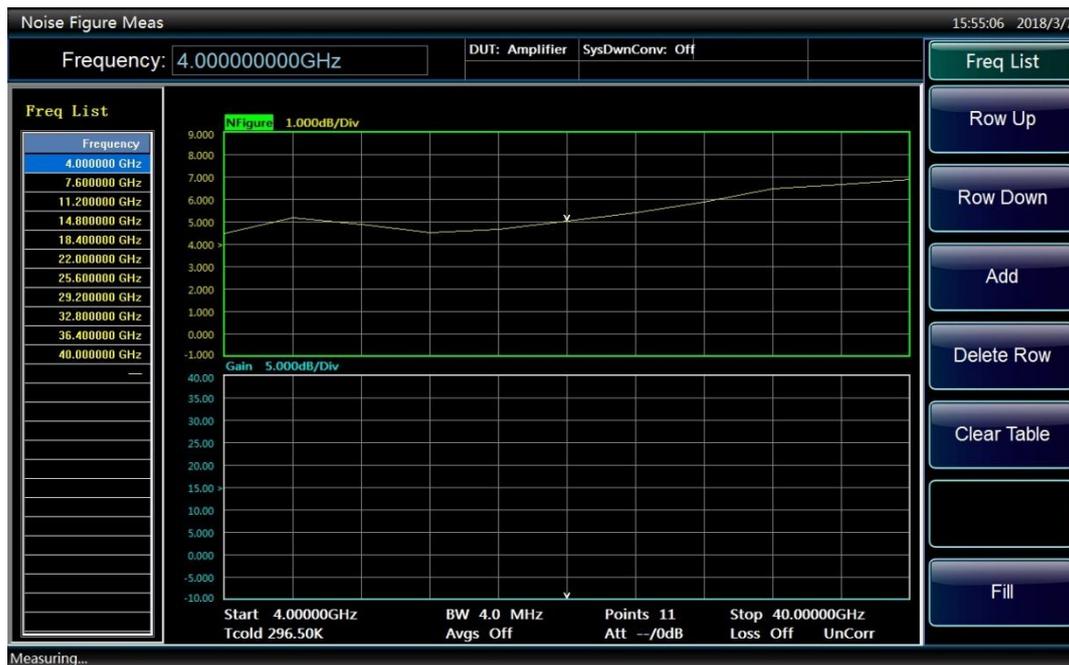


Fig. 3.28 Typical frequency list with entered data

**2) Creating a frequency list according to the sweep points**

You can create a frequency list according to the frequency range and number of points set in the sweep mode.

**Step 1.** Follow the above steps to set the frequency mode to List.

**Step 2.** Press the [More 1/2].

**Step 3.** Press the [Freq List].

**Step 4.** Press the [Fill]. This clears the current frequency list and fills the list with frequencies generated by the sweep frequency mode.

### 3.3.7 Set bandwidth and average

#### 3.3.7.1 Effect of the bandwidth and average on speed, jitter and measurement accuracy

Jitter is a natural occurrence when measuring random noise. To reduce jitter, you must increase the number of averages or increase the measurement bandwidth. If the bandwidth is reduced, you need to increase the number of averages to reduce jitter. The greater the number of averages set, the more accurate the measurement, as this reduces the jitter on measurement. However, this will also lead to slow measuring speed. Therefore, there is a trade-off between the measuring speed and accuracy.

#### 3.3.7.2 Setting the bandwidth

The default bandwidth is 4MHz. Set the bandwidth as follows:

**Step 1.** Press the **【BW】** key.

**Step 2.** Press the [BW] menu key to set it to Manual mode, enter the bandwidth value using the numeric keypad, and finish the input using unit menu keys. You can also use the **【▲】** and **【▼】** arrow keys or rotate the knob to change the bandwidth value. The 3986 series NFA provides 6 bandwidths for step change, which are 4MHz, 2MHz, 1MHz, 400kHz, 200kHz and 100kHz.

#### 3.3.7.3 Setting average

Increased number of averages reduces jitter and provides more accurate measurement result. However, the measurement speed is sacrificed. The maximum number of averages is 512, and the default value is 1, equivalent to setting the average to Off.

Set the number of averages as follows:

**Step 1.** Press the **【Avg】** key.

**Step 2.** Press the [Average] menu key to set the average mode to On. The default setting is Off.

**Step 3.** Enter the number of averages using the numeric keypad, and finish it with the **【Enter.↵】** key or **OK】** menu key. You can also use **【▲】** and **【▼】** arrow keys or the knob to change the number of averages. One step varies the number by +/-1.

### 3.3.8 Calibrate Noise Figure Analyzer

To compensate for the noise contribution of the NFA, the associated cabling and so forth in the measurement path, a calibration is necessary. The calibration measures the NFA's noise contribution with no DUT (device under test) in place. The correction is then applied to the measurement with the DUT in place. This correction is often referred to as the second stage calibration. To perform calibration, you need to enter the ENR values and set up the frequency range, measurement points, bandwidth, average and so on.

#### 1) Interpolated results

You obtain interpolated results from the NFA whenever you change certain measurement results, for example, changing the number of measurement points, or reducing the measurement frequency range.

#### 2) Correction mark

Whenever any of the NFA changes invalidates the current calibration, the annotation Corr at the bottom right corner of the display is switched to Uncorr. Fig. 3.29 shows this mark.

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Fig. 3.29 Corr/UnCorr mark

**NOTE**

If you change the frequency range to the value greater than the current calibration range, the NFA state is switched to UnCorr automatically; If you change the frequency range to the value less than the current calibration range, or if you change the measurement points, the corrected state of NFA maintains, however, a prompt “User cal interpolated” appears.

You must calibrate the NFA whenever:

- 1) You restart the instrument.
- 2) You preset the NFA.
- 3) You select a measurement frequency or frequency range outside the currently calibrated range.
- 4) You change the fixed IF frequency in the fixed IF frequency mode.
- 5) You change the frequency mode.
- 6) You change the measurement mode.
- 7) There is a large temperature variation since the last calibration.
- 8) The calibrated input attenuator ranges cannot satisfy your measurement requirement, for example, measuring a large-gain DUT.

**3.3.8.1 Performing a calibration**

**Step 1.** Verify that the correct ENR table is loaded in the NFA, or the ENR values of the noise source are entered into the NFA. For more details, please refer to [“3.3.5 Input ENR”](#).

**Step 2.** Configure the measurement mode, frequency range, number of points, number of averages, etc.

**Step 3.** Connect the noise source output directly to the NFA input, as shown in Fig. 3.30.

**Attention**

You may need to use connector adapters to connect the noise source output to the NFA input during calibration. The connectors you use need to be included in the measurement. If you remove the connectors from the measurement you need to apply loss compensation to compensate for any loss caused by the removal of connectors. For details, please refer to [“4.2.6 Loss compensation”](#).

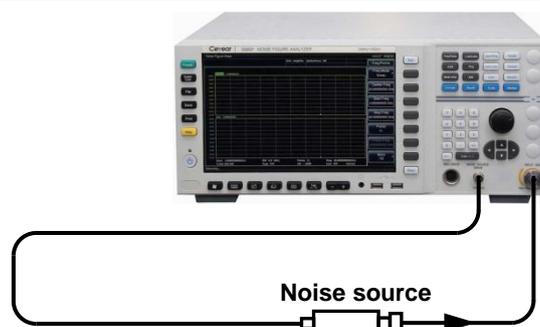


Fig. 3.30 Calibration connection

- Step 4.** If it is required to select an input attenuator range, press the **【Corr】** key to set the RF/ $\mu$ W Min Cal Att and RF/ $\mu$ W Max Cal Att.
- Step 5.** Press the **【Calibrate】** key to enter the Calibrate menu.
- Step 6.** Press [Calibrate] menu key twice to calibrate. The first time you press the menu key you are prompted to press it again. A message prompts as shown in Fig. 3.31:

Press "Calibrate" to continue,  
or "ESC" to abort !

Fig. 3.31 Calibration prompt

## Attention

This two-stroke key press feature prevents you from accidentally pressing the [Calibrate] menu key and erasing the calibration data. The purpose of calibration is to correct the second stage noise of NFA itself. After the calibration is finished, the Uncorr display at the bottom right corner changes to Corr display.

### 3.3.8.2 Selecting RF calibration attenuation range

When working in the RF frequency range of 10MHz to 4GHz, the 3986 series NFA has a default input attenuation range for calibration of 0dB to 20dB. The step value is 5dB. In the default mode, the calibration takes 5 sweeps as 5 attenuator ranges need to be calibrated. The greater the attenuator range selected, the greater the number of calibration sweeps there are, hence, the longer the calibration routine.

When measuring a high-gain device, you may need to increase the input attenuation. If you do not know the gain of the DUT, you can perform calibration using the default range.

If the gain is too large, there is a need to add an external attenuator to the DUT and correct for the attenuation using the loss compensation function. For details of this function, please refer to "[4.2.6 Loss compensation](#)".

Select the RF calibration attenuation range as follows:

- Step 1.** Press the **【Corr】** key to enter the Corr/Att setup menu.
- Step 2.** Press the [RF Min Cal Att] menu key, enter the attenuation value using numeric keys, and finish it using unit menu keys. You can also use **【▲】** and **【▼】** arrow keys or the knob to change the attenuation value. One step changes the value by +/-5dB.
- Step 3.** Press the [RF Max Cal Att] menu key, enter the attenuation value using numeric keys, and finish it using unit menu keys. You can also use **【▲】** and **【▼】** arrow keys or the knob to change the attenuation value. One step changes the value by +/-5dB.

### 3.3.8.3 Selecting Microwave calibration attenuation range

When working in the microwave frequency range of 4GHz to 18/26.5/40/50GHz, the 3986 series NFA has a default input attenuation for calibration of 10dB. You can set the microwave attenuation range manually, and the calibration is performed according to the attenuation range set. Unlike the RF attenuators, however, the microwave attenuators cannot autorange after calibration. Therefore, if the NF and gain of the DUT is too large, you need to change the microwave attenuation range manually. In most cases, 0dB attenuation is appropriate. The maximum microwave input power and measurement range of DUT are shown in Table 3.13.

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Table 3.13 Maximum microwave input power and measurement range of DUT

Attenuation	Maximum input power	Approximate measurement range
0dB	-35dBm	Combined NF and gain of DUT < 35dB
5dB	-30dBm	Combined NF and gain of DUT < 40dB
10dB	-25dBm	Combined NF and gain of DUT < 40dB

The measurement ranges given in Table 3.13 are obtained when the ENR of the noise source is assumed as 6dB and the operating bandwidth of the DUT is 5GHz. If the ENR of the noise source used is larger or the DUT bandwidth is wider, the target measurement range would decrease.

Select the microwave input attenuation range as follows:

- Step 1.** Press the **【Corr】** key to enter the Corr/Att setup menu.
- Step 2.** Press the [ $\mu$ W Min Cal Att], enter the attenuation value using numeric keys, and finish it using unit menu keys. You can also use **【▲】** and **【▼】** arrow keys or the knob to change the attenuation value. One step changes the value by +/-5dB.
- Step 3.** Press the [ $\mu$ W Max Cal Att], enter the attenuation value using numeric keys, and finish it using unit menu keys. You can also use **【▲】** and **【▼】** arrow keys or the knob to change the attenuation value. One step changes the value by +/-5dB.

#### 3.3.8.4 Setting the microwave input attenuation before measurement

The microwave attenuators cannot autorange according to the gain and NF of the DUT. Hence, when making a microwave measurement, you must manually set the microwave input attenuation to prevent the output power of the DUT from exceeding the maximum permissible input power of the NFA.

Set the microwave input attenuation before measurement as follows:

- Step 1.** Press the **【Sweep】** key.
- Step 2.** Press the [Manual Meas] menu key.
- Step 3.** Press the [Att Setup].
- Step 4.** Press the [ $\mu$ W Att] menu key to set it to the Fixed mode.
- Step 5.** Press the [ $\mu$ W Att] menu key and select the attenuation value you want.

### NOTE

If you want to set the RF input attenuation, the above procedure for setting the microwave input attenuation applies, except that you need to set the RF attenuation to [RF Att Auto Fixed] mode and select the appropriate RF attenuation value in Step 4 and Step 5.

#### 3.3.9 Display measurement result

The following display format are available:

- 1) Graph, Table or Meter mode
- 2) Single or dual-graph display allowing any two available result displayed simultaneously
- 3) Combine option to display two result on the same graph
- 4) Switch the marker indicating the trace value on and off
- 5) Switch the graticule on or off
- 6) Switch display annotation on or off

### 3.3.9.1 Selecting the display format

You can display the measurement result in:

- 1) Graph
- 2) Table
- 3) Meter

The dual-graph display is the default setting. The upper graph is the measurement trace of noise figure and the lower graph is the measurement trace of gain. In the Graph format and Meter format, you can choose to display two results. In the Table format, at most 6 results can be displayed.

#### 1) Set the display format as follows:

**Step 1.** Press the **【Format】** key.

**Step 2.** Press the [Display Format] menu key to access the display format menu.

**Step 3.** Press the [Graph] menu key to select the Graph format. This is the default setting.

Press the [Table] or [Meter] menu key to select the display mode you want, as shown in Fig. 3.32.



Fig. 3.32 Display format menu

#### 2) Changing the active trace

In the graph mode, the active graph is highlighted by a green border, and the result title of the active graph is highlighted in green background.

There are two methods to change the active trace:

Method 1: Press the **【】** key at the bottom of the screen.

Method 2: Press the **【Result】** key and press the [Result-Trc 1] or [Result-Trc 2] menu key to enable the trace you want.

### 3.3.9.2 Selecting the result types to display

The measurement results are as follows and shown in Fig. 3.33, with their units in parenthesis for selection:

- 1) Noise figure (dB or linear)
- 2) Gain (dB or linear)
- 3) Y-Factor (dB or linear)
- 4) Teffective (Kelvin, K; Celsius, C; Fahrenheit, F)
- 5) PHot (dB or linear)
- 6) PCold (dB or linear)

➤ Specify which result to display as follows:

➤ **Step 1.** Press the **【Result】** key to access the trace result selection menu.

3.3 Basic operating instructions

- **Step 2.** Press the [Result-Trc 1] or [Result-Trc 2] menu key to select the corresponding trace to display the result .
- **Step 3.** Press the [Noise figure], [Gain], [Y-Factor], [Teffective], [PHot] or [PCold] menu key to select the result you want to display.



Fig. 3.33 Measurement result menu

3.3.9.3 Setting graph displaying in graph format mode

1) Changing the display between single graph and dual graph

In graph format mode, the default setting is dual graph. You can press the  key at the bottom of the screen and then the active graph fills the screen as a single graph, as shown in Fig. 3.34. Pressing the key again returns the single-graph display to dual graph display.



Fig. 3.34 Typical single graph display

**NOTE**

When in single graph mode, pressing the Next Trace key displays the other single graph.

**2) Combining two graphs on the same graph**

You can combine the upper and lower graphs from a dual-graph display into a combined single graph. The title of the active trace is highlighted in green background. The default setting is [Combined On **Off**] and the two trace graphs are not combined. Combine the two trace graphs as follows:

**Step 1.** Press the **【Format】** key.

**Step 2.** Press the [Display Format] and [Graph] menu keys to select the graph format. This is the default setting.

**Step 3.** Press the [Combined] menu key to turn the Combined switch on, as shown in Fig. 3.35. The default setting is [Combined On **Off**].



Fig. 3.35 Typical display with two traces combined on the same graph

**3) Switching the graticule on or off**

When the [Graticule **On** Off] is set, the graticules are displayed on the screen. This is the default setting. When the [Graticule On **Off**] is set, the graticules are not displayed on the screen. Turn the graticule on or off as follows:

**Step 1.** Press the **【Format】** key to access the format control menu.

**Step 2.** Press the [Graticule] menu key to turn the graticule on or off. The graph with graticule off is shown in Fig. 3.36. The [Graticule **On** Off] mode is the default setting.

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Fig. 3.36 Typical graph display with graticule switched off

4) Switch display annotation on or off

When the [Annotation On Off] is set, measurement settings and markers are displayed. This is the default setting. When the [Annotation On Off] is set, measurement settings and markers are not displayed, as shown in Fig. 3.37.

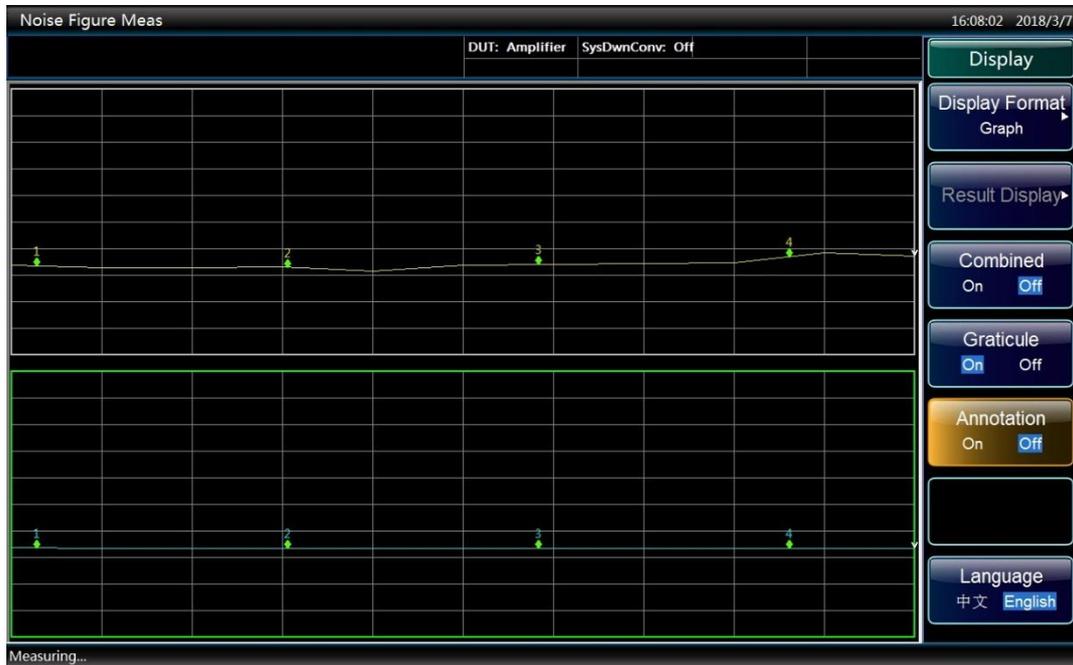


Fig. 3.37 Typical graph display with annotation switched off

Turn the annotation on or off as follows:

**Step 1.** Press the **【Format】** key to access the format control menu.

**Step 2.** Press the [Annotation] menu key to select displaying the measurement settings or not.

### 3.3.9.4 Setting the scaling

You can set the result's scale results in the active trace graph to view the result better.

## NOTE

Enable the Autoscale function. The NFA will automatically set the upper limit, lower limit and scale/division to optimize the trace display, with the trace displayed in approximately 80% area of the window.

#### 1) Setting the scale to display the trace

Select the active trace and set the scale results as follows:

**Step 1.** Press the **【Scale】** key.

**Step 2.** Press the [Trace] menu key to select the active trace of which the scale you want to set. A typical noise figure display in graph format is shown in Fig. 3.38.

**Step 3.** Press the [Units] menu key to select either dB or linear unit.

**Step 4.** Press the [Upper Limit] menu key, enter the upper limit value using numeric keys, and finish it by pressing the [OK] menu key.

**Step 5.** Press the [Lower Limit] menu key, enter the lower limit value using numeric keys, and finish it by pressing the [OK] menu key.

**Step 6.** Press the [Scale/Div] menu key, enter the scale per division value using numeric keys, and finish it by pressing the [OK] menu key.

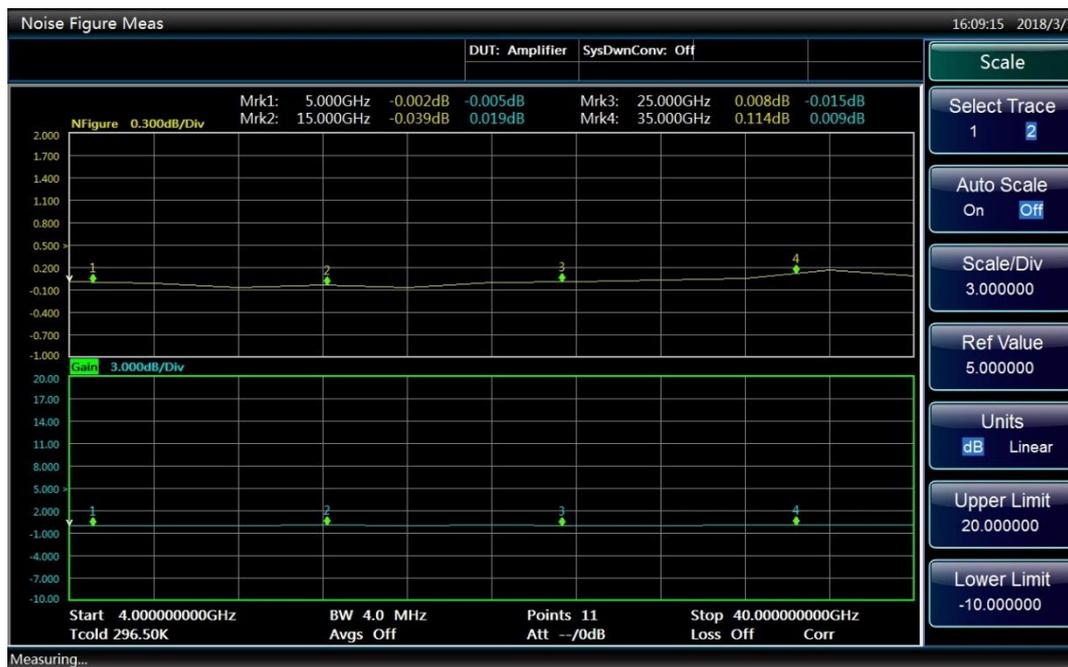


Fig. 3.38 Typical noise figure displayed on a graph

## NOTE

The [Upper Limit], [Lower limit] and [Scale/Div] settings are coupled, therefore changing one of these may affect the others.

## 3.3 Basic operating instructions

## 2) Setting the reference level

- Step 1.** Press the **【Scale】** key to access the scale setting menu. Some of these settings are only effective in graph format mode.
- Step 2.** Press the [Ref Value] menu key, enter the value using numeric keys, and finish it using the [OK] menu key.

## 3.3.9.5 Working with markers

**NOTE**

The marker functions only apply in graph format mode.

Marker functions measure frequency and measurement result by placing a diamond-shaped marker at a point on the trace. The measurement result displayed depends on the result type selected.

The NFA has 4 markers, Marker 1, Marker 2, Marker 3 and Marker 4. The markers are coupled to both the upper trace and lower trace.

Each marker can be enabled as a normal or delta marker. The active marker's frequency is displayed in the active function area. The enabled marker's results are displayed in the annotation above the upper graph, as shown in Fig. 3.39.

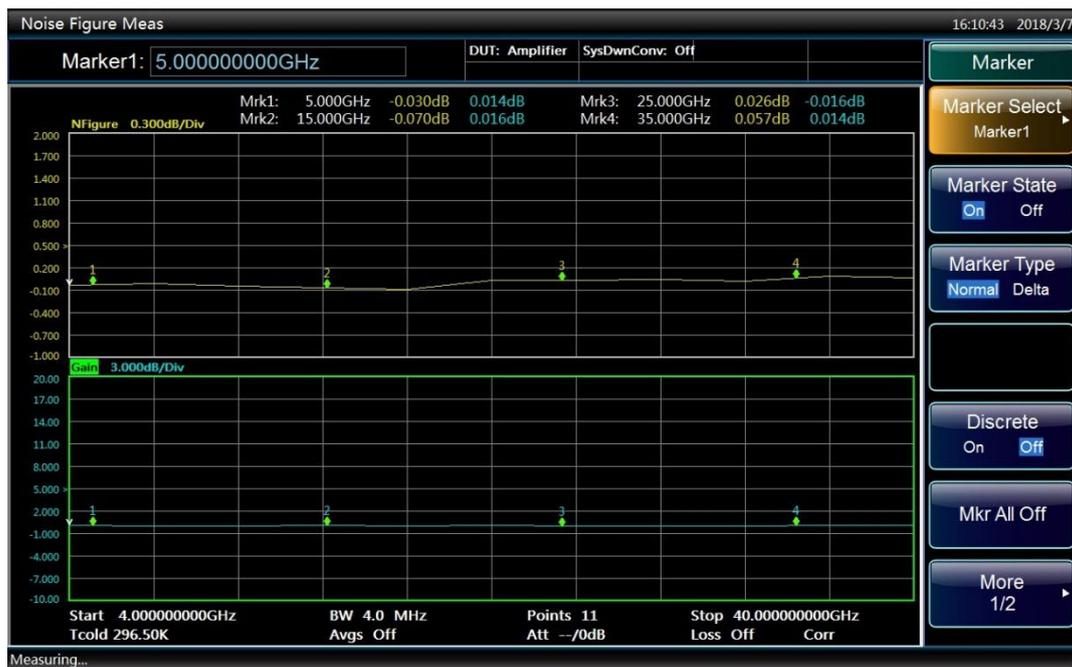


Fig. 3.39 Four normal markers

## 1) Setting normal markers

- Step 1.** Press the **【Marker】** key to access the marker setting menu.
- Step 2.** Press the [Marker Select] menu key.
- Step 3.** Press the [Marker 1], [Marker 2], [Marker 3] or [Marker 4] menu key to select the marker of interest. The [Marker 1] is the default option.
- Step 4.** Press the [Marker State] menu key to set the marker state to On. The default setting is [Marker State On Off].
- Step 5.** Press the [Marker Type] menu key to enable normal type markers. This is the default setting, as

## 3.3 Basic operating instructions

shown in Fig. 3.39. When the markers are enabled, turn the knob to place the markers at the points on the trace you want to measure or use numeric keys and unit keys to enter the frequency of interest. The marker frequency and measurement result are annotated above the graph. Its frequency value is displayed in the result input area.

## 2) Setting the delta marker

The delta markers enable you to measure the difference (including frequency and measurement results) between the reference marker and the delta marker position on the trace.

**Step 1.** Press the **【Marker】** key to access the marker setting menu.

**Step 2.** Press the [Marker Select] menu key.

**Step 3.** Press the [Marker 1], [Marker 2], [Marker 3] or [Marker 4] menu key to select the marker of interest. The [Marker 1] is the default option.

**Step 4.** Press the [Marker State] menu key to set it to [Marker State **On** Off].

**Step 5.** Press the [Marker type] menu key to set it to [Marker Type Normal **Delta**] mode, as shown in Fig. 3.40.

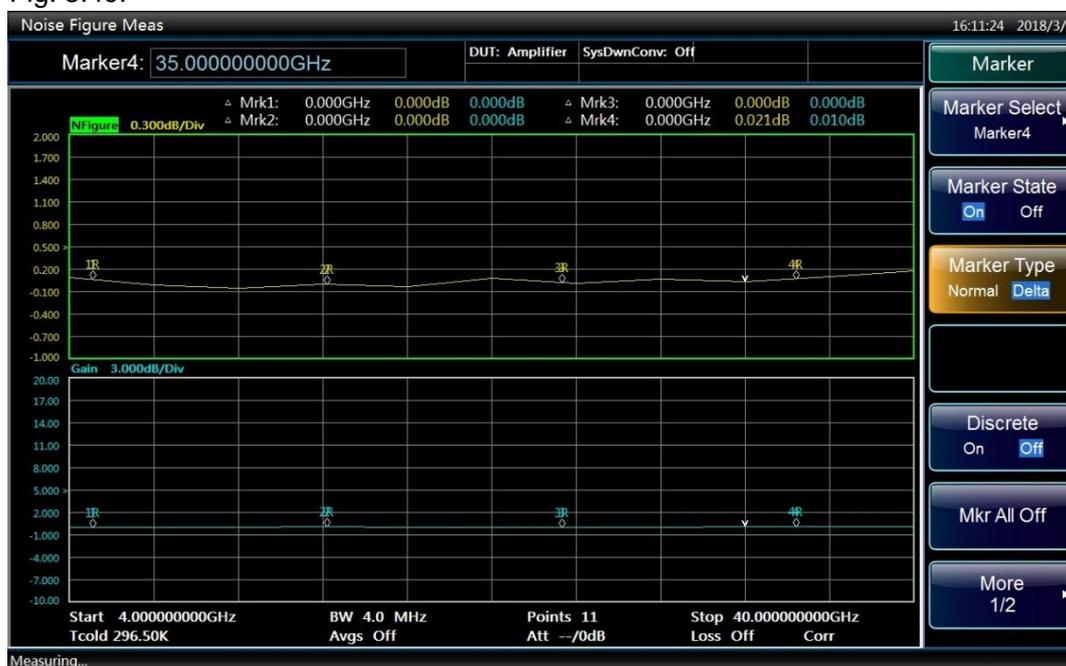


Fig. 3.40 Four delta markers

## 3) Turning an active marker off

**Step 1.** Press the **【Marker】** key to access the marker setting menu.

**Step 2.** Press the [Marker Select] menu key.

**Step 3.** Press the [Marker 1], [Marker 2], [Marker 3] or [Marker 4] menu key to select the marker you want to turn off.

**Step 4.** Press the [Marker State] menu key to set it to [Marker State **On** Off] mode.

## 4) Turning all markers off

**Step 1.** Press the **【Marker】** key to access the marker setting menu.

**Step 2.** Press the [Mkr All Off] menu key.

## 3.3 Basic operating instructions

## 5) Searching with markers

The Searching function allows you to place an active marker on the minimum or maximum point of the trace, while in normal or delta state. In normal marker state, the minimum or maximum point found is displayed; in delta marker state, the delta between the minimum or maximum point found and the reference level is displayed.

Search for minimum or maximum point as follows:

- Step 1.** Press the **【Marker】** key to access the marker setting menu.
- Step 2.** Press the [Marker Select] menu key.
- Step 3.** Press the [Marker 1], [Marker 2], [Marker 3] or [Marker 4] menu key to select the marker of interest
- Step 4.** Press the [Marker State] menu key to set it to [Marker State **On** Off].
- Step 5.** Press the [Marker Type] menu key to select normal or delta type markers.
- Step 6.** Press the [More 1/2] menu key.
- Step 7.** Press the [Search Type] menu key.
- Step 8.** Press the [Max] or [Min] menu key to select the point of interest.
- Step 9.** Press the [Find] menu key to search for minimum or maximum point on the trace. If you want to search for maximum or minimum point after each sweep, press the [Continuous] menu key to set it to [Continuous **On** Off] mode. The default setting is [Continuous **On** Off]. Fig. 4.41 shows the maximum point found.

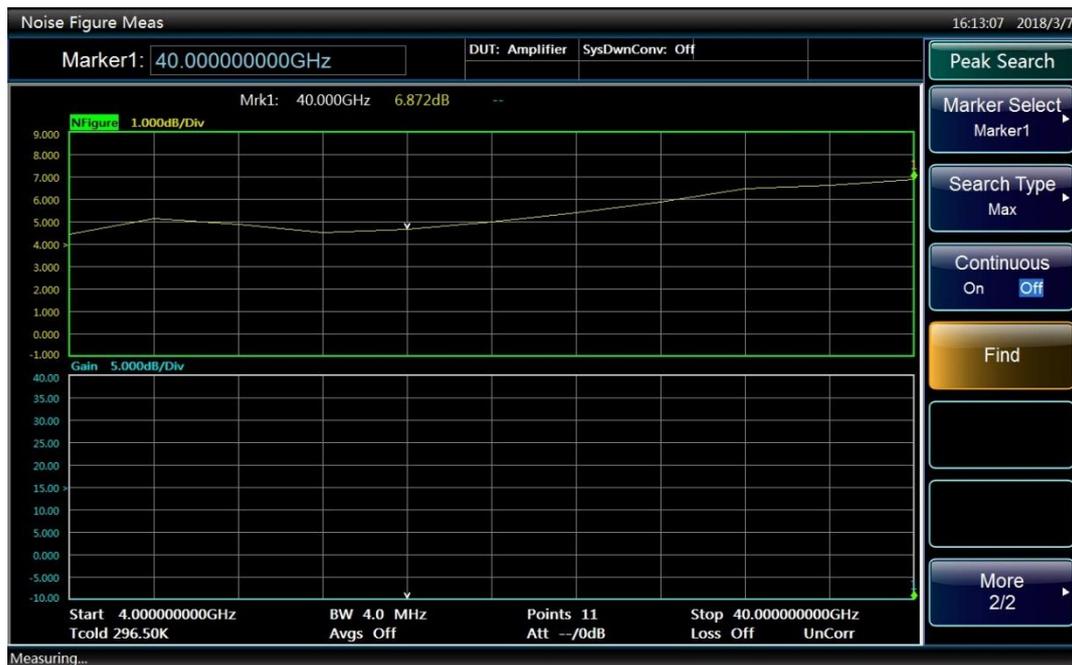


Fig. 3.41 Maximum point searching function

## 3.3.10 Measure fixed frequency

The fixed frequency measurement is the simplest type of measurement. It is made by measuring a device at a specific frequency. The meter display format is ideal for displaying the results of a fixed frequency measurement.

The following example measures an amplifier at a fixed frequency. The operating frequency range of the amplifier is within the frequency range of the NFA.

## 3.3 Basic operating instructions

You need to select an appropriate noise source, either a normal noise source or a SNS. The normal noise source input is connected to the +28V noise source drive port on the NFA front panel using a BNC cable and its output is connected to the input port of the NFA (50Ω). The SNS input is connected to the SNS port on the NFA front panel using a special multi-core cable and its output is connected to the input port of the NFA (50Ω).

The following example measures the corrected noise figure and gain of a device at a frequency of 50MHz and verifies that it meets the manufacturer's specification listed in Table 3.15. The average is On and set to 4. The bandwidth is set to the default 4MHz.

Table 3.15 Technical specifications of the DUT

Frequency range	Typical Gain	Typical noise figure
50MHz	-10dB	10dB

Make a fixed frequency measurement as follows:

- Step 1.** Turn the NFA on by pressing the **【Power】** key and wait for the initialization process to complete. To obtain greater accuracy, it is recommended to warm the NFA up for at least 30 min.
- Step 2.** Press the **【Preset】** key.
- Step 3.** Press the **【ENR】** key and [ENR Mode] menu key to select the Spot ENR mode.
- Step 4.** Press the [Spot] menu key, and press the [Spot Mode] menu key to select ENR. This is the default setting.
- Step 5.** Press the [Spot ENR] menu key, enter the corresponding ENR value using numeric keys and finish it using the [dB], [K], [C] or [F] unit menu key. The K, C or F entry is automatically converted to appear as dB. If the frequency you want to measure is not a listed ENR value, then you need to interpolate to an appropriate value. The default ENR value is 15.200dB.

## NOTE

If the noise source ENR data has been entered and saved previously, ignore Step 3 through Step 5. When an unlisted ENR value is used, the NFA interpolates point automatically. The normal noise figure ENR values are normally found on the body of the noise source, the certificate of calibration or on the disk supplied with the noise source. The SNS ENR values are loaded to the NFA automatically.

- Step 6.** Press the **【Freq/Points】** key.
- Step 7.** Press the [Freq Mode] menu key, and press the [Fixed] menu key to select the fixed frequency mode.
- Step 8.** Press the [Fixed Freq] menu key, enter 50 using numeric keys, and finish it by pressing the [MHz] unit menu key.
- Step 9.** Press the **【Avg】** key, and press the [Average] menu key to set it to [Average On Off] mode. Enter "4" using the numeric key, and finish it by pressing the [OK] menu key.
- Step 10.** Press the **【BW】** key, and press the [BW] menu key to set it to [BW Auto Manual] mode. Enter "4" using the numeric key, and finish it by pressing the [MHz] menu key. The default value is 4 MHz.
- Step 11.** Connect the noise source to the NFA for calibration as shown in Fig. 3.42. Press the **【Calibrate】** key to access calibrate menu, and press [Calibrate] menu key twice to calibrate the NFA.

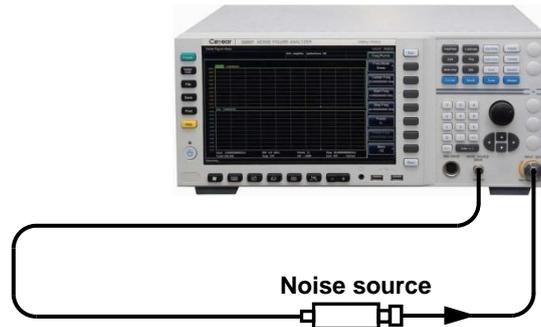


Fig. 3.42 Calibration connection

**Step 12.** Press the **【Format】** key, and the [Display Format] menu key to select the [Meter] menu key.

**Step 13.** Connect the device under test between the noise source output and the NFA input. The measurement result is displayed in meter format, similar to Fig. 3.43.



Fig. 3.43 Fixed frequency measurement result in meter format

The result displayed in Fig. 3.43 shows the DUT noise figure and gain at 50 MHz. The DUT meets the specifications listed in Table 3.15.

## 4 Operation guide

This chapter introduces how to operate the 3986 series NFA in different measurement modes and explains in detail the measurement procedures and related precautions.

- [Basic operation guide.....67](#)
- [Advanced operation guide.....82](#)

### 4.1 Basic operation guide

This part mainly covers the common operation of 3986 series NFA, such as the measurement mode, mode setup, system connection and external LO selection. It provides an example of a basic amplifier measurement to help users get familiar with the 3986 series NFA and grasp the basic measurement method quickly.

- [Measurement mode.....67](#)
- [Mode setup.....68](#)
- [System connection.....74](#)
- [External LO selection.....77](#)
- [Example of a basic amplifier measurement.....78](#)

#### 4.1.1 Measurement mode

The 3986 series NFA is able to measure the noise figure of an amplifier-type device or system and also display the gain result of the DUT. It is also able to measure the noise figure and gain of a quasi-linear device or system, such as an upconverter, downconverter and receiver. There are three measurement modes, amplifier, downconverter and up-converter.

Press the **【Mode Setup】** key to access the mode setup menu. Press the **[DUT Setup]** menu key to select the DUT type. There are three types of DUT, as shown in Fig. 4.1.



Fig. 4.1 DUT type selection menu

**1) Amplifier**—The DUT is an amplifier-type device with no frequency conversion. The amplifier mode includes a basic amplifier measurement mode and a system downconverter mode. The basic amplifier measurement mode is used when the frequency range of the DUT is within the NFA's frequency range. The measurement procedures of this basic measurement and the precautions are described in [“4.1.5 Example of a basic amplifier measurement”](#).

When the operating frequency of a device is beyond the NFA's frequency range, you can enable the system downconverter measurement mode. In this mode, the noise figure of the device is measured by adding an external mixer to the NFA. For details about the measurement procedure and precautions, refer to [“4.2.4 Example of a system downconverter measurement”](#).

## 4.1 Basic operation guide

**2) DownConv**—The frequency downconversion occurs in the DUT itself not in the measurement test system. There are two modes setup, fixed LO variable IF and variable LO fixed IF.

**3) UpConv**—The frequency upconversion occurs in the DUT itself not in the measurement test system. There are two modes setup, fixed LO variable IF and variable LO fixed IF.

The noise figure measurement involving frequency conversion includes the follow two cases:

1) The frequency conversion is part of the DUT. For example, the DUT is a down converter or a up converter.

2) The frequency conversion is part of the measurement test system (system downconverter). The DUT is to be measured at a higher frequency than the NFA's frequency range covers, hence an external system downconverter and local oscillator are added to the measurement test system to extend the NFA's frequency range.

The 3986 series NFA can make a single frequency conversion and also support multiple frequency conversion. In variable LO and fixed IF mode, the NFA can also control the output frequency and power of an LO source using the SCPI commands.

## 4.1.2 Mode Setup

## 4.1.2.1 Amplifier measurement mode setup

The 3986 series NFA provides dedicated user interface to allow easy measurement setup and integrated measurement parameters input. There is no need to switch between each setup to complete various settings in each measurement mode. The measurement mode setup is shown in Fig. 4.2. You can enable each setting by using the mouse or pressing the **【◀】** and **【▶】** arrow keys .

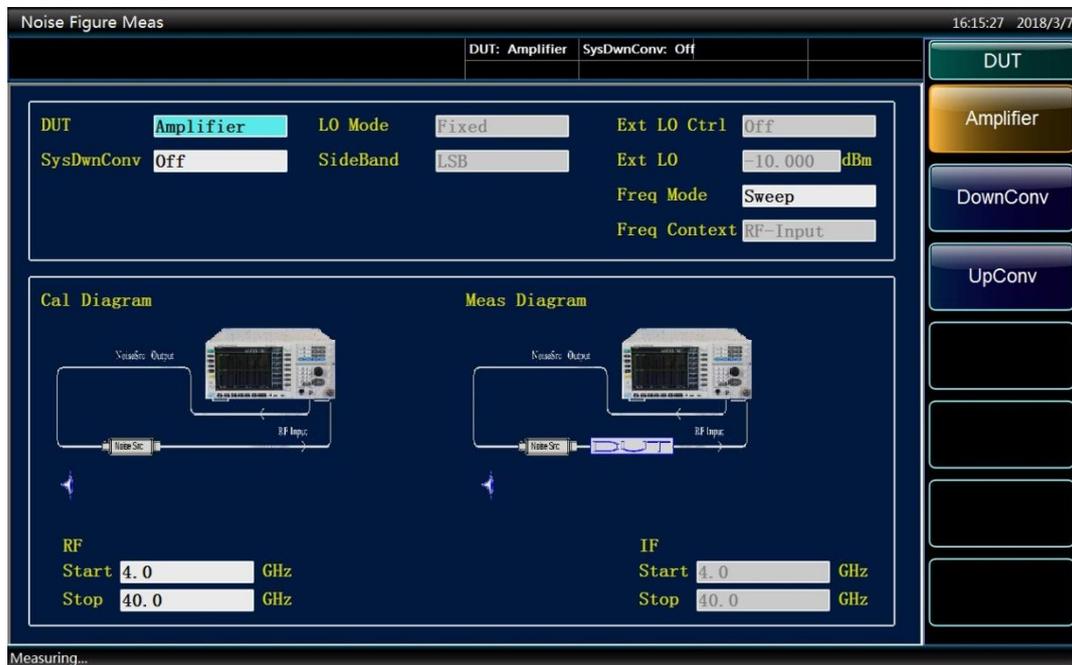


Fig. 4.2 Measurement mode setup display

## 1) Basic amplifier mode setup

The basic amplifier mode is the default setting of the 3986 series NFA when the instrument is switched on. You can also set the basic amplifier measurement mode as follows:

**Step 1.** Press the **【Preset】** key to return the instrument to the factory default state, and press the

【Mode Setup】 to access the mode setting menu.

- Step 2.** Press the [DUT Setup] menu key and the [Amplifier] menu key to select the amplifier measurement mode.
- Step 3.** In the mode setup display, set the system downconverter to Off.
- Step 4.** Enable the RF start and RF stop input respectively, enter the frequency value of measurement using numeric keys, and finish it using unit keys. You can also press the 【Freq/Points】 key, and then press the [Start Freq] and [Stop Freq] menu keys to set the frequency results of measurement.

## 2) System downconverter mode setup

The DUT is an amplifier-type device with the same input and output frequency, such as an amplifier or a filter and etc. However, the operating frequency of the DUT is beyond the frequency range the 3986 series NFA covers. Therefore, an external system downconverter is connected during noise figure measurement to convert the operating frequency within the NFA's frequency range. There are two available modes for selection in the system downconverter measurement:

### a) Variable LO and fixed IF

In this mode, the NFA is set at a fixed IF frequency. The sweep LO and system downconverter convert the RF frequency range to a fixed IF which the NFA can receive. The mode setup is as follows:

- Step 1.** Press the 【Preset】 key to return the instrument to the factory default state, and press the 【Mode Setup】 to access the mode setting menu.
- Step 2.** Press the [DUT Setup] menu key and the [Amplifier] menu key to select the amplifier measurement mode.
- Step 3.** In the mode setup display, set the system downconverter to On.
- Step 4.** Enable the LO mode setup, and select the “variable”.
- Step 5.** Enable the sideband setup, and set the measurement sideband based on the specific operating sideband of the system downconverter. There are three options, lower sideband (LSB), upper sideband (USB) and double sideband (DSB).
- Step 6.** Enable the external LO control option, and set the external LO control to On or Off. In the variable LO mode, it is recommended to set it to On.
- Step 7.** Activate the external LO power input box and input the external LO power value with the numeric key and complete the input setting with the unit key.
- Step 8.** Enable the frequency mode setup, and select the frequency sweep mode. There are two available modes, Sweep and List. Normally, the Sweep mode is selected.
- Step 9.** Activate the RF start frequency and RF stop frequency input box, input the measured frequency value with the numeric key, and complete the input with unit key.

## NOTE

In this variable LO and fixed IF mode, when the external LO control is set to On, the NFA can control the output frequency and power of the external LO through the LAN ports. The LO output frequency simultaneously traces the RF frequency to achieve automatic sweep measurement. If the external LO control option is set to “Off”, the user shall manually set the frequency and power value of the external LO. The formula for LO frequency is:  $F_{LO}=F_{RF}+F_{IF}$  (LSB),  $F_{LO}=F_{RF}-F_{IF}$  (USB) and  $F_{LO}=F_{RF}$  (DSB).

## 4.1 Basic operation guide

If the list mode is selected, you need to edit the sweep frequency list.

**Step 10.** Activate the fixed IF frequency input box and set the IF frequency. Input the IF frequency with the numeric key, and press the corresponding unit key to complete the input.

### b) Fixed LO and variable IF

In this mode, the external LO is locked at a fixed frequency and the NFA works within the IF frequency range of the system downconverter. The fixed LO and system downconverter convert the RF frequency range to the IF frequency range within the NFA. The mode setup is as follows:

- Step 1.** Press the **【Preset】** key to return the instrument to the factory default state, and press the **【Mode Setup】** to access the mode setting menu.
- Step 2.** Press the [DUT Setup] menu key and the [Amplifier] menu key to select the amplifier measurement mode.
- Step 3.** In the mode setup display, set the system downconverter to On.
- Step 4.** Enable the LO mode setup, and select “Fixed”.
- Step 5.** Enable the sideband setup, and set the measurement sideband based on the specific operating sideband of the system downconverter. There are two options, lower sideband (LSB) and upper sideband (USB).

---

### WARNING

When the system downconverter works in fixed LO and variable IF mode, only the single sideband measurement (including USB and LSB) can be set.

- Step 6.** Enable the external LO control option, and set the external LO control to On or Off. In the fixed LO mode, it is normally set to Off.
- Step 7.** Activate the external LO power input box and input the external local oscillator power value with the numeric key and complete the input setting with the unit key.
- Step 8.** Enable the frequency mode setting and select the frequency sweep mode. There are three modes available, Sweep, Fixed and List. Normally, the Sweep mode is selected.
- Step 9.** Activate the RF start frequency and RF stop frequency input box, input the measured frequency value with the numeric key, and complete the input with unit key. If List mode is selected, you need to edit the sweep frequency list.
- Step 10.** Activate the fixed LO frequency input box, input the frequency of local oscillator with the numeric key, and press the corresponding unit key to complete the input.

---

### NOTE

If the external LO control option is set to “Off”, the user shall manually set the frequency and power value of external LO.

#### 4.1.2.2 Downconverter measurement mode setup

In the downconverter measurement mode, the output frequency (IF) of the DUT is lower than the input frequency (RF), for example, the DUT is a mixer or receiver. There are two measurement modes setup for selection:

### 1) Variable LO and fixed IF

In this mode, the NFA works at a fixed IF frequency of the DUT. The mode setup is as follows:

- Step 1.** Press the **【Preset】** key to return the instrument to the factory default state, and press the **【Mode Setup】** to access the mode setting menu.
- Step 2.** Press the [DUT Setup] menu key and the [DownConv] menu key to select the downconverter measurement mode. When this measurement mode is selected, the system downconverter setup is disabled, i.e., the system downconverter mode is not available in the downconverter measurement mode.
- Step 3.** Enable the LO mode setup, and select the “variable”.
- Step 4.** Enable the sideband setup, and set the measurement sideband based on the specific operating sideband of the downconverter. The NFA provides three options, lower sideband (LSB), upper sideband (USB) and double sideband (DSB).
- Step 5.** Enable the external LO control option, and set the external LO control to On or Off. In the variable LO mode, it is recommended to set it to On.
- Step 6.** Activate the external LO power input box and input the external local oscillator power value with the numeric key and complete the input setting with the unit key.

#### NOTE

In this variable LO and fixed IF mode, when the external LO control is set to On, the NFA can control the output frequency and power of the external LO through the LAN ports. The LO output frequency simultaneously traces the RF frequency to achieve automatic sweep and NF measurement. If the external LO control option is set to “Off”, the user shall manually set the frequency and power value of external LO. The formulas for calculating the LO frequency are:  $F_{LO}=F_{RF}+F_{IF}$  (LSB);  $F_{LO}=F_{RF}-F_{IF}$  (USB); and  $F_{LO}=F_{RF}$  (DSB).

- Step 7.** Enable the frequency mode setup, and select the frequency sweep mode. There are three available modes, the Sweep, Fixed and List. Normally, the Sweep mode is selected.
- Step 8.** Activate the RF start frequency and RF stop frequency input box, input the measured frequency value with the numeric key, and complete the input with unit key. If List mode is selected, you need to edit the sweep frequency list.
- Step 9.** Activate the fixed IF frequency input box and set the IF frequency. Input the IF frequency with the numeric key, and press the corresponding unit key to complete the input.

### 2) Fixed LO and variable IF

In this mode, the LO of the mixer under test is locked at a fixed IF frequency and the NFA works within the IF frequency range of the mixer. The mode setup is as follows:

- Step 1.** Press the **【Preset】** key to return the instrument to the factory default state, and press the **【Mode Setup】** to access the mode setting menu.
- Step 2.** Press the [DUT Setup] menu key and the [DownConv] menu key to select the downconverter measurement mode. When this measurement mode is selected, the system downconverter mode is disabled, i.e., the system downconverter mode is not available in the downconverter measurement mode.
- Step 3.** Enable the LO mode setup, and select “Fixed”.

## 4.1 Basic operation guide

- Step 4.** Set the measurement sideband based on the specific operating sideband of the downconverter. The NFA provides three options for selection, the lower sideband (LSB), upper sideband (USB) and double sideband (DSB).
- Step 5.** Enable the external LO control option, and set the external LO control to On or Off. In the fixed LO mode, it is normally set it to Off.
- Step 6.** Activate the external LO power input box and input the external local oscillator power value with the numeric key and complete the input setting with the unit key.
- Step 7.** Enable the frequency mode setup, and select the frequency sweep mode. There are three available modes, the Sweep, Fixed and List. Normally, the Sweep mode is selected.
- Step 8.** Enable the measurement frequency type setup option, and select and set the RF or IF value of the DUT. This example selects the IF-Input. This means to set the IF frequency of the DUT, and the instrument calculates the RF frequency of the DUT automatically.
- Step 9.** Activate the fixed LO frequency input box, input LO frequency of the mixer the numeric key, and press the corresponding unit key to complete the input
- Step 10.** Activate the IF start frequency and IF stop frequency input box, input the IF frequency with the numeric key, and press the corresponding unit key to complete the input.

## NOTE

The downconverter works in the fixed LO and variable IF mode. Under the Mode Setup boot interface, the measurement frequency type defaults to "IF-input". It is recommended that the user prefer the default setting. If the user sets the type of measurement frequency as "RF-input", the operation corresponds to the Step 10. Activate the RF start frequency and RF stop frequency input box, input the RF start frequency and stop frequency of the mixer with numeric key and complete the input with unit key. If the external LO control option is set to "Off", the user shall manually set the frequency and power value of external LO.

### 4.1.2.3 Upconverter measurement mode setup

In the upconverter measurement mode, the output frequency (IF) of the DUT is higher than the input (RF), for example, the DUT is a receiver. There are two upconverter measurement modes for selection:

#### 1) Variable LO and fixed IF

In this mode, the NFA works at a fixed IF frequency of the DUT. The mode setup is as follows:

- Step 1.** Press the **【Preset】** key to return the instrument to the factory default state, and press the **【Mode Setup】** to access the mode setting menu.
- Step 2.** Press the [DUT Setup] menu key and the [UpConv] menu key to select the upconverter measurement mode. When the measurement mode is selected, the system downconverter setting is disabled, i.e. the downconverter mode is not available in the upconverter measurement mode.
- Step 3.** Enable the LO mode setup, and select the "variable".
- Step 4.** Enable the sideband setup option, and set the measurement sideband based on the specific operating sideband of the DUT. The NFA provides two options, the lower sideband (LSB) and upper sideband (USB).
- Step 5.** Enable the external LO control option, and set the external LO control to On or Off. In the

variable LO mode, it is recommended to set it to On.

**Step 6.** Activate the external LO power input box and input the external LO power value with the numeric key and complete the input setting with the unit key.

## NOTE

Upconverter works in the variable LO and fixed IF mode. When the external LO control option is set to “On”, the NFA can control the output frequency and power of external LO via the LAN. The LO output frequency simultaneously traces the RF frequency to achieve automatic sweep measurement. If the external LO control option is set to “Off”, the user shall manually set the frequency and power value of the external LO. The formulas for calculating the LO frequency are:  $F_{LO}=F_{RF}+F_{IF}$  (LSB) and  $F_{LO}=F_{IF}-F_{RF}$ (USB).

**Step 7.** Enable the frequency mode setup, and select the frequency sweep mode. There are three available modes, the Sweep, Fixed and List. Normally, the Sweep mode is selected.

**Step 8.** Activate the RF start frequency and RF stop frequency input box, input the measured frequency value with the numeric key, and complete the input with unit key. If List mode is selected, you need to edit the sweep frequency list.

**Step 9.** Activate the fixed IF frequency input box and set the IF frequency. Input the IF frequency with the numeric key, and press the corresponding unit key to complete the input.

## 2) Fixed LO and variable IF

In this mode, the LO of the DUT is locked at a fixed frequency and the NFA works within the IF frequency range of the DUT. The fixed LO and upconverter convert the RF frequency range to the IF frequency range within the NFA. The mode setup is as follows:

**Step 1.** Press the **【Preset】** key to return the instrument to the factory default state, and press the **【Mode Setup】** to access the mode setting menu.

**Step 2.** Press the [DUT Setup] menu key and the [UpConv] menu key to select the upconverter measurement mode. When the measurement mode is selected, the system downconverter setting is disabled, i.e. the downconverter mode is not available in the upconverter measurement mode.

**Step 3.** Enable the LO mode setup, and select “Fixed”.

**Step 4.** Set the sideband based on the operating sideband of the upconverter. The NFA provides two sideband setup options, the LSB and USB.

## ⚠ WARNING

In the upconverter measurement mode, only the USB and LSB can be set. The formulas for calculating the LO frequency are:  $F_{LO}=F_{RF}+F_{IF}$ (LSB) and  $F_{LO}=F_{IF}-F_{RF}$  (USB).

**Step 5.** Enable the external LO control option, and set the external LO control to On or Off. In the fixed LO mode, it is normally set to Off.

**Step 6.** Activate the external LO power input box and input the external LO power value with the numeric key and complete the input setting with the unit key.

**Step 7.** Enable the frequency mode setup, and select the frequency sweep mode. There are three available modes, the Sweep, Fixed and List. Normally, the Sweep mode is selected.

## 4.1 Basic operation guide

- Step 8.** Enable the measurement frequency type setup, and select and set the RF or IF value of the mixer. This example selects the IF-Input. This means to set the IF frequency of the mixer, and the instrument calculates the RF frequency of the mixer automatically.
- Step 9.** Activate the fixed LO frequency input box, input the LO frequency of the mixer with the numeric key, and press the corresponding unit key to complete the input
- Step 10.** Activate the IF start frequency and IF stop frequency input box, input the measured frequency value with the numeric key, and complete the input with unit key.

**NOTE**

The upconverter works in the fixed LO and variable IF mode. Under the Mode Setup boot interface, the measurement frequency type defaults to "IF-input". It is recommended that the user prefer the default setting. If the user sets the type of measurement frequency as "RF-input", the operation corresponds to the Step 10. Activate the RF start frequency and RF stop frequency input box, input the RF start frequency and stop frequency of the measured upconverter with numeric key and complete the input with unit key. If the external LO control option is set to Off, the user shall manually set the frequency and power value of the external LO.

## 4.1.3 System Connection

## 4.1.3.1 Basic Amplifier Measurement Mode

The calibration connection of the basic amplifier measurement mode is shown in Fig. 4.3. When a normal noise source is used, connect the noise source drive input end to the +28V noise source drive port on the noise figure analyzer panel with a BNC cable, and connect the noise source output to the input port (50Ω) of the noise figure analyzer. When a smart noise source is used, connect the noise source to the smart noise source drive port on the noise figure analyzer panel with a multi-core cable, and connect the noise source output to the input port (50Ω) of the noise figure analyzer.

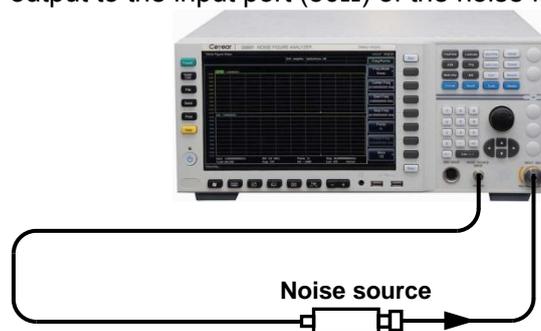


Fig. 4.3 Calibration Connection Diagram of Basic Amplifier Measurement Mode

After the calibration is completed, insert the DUT between the noise source output and the input port (50Ω) of the noise figure analyzer for measurement. The measurement connection of the basic amplifier measurement mode is shown in Fig. 4.4.

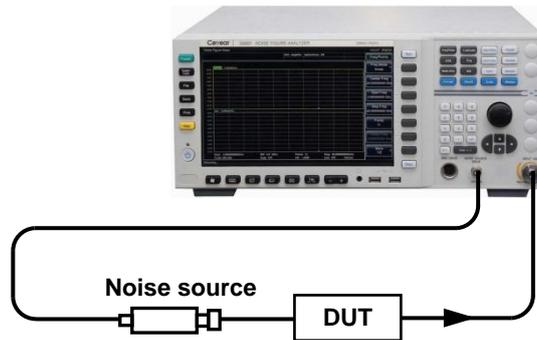


Fig.4.4 Measurement Connection Diagram of Basic Amplifier Measurement Mode

#### 4.1.3.2 System Downconverter Mode

##### Steps for system connection:

- Step1.** When a normal noise source is used, connect the noise source drive input end to the +28V noise source drive port on the noise figure analyzer panel with a BNC cable, and connect the noise source output to the RF input port of the system downconverter. When a smart noise source is used, connect the noise source to the smart noise source drive port on the noise figure analyzer panel with a multi-core cable, and connect the noise source output to the RF input port of the downconverter of the system. The IF output port of the system downconverter is connected to the input port (50Ω) of the noise figure analyzer.
- Step 2.** The noise figure analyzer controls external LO through the LAN interface. Connect the noise figure analyzer to the corresponding interface of the LO with a network cable. In the fixed IF mode setting of variable LO , control the output frequency and power of the LO with the LAN of the noise figure analyzer, so as to enable automatic sweep frequency measurement. The calibration connection of the system frequency conversion mode is shown in Fig. 4.5.

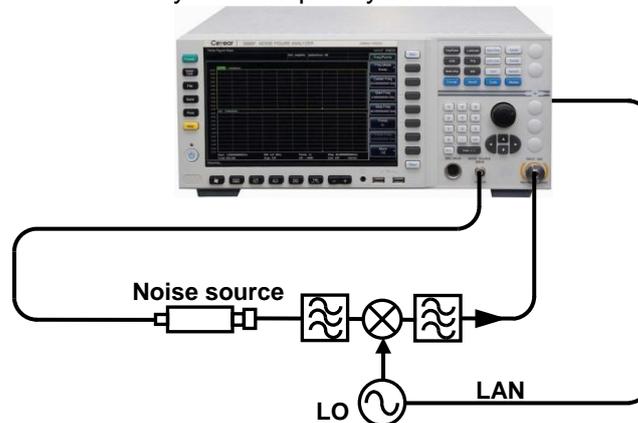


Fig.4.5 Calibration Connection Diagram of System Downconverter Mode

### Attention

The system downconverter mode is extend frequency measurement of amplifier-class DUTs. External mixer is used as part of the test system for the whole calibration and measurement process. In this mode, the frequency conversion is performed in the measurement system rather than in the DUTs. To reduce the measurement uncertainty, it is preferably to select the system downconverter with the small conversion loss and noise figure, and the IF output port of the system downconverter shall be well isolated from the LO.

## 4.1 Basic operation guide

**Step 3.** After the calibration is completed, insert the DUT between the noise source output and the RF input port of the system downconverter for measurement. The measurement connection of the system downconverter mode is shown in Fig.4.6.

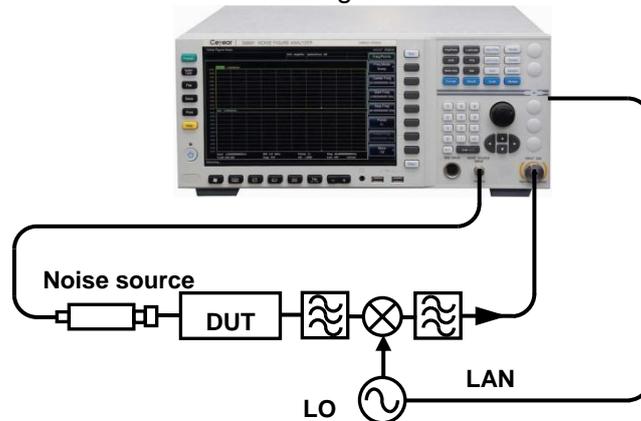


Fig.4.6 Measurement Connection Diagram of System Downconverter Mode

### NOTE

A 10 MHz time base frequency reference can be connected to lock the noise figure analyzer and the LO to the same frequency reference, for which the method is connecting the 10 MHz reference output/input of the noise figure analyzer to the 10 MHz reference input/output port of the LO.

#### 4.1.3.3 Upconverter and downconverter measurement mode

##### Steps for system connection:

- Step 1.** The noise figure analyzer controls external LO through the LAN interface. Connect the noise figure analyzer and the LO's corresponding interface with a network cable. In the variable LO and fixed IF mode, the noise figure analyzer control the output frequency and power of the LO with the LAN, so as to enable automatic sweep measurement of the noise figure.
- Step 2.** The calibration connection of the converter test mode is shown in Fig.4.7. Turn on the noise figure analyzer and press the **【Preset】** key to restore the factory default status.

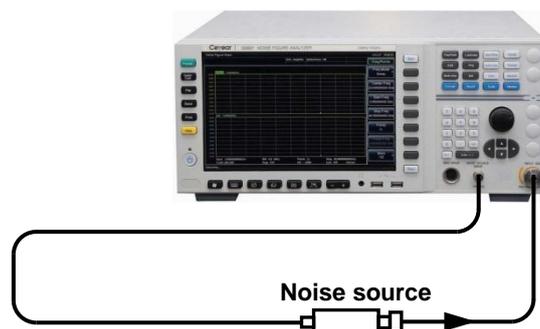


Fig.4.7 Calibration Connection of Upconverter and Downconverter Test Mode

**Step 3.** After the calibration is completed, insert the DUT between the noise source output and the input port (50Ω) of the noise figure analyzer for measurement. The measurement connection of the converter test mode is shown in Fig. 4.8.

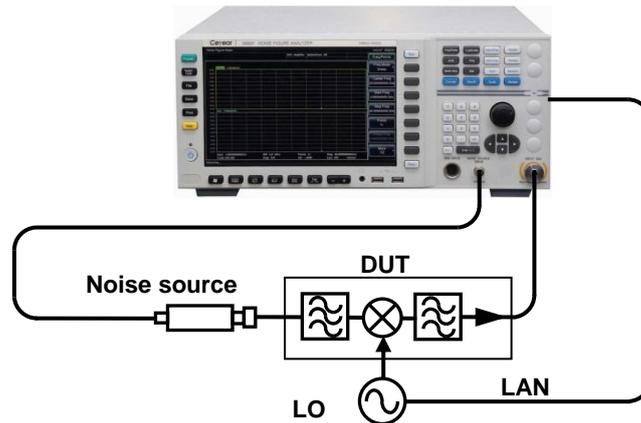


Fig.4.8 Measurement Connection of Upconverter and Downconverter Measurement Mode

## NOTE

The calibrations and measurement connections of the upconverter and downconverter are identical. A 10MHz time base frequency reference can be connected to lock the noise figure analyzer and local oscillator to the same frequency reference, for which the method is connecting the 10MHz reference output/input of the noise figure analyzer to the 10MHz reference input/output port of the local oscillator.

### 4.1.4 Selection of External Local Oscillators

When upconverter and downconverter measurements are performed, it is required to convert the RF range of the upconverter and downconverter to the IF frequency range that the noise figure analyzer can receive through the external local oscillator. In the measurement process of system downconverter mode, it is required to convert the RF frequency range of the DUT to the IF frequency range that the noise figure analyzer can receive through the external local oscillator and the system downconverter, so that the external local oscillator, the system downconverter and the noise figure analyzer can form a noise figure measurement system for extend frequency measurement. This section mainly describes the details related to the selection of external local oscillators.

#### 4.1.4.1 Setting External Local Oscillator

The noise figure analyzer can control the output frequency and power of the external local oscillator by mode setting. Special note: When the upconverter and downconverter or the system downconverter works in the variable LO and fixed IF mode, the noise figure analyzer control the output frequency and power of the LO with the LAN so as to enable automatic sweep measurement of the noise figure. The setting related to the control of external LO is shown as below:

- 1) Set the IP address of the external local oscillator.
- 2) Set the settling time of the local oscillator.
- 3) Set the multiplier of the local oscillator.
- 4) Set the divider of the local oscillator.
- 5) Set the frequency offset of the local oscillator.

#### 4.1.4.2 Influence of External Local Oscillator Signal Noise on Noise Figure Measurement

In the process of frequency conversion, the noise of the local oscillator signal may also enter the receiving frequency band of the noise figure analyzer. Due to the influence of local oscillator noise, the

#### 4.1 Basic operation guide

measured noise figure of the frequency converter is higher than the actual noise figure.

The power of the spurious signal of the local oscillator must be very low. If the spurious signal level of the local oscillator is high at a certain frequency, a peak value will appear on the IF when the noise figure is measured at the corresponding frequency point. Ideally the noise of local oscillator (including the power of spurious signal) should be kept below -90 dBm in general.

If the converter has good isolation so as to well suppress the local oscillator noise, the influence of the noise and spurious signals of the local oscillator on the measurement results can be reduced. If the isolation between the local oscillator and the IF of the converter is poor, the local oscillator is required to have a lower spurious power. If not, the noise of local oscillator can easily enter the noise figure analyzer through the converter due to poor isolation, resulting in higher measured noise figure.

### Attention

If the upconverter and downconverter adopt specific local oscillator signals in practical applications, it is better to select this local oscillator signal as the local oscillator source for the noise figure measurement. In this way the noise figure of the DUT under actual working conditions can be measured. When performing extend frequency measurement in the system downconverter mode, the local oscillator signal must have a low noise floor within the range of  $F_{LO} \pm F_{IF}$ , which can reduce the noise figure of the noise figure extend frequency test system and improve the noise measurement accuracy.

#### 4.1.4.3 Principles for Selecting Local Oscillators

- 1) The frequency range of the local oscillator should meet the requirements for the RF range, the IF range and sideband selection of the DUT.
- 2) When performing variable LO sweep measurement, the noise figure analyzer can control the frequency and power output of the LO through a LAN for the purpose of automatic sweeping measurement of noise figure.
- 3) The local oscillator should be able to provide enough power to drive the converter.
- 4) The local oscillator should have good frequency accuracy and repeatability.

#### 4.1.5 Examples of Basic Amplifier Measurement

The basic amplifier measurement is the most commonly used measurement mode of the noise figure analyzer, which is used for measuring DUTs without frequency conversion, such as amplifiers, attenuators and filters, isolators, and etc. And the frequency range of the selected noise figure analyzer can cover the operating frequency range of the DUT.

This section describes the basic noise figure measurement and various related operations with the attenuator measurement as the example. In the example, the frequency range of the attenuator is 1GHz~4GHz, and its technical specifications are shown in Table 4.1.

Table 4.1 Technical Specifications of Attenuator

Frequency range	Typical Gain	Typical noise figure
1GHz to 4GHz	-3dB	3dB

##### 4.1.5.1 Calibrate

The first step is to calibrate the noise figure analyzer for noise figure measurement with second-stage correction.

## 4.1 Basic operation guide

- Step 1.** Turn on the power switch and wait for the startup program of the NFA to be activated. For better measurement accuracy, it is recommended to warm up the NFA for more than 30 minutes.
- Step 2.** Press the green **【Preset】** key to restore the noise figure analyzer to the factory default state.
- Step 3.** Input the ENR of the noise source according to “[3.3.5 Input ENR](#)”.
- Step 4.** Press the **【Freq/Points】** key to set the measurement frequency parameters.
- 1) Freq Mode - Sweep, which is the default frequency mode for noise figure analyzer.
  - 2) Start Freq - 1GHz.
  - 3) Stop Freq - 4GHz.
  - 4) Points - 11, the default value of the noise figure analyzer is 11.
- Step 5.** Press the **【Avg】** key and the [Average] menu key panel to set the [Average On Off] mode, press the numeric key to input the average number "2", and press [OK] key to complete the input.
- Step 6.** Press the **【Corr】** key to set RF Min Cal Att and RF Max Cal Att as required. The default RF Min Cal Att is 0 dB while the RF Max Cal Att is 20 dB. When the default attenuation is used, this step can be omitted.
- Step 7.** As shown in Fig.4.9, connect the noise source drive input end to the +28V noise source drive port on the noise figure analyzer panel with a BNC cable. (When an smart noise source is used, connect the noise source to the smart noise source drive port on the noise figure analyzer panel with a multi-core cable), and connect the noise source output to the input port (50Ω) of the noise figure analyzer.

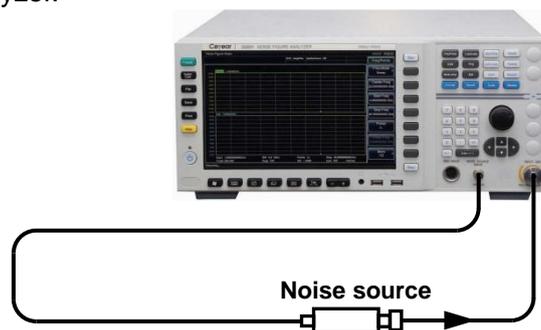


Fig. 4.9 Diagram of Calibration Connection with Normal Noise Source

- Step 8.** Press **【Calibrate】** key to enter the Calibrate menu, and press the [Calibrate] menu key twice for calibration.

4.1 Basic operation guide

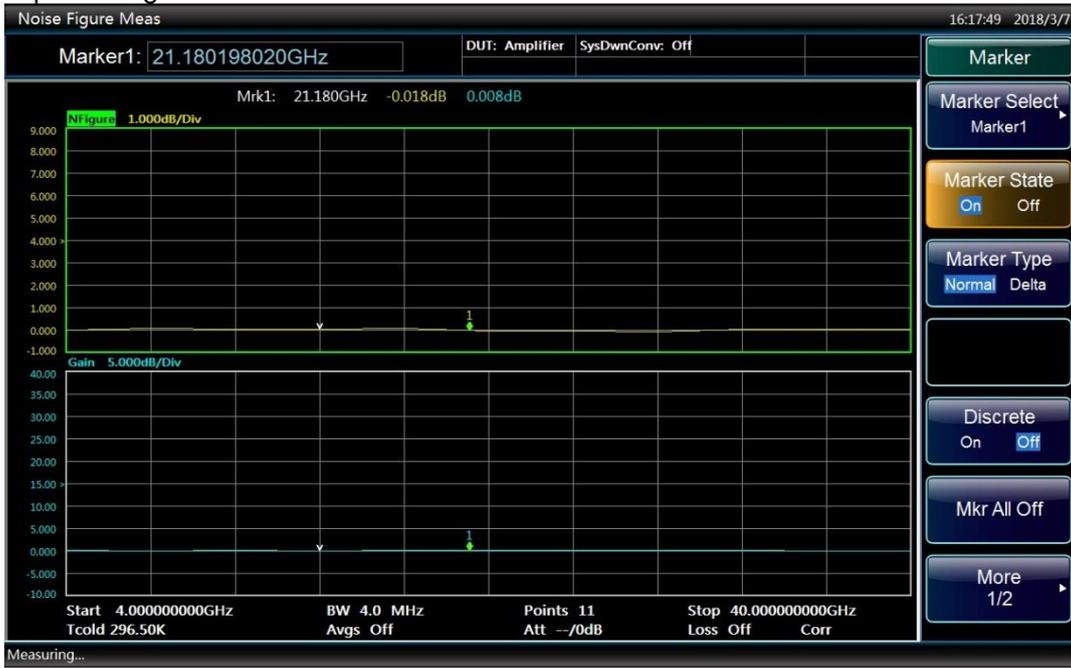


Fig.4.10 Typical Graph Display Result after Calibration

After the calibration is completed, the correction status at the bottom of the display screen will change from "Uncorr" to "Corr" automatically. If the DUT is not connected, the displayed values of noise figure and gain are close to 0 dB. The graph display is as shown in Figure 4.10, while table display is as shown in Fig. 4.11. Since the excitation is a white noise signal, the calibrated display values of noise figure and gain will jitter up and down around 0dB.



Fig. 4.11 Typical Table Display Result after Calibration

4.1.5.2 Measurement

After the calibration is completed, measure the noise figure and the gain of the DUT:

- Step 1.** Disconnect the noise source output port from the input port (50Ω) of the noise figure analyzer.
- Step 2.** Connect the DUT output to the input port (50Ω) of the noise figure analyzer.

**Step 3.** Connect the noise source output to the DUT input as shown in Figure 4.12. After the connection is completed, the measurement result will be displayed on the display screen of the noise figure analyzer. The graph display result is as shown in Fig.4.13.

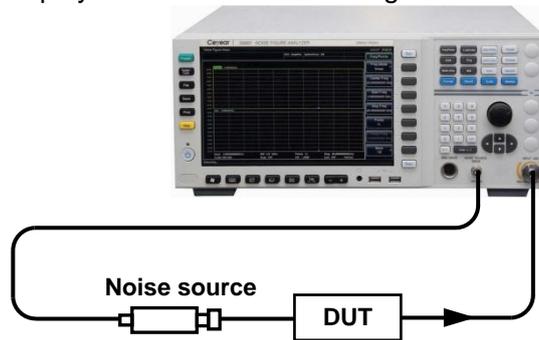


Figure 4.12 Connect DUT for Measurement

## Attention

The noise figure analysis can accurately measure a gain range of  $-20\text{dB} \sim +40\text{dB}$ . If the gain of the DUT exceeds the optimum gain measurement range of the noise figure analyzer, you can add an attenuator at the output of the DUT and utilize the loss compensation function of the noise figure analyzer to improve the noise figure measurement accuracy.



Figure 4.13 Graph Display of Measurement Results

**Step 4.** Press the **[Format]** key, **[Display Format]** menu key and the **[Table]** menu key to select the table display mode. The displayed result is shown in Figure 4.14.



Figure 4.14 Table Display of Measurement Results

The results shown in Figure. 4.13 and Figure. 4.14 show that the noise figure of the DUT is about 3.0dB, and the gain -3dB, which meets the specifications in Table 4.1.

### **WARNING**

#### **Prevent damages to the instrument:**

When measuring the active DUTs of the amplifier class, the power supplies of the DUT and the noise figure analyzer must be in common ground connection, otherwise front-end components of the internal receiver of the noise figure analyzer may be damaged.

## 4.2 Advanced operation guide

This part introduces the relatively complicated measurement and operation procedures of 3986 series noise figure analyzer, mainly including the measurement guide and examples of upconverter and downconverter, measurement guide and examples of system downconverter mode, frequency limit, loss compensation and limit lines, so as to help the user to use the noise figure analyzer with agility and master its extended functions.

- [Guide for Upconverter and Downconverter Measurement.....82](#)
- [Examples for Upconverter and Downconverter Measurement.....92](#)
- [Guide for System Downconverter Mode Measurement.....100](#)
- [Examples of System Downconverter Mode Measurement.....105](#)
- [Frequency Limit.....113](#)
- [Loss Compensation.....117](#)
- [Limit Lines.....121](#)

### 4.2.1 Guide for Upconverter and Downconverter Measurement

In the upconverter and downconverter measurement mode, the DUT (device under test) proceeds

## 4.2 Advanced operation guide

frequency transformation itself, but no frequency transformation occurs in calibration channel. During calibration, the noise source is to be connected to the input port of the noise figure analyzer, the hot and cold noise powers are measured, and then the noise figure analyzer calculates its native noise figure with the use of the ENR value corresponding to the intermediate frequency (IF) in ENR table. The hot and cold noise power and the noise figure analyzer's own noise figure are applied in the noise figure and gain calculation of DUT. During the measurement, noise figure analyzer measures the hot and cold noise power of the DUT cascaded with the noise figure analyzer when the noise source is on and off. Noise figure analyzer calculates the radio frequency (RF) input frequency of the DUT, and computes the noise figure with the use of the ENR value corresponding to the RF frequency in the ENR table. When the measured point is out of the nominal ENR frequency range, the instrument will apply the linear interpolation method to get the ENR value .

### Attention

In the upconverter and downconverter measurement mode, the 3986 series noise figure analyzer only calibrates within the IF range of the upconverter and downconverter. When the converter operates in variable LO mode, the default settings of the start frequency and stop frequency of 3986 series noise figure analyzer correspond to the RF range of the DUT; when the converter operates in fixed LO mode, the default settings of the start frequency and stop frequency correspond to the IF range of the DUT.

**The upconverter and downconverter measurements usually work in two modes.**

#### 1) Variable LO and fixed IF

When upconverter and down converter are in variable LO mode, they output fixed IF, and the noise figure analyzer operates at the fixed IF point of the DUT. This mode is applied to measure the RF response features of the DUT.

#### 2) Fixed LO and variable IF

When the upconverter and downconverter are in fixed LO mode, they output sweeping IF, and the noise figure analyzer operates at the sweeping IF range of the DUT. This mode is applied to measure the IF response features of the DUT.

Technical details related to the upconverter and downconverter noise figure measurement procedures are described in detail below, so to help you accurately measure the noise figure with the noise figure analyzer.

##### 4.2.1.1 Sideband and image frequency

For the upconverter and downconverter noise figure measurement, the noise source as the measurement standard excitation outputs the broadband white noise of which the noise sideband higher than the local oscillator is called as upper sideband, i.e. USB, and the noise sideband lower than the local oscillator is called as lower sideband, i.e. LSB. For the simple analysis, the output of mixer ideally includes the sum frequency and difference frequency signals of RF and LO frequency. Therefore, for the purpose of fixed IF frequency and fixed LO frequency, there are two different RF input frequencies being transformed to IF output frequency as shown in Fig.4.15.

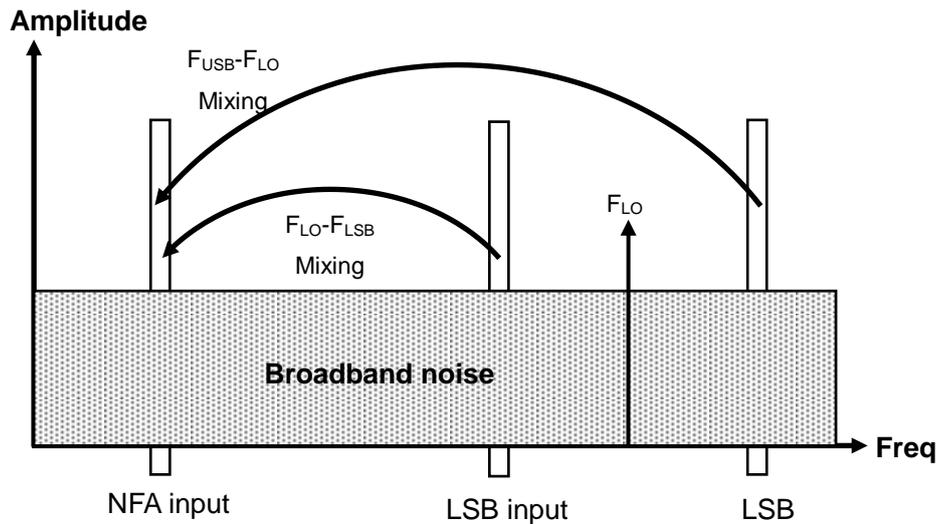


Figure 4.15 Sideband Description

The 3986 series noise figure analyzer is capable of measuring the single-sideband and double-sideband noise figure with the functions of setting, controlling the measurement and processing the data for the single sideband (upper sideband and lower sideband) and double sideband. The setting interface of sideband is as shown in Fig.4.16.

If the input port of mixer is connected with filter, only the noise from the upper sideband or lower sideband can enter the mixer and is transformed to the IF band which is then input into the noise figure analyzer. This measurement is called as the single-sideband measurement, i.e. the single-sideband (SSB), including LSB and USB. If no filter is provided at the input port of the mixer, the noise from both upper sideband and lower sideband can enter the mixer and is transformed to the IF band which is then input into the noise figure analyzer. This measurement is called as the double sideband measurement, i.e. the double sideband (DSB).

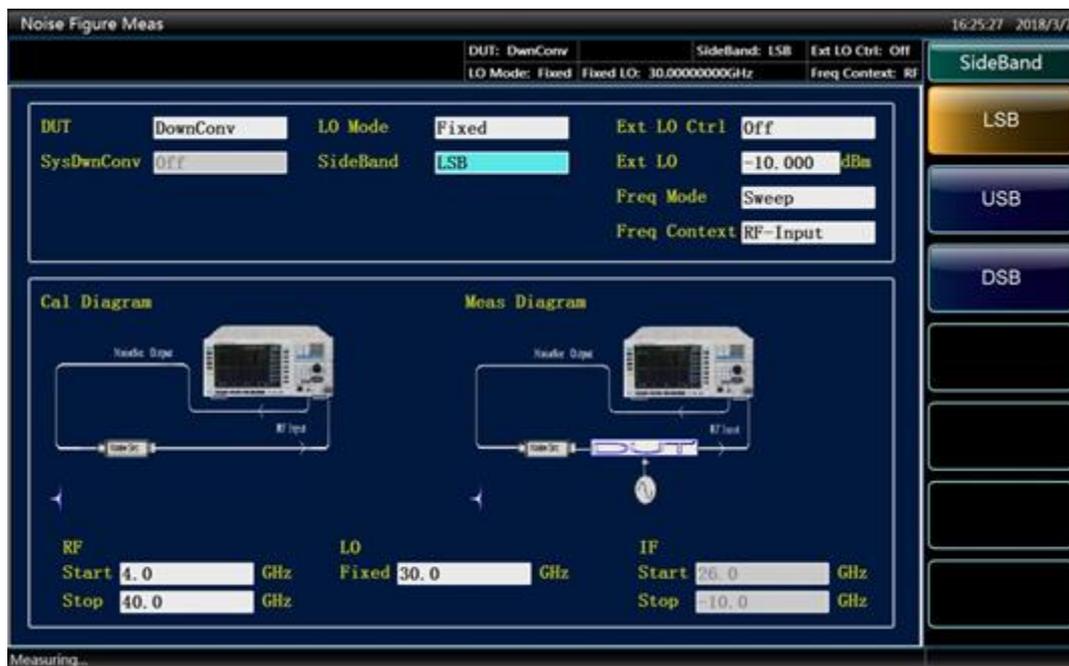


Fig.4.16 Sideband Setup

### 4.2.1.2 Single-sideband measurement

#### 1) Instructions for single-sideband (SSB) measurement

Most of the mixers are used for the single-sideband (SSB) mixing (including the lower sideband and upper sideband). Therefore, the single-sideband noise figure shall be measured. For the single-sideband measurement, the image frequency sideband, LO leakage and other products of higher-harmonic mix shall be removed with the proper filter. The expensive filter is necessary for the single-sideband measurement. Therefore, the double sideband measurement may also be selected with necessary correction and compensation.

The filter shall be selected properly according to the measurement requirements and in consideration of the following factors:

- First, determine the working frequency range of DUT: RF input, LO input and IF output.
- Calculate the image frequency range.
- Calculate the frequency range covered by the harmonic mixing mode of the LO.
- Select one filter between the noise source and DUT which permits the useful input frequency band and prevents the unnecessary sideband signals.
- Based on the local oscillator frequency range (and harmonic), determine whether the noise figure analyzer input shall be protected by a filter to prevent the analyzer sensitivity from deteriorating due to the local oscillator leakage.
- It is necessary to place one filter between the DUT and noise figure analyzer to prevent the noise figure measurement accuracy from being affected by the leakage from local oscillator to IF port.

If the filter is unable to meet all requirements due to the mutual conflict between any above frequency ranges, the frequency range may be measured in sections with different filter for each frequency section. If DUT is a complicated mixer and it already contains the filter for the corresponding frequency section, make sure that the mixer is working at the single-sideband mode. For the noise figure measurement of such mixer, the external filter is unnecessary.

Single-sideband mixer measurement is as shown in Fig.4.17 (downconverter, lower sideband), the built-in filter of the mixer inhibits the upper sideband signal to make sure that the mixer is working at the single-sideband mode. With the decrease of IF frequency, upper sideband and lower sideband become closer to local oscillator frequency, which makes the filtering more difficult. With the decrease of IF, it is impossible to conduct the filtering and single-sideband measurement. The filter bandwidth restricts the sweep range of LO or IF during the measurement.

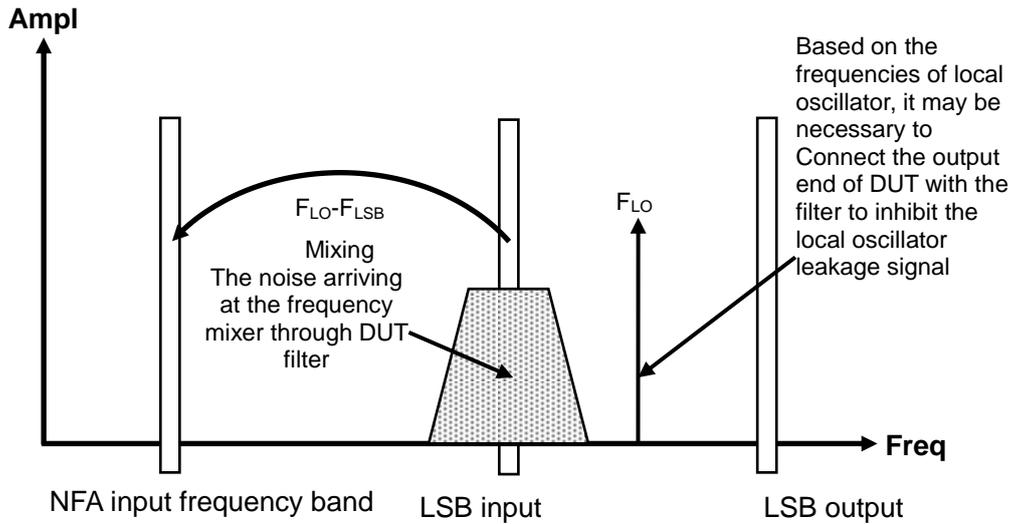


Fig. 4.17 Single-sideband Mixer Measurement

The noise figure analyzer according to the mixer measurement mode setup, conduct the corresponding frequency calculations, control the working frequency of noise figure analyzer and the output frequency of external local oscillator, and measure the noise figure properly.

**2) Local oscillator mode setup**

**a) Variable LO**

In the Variable LO (fixed IF) mode, the LO frequency of measured converter is under the sweep status, the IF frequency of converter which is input to the noise figure analyzer port is the fixed value.

**i. Lower sideband variable LO and fixed IF**

The changing situations of filter passband, RF frequency, sweep LO frequency and fixed IF for the downconverter sweep measurement of lower sideband variable LO and fixed IF mode are as shown in Fig.4.18. This mode measures the noise figure of the mixer, and this is the typical application of single-sideband mode.

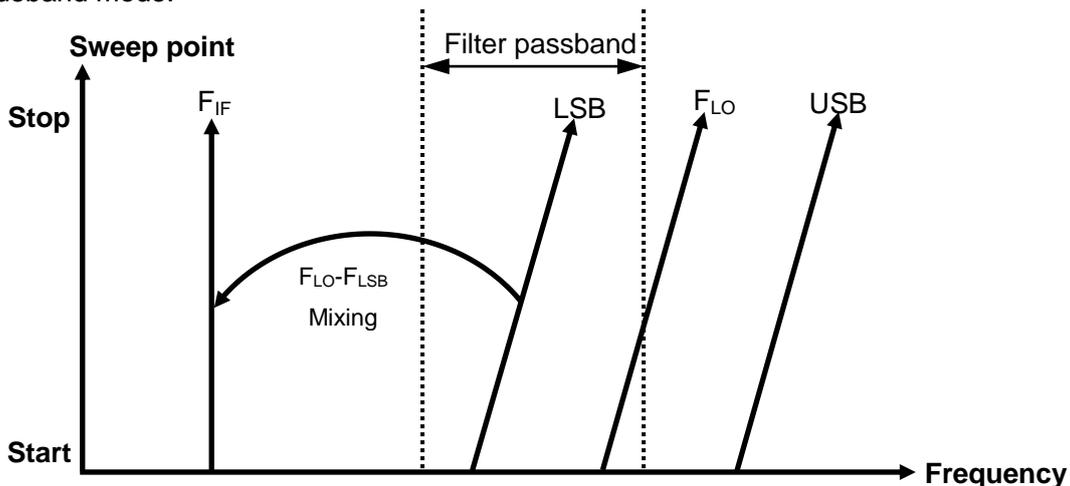


Fig.4.18 Lower Sideband Measurement

The filter is used to inhibit the upper sideband (USB) via the lower sideband (LSB). Actual filter has a certain transitional bandwidth. Therefore, a gap shall be left between the maximum frequency of lower sideband and the minimum frequency of upper sideband. For the actual measurement, a higher IF may

## 4.2 Advanced operation guide

be used to enlarge the frequency gap between the upper sideband (LSB) and lower sideband (LSB) so as to conduct the sweep measurement at broader range and simplify the filter design.

The filter may be low-pass type or band-pass type, and shall permit the signals within the lower sideband sweep frequency range but inhibits the signals within the upper sideband sweep frequency range. The sweep width as shown in Fig.4.18 shall not be more than  $2 \times \text{IF}$  frequency.

### ii. Upper sideband variable LO and fixed IF

Upper sideband variable LO and fixed IF mode is similar with the lower sideband variable LO and fixed IF mode, and the filter shall be band-pass type or high-pass type. Band-pass filter has the advantage of inhibiting the parasitic harmonic mixing mode signal. The related settings of this mode are as shown in Fig.4.19, similarly the sweep width shall be less than  $2 \times \text{IF}$  frequency range minus the filter transitional bandwidth.

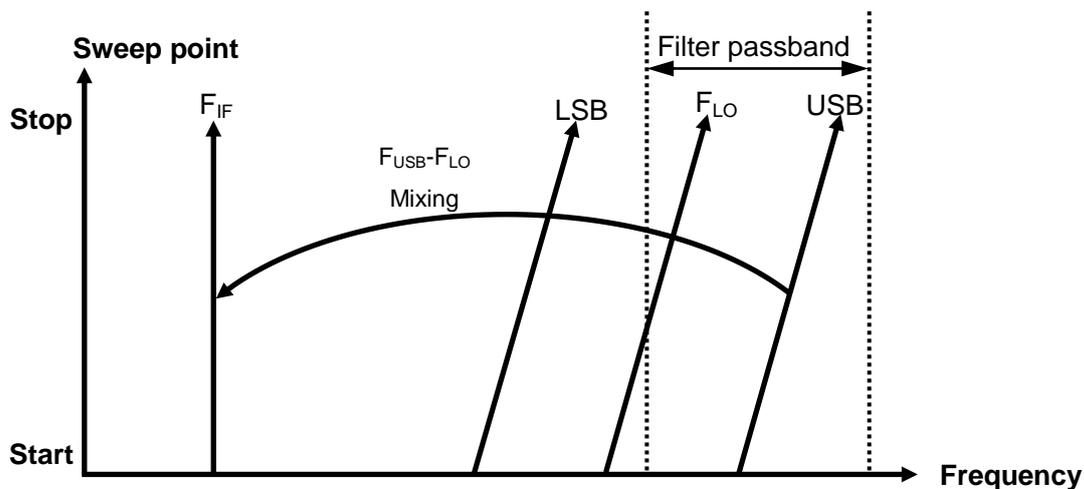


Fig.4.19 Upper Sideband Measurement

### b) Fixed LO

The main advantage of fixed LO is that the programmable local oscillator signal source is unnecessary. The disadvantages include the limited available sweep width and more stringent requirements for the sideband selection filter. At the fixed LO (variable IF) mode, the mixer's output sweep IF is input to the noise figure analyzer input port, and the LO frequency is fixed during the measurement.

#### i. Lower sideband fixed LO variable IF

Fig.4.20 shows how the noise figure analyzer sweeps the tuned receiving frequency reversely from HF to LF with the increase of RF frequency at the lower sideband measurement mode. The filter in need may be low-pass type or band-pass type, with the maximum sweep width not more than the maximum IF frequency minus the transitional bandwidth of filter.

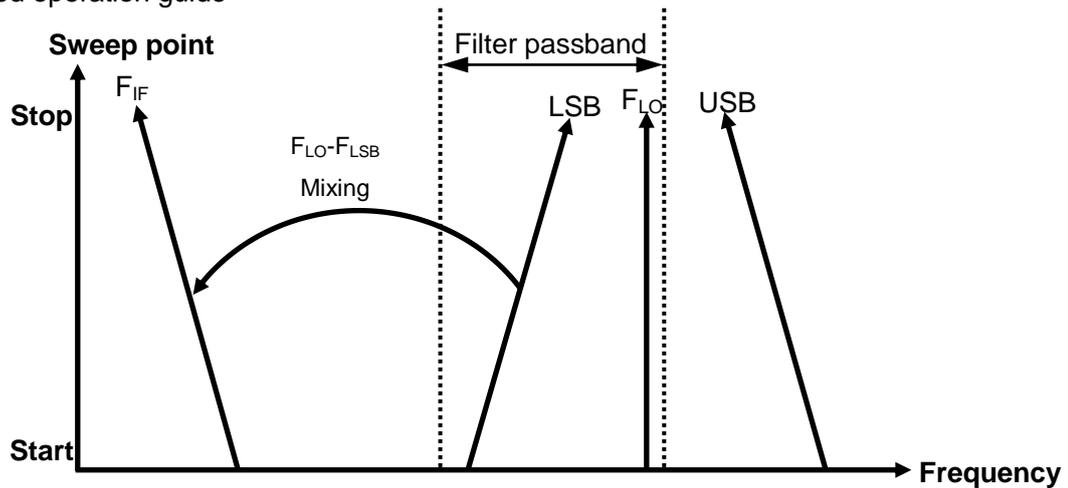


Fig.4.20 Lower Sideband Measurement

### ii. Upper sideband fixed LO variable IF

Fig.4.21 shows how the noise figure analyzer tunes the receiving frequency at normal direction at the upper sideband fixed LO mode. The filter may be band-pass type or high-pass type, with the maximum sweep width not more than the maximum IF frequency minus the transitional bandwidth of filter.

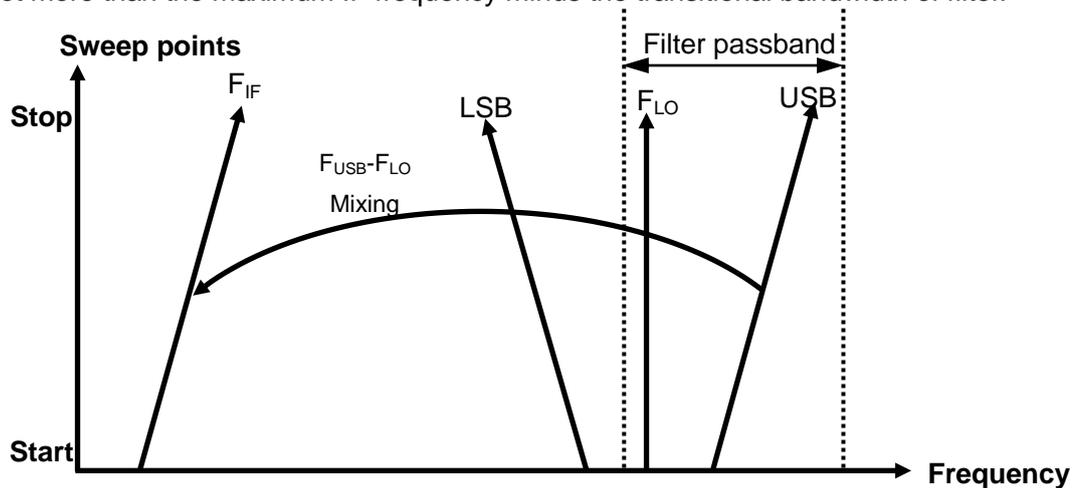


Fig.4.21 Upper Sideband Measurement

#### 4.2.1.3 Double sideband measurement

##### 1) Instructions for double sideband (DSB) measurement

Double sideband noise figure measurement mode is necessary for the following two conditions:

- The filter can not be provided for inhibiting the image frequency.
- Single-sideband filter can not cover the necessary measurement frequency range.

The filtering is necessary for the double sideband measurement. However, the performance indicator requirements for filter may be simplified significantly. The above measurement advantages of double sideband is at the expense of frequency resolution and measurement accuracy.

If the IF frequency of DUT is low, it can be ensured that the noise source ENR, DUT gain and noise figure is linear between two sidebands, and the average power of two sidebands is equal to the noise power of center frequency point and local oscillator frequency point.

Fig.4.22 shows that the noise from both sidebands will increase combinedly during the measurement

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process, and when DUT is not connected during the measurement, only the noise power within one frequency band of IF frequency is measured. If all performances between both sidebands remain unchanged, the power of received noise during the measurement will double (i.e. 3dB), but this will not happen during the calibration process. This effect may be corrected with the loss compensation function of noise figure analyzer by inputting -3dB fixed (Before DUT) loss compensation value and specifying the temperature (Before DUT) value for loss compensation correction which shall be equal to the cold temperature value of noise source. Through the above loss compensation correction method, the results similar to the single-sideband measurement may be obtained.

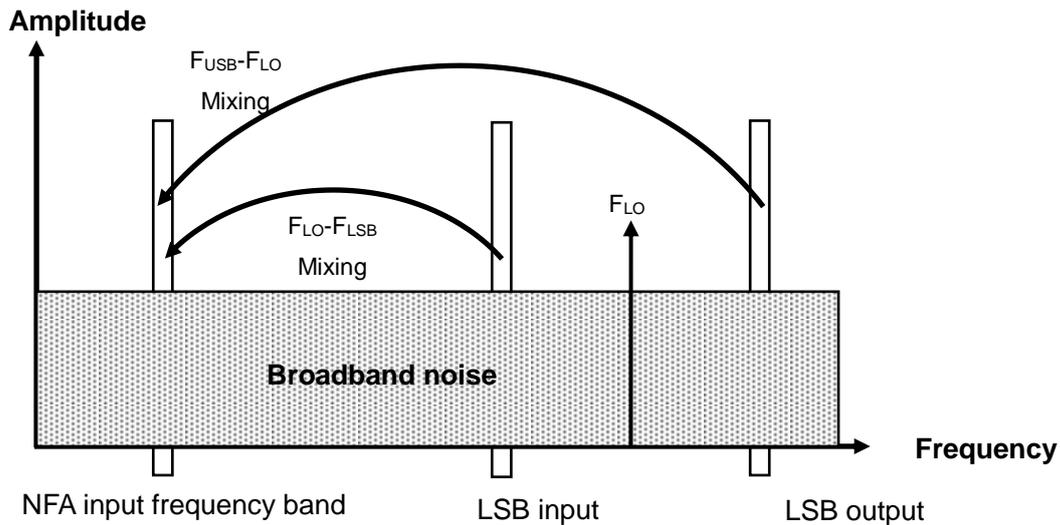


Fig. 4.22 Double sideband Measurement

If the high IF frequency shall be used or the performance changes between the upper and lower sidebands, the above assumption fails. The double sideband measurement will introduce larger measurement error. If DUT performance or noise source ENR changes greatly within  $[F_{LO} \pm F_{IF}]$  frequency range, the double sideband shall not be used for measurement.

## 2) Local oscillator mode setup

### a) Variable LO

At the variable LO (fixed IF) mode, IF frequency at noise figure analyzer input port is the fixed value, and the LO frequency of converter during the measurement is in the sweep status. The changing situations of upper and lower sidebands RF input frequency, sweep local oscillator frequency and fixed IF for the sweep measurement of double sideband downconverter are as shown in Fig.4.18. This mode measures the noise figure in the input frequency range of DUT, and this is the typical application of double sideband mode.

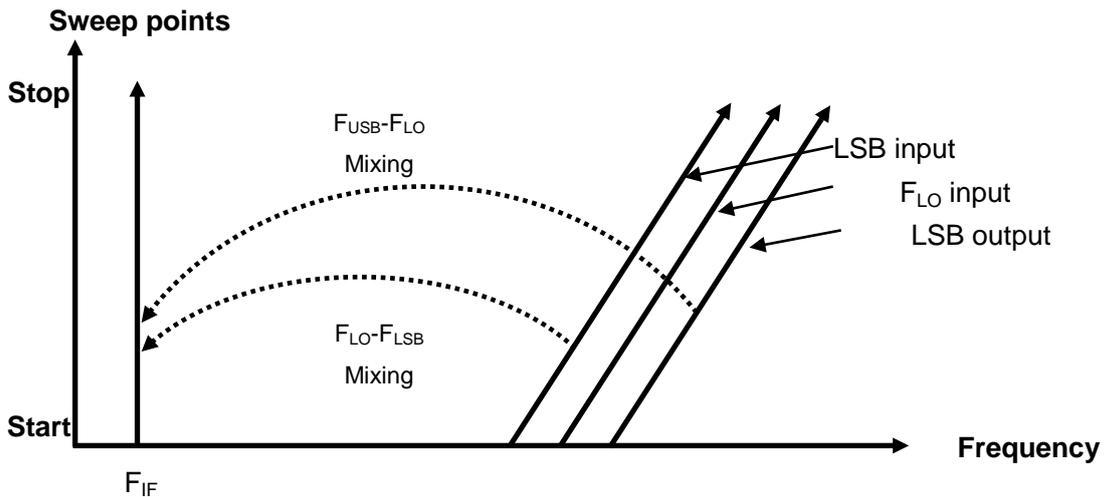


Fig.4.23 Fixed IF Measurement

### b) Fixed LO

As the local oscillator frequency remains unchanged, the IF frequency at the noise figure analyzer input port is at the sweep status, and Fig.4.24 shows how each signal frequency changes at this mode.

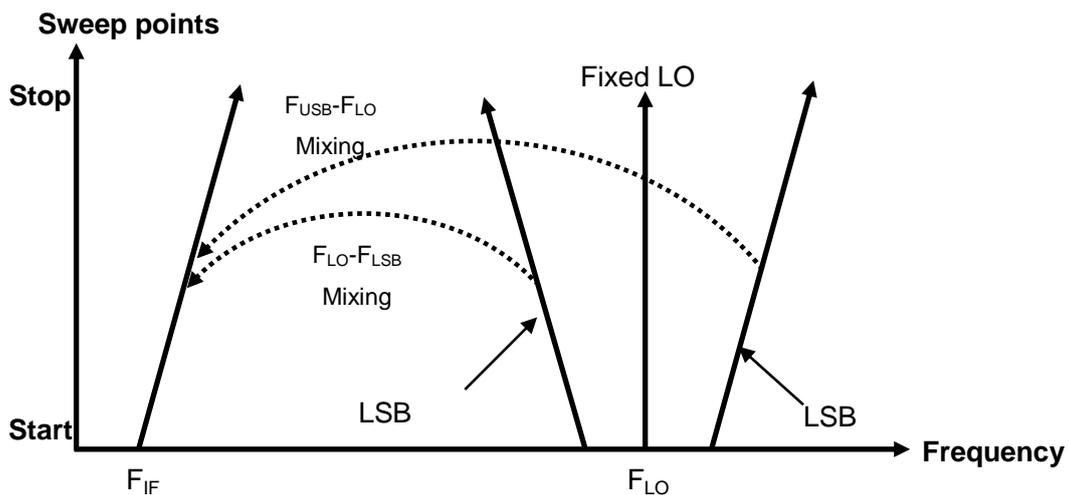


Fig.4.24 fixed LO Measurement

The fixed LO variable IF mode is used to measure the noise figure for the mixer with fixed LO and outputting the sweep IF signal application, of which the RF input of upper and lower sidebands are extended symmetrically against the local oscillator frequency, but the average value remains unchanged. This mode is very useful for the measurement application focusing on how the noise performance of mixer changes with the IF frequency sweep.

#### 4.2.1.4 Factors affecting the measurement of upconverter and downconverter noise figure

- 1) Some RF input signals directly leak to IF output.
- 2) Some local oscillator signals and their harmonics directly leak to IF output.
- 3) Input signal and local oscillator harmonic generate the mixing products.
- 4) Other disturbing signals from the noise figure test system.

##### 1) Signal leakage

As the frequency range of noise source is broad, the input signal may direct leak to the mixer output port.

Generally, the signal leakage has little influence on the noise figure measurement, unless the RF to IF leakage of mixer is larger.

## 2) Local oscillator leakage

The local oscillator power is usually higher than the maximum power of RF input signal used by the mixer. Compared with the levels of various signals involved in the noise figure measurement, the leakage local oscillator power level of mixer output port is rather higher. Therefore, for the measurement of the converter's noise, the influences of local oscillator leakage shall be considered.

### WARNING

#### **Avoid the invalid measurement and even the noise figure analyzer damage:**

When the noise figure analyzer is working at RF band, if the frequency of local oscillator is so low that it can pass through the RF input low-pass filter of noise figure analyzer (4.0GHz low-pass filter), the local oscillator leakage signal may result in the compression of the front high-gain low-noise amplifier, thus affecting the noise figure measurement accuracy of DUT. If the IF port leakage power of local oscillator is rather higher, the measurement may fail. The proper filter may be added between the DUT output and noise figure analyzer input port to filter the local oscillator frequency component via IF frequency to relieve the influence of local oscillator leakage on the noise figure measurement accuracy.

## 3) Local oscillator harmonic

The sine-wave local oscillator signals are adopted by the most of the mixers, but the products of local oscillator harmonic mixing may be very high. For the usual diode mixer, the proper local oscillator power level may be selected to make the diode work at saturated and cut-off state, and the mixer is working at the similar switching state. Therefore, the harmonic mixing product of standard balance mixer is similar with the harmonic mixing product of square wave driven mixer. Therefore, for the mixer measurement, in addition to the RF input signal frequency pair  $[F_{LO} \pm F_{RF}]$  at the fundamental wave mixing state, the following a series of RF input frequency pairs shall be considered:

$[F_{LO} \pm F_{IF}]$ ,  $[2F_{LO} \pm F_{IF}]$ ,  $[3F_{LO} \pm F_{IF}]$ ,  $[4F_{LO} \pm F_{IF}]$ ,  $[5F_{LO} \pm F_{IF}]$ .....

For these high-order mixing products, the filtering function shall be activated accordingly. For the much high-order harmonic mixing products, the attenuation of mixer against it is very large, and the influence of these mixing products on the measurement value is little.

## 4) Other disturbing signals from the noise figure test system.

The first mixer local oscillator leakage of noise figure analyzer may also interfere with the noise figure measurement. When the analyzer is tuned to the low end of 10 MHz, there shall be a certain limit to the local oscillator leakage of mixer. If the local oscillator leakage is too large, the working state of the noise figure analyzer's IF amplifier may be affected, resulting in the increase of the NFA's noise figure which will affect the uncertainty of noise figure measurement.

### 4.2.1.5 Measures to improve the measurement accuracy

#### 1) The method to reduce the influence of local oscillator leakage on measurement accuracy

When the noise figure analyzer operates at the RF band (less than 4GHz), the local oscillator frequency may be tuned to more than 4.5GHz to avoid the influence on measurement accuracy of the local

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oscillator leakage. If the local oscillator leakage signal frequency is lower than 4.5GHz, the local oscillator leakage will drive the front low noise amplifier of noise figure analyzer into the compressed state, thus resulting in the measurement error, and the increase of RF Attenuation will reduce the receiving sensitivity and measurement accuracy of noise figure analyzer. It is recommended to connect an appropriate filter at the DUT output end to filter the local oscillator leakage signal. For the measurement of double sideband downconverter with the local oscillator below 4.5GHz, connect a low-pass filter at the output end, select the cutoff frequency correctly to permit the IF frequency and enable the local oscillator signal to attenuate to the amplitude not affecting the normal working of noise figure analyzer within 10MHz~4.0GHz.

For the measurement of most double sideband downconverters, IF value is rather low relative to the RF and local oscillator frequency. Therefore, the requirement for filter may not be too complicated.

### 2) The method to reduce the influence of harmonic-related signal on measurement accuracy

Many mixers are capable of mixing output local oscillator harmonic related products. Depending on the type of mixer, these mixing output power levels may be sufficient to distort the measured noise figure. To avoid this situation, an input filter shall be added between noise source and DUT.

As for what kind of filter is needed, there is no general guideline to follow, and each case must be considered separately:

- Determine the frequency range of the mixer that must be included: input, local oscillator and output.
- Calculate the frequency range covered by the harmonic mixing mode.
- If the harmonic mixing related products distort the measurement, a filter shall be placed between noise source and DUT. This will permit the useful input frequency band and inhibit the input signal component corresponding to the harmonic mixing mode. If the frequency range is very wide, the measurement may be conducted for different frequency ranges, with a different filter used for each range.
- Based on the local oscillator (and harmonic) frequency range, determine if a filter is needed to protect the noise figure analyzer so that it does not affect the measurement accuracy due to the local oscillator leakage.

## 4.2.2 Examples of upconverter and downconverter mode measurement

DUT is a downconverter set, such as downconverter or receiver, and the downconverter measurement mode shall be selected. DUT is a upconverter set, such as upconverter or transmitter, and the upconverter measurement mode shall be selected.

Downconverter means that the output frequency (IF) is lower than the input frequency (RF).

Upconverter means that the output frequency (IF) is higher than the input frequency (RF).

### Attention

For the upconverter and downconverter measurement, the output frequency (IF) of DUT shall be within the frequency range covered by noise figure analyzer. Upconverter and downconverter may be the single-stage converter or the complex multi-stage converter receiver link.

#### 4.2.2.1 Variable LO and fixed IF

This section takes the downconverter as an example to describe how to perform the upconverter and

## 4.2 Advanced operation guide

downconverter noise figure measurement and various related operations. In this example, downconverter works in the fixed IF and variable LO mode. Fixed IF frequency is set to 1.0GHz, RF frequency range is 3.7GHz to 4.2GHz, and the lower sideband measurement is used with a 4.7GHz~5.2GHz sweep LO. 4.4GHz low-pass filter is used to filter the upper sideband (image frequency sideband). The relevant frequency information is as shown in Fig.4.25.

In the illustrated example, the noise figure analyzer measures the noise figure of the downconverter, the mode setup is fixed IF, variable LO and lower sideband, and the noise figure analyzer is locked at the fixed IF.

The corresponding step settings of this example may be modified to perform the measurement in the fixed LO and variable IF mode. In addition, the corresponding settings may also be modified based on this example for the measurement in the upper sideband and double sideband mode. For several other measurement modes, how to modify the example steps and settings is explained and illustrated.

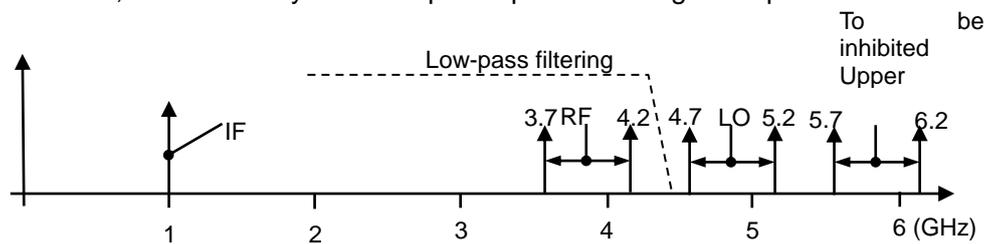


Fig. 4.25 Variable LO, fixed IF and lower sideband

## Attention

### Influence of local oscillator leakage on the DUT measurement:

The local oscillator power is usually higher than the maximum RF input power used by the mixer. Compared with the noise level involved in the noise figure measurement, the leakage local oscillator power level of the mixer output port is rather higher. Therefore, for the measurement of noise figure of the converter, the effect of local oscillator leakage shall be considered.

#### 1) Lower sideband measurement

##### Measurement steps:

##### a) Initial setup for measurement

- Step 1.** Turn on 3986 noise figure analyzer and the local oscillator source, preheat the test system according to the recommended period in order to obtain the accurate measurement value.
- Step 2.** If necessary, control the local oscillator source output frequency and power with the noise figure analyzer and lock the noise figure analyzer and local oscillator source at the same reference frequency. Please refer to the following explanation.

## NOTE

To lock the 3986 noise figure analyzer and local oscillator source at the same reference frequency, the 10MHz reference input or output at the rear panel of noise figure analyzer shall be connected to the 10MHz reference output or input of local oscillator source.

**Step 3.** Press the green **【Preset】** key to restore the noise figure analyzer to the factory default state.

**Step 4.** Load the excess noise ratio of noise source.

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- Step 5.** Set the local oscillator IP address on the 3986 noise figure analyzer.
- Step 6.** Set the local oscillator source IP address (the local oscillator source IP address shall be same with the local oscillator IP address which is set on the noise figure analyzer).
- Step 7.** Connect the system (sometimes the corresponding filter shall be connected for the single-sideband measurement)

**b) Select the mode and make the appropriate mode setup**

- Step 1.** Press the **【Mode Setup】** key to enter the Mode Setup menu.
- Step 2.** Press [DUT Setup] menu key and [Downconv] menu key to select the downconverter measurement mode. When this measurement mode is selected, the SysDwnConv setup is disabled, i.e., the system downconverter mode is not available in the downconverter measurement mode.
- Step 3.** Enable the LO mode setup, and select the "Variable".
- Step 4.** Activate the sideband setup option and select the "LSB".
- Step 5.** Enable the external LO control option, and set the external LO control to "On" or "Off". In the variable LO mode, it is recommended to set it to On.
- Step 6.** Activate the external LO power input box and input the external local oscillator power value with the numeric key and complete the input setting with the unit key.

**NOTE**

Downconverter works in the variable LO and fixed IF mode. When the external LO control option is set to "On", the noise figure analyzer can control the output frequency and power of external LO via the LAN. The LO output frequency simultaneously traces the RF frequency to achieve automatic sweep measurement. If the external LO control option is set to "Off", the user shall manually set the frequency and power value of external LO. The formula for local oscillator frequency are:  $F_{LO}=F_{RF}+F_{IF}$ (LSB);  $F_{LO}=F_{RF}-F_{IF}$  (USB); and  $F_{LO}=F_{RF}$  (DSB).

- Step 7.** Activate the Frequency Mode Setup item and select the frequency mode as "Sweep".
- Step 8.** Activate the RF start frequency input box, input the measured frequency value 3.7 with the numeric key, and press [GHz] unit key to complete the input. Activate the RF stop frequency input box, input the measured frequency value 4.2 with the numeric key, and press [GHz] unit key to complete the input. Additionally, input the RF start frequency and stop frequency also by pressing the **【Freq/Points】** key to enter the Freq/Points menu.
- Step 9.** Activate the fixed IF frequency input box, input "1" with the numeric key, and press [GHz] unit key to complete the input. Mode Setup interface is as shown in Fig.4.26:

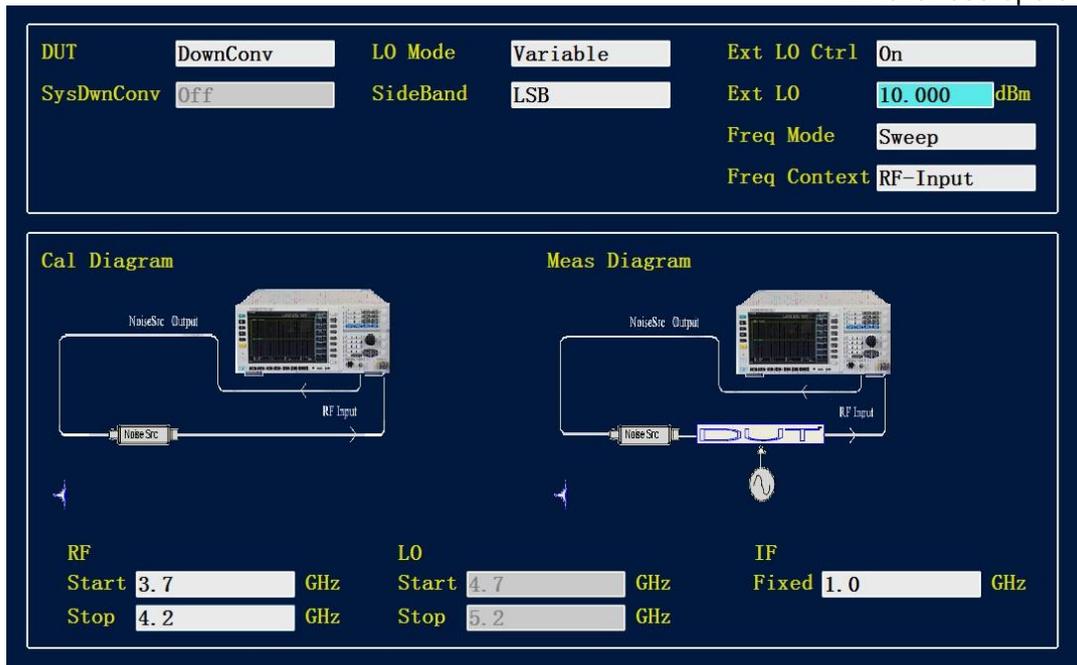


Fig. 4.26 Mode Setup interface

### c) Set the sweep point number and average value

- Step 1.** Press the **【Freq/Points】** key to enter the Freq/Points setup menu.
- Step 2.** Press [Points] menu key, input 21 with numeric key and press [Enter] menu key to complete the input.
- Step 3.** Press **【Avg】** key, and press [Average] menu key to set [Average ON/OFF] mode (it defaults to be "Off").
- Step 4.** Input average number "4" with numeric key and press [Enter] menu key to complete the input.

### d) Calibration

In this mode, the system connection for calibration shall be same with that for the basic amplifier measurement, and the noise source output is directly connected to the RF input port (50Ω) of 3986 noise figure analyzer as shown in Fig.4.27.

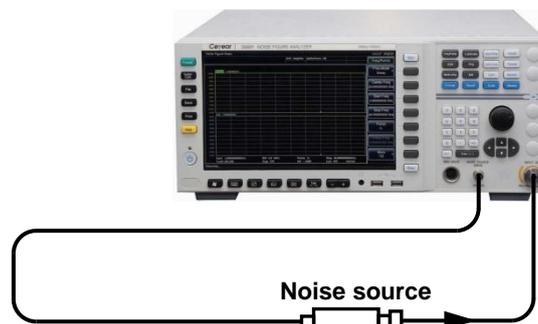


Fig.4.27 Scheme Diagram of Calibration Connection

- Step 1.** Press **【Calibrate】** key to enter the calibration menu.
- Step 2.** Press [Calibrate] menu key twice to calibrate. When [Calibrate] key is pressed for the first time, it is prompted to press again. After the calibration is completed, the typical results after calibration are displayed in the table format as shown in Fig.4.28.



Fig.4.28 Typical calibrated results at the downconverter measurement mode

### Attention

In the upconverter and downconverter measurement mode, if the DUT is not connected after the calibration, the gain and noise figure values are generally not zero. The reason is that the excess noise ratio corresponding to the upconverter and downconverter IF frequency is called by noise figure analyzer during calibration; and after the calibration is completed, the excess noise ratio is switched into the value corresponding to the RF frequency. In addition, if the RF or IF filter is added after calibration, the measurement error introduced by additional filter shall be corrected with the loss compensation function.

#### e) Measurement

For the noise figure and gain measurement for the stage-correction as shown in Fig.4.29, connect the DUT to the system and measure it. The measurement values of noise figure and gain are as shown in Fig. 4.30.

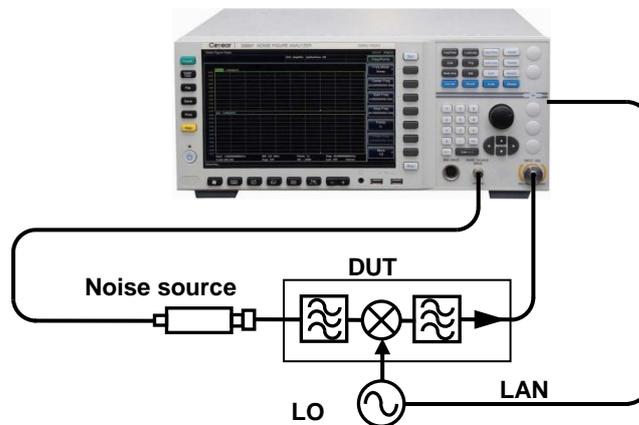


Fig.4.29 Schematic Diagram of Measurement Connection



Fig.4.30 Typical measurement values at the downconverter measurement mode

## 2) Upper sideband measurement

The steps for upper sideband measurement are basically the same as those of lower sideband, but it is generally required to provide a filter which filters the image frequency component of lower sideband. In the mode setup, the "USB" shall be selected.

## 3) Double sideband measurement

The steps for double sideband measurement are basically the same as those of lower sideband, but the image frequency inhibition filters are not required for the RF input ports of upconverter and downconverter. In the mode setup, the "DSB" shall be selected. In the double sideband measurement mode, it is recommended to set the DUT to the low IF output in order to obtain an approximate accurate noise figure measurement value.

### Attention

In the upconverter measurement mode, there are only two sideband settings, i.e. the upper sideband and lower sideband, and the LO frequency calculation formula is:  $F_{LO}=F_{RF}+F_{IF}$  (LSB) and  $F_{LO}=F_{IF}-F_{RF}$  (USB).

#### 4.2.2.2 Fixed LO and variable IF

##### 1) Lower sideband measurement

For this measurement mode, the LO of the mixer under test is locked at a fixed frequency, the noise figure analyzer works in the mixer's IF range, and the fixed LO and downconverter convert the RF frequency range to the sweep IF range which can be received by the noise figure analyzer. The measurement steps are as follows:

##### a) Initial setup for measurement

**Step 1.** Turn on noise figure analyzer and the LO source, preheat the test system according to the

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recommended period in order to obtain the accurate measurement value. Connect 10MHz reference if necessary.

**Step 2.** Press the green **【Preset】** key to restore the noise figure analyzer to the factory default state.

### NOTE

To lock the noise figure analyzer 3986 and local oscillator source at the same reference frequency, the 10MHz reference input or output at the rear panel of noise figure analyzer shall be connected to the 10MHz reference output or input of local oscillator source.

**Step 3.** Load the excess noise ratio of noise source.

**Step 4.** Connect the system (sometimes the corresponding filter shall be connected for the single-sideband measurement)

#### b) Select the measurement mode and make the appropriate mode setting

**Step 1.** Press the **【Mode Setup】** key to enter the Mode Setup menu.

**Step 2.** Press [DUT Setup] menu key and [Downconv] menu key to select the downconverter measurement mode. When this measurement mode is selected, the SysDwnConv setup is disabled, i.e., the system downconverter mode is not available in the downconverter measurement mode.

**Step 3.** Enable the LO mode setup, and select "Fixed".

**Step 4.** Activate the sideband setup option and select the "LSB".

**Step 5.** Activate the external LO control options and select the external LO control mode as "On" or "Off". In LO fixed mode, the general setting is "Off".

**Step 6.** Activate the external LO power input box and input the external local oscillator power value with the numeric key and complete the input setting with the unit key. If the LO control mode is set to "Off", user shall manually set the output frequency and power of local oscillator source.

### Attention

If the upconverter and downconverter work under the fixed LO and variable IF mode, generally, it is not necessary to control the output frequency and power of local oscillator source with the noise figure analyzer. However, the local oscillator frequency shall be input in the Mode Setup interface.

**Step 7.** Activate the Frequency Mode Setup item and select the frequency mode as "Sweep".

**Step 8.** Select the measurement frequency type as "IF-input".

**Step 9.** Activate the IF start frequency and stop frequency input box, input the measured frequency value with the numeric key, and complete the input with unit key. Additionally, set the IF start frequency and stop frequency also by pressing the **【Freq/Points】** key to enter the Freq/Points menu.

### NOTE

The downconverter works in the fixed LO and variable IF mode. Under the Mode Set boot interface, the measurement frequency type defaults to "IF-input". It is recommended that the user prefer the default setting. If the user sets the type of measurement frequency as "RF-input", the operation corresponds to the Step 9. Activate the RF start frequency and RF stop frequency input box, input the start frequency and stop frequency with numeric key and complete the input with unit key.

Set the sweep point number and average value

**Step 1.** Press the **【Freq/Points】** key to enter the Freq/Points setup menu.

**Step 2.** Press [Points] menu key, input the number of sweep points with numeric key and press [Enter] menu key to complete the input.

**Step 3.** Press **【Avg】** key, and press [Average] menu key to set [Average ON/OFF] as "ON".

**Step 4.** Input average number with numeric key and press [Enter] menu key to complete the input.

### c) Calibration

In this mode, the system connection for calibration shall be same with that for the basic amplifier measurement, and the noise source output is directly connected to the RF input port (50Ω) of the noise figure analyzer as shown in Fig.4.31.

**Step 1.** Press **【Calibrate】** key to enter the calibration menu.

**Step 2.** Press [Calibrate] menu key twice to calibrate. The first time you press the menu key you are prompted to press it again.

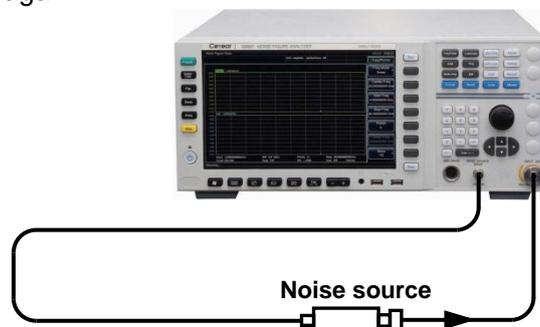


Fig.4.31 Schematic Diagram of Calibration Connection at the Downconverter Measurement Mode

### d) Measurement

For the noise figure and gain measurement for the second-stage correction as shown in Fig.4.32, connect the DUT to the system and measure it.

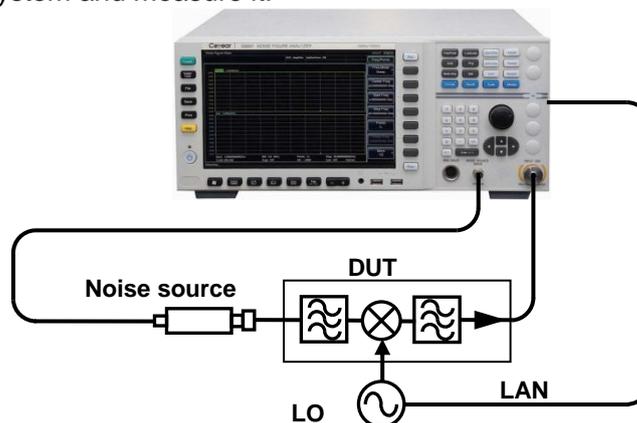


Fig.4.32 Schematic Diagram of Measurement Connection at the Downconverter Measurement Mode

## 2) Upper sideband measurement

The steps for upper sideband measurement are same as those of lower sideband. However, it is generally required to provide a filter which filters the image frequency component of lower sideband. In the mode setup, the "USB " shall be selected.

### 3) Double sideband measurement

The steps for double sideband measurement are basically the same as those of lower sideband, but the image frequency inhibition filters are not required for the RF input ports of upconverter and downconverter. In the mode setup, select the "DSB"

#### 4.2.3 Guide for System Downconverter Mode Measurement

In the system downconverter mode, the system downconverter is used to extend the frequency range of noise figure analyzer. When the frequency range of DUT is beyond the frequency range of noise figure analyzer, configure the system downconverter and noise figure analyzer composition test system to conduct the extended-frequency measurement of noise figure.

System downconverter is part of test system for calibration and measurement setup. During the correction process, measure the total noise performance of the system downconverter and noise figure analyzer. Therefore, obtain the accurate measurement value of DUT by performing the second-stage correcting measurement. The excess noise ratio data for the same frequency range is used for both the calibration process and measurement process.

#### Attention

The system downconverter mode is the extend frequency measurement of amplifier-class DUTs. System downconverter is part of test system for the calibration and measurement. In this mode, the frequency conversion is performed in the measurement system rather than in the DUTs. To reduce the measurement uncertainty, it is preferably to select the system downconverter with the small conversion loss and noise figure, and the IF output port shall be well isolated from the local oscillator signal.

##### 4.2.3.1 Sideband selection

In case of the broadband DUT, system downconverter is able to work in the upper sideband, lower sideband or double sideband mode, and conduct the calibration and measurement with the same settings. For the double sideband test mode, the correction for the sum of double sideband powers is unnecessary.

In case of narrowband DUT with the double sideband system downconverter, the calibration will be set at the true double sideband mode. However, the measurement mode setup is affected by the DUT bandwidth.

For the measurement at system downconverter mode, there are several possible scenarios:

- 1) DUT bandwidth greatly exceeds the frequency range of lower sideband-upper sideband. Therefore, the normal double sideband measurement value may be obtained.
- 2) DUT bandwidth is far less than the frequency range of lower sideband-upper sideband, and the sweep width is less than the gap between the upper sideband and lower sideband. Therefore, the single-sideband measurement value is generated. In case of the double sideband calibration, the gain shall be corrected.
- 3) DUT is broadband device with the sweep width sufficiently to switch among the upper sideband, lower sideband and double sideband. The different portions of measurement trace are at different measurement sideband. Upper sideband, lower sideband and double sideband may appear at different locations on the same measurement trace. The entire measurement value requires variable gain correction. This condition shall be avoided at the measurement setup.

#### 4.2.3.2 Downconverter measurement mode of double-sideband system

System downconverter works at the variable LO and fixed IF mode. The noise figure analyzer supports the double sideband system downconverter measurement mode. The advantages of double sideband measurement include the wide frequency coverage and the low requirement for filter. Double sideband measurement is suitable for broadband DUT. The general setting principle is to select the low IF if possible to reduce the gap between two sidebands so as to obtain the relatively high measurement accuracy and optimize the frequency resolution.

For the double sideband system downconverter mode, system assumes that the DUT characteristic and excess noise ratio of noise source change linearly in the upper sideband and lower sideband frequency ranges. Therefore, the excess noise ratio is the average frequency of the upper and lower sidebands, i.e. the value corresponding to the local oscillator frequency.

The system downconverter measurement mode of fixed LO and double sideband is as shown in Fig.4.33.

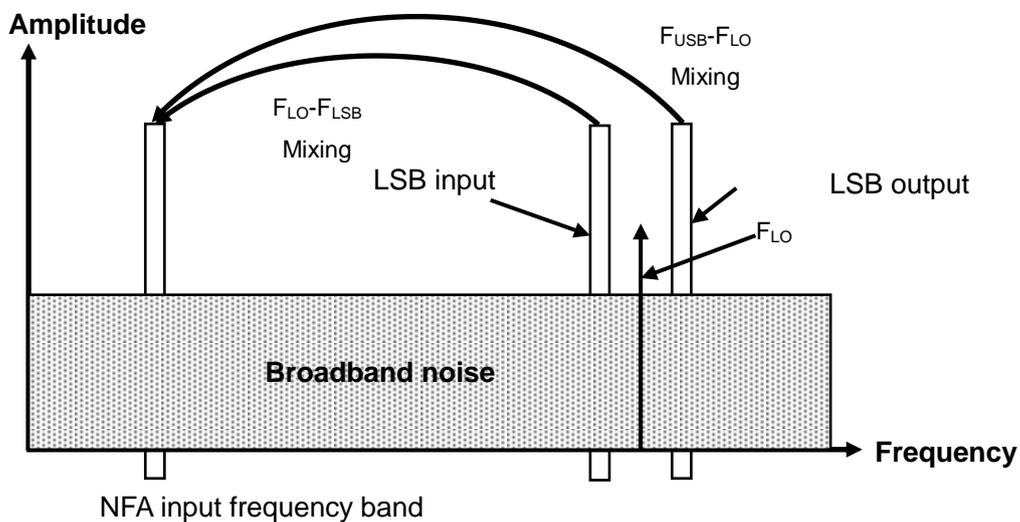


Fig.4.33 System Downconverter Measurement Mode of Fixed LO, Double Sideband

The frequency information for system downconverter measurement mode of fixed IF double sideband is as shown in Fig.4.34.

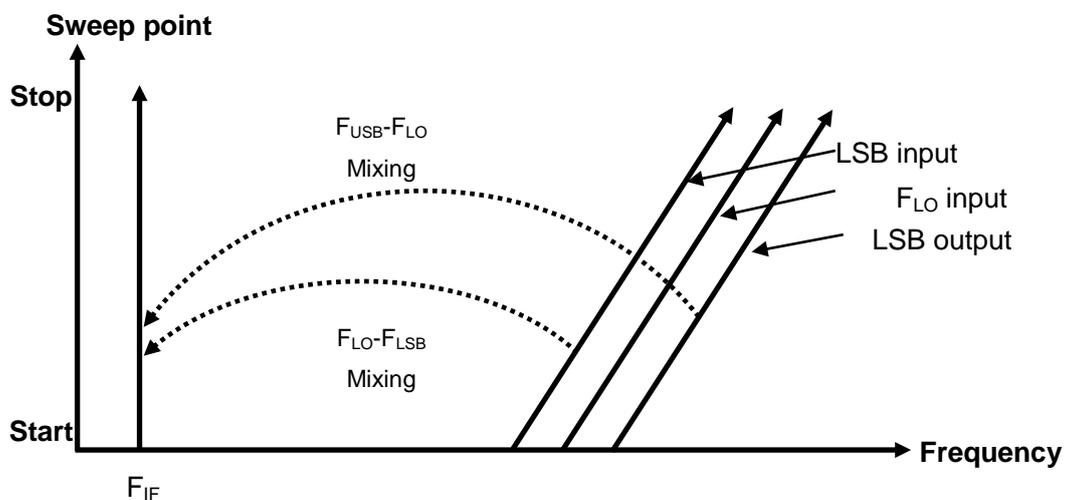


Fig.4.34 System Downconverter Measurement Mode of Fixed IF Double Sideband

### 4.2.3.3 System downconverter measurement mode of Single sideband

In the system downconverter measurement mode, the noise figure analyzer can perform the corresponding frequency conversion and local oscillator control according to the setting of upper sideband or lower sideband. User shall perform the filtering that satisfies the measurement accuracy requirements to conduct the correct upper sideband and lower sideband mode measurement. The filtering requirement depends on the specific measurement.

In the single-sideband measurement process, it is preferably to select a system downconverter with a high IF output to reduce the requirement for the filter separating the upper sideband and lower sideband. The filter required to perform the single-sideband measurement may be part of DUT, but if DUT does not contain a filter, an appropriate filter shall be selected based on the specific needs of measurement and connected to the input port of system downconverter.

For the single-sideband measurement, the filter bandwidth limits the sweep bandwidth of measurement. Therefore, single-sideband measurement is not suitable for broadband DUT. However, the variable LO single-sideband measurement can obtain a wider sweep frequency band than the variable IF measurement.

Fig.4.35 shows how to select a filter for lower sideband system downconverter measurement.

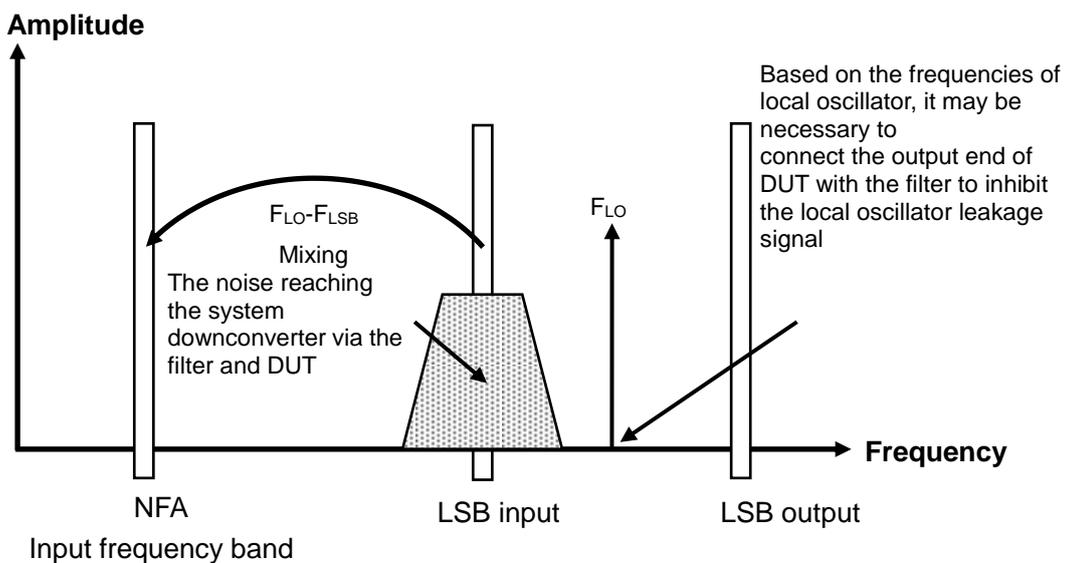


Fig.4.35 System Downconverter Measurement Mode of Fixed LO Lower Sideband

Fig.4.36 shows how to select a filter for upper sideband system downconverter measurement.

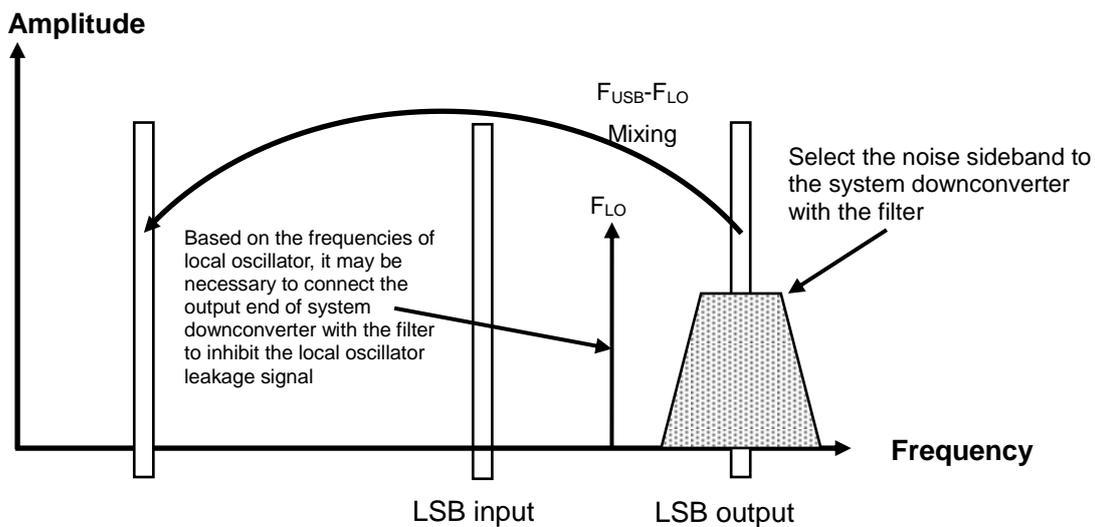


Fig.4.36 System Downconverter Measurement Mode of Fixed LO Upper Sideband

The noise figure analyzer can perform the corresponding frequency conversion and local oscillator control based on the setting of upper sideband or lower sideband. The analyzer can perform the measurements at the variable LO and fixed IF mode (noise figure analyzer works at the fixed IF frequency) and the fixed LO and variable IF mode (noise figure analyzer works within the range of sweep IF). The fixed LO mode is very useful for the system downconverter that contains a fixed LO.

## 1) Variable LO and fixed IF

### a) Lower sideband measurement

Fig.4.37 shows the settings of fixed IF, lower sideband, and system downconverter measurement mode, where the noise figure analyzer controls the local oscillator frequency and performs the sweep measurement according to the set sideband.

The filter is used to inhibit the upper sideband via the lower sideband. Actual filter has a certain transitional bandwidth. Therefore, a gap shall be left between the maximum frequency of lower sideband (at the stop end of sweep) and the minimum frequency of upper sideband (at the start end of sweep). A higher IF may be used to enlarge the frequency gap between the upper sideband and lower sideband so as to conduct the sweep measurement at broader range and simplify the filter design. The filter may be low-pass type or band-pass type, and shall permit the signals within the lower sideband sweep frequency range but inhibits the signals within the upper sideband sweep frequency range. The sweep width as shown in Fig.4.37 shall not be more than  $2 \times \text{IF}$  frequency.

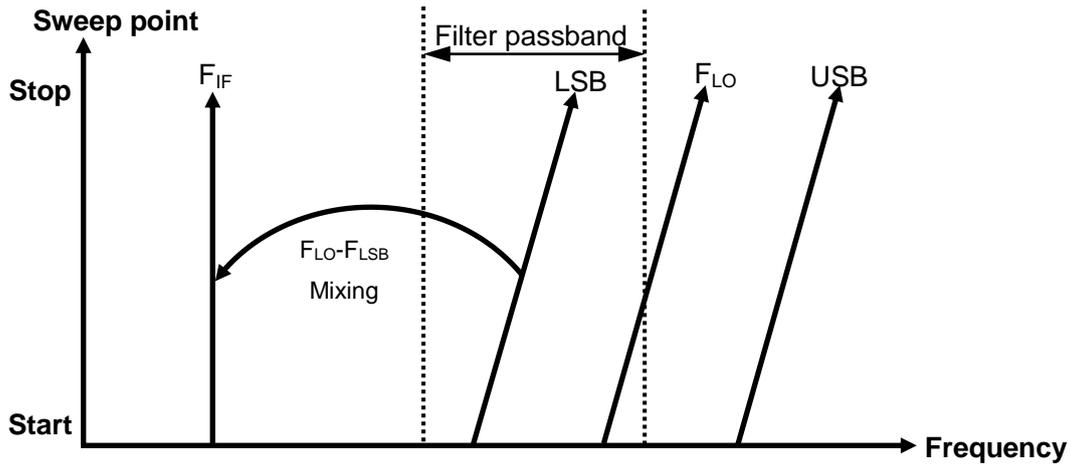


Fig. 4.37 System Downconverter Mode Measurement of Lower Sideband

**b) Upper sideband measurement**

Fixed IF upper sideband mode is similar with the fixed IF lower sideband mode, and the filter shall be band-pass type or high-pass type. The band-pass filter has the advantage of inhabiting the harmonic mixing mode signal. This mode is as shown in Fig.4.38, and similarly the sweep width shall be less than  $2 \times IF$  frequency range minus the filter transitional bandwidth.

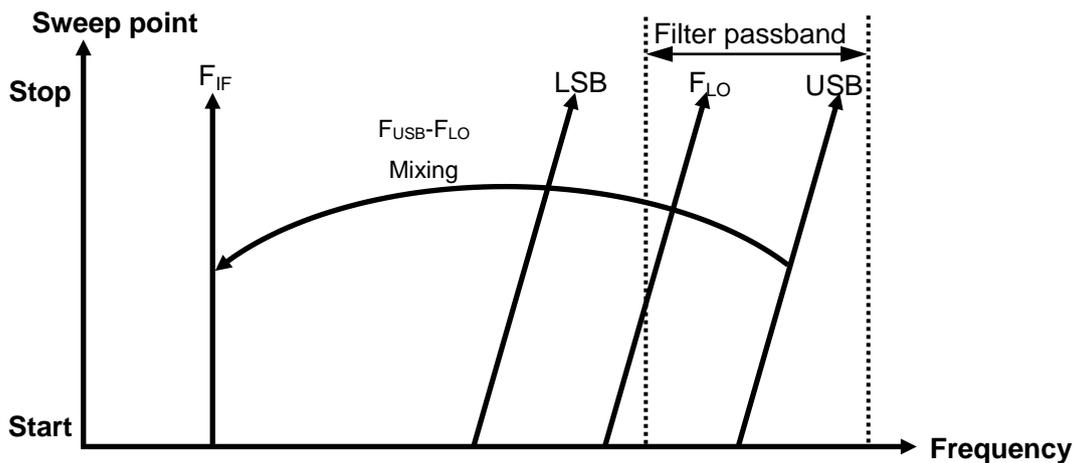


Fig.4.38 System Downconverter Measurement Mode of Upper Sideband

**2) Fixed LO and variable IF**

**a) Lower sideband measurement**

The main advantage of fixed LO and system downconverter mode is that the programmable local oscillator compound source is unnecessary. The disadvantages include the limited available sweep width and more stringent requirements for the sideband selection filter. These modes are suitable for DUT measurement with a narrow frequency band of less than 4MHz.

Fig.4.39 shows how the noise figure analyzer sweeps the input receiving frequency reversely from HF to LF and completes the measurement with the increase of measurement frequency at the fixed LO, variable IF and lower sideband measurement mode. The required filter may be in the form of low-pass or band-pass with the maximum sweep width not exceeding the maximum IF frequency minus the transitional bandwidth of filter.

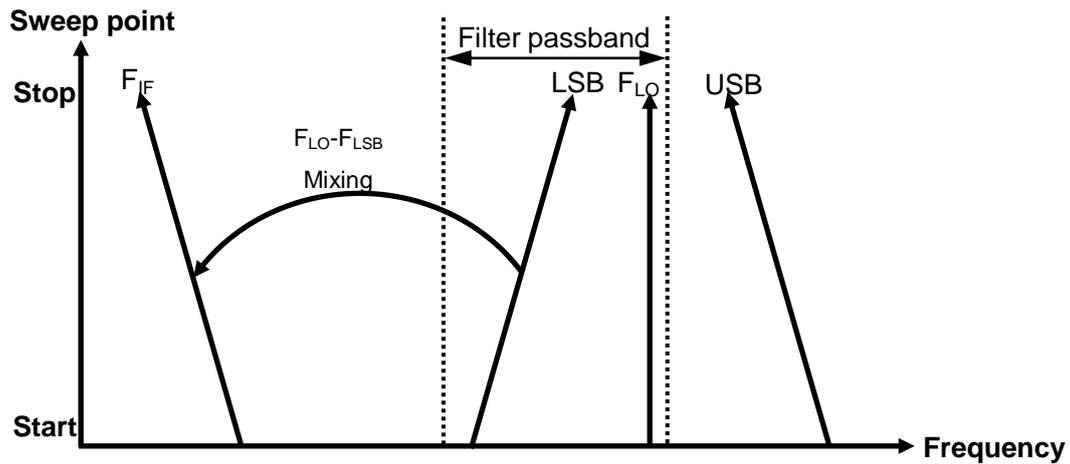


Fig.4.39 System Downconverter Measurement Mode of Lower Sideband

### b) Upper sideband measurement

Fig.4.40 shows that the noise figure analyzer tunes the receiving frequency at the fixed LO, variable IF and upper sideband mode. The filter may be band-pass type or high-pass type, with the maximum sweep width not more than the maximum IF frequency minus the transitional bandwidth of filter.

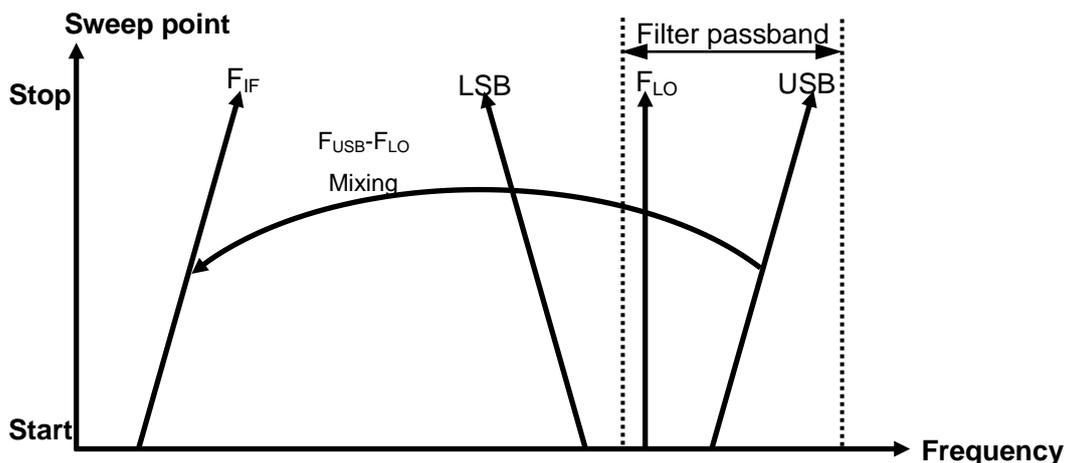


Fig.4.40 System Downconverter Measurement Mode of Upper Sideband

## 4.2.4 Examples of System Downconverter Mode Measurement

DUT is a non-variable device, e.g. the amplifier or filter, but its working frequency exceeds the frequency range of the noise figure analyzer. For the measurement, the system downconverter is required. The working frequency of DUT is transformed into the measurement frequency range of noise figure analyzer through the external mixer. The external mixer is used as part of test system.

### 4.2.4.1 Variable LO and fixed IF

This section takes the amplifier within 37GHz~42GHz as an example to describe how to perform the noise figure measurement under the system downconverter mode and various related operations.

In the illustrated example, the system downconverter works in the variable LO and fixed IF mode. The LO sweeps according to the change of RF input, and measures the noise figure and gain of DUT. With the fixed IF at 10GHz and RF within 37GHz~42GHz, the local oscillator frequency range within 47GHz~52GHz is obtained, the image frequency sideband within 57GHz~62GHz shall be inhibited. The frequency information is as shown in Fig.4.41.

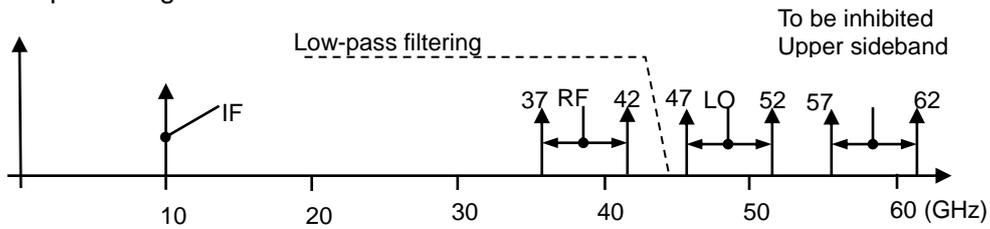


Fig.4.41 Downconverter Measurement of variable LO and fixed IF Lower Sideband System

The main technical specifications of amplifier in the example are as shown in Table 4.2. This example may be modified to implement the lower sideband measurement at the fixed LO and variable IF mode. In addition, the lower sideband and double sideband measurement may also be performed in the example. The modification of operating steps is explained in each method.

Table 4.2 Main Technical Specifications of Amplifier

Frequency range	Typical Gain	Typical noise figure
37GHz to 42GHz	-2.7dB	3dB

### 1) Lower sideband measurement

#### Measurement steps:

##### a) Initial setup for measurement

- Step 1.** Turn on 3986 noise figure analyzer and local oscillator source, preheat the test system according to the recommended period in order to obtain the accurate measurement value.
- Step 2.** If necessary, control the local oscillator source output frequency and power with the noise figure analyzer and lock the noise figure analyzer and local oscillator source at the same reference frequency. Please refer to the following explanation.

## NOTE

To lock the noise figure analyzer and the local oscillator source at the same reference frequency, the 10MHz reference input or output at the rear panel of noise figure analyzer shall be connected to the 10MHz reference output or input of local oscillator source.

- Step 3.** Press **【Preset】** key to preset the analyzer to the factory default state.
- Step 4.** Load the excess noise ratio of noise source.
- Step 5.** Set the local oscillator IP address on the noise figure analyzer.
- Step 6.** Set the local oscillator source IP address (the local oscillator source IP address shall be same with the local oscillator address which is set on the noise figure analyzer).
- Step 7.** Connect the test system (sometimes the corresponding filter shall be connected for the single-sideband measurement)

##### b) Select the measurement mode and make the appropriate mode setting

- Step 1.** Press the **【Mode Setup】** key to enter the Mode Setup menu.
- Step 2.** Press [DUT Setup] menu key and [Amplifier] menu key to select the amplifier measurement mode.
- Step 3.** Activate the system downconverter setting item in the Mode Setup interface and set the SysDwnConv to "On" status.
- Step 4.** Enable the LO mode setup, and select the "Variable".

- Step 5.** Activate the sideband setup option and select the "LSB".
- Step 6.** Enable the external LO control option, and set the external LO control to On or Off. In the variable LO mode, it is recommended to set it to On.
- Step 7.** Activate the external LO power input box and input the external local oscillator power value with the numeric key and complete the input setting with the unit key.

## NOTE

System downconverter works in the variable LO and fixed IF mode, When the external LO control option is set to "On", The noise figure analyzer can control the output frequency and power of external LO via the LAN. The LO output frequency simultaneously traces the RF frequency to achieve automatic sweep measurement. If the external LO control option is set to "Off", the user shall manually set the frequency and power value of external LO. The formula for local oscillator frequency are:  $F_{LO}=F_{RF}+F_{IF}(\text{LSB})$ ;  $F_{LO}=F_{RF}-F_{IF}(\text{USB})$ ; and  $F_{LO}=F_{RF}(\text{DSB})$ .

- Step 8.** Activate the Frequency Mode Setup item and select the frequency mode as "Sweep".
- Step 9.** Activate the RF start frequency input box, input "37" with the numeric key, and press [GHz] unit key to complete the input. Activate the RF stop frequency input box, input "42" with the numeric key, and press [GHz] unit key to complete the input.
- Step 10.** Activate the fixed IF frequency input box, input "10" with the numeric key, and press [GHz] unit key to complete the input. The mode setup interface is as shown in Fig.4.42.

## NOTE

Additionally, set the RF start frequency and stop frequency also by pressing the **【Freq/Points】** key to enter the Freq/Points menu.

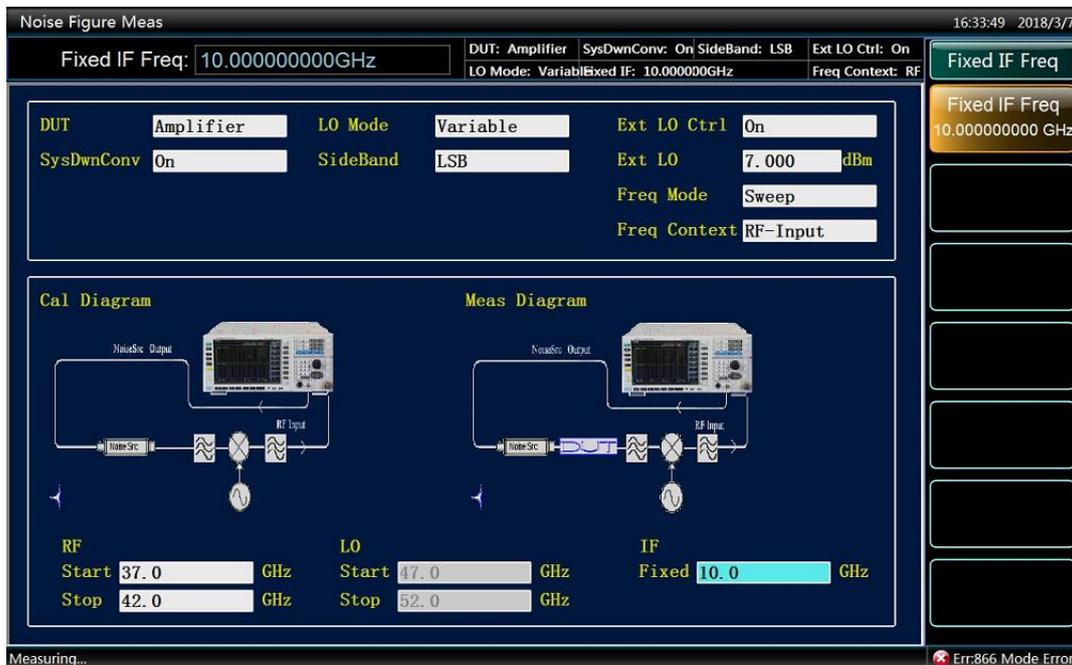


Fig. 4.42 Setting Interface of System downconverter Mode

## 4.2 Advanced operation guide

## c) Set the sweep point number and average value

**Step 1.** Press the **【Freq/Points】** key to enter the Freq/Points setup menu.

**Step 2.** Press [Points] menu key, input 11 with numeric key and press [Enter] menu key to complete the input.

**Step 3.** Press **【Avg】** key, and press [Average] menu key to set [Average ON/OFF] as "ON".

**Step 4.** Input average number "8" with numeric key and press [Enter] menu key to complete the input.

## d) Calibration

Perform the lower sideband measurement. During the calibration, connect the mixer local oscillator port to the local oscillator source output end, and connect the noise source output end with the filter at mixer RF input to inhibit the image frequency, and then connect the mixer IF output end with the noise figure analyzer input port (50Ω). The calibration connection is as shown in Fig.4.43.

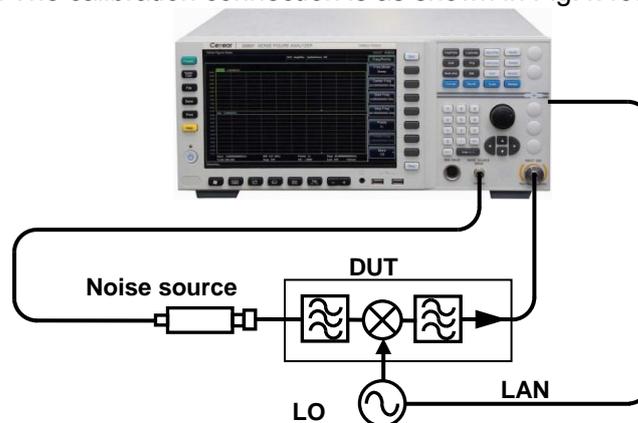


Fig.4.43 Schematic Diagram of Calibration Connection at the System Downconverter Mode

**Step 1.** Press **【Calibrate】** key to enter the calibration menu.

**Step 2.** Press [Calibrate] menu key twice to calibrate. When [Calibrate] key is pressed for the first time, it is prompted to press again. The typical calibrated results shall be displayed with table as shown in Fig.4.44.

Noise Figure Meas			16:36:45 2018/3/7	
DUT: Amplifier		SysDwnConv: On	SideBand: LSB	Ext LO Ctrl: On
LO Mode: VariablBxed		IF: 10.000000GHz	Freq Context: RF	
Freq (GHz)	NF figure (dB) Trc1	Gain (dB) Trc2		
37.0000	0.003	0.002		
37.5000	-0.001	0.012		
38.0000	-0.002	0.007		
38.5000	-0.015	0.009		
39.0000	0.002	0.003		
39.5000	-0.001	0.004		
40.0000	0.008	0.007		
40.5000	0.022	0.002		
41.0000	0.008	0.002		
41.5000	0.012	0.003		
42.0000	0.028	0.001		

Start 37.000000000GHz    BW 4.0 MHz    Points 11    Stop 42.000000000GHz  
Tcold 296.50K    Avgs 8    Att -∞/0dB    Loss Off    Corr

Measuring...

Fig.4.44 Typical Calibrated Results at the System Downconverter Measurement Mode

### e) Measurement

For the noise figure and gain measurement for the second-stage correction as shown in Fig.4.45, connect the DUT to the system and measure it with the results of noise figure and gain as shown in Fig.4.46.

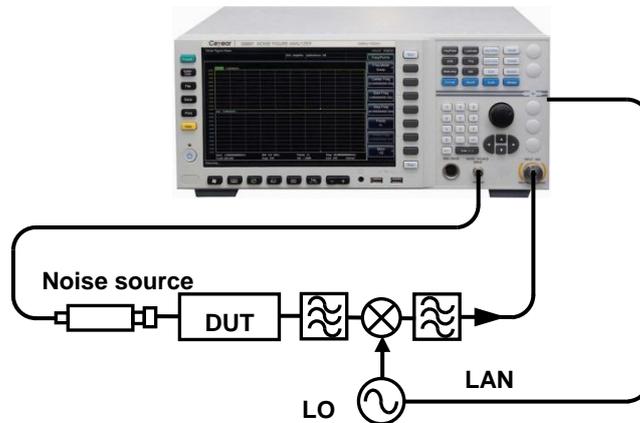


Fig.4.45 Schematic Diagram of Measurement Connection at the System Downconverter Mode

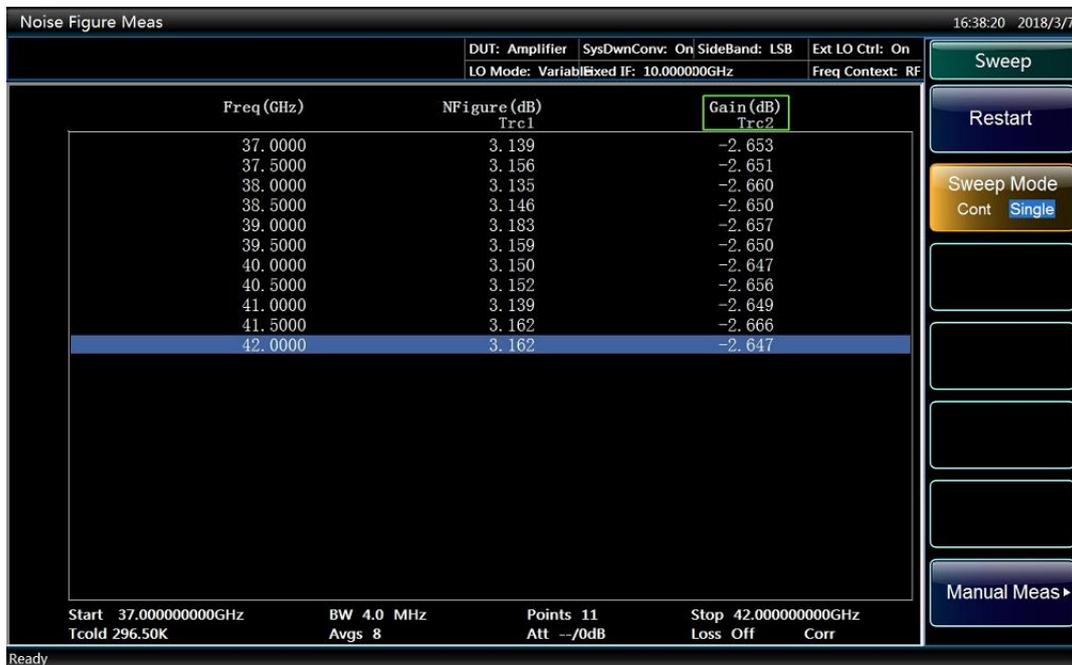


Fig.4.46 Typical Measurement Values at System Downconverter Measurement Mode

### 2) Upper sideband measurement

Upper sideband measurement setup is similar to the lower sideband measurement, but the filter shall be provided to inhibit the lower sideband image frequency signal. Follow the lower sideband setup steps, and set the sideband option to "Upper Sideband" in the Mode Setup interface. System calibration and measurement connection are same as those for lower sideband, and the relevant frequency information is as shown in Fig.4.47.

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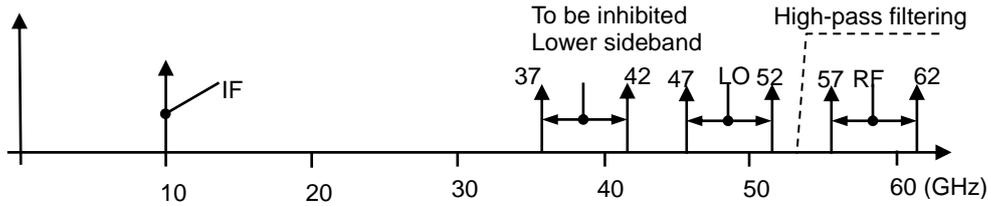


Fig.4.47 Measurement of Variable LO, Fixed IF, Upper Sideband and System Downconverter

3) Double sideband measurement

The steps for double sideband measurement are basically the same as those of lower sideband, but the image frequency inhibition filter is not required for the RF input port of downconverter. And set the sideband option to "DSB" in the Mode Setup interface. In the double sideband measurement mode, it is recommended to set the DUT to the low IF output in order to obtain an approximate accurate noise figure measurement value.

Example of double sideband measurement: RF frequency is set to 37GHz~42GHz, fixed IF to 1GHz, and the sideband to double sideband. The sweep range of local oscillator 37GHz~42GHz is obtained. Fig.4.48 shows the relevant frequency settings, and the calibration and measurement connections are as shown in Fig.4.49 and Fig.4.50.

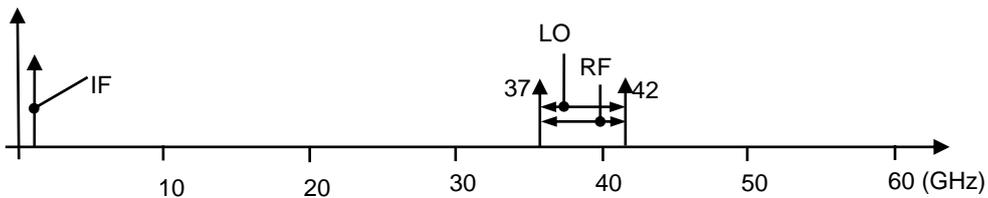


Fig. 4.48 Measurement of Variable LO, Fixed IF, Double Sideband and System Downconverter

**Attention**

To reduce the double sideband measurement error, it is preferable to select a low IF to reduce the measurement error caused by the excess noise ratio difference of upper and lower sidebands, DUT gain in two sidebands, the non-linear frequency response of noise figure analyzer, etc.

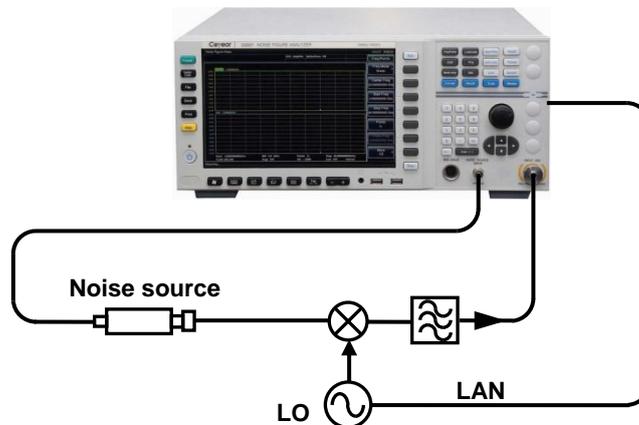


Fig.4.49 Scheme Diagram of Double Sideband Calibration Connection

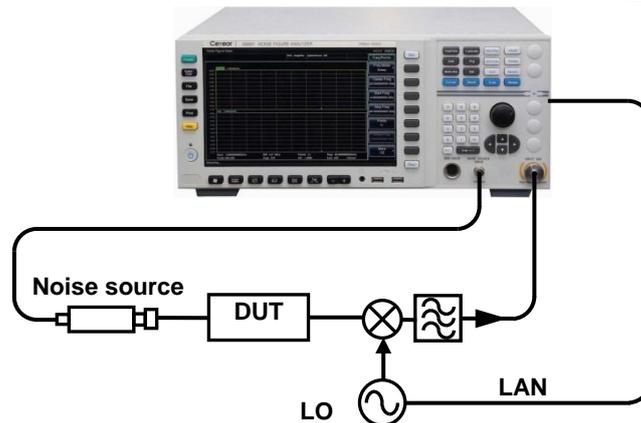


Fig.4.50 Schematic Diagram of Double Sideband Measurement

#### 4.2.4.2 Fixed LO and variable IF

##### 1) Lower sideband measurement

For this measurement mode, the local oscillator is locked at a fixed frequency point, the noise figure analyzer works in IF range of system downconverter, and the fixed LO and downconverter convert the RF frequency range to the IF range which can be received by the noise figure analyzer.

##### Measurement steps:

##### a) Initial setup for measurement

**Step 1.** Turn on noise figure analyzer and the local oscillator source, preheat the test system according to the recommended period in order to obtain the accurate measurement value.

**Step 2.** Connect 10MHz reference if necessary.

### NOTE

To lock the noise figure analyzer and local oscillator source at the same reference frequency, the 10MHz reference input or output at the rear panel of noise figure analyzer shall be connected to the 10MHz reference output or input of local oscillator source.

### Attention

At the fixed LO system downconverter mode, generally it is not necessary to control the output frequency and power of local oscillator source with the noise figure analyzer. However, the frequency of local oscillator shall be input in the Mode Setup menu.

**Step 3.** Press **【Preset】** key to preset the analyzer to the factory default state.

**Step 4.** Load the excess noise ratio of noise source.

**Step 5.** Connect the test system (the corresponding filter shall be connected for the single-sideband measurement)

##### b) Select the measurement mode and make the appropriate mode setting

**Step 1.** Press the **【Mode Setup】** key to enter the Mode Setup menu.

**Step 2.** Press [DUT Setup] menu key and [Amplifier] menu key to select the amplifier measurement mode.

## 4.2 Advanced operation guide

- Step 3.** Activate the system downconverter setting item in the Mode Setup interface and set the SysDwnConv to "On" status.
- Step 4.** Enable the LO mode setup, and select "Fixed".
- Step 5.** Activate the sideband setup option and select the "LSB".
- Step 6.** Activate the external LO control options and set the external LO control mode as "Off" in LO fixed mode.
- Step 7.** Activate the external LO power input box and input the external local oscillator power value with the numeric key and complete the input setting with the unit key. If the external LO control is set to "Off", manually set the frequency and power value on the local oscillator source.
- Step 8.** Activate the Frequency Mode Setup item and select the frequency mode as "Sweep".
- Step 9.** Activate the RF start frequency and stop frequency input box, input the measured frequency value with the numeric key, and complete the input with unit key.
- Step 10.** Activate the fixed LO frequency input box, input the frequency of local oscillator with the numeric key, and press the corresponding unit key to complete the input.

**c) Set the sweep point number and average value**

- Step 1.** Press the **【Freq/Points】** key to enter the Freq/Points setup menu.
- Step 2.** Press [Points] menu key, input the number of sweep points with numeric key and press [Enter] menu key to complete the input.
- Step 3.** Press **【Avg】** key, and press [Average] menu key to set [Average ON/OFF] mode.
- Step 4.** Input average number with numeric key and press [Enter] menu key to complete the input.

**⚠ WARNING**

In the system downconverter measurement mode of variable IF, only the single-sideband measurement mode can be selected. Therefore, the appropriate filter shall be selected to filter the unwanted sideband. The calibration in this mode is the same as that in the variable LO single-sideband mode. It is necessary to ensure that the filter is placed for calibration and measurement.

**d) Calibration**

Perform the lower sideband measurement. During the calibration, connect the mixer local oscillator port to the local oscillator source output port, and connect the noise source output port with the filter at mixer RF input to inhibit the image frequency, and then connect the mixer IF output port with the noise figure analyzer input port. If necessary, connect the IF output port of mixer with the filter to inhibit the unwanted disturbing frequency component with the IF component. The calibration connection is as shown in Fig.4.51.

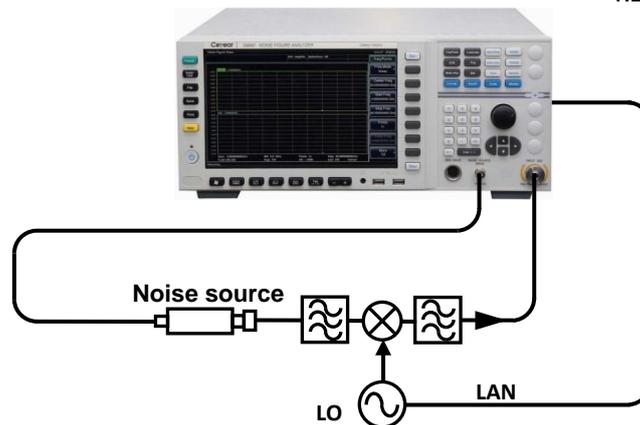


Fig.4.51 Schematic Diagram of Calibration Connection at System Downconverter Mode

**Step 1.** Press **【Calibrate】** key to enter the calibration menu.

**Step 2.** Press [Calibrate] menu key twice to calibrate. The first time you press the menu key you are prompted to press it again.

#### e) Measurement

For the noise figure and gain measurement for the second-stage correction as shown in Fig.4.52, connect the DUT to the system and measure it.

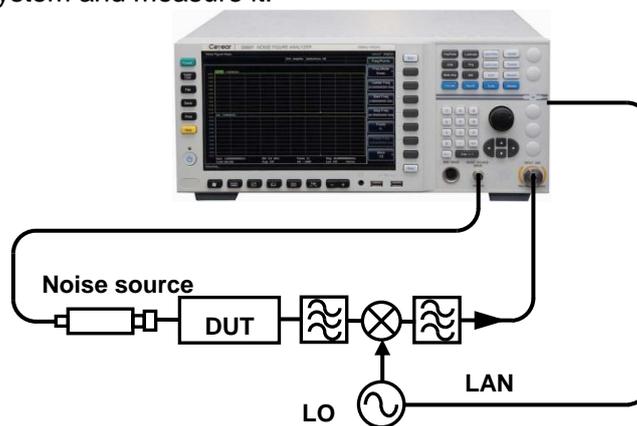


Fig.4.52 Schematic Diagram of Measurement Connection at the System Downconverter Mode

#### 2) Upper sideband measurement

The steps for upper sideband measurement are same as those of lower sideband. However, it is generally required to provide a filter which filters the image frequency component of lower sideband. In the Mode Setup, the "USB" shall be selected.

#### 4.2.5 Frequency Limit

To help user to solve the problem encountered during the setup of measurement mode, a frequency setup limit rule is made for the operation mode.

##### 4.2.5.1 List of Common Terms

Table 4.3 List of Common Terms

Term	Description
$f_{FIF}$	Fixed IF
$f_{FLO}$	fixed LO frequency

## 4.2 Advanced operation guide

$f_{LO}$	External local oscillator frequency
$f_{SIF}$	System input frequency
$f_{START}$	Start frequency
$f_{STOP}$	Stop frequency
IF	DUT output frequency or noise figure analyzer working frequency
RF	DUT input frequency

## 4.2.5.2 General limits

The following general limits apply to various measurement modes.

- 1) Fixed IF  $f_{FIF}$  limit depends on the measurement frequency range of noise figure analyzer.
- 2) fixed LO frequency  $f_{FLO}$  limit depends on the minimum frequency  $f_{LO(MIN)}$  and maximum frequency  $f_{LO(MAX)}$  of the external local oscillator.
- 3) For the mode with fixed IF, frequency range  $f_{SPAN}$  is limited to  $f_{STOP}-f_{START}$ .
- 4) For the mode with variable IF, frequency range  $f_{SPAN}$  is limited to  $f_{SIF(MAX)}-f_{SIF(MIN)}$ .

## 4.2.5.3 Limit for downconverter measurement mode frequency

In this mode, IF output of DUT is smaller than the RF input. For example, DUT is mixer or receiver.

## 1) Variable LO and fixed IF mode

Frequency setup of this measurement mode is limited as follows:

## a) Lower sideband limit

$$\triangleright f_{RF(START)} > f_{FIF}$$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 851 Mode Error" (RF start frequency shall be more than the fixed IF:851).

To rectify this incorrect setting condition, decrease  $f_{FIF}$  or increase  $f_{RF(START)}$ .

## b) Upper sideband limit

$$\triangleright f_{LO(START)} > f_{FIF}$$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 855 Mode Error" (LO start frequency shall be more than the fixed IF:855).

To rectify this incorrect setting condition, decrease  $f_{FIF}$  or increase  $f_{RF(START)}$ .

## c) Double sideband limit

$$\triangleright f_{RF(START)} > f_{FIF}$$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 851 Mode Error" (RF start frequency shall be more than the fixed IF:851).

To rectify this incorrect setting condition, decrease  $f_{FIF}$  or increase  $f_{RF(START)}$ .

## 2) Variable IF and fixed LO mode

Frequency setup of this measurement mode is limited as follows:

## a) Lower sideband limit

$$\triangleright f_{IF(START)} < f_{RF(START)}$$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 853 Mode

Error" (RF start frequency shall be more than IF start frequency:853).

Note:  $f_{RF(START)} = f_{LO} - f_{IF(START)}$

To rectify this incorrect setting condition, decrease  $f_{FLO}$  or increase  $f_{RF(START)}$ .

#### b) Upper sideband limit

➤  $f_{IF(STOP)} < f_{FLO}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 861 Mode Error" (IF stop frequency shall be less than the fixed LO frequency:861).

To rectify this incorrect setting condition, increase  $f_{FLO}$  or decrease  $f_{IF(STOP)}$ .

#### c) Double sideband limit

➤  $f_{IF(STOP)} < f_{RF(STOP)}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 860 Mode Error" (IF stop frequency shall be less than RF stop frequency:860).

To rectify this incorrect setting condition, increase  $f_{FLO}$  or decrease  $f_{IF(STOP)}$ .

### 4.2.5.4 Limit for upconverter measurement mode frequency

In this mode, IF output of DUT is more than the RF input. For example, DUT is transmitter.

#### 1) Variable LO and fixed IF mode

Frequency setup of this measurement mode is limited as follows:

##### a) Lower sideband limit

➤  $f_{RF(STOP)} < f_{FIF}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 857 Mode Error" (RF stop frequency shall be less than the fixed IF frequency:857).

To rectify this incorrect setting condition, increase  $f_{FIF}$  or decrease  $f_{RF(STOP)}$ .

##### b) Upper sideband limit

➤  $f_{RF(STOP)} < f_{LO(STOP)}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 859 Mode Error" (RF stop frequency shall be less than LO stop frequency:859).

To rectify this incorrect setting condition, increase  $f_{FIF}$  or decrease  $f_{RF(STOP)}$ .

#### 2) Variable IF and fixed LO mode

Frequency setup of this measurement mode is limited as follows:

##### a) Lower sideband limit

➤  $f_{IF(STOP)} < f_{FLO}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 866 Mode Error" (system input frequency is out of range: 866).

To rectify this incorrect setting condition, increase  $f_{FLO}$  or decrease  $f_{IF(STOP)}$ .

➤  $f_{IF(START)} > f_{RF(START)}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 854 Mode Error" (IF start frequency shall be more than RF start frequency: 854).

To rectify this incorrect setting condition, decrease  $f_{FLO}$  or increase  $f_{IF(START)}$ .

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**b) Upper sideband limit**➤  $f_{IF(START)} > f_{FLO}$ 

If the measurement setup does not satisfy this limit, the following message appears: "Err: 866 Mode Error" (system input frequency is out of range: 866).

To rectify this incorrect setting condition, decrease  $f_{FLO}$  or increase  $f_{IF(START)}$ .

➤  $f_{RF(STOP)} < f_{FLO}$ 

If the measurement setup does not satisfy this limit, the following message appears: "Err: 858 Mode Error" (RF stop frequency shall be less than the fixed LO frequency: 858).

To rectify this incorrect setting condition, increase  $f_{FLO}$  or decrease  $f_{IF(STOP)}$ .

**4.2.5.5 Limit for system downconverter mode frequency**

DUT is a non-variable device, e.g. the amplifier or filter, but its working frequency exceeds the frequency range of the noise figure analyzer. In the measurement system, the downconverter is required, i.e. an external mixer is used to convert the RF frequency of DUT to the IF frequency that within the frequency range of noise figure analyzer.

**1) Variable LO and fixed IF mode**

Frequency setup of this measurement mode is limited as follows:

**a) Lower sideband limit**➤  $f_{RF(START)} > f_{FIF}$ 

If the measurement setup does not satisfy this limit, the following message appears: "Err: 851 Mode Error" (RF start frequency shall be more than the fixed IF: 851).

To rectify this incorrect setting condition, decrease  $f_{FIF}$  or increase  $f_{RF(START)}$ .

**b) Upper sideband limit**➤  $f_{LO(START)} > f_{FIF}$ 

If the measurement setup does not satisfy this limit, the following message appears: "Err: 855 Mode Error" (RF start frequency shall be more than the fixed IF: 855).

To rectify this incorrect setting condition, decrease  $f_{FIF}$  or increase  $f_{RF(START)}$ .

**c) Double sideband limit**➤  $f_{RF(START)} > f_{FIF}$ 

If the measurement setup does not satisfy this limit, the following message appears: "Err: 851 Mode Error" (RF start frequency shall be more than the fixed IF: 851).

To rectify this incorrect setting condition, decrease  $f_{FIF}$  or increase  $f_{RF(START)}$ .

**2) Variable IF and fixed LO mode**

Frequency setup of this measurement mode is limited as follows:

**a) Lower sideband limit**➤  $f_{RF(STOP)} < f_{FLO}$ 

If the measurement setup does not satisfy this limit, the following message appears: "Err: 866 Mode Error" (system input frequency is out of range: 856).

To rectify this incorrect setting condition, increase  $f_{FLO}$  or decrease  $f_{RF(STOP)}$ .

➤  $f_{RF(START)} > f_{IF(START)}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 853 Mode Error" (IF start frequency shall be more than RF start frequency: 853).

To rectify this incorrect setting condition, decrease  $f_{FLO}$  or increase  $f_{RF(START)}$ .

➤  $f_{FLO} - f_{RF(STOP)} > f_{SIF(MIN)}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 866 Mode Error" (system input frequency is out of range: 866).

To rectify this incorrect setting condition, increase  $f_{FLO}$  or decrease  $f_{RF(STOP)}$ .

### b) Upper sideband limit

➤  $f_{RF(START)} > f_{FLO}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 866 Mode Error" (system input frequency is out of range: 866).

To rectify this incorrect setting condition, decrease  $f_{FLO}$  or increase  $f_{RF(START)}$ .

➤  $f_{IF(STOP)} < f_{FLO}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 861 Mode Error" (IF stop frequency shall be less than the fixed LO frequency:861).

To rectify this incorrect setting condition, increase  $f_{FLO}$  or decrease  $f_{RF(STOP)}$ .

➤  $f_{RF(START)} - f_{FLO} > f_{SIF(MIN)}$

If the measurement setup does not satisfy this limit, the following message appears: "Err: 866 Mode Error" (system input frequency is out of range: 866).

To rectify this incorrect setting condition, decrease  $f_{FLO}$  or increase  $f_{RF(START)}$ .

## 4.2.6 Loss compensation

The loss compensation function of noise figure analyzer may be used to compensate for the loss introduced by the newly added connecting cables, connectors etc. after the calibration of test system. These losses may occur between noise source and DUT (Before DUT) and /or between DUT and noise figure analyzer input port (After DUT). A single fixed loss value may be specified for all frequencies, or set the loss table for the entire frequency range in which the frequency and loss correspond to each other. In table mode, a linearly interpolated value is used for the loss of each entry, and it also needs to specify a temperature value for all frequencies.

### 4.2.6.1 Typical application of loss compensation function

- 1) For the amplifier with a waveguide input port, the lossy coaxial-waveguide adapter shall be equipped during the measurement.
- 2) For the measurement of transistor noise figure, the input and output modulator shall be provided.
- 3) For the measurement of Non-50Ω impedance DUT (eg. TV's tuner and amplifier), the impedance shall be transformed, and the attenuation and transformer for impedance matching shall be provided.
- 4) Compensation is provided to the fixed attenuation for improving the standing wave ratio.
- 5) Modify the double sideband measurement (receiver and mixer) to get the approximate single-sideband result.
- 6) If DUT gain exceeds the gain measurement range of noise figure analyzer, the attenuation shall be added at the output port of the DUT. The loss compensation function shall be used to improve the

#### 4.2.6.2 Setting of fixed loss compensation

##### 1) Set the Before DUT loss compensation

**Step 1.** Press **【Loss Comp】** key to enter the loss compensation menu.

**Step 2.** Press [Before DUT] menu key and [Fixed] menu key to select the compensation mode for the Before DUT fixed loss.

**Step 3.** Press [Fixed (Before)] menu key, input the loss value with numeric key, complete the input by pressing [dB] or [Linear] unit menu key. or the **【Enter.↵】** key, At this time, the corresponding unit is dB. The lower limit of loss is -100.000dB, the upper limit is 100.000dB, and the default is 0.000dB.

##### 2) Set the After DUT loss compensation

**Step 1.** Press **【Loss Comp】** key to enter the loss compensation menu.

**Step 2.** Press [After DUT] menu key and [Fixed] menu key to select the compensation mode for the After DUT fixed loss.

**Step 3.** Press [Fixed (After)] menu key, input the loss value with numeric key, complete the input by pressing [dB] or [Linear] unit menu key. or the **【Enter.↵】** key, At this time, the corresponding unit is dB. The lower limit of loss is -100.000dB, the upper limit is 100.000dB, and the default is 0.000dB.

#### 4.2.6.3 Setting of loss table

##### 1) Set the Before DUT loss table

**Step 1.** Press **【Loss Comp】** key to enter the loss compensation menu.

**Step 2.** Press [Before DUT] menu key and [Table] menu key to select the table compensation mode for the Before DUT loss.

**Step 3.** Press [Loss Table] and [Before Table] menu key to enter the edit menu of loss table. For details, see [“Creating the loss table”](#) in this section to create a new loss table; or refer to [“3.3.4.2 File saving/loading method”](#) to call the previously saved loss table.

##### 2) Set the After DUT loss table

**Step 1.** Press **【Loss Comp】** key to enter the loss compensation menu.

**Step 2.** Press [After DUT] menu key and [Table] menu key to select the table compensation mode for the After DUT loss.

**Step 3.** Press [Loss Table] and [After Table] menu key to enter the edit menu of loss table. For details, see [“Creating the loss table”](#) in this section to create a new loss table; or refer to [“3.3.4.2 File saving/loading method”](#) to call the previously saved loss table.

---

### Attention

A previously saved loss table may be loaded, but the type of loss table shall be specified based on the compensation position, i.e. "Before LossComp Files (\*.LOS)" or "After LossComp Files (\*.LOS)". Refer to [“3.3.4.2 File saving/loading method”](#).

---

### 3) Create the loss table

Create the loss table according to the following steps:

**Step 1.** Press **【Loss Comp】** key to enter the loss compensation menu.

**Step 2.** Press [Before DUT] menu key and [Table] menu key to select the table compensation mode for the Before DUT loss.

**Step 3.** Press [Loss Table] and [Before Table] menu key to enter the edit menu of loss table. The table edit and browse menu items will appear. For details on working with the table, please see “[3.3.4.5 Table Processing](#)”. At the same time, the first loss frequency point in the table is Activated. Please see Fig.4.53.



Fig. 4.53 loss table (Blank)

**Step 4.** Input the loss frequency value with numeric key, and complete the input with the unit menu key.

**Step 5.** After the frequency input, the activated entry will automatically move to the loss column. Input the loss and press the corresponding [dB ]or [Linear] unit key to complete the input. The result in the table is displayed in dB. Additionally, press **【Enter.↵】** key to can also complete the input, and the corresponding unit is dB.

### Attention

Loss value refers to the attenuation value of lossy device. In the measurement, if a 3dB attenuation is added before DUT, the loss of input is 3dB instead of -3dB.

**Step 6.** After the loss value input, the activated entry will automatically move to the next frequency point.

**Step 7.** Repeat steps 4 to 6 until all the required compensation frequencies/losses are input, and a loss table after the input of data is as shown in Fig.4.54.

### NOTE

The compensation frequency/loss may be inserted into the loss table in any order, and the noise figure analyzer will automatically arrange the table from the low frequency to high frequency.



- Step 2.** Press [After DUT] menu key and [Fixed] or [Table] menu key to select the loss compensation mode.
- Step 3.** Press [Temp (After)] menu key, input temperature value with the numeric key, press the corresponding [K], [C] or [F] unit menu key to complete the input. The value input with the [C] or [F] menu key is automatically converted to display in K. The input may be completed with **【Enter.↵】** key, and the corresponding unit is K. The lower limit of temperature is 0.0K, upper limit is 296, 50000.00K, and default is 290.00K.

### 4.2.7 Limit lines function

Limit lines is used to mark the upper limit or lower limit of activated trace. By setting the limit line, the noise figure analyzer will automatically send the prompt that the limit line fails when the measurement trace exceeds the limit line. Two limit lines may be applied to a trace, for example specified upper limit and lower limit.

Noise figure analyzer contains four independent limit lines, which can be used for trace 1, trace 2, and can be set as upper limit or lower limit.

#### 4.2.7.1 Selection of activated limit line

Limit line 1 is set as the default activated limit line.

- Step 1.** Press **【Limit Lines】** key to enter the limit line menu.
- Step 2.** Press [Limit Line] menu key .
- Step 3.** Press [LimitLine 1], [LimitLine 2], [LimitLine 3] or [LimitLine 4] menu key and select the number of limit line to activate the setting.

#### 4.2.7.2 Setting of limit line Type

The limit line may be set to upper limit or lower limit and select the application trace according to the settings of limit line.

- Step 1.** Press **【Limit Lines】** key to enter the limit line menu.
- Step 2.** Press [Limit Line] menu key .
- Step 3.** Press [LimitLine 1], [LimitLine 2], [LimitLine 3] or [LimitLine 4] to change the number of limit line. Limitline 1 is set as the default limit line.
- Step 4.** Press [Type] menu key, select [Type Upper Lower] or [Type Upper Lower]. Set the limit line type to upper or lower.
- Step 5.** Press [Test Trace], select [Trace 1] or [Trace 2]. Trace 1 is the default value.

#### 4.2.7.3 Creation of limit line

To create a limit line, it is necessary to specify the frequency, the corresponding value and whether or not to connect to the previous limit line point.

- Step 1.** Press **【Limit Lines】** key to enter the limit line menu.
- Step 2.** Refer to "[4.2.7.2 Setting of limit line type](#)" for the information about the setting of limit line.
- Step 3.** Press [Edit] menu key. The limit line editing interface is displayed. The first frequency point in table is the activated entry as shown in Fig. 4.55.





Fig.4.56 Typical Limit Line Table



Fig.4.57 Limit Line Connection

#### 4.2.7.4 Start of limit line test

Start the limit line test function only after setting the limit line type and test trace and establishing the limit line table according to the above steps. Set the trace test according to limit line. If you want to get the report result, select the test to be "On". At this point, when the test result fails, "Limit line failure" is displayed at the position as shown in Fig. 4.58. Four limit lines shall be set separately.

**Step 1.** Press **【Limit Lines】** key to enter the limit line operation menu.

**Step 2.** Press **[Test]** key to set the test to "On" state, i.e. enable the limit line test function.



Fig.4.58 Limit Line Failure indicator

#### 4.2.7.5 Limit line display

Select the limit line display only after setting the limit line type and test trace and establishing the limit line according to the above steps.

### NOTE

Limit line may only be displayed in the graphic display format.

To display the limit line in the graphic format, select the display to "On" state; if you do not want to display the limit line in the graphic format, select the display to "Off" state. Four limit lines shall be set separately.

**Step 1.** Press **【Limit Lines】** key to enter the limit line operation menu.

**Step 2.** Press [Display] menu key to set the display to "On" state, i.e. the limit line is displayed on the screen.

#### 4.2.7.6 Disable the display of all limit lines

**Step 1.** Press **【Limit Lines】** key to enter the limit line operation menu.

**Step 2.** Press [Disable All Limits] menu key to disable all limit lines displayed on the screen.

### NOTE

Whether the limit line is displayed or not does not affect the limit line test function and the limit line test result display.

## 5 Key Grouping and Menu Description

This chapter describes the keys on the front panel of 3986 noise figure analyzer and the corresponding menu keys. All keys are described according to various groups, while the corresponding menu keys are described.

- Measurement key group.....125
- Control key group.....136
- Display key group.....145
- System key group.....152

### 5.1 Measurement Key Group

- 【Freq/Points】 key.....125
- 【Calibrate】 key.....127
- 【ENR】 key.....129
- 【Avg】 key.....132
- 【Mode Setup】 key.....133
- 【BW】 key.....136

This section describes in detail the measurement key group and its corresponding menu item function, parameters and other information. The measurement key group is as shown in Fig.5.1.



Fig.5.1 Measurement Key Group

#### 5.1.1 【Freq/Points】 Key

Press this key to enter the menu keys for frequency mode, frequency set, number of sweep points as shown in Fig.5.2. For the setting of sweep frequency mode, the start frequency and stop frequency will appear in the measurement setting information display area below the display area. When inputting the frequency value, specify the unit such as Hz, kHz, MHz or GHz with the displayed menu key.

##### **【Freq Mode】**

Press the menu key, enter the frequency mode selection menu, noise figure analyzer provides three frequency modes such as sweep, fixed and list for the user to select.

**【Sweep】** Determine the measurement frequency according to the frequency range and number of measurement points. This is the default frequency mode setting.

**【Fixed】** Measure the fixed frequency.

**【List】** Get the measurement frequency from the Freq List.

##### **【Center Freq】**

The key is used to set the center frequency and to set the center value of measurement frequency range. After the center frequency value is set, the frequency range will be automatically converted to the start frequency and stop frequency according to the span and displayed in the display area of measurement

5.1 Measurement Key Group

setting information.

**[Start Freq]**

The key is used to set the start frequency of sweep measurement, and for the graphic format, the trace starts from the left side of square. After the setting of start frequency, the value is displayed in the display area of measurement setting information.

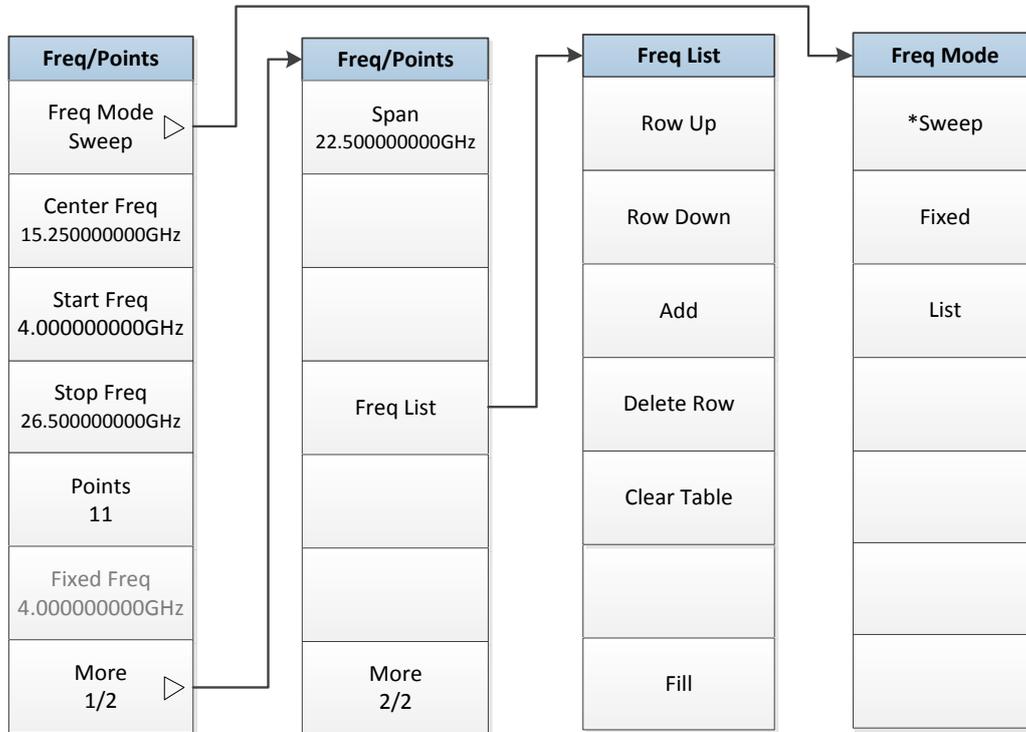


Fig.5.2 Freq/Points Menu

**[Stop Freq]**

The key is used to set the stop frequency of sweep measurement, and for the graphic format, the trace starts from the right side of square. After the setting of stop frequency, the value is displayed in the display area of measurement setting information.

**[Points]**

The key in the sweep frequency mode is used to set the number of discrete equidistant measurement frequency points. Minimum number is 2, maximum number is 401, and the default number is 11, and the number of sweep points is displayed in the display area of measurement setting information.

**[Fixed Freq]**

The key is used to set the frequency measurement point under the fixed frequency mode. When the fixed frequency value is set, the value is displayed as the start frequency and stop frequency in the display area of measurement setting information.

**[Span]**

The key is used to set the symmetrical frequency range with the center frequency as the center point. After the span value is set, the value will be automatically converted to the start frequency and stop frequency according to the setting of center frequency and displayed in the display area of measurement setting information.

**[Freq List]**

Press the key to enter the editing interface of Freq List, and create or edit the Freq List. Input the frequency points to be measured in the Freq List. The Freq List is limited as 401 entries. The total number is displayed in the display area of measurement setting information, and frequencies are automatically stored from low to high.

**[Row Up]** Select a specific entry in the list with this key by pressing the menu key to move upwards by one entry.

**[Row Down]** Select a specific entry in the list with this key by pressing the menu key to move downwards by one entry.

**[Add]** The key is used to add a new entry after the last valid entry at the bottom of list, and when the editing of new entry is completed, the list will be automatically rearranged from the low frequency to high frequency.

**[Delete Row]** The key is used to clear the currently activated single entry from the list.

**[Clear Table]** The key is used to clear all entries in the list.

**[Fill]** The key is used to clear the previously existing list and fill the Freq List with the current frequencies generated at sweep frequency mode.

**5.1.2 [Calibrate] Key**

Press the key to perform an internal calibration procedure. Calibration is similar to measurement, except that the DUT is not connected. This function is used to correct the second level noise, i.e. the additional noise of noise figure test system and to get the noise figure and gain of DUT, with the calibrate menu as shown in Fig.5.3.

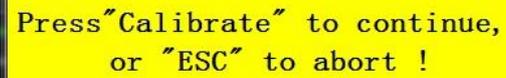
Calibrate
Calibrate

Fig.5.3 Calibrate Menu

## 5.1 Measurement Key Group

### Calibrate Steps:

First press **【Calibrate】** key to enter the Calibrate Menu, and then press the [Calibrate] menu key twice to conduct the calibration. When [Calibrate] key is pressed for the first time, it is prompted to press again, with the prompt information as shown in Fig.5.4.

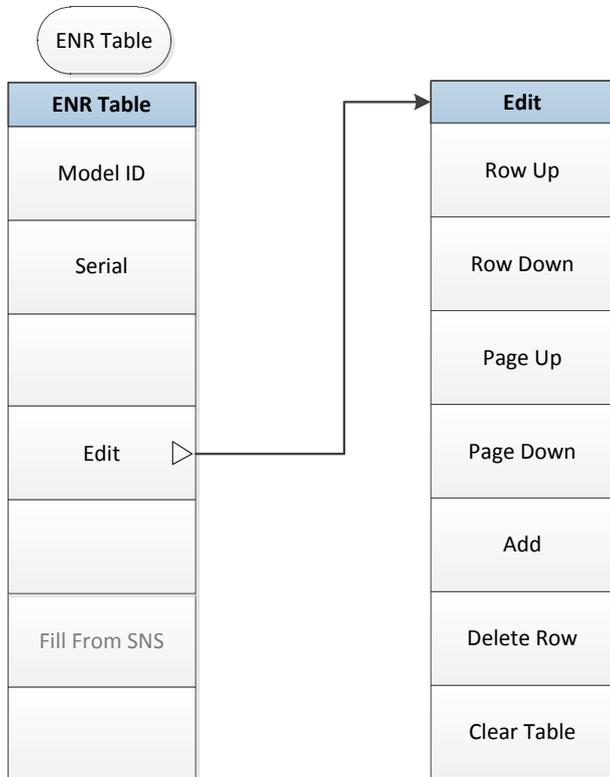
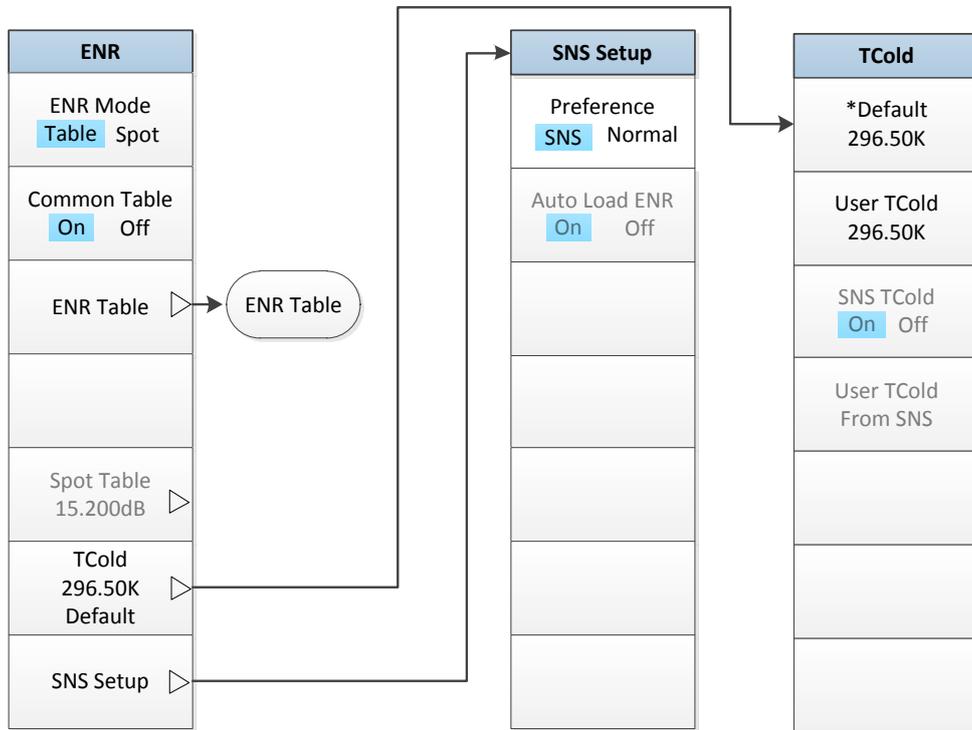


Press "Calibrate" to continue,  
or "ESC" to abort !

Fig.5.4 Calibrate Prompt Dialog

Press [Calibrate] key again to start calibration, or press **【Cancel】** key to stop. The value generated during calibration is used for the calibrated noise figure and gain measurement of DUT.

5.1.3 【ENR】 Key



5.1 Measurement Key Group

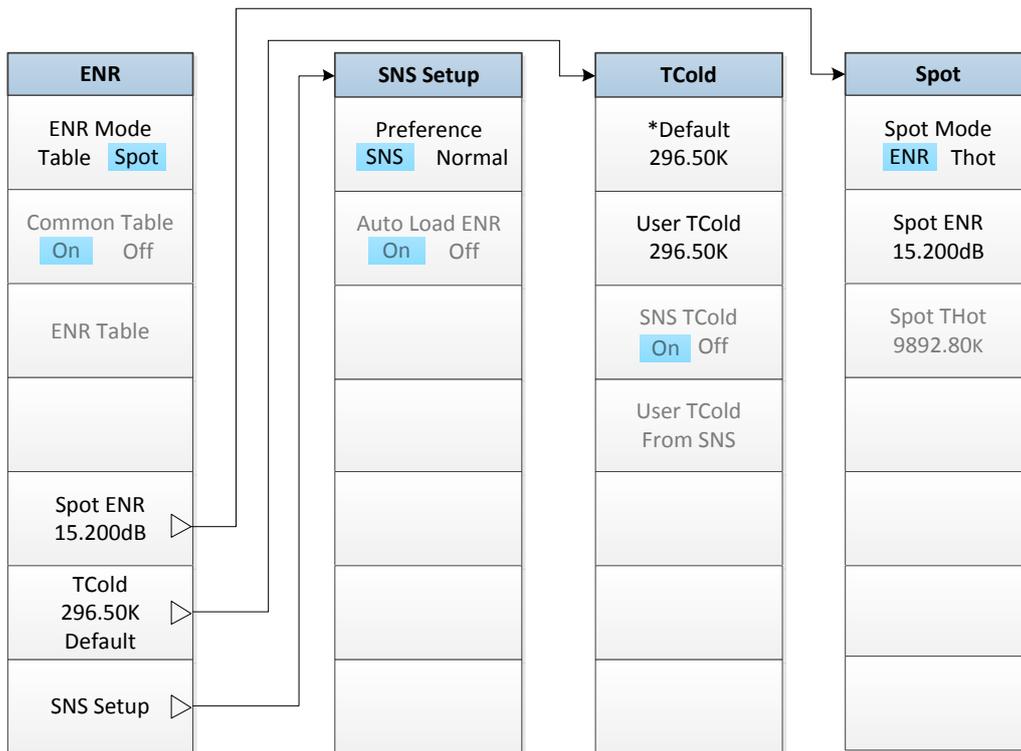


Fig.5.5 ENR Menu

Press this key to enter the ENR setting and editing menu. This includes the ENR Mode setting, Common Table on/off, ENR table editing, Spot Table setting, TCold setting, and SNS Setup, etc. ENR menu structure is as shown in Fig.5.5.

**[ENR Mode]**

This key is used to select [ENR Mode] as "Table" or "Spot" mode. [ENR Mode] defaults to "Table" mode. When [ENR Mode] is set to "Spot" mode, set a single excess noise ratio with [Spot ENR] or [Spot THot] menu key. The data in the ENR table is invalid.

**[Common Table]**

This key is used to set [Common Table] to "On" or "Off" state. [Common Table] defaults to "On" state. When the [Common Table] is set to "Off" state, the same measurement ENR table data is used for both the measurement and calibration. When the [Common Table] is set to "Off" state, the different measurement ENR table data is used for both the measurement and calibration.

**[ENR Table]**

This key is used to enter the editing menu of ENR table for inputting, changing or verifying the data, noise source model, noise source number, etc. in the ENR table.

**[Model ID]** The key is used to enter the input dialog box of noise source model. Input the noise source model with the external keyboard and numeric keypad, and press **[Enter.␣]** key panel to complete the input.

**[Serial]** The key is used to enter the input dialog box of noise source serial number. Input the number with the external keyboard and numeric keypad, and press **[Enter.␣]** key to complete the input.

**[Edit]** The key is used to enter the editing interface of frequency/ENR data. For details on how to edit the table data, please see ["3.3.4.5 Table Processing"](#).

**[Row Up]** Select a specific entry in the table with this key by pressing the menu key to move upwards by one entry.

**[Row Down]** Select a specific entry in the table with this key by pressing the menu key to move downwards by one entry.

**[Page Up]** The key is used to move up the entries by entire page.

**[Page Down]** The key is used to move down the entries by entire page.

**[Add]** The key is used to add a new entry. New entry is added after the last valid entry at the bottom of table, and when the editing of new entry is completed, the table will be automatically rearranged from low to high.

**[Delete Row]** The key is used to clear the currently activated single entry from the list.

**[Clear Table]** The key is used to clear all entries in the list.

When the [Common Table] is set to "Off" state, the different noise source excess noise ratio data is used for measurement and calibration. At this point, the measurement table and calibration table may be edited separately.

#### **[Meas Table]**

The key is used to enter the editing menu of ENR table for inputting, changing or verifying the data, noise source model, noise source number, etc. in the measurement ENR table.

#### **[Cal Table]**

The key is used to enter the editing menu of ENR table for inputting, changing or verifying the data, noise source model, noise source number, etc. in the calibration ENR table.

#### **[Spot]**

Press this key to enter the spot setup menu for selecting the spot mode, including Spot ENR and Spot Thot. This value is used throughout the frequency range during the calibration and measurement. This menu is valid only when the [ENR Mode] is set to "Spot" state and the default Spot ENR is 15.200dB.

**[Spot Mode]** The key is used to select the [Spot Mode] as "ENR" or "Thot" mode, and the default setting of [Spot Mode] is "ENR".

**[Spot ENR]** This key is used for inputting a Spot ENR, which is applied to the entire frequency range during the calibration and measurement. After [ENR Mode] is set as "Spot" mode and [Spot Mode] as ENR mode, the menu key and the value set by the menu key are valid. Default is 15.200dB. Input the ENR with the numeric keypad, and complete the input with the corresponding unit menu key. Input the Spot ENR with the [dB], [K], [C] or [F] unit key. The data in K, C or F will be automatically converted to and displayed in dB.

**[Spot THot]** The key is used for inputting a spot Thot, which is applied to the entire frequency range during the calibration and measurement. After [ENR Mode] is set as "Spot" mode and [Spot Mode] as "Thot", the menu key and the value set by the menu key are valid. The default is 9892.80K. Input THot with the numeric keypad, and select the unit menu key to complete the input. Input the Spot Thot with the [K], [C] or [F] unit key. The data in C or F will be automatically converted to and displayed in K.

#### **[TCold]**

The menu key is used to enter the cold temperature setting and input menu. When [TCold] is "Default", the cold temperature defaults to be 296.50K. When TCold is [User TCold], the cold temperature is input by user. If the smart noise source is connected, press [User TCold from SNS] menu key to fill the cold temperature value from SNS. When [SNS TCold] is set to "On", the ambient temperature value detected by the smart noise source is used, and the value will be automatically refreshed after each measurement

## 5.1 Measurement Key Group

sweep. The smart noise source function detects the temperature with the built-in temperature sensor, and the noise figure analyzer can load the value and use the cold temperature value for the temperature correction of noise figure calculation to improve the accuracy of noise figure measurement.

**[Default 296.50K]** This menu key is used to select the default 296.50K as the cold temperature value.

**[User TCold]** This key is used to set the [TCold] to the "user" state and set, change the user's cold temperature. Input the cold temperature value with the numeric keypad and select the unit menu key to complete the input. Input the cold temperature with [K], [C] or [F] unit. The data in C or F will be automatically converted to and displayed in K.

**[SNS TCold]** The key is used to set whether to automatically load the cold temperature from the built-in temperature sensor of smart noise source. When [SNS TCold] is set to "On", the cold temperature value is updated on each sweep. When [SNS TCold] is set to "Off", the cold temperature value is not automatically loaded. This function is valid only when the smart noise source is connected.

### **[User TCold from SNS]**

Press the key to load the cold temperature from the built-in temperature sensor of smart noise source. This function works only if the smart noise source is connected.

### **[SNS Setup]**

The key is used to select the type of noise source used. In addition, if the smart noise source is used, it is allowed to automatically load the ENR from the smart noise source.

**[Preference]** The noise source connected to the driver port of +28V noise source when the [Preference] is set to "Normal" mode, and if the noise source is already connected to the driver port of smart noise source, the noise source will be used when [Preference] is set to "SNS" mode. Smart noise source and noise source may be connected with noise figure analyzer at the same time. However, +28V driver of noise figure analyzer can only drive a noise source. Therefore, select the type of noise source to be used. [Preference] is set to "SNS" by default. This is the preference, but even if the default setting is selected, the noise figure analyzer will automatically use +28V standard noise source if the smart noise source is not connected.

**[Auto Load ENR]** When [Auto Load ENR] is set to "On" state, the noise figure analyzer will automatically load the ENR of smart noise source, and input the related data into the common ENR table. After the noise figure analyzer is started, the smart noise source is connected to the smart noise source port and will be automatically loaded. If [Auto Load ENR] is set to "Off" state, the ENR of smart noise source may not be automatically loaded.

### 5.1.4 **[Avg]** Key

Press the key to enter the average menu as shown in Fig.5.6. To enable the average function, set [Average] to "On" state. To disable the average function, set [Average] to "Off" state. When [Average] is set to "On", input the average in the average number dialog box with the numeric keypad and by pressing the [Enter] menu key, or select the proper average number by pressing [▲] and [▼] arrow keys or rotating the knob. The average number is displayed in the display area of measurement setting information. The setting range of average number is 1~512, and the default is "1" which means no averaging calculation is performed.

Average
Average 8
On <input checked="" type="checkbox"/> Off

Fig. 5.6 Average Menu

### 5.1.5 【Mode Setup】 Key

Press this key to enter DUT Setup, Ext LO Config, Uncertainty Calculator and Extend Setup as shown in Fig.5.7.

5.1 Measurement Key Group

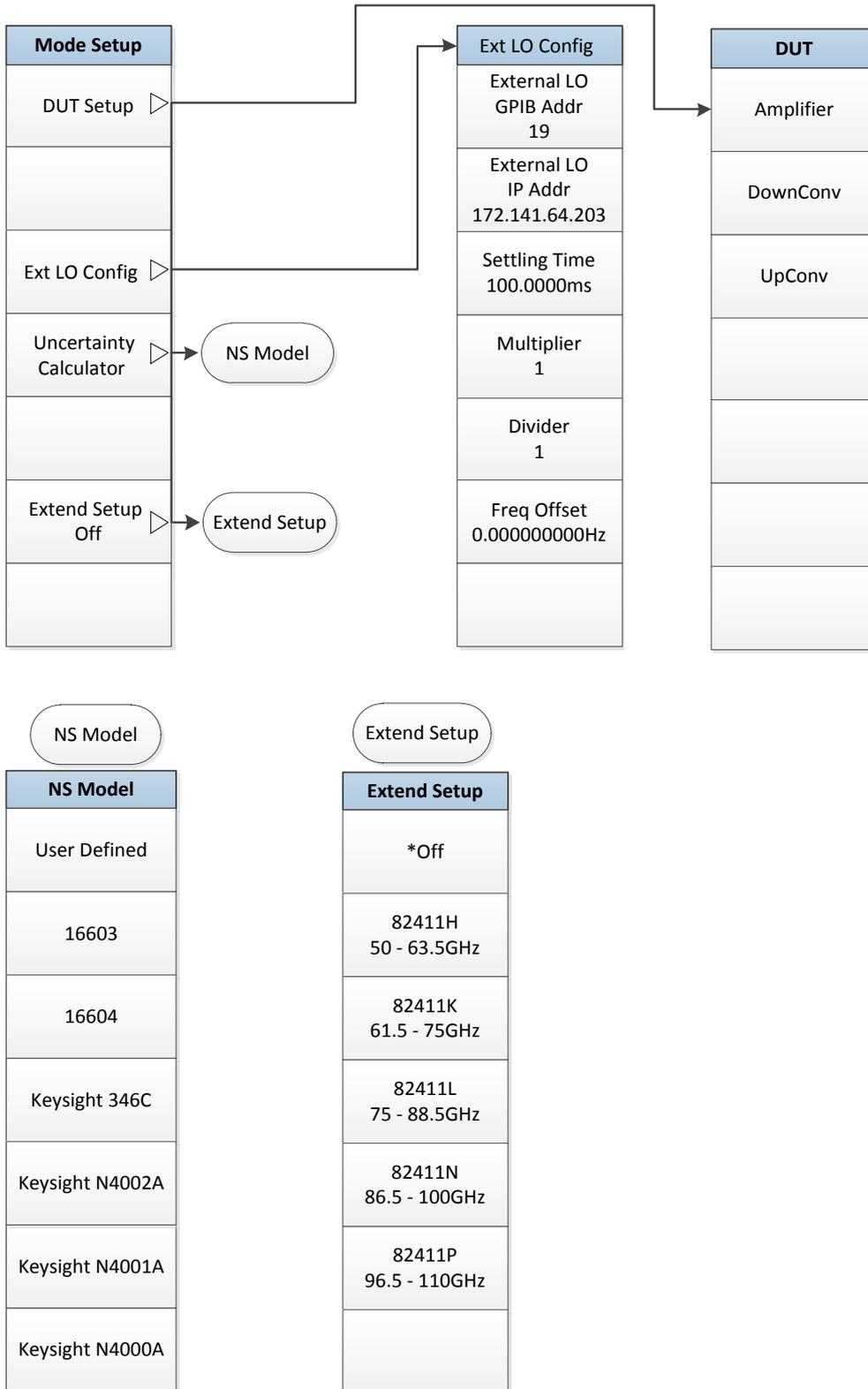


Fig. 5.7 Mode Setup menu

**[DUT Setup]**

The key is used to select the type of DUT to be measured.

**[Amplifier]** Press this key to select the amplifier as the type of DUT.

**[Downconv]** Press this key to select the downconverter as the type of DUT.

**[Upconv]** Press this key to select the upconverter as the type of DUT.

**[Ext LO Config]**

**[External LO GPIB Addr]**

This key is used to set the external local oscillator GPIB address. The default address is 19.

**[External LO IP Addr]**

This key is used to set the external local oscillator IP address. The default address is 172.141.64.203.

**[Settling Time]** The key is used to set the settling time of local oscillator source output. Input the time value with numeric keypad, and press the corresponding unit key to complete the input.

**[Multiplier]** The key is used to set the multiplier of local oscillator.

**[Divider]** The key is used to set the divider of local oscillator.

## NOTE

DUT is a harmonic/subharmonic mixer. Noise figure analyzer can automatically controls the local oscillator source output frequency by setting the multiplier and divider to achieve the noise figure and gain automatically sweep measurement.

**[Freq Offset]** The key is used to set the frequency of local oscillator frequency offset.

## NOTE

DUT is a receiver system. When a multi-stage converters is included, usually the mixing mode of one stage of converter is a variable local oscillator, and other stage of converter are the fixed LOs. Noise figure analyzer can automatically controls the variable local oscillator by setting the frequency offset of local oscillator and achieve the noise figure and gain automatically sweep measurement of multi-stage converters.

**[Uncertainty Calculator]**

Press the key to enter Uncertainty Calculator setup interface of the noise figure measurement, realizing the quantitative analysis of noise figure measurement uncertainty so as to help the user to perform comprehensive assessment for the measurement values. The selection of noise source type is related to the calculation of measurement uncertainty.

**[Extend Setup]**

Extend Setup and related menu keys may be activated only if the extend frequency measurement is selected.

**[Off]** Press the key to return to the measurement mode of basic amplifier.

**[82411H]** Press the key to automatically complete the setup of extend frequency measurement parameter for 82411H (50GHz~63.5GHz) module.

**[82411K]** Press the key to automatically complete the setup of extend frequency measurement parameter for 82411K (61.5GHz~75GHz) module.

**[82411L]** Press the key to automatically complete the setup of extend frequency measurement parameter for 82411L (75GHz~88.5GHz) module.

**[82411N]** Press the key to automatically complete the setup of extend frequency measurement parameter for 82411N (86.5GHz~100GHz) module.

**[82411P]** Press the key to automatically complete the setup of extend frequency measurement parameter for 82411P (96.5GHz~110GHz) module.

5.2 Control Key Group

5.1.6 【BW】 Key

Press the key to enter the bandwidth menu as shown in Fig.5.8. To manually set the bandwidth, first press the [BW] key to set [BW] to the "manual" state; the noise figure analysis provides six bandwidths, such as 4MHz, 2MHz, 1MHz, 400kHz, 200kHz and 100kHz, and user may press [▲] and [▼] arrow keys or rotate the knob to select the bandwidth, and may also input the bandwidth with numeric keypad. Press the corresponding unit key to complete the input. The bandwidth information is displayed in the display area of measurement setting information, and the bandwidth is 4MHz by default.



Fig.5.8 BW Menu

5.2 Control Key Group

- 【Loss Comp】Key.....137
- 【Mode】 Key.....139
- 【Limit Lines】 Key.....140
- 【Sweep】 Key.....142
- 【Corr】 Key.....143
- 【Restart】 Key.....145

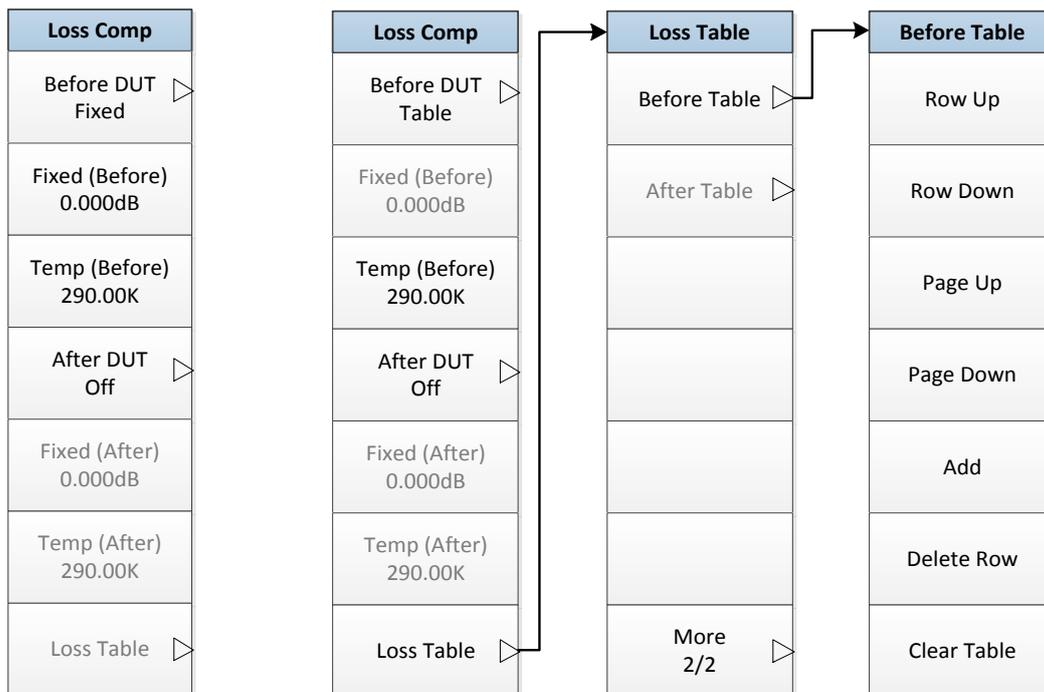
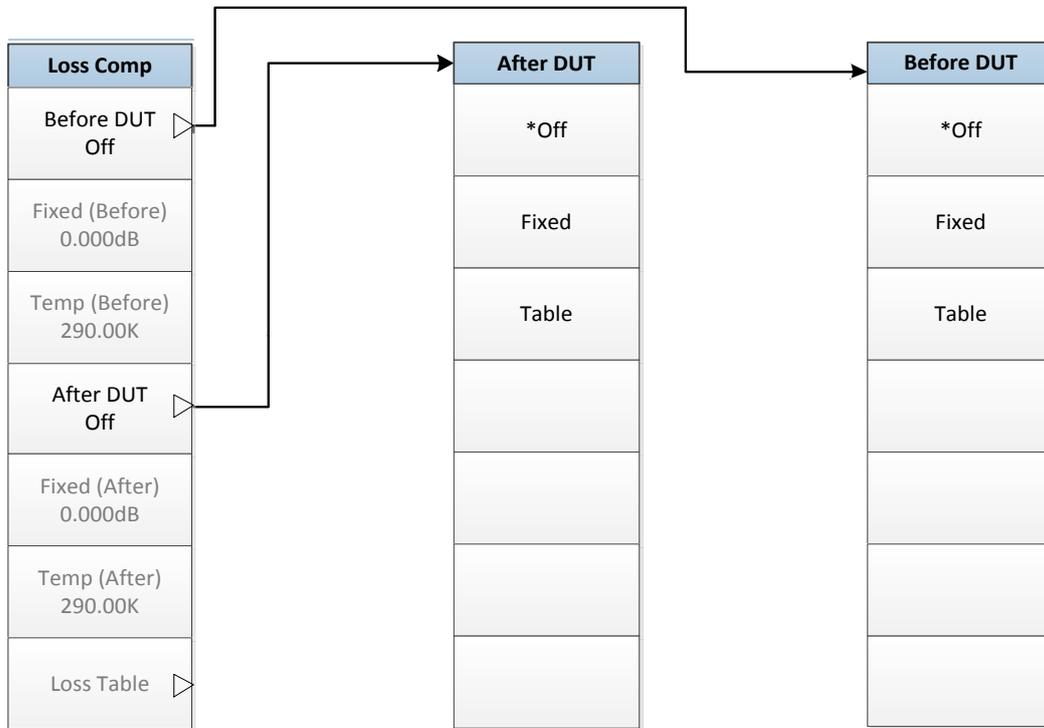
The section describes in detail the control key group and its corresponding menu item function, and control key group is as shown in Fig.5.9.



Fig.5.9 Control Key Group

### 5.2.1 【Loss Comp】 Key

Press the key to enter the loss compensation menu as shown in Fig.5.10. After the calibration, the additional loss will be added before and/or after the DUT due to the additional cable connection, and loss compensation function shall be enabled. The loss value may be the fixed value for all frequencies, or the loss table for the entire frequency range in which the frequency and loss correspond to each other.



## 5.2 Control Key Group

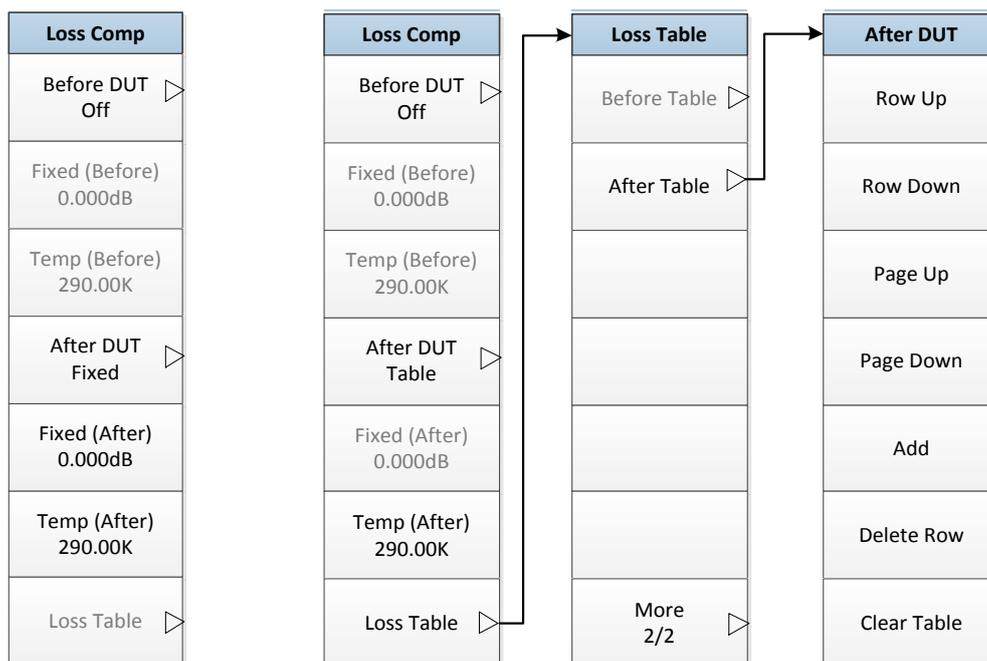


Fig. 5.10 LossComp Menu

**[Before DUT]**

The menu key is used for selecting the type of before DUT compensation. [Before DUT] is "Off" by default.

**[Off]** Press the menu key to close the before DUT loss compensation function.

**[Fixed]** Press the menu key to set the compensation type to "Fixed", i.e. specify a fixed value of before DUT for all frequencies.

**[Table]** Press the menu key to set the compensation type to "Table", i.e. set the before DUT loss with the loss table in which the frequency and loss correspond to each other.

**[Fixed (Before)]**

The menu key is valid only when [Before DUT] compensation type is set as "Fixed". Input the compensation value with numeric keypad, and press the corresponding [dB] or [Linear] unit key to complete input. The linear value is automatically converted to and displayed in dB. The lower limit of fixed value is -100.00dB, the upper limit is 100.00dB, and the default is 0.00dB.

**[Temp (Before)]**

The menu key is valid only when [Before DUT] compensation type is set as "Fixed" or "Table". Input the temperature value with numeric keypad and press the corresponding [K], [C] or [F] unit key to complete the input. The values in C and F are automatically converted to and displayed in K. The lower limit of temperature is 0.00K, upper limit is 296,50000.0K, and default is 290.00K.

**[After DUT]**

The menu key is used to select the After DUT compensation type. [After DUT] is set to "Off" state by default.

**[OFF]** Press the menu key to close the after DUT loss compensation function.

**[Fixed]** Press the menu key to set the compensation type to "Fixed", i.e. specify a fixed value of after DUT for all frequencies.

**[Table]** Press the menu key to set the compensation type to "Table", i.e. set the after DUT loss with the

loss table

where the different frequency points correspond to losses.

**[[Fixed (After)]]**

The menu key is valid only when [After DUT] compensation type is set as "Fixed". Input the compensation value with numeric keypad, and press the corresponding [dB] or [Linear] unit key to complete input. The linear value is automatically converted to and displayed in dB. The lower limit of fixed value is -100.00dB, the upper limit is 100.00dB, and the default is 0.00dB.

**[Temp (After)]**

The menu key is valid only when [After DUT] compensation type is set as "Fixed" or "Table". Input the temperature value with numeric keypad and press the corresponding [K], [C] or [F] unit key to complete the input. The values in C and F are automatically converted to and displayed in K. The lower limit of temperature is 0.00K, upper limit is 296, 50000.00K, and default is 290.00K.

**[Loss Table]**

The menu key is valid only when [Before DUT] or [After DUT] compensation type is set as "Table". The key is used to enter the editing menu of Before DUT table or After DUT table.

**[Before DUT]** It is valid only when the [Before DUT] compensation type is set as "Table".

**[After DUT]** It is valid only when the [After DUT] compensation type is set as "Table".

**[Row Up]** Select a specific row in the table with this key by pressing the menu key to move upwards by one entry.

**[Row Down]** Select a specific row in the table with this key by pressing the menu key to move downwards by one entry.

**[Page Up]** The key is used to move up the entries by entire page.

**[Page Down]** The key is used to move down the entries by entire page.

**[Add]** The key is used to add a new entry. Add a new entry at the bottom of table, and when the new entry is input, the entries will be automatically rearranged from the low frequency to high frequency. Input the loss value with the unit menu key or by pressing **【Enter↵】** key, and the corresponding unit is dB.

**[Delete Row]** The key is used to clear the currently activated single entry from the table.

**[Clear Table]** The key is used to clear all entries in the table.

### 5.2.2 **【Mode】** Key

The key is used for the development of analyzer extension test function. For the time being, only the noise figure measurement is supported.

5.2 Control Key Group

5.2.3 **【Limit Lines】 Key**

Press the key to enter the Setup Menu of limit line as shown in Fig.5.11. Limit line function is used to mark the boundaries of trace. There are four independent limit lines which are numbered from 1 to 4 and may be used for the test of trace 1 and trace 2 which may be set as the upper limit or lower limit. When the test trace exceeds the limit line, the "Limit line failed" prompt will be issued.

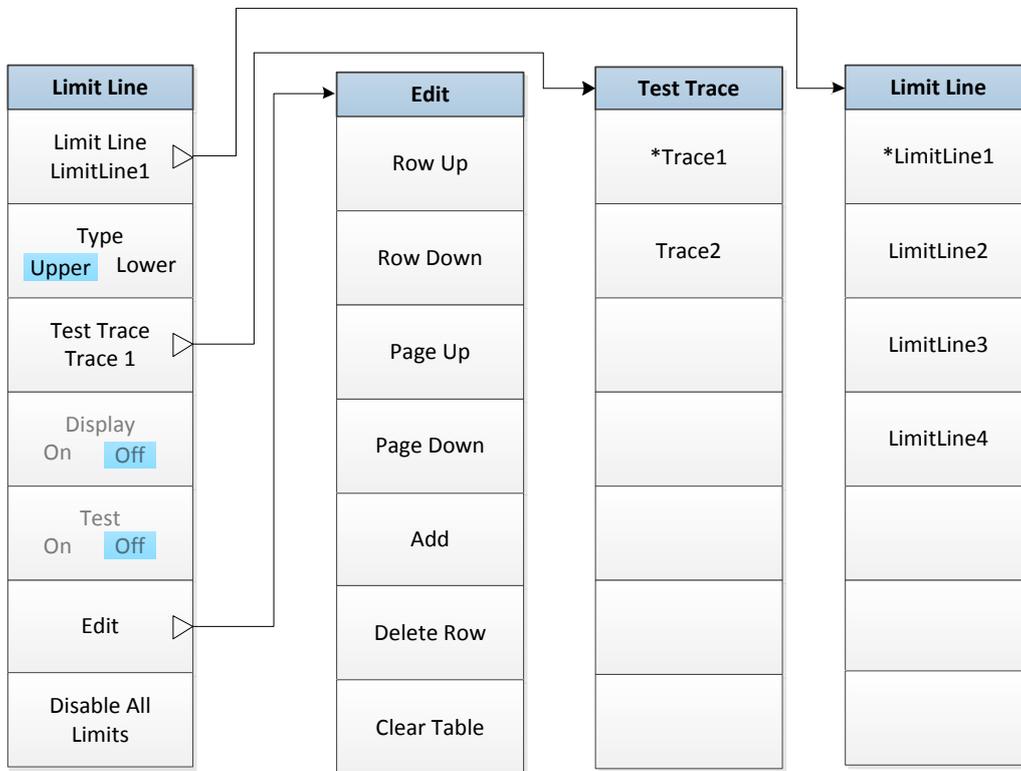


Fig.5.11 Limit Line Menu

**【Limit Line】**

It is used to select the number of activated limit line, and there are 4 limit lines available to select. Limitline 1 is the default number. After the number of limit line is selected, other limit line menus may be set according to this limit line.

**【LimitLine 1】** Select the limit line 1, which is the default setting.

**【LimitLine 2】** Select the limit line 2.

**【LimitLine 3】** Select the limit line 3.

**【LimitLine 4】** Select the limit line 4.

**【Type】**

The key is used to select the [type] of limit line as "upper limit" or "lower limit", and the [type] of limit line is "upper limit" by default.

**【Test Trace】**

The key is used to select the specified trace line for the limit line test. The default test trace is "trace 1".

**【Trace 1】** Set the specified limit line test for trace 1, i.e. the test trace of upper diagram in the graphic format.

**【Trace 2】** Set the specified limit line test for trace 2, i.e. the test trace of lower diagram in the graphic format.

**[Display]**

The menu key becomes the activated menu key after the limit line data is input, and it is used to set whether to display the activated limit line in graphic format. To display the limit line, set [Display] to "On" state. To close the limit line display, set [Display] to "Off" state. The "Off" state is the default setting.

**[Test]**

The menu key becomes the activated menu key after the limit line data is input, and it is used to set whether to enable the test function of activated limit line. To enable the test, set [Test] to "On" state. To disable the test, set [Test] to "Off" state. The "Off" state is the default setting.

**[Edit]**

Press the menu key to enter the editing interface of limit line table. After the value is input, the limit lines are automatically arranged from the low frequency to high frequency.

**[Freq]** This key is used to set the frequency of current entry.

**[Value]** This key is used to set the limit of current entry.

**[Connect]** The key is used to set whether the current point is connected or disconnected from the previous point. When it is set to Yes, the current point is connected to the previous point, and when it is set to No, the current point is disconnected from the previous point.

For the editing method of limit line table, see ["3.3.4.5 Table Processing"](#), or refer to the following description of how to input the value in the table.

**[Row Up]** Select a specific entry in the table. Press the menu key to move upwards by one row.

**[Row Down]** Select a specific entry in the table. Press the menu key to move downwards by one row.

**[Page Up]** The key is used to move up the entries by entire page.

**[Page Down]** The key is used to move down the entries by entire page.

**[Add]** The key is used to add a new entry. Add a new entry at the bottom of table, and when the new entry is input, the table will be automatically rearranged from the low frequency to high frequency.

**[Delete Row]** The key is used to clear the currently activated single entry from the table.

**[Clear Table]** The key is used to clear all entries in the table.

**[Disable All Limits]** The key is used to disable all limit lines, including all test results and annotations.

5.2 Control Key Group

5.2.4 **[Sweep]** Key

The menu key is used to set the restart, sweep mode and manual measurement of the noise figure analyzer as shown in Fig. 5.12.

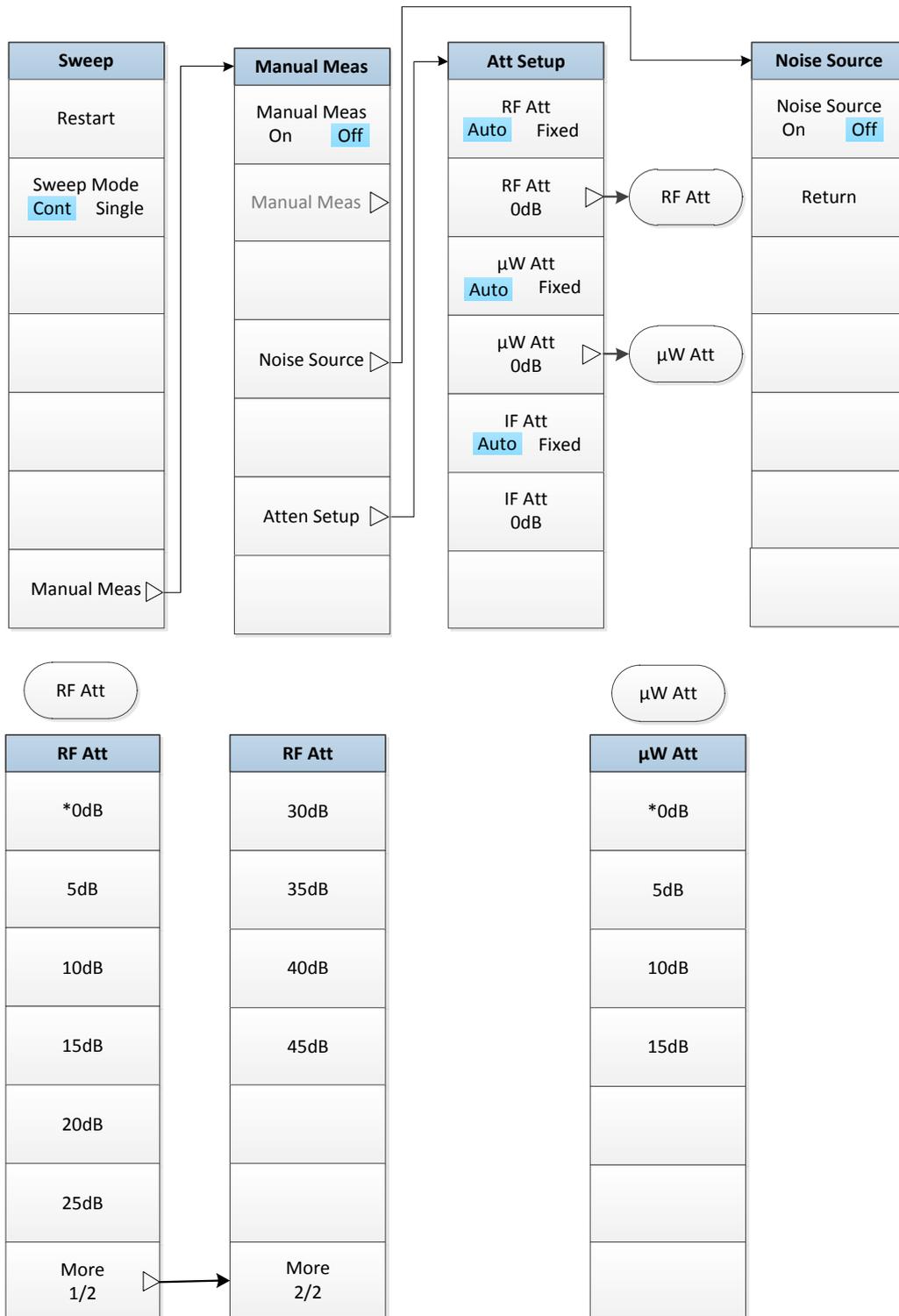


Fig.5.12 Sweep Menu

**[Restart]**

During the measurement process, if [Restart] menu key is pressed, the noise figure analyzer will terminate the current measurement and start a new measurement. The menu key has the same function as the **【Restart】** key.

#### **【Sweep Mode】**

The menu key is used to control the sweep mode of noise figure analyzer for one or more sweep measurements. To make the noise figure analyzer enter the hold state after a measurement is performed, set [Sweep Mode] to "Single" mode, and to make the noise figure analyzer continuously repeat the measurement, set [Sweep Mode] to "Cont" mode. The "Cont" mode is the default setting.

#### **【Manual Meas】**

**【Manual Meas】** The key is used to set [Manual Meas] to "On" or "Off" state to enable or disable the manual measurement function. It is set to "Off" state by default.

**【Manual Meas】** The key is used to set the manual measurement related operations.

**【Noise Source】** The key is used to enter the noise source on/off control menu.

**【Noise Source】** If [Noise Source] is set to "On" state, the hot power measurement will be performed at the selected frequency point. If [Noise Source] is set to "Off", the cold power measurement will be performed at the selected frequency point. It is "Off" by default.

**【Return】** The key is used to exit the manual setup state of noise source and return to the normal sweep state of noise figure analyzer.

**【Att Setup】** The key is used to manually set the RF/ $\mu$ W attenuation value and IF attenuation value.

**【RF Att】** The key is used to set the RF Att to "Auto" or "Fixed" state. [RF Att] is set to "Auto" state by default.

**【RF Att 0dB】** The key is used to manually set the RF attenuation value which ranges from 0dB to 45dB at the step of 5dB. Attenuation value is 0dB by default.

**【 $\mu$ W Att】** The key is used to set the  $\mu$ W attenuation to "Auto" or "Fixed" state. [ $\mu$ W Att] is set to "Auto" state by default.

**【 $\mu$ W Att 0dB】** The key is used to manually set the  $\mu$ W attenuation value which ranges from 0dB to 15dB at the step of 5dB. Attenuation value is 0dB by default.

**【IF Att】** The key is used to set the IF attenuation to "Auto" or "Fixed" state. [IF Att] is set to "Auto" state by default.

**【IF Att 20dB】** The key is used to manually set the IF attenuation value which ranges from 0dB to 30dB at the step of 1dB. Attenuation value is 20dB by default.

#### 5.2.5 **【Corr】** Key

Press the key to enter the Setup Menu of Corr/Att as shown in Fig.5.13. The key is used to turn on or off the correct function during the measurement process. The default state depends on whether the calibration has been performed before. When the calibration is performed, [NF Corr] is automatically set to "On" state. When the noise figure analyzer is not calibrated, [NF Corr] is automatically set to "Off" state. "Corr"/"Uncorr" prompt is displayed in the display area of measurement setting information. The key is also used to select the appropriate input attenuation of noise figure analyzer according to the gain range of DUT during the calibration process. This will make the calibration faster.

5.2 Control Key Group

Corr/Att	
NF	Corr
On	Off
RF Min Cal Att	
0dB	
RF Max Cal Att	
20dB	
$\mu$ W Min Cal Att	
0dB	
$\mu$ W Max Cal Att	
0dB	

Fig.5.13 Corr/Att Menu

**[NF Corr]**

The key is used to set whether to correct the second stage noise during the measurement. When the [NF Corr] is set to "On", the noise figure analyzer can obtain the accurate gain and noise figure of DUT. When the correct function is turned on, the "correct" annotation is displayed in the lower right corner of the display area of measurement setting information.

The following menu key is used to set the minimum and maximum attenuation value for the RF and  $\mu$ W calibration.

**[RF Min Cal Att]**

The menu key is used to set the minimum attenuation value of RF attenuation during the calibration process, RF frequency ranges from 10MHz to 4GHz. RF attenuation can select the proper attenuation value from 0dB to 45dB at the step of 5dB. The minimum attenuation value is 0dB by default.

**[RF Max Cal Att]**

The menu key is used to set the maximum attenuation value of RF attenuation during the calibration process, RF frequency ranges from 10MHz to 4GHz. RF attenuation can select the proper attenuation value from 0dB to 45dB at the step of 5dB. The maximum attenuation value is 20dB by default.

**[ $\mu$ W Min Cal Att]**

The menu key is used to set the minimum attenuation value of  $\mu$ W attenuation during the calibration process,  $\mu$ W frequency ranges from 4GHz to 18/26.5/40/50GHz.  $\mu$ W attenuation can select the proper attenuation value from 0dB to 15dB at the step of 5dB. The minimum attenuation value is 0dB by default.

**[ $\mu$ W Max Cal Att]**

The menu key is used to set the maximum attenuation value of  $\mu$ W attenuation during the calibration

5.3 Display Key Group

process,  $\mu W$  frequency ranges from 4GHz to 18/26.5/40/50GHz.  $\mu W$  attenuation can select the proper attenuation value from 0dB to 15dB at the step of 5dB. The maximum attenuation value is 0dB by default.

5.2.6 【Restart】 Key

During the measurement process, if [Restart] key is pressed, the noise figure analyzer will terminate the current measurement and start a new measurement. Single measurement or continuous measurement may be performed depending on the setup of Sweep Mode.

5.3 Display Key Group

- 【Format】 Key.....145
- 【Result】 Key.....146
- 【Scale】 Key.....147
- 【Marker】 Key.....150

This section describes in detail the display key group and its corresponding menu item functions, parameters and other information. The display key group is as shown in Fig.5.14.



Fig. 5.14 Display Key Group

5.3.1 【Format】 Key

The key is used to select the display format of measurement data (including graph, table and meter), result display, combined display, graticule, annotation, language selection, etc. as shown in Fig. 5.15.

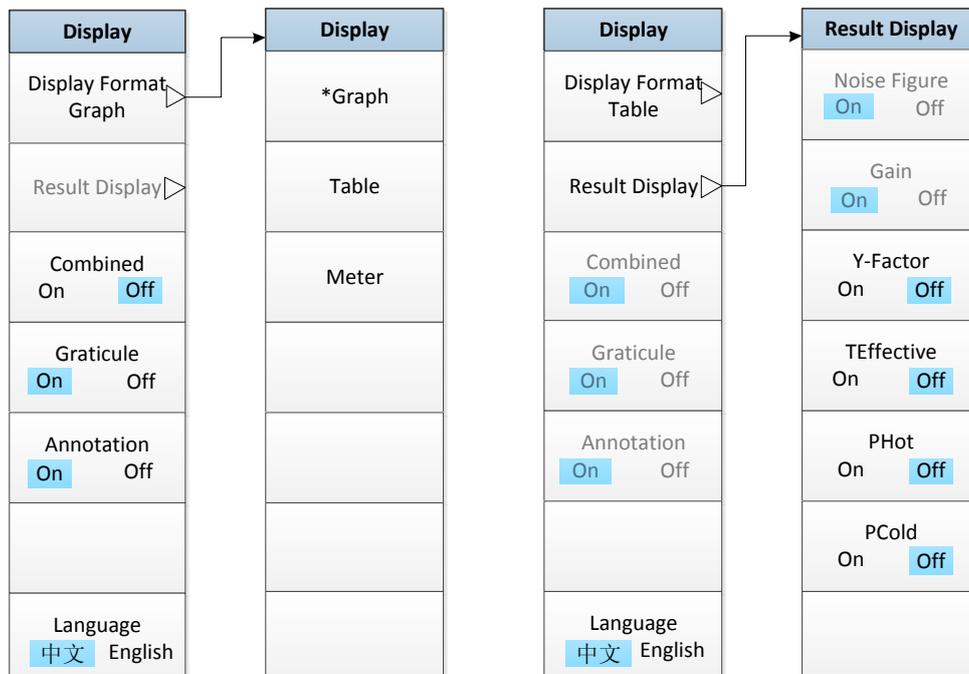


Fig. 5.15 Format Menu

### 5.3 Display Key Group

#### **[Display Format]**

The key is used to select the display format of measurement data.

**[Graph]** Press the key to display the measurement value in the graphic format, which is the default setting.

**[Table]** Press the key to display the measurement value in the table format.

**[Meter]** Press the key to display the measurement value in the meter format.

#### **[Result Display]**

The menu key can only be activated in the table mode, and is used to display the measurement parameters in the table mode. In the table mode, the parameters of trace 1 and trace 2 are the display parameter by default and located at the first two columns of display parameters in the table mode. At the table display mode, after the trace 1 and trace 2 are respectively activated, the display unit of measurement parameters may be set with the [Units] menu key under **【Scale】** For other measurement parameters not displayed, the user may trigger the parameter display by setting "On" or "Off" via the corresponding menu key, and the parameters will be displayed in the 3<sup>rd</sup> to 6<sup>th</sup> columns according to the opening sequence. Up to six measurement parameters can be displayed at the same time. 3<sup>rd</sup> to 6<sup>th</sup> columns are displayed in default units. The default display unit for equivalent temperature is K, and the default unit for other parameters is dB.

**[Noise Figure]** It is used to trigger the noise figure parameter display which is "On" by default.

**[Gain]** It is used to trigger the gain parameter display which is "On" by default.

**[Y-Factor]** It is used to trigger the Y-Factor parameter display which is "Off" by default.

**[TEffective]** It is used to trigger the equivalent temperature parameter display which is "Off" by default.

**[PHot]** It is used to trigger the hot power parameter display which is "Off" by default.

**[PCold]** It is used to trigger the cold power parameter display which is "Off" by default.

#### **[Combined]**

The menu is valid only in the graph display format. When [Combined] is set to "On", the up and down graphs of double-graph display are combined into one single graph which covers the up and down graphs. [Combination] is "Off" by default.

#### **[Graticule]**

The menu is valid only in the graph display format. When [Graticule] is set to "On", the graphic graticule is opened. This is the default setting. When [Graticule] is set to "Off", the graticule is closed and removed from the graph.

#### **[Annotation]**

When [Annotation] is set to "On", the screen annotation around graph is opened and displayed. This is the default setting. When [Annotation] is set to "Off", the screen annotation around graph is closed and removed from the display, but the menu key is still displayed on the screen.

#### **[Language]**

Select the display language (Chinese or English). Default is Chinese.

### 5.3.2 **【Result】** Key

Press the key to enter the trace result menu, set the display result type of activated trace as shown in Fig.5.16, and the display results are applicable to all display formats.

#### **[Result- Trc1]**

Press the menu key to enter the setting interface of trace 1 measurement value result which defaults to

be noise figure.

**[Noise Figure]** Press the key to select the noise figure as the display result of measurement value.

**[Gain]** Press the key to select the gain as the display result of measurement value.

**[Y-Factor]** Press the key to select Y-Factor as the display result of measurement value.

**[TEffective]** Press the key to select the equivalent temperature as the display result of measurement value.

**[PHot]** Press the key to select the hot power as the display result of measurement value.

**[PCold]** Press the key to select the cold power as the display result of measurement value.

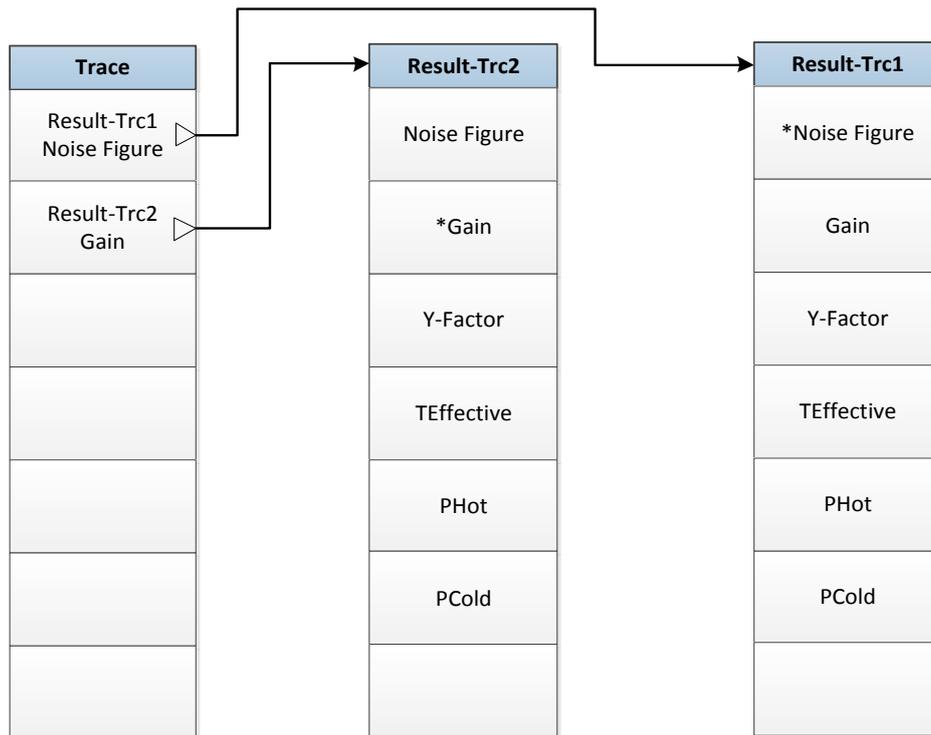


Fig. 5.16 Result Menu

#### **[Result-Trc2]**

Press the menu key to enter the setting interface of trace 2 measurement value result which defaults to be gain.

**[Noise Figure]** Press the key to select the noise figure as the display result of measurement value.

**[Gain]** Press the key to select the gain as the display result of measurement value.

**[Y-Factor]** Press the key to select Y-Factor as the display result of measurement value.

**[TEffective]** Press the key to select the equivalent temperature as the display result of measurement value.

**[PHot]** Press the key to select the hot power as the display result of measurement value.

**[PCold]** Press the key to select the cold power as the display result of measurement value.

#### 5.3.3 **[Scale]** Key

Press the key to display the scale menu which specifies the display auto scale, scale/div, ref value, units and upper/lower limit of coordinate for the activated measurement result as shown in Fig. 5.17. The

## 5.3 Display Key Group

coordinate auto scale, scale/div, ref value, upper/lower limit setup only applies to graphic format. but the unit setup is available for all display formats.

The scale menu to be displayed depends on the currently activated measurement result. The setup of upper/lower limit and reference value only affects the display position of data and will not affect the measurement value.

Scale	
Select Trace	1 2
Auto Scale	On Off
Scale/Div	1.000000
Ref Value	4.000000
Units	dB Linear
Upper Limit	9.000000
Lower Limit	-1.000000

Fig.5.17 Scale Menu

**[Select Trace ]**

The key is used to select the currently activated trace. When [Select Trace] is "1", trace 1 is activated. This is the default setup. When [Select Trace] is "2", trace 2 is activated.

**[Auto Scale]**

When [Auto Scale] is "On", the noise figure analyzer will automatically set the upper/lower limit of graphic display after each measurement, providing the best view of result data. [Auto Scale] It is "Off" by default, and measurement value is displayed at the corresponding position according to the fixed upper/lower limit of coordinate.

**[Scale/Div]**

The key is used to set the division size at Y-axis. Input the scale/div value with the numeric keypad, and press [Enter] menu key to complete the input. You can also press **【▲】** and **【▼】** arrow keys or rotate the knob to change the scale/div. Set this value to make the upper limit and lower limit of coordinate change, because these results are related to each other.

**[Ref Value]**

The key is used to adjust the vertical position of measurement trace in the display window. Input the reference value with numeric keypad, and press [Enter] menu key to complete the input. You can also press **【▲】** and **【▼】** arrow keys or rotate the knob to change the reference value.

**[[Units]**

The key is used to set the data display unit, and the corresponding optional units of measurement results are as shown in Table 5.1.

Table 5.1 Comparison Table of Measurement Results and Units

Measurement Results	Units
Noise figure	dB or linear
Gain	dB or linear
Y-Factor	dB or linear
Effective temperature	K, C or F
Hot power	dB or linear
Cold power	dB or linear

**[Upper Limit]**

The key is used to set the upper limit of Y-axis. Input the upper limit of coordinate with numeric keypad, and press [Enter] menu key to complete the input. You can also press **▲** and **▼** arrow keys or rotate the knob to change the upper limit of coordinate. Since the scale/div is associated with the upper limit, the scale/div setup will change with the upper limit setup.

**[Lower Limit]**

The key is used to set the lower limit of Y-axis. Input the lower limit of coordinate with numeric keypad, and press [Enter] menu key to complete the input. You can also press **▲** and **▼** arrow keys or rotate the knob to change the lower limit of coordinate. Since the scale/div is associated with the lower limit, the scale/div setup will change with the lower limit setup.

5.3 Display Key Group

5.3.4 **【Marker】** Key

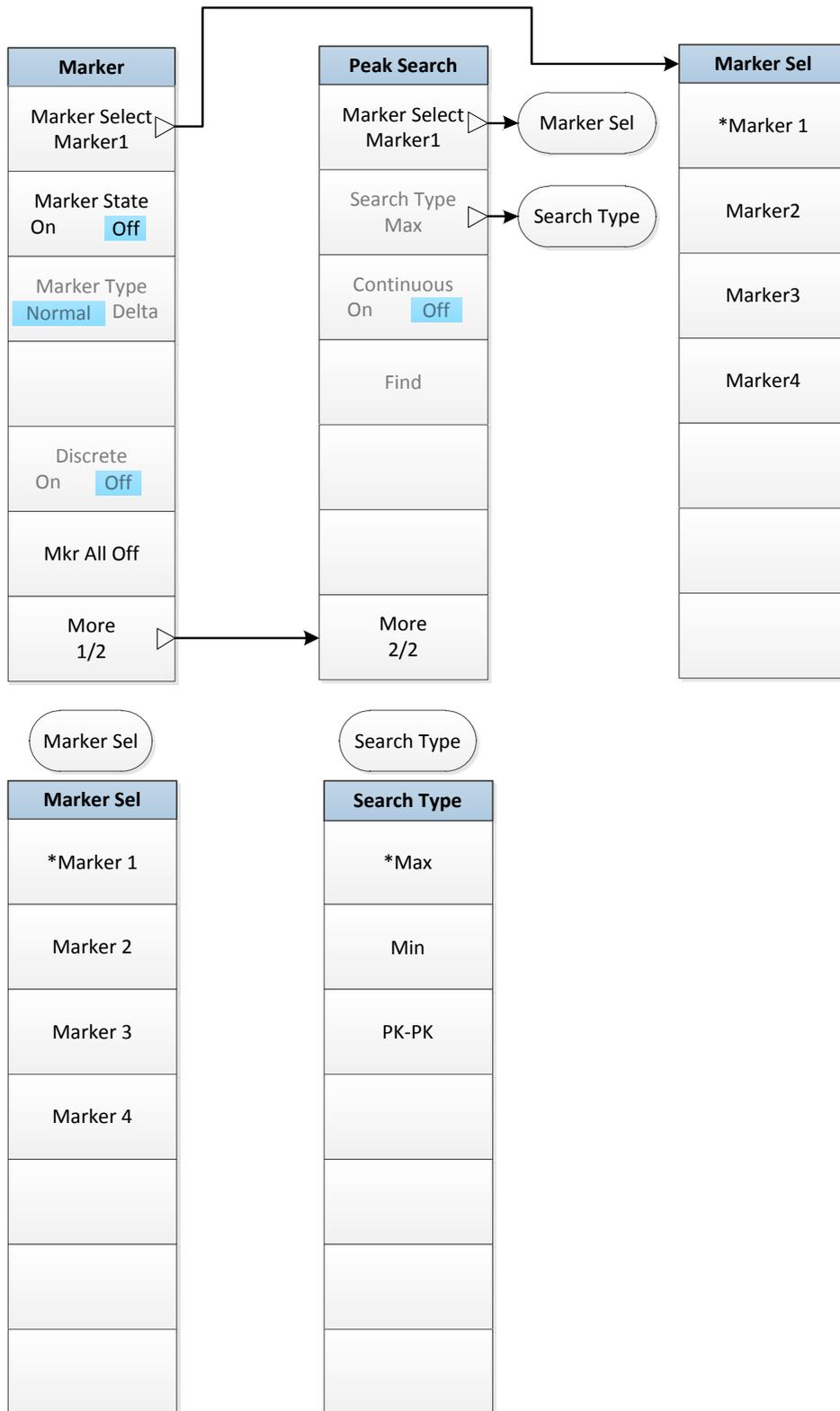


Fig.5.18 Marker Menu

The key is valid only in the graphic format, and is used to select the marker number, marker state and marker type, and turn off all markers, search type, continuous search, etc. as shown in Fig. 5.18. There

are up to four pairs of markers which may be distributed on different traces and can be displayed simultaneously. Only one pair of markers can be controlled at a time. The markers under control are called as the activated ones.

All enabled marker results are displayed in the marker display area above the graph. When one marker is activated, its frequency value is displayed in the result input area.

**[Marker Select]**

Noise figure analyzer provides four markers numbered 1, 2, 3 and 4. All markers may be enabled (if necessary), but only one is activated.

**[Marker 1]** Press the key to activate the marker 1. This is the default setup.

**[Marker 2]** Press the key to activate the marker 2.

**[Marker 3]** Press the key to activate the marker 3.

**[Marker 4]** Press the key to activate the marker 4.

**[Marker State]**

Press the key to set [Marker State] to "On" or "Off", and [Marker State] is "Off" by default.

**[Marker Type]**

Press the key to set [Marker Type] to "Normal" or "Delta". [Marker Type] is "Normal" by default. The key is only activated when [Marker State] is "On".

**[Discrete]**

The key is used to turn "On" or "Off" [Discrete]. When [Discrete] is set to "On" state, the marker only indicates the measurement value of actual measurement frequency point. [Discrete] defaults to be "Off".

**[Mkr All Off]**

Press the key to close all markers, including the marker display area information.

**[Search Type]**

Press the menu key to configure the marker search type on the trace which depends on the type setup. The default is "maximum value".

**[Max]** The key is used to place the activated marker on the maximum value of trace.

**[Min]** The key is used to place the activated marker on the minimum value of trace.

**[Pk-Pk]** The key is used to place the activated marker on the maximum and minimum values of trace. Reference marker is placed at the highest peak, Normal marker is placed at the lowest trough. Frequency and measurement results are shown in the display area of marker above the graph. The result is the difference between the normal marker and reference marker.

**[Continuous]**

When [Continuous] is set to "On" state, the activated marker continuously search for the maximum, minimum or peak-to-peak value according to the selected search type after each measurement. When [Continuous] is set to "Off" state, press [Find] menu key to perform the marker search function. [Continuous] defaults to be "Off".

**[Find]**

Press [Find] key to perform the cursor search function.

5.4 System Key Group

5.4 System Key Group

- **【Preset】** Key.....152
- **【System/Local】** Key.....152
- **【File】** Key.....157
- **【Save】** Key.....157
- **【Print】** Key.....158
- **【Help】** Key.....158

This section describes in detail the system key group and its corresponding menu item functions, results and other information. The system key group is as shown in Fig.5.19.



Fig. 5.19 System Key Group

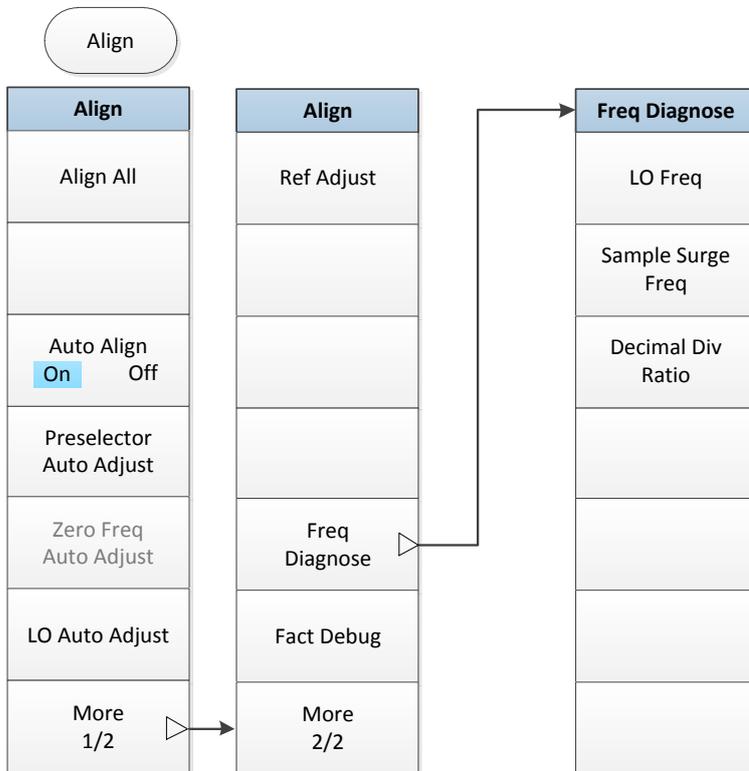
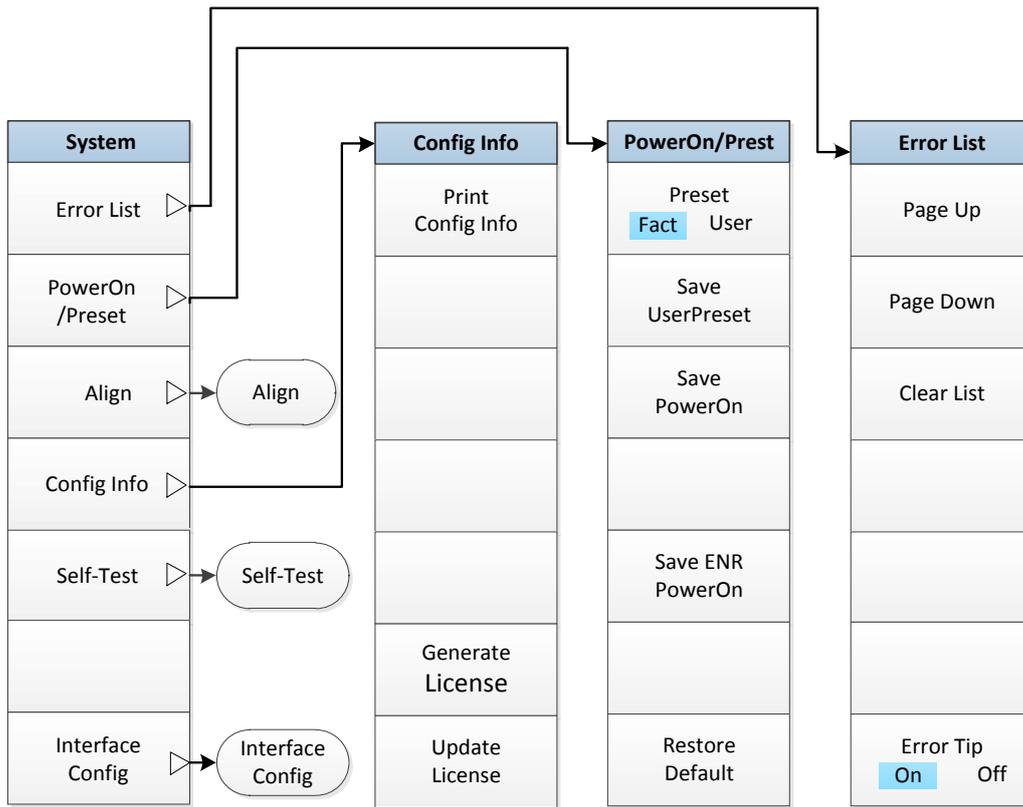
5.4.1 **【Preset】** Key

Press **【Preset】** key, control the noise figure analyzer to preset to the factory initial state or user preset state depending on the preset state setup.

5.4.2 **【System/Local】** Key

The **【System/Local】** key corresponds to the menu as shown in Fig. 5.20. When noise figure analyzer is in the remote control state, press the key to return noise figure analyzer to local state. In the local state, press the key to provide the functions related to the system setup, including the error list, poweron/preset, align, configuration information, self-test, interface configuration and other related information.

5.4 System Key Group



5.4 System Key Group

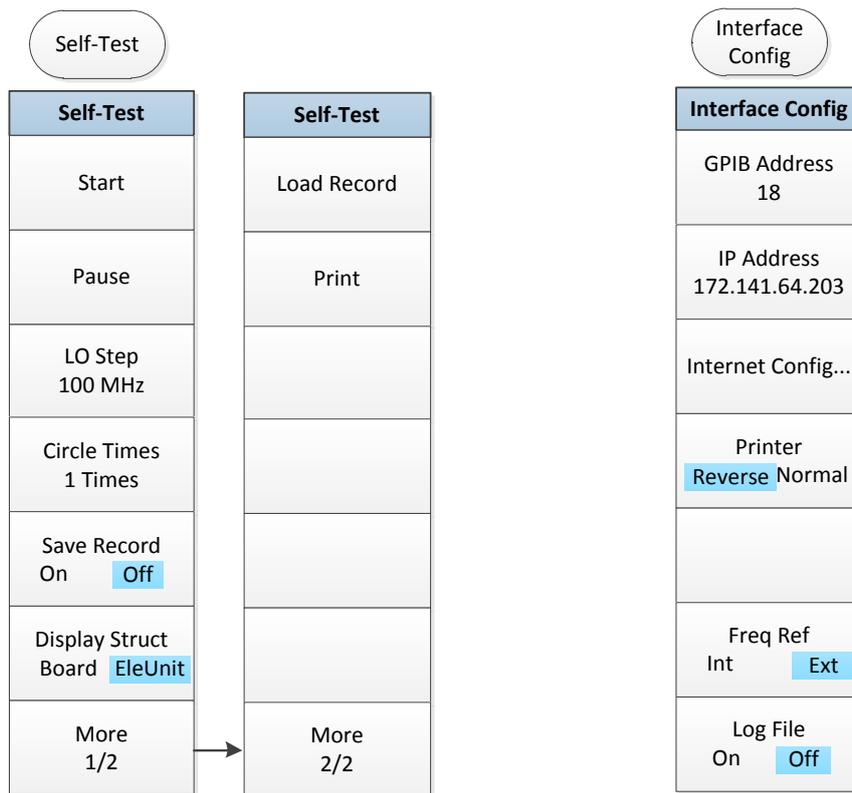


Fig.5.20 System/Local Menu

**[Error List]**

Press the menu key to display the error list of noise figure analyzer.

**[Page Up]** It is used to display the error information of previous page.

**[Page Down]** It is used to display the error information of next page.

**[Clear List]** It is used to clear all information from the error list.

**[Error Tip]** It is used to set [Error Tip] to "On" and "Off" state to determine whether the error state information is displayed in the display area of noise figure analyzer state and error information.

**[PowerOn/Preset]**

**[Preset]** Press [Preset] key to set the preset state. When user selects to press the【Preset】key, it is used to select the factory preset or user preset. [Preset] is "User" state by default, and noise figure analyzer performs the user preset. If the user does not save the user preset state, the analyzer remains in the current state.

**[Save UserPreset]** Press the menu key to save the current working state of noise figure analyzer as the user preset state. When menu [Preset] is set to "user" mode, if the 【Preset】 key is pressed, the working state of noise figure analyzer is automatically restored to the preset state saved by user.

**[Save PowerOn]** Press the menu key to save the current working state of noise figure analyzer as the user poweron state. If user saves the user poweron state, the noise figure analyzer will automatically enters the user poweron state each time the power is turned on. If the user does not save the user state, the noise figure analyzer will automatically enter the factory poweron state each time the power is turned on.

**[Align]**

Press the menu key to enter the auto adjustment and alignment menu of internal hardware of noise figure analyzer. Major menus include the auto adjustment of preselector and local oscillator, reference adjustment, frequency diagnosis, factory debugging, etc.

**[Align All]** Press the menu key to align all the results of noise figure analyzer. It usually takes a few minutes to calibrate.

**[Auto Align]** It is used to turn "On" or "Off" the auto align. [Auto Align] defaults to be "On". Noise figure analyzer automatically determines whether to perform the calibration based on the power on time, the internal temperature change of analyzer, etc. When [Auto Align] is set to "On", the auto align will be performed 15 min after the power on. If the analyzer detects an internal temperature change of more than 10°C within 15 minutes, the analyzer immediately stops the current test and performs the auto align. After the align is completed, measurement is continued. The auto align will be performed once when the temperature in the chassis changes by 10°C. If you do not want the analyzer to automatically perform an align thus interrupting the normal measurement, turn off [Auto Align]. However, if the internal temperature of analyzer changes greatly or if the self-calibration is not performed for a long time, the measurement value will be affected.

**[Preselector Auto Adjust]** It is used to automatically calibrate the center frequency of preselector and ensure the accuracy and consistency of the measurement results.

**[Zero Freq Auto Adjust]** It is used to automatically adjust the amplitude of zero-frequency signal to ensure the test requirement of LF signal.

**[LO Auto Adjust]** The menu is used to control the noise figure analyzer to optimize the setting of local oscillator control results. When the operating environment or the internal temperature of analyzer changes drastically, the control result of the oscillator circuit module inside the analyzer may need to be changed to ensure the normal and stable operation of analyzer local oscillator circuit. Noise figure analyzer automatically optimizes the control results of local oscillator based on the power on time, the internal temperature change of analyzer, etc. User can also manually control the analyzer to optimize the control results of local oscillator according to this menu.

**[Ref Adjust]** It is used to adjust the output frequency of internal reference time base.

**[Freq Diagnose]** It is used to display the soft menu of frequency diagnosis function, including the [LO Freq], [Sample Surge Freq] and [Decimal Div Ratio]. Note: In multi-band sweep, the displayed frequency corresponds to the starting sweep frequency of oscillator for corresponding band.

**[LO Freq]** It is used to show the starting frequency of first local oscillator corresponding to the current band.

**[Sample Surge Freq]** It is used to display the sampling oscillator frequency corresponding to the starting frequency of current band and the compensation value of sampling loop bandwidth.

**[Decimal Div Ratio]** It is used to display the division ratio of decimal frequency divider corresponding to the starting frequency of current band.

#### **[Config Info]**

Control and display the hardware/software information and option configuration of analyzer. Soft menu includes [Show Config Info], [Generate License] and [Update License].

**[Print Config Info]** It is used to display the configuration information of current hardware/software and option of analyzer.

**[Generate License]** It is used to configure the hardware/software and option of analyzer to generate the license.

#### 5.4 System Key Group

**[Update License]** It is used to upgrade the hardware/software by updating the license.

#### **[Self Test]**

It is used to control the analyzer to perform the self-test. The soft menu includes [Start], [Pause], [LO Step], [Circle Times], [Save Record], [Display Struct], [Load Record], [Print] etc.

**[Start]** It is used to control the analyzer to start the self-test when the [Self-Test] menu is entered for the first time or self-test is paused.

**[Pause]** It is used to control analyzer to pause the self-test when the analyzer performs self-test.

**[LO Step]** It is used to set the local oscillator step frequency when the analyzer performs the self-test. It is 100MHz by default.

**[Circle Times]** It is used to set the circle times when the analyzer performs self-test. After the analyzer finishes the loop tests, it will automatically stop the self-test.

**[Save Record]** It is used to determine whether the analyzer automatically saves self-test records after completing the self-test. [Save Record] is set to "Off" state by default.

#### **[Display Struct]**

It is used to control the display mode of analyzer self-test results. When it is set to "Board" mode, it shows the self-test results of internal circuit board module of analyzer; when it is set to "EleUnit" mode, it shows the self-test results of unit level module of analyzer. It is set to "Unit" mode by default.

**[Load Record]** It is used to load the last saved self-test result.

**[Print]** It is used to control the analyzer to print the currently displayed self-test result.

#### **[Interface Config]**

When the menu key is pressed, the soft menu related to the interface configuration of noise figure analyzer pops up, including [GPIB Addr], [Network Config], [Print] and [Log File].

**[GPIB Addr]** It is used to set the GPIB address of this machine which is "8" by default.

**[Network Config]** Windows dialog box for setting the IP address and gateway is displayed. IP address and gateway before leaving the factory

is preset to get IP address automatically. Both IP address and gateway can be changed manually. For details on how to change the IP address and host name, please refer to help document of Microsoft Windows 7.

#### **[Print]**

It is used to set the printing color as the normal or reverse color of the analyzer screen. The background of analyzer screen trace display area is black. For the ease of use, when the analyzer prints the screen trace display area, the printing color is "inverse" mode by default.

#### **[Log File]**

When [Log File] is set to "On" state, some information of analyzer information is written into the file, and the main information includes the program control command information, etc. The log file will be automatically generated in the Factdir/Log directory under the program running directory each time the analyzer is powered on. The switch is set to "Off" set in factory by default.

### 5.4.3 【File】 Key

The key is used to enter the file-related operation menu as shown in Fig.5.21, and to save or load the file, save the test data, and exit the file-related operation of noise figure analyzer.



Fig.5.21 File Menu

#### **【Save】**

When the menu key is pressed, a Windows standard "Save as" dialog box pops up. Select the save directory of file, input the name of file to be saved, select the save type, and then press the save button to complete the save operation. If you do not want to save the file, press [Cancel] key to terminate the save operation. For details, please refer to "[3.3.4 Perform file operations](#)" in this manual.

#### **【Load】**

When the menu key is pressed, a Windows standard "Open" dialog box pops up. Select the file directory, file type and file name, and click [Open] button to complete the file load. If you do not want to load the file, then press [Cancel] key to terminate the file load. For details, please refer to "[3.3.4 Perform file operations](#)" in this manual.

#### **【Save Test Data】**

Save the adjusted reference data in the file.

#### **【Exit】**

It is used to exit the software program of noise figure analyzer and enter the Windows operating system interface.

### 5.4.4 【Save】 Key

Press the key to quickly save the screen graph in the format of "\*.bmp".

5.4 System Key Group

5.4.5 **【Print】** Key

Press **【Print】** key to control the noise figure analyzer to print a screenshot. For details, please refer to [“3.3.4 Perform file operations”](#) in this manual.

5.4.6 **【Help】** Key

When **【Help】** key is pressed, the noise figure analyzer will display the content of the relative chapter in electronic manual corresponding to analyzer menu.

## 6 Remote Control

This chapter provides the basic information for operating the 3986 noise figure analyzer through remote control to enable users to operate the instrument remotely.

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- [Remote interface and its configuration.....173](#)
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### 6.1 Remote control basis

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#### 6.1.1 Remote interface

3986 noise figure analyzer supports two kinds of remote control interfaces: LAN, GPIB. It is shown in the table below:

Table 6.1 Types and VISA Addressing Strings of Remote Control Interfaces

Remote Interfaces	VISA Addressing Strings (Note 1)	Instructions
LAN (Local Area Network)	<b>Raw socket protocol:</b> TCPIP::host_address::port::SOCKET	Controller realizes remote control by connecting the instrument via the network port on the rear panel of the instrument. See <a href="#">“6.1.1.1 LAN Interface”</a> for the specific protocol.
GPIB (IEC/IEEE Bus Interface)	GPIB::primary address[::INSTR]	Controller realizes remote control by connecting the instrument via the port on the rear panel of the instrument. The IEC 625.1/IEEE 418 bus interface standard is observed. See <a href="#">“6.1.1.2 GPIB interface”</a> for details.

Note 1: VISA or Virtual Instrumentation Software Architecture is a standard software interface function library which can be used by the user to control the instrument through GPIB, RS232, LAN and USB interfaces. The user should first install the VISA library on the control computer and use it to implement remote control of the instrument. For details, please refer to the user manual of the installed VISA library.

##### 6.1.1.1 LAN interface

The 3986 series noise figure analyzer can be accessed to the 10 Mbps/100 Mbps/1,000 Mbps Ethernet through a RJ45 communication cable (shielded or unshielded CAT 5 twisted pair) for remote control via

## 6.1 Remote control basis

the LAN control computer. The noise figure analyzer has already been installed with an interface adapter and TCP/IP network protocol and configured with network service based on TCP protocol to realize the remote control in LAN.

The network interface adapter installed on the 3986 noise figure analyzer has three operating modes:

- 1) 10 Mbps Ethernet (IEEE802.3);
- 2) 100 Mbps Ethernet (IEEE802.3);
- 3) 1,000 Mbps Ethernet (IEEE802.3ab).

The interface adapter can automatically match with the appropriate network speed based on link condition. The cable connecting the noise figure analyzer shall generally not exceed 100 m in length. For more information about Ethernet, please refer to <http://www.ieee.org>.

The following describes the knowledge about LAN interface:

### 1) IP address

When the noise figure analyzer is remotely controlled via LAN, the physical network connection shall be guaranteed to be smooth. The address of the noise figure analyzer is set to the subnet where the host computer is located via menu "local IP". For example, if the IP address of host computer is 192.168.12.0, the IP address of the noise figure analyzer shall be set to 192.168.12.XXX, where XXX is a value between 1 and 255.

Only the IP address is required to establish a network connection. The VISA addressing string is as follows:

TCPIP::host address::port::SOCKET

Where,

- TCPIP - network protocol used;
- Host address is an instrument IP address or host name used to identify and control the instrument being controlled;
- Port is a socket port number. For 3986 noise figure analyzer, the socket port number is 5,000;
- SOCKET is resource class of original network socket.

Example:

When the raw socket connection is created, the following addressing string can be used:

TCPIP::192.1.2.3::5000::SOCKET

## NOTE

### Multi-instrument identification method in remote control system:

If multiple instruments are connected to the network, they can be identified by their individual IP address and associated resource string. The main control computer uses the respective VISA resource string for instrument identification.

### 2) Socket communication

The TCP/IP protocol connects the signal sources in the network through the LAN socket. As a basic computer network programming method, the socket enables applications with different hardware and operating systems to communicate in the network, This method enables two-way communication between the noise figure analyzer and the computer via port.

The socket is a special software class that defines the necessary information for network communication such as IP address and device port number and integrates some basic network programming operations. Sockets can be used in the operating system installed with a packaged library. UNIX Berkeley socket

and Winsock are commonly used.

The socket in the noise figure analyzer is Berkeley socket and Winsock compatible through the application program interface (API). In addition, other standard sockets are also compatible through the API. When the noise figure analyzer is controlled using SCPI command, the socket program created in the program issues command. For the noise figure analyzer, the socket port number is set to 5,000.

### 6.1.1.2 GPIB interface

GPIB, the only bus designed for instrument control, is still being widely used in automated test system. A GPIB interface is integrated on the rear panel of 3986 noise figure analyzer. For remote control, the main control computer should first be installed with the GPIB bus card, driver and VISA library. During communication, the main control computer achieves addressing of the controlled instrument through the GPIB address. The user can modify the GPIB address of the controlled instrument to avoid communication failure caused by an address conflict in the whole system.

There are detailed definitions and descriptions of GPIB and its relative interfaces in ANSI/IEEE Standard 488.1-1987 and ANSI/IEEE Standard 488.2-1992. For details of the standard, please refer to <http://www.ieee.org>.

When GPIB is connected, please pay attention to the following items:

- 1) Up to 15 equipment can be incorporated in the test system through the GPIB bus component;
- 2) The total length of the transmission cable should not be more than 20 m or twice the number of instruments in the system;
- 3) Generally, the maximum length of the transmission cable between equipment should not exceed 2 m;
- 4) If multiple instruments are connected in parallel, the "Or" connecting cables should be used;
- 5) The terminal of the IEC bus cable shall be connected to the instrument or the controller computer.

### 6.1.2 Message

Messages transmitted by data cable fall into the following two categories:

#### 1) Interface message

The interface message is specific to the GPIB bus. Only the instrument with the GPIB bus function can respond to the interface message. When the main control computer sends an interface message to the instrument, the attention line should be pulled down at first, and then the interface message can be transmitted to the instrument through the USB cable.

#### 2) Instrument message

For the structure and syntax of instrument message, refer to Section "5.1.4 SCPI Command". Instrument message can be divided into command and instrument response according to the different transmission directions. All remote control interfaces use instrument message in the same method unless otherwise stated.

##### a) Commands:

A command (programming message) is a message transmitted from the main control computer to the instrument for remote control of instrument functions and query of status information. It falls into the following two categories:

##### i Based on the impact on the instrument:

- 1) Set command: change the instrument setup status, for example, reset or set the frequency.

## 6.1 Remote control basis

- 2) Query command: query and return data, for example, identify instrument or query parameter values. The query command is always ended with a question mark.

### ii Based on the definition in the standard:

- 1) Common command: with functions and syntax defined in IEEE488.2, applicable to all types of instrument (if implemented) for the management of standard status register, reset, self-test, etc.
- 2) Instrument control command: Instrument characteristic command for instrument functions. For example: set the frequency. The syntax also follows SCPI specification.

### b) Instrument response:

The instrument response (response message and service request) is the query result information sent by the instrument to the computer. This information includes measurement result and instrument status.

## 6.1.3 SCPI

### 6.1.3.1 Brief introduction to SCPI

SCPI (Standard Commands for Programmable Instruments) is a command set that is established based on IEEE Standard 488.2 and applicable to all instrument. mainly to achieve the universality of SCPI, i.e.the same SCPI is generated and issued for the same function.

The SCPI consists of a command header and one or more parameters which are separated by a space. The command header contains one or more key fields. The command with question mark as postfix is a query command. Commands are divided into common commands and instrument-specific commands that are different in syntactic structure. SCPI has the following features:

- 1) The SCPI is established for the test functions rather than instrument operation description.
- 2) The SCPI reduces the repetition of the realization process of similar test functions, thus ensuring the programming compatibility;
- 3) Remote control message is defined in a layer that is independent of the communication physical layer hardware.
- 4) The SCPI is unrelated with the programming methods and languages, and the SCPI test program is easy to be transplanted;
- 5) The SCPI is scalable so that it is applicable to measurement control on different scales.
- 6) SCPI scalability makes it a "live" standard.

If you are interested in learning more about SCPI, please refer to:

- 1) IEEE Standard 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation. New York, NY, 1998.
- 2) IEEE Standard 488.2-1987, IEEE Standard Codes, Formats, Protocols and Comment Commands for Use with ANSI/IEEE Std488.1-1987. New York, NY, 1998.
- 3) Standard Commands for Programmable Instruments(SCPI) VERSION 1999.0.

For the collection of remote control commands, classification and description of 3986 noise factor analyzer, please refer to:

- 1) "[Appendix B Lookup Table of SCPI](#)" of this manual.
- 2) "3 Remote Control Command" in Remote Control Manual.
- 3) 6.1 Appendix A SCPI Command Tree in the Programming Manual.
- 4) 6.2 Appendix B Lookup Table of SCPI by Subsystem in the Programming Manual.
- 5) 6.3 Appendix C Lookup Table of SCPI by Menu in the Programming Manual.

### 6.1.3.2 SCPI description

#### 1) General terms

For the purpose of this section, the following terms should apply. It is necessary to know about the exact definitions of these terms for a better understanding of the content in various chapters.

##### a) Controller

A controller is any computer used to communicate with an SCPI equipment. The controller may be a personal computer, a small computer or a card inserted onto a cage. Some artificial intelligence equipment can also be used as a controller.

##### b) Equipment

An equipment is any device that supports SCPI. Most equipment is electronic measurement or excitation equipment and uses a GPIB interface for communication.

##### c) Remote control message

A remote control message is a combination of one or more properly-formatted SCPIs. It guides the equipment to measure and output the signal.

##### d) Response message

A response message is a collection of data in specified SCPI formats. It is always sent from the equipment to the controller or listener to remind the controller of the internal condition or measured value of the equipment.

##### e) Command

A command is an instruction that meets SCPI standard. The combination of controller commands forms a message. In general, a command includes the keyword, parameter and punctuation.

##### f) Event command

An event-type SCPI can't be queried. An event command generally has no corresponding key settings on front panel. Its function is to trigger an event at a particular moment.

##### g) Query

Query is a special command. When the controller is queried, it is necessary to return to the response message in conformity with syntax requirement of the controller. The query statement is always ended with a question mark.

#### 2) Command type

There are two types of SCPI commands: common commands and instrument-specific commands. Common commands are defined in IEEE 488.2 to manage macros, status registers, synchronization, and data storage. Common commands are easy to recognize as they all begin with an asterisk. For example \*IDN? , \*OPC and \*RST are common commands. Common commands don't belong to any instrument-specific command. The instrument uses the same method to interpret them without consideration to the current path setting.

It is very easy to identify instrument-specific commands because they contain a colon (:). The colon is used between the beginning of a command expression and a keyword, for example: FREQUENCY[:CW?]. Instrument-specific commands are divided into command subsets of corresponding subsystem

## 6.1 Remote control basis

according to the functional block inside the instrument. For example, the power subsystem (:POWer) contains the power-related command while the status subsystem (:STATus) contains the command for the status control register.

## 3) Instrument-specific command syntax

Table 6.2 Special Characters in Command Syntax

Symbol	Meaning	Example
	A vertical stroke between keyword and parameter indicates alternative choices.	[:SOURce]:AM: SOURce EXTernal INTernal EXTernal and INTernal are alternative choices
[]	Keywords or parameters in square brackets are optional when composing the command . These implied keywords or parameters also will be executed even if they are ignored.	[:SOURce]:AM[:DEPT]h:EXPon ential? SOURce and DEPT h are dispensable.
< >	The part inside the angle brackets can't be used literally in the command. They represent the needed item.	[:SOURce]:FREQ:STOP <val><unit> In this command, <val> and <unit> must be replaced by an actual frequency and unit. For example: :FREQ:STOP 3.5GHz
{ }	The part inside the braces indicates that the parameters in them are optional.	[:SOURce]:LIST:POWer <val>{,<val>} For example: LIST:POWer 5

Table 6.3 Command Syntax

Character, Keyword and Syntax	Example
Upper-case characters represent the minimum character set required by command execution.	[:SOURce]:FREQUency[:CW]?, FREQ is the short-format part of the command.
The lower-case characters portion of command is optional; Such flexible format is called “flexible listening”. For more information, please refer to the section “Command parameter and response”.	:FREQUency :FREQ, :FREQUency or :FREQUENCY, any of which is correct.
When a colon is placed between two command mnemonics, it moves the current path down one level in the command tree. For more information, please refer to the command path part in the section “Command tree”.	:TRIGger:OUTPut:POLarity? TRIGger is the topmost keyword of the command.
If a command requires more than one parameter, you must separate adjacent parameters using a comma. Parameters do not affect path layers	[:SOURce]:LIST:DWELl <val>{,<val>}

as they are not the portion of the command path.	
A semicolon separates 2 adjacent commands without affecting the current path.	:FREQ 2.5GHZ; :POW 10DBM
White space characters, such as <space> or <tab>, are generally ignored so long as they don't appear between or among keywords . However, you must use white space to separate parameters from commands, which does not affect the current path.	:FREQ uency or :POWER :LEVEl6.2 is not allowed. You must leave a white space between :LEVEl and 6.2. i.e. :POWER:LEVEl 6.2

A typical command consists of keywords with colon as prefix.. These keywords are followed by parameters.. An example of syntax statement is shown below.

```
[[:SOURce]:POWER[:LEVEl] MAXimum|MINimum
```

In the above example, the [:LEVEl] portion of the command immediately follows :POWER with no separating space. The part closely following the [:LEVEl]: The MINimum|MAXimum is the parameter part. There is a space between the command and the parameter. The description of other parts of the syntax expression is as shown in Table 6.2 and Table 6.3.

#### 4) Command tree

Most remote control programming tasks involve instrument-specific commands. When such a command is parsed, the SCPI uses a structure similar to a file system. This command structure is called a command tree.

The top command is root command, or simply “root”. In the case of command parsing, the command at the next layer is reached by following a specific route based on the tree structure. For example::POWER:ALC:SOURce?, where, POWER stands for AA,: ALC stands for BB, :SOURce stands for GG, and the whole command path is (:AA:BB:GG).

A software module in the instrument software—the command interpreter—is responsible for parsing each received SCPI. The command interpreter breaks up the command into individual command element using a series of rules for identifying the command tree path. After the current command is parsed, the current command path remains unchanged. In this way, the subsequent commands can be parsed more quickly and efficiently because the same command keyword may appear in different paths. After the power-on\*RST (reset) operation of the instrument, the current command path is reset as the root.

#### 5) Command parameter and response

Table 6.4 Types of SCPI Command Parameter and Response

Parameter Type	Response Data Type
Numeric	Real or Integer
Extended Numeric	Integer
Discrete	Discrete
Boolean	Numeric Boolean
String	String
Block	Definite Length Block

## 6.1 Remote control basis

	Indefinite Length Block
Non-decimal numeric	Hexadecimal
	Octal
	Binary

SCPI defines the rule based on which different data formats are used in remote control messages and response messages to accommodate the principle of “flexible listening” and “precise talking”. For more information, please refer to IEEE488.2. “Flexible listening” means that the formats of commands and parameters are flexible.

For example, for the noise figure analyzer, the frequency offset state command is set as :FREQUENCY:OFFSet:STATe ON|OFF|1|0,

The following command formats are used to set the frequency offset function as “On”:

:FREQUENCY:OFFSet:STATe ON, :FREQUENCY:OFFSet:STATe 1,

:FREQ:OFFS:STAT ON, :FREQ:OFFS:STAT 1

Each parameter type has one or more corresponding response data types. A numeric parameter will return a data type when queried. Response data are accurate, and strictly speaking, it is called “precise talking”.

For example, if you query the power state (:POWER:ALC:STATe?), when it is turned on, the response is always 1, regardless of whether you previously sent :POWER:ALC:STATe 1 or :POWER:ALC:STATe ON.

#### a) Numeric parameter

Numeric parameters can be used in both instrument-specific commands and common commands. It receives all common decimal systems including signs, decimal point and scientific notation. If a certain piece of equipment only receives a specified type of numeric parameter such as an integer, it will automatically round off the received numeric parameter.

Examples of numeric parameter:

- 1) no decimal point
- 2) 100                                      Optional decimal point
- 3) 1.23                                      With a sign bit
- 4) 4.56e<space>3                          space allowed after exponent marker e
- 5) -7.89E-01                                exponent marker e may be upper or lower case
- 6) +256                                      leading + allowed
- 7) 5 Front decimal point allowed

#### b) Extended numeric parameter

Most measurements related to Instrument-specific commands use extended numeric parameters to specify the physical quantities. Extended numeric parameters receive all numeric parameters and additional special values. All extended numeric parameters receive MAXimum and MINimum as parameter values. Other special values, such as UP and DOWN are received by the instrument parsing capability. SCPI command table will list all valid parameters.

Note: extended numeric parameters are not applicable to common commands or STATus subsystem commands.

Examples of extended numeric parameters:

- 1) 101    Numeric parameter
- 2) 1.2 GHz                                  The GHz can be used as an exponent (E009)

- |            |   |
|------------|---|
| 3) 200 MHz | The MHz can be used as an exponent (E006) |
| 4) -100 mV | -100 millivolts                           |
| 5) 10DEG   | 10 degrees                                |
| 6) MAXimum | Maximum valid setting                     |
| 7) MINimum | minimum valid setting                     |
| 8) UP      | Increase a step                           |
| 9) DOWN    | Decrease a step                           |

### c) Discrete parameter

When there are a finite number of parameter values to be set, discrete parameters are used for identification. A discrete parameter uses mnemonics to represent each valid setting. Like the SCPI mnemonics, the discrete parameter mnemonics can be set in long and short formats, with both capitalized and lowercase characters.

The following example illustrates the combined use of discrete parameter and command.

:TRIGger[:SEQuence]:SOURce BUS|IMMEDIATE|EXTernal

- 1) BUS GPIB,LAN,RS-232 trigger
- 2) IMMEDIATE Immediate trigger
- 3) EXTernal External trigger

### d) Boolean parameter

Boolean parameters represent a single binary condition that is either true or false. There are only four possible representations for a Boolean parameter.

Examples of Boolean parameters:

- 1) ON Logical true
- 2) OFF False
- 3) 1 True
- 4) 0 False

### e) String parameter

A string parameter allows the ASCII string to be sent as a parameter. Single and double quotes are used as separators.

Examples of string parameter:

'This is Valid' "This is also Valid" 'SO IS THIS'

### f) Real response data

A large portion of measurement data is real. They are formatted as basic decimal notation or scientific notation. Most high-level remote control languages all support these two formats.

Examples of real response data:

- 1) 1.23E+0
- 2) -1.0E+2
- 3) +1.0E+2
- 4) 0.5E+0
- 5) 0.23
- 6) -100.0
- 7) +100.0

## 6.1 Remote control basis

8) 0.5

### g) Integer response data

The integer response data are a decimal expression of an integer with the sign bit. When the status register is queried, the integer response data will be mostly returned.

Examples of integer response data:

- 1) Sign digit optional
- 2) +100 Leading + allowed
- 3) -100 Leading - allowed
- 4) 256 No decimal point

### h) Discrete response data

The discrete response data and discrete parameters are basically the same. The main difference is that the discrete response data can only be returned in the short format with capitalized characters.

Examples of discrete response data:

- 1) INTERNAL Amplitude stabilizing mode is internal
- 2) INTERNAL Amplitude stabilizing mode is external
- 3) MMHead Amplitude stabilizing mode is millimeter wave source module

### i) Numeric Boolean response data

Boolean response data returns a binary number 1 or 0.

### j) String response data

The string response data and string parameters are the same. The main difference is that the string response data use double quotes rather than single quotes as the separator. The string response data can also be inserted with double quotes inside which there can be no characters. Examples of string response data:

“This is a string”

“one double quote inside brackets: (“”)”

## 6) Systems of Values in Commands

The value of the command can be entered in binary, decimal, hexadecimal or octal format. In the binary, hexadecimal, or octal format, a suitable identifier should be added in front of the value. In the decimal (default) format, an identifier isn't required. When the value without an indicator is entered, the equipment will ensure that it is entered in decimal format. The identifiers required in all formats are listed as follows:

- #B indicates a binary value;
- #H indicates a hexadecimal value;
- #Q indicates an octal number.

The representations of the decimal value 45 in the SCPI are given as follows:

- #B101101
- #H2D
- #Q55

The following example shows setting of the RF output power as 10 dBm (or the value equivalent to the current selected unit including DBUV or DBUVEMF) with the hexadecimal value 000A.

:POW #H000A

In a non-decimal format, the measurement unit such as DBM or mV isn't used together with the value.

## 7) Command line structure

A command line may contain multiple SCPIs. To indicate the end of the current command line, the following methods can be used:

- Enter;
- Enter and EOI;
- EOI and the last data byte.

Commands in command line are separated by semicolons, and commands for different subsystems begin with a colon. For example:

```
MMEM:COPY "Test1", "MeasurementXY";:HCOP:ITEM ALL
```

The command line contains two commands of which the first one belongs to the MMEM subsystem and the second one belongs to the HCOP subsystem. If the adjacent commands belong to the same subsystem, the command path will be partially repeated and the command can be abbreviated. For example: For example:

```
HCOP:ITEM ALL;:HCOP:IMM
```

The command line contains two commands both of which belong to the HCOP subsystem of first level. Therefore, the second command can begin with the subordinate to HCOP and may not begin with a colon, which can be abbreviated to the following command line:

```
HCOP:ITEM ALL;:HCOP:IMM
```

### 6.1.4 Command sequence and synchronization

IEEE488.2 defines the difference between overlapped commands and sequential commands:

- 1) Sequential commands are sequences of commands that are executed continuously. Usually, each command is executed fast.
- 2) Overlapped commands indicate that the previous command is not executed automatically before the next command is executed. Normally overlapped commands take longer to process and allow the program to process other events synchronously.

Even if multiple commands are set in a command line, they are not necessarily executed in the order in which they are received. In order to ensure that the commands are executed in a certain order, each command must be sent as a separate command line.

#### **Example: Command line contains set and query commands**

If multiple commands in a command line contain query commands, the query result is unpredictable. The following command returns a fixed value:

```
:FREQ:STAR 1GHZ;SPAN 100;:FREQ:STAR?
```

Returned value: 1000000000 (1GHz)

The following command returns an unfixed value:

```
:FREQ:STAR 1GHZ;STAR?; SPAN 1000000
```

The returned value may be the current start frequency value of the instrument before the command is sent, because the host program executes the commands one by one only after receiving the command message. If the host program executes the command after receiving it, the returned value may also be 1 GHz.

**NOTE****Set command and query commands are sent separately:**

General rule: The setting and query commands should be sent in different program control messages so as to ensure a correct returned value for the query command.

**6.1.4.1 Preventing overlapping execution of the command**

In order to prevent the overlapped execution of commands, multiple threads or commands: \*OPC, \*OPC? or \*WAI can be used. These three commands can be executed only after the hardware is set. While programming, the computer can be forced to wait for some time to synchronize certain events. The details are separately described below:

**1) Controller program uses multiple threads**

Multiple threads are used to achieve the completion of wait command and the synchronization between user interface and remote control, that is, a separate thread waits for \*OPC? to complete without blocking the execution of GUI or remote control thread.

**2) The usage of the three commands in synchronous execution is shown in the table below:**

Table 6.5 Command Syntax

Method	Actions to be Executed	Programming Method
*OPC	After the command is executed, the operation complete bit in ESR register is set.	Set ESE BIT0; Set SRE BIT5; Send overlap command and *OPC; Wait for Service Request (SRQ) signal; SRQ represents the completion of execution of the overlapped command
*OPC?	The execution of current command is stopped until it returns until the value 1 is returned. The command is returned only when the operation completion bit in the ESR is set, which indicates that the previous command is processed.	Terminate the processing of the current command before executing other commands, and send the command directly after the current command.
*WAI	Before executing *WAI, wait until all commands are sent and continue processing unfinished commands.	Terminate the processing of the current command before executing other commands, and send the command directly after the current command.

**6.1.5 Status reporting system**

The status reporting system stores all current operation status information and error information of the instrument. Such information is stored in the status register and error queue respectively and can be queried through the remote interface.

### 6.1.5.1 Structure of the status register

The register classification is described as follows:

#### 1) STB, SRE

Status Byte (STB) register and its associated mask register, Service Request Enable (SRE) register, constitute the top-level register of the status reporting system. The STB saves the general working status of the instrument by collecting low-level register information.

#### ESR, SCPI status register

STB receives the information of the following registers:

- The value of Event Status Register (ESR) and Event Status Enable (ESE) mask register.
- SCPI status registers include: STATus:OPERation and STATus:QUEStionable registers (SCPI definition) which contain the specific operating information of the instrument. All SCPI status registers have the same internal structure (please refer to Section 2.1.5.2 “Structure of SCPI status register” in the Programming Manual).

#### 2) IST, PPE

Similar to SRQ, the single bit of IST flag("Individual Status") is a combination of all states of the instrument. The associated Parallel Query Enable Register (PPE) determines which data bits of STB act on IST flag.

#### Output buffer

The output buffer stores the message returned by the instrument to the controller. It doesn't belong to the status reporting system but determines the value of the MAV bit of STB.

For the details of the above registers, please refer to “2.1.6 Status Reporting System” in Remote Control Manual.

Please refer to Fig. 6.1 Hierarchy Diagram of Status Register.

---

### NOTE

#### SRE, ESE

The SRE can be used as an enable part of the STB. Similarly, the ESE can be used as an enable part of the ESR.

---

6.1 Remote control basis

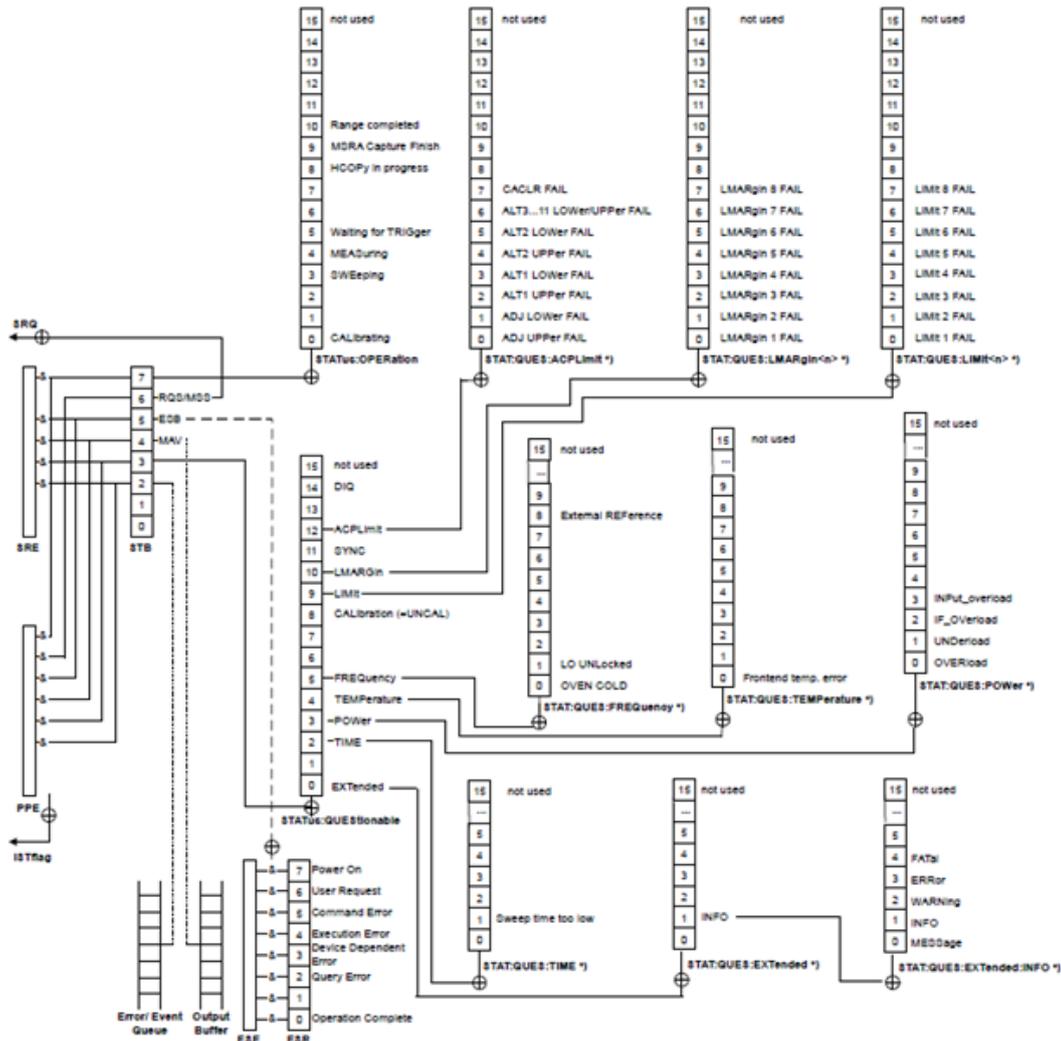


Fig 6.1 Hierarchy Diagram of Status Registers

6.1.5.2 Application of status reporting system

The status reporting system is used to monitor the status of one or more instruments in the test system. To correctly realize the function of the status reporting system, the controller in the test system must receive and evaluate the information of all instruments. The standard methods applied include:

- 1) Instrument initiated Service Request (SRQ);
- 2) Perform serial poll of all instruments in the bus system, which is initiated by the controller in the system in order to find out the initiator and reason of the service request.
- 3) Perform parallel query of all instruments;
- 4) Query of the status of specific instrument by remote control command;

For details about the application methods, please refer to the section “2.1.5 Application of the status reporting system” in the Programming Manual.

6.1.6 Programming considerations

1) Please initialize the instrument status before changing the settings

When setting the instrument remotely, you first need to initialize the instrument status (for example, send “\*RST”) and then implement the required status settings.

## 6.2 Remote interface and its configuration

**2) Command sequence**

In general, the setting and query commands should be sent separately; otherwise the returned value of the query command will change according to the current instrument operation sequence.

**3) Failure response**

The service request can only be initiated by the instrument itself. The controller program in the test system should instruct the instrument to initiate a service request when an error occurs, and then enter the corresponding interrupt service routine for processing.

**4) Error queue**

Each time the controller program processes a service request, the error queue rather than the status register of the instrument should be queried to obtain a more accurate error reason. The error queue should be frequently queried to obtain the wrong command sent by the controller to the instrument especially during testing of the controller program.

**6.2 Remote interface and its configuration**

- LAN.....173
- GPIB.....174

**6.2.1 LAN**

LAN (Local Area Network) remote control system controls 3986 noise figure analyzer using SICL-LAN.

**Attention****Use of USB main control port connector on front panel**

Type-A connector on front panel is the connector of USB master control port. In 3986 noise figure analyzer, this port is used to connect the flash disk of USB 1.1 interface to upgrade the instrument resident software. The noise figure analyzer can also be controlled by connecting USB keyboard and mouse. It is not possible to remotely control the instrument via this port.

**6.2.1.1 Connection**

3986 noise figure analyzer and external controller are connected to LAN using network cable. In particular, note that IP address settings may cause address conflicts. Before setting, you should first consult network administrator to prevent conflicts.

**6.2.1.2 Interface configuration**

When the noise figure analyzer is remotely controlled via LAN, the physical network connection shall be guaranteed to be smooth. As the noise figure analyzer does not support DHCP, domain name access and wide-area network connection, the network remote control setting is relatively simple. "IP address", "subnet mask" and "default gateway" are set to the subnet where the master controller is located following the path of **【System/Local】** →[Interface Conf]→[Network Conf].

## 6.3 Basic programming method of the VISA interface

**Attention**

**Ensure that the noise figure analyzer is physically connected properly by 10Base-T LAN or 100Base-T LAN cable**

Because the noise figure analyzer only supports the construction of a single LAN control system and the setting of static IP addresses, and it does not support DHCP and the access to the host through the DNS and domain name servers, the users do not need to modify the subnet mask, which is fixedly set to 255.255.255.0 in the instrument.

## 6.2.2 GPIB

## 6.2.2.1 Connection

3986 noise figure analyzer is connected to an external controller (computer) using GPIB cable.

## 6.2.2.2 Interface configuration

After entering the setting interface following the path of **【System/Local】** → [Interface Config] → [GPIB Addr], you can use the numeric keys on the front panel to makes changes in the local GPIB address input box.

## 6.3 Basic programming method of the VISA interface

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- [Initialization of controller.....174](#)
- [Initialization of instrument.....175](#)
- [Sending of setting command.....175](#)
- [Reading the instrument status.....175](#)
- [Reading of markers.....176](#)
- [Command synchronization.....176](#)

The basic methods for programming of remote control of the instrument through the VISA library are illustrated hereinafter. Take the C++ language as an example.

## 6.3.1 Installation of VISA library

At first, it is necessary to install the VISA library so as to achieve remote control. The VISA library packages the underlying transfer functions of underlying VXI, GPIB, LAN and USB interfaces so that the user can recall them directly. APIs supported by the noise factor analyzer: GPIB, LAN, and RS-232. The use of these interfaces in conjunction with VISA library and programming languages allows remote control of the noise figure analyzer.

## 6.3.2 Initialize Controller

```
/******
```

The following example shows how to open and establish a communication connection between VISA library and the instrument (specified by instrument descriptor).

```
///Initialize controller: open the default explorer and return the instrument handle analyzer
```

```
/******
```

```
void InitController()
```

## 6.3 Basic programming method of the VISA interface

```

{
ViStatus status;
status = viOpenDefaultRM(&defaultRM);
status = viOpen(defaultRM, analyzerString, VI_NULL, VI_NULL, &analyzer);
}

```

## 6.3.3 Initialization of instrument

```

/*****/

```

The following example shows how to initialize the instrument default status and clear status registers.

```

/*****/

```

**void InitDevice()**

```

{
ViStatus status;
long retCnt;
status = viWrite(analyzer, "*CLS", 4, &retCnt); //reset status registers
status = viWrite(analyzer, "*RST", 4, &retCnt); //reset the instrument
status = viWrite(analyzer, ":INST:SEL SA", 12, &retCnt); //set the working mode of the instrument (here
take the noise figure analyzer command as an example)
}

```

## 6.3.4 Sending of setting command

```

/*****/

```

The following example shows how to set the center frequency of 3986 noise figure analyzer.

```

/*****/

```

**void SimpleSettings()**

```

{
ViStatus status;
long retCnt;
//Set the center frequency to 128 MHz
status = viWrite(analyzer, ":FREQUENCY:CENTER 128MHz", 22, &retCnt);
}

```

## 6.3.5 Reading of instrument status

```

/*****/

```

The following example shows how to read the setting status of the instrument.

```

/*****/

```

**void ReadSettings()**

```

{
ViStatus status;
long retCnt;
char rd_Buf_CW[VI_READ_BUFLLEN]; // #define VI_READ_BUFLLEN 40

//Query center frequency

```

### 6.3 Basic programming method of the VISA interface

```
status = viWrite(analyzer, ":FREQ:CENT?", 10, &retCnt);
status = viRead(analyzer, rd_Buf_CW, 20, &retCnt);
//Print debugging information
sprintf("Cw is %s", rd_Buf_CW);
}
```

#### 6.3.6 Read Frequency Marker

```
/*-----*/
```

The following example shows how to read the measured marker.

```
/*-----*/
```

##### **void ReadMarker ()**

```
{
ViStatus status;
long retCnt;
char rd_Buf_Marker[VI_READ_BUFLEN]; // #define VI_READ_BUFLEN 20

//Open marker 1 and query marker peak (frequency and amplitude)
status = viWrite(analyzer, ":CALC:MARKER:MAX", 25, &retCnt);
status = viWrite(analyzer, ":CALC:MARK:Y?", 15, &retCnt);
//Print debugging information
sprintf("Marker is %s", rd_Buf_Marker);
}
```

#### 6.3.7 Synchronization of command

```
/*-----*/
```

The methods for command synchronization are illustrated hereinafter by taking sweep as an example.

```
/*-----*/
```

##### **void SweepSync()**

```
{
ViStatus status;
long retCnt;
ViEventType etype;
ViEvent eevent;
int stat;
char OpcOk [2];
/*-----*/
/*Command INITiate[:IMMediate] initiates a single sweep (INIT:CONT OFF when continuous sweep is OFF)*/
/* Only when the single sweep is completed can the next command in the command buffer be executed
*/
/*-----*/
status = viWrite(analyzer, ":INIT:CONT OFF", 13, &retCnt);
//Method 1 of waiting for sweep completion: use *WAI
```

```

status = viWrite(analyzer, ":INIT", 18, &retCnt);
status = viWrite(analyzer, "*WAI", 18, &retCnt);

//Method 2 of waiting for sweep completion: use *OPC?
status = viWrite(analyzer, ":INIT", 20, &retCnt);
status = viWrite(analyzer, "*OPC?", 18, &retCnt);
status = viRead(analyzer, OpcOk, 2, &retCnt); //wait for *OPC to return "1"

//Method 3 of waiting for sweep completion: use *OPC
//To use the GPIB service request, set "Disable Auto Serial Poll" as "yes"
status = viWrite(analyzer, "*SRE 32", 7, &retCnt);
status = viWrite(analyzer, "*ESE 1", 6, &retCnt); //Enable Service Request ESR
//Set the event enable bit, the operation is completed
status = viEnableEvent(analyzer, VI_EVENT_SERVICE_REQ, VI_QUEUE, VI_NULL);
//Enable SRQ event
status = viWrite(analyzer, ":INIT ", 18, &retCnt);
status = viWrite(analyzer, "*OPC?", 18, &retCnt);
//Start sweep synchronously with OPC
status = viWaitOnEvent(analyzer, VI_EVENT_SERVICE_REQ, 10000, &etype, &event)
//Wait for service request
status = viReadSTB(analyzer, &stat);
status = viClose(event); //Close event handle
//Disable the SRQ event
status = viDisableEvent(analyzer, VI_EVENT_SERVICE_REQ, VI_QUEUE);
//Continue running the main program.....
}

```

## 6.4 I/O library

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- [Installation and configuration of I/O library.....](#)178

### 6.4.1 Overview of I/O library

As a library of software programs pre-written for the instrument, the I/O library is called an instrument driver. It is considered as the intermediate layer of the software between the computer and the instrument hardware equipment, composed of function library, utility program and tool kit, and used as a software code module set that corresponds to a planned operation, e.g. configuring, reading from, writing to or triggering the instrument. It resides in the computer as the bridge and link between the computer and the instrument and provides a easily programmed high-level modular library so that the user no longer needs to learn complex low-level programming protocols specific to an instrument. The instrument driver is the key to rapid development and test of measurement applications.

Functionally, a general-purpose instrument driver is generally composed of function body, interactive developer interface, programming developer interface, subroutine interface and I/O interface, as shown in Figure 6.2.

## 6.4 I/O library

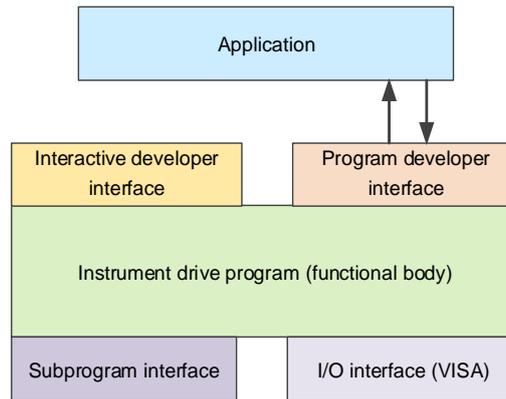


Figure 6.2 Instrument Driver Structure Model

The detailed description is given as follows:

- 1) Functional body. It is the main functional part of the instrument driver and can be understood as the framework program of the instrument driver.
- 2) Interactive developer interface. For user's convenience, a graphical interactive developer interface is generally provided in the application development environment that supports the development of the instrument driver. For example, the function panel in Labwindows/CVI is an interactive developer interface. In the function panel, each parameter of the instrument driver function is represented by a graphical control.
- 3) Program developer interface. It is a software interface for an application to call instrument driver function, e.g. the dynamic link library file .dll of instrument driver under Windows.
- 4) I/O interface. It is used to complete the actual communication between the instrument driver and the instrument. You can use bus-specific I/O software, such as GPIB, RS-232; you can also use common standard I/O software that spans multiple buses: VISA I/O.
- 5) Subroutine interface. It is a software interface for an instrument driver to access other support libraries, e.g. database, FFT function, etc. When the instrument driver needs to recall other software modules, operating systems, program code libraries and analysis function libraries to complete its task, the subroutine interface will be used.

### 6.4.2 Installation and configuration of I/O library

With the development of the test field application from the traditional instrument to the virtual instrument, the instrument driver has experienced different development processes in order to solve the instrument interchangeability and test program reusability of the automatic test system. The currently popular driver is IVI (Interchangeable Virtual Instruments) driver, which is based on IVI specification and defines a new instrument API and inserts class driver and VPP architecture into VISA to make test application completely independent from instrument hardware, and adds unique instrument simulation, range detection, status cache and other functions, improving the system operating efficiency and truly implementing the interconvertibility of instrument.

IVI driver is divided into two types: IVI-C and IVI-COM. IVI-COM is based on Microsoft Component Object Model (COM) and adopts COM API; IVI-C is based on ANSI C and adopts C API. Both types of drivers are designed according to the instrument class defined in IVI specification, and their application development environments are identical, including Visual Studio, Visual Basic, Agilent VEE, LabVIEW, CVI/LabWindows, etc.

Currently, it is necessary to provide two types of drivers in order to meet the demands of different users

## 6.4 I/O library

in different development environments. The IVI driver of the noise figure analyzer uses Nimbus Driver Studio to produce IVI-COM and IVI-C drivers as well as program installation package. For specific installation and configuration, please refer to documents accompanied with the control card and I/O Library of your choice.

The installed IVI driver is divided into an IVI intrinsic functional group and a instrument class functional group (a basic functional group and an extended functional group). For details about functional classification, functions and attributes, please refer to the accompanied help document of the driver.



## 7 Fault Diagnosis and Repair

This chapter will show you how to find out problems and accept after-sales service.

If you encounter any problems while using the 3986 series noise figure analyzer or need to purchase additional or optional parts for the device, we will provide complete after-sales service.

Generally, the problems come from hardware, software or improper use. If there is any problem, please contact us timely. If the noise figure analyzer is under warranty, we will repair it for free as promised under warranty. If the warranty period has expired, we will only charge you for the cost of repair.

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### 7.1 Working principle

To aid users in better understanding the functions of the 3986 series noise figure analyzer and solve encountered problems more efficiently, this section introduces the hardware block diagram and the working principles of the device.

The 3986 series noise figure analyzer is a microprocessor-controlled, triple-frequency, high-sensitivity superheterodyne sweeping receiver operated using Windows 7. It is composed of a high-sensitivity noise receiver front end, low-phase noise oscillator synthesizer, microwave drive, intermediate frequency processor, data acquisition and processing unit, embedded computer platform, control port, I/O port, power source, display, and system software. The block diagram of the system is illustrated in Figure 7.1.

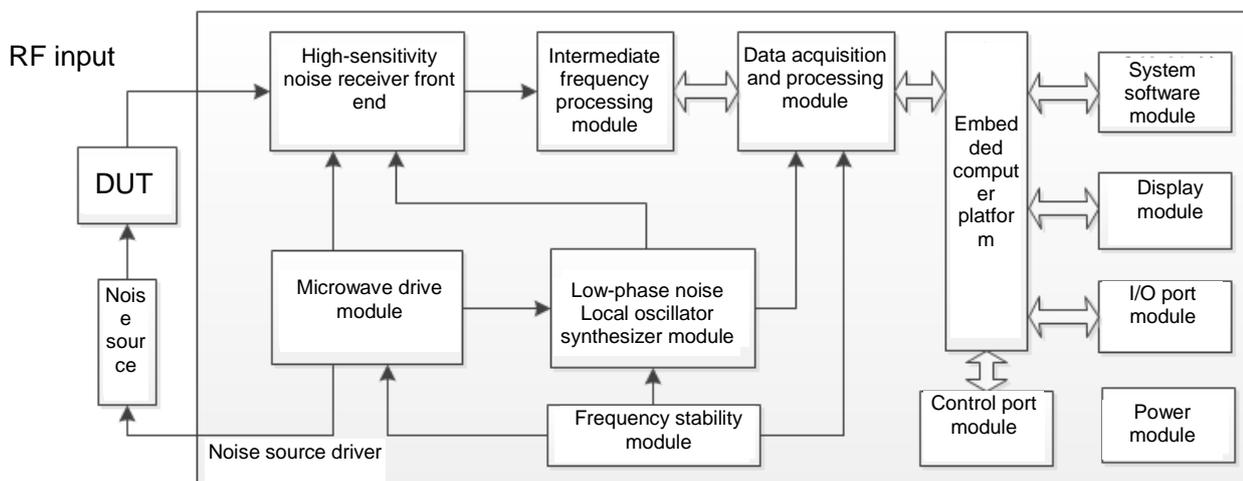


Figure 7.1 Block diagram of the 3986 series noise figure analyzer

Under excitation of the output noise signal from the noise source, the noise response signal generated at the output end is passed through a wide-band coaxial mechanical switch. This divides the signal into radio frequency (10MHz ~ 4GHz) and microwaves (4GHz ~ 18/26.5/40/50GHz), where the 10MHz~4GHz signals in the radio frequency band are subjected to suppression of image frequency and filtered through a multi-response low-pass filter. Then, the programmable step attenuator adjusts the power level and subsequently enters low-band frequency conversion module. Through mixing with the signal of the first local oscillator (YIG oscillator), an intermediate frequency of 5.225GHz is obtained,

## 7.2 Fault diagnosis and troubleshooting

which is then filtered through a 5.225GHz band-pass filter and input into the second inverter in the low-band frequency conversion. This results in a second intermediate frequency difference of 425MHz with the frequency of the second oscillator, 4.8GHz. The microwave section provides a four-band product at 4GHz~18/26.5/40/50GHz. The signals of the microwave section are first amplified using a low-noise pre-amplifier and then filtered through a YTF pre-selector. They are then input into the local oscillator mixing module and undergo fundamental wave mixing with the first local oscillator signal, directly outputting a second intermediate frequency of 425MHz.

Once a selection is made between low-band and high-band intermediate output signals from the intermediate frequency module, a signal is synthesized to perform a series of processing steps, including level adjustment within a large gain range, gain flatness compensation, and intermediate frequency filtering. The output of the local oscillator module is 500MHz and the mixed output of the third local oscillator is an intermediate frequency noise signal of 75MHz. Upon amplification and variable bandwidth filtering of the 75MHz intermediate frequency signal, it can be exported to the data acquisition and processing module. The data acquisition and processing module quantizes the 75MHz intermediate frequency noise signal into bandwidths of 4MHz/2MHz/1MHz/400kHz/200kHz/100kHz (optional), at a rate of 50MHz. The noise power signal is then transmitted to the host instrument.

The synthetic local oscillator module is mainly composed of four loops: reference loop, sampling loop, YTO loop, and fractional loop. In single-loop mode, the 3GHz~10GHz local oscillator signals are divided into two and enters the fractional frequency dividing module, generating a fixed intermediate frequency of 50 MHz. This is compared with signal of 50MHz from the reference loop. The error signal is sent to the YTO drive coil and the YTO frequency is adjusted until the sampled intermediate frequency output equals 50MHz. In four-loop mode, the 4GHz~10GHz signals from the local oscillator enter the sampler and the sampling loop provides signals at 618MHz~905MHz as the sample local oscillator. The sampling intermediate frequency output at 30MHz~64MHz and the 20-frequency output of the fractional ring are subjected to phase comparison. The error signal is sent to the YTO driver coil, and the YTO frequency is adjusted until the sampled intermediate frequency output equal the fractional loop output. Phase-locking synthesis significantly enhances the stability of the local oscillator. The micro-step interval (mHz) of the fractional loop output enables the local oscillator to step at 1-mHz intervals, thereby achieving a frequency resolution of 1Hz.

The embedded computer platform controls the internal operation of the noise figure analyzer. It receives various requests through the I/O port from either the front panel keypad or an external computer. The control program stored in the flash memory card determines the functions performed by the main controller. The main controller transmits relevant control signals to the microwave components such as the YTO, YTF, programmable step attenuator, and radio frequency switch via the microwave driver board.

## 7.2 Fault diagnosis and troubleshooting

- [Basic fault diagnosis process](#).....183
- [Common faults and troubleshooting methods](#).....183

In most cases, problems arise because of hardware/software malfunction or inappropriate use by the operator. Once a problem occurs, first observe the error information, analyze the possible causes, and solve the problem in advance by reference to the methods provided in "[7.2.1 Basic fault diagnosis process](#)" and "[7.2.2 Common faults and troubleshooting methods](#)". Alternatively, you can contact our

## 7.2 Fault diagnosis and troubleshooting

customer service center and provide the collected error information, and we will help you solve the problems as quickly as possible. For more information, please refer to the contact details in this manual or inquire online at [www.ceyear.com](http://www.ceyear.com) for contact details of the nearest technical support center.

### NOTE

#### Troubleshooting and error guide

This section is a guide on how to diagnose and handle issues that you may encounter while using the 3986 series noise figure analyzer. If necessary, please provide accurate feedback to the manufacturer with regards to the issues and we will assist you in finding a solution as quickly as we can.

#### 7.2.1 Basic fault diagnosis process

If the device malfunctions, please check the following:

- 1) Is the power outlet working?
- 2) Is the noise figure analyzer turned on? Check whether the green LED next to the power button is lit up. Check for noise from the internal fan to determine whether the cooling system is functioning properly.
- 3) If any other device, cable, or connector is used in conjunction with the noise figure analyzer, ensure that they are properly connected and are functioning normally.
- 4) If the noise figure analyzer cannot communicate over LAN, check the LAN cable and connection.

If the noise figure analyzer does not fully load or run the operating system, or if the application program fails to start up properly, there may be a fault in the hard drive. If the system recovery of the device has run for a sufficiently long time but still failed to be completed, please follow the instructions stated in [“3.1.2.4 Windows 7 system security and maintenance”](#).

- 1) When encountering a problem for the first time, check the measurement procedures. Have all settings been configured properly?
- 2) If the noise figure analyzer is not operating properly, please set [Reset] to “Factory” mode, then press the **【Preset】** button to revert the device to a previous known state.
- 3) Are the measurements being performed and the result consistent with the performance index and characteristics of the noise figure analyzer? Please refer to [“8 Specifications and test methods”](#) of the User Manual for performance indicators of the noise figure analyzer.

#### 7.2.2 Common faults and troubleshooting methods

The common faults and troubleshooting methods are listed by function.

##### 7.2.2.1 Problems that arise during system start-up

If the 3986 series noise figure analyzer malfunctions during start-up, there may be a problem with the power source, external processing hardware, or device configuration. This section will go through the power-on procedure of the 3986 series noise figure analyzer and analyze the possible causes of problems during the start-up process. The instrument takes approximately 3 minutes to start up. The start-up time will vary depending on the hardware configuration, installation options, and the number of measurement applications.

## 7.2 Fault diagnosis and troubleshooting

### 1) Lighting failure of yellow readiness indicator lamp

Plug the device into the power outlet and turn on the power from the rear panel. The power indicator at the bottom left hand corner of the front panel will turn yellow. If the yellow readiness indicator lamp does not light up, first ensure that the power button on the back of the noise figure analyzer is switched on. Then confirm that the voltage and frequency of the power source comply with the required working parameters of the 3986 series noise figure analyzer. Detailed requirements can be found in "[3.1.1.3 Power on/off](#)". If the power supply parameters meet the requirements, the problem may be caused by the instrument power failure. Please contact our customer service center and provide details on the error or malfunction. We will aid you as quickly as we can to solve the problem.

### 2) Abnormal functioning of green power indicator lamp

Push the power button on the bottom left hand corner on the front panel to turn on the device. At this time, the power indicator should turn from yellow to green. If the power indicator does not turn green, there may be an issue with the power source. If the power indicator switches between the stand-by yellow light and the power-on green light, ruling out the possibility of problems with the power supply, the device may be experiencing an abnormal internal load. Please contact our customer service center and provide details on the error or malfunction. We will aid you as quickly as we can to solve the problem.

### 3) Fan work failure

When the 3986 noise figure analyzer is powered on, all fans within the device should start working. If none of the fans work, it could be due to a problem of the power source. If individual fans are not working, then the error may be related to the fans themselves. Please contact our customer service center and provide details on the error or malfunction. We will aid you as quickly as we can to solve the problem.

### 4) Black screen

The screen may not display because of several reasons. If the three above-mentioned issues have been resolved, please continue to the following steps:

**Step 1.** Connect a CRT display device properly to the monitor connector on the rear connector and turn it on. Wait 30 seconds. If the CRT is displaying properly, then the BIOS parameters may have been modified. Turn off the computer, connect a PS/2 keyboard and turn on the computer again. Push the **[F2]** button on the keyboard until the BIOS configuration interface appears. Select [Load Setup Defaults] from the [Exit] to restore the factory BIOS configuration. Save and restart the device. If the device interface is still not displaying properly, there may be a fault with the LCD-related components of the device. Please contact our customer service center and provide details on the error or malfunction. We will aid you as quickly as we can to solve the problem.

**Step 2.** If there is still no display after being connected to a CRT device, the hardware of the instrument may fail, please contact our customer service center according to the contact information provided in this guidebook and provide the error information you have collected. We will help you to solve the problem as soon as possible.

### 5) BIOS test crash

If the noise figure analyzer remains in the display processor information state after turning on the power, then the BIOS test has crashed. Please follow these steps:

## 7.2 Fault diagnosis and troubleshooting

- Step 1.** Check whether a standard keyboard has been connected and whether the BIOS test was terminated. If not, please continue to the next step.
- Step 2.** Power off and then connect a PS/2 interface standard keyboard to the instrument. Power on, long press the **[F2]** key on the standard keyboard until entering the BIOS Setup interface, select the **[Load Setup Defaults]** option in the **[Exit]** tab, call the factory setup in the BIOS, select **[Save]** and then restart. If the problem is still unresolved, there may be a failure of the instrument hardware. Contact our customer service center according to the contact information provided in this guidebook and provide the error information you have collected. We will help you to solve the problem as quickly as possible.

**6) Failure to find system disk**

If the system is unable to find the hard disk after the noise figure analyzer has been turned on, please turn off the power on the back of the device and turn it back on after 1 to 2 minutes. Then, turn on the power on the front panel of the device to check whether the system disk could be found. If the disk is still not found, connect a PS/2 keyboard to enter the BIOS settings and check whether the IDE device exists. If it does not exist, there may be a malfunction in the hard disk of the apparatus. Please contact the customer service center and provide relevant information on the error. We will aid you in solving the problem as quickly as possible.

**7) Windows boot failure**

After the processor information has appeared, an operating systems menu appears with a timer where you may select Windows 7 start-up and system recovery tools. The default selection is Windows 7 system start-up. If you need to access system recovery, before the timer reaches 0, select “One-key GHOST V2011.07.01” using the up and down arrows, then press **[Confirm]**.

During the Windows start-up process, if a blue screen appears, the start-up crashes, or the process restarts, please follow these steps:

- Step 1.** First, ensure that there is no external USB drive connected to the instrument.
- Step 2.** Restart the noise figure analyzer. If the system starts normally and the error does not reappear frequently, then it was a random start-up malfunction encountered by Windows and the device can be used as usual. Otherwise, please continue to the next step.
- Step 3.** Power off and then connect a PS/2 interface standard keyboard to the instrument. Turn on the computer and push the **[F2]** button on the keyboard until the BIOS configuration interface appears. Select the **[Load Setup Defaults]** option from the **[Exit]** tab to restore the factory BIOS configuration. Save and restart. If the problem is solved, it indicates that the BIOS settings have been changed. Otherwise, there may be a problem with the device system. Please continue to the next step.
- Step 4.** Power off and then connect a PS/2 interface standard keyboard to the instrument. Turn on the computer and select the recovery option from the operating systems menu (before performing operating system recovery, please refer to the relevant notes on system recovery in this manual and contact the manufacturer). Perform system recovery by following the instructions. For detailed instructions, please refer to [“3.1.2.5 System backup and recovery”](#).
- Step 5.** If the device is unable to undergo proper system recovery, there may be a malfunction of the hard drive. Please contact the customer service center using the information provided in the

### 7.3 Repair Method

manual and provide detailed information on the relevant error. We will assist you in solving the problem as quickly as possible.

#### 7.2.2.2 Abnormal trace display

When the 3986 series noise figure analyzer enters the measurement interface and has completed all start-up and calibration processes, the device goes into normal scan test mode. The interface displays a continuously refreshing track. However, if certain parameters are configured incorrectly, then users may not see the anticipated track. If the track does not refresh normally, please first check the following settings.

##### 1) Checking the device connection

When a normal noise source is used, connect the noise source drive input end to the +28V noise source drive port on the noise figure analyzer panel with a BNC cable, and connect the noise source output to the input port (50Ω) of the noise figure analyzer.

When a smart noise source is used, connect the noise source to the smart noise source drive port on the noise figure analyzer panel with a multi-core cable, and connect the noise source output to the input port (50Ω) of the noise figure analyzer.

##### 2) Trace refresh failure

If the noise figure track (default device setting) does not refresh on the interface, please refer to the following steps:

**Step 1.** Press the **【Sweep】** key, set [Sweep Mode] as “Continuous”.

**Step 2.** Check again to see whether the trace refreshes. If the cursor does not move, try to restart the system. If the problem is still not solved, please contact the customer service center using the information provided in the manual, and provide detailed information on the relevant error. We will assist you in solving the problem as quickly as possible.

##### 3) Abnormal noise figure trace display

If the device does not display the correct noise figure trace or exceeds the standard technical range specified in “[8 Specifications and test methods](#)”, the noise figure analyzer may be experiencing hardware circuit failure. Please contact the customer service center using the information provided in the manual and provide detailed information on the relevant error. We will assist you in solving the problem as quickly as possible.

### 7.3 Repair Method

- [Contact us.....186](#)
- [Packaging and mailing.....187](#)

#### 7.3.1 Contact us

If 3986 series noise figure analyzer has any fault, firstly observe and save the error information, and then analyze possible causes and eliminate and solve the problems according to methods described in section “[7.2 Fault diagnosis and troubleshooting](#)”. Alternatively, you can contact our customer service center and provide the collected error information, and we will help you solve the problems as quickly as

possible. Please refer to our web site [www.ceyear.com](http://www.ceyear.com) to find the contact details about the nearest technical support center.

**Contact information:****Tel:** +86-0532-86896691**E-mail:** [sales@ceyear.com](mailto:sales@ceyear.com)**Web:** [www.ceyear.com](http://www.ceyear.com)**Address:** No.98, Xiangjiang Road, Qingdao City, China**Postal code:** 266555

### 7.3.2 Packaging and delivery

If you encounter a problem that is difficult to solve when using the noise figure analyzer, you can reach us via telephone or fax. If it is decided that the apparatus needs to be returned for repair, please package the noise figure analyzer using the original packaging material and box, and follow these steps:

- Step 1.** Include a detailed explanation of the problem that you've encountered when using the noise figure analyzer along with the instrument in the packaging box.
  - Step 2.** Use the original packaging material to package the instrument to minimize possible damage.
  - Step 3.** Place pads in the corners of the box and put the device into the box.
  - Step 4.** Seal the box tightly with tape and use nylon straps to reinforce the box.
  - Step 5.** Attach a label on the box with "Fragile! No Touch! Handle with Care!" indicated.
  - Step 6.** Please arrange the consignment as required for the precise instrument.
  - Step 7.** Keep the copies of all the shipping documents.
- 

#### Attention

**Notes on packaging the noise figure analyzer:**

The use of other materials to package the noise figure analyzer may cause damage to the device. It is forbidden to use polystyrene beads as the packaging material because they can't fully protect the instrument and may damage the instrument after being sucked into the instrument fan by the static electricity.

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#### NOTE

**Packaging and transporting the instrument**

The instrument should be transported or handled in strict accordance with the the precautions described in section "[3.1.1.1 Unpacking](#)".

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## 8. Specifications and Test Methods

This chapter introduces the specifications and main test methods of 3986 series noise figure analyzers.

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- [Product Features.....](#)189
- [Specifications.....](#)190
- [Supplementary Information.....](#)192
- [Performance Characteristics Test.....](#)193

### 8.1 Statement

Unless specifically stated, all specifications shall be tested at temperature of  $23^{\circ}\text{C}\pm 5^{\circ}\text{C}$  half an hour after start-up. Supplementary information of the instrument is to help users understand the instrument performance and is independent of specifications. The important entries are explained as follows:

**Specifications (spec):** unless otherwise specified, instrument calibrated is placed for at least two hours within the working temperature range, and performance is guaranteed after 30 minutes of warm-up; measurement errors are included. Data in this article are specifications unless otherwise stated.

**Typical value (typ):** A typical value refers to the typical performance that can be achieved by 80% of instruments; it isn't an assurance data and doesn't include uncertainty in the measurement process. It is valid only at room temperature (about  $25^{\circ}\text{C}$ ).

**Nominal (nom):** expected average performance or design performance characteristics, such as  $50\Omega$  connector. The measured value is not guaranteed. It is obtained at room temperature (about  $25^{\circ}\text{C}$ ).

**Measurement (meas):** the performance characteristics measured at design stage for comparison with expected performance. It isn't an assurance data; it is measured at room temperature (about  $25^{\circ}\text{C}$ ).

### 8.2 Product features

Table 8.1 Product Features

General Specifications	
<b>Temperature Range</b>	Operating: $0^{\circ}\text{C}\sim +40^{\circ}\text{C}$ Storage: $-40^{\circ}\text{C}\sim +70^{\circ}\text{C}$
<b>Altitude</b>	4,600m
<b>Electromagnetic Compatibility</b>	Compliance with the following requirements specified in 3.9.2 of GJB 3947A-2009: 1) CE102 power line conducted emission; 2) CS101 power line conducted sensitivity; 3) CS114 bulk cable injection conducted susceptibility; 4) RE102 electric field radiation emission; 5) RS103 electric field radiation sensitivity.
<b>Safety</b>	The instrument should meet the safety certification requirements defined in 3.10 of GJB 3947A-2009. 1) The resistance between power input end and housing of the equipment (power button in ON position) shall not be less than $100\text{M}\Omega$ under standard atmospheric pressure for

8.3 Specifications

		<p>testing and 2 MΩ in humid environment.</p> <p>2) When a 1,500VAC voltage is applied between the equipment power input end and the instrument enclosure, there should be no breakdown, flashover or flashing.</p> <p>3) The leakage current between the instrument enclosure and the ground should not exceed 3.5mA during equipment operation.</p>
Power requirement	Voltage and Frequency (Nominal)	<p>220V, 50Hz;</p> <p>The allowable range of steady-state voltage is 10% of nominal value, and the allowable range of steady-state frequency is 5% of nominal value.</p>
	Power consumption	<p>Maximum power consumption: 250W,</p> <p>Maximum standby power consumption: 20W.</p>
Display screen		<p>1280×800, XGA,</p> <p>10.1".</p>
Data Storage		<p>160G SSD,</p> <p>Support USB 2.0-compliant storage devices.</p>
Weight		<p>Net weight: below 23kg,</p> <p>Packed weight: 34kg (nominal).</p>
Size		<p>W×H×D (mm) = 426×177×460 (without handle, footing, foot pad and side strap),</p> <p>Allowable tolerance ±10mm.</p> <p>W×H×D (mm) = 510×190×534 (without handle, footing, foot pad and side strap), allowable tolerance ±10mm.</p>
Warranty		<p>3986 noise figure analyzer has a standard warranty period of 18 months.</p>
Reliability		<p>MTBF(<math>\theta_0</math>)≥5000h.</p>
Calibration period		<p>The recommended calibration period is one year and the calibration service is provided by a professional calibration agency.</p>

8.3 Specifications

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- Frequency reference accuracy.....191
- Frequency Tuning Accuracy.....191
- Noise Figure Measurement Range and Measurement Uncertainty.....191
- Gain Measurement Range and Measurement Uncertainty.....191
- Input VSWR.....191
- Instrument's own noise figure.....191
- Jitter.....191
- Noise Source Drive Voltage.....192

### 8.3.1 Frequency Range

Model	Frequency range
3986A	10MHz~4GHz
3986D	10MHz~18GHz
3986E	10MHz~26.5GHz
3986F	10MHz~40GHz
3986H	10MHz~50GHz

### 8.3.2 Frequency Reference Accuracy

$\pm < 0.2\text{pmm}$

#### 8.3.3 Frequency Tuning Accuracy

4MHz bandwidth

$\pm < (\text{frequency reference error} + 100\text{kHz})$  10MHz $\leq f \leq$ 4GHz

$\pm < (\text{frequency reference error} + 400\text{kHz})$  4GHz $< f \leq$ 50GHz

Less than 4MHz bandwidth

$\pm < (\text{frequency reference error} + 20\text{kHz})$  10MHz $\leq f \leq$ 4GHz

$\pm < (\text{frequency reference error} + \text{resolution bandwidth} \times 20\%)$  4GHz $< f \leq$ 50GHz

### 8.3.4 Noise Figure Measurement Range and Measurement Uncertainty

Measurement range 0~30dB, measurement uncertainty  $\pm < 0.10\text{dB}$  (ENR: 12dB~17dB)

Measurement range 0~35dB, measurement uncertainty  $\pm < 0.15\text{dB}$  (ENR: 20dB~22dB)

### 8.3.5 Gain Measurement Range and Measurement Uncertainty

Measurement range -20dB~+40dB, measurement uncertainty  $\pm < 0.17\text{dB}$

### 8.3.6 Input VSWR

$< 1.90:1$  10MHz $\leq f \leq$ 4GHz

$< 2.10:1$  4GHz $< f \leq$ 18GHz

$< 2.40:1$  18GHz $< f \leq$ 26.5GHz

$< 2.40:1$  26.5GHz $< f \leq$ 40GHz

$< 2.40:1$  40GHz $< f \leq$ 50GHz

### 8.3.7 Instrument's own Noise Figure

$< 8.0\text{dB}$  10MHz $\leq f \leq$ 4GHz

$< 7.5\text{dB}$  4GHz $< f \leq$ 18GHz

$< 8.0\text{dB}$  18GHz $< f \leq$ 26.5GHz

$< 10.0\text{dB}$  26.5GHz $< f \leq$ 40GHz

$< 12.0\text{dB}$  40GHz $< f \leq$ 50GHz

### 8.3.8 Jitter

$< 0.17\text{dB}$ (Y-factor deviation)

8. Specifications and Test Methods

8.4 Supplementary Information

8.3.9 Noise Source Drive Voltage

<1.0V (noise source OFF)

+28.0V±0.1V (noise source ON)

8.4 Supplementary Information

- Measurement Bandwidth.....192
- Sweep Points.....192
- Front Panel Port.....192
- Rear Panel Port.....192

8.4.1 Measurement Bandwidth

4MHz, 2MHz, 1MHz, 400kHz, 200kHz, 100kHz

8.4.2 Sweep Points

2~401

8.4.3 Front Panel Port

Table 8.2 Front Panel Port

Front Panel Port		
Input ports	3984A	3.5 mm (male)
	3984D	3.5 mm (male)
	3984E	3.5 mm (male)
	3984F	2.4mm (male)
	3984H	2.4mm (male)
Noise Source Drive	BNC female adapter	
Smart Drive	Multi-core connector	
USB2.0 Interface	It is used to connect mouse and keyboard to upgrade system software and back up data.	

8.4.4 Rear Panel Port

Table 8.3 Rear Panel Port

Rear Panel Port	
Keyboard Interface	Standard PS/2 interface for external standard computer keyboard.
Video Interface	VGA interface (15-core D-SUB adapter) for external display interface
LAN port	Standard RJ-45, 1000Base-T, for software upgrade, remote control, etc.
GPIB interface	IEEE-488 bus connector, 24-way plug (GPIB code: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, C0) for remote control
USB2.0 Interface	It is used to connect mouse and keyboard to upgrade system software and back up data.
10MHz In	50 Ω impedance, BNC female adapter, amplitude range -5 dBm to +10 dBm
10MHz Out	50 Ω impedance, BNC female adapter, output amplitude ≥0 dBm
Trig In	BNC female adapter
Trig 1 out	BNC female adapter
Trig 1 out	BNC female adapter

DET Out	BNC female adapter
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## 8.5 Performance Characteristics Test

- [Recommended test methods.....193](#)
- [Performance Test Record of 3986 Series Noise Figure Analyzers.....203](#)
- [Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers.....204](#)

### 8.5.1 Recommended test methods

This section provides recommended test methods for 3986 series noise figure analyzers (other equivalent test methods are also available). The instrument shall be warmed up for 30 min before test to ensure the internal components are in thermal equilibrium. Test requirements shall comply with 4.7.2 of GJB 3947A-2009. The test equipment shall meet the performance requirements necessary for the test and shall be properly maintained and calibrated in the specified test environment within the validation period. The test data obtained in accordance with this test method will be approved by us and can be used as a reference for determining whether the instrument is qualified at the time of handover.

#### 8.5.1.1 Frequency Range Test

According to the operating instruction of 3986 series noise figure analyzers, start frequency of 10MHz, stop frequency of 4GHz, start frequency of 4GHz and stop frequency of 18/26.5/40/50GHz are set on the front panel based on the product frequency range; if the instrument sweep status and the display are normal, write PASS in the corresponding item of “Performance Test Record Table of 3986 Series Noise Figure Analyzers”.

#### 8.5.1.2 Frequency Reference Accuracy Test

##### 1) Item description

Frequency reference, the time (frequency) reference, is the reference for the overall frequency. Frequency reference accuracy shall conform to “[8.3 Specifications](#)”.

##### 2) Test equipment and accessories

Frequency meter	Keysight 53230A
BNC (m-m) cable	1

##### 3) Test steps

**Step 1.** Connect the test instrument as shown in Figure 8.1 and warm it up for 30min.

**Step 2.** Press **【Preset】** key to reset 3986 noise figure analyzer to factory state.

**Step 3.** When the frequency meter reading is stable, record the results in Table B.1 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers”. This reading is the measured reference frequency of 3986 noise figure analyzer. The difference between measured value and 10 MHz frequency reference shall be within  $\pm 2\text{Hz}$ .

8.5 Performance Characteristics Test

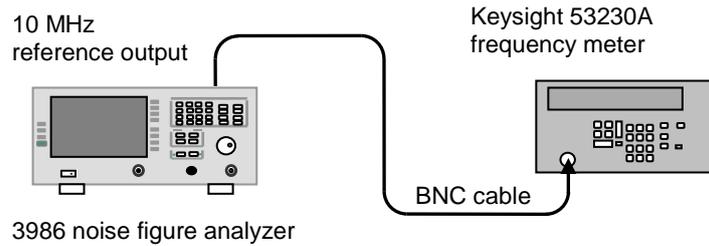


Figure 8.1 Test Block Diagram of Reference Frequency Accuracy

**Step 4.** Convert the measured reference accuracy expressed in Hz into ppm and fill in the corresponding item of "Performance Test Record Table of 3986 Series Noise Figure Analyzers". The conversion method is as follows:

$$\text{Frequency reference accuracy (ppm)} = \frac{\text{Frequency reference accuracy (Hz)}}{10 \times 10^6} \times 10^6 \quad (1)$$

8.5.1.3 Frequency Tuning Accuracy Test

1) Item description

The frequency tuning accuracy indexes of 3986 series noise figure analyzers are related to the shape of IF filter, stability of time base, and stability of the analyzer receiving channel. The center frequency of 3986 series noise figure analyzers is defined in the half power point of power measurement trace. The deviation between the measured center frequency and the set center frequency is the frequency tuning accuracy.

2) Test equipment and accessories

- Signal generator 1464
- BNC(m)-BNC(m) cable 1
- Rfcable 1

3) Test steps

**Step 1.** Connect the test equipment as shown in Figure 8.2 and warm it up for 30 min.

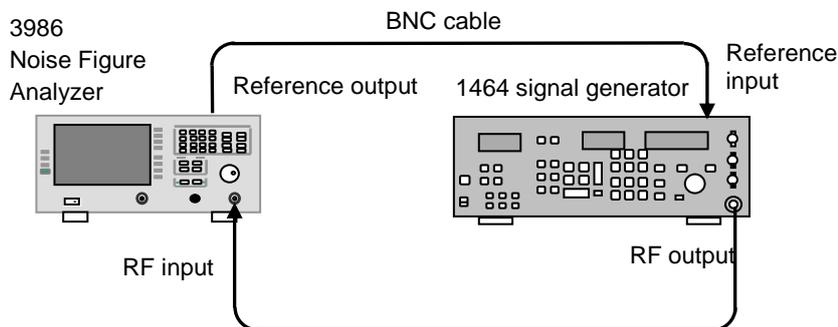


Figure 8.2 Test Block Diagram of Frequency Tuning Accuracy

**Step 2.** Set the signal generator output power to -60dBm and set the signal generator power output to ON.

**Step 3.** Press **【Preset】** key to reset 3986 noise figure analyzer to factory state.

**Step 4.** Set single graph display format and press the window key below the display .

**Step 5.** Set the measurement parameter to PHot.

- Step 6.** Set the number of measuring points to 201.
- Step 7.** Set the fixed IF attenuation to 30dB.
- Step 8.** Set the measurement units to linear and the auto scale to ON state.
- Step 9.** Set the sweep mode of 3986 noise figure analyzer to single.

**a) 4 MHz bandwidth test**

- Step 10.** Set the sweep span of 3986 noise figure analyzer to 8 MHz, and the bandwidth to 4MHz.
- Step 11.** Set the signal generator CW to 14MHz.
- Step 12.** Set the center frequency of 3986 noise figure analyzer to 14MHz.
- Step 13.** Press **【Restart】** key to sweep the test trace again.

Before performing test recording and data processing, ensure that the obtained PHot display approximates the shape of IF filter, as shown in Figure 8.3.

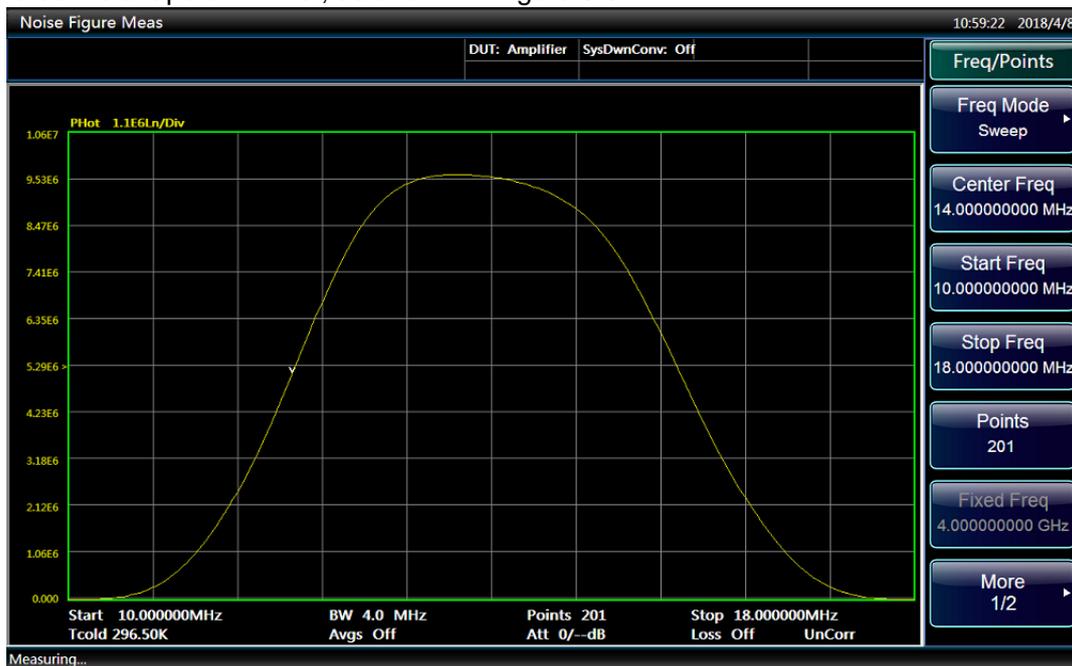


Figure 8.3 Shape of Typical IF Filter

- Step 14.** Press **【File】** to enter the file operation menu and press [Save...] to save the measured PHot value as trace file.
- Step 15.** Repeat Step 11) to Step 14), change the output frequency of signal generator and the center frequency of 3986 noise figure analyzer according to the frequency points given in Table B.2 of "Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers" until all the measuring frequency points are tested.

**b) 100 kHz bandwidth test**

- Step 16.** Set the signal generator CW to 1GHz.
- Step 17.** Set the bandwidth of 3986 noise figure analyzer to 100kHz, and the sweep span to 200kHz.
- Step 18.** Set the center frequency of noise figure analyzer to 1GHz.
- Step 19.** Keep the settings of Step 1) to Step 9) unchanged, and press **【Restart】** key to sweep the test trace again.
- Step 20.** After the sweep is completed, press **【File】** to enter the file save menu and press [Save...] to save the PHot value as trace file.

8.5 Performance Characteristics Test

**Step 21.** Restore the IF attenuation to auto setup

**Step 22.** Calculate the sum of power of 201 measurement points at each measuring frequency using Microsoft Excel tool to work out the half power and determine the frequency value corresponding to the half-power value closest to the cumulative value as measured center frequency, record it in the appropriate measured center frequency column in Table B.2 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers”. The difference between the measured center frequency and the set center frequency is frequency error which shall meet the specifications.

**8.5.1.4 Noise Figure Measurement Range and Measurement Uncertainty Test**

**1) Item description**

Noise figure measurement range and measurement uncertainty are determined by the linear region and linearity of A/D converter of noise figure analyzer, and related to the nominal value of ENR of noise source used. They may vary with the nominal value of ENR

**2) Test equipment and accessories**

Signal generator	1464
Precision step attenuation*	RSP

\*The attenuation is accurately calibrated at 50MHz.

**3) Test steps**

**Step 1.** Connect the test equipment as shown in Figure 8.4 and warm it up for 30 min.

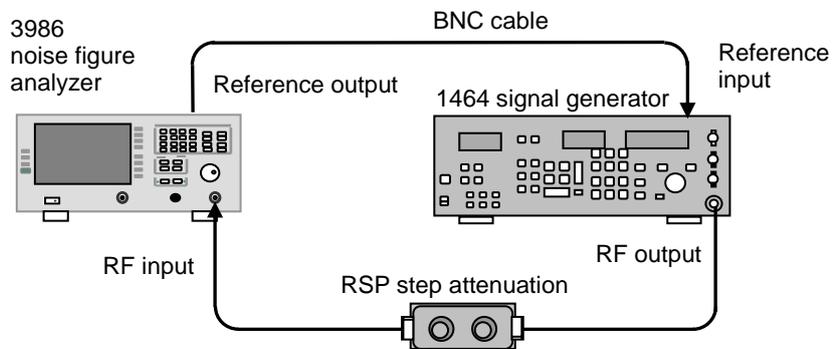


Figure 8.4 Test Block Diagram of Noise Figure Measurement Range and Measurement Uncertainty

**Step 2.** Set the signal generator CW to 50MHz and the output power to -56dBm.

**Step 3.** Set the step attenuation to 0dB.

**Step 4.** Press **【Preset】** key to reset 3986 noise figure analyzer to factory state.

**Step 5.** Set the frequency mode to fixed and the fixed frequency to 50MHz.

**Step 6.** Set the display format to Meter.

**Step 7.** Set the measurement parameter to PHot.

**Step 8.** Set the average to ON state. The average number is 8.

**Step 9.** Set the fixed IF attenuation to 30dB.

**Step 10.** Press **【Restart】** key.

**Step 11.** After the measurement is stable, record the measured PHot value in the position corresponding

## 8.5 Performance Characteristics Test

to 0dB attenuation in the measured P<sub>Hot</sub> columns of Table B.3 and B.4 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers” as the measured reference power value of noise figure analyzer.

- Step 12.** Keep the output power of signal generator unchanged. Change the step attenuation from 1dB to 22dB. After each change, press **【Restart】** key to sweep again. Record the measured P<sub>Hot</sub> value in the appropriate location of the test table.
- Step 13.** Restore the IF attenuation to auto setup.
- Step 14.** Record the set attenuation as theoretical power variation in the appropriate column. The theoretical power variation of less than 1dB is calculated by interpolation.
- Step 15.** Calculate the measured power variation with attenuation ranging from 1dB to 22dB with reference with the measured P<sub>Hot</sub> at 0dB attenuation. Record it as actual power variation in the appropriate location of Table B.3 and B.4 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers”. The actual power variation of less than 1dB is calculated by interpolation.
- Step 16.** Calculate the theoretical noise figure N<sub>Factual</sub> (indicated as C) and the measured noise figure N<sub>Fmeas</sub> (indicated as D) using the following formula.

$$NF_{actual} = ENR - 10 \lg(10^{\frac{A}{10}} - 1) \quad (2)$$

$$NF_{meas} = ENR - 10 \lg(10^{\frac{B}{10}} - 1) \quad (3)$$

- Step 17.** Record the calculation in the appropriate location of Table B.3 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers”.
- Step 18.** The difference between theoretical noise figure C and measured noise figure D is the measured uncertainty. The difference between the measured maximum and minimum noise figures is the figure measurement range. Fill in the appropriate item of Table A.1 of “Performance Test Record Table of 3986 Series Noise Figure Analyzers”.

### 8.5.1.5 Gain Measurement Range and Measurement Uncertainty Test

#### 1) Item description

Gain measurement range and accuracy depend on the adjustable range and calibration accuracy of IF attenuation. The measured gain of DUT is used for measuring the second-stage modified noise figure.

#### 2) Test equipment and accessories

Noise source Keysight 346C

Amplifier Keysight 8447F

Precision step attenuation\* RSP

\*The attenuation is accurately calibrated at 50 MHz.

#### 1) Test steps

##### a) Measurement range: -20dB~0dB

**Step 1.** Connect the test system as shown in Figure 8.5 and warm it up for 30min.

**Step 2.** Press **【Preset】** key to reset 3986 noise figure analyzer to factory state.

## 8. Specifications and Test Methods

### 8.5 Performance Characteristics Test

**Step 3.** Enter the ENR of noise source used.

**Step 4.** Set the display format to meter.

**Step 5.** Set the frequency mode to fixed, the fixed frequency to 50MHz.

**Step 6.** Set the average to ON state. The average number is 8.

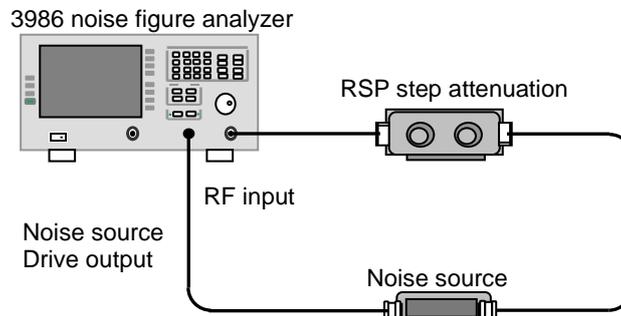


Figure 8.5 Test Block Diagram of Gain Measurement Range and Measurement Uncertainty

**Step 7.** Set the precision step attenuation to 0dB.

**Step 8.** Calibrate 3986 noise figure analyzer.

**Step 9.** Increase the step attenuation to 20dB at 1dB step. After each change, press **【Restart】** key to sweep again. Note the measured gain (G2) of noise figure analyzer at each step and record in Table B.5 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers”.

**Step 10.** Take the step attenuation as standard gain (G1). The difference between G1 and G2 is the gain measurement uncertainty.

#### b) Measurement range: 0dB~+40dB

**Step 1.** Connect the test system as shown in Figure 8.6 and warm it up for 30min.

**Step 2.** Press **【Preset】** key to reset 3986 noise figure analyzer to factory state.

**Step 3.** Enter the ENR of noise source used.

**Step 4.** Set the display format to meter.

**Step 5.** Set the frequency mode to fixed, the fixed frequency to 50MHz.

**Step 6.** Set the average to ON state. The average number is 8.

**Step 7.** Cascade 8447F two-stage amplifier and set the precision step attenuation, equivalent to the amplification of 8447F.

**Step 8.** Calibrate 3986 noise figure analyzer.

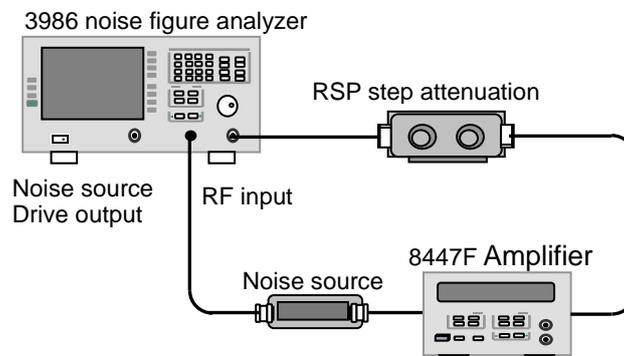


Figure 8.6 Test Block Diagram of Gain Measurement Range and Measurement Uncertainty

**Step 9.** Decrease the step attenuation 40dB at 1dB step. After each change, press **【Restart】** key to sweep again. Note the measured gain (G2) of noise figure analyzer at each step and record in Table B.5 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers”.

**Step 10.** Take the step attenuation as standard gain (G1). The difference between G1 and G2 is the gain measurement uncertainty.

### 8.5.1.6 Input VSWR Test

#### 1) Item description

The nominal input impedance of noise figure analyzer is usually  $50\Omega$  at the input port. The mismatch between nominal input impedance and actual impedance is generally expressed in Voltage Standing Wave Ratio (VSWR). The input VSWR of noise figure analyzer is an important specification, which affects the mismatch error of noise figure measurement.

#### 2) Test equipment and accessories

Vector network analyzer Keysight N5245A

Calibration kit Keysight 85056D

Test cable FEOBNOBL025.0

#### 3) Test steps

**Step 1.** Connect the test equipment as shown in Figure 8.7 and warm it up for 30min.

**Step 2.** Set the start frequency of N5245A vector network analyzer to 10MHz and the stop frequency to 4/18/26.5/40/50GHz.

**Step 3.** Set the output power of N5245A vector network analyzer to -30dBm, and the number of sweep points to 201, the measurement mode to S11, and the data format to SWR.

**Step 4.** Calibrate the single port of N5245A vector network analyzer.

**Step 5.** Set 3986 noise figure analyzer to 10MHz to 4GHz sweep status.

**Step 6.** Use cursor search function of N5245A vector network analyzer to search for the maximum SWR between 10MHz and 4GHz and record it in the appropriate item of Table A.1 of "Performance Test Record Table of 3986 Series Noise Figure Analyzers".

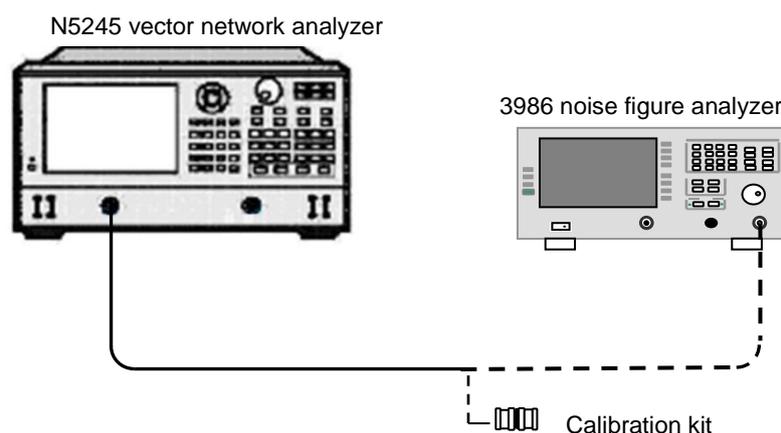


Figure 8.7 Test Block Diagram of Input VSWR

**Step 7.** Set the frequency range of 3986 noise figure analyzer according to the frequency range division requirements in Table A.1 of "Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers".

**Step 8.** Use the cursor function of N5245A vector network analyzer to find the maximum SWR within

### 8.5 Performance Characteristics Test

the corresponding frequency range,

Record it in the corresponding item of Table A.1 of "Performance Test Record Table of 3986 Series Noise Figure Analyzers" until all frequency bands are tested. The measurement result shall meet the requirements of port VSWR.

#### 8.5.1.7 Instrument's Own Noise Figure Test

##### 1) Item description

Instrument's own noise figure is an important specification of noise figure analyzer, the noise figure of noise figure analyzer directly determines the noise figure and gain range of the DUT, and also affects the noise figure measurement uncertainty. Connect the calibrated noise source to the RF input port of 3986 noise figure analyzer to measure the noise figure of the noise figure analyzer.

##### 2) Test equipment and accessories

Noise source Keysight 346C

Noise source Keysight 346CK01

##### 3) Test steps

**Step 1.** Connect the test equipment as shown in Figure 8.8 and warm it up for 30min.

**Step 2.** Press **【Preset】** key to reset 3986 noise figure analyzer to factory state.

**Step 3.** Enter the ENR of noise source used.

**Step 4.** Set the start frequency and stop frequency according to the segmentation requirements of performance index.

**Step 5.** Set the number of sweep points to 101.

**Step 6.** Press **【Restart】** key.

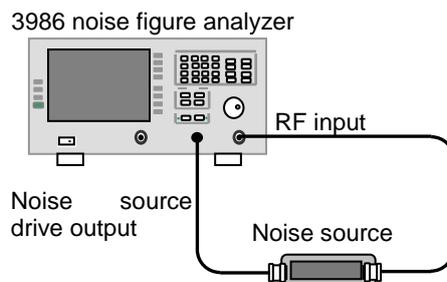


Figure 8.8 Test Block Diagram of Local Noise Figure

**Step 7.** Use cursor search function to search for the maximum noise figure in segments and record the result in the appropriate item of Table A.1 of "Performance Test Record Table of 3986 Series Noise Figure Analyzers".

#### 8.5.1.8 Jitter Test

##### 1) Item description

Jitter is the deviation of Y factor. Due to the inherent randomness of noise, there is a certain instability in the measurement of Y factor, i.e. jitter.

**2) Test equipment and accessories**

Noise source Keysight 346A

**3) Test steps**

**Step 1.** Connect the test equipment as shown in Figure 8.8 and warm it up for 30 min.

**Step 2.** Press **【Preset】** key to reset 3986 noise figure analyzer to factory state.

**Step 3.** Set the measurement result of 3986 noise figure analyzer to Y factor.

**Step 4.** Set the frequency of 3986 noise figure analyzer to 3.5GHz.

**Step 5.** Set 3986 noise figure analyzer to display in linear unit.

**Step 6.** Set 3986 noise figure analyzer display mode to meter.

**Step 7.** Set 3986 noise figure analyzer to single sweep mode.

**Step 8.** Press **【Restart】** key to record the result in Table B.6 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers”.

**Step 9.** Repeat Step 8 for a total of 100 times and record the measurement results in Table B.6 of “Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers”.

**Step 10.** Calculate the linear value of standard deviation using the following formula:

$$\sigma = \sqrt{\frac{n \sum x^2 - (\sum x)^2}{n(n-1)}} \quad (4)$$

Wherein: n—— the number of measurements, take 100;

x—— measured linear value of Y factor.

**Step 11.** Convert the linear value of standard deviation into logarithmic value using formula 5) . The value shall meet the specification requirements.

$$A(\text{dB})=10\lg(1+\sigma) \quad (5)$$

Where, A(dB)—— dB value of standard deviation;

$\sigma$ ——linear value of standard deviation.

**8.5.1.9 Noise Source Drive Voltage Test****1) Item description**

Noise source drive voltage includes noise source ON and OFF states. When the source is ON, the noise source drive voltage accuracy affects the level of noise source PHOt output, thereby affecting the measurement of noise figure.

**2) Test equipment and accessories**

Digital voltmeter 34410A

**3) Test steps**

**Step 1.** Connect the test equipment as shown in Figure 8.9 and warm it up for 30min.

## 8. Specifications and Test Methods

### 8.5 Performance Characteristics Test

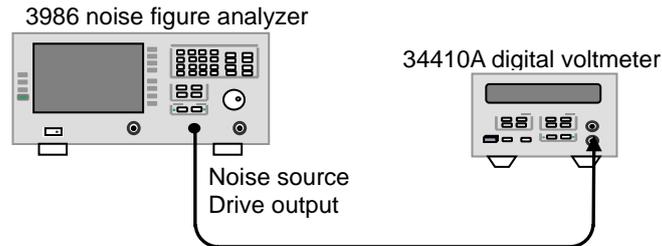


Figure 8.9 Test Block Diagram of Noise Source Drive Voltage

- Step 2.** Press **【Preset】** key to reset 3986 noise figure analyzer to factory state.
- Step 3.** Press **【Sweep】** key to enter the sweep setting menu.
- Step 4.** Press [Manual Measurement] key to enter manual measurement setting menu.
- Step 5.** Press [Noise Source Status] and [Noise Source] keys to set [Noise Source ON] and [Noise Source OFF].
- Step 6.** Measure the noise source drive output voltage with digital voltmeter and record it in the corresponding item of Table A.1 of “Performance Test Record Table of 3986 Series Noise Figure Analyzers”.
- Step 7.** Press [Return] key to restore the instrument sweep status.

## 8.5.2 Performance Test Record Table of 3986 Series Noise Figure Analyzers

## Performance Test Record of 3986 Series Noise Figure Analyzers

Instrument No.: \_\_\_\_\_

Tested by: \_\_\_\_\_

Test conditions: \_\_\_\_\_

Test date: \_\_\_\_\_

Table A.1 Performance Test Record of 3986A/D/E/F/H Noise Figure Analyzers

No.	Items	Unit	Standard Requirements	Test Result
1	Frequency range	GHz	0.01~4/18/26.5/40/50	
2	Frequency reference accuracy	ppm	$\pm < 0.2$ (23°C $\pm$ 3°C)	
3	Frequency tuning accuracy	kHz	$\pm <$ (reference frequency error +100) 10MHz~4GHz $\pm <$ (reference frequency error +400) 4GHz~50GHz	
4	Noise figure Measurement range and uncertainty	dB	Measurement range: 0~30 (ENR 12 dB~17 dB) Measurement uncertainty: $\pm < 0.10$	
			Measurement range: 0~35 (ENR 20dB~22dB) Measurement uncertainty: $\pm < 0.15$	
5	Gain measurement range and uncertainty	dB	Measurement range: -20~+40	
			Measurement uncertainty: $\pm < 0.17$	
6	Input VSWR	/	$< 1.90:1$ 10MHz $\leq$ f $\leq$ 4GHz	
			$< 2.10:1$ 4GHz $\leq$ f $\leq$ 18GHz	
			$< 2.40:1$ 18GHz $<$ f $\leq$ 26.5GHz	
			$< 2.40:1$ 26.5GHz $<$ f $\leq$ 40GHz	
			$< 2.40:1$ 40GHz $<$ f $\leq$ 50GHz	
7	Instrument's own noise figure	dB	$< 8.0$ 10MHz $\leq$ f $\leq$ 4GHz	
			$< 7.5$ 4GHz $<$ f $\leq$ 18GHz	
			$< 8.0$ 18GHz $<$ f $\leq$ 26.5GHz	
			$< 10.0$ 26.5 GHz $<$ f $\leq$ 40GHz	
			$< 12.0$ 40GHz $<$ f $\leq$ 50GHz	
8	Jitter	dB	$< 0.17$ (typical excess noise ratio 5dB)	
9	Noise source driver voltage	V	$< 1.0$ noise source (OFF)	
			$+28.0\pm 0.10$ noise source (ON)	

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8.5.3 Performance Test Auxiliary Table of 3986 Series Noise Figure Analyzers

Table B.1 Test Record of Frequency Reference Accuracy

Measurement Result	Calculation Method	Test Result (Hz)	Specification (Hz)
Reading 1	Direct read		
Frequency reference accuracy	Reading 1–10 MHz		$\pm < 2$

Table B.2 Test Record of Frequency Tuning Accuracy

Set Center Frequency (MHz)	Frequency Span (MHz)	BW (MHz)	Measured Center Frequency (MHz)	Frequency Error (kHz)	Performance Index (kHz)
14	8	4			$\pm < (100 + x)$
2000	8	4			$\pm < (100 + x)$
3996	8	4			$\pm < (100 + x)$
10000	8	4			$\pm < (400 + x)$
17996	8	4			$\pm < (400 + x)$
20000	8	4			$\pm < (400 + x)$
26496	8	4			$\pm < (400 + x)$
30000	8	4			$\pm < (400 + x)$
39996	8	4			$\pm < (400 + x)$
45000	8	4			$\pm < (400 + x)$
49996	8	4			$\pm < (400 + x)$
Set Center Frequency (MHz)	Frequency Span (MHz)	BW (MHz)	Measured Center Frequency (MHz)	Frequency Error (kHz)	Performance Index (kHz)
1000	0.2	0.1			$\pm < (20 + x)$

Note:  $x$  = test frequency point  $\times$  reference frequency accuracy

## 8.5 Performance Characteristics Test

Table B.3 Test Record of 30dB Noise Figure Measurement Range and Measurement Uncertainty

Excess noise ratio: 12dB~17dB, measurement range: 0dB~30dB

Attenuation (dB)	P <sub>Hot</sub> Measurement (dB)	Theoretical Power Variation A (dB)	Actual Power Variation B (dB)	Theoretical Noise Figure C (dB)	Measured Noise Figure D (dB)	Measurement Uncertainty =C-D (dB)
0		/	/	/	/	/
0.125	/	0.125				±<0.10
0.5	/	0.5				±<0.10
1		1				±<0.10
2		2				±<0.10
3		3				±<0.10
4		4				±<0.10
5		5				±<0.10
6		6				±<0.10
7		7				±<0.10
8		8				±<0.10
9		9				±<0.10
10		10				±<0.10
11		11				±<0.10
12		12				±<0.10
13		13				±<0.10
14		14				±<0.10
15		15				±<0.10

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Table B.4 Test Record of 35dB Noise Figure Measurement Range and Measurement Uncertainty

Excess noise ratio: 20dB~22dB, measurement range: 0dB~35dB

Attenuation (dB)	P <sub>Hot</sub> Measurement (dB)	Theoretical Power Variation A(dB)	Actual Power Variation B(dB)	Theoretical Noise Figure C(dB)	Measured Noise Figure D (dB)	Measurement Uncertainty =C-D (dB)
0		/	/	/	/	/
0.125	/	0.125				±<0.15
0.5	/	0.5				±<0.15
1		1				±<0.15
2		2				±<0.15
3		3				±<0.15
4		4				±<0.15
5		5				±<0.15
6		6				±<0.15
7		7				±<0.15
8		8				±<0.15
9		9				±<0.15
10		10				±<0.15
11		11				±<0.15
12		12				±<0.15
13		13				±<0.15
14		14				±<0.15
15		15				±<0.15
16		16				±<0.15
17		17				±<0.15
18		18				±<0.15
19		19				±<0.15
20		20				±<0.15
21		21				±<0.15
22		22				±<0.15

## 8.5 Performance Characteristics Test

Table B.5 Test Record of Gain Measurement Range and Measurement Uncertainty

Increased Attenuation (dB)	Theoretical Gain G1 (dB)	Measured Gain of Noise Figure Analyzer G2 (dB)	Measurement Uncertainty G1-G2 (dB)	Increased Attenuation G1 (dB)	Theoretical Gain G1 (dB)	NFA Measurement Gain G2 (dB)	Measurement uncertainty G1-G2 (dB)
1	-1			11	-11		
2	-2			12	-12		
3	-3			13	-13		
4	-4			14	-14		
5	-5			15	-15		
6	-6			16	-16		
7	-7			17	-17		
8	-8			18	-18		
9	-9			19	-19		
10	-10			20	-20		
Decreased Attenuation (dB)	Theoretical Gain G1 (dB)	Measured Gain of Noise Figure Analyzer G2 (dB)	Measurement Uncertainty G1-G2 (dB)	Decreased Attenuation (dB)	Theoretical Gain G1 (dB)	NFA Measurement Gain G2 (dB)	Measurement uncertainty G1-G2 (dB)
1	1			21	21		
2	2			22	22		
3	3			23	23		
4	4			24	24		
5	5			25	25		
6	6			26	26		
7	7			27	27		
8	8			28	28		
9	9			29	29		
10	10			30	30		
11	11			31	31		
12	12			32	32		
13	13			33	33		
14	14			34	34		
15	15			35	35		
16	16			36	36		
17	17			37	37		
18	18			38	38		
19	19			39	39		
20	20			40	40		

8. Specifications and Test Methods

8.5 Performance Characteristics Test

Table B.6 Jitter (Uneven) Test Record

Y Factor Measurement (Lin)									
1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Frequency Point (MHz)			Standard Deviation (dB)			Performance Index			
3500						<0.17dB			

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## Appendix A Terminology

### Noise

Noise is a natural phenomenon and a form of movement of matter. Broadly speaking, noise is an unexpected disturbance that interferes or disturbs useful signal, disturbing or distorting the signal transmitted via network. The common noise is a random process in which a large number of short pulses are superimposed. The noise power distribution conforms to the laws of probability theory and can be processed by statistical methods.

### Thermal noise

It refers to random electrical fluctuations that occur in conductor in a certain thermodynamic state. It is caused by the random thermal motion of free electrons in the conductor, and its amplitude depends on the thermodynamic state of the object.

### Shot noise

Shot noise, also known as Schottky noise, is caused by random fluctuations of DC current or voltage in active devices such as vacuum tube, P-N junction transistor, etc. There is a DC current in shot noise, and the thermal noise voltage is independent of DC. The mean current fluctuation of shot noise is zero, and its magnitude is described by mean square current, mean square voltage or power.

### Available noise power

It is the maximum power that a single-port network (noise generator) can transmit to the load.

### Spectral density for available noise power

It is the available noise power within unit bandwidth, commonly denoted by  $W_n$ .

### Noise temperature

According to Nyquist's theorem, hot noise power is a universal function of temperature, so a noise source can be represented by noise temperature. Noise temperature is denoted by  $T_n$ , the unit of thermodynamic temperature.

$$T_n = \frac{W_n}{k} \quad (6)$$

Where,

$T_n$ —— noise temperature (K);

$W_n$ —— noise power spectral density (J);

$k$  —— Boltzmann constant ( $1.38 \times 10^{-23}$  J/K).

**Appendix A Terminology****Equivalent input noise temperature**

Equivalent input noise temperature is a common parameter to describe the internal network noise performance. The internal network noise can be equivalent to the network input port and denoted by  $T_e$ , the equivalent input noise temperature. Such an actual network can be equivalent to a cascade of noise source with noise temperature of  $T_e$  and an ideal noise-free network. After the equivalent noise source passes through the ideal network, the noise contribution at network output end is equal to that at output end when noise is generated inside the actual network.

**Reference noise temperature**

Reference noise temperature is defined as 290K, and usually denoted by  $T_0$ .

**Noise figure**

When the network input end is at a reference noise temperature of 290K, the ratio of signal-to-noise power ratio at network input end to that at output end is defined as the network noise figure.

$$F = \frac{S_i / N_i}{S_o / N_o} \quad (7)$$

Where,

$S_i/N_i$ — Signal-to-noise power ratio at network input end;

$S_o/N_o$ — Signal-to-noise power ratio at network output end.

Noise figure  $F$  is expressed in decibels (dB) as:

$$NF_{(dB)} = 10 \lg F \quad (8)$$

**Hot and cold state**

Noise source ON is called hot state; noise source OFF is called cold state.

**Hot and cold noise power**

The noise power measured when the noise source is ON is defined as hot noise power, and the noise power measured when the noise source is OFF is defined as cold noise power.

**Y factor method**

Y factor method is one of the most commonly used noise figure measurement methods. This method requires a precisely calibrated noise source as standard source. Noise source must work in both ON and OFF states. The noise figure analyzer controls ON and OFF states of noise source and obtains the corresponding hot and cold noise power. The ratio of both hot and cold noise power is defined as Y factor. Y factor is an intermediate calculation in the noise figure measurement process. The method in which the equivalent input noise temperature of DUT can be calculated by measuring Y factor and the noise figure of DUT is calculated according to the relationship between equivalent input noise temperature and noise figure is called Y factor method.

**ENR**

It is defined as the multiple of the difference between equivalent output noise temperatures of noise source in ON and OFF states more than the reference noise temperature, abbreviated as ENR. It is

usually expressed in dB.

$$ENR_{(dB)} = 10 \lg \left( \frac{T_h - T_c}{T_0} \right) \quad (9)$$

Where,

$T_h$ —The equivalent output hot noise temperature when the noise source is ON;

$T_c$ —The equivalent output cold noise temperature when the noise source is OFF;

$T_0$ —Reference noise temperature of 290K.

### Noise Figure Analyzer

It is an instrument that can measure the noise figure of linear network. It has the ability to perform measurement calibration and automatic error correction according to the type of DUT. The noise figure analyzer can measure the noise figure of amplifier-like devices, up and down converters and the front end of receiver system.

### Noise Source

It is a device that can generate random continuous spectrum. A good noise source shall have a certain output noise power and a uniform power spectral density in specified frequency band. Main specification of noise source: frequency range, excess noise ratio, uncertainty of excess noise ratio, output port VSWR, etc.

### Noise sideband

Noise source outputs wideband white noise signal. When noise source is used as an excitation to measure the noise figure of multi-response receiver, the wideband noise will simultaneously enter signal channel and image frequency channel. For receiver with single-sideband response, a suitable filter shall be selected to filter out the corresponding image frequency response sidebands. When measuring noise figure, you must select the appropriate measurement sideband based on the sideband type of receiver. The noise figure analyzer provides three types of sidebands for selection: upper sideband (RF>LO), lower sideband (RF<LO) and double sideband (RF=LO).

### Measurement Mode

The noise figure analyzer generally provides three measurement modes: amplifier, up and down converters. When the amplifier-like DUT is measured, the instrument also provides the extended frequency range measurement of system down-converter mode. When the frequency range of noise figure analyzer cannot cover the working frequency band of DUT, it is necessary to provide an external mixer to extend the noise figure measurement frequency range. The external mixer is part of the test system. When the noise figure is measured, the measurement mode selected must correspond to the type of DUT. There is a corresponding mode setting and calibration measurement principle in each measurement mode.

### Loss Comp

The noise figure analyzer has loss compensation function which enables it to compensate for the loss introduced before and/or after DUT in the form of fixed value and/or table to achieve the accurate measurement of noise figure.

## Appendix A Terminology

### Preselector

It is a filter between low-noise pre-amplifier output and mixer input of noise figure analyzer. Due to the influence of YIG device operating frequency, a low-pass filter with fixed cut-off frequency is generally used in the low frequency band of noise figure analyzer. To reduce the requirement for filter skirt selectivity, the first-stage frequency conversion mode of low frequency band is up converter with the first IF much higher than the maximum of the corresponding frequency band; the high frequency band uses a center frequency adjustable YIG tracking bandpass filter to eliminate the multiple response and image response of super-heterodyne receiver.

### LO

It is the abbreviation for local oscillator. The noise figure analyzer has a built-in local oscillator source and is mixed with the received RF noise signal to generate instrument IF noise signal.

### Spurious responses

They are false signals that are not expected to appear in the receiving path of noise figure analyzer. False responses are divided into spurious and residual types. Spurious responses are abnormal responses displayed in noise figure analyzer along with input signal and are divided into harmonic, IM, image frequency, multiple and out-of-band types; spurious responses can also be classified into harmonic and non-harmonic ones, the non-harmonic response is an IM or residual response. The specific description is as follows:

#### 1) Harmonic distortion

When the amplitude increase of input signal is such that the receiver operates in non-linear state, the harmonic component of the input signal will be generated in the receiver. These harmonic components are referred to as harmonic distortion.

#### 2) Image frequency and multiple responses

In the process of mixing, two input signals can generate the same IF signal as the local oscillator signal at the same frequency. One signal frequency is one IF lower than the local oscillator and the other is one IF higher than the local oscillator. One signal is called the image frequency of the other one. For each frequency of local oscillator, the corresponding input signal has an image frequency, and the difference between signal and image frequencies is double IF.

Multiple responses are two or more responses of single-frequency input signal on display, i.e. responses to two or more LO frequencies. The difference between LO frequencies that generate multiple responses is double IF. Multiple responses occur only when the mixing modes overlap and the local oscillator sweeps across a sufficiently wide range that the input signal is mixed in more than one mixing mode. The principle structure of different noise figure analyzers is different, and the frequency of image and multiple responses is also different.

#### 3) Residual response

Residual response is the discrete response observed on the display when the noise figure analyzer receives no input signal.

## Frequency range

It is the range between minimum and maximum frequencies that can be measured by the noise figure analyzer when the specified performance is met. For the noise figure analyzer, the frequency range and the appropriate frequency band division shall be specified in the product specification.

## RF attenuation

A step attenuation at RF input port of the noise figure analyzer. RF attenuation is used to adjust the level of noise signal input to the front end of an receiver.

## Input impedance

Terminal impedance of DUT and noise source presented by the noise figure analyzer. The input impedance of the noise figure analyzer is usually  $50\Omega$ . The standard impedance of some systems (e.g. cable TV) is  $75\Omega$ . The mismatch between nominal and actual impedance is generally expressed in Voltage Standing Wave Ratio (VSWR).

## Gain compress

The increase in the level of input noise signal may make the circuits of preamplifier, mixer and other units of the noise figure analyzer close to saturation point. At this time, the output noise power no longer changes linearly with the input noise power. The measured noise power is low, which is caused by gain compression. Usually, 1dB (or 0.5dB) compression point is expressed by the input noise level corresponding to the low 1dB (or 0.5dB) output deviation from linearity.

## IF attenuation

The noise figure analyzer adjusts noise power input to AD converter through IF attenuation to achieve the whole gain measurement range and accuracy.

## Appendix B SCPI Command Lookup Table

## Appendix B SCPI Command Lookup Table

Schedule 1 Common Command Lookup Table

Index	Command	Function
1	<a href="#">*CLS</a>	Clear status
2	<a href="#">*ESE</a>	Set/Query the event status enable register
3	<a href="#">*ESR?</a>	Read the decimal value of the event status register
4	<a href="#">*IDN?</a>	Return the instrument identification
5	<a href="#">*OPC</a>	Set/Query operation completion
6	<a href="#">*RST</a>	Set most of the functions of the device to the known status predefined by the manufacturer
7	<a href="#">*SRE</a>	Set/Query the value of the service request enable register.
8	<a href="#">*STB?</a>	Query status byte
9	<a href="#">*TRG</a>	Execute the trigger command
10	<a href="#">*WAI</a>	Wait for execution of all blocked instrument jobs before executing subsequent instructions.

Attached Table 2 Quick Search Table of SCPIs of 3986 Series Noise Figure Analyzer

Index	Command	Function
1	<a href="#">:CALCulate:LLINe</a>	Set/Query the limit line number
2	<a href="#">:CALCulate:LLINe1 2 3 4:COUNT?</a>	Query the count of the selected limit line data
3	<a href="#">:CALCulate:LLINe1 2 3 4:DATA</a>	Set/Query the limit line data
4	<a href="#">:CALCulate:LLINe1 2 3 4:DISPlay[:STATe]</a>	Set/Query the ON/OFF state of limit line display
5	<a href="#">:CALCulate:LLINe1 2 3 4:FAIL?</a>	Query test failed
6	<a href="#">:CALCulate:LLINe1 2 3 4:TEST</a>	Set/Query the ON/OFF state of limit line test
7	<a href="#">:CALCulate:LLINe1 2 3 4:TRACe 1 2</a>	Set/Query the limit line test trace
8	<a href="#">:CALCulate:LLINe1 2 3 4:TYPE</a>	Set/Query the limit line type
9	<a href="#">:CALCulate:LLINe1 2 3 4[:STATe]</a>	Set/Query the ON/OFF state of limit line
10	<a href="#">:CALCulate:MARKer:ALL:CLOSe</a>	Close all markers displayed in graph
11	<a href="#">:CALCulate:MARKer1 2 3 4:AMPLitude:VALue?</a>	Query the amplitude value of the corresponding frequency selected marker of current trace and
12	<a href="#">:CALCulate:MARKer1 2 3 4:DISCrete</a>	Set/Query whether the selected marker is discretely displayed
13	<a href="#">:CALCulate:MARKer1 2 3 4:MAXimum?</a>	Query the maximum of selected marker of current trace and the corresponding frequency

## Appendix B SCPI Command Lookup Table

14	<a href="#">:CALCulate:MARKer1 2 3 4:MINimum?</a>	Query the minimum of selected marker of current trace and the corresponding frequency
15	<a href="#">:CALCulate:MARKer1 2 3 4:MODE</a>	Set/Query the type of the selected marker
16	<a href="#">:CALCulate:MARKer1 2 3 4:PTPeak?</a>	Query the peak to peak of selected marker of current trace and the corresponding frequency
17	<a href="#">:CALCulate:MARKer1 2 3 4:SEARCh:CONTInuous[:STATe]</a>	Set/Query the ON/OFF state of continuous search of selected marker
18	<a href="#">:CALCulate:MARKer1 2 3 4:SEARCh:TYPE</a>	Set/Query the search type of the selected marker
19	<a href="#">:CALCulate:MARKer1 2 3 4[:STATe]</a>	Set/Query whether the selected marker is displayed in graph
20	<a href="#">:CALCulate:UNCertainty:DUT:GAIN</a>	Set/Query the gain of DUT
21	<a href="#">:CALCulate:UNCertainty:DUT:MATCh:INPut</a>	Set/Query the input match of DUT
22	<a href="#">:CALCulate:UNCertainty:DUT:MATCh:OUTPut</a>	Set/Query the output match of DUT
23	<a href="#">:CALCulate:UNCertainty:DUT:NFIGure</a>	Set/Query the noise figure of DUT
24	<a href="#">:CALCulate:UNCertainty:INSTrument:GAIN</a>	Set/Query the instrument gain uncertainty
25	<a href="#">:CALCulate:UNCertainty:INSTrument:MATCh:INPut</a>	Set/Query the instrument input match
26	<a href="#">:CALCulate:UNCertainty:INSTrument:NFIGure:UNCertainty</a>	Set/Query the instrument noise figure uncertainty
27	<a href="#">:CALCulate:UNCertainty:INSTrument:NFIGure:VALue</a>	Set/Query the instrument noise figure
28	<a href="#">:CALCulate:UNCertainty:RSS?</a>	Query the uncertainty calculation
29	<a href="#">:CALCulate:UNCertainty:SOURce:ENR</a>	Set/Query the noise source ENR uncertainty
30	<a href="#">:CALCulate:UNCertainty:SOURce:MATCh</a>	Set/Query the noise source match
31	<a href="#">:CALCulate:UNCertainty:SOURce:TYPE</a>	Set/Query the type of noise source
32	<a href="#">:CALibration</a>	Calibration
33	<a href="#">:CALibration:AUTO:CALibration</a>	Set calibration execution ON/OFF
34	<a href="#">:CALibration:AUTO:MODE</a>	Set/Query the auto calibration mode
35	<a href="#">:CALibration:AUTO:STATe</a>	Set/Query the ON/OFF state of auto calibration
36	<a href="#">:DISPlay:ANNotation[:STATe]</a>	Set/Query the ON/OFF state of

**Appendix B SCPI Command Lookup Table**

		annotation display
37	<a href="#">:DISPlay:DATA:CORRections</a>	Set/Query the ON/OFF state of correction
38	<a href="#">:DISPlay:DATA:TRACe[1]2</a>	Set/Query the type of current trace
39	<a href="#">:DISPlay:DATA:UNITs</a>	Set/Query the result display unit
40	<a href="#">:DISPlay:FORMat</a>	Set/Query the measurement display format
41	<a href="#">:DISPlay:GRATicule</a>	Set/Query the ON/OFF state of graticule display
42	<a href="#">:DISPlay:PRESet</a>	Reset
43	<a href="#">:DISPlay:RESult:TYPE</a>	Set/Query the type of measurement parameter of current trace
44	<a href="#">:DISPlay:TRACe:COMBined</a>	Set/Query the ON/OFF state of combined graph display
45	<a href="#">:DISPlay:TRACe:WINDow</a>	Set/Query window, and set the current active graphics area
46	<a href="#">:DISPlay:TRACe:Y[:SCALE]:LOWer</a>	Set/Query the lower value of trace
47	<a href="#">:DISPlay:TRACe:Y[:SCALE]:PDIVision</a>	Set/Query the scale per division of trace
48	<a href="#">:DISPlay:TRACe:Y[:SCALE]:RLEVel:VALue</a>	Set/Query the value of a parameter reference line
49	<a href="#">:DISPlay:TRACe:Y[:SCALE]:UPPer</a>	Set/Query the upper value of trace
50	<a href="#">:DISPlay:WINDow:LANGuage</a>	Set/Query the instrument display language type
51	<a href="#">:DISPlay:ZOOM:WINDow</a>	Set/Query the zoom display of upper and lower graphics windows
52	<a href="#">:FETCh:CORReCted:GAIN?</a>	Query the gain of sweep frequency state corrected
53	<a href="#">:FETCh:CORReCted:NFIGure?</a>	Query the noise figure of sweep frequency state corrected
54	<a href="#">:FETCh:CORReCted:PCOLd?</a>	Query the cold power of sweep frequency state corrected
55	<a href="#">:FETCh:CORReCted:PHOT?</a>	Query the hot power of sweep frequency state corrected
56	<a href="#">:FETCh:CORReCted:TEFFective?</a>	Query the equivalent temperature of sweep frequency state corrected
57	<a href="#">:FETCh:CORReCted:YFACtor?</a>	Query the corrected Y factor of the sweep frequency state
58	<a href="#">:FETCh:SCALar:CORReCted:GAIN?</a>	Query the gain of dot frequency state corrected
59	<a href="#">:FETCh:SCALar:CORReCted:NFIGure?</a>	Query the noise figure of dot

## Appendix B SCPI Command Lookup Table

		frequency state corrected
60	<a href="#">:FETCH:SCALar:CORRected:PCOLd?</a>	Read the cold power of dot frequency state corrected
61	<a href="#">:FETCH:SCALar:CORRected:PHOT?</a>	Query the hot power of dot frequency state corrected
62	<a href="#">:FETCH:SCALar:CORRected:TEFFective?</a>	Query the equivalent temperature of dot frequency state corrected
63	<a href="#">:FETCH:SCALar:CORRected:YFACtor?</a>	Query Y factor of dot frequency state corrected
64	<a href="#">:FETCH:SCALar:UNCorrected:GAIN?</a>	Query the gain of dot frequency state uncorrected
65	<a href="#">:FETCH:SCALar:UNCorrected:NFIGure?</a>	Query the noise figure of dot frequency state uncorrected
66	<a href="#">:FETCH:SCALar:UNCorrected:PCOLd?</a>	Query the cold power of dot frequency state uncorrected
67	<a href="#">:FETCH:SCALar:UNCorrected:PHOT?</a>	Query the hot power of dot frequency state uncorrected
68	<a href="#">:FETCH:SCALar:UNCorrected:TEFFective?</a>	Query the equivalent temperature of dot frequency state uncorrected
69	<a href="#">:FETCH:SCALar:UNCorrected:YFACtor?</a>	Query Y factor of dot frequency state uncorrected
70	<a href="#">:FETCH:UNCorrected:GAIN?</a>	Query the gain of sweep frequency state uncorrected
71	<a href="#">:FETCH:UNCorrected:NFIGure?</a>	Query the noise figure of sweep frequency state uncorrected
72	<a href="#">:FETCH:UNCorrected:PCOLd?</a>	Query the cold power of sweep frequency state uncorrected
73	<a href="#">:FETCH:UNCorrected:PHOT?</a>	Query the hot power of sweep frequency state uncorrected
74	<a href="#">:FETCH:UNCorrected:TEFFective?</a>	Query the equivalent temperature of sweep frequency state uncorrected
75	<a href="#">:FETCH:UNCorrected:YFACtor?</a>	Query the uncorrected Y factor of the sweep frequency state
76	<a href="#">:INITiate:CONTInuous</a>	Set/Query the ON/OFF state of continuous sweep
77	<a href="#">:INITiate:REStart</a>	Restart
78	<a href="#">:INITiate[:IMMediate]</a>	Restart (compatible with N8975A)
79	<a href="#">:INPut:ATTenuation[:RF]:MAXimum</a>	Set/Query the maximum attenuation of calibrated RF
80	<a href="#">:INPut:ATTenuation[:RF]:MINimum</a>	Set/Query the minimum attenuation of calibrated RF
81	<a href="#">:INPut:ATTenuation:MWAVE:MAXimum</a>	Set/Query the maximum attenuation of calibrated

**Appendix B SCPI Command Lookup Table**

		microwave
82	<a href="#">:INPut:ATTenuation:MWAVe:MINimum</a>	Set/Query the minimum attenuation of calibrated microwave
83		
84	<a href="#">:MMEMory:LOAD:ENR</a>	Load the measurement or calibration excess noise table from a file
85	<a href="#">:MMEMory:LOAD:FREQuency</a>	Load the frequency list from the specified file
86	<a href="#">:MMEMory:LOAD:LIMit</a>	Load the limit line from the specified file
87	<a href="#">:MMEMory:LOAD:LOSS</a>	Load the selected loss compensation form from the specified file
88	<a href="#">:MMEMory:LOAD:STATe</a>	Load the instrument state from a file
89		
90	<a href="#">:MMEMory:STORe:ENR</a>	Store the measurement/calibration excess noise table to the specified file
91	<a href="#">:MMEMory:STORe:FREQuency</a>	Store the frequency list to the specified file
92	<a href="#">:MMEMory:STORe:LIMit</a>	Store the limit line to the specified file
93	<a href="#">:MMEMory:STORe:LOSS</a>	Store the selected loss compensation form to the specified file
94	<a href="#">:MMEMory:STORe:STATe</a>	Store the instrument state to the specified file
95	<a href="#">:MMEMory:STORe:TRACe</a>	Store the trace data to the specified file
96	<a href="#">:SENSe:AVERage:COUNT</a>	Set/Query the average count of factors
97	<a href="#">:SENSe:AVERage:MODE</a>	Set/Query the average mode (AV3984/5, N8975)
98	<a href="#">:SENSe:AVERage:STATe</a>	Set/Query the ON/OFF state of average state
99	<a href="#">:SENSe:BANDwidth[:RESolution]</a>	Set/Query the resolution bandwidth
100	<a href="#">:SENSe:CONFigure:LOSCillator:PARAmeter:DIVider</a>	Set/Query the divider value of external LO
101	<a href="#">:SENSe:CONFigure:LOSCillator:PARAmeter:MULTIplier</a>	Set/Query the multiplier value of external LO
102	<a href="#">:SENSe:CONFigure:LOSCillator:PARAmeter:OFFSet</a>	Set/Query the frequency offset of external LO
103	<a href="#">:SENSe:CONFigure:LOSCillator:PARAmeter:SETTling[:TIM</a>	Set/Query the settling time of

## Appendix B SCPI Command Lookup Table

	<a href="#">E]</a>	external LO
104	<a href="#">:SENSe:CONFigure:MODE:DOWNconv:FREQuency:CONText</a>	Set/Query the measurement frequency input type of down converter
105	<a href="#">:SENSe:CONFigure:MODE:DOWNconv:IF:FREQuency</a>	Set/Query the fixed IF in down conversion mode
106	<a href="#">:SENSe:CONFigure:MODE:DOWNconv:LOSCillator:FREQuency</a>	Set/Query the fixed LO frequency in down conversion mode
107	<a href="#">:SENSe:CONFigure:MODE:DOWNconv:LOSCillator:OFFSet</a>	Set/Query the sideband type in down conversion mode
108	<a href="#">:SENSe:CONFigure:MODE:DUT</a>	Set/Query the DUT mode
109	<a href="#">:SENSe:CONFigure:MODE:DUT:EXTend:LO:POWer</a>	Set/Query the external LO power in the frequency conversion mode
110	<a href="#">:SENSe:CONFigure:MODE:DUT:LO:CONTRol:STATe</a>	Set/Query the ON/OFF state of external LO in frequency conversion mode
111	<a href="#">:SENSe:CONFigure:MODE:DUT:LOSCillator</a>	Set/Query the LO mode in frequency conversion measurement mode
112	<a href="#">:SENSe:CONFigure:MODE:SYSTem:DOWNconv[:STATe]</a>	Set/Query the ON/OFF state in down conversion mode of the system
113	<a href="#">:SENSe:CONFigure:MODE:SYSTem:FREQuency:CONText</a>	Set/Query the measurement frequency input type of the system down converter
114	<a href="#">:SENSe:CONFigure:MODE:SYSTem:IF:FREQuency</a>	Set/Query the fixed IF frequency in down conversion mode of the system
115	<a href="#">:SENSe:CONFigure:MODE:SYSTem:LOSCillator</a>	Configure the LO mode in down conversion mode of the system
116	<a href="#">:SENSe:CONFigure:MODE:SYSTem:LOSCillator:FREQuency</a>	Set/Query the fixed LO frequency in down conversion mode of the system
117	<a href="#">:SENSe:CONFigure:MODE:SYSTem:LOSCillator:OFFSet</a>	Set/Query the sideband type in down conversion mode of the system
118	<a href="#">:SENSe:CONFigure:MODE:UPConv:FREQuency:CONText</a>	Set/Query the measuring frequency input type of the up converter
119	<a href="#">:SENSe:CONFigure:MODE:UPConv:IF:FREQuency</a>	Set/Query the fixed IF in up conversion mode
120		
121	<a href="#">:SENSe:CONFigure:MODE:UPConv:LOSCillator:FREQuency</a>	Set/Query the fixed local oscillator frequency in the up converter mode
122	<a href="#">:SENSe:CONFigure:MODE:UPConv:LOSCillator:OFFSet</a>	Set/Query the sideband type in up conversion mode

**Appendix B SCPI Command Lookup Table**

123	<a href="#">:SENSe:CORRection:ENR:AUTO[:STATe]</a>	Set/Query the ON/OFF state of auto load ENR form
124	<a href="#">:SENSe:CORRection:ENR:CALibration:TABLE:COUNT?</a>	Query the input count of ENR calibration table
125	<a href="#">:SENSe:CORRection:ENR:CALibration:TABLE:DATA</a>	Set/Query Data of ENR calibration table
126	<a href="#">:SENSe:CORRection:ENR:CALibration:TABLE:ID:DATA</a>	Set/Query ID of ENR calibration table
127	<a href="#">:SENSe:CORRection:ENR:CALibration:TABLE:SERial:DATA</a>	Set/Query the serial number of ENR calibration table
128	<a href="#">:SENSe:CORRection:ENR:CALibration:TABLE:SNS</a>	Load ENR calibration table from SNS
129	<a href="#">:SENSe:CORRection:ENR:COMMon:STATe</a>	Set/Query the ON/OFF state of ENR common table
130	<a href="#">:SENSe:CORRection:ENR:MEASurement:TABLE:COUNT?</a>	Query the input count of ENR measurement table
131	<a href="#">:SENSe:CORRection:ENR:MEASurement:TABLE:DATA</a>	Set/Query the data of ENR measurement table
132	<a href="#">:SENSe:CORRection:ENR:MEASurement:TABLE:ID:DATA</a>	Set/Query ID of ENR measurement table
133	<a href="#">:SENSe:CORRection:ENR:MEASurement:TABLE:SERial:DATA</a>	Set/Query the serial number of ENR measurement table
134	<a href="#">:SENSe:CORRection:ENR:MEASurement:TABLE:SNS</a>	Load ENR measurement table from SNS
135	<a href="#">:SENSe:CORRection:ENR:MODE</a>	Set/Query ENR mode
136	<a href="#">:SENSe:CORRection:ENR:SPOT</a>	Set/Query the spot ENR
137	<a href="#">:SENSe:CORRection:ENR:THOT</a>	Set/Query the fixed hot temperature of ENR
138		
139	<a href="#">:SENSe:CORRection:LOSS:AFTer:MODE</a>	Set/Query the type of loss compensation value after DUT
140	<a href="#">:SENSe:CORRection:LOSS:AFTer:TABLE:COUNT?</a>	Query the count of loss compensation tables after DUT
141	<a href="#">:SENSe:CORRection:LOSS:AFTer:TABLE:DATA</a>	Set/Query the data of loss compensation table after DUT
142	<a href="#">:SENSe:CORRection:LOSS:AFTer:VALue</a>	Set/Query the fixed loss compensation value after DUT
143	<a href="#">:SENSe:CORRection:LOSS:AFTer[:STATe]</a>	Set/Query the ON/OFF state in loss compensation mode after DUT
144	<a href="#">:SENSe:CORRection:LOSS:BEFore:MODE</a>	Set/Query the type of loss compensation value before DUT
145	<a href="#">:SENSe:CORRection:LOSS:BEFore:TABLE:COUNT?</a>	Query the count of loss compensation tables before DUT
146	<a href="#">:SENSe:CORRection:LOSS:BEFore:TABLE:DATA</a>	Set/Query the data of loss compensation table before DUT

## Appendix B SCPI Command Lookup Table

147	<a href="#">:SENSe:CORRection:LOSS:BEFore:VALue</a>	Set/Query the fixed loss compensation value before DUT
148	<a href="#">:SENSe:CORRection:LOSS:BEFore[:STATe]</a>	Set/Query the ON/OFF state in loss compensation mode before DUT
149	<a href="#">:SENSe:CORRection:SPOT:MODE</a>	Set/Query the spot ENR type
150	<a href="#">:SENSe:CORRection:TCOLd:SNS[:STATe]</a>	Set/Query the ON/OFF state of automatically reading cold temperature from SNS
151	<a href="#">:SENSe:CORRection:TCOLd:USER:SET</a>	Set the user cold temperature from SNS
152	<a href="#">:SENSe:CORRection:TCOLd:USER[:STATe]</a>	Set/Query the ON/OFF state of user cold temperature
153	<a href="#">:SENSe:CORRection:TCOLd:USER:VALue</a>	Set/Query the user cold temperature
154	<a href="#">:SENSe:CORRection:TEMPerature:AFter</a>	Set/Query the temperature in loss compensation mode after DUT
155	<a href="#">:SENSe:CORRection:TEMPerature:BEFore</a>	Set/Query the temperature in loss compensation mode before DUT
156	<a href="#">:SENSe:FREQuency:CENTer</a>	Set/Query the center frequency
157	<a href="#">:SENSe:FREQuency:FIXed</a>	Set/Query the fixed frequency
158	<a href="#">:SENSe:FREQuency:LIST:COUNt?</a>	Query the frequency count in frequency list
159	<a href="#">:SENSe:FREQuency:LIST:DATA</a>	Set/Query the frequency to frequency list
160	<a href="#">:SENSe:FREQuency:MODE</a>	Set/Query the frequency mode
161	<a href="#">:SENSe:FREQuency:SPAN</a>	Set/Query the sweep span
162	<a href="#">:SENSe:FREQuency:SPAN:FULL</a>	Set the full sweep width
163	<a href="#">:SENSe:FREQuency:STARt</a>	Set/Query the start frequency
164	<a href="#">:SENSe:FREQuency:STOP</a>	Set/Query the stop frequency
165	<a href="#">:SENSe:MANual:IF:FIXed</a>	Set/Query the manual measurement mode of fixed IF attenuation
166	<a href="#">:SENSe:MANual:IF:MODE</a>	Set/Query the manual measurement mode of IF attenuation
167	<a href="#">:SENSe:MANual:MWAVE:FIXed</a>	Set/Query the manual measurement of fixed microwave attenuation
168	<a href="#">:SENSe:MANual:MWAVE:MODE</a>	Set/Query the manual measurement mode of microwave attenuation
169	<a href="#">:SENSe:MANual:NOISe[:STATe]</a>	Set/Query the ON/OFF state of noise source in manual measurement mode

**Appendix B SCPI Command Lookup Table**

170	<a href="#">:SENSe:MANual:RF:FIXed</a>	Set/Query the manual measurement of fixed RF attenuation
171	<a href="#">:SENSe:MANual:RF:MODE</a>	Set/Query the manual measurement mode of RF attenuation
172	<a href="#">:SENSe:NFIGure:BANDwidth:AUTO</a>	Set/Query the manual mode or auto mode of span.
173	<a href="#">:SENSe:RENEw:SWEEp</a>	Renew sweep
174	<a href="#">:SENSe:SOURce:NOISe:STYLe</a>	Set/Query the type of noise source
175	<a href="#">:SENSe:SWEEp:POINts</a>	Set/Query sweep points
176	<a href="#">:SENSe:SYSTem:COMMunicate:GPIB:EXTLoscillator:ADDRess</a>	Set/Query GPIB address of instrument external LO
177	<a href="#">[:SENSe]:SYSTem:COMMunicate:GPIB:ADDRess</a>	Set/Query the instrument GPIB address
178	<a href="#">:SYSTem:PRESet</a>	Reset
179	<a href="#">:TRACe[:DATA]:CORReCted:AMPLitude:MAXimum?</a>	Query the maximum amplitude of the specified corrected trace and the corresponding frequency
180	<a href="#">:TRACe[:DATA]:CORReCted:AMPLitude:MINimum?</a>	Query the minimum amplitude of the specified corrected trace and the corresponding frequency
181	<a href="#">:TRACe[:DATA]:CORReCted:AMPLitude[:VALue]?</a>	Query the amplitude of the specified corrected trace at the specified frequency point
182	<a href="#">:TRACe[:DATA]:CORReCted:DELTA?</a>	Query the amplitude difference between frequency 1 and frequency 2 in the specified corrected trace
183	<a href="#">:TRACe[:DATA]:CORReCted:PTPeak?</a>	Query the difference between maximum and minimum amplitude in the specified corrected trace, and the frequency difference that produces the difference
184	<a href="#">:TRACe[:DATA]:UNCORReCted:AMPLitude:MAXimum?</a>	Query the maximum amplitude of the specified uncorrected trace and the corresponding frequency
185	<a href="#">:TRACe[:DATA]:UNCORReCted:AMPLitude:MINimum?</a>	Query the minimum amplitude of the specified uncorrected trace and the corresponding frequency
186	<a href="#">:TRACe[:DATA]:UNCORReCted:AMPLitude[:VALue]?</a>	Query the amplitude of the specified uncorrected trace at the specified frequency point

**Appendix B SCPI Command Lookup Table**

187	<a href="#">:TRACe[:DATA]:UNCorrected:DELTA?</a>	Query the amplitude difference between frequency 1 and frequency 2 in the specified uncorrected trace
188	<a href="#">:TRACe[:DATA]:UNCorrected:PTPeak?</a>	Query the difference between maximum and minimum amplitude in the specified uncorrected trace and the frequency difference that produces the difference

**Appendix C Quick Search Table of Error Messages****Appendix C Quick Search Table of Error Messages**

## Schedule 3 Local Error Message List

Error Code	Error Key Field	Description
1	USBINITERR	Instrument keyboard initialization failed, please check hardware and driver
2	LANINIT ERR	LAN port initialization failed, please check hardware and driver
3	HARDINIT ERR	Functional hardware initialization failed, please check hardware and driver
4	WINSOCKET ERR	Winsocket library initialization failed
5	SOCKETCRT ERR	SOCKET interface creation failed
6	SOCKETBAND ERR	SOCKET interface binding failed
7	LISTEN ERR	Interface listening failed
8	LINK ERR	Link creation failed
9	FMDATA ERR	Failed to call FM offset data
15	CALFILE ERR	Failed to call calibration file
20	GPS INIT	GPS initialization failed
30	FACTDATA ERR	Failed to call factory debug status data
31	FLATNESS ERR	Failed to call flatness data
32	LOADFILE ERR	Load file failed
33	SAVEFILE ERR	Save file failed
34	LICENSE ERR	Invalid License
35	LICENSE OPEN	License open failed
37	YTFTUNE ERR	Failed to call YTF tuning data
38	YTFTRC ERR	Failed to call YTF trace data
39	SAMPLL ERR	Failed to call sampling loop data
40	CRET EVT	Error in the creation of system synchronization event
41	NO MEMRY	Dynamic allocation of memory failed
42	SHUTDOWN FAIL	Instrument remote shutdown failed
43	SPACE LOW	Low disk space
44	CRET DIRY	Folder creation failed
45	CRET FILE	File creation failed
46	CHECK DISK	Disk free space check failed
47	READ FILE	Failed to read file
48	WRITE FILE	Failed to write file
90	CALCBAND	Error in waveband parameter calculation
100	LO ALLOT	LO allocation algorithm failed
101	FRACNLOW	Fractional ring lower-end losing lock
102	SAMP UPR	Sampling ring upper-end losing lock
103	YTO CHK	YTO ring locked for checking

## Appendix C Quick Search Table of Error Messages

104	OVERSTEP	The number of error voltage zero adjustments exceeds 15
105	CORS LOW	The coarse DAC value is out of range 0 to 255, less than 0
106	CORS UPR	The coarse DAC value is out of range 0 to 255, greater than 255
107	CORS LOW	In coarse tuning process, coarse DAC value of less than 0 is caused by the fine DAC value of less than 65
108	CORS UPR	In coarse tuning process, coarse DAC value of greater than 255 is caused by the fine DAC value of greater than 255
109	CORS UPR	In fine tuning process, coarse DAC value of greater than 255 is caused by the fine DAC value of greater than 255
110	CORS UPR	In fine tuning process, coarse DAC value of greater than 255 (out of range 0 to 255) is caused by the fine DAC value of greater than 191
111	CORS LOW	In fine tuning process, coarse DAC value of greater than 255 (out of range 0 to 255) is caused by the fine DAC value of less than 0
112	CORS LOW	In fine tuning process, coarse DAC value of greater than 255 (out of range 65 to 255) is caused by the fine DAC value of less than 0
113	SAMP LOW	Sampling ring lower-end losing lock
114	FRACNUPR	Fractional ring upper-end losing lock
115	LO1 FAIL	Local oscillator 1 adjustment failed
116	LO2 FAIL	Local oscillator 2 adjustment failed
201	LOAD CAL	Failed to call the file storing calibration data
202	DSP DATA	Failed to write calibration data to DSP
203	SAVE CAL	Failed to write or create the file storing calibration data
210	GETCALTR	Failed to get calibration sweep trace during calibration
220	CALFLTNS	Calibration data overrun when calibrating in-band flatness
221	40MFLTNS	40 MHz in-band flatness calibration error
222	13MFLTNS	13MHz in-band flatness calibration error
223	3M FLTNS	3MHz in-band flatness calibration error
224	1MFLTNS	100kHz in-band flatness calibration error
225	200MFLTN	200MHz in-band flatness calibration error
226	100MFLTN	100MHz in-band flatness calibration error
227	50MFLTNS	50MHz in-band flatness calibration error
230	200MError	Error in 200 MHz bandwidth conversion error calibration
231	100MError	Error in 100MHz bandwidth conversion error calibration
232	50MError	Error in 50MHz bandwidth conversion error calibration
233	40MError	Error in 40MHz bandwidth conversion error calibration
234	20MError	Error in 20MHz bandwidth conversion error calibration
235	10MError	Error in 10MHz bandwidth conversion error calibration
236	8MError	Error in 8MHz bandwidth conversion error calibration
237	5M Error	Error in 5MHz bandwidth conversion error calibration

**Appendix C Quick Search Table of Error Messages**

238	4M Error	Error in 4MHz bandwidth conversion error calibration
239	2.5M Err	Error in 2.5MHz bandwidth conversion error calibration
240	2M Error	Error in 2MHz bandwidth conversion error calibration
241	1.6M Err	Error in 1.6MHz bandwidth conversion error calibration
242	1M Error	Error in 1MHz bandwidth conversion error calibration
243	800k Err	Error in 800kHz bandwidth conversion error calibration
244	500kError	Error in 500kHz bandwidth conversion error calibration
245	400kError	Error in 400kHz bandwidth conversion error calibration
246	250kError	Error in 250kHz bandwidth conversion error calibration
247	200kError	Error in 200kHz bandwidth conversion error calibration
248	160kError	Error in 160kHz bandwidth conversion error calibration
249	100kError	Error in 100kHz bandwidth conversion error calibration
250	80kError	Error in 80kHz bandwidth conversion error calibration
251	50kError	Error in 50kHz bandwidth conversion error calibration
252	40kError	Error in 40kHz bandwidth conversion error calibration
253	25kError	Error in 25kHz bandwidth conversion error calibration
254	20kError	Error in 20kHz bandwidth conversion error calibration
255	16kError	Error in 16kHz bandwidth conversion error calibration
256	10kError	Error in 10kHz bandwidth conversion error calibration
257	8kError	Error in 8kHz bandwidth conversion error calibration
258	5kError	Error in 5kHz bandwidth conversion error calibration
259	4kError	Error in 4kHz bandwidth conversion error calibration
260	2.5kError	Error in 2.5kHz bandwidth conversion error calibration
261	2kError	Error in 2kHz bandwidth conversion error calibration
262	1.6kError	Error in 1.6kHz bandwidth conversion error calibration
263	<=1k Err	<=1 kHz bandwidth switching error calibration error
291	RF GAIN	RF variable gain calibration error
292	FLATGDAC	Flatness amplifier gain calibration error
294	NBIFGAIN	Narrowband IF variable gain calibration error
295	WBIFGAIN	Wideband IF variable gain calibration error
296	500MAMPL	Error in absolute amplitude error calibration during turn-off before narrowband
297	500MAMPL	Error in absolute amplitude error calibration during turn-off before wideband
298	500MAMPL	Error in absolute amplitude error calibration during turn-on before narrowband
299	500MAMPL	Error in absolute amplitude error calibration during turn-on before wideband
300	NB DEV	Failed to open narrowband acquisition device
301	NB INIT	Failed to initialize narrowband acquisition device
302	NB FPGA	Failed to configure FPGA of narrowband acquisition device

## Appendix C Quick Search Table of Error Messages

303	NB WRKP	Failed to set the working parameters of narrowband device
304	FIR FILE	Failed to call FIR file
305	FPGA FILE	Failed to open FPGA file of narrowband acquisition device
306	NB EVT	Failed to create narrowband acquisition device driver synchronization event
310	NBOVERTIME	Narrowband acquisition device sampling overtime
311	DIRVER READ	Failed to read narrowband acquisition device driver
312	DIRVER WRITE	Failed to write narrowband acquisition device driver
313	DRIVER DMA	Narrowband acquisition device driver DMA failed
315	WBOVERTIME"	Wideband acquisition device sampling overtime
320	WB DEV	Failed to open wideband acquisition device
321	WB INIT	Failed to initialize wideband acquisition device
322	WB FPGA	Failed to configure wideband acquisition device FPGA
323	WB WRKP "	Failed to set the working parameters of wideband device
325	FPGA FILE	Failed to open FPGA file of wideband acquisition device
326	WB EVT	Failed to create wideband acquisition device driver synchronization event
331	DIRVER READ	Failed to read wideband acquisition device driver
332	DIRVER WRITE	Failed to write wideband acquisition device driver
333	DRIVER DMA	Wideband acquisition device driver DMA failed
340	BBS DEV	Failed to open audio acquisition device
341	BBS INIT	Failed to initialize audio acquisition device
342	BBS FPGA	Failed to configure audio acquisition device FPGA
343	BBS WRKP	Failed to set the working parameters of audio device
345	FPGA FILE	Failed to open FPGA file of audio acquisition device
346	BBS EVT	Failed to create audio acquisition device driver synchronization event
350	OVERTIME	Audio acquisition device sampling overtime
351	DIRVER READ	Failed to read audio acquisition device driver
352	DIRVER WRITE	Failed to write audio acquisition device driver
353	DRIVER DMA	Audio acquisition device driver DMA failed
354	DATA LACK	Insufficient length of data collected by audio acquisition device
360	LARGEREF	Audio board large range reference calibration error
361	LARGEEND	Audio board large range ground calibration error
362	SMALLREF	Audio board large range reference calibration error
363	SMALLGND	Audio board large range ground calibration error
370	500MAMPL	Absolute amplitude error calibration error when the phase noise optimization preamplifier is off!
371	500MAMPL	Absolute amplitude error calibration error when the phase noise optimization preamplifier is on!

**Appendix C Quick Search Table of Error Messages**

400	FIR TMOU	Timeout error in continuous sweep
401	FIR RDERR	Data read error in continuous sweep, read points mismatch
831	ENR Data	Frequency is beyond ENR and ENR will be obtained by heterodyne
832	ENR Data	ENR table is empty, no ENR data is entered
841	CAL Invalid	User calibration is invalid, frequency is out of range
842	CAL Invalid	User calibration is valid
843	CAL Invalid	User calibration is interpolated
846	CAL Invalid	User calibration is invalid, mode setting is changed
847	CAL Invalid	User calibration is invalid, measurement mode is changed
850	Mode Error	Mode setting error
851	Mode Error	Mode setting error: the RF start frequency must be greater than the fixed IF frequency
852	Mode Error	Mode setting error: the RF start frequency must be greater than the fixed LO frequency
853	Mode Error	Mode setting error: the RF start frequency must be greater than the IF start frequency
854	Mode Error	Mode setting error: the IF start frequency must be greater than the RF start frequency
855	Mode Error	Mode setting error: the LO start frequency must be greater than the fixed IF frequency
856	Mode Error	Mode setting error: the IF start frequency must be greater than the fixed LO frequency
857	Mode Error	Mode setting error: the RF stop frequency must be less than the fixed IF frequency
858	Mode Error	Mode setting error: the RF stop frequency must be less than the fixed LO frequency
859	Mode Error	Mode setting error: the RF stop frequency must be less than the LO stop frequency
860	Mode Error	Mode setting error: the IF stop frequency must be less than the RF stop frequency
861	Mode Error	Mode setting error: the IF stop frequency must be less than the fixed LO frequency
862	Mode Error	Mode setting error: the RF start frequency must be less than the fixed LO frequency
863	Mode Error	Mode setting error: (LO-RF stop frequency) must be greater than or equal to the minimum input frequency of the instrument
864	Mode Error	Mode setting error: (RF start frequency - LO) must be greater than or equal to the minimum input frequency of the instrument
865	Mode Error	Mode setting error: the external local oscillator frequency is out of range
866	Mode Error	Mode setting error: the system input frequency is out of range

**Appendix C Quick Search Table of Error Messages**

867	Mode Error	Mode setting error: (LO-RF start frequency) must be greater than or equal to the minimum input frequency of the instrument
868	Mode Error	Mode setting error: the IF start frequency must be less than the fixed LO frequency
869	Mode Error	Mode setting error: the IF stop frequency must be greater than the RF stop frequency

Schedule 4 Remote Control Error Message Table

<b>Error Code</b>	<b>Error Key Field</b>	<b>Description</b>
600	CMD ERR	Parameters are allowed in commands
601	CMD ERR	Command parameter error
602	GPIB ERR	Command file in current mode corrupted
603	CMD ERR	The remote control command does not exist
604	CMD ERR	The command does not exist in current mode
605	GPIB ERR	Command file in receiver mode corrupted
606	GPIB ERR	Command file in phase noise mode corrupted
607	CMD ERR	Too many keywords with digits
608	CMD ERR	Digits are not allowed in keywords
610	SFP ERR	Recorder path link failed
650	GPIBINIT ERRO	GPIB initialization error
651	REGISTER ERRO	GPIB failed to access the register
652	GPIBMEM ERRO	GPIB memory initialization failed