4945B/C Radio Communications Test Set

User Manual

China Electronics Technology Instruments CO., LTD

Foreword

Thanks very much for purchasing and using the 4945B/C Radio Communications Test Set produced by China Electronics Technology Instruments CO., LTD. With high, precision and frontier technologies, the product enjoys the highest quality and cost performances compared with similar products. The Company follows the ISO9000 standard always during production and adheres to the customer-oriented and quality-first principles. Please read carefully the manual, so as to facilitate the operation. We will spare no efforts to meet your requirements, providing you with operating devices with the highest cost performance and first-rate after-sales services. We always adhere to the principle of “high quality and thoughtful services”, providing customers with satisfactory products and services as well as work convenience and shortcut. The hotline is shown below, and we are looking forward to hear from you:

Tel: (+86 532) 86896691

Website: www.ceyear.com

E-mail: sales@ ceyear.com

Address: No. 98, Xiangjiang Road, Qingdao City, China

Postal code: 266555

The manual introduces the application, performance and features, basic principles, usage, maintenance and precautions of the 4945B/C radio communications test set, facilitating your quick understanding the usage and key points of the tester. To operate the product well and provide you with higher economic effectiveness, please read the manual carefully.

Mistakes and omissions can hardly be avoided due to time urgency and writer’s knowledge limit. Your valuable comments and suggestions are highly welcome! We are sorry for any inconvenience caused due to our errors.

Note:	The manual is the second version of the 4945B/C Radio Communications Test Set Manual, with version number of A.2. The manual contents are subject to change without prior notice. The right of term interpretation in the manual belongs to China Electronics Technology Instruments CO., LTD.

Writer

November 10, 2018

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Chapter I Overview

Thanks for using the 4945B/C radio communications test set developed and produced by China Electronics Technology Instruments CO., LTD.

1 Applications

The radio communications test set is used to meet the comprehensive test requirements of such terminal devices as the radio, intercom, comprehensive data link, JIDS terminal equipment, microwave relay, satellite ground station and scattering communications, and solve such comprehensive test problems as emission, reception and auto test of the communication equipment in respect of wide bandwidth, wide frequency range, and rich test functions during reception and emission test.

The main functions and features of the product are as follows:

- Broadband high-speed frequency hopping signal generation and control;
- Broadband high-speed frequency hopping signal reception and analysis;
- Generation and analysis of broadband analog and digital modulation signals;
- Comprehensive test technology based on software radio;
- Generation and analysis of high precision audio signal;
- Real-time spectral analysis;
- Oscilloscope test;
- Editable and automatic guidance test;
- Menu in both Chinese and English for easy operation;
- AC or DC power supply available in the standard configuration; Built-in battery available for out-field operation;
- Built-in high-power attenuator for wider power measurement range.

2 Instrument composition

The basic composition of the 4945B/C radio communications test set is shown in Table 1-1.

Table 1-1 Basic composition

Item	Model	Name	Quantity
Mainframe	4945B/C	Radio communications test set	1
Appendixes		Three-core 220V AC power line	1
		N-BNC adapter	1
		N-SMA adapter	1
		TNC-SMA adapter	2
		User Manual (including the Programming Manual)	1
		Packing list	1

3 Precautions

Unpack, and check and verify the items in the box as per the steps shown below; read the “Power-up precautions” first before operation, so as to find problems in the first place and avoid any accident. In case of any problem, contact us for quick solution as per actual situation.

3.1 Unboxing inspection

- Check the packaging box for any damage.
- Take the instrument out of the packaging box, and check for any damage caused during transportation.
- Check whether all accessories and documents are provided together with the instrument as per the packing list.

Check to confirm the device flag of the instrument is as follows:

1) Model: 4945B or 4945C

2) Name: Radio communications test set

3) Production date and serial number: DD/MM/YY

4) Manufacturer name: China Electronics Technology Instruments CO., LTD

5) Manufacturer address: No. 98, Xiangjiang Road, Economic and Technological Development Zone, Qingdao, Shandong Province

In case of any damage to the packaging box or damping material in the box, check first for any item missing inside, and then conduct the mechanical or electrical performance test on the instrument.

Accessories and documents in the packaging box include the following: Power line (1 pc), N-BNC adapter (1 pc), N-SMA adapter (1 pc), TNC-SMA adapter (2 pcs), 4945B/C radio communications test set Manual (1 pc), and packing list (1 pc).

In case of any accessory missing or damage to the instrument occurred during transportation, inform us for quick repairing or replacement as required. Keep the transport materials for packing and transportation in the future. See the foreword for contact information.

3.2 Power supply inspection

Select the 220 V AC power supply for the instrument (Improper power supply will damage the internal hardware of the instrument). Table 1-2 shows the power supply requirement for normal operation of the instrument.

Adopt the 220V AC stabilized voltage supply for the instrument, so as to avoid or reduce mutual interference between multiple equipment due to the shared power supply (especially any damage to the instrument due to peak pulse interference caused by high power equipment).

Ensure good power supply grounding to avoid any damage to the instrument.

4945B/C is provided with the three-core power line to meet the international safety standard. Never use power lines without grounding.

Table 1-2 Working power supply change range

Power supply parameter	Applications
AC voltage	100V-242V
Rated output current	>2.0A
Max. power consumption	80W
Operating frequency	50-60Hz

Warning: Poor or improper grounding can result in instrument damage or even personal injury. Do ensure good contract between the instrument ground wire and that of the power supply first before turning on the power of the instrument.

Use the outlet with protective grounding. Do not use any external cable, power line or autotransformer without any protective grounding as the protective grounding line. In case of any autotransformer adopted, do connect the common terminal to the protective grounding line of the power connection.

3.3 Electrostatic protection

Since the static electricity can damage electronic parts and components, operations requiring anti-static measurement must be conducted on the anti-static workbench. The following two anti-static measurements are usually adopted:

1) Combination of the conductive table mat and wrist strap.

2) Combination of the conductive ground mat and ankle strap.

Using the above two anti-static measurements at the same time can provide good antistatic protection. If using one of them, only the former can provide antistatic protection. 1MΩ earth isolation resistor must be provided for the antistatic components at least for ensuring user safety.

Warning: The anti-static measurements mentioned above are not applicable for occasions with voltage of more than 500V!

Apply antistatic techniques to reduce damage to components and parts:

- Let the internal/external conductor of the cable contact the ground shortly first before connecting the coaxial cable with the instrument for the first time.
- Do wear anti-static wrist straps first before touching the joint core or conducting any assembly.
- Ensure all instruments are grounded properly, so as to avoid any static electricity.

3.4 Instrument safety

- Use the specified packing box for instrument transportation, and avoid any drop or violent collision during transport, so as to avoid any damage to the instrument.
- Adopt the 220V AC 3-core stabilized voltage supply for the instrument, so as to avoid any damage to the internal hardware to the instrument due to high-power peak pulse.
- Ensure good power supply grounding to avoid any damage to the instrument.
- Take antistatic measures such as wearing anti-static wrist strips to operate the instrument, so as to avoid any damage to the instrument due to static electricity.
- Do not input direct current signals at the input end of the instrument, and prevent any signal power from exceeding the allowable max. input power, so as to avoid any damage to the instrument.
- In case of any internal/external battery used for power supply, use the one of the same type or equivalent for replacement, so as to avoid any explosion risk. Cut off the external power supply when installing or replacing the battery.
- Do not put any object into the instrument from the opening on the shell of the instrument, or pour any liquid onto or into the instrument shell or the instrument respectively, so as to avoid any internal short circuit and / or electric shock, fire or personal injury.
- Do not cover up any notch or opening on the product, which is used for internal ventilation and preventing the product from getting overheat.
- Do not put the product on the sofa or blanket, or inside a closed shell, unless it is well ventilated.
- Do not put the product on heat-generating equipment such as the heating device or warming fan, and keep the environment temperature below the max. one specified in the manual.
- Please be noted that the instrument can discharge poisonous gas or liquid once on fire.

3.5 Personnel safety

- Use proper handbarrow to carry the instrument and packaging box with care, so as to avoid any personnel injury due to instrument falling.
- Ensure good power supply grounding to avoid any personnel injury.
- Power off first before wiping the instrument to avoid any electric shock, and use dry or slightly-wet soft cloth to wipe the instrument surface (Do not try to wipe the internal of the instrument).
- Provide operators with special training first before operating the products, and take care during operation. Assign personnel in normal healthy and mental conditions to operate the instrument, So as to avoid any personnel injury or property damage.
- Do not use the product with damaged power line. Check regularly the power line for normal condition. Take proper safety protection measures, and place the power line properly, so as to ensure it is free of damage and personnel will not be subject to power line tripping or electric shock.
- Do not use the instrument outdoor in such disastrous weathers as thunder, so as to avoid any instrument damage or personnel injury.

3.6 Environmental protection

We guarantee that the packing materials of the product are innocuous waste, which can be kept for further transport, or treated as per local environmental regulatory requirements.

Components and parts replaced during maintenance and upgrading will be recycled by China Electronics Technology Instruments CO., LTD; the scrapped instrument cannot be discarded or disposed at will, which must be recycled by China Electronics Technology Instruments CO., LTD or qualified professional recycling units.

Any battery replaced from the instrument cannot be discarded at will, which shall be recycled separately as per the chemical scrap list.

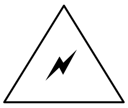
The above-mentioned operations shall be conducted as per the *Regulations on Recycling and Management of Waste Electrical and Electronic Products* and local environmental laws and regulations.

3.7 Other precautions

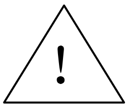
Read the manual carefully first before operating the instrument and pay attention to the following:

- Keep the instrument operating temperature at 0℃ ~ +50℃, and do not block the ventilation opening of the instrument cabinet during operation.
- Take antistatic measures such as antistatic table mat, ankle strip and wrist strip to prevent static electricity from damaging the instrument, with antistatic voltage not exceeding 500V.
- Do not put weight on the instrument, so as to avoid any extrusion or damage to it.
- Use connectors and cables meeting the test requirement, and check them first before operation.
- Ensure the input signal power at the radio frequency input port of the instrument is lower than the max. safety input level, so as to prevent the instrument from being burned down.
- During measurement, ensure the DC signal input power at the radio frequency input port is not higher than the rated value, so as to prevent internal components of the instrument from being damaged.
- During measurement, ensure there is no input signal at the radio frequency output port, so as to prevent internal components of the instrument from being damaged.
- The user must understand the feature of the signal under test, so as to set various parameters for the instrument properly.
- When testing the spectrum, radio frequency reception, and real-time spectrum, adjust the attenuator or reference level to show the peak value of the signal under test below the screen in the form of setting-flush or make the reference level at least 5dB higher than that of the signal under test.
- The user can delete the file saved by himself/herself rather than the system file.
- When transferring files via the USB port, make sure the carrier is security and reliable, so as to prevent the instrument from being compromised.
- In case of any instrument failure, do not disassemble it. Just send it back to the factory for maintenance.

safety symbols shown below are used in the manual. Please get familiar with them and their meanings and read Part I of the manual at least first before operation, so as to guarantee personnel safety and instrument performance.



Warning: "Warning" indicates a potential risk. It reminds the user of certain process to be paid special attention to. If proper operations or relevant rules are not conducted or followed respectively, instrument damage or personnel injury can occur.



Caution: "Caution" reminds the user of information to be paid special attention to. It reminds the user of the operation information or instruction to be paid attention to.

The manual consists of the following six chapters:

Chapter I introduces the features, application, basic composition and operation precautions of the 4945B/C radio communications test set.

Chapter II introduces the appearance of the 4945B/C radio communications test set.

Chapter III introduces the basic buttons and relevant functions of the 4945B/C radio communications test set.

Chapter IV introduces the operation instructions of the 4945B/C radio communications test set.

Chapter V introduces the operation principles of the 4945B/C radio communications test set.

Chapter VI introduces the main technical indexes and test methods of the 4945B/C radio communications test set.

Chapter VII introduces the maintenance and simple repairing methods of the 4945B/C radio communications test set.

The appendix provides the software programming guide for the instrument.

Part I Instructions

Chapter II Basic Instrument Instructions

Section I Initial power-up

Warning: Use the three-hole AC power cord provided together with the instrument to supply power for the instrument, and make sure it is grounded well, so as to ensure operation safety and normal instrument operation.

Warning: When the instrument operates in the cabinet, ensure sound ventilation for the instrument. A thermal power of every 100 watts generated in the cabinet requires the environment temperature (outside the cabinet) is 4 degrees centigrade lower than the max. operating temperature of the instrument. If the total thermal power exceeds 800 watts in the cabinet, ventilating measures are compulsive.

The product has been subject to complete assembly and configuration before delivery. The user can just connect it with a 3-hole AC power cord when operating it for the first time, with the start-up and warm-up steps shown below:

1) Connect it with the power cord, and press the power switch to start up the product.
2) It will take about 30s for the product to conduct a series of self - checking, adjusting, data loading and initialization procedures
3) Operate the product after being warmed up for more than 10 min.; to ensure the accuracy and stability of the index test, warm the product up for more than 30 min. The figure below shows the startup picture of the instrument:

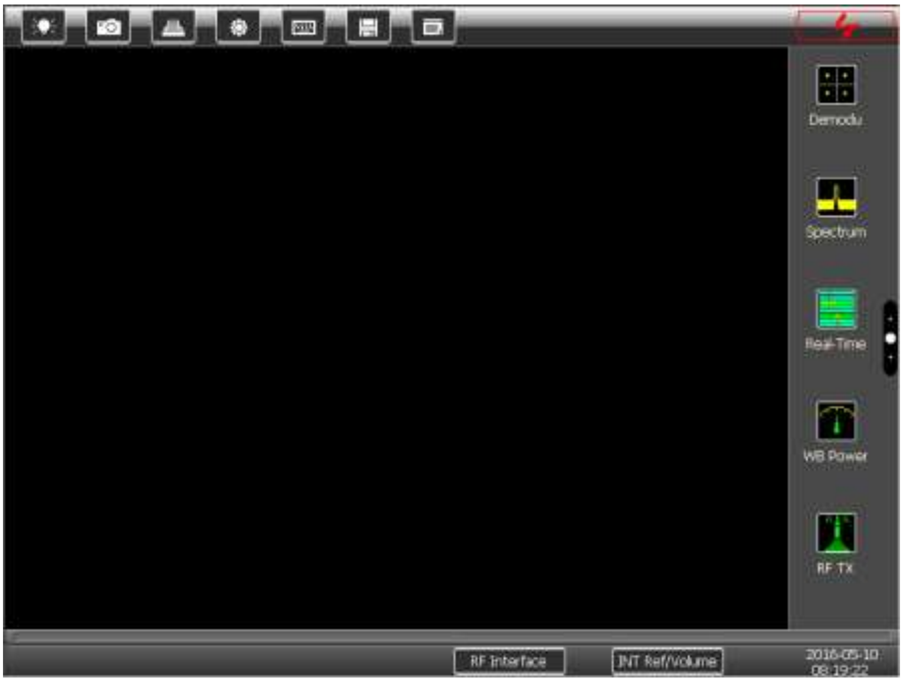


Fig.2-1 Startup picture of the 4945B/C radio communications test set

Section II Instrument appearance and front panel

The product is portable, with the shell being made with the plastic mould and internal structure being made with high-strength aluminum alloy. A draught fan is provided in the cabinet for forced air cooling. The external surface of the instrument is subjected to anti-static plastic coating, and the internal is made with ferronickel that features high permeability and electromagnetic shielding and is subjected to strict heat treatment, so as to guarantee its sound electromagnetic compatibility.

The main panel schematic diagram of the product is shown in Fig. 2-2, with the front panel being the main area for testing operation, including the power switch, high brightness color display, buttons in various functional areas, input and output connectors and various prompt signs.

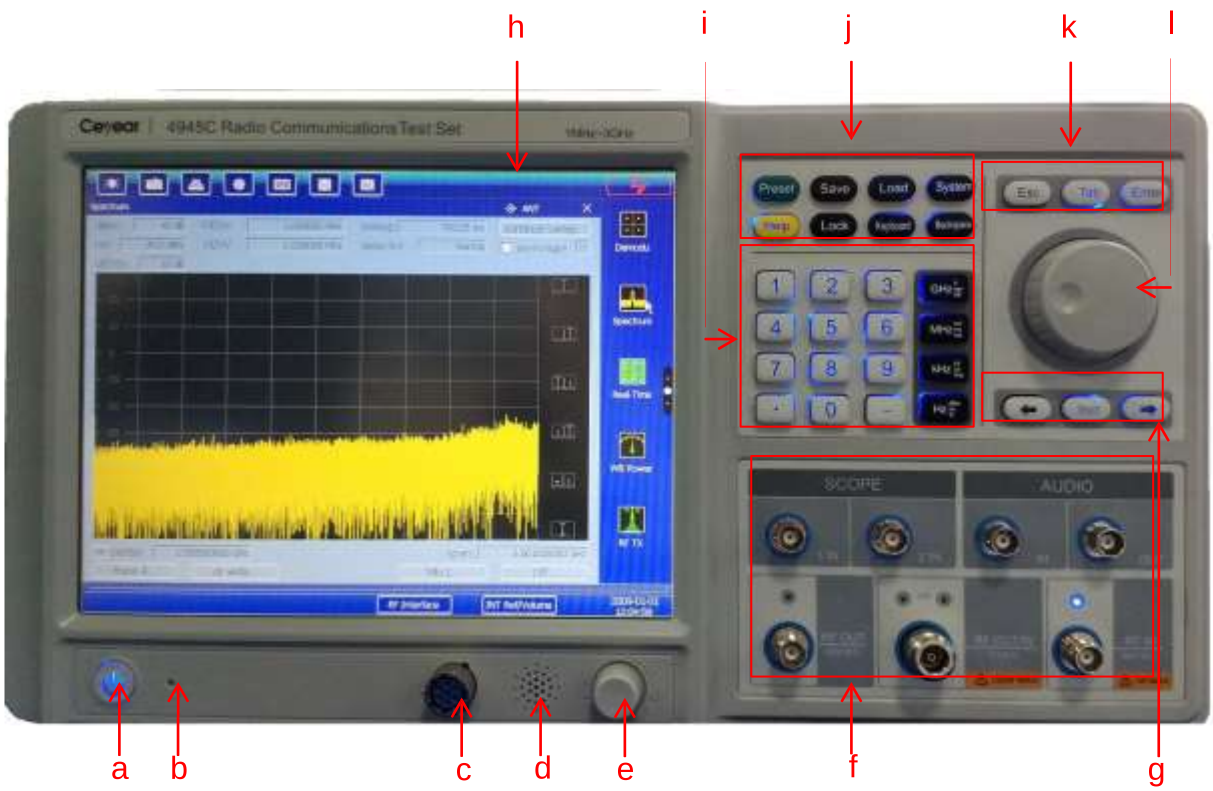


Fig. 2-2 Front panel schematic diagram of the 4945B/C radio communications test set

a Power switch

The backlight of the power switch turns on automatically in the start-up status.

b Charging indicator light

The charging indicator light turns on automatically in the charging status provided the battery option is available.

c Headset interface

The 7-core headset interface can be used for demodulation sound output, microphone input and transceiver control during speaking test as well as voice releasing during radio frequency reception and audio analysis. When identifying the microphone, the instrument switches the voice automatically from the built-in Voice to microphone. Its interface definition is as follows:

Table 2-1 7-core headset interface definition

Pin number	Definition	Remarks
1	PTT (input)	It is used to control the receipt and transmit of the tester in the speaking mode, that is, the tester is in the transmit status when grounded and in the receipt status when suspended.
2	MIC (input)	Microphone input
3	AGND	Ground wire, which is connected to the microphone shielded wire at the microphone end.
4	SPK+ (output)	Positive pole of the output voice
5	SPK- (output)	Negative pole of the output voice
6	--	Standby
7	Link sign (input)	Microphone identification line. It shall be shorted out to the AGND wire at the microphone end, so that the tester can identify the microphone is connected, and then switch the voice from the built-in Voice in the tester to the microphone.

Note: The 7-core headset interface can match the special microphone produced by China Electronics Technology Instruments CO., LTD or that customized as per the definition above.

d Voice

The 4945B/C radio communications test set is provided with a Voice to output in real time the voice demodulated by the analog modulation signal or analyzed by voice frequencies. The picture shows the Voice position, and the buzzer opening shall be kept clean, so as to guarantee the sound effect.

e Volume control knob

It is used to adjust the built-in Voice volume.

f Input/output connector

It consists of the N-type RF input/output, TNC RF input, TNC RF output, BNC oscilloscope 1 input, BNC oscilloscope 2 input, BNC audio input and BNC audio output.

g Stepping input area

【←】 and 【→】indicates leftwards and rightwards respectively, functioning the same with those of the left and right keys on the standard keyboard; During parameter setting, the middle step key can be used to call the input call dialog box for current parameter stepping setting.

h Display

The middle part of the display of the 4945B/C radio communications test set is the main display part, with the lower and left parts showing the test results, and the right part showing test function selection.

i Data input area

It consists number keys and unit keys for inputting decimal data and relevant units. j

Function key area

It consists of operational keys corresponding to various functions of the tester. It includes such functions as resetting, storage, calling, system, help, locking screen, and soft keyboard.

k Modifier key area

It includes the OK, Cancel, and TAB keys, with functions same with those of the corresponding keys on the keyboard.

l Roller

It is used to move the cursor and change current parameter values. It can be used to change the parameter as per current parameter stepping value easily.

Section III Back panel

The back panel schematic diagram of the product is shown in Fig. 2-3, which consists of various I/O interfaces and heat emission holes.

Fig. 2-3 Rear panel schematic diagram of the 4945B/C radio communications test set

In addition to the network interface, RS232 (for system information output interface, which cannot be remotely controlled), USB HOST, MINI USB (for system interface, which does not support USB storage device), grounding and other system interfaces, the special connectors for the rear panel of the 4945B/C are as follows:

a 10MHz reference output

b 10MHz reference input

c Demodulation audio output

It refers to the demodulation audio output in the radio frequency receiving function.

d Externally-modulated audio frequency input

It refers to the externally-modulated audio frequency input interface in the radio frequency emission function when analog modulation is activated. It is related to the modulation degree of the internal modulation source at about 1Vpp, with the max. input level not exceeding 1Vpp.

e Digital input synchronous clock (TTL level)

It refers to the digital input synchronous clock used for bit error rate measurement.

f Digital input (TTL level)

It refers to the 1-bit serial digital input during bit error rate measurement, which must be input together with the input clock.

g Digital output synchronous clock

It refers to the synchronous clock output digitally by the built-in vector digital source in the radio frequency emission function when vector modulation is activated.

h Digital output

It refers to the digital output of the built-in vector digital source in the radio frequency emission function when vector modulation is activated.

i Digital input synchronous clock (232 level)

It refers to the digital input synchronous clock used for bit error rate measurement.

j Digital input (232 level)

It refers to the 1-bit serial digital input during bit error rate measurement, which must be input together with the input clock.

m 24V DC supply interface

n 26-core test interface, with definition as follows:

Table 2-2 26-core test interface definition

Pin number	Type	Definition	Remarks
1		PTT (output)	It is used to control the receipt and emission of the communication device under test in automatic test (which must be supported by the communication device).
3	External vector modulation digital input	EXT_MOD_CLK (output)	Digital synchronous clock
5		EXT_MOD (input)	External modulation digital serial input (which must synchronize with the clock)
2		Q_NOISE_FLAG (input)	The silencing indication input in automatic test.
4		--	Standby
6		--	Standby
7	Standard RS232 serial port	CTS	Standby
9		RXD	Standby
11		RTS	Standby
13		TXD	Standby
8	Demodulation source code real - time output interface	DEMOD_CODE_ST (output)	One code element can output multiple bit serial signals during such higher-order demodulations as QPSK and 16QAM, and such signal is regarded as the output indication of one code element.
10		DEMOD_CODE_CLK (output)	Digital output synchronous clock
12		DEMOD_CODE_D (output)	Serial digital output
14	External real-time frequency hopping SPI control interface	EXT_HOP_D (input)	Serial frequency control word input
16		EXT_HOP_CLK (input)	Serial frequency control word input synchronous clock
18		EXT_HOP_LD (input)	It refers to the frequency hopping signal output control pulse, which is in the input status for receiving the frequency control word input at level 0 and closes the signal output at the same time, and locks and saves the frequency control word input at the upper rising edge of the pulse for the time being at level 1 and opens signal output at the same time.
15	Audio input/output auxiliary interface in automatic test	EXT_AFIN (input)	It refers to the audio input interface, which switches automatically the audio input interface from the front panel to this signal line when the tester identifies the 26-core interface connection flag bit.
17		AFOUT (output)	It refers to the audio output interface, which switches automatically the audio output interface

			from the front panel to this signal line when the tester identifies the 26-core interface connection flag bit.
19		LINK_FLAG (input)	It refers to the 26-core interface connection flag bit, which is available when grounded.
20		--	Standby
21	Power supply and grounding	+24V	When identifying the 26-core interface connection flag bit, the tester can enable the power supply automatically. Otherwise, it will be shut down. The max. current is about 0.4A.
22		+24V	
23		+5V	When identifying the 26-core interface connection flag bit, the tester can enable the power supply automatically. Otherwise, it will be shut down. The max. current is about 0.4A.
24		+5V	
25		GND	Grounding
26		GND	Grounding

Note: The 26-core test interface can match the special connector produced by China Electronics Technology Instruments CO., LTD or that customized as per the definition above.

o Battery mounting cover;

Since the battery is a special one, the special battery options from China Electronics Technology Instruments CO., LTD must be adopted. After battery installation, put the cover in place, ensuring the two plastic clips on the upper part of the cover are put in place to prevent the battery from falling.

Chapter III Button Menu Instructions

Since the functional system of the 4945B/C radio communications test set is very complex, this chapter enumerates and explains in details all control keys, function keys and various soft menus on the front panel of the instrument by combination of graphic symbols to facilitate users' locating and indexing, starting from the simple enter keys.

Note: All items in solid brackets ("【**】") shown in the manual are function keys, corresponding to various function keys indicating specific functions on the front panel, and each function is indicated on respective key.

All items in hollow brackets ("〖**〗") shown in the manual are function indications, corresponding to various functions shown in the soft menu area and various parameters shown in the main display area.

Please pay attention to the difference between them.

Section I Data input key

Keys in the data input key area include the number key, unit key, rotary pulse generator (RPG), stepping key, and left/right key, as shown in Fig. 3-1.

Fig. 3-1 Data input key area

There is no specific description on the function of number keys 【0】-【9】, because the number of the key is the one to be input, whereas 【—】 is used to input the negative sign "-" for a negative value, and 【▪】to input the decimal point.

There are 4 keys in the unit area, each of which can be set with 4 units, namely, the 3 units printed on the right of the key in addition to the frequency unit. In addition to setting units, the unit key can also act as the Enter key for confirming some dimensionless parameters setting. The four unit keys function the same in this circumstance.

The rotary pulse generator (RPG) and left/right keys can be used to change data conveniently and quickly. The disc RPG knob can be rotated clockwise and anticlockwise to increase and decrease corresponding data respectively. 【←】 and 【→】 are used to move the cursor.

【Step】 is used to control each parameter stepping. On any function interface, when the parameter input field is enabled and in the input status, press 【Step】 to pop up the step input dialog box for such input field, and then enter the step value (the step input supports only the confirmation function of the unit key after number entry rather than the RPG operation). After that, press 【Step】 again or 【ESC】 to return to the previous parameter setting status, or click the non-parameter input area on the screen to exit the step dialog box. After step setting, turn RPG to change the parameter.

Section II Function keys

The system auxiliary function keys of the 4945B/C radio communications test set are shown in Fig. 3-2, with detailed function description for each key shown below:

Fig. 3-2 Function keys area

a: 【Reset】 is used to return to the initial status of the system;

b: 【Save】 is used to save the test setting information, including current test window and parameter setting in each test window, which saves current test result report on the automatic test interface;

c: 【Load】 is used to load the saved test setting information (which is the test result report on the automatic test interface), as well as compare, view, export and print the test record;

d: 【System】 is used to view the system information;

e: 【Help】 is used to view the instrument help information;

f: 【Lock】 is used to lock the touchscreen, which will be disabled after being locked, and a lock sign will be shown in the upper title bar of the display interface;

g: 【Keyboard】 is used to enable/disable the system keyboard and realize auxiliary character input;

h: 【Backspace】 is used to delete data, with the same function with that of the standard keyboard; i:

【Esc】 is used to cancel data editing, with the same function with that of the standard keyboard; j:

【Tab】is used to edit data and make tables, with the same function with that of the standard keyboard; k:

【Tab】 is used to confirm data editing, with the same function with that of the standard keyboard.

Section III User interface introduction

The user startup interface is shown in Fig. 3-3:

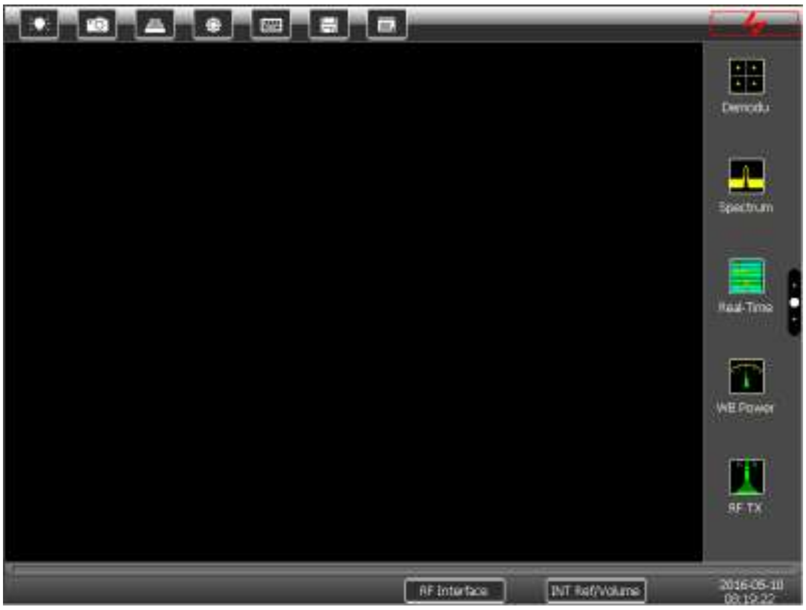


Fig. 3-3 Startup interface

The interface consists of four parts, namely, the upper feature bar, the right menu bar, the main working area and the bottom auxiliary bar. It can be further divided into the following parts:

a: Function shortcuts area

There are some function shortcuts in the area, as shown in Fig. 3-4, which can be clicked directly to realize relevant functions.

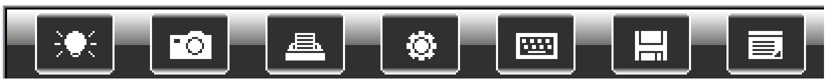


Fig. 3-4 Function shortcuts area

Specific functions are shown from the left to the right as follows:

1: BK-Light and display mode selection

the default BK-Light is 〖BK-Light 4〗, and default display mode is 〖Day〗, which can be changed by the user as required. The 〖Protect eye〗 mode interface is shown in Fig. 3-5:

Fig. 3-5 Protect eye mode

The 〖Night〗 mode interface is shown in Fig. 3-6:

Fig. 3-6 Night mode

2: Camera function

It can make screenshot, save it to the U disk or in the FTP directory as per user requirements (the user can access the 4945 FTP directory and copy the image remotely via a network cable), and record image and data conveniently.

3: Printing

It can print current screen image quickly provided the printer is connected, and relevant printing information can be set. The 4945 tester supports only the USB printer with the PCL language printing function, for example, the HP LaserJet 1022.

4: System option

The system option menu consists of the following options: 〖Memory〗, 〖TCP/IP〗, 〖Log〗, 〖Version/Update〗, 〖Option〗 and 〖Test〗. Whereas:

〖Memory〗 is used to view the total and remaining space of the storage memory, program memory, Nand Flash and SD card;

〖TCP/IP〗 is used to modify the IP, subnet mask, gateway and remote port number of the instrument;

〖Log〗 is used to view such information as user operation record and system error, with the function of 〖Clear record〗;

〖Version/Update〗 is used to view the software version number and machine serial number. The system software can be updated via 〖Update from USB〗 and 〖Update from FTP〗, and relevant options can be activated by inputting the option serial number provided by China Electronics Technology Instruments CO., LTD;

〖Option〗 is used to view and modify some system options, such as touch pen needle calibration and modification, and switching to the user idle status and system idle status. The system can hibernate the display automatically in the user idle status.

〖Test〗 is used to select the signal-to-noise ratio (SNR) measurement method in the Audio RX function.

5: Keyboard

It provides a keyboard to facilitate user's text message editing. It is similar with the 【Keyboard】 on the panel. Press it again to exit.

6: Save current status

It will save the current status to the local disk for loading. It saves current test records in the automatic test mode.

7: Load/history record option

The option is corresponding to different options in different modes. In the general test mode, it displays the status list saved previously, including four options (namely, 〖Clear list〗, 〖Delete selected〗, 〖Call selected〗 and 〖Cancel〗) corresponding to relevant functions. It is in the history status in the automatic test mode, showing the history test record list, view/comparison list, and the three options (namely, 〖Delete selected〗, 〖Clear list〗 and 〖View〗).

b: Main working area

The area occupies most part of the interface, is the main working area, can be used to display and modify relevant function options, which will be introduced in details below.

c: Bottom function area

It locates at the bottom of the instrument interface, as shown in Fig. 3-7, mainly including three functions, namely, RF connector selection, 10MHz frequency reference selection and date and time.

Fig. 3-7 Bottom function area

1: RF connector selection

The front panel of the instrument is provided with a RF input/output connector (T/R port), RF input connector (ANT port), and RF output connector (GEN port), from which the RF input/output port can be selected. The GEN port, ANT port and T/R port are used for only RF signal output, only RF signal input, and both RF signal input and RF signal output respectively (The T/R port is provided with built-in high-power attenuator, capable of supporting the input signal of up to 150W).

Click the icon on the title bar of each RF test function interface to switch the RF connector quickly.

The T/R port can be locked when testing the transmitter receiver. It will switch to the T/R port automatically when switching to transmitter test in the locked status. When switching to receiver test, because the signal source of the tester is output from the T/R port to the device under test, a prompt "Please confirm the device under test is in the RF receipt status" will pop up, so as to protect the tester. It will switch to the T/R port automatically after user confirmation.

2: 10MHz frequency reference selection

The tester is provided with a 10MHz constant-temperature crystal oscillator to provide frequency reference for the tester, which can be output from the rear panel of the tester; an external frequency reference signal can also be introduced to be the frequency reference of the tester, which is used for frequency marker synchronization between devices.

3: Date and time

It shows current date and time, which can be clicked to modify the time and date of the system.

4: Volume gear

The gear used to change the volume. Please select proper volume since too high volume can be compressed, resulting in sound distortion.

d: Right slidable function menu area

Paging can be realized in the right menu area by just pressing and holding the screen and moving up/down, or clicking the little dot in the right for quick paging. The menu area consists of 〖TX test〗, 〖RX Test〗, 〖Comm Test〗, 〖Auto Test〗, 〖Demodu〗, 〖Spectrum RX〗, 〖Real-Time 〗, 〖WB Power〗, 〖RF TX〗, 〖Audio TX〗, 〖Audio RX〗, 〖BER RX〗, 〖OSC〗 and 〖Debug〗 listed from the top to bottom. 〖Debug〗 is used by the manufacturer for instrument debugging purpose, and users have no permission to access or use it, whereas the remaining will be activated automatically as per the option configuration.

Relevant menu interfaces are introduced in details below.

After startup, click the function menu in the right of the touchscreen to enable relevant test functions, which can be used after such parameters as the frequency and amplitude are set.

1: 〖RF TX〗 function interface:

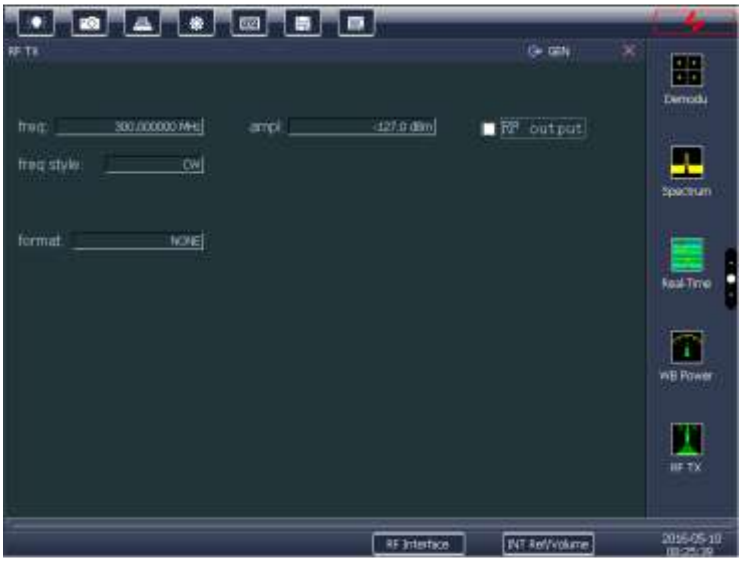


Fig. 3-7 RF TX interface

Click 〖×〗 in the top right of the title bar in the main working area to close the function window quickly and return to the empty interface defaulted for startup. Click 〖○→GEN〗 in the top right of the title bar in the working area to switch the RF output connector (switching between the GEN and T/R port) quickly, and click any data in the area to modify it accordingly, with the interface shown in Fig. 3-8, whereas:

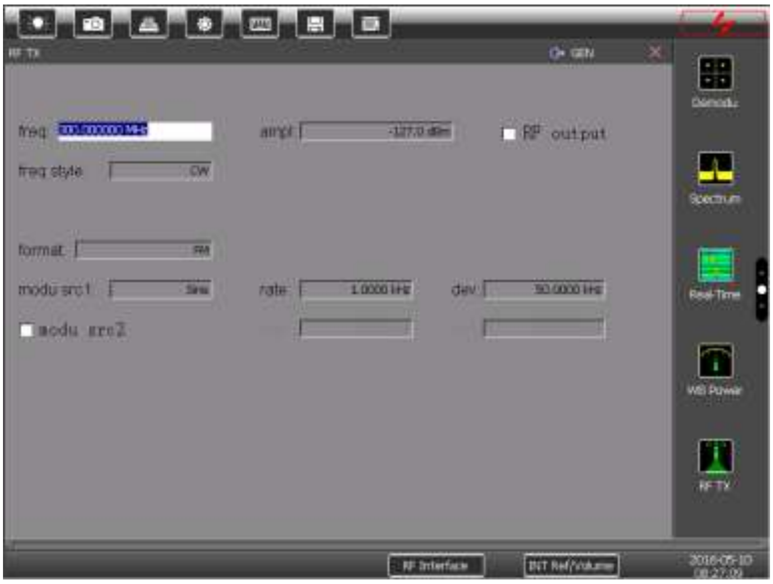


Fig. 3-8 Data modification interface

〖freq〗: It is used to set the frequency of the RF TX signal. The range of the output frequencies of the 4945B and 4945C are 100kHz～1.05GHz and 100kHz～3GHz respectively;

〖ampl〗: It is used to set the power of the output RF signal. The amplitude unit can be selected by clicking the unit (such units as dBm, dBuV, dBmV, dBV, Volts and Watts are available), with amplitude range of -127dBm~+8.0dBm (GEN port) and -130dBm~-30dBm (T/R port);

〖RF output〗: Check the small box in front of it to output signal from the selected RF connector;

〖freq style〗: Click the drop-down box in the right to select from the three frequency styles, namely, the continuous frequency, internally-repeated frequency hopping and external real-time frequency hopping. The continuous frequency is a type of dot frequency, the internally-repeated frequency hopping can set the carrier to be switched as per specified dot number and time in certain frequency band, and the external real-time frequency hopping can input control data from the serial port of the rear panel to set the frequency of the RF TX carrier, so as to control the carrier in real time;

〖modu format〗: Click the box in the right to select the modulation format, including BPSK, QPSK, DQPSK, 8PSK, 16QAM, 2ASK, 2FSK, MSK, TCM-8PSK, FM, AM, LSB, USB and None. Select any modulation format to activate relevant parameter setting, for example, select “BPSK” to set code element rate (300Hz~5.0MHz), filter (RC, RRC and GAUSS), serial number (PN5) and α/BT (0.1~1.0), select FM to select modulation sources (including the Sine, Square, Triangle, Sawtooth, 7-core microphone and external frequency), set such modulation parameters as the rate and frequency spectrum, and select “None” to output only the carrier signal with the RF signal not modulated.

2: The 〖Demodu〗 interface is shown in Fig. 3-9:

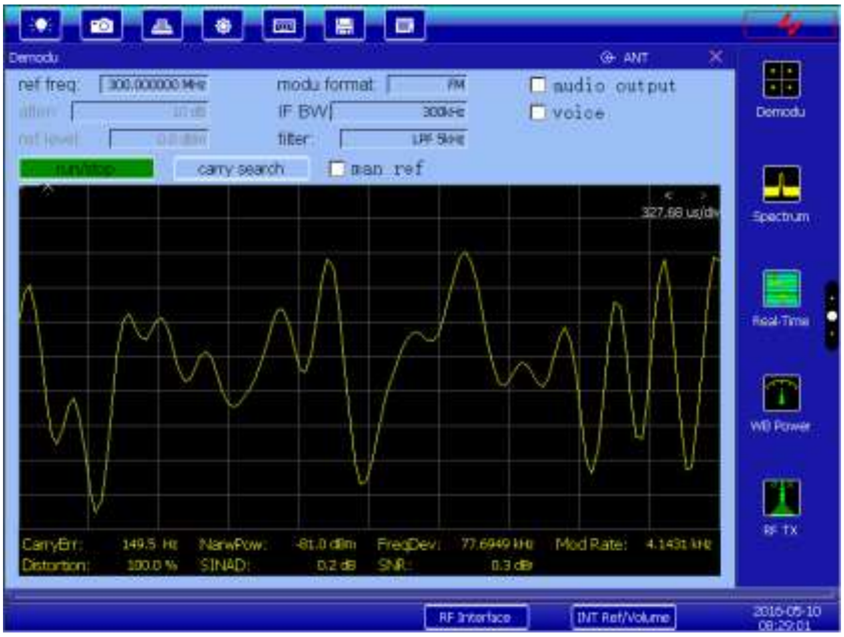


Fig. 3-9 Demodu interface

It is used to receive and analyze the signal, including signal modulation, and frequency error and power measurement.

〖ref freq〗: It is the carrier frequency used for receiving signal, which is set to 300MHz in Fig. 3-9. If the carrier frequency is uncertain, click 〖carry search〗 and select corresponding frequency band to be searched, and the tester will search the carrier automatically; such auto search function is realized via the spectrum function, and there is a little difference between the search result and actual carrier, resulting in improper modulation if the IF WB is set too small or during vector modulation. It is suggested to input the carrier frequency manually in this circumstance.

〖modu format〗: It is used to select the modulation format for receiving signals, including BPSK, QPSK, DQPSK, 8PSK, 16QAM, 2ASK, 2FSK, MSK, TCM-8PSK, FM, AM, LSB, USB and None.

〖atten〗 and 〖ref〗: Both of them can be used together, which are in the auto mode by default; when the reference level is set, the attenuation changes accordingly; the attenuation can also be set manually as required by clicking the box in the right of 〖atten〗; if the reference level is in the auto mode, its lower limit is set to 0dBm. Please switch to the manual reference level mode and lower the level as per the amplitude of the signal under test when measuring small signals.

Specific parameters for receiving and analyzing FM/AM/SSB analog modulation signals are as follows:

〖IF BW〗: It is used to set the intermediate frequency bandwidth in the receipt channel, which can be selected from 300kHz, 100kHz, 30kHz, 25kHz, 12.5kHz, 10kHz, 8.33kHz and 6.25kHz. The IF BW value selected shall not be lower than the IF BW value of the signal, and if the signal modulation format is FM, the IF BW value selected shall not be lower than 2 times of both the FM frequency deviation and modulation rate; if the signal to be measured is small, lower the intermediate frequency bandwidth accordingly, so as to avoid any improper modulation.

〖filter〗 is used to conduct lowpass filtering on the modulated sound signal, which can be selected from LPF 45kHz, LPF 20kHz, LPF 15kHz, LPF 5kHz, LPF 300Hz, LPF 50Hz (IF BW<30kHz), 300Hz ~20k, 300Hz ~15k, 300Hz ~5k and 300Hz ~3.4k. The filter shall be selected as per the modulated audio signal, with the frequency covering the frequencies of the audio signals under test;

〖run/stop〗: Click it to start and stop signal receipt and analysis;

〖audio output〗: Click to check the small box in front of it to output the modulated audio signal from corresponding connectors on the rear panel;

〖Voice〗: Click to check the small box in front of it to transmit the modulated audio signal to the Voice for sound production. After that, the modulated audio signal can be heard.

The modulated signal waveform is shown at the middle of the screen, and the display time can be set by clicking the top right, whereas the analysis results of the received signals are displayed at the bottom of the screen, including the carrier error, power, frequency deviation or modulation depth, modulation rate, distortion, SINAD and SNR.

Parameters for receiving and analyzing the FSK/PSK/QAM vector modulation signal are as follows:

〖SR〗: It is used to set the code element rate of the vector signal, with a range of 1kHz～5MHz;

〖symbol num〗: It is used to set the number of symbols analyzed at one time, which is related to the display, analysis and calculation of the results;

〖alpha/BT〗: It is used to set the form factor of the reference filter;

〖filter〗: It is used to set the reference filter, which can be selected from RC, RRC or GAUSS;

〖wave type〗: It is used to set the graph type, which can be selected from the star graph, vector graph, eye graph and time IQ graph;

〖seq output〗: Click to check the small box in front of it to output the modulated digital signal from the 26-core connectors on the rear panel;

Note: Click the square icon in the upper right of the modulation graph to change the graph display style.

3: 〖Spectrum〗interface:

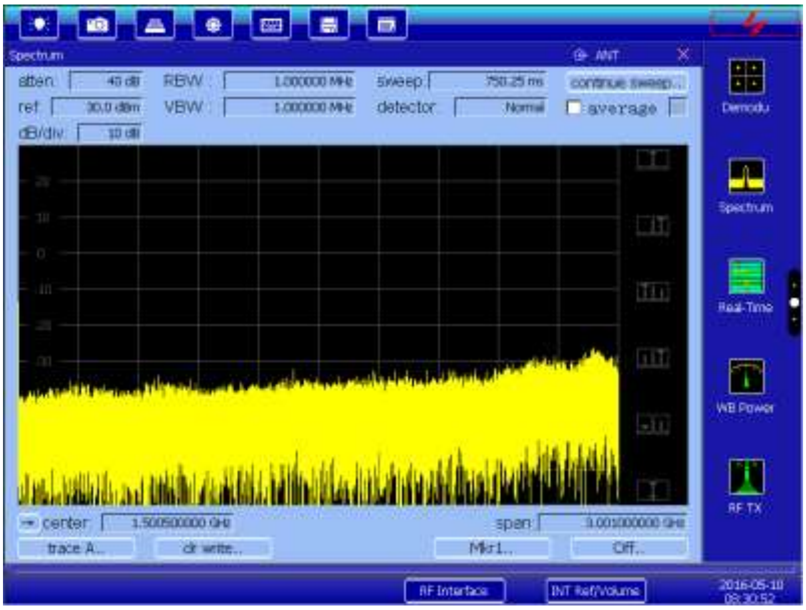


Fig. 3-10 Spectrum initial interface

〖atten〗 and 〖Ref〗: with functions same with that of 〖Demodu〗;

〖RBW〗: It is used to set the resolution Bandwidth, which is the min. distinguishable frequency space of the received signal and coupled automatically as per the sweep width be default. Click the box in the right to input the value, or change the value via RPG. It is switched to the manual status at this moment. The RBW setting value ranges 30Hz~3MHz;

〖sweep〗: It is used to set the sweep time, which is coupled automatically with RBW and VBW as per the sweep width by default, with setting range of 80ms~200s;

〖VBW〗: It is used to set the video bandwidth, which is coupled automatically with RBW by default. The setting method is the same with that of the RBW, with setting range of 30Hz~3MHz;

〖average〗: It is used to enable or disable the video average function, which is “disabled” by default. Check the small box in front of it to enable the video average function, and calculate the smooth trace via continuous average. Input the average times in the input box in the right of the screen;

〖detector〗: It is used to select the digital detection method for the tester, which can be selected from 〖normal〗, 〖Positive Peak〗, 〖Negative Peak〗 and 〖Sampling〗, with 〖normal〗 to be the mode for startup by default;

〖dB/div〗: It is used to set the amplitude scale, with setting range of 1～20dB/scale.

The sweep spectrum waveform is shown in the center of the screen, with such icons as the peak, secondary peak, left peak, right peak, minimum, peak to center shown in the right from the top to bottom.

Click 〖→〗 in the left of 〖center〗 to select 〖Show: Start-Stop〗 or 〖Show: Center-Sweeping〗 to set the frequency sweeping band, or click 〖Zero frequency adjustment〗 to change the zero frequency range of the spectrometer (which is set properly before delivery, and requires no adjustment from the user).

〖Show: Start-Stop〗 is used to set the displayed frequency range by setting the start and end frequencies;

〖Show: Center-Sweeping〗 is used to set the displayed frequency range by setting the center frequency and sweeping bandwidth.

〖trace A〗: Click it to select trace A or B.

〖clr write..〗: Click it to select Refresh (Clear), Max hold, Min. hold, Display or Blank:

Refresh: To refresh the sweeping result in real time;

Max hold: To hold the max. display at each frequency point;

Min. hold: To hold the min. display at each frequency point;

Display: To stop and save current refreshing result;

Blank: To hide the sweeping results.

〖Mkr 1〗: Click it to select the frequency marker, including Mkr 1, Mkr 2, Mkr 3 and Mkr 4;

〖Off〗: Click it to select the marker functions, including 〖Normal〗, 〖Marker error〗, 〖Separate in pair〗, 〖Trace in pair〗, 〖Close〗, 〖Trace: Auto〗, 〖Trace: A〗, 〖trace: B〗, 〖Noise Marker: On〗, 〖Noise Marker: Off〗, 〖Clear mark〗 and 〖Search setting〗:

〖Normal〗: To be in the normal status, which is set by default;

〖Marker error〗: To measure the error between two markers (click it to turn the RPG roller to move the marker with error, and show the frequency error and amplitude error between two markers in the middle of the screen)

〖Separate in pair〗 and 〖Trace in pair〗: The two markers move in opposite directions and in the same direction when separating in pair and tracing in pair respectively;

〖Close〗: To close the marker;

〖Trace: Auto〗: Click it to select the marker (which is in the automatic status be default), or select trace A or B;

〖Noise Marker: On〗: Click it to open the noise marker function to measure the signal noise;

〖Clear mark〗: Click it to clear all opened markers;

〖Search setting〗: Click it to pop up a marker search parameter window for searching, including the peak increase/decrease and peak limit.

4: 〖Real-Time〗 function

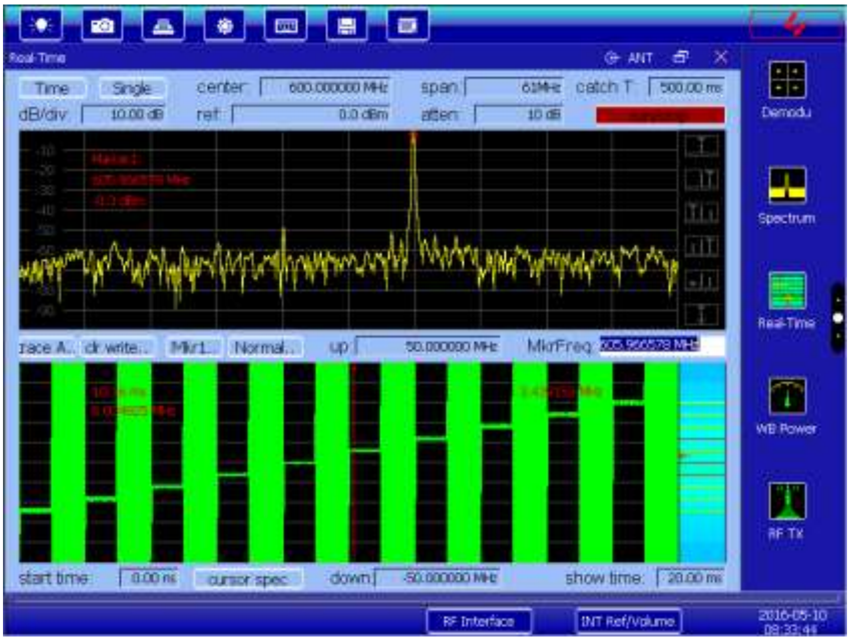


Fig. 3-11 Real-time spectrum analysis interface

Real-time spectrum analysis is used to analyze the real-time spectrum contents of the signal, with max. available analysis bandwidth of 60MHz. Click 〖Real-Time〗 to enter the function interface.

Click〖Time〗to select different domain range, including the〖Waterfall〗,〖Time (frequency and range)〗,〖Time (frequency)〗 and 〖Time (range)〗:

〖Waterfall〗: The signal frequency spectrum is shown at the top, and frequency spectrum contents at different frequency points distinguished with colors shown at the bottom (the red indicates more contents, whereas the green indicates less). In the single mode, the cursor can be dragged to view the frequency point as well as the frequency and amplitude of the probability graph at any time in the lower display window.

〖Time (frequency)〗: The signal frequency spectrum is shown at the top, and frequency contents (namely, the modulation domain graph) related to the signal and time shown at the bottom; in respect of frequency feature display, the probability at each frequency point is shown in the right of the lower display window (the darker the color is, the bigger probability of the signal appeared at such frequency point is within current show time), which can be used to test the frequency point of the frequency hopping signal within the show time. In the single mode, the cursor can be dragged to view the frequency point as well as the frequency and amplitude of the probability graph at any time in the lower display window.

〖Time (range)〗: The signal frequency spectrum is shown at the top, and the amplitude related to the signal and time shown at the bottom; the remaining measurement features are the same with those of the 〖Time (frequency)〗;

〖Time (frequency and range)〗: Both the frequency and amplitude related to the signal and time are shown at the bottom.

Click 〖Continuous〗 to select an analysis mode, including 〖Single〗 and 〖Continuous〗. In the〖Continuous〗 mode, click〖run/stop〗 to refresh continuously as per the display mode selected by the user rather than seamless refreshing (the signal between the interval of refreshing will be lost); in the〖Single〗, click 〖run/stop key〗 to capture signals seamlessly once, with capture length depending on the time value set in “catch T”. After that, 〖run/stop key〗changes from green to red automatically, and the frequency spectrum at any time within the duration can be viewed via the cursor.

Click 〖center〗 and 〖span〗 to set the frequency band of the signal to be analyzed.

Click 〖dB/div〗 to set the display scale, with range of 1dB~20dB.

Refer to 〖Demodu〗 mentioned above to set 〖ref〗 and 〖atten〗.

〖catch T〗 is available in the Single mode, which can be used to set the single capturing duration. The bigger the analysis bandwidth is, the smaller the duration will be. The max. duration is 1.34s when the max. available analysis bandwidth is 60MHz.

Refer to 〖Spectrum〗 mentioned above to set the trace and marker.

In the single mode, after capturing is completed, click the screen to activate the cursor at the lower part of the window, and drag the cursor to measure the graph displayed.

〖up〗 and 〖down〗 can be used to set the frequency range to be displayed. If 〖center〗, 〖up〗 and 〖down〗 are set to 300MHz, 50MHz and -50MHz respectively, the frequency range displayed is 250MHz~350MHz.

Within the capturing period, 〖start time〗 can be used to view the signal graph of corresponding start time.

Within the capturing period, 〖show time〗 can be used to view the signal graph of corresponding show time.

〖cursor spec〗 is available when the cursor is activated, which can be used to view the signal spectrum of 1024 sampling points starting from the position where current cursor locates. If the available analysis bandwidth is 60MHz, the sampling rate is 100MHz, and for other analysis bandwidth, the sampling rate increases by power of 2.

5: 〖Audio TX〗 function

Fig. 3-12 Audio frequency generation interface

Click 〖Audio TX〗 to enter the Audio frequency generation interface.

Click 〖audio src〗 to select〖Sine〗, 〖Square〗, 〖Triangle〗 and〖Sawtooth〗.

Click 〖Frequency〗 to set the frequency for the audio frequency generation, with range of 20Hz~20kHz.

Click 〖level〗 to set the power for the audio frequency generation, with range of 1mVrms~7Vrms.

Click 〖ohm〗 to select the output impedance from 150Ω, 600Ω and high-Z. Since the internal resistance of the tester is small, the signal output level is changed actually at different output impedance.

Check the small box in front of the 〖output〗 to output the set audio signal, which is the main switch for single or dual audio output.

If a dual audio output mode is required, set the frequency, level and relative phase of the auxiliary audio, check the small box in front of the 〖dule〗 to enable the dual audio output mode. In the dual audio output mode, the superposition level of the signal shall not exceed 7Vrms, otherwise the signal will be distorted severely.

6: 〖Audio RX〗 function

Click 〖Audio RX〗 to enter the Audio frequency analysis interface.

Click 〖wave〗 to select the graph display area below to display the time or spectrum.

Click 〖filter〗 to select different audio filters, including LPF 20kHz, LPF 15kHz, LPF 5kHz, LPF 300Hz, LPF 50Hz, 300Hz ~20k, 300Hz ~15k, 300Hz ~5k and 300Hz ~3.4k, which can be selected properly as per the bandwidth of the input signal.

Click 〖ohm〗 to select the input impedance for the tester from 150Ω, 600Ω and high-Z.

Click 〖RX chl〗 to select the audio analysis voltage range from 30V~8Vpp, 8V~1Vpp, 1V~200mVpp, <200mVpp and Auto as per the input signal level. Please note that when measuring the signal with DC offset, the measuring span must cover the DC level. If the signal amplitude is uncertain, select Auto. After that, the tester can specify the signal automatically and select proper span.

If 〖Auto Test Frequency〗 is selected, the test frequency is positioned at the peak frequency point automatically.

〖snr freq〗 is available only when the test frequency is in other modes rather than Auto, which is used to select the frequency for the test audio manually. For example, in case of multiple audio signals, the frequency of one of them can be selected for testing.

〖SNR ref lock〗 is available only when "reference is locked in case of any noise" in the SNR measuring mode. Click it, and the tester will record the noise power of current testing frequency (the test frequency must be set manually at this time). When the signal is activated, calculate the SNR via the ratio between the signal power and the noise power.

Click 〖Voice〗 to activate the sound of the real-time output audio of the built-in Voice.

After setting, the audio analysis waveform will be displayed on the main screen, and analysis data displayed on the lower part of the screen, including the frequency, level, distortion, sinad, SNR, and audio power.

Click the upper right on the waveform analysis screen to set the show time, that is, click 〖<〗 and 〖>〗 to increase and decrease the show time respectively.

Note: Click the square icon in the upper right of the modulation graph to change the graph display style.

Fig. 3-13 Audio analysis interface

7: 〖BER RX〗 function interface:

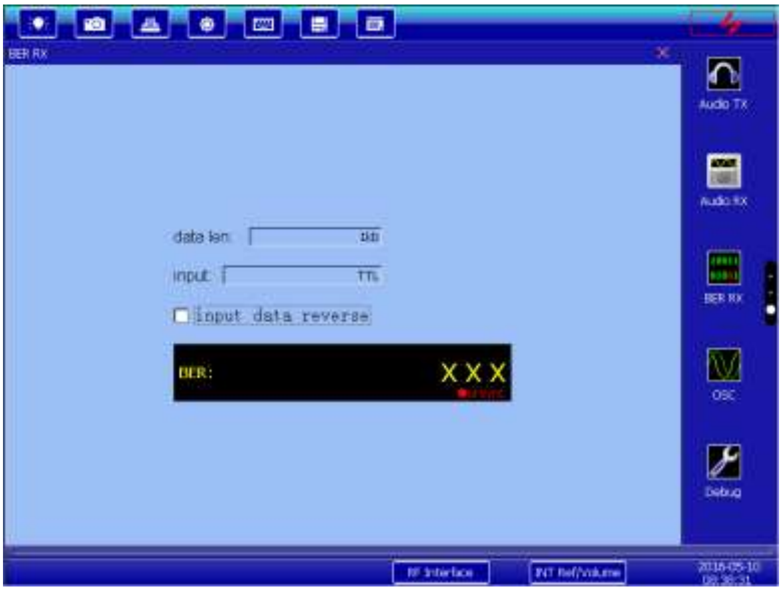


Fig. 3-14 Bit error analysis interface

Click 〖BER RX〗 to enter the bit error analysis function interface. The bit error analysis function shall be used together with the RF transmitting function for proper coder error measurement. The vector modulation function in the RF emission is used to modulate the original code flow to the carrier for transmitting and outputting to the equipment under test; after receiving the modulated signal, the equipment under test modulates the original code and outputs it to the tester, and then the tester compares such code flow with the internal original code flow, thus getting the bit error rate.

Click 〖data len〗 to set the length of single data analysis, including 1kb, 10kb, 100kb, 1Mb and 10Mb. In case of low signal rate, select a short analysis length.

Click 〖input〗 to select a level input interface on the rear panel, including the TTL level and 232 level.

Click the small box in front of 〖input data reverse〗 to realize data inverting.

The bit error rate tested will be shown in the test results. The word “unsynchronized” appeared below in red indicates the input code flow synchronous clock is abnormal or the bit error rate is too big (which cannot exceed 3 bits for every 10 continuous bits). Please check to confirm whether the input code flow synchronous clock is abnormal or the bit error rate is too big.

8: 〖WB Power〗 function interface:

Fig. 3-15 Wide-band power measurement interface

Click 〖WB Power〗 to enter the power measurement interface:

Click 〖freq〗 to set the frequency point for power measurement, with available frequency range of 400kHz～1.05GHz (4945B) and 400kHz～3GHz (4945C); set the reference frequency as per the carrier frequency of the signal under test to avoid too big measurement error.

Click 〖unit〗 to select the unit for the power to be measured, including dBm, dBuV, dBmV, dBV, V and Watts.

The signal power of such frequency point can be measured after setting. Please pay attention to the power measurement range of the ANT port and T/R port. If the input power is too small, it cannot be measured correctly, and the displayed value will be inconsistent with the actual power value.

9: 〖OSC〗 function

Click 〖OSC〗 to enter the oscilloscope function interface:

Click 〖mode〗 to select the mode from Auto and Normal. In the Auto mode, neither of the outputs can be triggered via rolling, that is, both outputs are displayed in waveform; in the normal mode, one input can be selected to be triggered and the other displayed in waveform. Click 〖trig time〗 in the lower right of the screen to set the time starting from triggering.

Click 〖run/stop〗 to run or stop the oscilloscope scanning.

Click〖Single〗to set the scanning to be in the single mode, which stops after scanning one frame; if the single mode is not selected, the oscilloscope will be in the continuous scanning mode.

Click 〖horizon〗 to set the display time.

Select channel 1 or 2 as per the interface of the oscilloscope connected, with each channel including the following functions:

〖coup style〗: Both DC and AC are available. The former shall be selected when the signal is a DC one or the frequency is very low, whereas the latter is selected when the signal frequency is high.

〖offset〗: It refers to the vertical deviation distance of the signal. When it is 0, the signal locates in the center of the screen vertical position.

〖ver scale〗: It is used to set the unit of the vertical coordinate.

〖ampl Mrk〗: It is used to measure the signal amplitude.

〖time Mrk〗: It is used to select different point in time for the signal.

〖trig time〗: It is used to select the starting time for triggering.

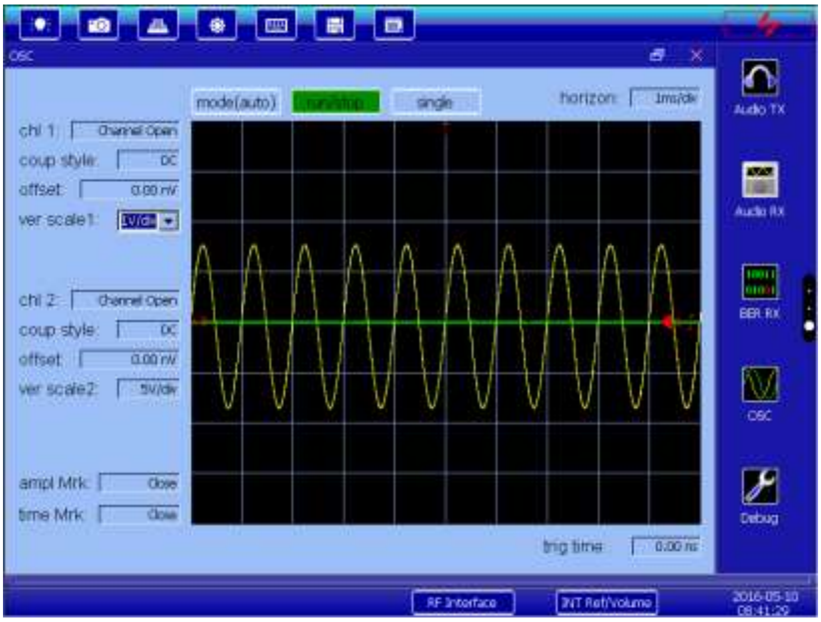


Fig. 3-16 Oscilloscope interface

In addition to single measuring function mentioned above, multiple interfaces of the tester can be combined together to facilitate user’s observation and measurement. In the combined interface, click 〖×〗 and 〖□〗 on the title bar in the upper right of each sub-interface to close or maximize it respectively. For example:

10: RF emission and audio analysis (receiver test):

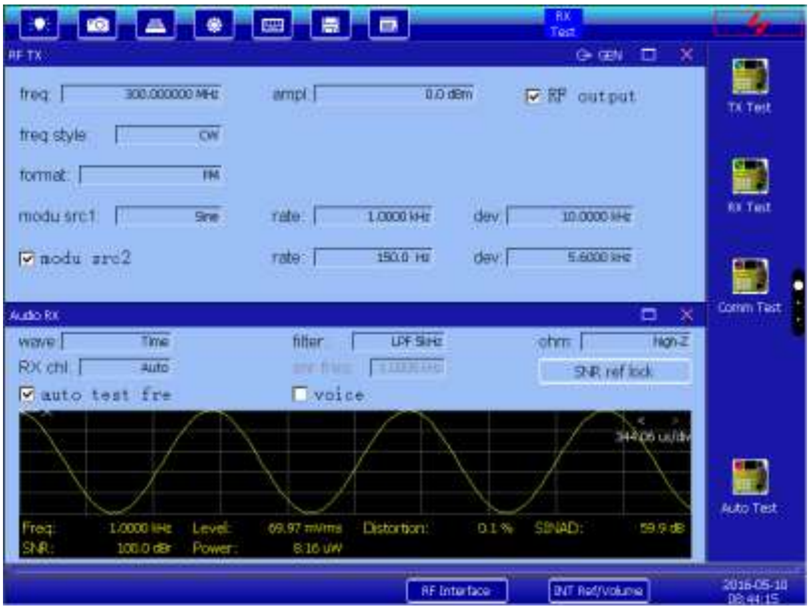


Fig. 3-17 Combined interface: RF emission and audio analysis

11: RF receipt and audio generation (transmitter test):

Fig. 3-18 Combined interface: RF receipt and audio generation

12: RF emission, RF receipt, audio generation and audio analysis:

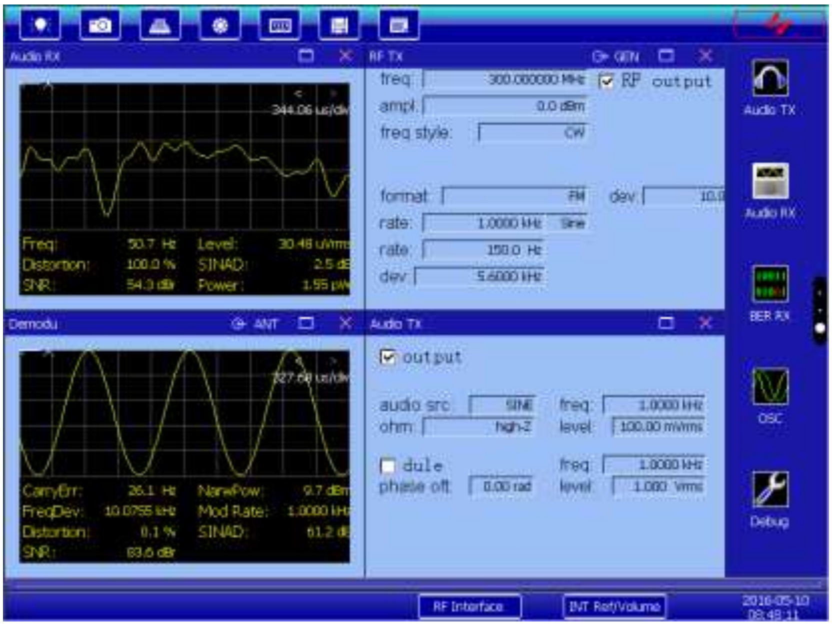


Fig. 3-19 Combined interface: RF emission, RF receipt, audio generation and audio analysis

13: Auto test:

Fig. 3-20: Auto test interface

The built-in auto test software of the tester is used to conduct auto test or auto guiding test on the equipment to be tested. The auto test software supports the working parameters of the equipment under test as well as such functions as qualification threshold editing, free selection of test items, auto measurement on test items during test, measuring report generation, and test result saving and viewing.

Click 〖Settings〗 and select 〖New〗 to create the name of the equipment to be tested. If the equipment same has been created, select 〖Select equipment under test〗 to select the equipment to be tested from the equipment names created. After that, click 〖Settings〗 > 〖Inherit〗 to create an inherited equipment for testing based on the current device parameters. Click 〖Settings〗 > 〖Edit〗 to edit current equipment parameters, 〖Settings〗 >〖Delete〗 to delete current equipment under test, and 〖Settings〗 > 〖Share to another instrument〗 to send the model and configuration file of current equipment to another comprehensive radio tester via the network cable.

Click 〖New〗, 〖Edit〗 or〖Inherit〗 to pop up the parameter editing dialog box of the equipment under test, from which the working parameters and qualification threshold can be edited, including the carrier, modulation/sensitivity, rejection ratio, audio/noise, frequency hopping and control options, whereas:

“Carrier” is used to set the working frequency and allowable error, emission power and allowable error, allowable harmonic wave and stray error, and parameters related to adjacent channel power measurement;

“Modulation/sensitivity” is used to select the modulation method, pilot frequency, rated frequency deviation, rated sensitivity and max. input power.

“Rejection ratio” is used to set the IF frequency point and its allowable rejection ratio, as well as the frequency point of the image frequency and its allowable rejection ratio;

“Audio/noise” is used to set the reference audio level, allowable level error, SNR of big signals, allowable audio wave distortion, and noise characteristics;

“Frequency hopping” is used to set the start frequency, end frequency, rated rate and switching time for frequency hopping;

“Control” is used to select whether to control the PPT of the equipment under test automatically. The 26-core test bus on the rear panel of the test is provided with the PPT control output cable. The receipt and transmission functions of the equipment under test that supports the PPT control can be controlled automatically during test rather than setting it to the receipt or transmission status manually.

Select the name of the equipment under test and then click 〖Option〗 to select the test items, including “Working frequency error”, “Emission power”, “Harmonic emission component”, “Parasitic emission component”, “Transmitter analog modulation...”, and “ACPR”.

After editing the auto test device and test options, click 〖Start〗 to enable the auto test function, 〖Stop〗 to stop the auto test function, 〖Cont〗 to continue auto test function after testing one index, 〖Clear〗 to clear current data and then 〖Start〗 to start the test again.

〖Single〗 indicates the auto test is in the single mode, which stops after the selected indexes are tested; 〖Cycle〗 indicates the auto test is in the cycle mode, which starts over again after the selected indexes are tested.

The tested indexes and results will be displayed on the main screen, including 〖output〗, 〖Pass〗, 〖Critical〗, 〖Error〗 and 〖UnTest〗.

After test, a prompt will pop up, indicating to save the test result as per the saving icon on the upper part of the screen.

Chapter IV Operating Instructions

The chapter introduces the functions and measuring techniques of the tester via some typical test examples.

Section I RF Emission

The section introduces the RF signal generation of the 4945B/C radio communications test set. Start up the tester and warm up for 15 minutes, and then click 〖RF TX〗 to switch to the signal source setting mode.

1 Dot frequency signal

1) Select 〖RF TX〗 in the function menu;
2) Click 〖freq〗 in the upper left of the screen to enter the frequency value;
3) Click 〖ampl〗 to enter the power value;
4) Click 〖RF output〗 in the upper left of the screen to enable the signal output function. After that, the dot frequency signal is output from the RF output connector, with the display interface shown in Fig. 4-1.

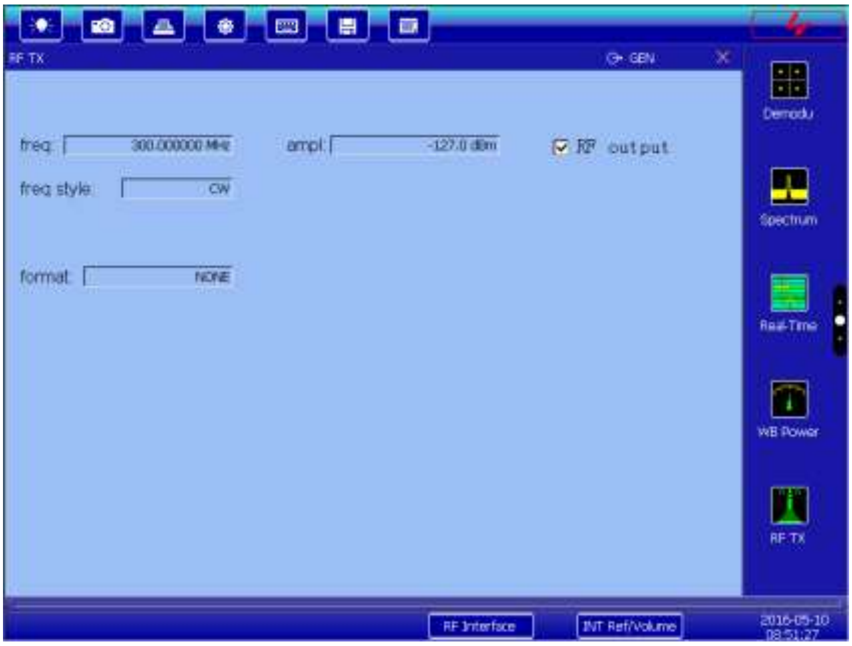


Fig. 4-1 RF TX startup interface

2 Analog modulation signal

1) Select 〖RF TX〗 in the function menu;
2) Click 〖freq〗 to enter the frequency value, and 〖ampl〗 to enter the amplitude value;
3) Click 〖modu format〗 to select the modulation format. For example, select FM, and click 〖Freq Dev〗 to set it to 10kHz;
4) Click 〖modu src〗 to select Sine, and 〖rate〗 to set it to 1 kHz;
5) Click 〖modu src 2〗 to enable or disable it as required;
6) Check 〖RF output〗 in the upper right of the screen to output the modulated signal from the RF output connector.

The modulated signal output is shown in Fig. 4-2, whereas the modulation source is internal, with the modulation rate, frequency deviation, carrier frequency and carrier amplitude of 1kHz, 10kHz, 300MHz and -127dBm respectively.

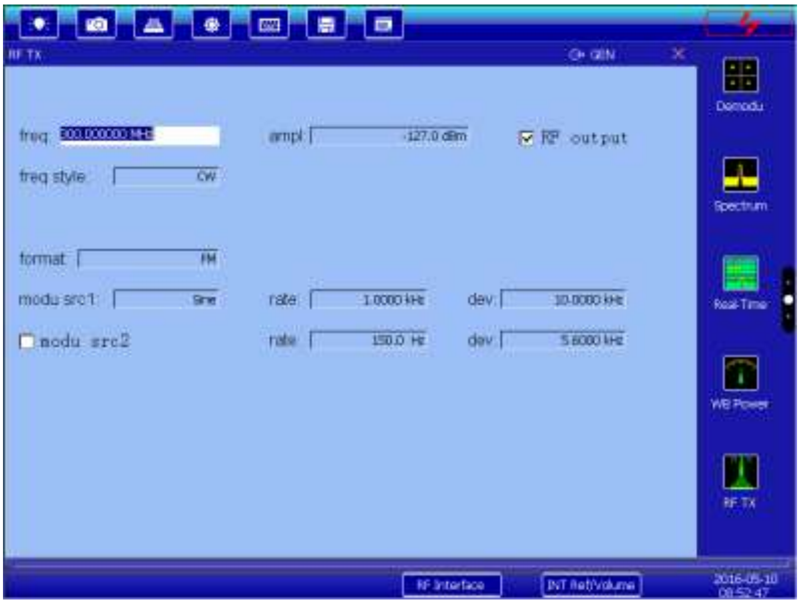


Fig. 4-2 FM signal output interface

3 Digital modulation signal

1) Select 〖RF TX〗 in the function menu;

2) Click 〖freq〗 to enter the frequency value, and 〖ampl〗 to enter the amplitude value;

3) Click 〖modu format〗 to select QPSK, 〖sym rate〗 to set it to 1MHz, 〖filter〗 to select RRC, and 〖α/BT〗 to set it to 0.50;

4) Check 〖RF output〗 in the upper right of the screen to output the modulated signal from the RF output connector.

The QPSK signal output is shown in Fig. 4-3, whereas the modulation source is internal, with the signal rate, filter type, α/BTvalue, carrier frequency and carrier amplitude of 1MHz, RRC, 0.5, 300MHz and 0dBm respectively.

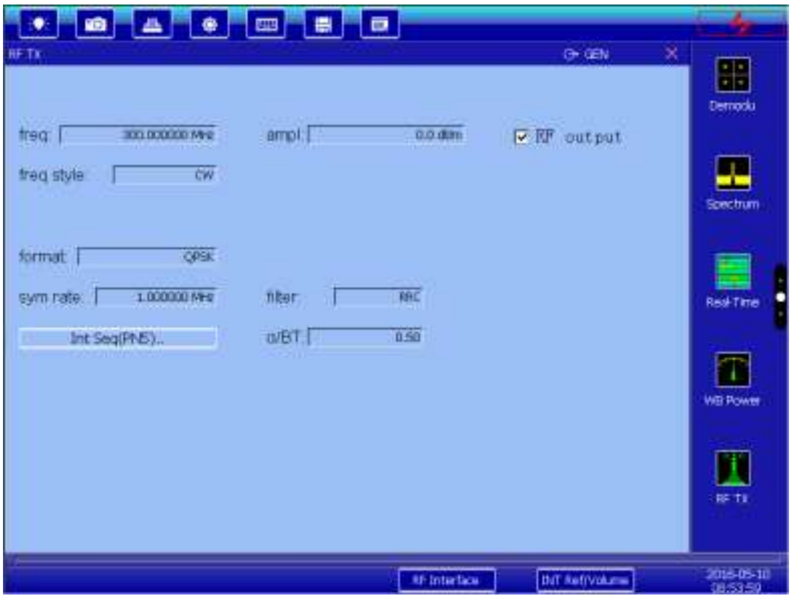


Fig. 4-3 Digital modulation signal output interface

4 Frequency hopping signal generation

1) Select 〖RF TX〗 in the function menu;

2) Click 〖freq style〗 to select the internally-repeated frequency hopping, and 〖set freq hop〗 to set the start frequency, end frequency and number of frequency points;

3) Click〖ampl〗 to enter the amplitude of 0dBm, and check 〖RF output〗 in the upper right of the screen to output the modulated signal from the RF output connector.

Frequency hopping signal output is shown in Fig. 4-4, with the format of modulation-free, frequency hopping format of internally-repeated frequency hopping, and carrier amplitude of 0dBm.

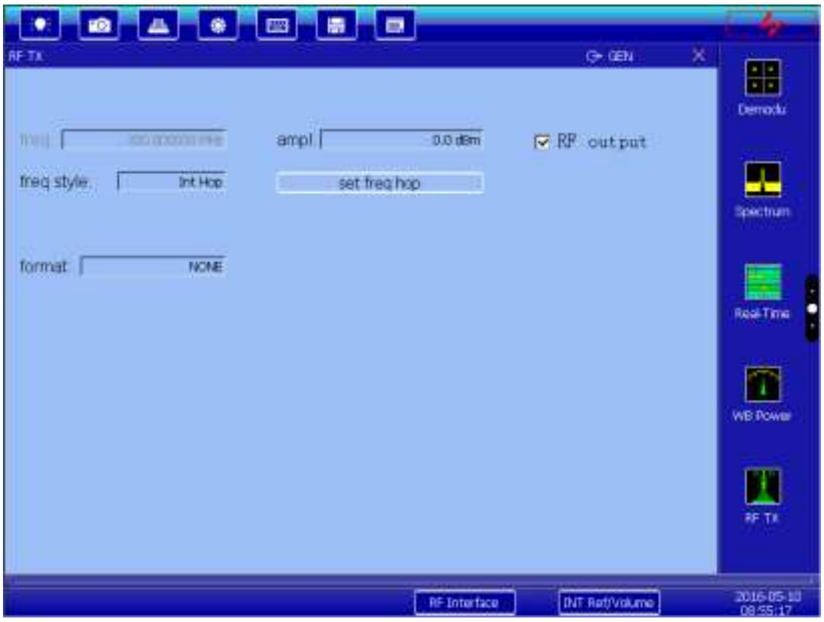


Fig. 4-4 Frequency hopping signal output interface

Section II RF receipt

The section introduces RF receipt operations of the 4945B/C radio communications test set, and takes the Aglient E4438C signal generator for RF signal generation, with instrument wiring shown in Fig. 4-5. Start up the tester and warm it up for 15 minutes, and then click 〖Demodu〗 in the upper right of the screen to switch to the RF receipt performance test mode.

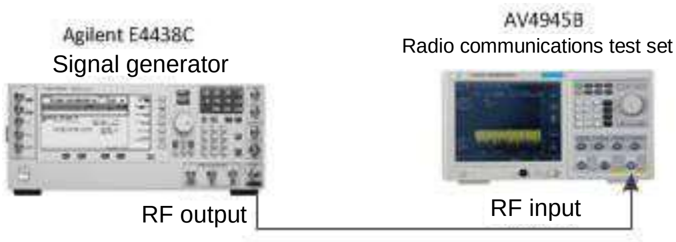


Fig. 4-5 RF receiver wiring diagram

1 FM demodulation

1) Connect the RF output of the signal generator to the RF input ANT port of the 4945B/C;

2) Reset and set the signal source as follows:

   Frequency: 300MHz

   Power: 0dBm

   FM modulation: Enable

   Modulation rate: 1kHz

   Frequency deviation: 100kHz

3) Turn on the signal source RF switch;

4) Click 〖Demodu〗 of the 4945B/C to enter the RF receipt performance test mode;

5) Click〖modu format〗in the left of the screen to switch it to FM，and set the IF bandwidth and audio filter as per the input frequency deviation and modulation rate. In this case, the instrument can be

set as follows:

Reference carrier: 300MHz

Modulation format: FM

IF bandwidth: 300kHz

Audio filter: LPF 5kHz

The screen will show the modulation rate, frequency deviation and other parameters of the signal modulated while waiting for second counting. It is shown in Fig. 4-6.

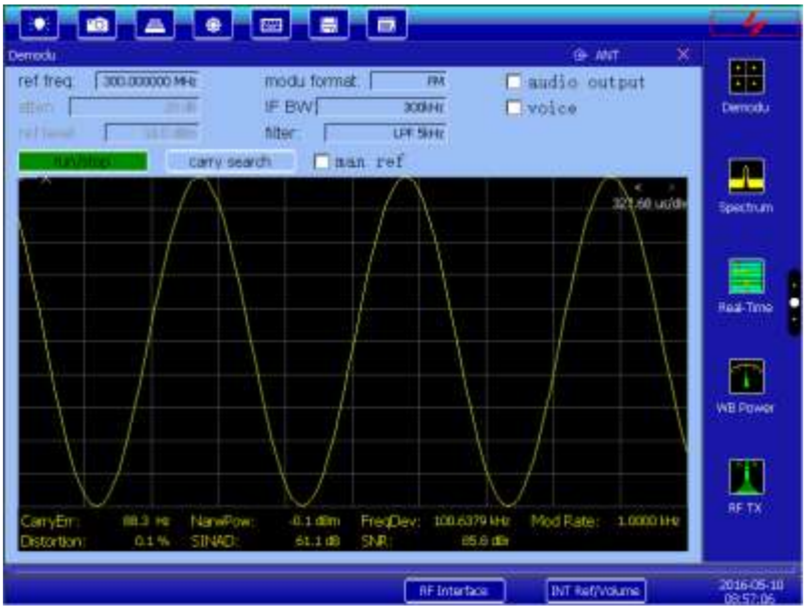


Fig. 4-6 FM demodulation interface

2 Digital demodulation

1) Connect the instrument;

2) Reset and set the signal source as follows:

Frequency: 300MHz

Power: +2dBm

Modulation format: QPSK

Code element rate: 1 MHz

Filter: RRC

α/β factor: 0.5

3) Turn on the signal source RF switch;

4) Click 〖Demodu〗 of the 4945B/C to enter the RF receipt performance test mode;

5) Click 〖modu format〗 to switch to QPSK, and conduct setting as per the input code element rate and filter. In this case, the instrument can be set as follows:

Reference carrier: 300MHz

Modulation format: QPSK

Code element rate: 1 MHz

Filter: RRC

α/βfactor:0.5

Vector graph type: Star

The screen will show the star diagram and parameter rest results while waiting for second counting. It is shown in Fig. 4-7.

Fig. 4-7 Digital demodulation interface

Section III Wide-band power measurement

The 4945B/C radio communications test set can be used to measure the broadband signal power, with measuring steps shown below:

1) Connect the instrument as per Fig. 4-5;
2) Reset and set the signal source as follows: Frequency: 1 GHz; power: 0dBm; turn on the signal source RF switch;
3) Click 〖WB Power〗 in the right menu of the main interface of 4945B/C:
4) Click 〖freq〗 and 〖unit〗 for relevant setting on the lower part of the screen as per the input signal. After that, the power value of the signal under test can be seen, as shown in Fig. 4-8.

Fig. 4-8 Power measuring result

Section IV Sweeping spectrum

The section introduces the signal measuring method via the sweeping spectrum function of the 4945B/C radio communications test set, and the 1473 programmable multimode signal source is adopted in this case. If other instrument is used for testing, the result may differ.

Start up the instrument and warm it up for 15 minutes, and then connect the instrument as per Fig. 4-9;

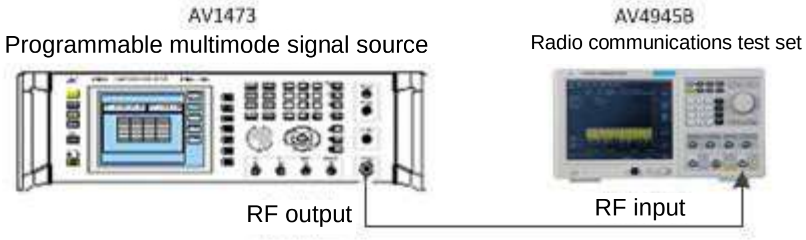


Fig. 4-9 Wiring diagram for sweeping spectrum measuring

The measuring steps are shown as follows:

1) Connect the instrument;
2) Reset and set the signal source as follows:

   Frequency: 300MHz

   Power: -15 dBm

3) Turn on the signal source RF switch;
4) Click 〖Spectrum〗 in the right menu of the main interface of 4945B/C to enter the sweeping spectrum working mode;
5) Click 〖center〗 and 〖sweep〗 for relevant setting on the lower part of the screen as per the input signal. After that, the spectrum of the signal under test can be seen, as shown in Fig. 4-10.

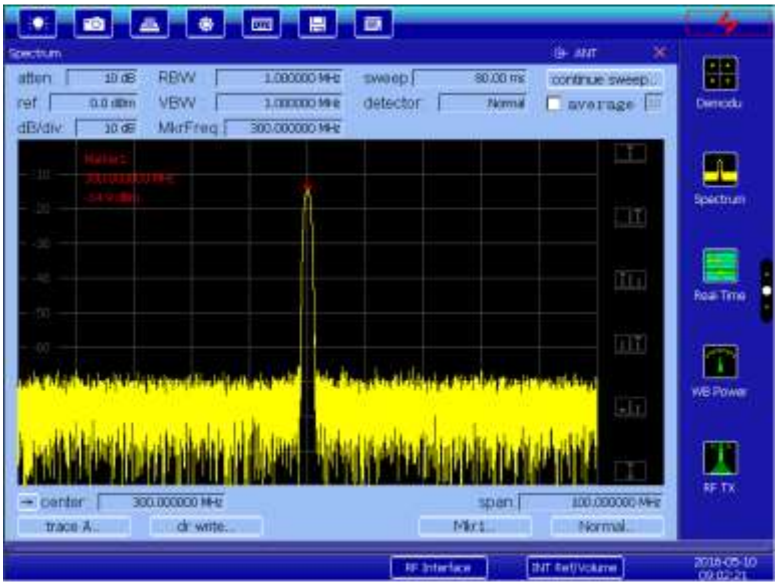


Fig. 4-10 Spectrum measuring interface

In the Spectrum mode, the power of specific frequency point can be measured easily via the marker. 4945B/C provides a shortcut option to use the marker for measurement, as shown in Fig. 4-11, through which such values as the peak, secondary peak, left peak and right peak can be measured easily. Meanwhile, the instrument can support multiple-marker measurement, and Markers 1-4 can be selected from the function menu in the left of the interface. The measuring case shown in Fig. 4-10 selects Marker 1 for peak measurement.

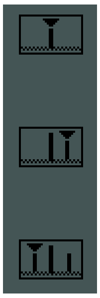


Fig. 4-11 Marker measurement shortcut

Section V Real-time signal analysis

The 4945B/C radio communications test set supports the real-time signal analysis of effective bandwidth of 60MHz, and the signal spectrum contents can be shown in real time in the form of waterfall, frequency time domain and amplitude domain. Start up the instrument and warm it up for 15 min., and then click 〖Real-Time〗 in the right menu of the main interface to enter the real-time spectrum analysis mode.

1) Connect the instrument as per Fig. 4-5;
2) Reset and set the signal source as follows:

   Sweeping type: Sweep

   Frequency start point: 570MHz

   Frequency end point: 630MHz

   Number of points: 11

   Power: 0dBm

3) Turn on the signal source RF switch;
4) Click 〖Real-Time〗 in the right menu of the main interface of 4945B/C to enter the real-time spectrum analysis mode;
5) Click 〖center〗 and 〖span〗, 〖up〗, 〖down〗 and 〖show time〗 for relevant setting on the lower part of the screen as per the input signal. After that, the spectrum of the signal under test can be seen, as shown in Fig. 4-12.

Fig. 4-12 Real-time spectrum analysis interface

Section VI Audio generation

The section introduces the audio signal generation of the 4945B/C radio communications test set. Start up the instrument and warm it for 15 min., and then click 〖Audio TX〗 in the right menu of the main interface to enter the audio generation mode.

The instrument supports both the single audio and dual audio modes. If only single audio is required, just click 〖output〗; if dual audio is required, click 〖dule (dual audio)〗. Check the IF output to set relevant parameters, including 〖audio src〗, 〖Frequency〗, 〖level〗 and 〖ohm〗 of the output audio. 〖phase oft〗 can be set in the dual audio mode. The interface is shown in Fig. 4-13:

Fig. 4-13 Audio output interface

Section VII Audio analysis

The section introduces audio signal analysis operations of the 4945B/C radio communications test set, and takes the Aglient E4438C signal generator for audio signal generation, with instrument wiring shown in Fig. 4-14. Start up the instrument and warm it for 15 min., and then click 〖Audio RX〗 in the right menu of the main interface to enter the audio analysis mode.

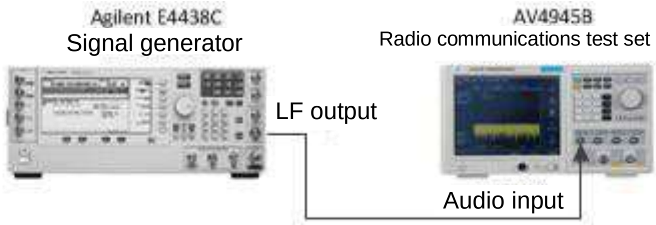


Fig. 4-14 Audio analyzer connection diagram

The 4945B/C radio communications test set supports the measurement on the audio frequency, amplitude, SNR and distortion. Here take the single audio signal for example to describe basic operations for audio analysis.

Reset and set the LF output frequency of the signal generator to be 1kHz, and amplitude to be 1Vrms.

In the audio analysis mode, set the input impedance and filter as per the input signal. After that, the signals under test and analysis results are shown on the interface. In this case, the filter, input impedance and self-selected frequency are set to LPF5kHz, high-Z and 1kHz respectively, with analysis results shown in Fig. 4-15.

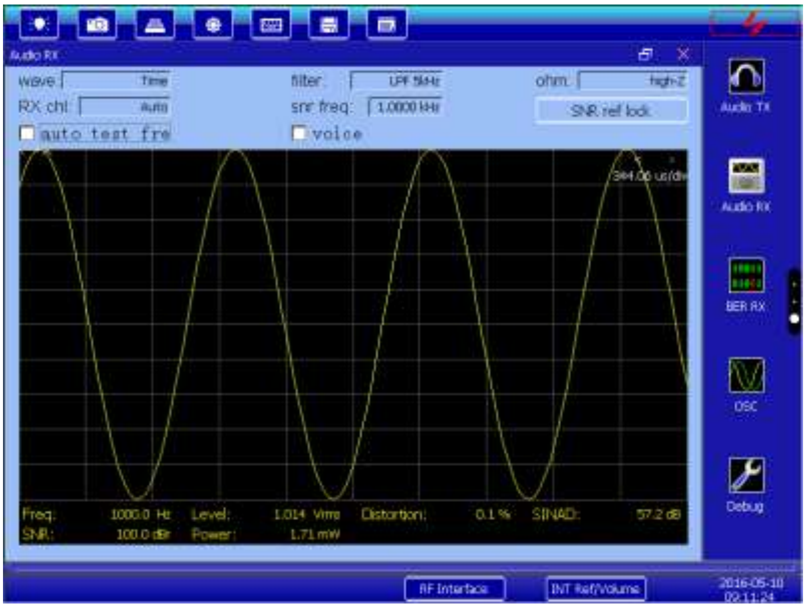


Fig. 4-15 Audio analysis results

Section VIII Bit error measurement

The 4945B/C radio communications test set supports data generation and bit error measurement, with measuring steps shown below:

1) Connect the data output clock with the data input clock (TTL), and the data output with data input (TTL) on the rear panel of the instrument respectively;
2) Click 〖RF TX〗 to set as follows:

   Carrier frequency: 1GHz, carrier amplitude: 0dBm;

   Format: BPSK;

   Code element rate: 500kHz, filter: RRC;

   Click 〖Int Seq (PN5)..〗 to set the bit error rate to be 0.0100000, and select the option to output it to the panel;
3) Click 〖BER RX〗 to set as follows:

   Single data length: 1Mb;

   Input level selection: TTL;

After that, the bit error rate test result can be seen, as shown in Fig. 4-16:

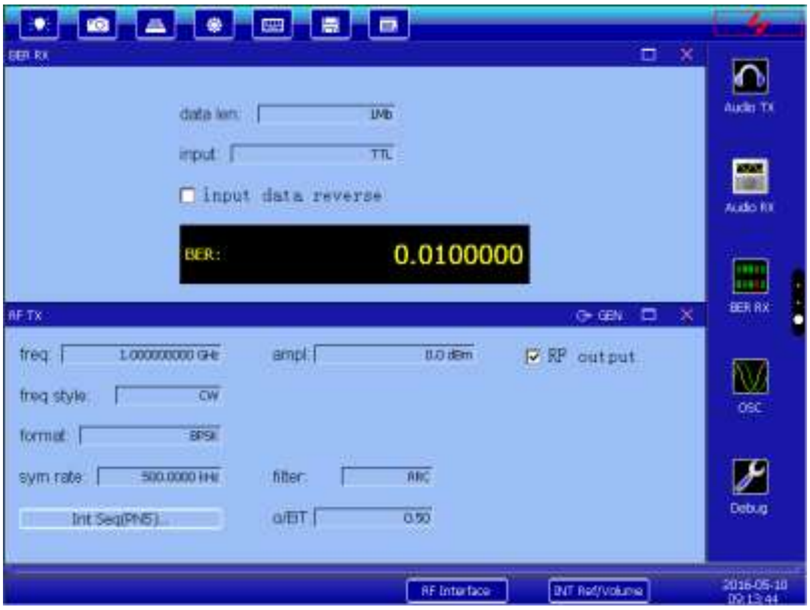


Fig. 4-16 Bit error measurement result

Section IV Oscilloscope

The section introduces the oscilloscope function operations of the 4945B/C radio communications test set, and takes the Aglient E4438C signal generator for input signal generation, with instrument wiring shown in Fig. 4-17. Start up the instrument and warm it for 15 min., and then click 〖OSC〗 in the right menu of the main interface to enter the oscilloscope operation mode.

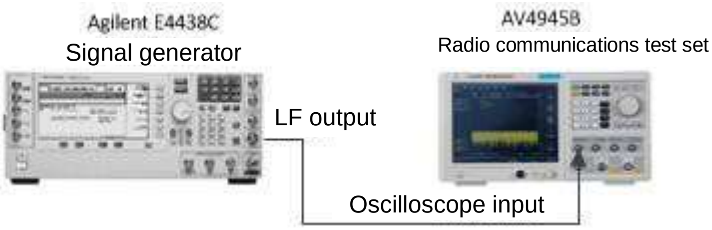


Fig. 4-17 Oscilloscope function connection diagram

The 4945B/C radio communications test set supports the signal input of dual-channel oscilloscope. Here take channel 1 of the oscilloscope to demonstrate the oscilloscope function.

1) Reset and set the signal generator as follows:

   LF output frequency: 1kHz

   Amplitude: 1.4Vp

2) Click 〖OSC〗 in the right of the main interface to set as follows:

   Horizontal scale: 500us/scale

   Channel 1: Open; coupling method: DC; vertical scale 1: 1V/ scale

   Channel 2: Close

   After that, click to operate.

The oscilloscope test result is shown in Fig. 4-18.

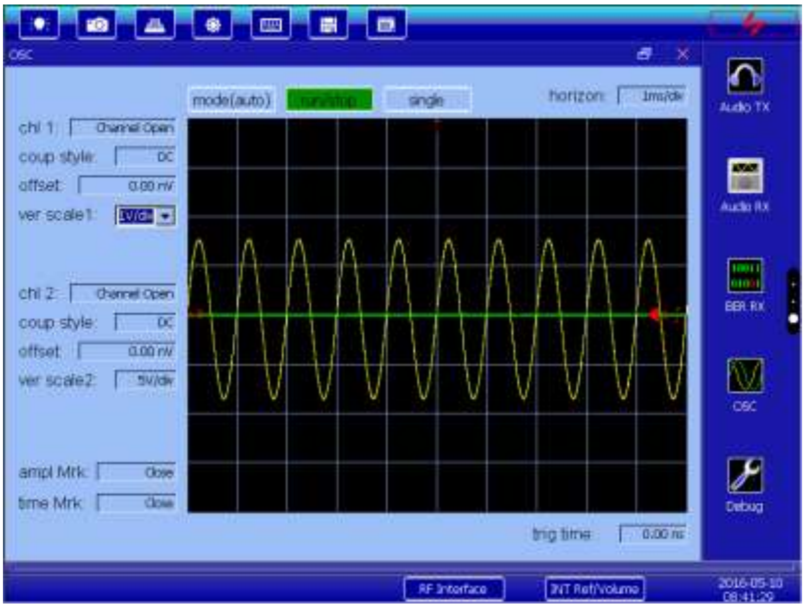


Fig. 4-18 Oscilloscope test result

Section X Auto test

The section introduces the audio test operation of the signal generation of the 4945B/C radio communications test set. Start up the instrument and warm it for 15 min., and then click 〖Auto Test〗 in the lower right of the main interface to enter the auto test mode.

Click 〖Settings〗 to create or select a device to be tested. When creating a device to be tested, the device parameters can be set as well, and parameters that can be set are shown in Table 4-1.

Table 4-1 Parameters of the device to be tested that can be set for auto test

<table>
<tr><td rowspan="7">Carrier</td><td>Operating frequency</td><td colspan="2">Allowable error</td></tr>
<tr><td>Emission power</td><td colspan="2">Allowable error</td></tr>
<tr><td>Allowable harmonic wave</td><td colspan="2">Allowable stray</td></tr>
<tr><td colspan="3">Number of adjacent channels to be measured</td></tr>
<tr><td colspan="3">Channel bandwidth</td></tr>
<tr><td colspan="3">Channel spacing</td></tr>
<tr><td colspan="3">Allowable error for adjacent channel power ratio</td></tr>
<tr><td rowspan="9">Modulation/sensitivity</td><td colspan="3">Modulation format</td></tr>
<tr><td rowspan="2">With pilot frequency</td><td colspan="2">Pilot carrier frequency</td></tr>
<tr><td colspan="2">Rated pilot frequency deviation</td></tr>
<tr><td colspan="3">Transmitter sensitivity</td></tr>
<tr><td colspan="3">Receiver sensitivity</td></tr>
<tr><td colspan="3">Sensitivity reference SINAD</td></tr>
<tr><td colspan="3">Max input power received</td></tr>
<tr><td colspan="3">Standard input power received</td></tr>
<tr><td colspan="3">Rated frequency modulation deviation</td></tr>
<tr><td rowspan="5">Rejection ratio</td><td rowspan="3">IF rejection ratio</td><td colspan="2">Amplitude</td></tr>
<tr><td rowspan="2">Frequency</td><td>Add</td></tr>
<tr><td>Delete</td></tr>
<tr><td rowspan="2">Image frequency rejection ratio</td><td colspan="2">Amplitude</td></tr>
<tr><td>Frequency</td><td>Add</td></tr>
</table>

			Delete
Audio/noise	Audio impedance		
	Reference output level	Allowable level error	
	Allowable big signal SNR		
	Allowable harmonic distortion		
	Noise sensitivity		
	Noise hysteresis		
Frequency Hopping	Start frequency of frequency Hopping		
	End frequency of frequency Hopping		
	Frequency Hopping rate		
	Frequency switching time		
Control	Auto control of the PTT of the equipment under test		

When creating a device to be tested, the existing device to be tested can be inherited to be a new one. Click 〖Settings〗 > 〖Select equipment under test〗 to select the device to be inherited for test, and then click 〖Settings〗 > 〖Inherit〗 to inherited current device and create a new one quickly. Click 〖Settings〗 to edit or delete the selected device to be tested, or 〖Settings〗 > 〖Share to another instrument〗 to share the parameter files of current device to be tested to another 4945B/C tester.

After editing the parameters of the device to be tested, click OK to save such parameters. After that, the device to be tested can be selected from the list of devices to be tested.

After select a device to be tested, click 〖Option〗 to select items for the test, which is to select all by default, and the user can select it based actual conditions. Click 〖Single〗 to switch it to 〖Cycle〗, that is, current test mode is switched to the cycle test, and vice versa. In the single mode, the test stops after all test items are completed; in the cycle mode, the test starts over again after all test items are completed, and the latest test result will overwrite the previous one, which can be used for continuous monitoring on several features of the device under test.

After selecting the test items and modes, click 〖Start〗 to start auto test. During the test, click 〖Pause〗 to pause the test, and 〖Stop〗 to stop and exit the test.

Current test results can be viewed via the output software interface both during and after the test. Click 〖output〗 to show current test progress and relevant prompt, 〖Pass〗 to view the passed test items, 〖Critical〗 to view the critical test items, 〖Error〗 to view the error test items, and 〖UnTest〗 to view the untested items.

After the test, click 【Save】 on the title bar on top of the interface to save the test result, and then 〖Clear〗 to clear current test result and data on the software interface.

During auto test, the RF interface is locked with the T/R port automatically, which cannot be set by the user. Fig. 4-19 shows the interface for testing the FM device.

Fig. 4-19 Auto testing interface

At present, the auto test software can support the communication feature test on communication devices in the analog system and emission performance test on frequency hopping signal, and relevant signal cable must be connected during test, with typical test connection diagram shown in Fig. 4-20.

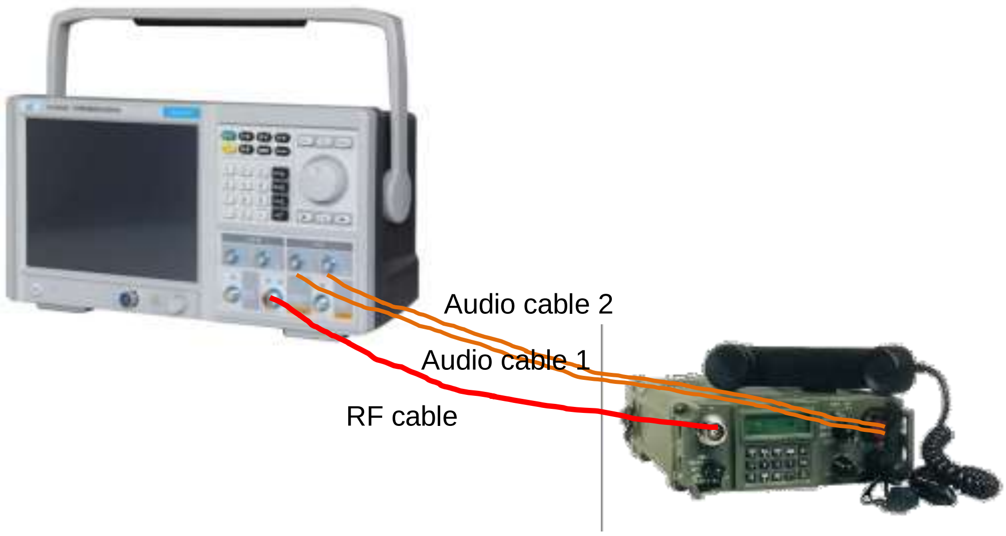


Fig. 4-20 Typical auto test connection diagram

As shown in the figure above, connect the antenna port of the radio under test, audio output port of the radio and audio input port of the radio with the T/R port of the tester, audio analysis input of the tester and audio generation output of the tester respectively. The audio output and input ports of some radios locate on the microphone connector. In this case, pull out the microphone and rotate the signal wire out. Before auto test, set relevant operation status for the radio; during the test, operate the radio as per the prompt shown on the screen of the tester, for example, to switch between the emission status and receipt status.

4945B/C is provided with a PTT signal control interface for radios supporting external PPT control of emission and receipt, which can be used to control the emission and receipt of the communication device automatically during the test. Set working parameters of the radio first before test, so as to avoid any operation on the radio and realize the one-click test featuring emission and receipt, with typical connection diagram of the tester and radio for the one-click test shown in Fig. 4-21.

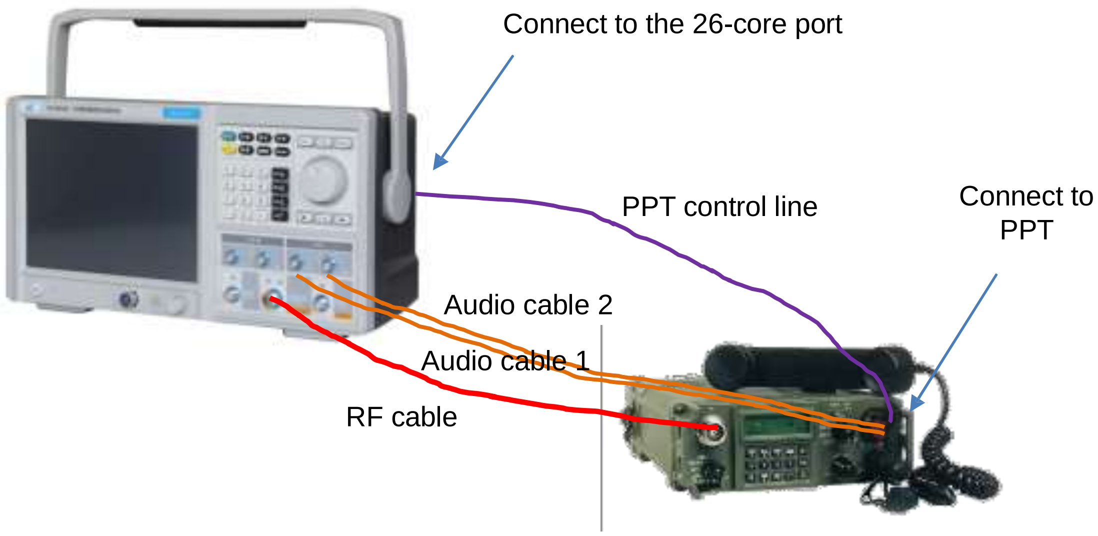


Fig. 4-21 Typical one-click auto test connection diagram

Part II Technical Instructions

Chapter V Working Principles

This chapter will briefly introduce the working principles of 4945B/C radio communications test set and its modules.

Section I Working Principles of the Tester

1. Overall Hardware Solution

The 4945B/C radio communications test set, combining the technical status of corresponding products at home and abroad and with the testing requirements of national defense equipment for frequency hopping communication and microwave communication, adopts the overall technical solution incorporating the digital intermediate frequency (IF) solution based on software radio and the microwave frequency conversion solution based on broadband frequency conversion and the software and hardware structure based on software radio. The design of the whole device focuses on the modularization of the structure and the integration of the functions for flexible configuration and optimization of the functions.

The hardware mainly consists of CPU processor control and driving module, audio/bit error generation and analysis module, IF signal analysis and modulation analysis module, IF signal generation and modulation generation module, general frequency hopping/coding controller module, broadband frequency hopping signal analysis module, broadband hopping local oscillator module, frequency reference generation module, microwave local oscillator synthesis module, signal reception microwave frequency mixing and filtering module, signal generation microwave frequency mixing and filtering module, fixed amplitude, attenuation, switch driving, power supply module and test interface module. The testing function is implemented through software DSP, which includes general frequency hopping/modulation coding control software, audio generation and analysis software, data generation and bit error analysis software, frequency hopping DDS generation software, digital IF signal generation software, broadband frequency hopping signal analysis software, and digital IF signal analysis software, etc. The broadband frequency conversion module includes 60 MHz bandwidth frequency hopping local oscillator generation module, low phase noise microwave synthesis local oscillator module, frequency mixing and filtering module, and switching filter module, etc.

The whole device adopts technical solutions based on software radio, and all testing functions are implemented by software. The technical solution system structure of the device consists of three parts, namely, the software (DSP+FPGA), DA/AD conversion, and RF channel/interface. The software part completes all the test functions of the whole device, and software design is also the most critical part of the whole device. The DA/AD conversion part completes the conversion between digital signals and analog signals, including the double DA conversion of digital IF DA and double DDS, broadband interleaved sampling AD, digital IF AD conversion, and audio DA/AD conversion; The RF channel / interface part includes RF TX up-conversion and RF RX down-conversion.

When a RF signal is generated, the software generates digital IF DDS signals. After DA conversion, 600 MHz IF signals are generated, with the instantaneous bandwidth of 60 MHz, carrying frequency hopping and modulation signals. After microwave up-conversion and switching filtering with the microwave synthesis local oscillator, the signals are output after fixed amplitude control and attenuation. When receiving radio frequency signals, the input signals are first down-converted to 600 MHz IF through microwave, where the 600 MHz IF is provided to the broadband sampling module for frequency hopping signal analysis, and the sampled signals are multiplexed in FPGA for digital IF analysis, including sweep spectrum analysis, modulation signal analysis, and frequency/power measurements, etc. The audio/bit error generation and analysis modules generate audio or bit error signals, which can be directly modulated internally or modulated after being encoded by the general frequency hopping/modulation coding module. The testing functions in the overall technical solution can all be implemented by software, showing strong expandability.

The hardware composition block diagram is shown in Fig. 5-1:

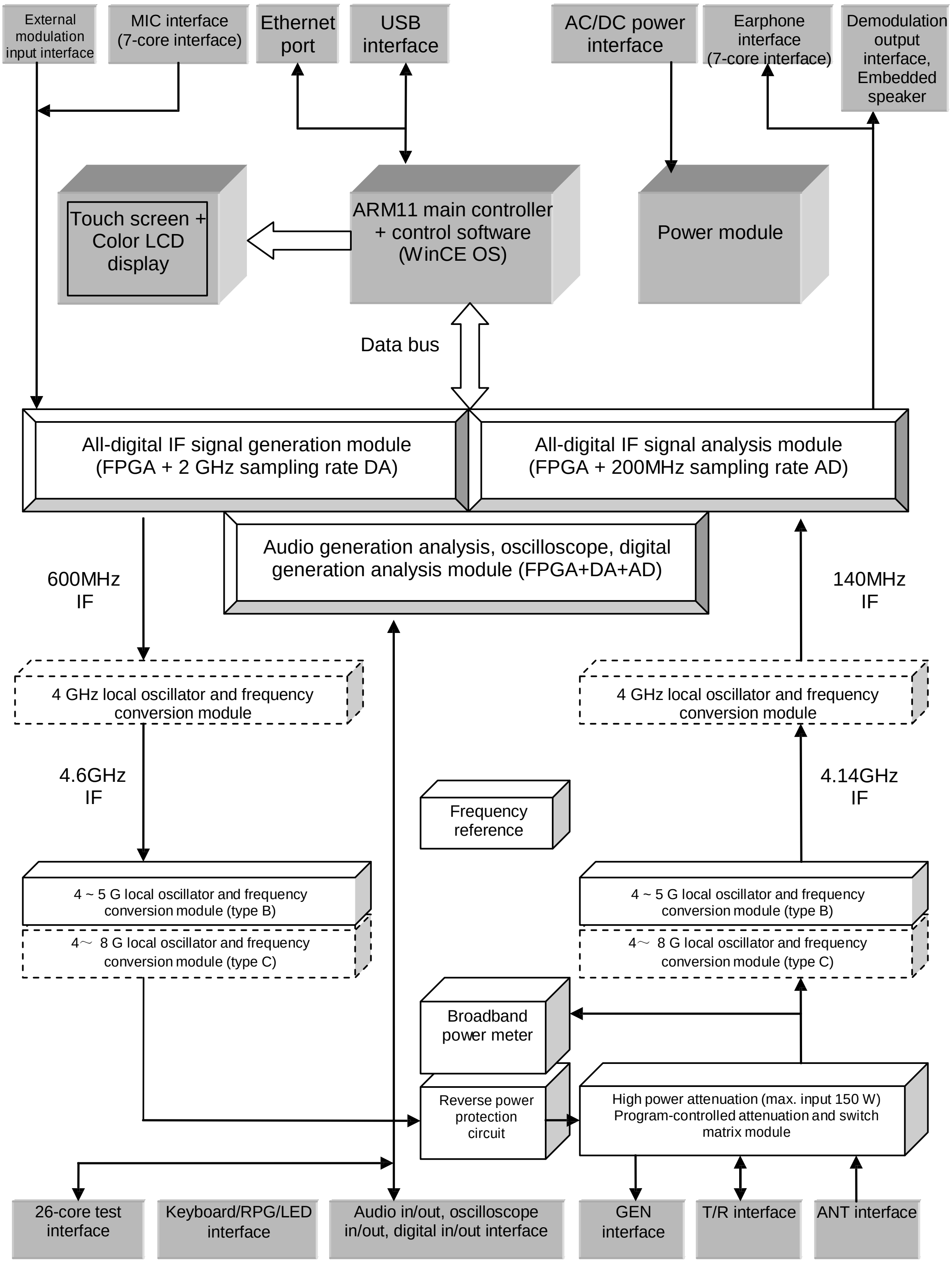


Fig. 5-1 Hardware block diagram of 4945B/C radio communications test set

2. Overall Software Solution

The tester is based on an all-digital architecture, and all testing functions are implemented by software, such as frequency hopping signal generation and analysis, analog/digital modulation signal generation and analysis, spectrum analysis, audio signal generation and analysis, bit error generation and analysis, power measurement, and frequency measurement, etc. The software, adopting an open architecture, is reconfigurable and extensible.

The software levels of the whole device, from top down, can be divided into the physical layer software, the driver layer software and the application layer software from bottom to top: the application layer software interacts with users and operating systems; The driver layer encapsulates drivers of software and hardware modules, with each hardware module corresponding to a unique driver. After the functions are expanded or the hardware modules are replaced, users will only need to update corresponding drivers; the physical layer software, including FPGA software, bottom control logic software, etc., implements various testing functions, . The functional block diagram of the host software is shown in Fig. 5-2:

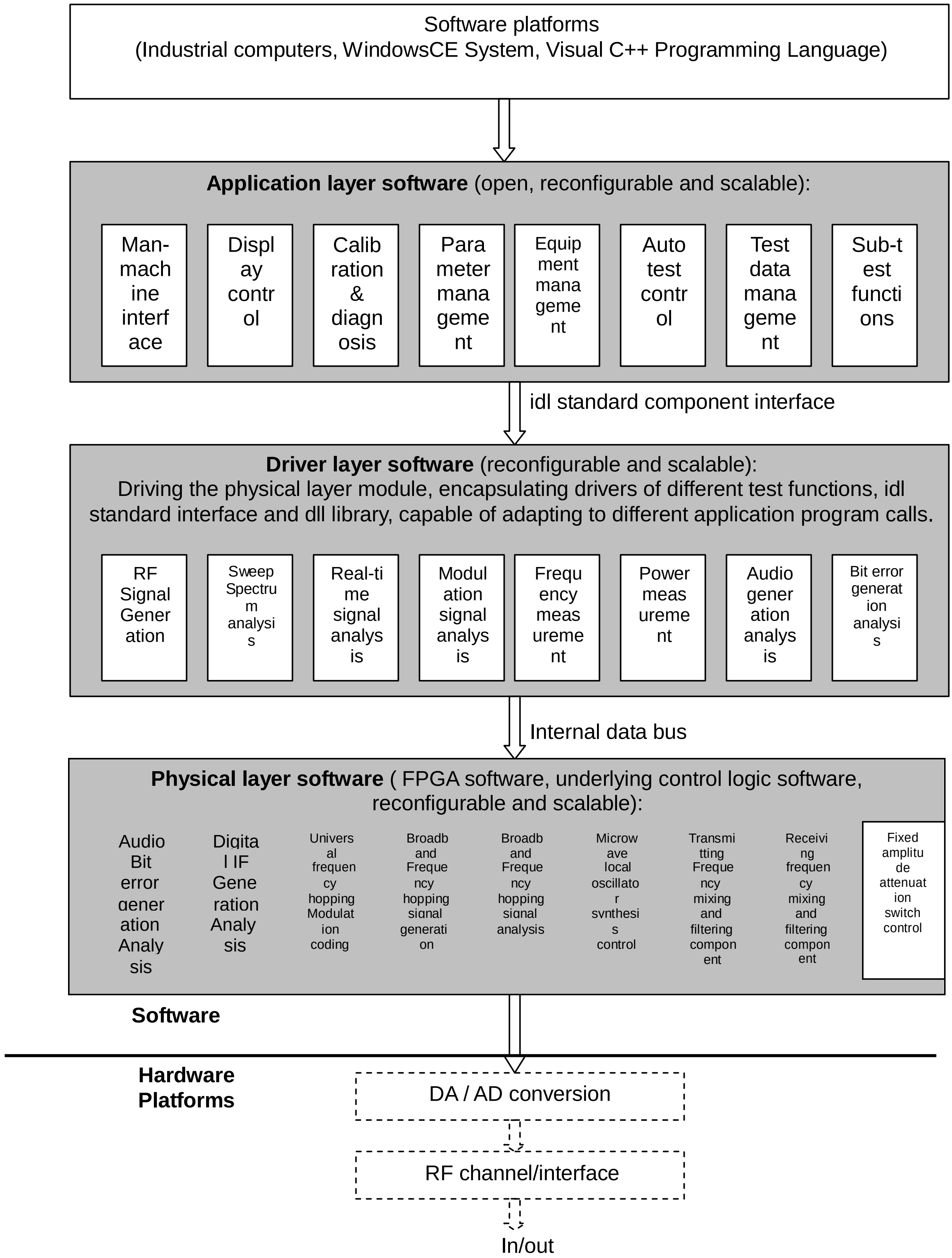


Fig. 5 -2 Overall software solution based on software radio

As shown in Fig. 5-2, his project adopts an appropriate industrial control computer as the software platform, which adopts standard buses for data exchange with various circuit modules. The host computer controls all modules. Considering the convenience of software development, ease of use of the user interface and system reliability, WindowsCE is adopted as the operating system of the main control computer, Visual C++ is adopted as the programming language, and visual studio 2005 is adopted as the compiler for software development.

The application layer software, adopting an open design, mainly includes man-machine interface software, display control, calibration and diagnosis software, parameter management, equipment management software, equipment automatic test software and test data management software, etc. The display control mainly provides the man-computer interaction function. It adopts WindowsCE as the platform to display various settings, test data and test waveforms; It also manages, stores and transmits various configuration files, result files and data stream files. The equipment management software can be used to set up databases. User can set test items, test parameters and test limits of the specific equipment to be tested, and store the information of the equipment to be tested in the local computer to be called conveniently. The automatic test software is responsible for automatically executing the tests or guiding the test processes according to the test items selected by users and the configured equipment parameters. During the test, each test sub-function or any combination of sub-functions is called internally to achieve the purpose of item-by-item test. The test data management software is used to store, call or export test parameters.

Section II Working Principles of the RF Frequency Conversion Module

The broadband RF transceiver module directly affects the performance and technical indicators of the instrument. Military communication mostly adopts the half-duplex transceiver mode. Therefore, the RF RX/TX module channel of this project is also designed to be the half-duplex transceiver mode. The modules mainly include reference generation, ultra-broadband local oscillator synthesis, broadband mixer, adjustable filter, RF switch, and attenuator, etc. In addition to the RF channel, the whole RF transceiver module also includes control of various circuits, such as filter adjustment, switch control, attenuation control, and Σ-Δ modulation, etc.

1 Working Principles of RF Signal Generation

The RF conversion function of the transmitter is to convert the 600 MHz IF into 1 MHz-1.05 GHz RF output, with the real-time bandwidth of 60 M. The local oscillation signal 4.601-7.6 GHz is provided by the local oscillation module of the transmitter board, and so is 4 GHz. The working principle is shown in Fig. 5-3.

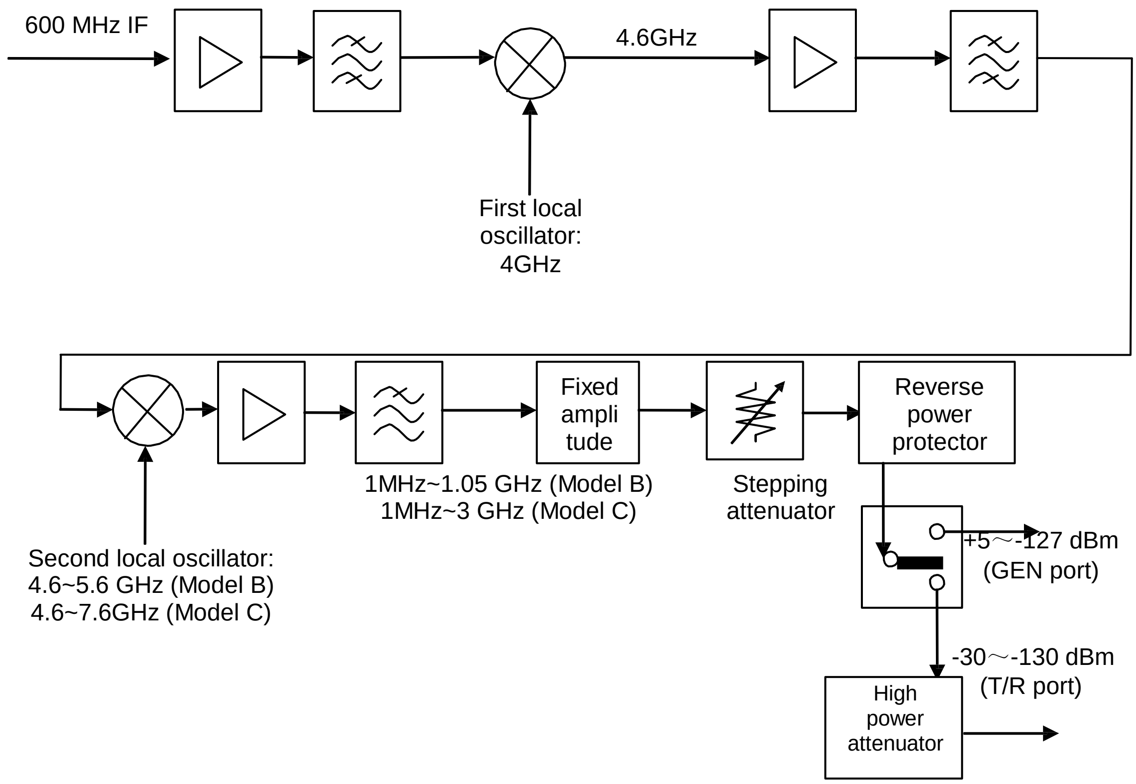


Fig. 5-3 RF conversion scheme of the transmitter

2 Working Principles of RF Signal Reception

The RF conversion function of the receiver is to convert the 1 MHz-1.05 GHz RF input into 600 MHz IF, with the real-time bandwidth of 60 MHz and the spectrum sweep function supported. The local oscillation signals, 4-8GHz of the first local oscillator and 4 GHz of the second local oscillator, are provided by the local oscillation module of the transmitter board. The working principle is shown in Fig. 5-4.

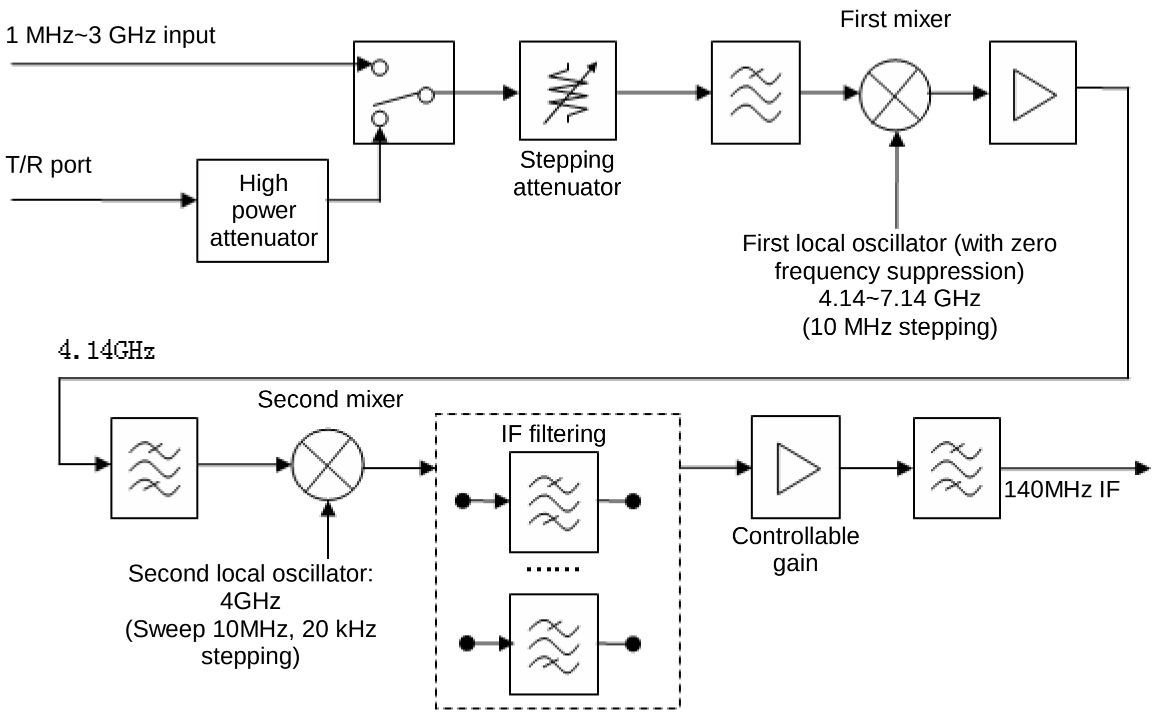


Fig. 5-4 RF conversion scheme of the receiver

3 Working Principles of the Local Oscillator Signal Generation

The local oscillators in this project are designed to 4-8GHz. The devices are implemented through integrated PLL and integrated broadband VCO. The working principle is shown in Fig. 5-5.

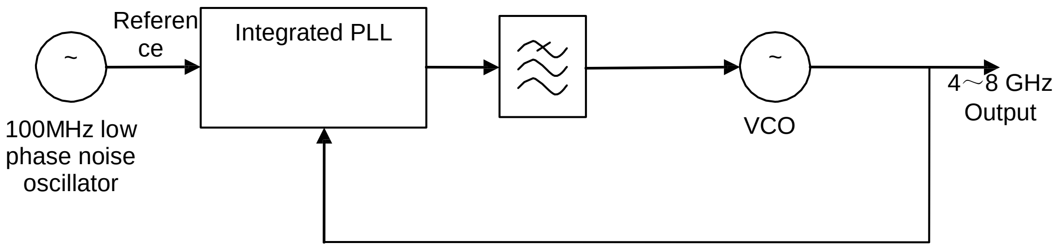


Fig. 5-5 Schematic diagram of local oscillation generation

Section III Working Principles of the Digital Processing Module

The digital board utilizes digital signal processing to realize such functions as the generation of IF (continuous wave generation, frequency hopping generation and modulation generation), the reception analysis of IF (broadband real-time signal analysis, spectrum analysis, and demodulation analysis), the generation and reception of audio frequency, the generation and reception of digital sequence, and test control (7-core and 26-core interface), etc. The digital processing module mainly includes the following functional units:

(1) Embedded CPU unit

It achieves man-machine interaction processing, device control and communication of LAN, USB and other interfaces.

(2) Signal RX analysis unit

The IF signal of 600 MHz is input to the digital processing board and is digitally sampled by ADC. The sampled data is sent to FPGA for such processes as digital down-conversion, bandwidth shaping filtering, analog modulation signal demodulation, and amplitude frequency calculation, and the results are sent to ARM for analysis and display.

The IF signal analysis of the receiver adopts a 200 MHz sampling ADC chip (IF 140 MHz). The block diagram for the principle of the digital signal processing part is shown in Fig. 5-6:

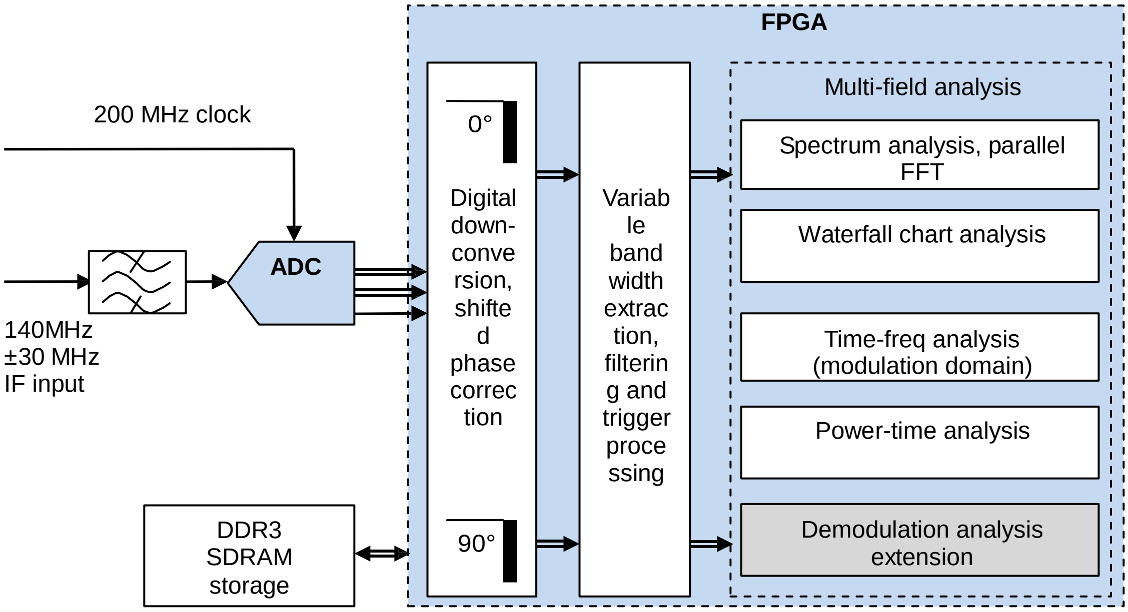


Fig. 5-6 Block diagram of receiver IF digital signal processing

(3) Signal generation unit

The DDS core in FPGA generates carrier signals and I and Q data of various modulation waveforms, which are sent to DAC after digital up-conversion in FPGA and then to the RF channel board after passing through the band-pass filter. The audio frequency process is as follows, digital signals are generated by DDS in FPGA and then output to the instrument panel after being converted into audio signals by the audio DAC. The internal design principle of FPGA is shown in Fig. 5-7:

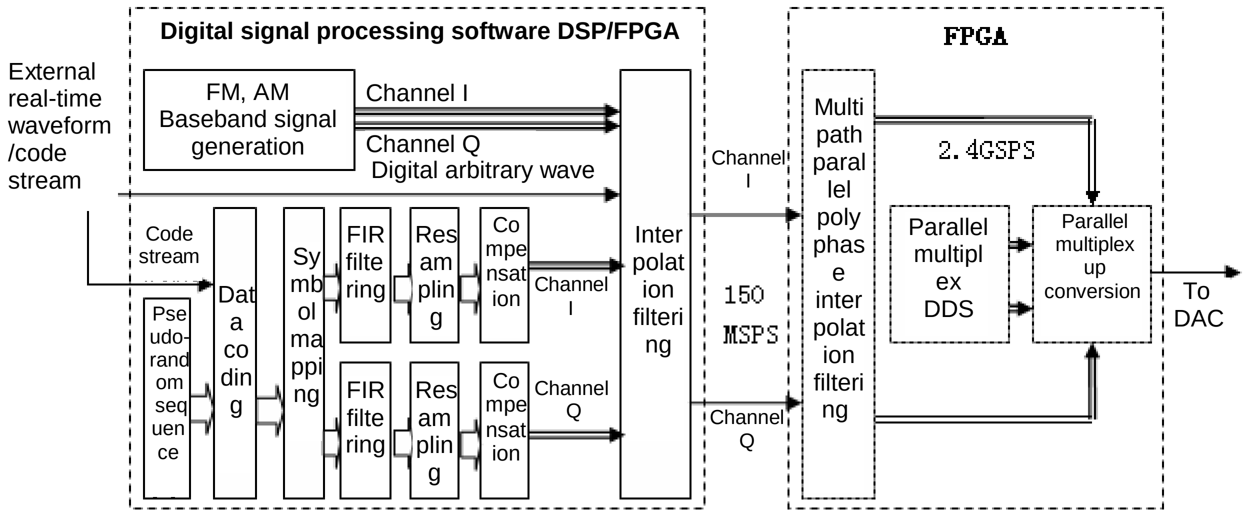


Fig. 5-7 Block diagram of transmitter IF digital signal processing

(4) Bit error test function unit

The FPGA generates a reference code pattern consistent with the code streams to be tested, then compares the reference code pattern with the code streams to be tested one by one, records the number of bit errors, and calculates the bit error rate.

(5) Clock generation function unit

The processing clock of each unit is provided. The clock generation chip includes a VCO, which is configu d by ARM 10 gene le clock signals of 200MHz and 2GHz and provide Ihem 10 IF ADCFPGA and IF DAC respeclively

Chapter VI Technical Indicators and Testing Methods

Section I Main Technical Indicators

1 RF Signal Generation

1.1 Frequency

Frequency range: 1 MHz~1.05 GHz(Model 4945B, available to 100 kHz)，1 MHz~3 GHz(Model 4945C, available to 100 kHz)

Resolution: 1 Hz

Accuracy: frequency standard ± 1 Hz (common time base), better than 10^{-6} (non-common time base)

1.2 Power

Power range: -130～-35 dBm(T/R port)，-110~+5 dBm (GEN port, complicated modulation up to 0 dBm)

Resolution: 0.1 dB

Accuracy: ±1.5 dB (≥-110 dBm), ±2.0 dB (＜-110 dBm)
Max Power: 150W

1.3 Spectrum purity

Harmonic: <- 25 dBc (>1 MHz)

Non-harmonic: <-35 dBc (>1 MHz, @+5 dBm output)

Phase noise: -93 dBc/Hz@20 kHz(≤1.05 GHz),-90 dBc/Hz@20 kHz (>1.05 GHz)

1.4 Analog modulation

Modulation sources: sine, square wave, triangle, sawtooth, dual tone (with pilot), external audio

Range FM: +5dBm to -110dBm

Internal FM frequency deviation: 0~150 kHz

Internal FM frequency deviation accuracy: ±5% (Frequency deviation range: 5~150 kHz)

Internal FM modulation rate: 20 Hz~20 kHz

Range AM: 0 to -110dBm

Internal AM modulation range: 0~100%

Internal AM accuracy: ±5 % (modulation range 10~90%)

Internal AM modulation rate: 20 Hz~20 kHz

Sensitivity: 10 μV for 10 dB EIA SINAD

Internal SSB modulation options: USB, LSB

Internal SSB modulation rate: 300 Hz~5 kHz

External FM/AM/SSB modulation rate: 20 Hz~15 kHz (FM, AM), 300 Hz~3 kHz (SSB)

1.5 Digital vector modulation (optional)

Modulation formats: 2ASK, 2FSK, GMSK, BPSK, QPSK, 8PSK, and 16QAM
Modulation bandwidth: 10 kHz～10 MHz

Maximum code element rate: 5 MHz

Data sources: alternating among PRBS, all 0, all 1, and 01

Filters: RC, RRC, and GAUSS

EVM: ≤2%rms (code element rate ≤1 MHz), ≤3% rms (symbol＞1 MHz)
1.6 Frequency hopping signal generation (optional)
Frequency hopping bandwidth: 1 MHz～60 MHz

Maximum non-repetitive frequency hopping pattern length: 4,000

Frequency agility time: < 10 μs

Maximum frequency hopping rate: 100,000 times/s
Hopping mode: Internal step repetition, external SPI frequency control

2 RF Signal Analysis

2.1 Sweep Spectrum Analysis (Receive Signal Strength Level Meter)

Frequency range: 100 kHz~1.05 GHz (Model 4945B, 100 kHz~3 GHz(Model 4945C)

Sweep: 0Hz ~ full sweep

Reference level range: +54 dBm~-50 dBm (T/R port), +20 dBm~-80 dBm (ANT port)

Display dynamic range: better than 70 dB

Units: V, dBm, dBuV, dBmV, and Watts

Level accuracy: ±1.5 dB

Average noise level: -125 dBm (ANT port, RBW=30 Hz, reference level-70 dBm),

-75 dBm (T/R port, RBW=30 Hz, reference level-10 dBm)
Resolution bandwidth: 30 Hz～3 MHz (1-10 steps)

Resolution bandwidth accuracy: ±10% (RBW=3 kHz, 30 kHz, 60 kHz, 300 kHz), ±25% (RBW=3 MHz), ±20% (RBW≤300 Hz)

Resolution bandwidth switching error: ±1 dB

Sweep time: 100 ms~100 s

Sweep mode: continuous, single time

2.2 Broadband Power Meter (RMS Detection Method)

Frequency range: 300kHz~1.05 GHz (Model 4945B, 300kHz~3 GHz(Model 4945C)
Power measurement range: when 100 mW~150 W (T/R port, ＞40 W, continuous input for a single time not exceeding 1 min, interval between two continuous inputs not shorter than 2 min), 0.1 mW~100 mW (ANT port)

Measuring accuracy: 15% (typical + 19 dBm input) or better than ± 1 dB

Signal types: continuous wave (CW), frequency modulation (FM)

2.3 Narrow-band Power Meter

Frequency range: 300 kHz~1.05 GHz (Model 4945B, low frequency depending on small IF bandwidth),

300 kHz~3GHz (Model 4945C, low frequency depending on small IF bandwidth)

Power range: +51 dBm~-40 dBm(T/R port)，+10 dBm~-80 dBm (ANT port)

Power measurement accuracy: ±2.0 dB

Sensitivity: 2.0μV for 10 dB EIA SINAD

AM RX bandwidth: 6.25, 8.33, 10, 12.5, 25, and 30 kHz

FM RX bandwidth: 6.25, 10, 12.5, 25, 30, 100, and 300 kHz

2.4 Frequency Error Meter

Frequency range: 300 kHz~1.05 GHz (Model 4945B, low frequency depending on small IF bandwidth),

300 kHz~3GHz (Model 4945C, low frequency depending on small IF bandwidth),

Frequency resolution: 1 Hz

Accuracy: frequency standard ± 1 Hz

2.5 Analog Modulation Signal Demodulation and Analysis (Transmitter Test)

Frequency range: 300 kHz~1.05 GHz, up to 100kHz(Model 4945B, low frequency depending on small IF bandwidth),

300 kHz~3GHz, up to 100kHz(Model 4945C, low frequency depending on small

IF bandwidth)

Demodulation formats: FM, AM, and SSB

Demodulation counter frequency range: 20 Hz~20 kHz

Demodulation counter resolution: 0.1 Hz

FM frequency deviation meter range: 0~150 kHz
FM frequency deviation meter accuracy: ±5% (Frequency deviation range: 5~150 kHz, modulation rate: 1 kHz)

FM frequency deviation meter modulation rate: 20 Hz~20 kHz
FM Narrowband Sensitivity: 2.0 μV for 10 dB EIA SINAD

FM Broadband Sensitivity: 10 μV for 10 dB EIA SINAD

AM modulation meter range: 0~100%

AM modulation meter accuracy: ±5% (modulation range 30%~90%, modulation rate 1 kHz)

AM modulation meter modulation rate: 20 Hz~20 kHz

AM Sensitivity: 10 μV for 10 dB EIA SINAD

SSB modulation meter modulation rate: 300 Hz~5 kHz

Demodulation bandwidth: 6.25, 8.33, 10, 12.5, 25, 30, 100, and 300 kHz

Reference level range: +54 dBm~-50 dBm (T/R port), +20 dBm~-80 dBm (ANT port)

Audio filter: Low-pass: 300Hz, 5 kHz, 15 kHz, and 20 kHz,

Band pass: 0.3~3.4 kHz, 0.3~5 kHz, 0.3~15 kHz, and 0.3~20 kHz

2.6 Digital Modulation Signal Demodulation and Analysis (Optional)

Frequency range: 300 kHz~1.05 GHz (Model 4945B, low frequency depending on small IF bandwidth),

300 kHz~3GHz (Model 4945C, low frequency depending on small IF bandwidth)

Demodulation formats: GMSK, BPSK, QPSK, 8PSK, and 16QAM

Modulation bandwidth: 10 kHz~10 MHz

Maximum code element rate: 5 MHz

Filters: RC, RRC, and GAUSS

2.7 Frequency Hopping Signal Analysis (Real-time Channel Spectrum Analysis, Optional)

Real-time analysis bandwidth: 60 MHz, 30 MHz, 15 MHz, 7.5 MHz, 3.75 MHz and 1.875 MHz

Analysis domains: time-frequency (modulation domain), time-amplitude, time-spectrum (3D waterfall),

Spectrum of any moment during the capturing period (single-time mode)

Single-time capture storage depth: 8Gb

Minimum time resolution: 10 ns

3 Audio Signal Generation

Waveform: sine, square wave, triangle, and sawtooth

Signal type: single-tone, dual-tone

Frequency: 20Hz~20 kHz (sine), 20 Hz~4 kHz (square wave, triangle, and sawtooth)

Frequency resolution: 0.1Hz

Frequency accuracy: 0.1 Hz

Level range: 1mv~7vrms (10 kΩ load)

Level accuracy: ±5% (10 kΩ load, ≥10 mVrms)

4 Audio Signal Analysis

4.1 Input

Input impedance: 150 Ω, 600 Ω, high impedance

Maximum input level: 30 Vrms (high impedance, positive peak or negative peak ≤42.5Vp)

Low pass filter: 300Hz, 5 kHz, 15 kHz, and 20 kHz

Bandpass filter: 0.3~3.4 kHz, 0.3~5 kHz, 0.3~15 kHz, and 0.3~20 kHz

4.2 Frequency Meter

Frequency range: 20 Hz~20 kHz Input

level: 20 mV~30 Vrms Resolution: 0.1Hz

Accuracy: 1 Hz

4.3 Level Meter

Frequency range: 20 Hz~20 kHz

Input level: 0~30 Vrms

Units: V, dBV, and dBm

Accuracy: ±5% (high impedance, ≥10 mVrms)

4.4 SINAD Meter Measuring range:

0~60 dB Resolution: 0.1 dB

Accuracy: ±1.0 Db @ 12dB

Frequency range: 300Hz~10kHz

Input level: 0.1~30 Vrms

4.5 Distortion Meter

Measuring range: 0~90%

Accuracy: ＜±0.5% (distortion＜10%), ＜±1.0% (distortion≥10%)

Frequency range: 300Hz~5kHz

Input level: 0.1~30 Vrms

4.6 SNR Meter

Measuring range: 3~60 dB

Accuracy: ±1.0dB (SNR ＞20 dB, ≤40 dB)

Frequency range: 300Hz~10kHz

Input level: 0.1~30 Vrms

5 Oscilloscope (Optional)

Number of channels: 2

Frequency range: DC~4MHz

Vertical scale: 10 mV~10V/scale (1, 2 and 5 steps)

Horizontal scale: 1 us~1 s/scale (1, 2 and 5 steps)

Coupling mode: DC, AC

Input impedance: 1 MΩ

Trigger source: channel 1, channel 2

Trigger mode: rising edge, falling edge

6 Digital Sequence and Bit Error Analysis (Optional)

Data format: PN3, PN5, PN9, PN11

Baud rate: 300 bps to 1 Mbps (BPSK, GMSK, 2FSK, 2ASK) Bit

error rate measurement range: 0.1~0.000001

7 Frequency Reference

Frequency: 10MHz

Aging rate: 1 x 10^{-7}/year

Temperature stability: ±0.05 ppm (0℃~50℃)

8 Functions of the Automatic Test Software

Automatic test software: encapsulates general test function of the whole device for automatic guided test of the transmission and reception of fixed-frequency analog communication equipment and the main characteristics of the transmission of the frequency hopping communication equipment.

The automatic test software includes such functions as online editing of parameters of the device under test, automatic guided testing, and management of test results.

9 Tactical Features of the Product

9.1 Structure and Appearance

Structure: portable casing and all structural parts are complete and assembled firmly;

Colors: the front panel is white, and the rear panel is dark gray, no scratches or obvious stains.

This instrument features neat and beautiful appearance, clear text display on the screen and panel, flexible key operation, and convenient and reliable connection of the connectors.

The Chinese operation interface is friendly, easy to operate and use.

9.2 Mechanical Features

Weight: about 10kg;

Maximum outside dimensions: W × H × D (in mm, excluding handles and legs): 426×223×180;

Mechanical stability: the instrument should not be turned over during normal operation and work.

9.3 Power Supply

It can be powered by AC power or DC power supply: external AC 198 V~ 242 V (100 V ~ 242 V acceptable), 50 Hz ± 5 Hz; or external DC 24 V ± 2 V (16~28 V acceptable);

It supports a dedicated internal rechargeable li-ion battery option.

9.4 Safety

Compliant with provisions in 3.10.2 of GJB 3947A-2009.

9.5 Environmental Adaptability

Compliant with level-3 environmental requirements in GJB3947A-2009.

9.6 Reliability

MTBF (θ0) ≥6000 h.

9.7 Electromagnetic Compatibility

Compliant with provisions in Table 4 in 3.9.1 of GJB3947A-2009.

9.8 Maintainability

The instrument should comply with Article 3.13 of GJB3947A-2009, with the specific requirements as follows:

Unit level maintenance should be achieved according to the functions of different units;

MTTR: shorter than 1 h.

9.9 Marking

The marking of the instrument should comply with Article 3.11 of GJB3947A-2009, with the specific requirements as follows:

a) Model and name: 4945B or 4945C radio communications test set;

b) Production month and year and number;

C) Manufaclurer: China Eleclronics Technology Inslrumenls COLTD

The graphic marking for packaging and slo ge should comply wilh GB/T191-2008

9.10 Inlerfaces

USB RS232 and LAN where Ihe LAN inlerface can be remolely conlrolled (see Appendix - Programmer's Manual for delails)

Section II Testing Methods

1 Testing Instruments

Instruments for testing the indicators of this device must have and maintain sufficient accuracy, quality and quantity of test equipment and inspection facilities, be verified and qualified by the metrological authorities, and be within the validity period of measurement. See Table 6-1 for testing instruments and equipment.

Table 6-1 Testing instruments and equipment

Serial No.	Device name	Main technical indicators	Recommended model
1	Signal generator	Frequency range: 250kHz~6GHz Frequency resolution: 0.01Hz Power output :-136 dBm~+20 dBm (max. fixed amplitude +19 dBm) Power accuracy: ±0.5 dB Low-frequency output frequency: 0.01 Hz ~ 100 kHz Low-frequency output amplitude: 4 mVp～5 Vp Support for low-frequency dual-tone output: amplitude percentage 0.1~99.9%	Agilent E4438C
2	Frequency meter	Frequency range: 10Hz~20GHz Sensitivity: ≤ -40 dBm Frequency resolution: 1 Hz	HP5350B or 3212
3	Spectrum analyzer (With vector signal analysis option)	Frequency scope: 2 Hz~13.6 GHz Average noise level: -169 dBm (3 GHz) Level measurement accuracy: ±0.4 dB IQ demodulation bandwidth: 10 MHz	R&S FSW13
4	Real-time spectrum analyzer (Option for measuring frequency hopping signal generation)	Frequency scope: 9kHz~14GHz Max. real-time acquisition bandwidth: 110MHz Min. time resolution: 6.6667 ns (110 MHz bandwidth)	RSA6114A
5	Audio analyzer	Audio analysis frequency range: 80 Hz~110 kHz AC level measurement accuracy: full scale ± 2% (1 kHz) Audio generation frequency range: 20 Hz~20 kHz Frequency accuracy: 0.005% Level accuracy: ±0.5 dB (≥-40dBV)	VA2230A
6	Oscilloscope calibrator (Option for measuring oscilloscope)	Resistance measurement accuracy: ±0.5%	Fluke9500B
7	Fast edge probe (Option for measuring oscilloscope)	Rising time: 150 ps Voltage output range: 5 mVpp-3 Vpp	Fluke9530

8	Digital multimeter	3.5 bits Test resistance range: 40 MΩ Resistance test resolution: 0.1 Ω	Fluke15B
9	Directional coupler	Frequency range: 1MHz~2GHz	70608
10	Load	50 Ω	Fujitec SMA-50JR

2 Functional Inspection Methods

2.1 Pre-operation Inspection

According to the results of visual inspection, the instrument should have complete outside structure, with the keys, switches, knobs, and connectors installed firmly, with clear on/off status, flexible rotation, correct position and without mechanical damages affecting normal operation.

2.2 Normal Functionality Inspection

Check 4945B/C for normal functionality according to the following method and record the results in Table A.1.

2.2.1 Generation and analysis of AM, FM, and SSB signals and digital vector signals

As shown in Fig. 6 - 1, connect the test instrument, set 4945B/C to the radio frequency RT mode with the frequency of 1.05 GHz and the amplitude of - 10 dBm; set the center frequency of the spectrum analyzer to 1.05 GHz, the reference level to 0 dBm, and the sweep to 10 kHz. Set the modulation format and modulation parameters of 4945B/C and the corresponding demodulation format of the spectrum analyzer as required to monitor the measured values of demodulated signals. AM, FM, and SSB signals and 2FSK, QPSK, 16QAM and other digital vector signal generation functions should all be normal.

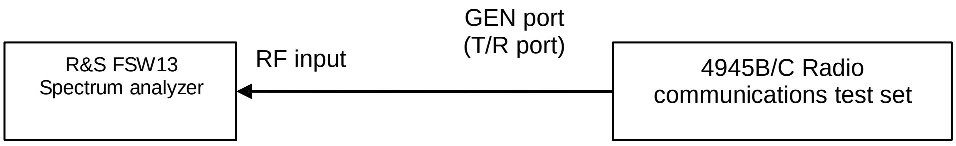


Fig. 6-1 Block diagram for RF signal generation characteristics test

As shown in Fig. 6-2, set the output frequency of the signal generator to 1.05 GHz and the amplitude to -10 dBm; set 4945B/C to the RF signal RX mode with the reference frequency of 1.05 GHz and the reference level of 0 dBm. Set the modulation format and modulation parameters of the signal generator and the corresponding demodulation format of 4945B/C as required to monitor the measured values of demodulated signals. AM, FM, and SSB signals and 2FSK, QPSK, 16QAM and other digital vector signal analysis functions should all be normal.

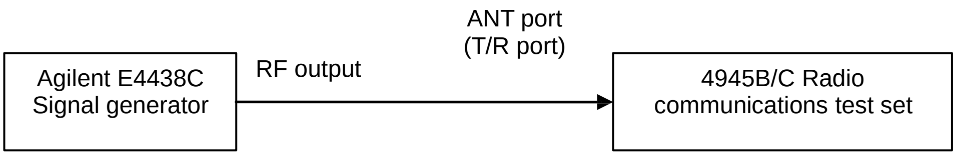


Fig. 6-2 Block diagram for RF RX and sweep spectrum characteristics tests

2.2.2 Generation and analysis of 60 MHz bandwidth frequency hopping signals

The generation and analysis functions of 60 MHz bandwidth frequency hopping signals should be normal as validated respectively with the testing methods mentioned in 3.1.9 and 3.2.15 of these specifications.

2.2.3 Full-sweep spectrum Analysis

As shown in Fig. 6-2, set 4945B/C to the sweep spectrum mode, and set the frequency value of the signal generator according to the full-sweep range, and the spectrum analysis function of 4945B/C should be normal.

2.2.4 Frequency error measurement, broadband and narrow-band power measurement

As shown in Fig. 6-2, set the output frequency of the signal generator to 1.05 GHz and the amplitude to -10 dBm; set 4945B/C to the RF RX mode with the reference frequency of 1.05 GHz, enable frequency error, broadband and narrow-band measurement functions, which should be normal after testing.

2.2.5 Measurement of audio level, frequency, SINAD, distortion and SNR;

As shown in Fig. 6-3, connect the test instrument and set the frequency and amplitude of signals output from the low frequency interface of the signal generator; set 4945B/C to the audio analysis mode and setting corresponding measurement parameters, and the audio level, frequency, SINAD, distortion and SNR measurement functions should be normal.

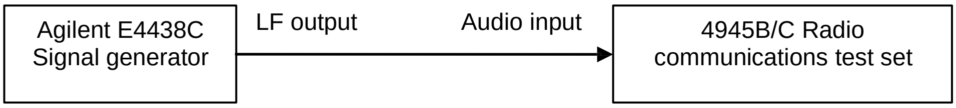


Fig. 6-3 Block diagram for audio signal analysis characteristics test

2.2.6 High-precision dual-tone audio signal source and built-in modulation source;

As shown in Fig. 6-4, connect the test instrument and set 4945B/C to the audio generation mode, and the function of the audio analyzer to measure the audio signal source should be normal. As shown in Fig. 6-1, connect the test instrument and set 4945B/C to the FM mode, and the function of the built-in modulation source should be normal.

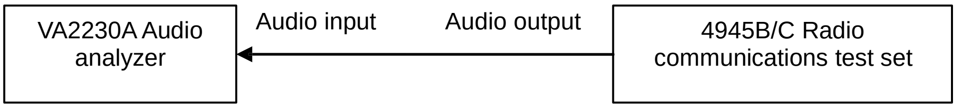


Fig. 6-4 Block diagram for audio signal generation characteristics test

2.2.7 Digital sequence generation and bit error analysis (optional)

The digital sequence generation and bit error analysis functions should be normal as validated with the testing method mentioned in 3.6.1 of these specifications.

2.2.8 Dual channel 4 MHz bandwidth oscilloscope

As shown in Fig. 6-5, set 4945B/C to the oscilloscope analysis mode; set the RF output frequency of the signal generator to 4 MHz and the amplitude to +6 dBm; and the analysis and display functions of the oscilloscope should be normal.

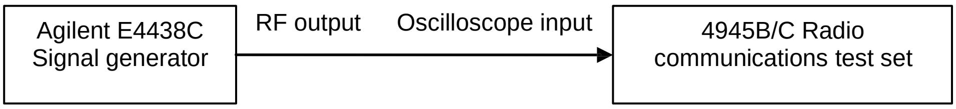


Fig. 6-5 Block diagram for oscilloscope characteristics test

2.2.9 Auto test software

Set 4945B/C to the automatic test mode, where test parameters, indicators and test items of typical radio stations or communication equipment can be configured, the test functions of automatic guided radio stations or communication equipment should be normal. For radio stations or communication devices with fixed frequency analog voice communication and supporting PTT controlled stations, one-key test can be performed. For such indicators of automatic guided test stations or communication equipment as working frequency error, transmission power, harmonic transmission component, parasitic transmission component, adjacent channel power ratio, transmitter modulation sensitivity, sideband suppression, carrier suppression, pilot frequency, pilot rated frequency deviation, frequency hopping signal bandwidth, frequency hopping signal amplitude, frequency hopping rate, frequency hopping frequency switching time, receiver sensitivity, large SNR, audio output power, and audio harmonic distortion, the test capabilities and technical indicators of the automatic tests are the same as those of general test functions; when it is necessary to change the cable or set the state of the radio station or communication equipment during the test, the user will be automatically prompted for corresponding operation, and the rest of the test process will be completed automatically after the operation; upon completion of the test, a test report is automatically generated, specifying qualified, critical and unqualified items, and supporting storage, viewing, comparison, export and other operations of the report.

For analog fixed-frequency voice communication stations, 4945B/C has the PTT signal control interface, which can control the transmitting and receiving of stations or communication equipment with corresponding control interfaces during the test, thus realizing one-key test of its main receiving and transmitting characteristics. An example of a typical one-key automatic test procedure is as follows:

1) Connect 4945B/C to the station under test, connect the T/R interface of 4945B/C to the antenna interface of the station, connect the PPT line in the 26-core interface of 4945B/C to the PPT interface of the station, connect the audio generation interface of 4945B/C to the audio input interface of the station, and connect the audio analysis interface of 4945B/C to the sound output interface of the station;

2) Set the station to the fixed-frequency operation mode, with the working frequency of 80 MHz and the communication mode of FM voice communication, and the power to rated value;

3) Switch 4945B/C to the automatic test interface, set the model of the station to be tested, edit the parameters of the station according to the characteristics of the station, such as: working frequency of 80 MHz, transmission power of 2 W, rated pilot frequency deviation of 2.5 kHz, reception sensitivity of -110 dBm, harmonic transmission component of -40 dB, and maximum audio output SNR of 40 dB, etc. After the edition, press the Save key to store such settings in 4945B/C;

4) Select the model of tested radio station model edited in step 3 from the automatic test interface, select the test items (all to be tested by default), select the one time or cyclic test method, press the "Start" key, and 4945B/C will prompt the user to confirm the connection method before the test. Press the "Continue" key to start automatic test after confirmation;

5) During the test, 4945B/C controls the transceiver status of the radio station by controlling PTT in the 26-core interface, receives and transmits signals from and to the radio station through the radio frequency interface, and generates and analyzes audio signals through the audio interface. After each test item is completed, 4945B/C will prompt whether the test item is qualified, and distinguish the qualified from the unqualified with different colors, and then automatically execute the next test.

6) After all test items are tested, press the "Save" key to save the test results. 4945B/C will prompt the user to input the tester, the test environment and the serial number of the tested station. 4945B/C will save the above input information together with the station model, date, time and test data into the test results;

7) After the test results are saved, all the test records saved in 4945B/C can be viewed with the "Load" key, and the test records can be compared and exported.

3. Performance Indicator Testing Methods

3.1 RF Signal Generation

3.1.1 Testing frequency range, accuracy and resolution of RF signals

a) Description of the test items

Frequency range refers to the frequency range in which 4945B/C generates qualified signals conforming to the specifications in the radio frequency transmission mode, usually explained by testing its upper limit frequency and lower limit frequency.

Frequency accuracy refers to the difference between the actual output carrier frequency and the set carrier frequency.

Frequency resolution refers to the minimum frequency interval of signals generated in 4945B/C radio frequency transmission mode.

Frequency range: 1MHz~1.05 GHz (Model 4945B, 1MHz~3 GHz(Model 4945C)

Resolution: 1 Hz

Accuracy: frequency standard ± 1 Hz

b) Testing steps

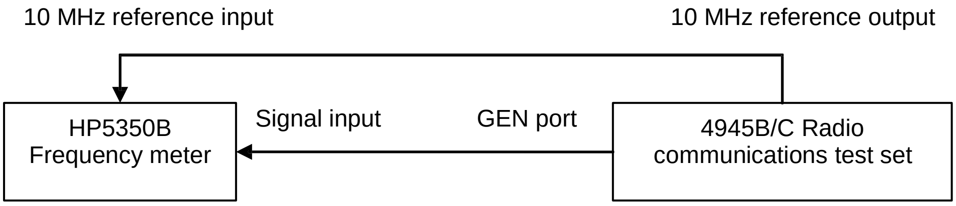


Fig. 6-7 Block diagram for RF signal generation frequency characteristics test

1) As shown in Fig. 6-7,connect the test instrument, set 4945B/C to the radio frequency TR mode, with the output frequency of 1 MHz and the amplitude of + 5 dBm; Set the impedance of the frequency meter to 1 MΩ, and record the measured value of the frequency meter at this time in corresponding space in Table A.1;

2) Set the output frequency of 4945B to 1.05 GHz (the output frequency of 4945C to 3 GHz), with the amplitude of - 10 dBm; set the frequency meter to the auto mode, and record the measured value of the frequency meter at this time in corresponding space in Table A.1;

3) If the measured value is within the range shown in Table A.1, the frequency generation range and frequency accuracy of RF signals are qualified;

4) Set the output frequency of 4945B/C to 300 MHz with the amplitude of -10 dBm; Set the impedance of the frequency meter to 1 MΩ and record the measured value f1 of the frequency meter at this time; set the output frequency of 4945B/C to 300.000001 MHz, and record the measured value f2 of the frequency meter at this time.

5) Calculate the difference of f2 and f1 and record it in corresponding space in Table A.1. If it is equal to the reference value, the frequency resolution is qualified.

3.1.2 Testing power range, accuracy and resolution of RF signals

a) Description of the test items

Power range refers to the range from the minimum power to the maximum power generated by the radio communications test set in the RF TX mode.

Power accuracy refers to the difference between the measured power and the set power.

Power resolution refers to the minimum interval for the radio communications test set to generate signal output power in the TX mode of.

Power range: -130～-35 dBm(T/R port)，-110~+5 dBm (GEN port, complicated modulation up to 0 dBm)

Resolution: 0.1 dB

Accuracy: ±1.5 dB (≥-110 dBm), ±2.0 dB (＜-110 dBm)

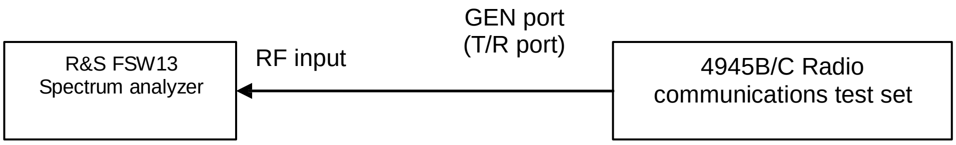


Fig. 6-8 Block diagram for RF signal generation power characteristics test

b) Testing steps

1) Test the RF signal generation power of the GEN port. As shown in Fig. 6-8, connect the GEN port of 4945B/C with the RF input port of the spectrum analyzer.

2) Set 4945B/C to the radio frequency TX mode with the frequency of 500 MHz and the amplitude of -110 dBm; set the center frequency of the spectrum analyzer to 500 MHz, the reference level to -60 dBm, attenuation to 0 dB, and the sweep to 1 kHz; peak marker, record the marker power value at this time to corresponding space in Table A.1.

3) Change the reference level of the spectrum analyzer to +10 dBm and the output power of 4945B/C to + 5 DBM; for peak marker, standard, record the marker power value at this time to corresponding space in Table A.1;

4) Test the RF signal generation power of the T/R port. Connect the T/R port of 4945B/C with the RF input port of the spectrum analyzer. Set the output frequency of 4945B/C to 500 MHz and the power to -130 dBm; set the reference level of the spectrum analyzer to -80 dBm, and the sweep to 100 kHz; peak marker, record the marker power value at this time to corresponding space in Table A.1.

5) Change the reference level of the spectrum analyzer to -30 dBm and the output power of 4945B/C to -35 DBM; for peak marker, standard, record the marker power value at this time to corresponding space in Table A.1;

6) If the measured value is within the range shown in Table A.1, the power generation range and power accuracy of RF signals are qualified;

7) Connect the GEN port of 4945B/C with the RF input port of spectrum analyzer, and set the output power of 4945B/C to - 5 dBm; Set the reference level of the spectrum analyzer to 0 dBm and the sweep to 10 kHz;

8) Peak marker. Enable marker difference, set the power of 4945B/C to -5.1 dBm, and record the marker difference at this time in corresponding space in table A.1., if it is equal to the reference value, the power resolution is qualified.

3.1.3 Testing harmonic, non-harmonic and phase noise of RF signals

a) Description of the test items

Harmonics are generated due to nonlinear distortion of signals, and their frequencies are all integer multiples of the signal carrier frequency. A non-harmonic refers to a parasitic or residual signal generated when a signal is generated, which is expressed as a fixed signal or a signal with a certain frequency deviation with the carrier. Harmonic and non-harmonic distortion indicators are characterized by the ratio of their power values to the carrier fundamental wave power values.

Phase noise refers to a continuous spectral sideband generated by random noise on carrier signal phase modulation. In general, the closer the carrier frequency is, the larger its value is, which is usually expressed by the ratio of noise power to carrier power (dBc/Hz) in a unit bandwidth in a single sideband at a certain frequency deviation from the carrier frequency.

Harmonic: <- 25 dBc (>1 MHz)

Non-harmonic: <- 35 dBc (>1 MHz)

Phase noise: -93 dBc/Hz@20 kHz(≤1.05 GHz),-90 dBc/Hz@20 kHz (>1.05 GHz)

b) Testing steps

1) As shown in Fig. 6-8, connect the GEN port of 4945B/C to the RF input port of the spectrum analyzer; set 4945B/C to the RF TX mode with the output frequency of 1 MHz and the amplitude of 0 dBm; set the start frequency of the spectrum analyzer to 1 MHz, and the reference level to 10 dBm;

2) Adjust the output signal frequency of 4945B from 1 MHz to 1.05 GHz (the output signal frequency of 4945C from 1 MHz to 3 GHz), while continuously adjusting the stop frequency of the spectrum analyzer more than 3 times of the current output frequency of 4945B/C; Observe and find the frequency point with the highest harmonic and record the measured value of harmonic power;

3) Set the output frequency of 4945B/C to 1 MHz and the amplitude to 5 dBm; Repeat step 2) to observe and find the frequency point with the highest non-harmonic and record the measured value of non-harmonic power;

4) Calculate the relative values of harmonic, non-harmonic and carrier powers, and record the results in corresponding spaces in Table A.1. If it is within the range shown, the harmonic and non-harmonic distortion indicators are qualified;

5)Set the output frequency of 4945B/C to 1 GHz and the amplitude to - 10 dBm; set the center frequency of the spectrum analyzer to 1 GHz, the reference level to 0 dBm, and the sweep to 50 kHz.

6) Peak marker is used to enable marker difference, set the frequency deviation of 20 kHz, enable noise marker function and video averaging function, and record the measured value in corresponding space in table A.1;

7) To test 4945C, change the output frequency to 3 GHz and the amplitude to - 10 dBm; Set the center frequency of the spectrum analyzer to 3 GHz, the reference level to 0 dBm, and the sweep to 50 kHz;

Repeat step 6);

8) If the measured value is within the range shown in Table A.1, the phase noise is qualified;

3.1.4 Testing maximum FM frequency deviation, accuracy and modulation rate of RF signals

a) Description of the test items

The maximum frequency deviation of frequency modulation refers to the maximum deviation of the instantaneous frequency of frequency modulation from the carrier frequency.

Accuracy refers to the difference between the measured frequency deviation and the set frequency deviation.

Modulation rate refers to the rate of the modulation signals.

Internal FM frequency deviation: 0~150 kHz

Internal FM frequency deviation accuracy: ±5% (Frequency deviation range: 5~150 kHz)

Internal FM modulation rate: 20 Hz~20 kHz

b) Testing steps

1) As shown in Fig. 6-8, connect the RF input of the spectrum analyzer to the GEN port of 4945B/C, set 4945B/C to the RF TX mode with the output frequency of 1.05 GHz, the amplitude of -10 dBm, the modulation format of FM, the modulation rate of 20 Hz and the frequency deviation of 5 kHz;

2) Set the spectrum analyzer to the analog demodulation mode, open the FM demodulation window, set the center frequency to 1.05 GHz, the reference level to 0 dBm, and the demodulation bandwidth to 800 kHz, and record the measured values of frequency deviation and modulation rate in corresponding spaces in Table A.1;

3) Change the modulation rate of 4945B/C to 20 kHz and the frequency deviation to 150 kHz, and record the measured values of frequency deviation and modulation rate in corresponding spaces in Table A.1;

4) If the measured values are within the range shown in Table A.1, the maximum frequency deviation, accuracy and modulation rate of the frequency modulation of RF signal generation are qualified;

3.1.5 Testing AM modulation range, accuracy and modulation rate of RF signal generation

a) Description of the test items

The amplitude modulation (AM) range refers to the extent of change of the AM carrier amplitude with the modulation signal level.

Accuracy refers to the difference between the measured AM depth and the set AM depth.

Modulation rate refers to the rate of the modulation signals.

Internal AM modulation range: 0~100%

Internal AM accuracy: ±5 % (modulation range 10~90%)

Internal AM modulation rate: 20 Hz~20 kHz

b) Testing steps

1) As shown in Fig. 6-8, connect the RF input of the spectrum analyzer to the GEN port of 4945B/C, set 4945B/C to the RF signal TX mode with the output frequency of 1.05 GHz, the amplitude of -10 dBm, the modulation format of AM, the modulation rate of 20 Hz and the frequency modulation depth of 30%;

2) Set the spectrum analyzer to the analog demodulation mode, open the AM demodulation window, set the center frequency to 1.05 GHz, the reference level to +10 dBm, and the demodulation bandwidth to 100 kHz, and record the measured values of AM depth and modulation rate in corresponding spaces in Table A.1;

3) Set AM parameters of 4945B/C according to Table A.1, and record the measured values of AM depth and modulation rate in corresponding spaces in Table A.1;

4) If the measured value is within the range shown in Table A.1, the AM range, accuracy, and modulation rate of RF signal generation are qualified;

3.1.6 Testing SSB modulation rate of RF signal generation

a) Description of the test items

SSB modulation, namely single sideband amplitude modulation, suppresses the carrier and one of the sidebands on the basis of amplitude modulation.

Internal SSB modulation options: USB, LSB

Internal SSB modulation rate: 300 Hz~5 kHz

b) Testing steps

1) As shown in Fig. 6-8, connect the RF input of the spectrum analyzer to the GEN port of 4945B/C, set 4945B/C to the RF TX mode with the output frequency of 1.05 GHz and the amplitude of -10 dBm;

2) Set the center frequency of the spectrum analyzer to 1.05 GHz, sweep width to 2 kHz, and reference level to 0 dBm; Peak marker of the spectrum analyzer, enable frequency marker, set the modulation format of 4945B/C to USB and the modulation rate to 300 Hz; and record the measured value in corresponding space in table A.1;

3) Set the sweep of the spectrum analyzer to 20 kHz; set the modulation format of 4945B/C to LSB and the modulation rate to 5 kHz; record the marker difference in corresponding space in table A.1;

4) If the measured value is within the range shown in Table A.1, the SSB modulation rate of RF signal generation is qualified;

3.1.7 Testing external analog modulation rate of RF signal generation

a) Description of the test items

External analog modulation means that the modulation signals are generated by external signal sources, and analog modulation signals are generated by input from the external modulation port of the rear panel of 4945B/C.

External analog modulation rates of 4945B/C: 20 Hz~15 kHz (FM, AM), 300 Hz~3 kHz (SSB)

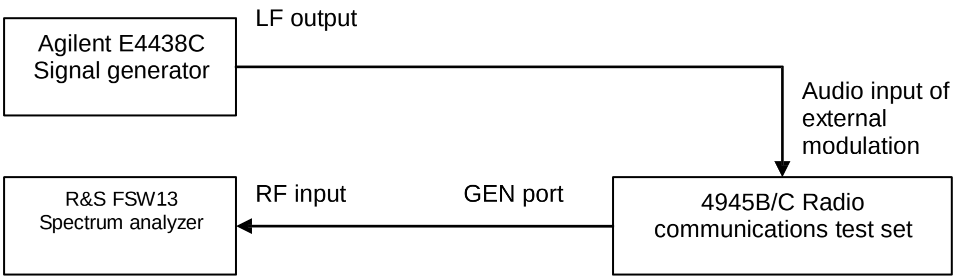


Fig. 6-9 Block diagram for external analog modulation characteristics test of RF signal generation

b) Testing steps

1) As shown in Fig. 6-9, connect the test instrument and set 4945B/C to the RF TX mode with the output frequency of 1.05 GHz and the amplitude of -10 dBm; select the modulation format to FM; select external audio as the modulation source and 100 kHz as the frequency deviation; set the spectrum analyzer to the analog demodulation mode, open the FM demodulation window, set the center frequency to 1.05 GHz and the demodulation bandwidth to 50 kHz; Set the LF output frequency of the signal generator to 20 Hz and the output amplitude to 200 mV_P, and record the measured value of modulation rate to corresponding space in Table A.1;

2) Set the LF output frequency of the signal generator to 15 kHz, and record the measured value of modulation rate to corresponding space in table A.1;

3) Set the external modulation format and modulation parameters of 4945B/C RF TX mode according to the requirements in Table A.1, set the demodulation format of the spectrum analyzer accordingly, and record the measured value of modulation rate in corresponding space of Table A.1;

4) If the measured value is within the range shown in Table A.1, the external modulation rate of RF signal generation is qualified;

3.1.8 Testing digital modulation bandwidth and code element rate of RF signal generation

a) Description of the test items

Modulation bandwidth and code element rate refer to the modulation bandwidth and code element rate that allow 4945B/C to generate qualified digital modulation signals in the RF TX mode.

Modulation bandwidth: 10 kHz～10 MHz

Maximum code element rate: 5 MHz

b) Testing steps

1) As shown in Fig. 6-9, connect the RF input of the spectrum analyzer to the GEN port of 4945B/C, set 4945B/C to the RF TX mode with the output frequency of 1.05 GHz, the amplitude of -10 dBm, the modulation format of BPSK, the code element rate of 1 MHz, the filter of RRC, the α factor of 1.0, and the data source of PN9;

2) Set the spectrum analyzer to the VSA (vector signal analysis) mode, the demodulation format of BPSK, the code element rate of 1 MHz, the filter of RRC, and the α factor of 1.0; record the measured EVM value in corresponding space in Table A.1; and the measured value of EVM should b ≤2 %rms.

3) Set the modulation format of 4945B/C to QPSK, the code element rate to 5 MHz, the filter to RC, and the α factor to 1.0; set the demodulation format of the spectrum analyzer to QPSK, the code element rate 5 MHz, the filter to RC, and the α factor to 1.0;

4) According to bandwidth = (1 + α factor) x code element rate and measured EVM value ≤3 %rms, the digital modulation bandwidth and code element rate of radio frequency signal are qualified.

3.1.9 Testing bandwidth and frequency agility time of frequency hopping signal generation

a) Description of the test items

Bandwidth refers to the bandwidth of the frequency hopping signal generated by 4945B/C in the RF TX mode.

Frequency agility time refers to the switching time of hopping frequency points.

Frequency hopping bandwidth: 1 MHz～60 MHz

Frequency agility time: < 10 μs

Maximum frequency hopping rate: 100,000 times/s

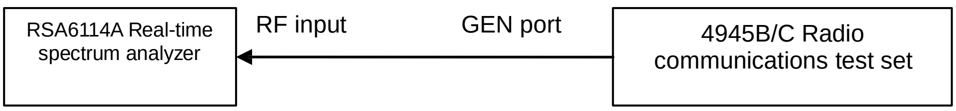


Fig. 6-10 Block diagram for frequency hopping generation characteristics test

b) Testing steps

1) As shown in Fig. 6-10, connect the test instrument and set 4945B/C to the RF TX mode with the amplitude of -10 dBm; in the list frequency hopping mode, the frequency hopping start frequency is 570 MHz, the frequency hopping stop frequency is 630 MHz, the number of frequency hopping points number is 4,000, the residence time is 5μs, and the switching time is 5 μs;

2) Set real-time spectrum analyzer to the digital afterglow mode, the reference level to 0 dBm, the analysis bandwidth to 100 MHz, measure the frequency hopping bandwidth with the cursor, and record the measured value in corresponding space of Table A.1;

3) Set the real-time spectrum analyzer to the frequency-time measurement mode, with the reference level of 0 dBm, the analysis bandwidth of 150 kHz, the time span of 200 ms, and 2 frequency hopping points. Measure the frequency agility time of the two frequency hopping points with the cursor and record the measured value in corresponding space of Table A.1;

4) If the measured frequency hopping bandwidth is within the range shown in Table A.1 and the frequency agility time is less than 10 μ s, the frequency hopping signal bandwidth and frequency agility time are qualified.

3.2 RF Signal Analysis

3.2.1 Testing sweep spectrum analysis frequency range

a) Description of the test items

Frequency range refers to the range between the minimum frequency and the maximum frequency that can be measured in the sweep spectrum analysis mode.

Frequency range: 100 kHz~1.05 GHz(Model 4945B, 100 kHz~3 GHz(Model 4945C)

Accuracy: ± (marker frequency x 2 x 10^{-6} + 1.1% x sweep + 10% x RBW)

Since the lowest output frequency of the signal source is 250 kHz, the frequency range is tested at a minimum of 300 kHz.

b) Testing steps

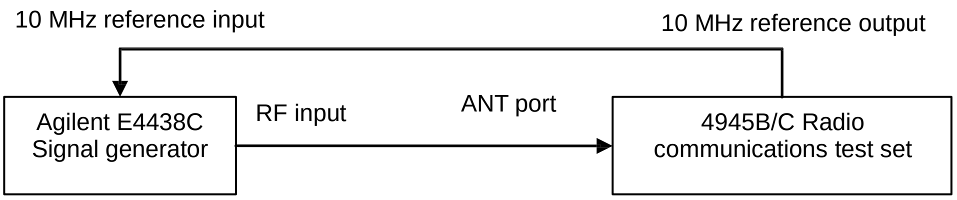


Fig. 6-11 Block diagram for sweep spectrum characteristics tests

1) As shown in Fig. 6-11, connect the test instrument, set the output frequency of the signal generator to 300 kHz and the amplitude to -10 dBm; set 4945B/C to the sweep spectrum mode with the center frequency of 300 kHz, the sweep of 100 kHz, the reference level of 0 dBm and the resolution bandwidth of 3 kHz;

2) In respect of peak marker, record the measured value at the marker in corresponding space of table A.1;

3) Set the output frequency of the signal generator to 1.05 GHz (3GHz when testing 4945C) with the amplitude of -10 dBm; Set the center frequency of 4945B to 1.05 GHz(center frequency of 4945C to 3 GHz), sweep to 200 kHz, reference level to 0 dBm, resolution bandwidth to 3 kHz, and repeat step 2);

4) If the measured frequency value is within the range shown in Table A.1, the sweep spectrum analysis frequency is qualified;

3.2.2 Testing reference level range and accuracy of sweep spectrum analysis

a) Description of the test items

Reference level range refers to the reference range of level that can be measured and displayed in the sweep spectrum analysis mode of 4945B/C.

Reference level range: +54 dBm~-50 dBm (T/R port), +20 dBm~-80 dBm (ANT port)

Level accuracy: ±1.5 dB

b) Testing steps

1)As shown in Fig. 6-11, connect the signal generator to the ANT port of 4945B/C, and set 4945B/C to the sweep frequency spectrum mode; set the input frequency of the signal generator to 300 MHz; set the center frequency of 4945B/C to 300 MHz, sweep width to 100 kHz, and other parameters to auto;

2) Set the output power of the signal generator and the reference level of 4945B/C according to Table A.1, and record the measured level value of 4945B/C in corresponding space of Table A.1;

3) Connect the signal generator with the T/R port of 4945B/C as shown in Fig. 6-8, and repeat step 2);

4) If the measured value is within the range shown in Table A.1, the reference level range and accuracy are qualified;

3.2.3 Testing average noise level of sweep spectrum analysis

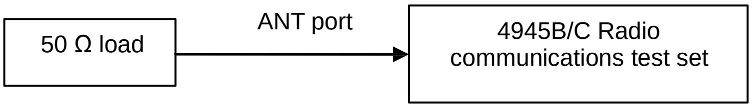


Fig. 6-12 Block diagram for average noise level test of sweep spectrum analysis

a) Description of the test items

When there is no signal input in the test, 4945B/C is in the sweep frequency spectrum analysis mode to test the display average noise level (DANL) at the minimum resolution bandwidth.

Average noise level: -125 dBm (ANT port, RBW=30 Hz, reference level-70 dBm),

-75 dBm (T/R port, RBW=30 Hz, reference level-10 dBm)

b) Testing steps

1) As shown in Fig. 6-12, connect the test instrument, set 4945B/C to the sweep spectrum mode with the center frequency of 300 MHz, zero sweep, the reference level of -70 dBm, the attenuation of 0 dB, the resolution bandwidth of 30 Hz, and enable video averaging and set the averaging times to 10;

2) Peak marker, record the measured power value at the marker in corresponding space of table A.1; when the test value is less than -125 dBm, the average noise level is qualified

3)Repeat step 2) to measure the T/R port, and record the measured results in corresponding space of table A.1

3.2.4 Testing resolution bandwidth and its accuracy and switching error of sweep spectrum analysis

a) Description of the test items

Resolution bandwidth refers to the ability of the radio communications test set to respond and separate two input signals in the spectrum analysis mode.

Resolution bandwidth accuracy refers to the difference between the actual bandwidth and the set ideal bandwidth.

Resolution switching error refers to the power measurement error of the measured signal with different resolution bandwidth settings.

Resolution bandwidth: 30 Hz～3 MHz (1-10 steps)

Resolution bandwidth accuracy: ±10% (RBW=3 kHz, 30 kHz, 60 kHz, 300 kHz), ±25% (RBW=3 MHz),

±20% (RBW≤300 Hz)

Switching error: ±1 dB

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator to the ANT port of 4945B/C, set the output frequency of the signal generator to 300 MHz and the power to -10 dBm; set 4945B/C to the sweep frequency spectrum mode, with the center frequency of 300 MHz and the reference level of 0 dBm;

2) Set the sweep width of 4945B/C to 30 kHz and the resolution bandwidth to 3 kHz, and set the resolution bandwidth of 4945B/C and the appropriate sweep width according to Table A.1, based on the peak value of the marker; in respect of peak marker, subtract the benchmark value from the peak marker and record the result in corresponding space of Table A.1; test the bandwidth value decreased by 3 dB and record it in corresponding space of Table A.1;

3) If the measured value is within the range shown in Table A.1, the resolution bandwidth accuracy and switching error are qualified.

3.2.5 Testing sweep time range of sweep spectrum analysis

a) Description of the test items

Sweep time range refers to the range between the maximum value and minimum value of the time taken by 4945B/C to complete a sweep in the sweep spectrum analysis mode.

Sweep time: 100 ms~100 s

Sweep accuracy: ±2%.

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator to the ANT port of 4945B/C, set the output frequency of the signal generator to 300 MHz and the amplitude to -10dBm, enable AM with the modulation rate of 100 Hz and the AM depth of 100%; set 4945B/C to the sweep spectrum mode, with the center frequency of 300 MHz, the sweep of 0 Hz, the reference level of 0 dBm, the amplitude unit of Volts and the sweep time of 100 ms;

2) In respect of the difference of the peak marker, measure the time of 9 sine cycles, and record the measured values divided by 9 and multiplied by 10 in corresponding spaces of table A.1;

3) Set the sweep time of 4945B/C to 100 s, set the modulation rate of the signal generator to 0.1 Hz, and repeat step 2);

4) If the measured value is within the range shown in Table A.1, the sweep time of sweep spectrum analysis is qualified;

3.2.6 Testing frequency range, level range and accuracy of broadband power meter

a) Description of the test items

Frequency range refers to the range of 4945B/C between the minimum and maximum measurable frequencies in the broadband power measurement mode.

Level range refers to the range between the minimum and maximum measurable levels of 4945B/C in the broadband power measurement mode.

Accuracy refers to the degree of difference between the measured level and the nominal levels.

Frequency range: 400 kHz~1.05 GHz (Model 4945B), 400kHz~3 GHz (Model 4945C)

Power measurement range: 100 mW~150 W (T/R port), 0.1 mW~100 mW (ANT power measurement)

Measurement accuracy: 10 % (+ 19 dBm typical)

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator with the ANT port of 4945B/C, and set 4945B/C to the broadband power measurement mode;

2) Set the output frequency of the signal generator to 400 kHz, and the amplitude to + 19 dBm (79.44 mW); set the reference frequency for broadband power measurement of 4945B/C to 400 kHz and the amplitude unit to Watts, and record the measured broadband power value in corresponding space of Table A.1;

3) Connect the signal generator with the T/R port of 4945B/C, set the output frequency of the signal generator to 1.05 GHz (3 GHz when testing 4945C), set the reference frequency for broadband power measurement of 4945B to 1.05 GHz (3 GHz for 4945C), and record the measured broadband power value in corresponding space of Table A.1;

4) If the measured value is within the range shown in Table A.1, the frequency range, level range and accuracy of the broadband power meter are qualified;

3.2.7 Testing frequency range, level range and accuracy of narrow-band power meter

a) Description of the test items

Frequency range refers to the range of 4945B/C between the minimum and maximum measurable frequencies in the narrow-band power measurement mode.

Level range refers to the range between the minimum and maximum measurable levels of 4945B/C in the narrow-band power measurement mode.

Accuracy refers to the degree of difference between the measured level and the nominal levels.

Frequency range: 300 kHz~1.05 GHz (Model 4945B, 300 kHz~3 GHz (Model 4945C).

Power range: +51 dBm~-40 dBm(T/R port)，+10 dBm~-80 dBm (ANT port).

Accuracy: ±2 dB.

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator to the T/R port of 4945B/C, and set the output frequency of the signal generator to 300 kHz and the amplitude to + 19 dBm. Set 4945B/C to the RF RX mode, narrow-band power measurement reference carrier to 300 kHz, reference level to +51 dBm, and IF bandwidth 10 kHz; record the measured narrow-band power value of the T/R port in corresponding space of Table A.1;

2) Set the output frequency and amplitude of the signal generator according to Table A.1, set the reference carrier and reference level of 4945B accordingly, and record the measured narrow-band

power value in corresponding space of Table A.1;

3) Connect the signal generator to the ANT port of 4945B/C, repeat step 2), and record the measured narrow-band power value of the ANT port in corresponding space of Table A.1;

4) If the measured power value is within the range shown in Table A.1, the frequency range, level range and accuracy of the narrow-band power meter are qualified;

3.2.8 Testing of frequency range, resolution and accuracy of frequency error meter

a) Description of the test items

Frequency range refers to the range between the minimum frequency and the maximum frequency that can be measured by 4945B/C in the RF signal analysis mode.

Frequency resolution refers to the minimum frequency interval of signals measurable in radio frequency transmission mode of 4945B/C.

Frequency accuracy refers to the difference between the measured output carrier frequency and the nominal carrier frequency.

Frequency range: 300 kHz~1.05 GHz (Model 4945B, 300 kHz~3 GHz (Model 4945C).

Frequency resolution: 1 Hz.

Accuracy: frequency standard ± 1 Hz.

b) Testing steps

1) As shown in Fig. 6-11, connect the test instrument and set the output frequency of the signal generator to 300 kHz and the power to - 10 dBm; set 4945B/C to the RF RX mode, with the reference carrier frequency of 300 kHz, IF bandwidth of 10 kHz, and reference level of 0 dBm; enable the function of frequency error meter, and record the measured frequency error value in corresponding space in table A.1;

2) Set the output power frequency of the signal generator and the carrier frequency of 4945B/C according to Table A.1, and record the measured frequency error values in corresponding spaces of Table A.1;

3) If the measured frequency values are within the range shown in Table A.1, the frequency range and frequency accuracy of the frequency error meter is qualified;

4) Set the output frequency of the signal generator to 300 MHz and the carrier frequency of 4945B/C to 300 MHz, record the measured value f1 of frequency error; set the output frequency of the signal generator to 300.000001 MHz and record the measured frequency error f2;

6) Calculate the difference between f2 and f1. If the difference is equal to the reference value, the frequency resolution of the frequency error meter is qualified.

3.2.9 Testing frequency range, counting frequency range, resolution and sensitivity of analog modulation signal demodulation and analysis

a) Description of the test items

Frequency range refers to the range between the minimum and maximum carrier frequencies of demodulation signals that can be demodulated and analyzed by 4945B/C.

Demodulation counting frequency range refers to the range between the minimum and maximum frequencies of demodulation and analysis modulation signals.

Resolution refers to the minimum interval between the frequencies of modulation signals that can be demodulated and analyzed.

Frequency range: 300 kHz~1.05 GHz (Model 4945B, 300 kHz~3 GHz (Model 4945C).

Demodulation counter frequency range: 20 Hz~20 kHz (accuracy ±1%), resolution: 0.1 Hz.

Sensitivity: ≤-100 dBm (10 dB SINAD)

These specifications takes AM signals as the test signals for testing demodulation and analysis frequency range, counting frequency range, resolution and sensitivity of analog modulation signals. FM signals are taken for sensitivity test.

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator to the ANT port of 4945B/C, set the output frequency of the signal generator to 300 kHz, the output amplitude to -10dBm, and enable AM with the modulation rate of 20 Hz and the AM depth of 50 %;

2) Set 4945B/C to the RF RX mode, the demodulation format to AM, the reference carrier to 300 kHz, the reference level to 0 dBm, the IF bandwidth to 30 kHz, the audio filter LPF to 300 Hz; record the measured modulation rate value in corresponding space in Table A.1;

3) Set modulation parameters of the signal generator and demodulation parameters of 4945B/C according to Table A.1, set the IF bandwidth to 300kHz when the modulation rate is 20kHz, and record the measured values of modulation rate in corresponding spaces in Table A.1;

4) If the measured modulation rate values are within the range shown in Table A.1, the demodulation and analysis frequency range and demodulation counting frequency range of analog modulation signals are qualified;

5) Set the output frequency of the signal generator to 1.05 GHz, the output amplitude to -10 dBm, enable AM, with the modulation rate of 20 Hz and the AM depth of 50 %; set 4945B/C to the RF RX mode, with the demodulation format of AM, reference frequency of 1.05 GHz, reference level of 0 dBm, IF bandwidth of 30 kHz, and audio filter LPF of 300 Hz; record the measured value f1 of modulation rate;

6) Change the AM modulation rate of the signal generator to 20.1 Hz; record the measured value f2 of modulation rate;

7) Calculate the difference of f2-f1, and if it is equal to the reference value, the demodulation counting resolution is qualified.

8) Set the output frequency of the signal generator to 1.05 GHz, the output amplitude to -100 dBm, and enable FM, with the modulation rate of 1 kHz and the frequency deviation of 10 kHz; set 4945B/C to the RF RX mode, with the demodulation format of FM, reference carrier of 1.05 GHz, reference level of -70 dBm, attenuation of 0 dB, IF bandwidth of 30 kHz, and audio filter LPF of 5kHz; record the measured SINAD value in corresponding space of Table A.1. If the SINAD value is ≥10dB, the sensitivity is qualified.

3.2.10 Testing demodulation and analysis frequency deviation, accuracy and modulation rate of FM signals

a) Description of the test items

Frequency deviation range refers to the range between the minimum and maximum frequency deviations of measurable by 4945B/C through FM signal demodulation and analysis in the RF RX mode.

Frequency deviation accuracy refers to the difference between the measured frequency deviation and the nominal frequency deviation.

Modulation rate refers to the audio rate of the demodulated FM signals by 4945B/C in the RF RX mode.

Frequency deviation range: 0~150 kHz.

FM frequency deviation accuracy: ±5% (Frequency deviation range 5~150 kHz, modulation rate 1 kHz)

Modulation rate: 20 Hz~20 kHz (accuracy ±1%).

b) Testing steps

1) As shown in Fig. 6 - 11, connect the signal generator with the ANT port of 4945B/C, set the output frequency of the signal generator to 1.05 GHz and the output amplitude to -10 dBm, and enable FM, with the modulation rate of 20 Hz and the frequency deviation of 150 kHz; set 4945B/C to the RF RX mode, with the demodulation format of FM, reference frequency of 1.05 GHz, reference level of 0 dBm, IF bandwidth of 300 kHz, and audio filter LPF of 300 Hz; Record the measured values of modulation rate and frequency deviation in corresponding spaces of Table A.1.

2) Set the FM modulation rate of the signal generator to 20 kHz, set the audio filter of 4945B/C to LPF 20 kHz, and record the measured modulation rate and frequency deviation in corresponding spaces of Table A.1;

3) If the measured values of modulation rate and frequency deviation are within the range shown in Table A.1, the demodulation and analysis frequency deviation range, accuracy and modulation rate of

FM signals are qualified;

3.2.11 Testing demodulation and analysis frequency deviation, accuracy and modulation rate of AM signals

a) Description of the test items

AM depth range refers to the range between the minimum and maximum AM depths measurable by 4945B/C through AM signal demodulation and analysis in the RF RX mode.

AM depth accuracy refers to the difference between the measured AM depth and the nominal AM depth.

Modulation rate refers to the audio rate of the demodulated AM signals by 4945B/C in the RF RX mode.

AM depth range: 0~100%.

AM modulation meter accuracy: ±5% (modulation range 30%~90%, modulation rate 1 kHz).

Modulation rate: 20 Hz~20 kHz.

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator to the ANT port of 4945B/C, set the output frequency of the signal generator to 1.05 GHz, the output amplitude to -15 dBm, enable AM with the modulation rate of 20 Hz and the AM depth of 30%;

2) Set 4945B/C to the RF RX mode, the modulation format to AM, the reference carrier to 1.05 GHz, the reference level to +10 dBm, the IF bandwidth to 10 kHz, and the audio filter LPF to 300 Hz; record the measured modulation rate and AM depth value in corresponding space in Table A.1;

3) Set the AM modulation parameters of the signal generator according to Table A.1, set appropriate audio filter of 4945B/C, and record the measured modulation rate and AM depth values in corresponding spaces of Table A.1;

4) If the measured values of modulation rate and AM depth are within the range shown in Table A.1, the demodulation and analysis AM depth range, accuracy and modulation rate of AM signals are qualified;

3.2.12 Testing demodulation and analysis frequency rate of SSB demodulation signals

a) Description of the test items

Modulation rate refers to the audio rate of the demodulated SSB signals by 4945B/C in the RF RX mode.

Modulation rate: 300Hz~5kHz.

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator to the ANT port of 4945B/C, set the output frequency of the signal generator to 0.999999700 GHz, and the output amplitude to -15 dBm;

2) Set 4945B/C to the RF RX mode, the demodulation format to LSB, the reference carrier to 1GHz, the reference level to +10 dBm, the IF bandwidth to 10 kHz, and the audio filter LPF to 5kHz; record the measured modulation rate value in corresponding space in Table A.1;

3) Change the output frequency of the signal generator to 1.000005000 GHz, set the modulation format of 4945B/C to USB, and record the measured modulation rate in corresponding space of Table A.1;

4) If the measured value of modulation rate is within the range shown in Table A.1, the demodulation and analysis modulation rate of SSB modulation signals are qualified;

3.2.13 Testing demodulation and analysis frequency range, demodulation bandwidth and maximum code element rate of digital demodulation signals

a) Description of the test items

Frequency range refers to the range between the minimum and maximum frequencies of signals that can be demodulated and analyzed by 4945B/C in the RF RX mode.

Demodulation bandwidth and maximum code element rate refer to the bandwidth and maximum code element rate of signals that can be demodulated and analyzed by 4945B/C.

Frequency range: 300 kHz~1.05 GHz (Model 4945B), 300kHz~3 GHz (Model 4945C)

Demodulation formats: GMSK, BPSK, QPSK, 8PSK, and 16QAM

Modulation bandwidth: 10 kHz~10 MHz

Maximum code element rate: 5 MHz

Filters: RC, RRC, and GAUSS

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator with ANT port of 4945B/C, set the output frequency of the signal generator to 300 kHz, and the output amplitude to -10 dBm, enable digital modulation, with the modulation format of QPSK, code element rate of 20 kHz, and filter of RRC/0.5; set 4945B/C to the RF RX mode, with the reference frequency of 300 kHz, reference level of 0 dBm, demodulation format of QPSK, code element rate of 20 kHz, and filter of RRC/0.5; record measured EVM values in corresponding spaces in Table A.1;

2) Set the output frequency of the signal generator to 1.05 GHz (3 GHz for 4945C), set the reference frequency of 4945B to 1.05GHz (3 GHz for 4945B), and record measured EVM values in corresponding spaces in Table A.1;

3) If the measured EVM value is ≤3 %rms, the demodulation and analysis frequency range of digital modulation signals is qualified;

4) Set the output frequency of the signal generator to 300MHz, the code element rate to 5 MHz, and the filter to RRC/1.0; set reference frequency of 4945B/C to 300 MHz, code element rate to 5MHz, and filter to RRC1.0; record measured EVM values in corresponding spaces of Table A.1;

5) According to bandwidth = (1 + α factor) x code element rate, if the measured EVM value is ≤3 %rms, the demodulation bandwidth and maximum code element rate of digital demodulation signals are qualified.

3.2.14 Testing real-time analysis bandwidth of frequency hopping signal analysis

a) Description of the test items

Real-time analysis bandwidth refers to the bandwidth of the frequency hopping signals measurable by 4945B/C in the real-time spectrum analysis mode.

Real-time analysis bandwidth: 60 MHz, 30 MHz, 15 MHz, 7.5 MHz, 3.75 MHz and 1.875 MHz (accuracy ±1%).

b) Testing steps

1) As shown in Fig. 6-11, connect the signal generator to the ANT port of 4945B/C, set the sweep mode of the signal generator, set the out range to 570 MHz~630 MHz, number of sweep points to 10, residence time to 100 ms, and output amplitude to -10 dBm;

2) Set 4945B/C to the real-time spectrum mode, with the center frequency of 1 GHz, reference level of 0 dBm, and analysis bandwidth of 60 MHz;

3) Open the spectrum window, with the trace held maximally. Enable the marker function, test the signal bandwidth, and record the measured values in corresponding spaces of Table A.1;

4) If the measured values are within the range shown in Table A.1, the real-time analysis bandwidth of frequency hopping signal analysis is qualified;

3.3 Audio Signal Generation

3.3.1 Testing for frequency range, resolution and accuracy of audio signal generation

a) Description of the test items

Frequency range refers to the range between the minimum frequency and the maximum frequency generated by 4945B/C in the audio generation mode.

Frequency resolution refers to the minimum frequency interval of signals generated by 4945B/C in the audio generation mode.

Frequency range: 20 Hz~20 kHz (sine), 20 Hz~4 kHz (square wave, triangle, and sawtooth) (accuracy ±1%).

Frequency resolution: 0.1Hz.

Accuracy: 0.1Hz.

These specifications test the audio signal generation indicators with sinusoidal signals. Due to the limits of audio analyzers for minimum frequency of measurement, these specifications adopt the frequency range of 80 Hz~20 kHz for the test.

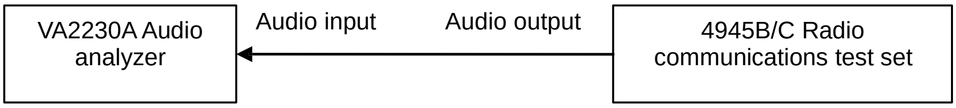


Fig. 6-13 Block diagram for audio signal generation characteristics test

b) Testing steps

1) As shown in Fig. 6-13,set 4945B/C to the audio generation mode, with the output frequency of 20 kHz, the amplitude of 200 mVrms, the waveform of sine, and the output impedance of high-Z; set the audio analyzer to the audio measurement mode, and record the measured frequency values in corresponding spaces of Table A.1;

2) Set the output frequency of 4945B/C to 80Hz, and record the measured value f1 in corresponding space of table A.1;

3) If the measured value is within the range shown in Table A.1, the frequency range of audio signal generation is qualified;

4) Set the audio output frequency of 4945B/C to 80.1 Hz, and record the measured value f2;

5) Calculate the difference between f2 and f1. If the difference is equal to the reference value, the frequency resolution and accuracy of audio signal generation are qualified.

3.3.2 Testing for level range and accuracy of audio signal generation

a) Description of the test items

Level range refers to the range between the minimum voltage and the maximum voltage of audio signals output by 4945B/C in the audio generation mode.

Level accuracy refers to the extent of difference between the measured audio amplitude and the nominal audio amplitude.

Level range: 1mv~7vrms (10 kΩ load).

Level accuracy: ±5% (10 kΩ load, ≥10 mVrms).

b) Testing steps

1) As shown in Fig. 6-13,connect the test instrument, set 4945B/C to the audio generation mode, with the output frequency of 20 kHz and the amplitude to 10 mVrms; record the measured level value of the audio analyzer in corresponding space of Table A.1;

2) Change the audio signal generation frequency of 4945B/C to 80 Hz and the frequency deviation to 7 Vrms, and record the measured level values of the audio analyzer in corresponding spaces of Table A.1;

3) If the measured level value is within the range shown in Table A.1, the level range and accuracy of audio signal generation are qualified;

3.4 Audio Signal Analysis

3.4.1 Testing for input impedance of audio signal analysis

a) Description of the test items

The audio signal analysis input impedances of 4945B/C radio communications test set are: 150 Ω, 600 Ω and high impedance.

b) Testing steps

1) Set 4945B/C to the audio analysis mode, with high input impedance; measure the ground resistance of the audio analysis input interface of 4945 with FLUKE15B digital multimeter directly, and record the measured values in corresponding spaces of Table A.1;

2) Set the input impedance of 4945B/C in the audio analysis mode according to the requirements in

Table A.1, and record the measured values in corresponding spaces of Table A.1;

3) If the measured values are within the range shown in Table A.1, the input impedance of audio signal analysis is qualified;

3.4.2 Testing for maximum input level of audio signal analysis

a) Description of the test items

The maximum input level for audio signal analysis of 4945B/C radio communications test set is 30 Vrms (high impedance).

Maximum input level: 30 Vrms (high impedance), (accuracy ±5%). Due to the limits of audio signal source for maximum output amplitude, these specifications adopt the upper limit 10 Vrms of the input level range for test.

b) Testing steps

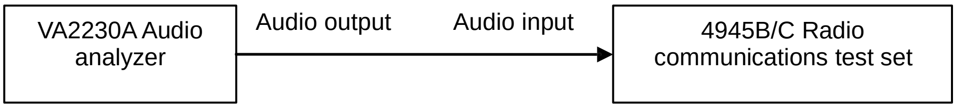


Fig. 6-14 Block diagram for audio signal analysis characteristics test

1) As shown in Fig. 6-14, connect the test instrument and set the output frequency of the audio analyzer to 1 kHz, and the amplitude to +14 dBV (600 Ω internal resistance, equal to high impedance of 10Vrms); set 4945B/C to the audio analysis mode, with the audio filter of 20 kHz LPF, high impedance input, and level test range of 30V~5V, and record the measured level values in corresponding spaces of Table A.1;

2) If the measured values are within the range shown in Table A.1, the maximum input level is qualified.

3.4.3 Testing for frequency range, resolution, accuracy and input level range of audio signal analysis frequency meter

a) Description of the test items

Frequency range of frequency meter refers to the range between the minimum and maximum frequencies that can be accurately measured by 4945B/C in the audio signal analysis mode with the frequency meter.

Resolution refers to the minimum interval between audio frequencies distinguishable with the frequency meter.

Input level range refers to the range between the minimum and maximum audio levels that can be accurately measured with the frequency meter.

Frequency range: 20 Hz~20 kHz (accuracy ±1%).

Resolution: 0.1Hz.

Accuracy: 1Hz.

Input level: 20 mV~30 Vrms. Due to the limits of audio signal source for maximum output amplitude, these specifications adopt the upper limit 10 Vrms of the input level range for test.

b) Testing steps

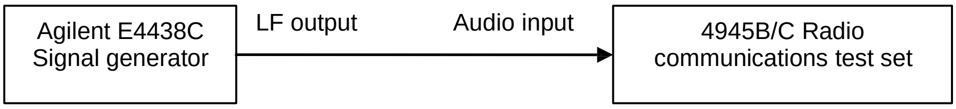


Fig. 6-15 Block diagram for audio signal analysis characteristics test

1) As shown in Fig. 6-14, connect the test instrument and set the output frequency of the audio analyzer to 20 kHz, and the amplitude to -40 dBV (equal to 20 mVrms); set 4945B/C to the audio analysis mode, with the audio filter of LPF 20 kHz, high impedance input, and level test range of below 50 mV, and record the measured frequency values in corresponding spaces of Table A.1;

2) Set the output frequency of the audio analyzer to 20 Hz, and the amplitude to +14 dBV (equal to 10

Vrms); set the audio filter LPF of 4945B/C to 300Hz and the level testing range to 30V~5V, and record the measured level values in corresponding spaces of Table A.1;

3) If the measured frequency values are within the range shown in Table A.1, the frequency range and input level range of the audio analysis frequency meter are qualified;

4) As shown in Fig. 6-15, connect the test instrument set the low-frequency output frequency of the signal generator to 20 Hz and the amplitude to 100 mV_P, and record the frequency measurement f1; change the low-frequency output frequency to 20.1 Hz and record the frequency measurement f2;

5) Calculate the value of f2-f1, and if it is equal to the reference value, the resolution and accuracy of the audio signal analysis frequency meter are qualified.

3.4.4 Testing frequency range, input level range and accuracy of audio signal analysis level meter

a) Description of the test items

Frequency range of level meter refers to the range between the minimum and maximum frequencies that can be accurately measured by 4945B/C in the audio signal analysis mode with the level meter.

Input level range refers to the range between the minimum and maximum audio levels that can be accurately measured with the level meter.

Accuracy refers to the difference between the audio measured level with the level meter and the nominal level.

Frequency range: 20 Hz~20 kHz.

Input level: 0~30 Vrms, due to the limits of audio signal source for maximum output amplitude, these specifications adopt the upper limit 10 Vrms of the input level range for test.

Accuracy: ±5% % (high impedance, ＞10 mVrms).

b) Testing steps

1) As shown in Fig. 6-14, connect the test instrument and set the output frequency of the audio analyzer to 20Hz, and the amplitude to +14 dBV (equal to high impedance of 10Vrms); set 4945B/C to the audio analysis mode, with the audio filter of 300Hz LPF, high impedance input and level range of 30V~5V, and record the measured level values in corresponding spaces of Table A.1;

2) Set the output frequency of the audio analyzer to 20 kHz, and the audio filter of 4945B/C to 20kHz LPF; record the measured level values in corresponding spaces of Table A.1;

3) If the measured level values are within the range shown in Table A.1, the frequency range, input level range and accuracy of the audio analysis level meter are qualified.

3.4.5 Testing frequency range, input level range, measuring range and accuracy of audio signal analysis SINAD meter

a) Description of the test items

Frequency range of SINAD meter refers to the range between the minimum and maximum frequencies that can be accurately measured by 4945B/C in the audio signal analysis mode with the SINAD meter.

Input level range refers to the range between the minimum and maximum audio levels that can be accurately measured with the SINAD meter.

Measurement range refers to the range from the lowest to the highest SINAD values that can be measured with the SINAD meter.

Accuracy refers to the difference between the measured SINAD and the nominal SINAD.

Frequency range: 300Hz~5kHz.

Input level: 0.1~30 Vrms. Due to the limits of signal generators for maximum output amplitude; these specifications adopt the upper limit 5 V_P of the input level range for test.

Measuring range: 3~60 dB.

Accuracy: ±1.0 dB.

b) Testing steps

1) As shown in Fig. 6-15, connect the test instrument and set the signal generator to the low-frequency output and dual-tone mode, with frequency 1 of 300 Hz and frequency 2 of 600 Hz (audio 2 takes up 50% of the amplitude), and the output level of 140 mV_P (100mVrms); set 4945B/C to the audio analysis mode, with the measuring frequency of 300 Hz, filter of 5 kHz LPF, and input range of 500 mV~50 mV, and record the measured SINAD values in corresponding spaces of Table A.1;

2) Set the signal generator to the low-frequency output mode, with frequency 1 of 5kHz and frequency 2 of 10kHz (audio 2 takes up 50% of the amplitude), and the output level of $5V_P$; set 4945B/C to the measuring frequency of 5kHz, filter of 20kHz LPF, and input range of 30V~5V, and record the measured SINAD values in corresponding spaces of Table A.1;

3) If the measured SINAD values are within the range shown in Table A.1, the frequency range and input level range of the audio analysis SINAD meter are qualified;

4) Set the signal generator to the low-frequency output mode, with frequency 1 of 1kHz and frequency 2 of 2kHz (audio 2 takes up 50% of the amplitude), and the output level of $500mV_P$; set 4945B/C to the measuring frequency of 1kHz, filter of 300Hz LPF, and input range of 500 mV~50 mV, and record the measured SINAD values in corresponding spaces of Table A.1;

5) Change the amplitude taken by audio frequency 2 of the signal generator to 0.1 %, and record the measured SINAD valued in corresponding spaced of Table A.1;

6) If the measured SINAD values are within the range shown in Table A.1, the measuring range and accuracy of the audio analysis SINAD meter are qualified;

3.4.6 Testing frequency range, input level range, measuring range and accuracy of audio signal analysis distortion meter

a) Description of the test items

Frequency range of distortion meter refers to the range between the minimum and maximum frequencies that can be accurately measured by 4945B/C in the audio signal analysis mode with the distortion meter.

Input level range refers to the range between the minimum and maximum audio levels that can be accurately measured with the distortion meter.

Measuring range refers to the range from the lowest to the highest distortion values that can be measured with the distortion meter.

Accuracy refers to the difference between the measured distortion and the nominal distortion.

Frequency range: 300 Hz~5 kHz.

Input level: 0.1~30 Vrms. Due to the limits of signal generators for maximum output amplitude, these specifications adopt the upper limit 5 V_P of the input level range for test.

Measuring range: 0~90%.

Accuracy: ＜±0.5% (distortion＜10%), ＜±1.0% (distortion＜20%).

b) Testing steps

1) As shown in Fig. 6-15, connect the test instrument and set the signal generator to the low-frequency output and dual-tone mode, with frequency 1 of 300 Hz and frequency 2 of 600 Hz (audio 2 takes up 9% of the amplitude), and the output level of 140 mV_P (100mVrms); set 4945B/C to the audio analysis mode, with the measuring frequency of 300 Hz, filter of 5 kHz LPF, and input range of 500 mV~50 mV, and record the measured distortion values in corresponding spaces of Table A.1;

2) Set the signal generator to the low-frequency output mode, with frequency 1 of 5kHz and frequency 2 of 10kHz (audio 2 takes up 9% of the amplitude), and the output level of $5V_P$; set 4945B/C to the measuring frequency of 5kHz, filter of 20kHz LPF, and input range of 30V~5V, and record the measured distortion values in corresponding spaces of Table A.1;

3) If the measured distortion values are within the range shown in Table A.1, the frequency range and input level range of the audio analysis distortion meter are qualified;

4) Set the signal generator to the low-frequency output mode, with frequency 1 of 1kHz and frequency 2 of 2kHz (audio 2 takes up 0.1% of the amplitude), and the output level of $800mV_P$; set 4945B/C to the measuring frequency of 1kHz, filter of 300Hz LPF, and input range of 500 mV~50 mV, and record the

measured distortion values in corresponding spaces of Table A.1;

5) Change the amplitude taken by audio frequency 2 of the signal generator to 47.4%, and record the measured distortion valued in corresponding spaced of Table A.1;

6) If the measured distortion values are within the range shown in Table A.1, the measuring range and accuracy of the audio analysis distortion meter are qualified;

3.4.7 Testing frequency range, input level range, measuring range and accuracy of audio signal analysis SNR meter

a) Description of the test items

Frequency range of SNR meter refers to the range between the minimum and maximum frequencies that can be accurately measured by 4945B/C in the audio signal analysis mode with the SNR meter.

Input level range refers to the range between the minimum and maximum audio levels that can be accurately measured with the SNR meter.

Measurement range refers to the range from the lowest to the highest SNR values that can be measured with the SNR meter.

Accuracy refers to the difference between the measured SNR and the nominal SNR.

Frequency range: 300Hz~5kHz.

Input level: 0.1~30 Vrms. Due to the limits of signal generators for maximum output amplitude, these specifications adopt the upper limit 5 V_P of the input level range for test.

Measuring range: 3~60 dB.

Accuracy: ±1.0 dB.

b) Testing steps

1) As shown in Fig. 6-15, connect the test instrument, and set the signal generator to low-frequency output with the frequency of 300 Hz and the output level 1 of 140 mV_P (100 mVrms); set 4945B/C to the audio analysis mode, the SNR measurement mode to "Lock reference in case of noise", self-selected measuring frequency of 300 Hz, filter of 5 kHz LPF, input range of 500 mV~50mV, and press the "SNR Reference Lock" key; change the output level 2 of the signal generator to 280 mV_P (200 mVrms); record the measured SNR values in corresponding spaces of Table A.1;

2) Set the signal generator to low-frequency output mode, with the output frequency of 5 kHz and the output level 1 of 2.5 V_P; set 4945B/C to the audio analysis mode, with the self-selected measuring frequency of 5 kHz, filter of 20 kHz LPF, and input range of 30V~5V, and press the "SNR Reference Lock" key; change the output level 2 of the signal generator to 5V_P); record the measured SNR values in corresponding spaces of Table A.1;

3) If the measured SNR values are within the range shown in Table A.1, the frequency range and input level range of the audio analysis SNR meter are qualified;

4) Set the signal generator to low-frequency output with the frequency of 1 kHz and the output level 1 of 100 mV_P; set 4945B/C to the audio analysis mode, the self-selected measuring frequency of 1 kHz, filter of 300 Hz~ 5 kHz, input range of 5 V~500 mV, and press the "SNR Reference Lock" key; change the output level 2 of the signal generator to 142 mV_P; record the measured SNR values in corresponding spaces of Table A.1;

5) Set the signal generator to low-frequency output mode, with the output frequency of 1kHz and the output level 1 of 4 mV_P; set 4945B/C to the audio analysis mode, with the self-selected measuring frequency of 1kHz, filter of 300 Hz~ 5 kHz, and input range of 5 V~500 mV， and press the "SNR Reference Lock" key; change the output level 2 of the signal generator to 4096 mV_P; record the measured SNR values in corresponding spaces of Table A.1;

6) If the measured SNR values are within the range shown in Table A.1, the measuring range and accuracy of the audio analysis SNR meter are qualified;

3.5 Oscilloscope

3.5.1 Testing oscilloscope input impedance

a) Description of the test items

The input impedance at the oscilloscope interface of 4945B/C is: 1 MΩ.

b) Testing steps

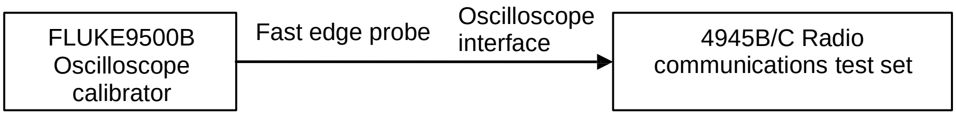


Fig. 6-16 Oscilloscope input characteristics test

1) As shown in Fig. 6-16, connect the oscilloscope calibrator with the oscilloscope input 1 interface of 4945B/C with a fast edge probe; set 4945B/C to the oscilloscope mode and the oscilloscope channel 1 to on;

2) Enable the resistance measurement function of the oscilloscope calibrator; record the measured impedance values in corresponding spaces in Table A.1;

3) As shown in Fig. 6-16, connect the oscilloscope calibrator with the oscilloscope input 2 interface of 4945B/C with a fast edge probe; set 4945B/C to the oscilloscope mode and the oscilloscope channel 2 to on; repeat step 2);

5) If the measured impedance values are within the range shown in Table A.1, the input impedance of the oscilloscope is qualified;

3.6 Digital sequence generation and BER

3.6.1 Testing Baud rate range and BER measuring range of digital sequence generation

a) Description of the test items

BER measuring range refers to the range between the minimum and maximum BERs that can be analyzed by 4945B/C for bit errors.

Baud rate: 300 bps to 1 Mbps (BPSK, GMSK, 2FSK, 2ASK)

Bit error rate measurement range: 0.1~0.000001.

b) Testing steps

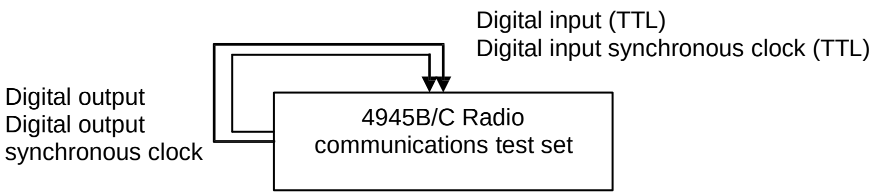


Fig. 6-17 Testing digital sequence generation and BER RX characteristics

1) As shown in Fig. 6-17, connect the digital output and digital input, digital output synchronous clock and digital input synchronous clock on the rear panel of 4945B/C;

2) Set 4945B/C to the RF generation and bit error measurement mode, with digital modulation on, modulation format of BPSK, data source of PN3, code element rate of 1 MHz, data output to rear panel on, and insert BER of 0.000001; record the measured BER values in corresponding spaces in Table A.1;

3) Set the code element rate of 4945B/C to 300Hz and insertion error rate to 0.1; record the measured BER values in corresponding spaces in Table A.1;

4) If the measured bit error value is equal to the reference value, the Baud rate range and BER measuring range of digital sequence generation are qualified.

Section III Comparison of Indicator Test Results

Table A.1 Inspection records of 4945B/C radio communications test set

Serial No.	Item		Unit	Standard requirement		Results
1	Appearance and structure		/	According to visual inspection, the instrument should have complete structure and be free of obvious mechanical damages and coating damages, and the control parts are installed correctly and reliably, allowing for flexible operation.		
2	Safety	Insulation resistance	MΩ	The insulation resistance between the power input end of the equipment and the casing should not be less than 100 MΩ under standard atmospheric conditions for testing.		
				The insulation resistance between the power input end of the equipment and the casing should not be less than 2 MΩ in humid environment.		
		Dielectric strength	/	AC 1.5kV/10mA/1min, no arc over or breakdown.		
		Leakage current	mA	Voltage 242 V, 1 min, leakage current ≤3.5 mA.		
3	Functional normality		/	After the power is turned on, the power supply, keys and port indicator lights are on, and the display and operation of the touch screen are normal. The switching of function windows is normal, the signal analysis waveform display is normal, and the parameter settings are correct. Self-test passed with no error prompt.		
4	RF signal generation frequency range and accuracy		/	1MHz: 0.999999 MHz~1.000001MHz		
				4945B/1.05GHz:	1.049999999GHz~1.050000001GHz	
				4945C/3GHz:	2.999999999GHz~3.000000001GHz	
5	RF TX frequency resolution		Hz	1		
6	RF TX power range and accuracy		dBm	GEN port -110~+5	500MHz/+5:+3.5～+6.5	
					500MHz/-110: -111.5~-108.5	
				T/R port -130~-35	500MHz/-35:-36.5～-33.5	
					500MHz/-130: -132~-128	
7	RF TX power resolution		dB	0.1		
8	RF TX harmonic and non-harmonic		dBc	Harmonic: ＜-25		
				Non-harmonic: ＜-35		
9	RF TX Single sideband phase noise		dBc/Hz	4945B/C: 1GHz:	≤-93	
				4945C: 3GHz:	≤-90	
10	Maximum frequency		/	Modulation rate/frequency	Modulation rate: 19.8Hz~20.2Hz	

	deviation, accuracy frequency modulation of RF TX FM		deviation 20Hz/5kHz	Frequency deviation: 4.75 kHz~5.25 kHz	
			Modulation rate/frequency deviation 20kHz/150kHz	Modulation rate: 19.8kHz~20.2kHz	
				Frequency deviation: 142.5kHz~157.5kHz	
11	AM range, accuracy and modulation rate of RF TX	/	Modulation rate/AM depth 20Hz/10%	Modulation rate: 19.8Hz~20.2Hz	
				AM depth: 9.5%~10.5%	
			Modulation rate/AM depth 20kHz/90%	Modulation rate: 19.8kHz~20.2kHz	
				AM depth: 85.5%~94.5%	

Table A.1 Inspection records of 4945B/C radio communications test set (Cont. 1)

Serial No.	Item	Unit	Standard requirement			Results
12	SSB modulation rate of RF signal generation	/	Modulation rate 300Hz~5kHz	300Hz/USB: 297Hz～303Hz		
				5kHz/LSB: 4.95kHz～5.05kHz		
13	External analog modulation rate of RF signal generation	/	FM modulation rate 20Hz~15kHz	20Hz: 19.8Hz~20.2Hz		
				15kHz: 14.85kHz~15.15kHz		
			AM modulation rate 20Hz~15kHz	20Hz: 19.8Hz~20.2Hz		
				15kHz: 14.85kHz~15.15kHz		
14	Maximum modulation bandwidth and code element rate for digital modulation of RF signal generation (optional)	/	Carrier frequency: 1.05 GHz	Modulation format: BPSK Code element rate: 1 MHz Filter/α factor: RRC/1.0	EVM≤2.0 %rms	
				Modulation format: QPSK Code element rate: 5MHz Filter/α factor: RC/1.0	EVM≤3.0 %rms	
15	Maximum bandwidth and frequency agility time of frequency hopping signal generation (optional)	/	Frequency band: 570~630MHz Residence/switching time: 5μs/5μs	Frequency hopping bandwidth: 59.4MHz~60.6MHz		
				Agility time: < 10 μs		
16	Sweep spectrum analysis frequency	/	300kHz: 298.6kHz~301.4kHz			
			4945B/1.05GHz: 1.0499965GHz～1.0500035GHz			
			4945C/3GHz: 2.9999926GHz～3.0000074GHz			

	range					
17	Reference level range and accuracy of sweep spectrum analysis	dBm	ANT port +20~-80	Power -90/reference level -80: -91.5~-88.5		
				Power 0/reference level +20: -1.5~+1.5		
			T/R port +54~-50	Power -60/reference level -50: -61.5~-58.5		
				Power +10/reference level +54: +8.5~+11.5		
18	Average noise level of sweep spectrum analysis	dBm	ANT port: ＜-125			
			T/R port: ＜-75			
19	Resolution bandwidth and its accuracy and switching error of sweep spectrum analysis	/	Frequency: 300MHz Power: -10 dB	30Hz	Modulation bandwidth: 24Hz～36Hz	
					Switching error: -1 dB~+1 dB	
				300Hz	Bandwidth: 240Hz～360Hz	
					Switching error: -1 dB~+1 dB	
				3kHz	Bandwidth: 2.7kHz～3.3kHz	
					Benchmark	
				30kHz	Bandwidth: 27kHz～33kHz	
					Switching error: -1 dB~+1 dB	
				60kHz	Bandwidth: 54kHz～66kHz	
					Switching error: -1 dB~+1 dB	

Table A.1 Inspection records of 4945B/C radio communications test set (Cont. 2)

Serial No.	Item	Unit	Standard requirement			Results
19	Resolution bandwidth and its accuracy and switching error of sweep spectrum analysis (Cont.)	/	Frequency: 300MHz Power: -10 dB	300kHz	Bandwidth: 270kHz～330kHz	
					Switching error: -1 dB~+1 dB	
				3MHz	Bandwidth: 2.25MHz～3.75MHz	
					Switching error: -1 dB~+1 dB	
20	Sweep time range of sweep spectrum analysis	/	Sweep time 100 ms~100 s	100 ms: 98 ms~102 ms		
				100S: 98 s~102 s		
21	Frequency	mW	ANT port	300kHz/+19dBm	71.49~87.3	

<table>
<tr><td rowspan="2"></td><td rowspan="2">range, level range and accuracy of broadband power meter</td><td rowspan="2"></td><td rowspan="2">T/R port</td><td>4945B: 1.05GHz/+19dBm</td><td rowspan="2">8mW</td><td></td></tr>
<tr><td>4945C: 3GHz/+19dBm</td><td></td></tr>
<tr><td rowspan="6">22</td><td rowspan="6">Frequency range, level range and accuracy of narrow-band power meter</td><td rowspan="6">dBm</td><td rowspan="3">T/R port
+51~-40</td><td colspan="2">300kHz/+19:+17～+21</td><td></td></tr>
<tr><td colspan="2">4945B:1.05GHz/-40:-42～-38</td><td></td></tr>
<tr><td colspan="2">4945C: 3GHz/-40:-42~-38</td><td></td></tr>
<tr><td rowspan="3">ANT port
+10~-80</td><td colspan="2">300kHz/+10:+8～+12</td><td></td></tr>
<tr><td colspan="2">4945B:1.05GHz/-80:-82～-78</td><td></td></tr>
<tr><td colspan="2">4945C: 3GHz/-80:-82~-78</td><td></td></tr>
<tr><td rowspan="3">23</td><td rowspan="3">Frequency range and accuracy of frequency error meter</td><td rowspan="3">Hz</td><td colspan="3">300kHz: -1Hz~+1Hz</td><td></td></tr>
<tr><td colspan="3">4945B/1.05GHz: -1Hz~+1Hz</td><td></td></tr>
<tr><td colspan="3">4945C/3GHz: -1Hz~+1Hz</td><td></td></tr>
<tr><td>24</td><td>Frequency resolution of frequency error meter</td><td>Hz</td><td colspan="3">1</td><td></td></tr>
<tr><td rowspan="3">25</td><td rowspan="3">Demodulation and analysis frequency range and demodulation counting frequency range of analog modulation signals</td><td rowspan="3">/</td><td colspan="2">Carrier 300 kHz/modulation rate 20 Hz</td><td>Modulation rate
19.8Hz~20.2Hz</td><td></td></tr>
<tr><td colspan="2">4945B
Carrier 1.05GHz/modulation rate 20kHz</td><td rowspan="2">Modulation rate
19.8kHz~20.2kHz</td><td></td></tr>
<tr><td colspan="2">4945C
Carrier 3GHz/modulation rate 20kHz</td><td></td></tr>
<tr><td>26</td><td>Demodulation and analysis sensitivity of analog modulation signals</td><td>dB</td><td colspan="2">Modulation rate/frequency deviation/amplitude
1kHz/10kHz/-100dBm</td><td>Measured SINAD: ≥10dB</td><td></td></tr>
<tr><td>27</td><td>Demodulation and analysis demodulation counting resolution of analog modulation signals</td><td>Hz</td><td colspan="3">0.1</td><td></td></tr>
<tr><td rowspan="4">28</td><td rowspan="4">Demodulation and analysis frequency deviation, accuracy and modulation rate of FM signal</td><td rowspan="4">/</td><td rowspan="2">Modulation rate/frequency deviation
20Hz/150kHz</td><td colspan="2">Modulation rate: 19.8Hz~20.2Hz</td><td></td></tr>
<tr><td colspan="2">Frequency deviation: 142.5kHz~157.5kHz</td><td></td></tr>
<tr><td rowspan="2">Modulation rate/frequency deviation
20kHz/150kHz</td><td colspan="2">Modulation rate: 19.8kHz~20.2kHz</td><td></td></tr>
<tr><td colspan="2">Frequency deviation: 142.5kHz~157.5kHz</td><td></td></tr>
</table>

Table A.1 Inspection records of 4945B/C radio communications test set (Cont. 3)

<table>
<tr><th>Serial No.</th><th>Item</th><th>Unit</th><th colspan="3">Standard requirement</th><th>Results</th></tr>
<tr><td rowspan="4">29</td><td rowspan="4">Demodulation and analysis frequency deviation, accuracy and modulation rate of AM signals</td><td rowspan="4">/</td><td rowspan="2">Modulation rate/AM depth 20Hz/30%</td><td colspan="2">Modulation rate: 19.8Hz~20.2Hz</td><td></td></tr>
<tr><td colspan="2">AM depth: 28.5%~31.5%</td><td></td></tr>
<tr><td rowspan="2">Modulation rate/AM depth 20kHz/90%</td><td colspan="2">Modulation rate: 19.8kHz~20.2kHz</td><td></td></tr>
<tr><td colspan="2">AM depth: 85.5%~94.5%</td><td></td></tr>
<tr><td rowspan="2">30</td><td rowspan="2">Demodulation and analysis frequency rate of SSB demodulation signals</td><td rowspan="2">/</td><td colspan="3">300Hz/LSB: 297Hz~303Hz</td><td></td></tr>
<tr><td colspan="3">5kHz/USB: 4.95kHz~5.05kHz</td><td></td></tr>
<tr><td rowspan="3">31</td><td rowspan="3">Demodulation and analysis frequency range of digital modulation signals (Optional)</td><td rowspan="3">/</td><td rowspan="3">Modulation format: QPSK
Code element rate: 20kHz
Filters/α factor RRC/0.5</td><td>Carrier 300 kHz</td><td rowspan="3">EVM≤3 %rms</td><td></td></tr>
<tr><td>4945B
Carrier 1.05 GHz</td><td></td></tr>
<tr><td>4945C
Carrier 3 GHz</td><td></td></tr>
<tr><td>32</td><td>Maximum demodulation bandwidth and maximum code element rate of digital demodulation signals (optional)</td><td>/</td><td colspan="2">Carrier frequency: 300 MHz
Modulation format: QPSK
Code element rate: 5MHz
Filter/α factor: RRC/1.0</td><td>EVM≤3 %rms</td><td></td></tr>
<tr><td>33</td><td>Maximum real-time analysis bandwidth of frequency hopping signal analysis (optional)</td><td>MHz</td><td>Frequency band: 570~630</td><td colspan="2">Bandwidth: 59.4~60.6</td><td></td></tr>
<tr><td rowspan="2">34</td><td rowspan="2">Frequency range of audio signal generation</td><td rowspan="2">/</td><td rowspan="2">80Hz~20kHz</td><td colspan="2">80Hz: 79.8Hz~80.2Hz</td><td></td></tr>
<tr><td colspan="2">20kHz: 19.8kHz~20.2kHz</td><td></td></tr>
<tr><td>35</td><td>Frequency resolution of audio signal generation</td><td>Hz</td><td colspan="3">0.1</td><td></td></tr>
<tr><td rowspan="2">36</td><td rowspan="2">Level range and accuracy of audio signal generation</td><td rowspan="2">/</td><td colspan="3">80Hz/7Vrms: 6.65Vrms~7.35Vrms</td><td></td></tr>
<tr><td colspan="3">20kHz/10mVrms: 9.5 mVrms~10.5 mVrms</td><td></td></tr>
<tr><td rowspan="2">37</td><td rowspan="2">Input impedance of</td><td rowspan="2">/</td><td colspan="3">High impedance: >10kΩ</td><td></td></tr>
<tr><td colspan="3">600Ω: 550Ω～650Ω</td><td></td></tr>
</table>

	audio signal analysis		150Ω: 140Ω～160Ω		
38	Maximum input level dance of audio signal analysis	Vrms	10Vrms: 9.5 Vrms~10.5 Vrms		
39	Frequency range and input level range of audio signal analysis frequency meter	/	20Hz~20kHz 20 mV～30 Vrms	20Hz/10Vrms: 19.8Hz~20.2Hz	
				20kHz/20mVrms: 19.8kHz~20.2kHz	
40	Frequency resolution of audio signal analysis frequency meter	Hz	0.1		
41	Frequency range, level range and accuracy of audio signal analysis level meter	Vrms	20Hz~20kHz 1mV～30 Vrms Accuracy: ±5 %	20Hz/10Vrms: 9.5Vrms~10.5Vrms	
				20kHz/10Vrms: 9.5Vrms~10.5Vrms	
42	Frequency range, level range and accuracy of audio signal analysis SINAD meter	dB	300Hz~5kHz 0.1~30Vrms	300Hz/600Hz/50%/140mV$_P$: 2dB~4dB	
				5kHz/10kHz/50%/5V$_P$: 2dB~4dB	

Table A.1 Inspection records of 4945B/C radio communications test set (Cont. 4)

Serial No.	Item	Unit	Standard requirement		Results
43	Frequency range and accuracy of audio signal analysis SINAD meter	dB	3~60 Accuracy: ±1.0	1kHz/2kHz/50%/500mV$_P$: 2~4	
				1kHz/2kHz/0.1%/500mV$_P$: 59~61	
44	Frequency range and input level range of audio signal analysis distortion meter	/	300Hz~5kHz 0.1~30Vrms	300Hz/600Hz/9%/140mV$_P$: 9.5%~10.5%	
				5kHz/10kHz/9%/5V$_P$: 9.5%~10.5%	
45	Frequency range and accuracy of audio signal analysis distortion meter	/	0~90% Accuracy: ＜ ±0.5% (distortion ＜10%), ＜ ±1.0% (distortion ＜20%)	1kHz/2kHz/0.1%/800mV$_P$: <0.5%	
				1kHz/2kHz/9%/800mV$_P$: 9.5%~10.5%	
				1kHz/2kHz/47.4%/800mV$_P$:	

				89%~91%	
46	Frequency range, level range and accuracy of audio signal analysis SNR	/	300Hz~5kHz 0.1~30Vrms	300Hz/140mV_P/280mV_P: 5dB~7dB	
				5kHz/2.5V_P/5V_P: 5dB~7dB	
47	Measuring range and accuracy of audio signal analysis SNR meter	dB	3~60 Accuracy: ±1.0	1kHz/100mV_P/142mV_P: 2~4	
				1kHz/4mV_P/4096mV_P: 59~61	
48	Oscilloscope Input impedance (Optional)	/	Impedance: 0.99MΩ~1.01MΩ	Channel 1	
				Channel 2	
			Capacity: ≤20pF	Channel 1	
				Channel 2	
49	Baud rate range and BER measuring range of digital sequence generation (Optional)	/	1×10^{-1}~1×10^{-6}	0.000001	
				0.1	
Comprehensive judgment					
Remarks: "√" indicates compliance and "x" indicates non-compliance.					
Blank below					

Part III Maintenance Instructions

Chapter VII Maintenance and Repair

Section I Maintenance

1 Routine Maintenance

This product is a precision instrument, please strictly follow the procedures and pay attention to the warning information during use. The casing of the instrument should be kept clean and can be wiped with clean soft cloth frequently to prevent small articles from falling into the instrument through the ventilation holes. During the operation of this instrument, avoid objects from blocking the ventilation holes. When this instrument is not in use, try to cover it with suitable cloth as far as possible to prevent the instrument from falling ash.

When the instrument is not in use, the ports should be covered. Clean ports can provide accurate data. A dust blower can be used to clean the dust on the measuring ports frequently. Always rotate the test ports gently during the test to avoid damaging the ports.

2 Power Requirements and Electrostatic Protection

Power supply and electrostatic protection requirements have been described in detail in chapter I. Improper use of power supply will cause instrument damage and even serious consequences like personal injury. Therefore, always check the power supply carefully before the instrument is powered on and operate the instrument in strict accordance with the instructions in the user manual. Electrostatic protection is a problem that is often ignored by users. The damage it causes to the instrument, although not shown immediately, will greatly reduce the reliability of the instrument. Therefore, whenever possible, electrostatic protection measures should be taken as far as possible and applied correctly in daily work.

To prevent or reduce mutual interference caused by multiple devices through power supply, especially spike interference caused by high-power devices which may cause damage to instrument hardware, it is better to use 220 V AC stabilized power supply to supply power to the instrument.

Please adopt the AC-DC adapter delivered along with the instrument to supply power to the instrument. Improper use of the power adapter will cause damage to the internal hardware of the instrument. If this instrument is powered by batteries or with batteries inside, please replace the battery, if necessary, with one of the same type, to avoid the risk of explosion.

Warning: Poor or improper grounding can result in instrument damage or even personal injury. Before turning on the power supply of the signal source, make sure that the ground wire is in good contact with the ground wire of the power supply.

Use a power outlet with grounding protection. Do not use any external cable, power line or autotransformer without any protective grounding as the protective grounding line. In case of any autotransformer adopted, do connect the common terminal to the protective grounding line of the power connection.

Section II General Maintenance

This section mainly introduces the problems that may occur during the use of this product and some measures that users may take to provide convenience for users as much as possible.

1 Possible Faults of the Instrument and Solutions

1.1 Blank Screen

If the screen is blanked, please follow the steps listed below for checking:

- Whether the standard power adapter is powered on and whether the power meets the working requirements of this product.
- Whether the power switch of the instrument is on.
- Is there a clicking sound of during the self-test of the instrument within 1 minute after the power switch is pressed?
- Check the fan operation.

If the conditions are normal after the above checks, the fault may be on the digital processing board or LDC screen of the instrument; If the fan does not rotate, the cause may be at the power supply of the instrument; If you can hear the click, the LCD may be broken.

1.2 Abnormal Startup

If the instrument cannot enter the normal working state after startup, please turn off the instrument and turn it on again. For your safety, please do not open the instrument casing without authorization.

1.3 Hardware Faults

This instrument has the functions of self-calibration of the whole instrument self-detection of each single board. If there is an error after self-calibration, it should be judged as a fault of the instrument. The causes may be various. Due to the high complexity of the circuit of this product, it is recommended that users do not disassemble the instrument, especially when it is within the warranty period. It is strictly prohibited for users to disassemble the instrument without permission. Please contact us as soon as possible in case of any problem. We will provide you with timely service.

2. Repair of the Instrument

When your 4945B/C radio communications test set has problems that are difficult to solve, we can provide you with advice by phone or fax. When it is confirmed that the hardware of the 4945B/C radio communications test set is damaged and needs to be repaired, please package the instrument with the original materials or other commercially used materials and follow the steps below:

- Prepare a detailed description of the failure of the instrument and put it in the package along with the instrument.
- Place the instrument in an anti-static plastic bag to reduce possible electrostatic discharge damage.
- Place foam cushions at the four corners of the outer packing carton, place the instrument in the outer packing carton, and fill foam boards in the gaps around.
- Seal the opening of the packing carton with adhesive tape and reinforce the packing carton with nylon tape.
- Specify text like “Fragile! Do not touch! Handel with care!” and so on.
- Please check by precision instrument.
- Keep a copy of all shipping documents.

Note: Using other materials for packaging the 4945B/C radio communications test set may damage the instrument. Do not use polystyrene pellets of any size as packaging materials. They cannot adequately cover the instrument or provide protection for the instrument placed in the carton during transportation. They can generate static electricity and be sucked into the fan, causing damage to the instrument.

Appendix A

Programming Guide

6.-1 LAN Connection

(1) Connect the computer to the switch with a network cable and connect the instrument to the switch. (2) After connecting the network cable, press 〖System〗 > 〖TCP/IP〗 on the instrument display and click on the 〖IP Address〗 or 〖Subnet Mask〗 input box to set the network IP address and subnet mask of the signal source. In the example in this chapter, the IP address is set to the default value of 192.168.1.15 and the subnet mask default value of 255.255.255.0.

(3) The LAN interface programming of this instrument conforms to the standard socket programming specifications of Windows operating system, and the default port number is 950.

(4) The VC++ language reference for user programming is as follows:.

```
CSocket mySocket;
mySocket.Create (0, SOCK_STREAM, NULL);
mySocket.Connect ("192.168.1.15 ", 950);
```

6-2 Local and Remote Control

When the 4945B/C radio communications test set is remotely controlled, and both the front panel keys and the soft menu keys have not failed, the remote control port symbol will be displayed on the top bar of the interface.

6-3 Data Transmission with Computers

The tester cannot automatically add units to the data received from the computer, and the user must specify it himself, as shown in Table A.2:

Table A.2 Data Units

Test data	Basic units
Frequency	GHz, MHz, kHz, and Hz
Power	dBm
Amplitude	V, mV and uV
Ratio	dB
Voltage	V
Time	s, ms, us and ns

6-4 Read Command Operations

Some commands in this instrument support read operations, for example:

The start frequency command for setting the sweep frequency spectrum is: NML:FA 10MHz

Then the command to read the start frequency is: NML:FA?

Read command returned characters: 10000000

The read command does not follow any parameters, but a "?" should be added at the end of the command. After sending the command, values returned from this instrument can be read by reading relevant bus.

6-5 Program Control Command Reference

This part mainly introduces the program control commands and relevant programming rules used in 4945B/C radio communications test set, and lists the program control commands by functional group. This part describes programming instructions for 4945B/C, as well as the description of the programming instructions, the description of syntax components and definitions of keywords. Table A.3 arranges program control commands by function and gives corresponding description.

Table A.3 Program Control Commands

Attribute	Command	Description	Parameter Description	Support reading command or not
System	*RST	Reset instrument	No parameters	No
	*IDN?	Query machine number	No parameters	—
	REF INT|EXT	Set internal/external reference	INT: Internal reference EXT: external reference	No
	REFOUTPUT ON|OFF	Set reference output on/off		Yes
	RUNMODE SEND|RECV|NML|REL|AUDIORX|AUDIOTX|OSC|BER|POW|ETEST ON|OFF	Open/close corresponding function windows	Transmitting Performance Test | Receiving Performance Test | Sweep Frequency Spectrum | Real Time Spectrum | Audio Receiving | Audio Generation | Oscilloscope | Error Rate Measurement | Power Measurement | Equipment Automatic Test Example: RUNMODE SEND ON is to turn on the RF TX function; RUNMODE RECV OFF is to turn off the RF RX function.	Yes
	RFIN ANT|TR	Set RF input interface	ANT: ANT port TR: T/R port	Yes
	RFOUT GEN|TR	Set RF output interface	GEN: GEN port TR: T/R port	Yes
Sweep spectrum	NML:FA	Set start frequency	Units GHz|MHz|kHz|Hz	Yes
	NML:FB	Set stop frequency	Units GHz|MHz|kHz|Hz	Yes
	NML:CF	Set center frequency	Units GHz|MHz|kHz|Hz	Yes
	NML:SP	Set sweep	Units GHz|MHz|kHz|Hz	Yes
	NML:RL	Set reference level	Units dBMV|dBm|dBV|V|W	Yes
	NML:LG	Set logarithmic scale	Unit dB	Yes
	NML:AUTOALL	auto coupling All parameter	No parameters	No
	NML:RB AUTO|HAND|value	Set resolution sweep		Yes
	NML:VB AUTO|HAND|value	Set video sweep		Yes
	NML:SWT AUTO|HAND|value	Set sweep time		Yes
	NML:RFATT AUTO|HAND|value	Set RF attenuation	The unit of RF attenuation is dB	Yes
	NML:AVG ON|OFF|average time	Set video averaging		No
	NML:SWPTYPE CTN|ONE	Set sweep mode	Continuous | single time	Yes

	NML:MKSEL 1|2|3|4	Select current active marker		Yes
	NML:MKF	Set the frequency or time of the current active marker (time at zero sweep)		Yes
	NML:MKA?	Query marker amplitude		—
	NML:MKPK HI|NH|RH|LH|LO	Set marker to	Peak value | sub - peak value | right peak value | left peak value | minimum value	No
	NML:MKDF	Set the frequency deviation or time deviation of the current active marker (time deviation at zero sweep)	Turn on difference marker synchronously	Yes
	NML:MKNM	Restore marker to normal marker	No parameters	No
	NML:MKDA?	Return marker difference and amplitude difference	Unit dB	—
	NML:MKOFF	Close currently selected marker	No parameters	No
	NML:MKNOISE OFF | frequency deviation	Turn noise market on/off	Read command returns measured noise value	Yes
	NML:MKCLR	Close all markers	No parameters	No
	NML:TRACEA FRESH|HOLD|SHOW|HIDE	Set trace A	Refresh | Maximum Hold | Show | Hide	No
	NML:TRACEB FRESH|HOLD|SHOW|HIDE	Set trace B	Refresh | Maximum Hold | Show | Hide	No
	NML:DET AUTO|MAXMIN|MAX|MIN|SAMPLE	Set detection mode	Auto | Positive and Negative Peak | Positive Peak | Negative Peak | Sampling	No
Real-time spectrum	REL:CF	Set center frequency		Yes
	REL:SP	Set analysis sweep		Yes
	REL:RL	Set reference level	Units dBMV|dBm|dBV|V|W	Yes
	REL:RFATT	Set attenuator	Unit: dB	Yes
	REL:LG	Set logarithmic scale	dB	Yes
	REL:MKSEL 1|2|3|4	Select current active marker		Yes
	REL:MKF	Set the frequency or time of the current active marker (time at zero sweep)		Yes
	REL:MKA?	Query marker amplitude		—
	REL:MKPK	Set marker to	Peak value | sub - peak value |	No

	HI|NH|RH|LH|LO		right peak value | left peak value | minimum value	
	REL:MKDF	Set the frequency deviation or time deviation of the current active marker (time deviation at zero sweep)	Turn on difference marker synchronously	Yes
	REL:MKNM	Restore marker to normal marker	No parameters	No
	REL:MKDA?	Return marker difference and amplitude difference	Unit dB	—
	REL:MKOFF	Close currently selected marker	No parameters	No
	REL:MKNOISE OFF|frequency deviation	Turn noise market on/off	Read command returns measured noise value	Yes
	REL:MKCLR	Close all markers	No parameters	No
	REL:TRACEA FRESH|HOLD|SHOW|HIDE	Set trace A	Refresh | Maximum Hold | Show | Hide	Yes
	REL:TRACEB FRESH|HOLD|SHOW|HIDE	Set trace B	Refresh | Maximum Hold | Show | Hide	Yes
	REL:RUNSTYLE RUN|STOP	Run or stop	RUN|STOP	No
	REL:RUNTYPE CONT|SING	Set continuous or single time	Continuous | single time	No
	REL:SHOWSTYLE 3D|TFREQ|TAMPL|TFNA	Set display type	Waterfall | Time domain diagram (frequency) | Time domain diagram (amplitude) | Time domain diagram (frequency and amplitude)	No
	REL:UPSCALE	Set upper scale of the time domain frequency diagram		No
	REL:DOWNSCALE	Set lower scale of the time domain frequency diagram		No
	REL:TIMELAST	Set display time		No
	REL:STARTTIME	Set start time		No
	REL:CATCHTIME	Set acquisition time		No
	REL:FRAMENUM	Set display frames		No
Oscilloscope	OSC:CHL1 ON|OFF	Turn on/off oscilloscope channel 1		Yes
	OSC:CHL2 ON|OFF	Turn on/off oscilloscope channel 2		Yes
	OSC:COUPSTYLE1	Set coupling mode of		Yes

	DC|AC	oscilloscope channel 1		
	OSC:COUPSTYLE2 DC|AC	Set coupling mode of oscilloscope channel 2		Yes
	OSC:OFT1	Set deviation of oscilloscope channel 1		Yes
	OSC: OFT2	Set deviation of oscilloscope channel 2		Yes
	OSC:VERSCALE1	Set vertical scale of oscilloscope channel 1		Yes
	OSC:VERSCALE2	Set vertical scale of oscilloscope channel 2		Yes
	OSC:AMPMKR ON|OFF	Turn on/off amplitude cursor		Yes
	OSC:TIMEMKR ON|OFF	Turn on/off time cursor		Yes
	OSC:MODE AUTO|NML	Set running mode	Auto|Normal	Yes
	OSC:SINGLE	Set single time running		No
	OSC:RUNSTYLE RUN|STOP	Set to run or stop	RUN|STOP	Yes
	OSC:HORSCALE	Set horizontal scale		Yes
	OSC:TRIGTIME	Set trigger time		Yes
Power measurement	POW:READ?	Query power measurement result	The unit is the set unit, dBm by default	—
	POW:FREQ	Set carrier frequency		Yes
	POW:AMPLUNIT	Set amplitude unit	After setting, the amplitude value of this unit will be returned when reading the results	Yes
RX performance test	RECV:FREQ	Set frequency		Yes
	RECV:MODE BPSK|QPSK|DQPSK|MSK|8PSK|TCM8|16QAM|2ASK|2FSK|FM|AM|LSB|USB|NONE	Set demodulation format	BPSK|QPSK|DQPSK|MSK|8PSK|TCM8|16QAM|2ASK|2FSK are vector demodulation formats, which require vector demodulation option; NONE refers to the non-demodulation format	Yes
	RECV:ATT	Set demodulation attenuator	Unit: dB	Yes
	RECV:REFLEVEL	Set reference level		Yes
	RECV:RUN RUN|STOP	Set display waveform to be refreshed or stopped		Yes
	RECV:IFBW 0|1|2|3|4|5|6|7	Select IF bandwidth of analog demodulation	300kHz|100kHz|30kHz|25kHz|12.5kHz|10kHz|8.33kHz|6.25kHz	Yes
	RECV:AUFIR 0|1|2|3|4|5|6|7|8|9	Select filter of analog demodulation	LPF20kHz|LPF15kHz|LPF5kHz|LPF300Hz|BPF300Hz-20kHz|BPF300Hz-15kHz|BPF300Hz-5kHz|BPF300Hz-3.4kHz|	Yes

			LPF 50Hz| LPF 45kHz	
	RECV:AUOUT ON|OFF	Set demodulation audio output on/off		Yes
	RECV:VOICEOUT ON|OFF	Set demodulation speaker output on/off		Yes
	RECV:AUTOCARRY	Set auto search carrier		No
	RECV:SNRLOCK	Set SNR reference locking		No
	RECV:RDFREQ	Read error values of measured frequencies		—
	RECV:RDLEVEL	Write command Set narrow-band or bandwidth power measurement, read command reads power measurement values	Parameter for write command: NARROW|WIDE	Yes
	RECV:RDFMDEV	Read the frequency deviation depth of FM demodulation results		—
	RECV:RDAMDEP	Read the depth of AM demodulation results		—
	RECV:RDRATE	Read the modulation rate of analog demodulation results		—
	RECV:RDDSTN	Read the distortion of analog demodulation results		—
	RECV:RDSINAD	Read the SINAD of analog demodulation results		—
	RECV:RDSNR	Read the SNR of analog demodulation results		—
	RECV:VEC:VRATE	Set the code element rate for vector demodulation	Require vector demodulation option	Yes
	RECV:VEC:VFILTER VRC|VRRC|VGAUSS	Set the filter for vector demodulation	RC filter|RRC filter|GAUSS filter; Require vector demodulation option	Yes
	RECV:VEC:VALPHA	Set the α or BT factor for vector demodulation	Require vector demodulation option	Yes
	RECV:VEC:VSYMNUM	Set the number of symbols for vector demodulation	requires vector demodulation option	Yes
	RECV:VEC:DIGIOUT ON|OFF	Set digital output for vector demodulation	Require vector demodulation option	Yes
	RECV:VEC:RDVFREQ	Read the frequency of vector demodulation results	Require vector demodulation option	—

	RECV:VEC:RDVLEVEL	Read the amplitude of vector demodulation results	Require vector demodulation option	—
	RECV:VEC:RDEVM	Read the EVM of vector demodulation results	Require vector demodulation option	—
	RECV:VEC:RDPHE	Read the amplitude error of vector demodulation results error	Require vector demodulation option	—
	RECV:VEC:RDAME	Read the amplitude error of vector demodulation results error	Require vector demodulation option	—
	RECV:VEC:RDDEV	Read the frequency deviation of 2FSK demodulation results	Require vector demodulation option	—
RF TX	SEND:REFFREQ	Set carrier frequency of RF TX		Yes
	SEND:REFLEVEL	Set carrier amplitude of RF TX		Yes
	SEND:FMDEV1	Set frequency deviation of FM modulation source 1 for RF TX		Yes
	SEND:AMDEP1	Set depth of AM modulation source 1 for RF TX		Yes
	SEND:SSBDEP1	Set depth of SSB modulation source 1 for RF TX		Yes
	SEND:FMDEV2	Set frequency deviation of FM modulation source 2 for RF TX		Yes
	SEND:AMDEP2	Set depth of AM modulation source 2 for RF TX		Yes
	SEND:SSBDEP2	Set depth of SSB modulation source 2 for RF TX		Yes
	SEND:DEMOTYPE BPSK|QPSK|DQPSK|MSK|8PSK|TCM8|16QAM|2ASK|2FSK|FM|AM|LSB|USB|NONE	Set modulation type of RF TX	BPSK|QPSK|DQPSK|MSK|8PSK|TCM8|16QAM|2ASK|2FSK are digital demodulation formats, which require digital demodulation option; NONE refers to the non-demodulation format	Yes
	SEND:POWER ON|OFF	Turn on/off RF TX	ON: on OFF: off	Yes
	SEND:TYPE CW|HOP|EX	Set carrier type of RF TX	Continuous Wave | List Frequency Hopping | Real Time	Yes

			Frequency Hopping	
	SEND:SRC1 SINE|SQUA|TRIA|HACK|MIC|AUDIO	Set type of modulation source 1 of RF TX analog modulation	Sine | Square Wave | Triangle | Sawtooth | 7 - Core Microphone | External Audio	Yes
	SEND:SPEED1	Set speed of analog modulation source 1 of RF TX		Yes
	SEND:SRC2 ON|OFF	Turn on/off analog modulation source 2 of RF TX	ON: on OFF: off	Yes
	SEND:SPEED2	Set speed of analog modulation source 2 of RF TX		Yes
	SEND:VEC:VRATE	Set the code element rate for digital modulation of RF TX	Require vector signal generation options	Yes
	SEND:VEC:VFILTER RC|RRC|GAUSS	Set filter type for digital modulation of RF TX	Require vector signal generation options	Yes
	SEND:VEC:VALPHA	Set the α or BT factor for digital modulation of RF TX	range 0.0~1.0; requires vector signal generation options	Yes
	SEND:VEC:VFMDEV	Set frequency deviation of 2FSK modulation source for RF TX	Require vector signal generation options	Yes
	SEND:VEC:VFMDEP	Set depth of 2ASK modulation for RF TX	Require vector signal generation options	Yes
	SEND:VEC:BERTYPE ALL0|ALL1|01|PN5|PN9|PN11|CUSTOM|EXT	Set the sequence for digital modulation of RF TX	CUSTOM: manual code; EXT: External code input; require vector signal generation options	Yes
	SEND:VEC:BERCUS	Set the manual code for digital modulation of RF TX	Valid in the CUSTOM mode; requires vector signal generation options	Yes
	SEND:VEC:BERERR ON|OFF|BER	Turn on/off the BER and Set BER for digital modulation of RF TX	Require vector signal generation options	Yes
	SEND:VEC:BEROUT ON|OFF	Set whether to output digital modulation of RF TX to the panel	Require vector signal generation options	Yes
	SEND:HOP:HOPSTA	Set the start frequency for list frequency hopping of RF TX	Require frequency hopping signal generation options	Yes
	SEND:HOP:HOPSTP	Set the stop frequency for list frequency hopping of RF TX	Require frequency hopping signal generation options	Yes
	SEND:HOP:HOPDT	Set the residence time for list frequency hopping of RF TX	Require frequency hopping signal generation options	Yes
	SEND:HOP:HOPCT	Set the switching time for list frequency hopping of RF TX	Require frequency hopping signal generation options	Yes

	SEND:HOP:HOPPT	Set the number of list frequency hopping points of RF TX	Require frequency hopping signal generation options	Yes
BER measurement	BER:READ?	Query BER measurement result		—
	BER: LEN 0|1|2|3|4	Set BER data length	1kb|10kb|100kb| 1Mb|10Mb	Yes
	BER:TYPE TTL|232	Set signal input level		Yes
	BER:REVE ON|OFF	Set data reversion	ON: Turn on data reversion OFF: Turn off data reversion	Yes
Audio generation Audio analysis	AUDIOTX:FREQ1	Set frequency of audio 1 for audio generation		Yes
	AUDIOTX: FREQ2	Set frequency of audio 2 for audio generation		Yes
	AUDIOTX: AMPL1	Set amplitude of audio 1 for audio generation		Yes
	AUDIOTX: AMPL2	Set amplitude of audio 2 for audio generation		Yes
	AUDIOTX: POWER ON|OFF	Turn on/off audio generation output	ON: on OFF: off	Yes
	AUDIOTX: SHAPE SINE|SQUA|TRIA|HACKLE	Set waveform of audio 1 for audio generation	Sine|square wave|triangle| sawtooth	Yes
	AUDIOTX: LOAD 600|150|HIGH	Set audio generation impedance	600Ω|150Ω| high impedance	Yes
	AUDIOTX: POWER2 ON|OFF	Turn on/off audio 2	ON: on OFF: off	Yes
	AUDIOTX: PHASE	Set relative phase of audio generation	Unit: rad	Yes
	AUDIORX: FILTER 0|1|2|3|4|5|6|7|8	Set audio RX filter selection	LPF 20kHz| LPF 15kHz| LPF 5kHz| LPF 300Hz| 300Hz-20k|300Hz-15k|300Hz-5k |300Hz-3.4k|LPF 50Hz	Yes
	AUDIORX: LOAD 600|150|HIGH	Set audio RX impedance	600Ω|150Ω|High impedance	Yes
	AUDIORX: CHL 0|1|2|3|AUTO	Set audio RX channel range	30V-5V|5V-500mV|500mV-50mV|<50mV|Auto	Yes
	AUDIORX: SNRFREQ	Set selected frequency of audio RX		Yes
	AUDIORX: AUTOSNR ON|OFF	Set audio RX, distortion/SINAD/SNR frequency to auto	ON: Auto mode on OFF: Auto mode off	Yes
	AUDIORX: SNRLOCK	Set SNR reference locking of audio RX		No
	AUDIORX: RDFREQ?	Query the frequency of audio RX measurement results		—

	AUDIORX: RDLEVEL?	Query the level of audio RX measurement results		—
	AUDIORX: RDDSTN?	Query the distortion of audio RX measurement results		—
	AUDIORX: RDSINAD?	Query the SINAD of audio RX measurement results		—
	AUDIORX: RDSNR?	Query the SNR of audio RX measurement results		—
Auto Equipment Test	ETEST:BROADCAST XXX	Select the model of the radio station to be tested	XXX refers to the radio model, XXX=TBR371, for instance	—
	ETEST:RUN START|CONTINUE|EXIT	Start or exit test	START: Start auto test CONTINUE: Continue the test from the prompted status EXIT: Exit the test	—
	ETEST:STATUS?	Read auto test status	Returned value 255: test idling (or completed) Returned value 254: paused for prompts 0~100: in normal test, current progress	—
	ETEST:PROMPTINFO?	Read prompt information in the pause status	The returned value is a character string containing prompt information	
	ETEST:TESTITEM DEFAULT|value	Select test item	DEFAULT: Set all test items by default (recommended);	—
			Value: 32-bit hexadecimal value, each bit representing a test item, as follows: D0: Working frequency error D1: Transmitting power D2: Sideband suppression D3: Carrier suppression D4: Harmonic Emission Component D5: Parasitic emission component D6: Pilot frequency / pilot frequency deviation D7: Transmitter analog modulation sensitivity D8: Transmitter adjacent channel power ratio D9: Frequency hopping bandwidth/frequency hopping signal amplitude D10: Frequency hopping rate/switching time	

			D11: Receiving sensitivity D12: SNR of large signal D13: Audio output power D14: Audio harmonic distortion D15: Intermediate frequency rejection ratio D16: Mirror frequency rejection ratio D17: Squelch sensitivity D18: Static noise hysteresis Example: If the value = 00000803, it represents 3 items, test reception sensitivity, operating frequency error and transmission power.	
	ETEST: RESAULT?	Read test results	The returned value is a character string containing test results of all test items, for example, “Transmitting power: 1W\n harmonic transmit component: 40dB\n ……”	