科创仪表局
KECHUANG INSTRUMENT ASSOCIATION

Handheld Dual-port Vector Network Analyzer

User Manual

Applicable to KC901J, KC901K, KC901R, KC901T, KC901B

(test first edition line)

Kexinshe

5KHz...2/4/7/9.8GHz, 1...22GHz KC901J/K/R/T/B

Network Analyzer

User Manual

(Trial)

Edition: May 2023, First Edition
Printed: May 2023 First

Executive Summary

This book is the user manual of the fourth generation of KC901 series products, which explains the product principle, functional features and usage skills in a more informative way, suitable for the product users and also for the reference of related technicians.

Development Team

System Engineer Liu Hu

Hardware Engineer Hu Shichao

Software Engineer Wu Qing

Lang Qilin

Mechanical Engineer Li Yun

Process Engineer Yuan Xinzhi

KC901x Network Analyzer User Manual

Author(s): Liu Hu

Publisher: Kexinshe

Contact us: 028-86691700

First edition, May 2023 Opening: 890×1240 1/32

First printing May 2023 Print: 1

Print run: 1-100 Word count: 30k

Security matters

KC901x is not a consumer product and the user must be a professional or have specialized knowledge.

In this manual:

Hazard Indicates that personal injury, significant risk, equipment damage, or other serious consequences may result.

Warnings Indicates that incorrect measurement results or general hazards may occur.

Note Indicates an action point or surrounding risk to be aware of.

Dangerous

Do not use the instrument when it gets water, shaking with strange noises or other obvious abnormalities.

Do not test outdoor equipment during thunderstorms, including outdoor equipment with lightning arrestors installed.

The instrument power adapter uses a floating ground, and the instrument housing must be connected to the ground of the device to be measured at equal potential.

The instrument should be kept away from flammable and explosive materials, pay attention to keep ventilation, and no other objects should be covered on the instrument and charger when it is turned on or charged. The instrument does not have explosion-proof function, and it is forbidden to use in the environment with explosive gas or dust.

Pay attention to the storage and use temperature range. Do not place in a car under sunlight exposure.

Use for improper purposes is prohibited. Caution should be used by those with interventional electronic devices. Use with caution in hospitals, airports and other sensitive areas.

Please bring it into the cabin when you fly, remove the antenna, set it to the spectrum mode and turn off the power. If local regulations and airport regulations contradict this manual, transport by other means.

The KC901x has a maximum charge capacity of 60 Wh. It is necessary to use qualified batteries, to store them properly according to their characteristics, and to anticipate the risk of combustion and explosion of lithium batteries.

When carrying and running, it is forbidden to hang the instrument in front of the body, otherwise it will cause injury in case of fall.

Please keep it out of the reach of children. When lending the KC901x, the user should be urged to read the user manual and be informed of safety precautions.

Preamble

KC901x is an "RF multi-meter". It is based on a dual-port vector network analyzer with extended spectrum, field strength and low-frequency signal generator functions for increased usability.

◆Main features[1]

Different models cover 5kHz~22GHz frequency range

1Hz frequency stepping

100dB dynamic range (at 1kHz RBW)

Good accuracy and stability

Secondary frequency conversion, strong anti-disturbance ability

Feature-rich and easy to carry

◆Main functions

S-parameter test

Low frequency and simple RF signal source

Spectrum display and field strength observation[2]

Dual Port Comparator[3]

◆Recommended Applications

KC901x is mainly used for tuning various RF circuits, such as filters, amplifiers, splitters, combiners, testing input and output impedance, evaluating the quality of antenna systems, and detecting signal amplitude at all levels of equipment. In some frequency bands can also be field strength measurement, interference finding and other work.

KC901x is a good tool for learning RF knowledge. In the professional field, it can be used in communication engineering, antenna manufacturing, daily maintenance of radio and television transmitters and RF circuit research and development, which can effectively improve operational efficiency, reduce the burden of carrying and improve the quality of work.

◆Acceptance of instruments

When accepting the instrument, please open the package after confirming that it is intact, read the preamble of the user's manual immediately, and check it.

The standard packaging of the instrument contains:

KC901x 1 unit

Charger 1pc

Shoulder strap 1pc

User manual 1 copy

Please check whether the items are complete according to the above list and whether there is any cosmetic damage. Pick up the KC901x and check if the screws are secure and shake for any abnormal rattles.

In the case that no abnormality is found in the general check, connect the charger and check if the power on is normal. If the battery has been installed, directly press the power button (POWER,PWR) for 0.5 seconds to power on.

◆Important Statement

To the extent permitted by law, the designer, producer, seller, and community event organizer of the KC901x (hereinafter collectively referred to as the manufacturer) shall in no event be liable for damages in excess of the purchase price of the product, and shall not be liable for any loss of time, business, inconvenience, profit, abuse, or any consequential damages. The manufacturer's decision to repair, replace or return the product or refund the purchase price is the sole remedy for the user and the purchaser. The warranty period is the final period for which the manufacturer is liable for the product.

In no event does the manufacturer guarantee the suitability, reliability, or safety of the KC901x for medical, military, or other uses. Any commitment made by a distributor does not imply knowledge or endorsement by the manufacturer.

Notes:

1、Subject to the data sheet

2、Informal function

3、Options, experimental nature of the function

* * * * * *

The remote control method is described in the Programming Manual.

The method of upgrading the firmware by the user is separately described in the Software Update Guide.

As the software may be updated at any time, any changes to the product will be made without further notice. Please go to the website *www.deepace.net* to download the latest software.

Special Tips

This manual foresees the functions that may be developed in the near future. Since the software is still under continuous development, the actual functions may be very different from this manual, so please pay attention to the software upgrade announcement.

Kechuang Instrument Association is a research community hosted by the Kechuang Research Institute, the creator and community collaboration organizer of KC901x.

Chengdu Kechuangshikong Keji Co.Ltd. is authorized by Kechuang Research Institute and is responsible for the product development and production of KC901x.

Sichuan Kexinshe Keji Co.Ltd. is authorized by Kechuang Research Institute and is responsible for the domestic sales of KC901x.

Guangdongshenkong Co.Ltd. is authorized by Kechuang Research Institute and is responsible for the international sales of KC901x.

Unless otherwise stated, Kechuang Research Institute and Chengdu Kechuangshikong Keji Co.Ltd. own all copyrights of KC901x software and hardware.

Components supplied by third parties and their attached firmware and tool chain products are authorized to be used in this product.

The KC901x uses the following open source software for some of its firmware:

Free RTOS

The KC “中” logo is a registered trademark of the Kechuang Research Institute, and “MEASALL” is a registered trademark of Techtronic Space & Time Inc.

Table of Contents

Chapter 1, Overview

The KC901 is an RF multi-meter based on the network analyzer architecture that has undergone several improvements over the past decade or so, with the latest being the fourth generation of the product.

The first generation of 901: KC901H, KC901E as the representative of scalar network analyzer. At that time, the level of instrumentation in the technology hobby community was very backward and objective measurement was far from being a habit. the popularity of KC901 changed the situation and promoted the quality of technology hobby and professional communication engineering works.

The second generation 901: contains only one model KC901S, which adopts the over-zero comparison and counting method for phase identification, and the amplitude and phase are measured separately, realizing the leap from scalar to vector. The product was only produced for less than a year due to the unsatisfactory phase accuracy.

The third generation 901: contains KC901C+, S+, V, M, Q and other models, using all-digital IF technology, phase error, trace noise, etc. are improved, the main problem is that the internal crosstalk is larger, so the dynamic range of transmission test is smaller. The third generation products were produced for seven years, and some of them are still in production.

Fourth generation 901: Domestic RF instruments have achieved miraculous development in recent years, and the upgrade work of KC901 has become urgent. Since 2022, we have systematically summarized the pros and cons of previous products, combined with the problems commonly reported by users, carefully organized the design work, and planned to launch KC901J, K, R, T, B and other models. The fourth generation 901 changed from the previous 1½ ports to full dual ports, adopted 4 strictly identical receivers and 24bit synchronous sampling ADC, improved circuit layout and shielding, and gained significantly improved functions and performance.

The fourth generation of products is expected to take about a year to come together, with the first product released in 2023.The initial product will have simpler software and fewer features, and will be gradually improved over the next year or two, allowing users to upgrade remotely.

Model	KC901J	KC901K	KC901R	KC901T	KC901B
Frequency	5k~2GHz	5k~4GHz	5k~7GHz	5k~10GHz	1G~22GHz

range					

For base-wave mixing network analyzer, it can be used as a simple signal source, field strength meter, comparator and spectrum meter, although the performance is a little lower than the corresponding specialized instruments, but it can completely help to solve practical problems.

KC901 is community-oriented and designed for popularity, on the one hand approaching or reaching the technical level of mainstream commercial instruments of the same period and extending practical functions as much as possible, on the other hand relying on structural innovation to achieve a lower price and make it an easily accessible tool. We hope that the fourth generation KC901 will continue to accompany everyone on their journey of progress.

1.1、Theory

A network analyzer is a device that measures scattering parameters.

The scattering parameters, or S-parameters. For a network with two ports (e.g., an attenuator), the S parameter consists of four components, denoted by S_{ij} , where i denotes the port to be detected and j denotes the incident port of the excitation signal.

S_{11} : The reflection of the signal from a port of the device under test (DUT), also known as return loss;

S_{21} : the change in the signal as it passes through the device under test (amplitude and phase change, also known as insertion loss or gain);

S_{12} : the change produced when the signal passes through the device under test in the opposite direction;

S_{22} : The reflection of the other port of the device under test to the signal entering from that port.

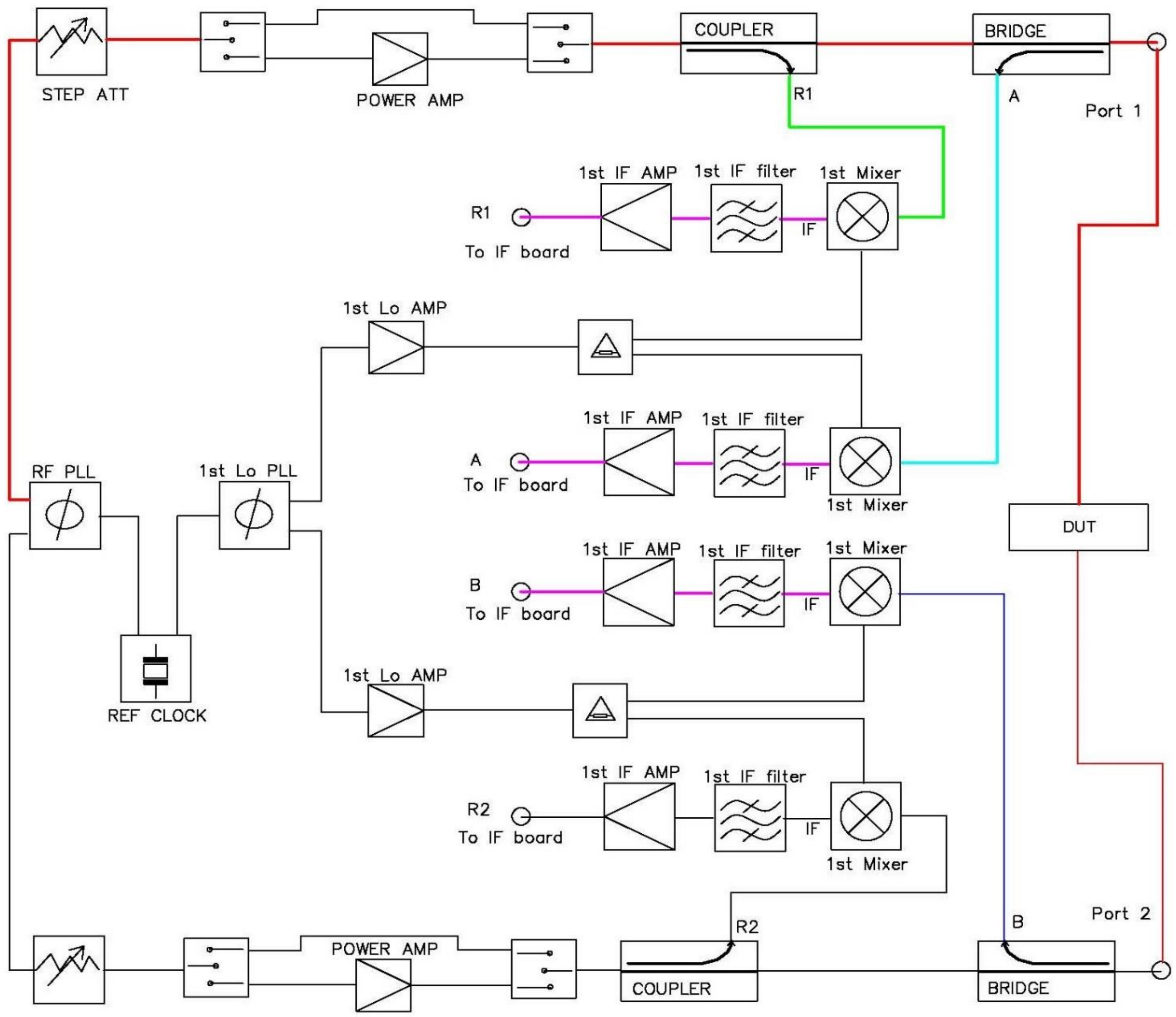
From the above definition, it can be seen that the scattering parameters can be measured by understanding the changes produced by the signal flowing through the device under test and reflected by the device. The network analyzer will generate an excitation signal by itself, let the excitation signal send into the device under test, and at the same time use multiple receivers to measure the characteristics of the excitation signal before and after entering the device under test respectively, compare them, and get the S-parameter by calculation.

The diagram at the top of the next page shows the RF block diagram of the KC901. Taking S_{11} and S_{21} of the measurement two-port device as an example, the path of the excitation signal is shown in red. After being generated by the frequency source, it is conditioned by the step attenuator and bypassable amplifier, and the forward reference signal R1 and reverse signal A are extracted through the forward and reverse couplers, outputted to the device under test (DUT) through port 1, outputted from the other port of the DUT, arriving at port 2, and extracted through the reverse coupler of port 2 to get Transmission signal B. The three signals R1, A and B are transformed to the same IF frequency by three identical mixers, filtered, amplified and ready to be sent to the IF unit.

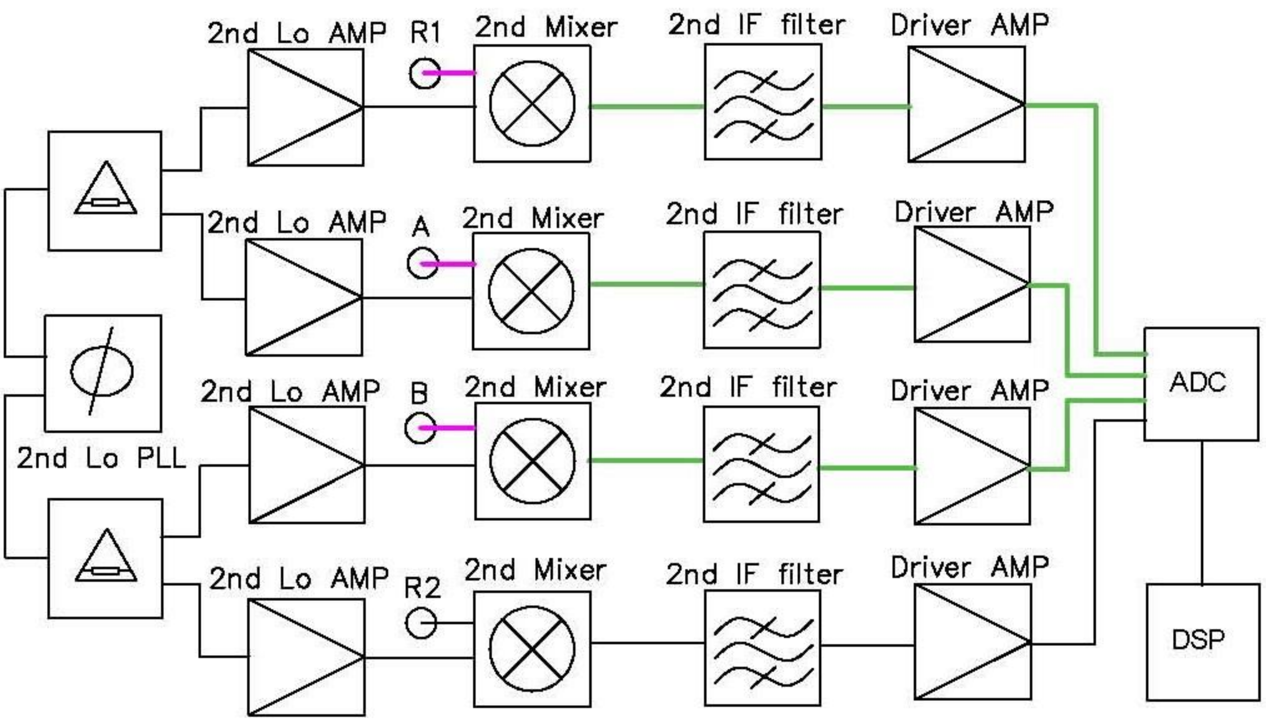
The second figure shows the IF block diagram, where the three IF signals R1, A and B are mixed for the second time in the IF unit to obtain the second IF, which is processed by the second IF filter and the ADC driver amplifier and finally sent to the ADC for sampling.

If the S_{12} and S_{22} of the device need to be measured, the excitation signal is output from port 2 and the amplitude difference and phase difference of the three signals R2, B and A are measured. The measurement process is automatically managed by the MCU, and the four S parameters can be obtained.

The signal path may be slightly different for different models of KC901, they are based on the same principle.



Top: RF block diagram; Bottom: IF block diagram



There is still a long way to go from amplitude difference and phase difference to S-parameters, where the main process is calibration. The amplitude and phase difference measured by the instrument contains both its own undesirable parameters, as well as the influence of external cables and connectors, and finally the influence of the component to be measured. The process of calibration is to have the instrument measured beforehand using some known or partially known parts to be measured, so that the instrument can distinguish between its own effects as well as those caused by external connections, and deduct them in the actual measurement.

1.2、Main parameters

Commonly used parameters are listed here for reference. The technical parameters are listed separately in the data sheet.

Name	Conditions	Minimum	Typical	Maximum	Remarks
Frequency range	Effective	5kHz		22GHz	Varies by model
Frequency range	Allow set	0		22.8GHz	Varies by model
Sweep Width	Effective	1kHz		21GHz	Varies by model
Maximum Output Level	J/K/R/T	-6dBm	0dBm	6dBm	
	KC901B	0dBm	10dBm	13dBm	
Internal attenuation range	J/K/R/T	0		60dB	
	KC901B	0		45dB	
Receiver normalized noise floor	J/K/R/T		-130dBm/Hz		
	KC901B		-136dBm/Hz		
S21 dynamic range	J/K/R/T		100dB		RBW:1kHz
	KC901B		110dB		
Coupler absolute directionality	KC901J/K		27dB		
	KC901R/T		23dB		
	KC901B		16dB		
Trace noise	RMS, straight through		0.005dB		
Scanning speed	RBW:10kHz		0.8ms/pt		

Scanning points		101		10001	
Ambient temperature		-40° C		55℃	Depends on the battery
Charged storage time		1a	2a		Battery initial voltage 7.5V
Net Quality			1.3kg	1.5kg	
Volume	Connector included	210×120×46mm(L×W×Th)			

* Some technical parameters are related to the software, such as noise floor, dynamic range, scanning speed, etc. With the improvement of the software may have a large change, please refer to the latest version of the actual parameters.

1.3、Charging time and Battery life

The KC901x battery pack has a rated charging current of 1A, and the charging time is related to the battery capacity. At present, the largest capacity commercial battery, single capacity up to 3.4Ah, if loaded into 4 sections, charging time is 4/2×3.4≈7h. If only 2 sections of 2.2Ah capacity battery, charging time is about 2.5h. The instrument will automatically stop charging when the single battery voltage reaches 4.2V and the battery pack voltage 8.4V. When the temperature is too low or too high, the instrument will automatically slow down the charging speed.

KC901x battery life is determined by the capacity of the battery and the functions used, the power consumption of various functions of the KC901x is different, the S21/S12 function requires the signal source and three receivers to be turned on at the same time, so the power consumption is the largest. The spectrum, field strength, and signal source functions are more power-efficient because only one of the signal sources or receivers is turned on. STOP state, the entire RF circuit is turned off, only the processor and display part of the power consumption.

In addition, the power consumption is also related to the output amplitude. Unless a strong excitation signal is really needed, the output gain should be set to 0 or negative value in the FUNC menu.

Loaded with 4 batteries, display brightness 20%, temperature 15℃, the endurance time of each function is shown in table below. This table is for reference only, the temperature is too high or too low and the actual capacity of the battery is not enough, etc., will shorten the endurance time.

Battery Capacity / Function Name	Endurance (hours)			
	2200mAh	2600mAh	3100mAh	3400mAh
Reflection (S11/S22)	2	2.5	3	3.5
Transmission/insertion loss (S21/12)	1.5	2	2..5	3
Spectrum/field strength	2.5	3	3.5	4
RF Signal Source	2.5	3	3.5	4
Audio Signal Source	3	3.5	4.5	5
Stop, Pause	5	6	7	8

If only 2 batteries are loaded, the range is slightly shorter than half of the above time because the discharge rate becomes larger.

The KC901B is even more power hungry, with a range of about 80% of the above chart.

Chapter 2, installation guide

Depending on the policies of different regions, the KC901x may be shipped from the factory without a battery installed and will need to be installed by the dealer or user. Before installing the battery, please power on the instrument with the power adapter and turn it on for inspection. After confirming that the instrument functions properly, turn off the power and unplug the power adapter.

2.1、Battery selection

KC901x uses Li-ion battery, its single cell charge cut-off voltage is 4.2V, discharge cut-off voltage is 2.6V, rated voltage is 3.7V, the combination of two parallel and two series. KC901x battery management circuit has overcharge, overdischarge, short-circuit protection, and automatic equalization.

The battery compartment is suitable for installation of cylindrical lithium batteries with a diameter of 18mm and a length of 65mm. The battery must be produced by a regular manufacturer in accordance with the relevant industry standards.

KC901x can be loaded with 2 or 4 batteries, 4 batteries are recommended. The rated charging current of the instrument is 1A. If only 2 batteries are loaded, the peak charging current for a single battery is 1.2A and the peak discharging current is 3A; if 4 batteries are loaded, the charging and discharging load of a single battery should be considered at slightly more than half of the above current.

The batteries loaded must be of the same type and should be from the same batch, do not mix old and new. Before loading, each battery should have basically the same voltage, the difference is not more than 50mV.

Please take care of the battery according to the manual of the battery. Normally low temperature resistant batteries can only be used in winter. When the ambient temperature exceeds 45℃, the temperature of the battery pack may exceed 65℃ due to the heat generated by the circuit, and heat-resistant batteries must be used.

2.2. Install the battery

Required tools: Hexagonal screwdriver with a diameter of 2mm.

Step 1: Place the instrument flat on the workbench and remove the two screws at the end (Figure 2-1).

Step 2: Slide the case (the keyboard side) towards the end for about 2cm (Figure 2-2). The method is to squeeze your fingers hard on both sides of the upper case, while pulling the RF connector outward. If it is difficult to slide, you can lightly hit the tail of the lower cover on the wooden board. Be careful not to use too much force, and the sliding distance should not exceed 4cm, otherwise the internal cable will be pulled off.

Step 3: Lift the top cover slightly and flip it over to the left side.

Step 4: Install the battery. The positive terminal of the battery is facing the direction of the RF connector. If only 2 batteries are installed, please install them on the leftmost and rightmost position of the battery box (Figure 2-3).

Figure 2-1 Step 1, Remove the bottom screws

Figure 2-2, step 2, slide the upper cover towards the end about 2 cm

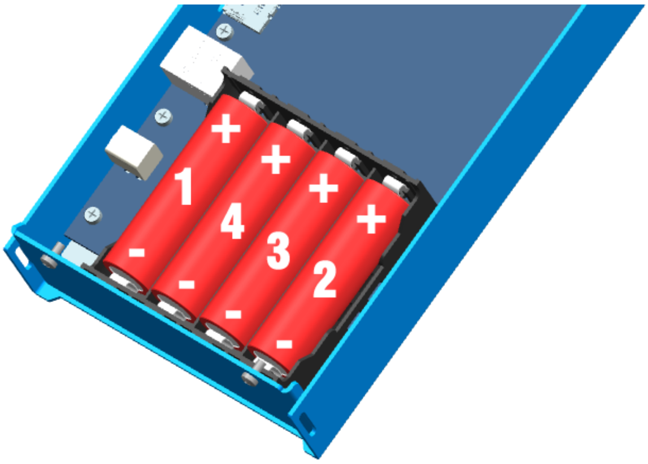


Figure 2-3, the direction of the battery and the order of installation

Step 5: Check the data cable plug, if there is an offset misalignment, it needs to be reinserted.

Step 6: Close the case according to the opposite steps and press the POWER button to turn on the power for inspection. If there is no abnormality, screw on the screws.

2.3、Installation of shoulder straps

The instrument has shoulder strap mounting holes at the tail and top (behind the RF port). So it can be carried either RF port up or tail up. If the instrument is to be used at any time while on the go, it is recommended that the tail mounting holes be used.

Unfold the shoulder straps, remove the ends from the plastic fasteners, thread them through the mounting holes, and then thread them back into the plastic fasteners to lock them in place.

Dangerous

The shoulder straps need to be checked frequently to see if they are secure and the plastic fasteners are intact. The standard shoulder straps are only used for normal carrying, and additional fall protection measures must be taken when working at height.

2.4, carry and grip

The shoulder strap is adjusted to the appropriate length and can be worn diagonally (the instrument is located at the waist) or squarely (located on the abdomen). If it needs to be used on the move, it is recommended to carry it upside down. When running, the shoulder strap should be shortened and worn diagonally across the shoulder, beware of the damage caused to the body.

The instrument is designed to be held in the left hand and operated by the right hand. When used in a standing position, the left hand holds the upper left side of the instrument, the thumb operates the knob, and the bottom of the instrument is held against the abdomen. The right hand is responsible for connecting the cable and operating the keyboard.

With very few exceptions, the upper knob serves the same function as the knob on the panel. The knobs are not required and the full operation of the KC901x can be performed using the keypad. The "+" and "-" buttons are equivalent to the rotary knob, and the ENTER button is equivalent to the depressed knob. To perform all operations with the keypad, hold both hands under the LCD and use your thumbs to press the keys.

The KC901x can be secured to the bench with screws through the shoulder strap holes in the upper part of the instrument.

Chapter 3, interface and functional description

The designers of KC901x have made a lot of efforts to make it easy to understand. Except for the keyboard which needs to be adapted, the fourth generation product retains almost all the operating habits of the previous products, and users with basic knowledge can be familiar with it after only one or two days of use. Therefore, as usual, this manual does not explain in detail the settings of each function, but focuses on introducing the interface and functional components, so that users can think positively about how to operate.

3.1, power switch and keyboard

The following figure (3-1) shows the keyboard function layout of KC901x. To turn on or off the instrument, press and hold the lower left power switch (**POWER**,PWR) continuously for 0.5 seconds. After turning on the instrument, the first measurement interface displayed remains the same as the last time it was turned off, and the soft menu displays the relevant setting items for the current mode.

Figure 3-1: Keyboard of KC901x

The first-level functions of the keyboard are shown in Table (3-1)

Key Name	Functional use
CENT	Set the sweep center frequency
SPAN	Set the sweep width (frequency span)
SCALE	Adjust the display scale and position; adjust the reference level in the spectrum function, and adjust the output amplitude in the signal source function.
MARK	Access to the marker function menu
HOME	Enter the function selection menu. Press repeatedly to toggle between the function selection menu and the function menu.
STOP/RUN	Stop scanning, start scanning

+, -	Equivalent to the rotary knob, the step is larger than the rotary knob when adjusting the frequency
FUNC	Enter and exit the system setting interface
SHIFT	Activate the secondary functions of the keyboard
POWER	Power Switch
CS	Hardware Reset

Table 3-1

The functions of CENT and SPAN can be set in the "Frequency Control" option in the FUNC menu.

The secondary functions of the keyboard are shown in Table (3-2). Note that "SHIFT+" means that the **SHIFT** icon will appear on the screen when you press the SHIFT button, and then press the other keys in combination with it, not both keys at the same time.

Key combinations	Functional use
SHIFT+CENT	Set the start frequency
SHIFT+SPAN	Set the termination frequency
SHIFT+SCALE	Quickly switch output levels
SHIFT+MARK	Find Peak
SHIFT+HOME	Disconnect from the host computer and switch to local mode
SHIFT+STOP/RUN	Switches to single sweep mode. In this mode, press STOP/RUN once to sweep once
SHIFT+1	Save data to memory card
SHIFT+2	Read curves and settings from memory card
SHIFT+3	Custom file names when saving data to memory card
SHIFT+4	Adjust screen brightness (10%, 30%, 100%)
SHIFT+5	Switch automatic shutdown function
SHIFT+6	Switch button beep
SHIFT+7	Switching resolution bandwidth (RBW, 1k, 10k)

SHIFT+8	Switching sweep points (101, 401, 1001)
SHIFT+9	Switching scanning speed (fast, medium, slow), the slower the more stable
SHIFT+.	Save current user calibration data
SHIFT+0	Reads user calibration data
SHIFT+ENTER	Locking keypad and knobs to prevent misuse

Table 3-2

3.2、Measurement port

The measurement ports on the 901x include: two external RF ports, and one audio port. The functions of the two RF ports are the same, and many functions can be used with both the left and right ports. When using the 901x, you need to specify the ports through the keypad and pay attention to the port indication icons at the top of the screen to avoid wrong connections. The measurement port is shown in Figure (3-2).

In the other technical documents, they are named Port 1, Port 3, and Port 2 from left to right according to the positions shown in Figure (3-2).

The N-type measurement port has a precise interface and needs to be protected with care. Please use good connectors and take care to check before connecting. If the core pin is protruding or bent, it must be repaired before connection. However, there is no need to connect unnecessary adapters to protect the port. The more adapters you connect, the less accurate the measurement will be.

The design life of the port is 1000 times unplugged, the aging of the port has a certain impact on the accuracy of vector measurement, and should be replaced in time after exceeding the life.

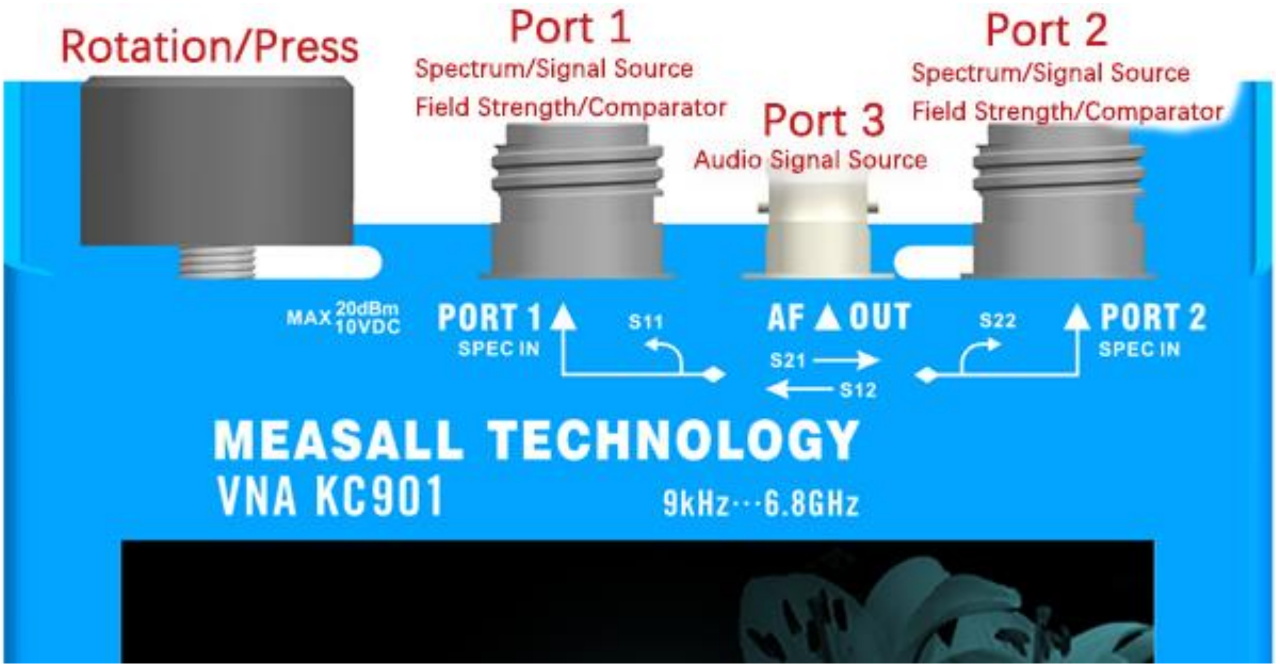


Figure 3-2, Top ports

3.3. Auxiliary ports

There are four interfaces on the right side of the instrument, which are: charging socket, network interface, memory card interface, and data interface, as shown in Figure (3-3).

Figure 3-3, Right Interface

The data port (Type-C) can also be used for charging. The new KC901 supports Type-C fast charging and can be charged using a phone charger, but compatibility is not guaranteed.

3.4、Display

The KC901x features a 4.2" display with a resolution of 800 x 480 pixels. The display interface is divided into five main areas from top to bottom, including status bar, marke(cursor) bar, graphic data area, setting parameter bar and soft menu.

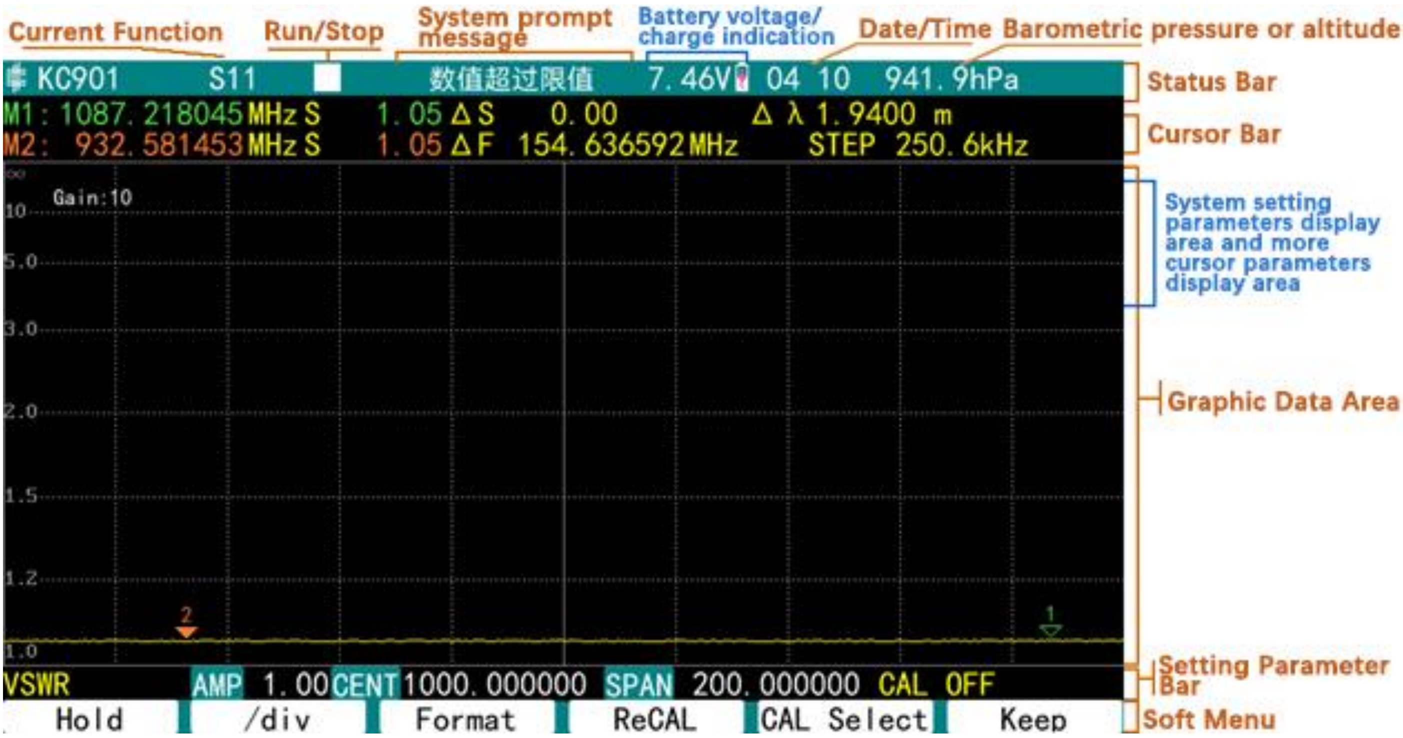


Figure 3-4, Display Zone

3.5, Function description

The instrument has five basic functions: S-parameter test (S11/S21/S12/S22), spectrum (SPEC), field strength meter (FIELD), RF signal source (RF SOURCE), and audio signal source (AF SOURCE). As software development progresses, time domain functions and dual-port comparators may also be provided. All functions other than S-parameter measurement are informal functions based on the complimentary network analyzer architecture.

•The **HOME** button is used to select a function. By pressing the **HOME** button repeatedly, the instrument switches between the function selection menu and the function menu.

· **The S-parameter measurement** are vector functions and they have various display options. Under a certain S-parameter menu, the specific display is selected by FORMAT. The second soft menu from the left provides more display options for circle and impedance displays.

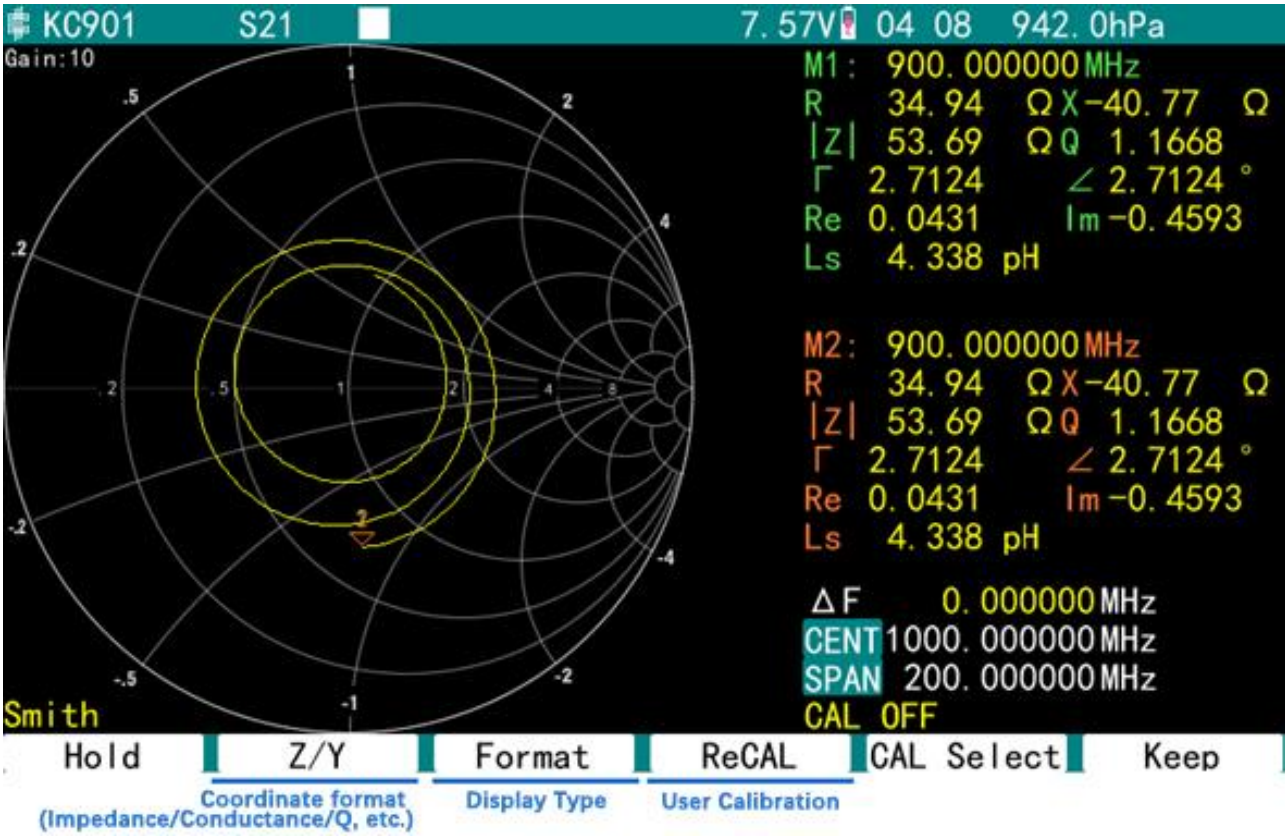


Figure 3-5, The display mode setting options on the main menu of the mode

To enter: Press the HOME key, then press the S parameter option in the menu, for example (S11).

The port number of the S parameter obeys the number printed on the panel and cannot be specified by software. For example, to measure S11 requires the use of port 1.

Because of the software development progress, currently KC901x can only display one curve at a time, the same display style as the third generation products. For the time being, it does not support displaying different S-parameter curves on the same screen, for example, S11 and S21 curves cannot be displayed at the same time. Multiple curve display will greatly complicate the operation logic and make the instrument less easy to use, so careful design is required. Please pay attention to the software version update.

- **The insertion loss test** is a single frequency point form of transmission test, characterized by continuous output of the signal source system and fast reading response.

To be consistent with the operating habits of common test receivers, the switch for the insertion loss test function is placed in the field strength mode.

To enter: press HOME, press FIELD option in the menu, and then press Insertion option, so that the bottom right corner of the screen shows "GEN ON (tracking source on)". When the insertion loss test is turned on, the measurement port selected in the field strength mode is also the input port for insertion loss.

- **Spectrum display** (SPEC) is typically used to monitor the occupancy and interference of a frequency band and also to debug any circuitry that generates RF signals. Connecting a matching KC-R100x type broadband directional antenna can be used to find concealed emission sources.

To enter: Press the HOME button, then press the SPEC(Spectrum) option in the menu.

The port used by the spectrum can be specified on the soft menu via the Port Switching option (PORT).

- **Field strength mode** (FIELD) typical use in addition to testing the field strength of the coverage, used to probe the circuit on the amplitude of the RF signal is also very convenient. The 901x port has DC isolation, so you can directly detect the signal level of each small signal stage of the receiver and transmitter with an external probe, but pay attention to impedance matching. When detecting the transmitter, the series connection of additional spacers and attenuators is also a necessary safety measure. After gaining some experience, you can use the field strength mode to determine very quickly whether the radio is transmitting strongly enough. The port for this mode needs to be specified in the software, and the PORT option in the soft menu is used to switch the port.

To enter: press HOME, select NEXT, then press the FIELD option in the menu.

- **RF SOURCE** is used to generate a small power signal, and its typical use is to transmit a weak signal into the air so that the sensitivity of the radio station can be judged at close range. For experienced people, this small signal will be very convenient to use. And more external attenuators can further expand the use of the signal source.

RF signal source function can adjust the size of the signal within a certain range through the built-in output attenuator. The output attenuator of the instrument also serves as an amplitude modulator, which can modulate the signal in ASK mode. But if the output attenuator has been used to adjust the output amplitude, the amount of attenuation has been used can no longer be used for modulation. So the modulation system and output attenuation are mutually exclusive, the greater the output attenuation, the smaller the modulation system can be used.

The port of the RF signal source can be specified in the software. The output amplitude of both ports is the same. Except for the KC901B, the output amplitude of the RF signal source of the fourth generation KC901 is smaller than that of the third generation because the signal must pass through the coupler.

To enter: Press **HOME**, select **NEXT**, and then press the **RF SOURCE** option in the menu.

· **AF SOURCE** is used to generate a low-frequency voltage signal, and its typical use is to condition the audio channels of electronic devices. Since the audio signal source is capable of generating a stable output of up to 50MHz with a variety of modulation methods, it is also used to debug RF circuits below 50MHz.

The audio signal source can actually be set to very high frequencies (but no indicators are guaranteed) and with the help of undersampling output, it can be used for radio sensitivity debugging and other purposes.

To enter: Press **MODE**, select **NEXT**, then select the **AF SOURCE** option.

3.6、Adjustment of operation status

When the instrument is just turned on, it changes to the STOP state by default after only one scan. To make the instrument start scanning, it must be started manually. The **RUN/STOP** button on the keypad is dedicated to controlling the operation of the instrument. Press the button once, the instrument runs continuously; press it again, it stops running.

The **RUN/STOP** button supports a secondary function; pressing the **SHIFT** button once and then pressing the **RUN/STOP** button, which transforms it into a single run button, and the display indicates "  ". At this time, the instrument runs only once for each press of the RUN/STOP button. Repeat SHIFT+RUN/STOP operation to cancel this function.

Single scan. Each time you press RUN/STOP, the instrument scans once.

Automatic scanning, the instrument scans continuously. In single sweep mode, this icon is also displayed while the instrument is scanning.

Stop scanning and the power to the RF circuit will be completely cut off.

*The instrument automatically scans once if the main setting parameters are changed when it is stopped.

Note

Due to the lack of warm-up time, the results of a single sweep have a slightly larger error. When more accurate data is required, please adjust to auto-sweep status.

3.7、Local oscillation mode

In the Spectrum (SPEC) and Field Strength (FIELD) functions, there is an Local Oscillation Mode for determining the mirror response.

Low Lo: Low local oscillation. The local oscillation is lower than the measured frequency, and the mirror interference comes from the lower frequency.

High Lo: High local oscillation. The local oscillation is higher than the measured frequency, and the mirror interference comes from the higher frequency.

If a signal, in either low or high local oscillation mode, appears at the same location on the screen, the signal is more likely to be real. If a signal disappears in either mode, the display must be false. If a signal appears in low oscillation mode and disappears in high oscillation mode, the possible true frequency is the appeared frequency minus 219.3MHz. if a signal appears in high oscillation mode and disappears in low oscillation mode, the possible true frequency is the appeared frequency plus 219.3MHz. The mnemonic is: low exposure, look down; high exposure, look up.

If the height of the floor noise is different in different local oscillation modes, the one with low floor noise should be preferred.

When below 200MHz or close to the upper frequency limit, the local oscillation mode setting is invalid, and an external preselector can be used to filter out the mirror ference.

The factory calibration of the spectrum and field strength modes are performed in the high local oscillation mode. In low local oscillation mode, the measurement may not be accurate.

3.8, Set the basic test parameters

To set the **center frequency,** you should press the CENT button and then use the numeric keypad to type it in. If the new frequency is near the current frequency, it can also be adjusted with the dial wheel or the "+" and "−" keys on the keyboard after pressing CENT.

To set the **sweep width**, press the SPAN button.

The start frequency (START) can be set with the key combination SHIFT+CENT.

The cutoff frequency (STOP) can be set with the key combination SHIFT+SPAN.

If you are accustomed to entering frequencies in the start and stop frequency mode, you can select the Frequency Control option as "Start Stop" in the FUNC menu.

To set the **reference level** and adjust the up and down position of the curve, you should press the SCALE button and use the dial wheel or the "+" and "-" buttons to adjust. The fourth generation KC901 has improved the circuit, no need for variable attenuator, so the REF level no longer needs to be set with skill, just adjust the curve to the right position for viewing.

The SCALE button is used to adjust the span of the vertical coordinate when performing voltage standing wave ratio (VSWR) measurements.

The sweep points are set in the FUNC menu, Sxx POINT (S-parameter sweep points) and SPEC POINT (spectrum sweep points) options. In general the S-parameter is set to 201 points, and the spectrum is set to 401 points, which normally does not need to be changed. The instrument will automatically select the appropriate frequency step (STEP) based on the sweep width.

SW Time (scanning speed) is set in the FUNC menu. There are three speeds: fast, medium and slow. Usually use medium speed. The fast speed can increase the speed, but the trace noise will be significantly larger, and an asterisk (*) will be displayed in the upper right corner of the screen to inform the user that the measurement may not be accurate.

The IF bandwidth (RBW) for the S-parameter measurement function needs to be selected in the FUNC menu. The smaller the RBW, the slower the instrument will scan. The factory calibration is performed at an RBW of 10 kHz, unless there is a special reason (e.g., a need for greater dynamic range), set the RBW to 10 kHz.

The analysis bandwidth of the spectrum is set with the RBW button on the spectrum function menu.

In the Mode menu of the S-parameter measurement mode, the option (dB/div) is used to toggle the vertical coordinate span.

3.9, Set the field strength mode

The field strength mode actually measures the level of the input port. The field strength value is calculated from the input level and the antenna coefficient. The antenna coefficient is mainly related to the frequency and antenna gain. Therefore, to get the correct field strength reading, the antenna gain must be told to the instrument.

Enter the field strength mode (FIELD), there is an antenna gain (ANT GAIN) option in the menu. After pressing, first use the "+/-" option in the menu to select the symbol, and then use the numeric keyboard to enter the antenna gain.

The refresh speed is divided into three grades: fast (FAST), medium (MIDDLE), and slow (SLOW), and MIDDLE is generally recommended. The refresh speed of the S meter is not affected by this setting and is used to observe the instantaneous change of signal strength.

3.10, Enter the insertion loss test mode

The insertion loss test is actually a single frequency point way of S21 or S12 measurement, which is essentially an S21 or S12 test that includes response calibration.

First enter the field strength measurement interface, in the menu on the far right (bottom right corner of the screen) there is "Insertion" (insertion loss) option. After pressing it, the lower right corner indicates that the tracking source is on (GEN ON), and the number on the left side of the display is still the absolute level value, while the reading on the right side has changed to the relative level. Put the RF port straight through and select the **AUTO CAL** option in the menu to make the relative level reading zero. Then connect the test cable to the device to be tested and the left side reading will be the insertion loss.

PORT in the soft menu is used to switch the signal direction of the insertion loss mode, that is to switch S21 and S12.

3.11. Storing data

If you need to save data, a micro SD card (TF card) must be inserted.

In the measurement function, press the key combination **SHIFT+ 1** to store a screenshot of the current screen and save the test results and settings as a number table.

The above file names for saving data are automatically generated by the system. I To write the file name manually, use the key combination **SHIFT+ 3**.

When connected to a computer with a USB cable, the instrument will virtually become a USB flash drive and the SD card is actually taken over by the computer, so no data can be stored when connected to the computer.

In the S-parameter test mode, in addition to saving the simple number table, depending on the function, it will also generate **S1P or S2P format** files at the same time.

3.12. Notes on system setup

Most of the time, press the FUNC button to enter or exit the system setup interface. In the FUNC interface, press SHTF+7 to enter the advanced setup interface. Some parameters in this interface need to be set correctly, otherwise it may lead to measurement errors. If the parameters are inadvertently set incorrectly, they can be reset to their default values by restoring the factory settings.

The following items need to be noted:

(1) Unless the cable is very long or more details are needed, try to select 201 scanning points to increase the speed.

(2) Medium speed should be used for scanning speed. Fast speeds will introduce

large noise and data bias. If the highest accuracy is required, a slow speed can be used, but user calibration must be performed.

(3) Both the clock (FREQ REF) and trigger (Triger) should be selected as "Internal (Int)".

(4) Coupler selection should be placed in the "Internal (Int)", unless an external coupler is really to be used.

(5) Excitation source gain RF GAIN > 0dB, the instrument turns on the power amplifier. In order to save power, usually set to ≤ 0, at this time the output excitation signal amplitude is less than -20dBm. If the dynamic range of the S parameter is not sufficient or the noise is high, it can be set to +20dB. Regardless of the setting, it is recommended to calibration after modifying this setting.

Chapter 4, Calibration

4.1. Overview

The KC901x is factory calibrated on its own port to eliminate the need for calibration in the field. For various reasons, factory calibration cannot perfectly correct for errors in the field and curves can drift undesirably, but when performing general engineering applications, there is no need to spend time on specialized calibration as long as the test results help in analysis and judgment.

Cables and a sufficient number of connectors are generally required for measurement, and cables and connectors can introduce losses and phase shifts. The performance of the instrument will drift as the temperature changes and as time passes. When these unfavorable conditions interfere more with the measurement, making the measurement results do not solve the problem, then calibration should be performed.

Calibration is only valid for the "test conditions at the time of calibration", including: the cables and adapters connected at the time of calibration, the temperature at the time of calibration, the analysis bandwidth at the time of calibration, the sweep speed at the time of calibration, etc. If these conditions change, new errors will be introduced. Therefore, the measured conditions should be as close as possible to the calibrated conditions, or conversely, the calibrated conditions should be as close as possible to the actual conditions at the time of measurement.

The number of conversions between different connectors should be minimized when testing, and it is especially not recommended to use unnecessary adapters in order to protect the port.

4.2、Calibration mode

The KC901x has three different calibration modes: factory calibration, system calibration, and user calibration.

Factory calibration: The instrument is factory calibrated for high density in all frequency bands and interpolated for higher density using calibration scaling algorithms. The factory calibration data is permanently stored in the instrument and cannot be reset or used directly by the user, but can be overwritten into the system calibration through the "restore factory settings" function.

System calibration: The instrument is shipped with the same system calibration data as the factory calibration. The system calibration is ready to use and allows the user to recalibrate. After performing a system calibration, the instrument will receive a basic error correction regardless of the frequency it is operating at, thus eliminating the need for calibration in most cases. By running "Restore Factory Settings", the instrument will discard the user-made system calibration and copy the factory calibration data to the system calibration data.

User calibration: A calibration performed by the user at any time. This calibration corrects each data point according to the prevailing conditions. As long as the frequency is not changed, there is no interpolation error, so the accuracy is higher than factory calibration and system calibration. User calibration is only valid for the setup parameters at the time of calibration, and if the setup parameters are changed, the calibration data will be meaningless. However, the last calibration data will be stored temporarily, and if you return to the last setting parameters, the calibration data will still be valid. If the user only changes the test frequency or sweep points, and the new frequency is within the frequency range set during calibration, the instrument will interpolate the calibration data, then the user calibration is still valid, but the accuracy is reduced.

4.3. Calibration operation

In any of the display modes of the S-parameter test function, there is a "**CAL Select**" on the far right side of the menu to toggle between system calibration, user calibration, and off calibration. When you enter "CAL Select", the menu will show all currently available calibration data, and gray out the ones that are not applicable.

If a user calibration is required, press the "**RE CAL**" option.

Under the **FUNC** menu, enter the system calibration by using the key combination **SHIFT+7.**

As soon as you enter the calibration interface, the instrument will start the calibration wizard, showing the specific operation procedure for the user to choose. The process steps are as follows:

Step 1: Select the calibration type. There are eight types of calibration: S11 calibration, S22 calibration, S21 response calibration, S12 response calibration, S21 enhanced response calibration, S12 enhanced response calibration, full dual-port calibration, and TRL calibration (not yet available). Except for TRL calibration, the SOLT calibration model is used for all of them. Based on the principle of the calibration model, TRL calibration is only available for full two-port calibration.

Step 2: Follow the procedure prompted by the instrument to connect the specified standard at the specified port, and press the Start button after the connection is made.

After executing the calibration of one standard part, the instrument will prompt to connect the next standard part, just follow the prompts until all the calibrations are executed.

For S11 and S22 calibration, you can choose to skip the load calibration (by pressing the SKIP button) after performing the open-short calibration.

After completing the second step, the instrument processes the calibration data until it indicates that calibration is complete and automatically returns to the test interface.

The parameters of the calibrator must be set in advance in the FUNC menu.

Once the calibration is complete, if the calibration may be used again at a later date, you can use “SHIFT+.” to store the user calibration in the TF card. Use SHIFT+0 to recall in the future use, and the instrument settings will revert to the calibrated state after the recall.

4.4, Calibrator

Calibrator,serves to produce some mathematical effect that facilitates the instrument's ability to solve for its own (and the test system's) error parameters. In the actual measurement, the instrument can then eliminate the test error based on the error parameters and bring out the true measured.

4.4.1, SOLT calibrator

SOLT calibration is the most classical calibration method. There are 4 pieces of SOLT calibrators, which are:

S: short, short-circuiting calibrator, providing total reflection with known phase shift (usually close to 180°);

O: open, open-circuit calibrator, providing total reflection with known phase shift (usually close to 0°);

L: load, matching the load calibrator, providing full absorption with zero reflection;

T: through, thru, straight-through calibrator, provides known delay and almost zero loss.

The actual calibrator is not likely to be completely ideal. In addition, there is a certain distance between the interface of the connector, or the phase reference plane, and the reflecting plane. Even with an ideal calibrator, there will be a phase shift during calibration. These undesirable quantities must be told to the instrument prior to calibration. The quantities include:

(1) The electrical length of the calibrator, which brings about a phase shift. The electrical length is generally expressed in units of length, and can also be expressed in terms of time delay since the electric wave propagates at a certain speed in the calibrator.

(2) The loss of the calibrator, which brings about a change in amplitude. The loss can be expressed in dB. But because the loss is related to frequency, expressed in dB, the instrument must be told the corresponding frequency, by the instrument according to the relationship between loss and frequency (about proportional to the square root of frequency) to calculate the loss curve. Another way is to tell the instrument the skin effect resistance per unit time delay at a certain frequency, in GΩ/s.

(3) The terminal reactance of the calibrator, which also introduces a phase shift. Usually only the terminal reactance of the open short circuit is taken into account and a polynomial fit is used in the representation. For an open circuit, its terminal capacitance can be expressed as:

$$C(f) = C_0 + C_1 f + C_2 f^2 + C_3 f^3$$

For a short circuit, its terminal inductance can be expressed as:

$$L(f) = L_0 + L_1 f + L_2 f^2 + L_3 f^3$$

The above $C_{0\sim3}$, $L_{0\sim3}$ are the polynomial coefficients that need to be told to the instrument and the instrument will automatically calculate their impact.

The straight-through calibratoris more special. It is usually recommended that the terminals of the test cable are male and female, so that after connecting, the phase shift is zero, no straight-through calibrator, the parameters of the straight-through calibrator in the instrument can be set to 0. If the male and female are not directly connected, it is necessary to use the physical straight-through calibrator, usually for the air line, which is quite troublesome. For simplicity, the straight-through calibrator can also be supported, but then there will be dielectric loss and some reflection loss, with more parameters, which are usually approximated by the loss of the specified frequency in engineering, or another way (for example, using a calibration model that supports unknown straight-through, but cannot cross octave, which is not convenient for broadband testing).

The manufacturer of the calibrator will usually give the electrical length, loss, and terminal reactance, or at least the electrical length, as required. Based on these parameters, the instrument calculates the actual "known quantity" of the calibrator at any frequency for calibration purposes. If a parameter is not given by the manufacturer, enter a 0 in the instrument and do not enter it speculatively. Entering a zero will only result in a larger measurement error, which is acceptable at lower frequencies.

When entering the calibrator parameters, pay attention to whether the manufacturer gives a single-range or dual-range value, and convert it if it is different from the requirements of the instrument. The electrical length of KC901 is a single-range value, and for the reflection calibrator , the loss parameter is a dual-range value.

KC951011 is a universal calibrator provided by our company. The user can also choose other appropriate calibrator. KC951011 has a nominal length of 5.256mm (one way), if you choose another calibrator, you need to enter the actual length, loss and terminal reactance in the "Cal kit data" field in the FUNC page of the instrument.

When attaching the calibrator to the instrument, tighten it with the maximum force that can be achieved when held between the thumb and index finger **tips.** If a torque wrench is used, the recommended torque is 1.35 N-m.

The calibrator is a valuable test accessory and needs to be used with care, stored properly and inspected regularly. Before calibration, be sure to inspect and clean the connector to avoid damaging the calibrator.

4.4.2, TRL calibrator

TRL calibration is generally used for non-coaxial measurement situations. For the KC901x calibration model, it needs to provide three calibrators:

(1) Straight-through, where two ports are connected together either directly or through a connector that is never removed, preferably male to female, using a planar type connector or a waveguide direct connection. Therefore, the straight-through calibrator may not be present, and if it is, then it cannot be removed for subsequent calibration and testing.

(2) Reflection or isolation, where both ports are reflected through a short.

(3) Transmission line, also called unknown straight through, connecting two ports together with a straight-through piece that meets certain conditions, the electrical length of the straight-through piece shall not be close to or equal to an integer multiple of one-half of the wavelength of any test frequency, and the loss shall be as small as possible.

For the waveguide test system, only a shorting plate and a straight waveguide of suitable length are required.

It is not necessary to enter the parameters of the TRL calibrator into the instrument as long as the above rules are followed.

TRL calibrator usually need to be homemade, and it is recommended to consult the information on TRL calibration for details.

4.5、Calibration before reflection test

If only reflection testing is required, such as testing the standing wave and impedance of an antenna, then you can calibrate only one port (select S11 or S22 when choosing a calibration item).

User calibration should be performed in the following cases:

1. Acceptance testing of important equipment. (For example: radio and television transmitter antenna).

2. The port to be measured cannot be directly connected to the instrument and must be connected through an additional cable.

After calibration, pay attention to check the correct position of the curve when open circuit and connected to load, if there are obvious abnormalities, it should be recalibrated. In VSWR mode, the curve should be above 20 when open circuit, and below 1.05 when connected to the calibration load.

Warning

When calibrating at the remote end of the external cable, if the electrical length of the external cable is more than half of the wavelength corresponding to the frequency step (STEP), it is necessary to increase the number of scanning points (or reduce the

SPAN) before calibrating in order to avoid phase overlap. For example, if a step of 3MHz is converted to a wavelength of 100m, the external cable cannot exceed 35m (electrical length = actual cable length / speed factor), otherwise do not use a step as large as 3MHz. Frequency step (STEP) = frequency span (SPAN) ÷ (number of sweep points - 1), shown in the marker(cursor) bar above the display.

During the reflection test, the total loss between the instrument port and the calibration plane should not exceed half of the absolute directionality of the instrument (expressed in dB), and should normally be left with a margin of 6dB or more, otherwise it cannot be calibrated. Specifically, it is recommended that the cable loss be less than 6dB.

Select "**Re CAL**" in S11/S22 mode, and follow the steps prompted by the instrument.

In some cases, the part to be tested is a printed circuit board or some electrical appliance that cannot be connected to the instrument with a coaxial connector. In this case, the end of the test cable needs to be stripped and soldered directly to the part to be tested. In such cases, the cable can be calibrated with an open and short circuit before it is connected to the part to be tested. For short-circuit calibration, the cores at the end of the coaxial cable are soldered to the shield; for open-circuit, they are separated and suspended. When the instrument prompts for Load calibration, select “Skip” on the soft menu. In this case, the electrical length of the calibrator should be set to 0.

Note

For the case of larger SPAN, after S11/S22 reflection calibration, if the test port is open or short-circuited, the curve should not converge to the far right or left side of the Smith chart, but should start from the far right or left side and spread clockwise along the outer circle of the Smith chart. If it converges to a point, it usually indicates that the calibrator parameters are set incorrectly. For details, please refer to the relevant application guide (KC document number 861016).

4.6. Calibration before transmission (S21/S12) measurement

In practice, it is often necessary to test only the transmission parameters, without paying attention to the reflection parameters. However, the DUT is definitely reflective, and the calibration model needs to know the reflection parameters in order to eliminate the errors caused by multiple reflections between the DUT and the instrument (which usually make the curve ripple) and get the most accurate transmission parameters possible. Therefore, strictly speaking, a full two-port calibration should be performed even though in many cases only the transmission parameters need to be tested.

If the requirements are not particularly stringent, it is allowed to simplify the calibration process by performing only frequency response calibration or enhanced response calibration.

Enhanced Response Calibration (E-RES) requires reflection calibration of one port (instrument output port) and performs a dual-port response calibration. That is, calibrate one port using short-circuit, open-circuit, and load calibrators, and then connect both ports. Total 4 steps. If the test interface polarity does not match, a straight-through calibrator (air line) should be used to connect the two ports; if the polarities match, the males and females are connected directly without the need for a calibrator. In order to reduce the reflection from the input port, a 3~10dB attenuator with good performance should be connected in series with the input port during calibration and testing, and the common attenuation amount is 3dB.

The enhanced response calibration meets the needs of most situations and is not particularly cumbersome because it eliminates the need for a port reflection calibration.

If the requirements are not so stringent and the port reflection of the device under test is small (standing wave less than 2), then only frequency response calibration can be done, i.e., using a straight-through calibrator(same polarity), or connect directly male and female to the test port and perform a calibration. Frequency response calibration is much more concise with only one step. However, frequency response calibration cannot eliminate the effects due to device reflections and port reflections. Such errors that cannot be eliminated cause the S21 test results to fluctuate periodically, with the period of fluctuation depending on the external cable, the electrical length of the part to be tested, and fluctuations that can sometimes exceed 3dB. To reduce such fluctuations, a 3dB attenuator can be connected in series with each of the output and input ports. Although the series attenuator can reduce the error, but will lose dynamic range.

Calibration Operations

If the device to be tested is light and small, allow one port of the device to be tested to be connected directly to the instrument. In this case, only one additional RF cable is needed to compose the test system.

For cases where one cable is used, this cable should be connected directly across the two ports of the instrument (Figure 4-1) and perform a **user calibration** operation before the test begins. If two cables are used and the connectors cannot be directly docked, connect them together with a connector of **known electrical length** (usually air wire) and then straddle the two ports of the instrument (Figure 4-2) and perform the user calibration.

Figure 4-1: Calibration connection when testing with one cable

Figure 4-2: Calibration connection when testing with two cables

If there are multiple cables in series in different places in a system, they can all be connected in series for a single calibration.

When testing power amplifiers, an attenuator should be connected in series with the output port of the amplifier to avoid high power entering the instrument. For small signal amplifiers, the output level of the instrument should be reduced (with the internal attenuator turned on), and if it is still not low enough, an attenuator should also be connected in series at the input of the amplifier to avoid too strong excitation signal. All attenuators and cables should be connected in series to perform the calibration operation.

To begin user calibration, select the "Re CAL" option in the Function menu and follow the prompts.

The parameters of the calibration parts (or connector with known electrical length) **must be set in the FUNC menu**. By setting the electrical length of the calibrator into the instrument, the instrument can automatically deduct the phase shift of the calibrator. For test systems with multiple cables and connectors, the electrical length of the straight-through calibrator in the FUNC menu should be set to offset of cable length between measurement and calibration.

If the frequency range is reduced after calibration, the calibration data will be interpolated and the accuracy will be reduced. If the changed frequency is out of the calibration frequency range, the system calibration parameters will be used automatically, while prompting for no user calibration.

4.7, Cable compensation (extension)

In order to connect the instrument to the item under test, some feeder line is usually required. When there is no condition to calibrate the end of the feeder, you can use the system calibration or perform user calibration on the port of the instrument, and then, use the port extension function to eliminate the influence of the cable. This method is less accurate than calibrating at the end of the cable, but better than not calibrating at all.

4.7.1, Manual port extension

Please strictly test the electrical length of the cable according to the method described in section 5.3. If the speed factor of the cable is known, the electrical length can also be calculated from the mechanical length of the cable, but it is not as accurate as the measurement in the field.

When the cable is connected to the antenna, the terminal cannot be opened and short-circuited, you can also measure the electrical length according to the method in section 5.4, and the frequency band with a stable trend of phase change and as straight a phase frequency characteristic curve as possible should be selected for measurement. This measured electrical length usually extends to the feed point of the antenna, more effective for antenna debugging. If you can calibrate at the end of the feed cable, you can still use this method to extend the phase plane to the feed point.

Press the **FUNC** button to enter the system setup interface, in the middle of which there is a "**Cable related parameters setting**" section, and "**Cable length**" is entered according to the measurement results above.

The "**cable attenuation**" is the one-way attenuation of the feed cable at the "**cable frequency**". The best way is to use the S21 function to test the cable attenuation, but since it is not possible to calibrate at the other port, it is usually impossible to perform the S21 test, which should be entered according to the data provided by the cable manufacturer. It can also be measured with the S11 function when the remote end is open/short, and the curve, if fluctuating, takes the wave peak with less attenuation near the final desired measurement band, noting that the reading should be divided by 2. When the "cable attenuation" is not clear, set to 0.

Once the "cable-related parameters" are set, the instrument will eliminate the influence of the cable as much as possible. After the test, the parameters should be zeroed in time to avoid causing errors.

The cable parameters are also valid for S21 measurements.

4.7.2, Automatic port extension

Later software provides automatic port extension function, you can find "port extension" option in the mode menu of S11 or S22, press it to enter the port extension menu, press ON/OFF to turn on or off the extension; press the extension key and follow the prompted steps to collect the necessary data. If the cable is connected to the measured part, the automatic port extension may be wrong, and the end of the cable should be suspended before extension.

4.8、Use of external coupler

Press **SHIFT+7** in the **FUNC** menu to enter the advanced setting interface, and set the "**Coupler Selection**" to "**External Coupler (EXT)**". At this point, the input of the external coupler should be connected to port 1 (left side), and the feedback of the external coupler should be connected to port 2 (right side), or vice versa. It is recommended to connect an attenuator in series to improve matching. If the external coupler input is connected to port 1, the S11 function should be used for measurement, otherwise the S22 function should be used. User calibration must be performed before testing.

The use of an external coupler with better indicators than the internal coupler improves the accuracy of reflection testing.

Chapter 5 Common Test Methods

This chapter gives a few examples, users can practice, experience and understand against it.

5.1. Preparation before testing

(1) Confirm the battery level before using it outside. Let the device run and observe the voltage indication, if it is above 8.0V, it means there is still at least half power left. In order to avoid forgetting to turn off the device to drain the battery, it is recommended to set automatic shutdown. Please bring the charger when you work for a long time. After verifying in advance that the "cell phone charger" can charge the instrument, you can also use it to supply power, paying attention to compatibility. Every 50Wh of power can extend the battery life by about 3 hours.

(2) If you work in the field a lot, especially when you are likely to encounter rainfall, water, etc., please use a waterproof suitcase or plastic bag.

(3) Please prepare sufficient attenuators when you may test amplifiers and transmitters. When the measured signal is likely to be larger than the tolerance limit of the instrument, be sure to connect the attenuator in series.

(4) In the radio and television tower and other antenna concentrated place test antenna, please use the terminal power meter to test the induction power of the antenna to be tested, shall not be greater than 0.1 W. When multiple sets of antennas are concentrated on the tower, some antennas are transmitting, the strong transmitting power through space coupling, may induct several watts of RF power on the antenna to be measured, which is bound to damage the instrument..

(5) When testing antenna near high voltage power line and substation, please use AC voltmeter to test the induced voltage of the port to be tested first, it should not be more than 15V. and the shield of coaxial line should be grounded.

(6) If you want to use the probe to test the RF signal on the board, please take care

to connect the outer shield of the test cable and the housing of the instrument, to the ground of the board first. Floating tests are dangerous and can damage the 901x and can burn out the board to be tested.

(7) The test of passive devices can be performed in the charging state, and the test of active devices should not be performed. If you insist on performing such a test, please take care to connect the ground of the 901x (the housing of the coaxial connector) to the ground of the device to be tested at equal potential. Prevent damage because the instrument and the device to be tested are not equipotential.

(8) If you need to climb high to test, please prepare enough strong safety rope and packing bag to prevent accidental fall. When there are people working on the tower, a warning area should be set up under the tower.

5.2、Adjustment of duplexer

The duplexer is an important part of the repeater, and its insertion loss and isolation affect the overall performance of the repeater. The KC901x (except 901B) provides better than 100dB operating range in common VHF/UHF bands, and the duplexer can be adjusted to the best condition under its monitoring.

Accessories to be prepared: one 50 Ω dummy load, two RF connection cables, one 6dB attenuator, and the necessary RF adapters.

It is recommended that the KC901x be fixed to the workbench.

Commissioning tools: screwdriver to match the duplexer adjustment screw, wrench to match the lock nut. If possible, fix the duplexer to be adjusted to the workbench.

Here is an example of a six-cavity duplexer with the notch filter principle to introduce the commissioning steps.

(1) Press HOME key, set KC901x to S21 mode, press CENTER and SPAN keys to set the frequency so that the frequency band covers the two original frequencies and two new frequencies of the duplexer. For example, the original frequency of duplexer is 451.5MHz and 461.5MHz, need to be tuned to 430.8MHz and 439.8MHz, then the instrument should be set to cover 430MHz~462MHz, for easy to observe the trend, it can be wider, for example 425~465MHz (CENT: 445MHz, SPAN: 40MHz). But it should not be too wide, otherwise more sweep points will be needed in order to STEP

to meet the debugging requirements, and the curve refresh speed will be slow.

(2) Press FUNC key, check the excitation gain setting, set it to +20dB; set RBW to 10kHz and sweep points to 401 points. +20dB is a larger excitation gain, the instrument has high output power and high dynamic range, suitable for adjusting duplexers such as more than 80dB notch filter. 401 sweep points, can ensure that STEP is small, the above example, STEP = 40MHz ÷ 400 = 100kHz.

(3) Press SCALE to set the reference level to make the topmost coordinate is 0dB or 10dB and the coordinate span is 10dB/div. Move mark1 and mark2 to the new receiver frequency and transmitter frequency near the duplexer respectively.

(4) Due to the selected S21 function, port 1 of the instrument is the output port and port 2 is the receive port. Short the two ports with two cables and adapters to perform enhanced response calibration. After calibration, gently shake the connecting cables and connectors to see if there is any jitter in the curve and confirm that there is no poor contact. The insertion loss of the cable should be as small and stable as possible. The cable quality should be good enough to provide good shielding. You can disconnect the two cables so that the connectors are away from each other and see where the noise floor of the instrument is located. It should be -90dB at 450MHz.

(5) Clean the socket of the duplexer, connect port 1 to the TX input port of the duplexer (generally labeled high), connect port 2 to the ANT (antenna) port of the duplexer, and connect a dummy load to the remaining RX output port (generally labeled low). (Figure 5-1)

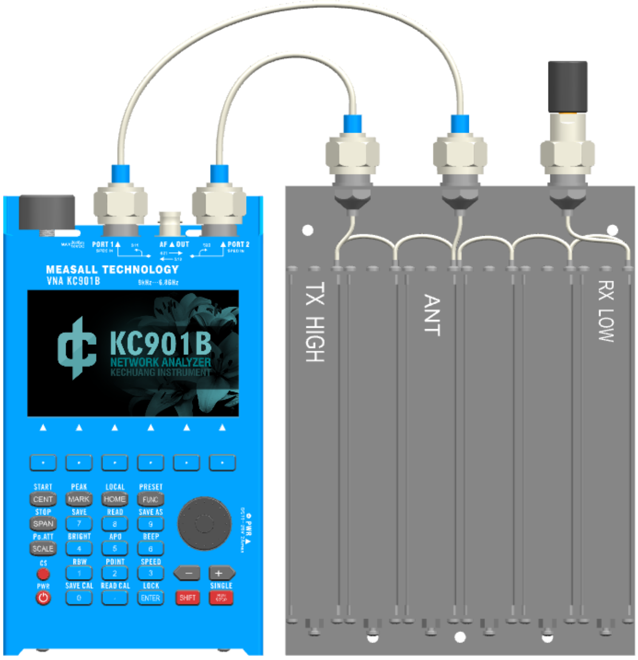


Figure 5-1: Example of test duplexer connection method

(6) Adjust the three screws near the TX port so that the wave valley moves to the position indicated by mark1 and overlaps as much as possible. Fine tune the screws in turn under mark1's S reading monitoring so that the reading is the smallest (most negative). Under normal conditions, it should reach -70dB or more. At this point, mark1 indicates the HIGH side isolation, and mark2 indicates the HIGH side insertion loss.

(7) Connect port 1 of the KC901x to the ANT port of the duplexer, port 2 is connected to the RX port, and the TX port is connected to the dummy load. Adjust the three screws near the RX port side so that the trough moves to the mark2 position and overlaps as smoothly as possible. Then, under the monitoring of mark2's S reading, repeatedly fine tune the three screws from the center to the RX side so that mark2's reading is minimal and should reach -70dB. At this point, mark2 indicates the LOW side isolation and mark1 indicates the LOW side insertion loss.

(8) Re-connect according to the method in step (6) and observe whether the curve is deteriorated. If there is deterioration, it means that there is mutual influence between the sending and receiving sides, so you can fine-tune it again. Similarly, you can also repeat step (7).

The duplexer has a huge amount of notch level and very little compression of the non-limiting frequencies. A small IF leakage and IF feedthrough can affect the dynamic range of the instrument. Therefore, if necessary, try to switch the local oscillation mode and choose the one with the lowest bottom of the curve. When commissioning the left and right parts of the duplexer, different local oscillation modes may be required.

The above steps simplify the calibration, mainly to improve the work efficiency. If you have plenty of time, you can also perform full duplex port calibration before debugging, and switch the function to observe the four S parameters. For the common duplexer, usually just tune S21, S11 on it, there is no need to carefully adjust each S parameter.

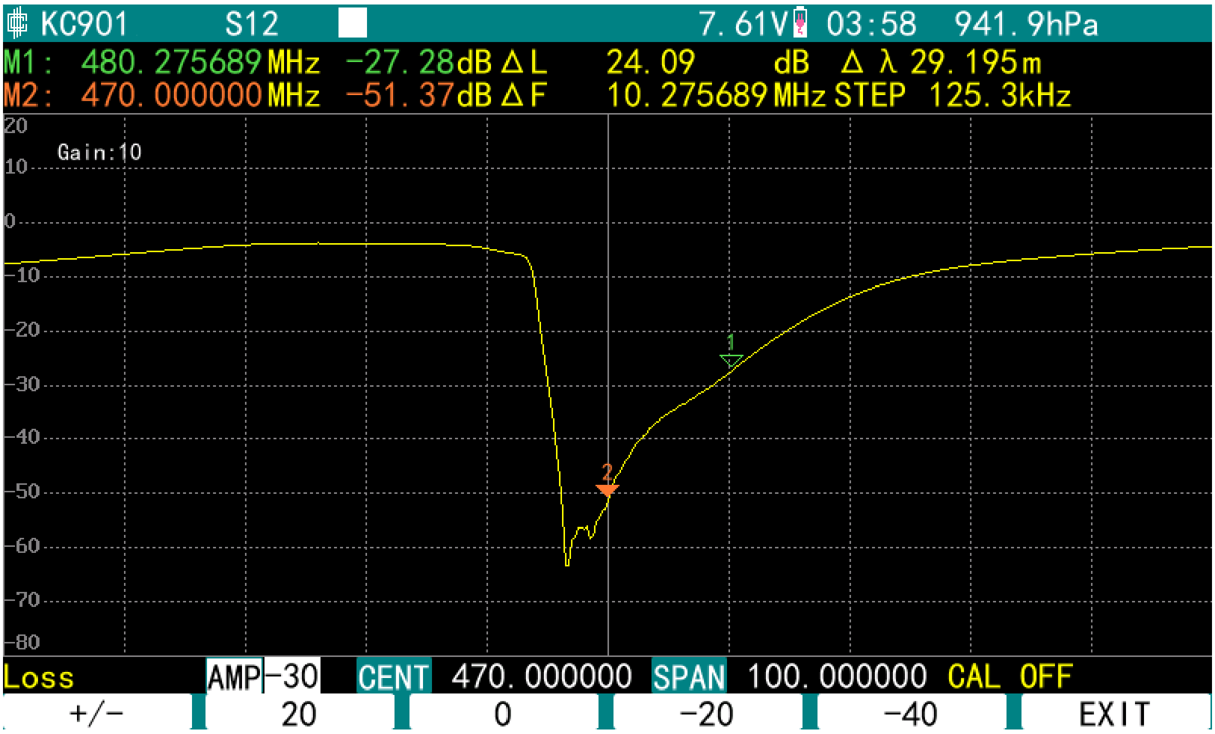


Figure 5-2: Typical curve of the LOW side of the duplexer, without compensation for cable loss

Do not tune the duplexer rejection curve too sharply. You can reduce the SPAN to 2MHz and look carefully at the bottom of the curve, which should have a width of 100kHz or more. If the curve is too sharp, the tip may drift outside the used frequency when the temperature and the matching condition of the antenna change.

When there is a conflict between insertion loss and suppression (isolation), the suppression of the RX side should be given priority. The transmitting power of the repeater should be reduced to lower the suppression requirement, and the principle of "TX inward and RX outward" should be followed to try to take into account the insertion loss.

If the insertion loss remains high, consider the S11 test (non-test port connected to a dummy load, should not be connected to the instrument input port) and try to adjust it to do a balance with other indicators to control the SWR to within 1.5. If always bad, or screws need to enter a long, may need to repair or modify the duplexer.

Tighten the fixing nut gradually during the adjustment process to make the parameters fixed.

Note

The rejection characteristics of the duplexer are strongly influenced by the port matching, and the results will vary slightly when measured with different instruments. Switching the connection relationship between the instrument and the duplexer port, the measured results will also be slightly different. And the impedance of different repeaters and antennas are also different, and the actual performance is poorly matched with the expectation. For the first time debugging, we need to summarize the experience according to the actual performance after installing the repeater.

As long as the dynamic range allows, a 3dB attenuator can be connected in series with the input port of the instrument to improve matching.

5.3 Test Antenna

Warning

The output port of the KC901x may produce more than 0dBm (1mW) and the KC901B may exceed 13dBm. When testing the antenna, the output of the 901x will be emitted over the air through the antenna and may cause harmful interference to other radio services. Reducing the excitation gain (setting **RF GAIN**) can reduce the emission, and recalibration (**Re CAL**) is recommended after the reduction.

5.3.1, Antenna standing wave test

Set the instrument in S11 or S22 mode and adjust the display (Format) to VSWR.

Set the CENT and SPAN to cover the desired test frequency. The setting of scanning points depends mainly on the size of SPAN and the bandwidth of the antenna, generally 201 points are enough. For multi-frequency narrowband antenna (such as "UV dual-band" antenna), because the SPAN needs to be set to hundreds of MHz or larger, and the antenna bandwidth is only a few MHz, it needs a small STEP to correctly show the working point, then need to increase the number of points, such as 1001 points or more. For this case, it is generally recommended to test in sections.

VSW is a scalar parameter, if the feed line loss is small and the data accuracy requirement is not high, the system calibration can be used directly. If the feed line is longer or requires higher test accuracy, the end of the feed line connected to the antenna should be disconnected and the feed line should be included for user calibration.

Connect the antenna under test to the corresponding port and the tester away from the antenna.

The antenna standing wave is related to the site environment. If there is no dark room that meets the requirements, you can choose an open outdoor environment, such as a rooftop.

Note

For unbalanced antennas, such as whip antennas, the feed line and the housing of the instrument may become part of the antenna. When testing unbalanced antennas, appropriate fixtures must be used to stabilize the test environment, such as using a large metal plate as a reference ground. Do not connect the whip antenna directly to the instrument for testing. Refer to the application guide (KC document number 888909) for details.

The 13.56 MHz antenna commonly used for RFID is almost impossible to connect directly with the instrument. At this point, you can DIY a small loop antenna, and then measure the standing wave of this small loop antenna. With a small loop antenna close to the RFID antenna, the standing wave will change. Properly summarize the experience, you can judge the performance of the antenna under test according to the change of the standing wave.

5.3.2, Cable deduction

When testing the antenna, sometimes it is not possible to calibrate the antenna at the port of the antenna, thus the influence of the feed line cannot be dispelled automatically. At this point, if you wish to know the reflection parameters of the antenna itself, you can enter the parameters of the cable in the instrument, and the instrument can deduct the cable.

Under the FUNC menu, there are two setting items "Cable Length" and "Cable Attenuation". The cable length is equal to the actual length of the cable divided by the speed factor. The cable attenuation can be estimated by combining the cable length with the attenuation per unit length given in the cable technical manual.

Both of the above items, refer to one-way parameters.

Cable deduction operation is generally only applicable to lower frequencies, e.g. below 30MHz. Whenever possible, user calibration should be performed at the remote end of the cable so that the effects of the cable can be accurately eliminated by the instrument.

If the feed line cannot be disconnected from the antenna, the automatic port extension function may be interfered by the antenna and not work correctly.

5.3.3, antenna impedance test

KC901x calculates the impedance of the antenna by testing the amplitude difference and phase difference of the incident and reflected signals. Since the amplitude difference and phase difference are related to the feed line, **user calibration must be performed at the feed point or at the end of the feed line**.

For printed circuit board antennas, if there is no coaxial interface, a thin coaxial cable can be used to lead the interface from the circuit board. It should be calibrated before measurement, and when the instrument prompts to connect open and short, the end of the thin coaxial cable should be opened and shorted according to the prompt. Then, skip (SKIP) the load calibration.

The impedance of the antenna is greatly influenced by the antenna installation environment. When testing, the antenna should be made as close to the use environment as possible. For the antenna installed on the intercom, router and other equipment, because it is working with the shell of the equipment, in the test must include the shell. For example, when testing the router antenna, should be tested together with the router host, disconnect the original feed line from the router internal, and then lead another test cable for the antenna, test cable near the antenna end to pass through the magnetic ring. When calibrating, this part of the cable should be included.

At lower frequencies, if it is not possible to include the cable for calibration, the electrical length and attenuation of the cable can be set in the FUNC menu in order to deduct its effect. When the frequency is higher (e.g. 2400 MHz), this method is not reliable.

5.3.4, Simple test of antenna gain, directional map

Using the S21 (or interpolation loss) function of the 901x with another set of antennas, you can test the horizontal directional map or front-to-back ratio of the antenna; if there is another set of antennas with known gain, you can test the gain of the antenna.

Test environment: dark room or standard test field. As an engineering test, a horizontal open field with dimensions larger than 20 times the wavelength is recommended. For antennas in bands above UHF, a flat roof is also acceptable.

Equipment: two antenna brackets, one of which has a turntable on top. The height of the antenna bracket should be in line with the design conditions of the antenna, in principle, greater than 2 working wavelength. The distance between the two brackets is better than 10 times the working wavelength (such as shortwave antennas and other antennas with very long working wavelength, the appropriate distance reduction is allowed). If necessary, you can do multiple tests at different distances, take the linear average (can not directly average the decibel value), in order to eliminate the impact of ground reflection. According to the distance of the bracket, prepare a long enough cable, try to make the instrument and testers up to 10 times the wavelength from the antenna. In addition to the antenna to be tested, another test antenna needs to be prepared, preferably a directional antenna. If you need to test the gain, you need to prepare another reference antenna with known gain.

Method: Mount the test antenna and the antenna to be tested on the bracket (Figure 5-3). The main flap of the test antenna should be aligned with the antenna to be tested. First make the antenna to be tested in a certain direction (expected main flap direction or mark a direction) to align with the test antenna, set the instrument to S21 mode and input the test frequency. Generally choose a small span, e.g. 1MHz, and perform frequency response calibration in S21 mode to bring the curve to zero. Rotate the antenna to be tested at certain angle intervals and record the S-parameters (dB number) corresponding to each angle. Finally, trace the points on the angle-gain coordinate map to get the directional map of the antenna under test.

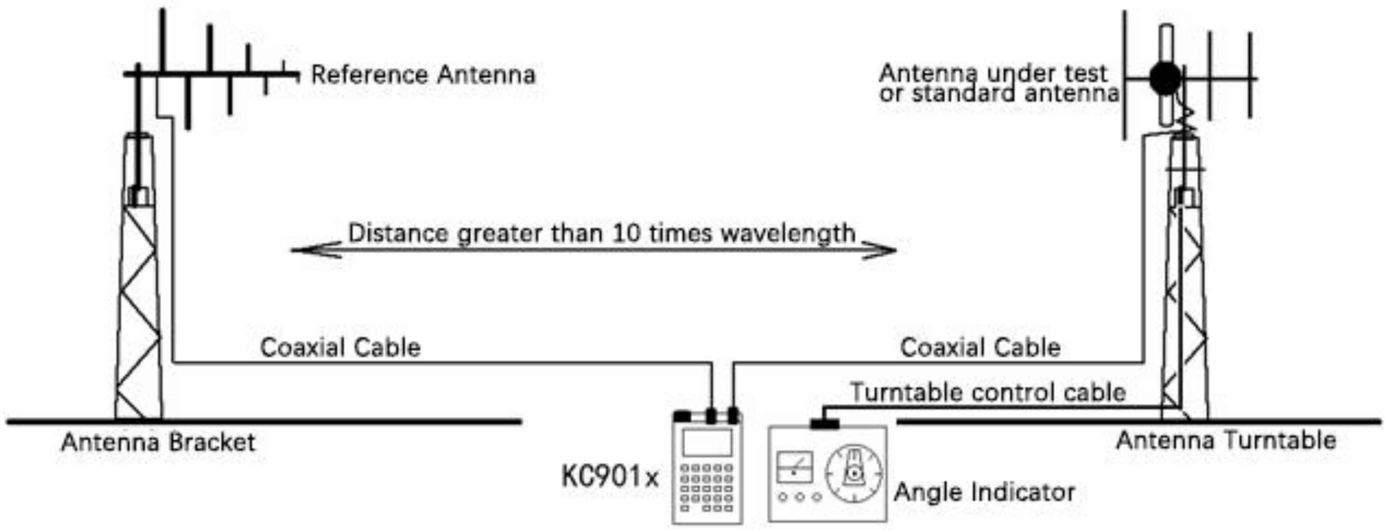


Figure 5-3, Measure antenna gain in open field

The above test can also be done using the insertion loss test mode. First enter FIELD mode, select the Insertion option to start the insertion loss test, and then press the Aoto CAL button to zero the insertion loss reading. The insertion loss value readings and S21 mode S parameter readings have the same meaning.

During testing, the SHIFT+1 key combination operation can be used to save each measurement for post-analysis. To reduce the complexity of operation, KC901x automatically names the files in chronological order. If there are more files that are easily confused, SHIFT+3 can be used to store them, at which point the file names can be manually specified.

If you want to test the gain of the antenna, you need to set up the reference antenna with known gain to the antenna bracket to be tested, adjust the orientation of the reference antenna and the test antenna (make the direction of the reference antenna with the given gain to the test antenna), and then perform the frequency response calibration in S21 mode. Then keep the setting parameters of the instrument, replace the reference antenna with the antenna under test, test and record the S parameters of its rotation at different angles. At this time the measured parameters plus the gain of the reference antenna, that is, the gain of the antenna at different angles.

If you need to measure the directional map and gain for multiple frequencies, you can repeat the above steps at different frequencies.

The frequency cannot be changed during a test, otherwise the user calibration will fail and the data will lose its relative meaning. When testing, personnel should stay away from the antenna, if you need to manually rotate the antenna to be tested, you should wait until the rotation is completed and the personnel leave the antenna before reading the data.

The use of two KC901x, one of which uses the signal source mode and the other is set to FIELD mode, can constitute a single frequency point of scalar network test system for two antennas far away from each other. One of the 901x used for transmitting, can also be replaced by a transmitter with better power stability. Since the isolation in this way is better than the internal isolation of a single instrument, and the feed line can be shorter, it can meet certain test applications that require large dynamic range (by the same token, if you do other tests that require large dynamic range, you can use a computer to control two KC901x at the same time).

5.4, Measurement of the electrical length of transmission line

The KC901x can be used to accurately measure the electrical length of a transmission line when it is terminated in an open or short circuit. Adjust to the reflection (S11) mode, calibrate on the instrument port, access the transmission line to be measured, adjust to the phase frequency characteristics (PHASE) display, take the section of the curve with smooth curve and obvious periodicity, measure the length of the frequency **difference** ($\Delta\lambda$) experienced when the phase rolls exactly one circle (the frequency difference between the two cursors is close to 0 degrees), and divide by

2 to obtain the electrical length of the transmission line. It is also possible to measure the length of the frequency difference experienced at a phase shift of 180 degrees and divide it by 4, or measure the length of the frequency difference experienced at two 360 degrees and read the result directly.

The smallest possible SPAN needs to be used so that the curve in the display area goes through approximately 1~2 cycles in order to obtain a high distance resolution.

Another approach is to switch the display mode to group delay and read out the time delay, thus calculating the electrical length (the reflected group delay is a two-way value). Care should be taken to choose a smaller SPAN or a larger number of sweep points to avoid phase aliasing.

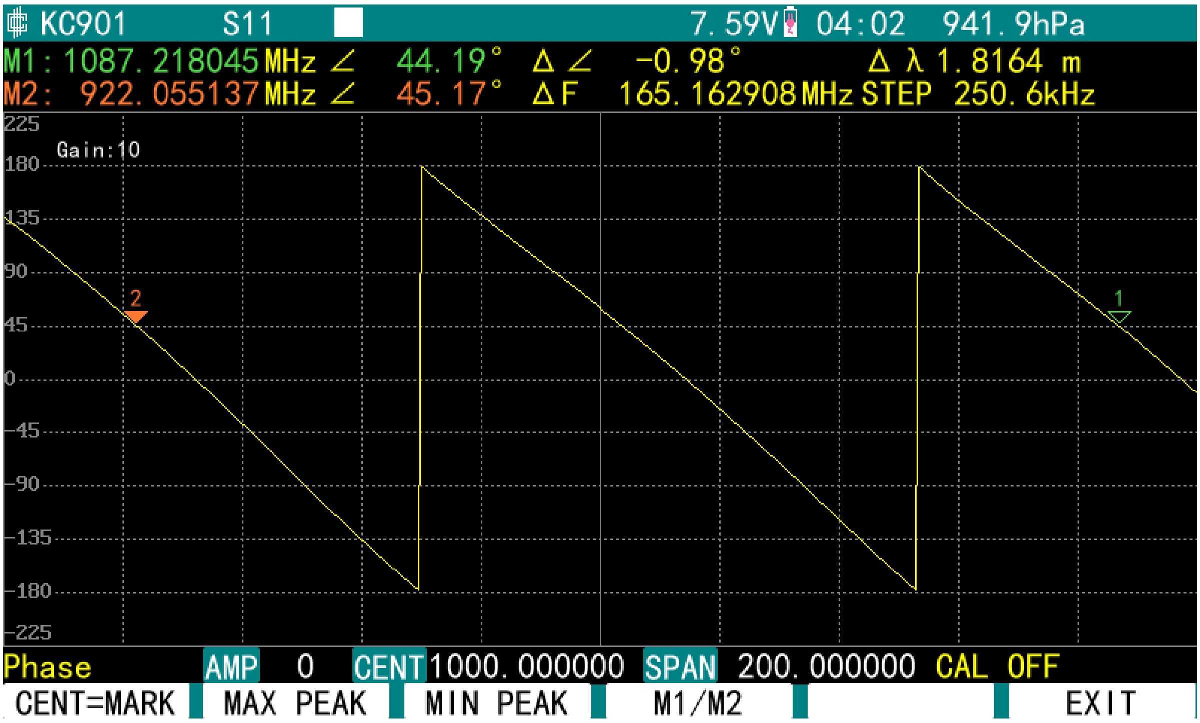


Figure 5-5. Measuring the electrical length of the cable in the phase frequency characteristic display

If you connect a transmission line to be tested via an adapter cable, you need to perform user calibration at the end of the adapter cable, and the cable length compensation in the FUNC menu must be set to zero at this time.

Figure 5-5 shows a typical curve when measuring the electrical length of the cable. The electrical length of this cable is 1.8164m and the actual length is known to be

1.357m, which can be calculated as a speed factor of 0.7471.

In the case of an open or short circuit at the termination of the cable, the cable loss is approximately equal to one-half of the return loss. The return loss at the non-operating frequency of the antenna, when the cable is connected with an antenna, can be used to initially assess the magnitude of the cable loss.

5.5、Spectrum display

The KC901x uses a base-wave mixed superheterodyne receiver and therefore provides a simple spectrum display.

⚠ Dangerous

The allowable limit level of the input port of the 901x is +20 dBm and the limit DC voltage is 15 V. If exceeded, the instrument will be immediately damaged. When testing the transmitter or amplifier, sufficient attenuators must be connected in series, using a straightener if necessary, so that the input does not exceed the limit under any unexpected circumstances.

ℹ Note

Limit level +20dBm is the maximum level of the instrument without damage, does **not mean that the signal can be tested accurately at that level**. For accurate testing, except for the 901B, the input level should be no greater than 3 dBm. for the 901B, it should be no greater than 13 dBm.

901x is a network analyzer, the spectrum will appear false response, test results are for reference only.

The 901x spectrum mode is subject to mirroring interference. If used for monitoring, it is recommended to connect an appropriate narrowband filter in series with the input port. When testing the shortwave spectrum, use a low-pass filter (KC9504.02) with a cutoff frequency of 30MHz and more than 80dB rejection at 110MHz, connected in series at the input port, to filter out mirror image interference and IF feed-through interference. Above 300MHz, the **Local Mode** can be used to identify the mirror response. If there is IF feed-through interference, a 110MHz notch filter or an appropriate narrowband preselector should be connected in series.

At a distance of 0.7 MHz from the main peak of the measured frequency, a peak of the second mirror interference may appear, which is about 40 dB lower than the main peak. The false peak can also be judged by switching between high and low local oscillations.

If the frequency range is narrow, narrowband antenna should be used as much as possible. Set CENT, SPAN according to the frequency span to be measured. Set the reference level according to the strength of the signal to be measured (in the SCALE menu). The fourth generation KC901x has no IF attenuator, and the setting of the reference level does not affect the sensitivity of the instrument.

Since the network analyzer is discrete scan, if STEP is large, signals between sweep points will be missed. To avoid omissions, use a smaller SPAN, more sweep points, and a larger analysis bandwidth (RBW) so that the frequency step (STEP) is smaller than the analysis bandwidth (RBW).

5.6, Locating the source of interference

In the band without mirror interference, you can use KC901x with directional antenna to find the source of interference by the large tone point method.

After entering the spectrum mode, set CENT to the frequency where the interference is likely to occur and SPAN to a smaller value (e.g. 1MHz). Adjust REF so that the noise floor is located near the bottom of the display area. Adjust the antenna pointing and polarization method to find the interference signal until the largest bump appears in the center of the spectrum. The azimuth of the antenna pointing is measured with the magnetic compass, and traced on the map as a directional line. Change the test location and measure again, and trace another directional line. The intersection of the two lines is the most likely location of the interference source.

The line connecting the two test points should try to maintain an angle of 30° to 60° with one of the lines, 45° is best, but 60° is acceptable to reduce maneuvering (Figure 5-4).

The test point should be as high as possible, avoiding obstructions. Move in the direction of the strongest interference signal and gradually approach the source of the interference. In general, the measured amplitude should be above 70dBμ (-37 dBm) when close to the interference source.

A bandpass filter connected in series between the antenna and the instrument can greatly improve the test confidence. This filter is usually a spiral or cavity structure, and its passband frequency can be adjusted under the monitoring of KC901x before use. Since the **fourth generation KC901x has lower sensitivity than the third generation**, when testing weak signals, a low noise amplifier (KC9601x) can be connected in series between the filter and the instrument.

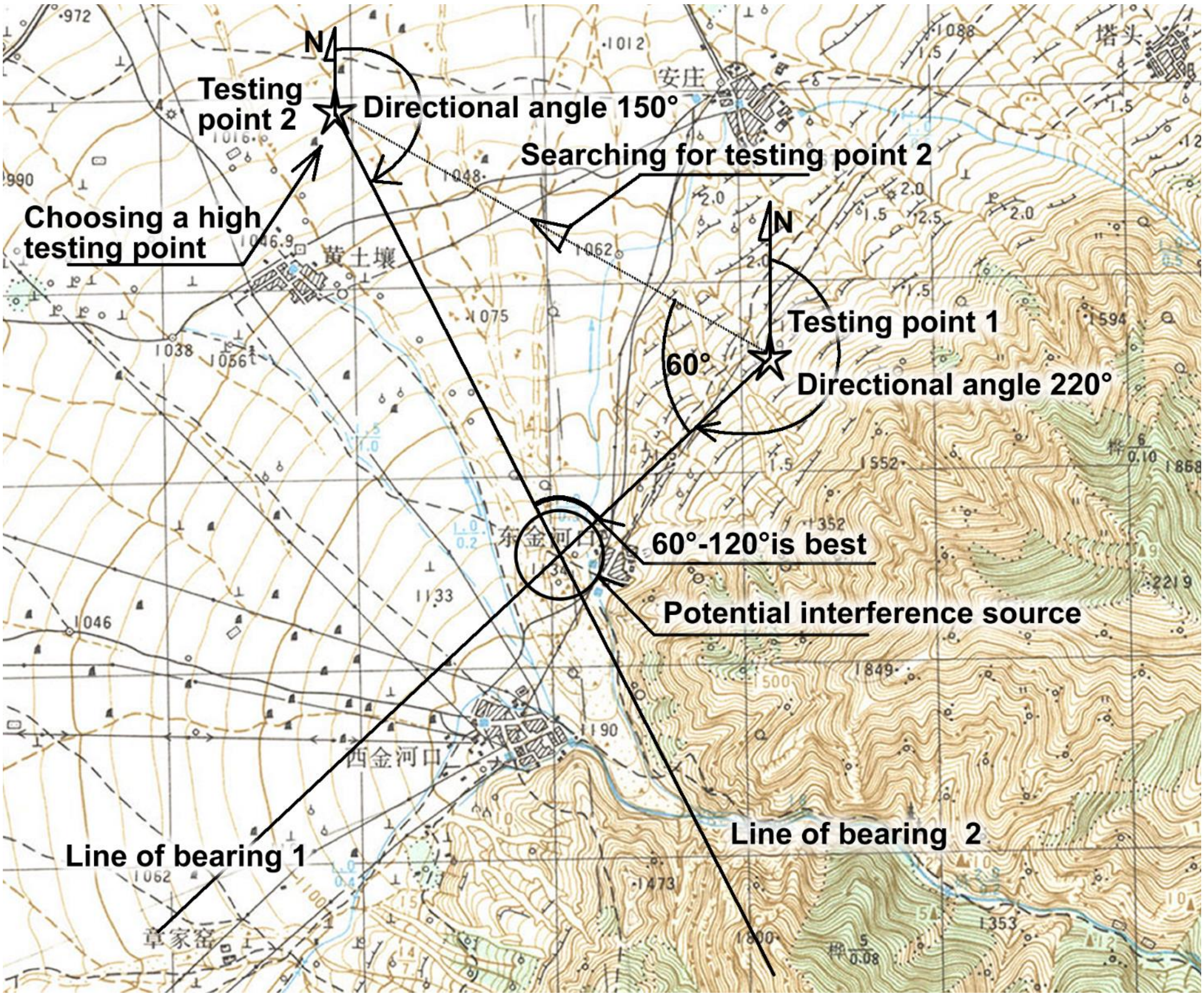


Figure 5-4, Example of cross-positioning and graphical operations

No matter what instrument is used, the orientation of the interference source is a combination of theory, experience and technology, and requires much practice to improve efficiency. In most tests, especially in urban or mountainous areas, there are numerous false directions due to the phenomenon of signal bypassing and reflection.

* For narrowband signals, the field strength mode is used to find the source of

interference with higher response speed.

Warning

Unless approved, do not use the 901x to monitor the spatial spectrum at non-operating frequencies, and do not pass it on to third parties even if it is measured by chance.

Chapter 6 Maintenance

6.1, Clean screen, keyboard and port

Please peel off the protective film of the display. The display has been made of tempered glass panel, which is extremely wear-resistant and replaceable, so there is no need to post protective film to protect it, otherwise it will reduce the sunlight viewing effect.

When the display and keyboard get dirty, wipe them with a moist non-woven cloth and then dry them with a dry cloth.

If the inner tribe has dust, the correct cleaning method is to remove the control circuit board, with 0.2 ~ 0.5MPa compressed air blowing clean, if necessary, replace the display glass and keyboard rubber.

Please clean the RF connectors frequently. Blow the inside of the port with compressed air, then wipe the steps on the inside surface of the connector housing with a cotton swab, and the holes on the core box can be wiped by screwing a fine dust-free paper towel into it.

Warning

The charger must be removed and all batteries removed before disassembly of the circuit board can begin. The user's own disassembly of the case and control circuit board for battery installation, display cleaning work will not affect the warranty period of the RF part, but the disassembly caused by the failure is not covered by the warranty.

Do not use organic solvents other than anhydrous alcohol to wipe any part of the equipment. Be careful to prevent liquids from flowing into the barometer.

6.2、Other notes

(1) KC901x should be placed in a package or suitcase for long distance handling, carry out should use the shoulder strap, avoid falling and collision, do not mix with construction tools and other hard objects. Handling, carrying should remove all kinds of cables, do not use the test cable as a carrying handle.

(2) When testing heavy devices or connecting sturdy feeders, use flexible cable adapter and eliminate the influence of the adapter cable by calibration.

(3) when installing the connector, should be aligned with the location, carefully inserted, lightly shake slowly screwed, feel the core pin into the core hole, and then tighten the threads. Screw threads should be operated with both hands, one hand holding the main body to avoid rotation, the other hand to rotate the screw sleeve, do not make the entire plug rotation. For unfamiliar connectors should pay attention to check, if the core pin is too long, tilted, etc., must be repaired or replaced before connecting.

(4) Protect from rain and moisture, do not enter the water. In case of rain, immediately make the back of the instrument up and shelter from rain as soon as possible. If accidental water ingress occurs, immediately turn off the power, shake out the water to the bottom, and quickly disassemble the case and remove all batteries. For frequent field use, a waterproof carrying case is recommended.

(5) When entering a heated room from outside in winter, please seal it with a plastic bag until the temperature is balanced and then take it out from the sealed bag. If there is dew on the instrument, it should be dried and then turned on again.

(6) In order to protect the battery, please charge the instrument frequently and do not wait until the power shortage alarm. Avoid long-term floating charge. If you need to connect the charger to work for a long time, please remove the battery. After removing the battery, it is not recommended to control the instrument on/off by turning on/off the external power frequently, otherwise it may lead to circuit damage. If there is such a need, please confirm the solution with the manufacturer.

(7) The instrument is not used for a long time, should be charged (discharged) to

8.0V after storage. **Charge to 8.0V at least once a year** during storage. It is recommended that the battery be removed before long-term storage.

(8) Do not allow the instrument to be near high-powered transmitting sources, including ordinary walkie-talkies.

(9) Ionizing radiation may damage the instrument, and large doses of exposure can cause irreversible damage.

(10) The USB socket is fragile, a soft data cable should be used and lateral force should be avoided.

(11) Please do not disassemble the case at will. Slight carelessness in disassembly can damage the circuitry and such damage is not covered by the warranty. Disassembly of the RF components will forfeit all warranty rights.

(12) The calibration cycle of the instrument is recommended to be 1 year.

(13) The quality and safety guarantee period of the main unit is 1 year. Normal wear and tear of ports and appearance, human damage and any use not in accordance with the instructions are not covered by the warranty.

(14) Depending on the intensity of use, it is recommended that the machine be scrapped 3 to 8 years after it is opened. This machine adopts leaded process, and should be properly recycled after scrapping.

[Ending]

Develop science and technology hobby

Promote scientific rationality

KC901